ProtoDUNE-SP Operations,Cryogenic and high voltage tests

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DUNE Collaboration Call
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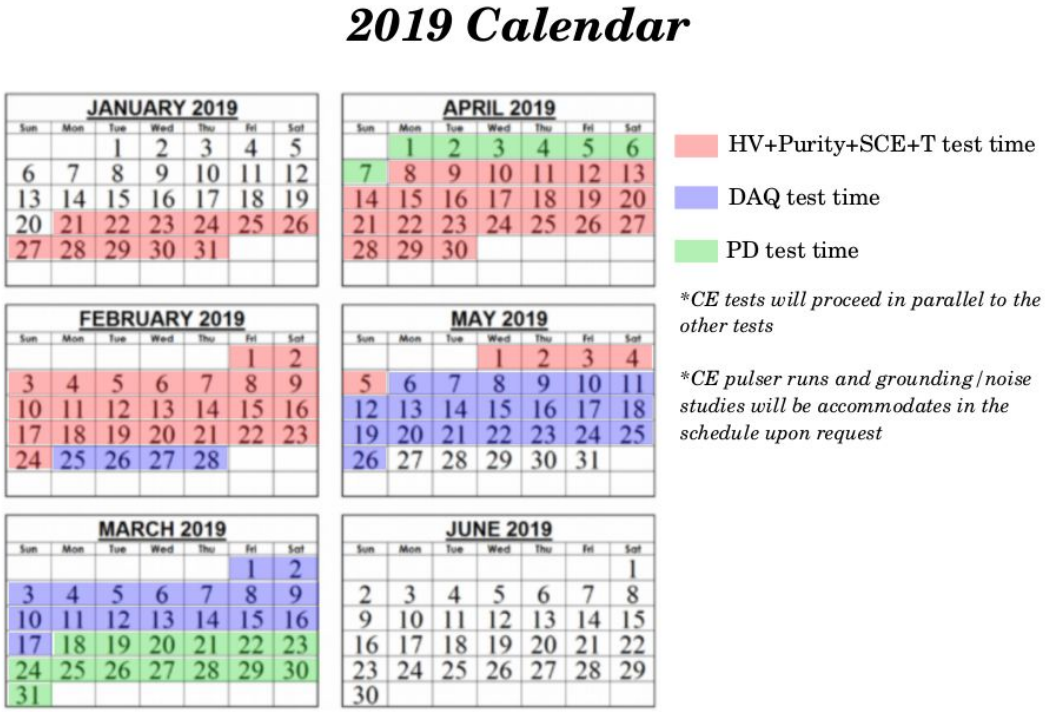
Yale Wright Laboratory

DUNE

ProtoDUNE-SP operations after the beam run

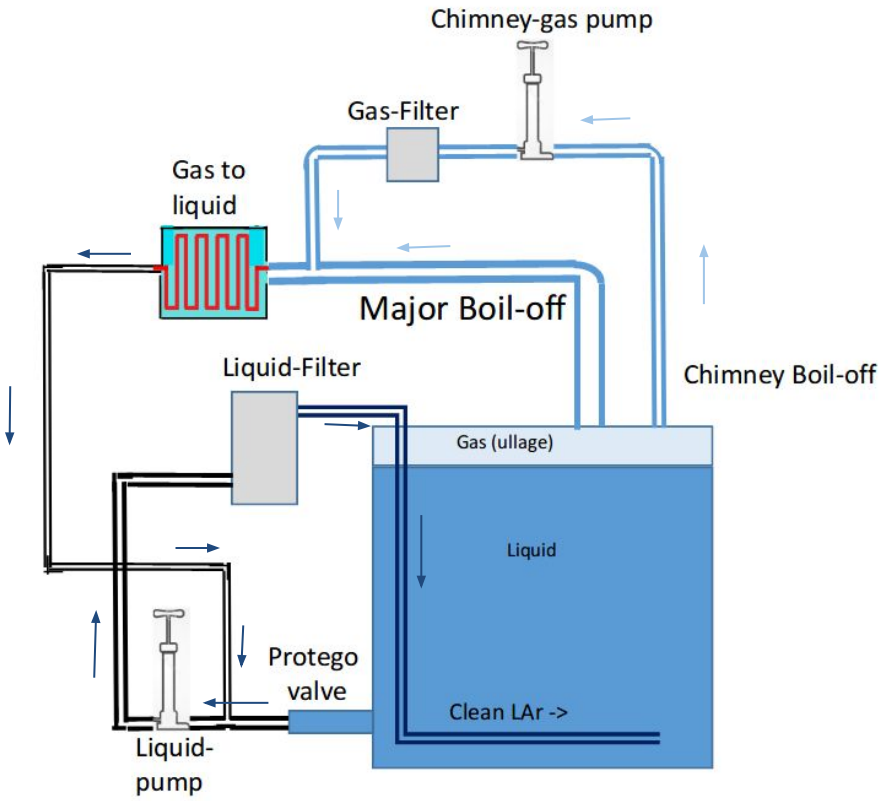
- Run plan for 2019 and beyond was presented by R. Acciarri at the last collaboration meeting
  - Continue to collect cosmics data with different detector configurations
  - Dedicated time slots for the subsystems for development and tests
- Rest of the presentation will show few highlights from the operations we have been performing since then



