

ARDENT

Advanced Radiation Dosimetry European
Network Training initiative

WP2: Solid state detectors

Zdenek Vykydal



POLITECNICO
DI MILANO



Objectives

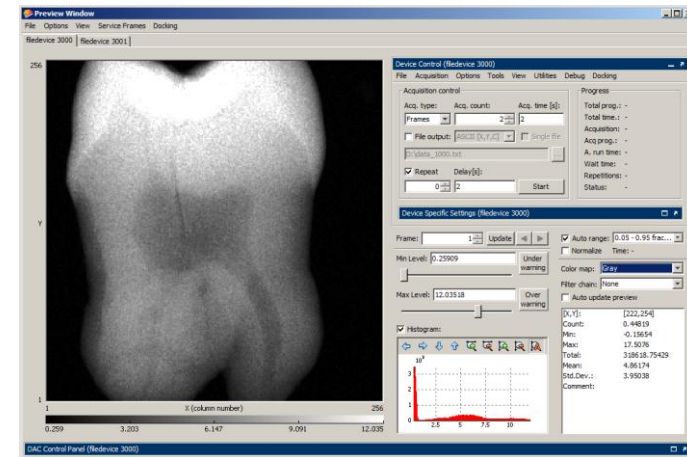
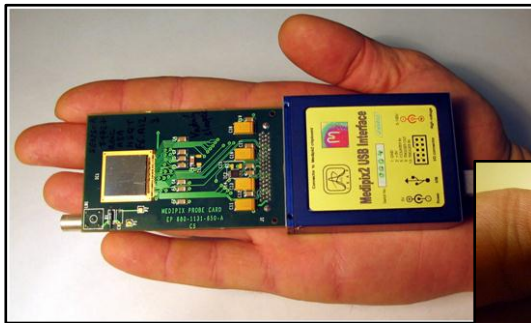
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- Advanced characterization of general mixed radiation fields for:
 - Particle accelerators
 - Homeland security
 - Aircrafts and space
 - Medical applications
 - Radiation safety
- Development and improvement of instrumentation and methodology for measurement of the mixed field particle composition and spectral characteristics
- Combining the information from different detectors

Present status

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- Medipix / Timepix technology (patent issued on the quantum dosimetry with pixel detectors)
- Several readout interfaces and dedicated software (Pixelman) available



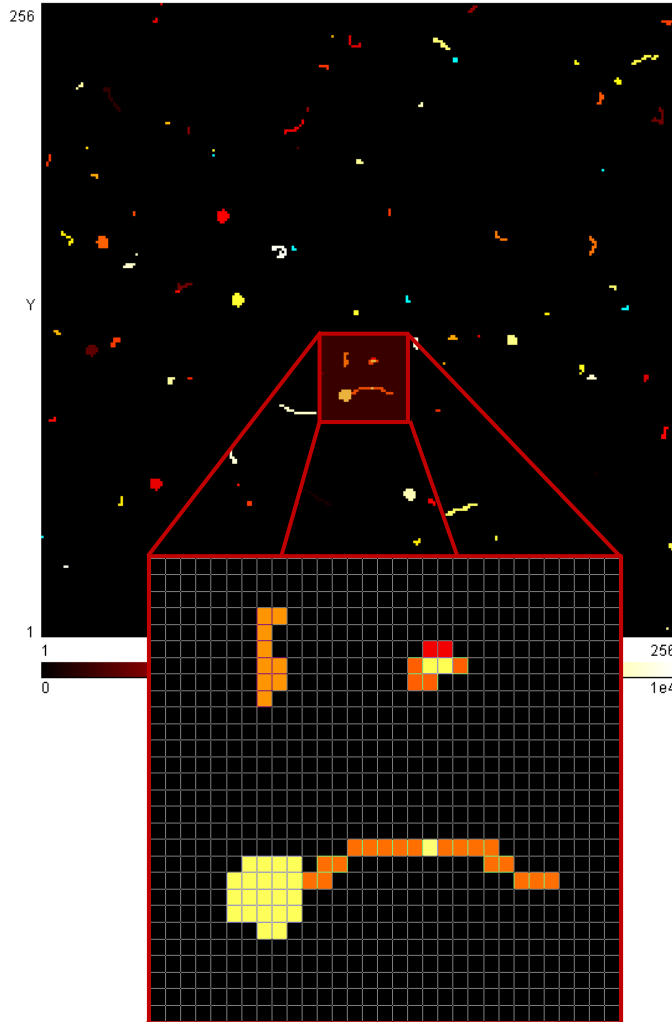
- Experience from measurements and calibrations
 - ATLAS experiment field
 - Hadron beam therapy (Heidelberg)
 - Neutron and photon fields
- First dosimetric calibrations of Medipix detectors in photon fields

