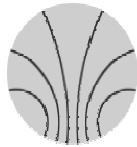
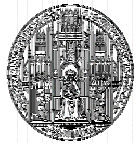


# Local Signal Processing on the ALICE Transition Radiation Detector

Marcus Gutfleisch



Kirchhoff Institute of Physics  
University of Heidelberg

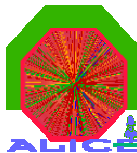


Chair of Computer Science / Computer  
Engineering

Prof. Dr. Volker Lindenstruth

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mail: [marcus.gutfleisch@kip.uni-heidelberg.de](mailto:marcus.gutfleisch@kip.uni-heidelberg.de)



A contribution to the ALICE TRD project.



# Overview

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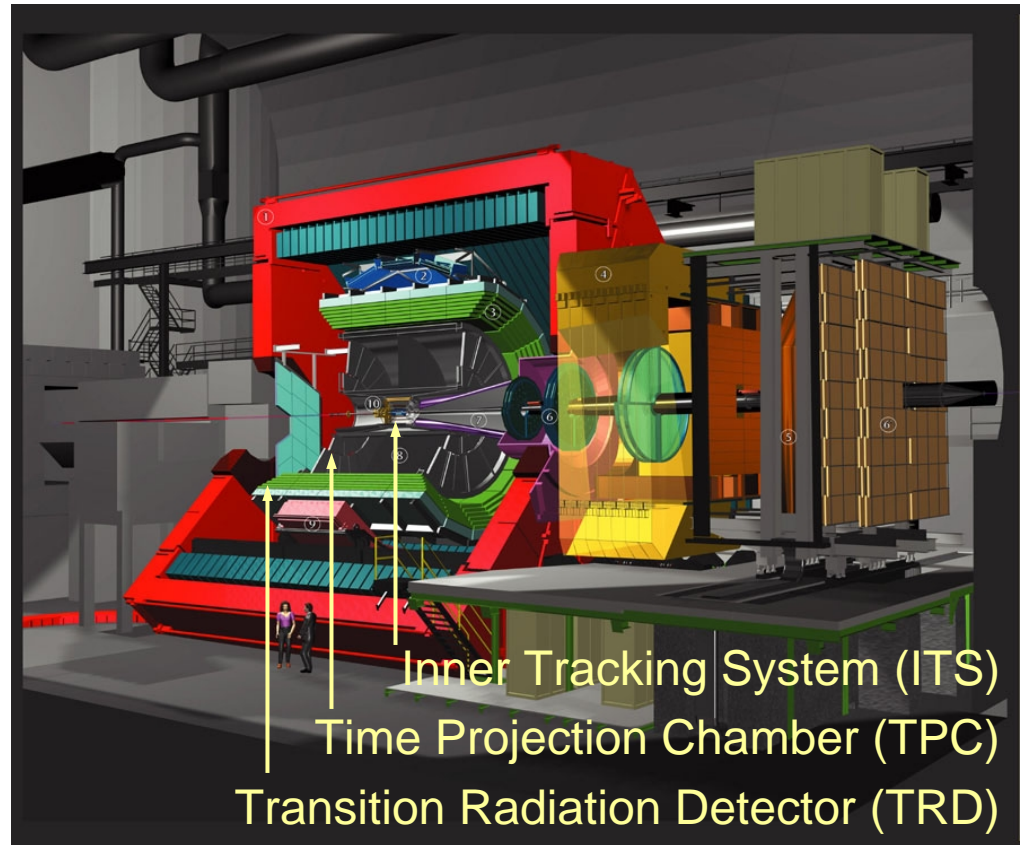
- The ALICE Transition Radiation Detector
- ALICE TRD Frontend Electronics
- Online Track Recognition
- Digital Filter
- Test Results





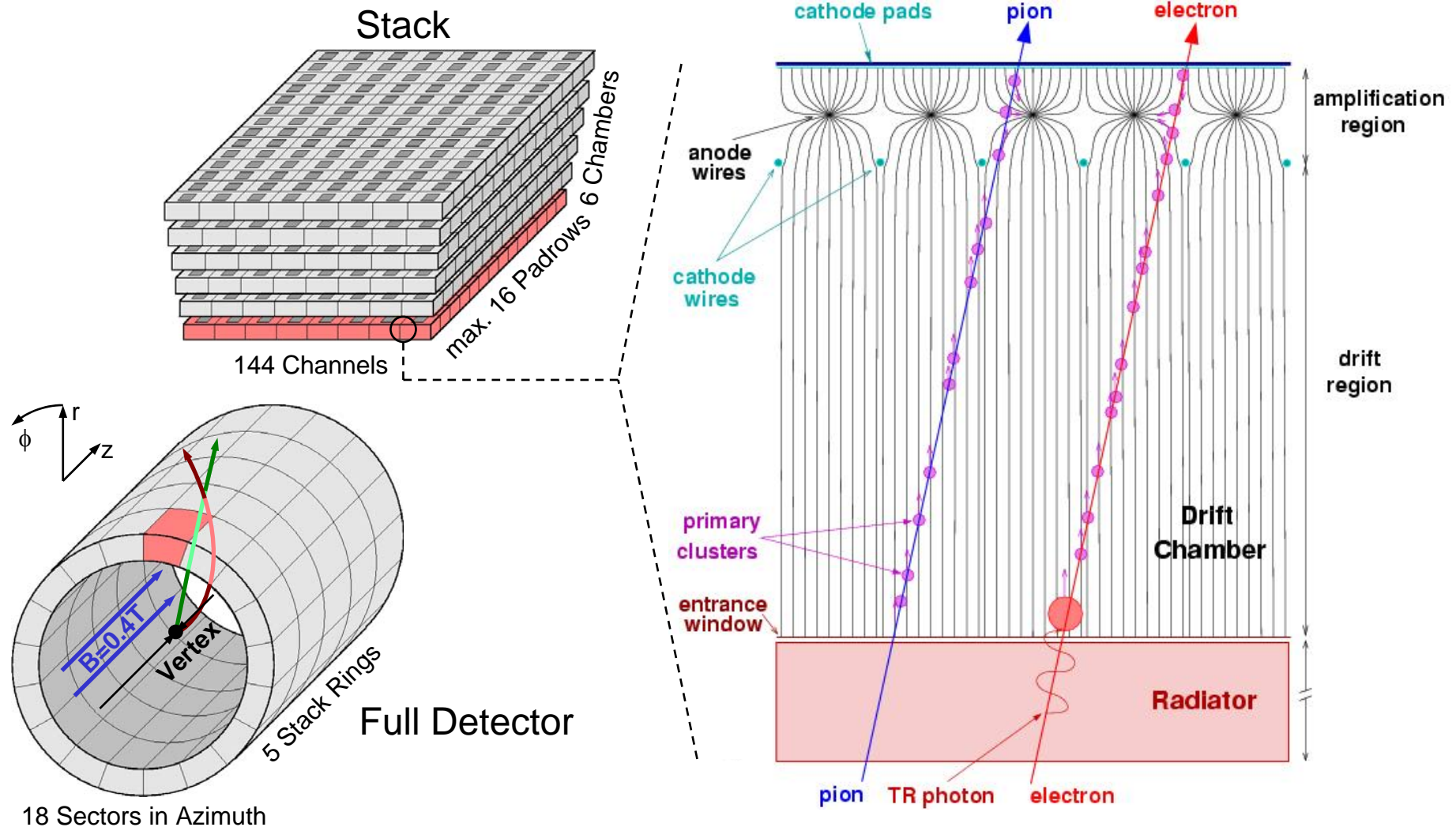
# A Large Ion Collider Experiment

- Pb-Pb Collision at 1.1 PeV/Nukleon
- Creation of Quark Gluon Plasma
- TRD is used as a trigger detector due to its fast readout time ( $2 \mu\text{s}$ ):
  - Transverse Momentum
  - Electron/Pion Separation





