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First Prototype Muon Test Beam Measurements

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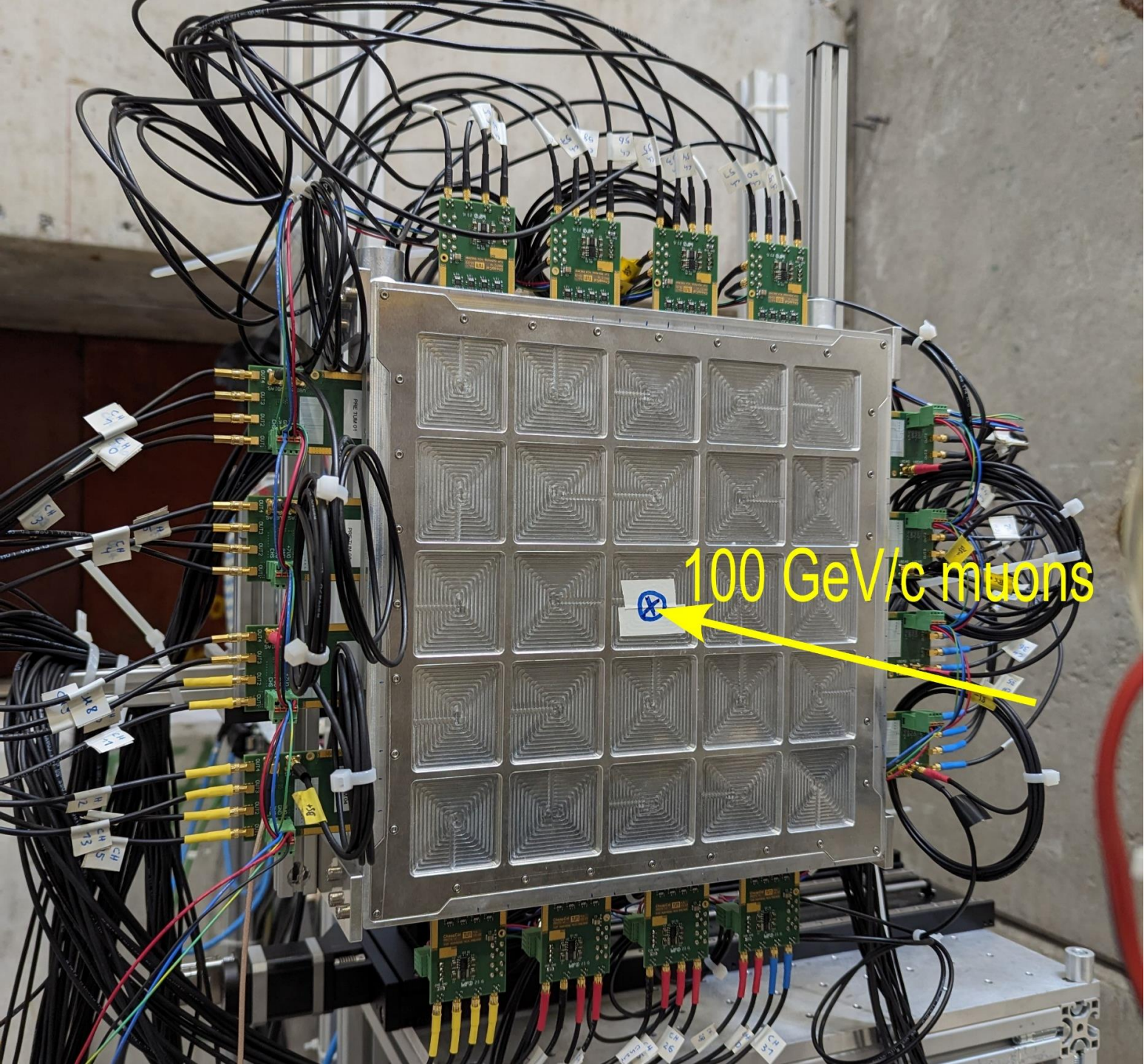
JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

