

VALIDATION OF SMALL FIELD TREATMENT PLANNING USING  
BRAINLAB ELEMENTS

By

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## Abbreviations

CPE: Charge particle equilibrium

CT: Computed tomography

DCAT: Dynamic conformal therapy

DICOM RT: Digital Imaging and Communications in Medicine Radiotherapy

IMRT: Intensity modulated radiation therapy

MPPG: Medical physics practice guideline

MLC: Multi leaf collimator

MC: Monte Carlo

PB: Pencil beam

PDD: Percent depth dose

SRS: Stereotactic radiosurgery

TRS: Technical report series

VMAT: Volumetric arc therapy

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## Abstract

**Purpose:** The purpose of this thesis is to validate the cranial and multiple brain METS module in Brainlab Elements treatment planning system (TPS) and document the validation process for small fields. Brainlab Elements is a template-based TPS that aims to standardize treatment planning for cranial stereotactic radiosurgery (SRS) by simplifying the process with predefined templates and protocols to create plans. Commissioning of the Elements system was done by OHSU. After commissioning was completed, TPS validation was performed to verify that the system accurately models and calculates dose distributions. Validation is carried out by generating calculated dose distributions and comparing them to measured data to identify any discrepancies. Since SRS involves small fields and there is no official guideline specifically for small field TPS validation, the validation process followed the recommendations outlined in AAPM's Medical Physics Practice Guideline 5.b (MPPG 5.b) and Task Group 119 (TG-119), with tests adapted for small fields.

**Methods:** Measurements were compared to Elements generated percent depth dose curves (PDD), profiles, and outputs using gamma analysis with various distance-to-agreement (DTA) criteria and dose difference (DD) criteria, along with percent difference calculations. Additional measurements were performed using Sun Nuclear's SRS MapCHECK detector following MPPG 5.b guidelines. Adapted TG-119 tests for the SRS MapCHECK, including single target, multi target, and C-shape plans were created in Elements and measured at the machine.

**Results:** PDDs achieved pass rates above 99% using the 1 mm/1% gamma criteria with global normalization and low dose thresholds based on the 20 cm depth dose for each field size, while stricter dose difference criteria resulted in a more pronounced decline in gamma pass rates. Profile validation showed decreased gamma pass rates for 2×2 cm<sup>2</sup> to 3×3 cm<sup>2</sup> multileaf

collimator (MLC) field sizes, with improvements at  $4 \times 4 \text{ cm}^2$ , and lower pass rates at deeper depths. Output validation showed percent differences within the 2% tolerance recommended by MPPG 5.b, with increasing MLC and jaw sizes resulting in higher dose values. Planar measurements showed acceptable pass rates above 90% at 2 mm/2% for smaller jaw sizes, consistent with the MPPG 5.b tolerance recommendation. However, pass rates decreased and fell below recommended thresholds as jaw size increased. TG-119 validation using 1 mm/3% gamma criteria resulted in a confidence limit of 5.3%, calculated from an average gamma pass rate of 98.0% with a standard deviation of 1.6% across all TG-119 adapted plans.

**Conclusion:** Pencil Beam validation results generally met the tolerances specified in MPPG 5.b, as well as other established criteria for PDDs, profiles, and TG-119 tests. However, further investigation is needed in areas where gamma analysis and percent dose differences exceeded recommended tolerances, such as the planar measurements performed with the SRS MapCHECK. Future work may include adjusting the low dose threshold in gamma analysis to better assess high dose regions, which are especially important in SRS treatments. Additionally, exploring the Monte Carlo algorithm could improve dose calculation accuracy, enabling a more accurate comparison between TPS calculated and measured dose data.

## 1. Introduction

Stereotactic radiosurgery (SRS) is a non-invasive intracranial radiation treatment that serves as an alternative to traditional surgery, where a highly precise radiation dose is delivered in one or a few fractions<sup>1-2</sup>. The purpose of SRS is to deliver a high dose of radiation to ablate the target. SRS treatments typically involve non-coplanar beam arrangements to achieve a conformal dose distribution to the target, while ensuring a steep dose falloff away from the target<sup>1</sup>. Radiation treatment is regarded as a safer option for intracranial procedures, as it helps minimize damage to the surrounding healthy tissue, especially in cases of arteriovenous malformations, functional disorders like trigeminal neuralgia, and tumors<sup>3</sup>. SRS treatments are typically limited to target volumes of less than about 35 cm<sup>3</sup>, where the target diameter is less than 3.5 cm<sup>1</sup>. Because the target diameter is small, SRS uses smaller field sizes compared to conventional radiational therapy<sup>25</sup>, where small fields are typically considered to be smaller than  $\leq 3 \times 3$  cm<sup>2</sup><sup>4</sup>.

Given that small fields introduce additional dosimetric challenges, accurately modeling the linear accelerator beam is essential for creating reliable dose calculations. The radiation delivered to a patient depends on the treatment plan created by the treatment planning system (TPS) where the dose distribution relies on beam data acquired during the initial commissioning of the linear accelerator. Commissioning is the process of acquiring measurements such as PDDs, beam profiles at various depths, scatter factors, and MLC characterization to create the beam model for the TPS, as described in AAPM's Task Group (TG) Report 106<sup>8</sup>.

Since small field dosimetry behaves differently than in larger fields, correction factors are required to adjust the raw detector readings. Output correction factors for small fields are tabulated as a function of the equivalent square field size. These correction factors account for both perturbation effects and volume averaging. The International Atomic Energy Agency

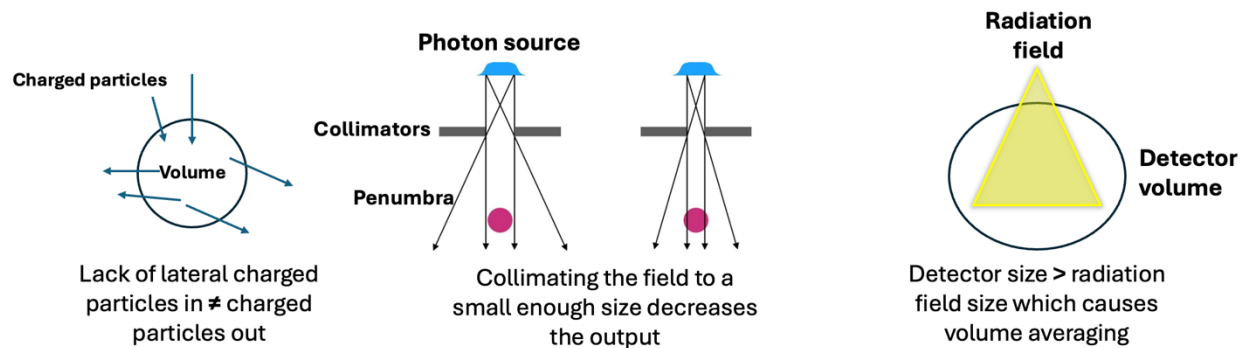
(IAEA) and American Association of Physicists in Medicine (AAPM) created a joint report Technical Report Series (TRS) 483 which describes the physics of small field dosimetry. TRS-483 provides tabulated correction data for different detectors and corresponding beam energies based on the equivalent square field size. Clinical incidents have occurred where patients were mistreated due to the use of uncorrected field output factors <sup>5</sup>. TRS 483 defines three conditions that determine whether a field size is considered a small field. If at least one of these conditions is met, the field can be considered as a small field, as shown in Figure 1 <sup>5</sup>.

The first condition is the loss of lateral charged equilibrium (CPE). CPE occurs when the field size is sufficiently large that for each charged particle entering a volume with a given particle type and energy another charged particle of equal type and energy is leaving the volume <sup>1</sup>. By establishing CPE one can determine the dose within the volume <sup>1</sup>. Since small fields lack lateral dimensions in their beam width, there is a loss of charged particles coming from the side to establish CPE.

The second condition is partial source occlusion, which occurs when the field is collimated to a sufficiently small size, given that the source has a finite size. When the jaws and multileaf collimators (MLCs) collimate the field to a small enough size, the beam central axis experiences a lower output because the source is partially blocked. This results in a wider and more blurred penumbra, making it more sensitive to source size, scatter contribution, and detector type. The combined effects of source occlusion and the loss of lateral CPE cause the output to decrease with field size <sup>5</sup>.

The third condition is the size of the detector relative to the radiation field. Detectors produce a signal proportional to the mean absorbed dose over their sensitive volume <sup>5</sup>. This results in a volume averaging effect, causing the detector to overmeasure in regions such as the penumbra.

To compensate for this effect, a detector with a smaller sensitive volume can be used to minimize volume averaging. Additionally, in small fields, a large detector may underestimate the dose at the field center because it includes lower dose regions outside the radiation field, which reduces the measured value.



**Figure 1: Conditions that define a small field according to the TRS-483 definition.**

Once the beam model is created from commissioning, TPS validation is performed by comparing calculated dose distributions to measured dose distributions. Validation can include comparing PDDs, beam profiles, and outputs. The purpose of validation is to verify the accuracy of the beam model created during commissioning.

Since the TPS uses the commissioned beam model to generate beam arrangements and dose distributions for treatment plans, having an accurate model is especially important, particularly under non-CPE conditions, such as when small fields are used <sup>6,7</sup>. By ensuring that the beam model is accurate, the radiation treatment can be delivered correctly and safely to the patient <sup>8</sup>.

Brainlab Elements is a TPS that divides the treatment planning process into modules, such as importing images, defining targets, and using predefined templates for prescriptions and beam arrangements to create the treatment plan. The system uses two algorithms for dose computation: the pencil beam (PB) algorithm and the Monte Carlo (MC) algorithm. The Brainlab Elements Technical Reference Guide provides instructions for acquiring specific beam measurements tailored to each algorithm and to the type of linear accelerator being modeled <sup>10</sup>.

The pencil beam algorithm divides the incident beams into several thin beamlets where each beamlet is corrected individually for different inhomogeneities, based on the density it traverses through <sup>10,21</sup>. The PB algorithm accounts for longitudinal inhomogeneity corrections but does not accurately model lateral scatter, leading to dose inaccuracies in heterogeneous regions, particularly at the boundaries of air cavities and other heterogeneities <sup>9,21</sup>. Its main advantage is faster computation due to the simplified one dimensional correction approach <sup>9</sup>.

In contrast, the MC algorithm is a more computationally intensive method that simulates the interactions of individual particles with matter. It is considered the gold standard for dose calculation because it can accurately model a wide range of radiation types, including photons, electrons, neutrons, and protons. In MC modeling, the linear accelerator head and its components are simulated, and the energy loss history of particles is tracked to compute dose distributions. The interaction properties are based on cross sections, which describe the probability of specific photon interactions such as photoelectric effect, Compton scattering, or pair production with a given material. Although highly accurate, MC requires significantly more computing time compared to PB algorithms <sup>1,9,10,22</sup>.

In Brainlab Elements, treatment plans are created by inputting the desired geometry and prescription. The program offers two treatment types: Dynamic Conformal Arc Therapy (DCAT)

and Volumetric Modulated Arc Therapy (VMAT). DCAT uses MLCs to create a field shape that conforms to the target where the radiation is delivered at a constant dose rate and gantry speed <sup>10</sup>. In contrast, for VMAT the MLC leaves intersect over the target and the dose rate varies throughout the treatment <sup>1</sup>. In Brainlab Elements, the Multiple Brain Metastases module can create either DCAT or VMAT plans, whereas the Cranial module only supports VMAT planning <sup>23,24</sup>.

The AAPM developed Medical Physics Practice Guideline 5.b (MPPG) as a standardized guide for commissioning and validating treatment planning dose calculations for photons and electrons. MPPG 5.b outlines the minimum recommended requirements and provides guidance on equipment selection and the types of data to acquire for TPS commissioning and validation. MPPG 5.b also references TG-119, which provides a set of intensity modulated radiation therapy (IMRT) validation tests that clinics can use to evaluate the overall performance of their treatment planning and delivery systems.

The purpose of this thesis is to emphasize the importance of validation of the TPS before clinical treatment can occur, particularly for small field applications. Since there is no official report that specifically outlines a validation methodology for small field TPS validation, the tests from MPPG 5.b and TG-119 were tailored and adapted in this thesis. At OHSU, measurement data were acquired according to Brainlab's recommendations to commission the Pencil Beam and Monte Carlo models in Elements for their TrueBeam system. TPS validation was then performed by comparing the measured OHSU data and newly acquired measurements to the corresponding TPS calculated dose distributions, using tests from MPPG 5.b and TG-119 adapted for small fields.

## 2. Materials and Methods

### 2.1 Equipment Setup for TPS Validation

The Brainlab Elements Technical Guide outlines the measurements required to create beam models for the Pencil Beam and Monte Carlo algorithms. A data checklist is provided based on the specific machine, which for OHSU is the Varian HD120 in standard irradiation mode and flattening filter-free mode. These measurements include linac calibration, MLC leakage, PDDs, profiles, output factors, diagonal radial profiles, and dynamic leaf shift <sup>10</sup>. For the Pencil Beam data, OHSU performed measurements using a Semiflex 3D, microDiamond, Dosimetry Diode P, microSilicon, and Exradin W2 1×1 detector. The microDiamond measurements were used as the "ground truth" due to the detector's small sensitive volume (0.004 mm<sup>3</sup>), tissue equivalence, and minimal perturbation effects for small field sizes <sup>4</sup>.

Elements does not allow direct water phantom creation, so a computed tomography (CT) image set is required. A solid water phantom setup was used with dimensions of 30 cm × 30 cm × 20 cm, consisting of six solid water slabs. Each slab had a width and length of 30 cm × 30 cm, and from bottom to top, the slab thicknesses were 4 cm, 5 cm, 3 cm, 2 cm, 1 cm, and 5 cm, creating a total phantom thickness of 20 cm as shown in Figure 2.

The slab setup was aligned to isocenter using room lasers. A BB was placed at the midway height (10 cm) on both the left and right sides of the phantom, and another BB was placed at the center of the top slab. The BBs served as references for identifying isocenter in the CT image scan. The CT scan was acquired with parameters of 2 mm slice thickness, 120 kV, 96 mAs, and 77 mA, resulting in a total of 166 slices. After the CT images were acquired, the CT dataset was imported into MIM under the appropriate patient ID and then exported to Brainlab Elements, replicating OHSU's clinical patient treatment workflow.

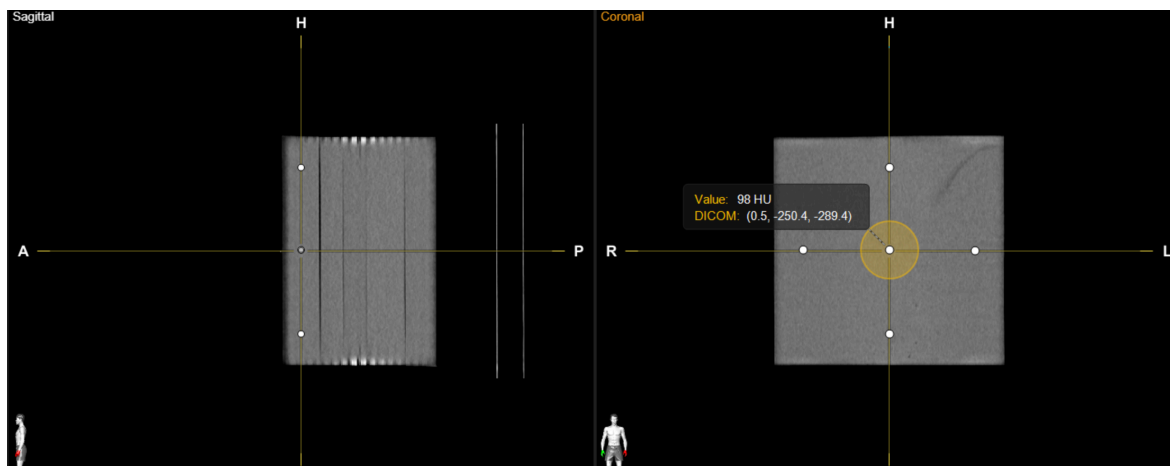


**Figure 2: Solid water phantom setup with dimensions of 30x30x20 cm width, length, height using multiple slabs.**

In Elements, Phantom Definition allows the preparation of the phantom model for QA by selecting the corresponding patient and CT image data. After selection, Object Management under Contouring to define objects by contouring and assign roles to the objects. The three BBs attached to the phantom were contoured using the brush tool and defined as objects. The water phantom slab was contoured using the Threshold tool, which segmented regions within a specified Hounsfield units (HU) range.

After the contours are defined, Phantom Definition is opened to select the couch top, HU–electron-density (ED) table, and treatment orientation (supine, head-to-gantry). The selected couch top was the Varian IGRT Thick, and the HU to ED table was MHR\_CT01\_23, which had a maximum HU value of 29,768 corresponding to a CT value of 1578.

If a table is added, only the outer contour of the phantom can be defined; however, if no table is included, the CT couch can be cropped out. The crop tool was used to define the outer contour of the water slab phantom where the outer contour is used for dose calculation. In this module, object electron densities can be overridden, or a specific material can be assigned to the object. The BBs ED were set to 0 to simulate air and their absence for dose calculation since it was only used as reference point. The phantom slab ED was overridden to  $1.0 \frac{g}{cm^3}$  to simulate water since the HU of the phantom slabs were around 70 HU compared to the HU value of  $0 \frac{g}{cm^3}$  for water as shown in Figure 3. A landmark was placed at the top of solid water phantom setup to define the SSD, setting it to 100 cm at that point.



**Figure 3: HU check for scanned solid water phantom center ROI with a HU value of 98.**

The phantom can then be saved and used for beam model verification to create a static beam. Beam model verification allows adjustment of the gantry angle, collimator rotation, monitor units (MUs), jaw positions, and MLC positions. The jaw and MLC positions can only be moved laterally and longitudinal in this module. Either the PB or MC dose calculation algorithm is selected and the desired dose grid resolution set. Jaw positions can be set (X1, X2, Y1, Y2) in millimeters, along with the MLC positions (mm) for Leaf Bank B (patient left), Leaf Bank A (patient right), Toward Leaf #1 (inferior), and Toward Leaf #60 (superior).

## 2.2 Generating PDDs and Profiles for Comparison

Following the recommendations of MPPG 5.b, specifically Test 5.3 (spot checks comparing calculated dose to commissioning data for PDDs and profiles) and Test 5.4 for non-static MLC-shaped fields, MPPG 5.b recommends field sizes of  $5 \times 5$  cm<sup>2</sup> and rectangular fields of  $5 \times 30$  cm<sup>2</sup> for PDDs and profiles. To adapt the tests to small fields, the field sizes used during commissioning were used instead, as shown in Table 1. PDD curves were used to evaluate central axis dose, while profile measurements were used to assess off axis dose. The PDDs and profiles were generated in Elements and were compared to measured water tank data to verify the TPS's modeling accuracy.

To generate the PDDs and profiles in Elements for comparison, the machine profile Linac2\_TB4180\_6FFF was selected for the pencil beam algorithm with the corresponding energy of 6 MV flattening filter free (FFF). For the pencil beam water scan measurements previously acquired at OHSU, the appropriate MLC and jaw dimensions (cm) in Table 1 were used to replicate each measurement condition, with each plan saved individually. Crossline and inline profiles were measured at depths of 1.3 cm, 5 cm, and 10 cm. The dose grid resolution was

set to 1 mm, following the recommendations of MPPG 9.a, where the resolution defines the size of each voxel used for calculating the dose <sup>2</sup>. After specifying the monitor units, the dose was then calculated.

MLC Setting (cm)	Jaw Setting (cm)
0.5 x 0.5	0.8 x 0.8
1.0 x 1.0	1.2 x 1.2
2.0 x 2.0	2.2 x 2.2
3.0 x 3.0	3.2 x 3.2
4.0 x 4.0	4.2 x 4.2
8.0 x 8.0	8.0 x 8.0
10.0 x 10.0	10.0 x 10.0

**Table 1: Field size dimensions MLC and jaw (cm) used for 6FFF Pencil Beam measurements for PDDs, crossline profiles, and inline profiles.**

Finally, the beam model verification plans were saved and exported as DICOM RT-Dose (Digital Imaging and Communications in Medicine Radiotherapy Dose) and DICOM RT-Plan files.

The DICOM RT-Dose file contains the calculated dose distribution from the treatment planning system. It shows how much radiation dose is delivered to different points within the patient's body, usually represented as a 3D grid. Each point in the grid has a dose value <sup>28</sup>. This file is used to evaluate dose comparisons against measured dose data.

The DICOM RT-Plan file contains all the information needed to deliver a radiation therapy treatment, including beam angles, MLC positions, jaw settings, prescribed dose,

isocenter coordinates, and number of fractions, which the linear accelerator uses to execute the treatment <sup>28</sup>.

To allow direct comparison between the TPS-calculated DICOM RT-Dose data and the measured microDiamond data, the DICOM RT-Dose files were converted into PTW's specific scanning MCC format to be opened in BEAMSCAN for comparison. This file conversion was performed using a PTW application called DICOM2MCC, which converts DICOM files into MCC format. The DICOM2MCC application requires both a DICOM RT-Dose file and a DICOM RT-Plan file; it then generates PDDs and profiles at specified depths, along with the corresponding off-axis values defined by the input parameters.

The converted Elements PDD and profile MCC files were compared to OHSU's previously acquired scan data using the microDiamond detector in BEAMSCAN. PDDs were normalized to the maximum dose, and profiles were normalized to the central axis. Normalizing both PDDs and profiles to a common reference point allows for direct comparison of the curve shapes between the TPS generated and measured data. The water scan measurements were used as the reference, as they served as the ground truth. Because PDDs and profiles are relative measurements, comparing TPS-generated and measured data helps eliminate daily fluctuations that can affect linac output, such as changes in temperature and pressure. Relative comparisons are appropriate because the TPS dose distribution is scaled based on a nominal output during beam modeling.

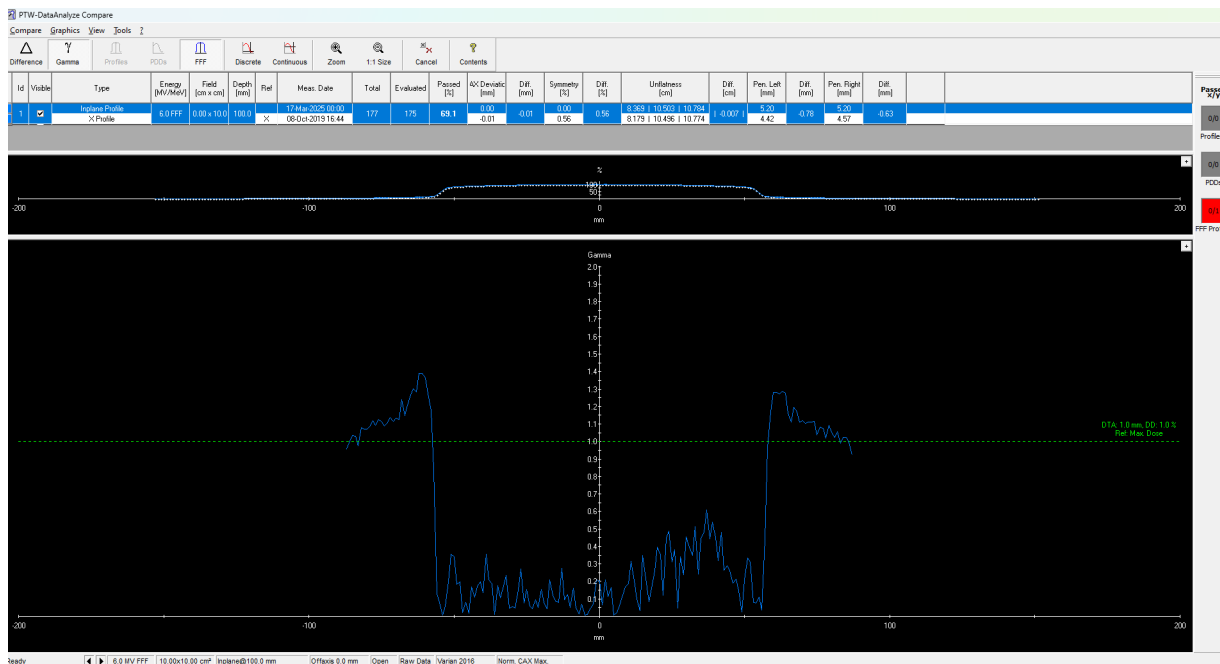
The gamma analysis is a method of evaluation when comparing two different dose distributions which is described by Low <sup>29</sup>. Gamma analysis can be performed in PTW BEAMSCAN software, where parameters such as distance-to-agreement (DTA) in mm, dose difference (DD) in %, low dose threshold (%), and exclusion of the buildup region can be

adjusted. A global analysis was used, where the dose difference was evaluated relative to the maximum dose in the reference distribution. The low dose threshold excludes points below a specified percentage of the maximum dose from evaluation, while suppression of the buildup region ignores a set number of points in that region because CPE does not exist. The gamma analysis was performed using the variables shown in Equation (1) where the gamma equation compares two points on a point by point basis,  $\vec{r}_e$  and  $\vec{r}_r$  where  $r$  is the spatial distance between the reference and evaluated points, and  $\delta$  is the dose difference.  $\Delta d$  represents the distance-to-agreement (DTA) criterion, and  $\Delta D$  is the dose difference criteria. A gamma value between 0 and 1 indicates the point is within both criteria and is considered a pass, while a value greater than 1 indicates a failure <sup>29</sup>.

$$\Gamma(\vec{r}_e, \vec{r}_r) = \sqrt{\frac{r^2(\vec{r}_e, \vec{r}_r)}{\Delta d^2} + \frac{\delta^2(\vec{r}_e, \vec{r}_r)}{\Delta D^2}} \quad (1)$$

### **Gamma analysis equation <sup>29</sup>**

In the PTW BEAMSCAN software, a green dashed line indicates the passing threshold for gamma analysis: points with gamma values  $\leq 1$  pass, while those above this threshold fail as shown in Figure 4 for the gamma analysis of a profile scan. The analysis reports the total number of points, the number of points evaluated, and the pass rate in %. Gamma criteria used for PDDs included 1mm/1%, 0.5mm/1%, 1mm/0.5%, and 0.5mm/0.5%, using a global analysis with a 1 mm buildup suppression applied. For TPS validation of small fields, a gamma criteria of 1mm/1% with an acceptable pass rate of  $>95\%$  was used for PDDs, based on a study that also performed small field TPS validation <sup>30</sup>.



**Figure 4: Gamma analysis in BEAMSCAN software for a 10x10 crossline profile using a gamma criteria of 1mm/1%, global analysis. Gamma points are highlighted in blue where points above the green dashed line are gamma points that have a value > 1 which fails the gamma criteria.**

Due to the 20 cm thickness of the solid water phantom and the fact that the Elements TPS PDD extended beyond 20 cm, the gamma analysis was limited to a depth of 20 cm. The low dose threshold was set to the PDD percentage value at 20 cm, where the low dose threshold values are summarized in Table 2 from the microDiamond PDD curve. The low dose threshold values were obtained using the discrete cursor tool in BEAMSCAN. These low dose thresholds were used for each field size because CPE is absent beyond this depth, and cranial SRS treatments typically do not exceed 20 cm.

MLC Setting (cm)	Jaw Setting (cm)	Low dose threshold at 20 cm depth (%)
0.5 x 0.5	0.8 x 0.8	25.5
1.0 x 1.0	1.2 x 1.2	27
2.0 x 2.0	2.2 x 2.2	28.2
3.0 x 3.0	3.2 x 3.2	29.1
4.0 x 4.0	4.2 x 4.2	30
8.0 x 8.0	8.0 x 8.0	33.2
10.0 x 10.0	10.0 x 10.0	34.5

**Table 2: Low dose threshold (%) values for PDDs from microDiamond water scans. The 20 cm depth was selected due to the physical limitation of the solid water phantom.**

The profiles followed a similar methodology, with low dose thresholds recorded at depths of 1.3 cm, 5 cm, and 10 cm for gamma profile comparisons between Elements and the microDiamond scans, as summarized in Tables 3–5. The low dose threshold was determined for each depth based on the ends of the microDiamond water scan profiles, and gamma criteria of 1 mm/1% and 2 mm/2% were used. The same tolerance was used for profiles as for PDDs, with an acceptable gamma pass rate of >95% for the 1 mm/1% criteria <sup>30</sup>.

MLC Setting (cm)	Jaw Setting (cm)	Profile Type	Low dose threshold (%)
0.5 x 0.5	0.8 x 0.8	Crossline	0.1
0.5 x 0.5	0.8 x 0.8	Inline	0.1
1.0 x 1.0	1.2 x 1.2	Crossline	0.1
1.0 x 1.0	1.2 x 1.2	Inline	0.1
2.0 x 2.0	2.2 x 2.2	Crossline	0.2
2.0 x 2.0	2.2 x 2.2	Inline	0.2
3.0 x 3.0	3.2 x 3.2	Crossline	0.4
3.0 x 3.0	3.2 x 3.2	Inline	0.4
4.0 x 4.0	4.2 x 4.2	Crossline	0.6
4.0 x 4.0	4.2 x 4.2	Inline	0.5
8.0 x 8.0	8.0 x 8.0	Crossline	1.2
8.0 x 8.0	8.0 x 8.0	Inline	1.2
10.0 x 10.0	10.0 x 10.0	Crossline	1.6
10.0 x 10.0	10.0 x 10.0	Inline	1.5

**Table 3: Low dose threshold values (%) were recorded for crossline and inline profiles at a depth of 1.3 cm for the given MLC and jaw combinations.**

MLC Setting (cm)	Jaw Setting (cm)	Profile Type	Low dose threshold (%)
0.5 x 0.5	0.8 x 0.8	Crossline	0.2
0.5 x 0.5	0.8 x 0.8	Inline	0.2
1.0 x 1.0	1.2 x 1.2	Crossline	0.1
1.0 x 1.0	1.2 x 1.2	Inline	0.1
2.0 x 2.0	2.2 x 2.2	Crossline	0.4
2.0 x 2.0	2.2 x 2.2	Inline	0.4
3.0 x 3.0	3.2 x 3.2	Crossline	0.7
3.0 x 3.0	3.2 x 3.2	Inline	0.6
4.0 x 4.0	4.2 x 4.2	Crossline	1.0
4.0 x 4.0	4.2 x 4.2	Inline	0.9
8.0 x 8.0	8.0 x 8.0	Crossline	2.0
8.0 x 8.0	8.0 x 8.0	Inline	2.0
10.0 x 10.0	10.0 x 10.0	Crossline	2.5
10.0 x 10.0	10.0 x 10.0	Inline	2.5

**Table 4: Low dose threshold values (%) were recorded for crossline and inline profiles at a depth of 5.0 cm for the given MLC and jaw combinations.**

MLC Setting (cm)	Jaw Setting (cm)	Profile Type	Low dose threshold (%)
0.5 x 0.5	0.8 x 0.8	Crossline	0.1
0.5 x 0.5	0.8 x 0.8	Inline	0.1
1.0 x 1.0	1.2 x 1.2	Crossline	0.1
1.0 x 1.0	1.2 x 1.2	Inline	0.1
2.0 x 2.0	2.2 x 2.2	Crossline	0.7
2.0 x 2.0	2.2 x 2.2	Inline	0.7
3.0 x 3.0	3.2 x 3.2	Crossline	1.2
3.0 x 3.0	3.2 x 3.2	Inline	1.1
4.0 x 4.0	4.2 x 4.2	Crossline	1.8
4.0 x 4.0	4.2 x 4.2	Inline	1.7
8.0 x 8.0	8.0 x 8.0	Crossline	3.5
8.0 x 8.0	8.0 x 8.0	Inline	3.4
10 x 10	10 x 10	Crossline	4.1
10 x 10	10 x 10	Inline	4.1

**Table 5: Low dose threshold values (%) were recorded for crossline and inline profiles at a depth of 10 cm for the given MLC and jaw combinations.**

### 2.3 Monitor-Unit Hand Calculation Using Measured Output Factors

MPPG 5.b Test 5.4 recommends comparing TPS calculated output factors to the commissioned output factors for validation and suggests field sizes of  $5 \times 5 \text{ cm}^2$  and  $5 \times 30 \text{ cm}^2$ .

However, the field sizes used for output factor validation were based on those used during

commissioning, as shown in Table 6. A dose-to-dose comparison was performed since the PDDs had been verified. The TPS calculated dose was compared to the dose obtained from a monitor unit (MU) hand calculation using the measured output factors as shown in Equation (2) and Equation (3) <sup>1</sup>. Output factors were measured in the water tank using the microDiamond chamber at an SSD of 100 cm and an effective depth of 10 cm. While initial measurements were acquired using 50 MU, they were scaled to 500 MU for the MU hand calculation dose. Dose values were extracted from the Beam Model Verification module using the point measurement tool, placing it 10 cm below the BBs to replicate the effective depth of 10 cm, same field size dimensions, and 500 MUs, where the dose values in cGy were recorded.

In equation (2)  $\mu$  represents the MUs while  $D$  is the dose (cGy) and  $\dot{D}$  is the dose rate in (cGy/MU). The dose can be computed by multiplying the dose rate by the MUs.  $S_{c,p}$  represents the output factor while  $\dot{D}_0$  is the nominal output. After calculating the dose, the percent difference was calculated using Equation (4) <sup>1</sup> determined to compare the water tank outputs to the Elements calculations, where a tolerance of 2% is considered acceptable according to MPPG 5.b <sup>5</sup>.

$$\mu = \frac{D}{\dot{D}} \quad (2)$$

#### **MU hand calculation equation**

$$\dot{D} = \dot{D}_0 * S_{c,p} * DD \quad (3)$$

#### **Dose rate equation**

$$\text{Percent Difference (\%)} = \frac{|\text{Measured Dose} - \text{TPS Dose}|}{\left(\frac{\text{Measured Dose} + \text{TPS Dose}}{2}\right)} \quad (4)$$

MLC Setting (cm)	Jaw Setting (cm)
0.5 x 0.5	0.8 x 0.8
0.5 x 0.5	1.2 x 1.2
0.5 x 0.5	2.2 x 2.2
1.0 x 1.0	1.2 x 1.2
1.0 x 1.0	2.2 x 2.2
1.0 x 1.0	3.2 x 3.2
2.0 x 2.0	2.2 x 2.2
2.0 x 2.0	3.2 x 3.2
2.0 x 2.0	4.2 x 4.2
3.0 x 3.0	3.2 x 3.2
3.0 x 3.0	4.2 x 4.2
3.0 x 3.0	6.0 x 6.0
4.0 x 4.0	4.2 x 4.2
4.0 x 4.0	6.0 x 6.0
4.0 x 4.0	8.0 x 8.0
8.0 x 8.0	8.0 x 8.0
8.0 x 8.0	10.0 x 10.0
10.0 x 10.0	10.0 x 10.0

**Table 6: Field sizes for MLC and jaw (cm) used for MU hand calc dose.**

## 2.4 Planar Dose Validation with SRS MapCHECK

After the PDDs, profiles, and doses were compared, additional measurements were acquired based on MPPG 5.b Test 7.2 for small MLC-defined fields using Sun Nuclear's SRS MapCHECK and StereoPHAN, which are used for stereotactic patient-specific QA at OHSU. For these measurements, the corresponding 6FFF dose calibration and array calibration files were used for all acquisitions. The SRS MapCHECK contains 1,013 diode detectors with a spacing of 2.47 mm and an array size of 7.7 cm × 7.7 cm. The StereoPHAN is a PMMA (polymethyl methacrylate) insert for the SRS MapCHECK <sup>31</sup>. The SRS MapCHECK is

commonly used for stereotactic applications given its high spatial resolution, which has been compared to Gafchromic film resolution <sup>12,13</sup>.

The SRS MapCHECK manual recommends acquiring a CT image set with the SRS MapCHECK inserted in the StereoPHAN. BBs were attached to the StereoPHAN crosshairs at isocenter to serve as reference markers in the CT image. Following similar steps to the water phantom slab setup in Phantom Definition, the StereoPHAN was contoured in Object Management using the threshold tool. The SRS MapCHECK was contoured separately, and the BBs were also contoured. Once the desired contours were created and all objects were saved, the couch top Varian IGRT Thick and the HU-to-ED table MHR\_CT01\_23 with a maximum HU value of 29,768 corresponding to a CT value of 1578 were selected, similar to the water phantom setup. The patient orientation was set to supine head to gantry. The StereoPHAN was assigned an electron density of  $1.20 \frac{g}{cm^3}$ , as recommended by the SNC Patient manual, while the BBs were assigned an electron density of  $0 \frac{g}{cm^3}$ . The landmark was set at the axial slice where all three BBs were visible and intersected by the crosshairs for isocenter.

After saving the phantom definition, the Beam Model Verification module was used to create the corresponding square and rectangular fields for dose measurements on the SRS MapCHECK, as shown in Table 7. Once the fields were created, the DICOM RT-Dose files were exported and opened in SNC Patient, enabling comparison between the measured data and the TPS calculated dose. Field sizes up to 6.0 x 6.0 cm were used, as the active region of the SRS MapCHECK is 7.7 cm x 7.7 cm.

MLC Setting (cm)	Jaw Setting (cm)
0.5 x 0.5	0.8 x 0.8
0.5 x 0.5	1.2 x 1.2
1.0 x 1.0	0.8 x 0.8
1.0 x 1.0	1.2 x 1.2
2.0 x 2.0	2.2 x 2.2
2.0 x 2.0	3.2 x 3.2
3.0 x 3.0	3.2 x 3.2
3.0 x 3.0	4.2 x 4.2
4.0 x 4.0	4.2 x 4.2
4.0 x 4.0	6.0 x 6.0
6.0 x 6.0	4.2 x 4.2
6.0 x 6.0	6.0 x 6.0

**Table 7: MLC and jaw field sizes (cm) used for SRS MapCHECK measurements on the TrueBeam.**

The SRS MapCHECK and StereoPHAN was set up on the treatment couch at the edge of the treatment table, where lasers were used to align to the isocenter using the indentations on the StereoPHAN. OHSU previously used MLC files containing preset MLC positions used for output factor measurements which were then used to acquire the measurements on the SRS MapCHECK where the jaws had to be set manually in service mode on the TrueBeam.

Measurements were then acquired using SNC Patient, where the measured dose was compared to the Elements calculated dose using gamma analysis criteria of 1 mm/1%, 2 mm/2%, and 1 mm/3%. A fixed amount of 100 MU was delivered for each measurement. Absolute comparison mode was used, with a low dose threshold of 10% and global normalization to the

maximum dose. Since positioning errors could occur when setting up the SRS MapCHECK, calc shifts were applied after each measurement on the SRS MapCHECK to ensure proper alignment between the measured dose and the TPS calculated reference dose, correcting for setup related discrepancies such as phantom positioning. A tolerance of 2mm/2% is considered acceptable with a pass rate > 95% based on the recommendations from MPPG 5.b for test 7.2 <sup>5</sup>.