# Transition Radiation Detector

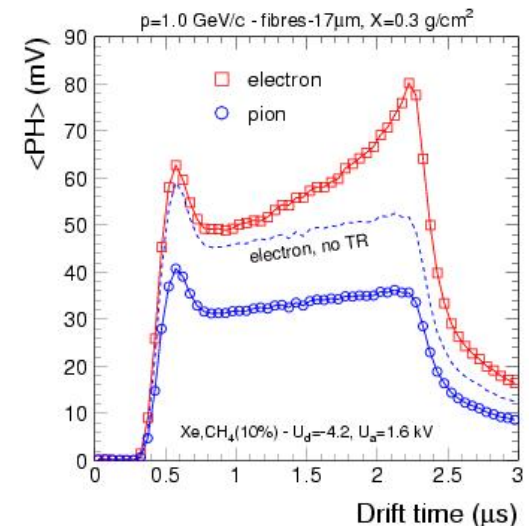
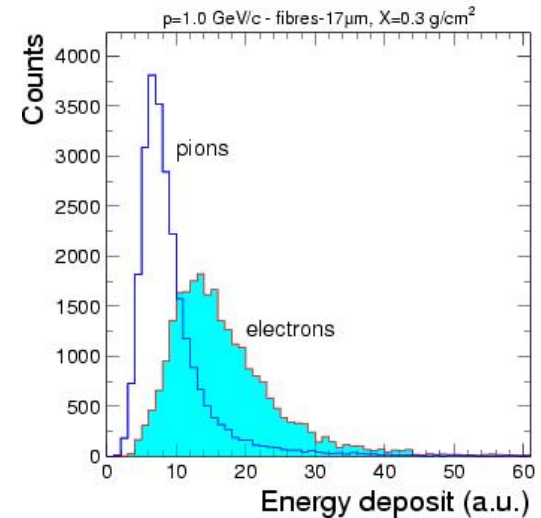


- Challenge:

- Data Generation in 1.2 Million Channels
- Peak Data Rate of 15.7 TB/s
- Electron/Pion Classification
- Tracking of up to 20,000 Particles

- Approach:

- Local Event Buffering and Readout of Accepted Events only
- Local Data Compression
- Local Electron/Pion Separation
- Local Tracking, Global Track Merging



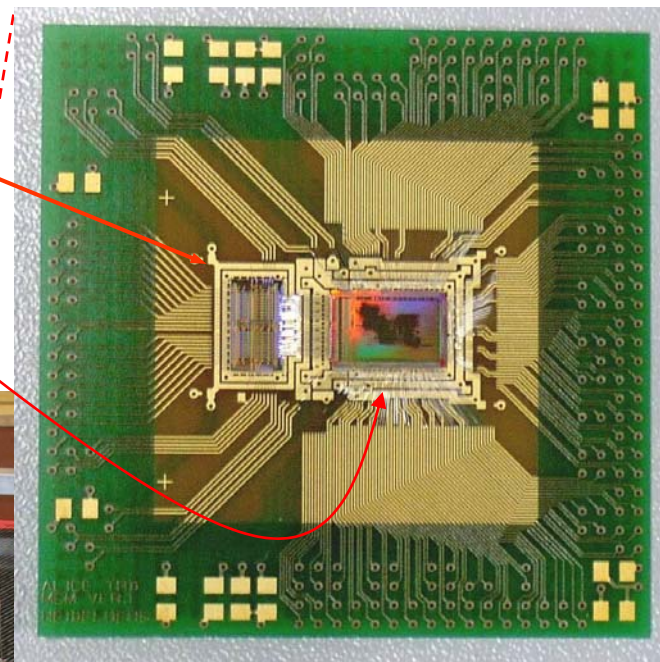
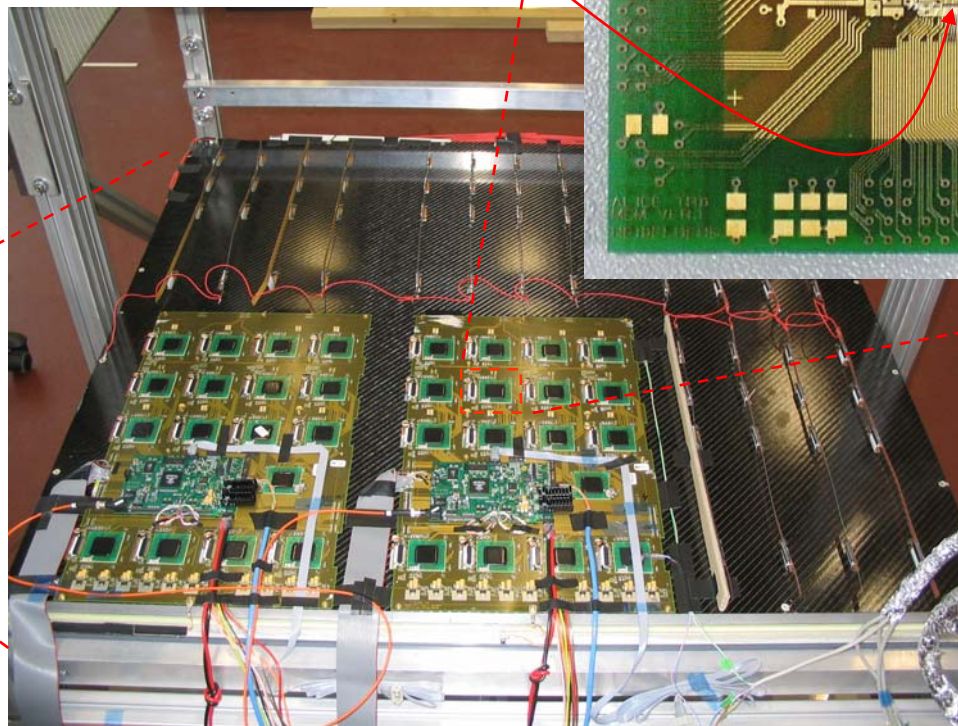
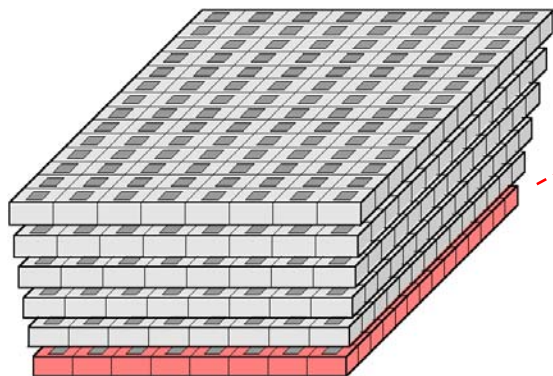


# TRD Frontend Electronics

Preamplifier and Shaper (PASA)

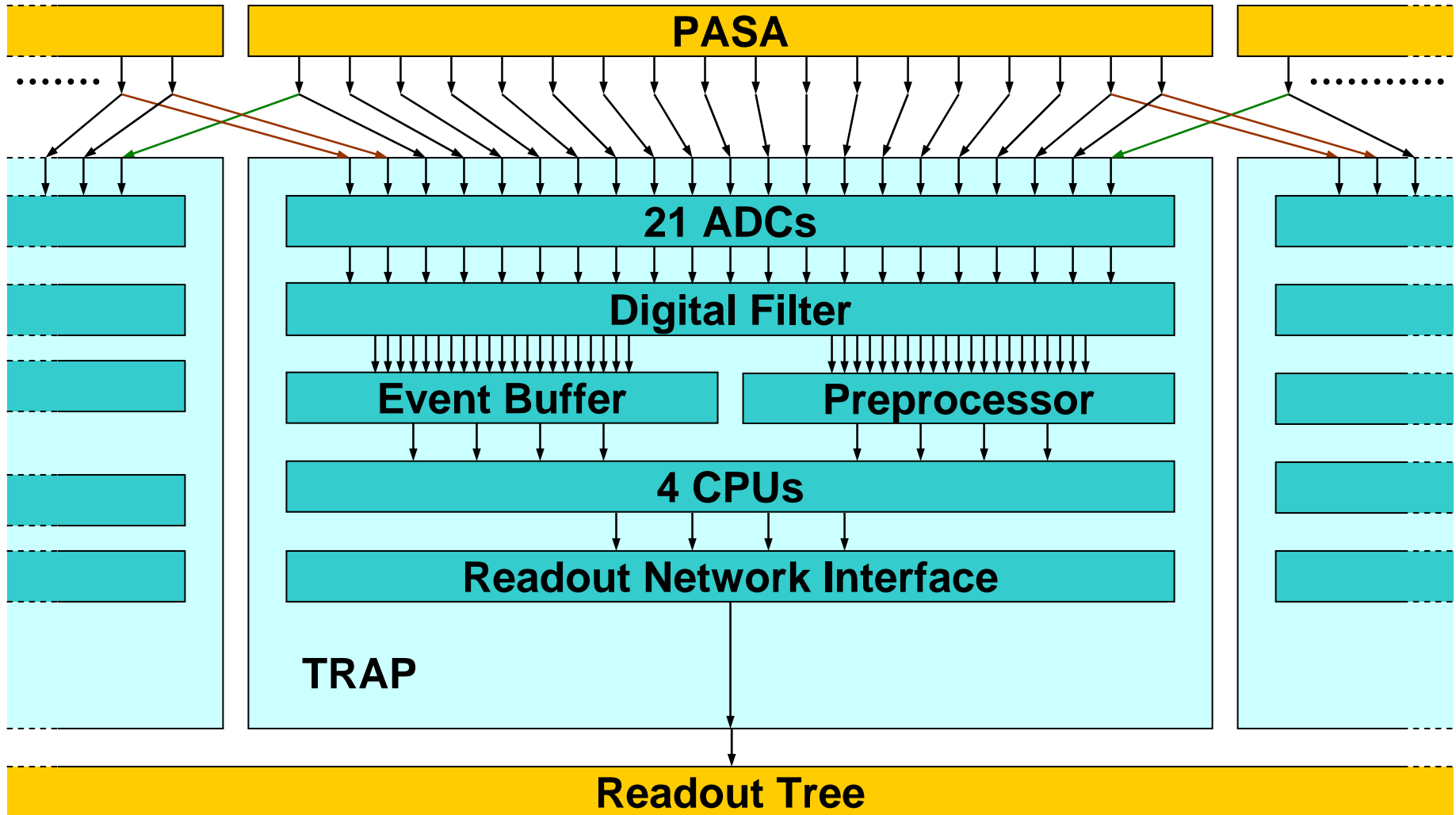
Tracklet Processing Chip (TRAP)