R. Acciarri @ the January collaboration meeting
https://indico.fnal.gov/event/16764/session/17/contribution/181/material/slides/0.pdf

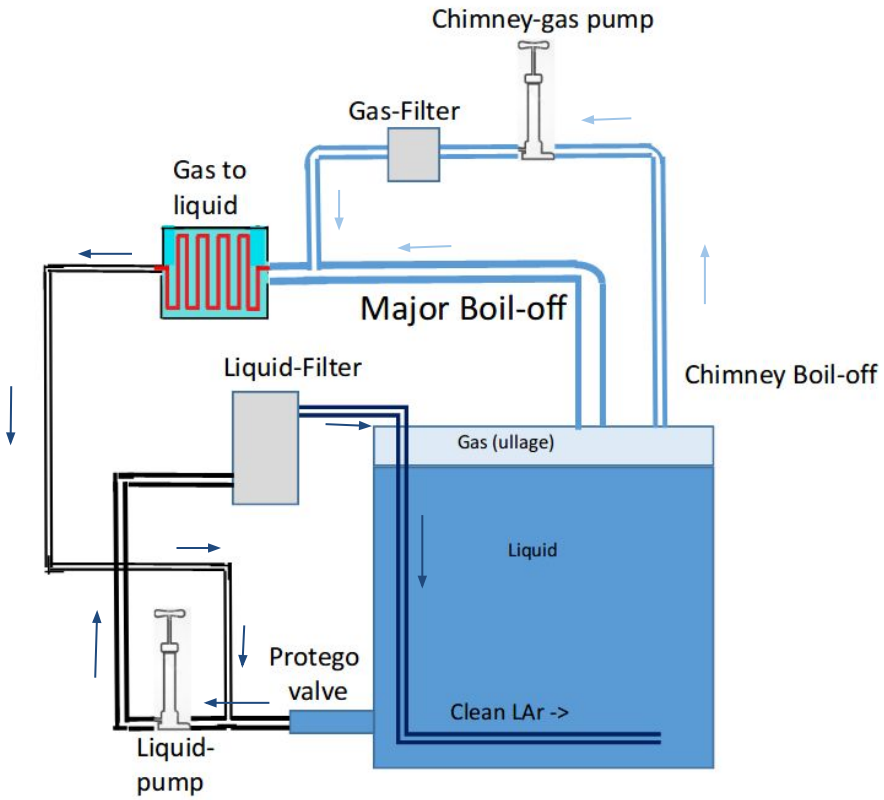
Cryogenic circulation studies

- How different cryogenic conditions affects the electron lifetime
- Presentation by Stephen Porden at ProtoDUNE-SP Operation meeting: https://indico.fnal.gov/event/20018/contribution/0/material/slides/0.pdf
- Standard operating conditions:
  - Full LAr circulation
  - All boiled off filtered



