

ELEKTA LEKSELL GAMMA KNIFE ICON™ SYSTEM: COMMISSIONING, QA AND WORKFLOW

THE BRISTOL
GAMMA KNIFE
CENTRE

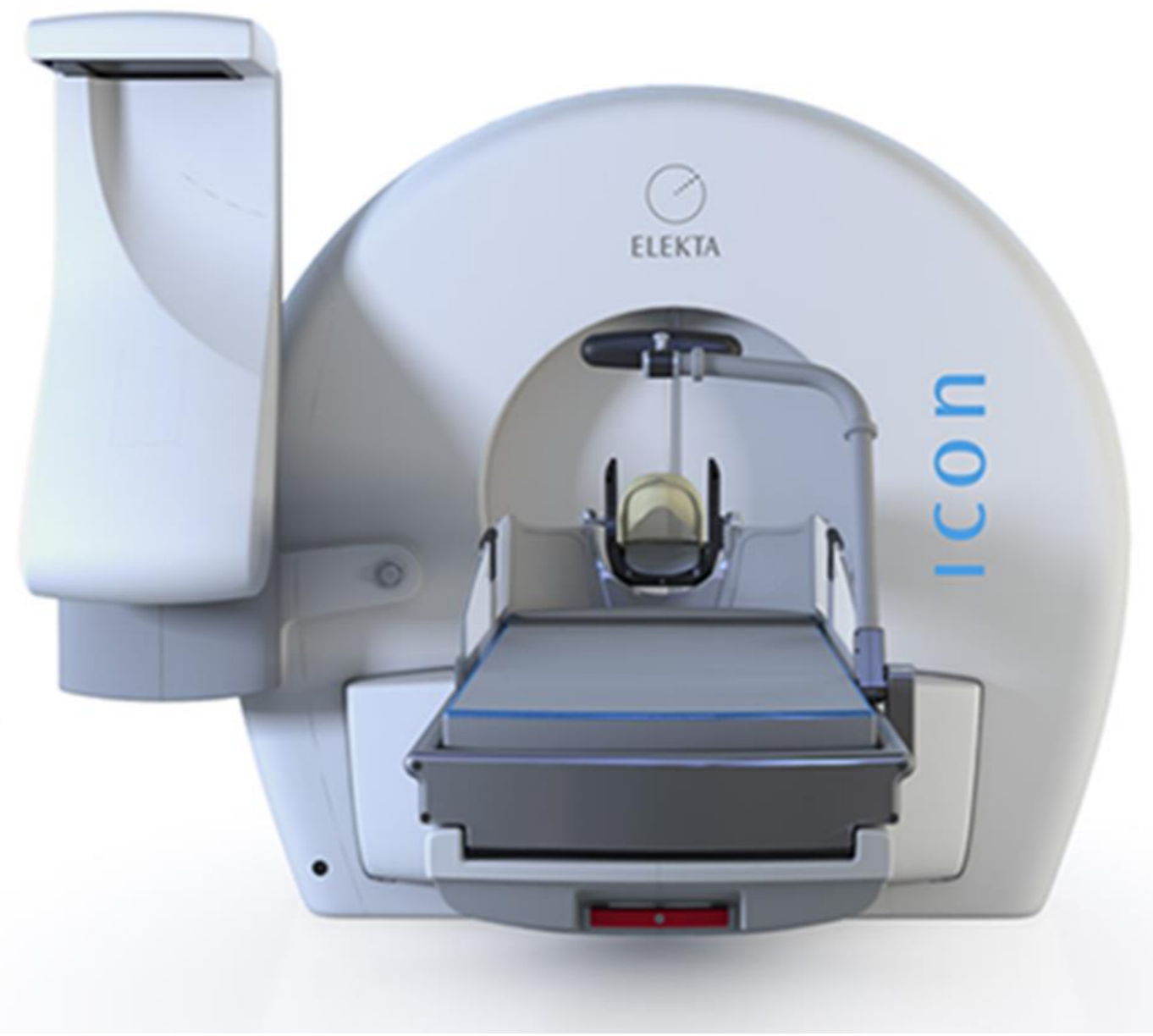
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INTRODUCTION

The new Elekta LGK Icon™ enables mask based fractionated stereotactic radiotherapy and radiosurgery (SRT/SRS) with a precision approaching that of a fixed frame system. It features cone beam CT image registration with MRI plus position monitoring during treatment using a High Definition Motion Management (HDMM) system.



