

Purpose

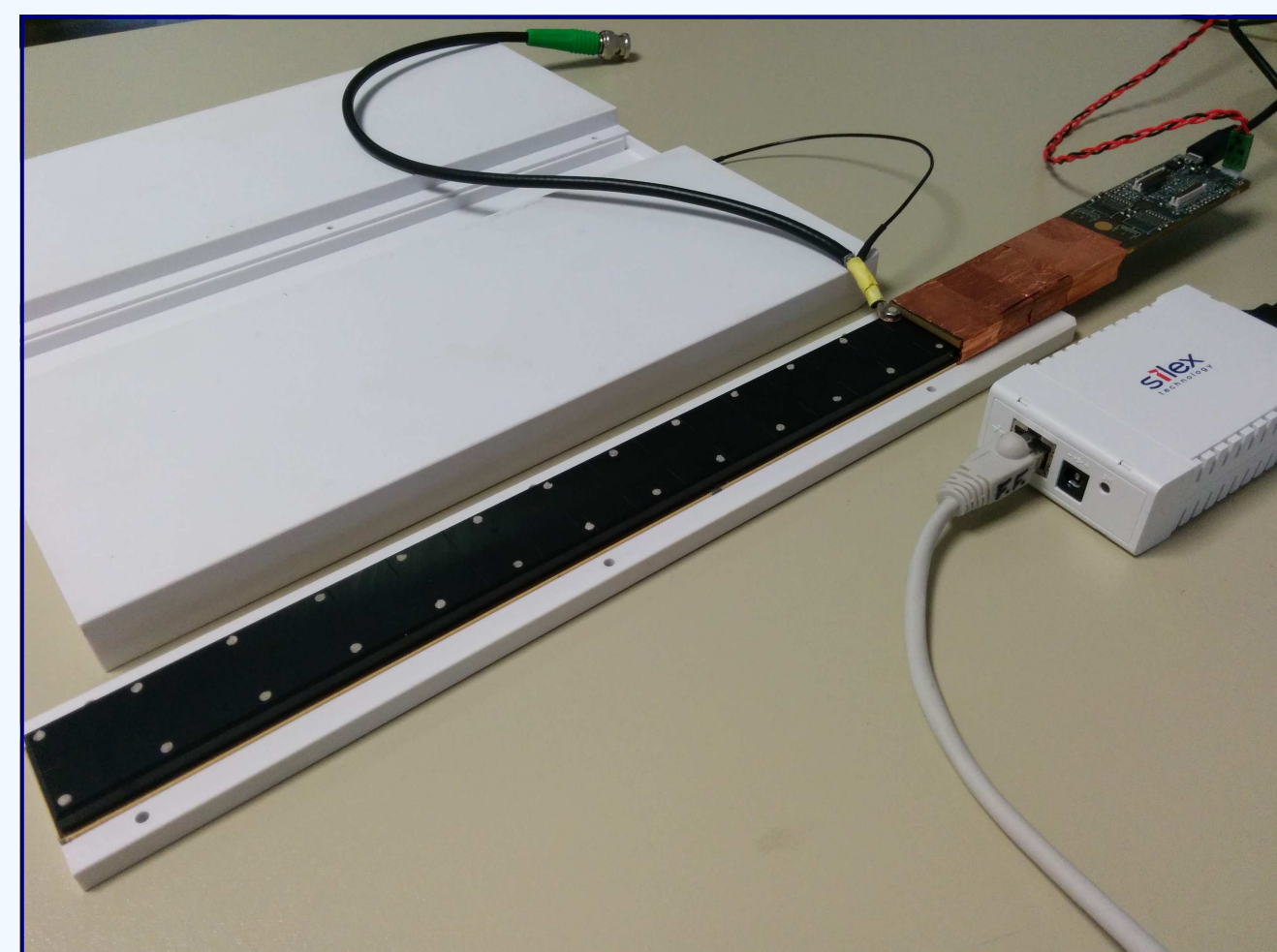
To characterize a new air vented ionization chamber technology for advanced external beam radiation therapy. Main technological features are:

- high spatial resolution;
- independence of sensitivity on dose per pulse;
- high long term stability.

Detector

A linear array of air vented ionization chambers pre-developed by IBA Dosimetry, featuring 80 pixels with 3.5mm spatial resolution and 4mm³ nominal sensitive volume.

