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Royal Surrey County Hospital NHS NHS Foundation Trust

Assessing the geometric and dosimetric accuracy of Stereotactic Radiosurgery (SRS)

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EPSRC Engineering and Physical Sciences Research Council

Contents

- What is SRS?
- Why is this project important?
- Methods
- Results
- Conclusions

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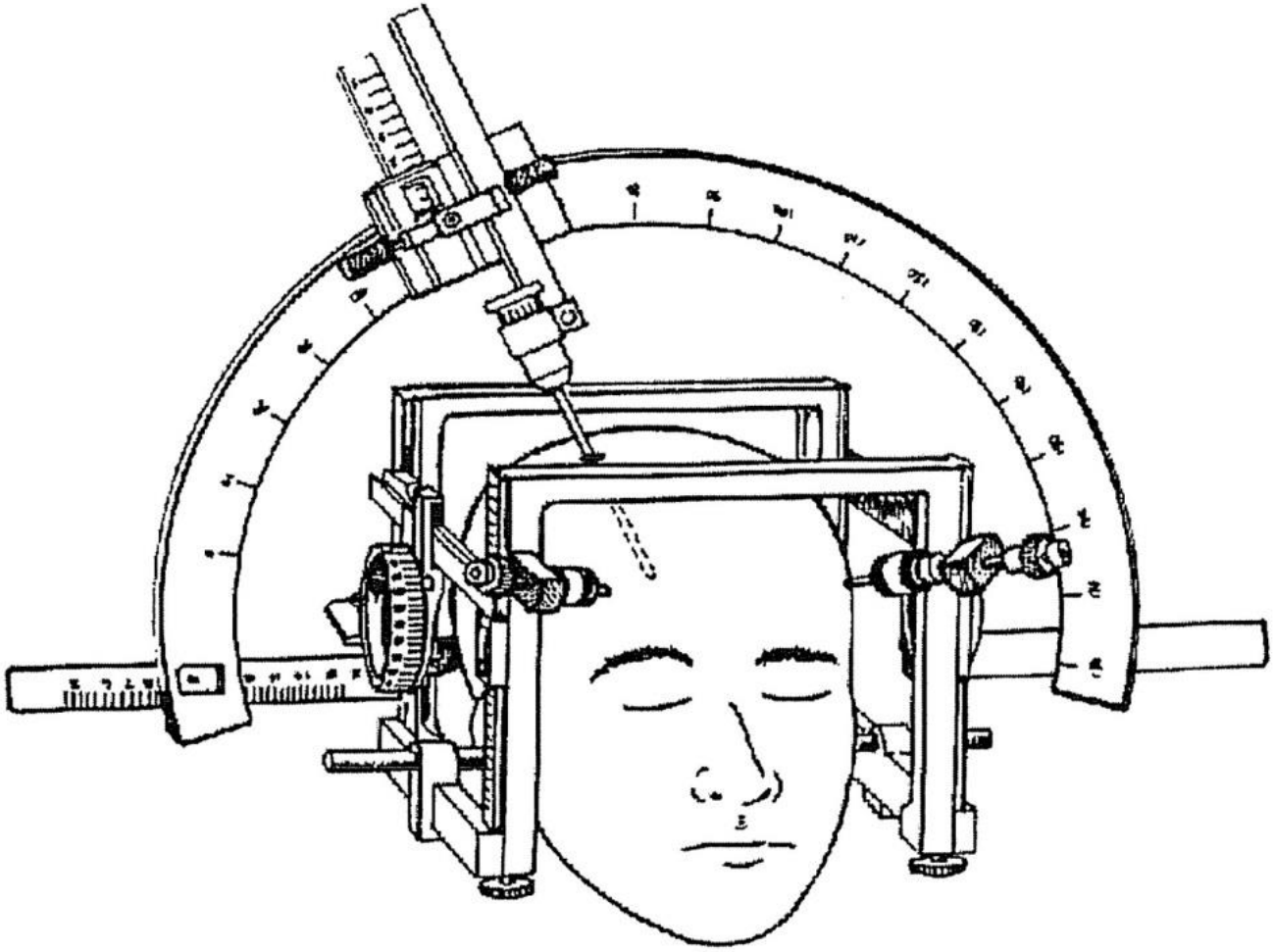
Stereotaxy (“Stereo” & “Taxis”)

Clark, R. & Horsley, V. (1906) *Br. Med. J.* 1799–1800



Used on humans in 1947

Spiegel, E., Wycis, H. T., Marks, M. & Lee, A. J. (1947) *Science 80;*106, 349–350

First “Stereotactic Radiosurgery” treatment in 1950

Leksell, L. (1950) . *Acta Chir. Scand.* 99, 229–233

Stereotactic Radiosurgery (SRS)

Definition by Leksell:

"The administration, through the intact skull, of a **single high dose of radiation**, stereotactically directed to an intracranial region of interest.