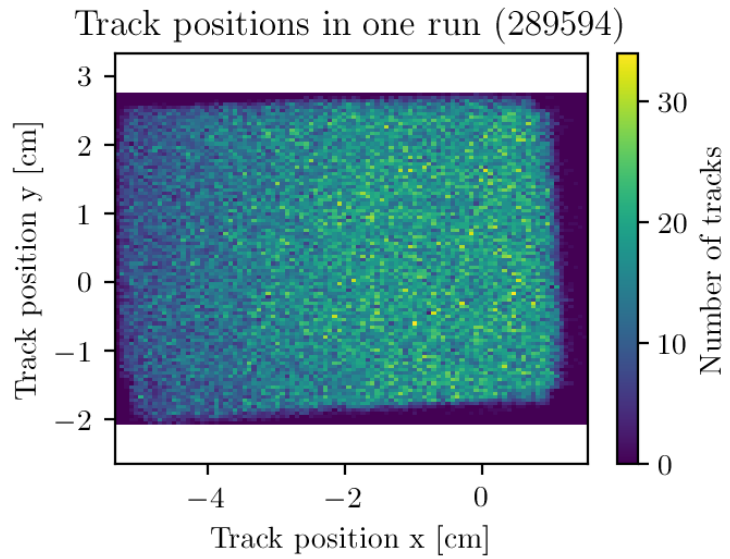
Overview

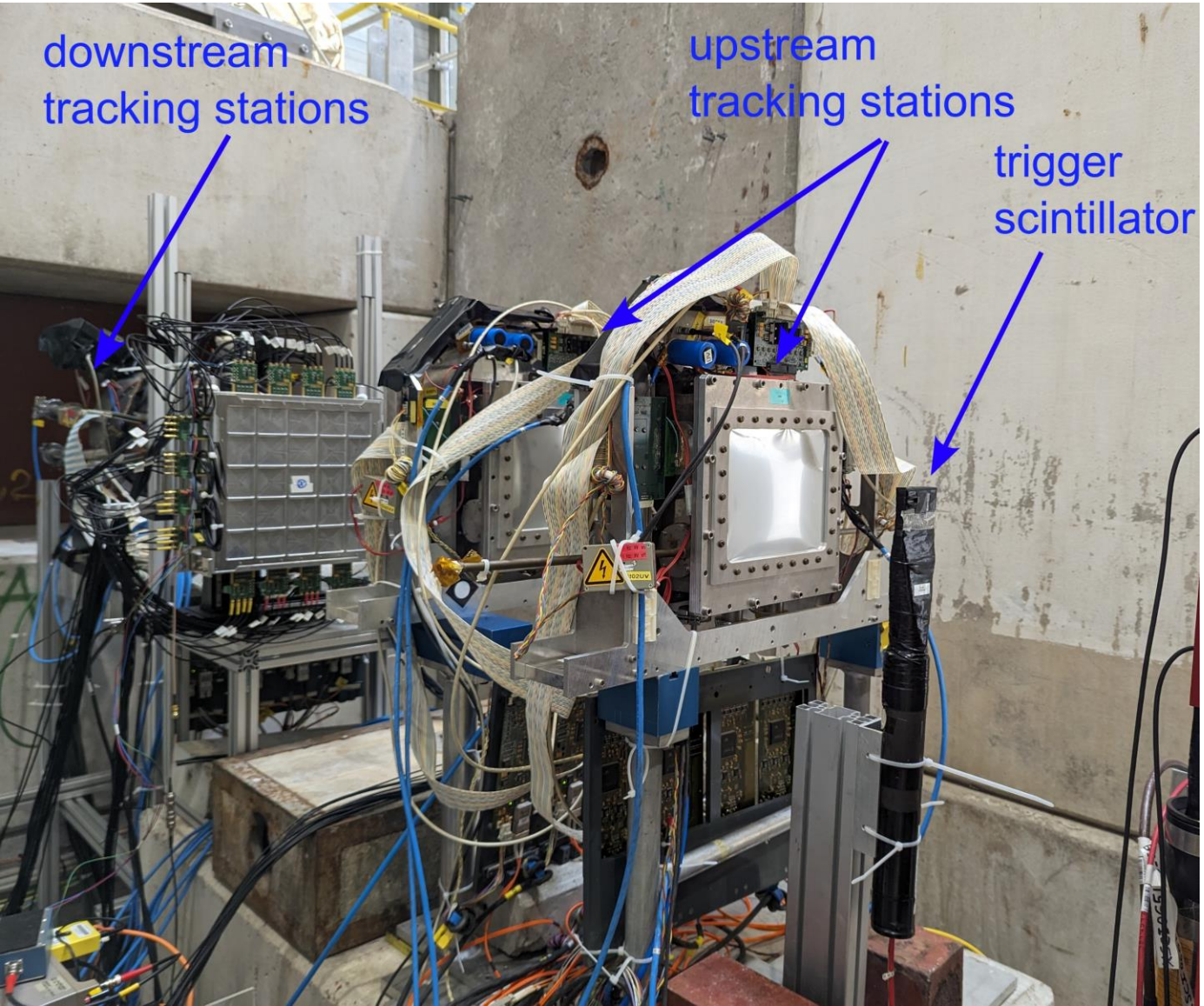
- Setup at CERN
- Measurements
- Analysis
- Outlook



Setup at CERN

- Beam Dump Test Stand of the AMBER experiment; September 2023
- Part of setup identical to Ida‘s: scintillator & pre-amplifiers
- Fixed to a 2D moving table, supplied by U Gießen





Setup at CERN – Silicon telescope & Trigger

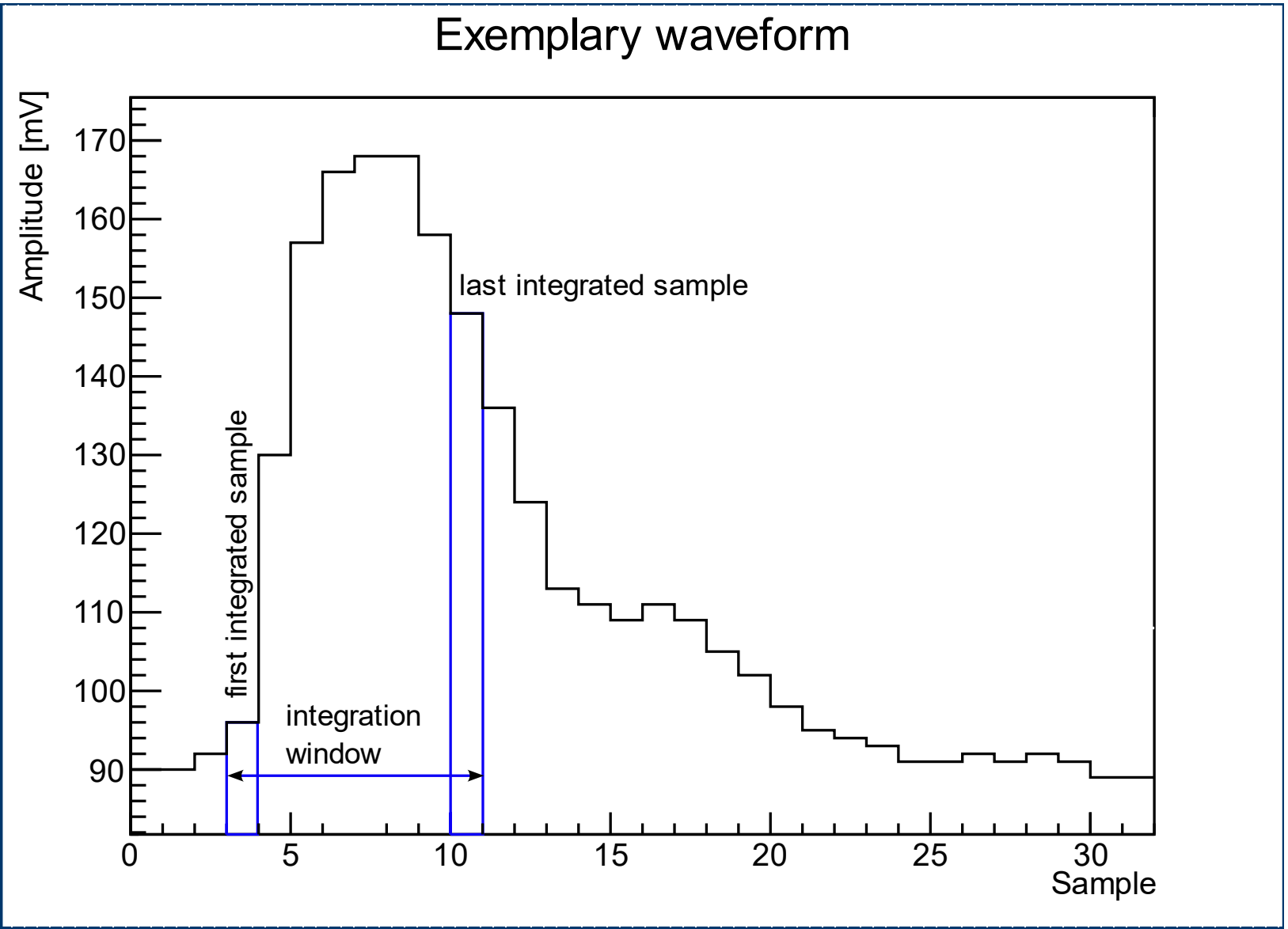
- Tracking telescope: 16 planes of silicon microstrip detectors, four stations
- Two stations upstream of detector, two downstream
- Tracker: $(5 \times 7)\ \mathrm{cm}^2$ active area
- Resolution: $20\ \mu\mathrm{m}$ (only $\mathrm{O}(\mathrm{mm})$ for the alignment of the prototype)
- Trigger: single plastic scintillator (BC408), size: $(5 \times 7)\ \mathrm{cm}^2$; readout by one PM tube

