

Spatial resolution study for ADC based DAQ-system

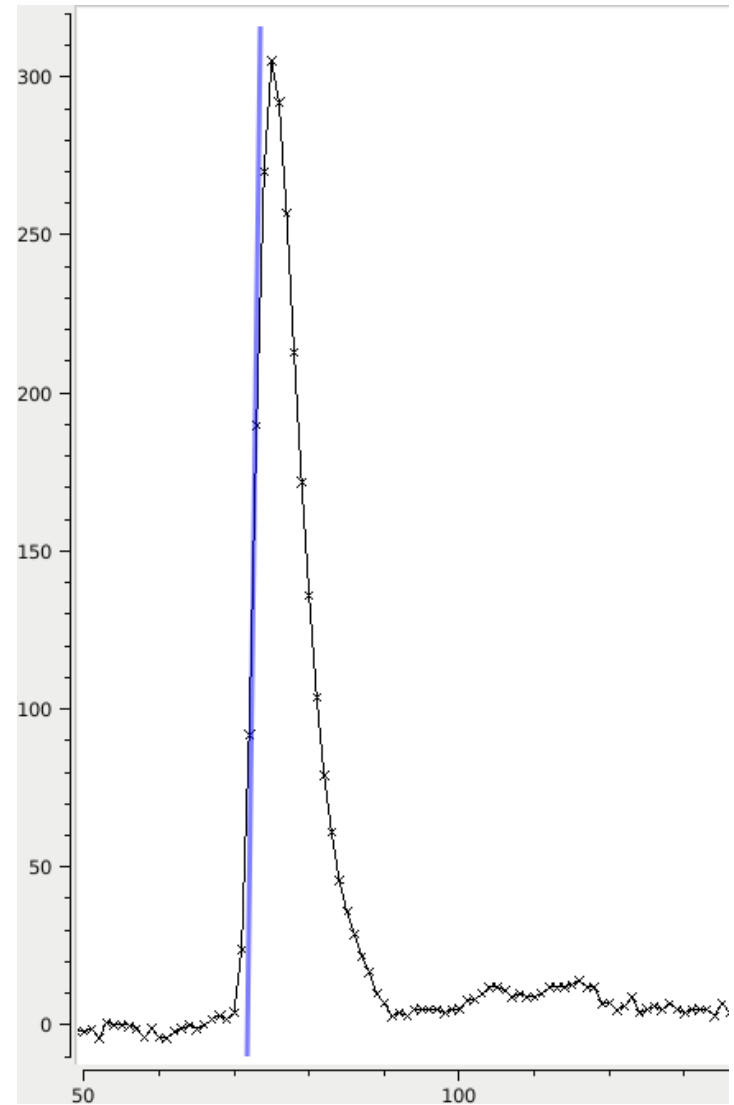
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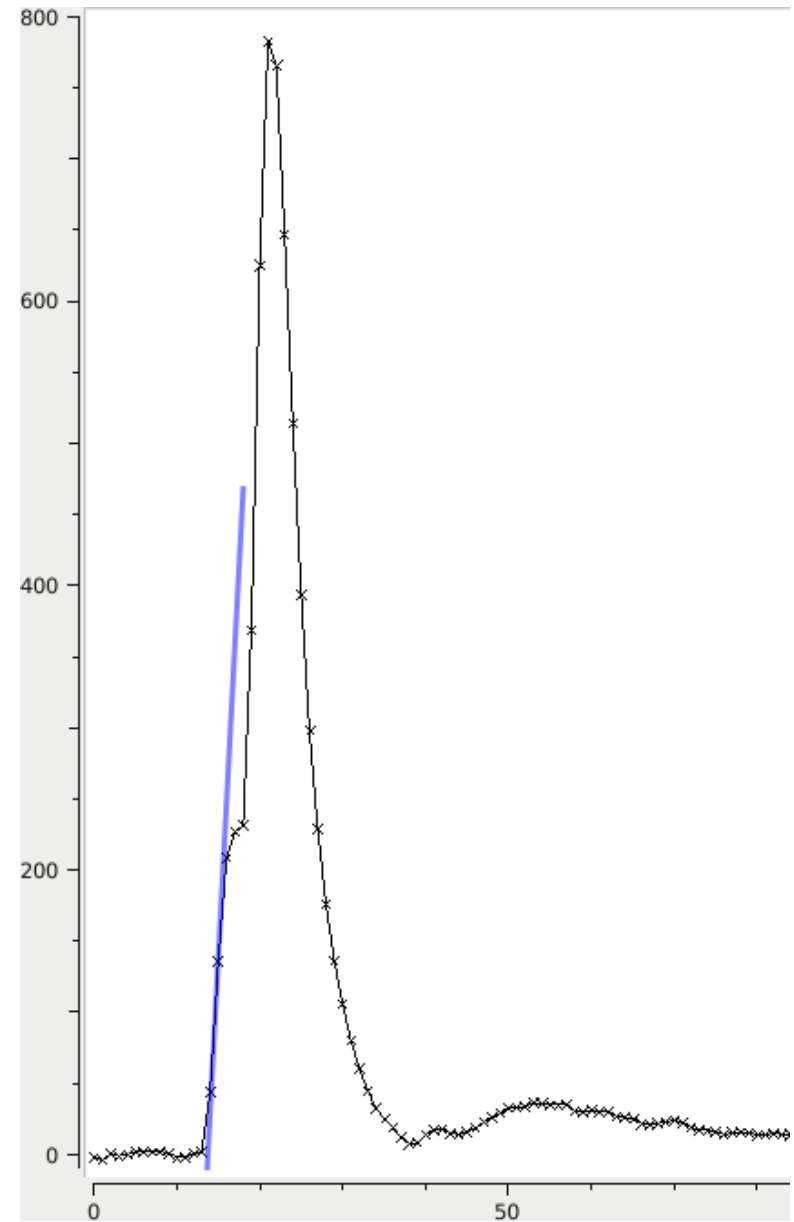
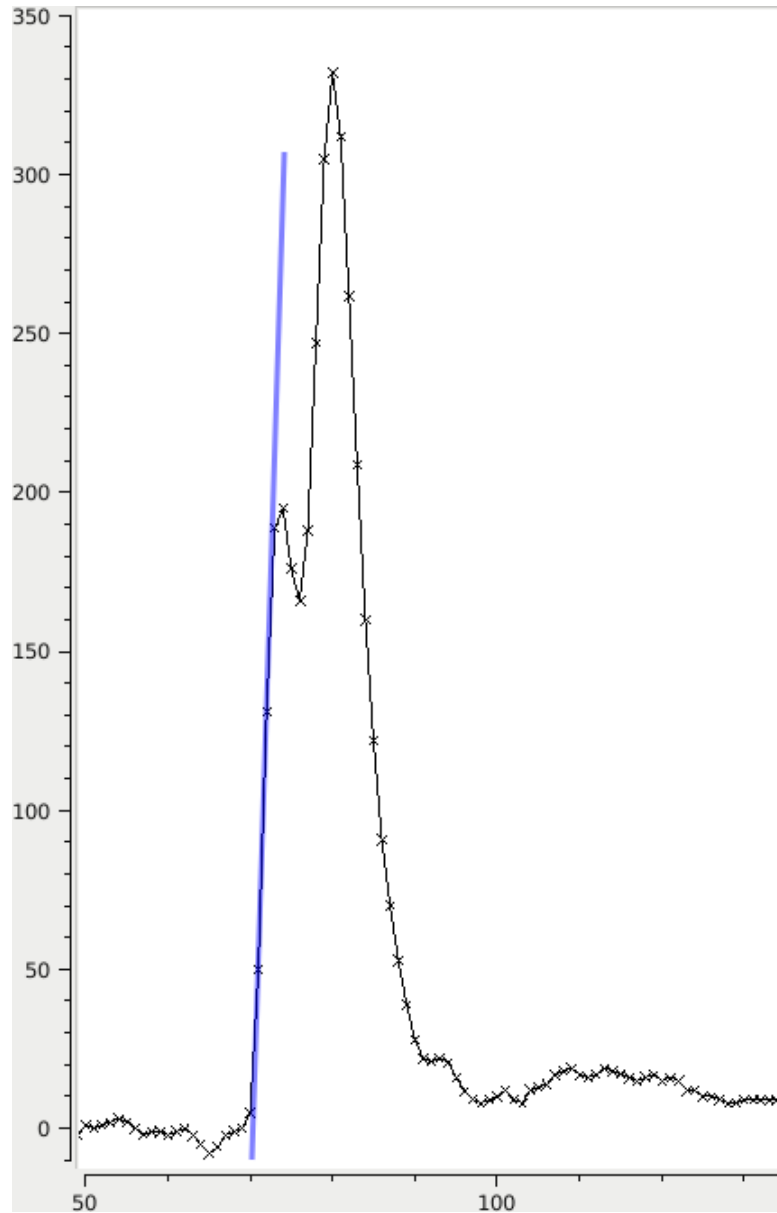
- Using data taken with our ADC prototype at COSY in May 2015, we studied the achievable spatial resolution
- Analysis
 - Extracting time, time to radius, tracking
- Results
 - Results from ADC-Prototype
 - Comparison with old system
 - Improvements