May be from X-rays, gamma rays, protons or heavy particles"

Key development for SRS

- Lars Leksell – 1950
- Gamma Knife – 1953
- Particle SRS – Late 50's (Berkley & Harvard)
- Linac-based SRS – 80's (ARG, ITA, USA, GER)
- Early-90's dedicated SRS-linacs

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Motivation

- Minimise delivery errors and clinical complications
- Improve patient care for a large number of pathologies
- Enhance standardisation in SRS

Challenges

- Variety of SRS practices
- Small field photon dosimetry

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Methods

- Survey to investigate current practices

(Submitted to BJR: “Current practices of SRS in the UK” – under review)

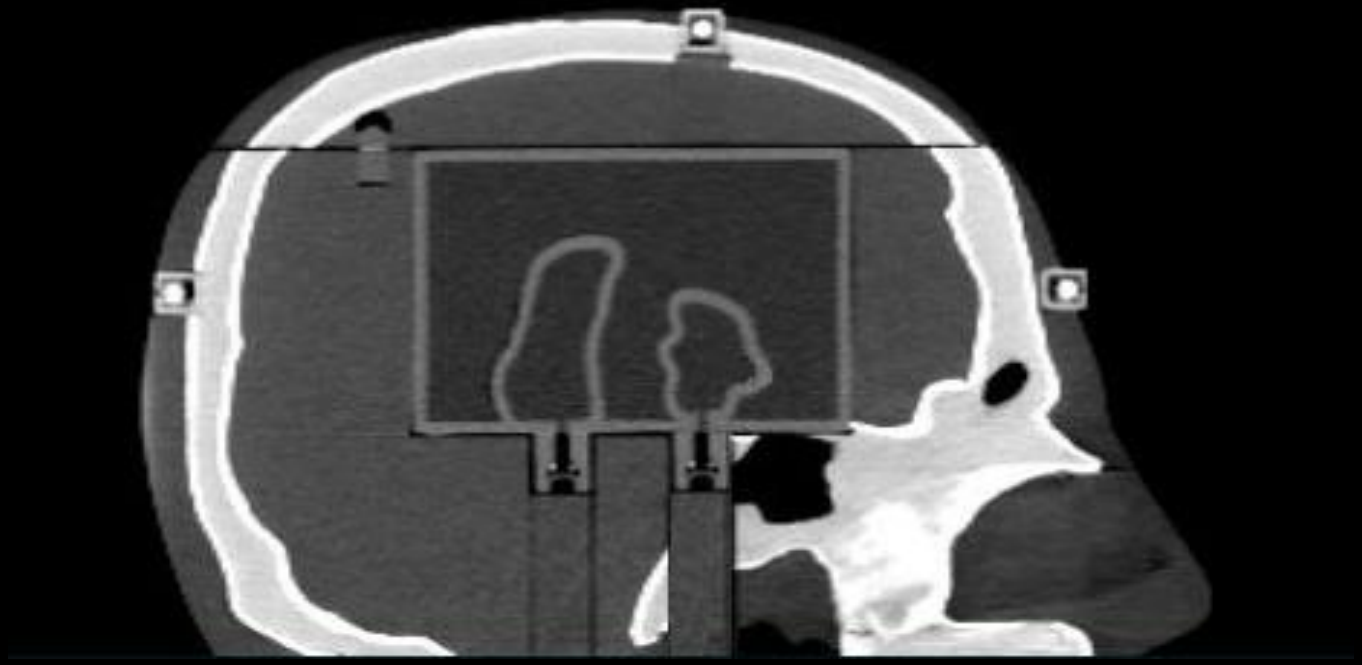
- Suitable phantom

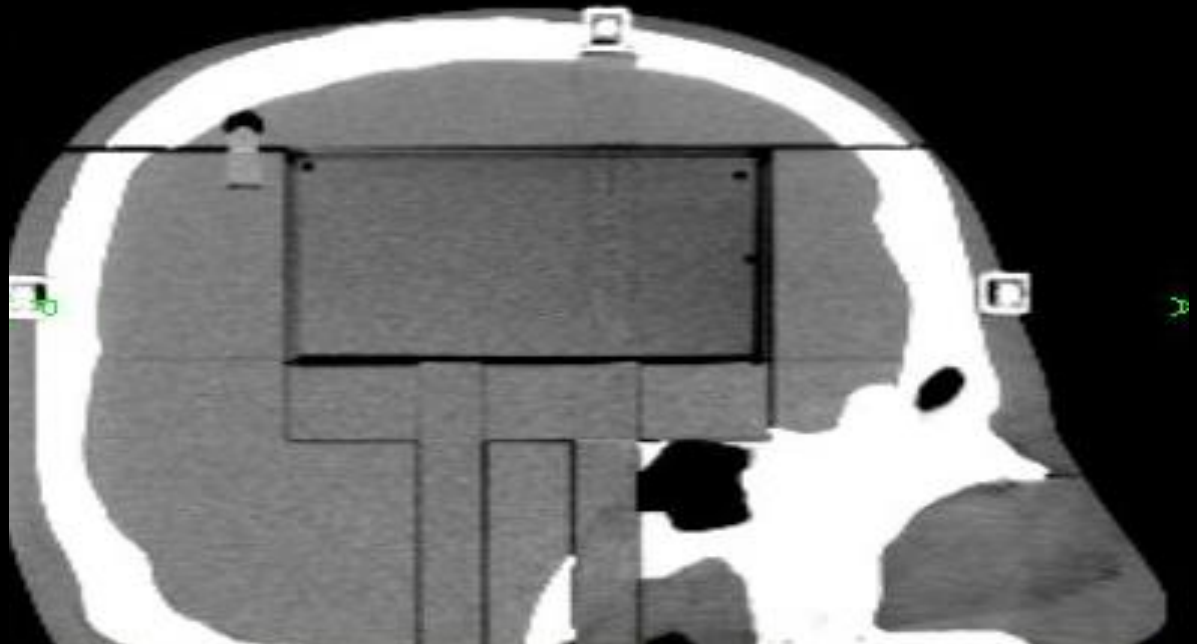
- Suitable detectors

STE$_2$EV Anthropomorphic phantom (CIRS, VI, USA)


TWO STEP 1


CIRS

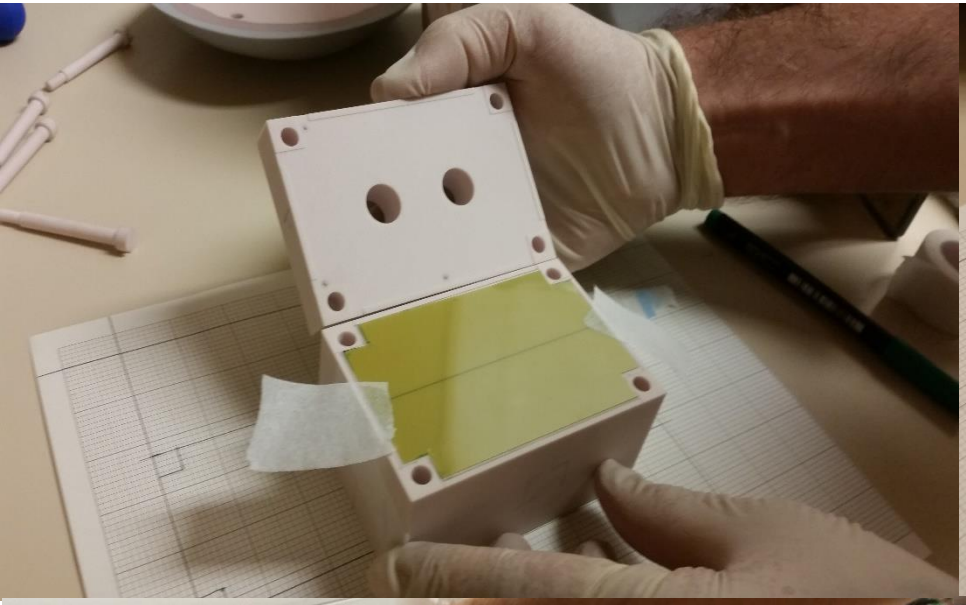
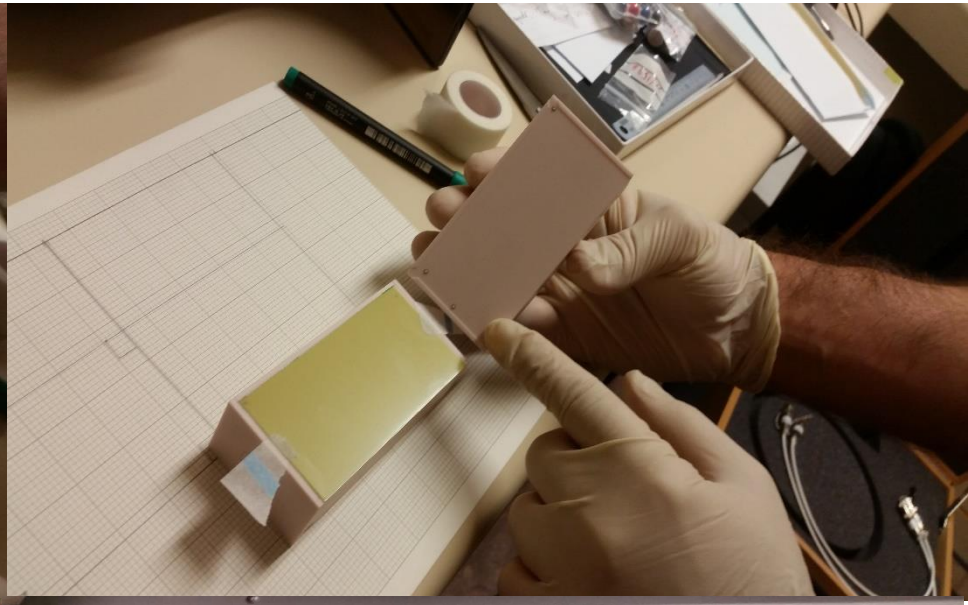
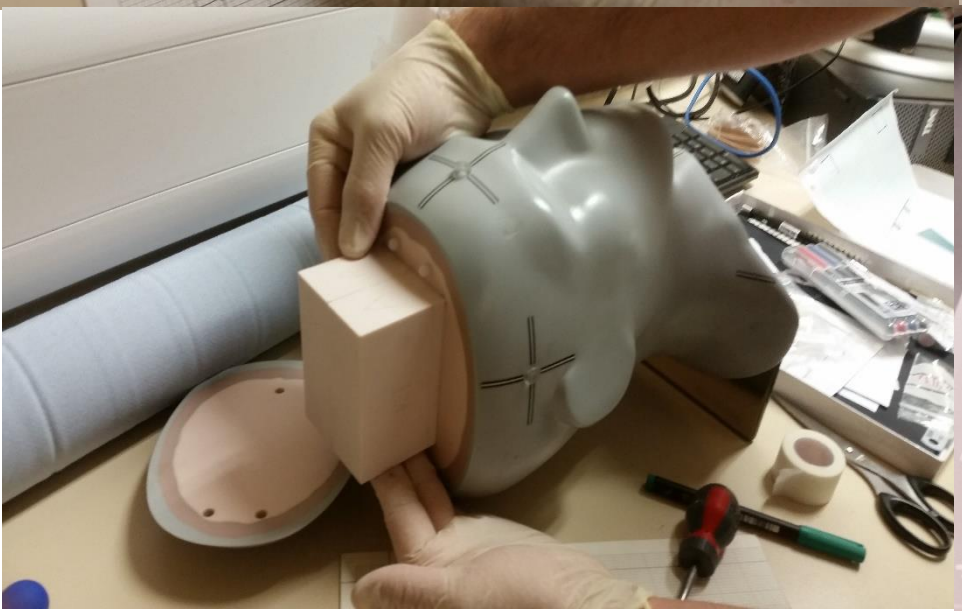
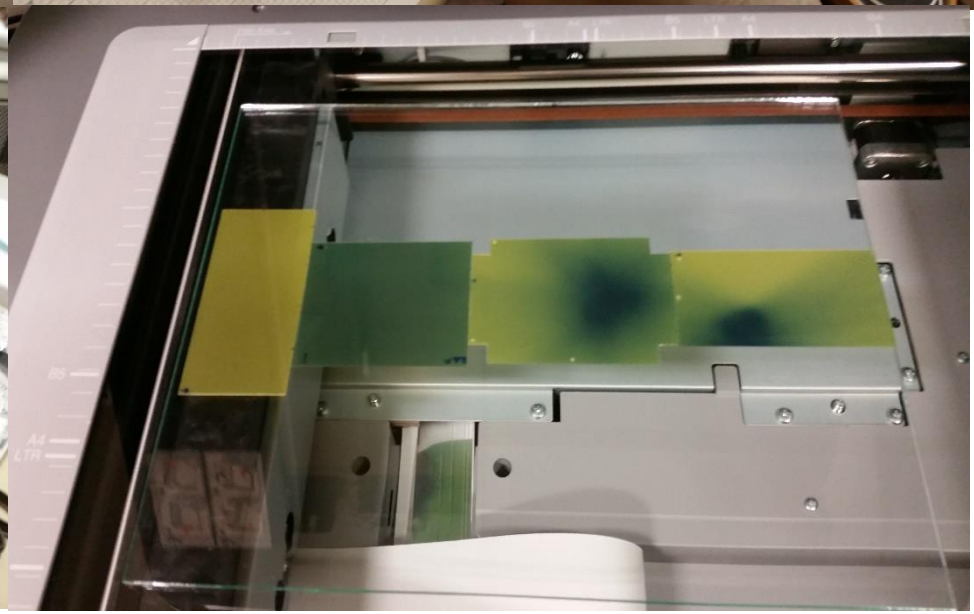




