JÜLICH
FORSCHUNGSZENTRUM

PANDA STT Workshop

Data analysis and results

30.1.2017 | **A. Erven** & L. Jokhovets

Analysis Tools

- Software Tool for analysis of straw pulses and estimation of spatial resolution developed

- Configurable; to examine the influence of different settings (like thresholds, algorithms for time determination or filtering)

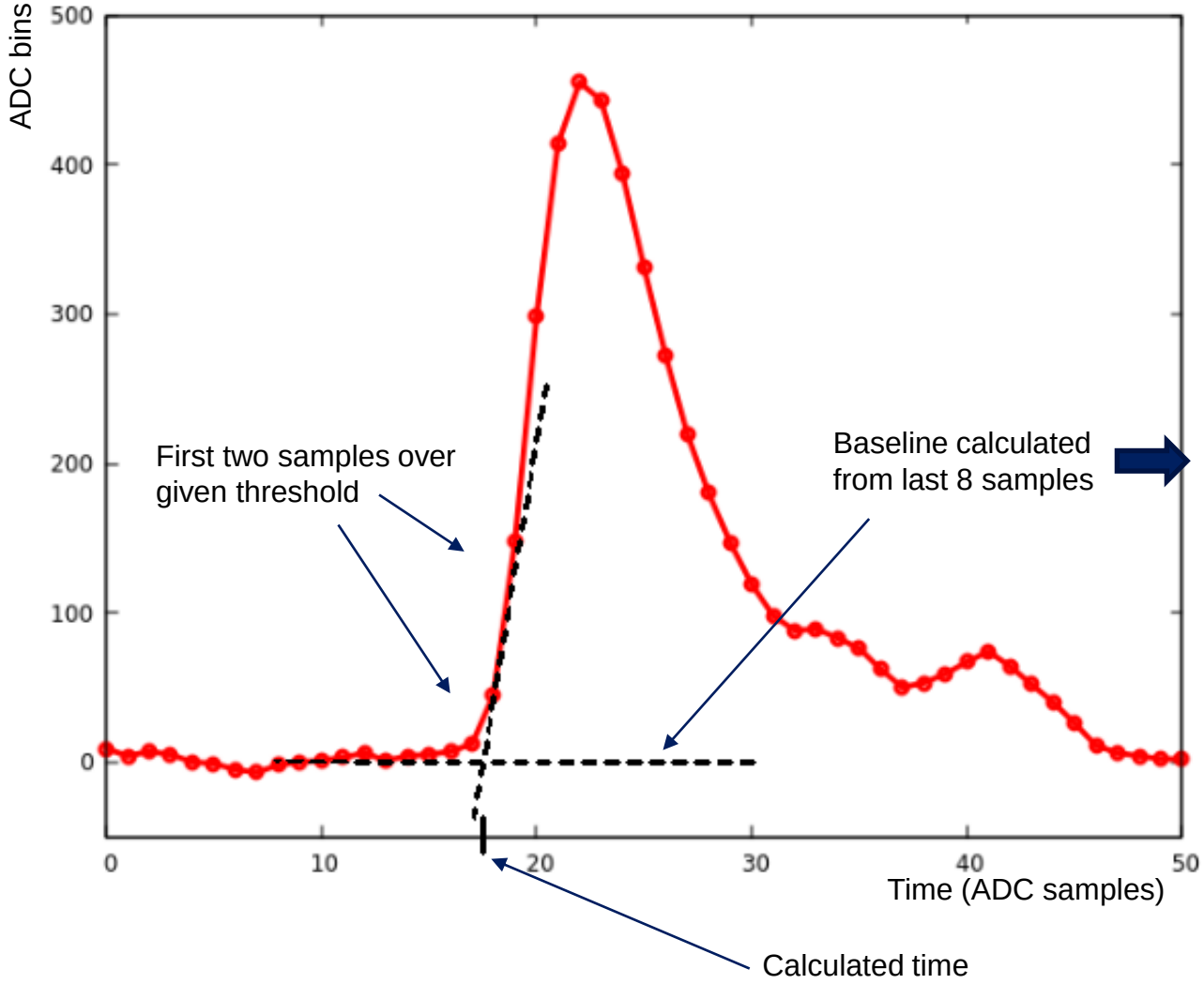
- Graphical tool showing pulses and resulting tracks; helps to recognize special cases and to verify processing
- Helpful for firmware development

Analysis Tools

Analysis Steps

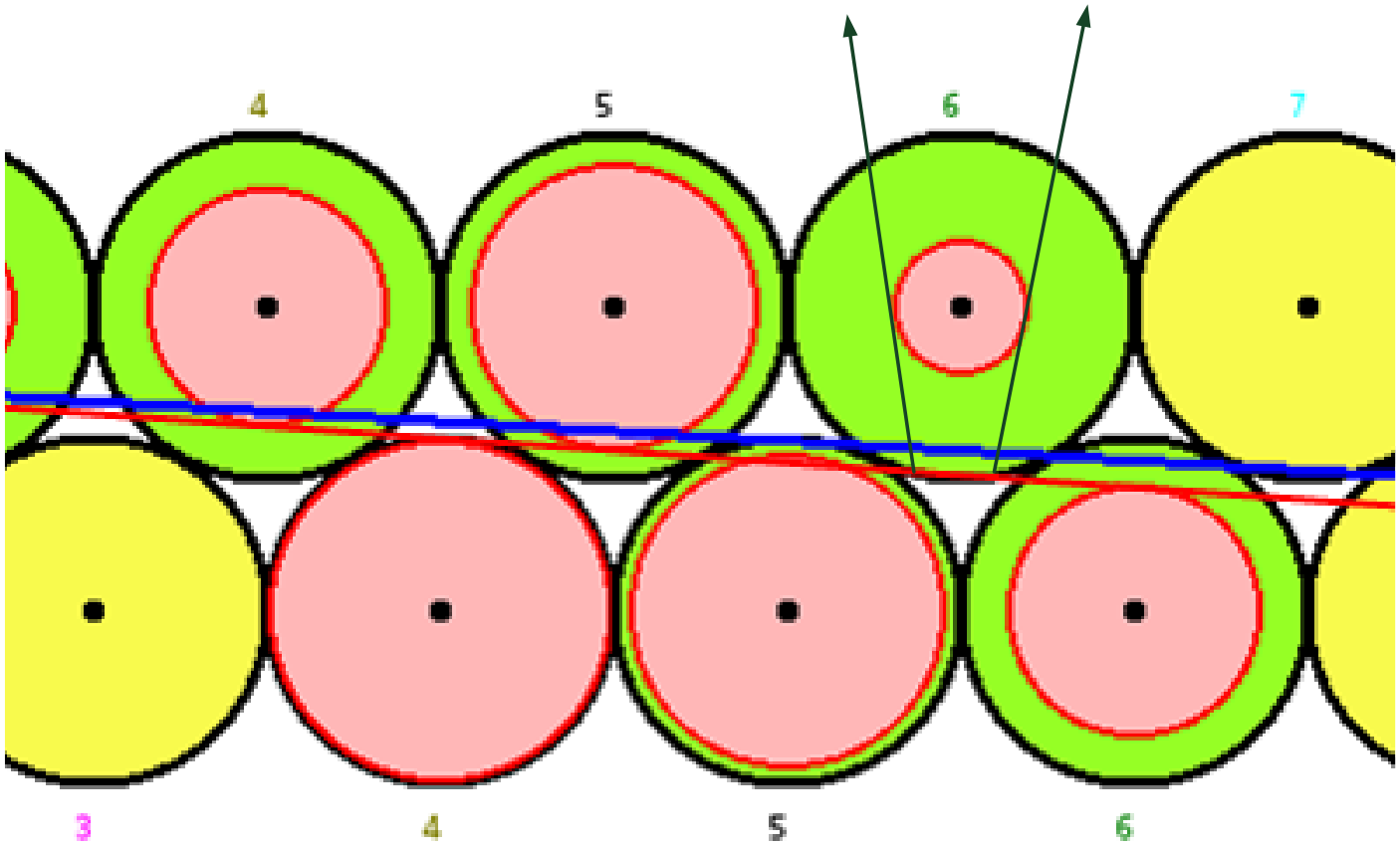
- Time determination
- Filtering
- Time to radius
- Tracking
- Residual calculation

