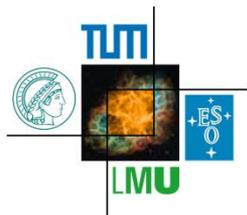
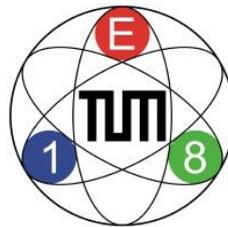


AFTER based Read Out for the GEM-TPC

Sverre Dørheim

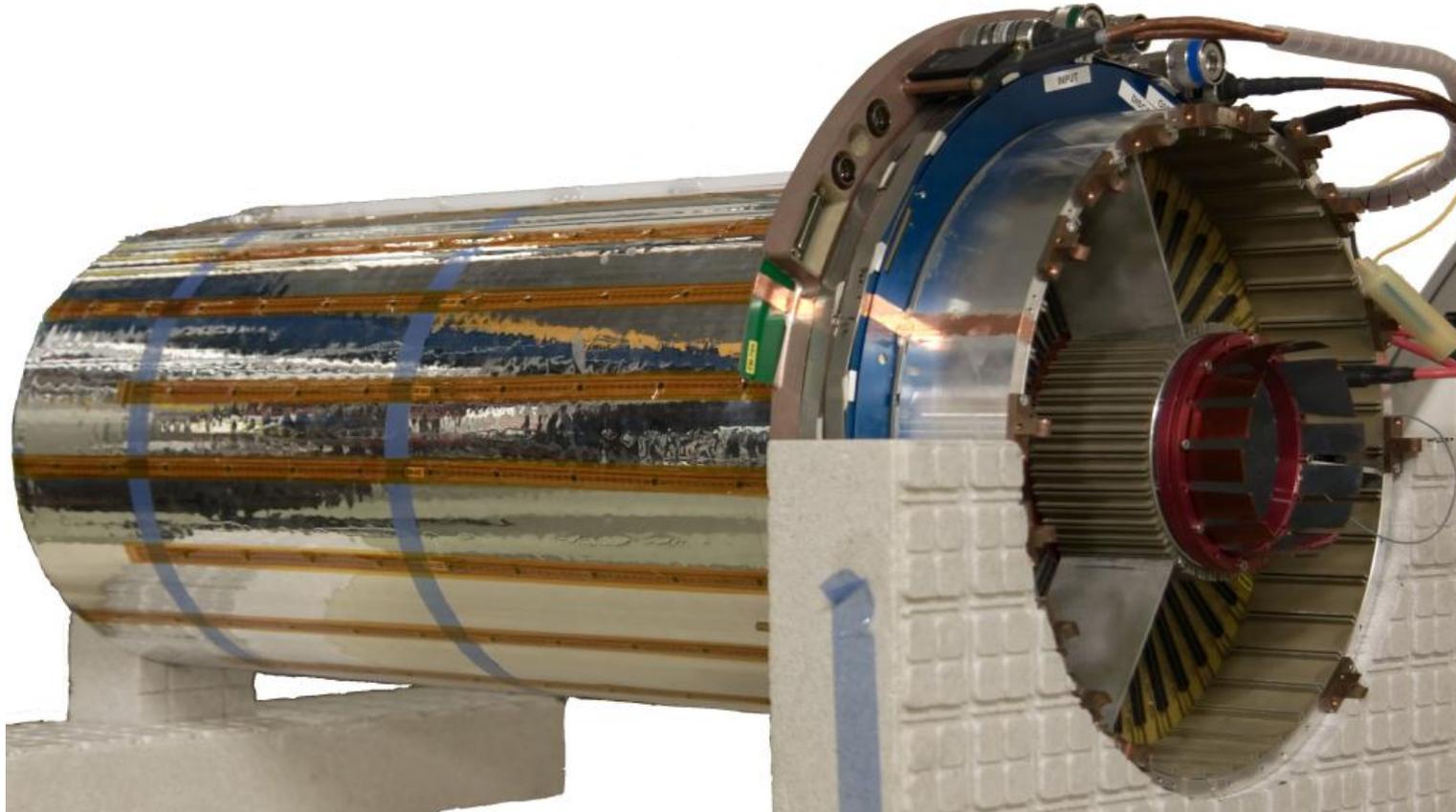
Physik Department E18
Technische Universität München
Germany