Methods

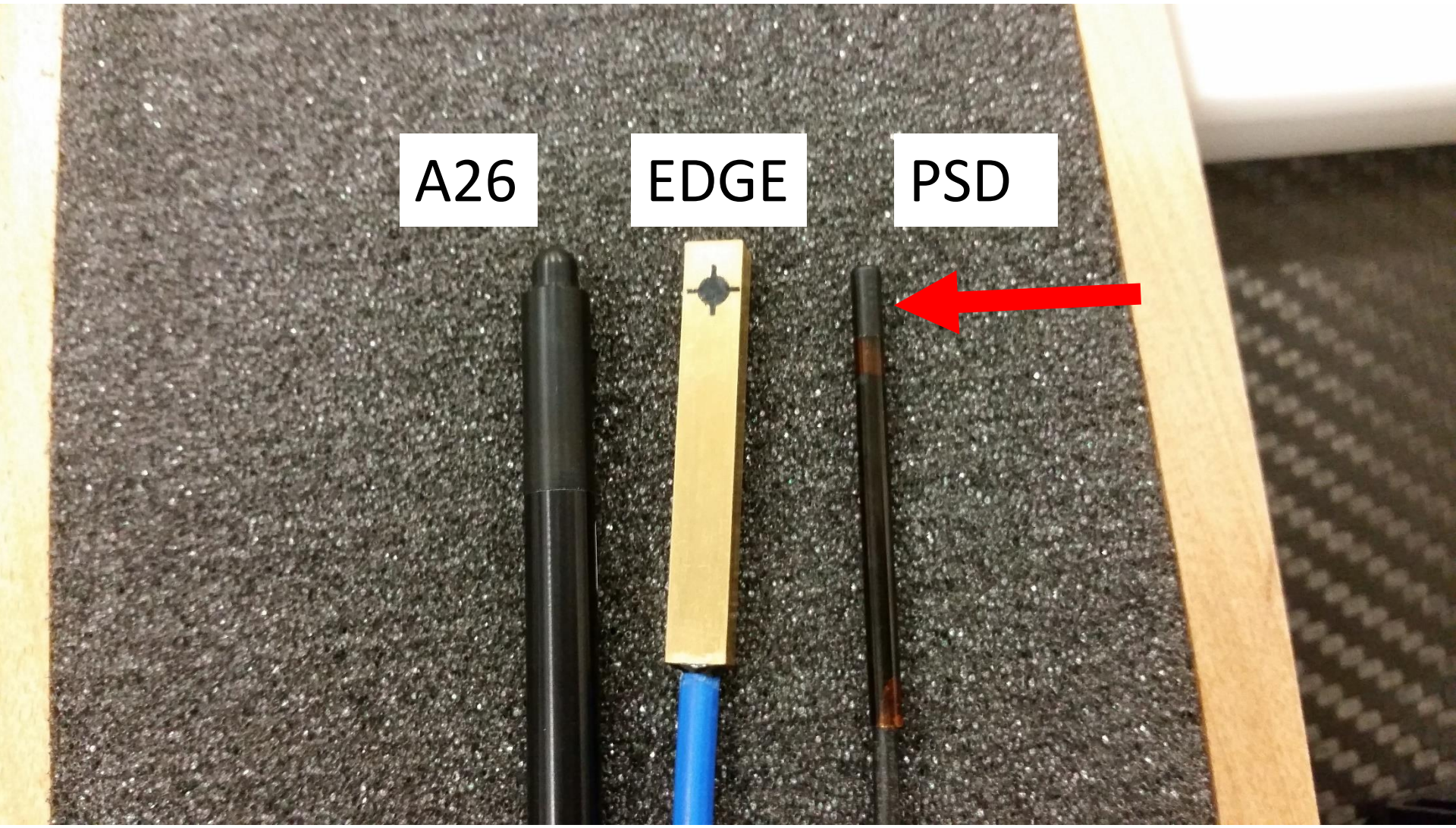
Detectors:

- Radiochromic film (Gafchromic EBT-3 or EBT-XD)
- Plastic Scintillation Detector (Exradin W1)
- Alanine