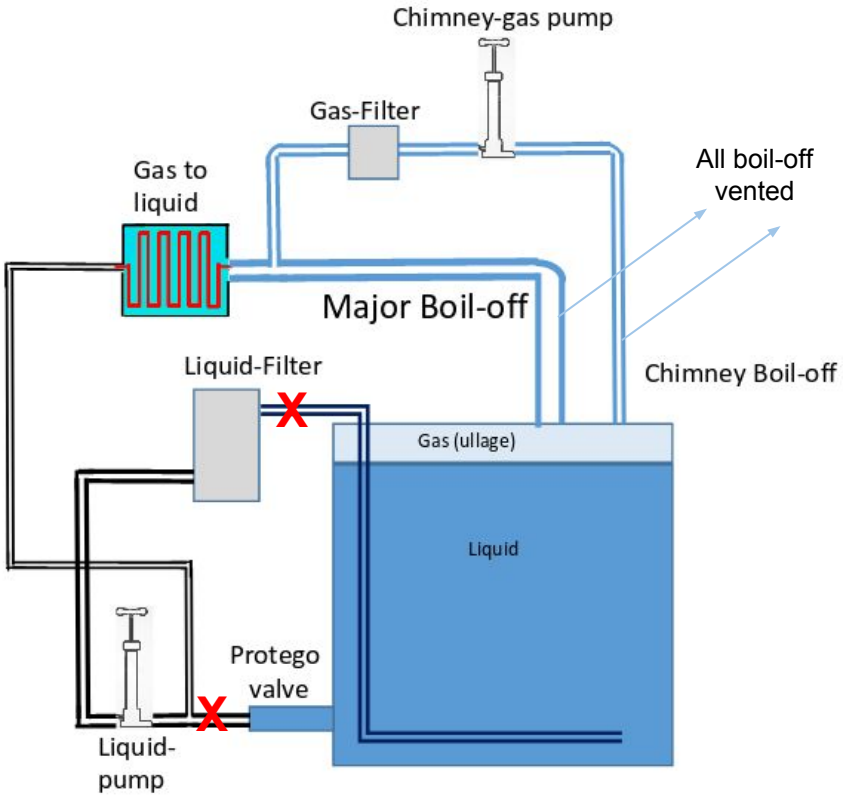
Cryogenic circulation studies

- Tested three non-standard configurations
  - Configuration-1:
    - Reduced LAr recirculation (~60% of usual rate)
    - All boil-off filtered



Cryogenic circulation studies

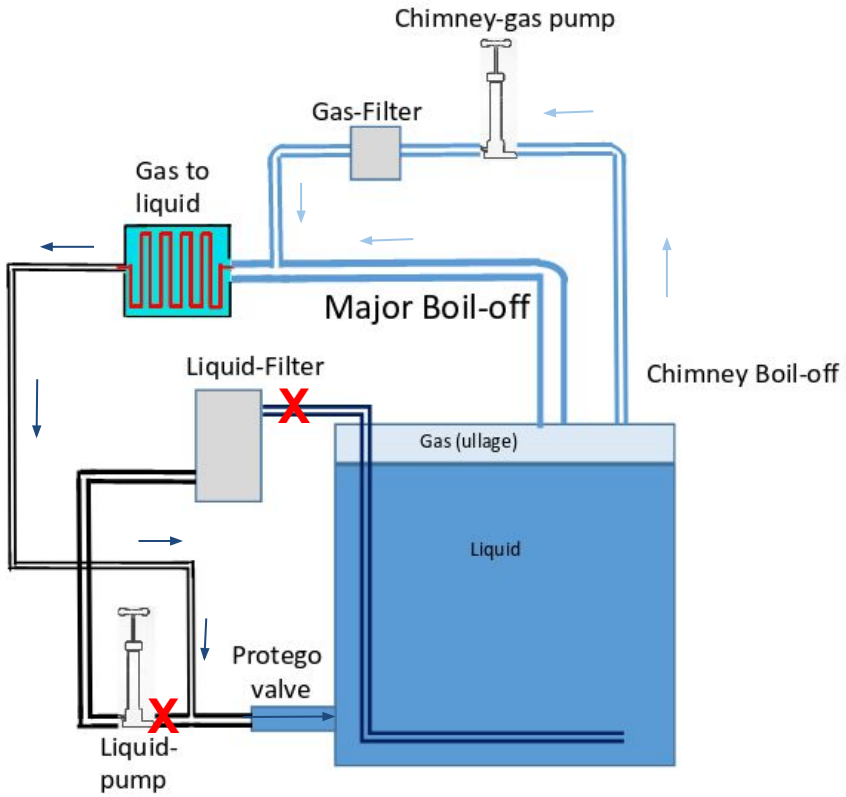
- Tested three non-standard configurations
  - Configuration-1:
    - Reduced LAr recirculation (~60% of usual rate)
    - All boil-off filtered
  - Configuration-2:
    - No LAr recirculation
    - All boil-off vented (thrown away ~180kg/hr)



