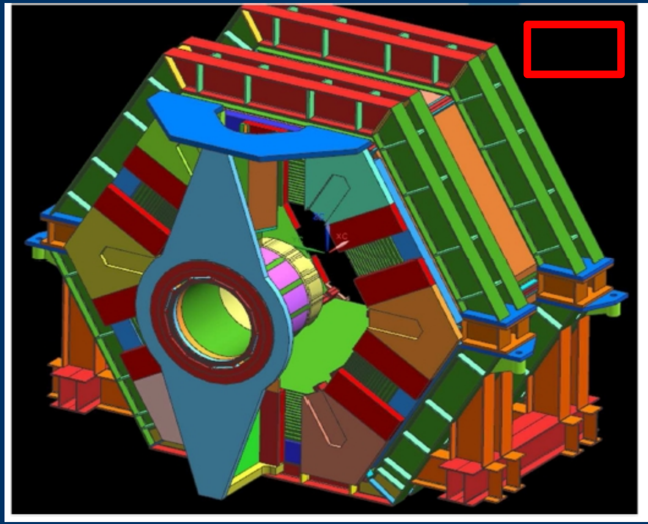
The IFR detector at SuperB



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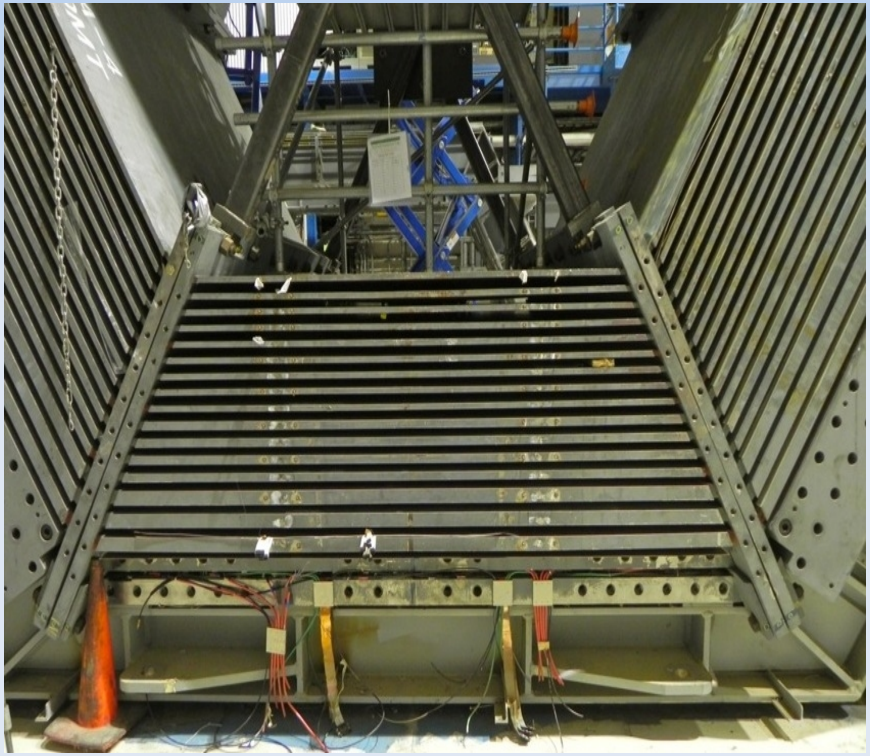
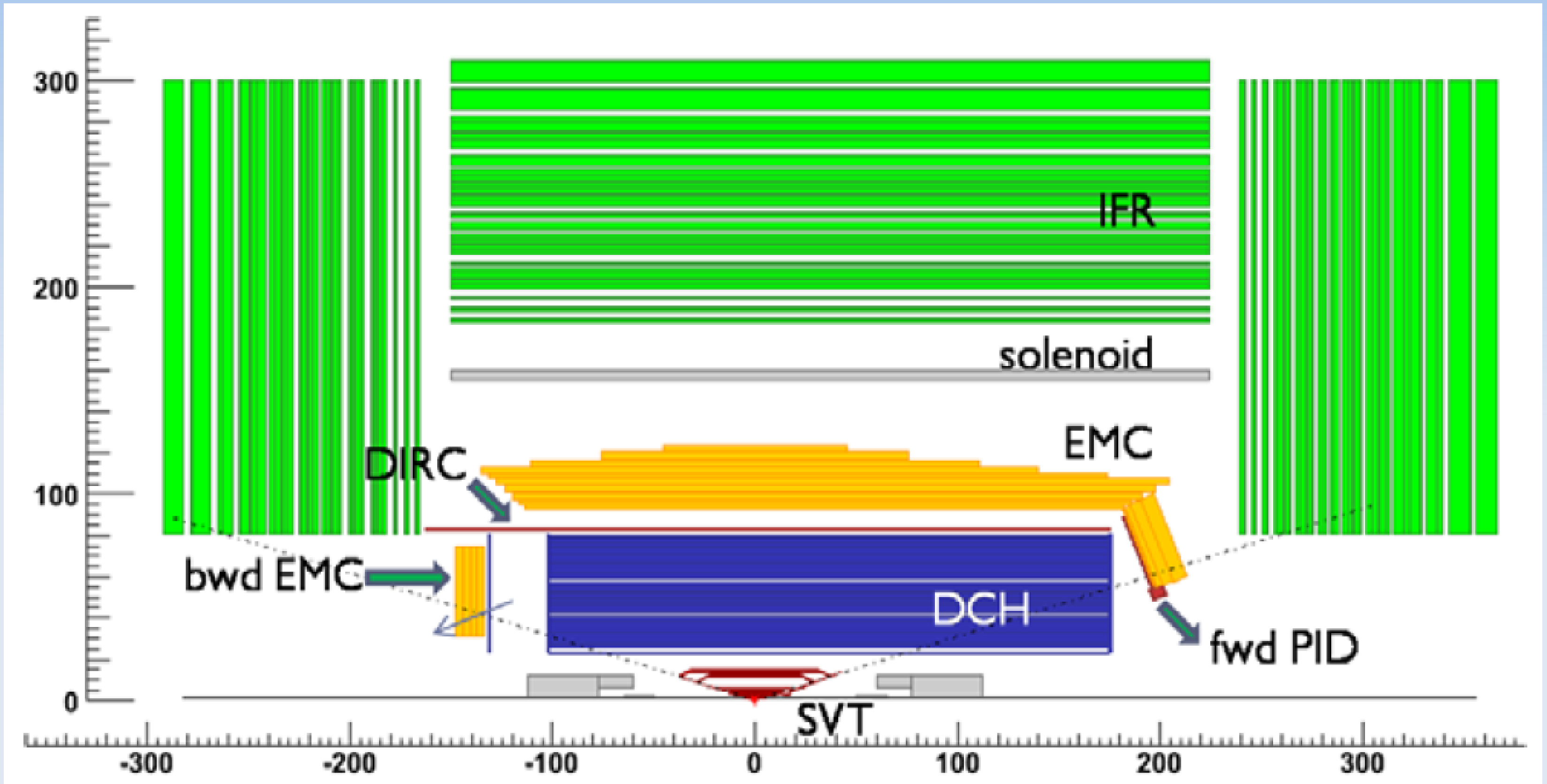
11.01.2012

