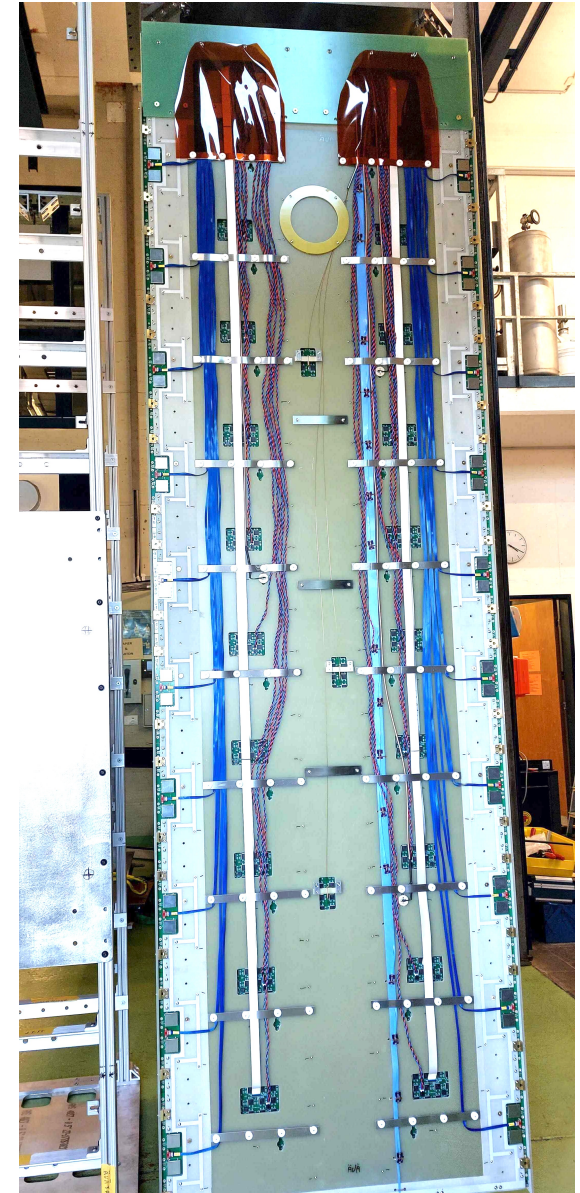


Nd-LAr Full-Scale Demonstrator Run Overview

15 November 2024

Saba Parsa, University of Bern



FSD Run Summary

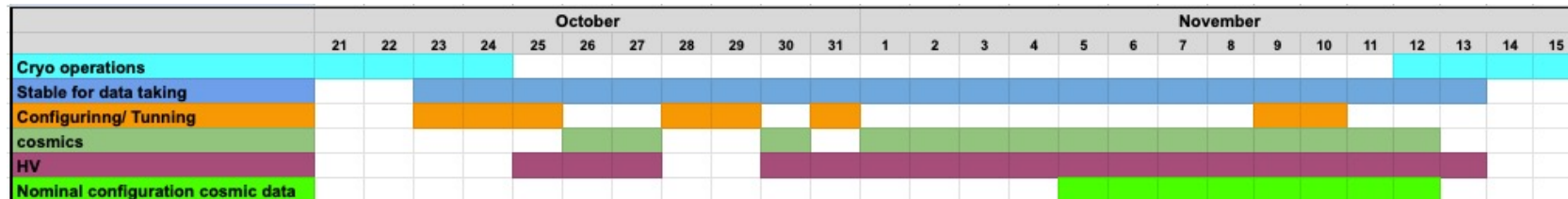
FSD Run was very successful!

Completed all the requested items in the run plan

- Successful cryogenics operation
- Successful Ramp up of the High Voltage to nominal
- LRS and CRS system collected high quality data
- Cosmics data taking > 3 days
- Radioactive source F18
- Low energy run Ar39
- Laser calibration test
- Double nominal HV ramp
- Vibration measurement of pump
- Recirculation with reduced top flow
- Zero recirculation run
- Static heat input of cryostat

FSD run timeline

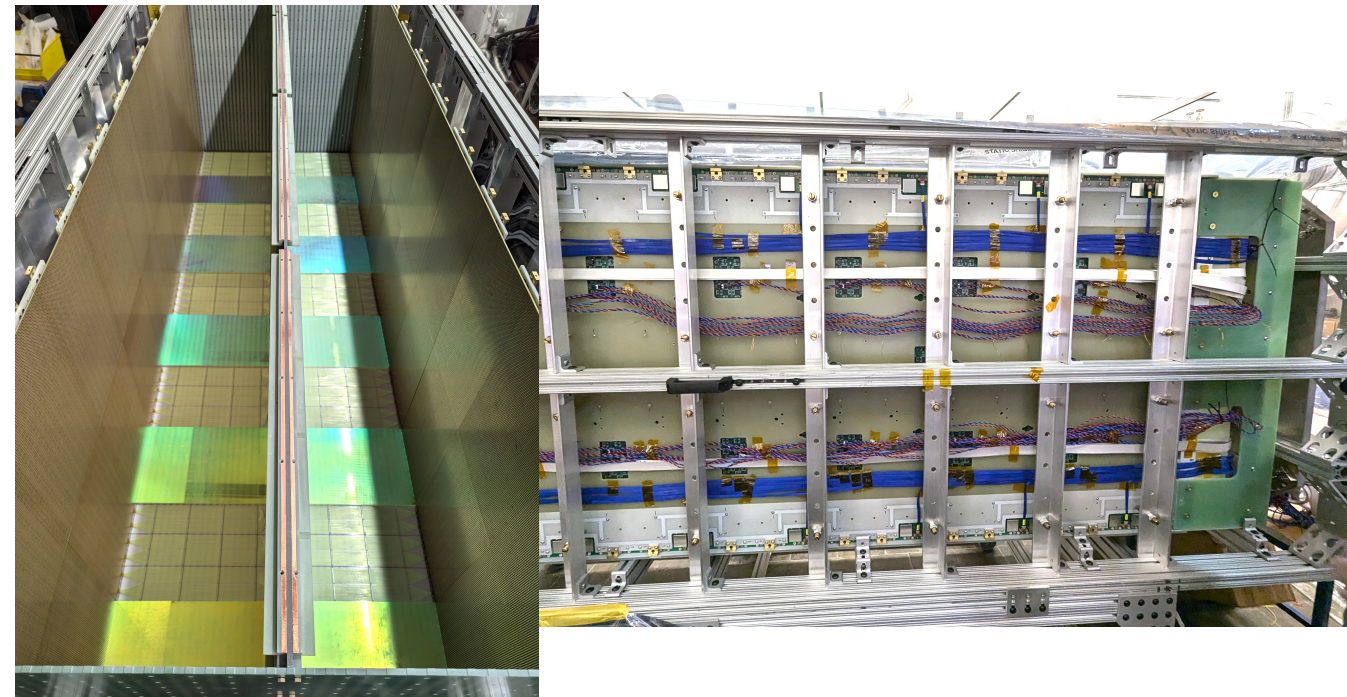
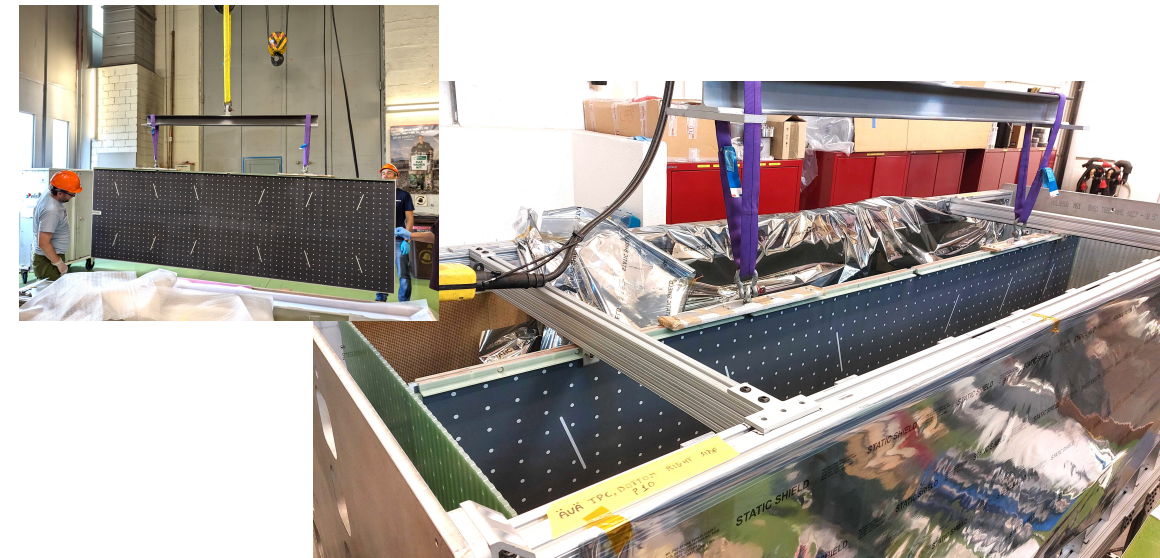
A	B	C	D	E
FSD run plan	Start date	End date	Duration[day]	Status
LAr Cooldown/Filling	Oct 21, 2024	Oct 24, 2024	3	1
Detector Cryostat Full	Oct 24, 2024	Oct 24, 2024	0	1
Cold commissioning	Oct 22, 2024	Oct 25, 2024	3	1
Ramp up HV	Oct 25, 2024	Oct 25, 2024	0	1
Initial data quality checks with cosmics	Oct 25, 2024	Oct 28, 2024	3	1
Ramp down HV	Oct 28, 2024	Oct 28, 2024	0	1
Tunning CRS	Oct 28, 2024	Oct 30, 2024	2	1
Ramp up HV	Oct 30, 2024	Oct 30, 2024	0	1
Radioactive source	Oct 30, 2024	Oct 30, 2024	0	1
CRS periodic reset scan	Oct 31, 2024	Nov 1, 2024	1	1
Laser calibration test	Nov 1, 2024	Nov 1, 2024	0	1
Laser calibration test	Nov 3, 2024	Nov 3, 2024	0	1
LRS double pulse	Nov 5, 2024	Nov 5, 2024	0	1
Low ennergy Ar39	Nov 5, 2024	Nov 5, 2024	0	1
Lead bricks added	Nov 6, 2024	Nov 6, 2024	0	1
Laser calibration test	Nov 6, 2024	Nov 6, 2024	0	1
Cosmics with nominal config	Nov 5, 2024	Nov 11, 2024	6	1
CRS ASIC configuration scan	Nov 9, 2024	Nov 11, 2024	2	1
Double nominal HV ramp	Nov 11, 2024	Nov 11, 2024	0	1
Cryo test: Reduced top flow	Nov 12, 2024	Nov 13, 2024	1	1
Vibration monitor test pump scan	Nov 13, 2024	Nov 13, 2024	0	1
Cryo test: zero recirculation	Nov 13, 2024	Nov 14, 2024	1	1
Drain to Storage	Nov 14, 2024	Nov 14, 2024	0	1
Warm up Detector	Nov 14, 2024	Nov 15, 2024	1	1
Extract FSD Module	NA	NA	0	0