Time determination: Initial rise approximation



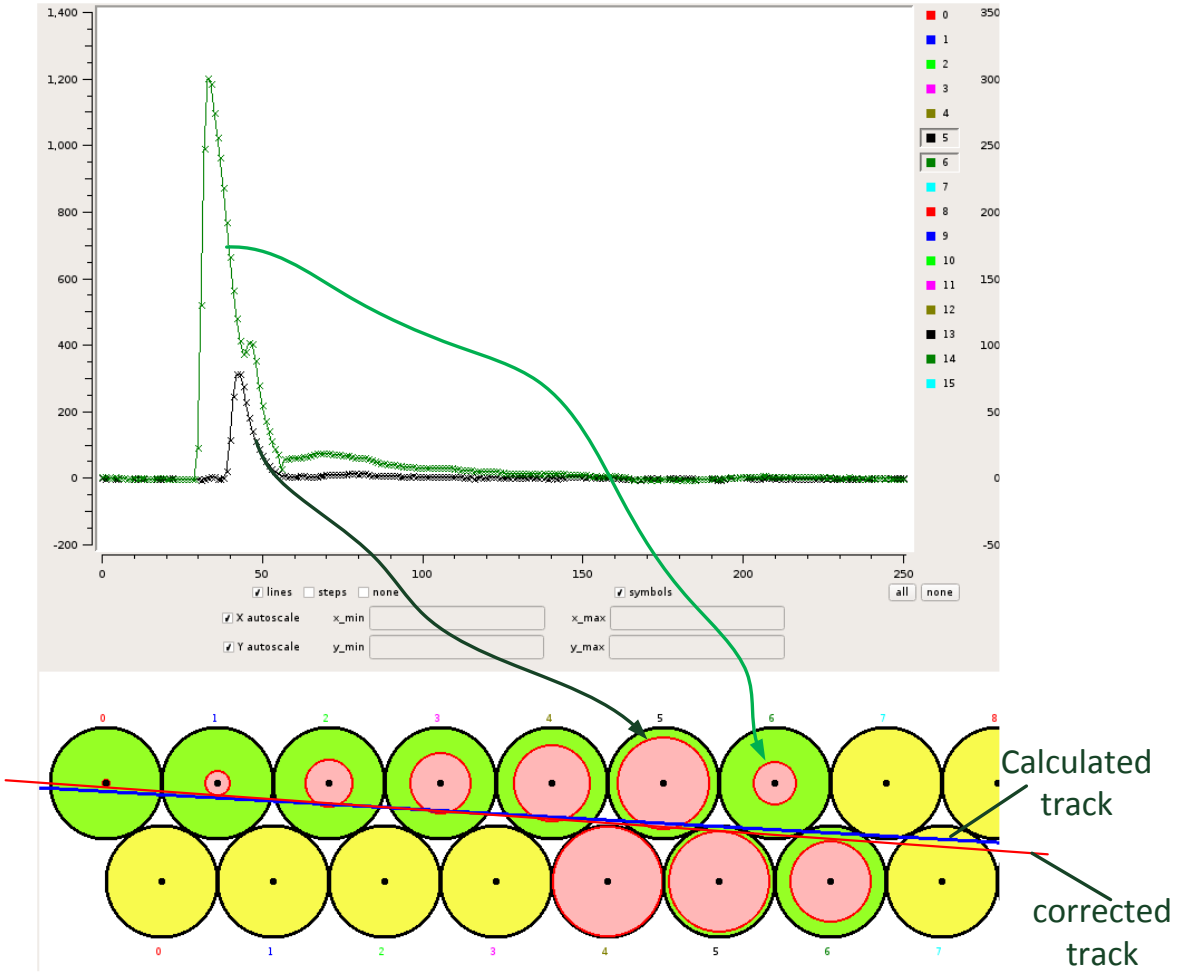
Energy Filtering

Delta electrons?? Energetic electrons ejected from atoms in matter by the passage of ionizing particles. In every primary ionizing collision between a charged particle and an atom, one or more electrons are ejected. Delta electrons are, by definition, that small fraction of these emitted electrons having energies which are large compared to the ionization potential.



Slide from L. Jokhovets “Hardware characterization of ADC based DAQ-System”, shown at PANDA Meeting 9/15

