

ND-LAr

Full-Scale Demonstrator

Run plan discussion









4th November 2024


Saba Parsa, University of Bern



Highlights of the FSD facility schedule

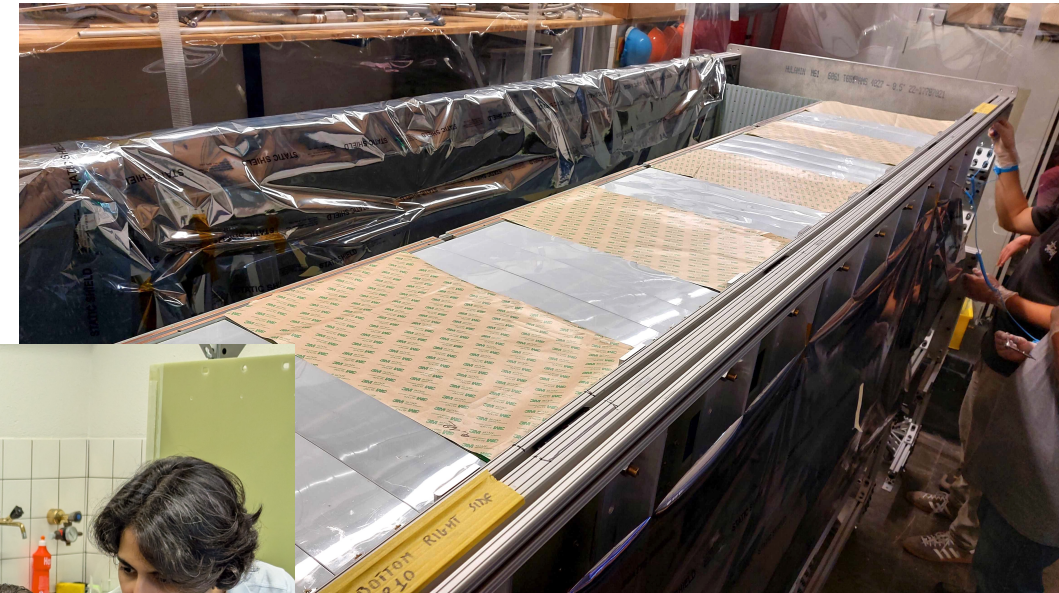
- Installation of the Cryogenics finished end of May
- Dummy module assembled and inserted into the detector cryostat end of July
- **End of August 2024: Cryo run** + Mechanical test
- Reception and Assembly of the FSD Module Mid September – 1st week of October
- **Mid October 2024 : FSD run**

- Assembly jig 
- Module structure (mechanical test) 
- HV filter 
- ArcLight/LCM 
- Charge readout  9, 17 September
- Light readout 
- Field shell  16 September
- Calibration system  30 September