Setup at CERN: Trigger and DAQ

- ADC: MSADCs developed for COMPASS
- Amplitude resolution: 12 bit
- DAQ: standalone version of the COMPASS DAQ

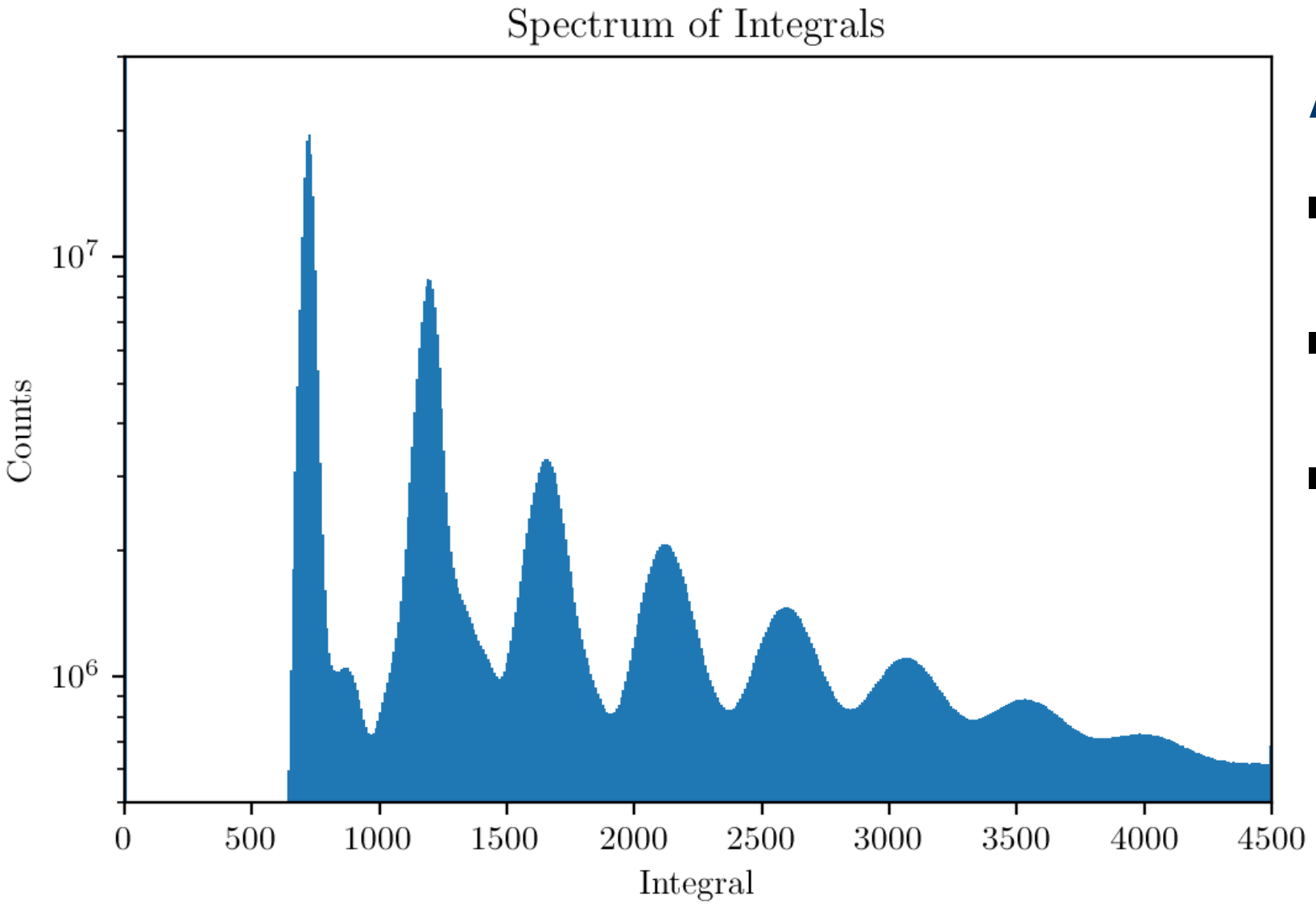
Analysis – Processing

- Data processed and aligned by colleagues in Munich
- Content: track information in x and y, waveforms with 32 samples (bin size: 12.5 ns)
- Kept data with the following parameters:
  - Number of hits in tracking telescope planes: more than 8 (out of 16)
  - Number of tracks per event: exactly 1
  - χ^2 of the track reconstruction: smaller than 30



