Trento Institute for Fundamental Physics and Applications

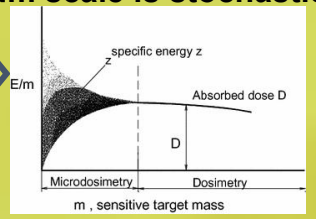
Physics PhD Workshop

UNIVERSITÀ DI TRENTO

HDM: Hybrid Detector for Microdosimetry

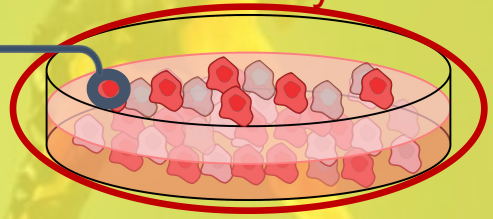
The physical parameters describing the radiation field are obtained by measuring the energy depositions in tissue at a **micrometer** scale (same of a cell nucleus, where the main radiation damage occurs -> DNA damage)

Energy deposition at µm scale is stochastic!



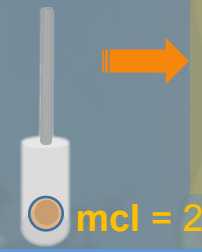
Microdosimetry

Dosimetry → mean values over cells population



Microdosimetric quantities

Lineal energy y (energy deposited over the TEPC **mean chord length (mcl)**)

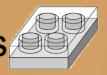


frequency spectra of y and other standard microdosimetric quantities are obtained for characterizing the radiation field

mcl = 2/3 * r

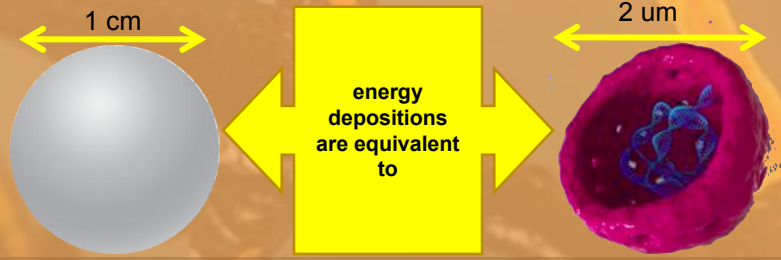
Detector

Existing detector for microdosimetry

1. solid state microdosimeters 
2. gas microdosimeters 

Tissue
Equivalent
Proportional
Counter

ACTIVE REGION: sphere filled with propane gas (tissue-equivalent) at such a low density that:



Hybrid

NEW

NEW

$$y_T = \frac{\varepsilon}{rtl}$$

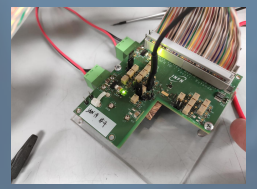
Energy deposition of all particles traversing the TEPC

Real track length of particles (with 4 layers of strips of LGAD)

+ improved spatial resolution

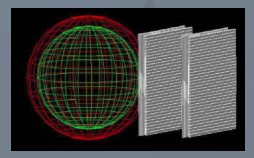
Missiaggia, M., et al. "**A novel hybrid microdosimeter for radiation field characterization based on TEPC detector and LGADs tracker: a feasibility study.**" Frontiers in Physics (2020).

READOUT



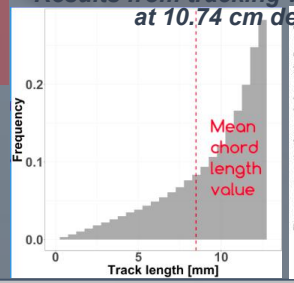
- FPGA-based
- chip and test board are being produced (INFN Turin, Italy)

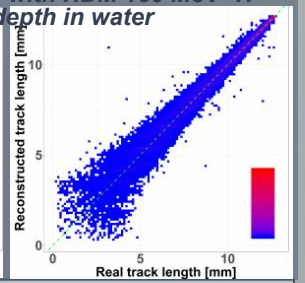
Geant4 simulations to assess the feasibility of HDM



- for ^{1}H and ^{12}C beams
- for different LGAD configurations

Results from tracking with HDM 150 MeV ^{1}H at 10.74 cm depth in water





FUTURE WORK:

- More advanced tracking algorithm via machine learning to be able to track particles even without a complete information
- Time-dependent Geant4 simulations of HDM to develop final FPGA-based readout of the hybrid detector
- New model to estimate the radiobiological damage based on HDM spectra

M. Missiaggia, E. Pierobon, M. Castelluzzo, A. Perinelli, F. Cordoni, M. Centis Vignali, G. Borghi, V. E. Bellinzona, E. Scifoni, F. Tommasino, V. Monaco, L. Ricci, M. Boscardin, C. La Tessa

Contact information: *marta.missiaggia@unitn.it, enrico.pierobon@unitn.it*