On behalf of the GEM-TPC collaboration

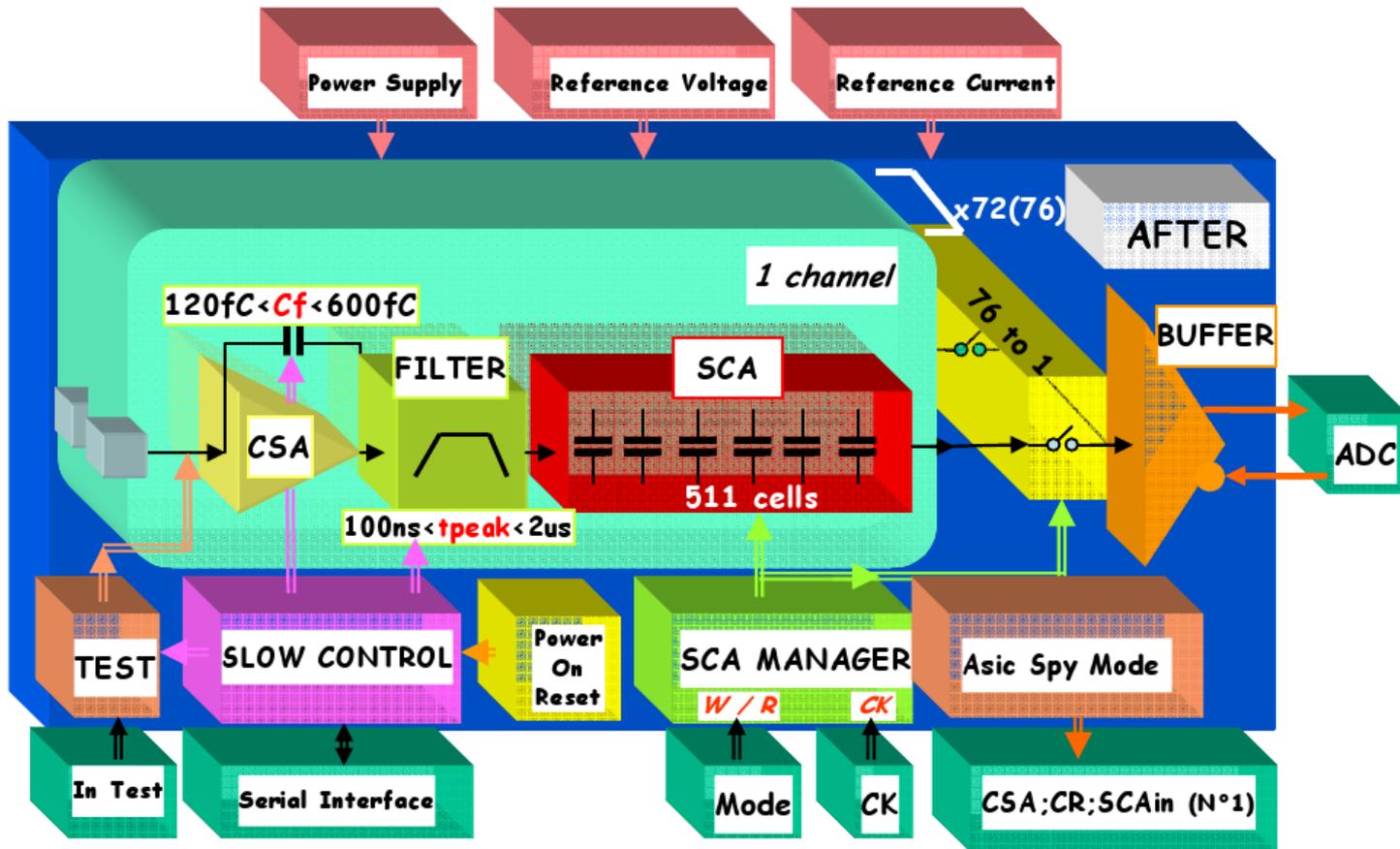


Bundesministerium
für Bildung
und Forschung

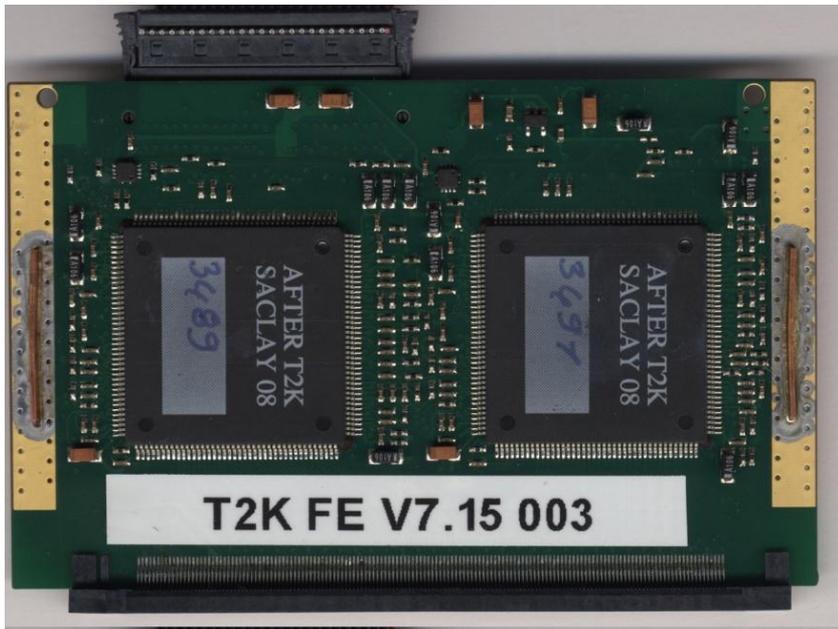
The GEM-TPC Prototype



The AFTER-chip



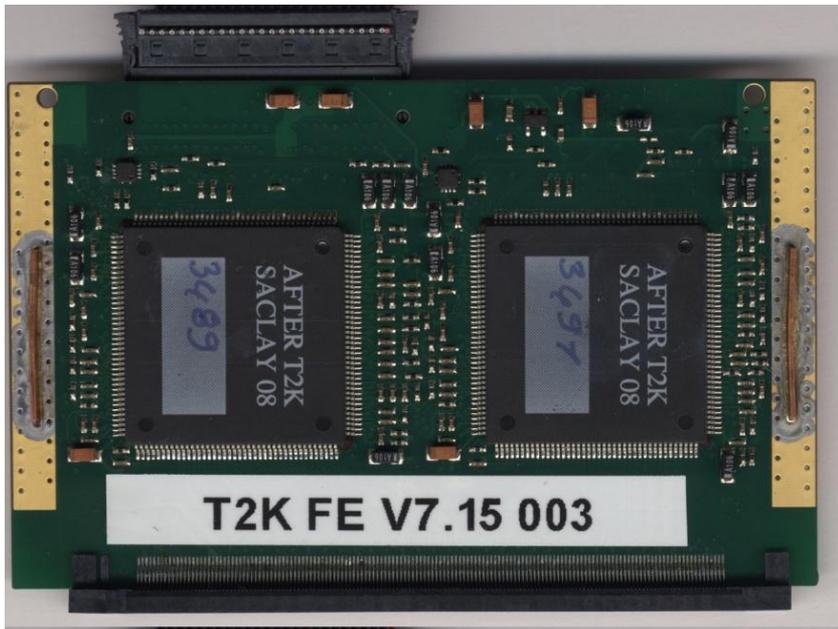
The AFTER chip continued



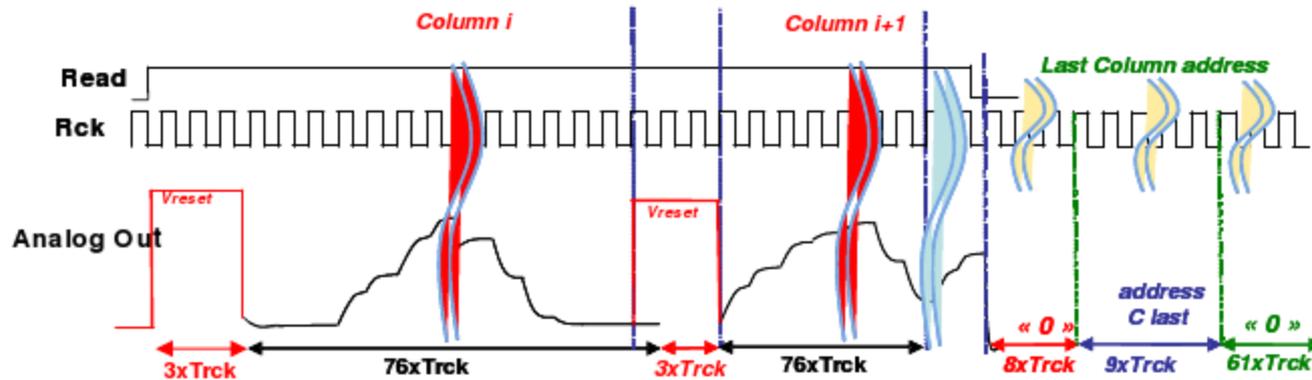
- Both signal polarities
- 72(64) channels
- Analog circular buffer of 511 samples
- Sampling frequency from 10 –50 MHz
