

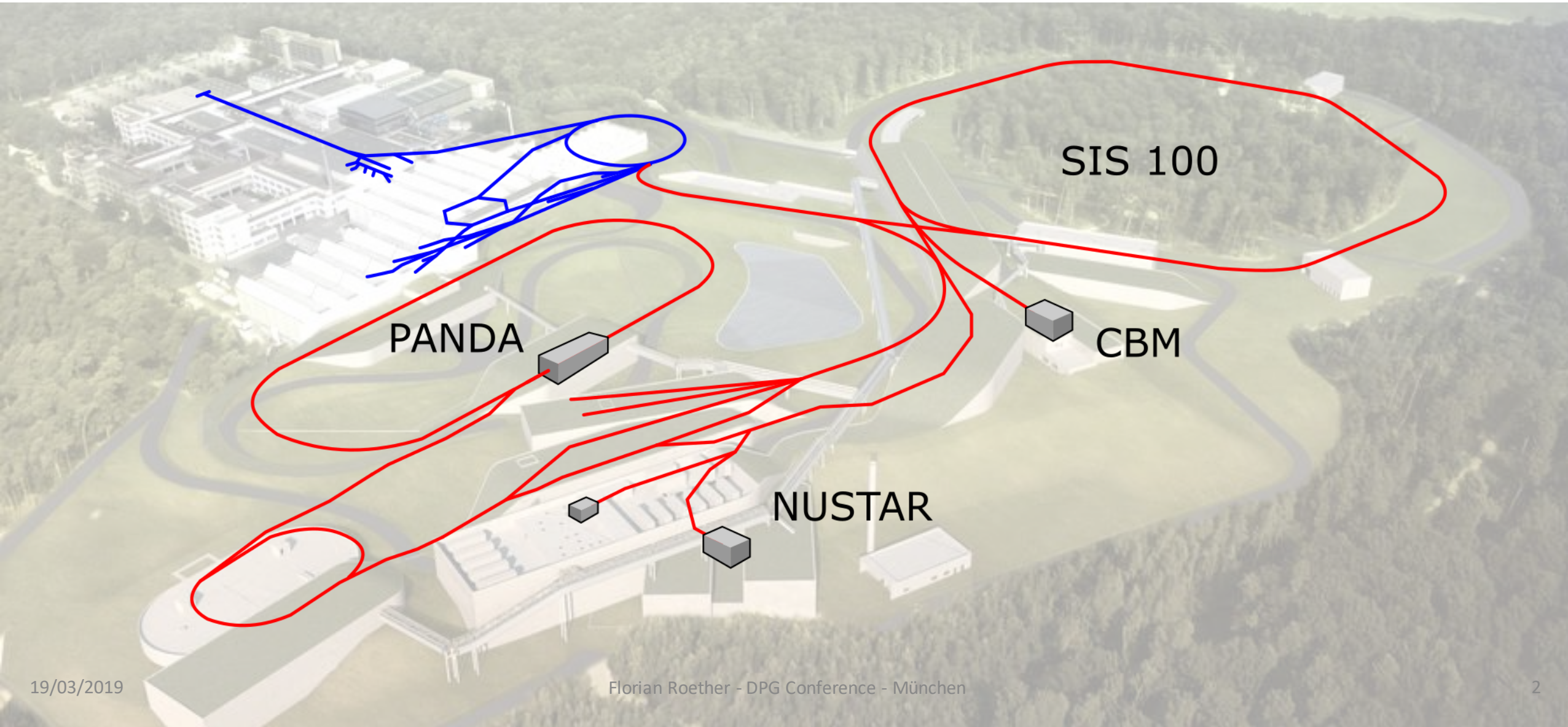
Evaluation of different feature extraction methods for the CBM-TRD

