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CHARITÉ

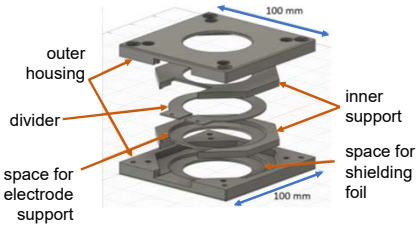
A low-budget transmission ionization chamber suitable for Flash-irradiations up to 1000 Gy/s

Abstract: A low-budget transmission ionization chamber was developed for Flash irradiations. The functionality and characteristic properties of the designed chamber were investigated with a 68 MeV proton beam.

Motivation

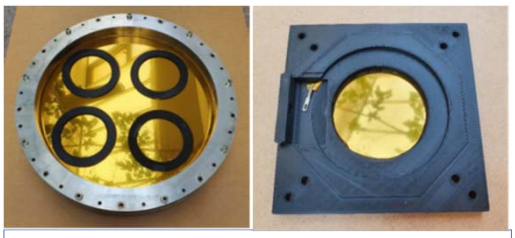
The so-called Flash-irradiation promises less side effects while maintaining tumour control. Very high dose rates in short times (more than 40 Gy/s) are applied. For precise dose delivery only a few ionisation chambers are available commercially, e.g., the Advanced Markus-chamber from PTW Freiburg. However, their influence on the beam makes them unsuitable as on-line dosimeters. Conventional ionization chambers exhibit saturation effects in the Flash-regime which may influence the precision of the dose application. In order to foster R&D in the Flash-regime at HZB, an ionisation chamber was developed, exhibiting a long range of linearity.

Construction



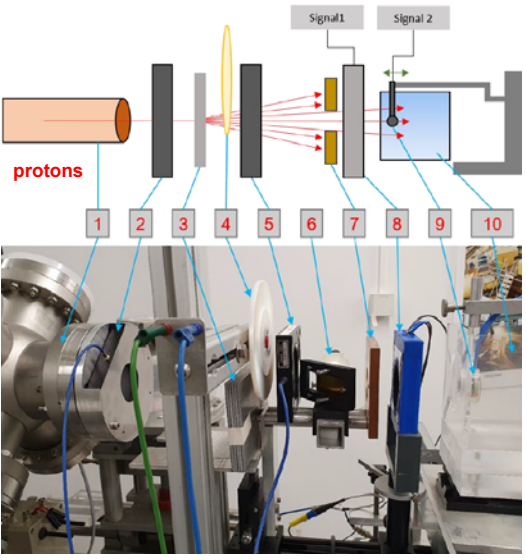
Exploded View of ionisation chamber: Between each of the five components a support ring covered with a foil is mounted: two electrodes and two shielding foils.
The outer size of 100 mm times 100 mm was chosen to allow a positioning of the Flash-chamber in the slots used for the standard ionisation chambers (model 7861, PTW Freiburg).

Electrodes



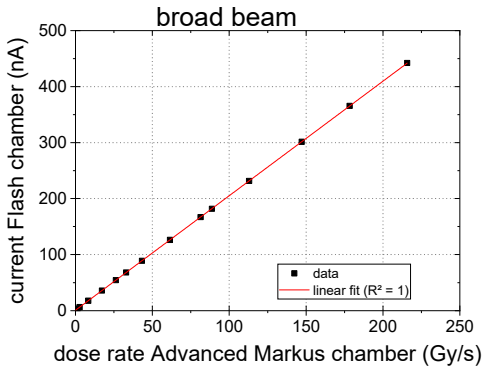
For the electrodes 25 mm Kapton foil with a coating of 30 nm Aluminium have been used. They were glued on the support rings. In order to avoid corrugations, the foils were tensioned in a sort of tambour frame. The electrical contact was made using a combination of clamps and soldering. To improve the shielding, the final version was equipped with an Aluminium housing.

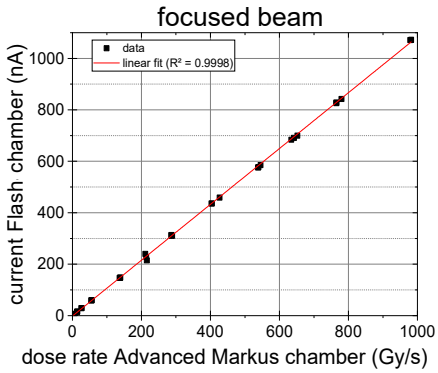
Experiments



(1) beamline, (2) ionisation chamber 7861, PTW, (3) absorber, (4) modulator wheel (5) ionisation chamber 7861, PTW, (6) mirror for light field, (7) aperture, (8) Flash-chamber, (9) Markus chamber, (10) Water phantom

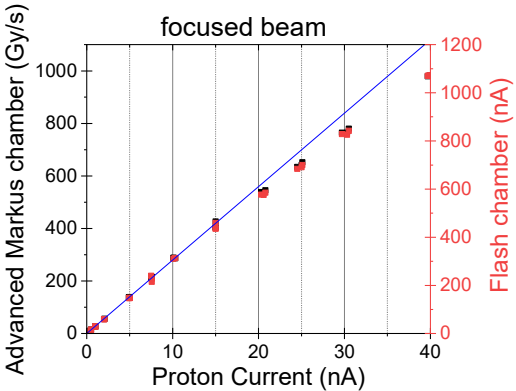
current in Flash chamber as a function of dose rate in Advanced Markus chamber
irradiation time: 200 ms





Results and Conclusion

- stability in time: better than 0.2%
- uniformity in space: better than 3%
- uniformity in place: better than 5%
- water equivalent thickness: 0.12 mm ± 0.01mm
- <u>dose linearity</u>
  - broad beam (tested up to 250 Gy/s): better than 1%
  - focused beam (tested up to 1000 Gy/s): better than 1% up to 380 Gy/s



A low-budget transmission ionisation chamber with low water-equivalent thickness has been built.
Stability over time and uniformity over space and place are good.
The Flash chamber exhibits the same response as the Advanced Markus chamber. For a focused beam for both chambers saturation effects are observed above 400 Gy/s.