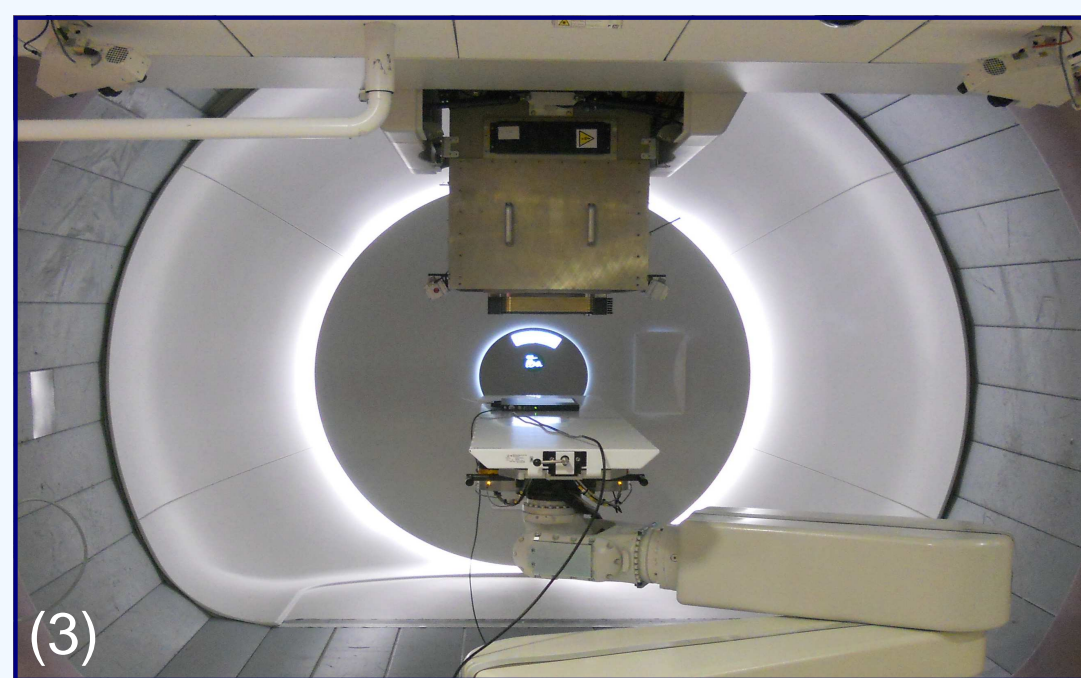
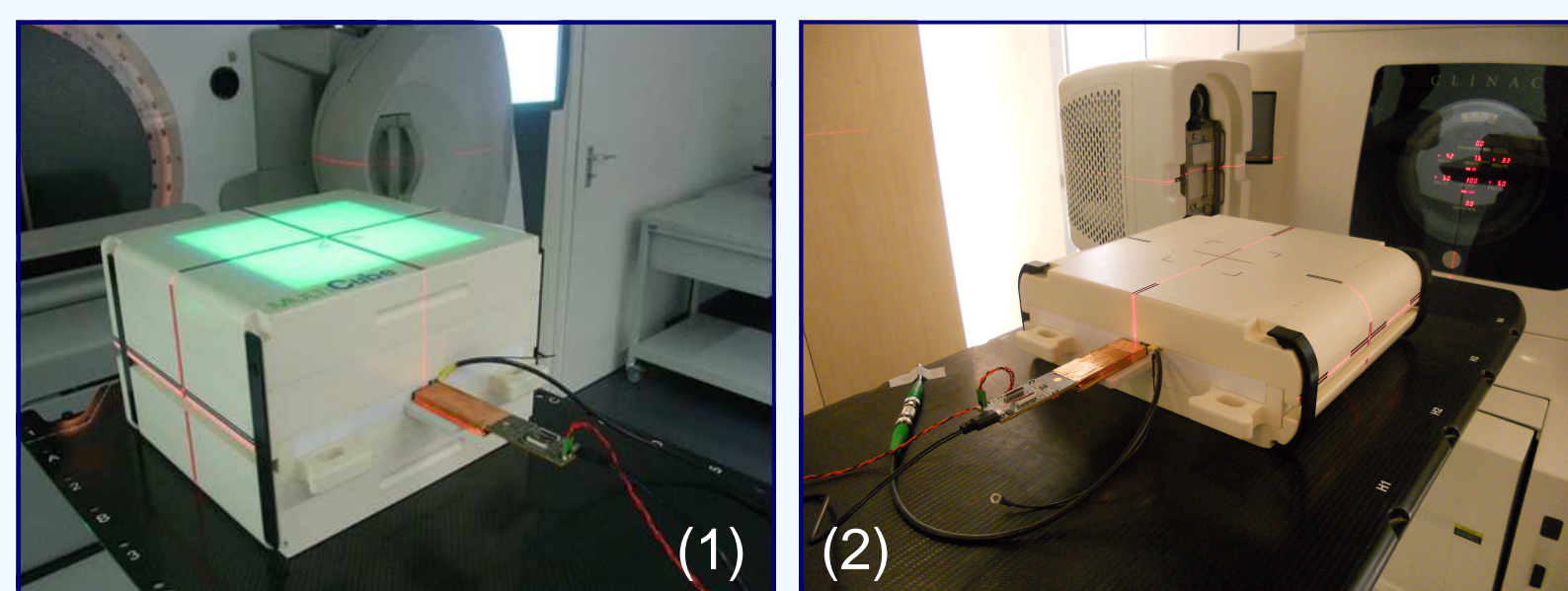
The detector is coupled with low noise electronics (down to 0.4fC).



Facilities

Characterization in a PMMA phantom at:

1. IBA Dosimetry DosLab (Schwarzenbrück, Germany): Elekta Agility linac & ⁶⁰Co Terabalt;
2. Klinikum rechts der Isar, TUM (München, Germany): Varian Trilogy linac;
3. Proton Therapy Center Czech s.r.o. (Prague, Czech Rep.): IBA Protheus 230 cyclotron.