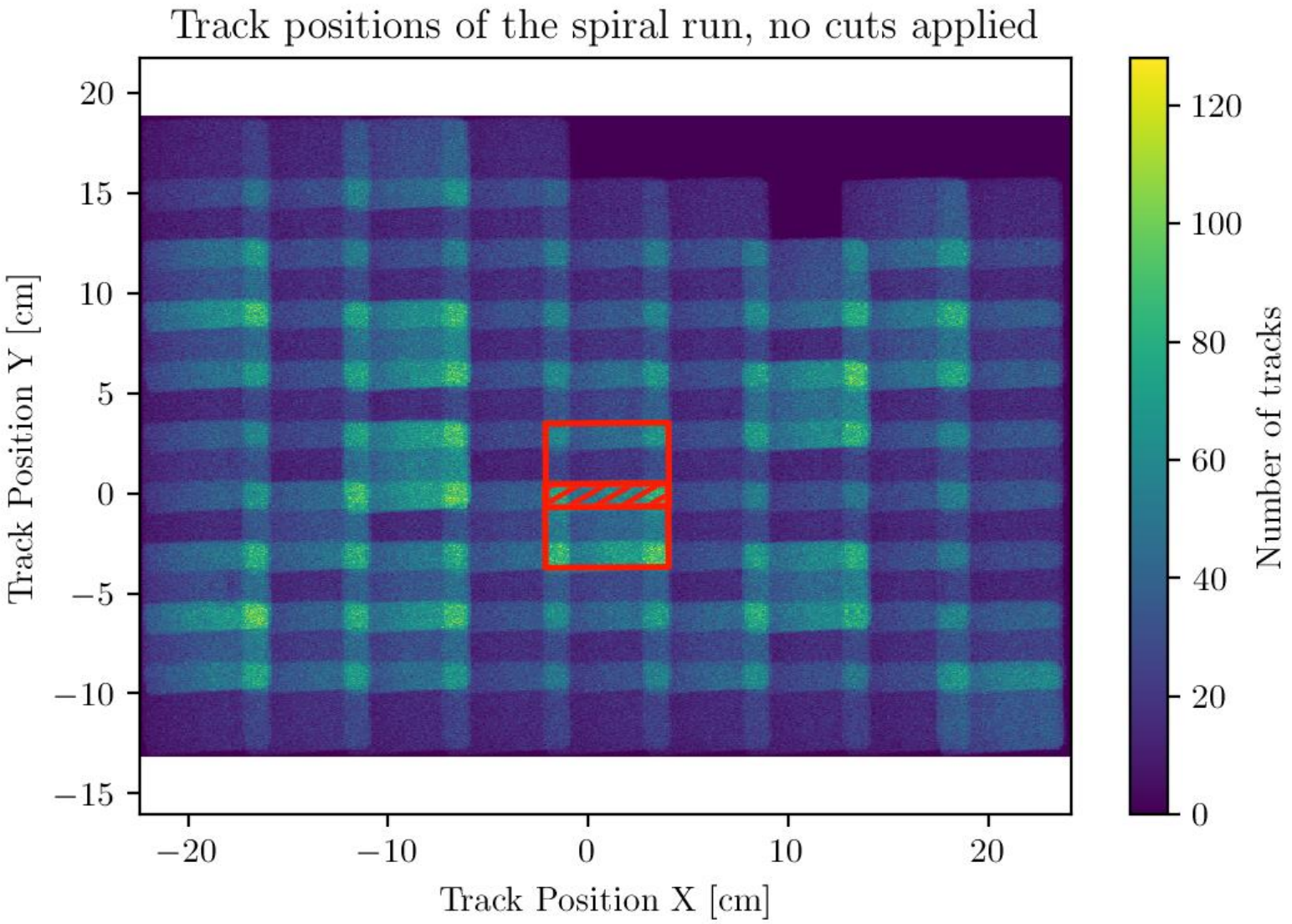
Analysis – Integrals

- Search for maximum in a specified range
- Integral: sum of waveform samples in a defined interval
- Example waveform in one channel from darkcount measurements, random trigger



