

EPID dosimetry – Characteristics of a commercial software: EPIgray

Kate Ricketts, Clara Navarro, Abiodun Adeyemi (RBH)

- Aims and current in vivo dosimetry
- Introduction to EPIgray
- Software commissioning and evaluation results:
 - Phantom measurements
 - Patients

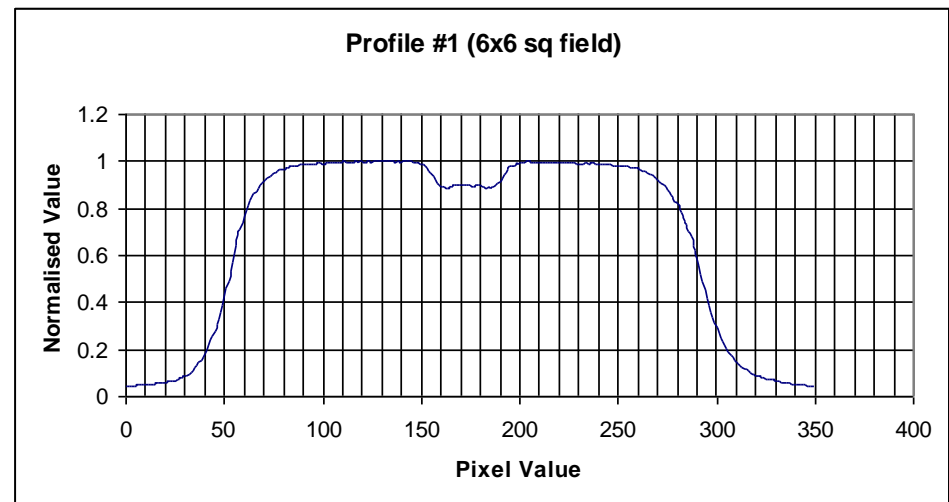
Towards Safer Radiotherapy report

“All centres must have protocols for in vivo dosimetry”

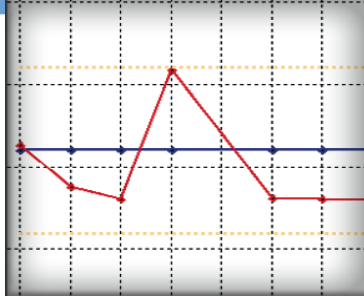
- **Aim:** To implement and evaluate a new *in vivo* dosimetry system for use at RBH

Current limitations - Diodes

- **Diodes** Surface dose only
- Sensitive to diode positioning
- One point per field
- **Time consuming**
- Dose shielding effect
- Not suitable for VMAT



Introduction to EPIgray

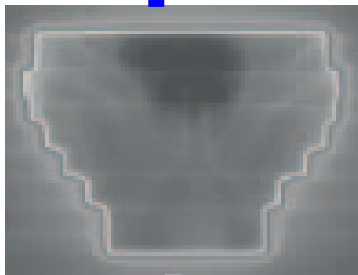


3. Dose of the day to reference point
– compare with planned expected
dose

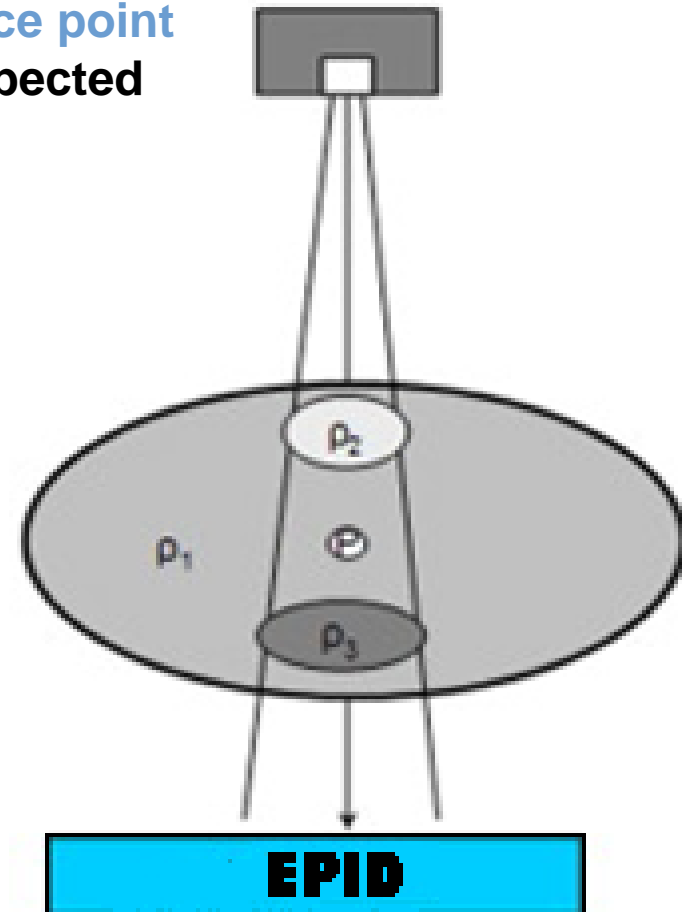


2. Transmission
dosimetry

EPIgray dose
reconstruction through
pCT + pixel value on day,
cf RTplan



1. EPID image –
during each
treatment field



Commissioning work

- Calibrate EPIDs for **dosimetry** (so far used for imaging only)

