Is proton therapy a low-LET therapy?

Mini-TEPC and silicon-telescope measurements at CATANA therapeutic centre

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MidiNet task 2. Final term meeting
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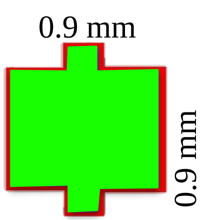
OUTLINE

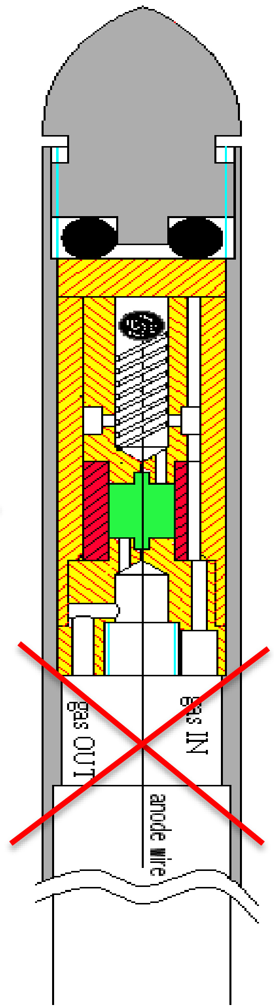
1. Detectors used in the CATANA therapeutic beam.
2. Microdosimetric spectra.
3. Microdosimetric spectra mean values and LET calculations.
4. Mini-TEPC – Silicon-Telescope data comparison.
5. RBE monitoring with mini-TEPC.

Two different microdosimiters have been used: the sealed mini-TEPC and the Silicon-Telescope