Outline

- IFR at SuperB
- Physics goals
- Detector overview
- IFR prototype
- Prototype data analysis
- Kraków studies



SuperB detector



- Silicon Vertex Tracker (SVT)
- Drift CHamber (DCH)
- Particle IDentification (PID)
- ElectroMagnetic Calorimeter (EMC)
- Instrumented Flux Return (IFR)

What is the IFR for...

Physical purposes:

- Muon identification
- Identification (along with the electromagnetic calorimeter) of the neutral hadrons – mostly K^0_L's

- Good separation between penetrating particles (muons) and charged hadrons is crucial for extracting signal of several important *B* decays like:

$$b \rightarrow s\, l^+ l^- \qquad B \rightarrow \mu\nu_\mu$$

$$b \rightarrow d\, l^+ l^- \qquad B \rightarrow \tau\nu_\tau$$

$$B \rightarrow \mu^+\mu^-$$

- identification of the neutral particles allows for background suppression (veto) in reconstruction of final states with missing energy (especially those with neutrinos)

IFR Institutions

- INFN, Sezione di Bologna
- INFN, Sezione di Ferrara
- INFN, Sezione di Padova

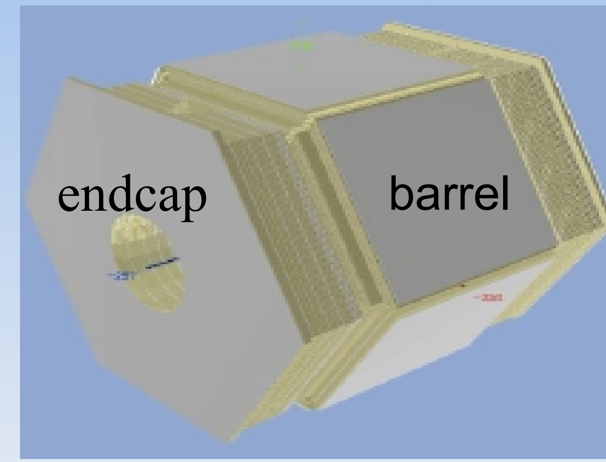
Krakow:

- Institute of Nuclear Physics PAS (software; prototype data analysis)

- AGH University of Science and Technology, Faculty of Electrical Engineering, Automatics, Computer Science and Electronics (studies of SiPM front-end electronics, readout and data acquisition system)

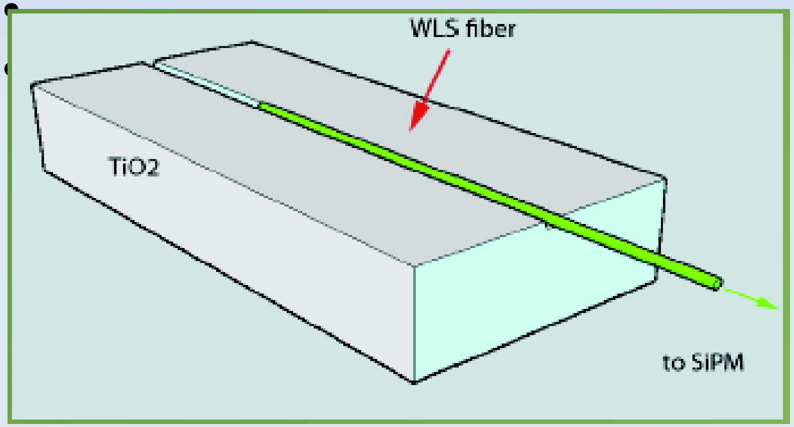
- the Cracow University of Technology, Faculty of Mechanical Engineering (numerical calculations, using Finite Element Method, supporting the design and construction process)

IFR detector- overview

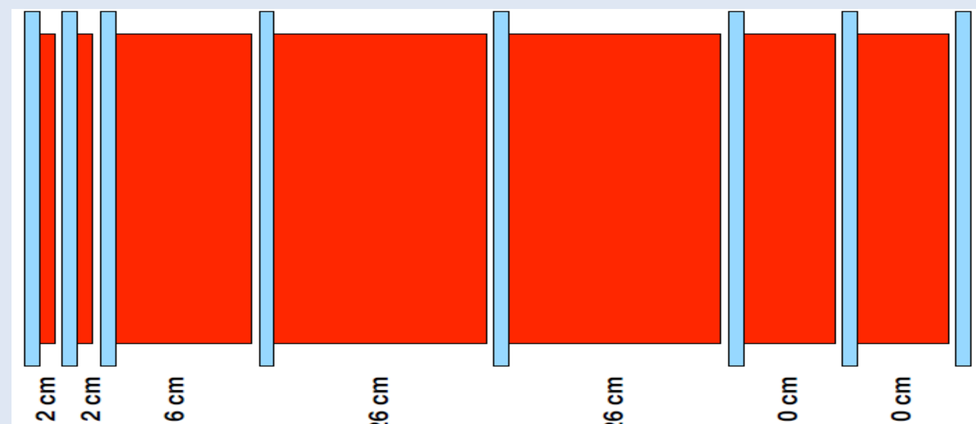


- Built in the magnet flux return
  → One hexagonal barrel and two endcaps

- extruded scintillator bars readout through 3 wavelength shifting (WLS) fibers and Silicon Photo-Multipliers (SiPM)



Various SiPM types and MPCC are being tested to achieve the best possible efficiency of the light detection and simplicity of the detector design



- 92cm of Iron interleaved by 8(9) active layers of highly segmented scintillators

- Plan to reuse BaBar flux return. Some mechanical modifications are necessary to achieve the desired thickness of the detector.
  - additional filling existing gaps with iron plates (brass or steel)
  - add material on the external surface of the detector

IFR readout

Baseline option:

Barrel: Time Readout (TDC-RO)