- Measure EPID and beam data for **EPIgray library**

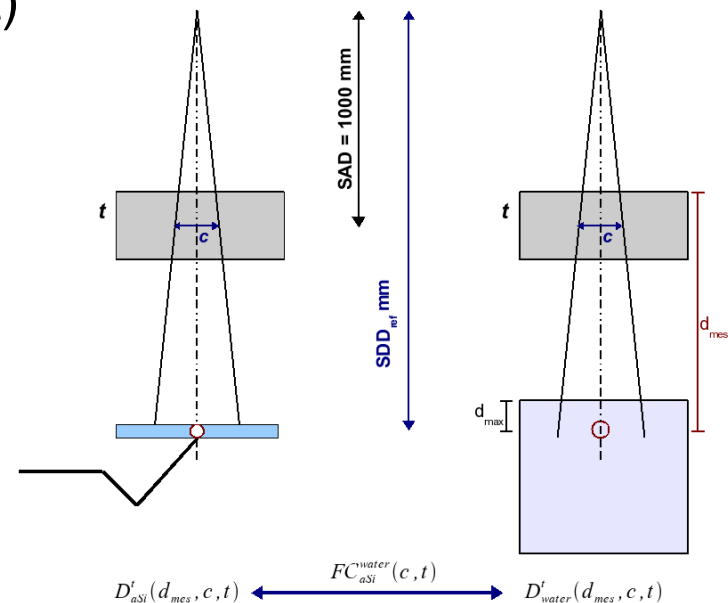
(chamber at EPID level vs EPID signal, finite TMR measurements, planning data – PDDs, beam profiles – open / wedged)

- **Connectivity:** between EPIgray, Eclipse, iViewGT and Mosaic

- **Workflow** (radiographer / physics input)

- Software evaluation – worked

closely with **DOSIsoft**



Software Evaluation

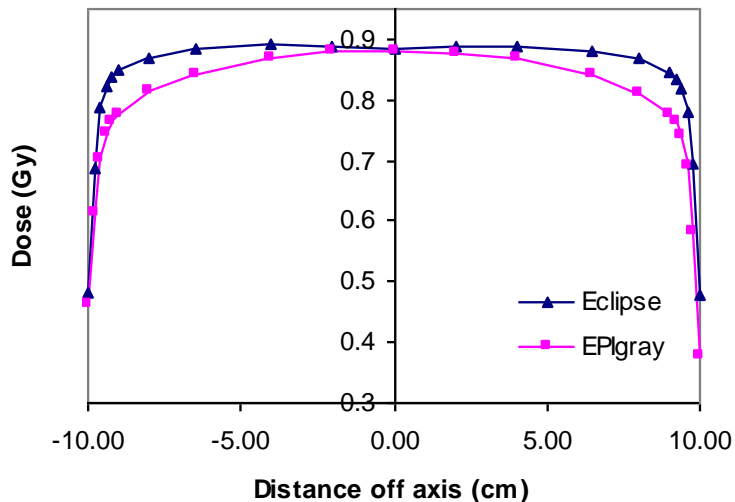
- Accuracy: field size effects, PDDs, wedges
 - Compared with TPS values, (future: to compare with measurement)
- Linearity with dose and reproducibility
- IMRT and VMAT capabilities

Sensitivity to errors:

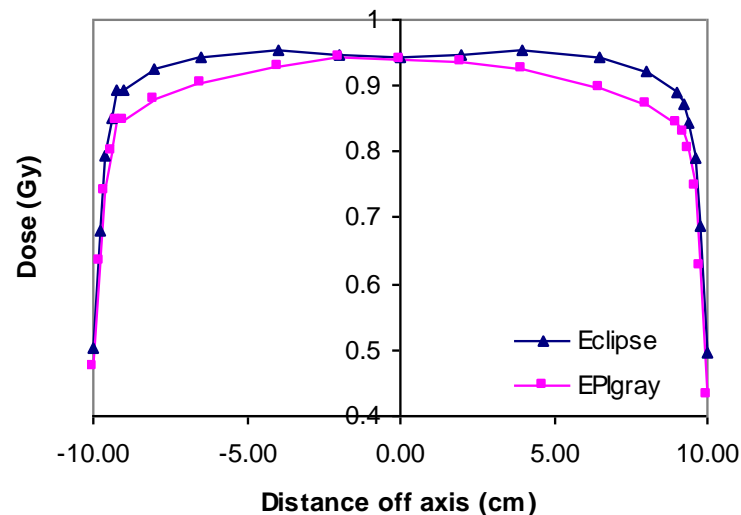
- Can **SSD** changes be picked up?
- Can **patient thickness** changes be identified?