Stack



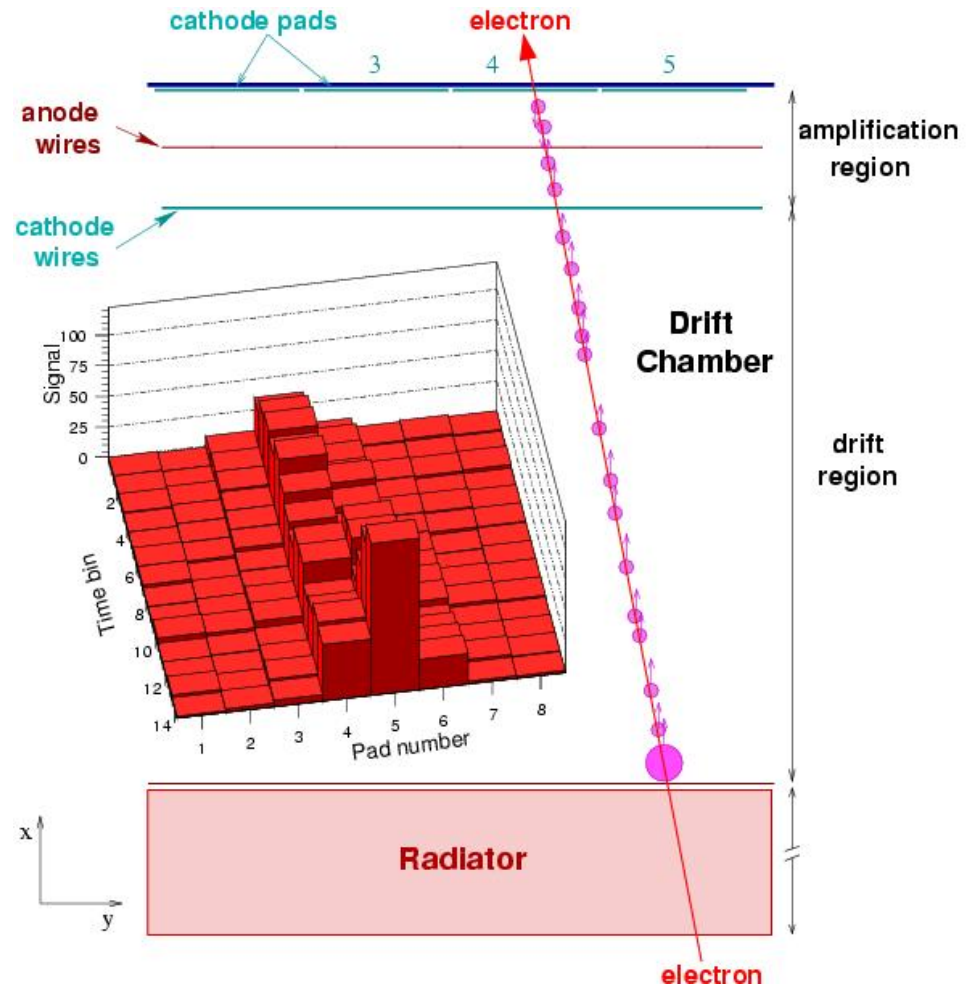


# Local Data Flow



# Tracklet Fitting Concept

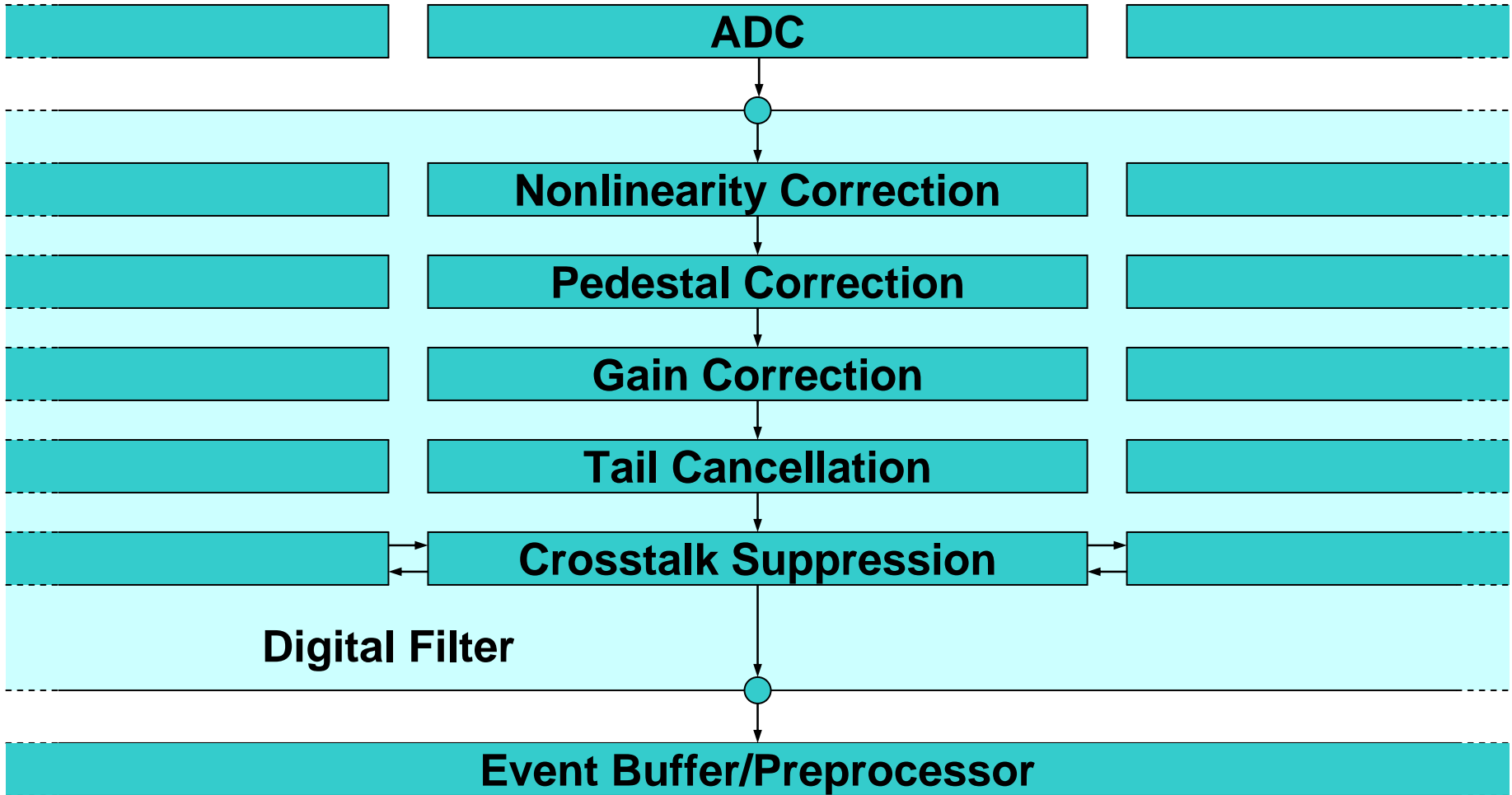
- During Drift Time (Preprocessor):
  - Charge Cluster Detection
  - Position Determination via Charge Sharing
  - Straight Line Fit in Associated Channel
- After Drift Time (CPUs):
  - Merging of Fit Parameters of Adjacent Channels
  - Fit Parameter Transmission





