Commissioning aS1000 electronic portal imaging device, EPID, for patient specific IMRT QA on a Varian Trilogy machine

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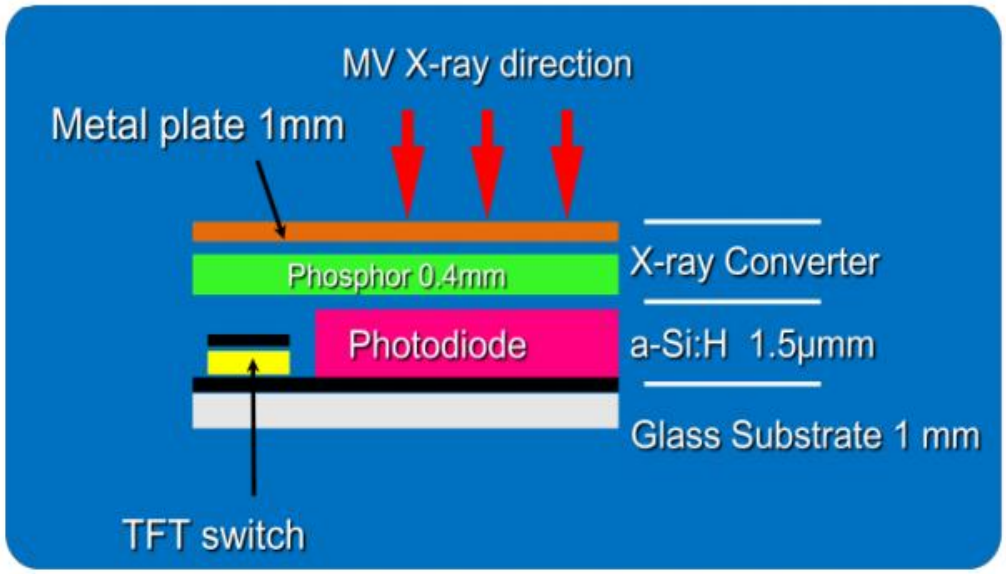
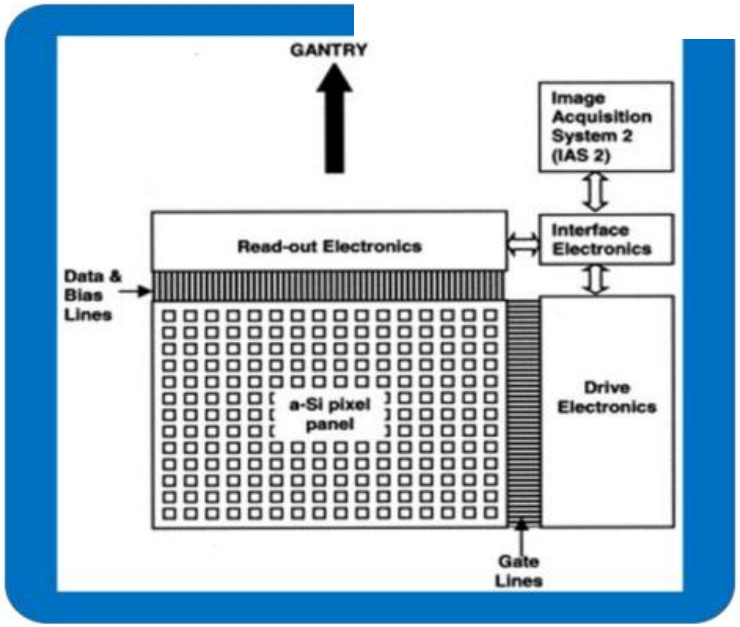
Outline

- aS1000 EPID
- Dosimetry calibration
- Verification plans
- Output factor measurement
- IMRT QA and comparison with 2-D diode array
- Summary