Energy Filtering



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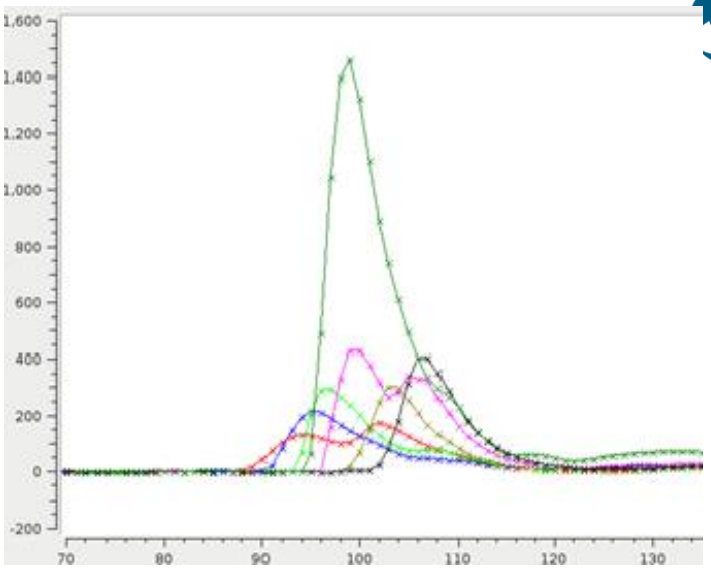
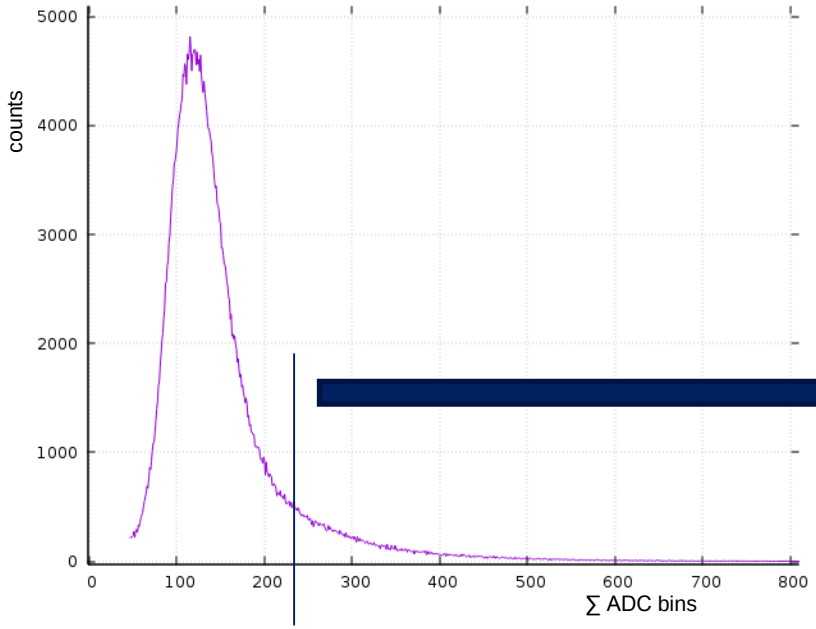
Energy Filtering



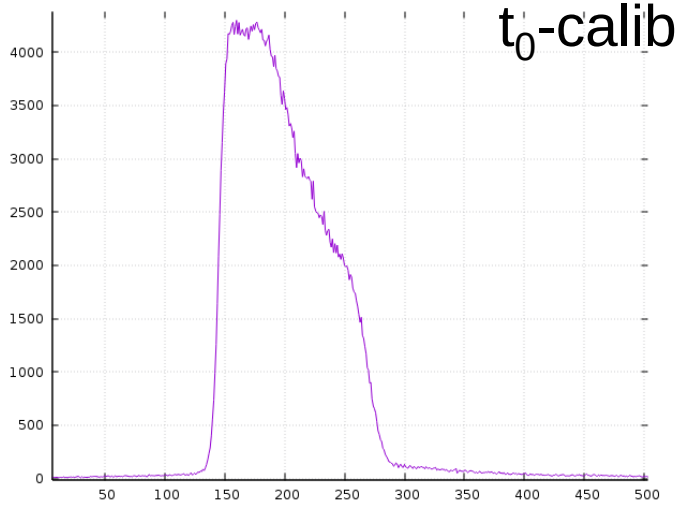
→ Calculate energy spectrum

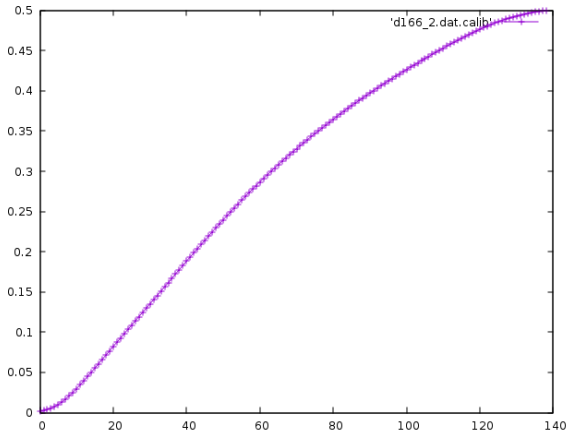


Discard pulses with high energy

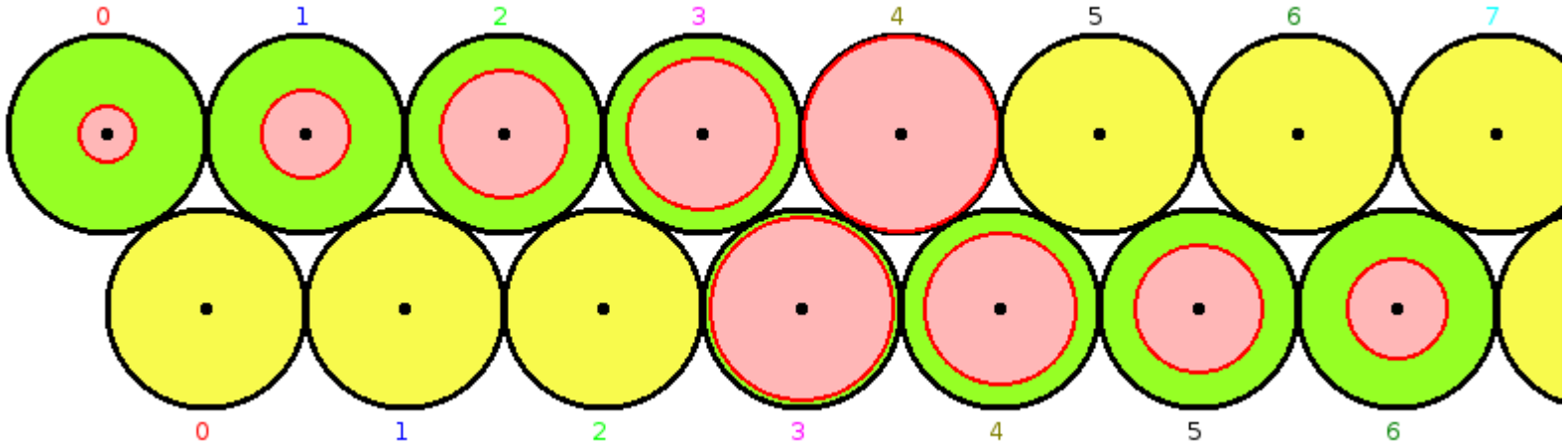
Analysis: Time to radius

- Common way: Drift time distribution, estimate t_0 & t_{max}, t_0-calibration, calibration curve