Beam Profiles

Open field 6MV 10cm deep



Open field 10MV 10 cm deep

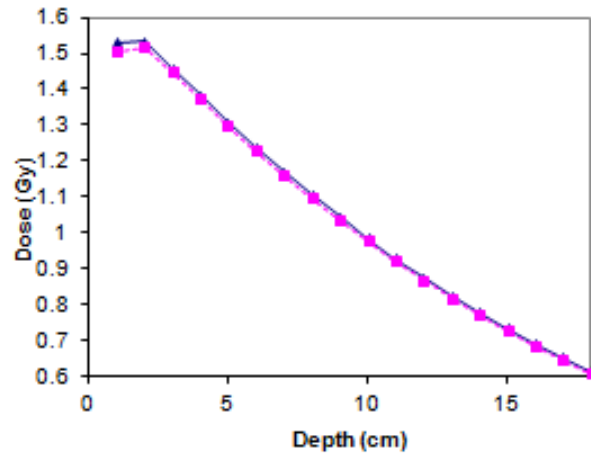


100 MU, 20 cm solid water, 20 x 20 cm field, 90 cm SSD

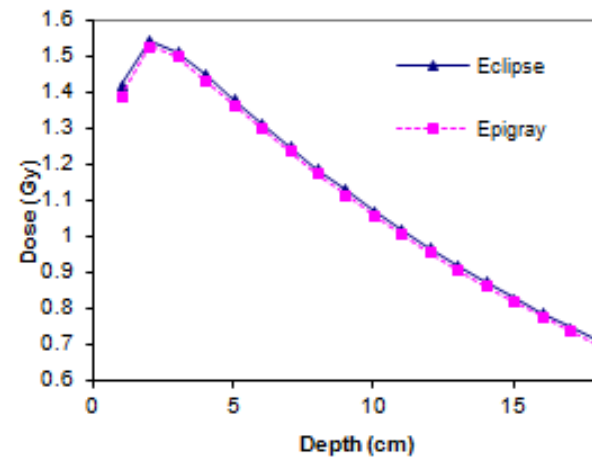
Good agreement: ΔD (EPIgray vs TPS) of 6 MV: -0.5% (0.4 cGy)
10 MV: -0.3% (0.3 cGy) on cax.
Off axis +/- 4 cm: max difference -2.4% and -3% for 6 and 10 MV

