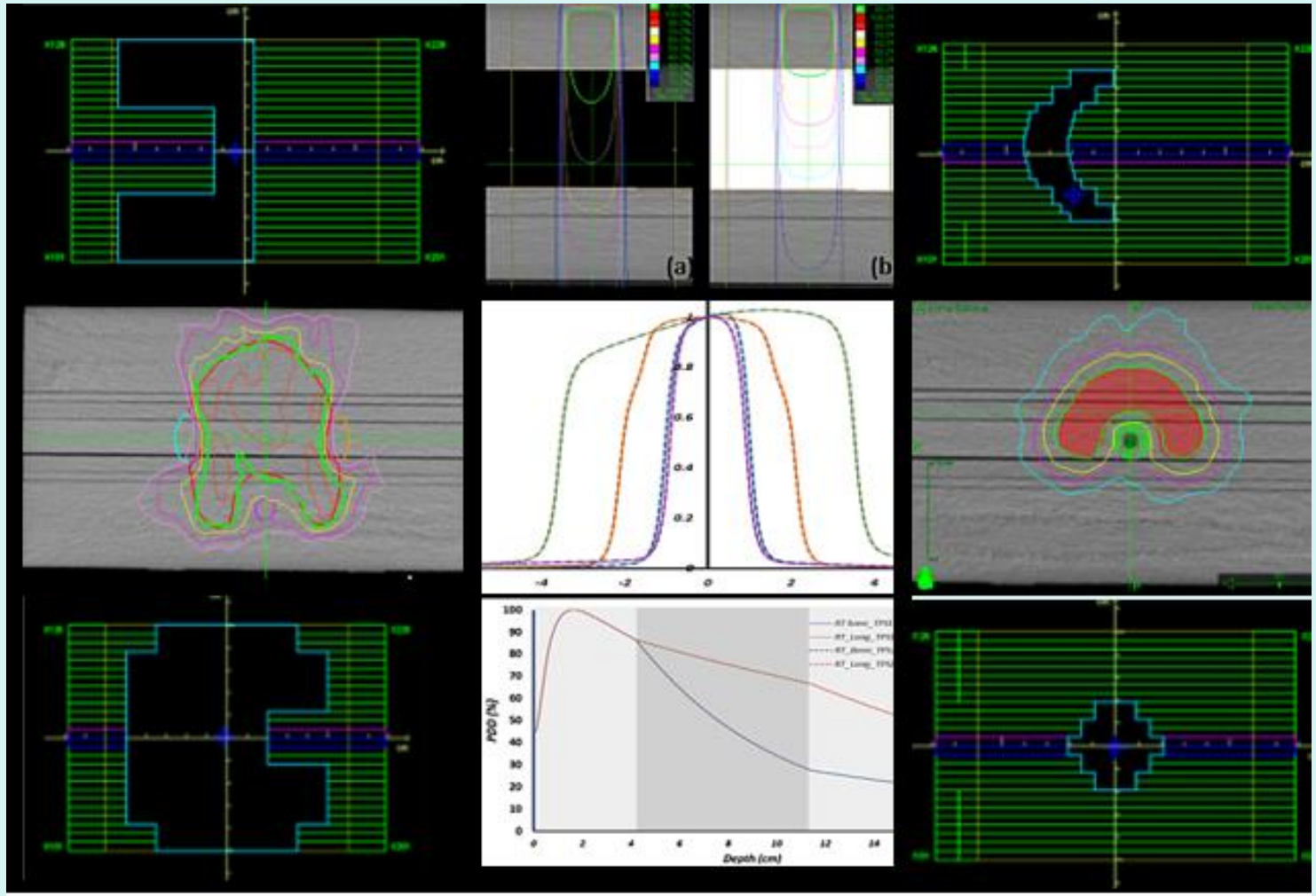
Implementation of Quality Assurance Program for CyberKnife Treatment Planning System



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Introduction

- **Treatment planning system (TPS) is an integral part of radiation therapy (RT).**
- **Errors in commissioning of TPS could impact many patients.**
- **Nearly one third of the serious incidents in RT involve TPS (ICRP 86).**
- **The major standards for TPS commissioning and QA over the last two decades: AAPM TG 53 and MPPG 5.a.**
- **Presented here necessary tests for implementing a QA program for CK dedicated TPS in accordance with MPPG 5.a.**

Outline

I. **Basic dose algorithm validation**

I.A. Basic field configurations (Fixed and Iris collimators).