aS1000 EPID: *Varian Trilogy System*



Cross-sectional view of the Varian aS1000

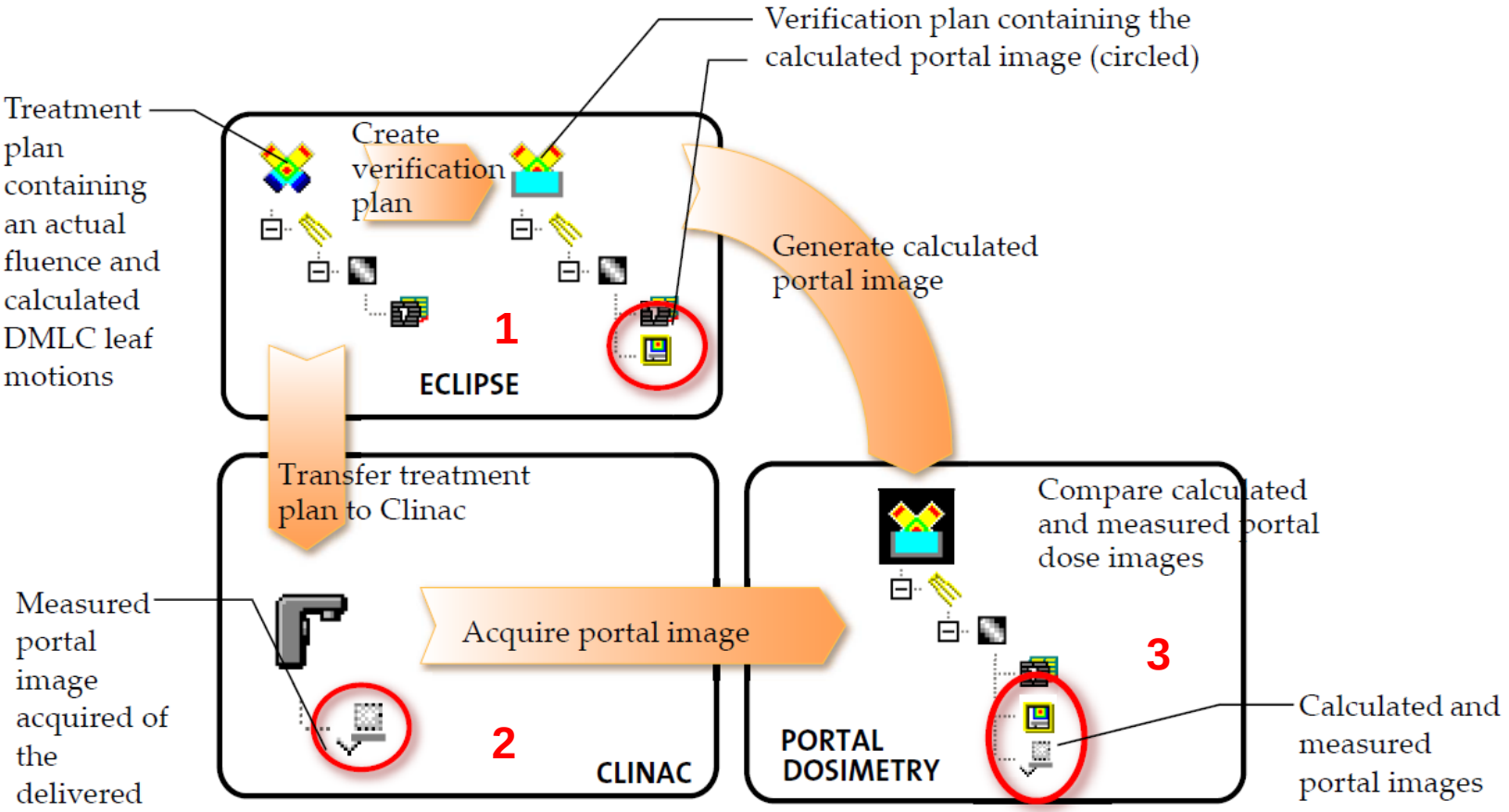


Simplified schematic of the electronics in Varian aS1000

- Each pixel in the matrix consists of aSi photodiode and a thin film transistor (TFT), with a pixel resolution of 0.39mm
- The image acquisition system enable up to 30 frames per second in aSi 1000 EPID

Workflow for Dosimetry for IMRT Plans using Portal Dose Calculation (PDC)

1. Prediction
2. Measurement
3. Comparison



Portal Dosimetry Pre-Configuration(PDPC)

- Configuration of new PDIP calculation model in Eclipse : *Beam Configuration*
- PDC calculates the portal dose image by convolving the fluence with Gaussian kernels
- Dosimetric Calibration of the Portal Imager on 4DITC workstation
  - Dark field and flood field correction

Dark field and flood field correction

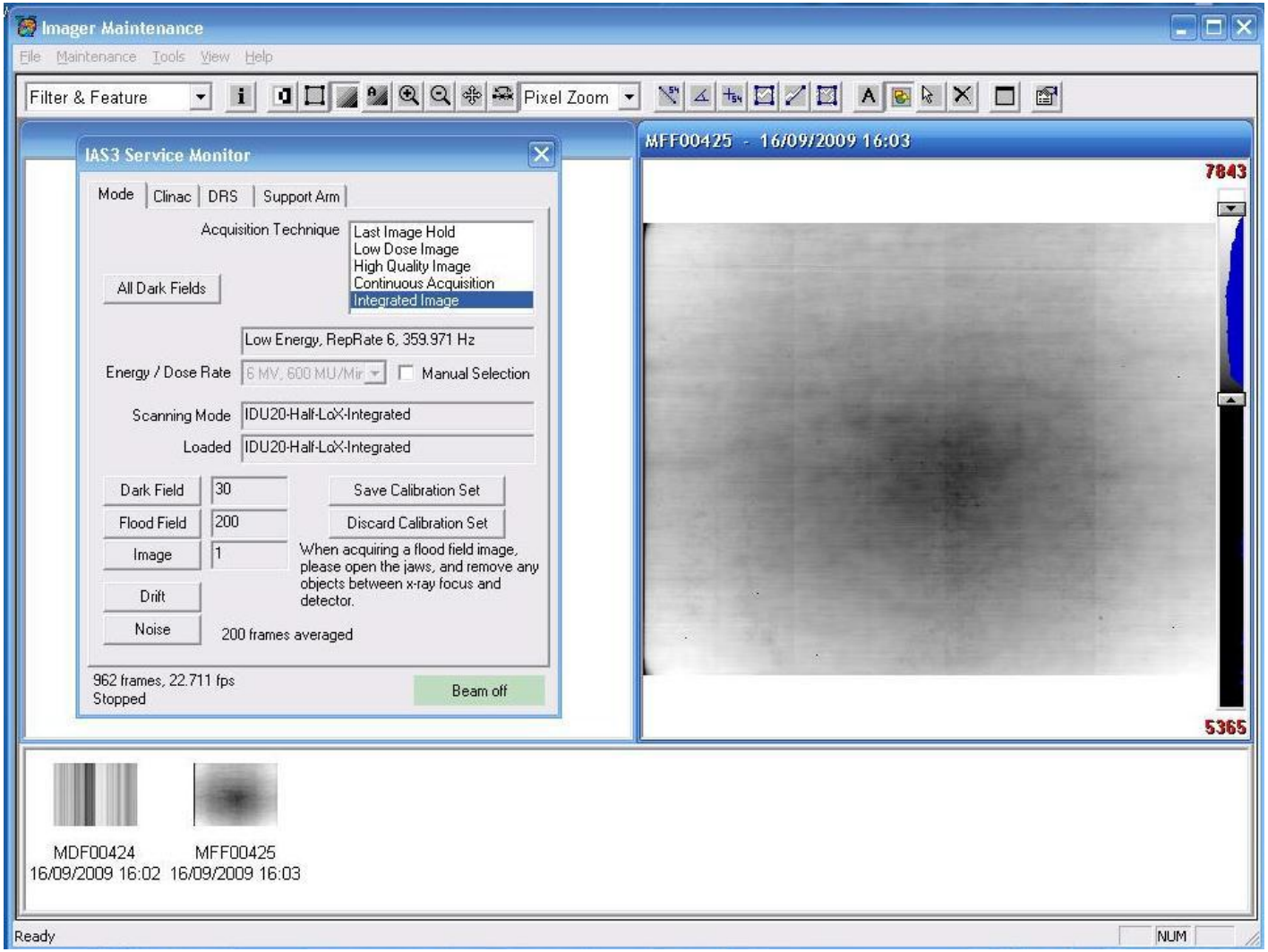
- Images acquired with the EPID were corrected for dark field and flood field:

$$I_{corrected} = \frac{I_{raw} - I_{DF}}{I_{FF} - I_{DF}}$$

I_{DF} : dark field image acquired in the absence of any radiation to correct for *electronic noise*

I_{FF} : flood field image acquired by uniformly irradiating the entire area of the detector to correct the *gain for each individual pixel*

Dark field and flood field correction



Flood Field Image

Dark field and flood field correction

- For flood field acquisition Y field sizes slightly larger than the EPID size were adjusted aiming for largely homogeneous irradiation.