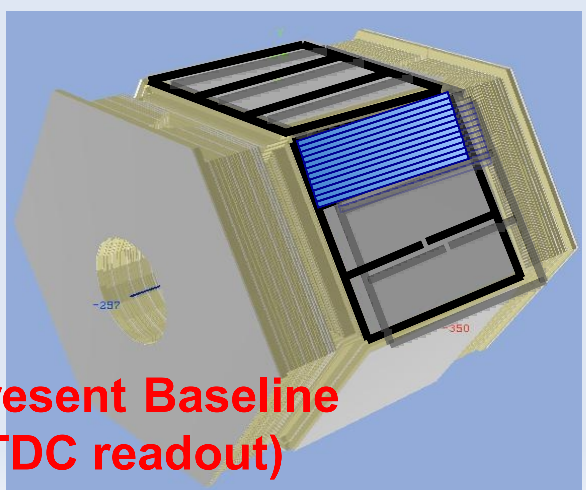
- azimuthal coordinate φ measured from the hit bar
- polar angle θ determined from the arrival time of the signal
  - → spatial resolution ~20cm
  - → ~4m long fibers, readout on both ends

Endcaps: BIRO readout (BiRO)

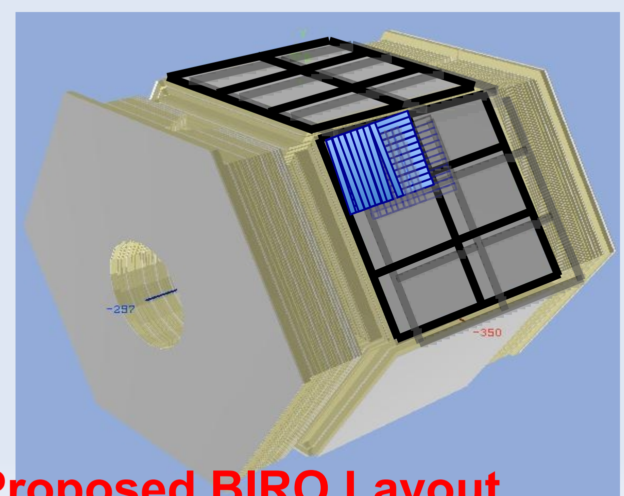
- Both coordinates measured through two orthogonal layers of ~1x5cm scintillator bars, fibers readout at one end only

New option after studies on the prototype:

A full BIRO readout

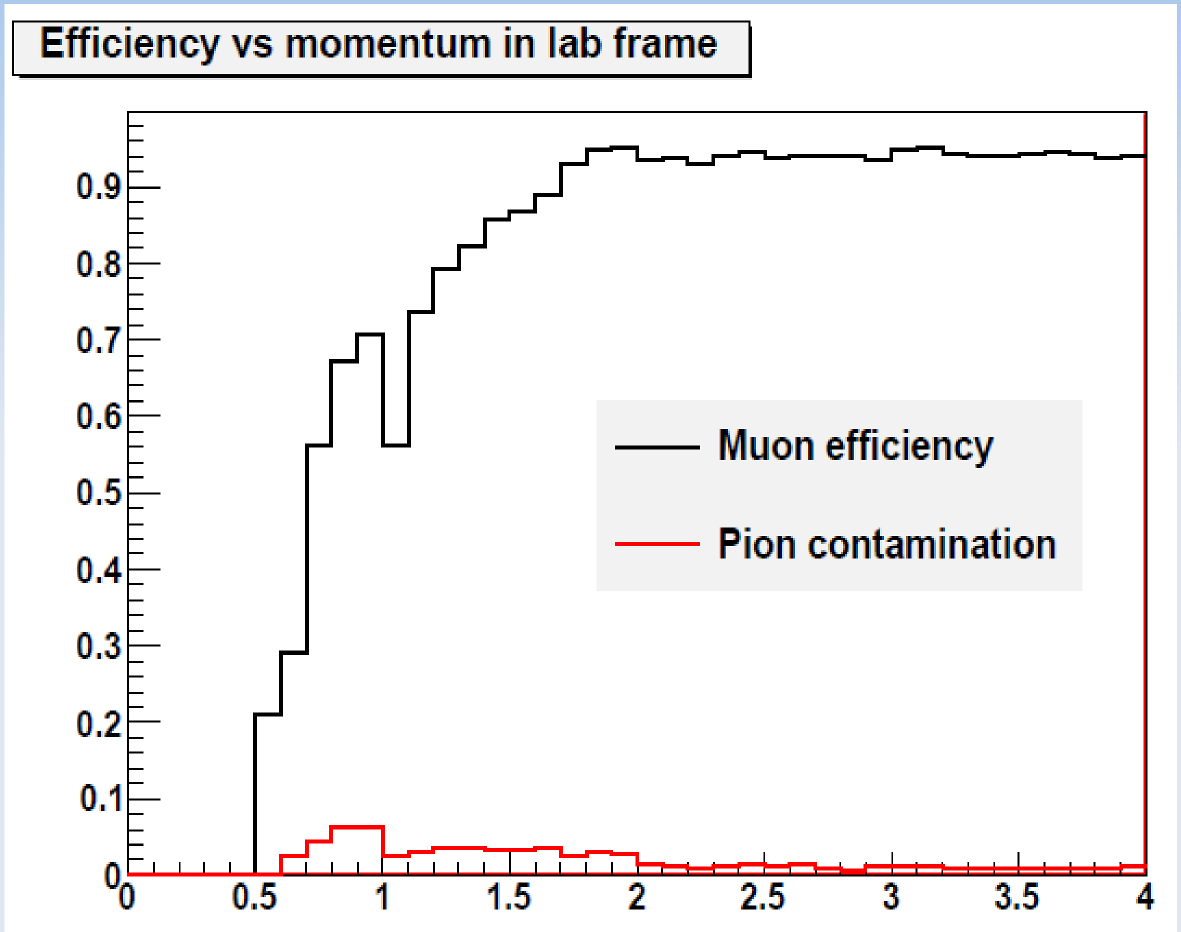


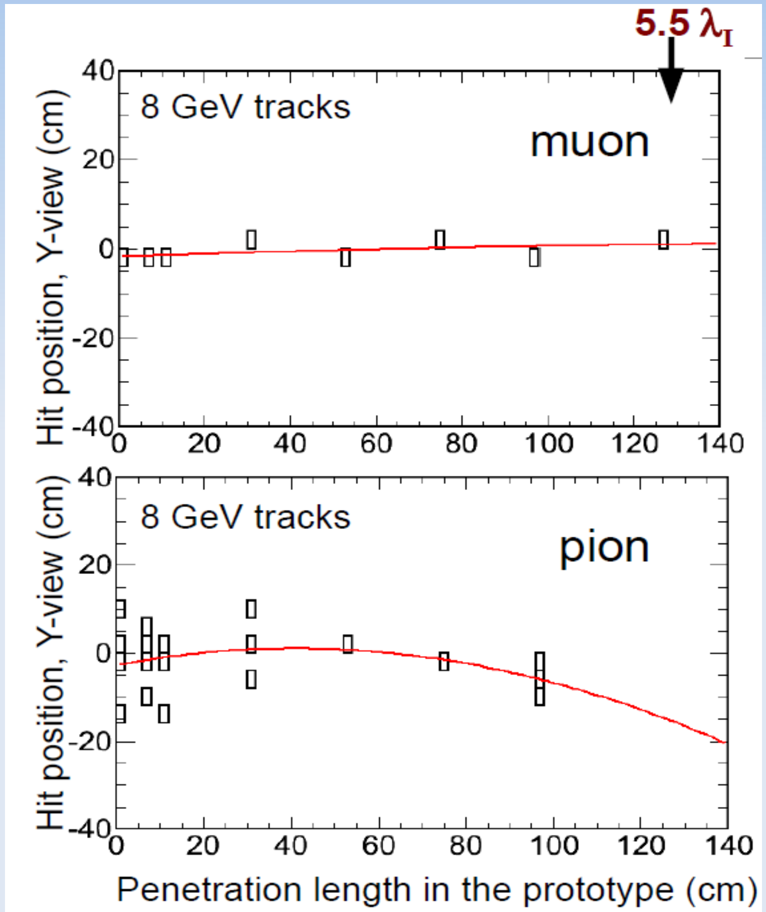
Present Baseline (TDC readout)



Proposed BIRO Layout

Muons/pions separation from the MC studies





Results from Geant4 based simulations
(single μ and π, cut based muon selector)

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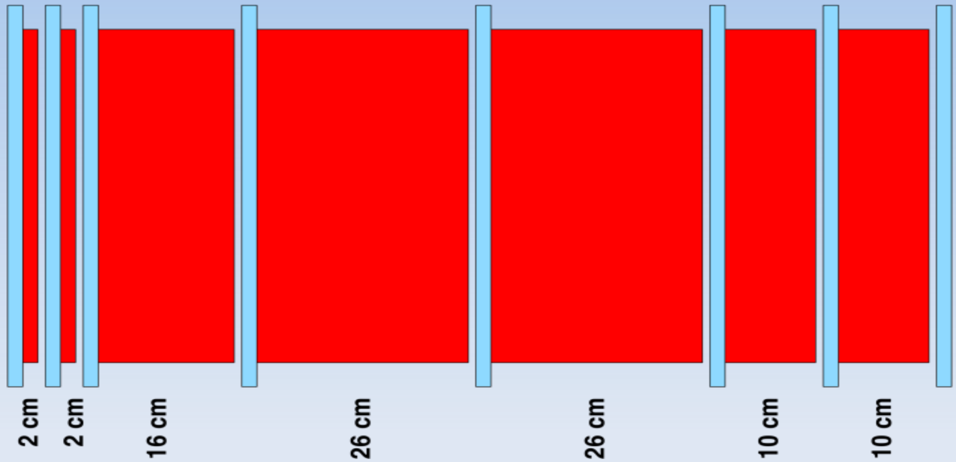
Prototype performance
(next slides)

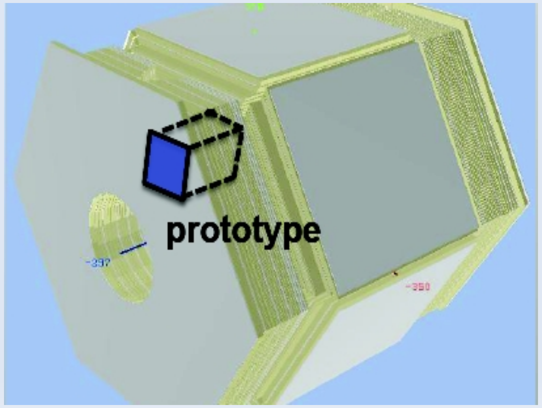
IFR prototype

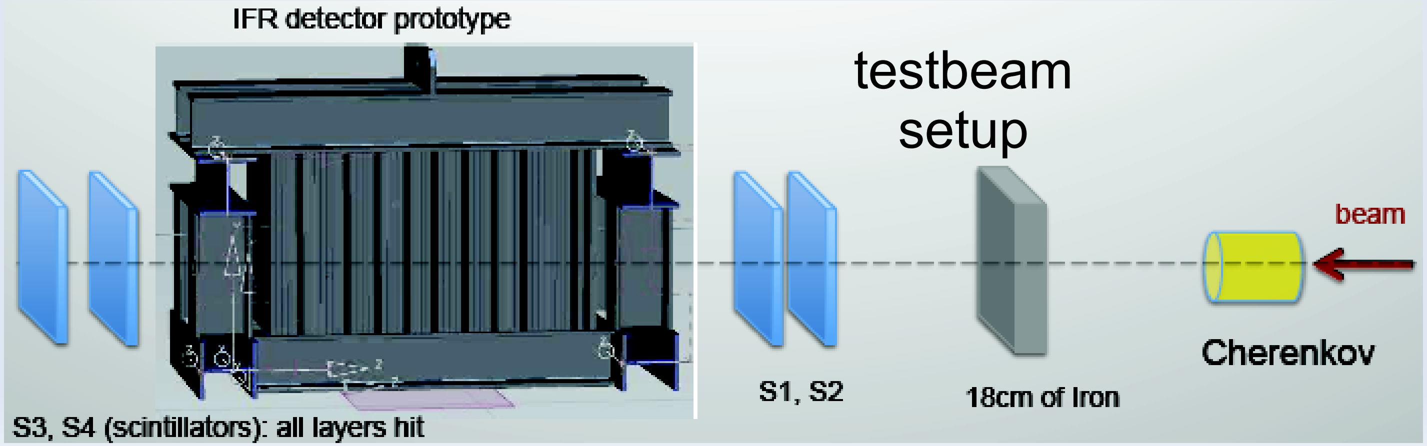


Iron:
60x60x92 cm^3 ,
3cm gaps for the active layers

- Muon/Pion separation on real data
- studies on the hadronic shower development

→ important for detector geometry optimization (segmentation, amount of material, etc) and input for the full simulations