I.B. Small MLC-shaped fields and large MLC-shaped field with extensive blocking

I.C. MLC special field blocking: spine block, corner block, convex, concave

I.D. Oblique incidence

II. **Heterogeneity correction validation**

II.A. Heterogeneity corrections distal to bone tissue

II.B. Heterogeneity corrections distal to lung tissue

III. **IMRT Validation**

III.A. Small field PDD verification, verification of output for small MLC-defined fields

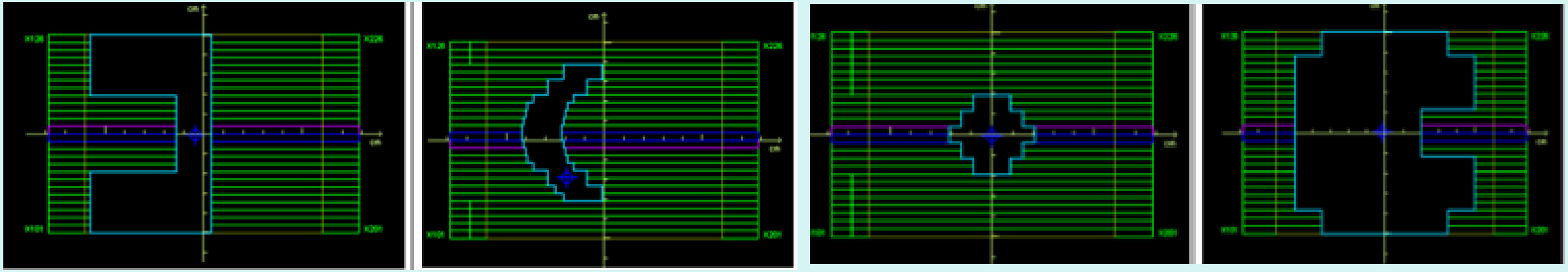
III.B. TG-119 tests: C shape easy, C-shape hard, C-shape RA, Head and Neck

III.C. Clinical Tests: prostate, SBRT lung, Head and Neck and Lung standard fractionation

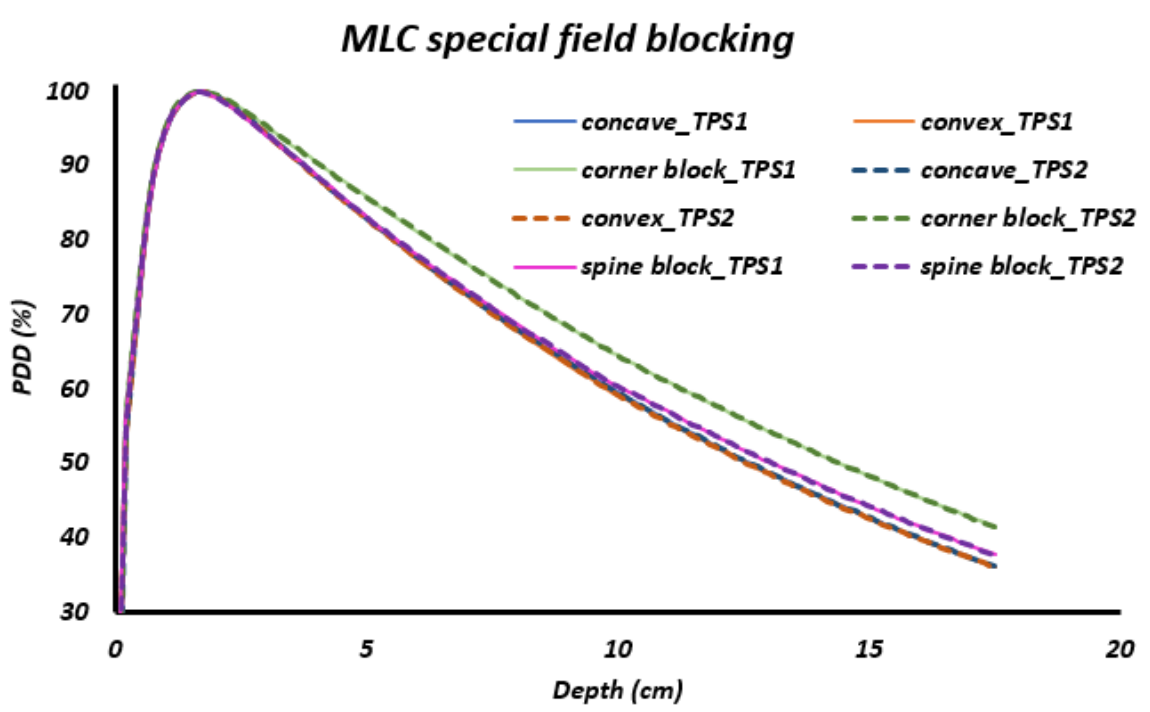
III.D. E2E cases, scanning an phantom, planning, delivery, and sending dosimeters out for external review