## **2.5 TG-119 Test**

### **2.5 a Single and Multi-Target**

After the MLC defined fields were measured and compared to the TPS calculated dose distributions, TG-119 tests were adapted based on MPPG 5.b test 7.3 to fit the SRS MapCHECK's active area (7.7 cm x 7.7 cm). The AP:PA test was converted into a single target at isocenter, while the bands test was modified to include three small spherical targets placed side by side, simulating a multitarget scenario. Both the AP:PA and bands tests were created using the Multiple Brain Mets module, which supports DCAT and VMAT. DCAT was used for these two tests, while the C-shape test was planned using the Cranial module with VMAT.

After selecting the SRS MapCHECK patient containing the CT images and entering the Multiple Brain Mets module under Object Management, the auto anatomy atlas was projected onto the phantom but was not used for object creation. Instead, by scrolling to the axial slice where all three BBs were visible, a small circle was drawn using the brush tool at the center where the crosshairs intersected all three BBs. A 5 mm margin was then applied in all directions to create a coin shaped target with a diameter of 18.4 mm and a length of 10.4 mm, for the single target test as shown in Figure 5.



**Figure 5: Single target structure created for use in the single target test**

To create the multiple target test, the anatomy feature in Object Management was used, which inserts typical cranial structures into the phantom, such as the eyes, brain, and lenses of the eyes. The left eye was selected because its shape closely resembled a sphere. A uniform margin reduction of -8.5 mm in all directions was applied to shrink the spherical structure to a 7 mm diameter. The target was then placed at isocenter, ensuring that all three BBs were visible in the axial slice. The spherical target was copied to create left and right targets, with a center-to-center spacing of 17.5 mm from left to right, as shown in Figure 6.

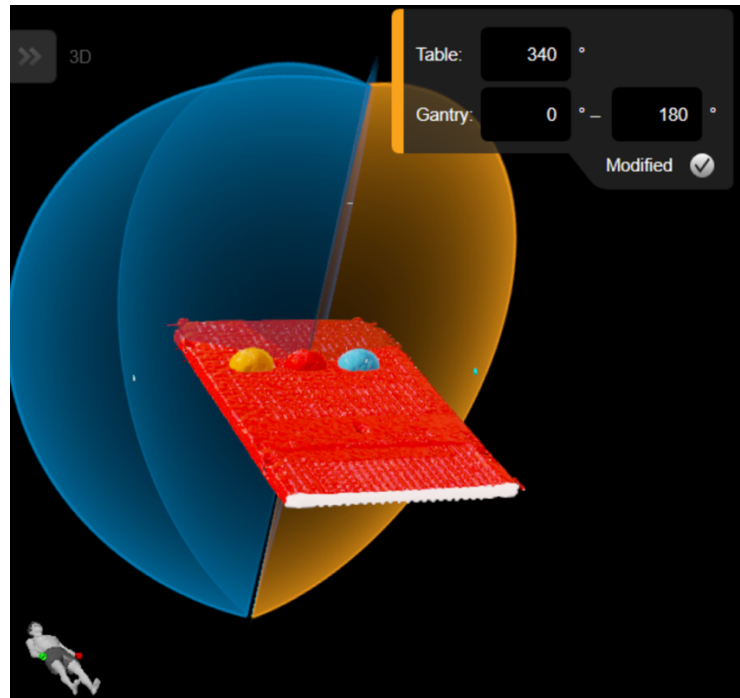
Plans were created with prescribed doses according to Elements protocols that were preset and the protocol that was used was the 15, 18, 24 Gy by 1 fx where the D99.5% is set to 1500, 1800, 2400 cGy, with the dose resolution set to 1 mm before calculating. To enable more advance options to adjust the gantry angle and doses the configuration button is clicked where then the advance editing options is toggled.

Elements allows to toggle targets as treated or untreated based on whether their role is assigned as the PTV. After dose calculation, Elements automatically generates the couch angle and arc arrangement based on the prescription selected.



**Figure 6: Multi-target objects shown on with the green, red, and purple spheres representing the left, middle, and right targets.**

Since the TrueBeam uses the IEC 61217 scale and Elements does not automatically account for the clockwise (CW) and counterclockwise (CCW) rotation convention where CW past  $180^\circ$  becomes  $181^\circ\text{E}$  and CCW past  $180^\circ$  becomes  $179^\circ\text{E}$ . A manual adjustment of one additional degree was applied to CCW arcs, which started from  $0^\circ$  to  $180^\circ$  CCW, which became  $181^\circ$  to  $0^\circ$  CCW to ensure proper recognition by the TrueBeam.



**Figure 7: 3D view of gantry arcs, where gantry and table parameters can be adjusted as needed.**

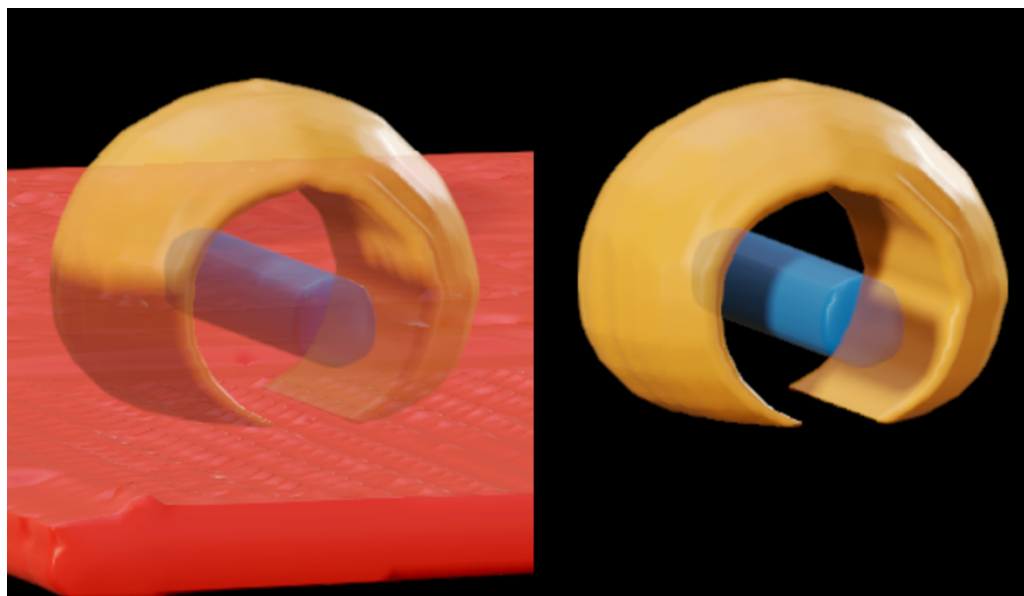
After recalculating the plan with the corrected gantry angle, the plan was saved. The left and right targets were then enabled for treatment, and the same procedure was followed, including the one-degree gantry adjustment for arcs starting from  $0^\circ$  to  $180^\circ$  CCW. The multi-target plan was then saved.

## 2.5 b C-shape

To create the C-shape test in the Cranial module, the same objects such as the stereoPHAN, SRS mapCHECK, and BBs used for the single and multi-target plans were utilized, along with the corresponding electron density overrides. To define the C-shape target at the center of the SRS array, scroll to the axial slice where all three BBs are visible and center the crosshair.

A brush size of 40 was used to create the first object, with a margin of 10 mm added in all directions except posterior, where the margin was set to 0 mm, creating a cylinder that is flat at the bottom. The first object was then selected again, and margins of 5 mm were added in all directions, with 20 mm margins applied to the superior and inferior to create a long cylinder for subtraction. Using the subtraction tool, the modified first object was subtracted from the long cylinder to create a C-shape. Finally, the original first object was selected, and margins of 10 mm to the head and 20 mm to the feet were added to create the core.

The blue core has a diameter of 4.5 mm, with the outer C-shape having a thickness of 5 mm. The distance between the core and the C-shape is 7 mm. The core is 31.0 mm in length, while the C-shape is 20.0 mm in length as shown in Figure 8.



**Figure 8: C-shape plan where the orange region represents the C-shape target and the blue region represents the core.**

After the objects were created, the C shape structure was assigned as the PTV. The protocol that was used is the 15 Gy 1 fx with  $D_{99\%} = 1500$  cGy.

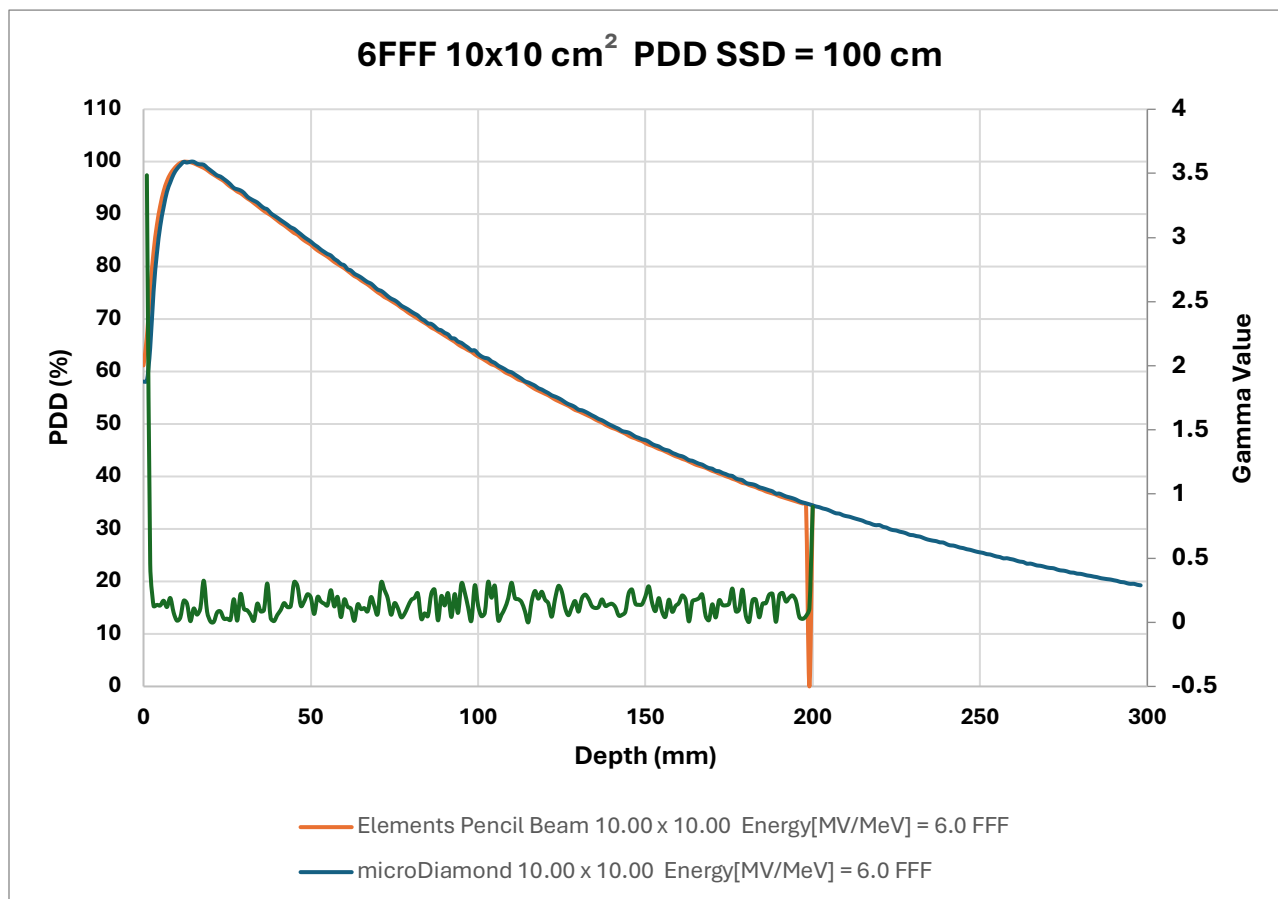
Since the plans could not be exported to MOSAIQ, all plans were exported as DICOM-RT Dose and DICOM-RT Plan files. The dose files were used in SNC Patient for comparison, while the DICOM-RT plan files were sent to the TrueBeam drive connected via a network drive, allowing the files to be uploaded and opened in file mode on the TrueBeam. Measurements were then taken in service mode.

The SRS MapCHECK was positioned at the edge of the treatment table inside the StereophAN, and the plans were delivered in service mode on the TrueBeam. The measured dose was then compared to the calculated dose from Elements in SNC Patient using gamma analysis criteria of 3%/1mm, 2%/1mm, 3%/2mm, 2%/2mm, and 1%/2mm. A gamma criteria of 1 mm/3% with a passing threshold of  $\geq 95\%$  was considered acceptable, consistent with an article that tailored TG-119 test plans for use with the SRS MapCHECK <sup>27</sup>. Confidence limits were calculated using the formula:  $CL = \text{mean} - 1.96 \times \text{standard deviation}$ , following the TG-119 methodology <sup>14</sup>. The confidence limit equation from TG-119 provides the lower bound of the gamma pass rate within a 95% confidence level, assuming a normal distribution. This means that, with 95% confidence, the gamma pass rate is at least equal to the calculated confidence limit.

### 3. Results

#### 3.1 PDDs

Scan	Dose at 0 cm depth (PDD %)	Depth of Maximum Dose (cm)	Dose at 10 cm depth (PDD %)
<b>Elements PB</b> (Calculated)	61.18	1.3	62.89
<b>microDiamond</b> (Measured)	58.10	1.2	63.39



**Figure 9:** The left vertical axis corresponds to the PB and microDiamond PDDs, while the right vertical axis corresponds to the gamma values shown in green. A gamma criteria of 1 mm/1%, a low dose threshold of 34.5%, and global normalization were used. Passing points are plotted in green, while points with gamma values above 1.0 indicate failure to meet the criteria.

The 10x10 cm 6FFF PDD PB from Elements was verified using a gamma criteria of 1mm/1% where the gamma pass rate % was 99.5% which is within the 95% acceptable tolerance. Visually looking at the PDDs overlaid the gamma evaluation fails at the beginning of the PDDs.

Element's PB PDDs were then compared to microDiamond PDDs for various MLC and jaw field size combinations using gamma criterias of 1mm/1%, 0.5mm/1%, 1mm/0.5%, and 0.5m/0.5%. The total evaluated points and evaluated pass rate was recorded from the gamma analysis built in analysis in BEAMSCAN, as shown in Table 8-11. The gamma analysis was performed using a 1 mm grid resolution, matching the dose grid used in Elements for the 20 cm phantom, resulting in 200 evaluated points.

MLC Setting (cm)	Jaw Setting (cm)	Total Points	Evaluated Points	Gamma Pass Rate (%)	Low Dose Threshold (%)
0.5 x 0.5	0.8 x 0.8	299	200	99.5	25.5
1.0 x 1.0	1.2 x 1.2	299	199	99.5	27.0
2.0 x 2.0	2.2 x 2.2	299	199	99.5	28.2
3.0 x 3.0	3.2 x 3.2	299	200	99.0	29.1
4.0 x 4.0	4.2 x 4.2	299	199	99.0	30.0
8.0 x 8.0	8.0 x 8.0	299	200	99.5	33.2
10.0 x 10.0	10.0 x 10.0	299	200	99.5	34.5

**Table 8: 6FFF gamma pass rates (%) for the given field sizes were obtained by comparing Elements-calculated PDDs to microDiamond-measured PDDs using 1 mm DTA / 1% DD criteria. A global gamma analysis was performed with the corresponding low dose thresholds at a depth of 20 cm, as outlined in Table 2.**

MLC Setting (cm)	Jaw Setting (cm)	Total Points	Evaluated Points	Gamma Pass Rate (%)	Low Dose Threshold (%)
0.5 x 0.5	0.8 x 0.8	299	200	98.5	25.5
1.0 x 1.0	1.2 x 1.2	299	199	99.0	27.0
2.0 x 2.0	2.2 x 2.2	299	199	97.0	28.2
3.0 x 3.0	3.2 x 3.2	299	200	96.5	29.1
4.0 x 4.0	4.2 x 4.2	299	199	98.5	30.0
8.0 x 8.0	8.0 x 8.0	299	200	98.5	33.2
10 x 10	10 x 10	299	200	99.0	34.5

**Table 9: 6FFF gamma pass rates (%) for the given field sizes were obtained by comparing Elements-calculated PDDs to microDiamond-measured PDDs using 0.5 mm DTA / 1% DD criteria. A global gamma analysis was performed with the corresponding low dose thresholds at a depth of 20 cm, as outlined in Table 2.**

MLC Setting (cm)	Jaw Setting (cm)	Total Points	Evaluated Points	Gamma Pass Rate (%)	Low Dose Threshold (%)
0.5 x 0.5	0.8 x 0.8	299	200	78.0	25.5
1.0 x 1.0	1.2 x 1.2	299	199	87.4	27.0
2.0 x 2.0	2.2 x 2.2	299	199	61.3	28.2
3.0 x 3.0	3.2 x 3.2	299	200	57.0	29.1
4.0 x 4.0	4.2 x 4.2	299	199	94.5	30.0
8.0 x 8.0	8.0 x 8.0	299	200	99.0	33.2
10.0 x 10.0	10.0 x 10.0	299	200	99.5	34.5

**Table 10: 6FFF gamma pass rates (%) for the given field sizes were obtained by comparing Elements-calculated PDDs to microDiamond-measured PDDs using 1 mm DTA / 0.5% DD criteria. A global gamma analysis was performed with the corresponding low dose thresholds at a depth of 20 cm, as outlined in Table 2.**

MLC Setting (cm)	Jaw Setting (cm)	Total Points	Evaluated Points	Gamma Pass Rate (%)	Low Dose Threshold (%)
0.5 x 0.5	0.8 x 0.8	299	200	62.0	25.5
1.0 x 1.0	1.2 x 1.2	299	199	71.9	27.0
2.0 x 2.0	2.2 x 2.2	299	199	35.2	28.2
3.0 x 3.0	3.2 x 3.2	299	200	30.0	29.1
4.0 x 4.0	4.2 x 4.2	299	199	79.9	30.0
8.0 x 8.0	8.0 x 8.0	299	200	97.5	33.2
10.0 x 10.0	10.0 x 10.0	299	200	99.0	34.5

**Table 11: 6FFF gamma pass rates (%) for the given field sizes were obtained by comparing Elements-calculated PDDs to microDiamond-measured PDDs using 0.5 mm DTA / 0.5% DD criteria. A global gamma analysis was performed with the corresponding low dose thresholds at a depth of 20 cm, as outlined in Table 2.**

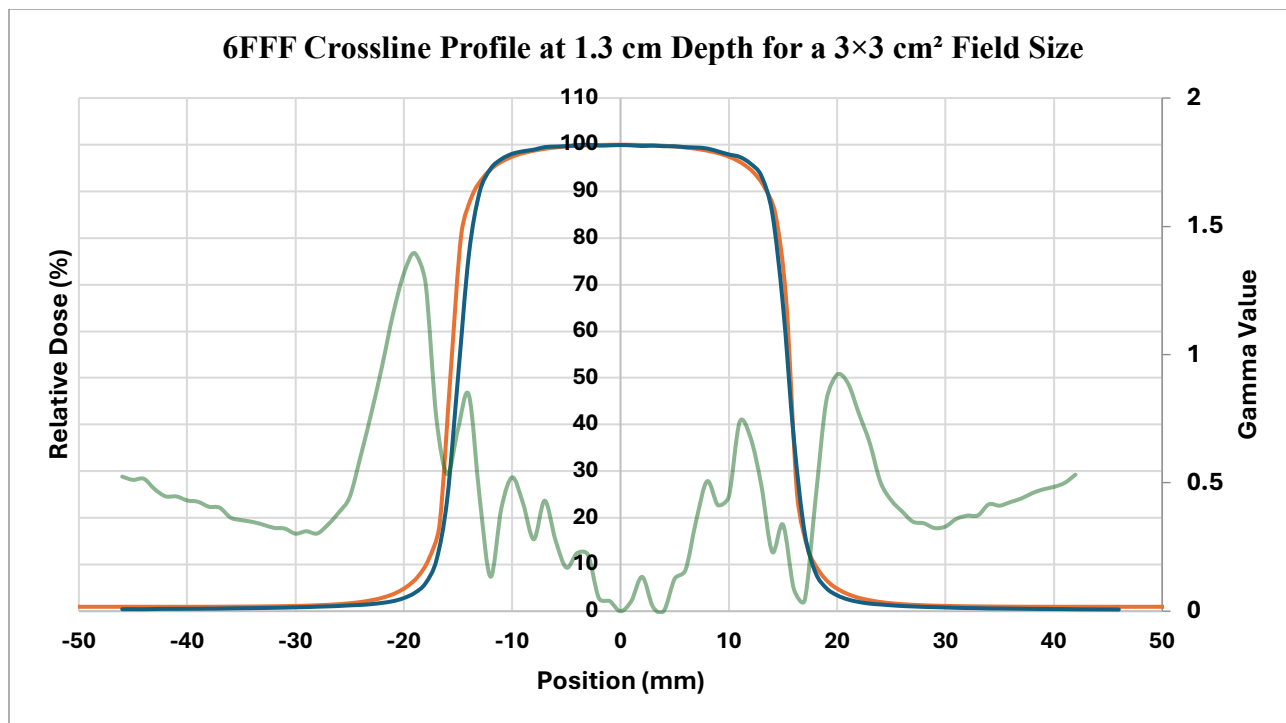
For the tolerance gamma criteria of 1 mm/1% with an acceptable pass rate of >95%, PDDs ranging from 0.5×0.5 cm<sup>2</sup> to 10×10 cm<sup>2</sup> were all within tolerance, as shown in Table 8. Gamma pass rates remained above 95% for the 0.5 mm/1% criteria across all field sizes; however, for the 1 mm/0.5% criteria, pass rates fell below 95% for field sizes smaller than 4.0×4.0 cm<sup>2</sup>.

### 3.2 Profiles

Similar to the PDD comparisons, Tables 12–14 show gamma analysis results for crossline profiles, where Elements PB profiles were compared to microDiamond water tank scans across several field sizes. Gamma criteria of 1%/1 mm and 2%/2 mm were applied at depths of 1.3 cm, 5 cm, and 10 cm, with corresponding pass rates recorded.

MLC Setting (cm)	Jaw Setting (cm)	Gamma Pass Rate (%)	Gamma Pass Rate (%)	Low Dose Threshold (%)
		1 mm DTA / 1 % DD	2 mm DTA / 2 % DD	
0.5 x 0.5	0.8 x 0.8	100	100	0.1
1.0 x 1.0	1.2 x 1.2	100	100	0.1
2.0 x 2.0	2.2 x 2.2	95.1	100	0.2
3.0 x 3.0	3.2 x 3.2	95.5	100	0.4
4.0 x 4.0	4.2 x 4.2	97.0	100	0.6
8.0 x 8.0	8.0 x 8.0	100	100	1.2
10.0 x 10.0	10.0 x 10.0	100	100	1.6

**Table 12: 6FFF Crossline profile gamma pass rates (%) at a depth of 1.3 cm were calculated using global analysis with low dose thresholds specified in Table 3, applying gamma criteria of 1 mm DTA / 1% DD and 2 mm DTA / 2% DD to compare Elements and microDiamond scans.**

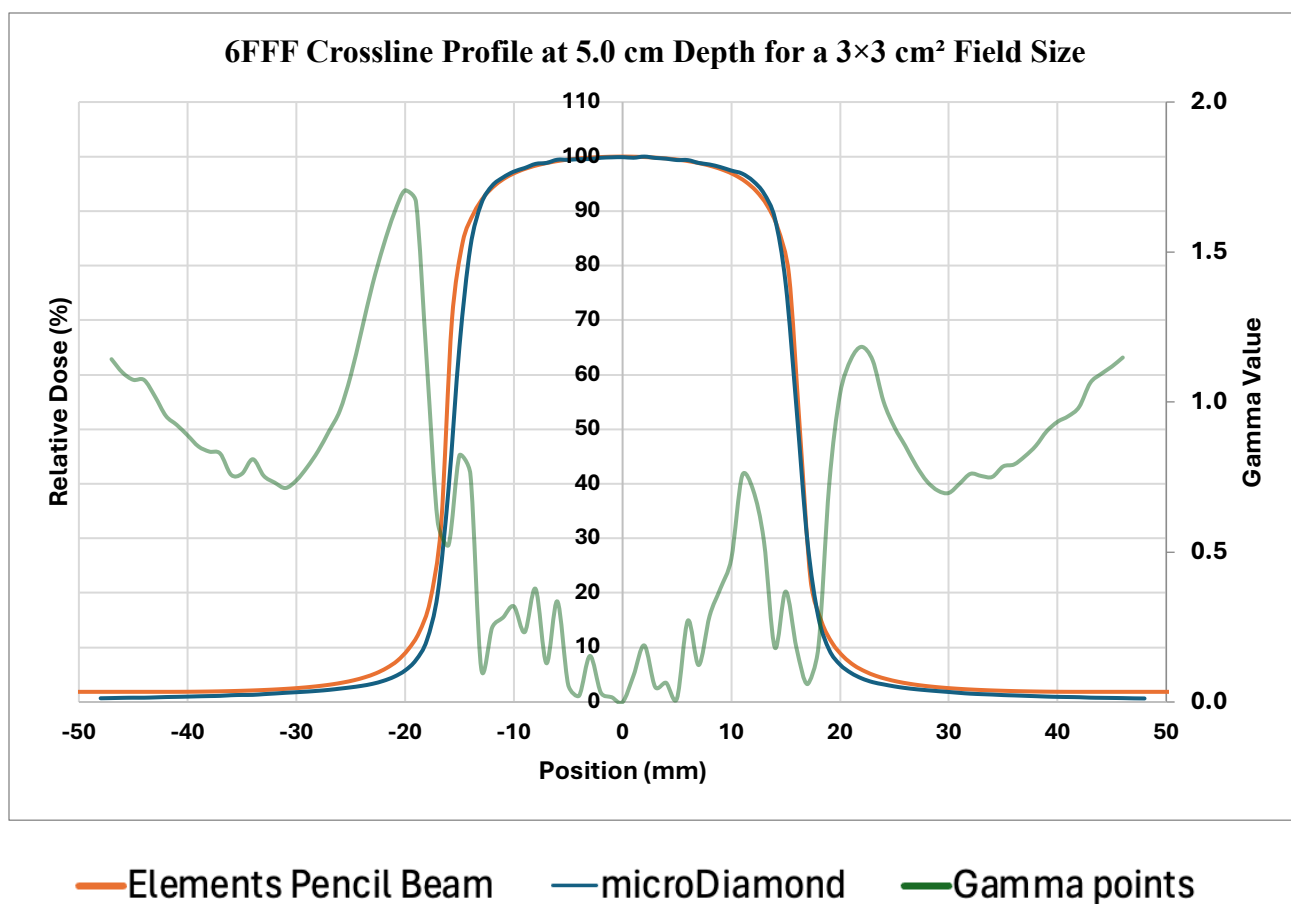


**Figure 10: 3×3 cm<sup>2</sup> crossline profile at a depth of 1.3 cm. The left vertical axis corresponds to the PB and microDiamond profiles, while the right vertical axis corresponds to the gamma values shown in green. A gamma criteria of 1 mm/1%, low dose threshold of 0.4% and global normalization were used.**

As shown in Figure 10 with a gamma criteria of 1mm/1% the pass rate for a crossline profile at a depth of 1.3 cm is 95.5% which is still within the 95% acceptable pass rate tolerance, where the failing gamma points are outside of the 50% isodose line.

MLC Setting (cm)	Jaw Setting (cm)	Gamma Pass Rate (%)	Gamma Pass Rate (%)	Low Dose Threshold (%)
		1 mm DTA / 1 % DD	2 mm DTA / 2 % DD	
0.5 x 0.5	0.8 x 0.8	100	100	0.2
1.0 x 1.0	1.2 x 1.2	94.7	100	0.1
2.0 x 2.0	2.2 x 2.2	92.8	100	0.4
3.0 x 3.0	3.2 x 3.2	76.6	100	0.7
4.0 x 4.0	4.2 x 4.2	94.3	100	1.0
8.0 x 8.0	8.0 x 8.0	95.3	100	2.0
10.0 x 10.0	10.0 x 10.0	95.2	100	2.5

**Table 13: 6FFF Crossline profile gamma pass rates (%) at a depth of 5.0 cm were calculated using global analysis with low dose thresholds specified in Table 4, applying gamma criteria of 1 mm DTA / 1% DD and 2 mm DTA / 2% DD to compare Elements and microDiamond scans.**



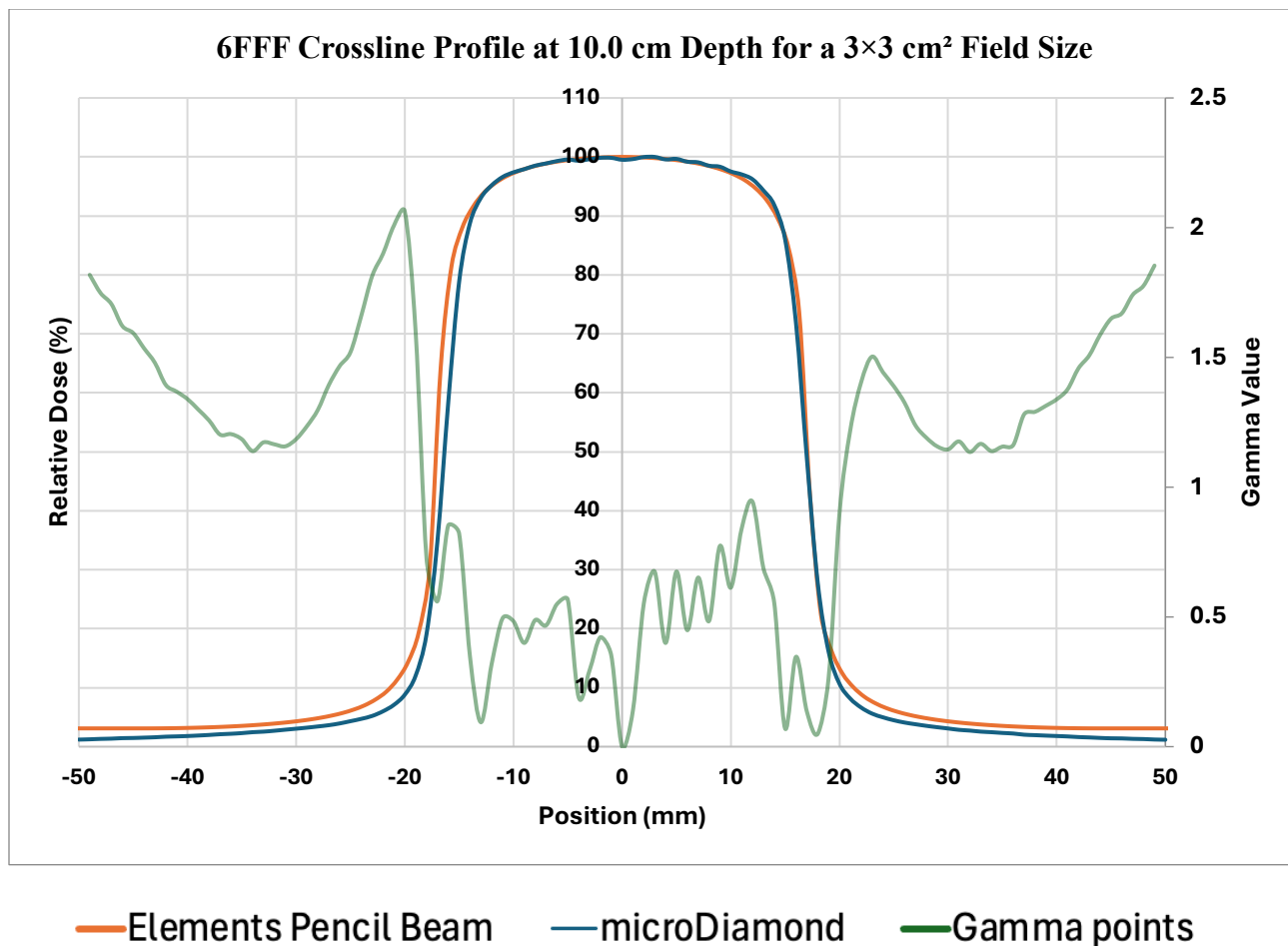
**Figure 11: 3×3 cm<sup>2</sup> crossline profile at a depth of 5.0 cm. The left vertical axis corresponds to the PB and microDiamond profiles, while the right vertical axis corresponds to the**

**gamma values shown in green. A gamma criteria of 1 mm/1%, low dose threshold of 0.7% and global normalization were used.**

As shown in Figure 11 with a gamma criteria of 1mm/1% the pass rate for a crossline profile at a depth of 5.0 cm is 76.6% which fails the 95% acceptable pass rate tolerance, where there are more failing gamma points are outside of the 50% isodose line compared to the crossline profile at 1.3 cm depth.

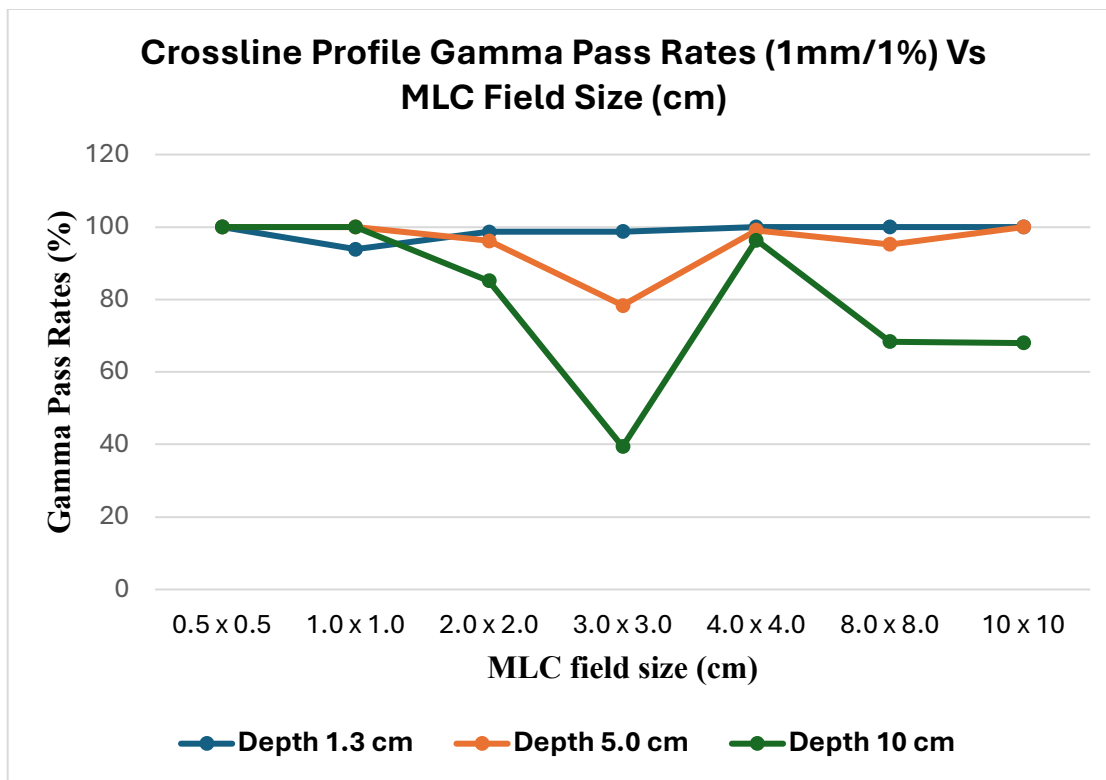
MLC Setting (cm)	Jaw Setting (cm)	Gamma Pass Rate (%)	Gamma Pass Rate (%)	Low Dose Threshold (%)
		1 mm DTA / 1 % DD	2 mm DTA / 2 % DD	
0.5 x 0.5	0.8 x 0.8	100	100	0.1
1.0 x 1.0	1.2 x 1.2	93.7	100	0.1
2.0 x 2.0	2.2 x 2.2	89.4	100	0.7
3.0 x 3.0	3.2 x 3.2	39.4	100	1.2
4.0 x 4.0	4.2 x 4.2	89.9	100	1.8
8.0 x 8.0	8.0 x 8.0	73.2	100	3.5
10.0 x 10.0	10.0 x 10.0	68.6	100	4.1

**Table 14: 6FFF Crossline profile gamma pass rates (%) at a depth of 10.0 cm were calculated using global analysis with low dose thresholds specified in Table 5, applying gamma criteria of 1 mm DTA / 1% DD and 2 mm DTA / 2% DD to compare Elements and microDiamond scans.**



**Figure 12: 3×3 cm<sup>2</sup> crossline profile at a depth of 10.0 cm. The left vertical axis corresponds to the PB and microDiamond profiles, while the right vertical axis corresponds to the gamma values shown in green. A gamma criteria of 1 mm/1%, low dose threshold of 1.2% and global normalization were used.**

Compared to Figures 10 and 11, Figure 12 shows several more gamma points outside the field edge of the 1.5×1.5 cm<sup>2</sup> field. This may indicate that the TPS struggles to accurately model in deeper depths.



**Figure 13: Gamma Pass Rates for Crossline Profiles at Depths of 1.3 cm, 5.0 cm, and 10.0 cm Using Global Gamma Analysis 1 mm/1% with a 10% Low Dose Threshold (Tables 12–14).**

Figure 13 shows a visual trend in the crossline profiles, where gamma pass rates decrease with increasing depth, especially for the  $3.0 \times 3.0 \text{ cm}^2$  field size.