- DAQ server preparation 

DAQ preparation

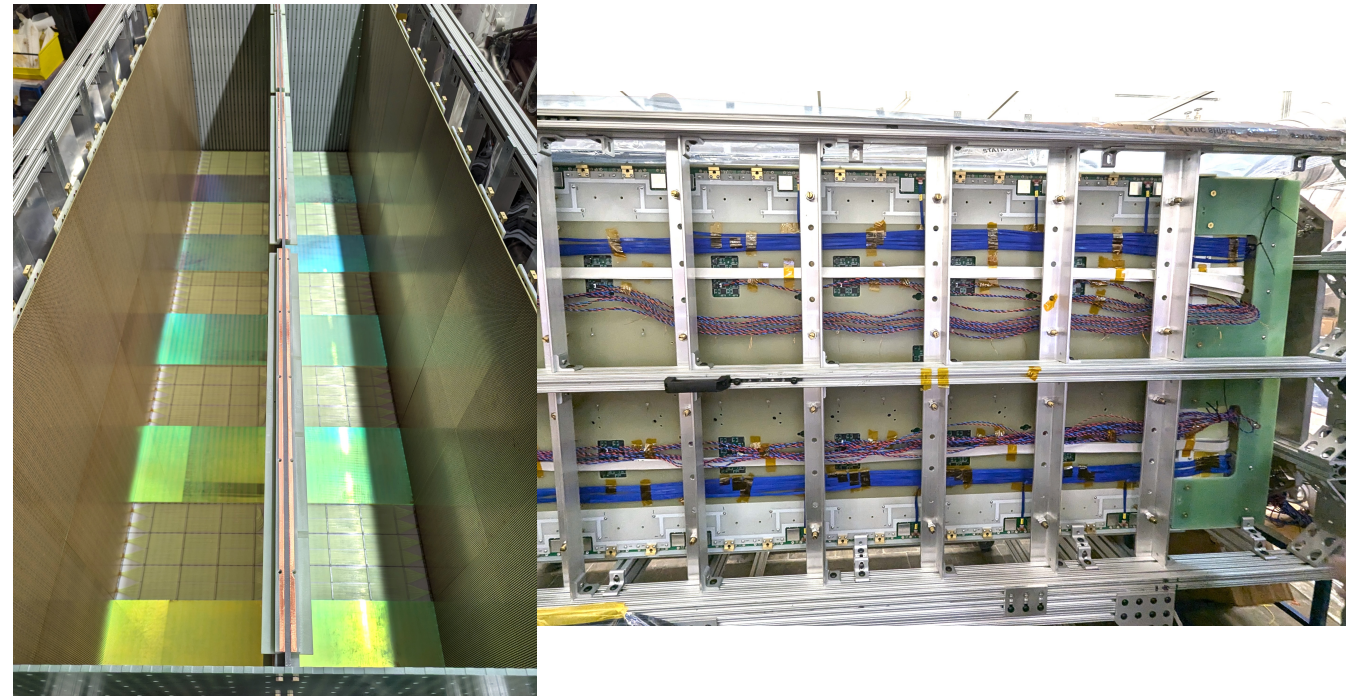
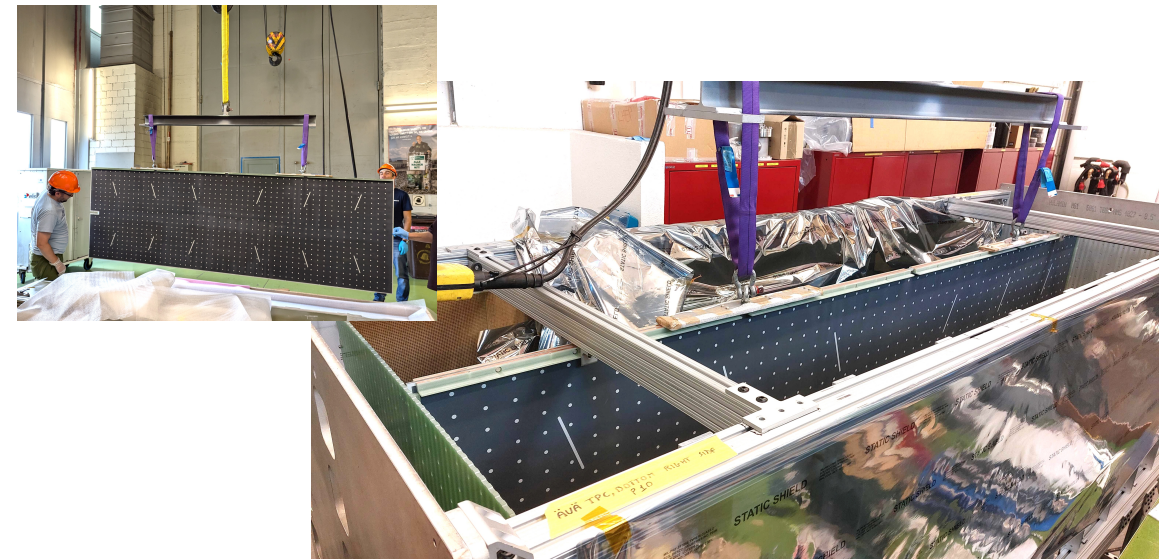
- Light and charge readout teams are working on the DAQ
- DQM preparation is ongoing -> Test with fake data
- All setup and working



Status of module installation

The Week of 30th Sep plan

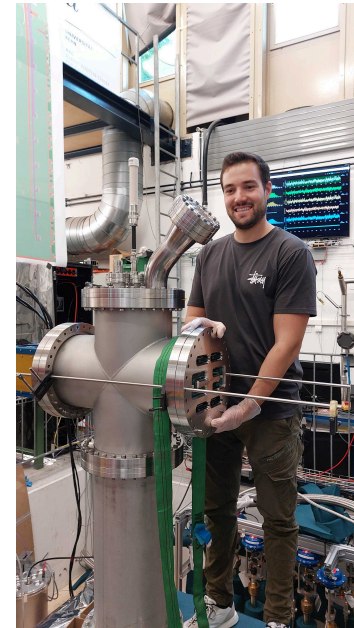
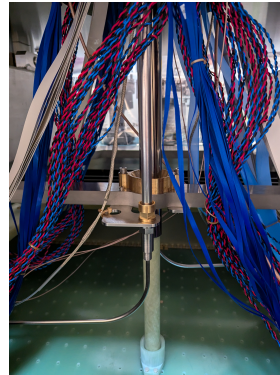
- Installation of the first field shaping side panel are ongoing -> Friday we paused the installation to clarify how to proceed with the clips that were not making contact, wrongly bent!
- Installation of the light modules on the second side
- Installation of the second field shaping side panel
- Cable 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