Florian Roether

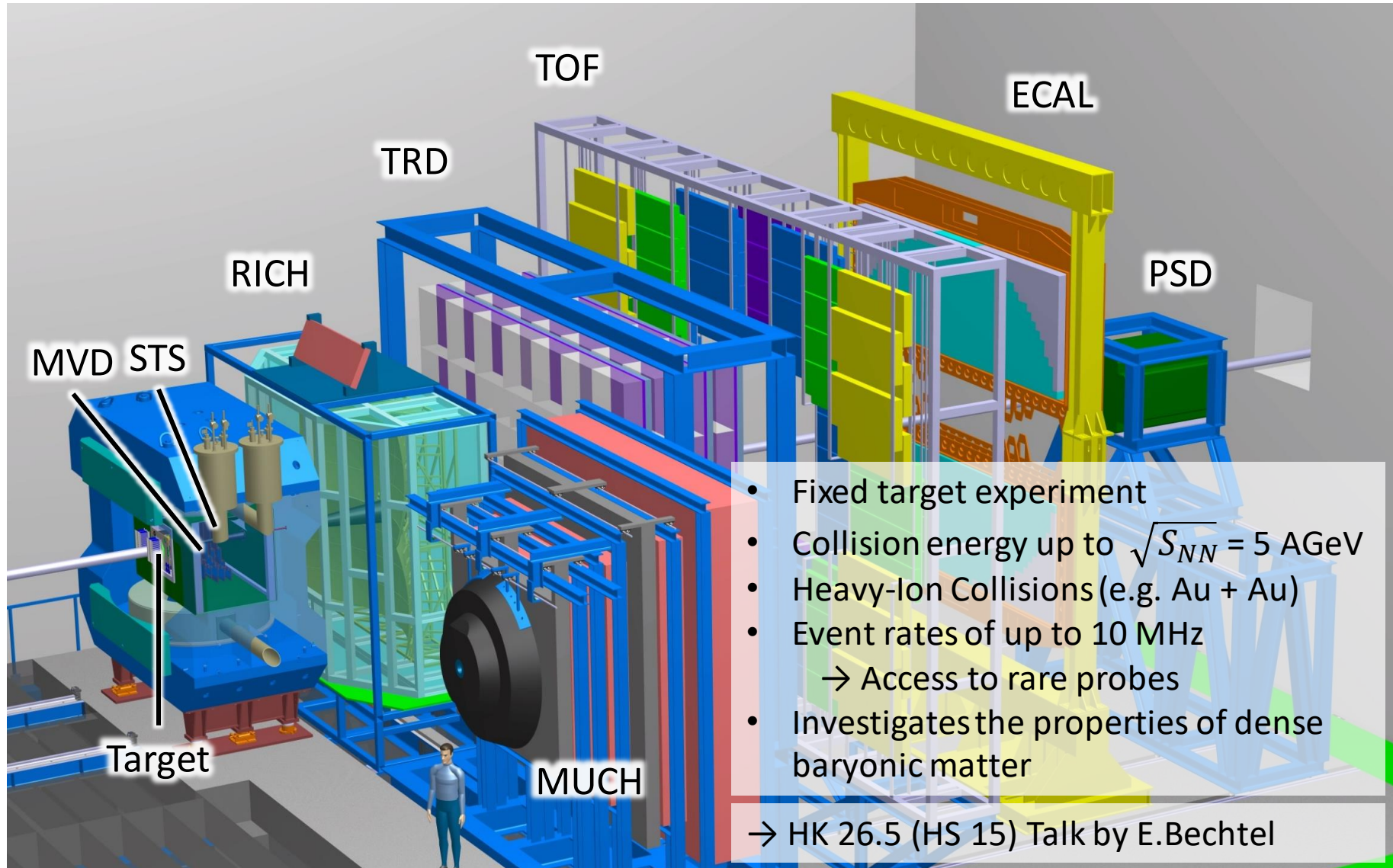
19.3.2019 - DPG Conference - München

The Compressed Baryonic Matter Experiment

At the international accelerator facility FAIR

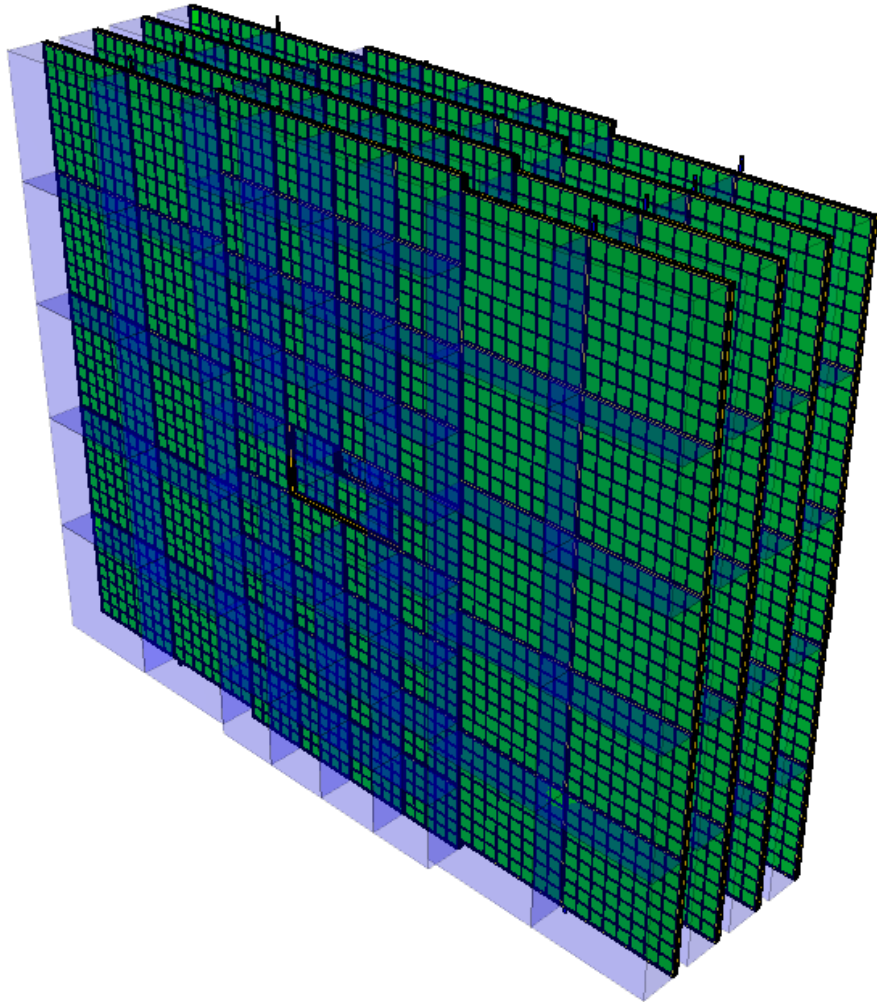


The Compressed Baryonic Matter Experiment Setup



The Transition Radiation Detector

Construction

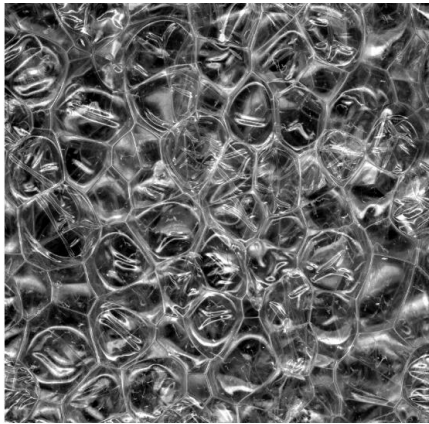
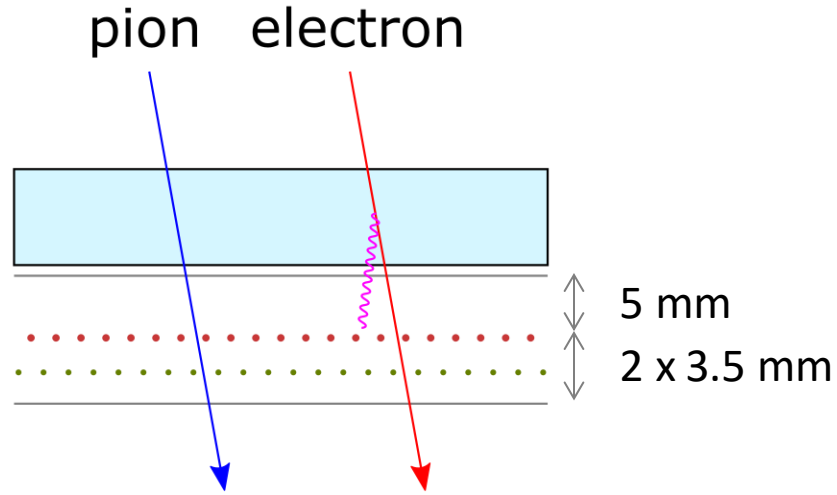
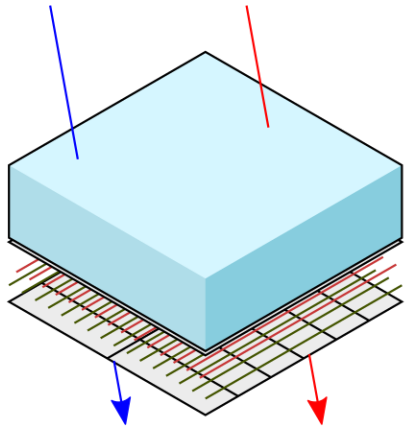


Design parameter (SIS100)

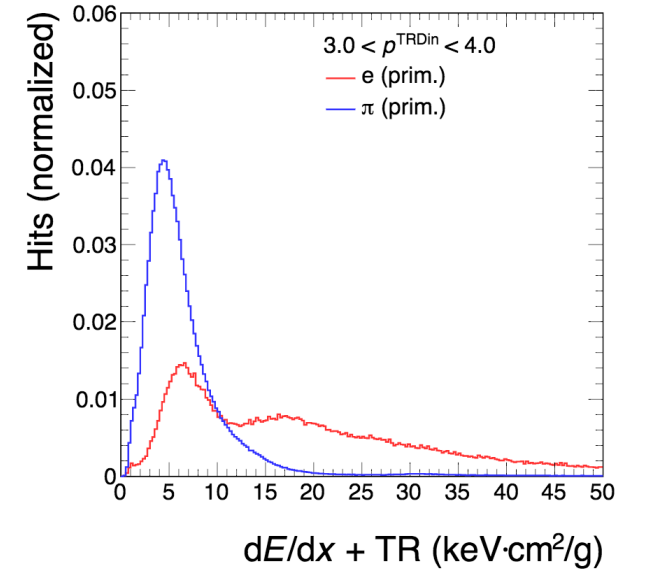
Max. signal collection time	0.3 μs
Typical space point resolution	$\sim 300 \mu\text{m}$
Pion suppression at 90 % electron efficiency and $p \geq 1.5 \text{ GeV}/c$	10 - 20
dE/dx resolution above $p = 1 \text{ GeV}$	< 25 %
Detector radiation length (active area)	< 5% X_0 per layer
Pseudo-rapidity coverage	$0.89 < \eta < 3.74$
Azimuthal coverage	2π

The Transition Radiation Detector

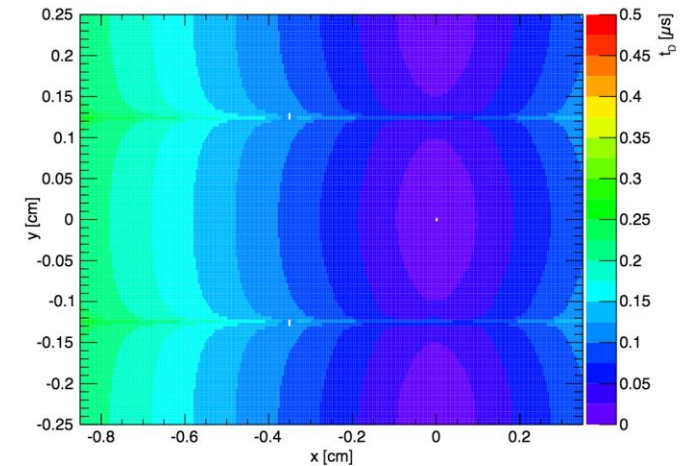
Chamber Design



- Gas: 85% Xe / 15% CO₂
- Radiator: foam material
- Energy resolution: $\sim 10\%$
- Electron drift time: $< 0.3 \mu\text{s}$



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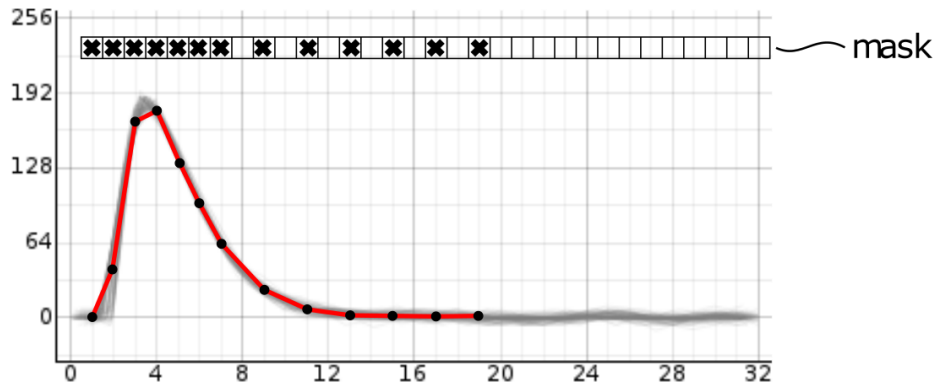
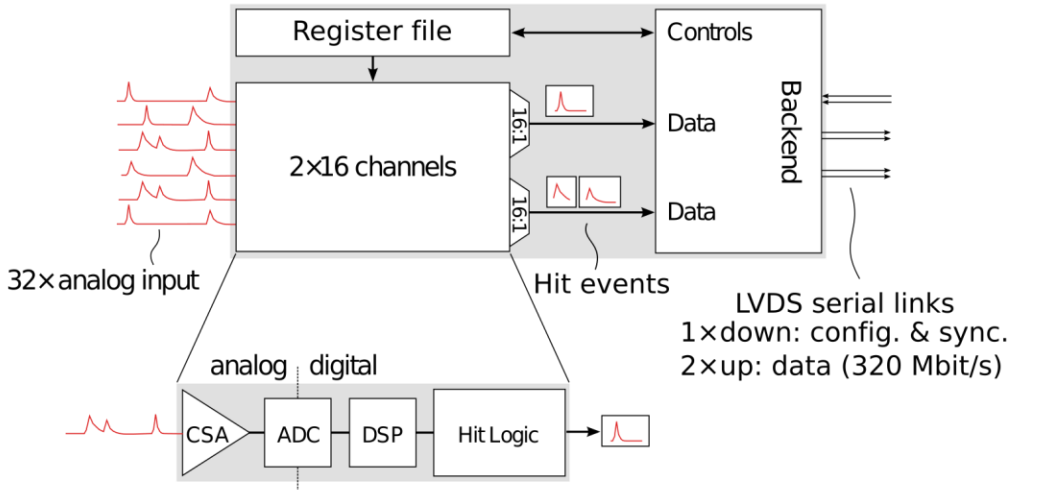