MLC Setting (cm)	Jaw Setting (cm)	Gamma Pass Rate (%)	Gamma Pass Rate (%)	Low Dose Threshold (%)
		1 mm DTA / 1 % DD	2 mm DTA / 2 % DD	
0.5 x 0.5	0.8 x 0.8	100	100	0.1
1.0 x 1.0	1.2 x 1.2	93.9	100	0.1
2.0 x 2.0	2.2 x 2.2	98.7	100	0.2
3.0 x 3.0	3.2 x 3.2	98.8	100	0.4
4.0 x 4.0	4.2 x 4.2	100	100	0.5
8.0 x 8.0	8.0 x 8.0	100	100	1.2
10.0 x 10.0	10.0 x 10.0	100	100	1.5

**Table 15: Inline profile gamma pass rates (%) for 6FFF at a depth of 1.3 cm were calculated using global analysis with low dose thresholds from Table 3, applying gamma criteria of 1 mm DTA / 1% DD and 2 mm DTA / 2% DD to compare Elements and microDiamond scans.**

MLC Setting (cm)	Jaw Setting (cm)	Gamma Pass Rate (%)	Gamma Pass Rate (%)	Low Dose Threshold (%)
		1 mm DTA / 1 % DD	2 mm DTA / 2 % DD	
0.5 x 0.5	0.8 x 0.8	100	100	0.2
1.0 x 1.0	1.2 x 1.2	100	100	0.1
2.0 x 2.0	2.2 x 2.2	96.2	100	0.4
3.0 x 3.0	3.2 x 3.2	78.4	100	0.6
4.0 x 4.0	4.2 x 4.2	99.1	100	0.9
8.0 x 8.0	8.0 x 8.0	95.2	100	2.0
10.0 x 10.0	10.0 x 10.0	100	100	2.5

**Table 16: Inline profile gamma pass rates (%) for 6FFF at a depth of 5.0 cm were calculated using global analysis with low dose thresholds from Table 4, applying gamma criteria of 1 mm DTA / 1% DD and 2 mm DTA / 2% DD to compare Elements and microDiamond scans.**

MLC Setting (cm)	Jaw Setting (cm)	Gamma Pass Rate (%)	Gamma Pass Rate (%)	Low Dose Threshold (%)
		1 mm DTA / 1 % DD	2 mm DTA / 2 % DD	
0.5 x 0.5	0.8 x 0.8	100	100	0.1
1.0 x 1.0	1.2 x 1.2	100	100	0.1
2.0 x 2.0	2.2 x 2.2	85.2	100	0.7

3.0 x 3.0	3.2 x 3.2	39.4	100	1.1
4.0 x 4.0	4.2 x 4.2	96.4	100	1.7
8.0 x 8.0	8.0 x 8.0	68.4	100	3.4
10.0 x 10.0	10.0 x 10.0	68.0	100	4.1

**Table 17: Inline profile gamma pass rates (%) for 6FFF at a depth of 10.0 cm were calculated using global analysis with low dose thresholds from Table 5, applying gamma criteria of 1 mm DTA / 1% DD and 2 mm DTA / 2% DD to compare Elements and microDiamond scans.**

Tables 15–17 show the corresponding gamma analysis results for the inline direction, using the same field sizes and depths (1.3 cm, 5 cm, and 10 cm), and applying the same gamma criteria of 1 mm/1% and 2 mm/2% as used for the crossline profiles. Gamma pass rates for the 3×3 cm<sup>2</sup> field size did not meet the 95% tolerance at depths of 5.0 cm and 10.0 cm using the 1 mm/1% criteria.

### 3.3 MU Hand calc dose

MLC Setting (cm)	Jaw Setting (cm)	Field Output Correction Factor	MU hand calc dose (cGy)	Brainlab PB TPS dose (cGy)	% Difference
0.5 x 0.5	0.8 x 0.8	0.962	180.5	183	1.38
0.5 x 0.5	1.2 x 1.2	0.962	185.2	187	0.97
0.5 x 0.5	2.2 x 2.2	0.962	185.1	187	1.02
1.0 x 1.0	1.2 x 1.2	0.984	228.7	230	0.57
1.0 x 1.0	2.2 x 2.2	0.984	232.1	234	0.82
1.0 x 1.0	3.2 x 3.2	0.984	232.6	234	0.60
2.0 x 2.0	2.2 x 2.2	0.997	256.4	258	0.62
2.0 x 2.0	3.2 x 3.2	0.997	258.2	259	0.31
2.0 x 2.0	4.2 x 4.2	0.997	258.6	260	0.54
3.0 x 3.0	3.2 x 3.2	1.000	268.7	269	0.11
3.0 x 3.0	4.2 x 4.2	1.000	270.2	271	0.30
3.0 x 3.0	6.0 x 6.0	1.000	271.8	272	0.07
4.0 x 4.0	4.2 x 4.2	1.000	278.7	279	0.11
4.0 x 4.0	6.0 x 6.0	1.000	281.0	281	0.00
4.0 x 4.0	8.0 x 8.0	1.000	282.4	282	0.14
8.0 x 8.0	8.0 x 8.0	1.000	307.6	307	0.20
8.0 x 8.0	10.0 x 10.0	1.000	309.5	310	0.16
10.0 x 10.0	10.0 x 10.0	1.000	317.5	317	0.16

**Table 18: Dose comparison between Brainlab Pencil Beam dose and hand calculated dose values based on water tank measurements using a microDiamond detector. For the MU hand calc and TPS MU 500 MU was used.**

For an MLC field size of  $0.5 \times 0.5 \text{ cm}^2$  and a jaw size of  $0.8 \times 0.8 \text{ cm}^2$ , the percent difference was 1.38%, which is within the 2% tolerance recommended by MPPG 5.b. The MU hand calculated dose was lower than the Brainlab TPS dose for field sizes up to a  $4 \times 4 \text{ cm}^2$  MLC with a  $6 \times 6 \text{ cm}^2$  jaw, where both doses matched at 281 cGy. As the MLC and jaw sizes increased, the MU hand calculated dose became slightly higher than the TPS dose, though the percent differences remained below 0.20%. The largest percent difference, 1.38%, occurred at the

smallest MLC size of  $0.5 \times 0.5 \text{ cm}^2$  and jaw size of  $0.8 \times 0.8 \text{ cm}^2$ . The dose for all field sizes were within the 2% tolerance.

### 3.4 Planar Measurements

MLC Setting (cm)	Jaw Setting (cm)	Gamma Pass Rate (%)
0.5 x 0.5	0.8 x 0.8	100
0.5 x 0.5	1.2 x 1.2	100
1.0 x 1.0	0.8 x 0.8	95.2
1.0 x 1.0	1.2 x 1.2	100
2.0 x 2.0	2.2 x 2.2	74.3
2.0 x 2.0	3.2 x 3.2	65.7
3.0 x 3.0	3.2 x 3.2	89.8
3.0 x 3.0	4.2 x 4.2	48.9
4.0 x 4.0	4.2 x 4.2	43.1
4.0 x 4.0	6.0 x 6.0	46.4
6.0 x 6.0	4.2 x 4.2	50.4
6.0 x 6.0	6.0 x 6.0	33.0

**Table 19: 6FFF gamma pass rates (%) comparing Elements to SRS MapCHECK measurements for square field sizes were calculated using 1 mm DTA/ 1% DD criteria, global analysis, and a low dose threshold of 10%.**

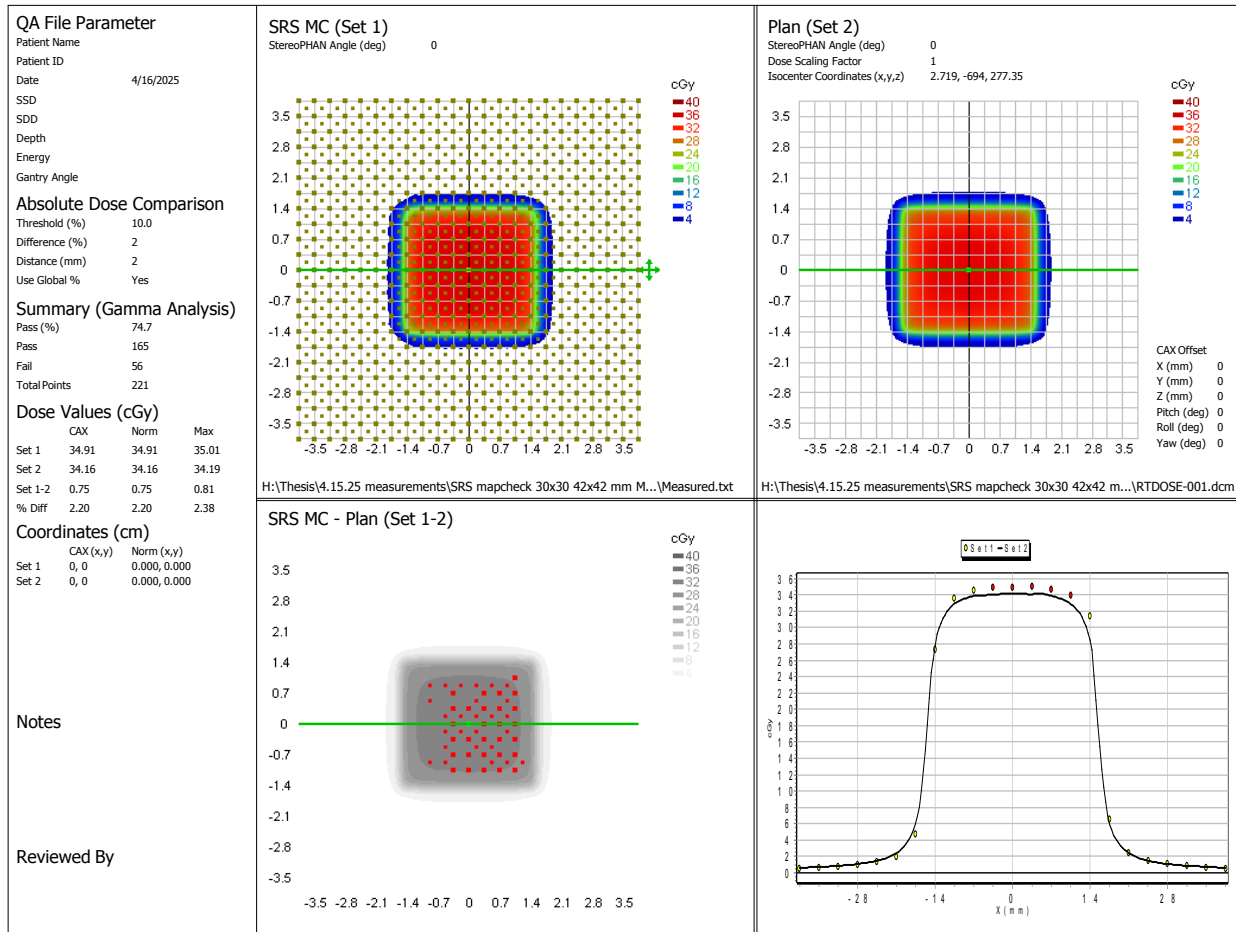
MLC Setting (cm)	Jaw Setting (cm)	Gamma Pass Rate (%)
0.5 x 0.5	0.8 x 0.8	100
0.5 x 0.5	1.2 x 1.2	100
1.0 x 1.0	0.8 x 0.8	100
1.0 x 1.0	1.2 x 1.2	100
2.0 x 2.0	2.2 x 2.2	95.2
2.0 x 2.0	3.2 x 3.2	94.3
3.0 x 3.0	3.2 x 3.2	100
3.0 x 3.0	4.2 x 4.2	74.7
4.0 x 4.0	4.2 x 4.2	68.7
4.0 x 4.0	6.0 x 6.0	72.7
6.0 x 6.0	4.2 x 4.2	68.5
6.0 x 6.0	6.0 x 6.0	57.8

**Table 20: 6FFF gamma pass rates (%) comparing Elements to SRS MapCHECK measurements for square field sizes were calculated using 2 mm DTA / 2% DD criteria, global analysis, and a low dose threshold of 10%.**

4/16/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:



**Figure 14: Measured dose distribution on SRS MapCHECK is shown in the left panel, while the Elements DICOM-RT dose is shown in the right panel. The bottom left highlights the locations of failed points from the gamma analysis. 3x3 cm field size with a gamma criteria of 2mm/2% using a low dose threshold of 10% and a global analysis. Gamma pass rate of 74.7%**

As shown in Figure 14, using the recommended gamma criteria of 2 mm/2%, the planar measurement has a pass rate of 74.7%, with 165 points passing and 56 points failing. This measurement does not meet the 95% acceptable tolerance recommended by MPPG 5.b.

MLC Setting (cm)	Jaw Setting (cm)	Gamma Pass Rate (%)
0.5 x 0.5	0.8 x 0.8	100
0.5 x 0.5	1.2 x 1.2	100
1.0 x 1.0	0.8 x 0.8	100
1.0 x 1.0	1.2 x 1.2	100
2.0 x 2.0	2.2 x 2.2	100
2.0 x 2.0	3.2 x 3.2	95.2
3.0 x 3.0	3.2 x 3.2	100
3.0 x 3.0	4.2 x 4.2	92.3
4.0 x 4.0	4.2 x 4.2	100
4.0 x 4.0	6.0 x 6.0	97.3
6.0 x 6.0	4.2 x 4.2	97.2
6.0 x 6.0	6.0 x 6.0	85.2

**Table 21: 6FFF gamma pass rates (%) comparing Elements to SRS MapCHECK measurements for square field sizes were calculated using 1 mm DTA/ 3% DD criteria, global analysis, and a low dose threshold of 10%.**

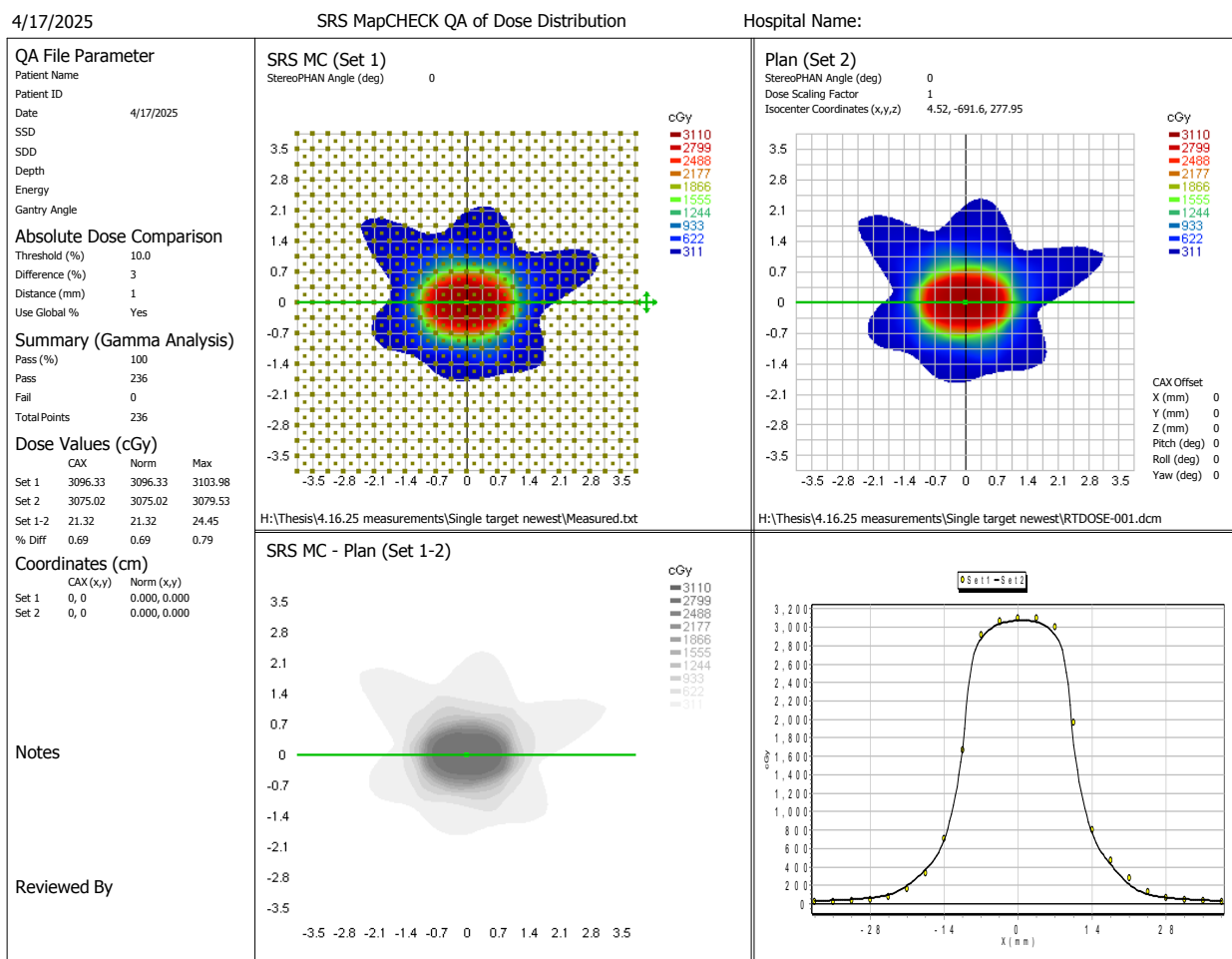
Gamma pass rates were recorded for different gamma criteria of 1mm/1%, 2mm/2%, and 1mm/3%. Planar dose distributions were evaluated to assess the agreement between the TPS to measured dose from the SRS MapCHECK, as shown in tables 19-21. As shown in Table 20, the gamma pass rate % generally decreases as both the MLC field size and jaw size increase. For smaller fields, such as 0.5×0.5 cm<sup>2</sup> and 1.0×1.0 cm<sup>2</sup> with jaw sizes up to 1.2×1.2 cm<sup>2</sup>, the gamma pass rates remained at 100%. For a 2.0×2.0 cm<sup>2</sup> MLC field size, pass rates slightly declined to 95.2% with jaw sizes of 2.2×2.2 cm<sup>2</sup> and which is within 95% acceptance threshold recommended by MPPG 5.b. However, for field sizes 3.0×3.0 cm<sup>2</sup> and larger, especially with

wider jaw openings > 4.2 cm<sup>2</sup>, gamma pass rates dropped more significantly. The lowest pass rate observed was 57.8% for a 6.0×6.0 cm<sup>2</sup> MLC and jaw configuration.

### 3.5 TG-119

Plan	(DTA/DD) 1 mm / 3%	(DTA/DD) 1 mm / 2%	(DTA/DD) 1mm / 1%	(DTA/DD) 2mm / 3%	(DTA/DD) 2mm / 2%	(DTA/DD) 2mm / 1%
Single Target	100%	100%	94.9%	100%	100%	99.6%

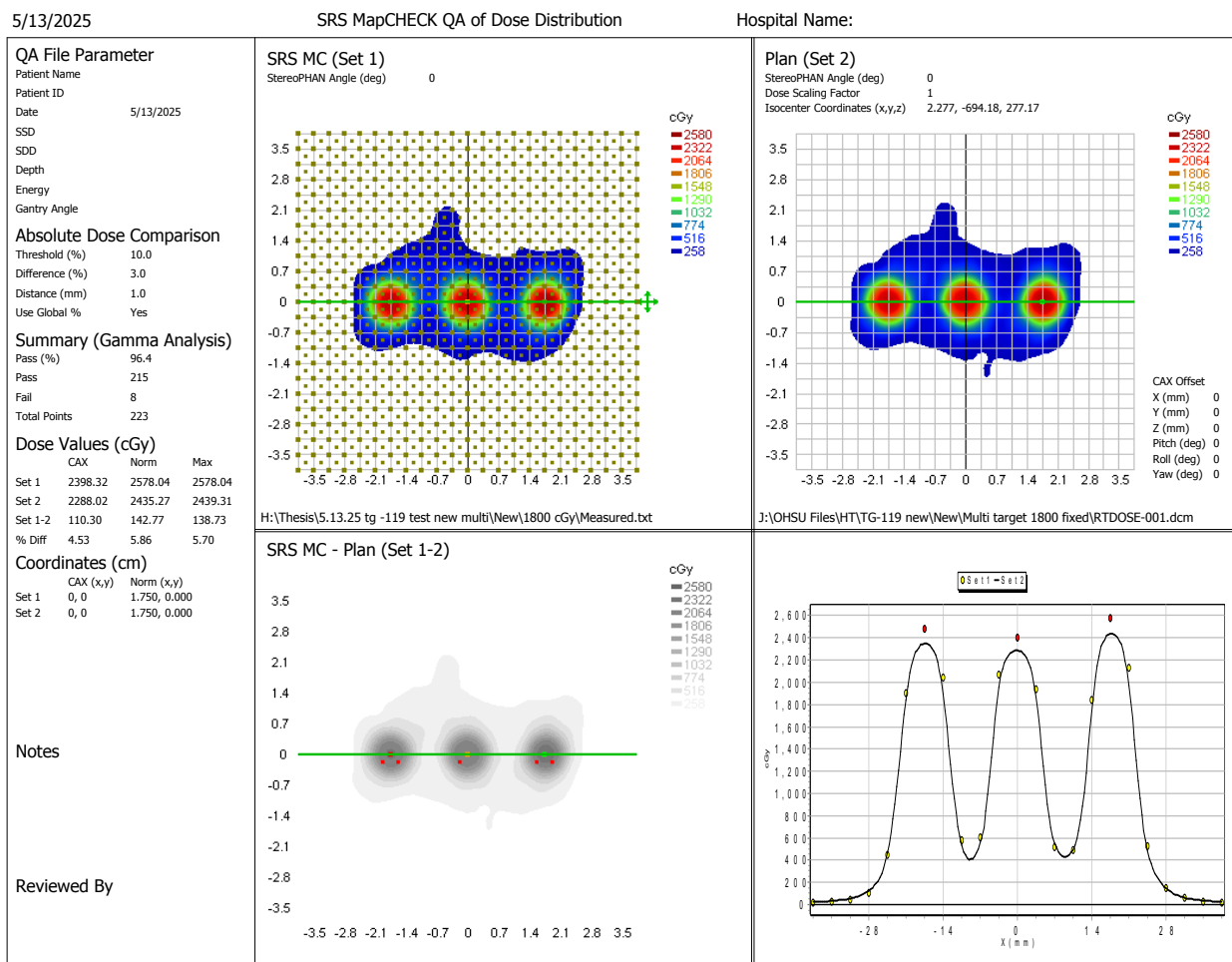
**Table 22: Gamma pass rates (%) for the single target test were measured using the SRS MapCHECK with various DTA/DD gamma criteria. A global analysis was used with a low dose threshold of 10% for all gamma criteria.**



**Figure 15: Measured dose distribution on SNC patient with a gamma pass rate of 100.0% for the single target test using gamma criteria of 1 mm/3%.**

Plan	(DTA/DD) 1 mm / 3%	(DTA/DD) 1 mm / 2%	(DTA/DD) 1mm / 1%	(DTA/DD) 2mm / 3%	(DTA/DD) 2mm / 2%	(DTA/DD) 2mm / 1%
Multi Target	96.4%	96%	94.6%	98.7%	98.2%	97.3%

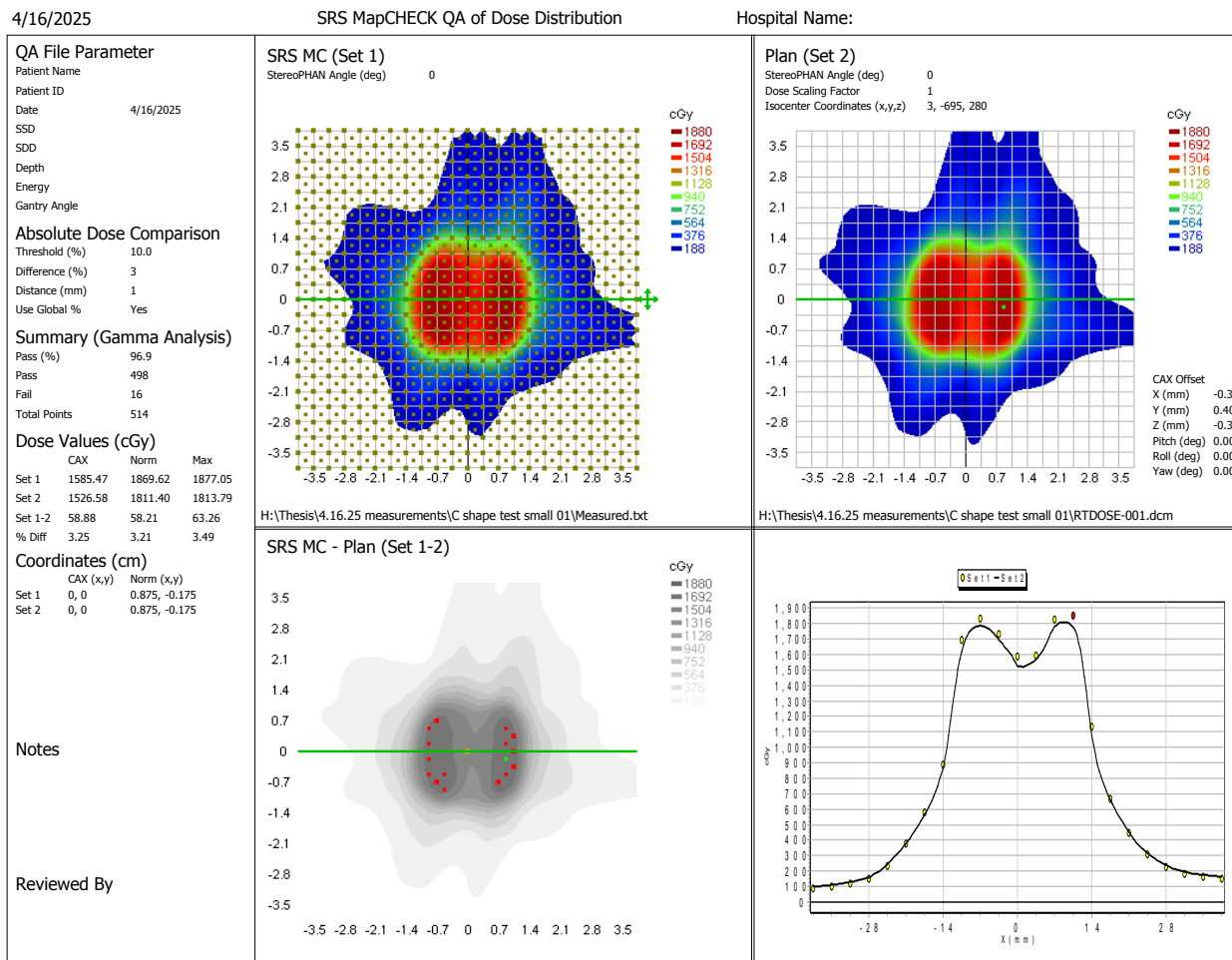
**Table 23: Gamma pass rates (%) for the multi-target test were measured using the SRS MapCHECK with various DTA/DD gamma criteria. A global analysis was used with a low dose threshold of 10% for all criteria.**



**Figure 16: Measured dose distribution on SNC patient with a gamma pass rate of 96.4% for the multi target test using gamma criteria of 1 mm/3%.**

Plan	(DTA/DD) 1 mm / 3%	(DTA/DD) 1 mm / 2%	(DTA/DD) 1mm / 1%	(DTA/DD) 2mm / 3%	(DTA/DD) 2mm / 2%	(DTA/DD) 2mm / 1%
C Shape	96.9%	94.9%	93.4%	98.4%	96.5%	95.7%

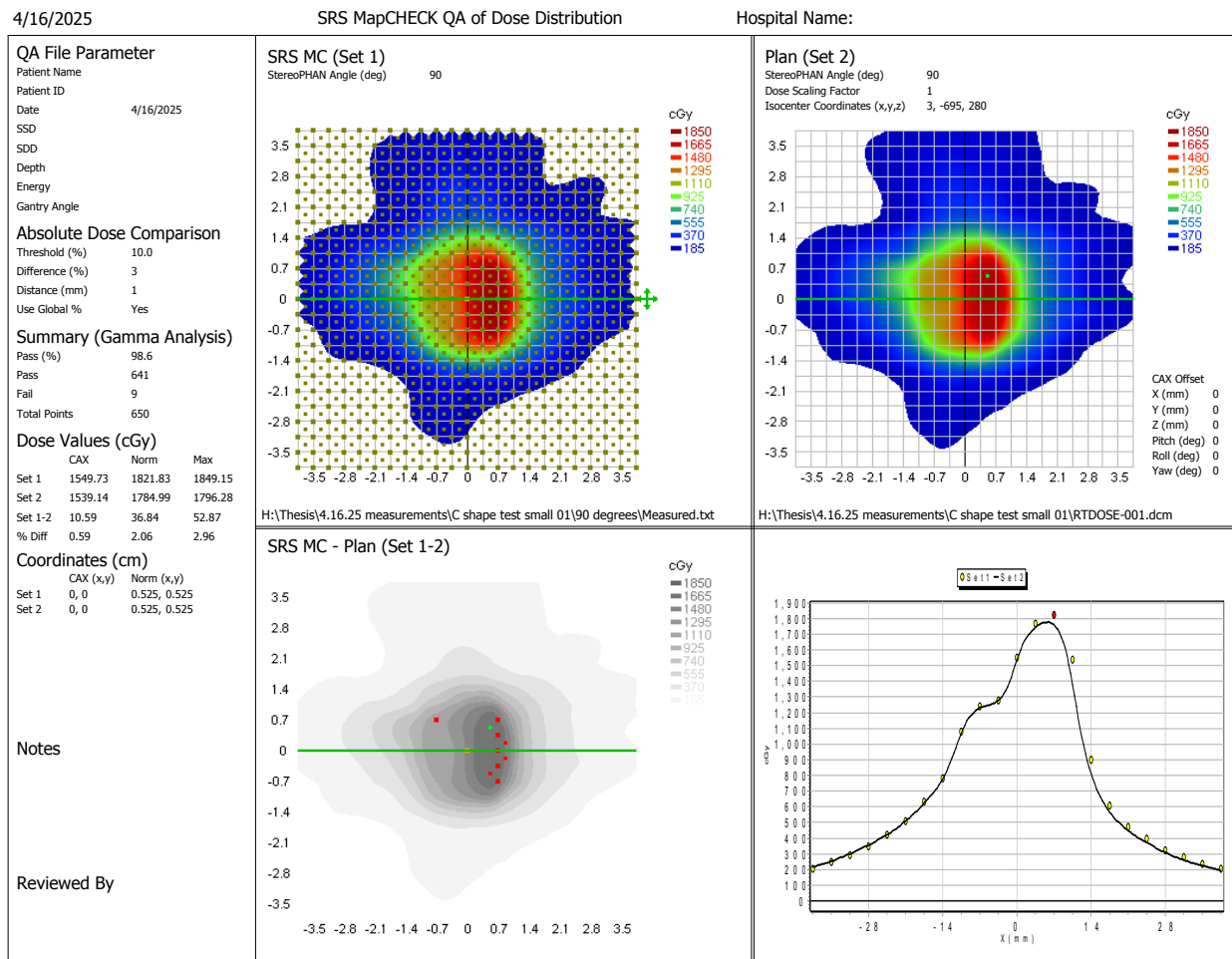
**Table 24: Gamma pass rates (%) for the C shape test were measured using the SRS MapCHECK with various DTA/DD gamma criteria. A global analysis was used with a low dose threshold of 10% for all criteria.**



**Figure 17: Measured dose distribution on SNC patient with a gamma pass rate of 96.9% for the C shape test using gamma criteria of 1 mm/3%.**

Plan	(DTA/DD) 1 mm / 3%	(DTA/DD) 1 mm / 2%	(DTA/DD) 1mm / 1%	(DTA/DD) 2mm / 3%	(DTA/DD) 2mm / 2%	(DTA/DD) 2mm / 1%
C Shape 90 Degrees	98.6%	98.0%	96.6%	99.5%	98.6%	98.3%

**Table 25: Gamma pass rates (%) for the C shape 90 ° test were measured using the SRS MapCHECK with various DTA/DD gamma criteria. A global analysis was used with a low dose threshold of 10% for all criteria.**



**Figure 18: Measured dose distribution on SNC patient with a gamma pass rate of 98.6% for the C shape 90 ° test using gamma criteria of 1 mm/3%.**

The single target, multi target, and C-shape TG-119 adapted tests were measured and compared to the DICOM-RT dose from Elements in SNC Patient using the SRS MapCHECK.

The gamma pass rate was recorded for gamma criteria of 1mm/3%, 1mm/2%, 1mm/1%,

2mm/3%, 2mm/2%, 2mm/1%. As shown in tables 22-25, higher gamma pass rates were observed for the single-target and multitarget tests across all gamma criteria, while the c shape test showed lower pass rates, particularly under tighter gamma criteria such as 1%/1 mm.

Gamma criteria	1mm/3%	1mm/2%	1mm/1%	2mm/3%	2mm/2%	2mm/1%
Mean Gamma pass rate all plans (%)	98	97.2	94.9	99.2	98.3	97.7
Standard Deviation (%)	1.6	2.3	1.3	0.7	1.4	1.6
95% Confidence limit (%)	94.7	92.8	92.3	97.7	95.5	94.5

**Table 26: Mean gamma pass rates for all plans were calculated along with the standard deviation to determine the confidence limit. All plans used a 10% low dose threshold and global analysis.**

Table 26 summarizes the mean gamma pass rates, standard deviations, and 95% confidence limits for the TG-119 adapted tests across different gamma criteria. The mean gamma pass rate was 98% for the 1 mm/3% criteria, which is the recommended tolerance with a passing threshold of >95%. A 95% confidence limit of 5.3% was calculated from the average gamma pass rate of the TG-119 plans, with a standard deviation of 1.6%.

## 4. Discussion

Table 8 shows the gamma pass rates comparing the Elements PB PDD to the microDiamond water scan measurements. Using a gamma criteria of 1 mm/1% pass rates were above 99.0% for all field sizes from  $0.5 \times 0.5 \text{ cm}^2$  up to  $10 \times 10 \text{ cm}^2$  which is within the acceptable tolerance of  $> 95\%$ . For a gamma criteria of 0.5mm/1% for all field sizes the lowest pass rate was 97% for a field size of  $2 \times 2 \text{ cm}^2$ . However, when the gamma criteria is 1mm/0.5% the lowest gamma rate is 57% for a field size of  $3 \times 3 \text{ cm}^2$ . This indicates that the dose difference for PDDs for the gamma criteria has more of an effect compared to the DTA criteria. Further reducing the gamma criteria to a 0.5mm/0.5% the gamma pass rates for a  $0.5 \times 0.5 \text{ cm}^2$  is 62.0% while the  $1 \times 1 \text{ cm}^2$  is 71.9% and then  $2 \times 2 \text{ cm}^2$  is 35.2%,  $3 \times 3 \text{ cm}^2$  is 30.0% then the gamma pass rates goes up at a  $4 \times 4 \text{ cm}^2$  with a pass rate of 79.9% and then increases as the field size increases.

For crossline gamma pass rates from Table 12 using the 1 mm/1% gamma criteria, pass rates were above 95.1% for all field size combinations at a depth of 1.3 cm. However, for the crossline measurements at 5 cm depth with the 1mm/1% gamma criteria, the pass rate is 100% for a  $0.5 \times 0.5 \text{ cm}^2$  MLC field size with an  $0.8 \times 0.8 \text{ cm}^2$  jaw size. The gamma pass rates then decrease as the MLC field size increases from 2 cm to 3 cm but rise again to 94.3% at a 4 cm MLC field size and continue to increase thereafter. The same trend follows at a depth of 10 cm but the pass rates are much lower with the MLC field size being at  $3 \times 3 \text{ cm}^2$  with a 39.4% pass rate. For the inline gamma pass rates from Tables 16-17 the trend is similar to that of the crossline pass rates, where at depths of 5 cm and 10 cm, the gamma pass rates drop for MLC field sizes between  $2 \times 2 \text{ cm}^2$  and  $3 \times 3 \text{ cm}^2$ , but increase again at a  $4 \times 4 \text{ cm}^2$  MLC field size.

Figures 11 and 12 show failing gamma points outside the 50% isodose line, which typically defines the field size for conventional fields ( $> 3 \times 3 \text{ cm}^2$ ). This suggests the TPS may not

be accurately modeling dose in the out of field region. This may be caused by the lack of lateral CPE and source occlusion which cause the penumbra to widen beyond the geometric field edge<sup>5</sup>. The dip in gamma pass rate from  $1 \times 1 \text{ cm}^2$  to  $3 \times 3 \text{ cm}^2$  further suggests that the model may struggle in this transitional field size range, as the pass rates increase again beyond  $3 \times 3 \text{ cm}^2$ .

For the MU hand calculated dose shown in Table 18, when the MLC field size is kept constant and the jaw size increases, the MU hand calculated dose in cGy increases as shown with a MLC field size of  $0.5 \times 0.5 \text{ cm}^2$  and  $0.8 \times 0.8 \text{ cm}^2$  jaw field size with a hand calc dose of 180.5 cGy compared to a dose of 185.2 cGy for a MLC field size of  $0.5 \times 0.5 \text{ cm}^2$  and  $1.2 \times 1.2 \text{ cm}^2$  jaw size. The Elements TPS dose follows a similar trend, where increasing the jaw size while keeping the MLC size constant results in a higher dose. A reasoning for this is because moving the jaws farther away exposes more of the MLC leaf ends, allowing additional scatter and leakage to contribute to the dose. When the jaws are collimated closer to the MLC field size, they help reduce leakage and transmission which causes a lower output<sup>16</sup>.

When comparing the MU hand calculated dose to the Elements TPS dose, the percent difference is greatest at the smallest field size of  $0.5 \times 0.5 \text{ cm}^2$  MLC and  $0.8 \times 0.8 \text{ cm}^2$  jaws, with a difference of 1.38%. For the same MLC size, increasing the jaw size to  $1.2 \times 1.2 \text{ cm}^2$  and  $2.2 \times 2.2 \text{ cm}^2$  results in percent differences of 0.97% and 1.02%. The percent difference significantly decreases as the field size increases, which may indicate that the model performs more accurately for conventional field sizes larger than  $3 \times 3 \text{ cm}^2$ . This also suggests that for the smallest fields, the model may struggle to compute dose accurately due to the absence of CPE and the effects of source occlusion, resulting in the largest percent difference. However, all percent differences remain within the 2% tolerance recommended by MPPG 5.b. These results

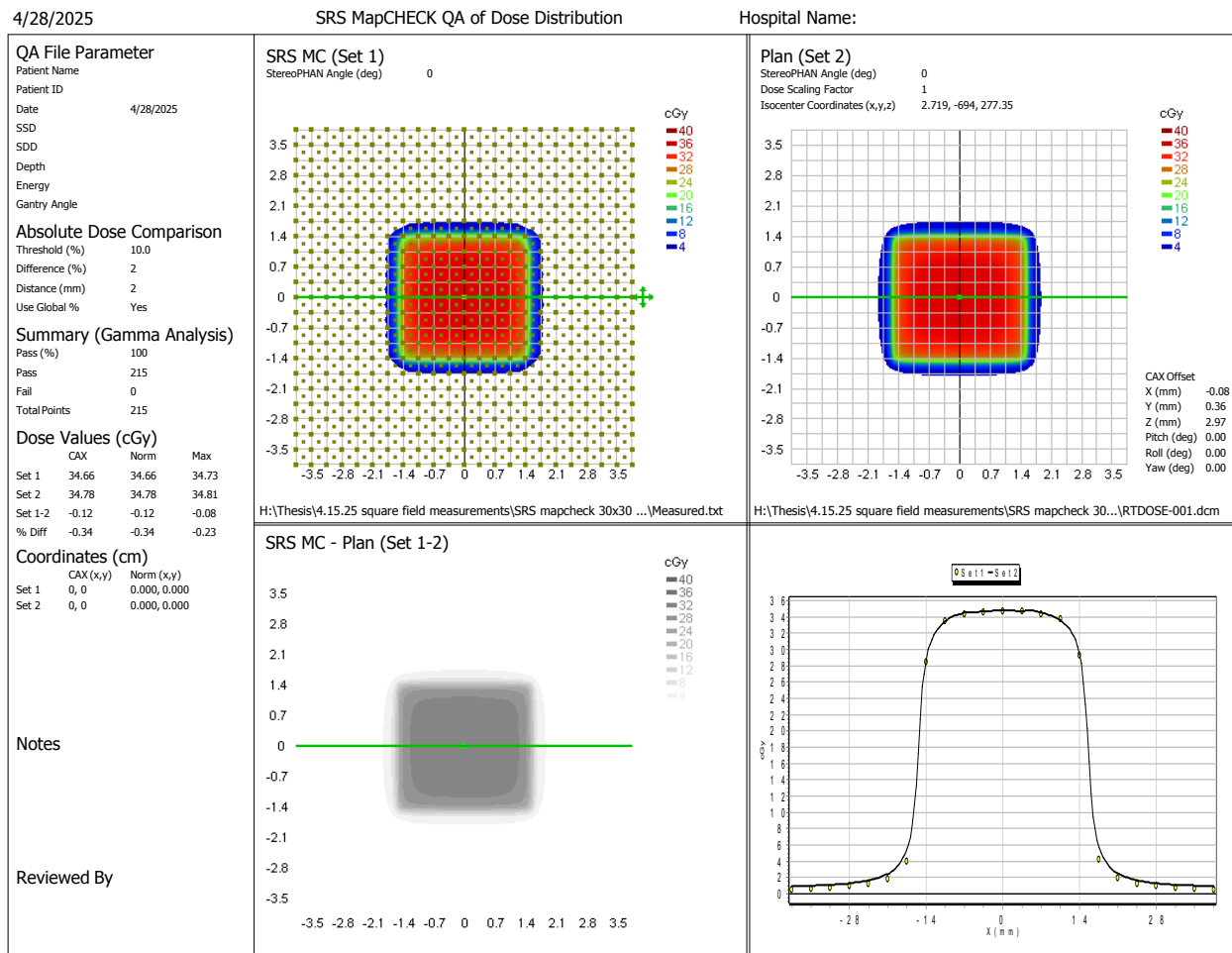
were calculated using 500 MU instead of the initially 50 MU to obtain an additional decimal precision in the TPS calculated dose.

