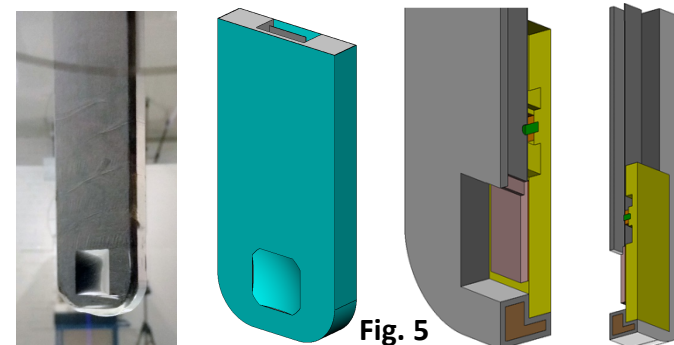


Background and aims

In the EMPIR project 18HLT04 UHDpulse, ADVACAM and Czech Metrology Institute work together on the development of methods for measurement of absorbed dose-to-water using Timepix3-based pixelated spectrometric radiation detectors, both inside and outside of pulsed beams with high dose-per-pulse. Monte Carlo (MC) simulations are used to determine the response of Timepix detectors to particular particle types, energies, and incidence angles which may not be possible to measure separately. MC simulations model the real track structure of the signal measured by the TimePix detector.

Monte Carlo and data analysis

- MCNP6.2 code used
- Pixel-level detailed model (256×256 pixels, 55×55 μm² pixel size) using a lattice, **Fig. 5**
- Deposited energy in pixels stored in ASCII file (PTRAC file) and evaluated afterwards
- Analysis using a dedicated Matlab script
- The script includes an analytical model of charge sharing effect (**Fig. 4**) for precise modelling of so-called clusters of adjacent hit pixels observed in measured data due to charge sharing and drift processes (**Fig. 3**), in addition to the particle track itself (**Figs. 1-2**)
- Output stored in the same format as measured data (list of adjacent pixels and deposited energies) for advance processing using ADVACAM Pixet track processing software.



Left to right: Timepix3 detector in water phantom; MC model of the same setup; front detail without waterproof cover; back detail without the cover.

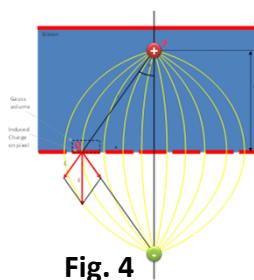


Fig. 4

Top:
Schematics of
charge sharing
effect
(provided by
ADVACAM)

Validation

- For Am-241 and Cs-137 photon fields (**Figs. 6-9**)
- For other sources and particle types under way
- Includes detector energy resolution.

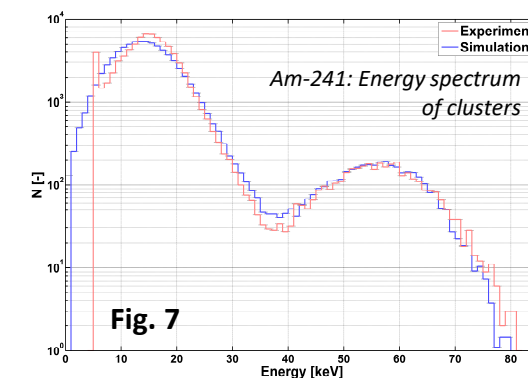


Fig. 7

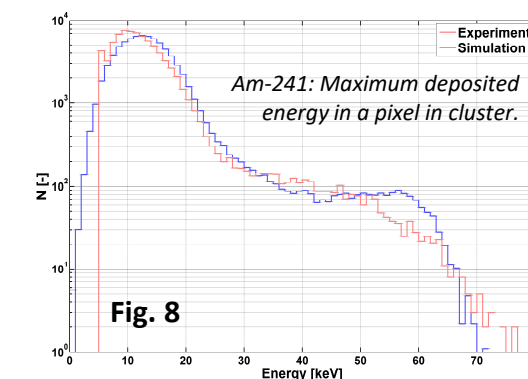


Fig. 8

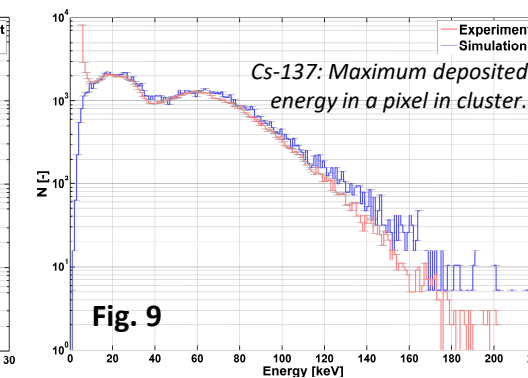


Fig. 9

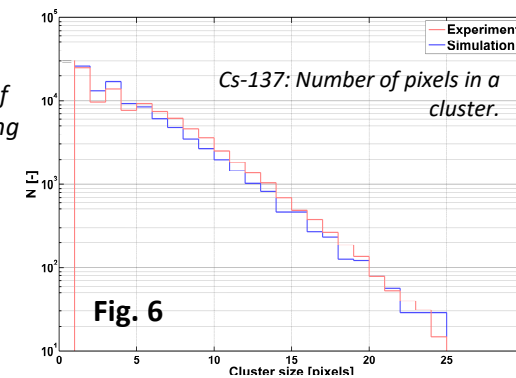


Fig. 6

Visualization of simulated clusters: left - 3 MeV electrons, centre - 230 MeV protons, right - 230 MeV protons with charge sharing effect. Particles are emitted from a single point located just in front of the detector.

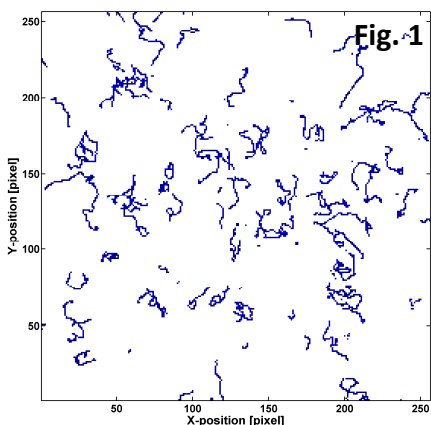


Fig. 1

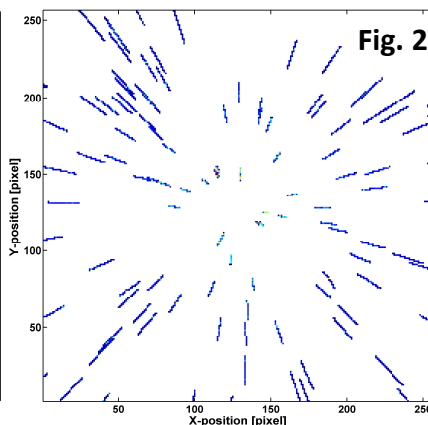


Fig. 2

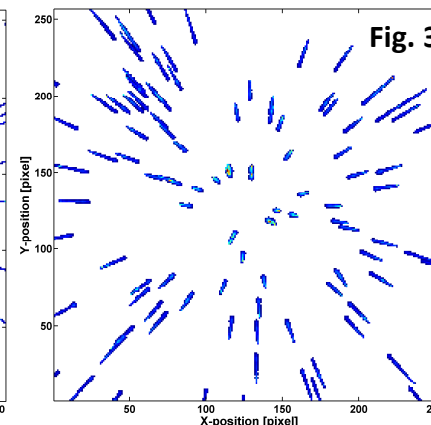


Fig. 3