

Dosimetric Properties of a Synthetic Single Crystal Diamond Diode in High Energy Clinical Proton Beams

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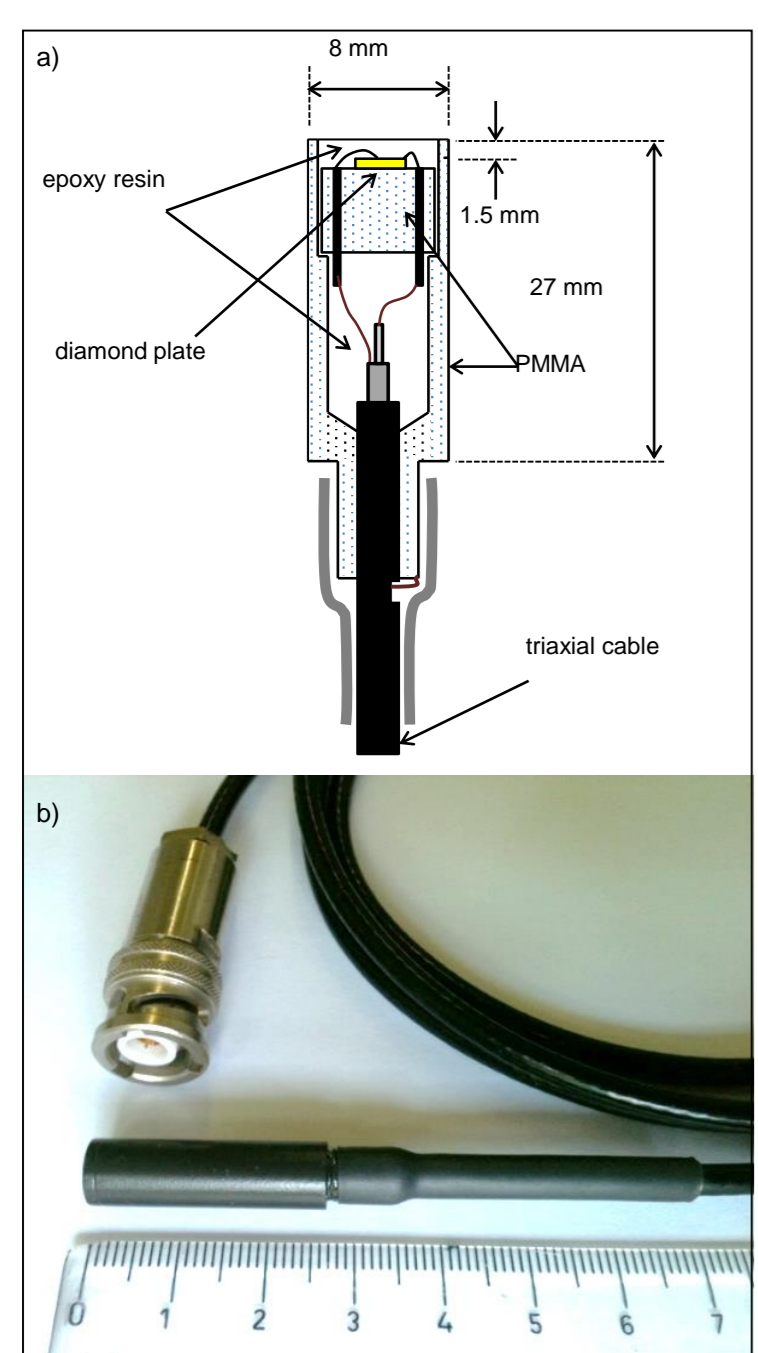
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Purpose: To evaluate the dosimetric properties of a pre-market prototype of PTW-Freiburg microDiamond dosimeter for accurate relative dose measurements in clinical proton beams.