For the planar measurements following MPPG 5.b Tables 19–21, the gamma pass rates generally decreased as field size increased. According to MPPG 5.b, a 2mm/2% gamma criteria with a 95% pass rate threshold and a 10% low dose threshold is the recommended acceptance criteria for planar measurements <sup>7</sup>. For the 0.5×0.5 cm<sup>2</sup> field size, only nine points are analyzed in the gamma analysis, resulting in a 100% pass rate across the 1mm/1%, 2mm/2%, and 1mm/3% criteria.

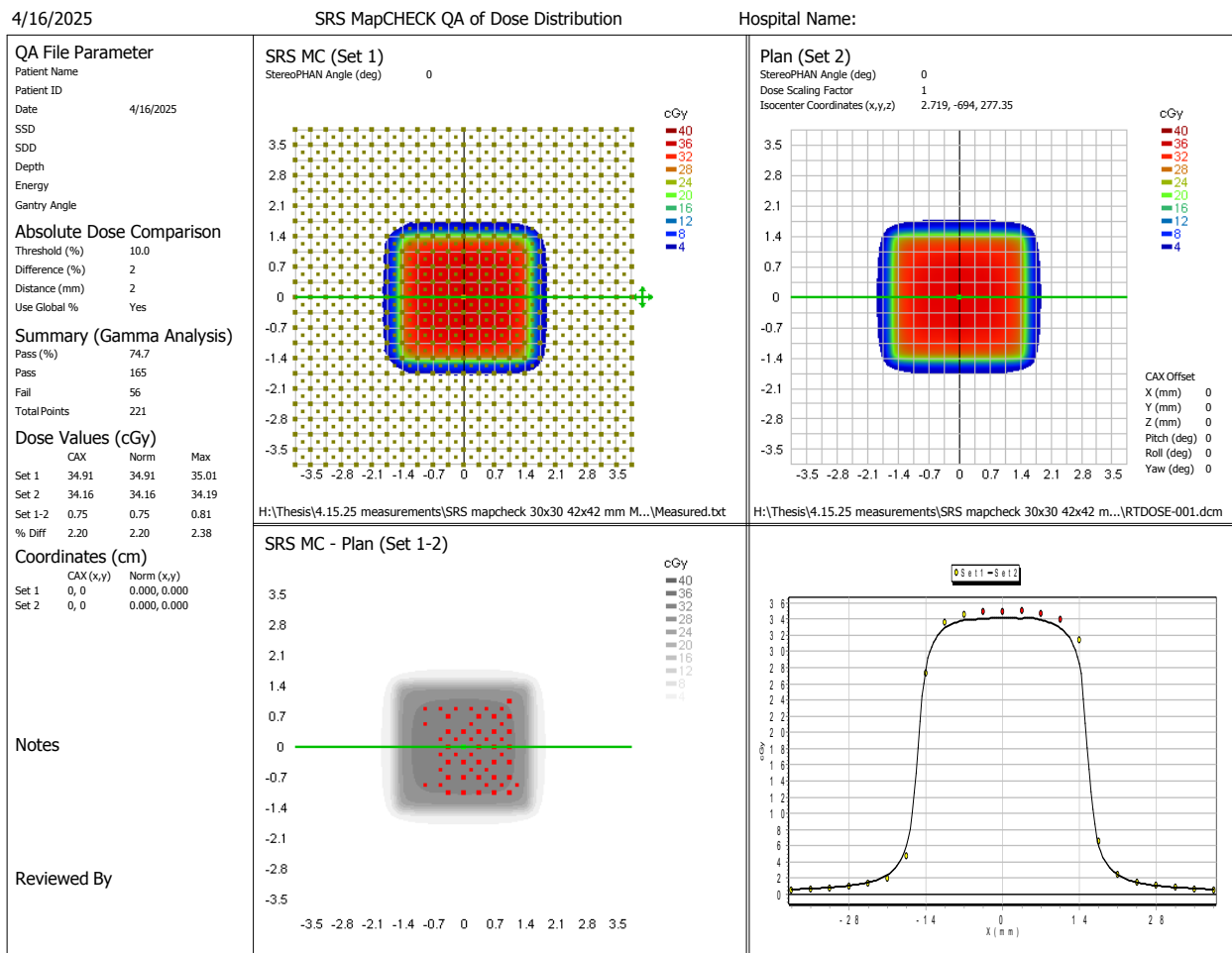
Across all three gamma criteria, a decrease in gamma pass rates is observed as both the MLC field size and jaw size increase. A fixed amount of 100 MU was delivered for each field, which may have contributed to lower gamma pass rates in larger field sizes due to reduced detector signal, leading to increased measurement uncertainty. When the MLC field size is kept constant, but the jaw size increases, a lower gamma pass rate is also observed. For example, the 3×3 cm<sup>2</sup> MLC field with a 3.2×3.2 cm<sup>2</sup> jaw had a 2 mm/2% gamma pass rate of 100.0%, while the same MLC field with a 4.2×4.2 cm<sup>2</sup> jaw had a pass rate of 74.7%.

As shown in Figures 19-20, the dose distribution from the SNC Patient reveals more hotspot failures when the jaw size is increased, which may be due to additional scatter introduced by the larger jaw settings. This increased scatter may not be fully accounted for in the TPS model, leading to dose discrepancies in the measured versus calculated distributions. For a gamma criteria of 2mm/2%, the pass rates are above 90% for an MLC field size of 3×3 cm<sup>2</sup> with a 3.2×3.2 cm<sup>2</sup> jaw size. However, as the jaw size increases beyond 3.2×3.2 cm<sup>2</sup>, the gamma pass rates drop below 74.7% as both the MLC and jaw sizes increase. Even though the planar field

did not pass, TG-119 plans were still measured, as they are more representative of clinical treatment delivery than planar measurements.



**Figure 19: Measured dose distribution on SRS mapCHECK is shown in the left panel, while the Elements DICOM-RT dose is shown in the right panel. The bottom left highlights the locations of failed points from the gamma analysis. 3x3 cm<sup>2</sup> MLC field size and 3.2x3.2 cm<sup>2</sup> jaw size with a gamma criteria of 2mm/2% using a low dose threshold of 10% and a global analysis. Gamma pass rate of 100.0%**



**Figure 20: Measured dose distribution on SRS mapCHECK is shown in the left panel, while the Elements DICOM-RT dose is shown in the right panel. The bottom left highlights the locations of failed points from the gamma analysis. 3x3 cm<sup>2</sup> MLC field size and 4.2x4.2 cm<sup>2</sup> jaw size with a gamma criteria of 2mm/2% using a low dose threshold of 10% and a global analysis. Gamma pass rate of 74.7%**

For the TG-119 plans, the analysis follows the TG-119 methodology for calculating confidence limits, which indicate the expected range of deviation within a 95% confidence interval. A gamma criteria of 1 mm/3% with a 10% low dose threshold was used, where a gamma pass rate of >95% is considered acceptable <sup>11,27</sup>. From Table 25, using gamma criteria of 1 mm/3%, the mean gamma pass rate across all plans is 98.0% with a standard deviation of 1.6%, resulting in a confidence limit of 5.3%. A confidence limit of 5.3% indicates that, with

95% confidence, the gamma pass rate will be at least 94.7% for future measurements.

Comparing these values to another institution that performed a much larger adapted SRS TG-119 dataset with the SRS MapCHECK, the results are slightly lower. That institution reported an average gamma pass rate of 99.8% with a standard deviation of 0.7% and a confidence limit of 1.7% using similar gamma criteria of 1 mm/3%<sup>27</sup>.

## 5. Sources of Error

Several sources of uncertainty may have influenced the agreement between measured and TPS calculated dose distributions. In Brainlab Elements, a 1 mm dose grid resolution was used for dose calculation, which may have impacted the accuracy of dose modeling in the penumbra region, where rapid dose falloff occurs. This could have affected the shape of the profiles, potentially influencing the gamma analysis comparison between the measured and TPS calculated dose distributions. Additionally, transferring data from Elements to DICOM2MCC may have introduced spatial uncertainties due to grid alignment or interpolation, which was not verified in this study. Given the 1 mm dose grid resolution used in Elements which would affect gamma analysis results in the penumbra region.

Detector-related uncertainties were also present, including limitations from the 2.47 mm diode spacing of the SRS MapCHECK. For small fields like 0.5×0.5 cm<sup>2</sup>, only a few detectors fall within the high dose region, reducing the number of points available for gamma analysis. Additionally, using 100 MU for all fields may have resulted in low signal, increasing the impact of statistical noise. These combined uncertainties should be considered when interpreting TPS validation results, especially for small fields where minor discrepancies can significantly affect gamma pass rates.

Another source of uncertainty is that the beam model was created using commissioning data from 2019, while the TPS validation for the new measurements such as the planar and TG-119 tests was performed in 2025. Over this six-year period, mechanical parameters of the linear accelerator, such as jaw and MLC calibration, may have shifted due to system aging or wear. This may have introduced discrepancies between the 2019 TPS model parameters and the current machine parameters, which may affect gamma pass rates.

## 6. Summary and Conclusion

Following MPPG 5.b guidelines, the Elements TPS was validated through PDDs, profiles, output measurements, and TG-119 tests. PDDs for all field sizes with a gamma criteria of 1mm/1% had a pass rate above 99.0%, where a stricter DD criteria showed lower gamma pass rates. Profile validation demonstrated that crossline and inline gamma pass rates decreased for MLC field sizes between  $2 \times 2$  cm<sup>2</sup> and  $3 \times 3$  cm<sup>2</sup>, but improved again at  $4 \times 4$  cm<sup>2</sup>. Lower pass rates were also observed at deeper depths when using the 1 mm/1% criteria, suggesting that the beam model may not accurately represent dose falloff in these regions, particularly in the out of field and penumbra areas, and may struggle with modeling the transition from small to conventional field sizes.

Output validation comparing MU hand calculations to Elements TPS doses showed that the percent difference was highest at the smallest field size of  $0.5 \times 0.5$  cm<sup>2</sup> MLC with  $0.8 \times 0.8$  cm<sup>2</sup> jaws, reaching 1.38%. This may be due to modeling challenges with small fields due to the lack of lateral CPE and the source occlusion effect.

Planar measurements showed a decrease in gamma pass rates as field and jaw sizes increased, with 2%/2 mm criteria yielding acceptable pass rates above 90% for a  $3 \times 3$  cm<sup>2</sup> MLC with a  $3.2 \times 3.2$  cm<sup>2</sup> jaw, but lower pass rates with larger jaw openings indicating that the model

may not fully model scatter or out of field contributions. TG-119 plan validation following the 1mm/3% gamma criteria showed a confidence limit of 94.7% with a gamma pass rate of 97.2% and a standard deviation of 1.6% for all plans. Compared to planar measurements, TG-119 plans showed better agreement with the TPS, suggesting that the model performs more accurately under clinically representative conditions than in simplified static fields. Although TG-119 plans had higher gamma pass rates, further investigation is needed for the planar SRS MapCHECK measurements at field sizes of  $3.0 \times 3.0 \text{ cm}^2$  and larger. It is important to verify simple static fields as these fields help isolate specific modeling issues that may be obscured by the averaging of multiple beams in the TG-119 plans.

## 7. Future work

Further exploration of gamma analysis parameters, such as adjusting the low dose threshold in the gamma criteria, could help identify failures in high dose regions, which are especially important in SRS treatments. Plan modulation could also be investigated to improve dose distributions by adjusting the modulation sliders available in both the Multiple Brain Metastases and Cranial modules. By increasing modulation and creating more complex fluence patterns the TPS dose distribution can be compared to SRS MapCHECK measurements, allowing for a more rigorous validation of the treatment planning system.

Additional tests beyond TG-119 could be incorporated, including those with smaller targets to better replicate clinical SRS treatments. Instead of relying solely on gamma analysis as the evaluation metric for plans, chamber and film measurements can provide additional datasets by calculating the measured dose and comparing it to the TPS calculated dose. Expanding both the measured and TPS calculated dose datasets would allow for a broader investigation of potential sources of error and enable the use of multiple detectors, ultimately contributing to

more statistically robust confidence limits. Collecting new PDD and profile scans and comparing them to the TPS model would help assess whether changes in machine parameters over time have contributed to discrepancies in gamma pass rates. Increasing the sample size of measurement datasets such as including additional field sizes, depths, or repeated measurements would improve statistical power and make the analysis more reliable. Additionally, external validation by an independent reviewer could help identify any remaining errors in the TPS validation process, as recommended by MPPG 5.b. The Monte Carlo algorithm data was not fully explored in this study and could be evaluated in future work, along with the use of 10 MV FFF data.

## References

1. McDermott PN, Orton CG. Proton Therapy Physics. In: The Physics and Technology of Radiation Therapy, 2nd Ed, EBook. Medical Physics Publishing, Inc; 2018.
2. Halvorsen PH, Cirino E, Das IJ, et al. AAPM-RSS Medical Physics Practice Guideline 9.a. for SRS-SBRT. *Journal of applied clinical medical physics*. 2017;18(5):10-21. doi:10.1002/acm2.12146
3. Vesper J, Bölke E, Wille C, et al. Current concepts in stereotactic radiosurgery - a neurosurgical and radiooncological point of view. *European journal of medical research*. 2009;14(3):93-101. doi:10.1186/2047-783X-14-3-93
4. Das IJ, Francescon P, Moran JM, et al. Report of AAPM Task Group 155: Megavoltage photon beam dosimetry in small fields and non-equilibrium conditions. *Medical physics (Lancaster)*. 2021;48(10):e886-e921. doi:10.1002/mp.15030
5. Palmans H, Andreo P, Huq MS, Seuntjens J, Christaki KE, Meghzifene A. Dosimetry of small static fields used in external photon beam radiotherapy: Summary of TRS-483, the IAEA–AAPM international Code of Practice for reference and relative dose determination. *Medical physics (Lancaster)*. 2018;45(11):e1123-e1145. doi:10.1002/mp.13208
6. Das IJ, Ding GX, Ahnesjö A. Small fields: nonequilibrium radiation dosimetry. *Med Phys*. 2008;35(1):206-215. doi:10.1118/1.2815356
7. Geurts MW, Jacqmin DJ, Jones LE, et al. AAPM MEDICAL PHYSICS PRACTICE GUIDELINE 5.b: Commissioning and QA of treatment planning dose calculations—Megavoltage photon and electron beams. *Journal of applied clinical medical physics*. 2022;23(9):e13641-n/a. doi:10.1002/acm2.13641

8. Das IJ, Cheng CW, Watts RJ, et al. Accelerator beam data commissioning equipment and procedures: Report of the TG-106 of the Therapy Physics Committee of the AAPM. *Medical physics (Lancaster)*. 2008;35(9):4186-4215. doi:10.1118/1.2969070
9. Elcim Y, Dirican B, Yavas O. Dosimetric comparison of pencil beam and Monte Carlo algorithms in conformal lung radiotherapy. *Journal of applied clinical medical physics*. 2018;19(5):616-624. doi:10.1002/acm2.12426
10. Brainlab Elements Technical Reference Guide. Brainlab AG, 2018.
11. Miften M, Olch A, Mihailidis D, et al. Tolerance limits and methodologies for IMRT measurement-based verification QA: Recommendations of AAPM Task Group No. 218. *Medical physics (Lancaster)*. 2018;45(4):e53-e83. doi:10.1002/mp.12810
12. Ahmed S, Zhang G, Moros EG, Feygelman V. Comprehensive evaluation of the high-resolution diode array for SRS dosimetry. *Journal of applied clinical medical physics*. 2019;20(10):13-23. doi:10.1002/acm2.12696
13. Sadowski BM, Fillmann M, Szałkowski D, Kukołowicz P. Evaluation of SRS MapCHECK with StereoPHAN phantom as a new pre-treatment system verification for SBRT plans. *Polish journal of medical physics and engineering*. 2022;28(2):84-89. doi:10.2478/pjmpe-2022-0010
14. Ezzell GA, Burmeister JW, Dogan N, et al. IMRT commissioning: Multiple institution planning and dosimetry comparisons, a report from AAPM Task Group 119. *Medical physics (Lancaster)*. 2009;36(11):5359-5373. doi:10.1118/1.3238104
15. Knill C, Sandhu R, Halford R, Snyder M, Seymour Z. Commissioning cranial single-isocenter multi-target radiosurgery for the Versa HD. *Journal of applied clinical medical physics*. 2021;22(4):108-114. doi:10.1002/acm2.13223

16. Chow JCL, Seguin M, Alexander A. Dosimetric effect of collimating jaws for small multileaf collimated fields. *Medical physics (Lancaster)*. 2005;32(3):759-765. doi:10.1118/1.1861413
17. Chaikh A, Giraud JY, Perrin E, Bresciani JP, Balosso J. The choice of statistical methods for comparisons of dosimetric data in radiotherapy. *Radiation oncology (London, England)*. 2014;9(1):205-205. doi:10.1186/1748-717X-9-205
18. Ghasemi A, Zahediasl S. Normality Tests for Statistical Analysis: A Guide for Non-Statisticians. *International journal of endocrinology and metabolism*. 2012;10(2):486-489. doi:10.5812/ijem.3505
19. Das IJ, Ding GX, Ahnesjö A. Small fields: Nonequilibrium radiation dosimetry. *Medical physics (Lancaster)*. 2008;35(1):206-215. doi:10.1118/1.2815356
20. Fraass B, Doppke K, Hunt M, et al. American Association of Physicists in Medicine Radiation Therapy Committee Task Group 53: Quality assurance for clinical radiotherapy treatment planning. *Medical physics (Lancaster)*. 1998;25(10):1773-1829. doi:10.1118/1.598373
21. Menon SV, Paramu R, Bhasi S, Gopalakrishnan Z, Bhaskaran S, Nair RK. Dosimetric comparison of iPlan® Pencil Beam (PB) and Monte Carlo (MC) algorithms in stereotactic radiosurgery/radiotherapy (SRS/SRT) plans of intracranial arteriovenous malformations. *Medical dosimetry : official journal of the American Association of Medical Dosimetrists*. 2020;45(3):225-234. doi:10.1016/j.meddos.2019.12.006
22. Wang L, Yorke E, Chui CS. Monte Carlo evaluation of tissue inhomogeneity effects in the treatment of the head and neck. *International journal of radiation oncology, biology, physics*. 2001;50(5):1339-1349. doi:10.1016/S0360-3016(01)01614-5

23. Brainlab Elements Multiple Brain Mets, Version 4.5 User Guide. Munich, Germany: Brainlab AG; 2018.
24. Brainlab Elements Cranial SRS, Version 4.5 User Guide. Munich, Germany: Brainlab AG; 2018.
25. Gibbons JP, Khan FM. Khan's the Physics of Radiation Therapy. Sixth edition. Wolters Kluwer; 2020.
26. Brainlab Elements RT QA, Version 4.5 User Guide. Munich, Germany: Brainlab AG; 2018.
27. Culcasi R, Baran G, Dominello M, Burmeister J. Stereotactic radiosurgery commissioning and QA test cases—A TG-119 approach for Stereotactic radiosurgery. *Medical physics (Lancaster)*. 2021;48(12):7568-7579. doi:10.1002/mp.15087
28. Law MYY, Liu B. Informatics in radiology: DICOM-RT and its utilization in radiation therapy. *Radiographics*. 2009;29(3):655-667. doi:10.1148/rg.293075172
29. Low DA, Harms WB, Mutic S, Purdy JA. A technique for the quantitative evaluation of dose distributions. *Medical physics (Lancaster)*. 1998;25(5):656-661. doi:10.1118/1.598248
30. Tahmasbi M, Capela M, Santos T, Mateus J, Ventura T, do Carmo Lopes M. Particular issues to be considered in small field dosimetry for TrueBeam STx commissioning. *Applied radiation and isotopes*. 2023;202:111066-111066. doi:10.1016/j.apradiso.2023.111066
31. Sun Nuclear Corporation. SRS MapCHECK: SRS & SBRT QA, No Film [data sheet]. Melbourne, FL: Sun Nuclear Corporation; September 12, 2022. Accessed June 2, 2025.

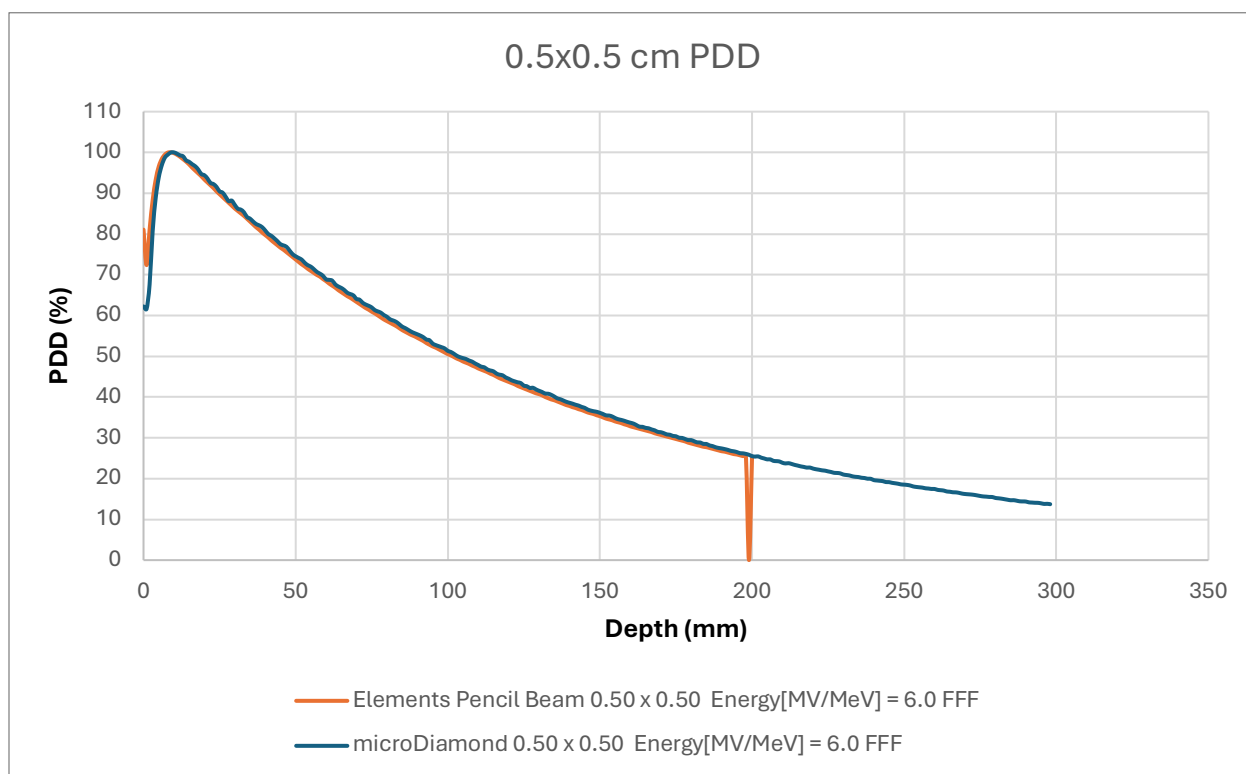


## Appendix

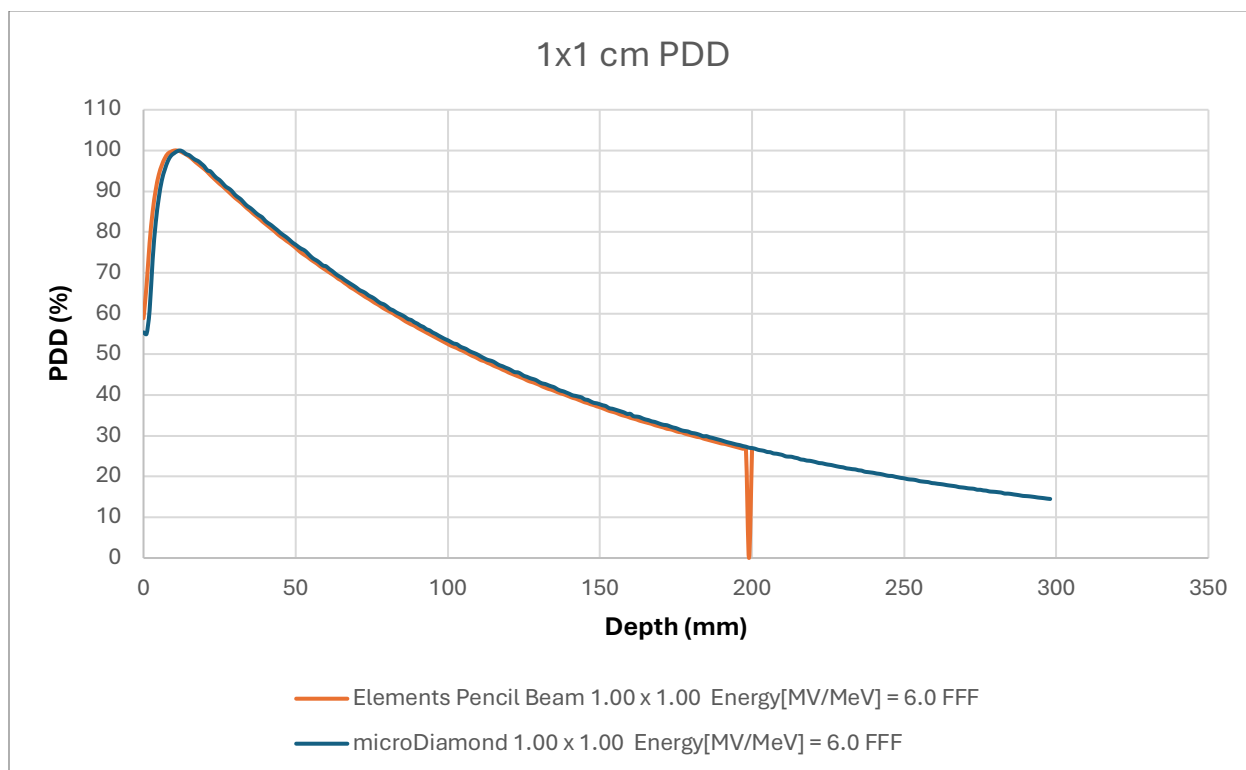
### 1. PDDs

All PDDs were taken at an SSD of 100 cm.

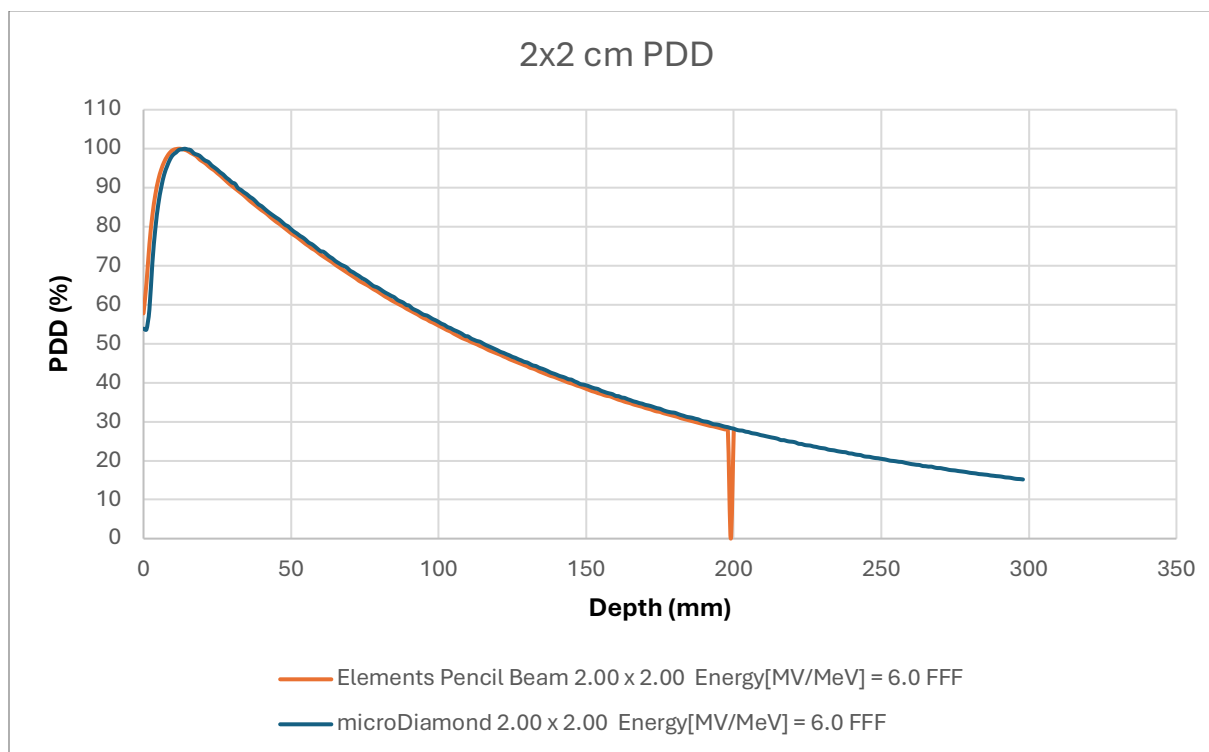
2. Scan	Dose at 0 cm depth (PDD %)	Depth of Maximum Dose (cm)	Dose at 10 cm depth (PDD %)
<b>Elements PB</b> (Calculated)	81.06	0.9	50.52
<b>microDiamond</b> (Measured)	62.23	0.9	51.32



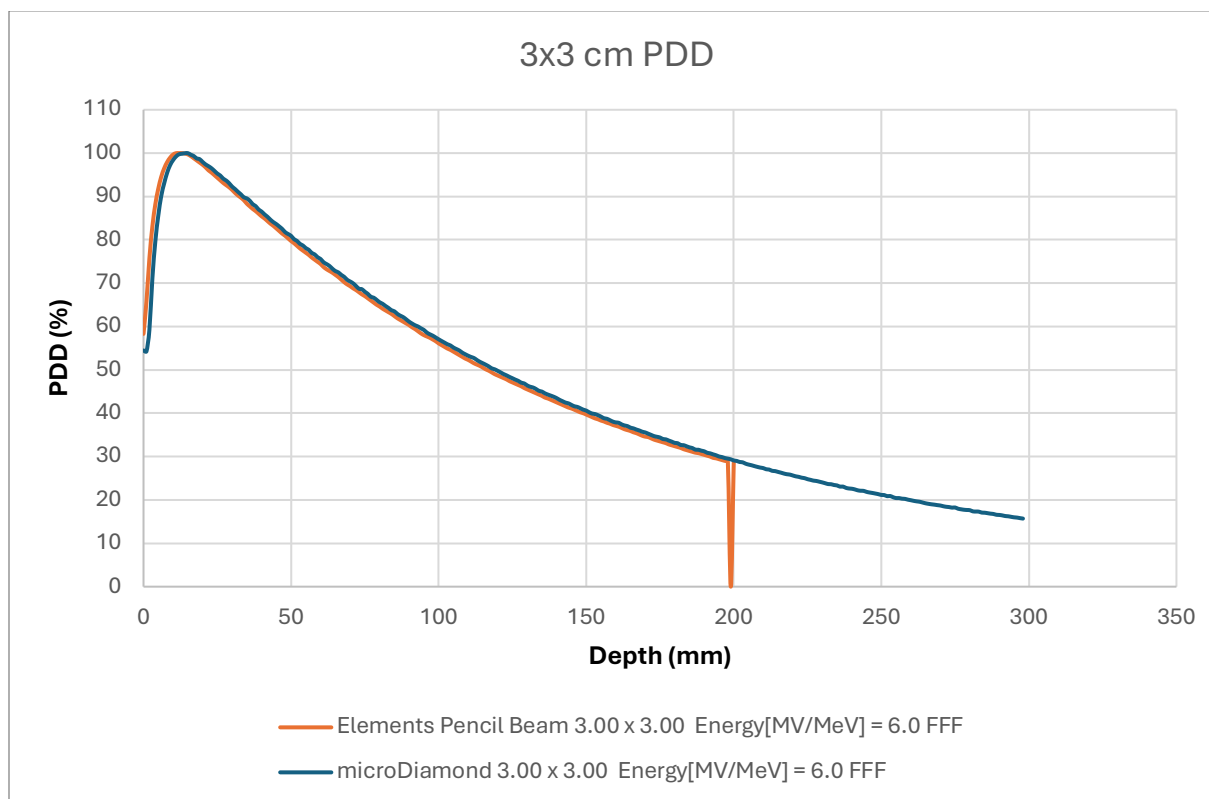
Scan	Dose at 0 cm depth (PDD %)	Depth of Maximum Dose (cm)	Dose at 10 cm depth (PDD %)
<b>Elements PB</b> (Calculated)	58.84	1.1	52.52
<b>microDiamond</b> (Measured)	55.37	1.1	53.43



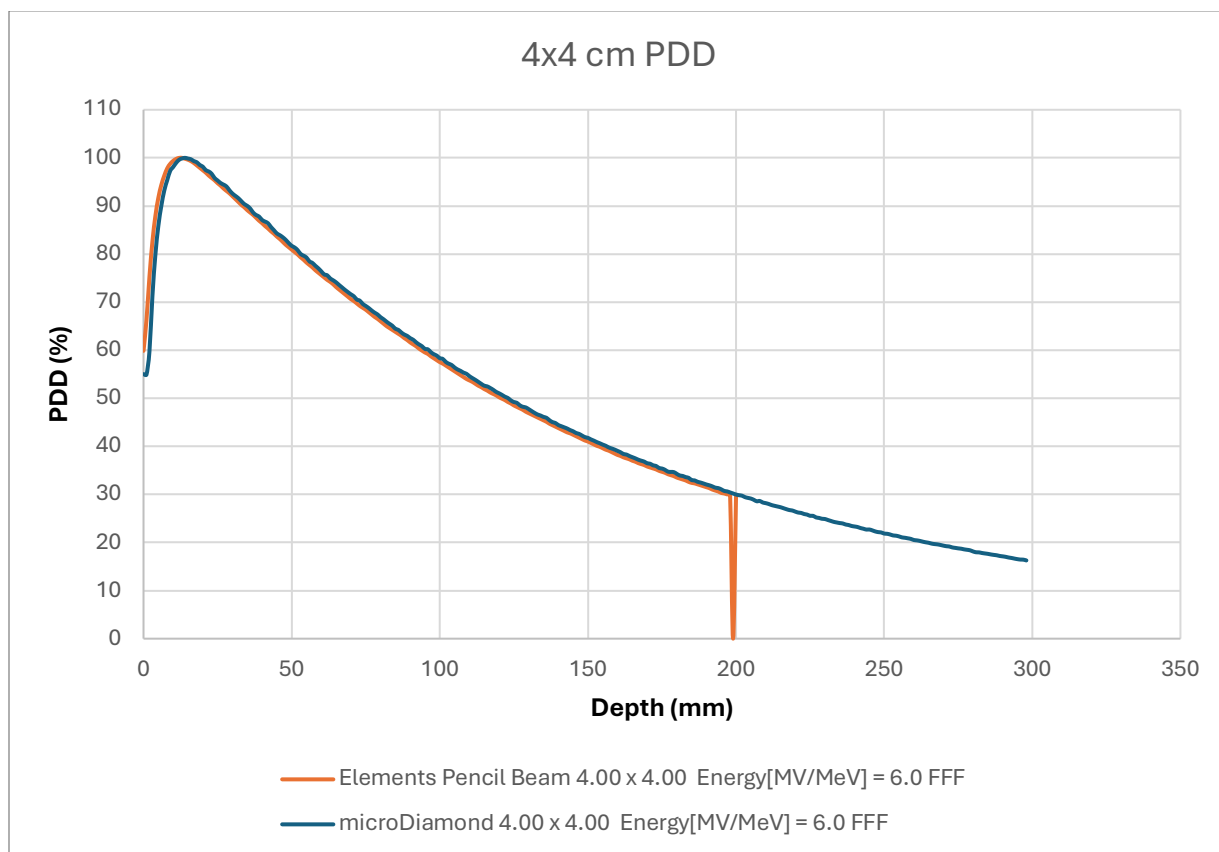
Scan	Dose at 0 cm depth (PDD %)	Depth of Maximum Dose (cm)	Dose at 10 cm depth (PDD %)
<b>Elements PB</b> (Calculated)	57.76	1.2	54.62
<b>microDiamond</b> (Measured)	53.85	1.2	55.57



