Status of the $\overline{\text{P}}$ANDA TPC Simulation

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Germany

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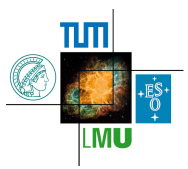
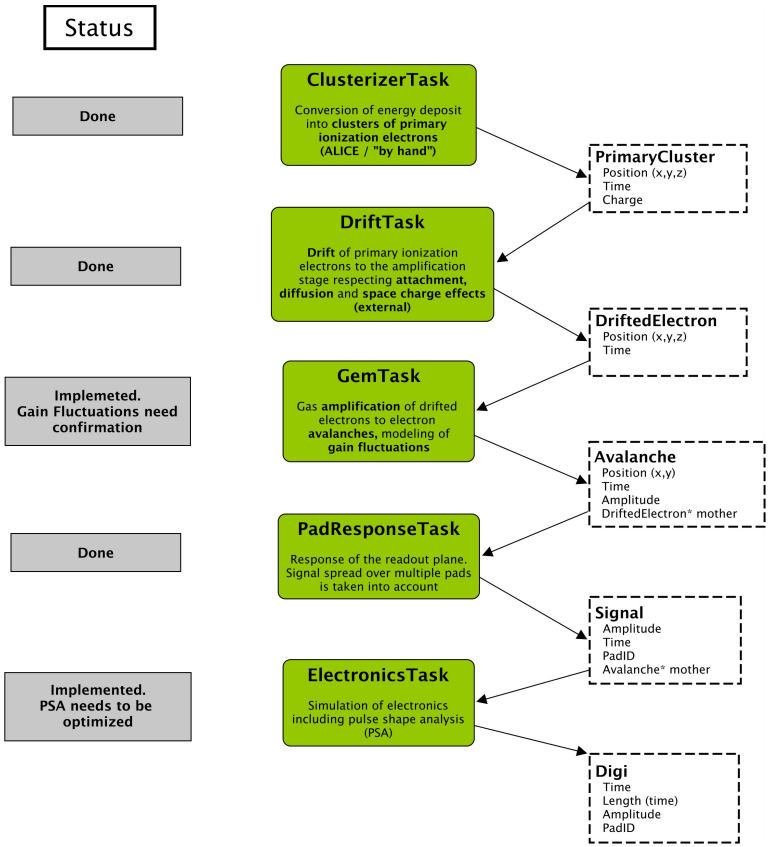
Stockholm, Sweden



TPC Simulation Software Status



Digitization

Status (Digi & Reco):

- Implementation work finished

Recent Developments:

- Integrated Test Chamber geometry into $\overline{\text{P}}$ANDAROOT
- Bridged data taking to $\overline{\text{P}}$ANDAROOT
- Implemented Hough Transform PR for real data (2D)

Things to be done:

- Test & optimize
  - Gain fluct. simulation
  - Pulse Shape Analysis
  - Clustering algorithms
  - Pattern recognition
  - dE/dx extraction & analysis

  ... based on real measurements

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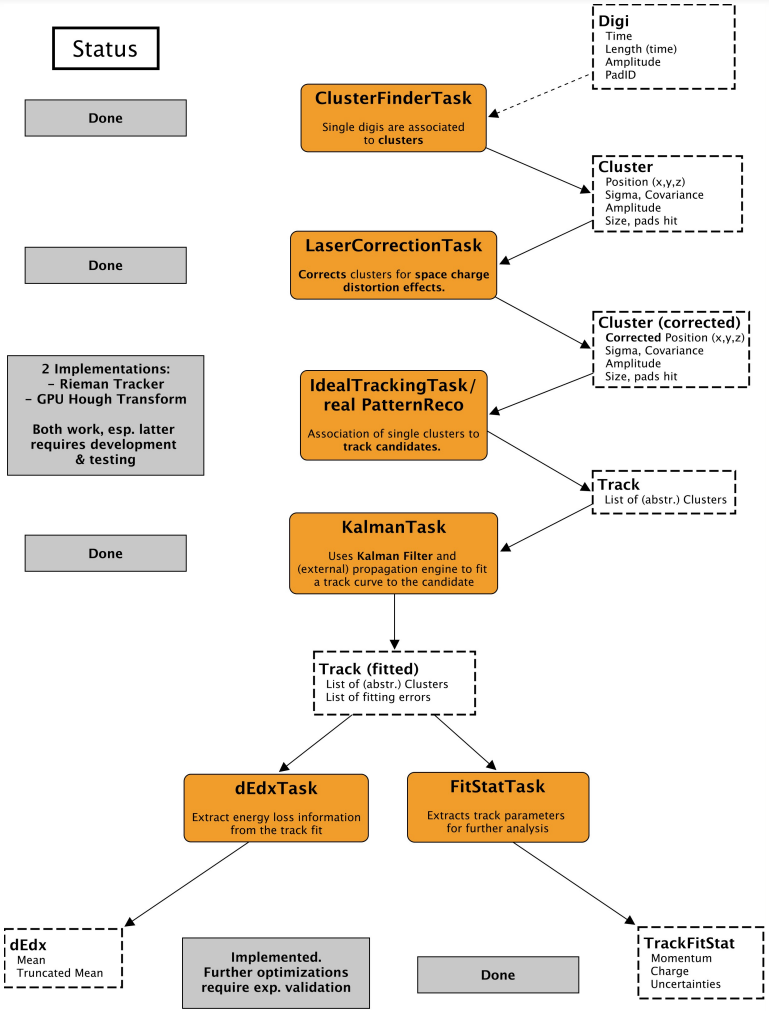

