

# NP04 HVS operation

June 12<sup>th</sup>, 2024

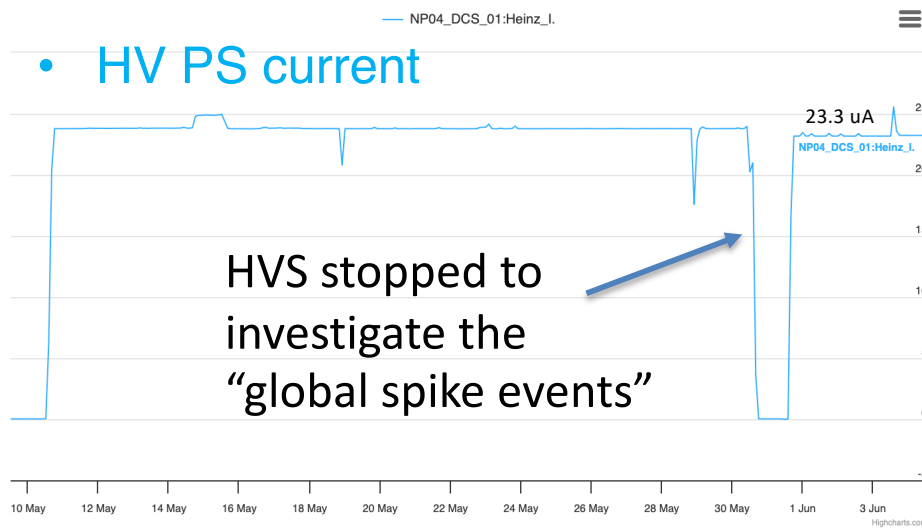
# NP04 HVS operation summary

- The HVS is up to the nominal voltage on the cathode ( $\sim 176$  kV) since May 10<sup>th</sup>
- In the first 20 days, the system up-time was  $> 99.9$  %
  - Two large voltage drops were observed and immediately recovered, but origin is unknown.
- An unexpected issue was detected by the DAQ on May 20<sup>th</sup> onward (see dedicated talk):
  - Events with synchronous signal peaks followed by ringing tail on ALL APAs
  - Stable rate  $\sim 1$  Hz, measured and monitored with dedicated trigger based on TPG.
- HVS was stopped for 1 day to investigate the issue on May 30<sup>th</sup>.
- After restarting and during 5 days:
  - two long lasting anomalous events recorded and extinguished
- Since June 3<sup>rd</sup>, very stable and quiet HVS operation @ 176 kV
  - Few current blips (6/day, lasting less than a second) with no voltage drop
  - Uptime  $>99.99\%$
  - No streamer-like events recorded so far

