



**Eclipse V18 Commissioning –
Adjusting your DLG is just the
beginning**



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Eclipse V18

Introduction / Agenda

- What Varian says you need to do
- What you actually need to do
- Differences between Halcyon, TrueBeam and Edge/STX
- How to perform beam matching in Eclipse V18
- How your patient QA will change in Eclipse V18



Background on Enhanced Leaf Model

Before Eclipse v18:

- Eclipse utilized a simplified MLC model where the MLC was modeled as a solid rectangle with a flat tip (homogenous)
- Characterized by: Leaf Transmission and Dosimetric Leaf Gap (DLG)
- Fluence between pair of MLC leaves: physical gap plus DLG
- Small MLC openings: required further adjustment of DLG and spot size
- Differences in MLC transmission off-axis were not considered

Before Eclipse v18: MLC Model

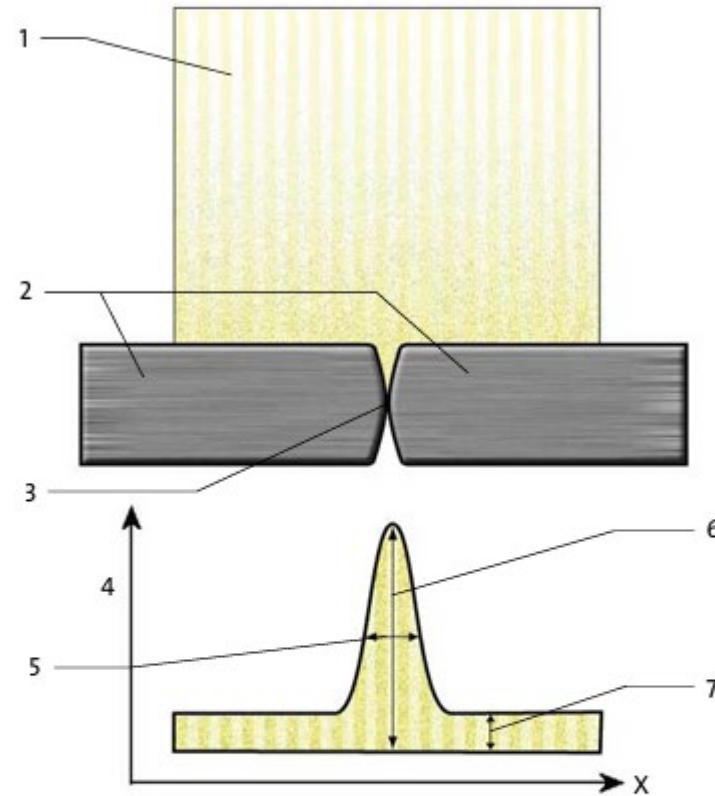


Figure 38 Rounded Leaf End Transmission

1. Radiation beam
2. MLC leaf pair
3. Rounded leaf ends
4. Dose
5. Nonzero apparent width for an aperture of nominally zero width
6. Dose transmitted through closed, rounded MLC leaf ends
7. Dose transmitted through MLC leaves

Image: Eclipse Photon and
Electron algorithm Manual



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Background on Enhanced Leaf Model

Following Eclipse v18:

- Model actual MLC leaf shape, including rounded leaf tip shape and the drive screw cutout (still limitations for inter-leaf leakage and tongue-and-groove)
- ELM models varying penumbra based on leaf position
- ELM applies correct MLC transmission both on-axis and off-axis
- MLC transmission accounts for the increased path length off-axis and reduction of interleaf leakage due to wider leaves in certain MLC configurations (HD-MLC)
- The Leaf Gap (LG) parameter is no longer a dosimetric parameter but now represents the mechanical leaf gap between the closed leaf tips.

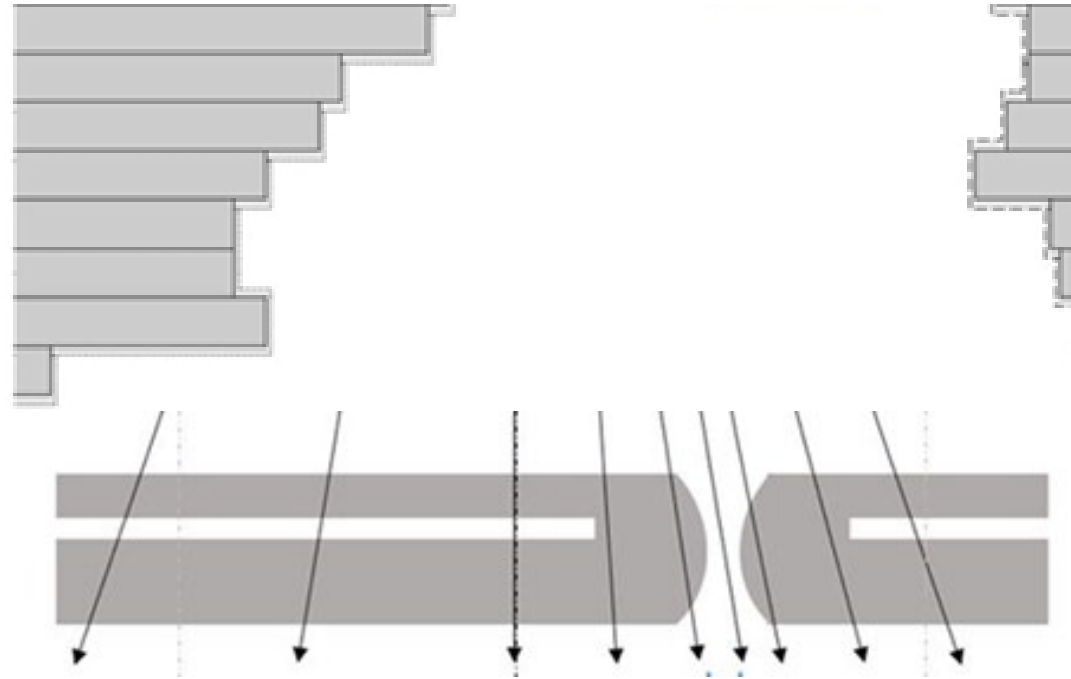


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Eclipse v18: ELM Model



- With ELM the whole leaf shape is accurately modeled
- MLC leaf thickness is modeled through divergent ray tracing through the leaf
- Transmission in all areas outside the measured CAX value is modeled relative to this value



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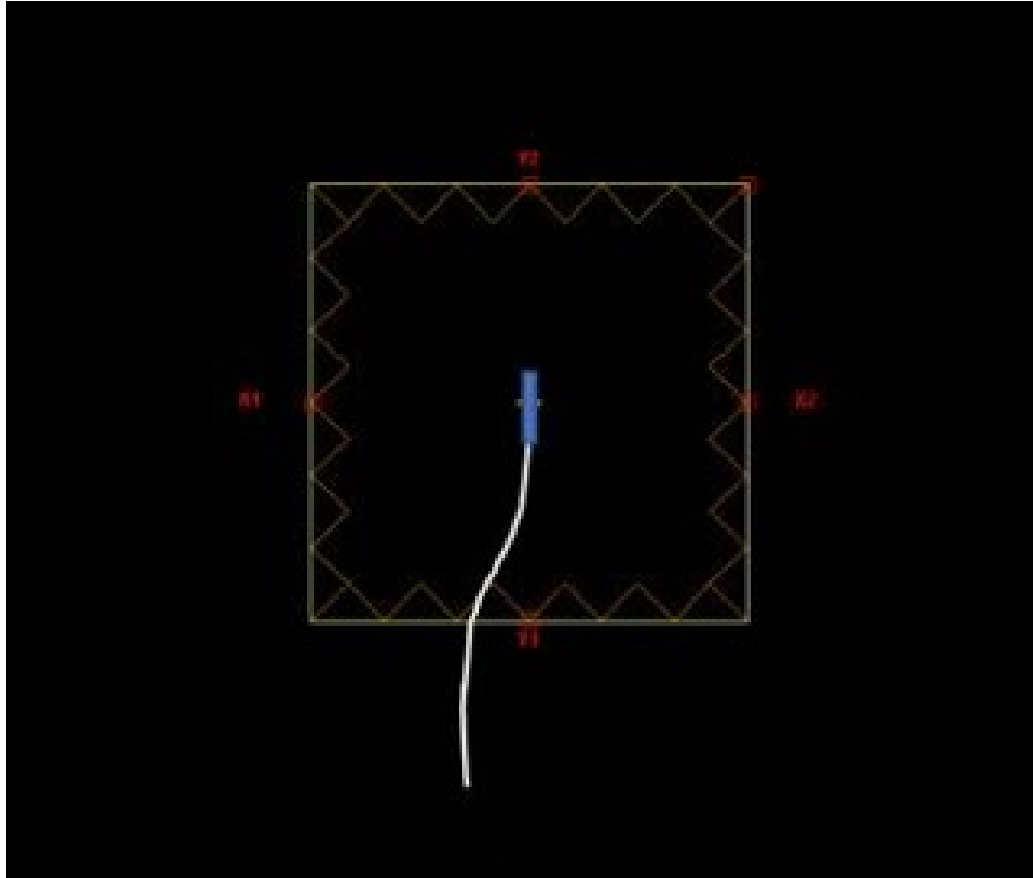


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Eclipse V18

- What Varian says you need to do
 - MLC values are calculated in Eclipse from direct measurements
 - All V18 beam models require use of ELM data
- ELM handout and files:
 - Measure ELM data
 - Add data to the Eclipse models MLC add-on
 - Beam data calculation outputs the ELM MLC gap
 - Perform some validation (point dose from ELM measurements)

ELM Configuration (Varian handout)



- ELM values are measured using Varian provided sweeping gap plans
- Transmission bank A & B
- Sweeping gaps of 4, 6, and 20 mm
- Use for measurements:
 - Medium or large ion chamber
 - Electrometer
 - Solid Water
 - SSD = 90 cm
 - Depth = 10 cm

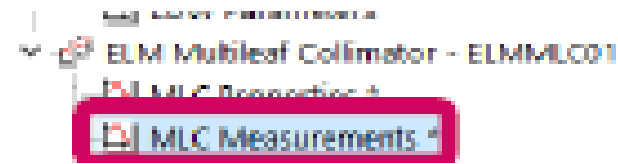


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ELM Measurements

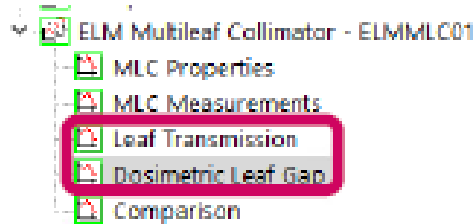


ELM Data for Eclipse	6X
Source Phantom Distance (mm)	900.0
Measurement depth (mm)	100.0
Open 10x10 [nC/100MU]	15.346
Transmission A [nC/100MU]	0.219
Transmission B [nC/100MU]	0.223
Gap 4 mm [nC/100MU]	0.845
Gap 6 mm [nC/100MU]	1.088
Gap 20 mm [nC/100MU]	2.847



ELM Measurements

Example V18 ELM model results for HD-MLC vs previous MLC data



ELM Calculation	6FFF
Leaf Transmission	0.010975
Dosimetric Leaf Gap	-0.036339

ELM Calculation	10FFF
Leaf Transmission	0.013303
Dosimetric Leaf Gap	-0.026999

Prev. MLC parameters	6FFF
Leaf Transmission	0.0106
Dosimetric Leaf Gap	0.047

Prev. MLC parameters	10FFF
Leaf Transmission	0.0132
Dosimetric Leaf Gap	0.062

ELM Verification (Varian handout)

Table 1: Measurements

	6 MV (nC/500MU)
01 10x10	
02 Transm_A	
03 Transm_B	
04 Swp_4mm	
05 Swp_6mm	
06 Swp_20mm	

- Convert raw data measured to dose
- Calculate the ELM fields with V18 model
- Use point dose value and compare with measured values



What You Actually Need To Do



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Eclipse V18

- ELM handout and files:
 - Measure ELM data
 - Add data to the Eclipse model
 - Perform some validation (point dose from ELM measurements)
- And more:
 - Algorithm configuration (?)
 - PO algorithm (?)
 - Test plans (?)
 - Small field (?)