Icon can be used to:

- Scan patient to create reference image in the treatment position
- Register scan with pre-treatment MRI
- Monitor patient position during treatment with HDMM
- Pause the treatment if patient movement outside limit for > 2 sec.

METHODS

Following installation checks of the following were made in order to verify that the system was within specification:

- CBCT Patient Dose and Image Quality
- CBCT Precision
- HDMM Accuracy
- End to End Verification of Plan Dosimetry

Options for workflow enabled by Icon were compared with those using the fixed frame system.

RESULTS

CBCT Patient Dose and Image Quality

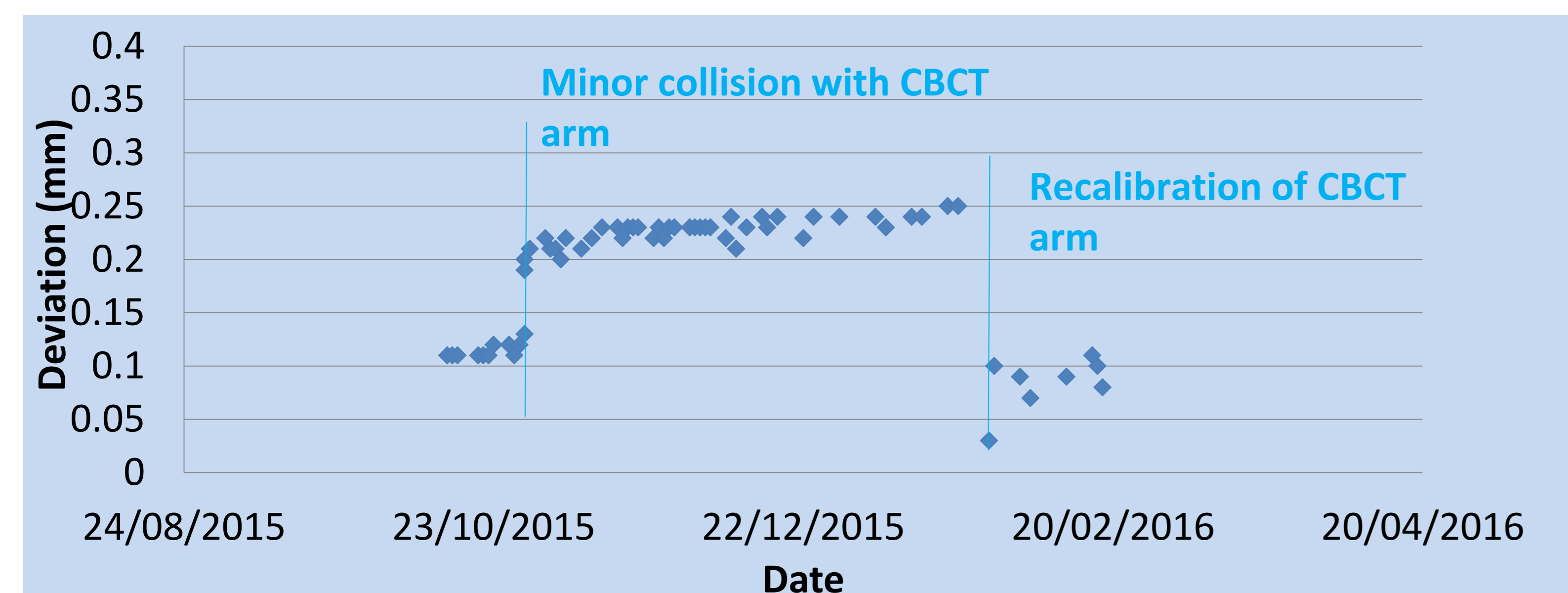
Doses were assessed using an ion chamber based system and a Catphan was used to measure spatial resolution, contrast to noise ratio & uniformity.