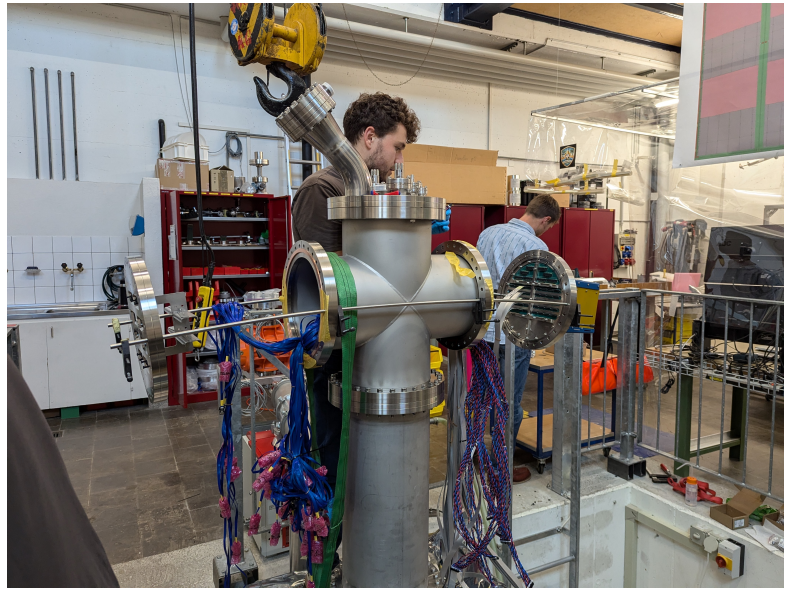
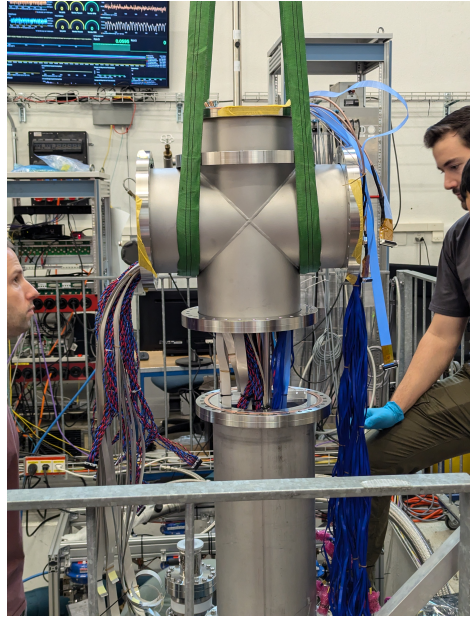
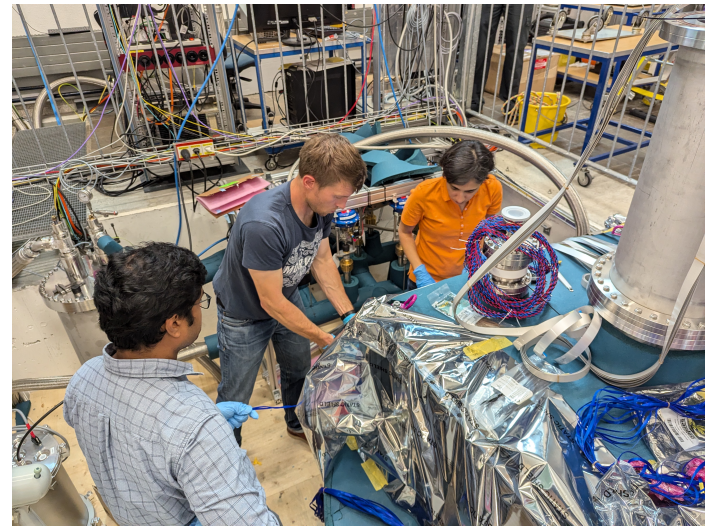


Status of module installation

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

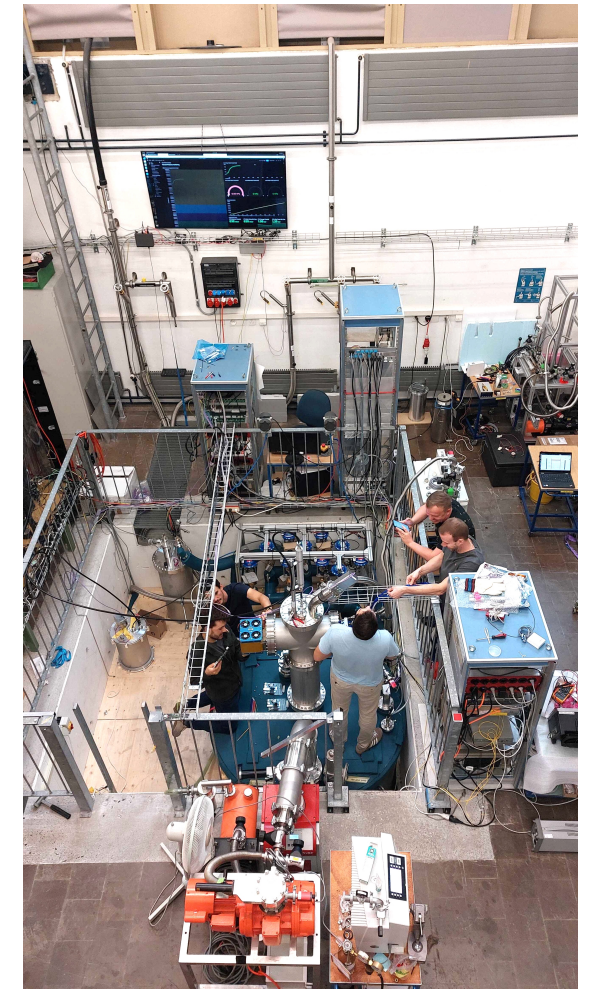
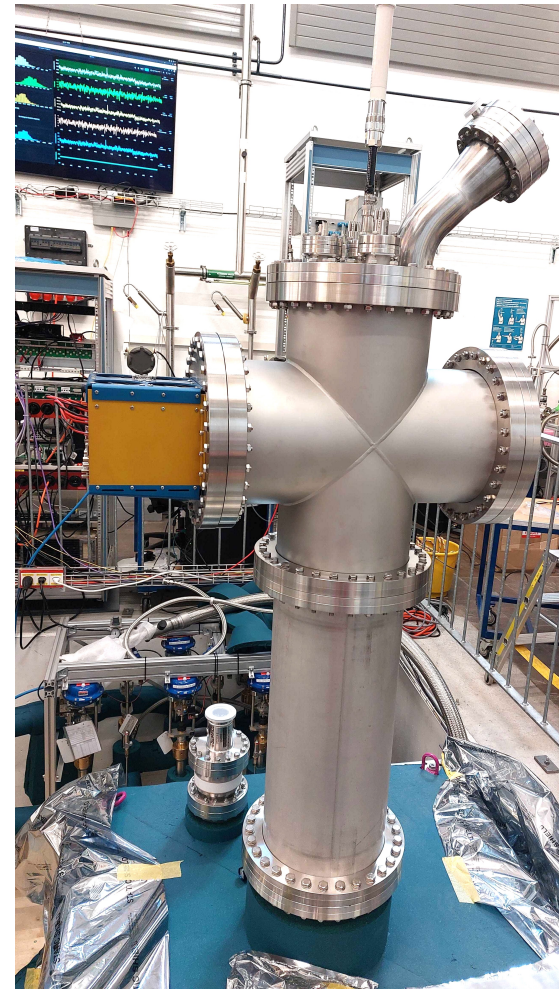