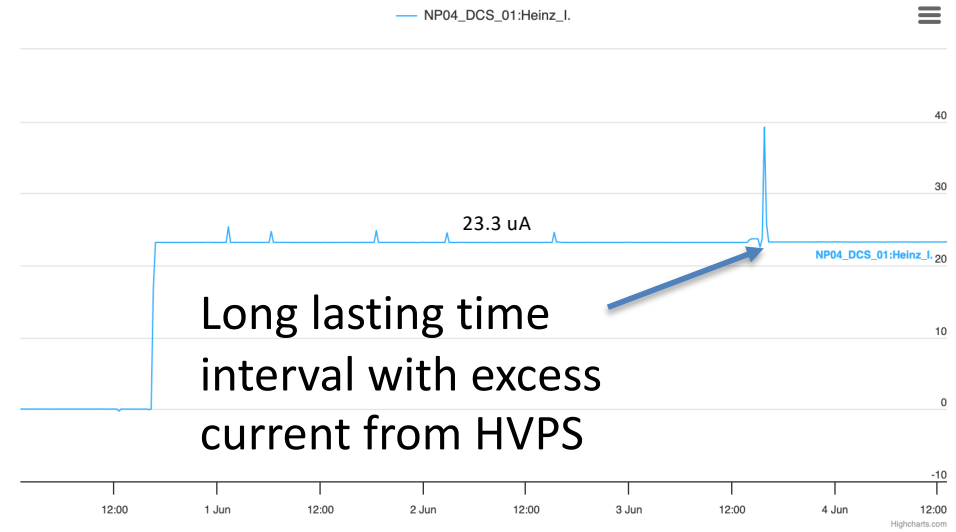
# NP04 HVS stability

- 25 days operation

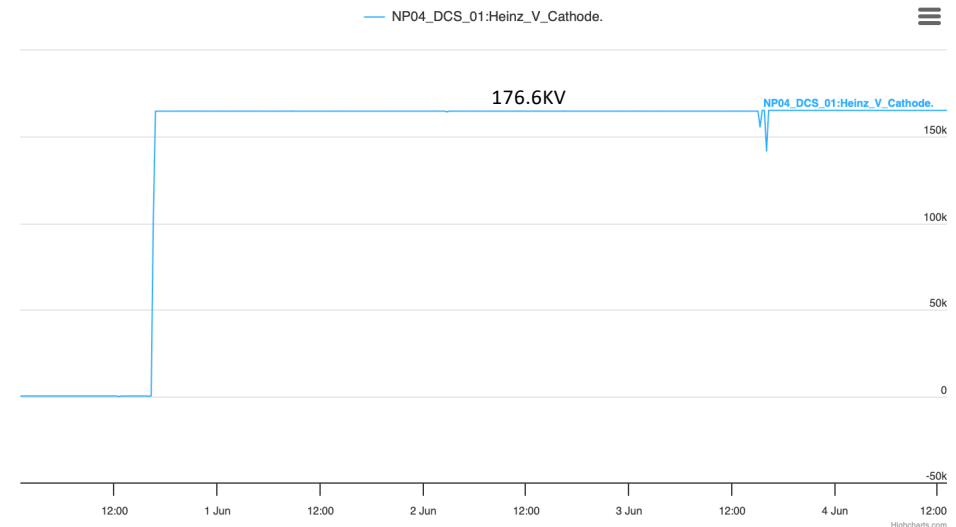
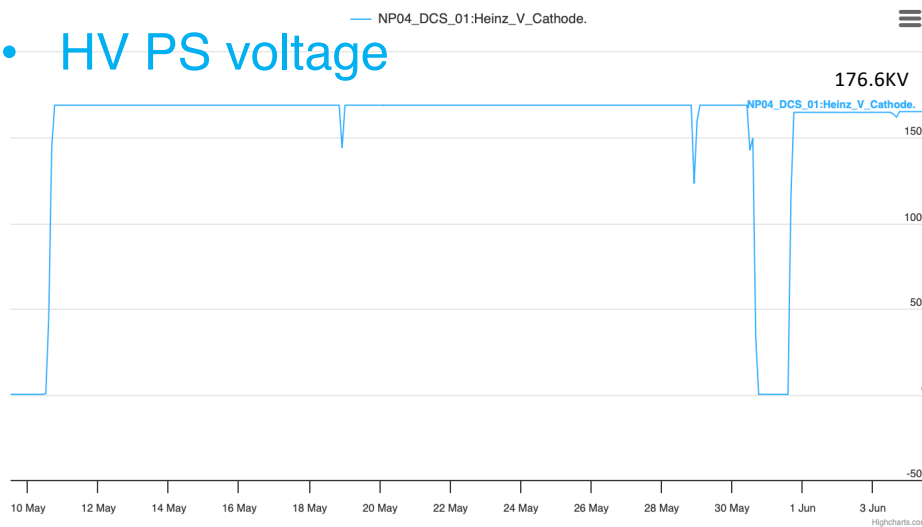
- HV PS current



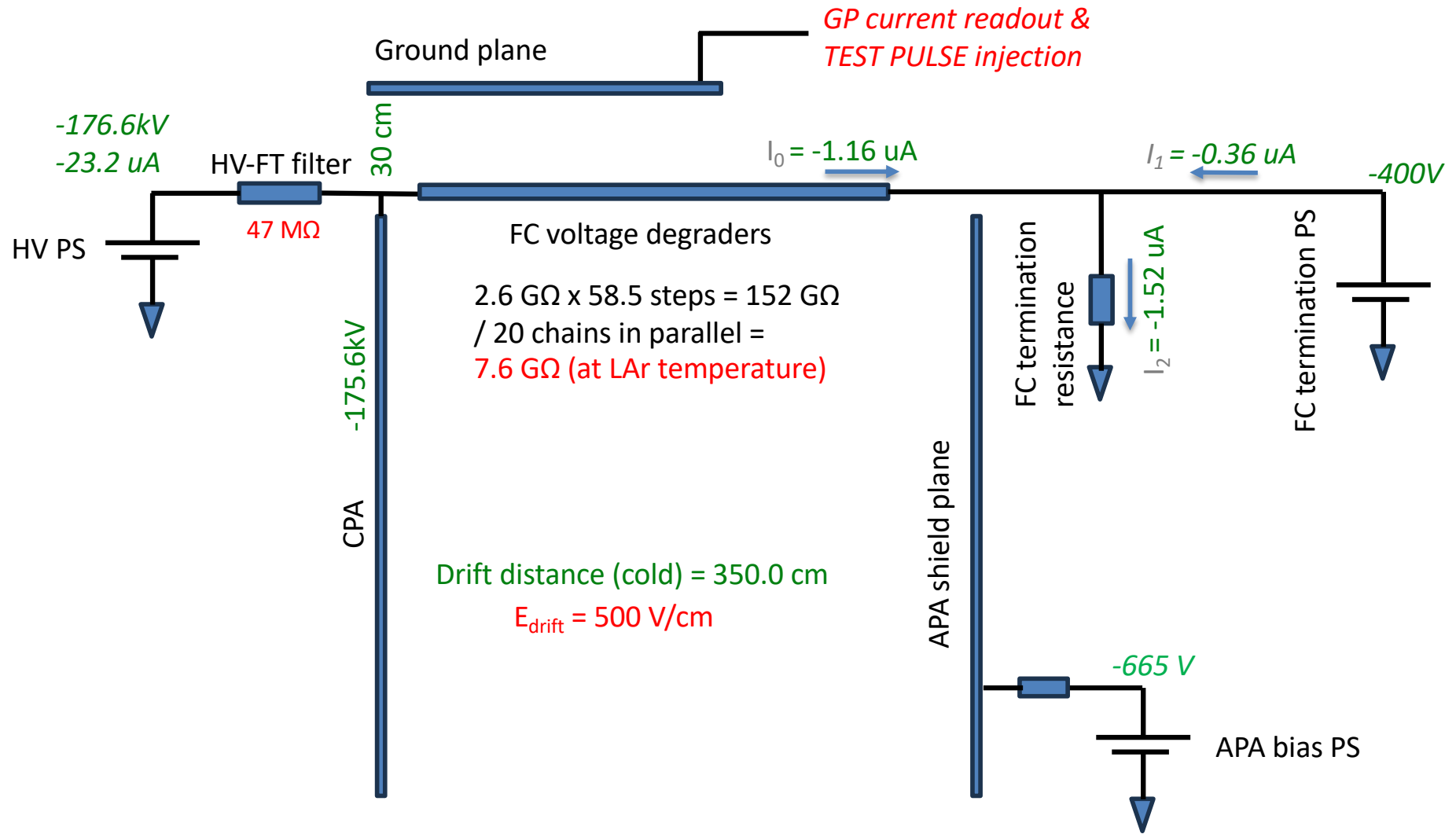
- following 5 days (May 31<sup>st</sup>, June 4<sup>th</sup>)