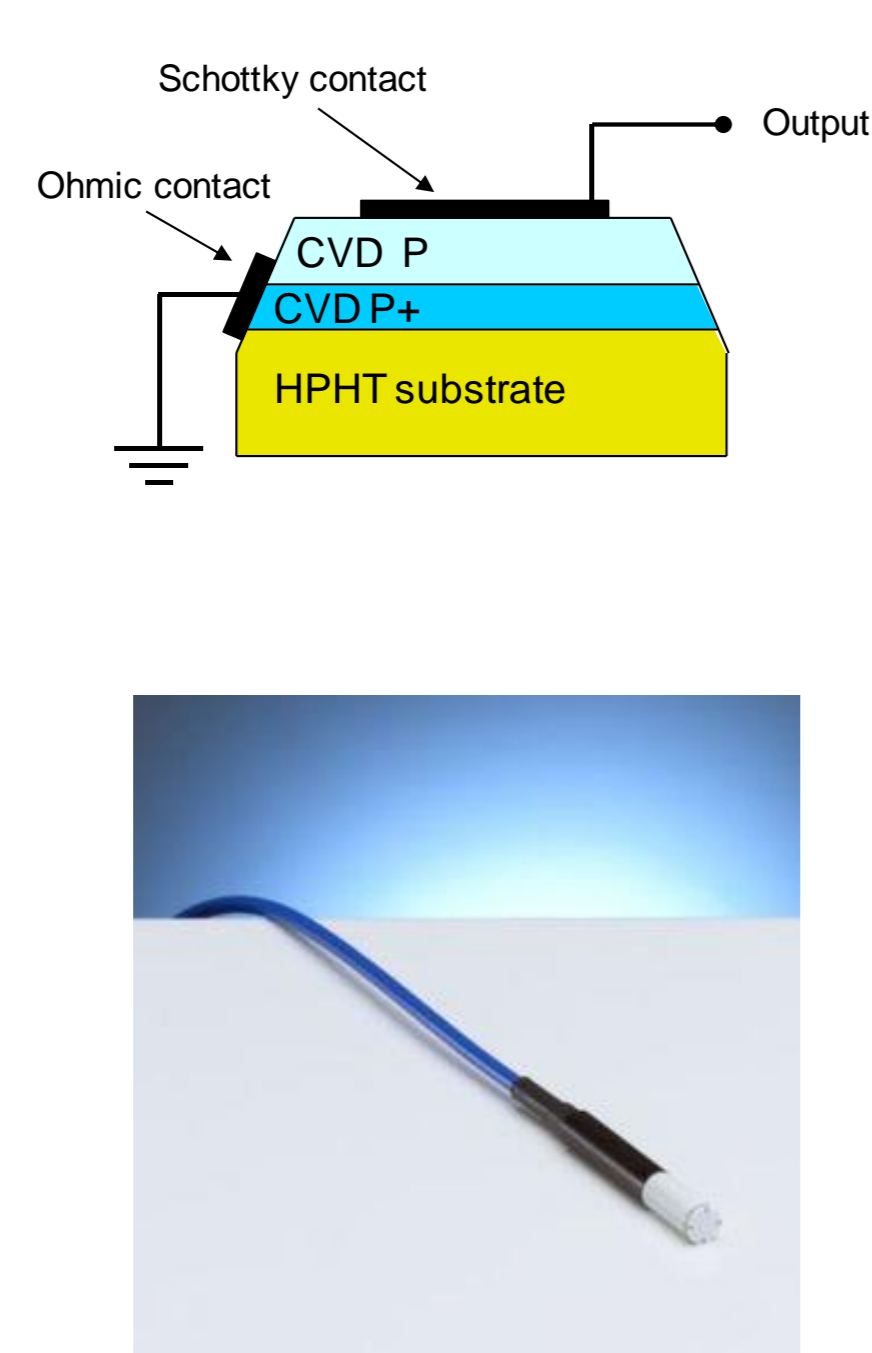
Methods: The dosimetric properties of the synthetic single crystal diamond diode (SCDD) fabricated at the University of Rome "Tor Vergata" were tested under high energy clinical proton beams at the Loma Linda University Medical Center. The performance were assessed by comparison with a reference parallel plate ionization chamber (PTW Markus Chamber 23343) and a micro ionization chamber (Exradin A16). All measurements were performed in a water phantom. The warm-up/stability of the detector response, dose linearity and dose-rate dependency were evaluated in a 250 MeV proton beam. Comparative dose measurements were performed by means of percent depth dose curves and lateral beam profiles in 126 MeV, 155 MeV and 250 MeV proton beam for a 14 cm square cerrobend aperture and for 3cm, 2cm and 1 cm diameter circular brass collimators.

THE DOSIMETER

Synthetic single crystal diamond Schottky diode
 Fabricated by Plasma CVD at Rome "Tor Vergata University Laboratory"



