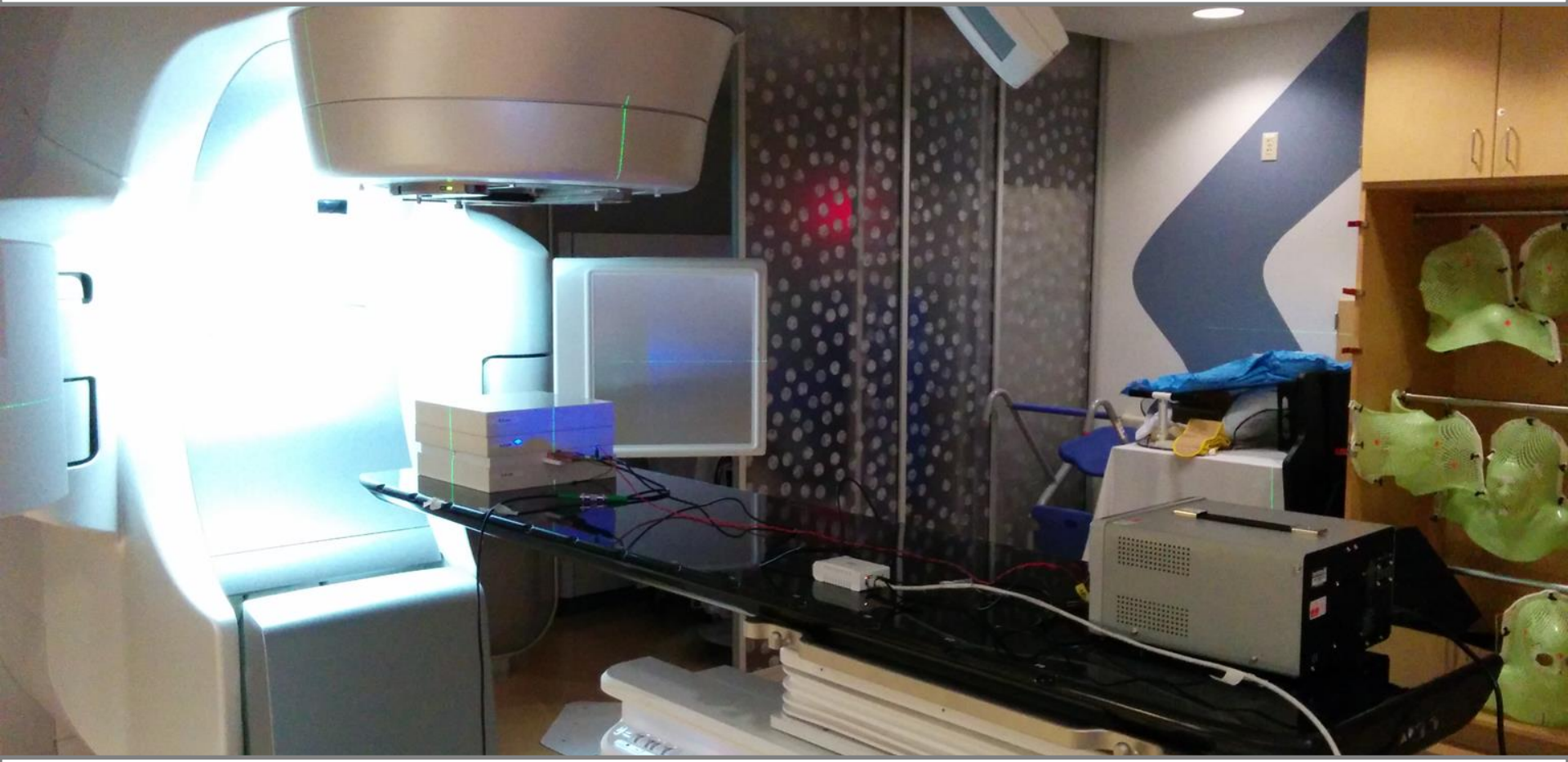
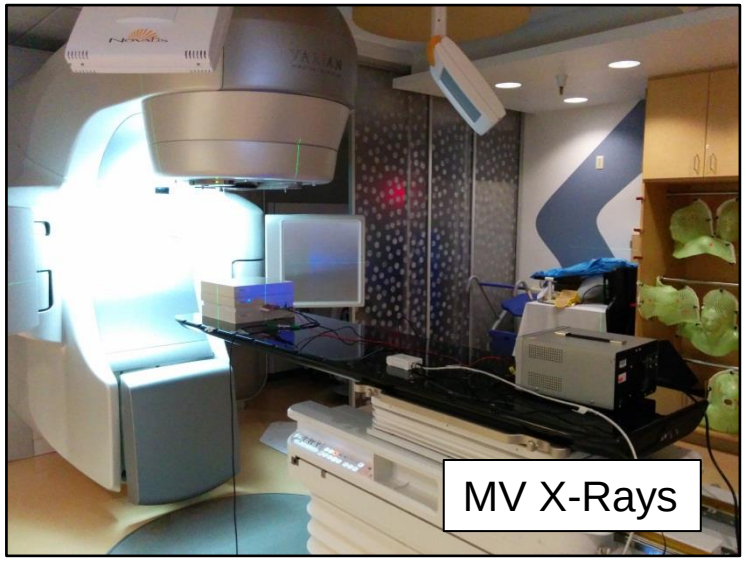
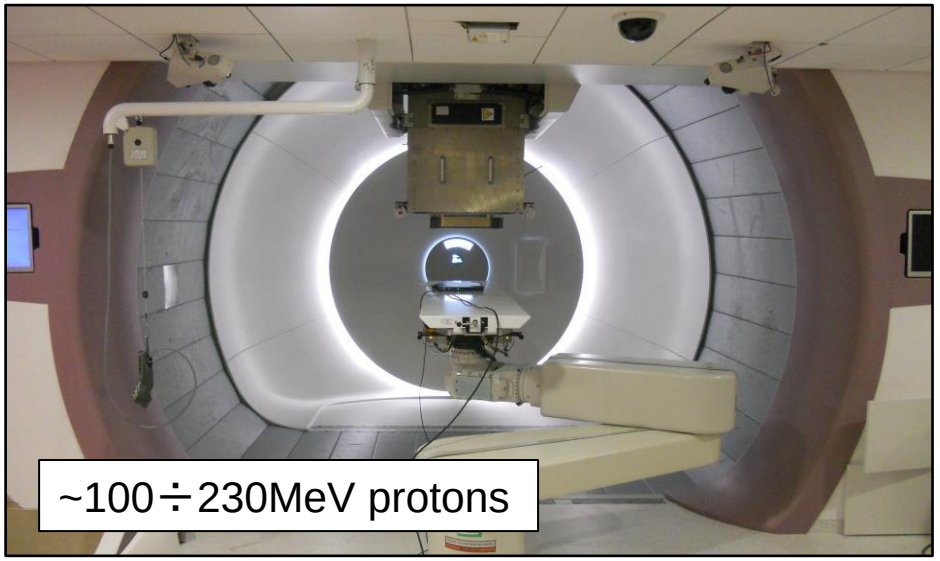
Ionization Chamber Array for External Beam Radiotherapy