Percentage depth doses

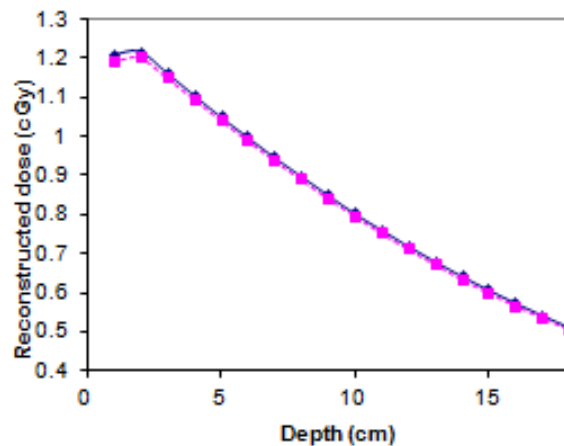
6MV 80cm SSD



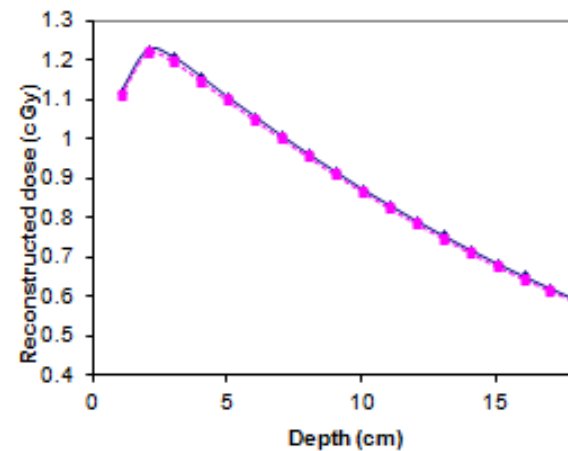
10MV 80cm SSD



6MV 90cm SSD

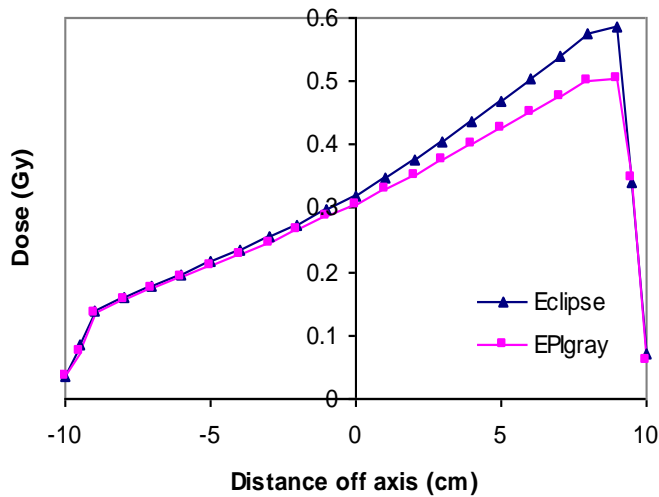


10MV 90cm SSD

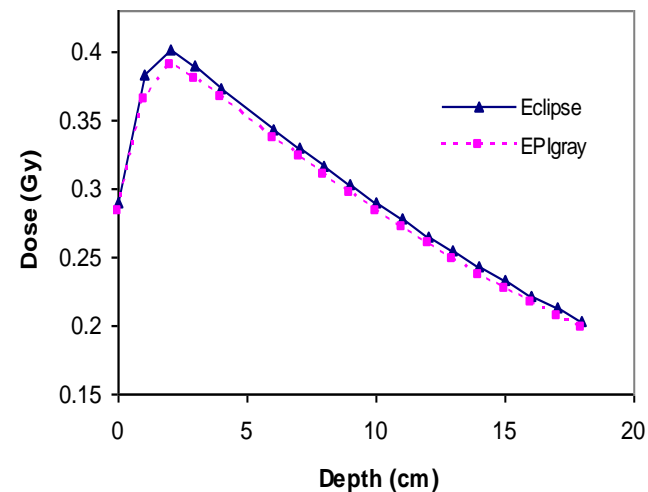
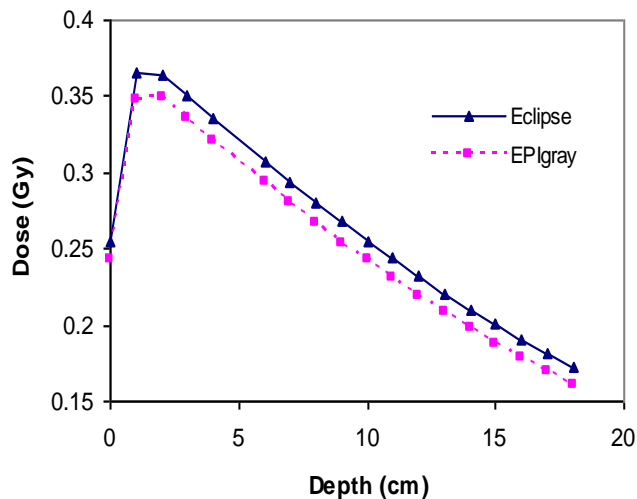
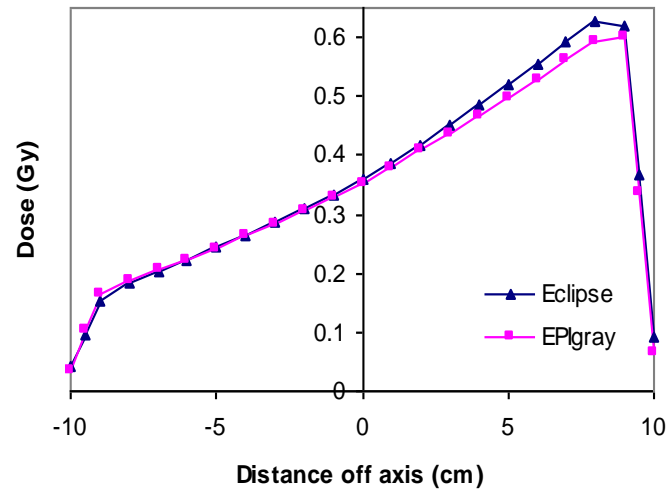


Wedged fields

Wedge 6MV



Wedge 10MV



Poorer agreement: ΔD (EPlgray vs TPS) of 6 MV: -4.5%

10 MV: -1.9% on cax.

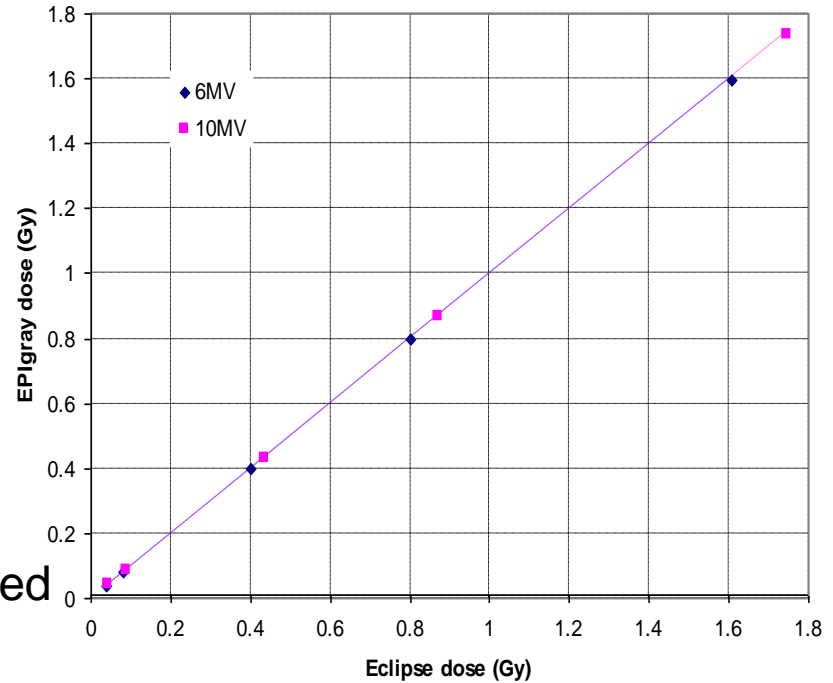
Off axis +/- 4 cm: thick end -3.2% (-1.1%) and thin end -8.5% (-3.9%) for 6 MV (10 MV)