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Eclipse V18

- What you actually need to do
 - Measure ELM data
 - Add data to the Eclipse model
 - Modify or evaluate source size based on Eclipse18 recommendations
 - Rerun PO algorithm with ELM add-on
 - Measure or know your physical DLG
 - Perform test plans to confirm that the ELM has been configured properly
 - Be prepared to adjust your ELM model (“fitting”) possibly
 - Evaluate treatments $\leq 2 \times 2$ cm (source size changes)



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Eclipse V18 Configuration

Small Field Treatments:

- Prior versions of Eclipse often required adjustments of dosimetric parameters
- Target spot sizes were adjusted to achieve acceptable results for small fields
- These prior alterations can affect calculation results with the ELM
- The algorithm spot-size values may need to be configured
- Varian provides new recommended values for algorithm spot size

Beam model configuration

- Verify beam data has been copied forward to v18 algorithms
- Verify current spot size values used for AAA and AXB

Consider using Varian recommended values for v18 models

Table 15 Example Values for Target Spot Size Parameters for 18.0 and Later Algorithms

Algorithm / Treatment Unit	Spot Size X-direction [mm]	Spot Size Y-direction [mm]
AAA / Varian non-Halcyon treatment unit	1.0	1.0
	0.0 if MLC in field	0.0 if MLC in field
AAA / Varian Halcyon treatment unit	1.2	1.5
Acuros XB / Varian non-Halcyon treatment unit	1.0	1.5
	0.5 if MLC in field	0.7 if MLC in field



Validation of source size modeling

- Source size will affect the calculated penumbra
- This effect is more significant for small fields
- Small field data recommissioning and measurements may be necessary to validate new source size values
- Perform small field MLC measurements and compare with planned data



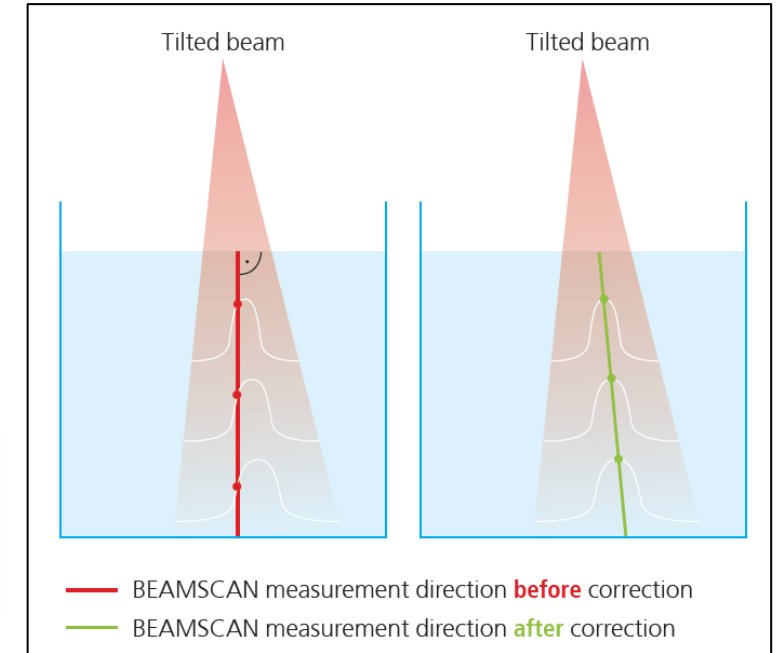
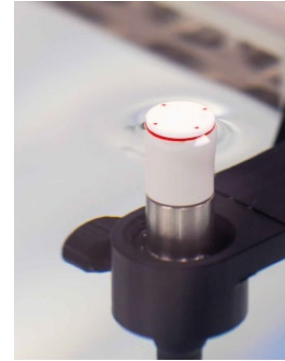
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Small field data measurements

- Small field setup with PTW BeamScan
 - Center detector positioning
(Auto Alignment)
 - Aligned with beam axis
(Beam Inclination correction)



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Auto Setup mode active

Auto Setup Linac Measurement

Adjust Parameters Edit...

Field Size	10.00 x 10.00 cm ²
Depth	30.0 mm

☐ Reference Run

 ✓

☐ Leveling

☒ Auto Leveling
☐ Manual Leveling
☐ Numerical Input

Inclination A [°] -0.092
 Inclination C [°] -0.193

✓

☒ Beam Center Adjustment

☐ User Shift ...

 ✓

Zero Shift A [mm] 2.7
 Zero Shift C [mm] 0.7

☒ Auto Field Alignment

 ✓

Rotation A - C [°] 0.115

Reset Load Download

Linac **Measurement**

Mounted
☐ vertical
☒ horizontal

Max. Dose Rate
 3.0 [Gy/min]

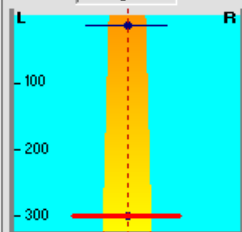
Continuous Scans

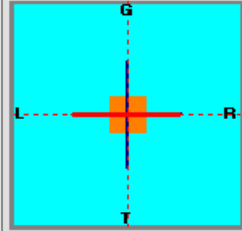
Scan Speeds[mm/s]
 PDD 10.00
 Profiles 10.00

Field Semiflex 3D
☒ with Reference
 Reference 31013 Sen EPOM Manual

Beam Inclination Defaults

Change View





Profiles

☒ Y Profiles
 Inclination Angle[°] -0.06

☒ X Profiles
 Inclination Angle[°] -0.06

Set Beam Inclination

Depths [mm]
 15.0 300.0

Estimated time [min:s] 2:26 Medium Water

Comment:

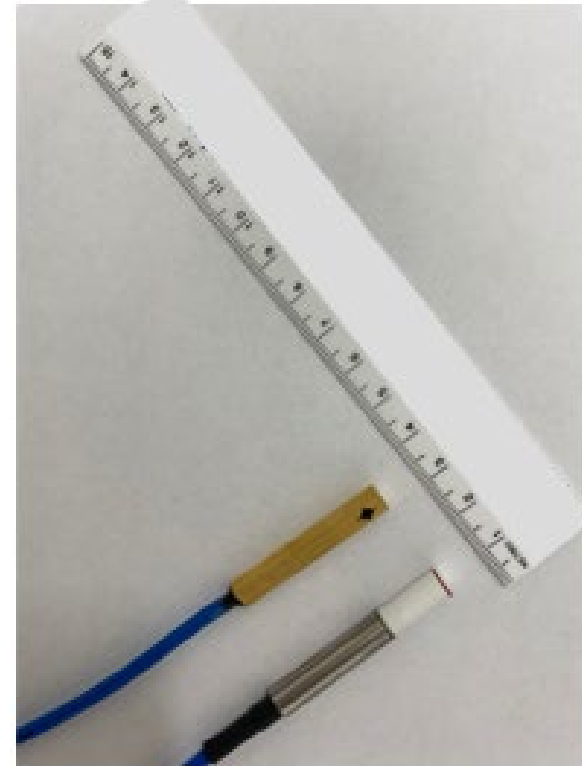
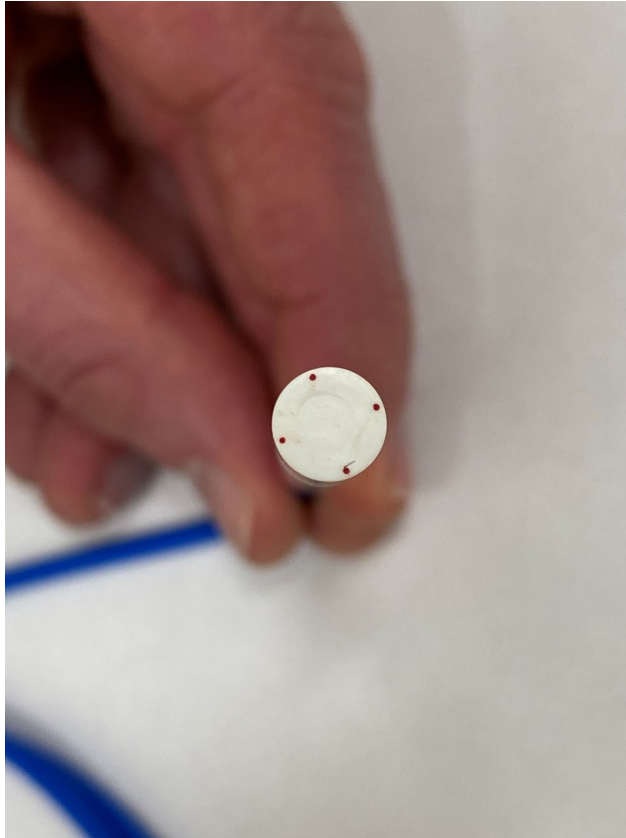