SID	X(cm)	Y(cm)	Gantry Angle (deg.)	Coll. Rotation (deg.)
100	40	32	0	0

Dosimetry Calibration

- The dosimetric calibration was performed at the same SID used for the dark field and flood field calibration.

- On the treatment machine:
  - Field size: X = 10 cm, Y = 10 cm
  - Monitor Units = 100

- ***1CU was scaled to 100 MU (at SID =100cm)***

Verification

- Creation of verification plans on eclipse
- Dose calculation for treatment plans
- Schedule acquisition of portal images
- Irradiation of verification plans on treatment console
- Evaluation of verification plans on eclipse workstation

Verification of MLC parameters Settings

The accuracy and performance of the Portal Dosimetry solution strongly depends on a proper setting of the;

- MLC Transmission Factor

  &

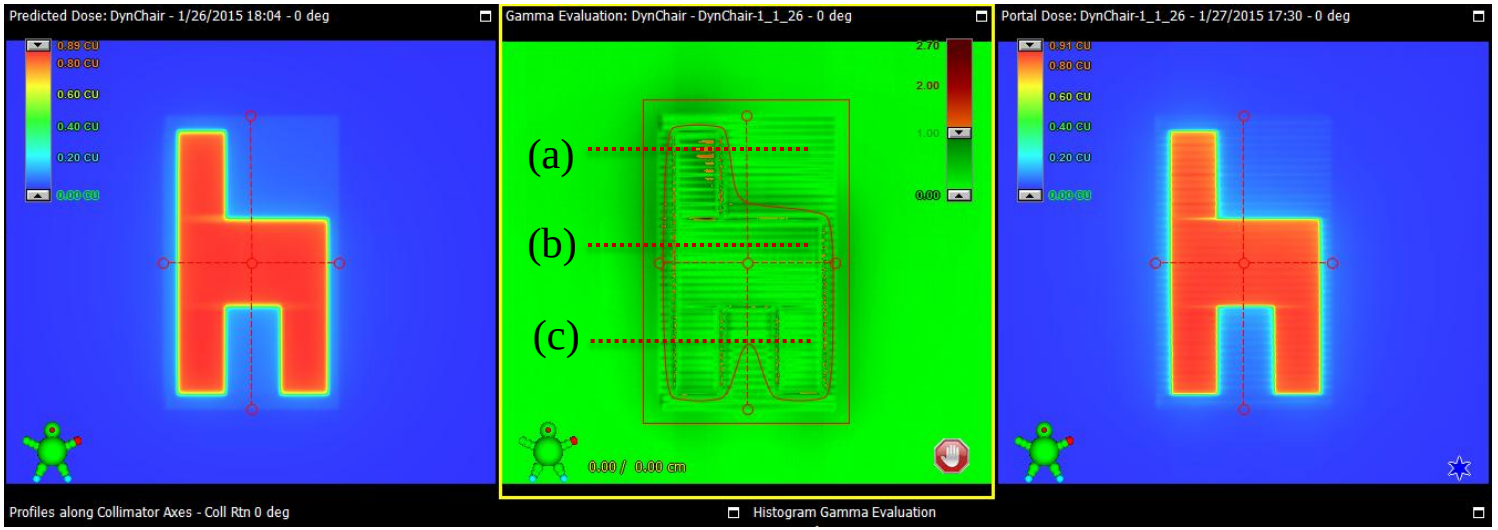
- Dosimetric Leaf Gap

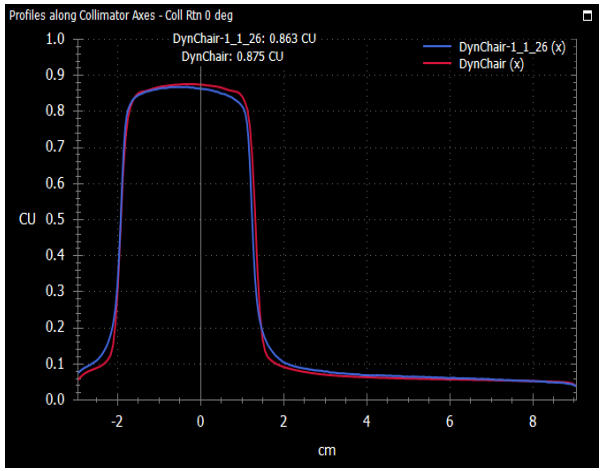
Impact of Transmission Factor and Dosimetric Leaf gap

Dynamic Chair (DynChair):