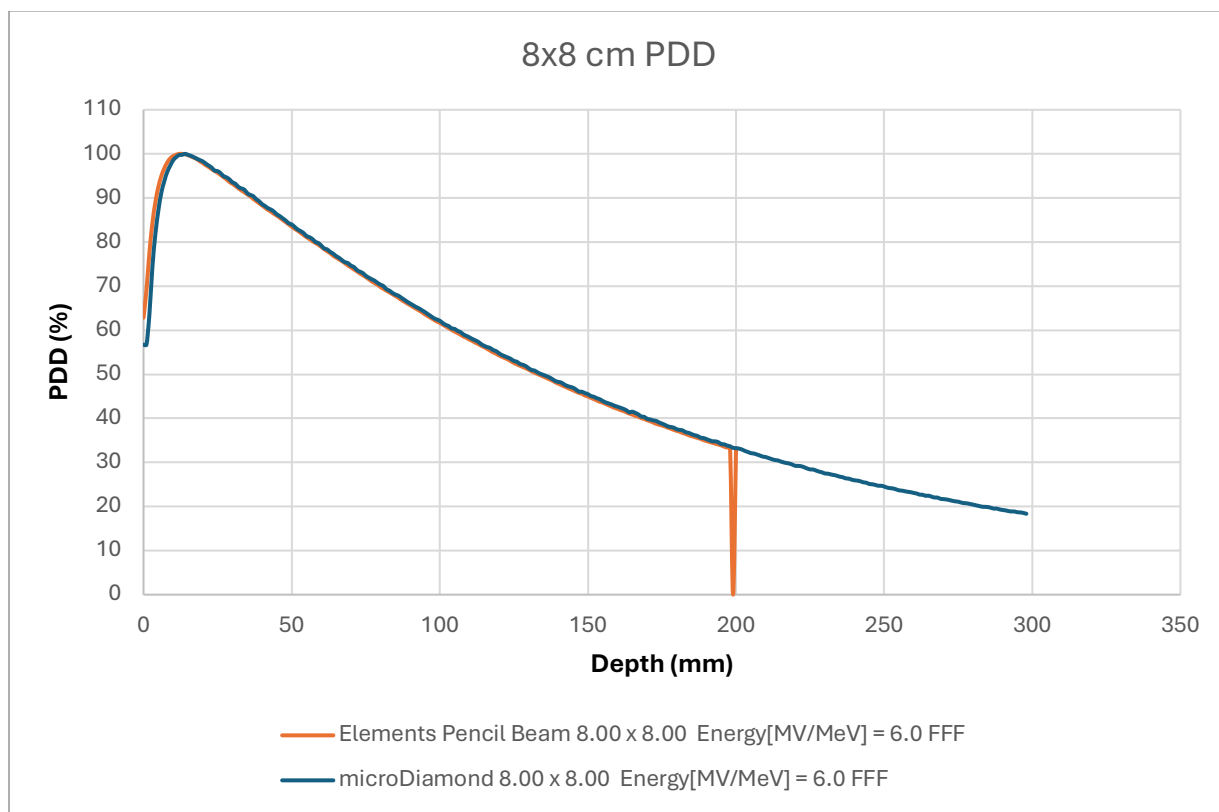
Scan	Dose at 0 cm depth (PDD %)	Depth of Maximum Dose (cm)	Dose at 10 cm depth (PDD %)
<b>Elements PB</b> (Calculated)	58.30	1.2	56.12
<b>microDiamond</b> (Measured)	54.48	1.2	57.06



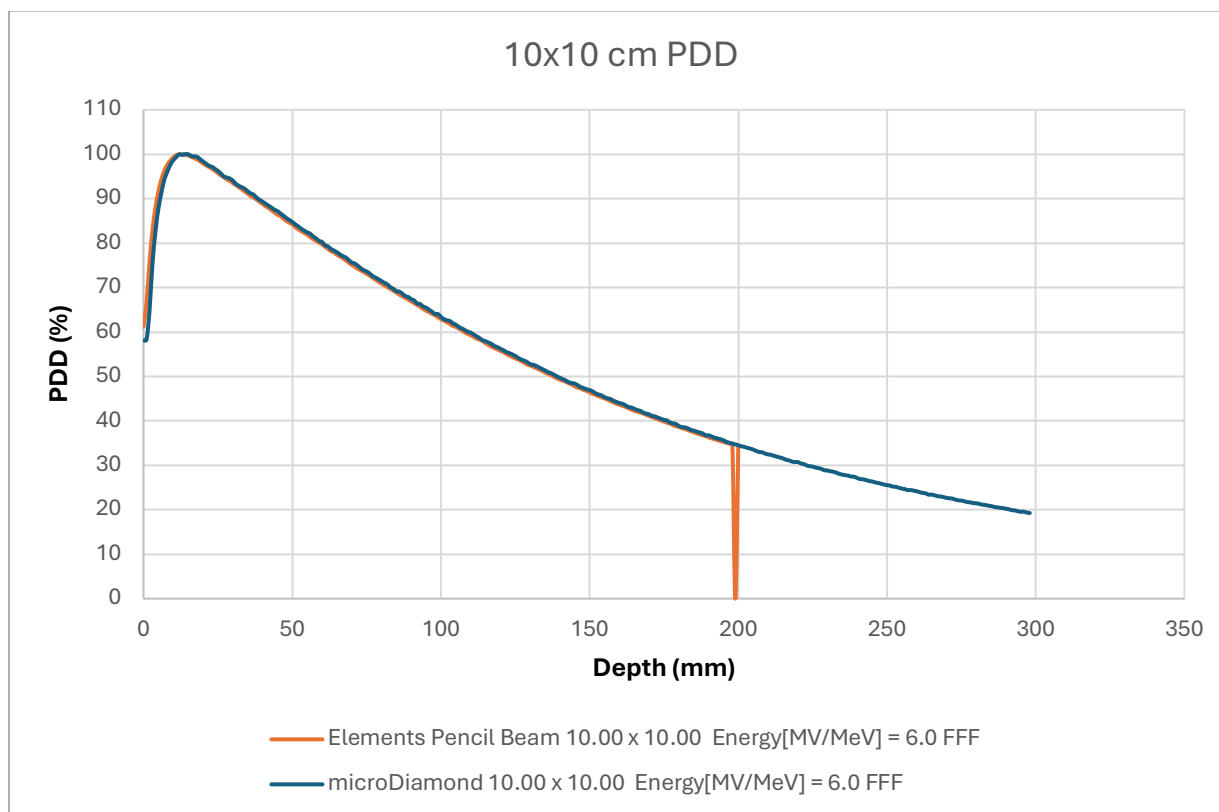
Scan	Dose at 0 cm depth (PDD %)	Depth of Maximum Dose (cm)	Dose at 10 cm depth (PDD %)
<b>Elements PB</b> (Calculated)	59.86	1.3	57.51
<b>microDiamond</b> (Measured)	55.02	1.2	58.33



Scan	Dose at 0 cm depth (PDD %)	Depth of Maximum Dose (cm)	Dose at 10 cm depth (PDD %)
<b>Elements PB</b> (Calculated)	62.82	1.3	61.66
<b>microDiamond</b> (Measured)	56.71	1.2	62.14



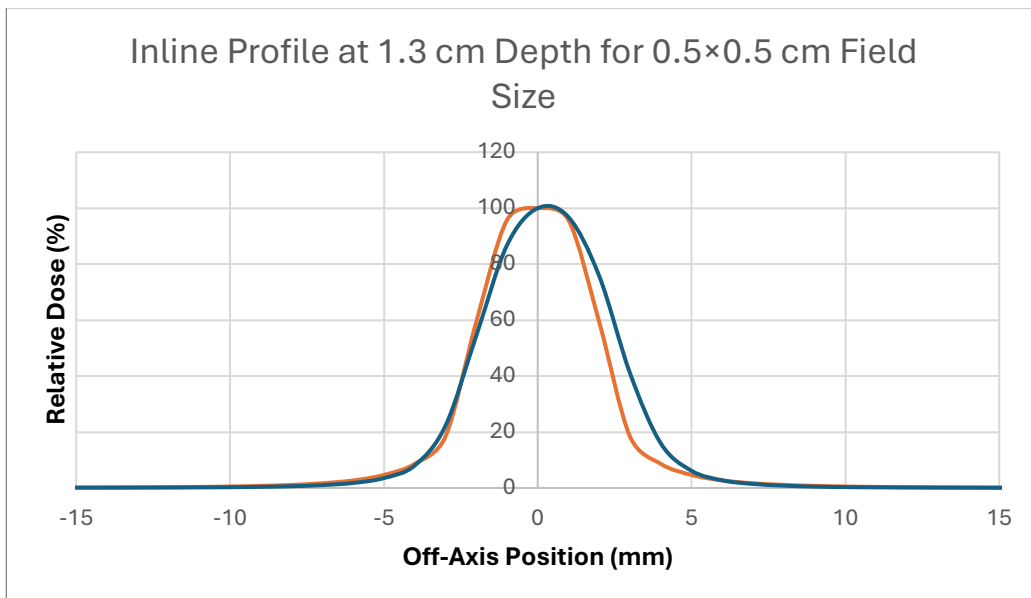
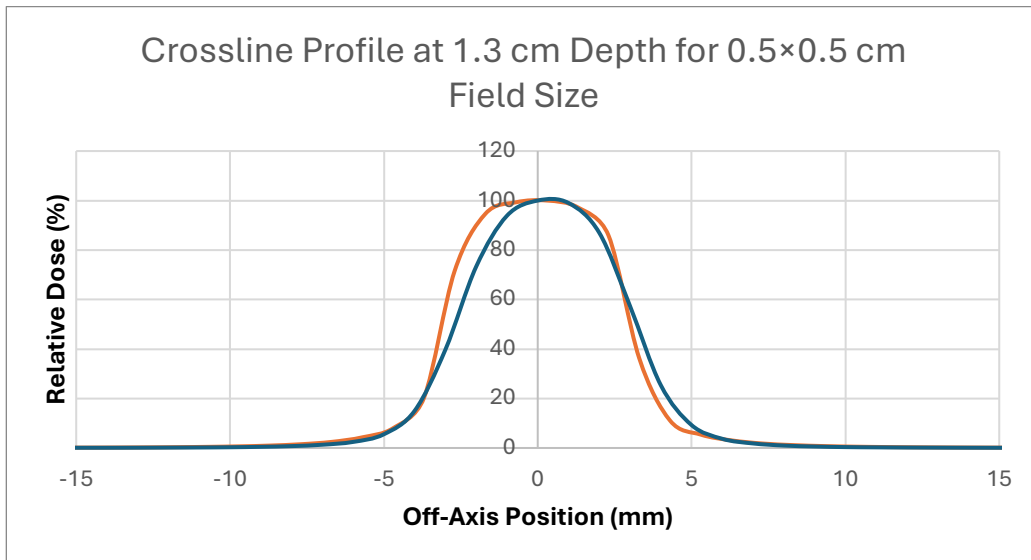
Scan	Dose at 0 cm depth (PDD %)	Depth of Maximum Dose (cm)	Dose at 10 cm depth (PDD %)
<b>Elements PB</b> (Calculated)	61.18	1.3	62.89
<b>microDiamond</b> (Measured)	58.10	1.2	63.39

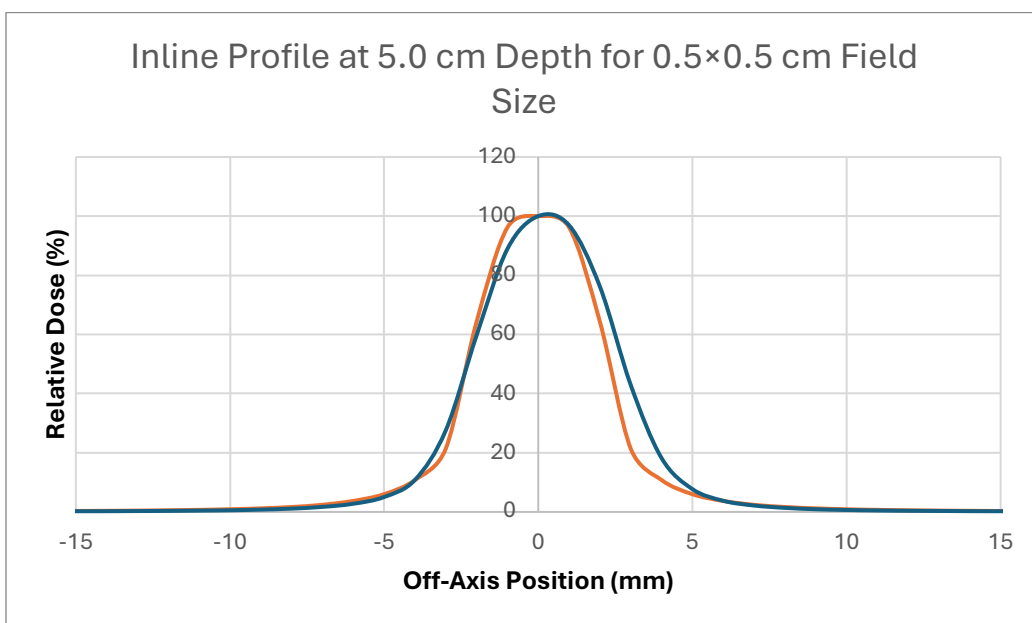
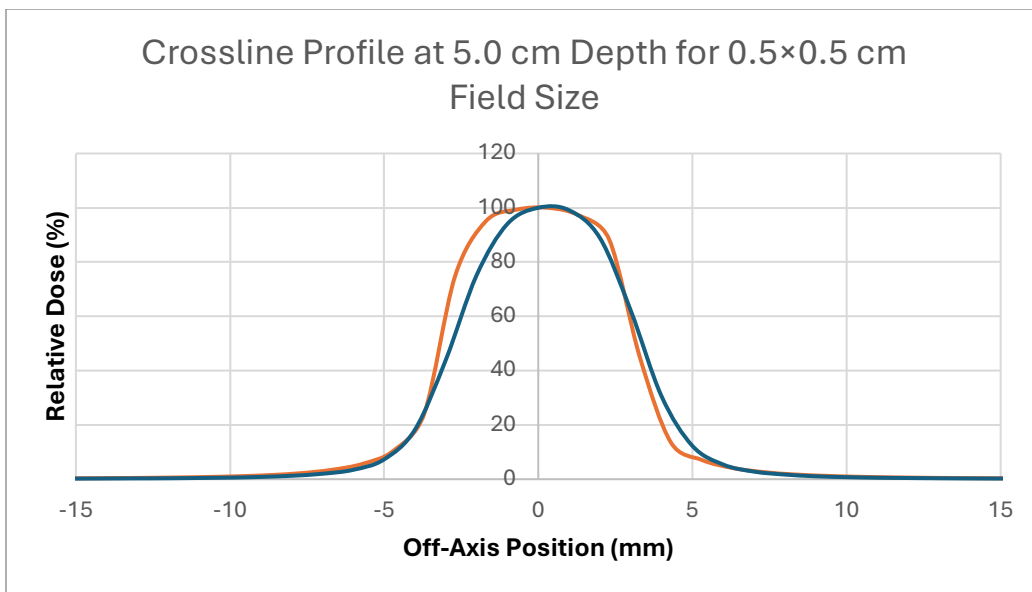


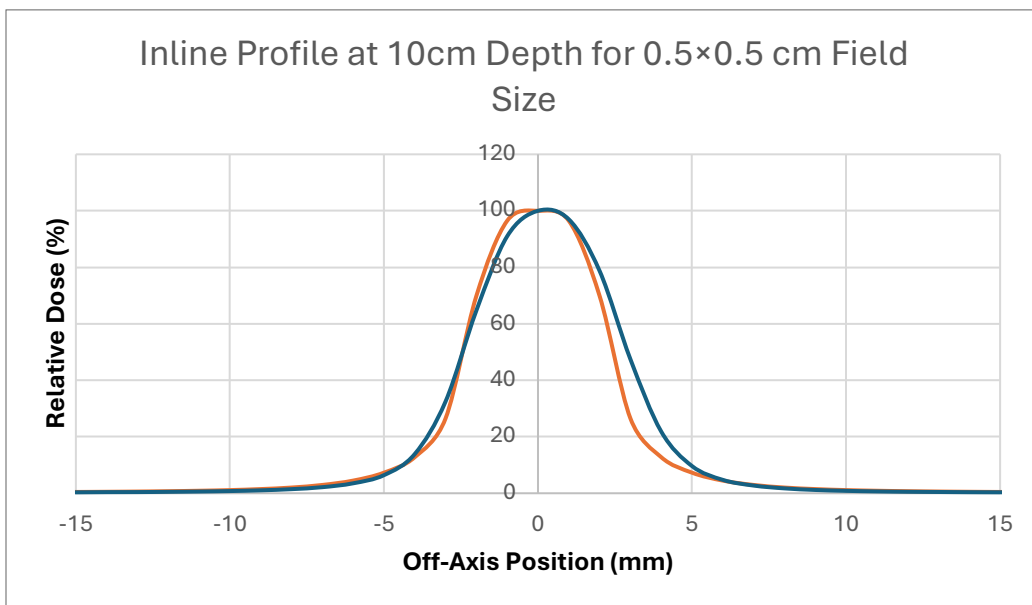
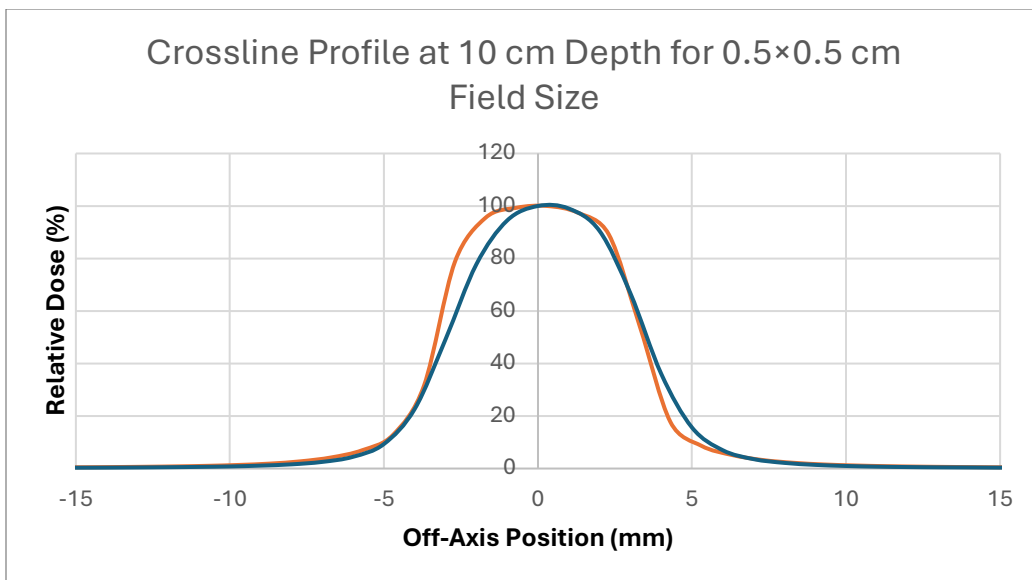
### 3. Profiles

#### Profiles – 0.5x0.5 cm Field Size

(Orange – Elements PB, Blue – microDiamond)

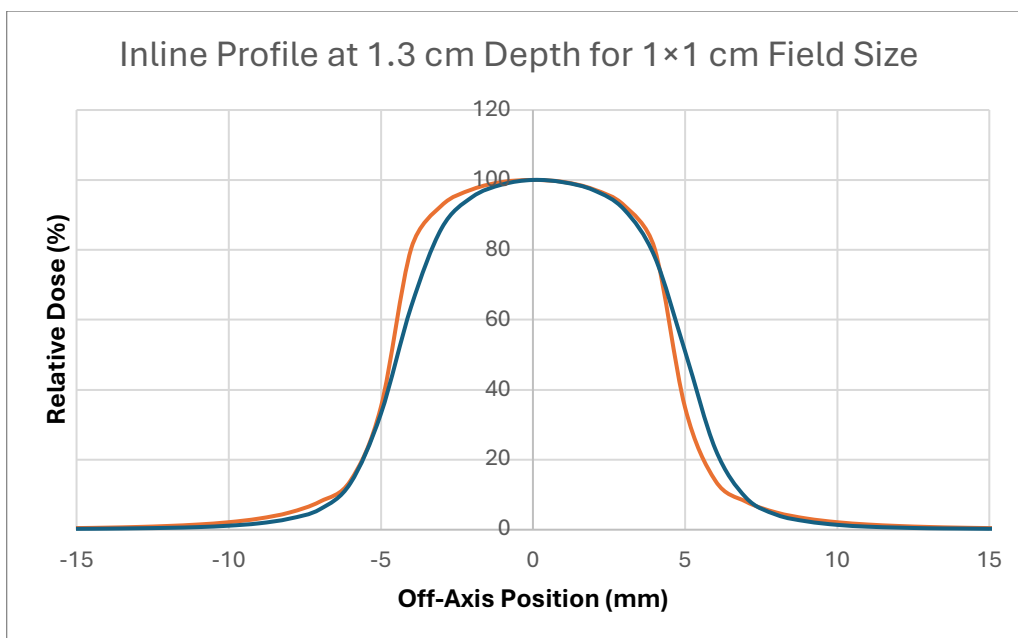
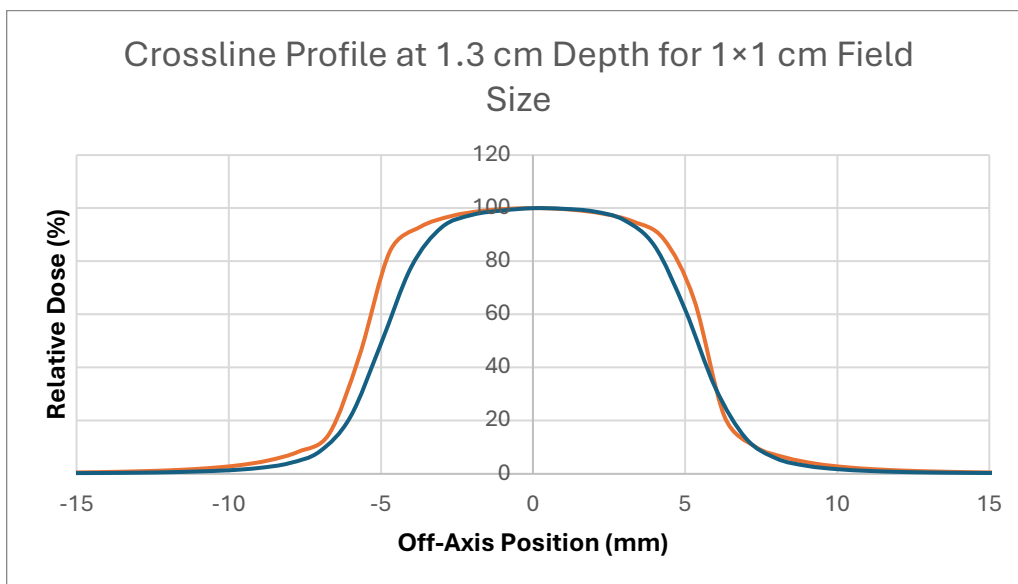


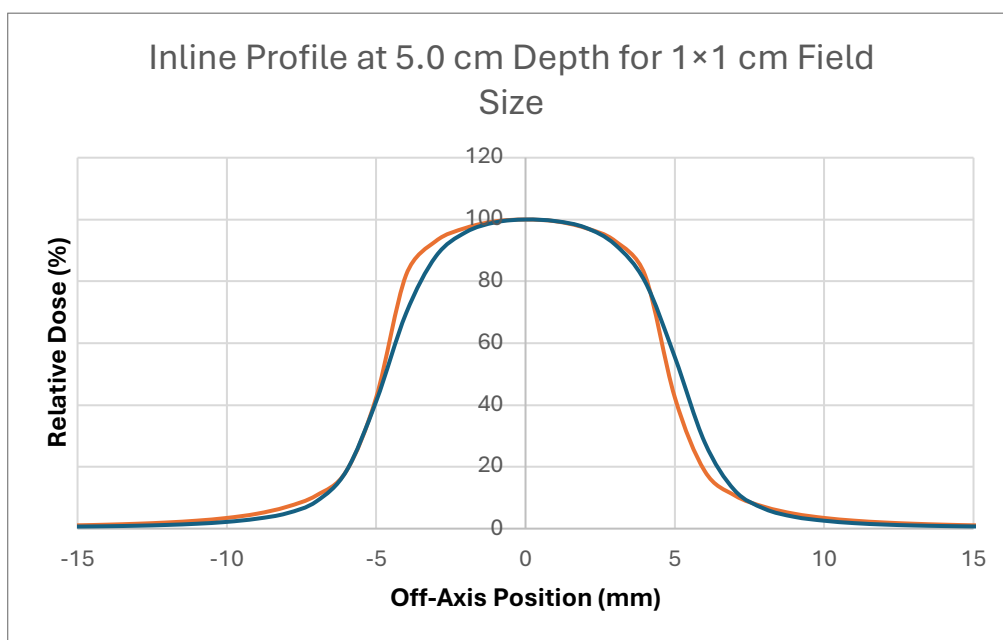
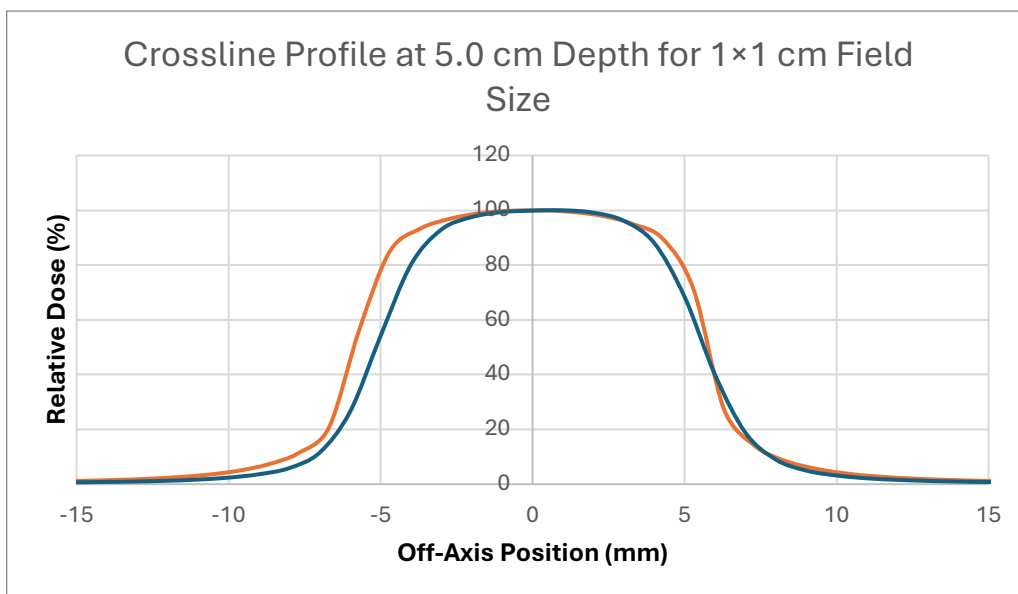


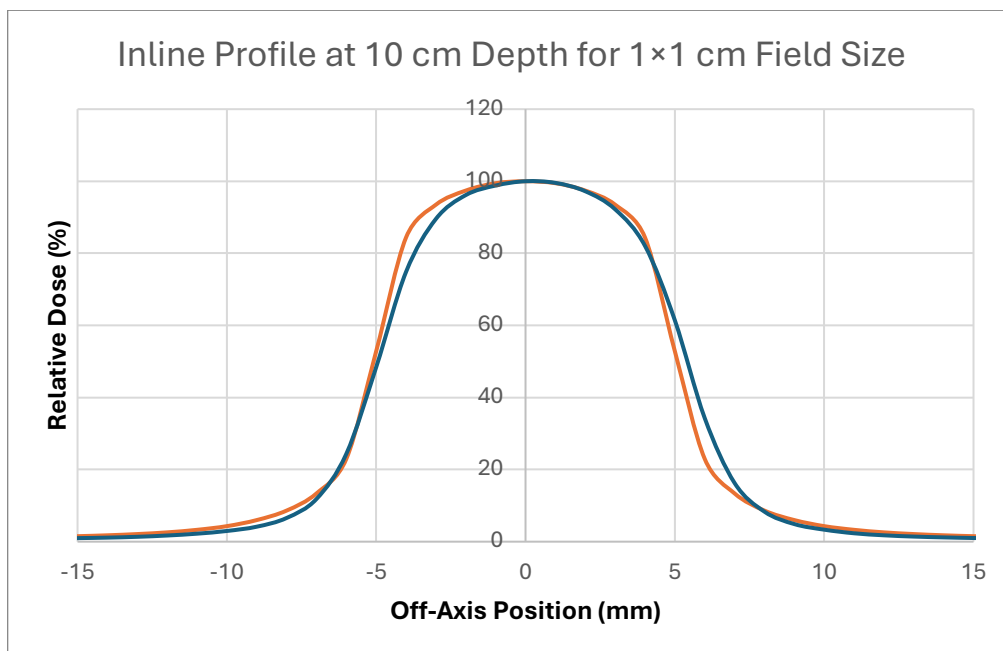
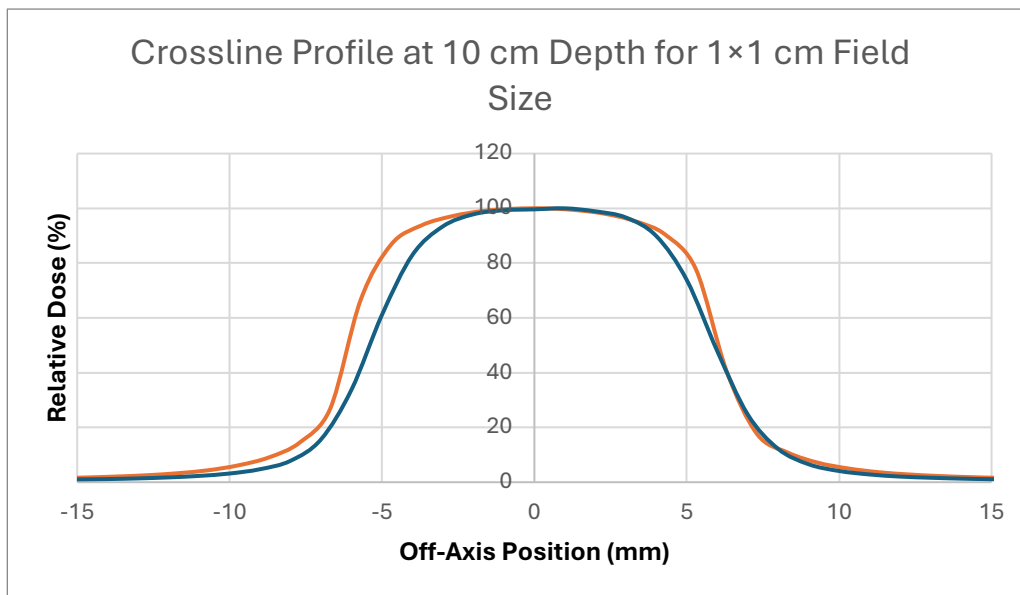


**Profiles – 1×1 cm Field Size**

(Orange – Elements PB, Blue – microDiamond)

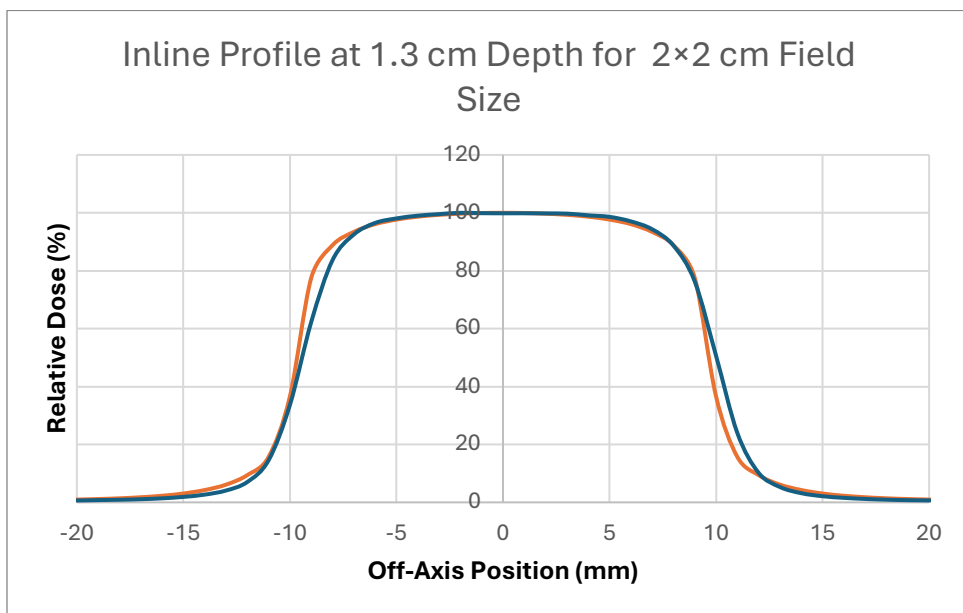
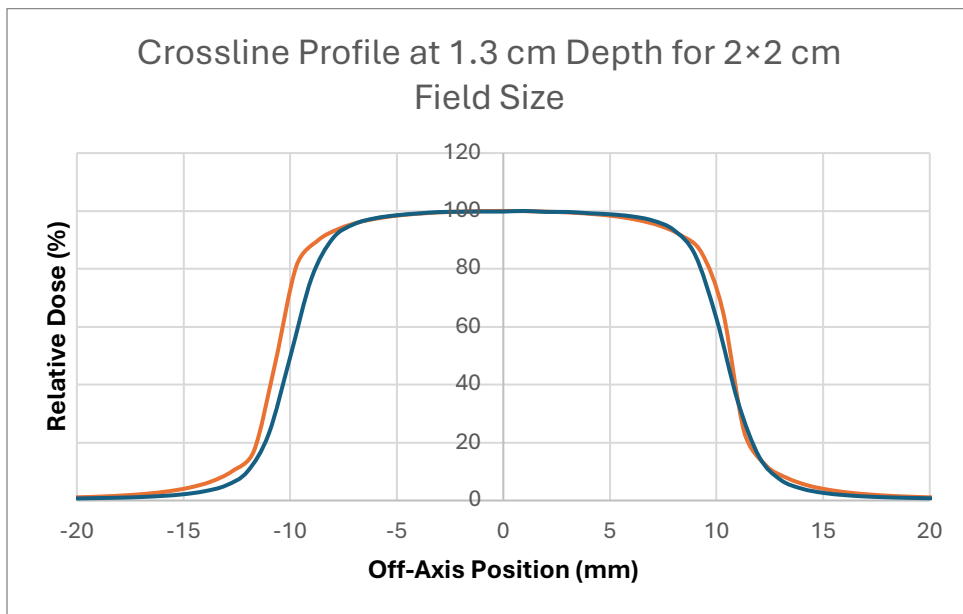




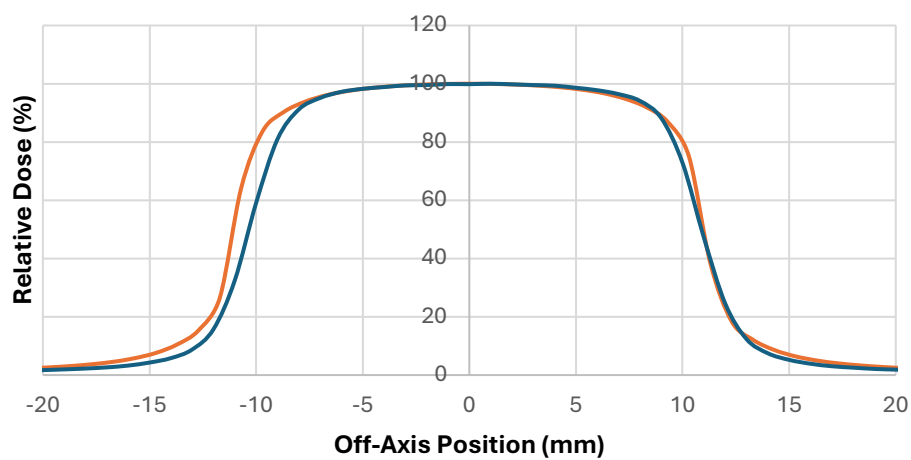


**Profiles – 2×2 cm Field Size**

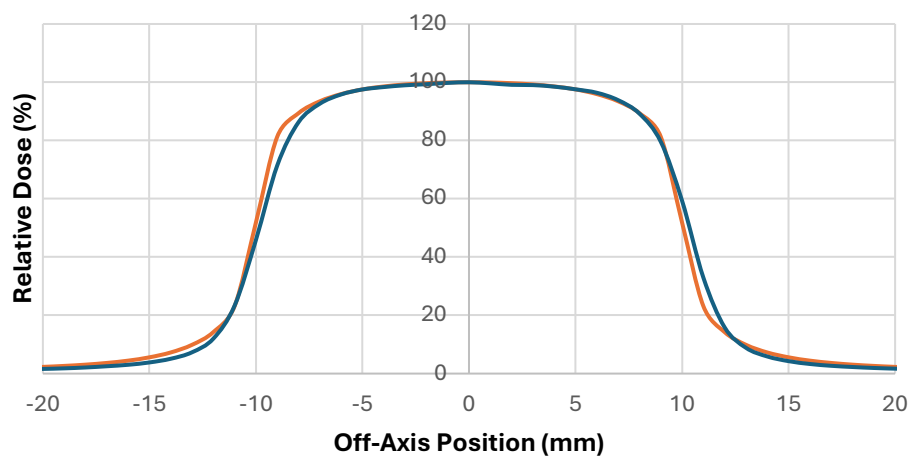
(Orange – Elements PB, Blue – microDiamond)



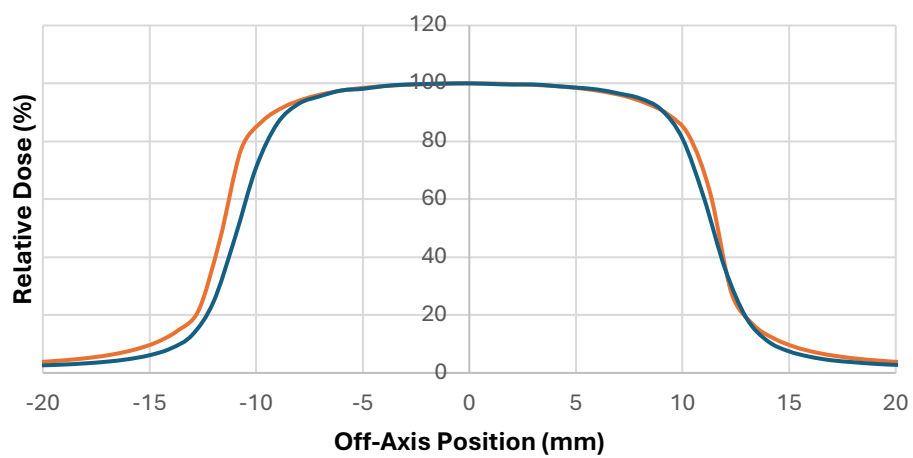
Crossline Profile at 5.0 cm Depth for 2×2 cm Field Size