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Small Field Detectors

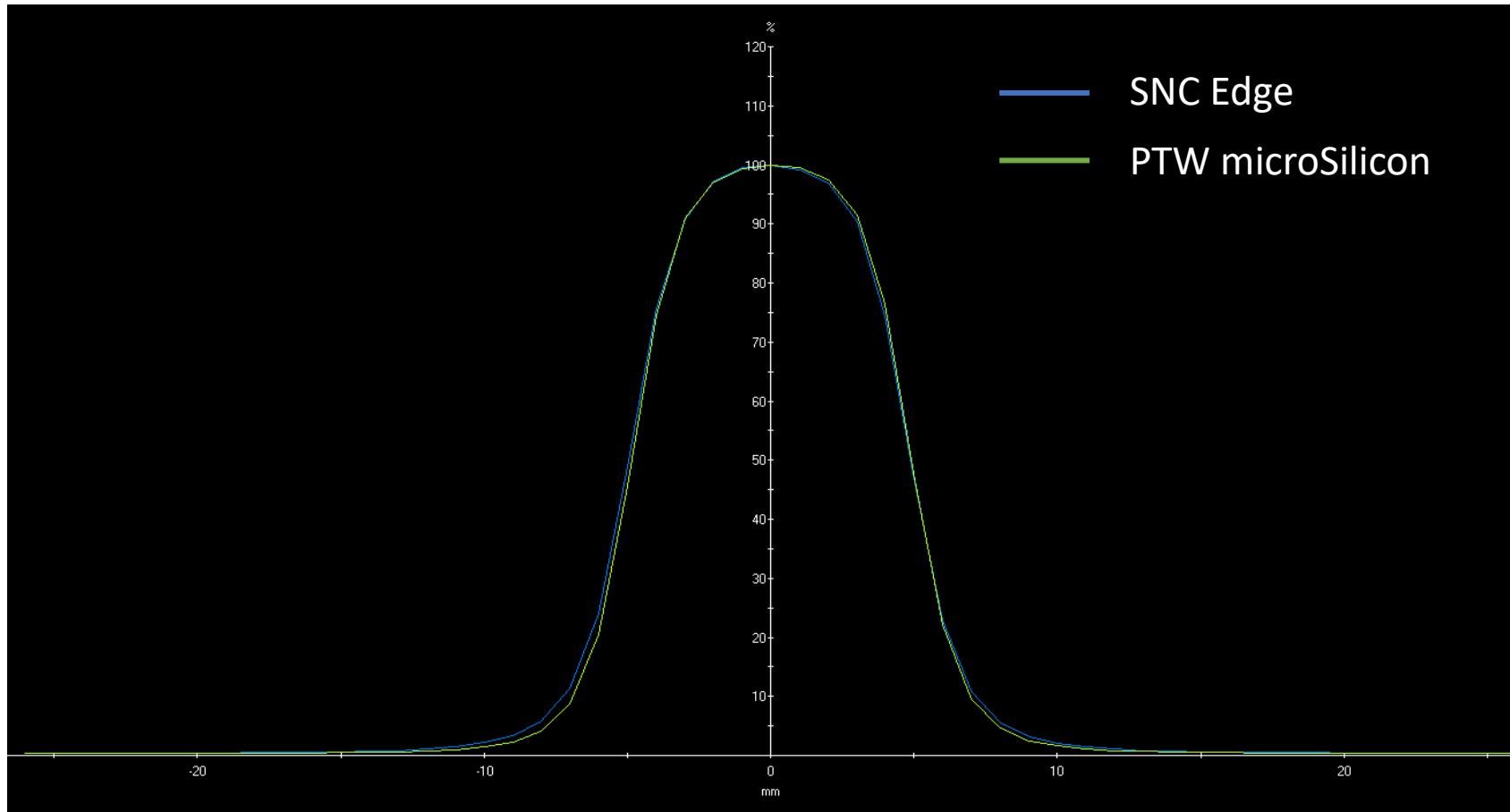


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Detectors comparison



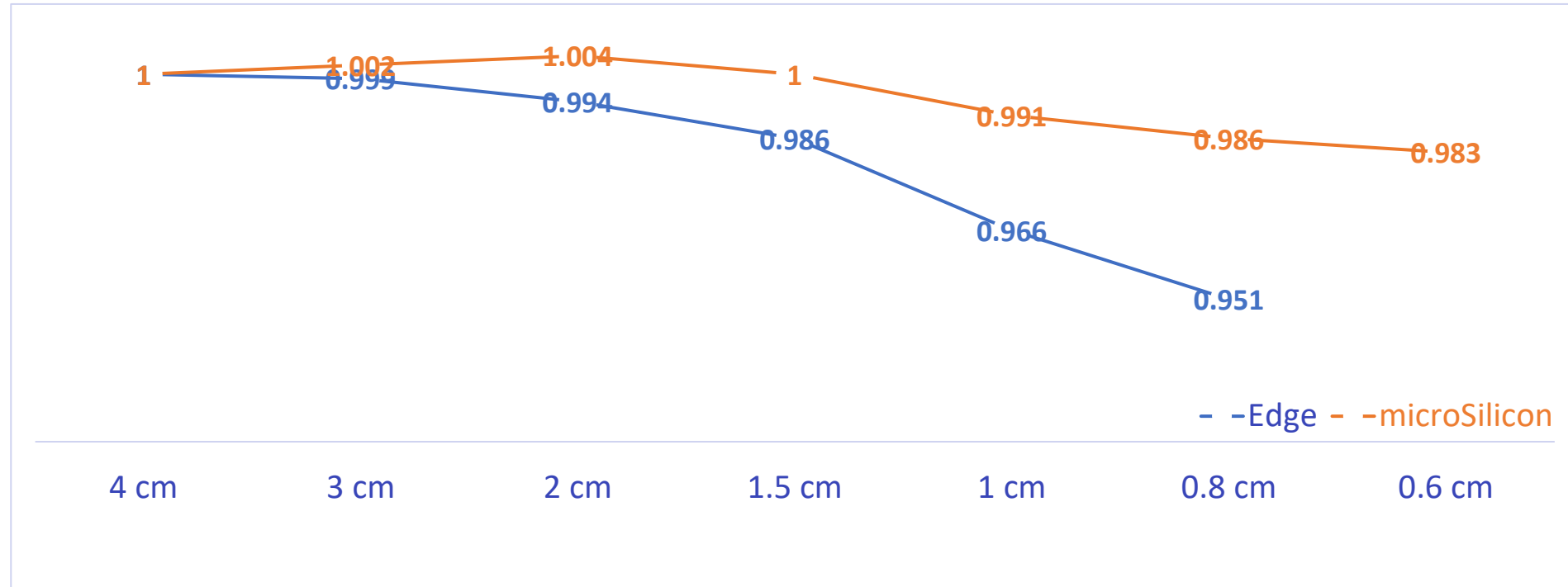
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Small Field Detectors

Correction Factors



Edge factors from TRS-483

MicroSilicon factors from "Small Field output correction factors of the microSilicon detector and a deeper understanding of their origin by quantifying perturbation"
Med Phys 47 (7), July 2020

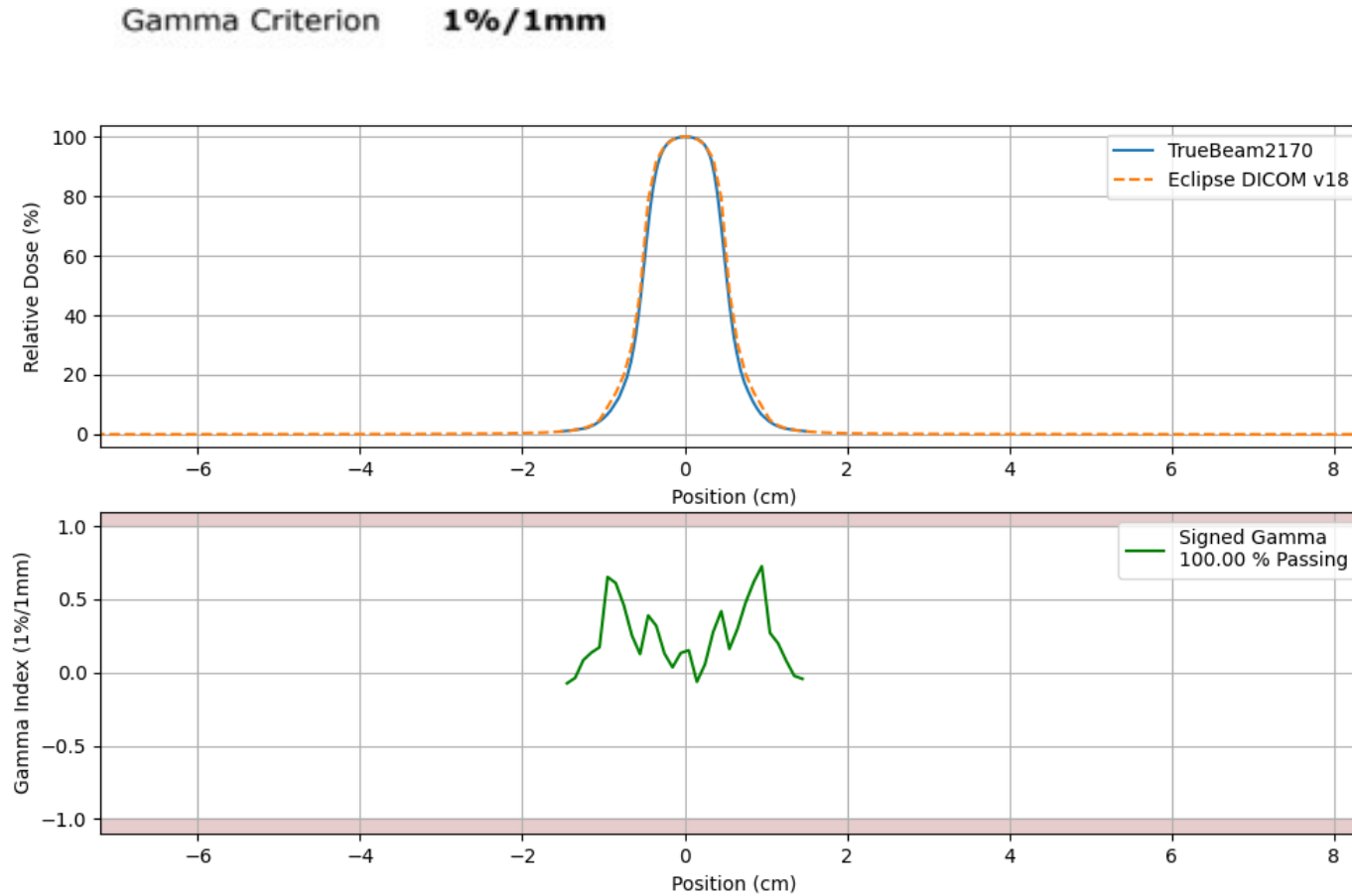


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Validation of source size modeling



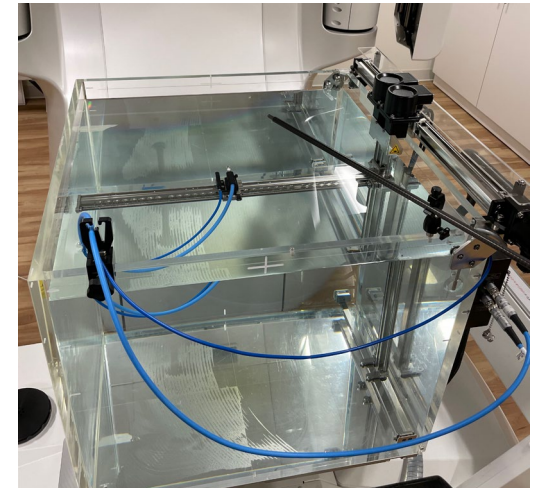
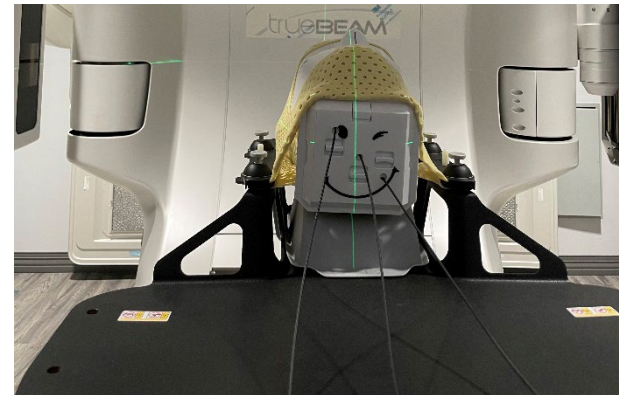
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Eclipse V18 Configuration Tests

- Sample fluence patterns and test plans should be used during commissioning and for ongoing QA tests of algorithm, upgrades, etc.
- Equipment for commissioning tests (Array system, chamber and phantoms, portal dosimetry, water phantom and small field detectors for validating small fields, etc.)