Status of module installation

The Week of 30th Sep plan

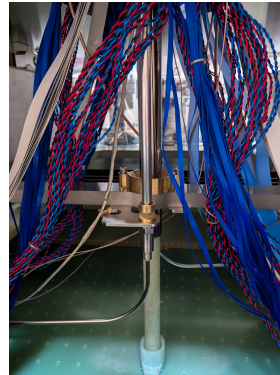
- Installation of the first field shaping side panel are ongoing -> Friday we paused the installation to clarify how to proceed with the clips that were not making contact, wrongly bent!
- Installation of the light modules on the second side
- Installation of the second field shaping side panel
- Cable and fiber routing on the back of the Anode
- Connectivity checks charge/light readout
- Rotation of the Module, installation of the top flange
- Insertion into the cryostat

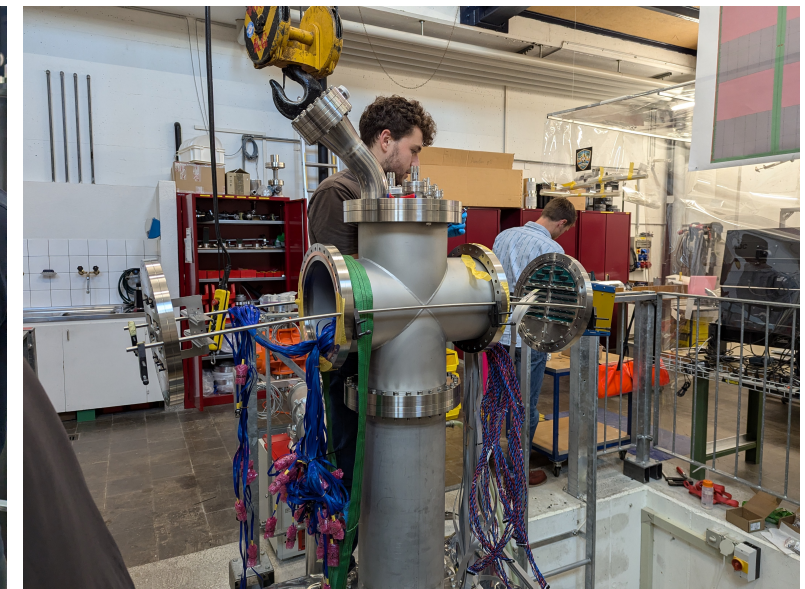
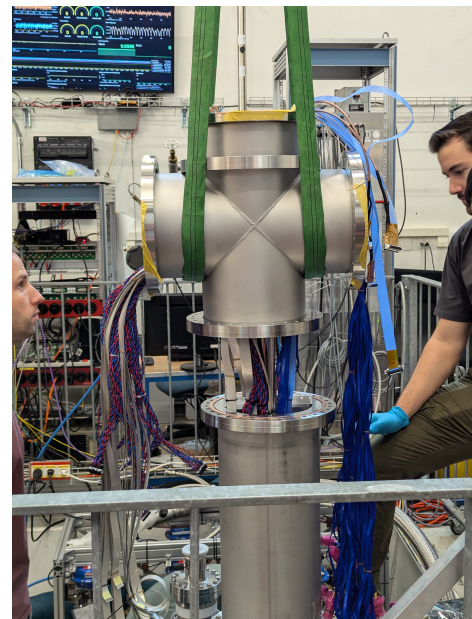
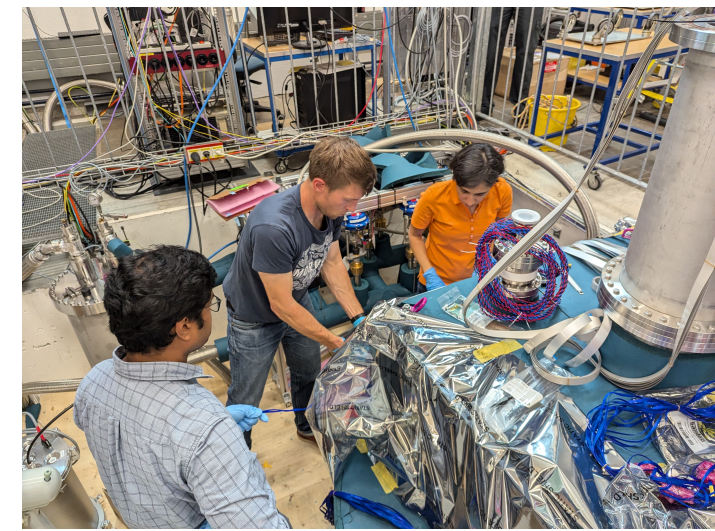
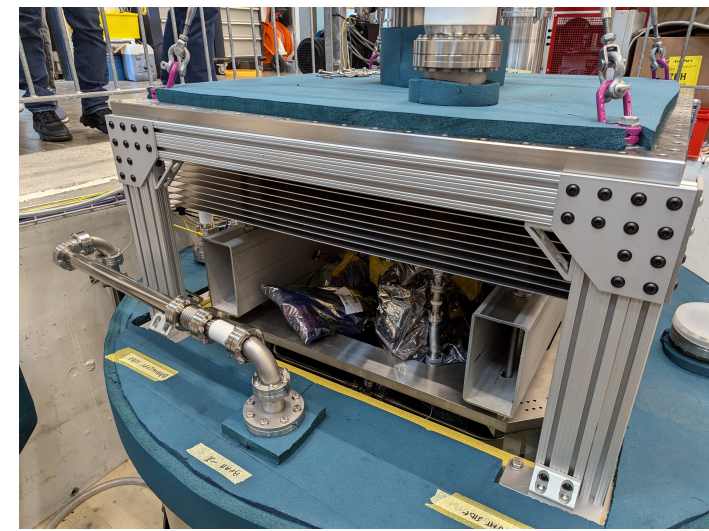


Status of module installation

The Week of 7th October plan

- Cable dressing
- Finishing the calibration fiber routing
- Rotation & insertion
- Extension tube and cabling to the feedthrough
- Connectivity test of charge readout
- Closing of the feedthroughs
- Lowering and closing the cryostat