Analysis: zero crossing

- Calculate zero-crossing times for pulses
 - Find maximum rise in leading edge
 - Stop searching if derivative decreases
 - Calculate tangent at point found
 - Intersection with baseline gives zero crossing time

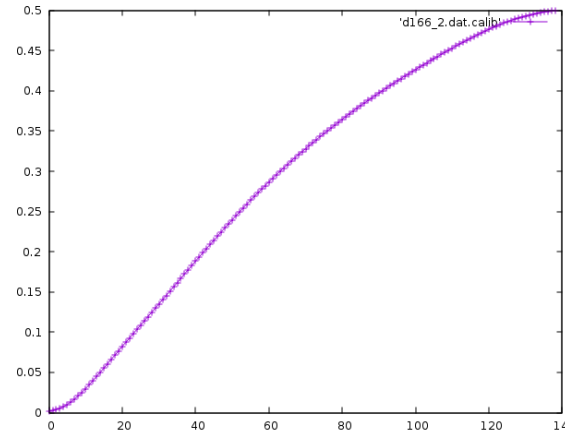
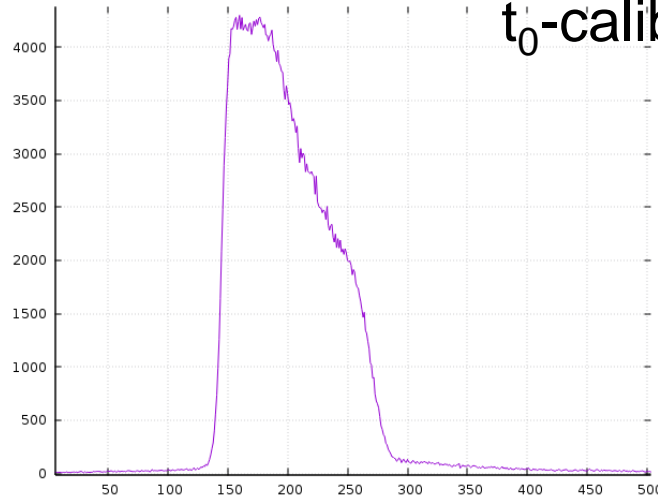