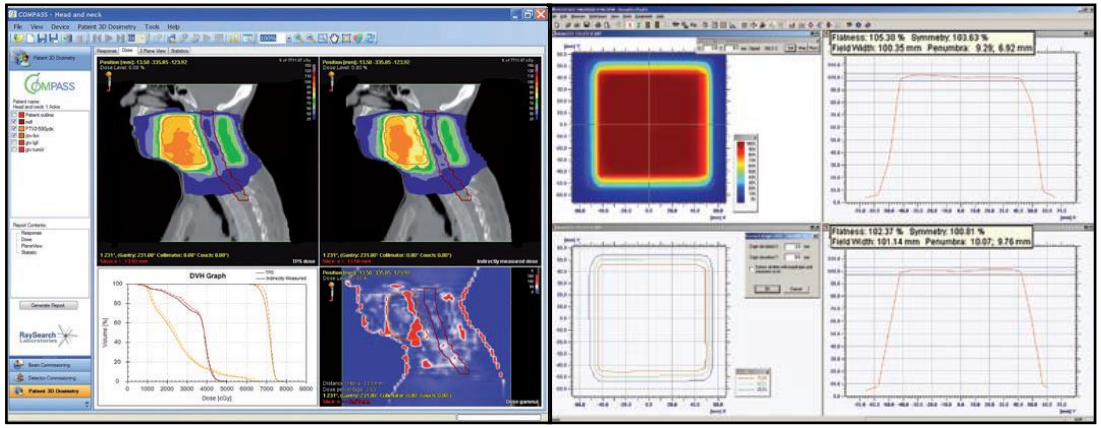


Project goal

A short summary







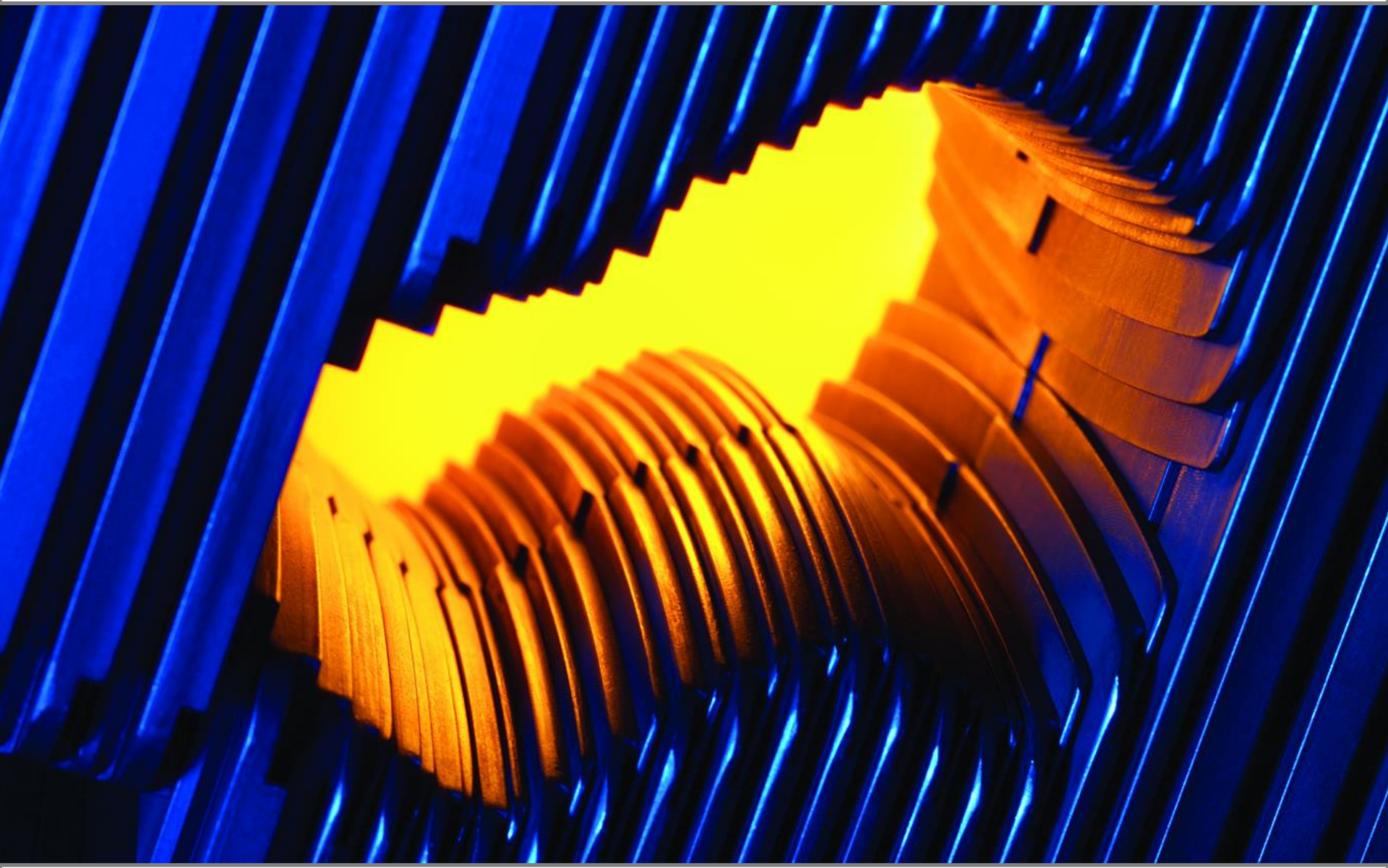
- Absolute dose measurement
- Machine quality assurance
- Patient quality assurance

Outline

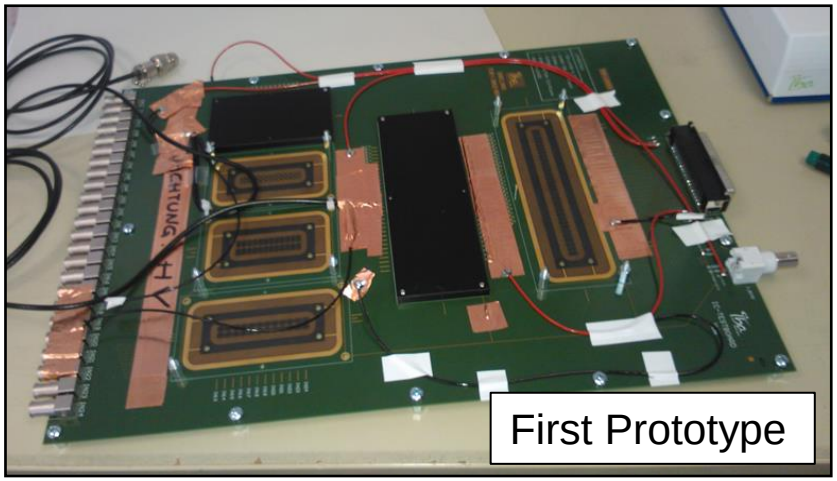
- Experimental Activity
  - Characterization at IBA DosLab
  - Characterization at Klinikum rechts der Isar & University of California (San Francisco)-Radiation Oncology dep.
  - Characterization at Proton Therapy Center Czech s.r.o.

- Ongoing activities and future work
- ARDENT project: trainings, conferences, secondments