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Eclipse V18 ELM Test Plans

- Plans are used to confirm the expected changes with ELM model
- Plans will confirm that the configuration and ELM parameters used are correct
- Start from basic tests (dose measurements) to more complex tests (fluence patterns) to finally rerun existing clinical plans
- The test plans help identify and confirm the correct configuration (adjustments?)
- Reference from Ann Van Esch et al. (Med Phys 2022,; 49:7754-7765). *“The test plans emphasize the flaws in the original MLC model, the ELM resolves all of the observed discrepancies”*.
- See two relevant test plans to validate ELM model in next couple of slides



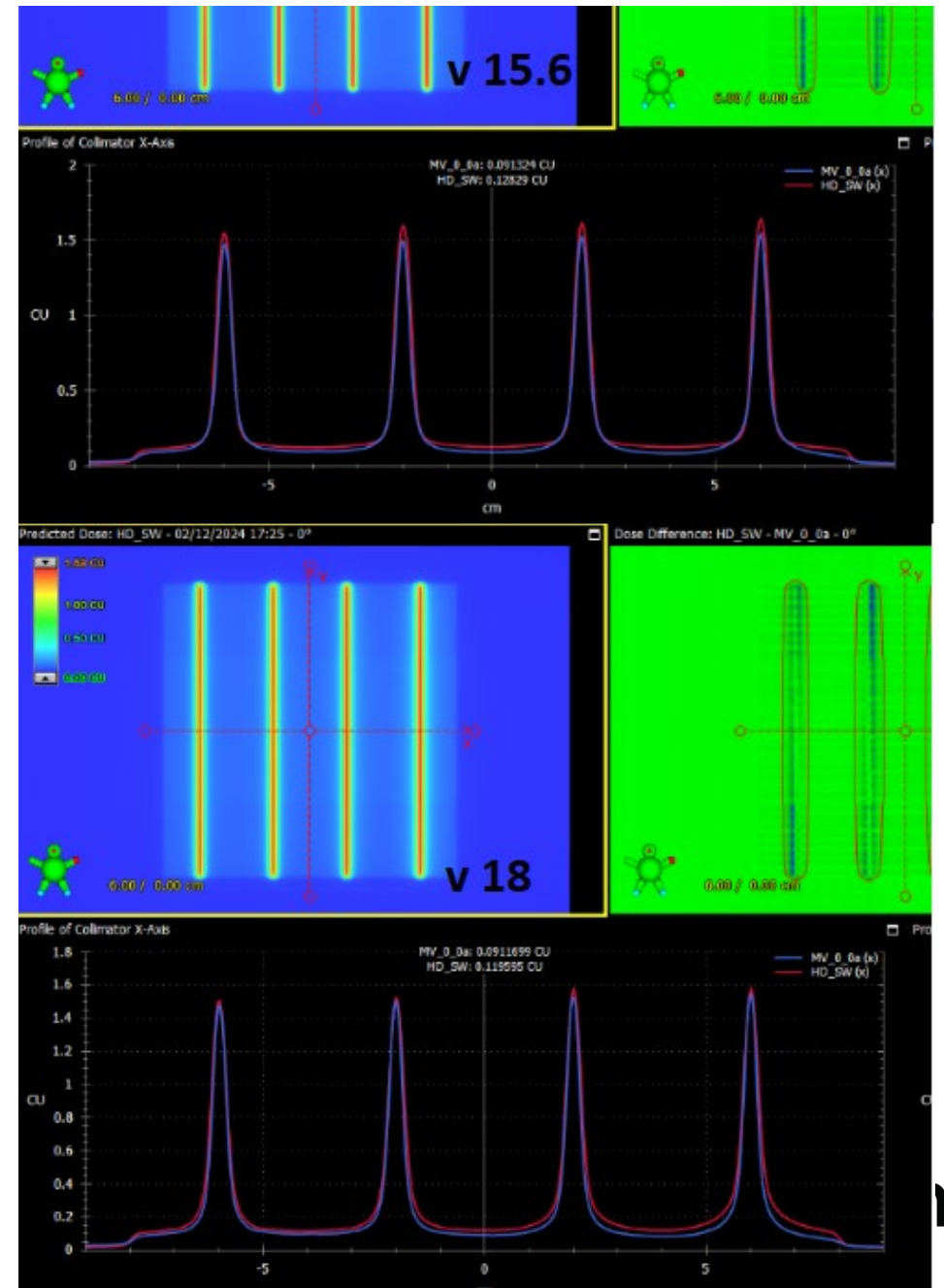
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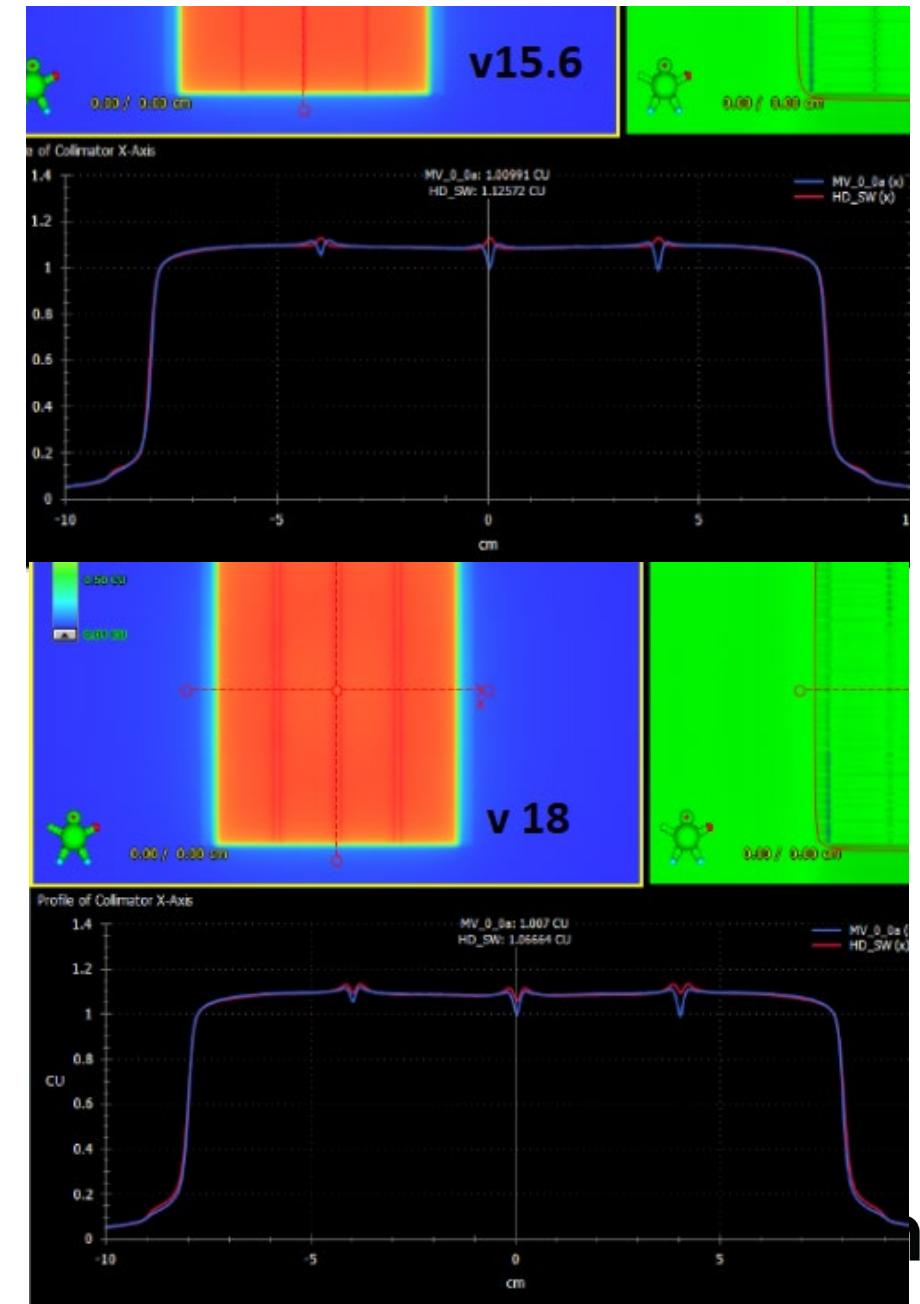
STATIC NARROW MLC STRIPS PLAN

- The Static Narrow strips plan is used to evaluate dose through narrow MLC gaps
- Test plan:
 - Small slits are located at distances off-axis
 - Each subfield defines a very small MLC gap
- Results show the new V18 model demonstrates better agreement with measurement, especially in peak doses and off-axis penumbra
- Deliver and evaluate the plan with high-resolution array, Portal Dosimetry, and/or film



STATIC WALLPAPER PLAN

- The Static Wallpaper plan is a pattern that evaluates the modeling of the rounded leaf edge
- Test plan:
 - Each subfield is ~4 cm wide, slightly overlapping at junctions. Four bands were used for these tests.
- Calculated plan for versions before 18 should result in a flat fluence or slight peaked around each junction
- The new Eclipse 18 model should show slight bumps with a dip around a central dip at each junction.
- Deliver and evaluate the plan with high-resolution array, Portal Dosimetry, and/or film



Fluence plans to validate Eclipse18

- The fluence plans may need to be adjusted based on the physical DLG to make sure the effect is noticeable
- Standard plans may not work for your clinic
- Example: Static wallpaper test
 - TrueBeam with a physical measured DLG of 0.94 mm and an Eclipse DLG of 1.3 mm.
 - Created a plan with junction overlaps of 1.0 mm to see the effect:
 - Flat or inverted for pre-Eclipse18
 - A dip at the overlap for Eclipse18



How Beam Matching Works

- Not enough data regarding the appropriate values for optimal ELM
- Discussions are on-going on the feasibility of a “machine average ELM”
- Additional testing required to validate and optimize the MLC parameters for beam-matching consideration



