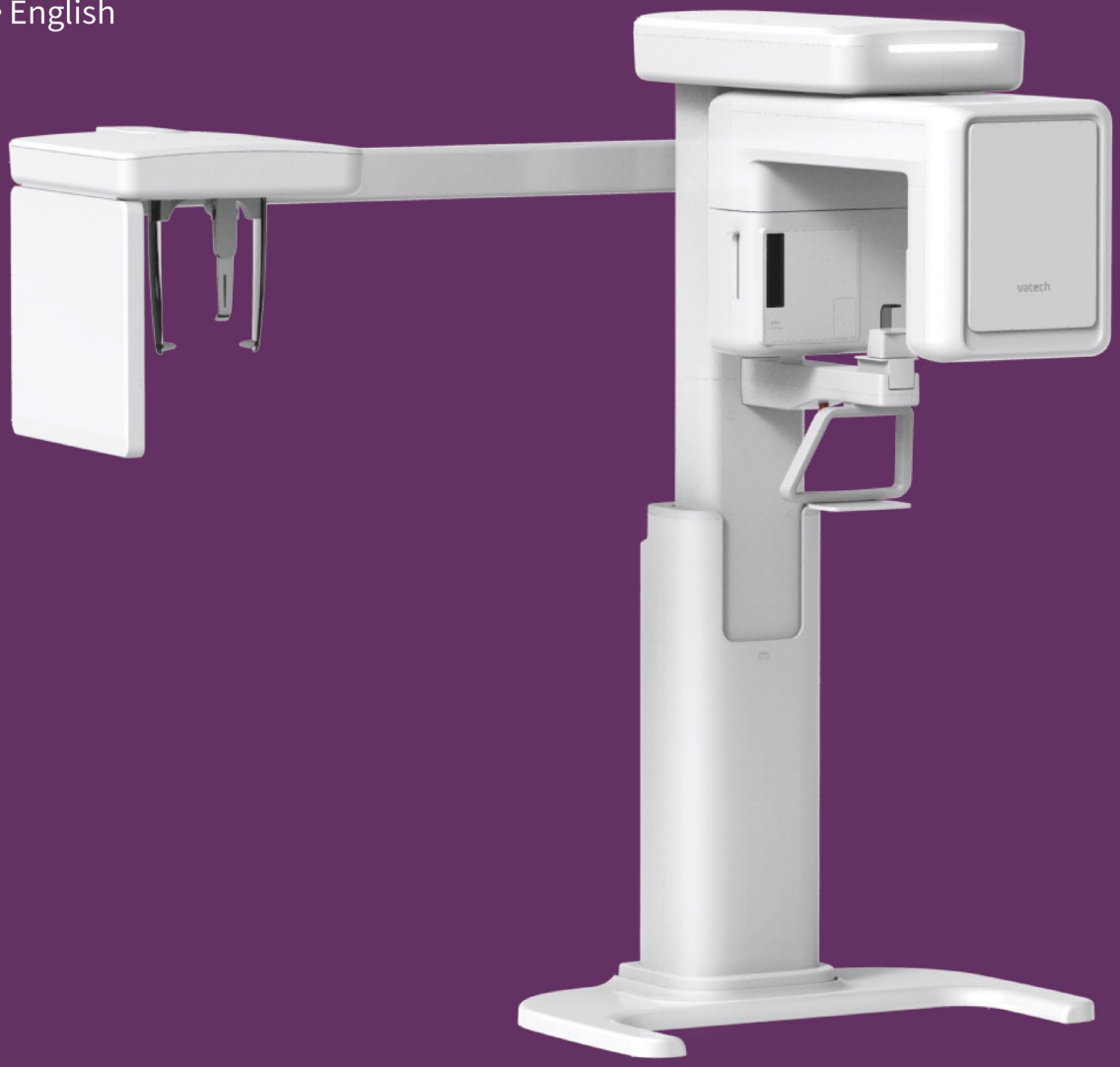
vatech A9

Technical manual

Model : PHT-30CSS
Version : 1.00

- English



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General Information

The document is created by VATECH Co., Ltd., cooperating with worldwide field technicians and VATECH engineers for years aiming to give effective service guidelines. Therefore, the instructions and safety information maintained in this manual provides the maximum degree of protection with VATECH's know-how techniques and schemes concerning not only repair but maintenance. We strongly recommend familiarizing yourself with this Technical manual to carry out the necessary information on the VATECH equipment.

The information contained in this Technical manual may be subject to change at any time without notice, justification, or notification to the persons concerned. Revisions and redistribution of this manual may occur due to upgrades or design modifications.

Manual Version

vatech A9 (PHT-30CSS) Technical manual Ver. 1.00 - ENG

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Contents

General Information 1
Before you begin 8
Conventions in this Guide 8
Safety Information 9
Equipment Safety Instructions 10
Radioactive Warning 11
Pre-check points for Service Technician 12
Chapter 1. Hardware Part Service Guide 13
1. vatech A9(PHT-30CSS) System Block Diagram 13
2. vatech A9(PHT-30CSS) Board Configuration 14
2.1. Vertical Frame Part 14
2.2. Handle Unit 19
2.3. Rotating Unit Part 21
2.4. CEPH Unit 25
3. vatech A9(PHT-30CSS) Connection Diagram 27
3.1. Power and Ground Connection Diagram 27
3.2. Main MCU and SENSOR Connection Diagram 30
3.3. Sensor Part Connection Diagram 32
3.4. CEPH SENSOR Part Connection Diagram 32
3.5. Connection Diagram (Total assembly) 33
4. Disassembly of vatech A9(PHT-30CSS) Covers 34
4.1. Vertical Frame Part 34
4.2. Rotating Unit Part 35
4.3. Handle Frame Unit Part 42
4.4. CEPH Unit Part 47
Chapter 2. CT Image Optimization 51
1. Geometry information 51
2. Equipment default values 52
2.1. Check the equipment horizontal level 52
2.2. Check the sensor horizontal level 53
2.3. Equipment Start Position Setting 53
2.4. Bite location (CT mode) 54
3. CT Sensor Calibration 55
3.1. CT Sensor Calibration Standard 55
3.2. Before CT sensor calibration 56
3.3. CT sensor setting 56
3.4. CT sensor: Dark calibration 58
3.5. CT sensor: Bright calibration 59

3.6. CT Bad Pixel Verification 65
4. CT Geometry Calibration 67
4.1. Sensor Uoffset setting 67
4.2. Bead Phantom Image Acquisition 71
4.3. Handle Frame Align 78
5. CT Collimator Alignment 85
5.1. CT Collimator Alignment 85
5.2. CT Collimator Alignment with EzAlign 87
6. DAP Calibration 88
7. CT Number Calibration 92
7.1. Acquire CT Phantom Image 93
Chapter 3. CT Image Evaluation 100
1. Spatial Resolution(MTF) evaluation 100
1.1. Spatial Resolution (MTF) standards 100
1.2. Phantom Specification 100
1.3. Test Method 101
1.4. Test Result 101
2. Contrast evaluation 102
2.1. Contrast standards 102
2.2. Phantom Specification 102
2.3. Test Method 102
2.4. Test Result 102
3. Noise evaluation 103
3.1. Noise standards 103
3.2. Phantom Specification 103
3.3. Test Method 103
3.4. Test Result 103
4. Homogeneity evaluation 104
4.1. Homogeneity standards 104
4.2. Phantom Specification 104
4.3. Test Method 104
4.4. Test Result 104
5. CT Number Accuracy evaluation 105
5.1. CT Number standards 105
5.2. Phantom Specification 105
5.3. Test Method 106
5.4. Test Result 106
6. High Contrast Resolution evaluation 107
6.1. High Contrast Resolution standards 107
6.2. Phantom Specification 107

6.3. Test Method 107
6.4. Test Result 108
7. Low Contrast Resolution evaluation 109
7.1. Low Contrast Resolution standards 109
7.2. Phantom Specification 109
7.3. Test Method 109
7.4. Test Result 109
8. Slice Thickness Evaluation 110
8.1. Slice Thickness Standard 110
8.2. Phantom Specification 110
8.3. Test Method 110
8.4. Test Result 110
9. Collimator Alignment Evaluation 111
9.1. Collimator Alignment Standard 111
9.2. Test Method 112
9.3. Test Result 112
Chapter 4. PANO Image Optimization 113
1. Geometry information 113
2. Equipment default values 113
2.1. Bite location (PANO mode) 113
3. PANO Sensor Calibration 114
3.1. PANO Sensor Calibration Standard 114
3.2. Before PANO sensor calibration 114
3.3. PANO sensor setting 115
3.4. PANO sensor: Dark calibration 116
3.5. PANO sensor: Bright calibration 118
4. PANO Collimator Alignment 121
4.1. PANO Collimator Alignment 121
4.2. PANO Collimator Alignment with EzAlign 123
5. PANO Collimator Speed Alignment 124
5.1. PANO Collimator Speed Alignment 124
5.2. PANO Collimator Speed Alignment with EzAlign 129
6. PANO Geometry Calibration 130
6.1. PANO Geometry Calibration Standard 130
6.2. Right and Left Pin Distance Calibration 131
6.3. Center Pin Position Calibration (POFS) 133
6.4. Center Ball Size Calibration 134
6.5. Line Pair Resolution 135
7. Vertical Laser Beam Align 136

Chapter 5. PANO Image Evaluation 137

1. Line Pair Resolution evaluation 137

1.1. Resolution standards 137

1.2. Phantom Specification 137

1.3. Test Method 137

1.4. Test Result 137

2. Low Contrast Resolution evaluation 138

2.1. Low Contrast standards 138

2.2. Phantom Specification 138

2.3. Test Method 138

2.4. Test Result 138

3. Noise evaluation 139

3.1. Noise standards 139

3.2. Phantom Specification 139

3.3. Test Method 139

3.4. Test Result 139

4. Homogeneity evaluation 140

4.1. Homogeneity standards 140

4.2. Phantom Specification 140

4.3. Test Method 140

4.4. Test Result 140

5. Collimator Alignment Evaluation 141

5.1. Collimator Alignment Standard 141

5.2. Test Method 141

5.3. Test Result 141

Chapter 3. CEPH Image Optimization 142

1. CEPH Sensor Calibration 142

1.1. Before CEPH sensor calibration 142

1.2. CEPH sensor setting 143

1.3. CEPH sensor: Dark calibration 144

1.4. CEPH sensor: Bright calibration 145

1.5. Bright calibration: 5 points 146

1.6. Bad pixel spec. & definition 148

2. CEPH Geometry Calibration 149

2.1. Lateral Mode Start Position Setting 149

2.2. PA Mode Start Position Setting 151

2.3. Line Pair Resolution 153

2.4. CEPH Ear-Rod Alignment 154

3. CEPH Collimator Alignment 157

3.1. CEPH Collimator alignment 157

3.2. CEPH Collimator align with EzAlign 159
4. How to use V.I.P.S 160
4.1. Point setting method for Lateral Mode image 162
4.2. Point setting method for Frontal Mode image 165
4.3. Cautions when setting V.I.P.S Point 166
Chapter 6. CEPH Image Evaluation 167
1. Lateral Mode Start Position Evaluation 167
1.1. Lateral Mode Starting position standard 167
1.2. Phantom Specification 167
1.3. Test Method 167
1.4. Test Result 167
2. PA Mode Start Position Evaluation 168
2.1. PA Mode starting position standard 168
2.2. Phantom Specification 168
2.3. Test Method 168
2.4. Test Result 168
3. Line Pair Resolution Evaluation 169
3.1. Noise standards 169
3.2. Phantom Specification 169
3.3. Test Method 169
3.4. Test Result 169
4. Low Contrast Resolution evaluation 170
4.1. Homogeneity standards 170
4.2. Phantom Specification 170
4.3. Test Method 170
4.4. Test Result 170
5. Collimator Alignment Evaluation 171
5.1. Collimator Alignment Standard 171
5.2. Test Method 172
5.3. Test Result 172
Chapter 7. Firmware Upgrade Guide 173
1. Firmware Upgrade Procedure (Ethernet Communication) 173
2. Installing Firmware Upgrade Software (Serial Communication) 175
3. Firmware Upgrade Procedure (Serial Communication) 176
4. Checking Firmware Version (Serial Communication) 182
5. Appendix 183
5.1. Main MCU Board Parameters 183
Chapter 8. Command-List Guide 188
1. Communication Protocol 188
1.1. Communication Setting 188

1.2. Command Formation 189
2. vatech A9(PHT-30CSS) Command-List 190
3. Procedure for using remote exposure function 197
3.1. When exposure the PANO/CEPH in Console Software 197
3.2. Remote exposure sequence when acquiring the Bright Calibration 197
3.3. TUTS Test 197
3.4. XTST Test 197
4. Error Message List 198
Chapter 9. Console software error message List 200
1. Hardware Error Code 200
2. Software Error Code 203
3. Acquisition Module Error Code 208
4. Image Processing Error Code 209
5. Stitching SW Error Code 212

Before you begin

Conventions in this Guide

The operator should perform the procedure according to the following Safety instruction. This Manual is intended only for VATECH Co., Ltd. authorized engineers only to avoid personal injury and damage. VATECH Co., Ltd. holds no liability for the problems caused by unauthorized engineers.

To effectively describe safety information, the following signs are used in this manual.

⚠WARNING	**WARNING**	Critical application information that could result in critically severe injury or damage on both operator and equipment is described.
⚠CAUTION	**CAUTION**	Important application instructions that could result in serious personal injury or equipment damage are described.
IMPORTANT	**IMPORTANT**	Necessary instructions or application information are indicated.
NOTICE	**NOTICE**	Useful information or possible harmful situations are indicated.
	**RADIATION**	Radioactivity sign to signify the radiation hazard.

Safety Information

X-rays can be dangerous if not used properly, followed by safety instructions. All safety instructions and warnings must be carefully observed to guarantee the maximum protection of technicians from X-Ray hazards. To operate and service the device, follow the instructions contained in this manual.

IMPORTANT	**Operator Qualifications** This equipment can only be operated or serviced by VATECH authorized engineers who are fully trained. To operate this equipment, all operators must: • have read and understood the Technical manual before application. • be familiar with the fundamental structures and functions of the equipment with enough experience. • Only VATECH authorized operator can handle the electrical circuit board, and an understanding of the electric and electrical system is required. • Be able to recognize operation malfunction and implement appropriate measures to take care of irregularities.
IMPORTANT	**General Safety Precautions** • To operate and service the device, following instructions, Note, Important, Caution, and Warning must be carefully • Do not place any objects within the equipment operational boundary. It can physically damage equipment. • Ensure that this medical equipment is kept away from water, moisture, or foreign substances at all times. • The sudden change of temperature may affect equipment operation conditions by causing condensation. Wait until the equipment reaches room temperature then turn it on. • This product may only be operated with VATECH original accessories or third-party accessories only approved by VATECH Co., Ltd.

Equipment Safety Instructions

This electro-medical device contains high voltage and current flowed parts, and the following instructions must be followed to avoid critical damage to the body and equipment.

⚠CAUTION	**Electrical Safety Caution** • The equipment and PC should be connected to a common protective earth. Confirm that the equipment is well-grounded. • High voltage and current flows throw equipment. Turn off equipment power and wait at least 2 minutes before the operation begins. • Do not connect this equipment to any device without authorization from VATECH Co., Ltd. • Do not connect this equipment to a Multiple Portable Socket- Outlet (MPSO) or extension wires • Keep in mind that MCU boards are electrically sensitive that operators need to wear shielding gloves while operating. • The only part that can be replaced by the users is the input fuses. Check if the fuses comply with the manufacturer's specifications.
⚠CAUTION	**Mechanical Safety Caution** • Be aware that fingers or parts of your body are not shut in the equipment. • If a problem occurs during operation, immediately press the red emergency stop button to stop equipment operation and cut off all power to the equipment. • Never touch the patient while touching the connector of SIP/SOP. • While adjusting the patient, ensure that the laser beam is not directed at the patient's eyes. • Never expose the equipment to liquids, mists, or sprays. Any liquid may cause an electrical shock or otherwise damage the system. • Do not use spray cleaners on the equipment to avoid fire. • Do not use solvent aerosol or spray cleaning agents directly on the surface of the equipment. It can damage equipment, including the LCD panel.

Radioactive Warning

It is important to read this manual carefully and strictly abide by all warnings and cautions stated. Since rules and regulations concerning radiation safety differ by country, it is the users' responsibility to comply with all applicable rules and regulations concerning radiation safety and protection in their area.

Radiation Safety Caution

- The equipment must be housed inside an X-ray shielded room.
- Or operators should use a shielding plate to minimize radiation exposure while operating the system.
- The equipment exposes radioactive rays, and only specialized engineers can operate the system. Read and understand related regulations and warnings.
- Press the emergency button to stop equipment malfunction while image capturing.
- The patient must wear a lead apron with neck and thyroid protection during X-ray exposure.
- The only patient can remain in the shielding room during image capturing. Do not enter the X-ray exposing area without protection.
- Children and pregnant women must consult with a doctor before X-ray exposure.

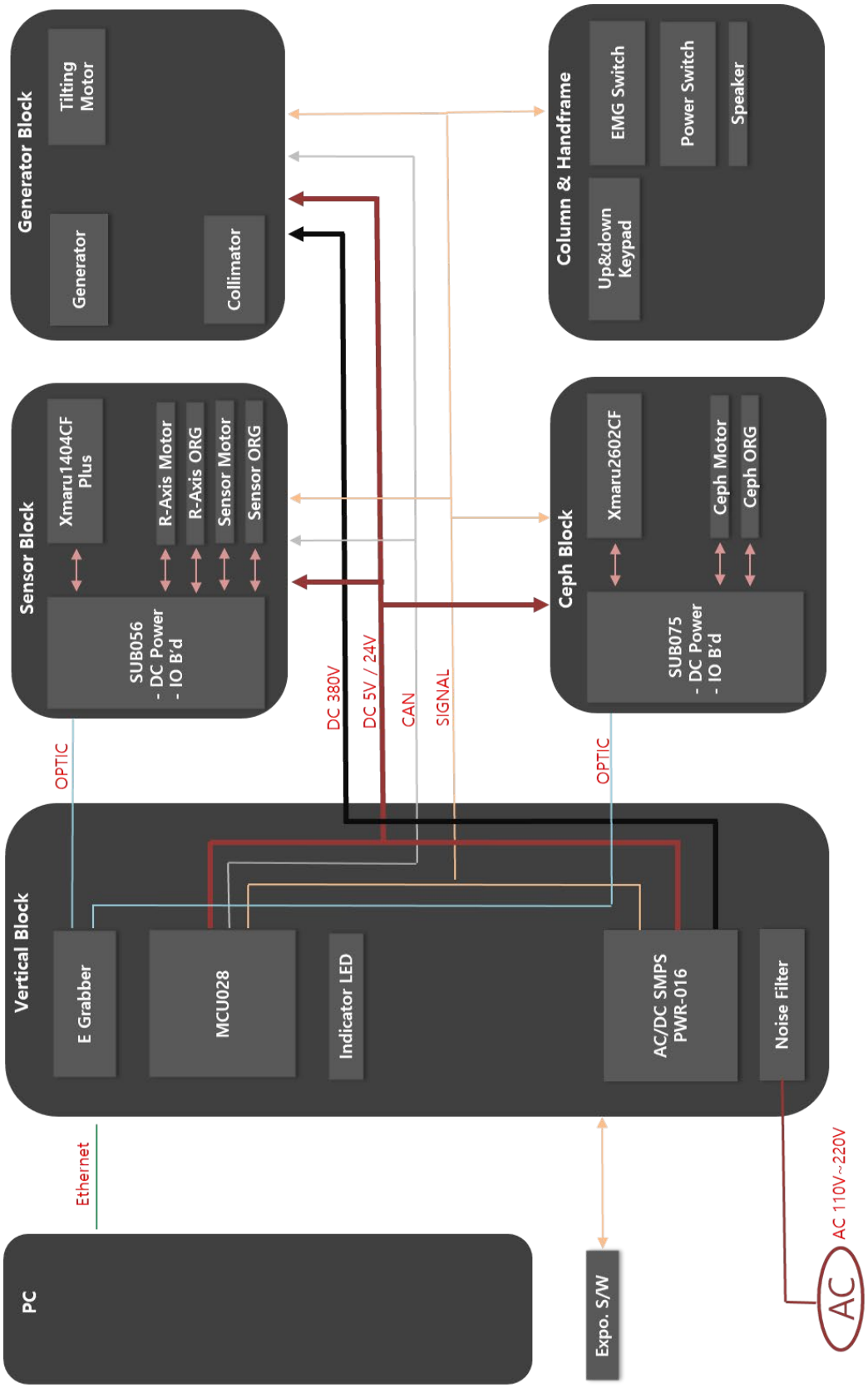
Pre-check points for Service Technician

The following checkpoints must be confirmed before performing the next procedure.

No.	Check Point	Pass	Fail
1	Do the equipment power, and PC condition work fine?	□	□
2	Is the power off before the equipment repair begins?	□	□
3	Is the voltage range indicated back of the equipment observed properly?	□	□
4	Is the equipment grounding connection working fine?	□	□
5	Are there any unnecessary accessories that can affect the X-ray exposure condition?	□	□
6	Are at least two operators ready to start operation with enough understanding of the equipment?	□	□
7	Are all required tools ready?	□	□

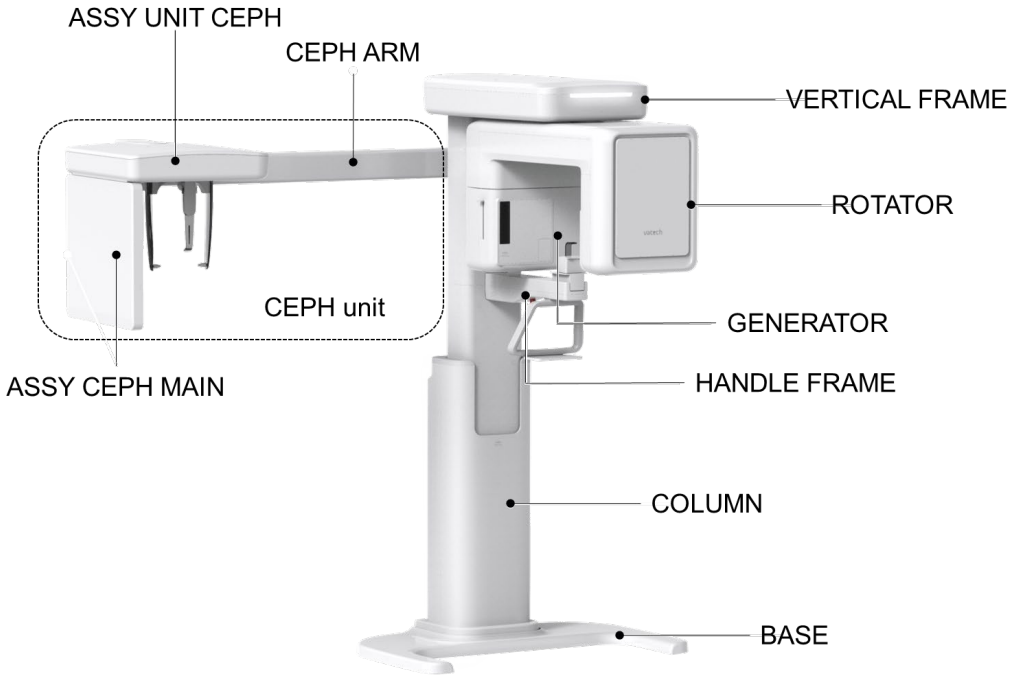
Chapter 1. Hardware Part Service Guide

1. vatech A9(PHT-30CSS) System Block Diagram



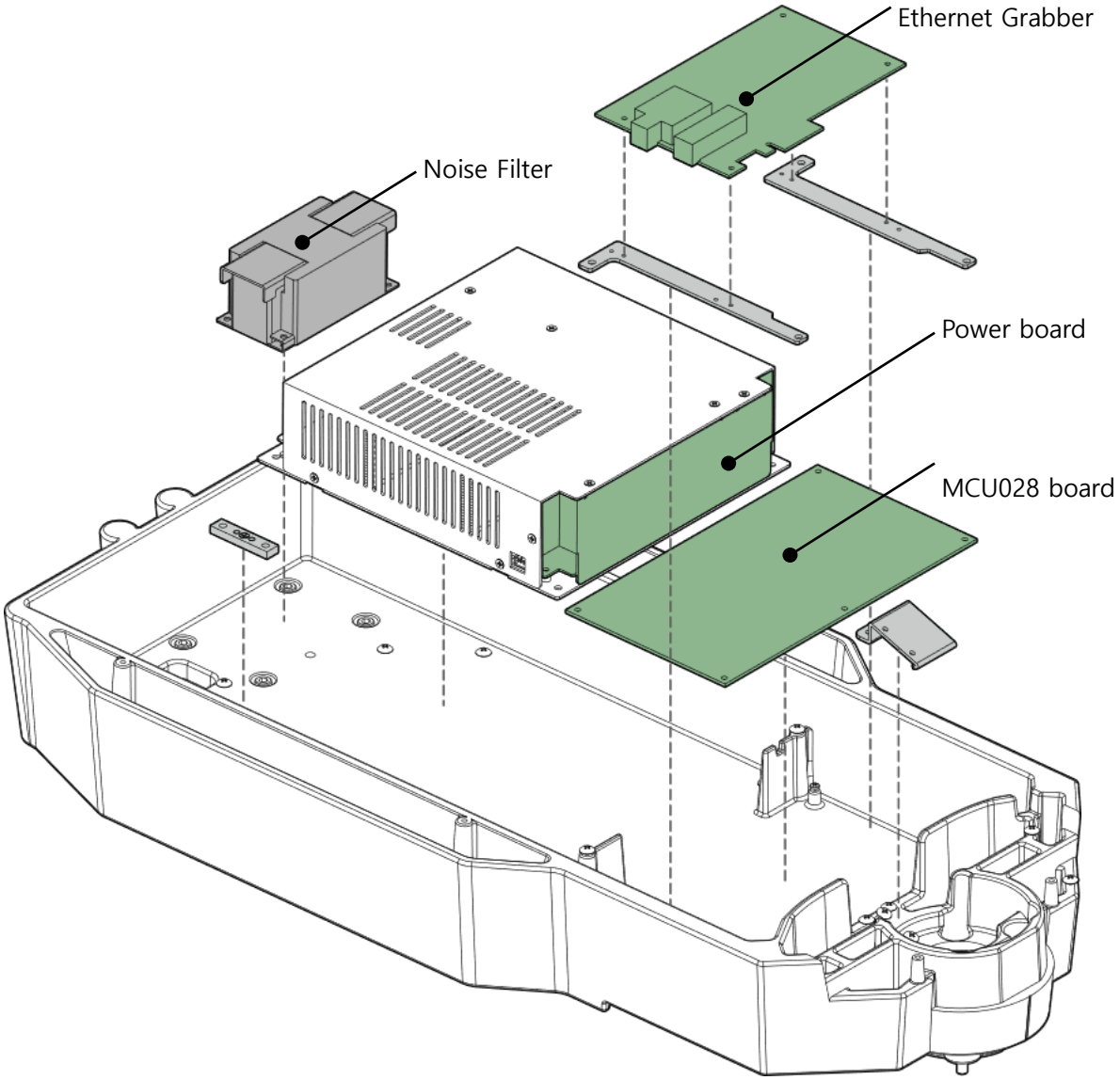
2. vatech A9(PHT-30CSS) Board Configuration

The position of the board mounted on the equipment is as follows.

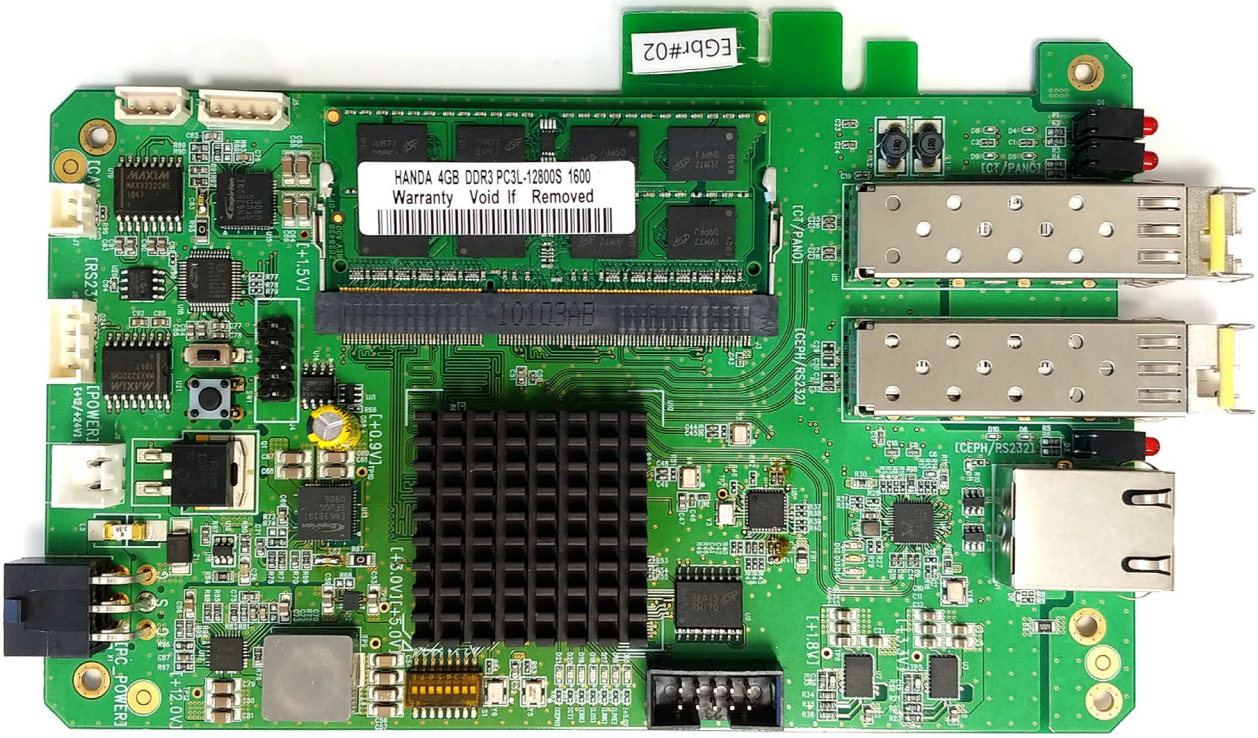


2.1. Vertical Frame Part

The following boards are mounted on the vertical unit.

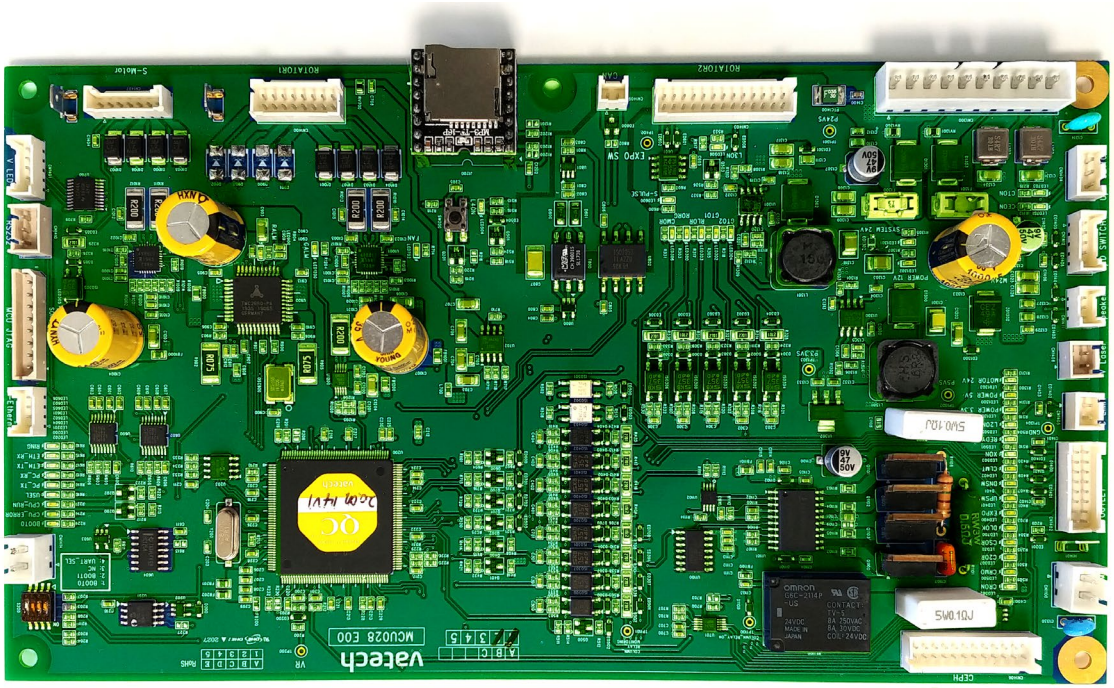


2.1.1. Ethernet Grabber



Function	• 12V/24V DC Input • RS232 to MCU • CAN to MCU (Reserve) • 2 Optic signal input (Tx 1550/Rx 1310) • 1 G-Ethernet output • 4Gbyte memory

2.1.2. Main MCU BOARD (MCU028)



Function	• LAN communication to PC
	• CAN communication to Sensor, Inverter, Key Pad
	• Motor control
	  - Rotator 1 axis
	  - Generator Tilting
	  - Column Up/Down
	  - Collimator Moving
	  - Sensor Moving
	  - CEPH Sensor Moving
	• Fan control
	• Sensor Power On/ Off control
	• Laser On/Off control
	• X-Ray control
	• X-Ray Warning Lamp control
	• Exposure Switch detection
	• MP3 control
	• Sync Pulse Generation when exposing the X-ray
	• Lighting LED control

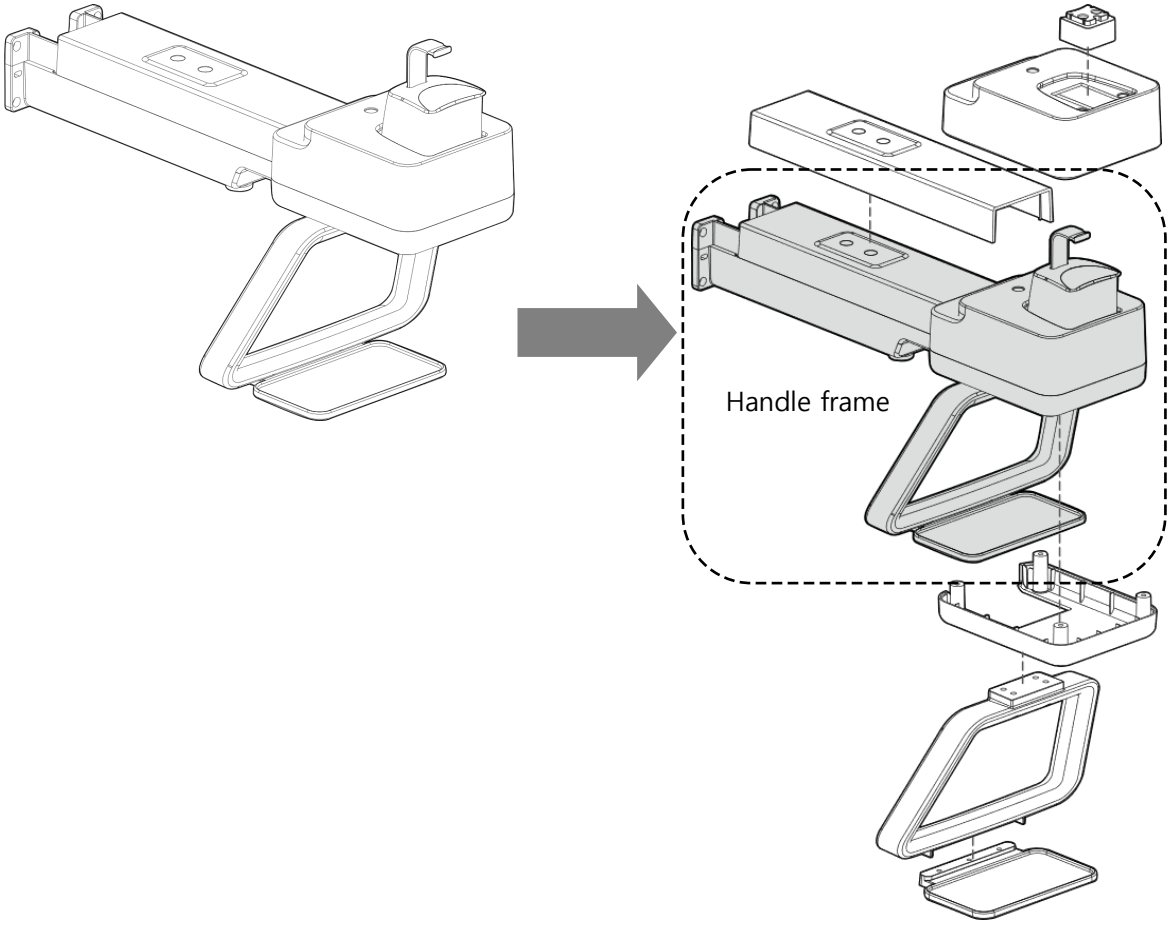
2.1.3. Power Board (VT-PWR-016)

Function	• **24V DC Output** : System, Motor, Sensor, Inverter • **380V DC Output** : Generator • **Emergency Switch Input** : Power Shutdown

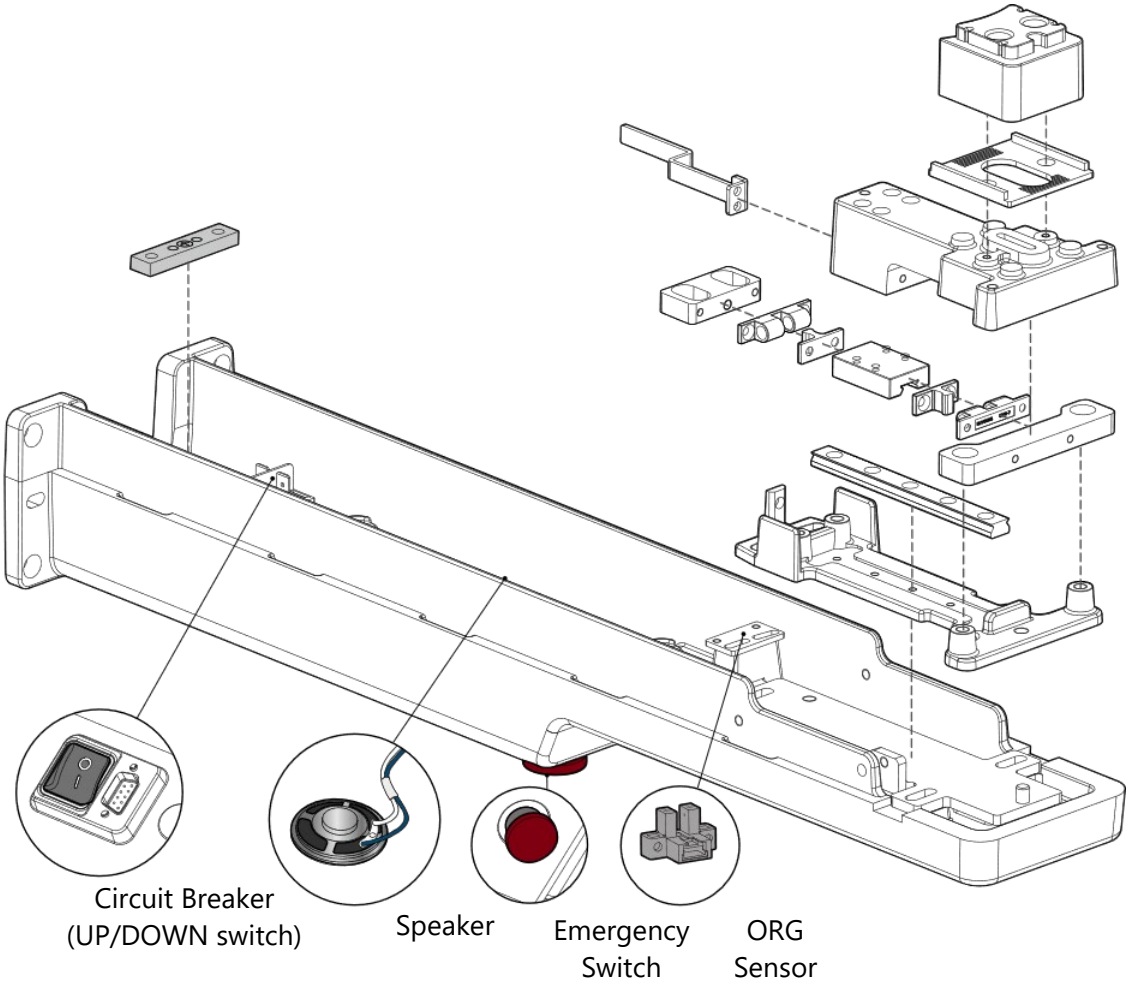
2.1.4. Noise Filter

2.2. Handle Unit

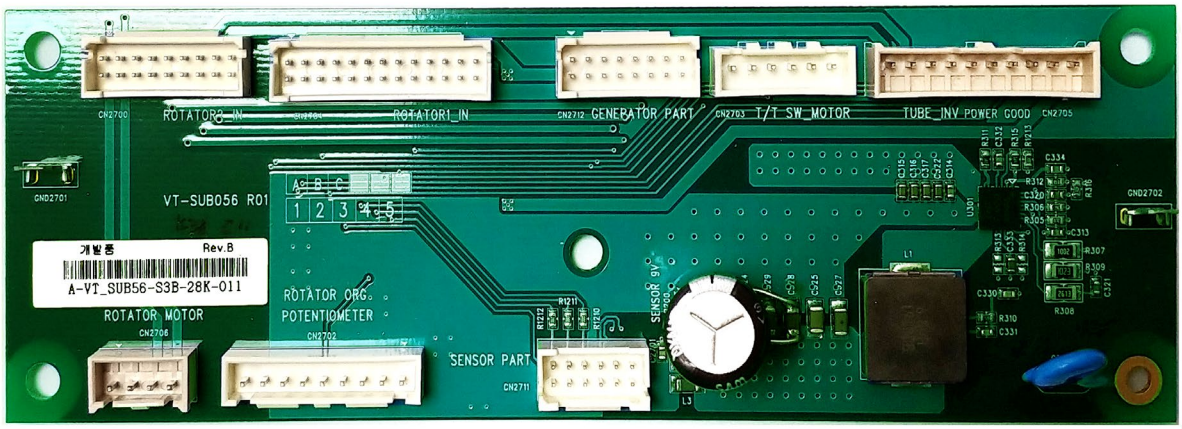
Remove the cover from the Handle Unit as shown in the image below.



Remove the cover from the Handle frame as shown in the image below.

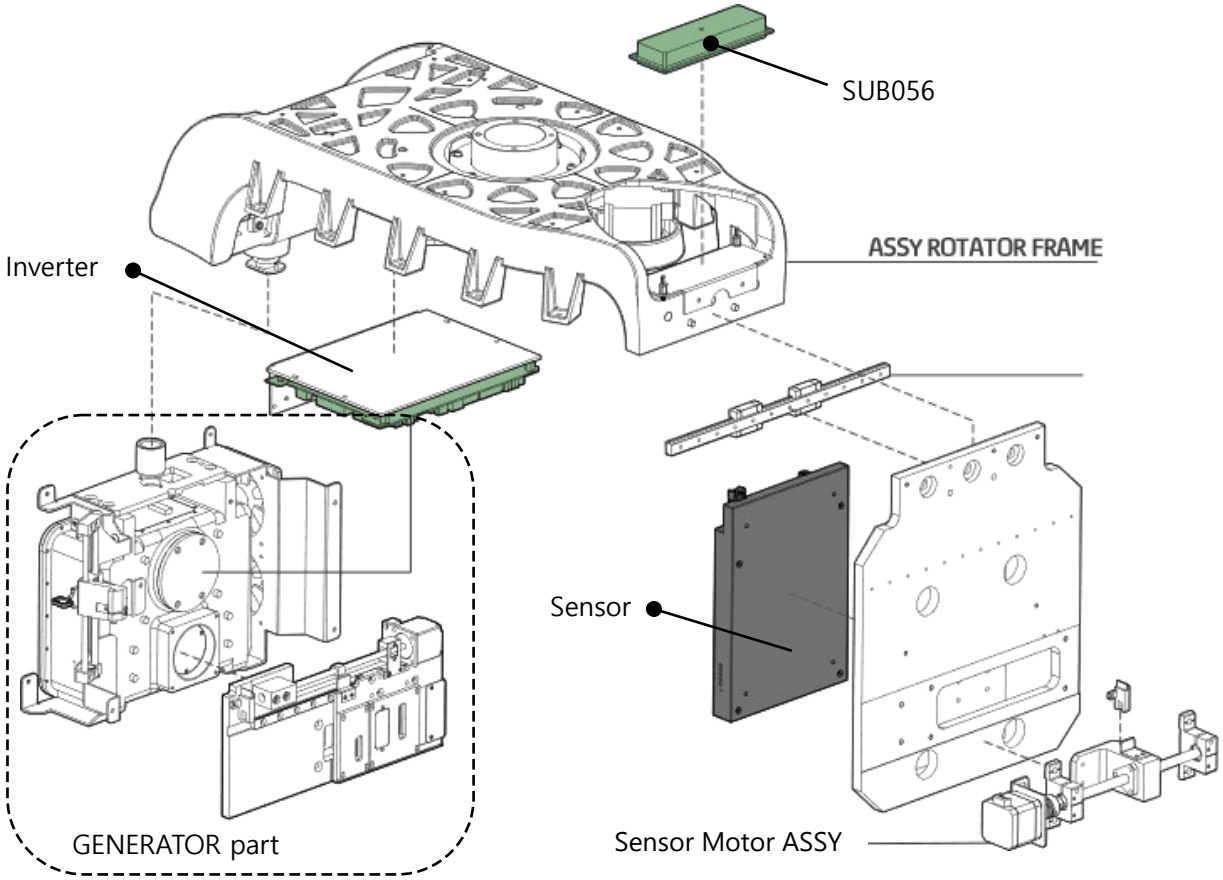


2.2.1. TOUCH KEYPAD

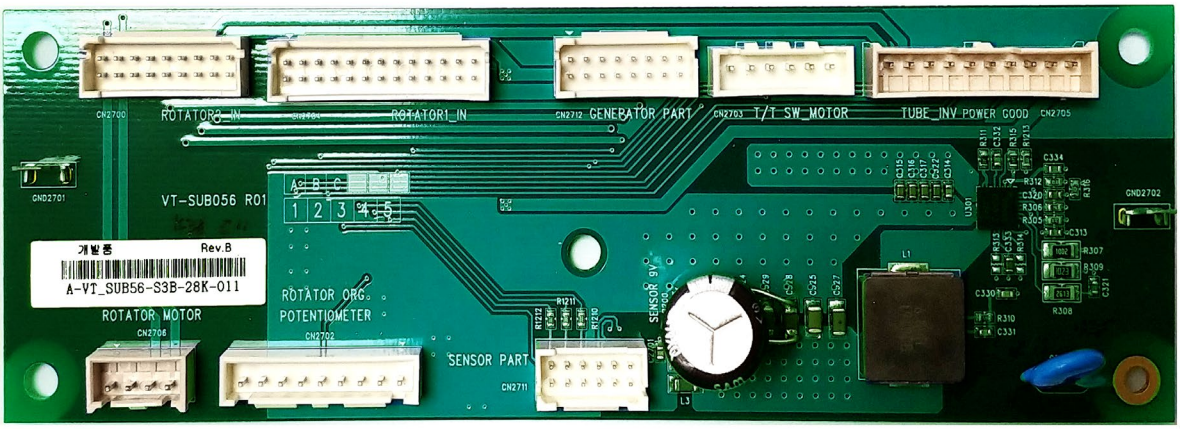


2.3. Rotating Unit Part

Disassemble the ROTATOR PANO as shown in the image below.

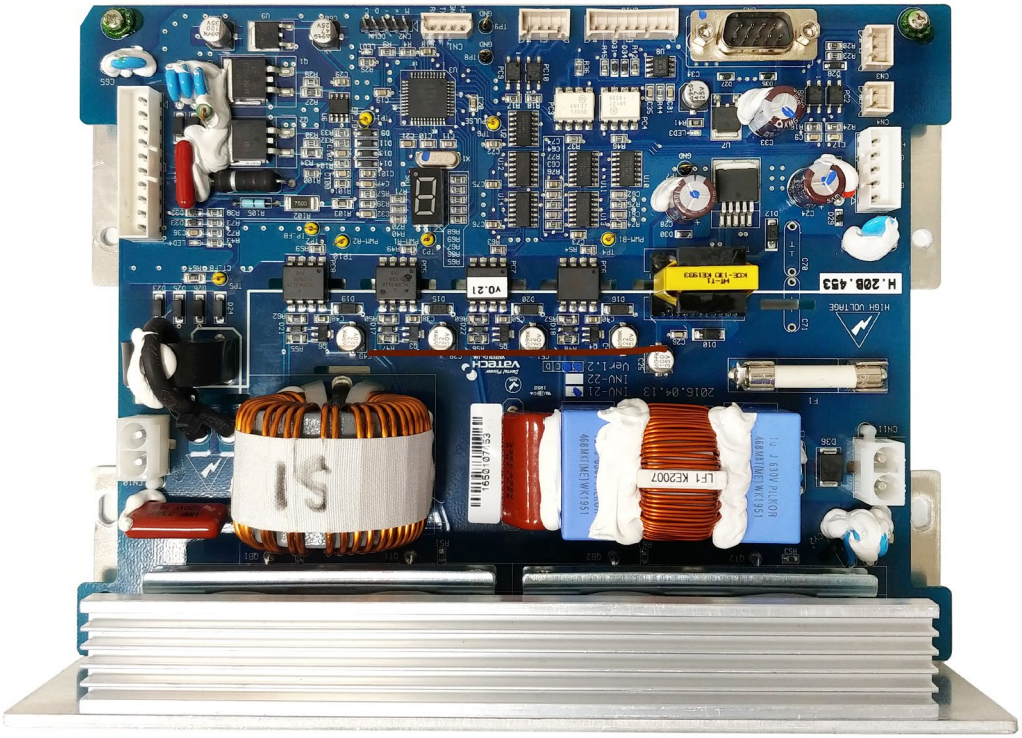


2.3.1. Sensor Interface (SUB056)



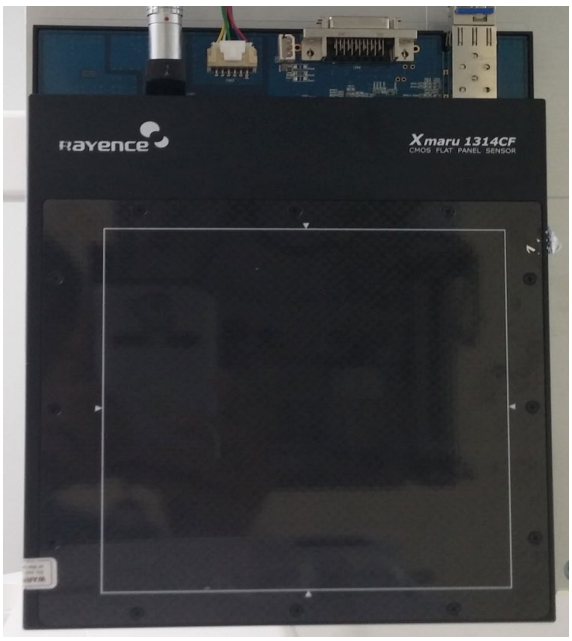
Function	• Control Signal Interfacing of : Sensor moving motor, Rotator motor, and the Sensor • Control Power Interfacing of Sensor

2.3.2. Inverter

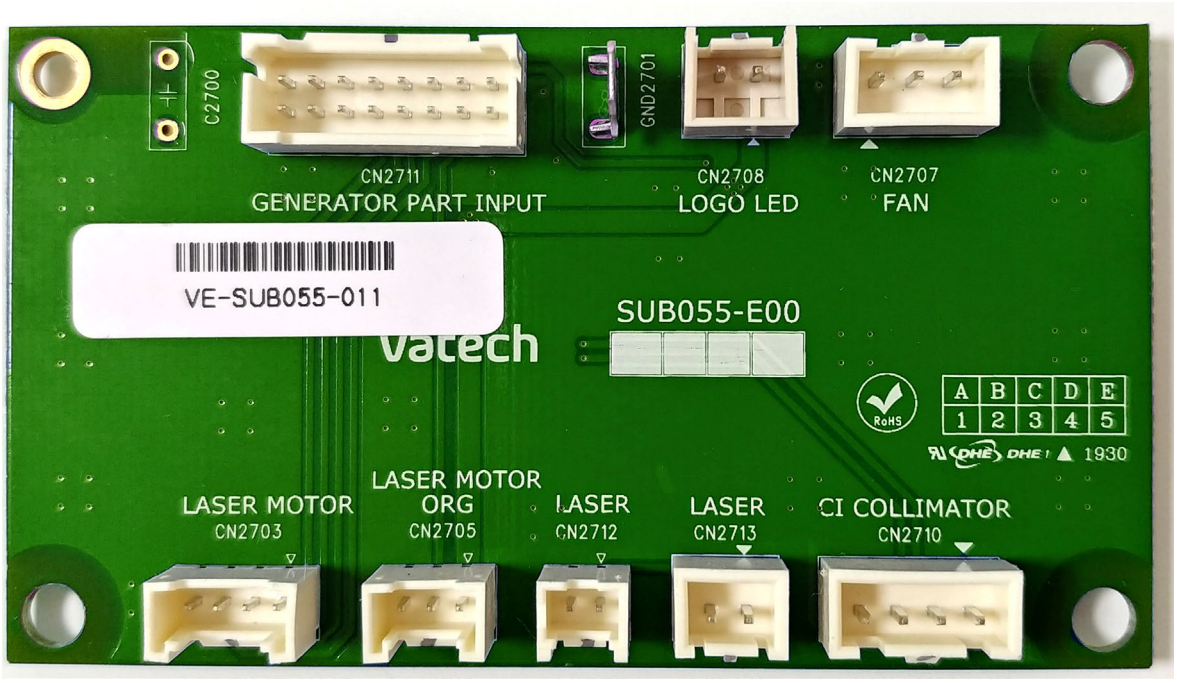


Function	• Supply High DC/AC Power

2.3.3. CT/PANO Sensor (Xmaru1314CF)

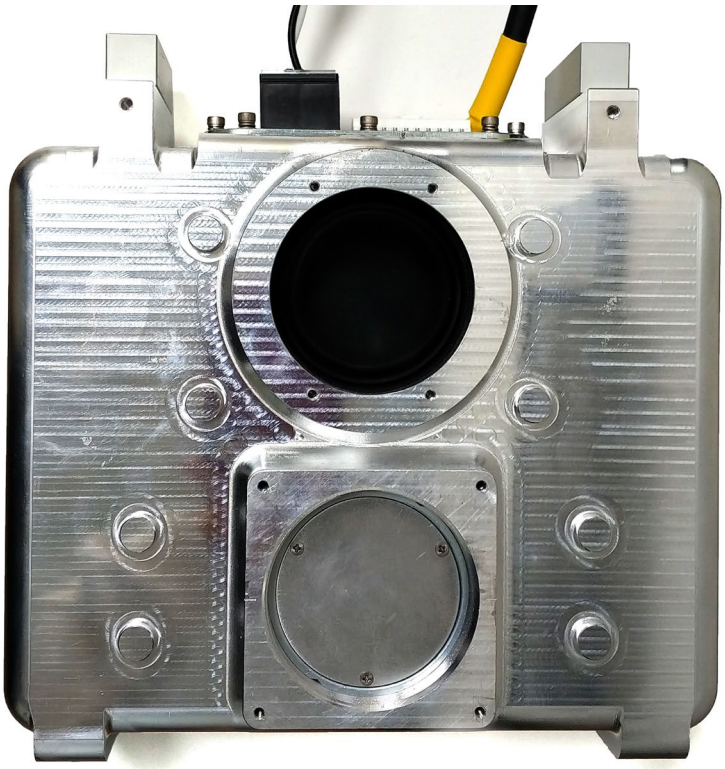


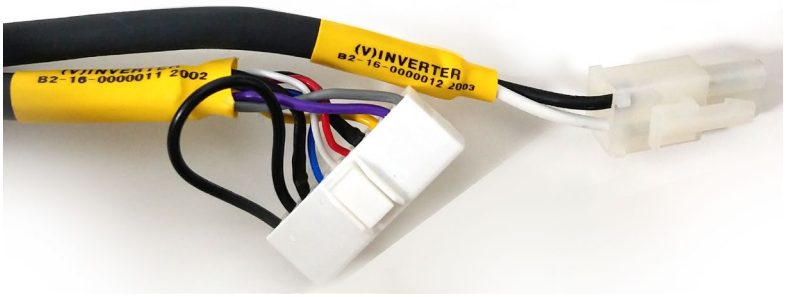
2.3.4. Generator Interface (SUB055)



Function	• **Control Signal Interfacing** : Generator, Generator Tilting motor, Laser, Laser motor, Collimator, Fan, Sensor (CT/PANO) • **Control Power Interfacing** : Sensor (CT/PANO), Collimator * Generator Part Interfacing Board

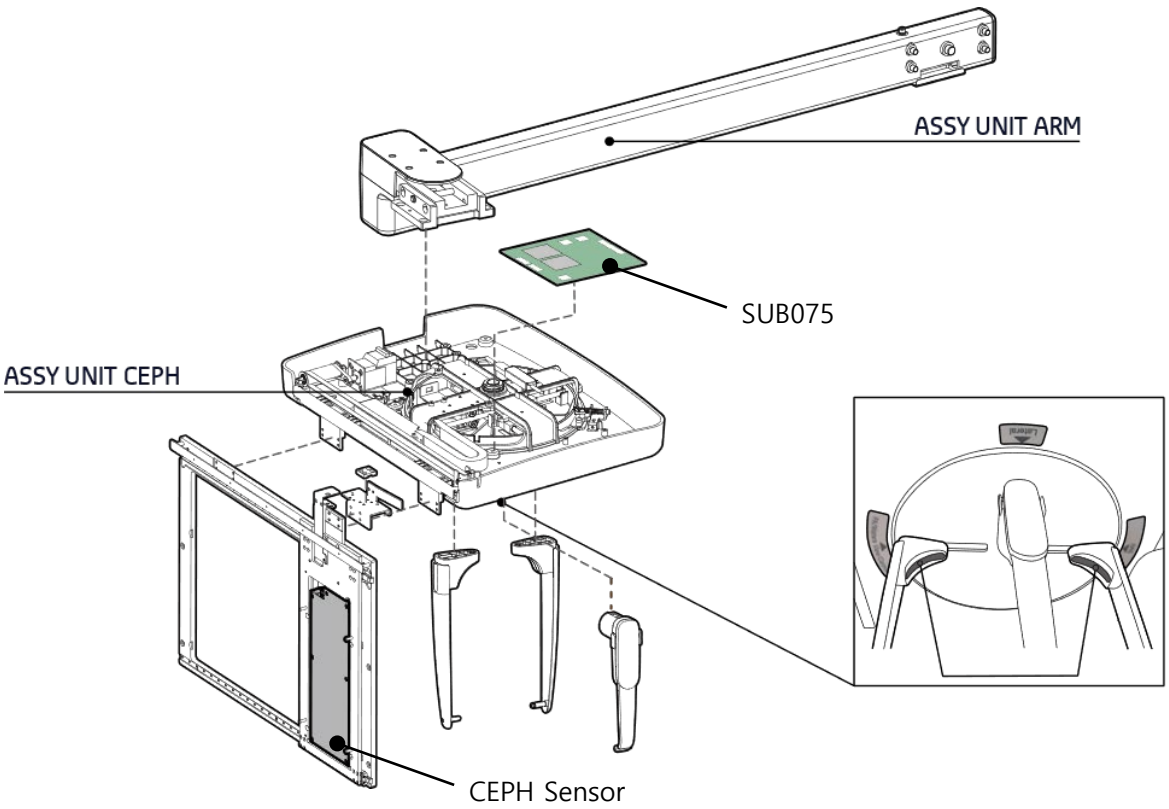
2.3.5. Generator (DG-07E22T2)



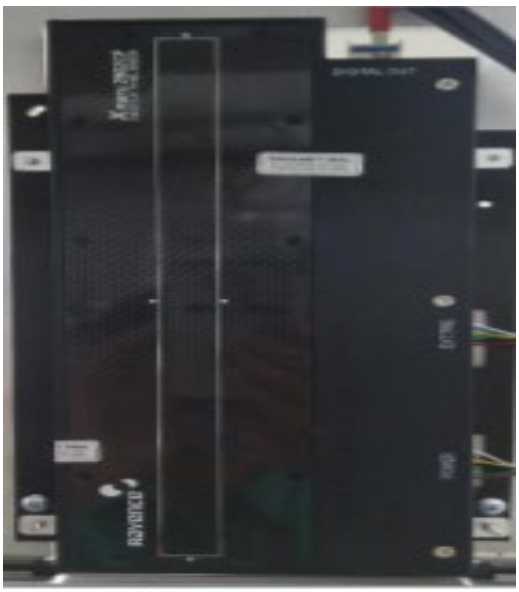


2.4. CEPH Unit

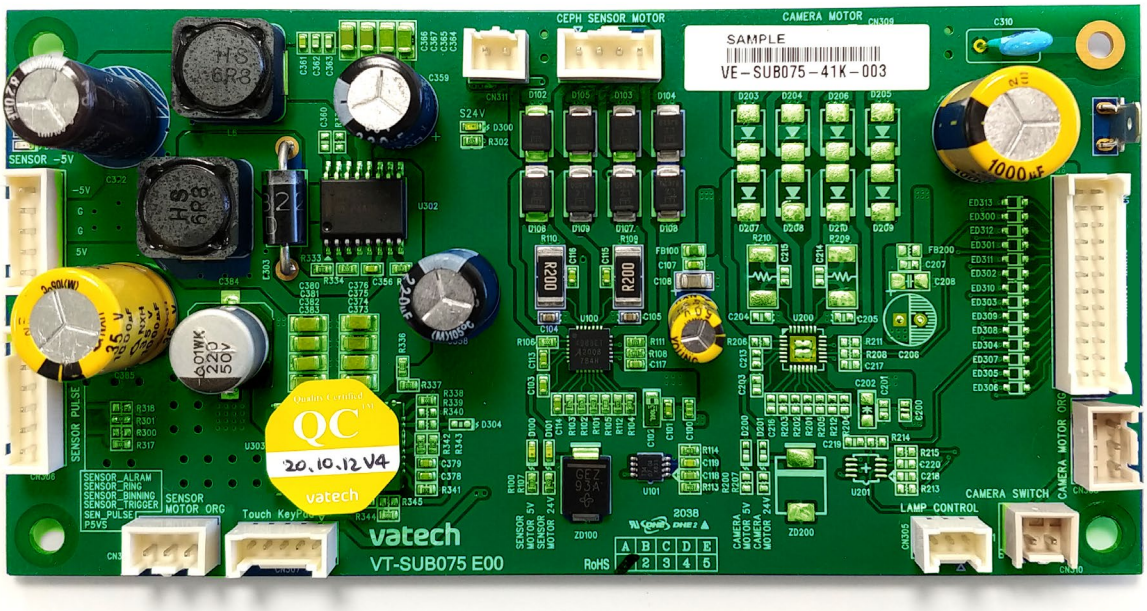
Disassemble the CEPH Unit as shown in the image below.