Parameter	Low Dose			High Dose		
	Spec	Meas	Pass	Spec	Meas	Pass
CTDI _{water} mGy	<2.5	2.4	✓	<6.3	6.0	✓
Spatial Resolution lp/cm	>6	7	✓	>6	8	✓
Contrast to Noise Ratio	>0.5	1.1	✓	>0.5	1.8	✓
Image Uniformity	<21%	11	✓	<21%	8	✓

The X-ray leakage @ 1m was 0.009 mGy/hr which was within the limit <0.01 mGy/hr @ 1m.

CBCT Precision

This was measured using a ball bearing phantom and represents the deviation of the CBCT reconstruction centre from the centre of irradiation.

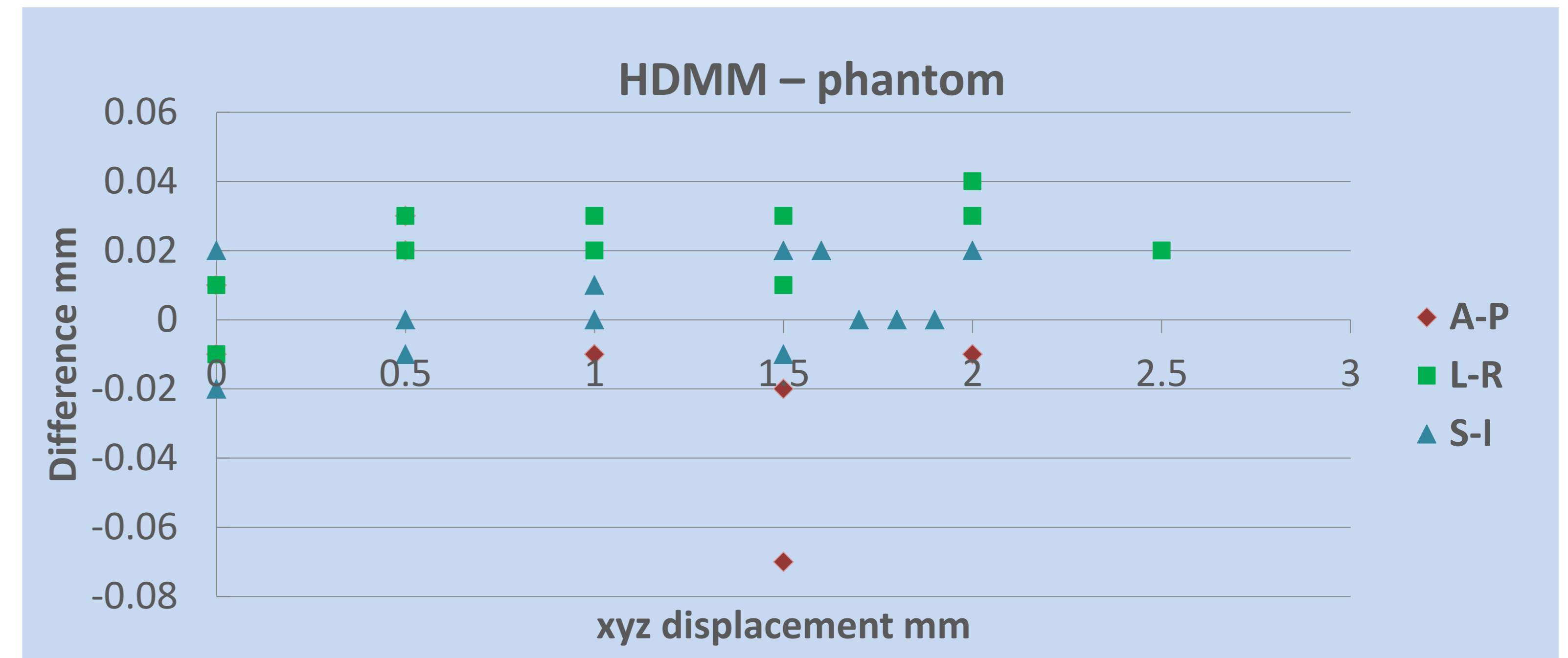
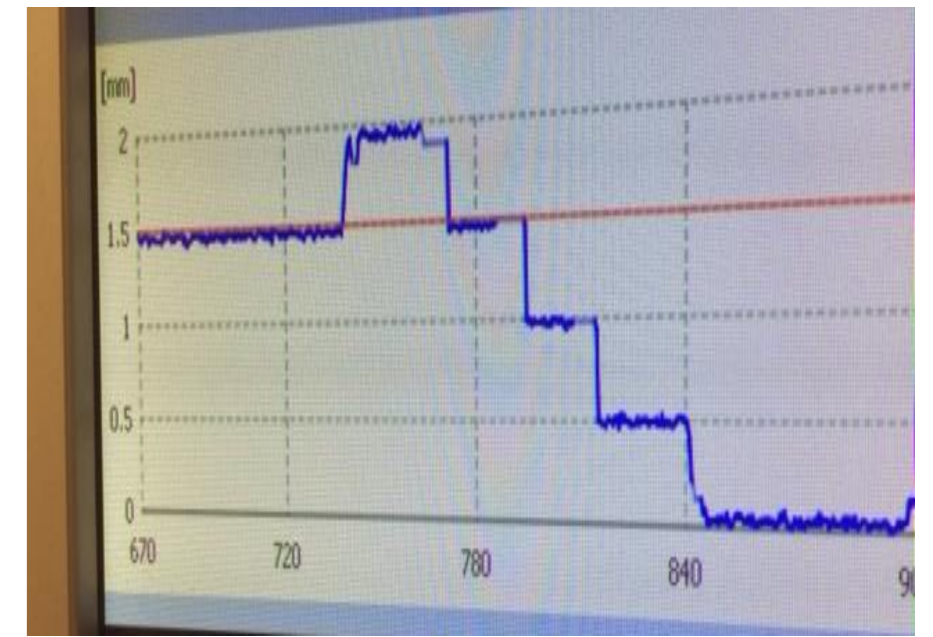


