DPS Summary

FACET-II

Facility for Advanced Accelerator Experimental Tests

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SLAC NATIONAL ACCELERATOR LABORATORY

Stanford University | U.S. DEPARTMENT OF ENERGY

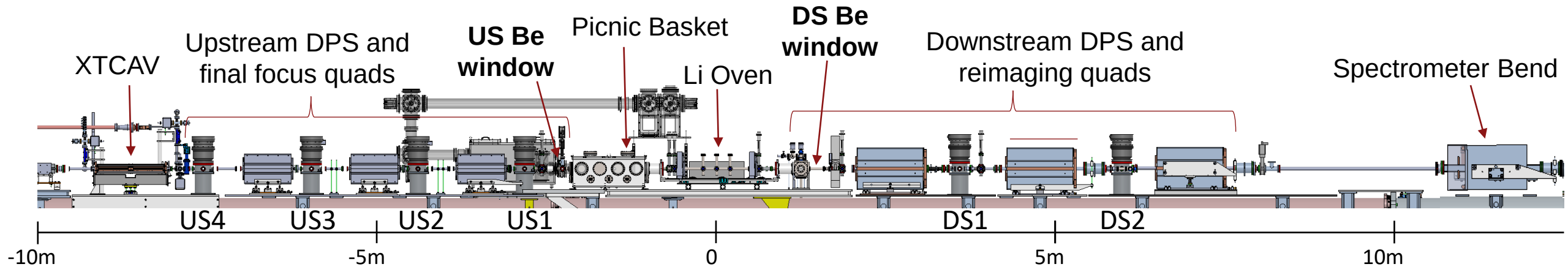
Outline

- Summary of hardware
- Performance
- DPS for operators
  - Vacuum page
  - Watcher
  - Hardware locations
  - How to troubleshoot
- DPS for users
  - Current performance
  - Control panels and instructions for use

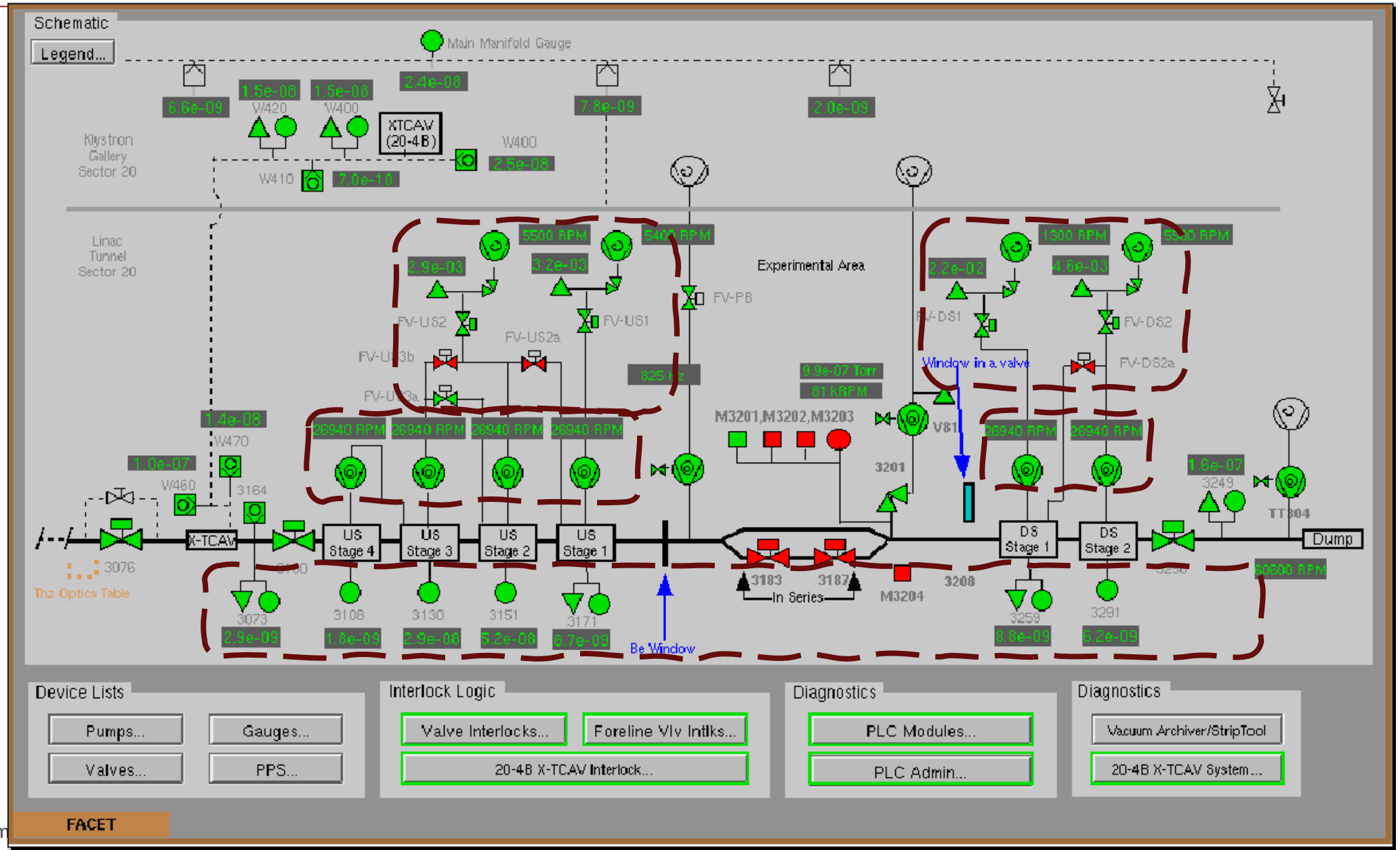
Overview of DPS system

- Required to allow experimental gasses up to few Torr in the IP, while:
  - Maintaining nTorr at XTCAV and linac
  - << mTorr in spectrometer to limit emittance growth (in fact we can maintain <1e-6 Torr)
  - No solid material in the beam path – i.e. Be windows