2.4.1. CEPH Sensor (Xmaru2602)



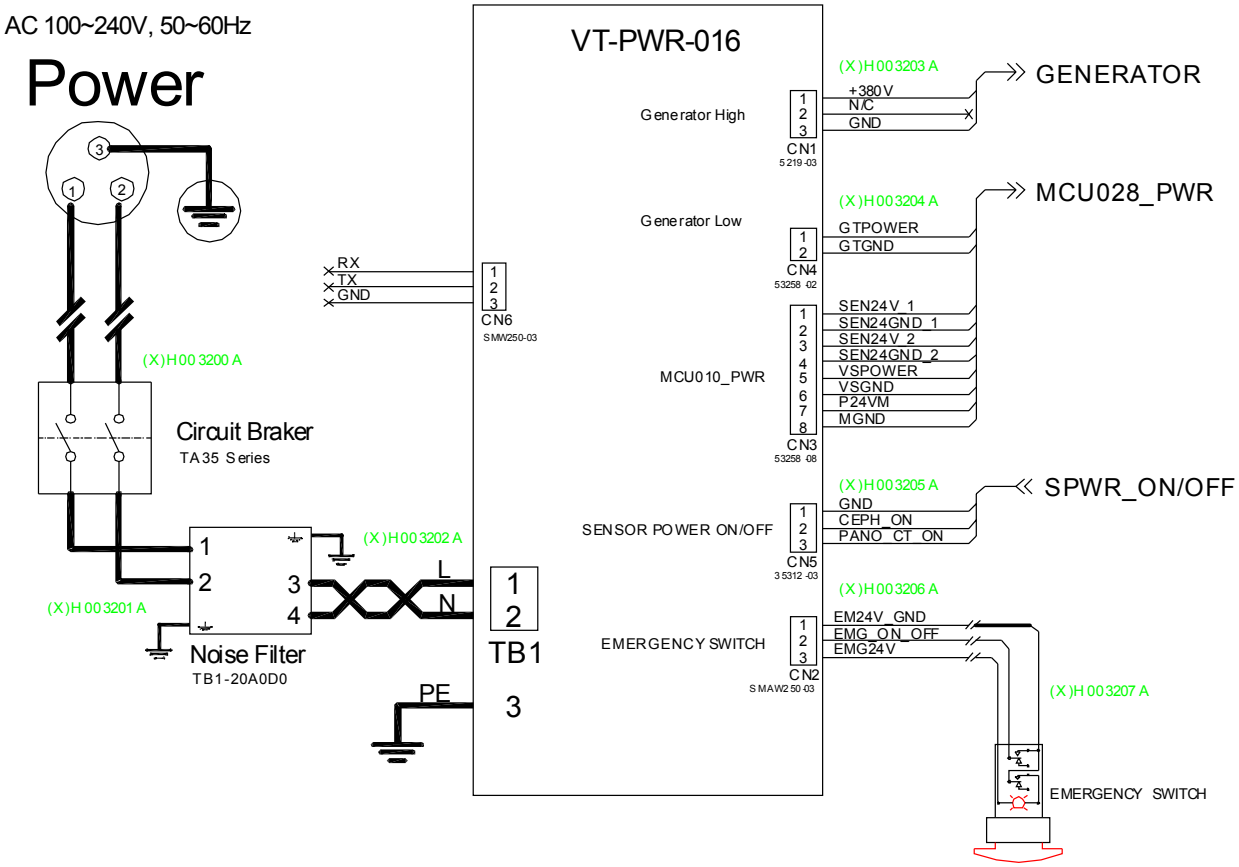
2.4.2. CEPH Interface (SUB075)

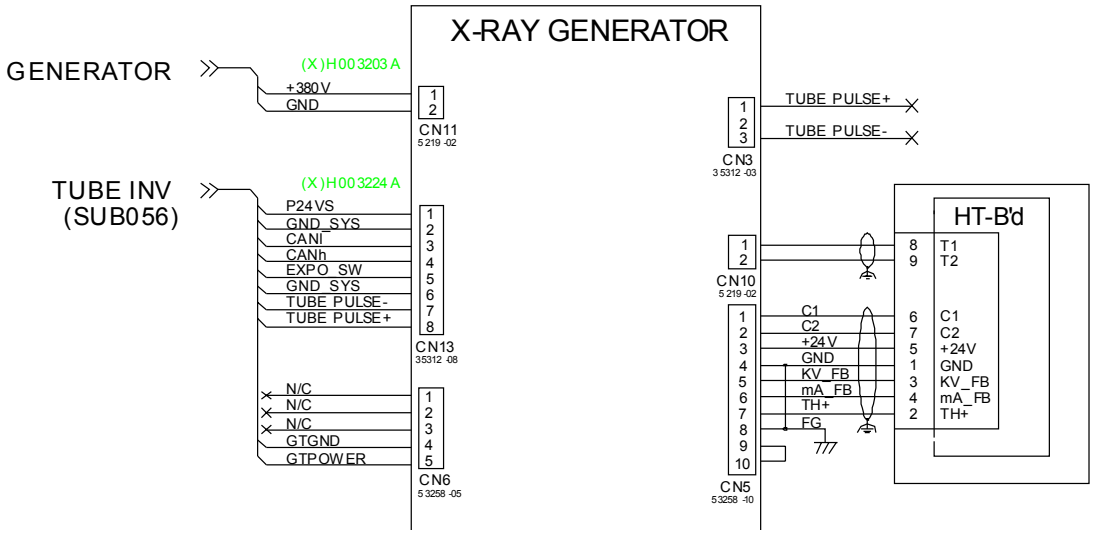


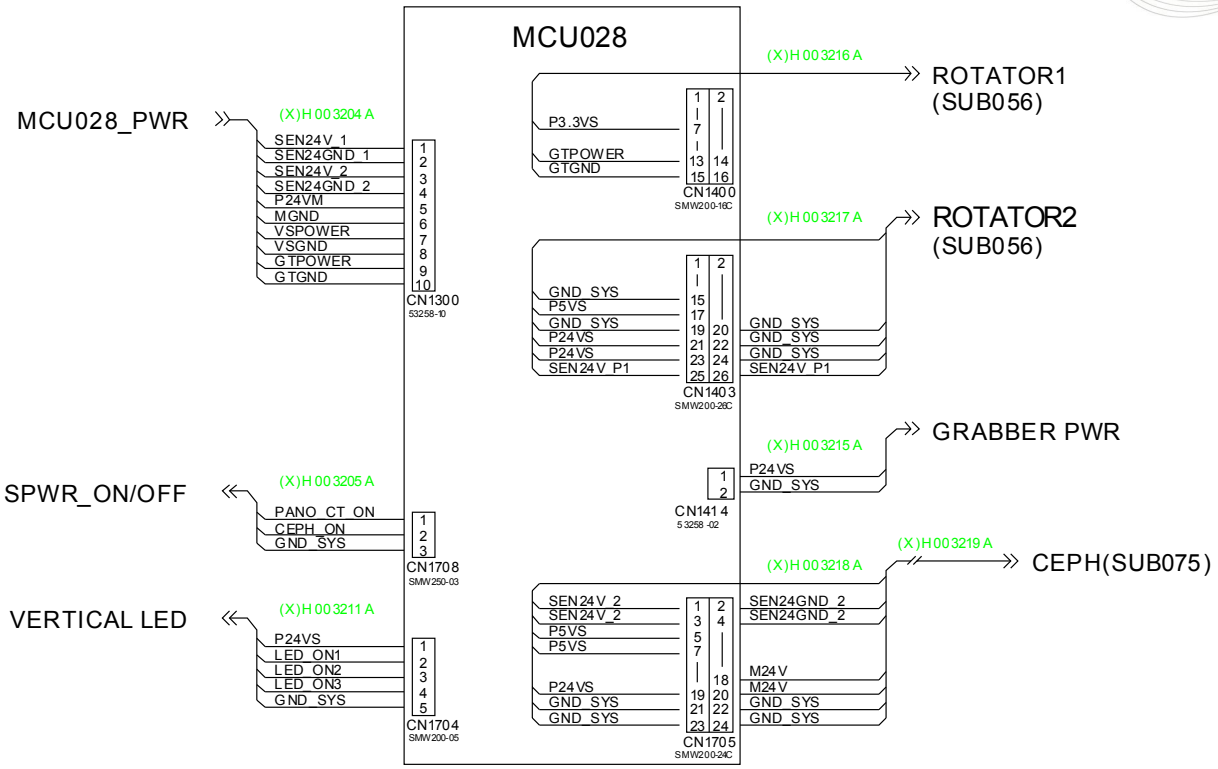
Function	• Interfacing : Main MCU Board (MCU026) and CEPH Motors • CEPH sensors Control • Sensor Power Regulation : 24V → ± 5V

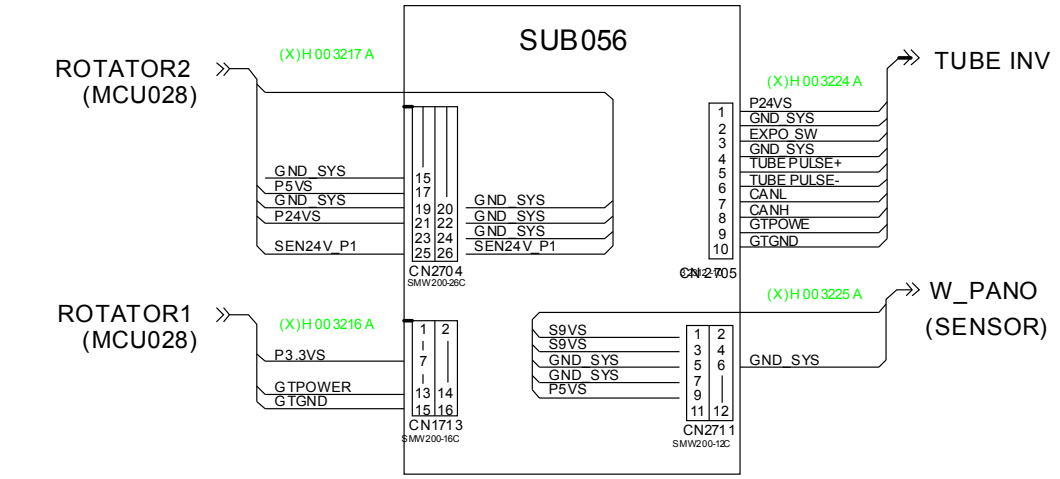
3. vatech A9(PHT-30CSS) Connection Diagram

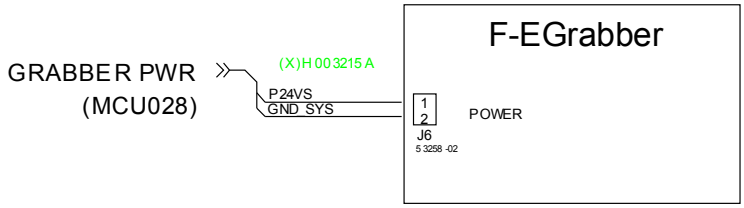
3.1. Power and Ground Connection Diagram

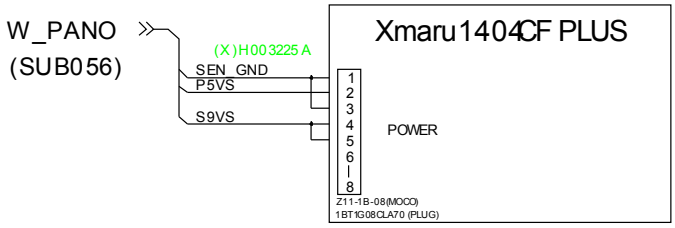


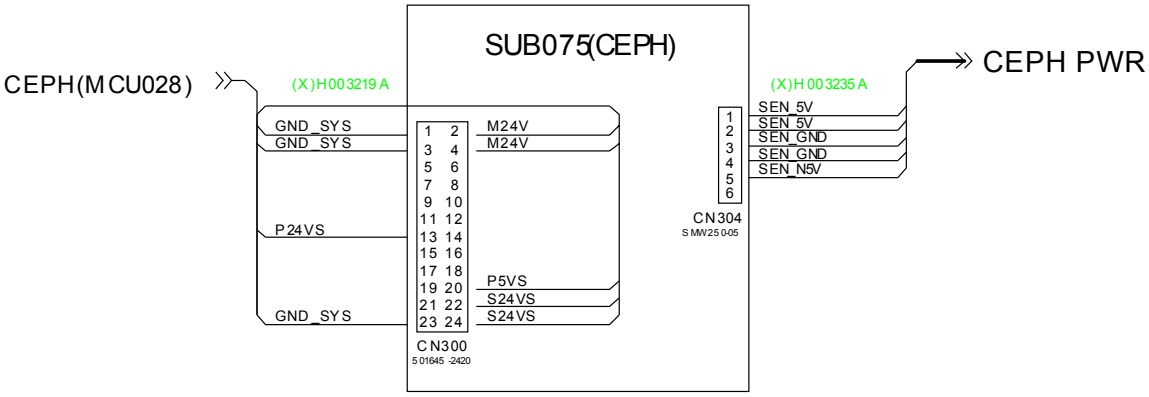


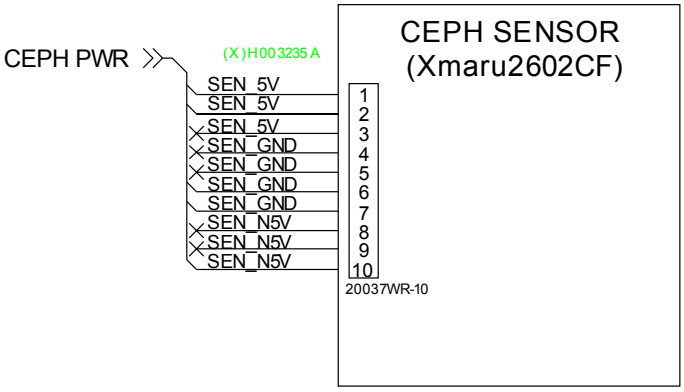




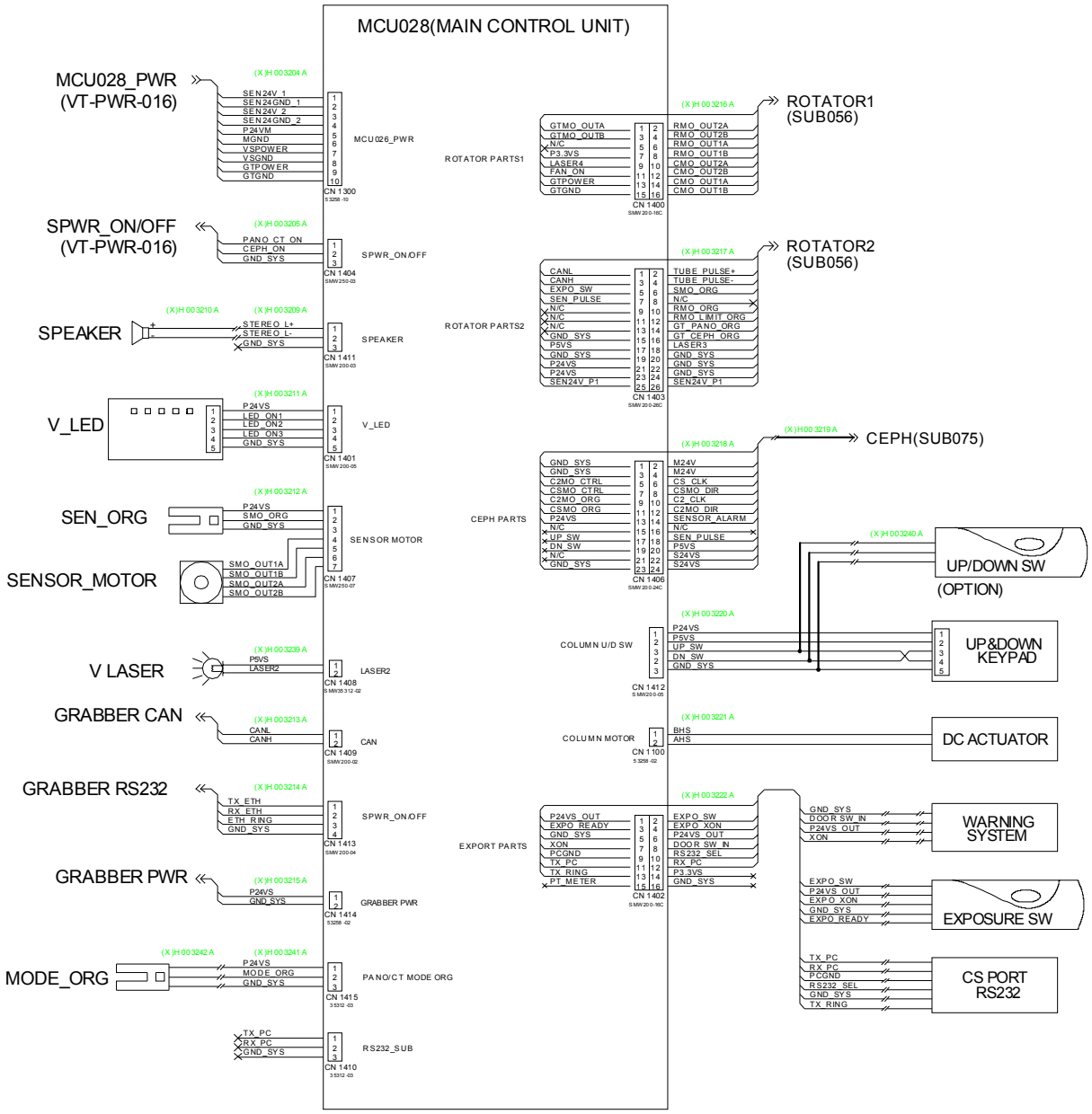


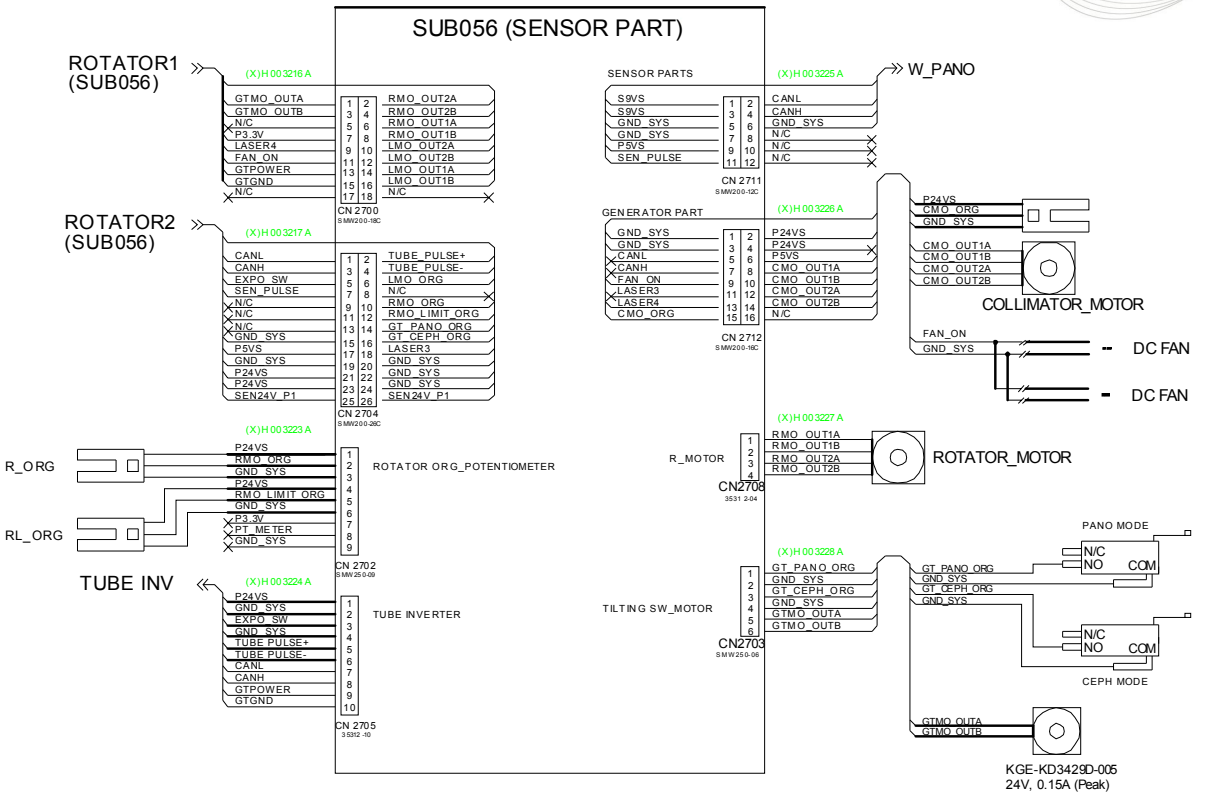


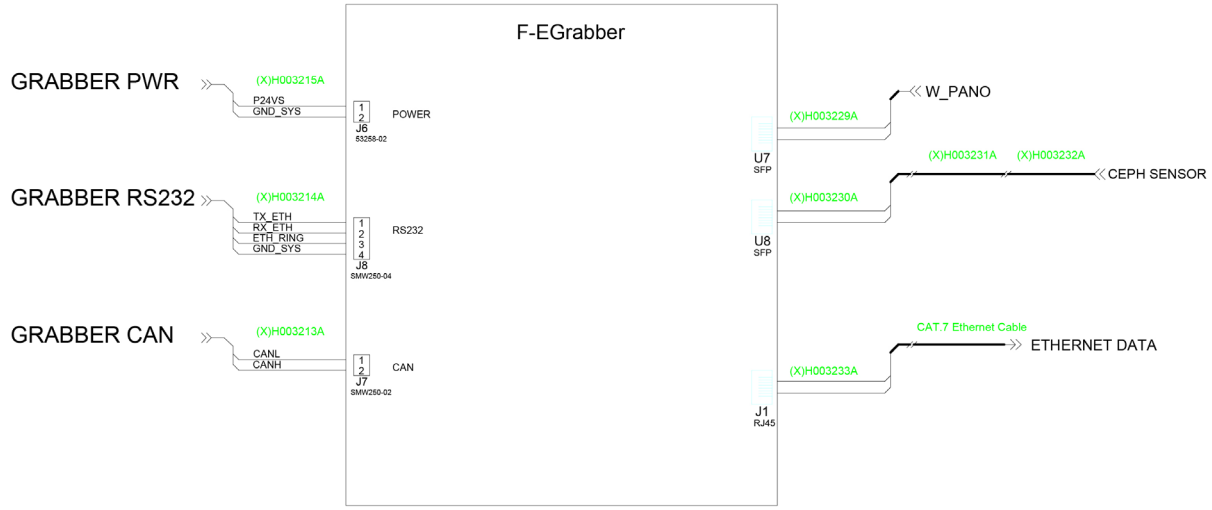




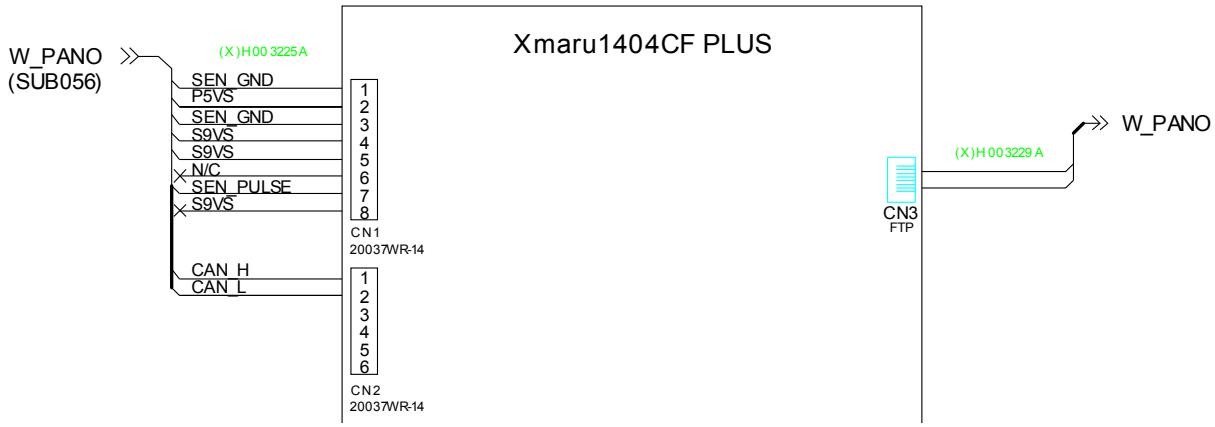
3.2. Main MCU and SENSOR Connection Diagram



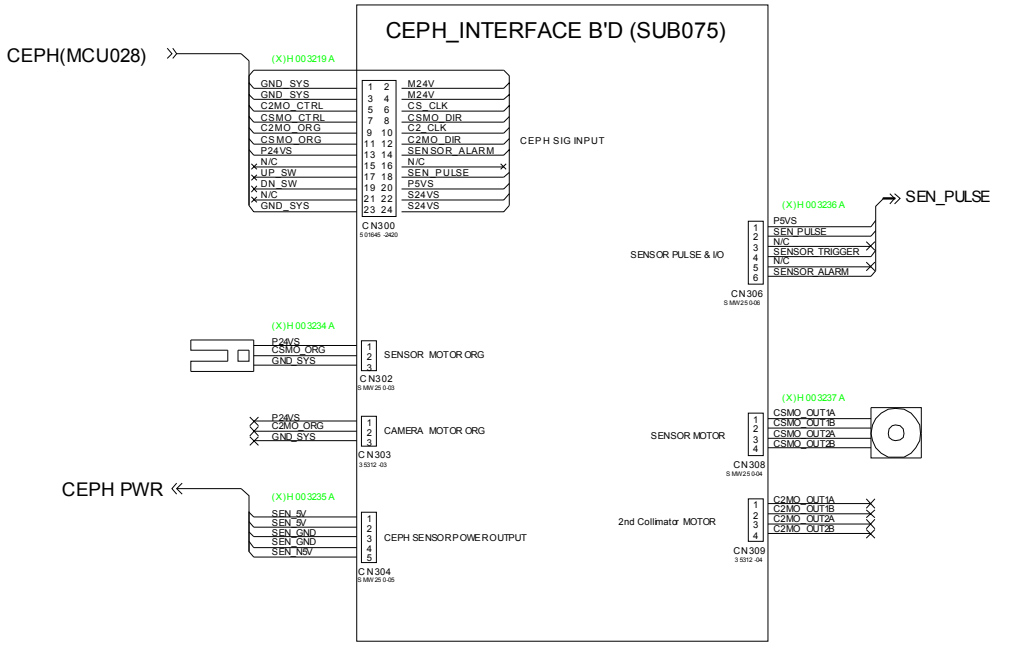


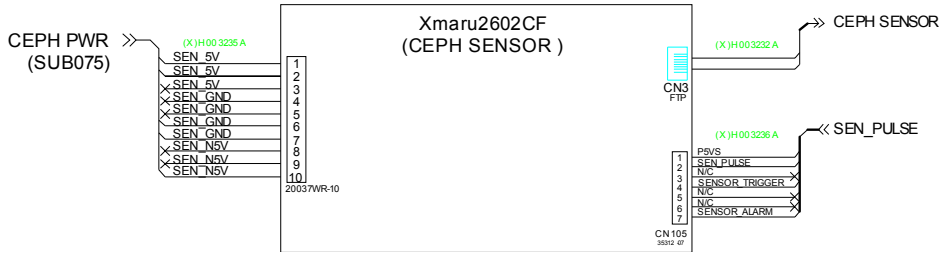


3.3. Sensor Part Connection Diagram

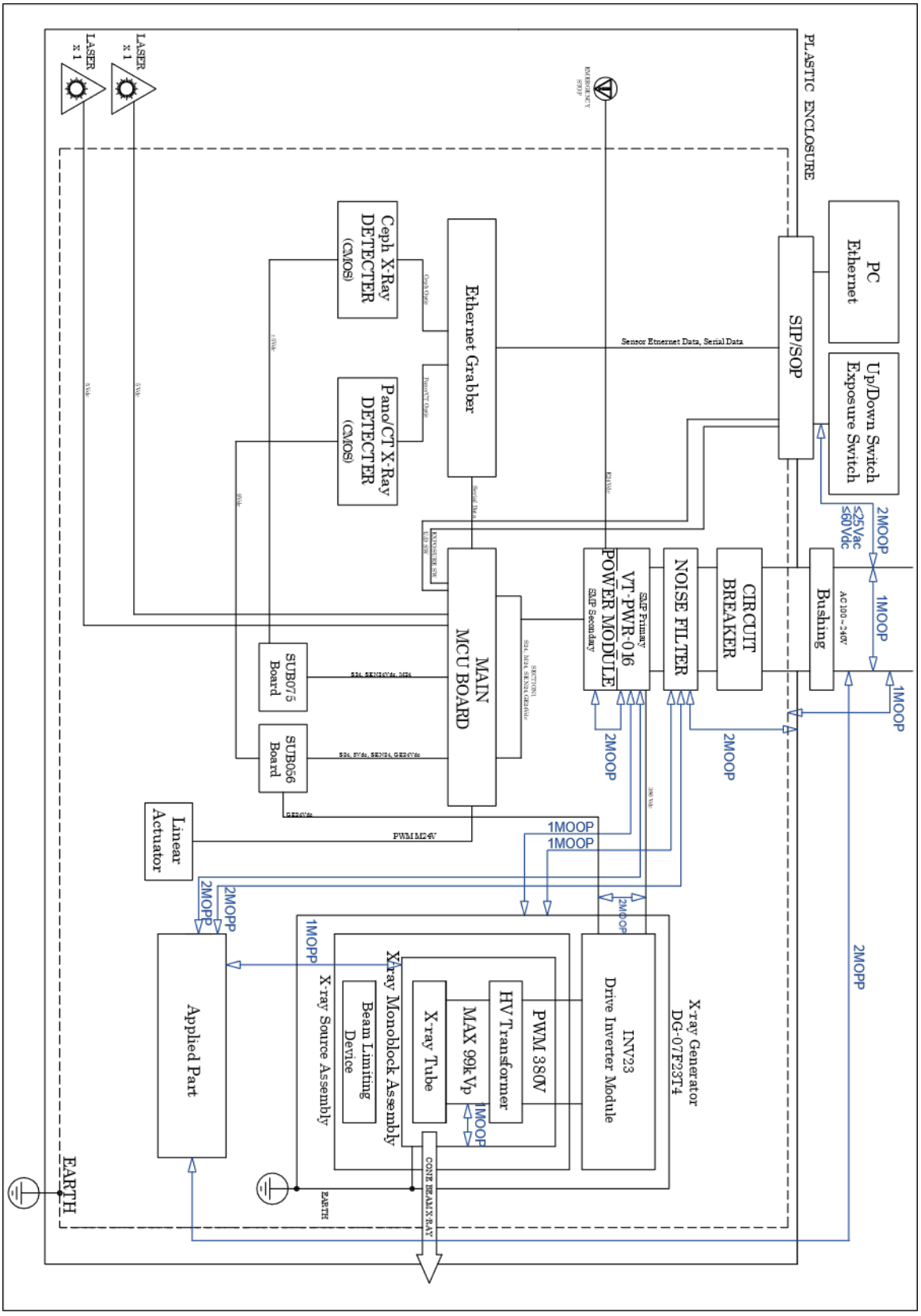


3.4. CEPH SENSOR Part Connection Diagram





3.5. Connection Diagram (Total assembly)



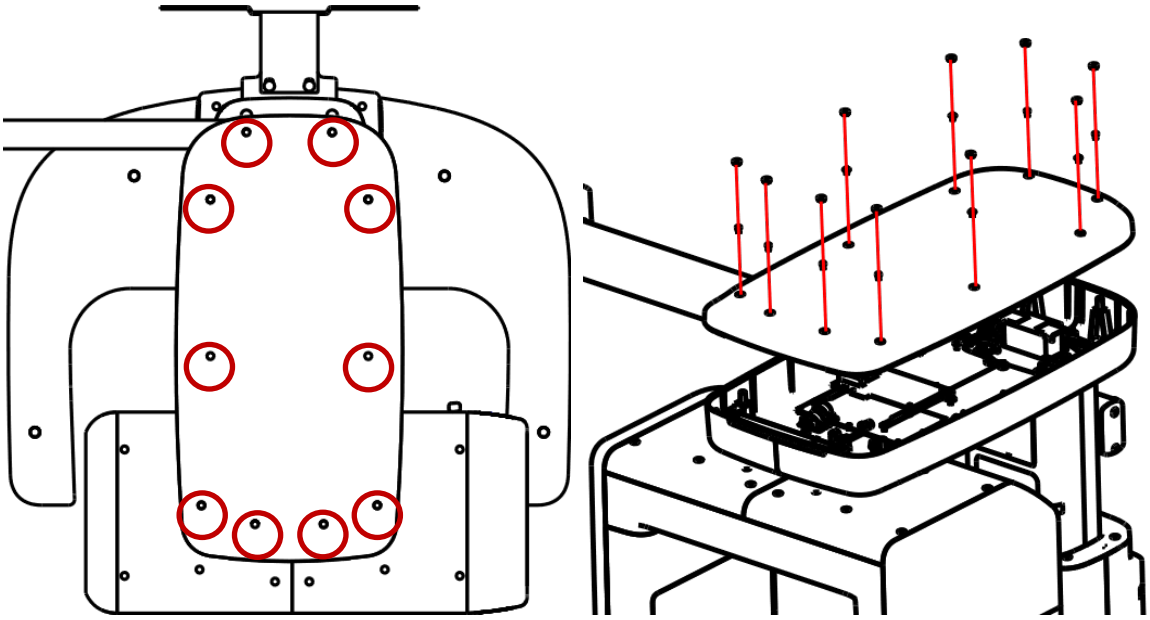
4. Disassembly of vatech A9(PHT-30CSS) Covers

NOTICE	• The truss head screws on the cases of equipment are covered with rubber caps. Remove the rubber caps before unscrewing the truss head screws. • In this manual, the procedures for removing the rubber caps are omitted for convenience. • The following illustrations may look different from actual products depending on the options.

4.1. Vertical Frame Part

4.1.1. DISASSEMBLY OF THE VERTICAL UPPER COVER

1. Loosen all bolt caps and bolts on the VERTICAL UPPER COVER.



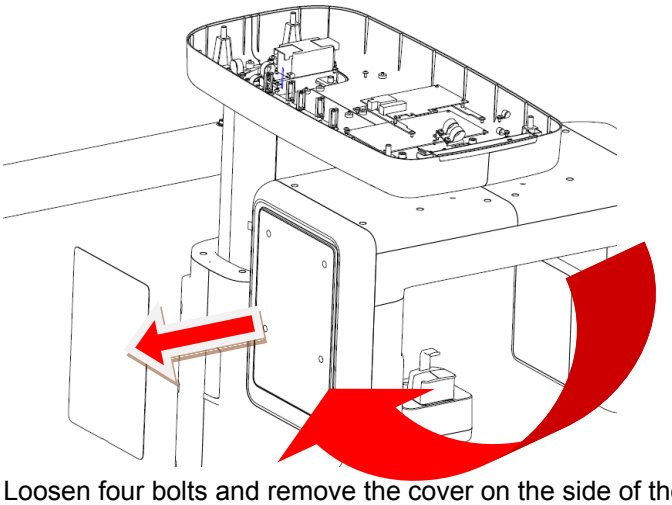
By doing this, you can access

- *Ethernet Grabber*
- *Main MCU BOARD (MCU028)*
- *Power Board*
- *Noise Filter*

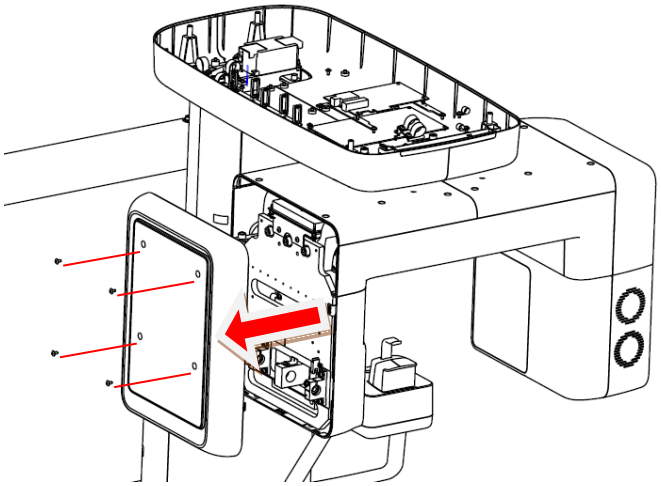
4.2. Rotating Unit Part

4.2.1. DISASSEMBLY OF THE ROTATOR COVERs

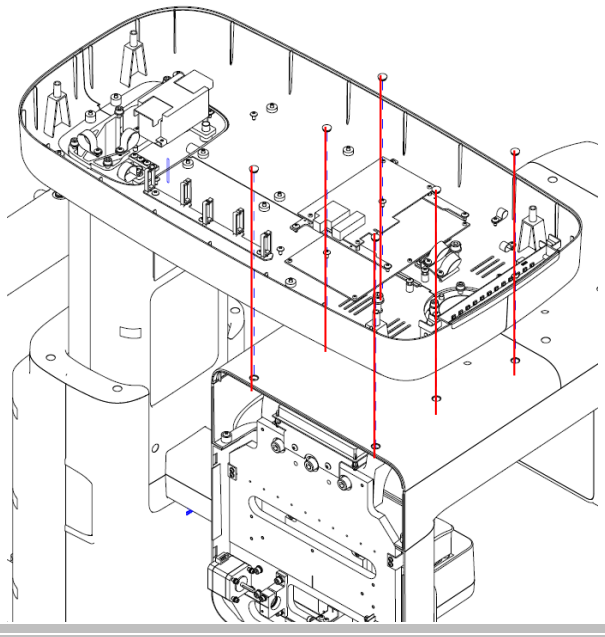
1. Rotate the rotator as shown in the image below and remove the side cover of the rotator.



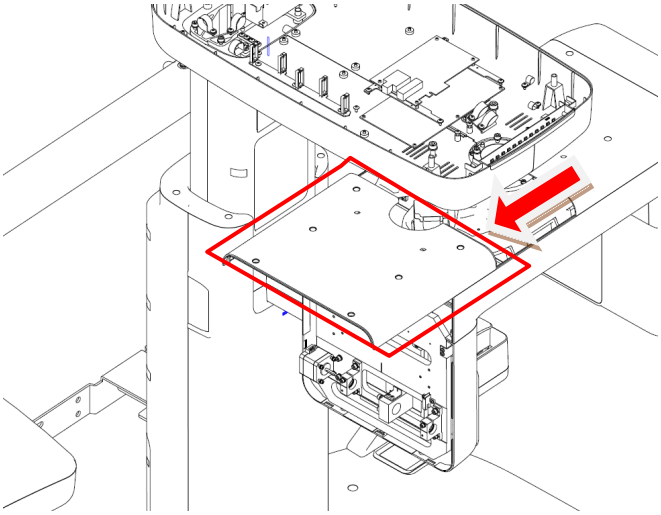
2. Loosen four bolts and remove the cover on the side of the rotator.



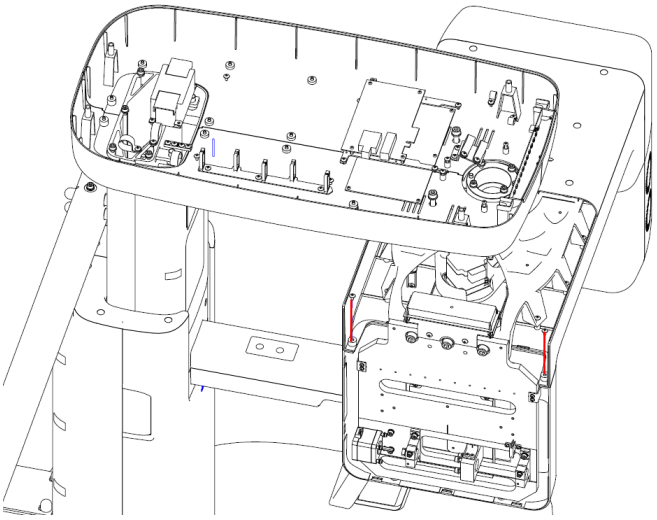
3. Remove the six bolt caps on the top of the rotator and loosen the six bolts.



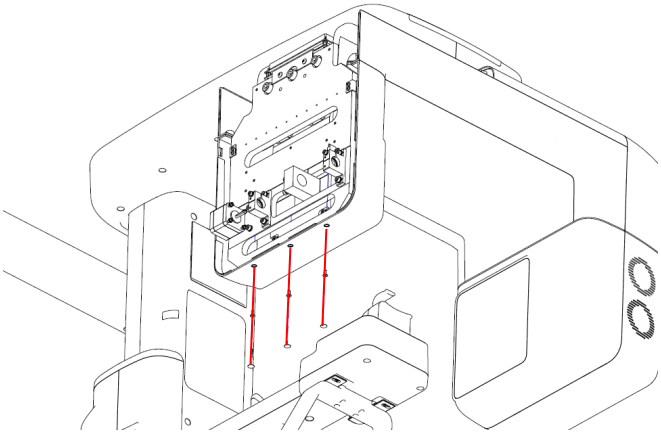
4. Remove the cover from the top of the rotator.



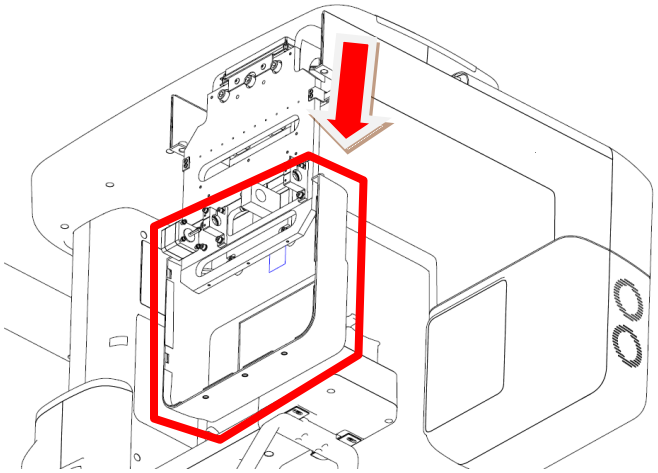
5. Loosen the two bolts as shown in the image below.



6. Remove three bolt caps and loosen three bolts as shown in the image below.



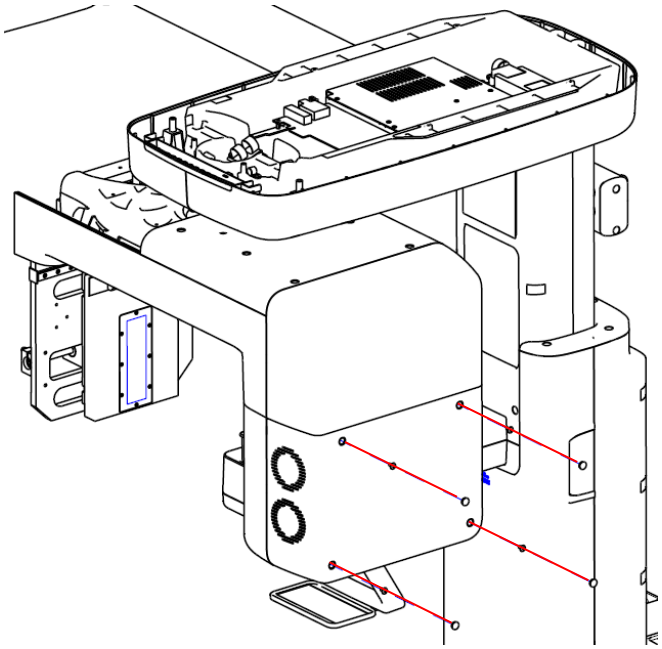
7. Remove the cover by pulling it down as shown in the image below.



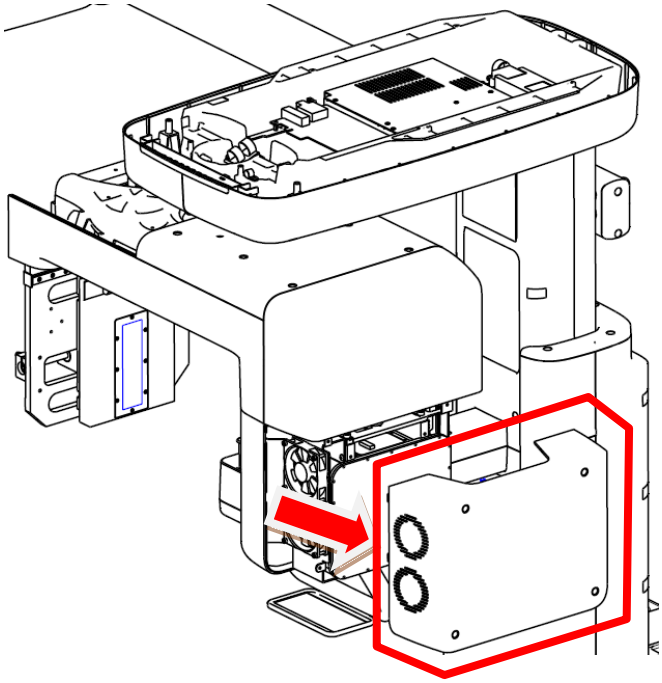
By doing this, you can access

- *Sensor*
- *Rotator motor*
- *SUB056*

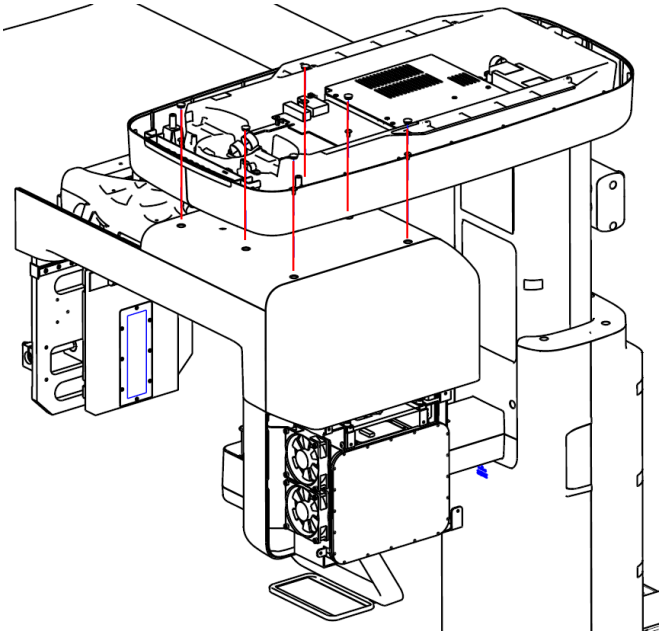
8. Remove four bolt caps and loosen four bolts as shown in the image below.



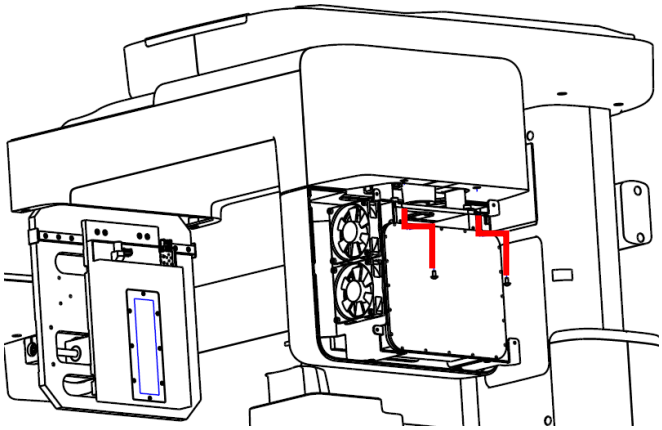
9. Remove the cover as shown in the image below.



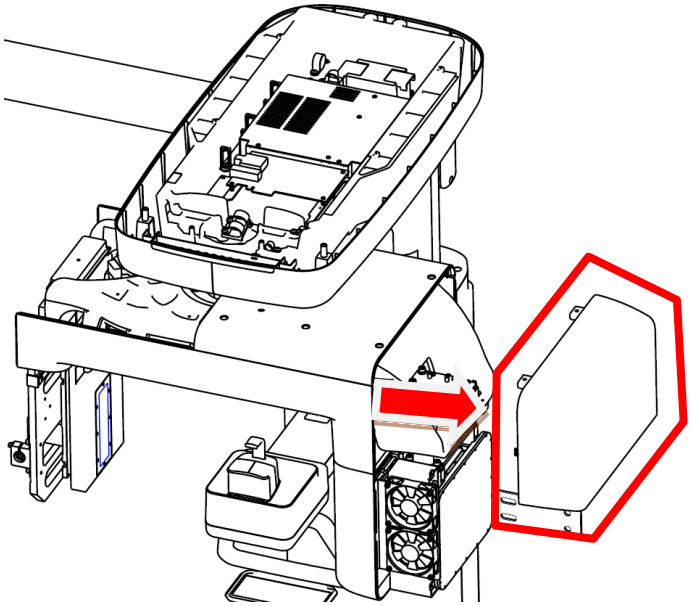
10. Remove the six bolt caps on the top of the rotator and loosen the six bolts.



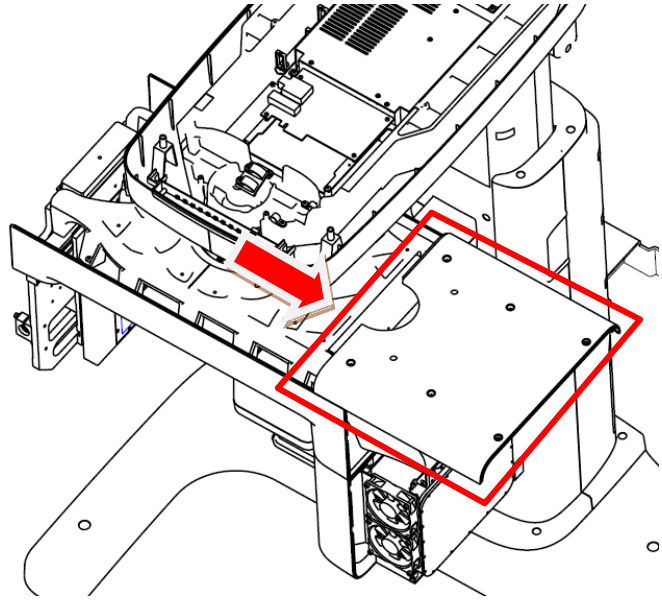
11. Loosen two bolts as shown in the image below.



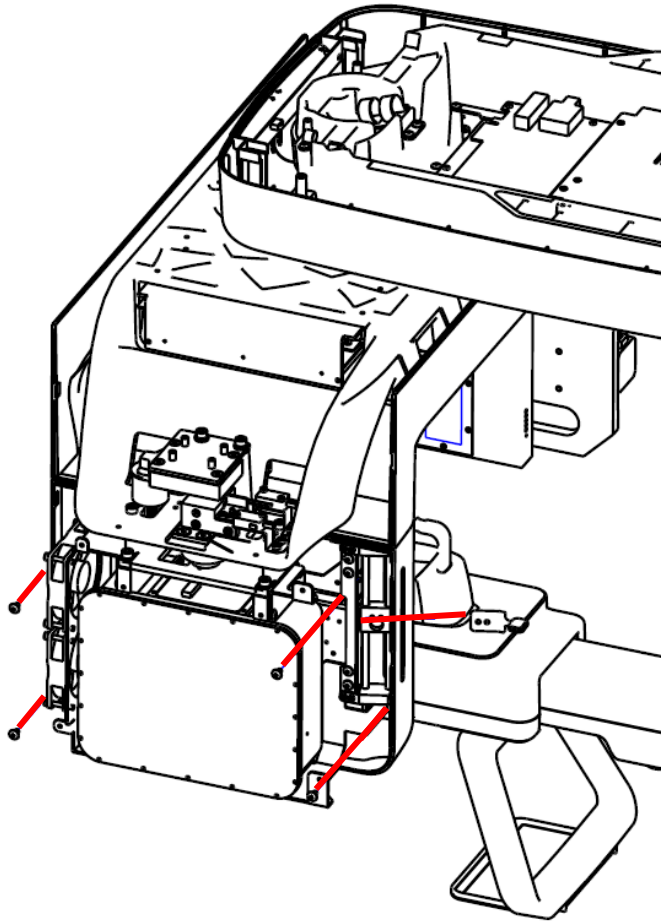
12. Remove the cover as shown in the image below.



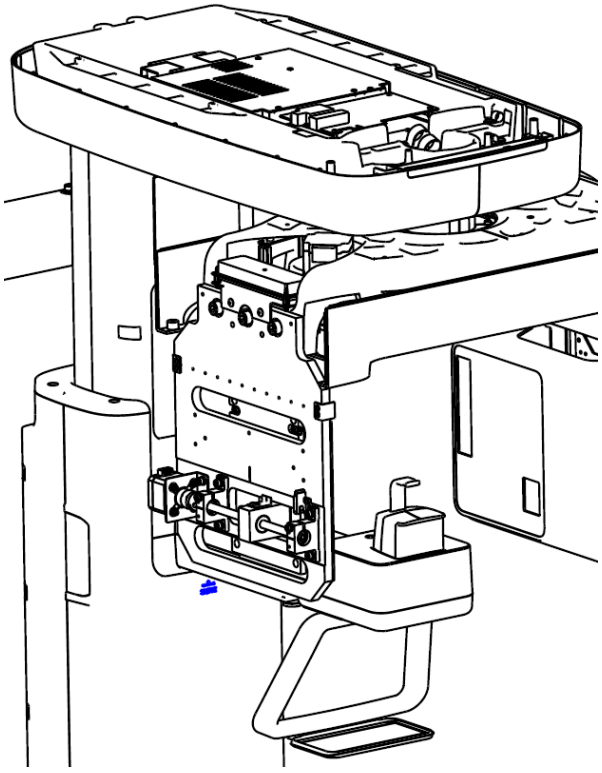
13. Remove the cover as shown in the image below.



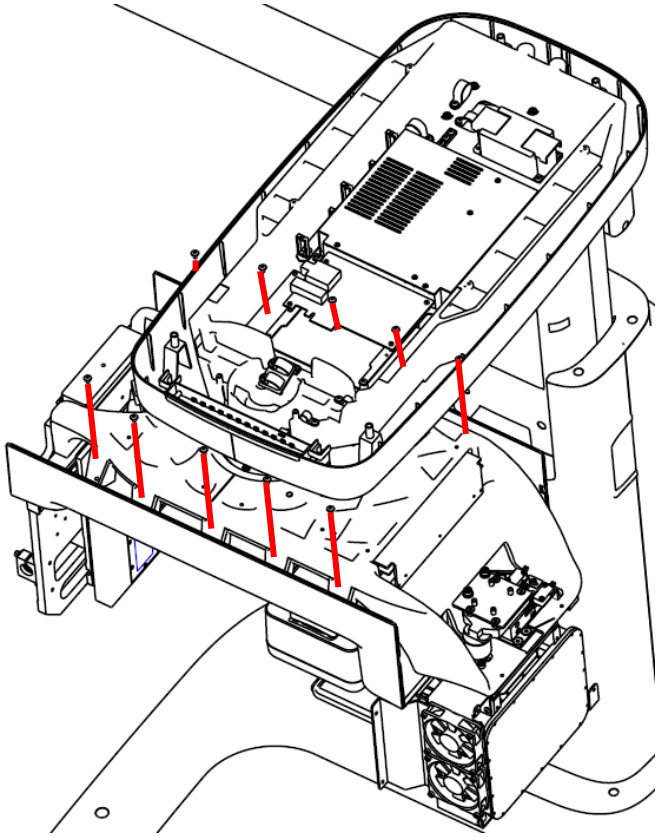
14. Loosen six bolts as shown in the image below.



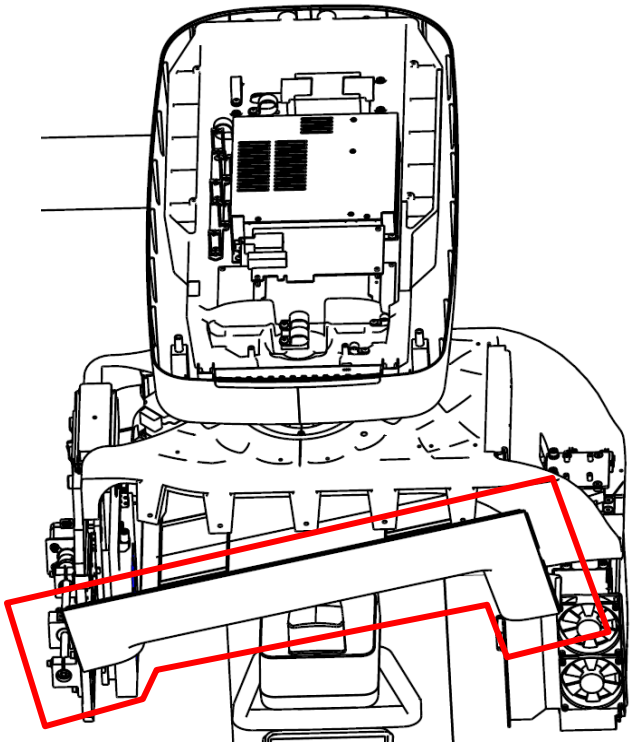
15. Refer to the image below for the appearance after removing the bolt and removing the generator.



16. Loosen ten bolts as shown in the image below.



17. Remove the cover as shown in the image below.



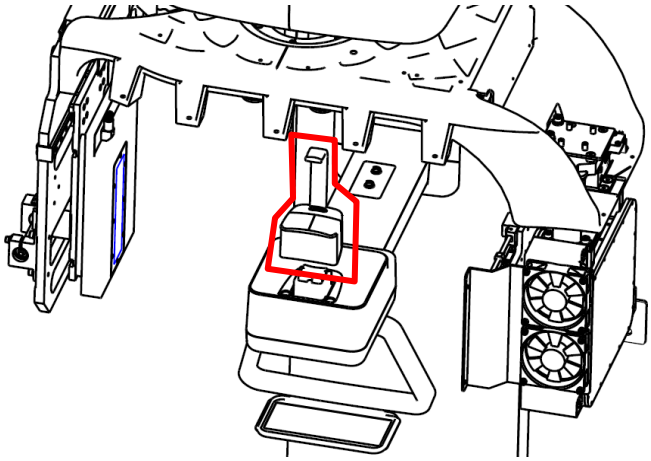
By doing this, you can access

- *Inverter*
- *Generator*
- *SUB056*

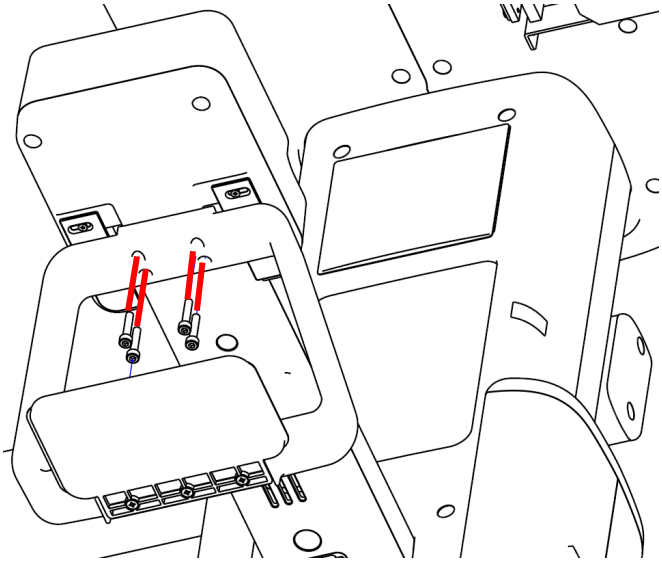
4.3. Handle Frame Unit Part

4.3.1. DISASSEMBLY OF THE HANDLE FRAME COVERS

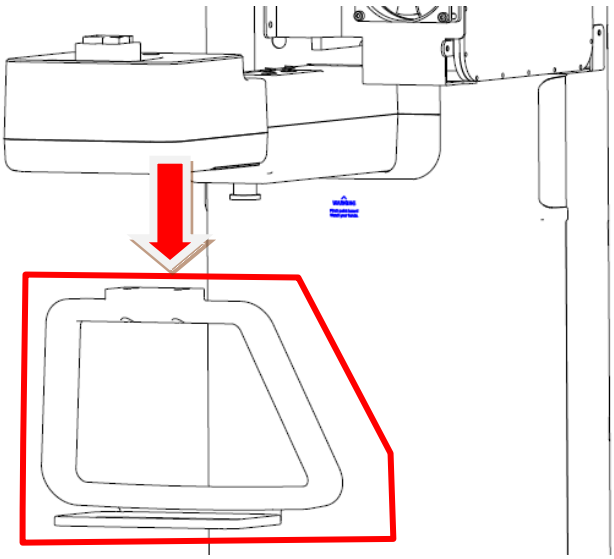
1. Remove the Chinrest as shown in the image below.



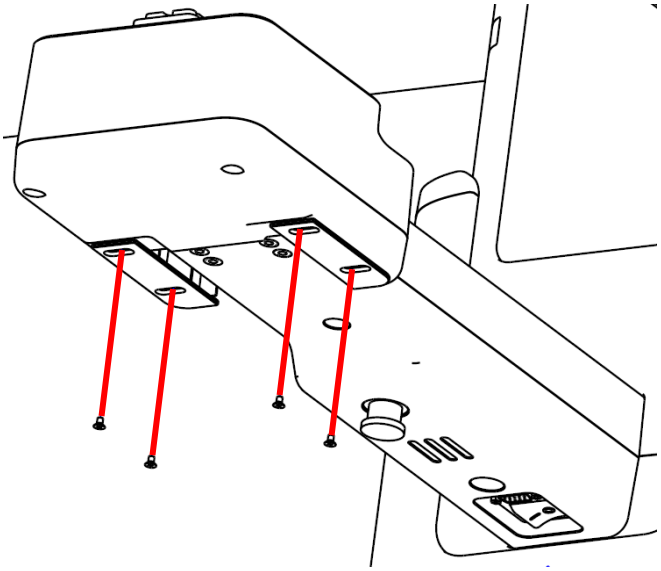
2. Loosen the four bolts as shown in the image below.



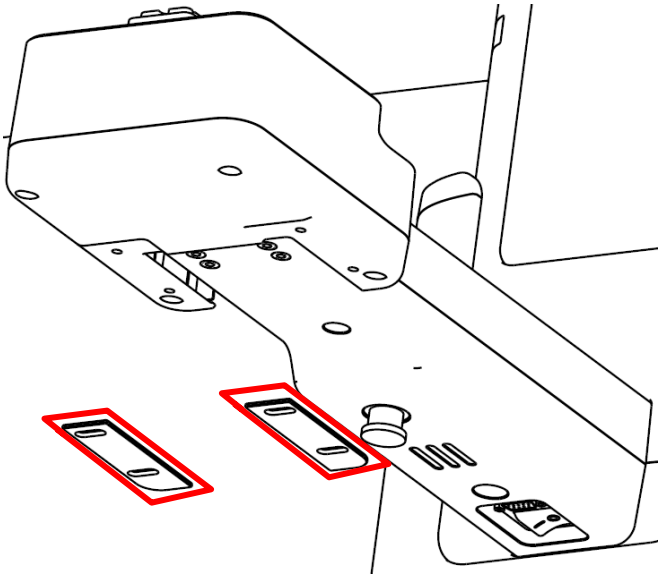
3. Remove the handle as shown in the image below.



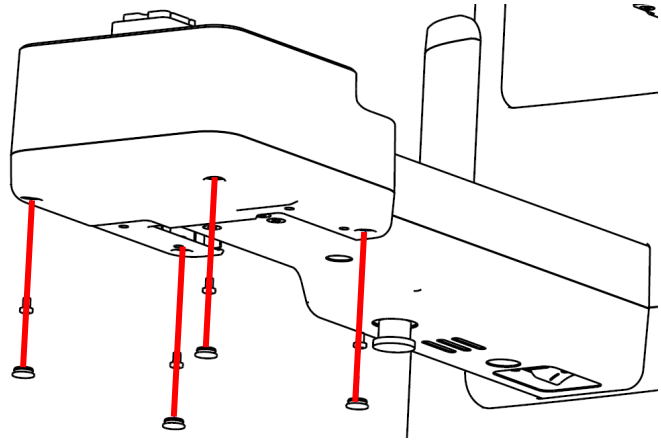
4. Loosen the four bolts as shown in the image below.



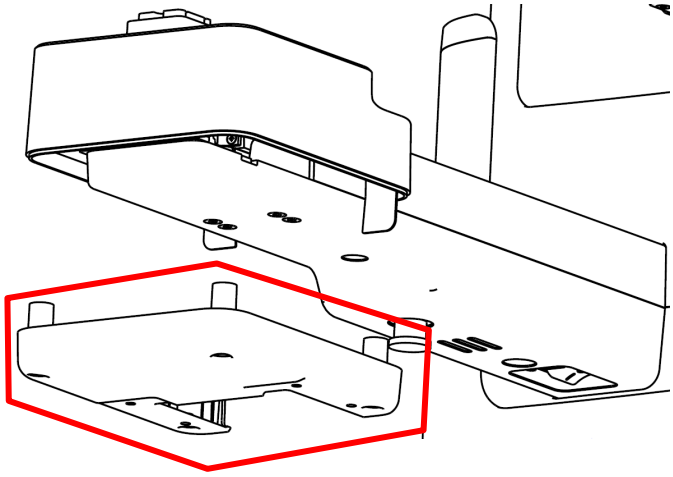
5. Remove the parts as shown in the image below.



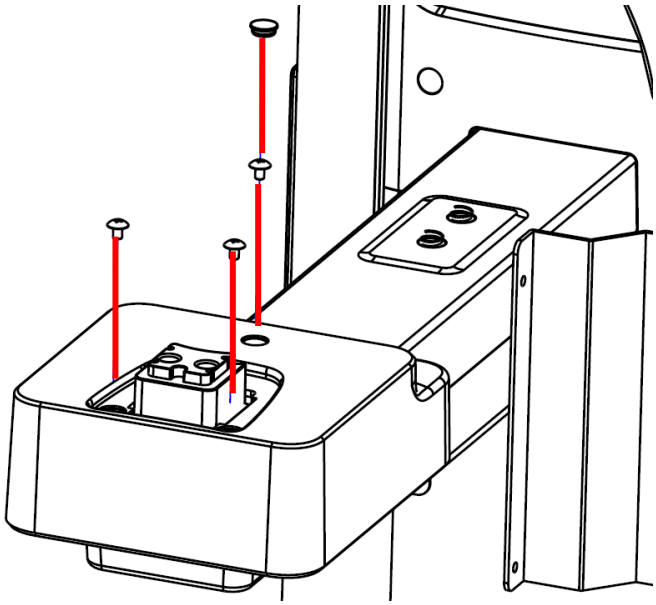
6. Remove four bolt caps and loosen four bolts as shown in the image below.



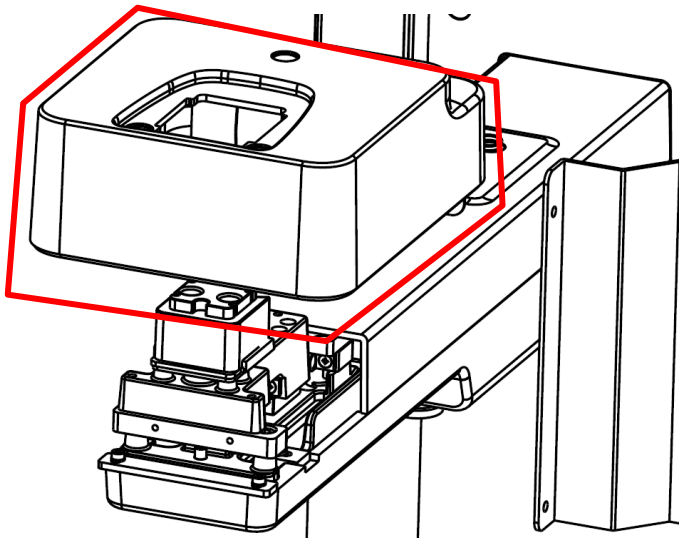
7. Remove the cover as shown in the image below.



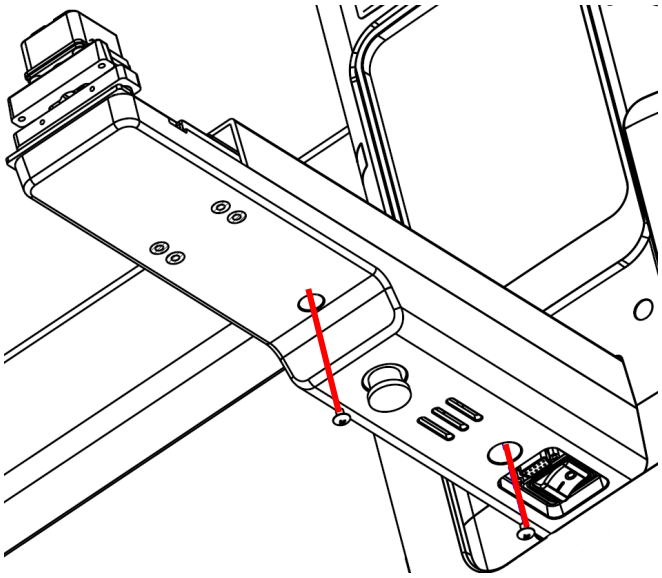
8. Remove the bolt cap and loosen three bolts as shown in the image below.



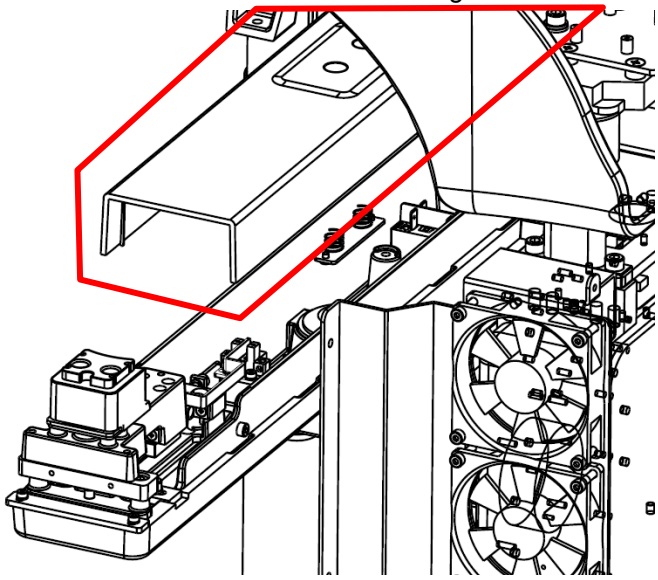
9. Remove the part as shown in the image below.



10. Loosen the two bolts as shown in the image below.



11. Remove the cover as shown in the image below.

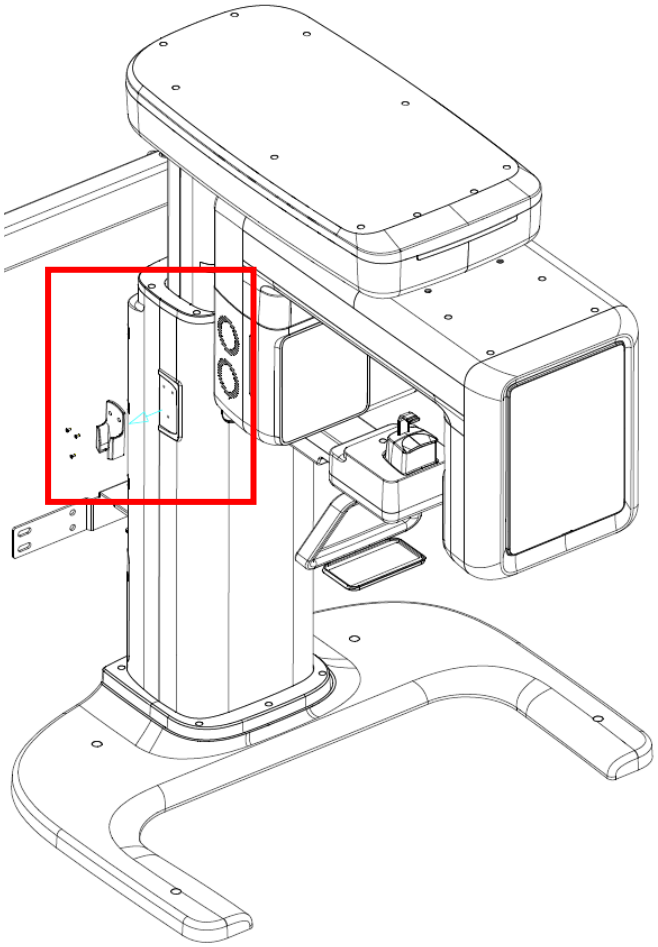


By doing this, you can access

- Circuit Breaker (UP/DOWN switch)
- *Speaker*
- *Emergency Switch*
- *ORG Sensor*
- *Touch Keypad*

4.3.2. DISASSEMBLY OF THE OTHERS

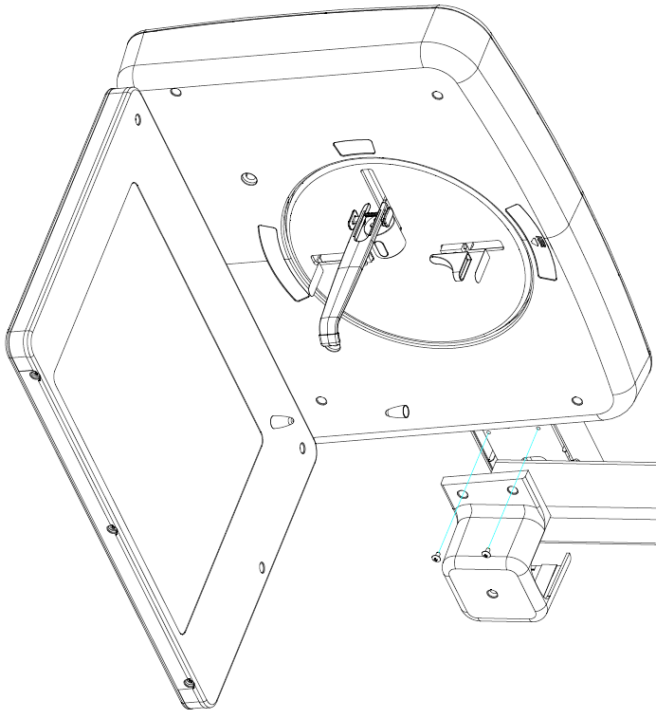
1. Remove the switch holder by loosening three bolts as shown in the image below.



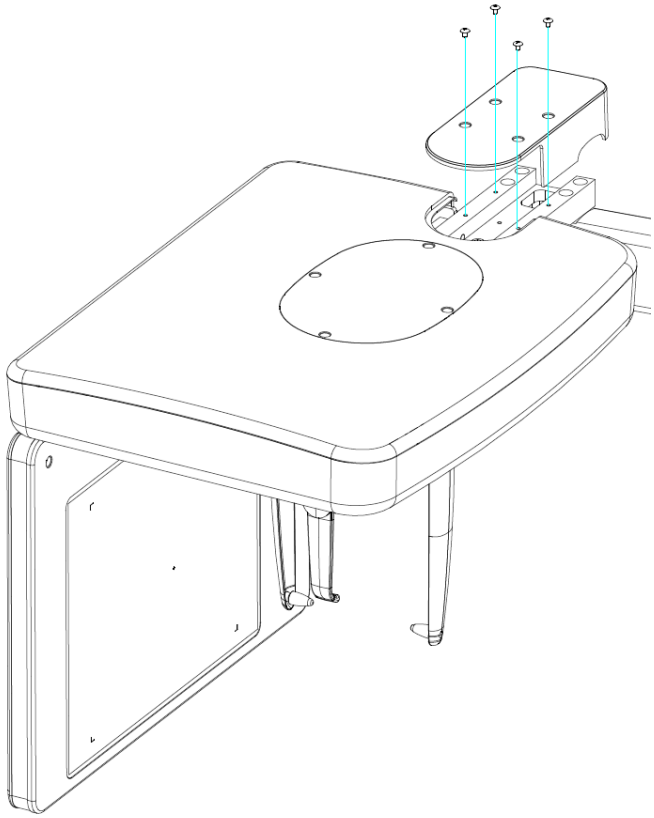
4.4. CEPH Unit Part

4.4.1. DISASSEMBLY OF THE CEPH COVERs

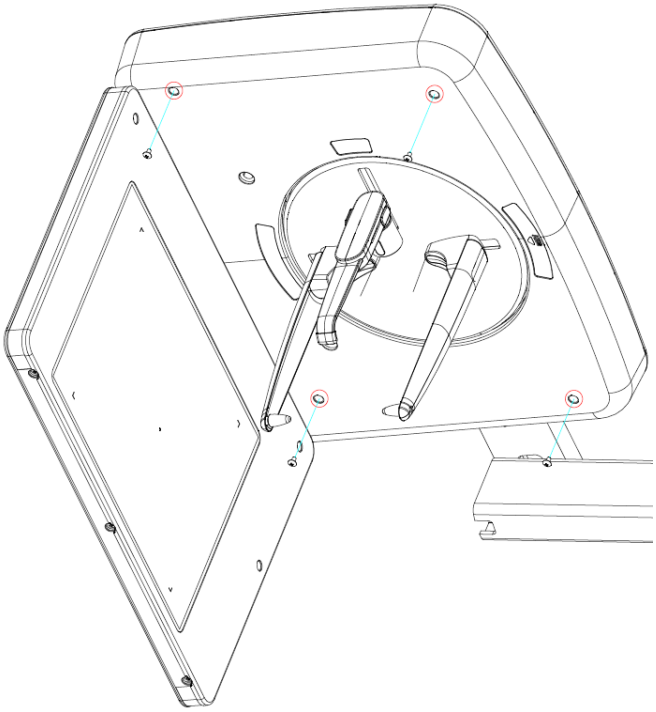
1. Loosen the two bolts as shown in the image below.