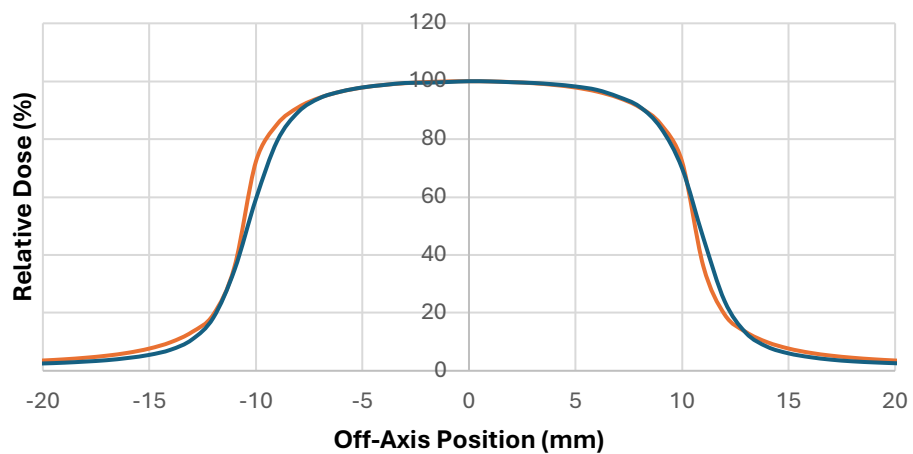
Inline Profile at 5.0 cm Depth for 2×2 cm Field Size



Crossline Profile at 10 cm Depth for 2×2 cm Field Size

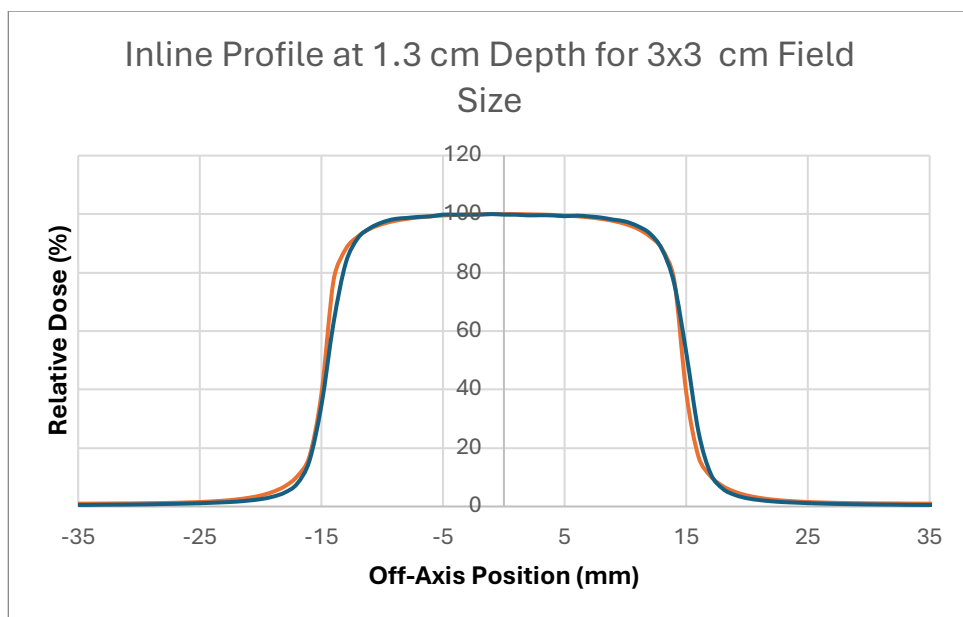
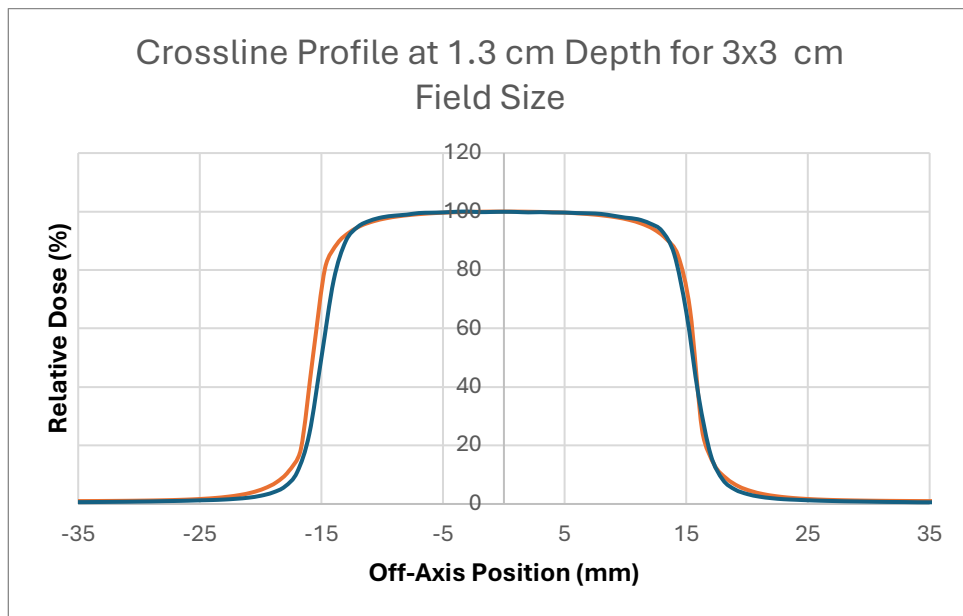


Inline Profile at 10 cm Depth for 2×2 cm Field Size

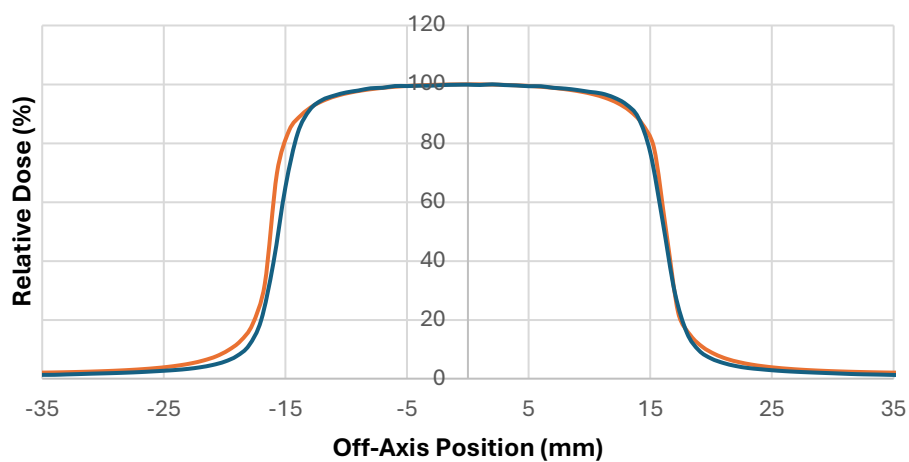


**Profiles – 3×3 cm Field Size**

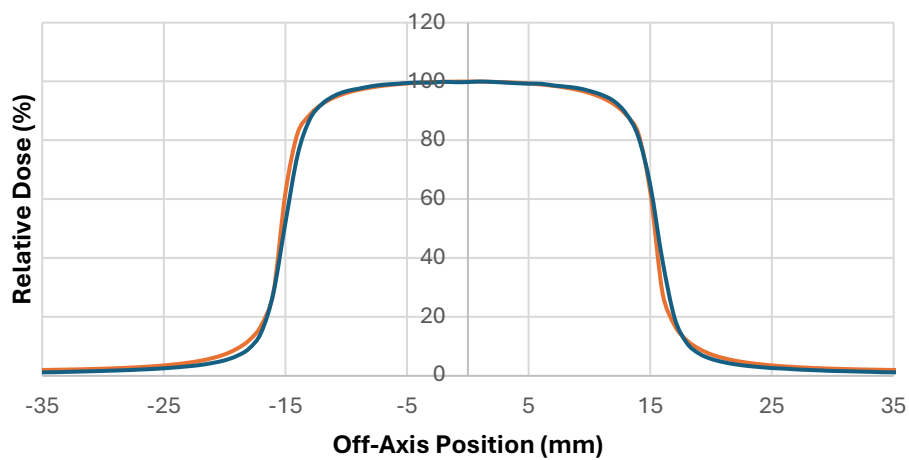
(Orange – Elements PB, Blue – microDiamond)

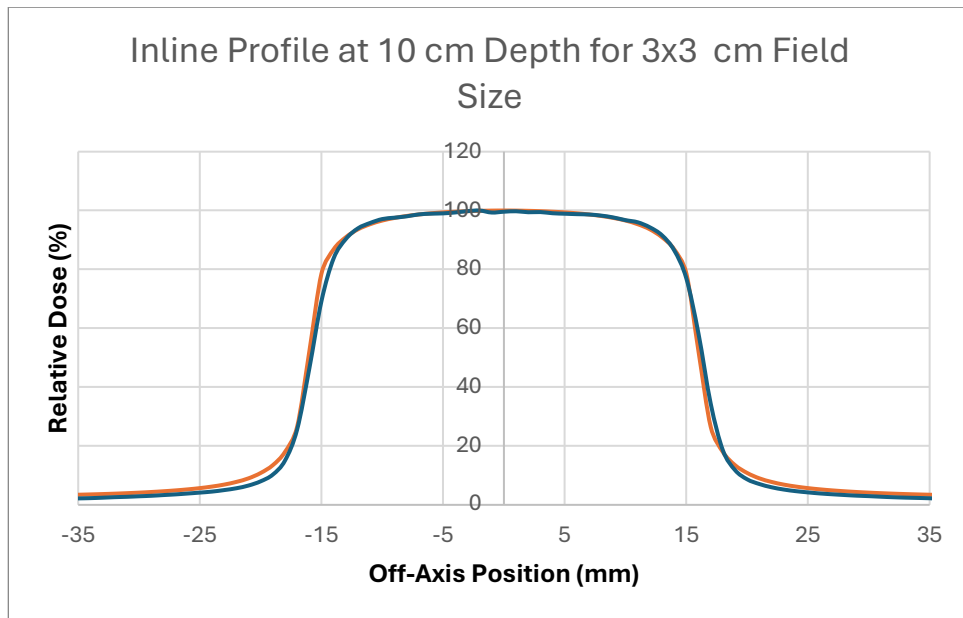
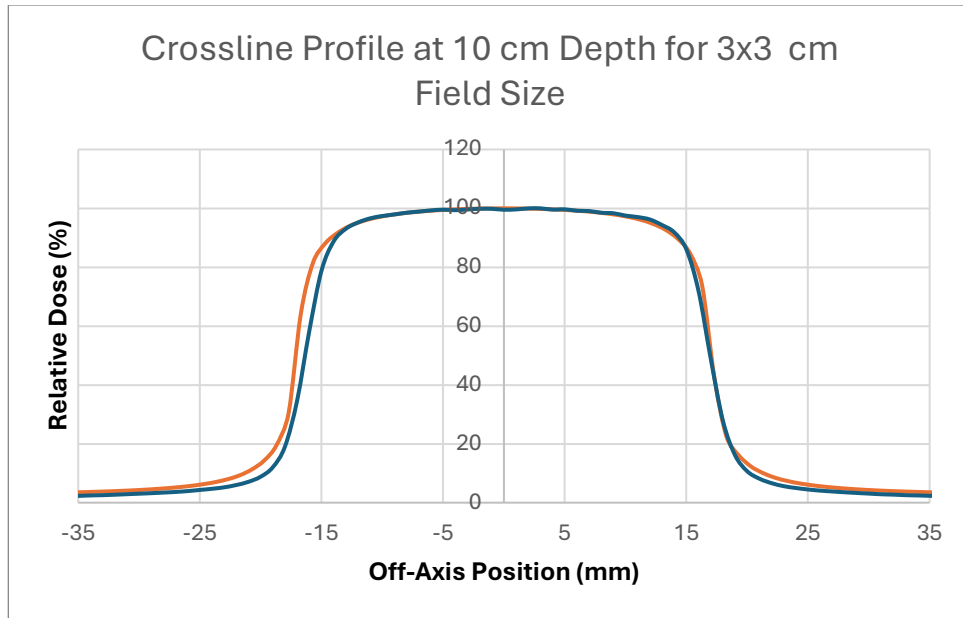


Crossline Profile at 5.0 cm Depth for 3x3 cm Field Size



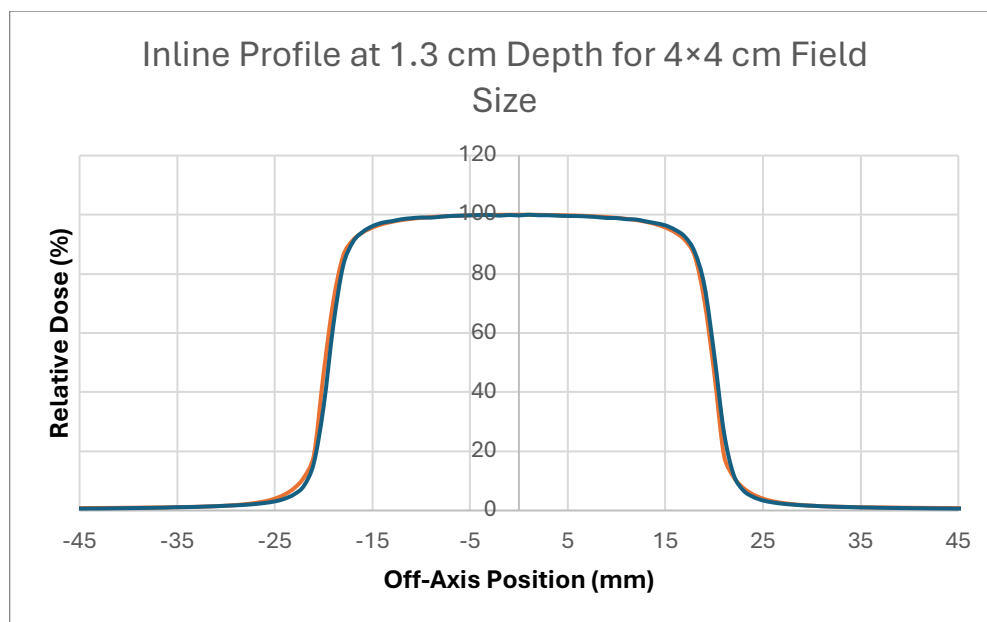
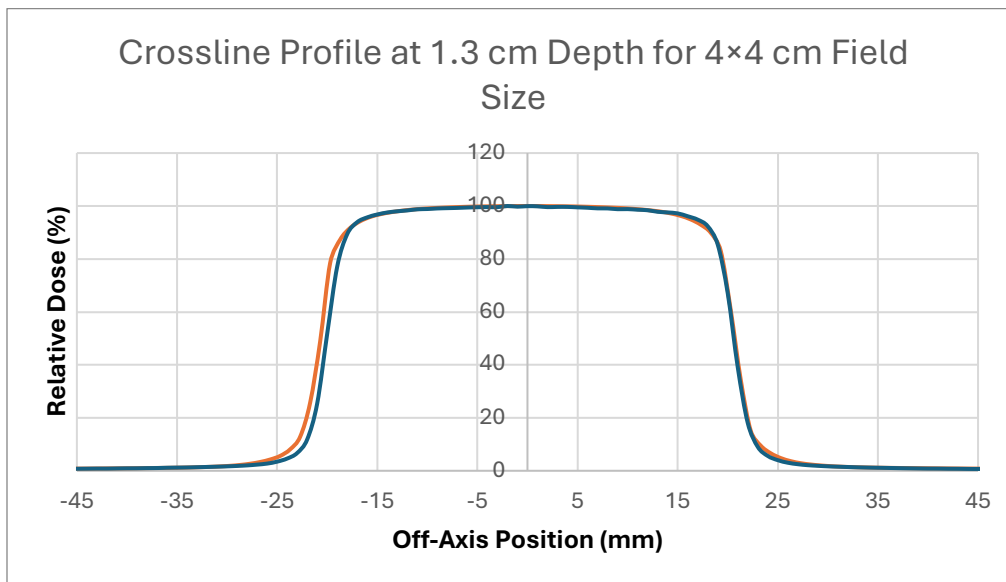
Inline Profile at 5.0 cm Depth for 3x3 cm Field Size



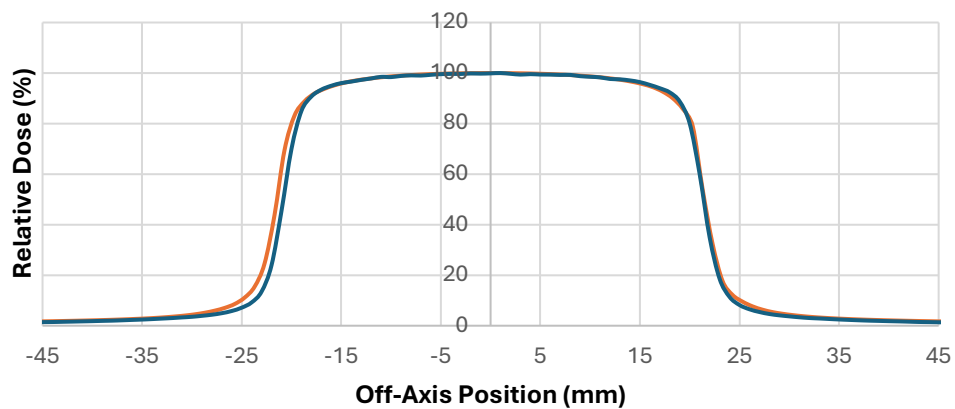


**Profiles – 4×4 cm Field Size**

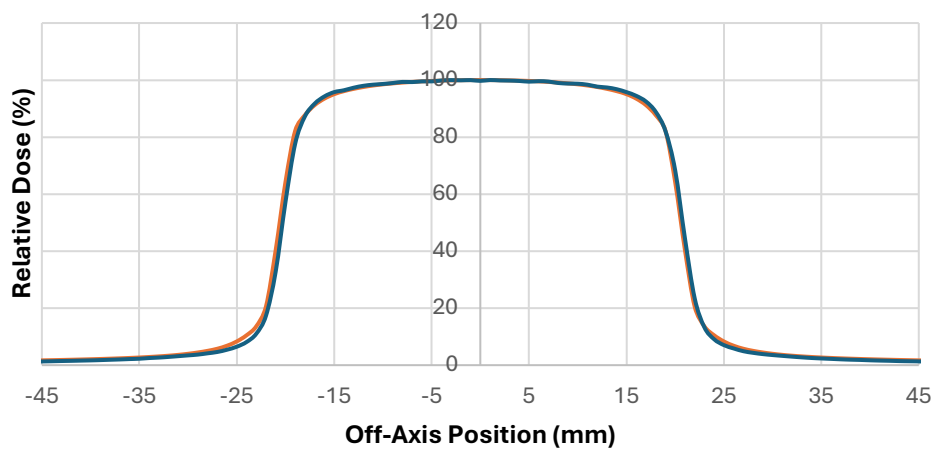
(Orange – Elements PB, Blue – microDiamond)



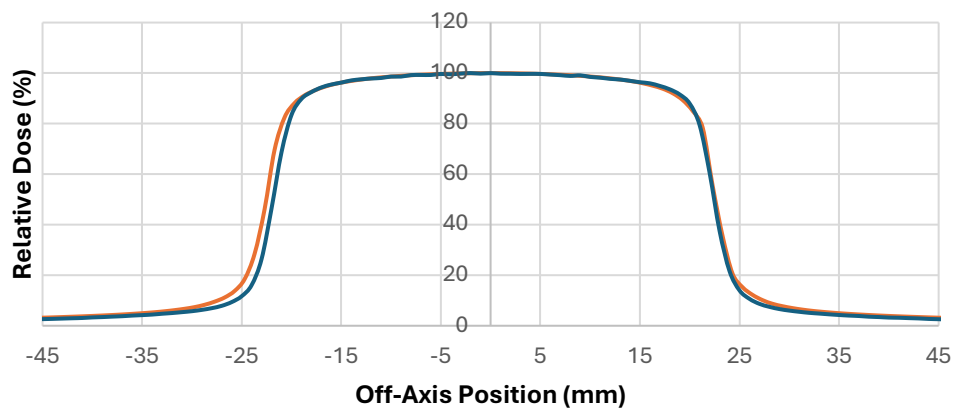
Crossline Profile at 5.0 cm Depth for 4×4 cm Field Size



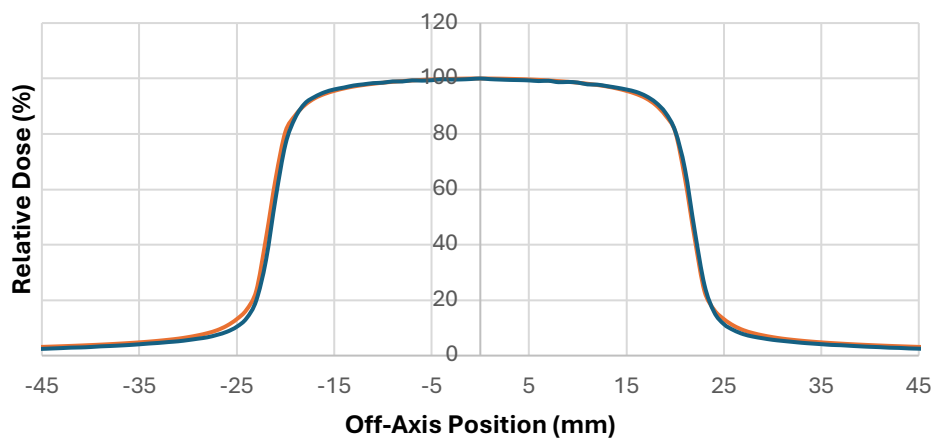
Inline Profile at 5.0 cm Depth for 4×4 cm Field Size



Crossline Profile at 10 cm Depth for 4×4 cm Field Size

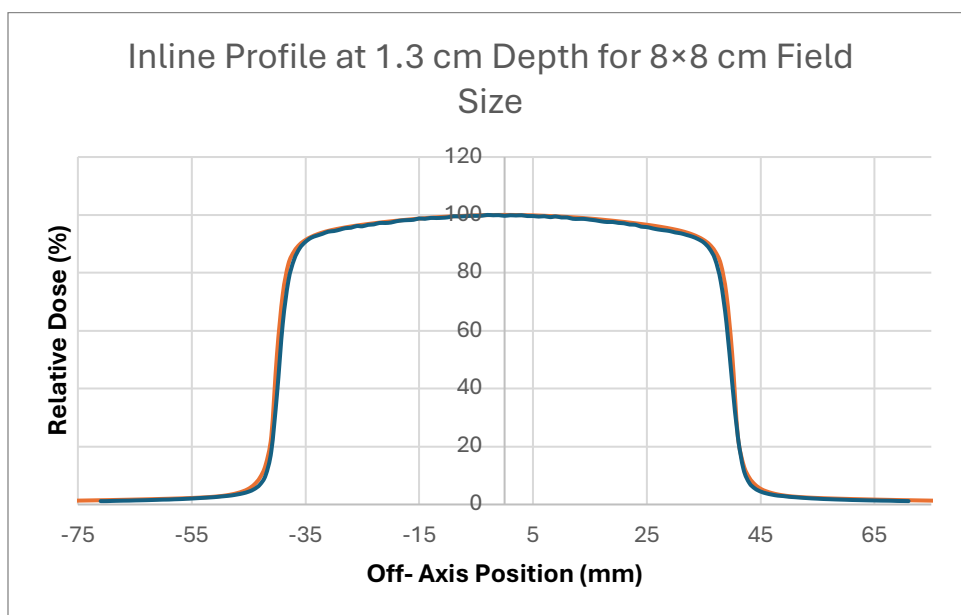
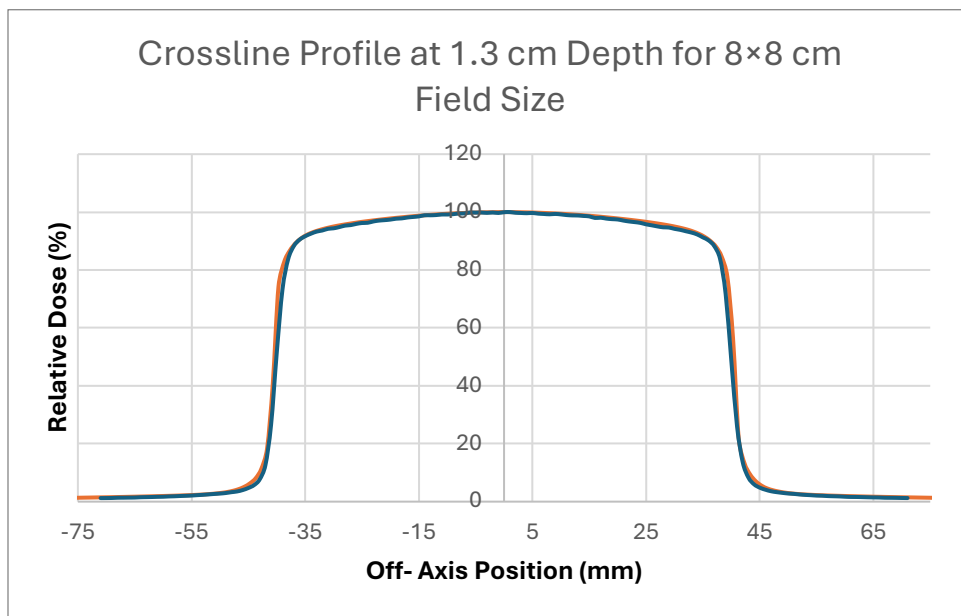


Inline Profile at 10 cm Depth for 4×4 cm Field Size

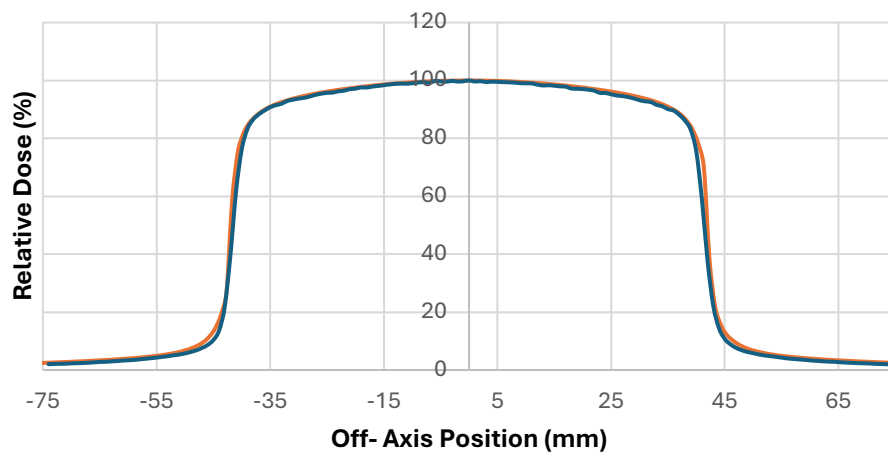


**Profiles – 8×8 cm Field Size**

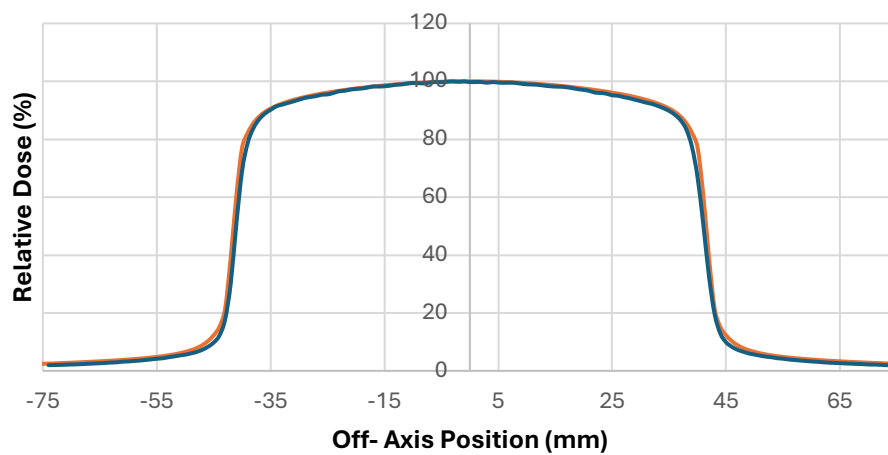
(Orange – Elements PB, Blue – microDiamond)



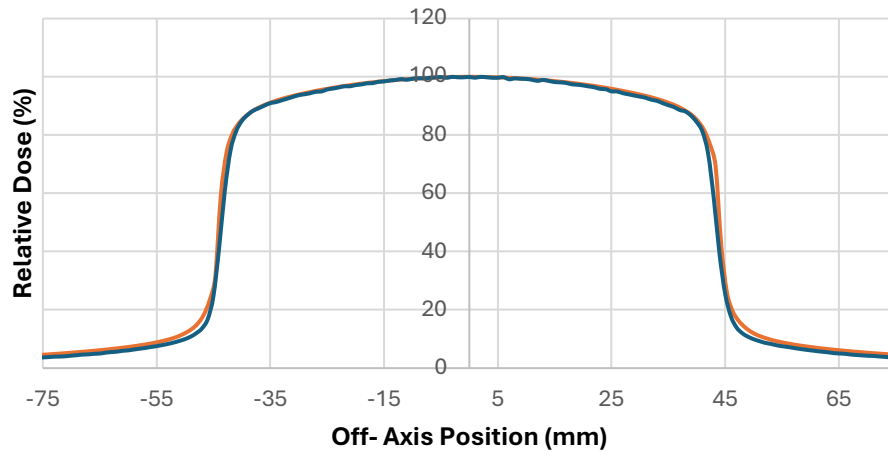
Crossline Profile at 5.0 cm Depth for 8×8 cm  
Field Size



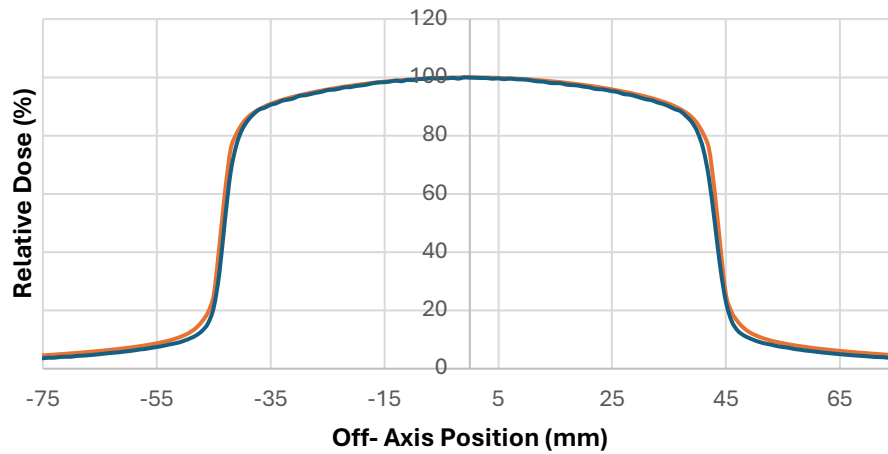
Inline Profile at 5.0 cm Depth for 8×8 cm Field  
Size



Crossline Profile at 10cm Depth for 8×8 cm  
Field Size

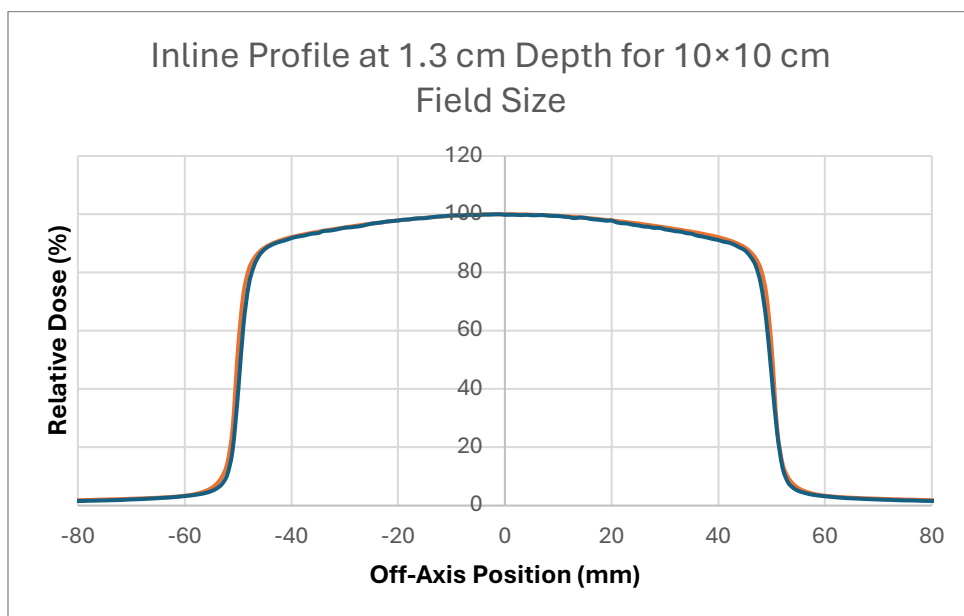
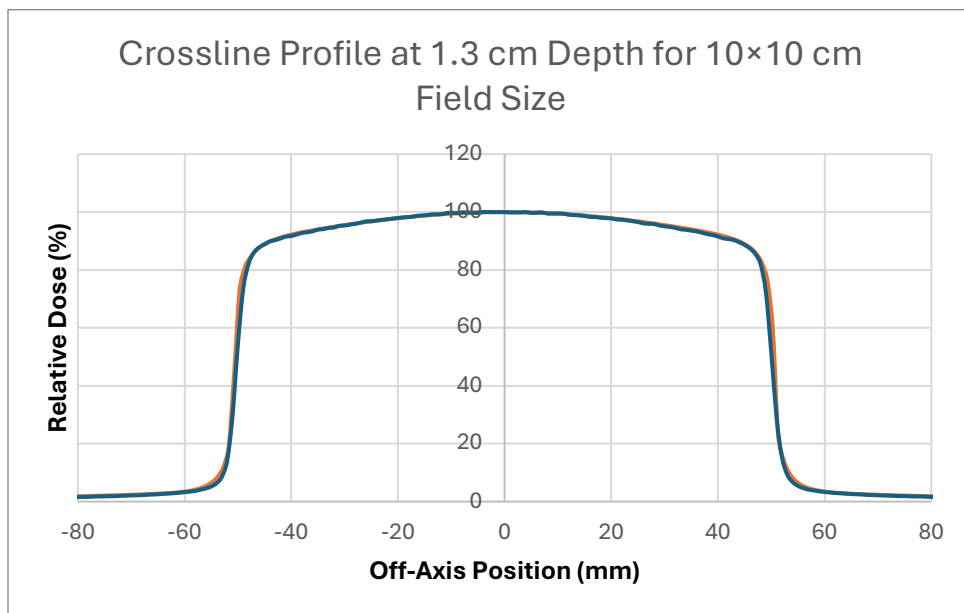


Inline Profile at 10 cm Depth for 8×8 cm Field  
Size

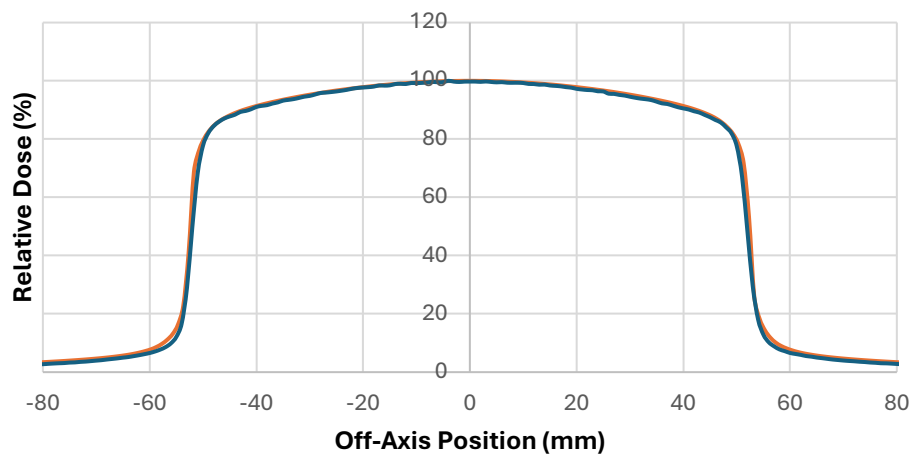


**Profiles – 10×10 cm Field Size**

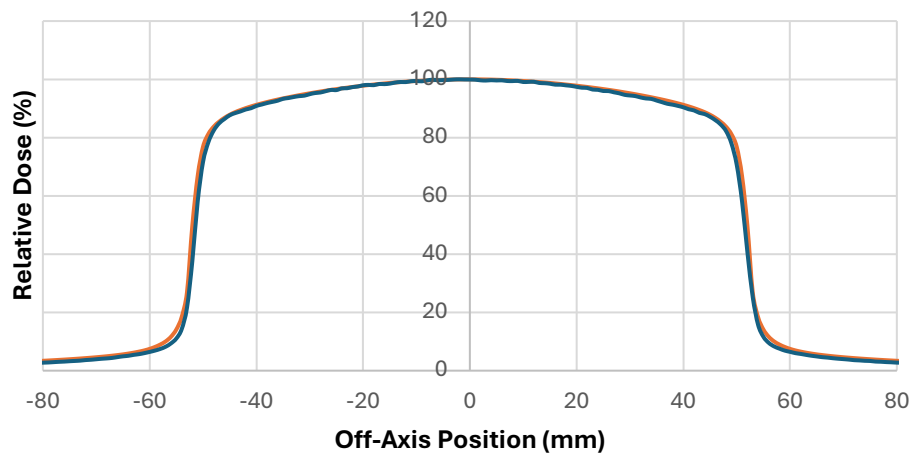
(Orange – Elements PB, Blue – microDiamond)



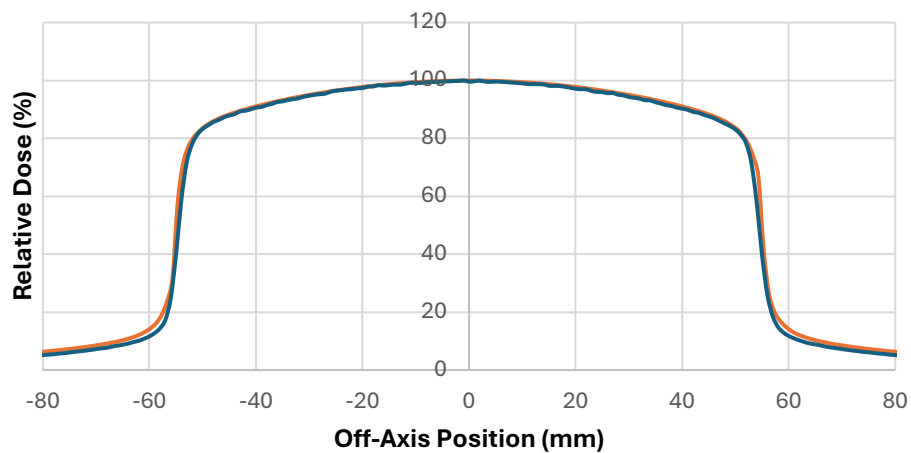
Crossline Profile at 5.0 cm Depth for 10×10 cm  
Field Size



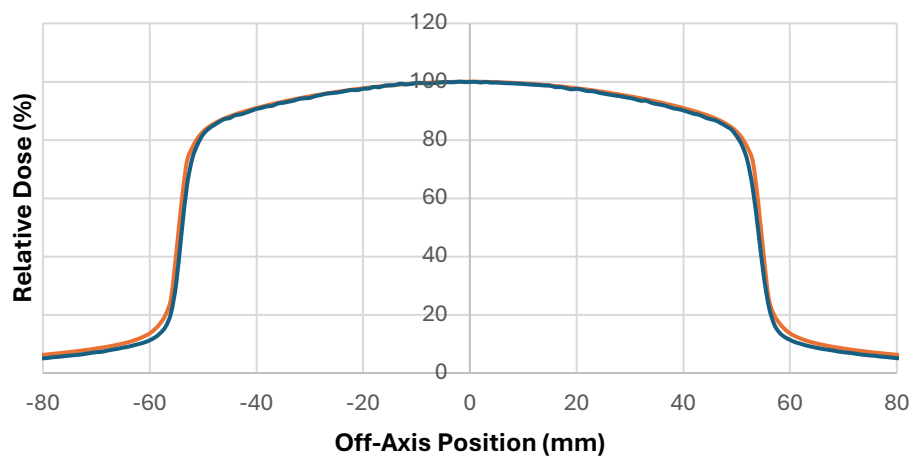
Inline Profile at 5.0 cm Depth for 10×10 cm  
Field Size



Crossline Profile at 10cm Depth for 10×10 cm  
Field Size



Inline Profile at 10.0 cm Depth for 10×10 cm  
Field Size

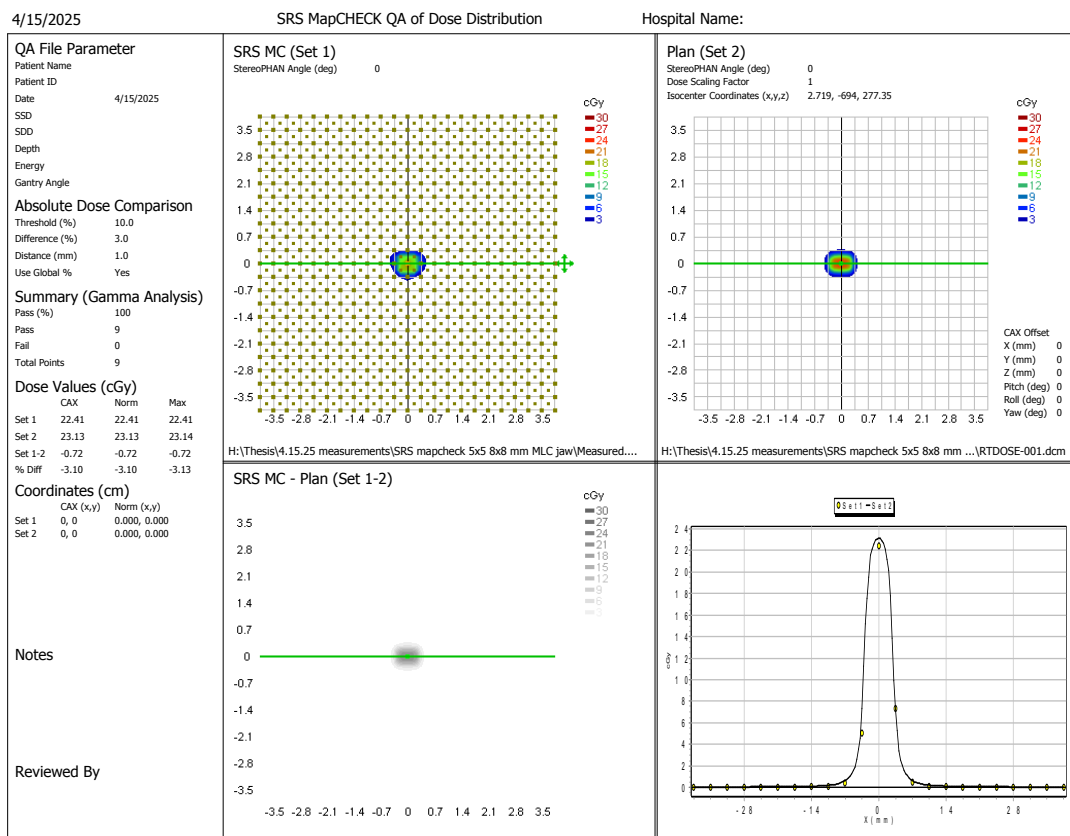


### 4. SRS mapCHECK planar measurements

The left panel displays the measured dose distribution on the SRS MapCHECK. The right panel shows the DICOM-RT Dose from Elements using the Pencil Beam algorithm with the same parameters. For all measurements, global percentage normalization, absolute dose mode, and a low-dose threshold of 10% were used.