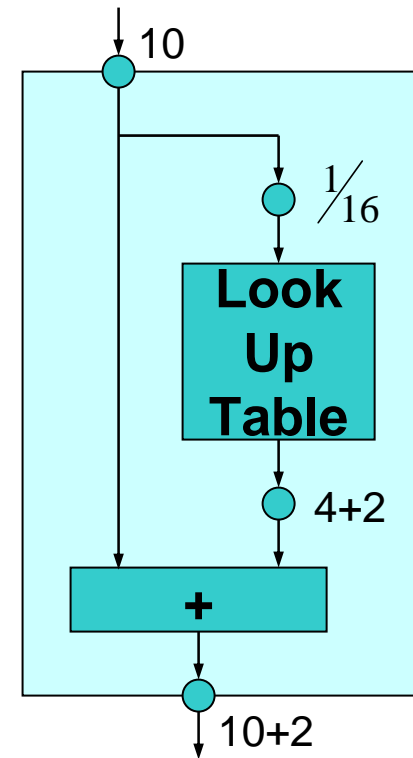
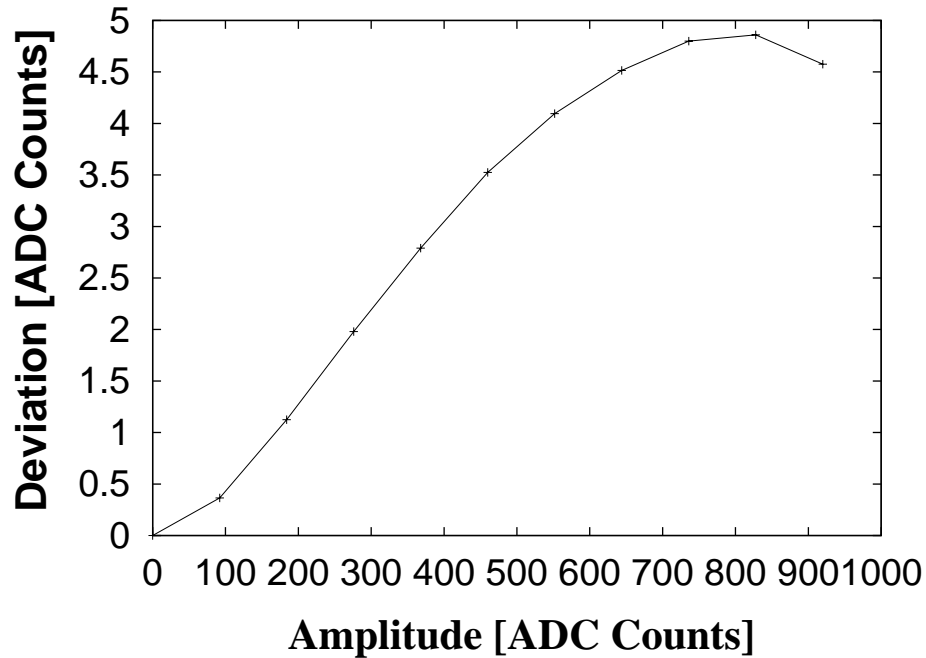


# Signal Improvement



# Nonlinearity Correction

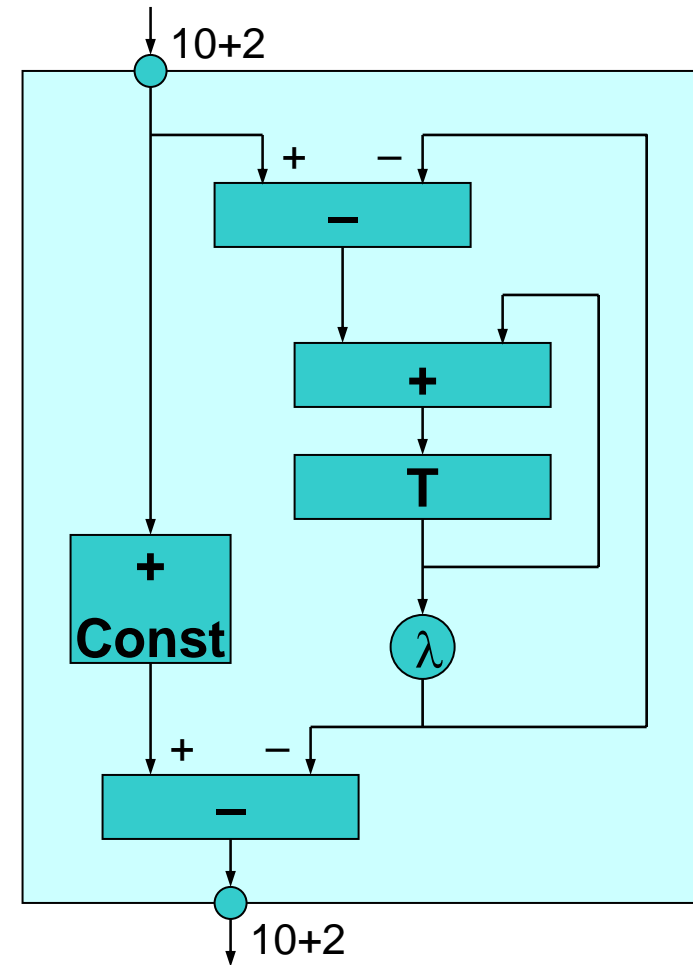
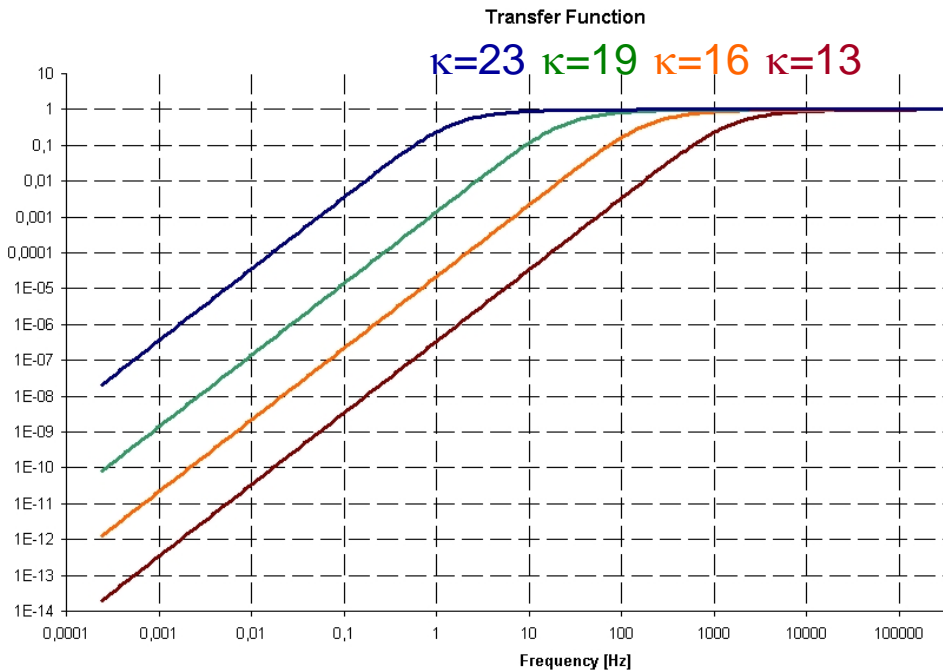
- Compensation of Common Nonlinearity