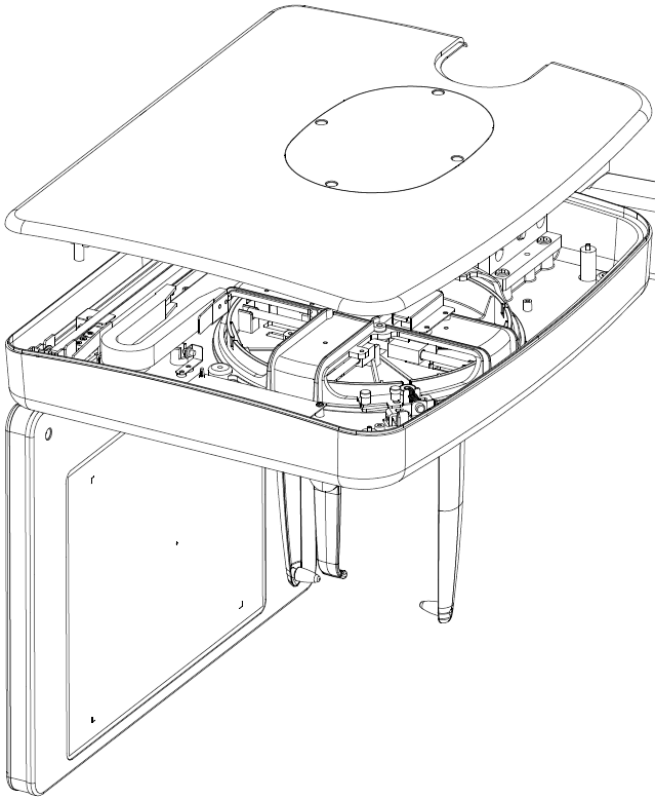
2. Loosen the four bolts as shown in the image below.



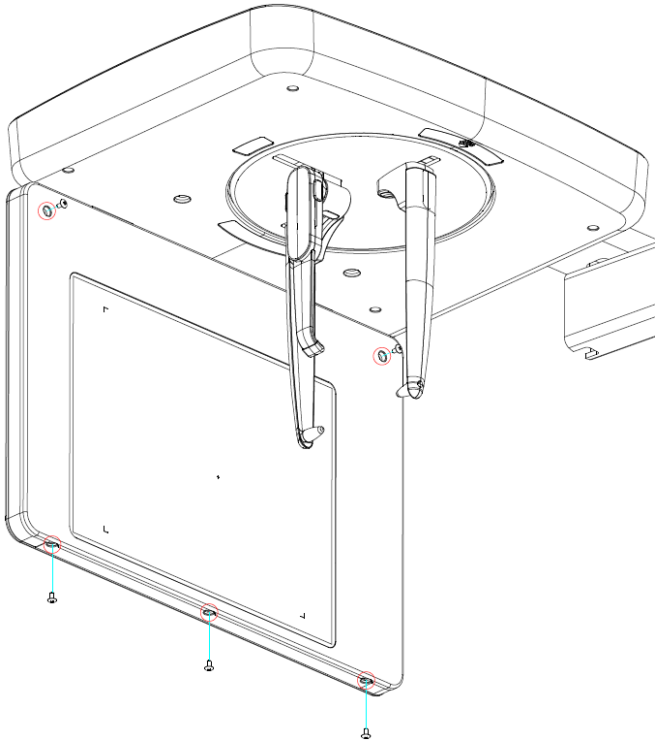
3. Loosen the four bolts as shown in the image below.



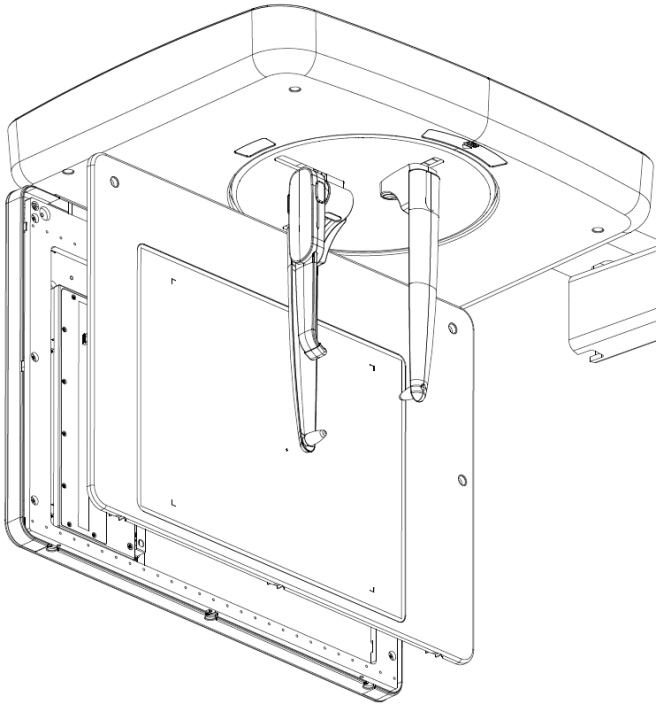
4. Remove the cover as shown in the image below.



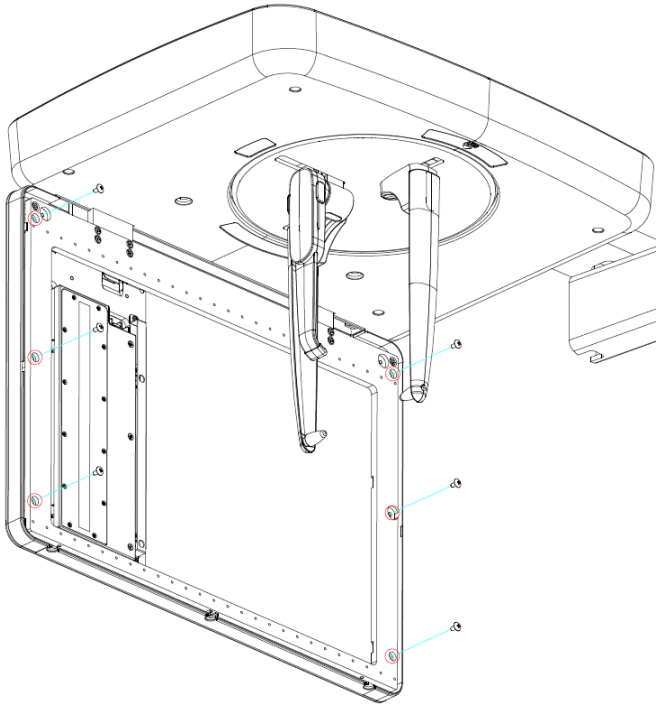
5. Loosen the five bolts as shown in the image below.



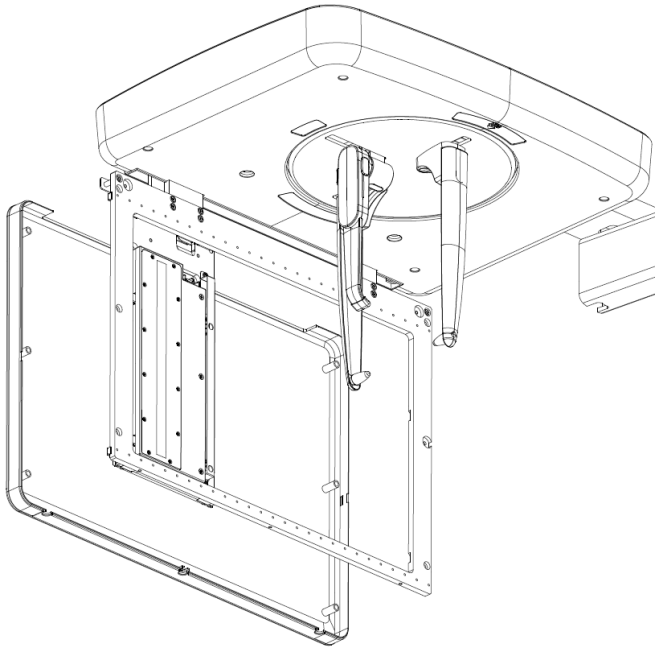
6. Remove the cover as shown in the image below.



7. Loosen the six bolts as shown in the image below.

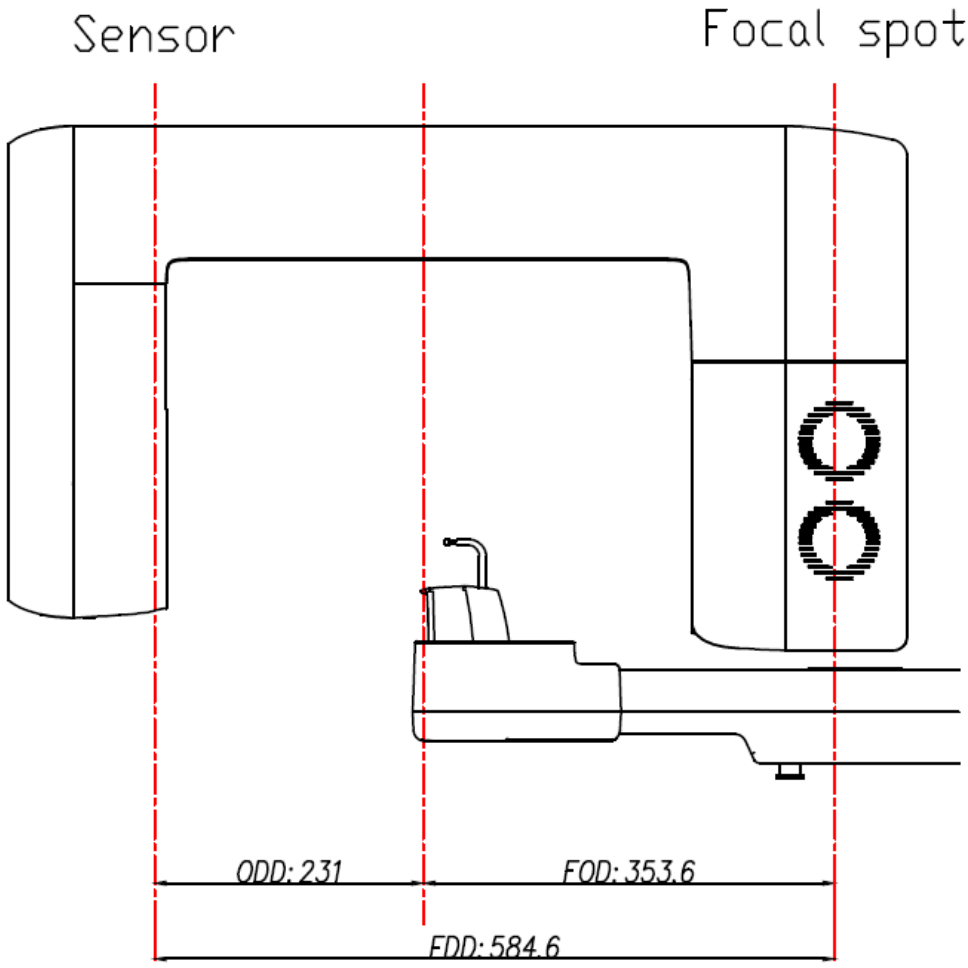


8. Remove the cover as shown in the image below.



Chapter 2. CT Image Optimization

1. Geometry information



<CT>

- FDD: Distance from the X-ray source to the sensor (584.6 mm)
- FOD: Distance from the X-ray source to the center of rotation (353.6 mm)
- vatech A9 FOV: 80 x 80

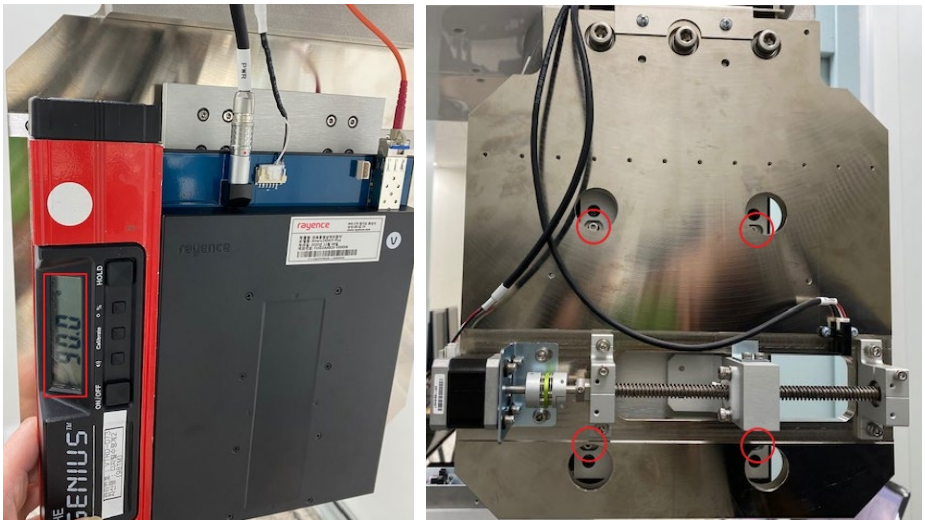
2. Equipment default values

2.1. Check the equipment horizontal level

1. Check the equipment level at the same position as the picture above (standard: ± 0.1° or less).
2. At the position where the sensor is looking at the column, visually check whether the vertical and the part marked by the red dotted line of the rotator are parallel.
3. If it is not parallel, send the [SPM_ ACHF_XXXX] command to set the CT Mode Half Value to make it parallel, and input the same value to PANO Mode Half Value [SPM_HFST_XXXX] command.

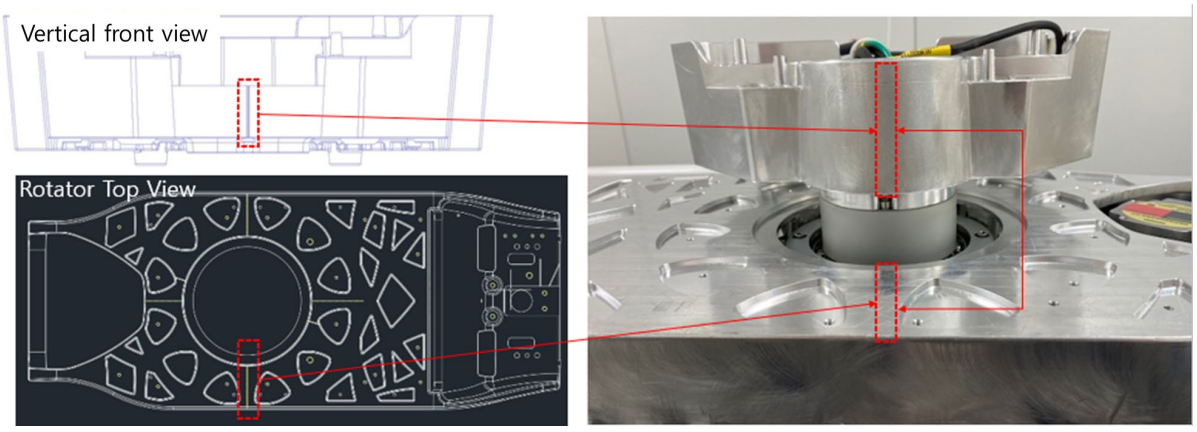
NOTICE	• As the value increases, the sensor moves to the right.

2.2. Check the sensor horizontal level



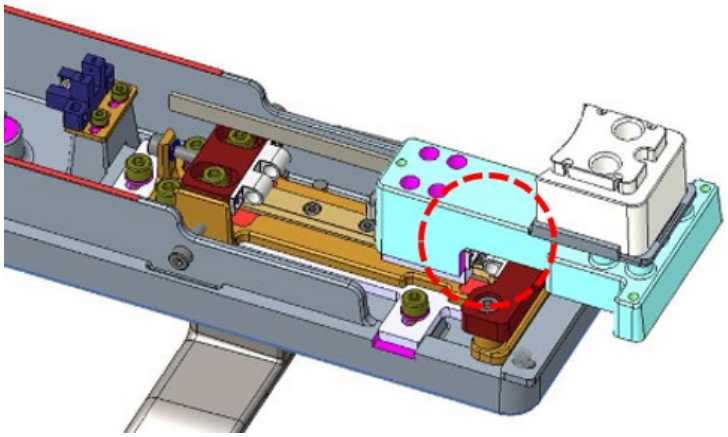
1. Place the digital level at the position as shown in the picture above, and check the horizontal level. (Standard: ± 0.1° or less)
2. If the sensor level does not meet the standard, loosen the 4 point bolts in the red circle, adjust it to meet the standard, and then refasten it.

2.3. Equipment Start Position Setting



1. As shown in the image above, set the Half value to [SPM_ACHF_XXXX] so that the guide line of the rotator and the vertical are aligned in a straight line.
2. Send the same values for CT half value [SPM_ACHF_XXXX] in the PANO half [SPM_HFST_XXXX] and the CEPH half [SPM_CPHF_XXXX].

2.4. Bite location (CT mode)



1. Move the bite position according to the Modality as shown in the image above.

   CT Mode: The position combined with the stopper in the opposite direction (right side) of the column

3. CT Sensor Calibration

To optimize CT image quality in the equipment, the operator should perform the Sensor Calibration operation according to the following procedures.

Regular Sensor Calibration check-up is recommended to perform for image optimization against temperature and humidity variation.

3.1. CT Sensor Calibration Standard

- **CT Sensor Dark Calibration Standard Value**

  As a dark acquisition step, check the operation of the sensor and the dark level through the acquired dark.

	Min	Max
Median value	700	2300

- **CT Sensor Bright Calibration Standard Value**

※ Using filter by each calibration point

Acquisition conditions		Half Scan	
		4 point	2 point
Filter	1 axis filter	Al	Al
	Additional filter(Cu 1 mm)	O	X

The standard of the level value for each bright calibration point is as follows.

※ Bright standard value: 4 points with Cu 1 mm filter

Bright		Min	Max
Median value	Cal Point 1	80	120
	Cal Point 2	150	700
	Cal Point 3	800	1800
	Cal Point 4	2000	2500

※ Bright standard value: Additional 2 points

Bright		Min	Max
Median value	Cal Point 1	4500	5500
	Cal Point 2	9500	10500

NOTICE	• From the achieved CT Sensor Bright Calibration data file, the 1,2 Point Bright data and the 1,4 Point Bright data file should meet the standard value. Other results from different points Bright Datafile can be varied by characteristics of each sensor.

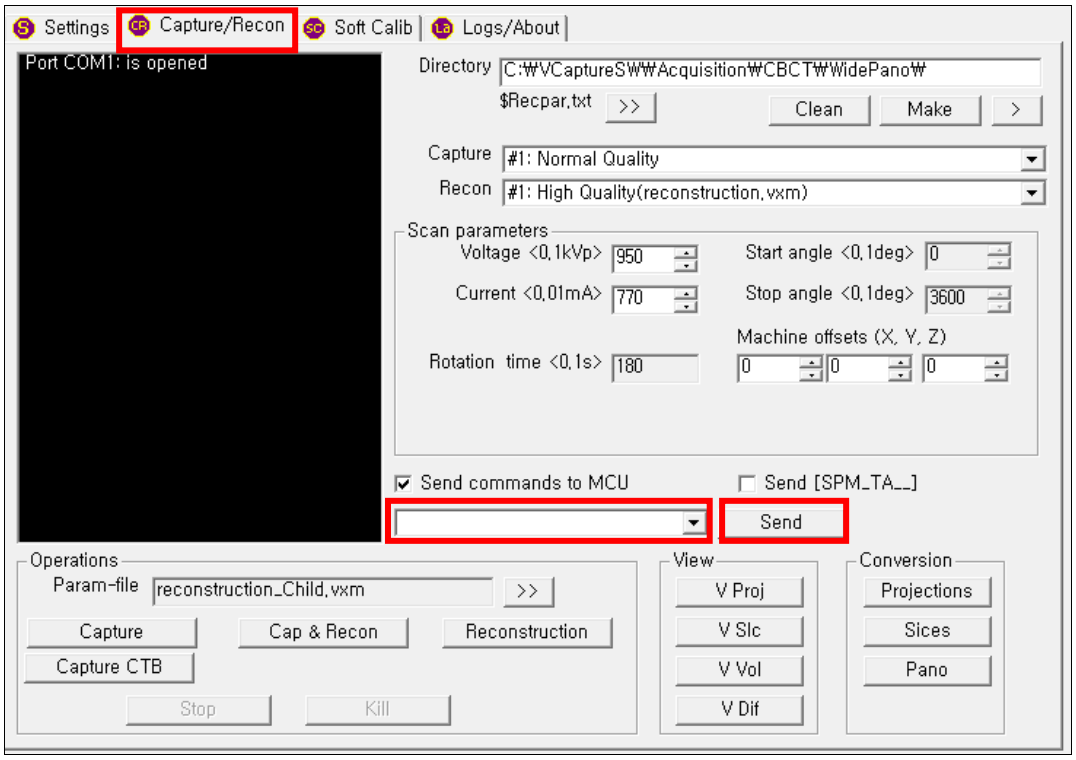
3.2. Before CT sensor calibration

1. Remove the Normal Chin Block from the unit.
2. Disassemble the Tube cases (Refer to **Chapter 1. Hardware Part Service Guide**).
3. Rename the CAL folder (*C:\VCaptureSW\Acquisition\CBCT\WidePANO\CAL*) name for backup.

3.3. CT sensor setting

NOTICE	• VAKCAP.exe file is required for CT Sensor Calibration operation. Path : C:\VCaptureSW\Acquisition\CBCT\WidePANO\CAL folder
IMPORTANT	• Before the CT Sensor Calibration operation, the operator must back up the prior CT Sensor Calibration folder. • CT Sensor Calibration file folder: C:\VCaptureSW\Acquisition\CBCT\WidePANO\CAL

1. Go to **C:\VCaptureSW\Acquisition\CBCT\WidePANO** folder.
2. Run **VAKCAP.exe** file.
3. Click the **Capture/Recon** tab and send the following commands in the command field.



CT pixel size : 184 x 686

Command	Function
[SPM_ARCT]	CT mode
[SPM_CSON]	CT sensor power on
[SPM_FISS_0001]	Normal Mode : 4x4 binning & High gain
[SPM_FIPM_0001]	Sensor size setting
[SPM_FISM_0001]	Sensor clock (1:External, 0: Internal)
[SPM_FREQ_0100]	Sensor frequency 100 Hz
[SPM_COLM_0004]	AL filter position (2 Point) If Al Filter is not completely covered, adjust with [SPM_CEST_XXXX]
[SPM_COLM_0010]	1T Cu + AL filter location (4 Point) If 1T Cu + Al Filter is not all covered, send [SPM_CBST_XXXX] to adjust.
[SPM_AAMS]	Uoffset driven
[SPM_ABMS]	FOV 8x8 driven

3.4. CT sensor: Dark calibration

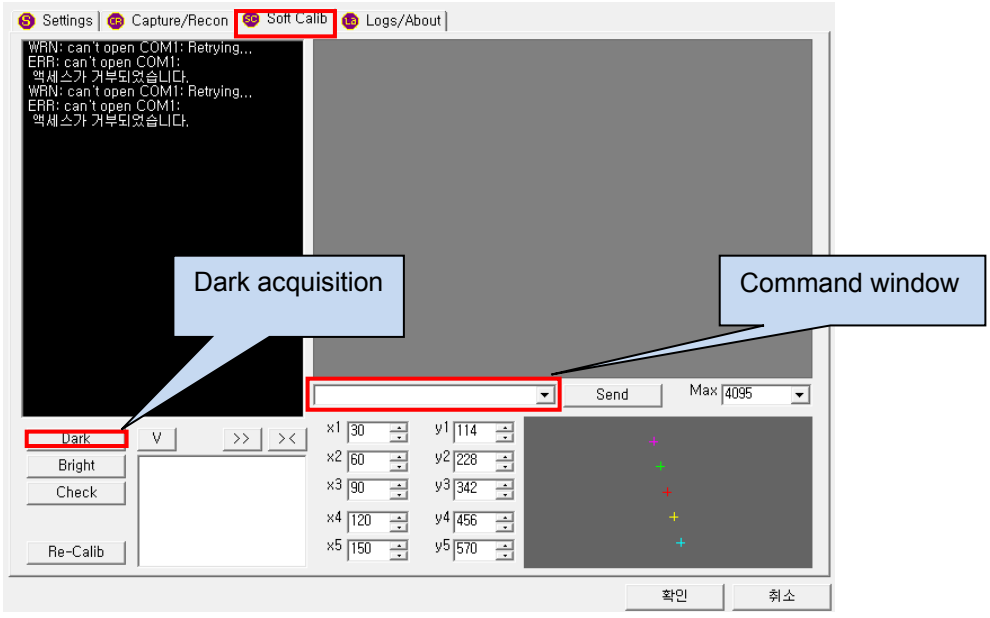
- As a dark acquisition step, check the operation of the sensor and the dark level through the acquired dark.

※ Dark standard value

	Min	Max
Median value	700	2300

1. Run the C:\VCaptureSW\Acquisition\CBCT\WidePANO\VACAP.exe file.
2. Send [SPM_ARCT], [SPM_CSON], [SPM_FIPM_0001], [SPM_FISS_0001], [SPM_FISM_0001], [SPM_COLM_00010] commands to the command window to set the CT sensor and collimator.

Command	Function
[SPM_ARCT]	CT mode
[SPM_CSON]	CT sensor power on
[SPM_FISS_0001]	Normal Mode : 4x4 binning & High gain
[SPM_FIPM_0001]	Sensor size setting
[SPM_FISM_0001]	Sensor clock (1:External, 0: Internal)
[SPM_COLM_0010]	1T Cu + AL filter location (4 Point) If 1T Cu + Al Filter is not all covered, send the [SPM_CBST_XXXX] command to adjust.



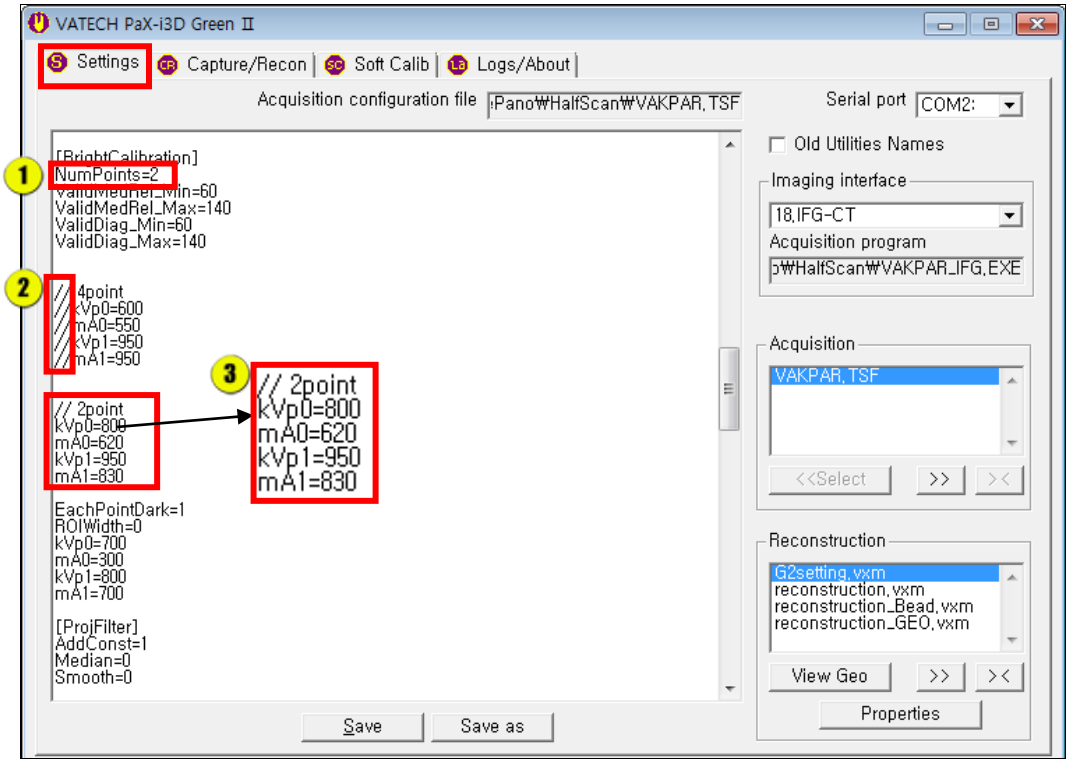
3. Click the **Dark** button to acquire an image.
4. Check if it is a normal dark image through the maximum and minimum standard of the median value.
5. Check if it satisfies the Dark standard value, and if not, replace the sensor because it is defective.

3.5. CT sensor: Bright calibration

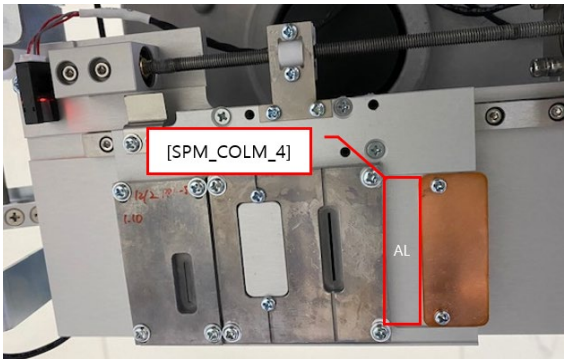
	• Stay outside of the X-ray shielding room during Bright Calibration data achievement.

3.5.1. Bright calibration: 2 points

1. Run the C:\VCaptureSW\Acquisition\CBCT\WidePANO\VACAP.exe file.
2. In the **Settings** tab and make sure that the parameters under [BrightCalibration] are as shown below and click the **Save** button if something is changed.



3. When acquiring 2 points bright calibration, the initial value is as follows and it is set according to the standard by adjusting kVp.

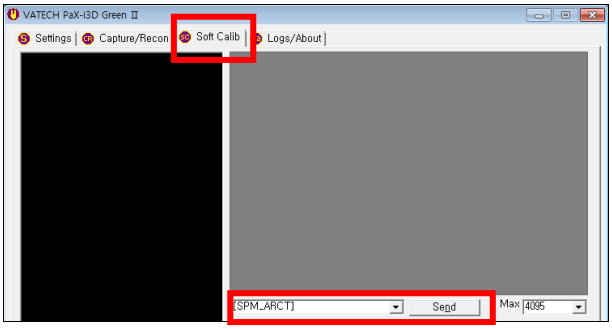


Acquisition conditions		Half Scan	
		4 point	2 point
exposure condition	kVp0	580	710
	mA0	530	700
	kVp1	920	830
	mA1	950	900

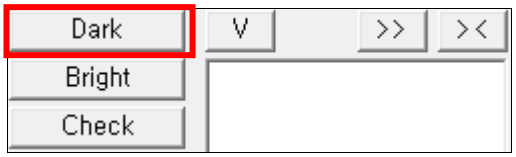
4. Click the **Soft Calib** tab.

5. Send [SPM_ARCT], [SPM_CSON], [SPM_FIPM_0001], [SPM_FISS_0001], [SPM_FISM_0001], [SPM_COLM_0004] commands to the command window to set the CT sensor and collimator.

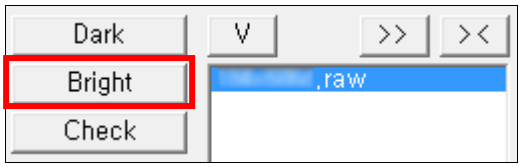
Command	Function
[SPM_ARCT]	CT mode
[SPM_CSON]	CT sensor power on
[SPM_FISS_0001]	Normal Mode : 4x4 binning & High gain
[SPM_FIPM_0001]	Sensor size setting
[SPM_FISM_0001]	Sensor clock (1:External, 0: Internal)
[SPM_COLM_0004]	AL filter position (2 Point) If Al Filter is not completely covered, adjust with [SPM_CEST_XXXX] command



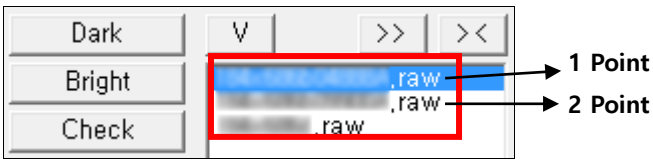
6. Click the **Dark** button to acquire Dark Calibration Data.



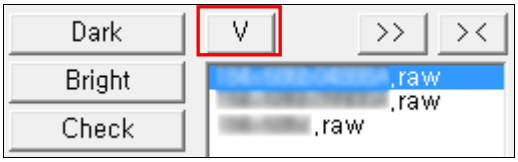
7. Click the **Bright** button.



8. When the **HOLD THE BUTTON FOR ~3 SEC** message shows up on the status window, press the X-ray Exposure switch. Then release the button when **RELEASE THE BUTTON** shows up.
9. Do step 8 two times and 2 points of bright calibration data are acquired.



10. Click the **V** button to open View16.



11. Click each point Bright Calibration data file on View16 and make sure that the Median value meets the standard
12. If the standard is not satisfied, set them according to the standard by adjusting kVp0 and kVp1.

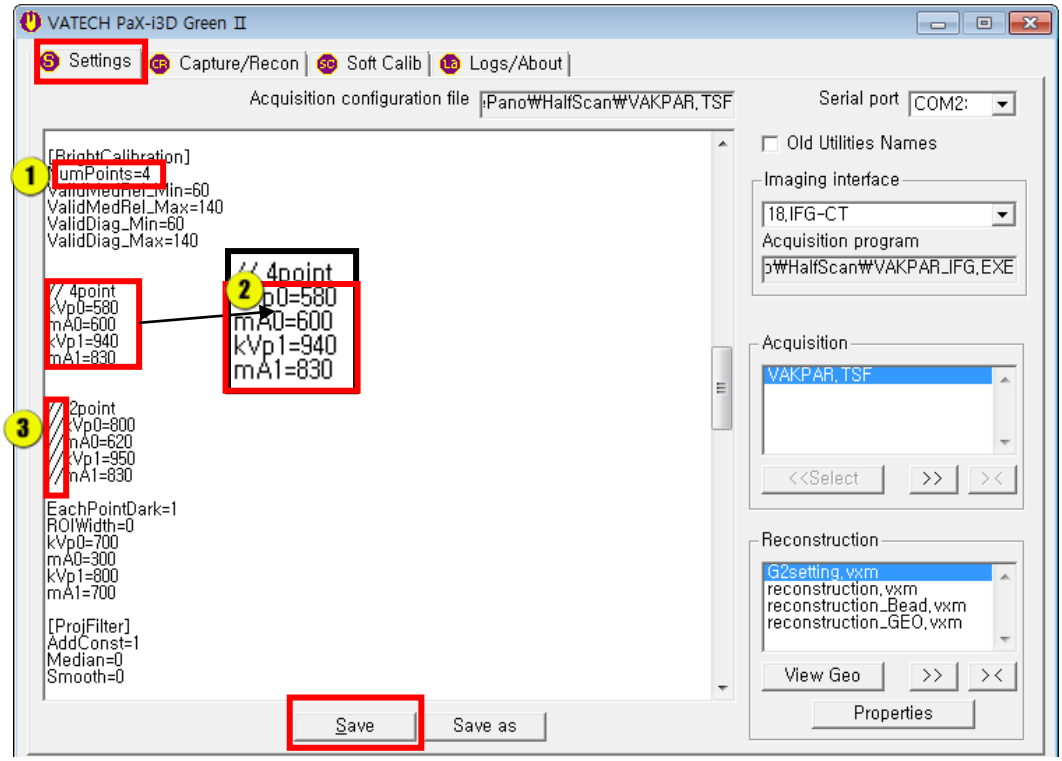
※ Bright standard value: Additional 2 points

Bright		Min	Max
Median value	Cal Point 1	4500	5500
	Cal Point 2	9500	10500

13. Bright cal data is saved in the C:\VCaptureSW\Acquisition\CBCT\WidePANO\CAL folder.
14. Create a new folder in the CAL folder and change the folder name to OPEN.
15. Copy these files to the C:\VCaptureSW\Acquisition\CBCT\WidePANO\CAL\OPEN folder.

3.5.2. Bright calibration: 4 points

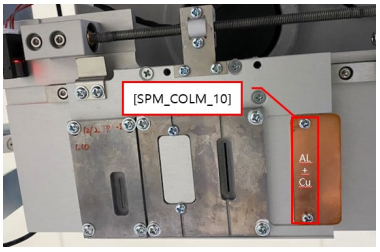
1. Run the C:\VCaptureSW\Acquisition\CBCT\WidePANO\VACAP.exe file.
2. Click the **Settings** tab and make sure that the parameters under [BrightCalibration] are as shown below and click the **Save** button if something is changed.



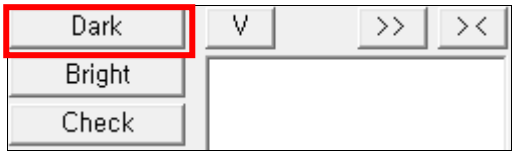
3. Click the **Soft Calib** tab.
4. When acquiring 4 point cal, the initial value is as follows and it is set according to the standard by adjusting kVp.

Acquisition conditions		Half Scan	
		4 point	2 point
exposure condition	kVp0	580	710
	mA0	530	700
	kVp1	920	830
	mA1	950	900

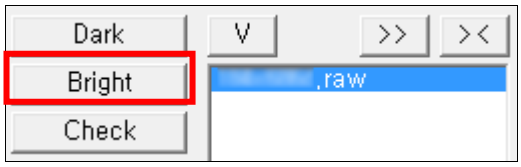
5. Send [SPM_ARCT], [SPM_CSON], [SPM_FIPM_0001], [SPM_FISS_0001], [SPM_FISM_0001], [SPM_COLM_0010] commands to the command window to set the CT sensor and collimator.



6. Click the **Dark** button to acquire Dark Calibration Data.

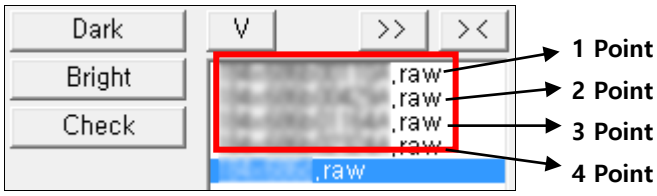


7. Click the **Bright** button.

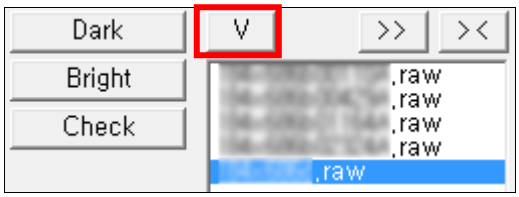


8. When **the HOLD THE BUTTON FOR ~3 SEC** message shows up on the status window, press the X-ray Exposure switch. Then release the button when the **RELEASE THE BUTTON** appears.

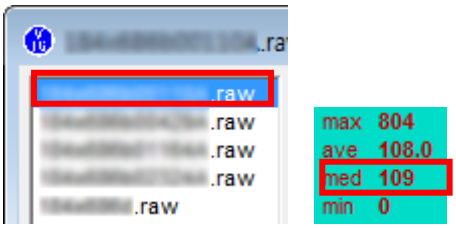
9. Do step 8) repeatedly until 4 point bright calibration data are acquired.



10. Click the **V** button to open View16.

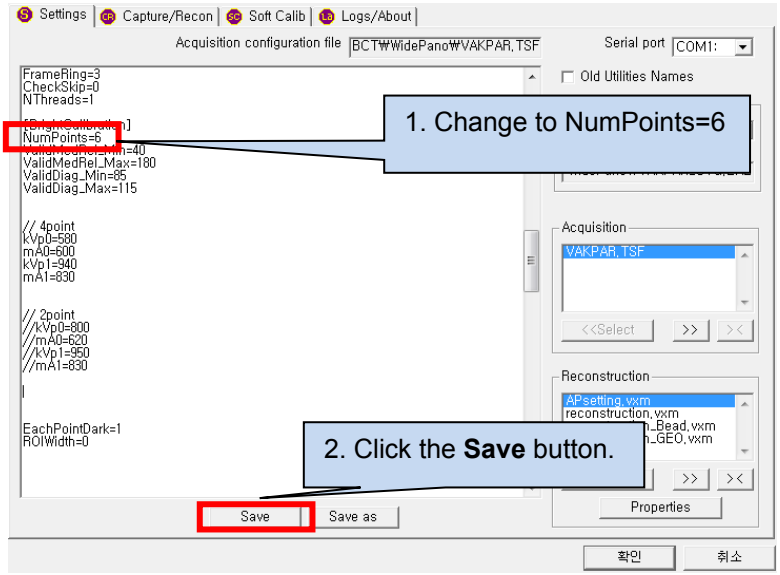


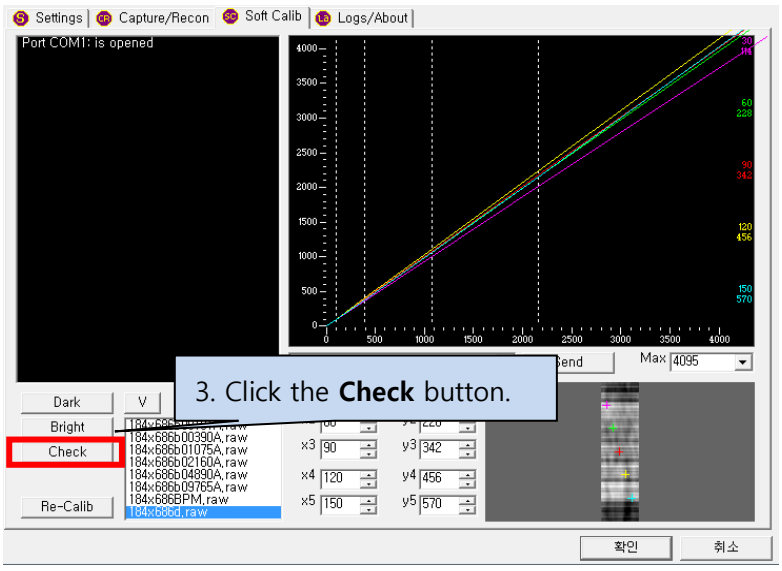
11. Click each point Bright Calibration data file on View16 and make sure that the Median value meets the standard.



12. If the standard is not satisfied, set them according to the standard by adjusting kVp0 and kVp1.

13. Copy the bright cal data files in C:\VCaptureSW\Acquisition\CBCT\WidePANO\CAL folder to the C:\VCaptureSW\Acquisition\CBCT\WidePANO\CAL\OPEN folder.
14. Copy a total of 6 files in C:\VCaptureSW\Acquisition\CBCT\WidePANO\CAL\OPEN folder to the C:\VCaptureSW\Acquisition\CBCT\WidePANO\CAL folder.
15. When the normal bright cal acquisition is completed, click the **Check** button to create an Auto bad pixel map.





3.6. CT Bad Pixel Verification

3.6.1. Bad pixel definition

- Dead pixel: no responsive pixel (value : 0 or 16384)
- Non-uniform response pixel: Pixels with ±30% response deviation from neighboring pixels

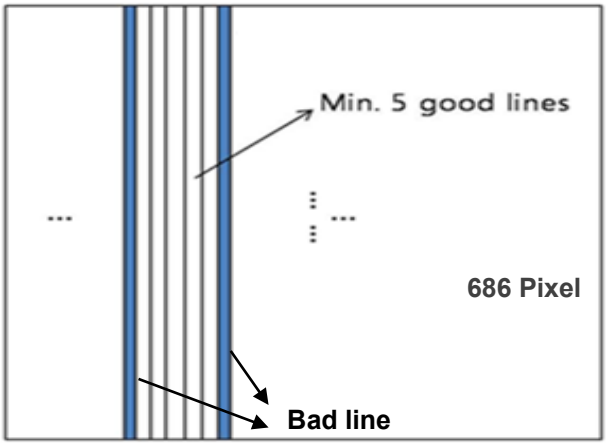
3.6.2. Bad line definition

- Bad pixels over 50% of effective area width and height are defined as bad lines

  ➔ When it is an effective area of M x N,

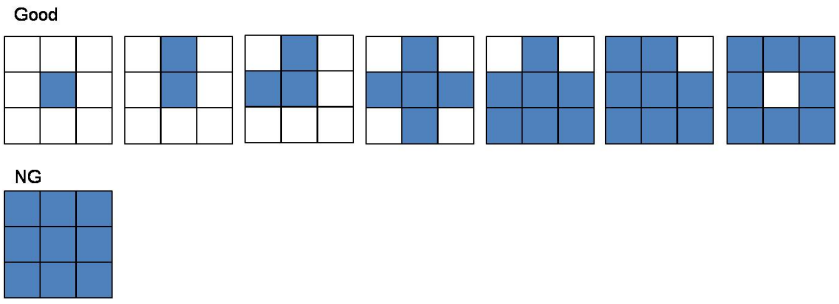
  1 x M or N x 1 or more is defined as a bad line

- Total max. 7 line
- There should be at least 5 lines of normal pixels between bad and bad lines.



3.6.3. Cluster definition

- Continuous bad pixels with 3 x 3 or more continuous . (Single bad pixel is surrounded by bad pixels in all directions (up/down/left/right/diagonal))

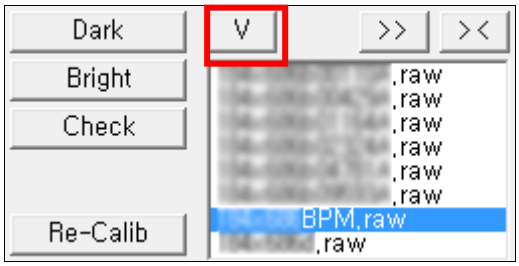


3.6.4. Bad Pixel Verification

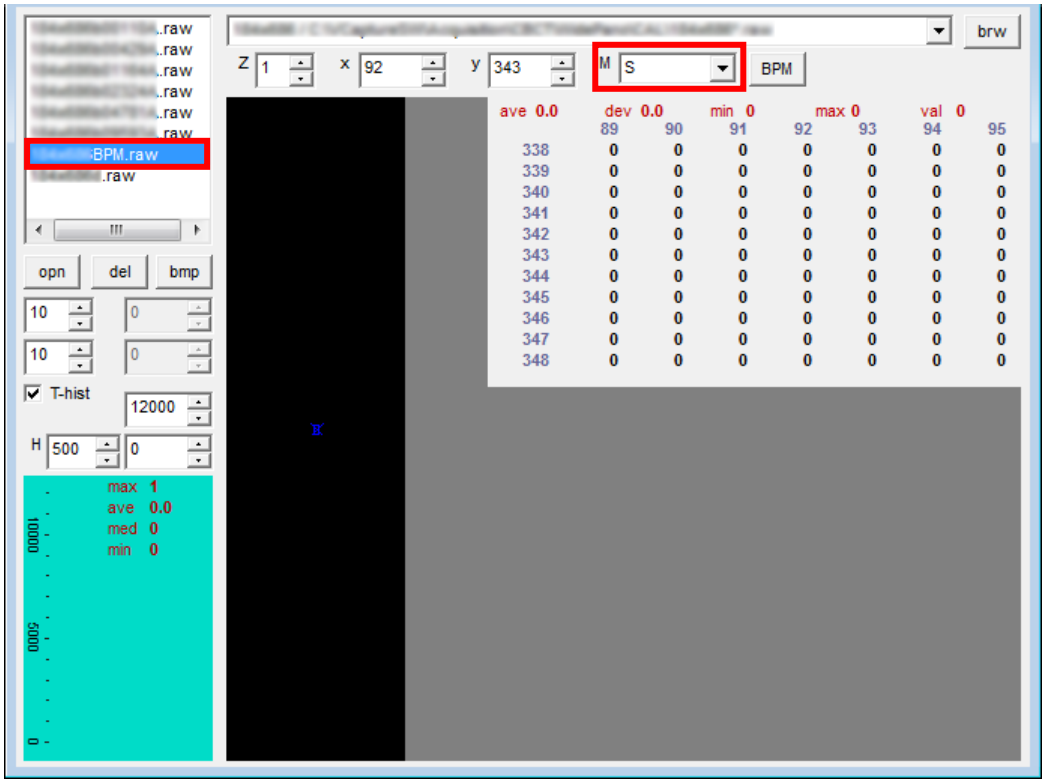
NOTICE	• If a BPM file is not created by clicking the **Check** button in the earlier section, Bad Pixel Verification is not necessary.

1. Run **VAKCAP.exe** file. > Click the **Soft Calib** tab > Click the **V** button to open the **View16** program.

NOTICE	• VAKCAP.exe file Path : **C:\VCaptureSW\Acquisition\CT\WidePANO** folder



2. Choose **S** in the **M** box and click the **184x686BPM.raw** in the raw file list
3. Examine the sensor effective area to make sure that there is a bad pixel of a bad line.



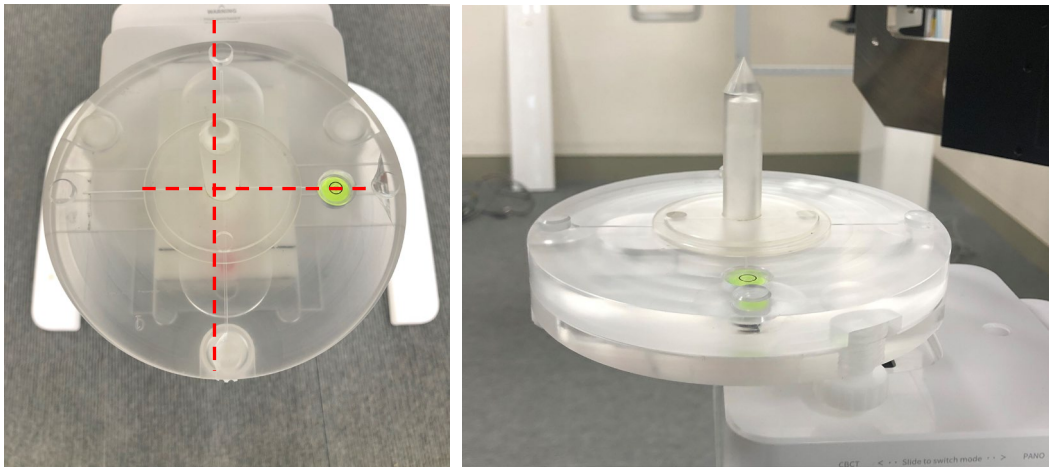
4. CT Geometry Calibration

4.1. Sensor Uoffset setting

To optimize CT image quality in the equipment, the operator should perform the Geometry Calibration operation according to the following procedures.

IMPORTANT	• **Sensor Leveling** If you installed a new sensor, make sure that you made it level before CT Geometry Calibration.

1. As shown in the image below, attach CT Phantom Jig to Bite Block.
2. Place the Cone-phantom in the middle of the Jig.



Cone-phantom position

3. Run **VAKCAP.exe** file.

NOTICE	VAKCAP.exe Path : C:\VCaptureSW\Acquisition\CBCT\WidePANO folder

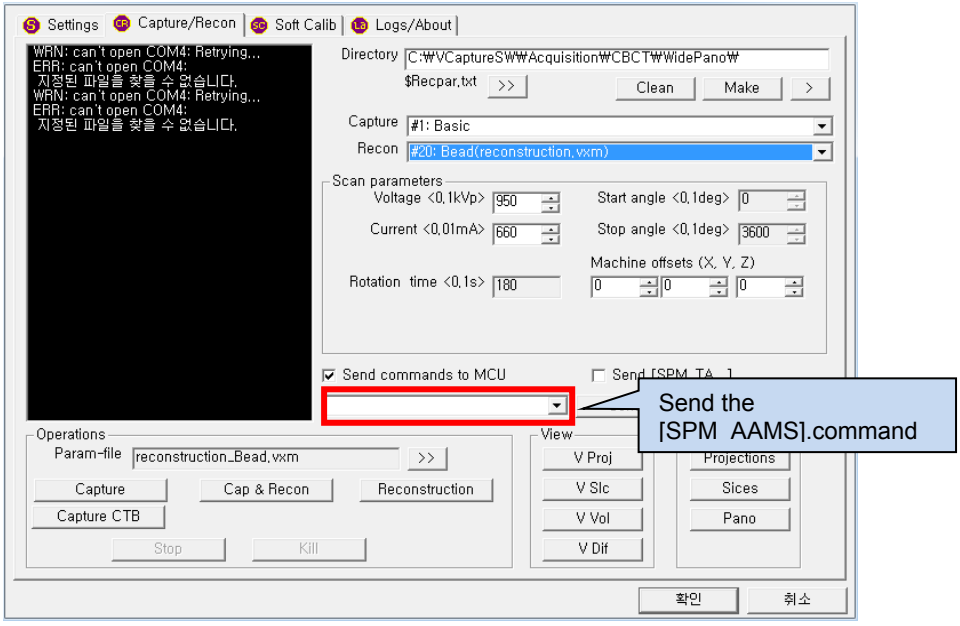
4. Click the **Capture/Recon** tab and send the **[SPM_ARCT]** command to initiate the system into CT mode.

5. When the equipment stops operating, send the following commands in the table below to supply power to the CBCT Sensor.

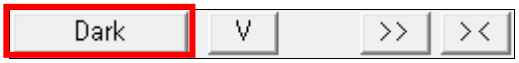
Command	Function
[SPM_CSON]	CBCT sensor Power On
[SPM_FISS_0001]	Sensor Sensitivity & Binning mode setting //0000: High Gain, 2x2 Binning //0001: High Gain, 4x4 Binning //0002: Low Gain, 2x2 Binning (default) //0003: Low Gain, 4x4 Binning
[SPM_FIPM_0001]	Sensor Partial mode setting // Sensor size: 0000~0032
[SPM_FISM_0001]	Sensor Internal/External mode setting //0000: Internal //0001: External
[SPM_COLM_0004]	Collimator Position set

6. Send the **[SPM_AAMS]** command to go into CT Uoffset Align check mode.

NOTICE	* vatech A9 standard: 82 +-1 pixel



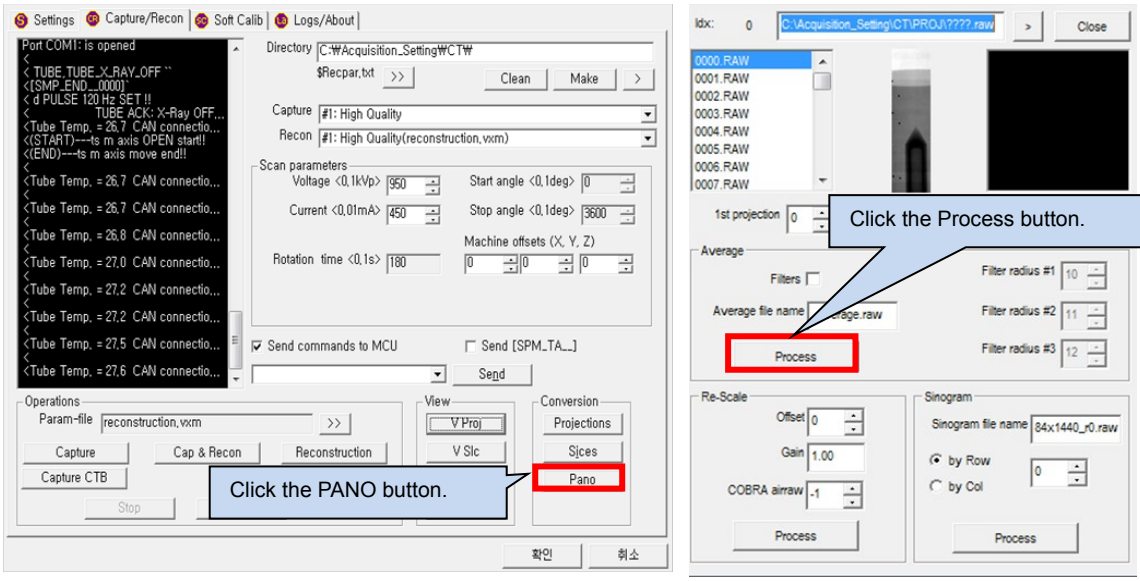
7. Click the **Soft Calib** tab and click the **Dark** button to acquire Dark Calibration Data.



8. Click the **Capture/Recon** tab and choose **#20: Bead(reconstruction.vxm)** for Recon mode.
9. Click the **Capture** button and make the exposure by pressing the X-ray exposure switch.

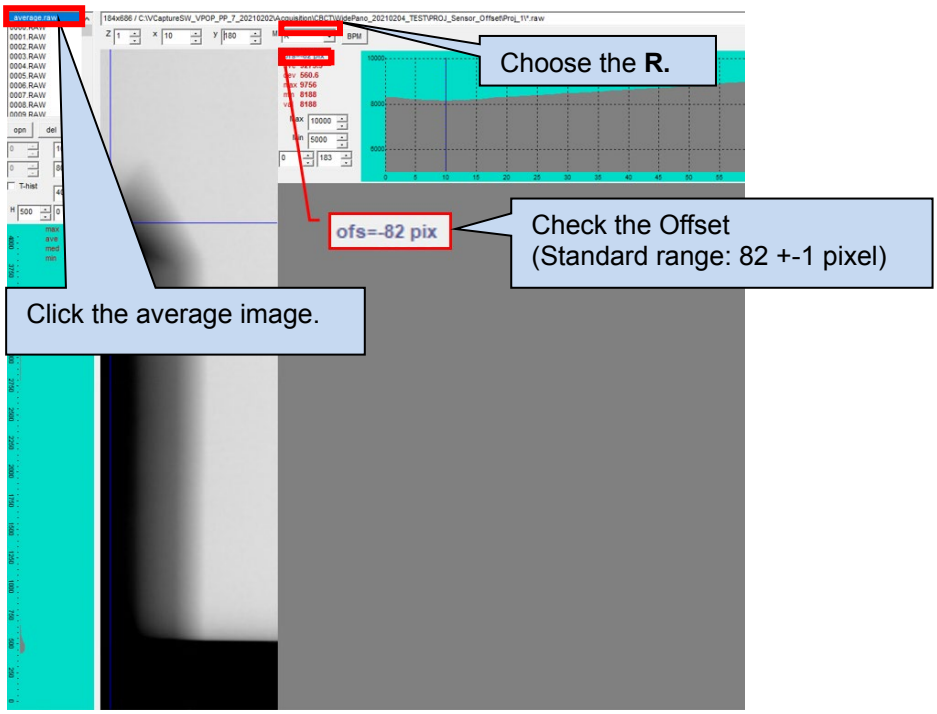
	• Stay outside of the X-ray shielding room to avoid unnecessary X-ray radiation during the exposure.

10. Click the **PANO** button, and use the **Process** button to generate the average.raw of PROJ files.



Average after capturing the image

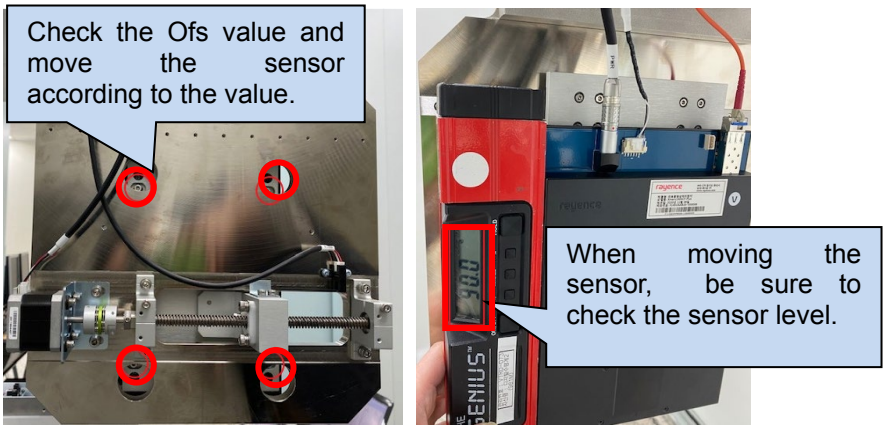
11. Click the **V Proj** button to see the averaged PROJ file.



12. If it does not meet the standard, move the sensor with a command and adjust it.

NOTICE

- When the ofs value increases, move the sensor to the ORG direction (Right): [spm_CMCT_xxxx] value decrease
- When the ofs value decreases, move the sensor in the opposite direction to the ORG (Left): [spm_CMCT_xxxx] value increase



- [spm_CMCT_xxxx] value increase

  * To modify ofs value by 1, modify CMCT value by 2.

13. When the standard pass, enter the ofs value in the DETOFFSETYY parameter in the reconstruction.vxm, reconstruction_Bead.vxm, and reconstruction_GEO.vxm files in the following folder

    Half beam

    - Path: C:\VCaptureSW\VCaptureSW\Acquisition\CBCT\WidePANO\REC
    - File: (1) reconstruction.vxm, (2) reconstruction_Bead.vxm, (3) reconstruction_GEO.vxm
    - Parameter: DETOFFSETYY = -xxx setting in (1) & (2) & (3) files

    When the CMCT value is determined, enter the PMCT value as (CMCT value + 149).

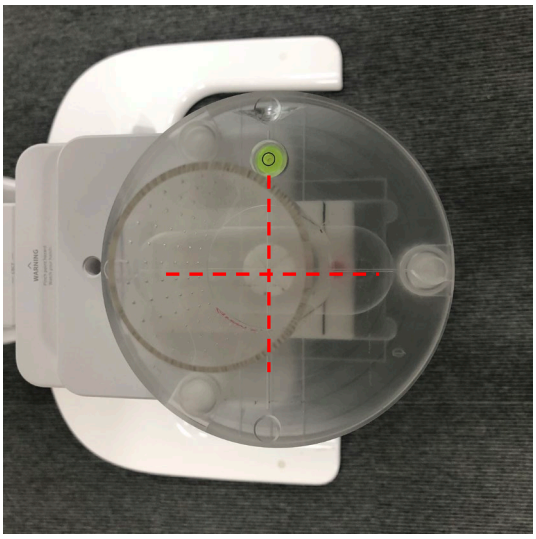
    ex. [SPM_CMCT_431] → [SPM_PMCT_580]

4.2. Bead Phantom Image Acquisition

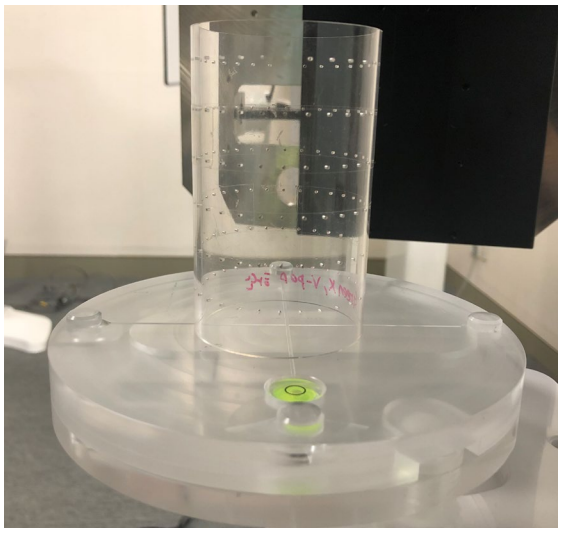
NOTICE	• Geometry related file path: C:\VCaptureSW\Acquisition\CBCT\WidePANO\REC • Geometry related files: reconstruction.vxm, reconstruction_Bead.vxm, reconstruction_GEO.vxm

Filename	Function
Reconstruction.vxm	Parameter file used when reconstructing objects
Reconstruction_Bead.vxm	Parameter file used for bead phantom reconstruction
Reconstruction_GEO.vxm	Parameter file used when generating geometry cal data

1. Check that there is no image path at the bottom of the Settings tab in the VAKCAP.exe file. (If there is, delete it and save.)
2. The bead phantom consists of 4 rows and 28 columns, and the side with a lot of empty space should be placed downward.
3. Angle.bin, RCP.bin, Uoffset.bin, and Voffset.bin files should always be present when setting geometry.
4. If Angle.bin, RCP.bin, Uoffset.bin, and Voffset.bin files are created incorrectly, delete all bin files and utilize the bin files from the base para folder.
5. The position of the bead phantom is located as follows.



TOP view



Side view

BEAD Phantom position

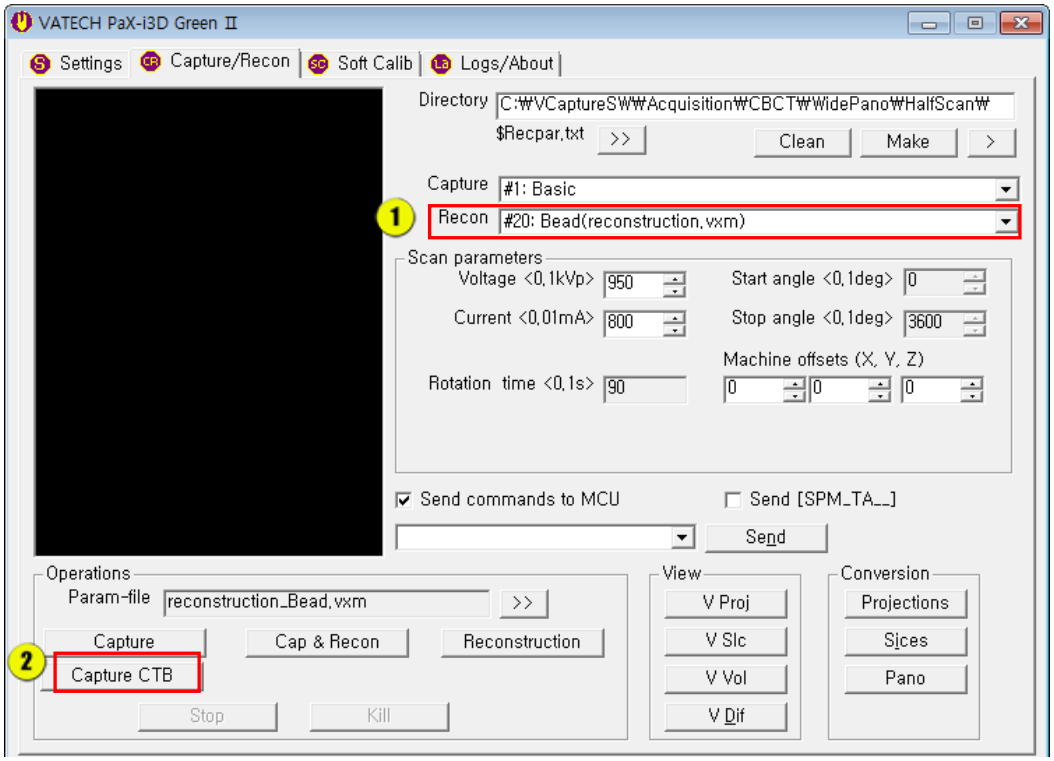
6. Run **VAKCAP.exe** file.
7. Click the **Capture/Recon** tab and send the **[SPM_ARCT]** command to initiate the system into CT mode.

8. When the equipment stops operating, send the following commands in the table below to supply power to the CBCT Sensor.

Command	Function
[SPM_CSON]	CBCT sensor Power On
[SPM_FISS_0001]	Sensor Sensitivity & Binning mode setting //0000: High Gain, 2x2 Binning //0001: High Gain, 4x4 Binning //0002: Low Gain, 2x2 Binning (default) //0003: Low Gain, 4x4 Binning
[SPM_FIPM_0001]	Sensor Partial mode setting // Sensor size: 0000~0032
[SPM_FISM_0001]	Sensor Internal/External mode setting //0000: Internal //0001: External
[SPM_COLM_0004]	Collimator Position set

9. Click the **Soft Calib** tab and click the **Dark** button to acquire Dark Calibration Data.

10. Click the **Capture/Recon** tab and set the parameters and then click the **Capture CTB** button.

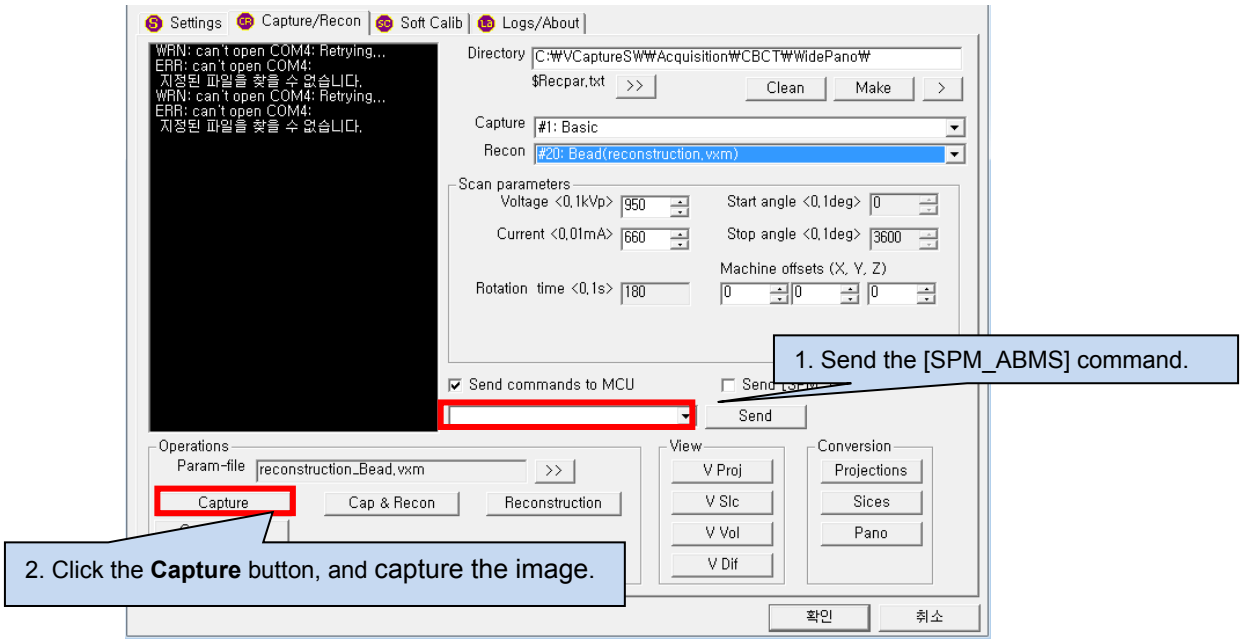


11. When the VAKPAR screen shows, press the X-ray exposure switch button.

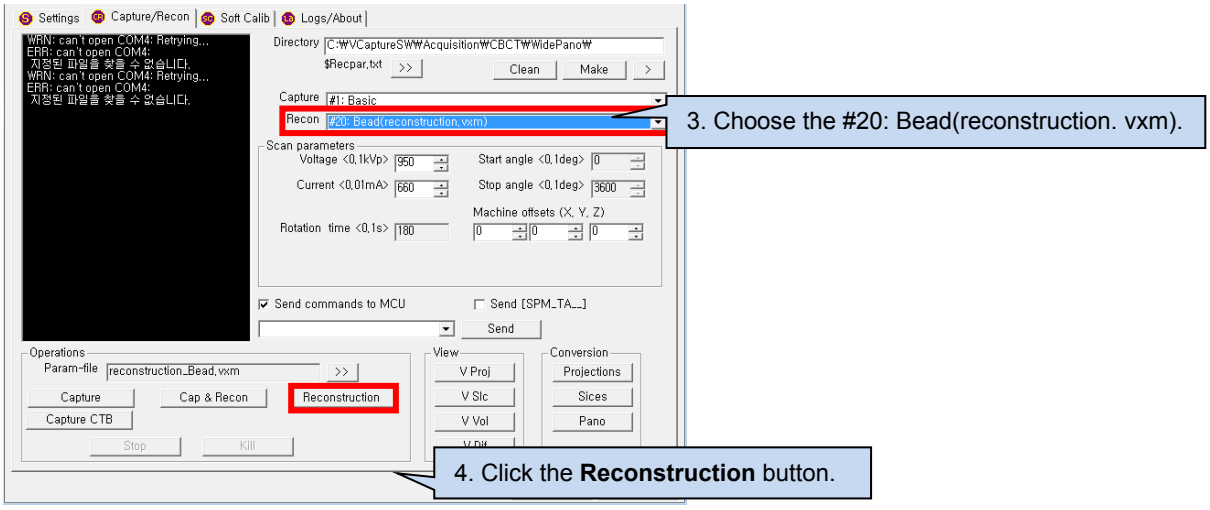
12. Release the button when about 10% is acquired.