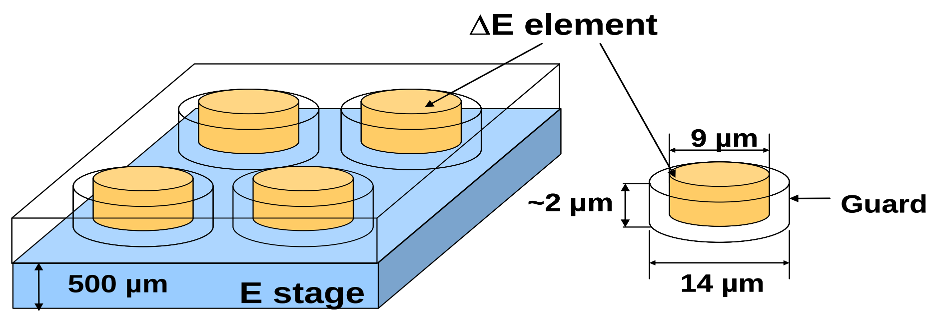
The sealed mini-TEPC



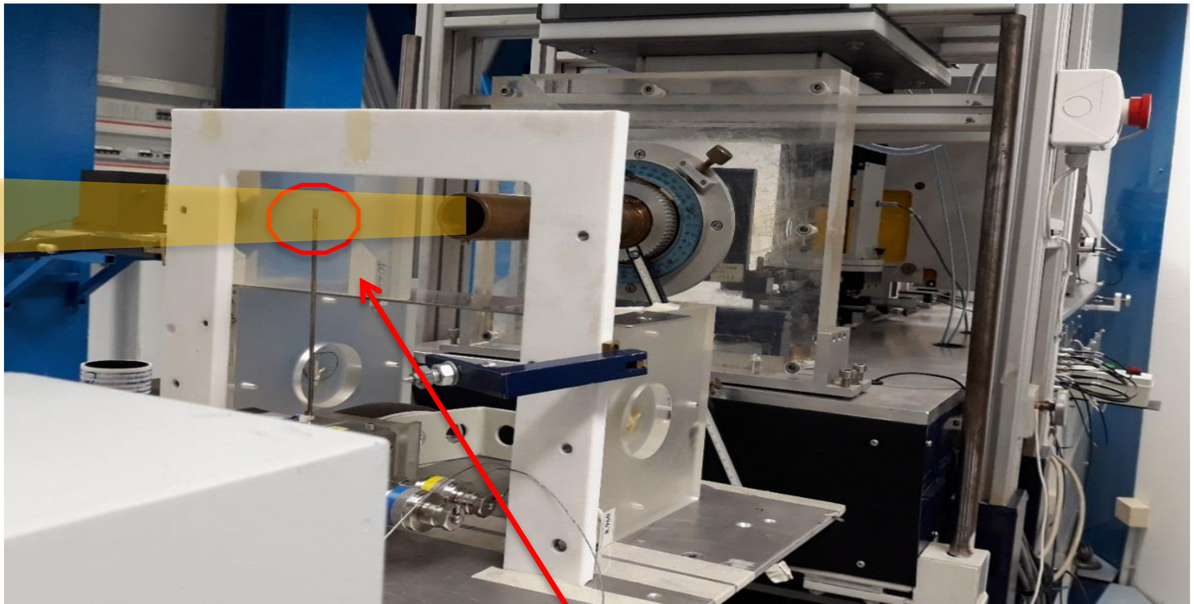
Sensitive Volume



The Silicon-Telescope with 7,000 pixels



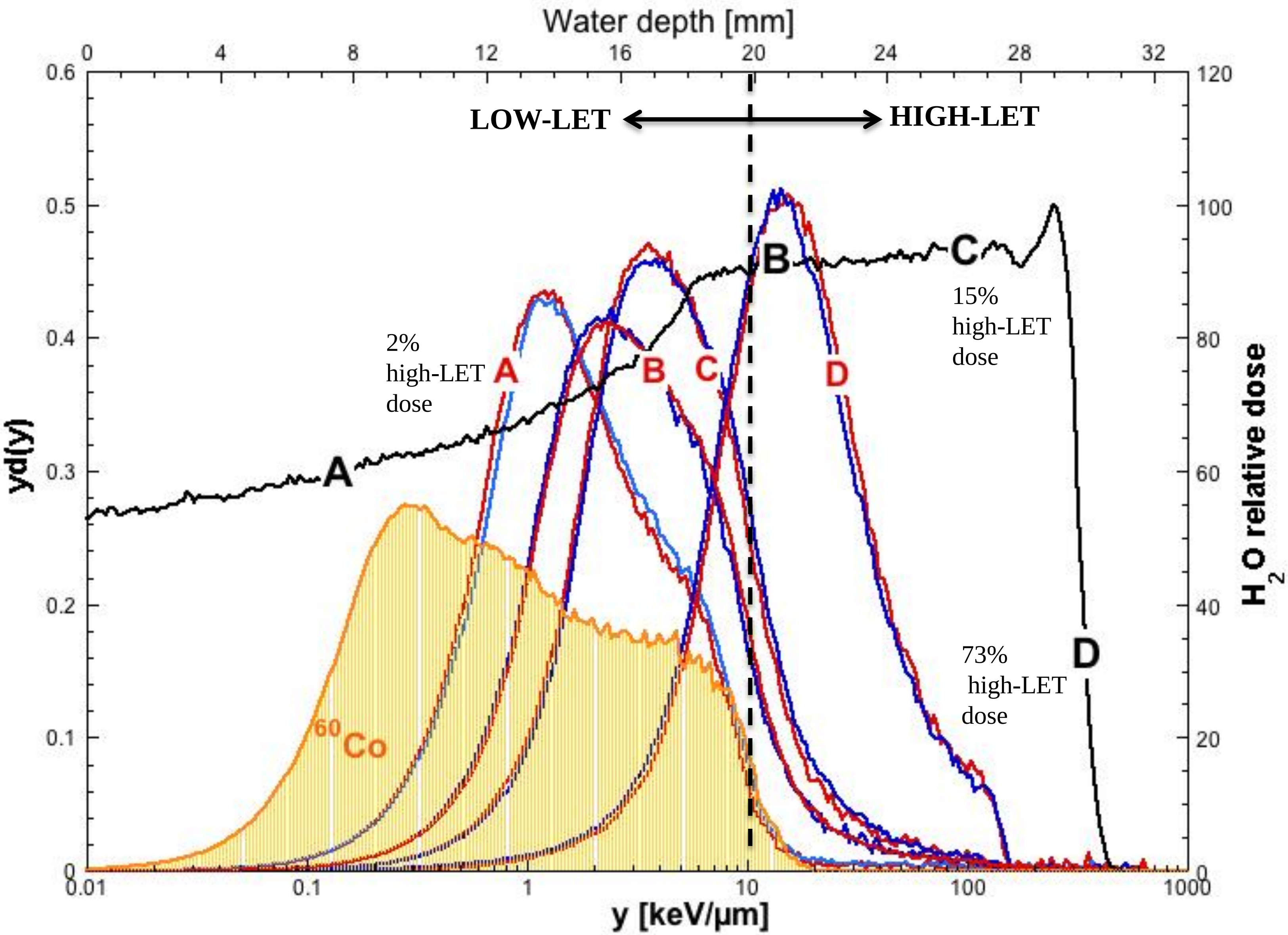
The proton therapeutic centre CATANA. Catania – Italy



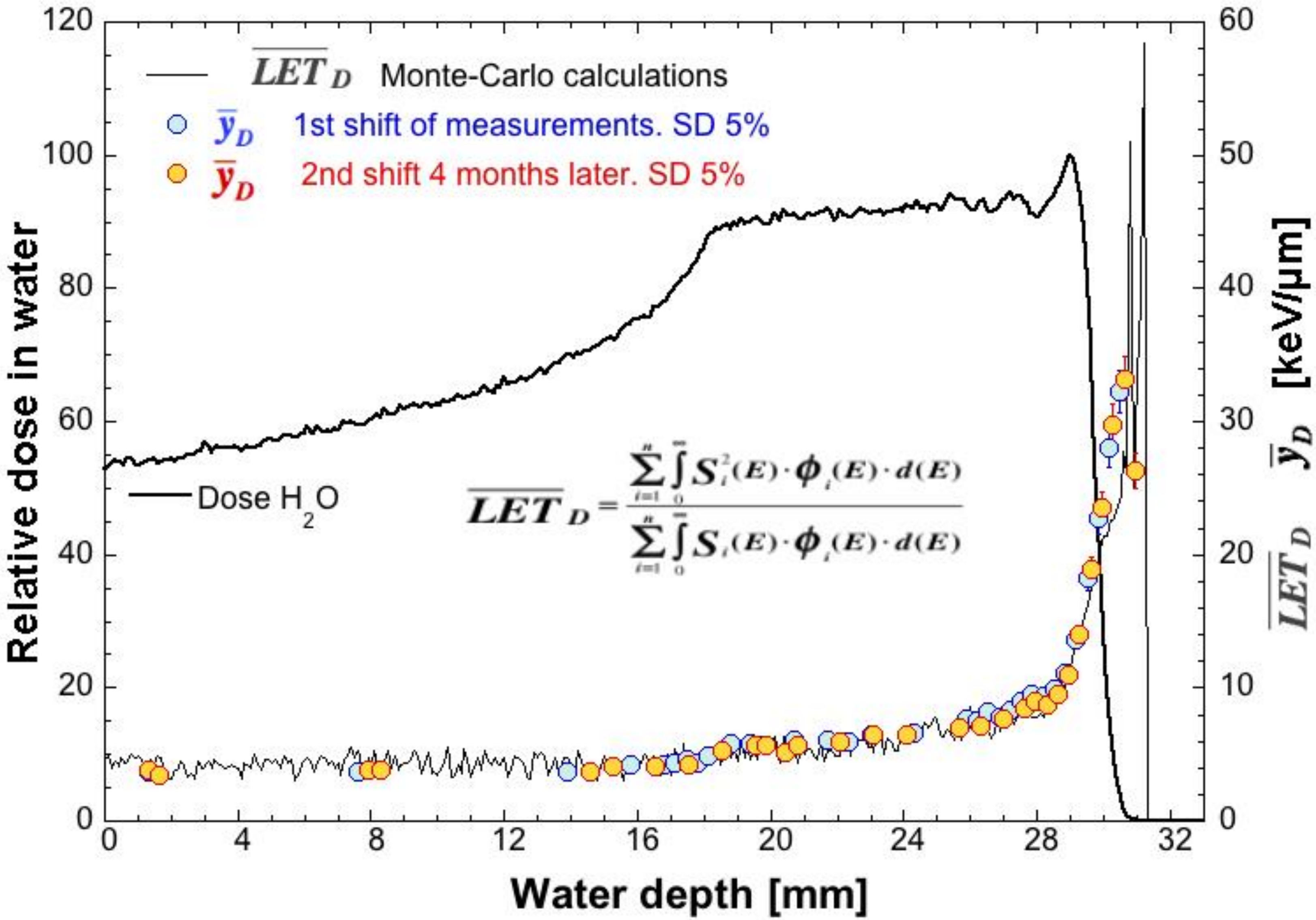
Mini-TEPC

62 MeV modulated-proton therapy beam: range of 2.9 cm. Measurements performed at different positions along the Spread–Out Bragg Peak, corresponding to positions of clinical relevance (entrance, proximal, central, and distal end of the SOBP