Reconstruction

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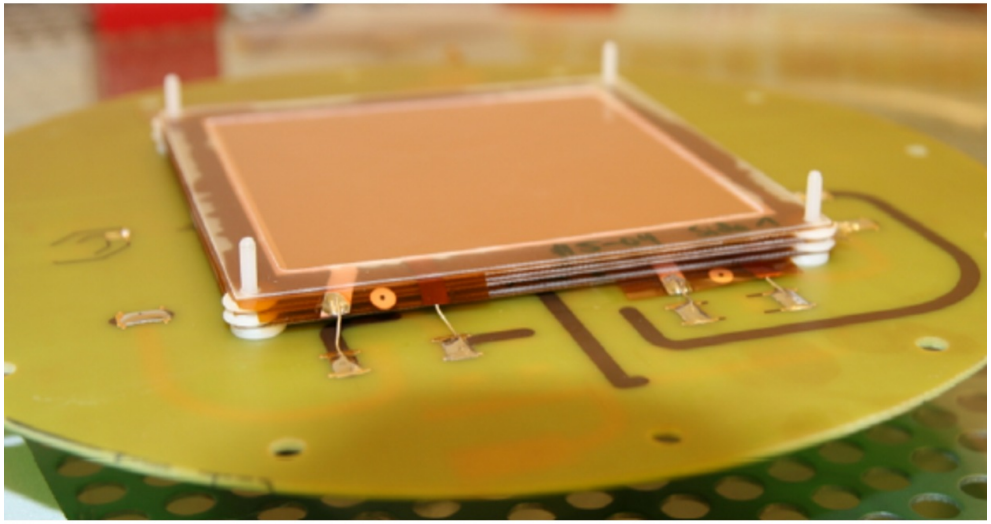
The Small GEM-TPC Test-Chamber

Hardware:

- $10 \times 10\,\mathrm{cm}^2$ active area
- Triple-Gem stack for amplification
- 8 cm drift length
- 1500 hexagonal pads:
  - 1.5 mm outer radius
  - 1.25 mm outer radius



Electronics:

- T2K AFTER chip (Saclay)
- 4 chips $\times$ 74 (64) channels per FE card
- 0.4 W power consumption / chip
- Analog sampling at 10 - 50 MHz
- Noise: $< 600\,e^-$
- Sensitivity: 0.063 fC / ADC ch. = 397 e^- / ADC ch.

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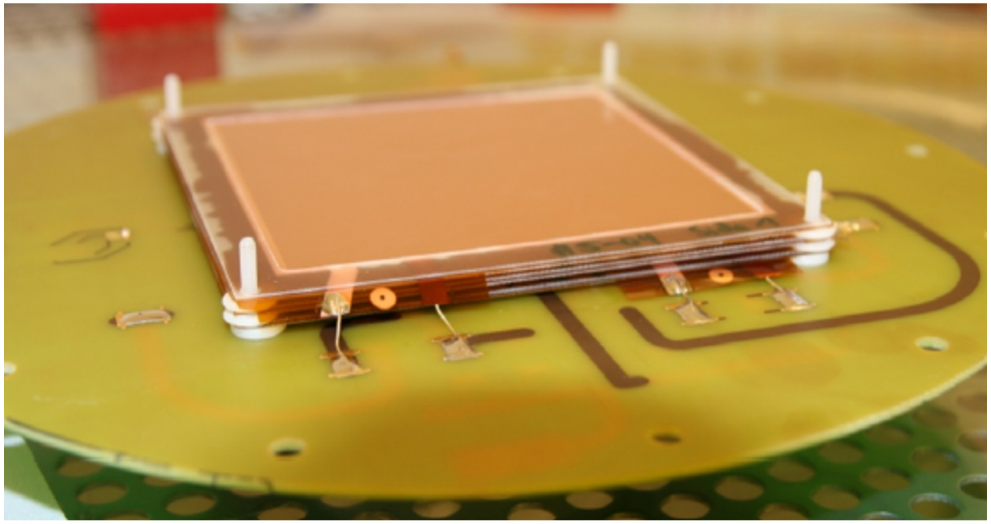