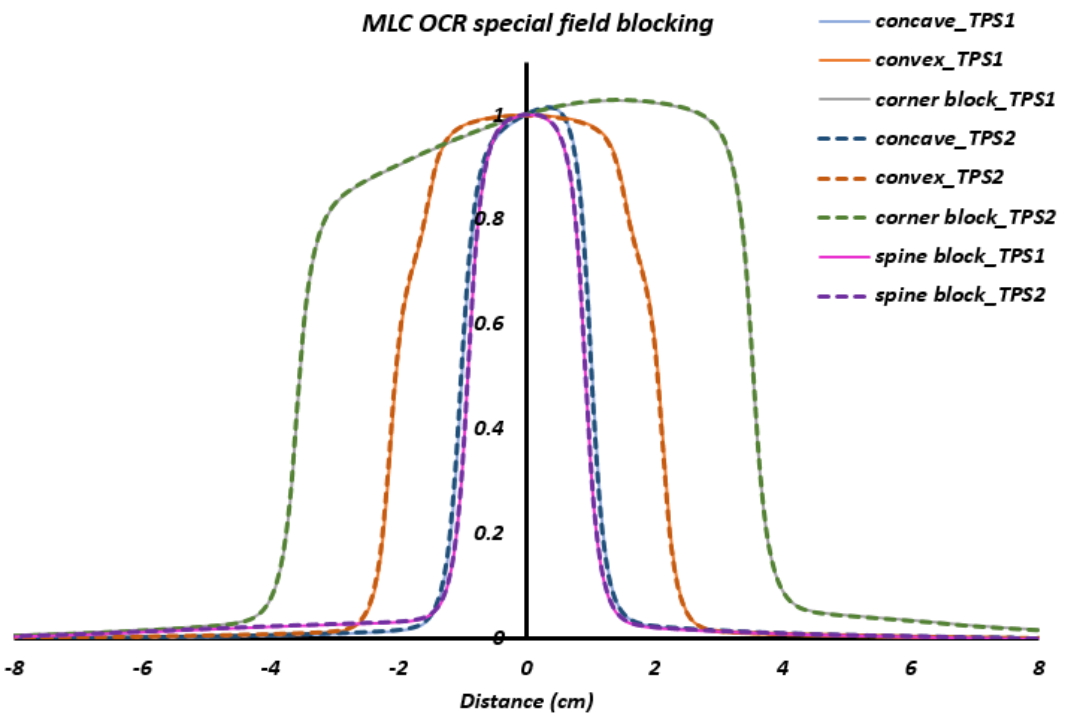
Basic photon beam configuration

Test Name	Objective	Description
Test Basic_Field.1.	FC and IRIS	7.5 mm, 30 mm, 60 mm
Test Basic_Field.2.	Small and large MLC-shaped field	25x25 mm2, 100x100 mm2, 100x115 mm2
Test Basic_Field.3.	Extensive blocking MLC-shaped field	25x100, 100x25 mm
Test Basic_Field.4.	MLC special field blocking	Spine Block, Corner Block, Convex, Concave
Test Basic_Field.5	Oblique Incidence	30-degree oblique angle phantom