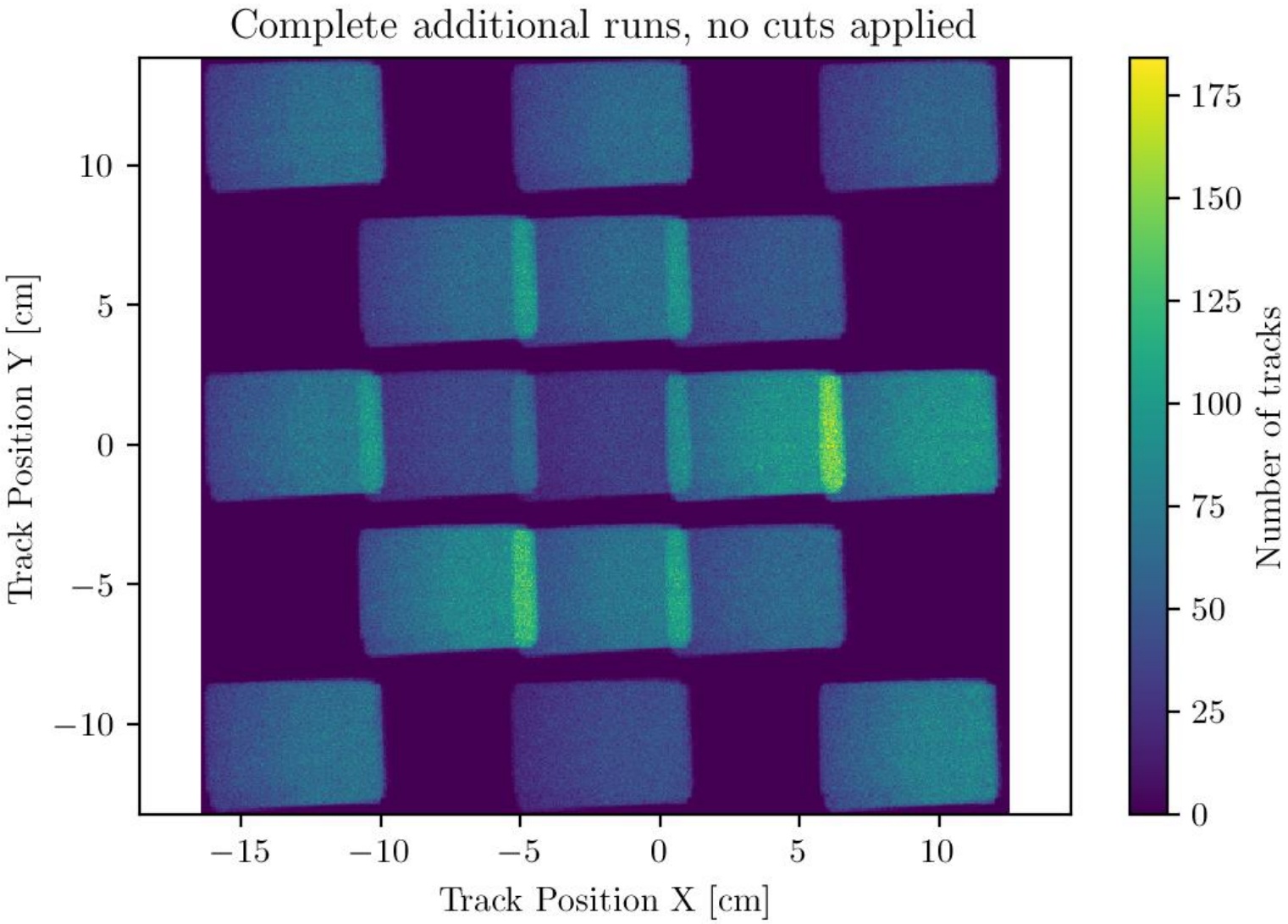
Analysis – Integrals

- Resulting integral spectrum
- All runs with positional data, no further cuts
- Separation of photo electron peaks



Measurements – Track positions

- First set of runs: covering the whole surface of the detector and more (two runs in red)
- Overlap between each run: 2 cm in x and y direction (overlap area shaded)