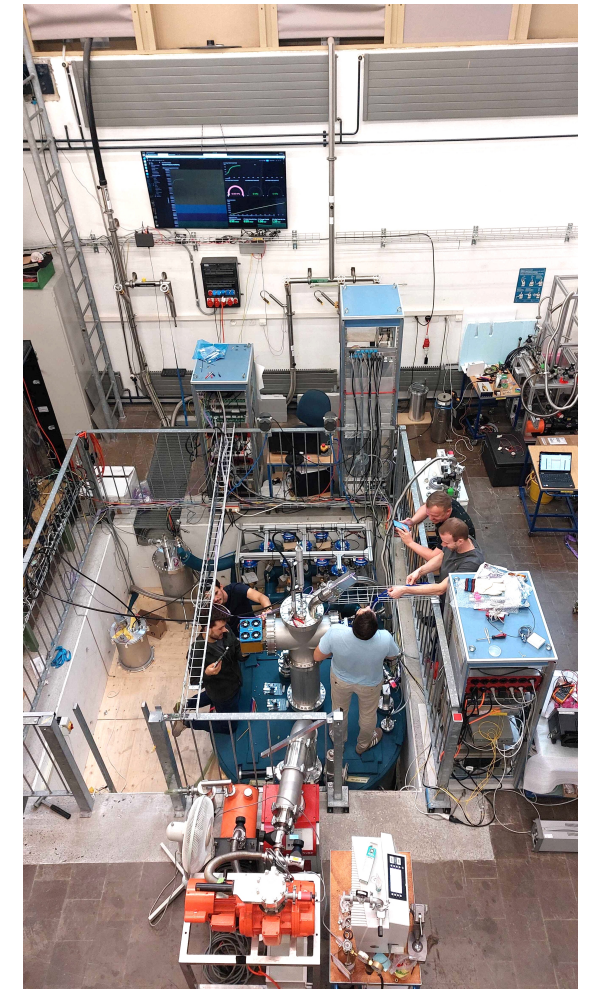
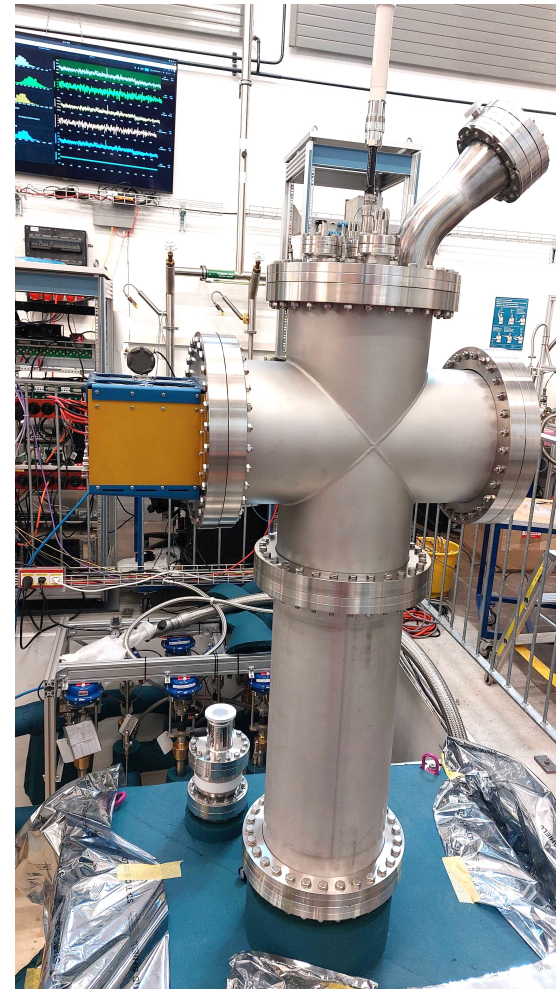


We need well thought solution for cable management during FSD disassembly, Next runs, ND-LAr

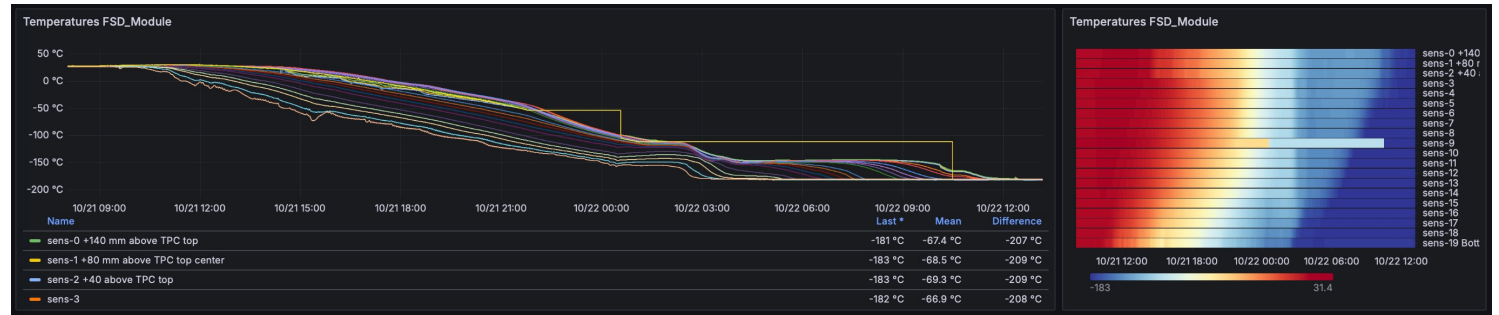
FSD Run status

The Week of 14th Oct

- Indium and grease in the groove
- Lowering and closing the cryostat
- Connectivity test of light readout
- Connectivity test of HV feedthrough
- Install Gas Flow meter
- Vacuum pumping
- Leak testing
- Pressurizing with Gas Ar
- Warm tests for light and charge
- Start of cooldown and Filling

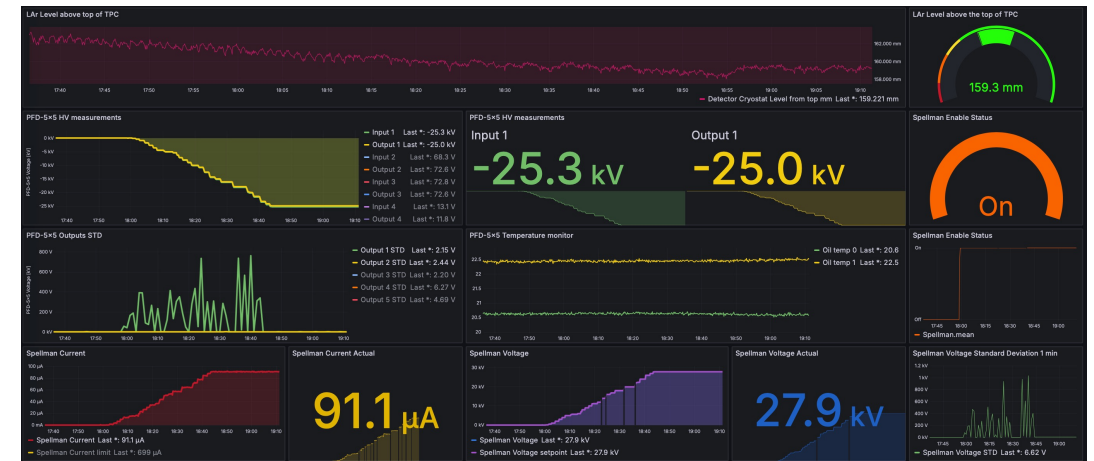


FSD Run status



The Week of 21st Oct

- Start of Shifts, Start of Cooldown (rate: 0.1 K/min)
- LAr Filling up to 2.6 m
- Identified the HV return current overload
 - Short to detector ground >> Follow up discussion is planed
- Start recirculation of detector cryostat
 - System is closed
 - Cooling power from Nitrogen evaporation 4 kW
- LAr Filling (top off) up to 3.4 m -> 10cm above target level
- Installed a new Oxygen sensor
- Cold Commissioning LRS and CRS
- Ramp of HV to -25 kV on the Cathode



HV First Ramp up

- Slow ramp rate: 16 V/s
- Diagnostic tools available:
 - HV return monitor on TPC A -> disabled
 - LRS data rate
 - CRS stability
- Hold at every 5 kV for 2 to 3 min to check system stability
- Target nominal voltage is -25 kV at the Cathode
- Requests:
 - At least 3 days at nominal V for field uniformity studies
 - Ramp beyond nominal until instability is observed or Spellman hit the limit (If this is done initially without CRS, then repeat with CRS)