13. Click the **V Proj** button to open View 16.

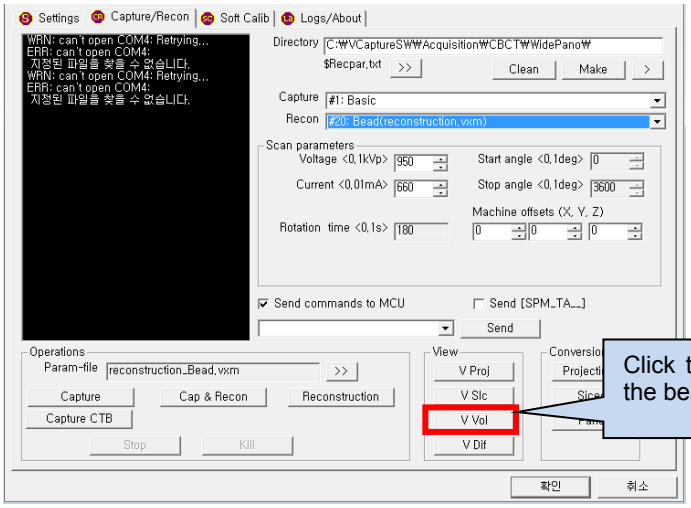
14. Check the height of the bead with Capture CTB.
15. Check that all 4 rows appear on the bead height.
16. If the standard is not met, adjust the column height and acquire the image again.
17. If the height is correct, send the [SPM_ABMS] command and capture the image.

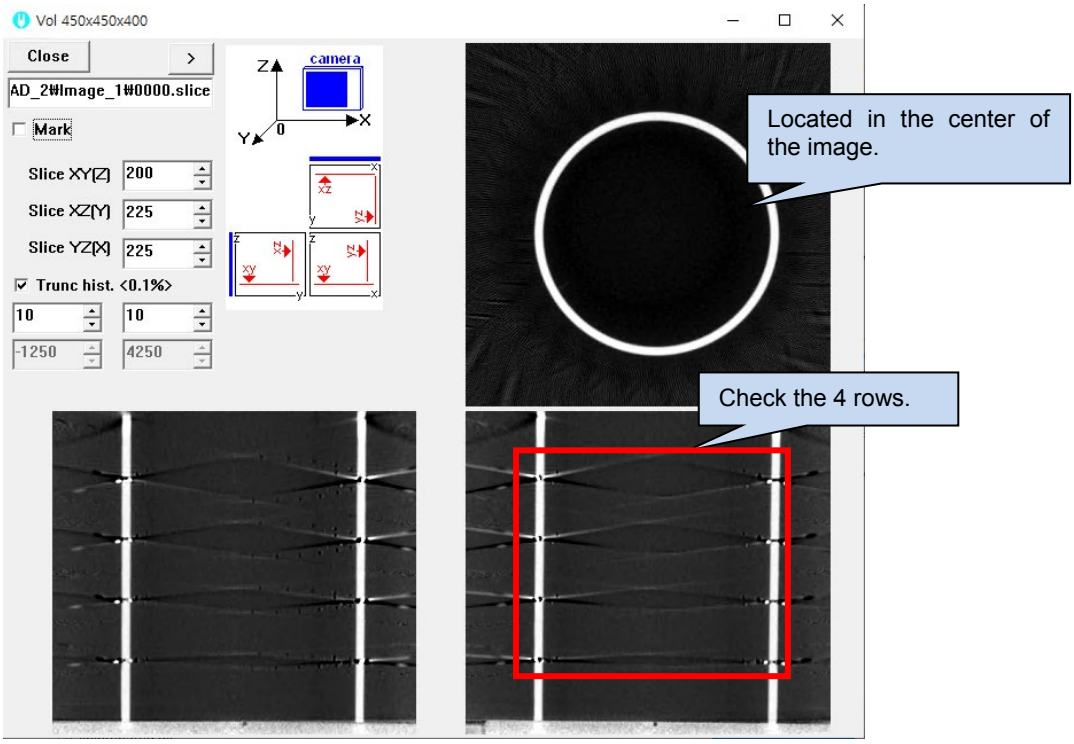


18. When the exposure is completed, select the **#20: Bead(reconstruction. vxm)** for Recon type and click the **Reconstruction** button to reconstruct the Bead Phantom image.



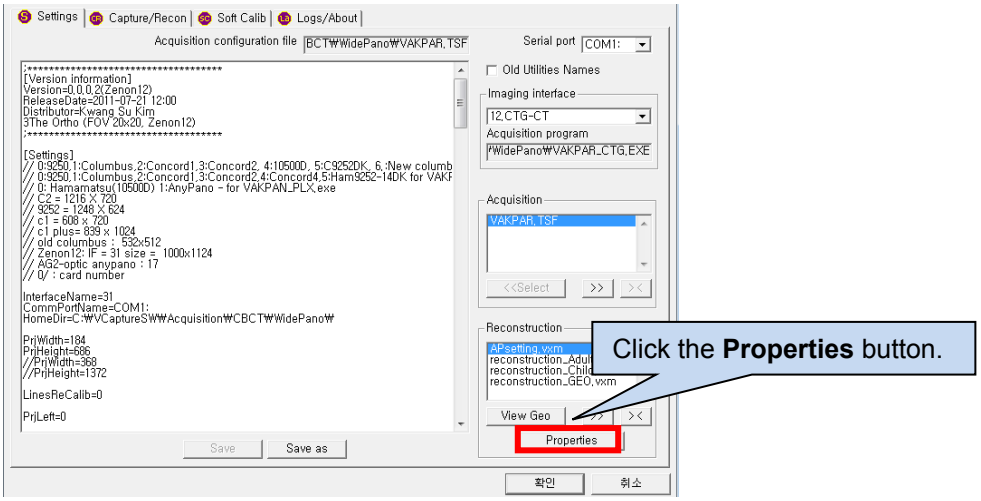
19. When reconstruction is complete, click the **V Vol** button to check the Bead Position.



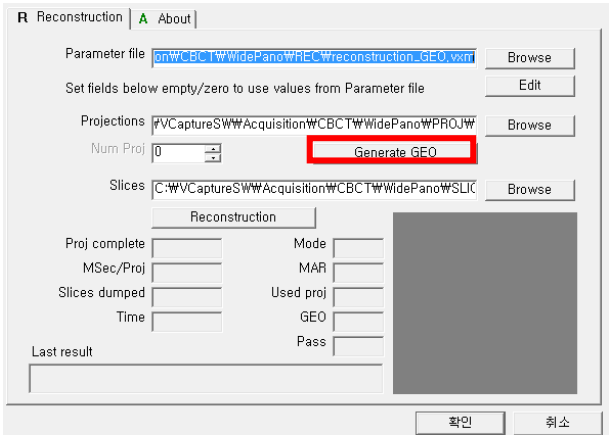


IMPORTANT	• The bead Position should be located in the center of the image, and all 4 rows should be displayed.

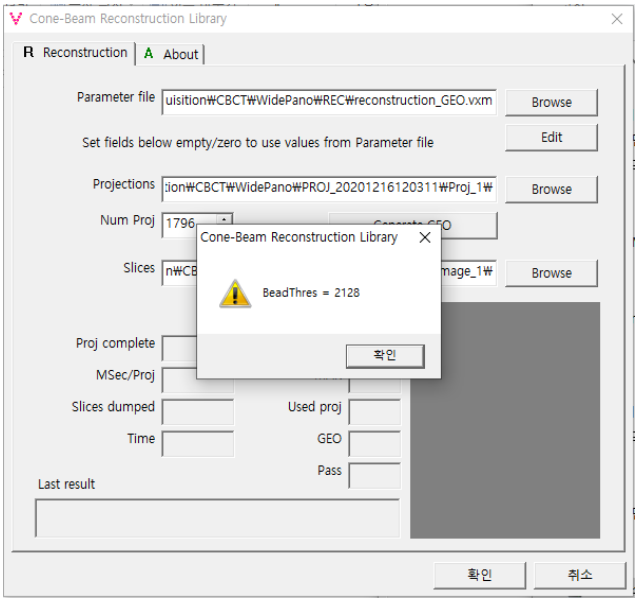
20. When the bead position is confirmed, click the **Properties** button.

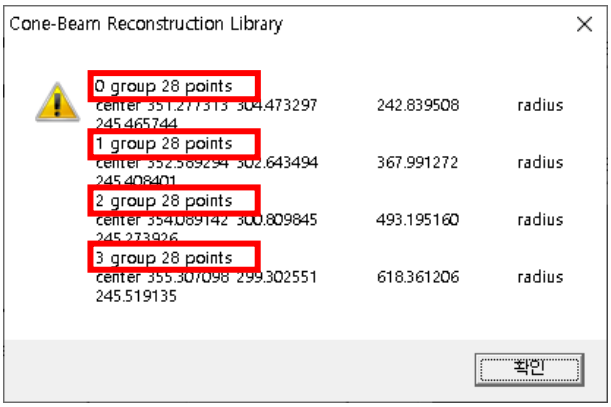


21. Click the **Generate GEO** button to perform geometry cal.



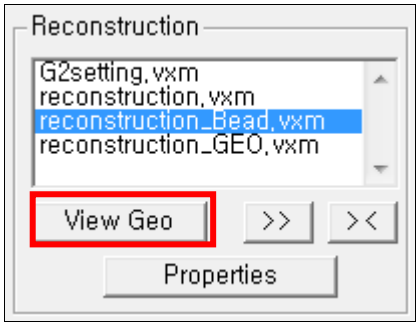
22. After clicking the **Generate GEO** button, the following window will appear. It should appear in a total of 4 groups, and the points should be marked as 28 each.





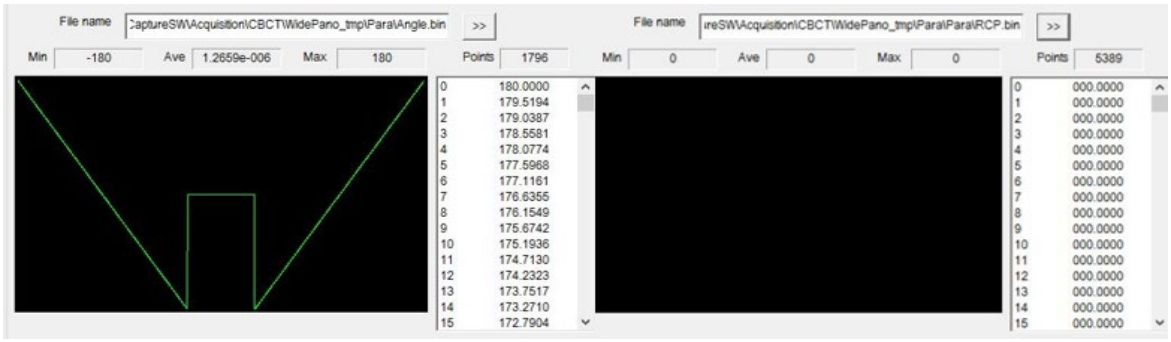
23. When the pop-up window which shows Geometry generation results appears, click the **OK** button.

24. Click the **View Geo** button to see the Geometry graph.



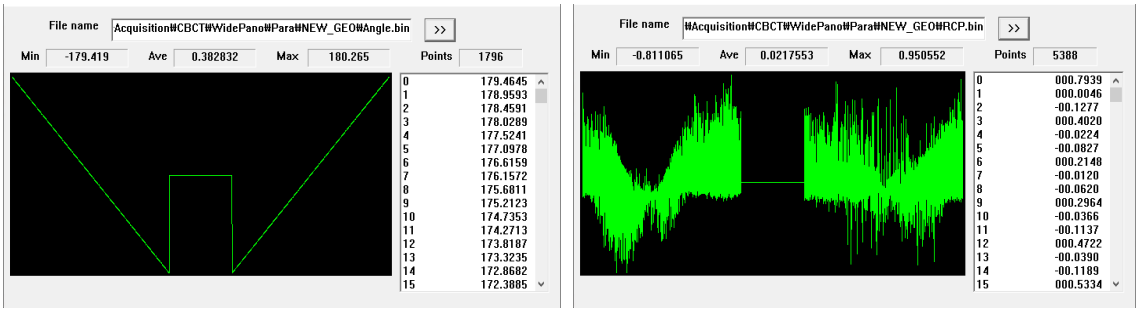
25. Click the **view Geo** button to check the set geometry graphically.

    [SPM_ABMS] : View GEO Graph



Angle.bin before operation

RCP.bin before the operation



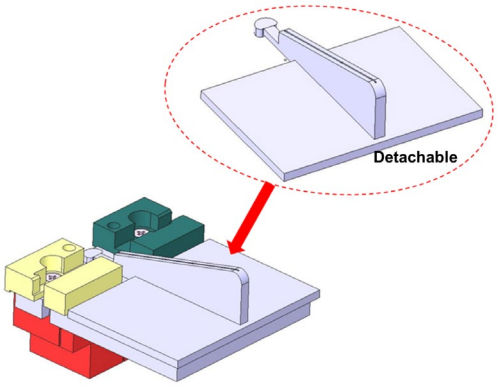
Angle.bin after operation

RCP.bin after the operation

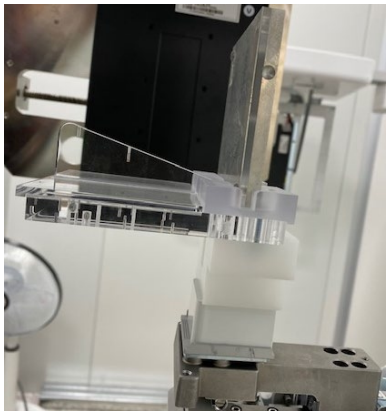
4.3. Handle Frame Align

4.3.1. Rotator Position setting command

1. Make sure that the Handle Frame Align Jig is at the Bite position in PANO Mode as shown in the picture below and then fasten.



Handle Frame Align Jig



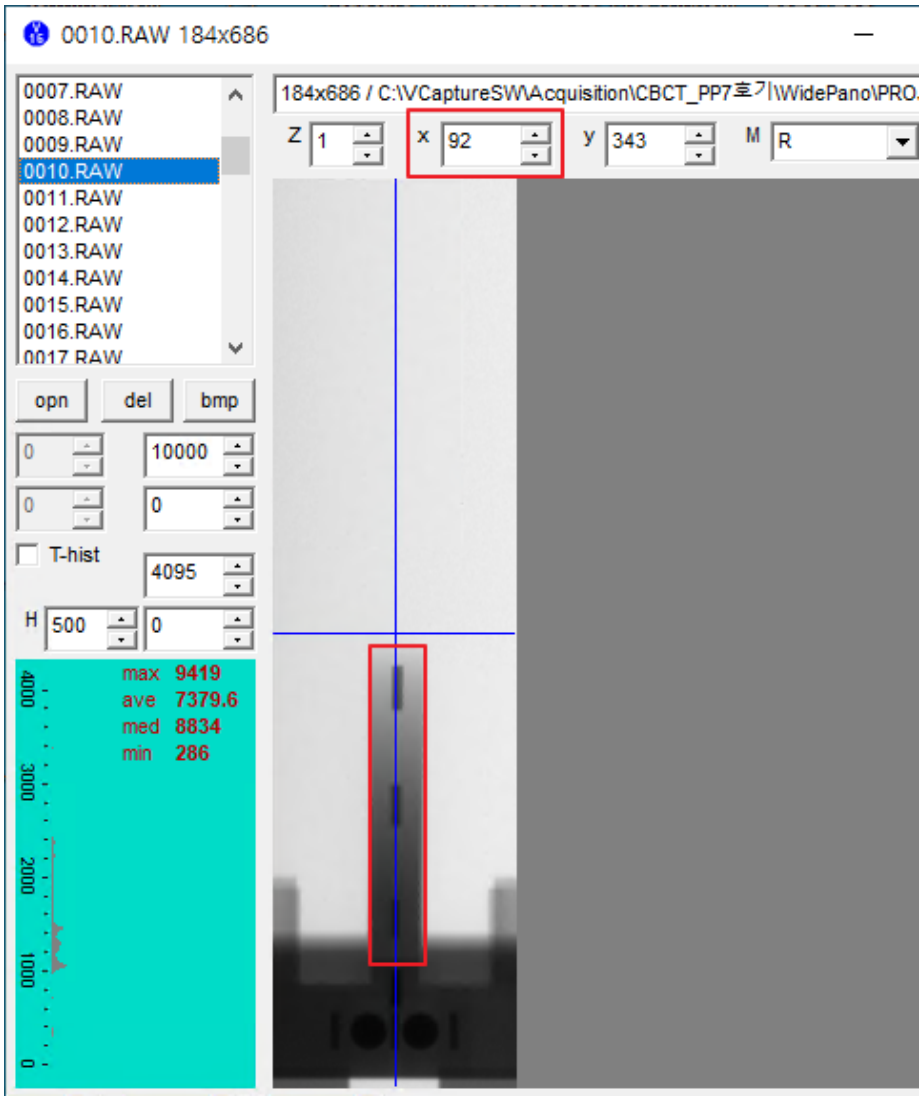
Side View

2. Run the VAKCAP.exe file in C:\VCaptureSW\Acquisition\CBCT\WidePANO folder.
3. Click the **Capture/Recon** tab and send the **[SPM_ARCT]** command to initiate the system into CT mode.

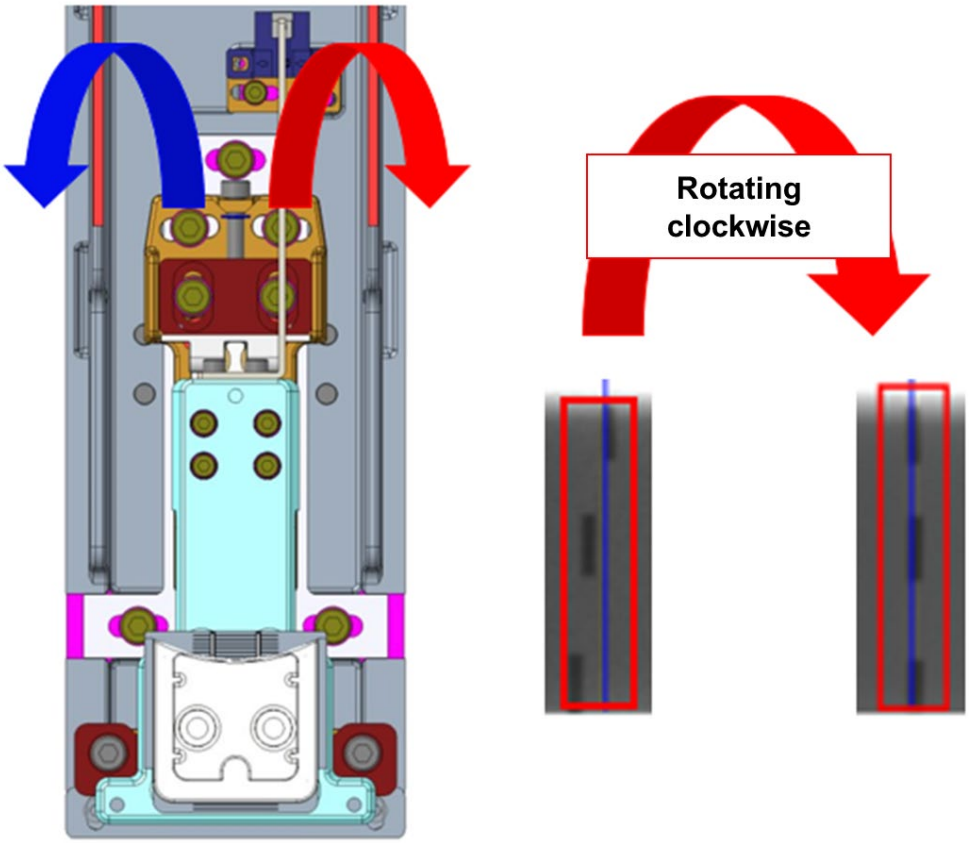
4. When the equipment stops operating, send the following commands in the table below to supply power to the CBCT Sensor.

Command	Function
[SPM_CSON]	CBCT sensor Power On
[SPM_FISS_0001]	Sensor Sensitivity & Binning mode setting //0000: High Gain, 2x2 Binning //0001: High Gain, 4x4 Binning //0002: Low Gain, 2x2 Binning (default) //0003: Low Gain, 4x4 Binning
[SPM_FIPM_0001]	Sensor Partial mode setting // Sensor size: 0000~0032
[SPM_FISM_0001]	Sensor Internal/External mode setting //0000: Internal //0001: External
[SPM_COLM_0004]	Collimator Position set

5. Click the **Soft Calib** tab and click the **Dark** button to acquire Dark Calibration Data.
6. Enter the (HFST value worked in step 2.3) + 3600.
   ex. If it is [SPM_HFST_200], input [SPM_HFST_3800].
7. Click the **Capture_CTB** button to acquire an image.
8. Click the **V Proj** button to check the image.
9. Enter **92** on the X-axis and check if the three pins are aligned in a line as shown in the image below.



10. If it is not aligned, loosen the fixed point of the chinrest drive and move the chinrest drive module.
    - When rotating **clockwise**, the top pin moves to the **left**.
    - When rotating **counterclockwise**, the top pin moves to the **right**.

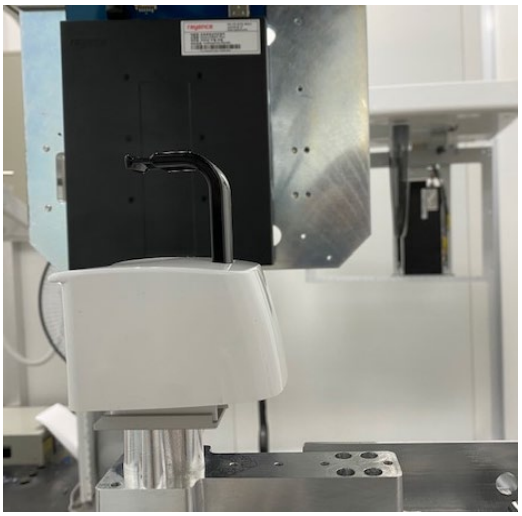


11. After alignment, recover the value by sending the original HFST value.

    ex. If it is [SPM_HFST_3800], input [SPM_HFST_200].

4.3.2. Rotator Y, Z-axis setting

1. Put the chin block and the normal bite on the unit as shown below.



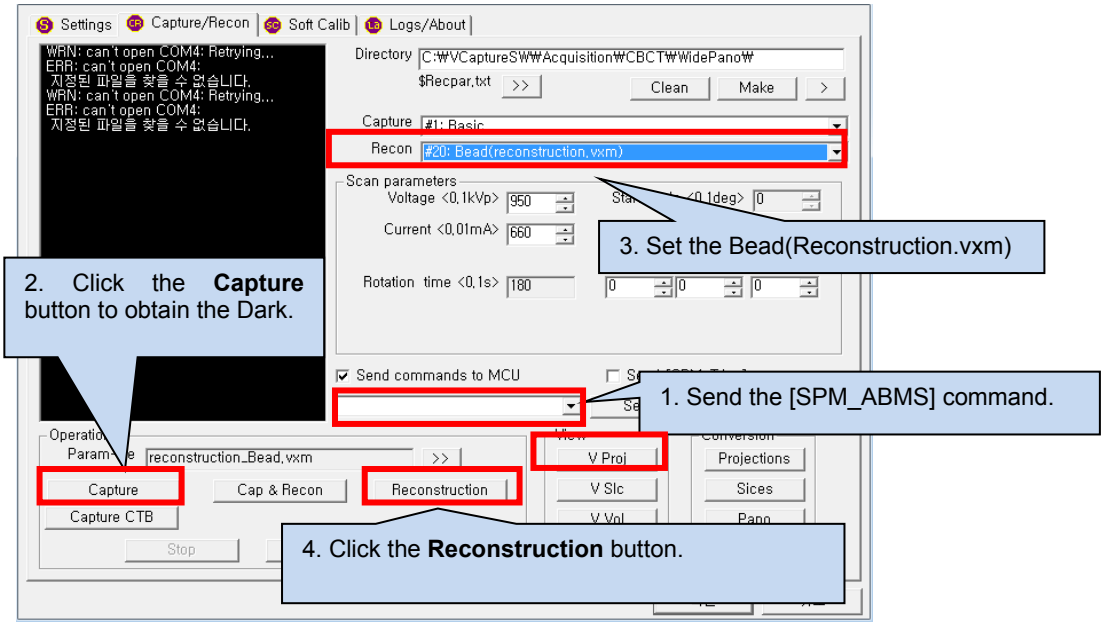
2. Run **VAKCAP.exe** file.
3. Click the **Capture/Recon** tab and send the **[SPM_ARCT]** command to initiate the system into CT mode.

4. When the equipment stops operating, send the following commands in the table below to supply power to the CBCT Sensor.

Command	Function
[SPM_CSON]	CBCT sensor Power On
[SPM_FISS_0001]	Sensor Sensitivity & Binning mode setting //0000: High Gain, 2x2 Binning //0001: High Gain, 4x4 Binning //0002: Low Gain, 2x2 Binning (default) //0003: Low Gain, 4x4 Binning
[SPM_FIPM_0001]	Sensor Partial mode setting // Sensor size: 0000~0032
[SPM_FISM_0001]	Sensor Internal/External mode setting //0000: Internal //0001: External
[SPM_COLM_0004]	Collimator Position set

5. Send the [SPM_ABMS] command to acquire dark.
6. Click the **Soft Calib** tab and click the **Dark** button to acquire Dark Calibration Data.

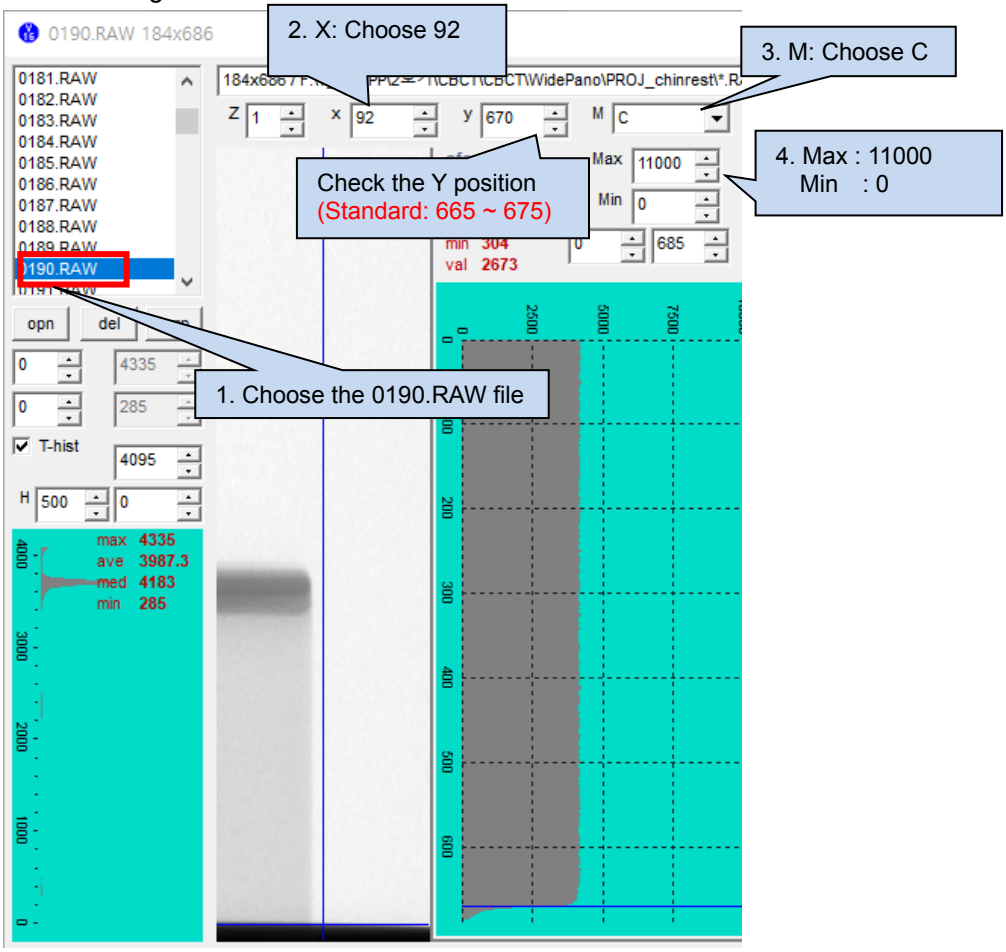
7. Click the **Capture/Recon** tab and set the parameters and then click the **Capture** button



8. When the VAKPAR screen shows, press the X-ray exposure switch button.

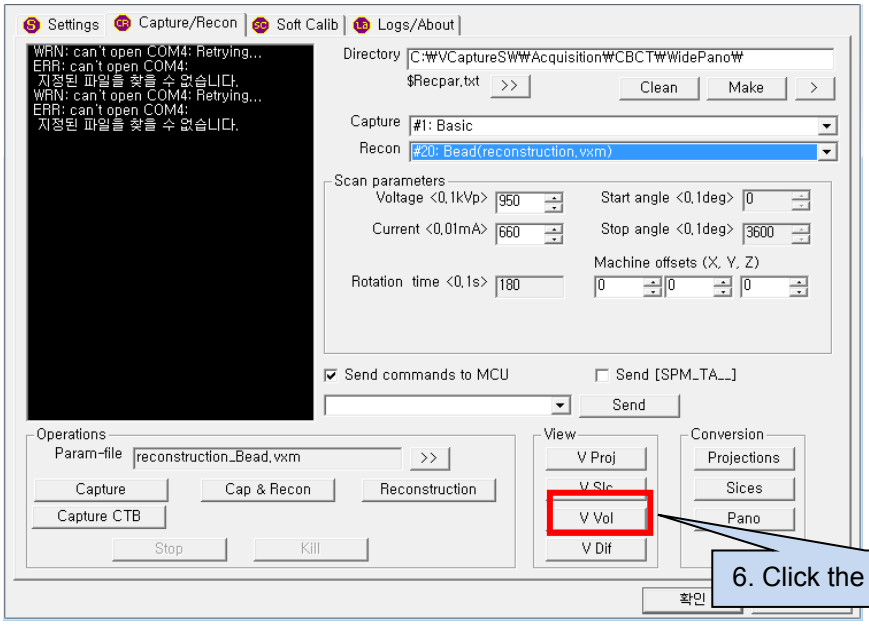
9. When the exposure is completed, click the **V Proj** button to open the raw files.

10. Click the height of the chinrest block in the recorded PROJ file.



Chinrest block standard: 10~ 20 pixels (1.98 ~ 3.96 mm)
: Y value = 665~675

※ If the Chinrest block is measured higher than 20 pixels, replace it with thin sheet metal.
If the chinrest block is lower than 10 pixels, it is replaced with thick sheet metal.

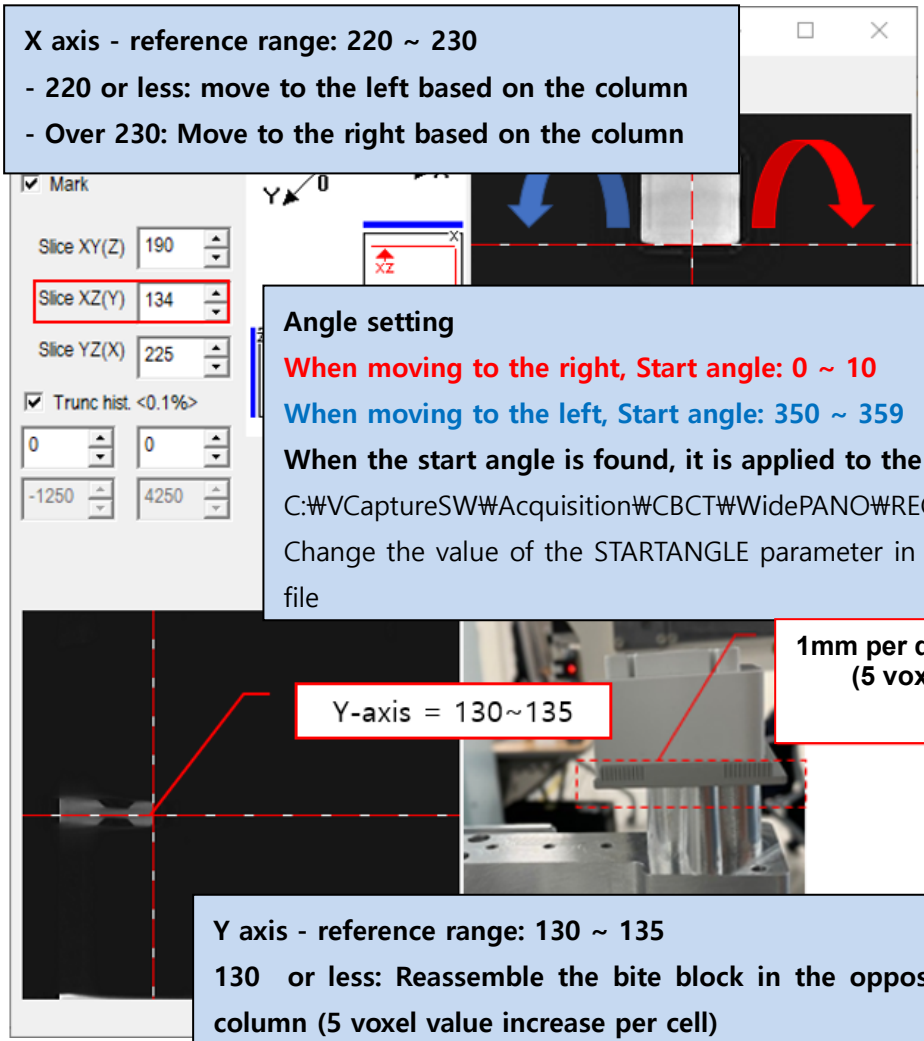


6. Click the **V Vol** button.

X axis - reference range: 220 ~ 230

- 220 or less: move to the left based on the column

- Over 230: Move to the right based on the column



Angle setting

When moving to the right, Start angle: 0 ~ 10

When moving to the left, Start angle: 350 ~ 359

When the start angle is found, it is applied to the following folders.

C:₩VCaptureSW₩Acquisition₩CBCT₩WidePANO₩REC₩reconstruction.vxm

Change the value of the STARTANGLE parameter in the reconstruction.vxm file

1mm per division (5 voxel)

Y axis - reference range: 130 ~ 135

130 or less: Reassemble the bite block in the opposite direction of the column (5 voxel value increase per cell)

135 or more: Reassemble the bite block in the direction of the column (5 voxel value decrease per cell)

5. CT Collimator Alignment

5.1. CT Collimator Alignment

1. Run the C:\VCaptureSW\Acquisition\CBCT\WidePANO\VACAP.exe file.
2. Send [SPM_ARCT], [SPM_CSON], [SPM_FIPM_0001], [SPM_FISS_0001], [SPM_FISM_0001], [SPM_COLM_0001] commands to the command window to set the CT sensor and collimator.
3. Set 94 kvp, 7.0 mA in VACAP and click the **CTB** button to acquire the image.
4. Use the Collimator control command to find a value that satisfies the standard below.

Command	Function
[SPM_CCST_03450]	PANO collimator position movement control
[SPM_CAST_09200]	CEPH collimator position movement control
[SPM_CFST_06350]	CT collimator position movement control

5. Run EzEval.exe file

   (Path : C:\VCaptureSW\Utility\EzEval_Phantom)
6. Choose EzEvaluation for the tap menu on the top left, and choose collimator viewer from the tap menu on the top right.
7. Set the Threshold value concerning the following standard, and check if 0010.raw satisfies the collimator alignment cut standard.

   The collimator alignment standard for each FOV is as follows.

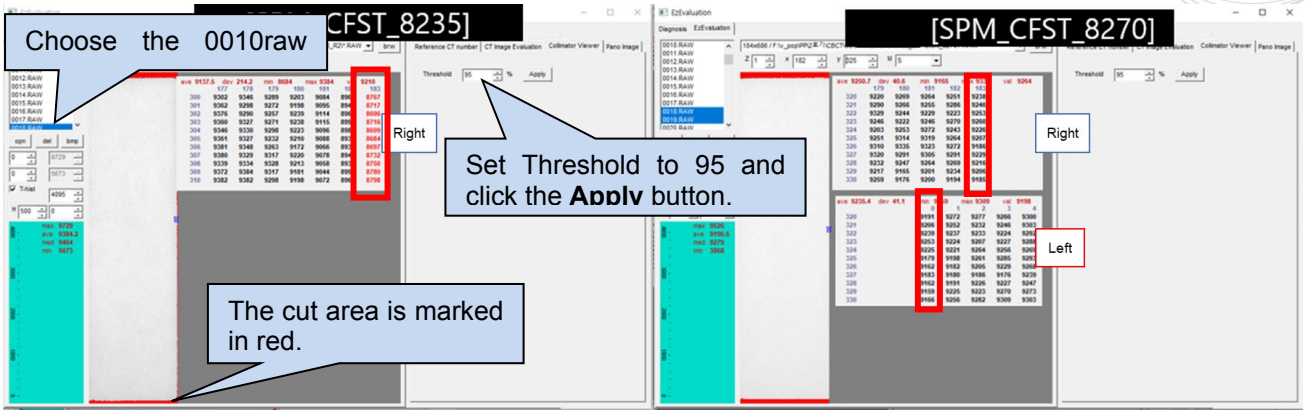
※ Collimator alignment standard value

Collimator		Min pixels	Max pixels
Threshold 95%	Left	1	2
	Right	1	2
Threshold 75%	Upper	1	10
	Lower	1	10

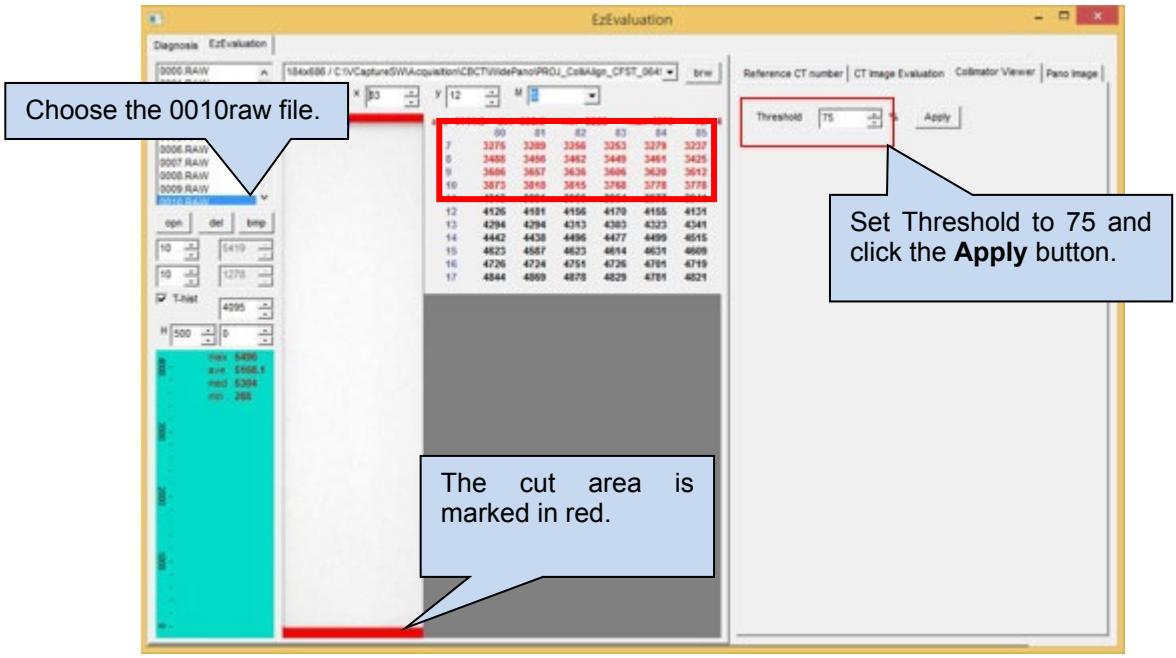
8. When 1~2 pixels are visible on the left, subtract the collimator parameter as much as 0.35 collimator value.

   Ex. [SPM_CFST_8235] → [SPM_CFST_8200]
9. When 1~2 pixels are visible on the right side, Add the collimator parameter as much as 0.35 collimator value.

   Ex. [SPM_CFST_8235] → [SPM_CFST_8270]

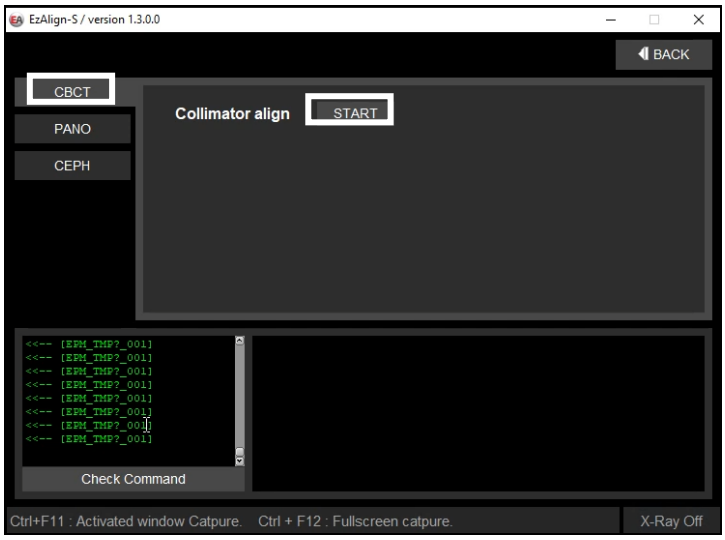


▲ Left/Right Collimator Setting

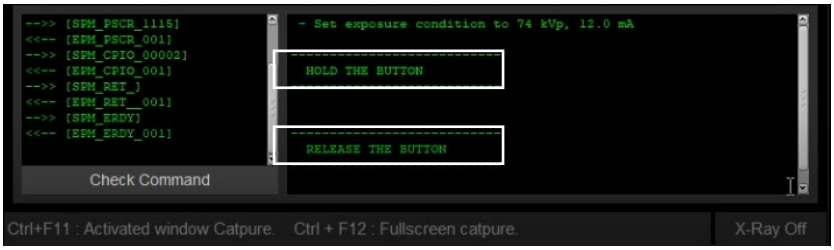


▲ Upper/Lower Collimator Setting

5.2. CT Collimator Alignment with EzAlign

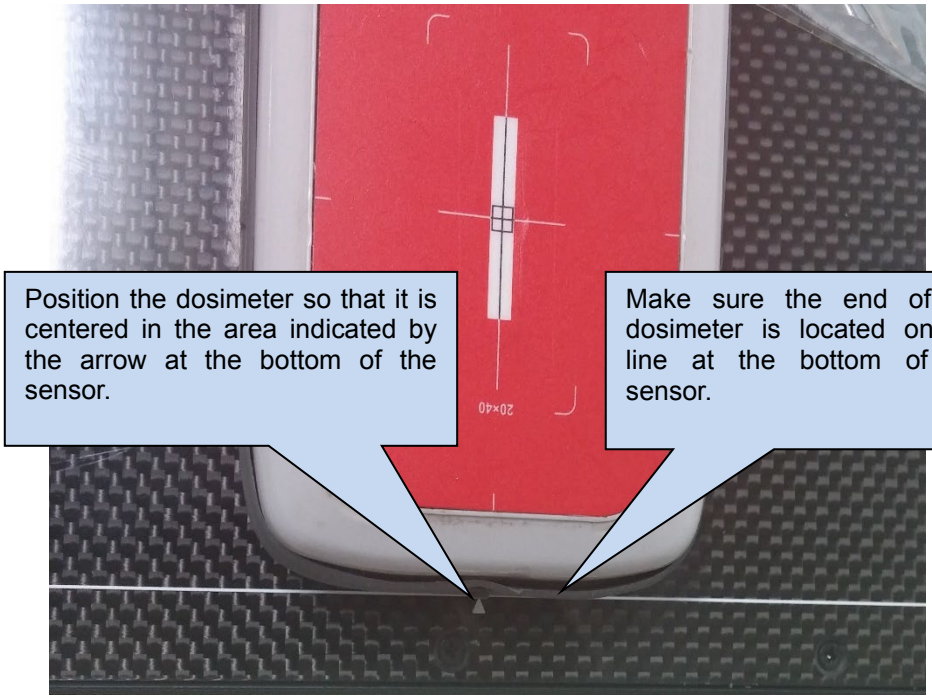


1. Select **CBCT** and click the **Start** button: The system will move into its capturing position and Collimator auto-align will be started.
2. Remove the Bite Block.
3. When you see the message **HOLD THE BUTTON** as marked in the white box below, press and hold the exposure switch until **RELEASE THE BUTTON** message appears.

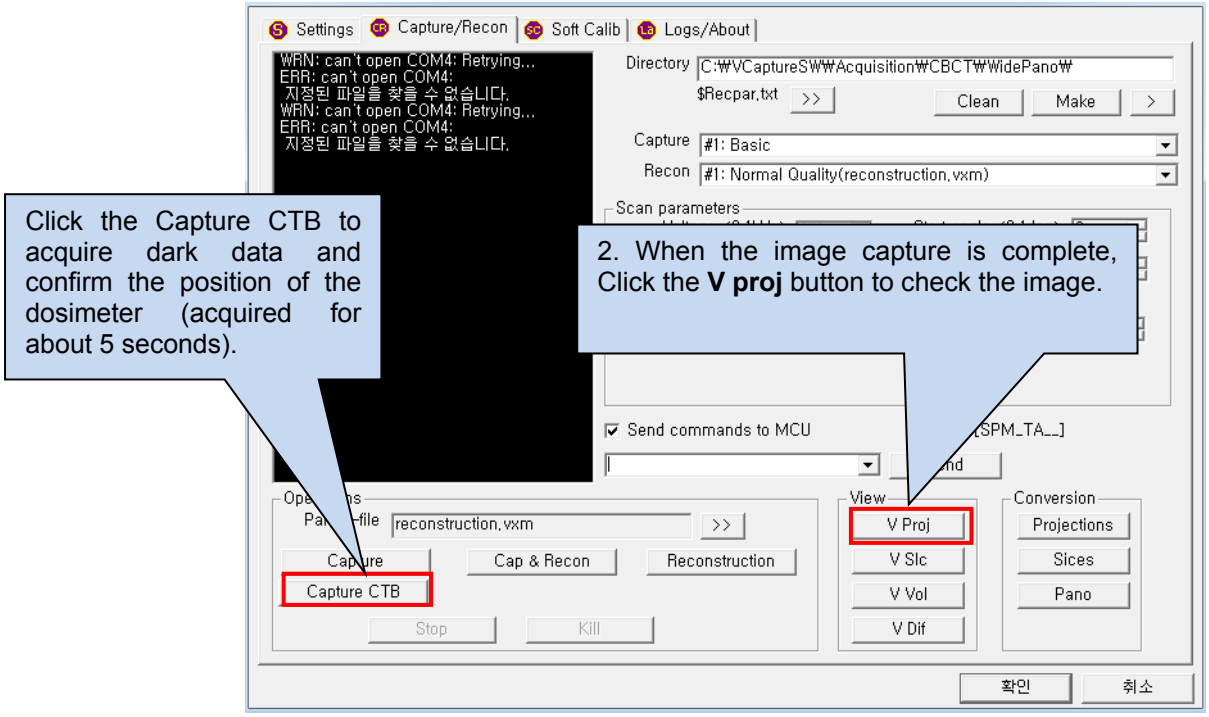


4. If the system displays the **HOLD THE BUTTON** message again instead of the succeeding message, repeat step 3.
5. If the CBCT Auto Alignment is completed successfully, the pop-up message which notifies the completion of the alignment displays on the screen. Then, click the **OK** button to finish.
6. If the Error message appears, follow the guide. Then proceed the steps 1~5.

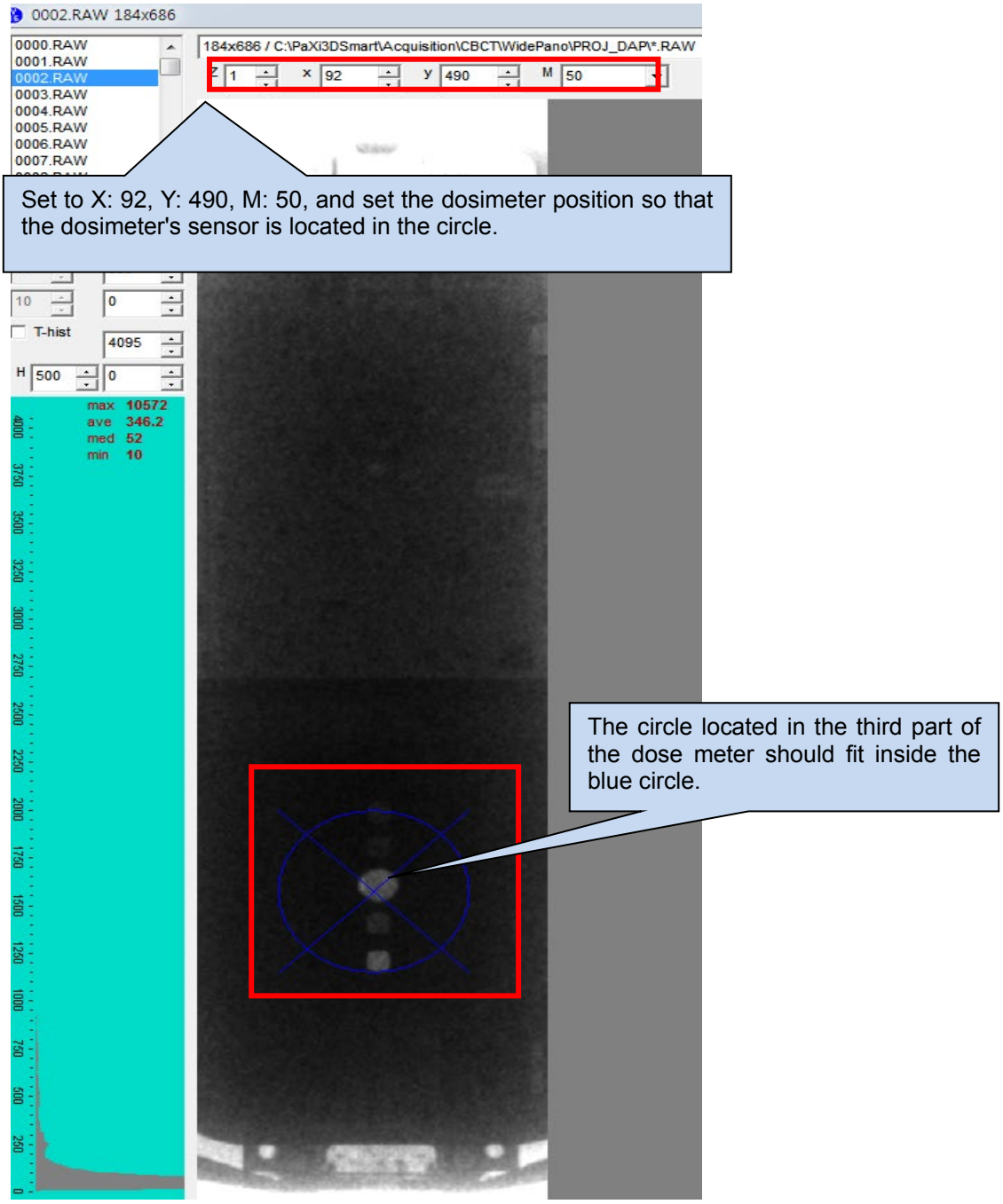
6. DAP Calibration



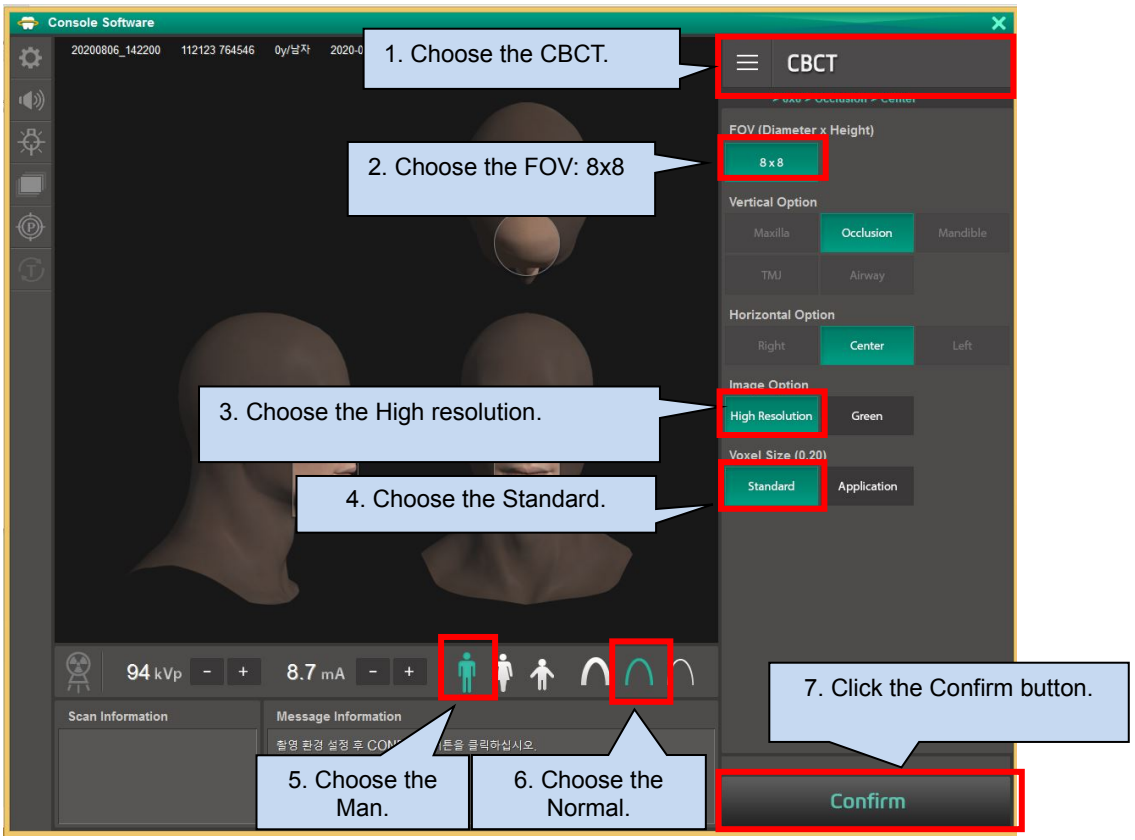
1. The position of the dosimeter is fixed at the position shown above.



2. Check the location of the dosimeter again through the PROJ file.
3. If the location of the dosimeter is not in the circle, re-locate the position and capture it again.



4. After confirming of position, capture the image to measure DAP.
5. Run the Console Software, and set as below and capture the image.

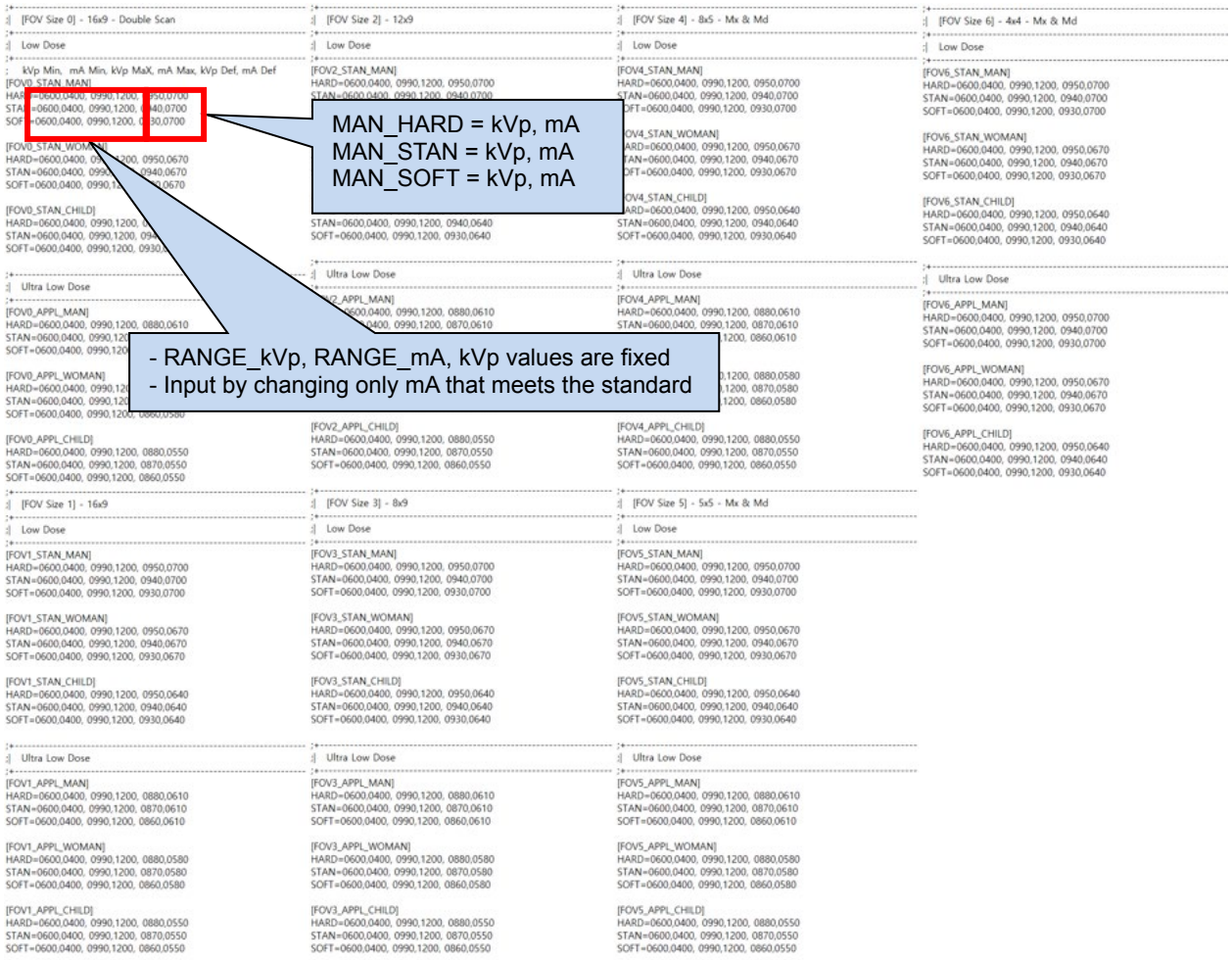


6. Measure mGy and check if it meets the standard as follows. If not, adjust mA and re-capture.

※ Background level standard value

Mode	exposure condition	mGy	Background Level
Man (High resolution)	95kVp	8.5 (±0.1)	7000 ~ 11500
Man (Green)	80kVp	5.4 (±0.1)	2000 ~ 5500

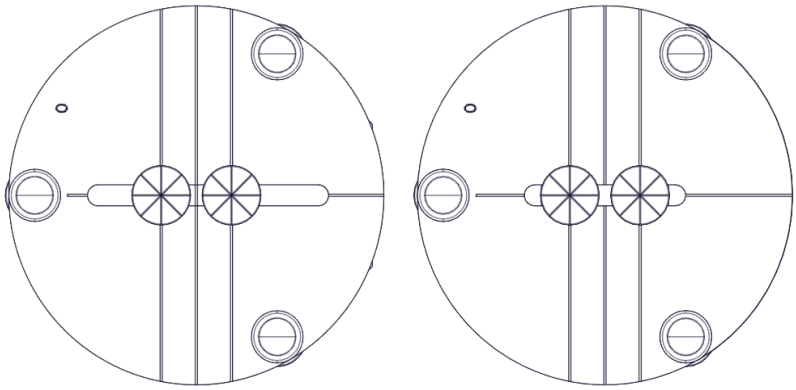
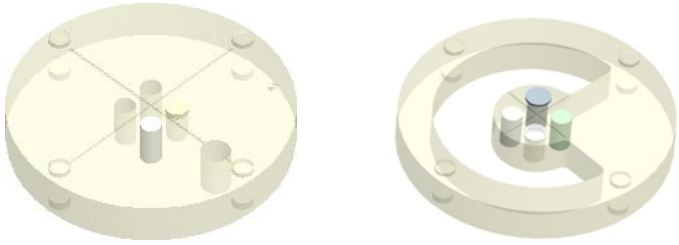
7. When 8.5mGy is measured at 95kVp, input the mA value to PwrParam_CBCT.ini. (C:\VCaptureSW\Acquisition\CBCT\WidePANO\UserParam\PwrParam_CBCT.ini)



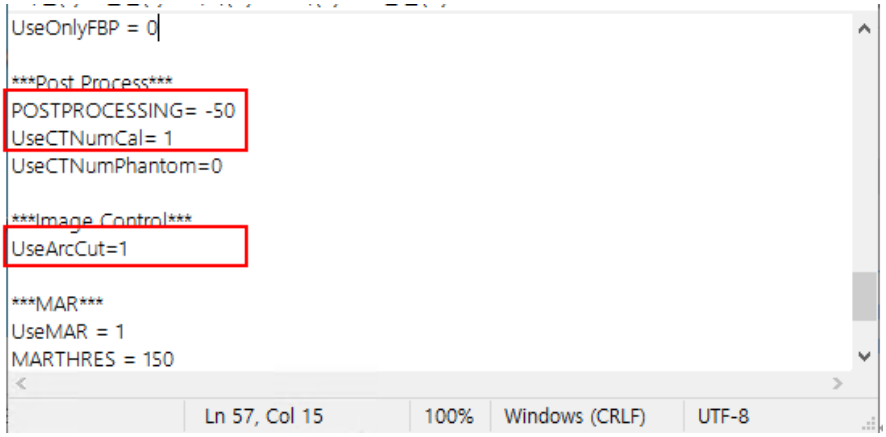
8. If 8.5 mGy is measured at 95 kVp 7.3 mA, input all mA values in the above exposure condition table as +30 increments.
9. Compare with the DAP value output from the Console Software and check if it is within 15%.
10. If the output DAP of the Console SW is more than 15% different from the measured DAP, correct the DAP Level in the Control Panel so that the difference is within 15%.
11. DAP levels can be modified in three levels: Low, Normal, and High.
12. Since kVp values are the same, choose High, Normal, or Low depending on mA.

7. CT Number Calibration

To optimize CBCT image quality, the operator should perform the CBCT CT Number Calibration according to the following procedures.

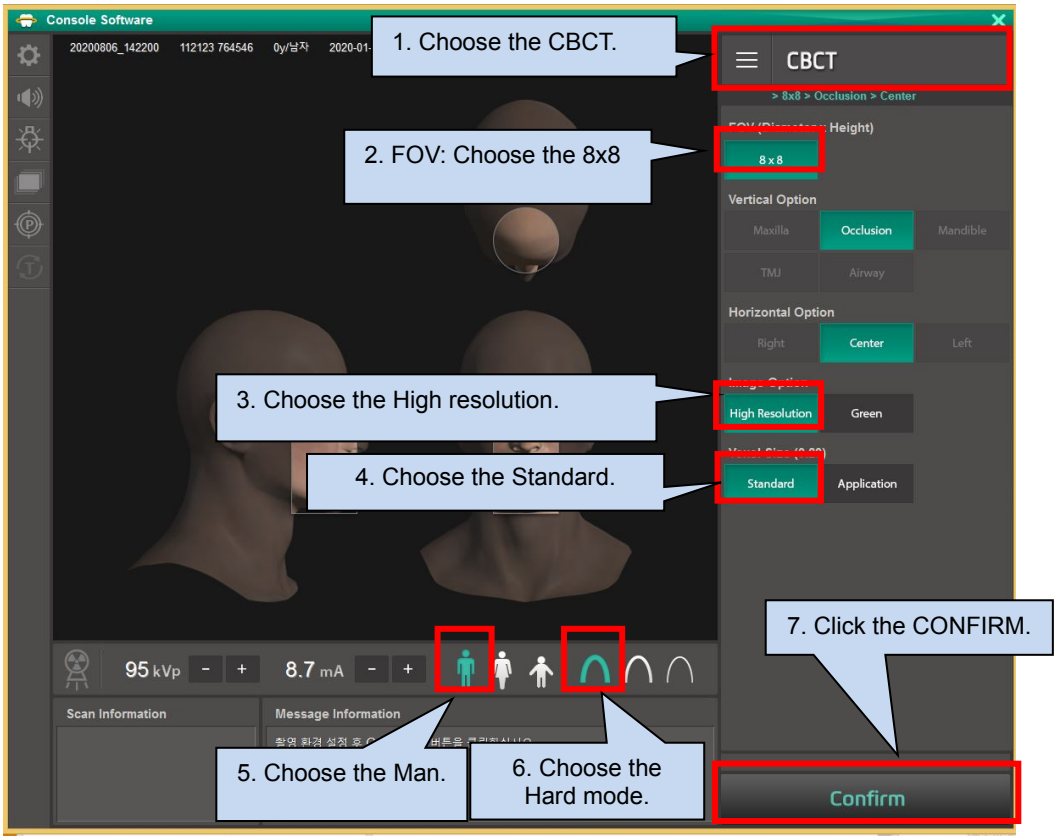
IMPORTANT	Make sure that the operator should use **TYPE A** as CT PHANTOM JIG during the CT Number Calibration.  **<Type A>** **<Type B>**
IMPORTANT	Make sure that the operator should use **TYPE A** as CT NUMBER CHECK PHANTOM during the CT Number Calibration.  **<Type A>** **<Type B>**

1. Run the C:\VCaptureSW\Acquisition\CBCT\WidePANO\VAKCAP.exe file.
2. Open the Reconstruction.vxm file to open it.
   (C:\VCaptureSW\Acquisition\CBCT\WidePano\REC)



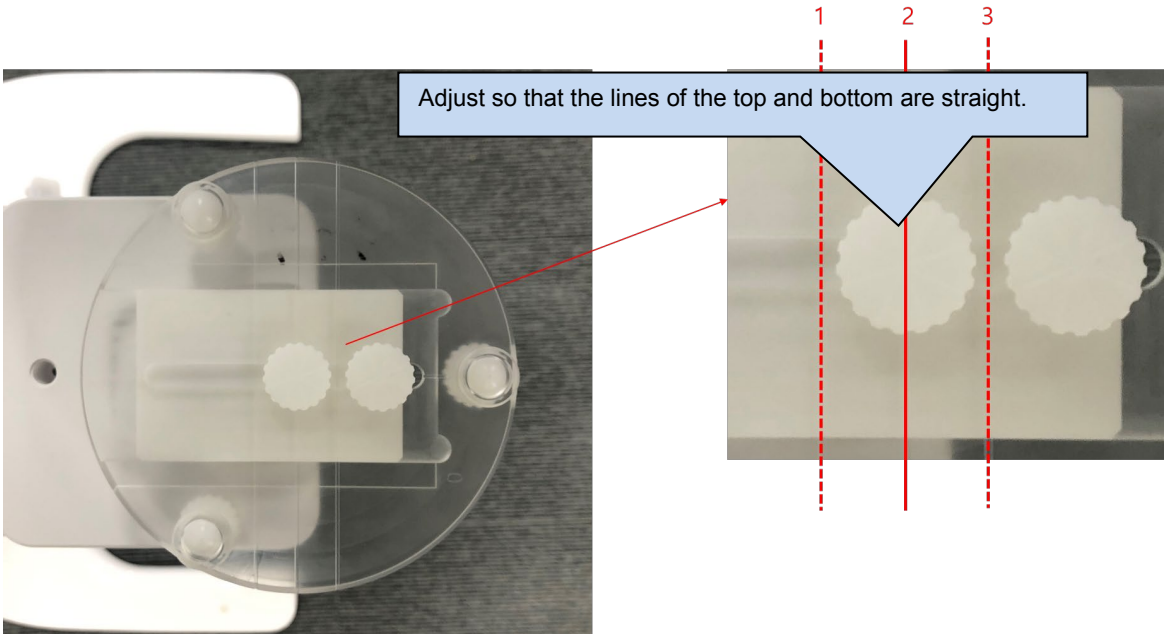
3. Change to POSTPROCESSING = 0, UseCTNumCal = 0, UseArcCut = 0 and save the file.

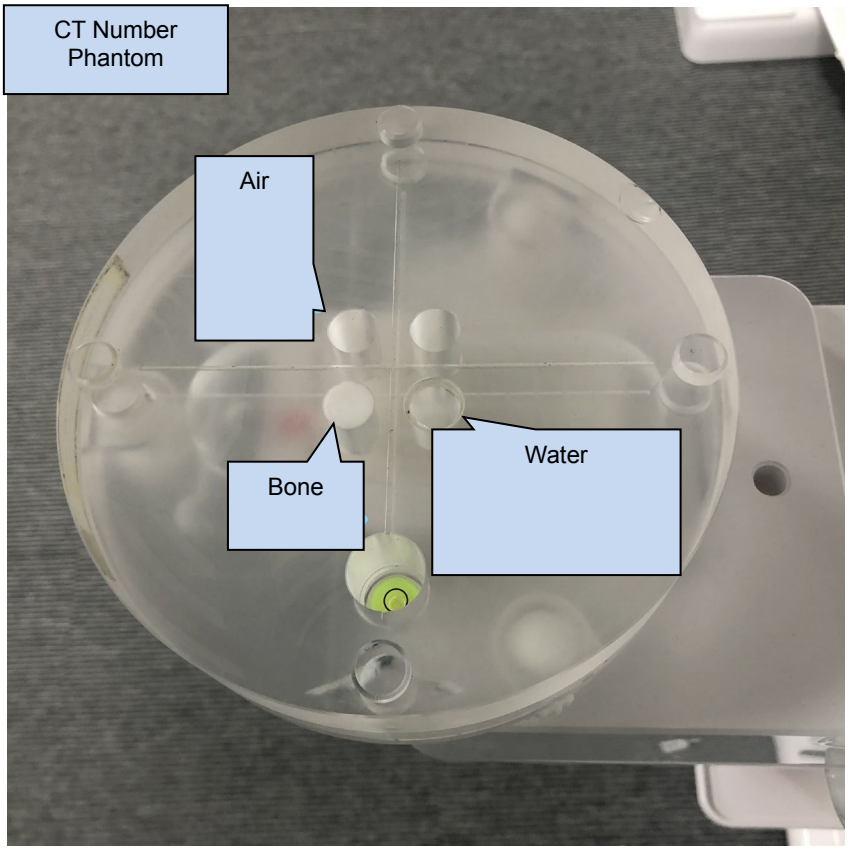
7.1. Acquire CT Phantom Image



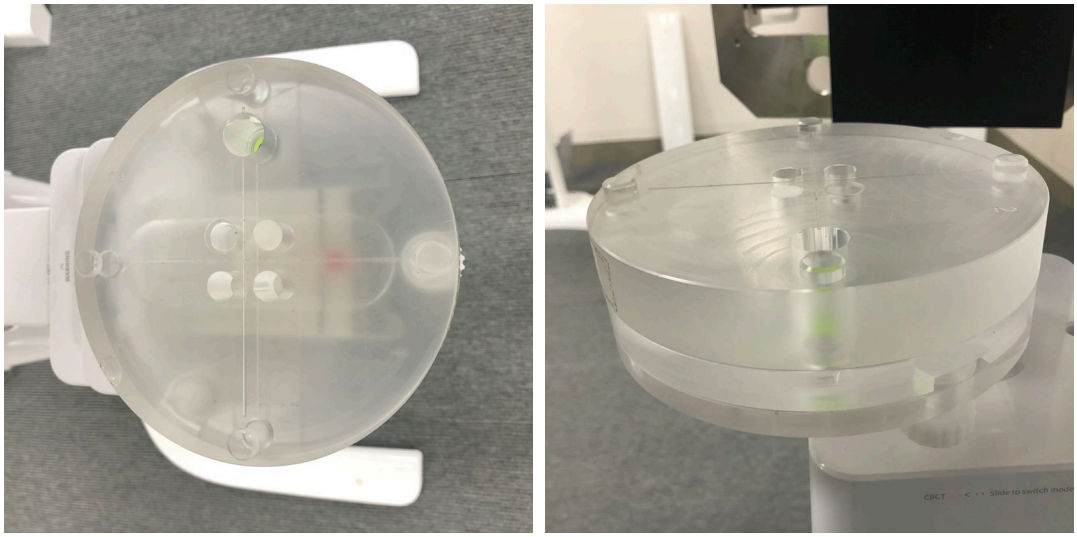
1. Run the Console Software, choose FOV 8x8, High resolution, Man, Hard mode, and click the **Confirm** button.