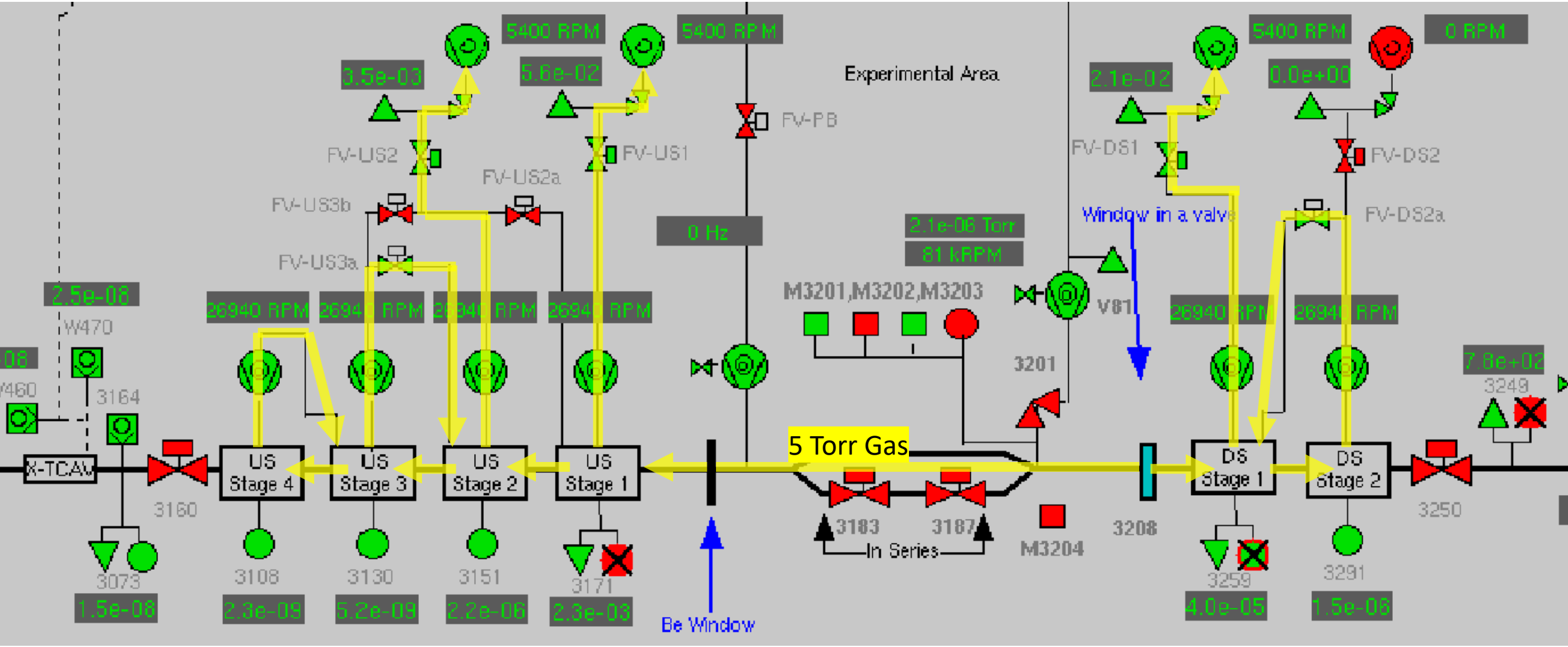
- Two systems running in parallel
  - US-DPS (upstream): 4x turbopumps and 2x roughing pumps
  - DS-DPS (downstream): 2x turbopumps and 2x roughing pumps



Schematic of the system



Schematic of the system – foreline system



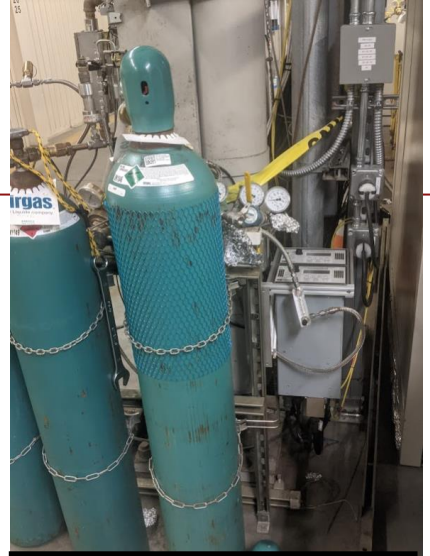
Summary of hardware

- Turbopumps: Ebara EMT2204 - ~2000 l/s mag-lev turbos
  - Pumps directly on beamline
  - Controllers are in gallery:
    - 4 US pump controllers at Penetration 20-10
    - 2 DS pump controllers at Penetration 20-12