Analysis: zero crossing

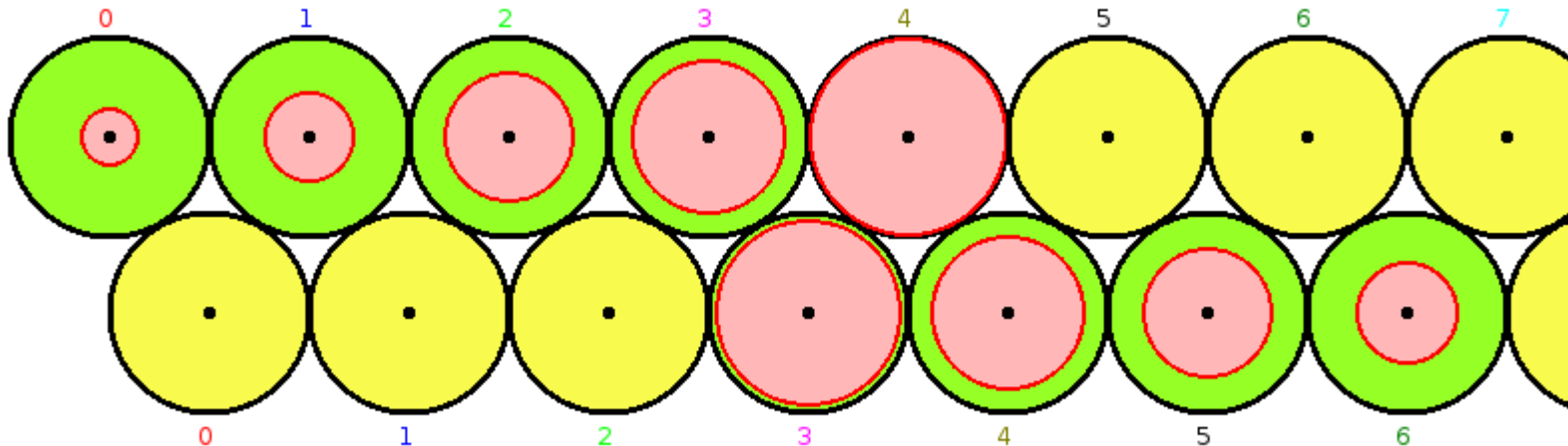


Analysis: Time to radius

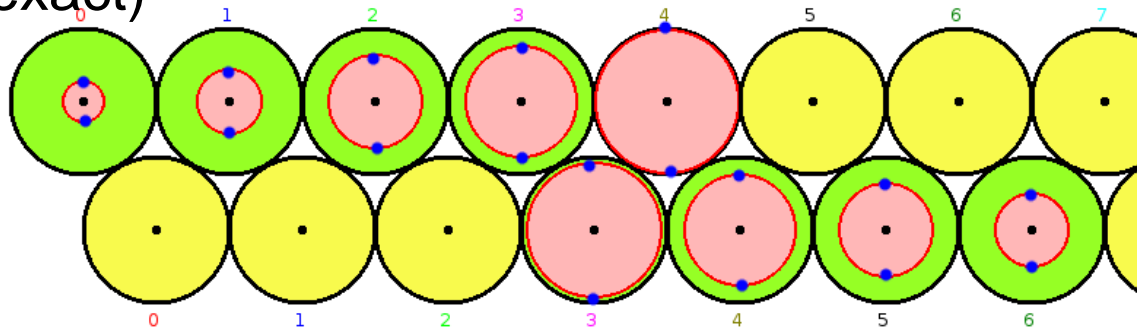
- Common way: Drift time distribution, estimate t_0 & t_{\max} , t_0 -calibration, calibration curve



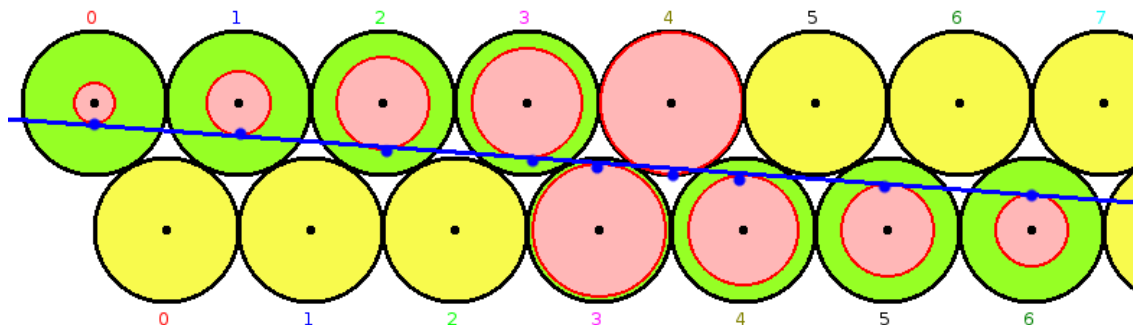
→ get radius of particles passing straw



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

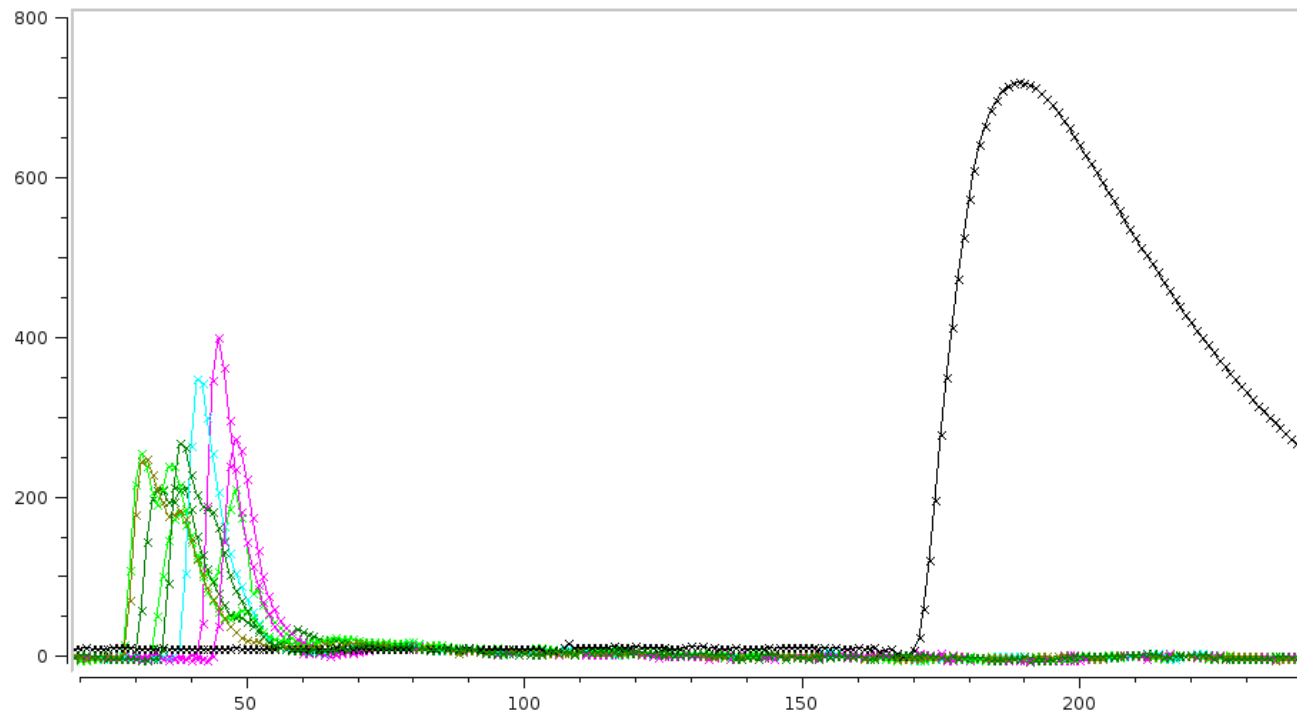


- Linear fit with all possible combinations of above / below
 - → combination with least error gives track