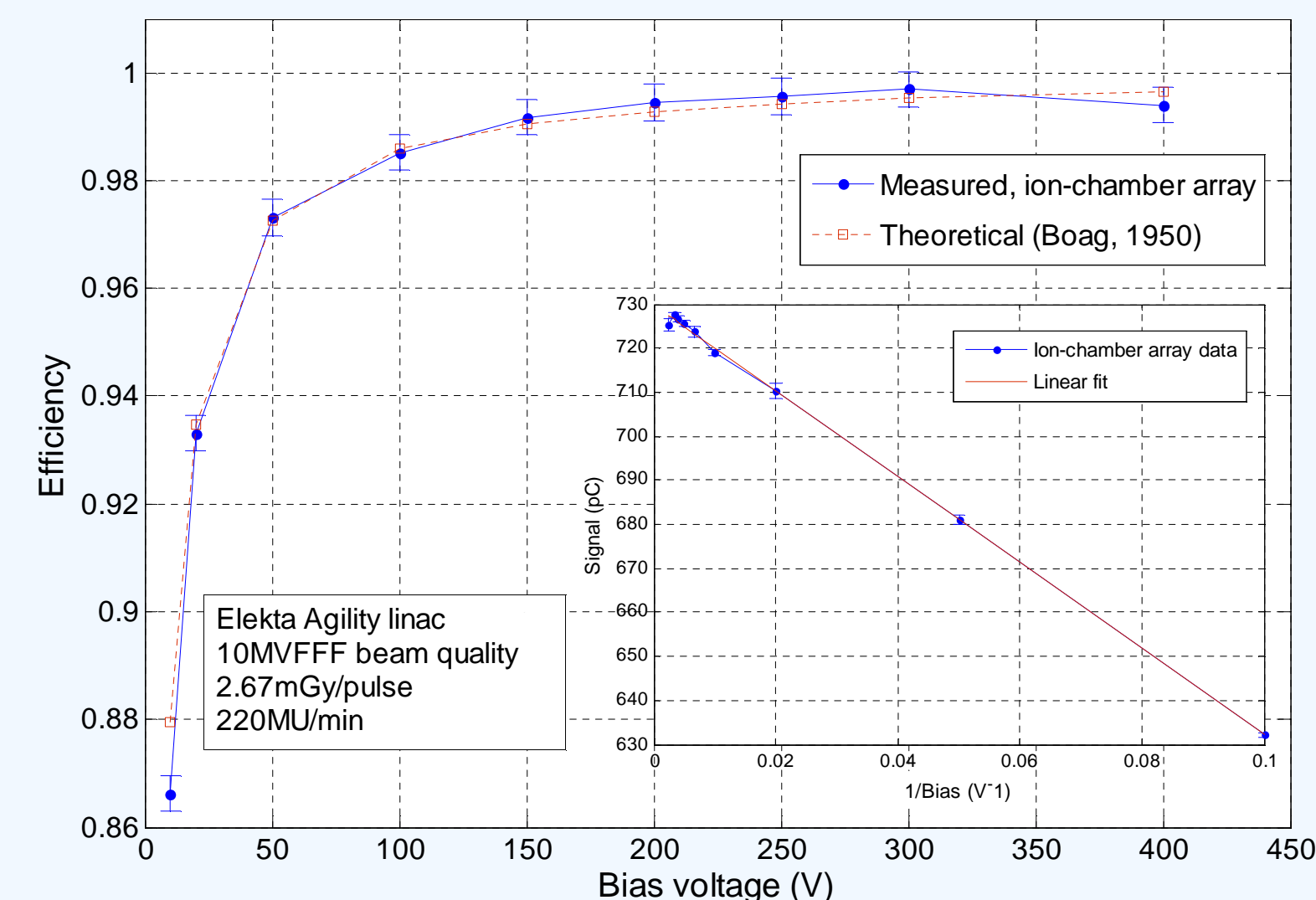
Results

(a) Charge collection efficiency and sensitivity dependence on dose per pulse.