SCDD prototype



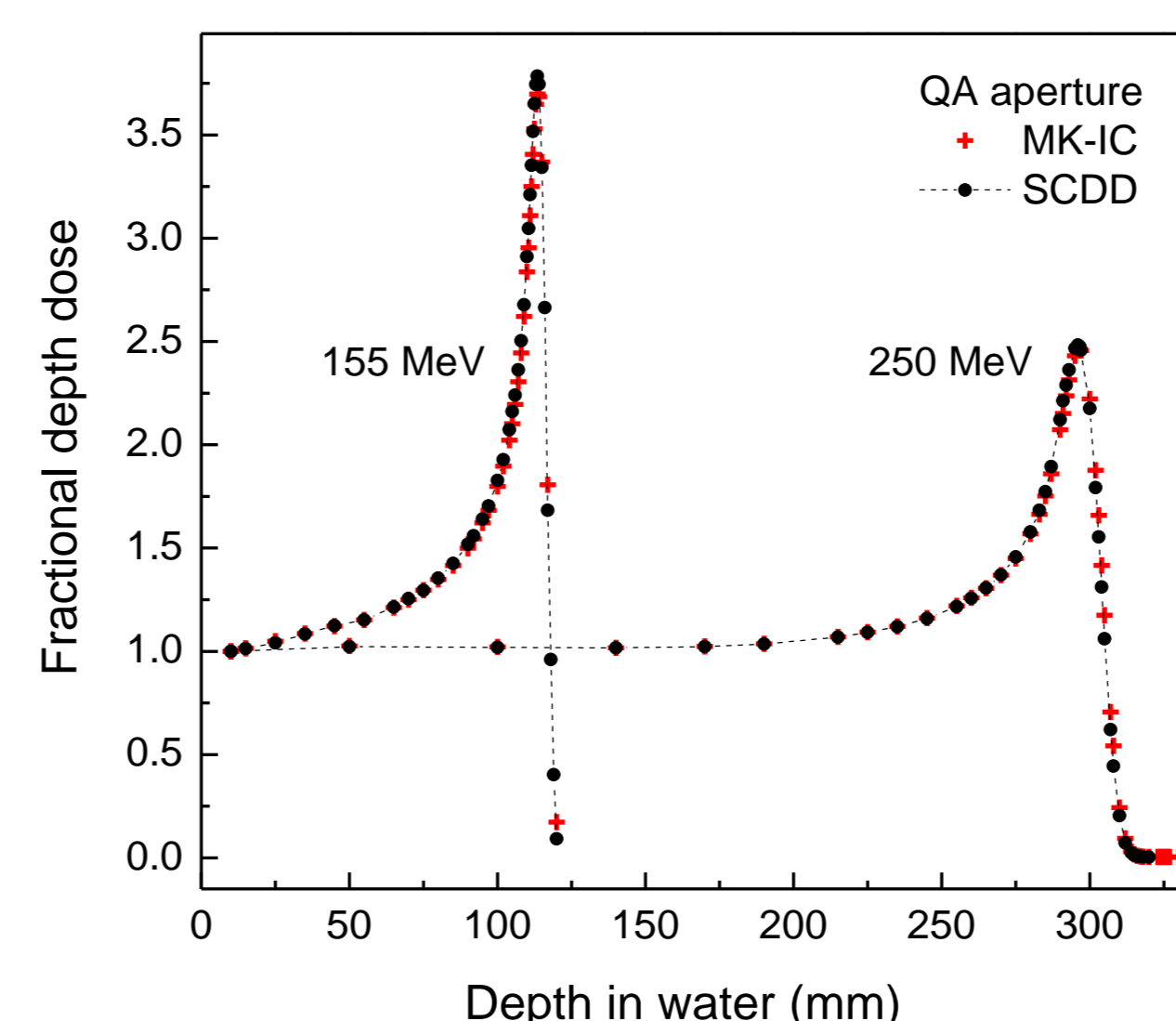
microDiamond™ (PTW T60019)

Specifications

- Design: waterproof, disk-shaped, sensitive volume perpendicular to detector axis
- Measured quantities: absorbed dose to water
- Nominal sensitive volume: 0.004 mm³
- Reference point: on detector axis, 1 mm from detector tip, marked by ring
- Nominal response: 1 nC/Gy
- Detector bias: 0 V
- Radiation quality: 100 keV ... 25 MV photons / (6 ... 25) MeV electrons
- Field size: (1 x 1) cm² ... (40 x 40) cm²