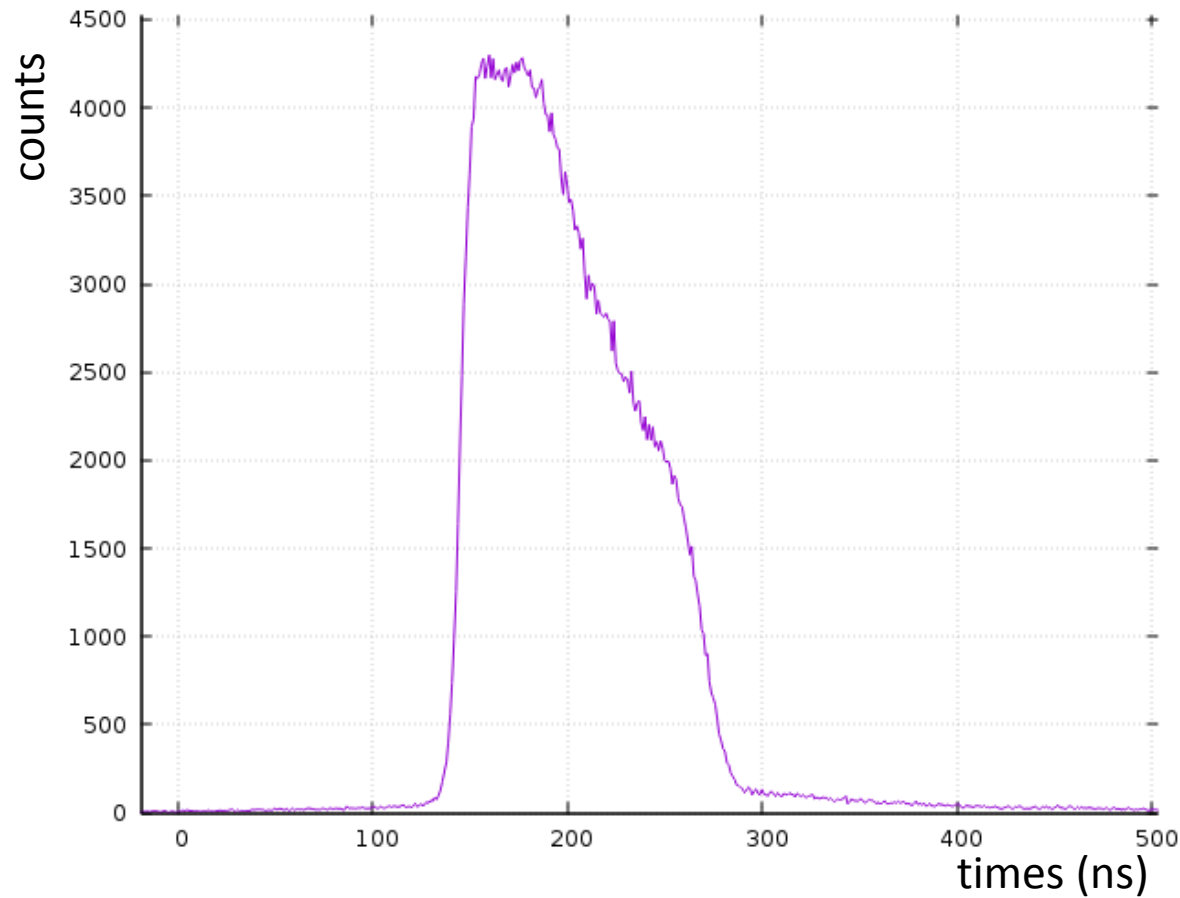
Data from May 2015

- ADC-prototype: 16 channel
- One channel used for reference signal
- -> one layer with 8 and one layer with 7 straws
- Sampling with 166 MHz and 133 MHz
- Beam parameter: 0.8 GeV, 90/10, 1850V