The DAQ Chain

Front End Electronic

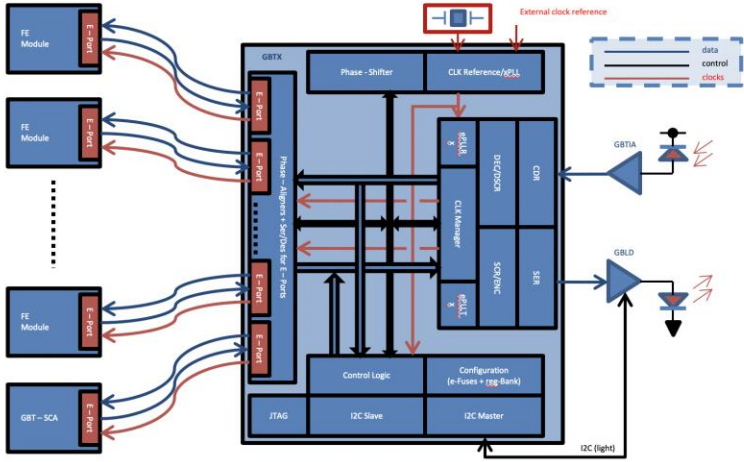


- Features of SPADIC 2.2:
- 9-bit 16 Mhz ADC
 - Hit detection logic
 - Forced neighbour trigger
 - Multi-hit flag
 - Running baseline average
 - Selection mask: Selects the transmitted samples per pulse



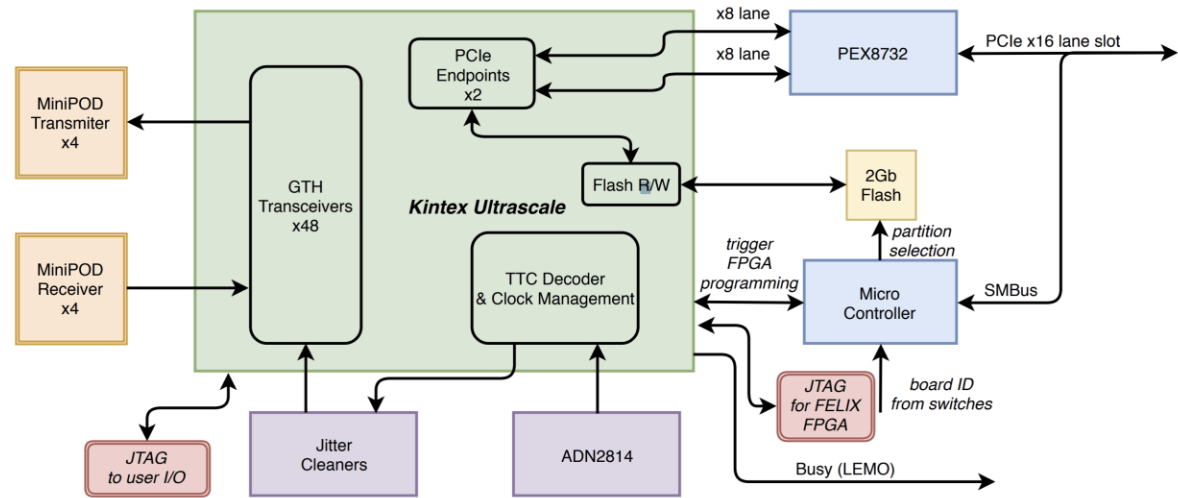
The DAQ Chain

Read Out Board



- 3x radiation hard transceivers (GBTx)
- Each ROB can connect up to 21 SPADICs
- Aggregates and converts the electrical signals to optical signals

Data Processing Board (FLX-712)

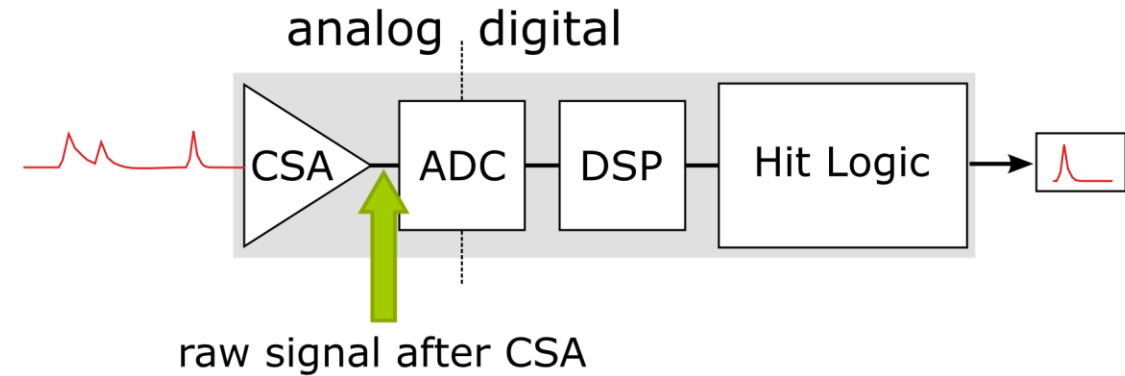
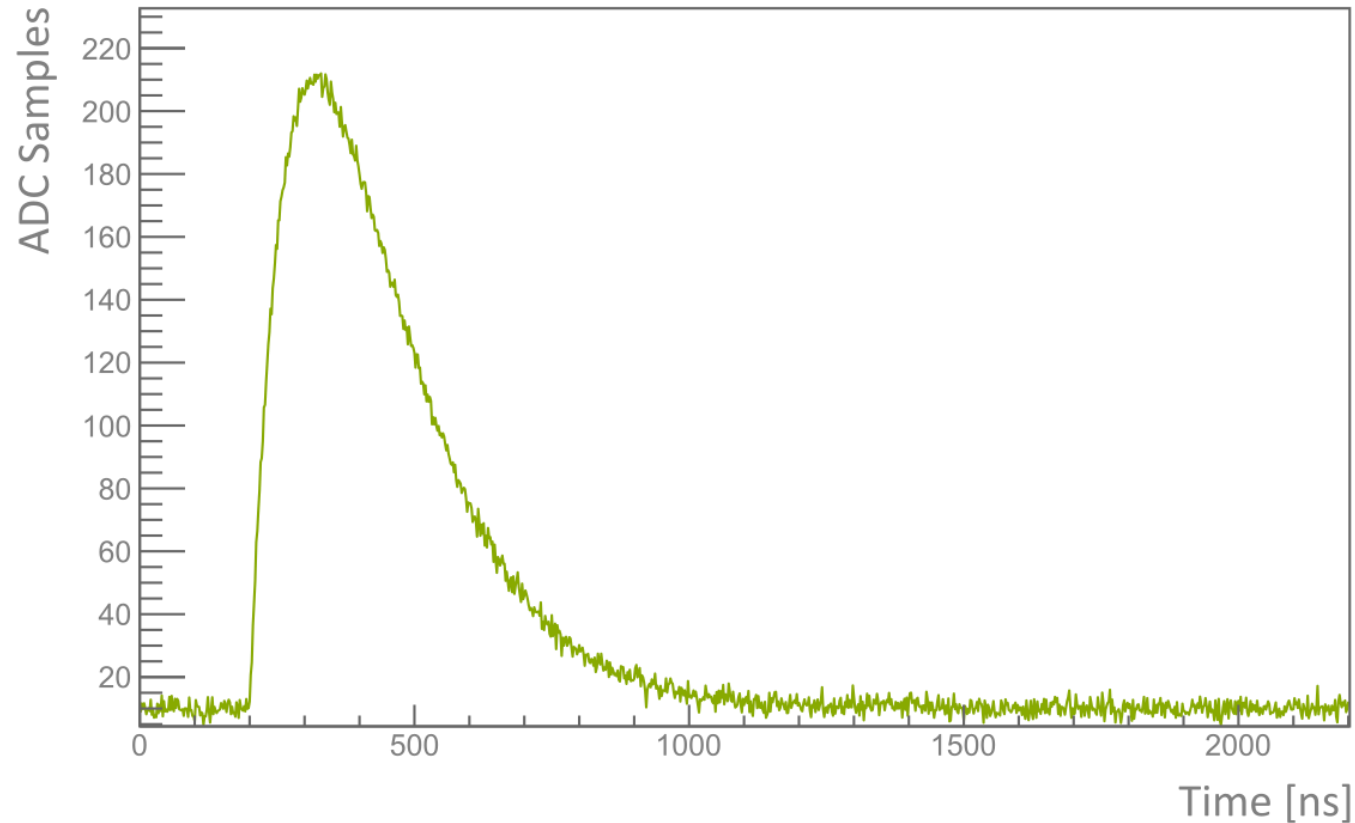


- 48 bidirectional optical links (4.8 Gb/s in GBT mode)
- 16-lane PCIe Gen3
- FPGA: Kintex UltraScale XCKU115
- Can be used for feature extraction