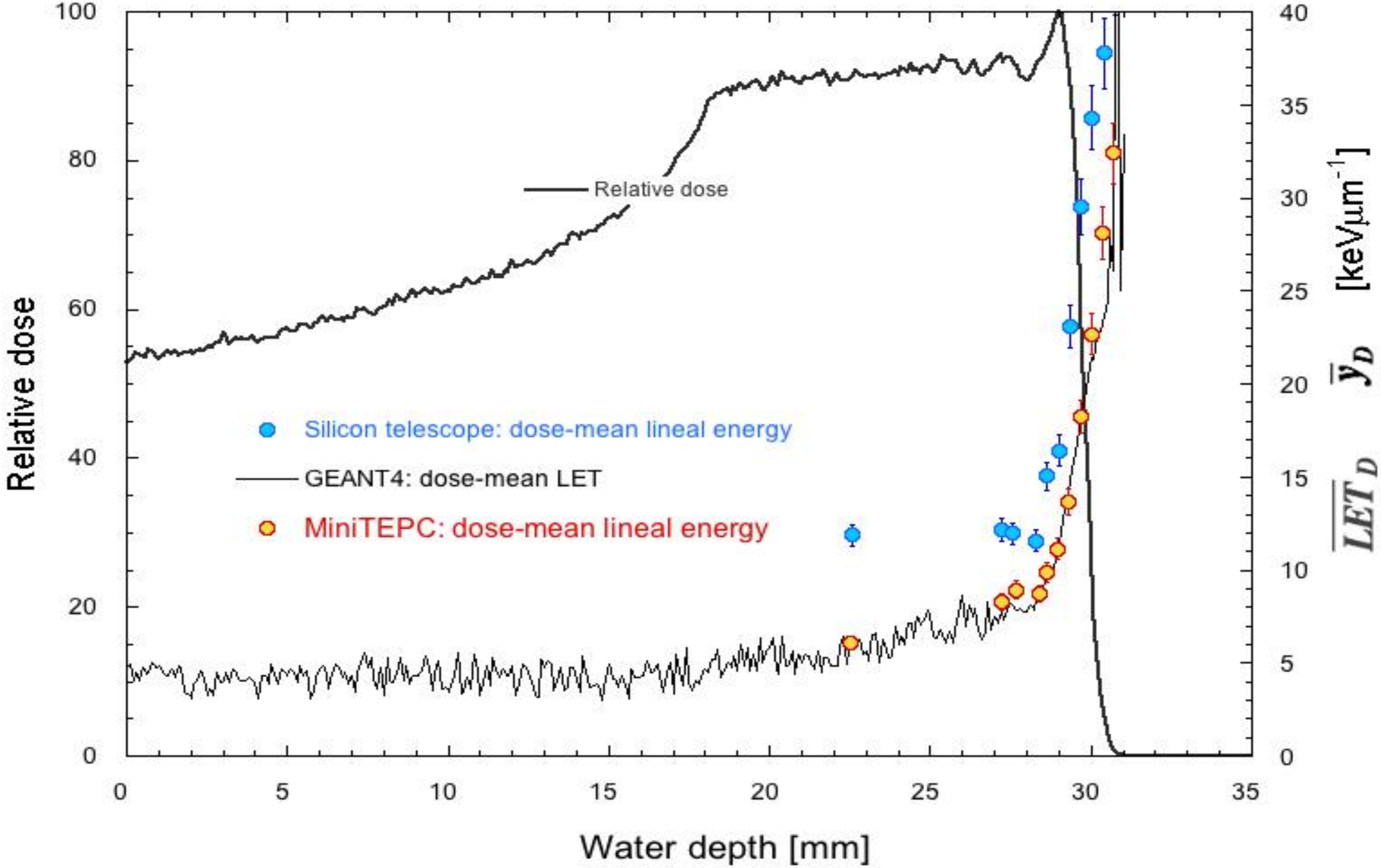
Is really the proton therapy a low-LET therapy ?



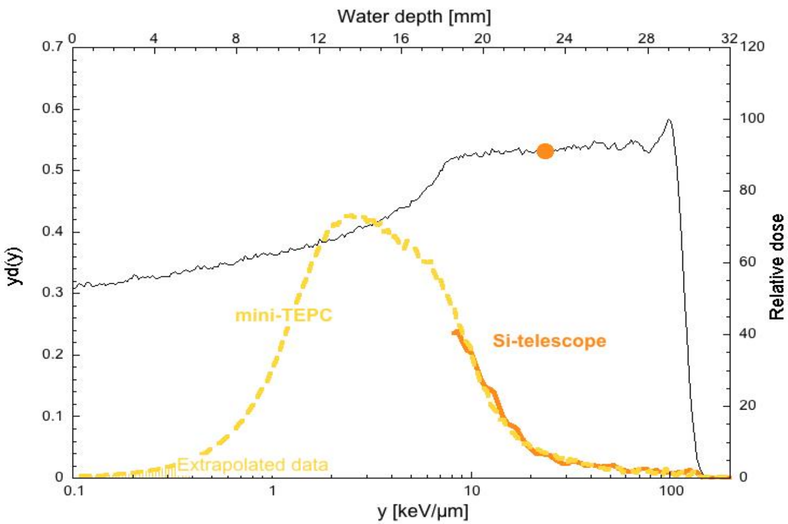
The dose-mean lineal energy $\bar{y}_D$ can be used as a measurement of dose-mean LET $\overline{LET}_D$