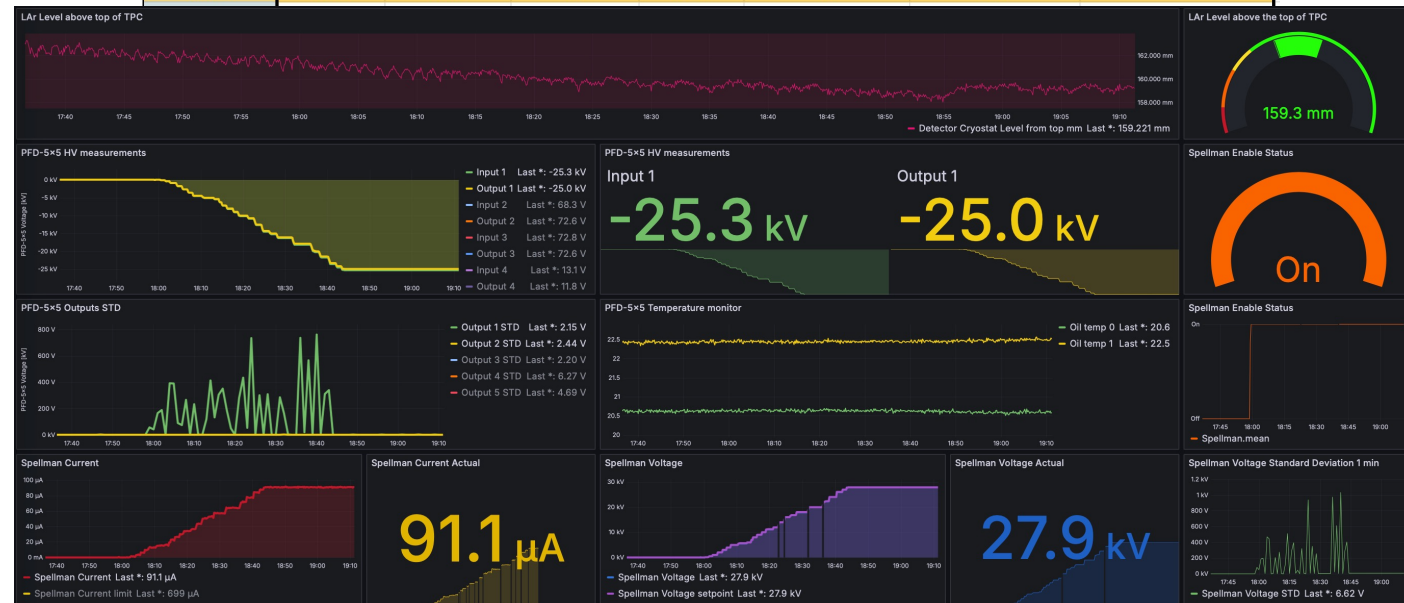
[Link](#) to HV Ramp procedure

[Link](#) to HV Ramp log

FSD First HV RAMP Log

Info: RAMP rate: 16 V/s >1kV/min

Spellman PS V [kV]	Spellman I [mA]	CH0 input HV [kV]	CH1 output HV V Cathode [kV]	Wait time [min]	Light trigger rate [Hz]	Charge packet rate [kp/s]	Comments
OFF	0	0.076	0.069	-	-	-	
ON disabled	0	0.076	0.069	-	67.7	68	
ON Enabled at 0	0	0.051	0.046	-	68.4	67.6	
-0.1	0	-0.039	-0.041	-	67.9	69.5	
-0.5	0	-0.394	-0.392	-	65.7	71.1	
-1	1.508 micro	-0.847	-0.841	-	67.5	65.4	
-2	4.5	-1.76	-1.74	-	66.9	56.9	
-3	6.5	-2.67	-2.64	-	65	33.8	
-4	10.5	-3.58	-3.54	-	64.2	13.8	
-5	13.558	-4.49	-4.43	-	62.7	10.8	
-5.63	15.06	-5.07	-5	2 min	62.5	21.9	
-6	16.5	-5.4	-5.33	-	62.8	3.72	
-7							
-8	22.5	-7.22	-7.13	-	61.1	4.42	
-9	25.61	-8.13	-8.02	-	59.7	1.55	
-10	30.12	-9.04	-8.92	-	59	9.19	
-11.2	34.64	-10.1	-10	2 min	58.1	0.6	
-12	36.15	-10.8	-10.7	-	58	4.39	
-14	43.68	-12.7	-12.5	-	55.6	0.2	
-16	51.7	-14.5	-14.3	-	55.2	6.88	
-16.8	53.22	-15.2	-15	2 min	54.6	1.91	
-18	57.2	-16.3	-16.1	-	54.2	3.44	
-20	63.2	-18.1	-17.9	-	53.7	0.043	
-22.35	72.3	-20.2	-20	2 min	53	6.87	

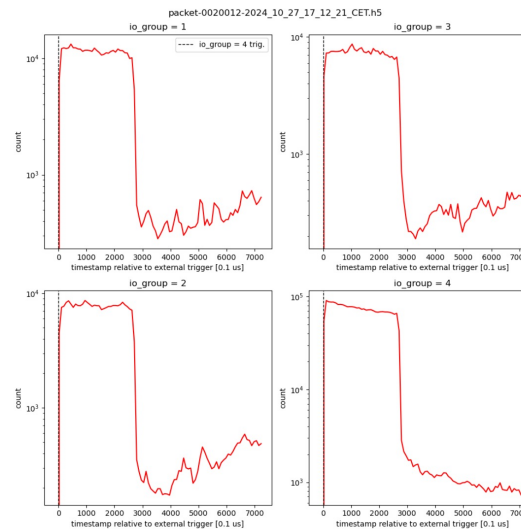


FSD Run status

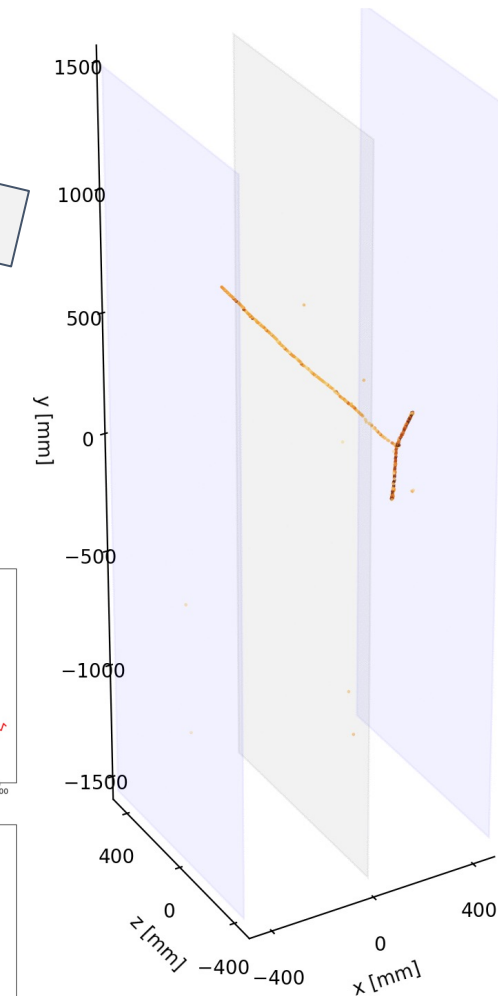
The Week of 28th Oct

- Tuning and optimizing the CRS & LRS
 - CRS: Thresholds, Reset frequency, Pedestal RMS,
 - LRS: Thresholds & data rate, Noise study, Stability
- Setting up Radioactive source F18 & data taking
 - Identified geometry problem
- Setting up Laser calibration & data taking
 - Identified event builder min hit 20
- CRS tuning, defining nominal configuration
 - Identified missing data in CRS (investigating)
- Take cosmics data ~~with nominal configurations~~

Are we taking good quality data ?

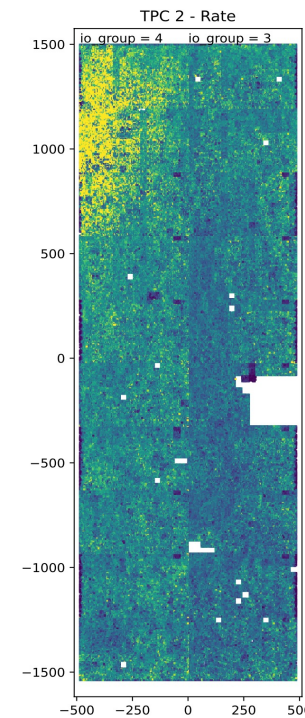
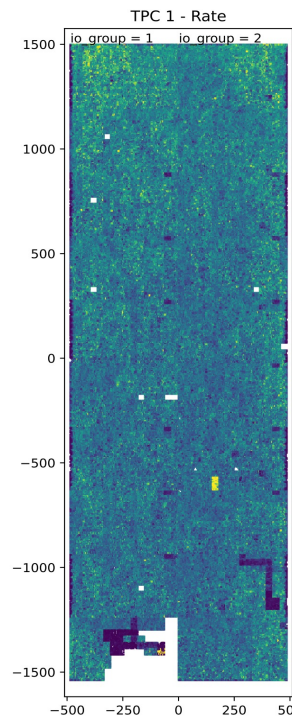
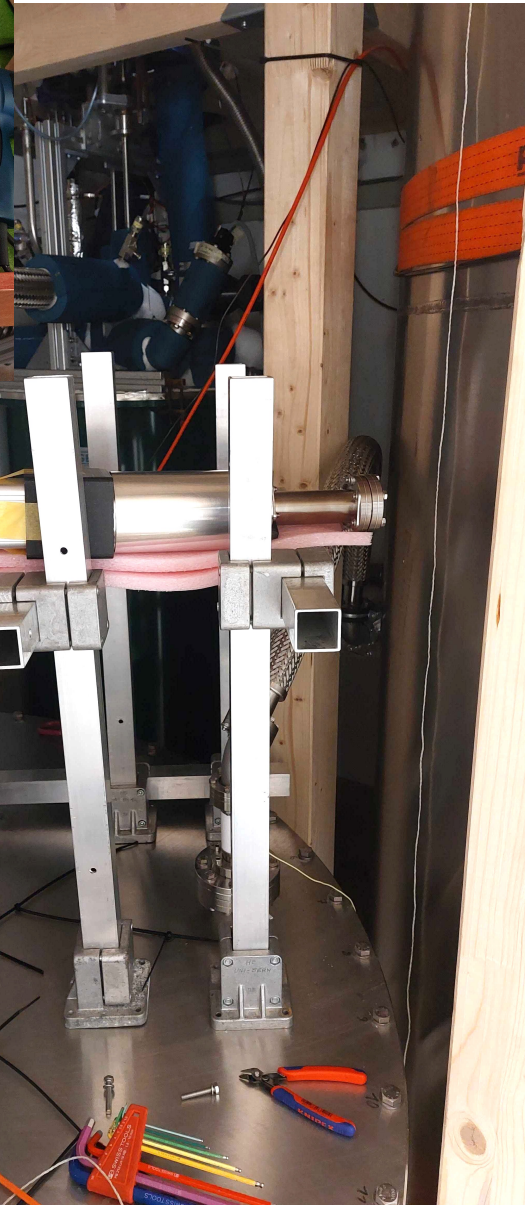
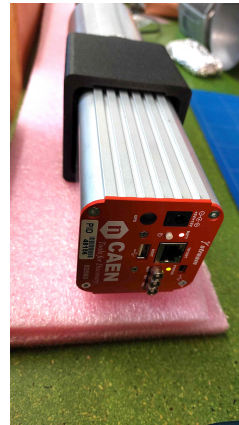
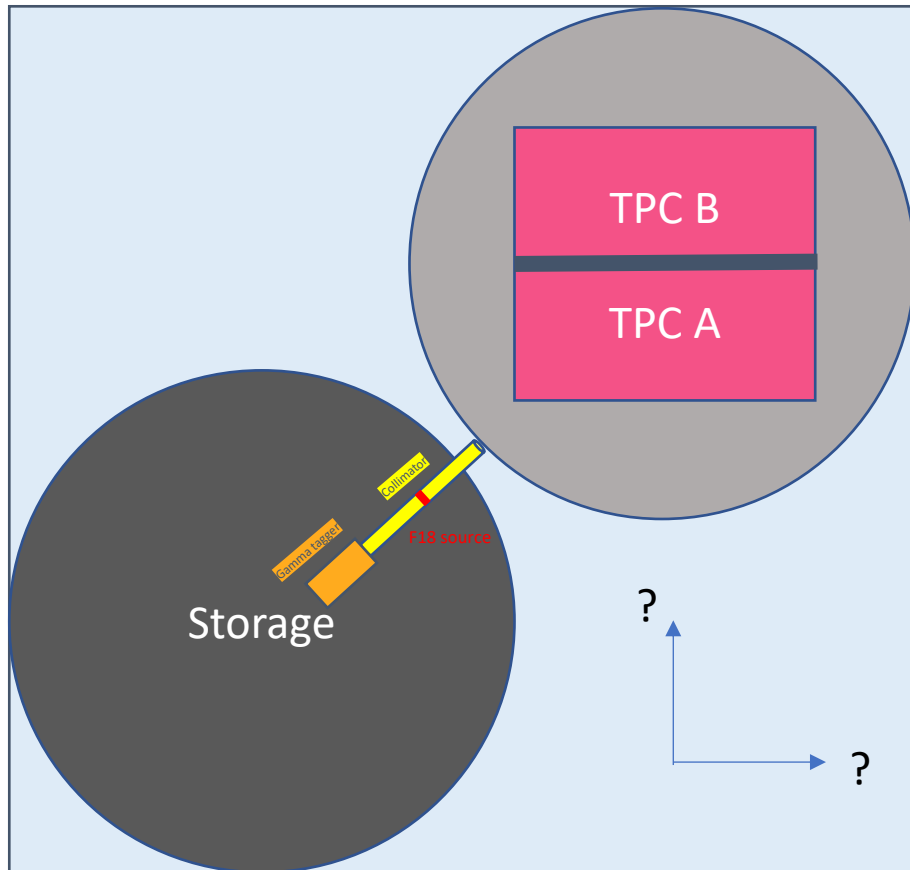