Feature Extraction

Raw Signal



Simulated signal according to the CSA shaper function

$$h(t) \propto t^N \cdot e^{-t/\tau}$$

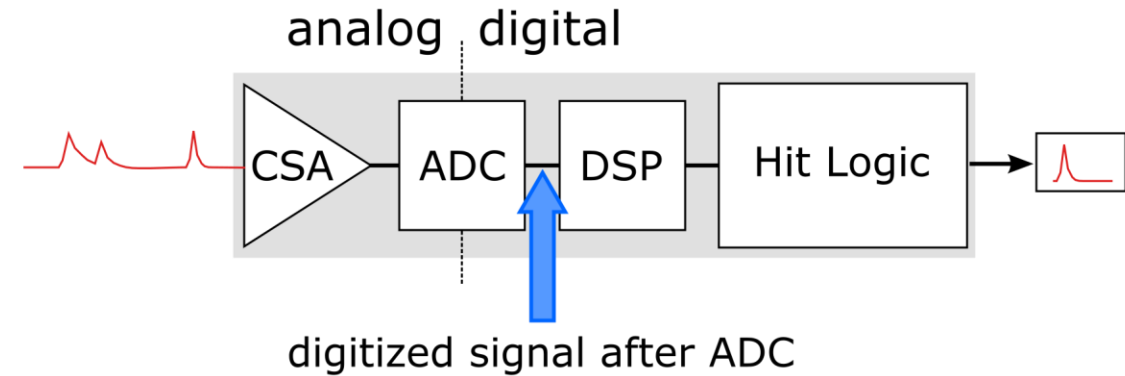
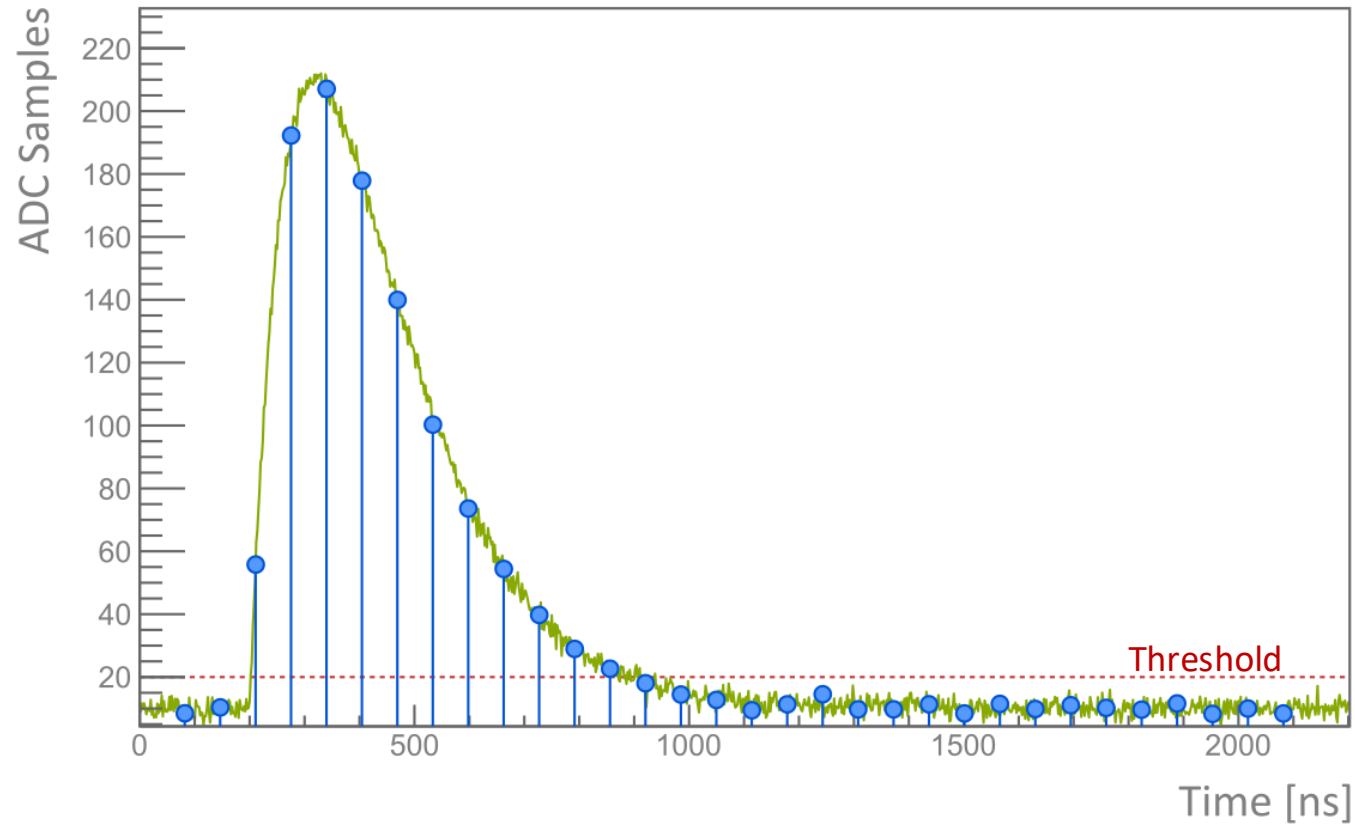
Shaping time: $\tau = 120 \text{ ns}$

Order: $N = 1$

Noise: $\sigma = 2 \text{ ADC values}$

Feature Extraction

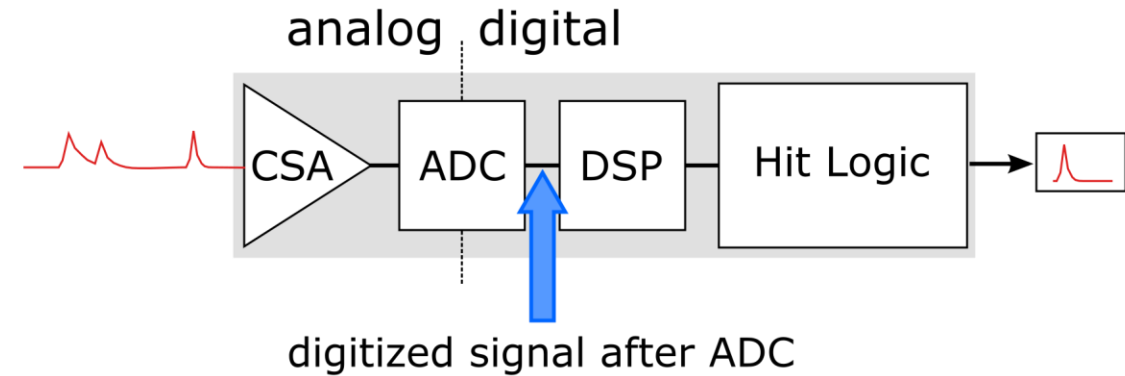
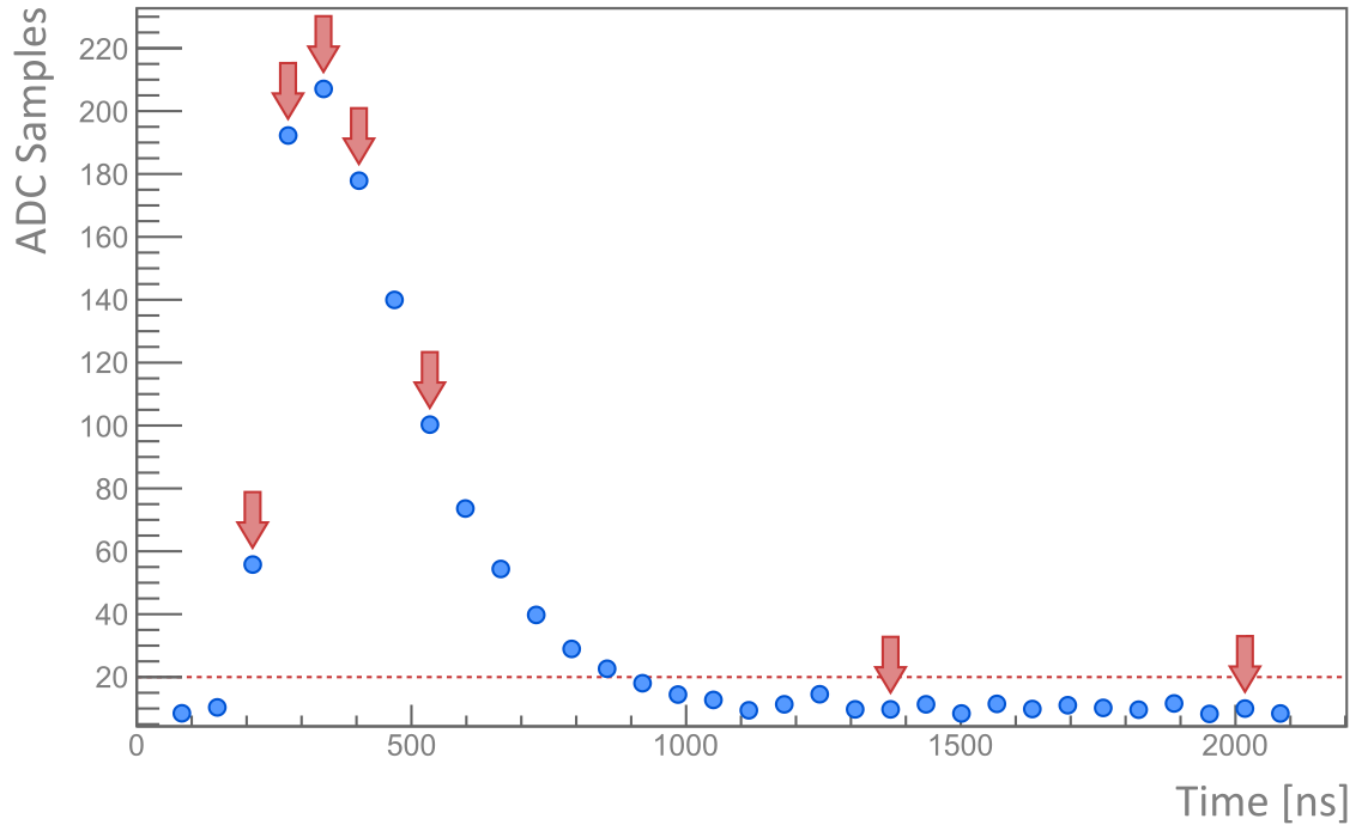
Sampled Signal