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How Beam Matching Works

- Example of a site with two TrueBeam STx with slightly different MLC transmission values.
- Manually override the ELM calculated values with “beam –matched” parameters.
- Same ELM add-on should be used and matched to both machines
 - Only one ELM add-on should be created

ELM Calculation Linac1	6X
Leaf Transmission	0.011655
Dosimetric Leaf Gap	-0.034069

ELM Calculation Linac2	6X
Leaf Transmission	0.012957
Dosimetric Leaf Gap	-0.027996

ELM ECLIPSE V.18.1	6X
Leaf Transmission	0.012306
Dosimetric Leaf Gap	-0.031033



Beam Matching ELM Configuration Tests

Linac1

Field	Measured	Acuros V.18	% Difference
Transmission	0.046	0.049	
Gap 4mm	0.197	0.199	1.24%
Gap 6mm	0.260	0.264	1.59%
Gap 20mm	0.718	0.721	0.37%
Field	Measured	Acuros V.15.6	% Difference
Transmission	0.046	0.048	
Gap 4mm	0.197	0.198	0.74%
Gap 6mm	0.260	0.264	1.59%
Gap 20mm	0.718	0.721	0.37%

Linac2

Field	Measured	Acuros V.18	% Difference
Transmission	0.051	0.049	
Gap 4mm	0.203	0.199	-2.20%
Gap 6mm	0.269	0.264	-1.87%
Gap 20mm	0.725	0.721	-0.53%
Field	Measured	Acuros V.15.6	% Difference
Transmission	0.051	0.048	
Gap 4mm	0.203	0.198	-2.72%
Gap 6mm	0.269	0.264	-1.87%
Gap 20mm	0.725	0.721	-0.53%

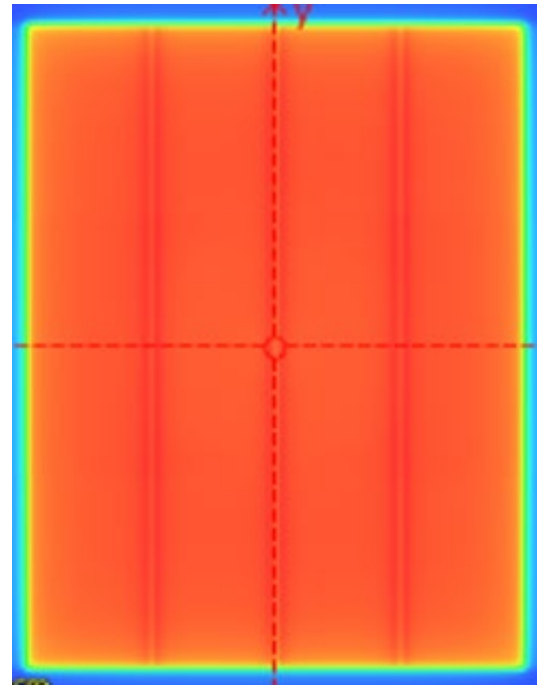
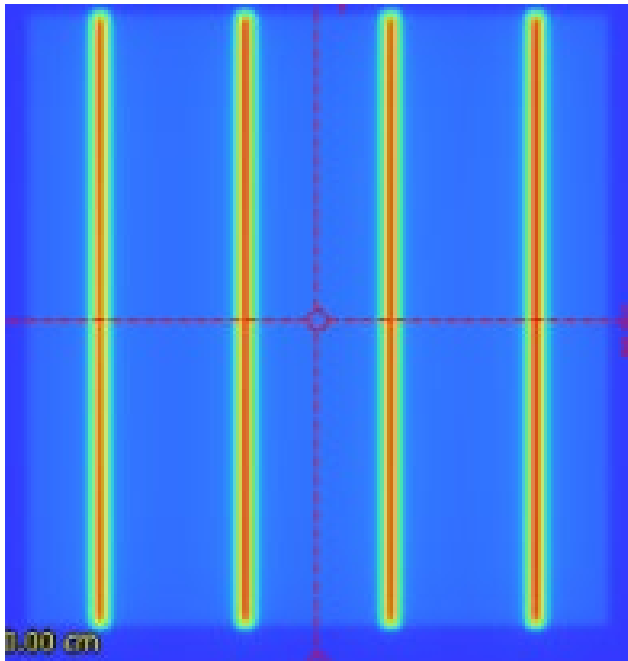


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Fluence plans to validate ELM match



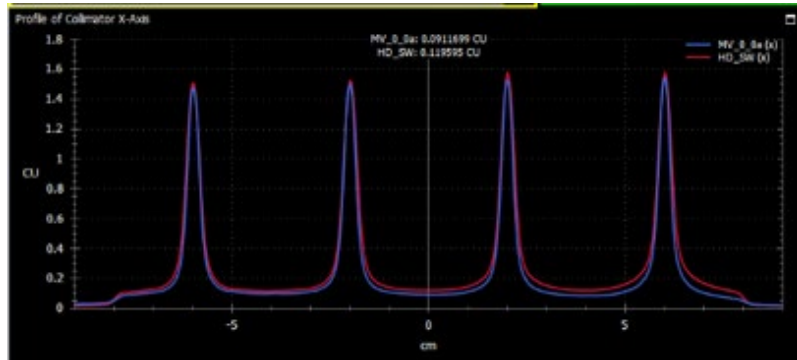
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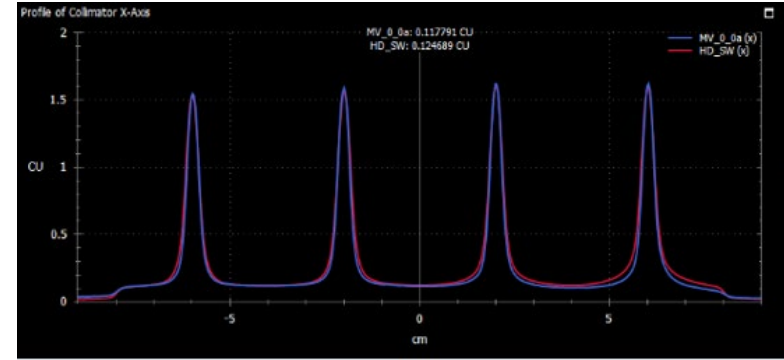
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Beam Matching ELM Configuration Tests

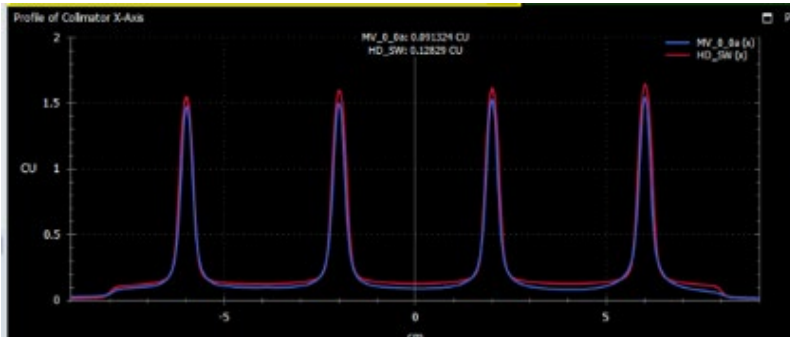
Linac1 V18



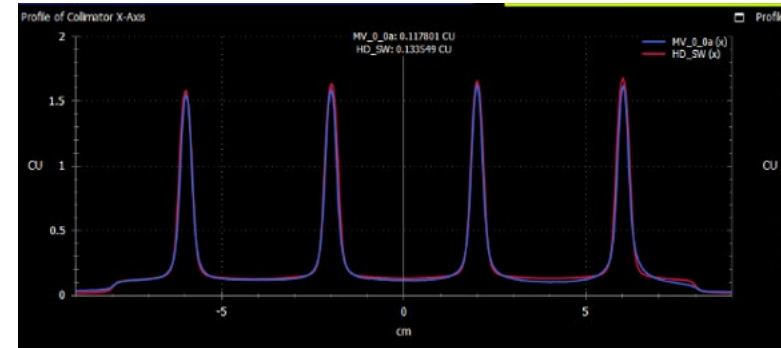
Linac2 V18



Linac1 V15.6



Linac2 V15.6



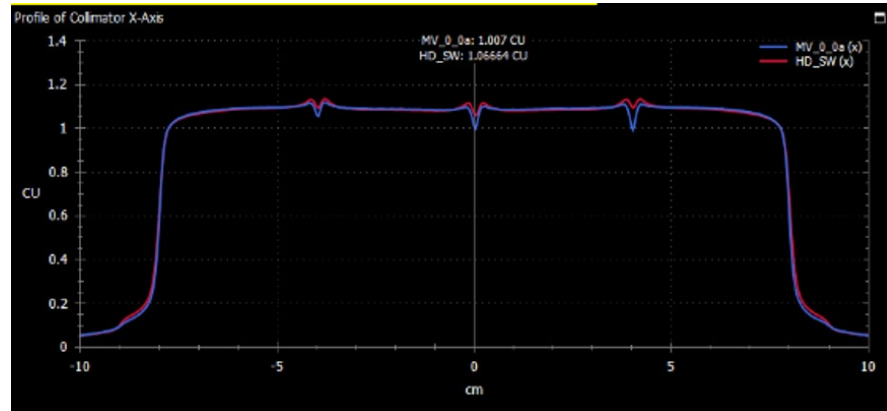
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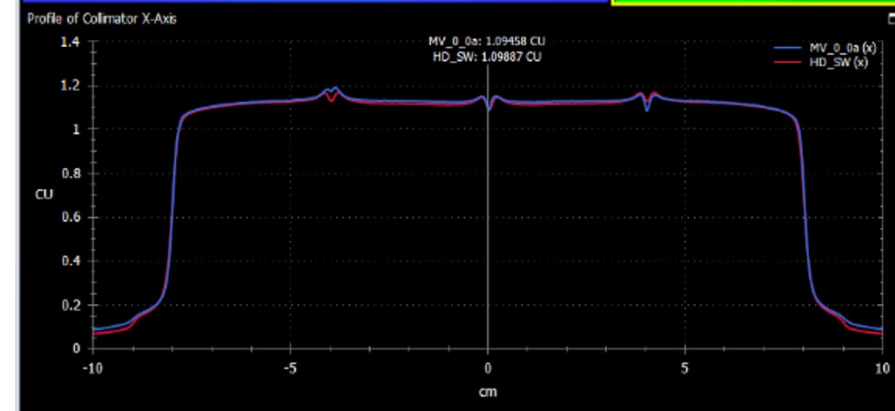
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Beam Matching ELM Configuration Tests