Event 132, ID 132 - 2024-11-06 21:02:59 UTC



Purity is very good

Scheme of the FSD module and F18 radioactive source



Tom Murphy

FSD Run status

The Week of 4th Nov

- Are we taking good quality data?
 - CRS? -> Yes
 - LRS? -> Yes
- CRS investigation and tuning ->> Data loss issue is resolved
- LRS special tests
 - LED timing study double pulse (Tuesday-Thursday)
 - Low threshold data taking one TPC at a time
 - Noise background data taking
 - Threshold scan -> Planning for low energy run configuration (Monday)
- Additional run with Laser and periodic trigger readout of CRS
- Vibration monitor -> Sensor connected to the cryostat, data monitor in grafana
- Visual observation of bubbling -> View port @50% pump
- Low energy run >> Ar 39
- Take cosmics data with nominal configurations (3days) + Lead bricks
- HV higher than nominal run
- Zero recirculation test

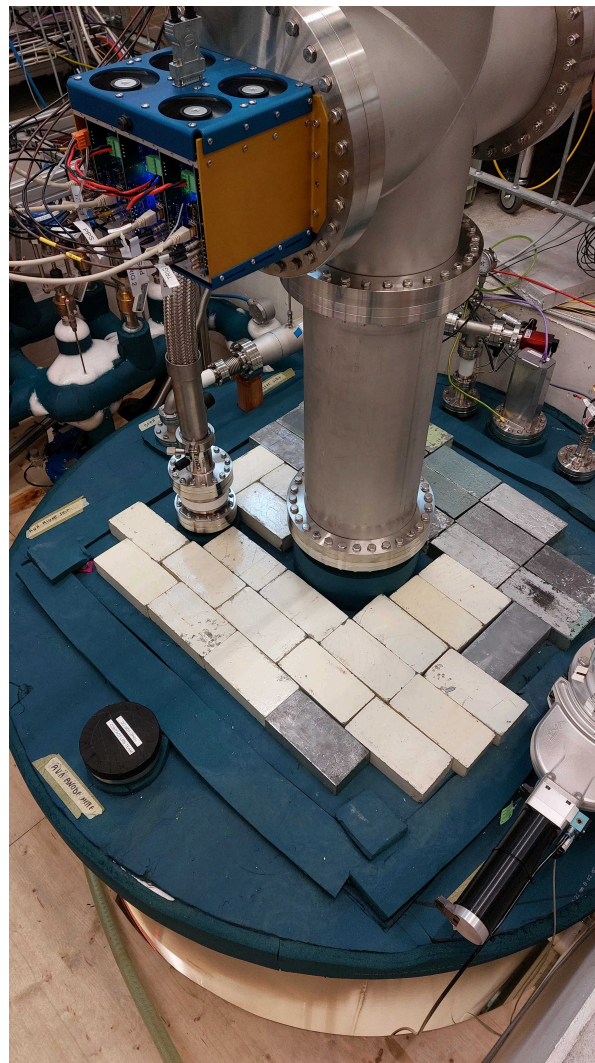
Can we finish this program this week?

We probably continue running next week

Please Extend your availability in shifter table

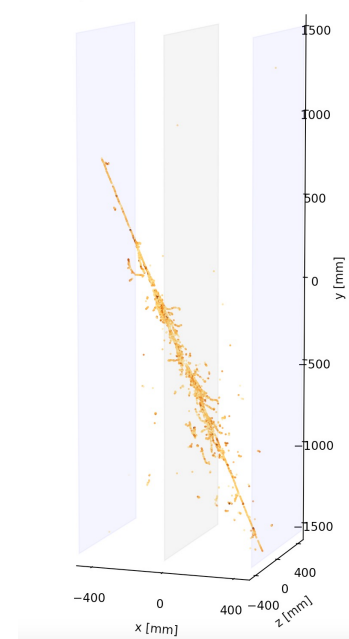


View port inspection with pump at 50%
11/15/24

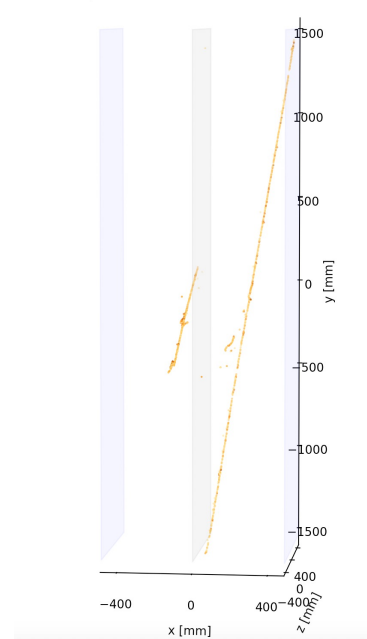


Placed 450 kg Lead bricks on top of cryostat
Saba Parsa | FSD run overview

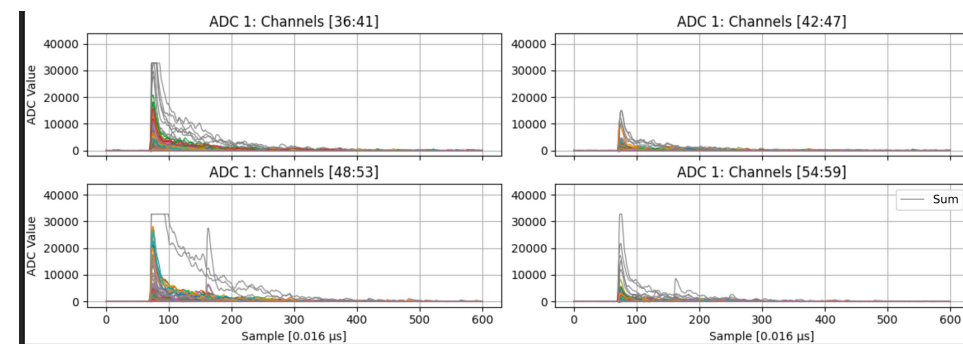
Event 5, ID 9450 - 2024-11-06 20:39:14 UTC



