

# **USER MANUAL BEAM DATA ZAP-X SYSTEM REV A**



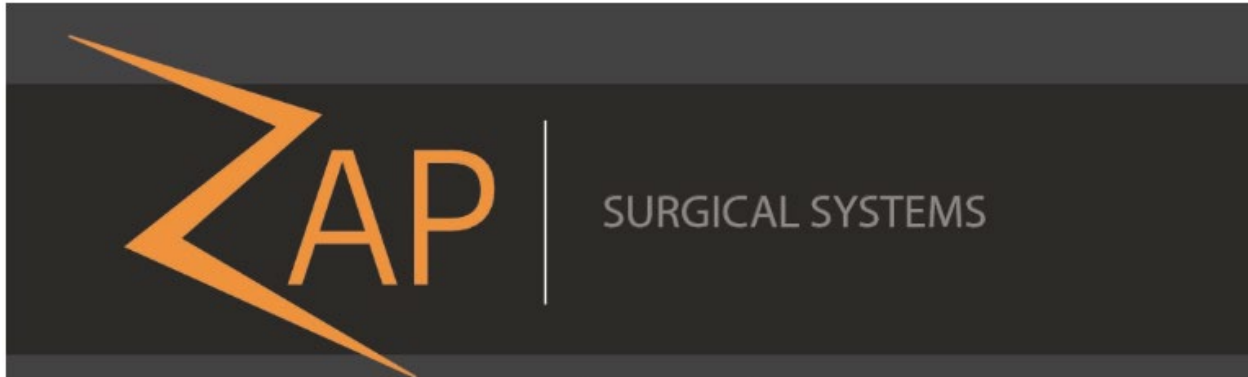
# **Zap-X Radiosurgery System**

## **Beam Data Manual**

### **E0920-00002**

Zap Surgical Systems  
590 Taylor Way, Suite A  
San Carlos, CA 94070, USA

# Preface



Zap Surgical Systems provides this guide without warranty of any kind, either implied or expressed, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Zap Surgical Systems and its directors, officers, representatives, subsidiaries, employees, agents, heirs and assignees assume no responsibility or liability, either expressed or implied, for injury, death or losses to consumers, users or service personnel resulting from improper handling of the Radiosurgery products by unauthorized, untrained or otherwise unqualified personnel. Zap Surgical Systems expressly denies any responsibility or liability for abuse, neglect, misuse or tampering with Radiosurgery system components by persons not authorized, trained, or associated with Zap Surgical Systems.

If any products are modified in any manner, all warranties associated with such products shall become null and void. Zap Surgical Systems does not assume any responsibility or liability with respect to unauthorized modification or substitution of subsystems or components.

With proper care and maintenance, the expected operating life of the system is 10 years.

This manual applies to the Zap-X Radiosurgery System.

# Intended Use

This manual describes the beam data acquisition procedure.

**Quality assurance activities are ultimately the responsibility of the site Medical Physicist or designee and may have a broader scope than those listed in the manuals.**

## System Information



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**Caution:** In the United States, law restricts this device to sale by or on the order of a physician.

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### Notice:

The user manual contains instructions for multiple features of the Zap-X Radiosurgery System. Since some features of the Radiosurgery System are optional, some of the instructions in this manual may not apply to your system.

The availability of options is dependent on regulatory approvals in a particular country and varies from country to country.

Zap Surgical Systems reserves the right to revise this publication and to make changes in content from time to time as necessary to ensure proper beam data acquisition and use of the Zap-X Radiosurgery System.

## Device Description

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The Zap-X Radiosurgery System ("Zap-X System") is a computer controlled system for performing non-invasive stereotactic radiosurgery that is self-shielded for ionizing radiation and uses a linear accelerator mounted on a gantry along with an imaging system (kV imaging system) to accurately locate the treatment target. The system uses patient skeletal anatomy to align the treatment target with respect to the system isocenter. The Zap-X System uses the kV imaging system to track patient movement and adjust the table precisely to compensate for such movement during treatment.

## Indications for Use

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The Zap-X Radiosurgery System is intended to provide treatment planning and image-guided stereotactic radiosurgery and precision radiotherapy for tumors, lesions, and conditions in brain, head, and neck when radiation treatment is indicated.

## Safety Precautions and Warnings

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Safe Operation of the Radiosurgery System requires careful attention to the serious hazards associated with the use of linear accelerators and other complex radiosurgery and radiotherapy equipment and ways to avoid or minimize the hazards, and familiarity with emergency procedures. Untrained or careless operation of the Radiosurgery System can damage the system, its components, or other property; cause poor performance; or lead to serious bodily injury and possibly death. Anyone who operates, services, maintains, or is otherwise associated with the Radiosurgery System must read, understand and be thoroughly familiar with the information in this manual, and take precautions to protect themselves, their associates, patients, and the equipment. At each step in the installation, specific warnings and cautions are given for specifications. Only authorized personnel are allowed to install the system.

Personnel must be trained by Zap-X Surgical Systems before the Radiosurgery System is used for clinical purposes.



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**Warning: System can emit lethal doses of radiation at high energy. The assemblies contain high voltage circuits that can deliver lethal electric shocks. Always observe safety precautions when operating or working on the Radiosurgery System.**

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Only qualified service personnel should service or maintain hardware components. If you feel that Radiosurgery System hardware components or associated Treatment Planning System features or functions do not perform as expected, or they provide results that are inconsistent with your established clinical protocols, contact Zap Surgical Systems, Inc.

## Device Disposal

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When a Zap product reaches the end of its useful life and your facility desires to remove the device, contact Zap Customer Support to decommission, uninstall, and appropriately dispose of the components.

## Regulatory Classification

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The Zap-X Radiosurgery System is classified by the following:

- Protection against electric shock: Class I, permanently connected.
- Applied part: patient treatment table only. Type B
- Methods of sterilization or disinfection: Not required.
- Degree of safety in the presence of flammable mixtures:
  - Not suitable for use in the presence of flammable mixtures.
- Mode of operation: Continuous.

## Conventions

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The conventions described below are used in this manual. Familiarize yourself with these conventions before using the Zap-X Radiosurgery Device.

### Numeric Display Format

The Zap-X Radiosurgery System software and the Treatment Planning System use the following notation conventions to display numerals:

- The period character (.) is used as a decimal separator.
- The comma character (,) is used as the thousands separator.



**Warning:** Regardless of the language translation, all numeric data that you enter or that is displayed in the software uses the period character (.) as a decimal separator. Be aware of this notation convention when interpreting or entering numeric data. Incorrect entry of numeric data could result in incorrect treatment or patient harm.

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## Computer Terminology

This manual uses standard personal computer terminology. Zap Surgical Systems assumes the system operator knows how to use a standard personal computer to navigate through windows and files on the computer workstation. See the documentation that came with the computer. The following conventions are used in this manual.

<b>Click</b>	Press the left mouse button.
<b>Right-click</b>	Press the right mouse button.
<b>Double-Click</b>	Press the left mouse two times in rapid succession.
<b>CTRL-click</b>	Hold down the <b>CTRL</b> key and press the left mouse button.
<b>SHIFT-click</b>	Hold down the <b>SHIFT</b> key and press the left mouse button.
<b>Scroll</b>	Rotate the scroll wheel on the mouse. A <i>backward scroll</i> rotates the scroll wheel with the finger moving away from the hand. A <i>forward scroll</i> rotates the scroll wheel with the finger moving toward the hand.
<b>Hold</b>	Press the mouse button and hold it down while you perform another function.
<b>Drag</b>	Position the cursor over an area of interest, click, hold the button down, and move the mouse to select an area, create a window, or relocate a selected item.
<b>Select</b>	Place the cursor over a name button and click once, or place the cursor at the beginning of the name, click, hold, and drag across the name until it is highlighted (changes colors).
<b>Open</b>	Double-click the name of a window to open it.

## Warning, Caution, and Note Symbols

This manual uses the special notations below to bring your attention to important information.



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**Warning:** Is a statement that alerts the user to the possibility of injury, death, or other serious adverse reactions associated with the use or misuse of the device.

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**Caution:** Is a statement that alerts the user to the possibility of a problem with the device associated with its use or misuse. The caution statement includes the precaution that should be taken to avoid the hazard.

**Note:** Provides more information about a subject.



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# Chapter 1: Introduction

This manual describes beam data acquisition method using Zap-X and test procedures are solely based on PTW MP3-XS water Phantom, PTW detectors and PTW BeamScan 4.4 version. Beam acquisition using different dosimetry suppliers will be subjected to future activities per customer needs. Examples of typical mistakes made during setting up PTW Water Phantom and Beam data collection are added to improve the quality of the beam data collection. For Zap QA Kit description and operation are not covered in this manual. Please refer to Zap document E0920-00005 Quality Assurance Manual Zap-X System.



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**Warning: The examples or data included in this manual are for demonstration only. They are not for clinical use.**

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## Chapter 2: Equipment & Materials

This section describes the equipment and materials used to perform Beam Data Acquisition for Zap-X in this manual:

1. PTW Tandem/Controller unit
2. PTW MP3-XS Water Phantom
3. E0010-00320 Frame, Water Phantom
4. PTW Model TN60023 microSilicon  
(*for PDD, beam profile measurement and Output Factors*)
5. PTW Trufix with corresponding holders, thimbles, and pointing device with cone point
6. PTW Model TN34091 T-REF Chamber 10.5 cc with holder  
(*for PDD and beam Profile measurement*).
7. PTW UNIDOS (*for Point Dose Measurements*)
8. Barometric Pressure/Humidity/Temperature Datalogger (Extech Instruments)  
(*accessory for Output Factor measurement*).
9. Thermometer (*for measuring Water Tank temperature*)
10. E0023-00121, E0023-00122 (J-Z) Center Jigs (*for water phantom centering*)
11. USB to RS232 Adaptor
12. E0021-00373 Zap Pin Pointer
13. Inclometers: Mitutoyo Digital Protractor Pro 3600 or equivalent with 2 decimal numerical display.  
(*for leveling the Water Tank on Patient Table*)
14. Distilled Water (10 one-gallon bottles).
15. Desktop Computer or Laptop with *BeamScan 4.4* installed

Table 1: Images of required equipment and materials:

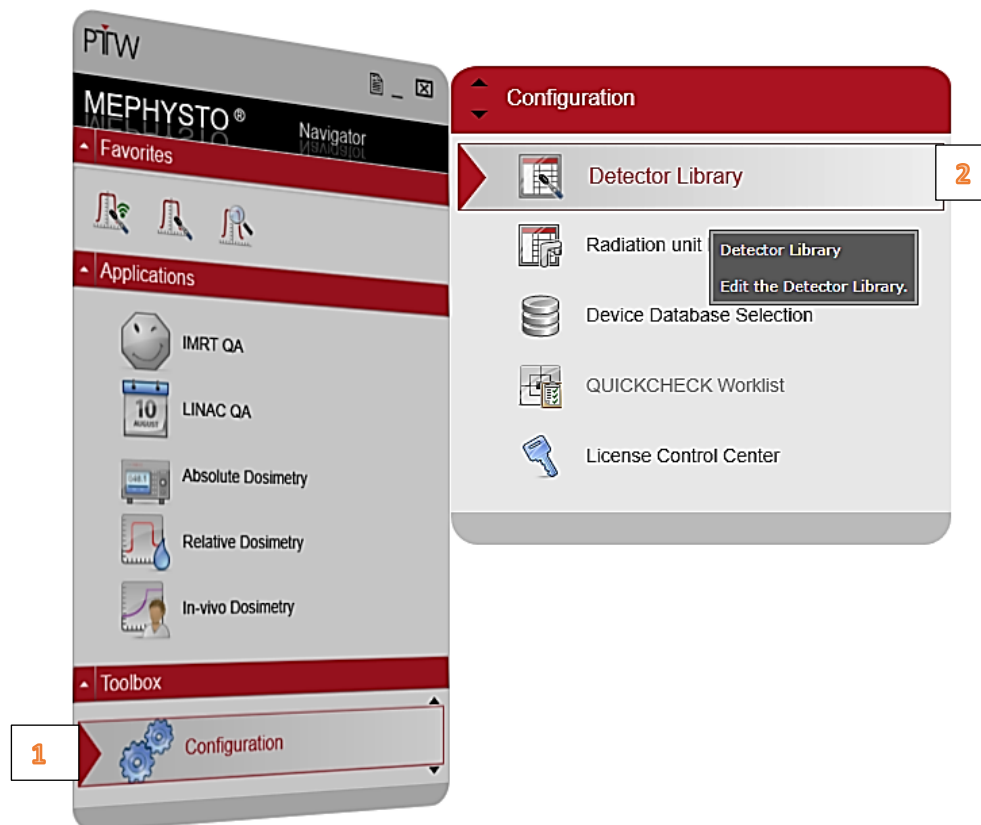
<b>PTW Tandem /Controller</b> 	<b>PTW MP3-XS</b> 	<b>PTW supporting Bracket</b> 
<b>microSilicon diode</b>  Holder: Axial: 431 / 4311	<b>PTW TruFix fixtures</b> 	<b>T-Ref reference detector</b> 
<b>PTW UNIDOS electrometer</b> 	<b>Extech Datalogger</b> 	<b>Thermometer</b> 
<b>Centering jigs</b>  J-C    J-Z	<b>USB to R232 Adapter</b> 	<b>Zap Pin Front Pointer</b> 
<b>Digital Protractor</b> 	<b>10 One-Gallon Distilled Water</b> 	<b>Laptop Computer</b> 
<b>Optional: PTW microDiamond</b>  Holder Axial: 431 / 4308		

## Chapter 3: PTW BeamScan Version 4.4 Software Configuration and Setup

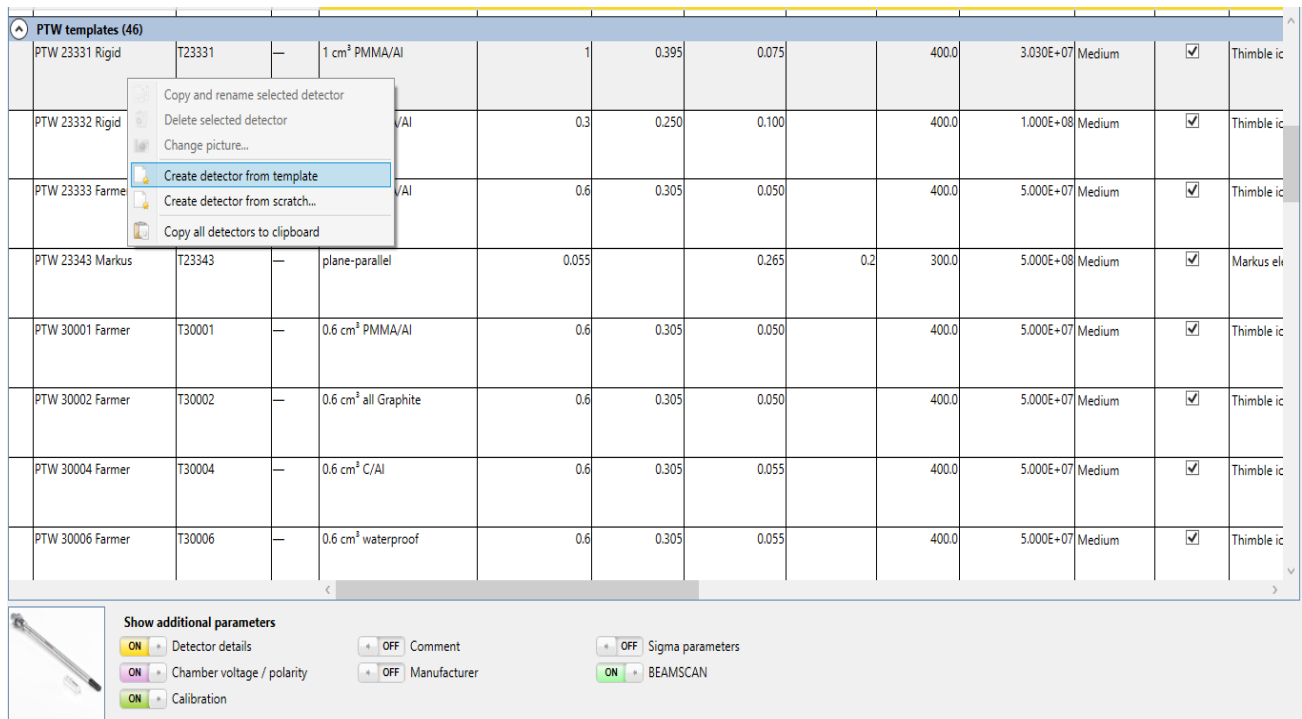
This procedure is written specifically for Zap-X beam data acquisition covering topics limit to Zap-X applications and beam data collections using PTW BeamScan 4.4 version. For additional features, detail descriptions or missing operation procedures of BeamScan 4.4 in this manual, please refer to PTW BeamScan 4.4 operation manual. For PTW MP3-XS Water Phantom Calibration, BeamScan 4.4 software license and installation procedure, please contact your local PTW representatives for assistance.

### A) Setup PTW Ion Chambers for Zap-X Applications:

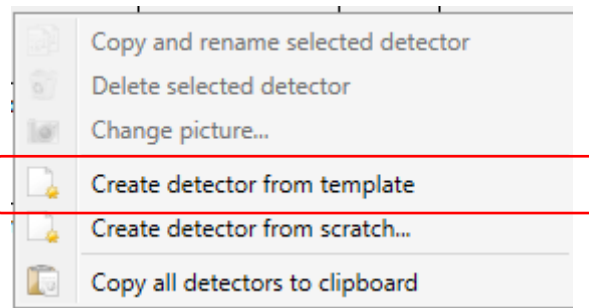
From Toolbox: select **Configuration** and **Detector Library**



From the **PTW templates**, select applicable detector and right Click on the selected detector:



Select **“Create Detector from template”**



Input **S/N** (Serial Number) to each newly created detector.

Repeat the same procedure with current applicable detectors.

Now **User defined detectors** table is created:

PTW-Detector Library

File Edit Tools Help

	Name	Type number	SN	Description	Nominal measuring volume [cm <sup>3</sup> ]	Measurement volume radius [cm]	Central electrode radius [cm]	Measuring volume depth [cm]	Nominal HV [V]	Nominal cal. factor N [Gy/C]	Range for BEAMSCAN	Air density correction	D
<b>User defined detectors (11)</b>													
<input checked="" type="checkbox"/>	PTW 23331 Rigid (1)	T23331	—	1 cm <sup>3</sup> PMMA/Al	1	0.395	0.075		400.0	3.030E+07	Medium	<input checked="" type="checkbox"/>	Thimble ic
<input checked="" type="checkbox"/>	PTW 31010 Semiflex (1)	T31010	006228	0.125 cm <sup>3</sup> PMMA/Al	0.125	0.275	0.055		400.0	3.030E+08	Medium	<input checked="" type="checkbox"/>	Thimble ic
<input type="checkbox"/>	PTW 31010 Semiflex (2)	T31010	—	0.125 cm <sup>3</sup> PMMA/Al	0.125	0.275	0.055		400.0	3.030E+08	Medium	<input checked="" type="checkbox"/>	Thimble ic
<input checked="" type="checkbox"/>	PTW 34091 T-REF (1)	T34091	—	Thin Window plane-parallel	10.5			0.2	400.0	3.080E+06	Medium	<input checked="" type="checkbox"/>	Plane par
<input checked="" type="checkbox"/>	PTW 60018 Diode SRS (1)	T60018	000463	Diode	0.0003			0.025	0.0	5.710E+06	High	<input type="checkbox"/>	Dosimetry
<input checked="" type="checkbox"/>	PTW 60018 Diode SRS (2)	T60018	000626	Diode	0.0003			0.025	0.0	5.710E+06	High	<input type="checkbox"/>	Dosimetry
<input checked="" type="checkbox"/>	PTW 60018 Diode SRS (3)	T60018	—	Diode	0.0003			0.025	0.0	5.710E+06	High	<input type="checkbox"/>	Dosimetry
<input checked="" type="checkbox"/>	PTW 60019 microDiamond	T60019	—	Diamond	3.8E-06			0.0001	0.0	1.000E+09	Low	<input type="checkbox"/>	Diamond

Show additional parameters

☒ Detector details
 ☐ Comment
 ☐ Sigma parameters

☒ Chamber voltage / polarity
 ☐ Manufacturer
 ☒ BEAMSCAN

☒ Calibration

From the **User defined detectors**, select the correct detectors by clicking on the check boxes:

PTW-Detector Library

File Edit Tools Help

	Name	Type number	SN	Description	Nominal measuring volume [cm <sup>3</sup> ]	Measurement volume radius [cm]	Central electrode radius [cm]	Measuring volume depth [cm]	Nominal HV [V]	Nominal cal. factor N [Gy/C]	Range for BEAMSCAN	Air density correction
<b>User defined detectors (11)</b>												
<input checked="" type="checkbox"/>	PTW 23331 Rigid (1)	T23331	—	1 cm <sup>3</sup> PMMA/Al	1	0.395	0.075		400.0	3.030E+07	Medium	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	PTW 31010 Semiflex (1)	T31010	006228	0.125 cm <sup>3</sup> PMMA/Al	0.125	0.275	0.055		400.0	3.030E+08	Medium	<input checked="" type="checkbox"/>
<input type="checkbox"/>	PTW 31010 Semiflex (2)	T31010	—	0.125 cm <sup>3</sup> PMMA/Al	0.125	0.275	0.055		400.0	3.030E+08	Medium	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	PTW 34091 T-REF (1)	T34091	—	Thin Window plane-parallel	10.5			0.2	400.0	3.080E+06	Medium	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	PTW 60018 Diode SRS (1)	T60018	000463	Diode	0.0003			0.025	0.0	5.710E+06	High	<input type="checkbox"/>
<input checked="" type="checkbox"/>	PTW 60018 Diode SRS (2)	T60018	000626	Diode	0.0003			0.025	0.0	5.710E+06	High	<input type="checkbox"/>
<input checked="" type="checkbox"/>	PTW 60018 Diode SRS (3)	T60018	—	Diode	0.0003			0.025	0.0	5.710E+06	High	<input type="checkbox"/>
<input checked="" type="checkbox"/>	PTW 60019 microDiamond	T60019	—	Diamond	3.8E-06			0.0001	0.0	1.000E+09	Low	<input type="checkbox"/>

Show additional parameters

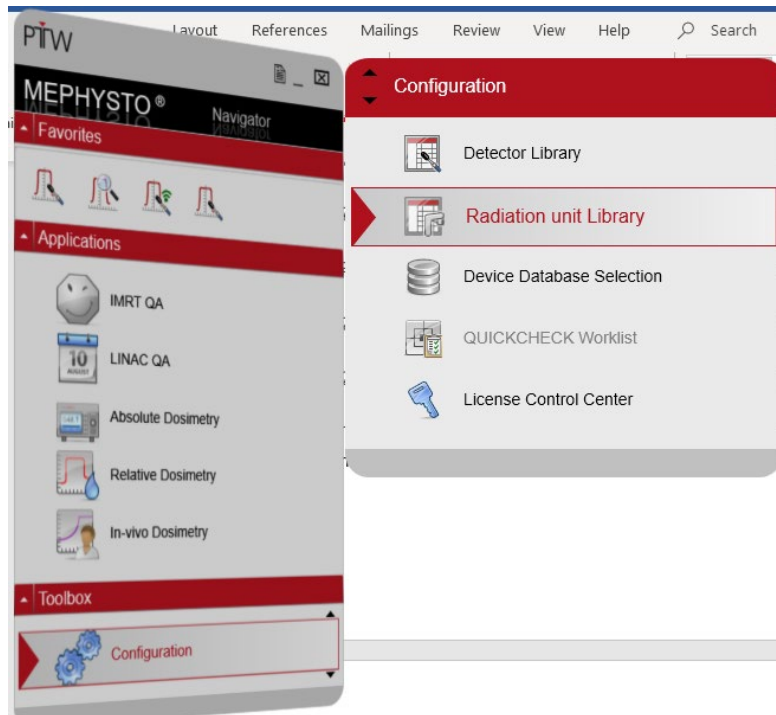
☒ Detector details
 ☐ Comment
 ☐ Sigma parameters

☒ Chamber voltage / polarity
 ☐ Manufacturer
 ☒ BEAMSCAN

☒ Calibration

## B) Setup Radiation Unit Library:

From **Configuration**, Select **Radiation unit Library**:



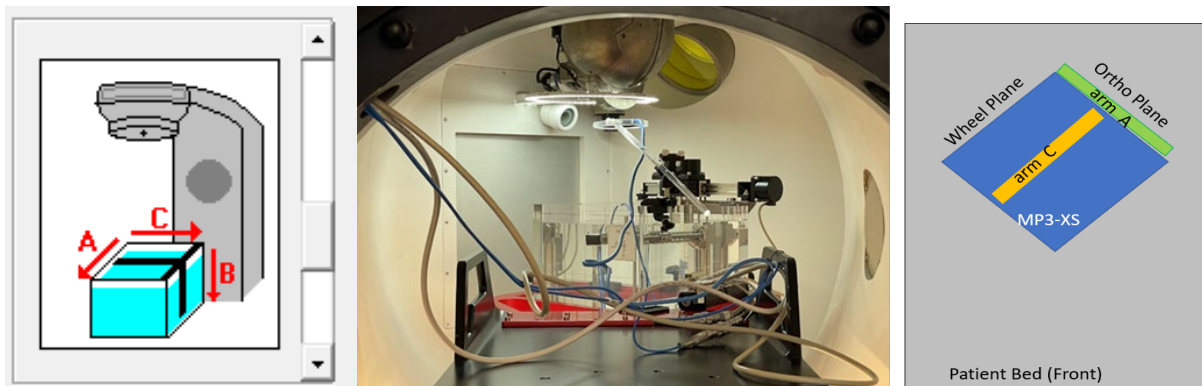
Copy the contents of below tables for each tab highlighted on the left column.