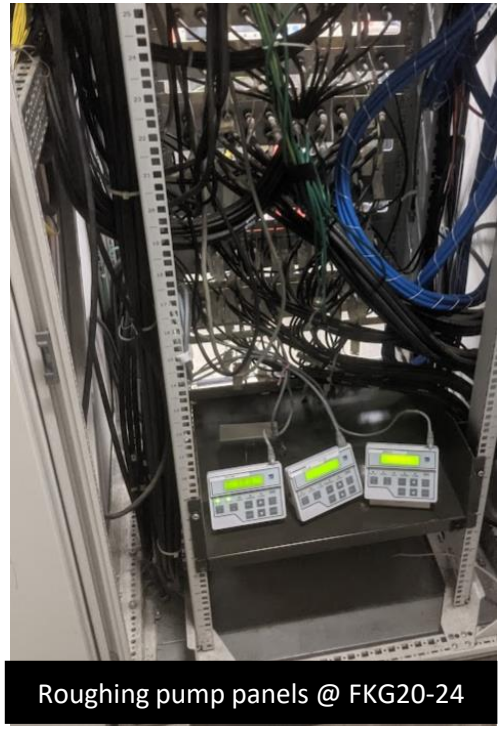
- Roughing pumps: Ebara EVS-100P- 10,000 l/s
  - Pumps installed under the beamline, directly below the turbos
  - No remote controller, but remote status panel in rack FKG20-24
  - Powered from circuit breaker 2PK102E2

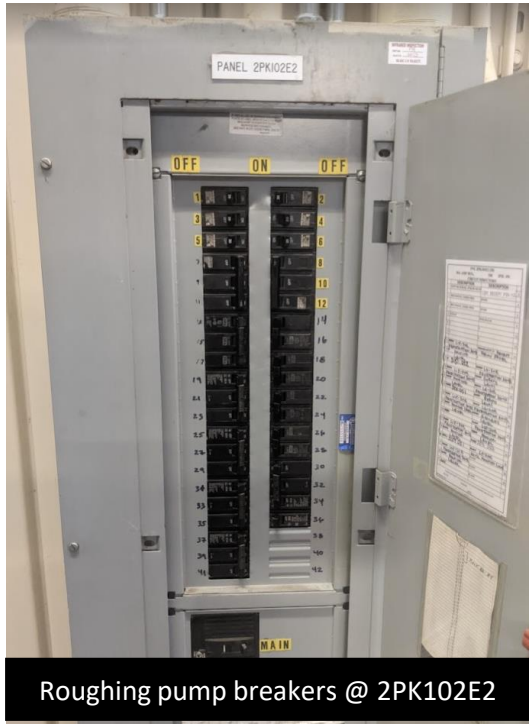
- Foreline valves between turbos and roughing pumps
  - Interlocked to foreline pressure
  - Controllable through EPICS