- Sampling frequency: 16 MHz
- Resolution: 9-bit

Feature Extraction

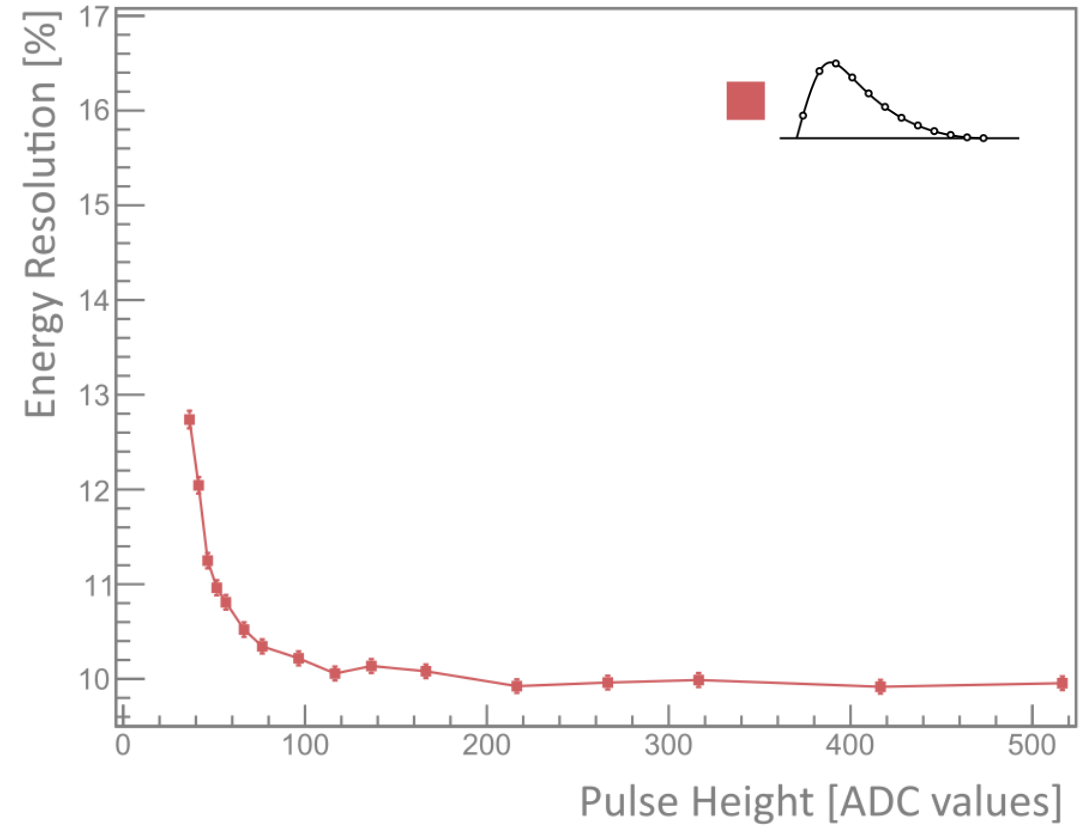
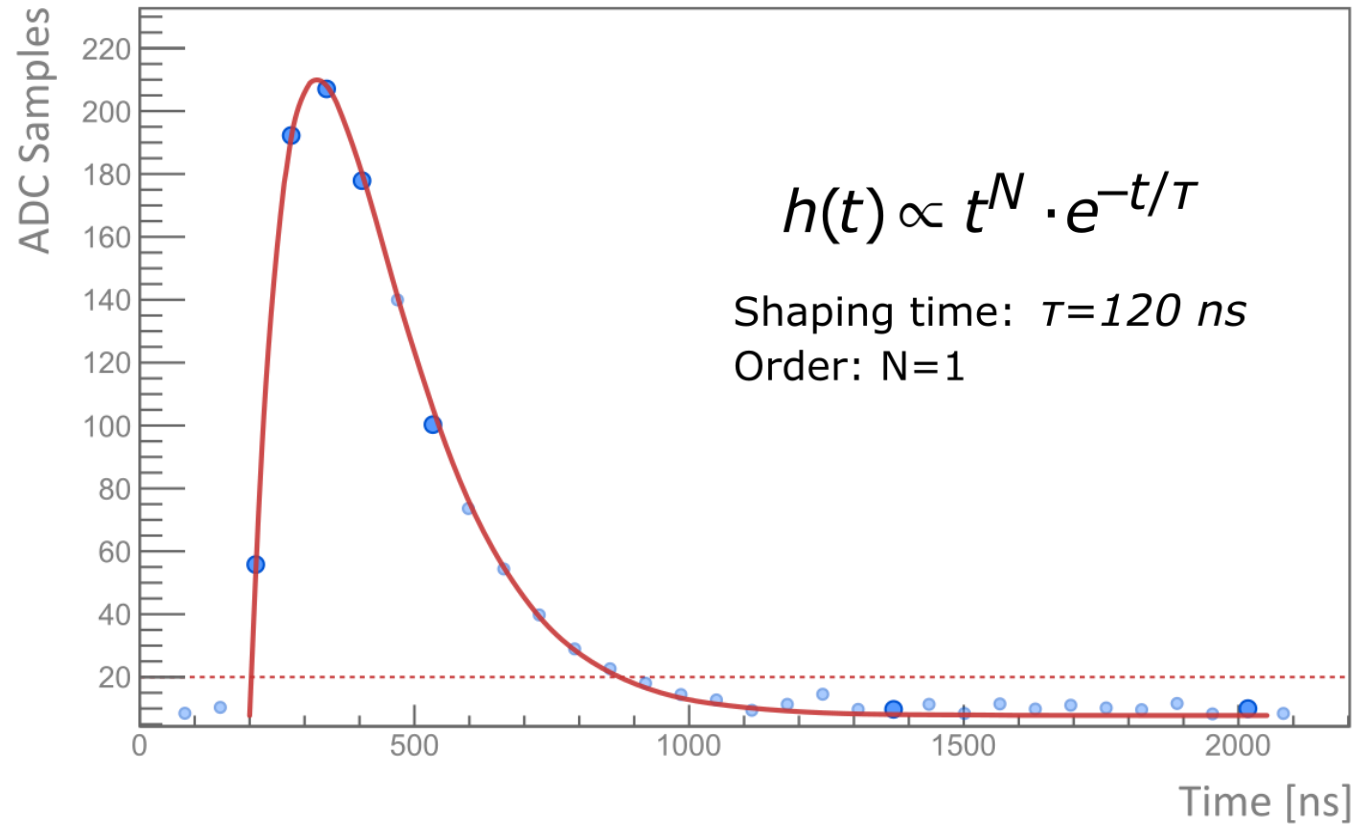
Sampled Signal