General
Quality
Collimator
SSD
Field
Wedge
Applicator
Accessory
EPID
MV imaging system
Manufacturer
Comment



PTW - Radiation unit Library		
File Edit Tools Help		
Zap_X		
General	Name	Zap_X
Quality	Radiation unit type	Linear accelerator
Collimator	Source collimator distance [cm]	
SSD	Source isocenter distance [cm]	45.0
Field	Isocenter height [cm]	
Wedge	Flattening filter	
Applicator	Gantry rotation direction	Clockwise
Accessory	Gantry upright position	0°
EPID	Linac asymmetry	(None)
MV imaging system		
Manufacturer		
Comment		

Assigning correct designated Plane based on the following setup:



Inplane axis designation	Ortho (A arm, Y)
Crossplane axis designation	Wheel (C arm, X)
Depth axis designation	Depth
Inplane axis direction	Gun to target
Crossplane axis direction	Left to right

PTW - Radiation unit Library

File Edit Tools Help

Zap Surgical Systems

General Changes made to existing values affect all radiation units using the beam quality. New Delete

Quality

Collimator Used Modality Energy [MV/MeV] FFF Nominal dmax [mm]

SSD **Photons (1)**

Field	Used	Modality	Energy [MV/MeV]	FFF	Nominal dmax [mm]
<input checked="" type="checkbox"/>	Photons	3.0	<input type="checkbox"/>	7.0	

Wedge

Applicator

Accessory

EPID

MV imaging system

Manufacturer

Comment

Ready

PTW - Radiation unit Library

File Edit Tools Help

Zap Surgical Systems

General Changes made to existing values affect all radiation units using the collimator. New Delete

Quality

Collimator Used Name Number of leaves Leaf width [cm] Leaf direction

Field	Used	Name	Number of leaves	Leaf width [cm]	Leaf direction
<input checked="" type="checkbox"/>	Wheel				

SSD

Field

Wedge

Applicator

Accessory

EPID

MV imaging system

Manufacturer

Comment

Ready

PTW - Radiation unit Library

File Edit Tools Help

Zap Surgical Systems ▾

General Changes made to existing values affect all radiation units using the SSD. New Delete

Quality

Collimator

SSD

Field

Wedge

Applicator

Accessory

EPID

MV imaging system

Manufacturer

Comment

Used	SSD [cm]
<input checked="" type="checkbox"/>	45.0

Ready

PTW - Radiation unit Library

File Edit Tools Help

Zap Surgical Systems ▾

General Changes made to existing values affect all radiation units using the field. New Delete

Quality

Collimator

SSD

Field

Wedge

Applicator

Accessory

EPID

MV imaging system

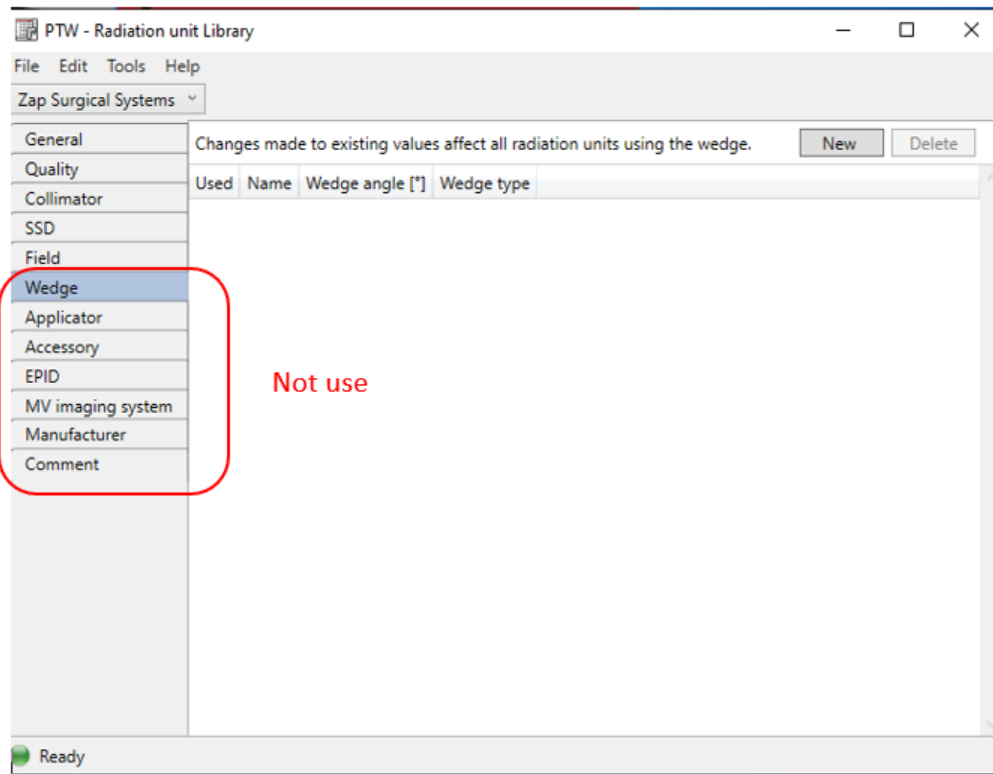
Manufacturer

Comment

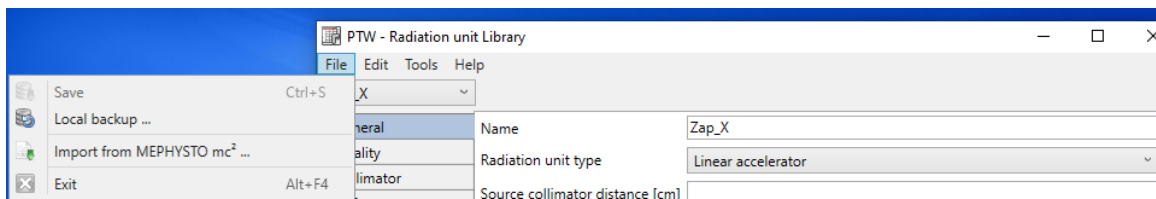
Used	Inplane [cm]	Crossplane [cm]	Shape
<input checked="" type="checkbox"/>	0.4	0.4	Circular
<input checked="" type="checkbox"/>	0.5	0.5	Circular
<input checked="" type="checkbox"/>	0.75	0.75	Circular
<input checked="" type="checkbox"/>	1.0	1.0	Circular
<input checked="" type="checkbox"/>	1.25	1.25	Circular
<input checked="" type="checkbox"/>	1.5	1.5	Circular
<input checked="" type="checkbox"/>	2.0	2.0	Circular
<input checked="" type="checkbox"/>	2.5	2.5	Circular

Ready

Skip these sections:

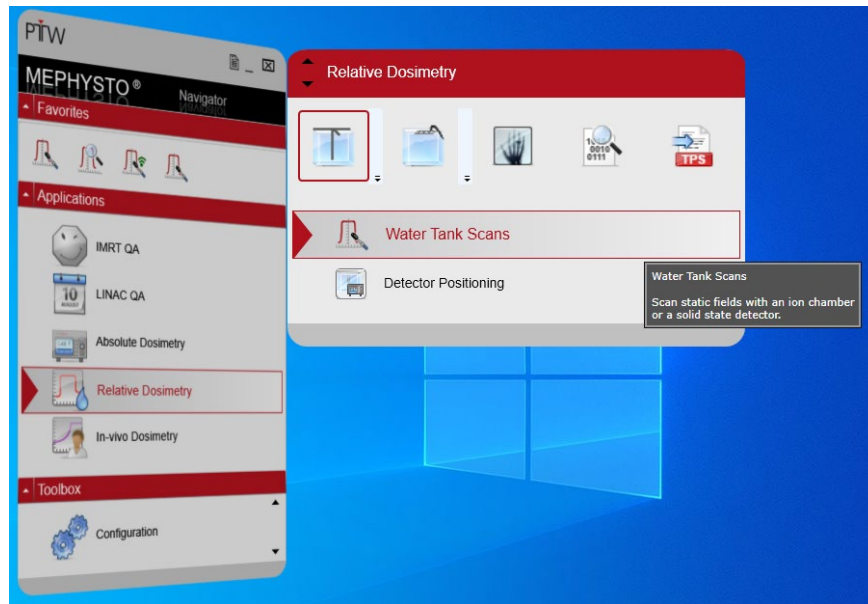


Select File and save when it is done.

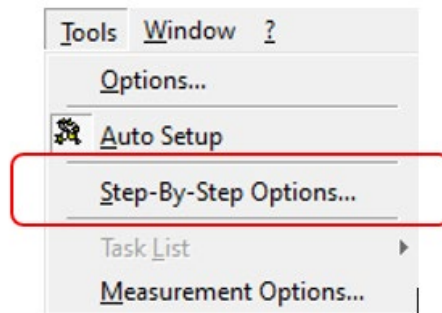


## C) Setup Zap Step-By-Step Options:

Go to **Relative Dosimetry**: select **MP3-XS** and **Water Tank Scans**



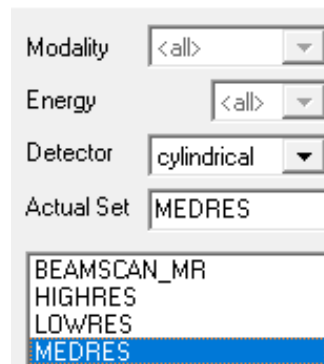
On **Water Tank Scans** Page, Select **Tools** and **Step-By-Steps Options**



On **Step-By-Step Options** Page, Set **Cylindrical** from the drop-down tab from **Detector**.

Select any of the pre-load options with high-lighted in Blue:

### Step-By-Step Options

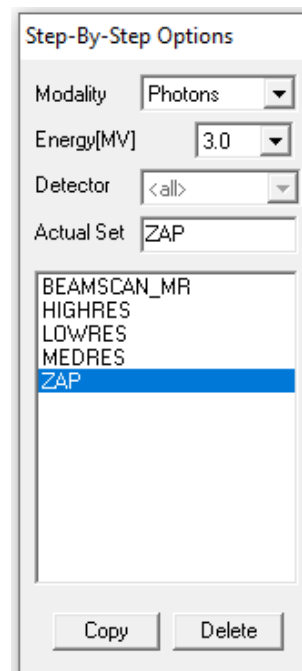


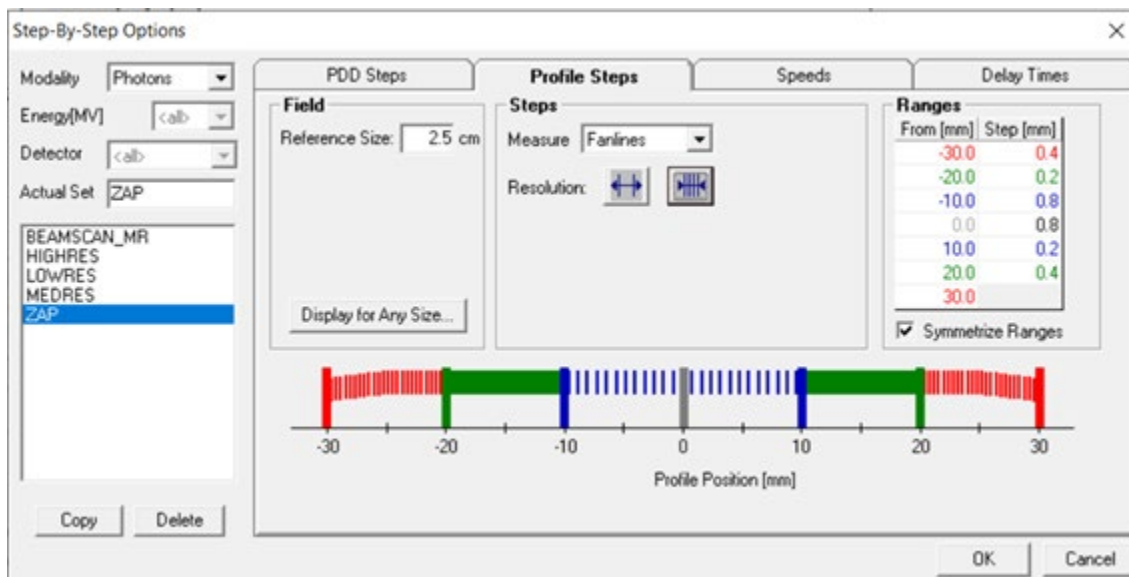
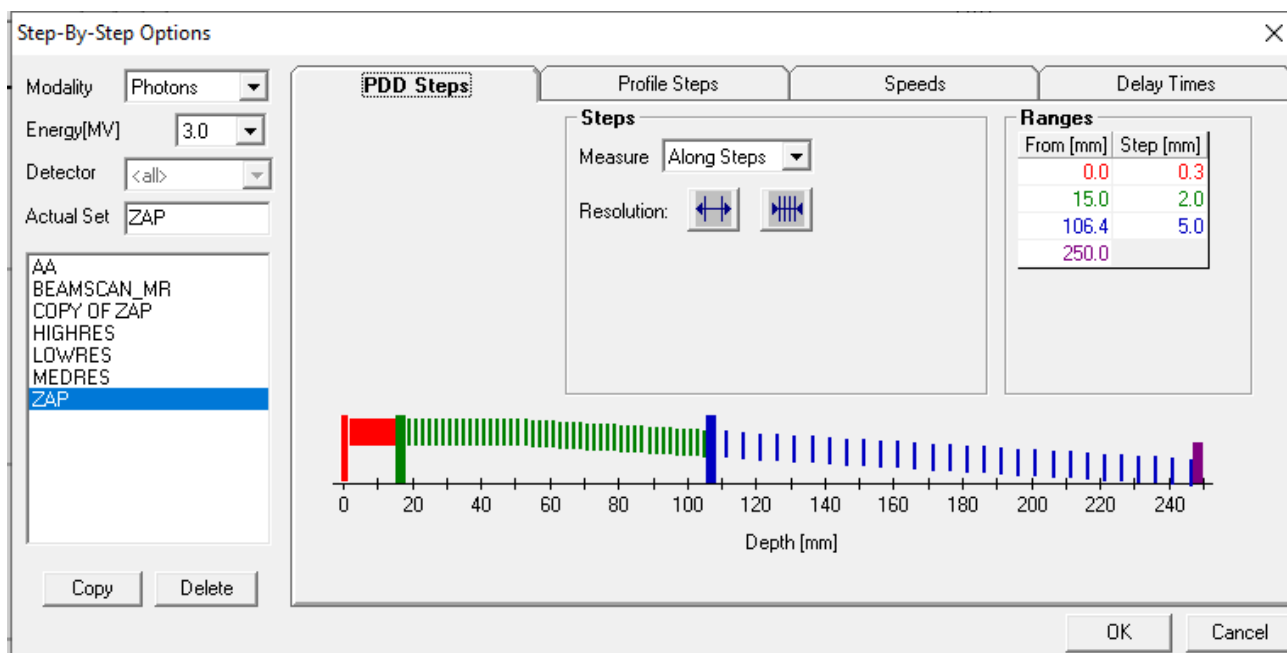
Click on , “Copy of Medres” is created,

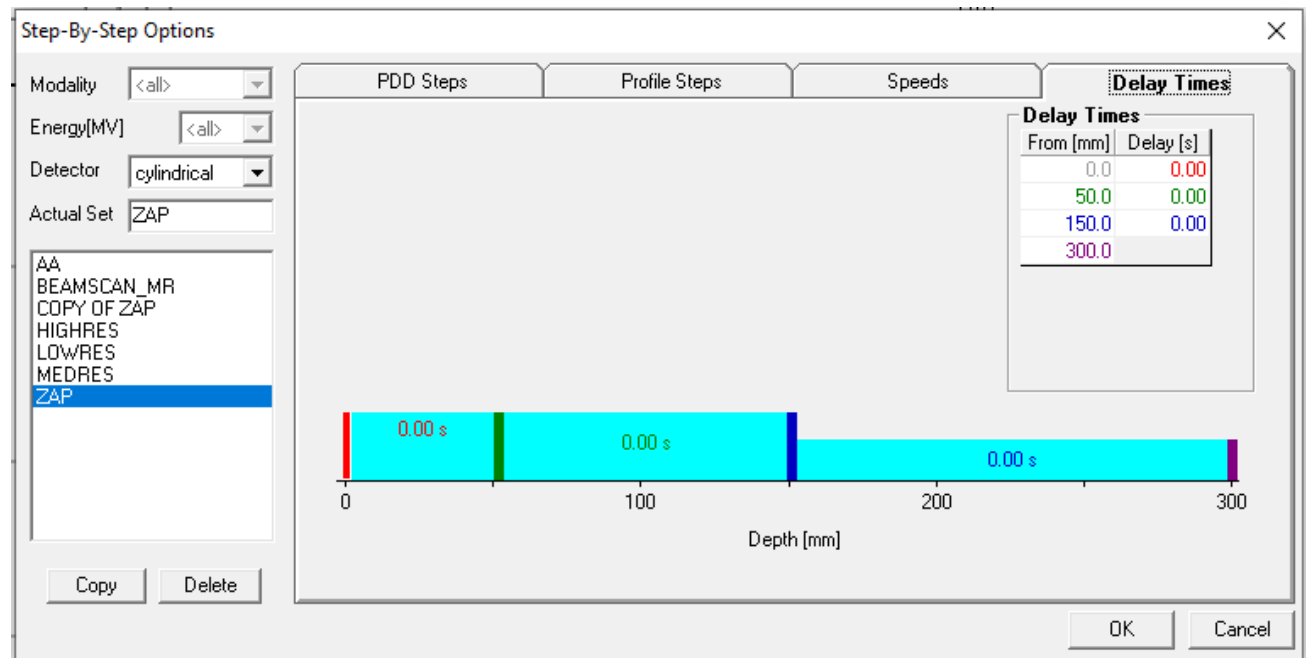
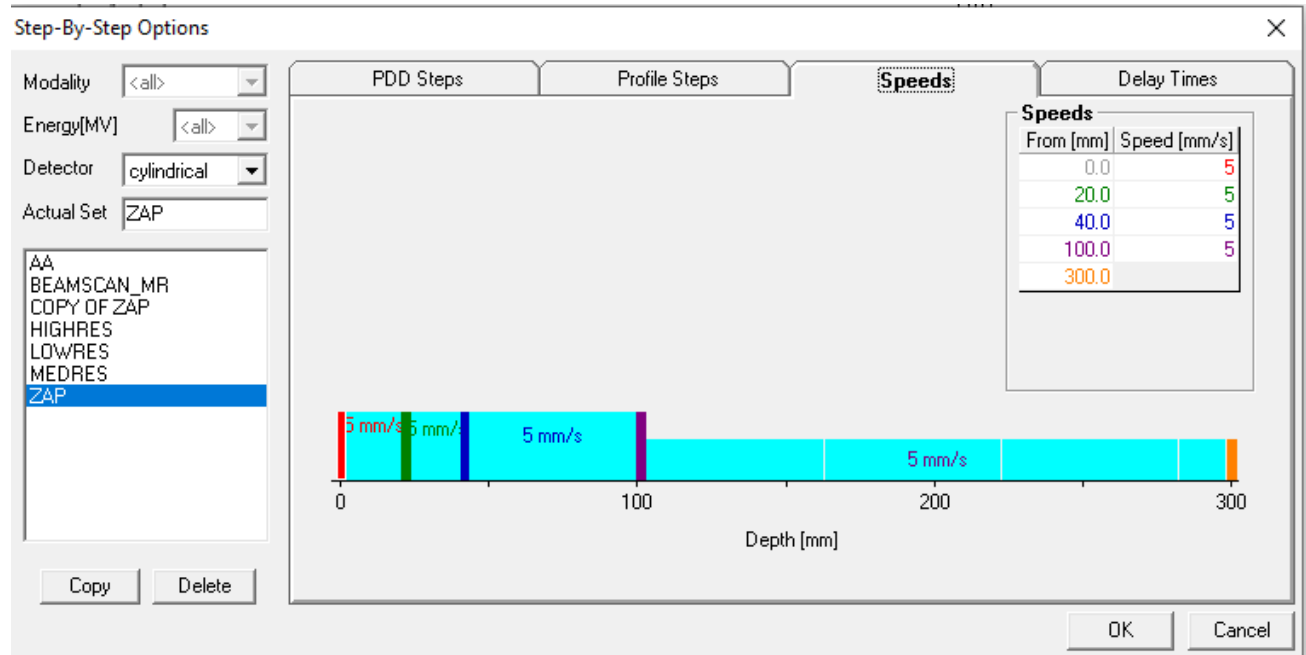


On **Actual Set**, change to ZAP:

Following the **Tab**s and edit the content as recommended:



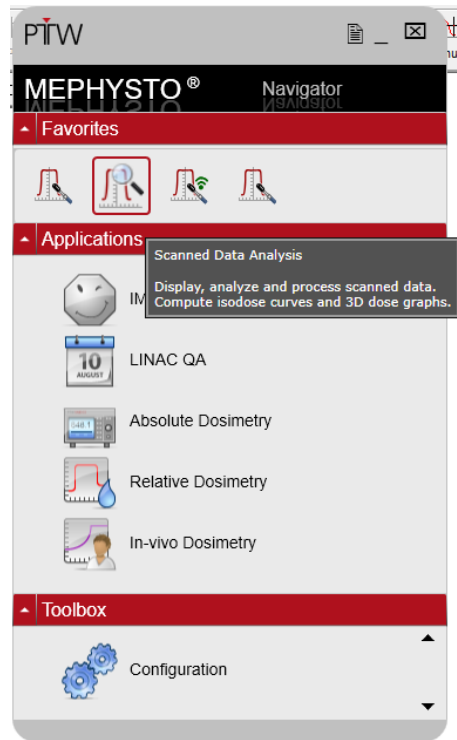






## D) Setup Zap Analysis Protocol:

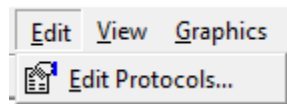
On Below page, select Icon



**Open** any existing **Mephysto Files** and select profile scan from **MCC Files** from your folders.



Click on Icon **Analyze** to perform Analysis on any of the selected **Wheelplane** or **Orthoplane** Profile.  
On the **PTW-DataAnalyze Analyze** page, click on **Edit** and then click on **Edit Protocols**

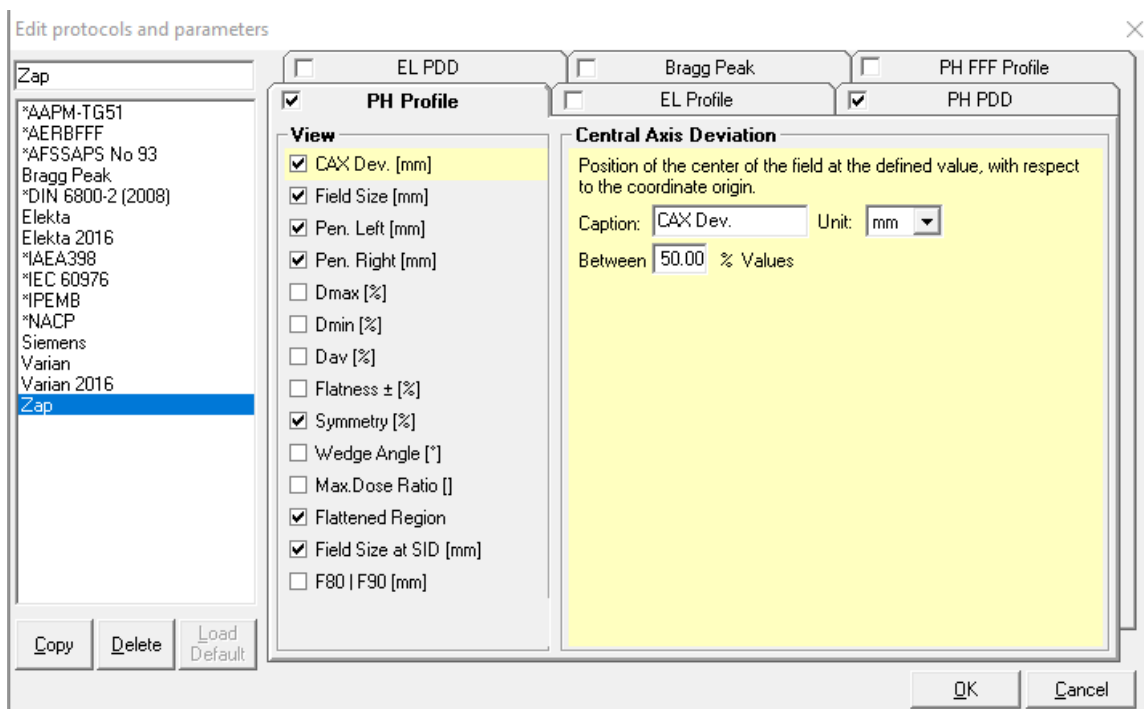


Select **Siemen** and Click **Copy**, then change **Copy of Siemens** to **Zap**.