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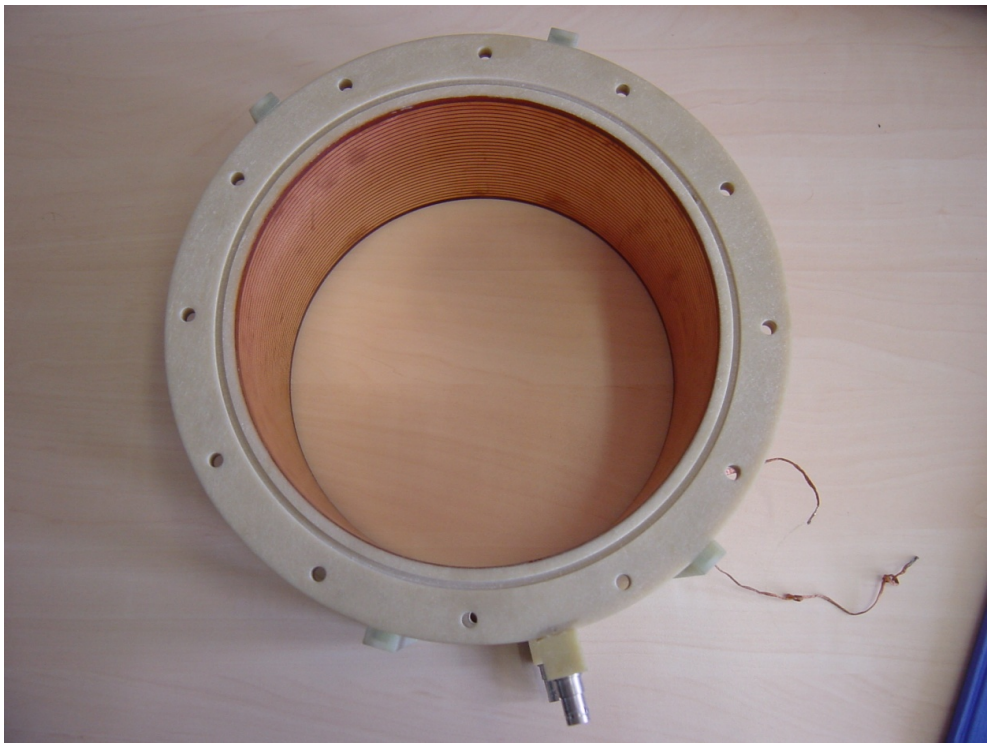

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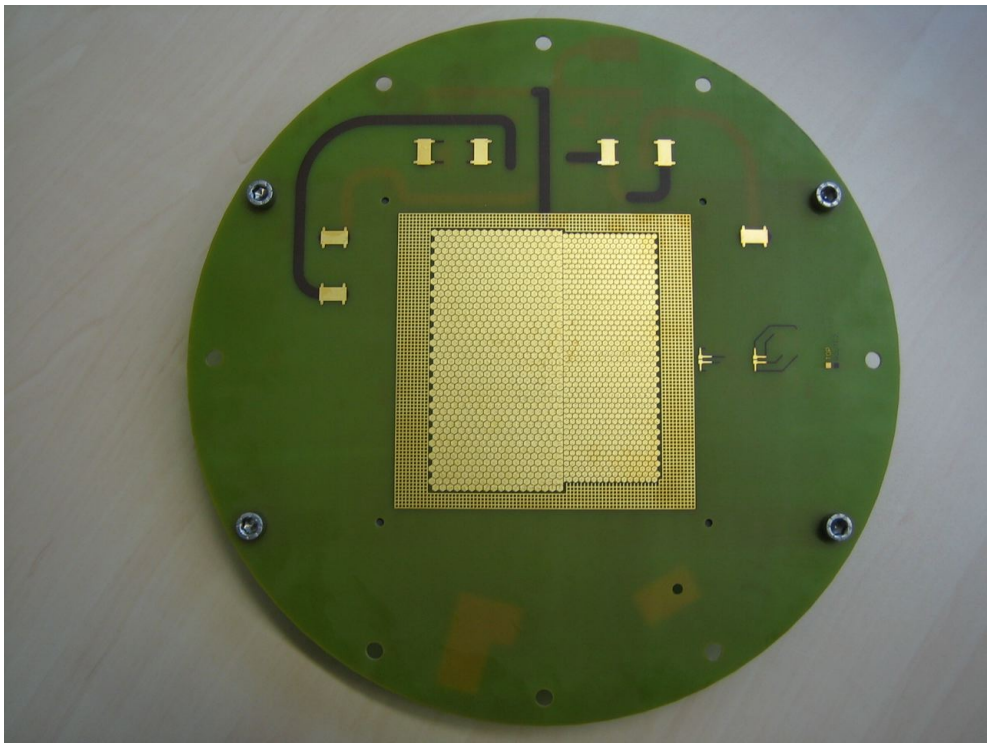