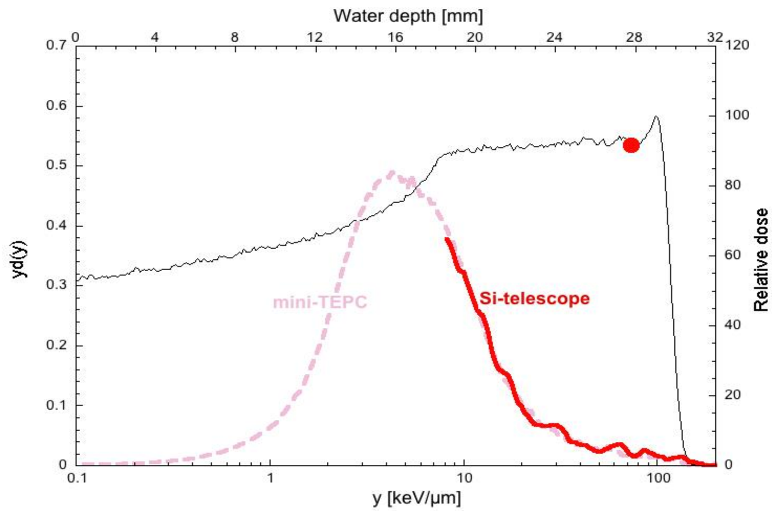


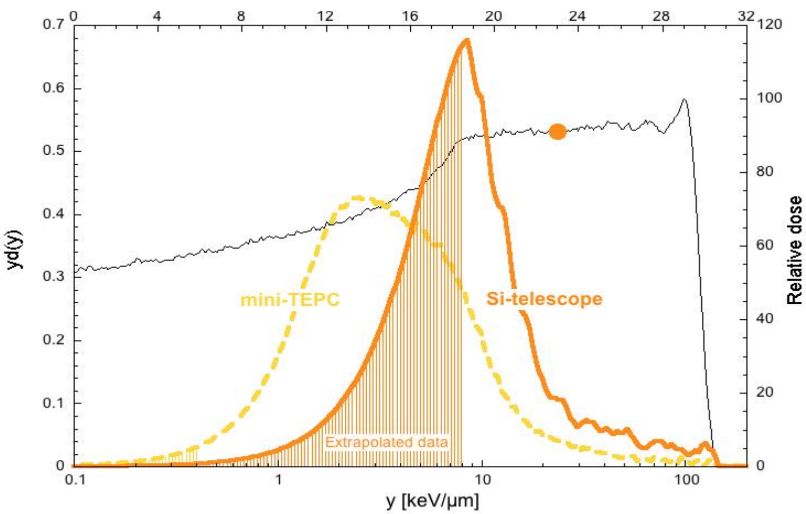
Also the $\overline{y}_D$ values measured with the silicon-telescope copy the $\overline{LET}_D$ values ?

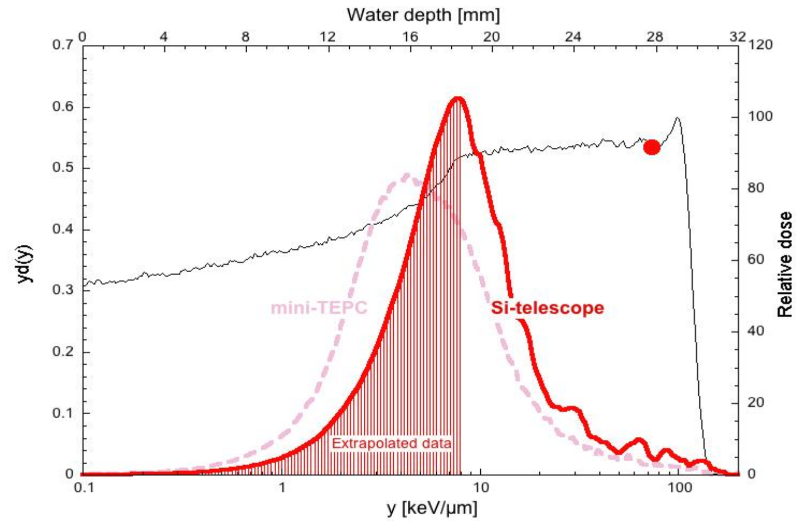


Silicon-telescope data are indeed equal to mini-TEPC data, but they suffer the high detection threshold