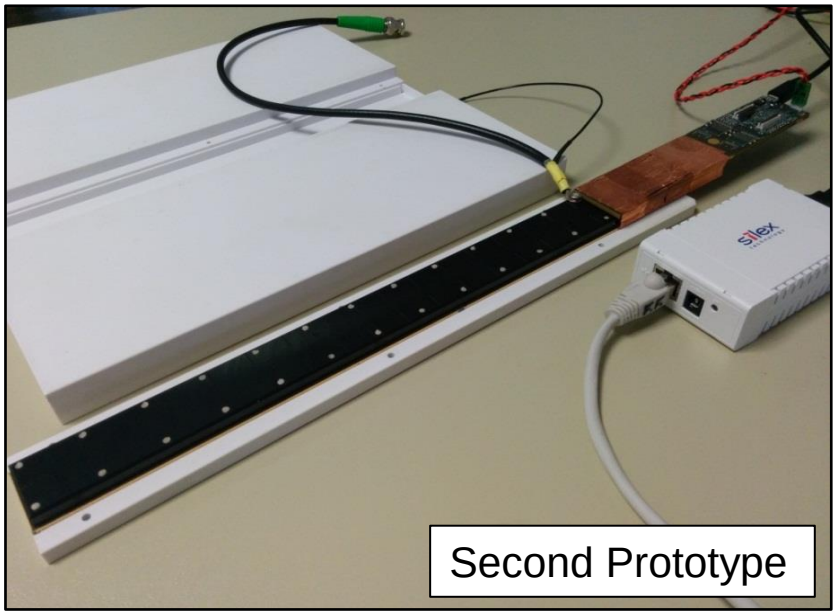
Experimental Activity



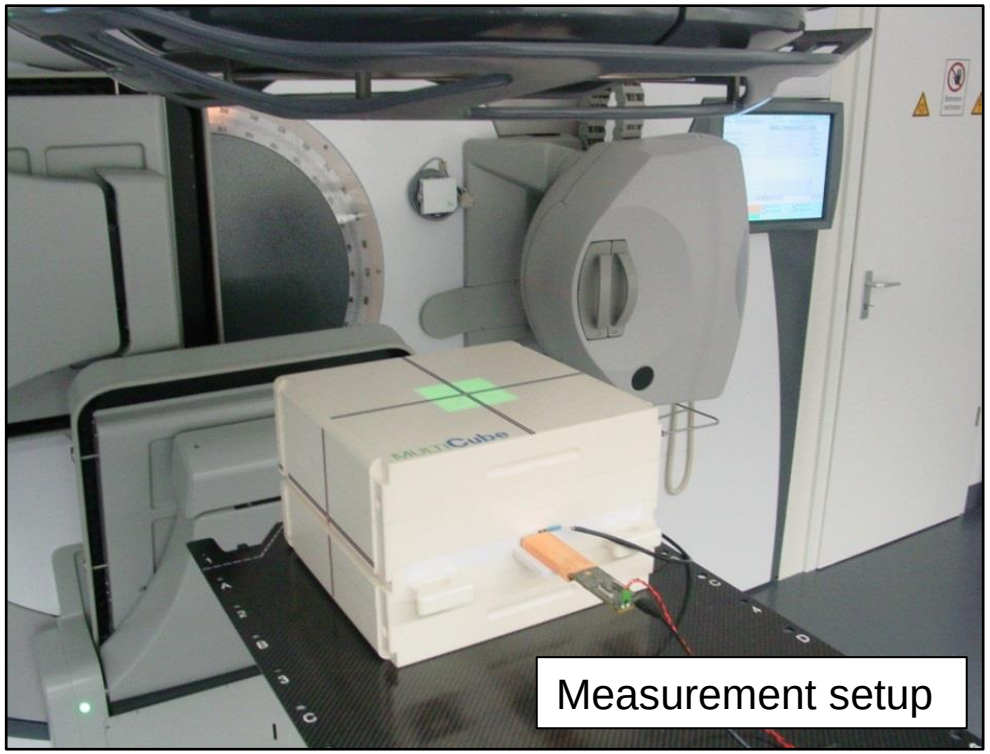
Detector evolution



First Prototype



Second Prototype



Measurement setup

- 80 ionization chambers, 3.5mm pitch

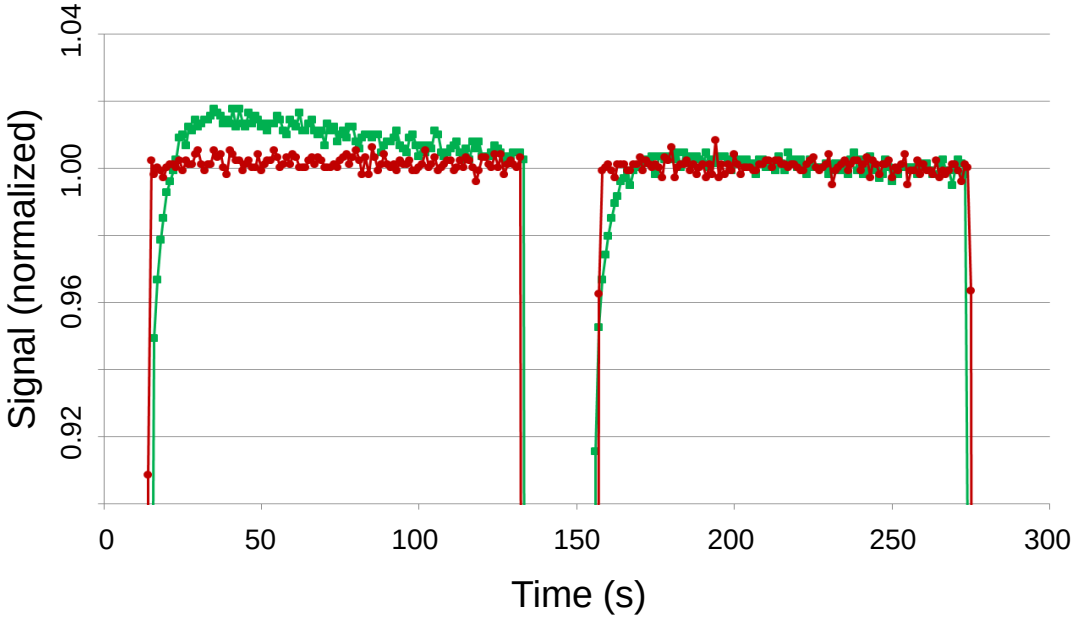
Characterization at IBA DosLab

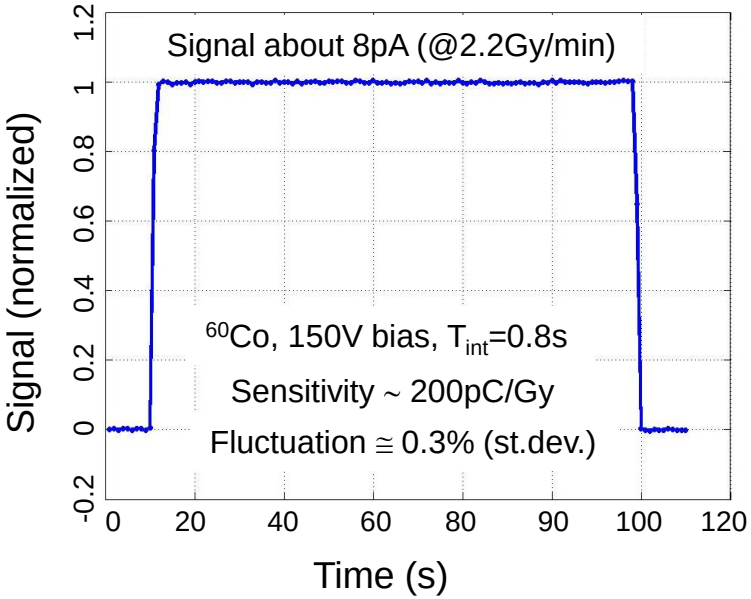
Prototype optimization

Main debug issue: time stability of the chamber current.

Example: two ^{60}Co irradiations (detector biased at 100V).

Current ~ 10pA





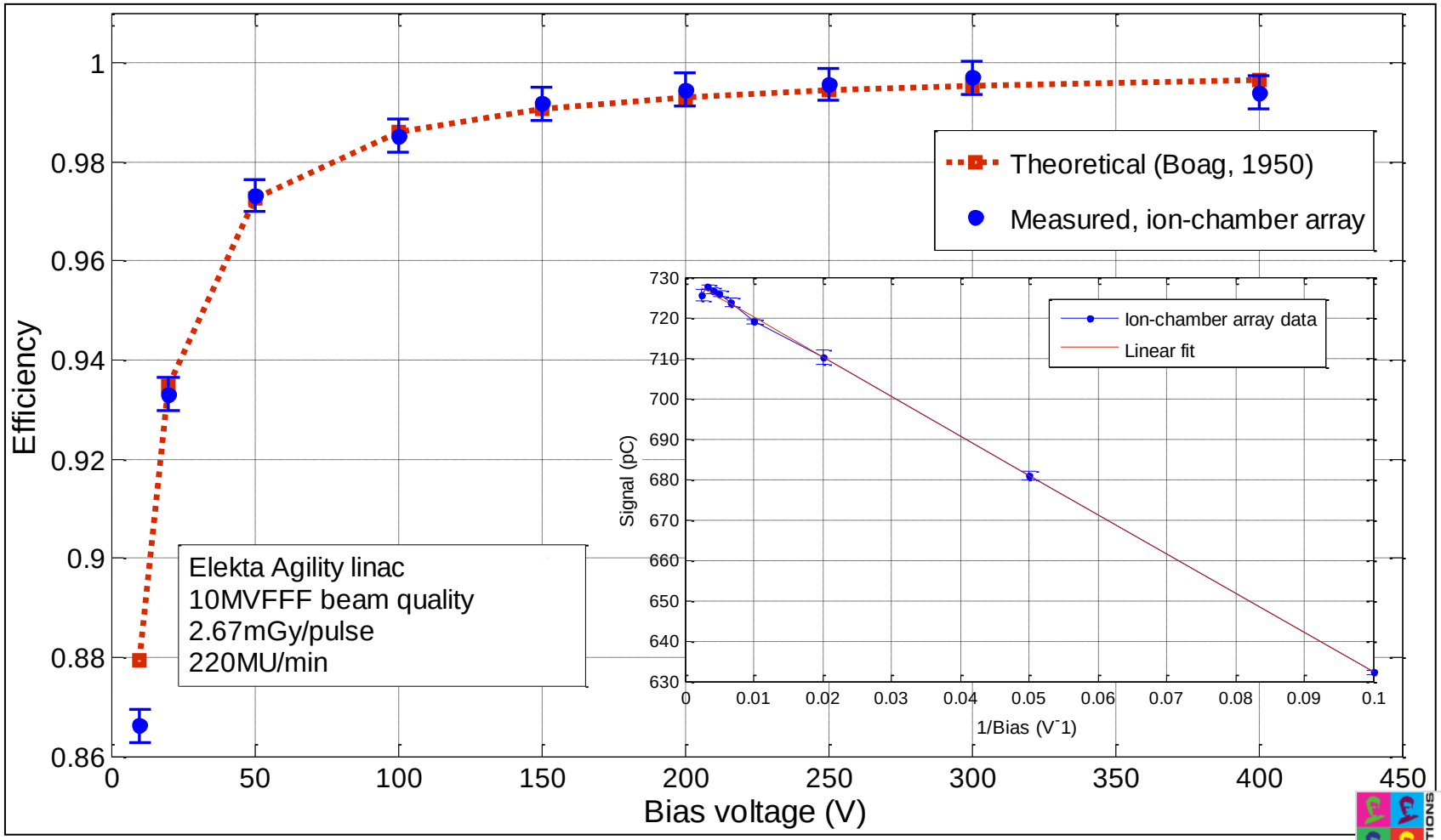
Optimization of signal routing led to a better time stability of the sensor:

- Pretty good stability in time of the signal
- Prompt rise and fall time

Characterization at IBA DosLab

Charge collection efficiency

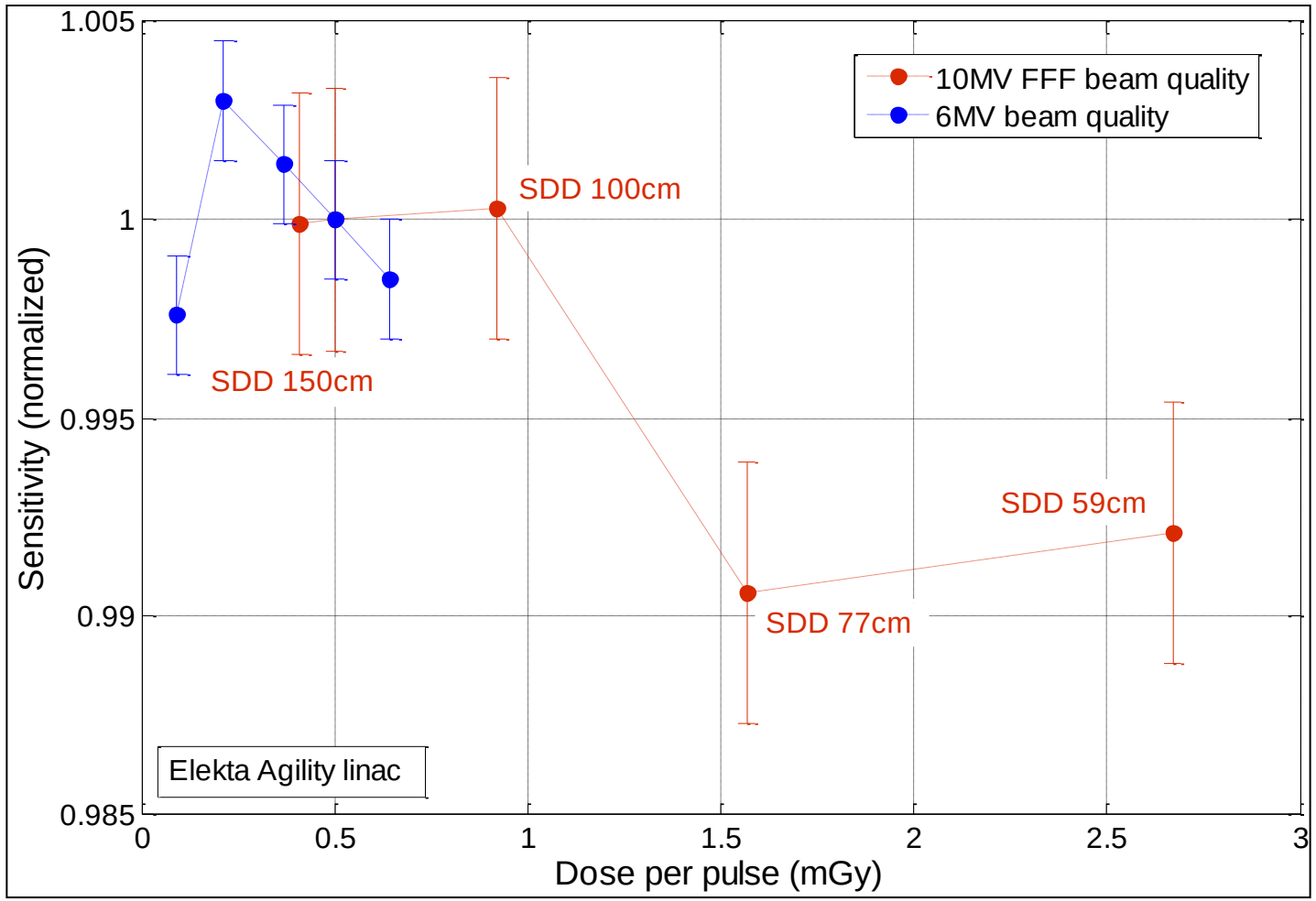
- Charge collection efficiency higher than 99% already at 150V (99.5% ± 0.3% at 250V)