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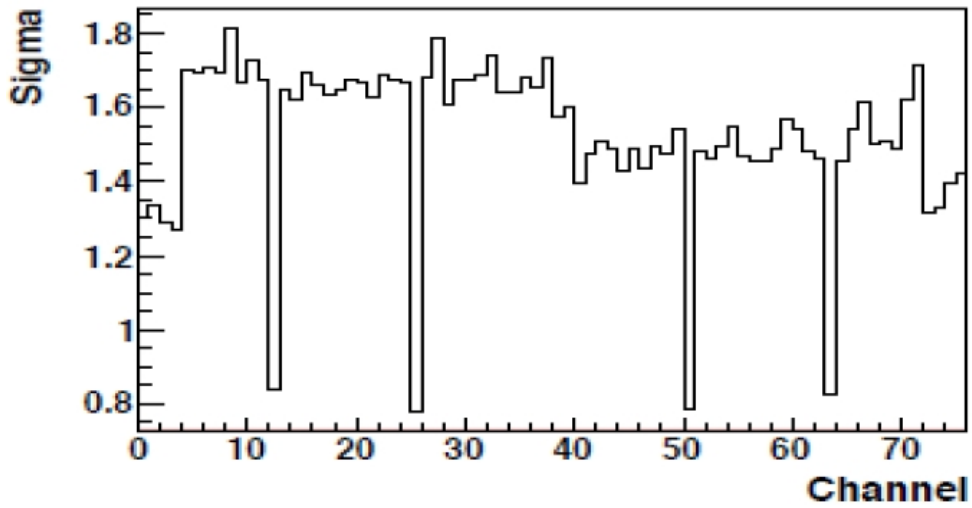
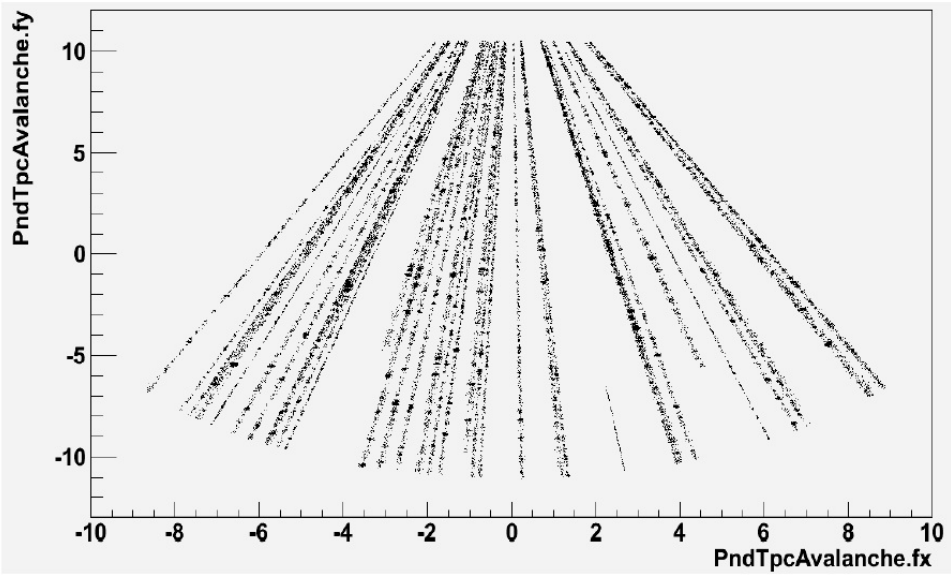


Simulation

Some Simulation Details

- Simulating “cosmics events” within the $\overline{\text{P}}$ANDAROOT framework (ionization, drift, GEM amplification, avalanche spread)
- Signal induction
- ADC sampling
- Pulse shape analysis (PSA) (also used for data, of course)



Avalanches produced in the GEM stack

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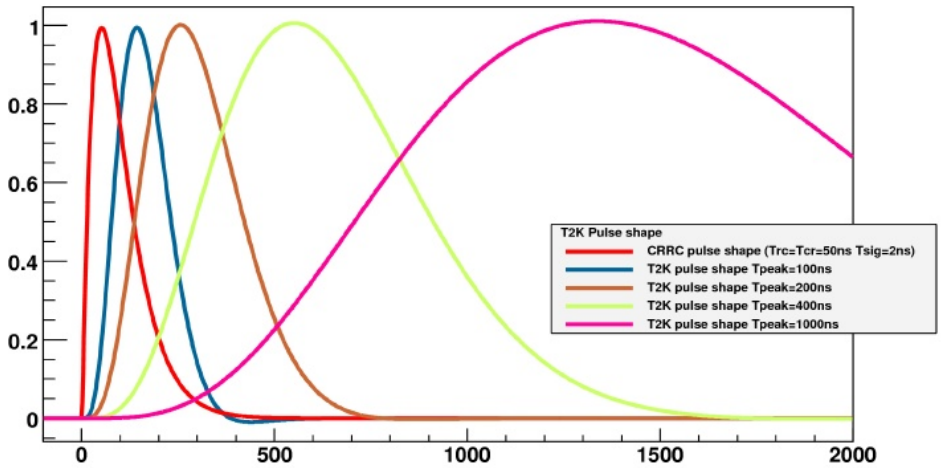

Pulse shape of AFTER-T2K for different sampling times

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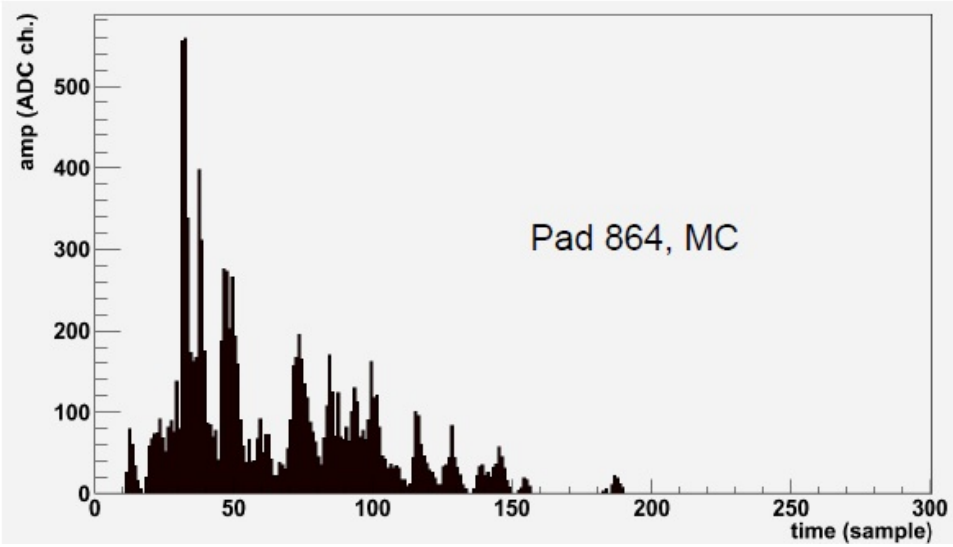