Energy and time information

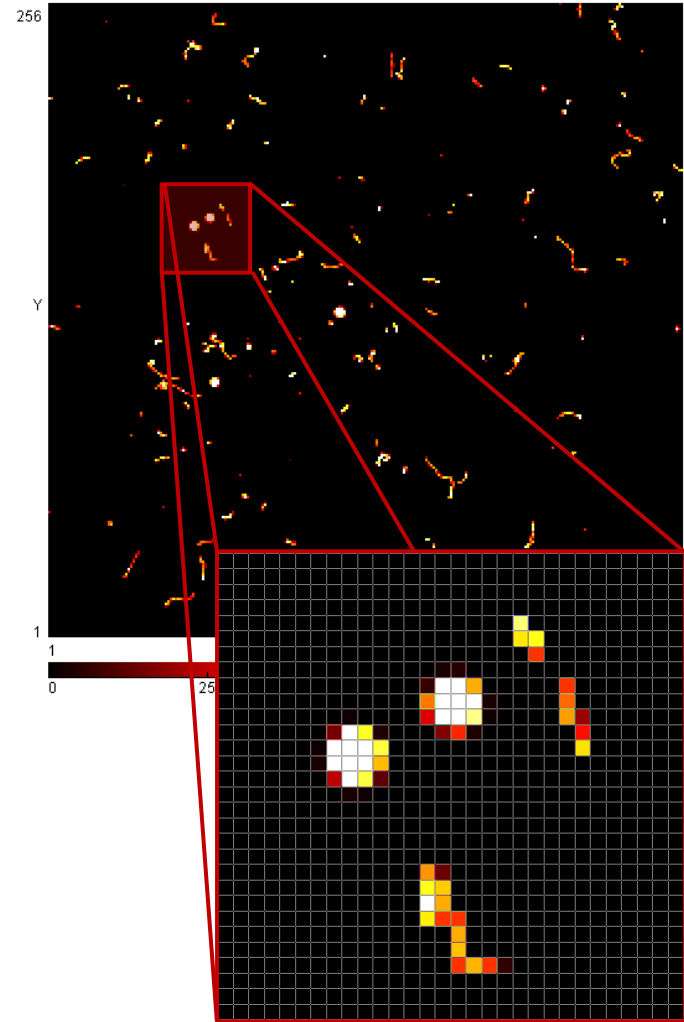
Timepix in tracking mode in response to ^{226}Ra source

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Time of Arrival mode \sim TIME