**Field Size: 0.5×0.5 cm (MLC), 0.8×0.8 cm (Jaw)**

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	100
Points passed	9
Points failed	0
Total points	9
CAX offset X,Y,Z (mm, mm, mm)	None



**Field Size: 0.5×0.5 cm (MLC), 0.8×0.8 cm (Jaw)**

Gamma criteria used	2 mm DTA, 2% DD
Gamma pass rate (%)	100
Points passed	9
Points failed	0
Total points	9
CAX offset X,Y,Z (mm, mm, mm)	None

4/15/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date: 4/15/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 2  
Distance (mm) 2  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 100  
Pass 9  
Fail 0  
Total Points 9

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	22.41	22.41	22.41
Set 2	23.13	23.13	23.14
Set 1-2	-0.72	-0.72	-0.72
% Diff	-3.10	-3.10	-3.13

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.000, 0.000
Set 2	0, 0	0.000, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 5x5 8x8 mm MLC jaw\Measured....

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

H:\Thesis\4.15.25 measurements\SRS mapcheck 5x5 8x8 mm ...\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

H:\Thesis\4.15.25 measurements\SRS mapcheck 5x5 8x8 mm ...\RTDOSE-001.dcm

**0 Set 1 - Set 2**

**Field Size: 0.5×0.5 cm (MLC), 0.8×0.8 cm (Jaw)**

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	100
Points passed	9
Points failed	0
Total points	9
CAX offset X,Y,Z (mm, mm, mm)	None

4/15/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date: 4/15/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 1 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 100 Pass 9 Fail 0 Total Points 9</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>22.41</td> <td>22.41</td> <td>22.41</td> </tr> <tr> <td>Set 2</td> <td>23.13</td> <td>23.13</td> <td>23.14</td> </tr> <tr> <td>Set 1-2</td> <td>-0.72</td> <td>-0.72</td> <td>-0.72</td> </tr> <tr> <td>% Diff</td> <td>-3.10</td> <td>-3.10</td> <td>-3.13</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX (x,y)</th> <th>Norm (x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	22.41	22.41	22.41	Set 2	23.13	23.13	23.14	Set 1-2	-0.72	-0.72	-0.72	% Diff	-3.10	-3.10	-3.13		CAX (x,y)	Norm (x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b></p> <p>StereoPHAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 5x5 8x8 mm MLC jaw\Measured....</p>	<p><b>Plan (Set 2)</b></p> <p>StereoPHAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 5x5 8x8 mm ...\RTDOSE-001.dcm</p>
	CAX	Norm	Max																												
Set 1	22.41	22.41	22.41																												
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	CAX (x,y)	Norm (x,y)																													
Set 1	0, 0	0.000, 0.000																													
Set 2	0, 0	0.000, 0.000																													
<p><b>SRS MC - Plan (Set 1-2)</b></p>																															

**Field Size: 0.5×0.5 cm (MLC), 1.2×1.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	100
Points passed	10
Points failed	0
Total points	10
CAX offset X,Y,Z (mm, mm, mm)	-0.17, 0.17, 1.57

4/28/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/28/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 3 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 100 Pass 10 Fail 0 Total Points 10</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>22.96</td> <td>22.96</td> <td>22.96</td> </tr> <tr> <td>Set 2</td> <td>23.71</td> <td>23.71</td> <td>23.78</td> </tr> <tr> <td>Set 1-2</td> <td>-0.75</td> <td>-0.75</td> <td>-0.82</td> </tr> <tr> <td>% Diff</td> <td>-3.17</td> <td>-3.17</td> <td>-3.46</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	22.96	22.96	22.96	Set 2	23.71	23.71	23.78	Set 1-2	-0.75	-0.75	-0.82	% Diff	-3.17	-3.17	-3.46		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 square field measurements\SRS mapcheck 5x5 12x...Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) -0.17 Y (mm) 0.17 Z (mm) 1.57 Pitch (deg) 0.00 Roll (deg) 0.00 Yaw (deg) 0.00</p> <p>H:\Thesis\4.15.25 square field measurements\SRS mapcheck 5x...RTDOSE-001.dcm</p>
	CAX	Norm	Max																												
Set 1	22.96	22.96	22.96																												
Set 2	23.71	23.71	23.78																												
Set 1-2	-0.75	-0.75	-0.82																												
% Diff	-3.17	-3.17	-3.46																												
	CAX(x,y)	Norm(x,y)																													
Set 1	0, 0	0.000, 0.000																													
Set 2	0, 0	0.000, 0.000																													
<p><b>SRS MC - Plan (Set 1-2)</b></p>	<p><b>0.8x1.1-0.8x1.2</b></p>																														

**Field Size: 0.5×0.5 cm (MLC), 1.2×1.2 cm (Jaw)**

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	100
Points passed	10
Points failed	0
Total points	10
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/16/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 2  
Distance (mm) 2  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 100  
Pass 10  
Fail 0  
Total Points 10

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	22.96	22.96	22.96
Set 2	23.68	23.68	23.68
Set 1-2	-0.72	-0.72	-0.72
% Diff	-3.03	-3.03	-3.06

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.000, 0.000
Set 2	0, 0	0.000, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 5x5 12x12 mm MLC...\Measured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

H:\Thesis\4.15.25 measurements\SRS mapcheck 5x5 12x12 mm ...\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**0 Set 1 - Set 2**

**Field Size: 0.5×0.5 cm (MLC), 1.2×1.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	100
Points passed	10
Points failed	0
Total points	10
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/16/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 1.0  
Distance (mm) 1.0  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 100  
Pass 10  
Fail 0  
Total Points 10

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	22.96	22.96	22.96
Set 2	23.68	23.68	23.68
Set 1-2	-0.72	-0.72	-0.72
% Diff	-3.03	-3.03	-3.06

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.000, 0.000
Set 2	0, 0	0.000, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 5x5 12x12 mm MLC...\Measured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

H:\Thesis\4.15.25 measurements\SRS mapcheck 5x5 12x12 mm ...\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**0 Set 1 - Set 2**

**Field Size: 1×1 cm (MLC), 0.8×0.8 cm (Jaw)**

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	100
Points passed	21
Points failed	0
Total points	21
CAX offset X,Y,Z (mm, mm, mm)	None

4/17/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/17/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 3  
Distance (mm) 1  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 100  
Pass 21  
Fail 0  
Total Points 21

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	24.19	24.19	24.19
Set 2	24.80	24.80	24.81
Set 1-2	-0.61	-0.61	-0.62
% Diff	-2.46	-2.46	-2.48

**Coordinates (cm)**

	CAX(x,y)	Norm(x,y)
Set 1	0, 0	0.000, 0.000
Set 2	0, 0	0.000, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 10x10 8x8 mm M... \Remeasured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 10x10 8x8 mm ... \RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**0.8x1.1 - 0.8x1.2**

**Field Size: 1×1 cm (MLC), 0.8×0.8 cm (Jaw)**

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	100
Points passed	21
Points failed	0
Total points	21
CAX offset X,Y,Z (mm, mm, mm)	None

4/17/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/17/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 2  
Distance (mm) 2  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 100  
Pass 21  
Fail 0  
Total Points 21

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	24.19	24.19	24.19
Set 2	24.80	24.80	24.81
Set 1-2	-0.61	-0.61	-0.62
% Diff	-2.46	-2.46	-2.48

**Coordinates (cm)**

	CAX(x,y)	Norm(x,y)
Set 1	0, 0	0.000, 0.000
Set 2	0, 0	0.000, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 10x10 8x8 mm M... \Remeasured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 10x10 8x8 mm ... \RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**0.8x1.1 - 8x1.2**

**Field Size: 1×1 cm (MLC), 0.8×0.8 cm (Jaw)**

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	95.2
Points passed	20
Points failed	1
Total points	21
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/16/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 1  
Distance (mm) 1  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 95.2  
Pass 20  
Fail 1  
Total Points 21

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	24.19	24.19	24.19
Set 2	24.80	24.80	24.81
Set 1-2	-0.61	-0.61	-0.62
% Diff	-2.46	-2.46	-2.48

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.000, 0.000
Set 2	0, 0	0.000, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 10x10 8x8 mm ...\Remeasured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 10x10 8x8 m...\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**0 Set 1 - Set 2**

**Field Size: 1x1 cm (MLC), 1.2x1.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	100
Points passed	31
Points failed	0
Total points	31
CAX offset X,Y,Z (mm, mm, mm)	None

4/15/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/15/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 3 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 100 Pass 31 Fail 0 Total Points 31</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>28.82</td> <td>28.82</td> <td>28.82</td> </tr> <tr> <td>Set 2</td> <td>29.15</td> <td>29.15</td> <td>29.15</td> </tr> <tr> <td>Set 1-2</td> <td>-0.33</td> <td>-0.33</td> <td>-0.33</td> </tr> <tr> <td>% Diff</td> <td>-1.12</td> <td>-1.12</td> <td>-1.13</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX (x,y)</th> <th>Norm (x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	28.82	28.82	28.82	Set 2	29.15	29.15	29.15	Set 1-2	-0.33	-0.33	-0.33	% Diff	-1.12	-1.12	-1.13		CAX (x,y)	Norm (x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b> StereoPHAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 10x10 12x12 mm ...\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereoPHAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 10x10 12x12 ...\RTDOSE-001.dcm</p>
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**Field Size: 1x1 cm (MLC), 1.2x1.2 cm (Jaw)**

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	100
Points passed	31
Points failed	0
Total points	31
CAX offset X,Y,Z (mm, mm, mm)	None

4/17/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/17/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 2 Distance (mm) 2 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 100 Pass 31 Fail 0 Total Points 31</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>28.82</td> <td>28.82</td> <td>28.82</td> </tr> <tr> <td>Set 2</td> <td>29.15</td> <td>29.15</td> <td>29.15</td> </tr> <tr> <td>Set 1-2</td> <td>-0.33</td> <td>-0.33</td> <td>-0.33</td> </tr> <tr> <td>% Diff</td> <td>-1.12</td> <td>-1.12</td> <td>-1.13</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	28.82	28.82	28.82	Set 2	29.15	29.15	29.15	Set 1-2	-0.33	-0.33	-0.33	% Diff	-1.12	-1.12	-1.13		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 10x10 12x12 mm M...\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 10x10 12x12 m...\RTDOSE-001.dcm</p>
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	<p><b>SRS MC - Plan (Set 1-2)</b></p>	<p><b>0.8 x 1.1 - 8 x 1.2</b></p>																													

**Field Size: 1x1 cm (MLC), 1.2x1.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	100
Points passed	31
Points failed	0
Total points	31
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/16/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 1 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 100 Pass 31 Fail 0 Total Points 31</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>28.82</td> <td>28.82</td> <td>28.82</td> </tr> <tr> <td>Set 2</td> <td>29.15</td> <td>29.15</td> <td>29.15</td> </tr> <tr> <td>Set 1-2</td> <td>-0.33</td> <td>-0.33</td> <td>-0.33</td> </tr> <tr> <td>% Diff</td> <td>-1.12</td> <td>-1.12</td> <td>-1.13</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	28.82	28.82	28.82	Set 2	29.15	29.15	29.15	Set 1-2	-0.33	-0.33	-0.33	% Diff	-1.12	-1.12	-1.13		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 10x10 12x12 mm M...\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 10x10 12x12 m...\RTDOSE-001.dcm</p>
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**Field Size: 2×2 cm (MLC), 2.2×2.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	100
Points passed	105
Points failed	0
Total points	105
CAX offset X,Y,Z (mm, mm, mm)	None

4/15/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/15/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 3  
Distance (mm) 1  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 100  
Pass 105  
Fail 0  
Total Points 105

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	33.03	33.03	33.23
Set 2	32.56	32.56	32.58
Set 1-2	0.47	0.47	0.66
% Diff	1.45	1.45	2.01

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.000, 0.000
Set 2	0, 0	0.000, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereoPHAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 20x20 22x22 mm ...\Measured.txt

**Plan (Set 2)**  
StereoPHAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 20x20 22x22 ...\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**Field Size: 2×2 cm (MLC), 2.2×2.2 cm (Jaw)**

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	95.2
Points passed	100
Points failed	5
Total points	105
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/16/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 2 Distance (mm) 2 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 95.2 Pass 100 Fail 5 Total Points 105</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>33.03</td> <td>33.03</td> <td>33.23</td> </tr> <tr> <td>Set 2</td> <td>32.56</td> <td>32.56</td> <td>32.58</td> </tr> <tr> <td>Set 1-2</td> <td>0.47</td> <td>0.47</td> <td>0.66</td> </tr> <tr> <td>% Diff</td> <td>1.45</td> <td>1.45</td> <td>2.01</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	33.03	33.03	33.23	Set 2	32.56	32.56	32.58	Set 1-2	0.47	0.47	0.66	% Diff	1.45	1.45	2.01		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 20x20 22x22 mm M... \Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 20x20 22x22 m... \RTDOSE-001.dcm</p>
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**Field Size: 2×2 cm (MLC), 2.2×2.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	74.3
Points passed	78
Points failed	27
Total points	105
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/16/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 1 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 74.3 Pass 78 Fail 27 Total Points 105</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>33.03</td> <td>33.03</td> <td>33.23</td> </tr> <tr> <td>Set 2</td> <td>32.56</td> <td>32.56</td> <td>32.58</td> </tr> <tr> <td>Set 1-2</td> <td>0.47</td> <td>0.47</td> <td>0.66</td> </tr> <tr> <td>% Diff</td> <td>1.45</td> <td>1.45</td> <td>2.01</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	33.03	33.03	33.23	Set 2	32.56	32.56	32.58	Set 1-2	0.47	0.47	0.66	% Diff	1.45	1.45	2.01		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 20x20 22x22 mm M... \Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 20x20 22x22 m... \RTDOSE-001.dcm</p>
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**Field Size: 2×2 cm (MLC), 3.2×3.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	95.2
Points passed	100
Points failed	5
Total points	105
CAX offset X,Y,Z (mm, mm, mm)	None

4/17/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/17/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 3 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 95.2 Pass 100 Fail 5 Total Points 105</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>33.22</td> <td>33.22</td> <td>33.39</td> </tr> <tr> <td>Set 2</td> <td>32.74</td> <td>32.74</td> <td>32.77</td> </tr> <tr> <td>Set 1-2</td> <td>0.48</td> <td>0.48</td> <td>0.63</td> </tr> <tr> <td>% Diff</td> <td>1.46</td> <td>1.46</td> <td>1.92</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX (x,y)</th> <th>Norm (x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	33.22	33.22	33.39	Set 2	32.74	32.74	32.77	Set 1-2	0.48	0.48	0.63	% Diff	1.46	1.46	1.92		CAX (x,y)	Norm (x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 20x20 32x32 mm M...\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 20x20 32x32 m...\RTDOSE-001.dcm</p>
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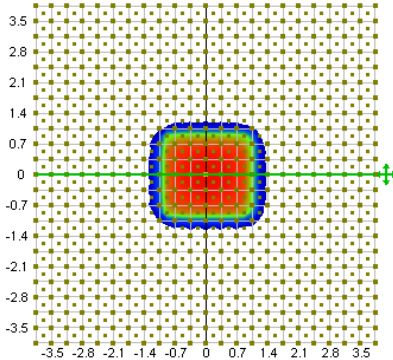
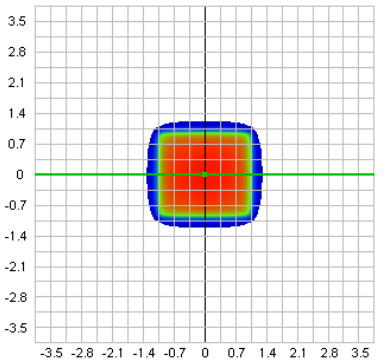
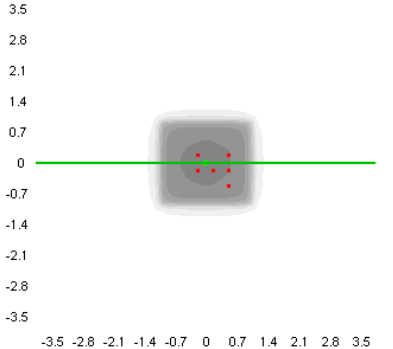
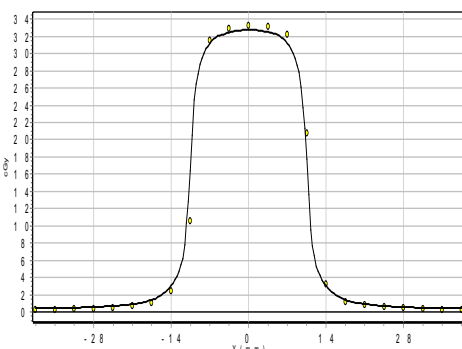
**Field Size: 2×2 cm (MLC), 3.2×3.2 cm (Jaw)**

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	94.3
Points passed	99
Points failed	6
Total points	105
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/16/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 2 Distance (mm) 2 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 94.3 Pass 99 Fail 6 Total Points 105</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>33.22</td> <td>33.22</td> <td>33.39</td> </tr> <tr> <td>Set 2</td> <td>32.74</td> <td>32.74</td> <td>32.77</td> </tr> <tr> <td>Set 1-2</td> <td>0.48</td> <td>0.48</td> <td>0.63</td> </tr> <tr> <td>% Diff</td> <td>1.46</td> <td>1.46</td> <td>1.92</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p><b>Notes</b></p> <p><b>Reviewed By</b></p>		CAX	Norm	Max	Set 1	33.22	33.22	33.39	Set 2	32.74	32.74	32.77	Set 1-2	0.48	0.48	0.63	% Diff	1.46	1.46	1.92		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p>  <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 20x20 32x32 mm M...Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p>  <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 20x20 32x32 m...RTDOSE-001.dcm</p>
	CAX	Norm	Max																												
Set 1	33.22	33.22	33.39																												
Set 2	32.74	32.74	32.77																												
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Set 1	0, 0	0.000, 0.000																													
Set 2	0, 0	0.000, 0.000																													
	<p><b>SRS MC - Plan (Set 1-2)</b></p> 	<p><b>0.8 ± 1.1 - 0.8 ± 1.2</b></p> 																													

**Field Size: 2×2 cm (MLC), 3.2×3.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	65.7
Points passed	69
Points failed	36
Total points	105
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025 SRS MapCHECK QA of Dose Distribution Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/16/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 1.0  
Distance (mm) 1.0  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 65.7  
Pass 69  
Fail 36  
Total Points 105

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	33.22	33.22	33.39
Set 2	32.74	32.74	32.77
Set 1-2	0.48	0.48	0.63
% Diff	1.46	1.46	1.92

**Coordinates (cm)**

	CAX(x,y)	Norm(x,y)
Set 1	0, 0	0.000, 0.000
Set 2	0, 0	0.000, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 20x20 32x32 mm M...Measured.txt

**SRS MC - Plan (Set 1-2)**

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 20x20 32x32 m...RTDOSE-001.dcm

**0.8 ± 1.1 - 0.8 ± 1.0**

**Field Size: 3×3 cm (MLC), 3.2×3.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	99.5
Points passed	215
Points failed	1
Total points	216
CAX offset X,Y,Z (mm, mm, mm)	None

4/15/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/15/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 3 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 99.5 Pass 215 Fail 1 Total Points 216</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>34.66</td> <td>34.66</td> <td>34.73</td> </tr> <tr> <td>Set 2</td> <td>33.96</td> <td>33.96</td> <td>33.99</td> </tr> <tr> <td>Set 1-2</td> <td>0.71</td> <td>0.71</td> <td>0.74</td> </tr> <tr> <td>% Diff</td> <td>2.08</td> <td>2.08</td> <td>2.18</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX (x,y)</th> <th>Norm (x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	34.66	34.66	34.73	Set 2	33.96	33.96	33.99	Set 1-2	0.71	0.71	0.74	% Diff	2.08	2.08	2.18		CAX (x,y)	Norm (x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b></p> <p>StereoPHAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 30x30 32x32 mm ...\Measured.txt</p>	<p><b>Plan (Set 2)</b></p> <p>StereoPHAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 30x30 32x32 ...\RTDOSE-001.dcm</p>
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Set 1	0, 0	0.000, 0.000																													
Set 2	0, 0	0.000, 0.000																													
<p><b>SRS MC - Plan (Set 1-2)</b></p>	<p><b>1-Set1-Set2</b></p>																														

**Field Size: 3×3 cm (MLC), 3.2×3.2 cm (Jaw)**

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	100
Points passed	215
Points failed	0
Total points	215
CAX offset X,Y,Z (mm, mm, mm)	-0.08, 0.36, 2.97

4/28/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date: 4/28/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 2 Distance (mm) 2 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 100 Pass 215 Fail 0 Total Points 215</p> <p><b>Dose Values (cGy)</b></p> <table border="1" style="font-size: small;"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>34.66</td> <td>34.66</td> <td>34.73</td> </tr> <tr> <td>Set 2</td> <td>34.78</td> <td>34.78</td> <td>34.81</td> </tr> <tr> <td>Set 1-2</td> <td>-0.12</td> <td>-0.12</td> <td>-0.08</td> </tr> <tr> <td>% Diff</td> <td>-0.34</td> <td>-0.34</td> <td>-0.23</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1" style="font-size: small;"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	34.66	34.66	34.73	Set 2	34.78	34.78	34.81	Set 1-2	-0.12	-0.12	-0.08	% Diff	-0.34	-0.34	-0.23		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<div style="display: flex;"> <div style="flex: 1;"> <p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 square field measurements\SRS mapcheck 30x30 ...\Measured.txt</p> </div> <div style="flex: 1;"> <p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) -0.08 Y (mm) 0.36 Z (mm) 2.97 Pitch (deg) 0.00 Roll (deg) 0.00 Yaw (deg) 0.00</p> <p>H:\Thesis\4.15.25 square field measurements\SRS mapcheck 30... \RTDOSE-001.dcm</p> </div> </div> <div style="display: flex; margin-top: 10px;"> <div style="flex: 1;"> <p><b>SRS MC - Plan (Set 1-2)</b></p> </div> <div style="flex: 1;"> <p><b>0.8 ± 1.1 - 0.12</b></p> </div> </div>
	CAX	Norm	Max																											
Set 1	34.66	34.66	34.73																											
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Set 1-2	-0.12	-0.12	-0.08																											
% Diff	-0.34	-0.34	-0.23																											
	CAX(x,y)	Norm(x,y)																												
Set 1	0, 0	0.000, 0.000																												
Set 2	0, 0	0.000, 0.000																												

**Field Size: 3×3 cm (MLC), 3.2×3.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	89.8
Points passed	193
Points failed	22
Total points	215
CAX offset X,Y,Z (mm, mm, mm)	-0.08, 0.36, 2.97

4/17/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/17/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 1 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 89.8 Pass 193 Fail 22 Total Points 215</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>34.66</td> <td>34.66</td> <td>34.73</td> </tr> <tr> <td>Set 2</td> <td>34.78</td> <td>34.78</td> <td>34.81</td> </tr> <tr> <td>Set 1-2</td> <td>-0.12</td> <td>-0.12</td> <td>-0.08</td> </tr> <tr> <td>% Diff</td> <td>-0.34</td> <td>-0.34</td> <td>-0.23</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	34.66	34.66	34.73	Set 2	34.78	34.78	34.81	Set 1-2	-0.12	-0.12	-0.08	% Diff	-0.34	-0.34	-0.23		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b></p> <p>StereoPHAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 30x30 32x32 mm M...\Measured.txt</p>	<p><b>Plan (Set 2)</b></p> <p>StereoPHAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) -0.08 Y (mm) 0.36 Z (mm) 2.97 Pitch (deg) 0.00 Roll (deg) 0.00 Yaw (deg) 0.00</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 30x30 32x32 m...\RTDOSE-001.dcm</p>
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Set 2	0, 0	0.000, 0.000																													
<p><b>SRS MC - Plan (Set 1-2)</b></p>		<p><b>0.8 ± 1.1 - 8 ± 1.2</b></p>																													

**Field Size: 3×3 cm (MLC), 4.2×4.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	92.3
Points passed	203
Points failed	17
Total points	220
CAX offset X,Y,Z (mm, mm, mm)	-0.22, 0.25, 0.14

4/17/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/17/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 3  
Distance (mm) 1  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 92.3  
Pass 203  
Fail 17  
Total Points 220

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	34.91	34.91	35.01
Set 2	34.19	34.19	34.22
Set 1-2	0.72	0.72	0.79
% Diff	2.09	2.09	2.31

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.000, 0.000
Set 2	0, 0	0.000, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 30x30 42x42 mm M...\Measured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

CAX Offset  
X (mm) -0.22  
Y (mm) 0.25  
Z (mm) 0.14  
Pitch (deg) 0.00  
Roll (deg) 0.00  
Yaw (deg) 0.00

H:\Thesis\4.15.25 measurements\SRS mapcheck 30x30 42x42 m...\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

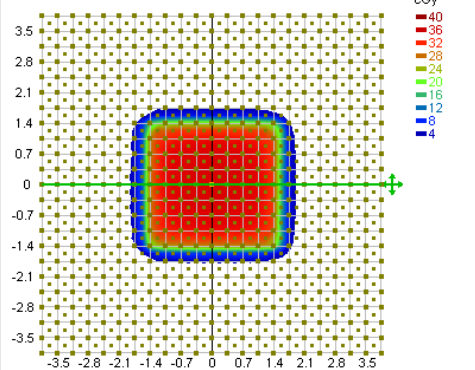
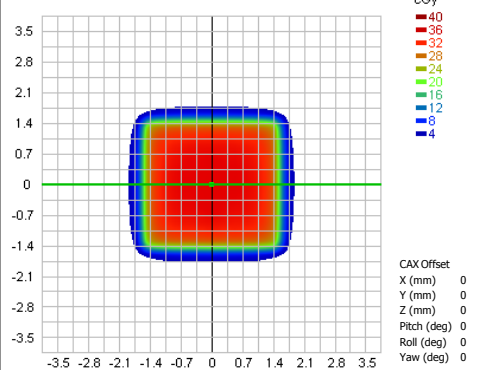
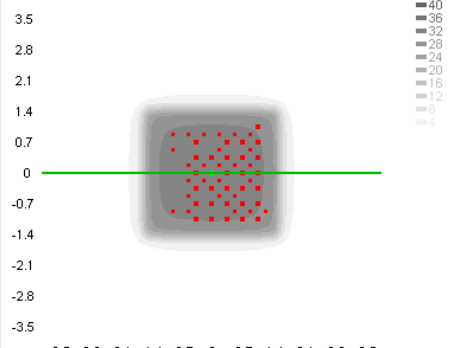
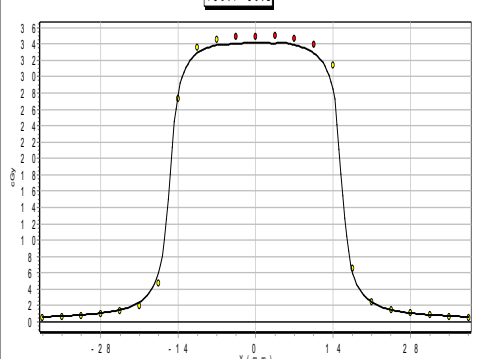
**Field Size: 3×3 cm (MLC), 4.2×4.2 cm (Jaw)**

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	74.7
Points passed	165
Points failed	56
Total points	221
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025

SRS MapCHECK QA of Dose Distribution

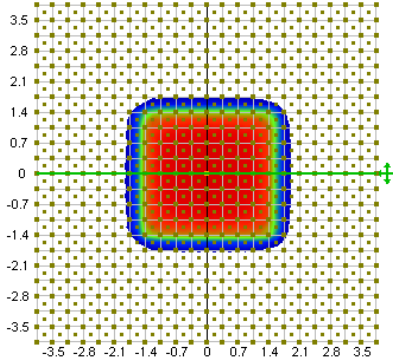
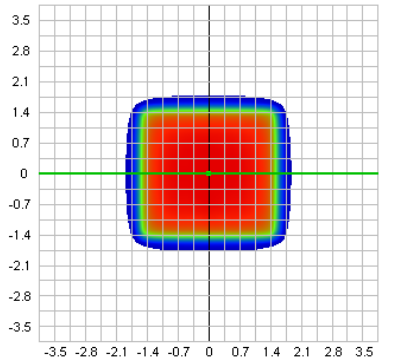
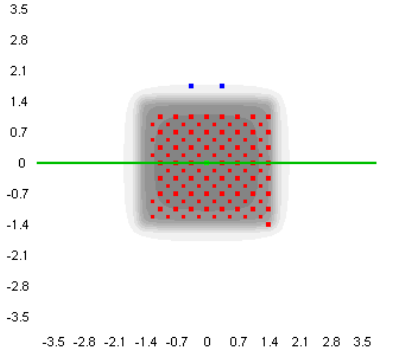
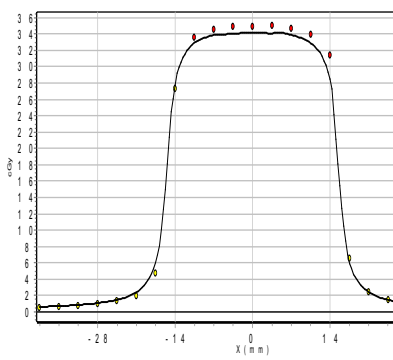
Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/16/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 2 Distance (mm) 2 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 74.7 Pass 165 Fail 56 Total Points 221</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>34.91</td> <td>34.91</td> <td>35.01</td> </tr> <tr> <td>Set 2</td> <td>34.16</td> <td>34.16</td> <td>34.19</td> </tr> <tr> <td>Set 1-2</td> <td>0.75</td> <td>0.75</td> <td>0.81</td> </tr> <tr> <td>% Diff</td> <td>2.20</td> <td>2.20</td> <td>2.38</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	34.91	34.91	35.01	Set 2	34.16	34.16	34.19	Set 1-2	0.75	0.75	0.81	% Diff	2.20	2.20	2.38		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p>  <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 30x30 42x42 mm M...\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p>  <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 30x30 42x42 m...\RTDOSE-001.dcm</p>
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	<p><b>SRS MC - Plan (Set 1-2)</b></p> 	<p><b>0.8 ± 1.1 - 8 ± 1.2</b></p> 																													

**Field Size: 3×3 cm (MLC), 4.2×4.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	48.9
Points passed	108
Points failed	113
Total points	221
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date: 4/16/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 1 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 48.9 Pass 108 Fail 113 Total Points 221</p> <p><b>Dose Values (cGy)</b></p> <table border="1" style="font-size: small;"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>34.91</td> <td>34.91</td> <td>35.01</td> </tr> <tr> <td>Set 2</td> <td>34.16</td> <td>34.16</td> <td>34.19</td> </tr> <tr> <td>Set 1-2</td> <td>0.75</td> <td>0.75</td> <td>0.81</td> </tr> <tr> <td>% Diff</td> <td>2.20</td> <td>2.20</td> <td>2.38</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1" style="font-size: small;"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	34.91	34.91	35.01	Set 2	34.16	34.16	34.19	Set 1-2	0.75	0.75	0.81	% Diff	2.20	2.20	2.38		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<div style="display: flex;"> <div style="flex: 1;"> <p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p>  <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 30x30 42x42 mm M...\Measured.txt</p> </div> <div style="flex: 1;"> <p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p>  <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 30x30 42x42 m...\RTDOSE-001.dcm</p> </div> </div> <div style="display: flex; margin-top: 10px;"> <div style="flex: 1;"> <p><b>SRS MC - Plan (Set 1-2)</b></p>  </div> <div style="flex: 1;"> <p><b>0.8 ± 1.1 - 8 ± 1.2</b></p>  </div> </div>
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**Field Size: 4×4 cm (MLC), 4.2×4.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	100
Points passed	367
Points failed	0
Total points	367
CAX offset X,Y,Z (mm, mm, mm)	None

4/15/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/15/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 3  
Distance (mm) 1  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 100  
Pass 367  
Fail 0  
Total Points 367

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	36.11	36.23	36.23
Set 2	35.19	35.21	35.26
Set 1-2	0.92	1.02	0.97
% Diff	2.61	2.88	2.75

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.000, -0.350
Set 2	0, 0	0.000, -0.350

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 40x40 42x42 mm ...\Measured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 40x40 42x42 ...\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**1-Set1-Set2**

**Field Size: 4x4 cm (MLC), 4.2x4.2 cm (Jaw)**

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	68.7
Points passed	252
Points failed	115
Total points	367
CAX offset X,Y,Z (mm, mm, mm)	None

4/17/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/17/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 2 Distance (mm) 2 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 68.7 Pass 252 Fail 115 Total Points 367</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>36.11</td> <td>36.23</td> <td>36.23</td> </tr> <tr> <td>Set 2</td> <td>35.19</td> <td>35.21</td> <td>35.26</td> </tr> <tr> <td>Set 1-2</td> <td>0.92</td> <td>1.02</td> <td>0.97</td> </tr> <tr> <td>% Diff</td> <td>2.61</td> <td>2.88</td> <td>2.75</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	36.11	36.23	36.23	Set 2	35.19	35.21	35.26	Set 1-2	0.92	1.02	0.97	% Diff	2.61	2.88	2.75		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, -0.350	Set 2	0, 0	0.000, -0.350	<p><b>SRS MC (Set 1)</b></p> <p>StereoPHAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 40x40 42x42 mm M...Measured.txt</p>	<p><b>Plan (Set 2)</b></p> <p>StereoPHAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 40x40 42x42 m...RTDOSE-001.dcm</p>
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**Field Size: 4x4 cm (MLC), 4.2x4.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	43.1
Points passed	158
Points failed	209
Total points	367
CAX offset X,Y,Z (mm, mm, mm)	None