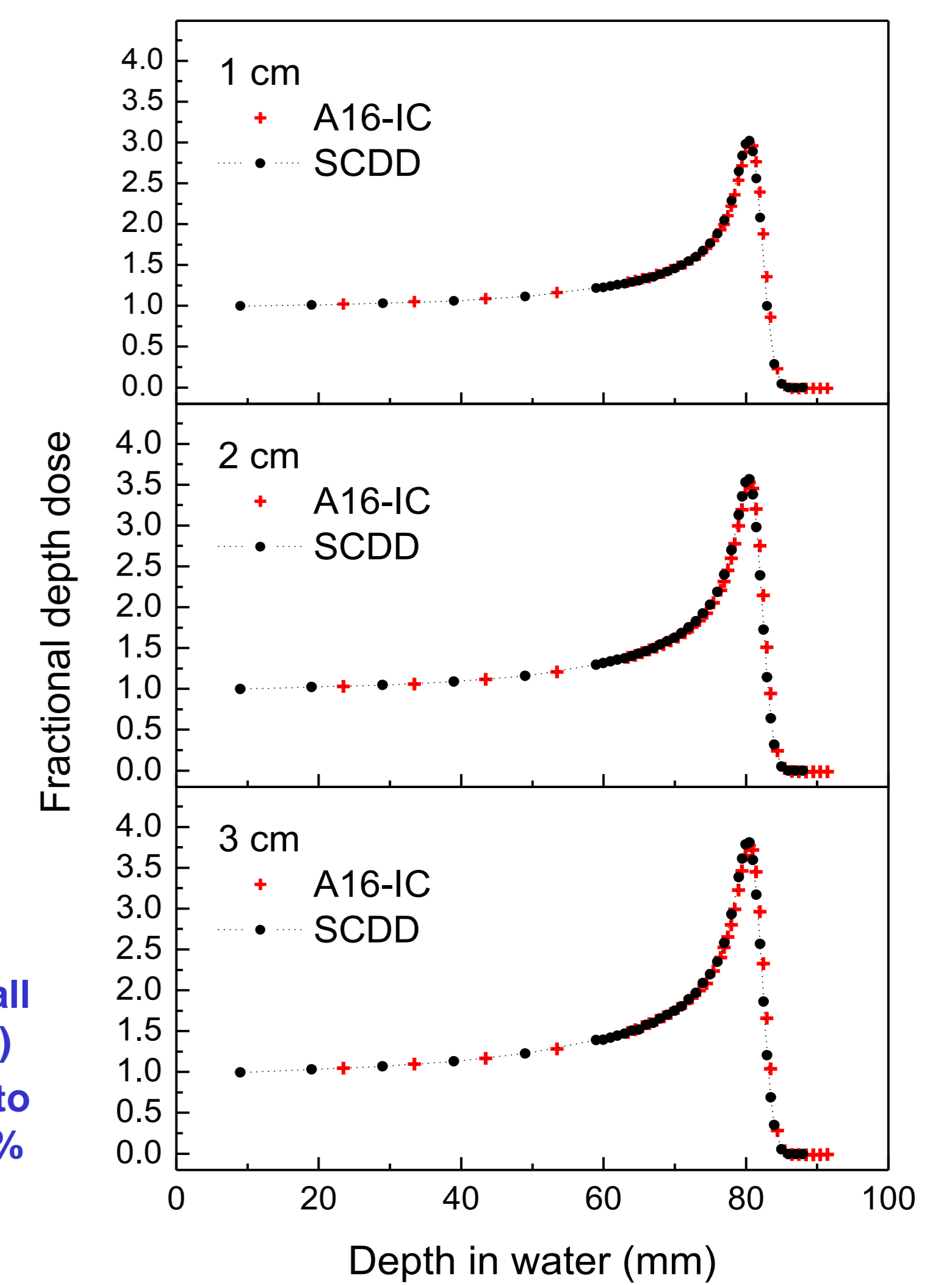
BRAGG PEAKS

14 x 14 cm² square aperture



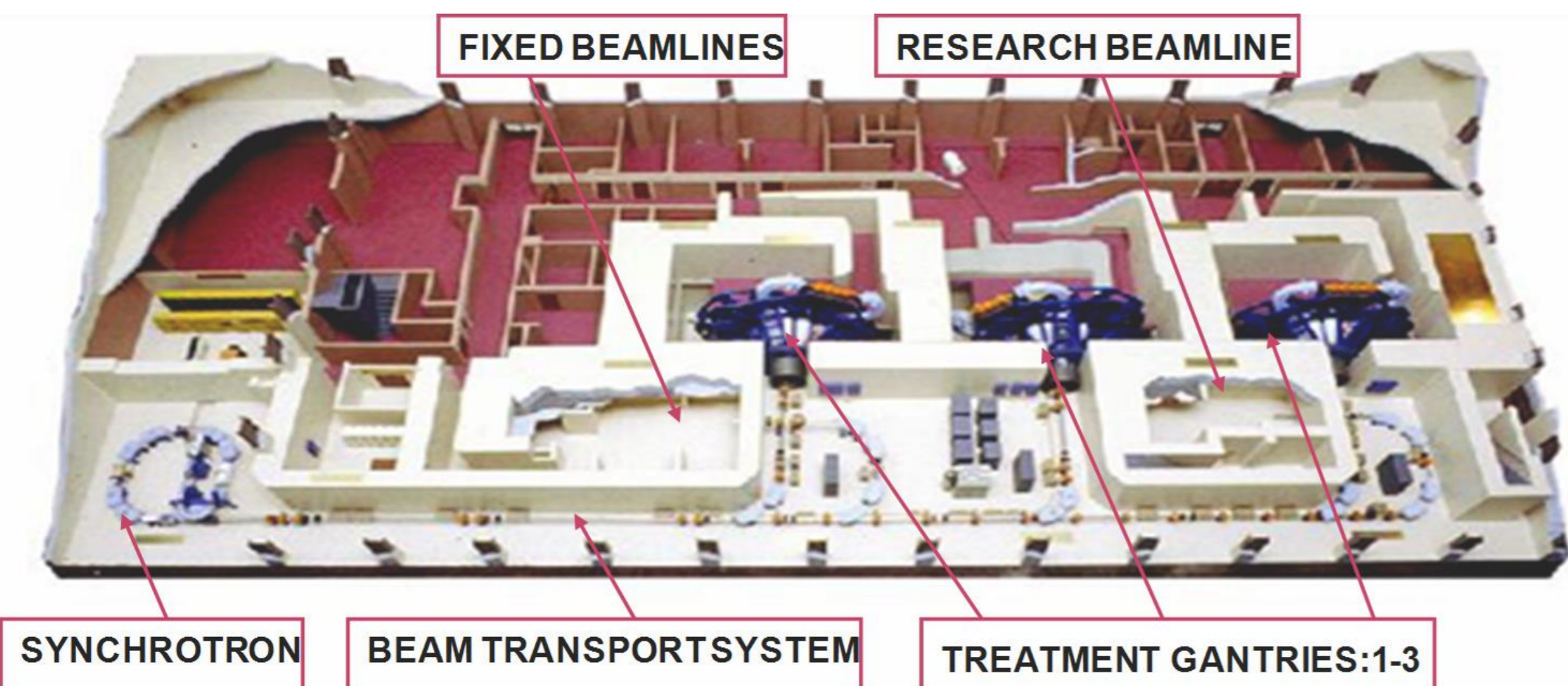
- Good agreement with Markus parallel plate ion chamber
- Differences in the peak to plateau ratio lower than 2%

Small circular apertures



- Good agreement with small ion chamber (Exradin A16)
- Differences in the peak to plateau ratio lower than 1%