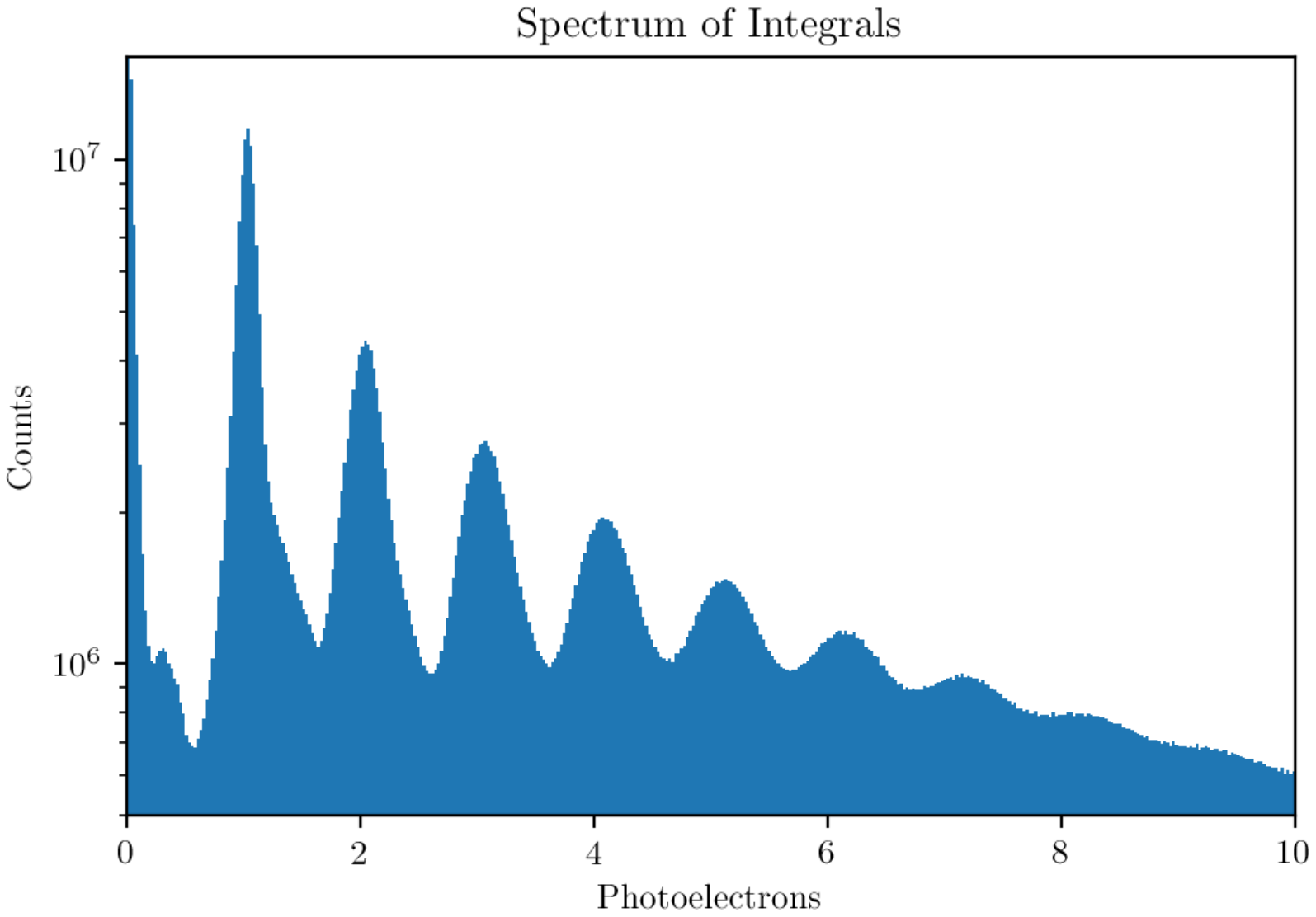


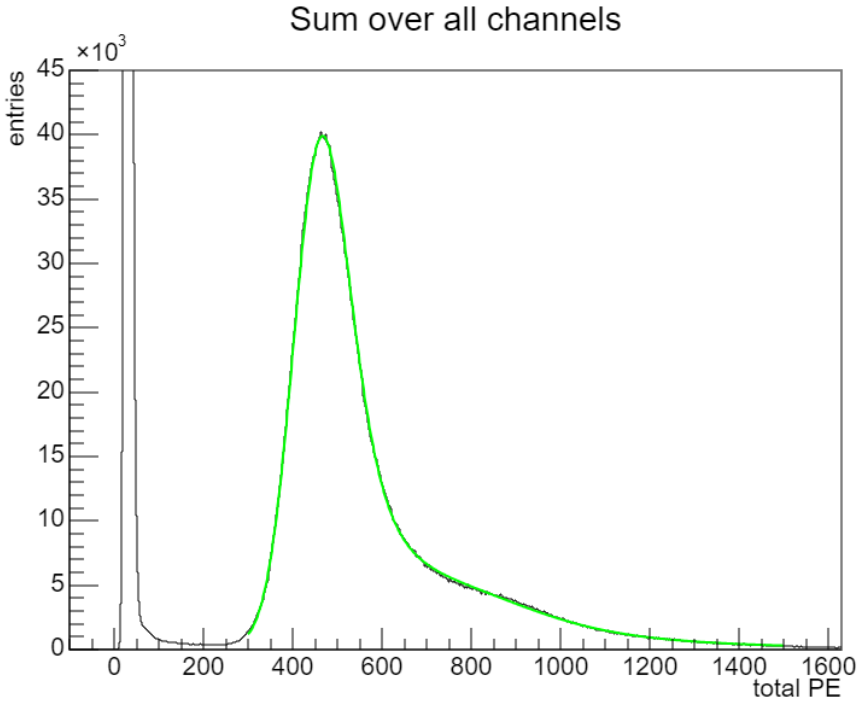
Measurements – Track positions

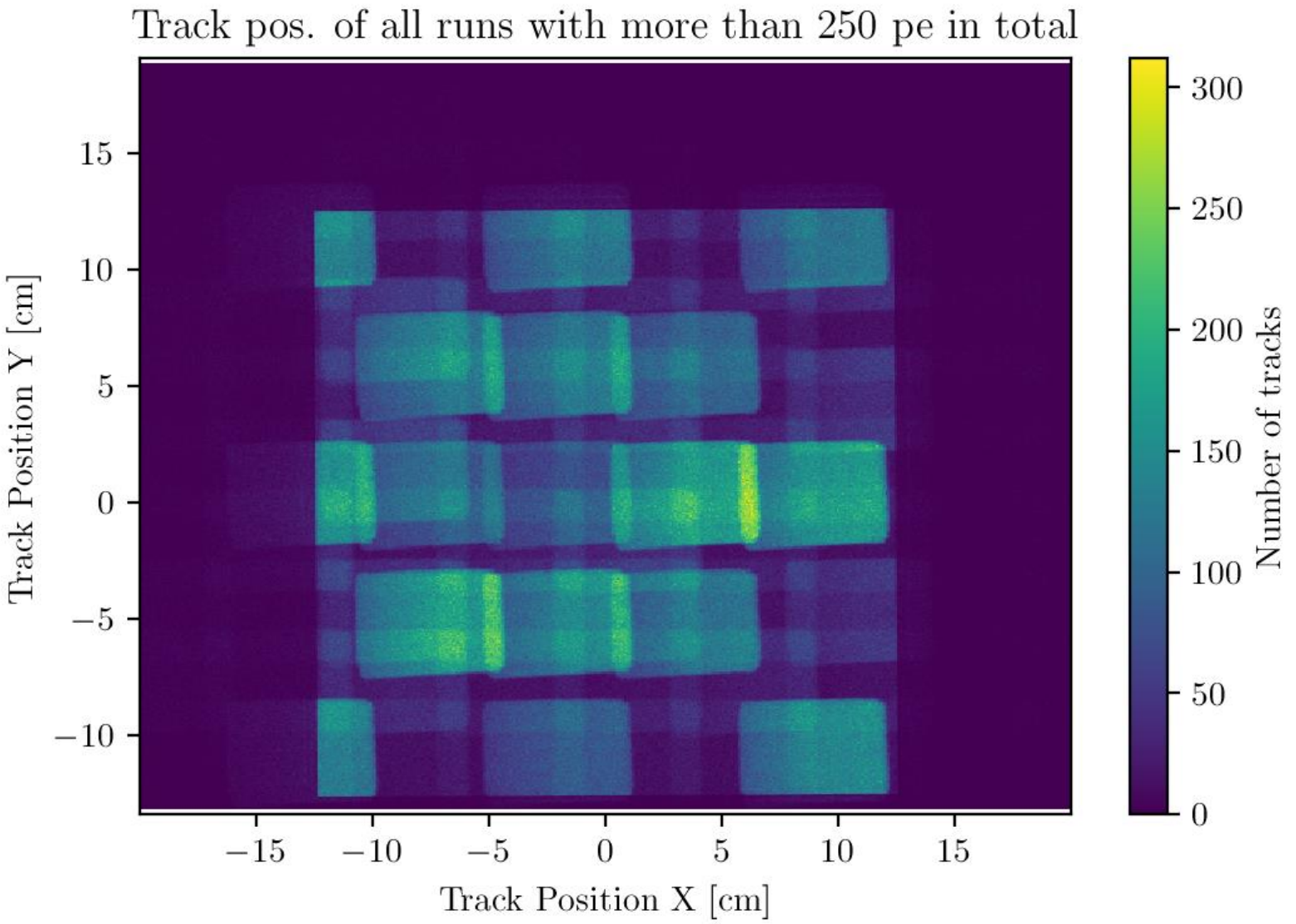
- Second set of runs: taking more data on seventeen positions

Analysis – Integrals

- $n_{pe} = \frac{I-p}{G}$ with
  - I: integral value
    p: pedestal
    G: gain
  - G and p have been obtained by fitting the darkcount spectra (bottom right; fit in green)