Performance was at all times within system tolerance = 0.4 mm. A minor collision of the CBCT arm with the couch was corrected by recalibration at a later date.

HDMM

The HDMM trace (shown) records the patient movement during treatment. HDMM accuracy was checked using a linac 'Synergy' phantom to adjust the position of a reflector and compare with measurement.

Interruption of the treatment was verified by moving a phantom with a reflector attached.



Apart from one, all points lie within a range of -0.02 to +0.04 mm.

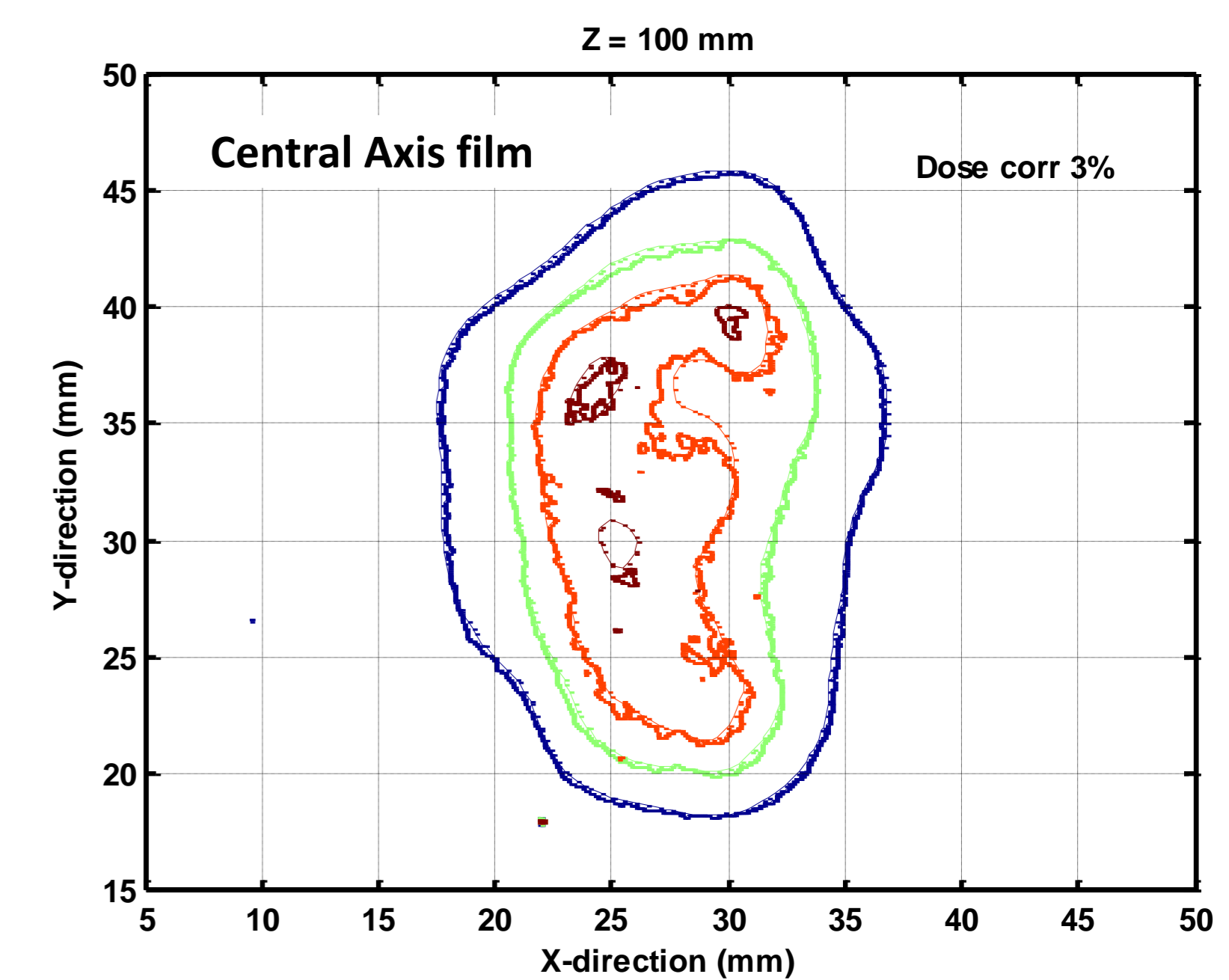
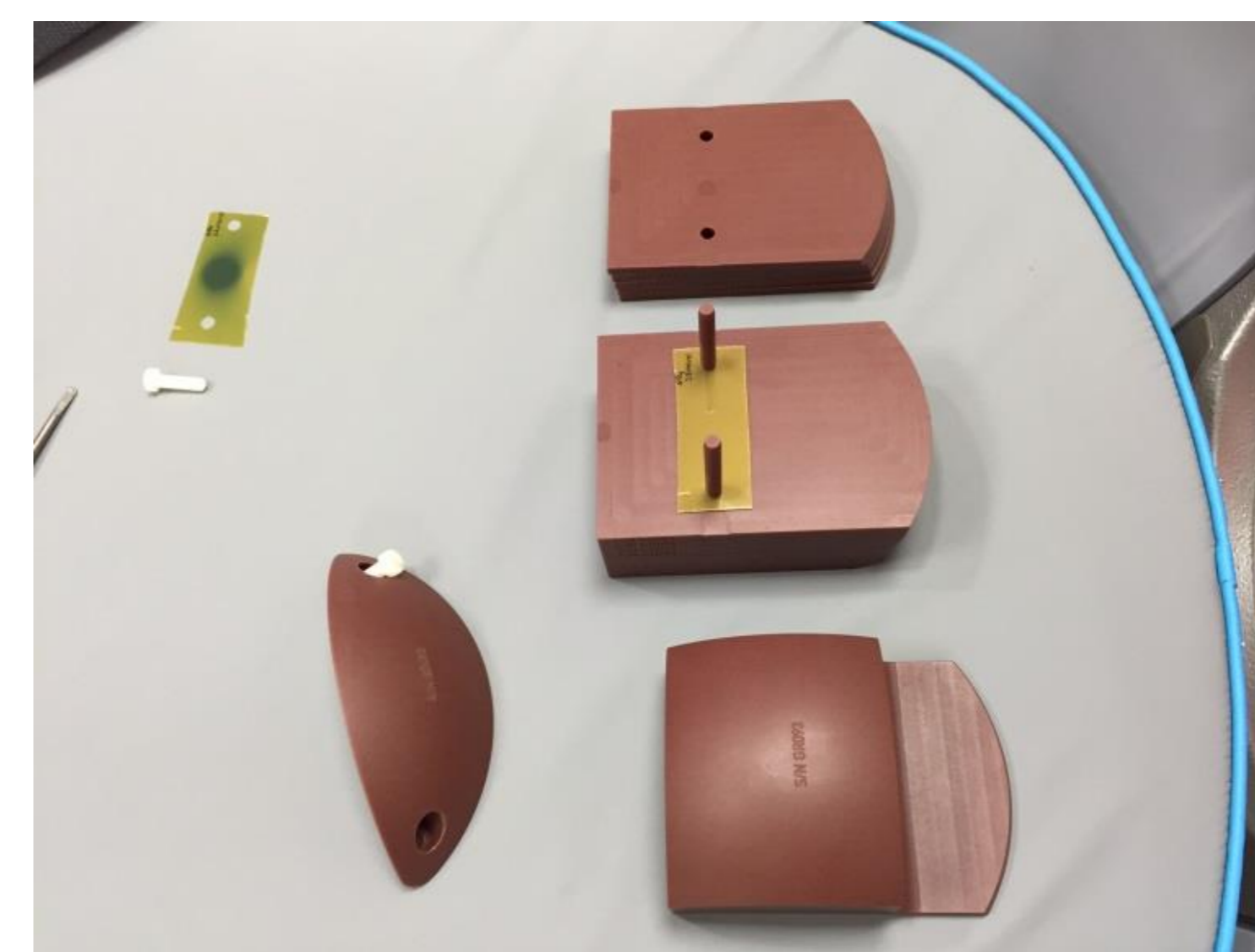
End to End Dosimetry Check