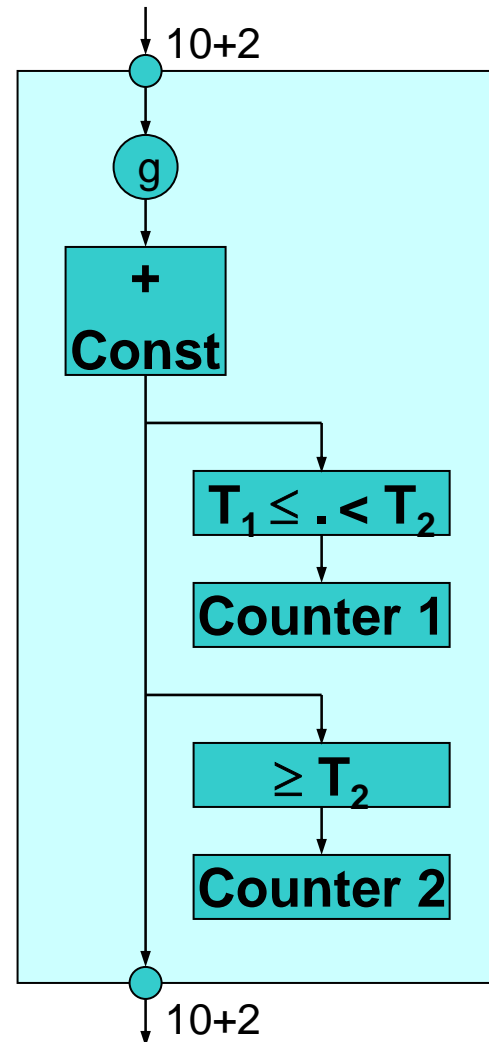
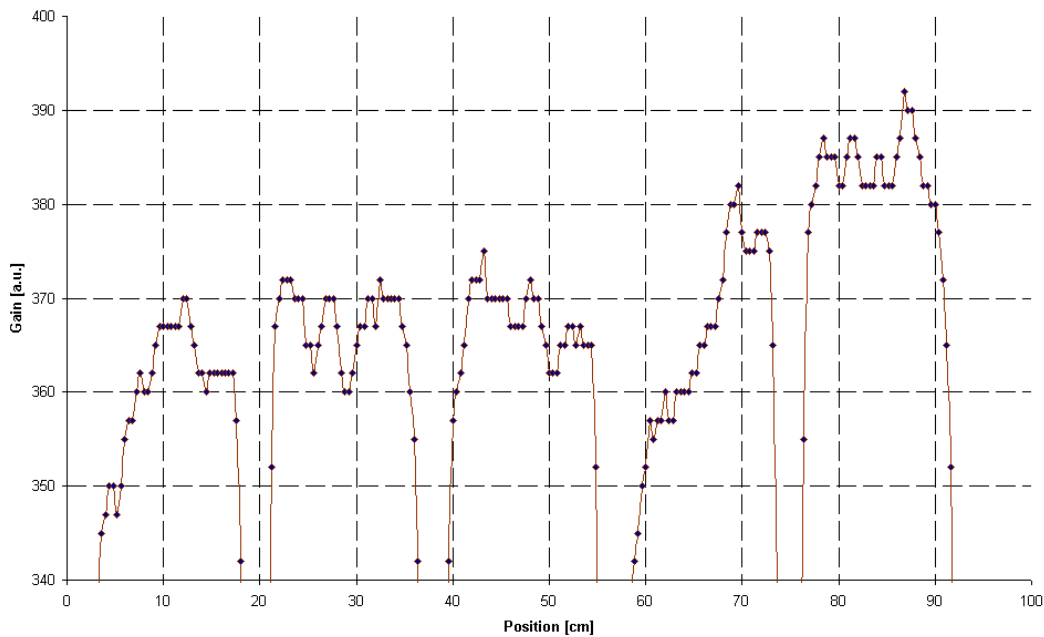
# Pedestal Correction

- Programmable First Order Relaxation Filter

$$\lambda = 1 - 2^{-\kappa}$$

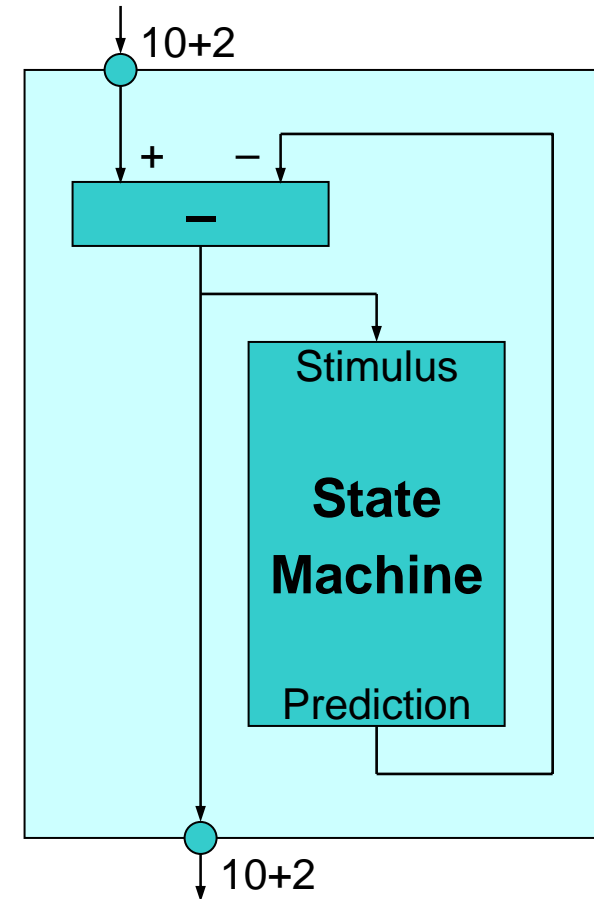
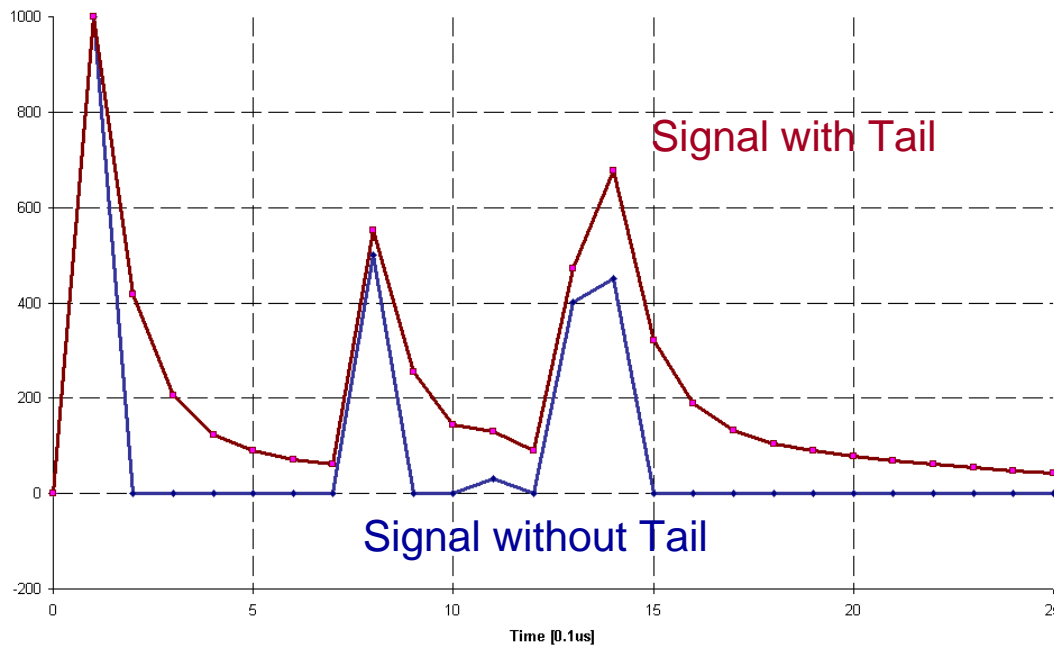