 - 10 - 51 μ s read out window
- Noise: \sim 700 e- ENC, connected to prototype
- Adjustable shaping time
 - 100 ns –2 μ s
- Tunable dynamic range
 - 120 fC – 600 fC
- \sim 0.8 W/chip

The AFTER chip continued 2

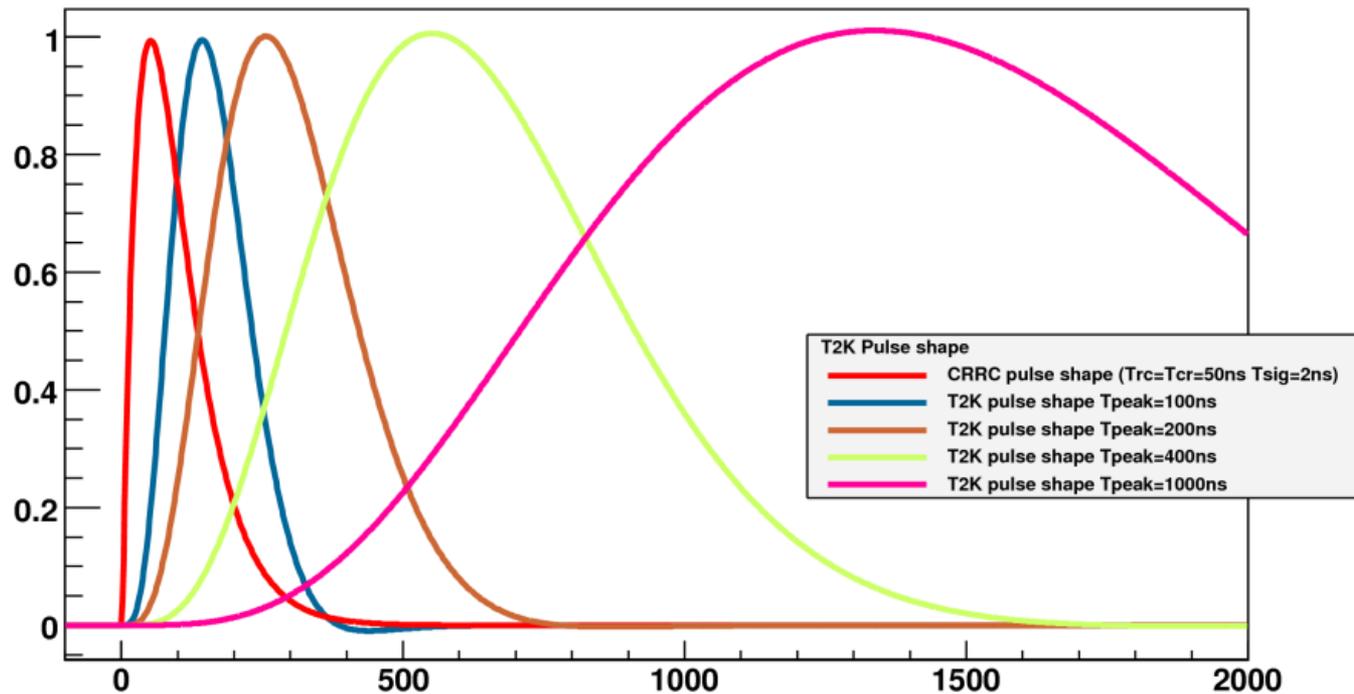
- 20 MHz read out frequency
 - ~ 2 ms full event read out time
 - Max trigger rate 500 Hz
 - Might be possible with 40 MHz
- Stable power consumption
 - Easy to regulate