Linearity

- Tested 5 MU – 500 MU at 6 MV and 10 MV
- Pink line: EPIgray = Eclipse dose
- All points lie on pink line
- Linear response of EPID

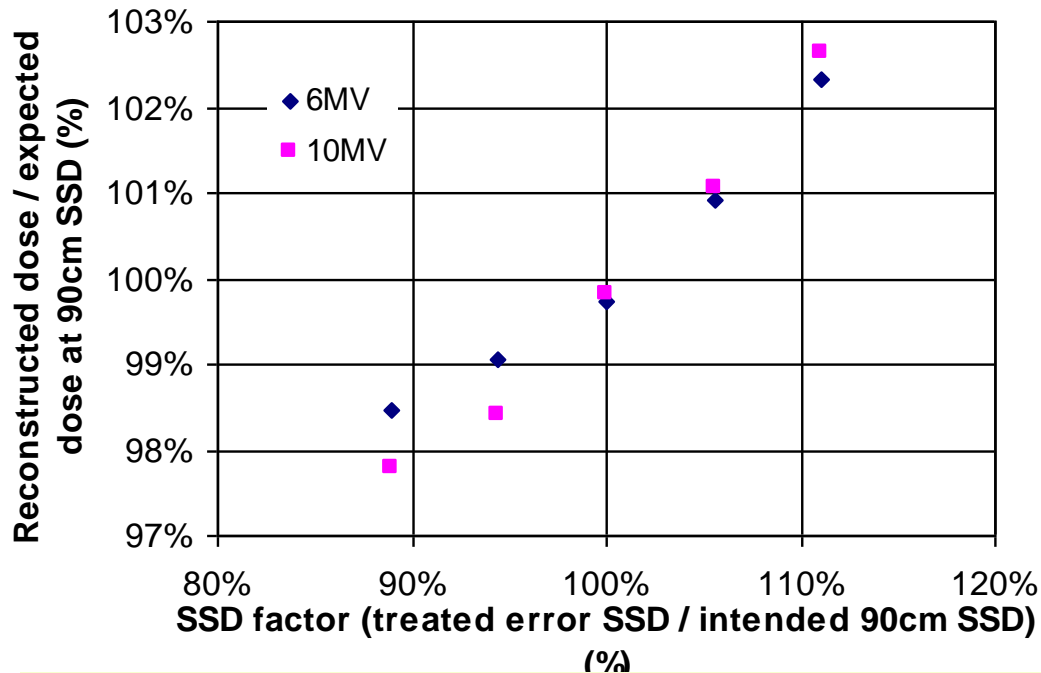
Reproducibility

- Tested for images taken on same day
- Day-to-day reproducibility yet to be tested



	6 MV	10 MV
CAX (5 cm and 10 cm deep)	1.15% (0.01 Gy)	1.5% (0.01 Gy)
± 2 cm laterally off-axis (10 cm deep)	All results within 2.0%	2.5% (0.02 Gy)

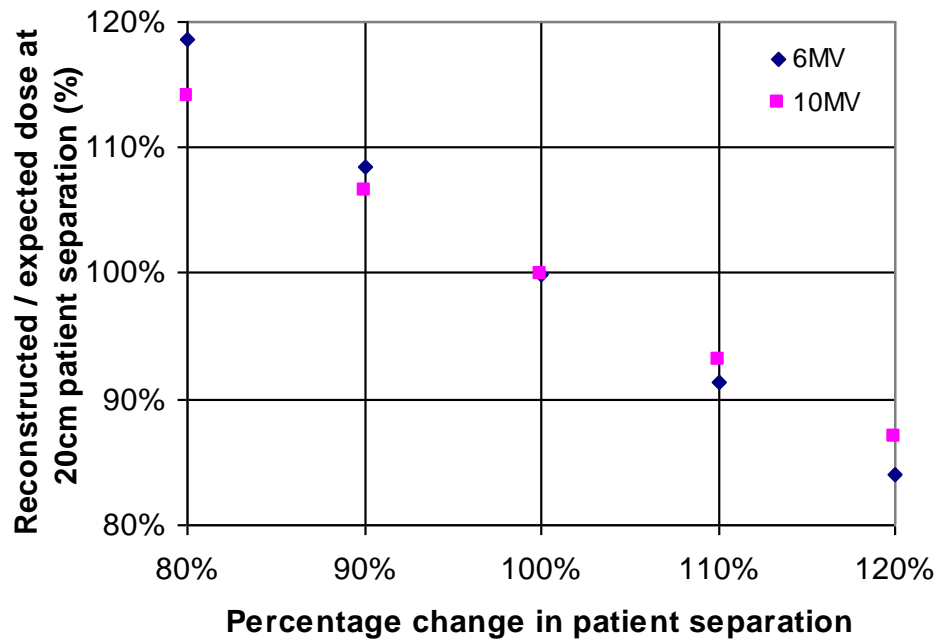
Sensitivity to FSD changes



**Not sensitive to
FSD error**

- 10% difference in FSD gives ~ 2% difference in reconstructed dose
- Require additional FSD check