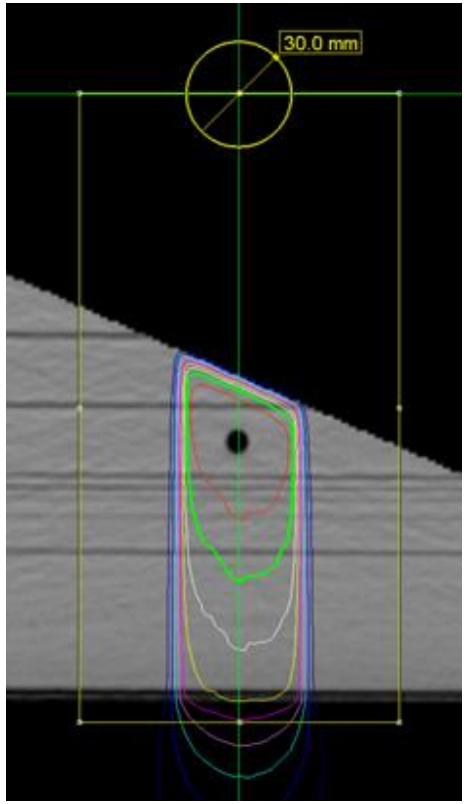
Analysis of PDDs and Profiles

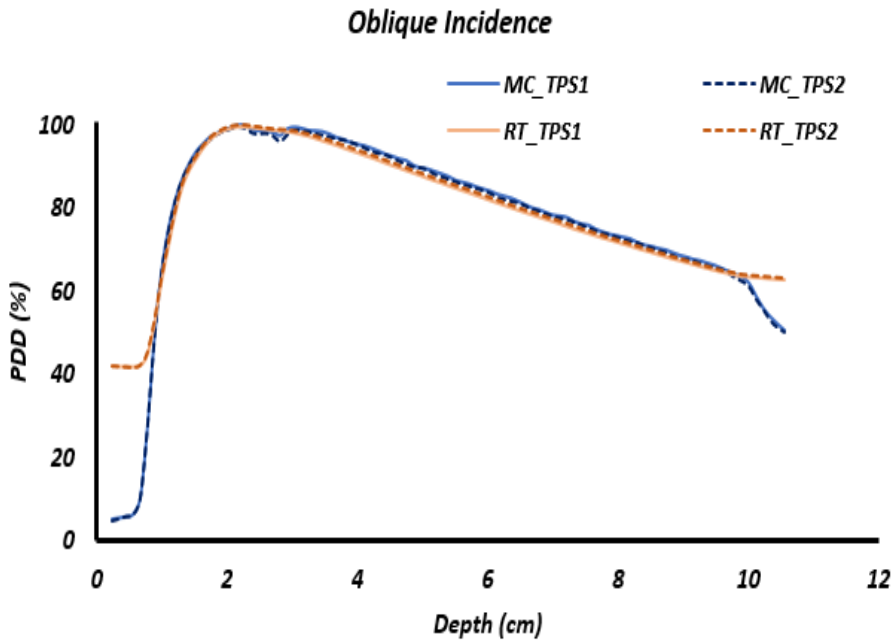


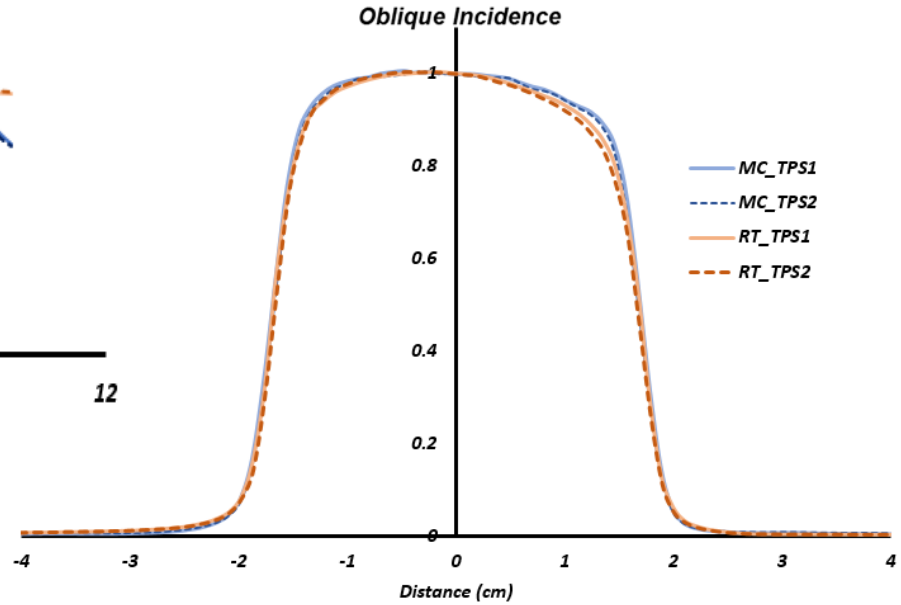


- **Axial Planar doses - RIT113 (DICOM RT Import files)**
- **Beam measurement tools: depth profile (PDDs) and cross profile (at Dmax)**
- **Dose calculation box was not modified between TPS1 and TPS2 calculations**