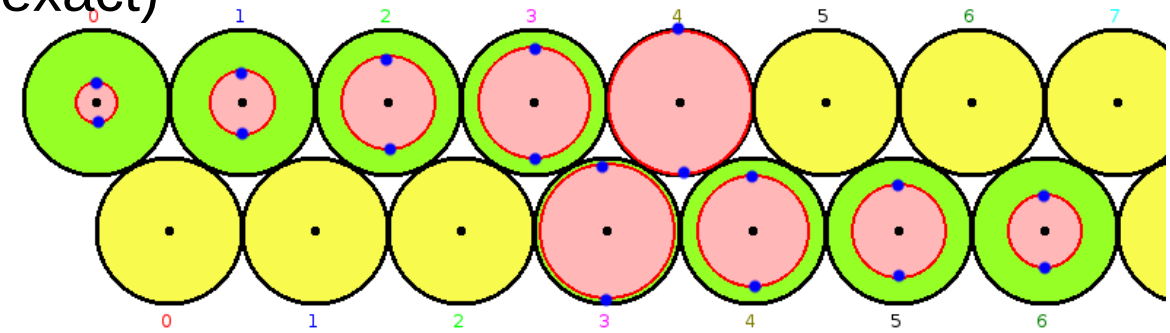


→ get radius of particles passing straw

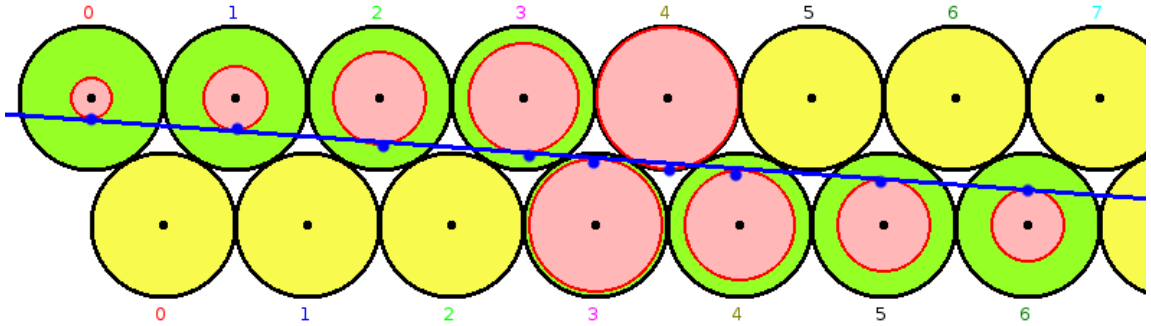


Simple Tracking

- Have only 2 layer and linear track
- Assume point vertical above or below wire as interaction point (not exact)



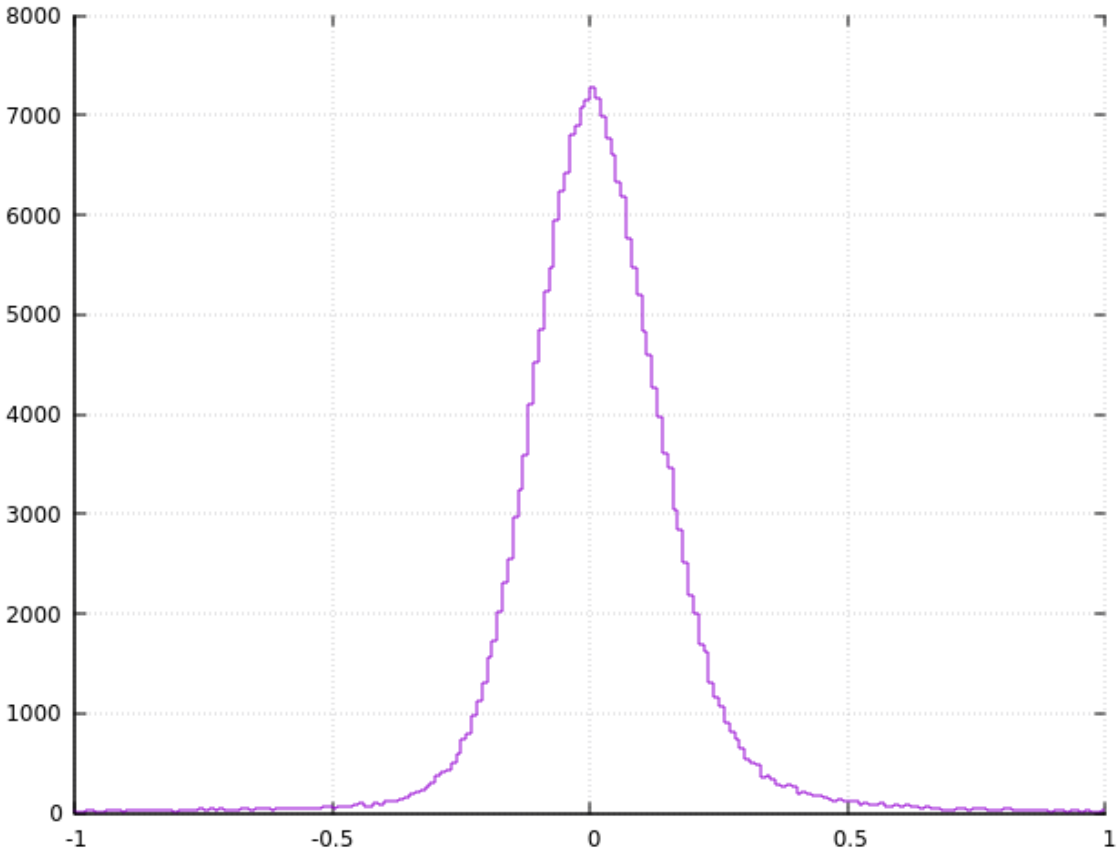
- Linear fit with all possible combinations of above / below
  - → combination with least error gives track