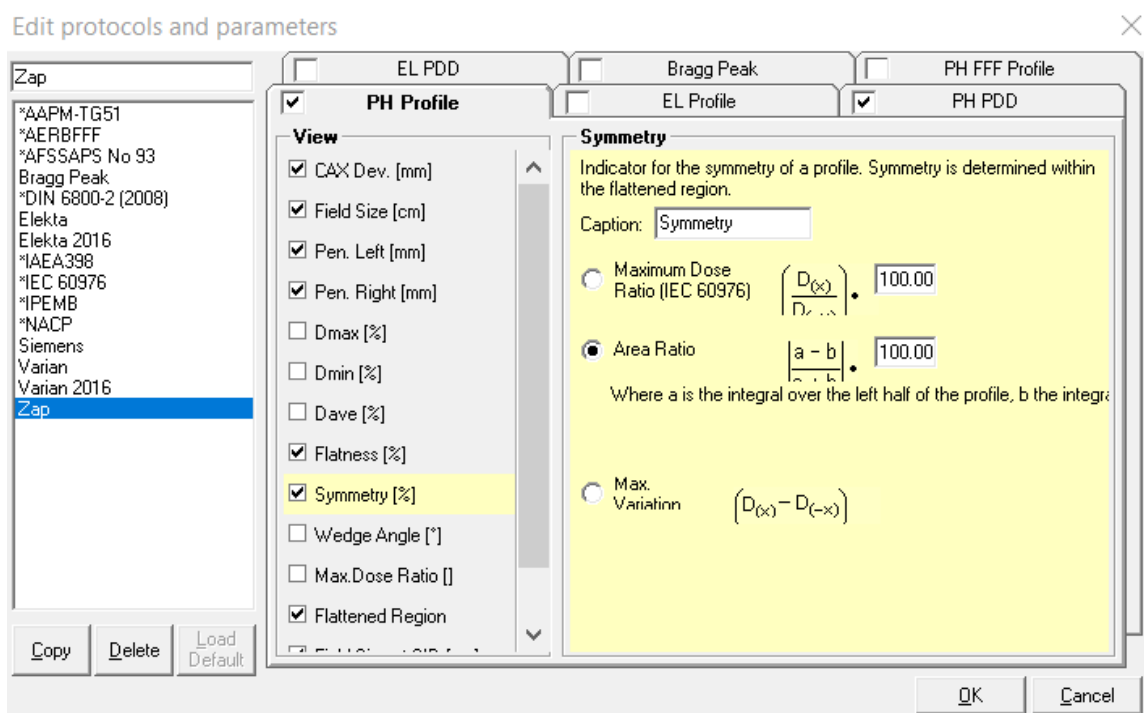
on **Edit protocols and parameters**

Click and Edit **PH profile** & **PH PDD** as shown below:

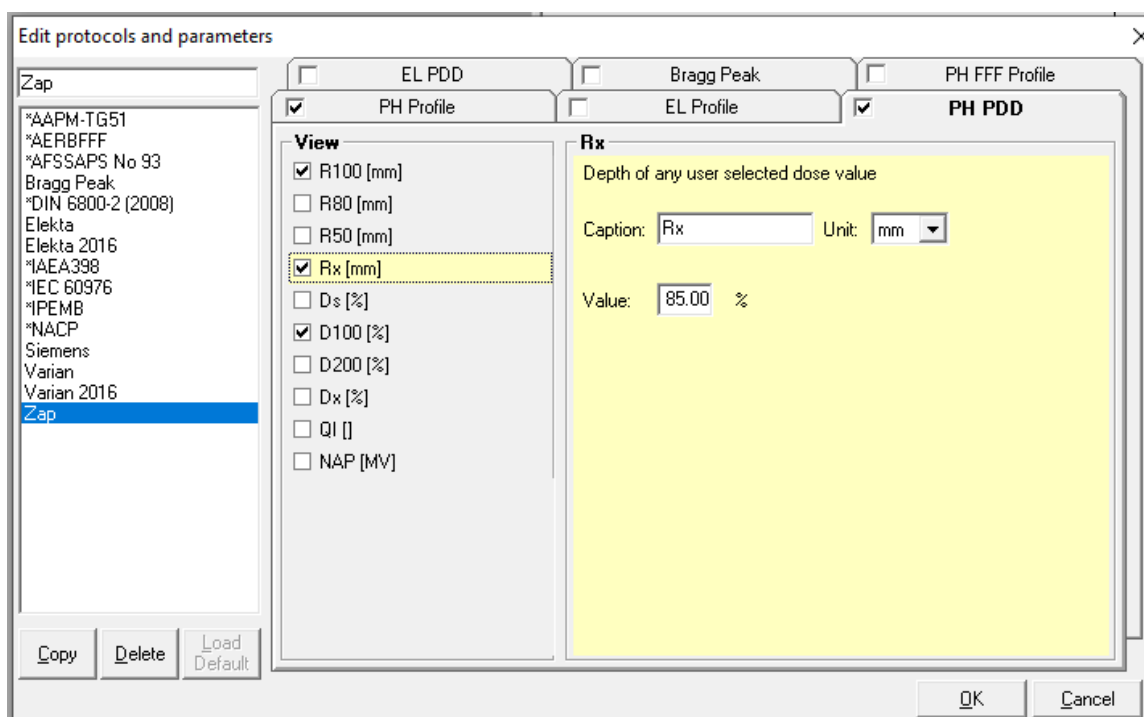
Edit **PH Profile** and change unit to **mm**




On **Symmetry (%)** of **PH Profile**, change to below high-lighted selection:



Edit **PH PDD** and change the unit to **mm**,



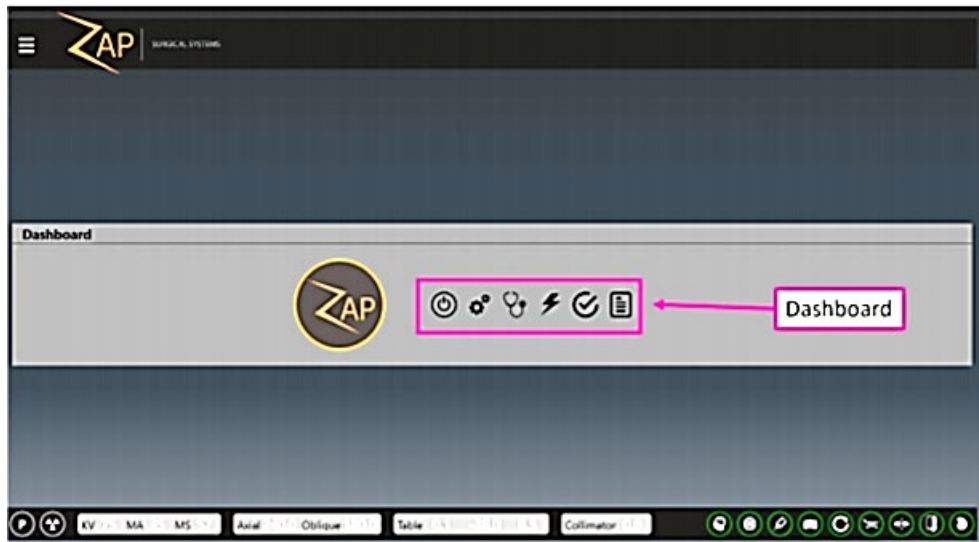
Click  and exit.

## Chapter 4: System Setup with PTW Water Phantom MP3-XS

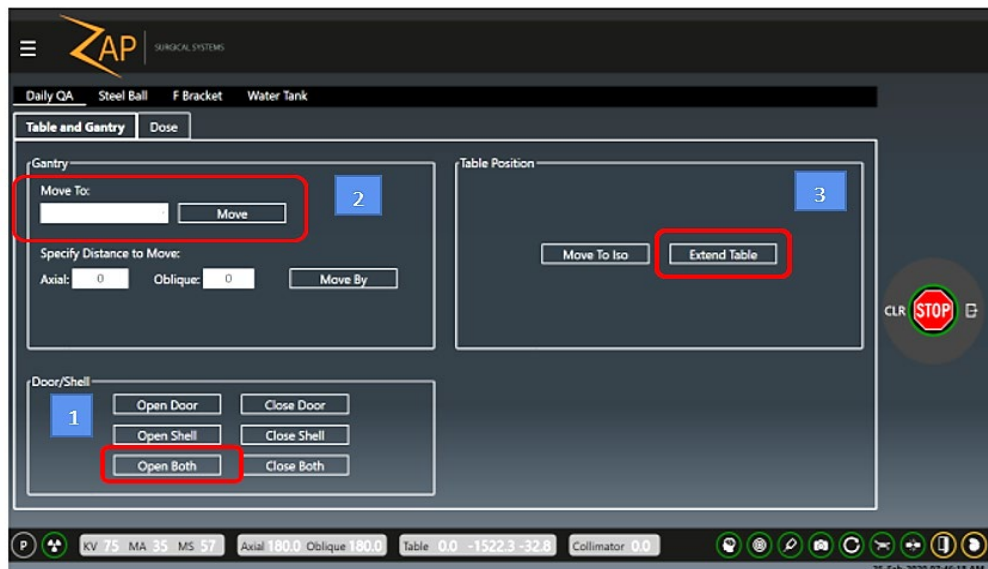
### PTW Water Tank Mechanical Set Up:

1. Login **Zap-X** and power up the system
2. From the dashboard,

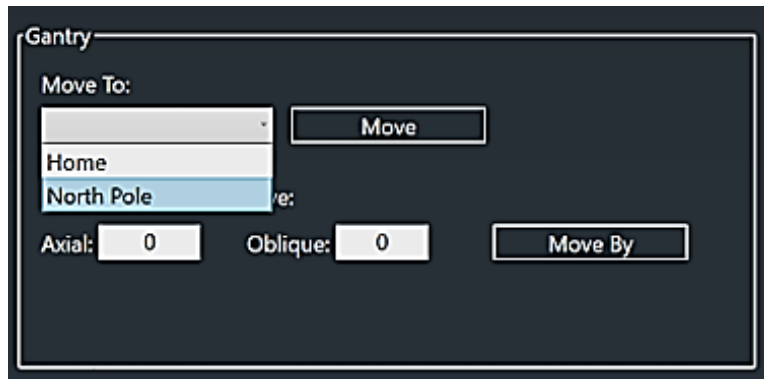
3. Click  &  for **System Initialization** and Daily QA respectively.



4. On **Daily QA: Table and Gantry**, click **Open Both** on **Door/Shell** section to open Shell and door at the same time.



- On **Gantry** section, use drop down tab to move gantry to **North Pole**



- Select **North Pole** and click **Move**
- On **Table Position**, Click **Extend Table** to move patient Table all the way out.
- Select **Water Tank** Tab for beginning PTW water Phantom setup



9. Zap recommends using a tarp sheet inside the treatment chamber to prevent accidental water spill during water tank movement.

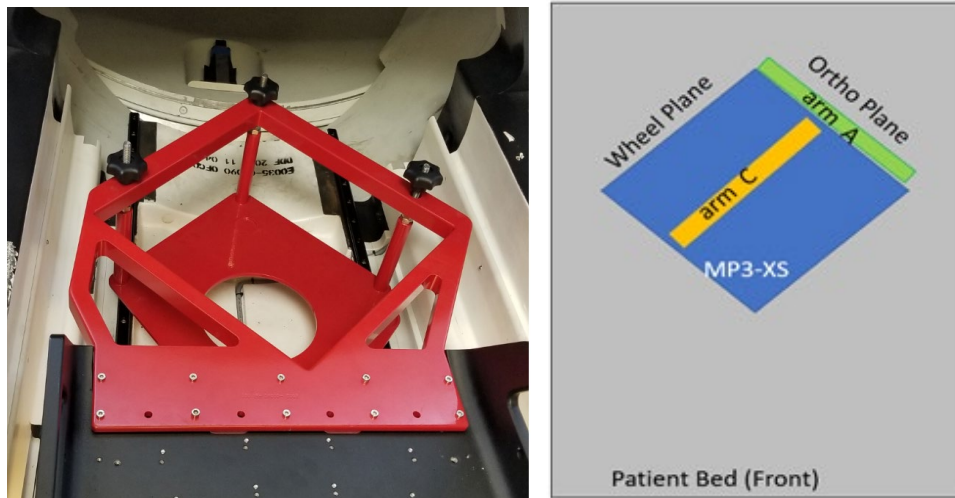


**Note:** No more axial movement until you remove the tarp!

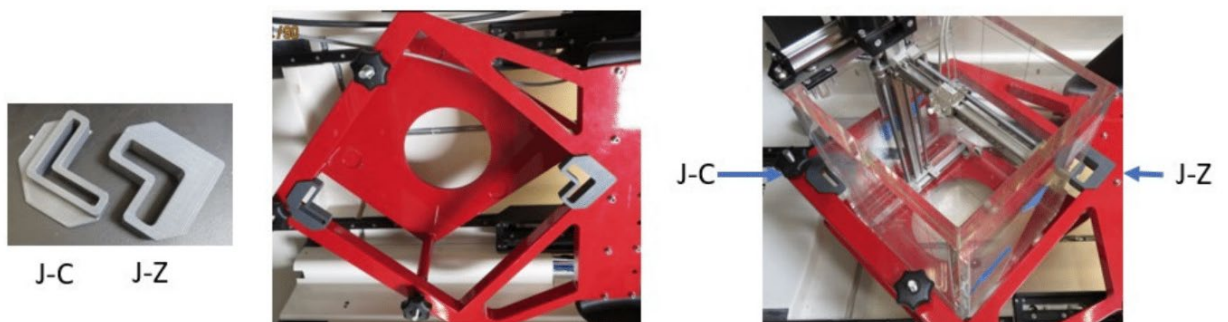
10. Remove the **Head Rest** from the Patient Table (screws were inserted from the bottom surface)



11. Install PTW Supporting Bracket (Ten screws are inserted from the top)

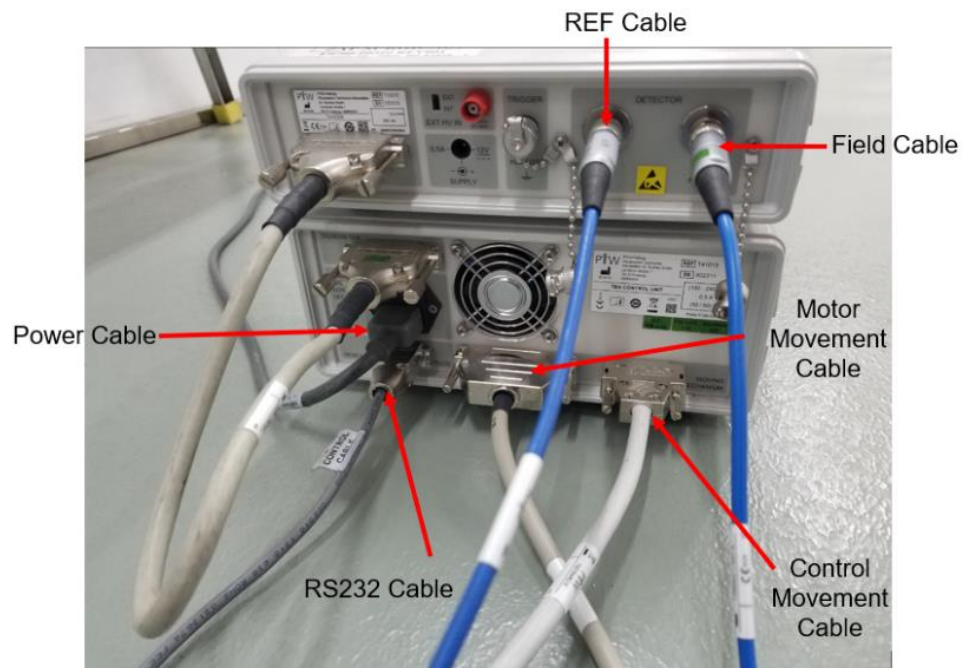


12. Remove three legs from the PTW MP3-XS and place the empty Tank on the PTW Supporting Bracket.
13. Insert 2 centering jags J-C (front) and J-Z (back) to align and secure the tank to the Bracket.





14. Place PTW Tandem, Controller and Unidos Romeo next to the console
15. Connect all the cables to control unit and Tandem as shown below:



16. Insert all PTW cables except RS232 cable through the side hole of the system next to Console.





17. Connect **RS232 cable** to your laptop or desktop computer
18. Connect power to PTW Tandem, and Unidos Romeo
19. Connect PTW cables “Motor movement” and “Control Movement” to the PTW junction box.
20. Hook up 3 axes cables to junction box. (A, B, C) and cable to control pendant (at the anterior of junction box).

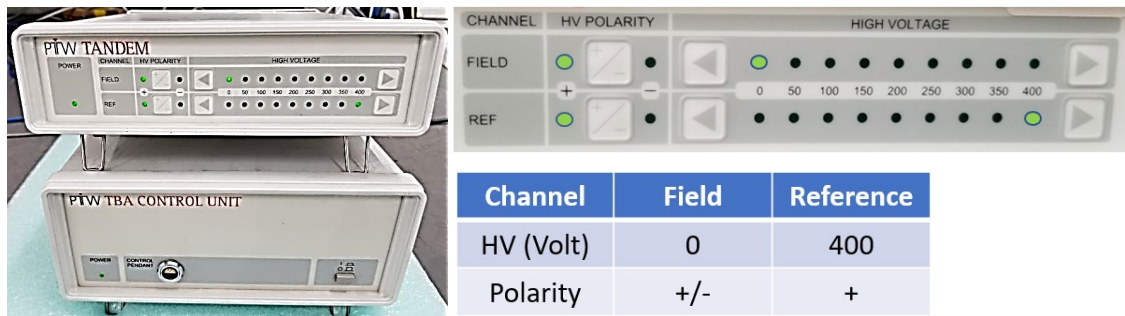


PTW Pendant  
Controller

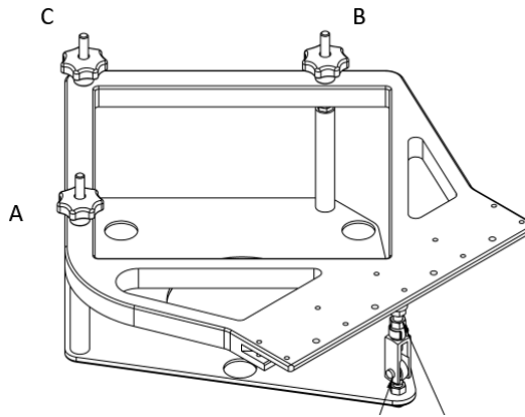
21. Connect PTW Pendant to the Pendant Controller.



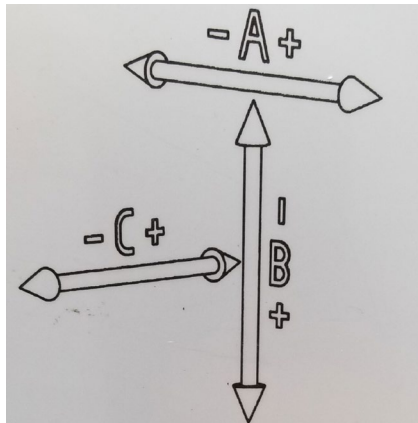
22. Press power button to turn on TBA control and set HV/Polarity of Field and Ref Channel:



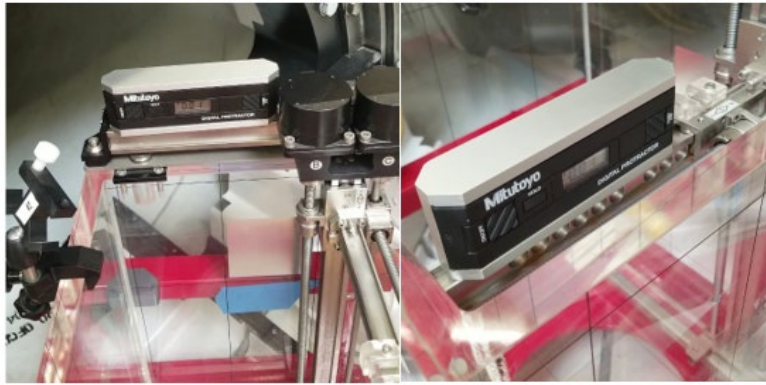
23. Move all three knobs and top nuts to the top and verify the bracket is not touching the rails underneath.



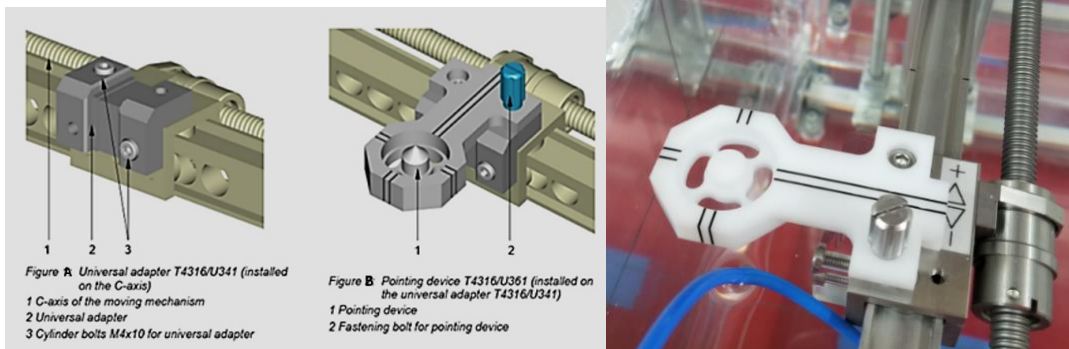
24. Prior to leveling the water tank, verify the protractor whether calibration is needed or not by comparing the reading at 0 and 180 degree on the same location. If the difference is more than 0.01 degree, perform Protractor calibration until the difference is < 0.01 degree. (follow vendor manual to perform calibration.)
25. Verify the alignment of **A**, **B** and **C** arm per PTW manual.
26. Use the PTW Pendant to move detector mount close the end of A and C arm in + direction.



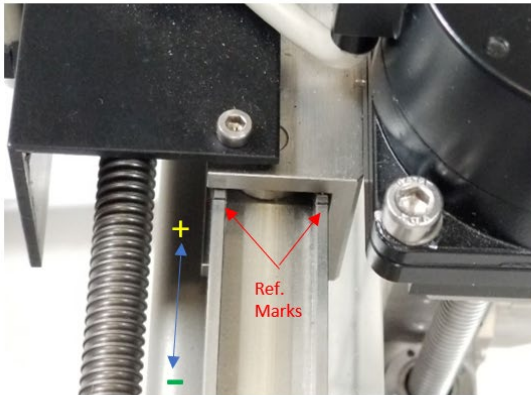
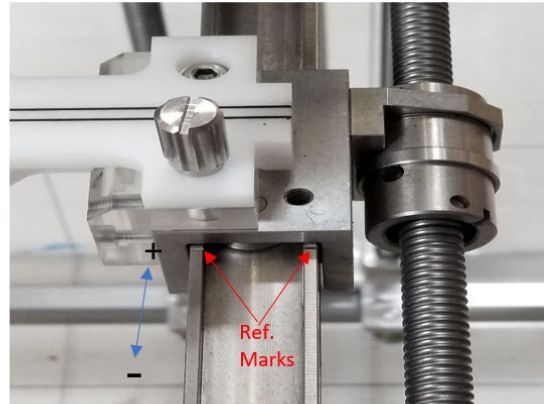
27. Fill the water tank with 7 gallons of distilled water or 2/3 of the tank using 1- gallon bottles.
28. Move the C arm above the water level if the arm located is below water level.
29. Adjust the leveling of the water tank with the knots by measuring the angle of A and C arm by placing the protractor on top of either A or C arm. Try to set  $< 0.1$  degree for both A and C arm if possible.