- Beamline valves
  - Interlocked to beamline pressures


DS TMP controllers @ P20-12

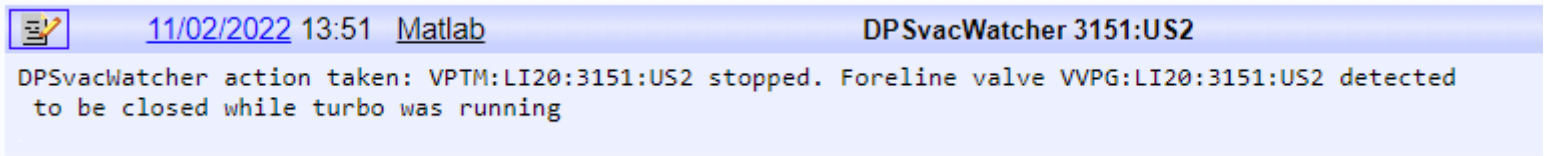

US TMP controllers @ P20-10


Roughing pump panels @ FKG20-24



Roughing pump breakers @ 2PK102E2

DPS Watcher

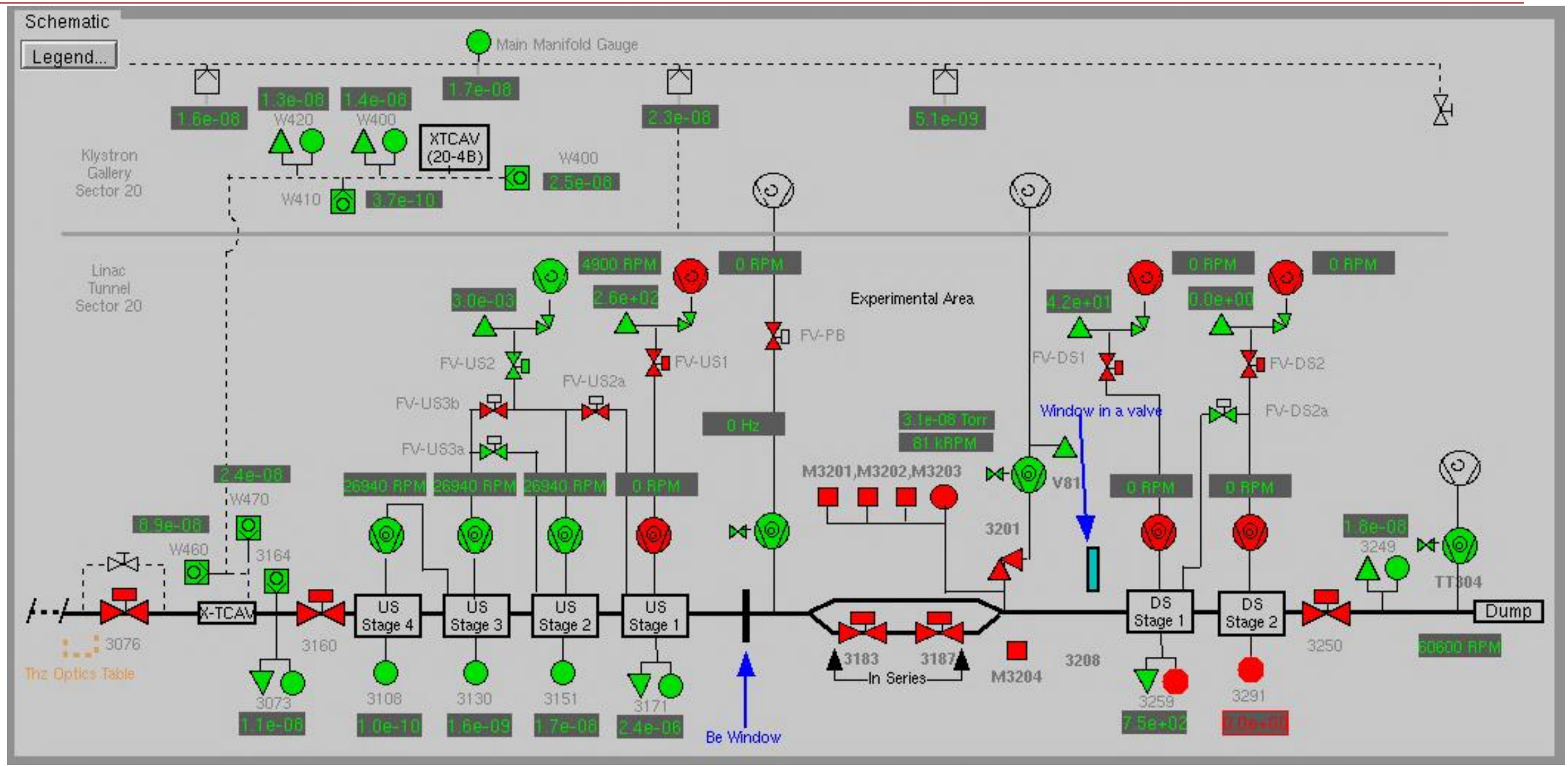


- **Important note:** Green on the watcher panel only means the watcher is running. The color DOES NOT change if there are problems.

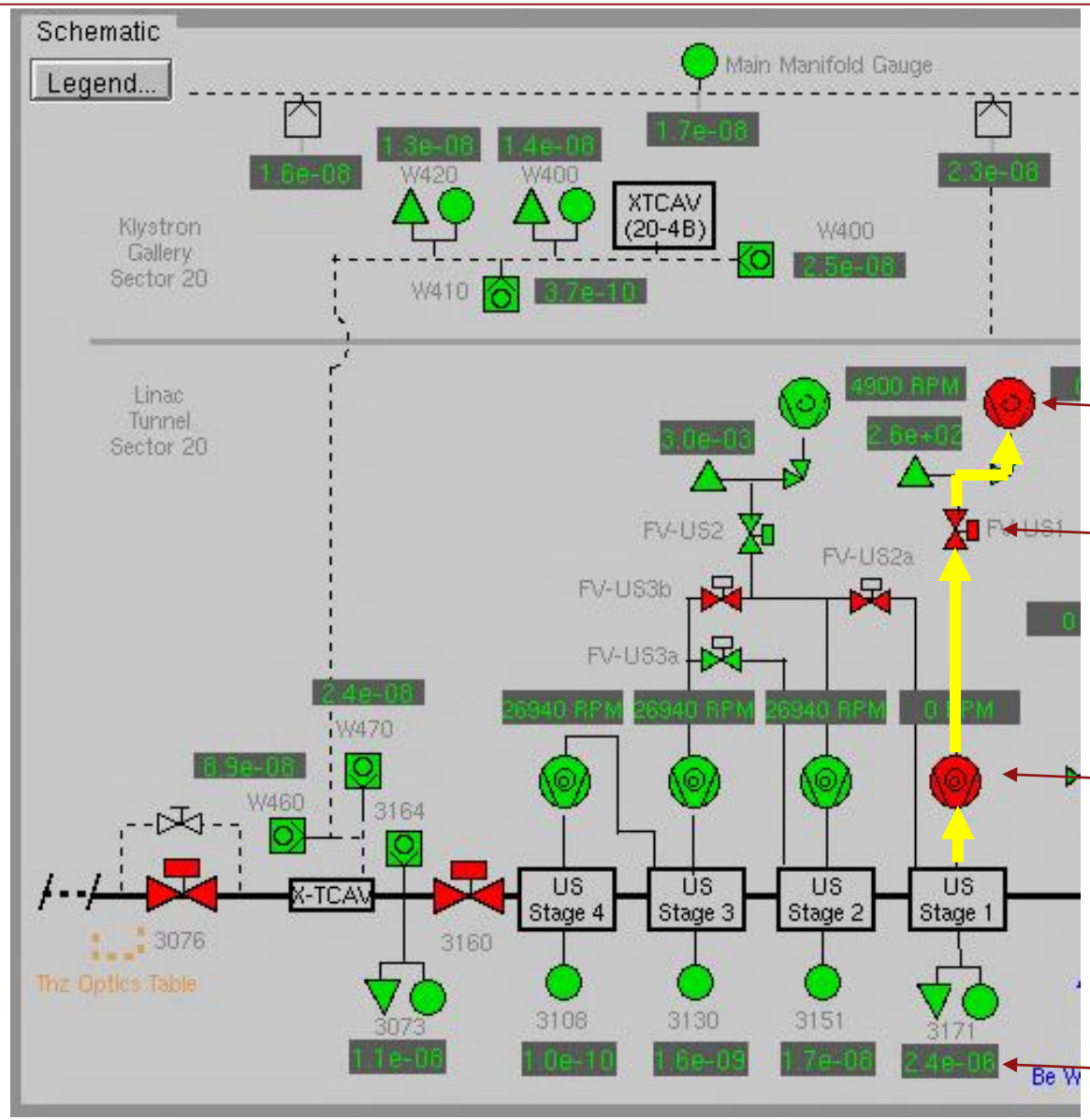
Main failure modes – in order of likeliness