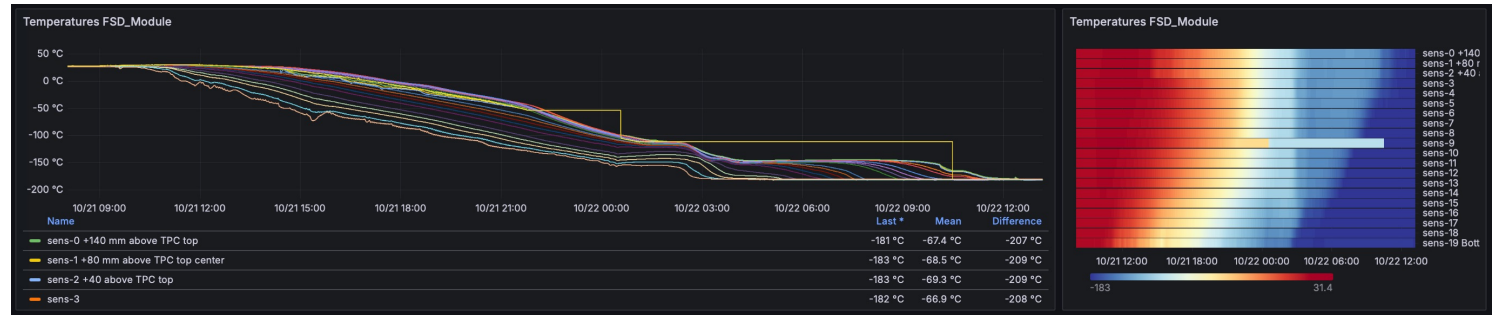
FSD Run status

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

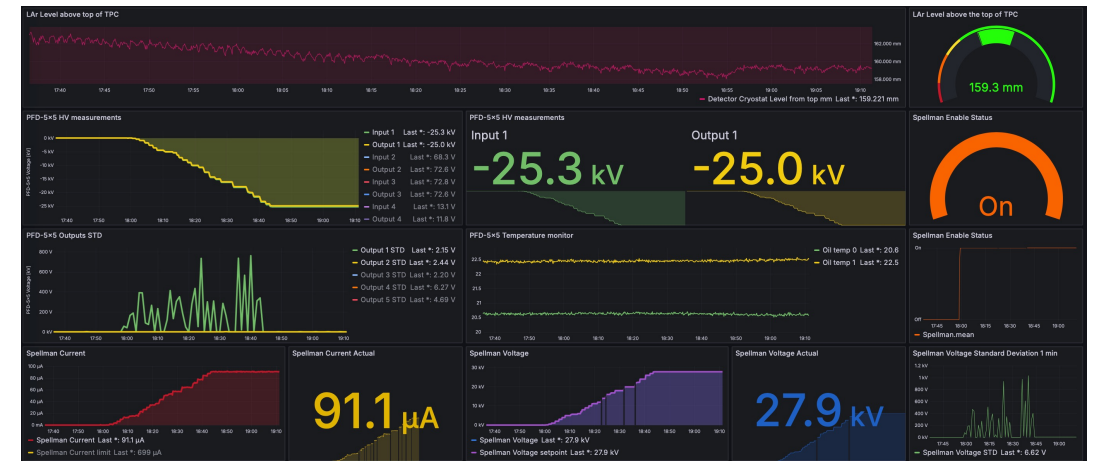


FSD Run status

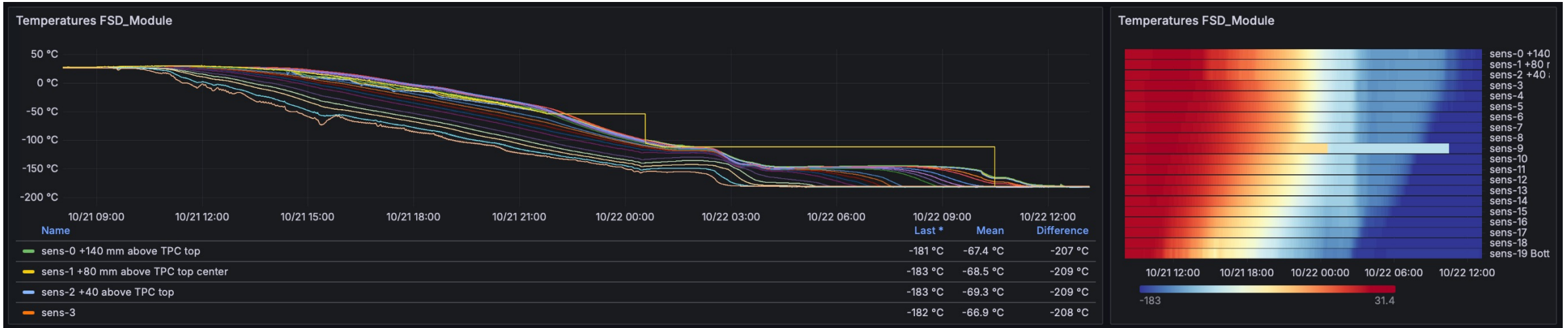


The Week of 21st Oct

- 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



Cooldown Summary (Mon-Tue)