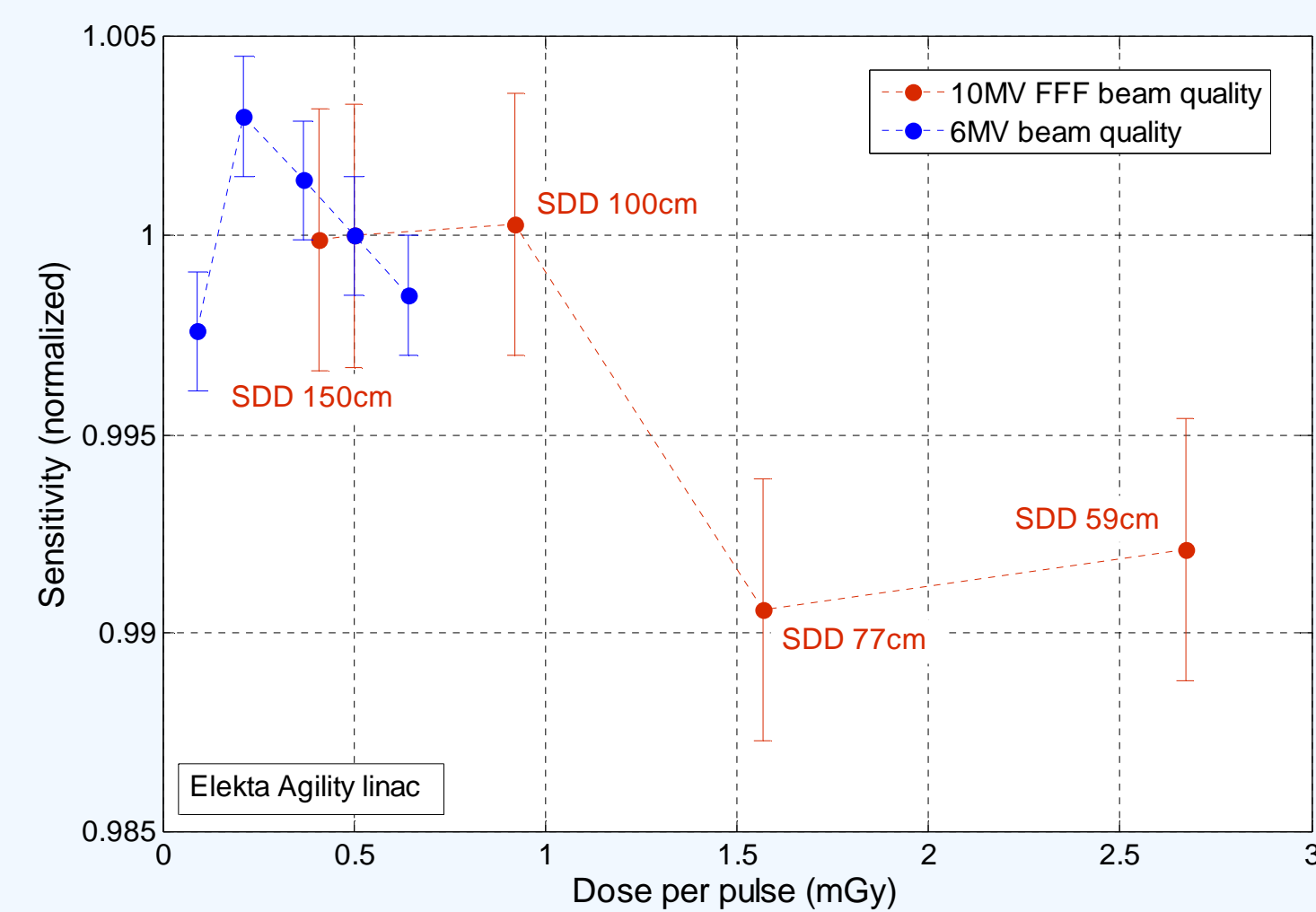
For 2.67mGy/pulse:

- charge collection efficiency is higher than 99% already at 150V;
- reaching 99.5% ± 0.3% at 250V.

Very good agreement with Boag's analytical model [1][2].