Trip:	Sign of the fault
Radiation trips roughing pump	• Foreline pressure rise → Foreline valve closes → Watcher shuts off turbo → message to FACET elog • Could result in beamline pressure rise, depending on conditions of trip → beamline valves go in, MPS fault • Pump statuses show off and probably an error message (deep in status panels)
Turbopump trip	• TMP stops → Watcher should notice and close foreline valve → message to elog. • Could result in beamline pressure rise, depending on conditions of trip → beamline valves go in, MPS fault
DPS watcher glitch – i.e. bad input	• Usually results in watcher stopping a TMP and closing a foreline valve → message to elog
Some other service glitch	• If a pump overheats, or shuts itself off, then the interlocks/watcher should intervene

For Example – US1 roughing pump failure



For Example – US1 roughing pump failure



This pump is off

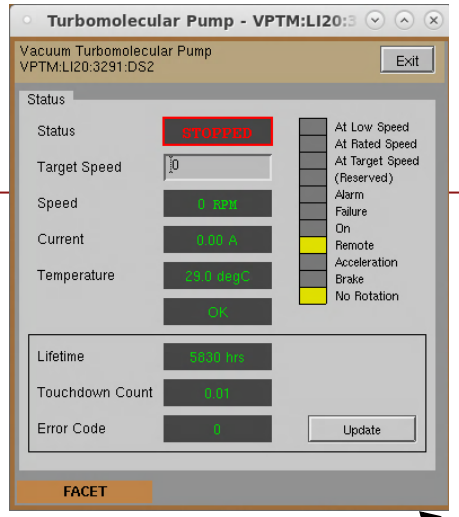
This valve is closed

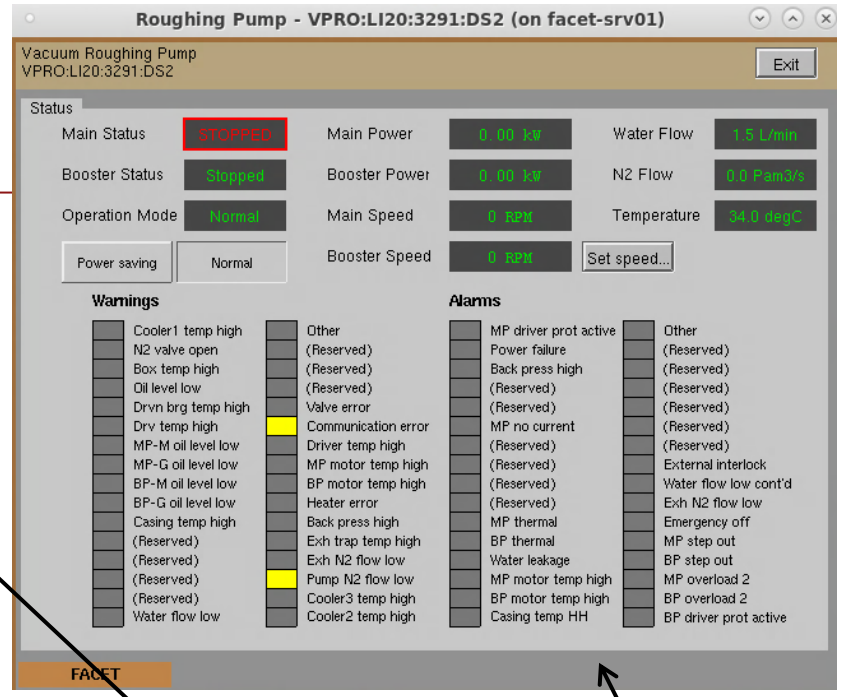
This turbo is off

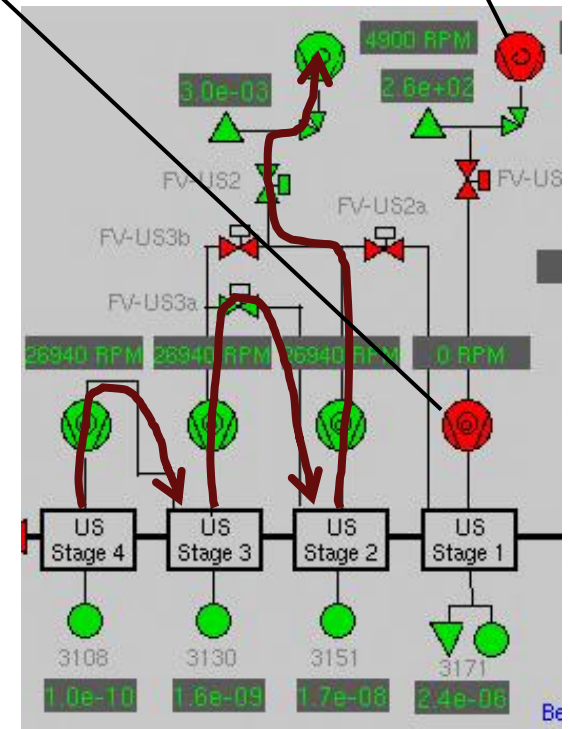
This pressure is above normal

How to troubleshoot

1. Determine what pump is the problem
   - Check the vacuum schematic
     - First look at pressures
     - Then look at pumps
   - Check the message in the elog
2. Once you find the problem pump – see what's up
   - open the pump panel and click "More…" to see the warning/alarm statuses
     - Turbopump status panel and roughing pump status panel shown above
3. More info here:
   - https://confluence.slac.stanford.edu/display/FACET/DPS+Pump+Troubleshooting







Note!

