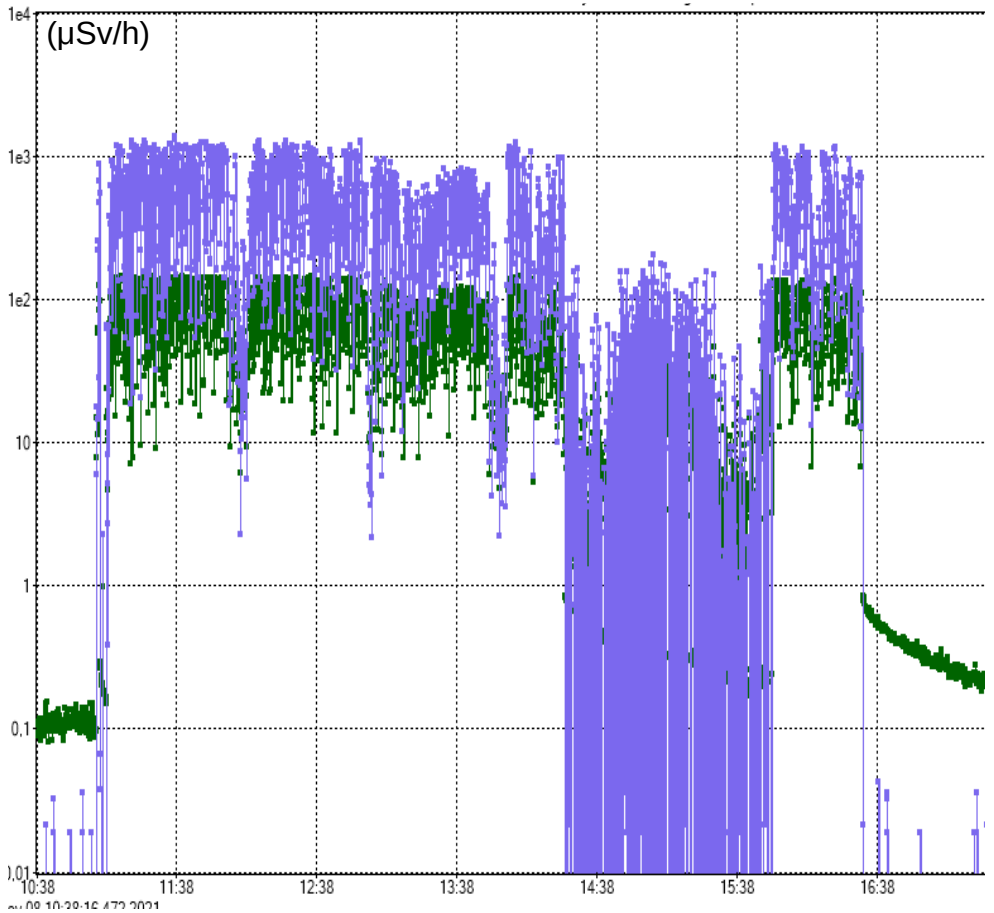
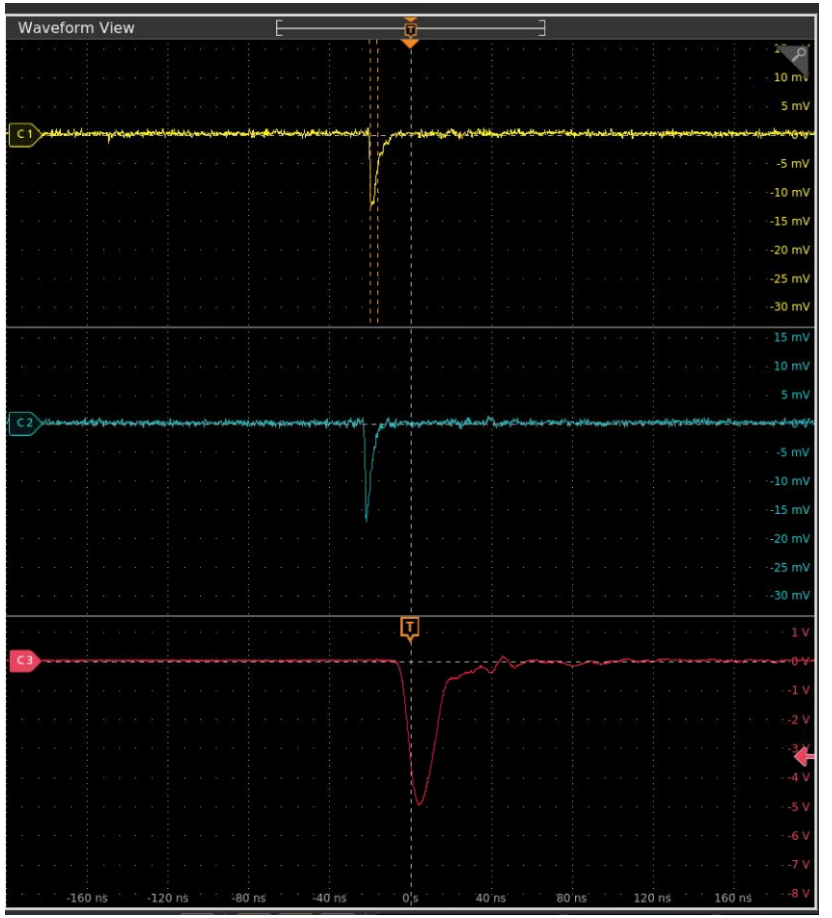
Unlimited Power: The DESY R-Weg





HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

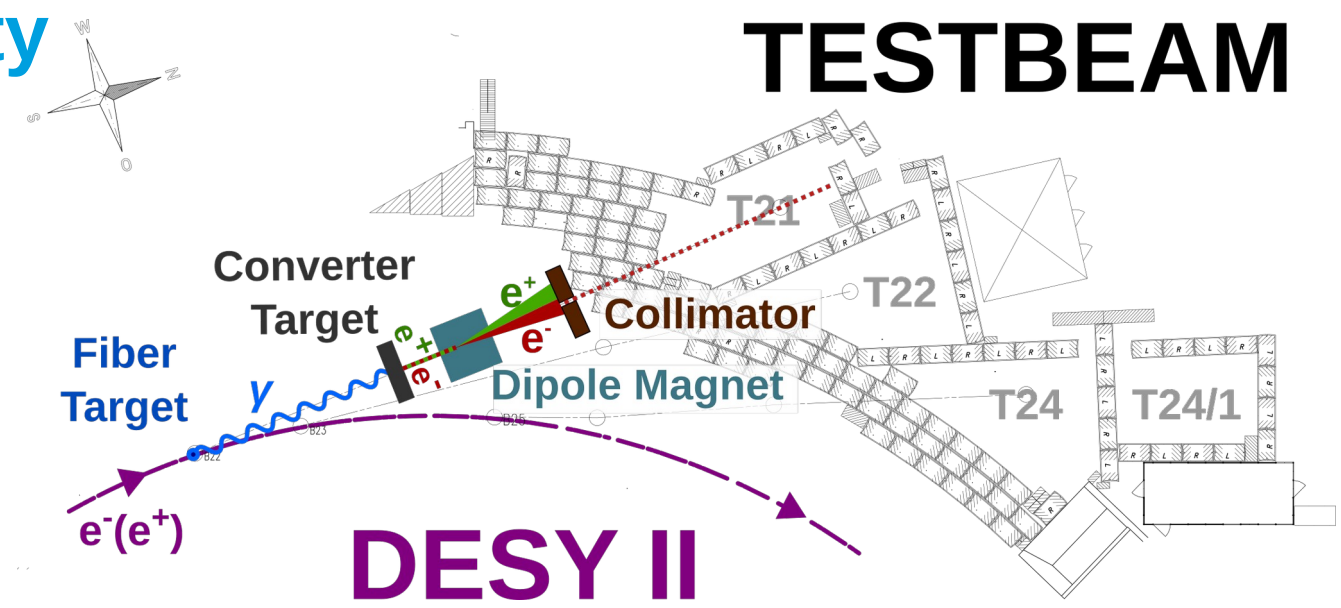
DESY TEST BEAM.

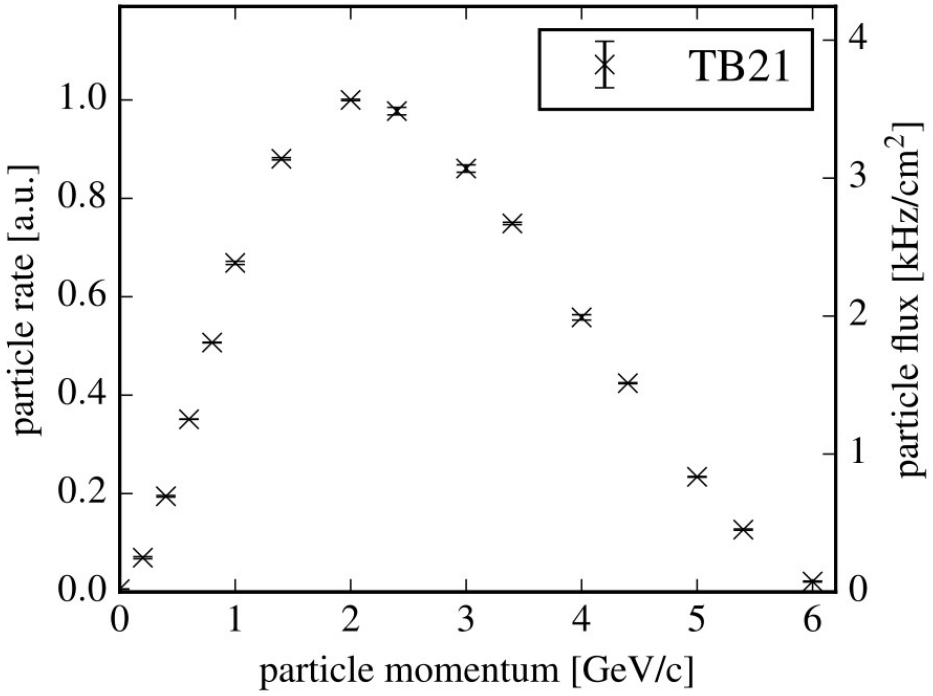
STRIDENAS.

DESY.

The DESY II Test Beam Facility

- Split into three separate beamlines (T21, T22 and T24).
- Parasitic operation via double conversion scheme.
- Energy choosable on the fly between 1 and 6 GeV.
- Rates of up to a few tens of kHz.