Characterization at IBA DosLab

Sensitivity dependence on dose per pulse

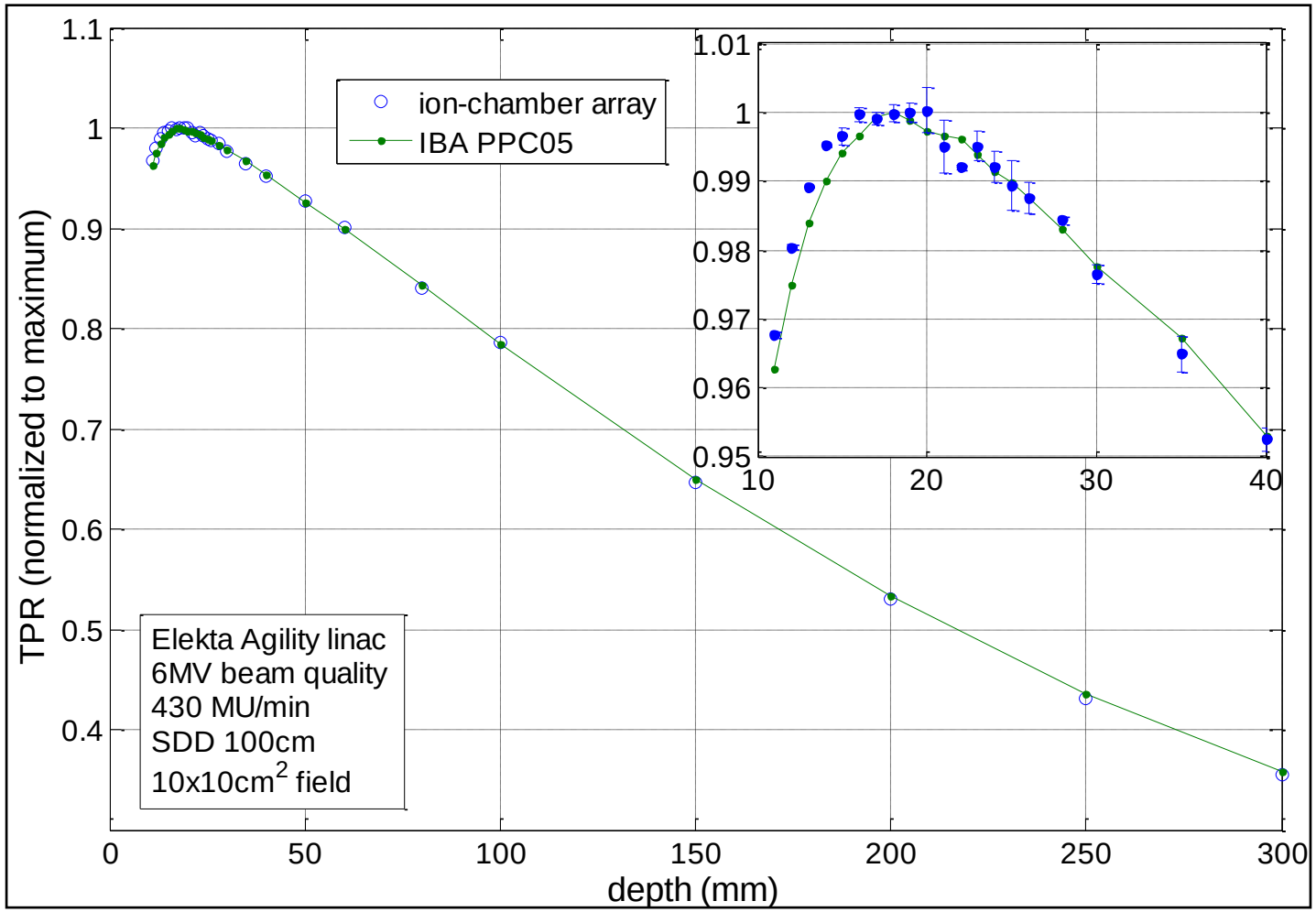
- ± 0.8% sensitivity change on dose per pulse in the range 0.09÷2.67mGy/pulse



Characterization at IBA DosLab

Tissue to phantom ratio measurement

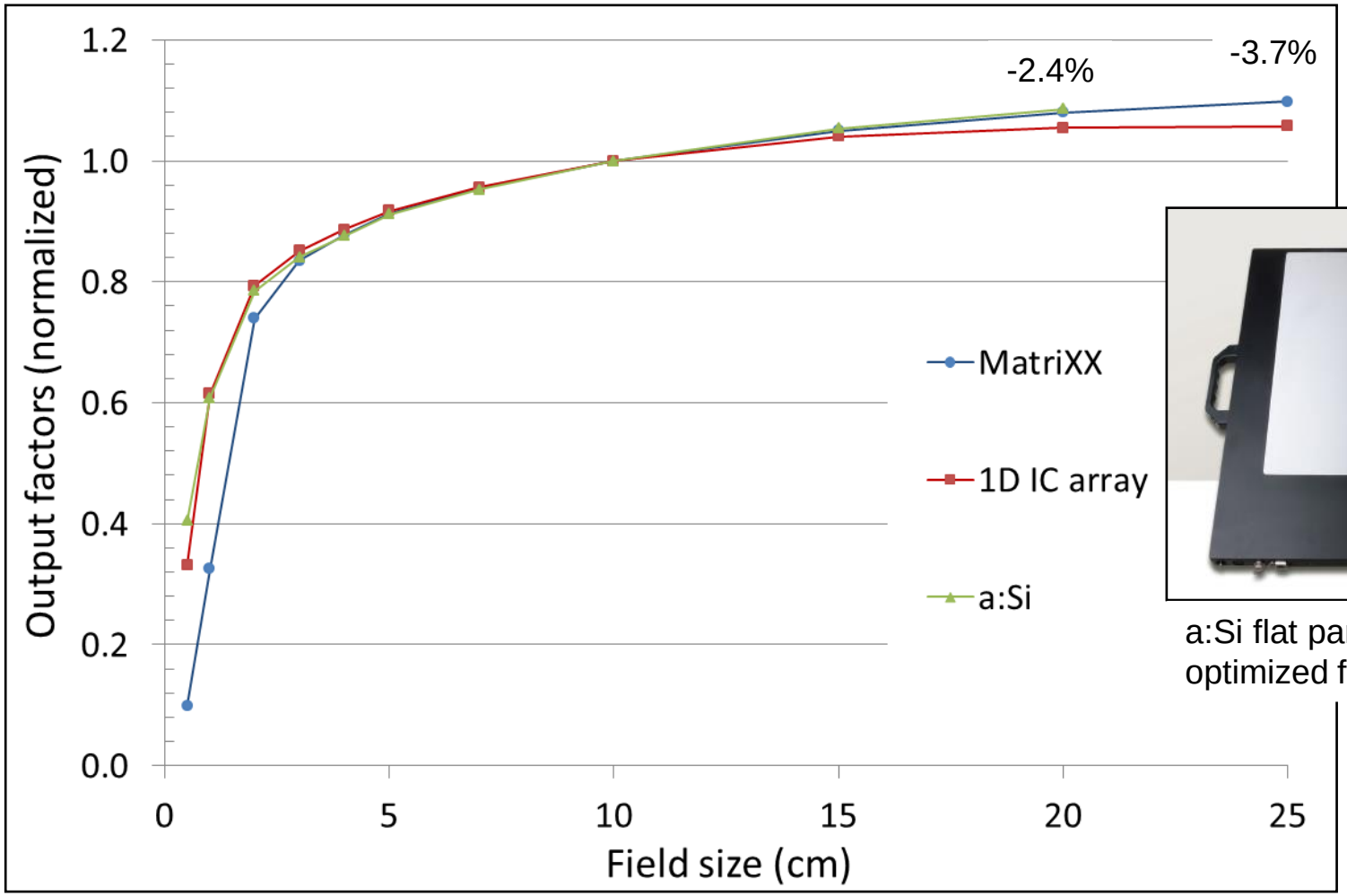
- Very good agreement with PPC05 (better than 0.5%) at every depth of measurement