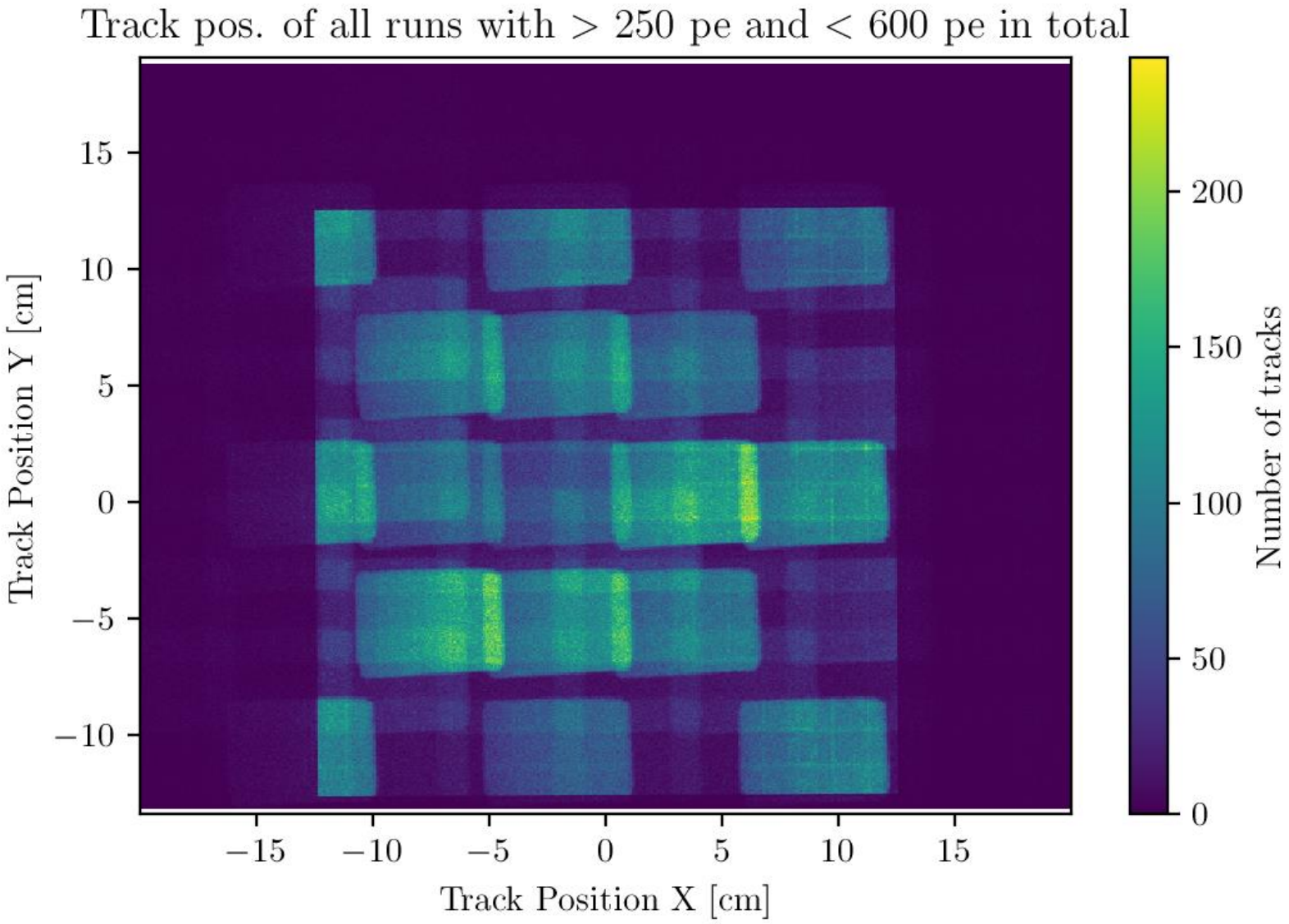






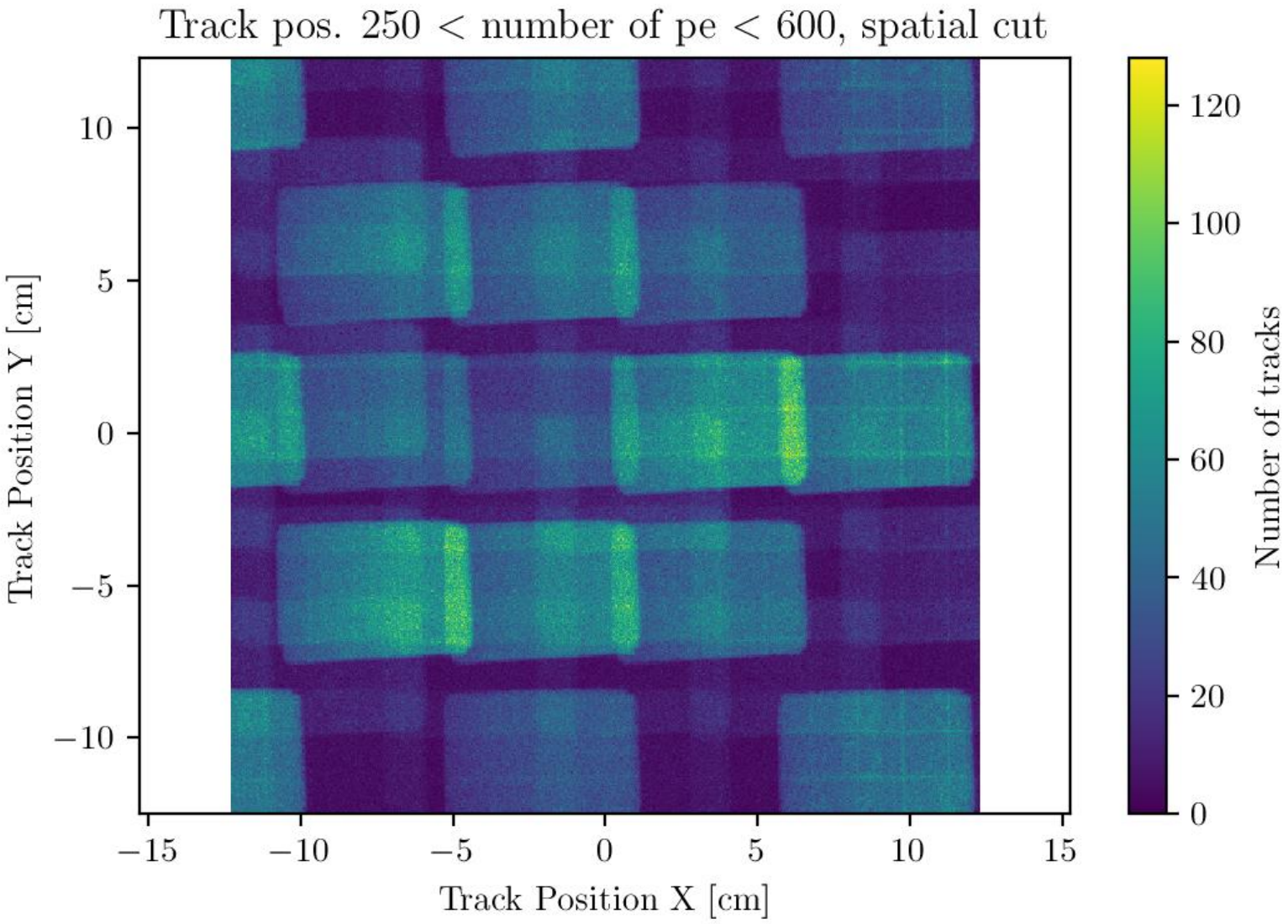
Analysis – Integrals

- Retain all events with a light yield > 250 pe/ whole detector (64 channels), i.e. 3.4 pe per channel
- Aim: remove outside events
- Outlines of the detector are visible



Analysis – Integrals

- Keep all events with more than 250 pe and less than 600 pe across the whole detector
- Aim: remove multiple MIP events
- Fibres visible



Analysis – Cuts