Event 94, ID 25636 - 2024-11-06 20:40:00 UTC



CRS confirmed taking good quality data

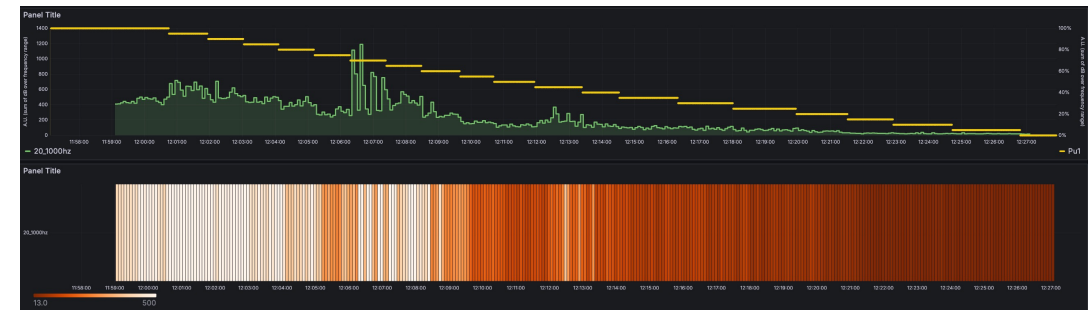
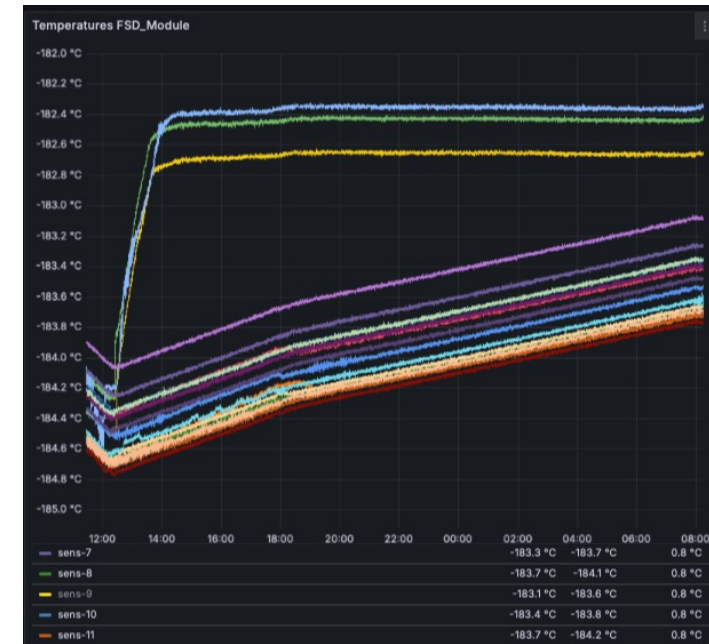
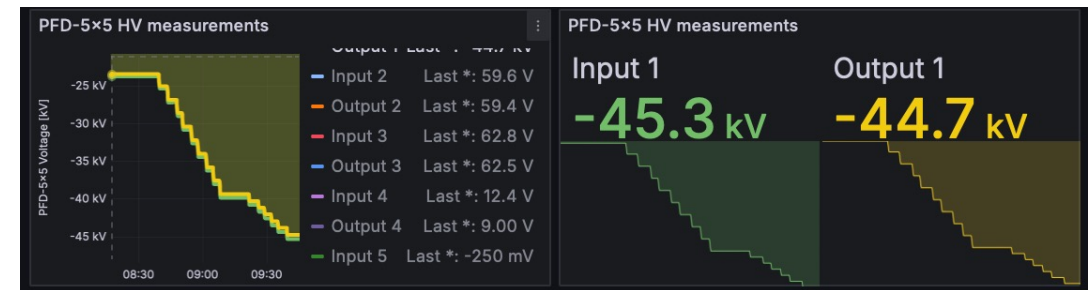


LRS confirmed taking good quality data

FSD Run status

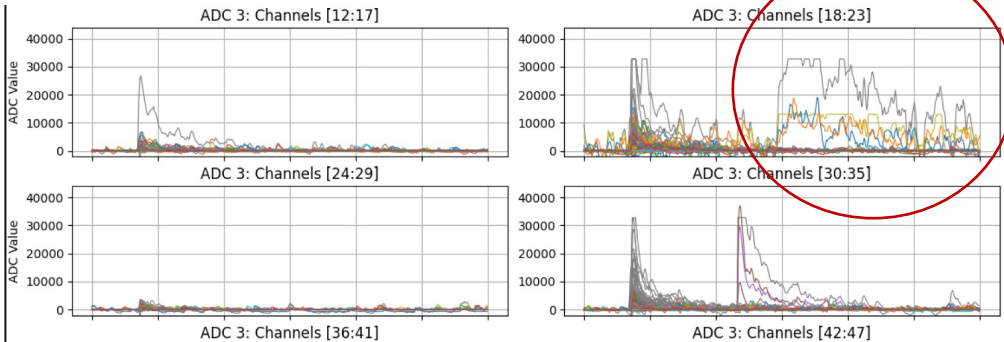
The Week of 11th Nov

- HV higher than nominal run
- HV off, CRS pedestal run + additional tests
- Reduced flow form top instead of zero recirculation test
- Vibration monitor -> pump power scan
- Zero recirculation, power measurement
- Electronics OFF, power measurement
- LAr transfer to Storage
- Warm up with heaters
- End of shifts Friday 15 November 2024

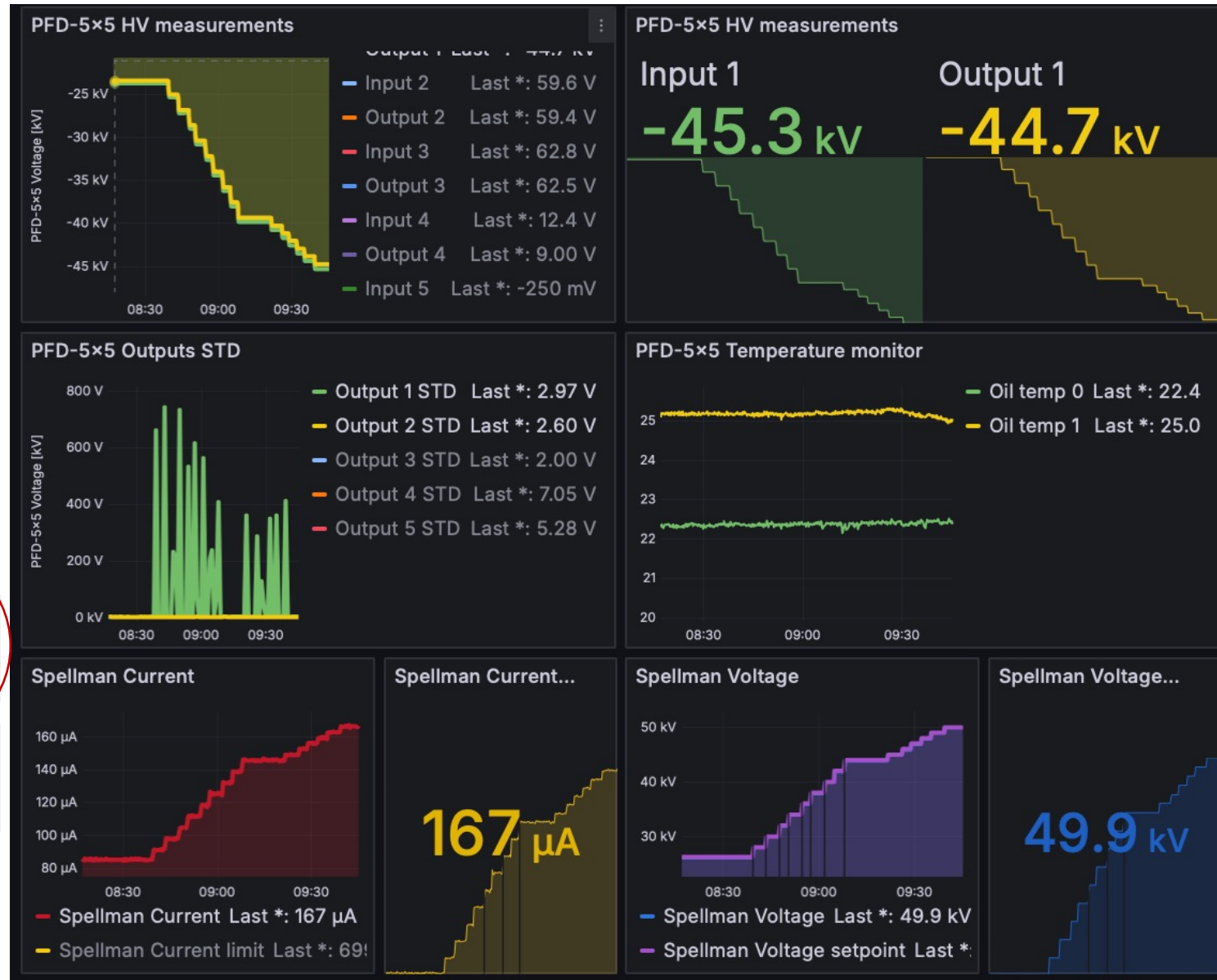


HV higher than nominal

- Went to Max HV possible with Spellman set to 50 kV
 - Cathode: 44.7 kV
 - E field: 0.96 kV/cm
 - LRS and CRS rates were stable
 - Jan observed some strange waveforms (local discharge?)