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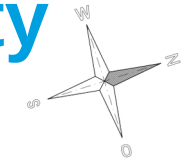

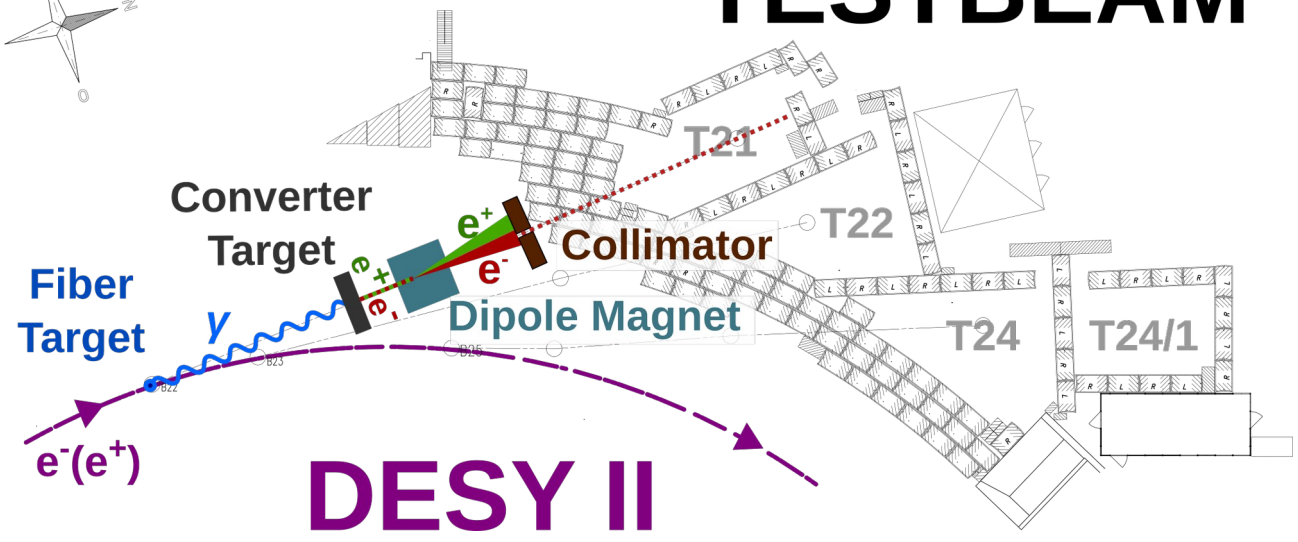

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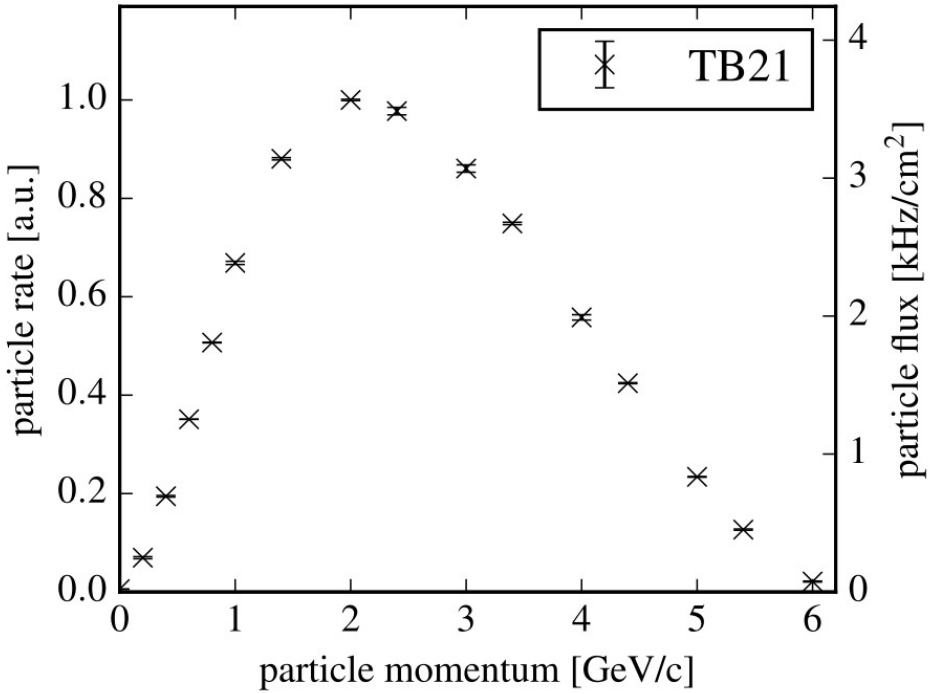

The R-Weg

- Extraction Beamline from DESY II used to fill DORIS.

- After a long list of feasibility tests equipped in 2021 with:
  - Shutter.
  - Interlock.
  - Power.
  - Network.
  - Pandoras.
  - Labyrinth.

  For use as a test area.

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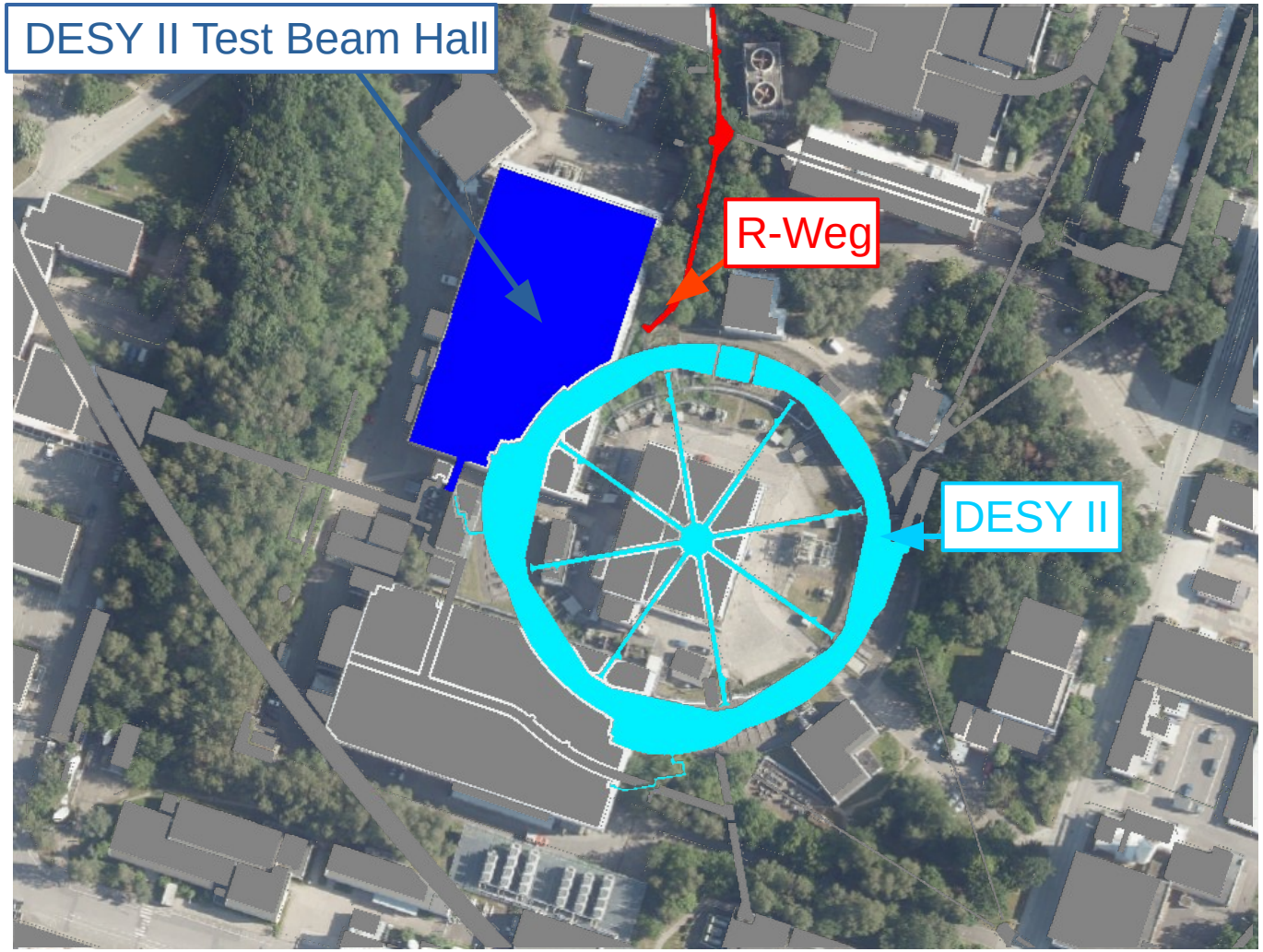
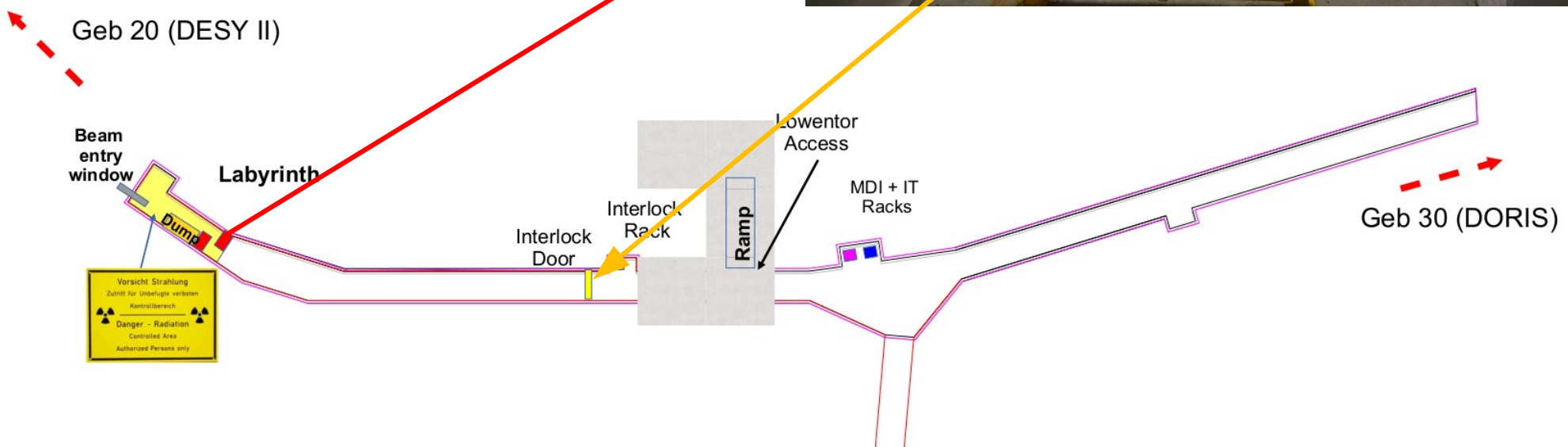


The R-Weg Tunnel

- Radiation Concerns:
  - Interlock door is located far downstream of actual area to reduce radiation.
  - Addition of a labyrinth
  - Anything within the Labyrinth is considered a controlled area.