Signal sampling

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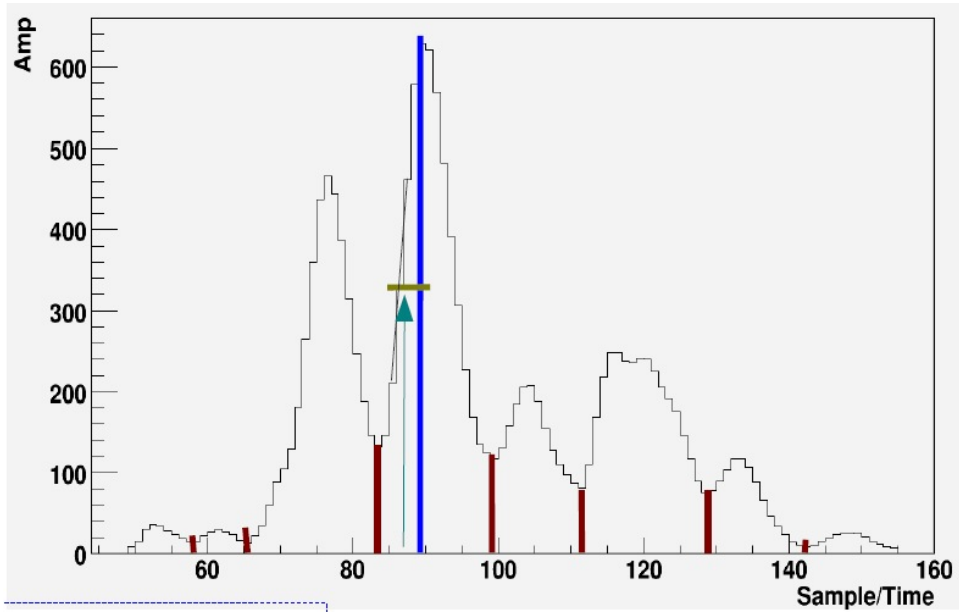
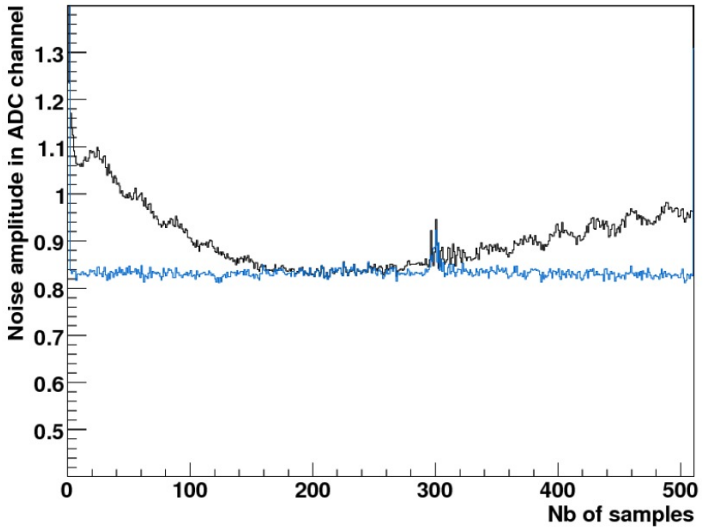