30. After tank leveling is done, install PTW T4316/U341 Universal Adapter following with T4316/U361 Pointing device for water leveling adjustment.



31. Use Pendent to move **A** and **C** arm to the reference marks for centering the **Pointing Device** to the center of the scanning region.

**A arm****C arm**

32. Move **B** arm in **-B** direction to 1/3 below the water tank top

For the next steps, it will need 2 persons to continue the water tank setup.

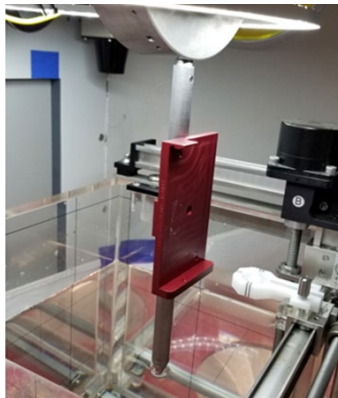
33. To determine the level of water located at 450 mm SAD, you will need to use Zap Pin Pointer to do that.
34. Lie on the table with the pointer on your hand. (be careful with the sharp tip of the pin pointer)



35. 1<sup>st</sup> person provides guidance to 2<sup>nd</sup> person pushing the water tank toward the back of the Gantry until PTW Pointing Device is roughly below the collimator wheel.



36. Insert Zap Pin Pointer into collimator 25mm hole to define the 450 mm SAD position.

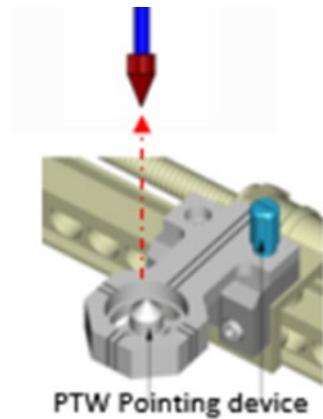
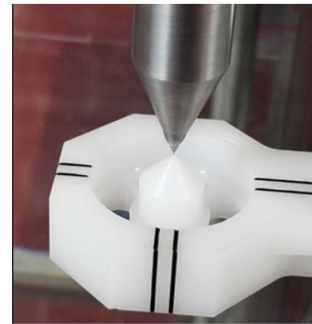


37. Move the PTW Pointing Device up slowly closer to Zap Pin Pointer (not touching leaving 2 to 3 mm gap) with the Pendant and adjust the position of the Water Tank with the help from the 2<sup>nd</sup> person.





**Warning: When aligning the PTW Pinpoint device to Zap pointing device, use slow mode for final adjustment as tip of PTW Pointer Device can be damaged easily!**



Ortho  
Plane Side

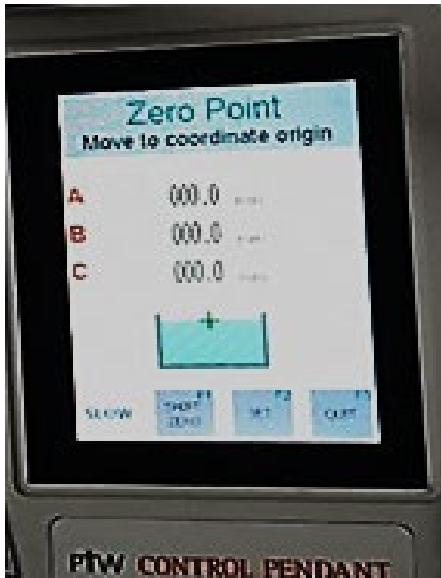
Wheel Plane Side

38. Once both tips **almost** touching, adjust the **Pointing Device** tips from the **wheel** plane side and then from the **ortho** plane side.
39. Use slow mode to raise PTW Pointing Device to touch the pin pointer tip with B arm in **-B** direction
40. Immediately go to PTW Control Pendant and set this position as **Zero** by pressing  key, then press  key to set the water level to 450 mm SAD.

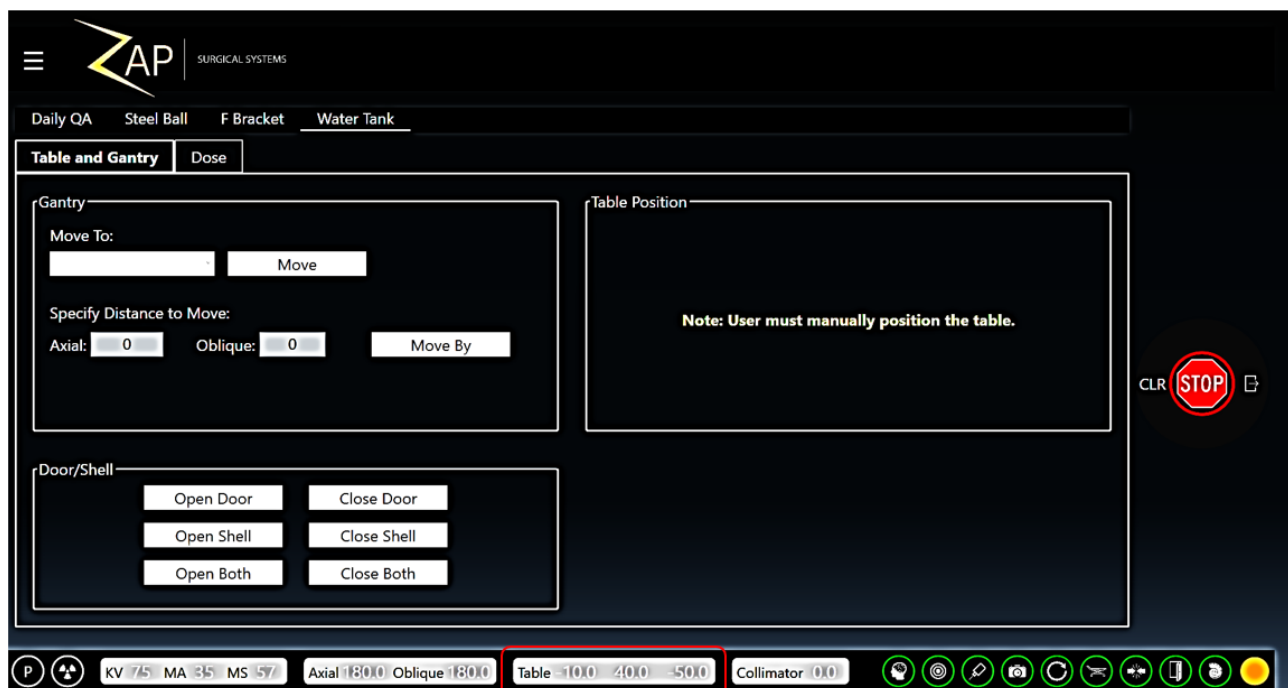


41. Verify the value of A, B, and C are “0” on the PTW Control Pendant. This will be “Zero” position

and press  key to exit.




42. Request the 2<sup>nd</sup> person to record the position of the Patient Table from the monitor by writing it down or take a picture from the monitor screen. The Table Coordinate information will be needed for initial detector centering later.



43. Press  key on the Pendant to lower **PTW Pointing Device** away from the **Zap Pin Pointer** about **80 to 100 mm** using **B** arm.

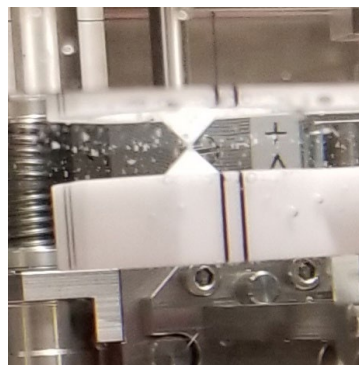
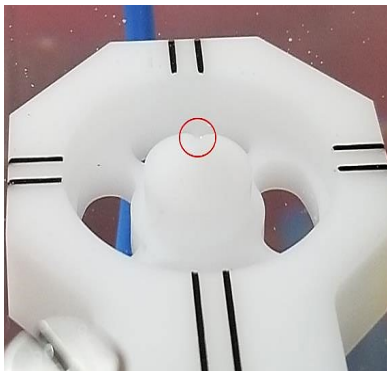


**Warning:** if you use **Fast** mode by mistake in opposite direction, the tip of PTW Pointing Device can be destroyed, and this device needs to be replaced.

44. Go the collimator wheel and carefully remove the Zap Pin Pointer  
45. Request 2<sup>nd</sup> person to pull the Patient Table all the way out  
46. After you get off the Patient Table, press  key to move the arms to zero position for setting water level to 450 mm SAD. (SSD= 450 mm)





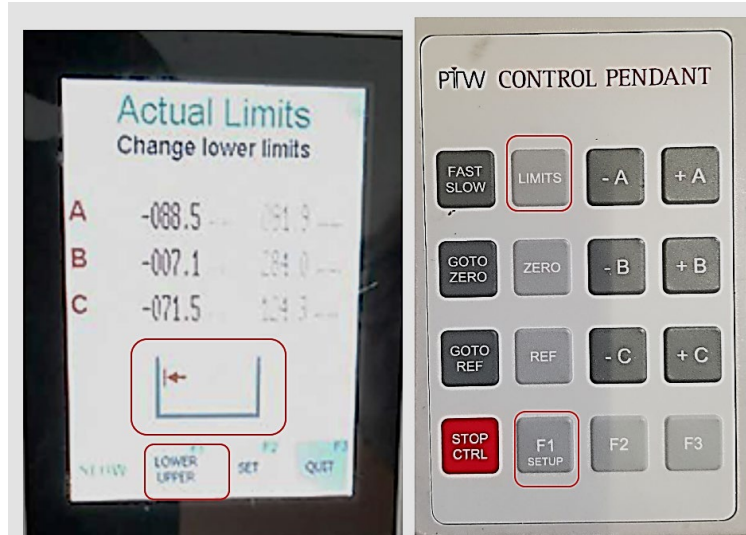
47. Fill the tank with distilled water until the water level same as the tip of the PTW pointing device. It can be confirmed to look at the reflection of the Pointer device tip from below of the water.





48. Set the limits of Water Tank servo motor to LOWER and UPPER Limit of three Arms with following steps:

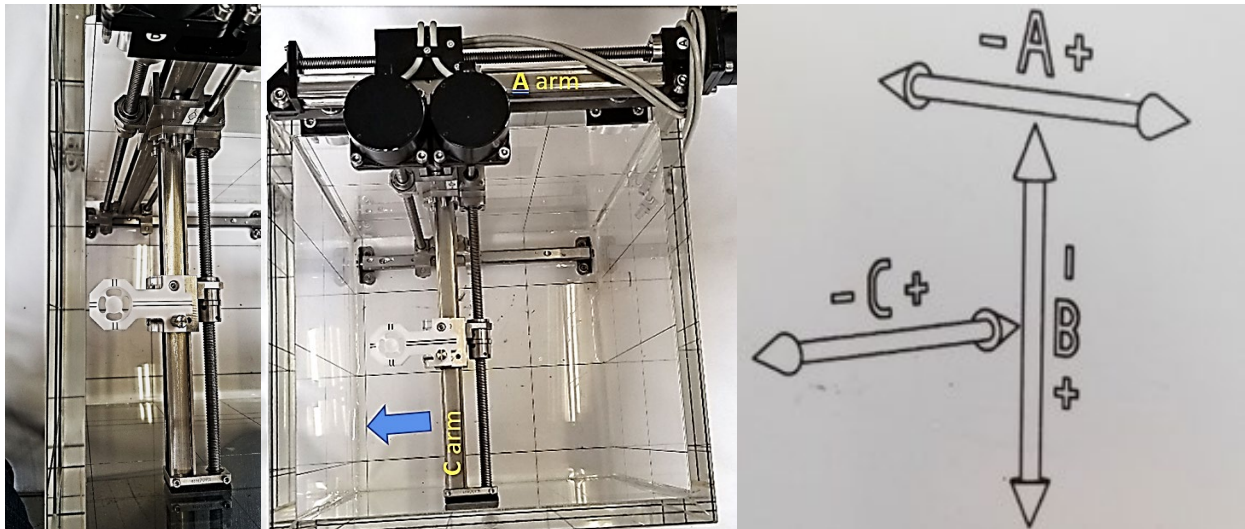
- a. Press “” Key on the PTW Control Pendant and then press  key to show the LOWER limit as shown below:









- b. Start with Serve Motor of A arm first by pressing “-A” Key to move the C arm to the left slowly without touching the water tank wall and press F2 key to set.





**Warning: Avoid touching the Water Tank wall when moving the A arm with PTW Pointing Device. If the Pointing Device hit the tank wall, it can tilt the B arm and cause misalignment with a small angle instead of perpendicular to the water surface.**



- c. Press  key to move the serve motor of **A** arm to **Zero** position with Fast mode
- d. Continue set up **Lower** limit of -B and -C by pressing  and  key respectively.
- e. Press  key to set **Lower** limits of A, B & C Servo motors.
- f. Press  key to switch to **Upper** limit set up
- g. Complete Upper Limits with A, B and C Servo motor by pressing Press  key to +A, +B and +C keys same way as Lower Limits.



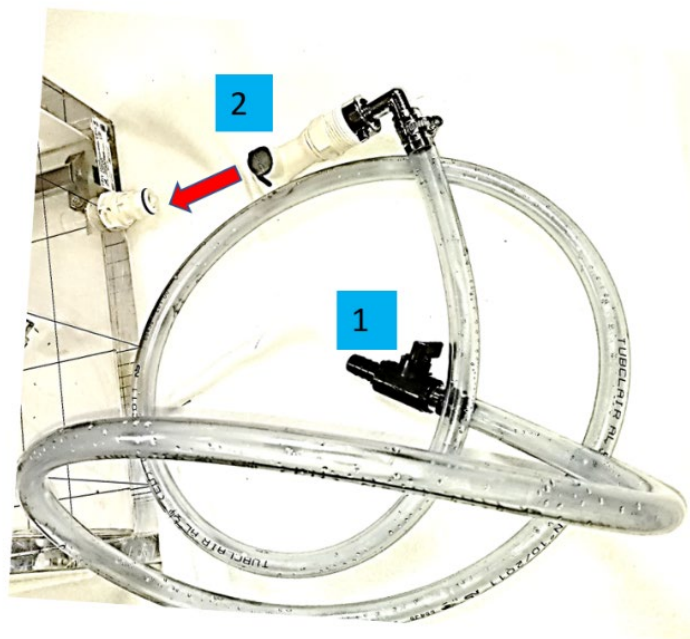
- h. Press  key to set **Upper** limits for A, B & C Servo motors.
49. Press  key on PTW control pendant to move back to zero position for A, B and C.
50. PTW Water Phantom Setup is completed and ready to perform Beam Data Acquisition

51. When beam acquisition is done, remove PTW Water Tank Phantom with the following procedures:

- a. Go to Zap-X **Daily/Water Tank** page and Click on **Open Both** in **Shell/Door**



- b. Click **Open Both** to open the Door and Shell.
- c. Pull the patient table very slowly all the way out until it stops
- d. Turn off the power of Tandem/Controller or dosimeters.
- e. Disconnect all the cables and remove them from Zap-X through the side port.
- f. Remove the installed PTW detector, holders and T-Ref from the Water Tank
- g. Close the manual valve on one end of the water hose and the other end connects to the bottom of the water tank using Quick-disconnects as below:



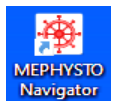
- h. Open the manual valve and drain the water from the water tank back into multiple 1-gallon bottles,




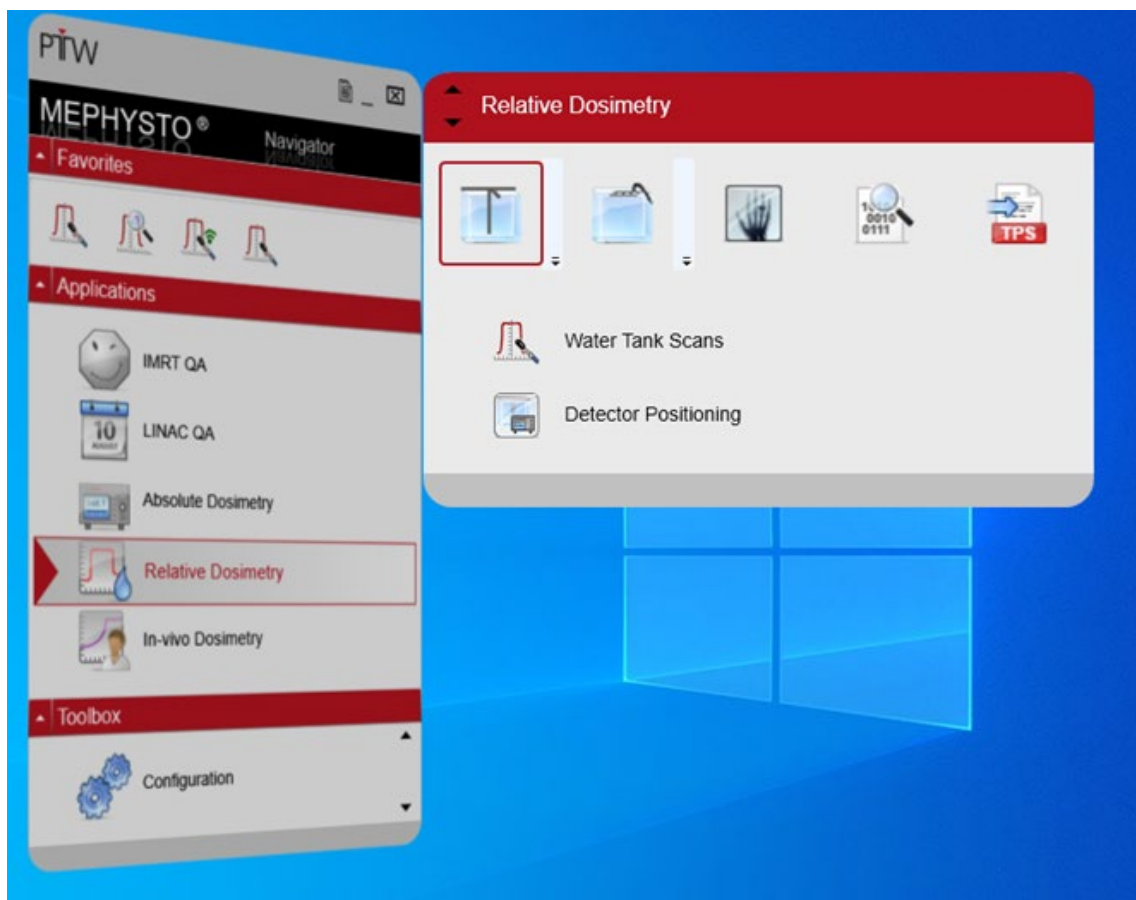
- i. Remove Center Jigs and the water tank from the system
- j. Remove PTW Supporting Bracket
- k. Reinstall the Patient Head Rest with screws inserted from the bottom side.
- l. Water Tank removal is completed .and ensure that there is no water droplets left on the system.

## Chapter 5: Centering PTW Detector on Water Tank Phantom

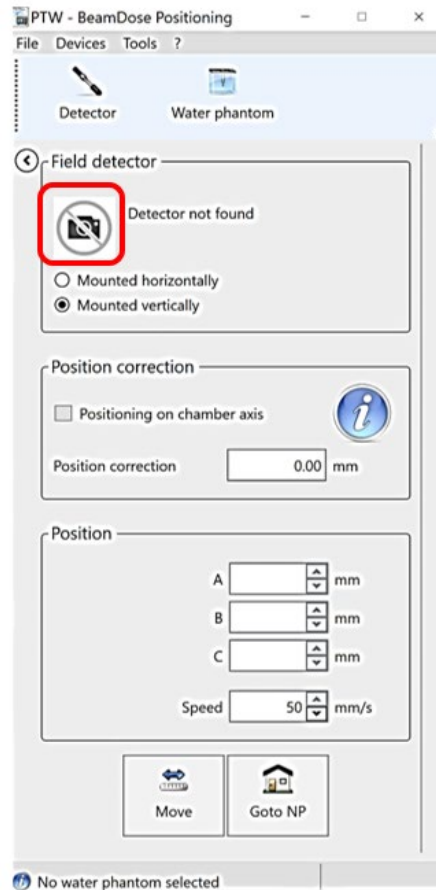
Centering PTW detector to photon beam is important to achieve accurate CAX, Dmax, PDD % Dose, D10, and Penumbra Left/ Right during the Beam Data Acquisition. In **BeamScan 4.4**, Center-check feature was eliminated from the Mephysto and becomes part of **Relative Beam measurement** under **Auto Setup Mode**.



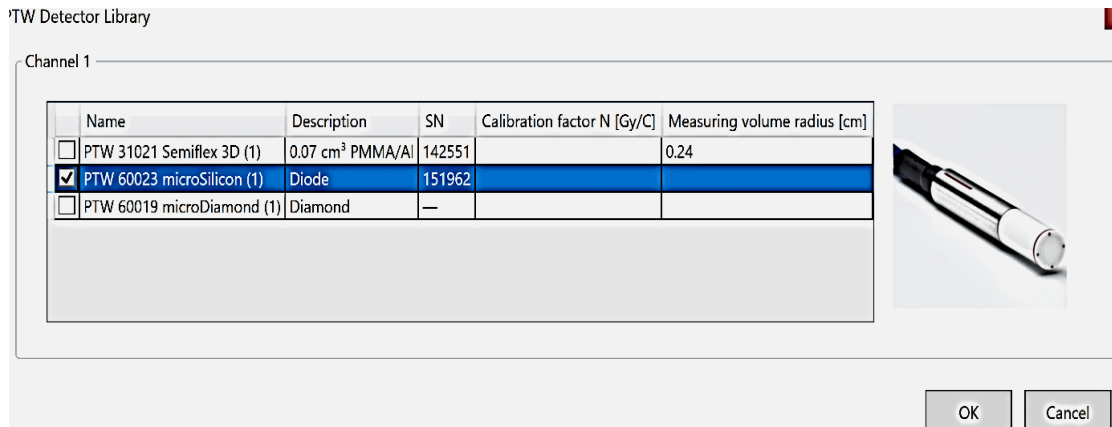
On your desktop, click on  icon, Select **Relative Dosimetry**:



1. Select **Detector Positioning**:





2. On the **Field Detector**, click on the picture to select your detector which created in the **User defined detectors** and select the detector of your choice. For Zap-X, we recommend using **PTW 60023 microSilicon** Diode detector. (Optional with **microDiamond**)

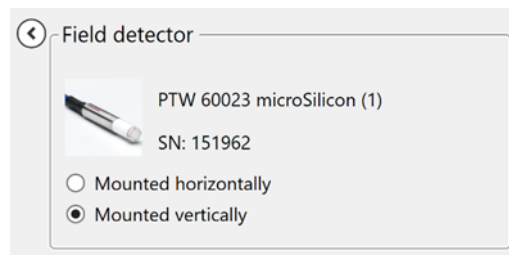


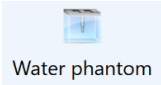
3. Use correct Holder and Thimble according to your dose measurement:

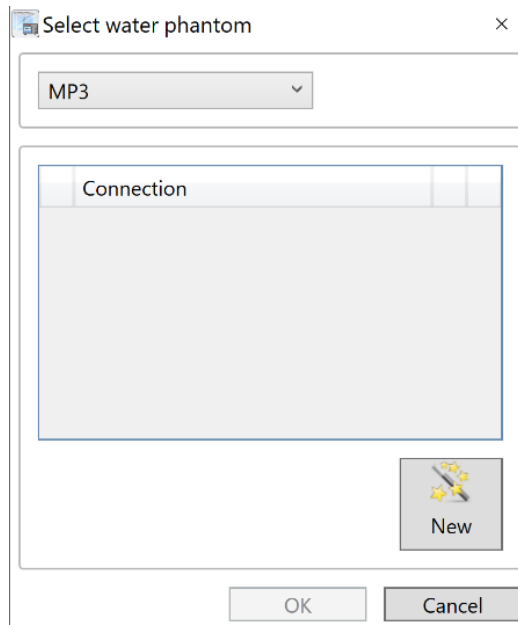
Type of Measurement	Holder	Thimble	Mounting	Detector	T-Ref	Preference
Relative	431	4311	Vertical	microSilicon	No	Zap
Relative	431	4309	Vertical	microDiamond	No	Optional

4. After PTW water Phantom setup is completed, press  key on the PTW Control Pendant to move the detector mount to previously set SAD position.