Characterization at IBA DosLab

Elekta Agility Output Factors

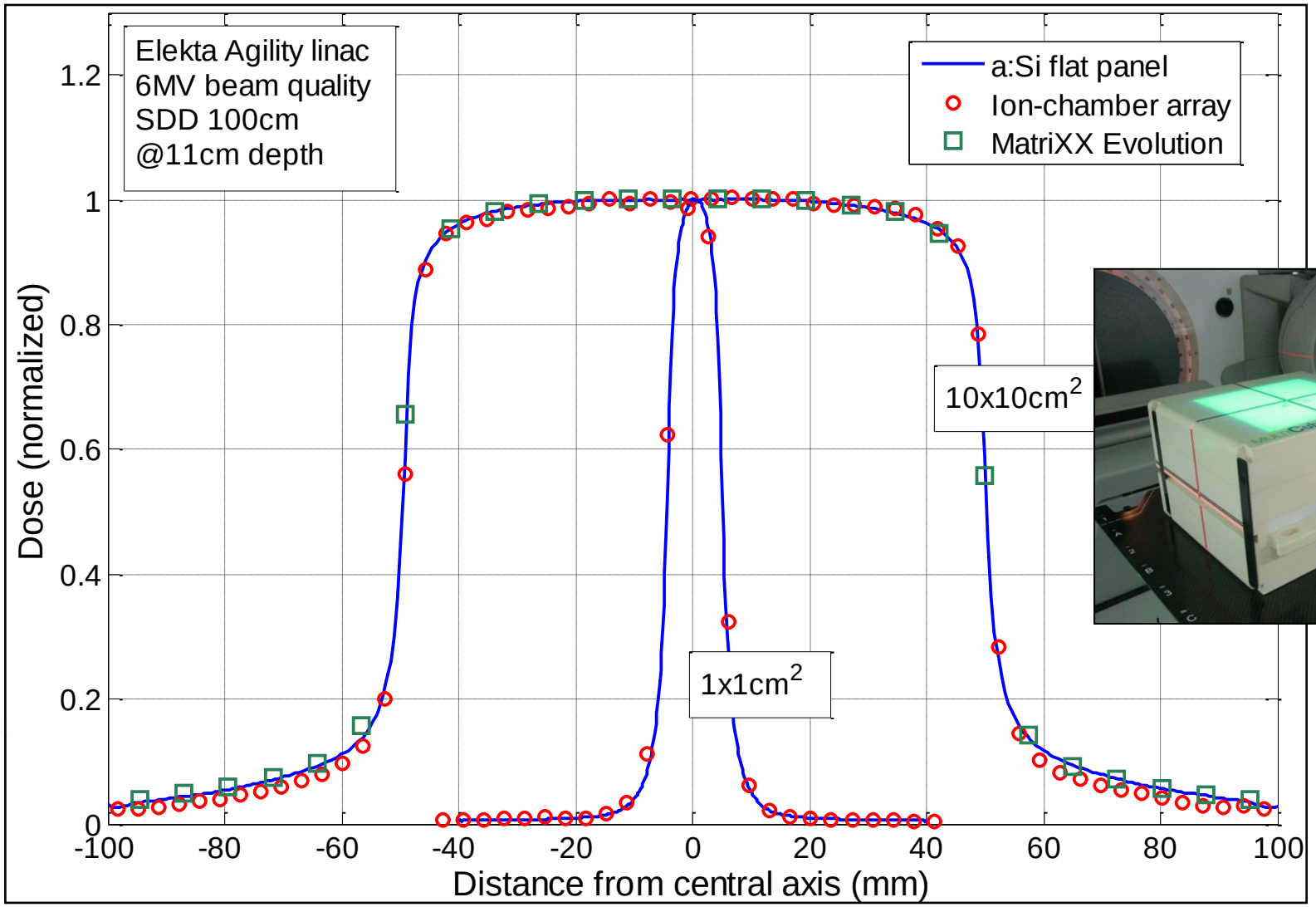
- Good agreement with reference for small fields, reduced sensitivity with large fields

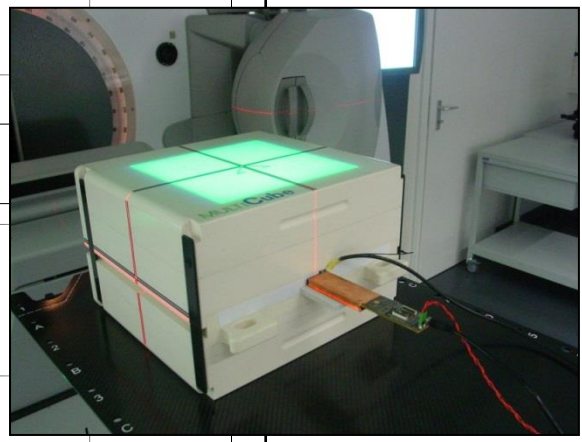


a:Si flat panel, a prototype optimized for dosimetry

Characterization at IBA DosLab

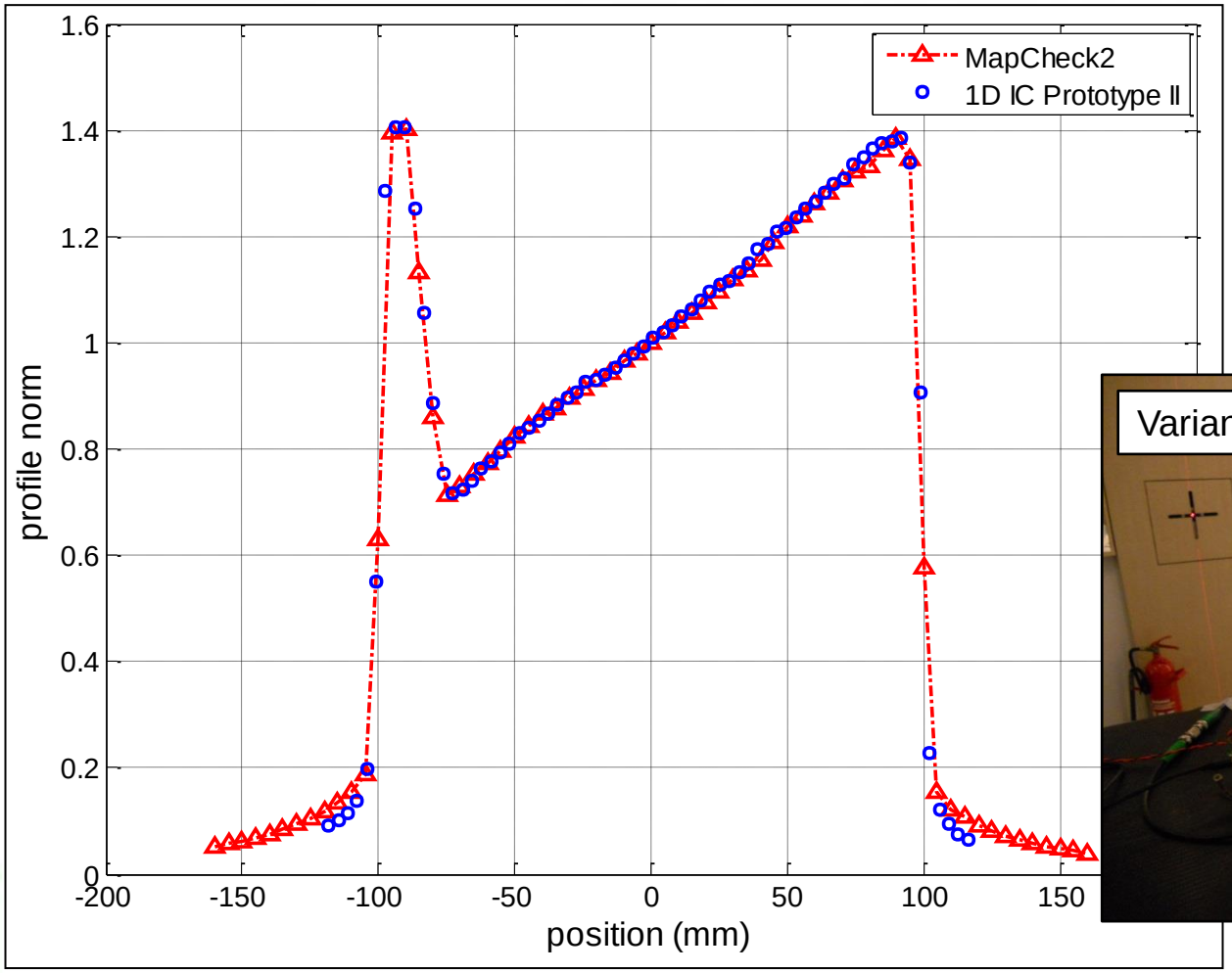
Beam profiles (photons)



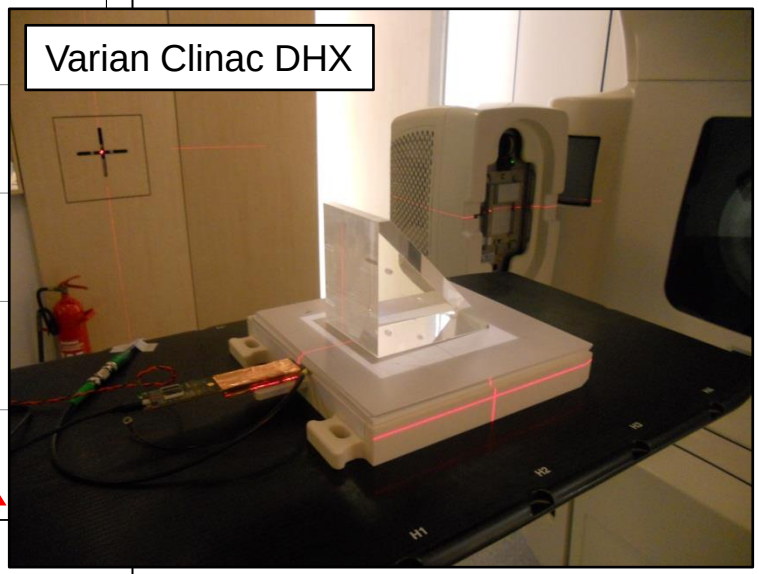


Characterization at MRI

Machine QA: virtual wedges, MLC QA, dose in depth (see pics)