Results: Drift time distribution

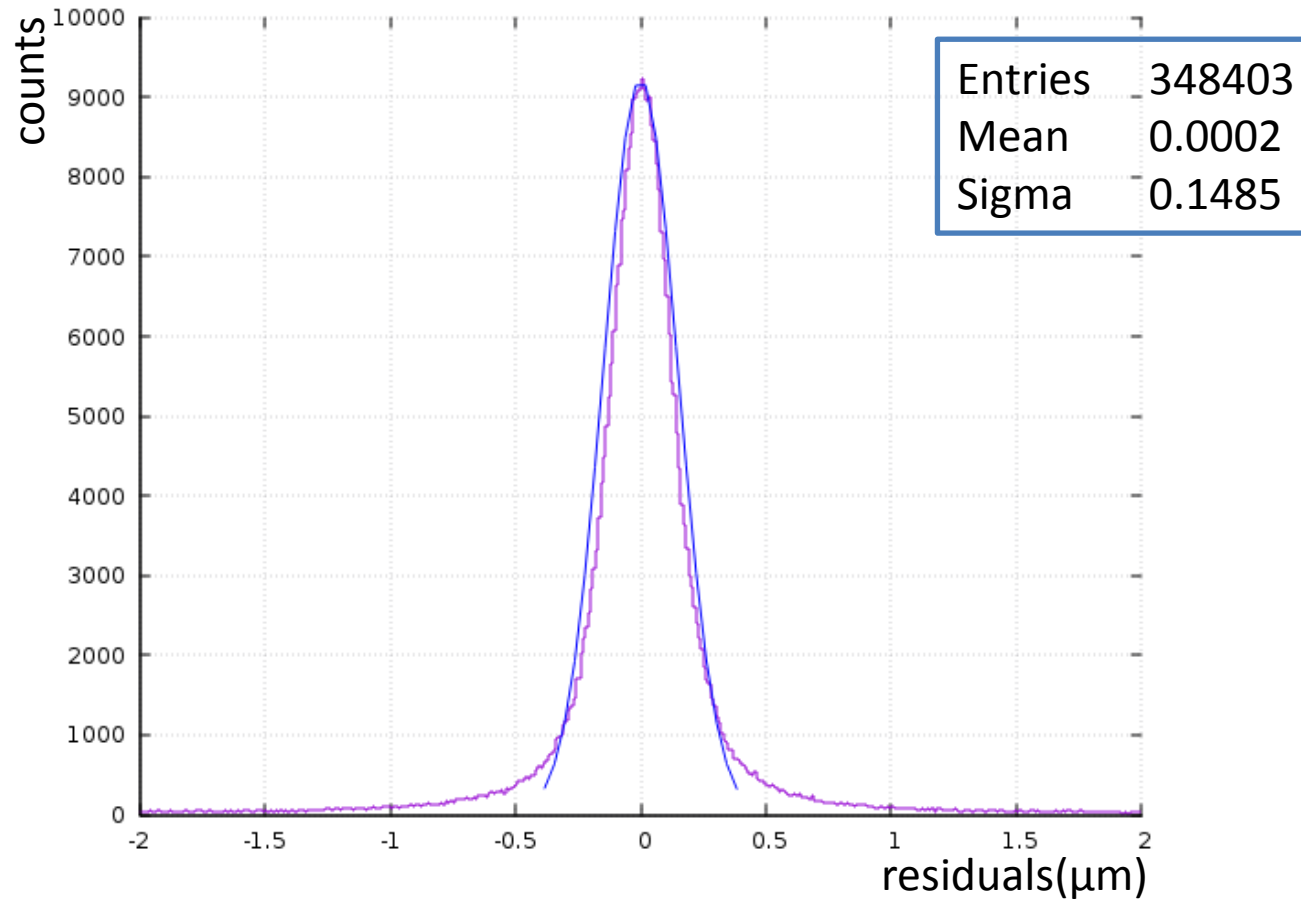
- Sampling frequency: 166 MHz



$$t_{\max} - t_0 = 140\text{ns}$$

Results: Histogram residuals

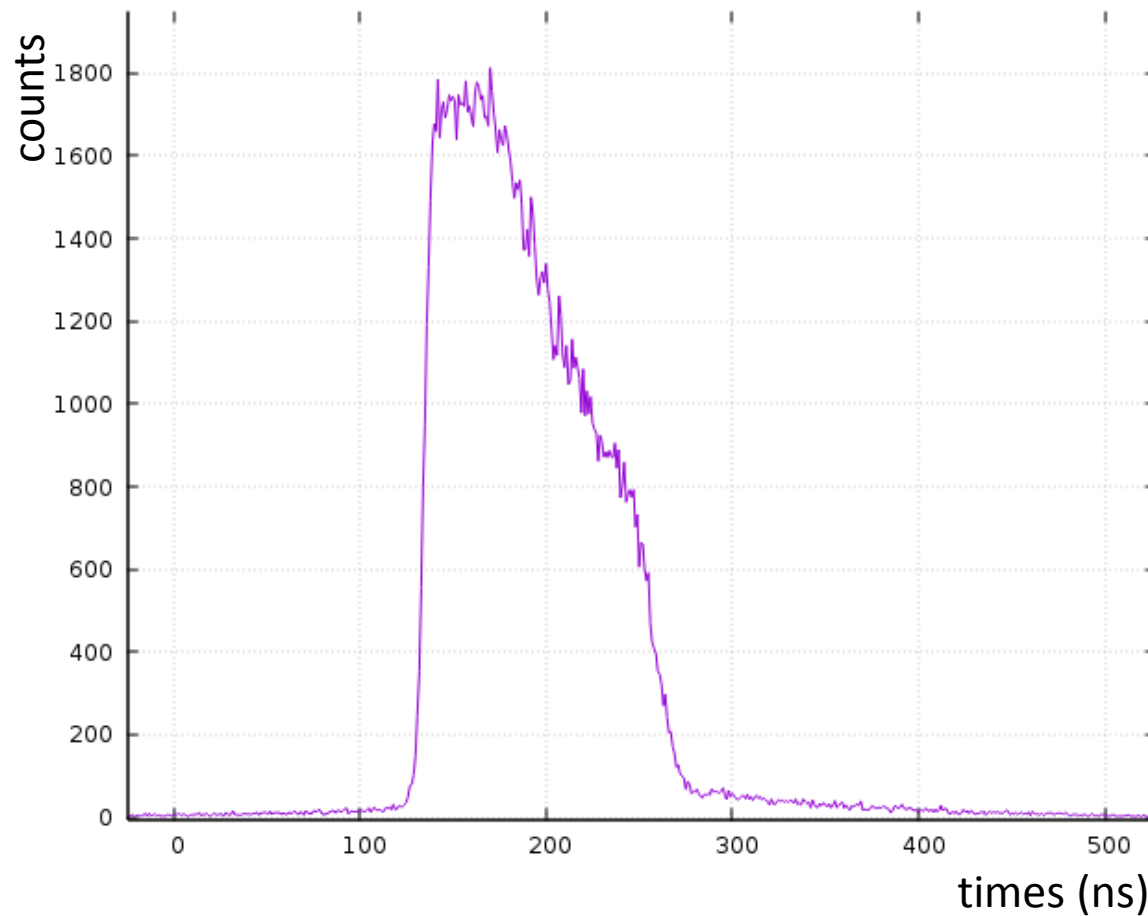
- Sampling frequency: 166 MHz



→ Spatial resolution: 149 μm

Results: Drift time distribution

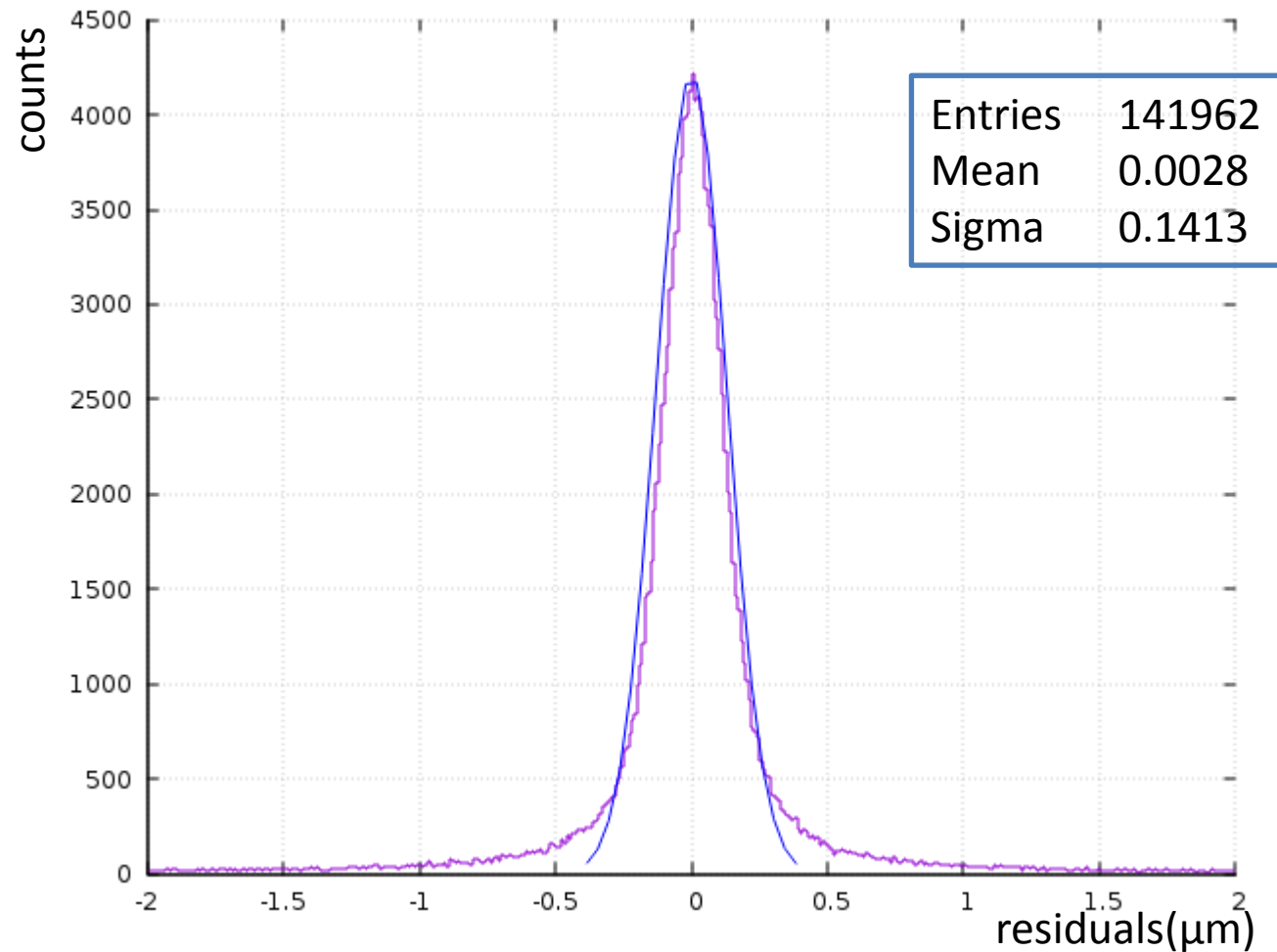
- Sampling frequency: 133 MHz