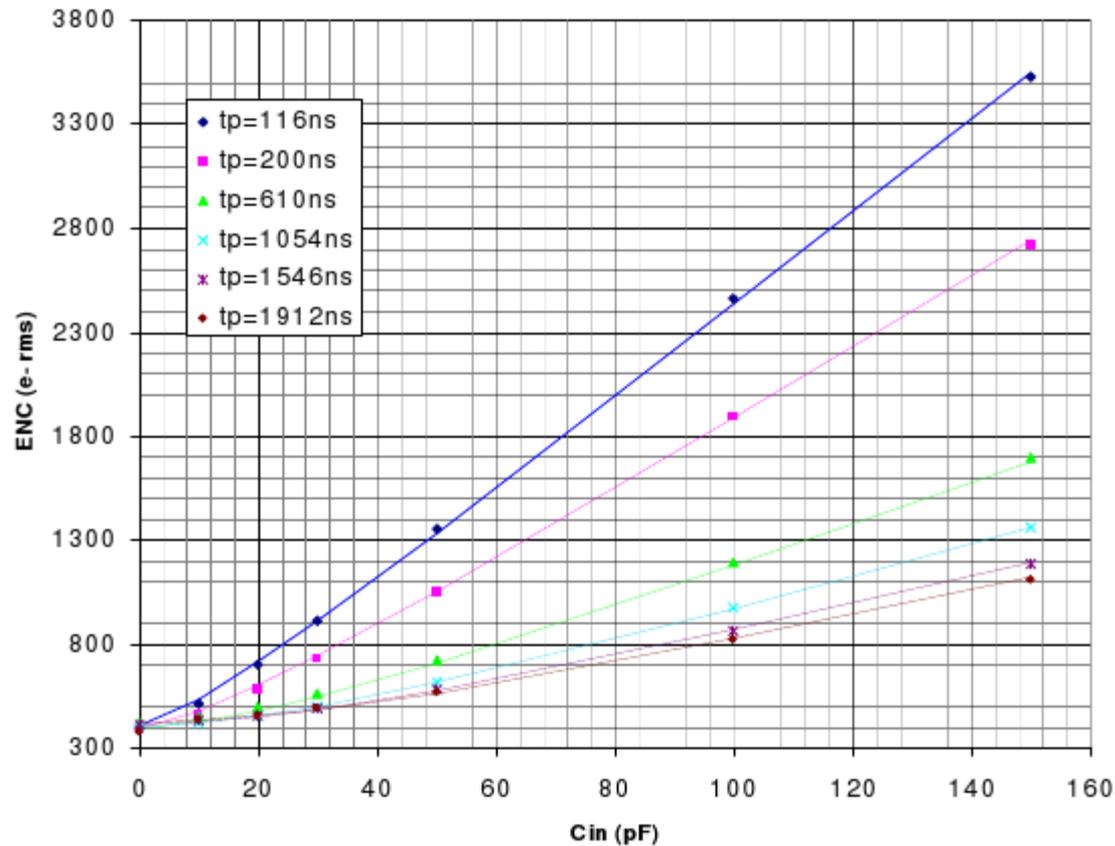
Data stream



Shaping time

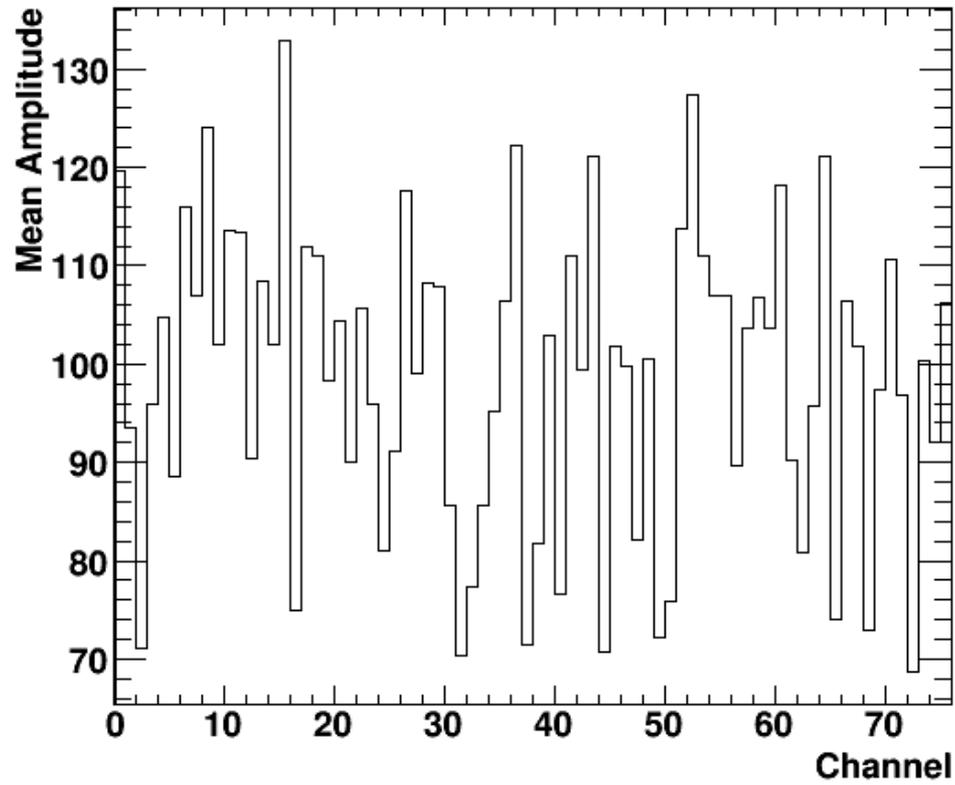


Noise vs Input capacitance



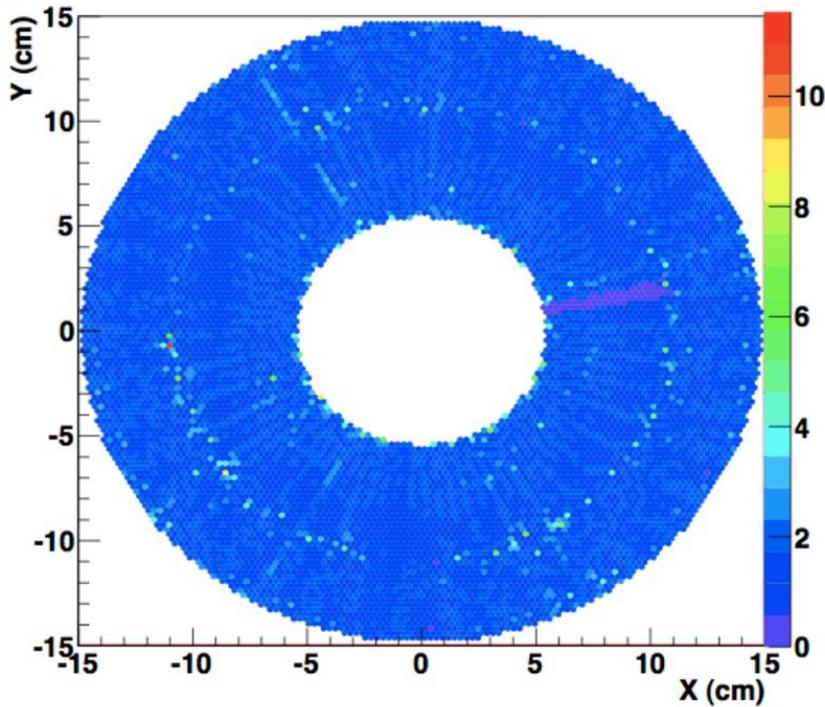
Baseline

Pedestal t2k card 2, chip 1