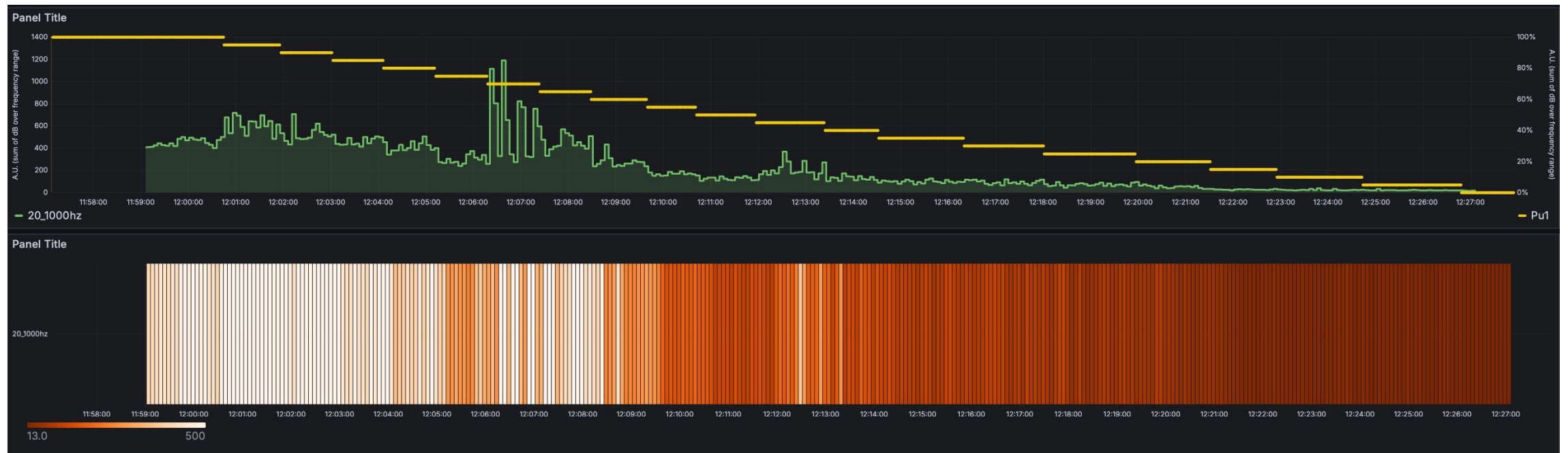


- 30 min data at each 4 kV interval



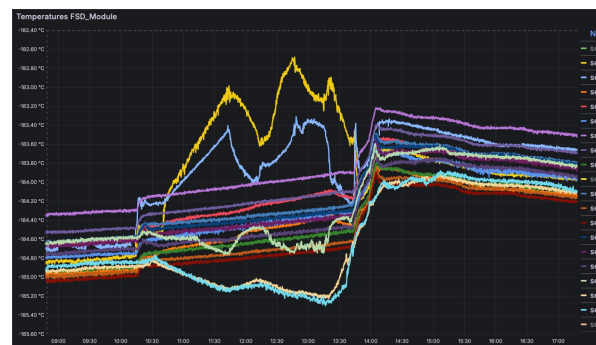
Vibration Monitor test

- Vibration sensor (Lukas) -> Piezo element
- At least 6 min data taking at each 5% interval pump setting from 40% to 100%
- Observed resonances at 65-70% pump power (Audibly noisier)

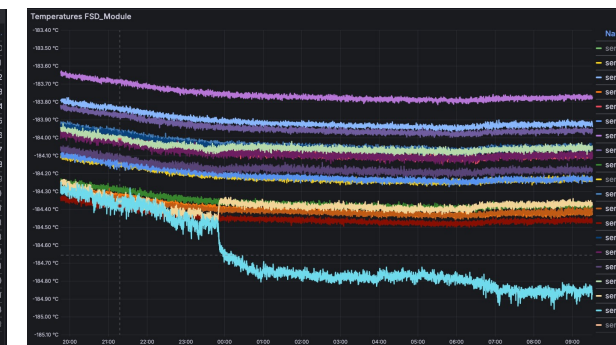


Cryo tests

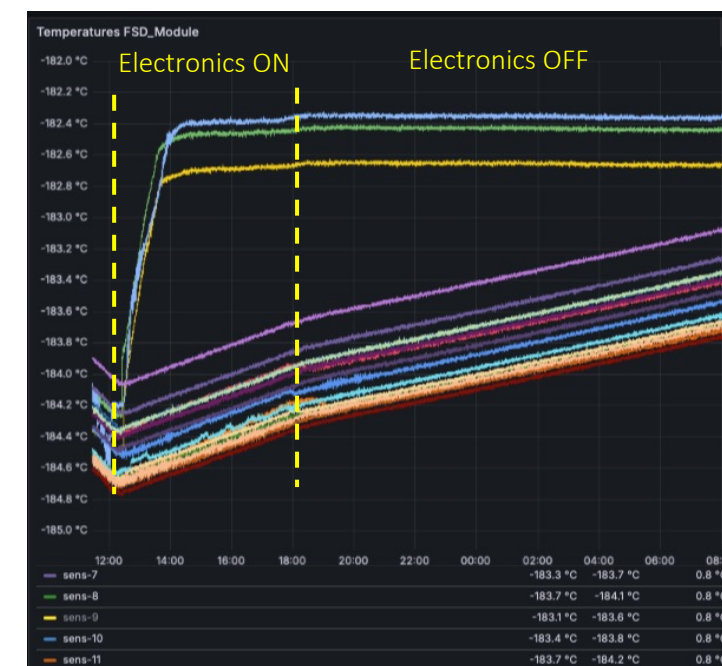
- 2 kg/min top flow -> **Not stable**
 - Top temp sensors increased rapidly
 - Temperatures in the LAr bulk keep increasing in a steady rate 0.07 K/h
 - Bottom sensors got much colder
- 10 kg/min top flow -> **Stable**
 - Total Flow 25 kg/min
 - LN pressure 1.45
- Zero recirculation test
 - Bulk LAr temp ~ 2 K below boiling point thanks to LN cooling
 - Overpressure rose until the PID valve opened
 - Venting from latent heat ~ 25 lit/min -> Power ~ 83 W
 - Bulk LAr Temperatures rising 0.3 K/145 min -> Power ~ 380 W
- Static Heat input to cryostat
 - HV, CRS, LRS, Pump All OFF
 - Vent from latent heat 16 lit/min -> Power ~ 53 W
 - Bulk LAr Temperature rise 0.5 K/720 min -> Power ~ 130 W