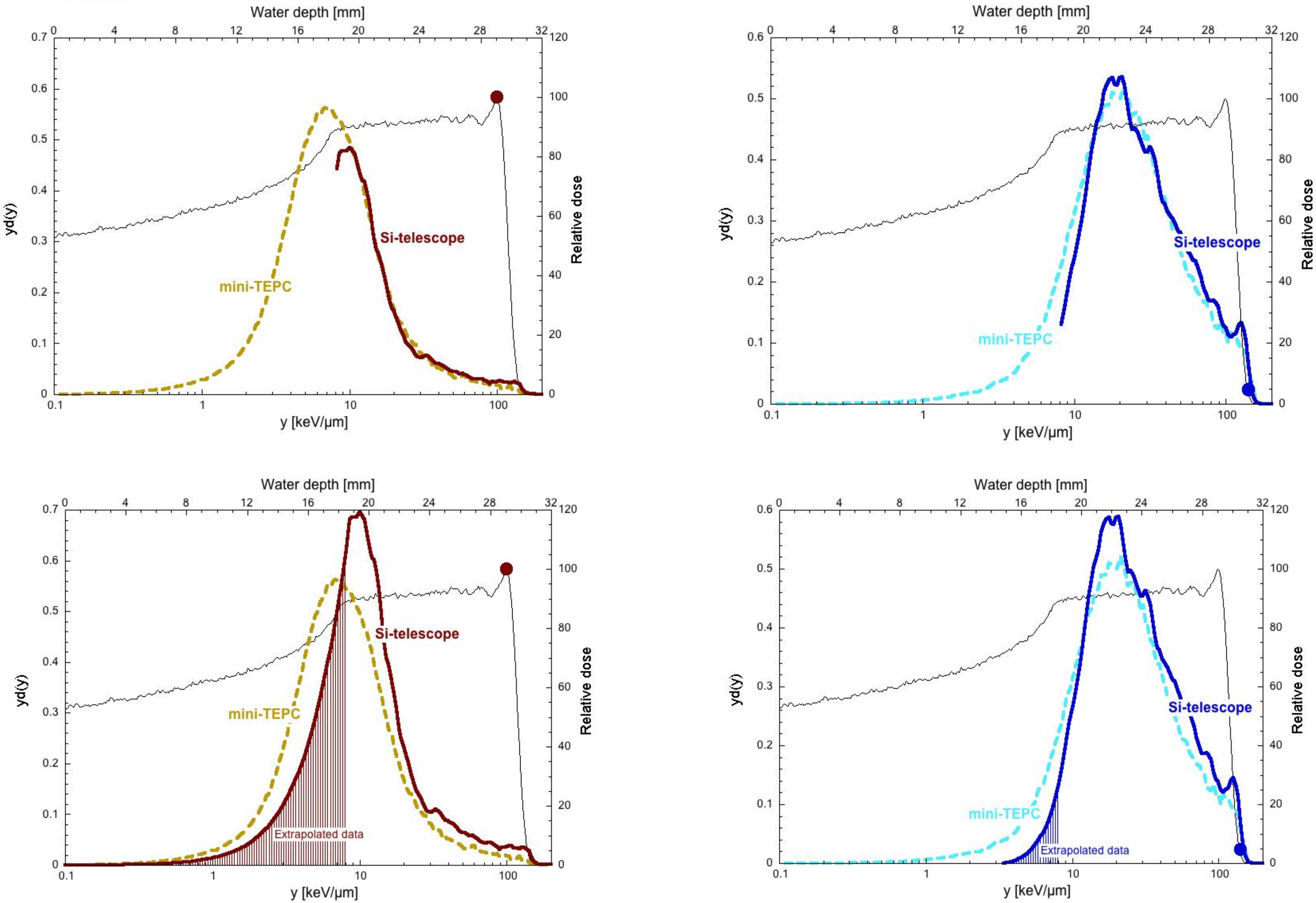




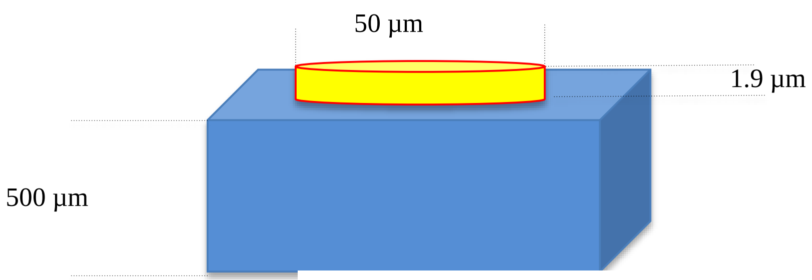




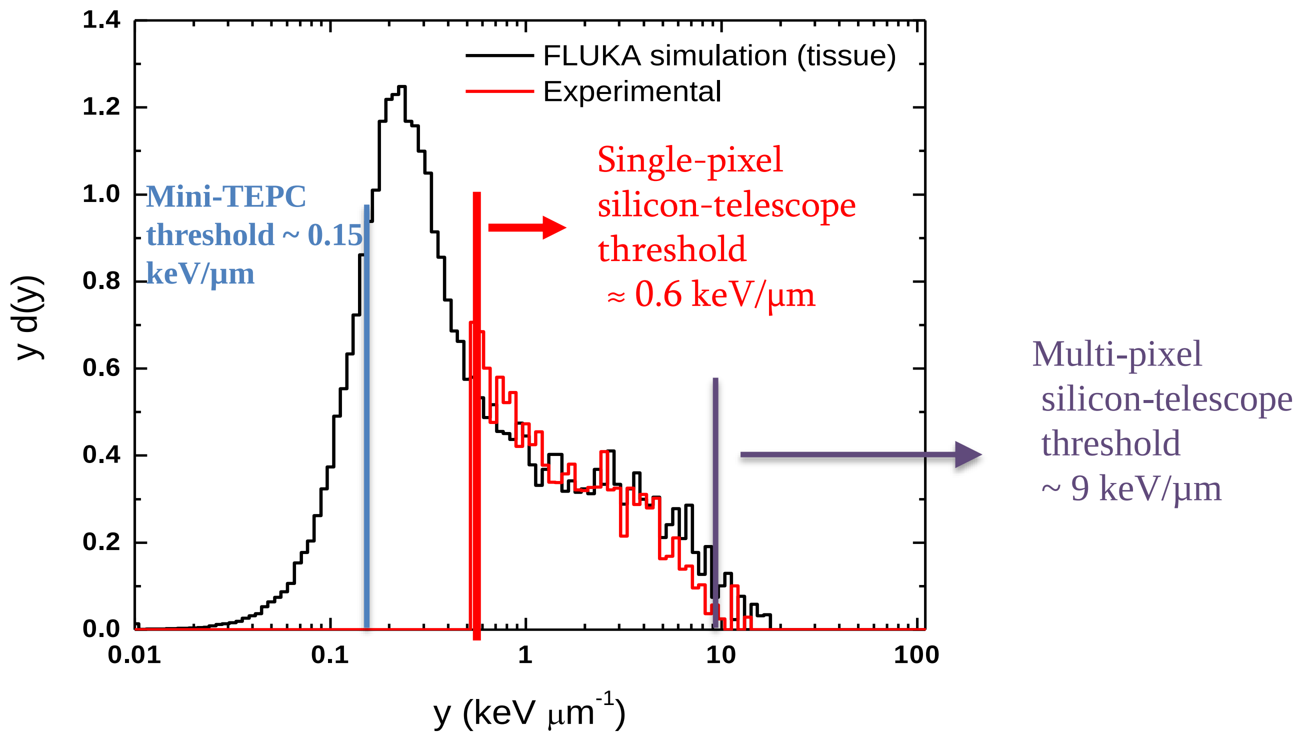
Only in the distal edge the silicon-telescope detection threshold distorts less the microdosimetric spectrum