$$t_{\max} - t_0 = 138\text{ns}$$

Results: Histogram residuals

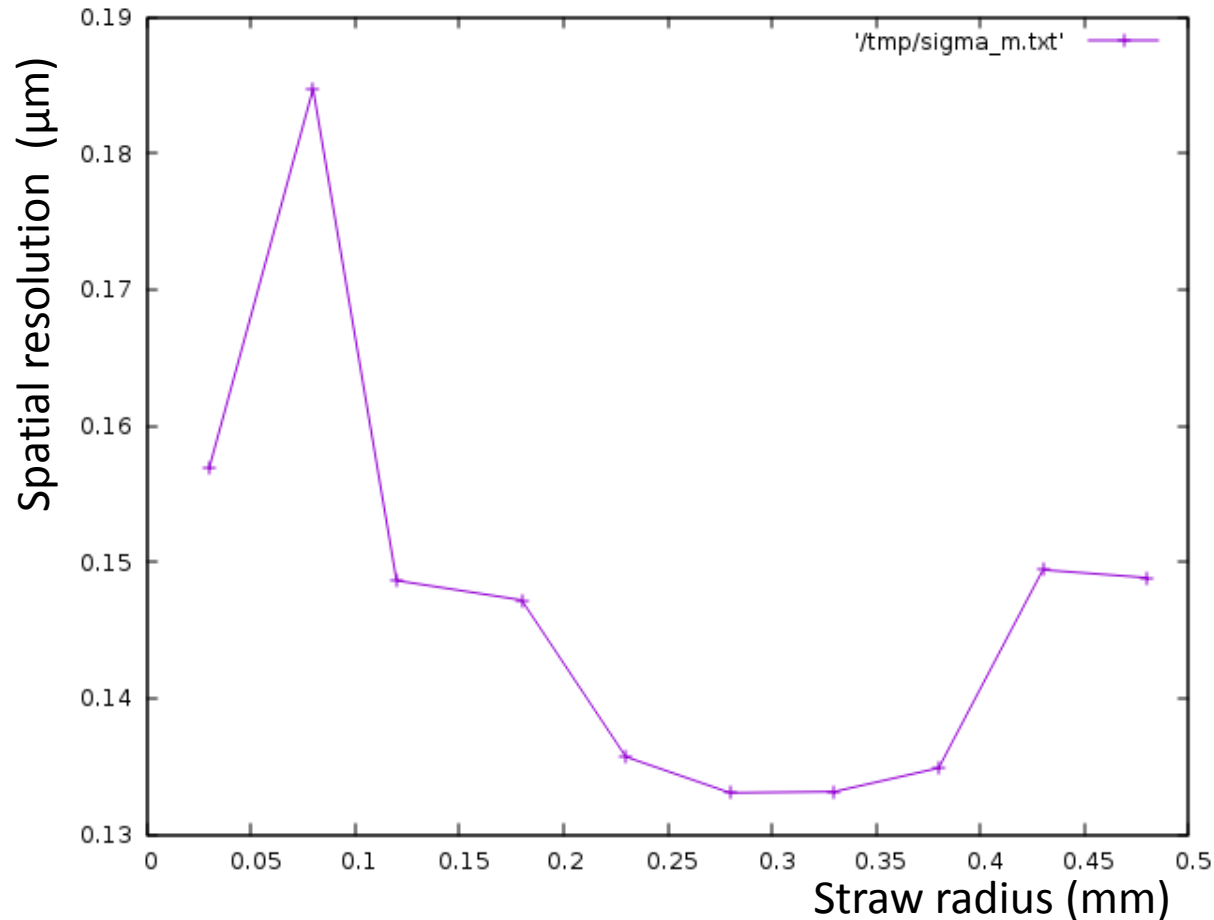
- Sampling frequency: 133 MHz



→ Spatial resolution: 141 μ m

Results: Position resolution

- Sampling frequency: 166 MHz
- Resolution dependent on radius



Results: old QDC

- Data was taken with old QDC in parallel
- Limit to 8+7 layer to get comparable results