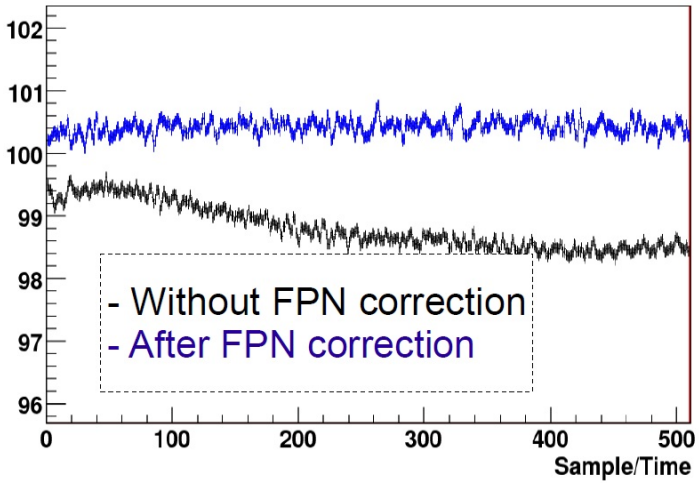
One method of PSA

Cosmics @ Munich

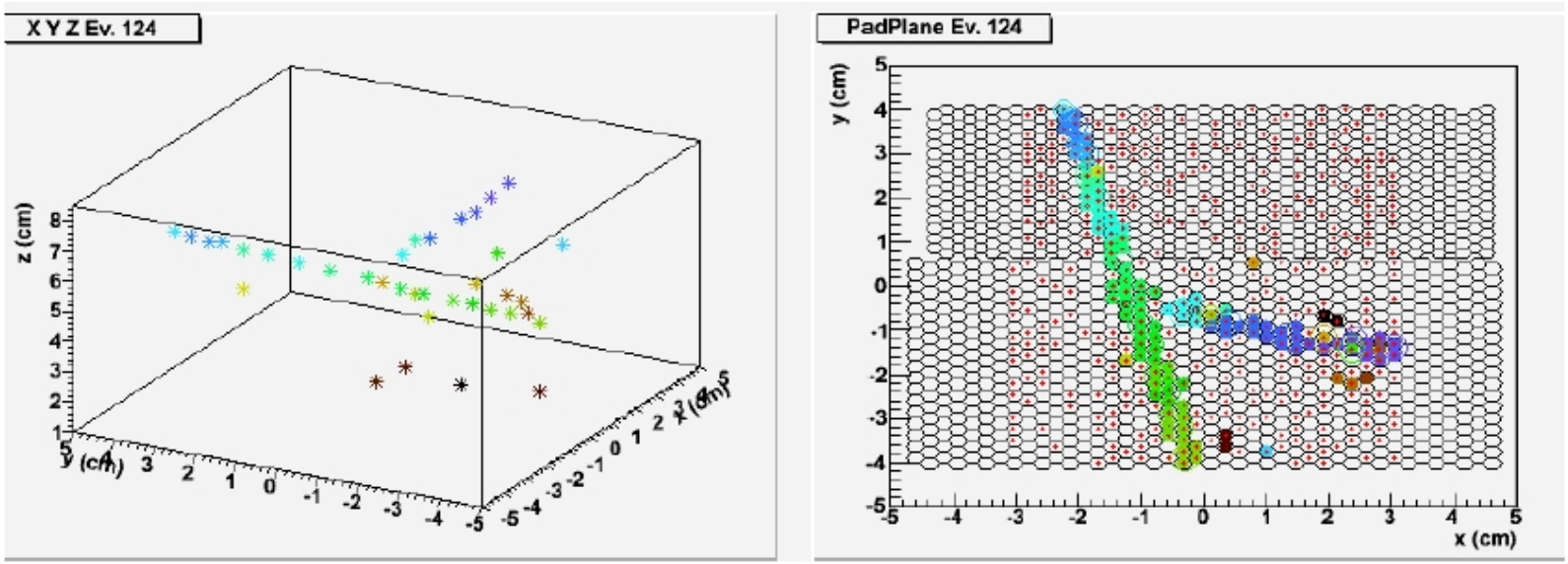
Data Correction

1. Zero suppression on the ADC level
2. Offline correction:
   - Common noise suppression
3. Fixed Pattern Noise (FPN) correction:
   - One observes a time dependence of the signals along the analog memory of the AFTER-T2K chip
   - Can be corrected using unconnected channels (see picture)





An Example Cosmic Event @ Munich Lab



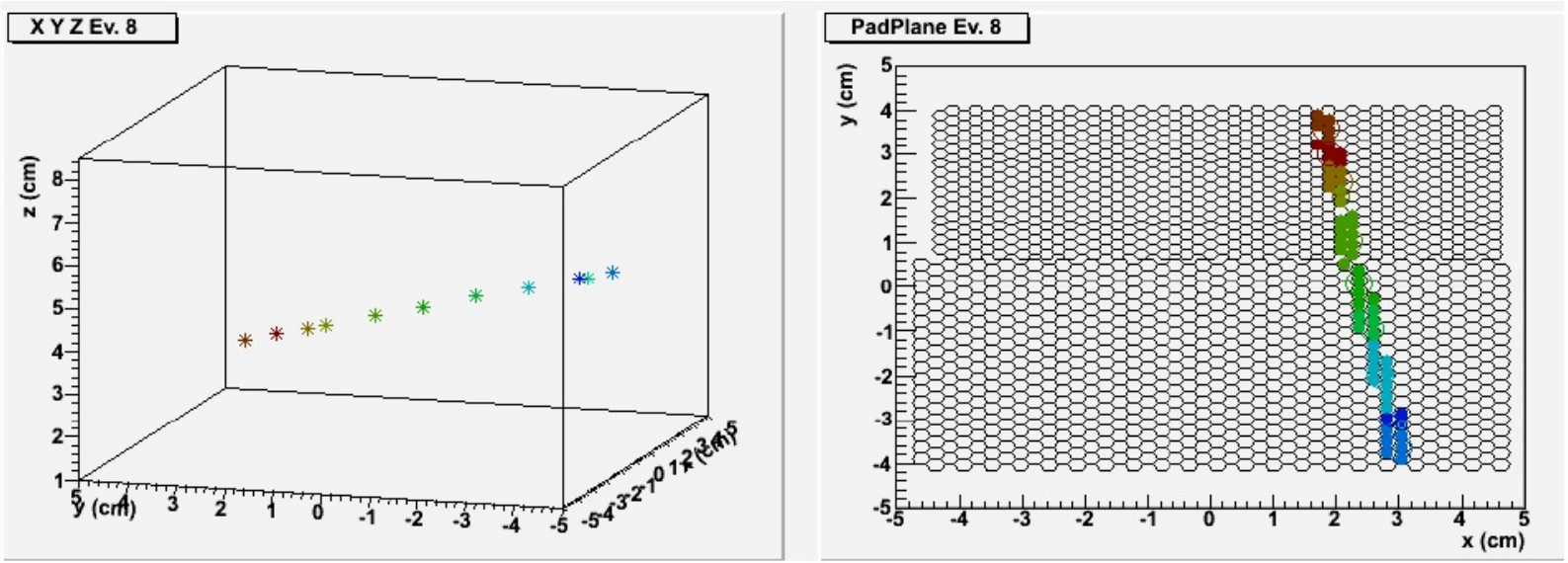
Left: 3D-View; Right: Digis and clusters on the padplane