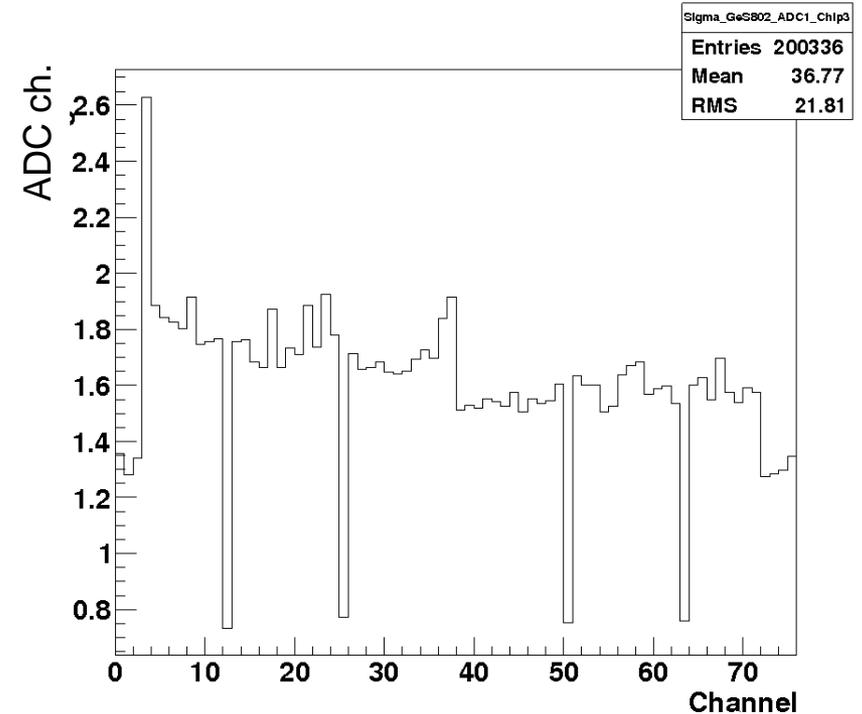


Noise uniformity

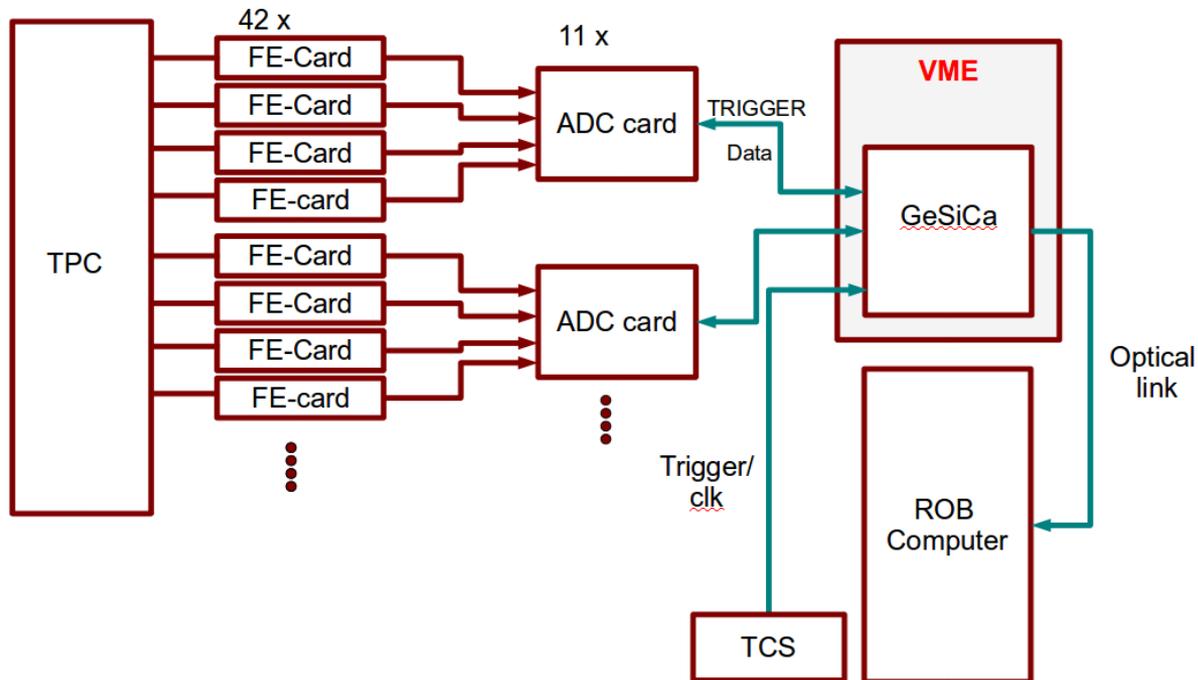
- Full chamber read out, uniform noise
- Average noise at $\sim 700 e^-$
- In total 12768 channels read out (including empty channels)