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SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/17/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 1 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 43.1 Pass 158 Fail 209 Total Points 367</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>36.11</td> <td>36.23</td> <td>36.23</td> </tr> <tr> <td>Set 2</td> <td>35.19</td> <td>35.21</td> <td>35.26</td> </tr> <tr> <td>Set 1-2</td> <td>0.92</td> <td>1.02</td> <td>0.97</td> </tr> <tr> <td>% Diff</td> <td>2.61</td> <td>2.88</td> <td>2.75</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	36.11	36.23	36.23	Set 2	35.19	35.21	35.26	Set 1-2	0.92	1.02	0.97	% Diff	2.61	2.88	2.75		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, -0.350	Set 2	0, 0	0.000, -0.350	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 40x40 42x42 mm M...\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 40x40 42x42 m...\RTDOSE-001.dcm</p>
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**Field Size: 4×4 cm (MLC), 6×6 cm (Jaw)**

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	97.3
Points passed	364
Points failed	10
Total points	374
CAX offset X,Y,Z (mm, mm, mm)	-0.30, 0.31, 0.18

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Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/17/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 3 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 97.3 Pass 364 Fail 10 Total Points 374</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>36.41</td> <td>36.40</td> <td>36.41</td> </tr> <tr> <td>Set 2</td> <td>35.53</td> <td>35.56</td> <td>35.58</td> </tr> <tr> <td>Set 1-2</td> <td>0.88</td> <td>0.84</td> <td>0.83</td> </tr> <tr> <td>% Diff</td> <td>2.47</td> <td>2.35</td> <td>2.33</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX (x,y)</th> <th>Norm (x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	36.41	36.40	36.41	Set 2	35.53	35.56	35.58	Set 1-2	0.88	0.84	0.83	% Diff	2.47	2.35	2.33		CAX (x,y)	Norm (x,y)	Set 1	0, 0	0.000, -0.350	Set 2	0, 0	0.000, -0.350	<p><b>SRS MC (Set 1)</b> StereoPHAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 40x40 60x60 mm M...\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereoPHAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) -0.30 Y (mm) 0.31 Z (mm) 0.18 Pitch (deg) 0.00 Roll (deg) 0.00 Yaw (deg) 0.00</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 40x40 60x60 m...\RTDOSE-001.dcm</p>
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	<p><b>SRS MC - Plan (Set 1-2)</b></p>	<p><b>1-2</b></p>																													

**Field Size: 4×4 cm (MLC), 6×6 cm (Jaw)**

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	72.7
Points passed	271
Points failed	102
Total points	373
CAX offset X,Y,Z (mm, mm, mm)	None

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<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/16/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 2 Distance (mm) 2 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 72.7 Pass 271 Fail 102 Total Points 373</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>36.41</td> <td>36.40</td> <td>36.41</td> </tr> <tr> <td>Set 2</td> <td>35.49</td> <td>35.51</td> <td>35.55</td> </tr> <tr> <td>Set 1-2</td> <td>0.92</td> <td>0.89</td> <td>0.85</td> </tr> <tr> <td>% Diff</td> <td>2.60</td> <td>2.51</td> <td>2.41</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	36.41	36.40	36.41	Set 2	35.49	35.51	35.55	Set 1-2	0.92	0.89	0.85	% Diff	2.60	2.51	2.41		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, -0.350	Set 2	0, 0	0.000, -0.350	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 40x40 60x60 mm M...\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 40x40 60x60 m...\RTDOSE-001.dcm</p>
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**Field Size: 4×4 cm (MLC), 6×6 cm (Jaw)**

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	46.4
Points passed	173
Points failed	200
Total points	373
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025

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<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/16/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 1 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 46.4 Pass 173 Fail 200 Total Points 373</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>36.41</td> <td>36.40</td> <td>36.41</td> </tr> <tr> <td>Set 2</td> <td>35.49</td> <td>35.51</td> <td>35.55</td> </tr> <tr> <td>Set 1-2</td> <td>0.92</td> <td>0.89</td> <td>0.85</td> </tr> <tr> <td>% Diff</td> <td>2.60</td> <td>2.51</td> <td>2.41</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	36.41	36.40	36.41	Set 2	35.49	35.51	35.55	Set 1-2	0.92	0.89	0.85	% Diff	2.60	2.51	2.41		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, -0.350	Set 2	0, 0	0.000, -0.350	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 40x40 60x60 mm M...\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 40x40 60x60 m...\RTDOSE-001.dcm</p>
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**Field Size: 6×6 cm (MLC), 4.2×4.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	97.2
Points passed	386
Points failed	11
Total points	397
CAX offset X,Y,Z (mm, mm, mm)	None

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SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/17/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 3 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 97.2 Pass 386 Fail 11 Total Points 397</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>36.26</td> <td>36.22</td> <td>36.29</td> </tr> <tr> <td>Set 2</td> <td>35.22</td> <td>35.24</td> <td>35.28</td> </tr> <tr> <td>Set 1-2</td> <td>1.04</td> <td>0.98</td> <td>1.01</td> </tr> <tr> <td>% Diff</td> <td>2.97</td> <td>2.79</td> <td>2.87</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX (x,y)</th> <th>Norm (x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> </tbody> </table>		CAX	Norm	Max	Set 1	36.26	36.22	36.29	Set 2	35.22	35.24	35.28	Set 1-2	1.04	0.98	1.01	% Diff	2.97	2.79	2.87		CAX (x,y)	Norm (x,y)	Set 1	0, 0	0.000, -0.350	Set 2	0, 0	0.000, -0.350	<p><b>SRS MC (Set 1)</b> StereoPHAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 60x60 42x42 mm M...\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereoPHAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 60x60 42x42 m...\RTDOSE-001.dcm</p>
	CAX	Norm	Max																												
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<p>Notes</p> <p>Reviewed By</p>	<p><b>SRS MC - Plan (Set 1-2)</b></p>	<p><b>1-2 Set 1 - Set 2</b></p>																													

**Field Size: 6×6 cm (MLC), 4.2×4.2 cm (Jaw)**

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	69.5
Points passed	272
Points failed	125
Total points	397
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/16/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 2  
Distance (mm) 2  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 68.5  
Pass 272  
Fail 125  
Total Points 397

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	36.26	36.22	36.29
Set 2	35.22	35.24	35.28
Set 1-2	1.04	0.98	1.01
% Diff	2.97	2.79	2.87

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.000, -0.350
Set 2	0, 0	0.000, -0.350

Notes

Reviewed By

**SRS MC (Set 1)**  
StereoPHAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 60x60 42x42 mm M...\Measured.txt

**Plan (Set 2)**  
StereoPHAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 60x60 42x42 m...\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**1-Set1-Set2**

**Field Size: 6×6 cm (MLC), 4.2×4.2 cm (Jaw)**

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	50.4
Points passed	200
Points failed	197
Total points	397
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/16/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 1 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 50.4 Pass 200 Fail 197 Total Points 397</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>36.26</td> <td>36.22</td> <td>36.29</td> </tr> <tr> <td>Set 2</td> <td>35.22</td> <td>35.24</td> <td>35.28</td> </tr> <tr> <td>Set 1-2</td> <td>1.04</td> <td>0.98</td> <td>1.01</td> </tr> <tr> <td>% Diff</td> <td>2.97</td> <td>2.79</td> <td>2.87</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX(x,y)</th> <th>Norm(x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, -0.350</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	36.26	36.22	36.29	Set 2	35.22	35.24	35.28	Set 1-2	1.04	0.98	1.01	% Diff	2.97	2.79	2.87		CAX(x,y)	Norm(x,y)	Set 1	0, 0	0.000, -0.350	Set 2	0, 0	0.000, -0.350	<p><b>SRS MC (Set 1)</b></p> <p>StereoPHAN Angle (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 60x60 42x42 mm M...Measured.txt</p>	<p><b>Plan (Set 2)</b></p> <p>StereoPHAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 2.719, -694, 277.35</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.15.25 measurements\SRS mapcheck 60x60 42x42 m...RTDOSE-001.dcm</p>
	CAX	Norm	Max																												
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	CAX(x,y)	Norm(x,y)																													
Set 1	0, 0	0.000, -0.350																													
Set 2	0, 0	0.000, -0.350																													
	<p><b>SRS MC - Plan (Set 1-2)</b></p>	<p><b>0.8 ± 1.1 - 8 ± 1.2</b></p>																													

**Field Size: 6×6 cm (MLC), 6×6 cm (Jaw)**

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	85.2
Points passed	646
Points failed	112
Total points	758
CAX offset X,Y,Z (mm, mm, mm)	0.29, -0.08, 0.18

4/17/2025 SRS MapCHECK QA of Dose Distribution Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
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SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 3  
Distance (mm) 1  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 85.2  
Pass 646  
Fail 112  
Total Points 758

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	38.26	38.26	38.35
Set 2	37.02	37.02	37.03
Set 1-2	1.24	1.24	1.32
% Diff	3.35	3.35	3.57

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.000, 0.000
Set 2	0, 0	0.000, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereoPHAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 60x60 60x60 mm M...\Measured.txt

**Plan (Set 2)**  
StereoPHAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

CAX Offset  
X (mm) 0.29  
Y (mm) -0.08  
Z (mm) 0.18  
Pitch (deg) 0.00  
Roll (deg) 0.00  
Yaw (deg) 0.00

H:\Thesis\4.15.25 measurements\SRS mapcheck 60x60 60x60 m...\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**Plot (Set 1-2)**

**Field Size: 6×6 cm (MLC), 6×6 cm (Jaw)**

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	57.8
Points passed	439
Points failed	321
Total points	760
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

**QA File Parameter**

Patient Name

Patient ID

Date 4/16/2025

SSD

SDD

Depth

Energy

Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0

Difference (%) 2

Distance (mm) 2

Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 57.8

Pass 439

Fail 321

Total Points 760

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	38.26	38.20	38.35
Set 2	36.97	36.97	36.99
Set 1-2	1.29	1.23	1.37
% Diff	3.49	3.34	3.69

**Coordinates (cm)**

	CAX(x,y)	Norm(x,y)
Set 1	0, 0	0.000, 0.700
Set 2	0, 0	0.000, 0.700

Notes

Reviewed By

**SRS MC (Set 1)**

StereoPHAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 60x60 60x60 mm M...\Measured.txt

**Plan (Set 2)**

StereoPHAN Angle (deg) 0

Dose Scaling Factor 1

Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 60x60 60x60 m...\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**0.8x1.1-0.8x1.2**

**Field Size: 6×6 cm (MLC), 6×6 cm (Jaw)**

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	33
Points passed	251
Points failed	509
Total points	760
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025 SRS MapCHECK QA of Dose Distribution Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/16/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 1  
Distance (mm) 1  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 33  
Pass 251  
Fail 509  
Total Points 760

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	38.26	38.20	38.35
Set 2	36.97	36.97	36.99
Set 1-2	1.29	1.23	1.37
% Diff	3.49	3.34	3.69

**Coordinates (cm)**

	CAX(x,y)	Norm(x,y)
Set 1	0, 0	0.000, 0.700
Set 2	0, 0	0.000, 0.700

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 60x60 60x60 mm M...\Measured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.719, -694, 277.35

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

H:\Thesis\4.15.25 measurements\SRS mapcheck 60x60 60x60 m...\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**0.8x1.1-0.8x1.2**

## 5. SRS mapCHECK TG-119 measurements

### Single Target

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	33
Points passed	236
Points failed	0
Total points	236
CAX offset X,Y,Z (mm, mm, mm)	None

4/17/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/17/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 3 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 100 Pass 236 Fail 0 Total Points 236</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>3096.33</td> <td>3096.33</td> <td>3103.98</td> </tr> <tr> <td>Set 2</td> <td>3075.02</td> <td>3075.02</td> <td>3079.53</td> </tr> <tr> <td>Set 1-2</td> <td>21.32</td> <td>21.32</td> <td>24.45</td> </tr> <tr> <td>% Diff</td> <td>0.69</td> <td>0.69</td> <td>0.79</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX (x,y)</th> <th>Norm (x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.000, 0.000</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	3096.33	3096.33	3103.98	Set 2	3075.02	3075.02	3079.53	Set 1-2	21.32	21.32	24.45	% Diff	0.69	0.69	0.79		CAX (x,y)	Norm (x,y)	Set 1	0, 0	0.000, 0.000	Set 2	0, 0	0.000, 0.000	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p> <p>H:\Thesis\4.16.25 measurements\Single target newest\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 4.52, -691.6, 277.95</p> <p>H:\Thesis\4.16.25 measurements\Single target newest\RTDOSE-001.dcm</p>
	CAX	Norm	Max																												
Set 1	3096.33	3096.33	3103.98																												
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% Diff	0.69	0.69	0.79																												
	CAX (x,y)	Norm (x,y)																													
Set 1	0, 0	0.000, 0.000																													
Set 2	0, 0	0.000, 0.000																													
<p>Notes</p> <p>Reviewed By</p>	<p><b>SRS MC - Plan (Set 1-2)</b></p>																														

### Single Target

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	100
Points passed	236
Points failed	0
Total points	236
CAX offset X,Y,Z (mm, mm, mm)	None

4/17/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/17/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 2.0 Distance (mm) 2.0 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 100 Pass 236 Fail 0 Total Points 236</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>3096.33</td> <td>3096.33</td> <td>3103.98</td> </tr> <tr> <td>Set 2</td> <td>3075.02</td> <td>3075.02</td> <td>3079.53</td> </tr> <tr> <td>Set 1-2</td> <td>21.32</td> <td>21.32</td> <td>24.45</td> </tr> <tr> <td>% Diff</td> <td>0.69</td> <td>0.69</td> <td>0.79</td> </tr> </tbody> </table>		CAX	Norm	Max	Set 1	3096.33	3096.33	3103.98	Set 2	3075.02	3075.02	3079.53	Set 1-2	21.32	21.32	24.45	% Diff	0.69	0.69	0.79	<p><b>SRS MC (Set 1)</b> StereophAN Angle (deg) 0</p> <p>H:\Thesis\4.16.25 measurements\Single target newest\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereophAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 4.52, -691.6, 277.95</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.16.25 measurements\Single target newest\RTDOSE-001.dcm</p>
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	CAX(x,y)	Norm(x,y)																				
Set 1	0, 0	0.000, 0.000																				
Set 2	0, 0	0.000, 0.000																				

### Single Target

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	94.9
Points passed	224
Points failed	12
Total points	236
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date: 4/16/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 1  
Distance (mm) 1  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 94.9  
Pass 224  
Fail 12  
Total Points 236

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	3096.33	3096.33	3103.98
Set 2	3075.02	3075.02	3079.53
Set 1-2	21.32	21.32	24.45
% Diff	0.69	0.69	0.79

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.000, 0.000
Set 2	0, 0	0.000, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.16.25 measurements\Single target newest\Measured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 4.52, -691.6, 277.95

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

H:\Thesis\4.16.25 measurements\Single target newest\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**08x11-0x12**

### Multi Target

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	96.4
Points passed	215
Points failed	8
Total points	223
CAX offset X,Y,Z (mm, mm, mm)	None

5/13/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 5/13/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 3.0  
Distance (mm) 1.0  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 96.4  
Pass 215  
Fail 8  
Total Points 223

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	2398.32	2578.04	2578.04
Set 2	2288.02	2435.27	2439.31
Set 1-2	110.30	142.77	138.73
% Diff	4.53	5.86	5.70

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	1.750, 0.000
Set 2	0, 0	1.750, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\5.13.25 tg -119 test new multi\New\1800 cGy\Measured.btx

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.277, -694.18, 277.17

J:\OHSU Files\HT\TG-119 new\New\Multi target 1800 fixed\RTDOSE-001.dcm

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

**SRS MC - Plan (Set 1-2)**

### Multi Target

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	98.2
Points passed	221
Points failed	4
Total points	225
CAX offset X,Y,Z (mm, mm, mm)	0.04, 0.46, -0.26

5/13/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 5/13/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 2  
Distance (mm) 2  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 98.2  
Pass 221  
Fail 4  
Total Points 225

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	2398.32	2578.04	2578.04
Set 2	2288.43	2433.14	2435.60
Set 1-2	109.89	144.90	142.44
% Diff	4.52	5.96	5.85

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	1.750, 0.000
Set 2	0, 0	1.750, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\5.13.25 tg -119 test new multi\New\1800 cGy\Measured.btx

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.277, -694.18, 277.17

CAX Offset  
X (mm) 0.04  
Y (mm) 0.46  
Z (mm) -0.26  
Pitch (deg) 0.00  
Roll (deg) 0.00  
Yaw (deg) 0.00

J:\OHSU Files\HT\TG-119 new\New\Multi target 1800 fixed\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**18 Set 1 - Set 2**

### Multi Target

Gamma criteria used	1 mm DTA , 1% DD
Gamma pass rate (%)	94.6
Points passed	211
Points failed	12
Total points	223
CAX offset X,Y,Z (mm, mm, mm)	None

5/13/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 5/13/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 1  
Distance (mm) 1.0  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 94.6  
Pass 211  
Fail 12  
Total Points 223

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	2398.32	2578.04	2578.04
Set 2	2288.02	2435.27	2439.31
Set 1-2	110.30	142.77	138.73
% Diff	4.53	5.86	5.70

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	1.750, 0.000
Set 2	0, 0	1.750, 0.000

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\5.13.25 tg -119 test new multi\New\1800 cGy\Measured.btx

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 2.277, -694.18, 277.17

J:\OHSU Files\HT\TG-119 new\New\Multi target 1800 fixed\RTDOSE-001.dcm

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

**SRS MC - Plan (Set 1-2)**

### Multi Target (Source of error)

Gamma criteria used	1 mm DTA , 3% DD
Gamma pass rate (%)	88.9
Points passed	648
Points failed	81
Total points	729
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/16/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 3  
Distance (mm) 1  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 88.9  
Pass 648  
Fail 81  
Total Points 729

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	4997.85	7394.72	7457.44
Set 2	4930.44	7332.91	7357.15
Set 1-2	67.41	61.81	100.30
% Diff	0.92	0.84	1.37

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	2.275, 0.175
Set 2	0, 0	2.275, 0.175

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.16.25 measurements\Multitarget 03\Measured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) -0.265, -692.27, 278.04

I:\OHSU Files\HT\4.16.25 measurements\Multitarget 03\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**08x11-8x12**

### Multi Target (Source of error)

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	90.8
Points passed	642
Points failed	67
Total points	729
CAX offset X,Y,Z (mm, mm, mm)	None

4/17/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

**QA File Parameter**  
 Patient Name  
 Patient ID  
 Date 4/17/2025  
 SSD  
 SDD  
 Depth  
 Energy  
 Gantry Angle

**Absolute Dose Comparison**  
 Threshold (%) 10.0  
 Difference (%) 2.0  
 Distance (mm) 2.0  
 Use Global % Yes

**Summary (Gamma Analysis)**  
 Pass (%) 90.8  
 Pass 662  
 Fail 67  
 Total Points 729

**Dose Values (cGy)**

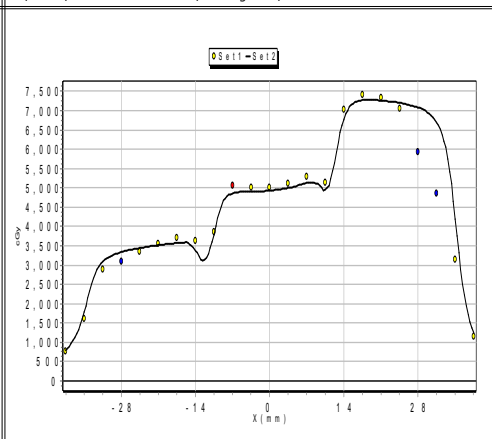
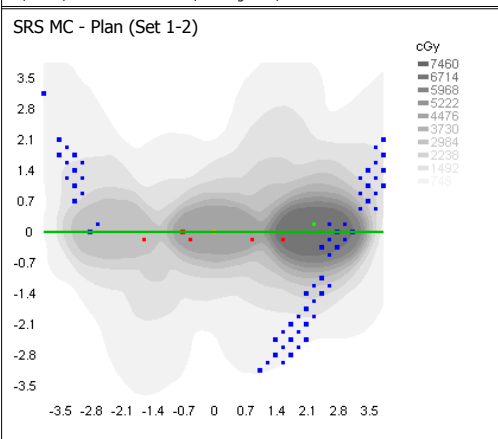
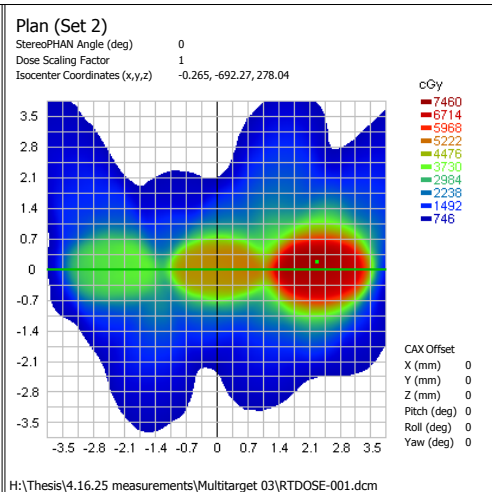
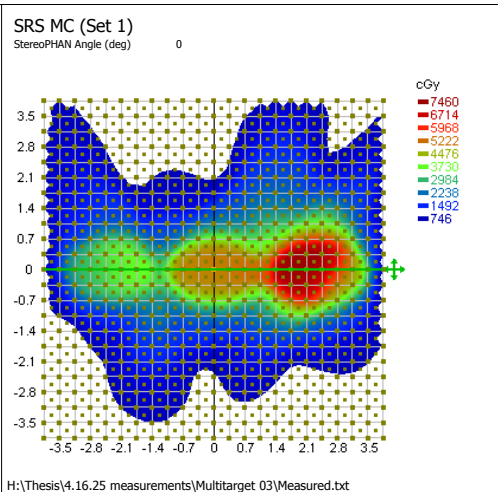
	CAX	Norm	Max
Set 1	4997.85	7394.72	7457.44
Set 2	4930.44	7332.91	7357.15
Set 1-2	67.41	61.81	100.30
% Diff	0.92	0.84	1.37

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	2.275, 0.175
Set 2	0, 0	2.275, 0.175

Notes

Reviewed By



### Multi Target (Source of error)

Gamma criteria used	1 mm DTA, 1% DD
Gamma pass rate (%)	74.5
Points passed	543
Points failed	186
Total points	729
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

**QA File Parameter**  
 Patient Name  
 Patient ID  
 Date 4/16/2025  
 SSD  
 SDD  
 Depth  
 Energy  
 Gantry Angle

**Absolute Dose Comparison**  
 Threshold (%) 10.0  
 Difference (%) 1  
 Distance (mm) 1  
 Use Global % Yes

**Summary (Gamma Analysis)**  
 Pass (%) 74.5  
 Pass 543  
 Fail 186  
 Total Points 729

**Dose Values (cGy)**

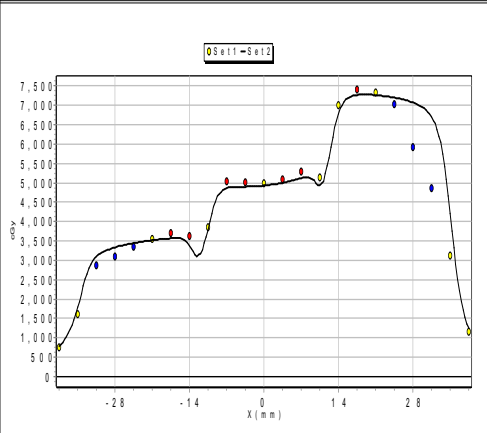
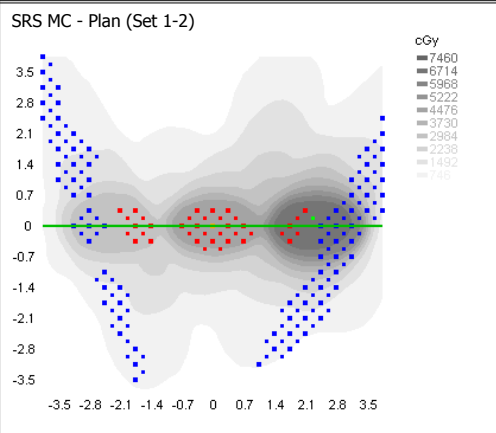
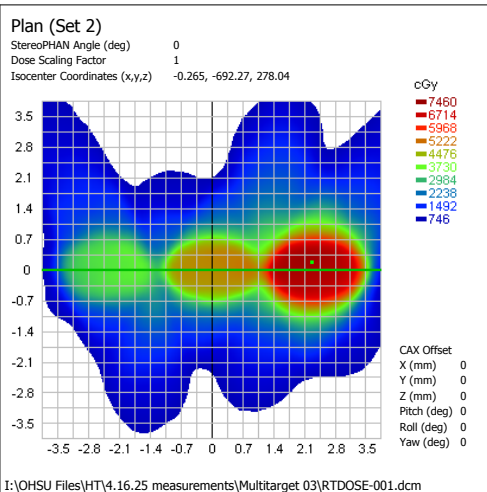
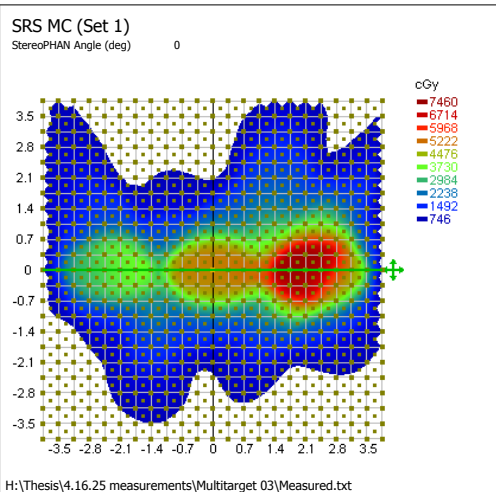
	CAX	Norm	Max
Set 1	4997.85	7394.72	7457.44
Set 2	4930.44	7332.91	7357.15
Set 1-2	67.41	61.81	100.30
% Diff	0.92	0.84	1.37

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	2.275, 0.175
Set 2	0, 0	2.275, 0.175

Notes

Reviewed By



### C Shape

Gamma criteria used	1 mm DTA, 3% DD
Gamma pass rate (%)	96.9
Points passed	498
Points failed	16
Total points	514
CAX offset X,Y,Z (mm, mm, mm)	-0.34, 0.40, -0.33

4/16/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/16/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 3 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 96.9 Pass 498 Fail 16 Total Points 514</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>1585.47</td> <td>1869.62</td> <td>1877.05</td> </tr> <tr> <td>Set 2</td> <td>1526.58</td> <td>1811.40</td> <td>1813.79</td> </tr> <tr> <td>Set 1-2</td> <td>58.88</td> <td>58.21</td> <td>63.26</td> </tr> <tr> <td>% Diff</td> <td>3.25</td> <td>3.21</td> <td>3.49</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX (x,y)</th> <th>Norm (x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.875, -0.175</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.875, -0.175</td> </tr> </tbody> </table>		CAX	Norm	Max	Set 1	1585.47	1869.62	1877.05	Set 2	1526.58	1811.40	1813.79	Set 1-2	58.88	58.21	63.26	% Diff	3.25	3.21	3.49		CAX (x,y)	Norm (x,y)	Set 1	0, 0	0.875, -0.175	Set 2	0, 0	0.875, -0.175	<p><b>SRS MC (Set 1)</b> StereoPHAN Angle (deg) 0</p> <p>H:\Thesis\4.16.25 measurements\C shape test small 01\Measured.txt</p>	<p><b>Plan (Set 2)</b> StereoPHAN Angle (deg) 0 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 3, -695, 280</p> <p>CAX Offset X (mm) -0.34 Y (mm) 0.40 Z (mm) -0.33 Pitch (deg) 0.00 Roll (deg) 0.00 Yaw (deg) 0.00</p> <p>H:\Thesis\4.16.25 measurements\C shape test small 01\RTDOSE-001.dcm</p>
	CAX	Norm	Max																												
Set 1	1585.47	1869.62	1877.05																												
Set 2	1526.58	1811.40	1813.79																												
Set 1-2	58.88	58.21	63.26																												
% Diff	3.25	3.21	3.49																												
	CAX (x,y)	Norm (x,y)																													
Set 1	0, 0	0.875, -0.175																													
Set 2	0, 0	0.875, -0.175																													
<p><b>Notes</b></p> <p><b>Reviewed By</b></p>	<p><b>SRS MC - Plan (Set 1-2)</b></p>																														

### C Shape

Gamma criteria used	2 mm DTA, 2% DD
Gamma pass rate (%)	96.5
Points passed	496
Points failed	18
Total points	514
CAX offset X,Y,Z (mm, mm, mm)	None

4/17/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/17/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 2.0  
Distance (mm) 2.0  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 96.5  
Pass 496  
Fail 18  
Total Points 514

**Dose Values (cGy)**

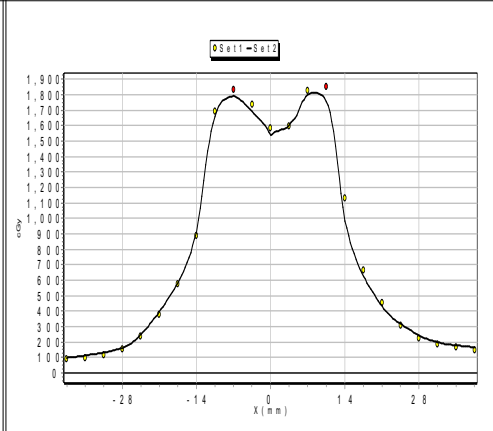
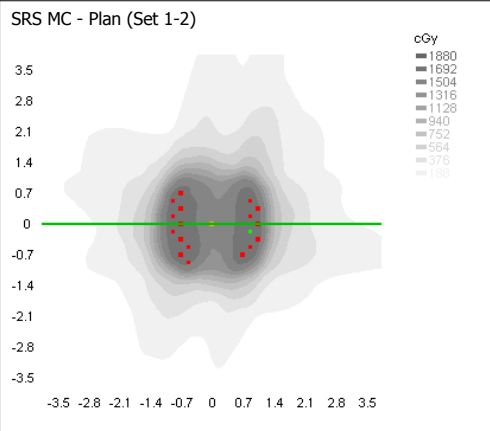
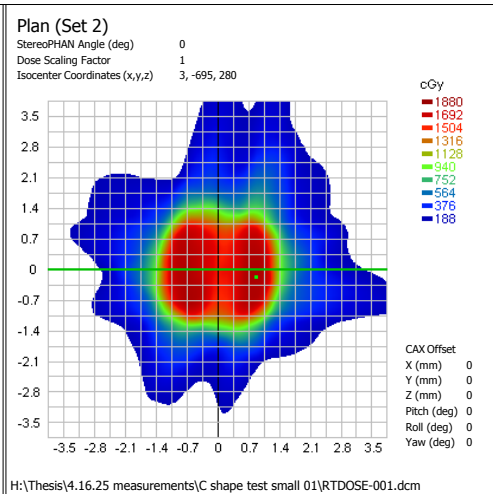
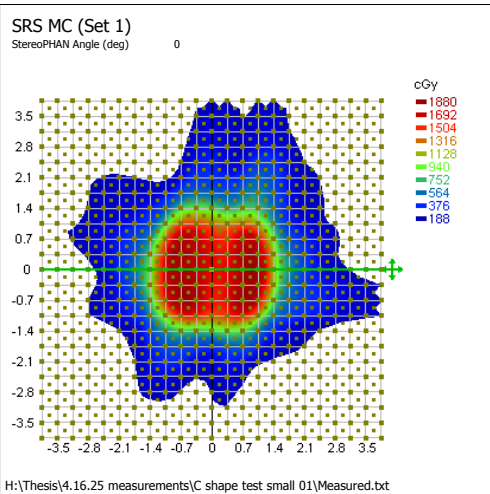
	CAX	Norm	Max
Set 1	1585.47	1869.62	1877.05
Set 2	1539.14	1810.96	1815.25
Set 1-2	46.32	58.66	61.79
% Diff	2.56	3.24	3.41

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.875, -0.175
Set 2	0, 0	0.875, -0.175

Notes

Reviewed By



### C Shape

Gamma criteria used	1 mm DTA, 1% DD
Gamma pass rate (%)	91.4
Points passed	480
Points failed	34
Total points	514
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date: 4/16/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 1  
Distance (mm) 1  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 93.4  
Pass 480  
Fail 34  
Total Points 514

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	1585.47	1869.62	1877.05
Set 2	1539.14	1810.96	1815.25
Set 1-2	46.32	58.66	61.79
% Diff	2.56	3.24	3.41

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.875, -0.175
Set 2	0, 0	0.875, -0.175

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 0

H:\Thesis\4.16.25 measurements\C shape test small 01\Measured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 0  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 3, -695, 280

H:\Thesis\4.16.25 measurements\C shape test small 01\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**0 Set 1 - Set 2**

### C Shape rotated 90°

Gamma criteria used	1 mm DTA, 3% DD
Gamma pass rate (%)	98.6
Points passed	641
Points failed	9
Total points	650
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025

SRS MapCHECK QA of Dose Distribution

Hospital Name:

<p><b>QA File Parameter</b></p> <p>Patient Name Patient ID Date 4/16/2025 SSD SDD Depth Energy Gantry Angle</p> <p><b>Absolute Dose Comparison</b></p> <p>Threshold (%) 10.0 Difference (%) 3 Distance (mm) 1 Use Global % Yes</p> <p><b>Summary (Gamma Analysis)</b></p> <p>Pass (%) 98.6 Pass 641 Fail 9 Total Points 650</p> <p><b>Dose Values (cGy)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX</th> <th>Norm</th> <th>Max</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>1549.73</td> <td>1821.83</td> <td>1849.15</td> </tr> <tr> <td>Set 2</td> <td>1539.14</td> <td>1784.99</td> <td>1796.28</td> </tr> <tr> <td>Set 1-2</td> <td>10.59</td> <td>36.84</td> <td>52.87</td> </tr> <tr> <td>% Diff</td> <td>0.59</td> <td>2.06</td> <td>2.96</td> </tr> </tbody> </table> <p><b>Coordinates (cm)</b></p> <table border="1"> <thead> <tr> <th></th> <th>CAX (x,y)</th> <th>Norm (x,y)</th> </tr> </thead> <tbody> <tr> <td>Set 1</td> <td>0, 0</td> <td>0.525, 0.525</td> </tr> <tr> <td>Set 2</td> <td>0, 0</td> <td>0.525, 0.525</td> </tr> </tbody> </table> <p>Notes</p> <p>Reviewed By</p>		CAX	Norm	Max	Set 1	1549.73	1821.83	1849.15	Set 2	1539.14	1784.99	1796.28	Set 1-2	10.59	36.84	52.87	% Diff	0.59	2.06	2.96		CAX (x,y)	Norm (x,y)	Set 1	0, 0	0.525, 0.525	Set 2	0, 0	0.525, 0.525	<p><b>SRS MC (Set 1)</b></p> <p>StereoPHAN Angle (deg) 90</p> <p>H:\Thesis\4.16.25 measurements\C shape test small 01\90 degrees\Measured.txt</p>	<p><b>Plan (Set 2)</b></p> <p>StereoPHAN Angle (deg) 90 Dose Scaling Factor 1 Isocenter Coordinates (x,y,z) 3, -695, 280</p> <p>CAX Offset X (mm) 0 Y (mm) 0 Z (mm) 0 Pitch (deg) 0 Roll (deg) 0 Yaw (deg) 0</p> <p>H:\Thesis\4.16.25 measurements\C shape test small 01\RTDOSE-001.dcm</p>
	CAX	Norm	Max																												
Set 1	1549.73	1821.83	1849.15																												
Set 2	1539.14	1784.99	1796.28																												
Set 1-2	10.59	36.84	52.87																												
% Diff	0.59	2.06	2.96																												
	CAX (x,y)	Norm (x,y)																													
Set 1	0, 0	0.525, 0.525																													
Set 2	0, 0	0.525, 0.525																													
<p><b>SRS MC - Plan (Set 1-2)</b></p>	<p><b>08x11-8x12</b></p>																														

### C Shape rotated 90°

Gamma criteria used	2 mm DTA , 2% DD
Gamma pass rate (%)	98.6
Points passed	641
Points failed	9
Total points	650
CAX offset X,Y,Z (mm, mm, mm)	None

4/17/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date 4/17/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 2.0  
Distance (mm) 2.0  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 98.6  
Pass 641  
Fail 9  
Total Points 650

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	1549.73	1821.83	1849.15
Set 2	1539.14	1784.99	1796.28
Set 1-2	10.59	36.84	52.87
% Diff	0.59	2.06	2.96

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.525, 0.525
Set 2	0, 0	0.525, 0.525

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 90

cGy  
1850  
1665  
1480  
1295  
1110  
925  
740  
555  
370  
185

H:\Thesis\4.16.25 measurements\C shape test small 01\90 degrees\Measured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 90  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 3, -695, 280

cGy  
1850  
1665  
1480  
1295  
1110  
925  
740  
555  
370  
185

CAX Offset  
X (mm) 0  
Y (mm) 0  
Z (mm) 0  
Pitch (deg) 0  
Roll (deg) 0  
Yaw (deg) 0

H:\Thesis\4.16.25 measurements\C shape test small 01\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

cGy  
1850  
1665  
1480  
1295  
1110  
925  
740  
555  
370  
185

-3.5 -2.8 -2.1 -1.4 -0.7 0 0.7 1.4 2.1 2.8 3.5

**0 Set 1 - Set 2**

cGy

x (mm)

### C Shape rotated 90°

Gamma criteria used	1 mm DTA, 1% DD
Gamma pass rate (%)	96.6
Points passed	626
Points failed	22
Total points	648
CAX offset X,Y,Z (mm, mm, mm)	None

4/16/2025
SRS MapCHECK QA of Dose Distribution
Hospital Name:

**QA File Parameter**

Patient Name  
Patient ID  
Date: 4/16/2025  
SSD  
SDD  
Depth  
Energy  
Gantry Angle

**Absolute Dose Comparison**

Threshold (%) 10.0  
Difference (%) 1  
Distance (mm) 1  
Use Global % Yes

**Summary (Gamma Analysis)**

Pass (%) 96.6  
Pass 626  
Fail 22  
Total Points 648

**Dose Values (cGy)**

	CAX	Norm	Max
Set 1	1549.73	1821.83	1849.15
Set 2	1526.88	1776.98	1790.84
Set 1-2	22.85	44.85	58.31
% Diff	1.29	2.52	3.28

**Coordinates (cm)**

	CAX (x,y)	Norm (x,y)
Set 1	0, 0	0.525, 0.525
Set 2	0, 0	0.525, 0.525

Notes

Reviewed By

**SRS MC (Set 1)**  
StereophAN Angle (deg) 90

H:\Thesis\4.16.25 measurements\C shape test small 01\90 degrees\Measured.txt

**Plan (Set 2)**  
StereophAN Angle (deg) 90  
Dose Scaling Factor 1  
Isocenter Coordinates (x,y,z) 3, -695, 280

H:\Thesis\4.16.25 measurements\C shape test small 01\RTDOSE-001.dcm

**SRS MC - Plan (Set 1-2)**

**0 Set 1 - Set 2**