Sensitivity to patient thickness



Sensitive to patient thickness change

- 10% change in patient separation seen as ~ 10% change in reconstructed dose

Detectable errors

- MU errors
- Patient set-up
- MLC/ wedge errors

Treatment Delivery Errors

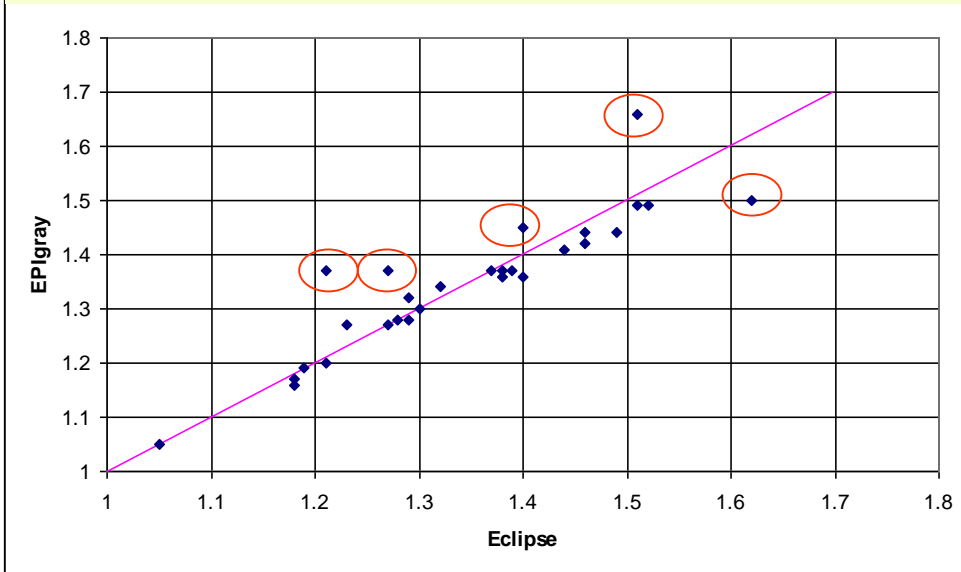
- Patient thickness
- Anatomical changes – bowel gas, respiration, bladder filling