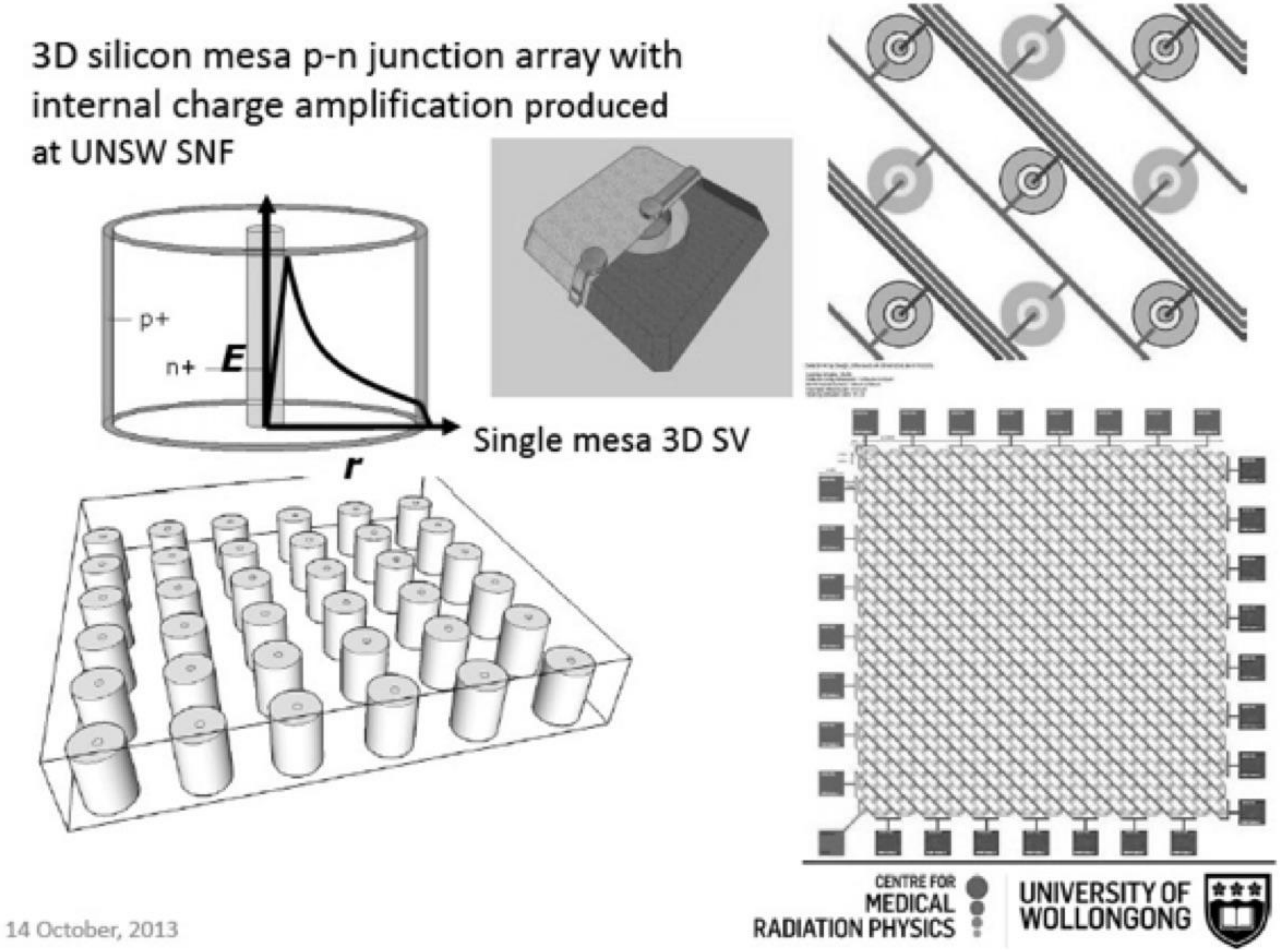
Silicon-telescope future: a large single pixel detector. It has the detection threshold comparable to that one of the mini-TEPC



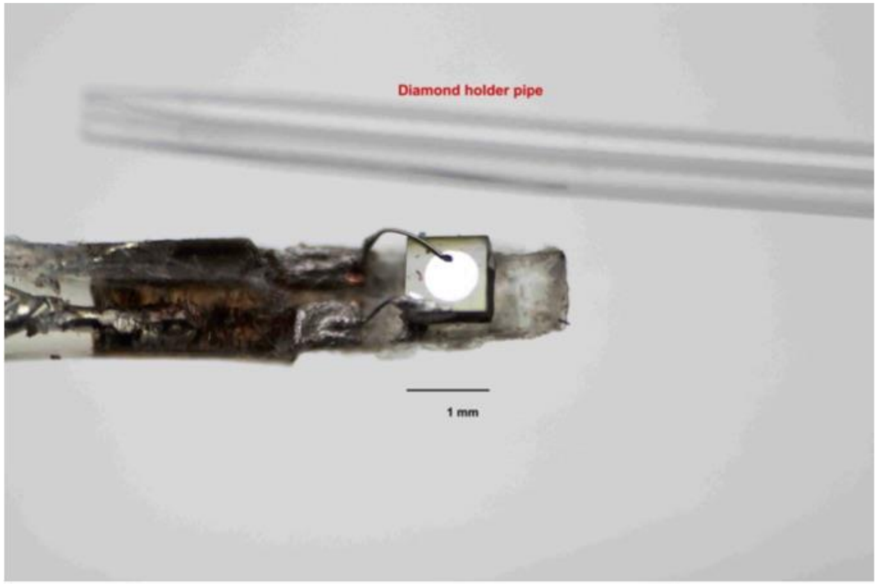
A telescope constituted by a **single ΔE cylinder** coupled to an E stage was irradiated with β particles emitted by a ^{137}Cs source

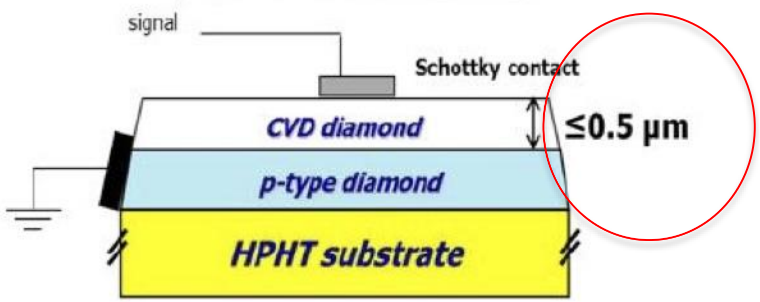


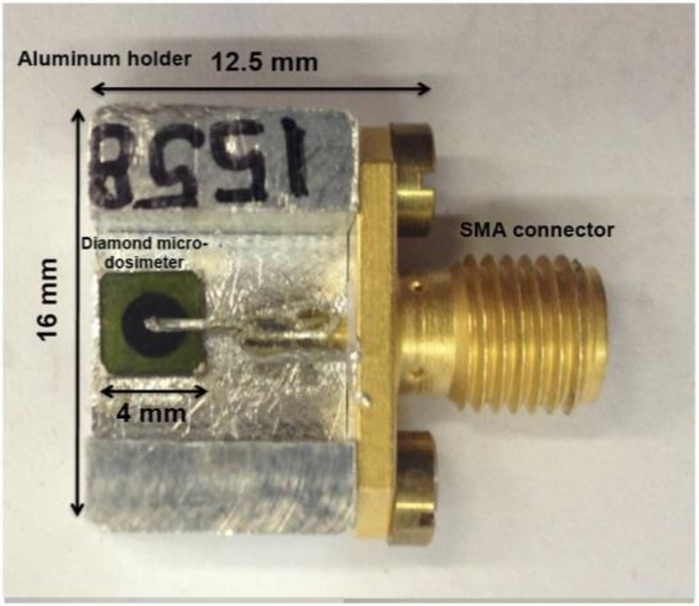
17 µm thick silicon detector is under experimental test with the 62 MeV therapeutic proton beam