Configuration-2

Cryogenic circulation studies

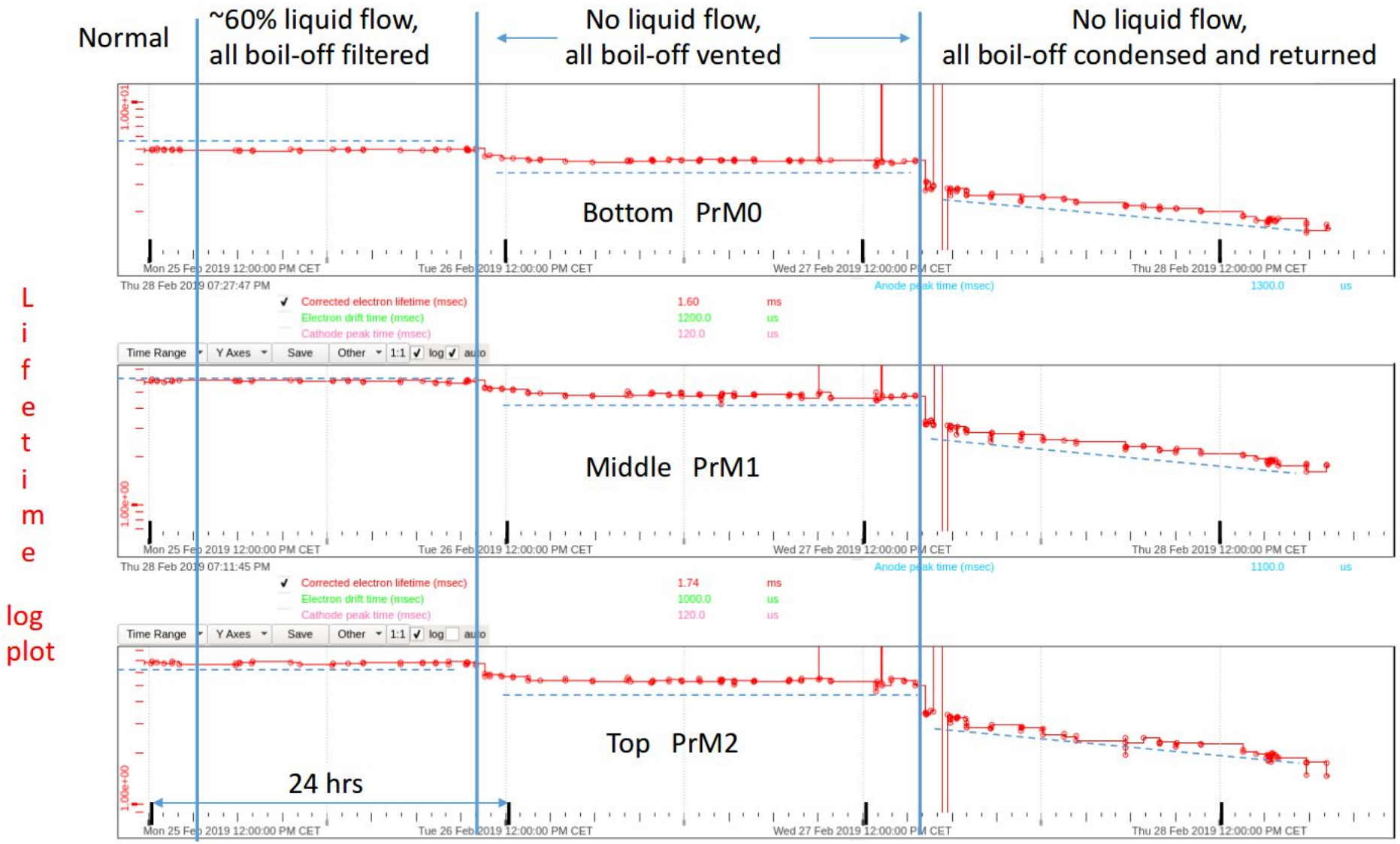
- Tested three non-standard configurations
  - Configuration-1:
    - Reduced LAr recirculation (~60% of usual rate)
    - All boil-off filtered
  - Configuration-2:
    - No LAr recirculation
    - All boil-off vented (thrown away ~180kg/hr)
  - Configuration-3:
    - The cryogenic pump stop condition
    - No LAr recirculation
    - Boil-off condensed and returned to the cryostat (most of it without being filtered)