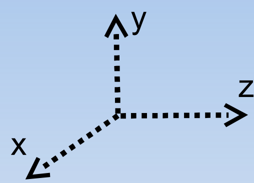


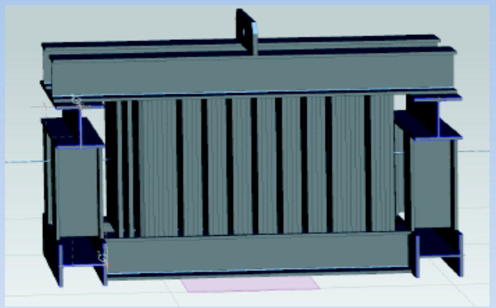


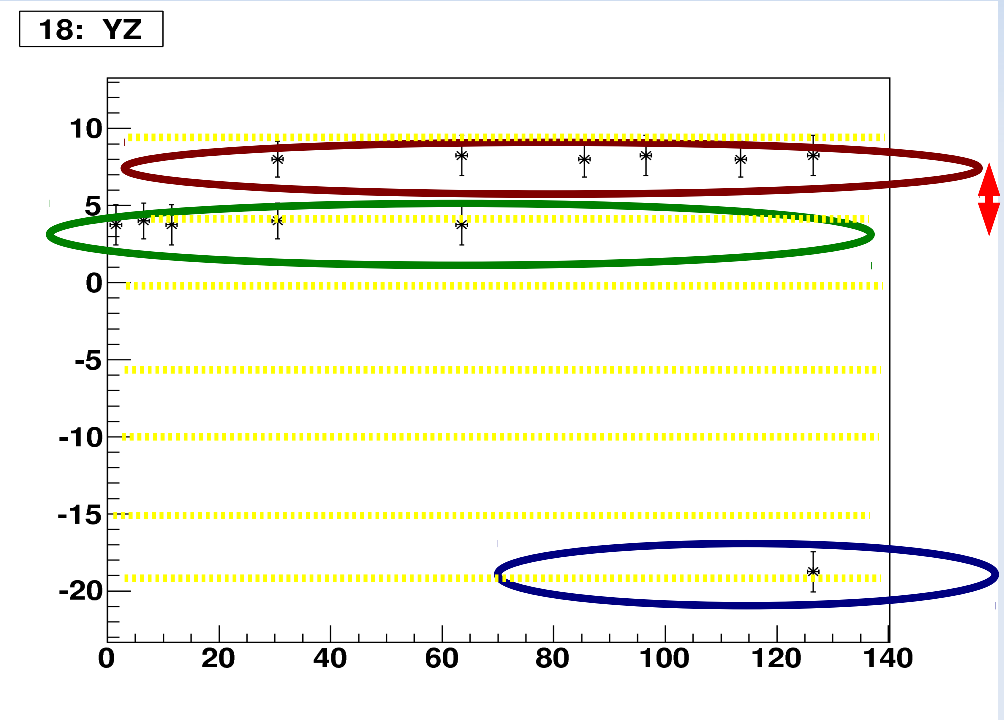
Prototype data analysis

(J.Wiechczyński)

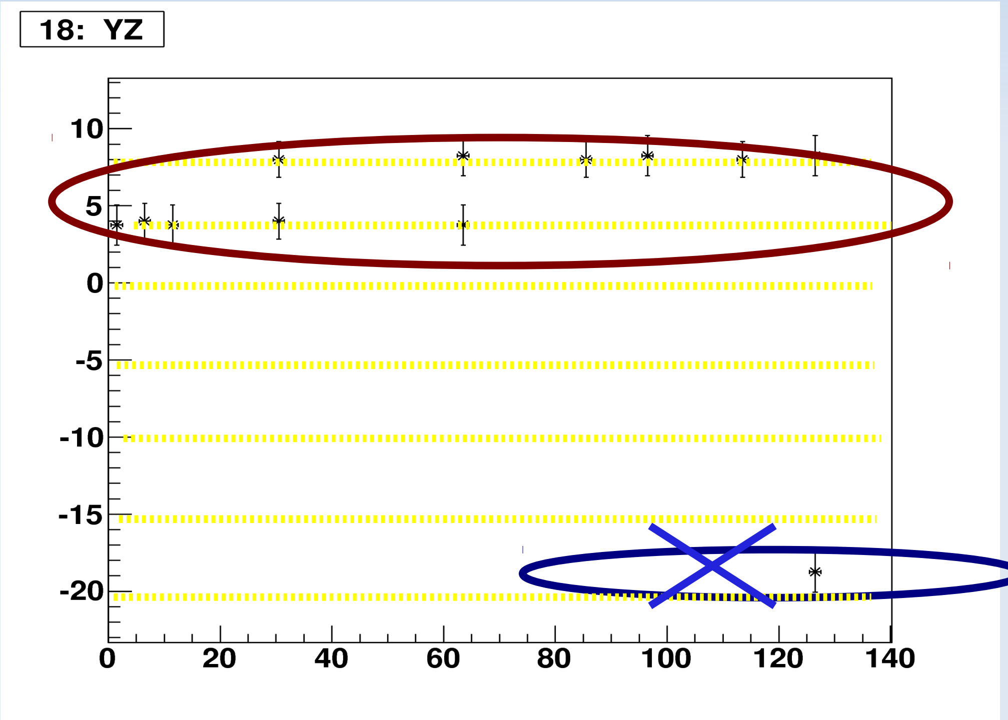
- Clusterizing algorithm
  → rejection of the background hits