- The forelines are reconfigurable, so be aware of the flow of gas.
- Generally, gas will flow from a lower pressure volume, through a working pump, into a higher pressure volume.
- Do not open/close any foreline valve with a letter suffix, i.e. FV-DS2a

Main failure modes – How to try to clear a fault

- https://confluence.slac.stanford.edu/display/FACET/DPS+Pump+Troubleshooting

Trip:	Sign of the fault	Things to try
Radiation trips roughing pump	• Foreline pressure rise, • Foreline valve closed • turbo stopped • Warning and/or Alarm code	1) Hit "Reset" on roughing pump panel 2) If error does not clear, then try again over a few minutes 3) Reset the power to the pump (cycle circuit breaker) 4) Sometimes an extended time with no power brings the pump back (i.e. ~30 minutes)
Turbopump trip	• TMP stops • Foreline valve closed • Foreline pressure is still low • "Failure" or "Alarm" code	1) Hit "Reset" on turbopump panel 2) If error does not clear, then try again over a few minutes 3) Cycle the power on the controller in the gallery (power switch is on the back)
DPS watcher glitch – i.e. bad input	• Things are off, but no errors	1) Check EPICs to see if the readback looks ok 2) Usually this is a temporary glitch 3) Check that the watcher is still running (restart if its not)
Some other service glitch	• Things are off, but no errors, or error in temp or water flow	1) Call for help

How to restart a DPS stage

Confluence page:

- https://confluence.slac.stanford.edu/display/FACET/Restarting+DPS+pumps#RestartingDPSpumps-StartingorRestartingtheDS-DPSpumpswhenthebeamlineisundervacuum

- Basic steps are:
  - Start the roughing pump, or ensure it is running:
  - Check that the foreline pressure is good i.e. <1e-2 Torr, and clear interlocks
  - Start the turbopump
  - When then turbo speed is >5000RPM, then open the foreline valve
  - Watch to make sure the turbo reaches the full speed and the foreline valve stays open

- Things to watch out for
  - The watcher sometimes interferes. you may need to stop it, then restart after pumps are sorted
  - Interlocks can be tricky to manage. If you don't understand EXACTLY what you are doing, then you shouldn't be messing with them

Summary of confluence articles:

- DPS trouble shooting guide:
  - https://confluence.slac.stanford.edu/display/FACET/DPS+Pump+Troubleshooting

- How to guides:
  - Gas jet with DPS: https://confluence.slac.stanford.edu/display/FACET/How+to+DPS+with+Gas+Jets
  - Stop the DPS pumps: https://confluence.slac.stanford.edu/pages/viewpage.action?pageId=349294120
  - Restart DPS pumps: https://confluence.slac.stanford.edu/display/FACET/Restarting+DPS+pumps

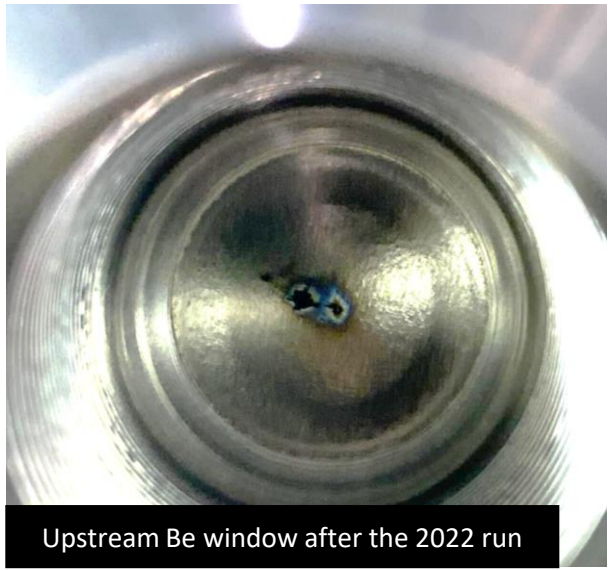
DPS performance

- Can support 4 modes of operation:

- No straws or apertures installed, but the Be windows are left as-is
  - US Be window is fixed, and has large holes
  - DS Be window is removable, but also has holes

- Radiation shielding has been added to the downstream roughing pumps

Mode:	Gas:	Pressure:
0: High vacuum	none	1e-6 at IP, 1e-9 in US-DPS/DS-DPS
1: Li oven	He	$\leq$ 5 Torr at IP (US-Be to DS-Be)
2: H2 plasma	H_2	$\leq$ 5 Torr at IP (US-Be to DS-Be)
3: Gas jets	He, H_2	Ok to 10 Hz, depending on backing pressure + opening time. No DS-Be required