1 ADC ch= $\sim 400 e^-$



Read out scheme



The ADC module

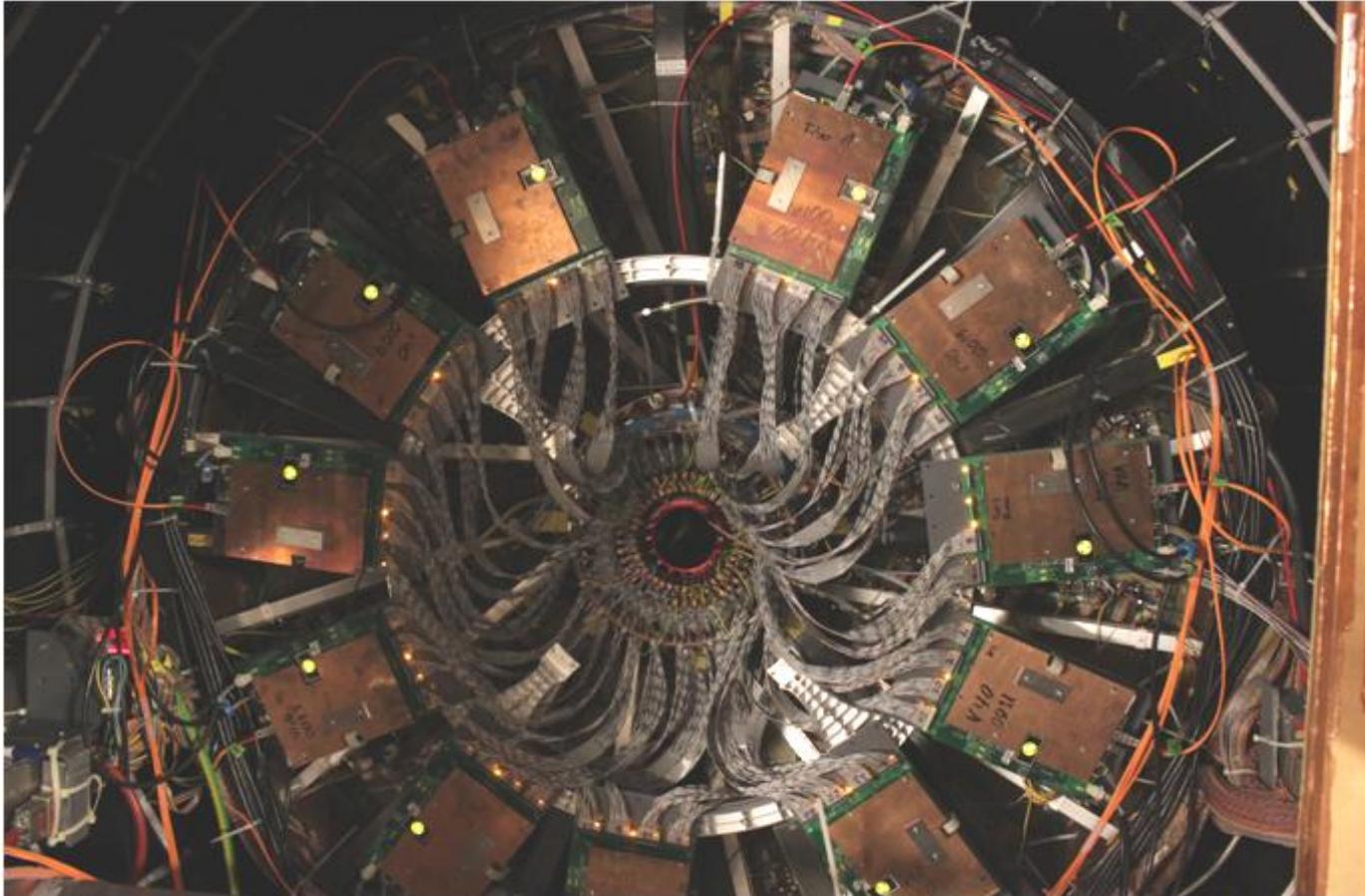


- Developed for APV-read out at COMPASS
- Two ADC-chips sampling in total 16 front end chips
- Virtex4 FPGA
 - Baseline subtraction
 - Zero suppression
 - FPN-corrections/CM-corrections
- Optical link for data transfer and synchronization