Residual distribution

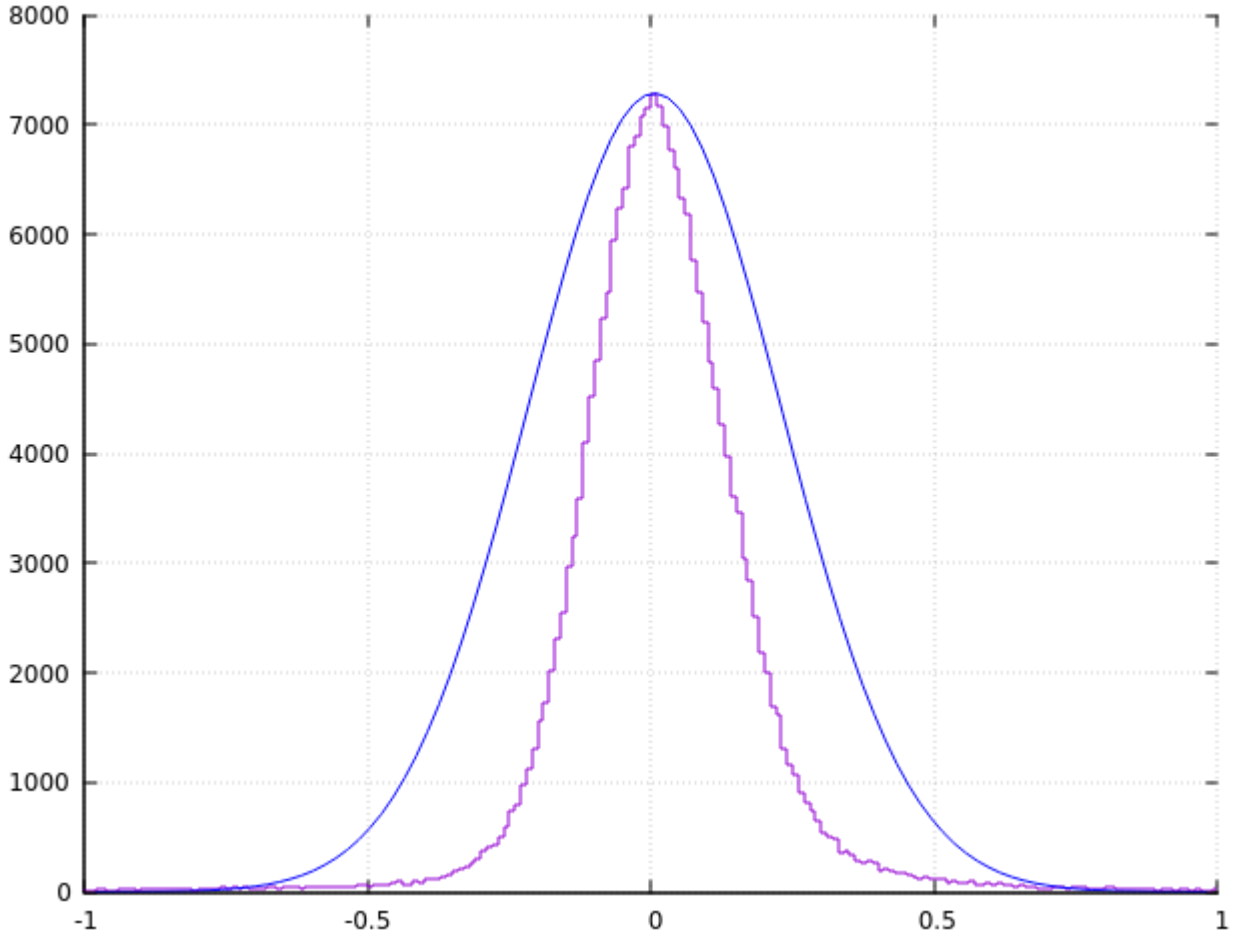
- Calculate histogram from residuals from linear fit

  → get Gaussian-like shape



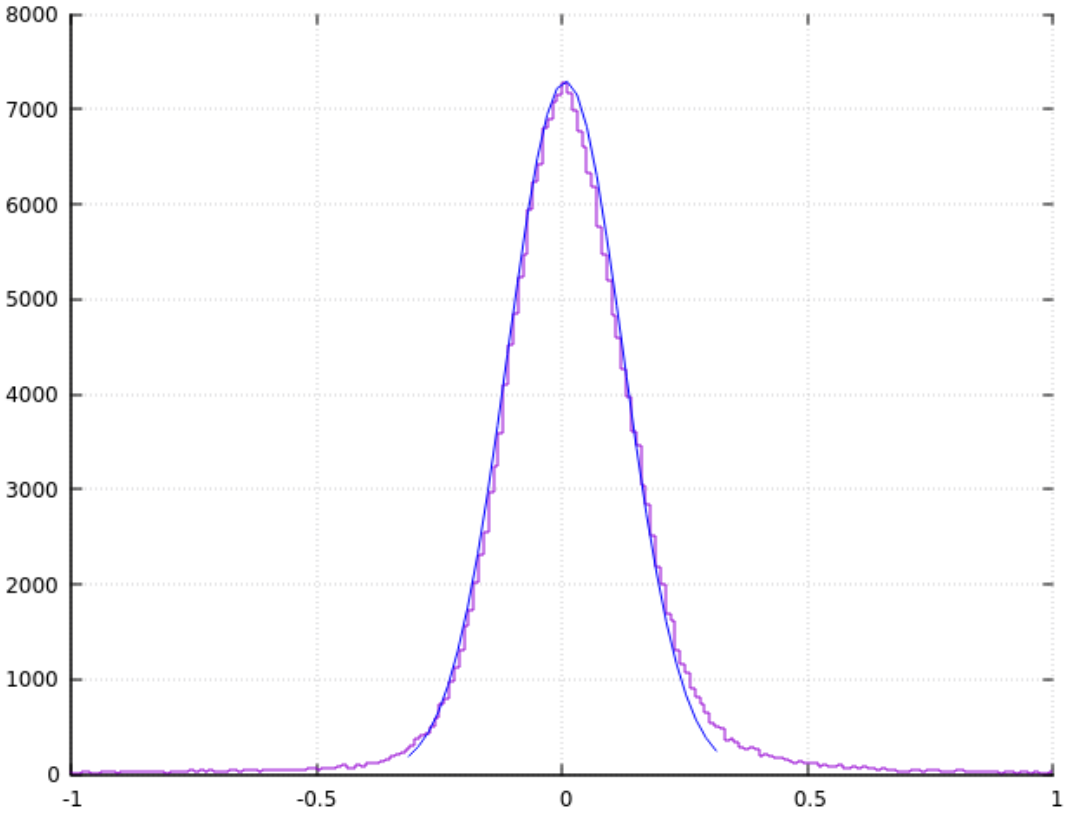
Residual distribution: σ Calculation

Shape is not really Gaussian → get no helpful fit when applying the whole range



Residual distribution: σ Calculation

Limit Gauss fit calculation to smaller range:



- Question: How can this range be defined?
- Doing Gauss fit for several ranges, choosing the range with smallest deviation

Results

- Beamtime in April 2016:

  Test with ADC-prototype at different sample rates

- Beam parameter:

  Protons

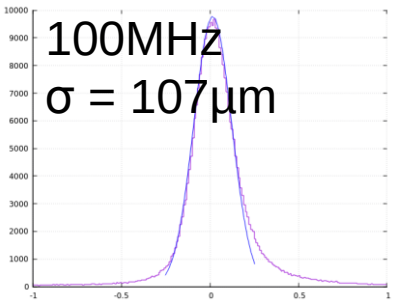
  Beam momentum: 1.0 GeV/c

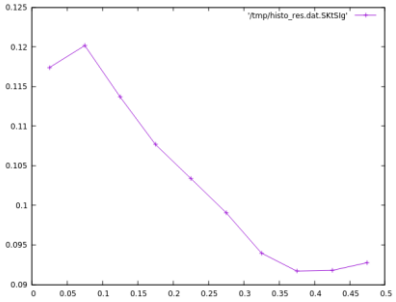
- High Voltage: 1800V

- Straw layout: 15 straws from one layer

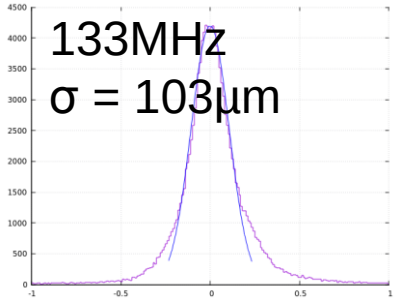
Results, different sample rates

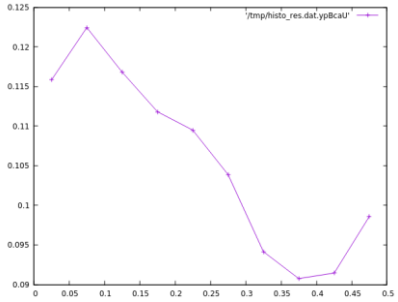
100MHz
σ = 107µm



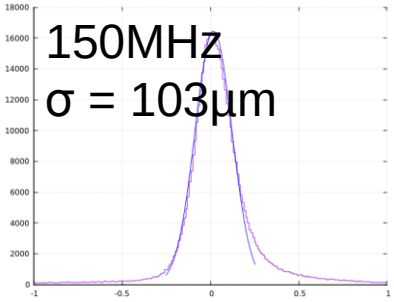


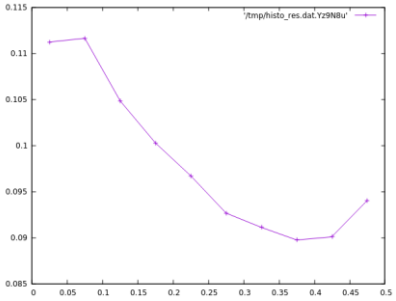
133MHz
σ = 103µm



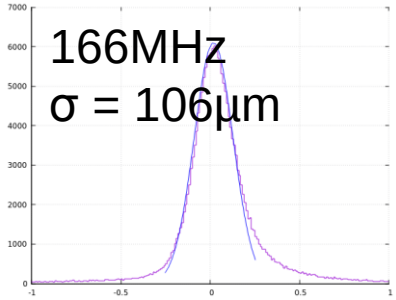


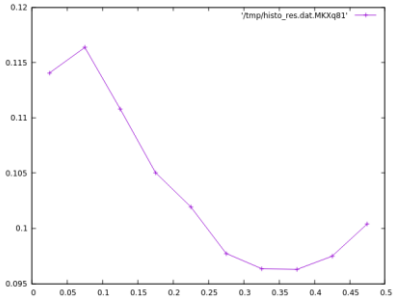
150MHz
σ = 103µm



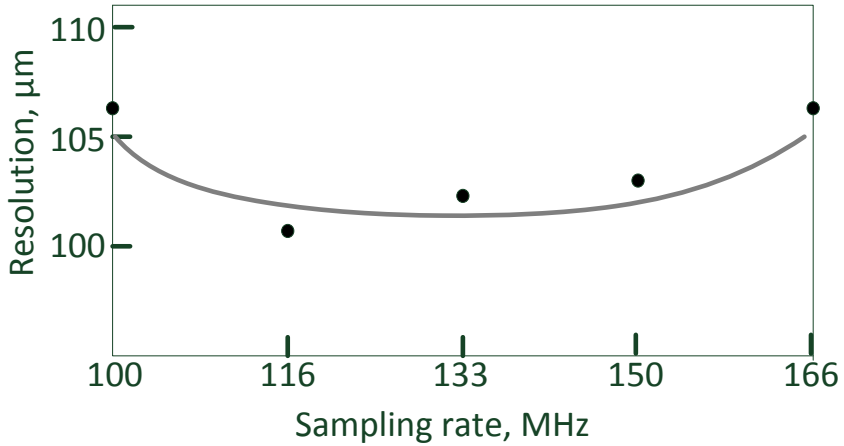


166MHz
σ = 106µm



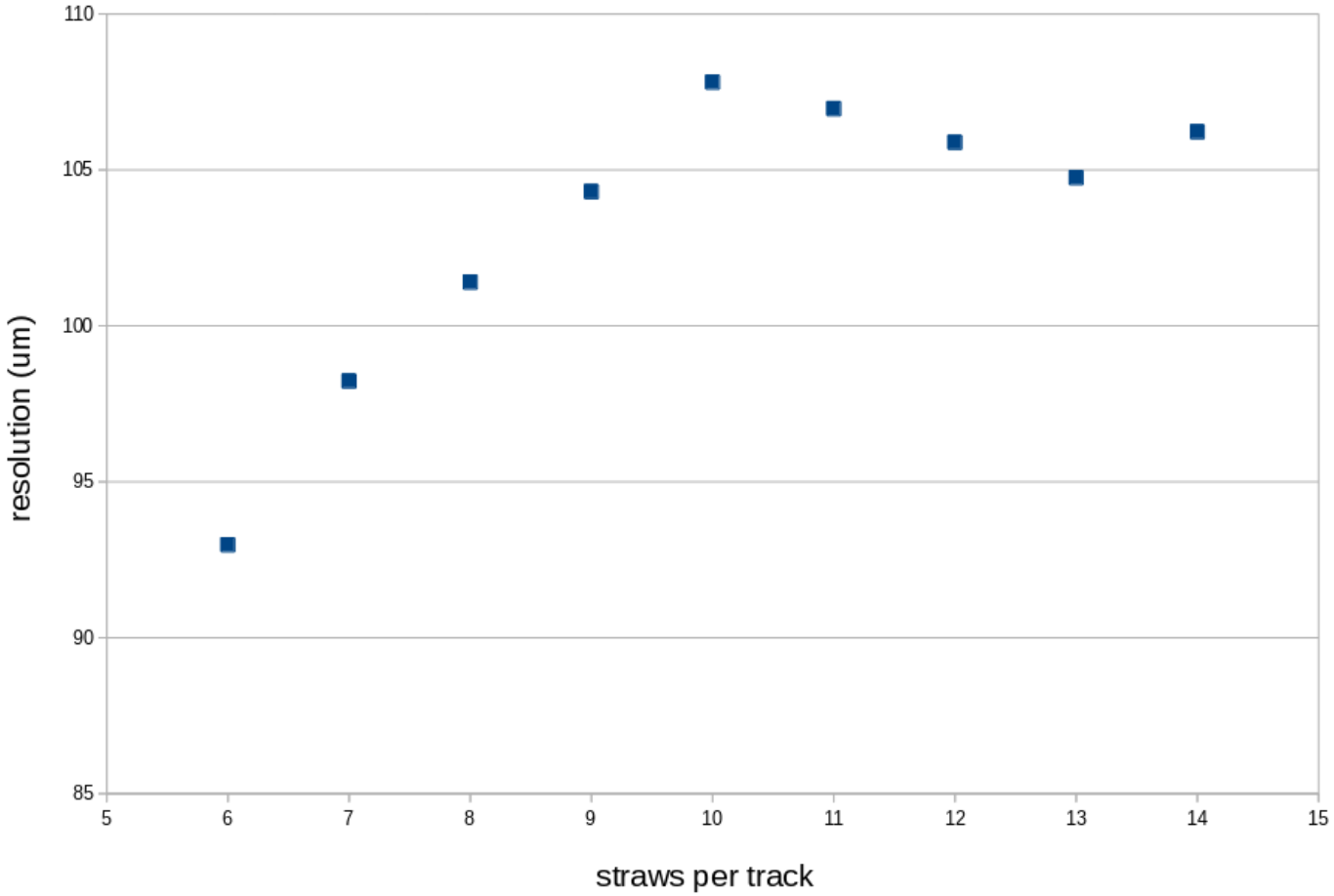


Results, different sample rates



- Higher sampling rate doesn't improve resolution necessarily
- Tested sampling rates are in an optimum range for chosen peaking time of shaper and processing methods
- Results are conform with simulation