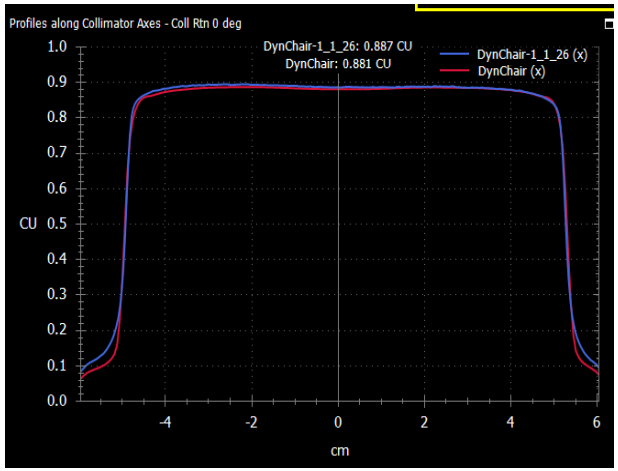
Predicted

Measured

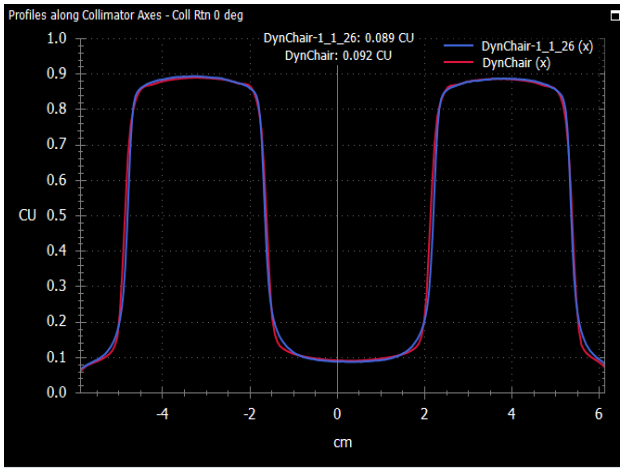




(a)



(b)

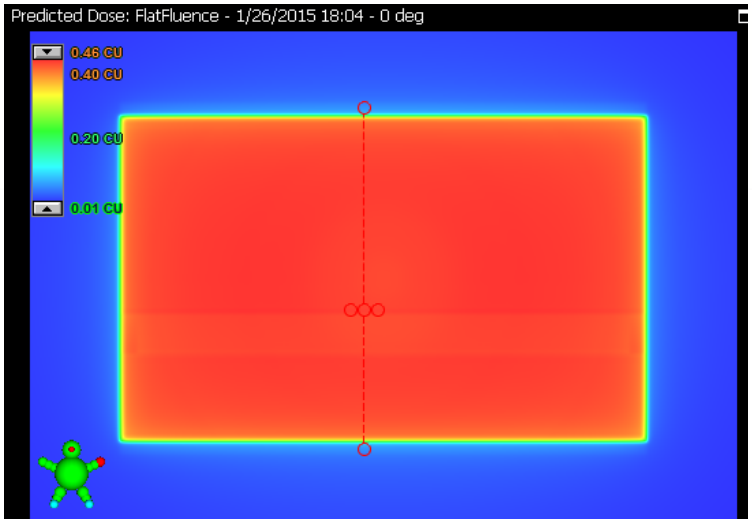


(c)

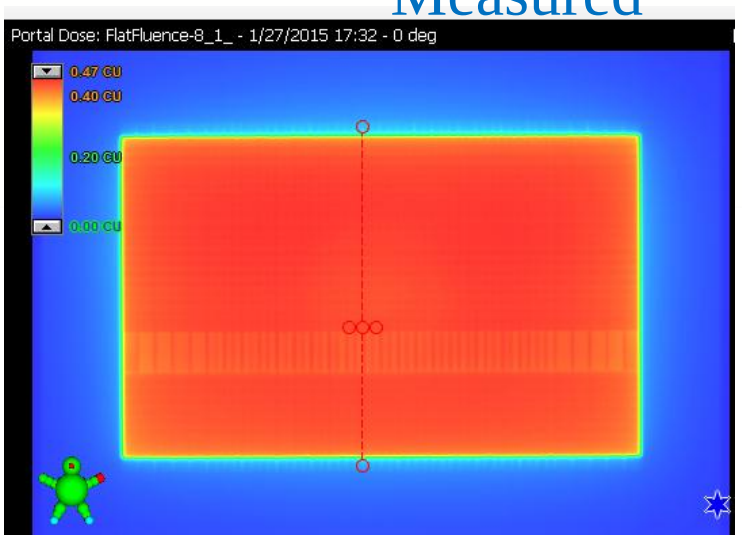
Impact of Transmission Factor and Dosimetric Leaf gap

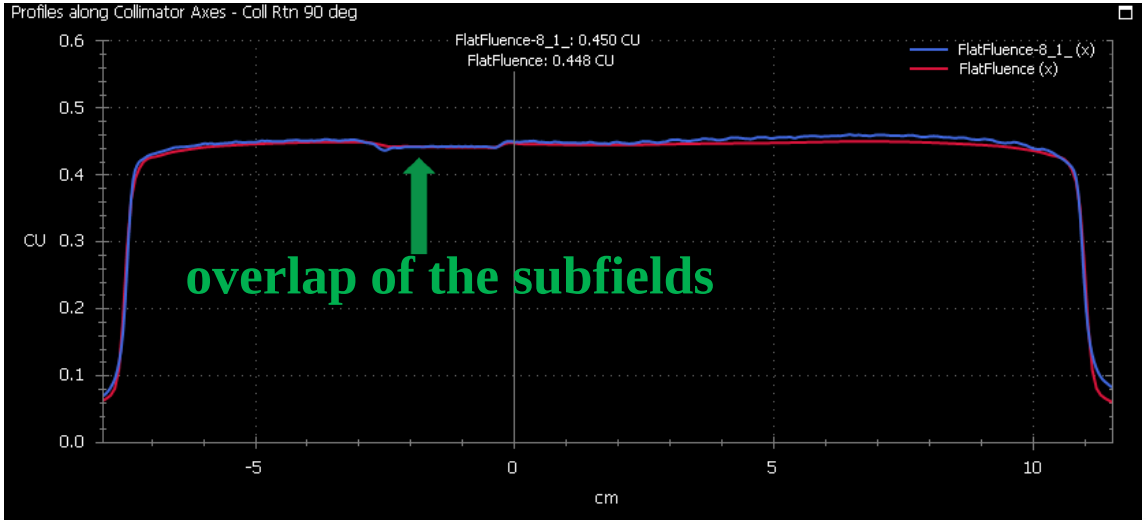
Flat Fluence:

Predicted



Measured

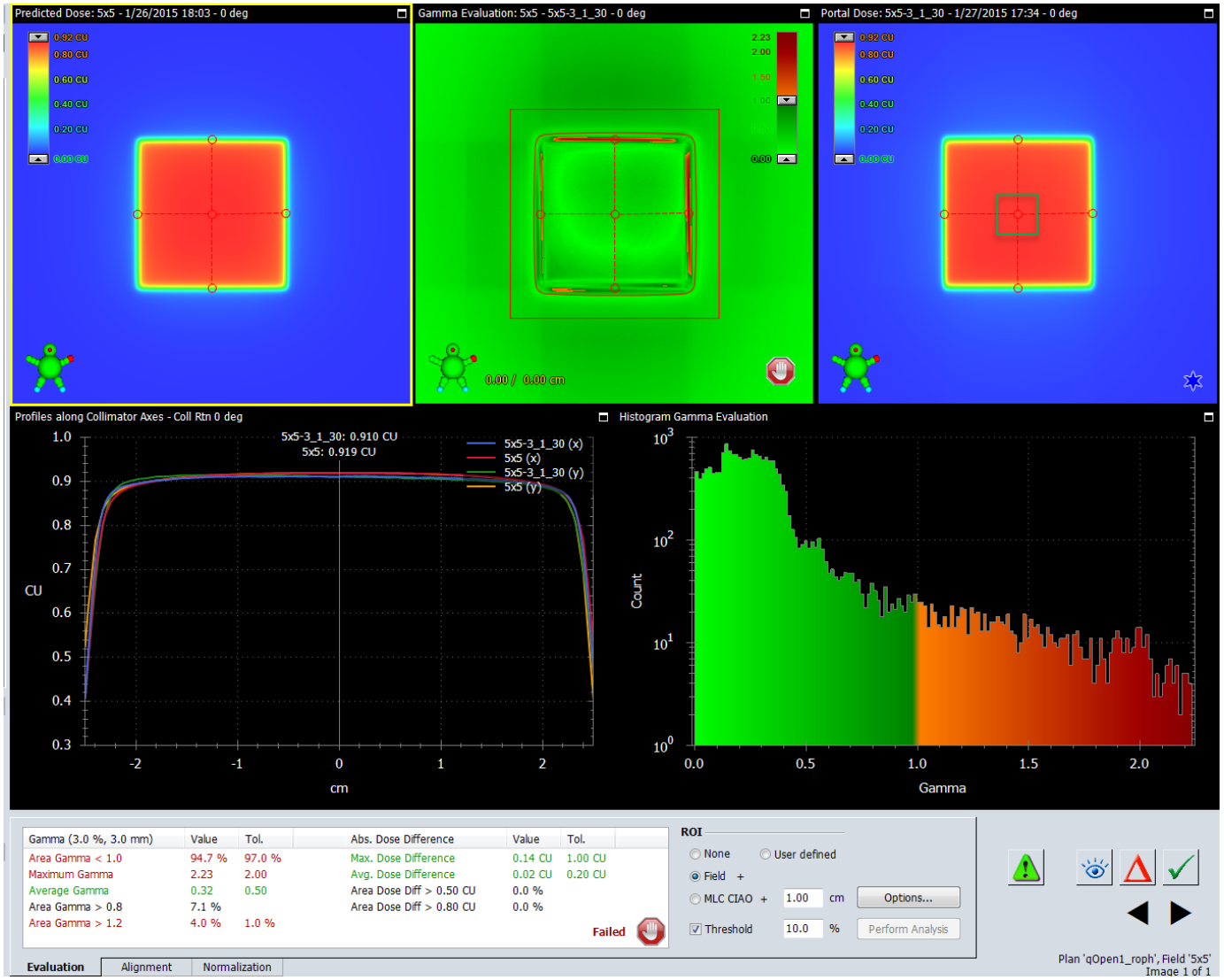




Output Factors

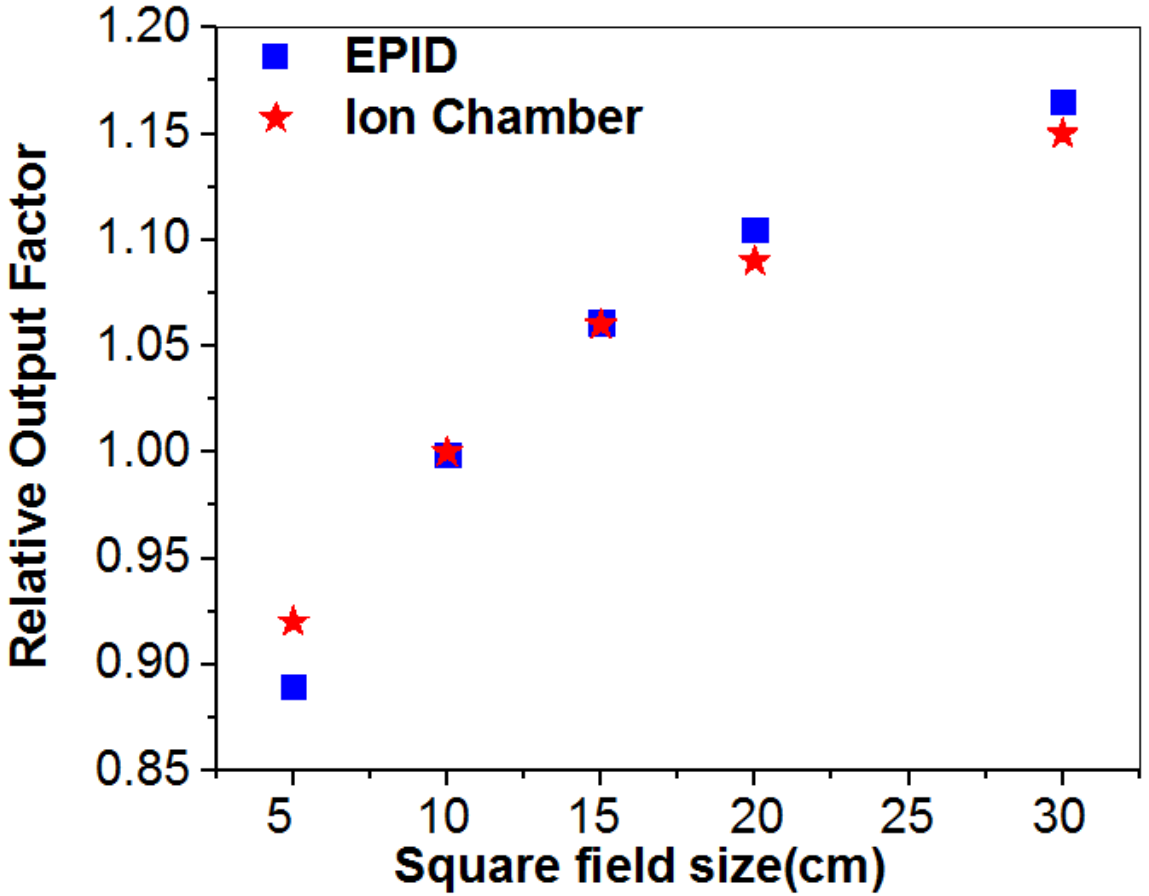
Predicted

Measured



Output Factors

- There were only 1.3% variations between EPID and Ion chamber measurements, except for the small field
- For 5x5 cm^2 field the variation was 3.4%