- Old QDC-Module

240 MHz	120 MHz
165 μm	169 μm

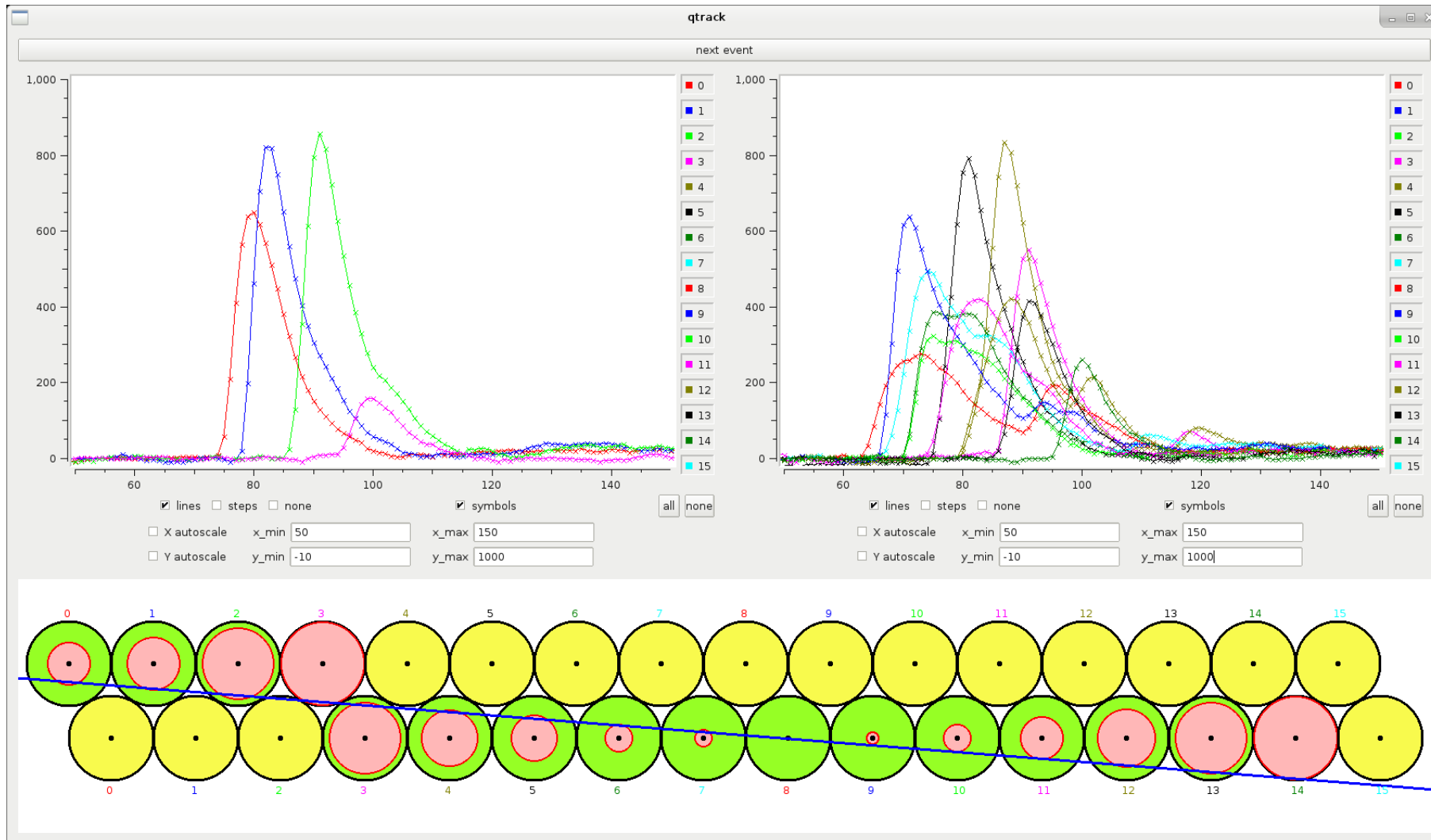
- New ADC prototype

166 MHz	133 MHz
149μm	141μm

- New ADC has better results: less noise and more accurate reference time

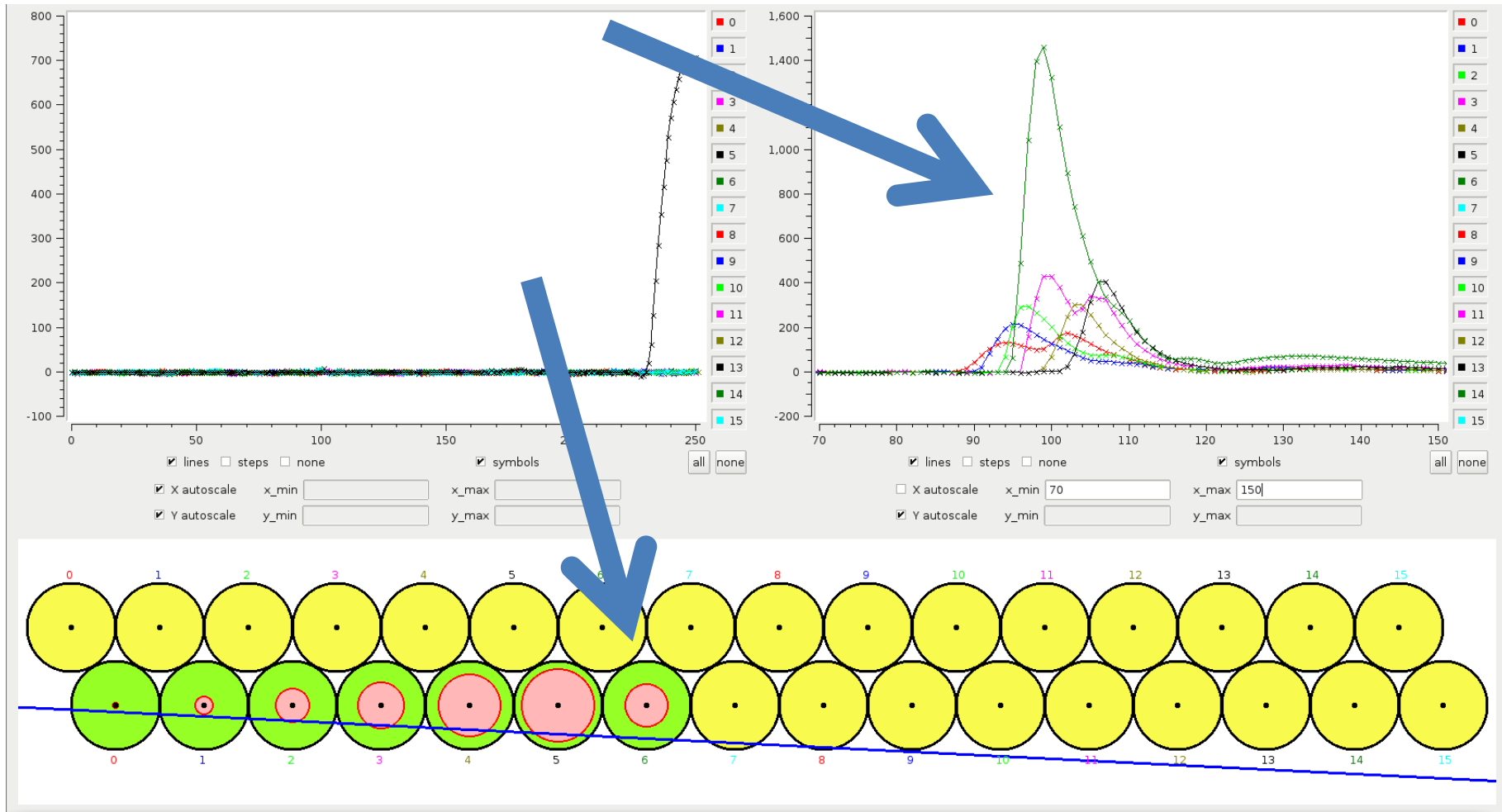
Detailed analysis

- Tool showing pulses and resulting track



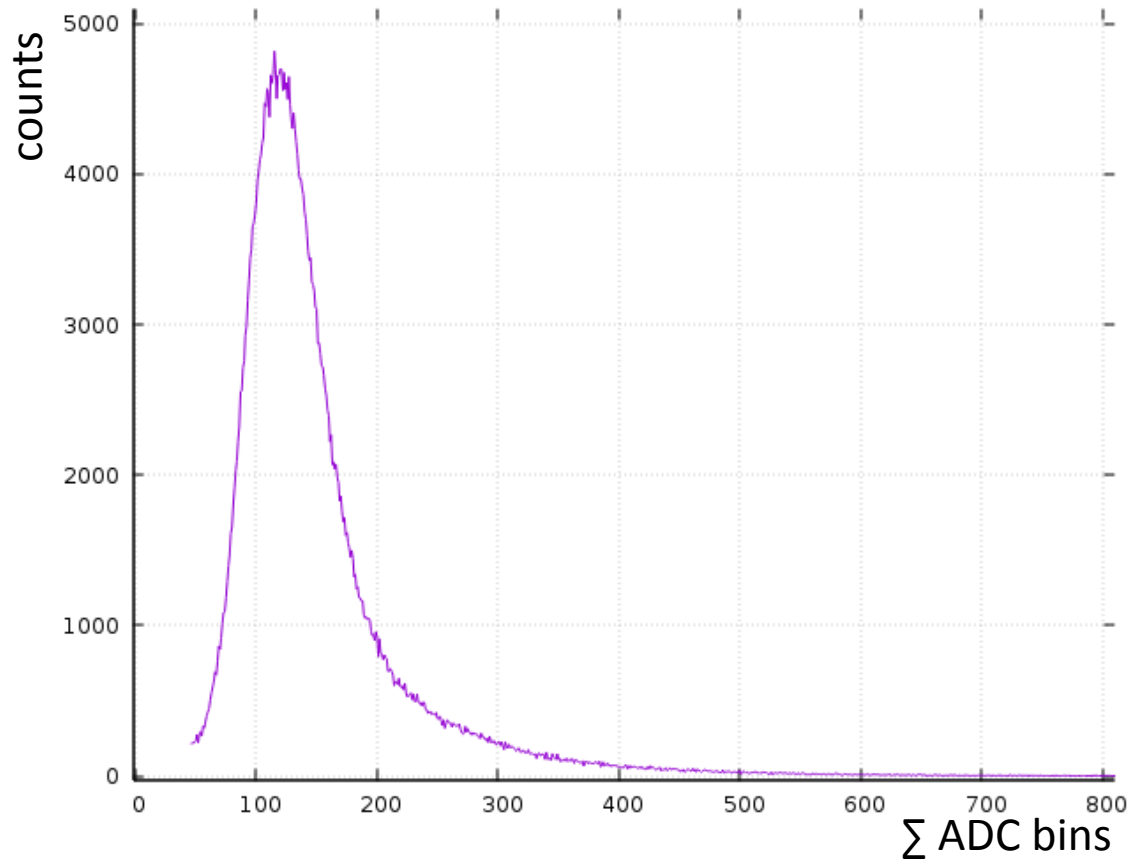
Detailed analysis: high energy

- Specialty found: pulse with higher energy gives wrong time



Detailed analysis: high energy

- Ignore pulses with high energy
- Sum up ADC-values of pulses, histogram to get overview of energies



Detailed analysis: high energy

- Determine spatial resolution, ignoring pulses with energy higher limit

166 MHz

Energy limit	Spatial res.	Straws per event
-	149 μ m	7.65
600	149 μ m	7.64
500	149 μ m	7.62
400	147 μ m	7.55
300	142 μ m	7.36
250	138 μ m	7.15
200	134 μ m	6.79

133 MHz

Energy limit	Spatial res.	Straws per event
-	141 μ m	7.67
600	141 μ m	7.67
500	140 μ m	7.65
400	139 μ m	7.59
300	134 μ m	7.41
250	129 μ m	7.2
200	124 μ m	6.84

- **Successful tracking with data taken from ADC prototype**
- **Estimated spatial resolution comparable with / better than results from old 240MHz system**
 - **→ ADC and its sampling rate provide required resolution**
- **Tool for investigation special pulse characteristics**
- **Results can be improved by filtering of pulses**

THANK YOU!