- Example cosmic track emits delta electron
- Pattern recognition finds both
- Full analysis of large dataset ongoing

Cosmics vs. “MC Cosmics”

Monte Carlo vs. Data

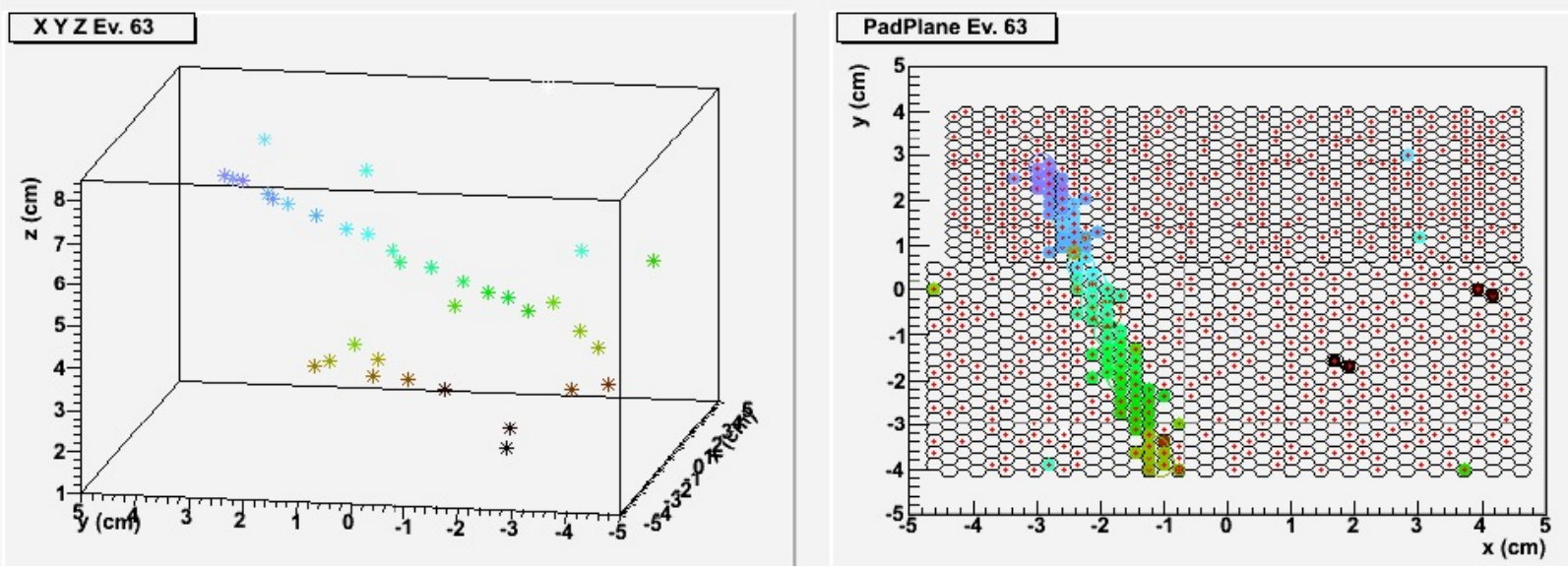
A Track:



A simulated “cosmic track”