2. Put the Phantom jig on the Chinrest.



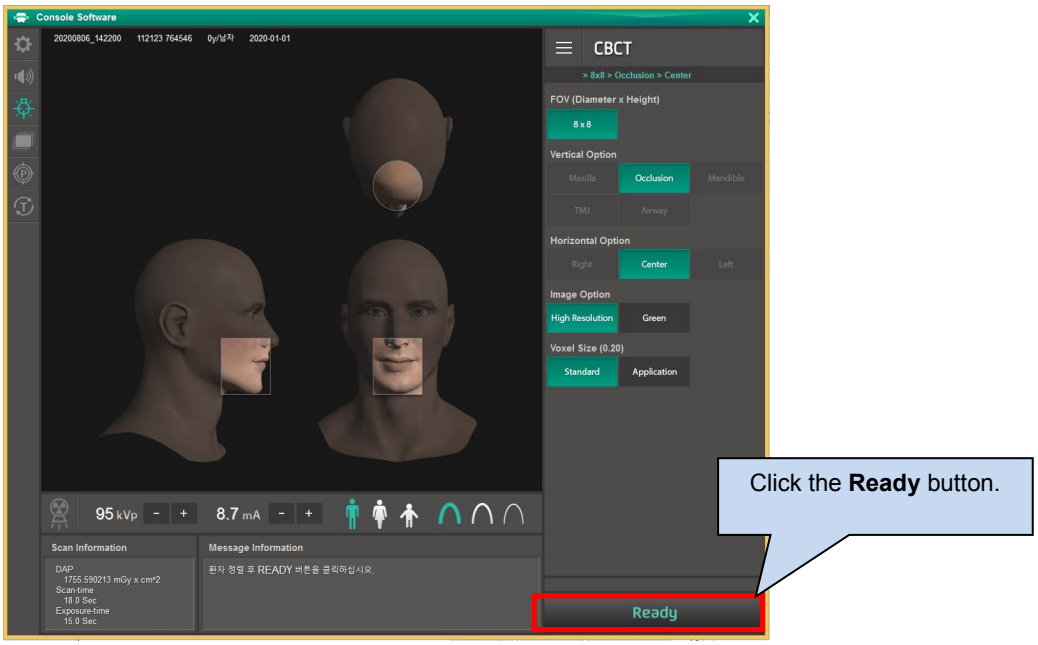


3. Put CT Number Phantom on the Phantom Jig.

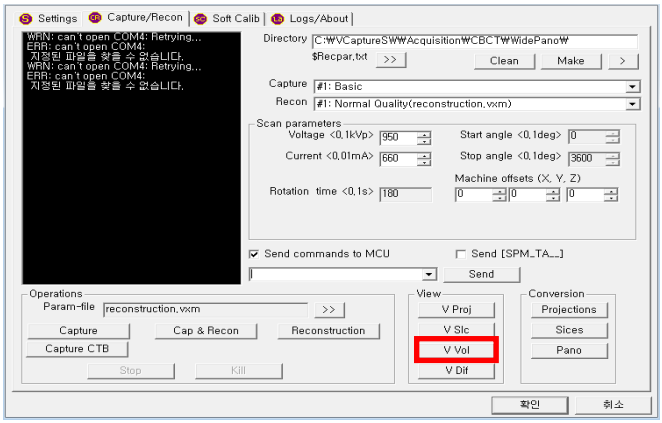


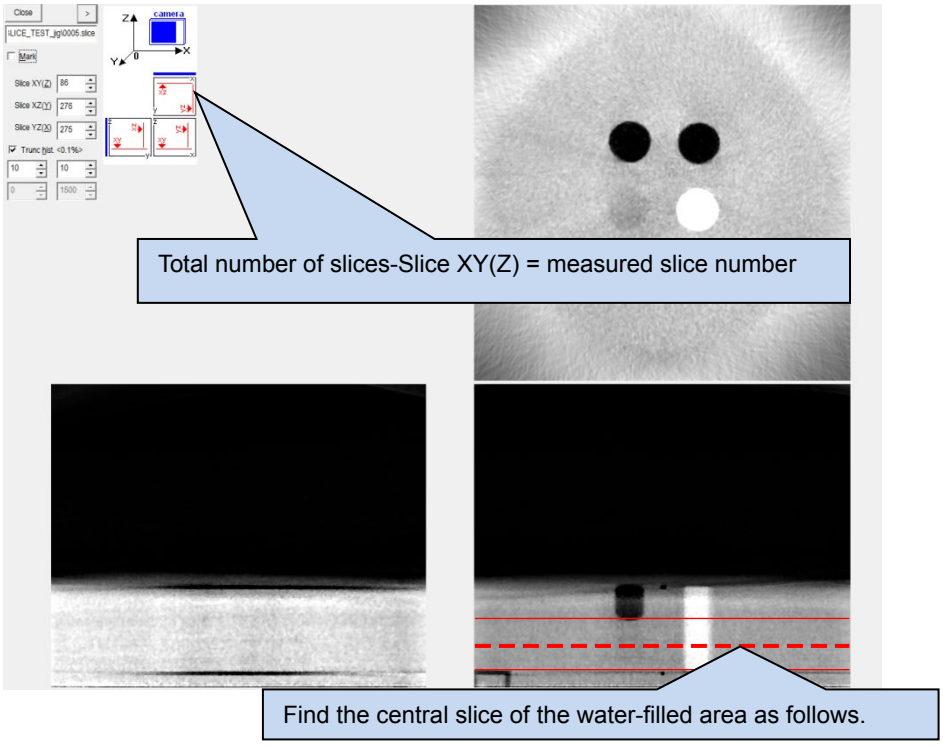
Phantom Jig and CT Number Phantom Position

4. Click the **Ready** button and acquire the image.



5. Click the **V Vol** button.

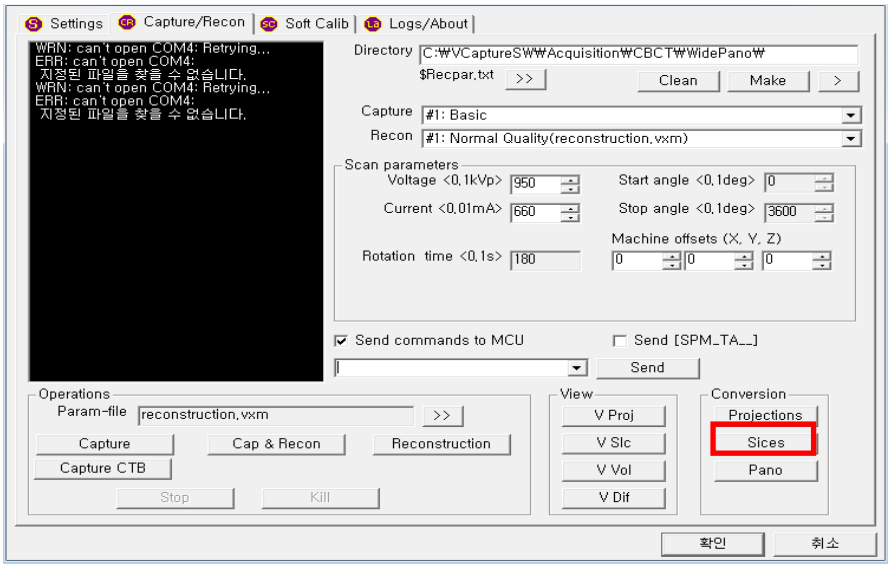


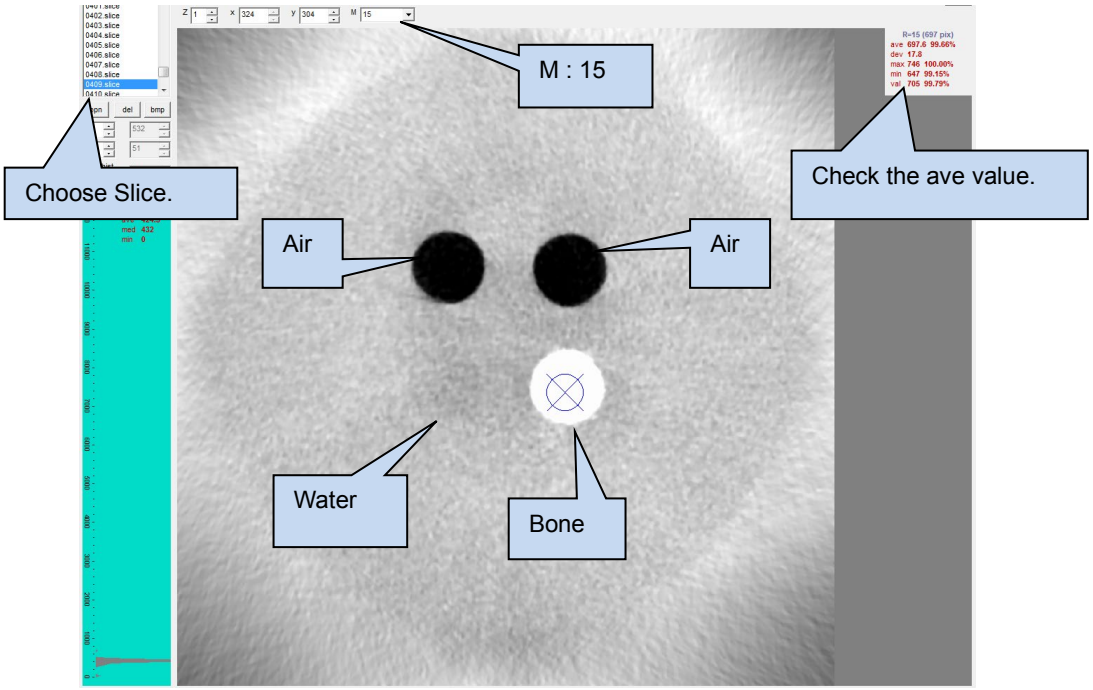


6. Find the central slice of the water-filled section.

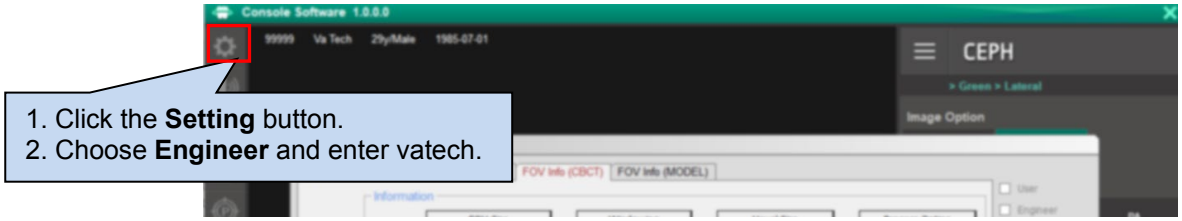
   Ex) Total number of slices-Slice XY(Z) = number of slices measured

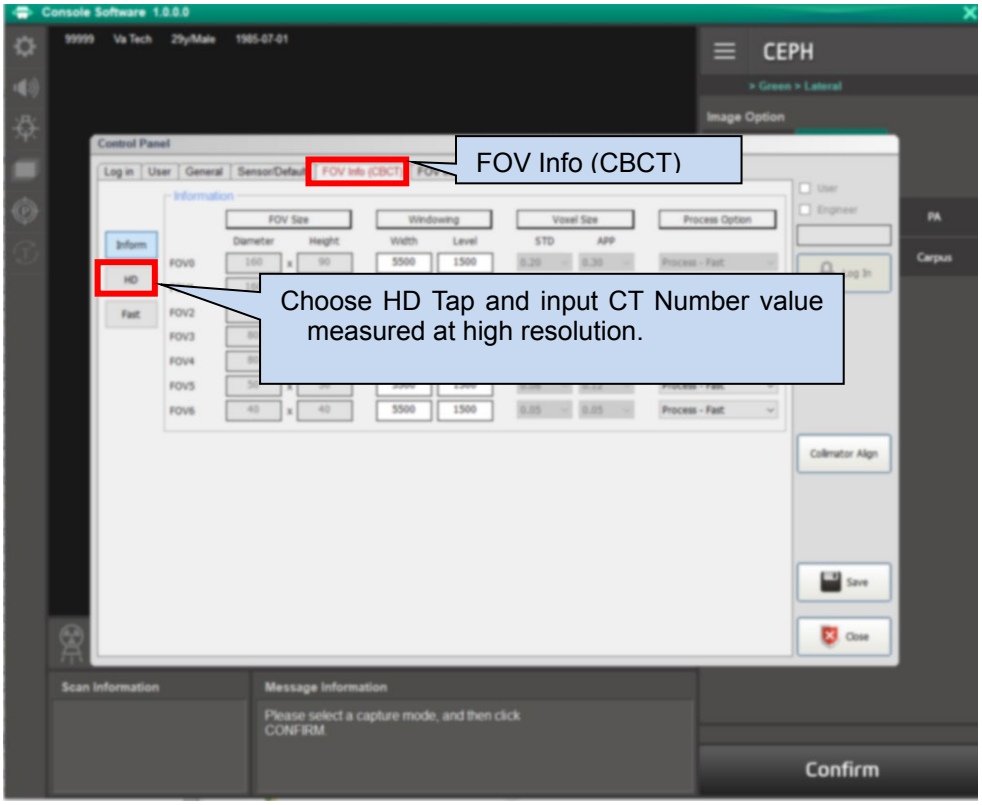
   450 - 100 = 350





7. Open the measurement slice and measure air, water, and bone as above.

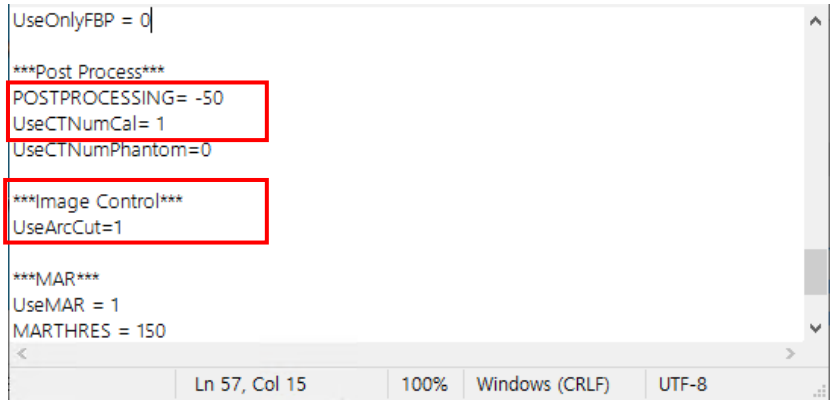




8. Enter the measured CT Number value and click the **Save** button.

9. When CT Number Calibration is completed, open **Reconstruction.vxm** and recover the parameter as shown below.

   - **POSTPROCESSING = 0 → POSTPROCESSING = -50**
   - **UserCTNumCal = 0 → UserCTNumCal = 1**
   - **UseArcCut= 0 → UseArcCut= 1**



10. Capture the CT Number phantom and evaluate CT Number accuracy.
    (refer to 5. CT Number Accuracy evaluation.)

※ CT Number standard value

Parameter	LSL(Lower Specification Limit)	USL(Upper Specification Limit)
Air	-1030	-900
Water	-20	20
Teflon(Bone)	900	1100

11. If CT Number does not meet the standard as above, adjust the CT Number value.

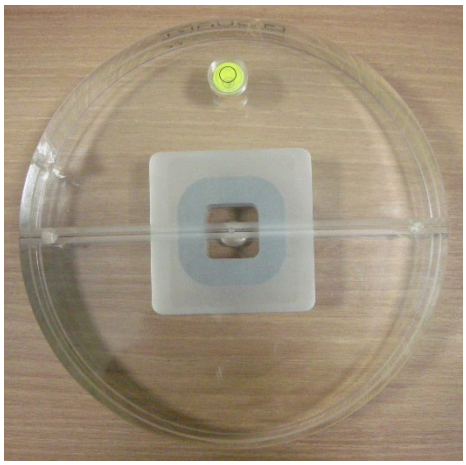
Chapter 3. CT Image Evaluation

1. Spatial Resolution(MTF) evaluation

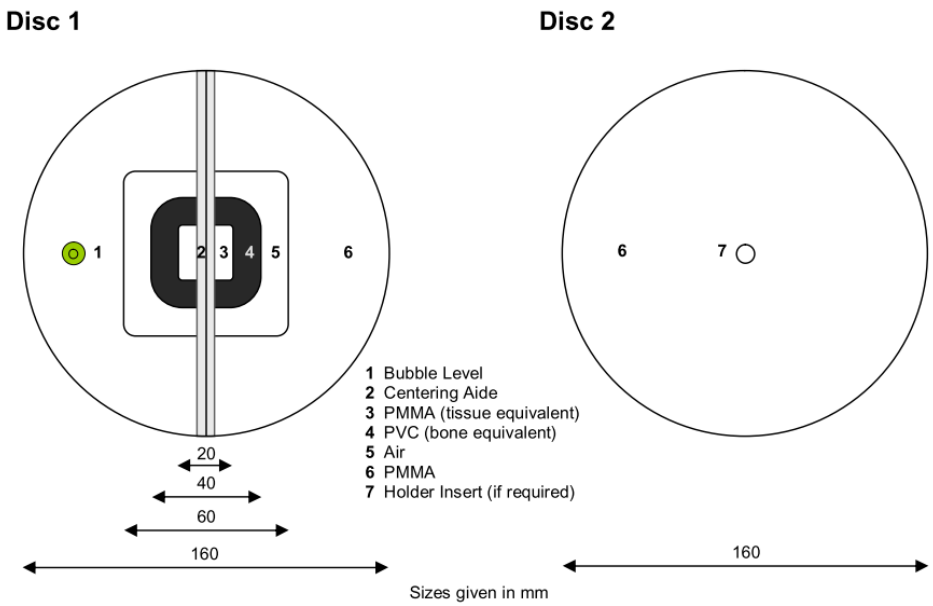
1.1. Spatial Resolution (MTF) standards

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
MTF 10% <lp/mm>	1.00	3.50

1.2. Phantom Specification



QUART: DVT Phantom



1.3. Test Method

1. Run Console Software and click CBCT to go into CBCT mode.
2. Choose FOV 8x8/Adult/Normal/High Resolution/Standard as the image option and click the Confirm button.
3. Put the Phantom jig on the unit and make the phantom jig level by using bubble level and three align pins.
4. Put the DVT Phantom on the phantom jig.
5. Press the **Ready** button and acquire an image.
6. When reconstruction is completed, save the CT folder name in the C:\VCaptureSW\ImageOutput folder as CT_DVT
7. Run the DVTpro Software and conduct the evaluation.

1.4. Test Result

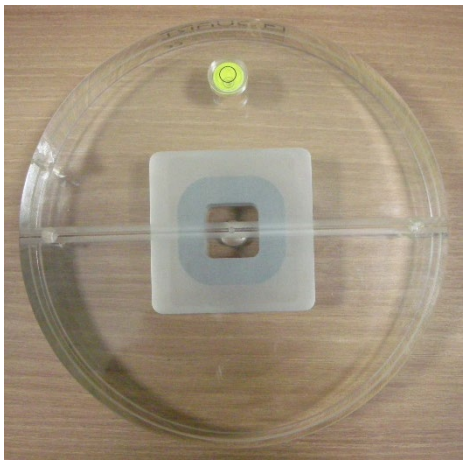
Parameter	LSL	Measurement value	USL	Pass/Fail
MTF 10% <lp/mm>	1.00		-	

2. Contrast evaluation

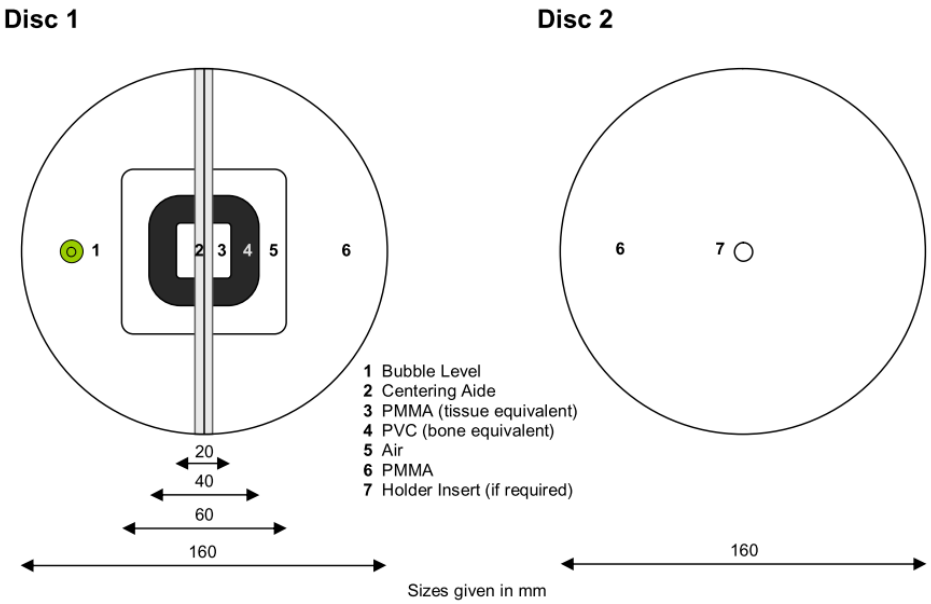
2.1. Contrast standards

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
Contrast<1000HU>	500	-

2.2. Phantom Specification



QUART: DVT Phantom



2.3. Test Method

1. The evaluation is conducted in the same manner as in the evaluation method in Section 1.3.

2.4. Test Result

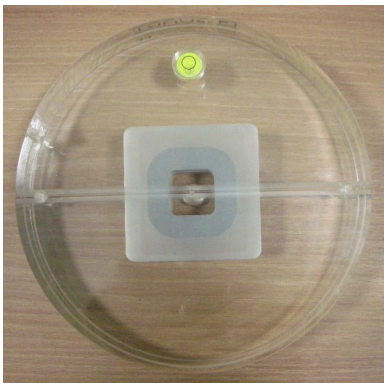
Parameter	LSL	Measurement value	USL	Pass/Fail
Contrast<1000HU>	500		-	

3. Noise evaluation

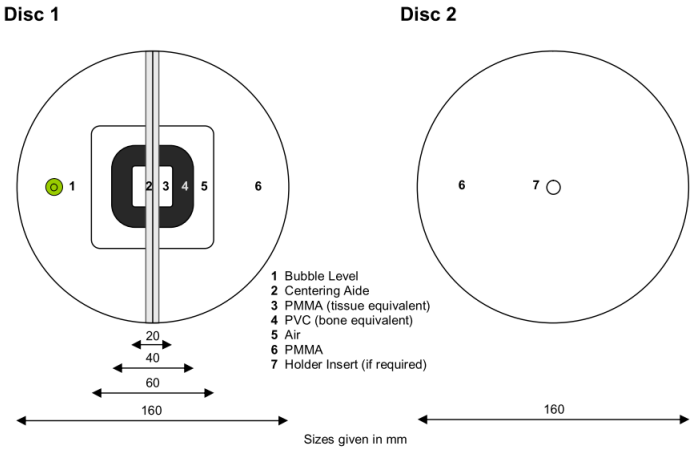
3.1. Noise standards

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
Noise	5.00	-

3.2. Phantom Specification



QUART: DVT Phantom



3.3. Test Method

1. The evaluation is conducted in the same manner as in the evaluation method in Section 1.3.

3.4. Test Result

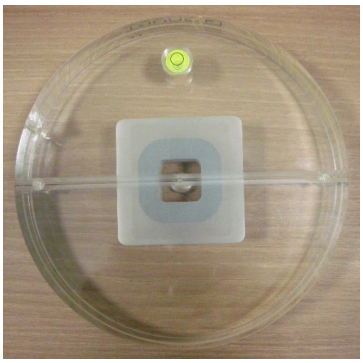
Parameter	LSL	Measurement value	USL	Pass/Fail
Noise(CNR)	500		-	

4. Homogeneity evaluation

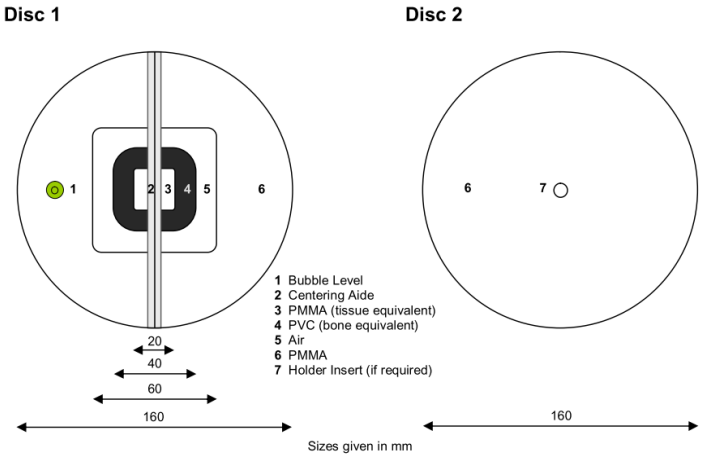
4.1. Homogeneity standards

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
Homogeneity	10.00	150.00

4.2. Phantom Specification



QUART: DVT Phantom



4.3. Test Method

1. The evaluation is conducted in the same manner as in the evaluation method in Section 1.3.

4.4. Test Result

Parameter	LSL	Measurement value	USL	Pass/Fail
Homogeneity	10.00		150.00	

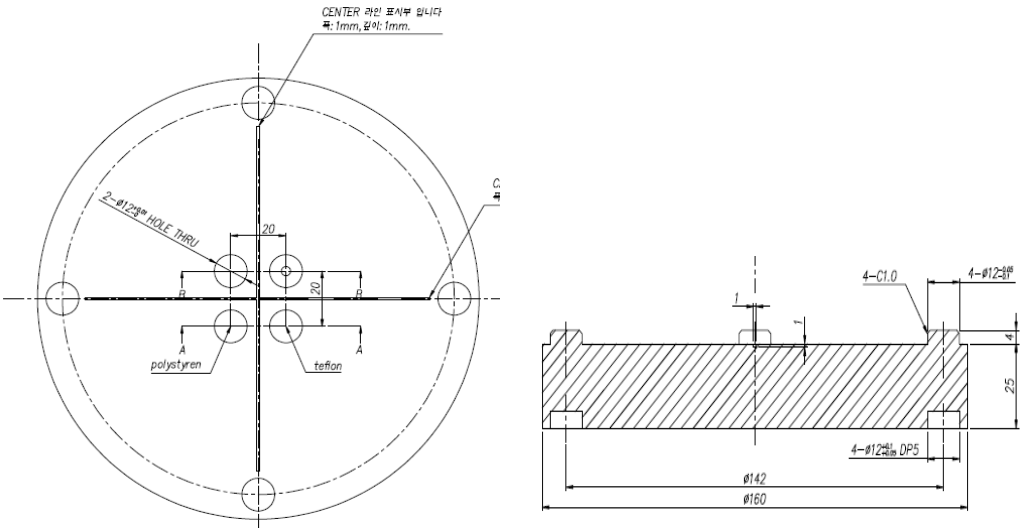
5. CT Number Accuracy evaluation

5.1. CT Number standards

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
Air	-1030	-900
Water	-20	20
Teflon	900	1100

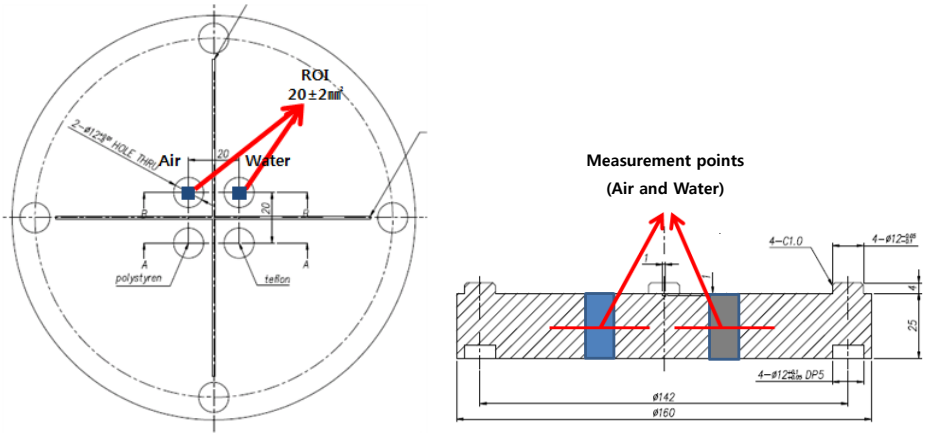
5.2. Phantom Specification

CT Number Phantom



5.3. Test Method

1. Put the Phantom jig on the unit and make the phantom jig level by using bubble level and three align pins.
2. Put the CT Number Phantom on the phantom jig.
3. Run the Console Software and click the CBCT button to go into CBCT mode.
4. Choose the FOV 8x8/Adult/Normal/High Resolution/Standard as the image option and click the Confirm button.
5. Press the Ready button and acquire an image.
6. When the reconstruction is completed, save the CT folder name in the C:\VCaptureSW\ImageOutput folder as CT_CTnum Phantom.
7. Open the saved image through 3D Viewer.
8. Go to the Axial view in full-screen mode and click Measurement > ROI (for Ez3D i)
9. Make the boxes(20±2 mm2) on the WATER, BONE(TEFLON), and AIR area to measure the CT Number value and check if it does meet the standard.



5.4. Test Result

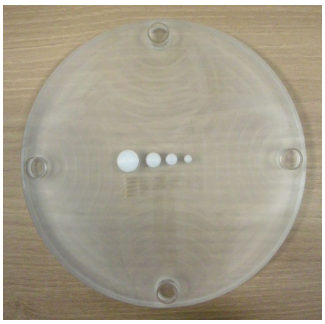
Parameter	LSL	Measurement value	USL	Pass/Fail
Air	-1030		-900	
Water	-20		20	
Teflon	900		1100	

6. High Contrast Resolution evaluation

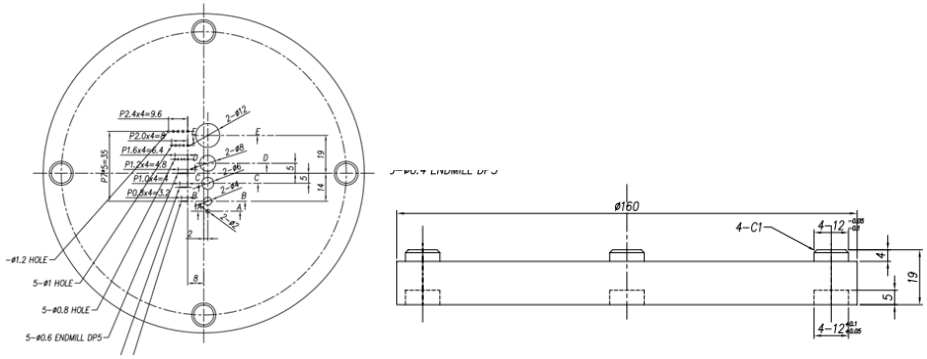
6.1. High Contrast Resolution standards

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
High Contrast Resolution	-	1.0 mm

6.2. Phantom Specification



S&C Phantom



6.3. Test Method

1. Put the Phantom jig on the unit and make the phantom jig level by using bubble level and three align pins.
2. Put the S&C Phantom on the phantom jig.
3. Run the Console Software and click the CBCT button to go into CBCT mode.
4. Choose the FOV 8x8/Adult/Normal/High Resolution/Standard as the image option and click the Confirm button.
5. Press the Ready button and acquire an image.
6. When the reconstruction is completed, save the CT folder name in the C:\VCaptureSW\ImageOutput folder as CT_S&C Phantom.
7. Open the saved image through 3D Viewer.
8. Go to the Axial view in full-screen mode and adjust the brightness and contrast of the image.
9. Make sure that you can see the minimum size of Air hole and PE(PolyEthylene) cylinder at the distance of 50 cm(20 inches) from the monitor.

6.4. Test Result

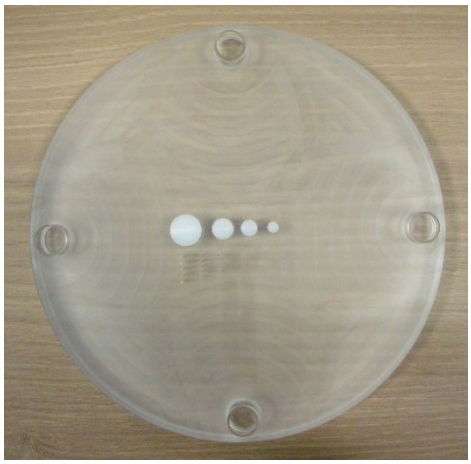
Parameter	LSL	Measurement value	USL	Pass/Fail
High Contrast Resolution	-		1.0 mm	

7. Low Contrast Resolution evaluation

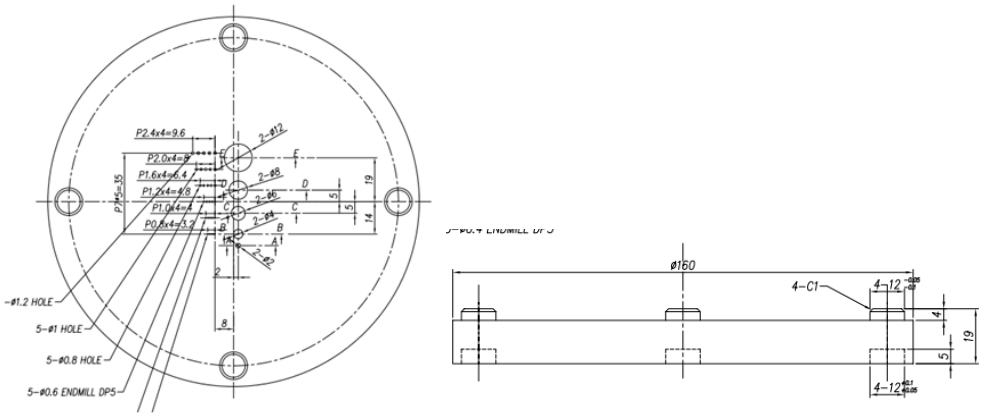
7.1. Low Contrast Resolution standards

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
Low Contrast Resolution	-	9.0 mm

7.2. Phantom Specification



S&C Phantom



7.3. Test Method

1. The evaluation is conducted in the same manner as in the evaluation method in Section 6.3.

7.4. Test Result

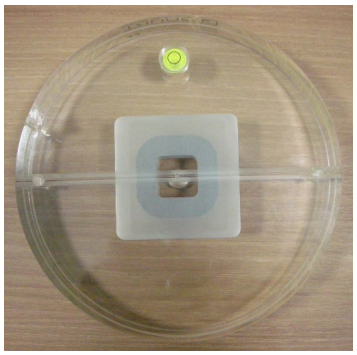
Parameter	LSL	Measurement value	USL	Pass/Fail
Low Contrast Resolution	-		8 mm	

8. Slice Thickness Evaluation

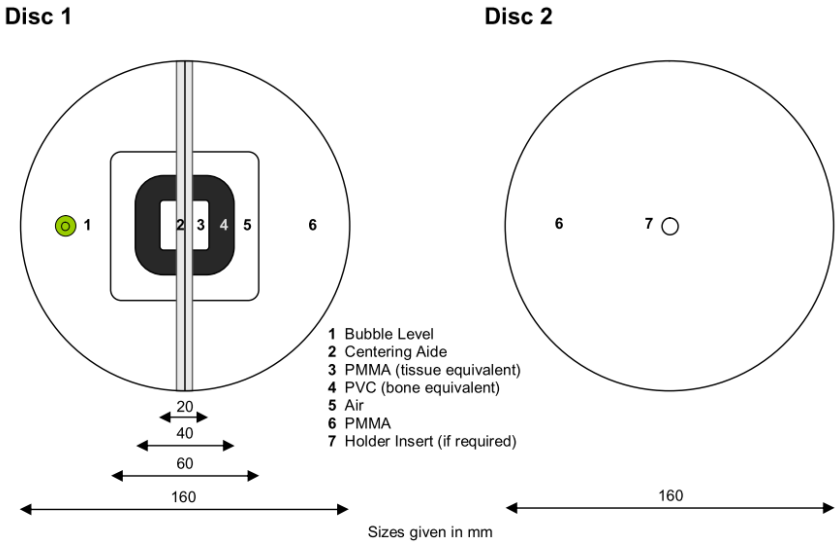
8.1. Slice Thickness Standard

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
Slice Thickness	38.0 mm	42.0 mm

8.2. Phantom Specification



QUART: DVT Phantom



8.3. Test Method

1. Open the CT_DVT Phantom image captured in Section 1.3 through the 3D Viewer
2. Measure the length of the phantom in the Sagittal view.

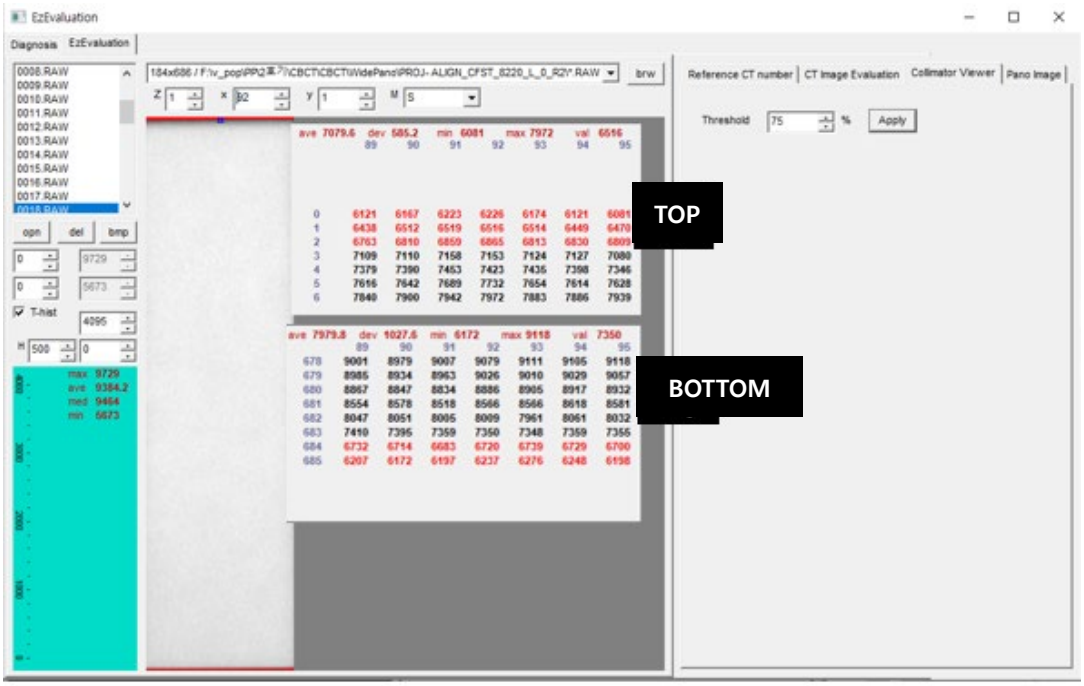
8.4. Test Result

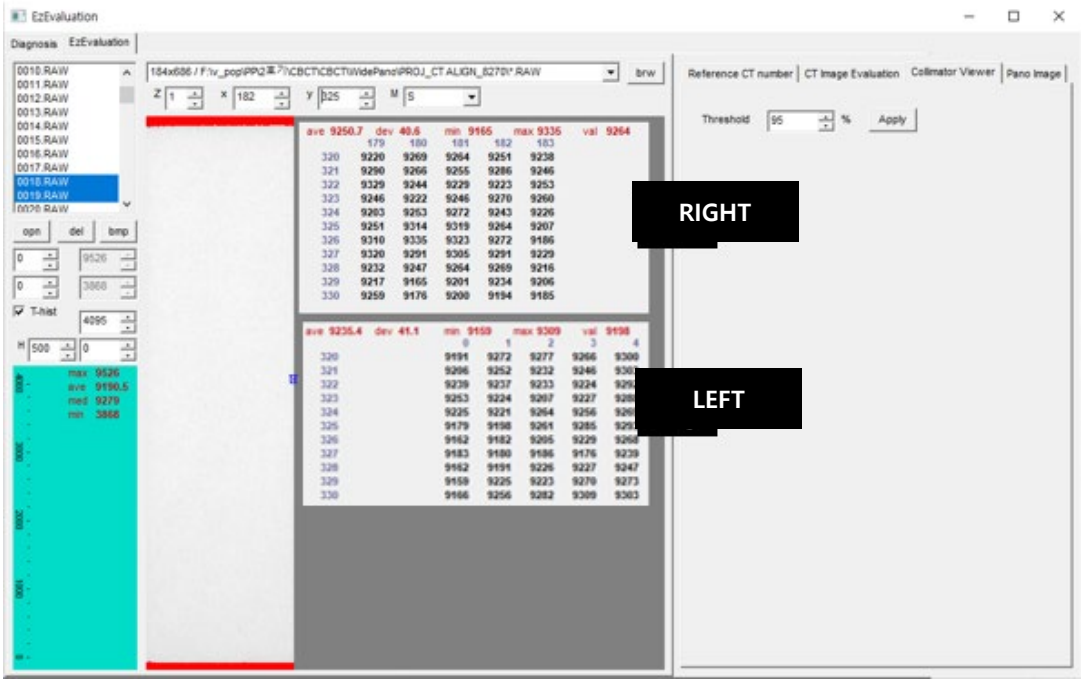
Parameter	LSL	Measurement value	USL	Pass/Fail
Slice Thickness	38.0 mm		42.0 mm	

9. Collimator Alignment Evaluation

9.1. Collimator Alignment Standard

Parameter		LSL (Lower Specification Limit)	USL (Upper Specification Limit)
Threshold 95%	Left	1	2
	Right	1	2
Threshold 75%	Upper	1	10
	Lower	1	10





9.2. Test Method

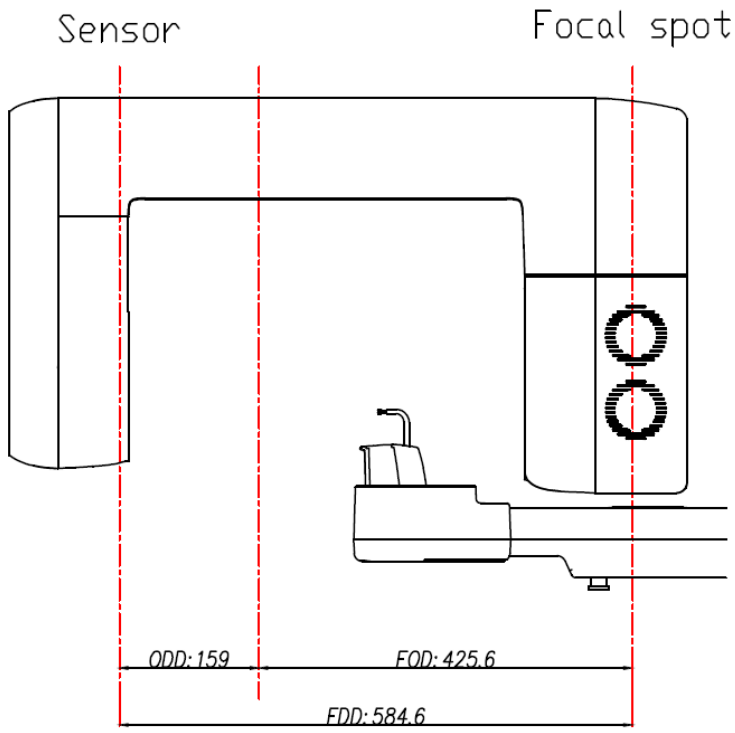
1. Complete the collimator setup and acquire the image in the stopped state.
2. Run the C:\VCaptureSW\Util\EzEval_Phantom\EzEval.exe program.
3. Input the threshold 75%, and check the upper and lower.
4. Input the threshold 95%, and check the left and right.
5. Check whether the Collimator Alignment Result is satisfied with the standard.

9.3. Test Result

Parameter		LSL	Measurement value	USL	Pass/Fail
Threshold 95%	Left	1		2	
	Right	1		2	
Threshold 75%	Upper	1		10	
	Lower	1		10	

Chapter 4. PANO Image Optimization

1. Geometry information

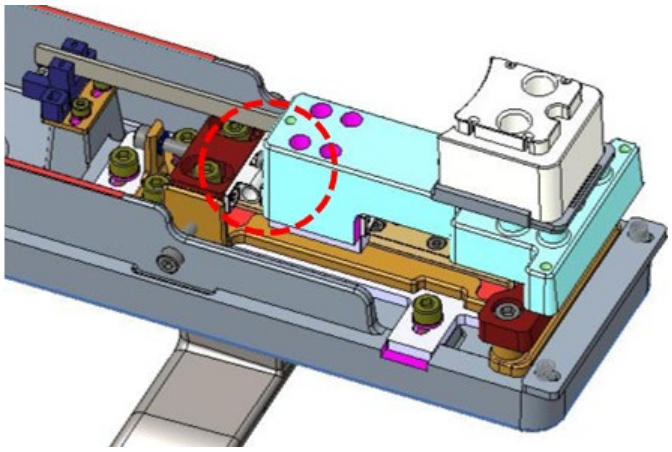


<PANO>

- FDD: Distance from the X-ray source to the sensor (584.6 mm)
- FOD: Distance from the X-ray source to the center of rotation (425.6 mm)

2. Equipment default values

2.1. Bite location (PANO mode)



1. Move the bite position according to the Modality as shown in the image above.
2. PANO Mode: The position combined with the stopper in the direction (Left side) of the column

3. PANO Sensor Calibration

To optimize PANO image quality in the equipment, the operator should perform the Sensor setting & calibration operation according to the following procedures.

Regular Sensor Calibration check-up is recommended to perform for image optimization against temperature and humidity variation.

3.1. PANO Sensor Calibration Standard

- **PANO Sensor Dark Calibration Standard Value**
  - Dark data file median value: **700 ~ 2300**
- **PANO Sensor Bright Calibration Standard Value**

※ Bright standard value: 5 points with Cu 1 mm filter

Bright		Min	Max
Median value	Cal Point 1	50	80
	Cal Point 2	80	200
	Cal Point 3	200	400
	Cal Point 4	400	600
	Cal Point 5	600 ~	

NOTICE	• From the achieved PANO Sensor Bright Calibration data file, the 1 Point Bright Data file and 5 Point Bright data file should meet the standard value. Other results from different points Bright Datafile can be varied by characteristics of each sensor.

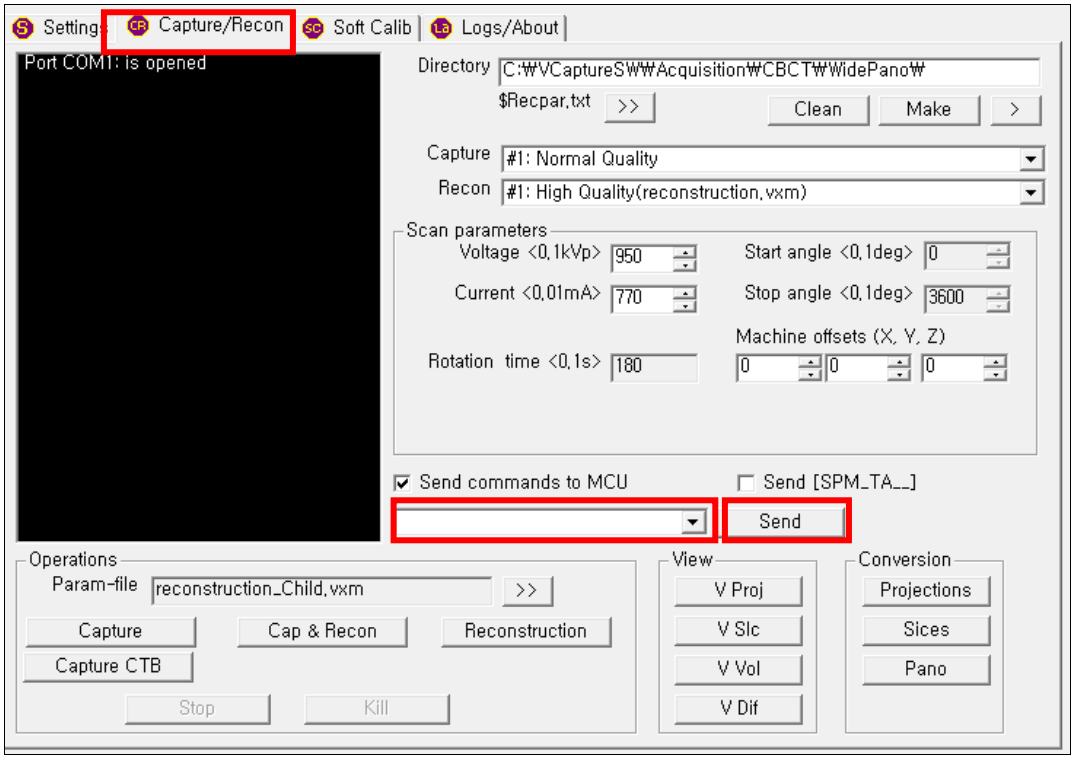
3.2. Before PANO sensor calibration

1. Remove the Normal Chin Block from the equipment.
2. Disassemble the Tube case (Refer to **Chapter 1. Hardware Part Service Guide**).
3. Rename the CAL folder (*C:\VCaptureSW\Acquisition\PANO\WidePANO\CAL*) name for backup.

3.3. PANO sensor setting

NOTICE	• VAKCAP.exe file is required for PANO Sensor Calibration operation. Path : C:\VCaptureSW\Acquisition\PANO\WidePANO folder
IMPORTANT	• Before the PANO Sensor Calibration operation begins, the operator must back up the prior PANO Sensor Calibration folder. PANO Sensor Calibration file folder : C:\VCaptureSW\Acquisition\PANO\WidePANO\CAL folder

1. Run the VACAP.exe file in the C:\VCaptureSW\Acquisition\PANO\WidePANO folder.
2. Click the **Capture/Recon** tab.



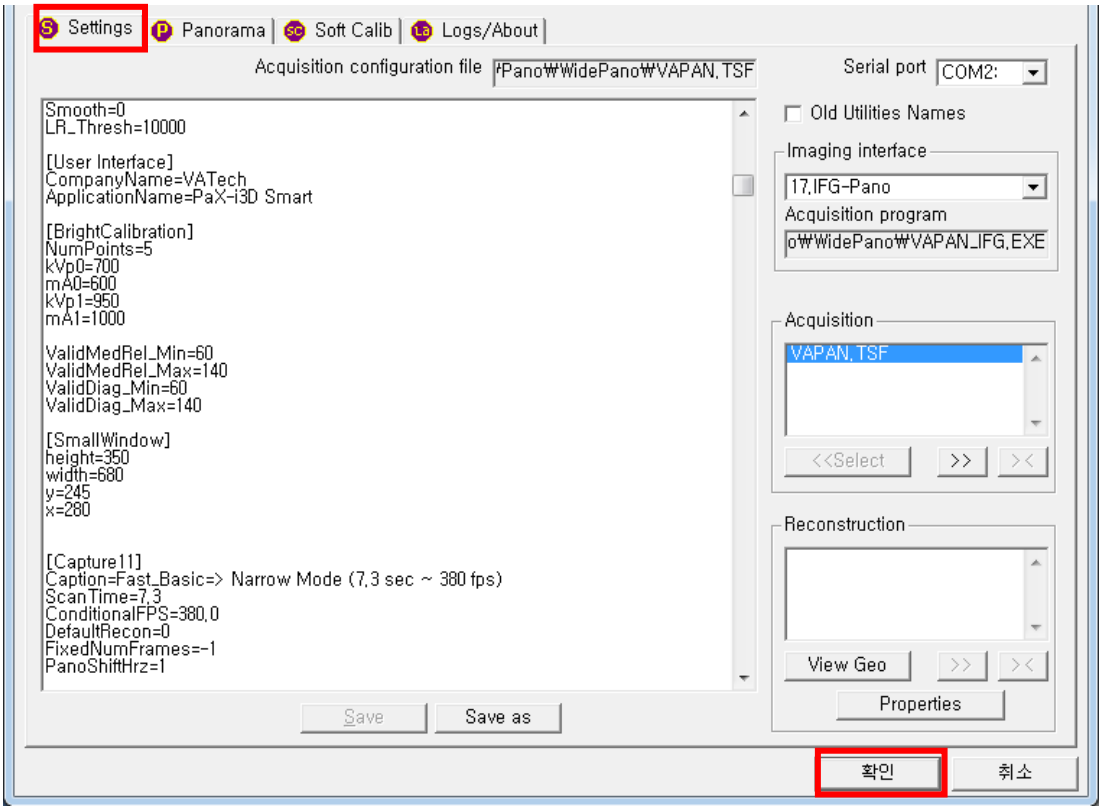
3. Send the following commands in the command field.

PANO Pixel Size: 30 x 686

Command	Function
[SPM_PANO]	PANO mode
[SPM_PSON]	PANO sensor power on
[SPM_FISS_0001]	Normal Mode : 4x4 binning & High gain
[SPM_FIPM_0004]	Sensor size setting
[SPM_FISM_0001]	Sensor clock (1:External, 0: Internal)
[SPM_FREQ_0238]	Sensor frequency 238 Hz
[SPM_COLM_0003]	1T Cu Collimator location If Cu Filter is not covered, send [SPM_CDST_XXXX] to adjust.
[SPM_COLM_0007]	PANO Collimator Position

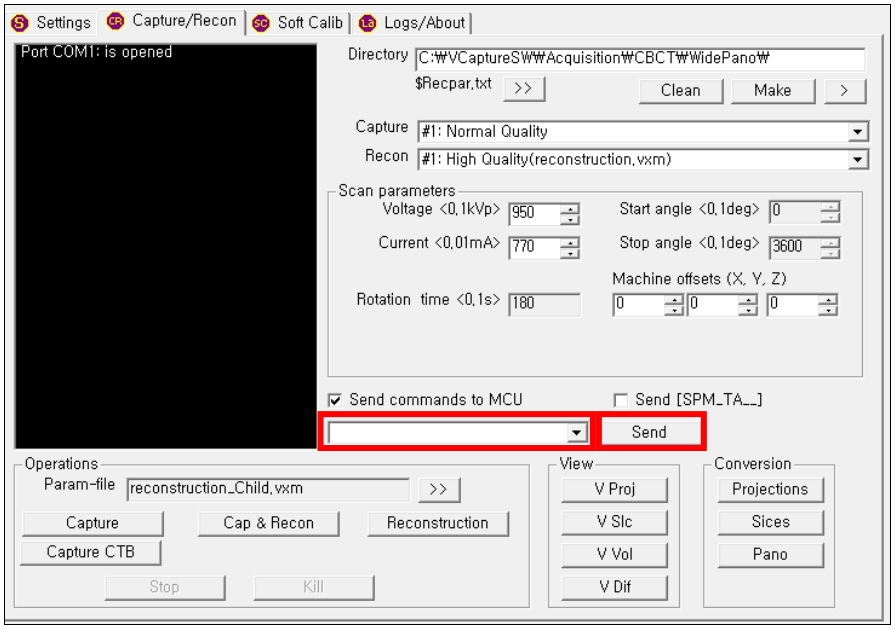
3.4. PANO sensor: Dark calibration

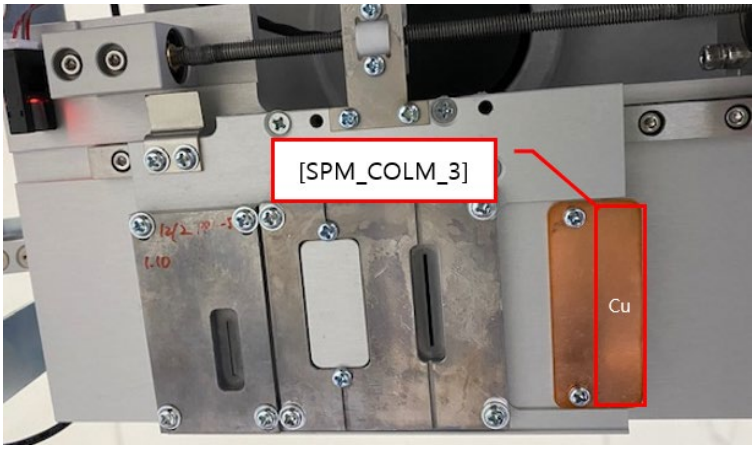
1. Run the VACAP.exe file in the C:\VCaptureSW\Acquisition\PANO\WidePANO folder.
2. Click the **Settings** tab.
3. Click the **OK** and restart the program.



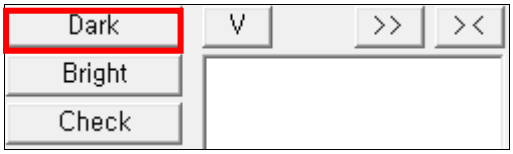
4. Click the **Capture/Recon** tab.

5. Send [SPM_PANO], [SPM_CSON], [SPM_FISS_0001], [SPM_FIPM_0004], [SPM_FISM_0001], [SPM_COLM_3] commands to the command window to set the sensor and collimator.

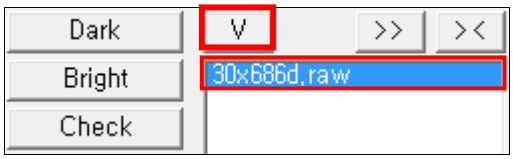




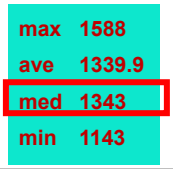
6. Click the **Dark** button to acquire an image.



1) Choose **30x686d.raw** and click the **V** button to open View16.



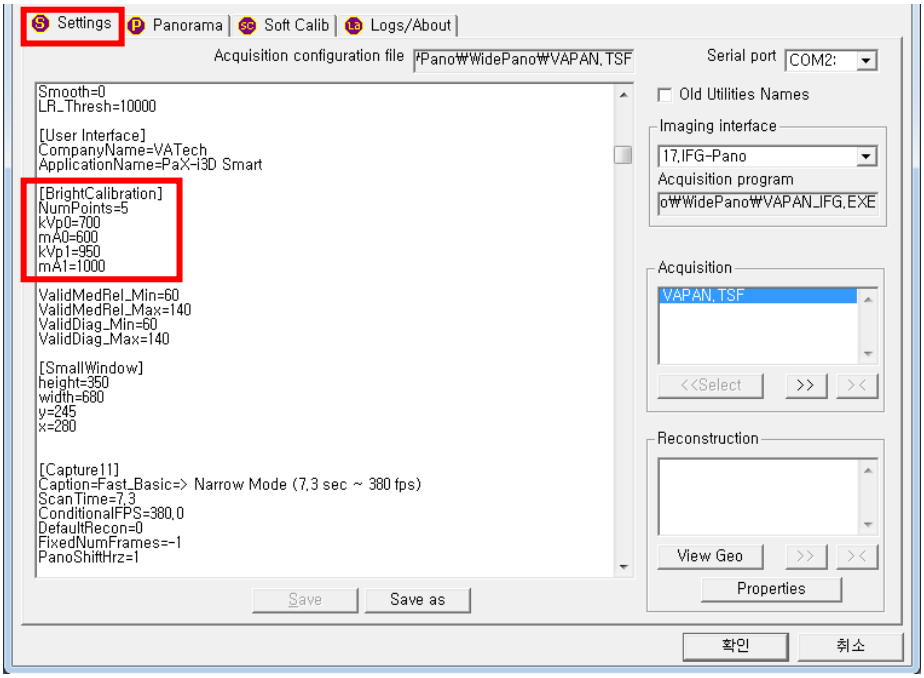
2) Make sure that the Median value meets the standard(700~2300).



3.5. PANO sensor: Bright calibration

	• Stay outside of the X-ray shielding room during Bright Calibration data achievement.

1. Run the C:\VCaptureSW\Acquisition\Pano\WidePANO\VACAP.exe file.
2. Click the **Settings** tab and ensure that **[BrightCalibration]** kVp and mA are set



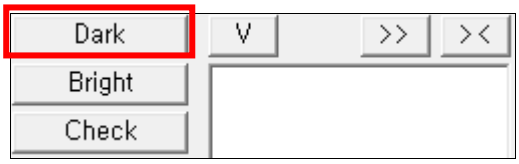
3. When acquiring 5 Point cal, the initial value is as follows, and it is set according to the standard by adjusting kVp.

Acquisition conditions		5 point
exposure condition	kVp0	570
	mA0	550
	kVp1	850
	mA1	870

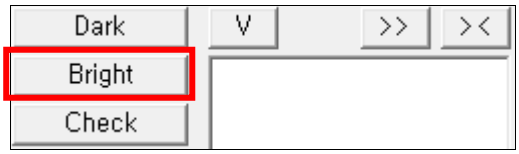
NOTICE	1. If the standard is not satisfied, set them according to the standard by adjusting kVp0 and kVp1. 2. Click the "Bright" button to obtain 5 points of Bright Cal Data and check if the following standard is met.

4. Send the **[SPM_PSON]** command to supply power to the PANO Sensor.

5. Click the **Dark** button to acquire Dark Calibration Data.

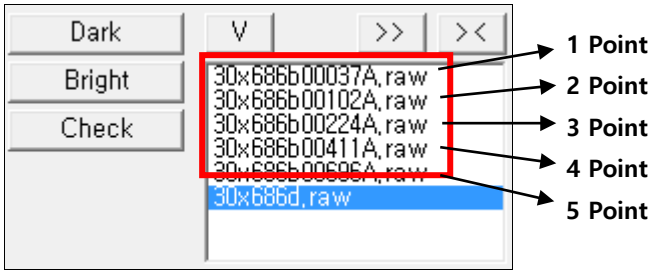


6. Click the **Bright** button.

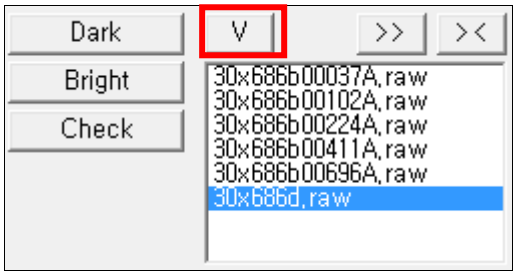


7. When the **HOLD THE BUTTON FOR ~3 SEC** message shows up on the status window, press the X-ray Exposure switch. Then release the button when the **RELEASE THE BUTTON** shows up.

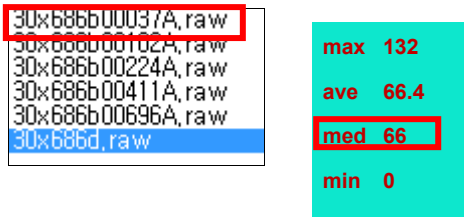
8. Do step 7 repeatedly until all 5 point bright calibration data are acquired.



9. Click the **V** button to open View16.



10. Click the 1 Point Bright Calibration data file on View16 and make sure that the Median value meets the standard.



※ Bright standard value: 5 points with Cu 1 mm filter

Bright		Min	Max
Median value	Cal Point 1	50	80
	Cal Point 2	80	200
	Cal Point 3	200	400
	Cal Point 4	400	600
	Cal Point 5	601 ~	

If the median value does not meet the requirement, do the steps that follow:

- Click the **Settings** tab.
- Adjust **kVp0** value by 10 in the **[BrightCalibration]** field.
- Click the **Save** button**.**
- Acquire Bright calibration data again.

11. Click the 5 Point Bright Calibration data file on View16 and make sure that the Median value meets the standard.

If the median value does not meet the requirement, do the steps that follow:

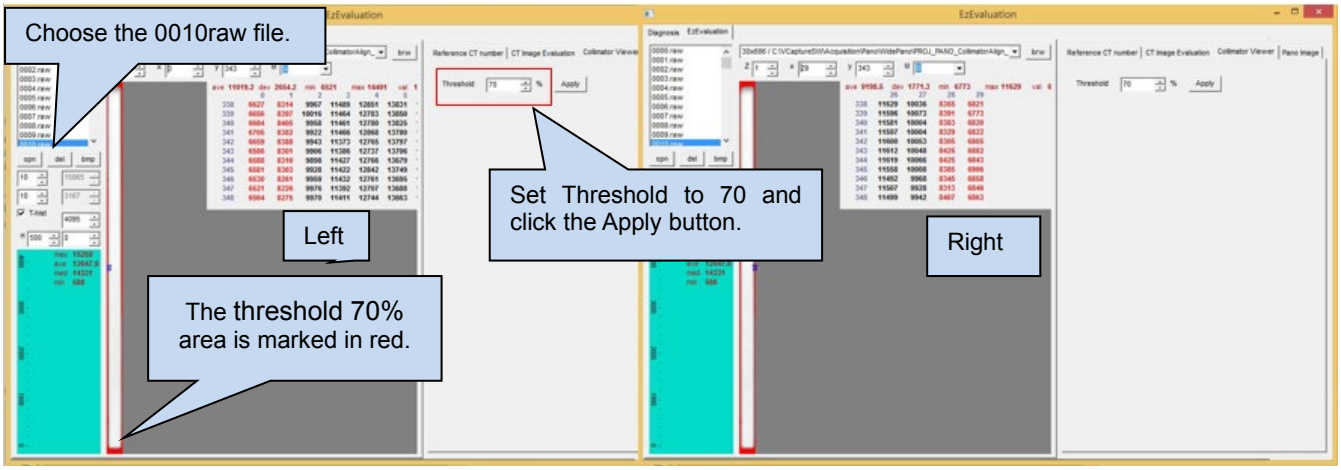
- Click the **Settings** tab.
- Adjust **kVp1** value by 10 in the **[BrightCalibration]** field.
- Click the **Save** button.
- Acquire Bright calibration data again.

NOTICE	• From the achieved PANO Sensor Bright Calibration data file, the 1 Point Bright Data file and 5 Point Bright data file should meet the standard value. Another result from different points Bright Datafile can be varied by the characteristics of each sensor.

4. PANO Collimator Alignment

4.1. PANO Collimator Alignment

1. Run the C:\VCaptureSW\Acquisition\PANO\WidePANO\VACAP.exe file.
2. Send [SPM_PANO], [SPM_PSON], [SPM_FIPM_0004], [SPM_FISS_0001], [SPM_FISM_0001], [SPM_COLM_0007] commands to the command window to set the PANO sensor and collimator.
3. Send [SPM_HV___0740], [SPM_HA___1200], and [SPM_SSB_] commands in the VACAP's Command window, and acquire the image.
4. Run EzEval.exe file, choose EzEvaluation for the tap menu on the top left and choose collimator viewer from the tap menu on the top right.



5. Set the threshold value concerning the following standard, and check 0010.raw to check if it satisfies the collimator alignment standard below.
6. If the Left/Right does not meet the standard, adjust the [SPM_CCST_XXXX] command.
7. Top/Bottom should be 1~10 pixels. If it does not meet the standard, check the collimator position and move it.

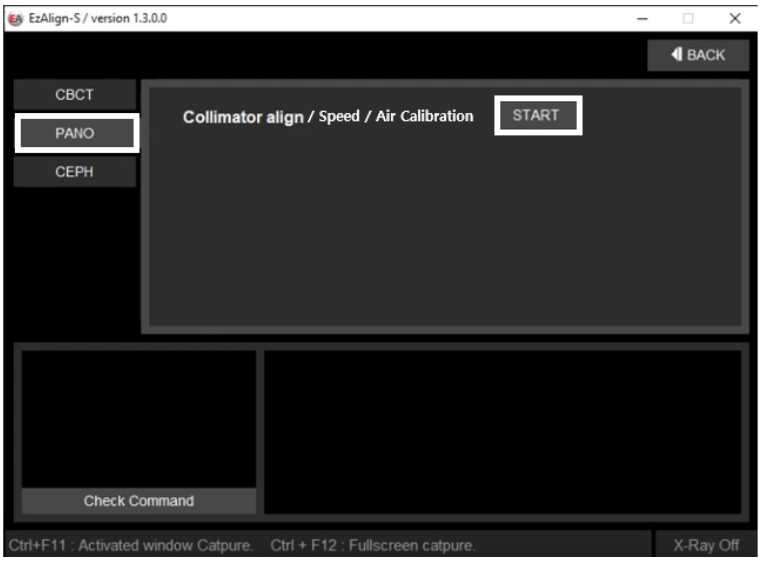
※ Collimator Alignment standard value

Collimator		Min pixels	Max pixels
Threshold 70%	Left	2	2
	Right	1	2
	Top	1	10
	Lower	1	10

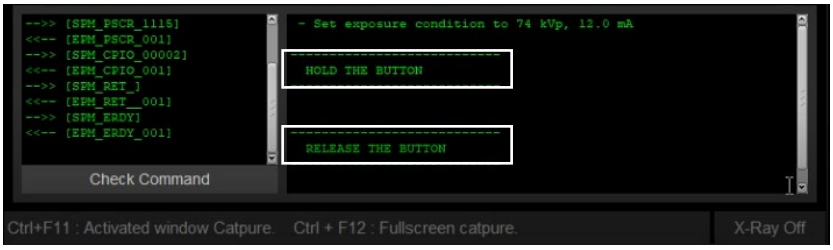
NOTICE

- If Collimator Alignment was performed and changed values, you must perform Collimator Speed Calibration.
- Collimator Align can also be done using the EzAlign program provided by the manufacturer.

4.2. PANO Collimator Alignment with EzAlign



1. Select **PANO** and click the **Start** button: The system will move into its capturing position and Collimator auto-align will be started.
2. Remove the Bite Block.
3. When you see the message **HOLD THE BUTTON** as marked in the white box below, press and hold the exposure switch until **RELEASE THE BUTTON** message appears.