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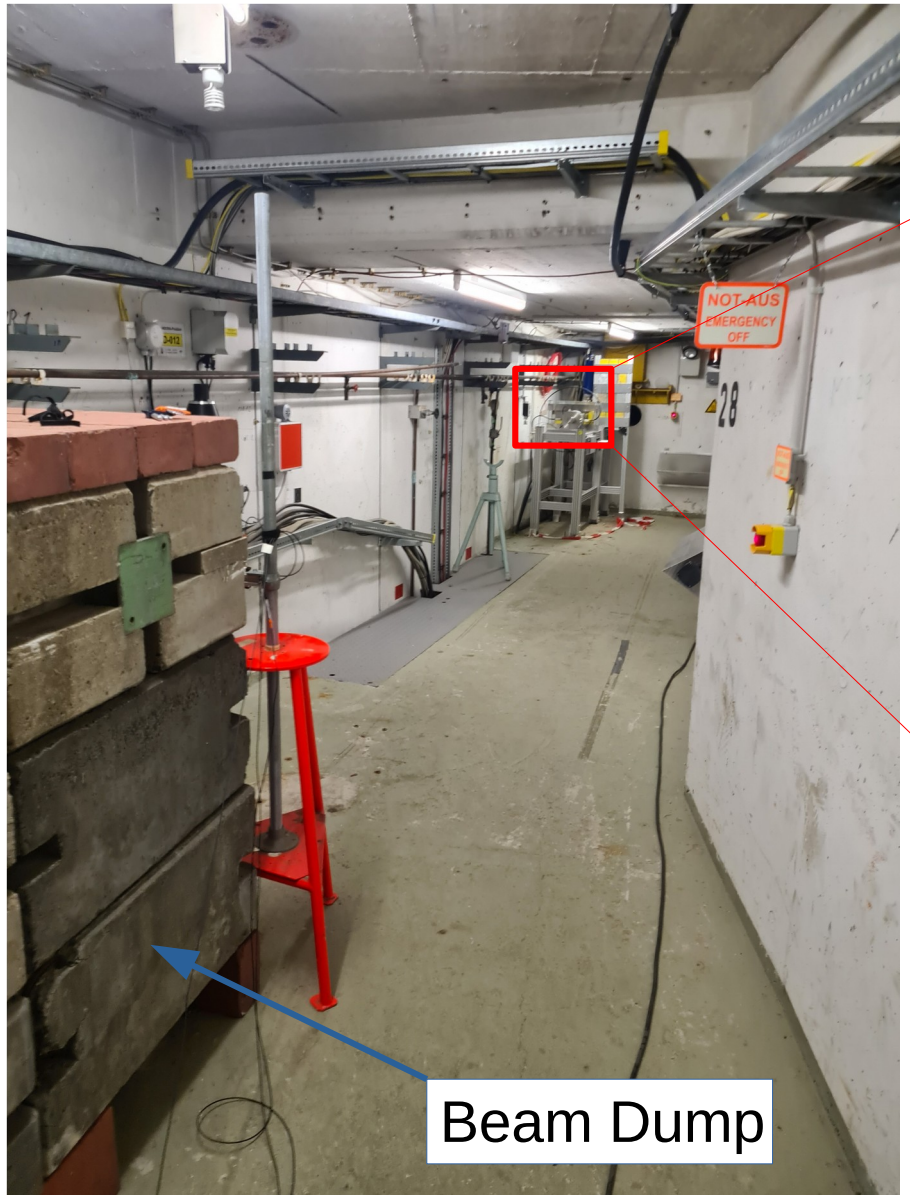
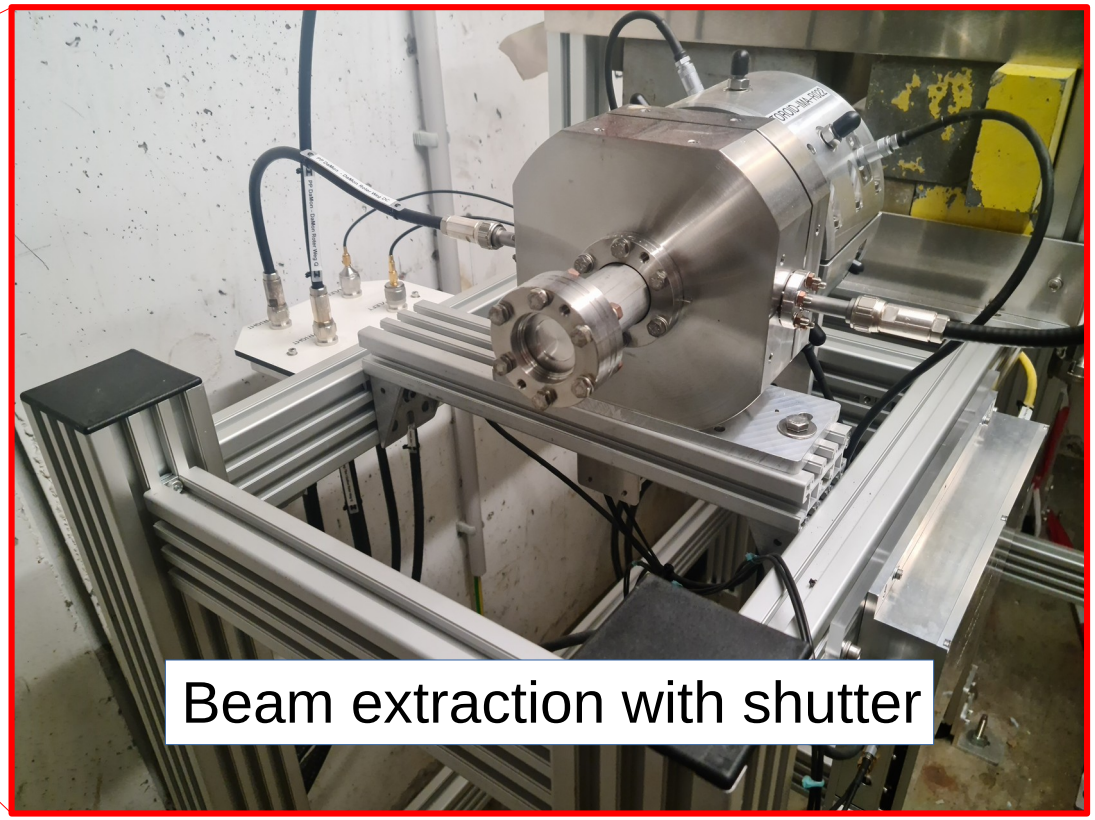
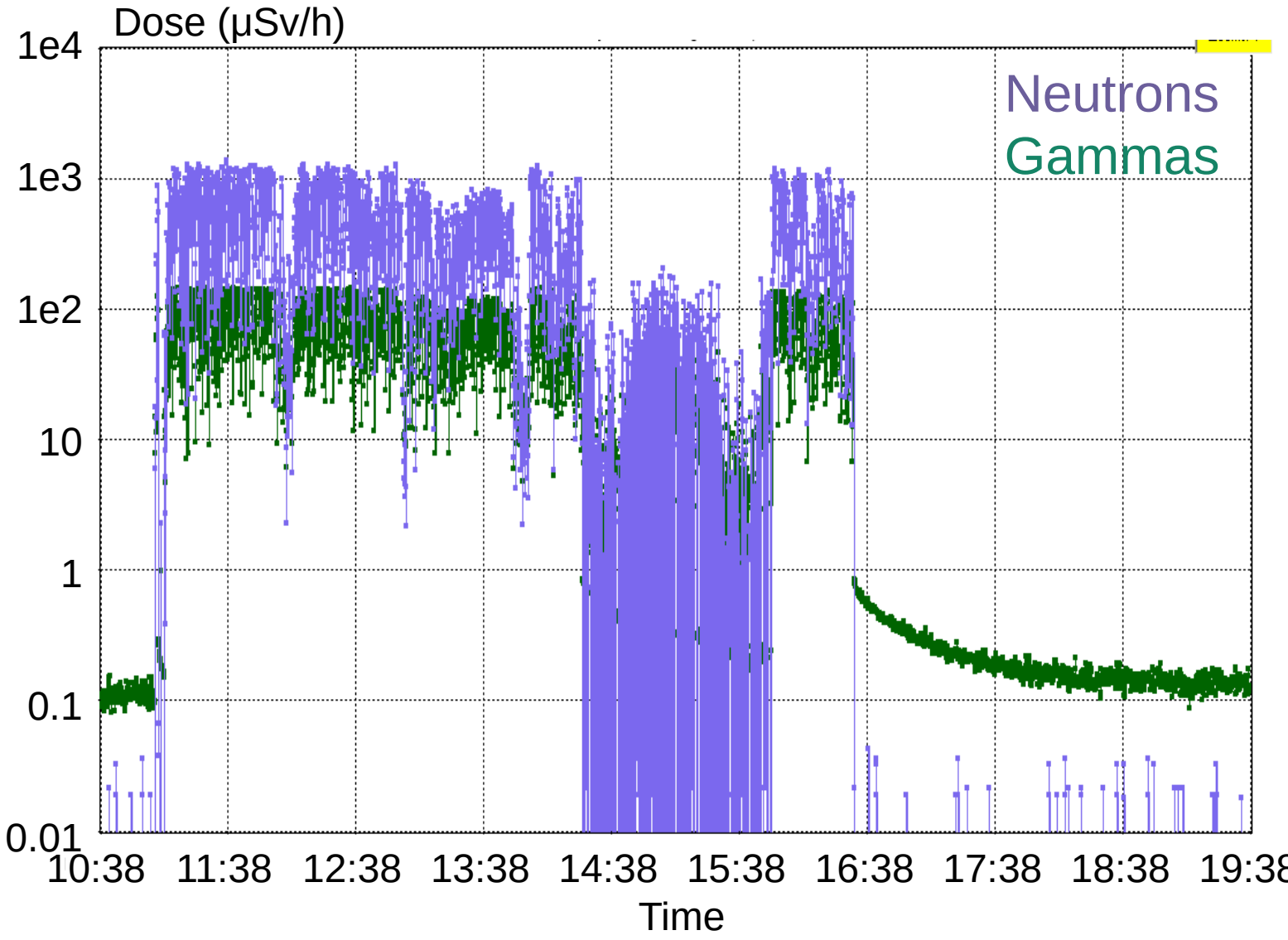




R-Weg Operation

- Significant doses within R-weg during operation.
  - Survey on activity needs to be conducted after R-Weg Operation upon first entry.
- Entirely separate safety lecture.

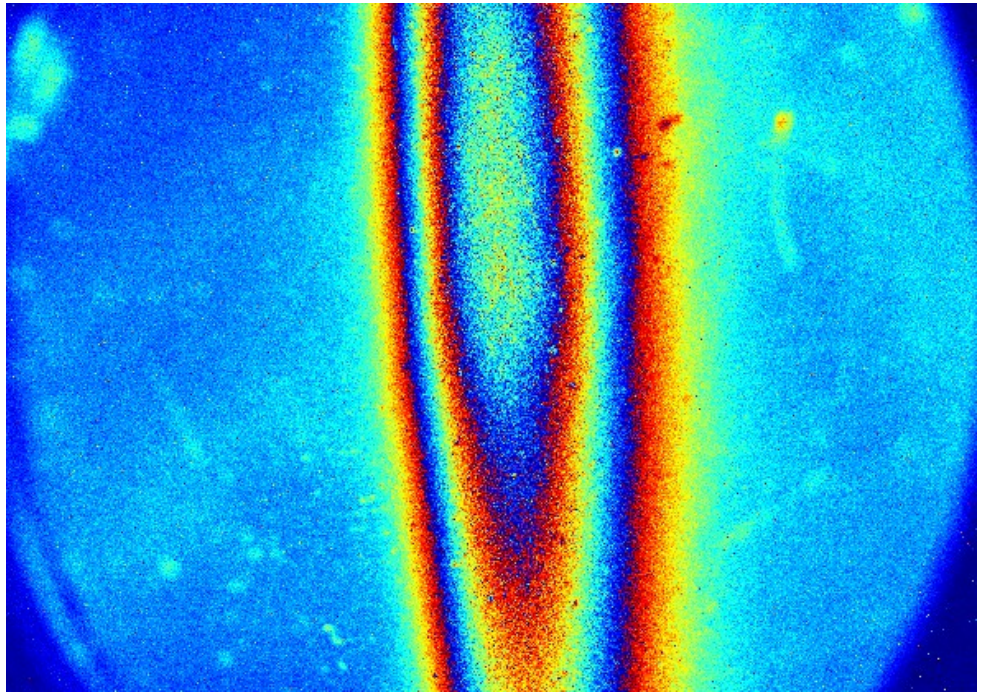


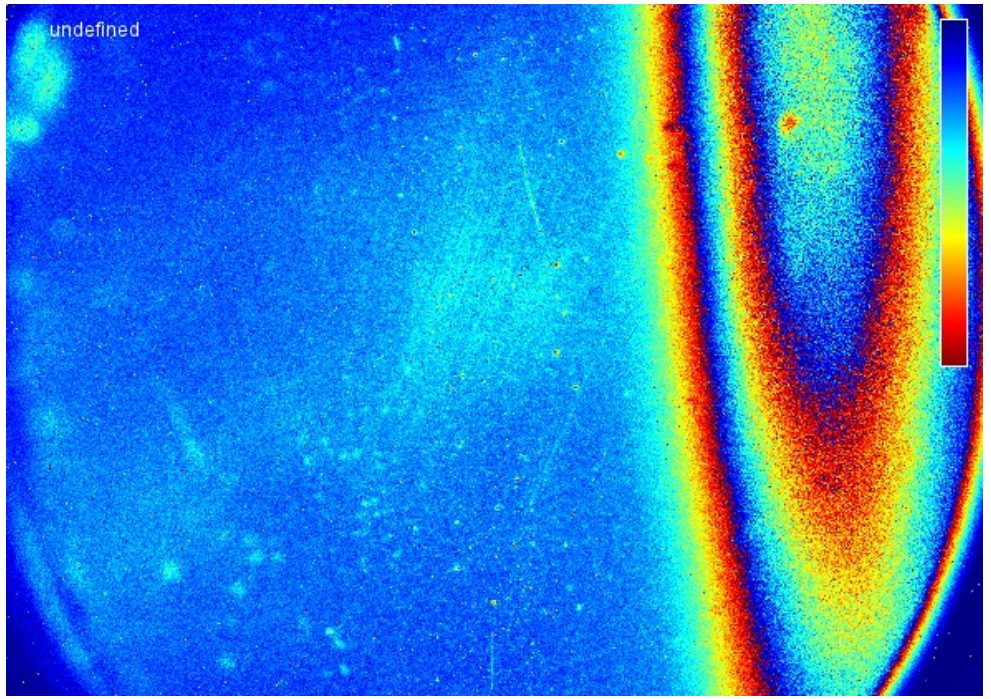
R-Weg Operation

- Large fluctuations in the beam position.
- PETRA III operation stability concerns .