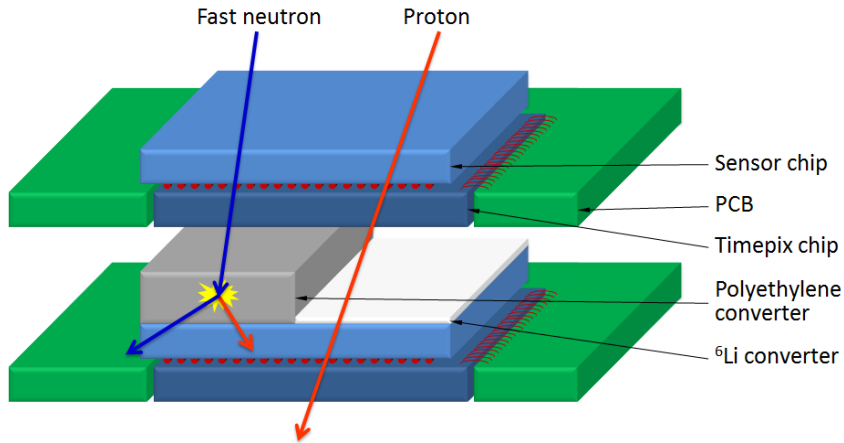
Time over Threshold mode \sim ENERGY



Coincidence information

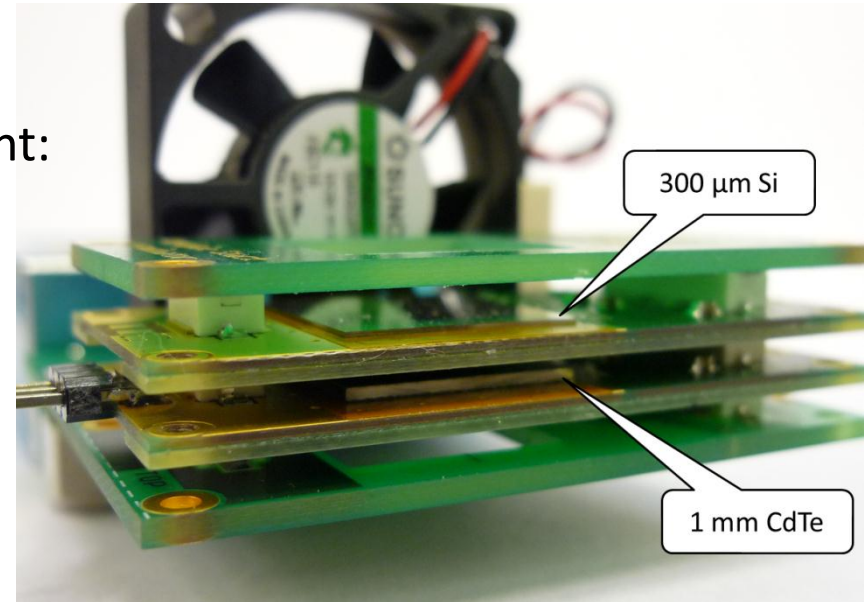
Timepix telescope

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- Several sensitive layers to measure angular dependence of the radiation field
- Converter/filter materials in between for noncharged particles identification

- Possibility to combine different:
 - Sensor materials
 - Sensor thicknesses
 - Bias voltages

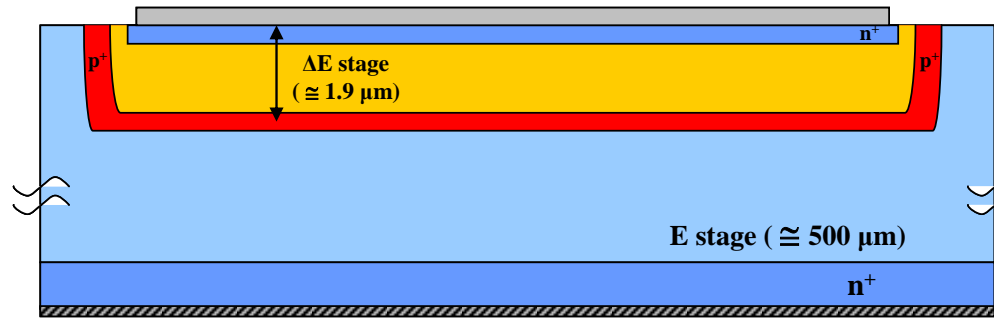


Silicon microdosimeter

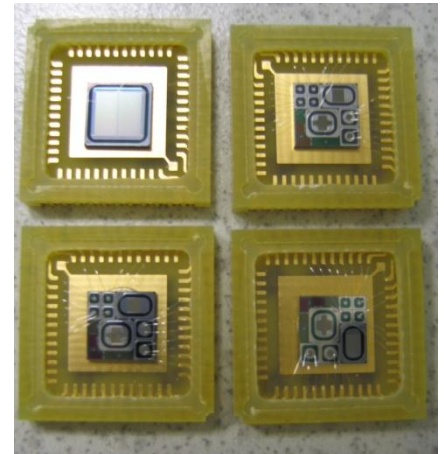
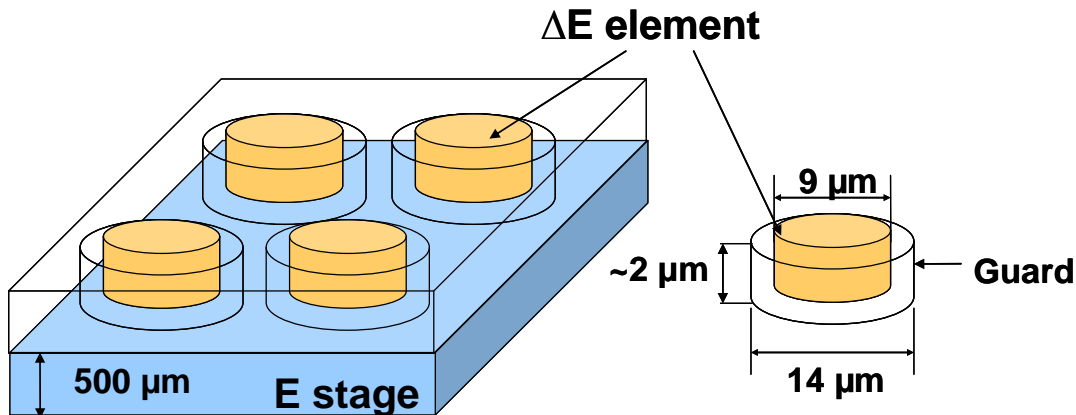
(designed in collaboration with ST-Microelectronics)

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Segmented silicon telescope:
a thin ΔE stage (1.9 μm thick)
coupled to a residual energy
stage E (500 μm thick) on the
same silicon wafer.