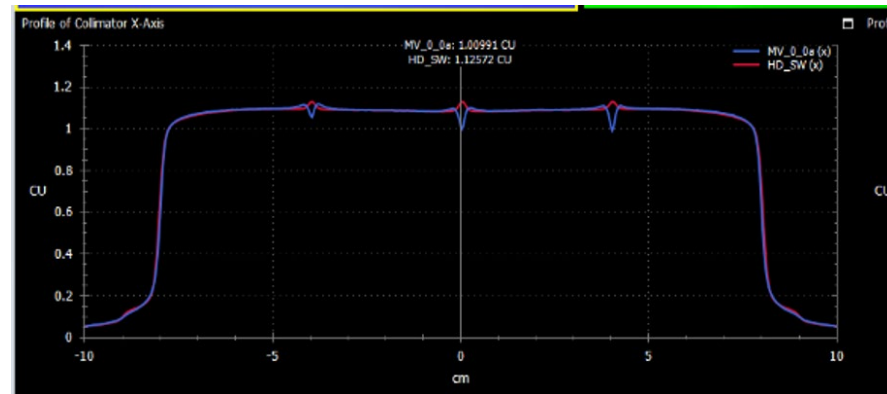
Linac1 V18



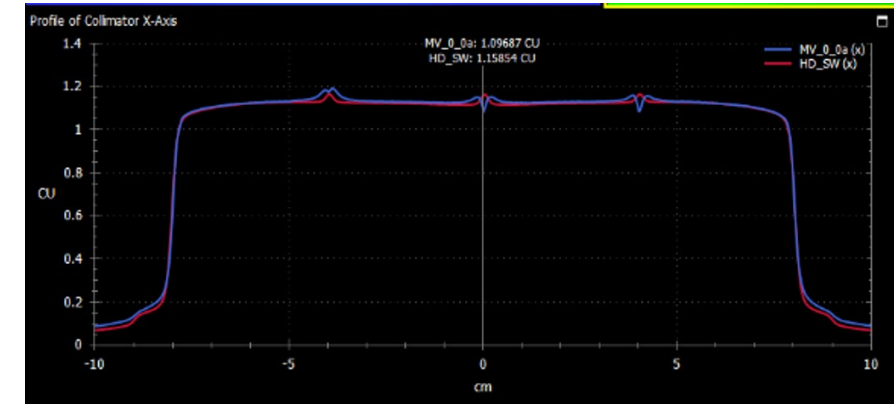
Linac2 V18



Linac1 V15.6



Linac2 V15.6



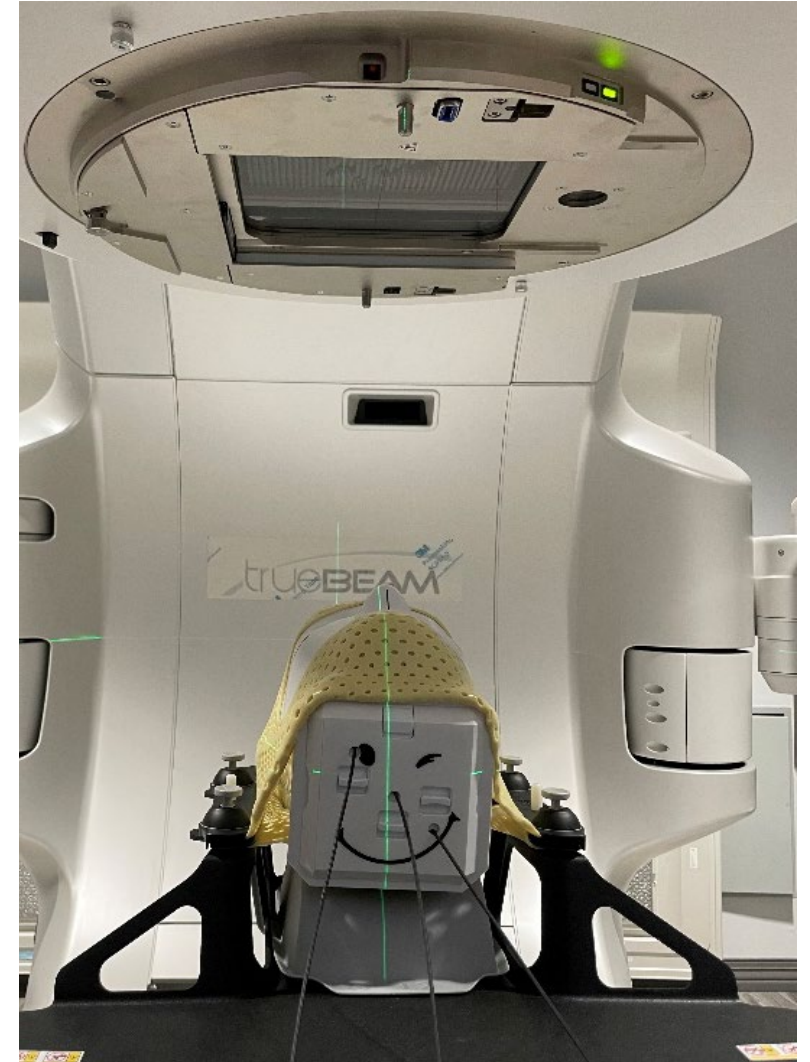
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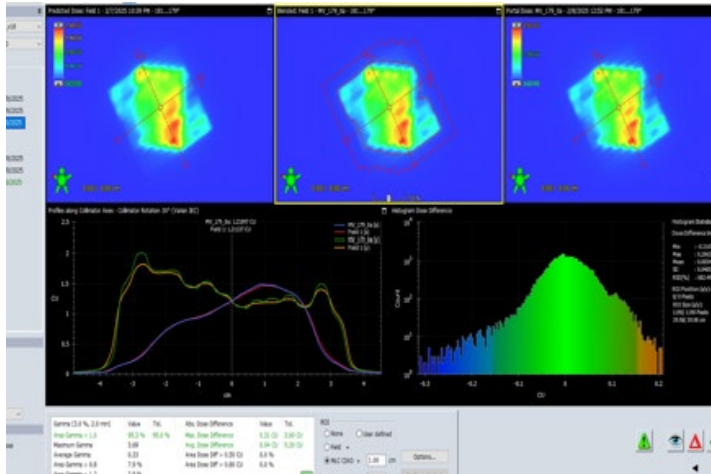
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OFF-AXIS TARGET FLUENCE PLANS

- Develop a fluence pattern with small targets at increasing distances from the CAX
- Alternatively, use a clinical plan with single isocenter and multiple targets
 - Plan should be designed to demonstrate improvements in off-axis dose agreement with V18
- This improvement is relevant for HyperArc or single isocenter multiple target treatments



CLINICAL TEST PLANS

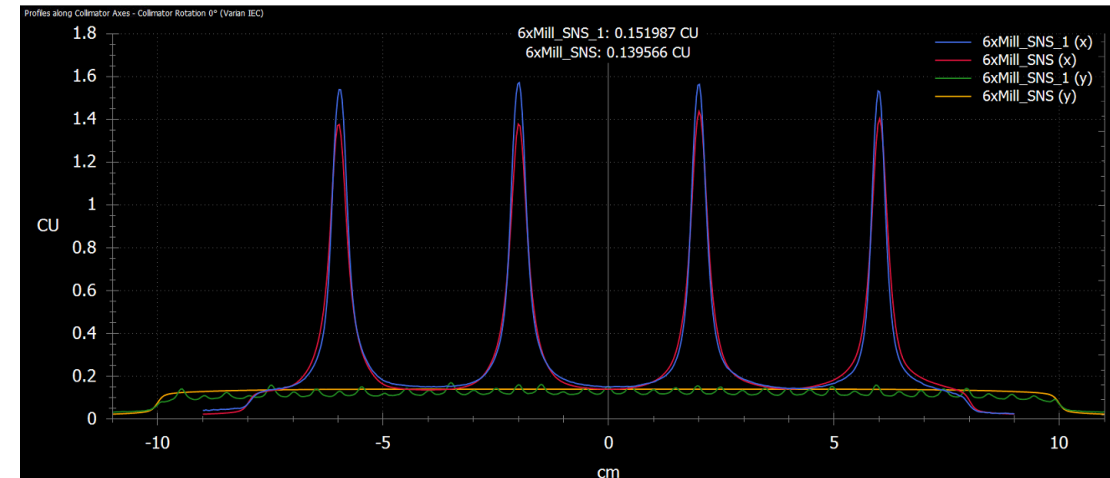


- Use a set of previously tested clinical test plans with a varying degree of modulation
- This is used to confirm that the use of ELM produces as good or better QA results for clinical plans



TrueBeamM120 Experience

- Existing older TrueBeam upgrading from v15.6 to v18
- Followed the recommended process
- Point doses passed
- Small field analysis passed
- Portal Dosimetry test plans were not ideal
 - Static Narrow Strips
 - Dynamic Chair Pattern
 - HN RA plan
- What do we do now?