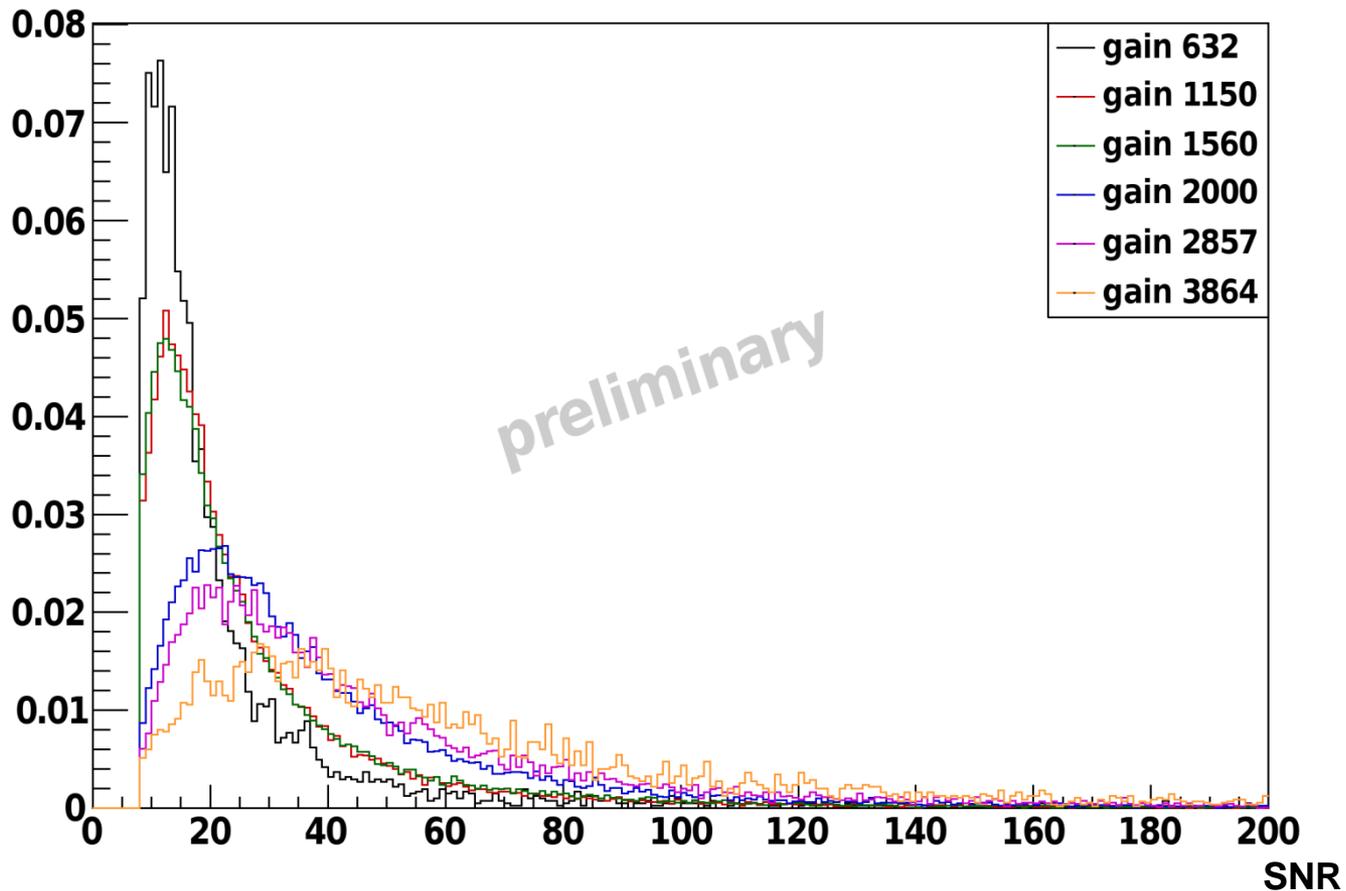
The FPN-Correction

- All channels are baseline subtracted (individual baselines)
- The average of the two FPN channels of one SCA is subtracted
- Adds noise from the two channels
- Partly corrects for SCA leakage
- Corrects for Common Mode noise

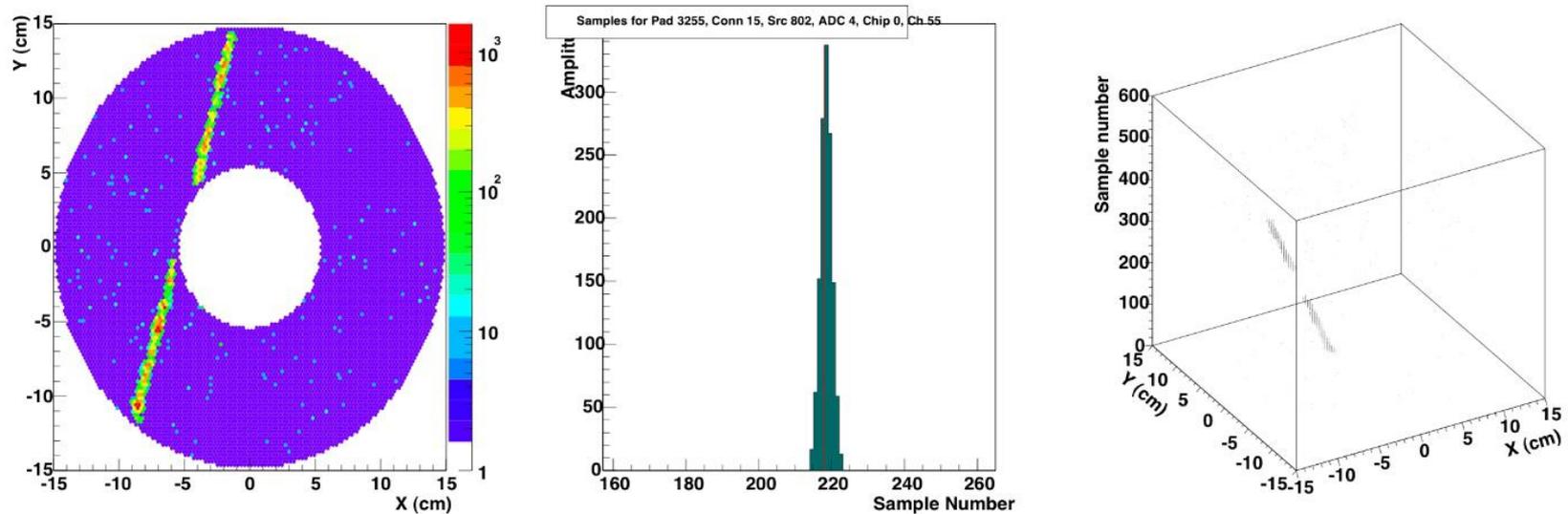
The GEM-TPC at FOPI@GSI (Darmstadt, Germany)