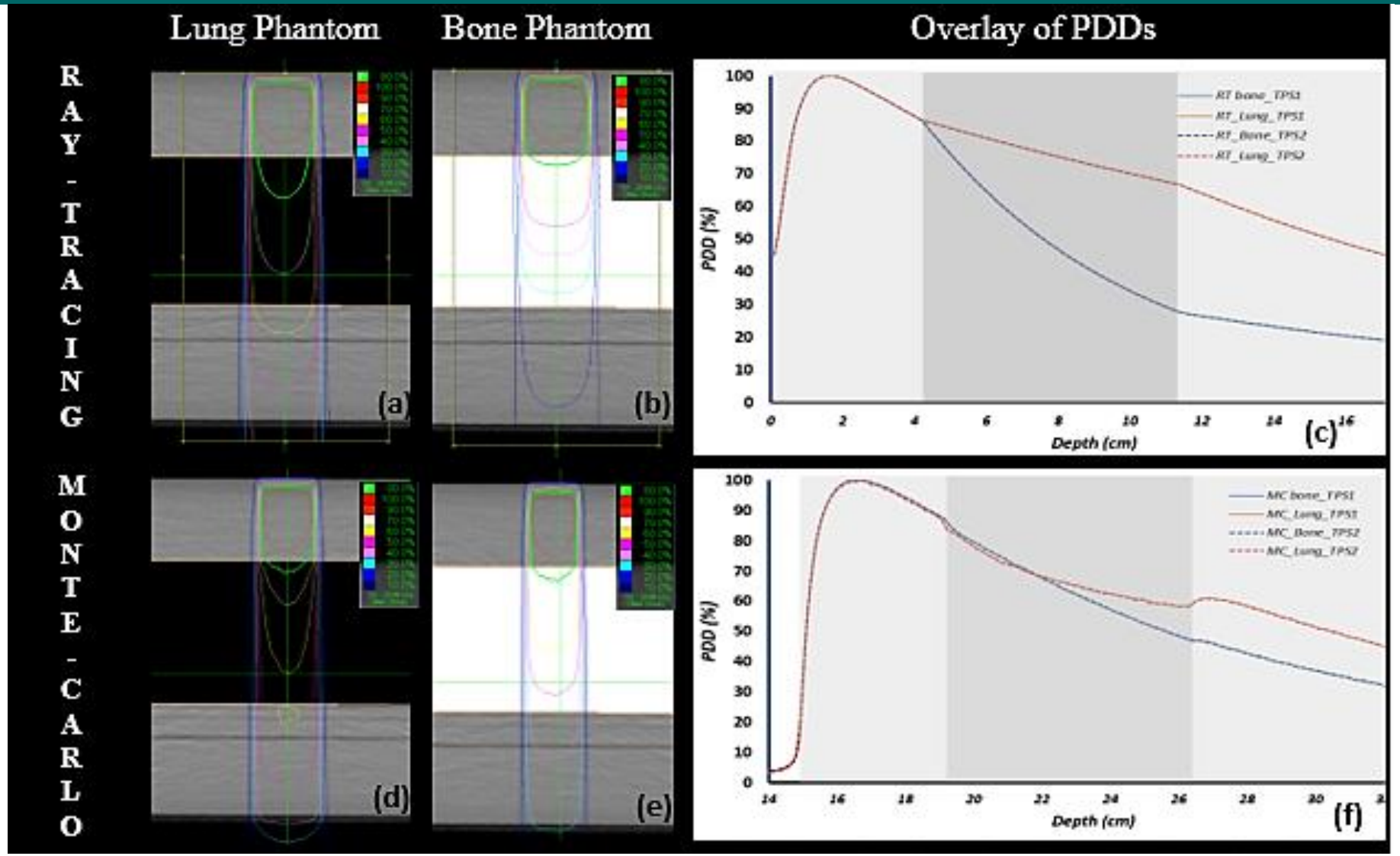
Oblique Incidence





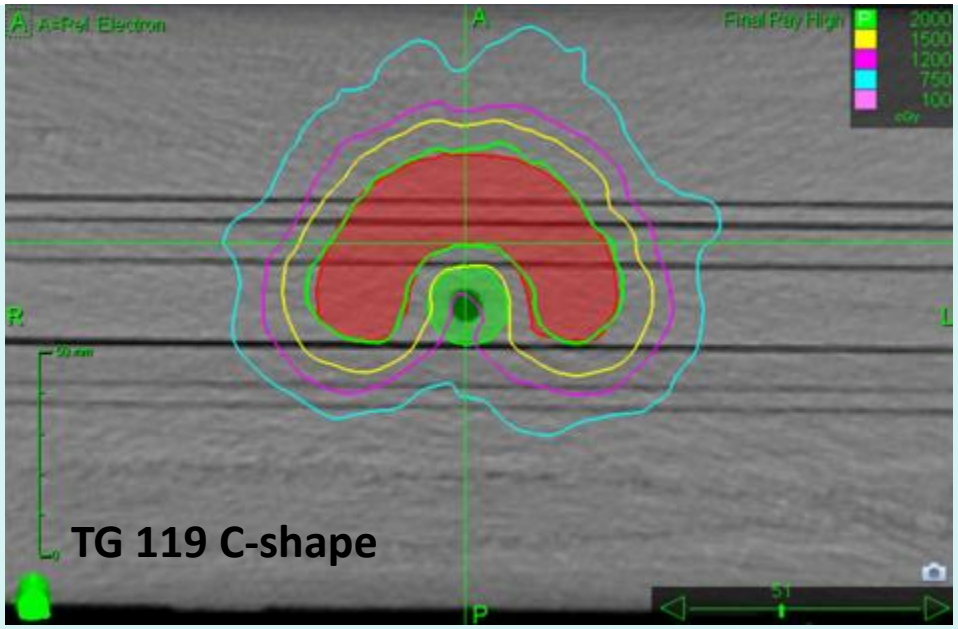


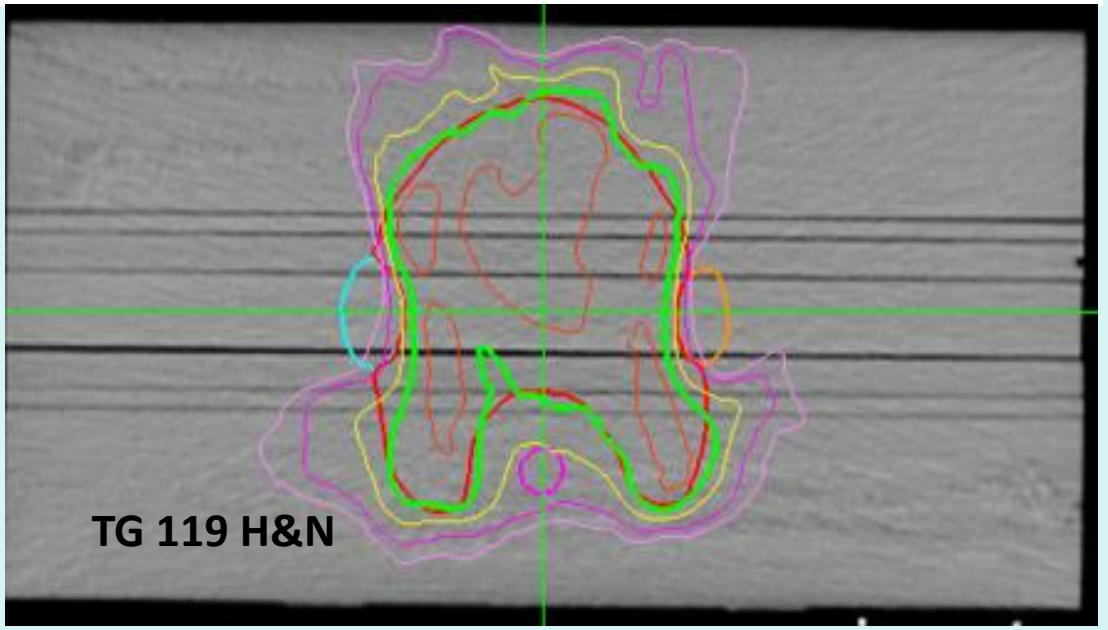
Heterogeneity correction validation



IMRT validation

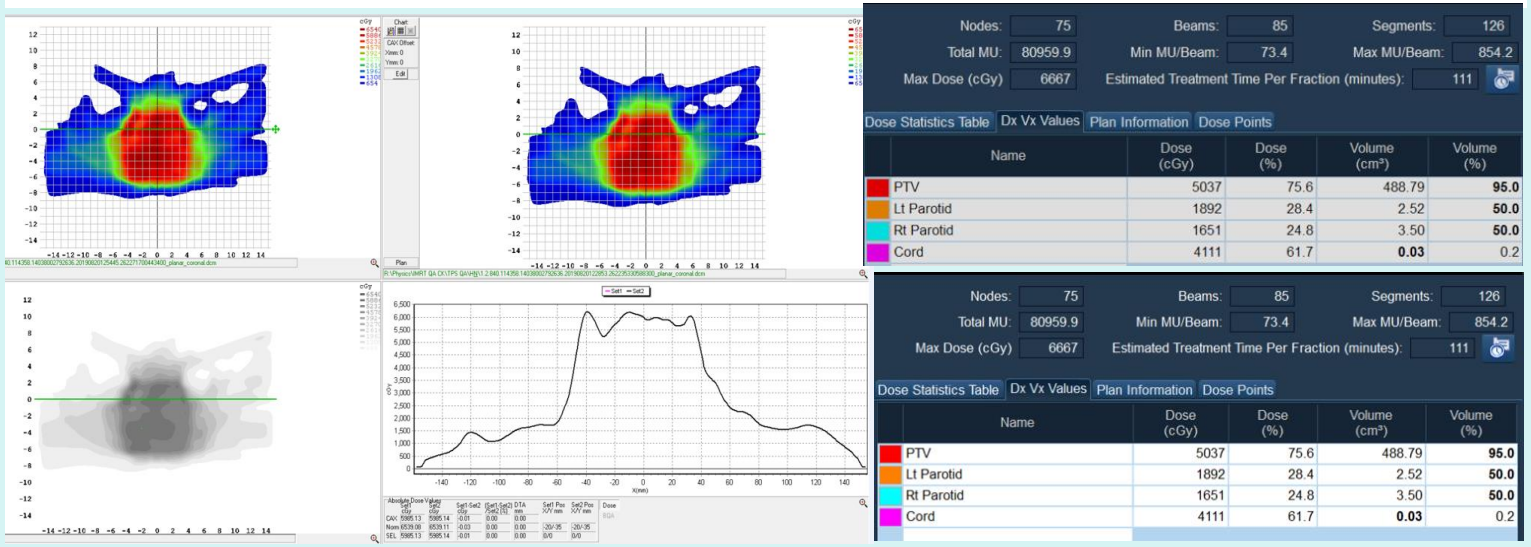
Test Name	Objective	Description
Test IMRT.1.	Verification Small field PDD*	MLC-shaped field 7.6x7.5mm2
Test IMRT.2.	TG-119 tests	Head and Neck and C-shape cases
Test IMRT.3.	Clinical test	Brain, Spine, Lung and Abdomen





Patient specific QA

Tests	Algorithm	Comparison	Diff/Dist, Threshold	Passed Pixels
Tets IMRT.2. C-shape	FSPB	TPS1 vs TPS2	1%/1mm, 10%	100 %
Test IMRT.2. H&N	FSPB	TPS1 vs TPS2	1%/1mm, 10%	100 %
Test IMRT.3. Brain	FSPB	TPS2 vs Measured	2%/2mm, 10%	100%
Test IMRT.3. Spine	FSPB	TPS2 vs Measured	2%/2mm, 10%	100%
Test IMRT.3. Abdomen	FSPB	TPS2 vs measured	2%/2mm, 10%	100%
Test IMRT.3. Lung	MC	TPS2 vs measured	2%,2mm, 10%	100%