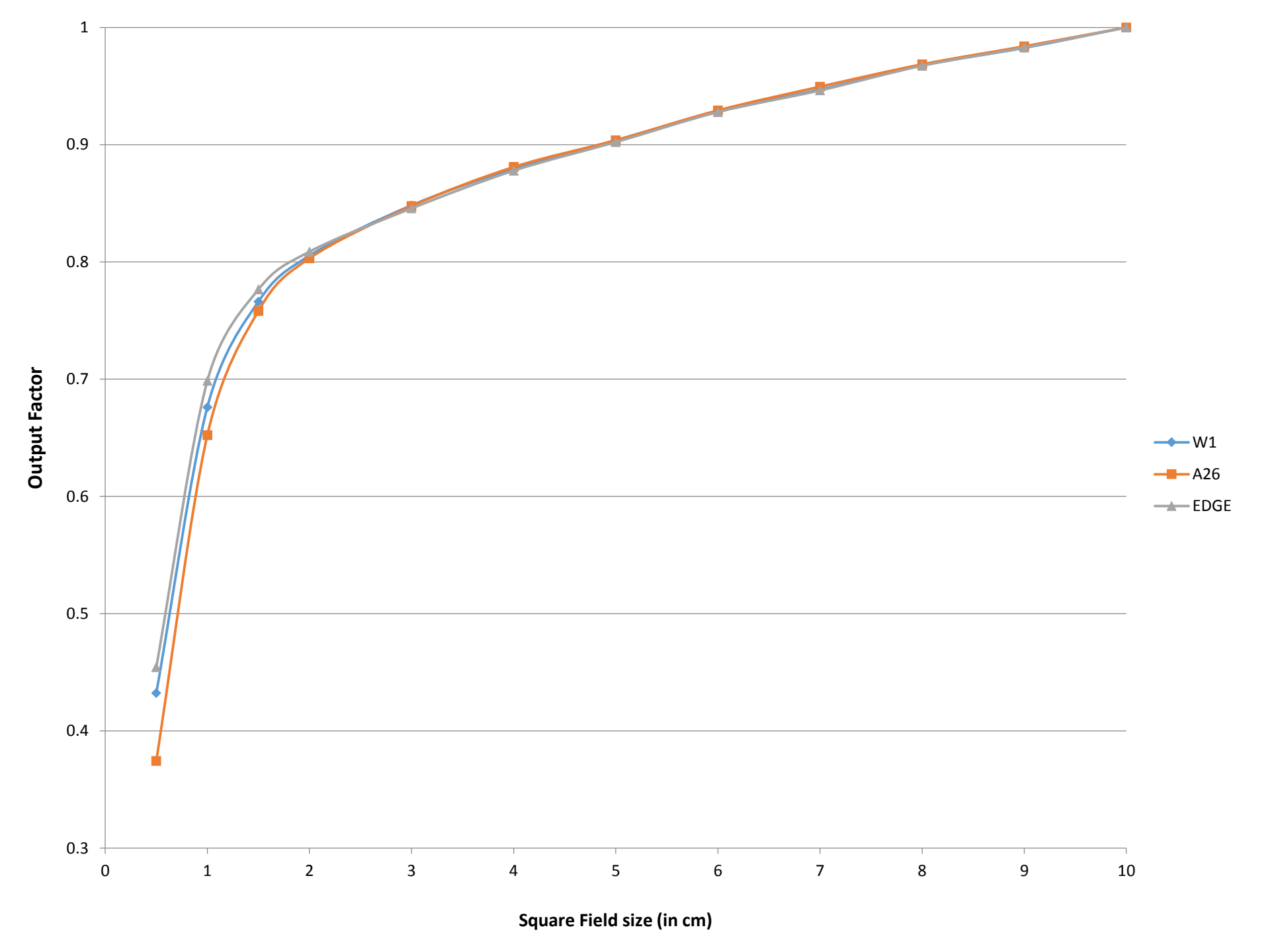
Gafchromic EBT-XD

Palmer, A., Dimitriadis, A., Nisbet, A. and Clark C.H. (2015) *Phys Med Biol* 21;60(22) 8741-52



Plastic Scintillation Detector (PSD)

Beierholm, A., Behrens, C.F. and Andersen, C.E. (2014) *Radiat. Meas*. 69, 50–56
Carasco et al. (2015) *Med. Phys*. 42, 297–304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0.8
0.7
0.6
0.5
0.4
0.3
0
1
2
3
4
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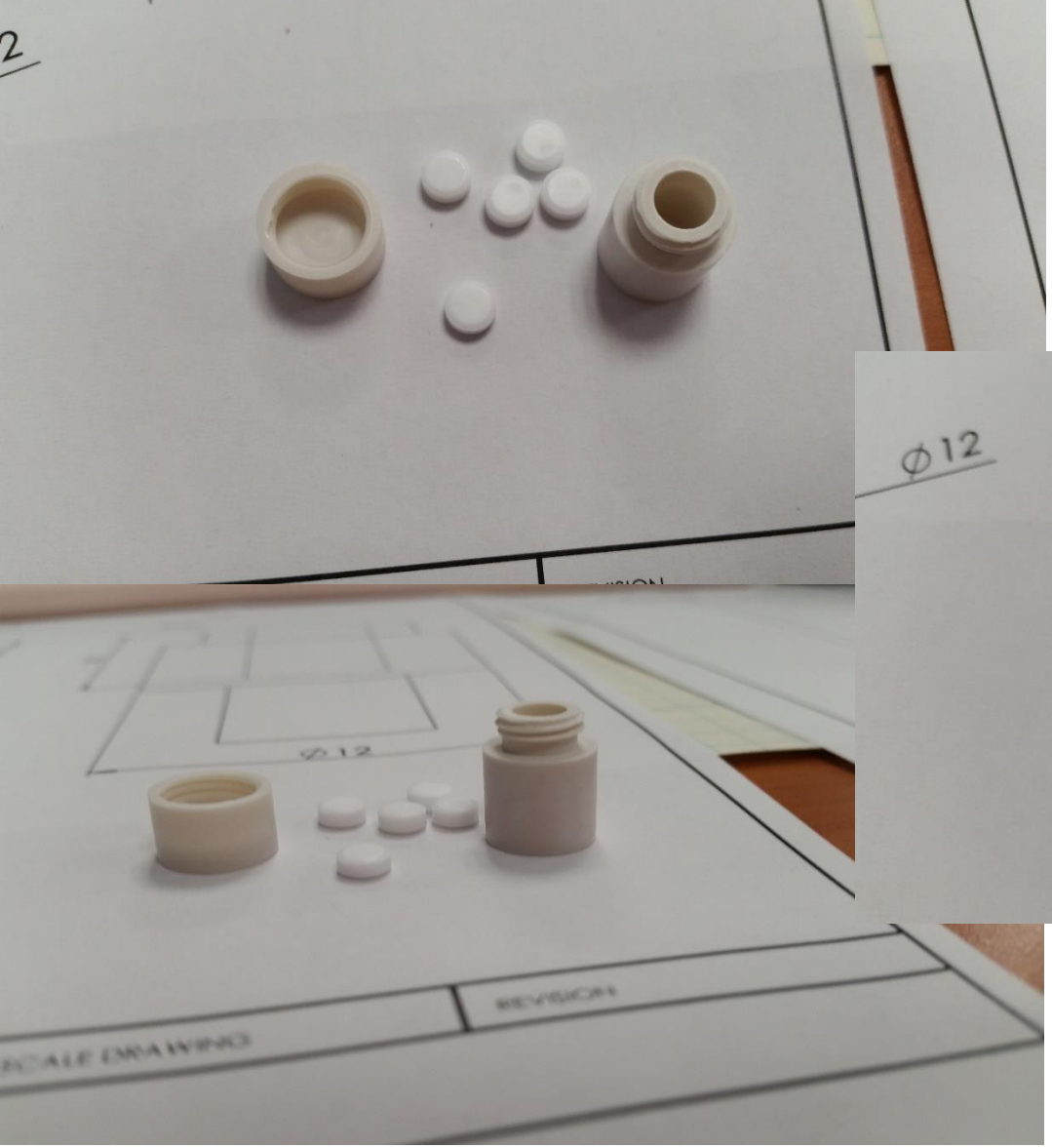
6
7
8
9
10
Square Field size (in cm)
W1
A26
EDGE