Signal to noise level, Ne/CO₂ (zero suppressed)



Cosmic Tracks in the TPC - Online Monitoring



- Left: Sample amplitude
- Middle: Sample of selected pad
- Right: 3D sample view

The GEM-TPC collaboration



TU München, E18

H. Angerer, M. Ball, F. Böhmer, S. Dørheim,
C. Höppner, B. Ketzer, I. Konorov, S. Neubert,
S. Paul, J. Rauch, S. Uhl, M. Vandenbroucke

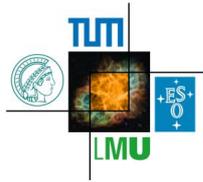
GSI, Darmstadt



R. Arora, J. Frühauf, J. Hehner, M. Kis¹,
V. Kleipa, J. Kunkel, N. Kurz, Y. Leifels,
H. Risch, C. Schmidt, S. Schwab,
D. Soyk, B. Voss, J. Voss, J. Weiner
¹ also at RBI Zagreb

TUM, Exc. Cluster Universe

M. Berger, J. Chen, F. Cusanno,
L. Fabbietti, R. Münzer



Stefan-Meyer-Institut, Wien

P. Müllner, K. Suzuki, J. Zmeskal



HISKP Bonn

R. Beck, D. Kaiser, M. Lang, R. Schmitz
D. Walther, A. Winnebeck

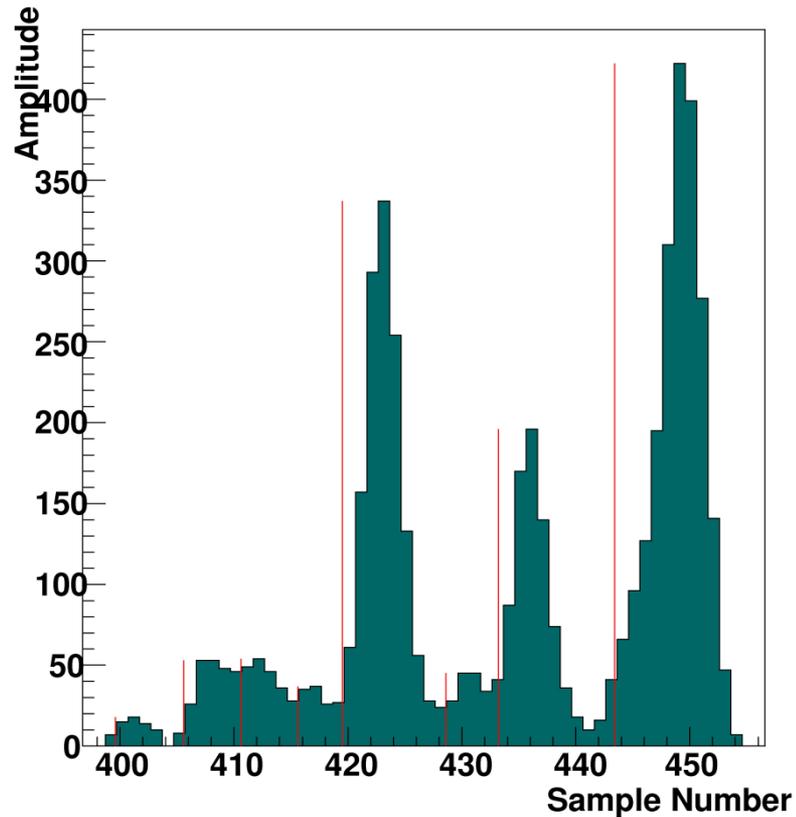


Universität Heidelberg

N. Herrmann



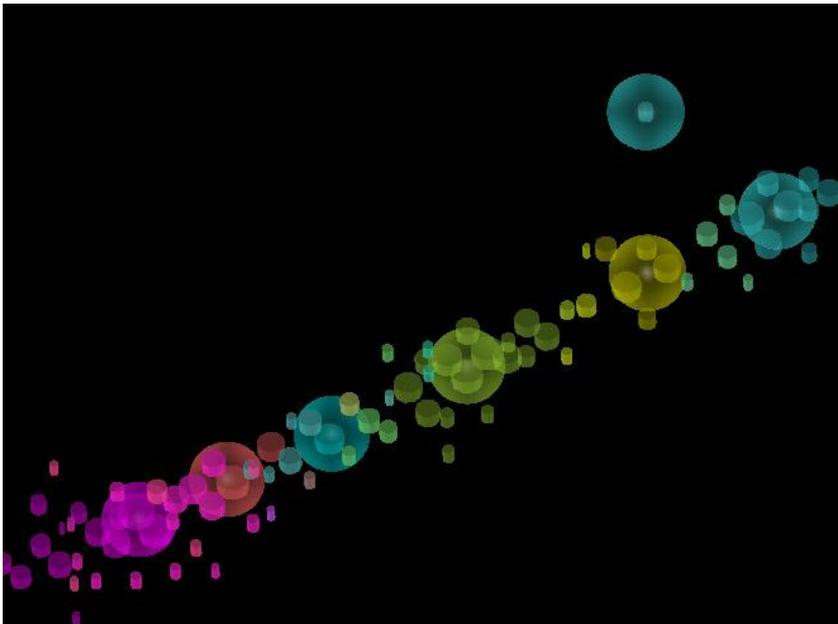
Pulse Shape analysis



Simple PSA algorithm

- Find local minima
- Pulse amplitude: Maximal amplitude of pulse
- Pulse time: Time of maximal sample minus the rise time of the shaper.

Clustering



Simple clustering:

- Create cluster around local maxima in digi amplitudes
- Attach digis to clusters, if
 - They are adjacent (Pad-wise)
 - They have a z-value within a certain time slice around the cluster center of gravity
- Digi splitting between clusters possible