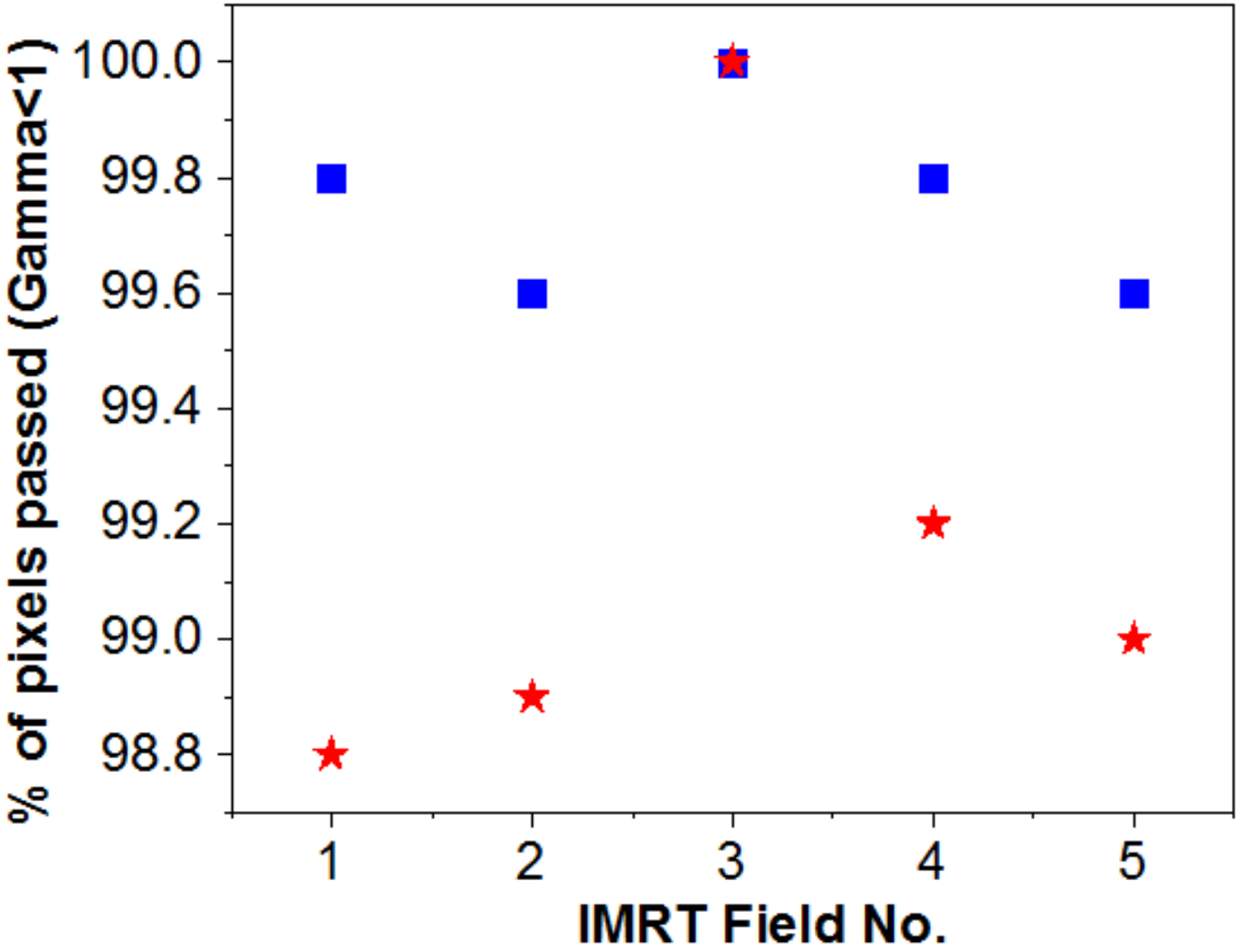
IMRT QA

- The performance of the EPID dosimetry module was evaluated by measuring 6 IMRT plans, covering different anatomical sites (i.e. Pelvis, Rectum, Lung, Breast), using both the portal imager and a 2-D diode detector array.

- The gamma index parameters were set to 3% dose difference and 3 mm distance to agreement.

IMRT QA

Case 1: Rectum



Gamma Criteria:

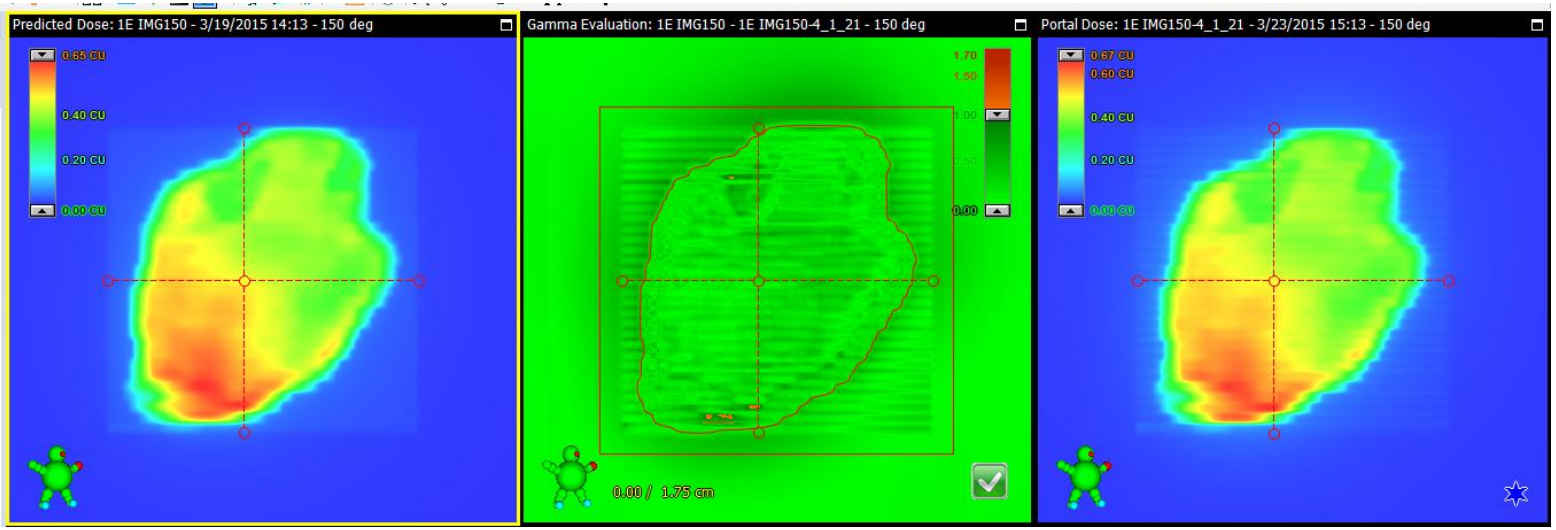
% Diff. : 3.0
DTA: 3 mm
Threshold %: 10.0

IMRT QA

Case 1: Rectum

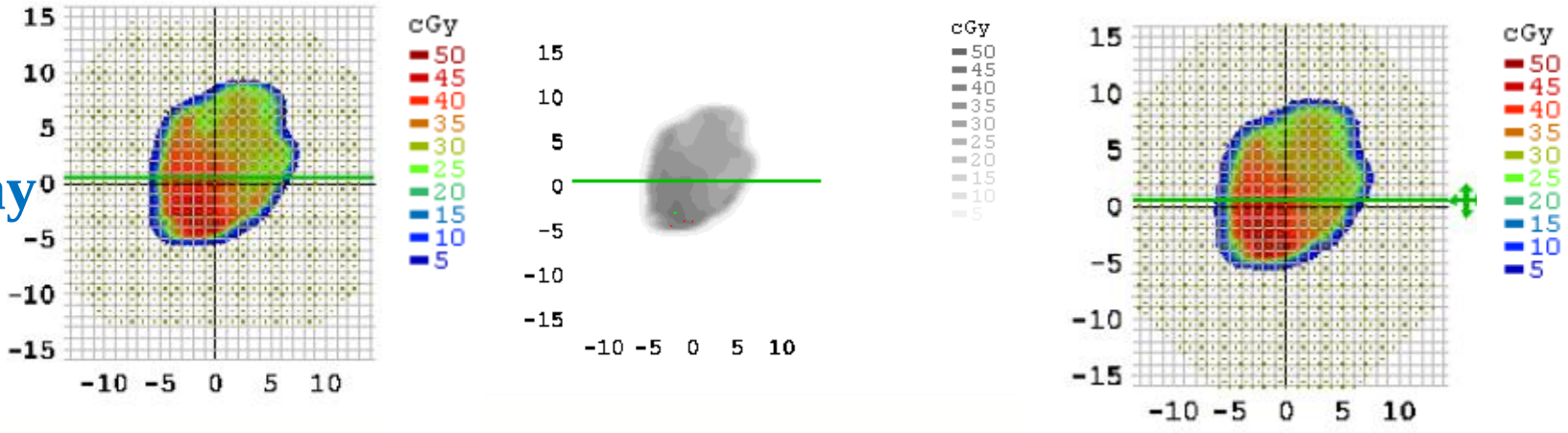
Predicted | Measured-Predicted | Measured