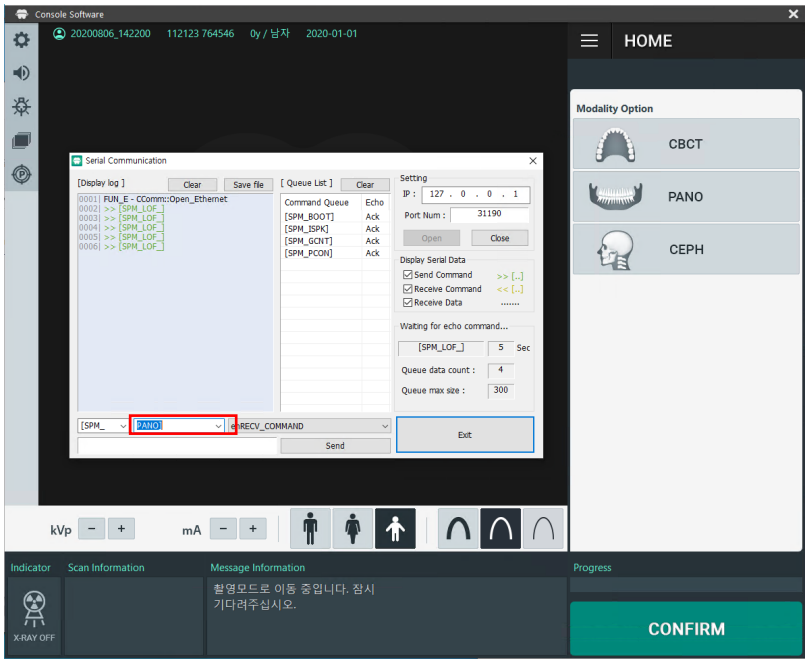


4. If the system displays the **HOLD THE BUTTON** message again instead of the succeeding message, repeat step 3.
5. If the PANO Auto Alignment is completed successfully, the pop-up message which notifies the completion of the alignment displays on the screen. Then, click the **OK** button to start **PANO Collimator Speed Alignment**.
6. If the Error message appears, follow the guide. Then proceed the steps 1~5.

5. PANO Collimator Speed Alignment

5.1. PANO Collimator Speed Alignment

1. Run Console Software.
2. Press the shortcut key [Ctrl+s] to open the Serial Communication command window.



3. Send the [PPON_0] command in the red square.
4. Press the Exit button to exit the command window.
5. Acquire the image without an object in Pano Normal Mode.
6. Run C:\VCaptureSW\Utility\EzEval_Phantom\EzEval.exe file.

Step 1. Check if the left cutting pixel at the middle position is 2 pixels.

Apply Threshold 70% and check whether the number of pixels cut based on the left of the average projection at the middle position is 2 pixels.

(Left Cutting Pixel of Average Projection at Middle Position = Collimator Align Left Cutting Pixel)

NOTICE

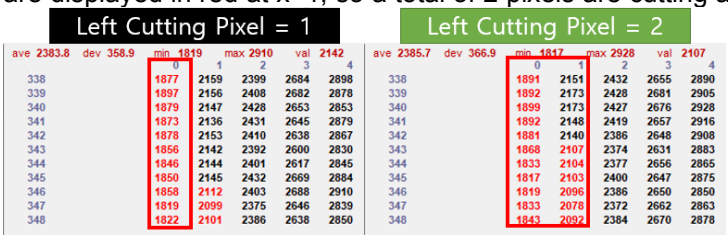
Projection position	Projection range	
Beginning	87	387
Middle	1524	1624
End	2820	3120

▲ Average projection calculation range according to Projection position

NOTICE

The standard of the number of cutting pixels is measured as follows.

1. Go to x=0, y= 343 at the middle position of projection.
2. If more than half of the cutting area (indicated in red) appears in each x value, it is 1 pixel. If not, it is 0 pixel.
3. For example, in the picture on the right below, 6 cutting areas are displayed in red at x=1, so a total of 2 pixels are cutting areas.



▲ Cutting Pixel calculation

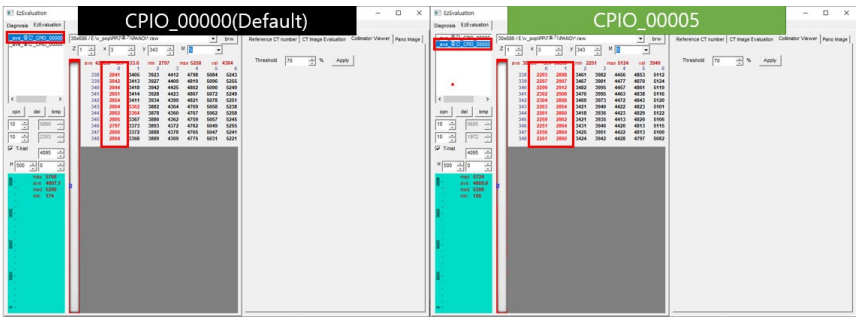
If the left cutting pixel at the middle position does not satisfy the 2 pixels, perform the following operation.

* Send the [SPM_CPIO_0XXXX] command to move the collimator so that it is located at the recommended standard.

Command	Function
[SPM_CPIO_0XXXX]	When the value increases, the number of Projection Left Cutting Pixels increases.
[SPM_CPIO_1XXXX]	When the value increases, the number of Projection Left Cutting Pixels decreases.

*. It moves by 1 pixel for every 5 CPIO values.

([SPM_CPIO_00000] = Default value)



▲ The trend of Left Cutting Pixel according to CPIO value

Step 2. Checking the reference of the end position from the beginning

If Step 1 is satisfied, check if the Left Cutting Pixel of the average projection at the Beginning/Middle/End position satisfies the standard range below.

Exposure section	Projection range		Manufacturing operation standards						
Beginning	87	387	1	1	2	2	2	3	3
Middle	1524	1624	2	2	2	2	2	2	2
End	2820	3120	1	2	1	2	3	2	3

▲ Left Cutting Pixel Standard of Average Projection at Beginning/Middle/End Position

If not, perform the following tasks to satisfy the standard.

i. When the number of Left Cutting Pixels is Beginning <Middle <End

: Increase the value of [SPM_PSCR_XXXX]. (Note: [SPM_PSCR_1125] = Default value)

* It moves by 1 pixel for every 5 PSCR values.

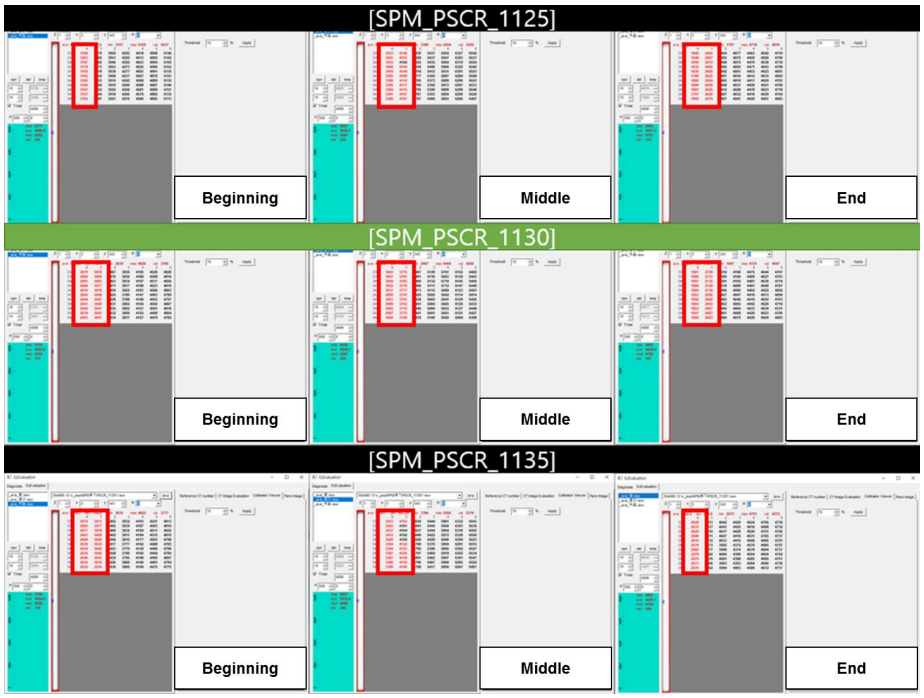
When the **PSCR** value **increases**, the number of Left Cutting Pixels of the projection at the **end position decreases**.

ii. When the number of Left Cutting Pixels is Beginning> Middle> End

: Decrease the value of [SPM_PSCR_XXXX]. (Note: [SPM_PSCR_1125] = Default value)

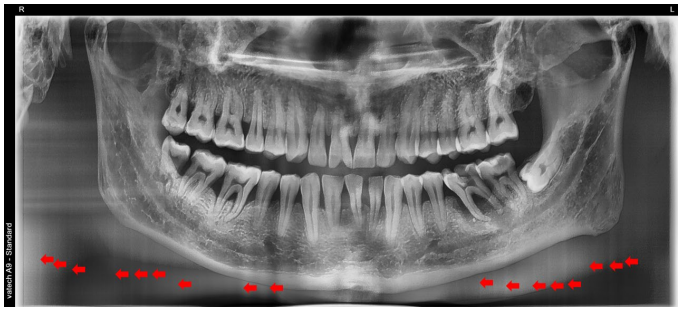
* It moves by 1 pixel for every 5 PSCR values.

When the **PSCR** value **decreases**, the number of Left Cutting Pixels of the projection at the **end position increases**.



▲ The trend of the number of Left Cutting Pixels in the exposure section according to PSCR

iii. When the standard range is satisfied by i, ii, but vertical lines are expressed in the final skull image (Refer to the image below)

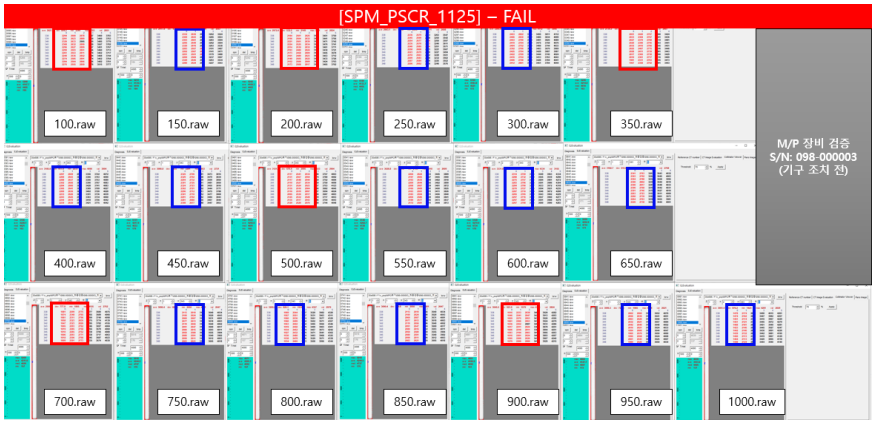


▲ Vertical line expression image (red arrow = vertical line)

Compare the difference between Left Cutting Pixels of Projection 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000.raw

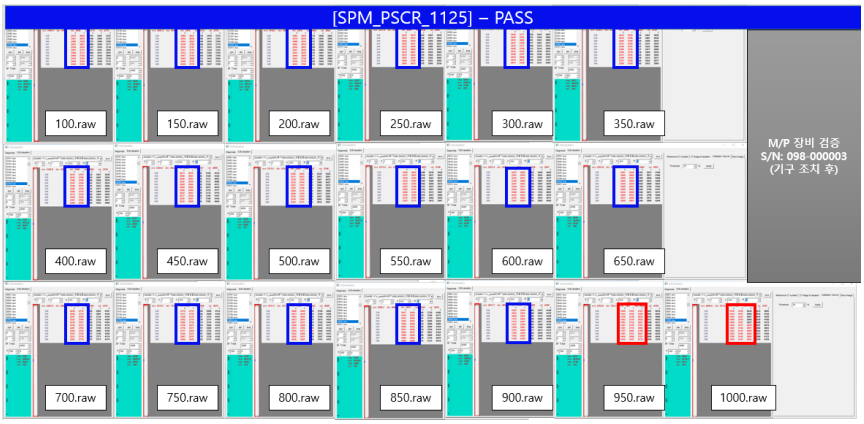
Starting from 100.raw, check if the difference of Left Cutting Pixels between specific projection and next projection is more than 1 pixel.

Check if the difference of left cutting pixels between a specific projection and the next projection occurs in more than 3 cases. (Refer to the image below)



▲ Projection Left Cutting Pixel image - Fail

In case of the above situation, check the hardware part related to the movement of the collimator and sensor.



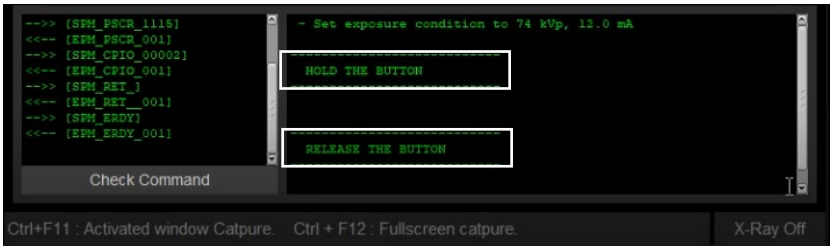
▲ Projection Left Cutting Pixel image - Pass

▲ Normal Skull image after work

7. If **step 2** is completed, the collimator speed correction is complete.

5.2. PANO Collimator Speed Alignment with EzAlign

1. After PANO Auto Alignment is completed, PANO Collimator Speed Alignment will be started automatically.
2. When you see the message **HOLD THE BUTTON** as marked in the white box below, press and hold the exposure switch until **RELEASE THE BUTTON** message appears.



3. If the system displays the **HOLD THE BUTTON** message again instead of the succeeding message, repeat step 2.
4. If the PANO Collimator Speed Alignment is completed successfully, the pop-up message which notifies the completion of the alignment displays on the screen. Then, click the **OK** button to finish.
5. If the Error message appears, follow the guide. Then click the **Start** button again.

6. PANO Geometry Calibration

6.1. PANO Geometry Calibration Standard

IMPORTANT	• To perform the PANO Geometry Calibration, PANO BALLPHANTOM should be prepared in advance.
NOTICE	• During the PANO BALLPHANTOM Geometry operation, the measurements must be checked by using the Raw File.

• PANO BALLPHANTOM RIGHT/LEFT PIN DISTANCE ERROR

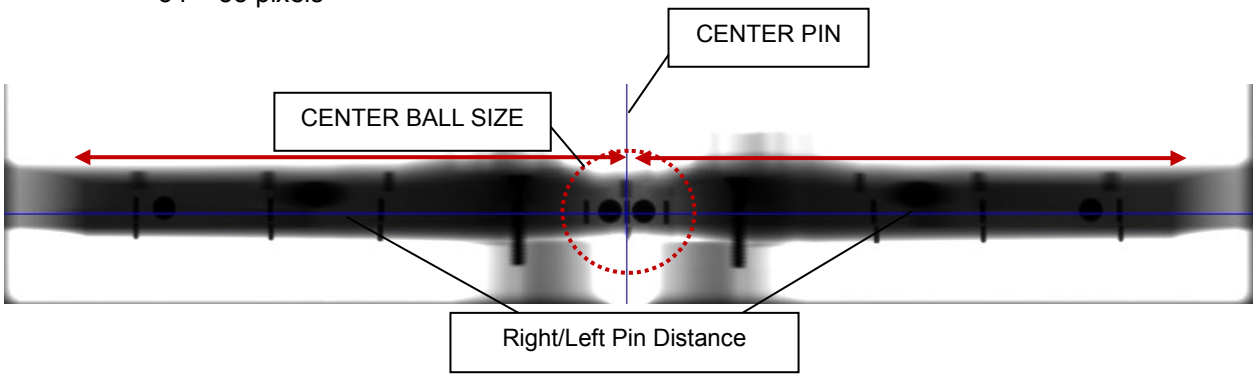
- within ±30 pixels

• PANO BALLPHANTOM CENTER PIN POSITION

- Within 1574 ±10 pixel

• PANO BALLPHANTOM CENTER BALL SIZE

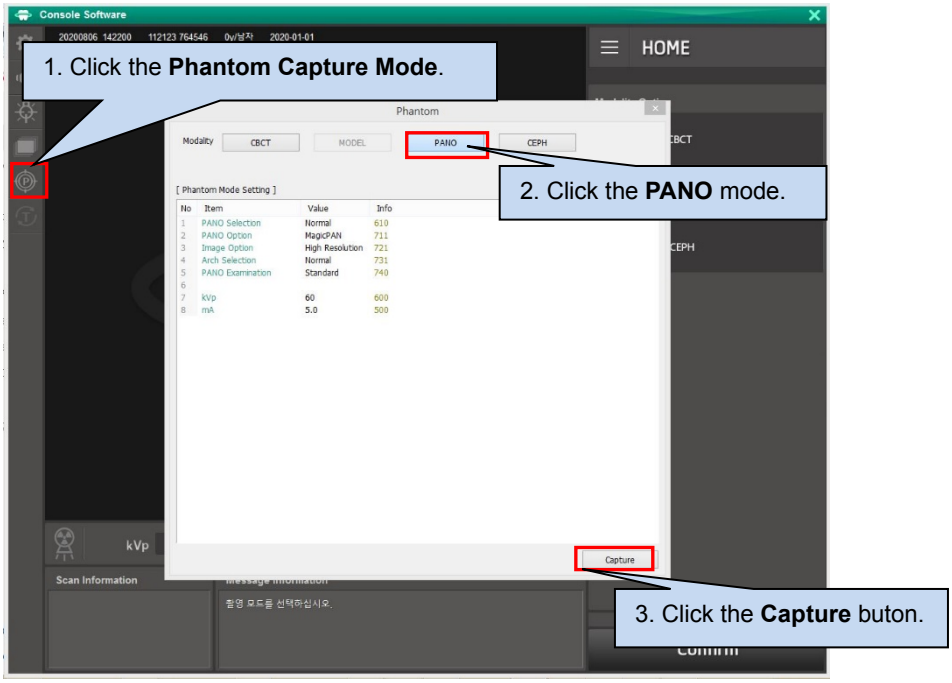
- 54 ~ 55 pixels



6.2. Right and Left Pin Distance Calibration

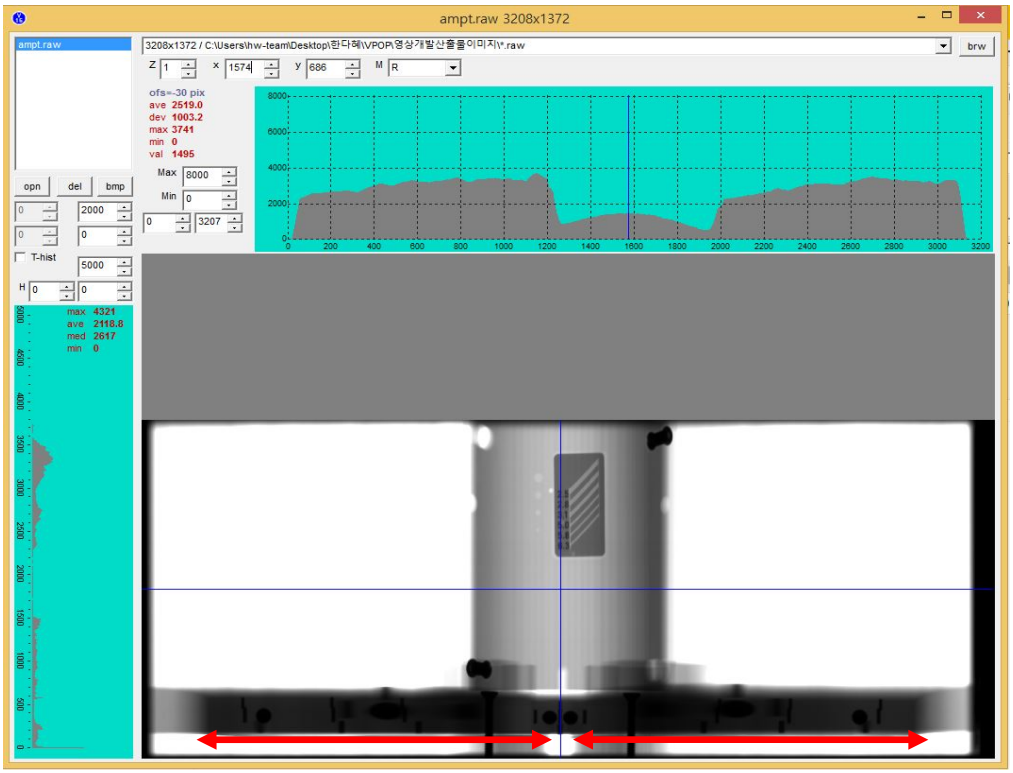
NOTICE	• Make sure to move the Chin Block to the PANO Mode Position.

1. Attach the PANO BALL Phantom on Chinrest.



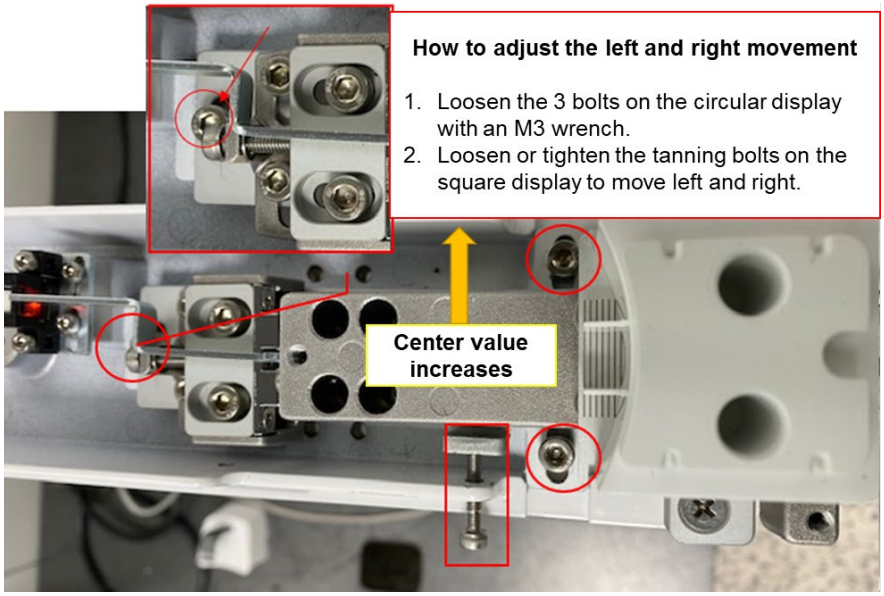
2. Run the Console Software and click the **Phantom Capture Mode** icon.
3. Click the **PANO** mode and acquire the phantom image.
4. When the image acquisition is completed, run the VAKCAP.exe file.

5. Save the Captured image as ampt.raw file in C:\VCaptureSW\Acquisition\PANO\WidePANO\PAN folder.



- PANO image size: 3208 (variable) x 1372 (constant)
  - Center Pin Position: 1574 ±10 pixel
  - Right/Left Pin Distance: ±30 pixel: ±30 pixel

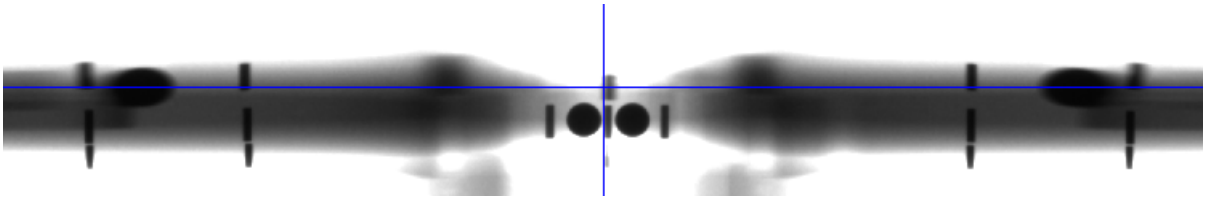
6. Center Pin Position is not correct, as shown in the picture below, loosen the three points of the Chinrest drive and move it.



7. When moving to the right, the center of the image moves to the left. (Center value increases)

6.3. Center Pin Position Calibration (POFS)

If Center pin position does not meet the standard by adjusting chinrest, adjust POFS value."



1. Acquire a Phantom image and open it.
2. Make sure that the Center Pin pixel number meets the standard and the ghost image has bilateral symmetry as shown above.
3. If it is out of the standard value, change the [SPM_POFS_xxxxx] value and adjust it according to the standard.

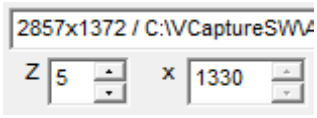
   The pofs value is changed by about 2 pixels per 100 and has the following directionality.

   * Default value: 00001

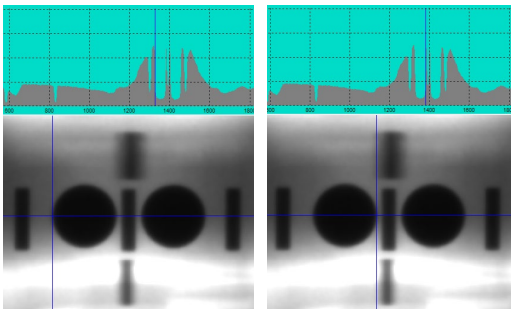
   - +: Move the image center to the left
   - *-: Move image center to the right

6.4. Center Ball Size Calibration

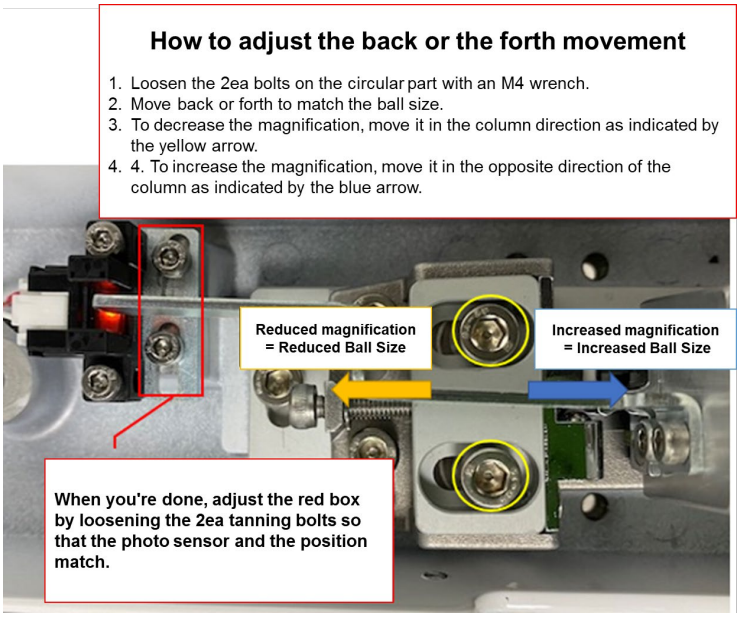
1. Acquire the PANO Ball Phantom image and open it.
2. Enter 5 in the Z box, and drag the mouse to see the Center Balls



3. Click the starting point of the Right Center Ball and read the X value by pixel.
4. Click the end point of the Right Center Ball and read the X value by pixel.
5. Subtract the starting point value from the end point value to measure the Right Center Ball size.



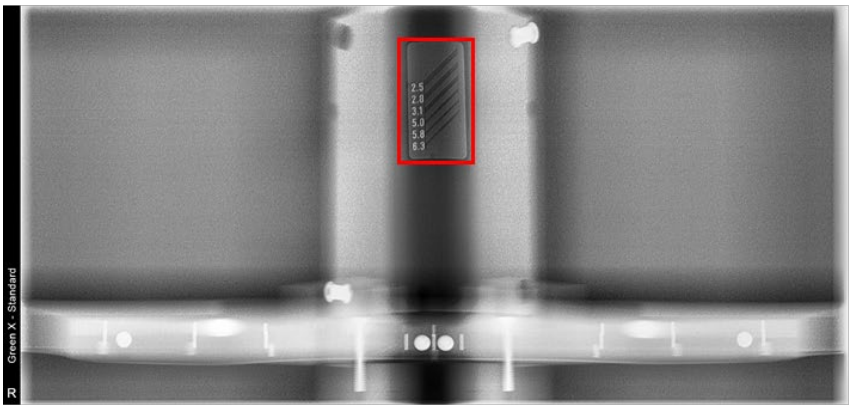
6. Check the Right Center Ball size meets the standard(54 ~ 55 pixels).
7. Do steps 3 ~ 6 for the Left Center Ball.
8. If it is out of the standard value, move the position of the PANO Mode Chinrest Fixed Block and adjust the ball size.
9. When Ball Size is 56 Pixels or more: Move the Chinrest in the direction of Column.
10. If the ball size is less than 53 Pixel: Move the Chinrest in the opposite direction of Column.

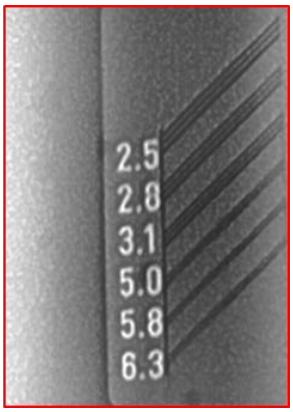


When all of the above operations are completed, adjust by loosening 2 headless bolts on the red square display so that there is no interference between the photo sensor and the blade.

6.5. Line Pair Resolution

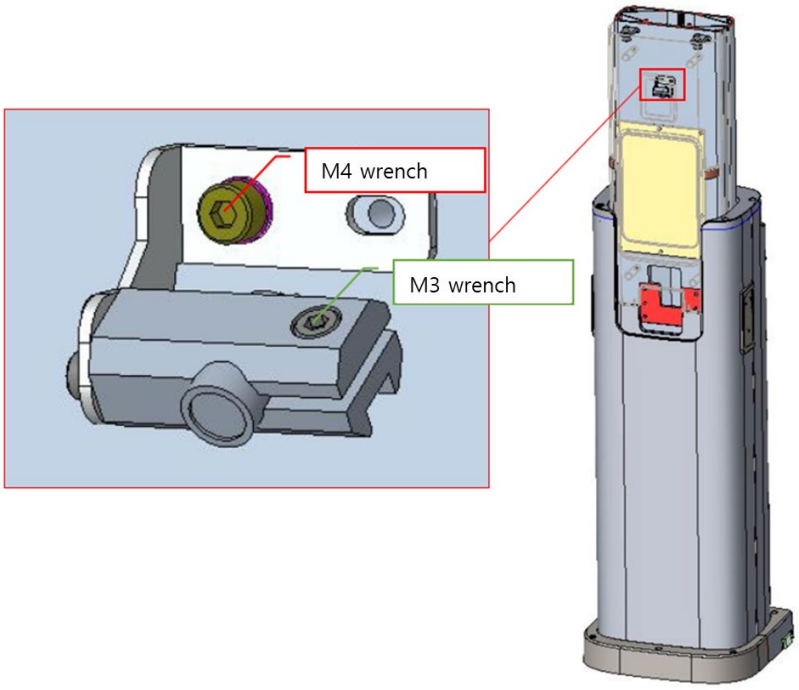
1. Run Console Software and click the **PANO** button to go into PANO mode.
2. Click the **CONFIRM** button.
3. Attach PANO BALL Phantom + Quart Phantom Ass'y on Chinrest.
4. Attach 1.8 mm(or 1.0 mm + 0.8 mm) Copper Filter on X-Ray Tube.
5. Click the **READY** button, and acquire/save the image according to the Console Software guidance.
6. Open the 2D Viewer and save the image.
7. Make sure that the lines can be seen clearly at 3.1 lp/mm.





7. Vertical Laser Beam Align

1. Run the Console Software.
2. Click the **Confirm** button and attach the ball phantom with a laser beam jig.
3. Click the laser beam mode to check whether the vertical beam is located at the reference line of the ball phantom.
4. If the position is not correct, loosen the assembly point with an M4 wrench and move it left/right so that it comes to the reference line.
5. If the angle of the vertical laser beam is not correct, loosen it with an M3 wrench as shown in green in the picture below and adjust the angle.



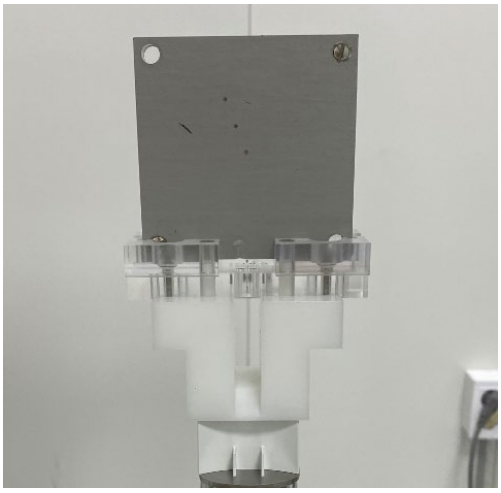
Chapter 5. PANO Image Evaluation

1. Line Pair Resolution evaluation

1.1. Resolution standards

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
Lp/mm	3.1	-

1.2. Phantom Specification

	
QUART Phantom	**QUART - Ball Phantom**

1.3. Test Method

1. Run the Console Software and click the PANO button to go into PANO mode.
2. Choose HD Mode/MAN/Normal mode/exposure condition 70 kVp, 7 mA as the image option and click the Confirm button.
3. Attach PANO BALL Phantom + Quart Phantom Ass'y on Chinrest.
4. Attach 1 .8 mm Copper Filter on X-Ray Tube.
5. Click the READY button, and acquire/save the image according to the Console Software guidance.
6. Open the 2D Viewer and save the image.
7. Make sure that the lines can be seen clearly at 3.1 lp/mm.

1.4. Test Result

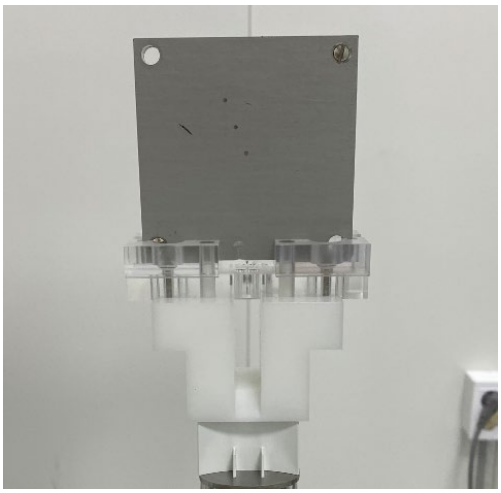
Parameter	LSL	Measurement value	USL	Pass/Fail
Lp/mm	3.1		-	

2. Low Contrast Resolution evaluation

2.1. Low Contrast standards

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
Hole	-	1.5 mm

2.2. Phantom Specification

	
QUART Phantom	**QUART - Ball Phantom**

2.3. Test Method

- The evaluation is conducted in the same manner as in the evaluation method in Section 1.3.

2.4. Test Result

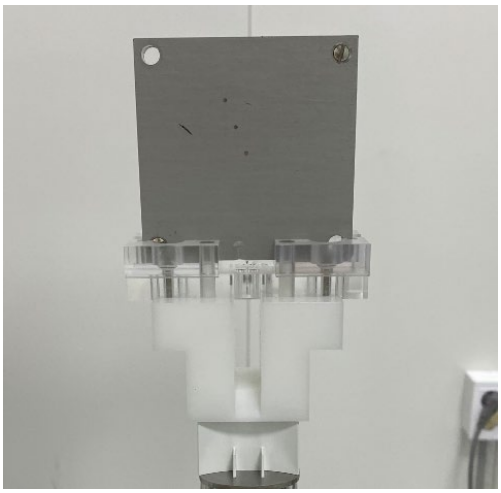
Parameter	LSL	Measurement value	USL	Pass/Fail
Hole	-		1.5 mm	

3. Noise evaluation

3.1. Noise standards

Parameter	ROI 1	ROI 2	ROI 3	Remark
Noise(Dev)	40 or less		30 or less	-

3.2. Phantom Specification

	
QUART Phantom	**QUART - Ball Phantom**

3.3. Test Method

1. Run the Console Software and click the PANO button to go into PANO mode.
2. Choose the PANO Phantom mode, and click the Confirm button.
3. Attach PANO BALL Phantom + Quart Phantom Ass'y on Chinrest.
4. Click the READY button, and acquire/save the image according to the Console Software guidance.
5. Run VAKCAP.exe
6. Click the Panorama tab and click V Pan to open View 16.
7. Click brw and select "ampt.raw" created in the C:\VCaptureSW\Acquisition\PANO\WidePANO\PROJ_exposure time folder.
8. Set it as [M size = 40] and evaluate noise(dev) and Homogeneity(ave) of each ROI.

3.4. Test Result

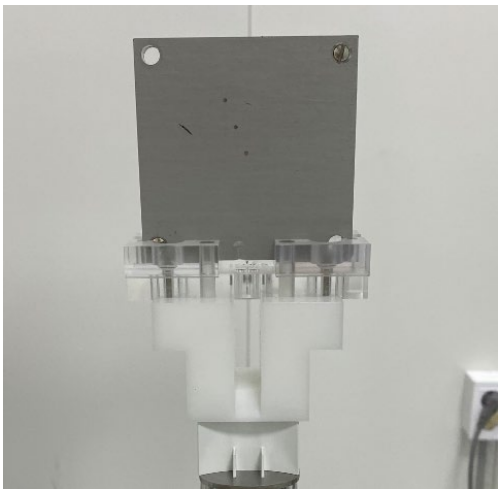
Parameter	ROI 1 (600, 800)	ROI 2 (2550, 800)	ROI 3 (1574, 800)	Pass/Fail
Noise(Dev)				

4. Homogeneity evaluation

4.1. Homogeneity standards

Parameter	ROI 1	ROI 2	ROI 3	Remark
Homogeneity (Ave)	8000 or more		1200 or more	The difference between ROI 1,2 values is 10% or less

4.2. Phantom Specification

	
QUART Phantom	**QUART - Ball Phantom**

4.3. Test Method

- The evaluation is conducted in the same manner as in the evaluation method in Section 3.3.

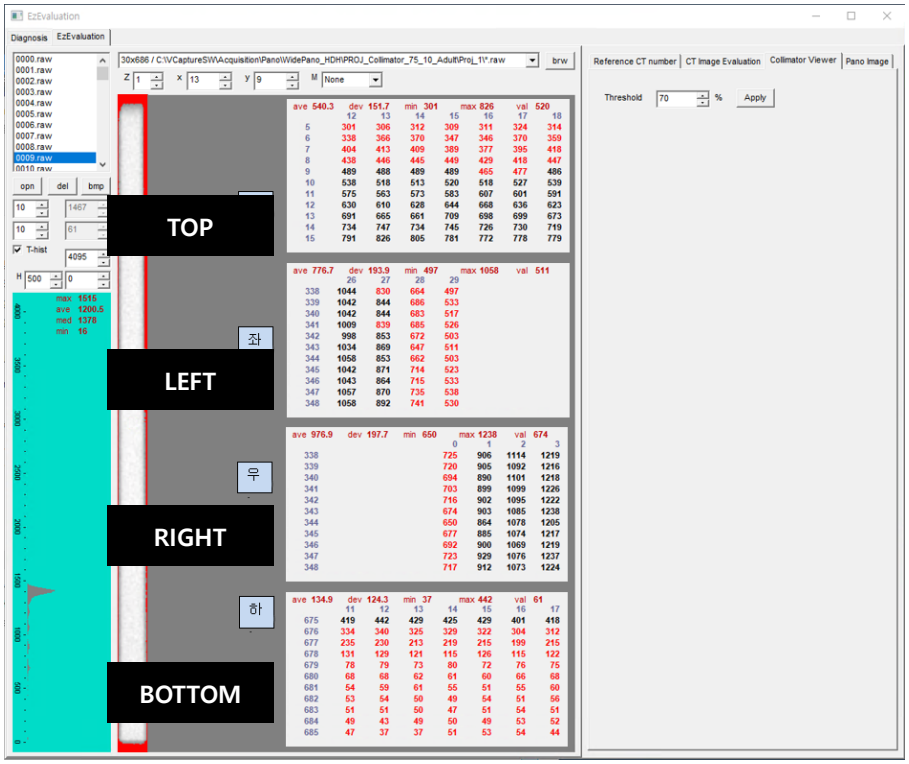
4.4. Test Result

Parameter	ROI 1 (600, 800)	ROI 2 (2550, 800)	ROI 3 (1574, 800)	Pass/Fail
Homogeneity(Ave)				

5. Collimator Alignment Evaluation

5.1. Collimator Alignment Standard

Parameter		LSL (Lower Specification Limit)	USL (Upper Specification Limit)
Threshold 70%	Upper	1	10
	Lower	1	10
	Left	2	2
	Right	1	2



Collimator Align Align Image

5.2. Test Method

1. Complete the collimator setup and acquire the image in the stopped state.
2. Run the C:\VCaptureSW\Util\EzEval_Phantom\EzEval.exe program.
3. Input the threshold 75%, and check whether the Collimator Alignment Result is satisfied with the standard.

5.3. Test Result

Parameter		LSL	Measurement value	USL	Pass/Fail
Threshold 70%	Upper	1		10	
	Lower	1		10	
	Left	2		2	
	Right	1		2	

Chapter 3. CEPH Image Optimization

1. CEPH Sensor Calibration

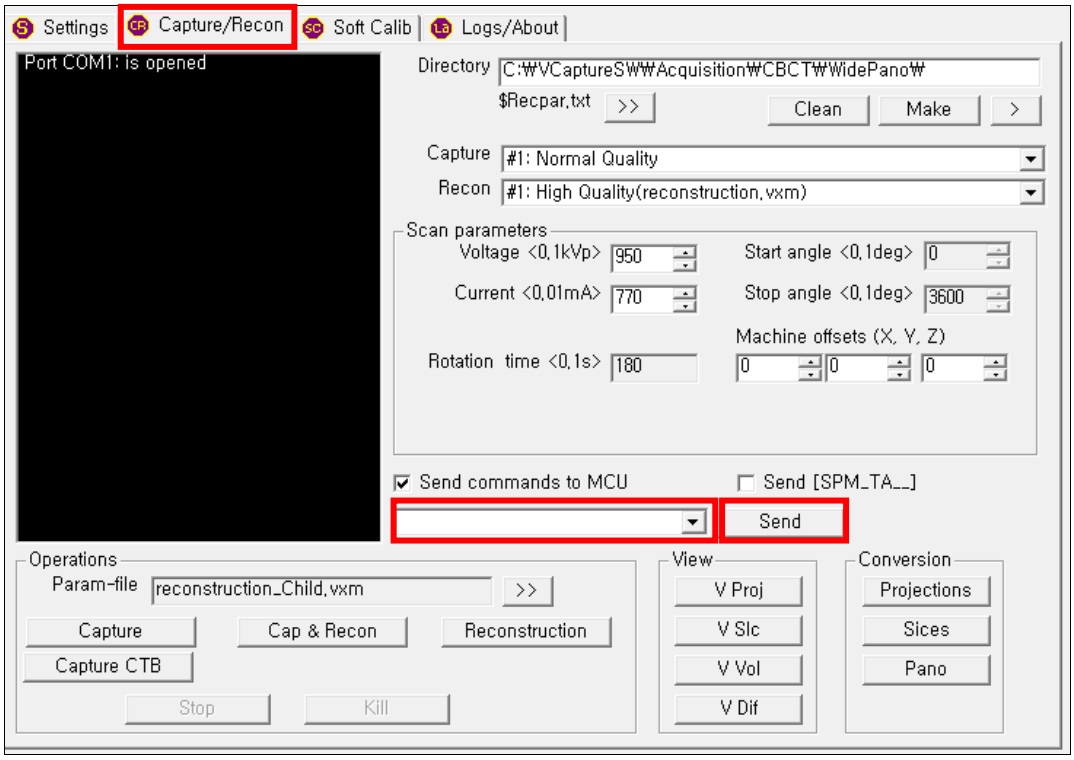
1.1. Before CEPH sensor calibration

NOTICE	• VAKCAP.com program is required for CEPH Sensor Calibration. Path: **C:\VCaptureSW\Acquisition\Ceph\WideCeph\Norm** folder
IMPORTANT	• Before the CEPH Sensor Calibration operation begins, the operator must backup the existing CEPH Sensor Calibration folder. • CEPH Sensor Calibration file folder path: **C:\VCaptureSW\Acquisition\CEPH\WideCeph\Norm\CAL**

1. Remove the Normal Chin Block from the equipment.
2. Remove the CEPH ear rods and fold the nasal positioned to avoid CEPH sensor blocking.
3. Disassemble the Tube cases (Refer to Chapter 1. Hardware Part Service Guide).
4. Rename the CAL folder (C:\VCaptureSW\Acquisition\Ceph\WideCeph\Norm\CAL) name for backup.

1.2. CEPH sensor setting

1. Run the C:\VCaptureSW\Acquisition\CEPH\WideCEPH\Norm\VACAP.exe file.
2. Click the **Capture/Recon** tab.



3. Send the following commands in the command field.

CEPH pixel size: 76x1296

Command	Function
[SPM_CEPH]	CEPH mode
[SPM_HSON]	CEPH sensor power on
[SPM_FREQ_160]	Norm Mode Sensor Frequency Setting
[SPM_FREQ_313]	Fast Mode Sensor Frequency Setting
[SPM_COLM_0003]	1T Cu filter location
[SPM_COLM_0005]	CEPH Mode Collimator location

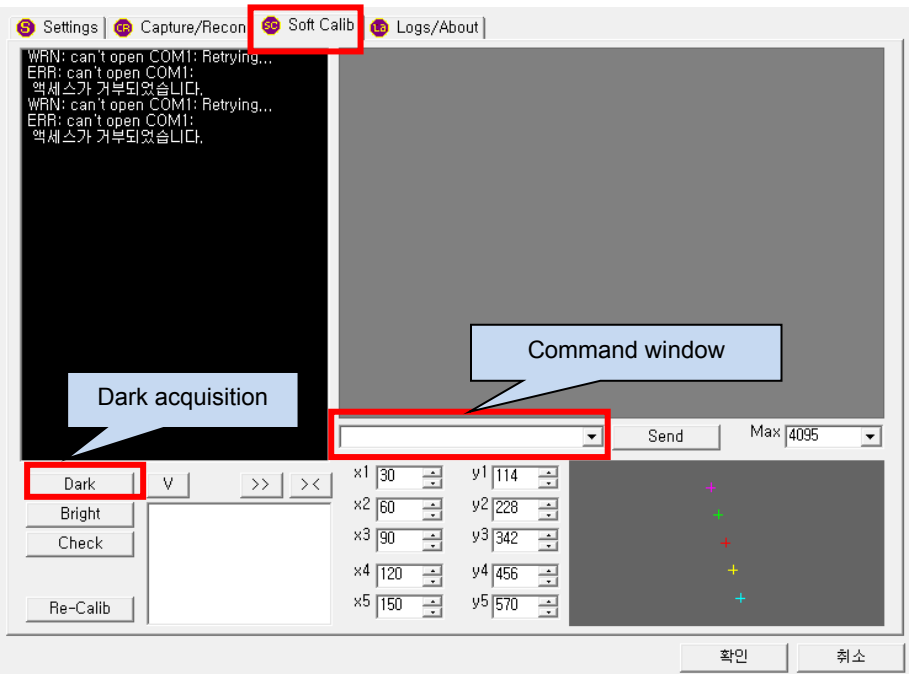
1.3. CEPH sensor: Dark calibration

※ Dark standard value

	Min	Max
Median value	1000	3000

1. Run the C:\VCaptureSW\Acquisition\CEPH \WideCEPH \Norm\VACAP.exe file.
2. Send the [SPM_CEPH] and [SPM_HSON] commands in the command window, and send the following commands for each mode to set the FPS.
   - Norm Mode: [SPM_CFRQ_0160]
   - Fast Mode: [SPM_CFRQ_0313]
3. Send the [SPM_COLM_0003] command to the command window and move the collimator to the 1T Cu filter position.

   * In the Fast folder, use the [SPM_FREQ_313] command instead of the [SPM_FREQ_160] command.



4. Click the **Dark** button to acquire an image.
5. Check if it is a normal dark image through the maximum and minimum standard of the median value.
6. Check if it satisfies the dark standard value, and if not, replace the sensor with a bad sensor.

1.4. CEPH sensor: Bright calibration

1. Acquire Sensor Bright Calibration in Norm and Fast Mode respectively.
2. Run the C:\VCaptureSW\Acquisition\CEPH\WideCEPH\Norm\VACAP.exe file.
3. The standard of Lv value for each bright calibration point is as follows.

※ Norm Mode Bright standard value: 5 points with Cu 1 mm filter

Bright		Min	Max
Median value	Cal Point 1	200	300
	Cal Point 5	1200 ~ 1400	

※ Fast Mode Bright standard value: 5 points with Cu 1 mm filter

Bright		Min	Max
Median value	Cal Point 1	200	300
	Cal Point 5	600 ~ 800	

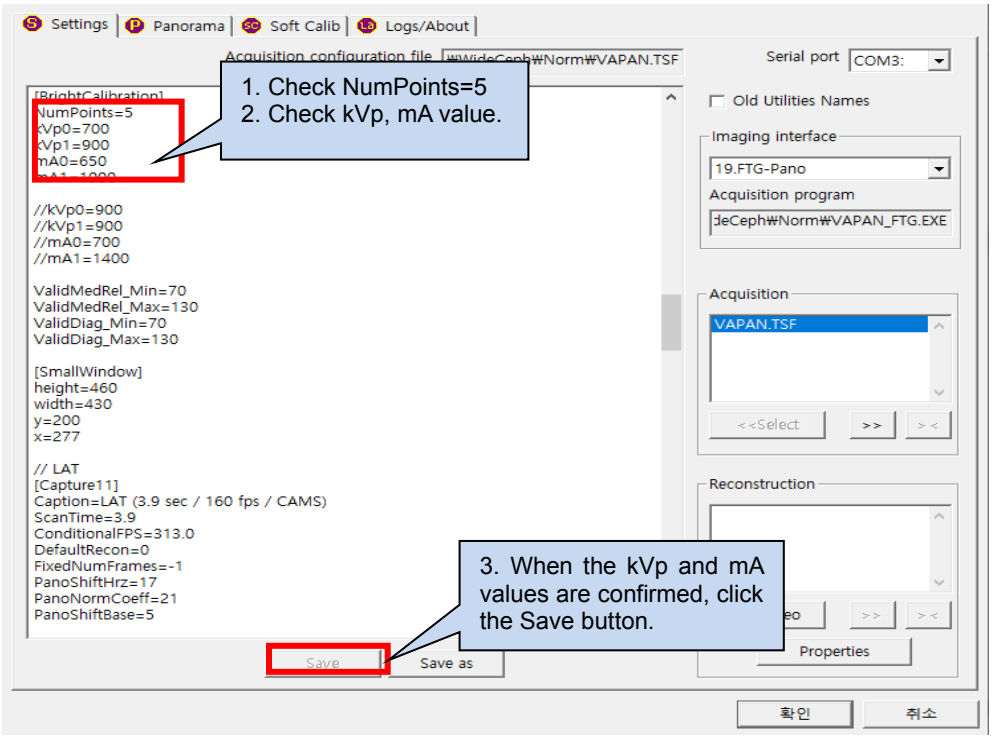
1.5. Bright calibration: 5 points

1. Run the C:\VCaptureSW\Acquisition\CEPH\WideCEPH\Norm\VACAP.exe file.
2. Send the [SPM_CEPH] and [SPM_HSON] commands in the command window, and send the following commands for each mode to set the FPS.
   - Norm Mode: [SPM_CFRQ_0160]
   - Fast Mode: [SPM_CFRQ_0313]
3. Send the [SPM_COLM_0003] command to the command window and move the collimator to the 1T Cu filter position.

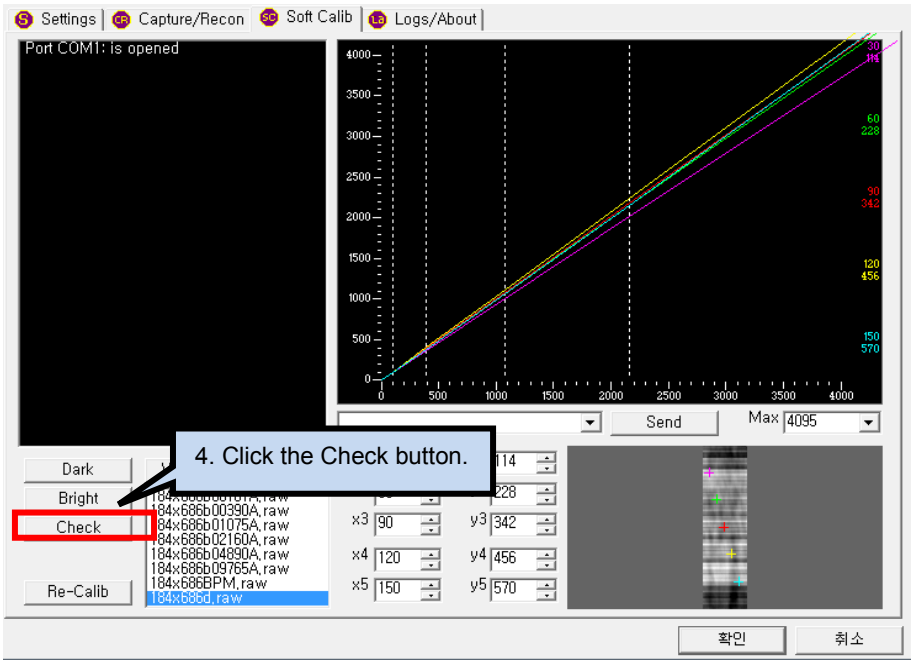
Acquisition conditions		5 point
exposure condition	kVp0	680
	mA0	650
	kVp1	900
	mA1	1400

4. If the standard is not satisfied, set them according to the standard by adjusting kVp0 and kVp1.
5. Click the **Bright** button to obtain 5 points of bright cal data and check if the above standard is satisfied.

6. Save the bright cal data in a folder for each mode.
   - Norm Mode Path: C:\VCaptureSW\Acquisition\CEPH\WideCEPH\Norm\CAL
   - Fast mdoe Path: C:\VCaptureSW\Acquisition\CEPH\WideCEPH\Fast\CAL



7. When the normal bright cal acquisition is completed, click the **Check** button to create an auto bad pixel map.



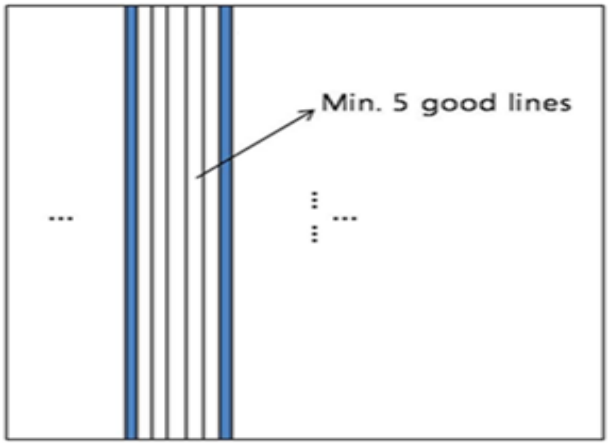
1.6. Bad pixel spec. & definition

1.6.1. Bad pixel definition

- Dead pixel: no responsive pixel (value : 0 or 16384)
- Non-uniform response pixel: Pixel that shows a ±30% response deviation from neighboring pixels.

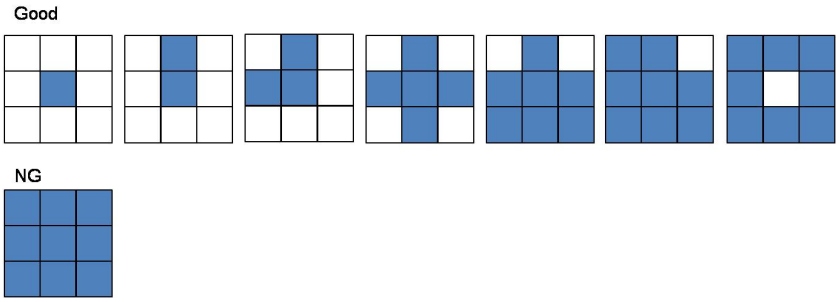
1.6.2. Bad line definition

- Bad pixels over 50% of effective area width and height are defined as bad lines
  - ➔ When having an effective area of M x N, 1 x M or N x 1 or more is defined as a bad line
- Total max. 7 line
- There should be at least 5 lines of normal pixels between bad lines.



1.6.3. Cluster definition

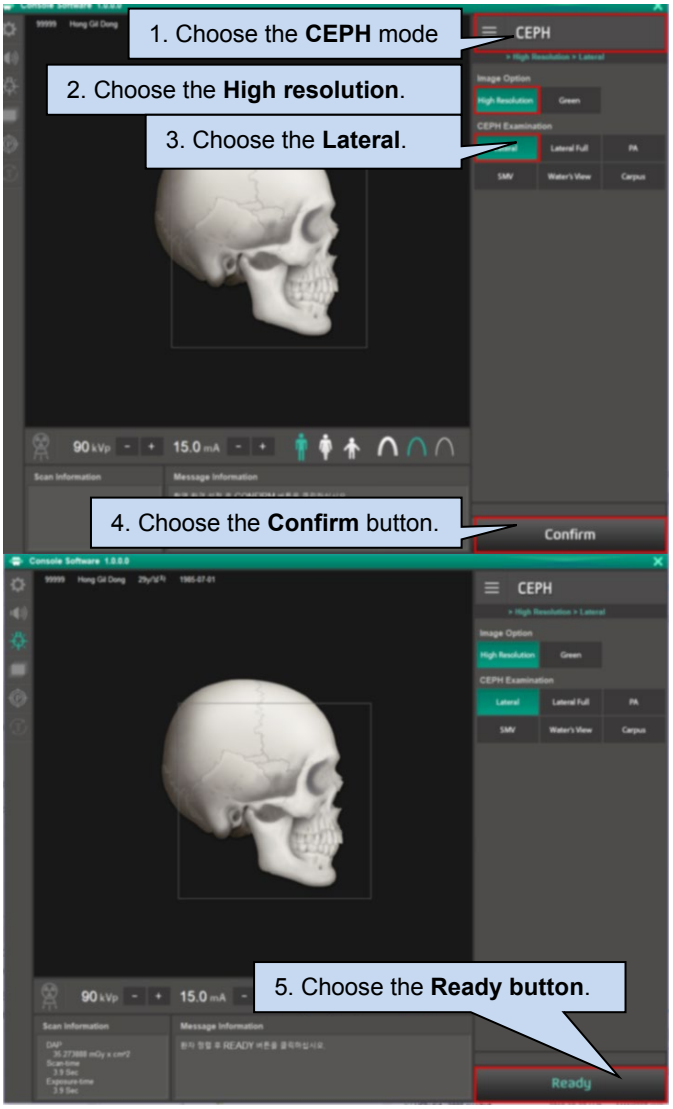
- Continuous bad pixels with 3 x 3 or more in a row (single bad pixels are surrounded by bad pixels in all directions (up/down/left/right/diagonal))



2. CEPH Geometry Calibration

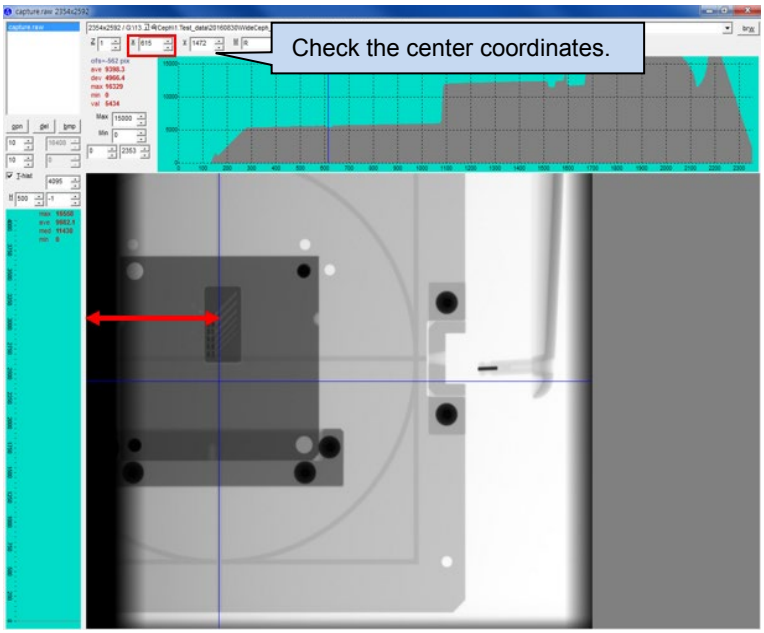
2.1. Lateral Mode Start Position Setting

1. Identify the starting position using the CEPH standard phantom.
2. Attach 0.8T of Cu in front of the collimator and set the exposure condition to 80kVp 10mA.
3. Attach CEPH standard phantom to the ear rod, click the console software as shown in the picture below, and capture the Normal LAT Mode.



4. As shown in the image below, adjust [SPM_XRFA_xxxx] so that the center value is 605~625 pixels.

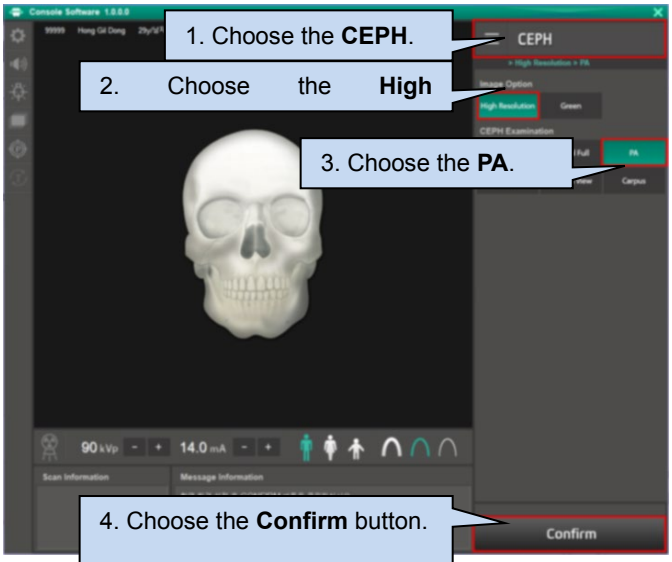
* As the value decreases, it moves to the left and moves about 10 pixels per value.

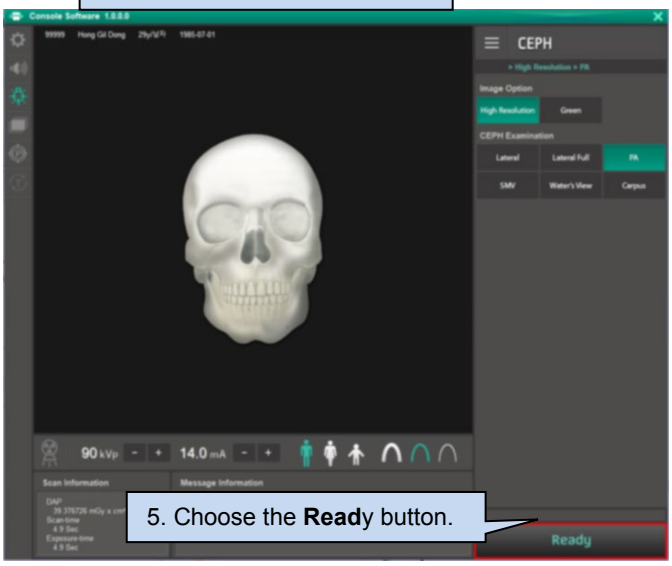


CEPH standard phantom image

2.2. PA Mode Start Position Setting

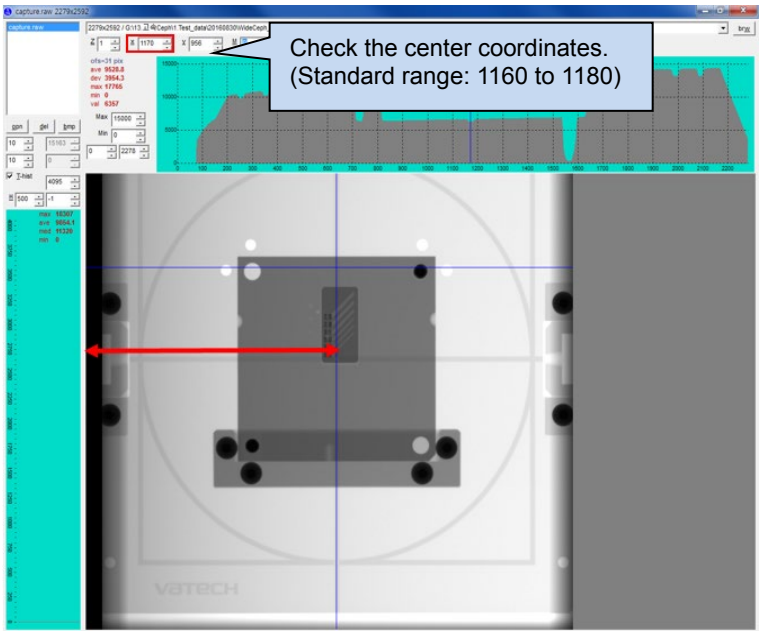
1. Attach Cu 0.8T in front of the collimator.
2. Attach the CEPH standard phantom to the ear rod
3. Click the Console software as shown in the picture below to capture the Normal PA Mode.





4. As shown in the image below, adjust [SPM_UBTT_xxxx] so that the center value is 1160~1180 pixels.

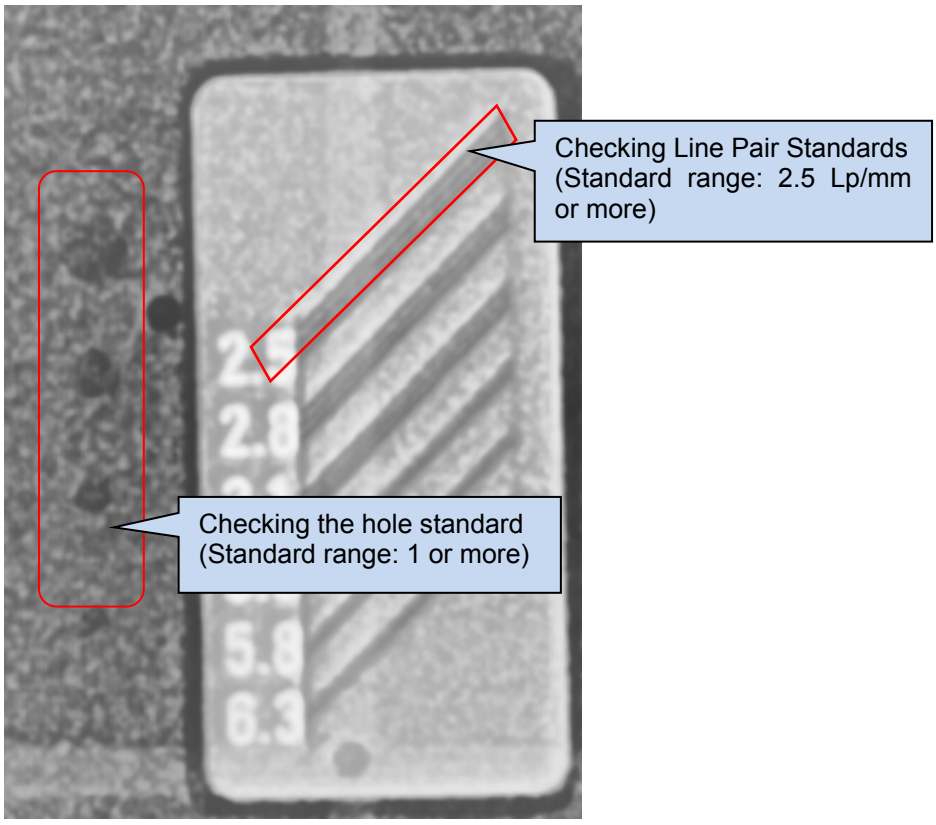
   * As the value decreases, it moves to the left and moves about 10 pixels per value.



CEPH standard phantom image

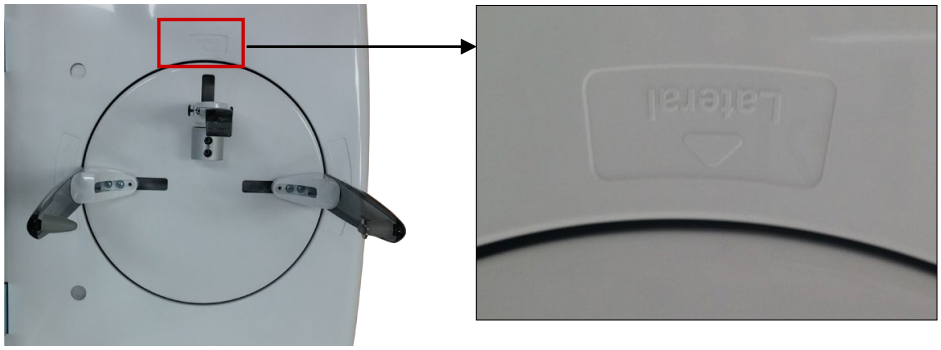
2.3. Line Pair Resolution

1. Capture PA mode with Ceph phantom and Quart Phantom, and check Line Pair & Low Contrast Resolution.
2. [Line Pair Resolution] Make sure that the lines can be seen clearly at 2.5 lp/mm
3. [Low Contrast Resolution] Make sure that 1 or more holes can be seen clearly.

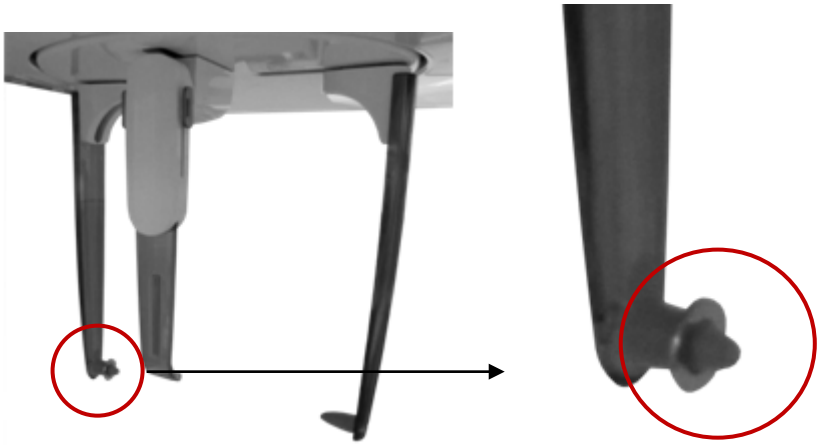


2.4. CEPH Ear-Rod Alignment

1. Run the Console Software.
2. Click **CEPH** > **High Resolution** > **Lateral** > **CONFIRM** and wait until **READY** button is enabled.
3. Turn CEPH Ear-Rod to the Lateral Mode position as shown in the figure.