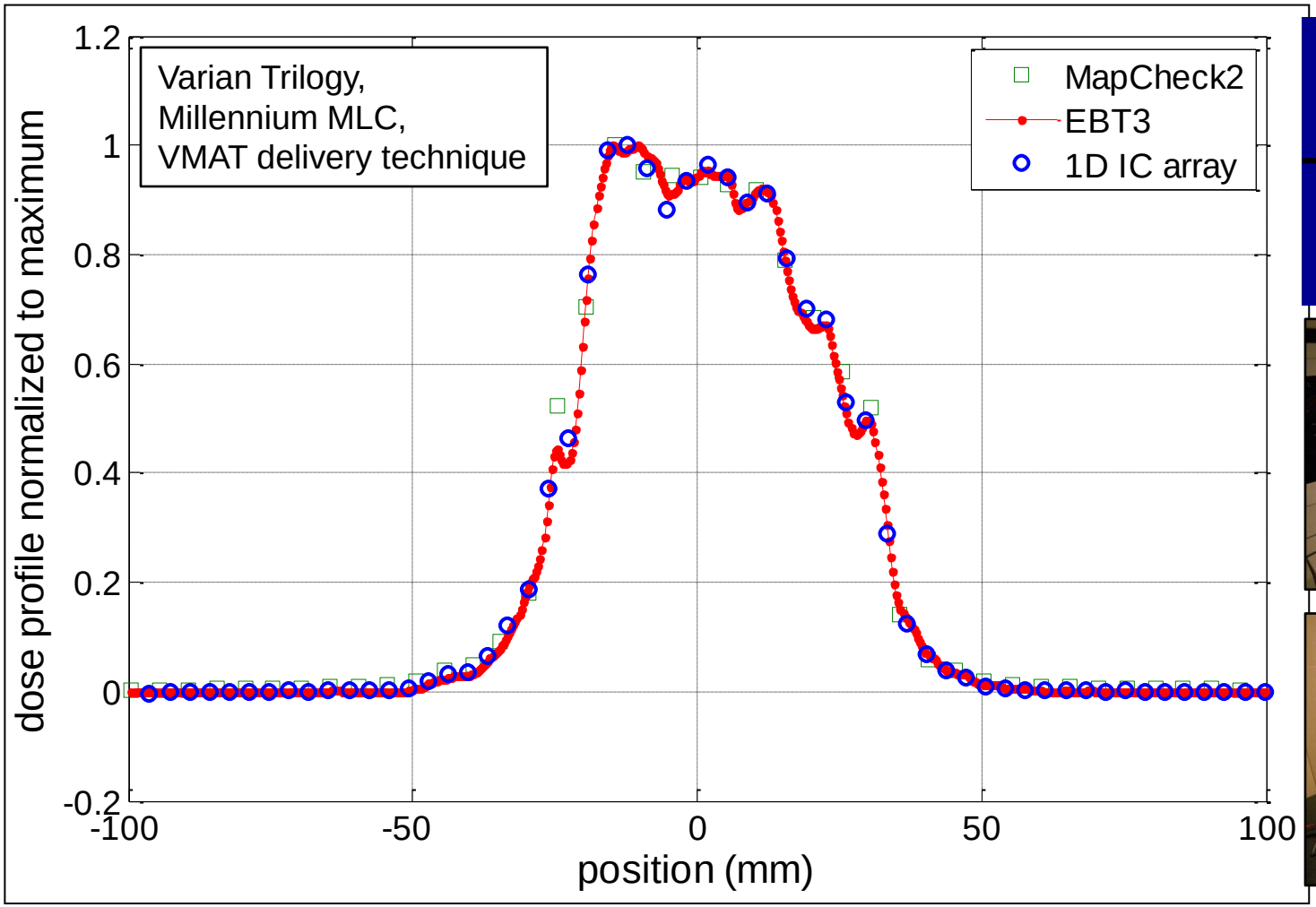
MapCheck2 (SunNuclear) diode array

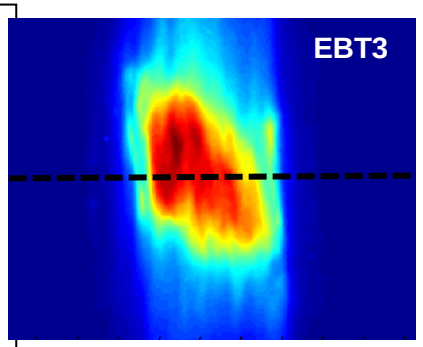


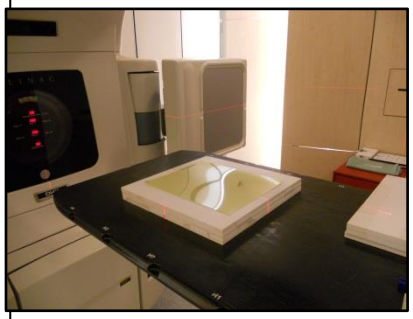
- Secondment, 22nd April - 3rd May, Klinikum rechts der Isar (Munich)