- Scaling of the individual Channels to achieve local Gain Uniformity



# Tail Cancellation

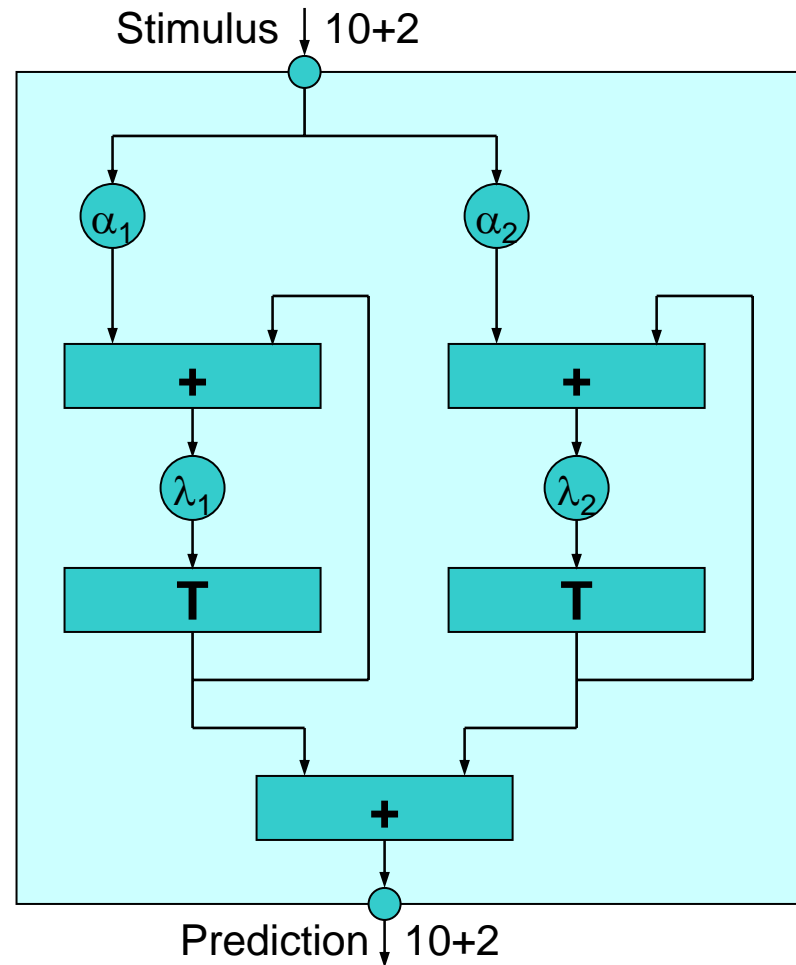
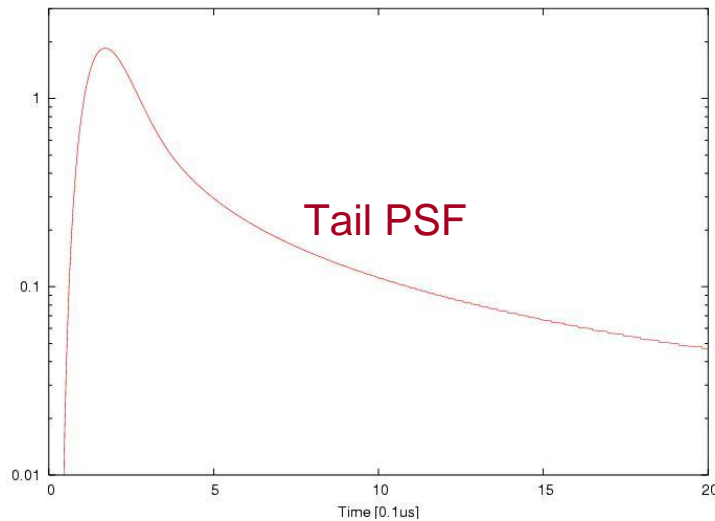
- Substraction of expected Ion Tail
- Prediction of future Tail by reconstructed Stimulus





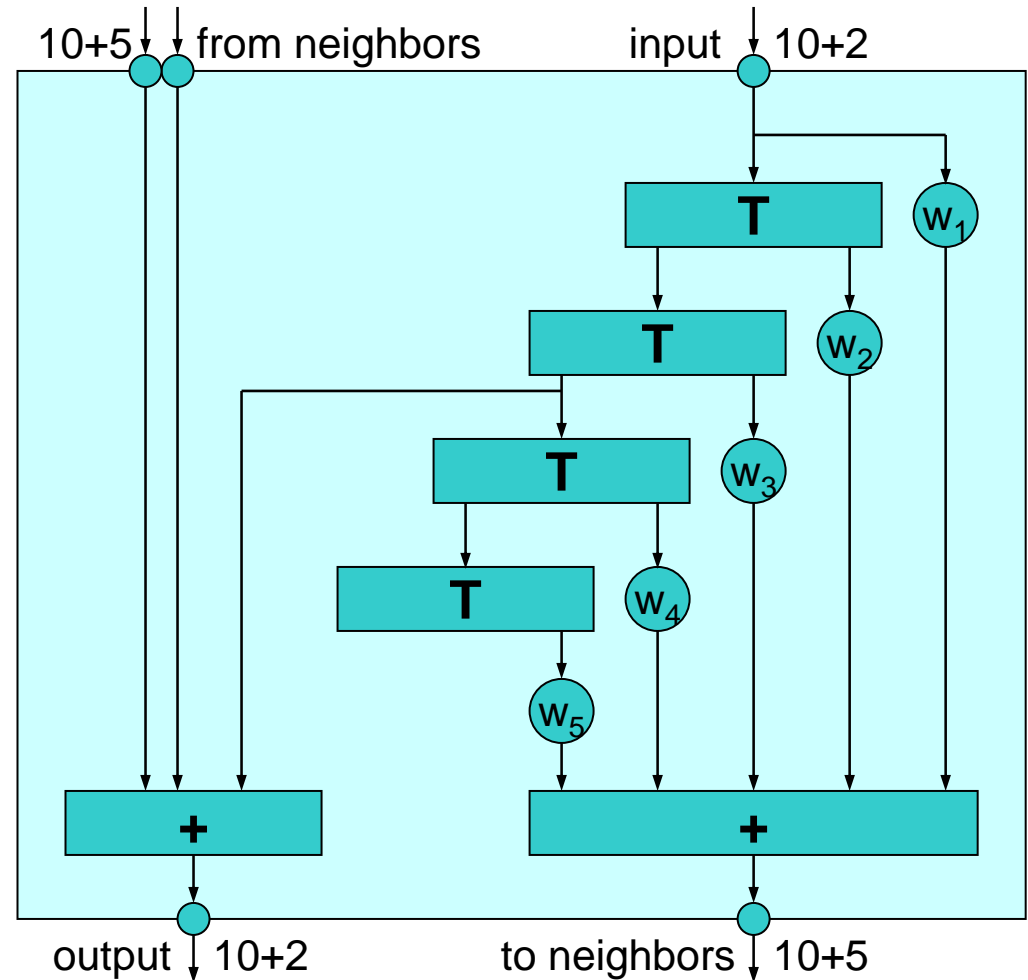
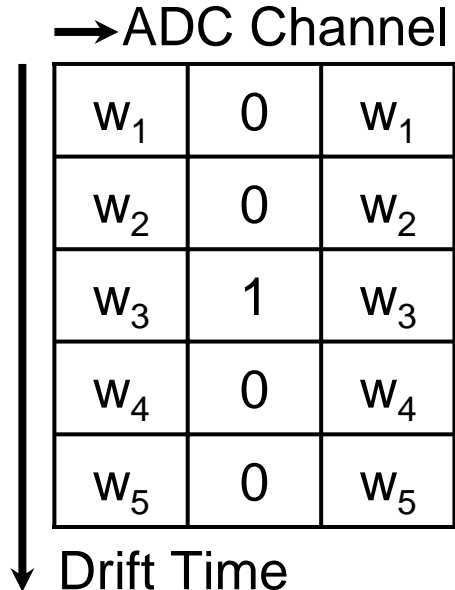
# Tail Cancellation/State Machine

- Programmable second Order IIR Filter



# Crosstalk Suppression

- Programmable 2D filter matrix
- Crosstalk as Slow Derivative of adjacent Input Pulse