5. After select , the picture of the selected detector will appear and select the mounting orientation of the field detector in **vertical** position as shown below:

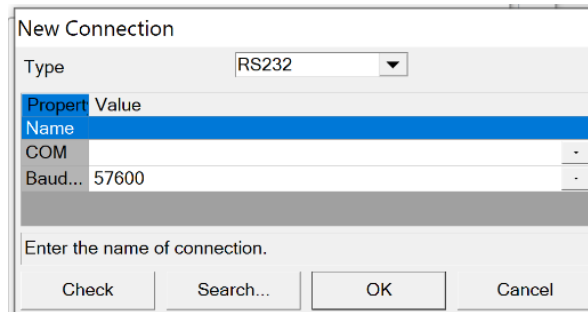


6. Next, click  icon to select MP3 as water Phantom.

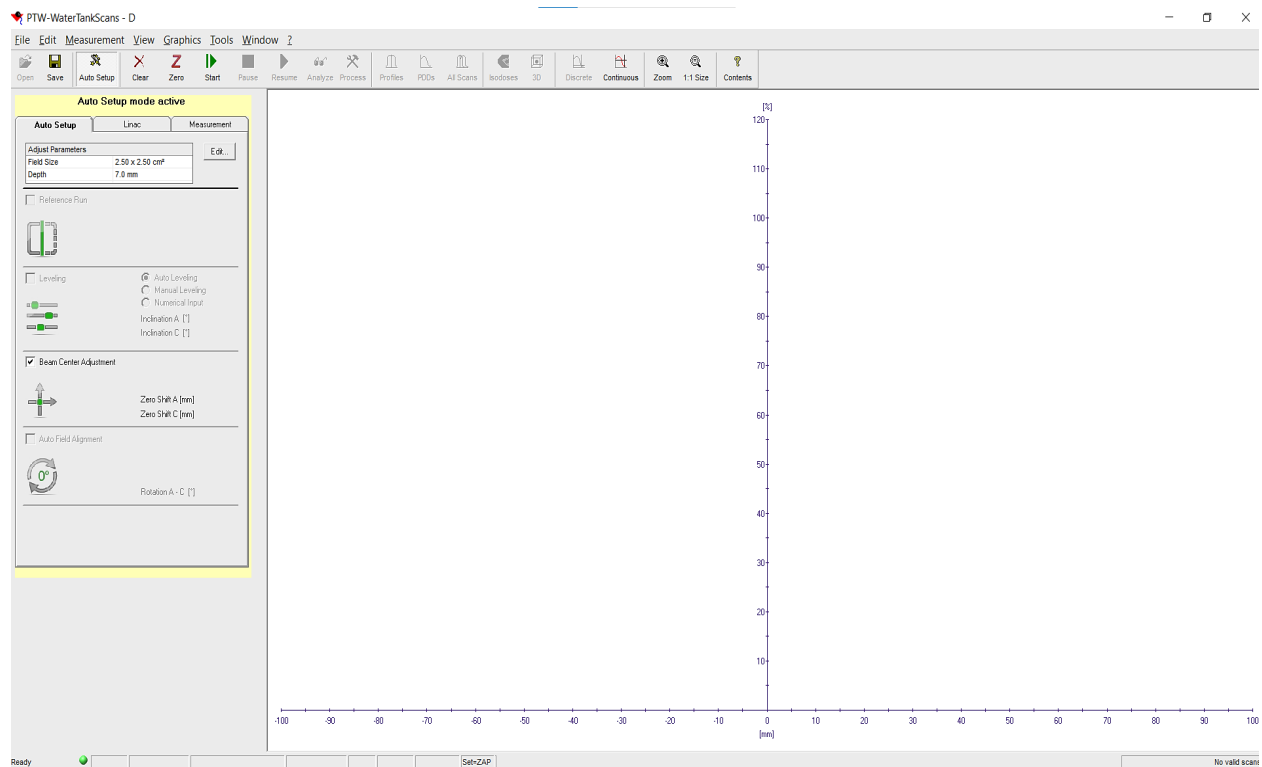




7. Click  to connect dosimeter/controller to your computer by select **RS232** on **Type**








8. Select “**Search**” to connect and select **Ok**.  
 9. Once your laptop is communicated with the dosimeter successfully, exit **Detector Positioning**.  
 10. Select **Water Tank Scan** to start detector centering.



11. At **Auto Setup mode active** (yellow high-lighted), edit **Field Size** and **Depth** on **Adjust Parameters**.  
 12. Click **Beam center adjustment** box to position the detector relative to the beam center.

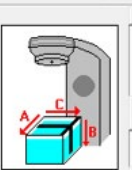
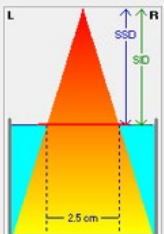


**Auto Setup mode active**


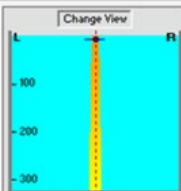
Auto Setup	Linac	Measurement
<div style="border: 1px solid black; padding: 5px;"> <b>Adjust Parameters</b> <div style="float: right; border: 1px solid black; padding: 2px;">Edit...</div> <div style="clear: both;"></div> <div style="display: flex; justify-content: space-between;"> <div>Field Size</div> <div>2.50 x 2.50 cm<sup>2</sup></div> </div> <div style="display: flex; justify-content: space-between;"> <div>Depth</div> <div>7.0 mm</div> </div> </div>		
<input type="checkbox"/> Reference Run		
		
<div style="display: flex; justify-content: space-between;"> <div> <input type="checkbox"/> Leveling           <div style="margin-top: 5px;">   </div> </div> <div> <input checked="" type="radio"/> Auto Leveling  <input type="radio"/> Manual Leveling  <input type="radio"/> Numerical Input            Inclination A [°]            Inclination C [°]         </div> </div>		
<input checked="" type="checkbox"/> Beam Center Adjustment		
 <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div>Zero Shift A [mm]</div> <div>Zero Shift C [mm]</div> </div>		
<input type="checkbox"/> Auto Field Alignment		
 <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div>Rotation A - C [°]</div> </div>		

13. Click on **LINAC** and **Measurement** tab to verify or edit the setup as below:

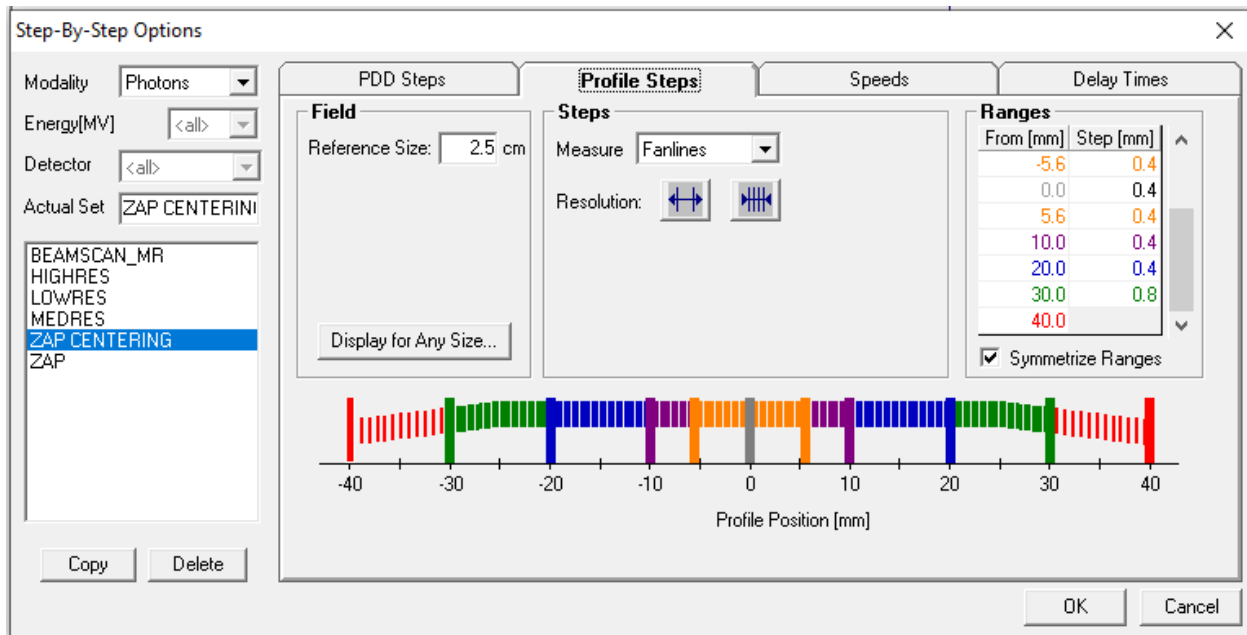
**Auto Setup mode active**


Linac	Measurement
	
<b>Accelerator</b> <div style="display: flex; justify-content: space-between;"> <div>Name: Zap Surgical S<sub>y</sub></div> <div>Modality: PHOTONS</div> </div> <div style="display: flex; justify-content: space-between;"> <div>Energy [MV]: 3.0</div> <div>Wedge: Open</div> <div>Block: None</div> </div>	
<b>Field</b> [cm] x [cm] <div style="display: flex; justify-content: space-between;"> <div>Ortho (Y): 2.50</div> <div>Wheel (X): 2.50</div> </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div>Field size defined at: SID</div> </div>	
<b>Setup</b> <div style="display: flex; justify-content: space-between;"> <div>SSD [cm]: 45</div> <div>Gantry [°]: 0.0</div> <div>Collimator [°]: 0.0</div> </div>	
<div style="border: 1px solid black; padding: 5px;">  </div>	
<div style="border: 1px solid black; padding: 5px;">             Comment:           </div>	

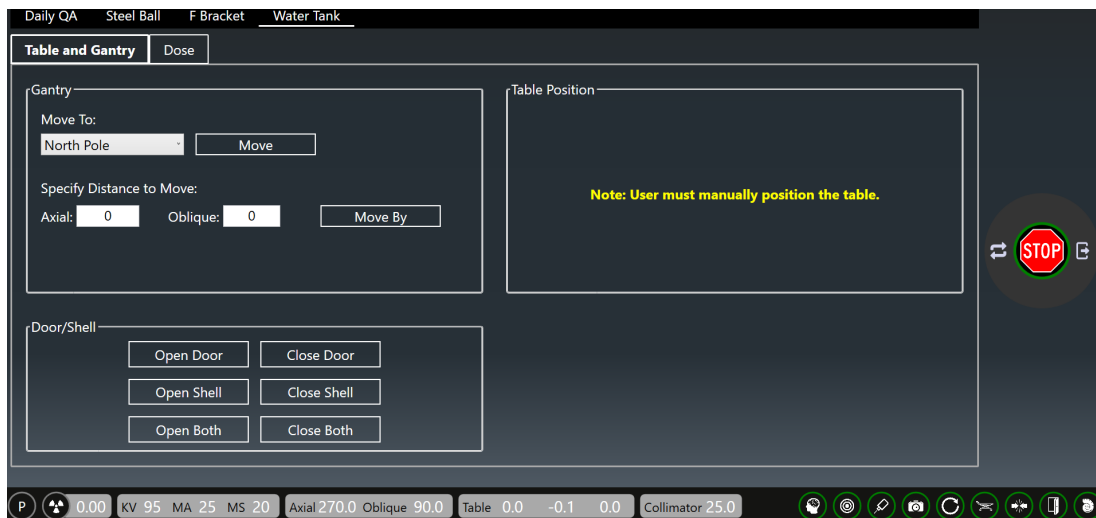
**Auto Setup mode active**

Auto Setup	Linac	Measurement
		
<b>TANDEM</b> <div style="display: flex; justify-content: space-between;"> <div>Max. Dose Rate: 3.0 [Gy/min]</div> <div>Meas. Time [s]: 0.10</div> </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div>60023 microSilicon (1)</div> <div>34091 T-REF (1)</div> </div>		
<b>AutoSetupMode</b> <div style="display: flex; justify-content: space-between;"> <div> <div style="border: 1px solid black; padding: 5px;">  </div> <div> <input type="checkbox"/> Use settings for non Auto Setup measurements           </div> </div> </div>		
<div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div>Medium: Water</div> </div>		
<div style="border: 1px solid black; padding: 5px;">             Comment:           </div>		

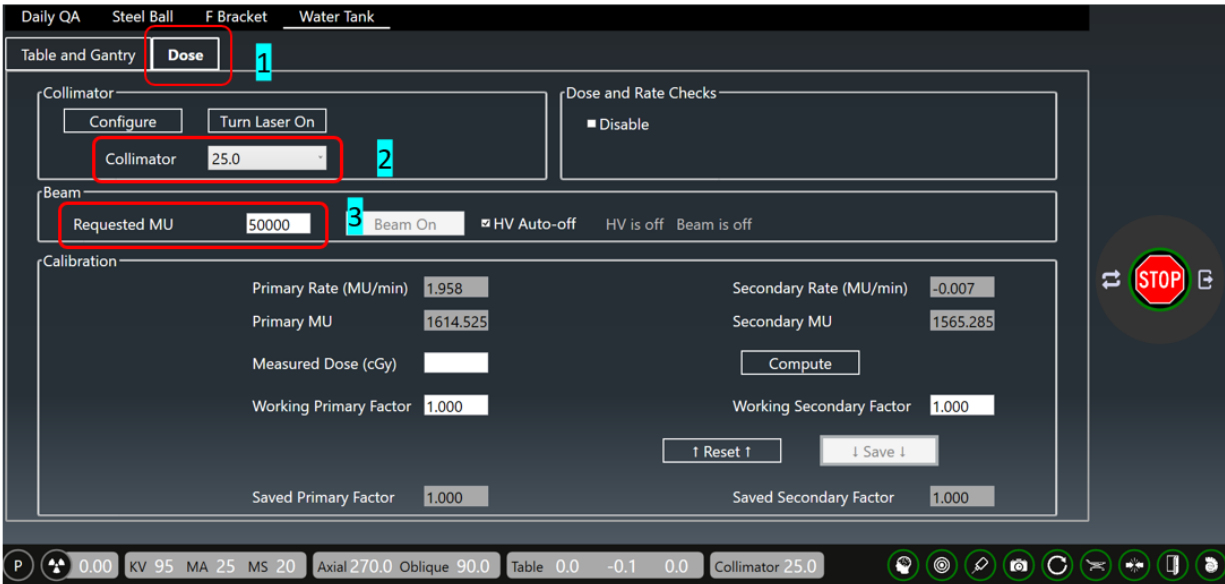
14. Zap recommends having different Profile Steps for Centering the detector with higher scanning resolution by creating a new protocol as **Zap Centering** as an example:



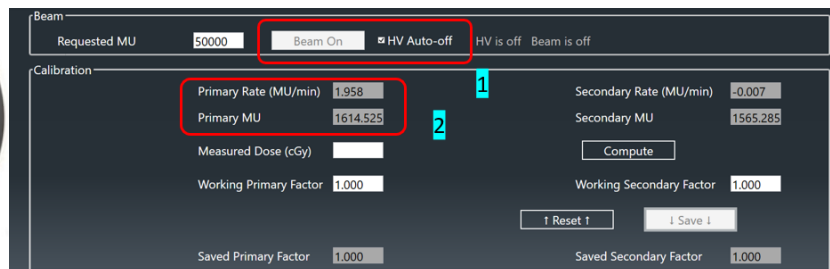
15. Prior to detector Centering, click  icon to zero the dosimeter.
16. If error occurs during Zeroing, check **RS232/USB cable** or **USB Port connection**.
17. Once Zeroing is done, go to **Daily QA/ Water Tank** on Zap-X to do the followings:




- Verify Gantry is at North Pole position
- Click on **Dose** and use the dropdown tab of **Collimator** to select 25 mm collimator
- Set Dose to 10,000 Mu and



- At Console, press the left button to turn on **HV** and click **Beam-On** tab in Beam section. Once **Beam-On** is click, it will change to yellow color. It is recommended to select HV Auto-off to turn off the beam when required dose is met.



- As soon as Dose or Dose Rate appears, click  on **BeamScan** to begin profile scanning for both Ortho and Wheel plane.
- After the 1<sup>st</sup> Profile Scan, BeamScan will display how much detector was off from the center of the beam in XY plane (A & C arm) as shown below:

**Auto Setup mode active**

**Auto Setup**    Linac    Measurement

Adjust Parameters    Edit...

Field Size	2.50 x 2.50 cm <sup>2</sup>
Depth	7.0 mm

☐ Reference Run

☐ Leveling

☒ Auto Leveling  
☐ Manual Leveling  
☐ Numerical Input

Inclination A [°]  
Inclination C [°]

☒ Beam Center Adjustment

Zero Shift A [mm]    0.2  
Zero Shift C [mm]    0.0

☐ Auto Field Alignment

Rotation A - C [°]

20. Repeat the profile scan again with the same steps, detector will be moved automatically to the beam center and the Beam Center Adjustment will show **Zero Shift** for both **A** and **C** position.

☒ Beam Center Adjustment

Zero Shift A [mm]  
Zero Shift C [mm]

21. CAX Dev. of OrthoPlane (A arm) and WheelPlane (C arm) should show value close to Zero mm as below:

	CAX Dev. [mm]	Field Size [mm]
OrthoPlane (A arm)	0.00	25.34
WheelPlane (C arm)	0.00	25.41

22. Now the center of the detector is now aligned to Photon Beam.
23. Beside centering procedure uses on detector/photon beam alignment, it can also be used to pre-scan detector at different collimator size prior to **Output Factor Measurement** especially all collimator sizes smaller than 10 mm for accurate results.

## Chapter 6: Percentage Depth Dose (PDD) and Beam Profiles

To perform Percentage Depth Dose and Beam Profiles, Zap recommends using microSilicon and T-Ref are recommended for all the measurements. microdiamond is an optional alternative detector depending on customer's preference.

Type of Measurement	Holder	Thimble	Mounting	Detector	T-Ref	Preference
PDD / Profiles	431	4311	Vertical	microSilicon	Yes	Zap
PDD / Profiles	431	4308	Vertical	microDiamond	Yes	Optional

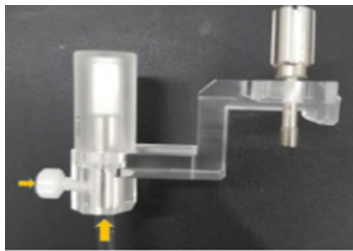
Note: T-Ref Chamber Type 34091

After PTW Water Tank setup is completed with known coordinates of the Patient Table, it is ready to setup the water tank to do PDD and Beam Profiles. Below table shows the needed PTW Trufix fixtures and detectors setup:

1. Hand tighten the Thimble 4311 into the PTW 431 Holder



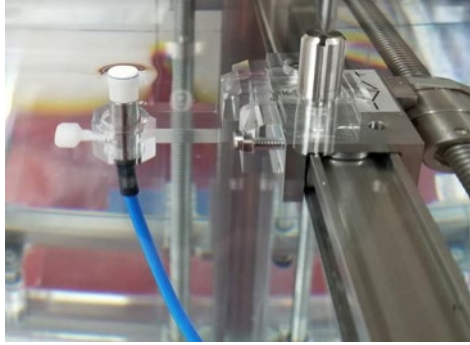
2. Insert PTW microSilicon detector into the thimble/Holder and ensure that the detector touch the top of the thimble before hand-tightening the plastic screw to secure the detector to the holder.



3. Remove the Thimble from the holder



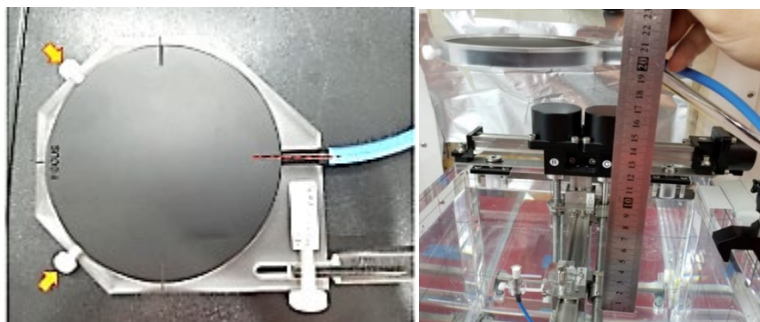
4. Remove the PTW Pointing device and install detector on the PTW T4316/U341 Universal Adapter.




5. Connect PTW **microSilicon** Detector to PTW **Tandem** through the Field Cable (Blue color)
6. Setup **T-Ref Chamber** on the **Water Tank Phantom**:
  - a. Assemble the rod to the **T-Ref holder** T4316/U563 by hand-tighten the plastic screw.



- b. Mount the **C-clamp** on the side wall of the **Water Tank** by tightening 2 screws and install the **T-Ref holder** kit on the **C-clamp**.
- c. Adjust the center of the **T-Ref holder** right above the **microSilicon** detector. Ensure that the distance between **T-Ref holder** and the detector is more than 20 cm as recommended per manual.
- d. Place **T-Ref Chamber** on the T-Ref holder with the flat surface on top and secure the T-Ref chamber by hand-tightening 2 plastic screws on the sides.



- e. Verify the required distance again and tighten all the screws one more time.
- f. **T-Ref Chamber** setup is completed
7. Inspect all the cables inside the gantries and ensure they have enough length or not restricting the movement of the **Patient Table**.
8. Double check the Detector is located at Zero position or press  on the **Control Pendant**.

9. Slowly move the Water Tank into the gantries slowly without spilling the water by hand manually.
10. Manually move both top and bottom section of **Patient Table** slowly without spilling the water outside the water tank.
11. When the bottom section of Patient Table stops moving, request the 2<sup>nd</sup> person to guide you to move the Water Tank to the previously recorded position for SAD by hands. (Refer to Chapter 4 water tank setup section).




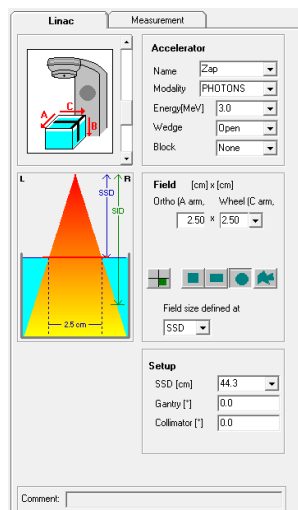
**Warning: Patient Table movement is disabled while Zap-X is on Water Tank mode. Do not use system control mode to move the patient table as rapid vibration can occur due to the feedback of servo-motor to water movement in Water Tank.**

12. Try to adjust the **Water Tank** within +/- 0.1 of previous defined **Patient Table** position.
13. Close both Shell and Door.
14. Go to **BeamScan** and follow **Chapter 5** to perform detector centering with microSilicon or detector of your choice.

To have accurate beam profiles without worrying about leveling the Water tank perfectly, **BeamScan 4.4** offers **Beam Inclination Offset Mode** to provide auto adjustment based on the inclination of the Water Tank setup.