- HV PS voltage

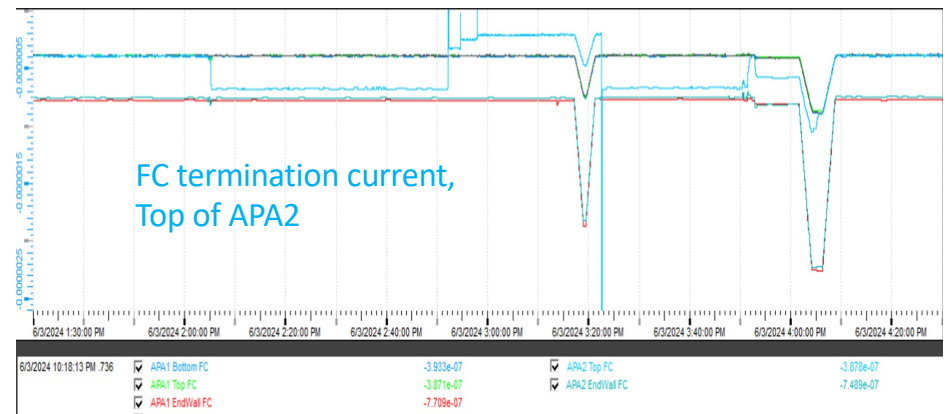
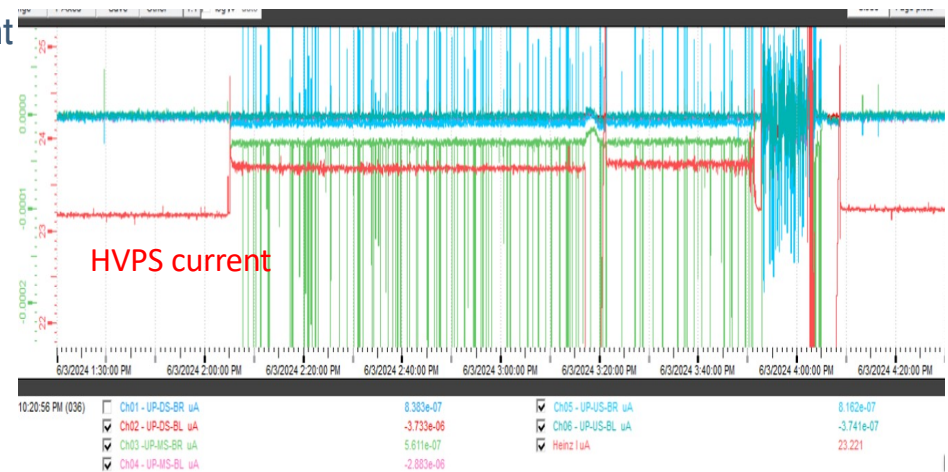
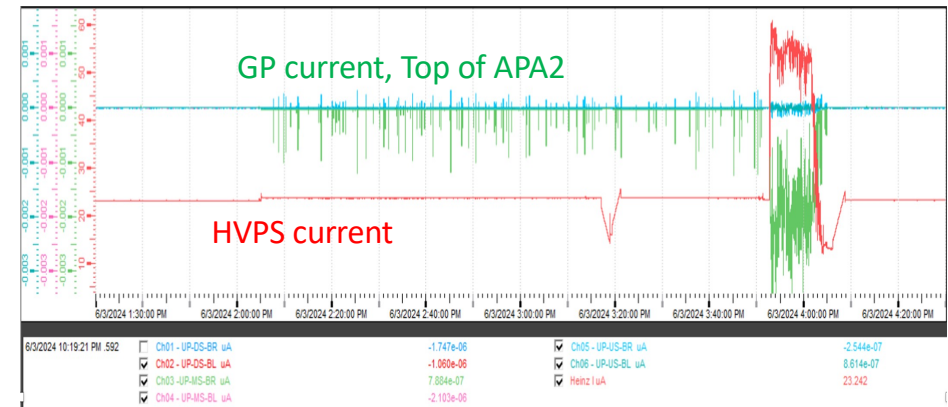