After Filling: All FSD Module sensors are submerged, and we are cooling the LAr



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)

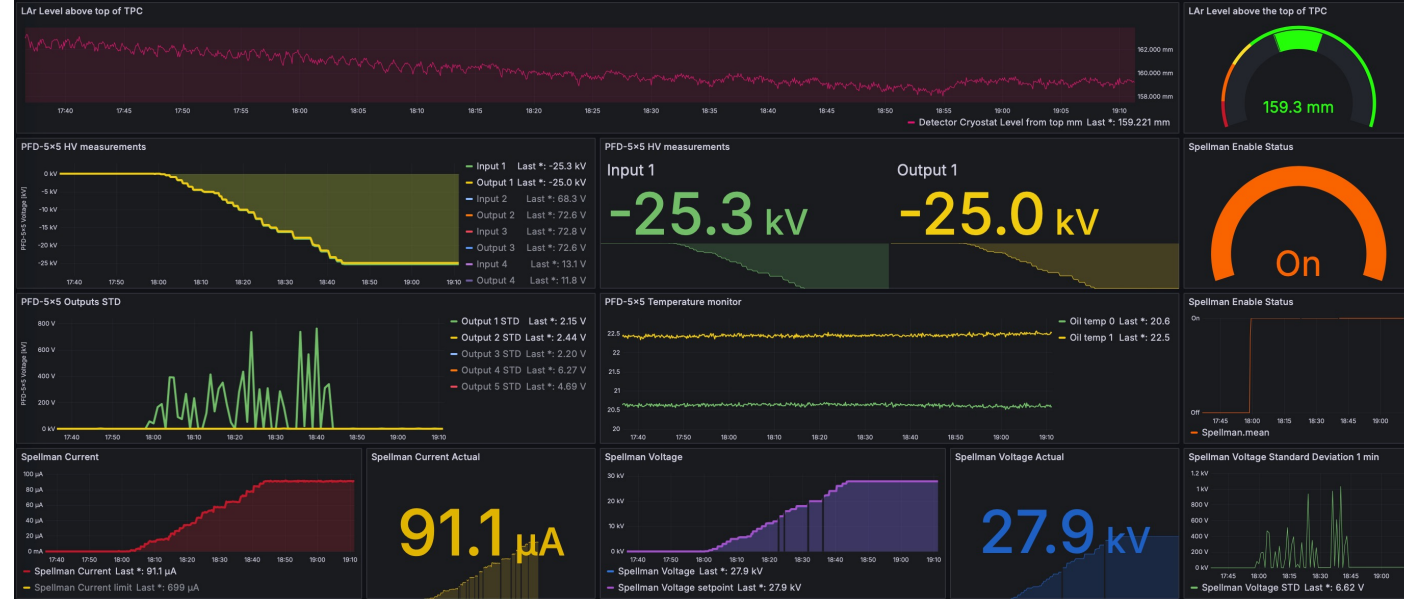
[Link](#) to HV Ramp procedure

[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	

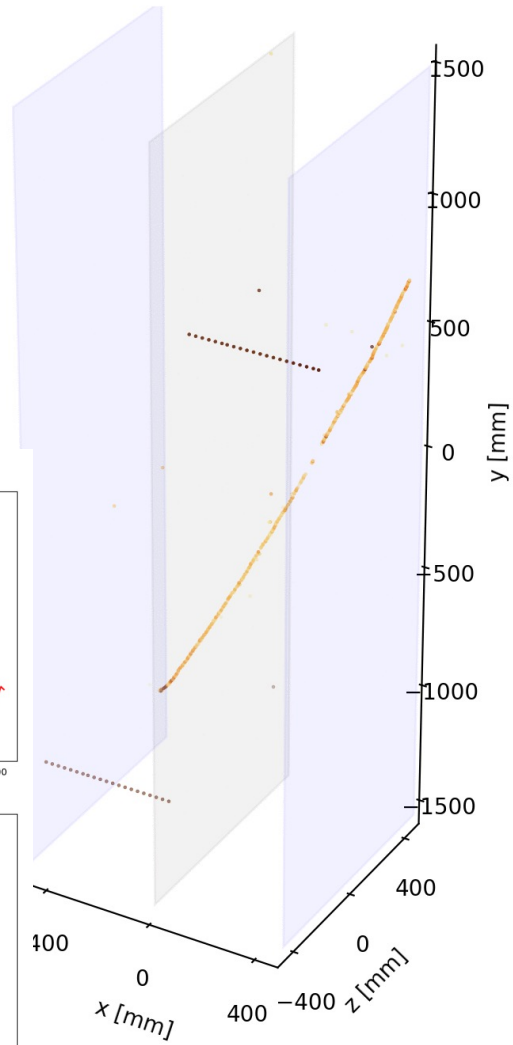
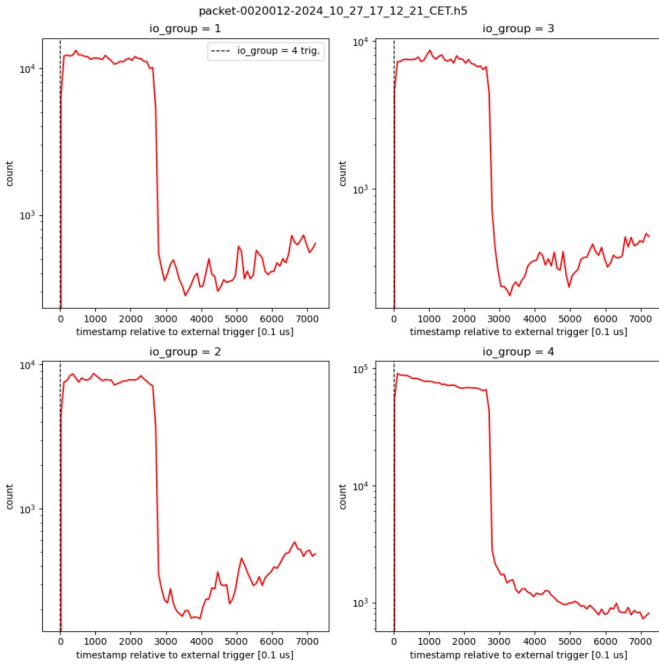