For this check a pituitary plan was recalculated on a spherical phantom.

The phantom contained inserts for chamber or film. The dose was verified using pinpoint chamber plus Gafchromic™ EBT3 film.

The pinpoint chamber measurements are shown below. The central axis film measurements (see below) showed excellent agreement with the plan and measured doses within 3%.

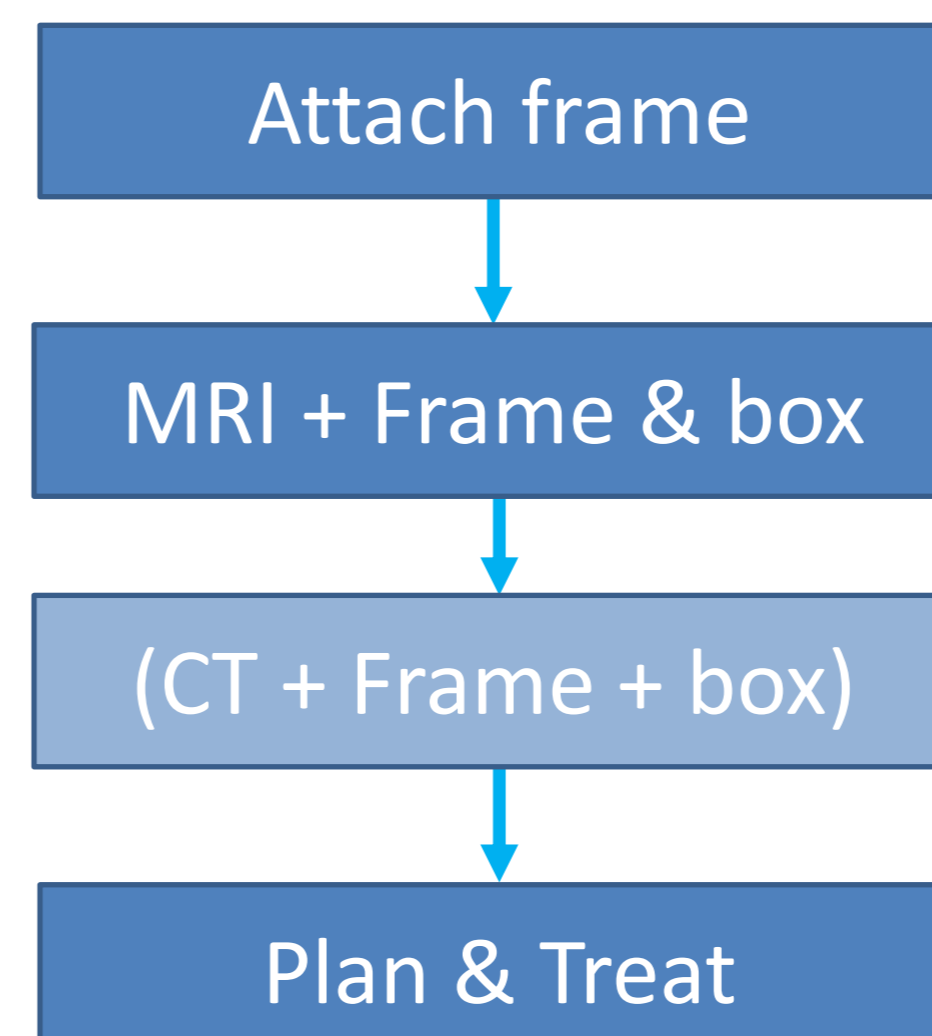
	Planned dose Gy	Measured dose Gy	Diff %
Patient 1	1.90	1.94	+2.1
Patient 2	1.86	1.87	+0.3