15. Below steps describes how to activate the **Beam Inclination Offset Mode**:

- a. Once Detector centering is completed, press  once to disable Auto Setup. Only Linac and Measurement Tab appear as shown below:



- b. On **Linac** Page, copy all the information as shown below:

**Linac** Measurement

**Accelerator**

Name: Zap Surgical Sy  
Modality: PHOTONS  
Energy[MV]: 3.0  
Wedge: Open  
Block: None

**Field** [cm] x [cm]  
Ortho [Y]: 2.50 x Wheel [X]: 2.50

Field size defined at: SID

**Setup**

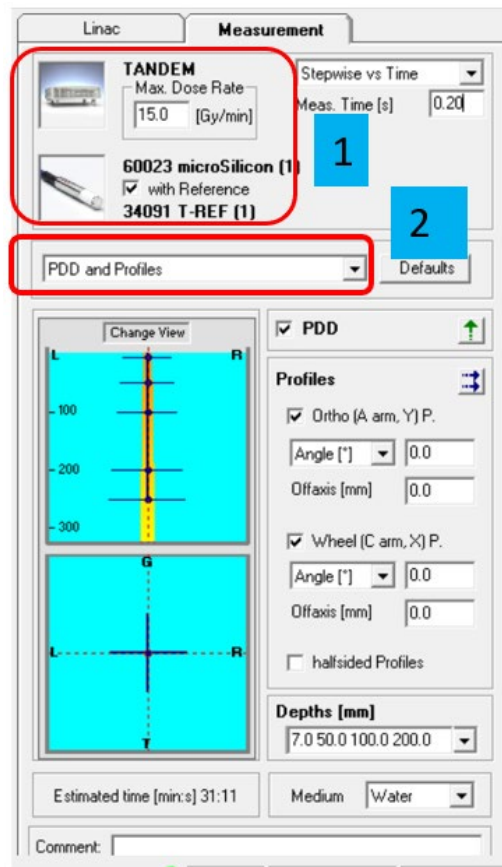
SSD [cm]: 45  
Gantry [°]: 0.0  
Collimator [°]: 0.0

Comment:

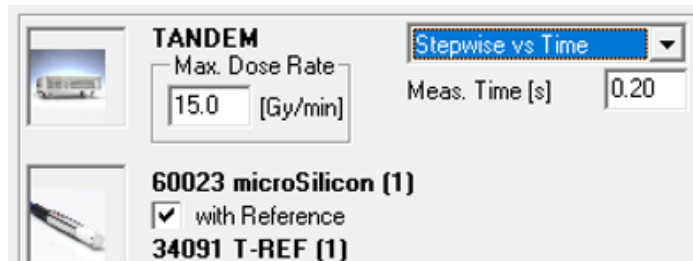
- c. Set the Zap-X Linac Configuration by sliding the drop-down key (choose the 3<sup>rd</sup> setting)
- d. The field size will be changed based on what size of collimator is being used.
- e. All Zap-X beams are cone shape.



- f. On **Measurement** Page, please refer to the circled areas for setting up the configuration:




- g. Click on the picture and select Tandem. Copy Dose-rate and Step information as shown:



- h. Click on the picture of detector and select ***With Reference***. Select PTW 60023 microSilicon for Field Channel and PTW 34091 T-REF for Reference channel respectively.

Field Channel

	Name	Description	SN	Calibration factor N [Gy/C]	Nominal HV [V]
<input checked="" type="checkbox"/>	PTW 60023 microSilicon (1)	Diode	151962		0
<input type="checkbox"/>	PTW 34091 T-REF (1)	Thin Window plane-parallel	—		400

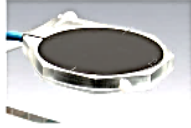


Calibrated in Electrometer

k <sub>TP</sub>	1.000
k <sub>User</sub>	1.000
k <sub>TP</sub> * k <sub>User</sub>	1.000

Reference Channel PTW 34091 T-REF (1)

	Name	Description	SN	Calibration factor N [Gy/C]	Nominal HV [V]
<input type="checkbox"/>	PTW 60023 microSilicon (1)	Diode	151962		0
<input checked="" type="checkbox"/>	PTW 34091 T-REF (1)	Thin Window plane-parallel	—		400



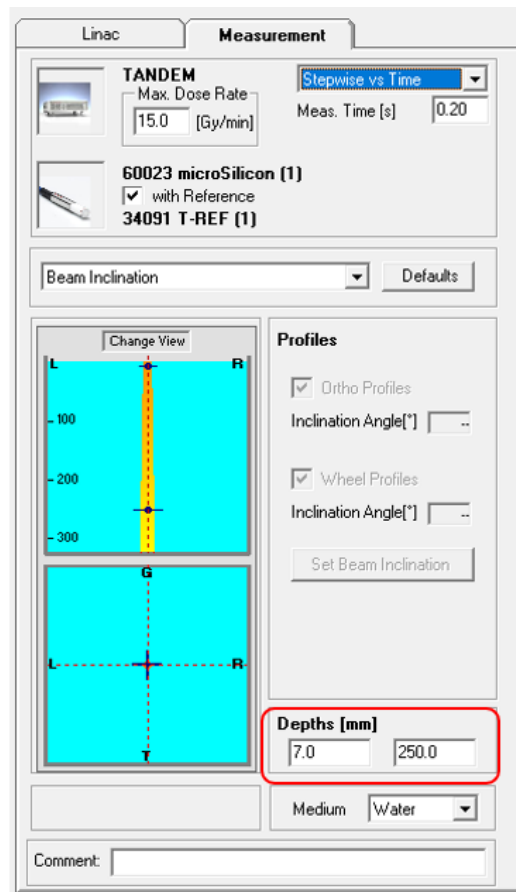
OK Cancel


- i. From the drop-down tab, select ***Beam Inclination***

Beam Inclination

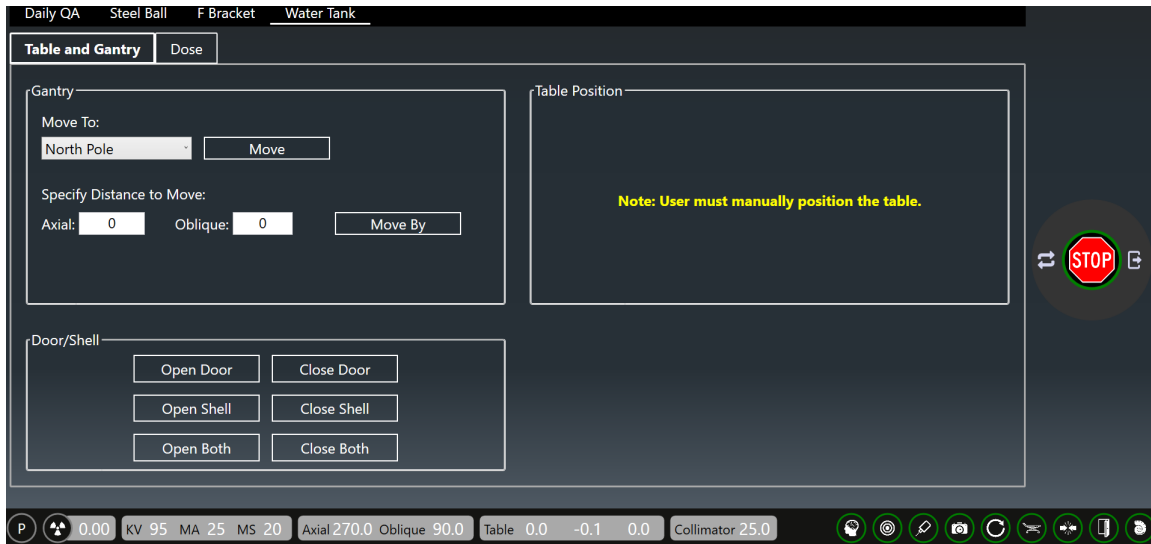
- Points
- Continuous TPR Measurement
- Step-By-Step TPR Measurement
- BeamAdjust
- Beam Inclination**
- OutputFactors
- Stationary Scans
- TG51 Lead Foil Distance

- j. Once **Beam Inclination** is selected, edit measurement **Depths** from 7.0 mm and 250 mm

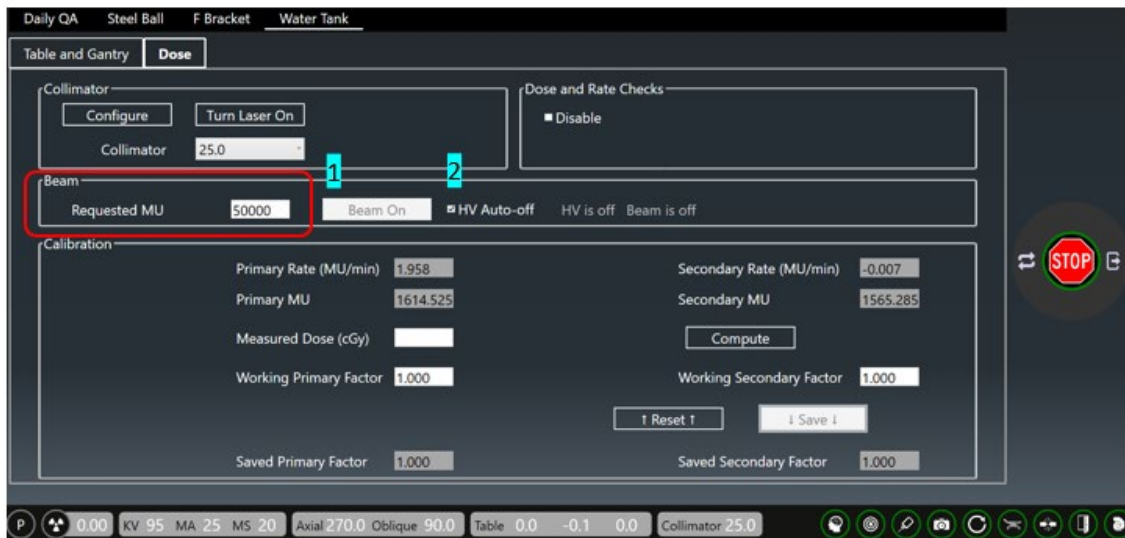



- k. Now **Beam Inclination Offset Mode** setup is completed.
16. Prior to **Beam Inclination** runs, Click  to zero Dosimeter. If error occurs during Zeroing, check **R232/USB cable** or **USB port** connection.

17. Once Zeroing is done, go to **Daily QA/Water Tank** on **Zap-X** to do the followings:
- Verify Gantry is at **North Pole** on **Table and Gantry Tab**

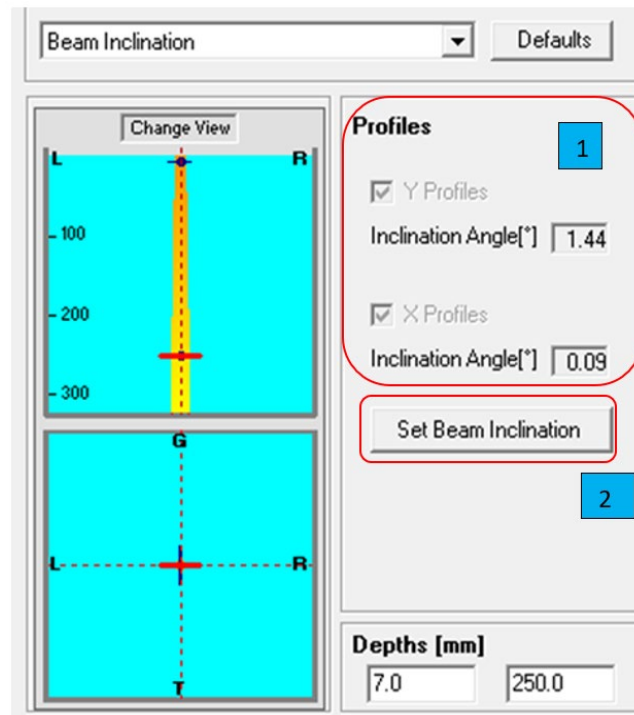


- Click on **Dose** Tab and enter 30,000 Mu.
- Press **HV** to turn on the power.
- click **Beam on** to turn the beam.



- As soon as **Dose** or **Dose Rate** appears, click  on **BeamScan** to begin profile scanning for both Ortho and wheel plane.

- f. After scanning **Wheel** and **Ortho plane** at **7** and **250mm**, **Inclination Angle (Y profile)** for **Ortho** and Inclination Angle (X Profile) for **Wheel** plane will display Inclination Angle for Ortho and Wheel Plane as shown below:

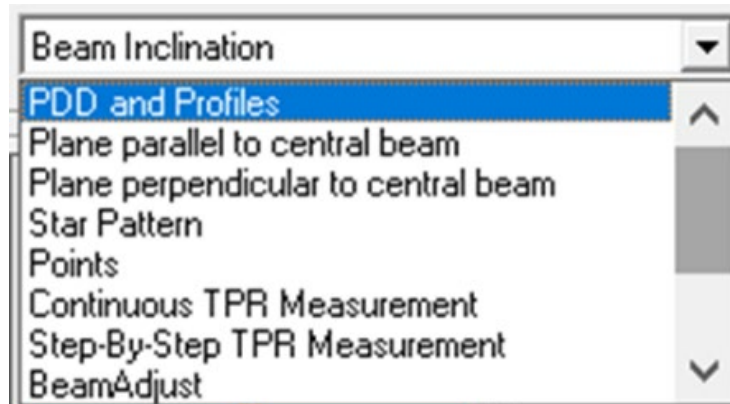


- g. Click **Set Beam Inclination** to save the leveling of water tank and **Beam inclination Offset Mode** becomes active.

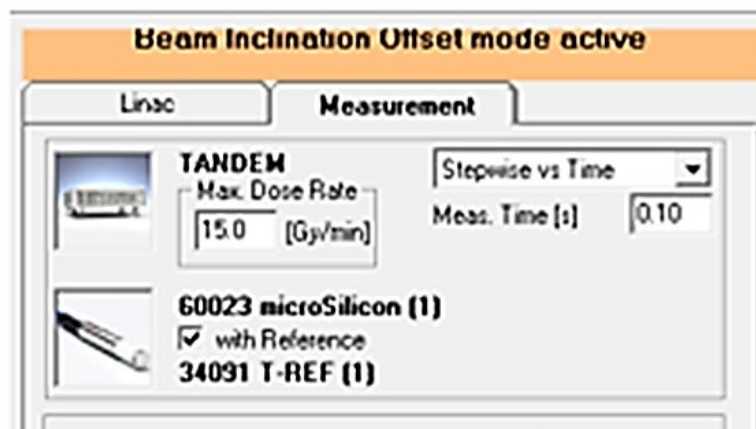
**Note:** For **BeamScan 4.4**, it allows some imperfections in leveling the Water Tank with a small inclination ( $< 1.0$  degree). Beam Profile will be automatically adjusted based on the inclination angle measured and a highlighted in **Orange** color above the **Linac** and **Measurement** Tab indicates **Beam Inclination Offset Mode** is activated. For good practice, we should level the **Water Tank** the best we can within  $< 0.1$ -degree inclination for both Ortho and Wheel Plane.

- h. Now you are ready to do PDD and Beam Profile of required collimator Size at various depths.

18. To begin PDD and Profile measurement, Go to Drop-down tab of **BeamScan** to select **PDD and Profile**.



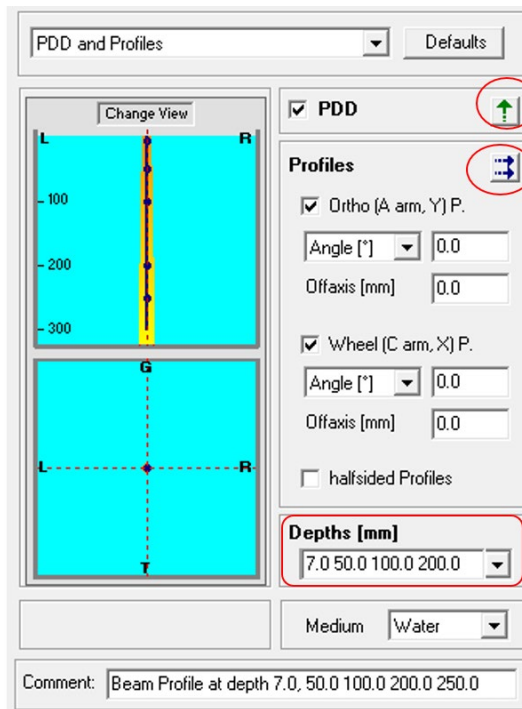
19. As soon as **PDD and Profile** is selected, an Orange frame will appear as below:






**Precaution:** Once you exited Relative Dosimetry, Beam Inclination Offset will not be saved for the next beam scanning. You will need to repeat Beam Inclination runs.

20. If you do not see the highlighted bar or frame with Beam Inclination Offset Mode Active, you need to repeat the same process until the orange bar shows.

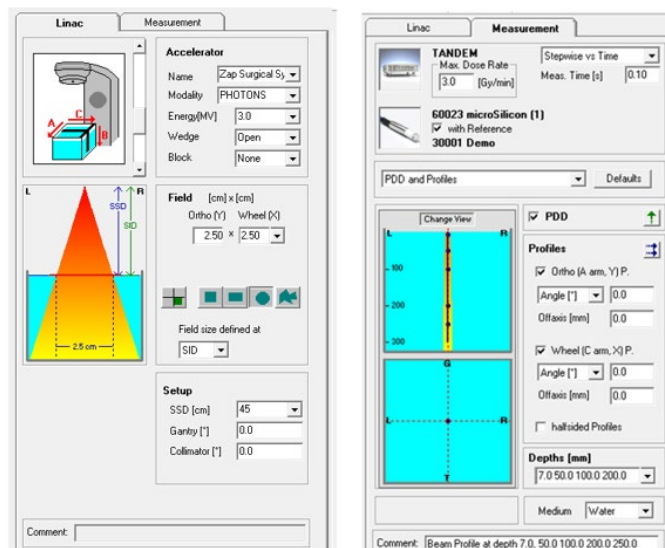
21. Click the boxes, copy the information as shown below and input different Depths per your requirements:



22. Typically, 5 different depths were selected for **Profile Measurements** such as 7, 50, 100, 200 and 250 mm.

23. Please use either  or  for Profile scanning. Using  may not give repeatable results with different scanning direction.

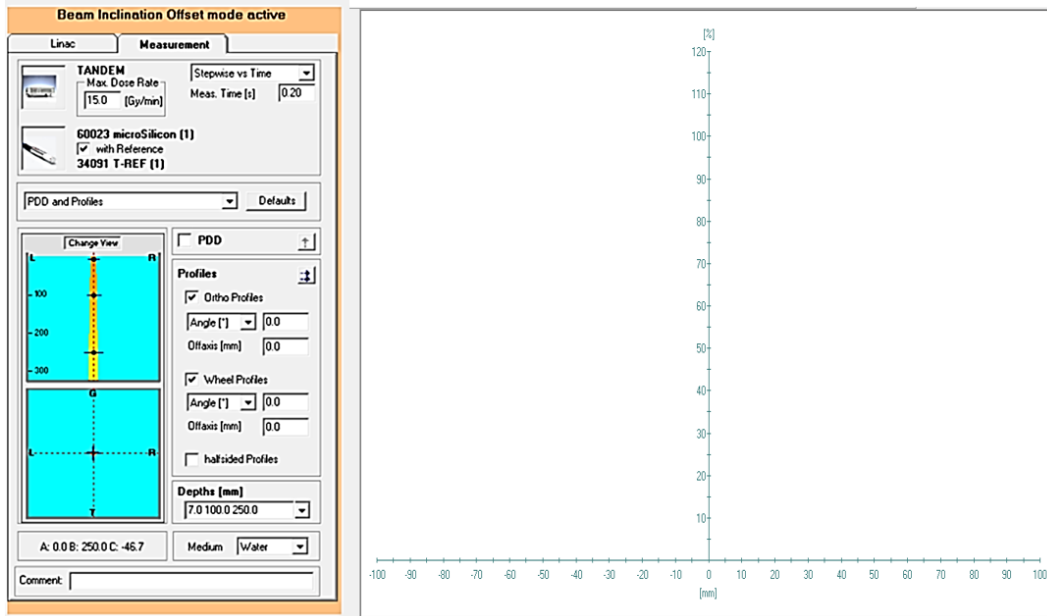
24. Setup should look like below pictures with 25 mm collimator:



25. Once contents of **Linac** and **Measurement Tab** are setup completely, you are ready to obtain get PDD and Profiles from different collimator sizes and Depths.

**As reminder, you need to change collimator size before moving on to the next test if collimator size is different.**

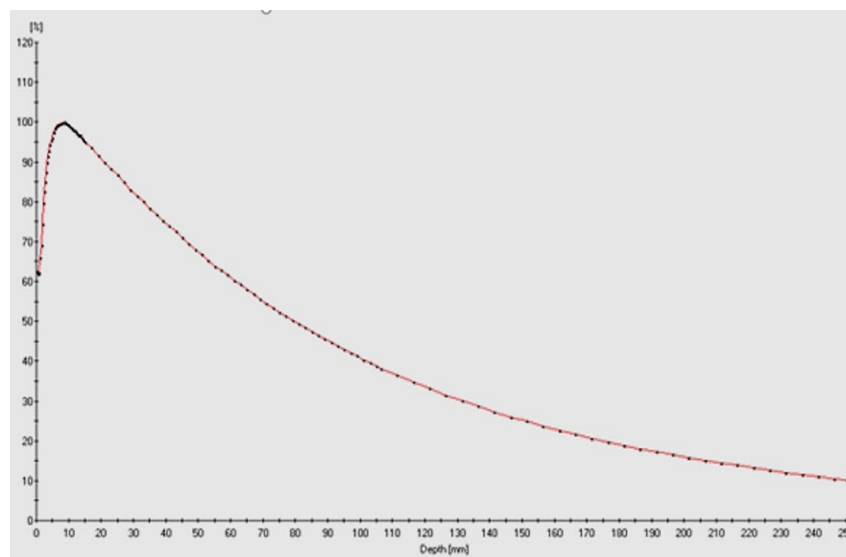
26. Final Screen for PDD and Profile measurement should be displayed as below:



**Note:** If you do not see the **Orange** frame or highlighted box, you need to repeat the step for **Beam Inclination Offset Mode** and **PDD/Beam Profile** until the **Orange** frame appears.

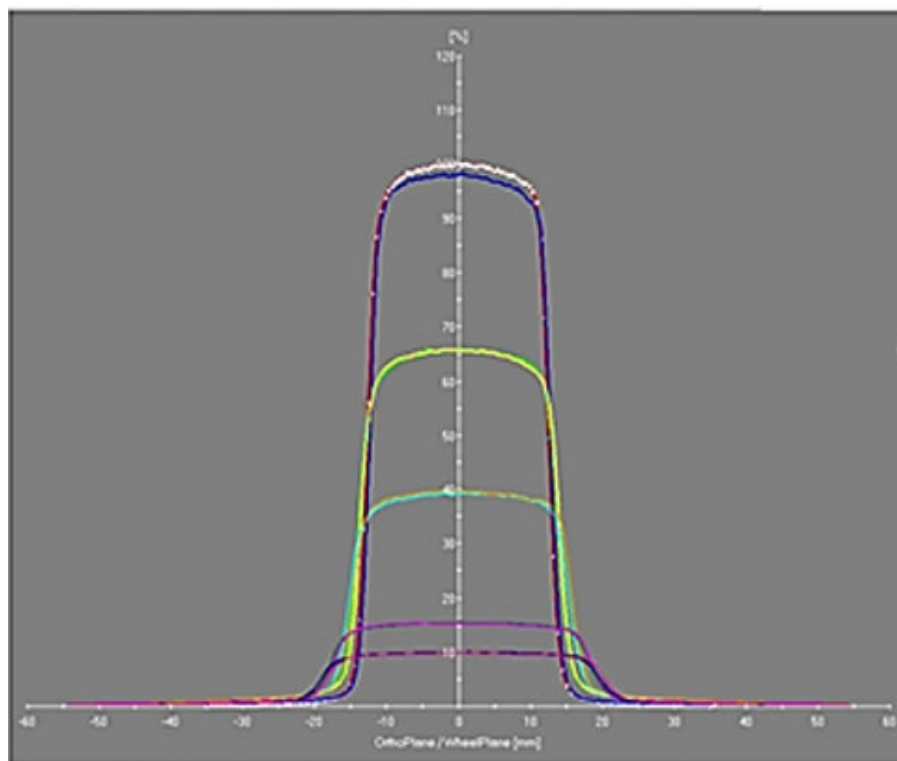
27. Examples of typical plots for Zap-X **PDD and Profiles** at various depths are shown below:

a) PDD





b) Typical **Profiles** at 7, 50, 100, 200- and 250-mm Depth



## Chapter 7: Output Factors Measurement

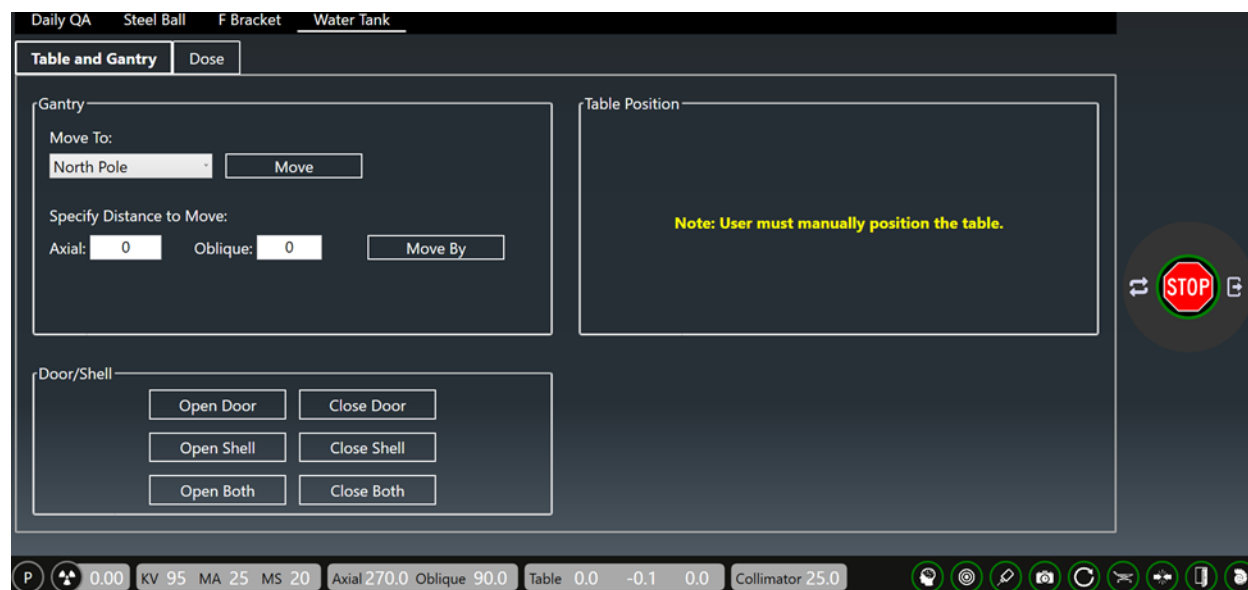
Normally, Output Factor measurement is done right after PDD/Profiles measurement. For Output Factor Measurements, it has slightly different setup comparing to PDD and Profile Measurement. Zap recommends using **microSilicon** mounted vertically for this measurement and **microDiamond** can also be used as optional choice.