FSD Run status

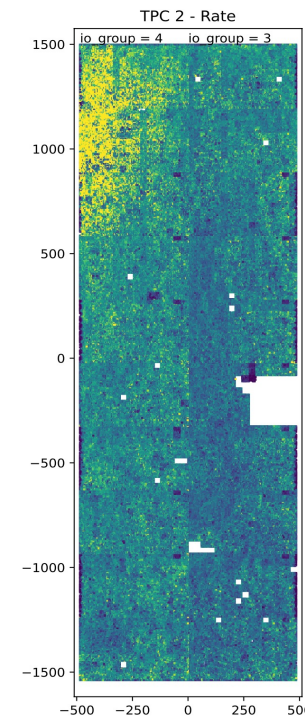
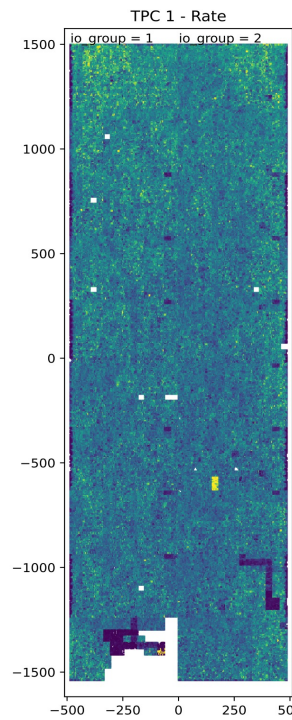
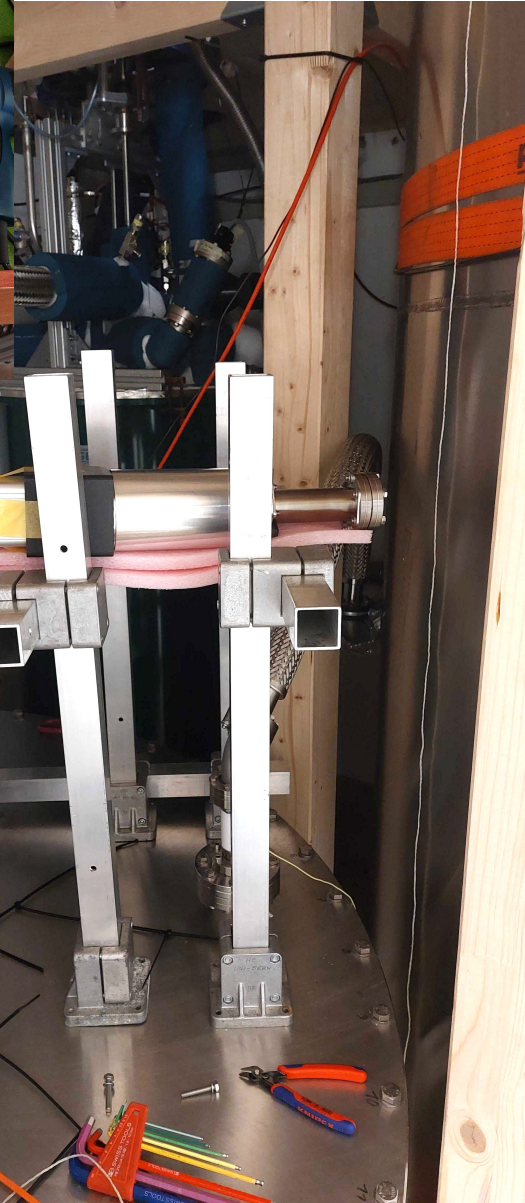
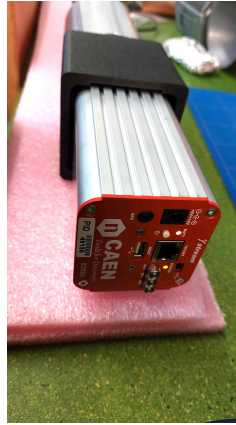
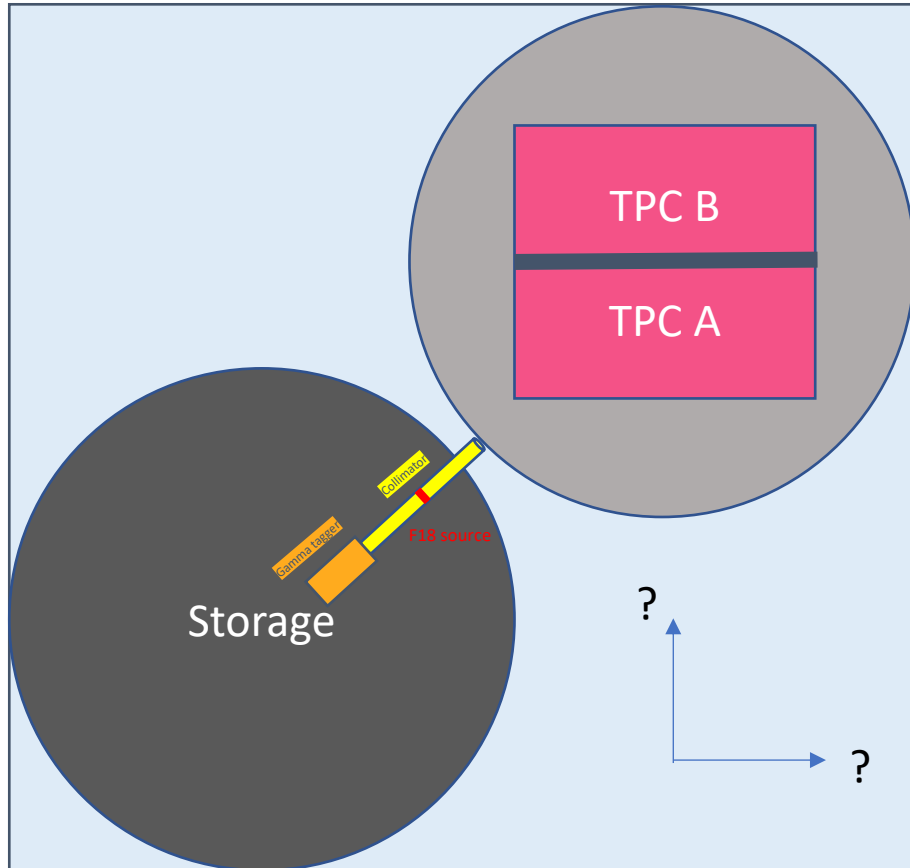
The Week of 28th Oct