# Functional Tests



CERN  
Positron Synchrotron  
25.10. – 05.11.2004

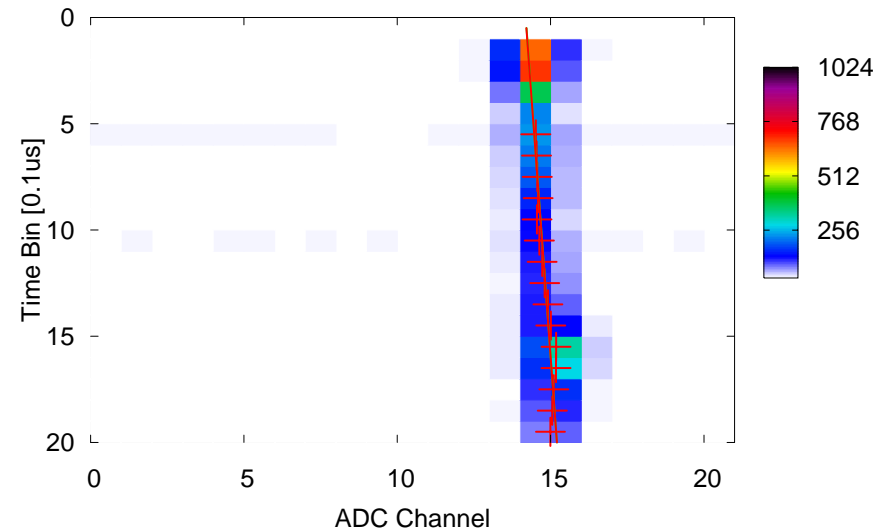




# CERN 2004 Beamtime Analysis

- Test of Preprocessor

- Track Segment Identification
- Number of Hit Points
- Angle Reconstruction



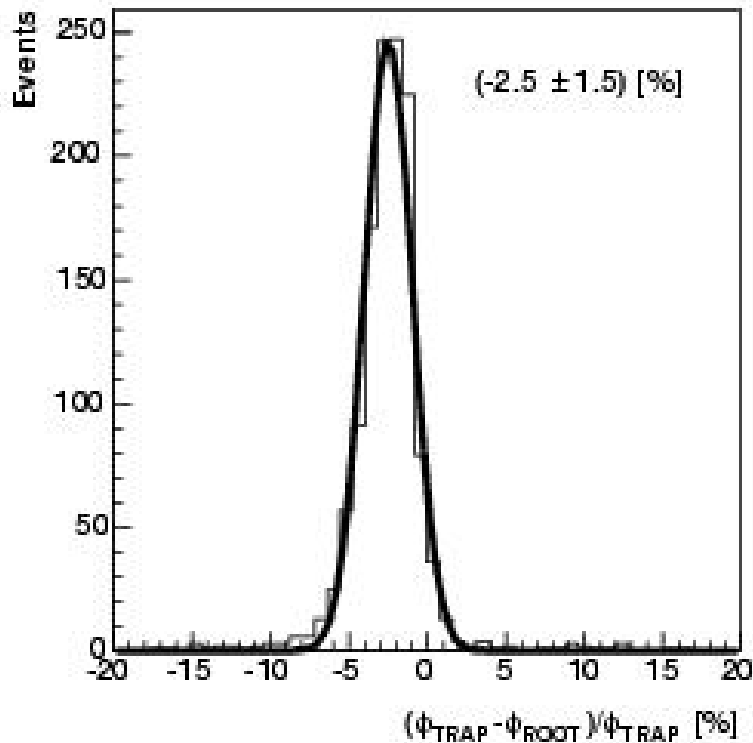
- Good agreement to a level of less than 1/1000 Track Segments



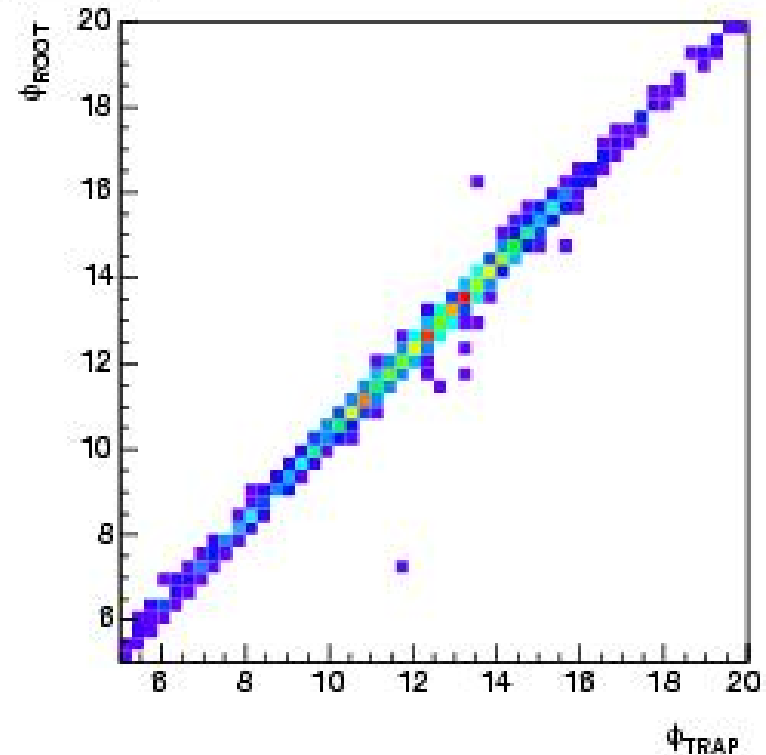


# Comparison to Offline Analysis

**hDiArel**



**hDiA2**



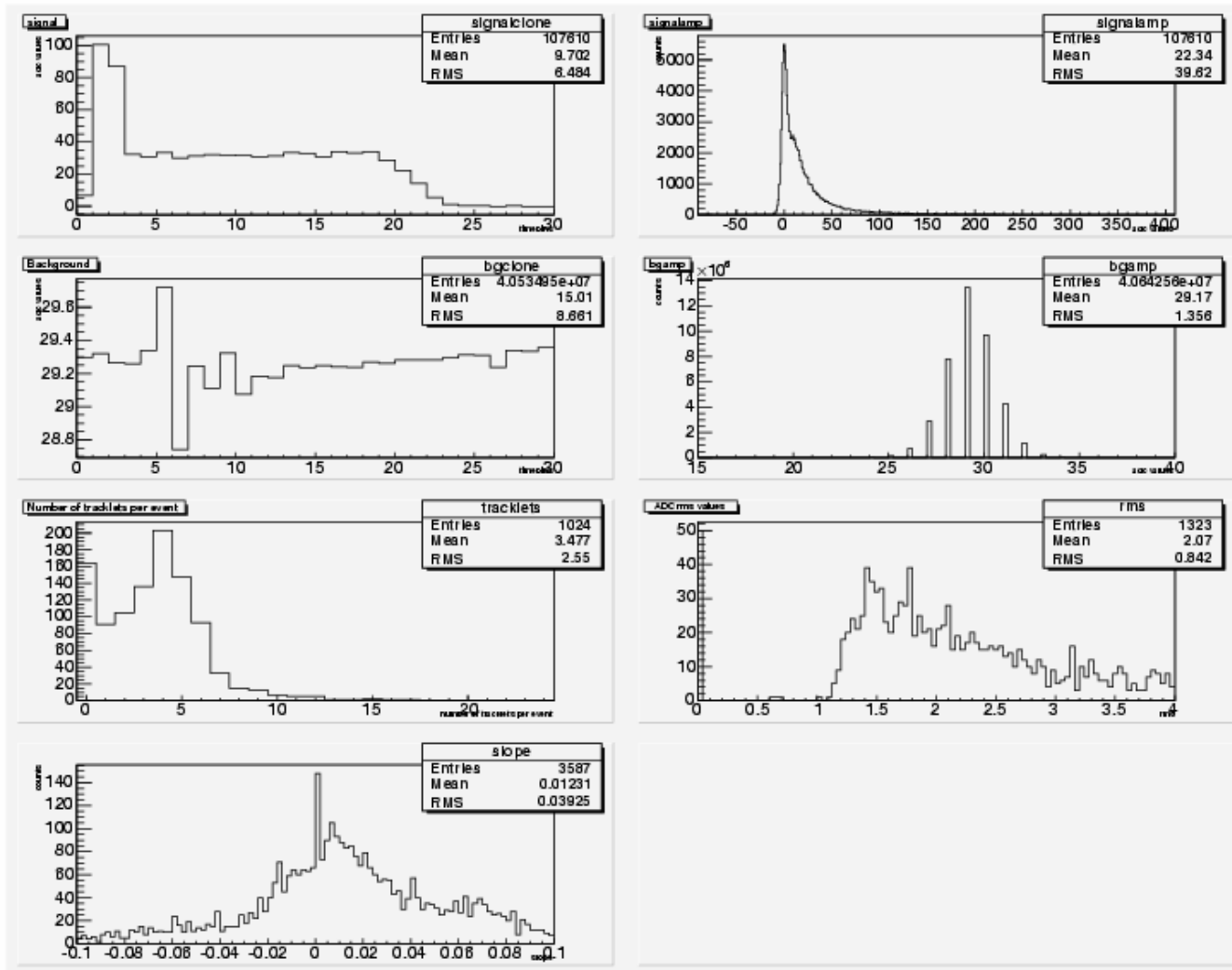
- Angle Reconstruction of TRAP compared to TRAP-like algorithm in ROOT