# NP04 HVS electric scheme (simplified)

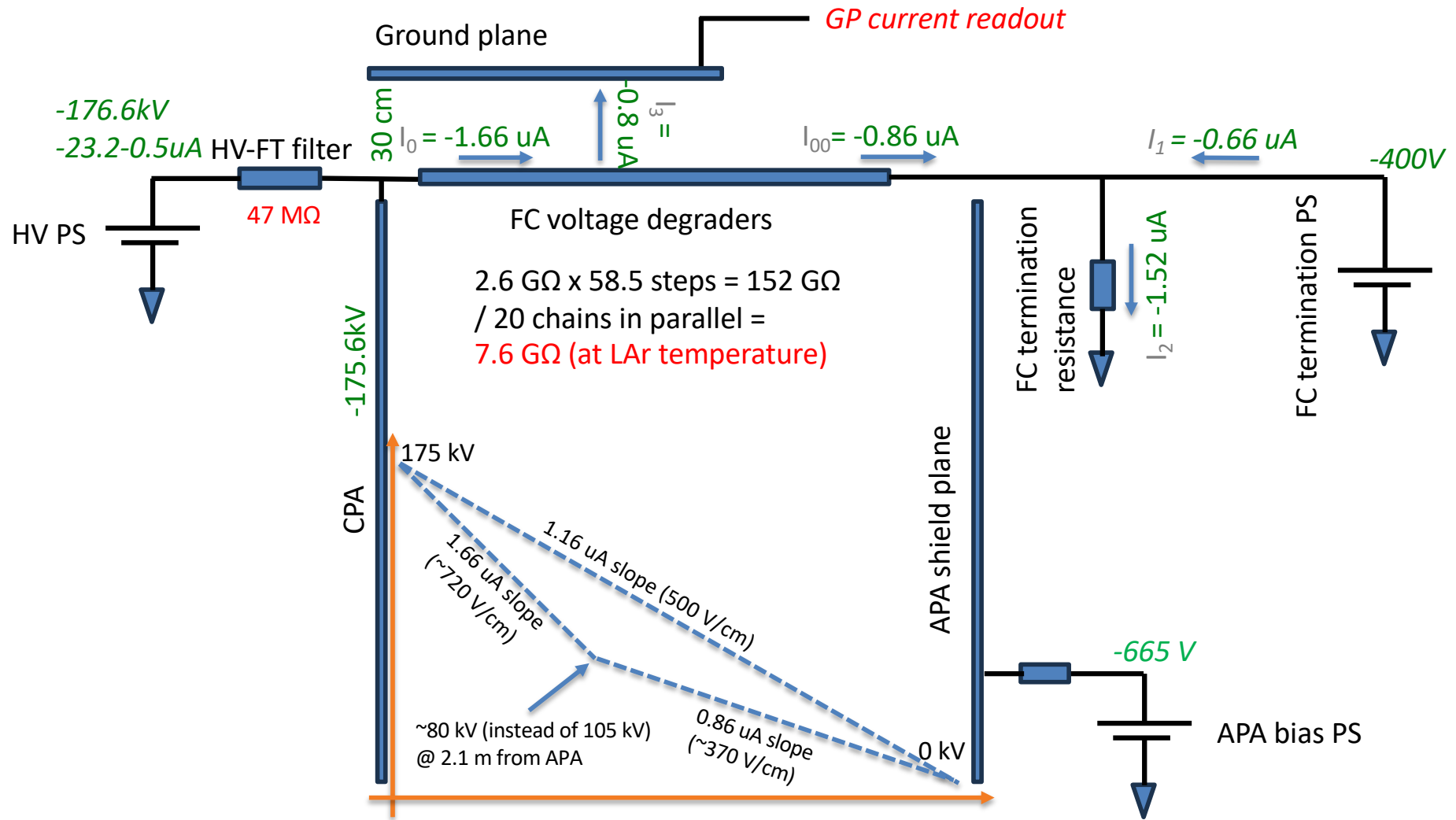


# Long-lasting HVPS excess current

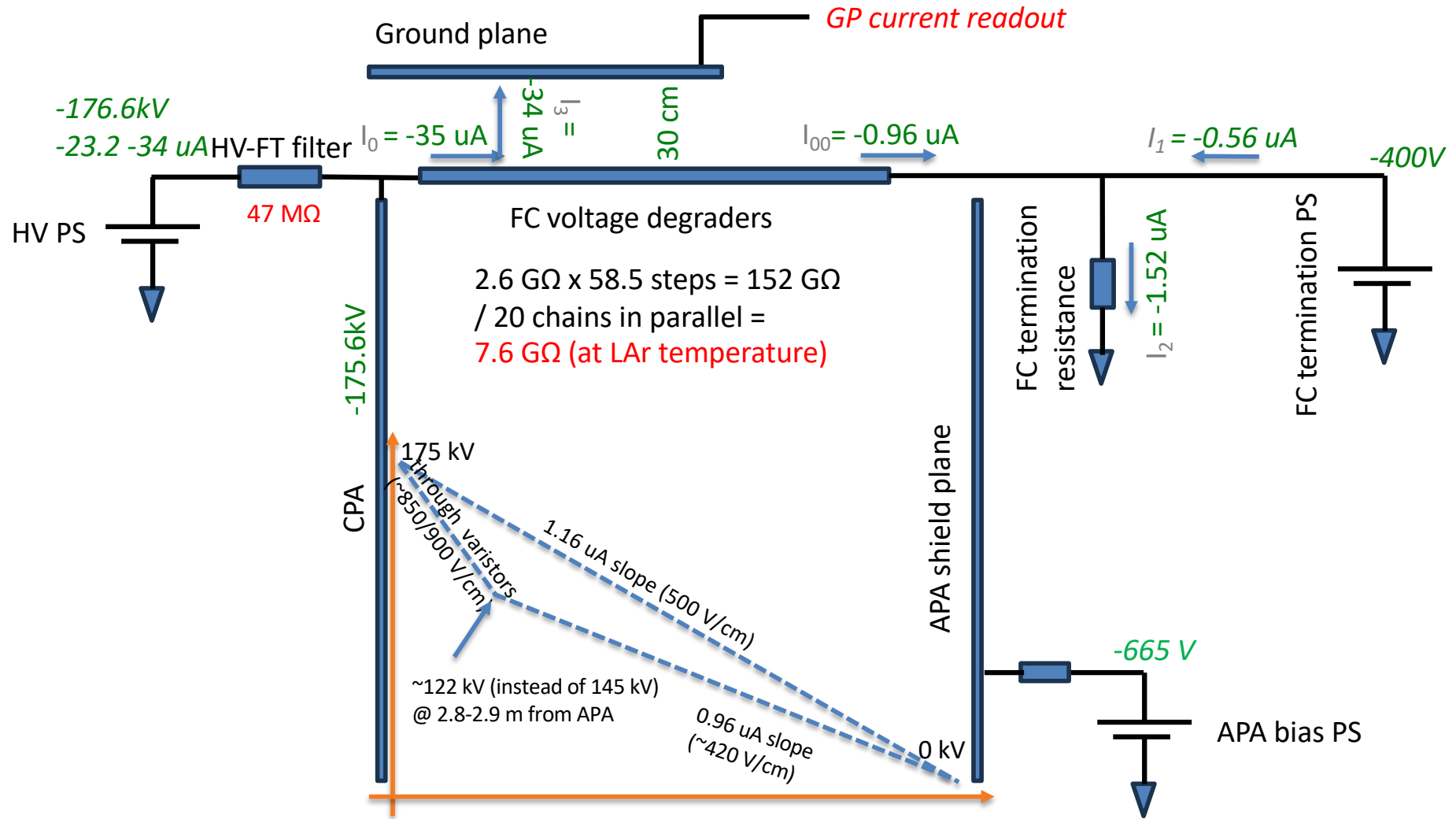
- Event occurred June 3<sup>rd</sup> at 2pm
- First occurrence: lasting 2 hours and self extinguishing
  - sudden *stable* increase ( $\sim 0.5 \mu\text{A}$ ) of the HVPS current
  - Continuous current + large frequent spikes recorded on GP on top of APA2
  - Sudden *stable* decrease ( $0.3 \mu\text{A}$ ) of the termination current on the Top FC of APA2