  → Beam only for a few hours per day.
- Not possible for BKR to activate R-weg as there is no clear interface yet.

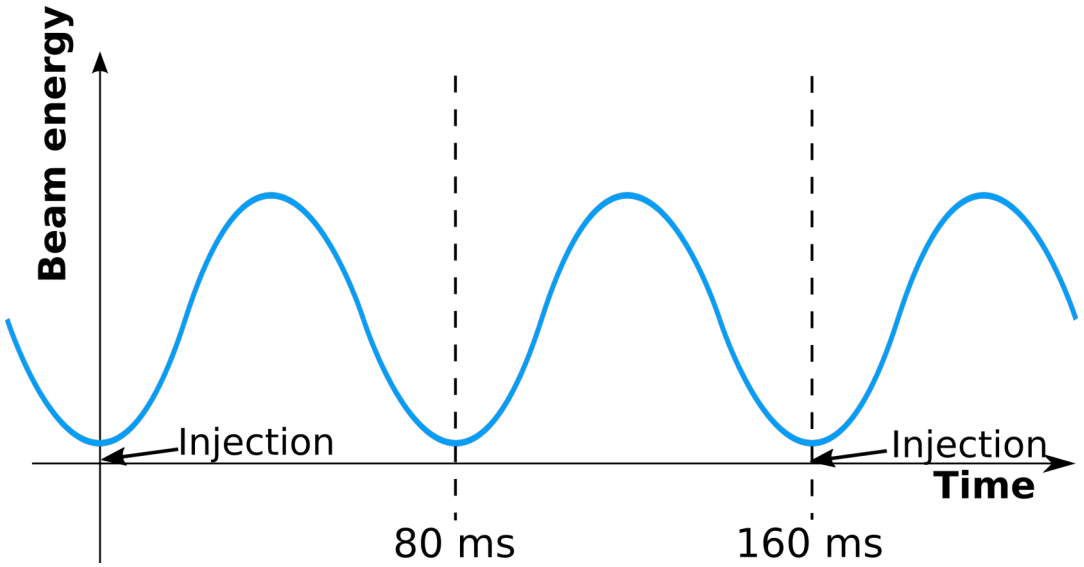
  → Only experts can activate it.





The R-Weg in Numbers

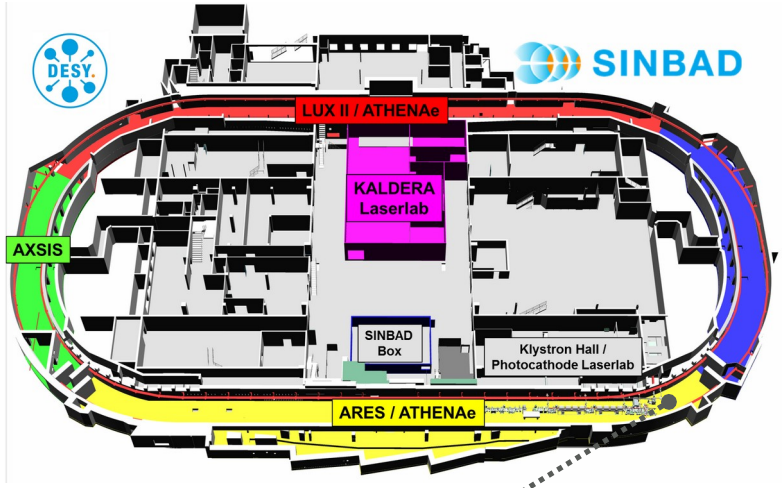
- The entire DESY beam is dumped into the R-weg.
- Full DESY particle count extracted into R-weg:
  - Min: $1x10^{8}$ electrons
  - Max: $3x10^{10}$ electrons
- Length of extraction = Bunch length.
  - < 100 ps
- Repetition rate of either 6.25 or 12.5 Hz.
- Beam energy between 0.4 GeV and 6.3 GeV.



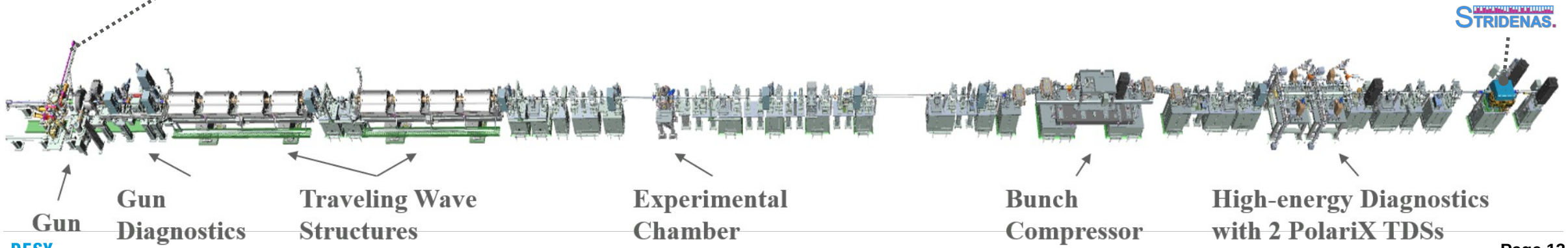
Normal Beamline

R-Weg Beamline

SINBAD – ARES overview



- SINBAD provides infrastructure for **accelerator R&D** and is located in the old DORIS hall.
- One of the experiments at SINBAD is the **ARES** linear accelerator.
  - **ARES** aims to deliver **reliable** and **well-characterized** electron beams with **sub-fs duration**.
    → Ideally suited for injection into novel **high-gradient structures**.
- Low charge throughput expected → difficult to detect with conventional diagnostics.

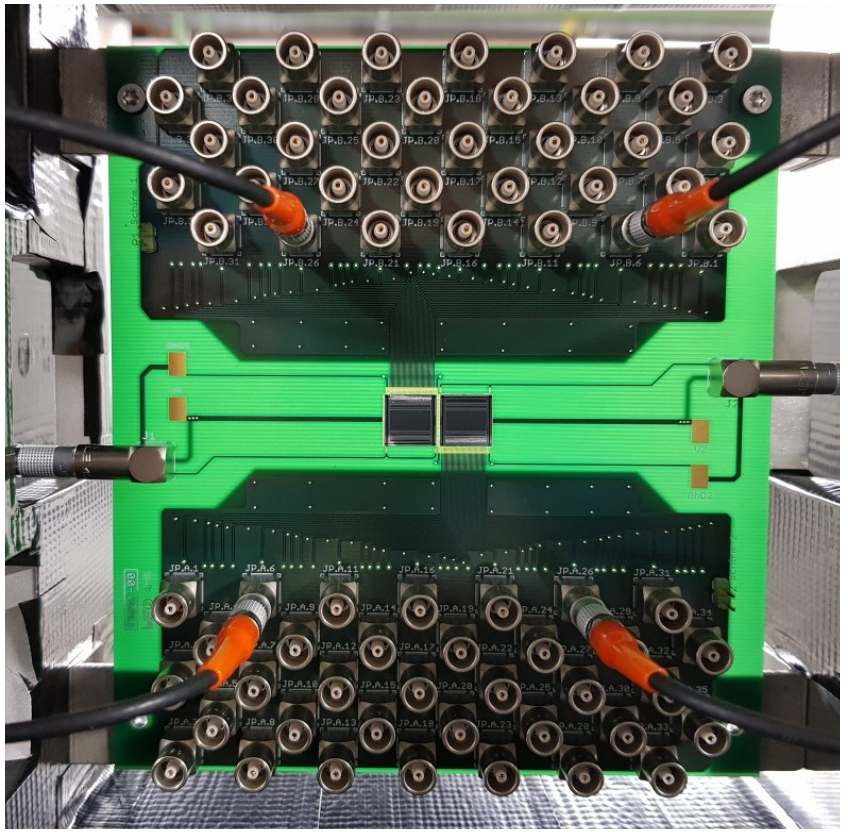


STRIDENAS overview

- DESY strategy fund for a collaboration between FH-ATLAS and MPY-1.
- Aims at detecting electron bunches with < 1 pC charge.
- STRIDENAS prototype designed based on ATLAS mini sensors.
- Expected to get between 10 and 234000 electrons per 8mm x 224µm (3 combined strips)

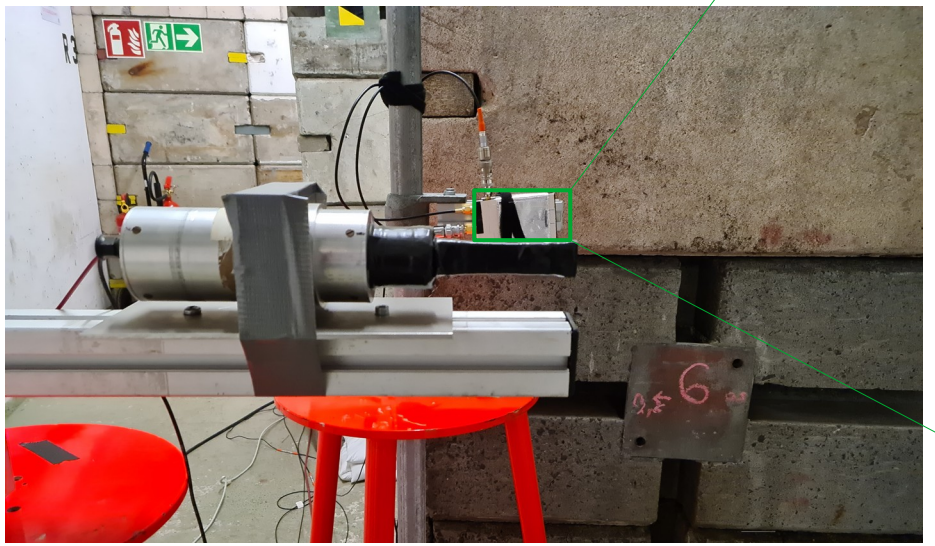
  → Readout needs to be able to handle wide range of accelerator intensities.