Alanine Pellets for measuring small photon fields

Hussein, M. *et al.* (2013) *Radiother. Oncol.* **108,** 78–85

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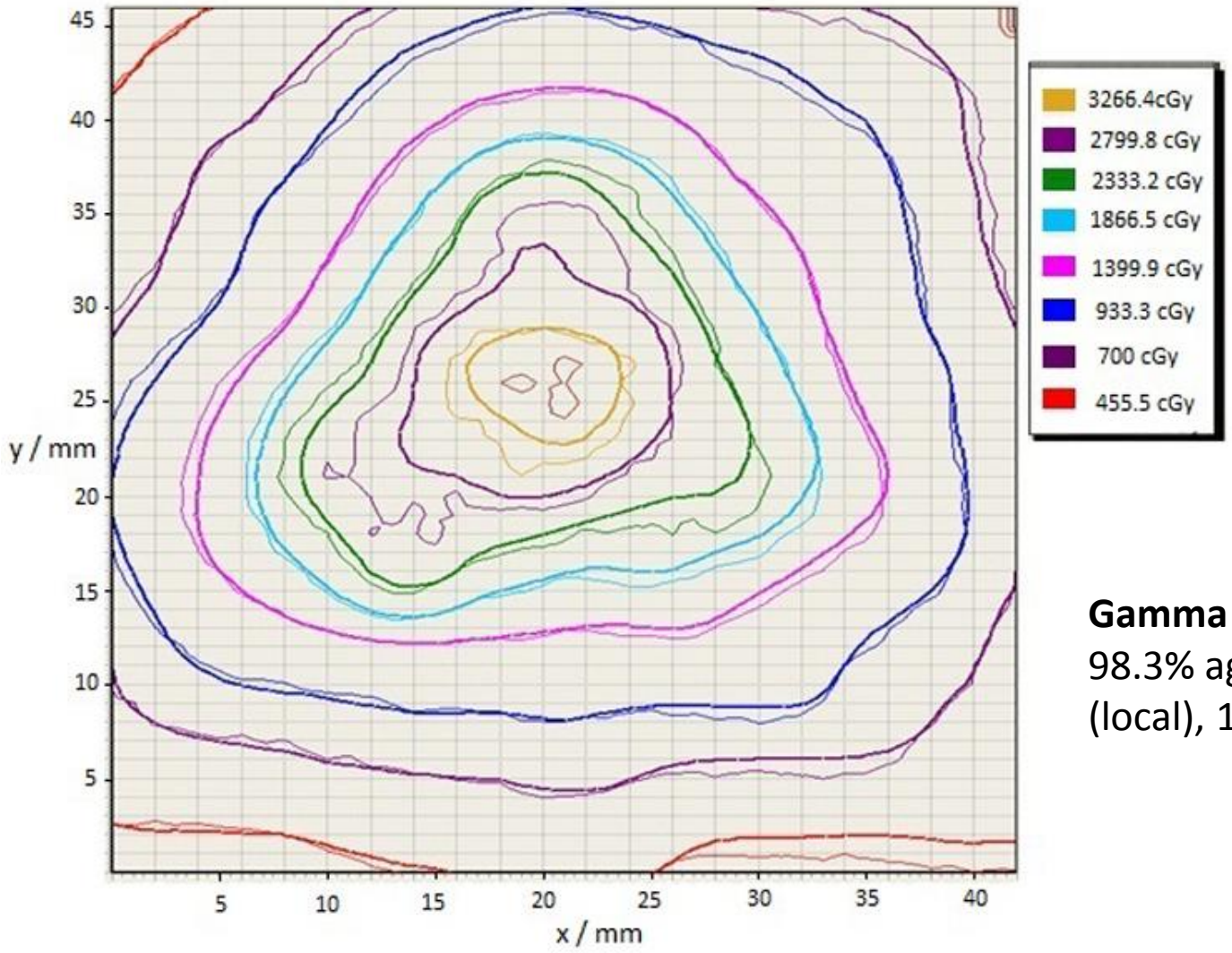
Results



Gamma analysis:
98.3% agreement at 3% (local), 1.5 mm criteria.