ΔE stage : matrix of cylindrical diodes ($h = 2 \mu\text{m}$, $d = 9 \mu\text{m}$)

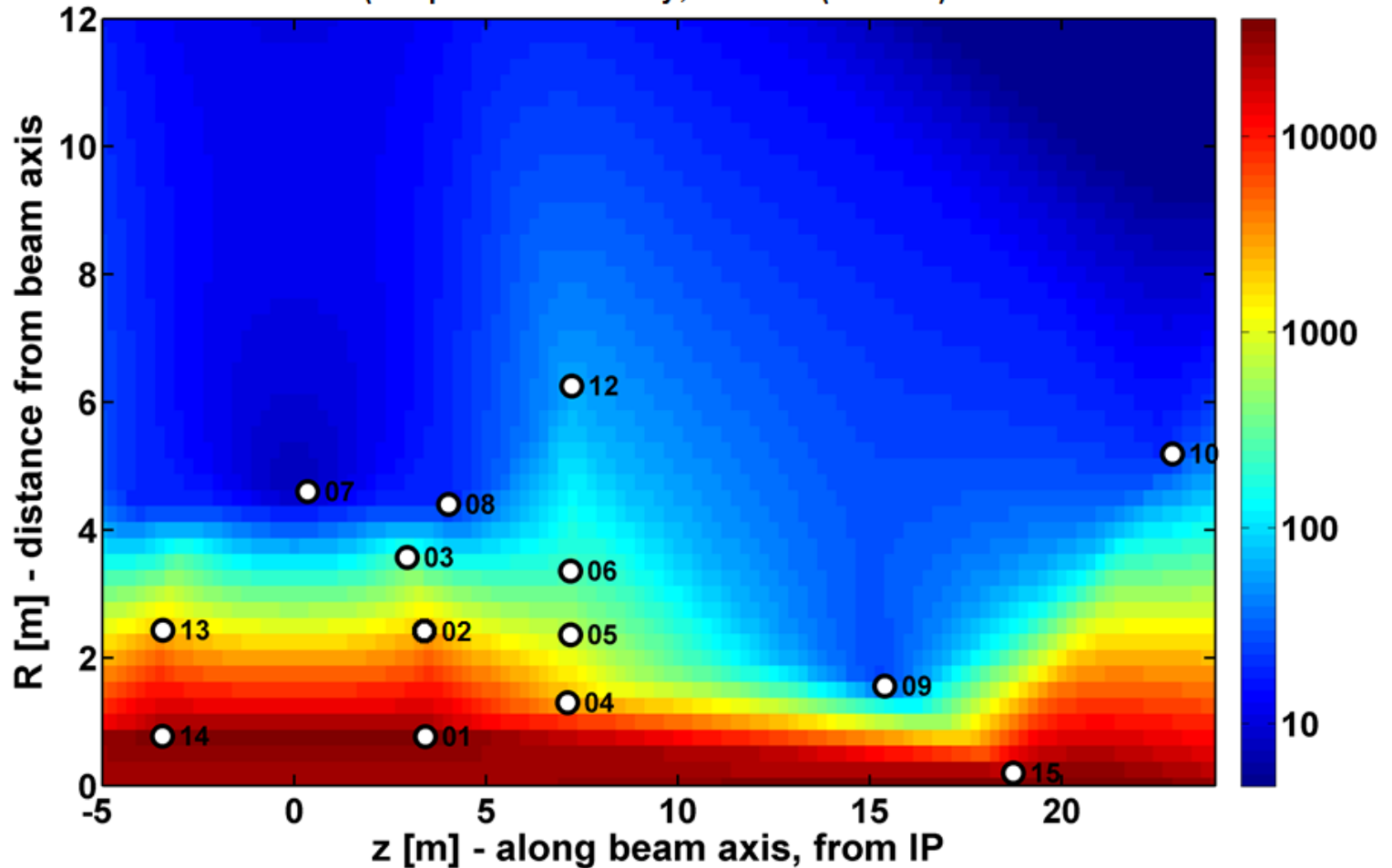


More than 7000 pixels are connected in parallel to give an effective detection area of the ΔE stage of about 0.5 mm²

ATLAS-MPX - combined information from distributed network of Medipix detectors

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Thermal neutron flux distribution measured by ATLAS-MPX detectors
(flux per unit luminosity; neutrons/(cm².nb⁻¹))



Next steps

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- Upgrade of the current Timepix readout interface to radiation hard environments
- Dosimetric calibrations for highly ionizing particles and other radiation of interest
- Optimization of the coincidence information from the telescope
- Improvements in the pattern recognition system using the information from TOT, TOA and/or from neighboring detectors
- Software for combination of the results from several distributed external units (of the same or different type).

Collaborations

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- CERN
- CTU
- POLIMI
- Jablotron
- University of Houston
- University of Wollongong
- ...

Backup slides

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Comparison of microdosimetric spectra measured by the silicon device with those obtained with a reference cylindrical TEPC: 62 MeV clinical proton beam @ CATANA facility (LNS-INFN)

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