  → Possible plasma effect within silicon at high electron density might bring sensor into saturation



STRIDENAS R-Weg Setup

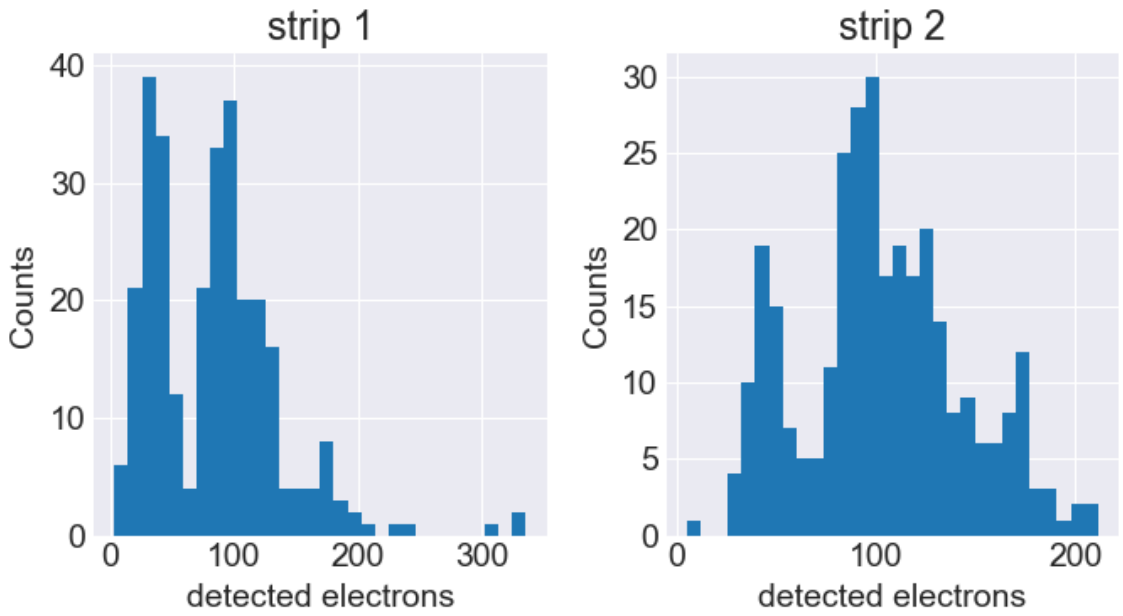
- Single ATLAS12 Mini with 2 strips connected.
- Direct readout of analog signal via oscilloscope.
- Device ~10cm away from beam center.
- Trigger scintillator placed in front to verify signal:
  - Typical working point -1000V.
  - Operated at -350V as otherwise peaks go beyond range of Oscilloscope.

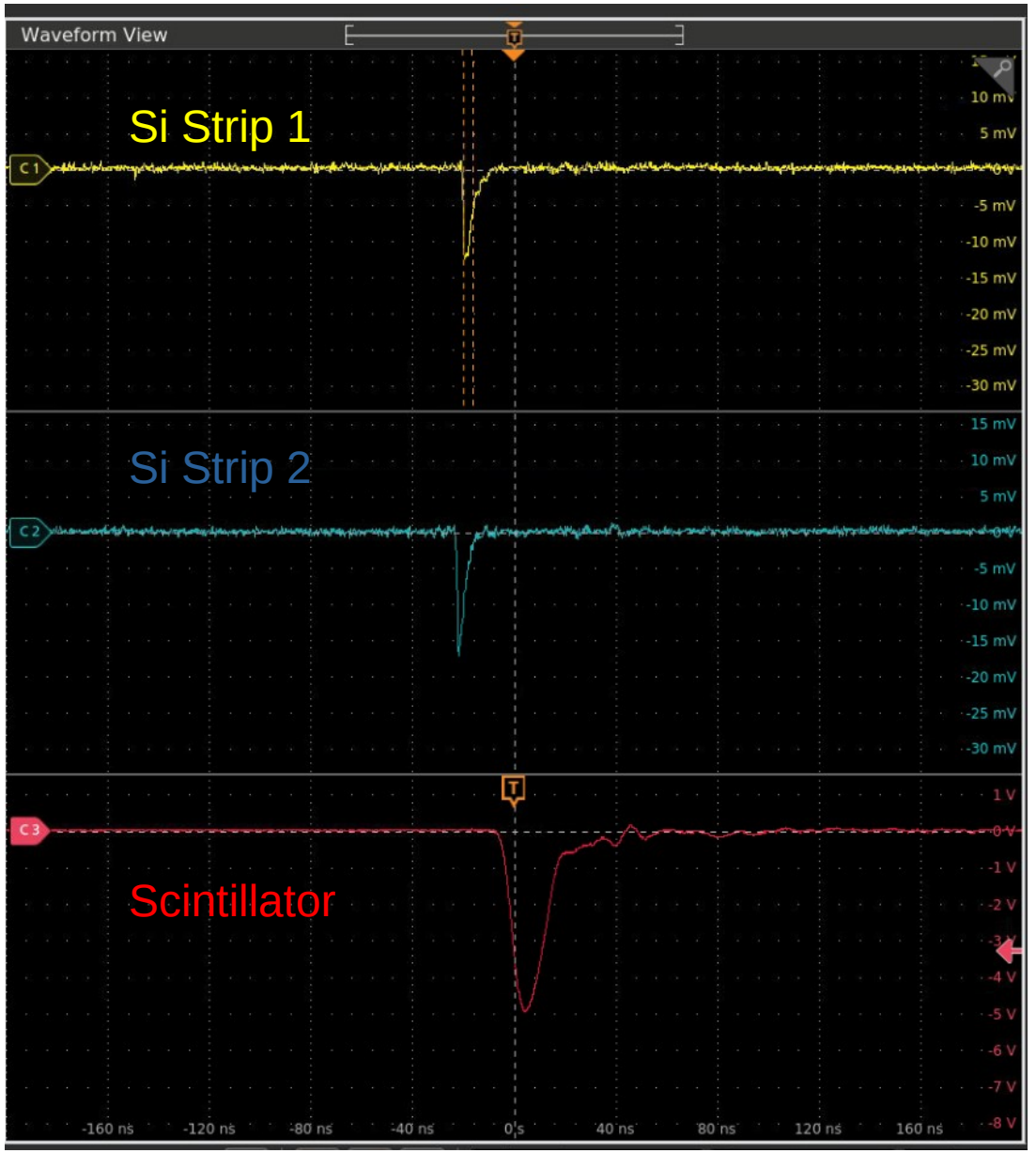


STRIDENAS Results

- Unamplifiefed analog pulses visible on the oscilloscope.
- Wide pulse range detected

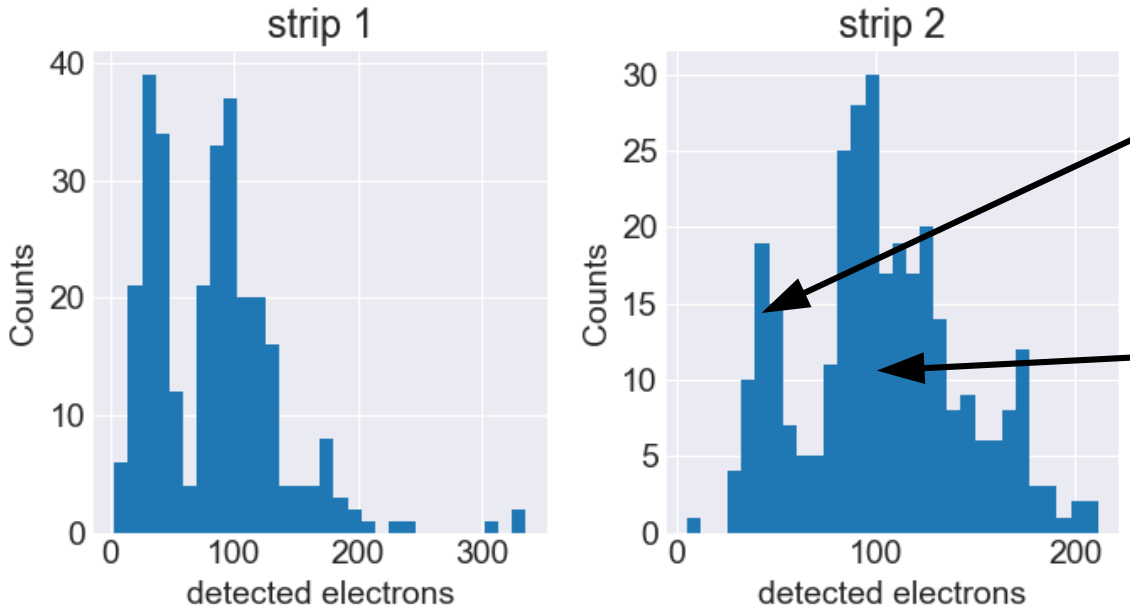
  → Up to 300 electrons passed through the strips.





Double Peak Feature

- Large variation in parts due to R-Weg beam instabilities.