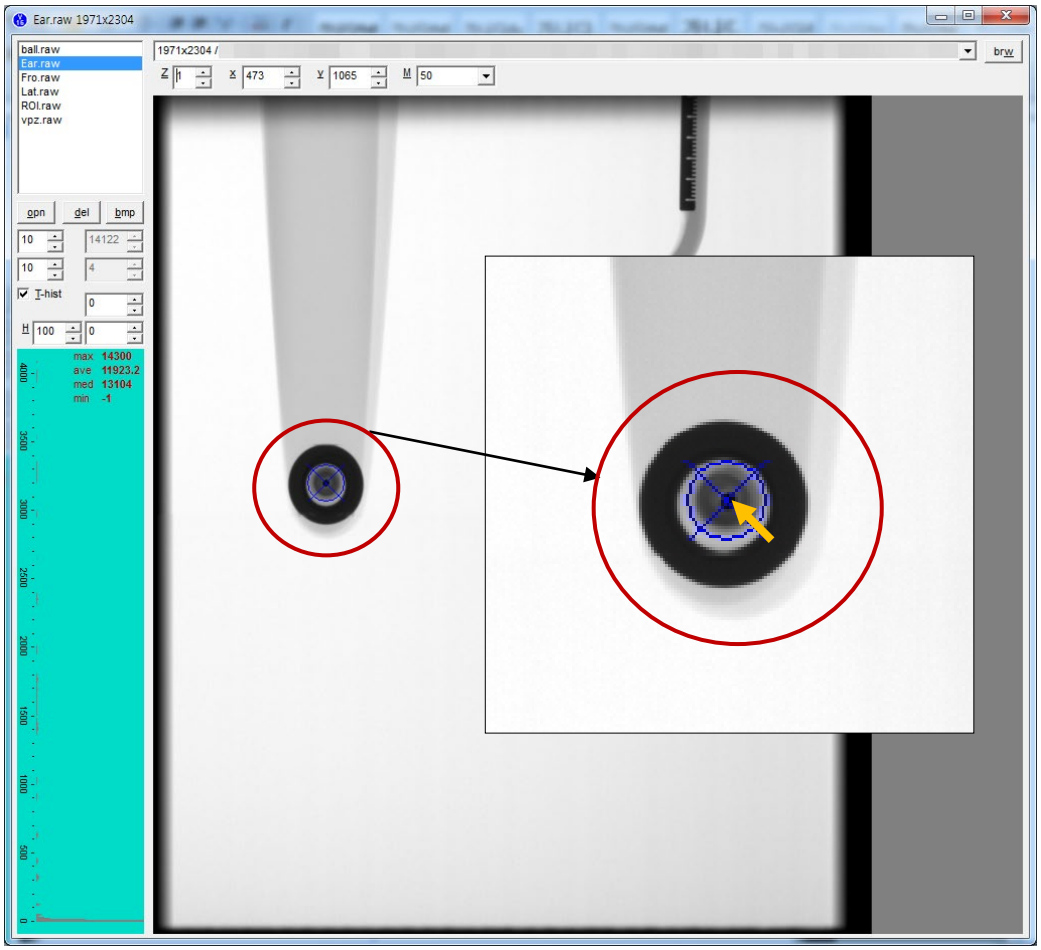
4. Put a flat washer into the right Ear-Rod as shown below.



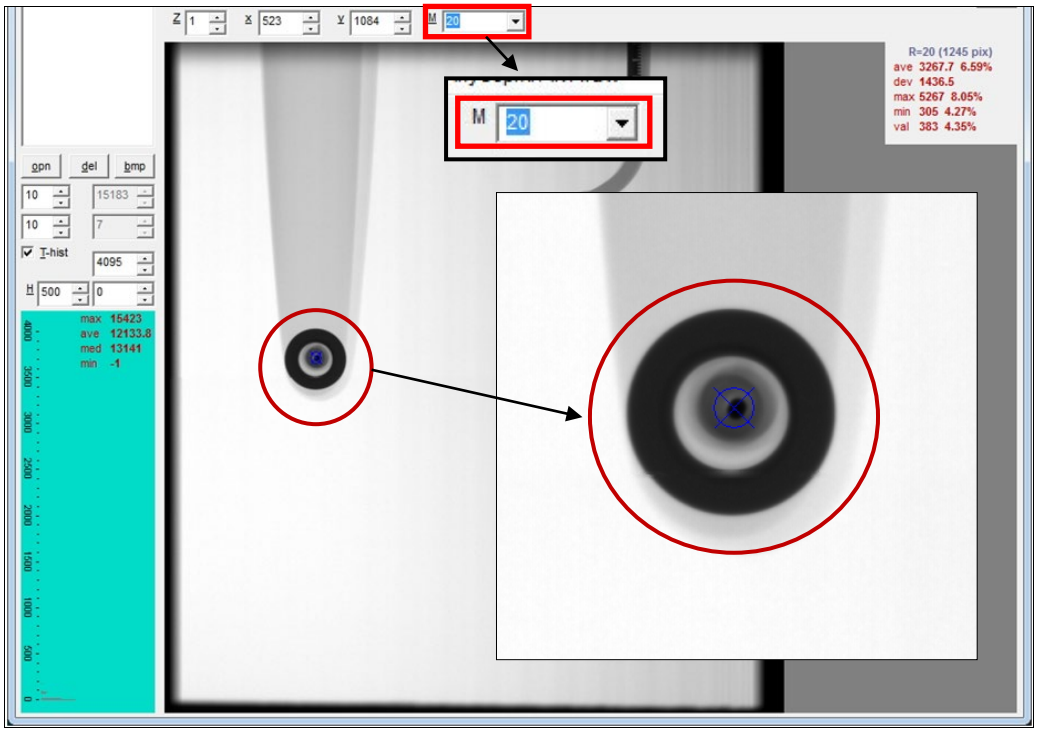
5. Click the **READY** button.
6. Perform the image acquisition according to the Console Software guidance.
7. When the image acquisition is completed, run the **VAKCAP.exe** file.
8. Click the **Panorama** tab > **V Pan** button to open the View16 program.
9. Click the **Brw** button and select the **Capture.raw** file to open the captured image.

NOTICE	• **Capture.raw** file path : **C:\VCaptureSW\Acquisition\Ceph\AnyCeph\Fast\PAN** folder

10. Select **50** in the **M** box and click the center of the flat washer.



11. Select **20** in the **M** box and make sure that the Ear-Rod guide pin is in the blue ROI area.

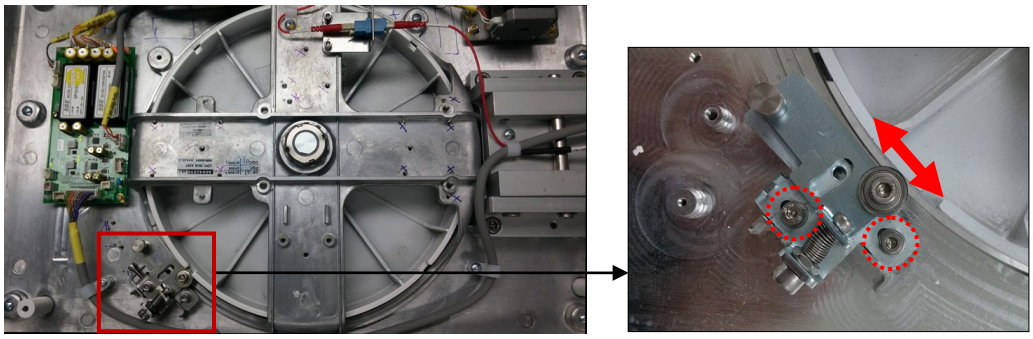


12. If the pin is out of the blue ROI area, do the steps that follow

① Disassemble the top cover from CEPH Unit. Refer to **Chapter 2. Hardware Part Service Guide**.

② Loosen 2 wrench bolts and adjust the fixed block of EAR-ROD as shown below.

NOTICE	• If turn the fixed block of EAR-ROD to the right on the picture below, the Guide Pin of EAR-ROD will move from the right to the left on the picture in the step11), and vice versa.



③ Exit **VAKCAP**. Acquire the PHANTOM image again and measure the Pixel Number at the center of PHANTOM.

④ Repeat the procedures until the Ear-Rod is aligned correctly.

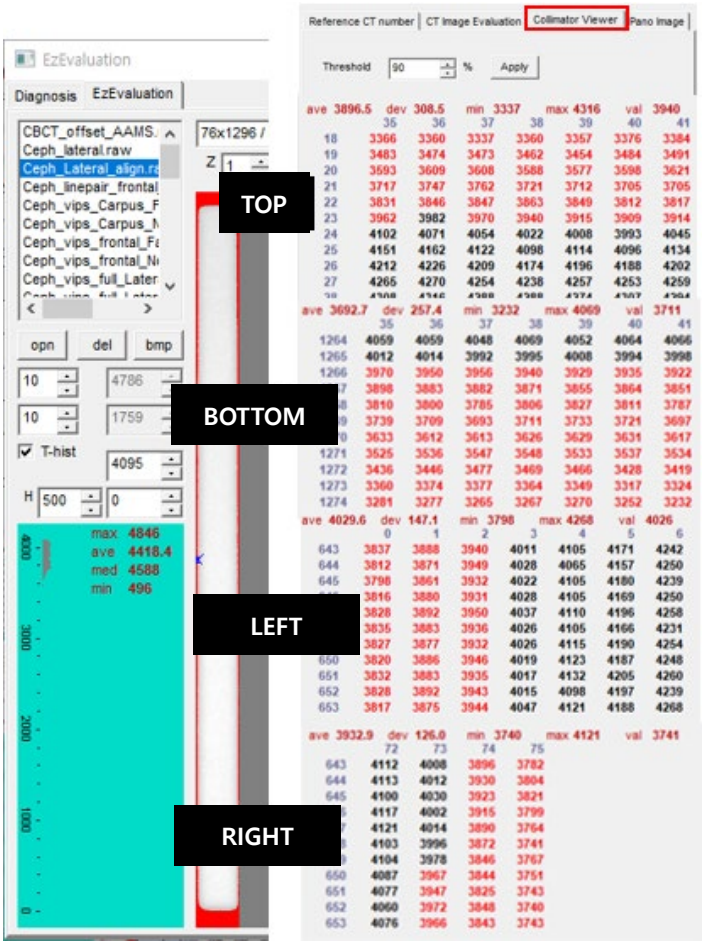
3. CEPH Collimator Alignment

3.1. CEPH Collimator alignment

1. Run the C:\VCaptureSW\Acquisition\CEPH\WideCEPH\Norm\VACAP.exe file.
2. Send [SPM_CEPH], [SPM_HSON], [SPM_FREQ_0160], [SPM_COLM_0005], [SPM_CAMS], [SPM_RET_], and [SPM_ERDY] commands to the Command window to configure the CEPH sensor and collimator.
3. Set 90kvp, 10mA in VACAP, send the [SPM_SSB_] command to the Command window, and click the **Capture** button to acquire the image.
4. Use the Collimator control command to find a value that satisfies the standard below.

Command	Function
[SPM_CAST_XXXXX]	CEPH mode collimator movement control

5. Run EzEval.exe, choose EzEvaluation for the tap menu on the top left and choose collimator viewer from the tap menu on the top right.



6. Set the Threshold value concerning the following standard, and check 0010.raw to check if it satisfies the collimator alignment standard.
7. The collimator alignment standard is as follows.

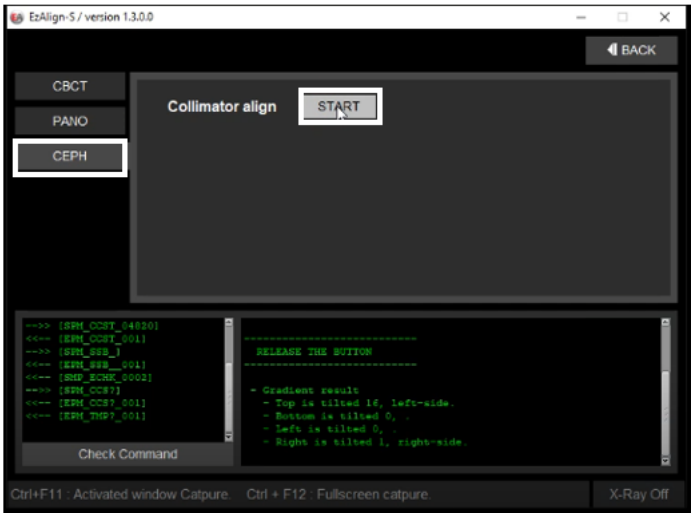
※ Collimator Alignment standard value

Collimator		Min pixels	Max pixels
Threshold 90%	Left	1	5
	Right	1	5
	Upper	20	40
	Lower	20	40

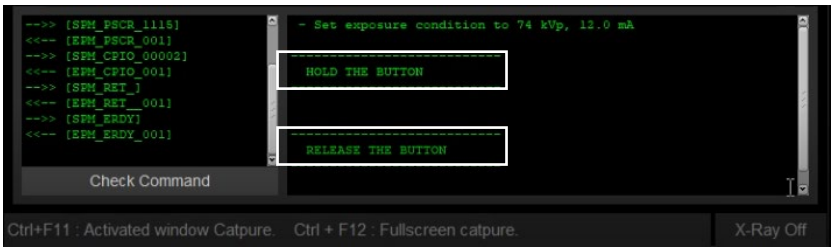
8. If the red pixel count is out of the permitted value, change the collimator position values by [SPM_CAST_XXXXX].

NOTICE	Collimator Align can also be done using the EzAlign program provided by the manufacturer.

3.2. CEPH Collimator align with EzAlign



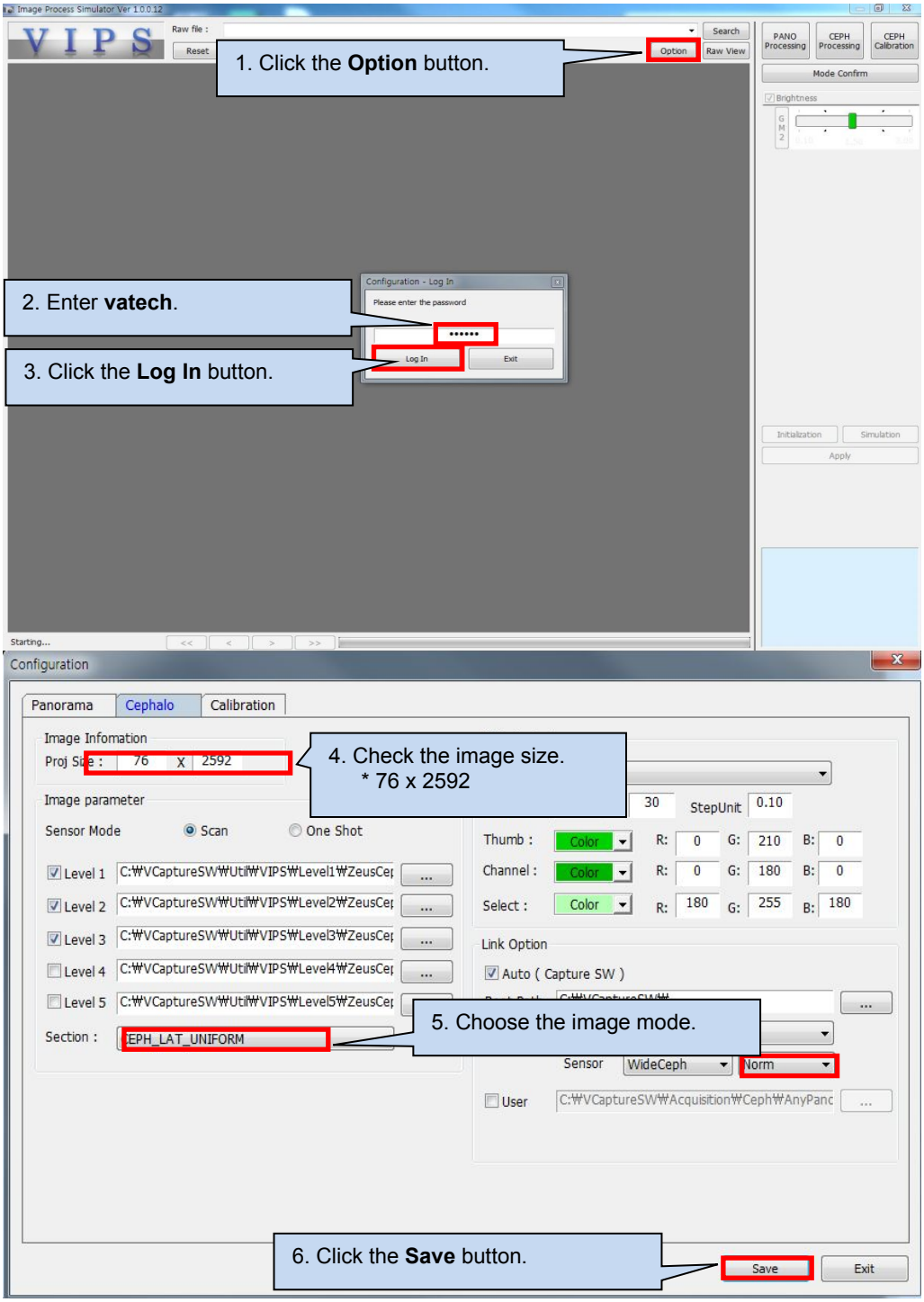
1. Select **CEPH** and click the **Start** button: The system will move into its capturing position and Collimator auto-align will be started.
2. Remove the Bite Block and Ceph ear rods.
3. When you see the message **HOLD THE BUTTON** as marked in the white box below, press and hold the exposure switch until **RELEASE THE BUTTON** message appears.

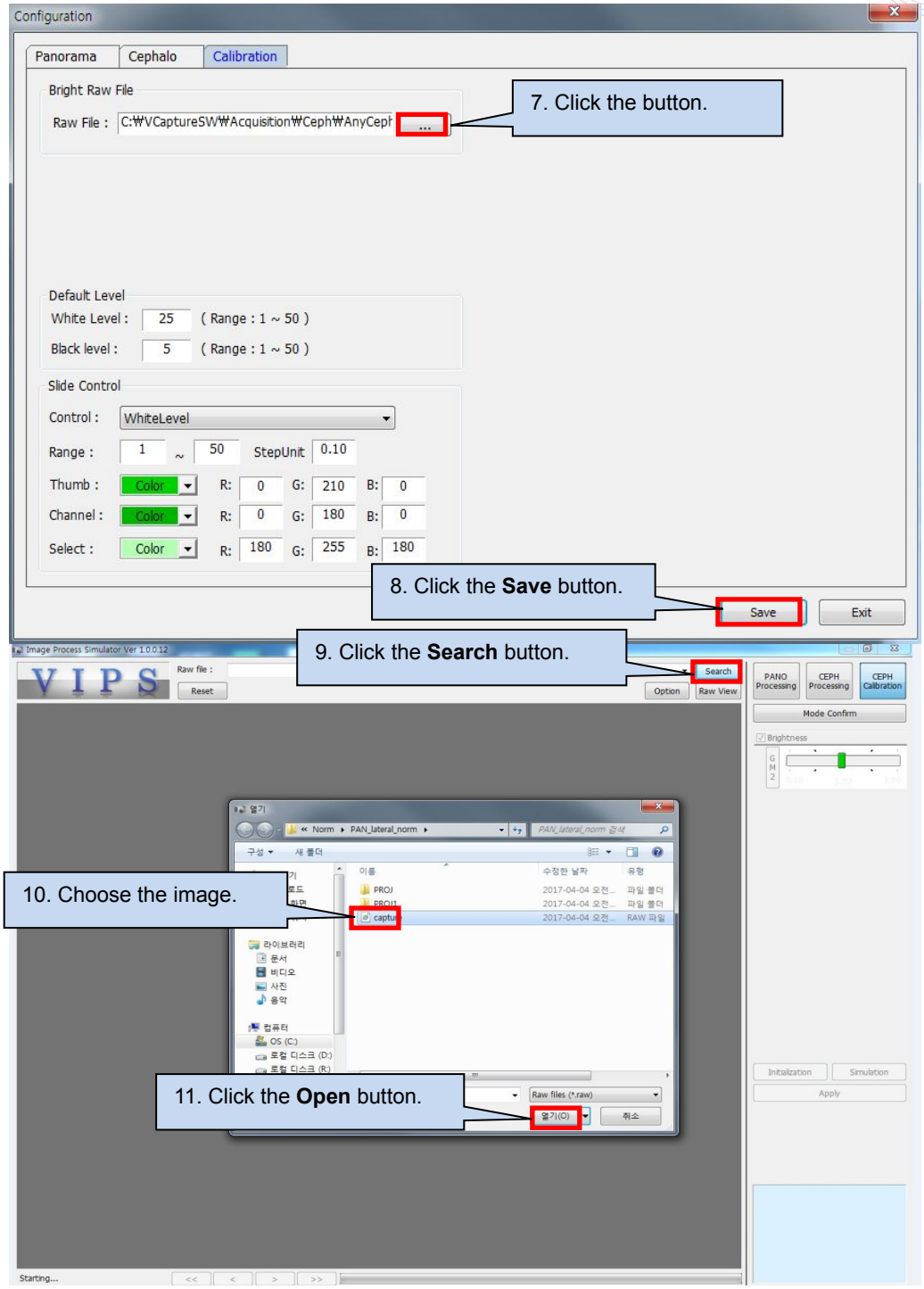


4. If the system displays the **HOLD THE BUTTON** message again instead of the succeeding message, repeat step 3.
5. If the CEPH Auto Alignment is completed successfully, the pop-up message which notifies the completion of the alignment displays on the screen. Then, click the **OK** button to finish.
6. If the Error message appears, follow the guide. Then proceed the steps 1~5.

4. How to use V.I.P.S

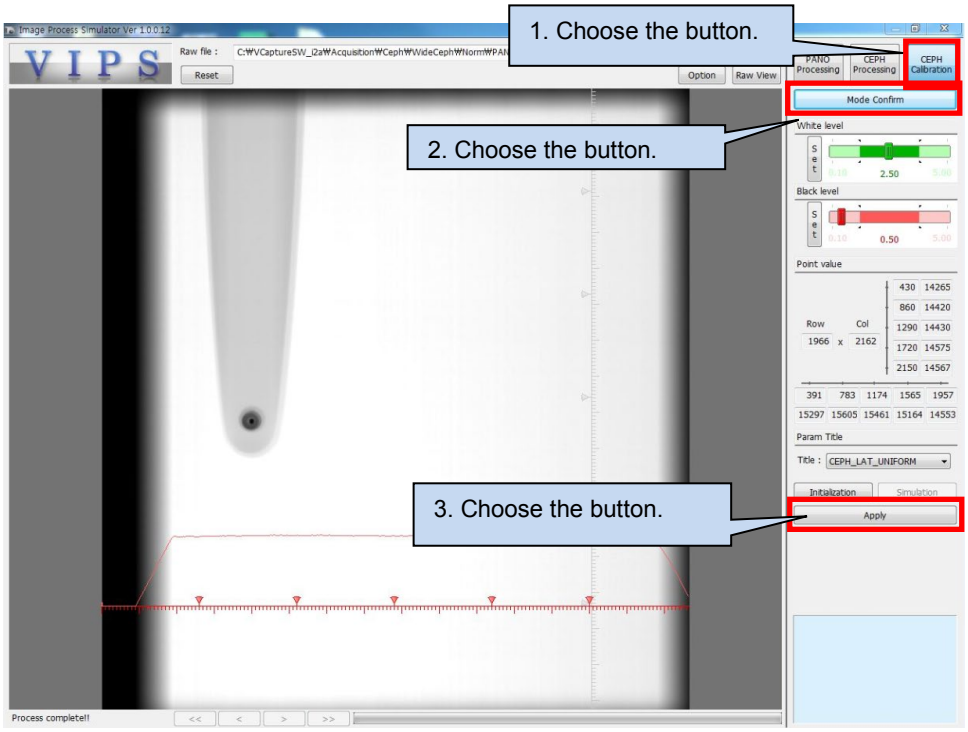
1. Run the C:\VCaptureSW\Util\VIPS.exe file.
2. Set options for each mode, as shown in the picture below.

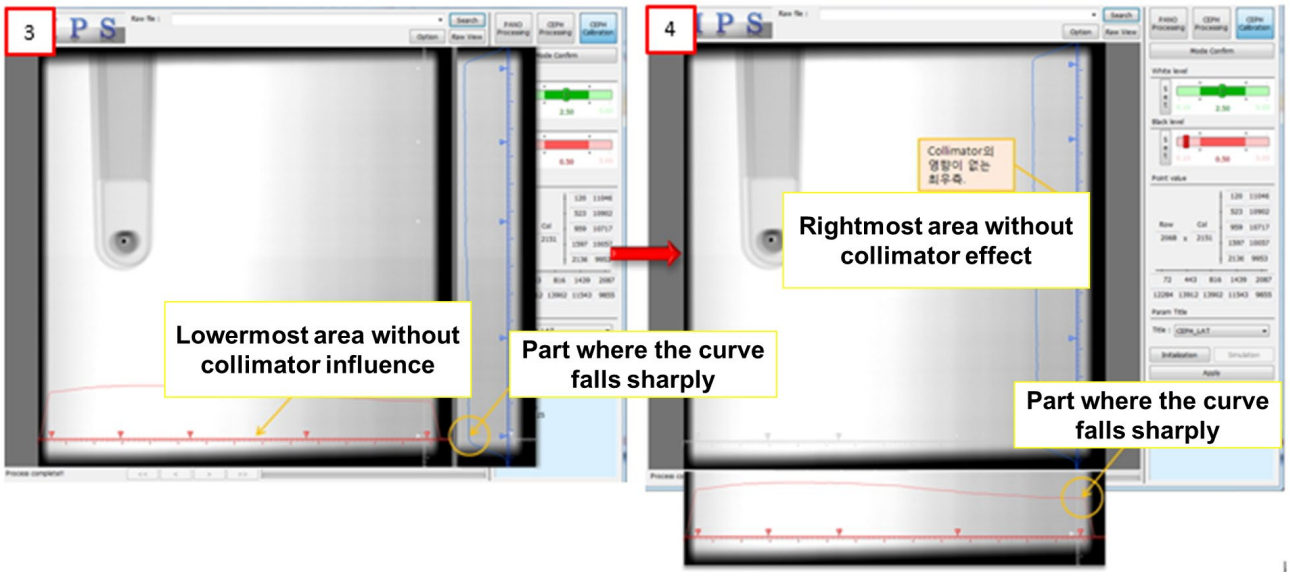




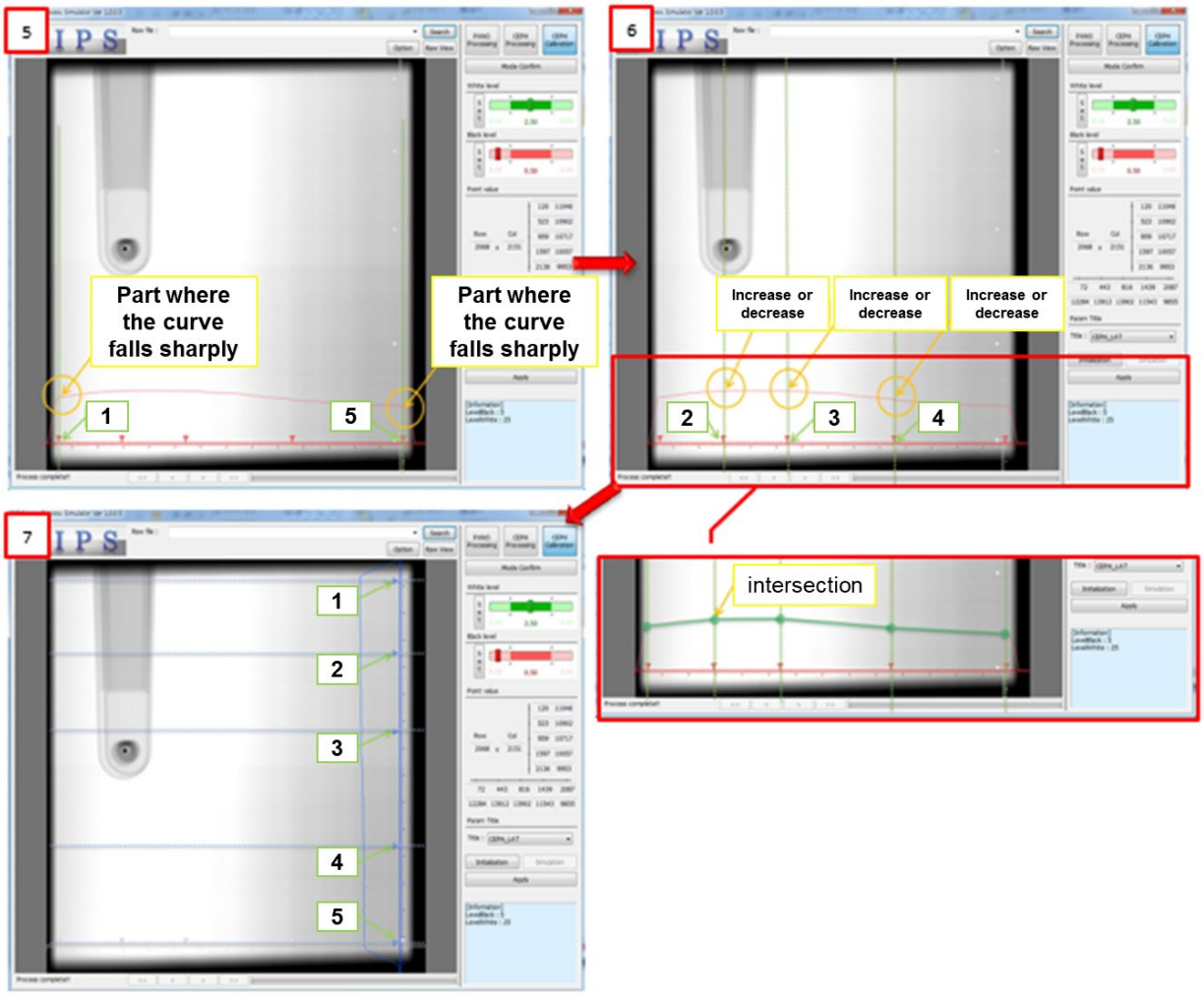
4.1. Point setting method for Lateral Mode image

1. The Row Guide Line sets the lower part without the influence of the collimator.
2. Use the Histogram of the column guideline to set within the range before the curve descends rapidly.
3. When you complete the settings, as shown in the pictures from 3 to 7, 8, choose the **Apply** button.





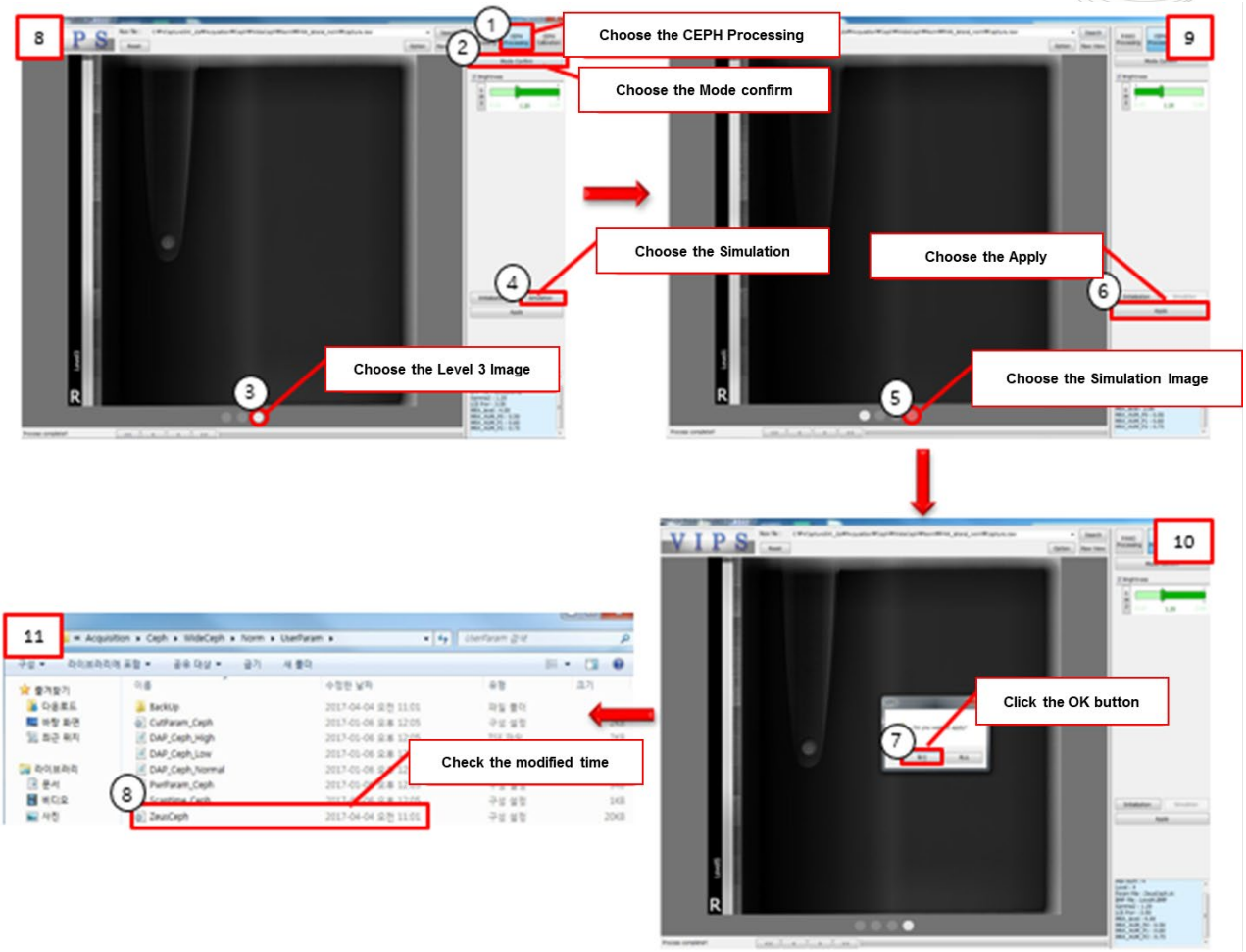
V.I.P.S execution screen



4. As in [5], Row Points 1 and 5 set the endpoint without the influence of the left and right collimators.

   This is set at the point before the left, and the right curves descend sharply in the raw histogram.

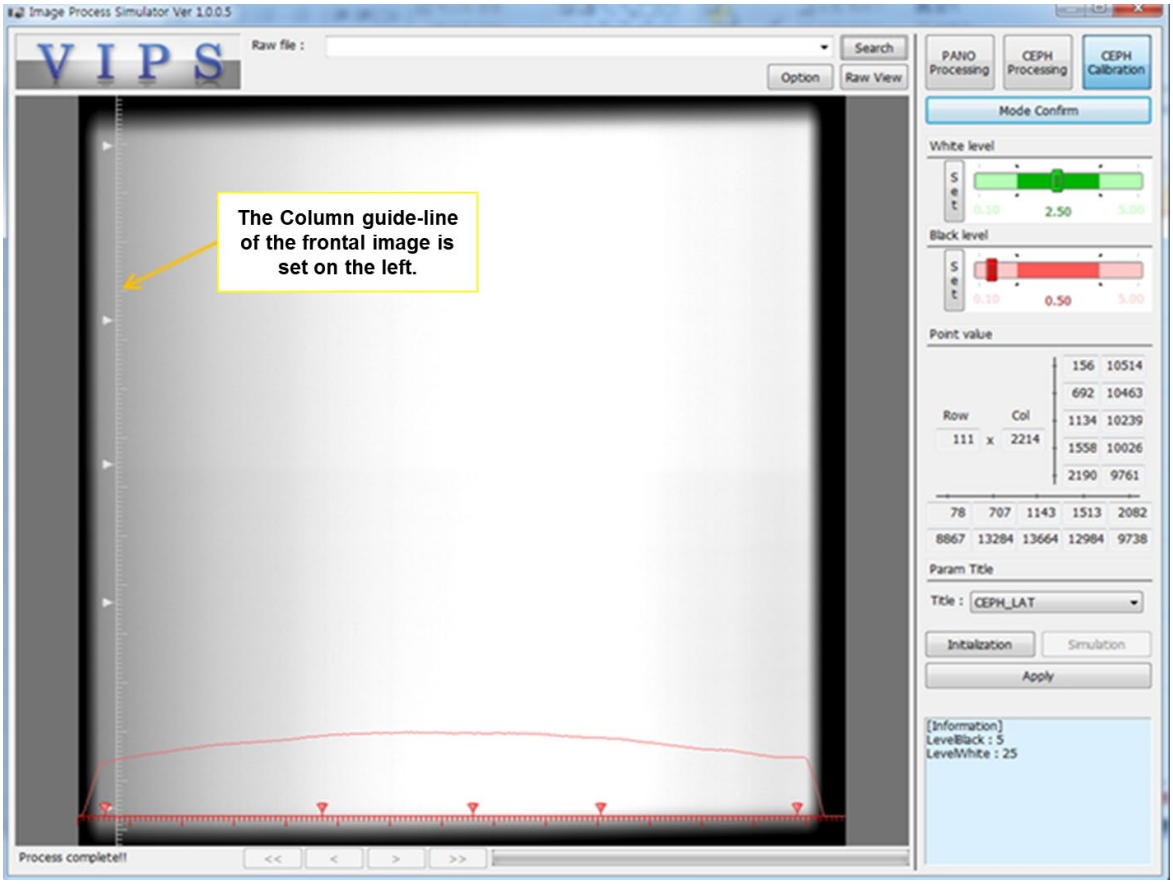
5. As in [6], Row Points 2, 3, and 4 are set to positions that can reflect the trend of the histogram.
6. In the histogram, set the part where the curve increases and decreases.
7. As shown in [7], if the intersections between the vertical lines of Row Points 1 to 5 and the Histogram are almost identical to each other, if the curve of the Histogram is almost identical, the correct point is set.
8. If there are many differences from the line connecting the histogram and the intersection, reset the point.
9. Column Points 1 to 5 is set in the same way as Row Points 1 to 5.



10. Complete the CEPH Calibration, and choose the ①CEPH Processing button, as shown in [8].
11. When the Mode Confirm button is chosen, Level 1~3 images are created.
    * Level 1~3: Level 3 has the highest contrast due to the difference in contrast.
12. Choose the O mark on the far right of ③, which is an image of Level 3 among the created images.
13. When the Simulation button is chosen, an image of O marked in red, as shown in [9], is created.
14. Choose O marked in red and ⑥ click the **Apply** button.
15. When a pop-up window is created, as shown in [10], ⑦ click the **OK** button.
16. As shown in [11], check that the time of the modified date of Acquisition/WideCEPH /Norm or Fast/UseParam/ZeusCEPH is the same as the time when the work is completed.

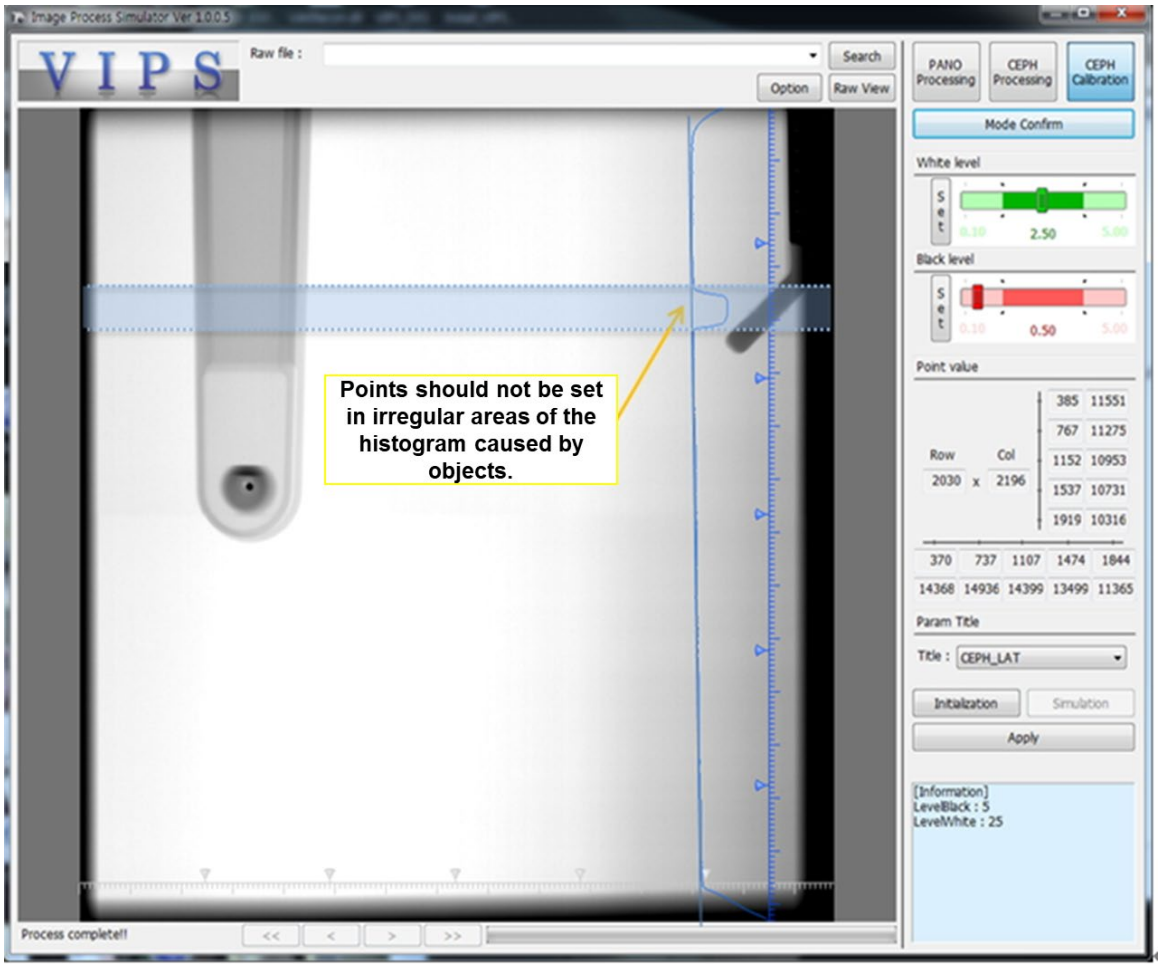
4.2. Point setting method for Frontal Mode image

1. The values set in Frontal Mode are the same as SMV, Carpus, and Waters View.
2. The lateral image Point setting method is the same, and the column guideline is set on the left.



4.3. Cautions when setting V.I.P.S Point

1. The point should not be set in the histogram irregular area caused by object or noise in the image.



2. Countermeasures when background noise occurs even after calibration is applied
   - In the case of lateral images, the column guideline is basically set on the right side, and it is changed to the left side and set again.
   - In the case of the frontal image, the column guideline is basically set from the left side, and it is changed to the right side and set again.
   - If the same phenomenon occurs in the above two cases, there may be Alignment or other problems with the equipment, and set again from the beginning after checking. When the setting is completed, as shown in the pictures from 3 to 7, 8. Choose the Apply button.

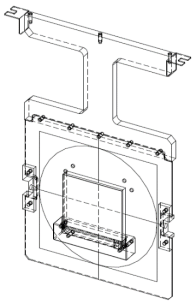
Chapter 6. CEPH Image Evaluation

1. Lateral Mode Start Position Evaluation

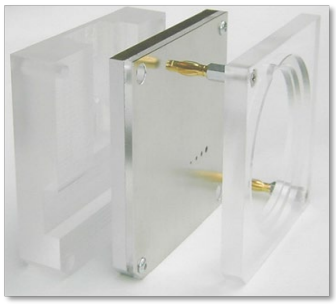
1.1. Lateral Mode Starting position standard

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
LAT start position	605	625

1.2. Phantom Specification



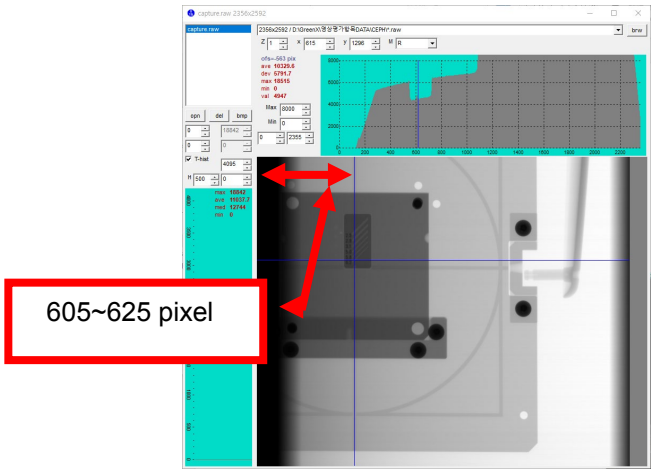
CEPH Phantom



QUART Phantom

1.3. Test Method

1. Run Console Software and click the **CEPH** to go into ceph mode.
2. Set the High-Resolution/Lateral Mode/exposure condition 80 kVp, 10 mA, and click the **Confirm** button.
3. Place the CEPH Phantom on the ear rod.
4. Attach 0.8 mm Copper Filter on X-Ray Tube.
5. Click the **READY** button and acquire and save the image according to the Console Software guidance.
6. Run View16.exe and open the capture.raw file to measure the center position of the Phantom.



1.4. Test Result

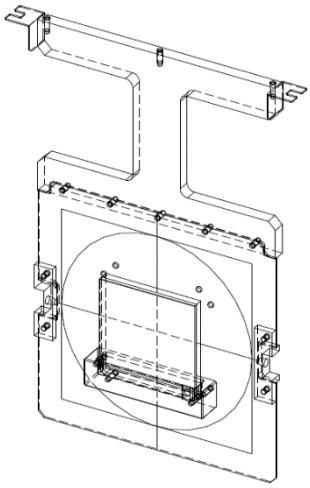
Parameter	LSL	Measurement value	USL	Pass/Fail
LAT start position	605		625	

2. PA Mode Start Position Evaluation

2.1. PA Mode starting position standard

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
PA Start Position	1160	1180

2.2. Phantom Specification

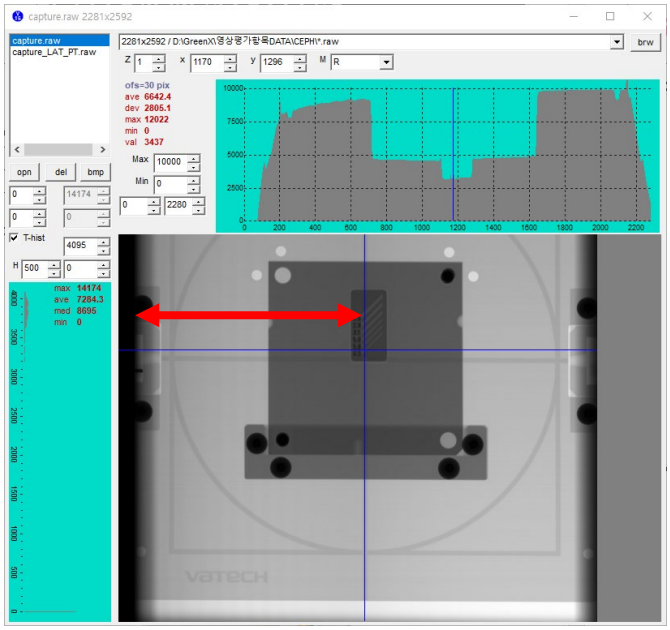


CEPH Phantom

QUART Phantom

2.3. Test Method

1. Acquire images in High-Resolution PA Mode.
2. The evaluation is conducted in the same manner as in the evaluation method in Section 1.3.



2.4. Test Result

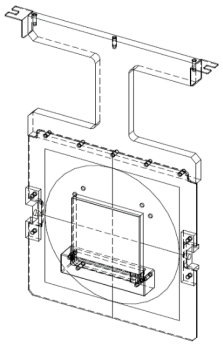
Parameter	LSL	Measurement value	USL	Pass/Fail
PA Start Position	1160		1180	

3. Line Pair Resolution Evaluation

3.1. Noise standards

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
Line Pair Resolution	2.5	-

3.2. Phantom Specification



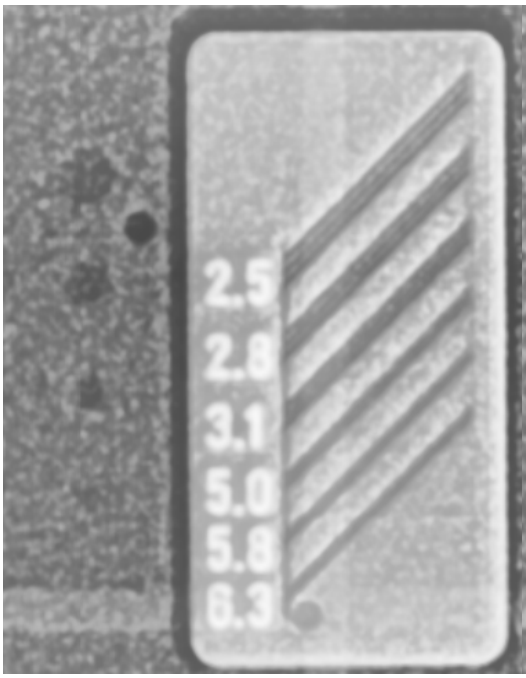
CEPH Phantom

QUART Phantom

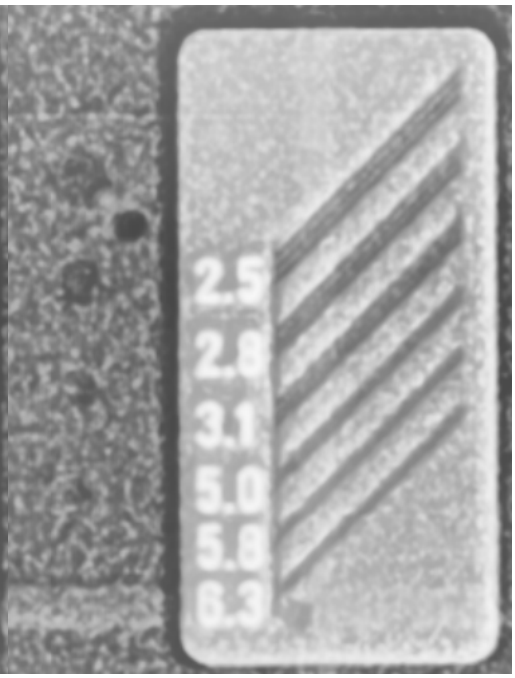
3.3. Test Method

1. The evaluation is conducted in the same manner as in the evaluation methods of 1.3 and 2.3.

3.4. Test Result



High-Resolution PA Mode



Green PA Mode

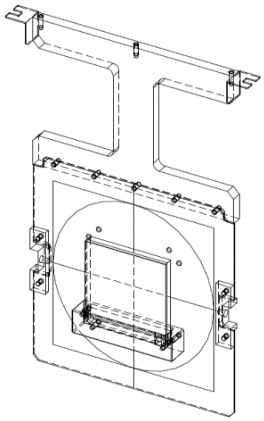
Parameter	LSL	Measurement value	USL	Pass/Fail
Line Pair Resolution	2.5	High Resolution : Green :	-	

4. Low Contrast Resolution evaluation

4.1. Homogeneity standards

Parameter	LSL (Lower Specification Limit)	USL (Upper Specification Limit)
Low Contrast Resolution	-	2.5 mm

4.2. Phantom Specification



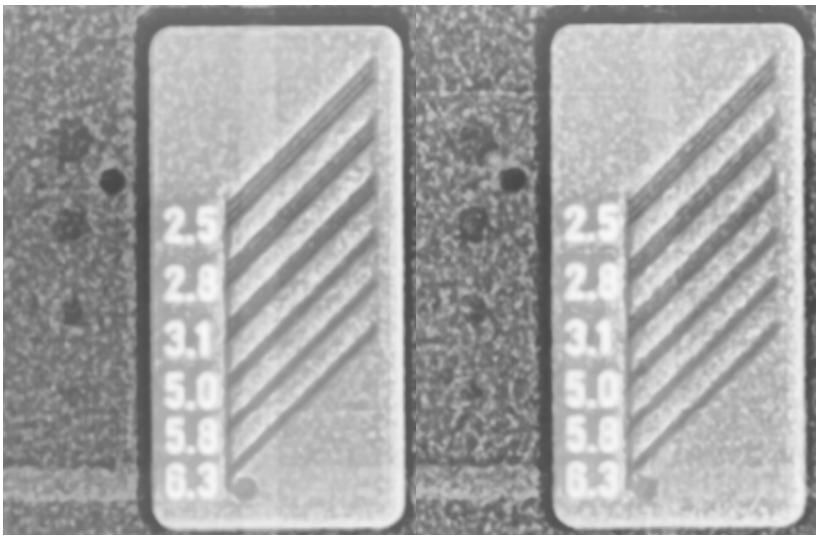
CEPH Phantom

QUART Phantom

4.3. Test Method

1. The evaluation is conducted in the same manner as in the evaluation methods of 1.3 and 2.3.

4.4. Test Result



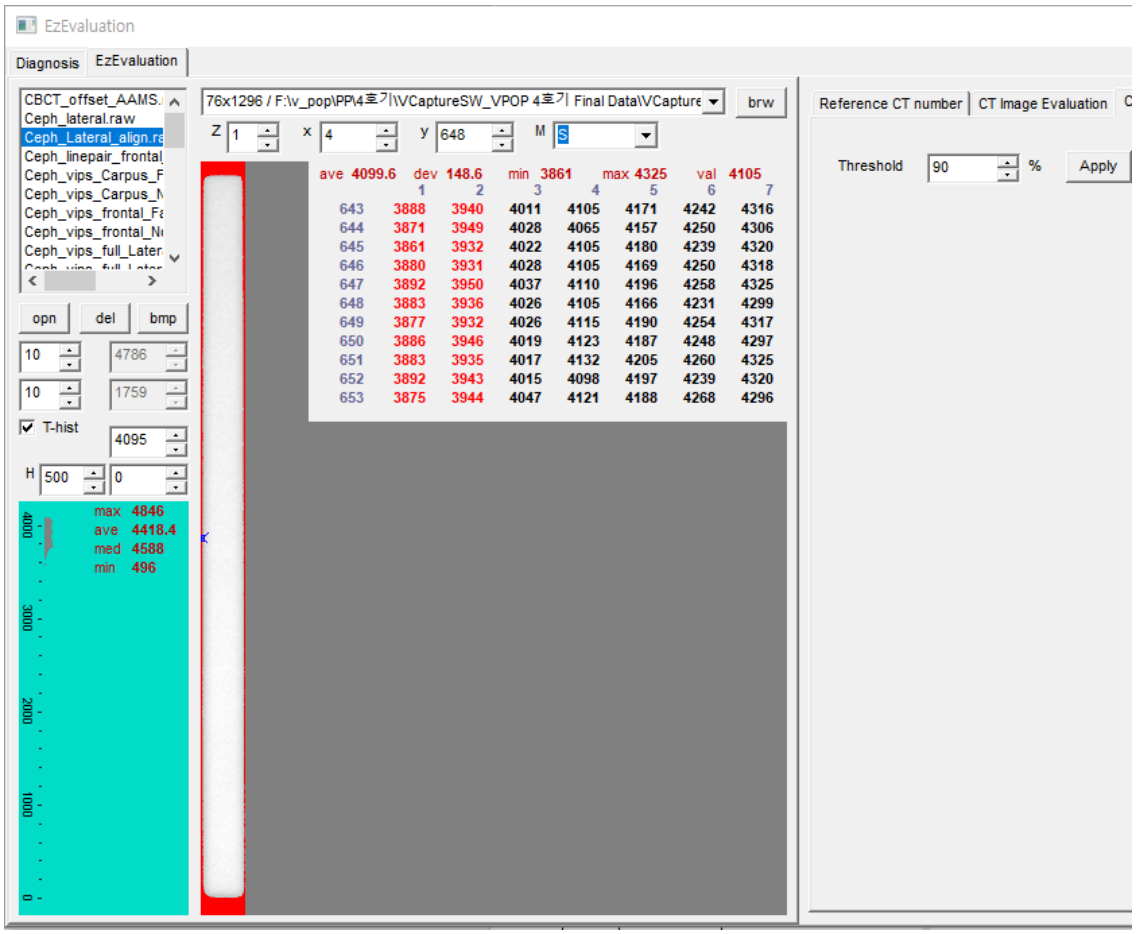
High-Resolution PA Mode Green PA Mode

Parameter	LSL	Measurement value	USL	Pass/Fail
Low Contrast Resolution	-	High Resolution : Green :	2.5 mm	

5. Collimator Alignment Evaluation

5.1. Collimator Alignment Standard

Parameter	LSL (Lower Specification Limit)		USL (Upper Specification Limit)	
Threshold: 90%	Upper	20	Upper	40
	Lower	20	Lower	40
	Left	1	Left	5
	Right	1	Right	5

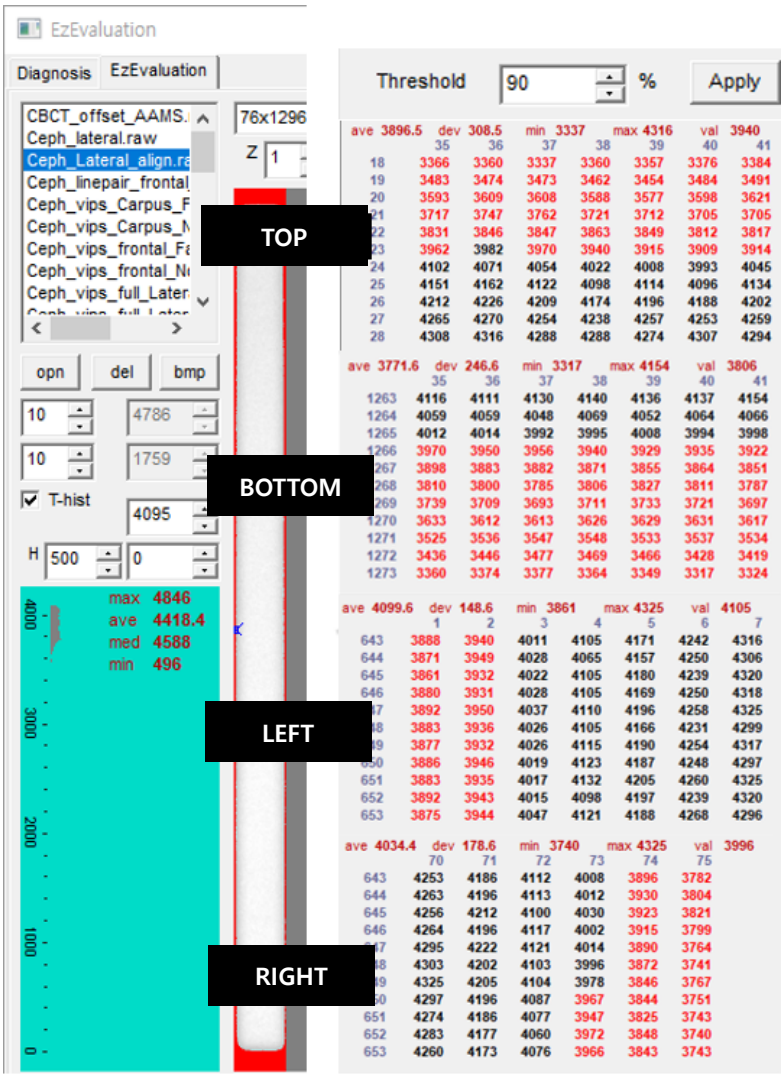


Collimator Alignment Image

5.2. Test Method

1. Complete the collimator set up and acquire the image in the stopped state.
2. Run C:\VCaptureSW\Utility\EzEval_Phantom\EzEval.exe program.
3. Enter 90% as the threshold standard and check if it satisfies the Collimator Alignment standard.

5.3. Test Result



High-Resolution Lateral Mode

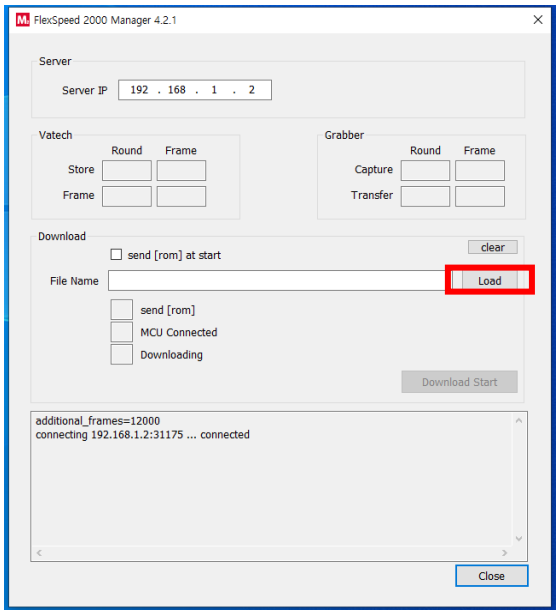
Parameter		LSL	Measurement value	USL	Pass/Fail
Threshold: 90%	Upper	20		40	
	Lower	20		40	
	Left	1		5	
	Right	1		5	

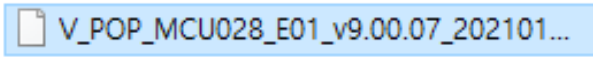
Chapter 7. Firmware Upgrade Guide

The MCU (Micro Controller Unit) operates the system by installed the Firmware program. Therefore, when new functions or patches are released, Firmware files should be upgraded to apply the changes.

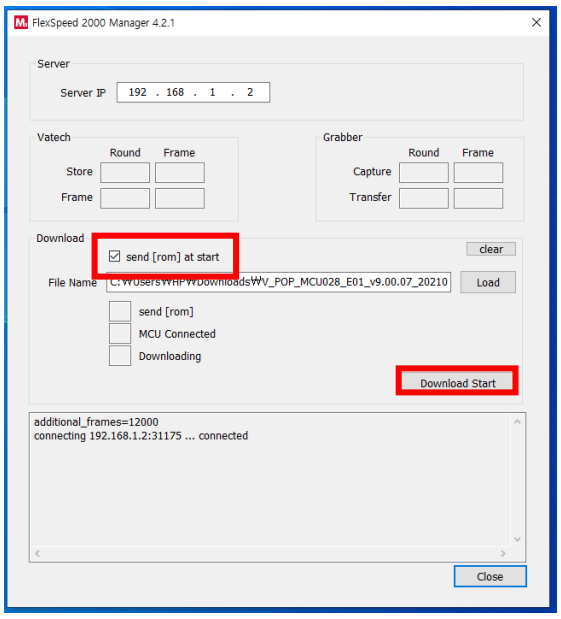
1. Firmware Upgrade Procedure (Ethernet Communication)

1. Run the Flexspeed2000Manager.
2. Click the **Load** button to find a file to download.

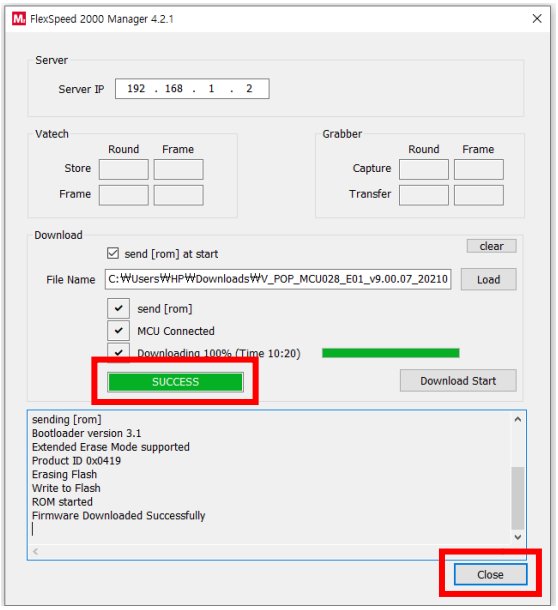




3. Choose the **send [rom] at the start** item and click the **Download Start** button.

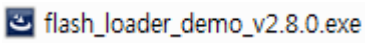


4. When the download is complete, the **Success** button appears as shown below. Click the **Close** button to exit.



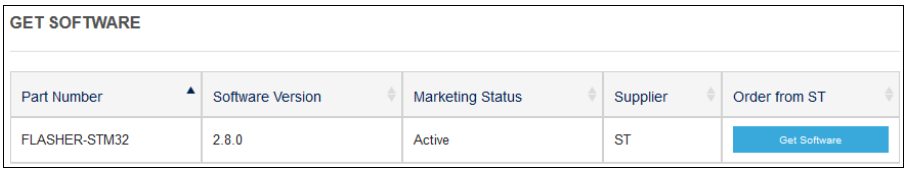
2. Installing Firmware Upgrade Software (Serial Communication)

1. Run the **flash_loader_demo_v2.8.0.exe** file.

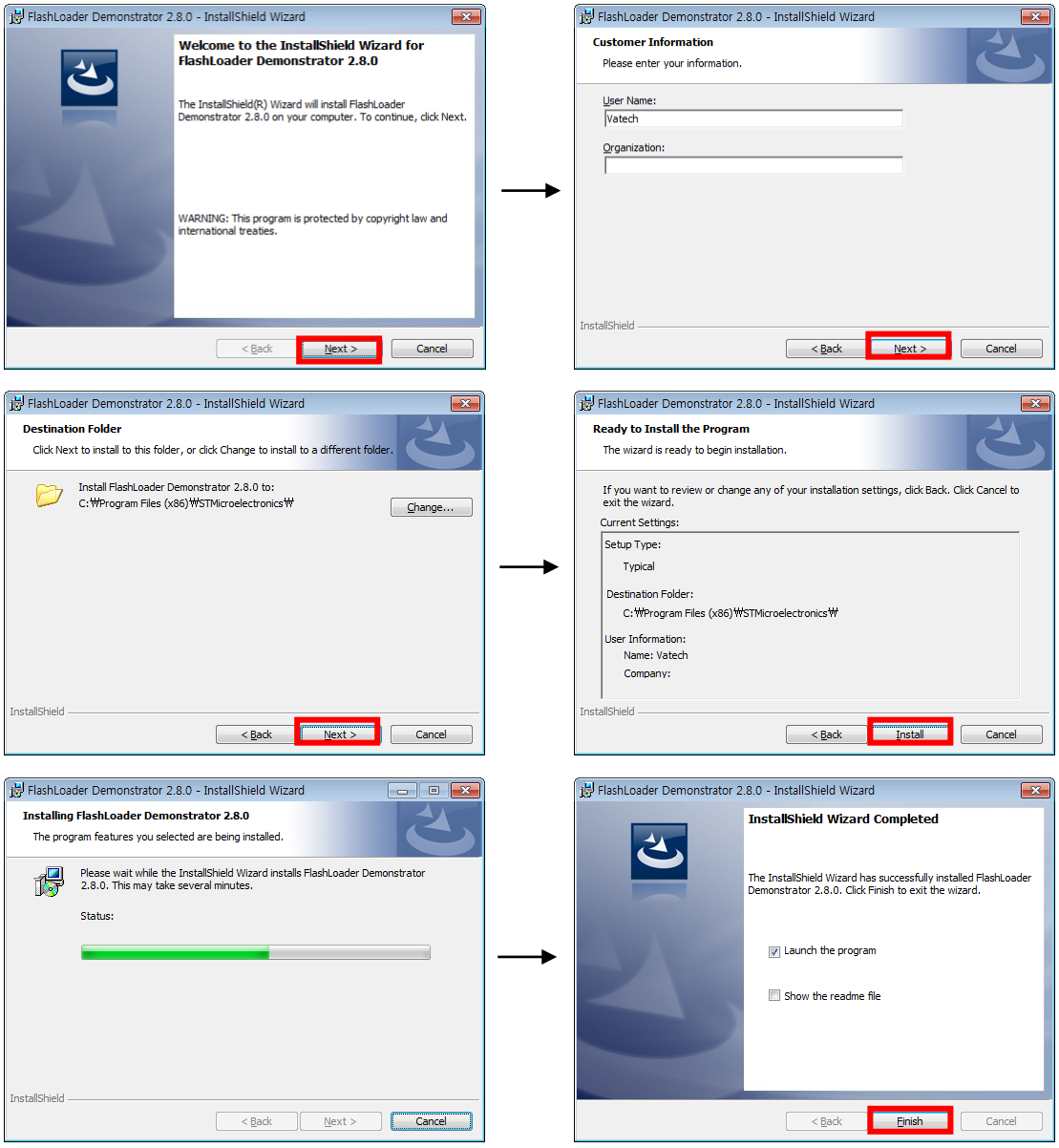


NOTICE

You can download the software at http://www.st.com/en/development-tools/flasher-stm32.html.



2. Continue with installation procedures, as shown below:



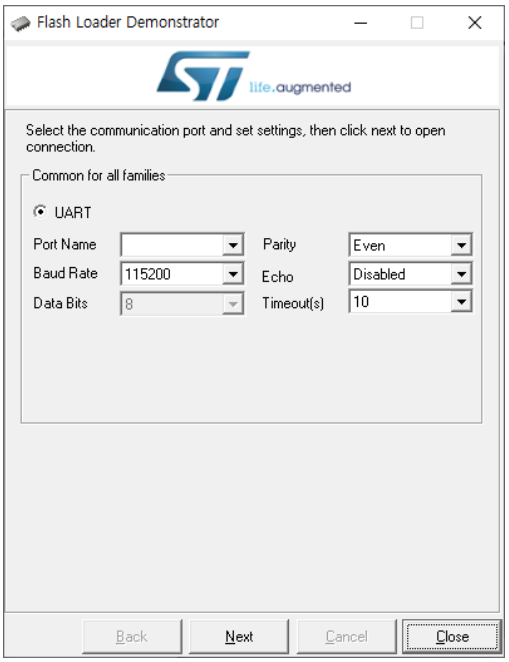
3. Firmware Upgrade Procedure (Serial Communication)

IMPORTANT	RS232 cable should be connected between PC and System.

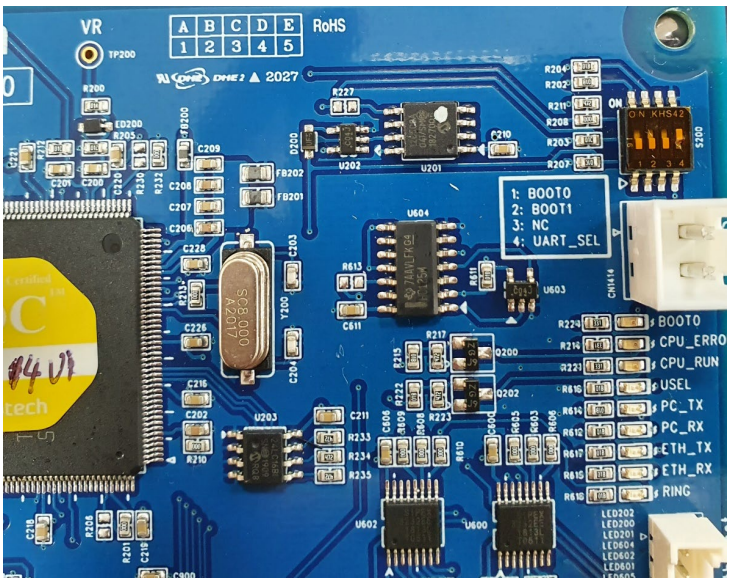
1. Run **STMFlashLoader Demo.exe**.