Type of Measurement	Holder	Thimble	Mounting	Detector	T-Ref	Preference
Output Factors	431	4309	Vertical	microSilicon	No	Zap
Output Factors	431	4309	Vertical	microDiamond	No	Optional

PTW detector should be set at 450 mm from the source as a single point measurement with 7 mm water above the detector (SSD= 443 mm). Since T-Ref detector is not needed for this measurement, it should be removed from the Water Tank.

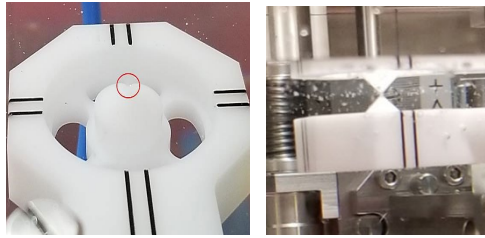
Zap also recommends using PTW UNIDOS dosimeter series for more accurate measurement especially for smaller beam size less than 10 mm. For measurement unit, either cGy or nC can be used.


1. Go to Zap-X **Daily/Water Tank** page and Click on **Open Both** in **Shell/Door** section:

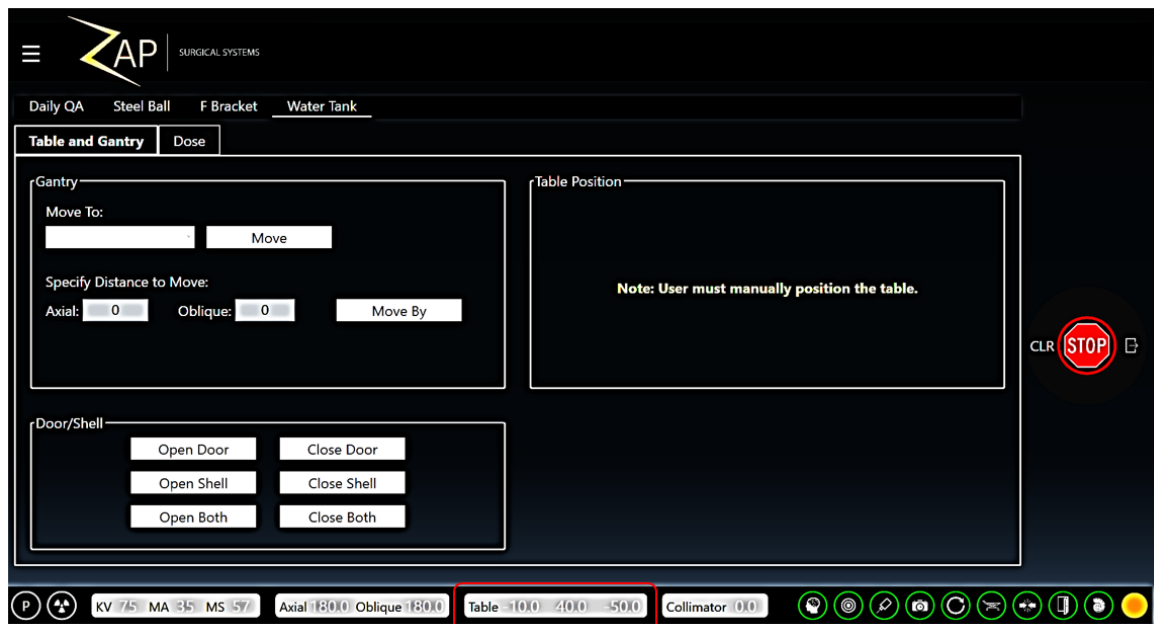



2. Pull the Patient Table slowly out of the gantry manually all the way out until it stops.
3. Press  key on PTW Control Pendant to move the detector to SAD position.
4. Raise the detector to -7.0 mm by pressing  key on the Pendant.
5. Remove the microSilicon together with holder and place it on the side of the Water Tank without loosening the white plastic screw holding the detector.
6. Replace the holder with PTW Pointing Device.

7. Add distilled water until the water level reaches the top of the tip and remove water if needed to ensure water level is correctly done.



8. Remove the PTW Pointing Device and replaced with PTW microSilicon /Holder.
9. Press  to move the detector back to SAD position (0,0,0).
10. Push the Patient Table with Water Tank all the way inside the gantry. With the 2<sup>nd</sup> person's guidance, move the Water Tank manually to the position previously recorded with Zap Pin Pointer. (While moving Patient Table into the gantries, bottom section of the Table must be all the way in until stop first before moving the top section further in).
11. Go to Zap-X on Daily QA / Water Tank



12. Press  key on the Door/Shell section.
13. Perform detector Centering as described in **Chapter 5**.
14. Output Factor Measurement for Zap-X involves 8 different collimator Sizes such as 25, 20, 15, 12.5, 10, 7.5, 5 and 4 mm.
15. Dose delivery for each collimator will be set at **200-500 Mu** and the Dose of each collimator is measured with PTW **microSilicon** detector at SAD of 450 mm. Normally Zap recommends running 3 or more times to confirm reproducible results.
16. After detector is centered to the Photon Beam, disconnect the Field detector cable from the Tandem and connect it to PTW UNIDOS dosimeter.

17. There are 3 different types of PTW UNIDOS dosimeter such as UNIDOS Webline, UNIDOS Romeo and UNIDOS Tango. In the manual we will only discuss method using UNIDOS Webline and UNIDOS Romeo.

18. For **UNIDOS Webline** setup and operations:

- a. Turn on power Switch at the rear of the dosimeter and press the on button immediately at the front as shown:

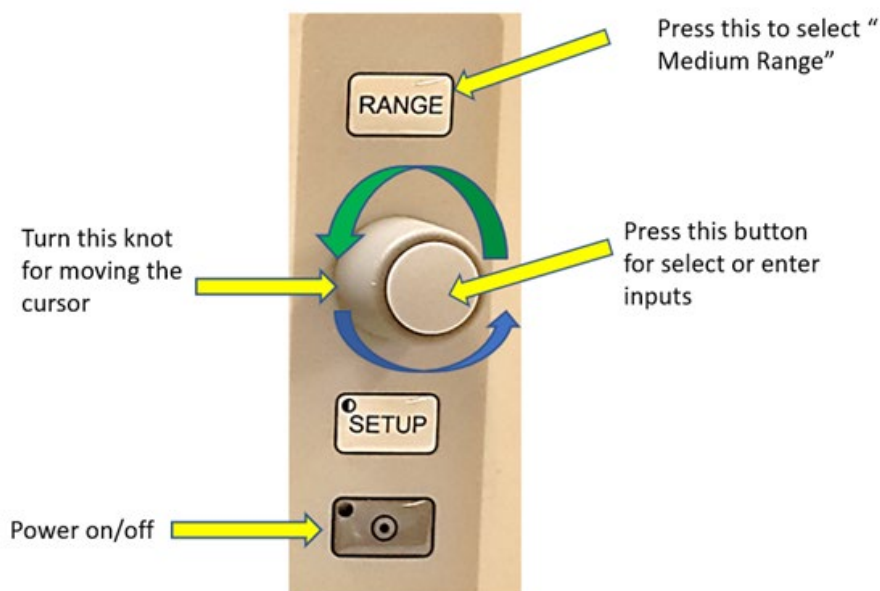



Turn on Power

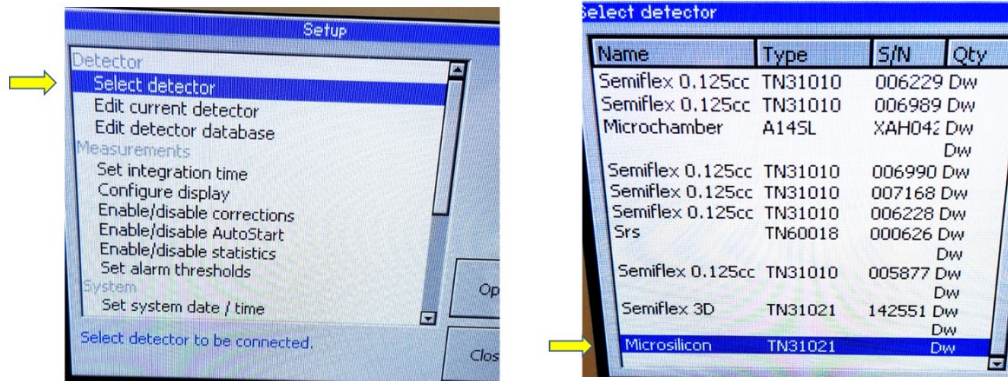


Press this button to turn on  
(Green LED light will goes off.)

- b. Use below information to select or change detector with below **UNIDOS Webline** features.



- c. Press  to choose **Select detector** and then select **microSilicon** for **Output Factor Measurement**. If more than one microSilicon Detector installed, record your serial number prior to use.



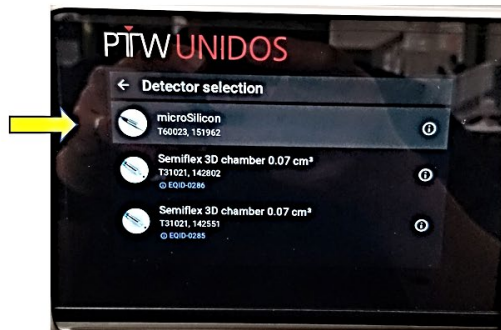
- d. Turn the Knot to select **microSilicon** or (**microDiamond** if preferred) and press button to select.
- e. For details of UNIDOS operation or adding detector to UNIDOS, please referred to PTW UNIDOS operation manual for instructions.

19. For **UNIDOS Romeo** Setup and Operations:

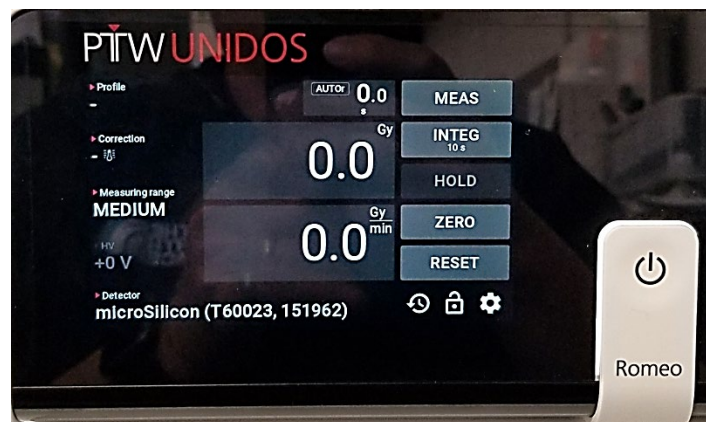
- a. Turn on **Power Switch** at the rear of the dosimeter and press the on the power button on the front as shown:



- b. Touch the detector section near the bottom of the dosimeter screen and turn into another page for Detector Selection. Select **microSilicon** (or **microDiamond** if preferred)



- c. After verified detector type and recorded Serial number, it is ready to perform Output factor measurements.





20. If Radiological unit is selected, we will need to measure the temperature of the water in the Water Tank as well as barometric pressure for Temperature/Pressure Correction.

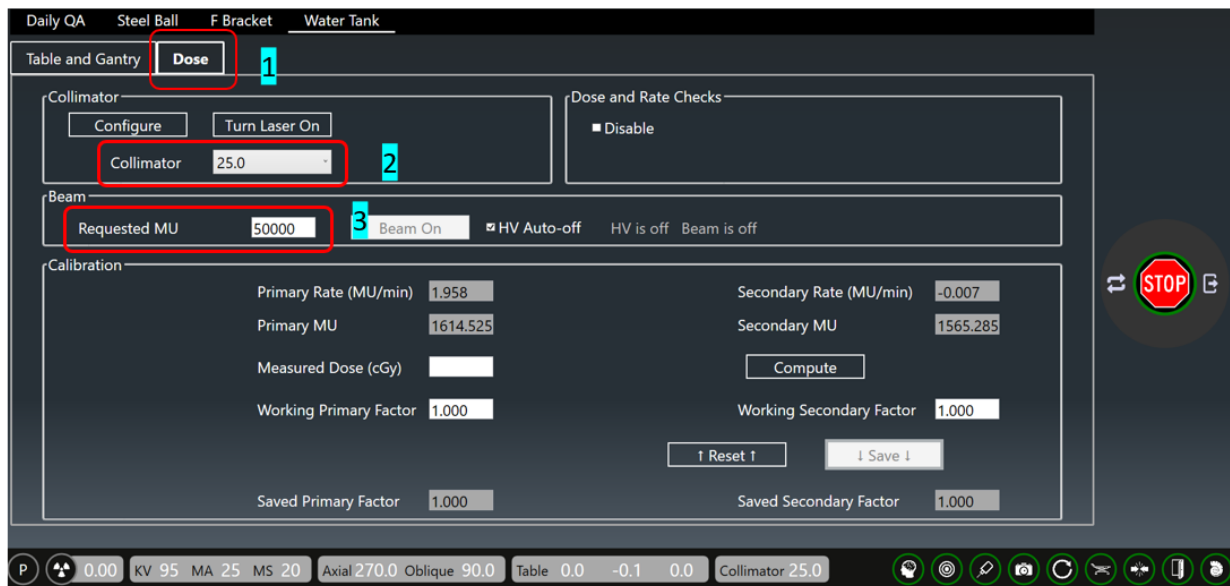
21. Finally, press **Zero** button ready for **Output Factor Measurement**:

22. Go to Zap-X **Daily/Water Tank** page and confirm Gantry is at North Pole:



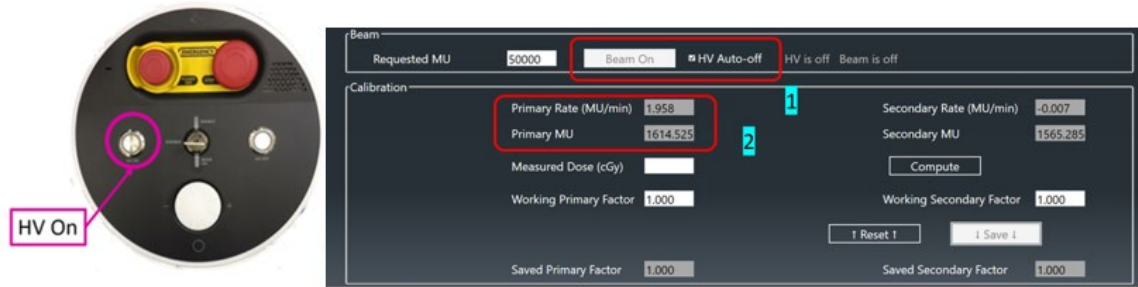
23. Click on **Dose Tab** and Use the **Dropdown Tab** of Collimator to select 25 mm collimator.

24. On the Request Dose Tab, input 500 Mu.

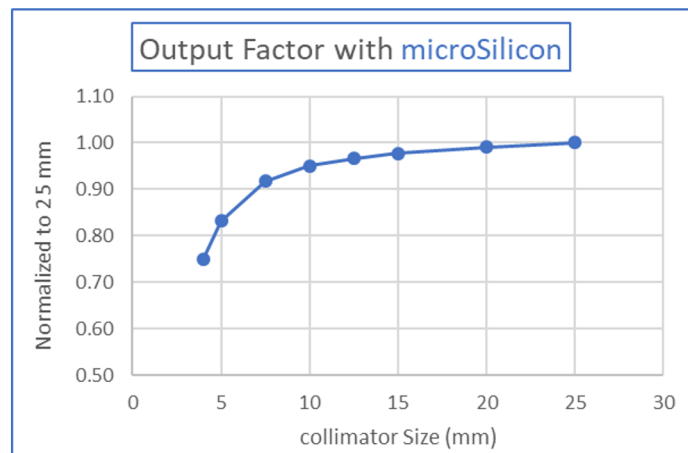
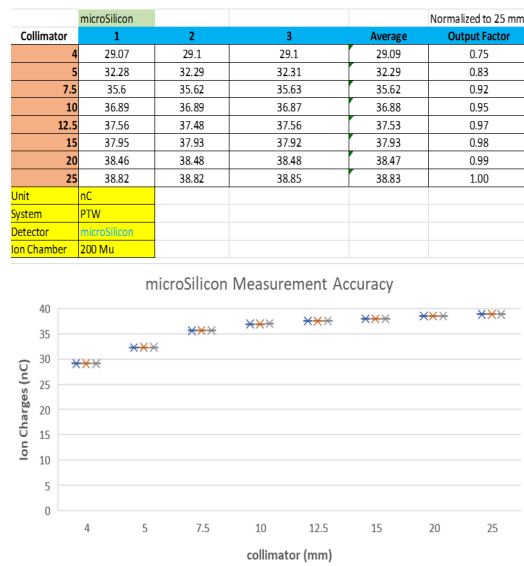


25. At Console, press the left button to turn on **HV** and click **Beam-On tab** in Beam section.

26. Once **Beam-On** is click, it will change to yellow color. It is recommended to select HV Auto-off to turn off the beam when required dose is met.



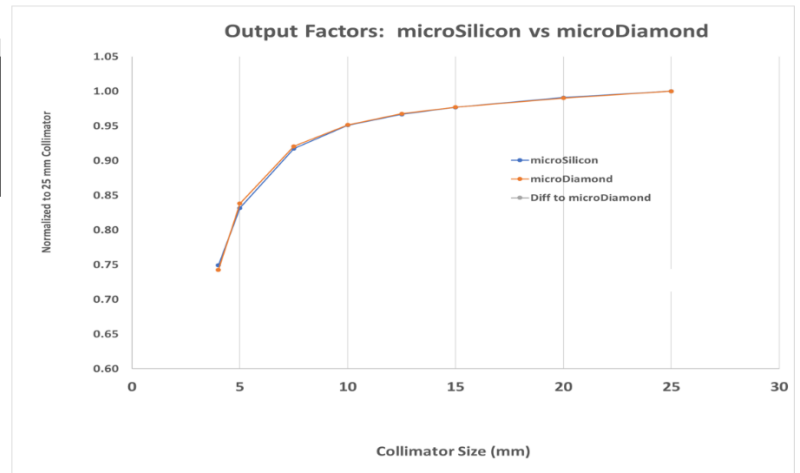
27. As soon as Dose or Dose Rate appears, UNIDOS will display both Dose and Dose Rate same time. Once HV is off, only Dose remain on the display until the next HV on.
28. Record all three or more measurements and average them for each collimator
29. Normalize Dose measurement by dividing all averaged dose measurement of all collimators by the average dose value of 25 mm collimator.
30. Example of typical Output Measurement plot with normalized value of each collimator against all 8 Collimator sizes as shown below:



31. When comparing Output Factor between microSilicon and microDiamond, the differences are very small.




Collimator	microSilicon	microDiamond	Diff to microDiamond
4	0.75	0.74	-0.01
5	0.83	0.84	0.01
7.5	0.92	0.92	0.00
10	0.95	0.95	0.00
12.5	0.97	0.97	0.00
15	0.98	0.98	0.00
20	0.99	0.99	0.00
25	1.00	1.00	0.00

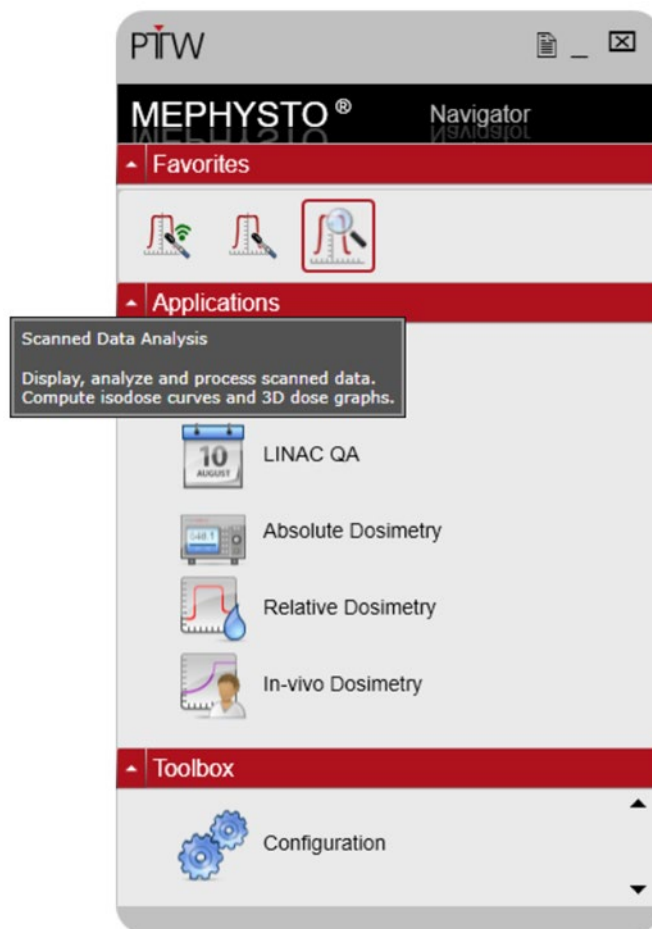


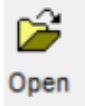
32. Output factor measurement is done.
33. Open both Door and Shell.
34. Remove both PTW water Tank and PTW Supporting Bracket from the system following procedure on Chapter 4.