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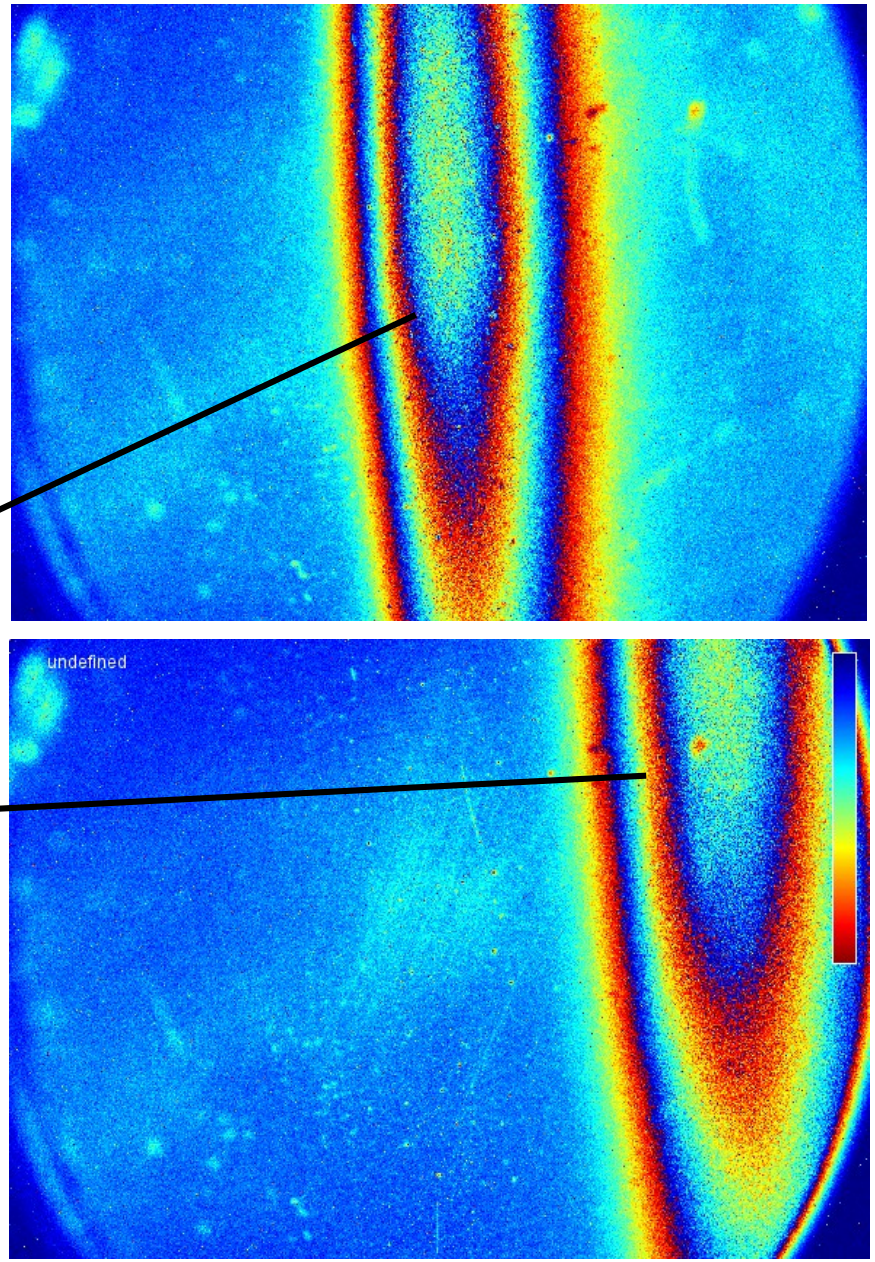
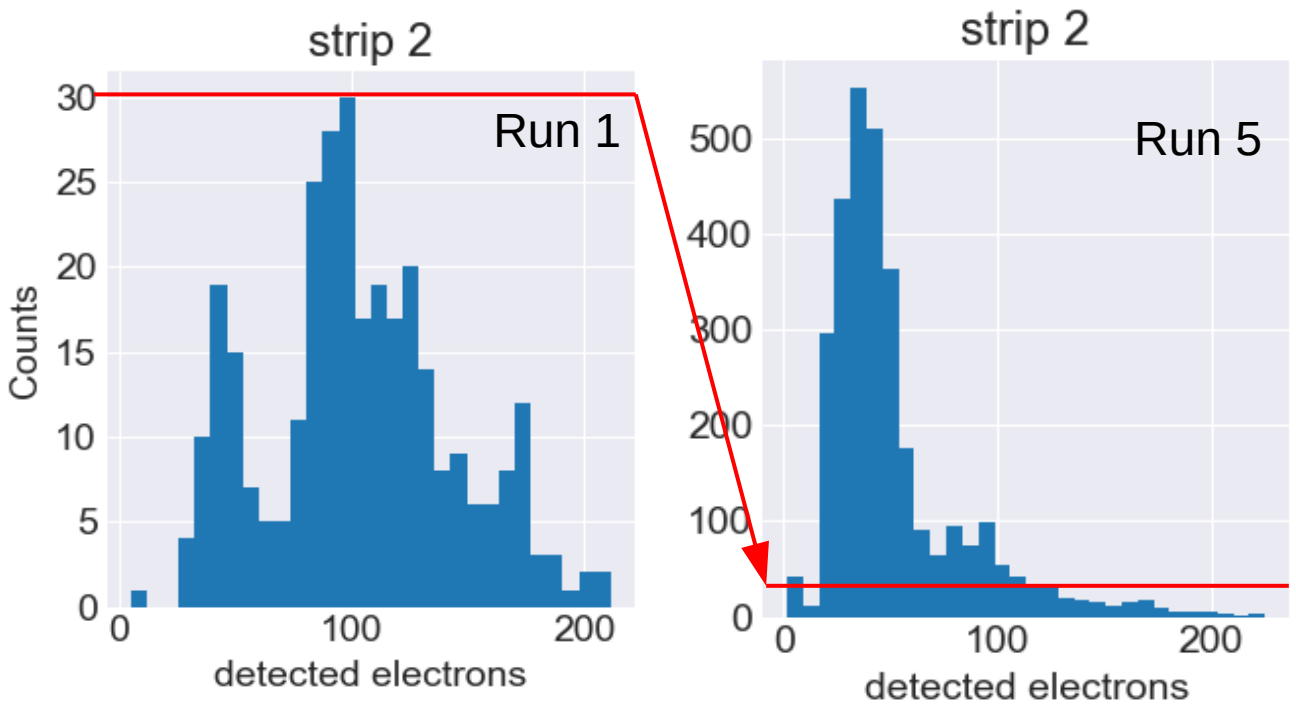
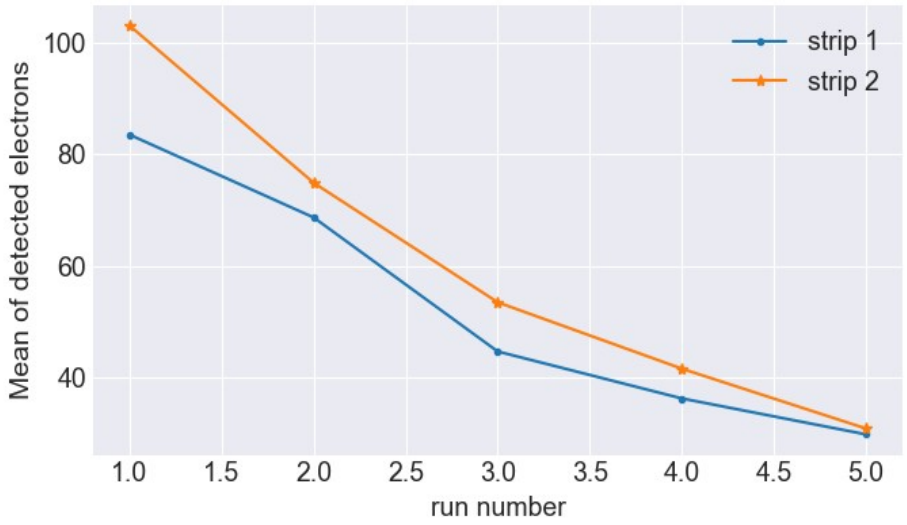
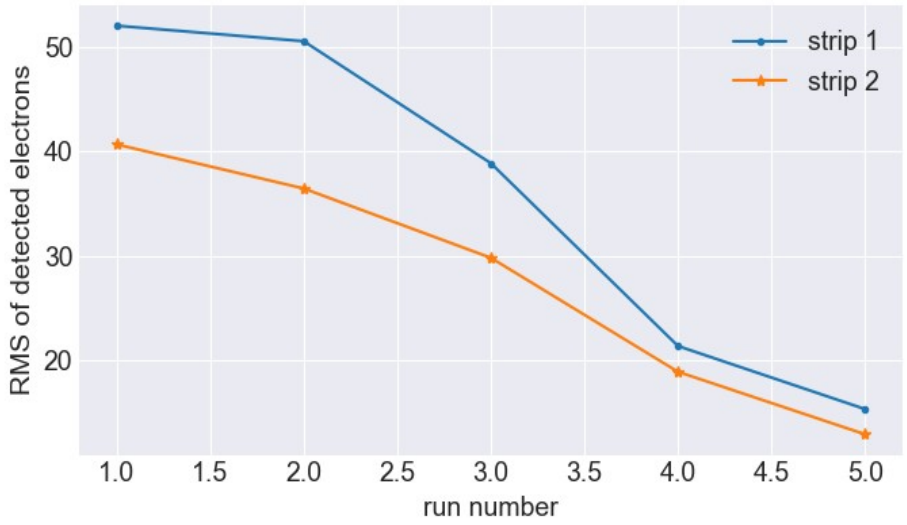


R-Weg Progress

- Instability mostly due to early operational issues
  - Size of secondary peak reduces with progressing run number.
  - Number of beam opportunities also increased over time.
    - 3h/week → 5h/day