  - All other FCs and GPs currents, very stable
  - *Some, expected, capacitive coupling between adjacent GPs and BP.*
- Second occurrence
  - Much larger, less stable current ( $\sim 30 \mu\text{A}$ ) from same FC module and GP
  - It was extinguished by ramping down the HVS and restarting it after few minutes
- VERY QUIET operation since then
  - No current spikes recorded so far.



# NP04 HVS electric scheme (small leak)

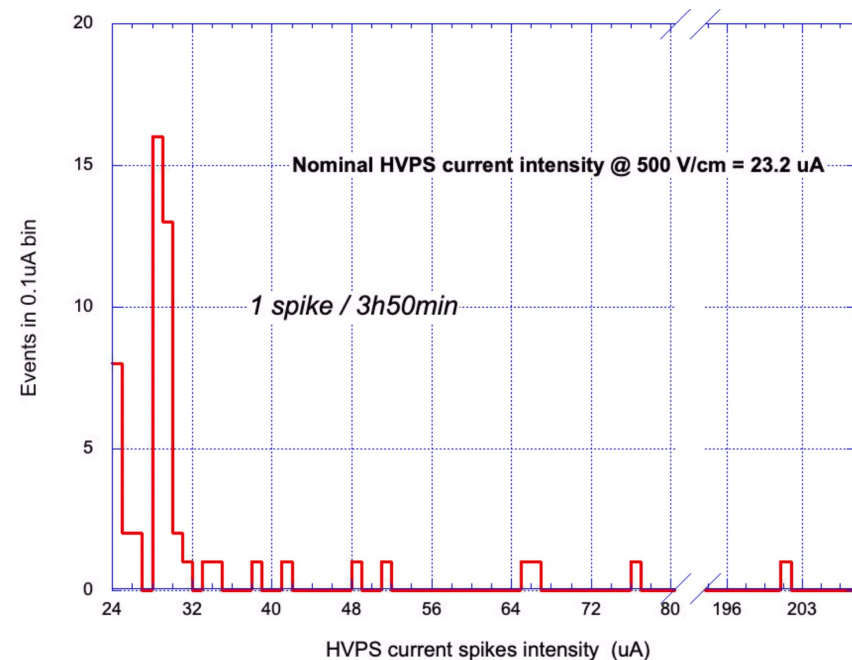
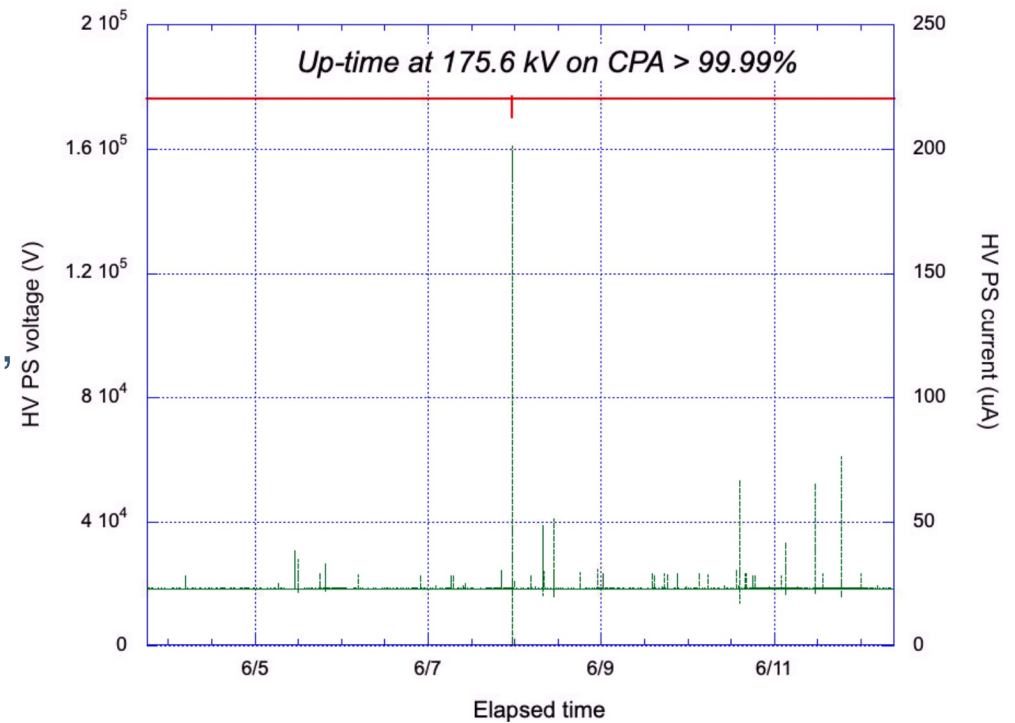