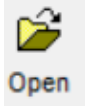
## Chapter 8: Beam Data Analysis and Examples of Typical Errors

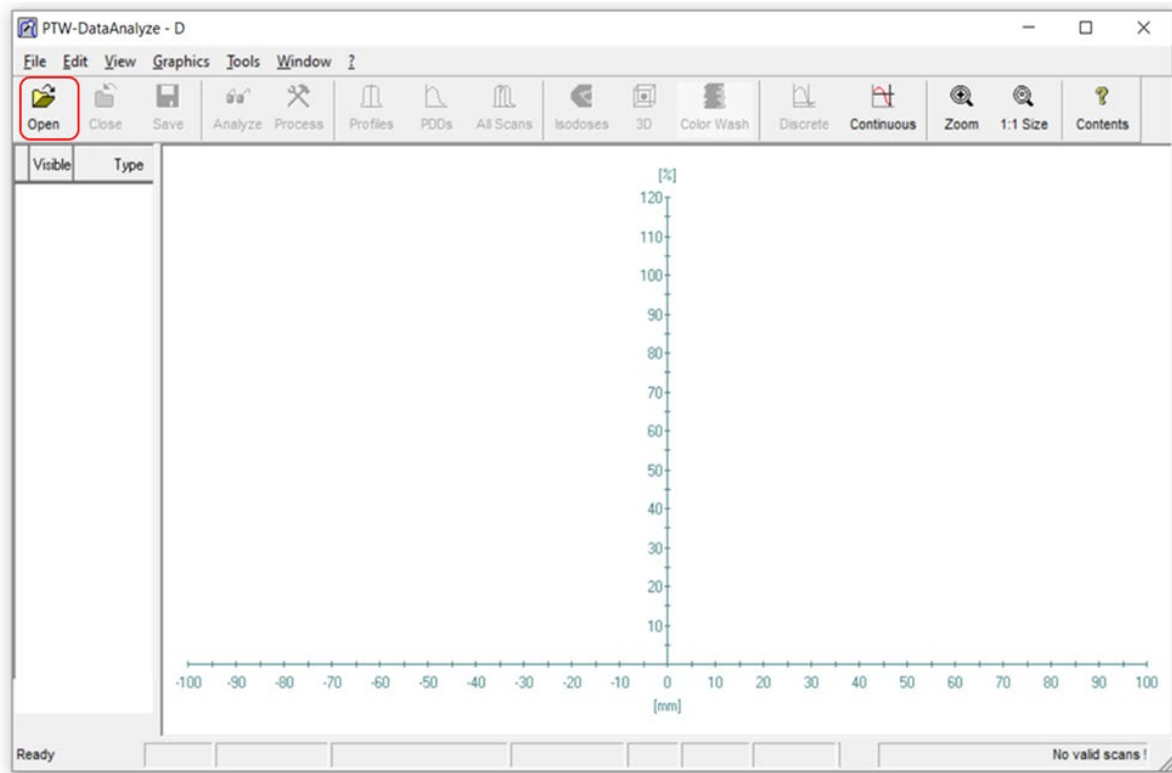
The details of protocols for **PH PDD** and **PH Profile** data analysis setup has been provided in **Chapter 3**. This chapter provides instructions how to review the beam data for validation and examples of incorrect setup during PTW water tank setup.

1. Click Mephysto of BeamScan 4.4 on your desktop, select  icon for scanned data analysis.

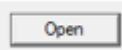


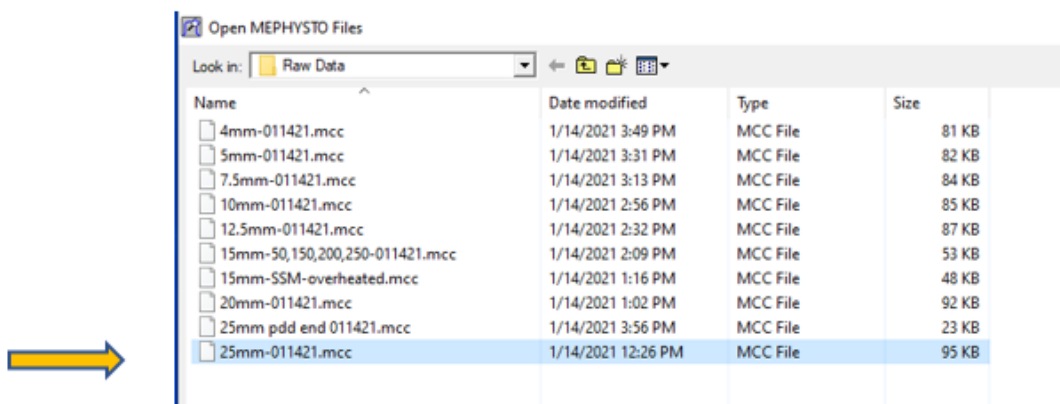


2. Click on  and select the folder needs to be perform analysis.

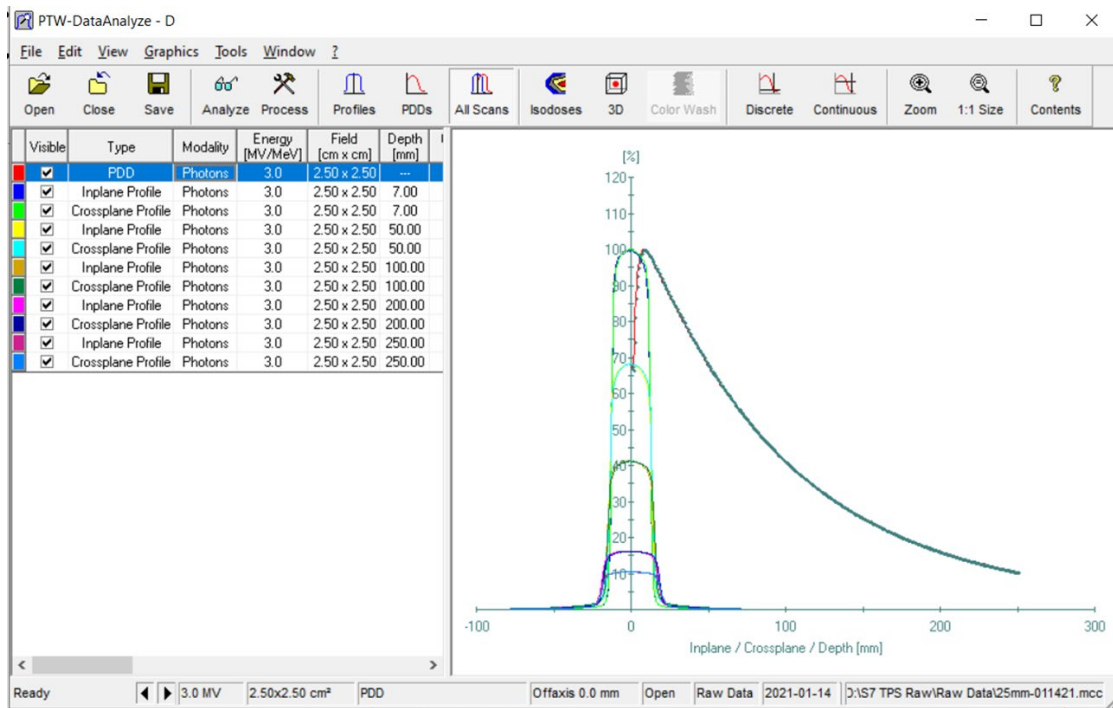



3. Hold the Ctrl key on your keyboard and select the file or files to be analyzed.

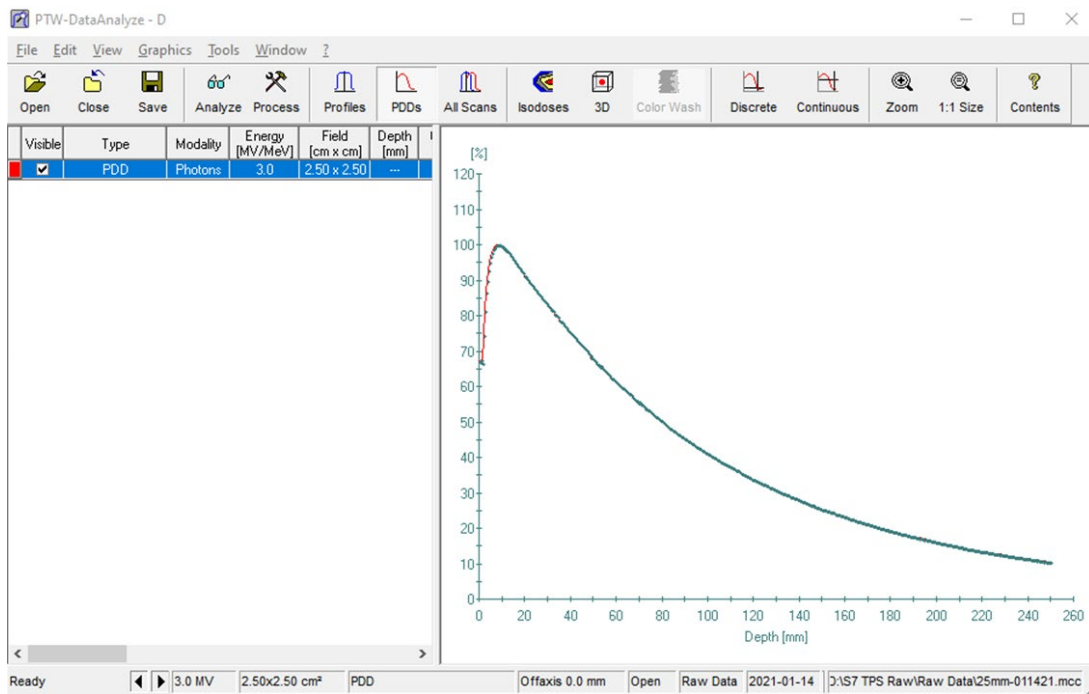
4. Click  near the bottom of the page and select the file of interest.



5. After the selected file is opened, both PDD and Profiles of the selected files will display as below:

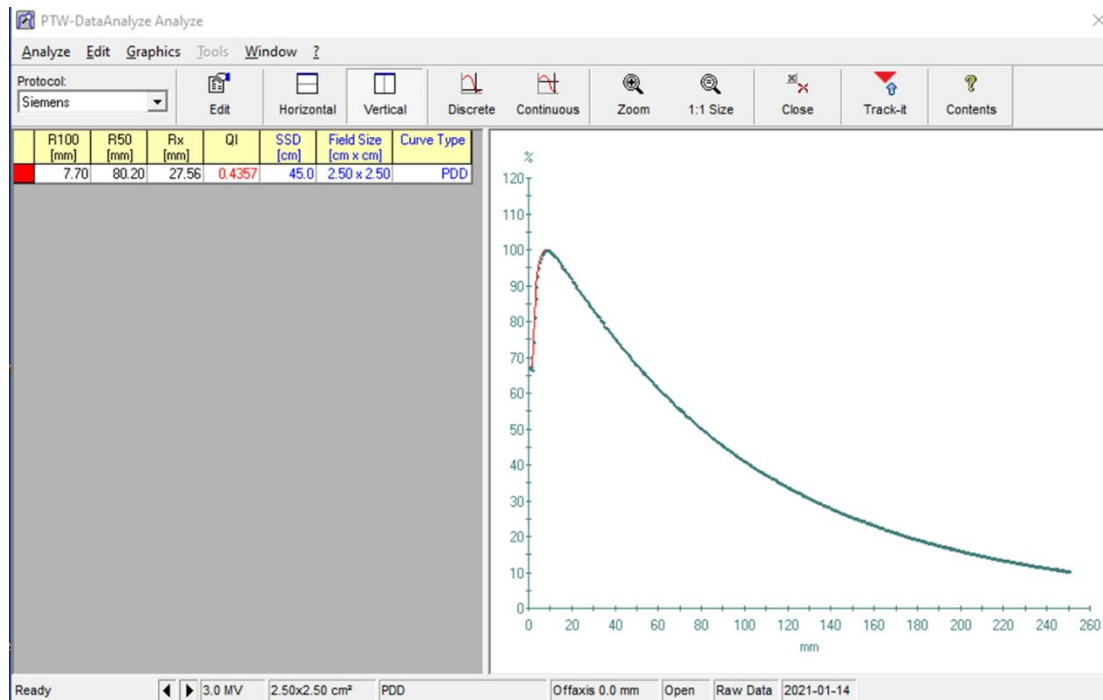


6. For PDD analysis, click on  icon and only PDD plot will appear with no profile plots as shown below:

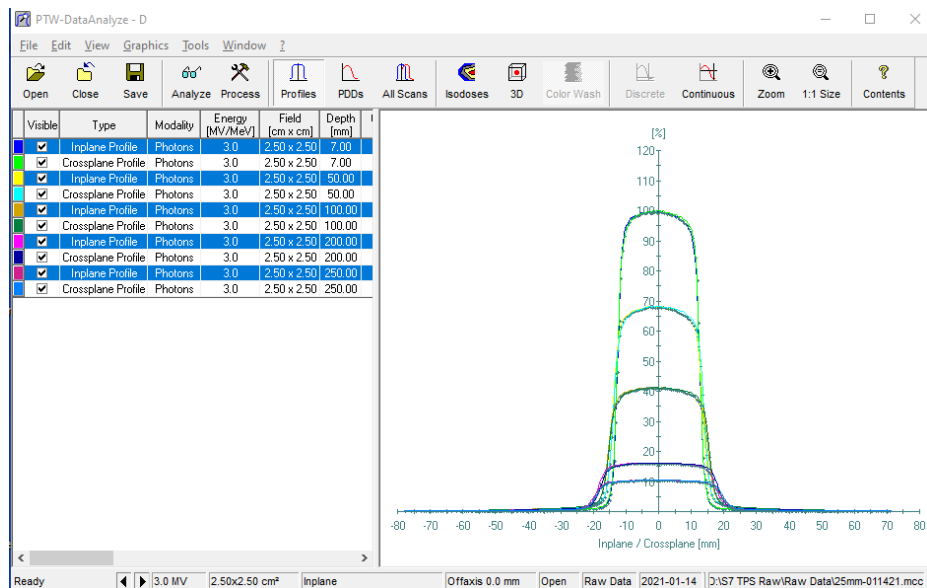




7. Click **Analyze** icon to perform analysis and the results displayed on the left side:



8. For profile plots, click **Profiles** icon and all profiles at different depths appear in below:



9. Click on ☒ to uncheck the plot and profile of the unchecked one will be removed from the display.

10. For Profile analysis, hold the **Ctrl** key on your keyboard and left- click on the mouse to select the depths for analysis.(The selected ones are high-lighted in blue)



11. Click **Analyze** icon to perform analysis and the result of selected files for different depths appears as below:

PTW-DataAnalyze Analyze

Analyze Edit View Graphics Tools Window ?

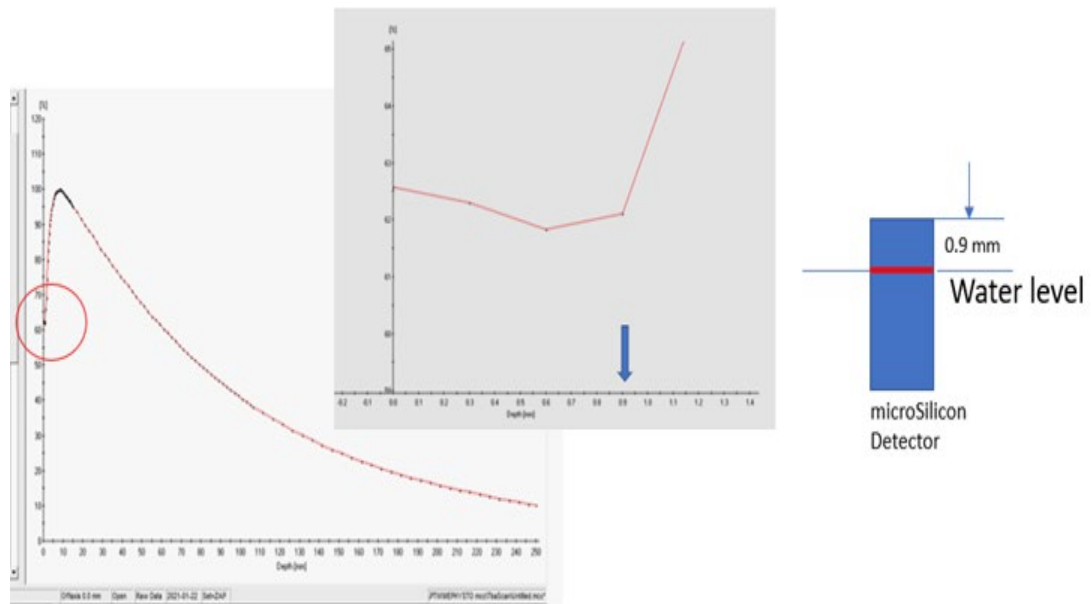
Protocol: Zap-X

Edit Details Symmetry Horizontal Vertical Discrete Continuous Zoom 1:1 Size Close Track-it

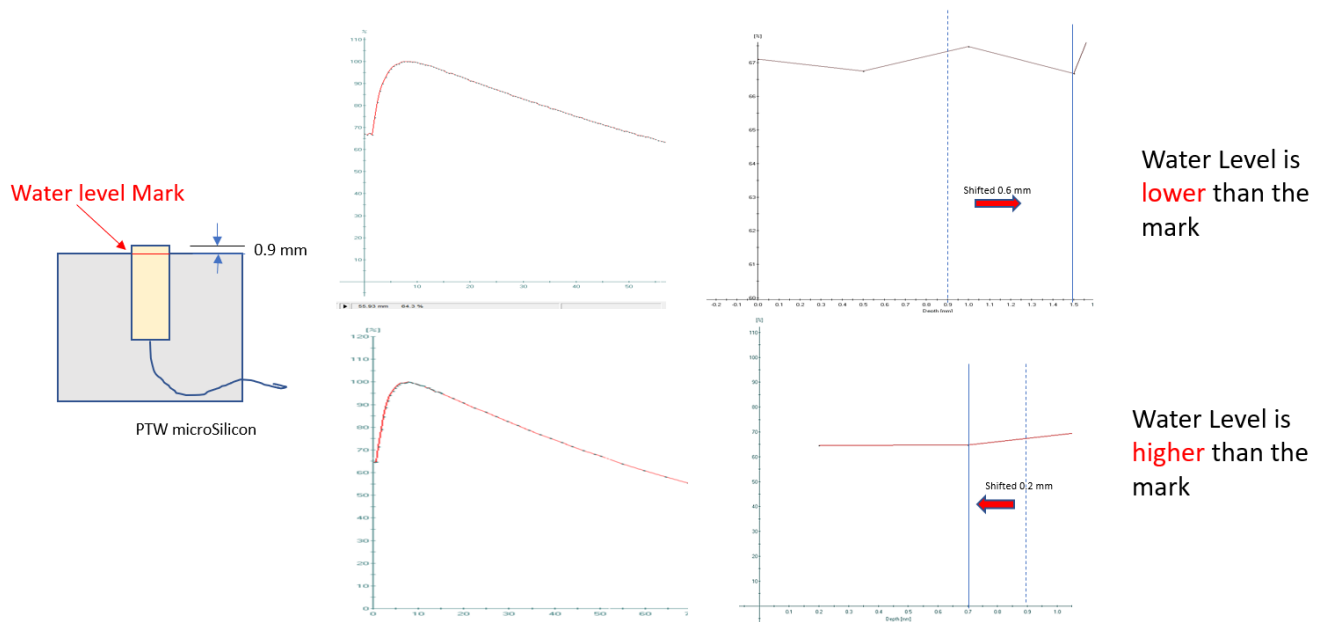
Contents

	CAX Dev. [mm]	Field Size [mm]	Pen. Left [mm]	Pen. Right [mm]	Dmax [%]	Dmin [%]	Flatness [%]	Symmetry [%]	Field Size at SID [cm]	SSD [cm]	Field Size [cm x cm]	Curve Type	Depth [mm]
	-0.01	25.17	2.02	2.13	100.18	91.88	109.03	0.61	2.479	45.0	2.50 x 2.50	Inplane Profile	7.00
	-0.20	27.57	2.53	2.64	100.15	89.92	111.37	0.55	2.481	45.0	2.50 x 2.50	Inplane Profile	50.00
	-0.11	30.38	2.93	3.10	100.50	90.22	111.40	0.55	2.486	45.0	2.50 x 2.50	Inplane Profile	100.00
	-0.48	36.00	3.71	3.96	100.21	89.57	111.88	0.46	2.492	45.0	2.50 x 2.50	Inplane Profile	200.00
	-0.23	38.79	4.12	4.35	100.44	89.38	112.37	0.48	2.494	45.0	2.50 x 2.50	Inplane Profile	250.00

12. It is important to confirm that the water tank setup is correctly done prior to your PDD profile scan as it will affect some of the key parameters such as Dmax, D50% and D100%. Common mistakes are the water level is set too low (most cases) due to water evaporation if water tank stayed too long inside the gantry. Typical total air flow going through the gantry is about 12 m/s at 22 degree C and water evaporation occurs sooner at warmer and lower humidity environment.
13. The easy way to verify the water level setting without using Trufix or opening the shell/door is do an initial PDD scan and perform analysis immediately. Here is an example to illustrate a correct setup:
- By using the Zoom icon to enlarge the circled area, you can verify whether your water level is too low or too high. For microSilicon, it should be 0.9mm +/- 0.1 mm as shown below:



14. Below plots shows the impact of incorrect water level in the water tank:



15. Normally, water evaporates if water tank has been placed inside the gantry at high air flow after 4 or 5 hours. It is recommended to verify water level again with PTW Pointing Device if PDD and profile tests took more than 4 hours.

16. To verify correct water level, make sure the reflection of tip and the Pointing Device touches as shown:



17. This can be corrected by shifting the PDD plot manually by the same amount of change.

- For water level is **higher** than the mark, shift the PDD plot to the **right** of the same difference.



- b. For water level is **lower** than the mark, shift the PDD to the **left** of the same difference.
18. For Output Factor Measurements, it is recommended to perform Detector Centering for each collimator smaller than 10 mm. This will ensure that collimator is aligned well with the photon beam.

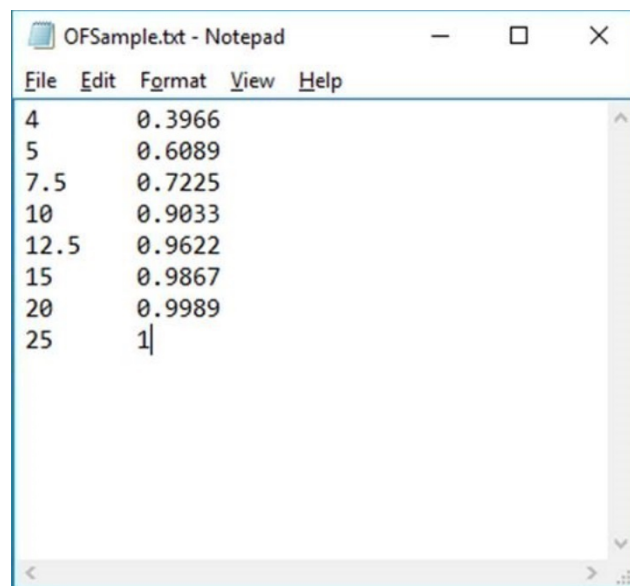
## Chapter 9: Beam Data Acquisition for Dose Calibration Algorithm

### Beam Data File Format

Plain text (ASCII) beam data files must be generated in accordance with the specific formatting procedures as described further in this section.

### Output Factor – 1 File

The Output Factor file contains two columns and eight lines. The left column is the collimator sizes. The right column is the output factor values which correspond with the individual collimator size to the left (see Figure 1-22 for an example).



The screenshot shows a Notepad window titled 'OFSample.txt - Notepad'. The menu bar includes File, Edit, Format, View, and Help. The text content is as follows:

4	0.3966
5	0.6089
7.5	0.7225
10	0.9033
12.5	0.9622
15	0.9867
20	0.9989
25	1

Figure 1-22 Output Factor File

### MCC Files

The data generated by the PTW measuring and analysis modules are saved in ASCII files with the file extension \*.mcc.

Each line of such a file consists of a keyword and note, one or several data values. Only the data values essential for describing the task are included in the file. See Appendix A of *PTW User Manual* for more information.

For Zap-X Radiosurgery System, the following files need to be generated based on the PTW measurement data described in previous sections as input for the Treatment Planning System (TPS):

- Tissue Phantom Ratio (TPR) – 1 File
- Off Center Ratio (OCR) – 1 File

Where TPR data are converted from PDD data. Please consult with Zap personnel on how to convert the PTW measurement data to the proper data format for TPS.

# Glossary

## Acronyms and Abbreviations Definitions

**A**

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**B**

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**C**

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**D**

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**E**

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**F**

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**Field Size**

The size of the radiation field. Usually defined at a reference SAD. Zap-X field sizes are defined at 450mm SAD.

**G**

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**H**

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**I**

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**J**

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**K**

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**L**

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**M**

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**N**

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**O**

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**OCR – Off Center Ratio**

The ratio of absorbed dose at a given off-axis point to the dose at the central axis at the same depth.

**OF – Output Factor**

The ratio of the absorbed dose of a particular field size to the dose at a reference field size. For the Zap-X System, the reference field size is 25 mm.

**P**

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**PDD – Percent Depth Dose**

The ratio of the absorbed dose at any depth to the absorbed dose at a fixed reference depth using a constant SSD. Specified as percentage.

**Q**

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**R**

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**S**

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**SAD – Source to Axis Distance**

The distance from the radiation source to the axis of rotation for the radiation source. The Zap-X nominal SAD is 450 mm.

**SSD – Source to Surface Distance**

The distance from the radiation source (X-ray target) to the surface of the phantom.

**T**

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**TPR – Tissue Phantom Ratio**

The ratio of absorbed dose at a given point to the dose at a fixed reference depth using constant SAD. Zap-X's reference depth is 7.0 mm.

**U**

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**V**

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**W**

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**X**

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**Y**

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**Z**

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