EPID



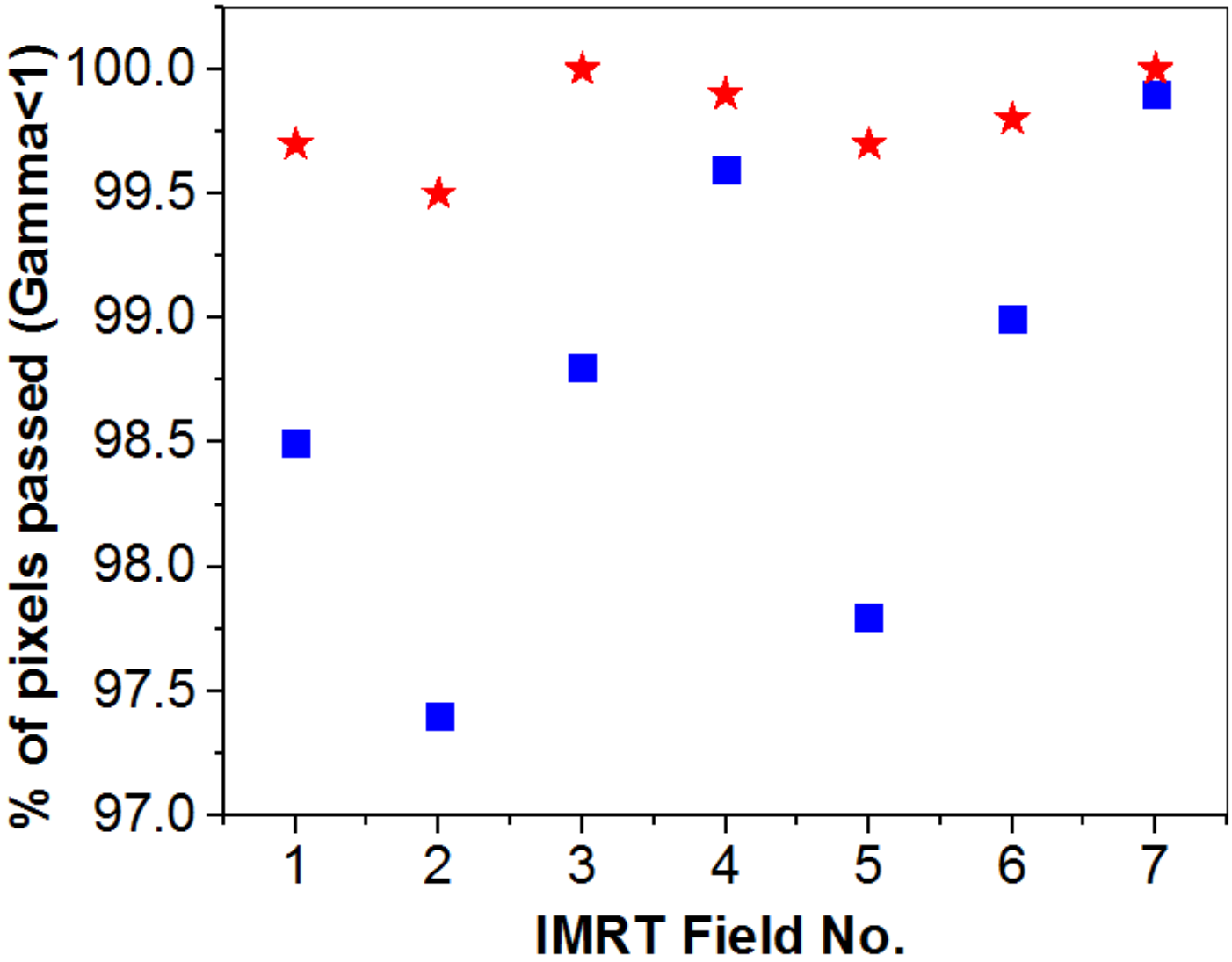
Planned | Measured-Planned | Measured

2-D Array



IMRT QA

Case 2: Pelvis

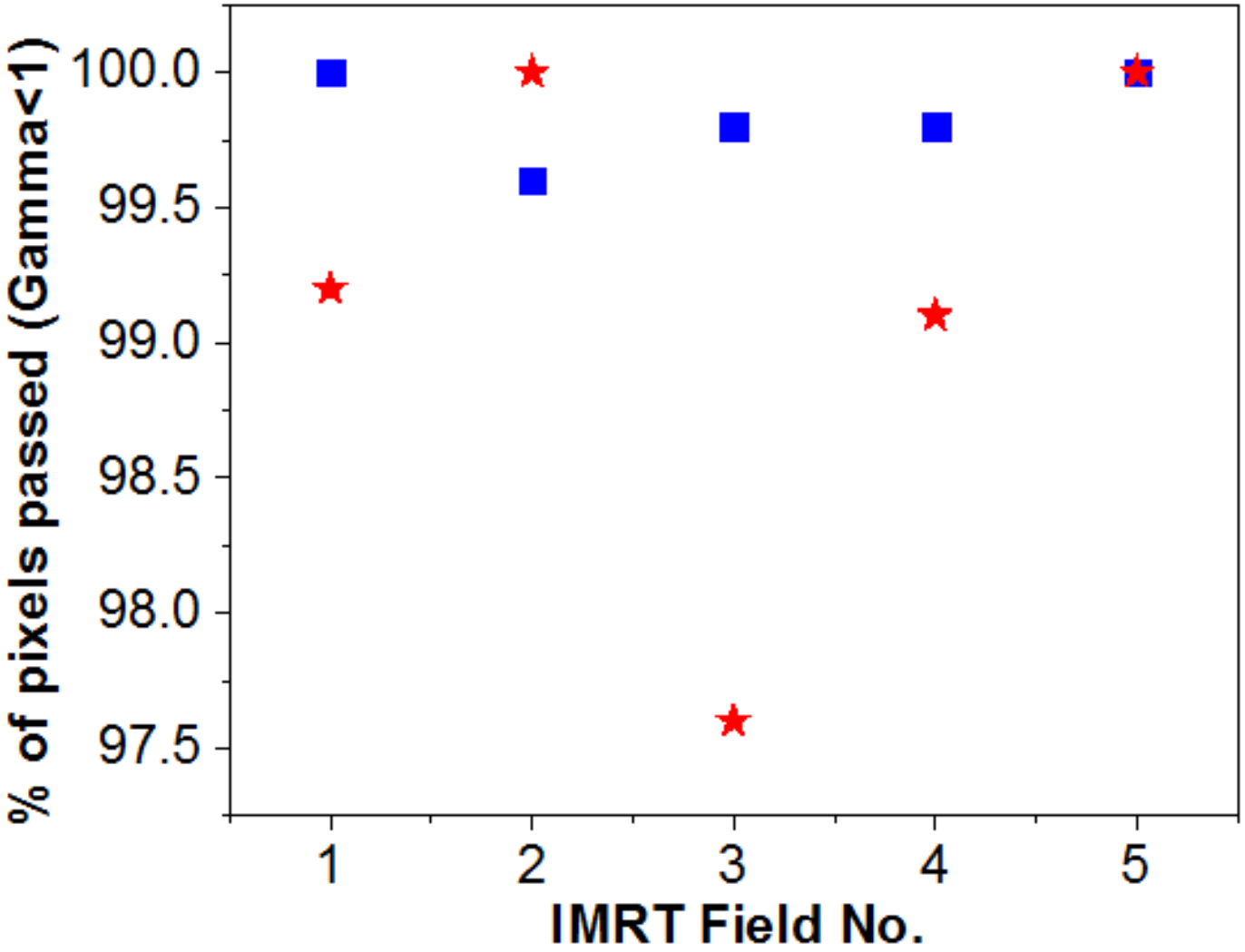


Gamma Criteria:

% Diff. : 3.0
DTA: 3 mm
Threshold %: 10.0

IMRT QA

Case 3: Breast



Gamma Criteria:

% Diff. : 3.0
DTA: 3 mm
Threshold %: 10.0

Summary

- The gamma passing rate for both detectors was comparable, ranging from 96.2% to 100%.
- From resource, workflow, and dosimetric accuracy perspectives, the EPID is a feasible alternative to diode detector for static gantry field by field IMRT QA.
- The QA process can be easily integrated with the treatment planning and data analysis while the delivery could be performed in a standard patient treatment slot without the need to setup large cumbersome phantoms.
- No extra detector or array to purchase and maintain.