   C:\Program Files (x86)\STMicroelectronics\Software\Flash Loader Demo

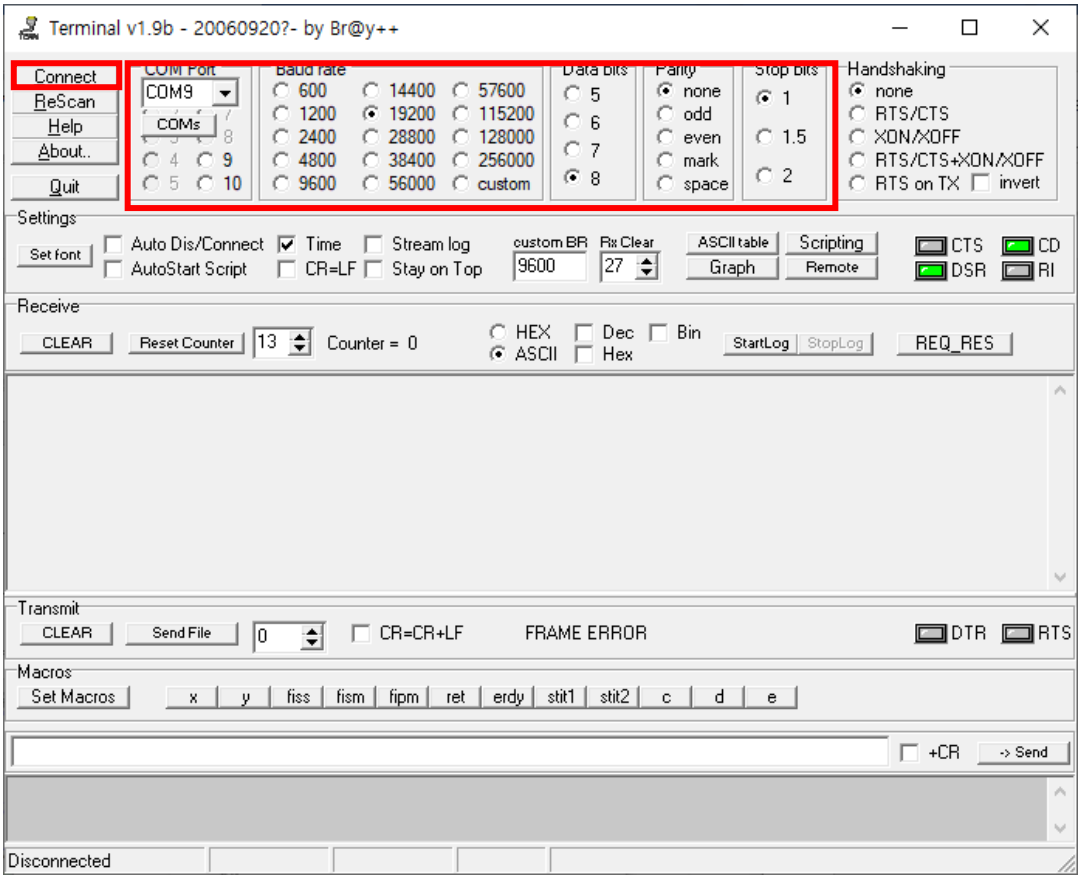
NOTICE	Demonstrator GUI can be found by searching the program by keyword.



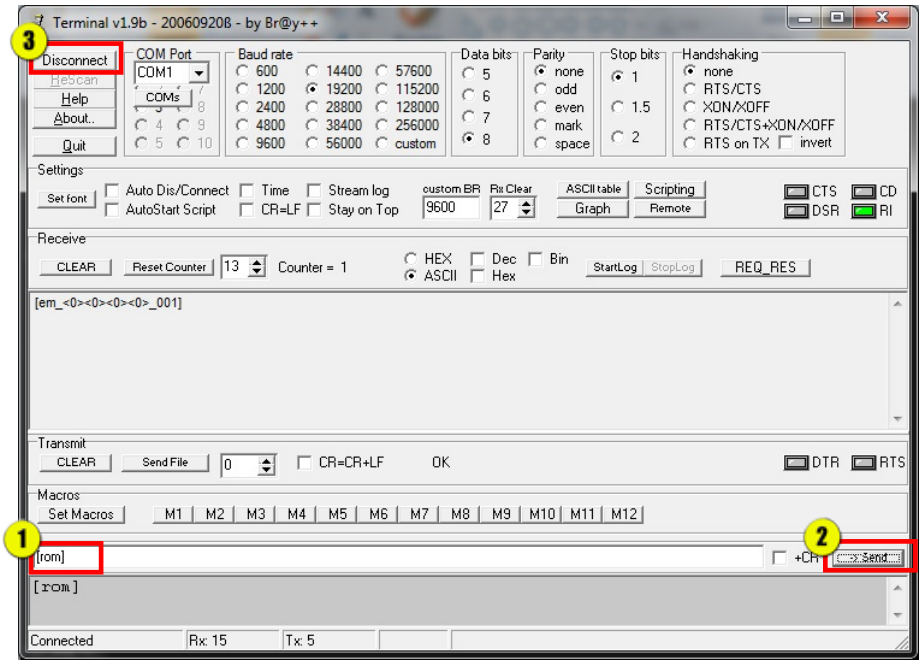
2. Attach RS232, depending on the choose connection method, set switch 4 on the board. (S200 switch No. 4 ON RS232)



3. Run Terminal v1.9b and set the Com Port, Baud rate(19200), Data bits(8), Parity(none), Stop bits(1), and click the **Connect** button.

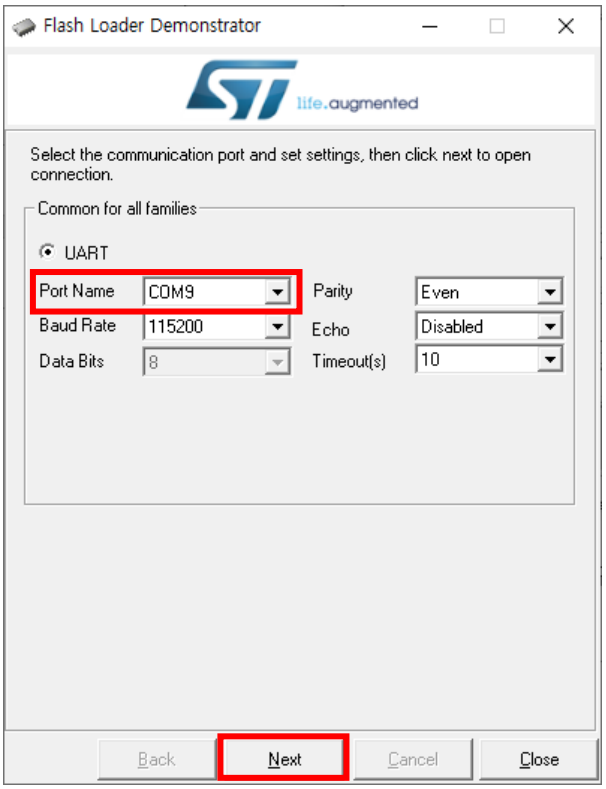


4. send the **[rom]** command and click the **Disconnect** button.

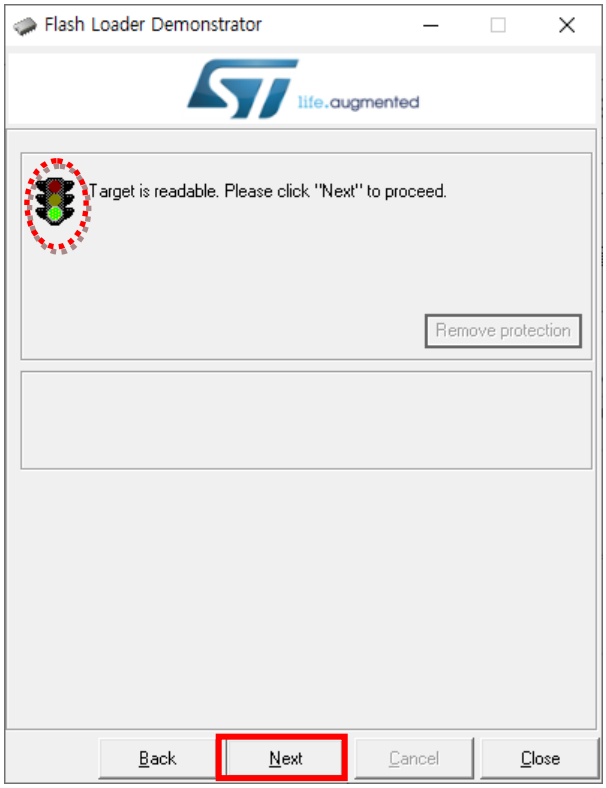


5. Check the Port Name is **COM1** button and click the **Next** button.

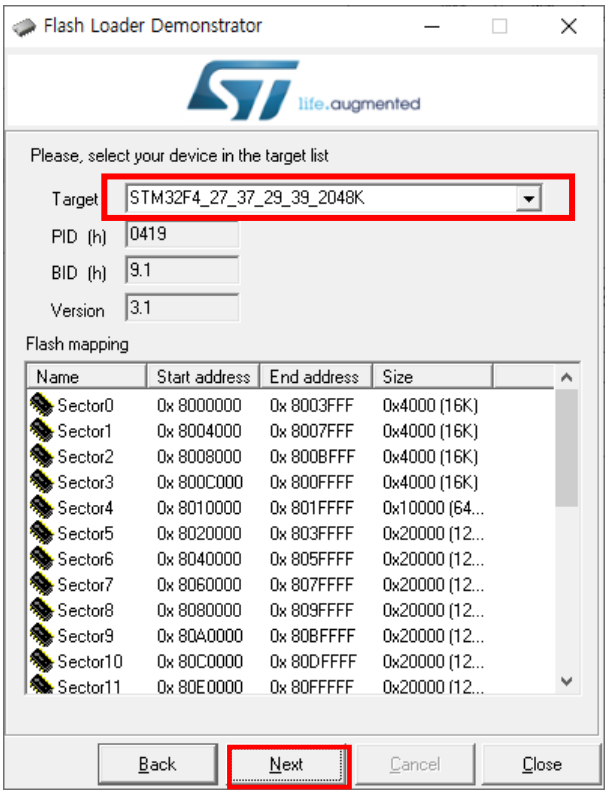
IMPORTANT	Port Name must be the same Port as the Terminal v1.9b program.



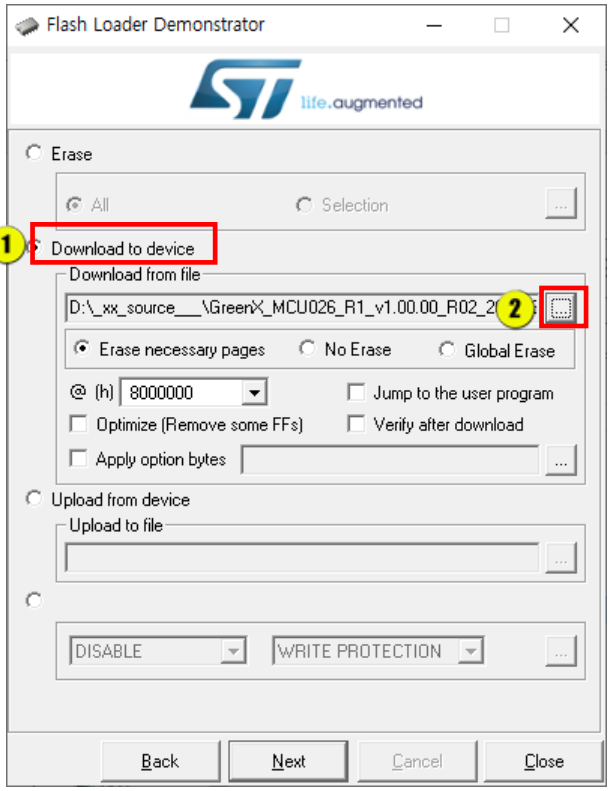
6. Check the **Target is readable. Confirm the phrase Please click the “Next” to proceed.** and click the **Next** button.



7. Choose STM32F4_27_37_29_39_2048K corresponding to STM32F427II MCU, and click the **Next** button.



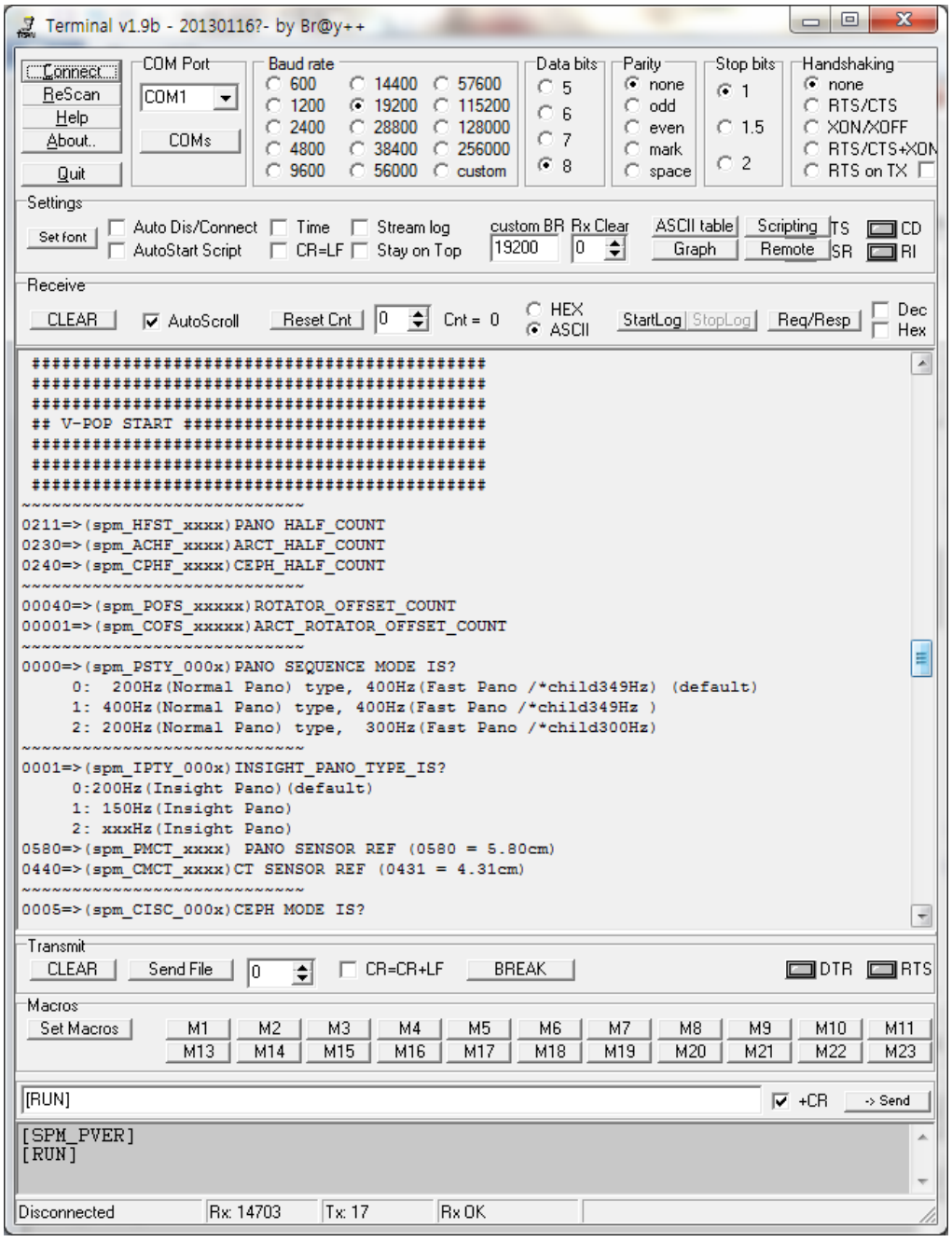
8. Choose **Download to device** and browse a firmware to upgrade and open the file.



9. Click the **Next** button to continue with a firmware upgrade.

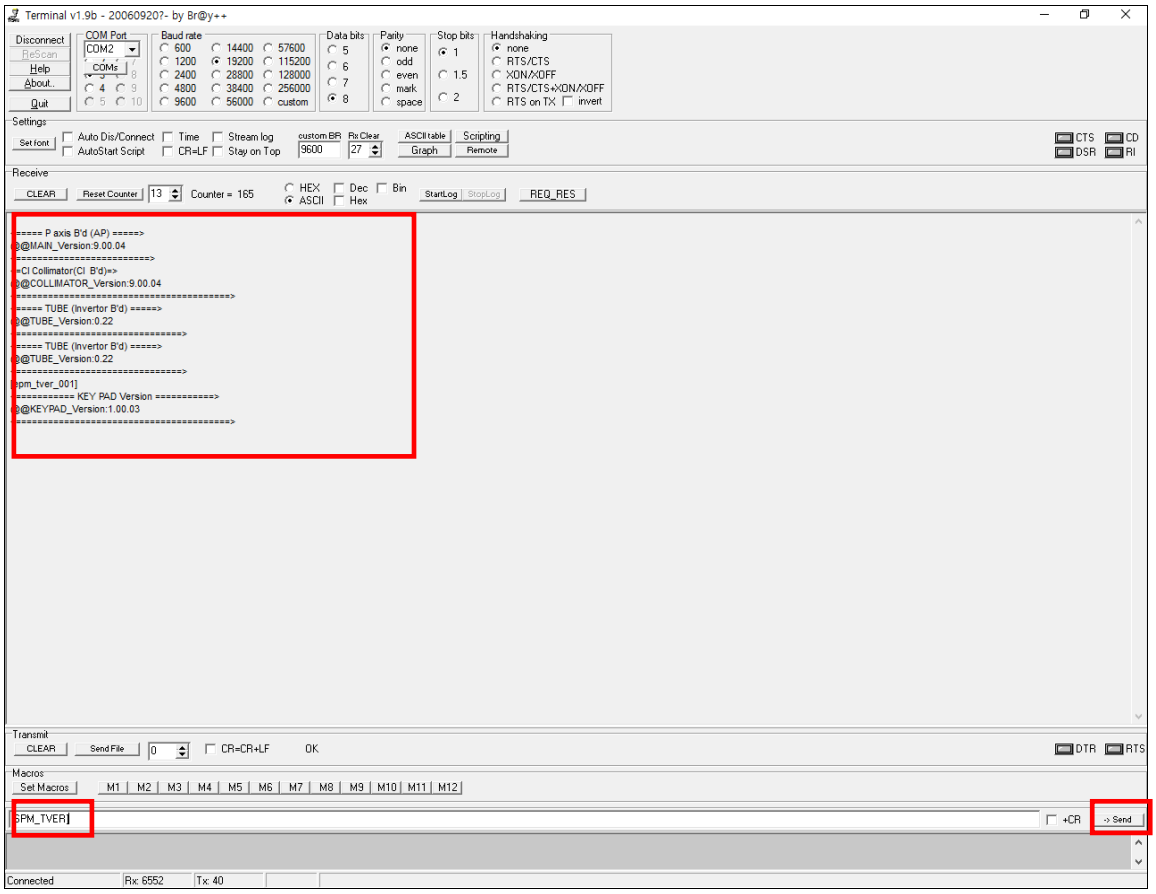
10. When the firmware upgrade is completed, the "**Download operation finished successfully**" message will show up.

11. Click the **Close** button to exit the program.
12. Run Terminal v1.9b and input the **[RUN]** command in the Command window, and check the serial message.



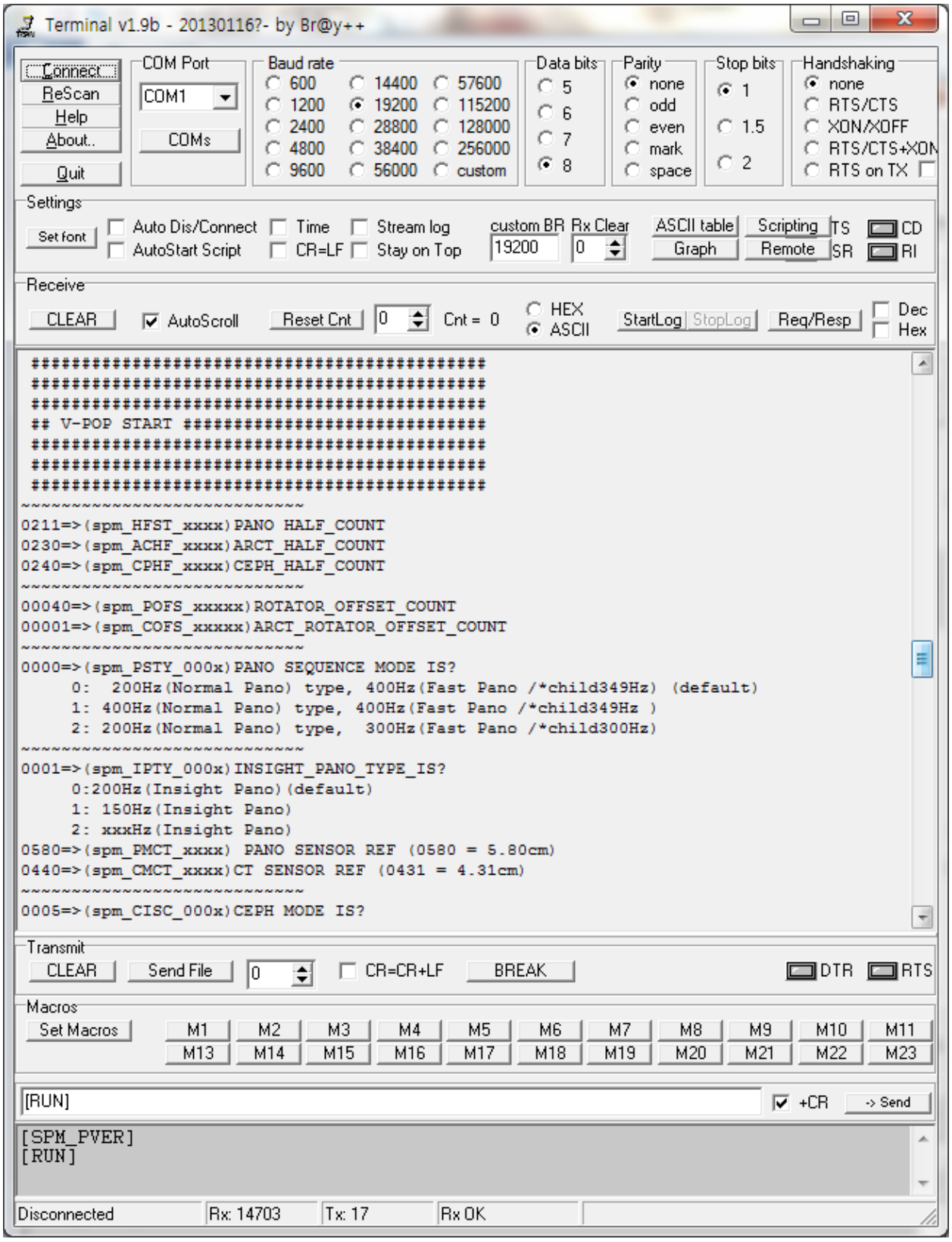
4. Checking Firmware Version (Serial Communication)

1. Run **Terminal v1.9b**.
2. Send the **[SPM_TVER]** command.
3. Check the Firmware Version of the MCU Boards.



5. Appendix

5.1. Main MCU Board Parameters



NOTICE	To check the saved Parameter value in MAIN MCU BOARD, send the [SPM_PVER] command in the Terminal 1.9b program.
⚠CAUTION	The Parameter values in this manual are random numbers only for explanation. Thus do not refer to the Parameter Values written in this manual since the actual Parameter Values for your system differ from these values. Wrong inputs of the Parameter value may damage the equipment.

<===== V-POP   (MCU028) =====>
@@MAIN_Version:9.00.00
<========================>

##
##
##
V-POP START
##
##
##
~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- R-axis initial position by exposure mode

0191=>(spm_HFST_xxxx)PANO HALF_COUNT
0226=>(spm_ACHF_xxxx)ARCT_HALF_COUNT
0226=>(spm_CPHF_xxxx)CEPH_HALF_COUNT
~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- PANO, ARCT R axis starting position offset

00095=>(spm_POFS_xxxxx)ROTATOR_OFFSET_COUNT
00001=>(spm_COFS_xxxxx)ARCT_ROTATOR_OFFSET_COUNT
~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- PANO sequence typesetting(not used)

0000=>(spm_PSTY_000x)PANO SEQUENCE MODE IS?
    0: 200Hz(Normal PANO) type, 400Hz(Fast PANO /*child349Hz) (default)
    1: 400Hz(Normal PANO) type, 400Hz(Fast PANO /*child349Hz)
    2: 200Hz(Normal PANO) type, 300Hz(Fast PANO /*child300Hz)
~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- CT/PANO Sensor initial position by exposure mode

0580=>(spm_PMCT_xxxx) PANO SENSOR REF (0580 = 5.80cm)
0438=>(spm_CMCT_xxxx)CT SENSOR REF (0431 = 4.31cm)
~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- CEPH mode setting

0005=>(spm_CISC_000x)CEPH MODE IS?
    0: Disable
    1: Scan CEPH (cone beam ceph)
~~~~~~~~~~~~~~~~~~~~~~~~~~~~

2: Scan CEPH (fan beam ceph-No USE!!)
3: One-Shot CEPH (R-Troy, Large FOV)
4: One-Shot CEPH (TOK-Troy, Small FOV)
5: Scan CEPH (Table Control)

~~~~~~

~~~ceph sensor start position offset~~~

1700=>(spm_UATT_xxxx)CEPH_TABLE_A_START_OFFSET_COUNT (0165 = 16.5cm).

0300=>(spm_UBTT_xxxx)CEPH_TABLE_B_START_OFFSET_COUNT (0165 = 16.5cm).

1700=>(spm_UCTT_xxxx)CEPH_TABLE_C_START_OFFSET_COUNT (0165 = 16.5cm).

0350=>(spm_UDTT_xxxx)CEPH_TABLE_D_START_OFFSET_COUNT (0165 = 16.5cm).

1700=>(spm_UETT_xxxx)CEPH_TABLE_E_START_OFFSET_COUNT (0165 = 16.5cm).

0350=>(spm_UFTT_xxxx)CEPH_TABLE_F_START_OFFSET_COUNT (0165 = 16.5cm).

1700=>(spm_UGTT_xxxx)CEPH_TABLE_G_START_OFFSET_COUNT (0165 = 16.5cm).

0350=>(spm_UHTT_xxxx)CEPH_TABLE_H_START_OFFSET_COUNT (0165 = 16.5cm).0313(HZ)=>(spm_CFRQ_xxxx)CEPH PULSE HZ SET

1790=>(spm_XRFA_xxxx)CEPH_REF_X1_START POSITION (1730 = 17.3cm)

~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Collimator type

0002=>(spm_COTY_xxxx)COLLIMATOR TYPE SET (0: No collimator)(1: Using 4axis collimator)(2: Using 1axis collimator)

~~~~~~~~~~~~~~~~~~~~~~~~~~~~

10200=>(spm_COVS_xxxxx)1axis-COL_OFFSET_VAL(1xxxx=> "-val" (1 = 0.01016mm)

~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- 1-axis collimator position by exposure mode

11395=>(spm_CBST_xxxxx)COL_PANO_CHILD_VAL (1axis collimator) (00001 = 1pulse)

912 is default by machanical data

03685=>(spm_CCST_xxxxx)COL_PANO_VAL (1axis collimator) (00001 = 1pulse)

3450 is default by machanical data

06660=>(spm_CFST_xxxxx)COL_CT_VAL (1axis collimator) (00001 = 1pulse)

6350 is default by machanical data

09150=>(spm_CGST_xxxxx)COL_CEPH_VAL (1axis collimator) (00001 = 1pulse)

8899 is default by machanical data

11969=>(spm_CDST_xxxxx)COL_FILTER_VAL (1axis collimator) (00001 = 1pulse)

11969 is default by machanical data

~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Sensor and collimator drive ratio

122=>(SPM_PSCR) pano_sm_cm_ratio

~~~~~~~~~~~~~~~~~~~~~~~~~~~~

R axis motor torque setting

0025 =>(SPM_RMRT_0001) R_M_RUN_TORQUE

0005 =>(SPM_RMST_0001) R_M_STOP_TORQUE

~~~~~~~~~~~~~~~~~~~~~~~~~~~~

PANO,CT sensor mortor, Collimator motor, CEPH sensor motor torque setting - GMRT, GMST disabled (3D camera)

2000 =>(SPM_LMRT_0001) LASER_M_RUN_TORQUE

0050 =>(SPM_LMST_0001) LASER_M_STOP_TORQUE

2500 =>(SPM_TSRT_0001) TEMPLE_M_RUN_TORQUE

0200 =>(SPM_TSST_0001) TEMPLE_M_STOP_TORQUE
20000 =>(SPM_GMRT_0001) G_M_RUN_TORQUE
01000 =>(SPM_GMST_0001) G_M_STOP_TORQUE
20000 =>(SPM_HMRT_0001) H_M_RUN_TORQUE
01000 =>(SPM_HMST_0001) H_M_STOP_TORQUE
~~~~~~

- Disabled (3D camera lighting)

00600 =>(SPM_CWFQ_0600) CWLED_PULSE_HZ
00050 =>(SPM_CWDT_0050) CWLED_PULSE_DT
~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- Door lock setting

0000=>(spm_DROP_000x)DOOR_TYPE
0: NO door switch Mode
1: Using door switch mode

- Tube tilting setting

0001=>(spm_TITY_000x)TILT_TYPE
0: NO tube tilting Mode (for only PANO Model)
1: Using tube tilting mode

- Auto Return setting

0001=>(spm_RTOP_000x)RETURN_TYPE
0: NO Auto Return Mode
1: Using Auto Return mode

- Exposure voice settings

0000=>(spm_EPOP_000x)EXPOSURE_TYPE
0: Normal Mode
1: Sound delay mode

- Fan temperature setting

0400=>(spm_FANT_xxxx)FAN_On_Temp (0400 = 40 degrees C)

- Serial number setting

000000000=>(spm_SNUM_xxxxxxxxx) SERIAL NUMBER

- MP3 type setting

0003=>(spm_MPOP_000x) MP3 MUSIC Option SET!!
0: Different music played each capture mode
1: Same music played each capture mode
2: Beep sound
3: Beep&AutoReturn sound(default)

- MP3 option settings

0001=>(spm_MPEN_000x) MP3 Player board SET!!

MP3 volume setting

0074=>(spm_VOLU_00xx) MP3 Player board SET!!(1~82)
~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- Number of exposures per mode

01855=>(spm_GCNT)PANO_CAPTURE_CNT
00898=>(spm_GCNT)CEPH_CAPTURE_CNT
00665=>(spm_GCNT)ARCT_CAPTURE_CNT ct/ent

- Rotator initialization option when exposure the CEPH

0001=>(spm_MRTP_x)MODE_RESET_TYPE
~~~~~~~~~~~~~~~~~~~~~~~~~~~~

0: xyr axis reset when ceph mode change.
1: no xyr axis reset when ceph mode change.

- Exposure switch Ready LED On Delay setting

3000=>(spm_RDTS_000x)Ready Delay Time Set

- Patient detection options setting(not used)

0000=>(spm_PDSS_000x)Patient Detect Sensor Set

- Touch sound effect options setting

0000=>(spm_TSES_000x)Touch Sound Effect Set

- set the location of the sensor and collimator when exposure CT,

0344 =>(SPM_CSMV) ct_sensor_move_val
0664 =>(SPM_CCMV) collimator_move_val
~~~~~~~~~~~~~~~~~~~~~~~~~~~~

- MP3 language setting

us=>(spm_L_XX)NATION CODE
~~~~~~~~~~~~~~~~~~~~~~~~~~~~
[epm_pver_001]

Chapter 8. Command-List Guide

The command listed on this document is intended to communicate with equipment. The command is a directive to PC acting as an interpreter to perform a specific task to VATECH equipment.

1. Communication Protocol

1.1. Communication Setting

The vatech A9 commands input and output data by Serial communication in HyperTerminal Program. And the communication setting parameters are in the table below.

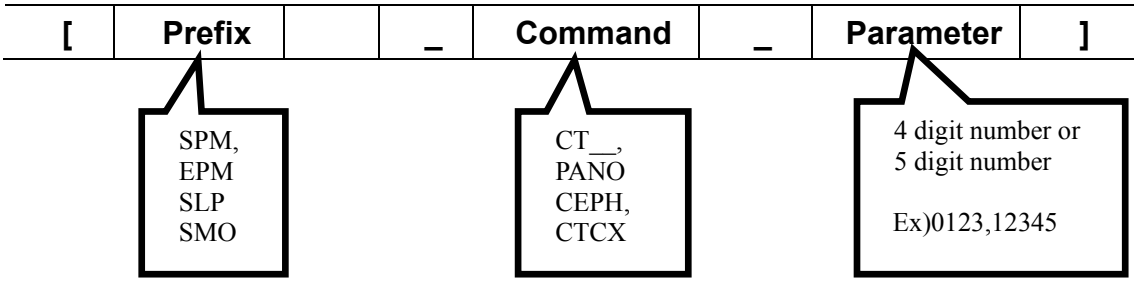
Order	Parameter	Setting value
1	Baud(speed)	19200 bps
2	Data bit	8 bit
3	Stop bit	1 bit
4	Parity	Not applied
5	Flow Control	Not applied

- **Baud:** The number of signal changes made to the transmission medium per second. Each symbol can represent or convey several bits of data.
- **Data bit:** The number of bits that are conveyed or processed per unit of time in data communication. The data bit is quantified the actual data using bits per second except Parity, Start bit, Stop bit, or control signals.
- **Stop bit:** In Asynchronous data transmission, a stop signal (last 2 bits) is sent after each codeword to bring the receiving mechanism to rest in preparation for the reception of the next symbol.
- **Parity:** A bit added to ensure that the number of bits with the value one in a set of bits.
- **Flow Control**: The process of managing the data transmission rate, so that the receiving node is not to miss or lock up by overwhelmed data

1.2. Command Formation

Command format = **'['** + **'prefix'** + **'_'** + **'command'** + **'_'** + **'parameter'** + **']'**

Ex) [SPM_CTCX_0123]



- **'['** = Start symbol

- **'prefix'** = 3 letters arrangement.

  First letter: **S**end/**E**cho

  Second letter: **P**c/**M**cu/**L**cd/**O**ptic

  Third letter : **P**c/**M**cu/**L**cd/**O**ptic

  Ex) SPM: Send PC to MCU, SLP: Send LCD to PC, SMO: Send MCU to OPTIC,
  EPM: Echo SPM, ELP: Echo SLP, EPO: Echo SPO

- **'Command' =** 4 letters arrangement. If it is less than 4 letters, the command should be filled up

  with "_".

  Ex) [SPM_CT__]

- **'Parameter'** = only when commands come with a parameter, 4~5 letters arrangement. If it is less than 4 or 5 letters, the parameter should be filled up with "0".

  Ex) In case of 4 letters parameter- [SPM_XPST_0234]

  In case of 5 letters parameter- [SPM_COAX_ 00100]

  In the case of 4 letters parameter only with "0"- [SMP_STOP_0000]

- **']'** = End symbol

2. vatech A9(PHT-30CSS) Command-List

Command	Remark
[SPM_PANO]	Command to enter PANOrama mode
[SPM_CEPH]	Command to enter CEPH mode
[SPM_ARCT]	Command to enter Arch-CT mode
[SPM_RET_]	Move to the shooting start position for each mode (PANOrama, CEPH, CT)
[SPM_ERDY]	Exposure switch press-ready command
[SPM_ERDC]	Exposure switch press cancel command
[SPM_PCON]	Command to let capture S/W run
[SPM_PCOF]	Command that the exposure software has ended (Cancel switch press-ready cancel function + laser off function)
[SPM_HV___0000]	Tube Voltage Setting Command (ex) 0600 = 60kVp
[SPM_HA___0000]	Tube Current Setting Command (ex) 0400 = 4mA
[SPM_LON_]	Laser on depending on the capture mode
[SPM_LOF_]	Turn off all lasers
[SPM_CPON]	sensor power on (Operation for each mode)
[SPM_CPOF]	sensor power oFF (Operation for each mode)
[SPM_CSON]	CT sensor power on (Independent of the current mode)
[SPM_CSOF]	CT sensor power off (Independent of the current mode)
[SPM_PSON]	PANOrama sensor power on (Independent of the current mode)
[SPM_PSOF]	PANOrama sensor power off (Independent of the current mode)
[SPM_HSON]	CEPH sensor power on (Independent of the current mode)
[SPM_HSOF]	CEPH sensor power off (Independent of the current mode)
[SPM_PVER]	Know your motherboard firmware version (must be used when the device is down. Transmission during operation may cause equipment malfunction.)
[SPM_IVER]	Knowing the Firmware Version of the Inverter Board
[SPM_TVER]	Know the firmware version of the Main Board, Collimator Board, Column Board, Inverter Board, MP3, Keypad
[SPM_TUTS]	Tube feedback test with exposing switch
[SPM_XTST_0000]	exposure time test. Input the command [SPM_XTST_number] used for authentication (Number is exposure time, 1 second = 0100, 10 seconds = 1000)
[SPM_XON_]	Turn on X-ray exposure
[SPM_XOF_]	Turn off X-ray exposure
[SPM_TMP?]	Tube temperature requirements

Command	Remark
[SPM_FANT_0000]	Set the reference temperature at which the tube fan turns on (ex. 400 = 40 degrees or more, Fan ON)
[SPM_COLM_0000]	4-Axis Collimator Move Instruction 0001: CT inner circle position 0002: CT outer circle position 0003: Cu filter position 0004: Al filter position 0005: Scan CEPH 0007: PANO position 0010: Cu + Al filter position
[SPM_CINT]	Initializer position initialization (initializing instruction to move to origin)
[SPM_CISC_000X]	CEPH function enabled/disabled setting. 00: CEPH mode disable. 01 : Scan CEPH (cone beam) enable 02: Scan CEPH (fan beam) enable 03 : One-shot CEPH (Large FOV) enable 04: One-shot CEPH (Small FOV, TOK-Troy) enable 05 : Scan CEPH (cone beam)Table Scan Enable
[SPM_PKEN_000x]	Packing mode setting command (0001: Packing mode enable, 0000: Packing mode disable)
[SPM_ISPK]	The command asks if packing mode is set. Notify that in packing mode or not.
[SPM_ECHK]	Command to check the exposure switch pressed in capture software. ([epm_echk_001] : exposure switch not pressed, [epm_echk_002] exposure switch pressed
[SPM_DCHK]	Command to check the door status in capture software. [epm_dchk_001] : Door Normal (closed) [epm_dchk_002] : Door Abnormal (open) * Always send [epm_dchk_001] if the Door Lock option is disabled.
[SPM_PPON_000x]	Command to set whether to apply power profile when shooting panoramas (0001: apply power profile, 0000: do not apply power profile) Initialized by applying power profile every time the instrument is turned on (not saved in ROM)
[SPM_GCNT]	Command to Require the X-Ray Count [SMP_PCNT_xxxxx]: PANOrama capture count response [SMP_HCNT_xxxxx]: CEPH capture count response [SMP_PCNT_xxxxx]: ARCT capture count response
[SPM_ICNT_000x]	Command to initialize the X-ray exposure count. 0000: PANO/CT/CEPH/ARCT initialization, 0001: PANO initialization, 0002: CT initialization, 0003: CEPH initialization 0004: ARCT initialization
[SPM_TMP?]	Read the current canine laser beam position

Command	Remark
[SPM_TITY_000x]	Enable/disable the tube tilting function 0000: Tube tilting not used (Disable tilting for Pan-only models) 0001: Tube tilting used (default)
[SPM_TIT?]	Indicate whether to use the currently set tube tilting function (0000: don't use, 0001: don't use)
[SPM_TIPA]	Tube tilting in pano direction
[SPM_TICE]	Tube tilting in CEPH direction
[SPM_TIFR]	Release tube tilting to set free state (hand controllable)
[SPM_VOLU_00xx]	MP3 volume control (0~82)
[SPM_L_xx]	xx Country code uses TWO LETTER CODE. Choose a language to play on the mp3 board. (default: US) r === TWO LETTER CODE Example === 1. IT - Italy - Italia 2. KR - Korea 3. CN - China 4. DE - Germany - Deutschland 5. ES - Spain - Espana 6. FR - France 7. JP - Japan 8. RU - Russia - Rossiya 9. TW - Taiwan - T'ai-wan 10. US - United States of America 11. AE - Arab Emirates 12. PT – Portugal 13. CZ - Czech Republic 14. PL - Poland
[SPM_MPOP_000x]	Choose music from X-ray exposure. 0000: Play different music for each PANO/CT/CEPH mode 0001: Play the same music in both PANO/CT/CEPH modes 0002: Beep sound playback (default) 0003: Beep sound playback
[SPM_MPEN_000x]	Add the MP3 On/Off function. 0: MP3 OFF 1: MP3 On (default)
[SPM_DROP_000x]	Enable/disable the Door Lock function 0000: Disable the Door Lock 0001: Enable the Door Lock function (default)
[SPM_ISDR]	Indicate whether to use the Door Lock function.
[SPM_RTOP_000x]	Enable/disable the Auto Return function after capture 0000: Disable Return function after capture 0001: Return function is used after capture
[SPM_ISRT]	Indicate whether to use the Auto Return function after capture

Command	Remark
[SPM_ISRK]	Indicate whether the auto-return is completed after capture
[SPM_SNUM_xxxxxxxxx]	Omit the "-", ex) 123-4567 => send [SPM_SNUM_1234567]
[SPM_SNU?]	Request the Serial Number
[SPM_SMRT_0000]	Sensor motor Run Torque Value Setting
[SPM_SMST_0000]	Sensor motor Stop Torque Value Setting
[SPM_CMRT_0000]	Collimator motor Run Torque Value Setting
[SPM_CMST_0000]	Collimator motor Stop Torque Value Setting
[SPM_RMRT_0000]	Rotator Run Torque Value Setting
[SPM_RMST_0000]	Rotator Stop Torque Value Setting
[SPM_HMRT_0000]	CEPH Sensor Run torque set
[SPM_HMST_0000]	CEPH Sensor Stop torque set
[SPM_UATT_xxxx]	Offset start position of the table on the CEPH sensor axis
[SPM_UAT?]	Read start offset of the table of CEPH sensor axis
[SPM_CSNM]	Normal resolution capture mode.
[SPM_ACSH]	Sharp arch
[SPM_ACST]	Standard arch.
[SPM_ACSQ]	Square arch
[SPM_ACCH]	Child’s arch
[SPM_TLA_]	TMJ lateral
[SPM_TPA_]	TMJ PA
[SPM_SLA_]	Sinus lateral
[SPM_SPA_]	Sinus PA
[SPM_CAAL]	Exposure all areas
[SPM_CAFT]	Exposure only the front part.
[SPM_CALT]	Exposure only the left side.
[SPM_CART]	Exposure only on the right side.
[SPM_ACMS]	Arct C mode
[SPM_ADMS]	Arct D mode
[SPM_LATF]	CEPH Lateral mode
[SPM_FRO_]	CEPH Frontal mode
[SPM_CAR_]	CEPH Carpus mode
[SPM_SMV_]	CEPH SMV mode
[SPM_CTB_]	Bright calibration starts in CT mode
[SPM_AXIS_xxxx]	Command for test purpose such as the motor movement of each axis, and explained by sending [SPM_AXIS]
[SPM_CSEQ_xxxx]	Used to forcibly initialize and set a running sequence of commands (command for equipment debugging).

Command	Remark
[SPM_TEST_xxxx]	Commands for test purposes such as Input/Output Check and Motor Aging test
[SPM_FISS_xxxx]	Command to set CT sensor sensitivity and binning mode (FISS) and to read its value (FISR) 0000: High Gain, 2x2 Binning 0001: High Gain, 4x4 Binning 0002: Low Gain, 2x2 Binning (Default when equipment power On/Off and not saved.) 0003: Low Gain, 4x4 Binning
[SPM_FISR]	X-axis Stop Torque Value Setting
[SPM_FISM_x]	Sensor sync signal mode 0 : Internal Sync 1 : External Sync
[SPM_FIPM_x]	Sensor size setting = x (x= 0~32)
[SPM_MAGI]	Manufacturing Aging Test start command (all motors run, but not for bib up/down motors)
[SPM_MAG?]	Request Manufacturing Aging Test Count Value
[SPM_MAGE]	Manufacturing Aging Test End Command
[SPM_MATS_xxxx]	Aging test time setting (0001: 1 minute)
[SPM_MAT?]	Request Manufacturing Aging Test Time Setting Value
[SPM_RINT]	The set parameter value is initialized and the value of the saved parameter is returned to the default value. When initialized, the existing [spm_pver] value is viewed and re-entered, mp3 language setting initialization is domestic. No sound when voice is changed by mode. Easy to modify when saving the existing parameter value.
[SPM_XFTA_0000]	Setting the CEPH Sensor Axis Motor FRONTAL Start Position in CEPH Mode
[SPM_XFT?]	Requesting CEPH sensor axis motor FRONTAL starting position value in CEPH mode
[SPM_XLTA_0000]	Setting the CEPH Sensor Axis Motor LATERAL Start Position in CEPH Mode
[SPM_XLT?]	Requesting CEPH sensor axis motor LATERAL starting position value in CEPH mode
[SPM_POFS_00000]	Saving the recording rotator start position offset value in PANO mode (1st clockwise is "1, clockwise if 0")
[SPM_PO?_]	Requesting the image rotator start position offset value in PANO mode
[SPM_COFS_00000]	Saving the recording rotator start position offset value in ARCT mode (1st clockwise is "1, clockwise if 0")
[SPM_CO?_]	Requesting the image rotator start position offset value in ARCT mode
[SPM_FOFS_00000]	Saving the recording rotator start position offset value in FAST PANO mode (1st clockwise is "1, clockwise if 0")

Command	Remark
[SPM_FO?_]	Requesting the image rotator start position offset value in FAST PANO mode
[SPM_CFRQ_0000]	Setting CEPH Sensor Supply Frequency (Normal Scan)
[SPM_CFR?]	Request CEPH sensor supply frequency value (Normal Scan)
[SPM_CCTM_0000]	Setting CEPH Total Recording Time (Normal Scan)
[SPM_CCT?]	Requesting CEPH Total Recording Time Value (Normal Scan)
[SPM_CAST_xxxxx]	Setting Position value for 1-axis Collimator (Left/Right) (CEPH)
[SPM_CAS?]	Calling CAST Stored Values
[SPM_CBST_xxxxx]	Setting Position value for 1-axis Collimator (Left/Right) (Cu + Al filter)
[SPM_CBS?]	Calling CBST Stored Values
[SPM_CCST_xxxxx]	PANO mode collimator reference position setting command
[SPM_CCS?]	Call CCST Stored Value
[SPM_CDST_xxxxx]	Position value setting for 1-axis Collimator (Left/Right) Cu filter
[SPM_CDS?]	Call CDST Stored Value
[SPM_CEST_xxxxx]	Position value setting for 1-axis Collimator (Left/Right) Al filter
[SPM_CES?]	Call CEST Stored Value
[SPM_CFST_xxxxx]	CT mode collimator reference position setting command
[SPM_CFS?]	Call CFST Stored Value
[SPM_CSCN_xxxxx]	CEPH scan distance
[SPM_CSC?]	Request CEPH scan distance value
[SPM_XRFA_xxxx]	Set the CEPH sensor side reference position
[SPM_XFA?]	Request the CEPH sensor side reference position value
[SMP_END__0000]	Notifies to PC that the exposure switch is no longer pressed, and It came to the lamp position (End after normal captured)
[SMP_STOP_0000]	Notifies to PC that the exposure switch is no longer pressed (Ended after abnormal captured)
[SMP_STAR_0000]	Notifies PC to start capture
[SMP_LOF__0000]	Notifies the PC that the laser is off.
[SMP_LON__0000]	Notifies the PC that the PANO mode laser is on.
[SMP_PKEN_0000]	Notifies the PC that it is booted in Packing mode. (Notified in response to [SPM_ISPK] or [SLM_ISPK] commands)
[SMP_DROP_0000]	Notifies the PC that the door lock function is in use (notified in response to [SPM_ISDR] command)
[SMP_DCHK_0002]	Message sent before the [SMP_STOP_0000] command is sent at the end of abnormal capture because the door is opened.

Command	Remark
[SMP_ECHK_0002]	At the end of abnormal shooting by releasing the irradiation switch, Messages sent before [SMP_STOP_0000]-Purpose of identifying the cause of the outage
[SMP_CPOF]	This command is to turn off the power of the sensor and notify it when there is no command input for 30 minutes.
[SPM_STIT_0000]	Xxxx captures in CT stitching mode
[SPM_PMCT_0000]	PANO mode sensor reference position setting command
[SPM_CMCT_0000]	CT mode sensor reference position setting command
[SPM_CSMV_0000]	The command for setting collimator drive amount between the inner circle and outer circle during CT mode capture
[SPM_CCMV_0000]	The command for setting collimator drive amount between the inner circle and outer circle during CT mode capture
[SPM_PSCR_0000]	PANO mode sensor, collimator drive frequency ration setting
[SPM_CSCR_0000]	CEPH mode sensor, collimator drive frequency ration setting
[SPM_CPIO_0000]	PANO mode collimator's capture initial position offset setting
[SPM_CHP?]	Command to check chin rest position
[SPM_XRES]	X-ray remote exposure start
[SPM_XREE]	X-ray remote exposure end
[SPM_XRET]	X-ray remote exposure time set (ex) 0500 = 5 sec
[SPM_XREH]	X-ray remote exposure halt
[SPM_LONV]	Vertical beam on
[SPM_LOFV]:	Vertical beam off

3. Procedure for using remote exposure function

⚠WARNING	• *To use the remote exposure function for the first time, approval and login of the hospital personnel are required.*
⚠WARNING	• *Do not use the remote exposure function when exposure a patient.*
⚠CAUTION	• *Before using the remote exposure function, check with the hospital personnel to make sure there are no people around the equipment/X-ray room, and use this function.*

3.1. When exposure the PANO/CEPH in Console Software

1. Run the Console Software.
2. Open the command input window with the **Ctrl + S** key.
3. Send the [SPM_XRES] command to activate the remote exposure mode.
4. Set the mode (PANO/CEPH) in the Console Software.
5. Click the **Confirm** button and **Ready** button in the Console Software.
6. Automatically start the exposure 3 seconds after the Dark acquisition.

3.2. Remote exposure sequence when acquiring the Bright Calibration

1. Open the VAKCAP.exe file of the applicable mode.
2. Move to the Soft Calib Tab.
3. Acquire DARK.
4. Check the DARK is Normal.
5. Send the [SPM_XRES] command to activate remote exposure mode.
6. Send the [SPM_XRET_0500] command to exposure for 5 seconds.
7. Press the **Bright** button to acquire Brightness for each point.

3.3. TUTS Test

1. Run the Terminal or the VAKCAP.exe file.
2. Send the [SPM_XRES] command to activate the remote exposure mode.
3. Use the [SPM_XRET_xxxx] command to set the desired exposure time.
   ex) [SPM_XRET_0900] = 9 seconds
4. Input the [SPM_TUTS] command to exposure X-ray for the set time.
5. To stop X-ray exposure before the set exposure time during X-ray exposure, stop with the [SPM_XREH] command.

3.4. XTST Test

1. Run the Terminal or the VAKCAP.exe file.
2. Send the [SPM_XRES] command to activate the remote exposure mode.
3. Set and input the desired exposure time using the [SPM_XTST_xxxx] command, X-ray exposure proceeds for the set time.

4. Error Message List

- **Tube Error Message Sent From MCU To PC**

Command	Description
[SMP_ERRR_0001]	The tube is not ready
[SMP_ERRR_0002]	Tube Mono Block and Inverter Board Cable are not connected
[SMP_ERRR_0003]	Current is more than maximum permissible current while Inverter Board is working (X-Ray exposure)
[SMP_ERRR_0004]	This error occurs when there is a problem with the tube voltage Ref. This error occurs when there is a difference of + -10 kV or more in the Ref. normal value.
[SMP_ERRR_0005]	This error occurs when there is a problem in the tube current Ref. and there is a difference of +-0.5mA or more in the Ref. normal value.
[SMP_ERRR_0006]	An error occurs when there is a problem with the tube voltage feedback. This error occurs when there is a difference of + -20kV or more in the normal value of Feed Back.
[SMP_ERRR_0007]	An error occurs when there is a problem with the tube's current feedback. This error occurs when there is a difference of + -1 mA or more in the normal value of Feed Back.
[SMP_ERRR_0008]	The temperature of Mono Block is over 55 ℃
[SMP_ERRR_0009]	The current of High Voltage(EP, IP) is more than the permissible current during X-Ray exposure.
[SMP_ERRR_0010]	Although X-Ray Switch is turned on, X-Ray On Command is not send in the System
[SMP_ERRR_0011]	Although X-Ray Switch is turned off, X-Ray Off Command is not sending in the System
[SMP_ERRR_0012]	During X-Ray exposure, kVp Feedback is less than -20 kVp off from the setting value. Error “3” is displayed on Inverter Board.
[SMP_ERRR_0013]	During X-Ray exposure, kVp Feedback is more than +20 kVp off from the setting value. Error “4” is displayed on Inverter Board.
[SMP_ERRR_0014]	During X-Ray exposure, mA Feedback is less than 50% off from

	the setting value. Error “5” is displayed on Inverter Board.
[SMP_ERRR_0015]	During X-Ray exposure, mA Feedback is more than 150% off from the setting value. Error “6” is displayed on Inverter Board.

- **Motor Error Message sent from MCU to PC**

Command	Description
[SMP_ERRR_0021]	Error on the operation of Rotator motor : Check Rotator motor and Photo Sensor operation
[SMP_ERRR_0027]	Error on the operation of CEPH Sensor motor : Check CEPH Sensor motor and Photo Sensor operation
[SMP_ERRR_0029]	Error on the operation of Sensor tilting motor : Check Sensor tilting motor and Photo Sensor operation
[SMP_ERRR_0036]	Error on operation of 1st Collimator(1-axis) left/right movement : Check 1st Collimator Right/Left motor and Photo Sensor operation
[SMP_ERRR_0037]	Error on the operation of Tube Tilting : Check Tube Tilting motor and Limit Sensor operation
[SMP_ERRR_0041]	Error on the operation of Sensor X-axis motor : Check Sensor X-axis motor and Photo Sensor operation

- **Exposure Switch Error Message sent from MCU to PC**

Command	Description
[SMP_ERRR_0060]	X-ray Exposure Switch was pressed when the system power is turned on

- **Misc. Error Message sent from MCU to PC**

Command	Description
[SMP_ERRR_0102]	CAN communication error(No response)
[SMP_ERRR_0105]	Chinrest position error

Chapter 9. Console software error message List

1. Hardware Error Code

NOTICE	• **Error code sending method** Method: Serial communication (RS232) Format : [SMP_ERRR_####] - #### Error code, tail code only Classify sub code using Converting function.
NOTICE	• **Error code output method** [Code : E001.000.000] Multilingual error phrases output

Main Code	Sub Code	Tail Code	Description	Message
E001	------	---	Hardware related error	
	000	----	Success	
	001	---	[Generator related error]	
		000	- Unknown error	
		001	- An error that occurs because the TUBE is not ready	TUBE READY ERROR
		002	An error occurred when the cable of Mono Block and Inverter B'd are not connected	TUBE MONOBLOCK ERROR
		003	- This error occurs when the current flows over the maximum allowable current when driving the inverter (in case of X-Ray exposure).	TUBE MA OVER ERROR
		004	This error occurs when there is a problem with the tube voltage Ref.	TUBE KV ref ERROR
		005	This error occurs when there is a problem with the tube current Ref.	TUBE mA ref Error
		006	-An error occurs when there is a problem with the tube voltage feedback.	TUBE KV feedback error
		007	-An error occurs when there is a problem with the tube's current feedback.	TUBE mA feedback error
		008	-An error occurs when the Mono Block temperature is above the set temperature.	TUBE TEMP over error
		009	-An error occurs when the inverter output current is abnormal during X-Ray exposure.	TUBE mA OUTPUT error

		010	- This error occurs when the exposure switch is off after the Exposure on command.	TUBE EXP ON-COMMAND ERROR
		011	- his error occurs when there is no exposure off command within 0.5 seconds after the exposure switch is turned off during exposure.	TUBE EXP OFF COMMAND ERROR
		012	-This error occurs when kV Feedback differs by -20kV from the set value during X-ray exposure.	TUBE kV feedback (-)error
		013	-This error occurs when kV Feedback differs by +20kV from the set value during X-ray exposure.	TUBE kV feedback (+)error
		014	- This error occurs when mA feedback is 50% or less than the set condition during X-ray exposure.	TUBE mA feedback (-)error
		015	- This error occurs when mA feedback is more than 150% of the setting condition during X-ray exposure.	TUBE mA feedback (+)error
	002	----	[Motor related error]	
		000	- Unknown error	
		020	-This error occurs during the original movement of the P-axis motor.	Motor P axis error
		021	- This error occurs during the original movement of the rotor axis motor.	Motor R axis error
		022	- This error occurs while moving the origin of the chinrest up/down axis motor.	Motor jaw up/down the error
		023	- - This error occurs while moving the origin of the chinrest Left/Right axis motor.	Motor jaw left/right error
		024	- This is an error that occurs while moving the origin of the CT horizontal laser up/down axis motor.	Motor CT H up/down the error
		025	- This error occurs during the Canine beam adjustment motor origin movement.	Motor canine axis error
		026	- This error occurs while moving the origin of the CEPH secondary collimator motor.	Motor CEPH 2nd axis error
		027	- This error occurs while moving the origin of the CEPH sensor motor.	Motor CEPH sensor axis error
		028	- This error occurs while moving the headband motor home.	Motor headband axis error
		029	- This error occurred during sensor tilting motor origin movement.	Motor Sensor Tilting axis error
		030	- This error occurs while moving the origin of the left side of the 4-axis collimator.	Motor 4 Collimator left axis error

		031	- This error occurs while moving the origin of the right side of the 4-axis collimator.	Motor 4 Collimator right axis error
		032	- This error occurs while moving the origin of the 4-axis collimator Up.	Motor 4 Collimator up axis error
		033	- This is an error that occurs while moving the 4-axis collimator down the origin.	Motor 4 Collimator down axis error
		034	- This error occurs while moving the 2-axis collimator UP/Down origin.	Motor 2 Collimator up/down axis error
		035	- This error occurs while moving the origin of the Left/Right 2-axis collimator.	Motor 2 Collimator left/right axis error
		036	- This error occurs while moving the origin of the Left/Right 1-axis collimator.	Motor 1 Collimator left/right axis error
		037	- This error occurs during Generator Tilting.	Motor generator tilting axis error
		039	- This error occurs while moving the origin of the X-axis motor.	Motor X-axis error
		040	- This error occurs while moving the origin of the Y-axis motor.	Motor Y-axis error
		041	- This error occurs while the sensor X-axis motor origin is moving.	Motor Sensor X-axis error
	003	----	[Exposure Switch related error]	
		000	- Unknown error	
		060	- This error indicates that the exposure switch is pressed when the device is turned on.	EXP Push error
		061	- This is an error that stops X-Ray exposure by releasing the exposure switch.	
	004	----	[Other errors]	
		000	- Unknown error	
		100	- Headrest error. In PANO mode, the headrest must be removed.	Headband support error
		101	- Hand frame error. The hand frame is open. Equipment stops running.	Hand frame support error
		102	- This error occurs when CAN communication is not responding.	CAN communication error
		103	- This error occurs when the column position sensor is not responding.	Column position sensor error
		104	- This error occurs when the column is not automatically adjusted.	Column auto control error

2. Software Error Code

NOTICE	• **Error code sending method** Method: Self-return
NOTICE	• **Error code output method** [Code : E002.001.001] Print out additional error information, print out multilingual error phrases

Main Code	Sub Code	Tail Code	Description
E002	------	------	Console Software related error
	000	------	Success
	001	------	[sequence-related]
		000	- Unknown error
		001	- Packing mode enable
		002	- Door Open Check
		003	- Expose Switch Push Check
	010	------	[PC related] - resolution
		000	- Unknown error
		001	- Not supported (less than 1280x1024)
		002	- Not supported (less than 1200x960)
	011	------	[PC related] - Storage space
		000	- Unknown error
		001	- Insufficient free disk space (less than 1 GB)
		002	- Insufficient free disk space (less than 2GB)
		003	- Insufficient free disk space (less than 3GB)
	020	------	[Network related] - Connect
	021	------	[Network related] - Transfer
	022	------	[Network related] - Close
	023	------	[Network related] - Response
	024	------	[Network related] - End
		000	- Unknown error
		001	- Invalid IP Address
		002	- Invalid Port
		003	- Time Out
		004	- Socket Error
		005	- Socket Closed
		006	- Invalid Command
		007	- Invalid Digit

		008	- Error Command
		009	- Ping Delay
	030	------	[Library related] - Loading
	031	------	[Library related] - Calculate
	032	------	[Library related] - Parameter
	032	------	[Library related] - Action
	033	------	[Library related] - initialization
	034	------	[Library related] - End
	035	------	[Library related] - Cancellation
		000	- Unknown error
		001	- Invalid file path
		002	- Invalid parameter
		003	- Invalid file size
		004	- No access rights
		005	- Out of memory
		006	- Memory allocation failure
		007	- Insufficient storage capacity
		008	- Read property
		009	- NULL
		010	- Combination failed
		011	- Search failed
	040	------	[Directory related] - Creation failed
	041	------	[Directory related] - Deletion failed
	042	------	[Directory related] - Search failed
	043	------	[Directory related] - Copy failed
	044	------	[Directory related] - Compression failed
	045	------	[Directory related] - Backup failed
		000	- Unknown error
		001	- Invalid file path
		002	- Invalid parameter
		003	- Invalid file size
		004	- No access rights
		005	- Out of memory
		006	- Memory allocation failure
		007	- Insufficient storage capacity
		008	- Read property
		009	- NULL
		010	- Does not exist

	060	------	[File related] - Creation failed
	061	------	[File related] - Loading failed
	062	------	[File related] - Open failed
	063	------	[File related] - Read failed
	064	------	[File related] - Write failed
	065	------	[File related] - Deletion failed
	066	------	[File related] - Find failed
	067	------	[File related] - Close failed
	068	------	[File related] - Execution failed
	069	------	[File related] - Copy failed
	070	------	[File related] - Compression failed
	071	------	[File related] - Backup failed
		000	- Unknown error
		001	- Invalid file path
		002	- Invalid parameter
		003	- Invalid file size
		004	- No access rights
		005	- Out of memory
		006	- Memory allocation failure
		007	- Insufficient storage capacity
		008	- Read property
		009	- NULL
		010	- Does not exist
		011	- INI section not found
		012	- INI key not found
	080	------	[Memory related] - Assignment failed
	081	------	[Memory related] - Loading failed
	082	------	[Memory related] - Read failed
	083	------	[Memory related] - Write failed
	084	------	[Memory related] - Deletion failed
	085	------	[Memory related] - Find failed
	086	------	[Memory related] - cancellation failed
	087	------	[Memory related] - Copy failed
	088	------	[Memory related] - Access failed
		000	- Unknown error
		001	- Invalid file path
		002	- Invalid parameter
		003	- Invalid file size

		004	- No access rights
		005	- Out of memory
		006	- Memory allocation failure
		007	- Insufficient storage capacity
		008	- Read property
		009	- NULL
		010	- Out of range
	100	------	[Mode related] - Condition failed
	101	------	[Mode related] - Scope failed
		000	- Unknown error
		001	- Incorrect mode entry
		002	- Incorrect Case entry
		003	- Out of Maximum range
		004	- Out of Minimum range
	120	------	[Registry related] - Assignment failed
	121	------	[Registry related] - Loading failed
	122	------	[Registry related] - Read failed
	123	------	[Registry related] - Write failed
	124	------	[Registry related] - Deletion failed
	125	------	[Registry related] - Find failed
	126	------	[Registry related] - Cancellation failed
	127	------	[Registry related] - Copy failed
	128	------	[Registry related] - Access failed
		000	- Unknown error
		001	- Invalid file path
		002	- Invalid parameter
		003	- Invalid file size
		004	- No access rights
		005	- Out of memory
		006	- Memory allocation failure
		007	- Insufficient storage capacity
		008	- Read property
		009	- NULL
		010	- Out of range
	140	------	[DICOM related] - Creation failed
	141	------	[DICOM related] - Convert failed
		000	- Unknown error
		001	- Invalid file path

		002	- Invalid parameter
		003	- Invalid file size
		004	- No access rights
		005	- Out of memory
		006	- Memory allocation failure
		007	- Insufficient storage capacity
		008	- Read property
		009	- NULL
		010	- Does not exist
	160	------	[Database related] - Assignment failed
	161	------	[Database related] - Loading failed
	162	------	[Database related] - Read failed
	163	------	[Database related] - Write failed
	164	------	[Database related] - Deletion failed
	165	------	[Database related] - Find failed
	166	------	[Database related] - Cancellation failed
	167	------	[Database related] - Copy failed
	168	------	[Database related] - Access failed
	169	------	[Database related] - Initialization failed
	170	------	[Database related] - Close failed
	171	------	[Database related] - End failed
		000	- Unknown error
		001	- Invalid file path
		002	- Invalid parameter
		003	- Invalid file size
		004	- No access rights
		005	- Out of memory
		006	- Memory allocation failure
		007	- Insufficient storage capacity
		008	- Read property
		009	- NULL
		010	- Out of range

3. Acquisition Module Error Code

NOTICE	• **Error code sending method** Method: Broadcast Message MsgName: K-DEVICE WParam : HIWord = Main Code (If less than 0, an error) LoWord : 0xAAAA LParam : HIWord = Sub Code LoWord : 0xAAAA or Tail Code
NOTICE	[Code : E003.000.000] Multilingual error phrases output

Main Code	Sub Code	Tail Code	Description
E003	------	------	Acquisition Module related error
	000	------	Success
	010	------	[Initialization failure related]
		000	Can't open the COM port.
		001	Can't initialize frame grabber interface or can't reserve memory for acquisition.
		002	Can't communicate to MCU or Modem Ring signal has an improper state.
	020	------	[Capture failure related]
		000	Capture error.
	030	------	[Reconfiguration failure related]
		000	Can't initialize COBRA COM-server.
		001	Reconstruction error. Some bugs in VXM-file or insufficient memory.
	061	------	[HW Error related]
		HW Error No	[smp_errr value transfer]: HW Error is transmitted when an equipment error occurs while the Acquisition module is running. (refer to the HW Error Code)

4. Image Processing Error Code

NOTICE	• **Error code sending method** Method : Function return Format : LPARAM enabled : Highword=SubCode, Lowword=TailCode
NOTICE	[Code : E004.000.000] Multilingual error phrases output

Main Code	Sub Code	Tail Code	Description
E004	------	------	Image Processing related error
	000	------	Success
	001	------	[Zeus3D related]
		000	- Unknown error
		001	- When an error occurs in function 1 of the CT image processing module
		⋮	
		100	- When an error occurs in function 100 of the CT image processing module
		201	- If the path of the input configuration file is invalid
		202	- If the section name of the input configuration file is invalid
		203	- When the method type value received is invalid
		204	- When the input image size information is invalid
		205	- When the specific pixel value of the input image is outside the specified range
		206	- When invalid memory is accessed
		207	- If an error occurs when releasing the memory used inside the library
	002	------	[ZeusPANO related]
		000	- Unknown error
		001	- When an error occurs in function 1 of the PANO image processing module
		⋮	
		100	- When an error occurs in function 100 of the PANO image processing module
		201	- If the path of the input configuration file is invalid
		202	- If the section name of the input configuration file is invalid
		203	- When the method type value received is invalid
		204	- When the input image size information is invalid
		205	- When the specific pixel value of the input image is outside the specified range

		206	- When invalid memory is accessed
		207	- If an error occurs when releasing the memory used inside the library
	003	------	[ZeusDBP related]
		000	- Unknown error
		001	- When an error occurs in function 1 of the DBP image processing module
		⋮	
		100	- When an error occurs in function 100 of the DBP image processing module
		201	- If the path of the input configuration file is invalid
		202	- If the section name of the input configuration file is invalid
		203	- When the method type value received is invalid
		204	- When the input image size information is invalid
		205	- When the specific pixel value of the input image is outside the specified range
		206	- When invalid memory is accessed
		207	- If an error occurs when releasing the memory used inside the library
	004	------	[ZeusCEPH related]
		000	- Unknown error
		001	- When an error occurs in function 1 of the CEPH image processing module
		⋮	
		100	- When an error occurs in function 100 of the CEPH image processing module
		201	- If the path of the input configuration file is invalid
		202	- If the section name of the input configuration file is invalid
		203	- When the method type value received is invalid
		204	- When the input image size information is invalid
		205	- When the specific pixel value of the input image is outside the specified range
		206	- When invalid memory is accessed
		207	- If an error occurs when releasing the memory used inside the library
	005	------	[ZeusMP related]
		000	- Unknown error
		001	- When an error occurs in function 1 of the MagicPANO image processing module
		⋮	
		100	- When an error occurs in function 100 of the MagicPANO image

			processing module
		201	- If the path of the input configuration file is invalid
		202	- If the section name of the input configuration file is invalid
		203	- When the method type value received is invalid
		204	- When the input image size information is invalid
		205	- When the specific pixel value of the input image is outside the specified range
		206	- When invalid memory is accessed
		207	- If an error occurs when releasing the memory used inside the library
	006	------	[ZeusPone related]
		000	- Unknown error
		001	- When an error occurs in function 1 of the Pone image processing module
		⋮	
		100	- When an error occurs in function 100 of the Pone image processing module
		201	- If the path of the input configuration file is invalid
		202	- If the section name of the input configuration file is invalid
		203	- When the method type value received is invalid
		204	- When the input image size information is invalid
		205	- When the specific pixel value of the input image is outside the specified range
		206	- When invalid memory is accessed
		207	- If an error occurs when releasing the memory used inside the library

5. Stitching SW Error Code

NOTICE	• **Error code sending method** Method: Broadcast Message Format : LPARAM Enabled : Highword=SubCode, Lowword=TailCode
NOTICE	[Code : E007.000.000] Multilingual error phrases output

Main Code	Sub Code	Tail Code	Description
E007	------	------	Stitching related error
	000	------	Success
	001	------	[Internal function related]
		000	- Unknown error
		001	- When an error occurs in internal function # 1 (VR_ERROR)
		002	- When an error occurs in internal function # 2 (FD_ERROR)
		003	- When an error occurs in internal function # 3 (ZERO_FEATURE_FD)
		004	- When an error occurs in internal function # 4 (ZERO_FEATURE_FOI)
	002	------	[Sequence related]
		000	- Unknown error
		001	- When the INI file cannot be read
		002	- When the Argument of the EXE program is sending incorrectly
		003	- When the value of the INI file is incorrect
		004	- When the input data size and the actual file size are different
		005	- File reading failed
		006	- File write failed
		007	- Folder write failed
		008	When the connection to the DLL handler failed
		009	- When the DLL is not initialized

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