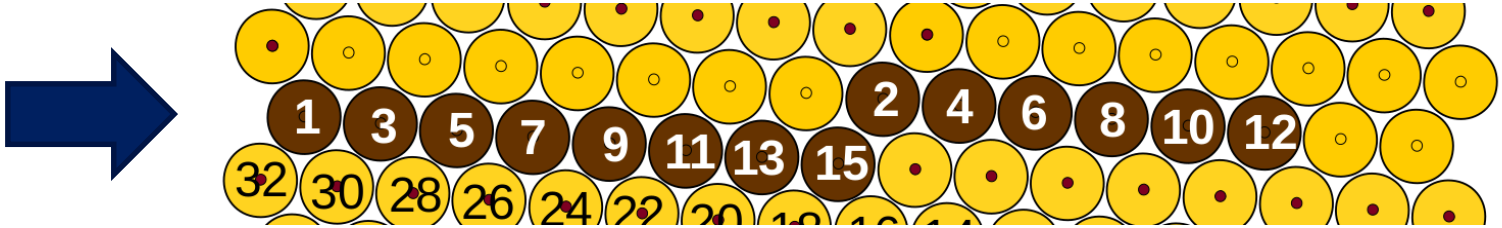
Number of straws per track vs resolution



Results

Beamtime in November 2016:

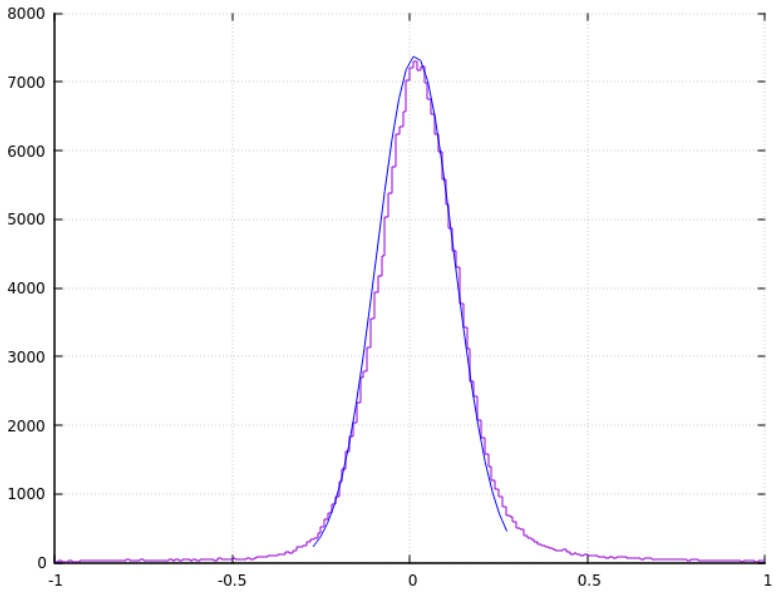
- Measurements with new ADC prototype-board with integrated amplifier
- Several different setups with different amplifier-types and different gains at various energies



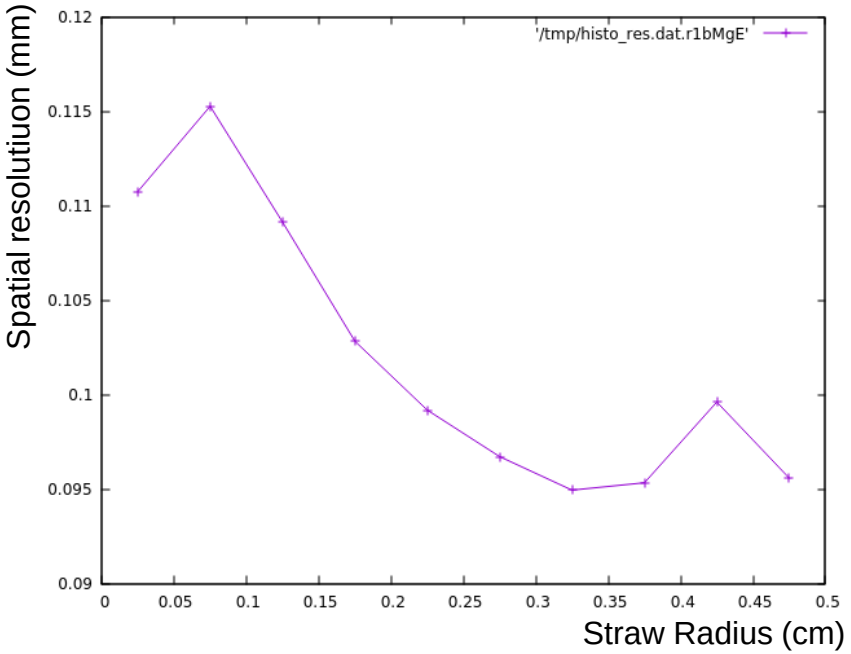
Results, spatial resolution

Amplifier 1, Sample Rate 150MHz
Beam Momentum: 1.5 GeV/c

Residuals



Position Resolution

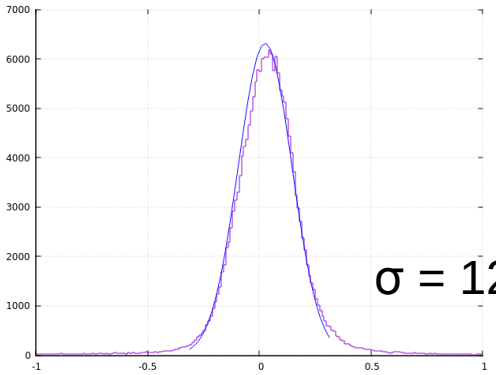


σ = 115µm
Ø 10.6 straws per event

Results, different energies

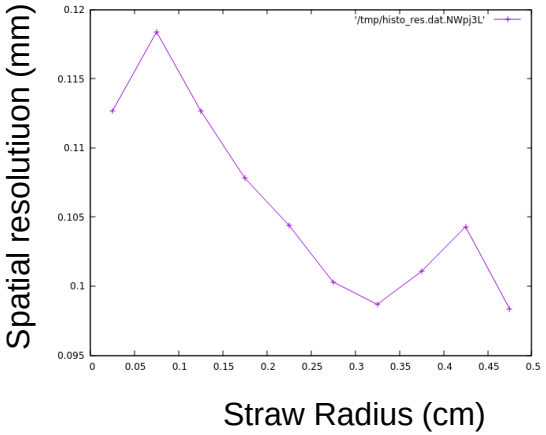
Amplifier 2, Sample Rate 150MHz, Beam Momentum: **1.5 GeV/c**