- Spatial cut on minimal and maximal values for x and y

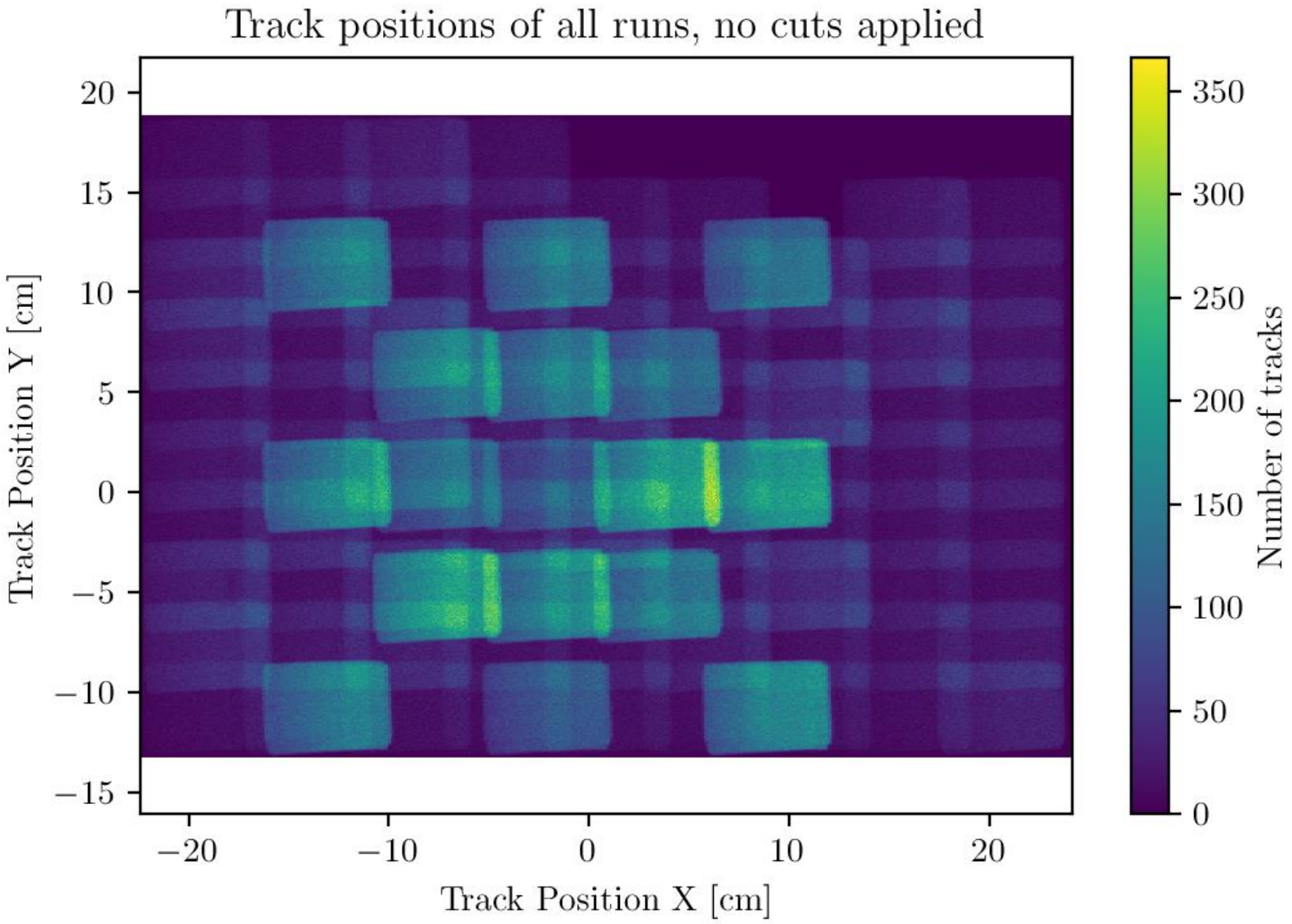
Outlook – Further Analysis

- Light yield as a function of the position of the detector
- Determine the spatial resolution
  - 2D reconstruction with a weighted mean/Poisson-Likelihood function/analytic fit function
- Determintation of detector efficiency

Thank you for listening

Setup at CERN – Silicon telescope

- View of the downstream tracking stations



Measurements

- All available runs superimposed in one plot