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Results

	Alanine		PSD	
Location	TPS (in Gy)	Alanine (in Gy)	TPS (in Gy)	PSD (in Gy)
Target 1	26.98	26.70	26.96	27.10
Target 2	26.64	26.32		
Target 3	26.07	25.80		
Target 4	25.43	24.95		
Location	TPS (in Gy)	Alanine (in Gy)	TPS (in Gy)	PSD (in Gy)
OAR 1	2.64	2.90	2.73	2.95
OAR 2	2.92	3.14		
OAR 3	3.15	3.21		
OAR 4	3.24	3.35		

Absolute dose comparisons between TPS and detectors in **agreement within +/- 0.3 Gy**

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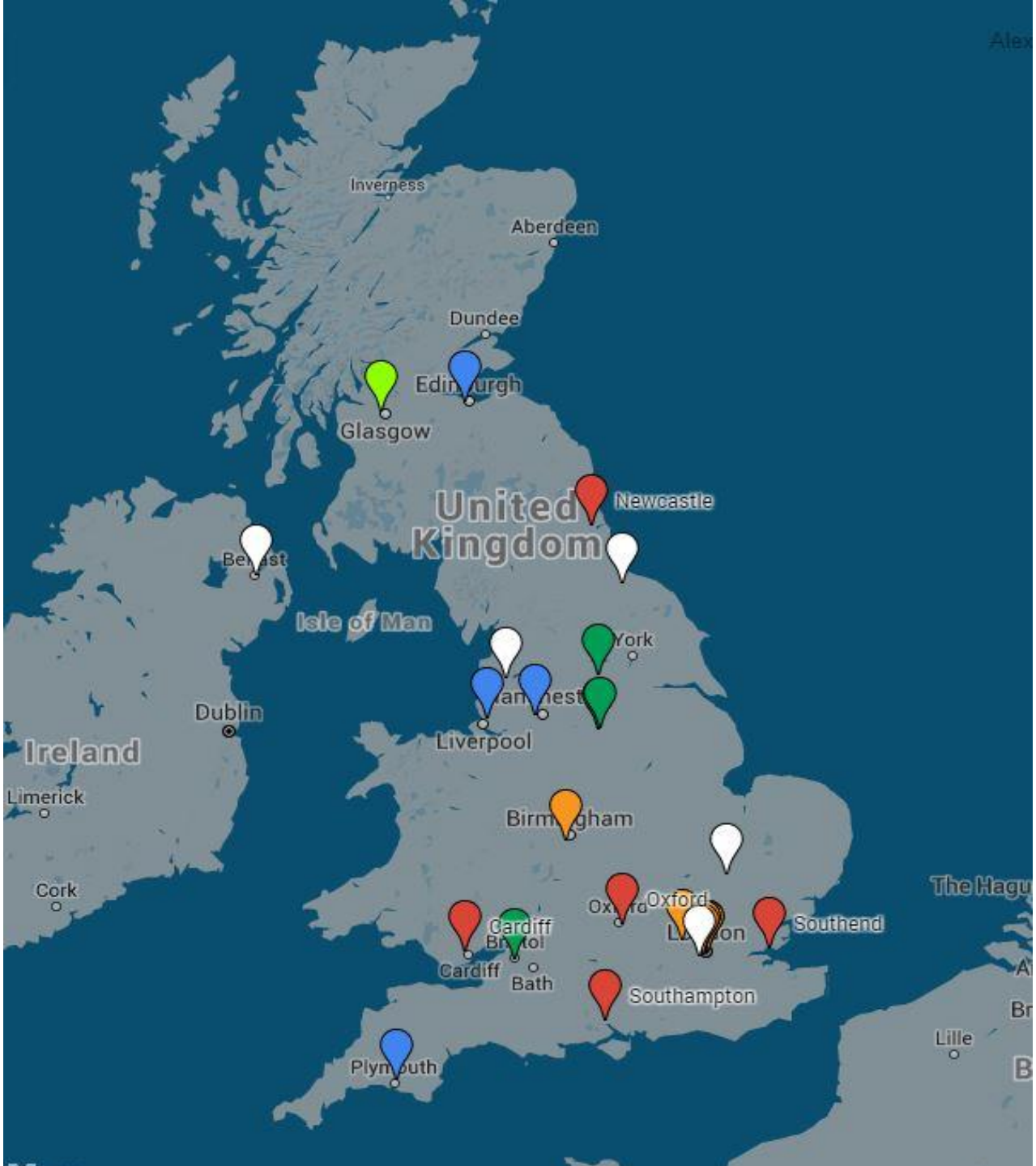
Conclusions

- Suitable methodology for dosimetric assessment
- Tested on GK, CK and LB platforms

Future work

- Visit 2 more centres to complete pilot study
- Develop methodology for assessing the geometric accuracy
- Go on tour!


Inverness
Aberdeen
Dundee
Glasgow
United Kingdom
Newcastle
Isle of Man
York
Dublin
Liverpool
Ireland
Limerick
Cork
Cardiff
Bath
Oxford
Southend
Southampton
Lille

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- Spiegel, E., Wycis, H. T., Marks, M. & Lee, A. J. Stereotaxic apparatus for operations on the human brain. *Science 80;*106, 349–350 (1947).