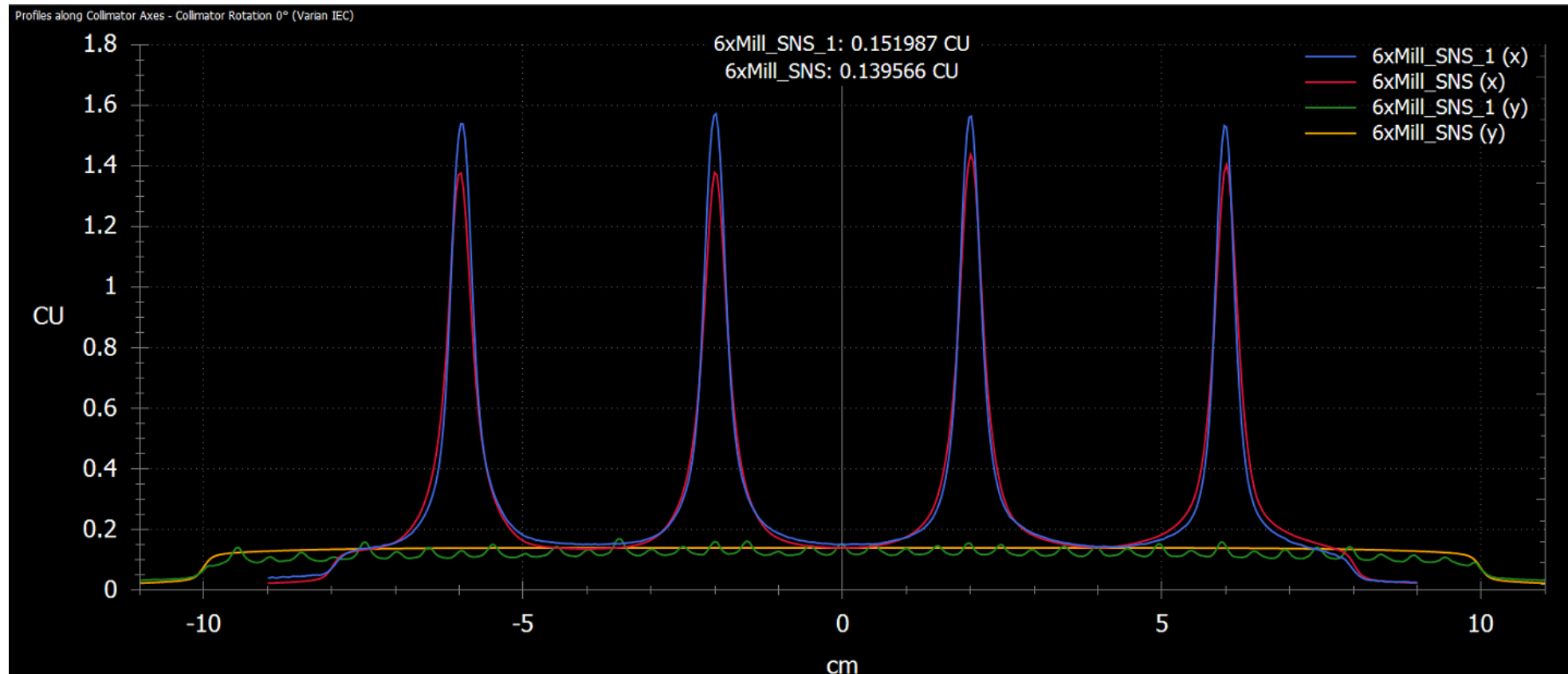


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TrueBeamM120 Experience

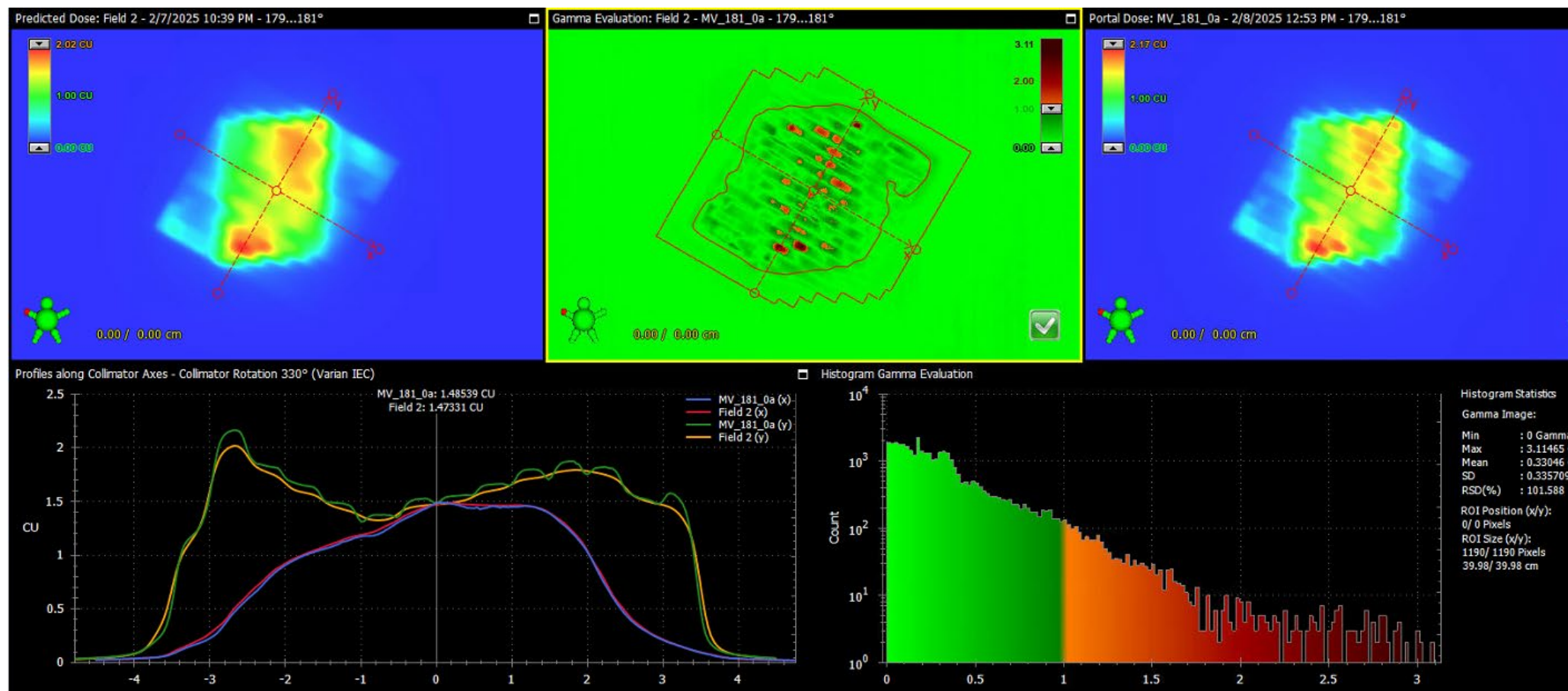


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TrueBeamM120 Experience



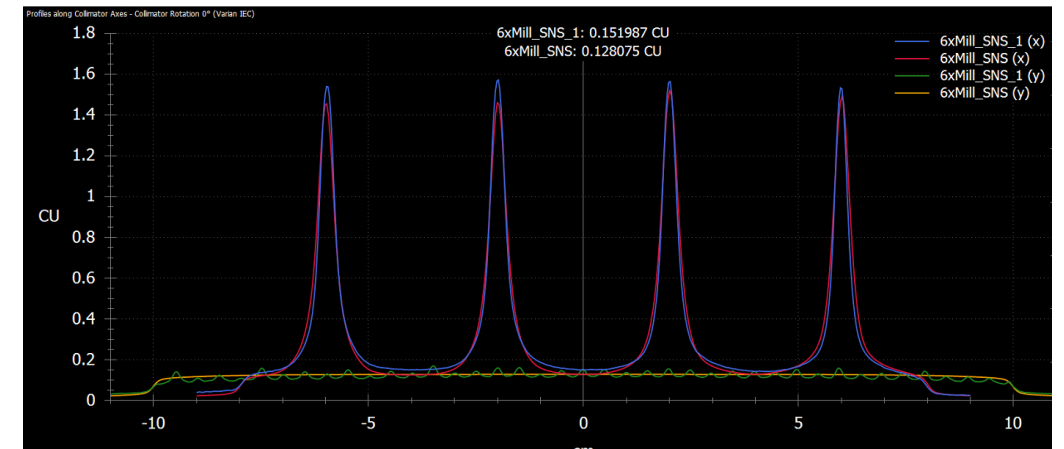
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TrueBeamM120 Experience

- Measured ELM data
 - Eclipse calculated DLG was -0.095
 - Eclipse calculated MLC Transmission was 0.0144
- Ran iterations of tests while making adjustments to the DLG and Transmission based on:
 - Static Narrow Strips
 - Dynamic Chair Pattern
 - HN RA plan
- Final ELM data – best compromise
 - DLG: -0.050
 - Transmission: 0.0125