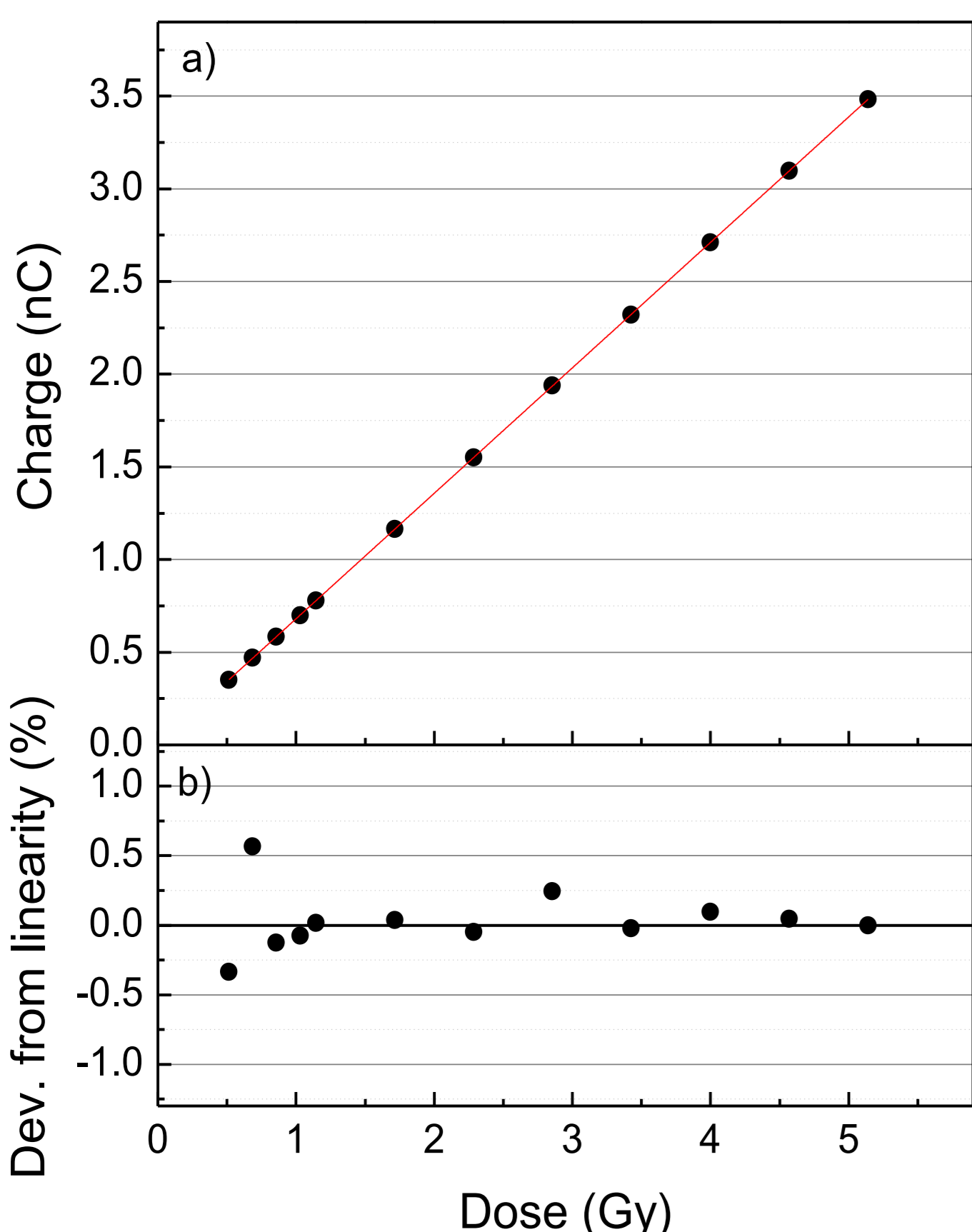
PROTON IRRADIATION FACILITY



LOMA LINDA UNIVERSITY
 MEDICAL CENTER

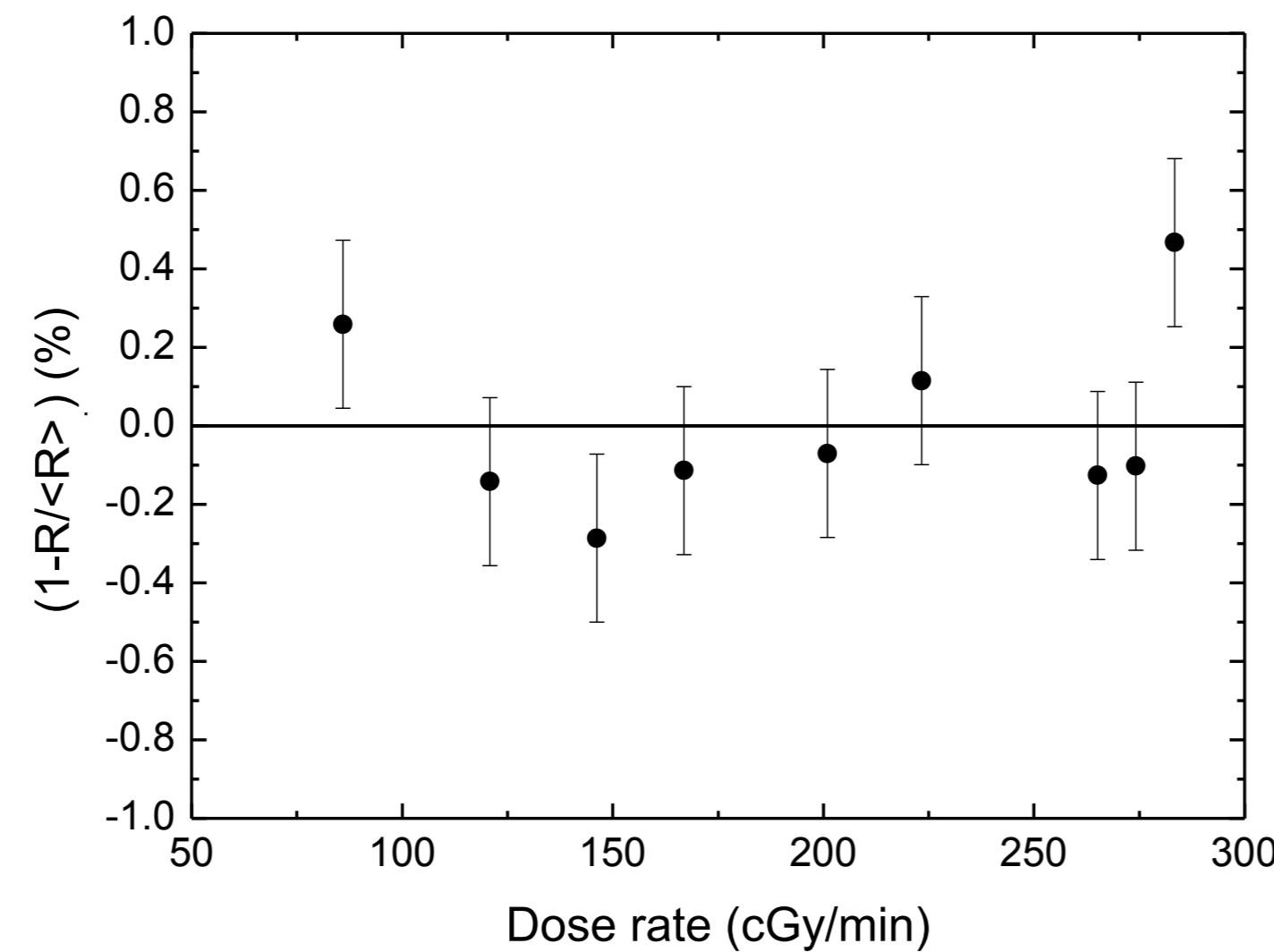
LINEARITY AND DOSE RATE DEPENDENCE

250 MeV proton beam



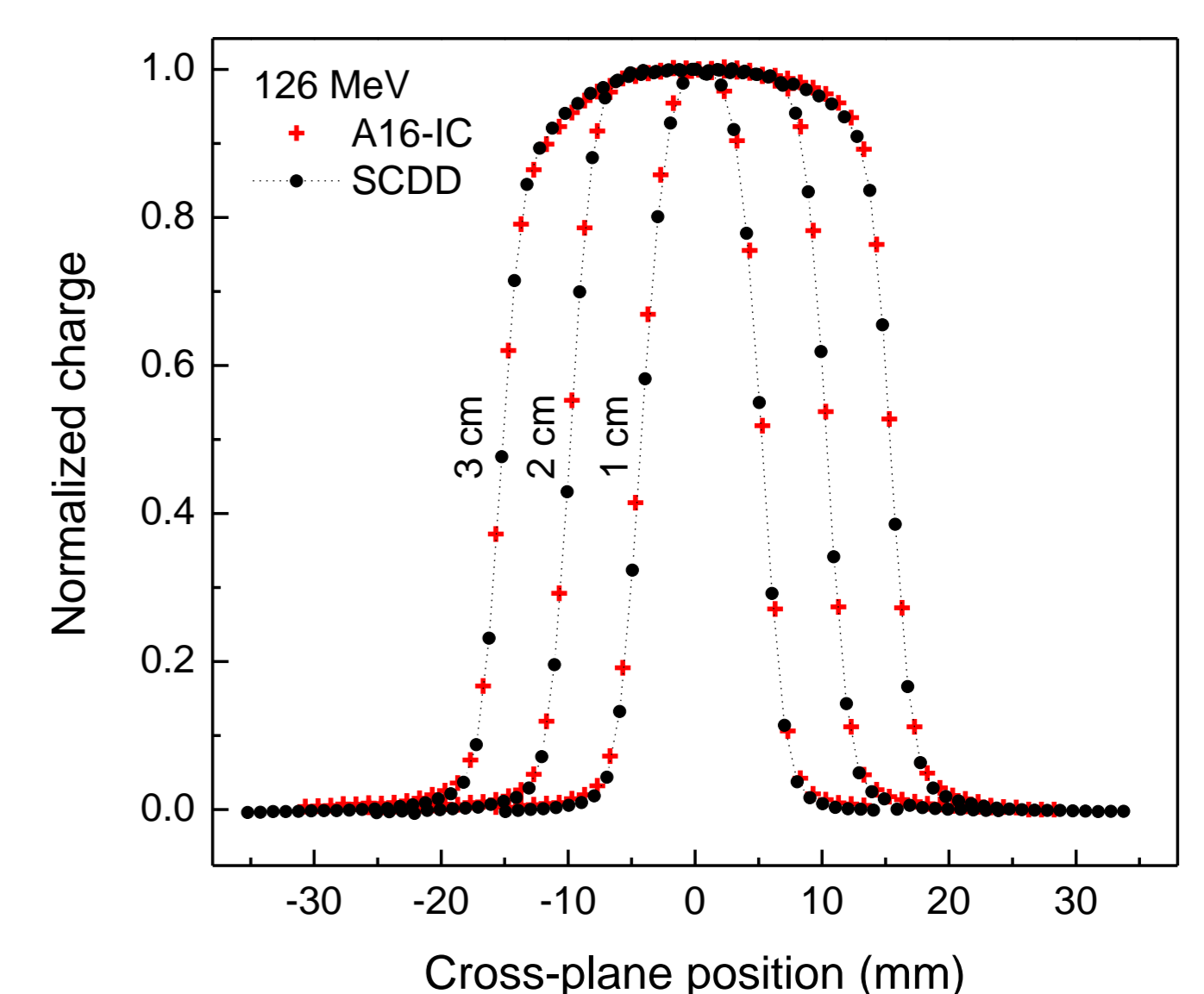
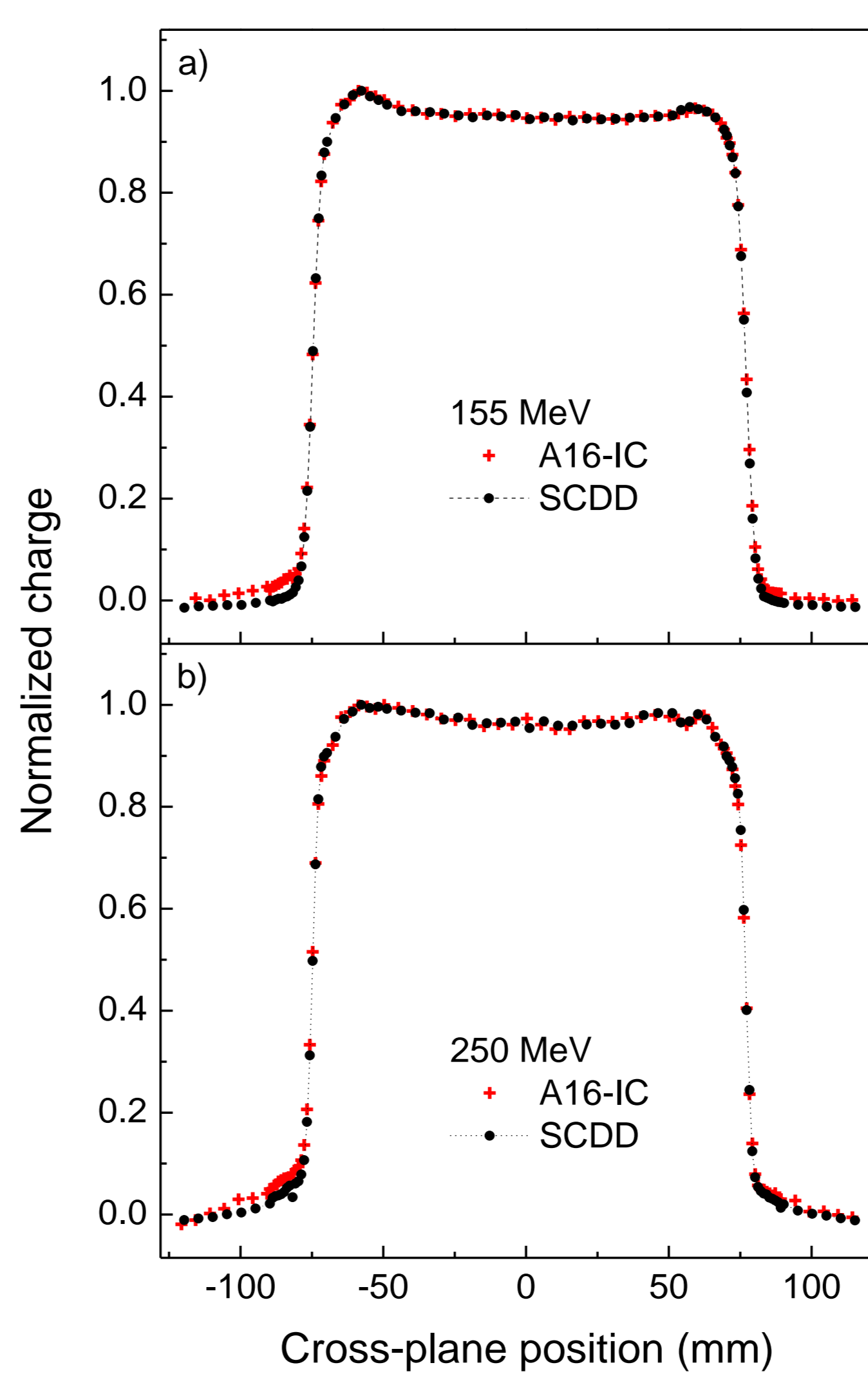
Linearity of the response: $R^2 = 1 \pm 10^{-6}$
 Deviations from linearity about $\pm 0.5\%$

126 MeV proton beam



Dose rate dependence plot.
 Deviation below $\pm 0.5\%$

BEAM PROFILES



- Good agreement with small ion chamber (Exradin A16)
- Smaller penumbra value measured by the diamond dosimeter
- No radiation damage observed up to maximum delivered dose (10 kGy)

CONCLUSIONS

The performed dosimetric tests evidenced that the SCDD response is stable, reproducible and LET independent, thus indicating its suitability for accurate relative dosimetric measurements in large and small field clinical proton beams.