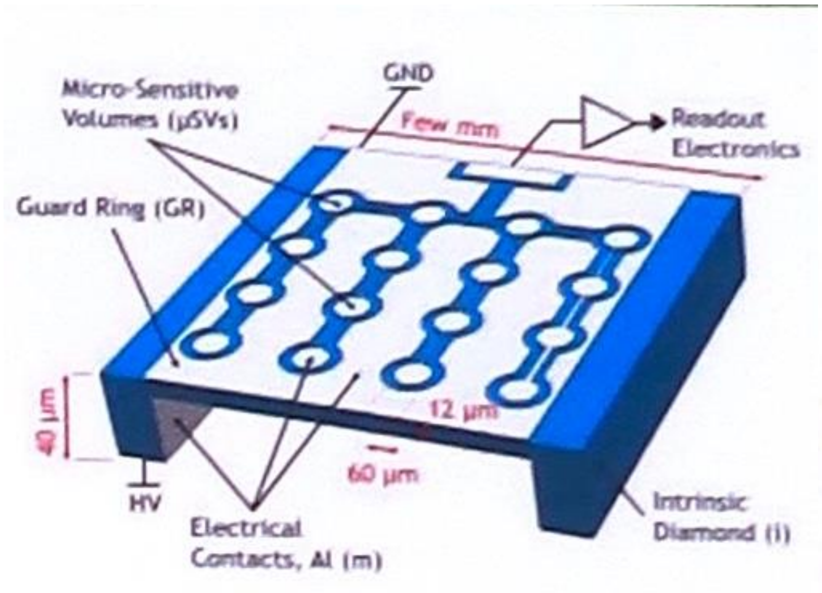
2 μm thick diamond detector

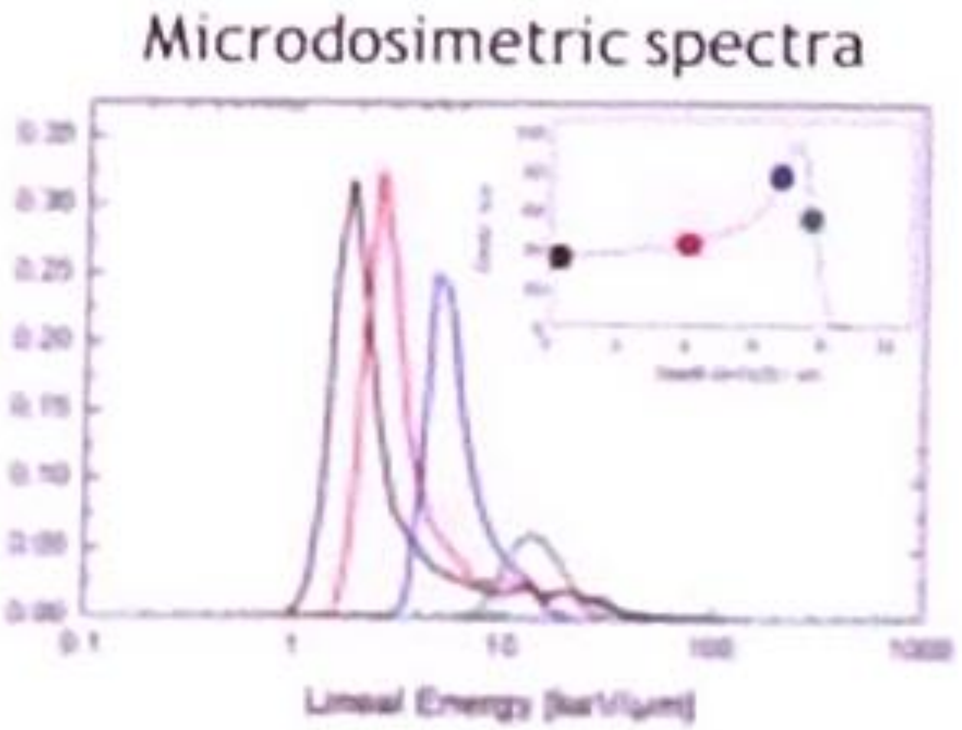




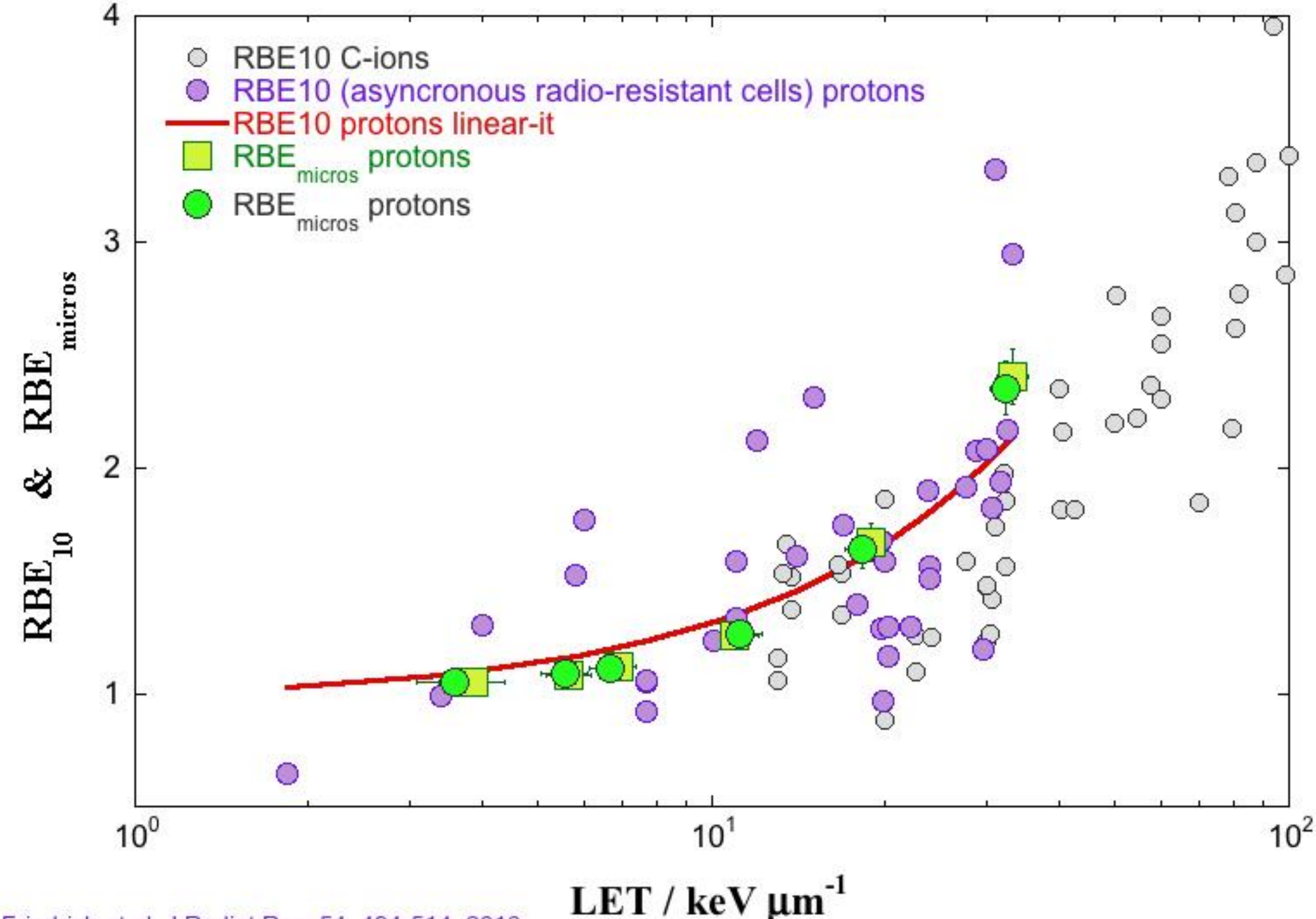


40 µm thick diamond detector



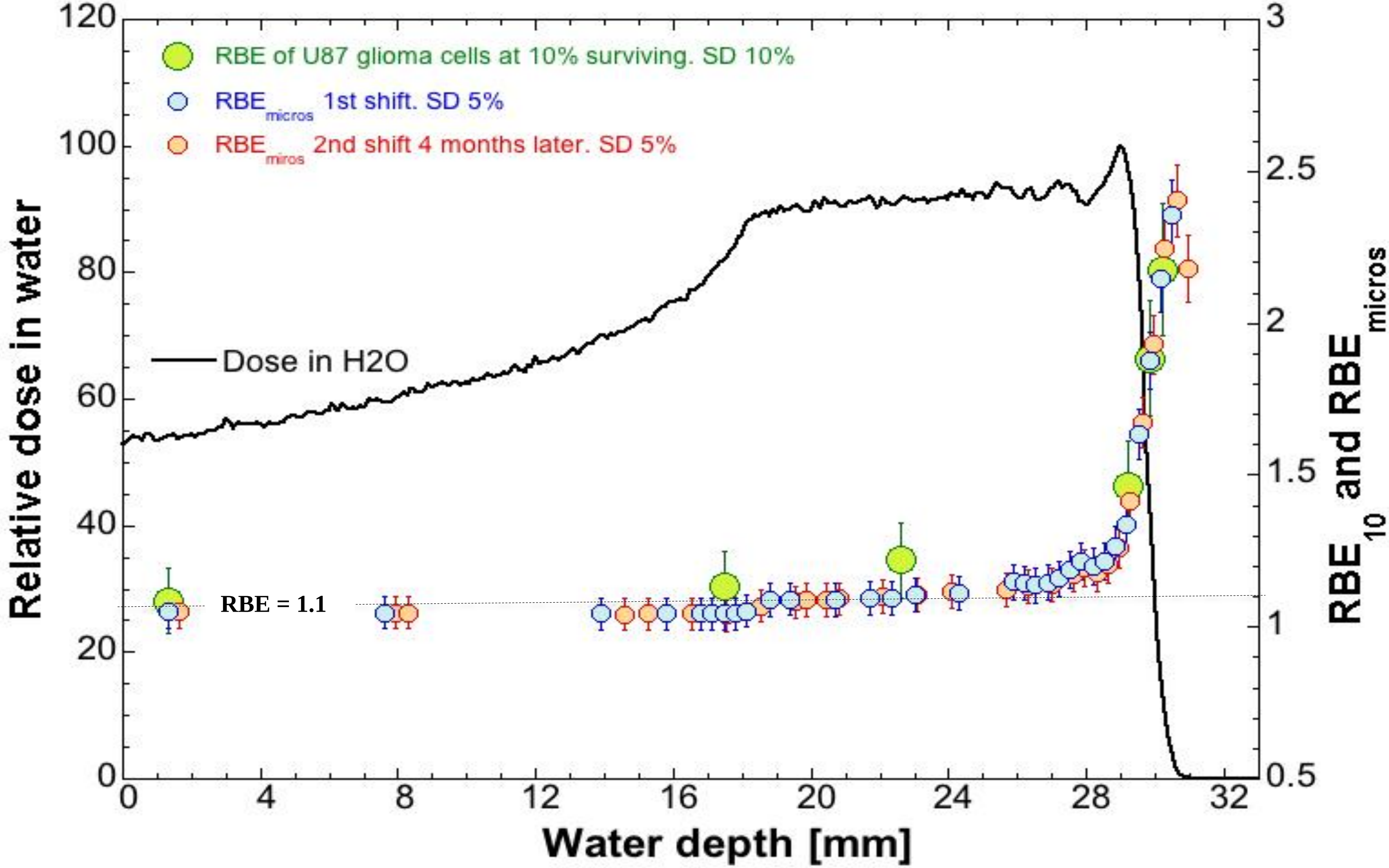


With a low detection threshold, it is possible to monitor with accuracy also the proton RBE



T.Friedrich et al. J.Radiat.Res. 54, 494-514, 2013

Microdosimetric monitoring of CATANA beam RBE



CONCLUSIONS

1. Mini-TEPCs can measure in sealed mode for months without significant modifications of the response.

1. That finding open to the possibility of using sealed mini-TEPC in clinic.

1. Mini-TEPCs are able to monitor with accuracy both the RBE and $\overline{LET}_D$ of therapeutic proton beams.

4. Because of the high detection threshold, the actual silicon-telescope detectors are able to monitor $\overline{LET}_D$ only in the distal-edge of the proton SOBP.

5. First measurements with a large "single-pixel" silicon telescope point out that the new silicon-telescope detectors could monitor $\overline{LET}_D$ of therapeutic proton beams at all the depths.

6. Recent measurements suggest that thick solid-state detectors (10-40 µm) could monitor $\overline{LET}_D$ of therapeutic proton beams with reasonable accuracy. Experimental data are in progress.