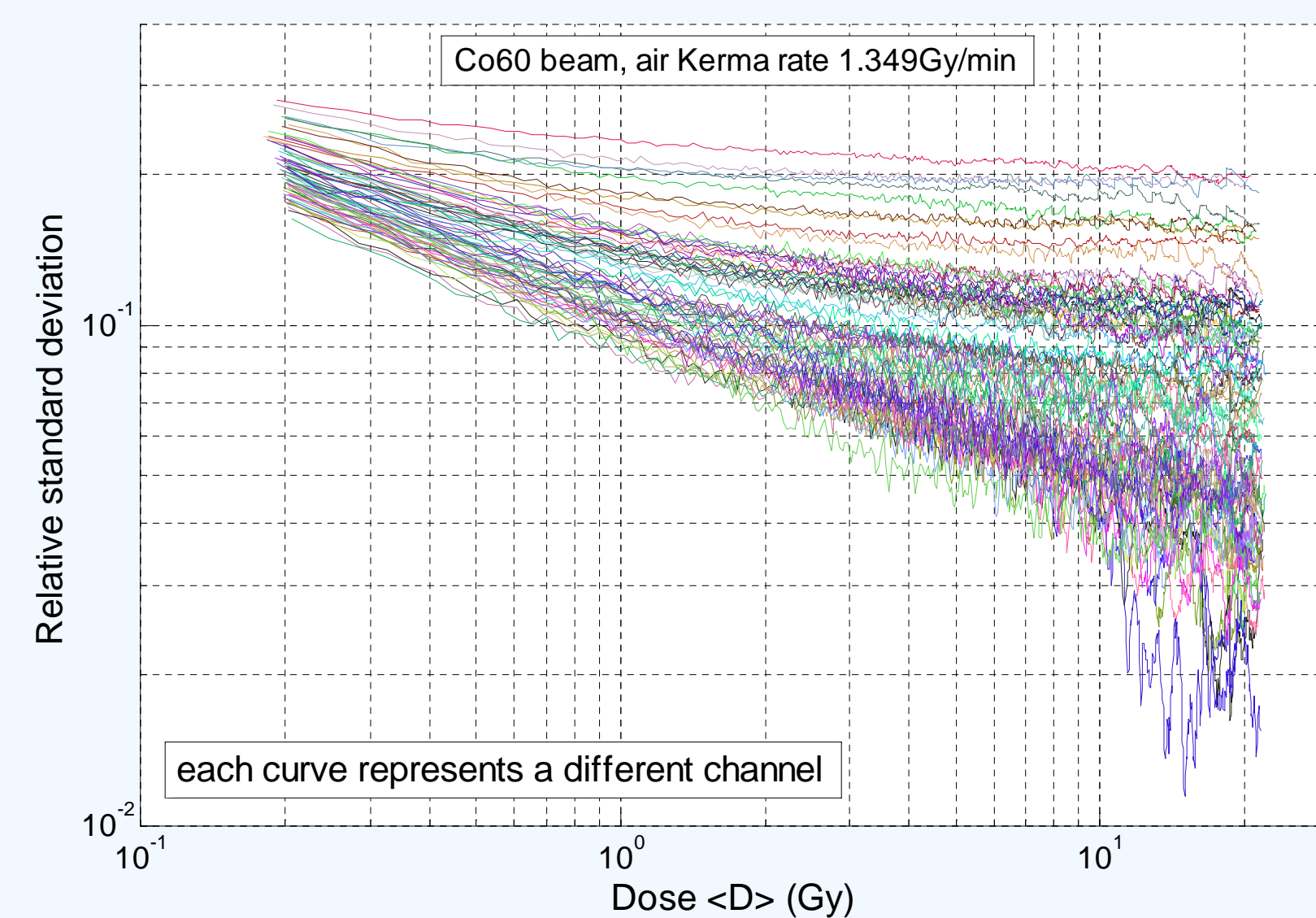


±0.8% sensitivity change on dose per pulse in the range 0.09÷2.67mGy/pulse (covering both flattened and unflattened applications).



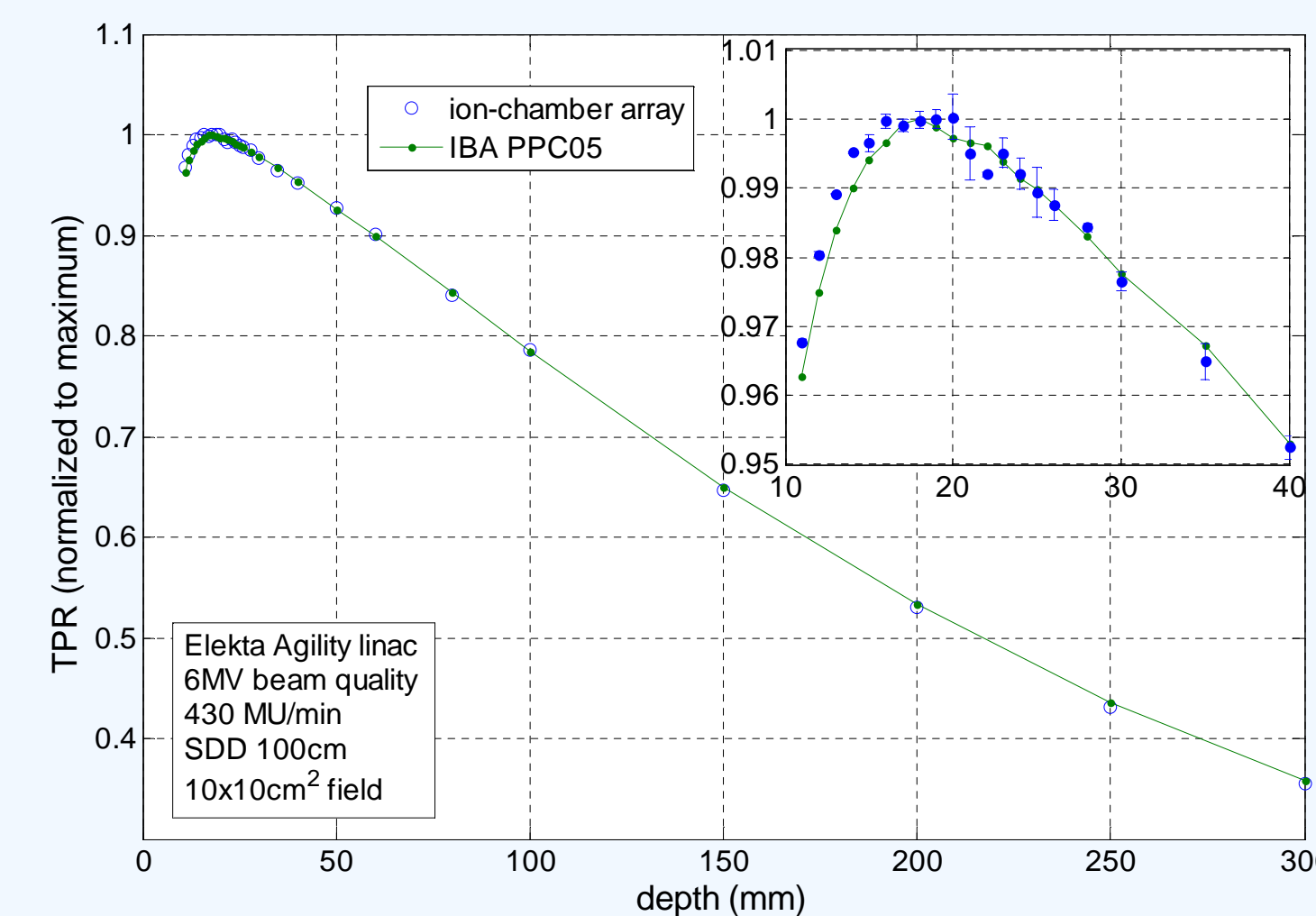
(b) Repeatability.