2 kg/min top flow



10 kg/min top flow



Zero recirculation test

Data run log

[Link](#) to FSD run log

[Link](#) to data on NERSC

[Link](#) to online event display

Run numbers with green color are cosmics data for analysers

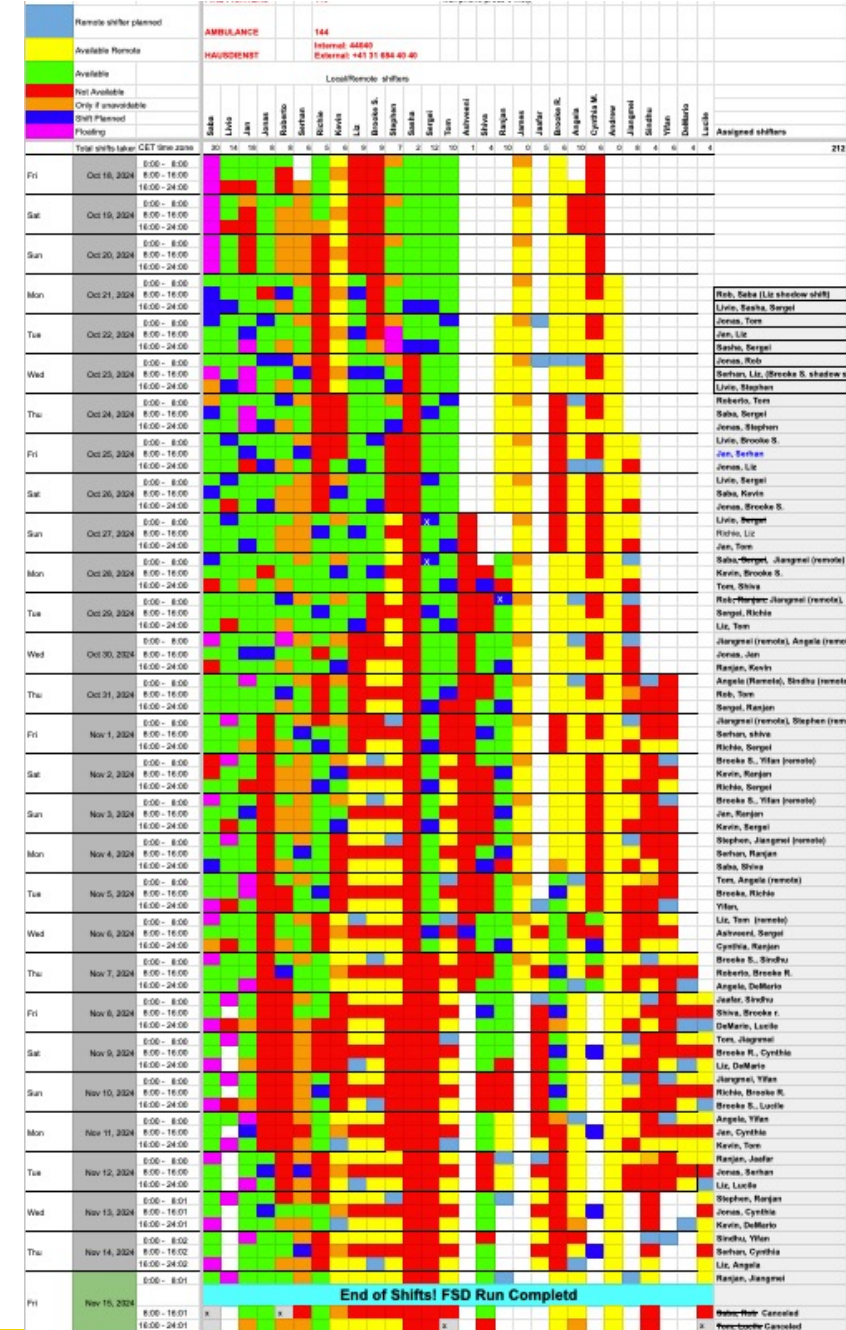
-> Add more info to this table

- Info about CRS -> Good data/Bad data
- Info about event builder settings in flow

A	B	C	D	E	F	G	H	I	J	K
Recirculation	Cathode HV [kV]	Drift field [kV/cm]	run number	Start Timestamp [from first crs datafile]	LArPix Data Directory	Light R/O Directory	LRS sum threshold [ADC]	LRS trigger scaling	LRS VGA gain [dB]	Comments 1
55%	23.4	0.5	20042	2024_10_31_07_41_58_CET	/storage/data/CRS/cosmics/config	/storage/data/LRS/data_bin_02	10K	10	10	CRS config scan iteration 13
50	23.4	0.5	20043	2024_10_31_08_14_38_CET	/storage/data/CRS/cosmics/config	/storage/data/LRS/data_bin_02	10K	10	10	CRS config scan iteration 14
50	23.4	0.5	20044	2024-10-31-11-19-12 CET	/storage/data/CRS/cosmics/config	/storage/data/LRS/data_bin_02	10K	10	10	CRS config scan iteration 15
50	23.4	0.5	20045	2024-10-31-13-26-31 CET	/storage/data/CRS/cosmics/config	/storage/data/LRS/data_bin_02	10K	10	10	Disregard this run, wrong CRS directory
50	23.4	0.5	20046	2024-10-31-13-29-50 CET	/storage/data/CRS/cosmics/31Oct2	/storage/data/LRS/data_bin_02	10K	10	10	started run after new CRS config scans, corresponds to SCAN2 = iteration equivalent 2
50	23.4	0.5	20047	2024-10-31-17-44-27 CET	/storage/data/CRS/debug	/storage/data/LRS/data_bin_02	10K	10	10	testing new pacman server on io_group=4 to see if it helps mitigate observations of dropped packets
50	23.4	0.5	20048	2024-10-31-19-54-08 CET	/storage/data/CRS/cosmics/31Oct202	/storage/data/LRS/data_bin_02	10K	10	10	back to 20046 config, back to pacman server that was used previously on io_group 4
LASER Calibration system test										
50	23.4	0.5	20049	2024-11-01-12-17-30 CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_run_01	LASER trigger	0	10	Checking fibers with low intensity power and filter Laser connected via optical fiber to Side A feedthrough 3. With ND filter in between two connecting fibers TPC A: Fiber 3 is ok, Fiber 6 is ok, TPC B: Fiber 4 is broken, Fiber 1 is ok
50	23.4	0.5	20050	2024-11-01-13-05-25-CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_run_01	LASER trigger	0	10	Aua side - feedthrough 6 - top fiber (~ 65uJ power measured) - Laser at 10Hz
50	23.4	0.5	20051	2024-11-01-13-27-36-CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_run_01	LASER trigger	0	10	Aua side - feedthrough 3 - Middle fiber (~ 62uJ power measured)Laser at 10Hz
50	23.4	0.5	20052	2024-11-01-14-57-20-CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_run_01	LASER trigger	0	10	Baren side - feedthrough 1 - Bottom (~ 66uJ) - Laser at 10Hz
50	23.4	0.5	20053	2024-11-01-15-31-12-CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_run_01	LASER trigger	0	10	Aua side - feedthrough 6 - top fiber (~ 100uJ power measured) - Laser at 10Hz
Calibration system test stopped										
50	23.4	0.5	20054	2024_11_01_17_23_33_CET	/storage/data/CRS/calibration					disregard this run. location of crs files was not set properly
50	23.4	0.5	20055	2024_11_01_17_27_02_CET	/storage/data/CRS/cosmics/01N	/storage/data/LRS/data_bin_03	10 K	10	10	CRS test with slower UART transmission speed
50	23.4	0.5	20056	2024_11_01_20_33_48_CET	/storage/data/CRS/cosmics/01N	/storage/data/LRS/data_bin_03	10 K	10	10	Same as previous run + CRS disabled noisy channels
50	23.4	0.5	20057		/storage/data/CRS/cosmics/01N	/storage/data/LRS/data_bin_03	10 K	10	10	
Start calibration runs										
50	23.4	0.5	20058	2024-11-03-15-21-10-CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_calib_runs	LASER trigger	0	10	filter: 4.0 OD
50	23.4	0.5	20059	2024-11-03-15-24-29-CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_calib_runs	LASER trigger	0	10	restart, collecting LRS data now too; filter: 4.0 OD
50	23.4	0.5	20060	2024_11_03_15_33_07_CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_calib_runs	LASER trigger	0	10	filter: 4.0 OD
50	23.4	0.5	20061	2024_11_03_15_42_18_CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_calib_runs	LASER trigger	0	10	filter: 4.0 OD
50	23.4	0.5	20062	2024_11_03_16_02_09_CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_calib_runs	LASER trigger	0	10	filter: 4.0 OD + 2.0 OD
50	23.4	0.5	20063	2024_11_03_16_11_14_CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_calib_runs	LASER trigger	0	10	filter: 4.0 OD + 2.0 OD
50	23.4	0.5	20064	2024_11_03_16_19_41_CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_calib_runs	LASER trigger	0	10	filter: 4.0 OD + 2.0 OD
50	23.4	0.5	20065	2024_11_03_16_36_34_CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_calib_runs	LASER trigger	0	10	filter: 2.0 OD
50	23.4	0.5	20066	2024_11_03_16_44_03_CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_calib_runs	LASER trigger	0	10	filter: 2.0 OD
50	23.4	0.5	20067	2024_11_03_16_48_35_CET	/storage/data/CRS/calibration	/storage/data/LRS/laser_calib_runs	LASER trigger	0	10	filter: 2.0 OD
End calibration runs										
50	23.4	0.5	20068	2024-11-03-17-23-42 CET	/storage/data/CRS/debug	/storage/data/LRS/data_bin_04	10 K	10	10	CRS Test: Removing trigger cable from io_group 4
50	23.4	0.5	20069	2024-11-03-17-57-24 CET	/storage/data/CRS/debug	/storage/data/LRS/data_bin_04	10 K	10	10	swap trigger cables on iog 4 and iog 1 so that iog 1 is getting every trigger and iog 4 is getting prescaled triggers (like iog 2 and 3)
50	23.4	0.5	20070	2024-11-03-18-15-51 CET	/storage/data/CRS/cosmics/04Nov202	/storage/data/LRS/data_bin_04	10 K	10	10	Back to original ext trigger scheme for CRS: iog 1,2,3 get prescaled, and iog 4 gets every trigger
50	23.4	0.5	20071	2024-11-03-21-04-31 CET	/storage/data/CRS/cosmics/04Nov202	/storage/data/LRS/data_bin_04	10 K	10	10	increase threshold on CRS (+2 global threshold DAQ on all channels)

Thanks to local and Remote Shifters

- 26 days of shifts
- 212 shift slots of 8 hours = 1696 hours
- 8 days of fully local shifts then introduced remote shifts
- 26 shifters (local & remote)



List of actions after FSD operation is finished

- Upgrade the PLC windows machine
- Remote control software for PLC
- Measure the exact distance of TPC top to the top flange
- Check why 5 SiPMs were dead -> Check in warm
- Check FSD temp sens-9
- Upgrade the Green filter setup -> Very large heat input -> Ice on top. Loss of vacuum in Jacket
- Test and Improve the differential pressure read -> Test with clean ground,
- Consider using the capacitive level meter from single module cryostat
- Replace diff pressure sensor on Storage Cryostat
- Fix LN level meter electronics
- Add shield from melting ice for the electronics in the pit
- Add Cryo Camera on Detector cryostat
- Add view port on Storage cryostat
- Change the keyhole LED feedthrough
- Add purity monitor
- Fix the ground return short with Capton tape >> What about the edge tile noise?
- Regenerate Green Filter and Filling Filter
- Solution for cable management during rotation and top structure assembly

Thanks everyone for a smooth and successful FSD Run