- 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 (not addressed)
- Setting up Laser calibration & data taking
 - Identified event builder min hit that discard our signal (files not reflowed?)
- CRS tuning, defining nominal configuration
 - Identified missing data in CRS (investigating)
- Take cosmics data with nominal configurations (3days)

Are we taking good quality data ?



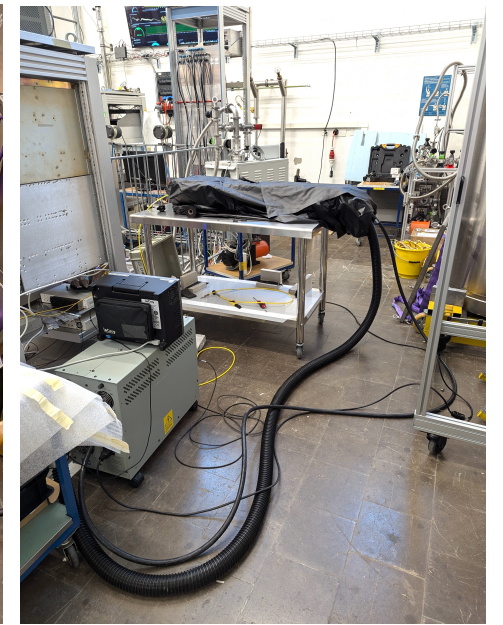
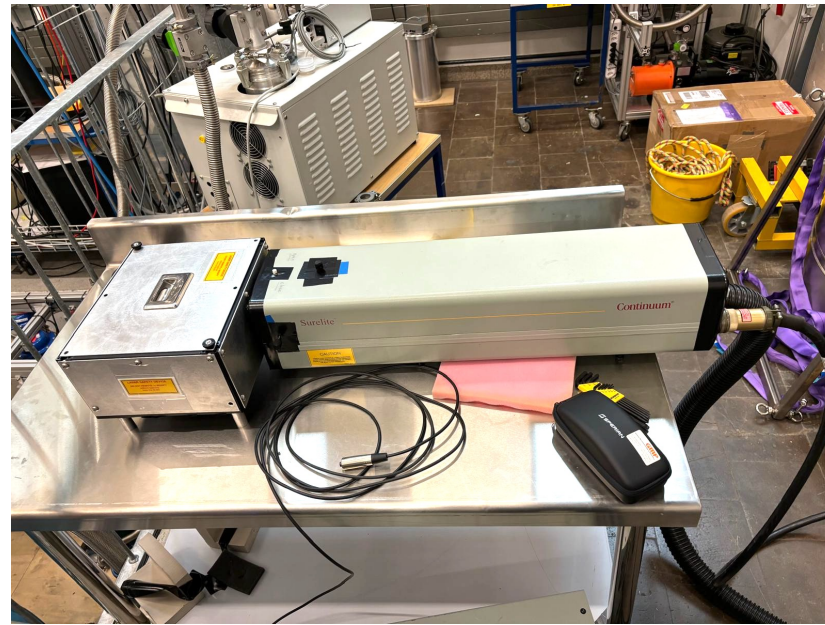
Scheme of the FSD module and F18 radioactive source



