ESTIMATION OF THE UNCERTAINTY OF ENERGY MEASUREMENTS IN CHARGED PARTICLE BEAMS USING RADIOCHROMIC FILMS

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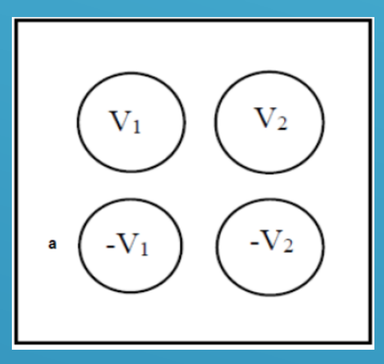
A few years ago, our group has developed anew method for measuring doses in ultra high dose rate charged particle beams, based on multivolume ion chambers - the QUADDRO detector. The measurement, however, did not account for the energy of the particles in the beam and such a measurement was done using radiochromic films placed axially in the beam. While performimg energy measurements in 10 MeV proton beams it became apparent that the accuracy of the energy measurement is very sensitive to the accuracy of the axial allignment of the film. The present work is meant to estimate the errors due to missalignment. Several experiments have been made using Gafchromic EBT4 films in axial presentation, both in electron an proton beams. We present here the error estimations resulting from these measurements, as well as their impact of the dose measurements using the new QUADDRIL detector.

QADDRO – THE DETECTOR CONCEPT

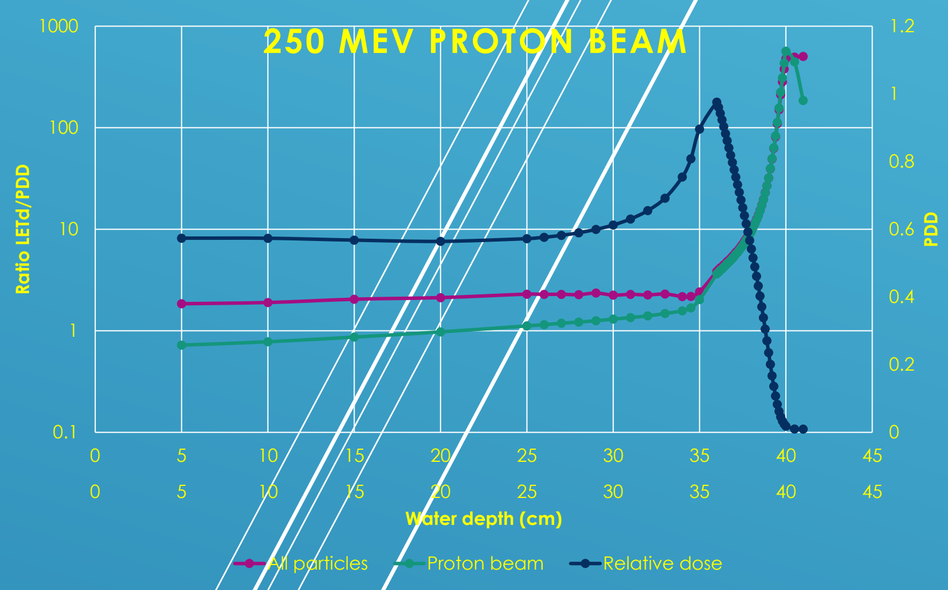


The QADDRO detector – from the design to the proof of concept . For UHDR fields, the recombination correction is determined via the Peterson logistical model (hence the need for calibration):