# NP04 HVS electric scheme (large leak)



# HVS stability

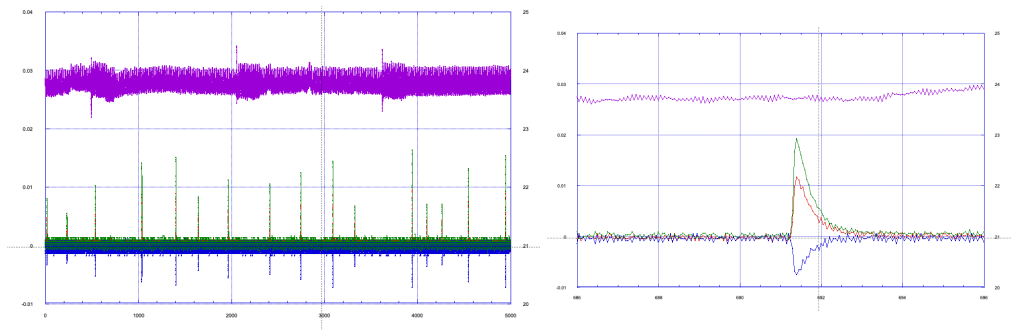
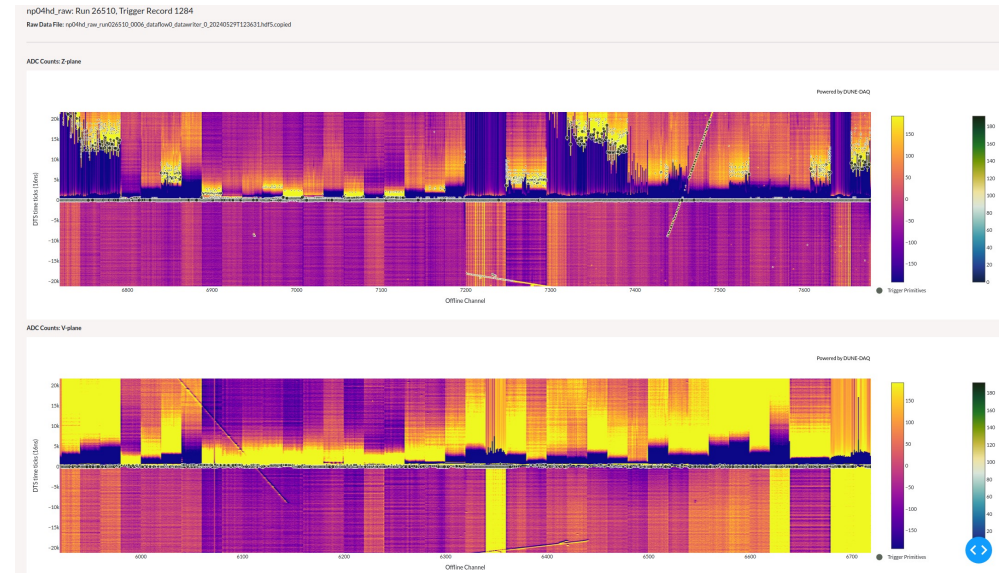
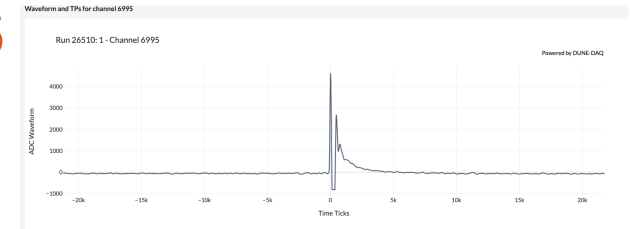
- After the long-lasting episode of June 3<sup>rd</sup>, very stable behavior of the HV System for the past 9 days at the nominal E field of 500 V/cm (176.6 kV on CPA, 23.2 uA)
- Fast current spikes still present
  - 53 events lasting less than 2 s, few uA excess current, no voltage drop
  - 1 event with 200 uA excess current, lasting ~5s and with ~5 kV voltage drop, self recovered.
  - No instability recorded on BP, GP's, FC terminations.
- No streamer-like events, similar to those of NP04 phase I, observed so far.