Repeatability better than 0.4% for all the pixels down to 0.2Gy.



(c) Tissue Phantom Ratio measurement.

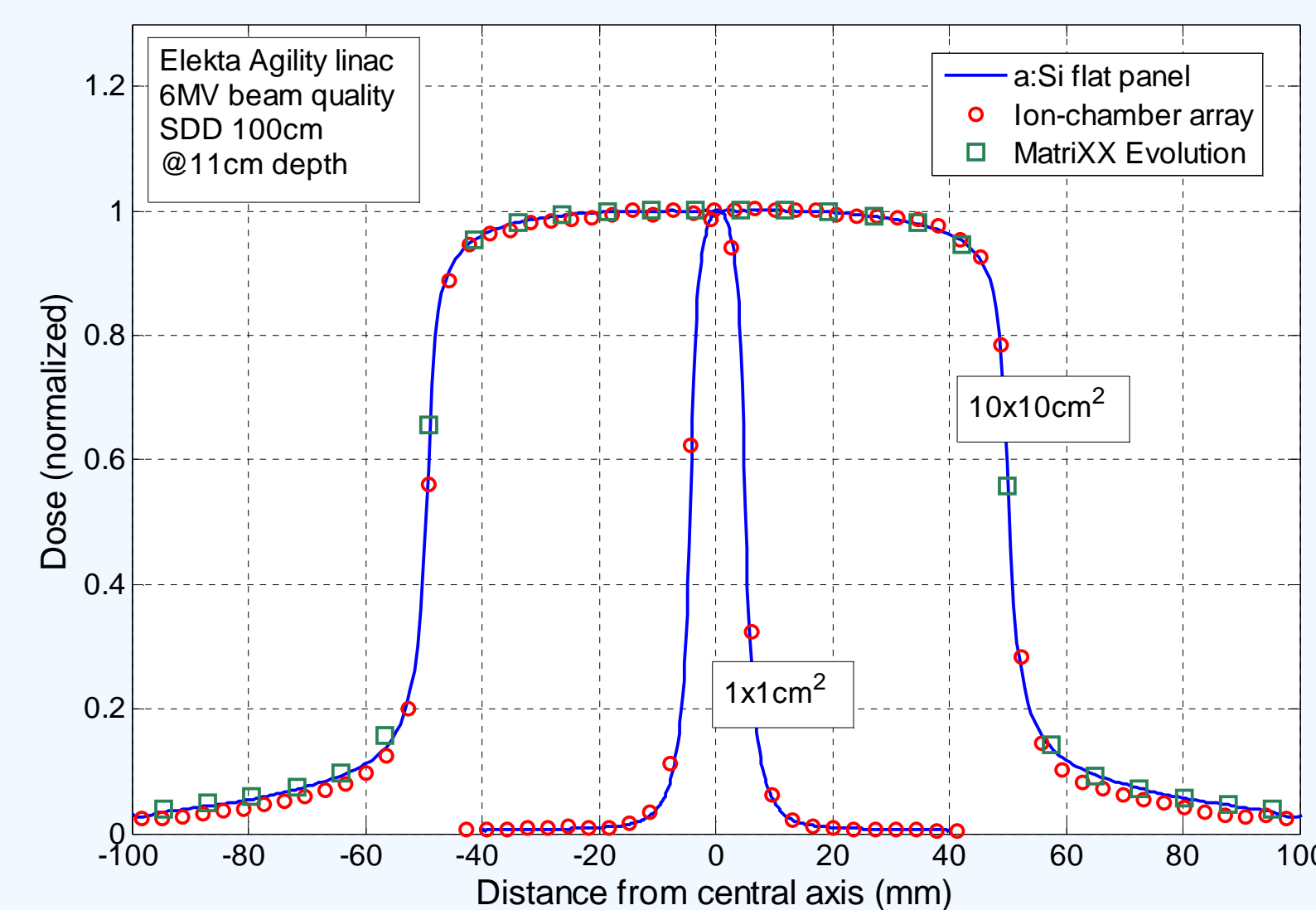
Very good agreement with PPC05 parallel plate chamber (better than 0.5%) at every depth of measurement.



(d) Beam profiles (photons)

Complete agreement with reference detectors:

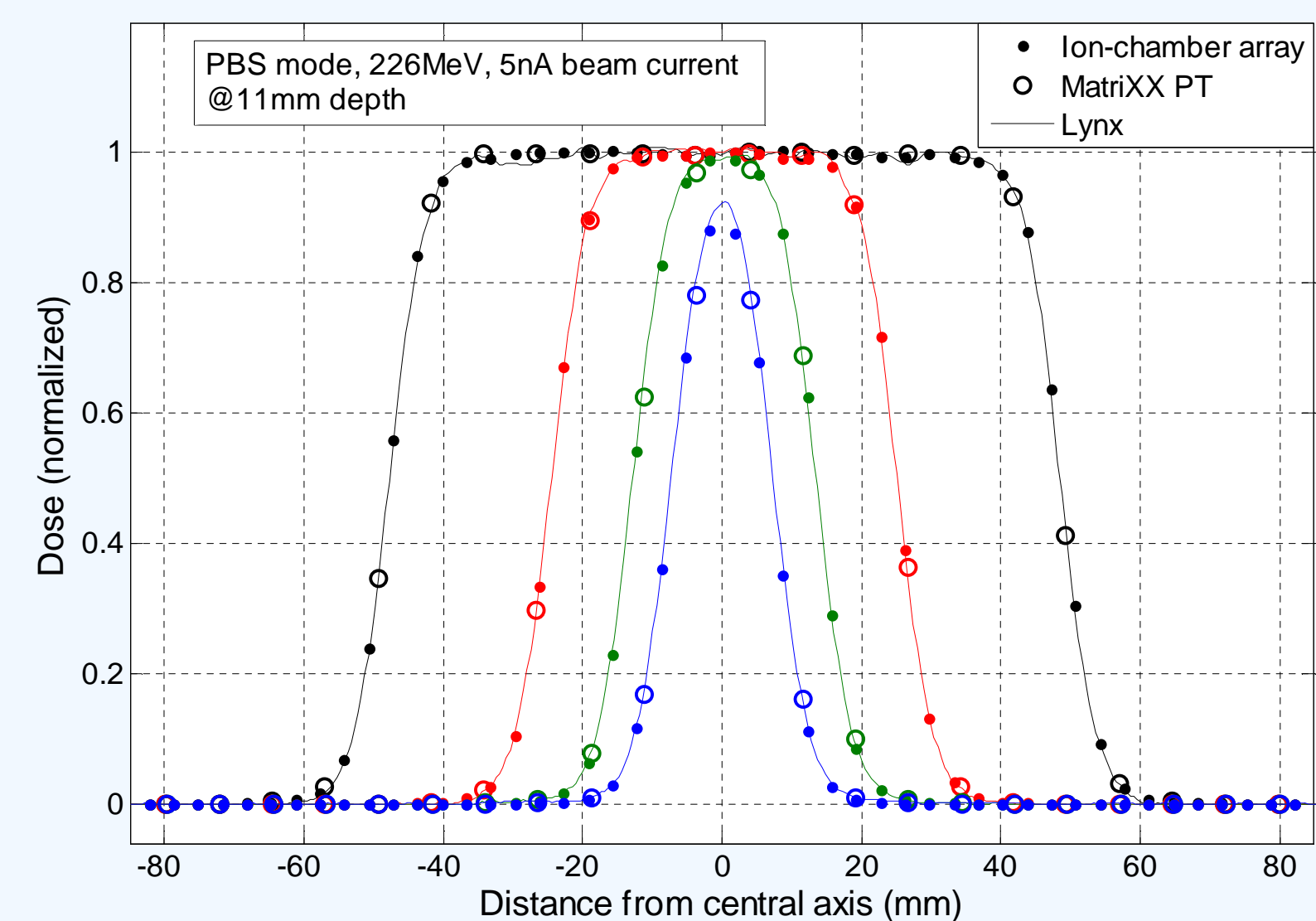
- MatriXX^{Evolution} (IBA Dosimetry): air IC array, 7.6mm resolution;
- a:Si flat panel optimized for dosimetry, 0.2mm resolution.



(e) Beam profiles (protons)

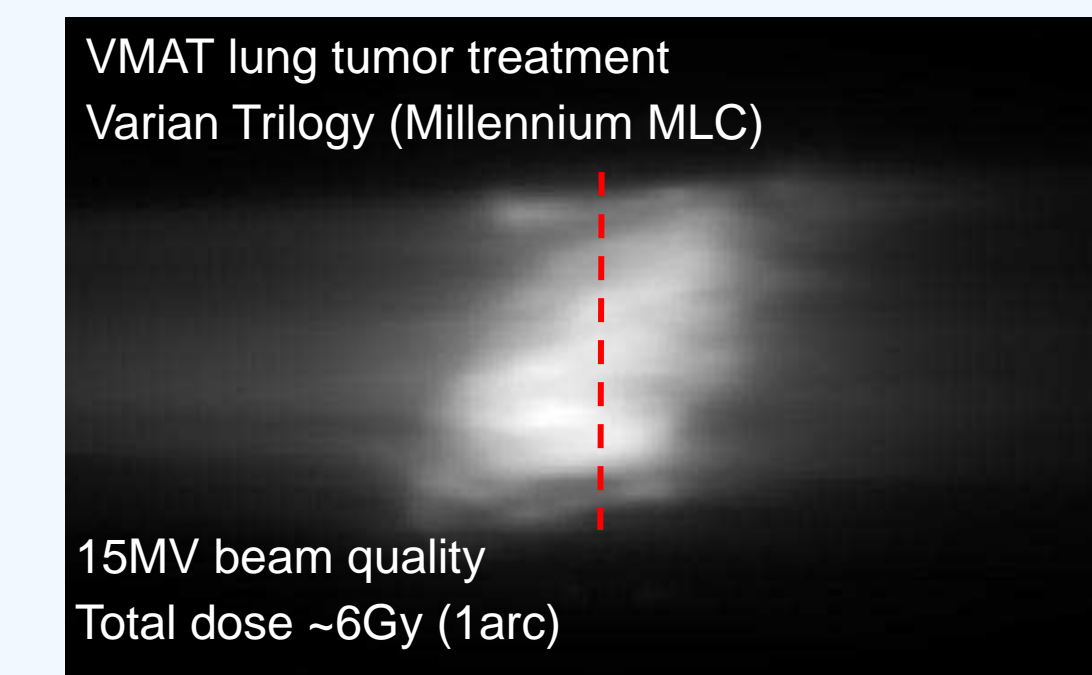
Excellent penumbra definition in PBS (*Pencil Beam Scanning*) proton dose maps. Reference detectors:

- Lynx (IBA Dosimetry): scintillator based, 0.5mm resolution;
- MatriXX PT (IBA Dosimetry): air IC array for PT applications, 7.6mm resolution.