Configuration-3

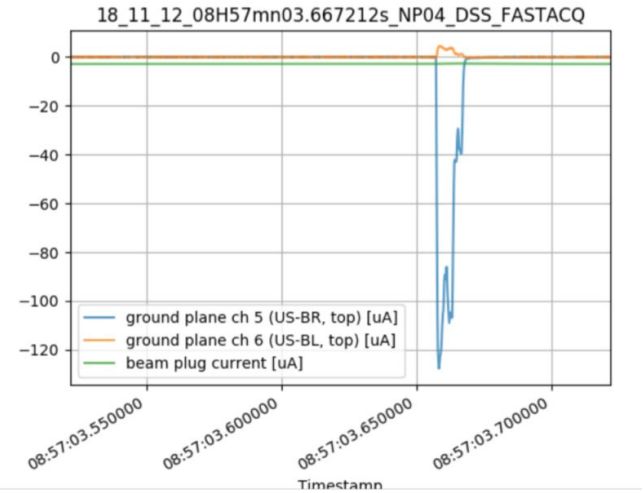
- **Compare the effect of these three conditions on the electron lifetimes**

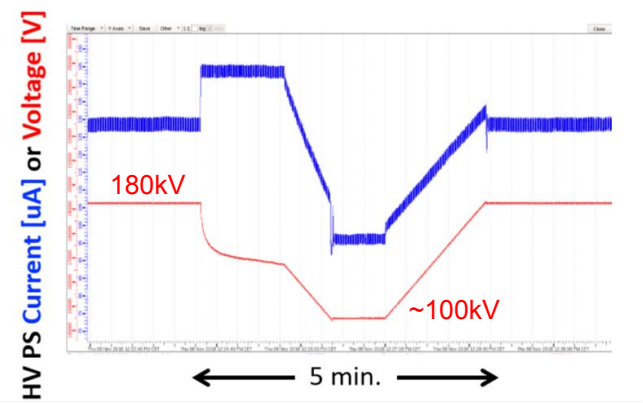
Electron lifetime measurements



ProtoDUNE high voltage experience

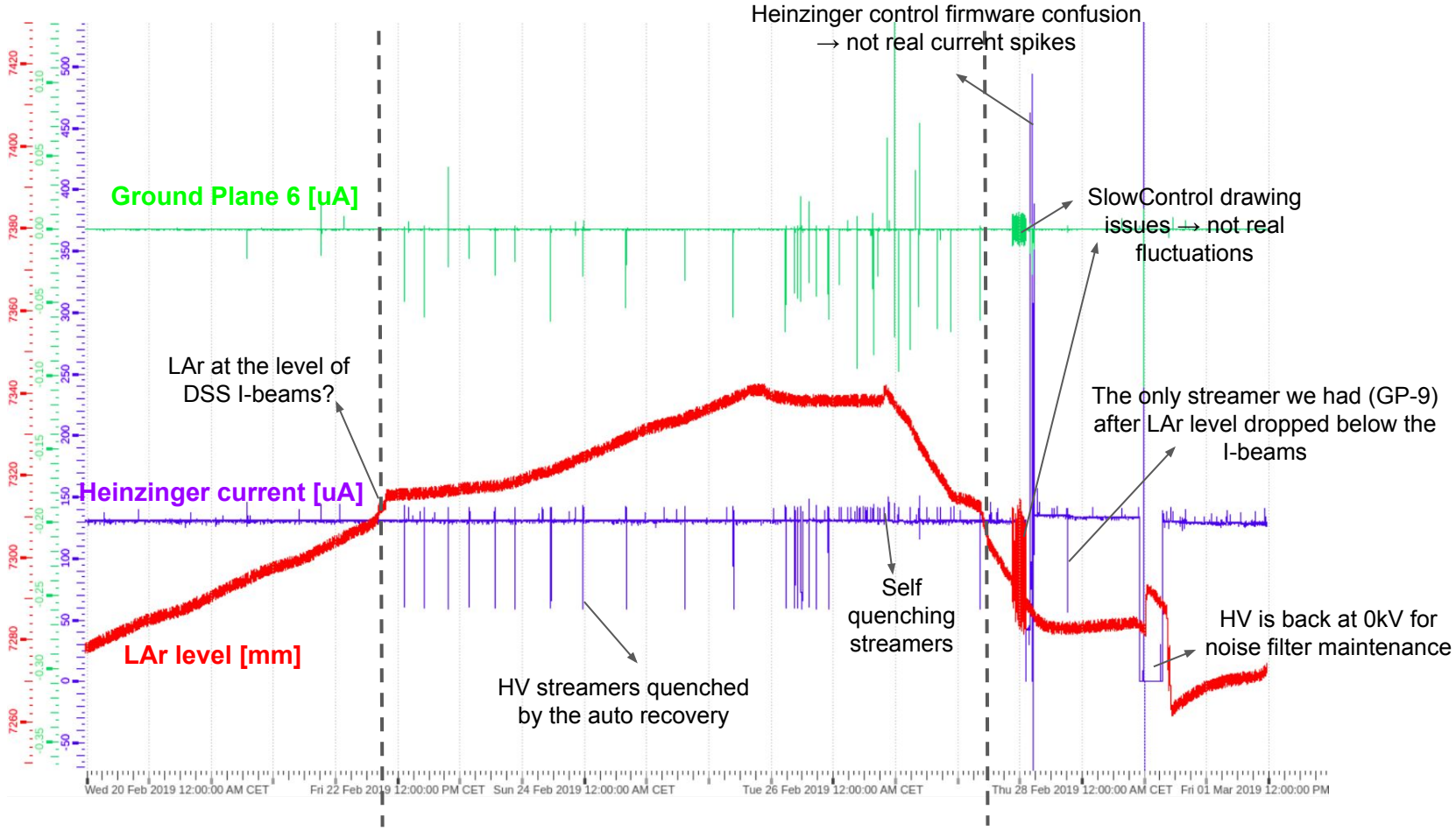
- Very encouraging experience with successful 180kV operations
- Downtime imposed by the high voltage system was at the few percent level
- Two types of instabilities:
  - Current blips:
    - O(10/day), ~10ms duration
    - Matching current signal between GP and HVPS
  - Sustained excessive current (“streamers”):
    - Few per day (rate builds up over time)
    - Typically current limiting
    - Only a fraction of the PS current visible on ground planes & beam plug
    - Ground plane activity is usually localized to the US-BL-Top channel (#6)
    - Quenched by dropping the voltage
    - Auto-suppression script implemented on the HVPS.





Streamer activity during the cryogenic studies

- We have been studying streamer and blip frequency since Feb 6 @180kV
- Realized correlation between streamers and LAr level



DAQ test and development weeks

- Very productive and active DAQ dedicated weeks
  - RC bug fixes (separation of logical elements from GUIs)
  - EventBuilder resilience tests and improvements (DAQ is able to recover from killed/died EBs.)
  - CTB firmware upgrade with new inputs supported (as a whole chain it doesn't work yet, under investigation)
  - HitFinding tests and developments
  - FELIX On-Host BoardReader development (almost done)
  - 1 second readout tested again (problems identified)
  - Several ArtDAQ improvements
  - Server interventions carried out on srv11-14.
  - BoardReader to receive timing fragments are under development

Summary

- Data collection, tests and developments are ongoing in ProtoDUNE-SP
- Cryogenic circulations studies
  - Many thanks to CERN cryogenic team
  - It would be preferable to vent boil-off during power outage of limited duration rather than returning unfiltered liquid
  - It seems that a system to deal with all the boil-off gas, not just gas from chimneys, would be useful
- Behaviors we observed probably depend on the specifics of the cryostat and cryogenics system

- HV streamer studies
  - Correlation between LAr level and streamers
  - We'll repeat this test by changing the LAr level
  - Started to study streamer and blip frequency @ 120kV
    - This corresponds to the field between ground planes and field cage that is at the moment in the DUNE design

- Has been very productive and active two DAQ dedicated weeks. Work will continue next week as well.