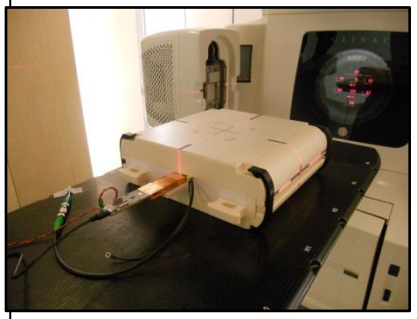
Characterization at MRI

Example of patient QA



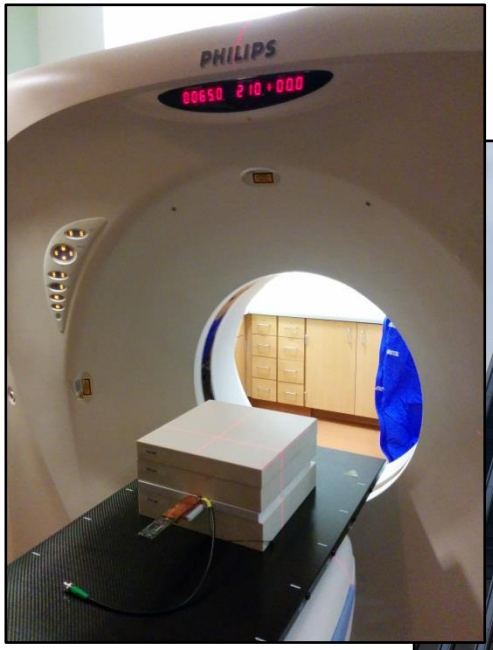


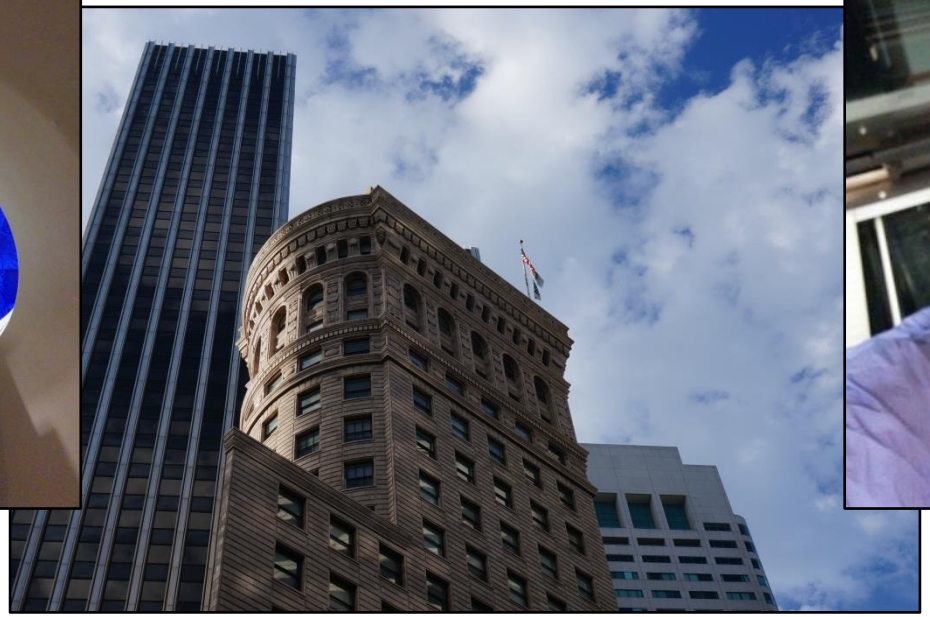


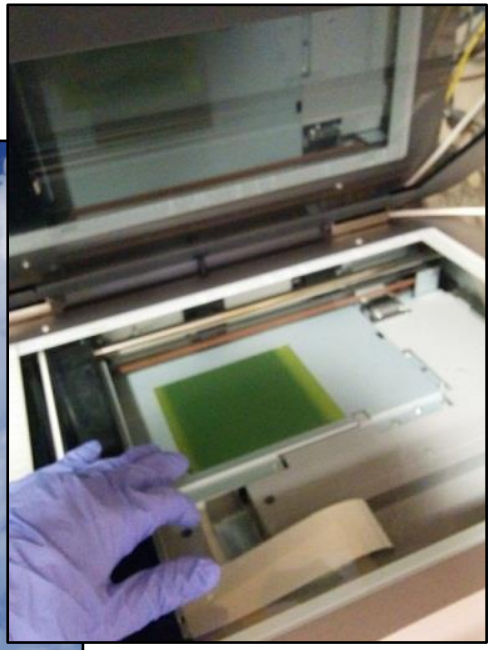


Characterization at UCSF

Clinical tests & clinical training



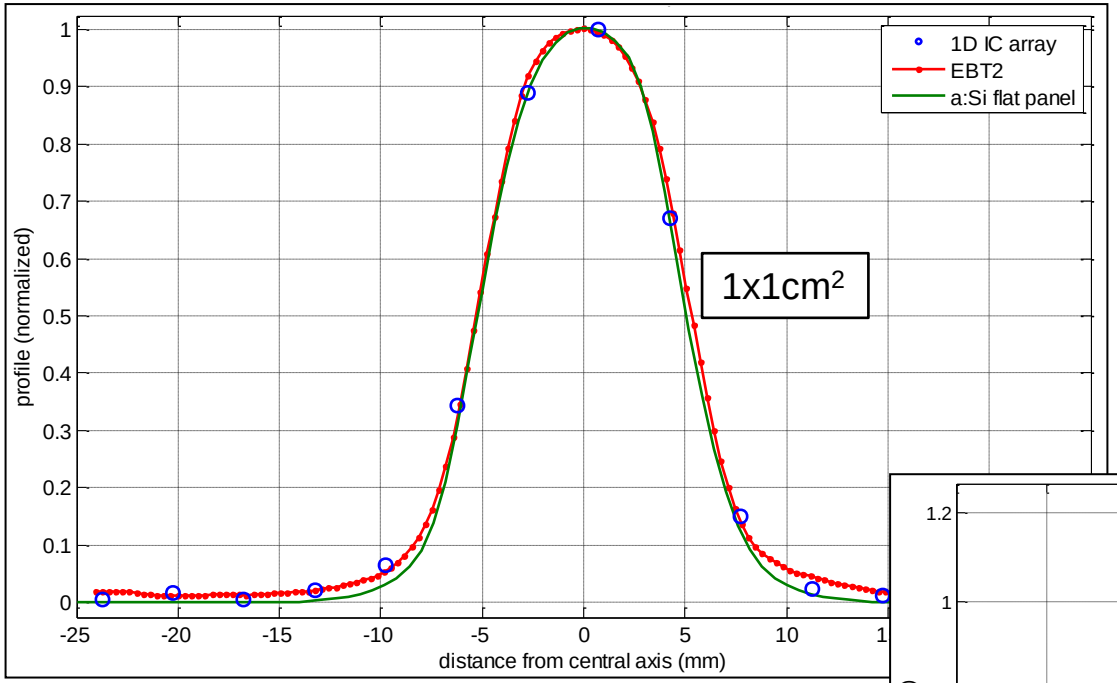


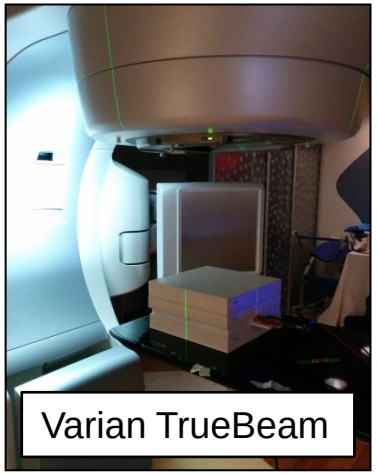


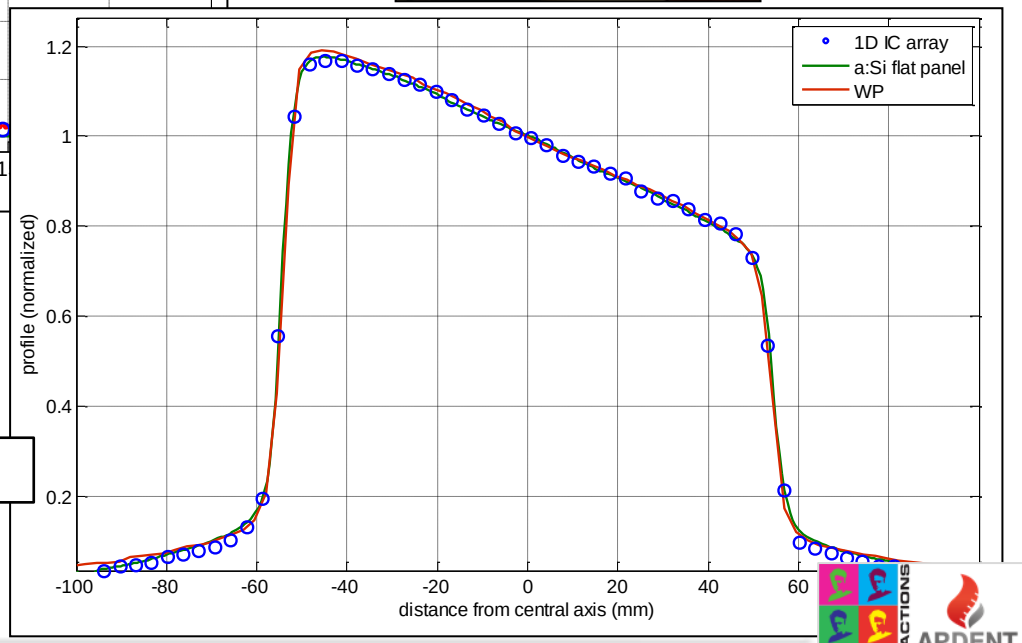
- Secondment, 28th July - 8th August, UCSF department of Radiation Oncology;
- Detector characterization through clinical test;
- Clinical training:
  - Machine QA;
  - Introductory training to Pinnacle TPS;
  - Use of gafchromic films;
  - Joined the daily activity of medical physicists.

Characterization at UCSF

Example of small field dosimetry and linac commissioning



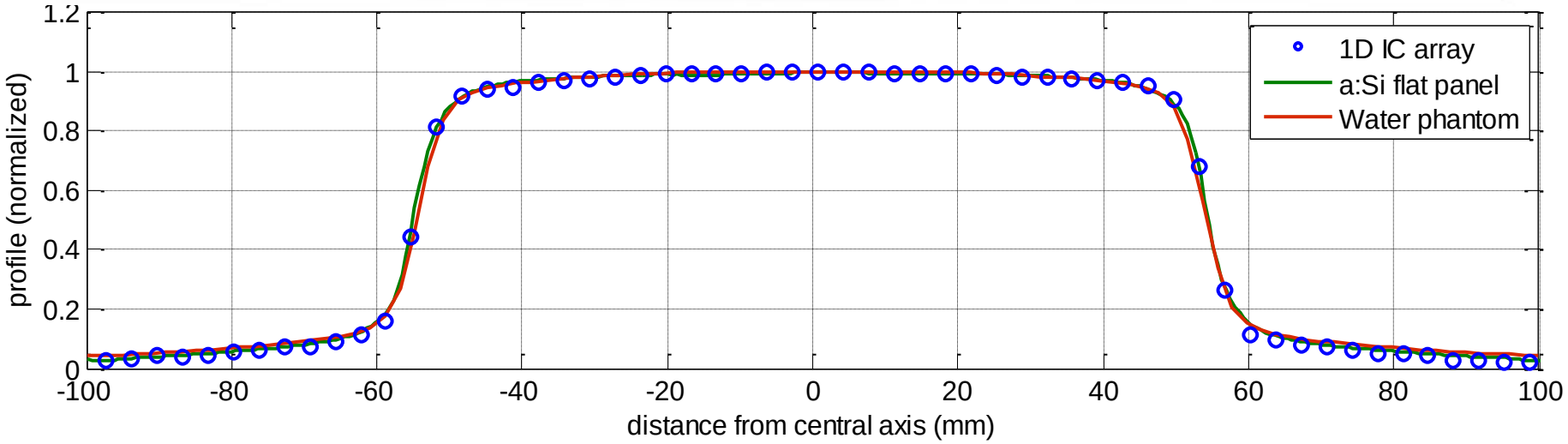


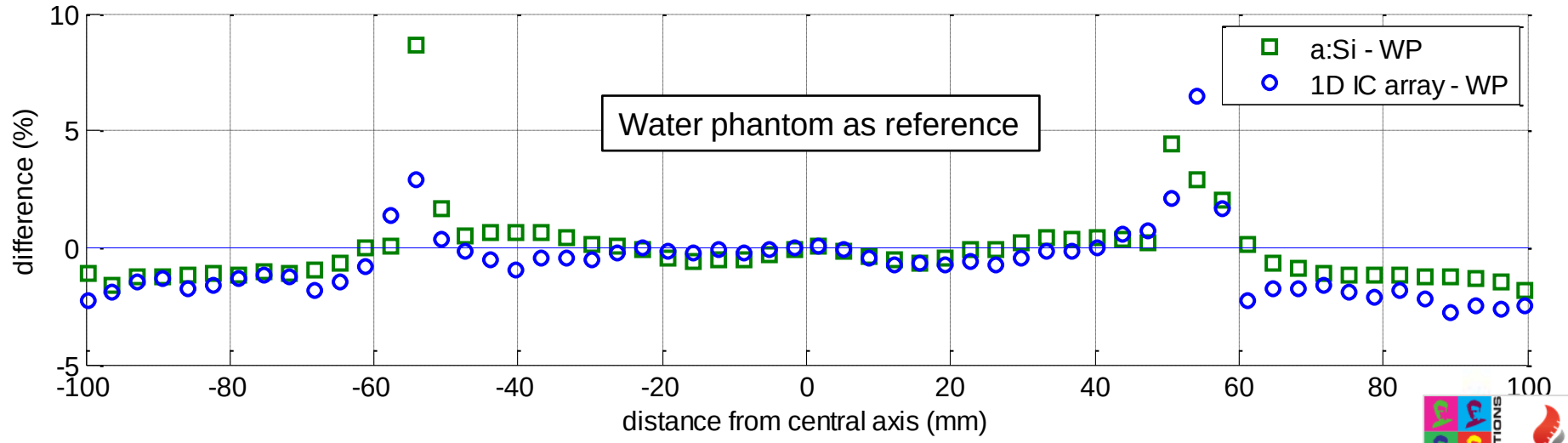


Virtual wedge 45°

Characterization at UCSF

Example of linac commissioning measurement





Characterization at PTC czech s.r.o.