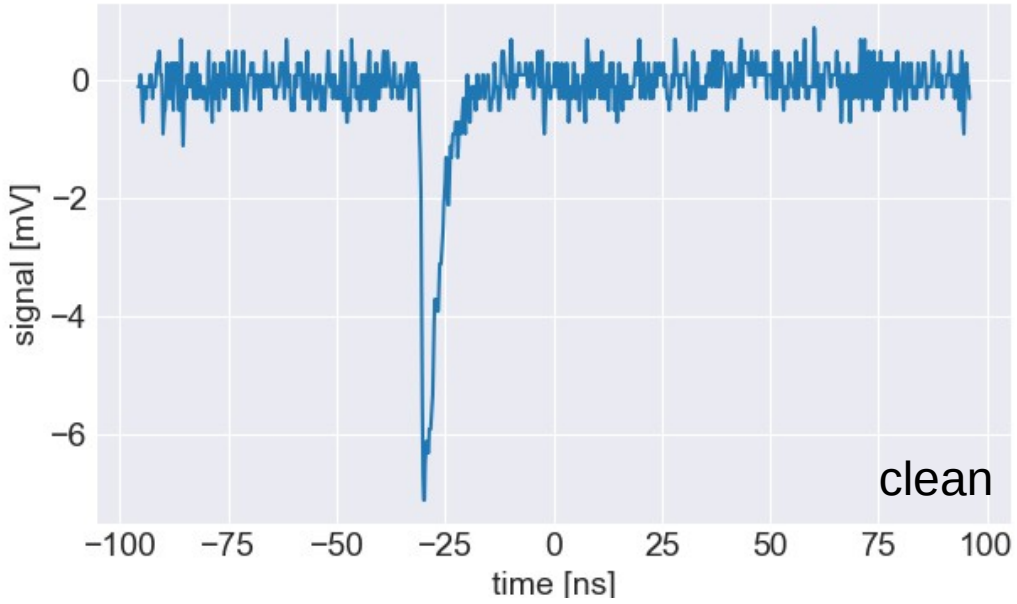


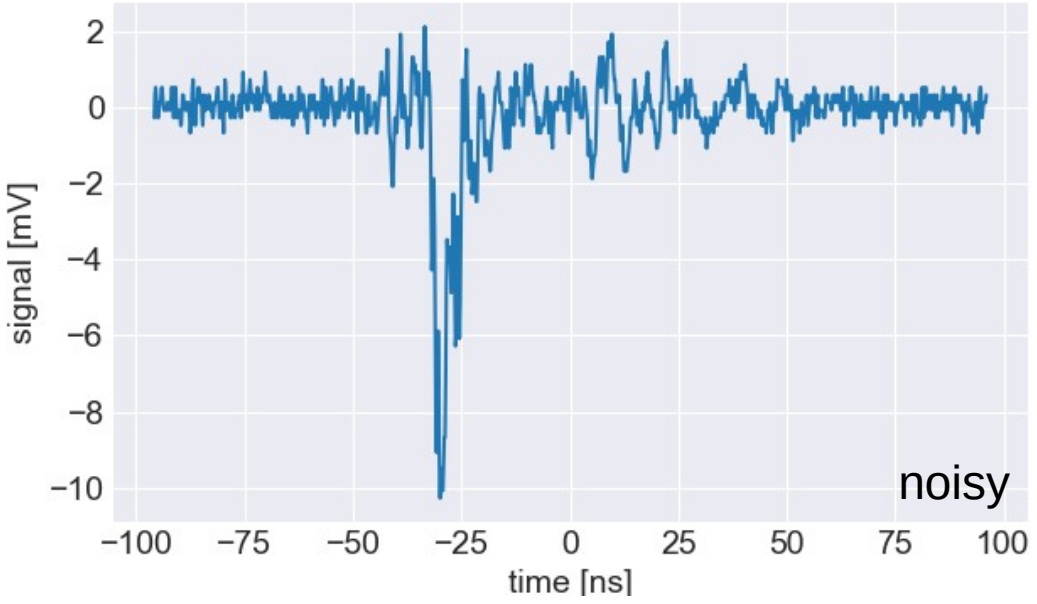




R-Weg Noise

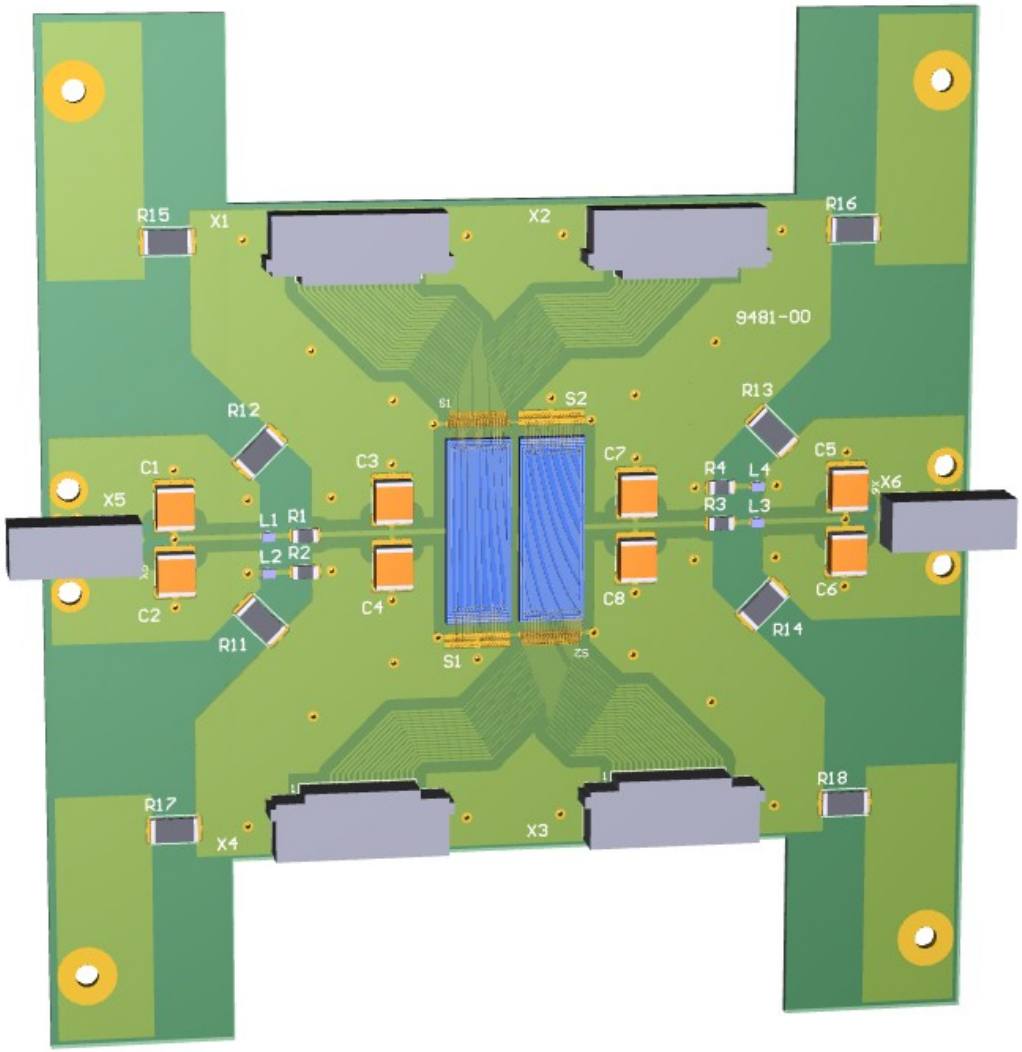
- Still significant noise present in the system.
- Only present in some of the pulses and only when beam is active.
- Could not correlate with obvious sources.
  - Such as High neutron flux due to interaction with the beam pipe.





STRIDENAS Next Steps

- Finalize results of current data sets.
- Install a movable stage inside the R-Weg.
  - Scan the sensor through the beam.
  - Check if we see saturation at some point due to plasma effect.
- Move from prototype to full channel system with QDC readout.



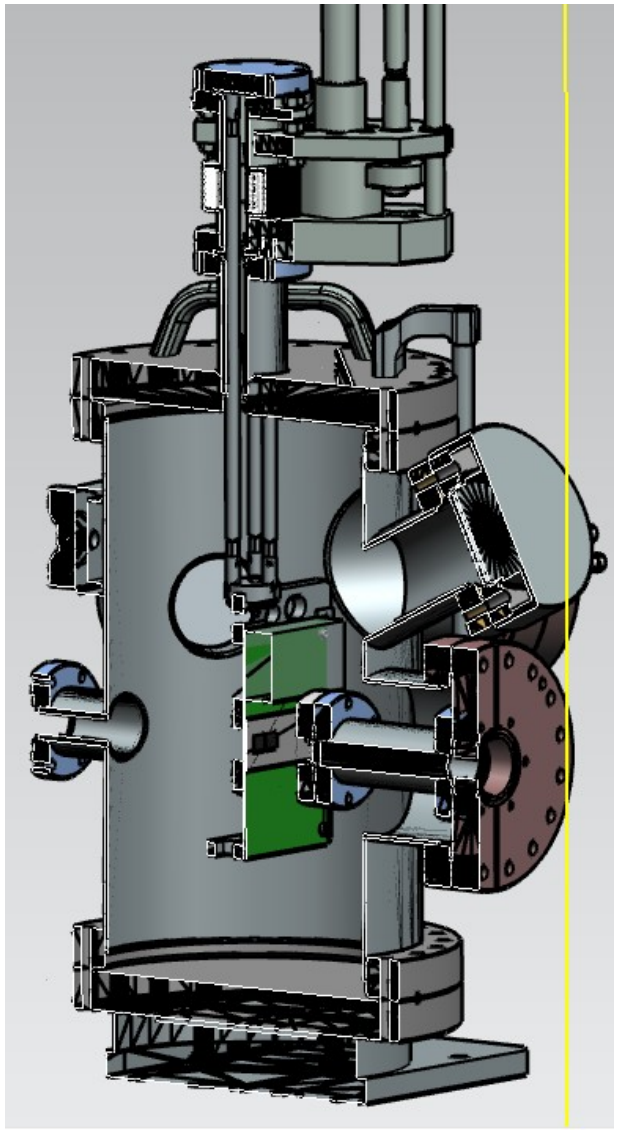
DeR-Weg in die Zukunft

- While the R-Weg is still in its early stages, the general functionality is already there.
- The next steps are to characterize the beam and find more applications for the beam line.
- Dohun Kim, a new PhD student will work on/with the R-Weg:
  - Beam characterization and FLUKA simulations.
  - Electron irradiation of silicon.

- Further potential upgrades of the R-Weg to widen the scope of potential tests are under consideration such as a low rate Hadron beam line.
- No clear timeline yet for potential user operation at the R-Weg.

BACKUP

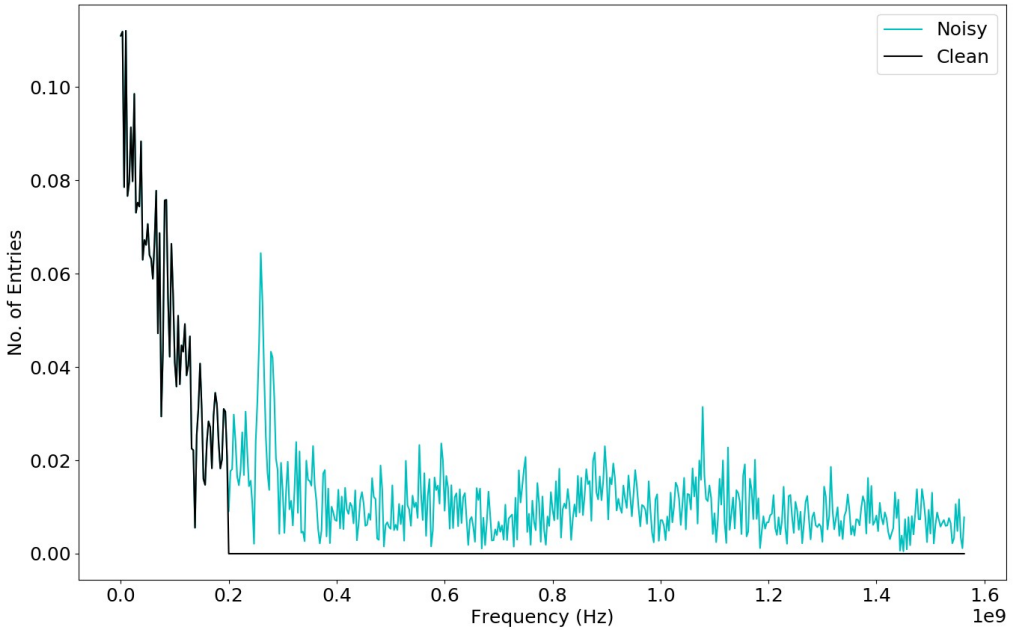
Installation of vacuum chamber for STRIDENAS tests at ARES

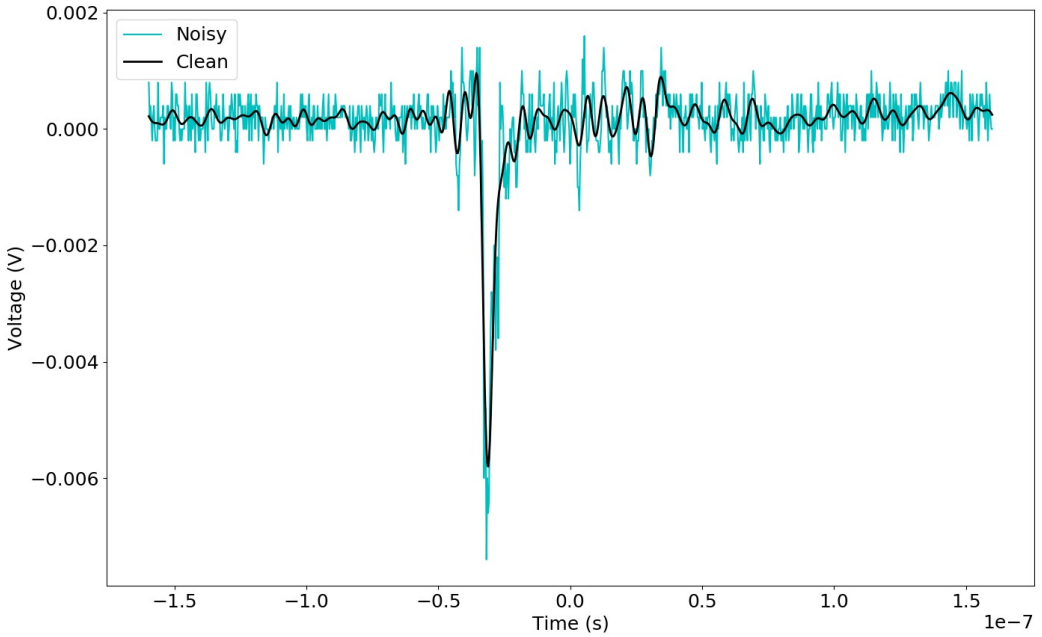


- STRIDENAS will be located at the spectrometer arm at ARES.
- Dedicated vacuum chamber and vacuum window will be used.
- Enabling detector tests and usage outside of the machine vacuum.
- Coordination of chamber and window design together with MVS.