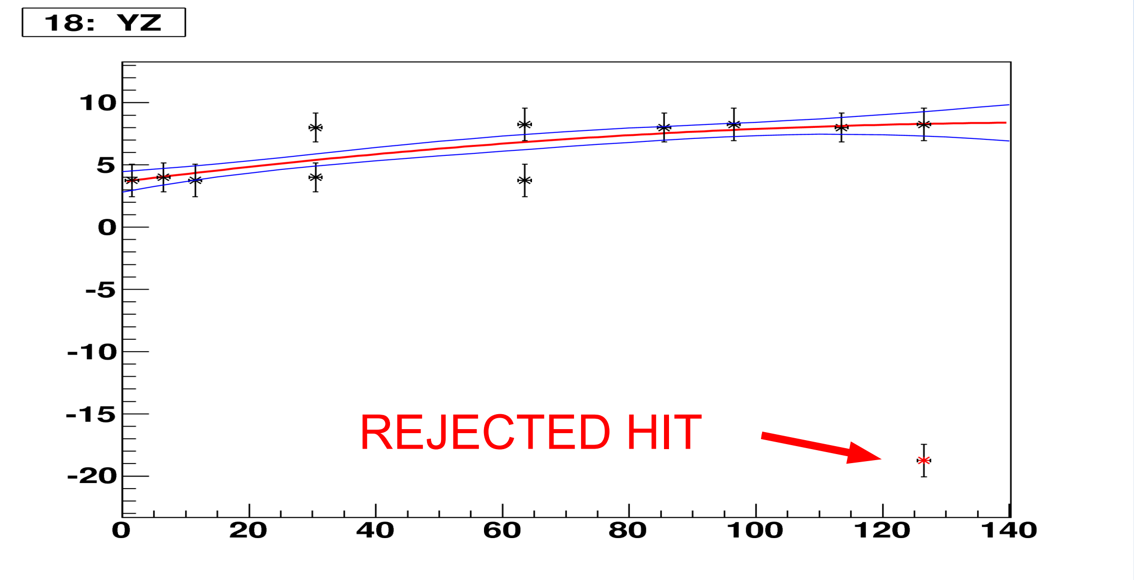
the biggest cluster – good muon track



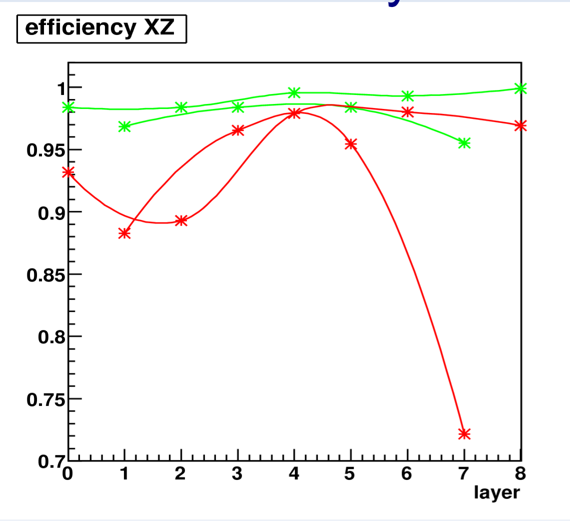
adjacent clusters merged if close enough

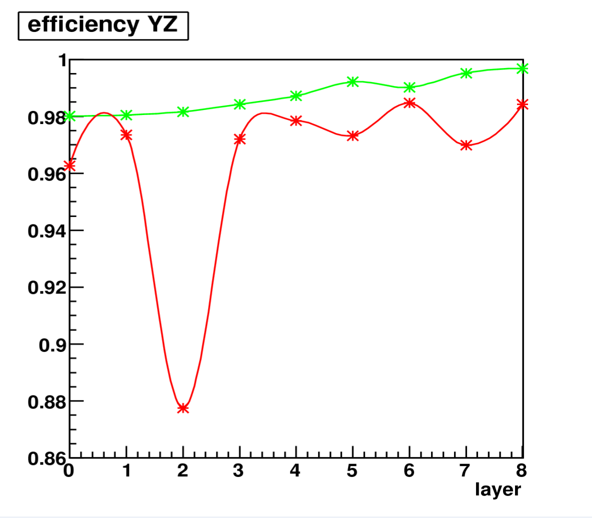
prototype data analysis

- Fit to the obtained muon track:

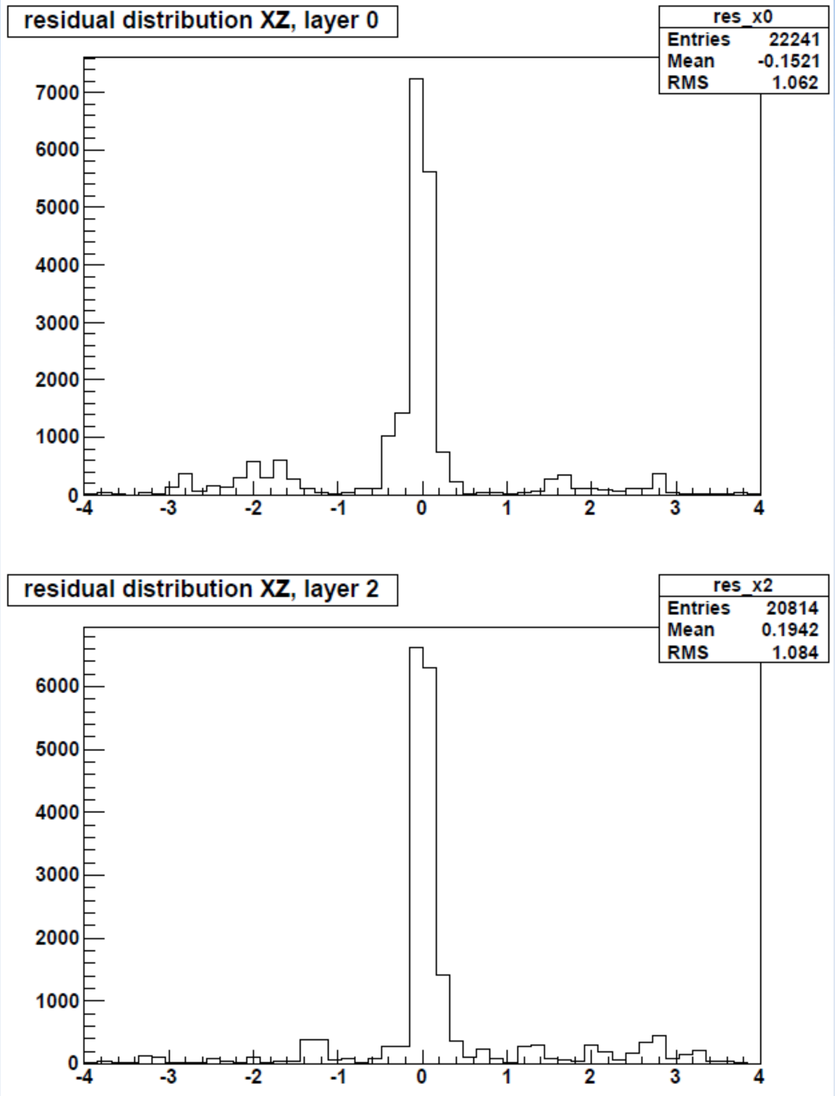


- efficiency evaluation



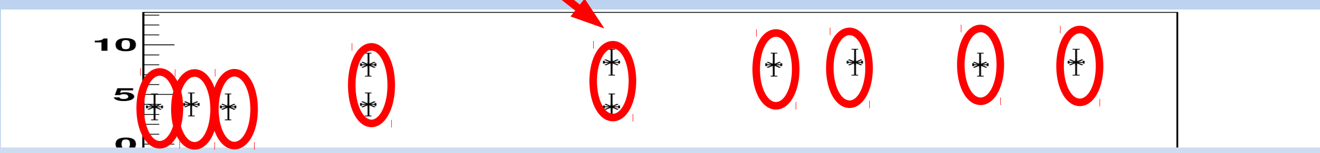


- Example of residual distribution

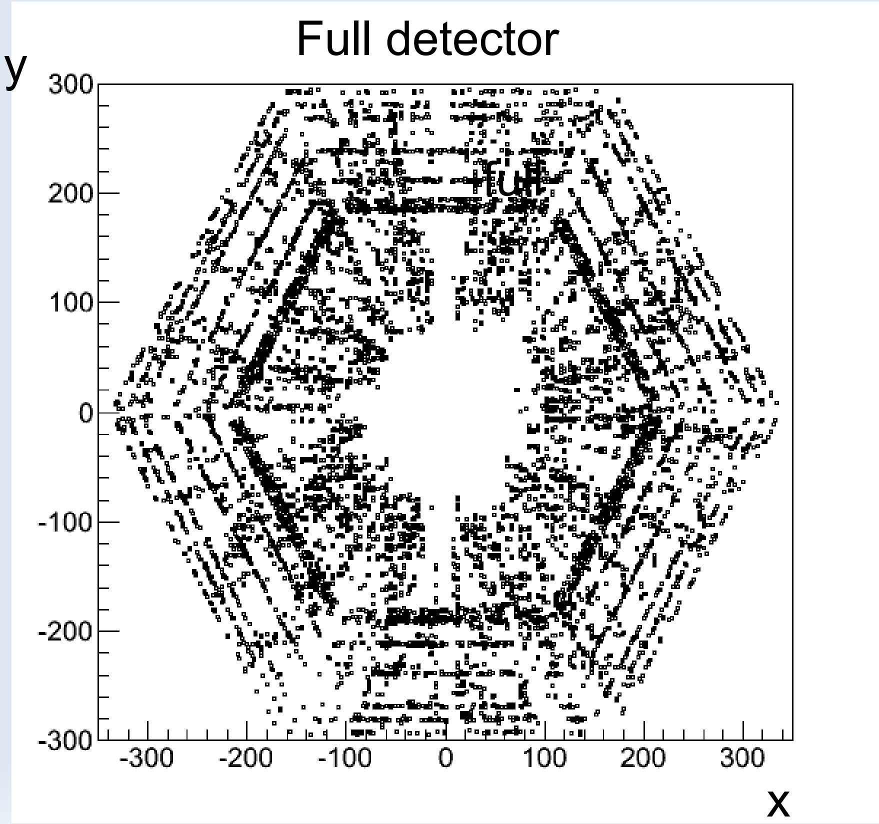


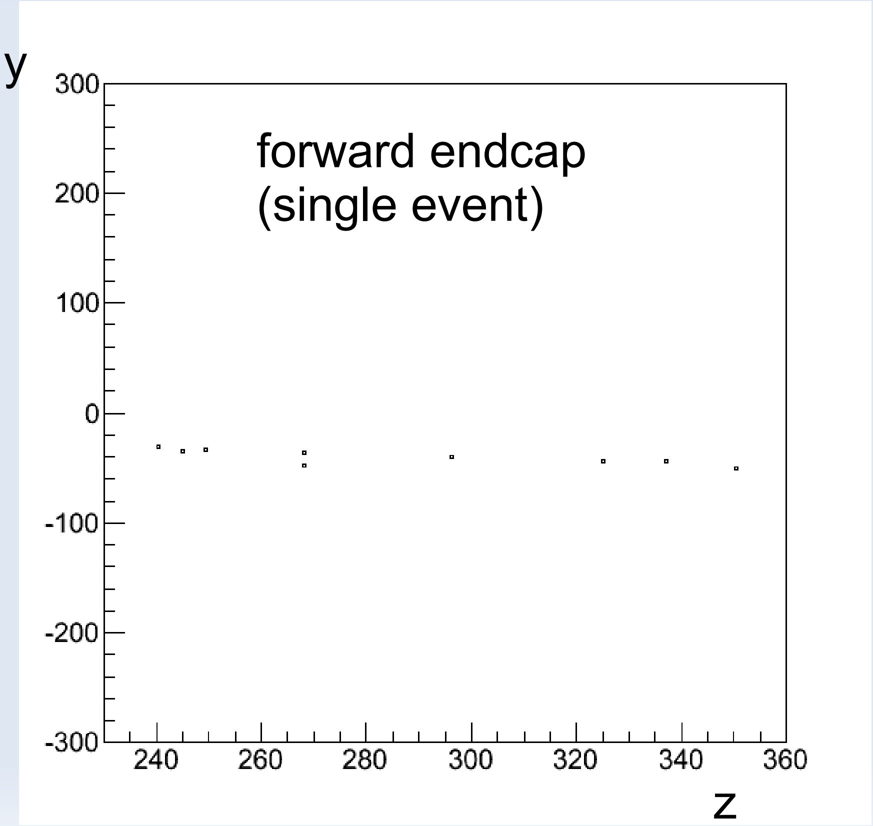
Integration with IFR software

- 1dim clusters already implemented in the IFR code:



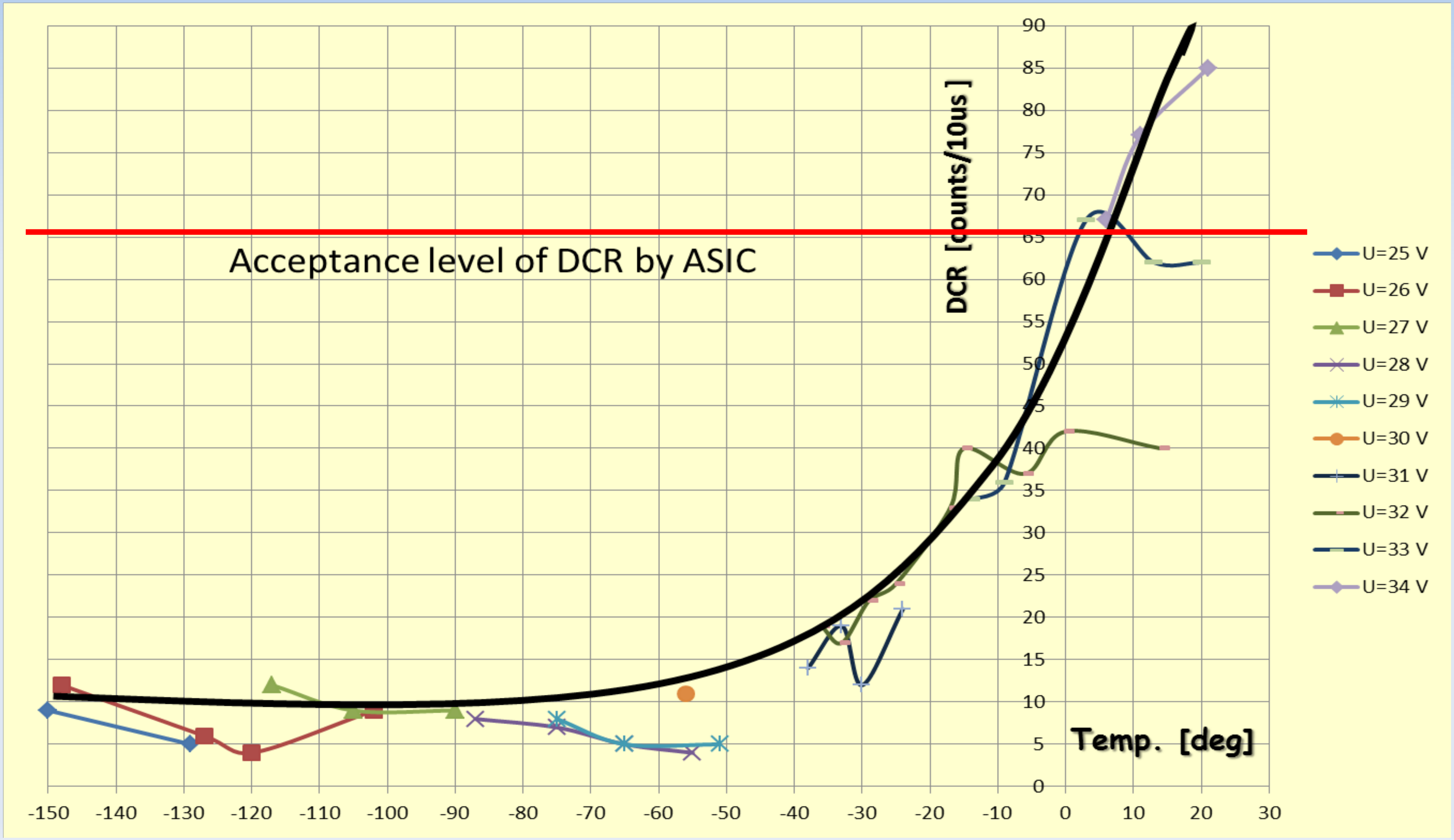
- implementing 2D clusterizer in the IFR code – in preparation!



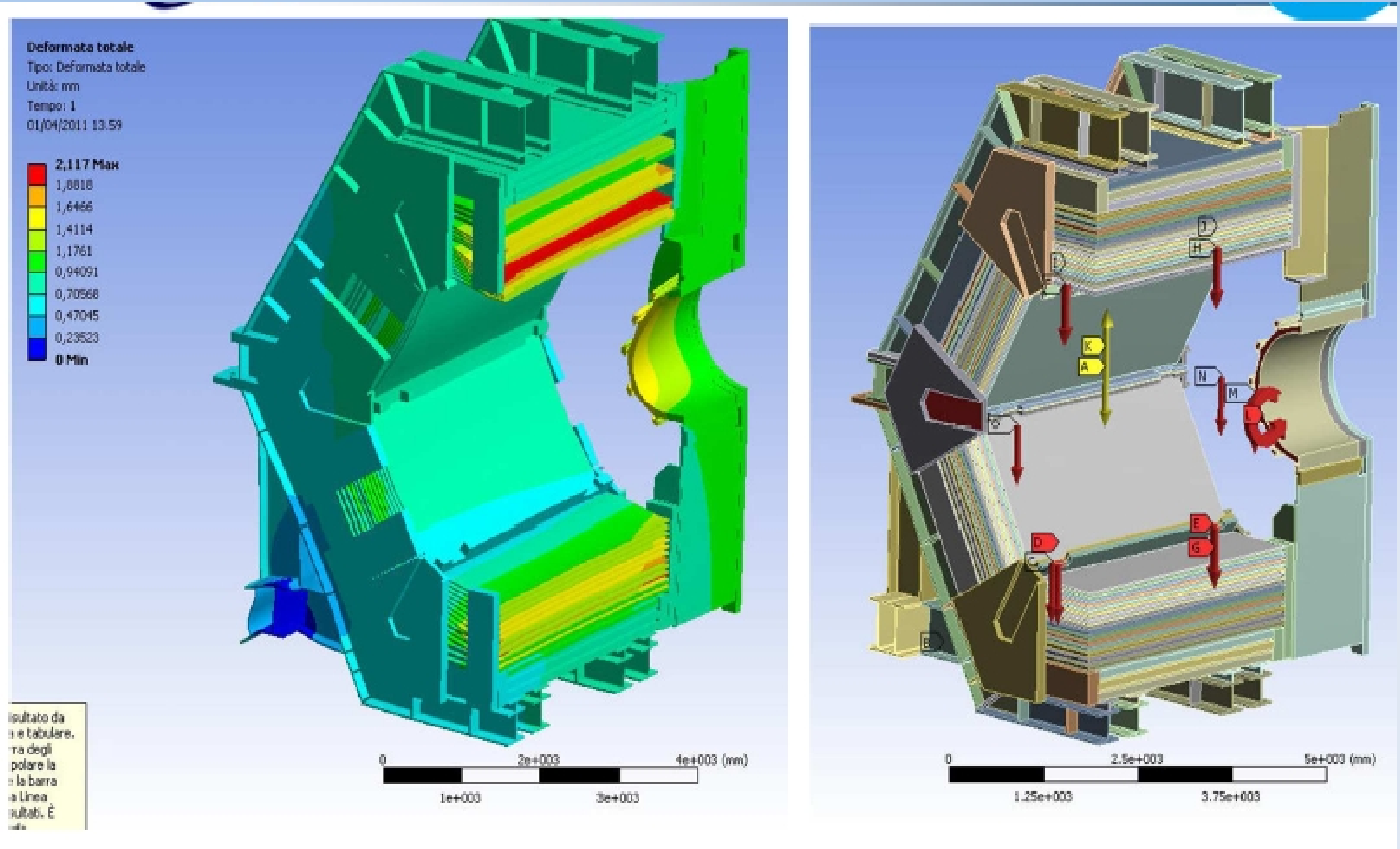


Some results from Kraków studies: SiPMs

DCR – dark current rate, ASIC – application specific integrated circuit



Some results from Kraków studies: flux return



Summary

- Investigations on the final shape of the detector are still ongoing
- Full BiRO readout as the baseline option for the TDR
- Many ongoing activities:
  - software development
  - MC studies (eg. background simulations)
  - flux return configuration
  - electronics and SiPM irradiation tests
  - prototype data analysis
- A new beam test is scheduled for the end of February