- Sampling frequency: 16 MHz
- Resolution: 9-bit

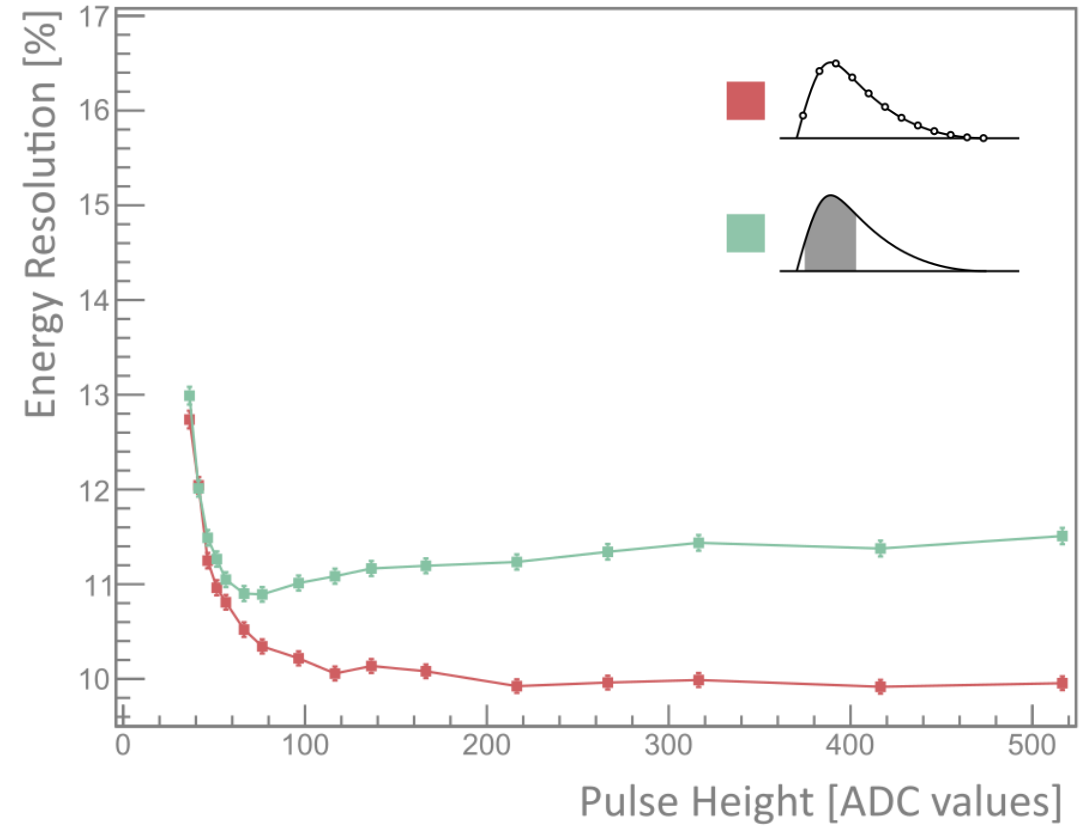
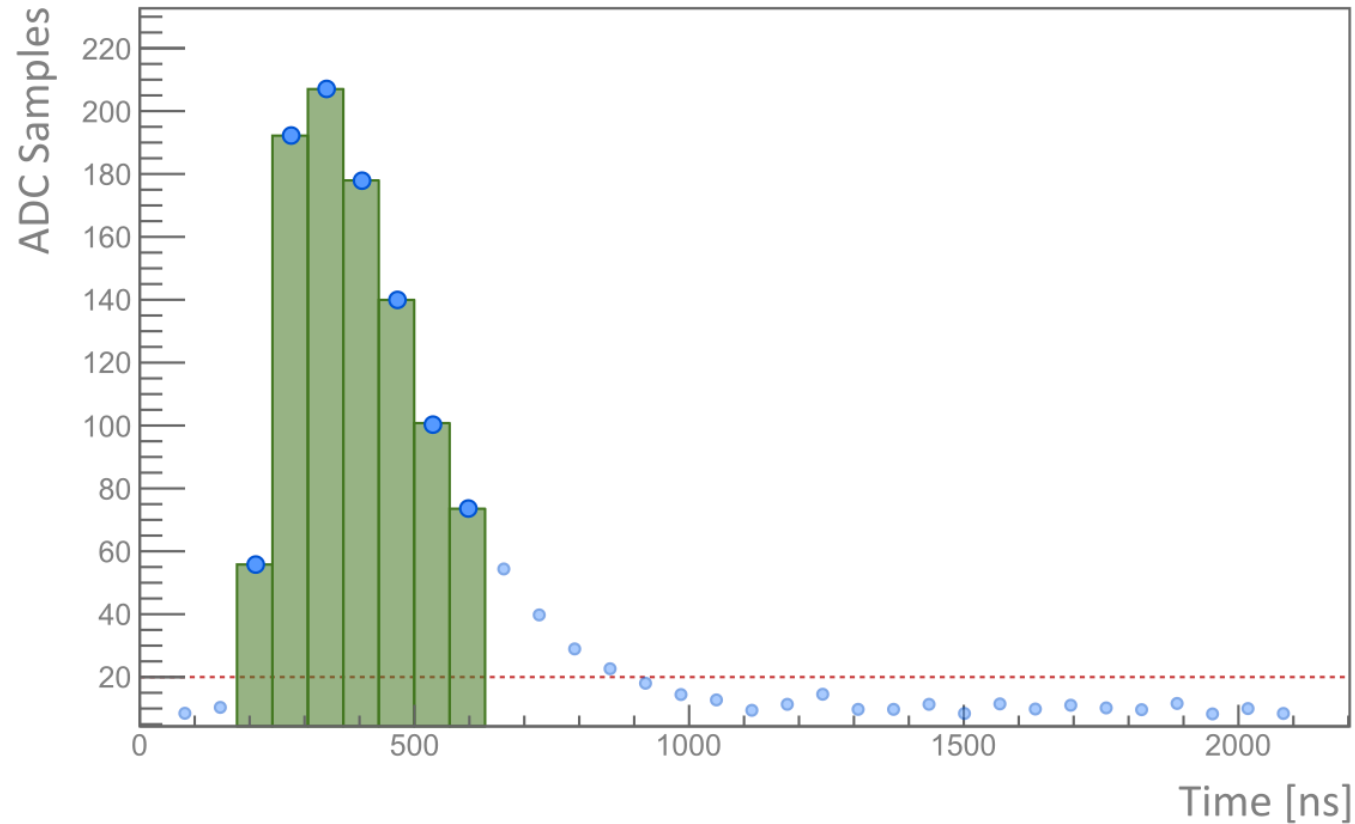
Feature Extraction

Fit



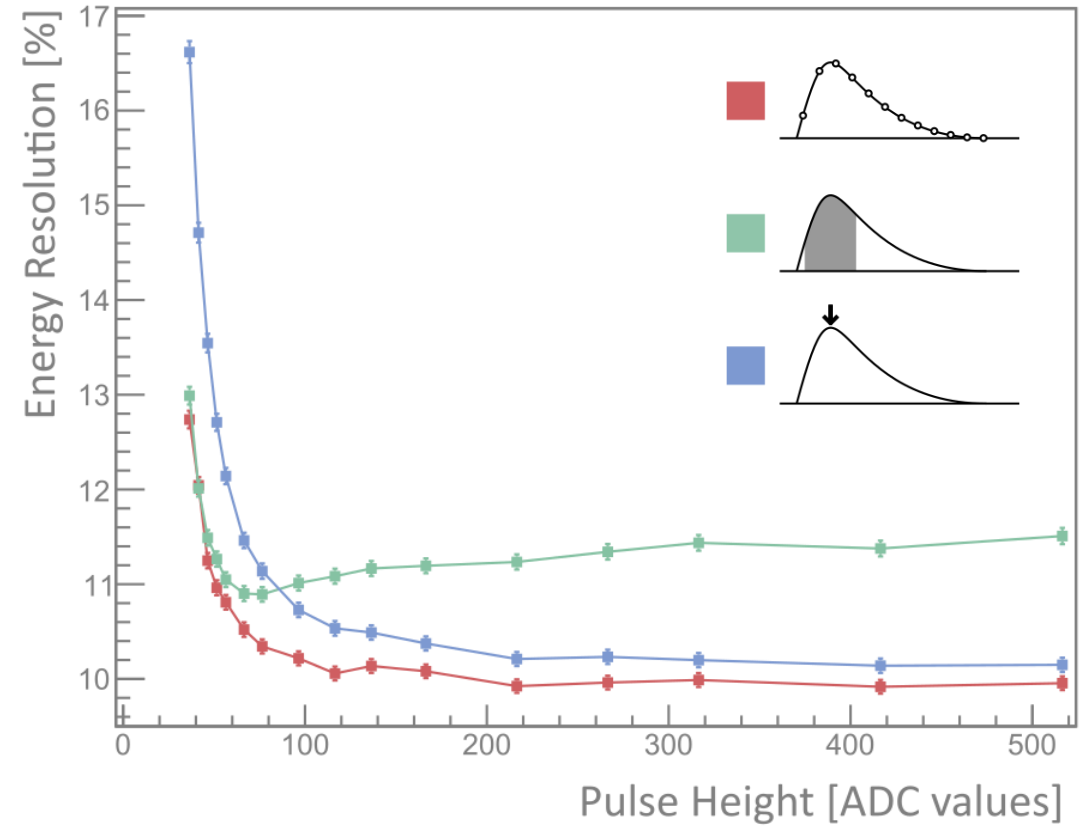
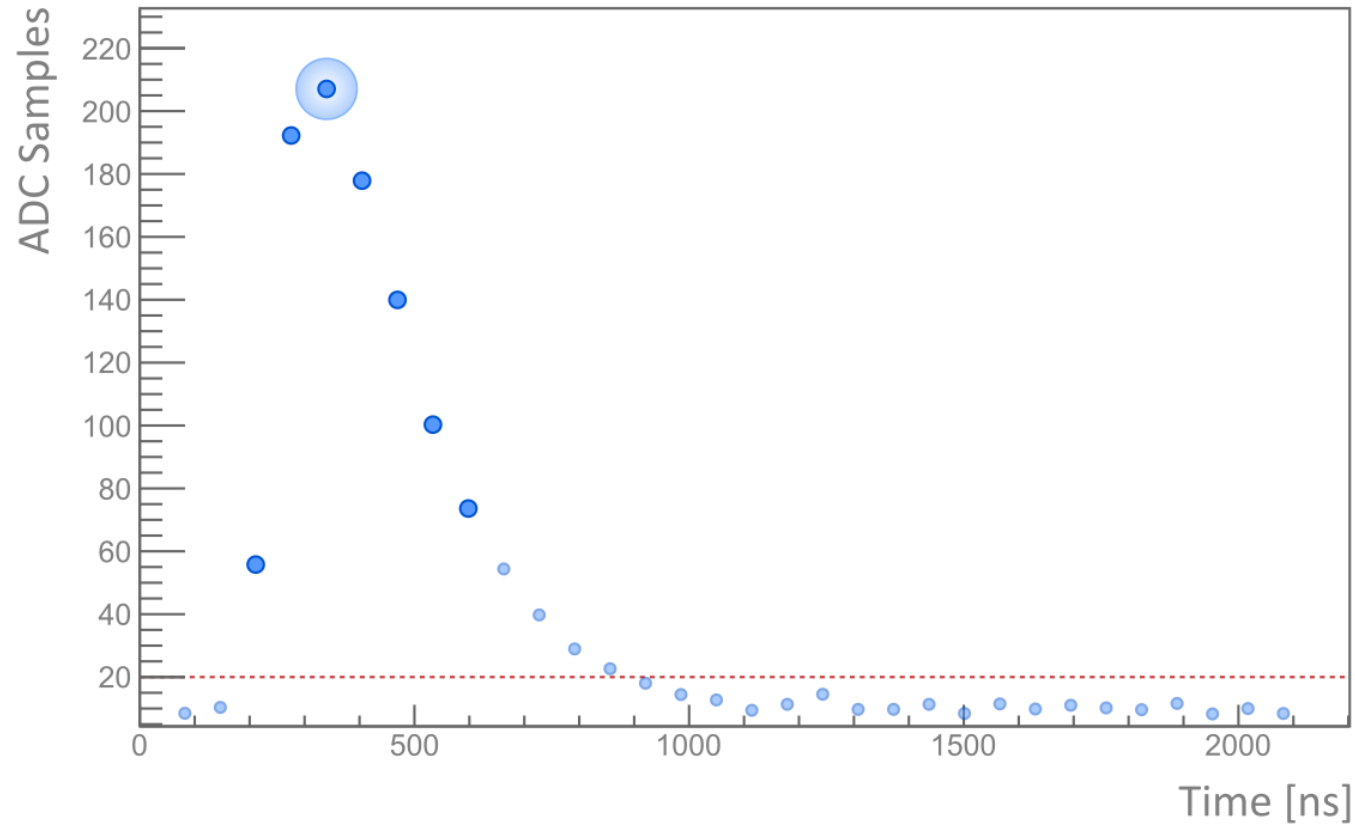
Feature Extraction