# The “global spikes” events

- Observations:
  - The event rate is stable around 1 Hz
  - The channels within the same CE boxes seems produce highly correlated waveforms after the “synchronous” spike
  - HVS slow controls do not show cathode voltage instability
- These observations seems to indicate that the “spike signal” is maybe injected through the ground system of the CE
- On May 30<sup>th</sup> an attempt for find the source was conducted
  - In turn, all running systems were switched off: Laser, cameras, heaters, PDS, APA bias, FC termination bias, ...
  - No effects on the “global spikes” event rate was observed
  - **ONLY switching OFF the HV system was effective to remove the events**
  - **Some spikes are recorded, on adjacent GPs (Top of APA1 and APA2), :**
    - occurring at a ~ 3 HZ rate,
    - Seem capacitive coupled to each other
    - The plan is to compare their time stamps with the ones of the global spikes events to point out any correlation
  - **In the next few days, we plan to replace the HV PS as a last attempt to identify the source**



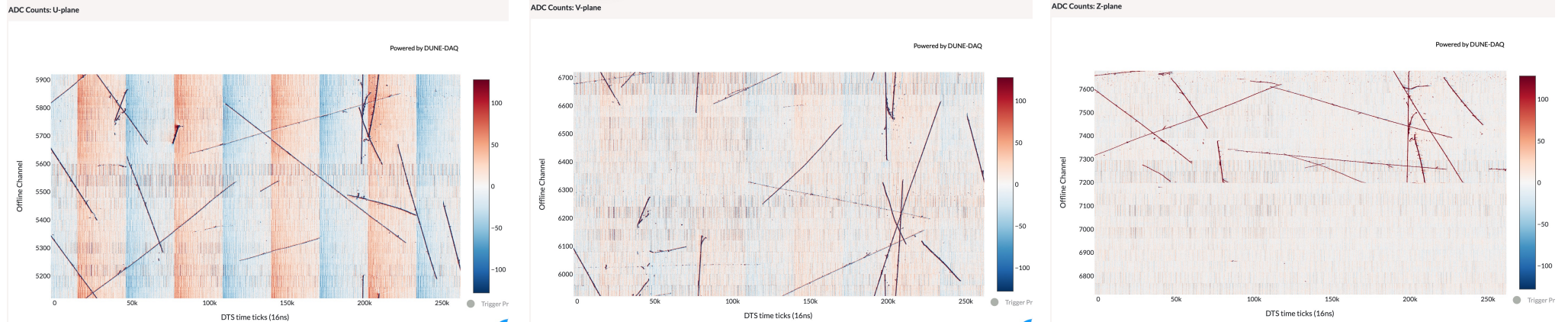
# Test pulse on GP, top of APA2

Square wave, ~4V pp, 1 kHz

np04hd\_raw: Run 26700, Trigger Record 1

Raw Data File: np04hd\_raw\_run026700\_0000\_dataflow0\_datawriter\_0\_20240605T152414.hdf5.copied

## APA2



## APA1



# Test pulse on GP, top of APA2

Square wave, ~4V pp, 1 kHz

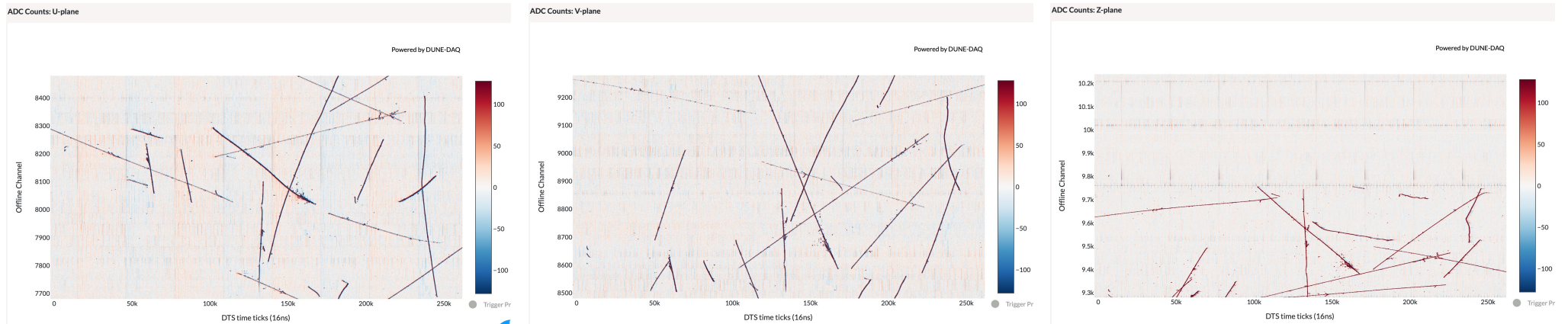
np04hd\_raw: Run 26700, Trigger Record 1