Patient Changes

Limitations: not sensitive to changes in SSD

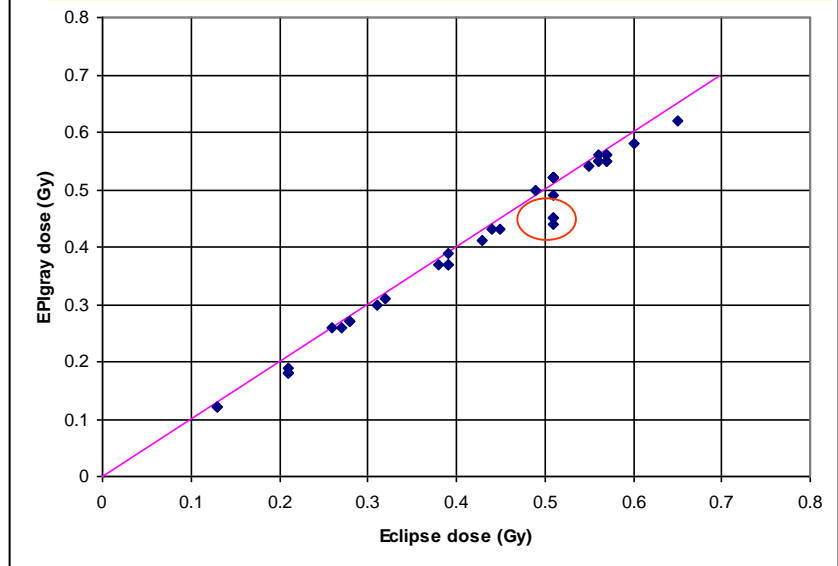
Patient trial results

Breast 18 fields



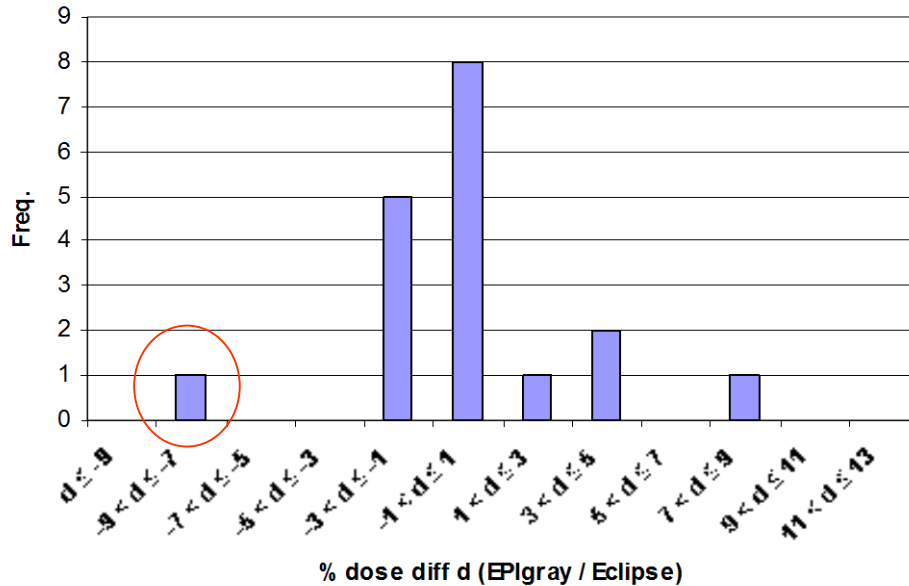
All fails = chest wall patients

3D conformal 38 fields



Fails = bowel gas

Breast 18 fields

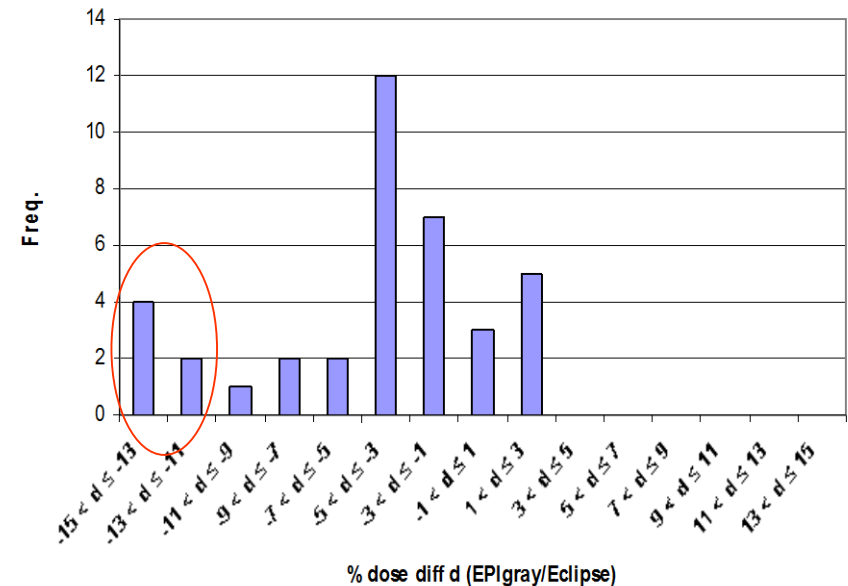


Mean= -0.2% ± 3.2 % (1σ)

[-0.4 cGy ± 4.5 cGy]

Max abs. dose diff = -12 cGy

3D conformal 38 fields



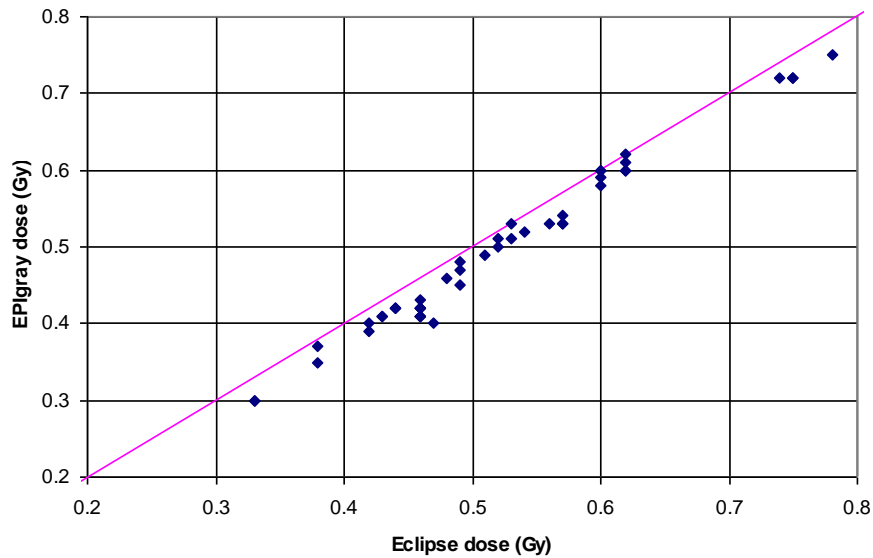
Mean= -4.3% ± 4.8 % (1σ)

[-1.5 cGy ± 1.8 cGy]

Excluding rectum (brain only)

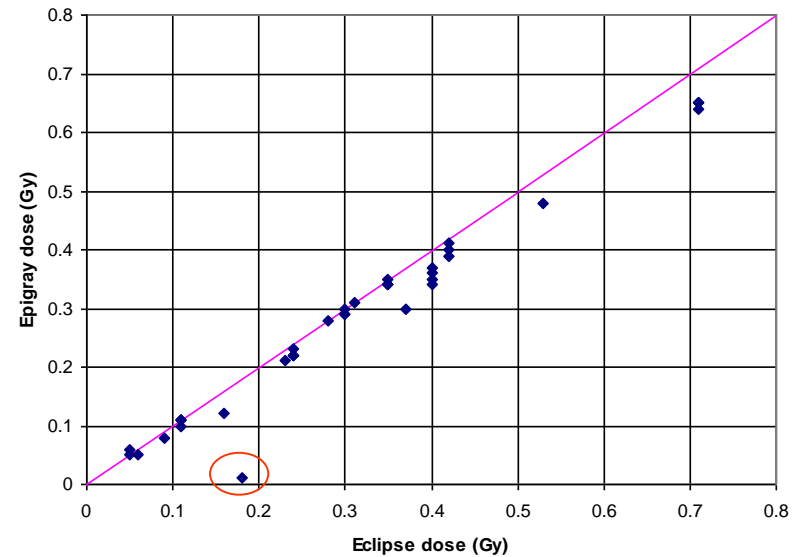
Mean= -3.1% ± 2.4 % (1σ)