Sum



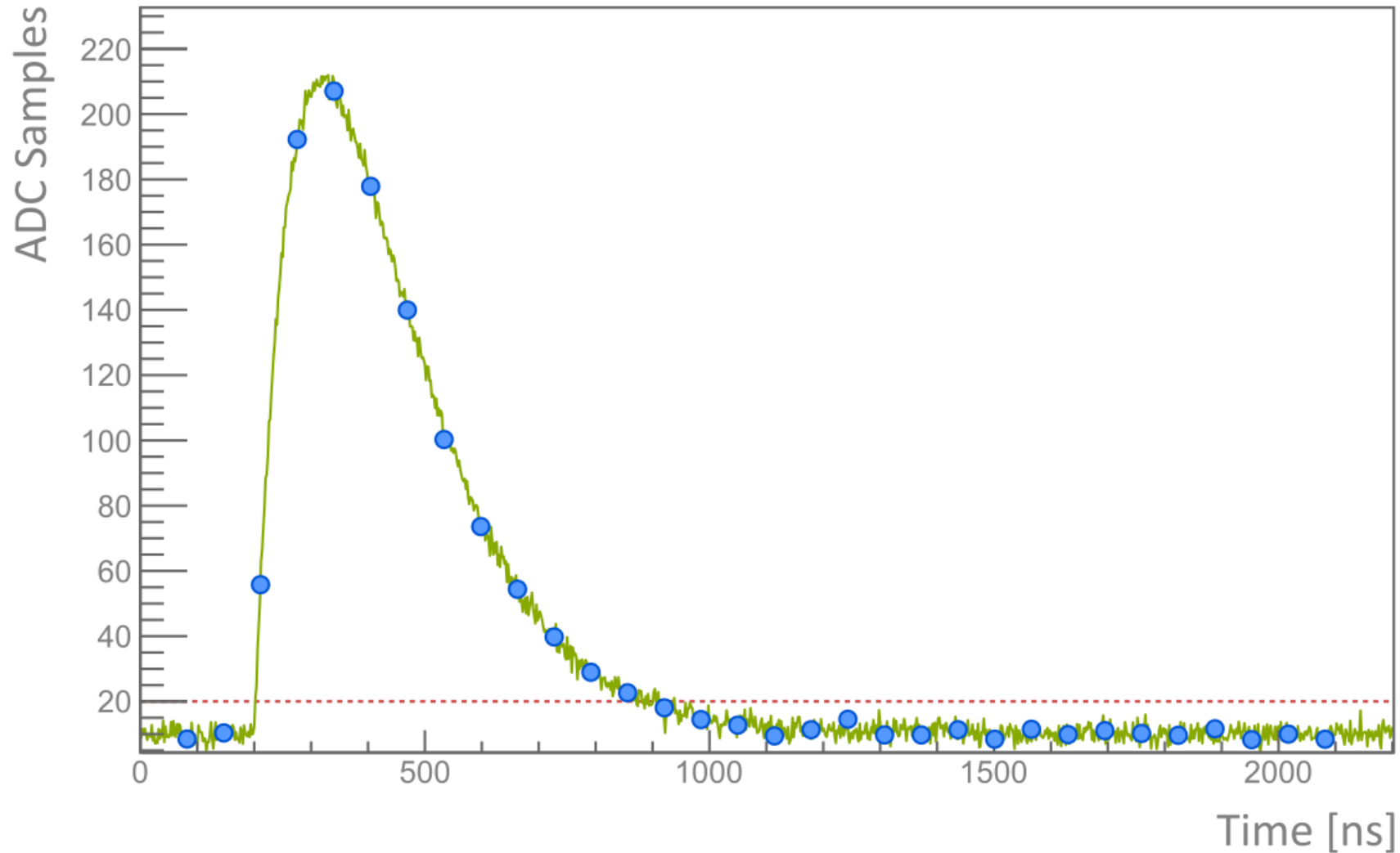
Feature Extraction

Max ADC



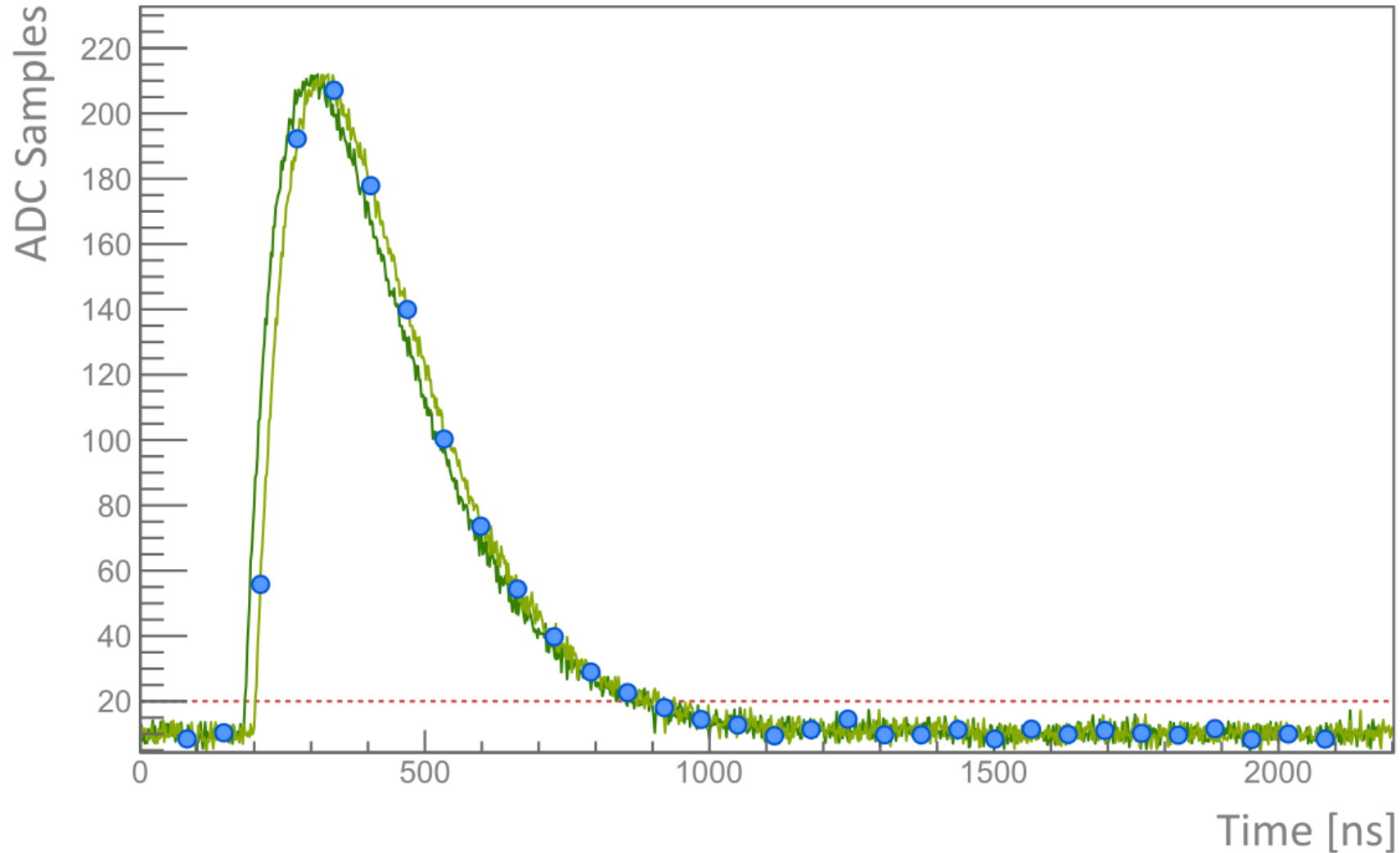
Feature Extraction

Timeshift



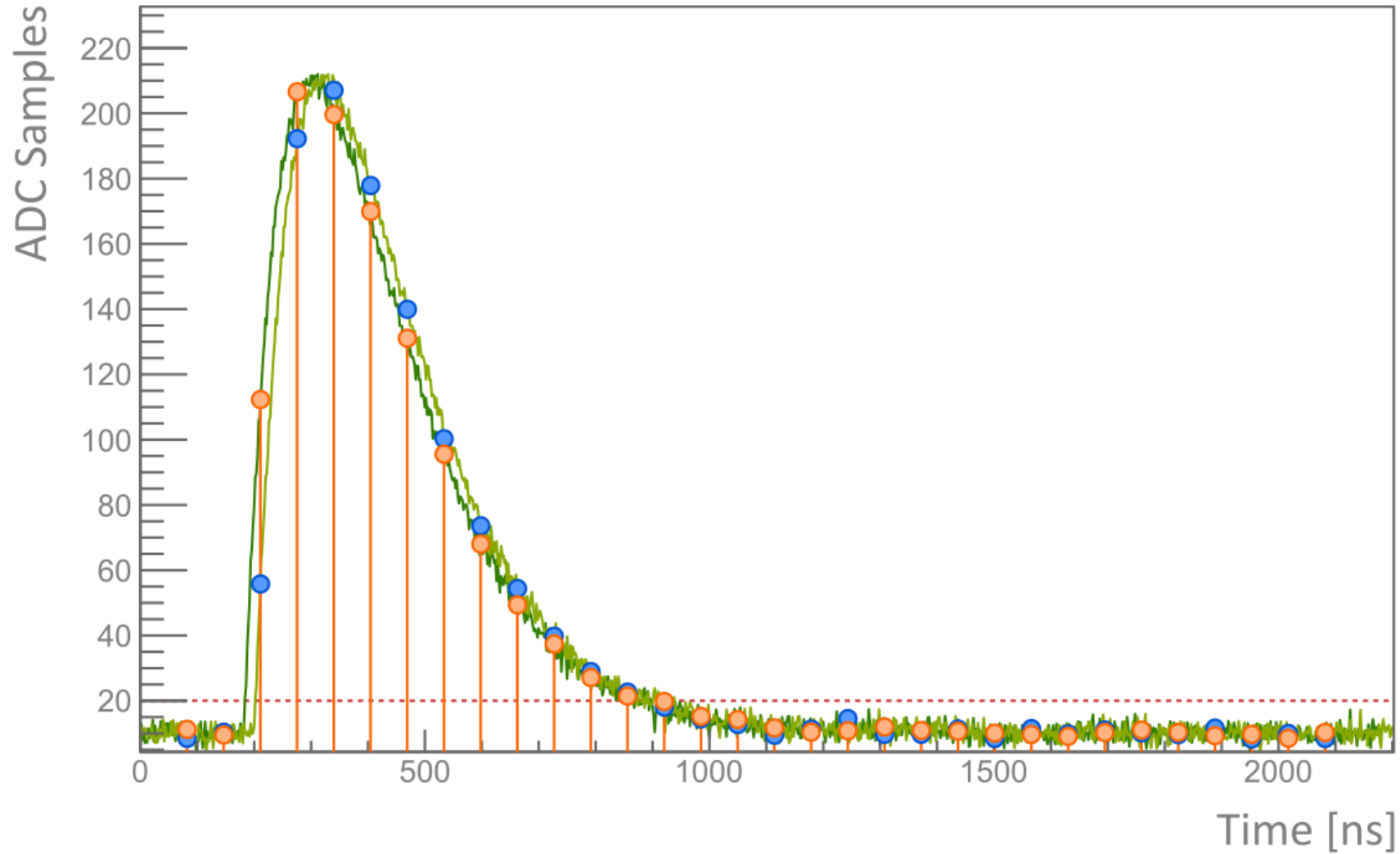
Feature Extraction

Timeshift



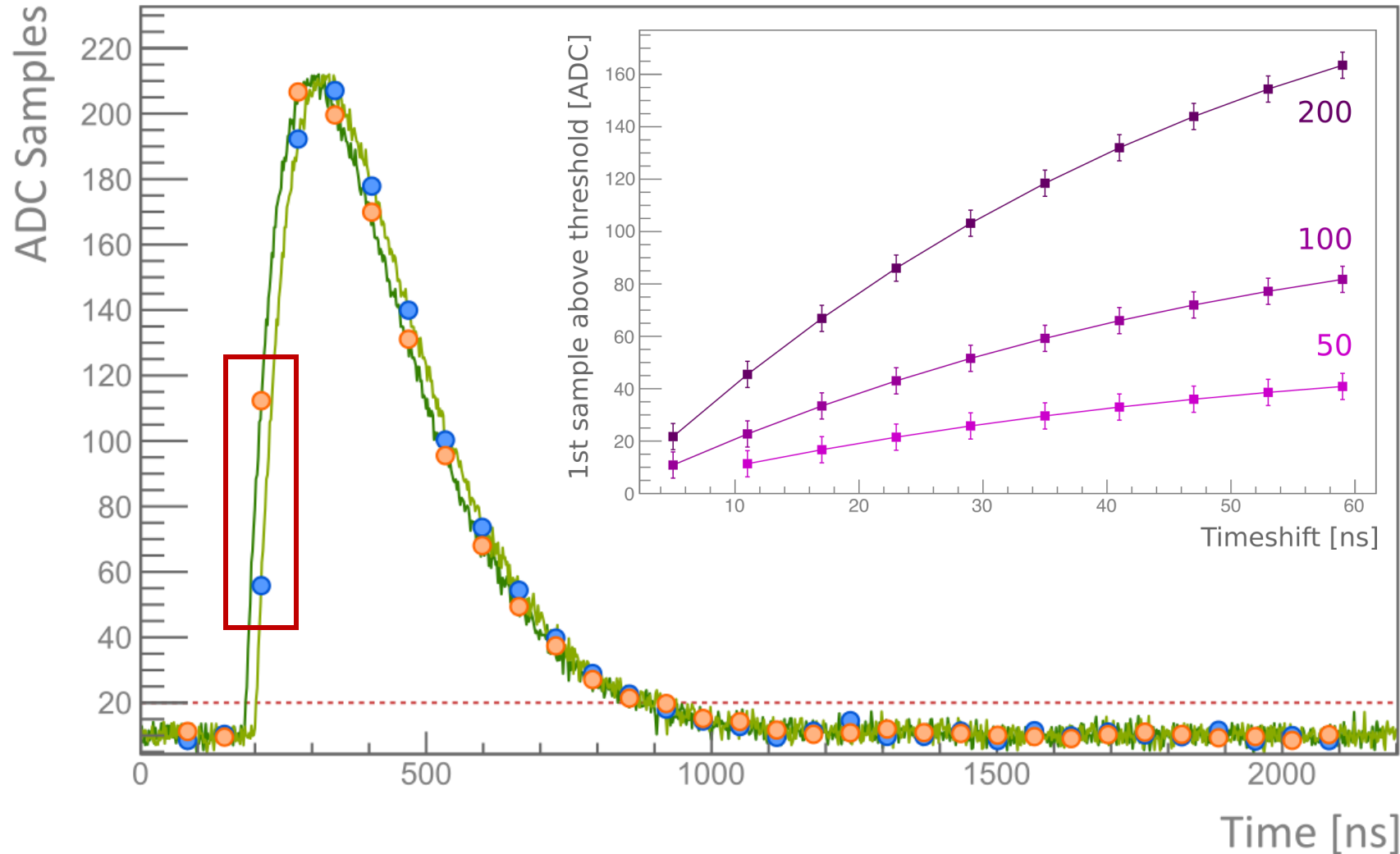
Feature Extraction

Timeshift



Feature Extraction

Timeshift



Conclusion & Outlook

- ✓ Feature extraction can be done in the FPGA of the DPB
- ✓ The time resolution is not limited to the sampling rate

Still under investigation:

- Influence of noise
- Impact of multi-hits
- Performance with 2nd order shaper
- Application on real data

Upcoming talks:

- Di, 17:45 HK 26.5 Performance simulation of the Transition Radiation Detector of the CBM experiment
- Fr, 15:15 HK 63.5 Electron Detection Efficiency of CBM-TRD Prototypes in Testbeams at DESY
- Fr, 15:30 HK 63.6 CBM-TRD high-rate detector tests at the CERN-GIF