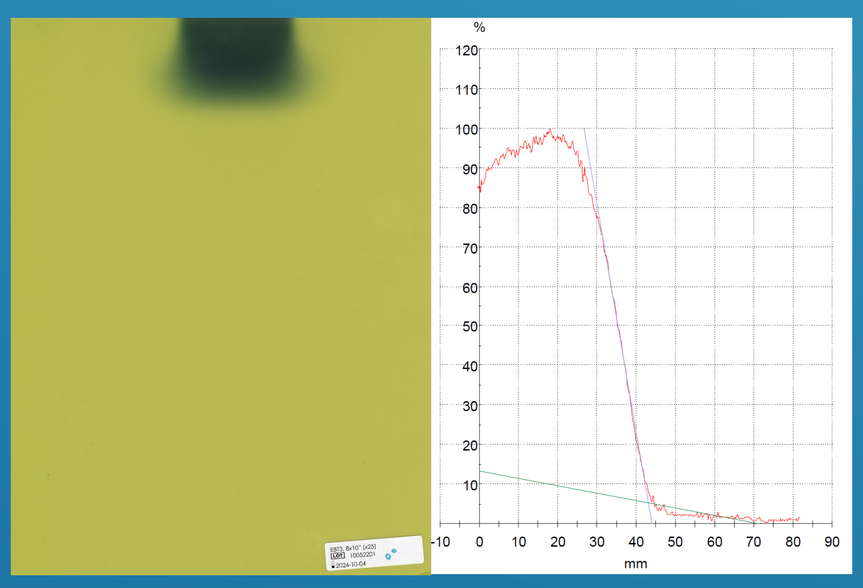
$$k_s = \left[1 + \left(\frac{D_p}{k_s V}\right)^{\alpha}\right]^{\beta}$$

QADDRIL – A SOLUTION FOR UHDR & LET MEASUREMENTS

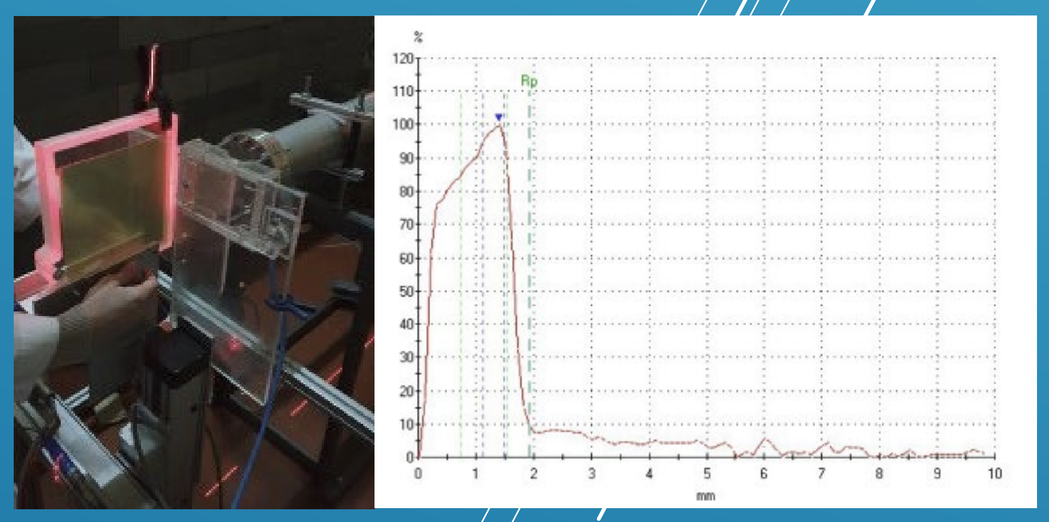
- Based on a combination between QADDRO-fm and PDD measurements
- LET measurement is necessary for dose & LET based TP (variable RBE)
- QADDRIL will use the PDD measurements made with QADDRO and the FLUKA simulations to calculate LET_D from the PDD



Energy Measurements using EBT3 Films



Electrons: 9.11 MeV (nominal energy 10 MeV)



Protons: Rp [mm] 1.92 → 14 MeV

Gantry angle (deg.)	Measured energy (Ep(0), MeV)	Deviation from 0° (%)
0°	9.11	-
1°	9.13	+0.22%
2°	9.08	-0.33%
3°	9.14	+0,33%
4°	9.12	+0.11%
5°	9.15	+0.44%

- **CONCLUSION**: The use of radiochromic films for energy measurements in axial geometry is a relaible method; for 10 MeV electrons this method was not significantly angle dependent for the range 0° – 5° . The errors due to misalignments at lower electron energies and protons are still evaluated, but we do not expect significant errors.