Workflow

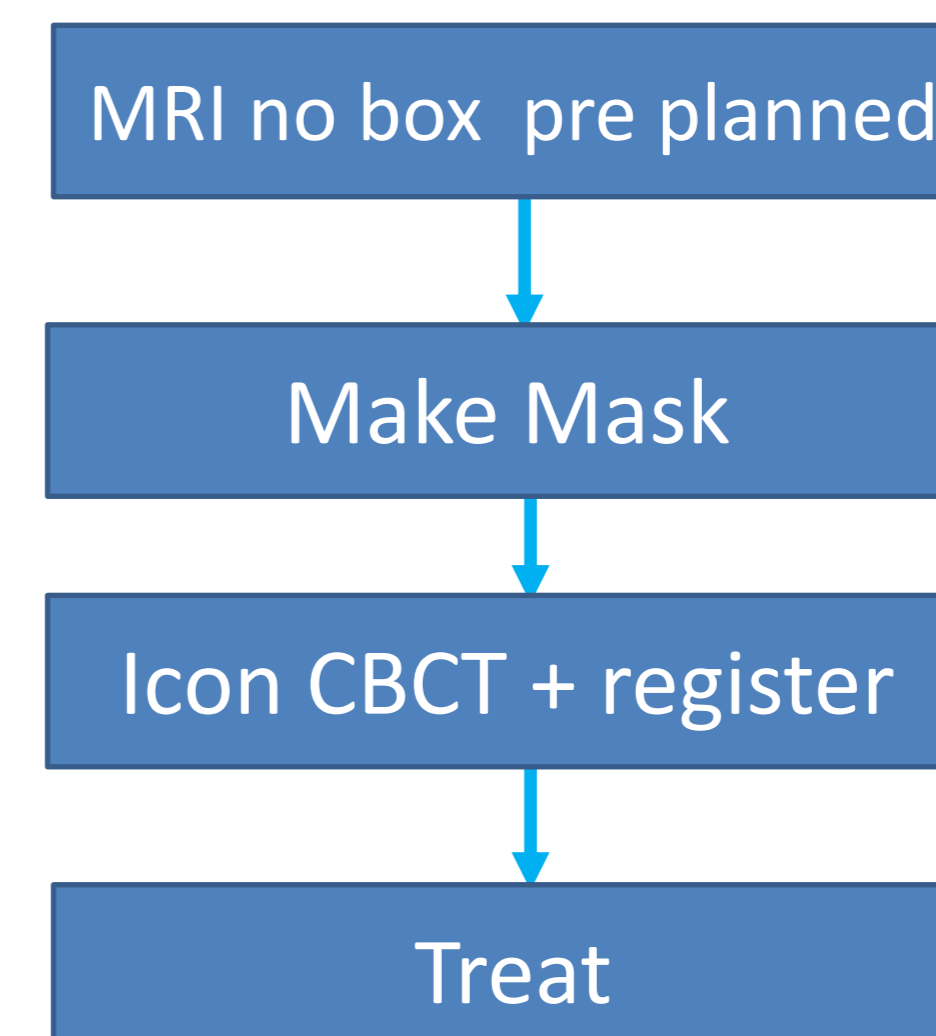
Fixed frame

All in one day



Icon + mask

Over one or more days



Using Icon enables image registration *without* fiducials. The preferred fixation device can be chosen post frameless MR, and different workflows are made possible.

CONCLUSIONS

Icon is a novel and highly versatile system which allows the delivery of fractionated treatments using a masked based system. Performance exceeds specification in the areas tested, providing an excellent platform for stereotactic radiotherapy and radiosurgery.