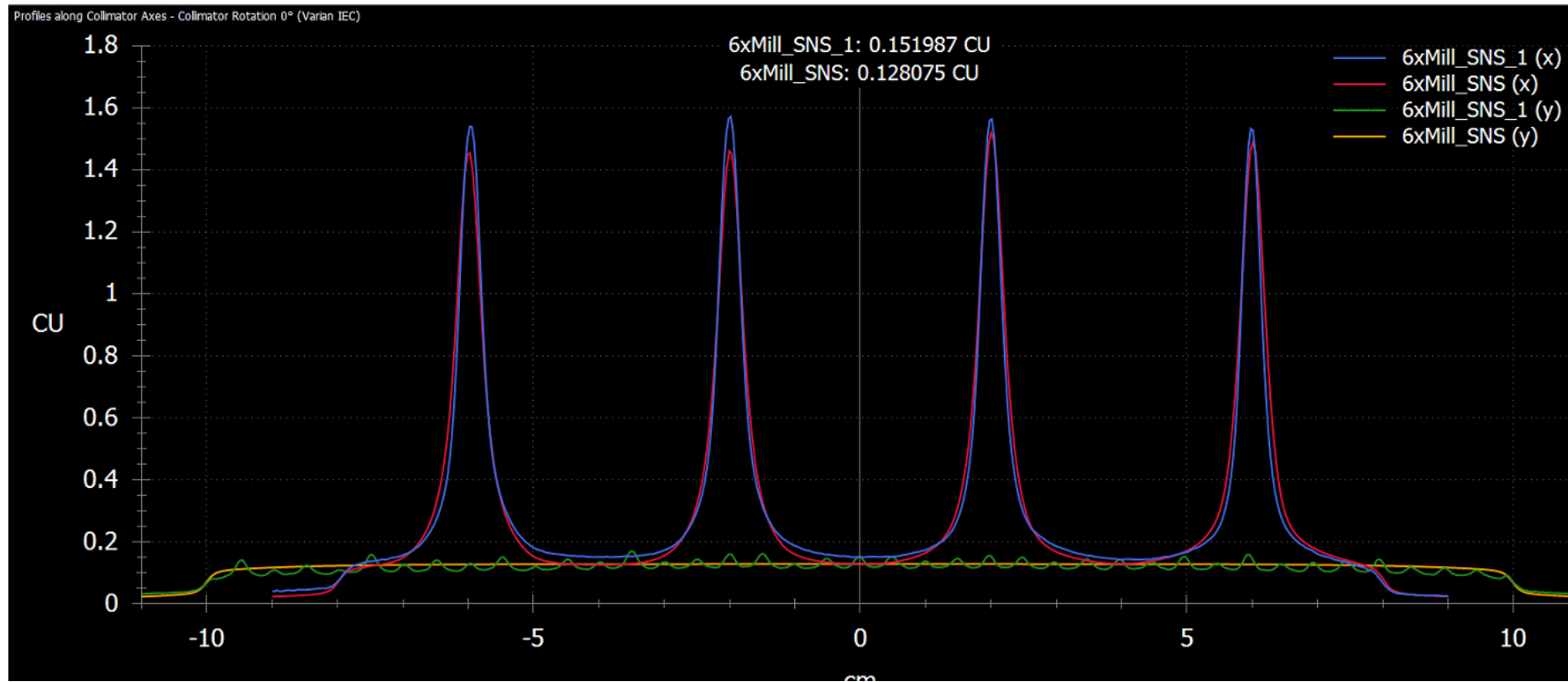


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TrueBeamM120 Experience

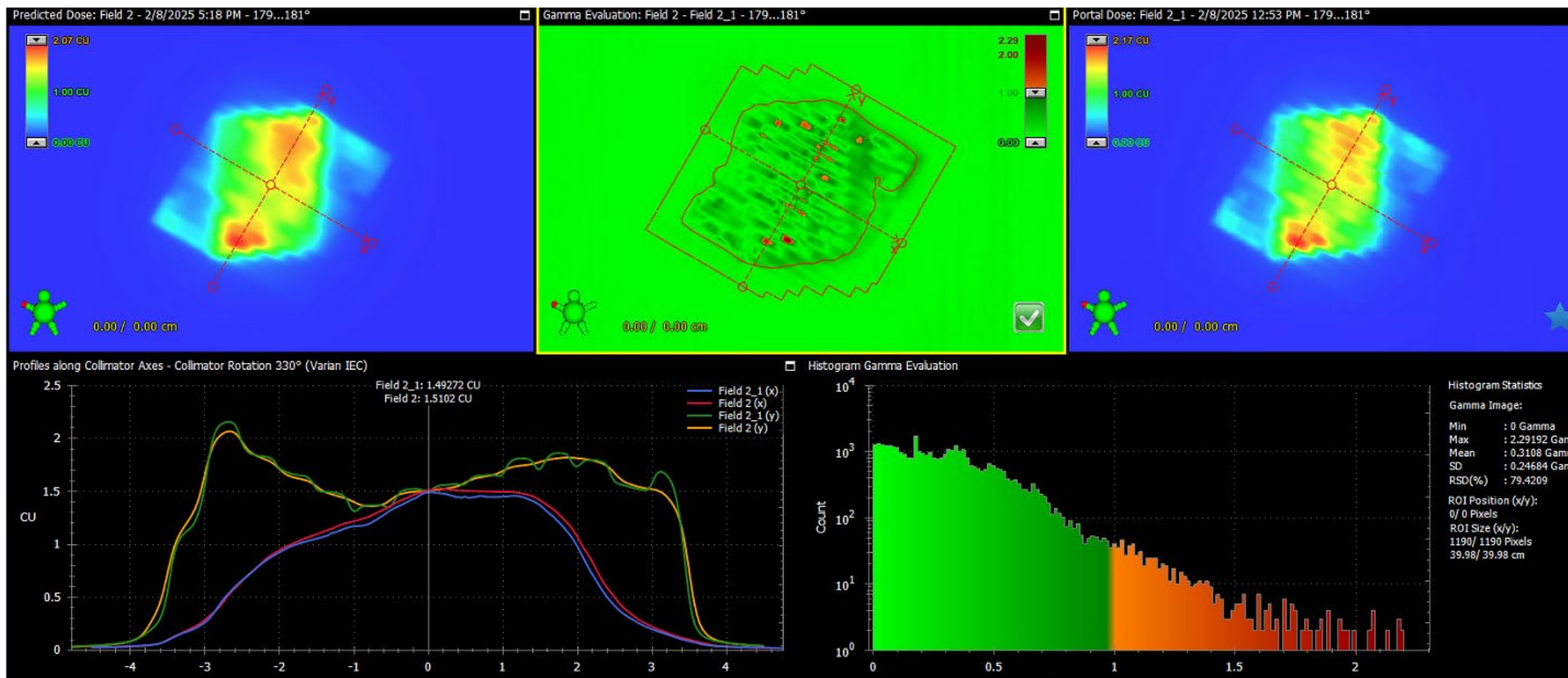


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TrueBeamM120 Experience

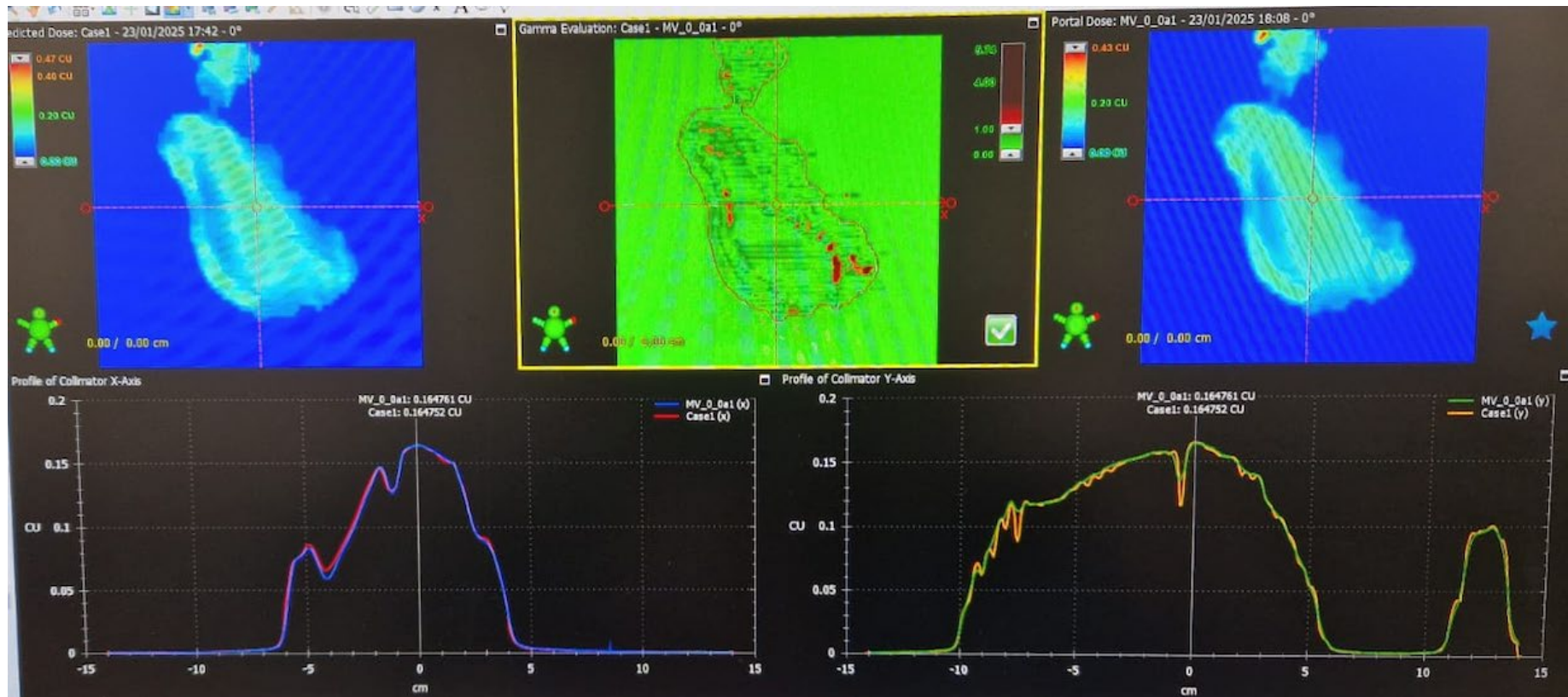


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Halcyon / Ethos

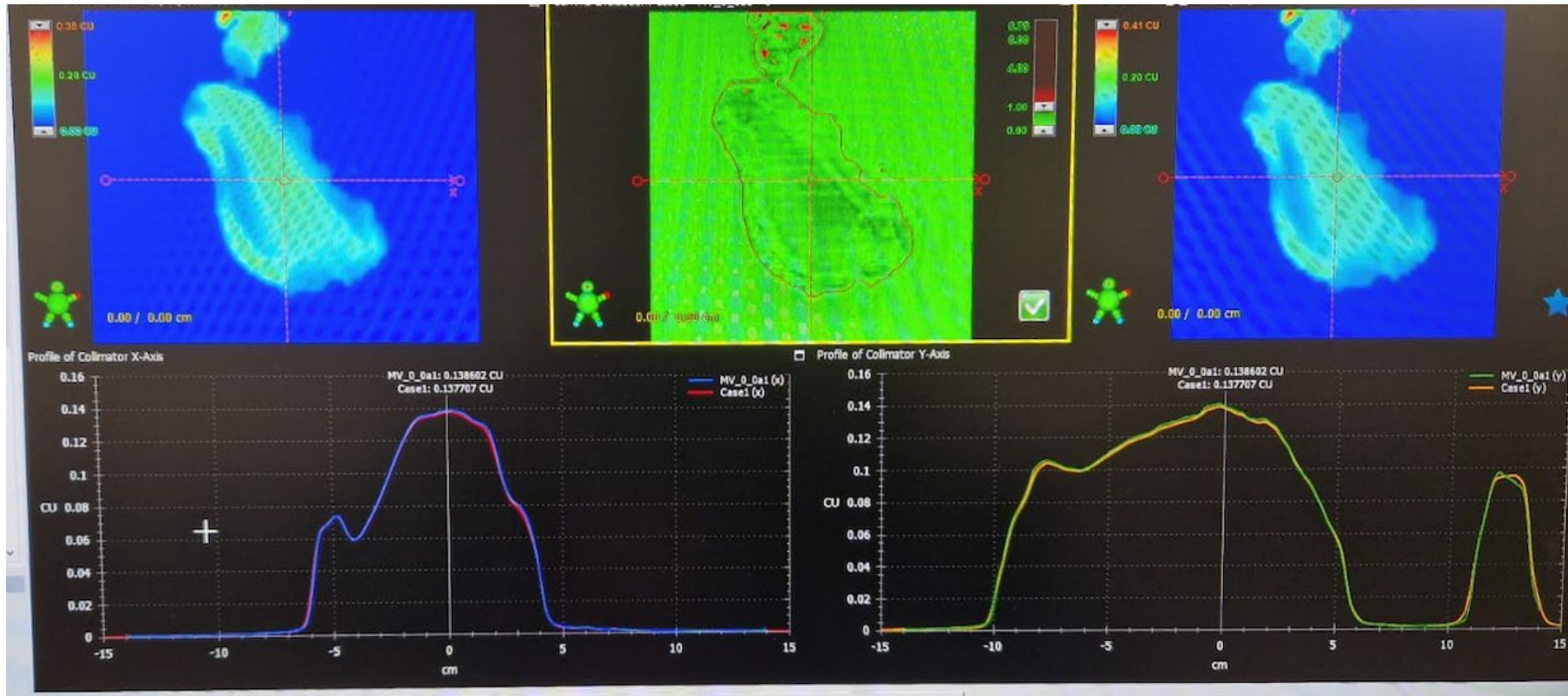


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Halcyon / Ethos



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Halcyon / Ethos – Other References

“Furthermore, the introduction of ELM in Eclipse considerably enhanced the VMAT dose calculation. ELM addresses the limitations of traditional leaf models and reduces uncertainties in Halcyon dose calculations.”

Commissioning of Halcyon enhanced leaf model in the Eclipse treatment planning system: Focus on simple slit fields and VMAT dose calculation - Miyasaka et. al., Journal of Applied Clinical Physics, 2025



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Halcyon / Ethos – Sneak Peak

- For Halcyon one bank of MLC leaves trails behind the other during treatment
- Studying the effect of trailing distance and gap size on accuracy
- In Eclipse V16 – up to 40% difference for 2 mm gap and above 2% for most gaps and trailing distances
- In Eclipse V18 – Differences below 2% for all gaps and trailing distances except for 2 mm
- Portal dosimetry confirms these results

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How We Can Help

TrueNorth and MPS are working together to help you with:

Eclipse V18 upgrades commissioning

Small field commissioning

HyperArc, SRS, SBRT implementation and implementation support

Linear accelerator commissioning

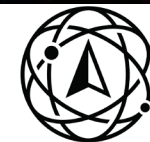
Treatment planning commissioning

Shielding

Physics Support



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Special Thanks

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