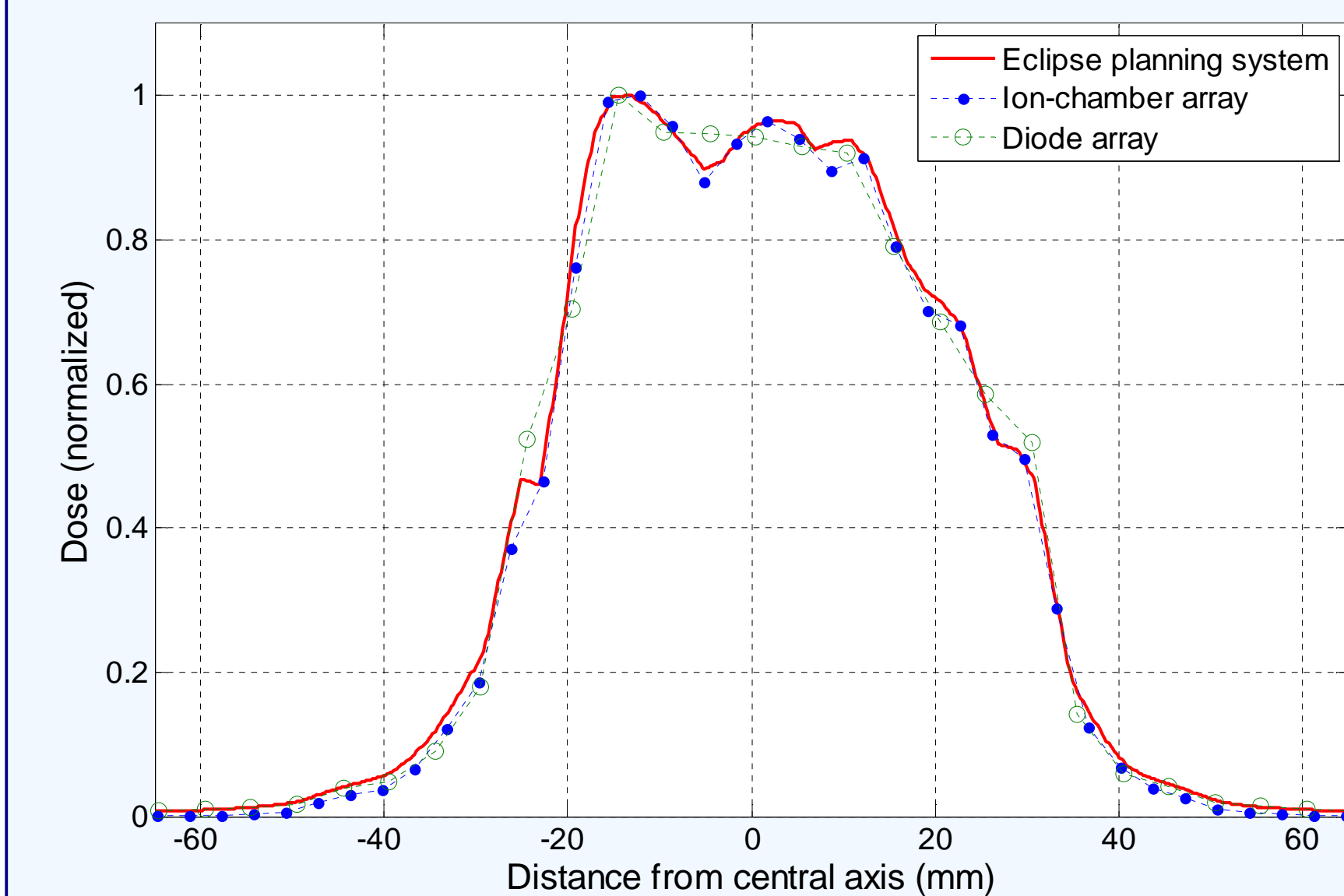


(f) Treatment plan verification.

Analysis of 1D dose distribution (along the red dashed line):



- good agreement with dose from planning system;
- slightly better performances than a commercial solution (diode based array, 7mm detector spacing).



Conclusions

The array represents a valuable tool to characterize external radiotherapy beams (including unflattened photons and proton beams) due to:

- high spatial resolution associated with air vented ion-chamber technology;
 - sensitivity independent from dose per pulse and dose rate.
- Encouraging results suggest the extension of this technology to 2D detectors.

References, Acknowledgements & Affiliations

- [1] Boag, *Brit. Journ. Rad.*, 1950, xxiii, 601.
- [2] Boag et al, *Brit. Journ. App. Phys.*, 1952, iii, 222.

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