Monte Carlo vs. Data

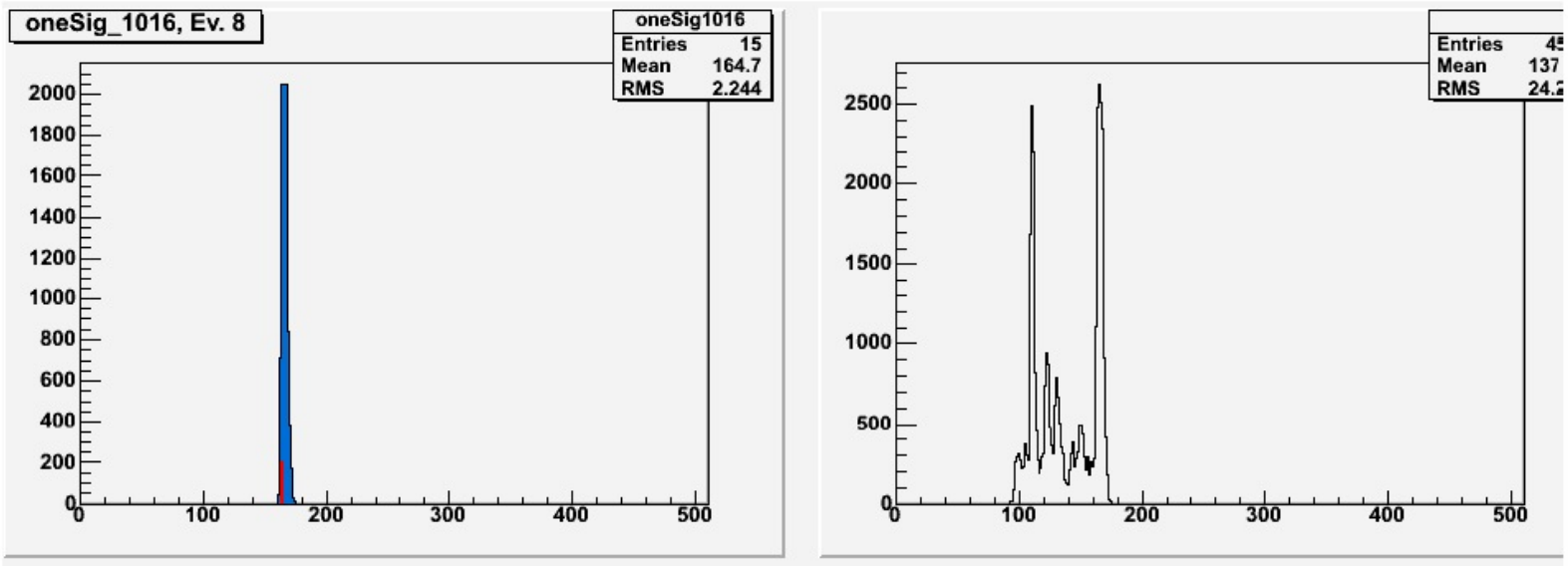
A Track:



A real cosmic track

Monte Carlo vs. Data

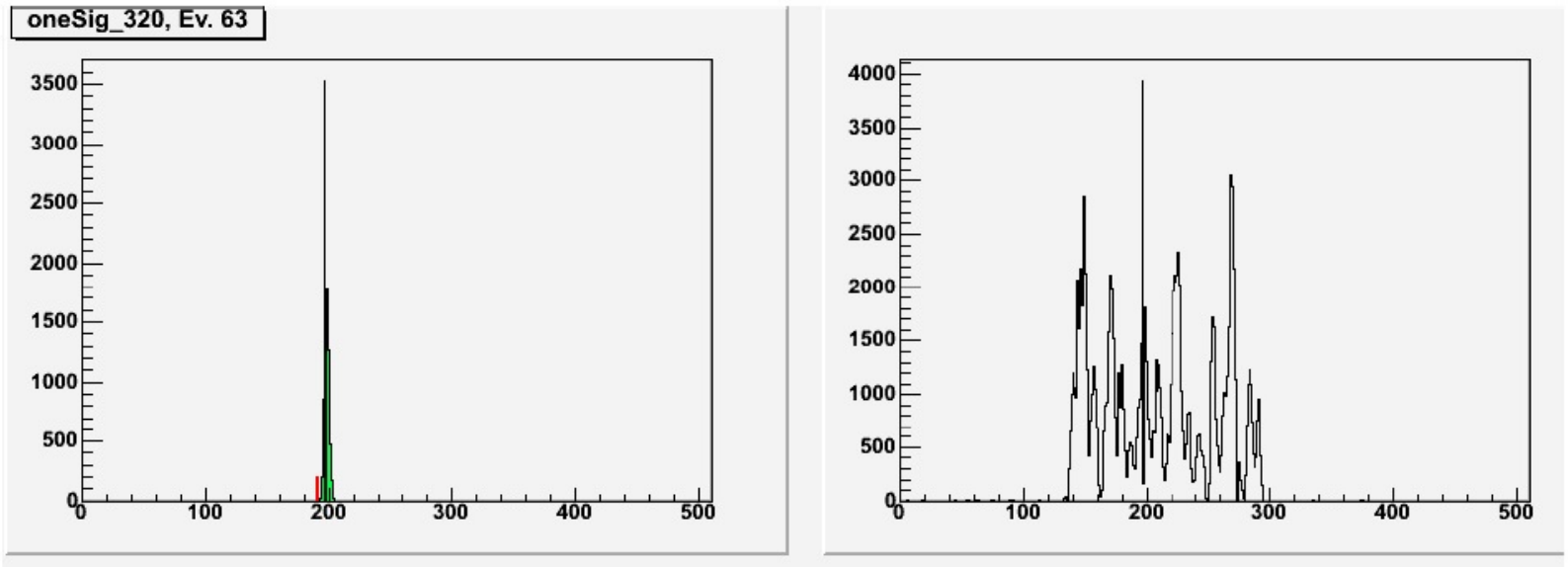
Samples:



Corresponding samples in simulation

Monte Carlo vs. Data

Samples:



Real event samples

Conclusion

Conclusion & Outlook

Status Quo:

- We have a working test detector
- We are taking data, **analysis ongoing**
- Full set of track finding & fitting algorithms in place and performing well
- Our full detector simulation is able to reproduce the data taken

Next Steps:

- Analyze taken data
- New beam test coming up this summer at CERN (COMPASS) with high-energetic muons (⟶ **First dE/dx benchmark**)
- Online monitoring program under development
- **Optimize simulation based on experimental results**