IMRT pelvis 44 fields



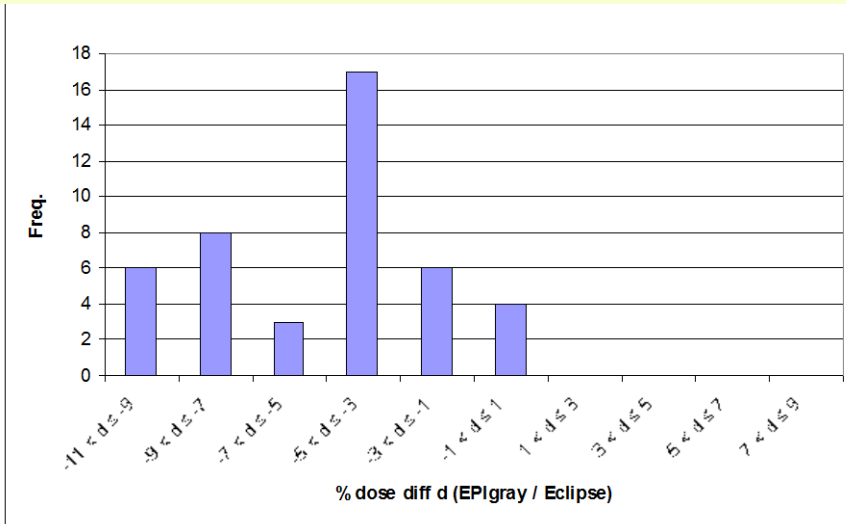
- EPIgray Systematically lower than TPS dose

IMRT head and neck 33 fields



- Point not in open field
- Air gaps changeable

IMRT Pelvis 44 fields



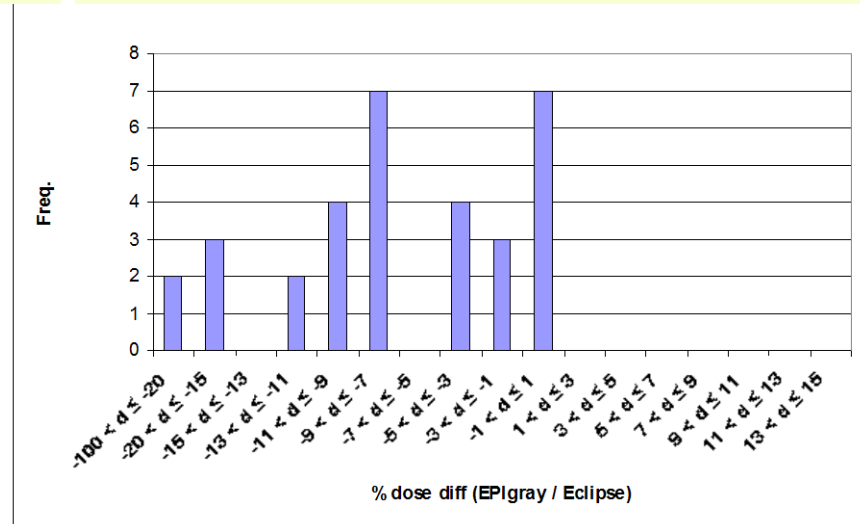
Mean= $-5.2\% \pm 3.3\%$ (1σ)

$[-2.5 \text{ cGy} \pm 1.5 \text{ cGy}]$

Fail Point under MLC for most segments

Point dose comparison not suitable for IMRT dose verification

IMRT Head and Neck 34 fields



Mean= $-8.9\% \pm 17\%$ (1σ)

$[-2.7 \text{ cGy} \pm 3.5 \text{ cGy}]$

Max absolute dose difference = -17 cGy

Exploring use of local gamma index – new feature of EPlgray

Results:

IMRT pelvis: 52 points Avg: 0.75 **std: 0.5**

IMRT H&N: 34 points Avg:0.6 **std:0.3**

Pass = gamma index < 1

Initial tolerances based on patient trial – to be reviewed

Breast FinF plans: 5% (7% chest wall)

Conformal plan: 5% brain 7% rectum

IMRT pelvis: gamma index < 1 (5%/5mm)

IMRT head and neck gamma index < 1 (5%/5mm)

- Dose reconstruction point should lie:
 - < 2cm from cax
 - > 2 cm from field edge
 - not in low or high density region
 - Not in region where beam path traverses inhomogeneity / rapidly changing body contour
- Isocentre taken as default point for majority of fields
- EPIgray not sensitive to FSD error: require additional FSD check

Conclusions

- Commissioning easy
- EPIgray tests reveal good agreement with TPS dose on cax
 - linearity, reproducibility, patient thickness, FSD changes
- Further work to improve performance of wedge modelling
- Patient trial needed to set initial tolerances

Thank you