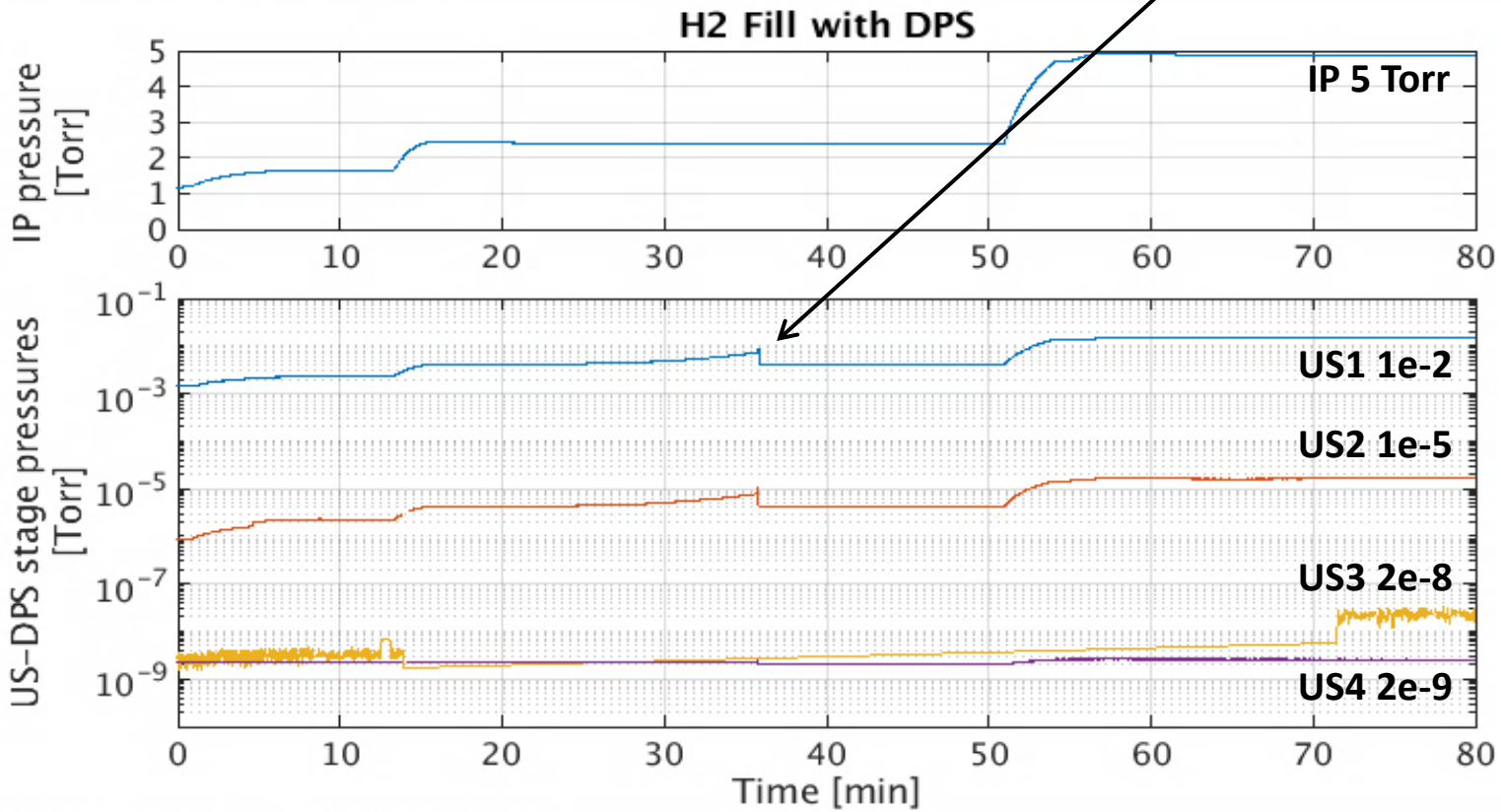


Upstream Be window after the 2022 run

DS1 Roughing Pump

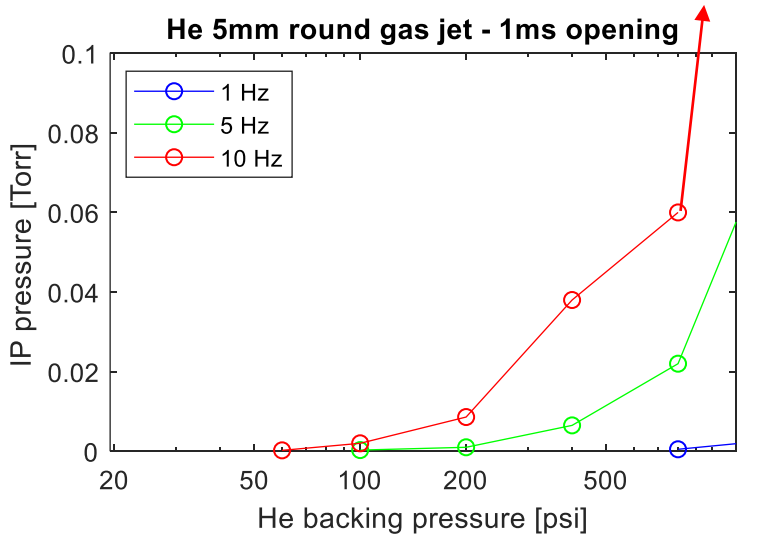
DPS performance – static fill

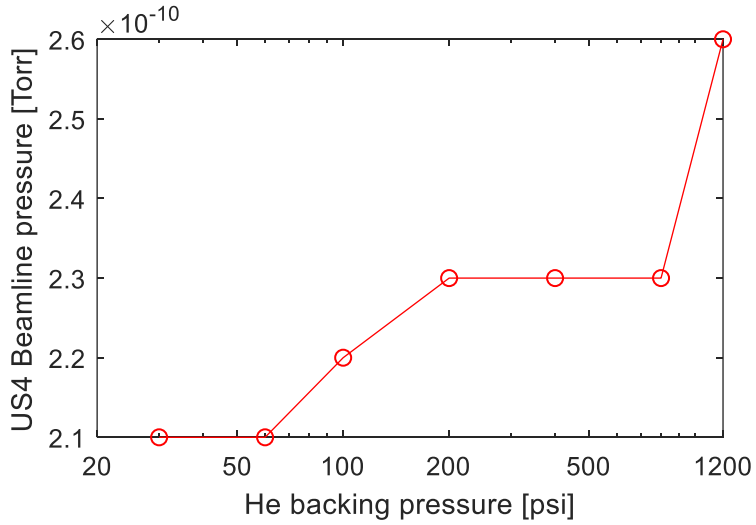
- Better than %-level stability over hours (until radiation trip)
- Improvements since 2022 run mean up to 5 Torr H2 is possible with addition of purge gas into the roughing pump
- Still tricky to manage the gas fill (local control only)



DPS performance – Gas jets

- Problems earlier in the summer when the gas jets were set to long opening time
  - Fixed on IOTA controller
- Main limitation now comes from the picnic basket turbo evacuating gas between shots
  - US4 pressures good to 1200 psi He
  - Need to retest with H2 with purge gas
- Nominal operating mode is to stop gas when not actively take data/aligning

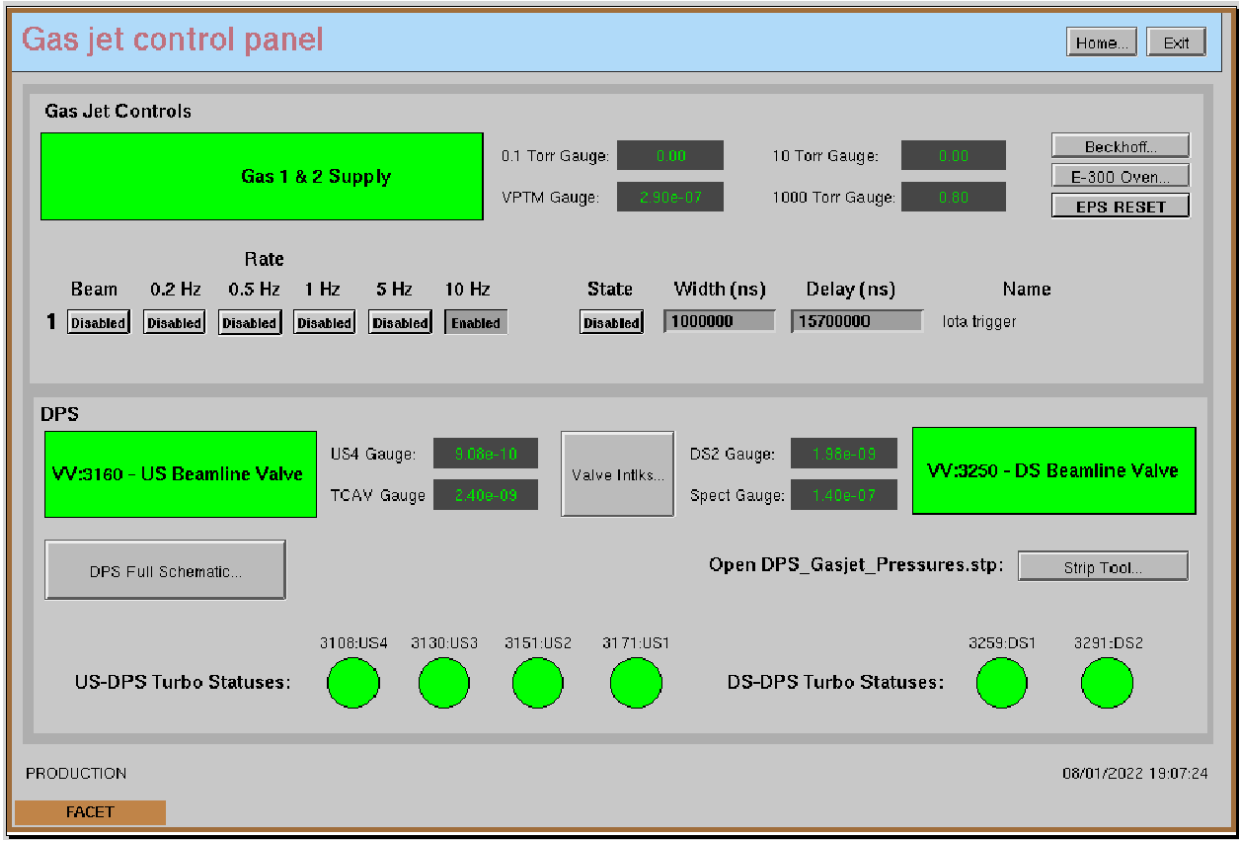




DPS operation with **Gas Jets**, from a user perspective

- DPS with gas jets has been well practiced and many kinks worked out
- Control by trained users is encouraged!
  - https://confluence.slac.stanford.edu/display/FACET/How+to+DPS+with+Gas+Jets

- Gas jet control panel contains controls and status summaries
  - Gas supply status (EPS)
  - Pressures
  - Simplified gas jet controls
  - DPS status
    - Beamline valve statuses
    - Beamline pressure
    - Turbo statuses
- Anything red means trouble



DPS operation with **static fill**, from a user perspective

- This is trickier to manage…. Not ready for prime time yet

- Things to sort out to make this user friendly
  - Remote management of the gas supply
  - Robustness of pumps (hopefully shielding works)
  - Integration into E300 control panel

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Questions?