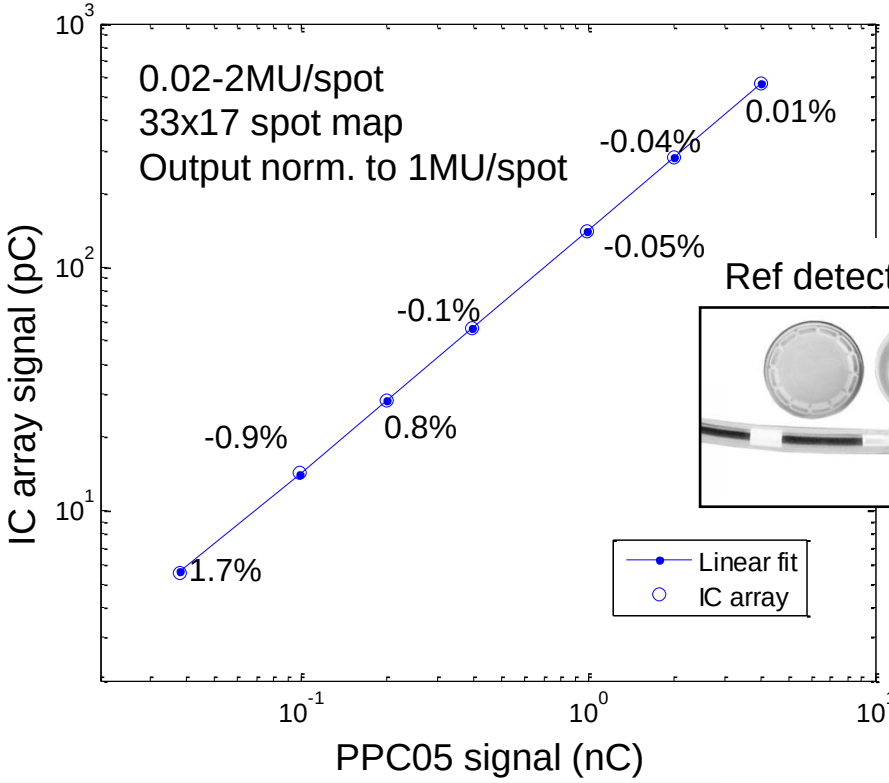
Dose linearity

PBS mode only

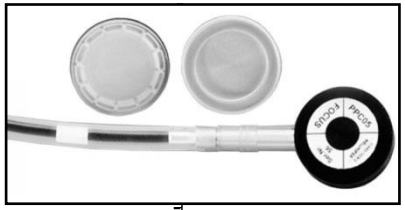
~1ms pulse duration,

~10ms pulse period,

3.5mm spot σ at 226MeV

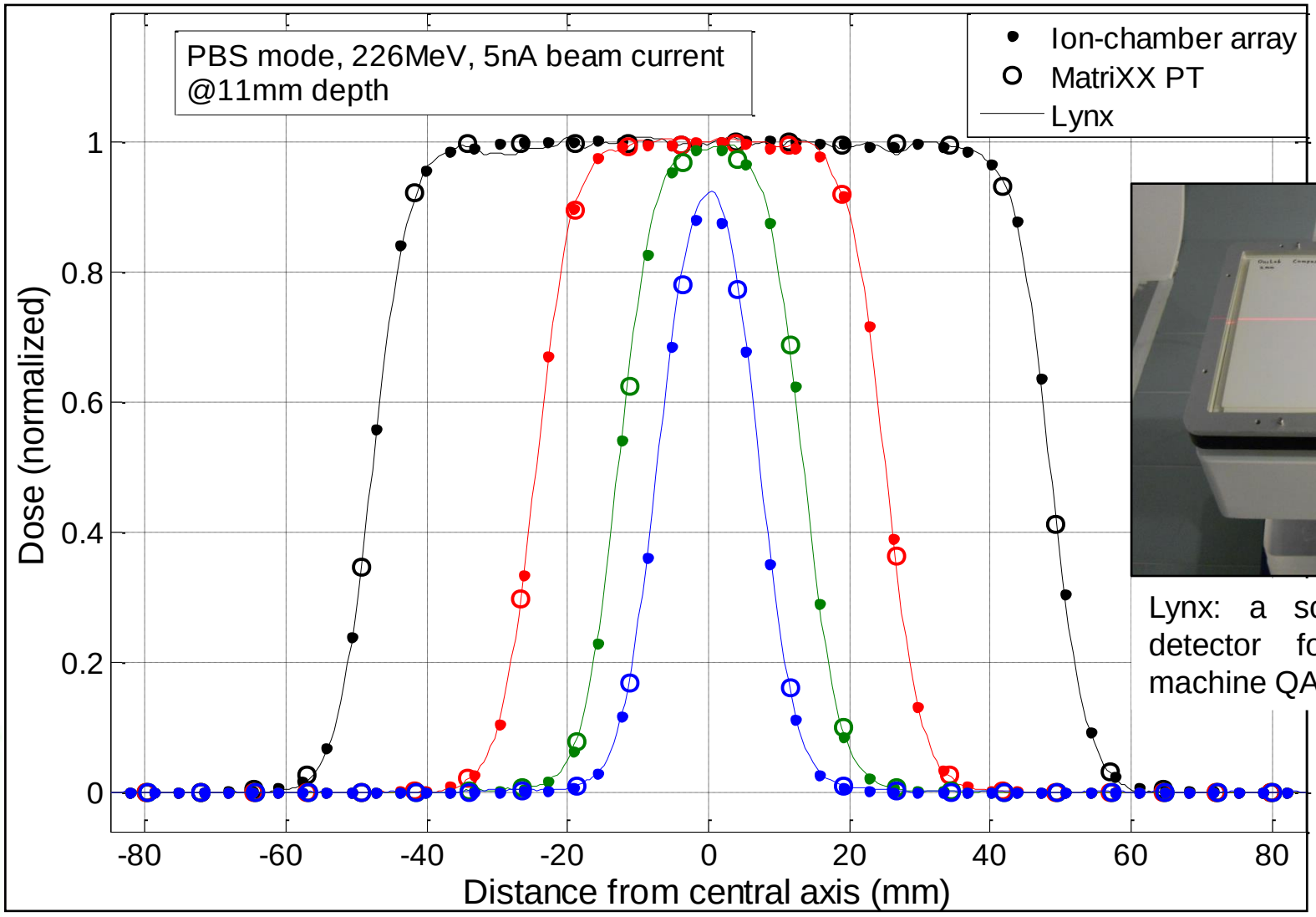


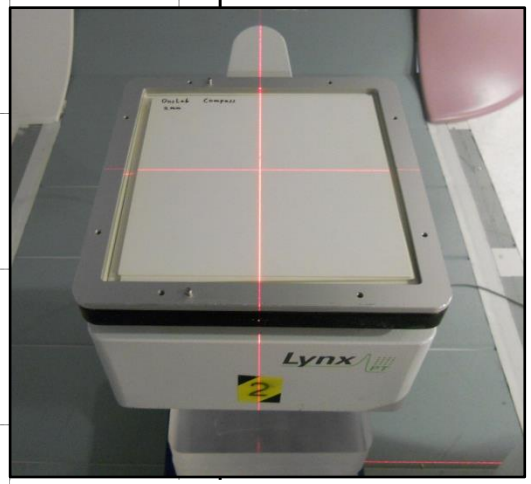
Ref detector: PPC05



Characterization at PTC czech s.r.o.

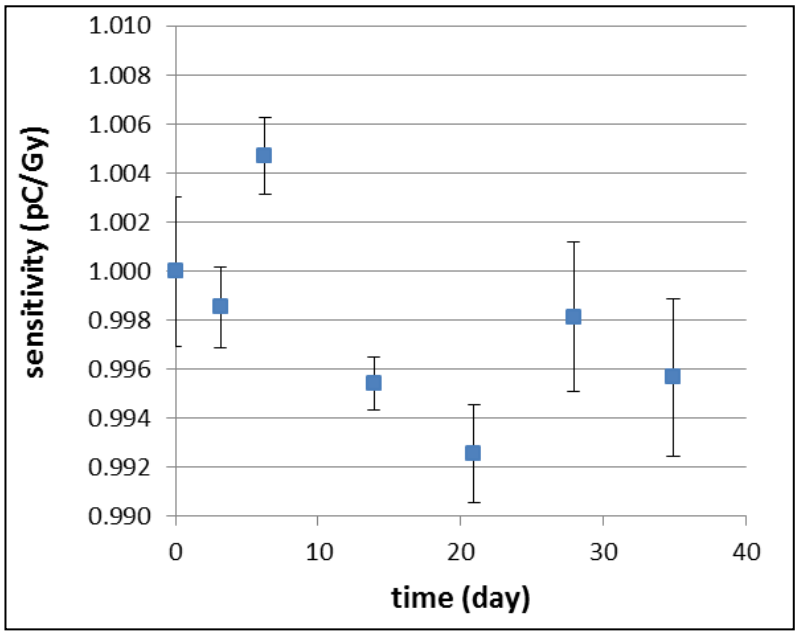
Beam profiles (protons)

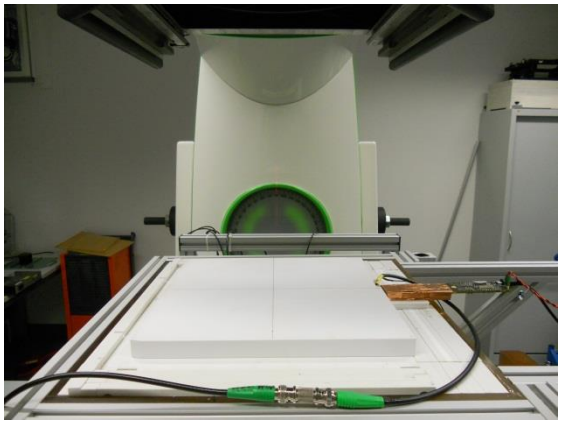




Lynx: a scintillator based detector for PBS mode machine QA

Ongoing activities/Future work





- Long term stability measurements with ^{60}Co

- Further test with PBS proton beams;
- Paper about the characterization of the 1D IC array prototype;
- Extend the technology to a 2D detector - components drawing already started, first prototype assembling foreseen for the end of the year.

Trainings, conferences, secondments…

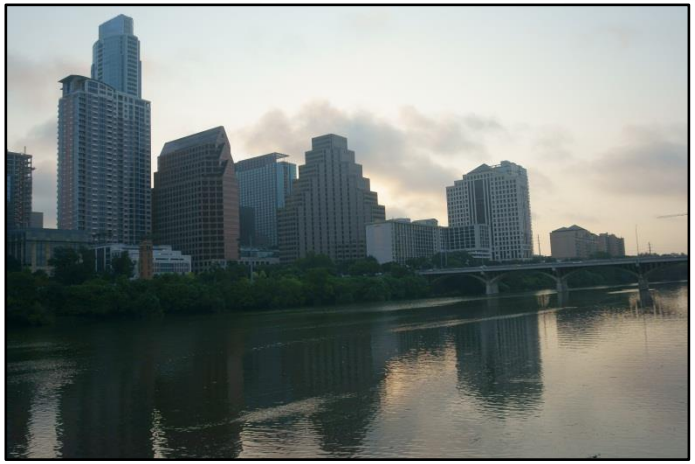
Secondments

Klinikum rechts der Isar, Munich (22.04 - 03.05.2014)

UCSF RadOnc dep., S.Francisco (28.07 - 08.09.2014)

- Upcoming:
  - B&A secondment at STMicroelectronics (Catania, July 2015 tentative)
  - UCSF (early 2015 tentative)

Conferences, trainings…



- AAPM, Austin (TX), 20.07 - 25.07.2014

Poster presentation: "*An Ionization Chamber Array with High Spatial Resolution for External Beam Radiotherapy*", M.Togno, D.Menichelli, J.J.Wilkens.

Upcoming: AAPM 2015, …

- Trainings:
  - Clinical trainings at MRI & UCSF (already mentioned);
  - Radiation protection training (IBA Dosimetry);
  - Training on SBRT radiotherapy technique (Klinikum rechts der Isar);

- ARDENT B&A training (CERN): Technology Transfer, Management, Entrepreneurship.

- PhD activities: already spent more than 2 weeks at the University to teach students at physics labs.

Thank you!