Noise Filtering

- Still searching for the source of the noise.
- Going to replace current normal Lemo cables with better shielded SMA cables
- Currently attempting to include an FFT based noise filtering.
- Already removes some of the issues we see but is not at all optimized





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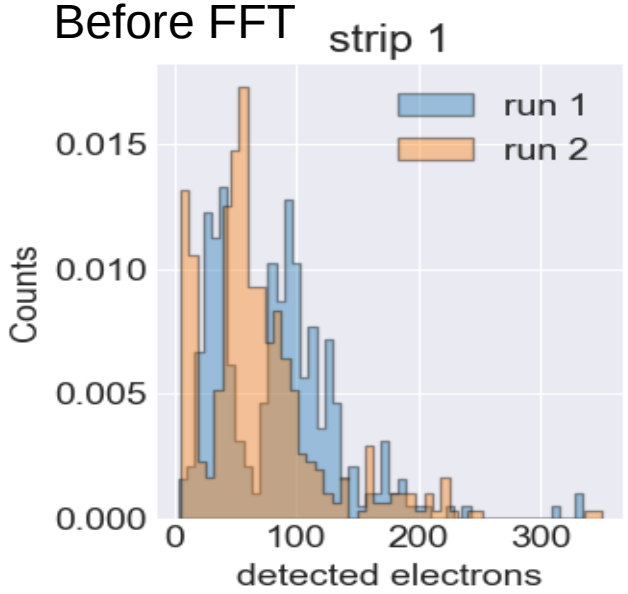
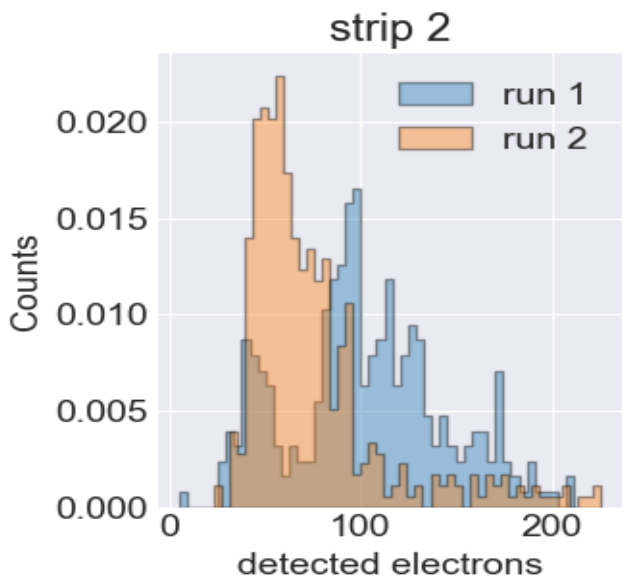
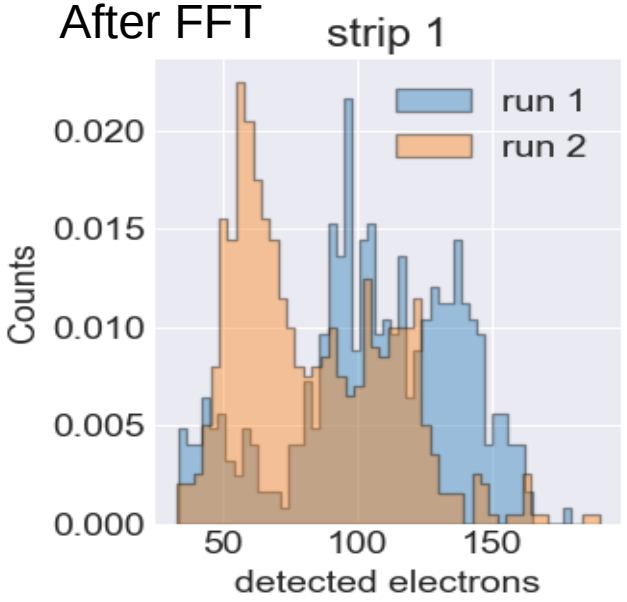
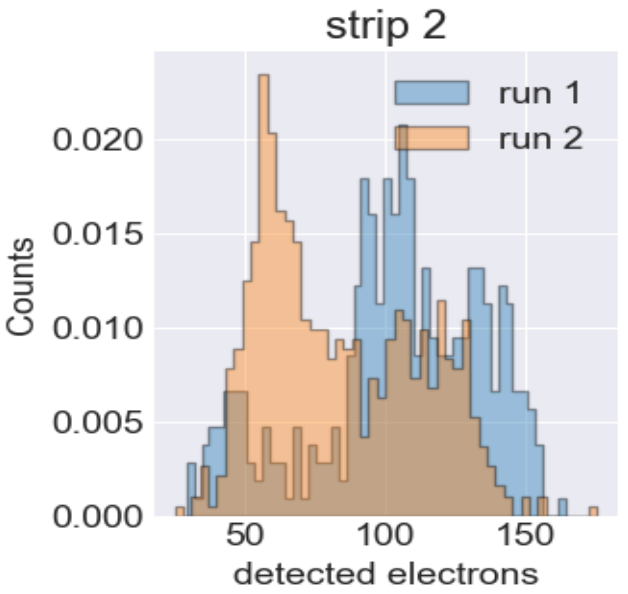




After FFT





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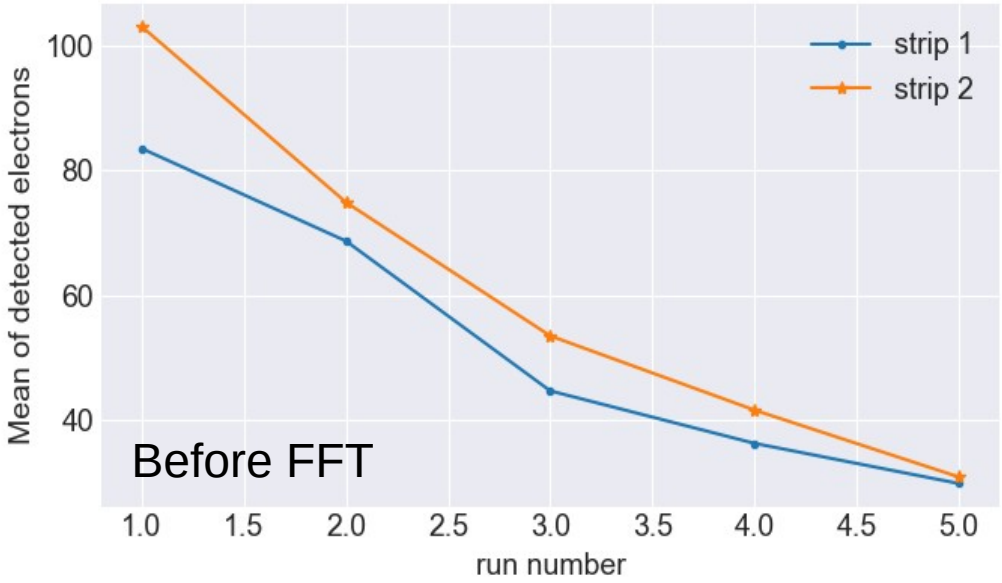

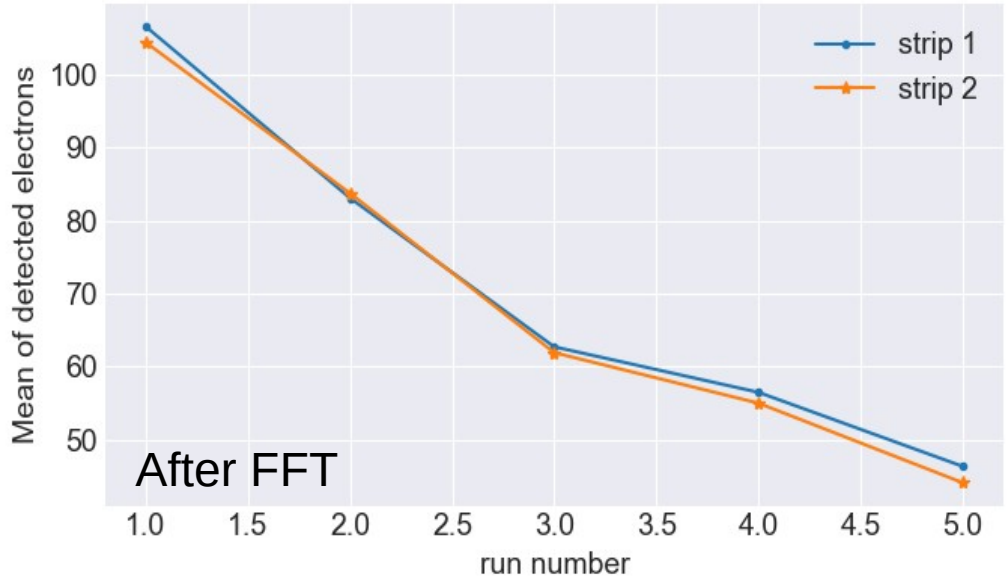

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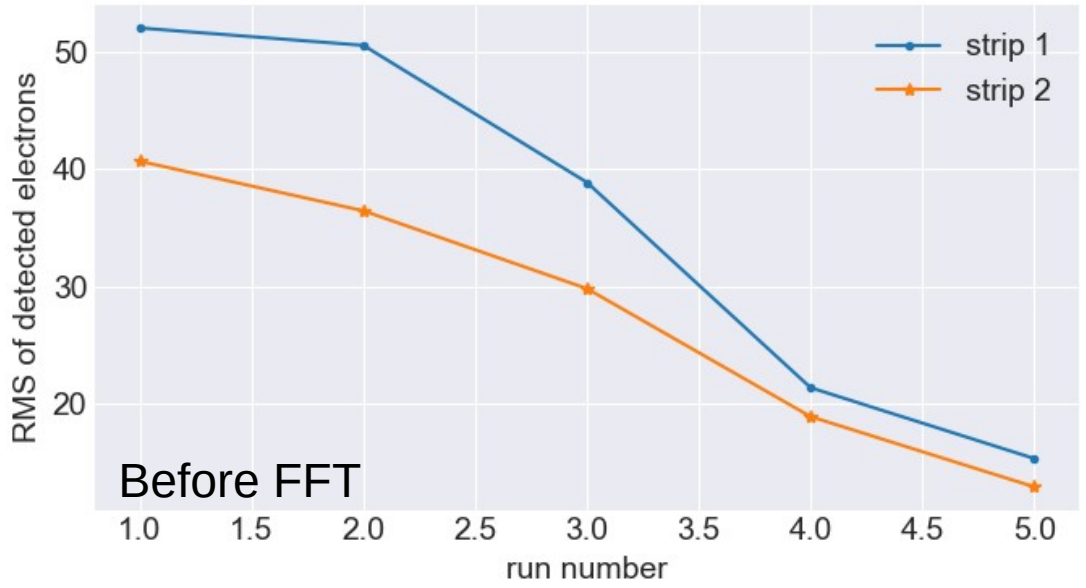

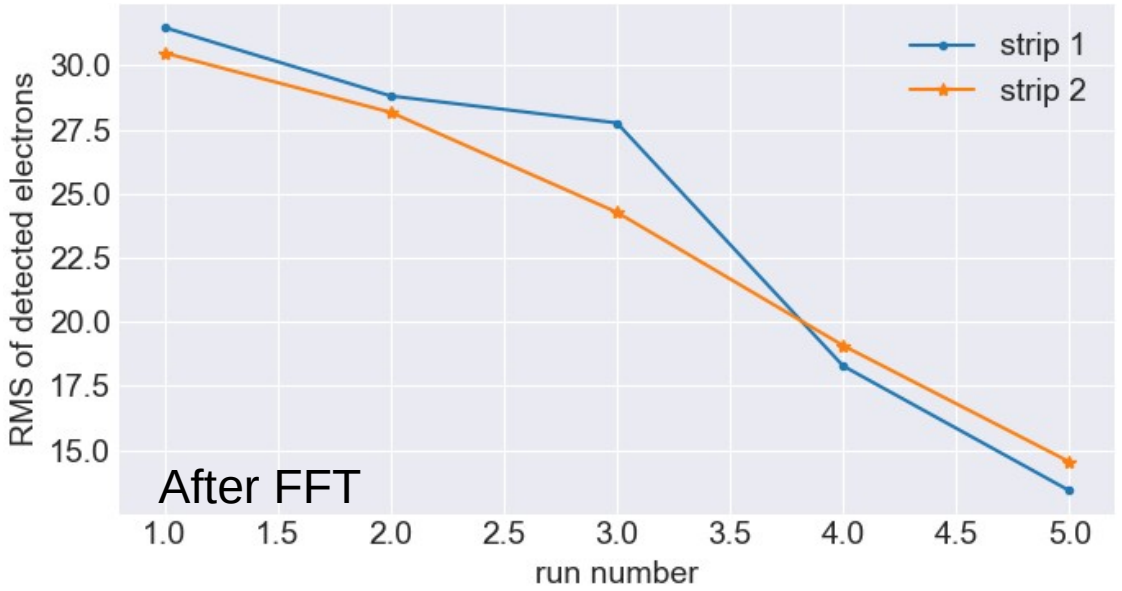

Large Signal