Residuals



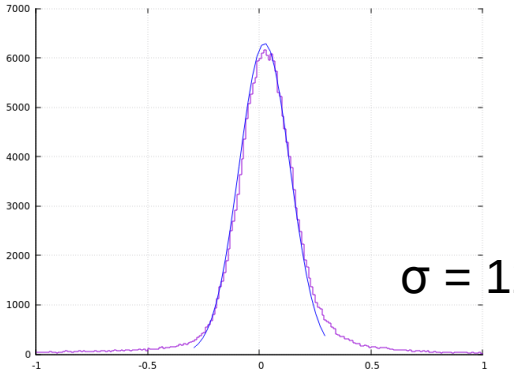
σ = 129µm

Position Resolution

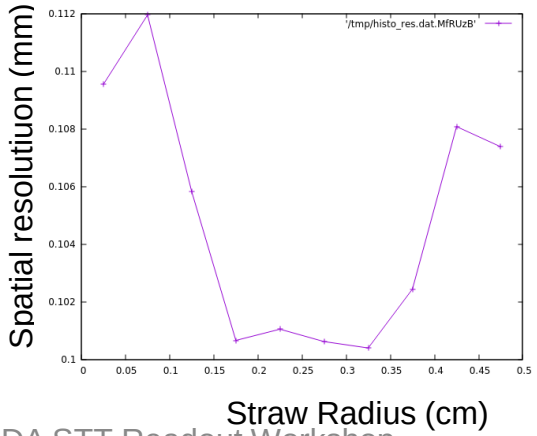


Lower momentum
→ higher pulses
→ better SNR
→ better resolution

Amplifier 2, Sample Rate 150MHz, Beam Momentum**: 0.6 GeV/c**



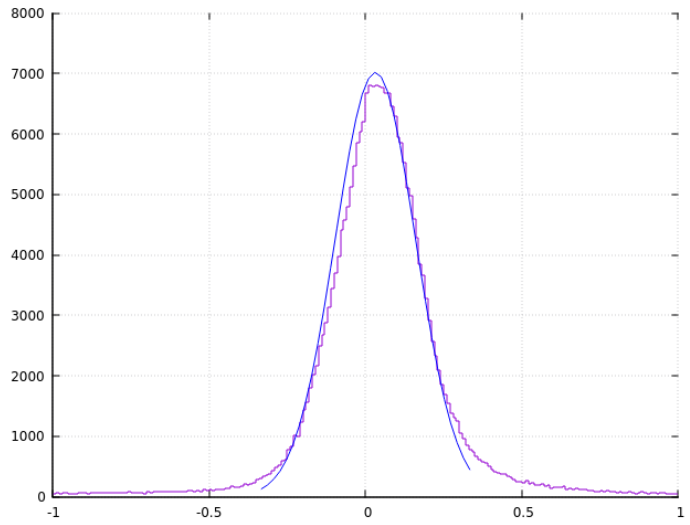
σ = 120µm



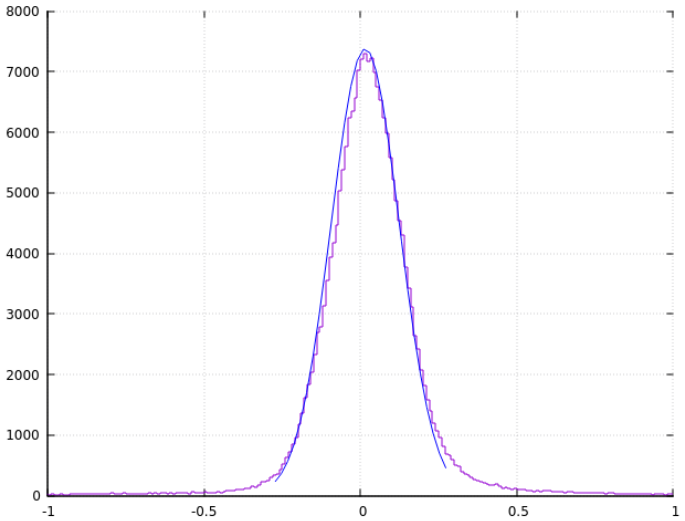
Results, improvement with energy filtering

Beamtime November 2016, Sample Rate 150MHz,
Beam momentum 1.5GeV/c

Without Filtering	With Filtering



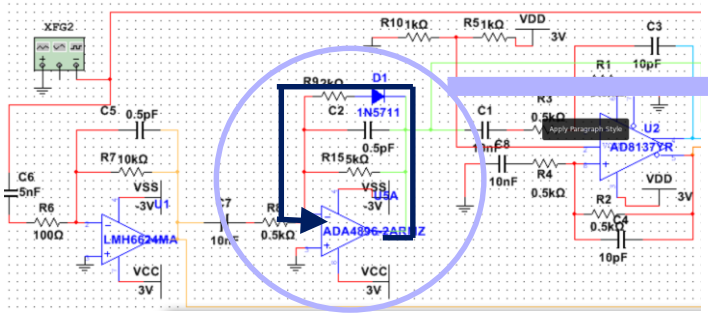
σ = 135µm
Ø 10.9 straws per event



σ = 115µm
Ø 10.6 straws per event

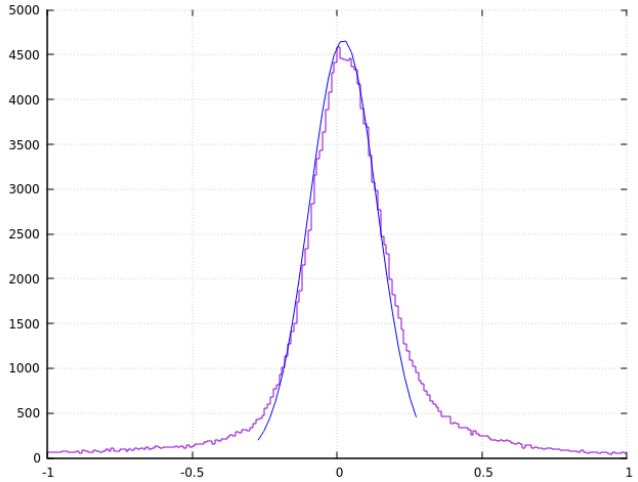
➡ Clear improvement

Logarithmic response



Feedback at amplifier

Beamtime November 2016, Sample Rate 150MHz,
Beam momentum 1.5GeV/c



- Measured, not completely analyzied
- σ = 117µm
- Keep it as option

Summary

- Optimum combination of shaper characteristic, sampling rate and processing algorithm gives good results:

  Calculated spatial resolution in a range around 120µm ✓

- Open for comparison with other analysis

Outlook