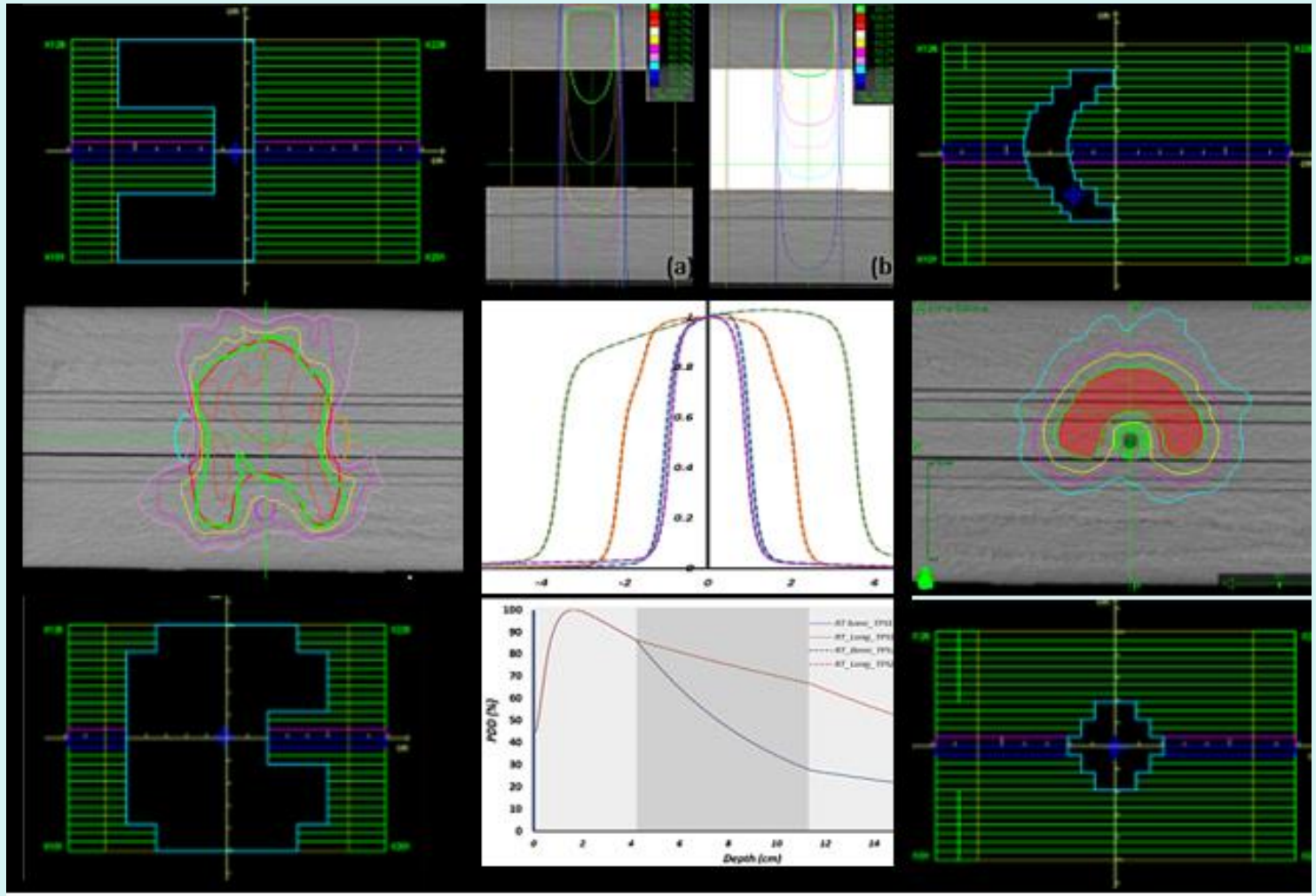


Head and Neck, TPS1 vs TPS2

Conclusions

- **Implementation of MPPG 5a tests into CK TPS was successful.**
- **Differences in PDDs and profiles were minimal <1%, except for oblique incidence (up to 4%)**
- **Created set of tests will be used for subsequent TPS upgrades, as well as routine TPS QA at our center**
- **This work could serve as seminal benchmark for TPS commissioning and QA of CK TPS**

Monte Carlo Commissioning for CyberKnife Multileaf Collimator and Proposed Acceptance Criteria



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THANK YOU!

QUESTIONS?

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