**B. Vulpescu**

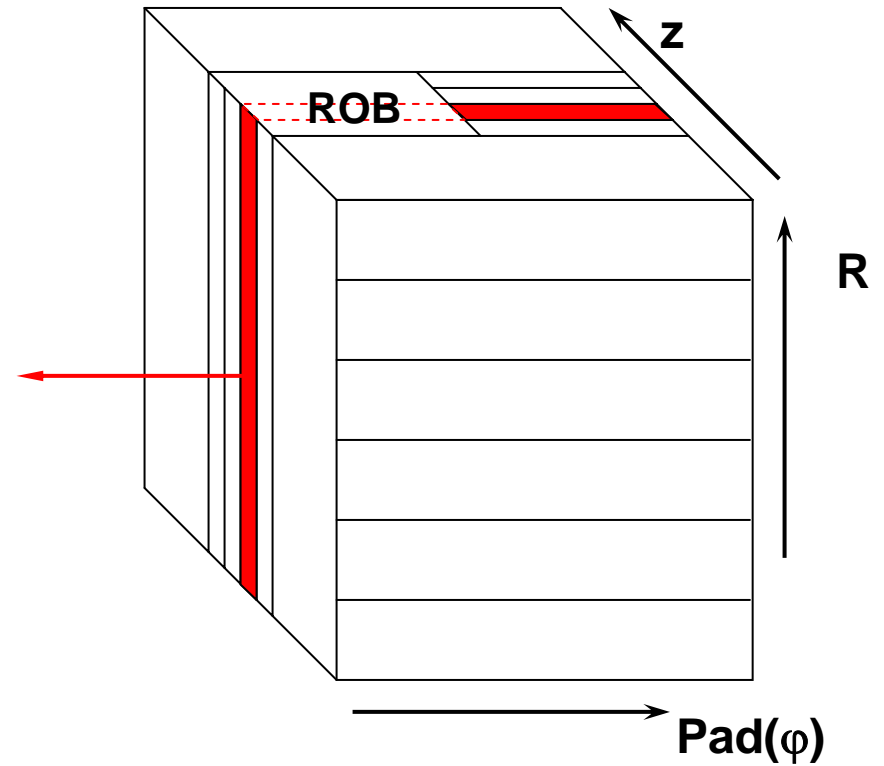
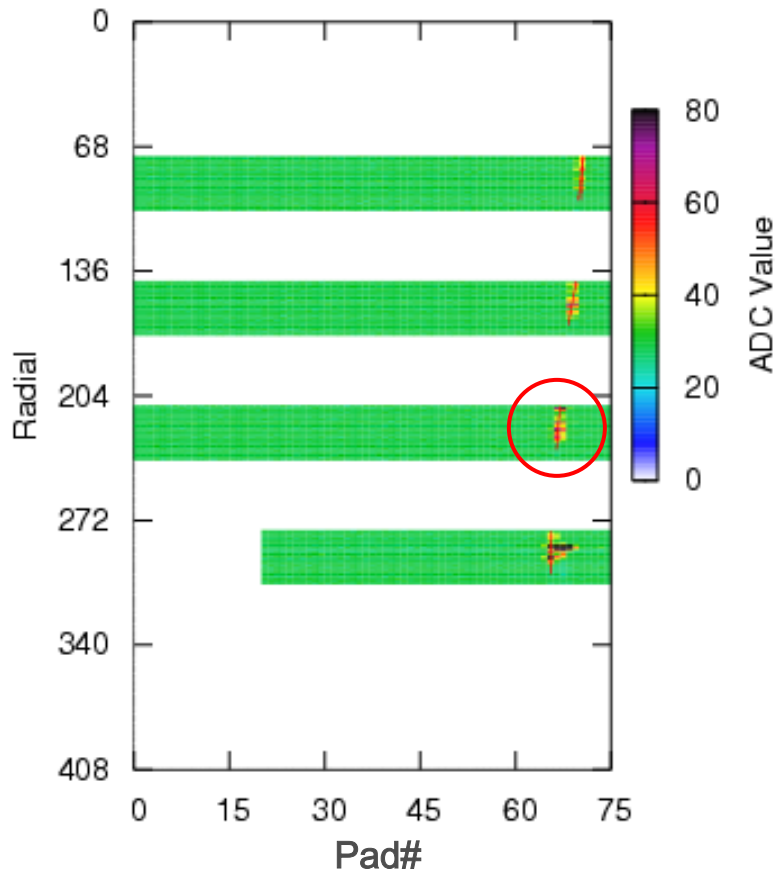




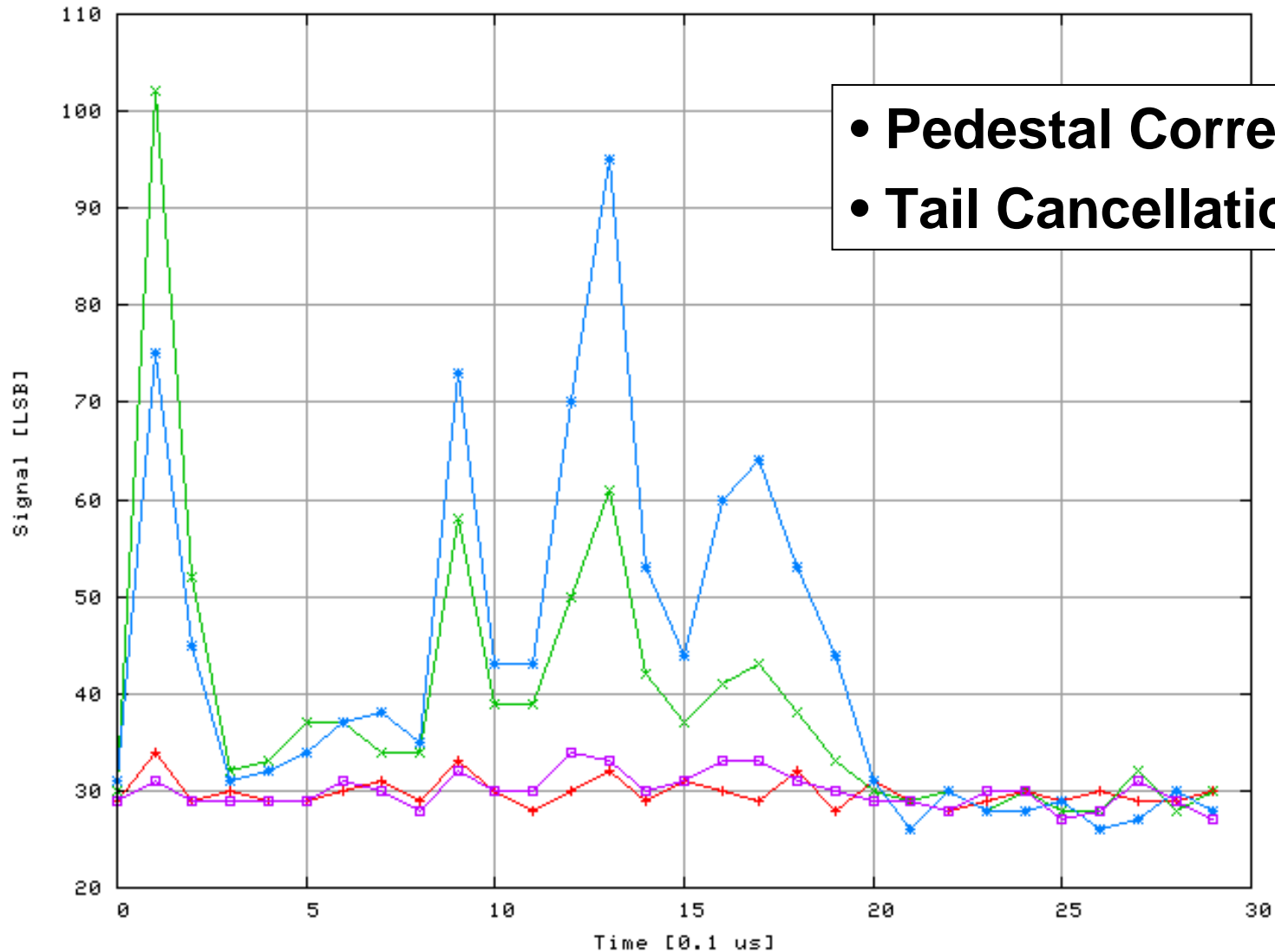
- Track Segment Postprocessing included into TRAP CPU program
- Transmission of Tracklet Words
- Filter Calibration



# Example Event



# Example Signal





# Summary

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- ALICE TRD frontend electronics performs online tracking.
- For data acquisition, digital filtering and local tracking the TRAP chip has been developed.
- The chip functionality has been shown by cosmic measurements and a CERN beamtime.
- A calibration scheme for filter parameters is under development.