Raw Data File: np04hd\_raw\_run026700\_0000\_dataflow0\_datawriter\_0\_20240605T152414.hdf5.copied

## APA2



## APA4



# Test pulse on GP, top of APA2

Square wave, ~4V pp, 1 kHz

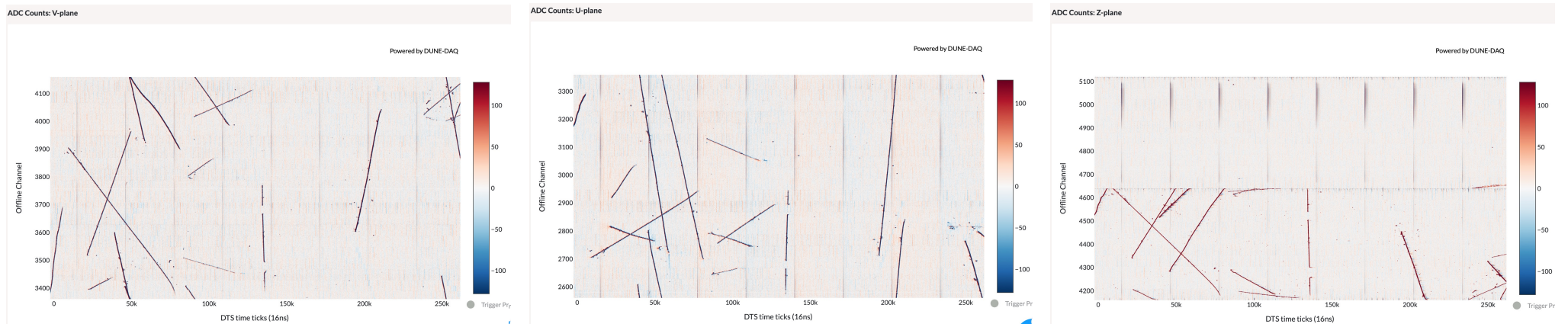
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## APA2



## APA3



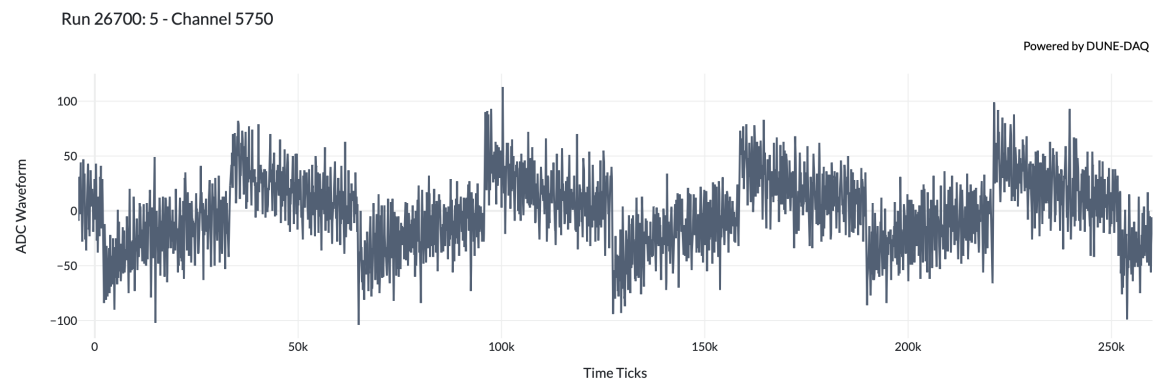
# Test pulse on GP, top of APA2

Square wave, ~4V pp, 1 kHz

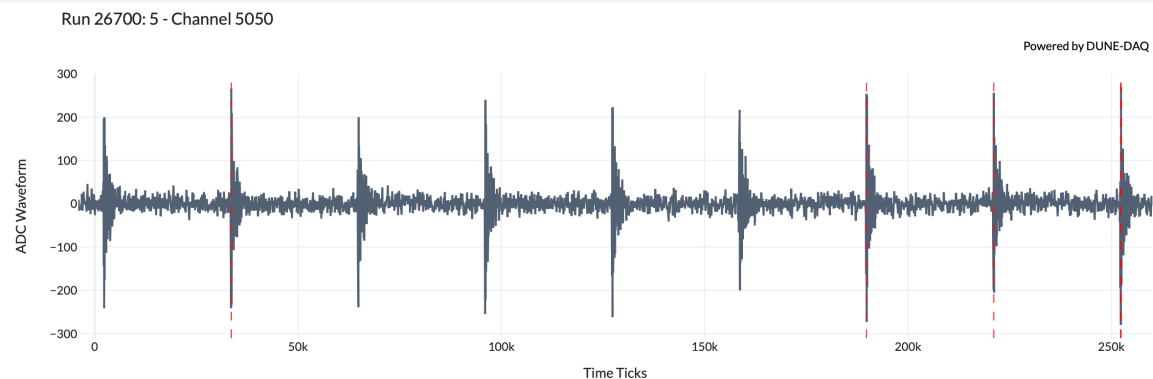
np04hd\_raw: Run 26700, Trigger Record 5

Raw Data File: np04hd\_raw\_run026700\_0000\_dataflow0\_datawriter\_0\_20240605T152414.hdf5.copied

Waveform and TPs for channel 5750



APA2 U-plane waveform



APA3 X-plane (membrane side) waveform