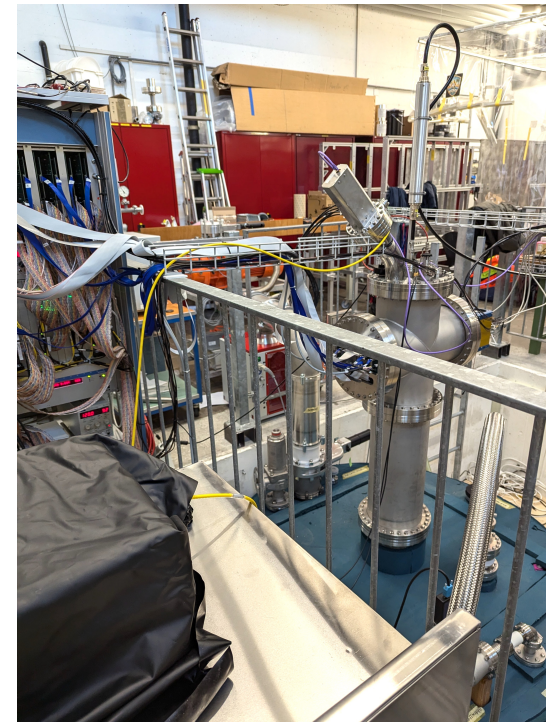
Tom Murphy

UV Laser setup

- Ranjan and Shivaraj prepared the laser setup
- Test with Low intensity & Filters with one SiPM to check light injection -> Run 20049
 - TPC A: fiber 3 ok(middle), fiber 6 ok (top)
 - TPC B: fiber 4 broken, fiber 1 ok (bottom)
- Taking self triggering data CRS and LRS OFF
 - Run 20050 Fiber 6, TPC A top
 - Run 20051 Fiber 3, TPC A middle
 - Run 20052 Fiber 1, TPC B bottom
- Liz is looking at the data for signals. We could not confirm seeing any signals yet
 - Identified event builder had min hit requirement. These files have to be reflow
- Test of laser tuning for low intensity light for light calibration
- What is the plan to repeat test with different CRS setting?



Ranjan



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/04Nov20	/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/04Nov20	/storage/data/LRS/data_bin_04	10 K	10	10	increase threshold on CRS (+2 global threshold DAQ on all channels)

FSD Run status

Data Quality Assessment tasks

- Check synchronization -> done on one event manually
- Electron lifetime measurement
- Fix geometry in CRS -> Flow?
- Event display light + charge -> check geometry
- Check LRS threshold by looking at untriggered CRS events energy deposit.
- CRS investigation on missing packets. And Firmware issues

- Noise assessment? Did CRS or LRS observe noise?

FSD Run status

The Week of 4th Nov

- Are we taking good quality data?
 - CRS?
 - LRS? -> Yes
- CRS investigation and tuning
- LRS special tests
 - LED timing study
 - Threshold scan -> Planning for low energy run configuration (Monday)
- Additional run with Laser and continuous readout of CRS
- Vibration monitor -> Can we run the setup?
- Visual observation of bubbling -> View port

- Take cosmics data with nominal configurations (3days)

- Low energy run >> Ar 39
- Lead bricks run
- 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

Basic Run plan

[Run plan spreadsheet](#)

[Shifters Table](#)

- Vacuum + leak test (Tue-Wed) >> reached 1.5 e-3 mbars
- Warm tests of subsystems (Thu-Fri) + Weekend
 - Light: LED calibration, Bias voltage tuning
 - Charge: Hydra network, Pedestal data taking, check environmental noise
- Fill Filter with Nitrogen (Wed) >> Storage recirculating since then
- Cooldown & filling (Mon-Tue)
 - Using heater to uniform the cooldown, if needed fill from top, try to avoid liquid dripping on the module
- Recirculation & reaching stable cryo (Tue)
- Cold commissioning (3 days: Tue-Thu)
 - Light: LED calibration, Bias voltage
 - Charge: Hydra network, Pedestal data, thresholds, Leakage data
- Discuss the HV ground return shortage, and consequences for CRS and green light for HV ramp
- Ramp up HV (1 day: Fri)
- Taking cosmic data + Tuning (4 days Sat-Tue)
 - Threshold tuning of charge/light readout -> HV down (Mon-Tue)
 - Assessment of LAr purity with cosmic data (Who will do this? DeMario)
- Online data quality assessments of charge and light data. -> CRS online monitoring is not usable!
- Define nominal conditions for readout systems -> input form analyzers who have looked at 2x2 data?
- Visual inspection for bubbling (Mon: vibrating LAr surface with pump 67%. Repeat with pump at 50%)
- Radioactive source Data taking with lower threshold (1 day Wed) -> Tom Murphy
- Configuration scan of reset frequency (8 hours -> Analysis 2 days)
- Calibration system test and commissioning (1-2 days)
 - Light calibration
 - Data collected from laser on targets -> look for signal
- Cosmics Data taking with nominal conditions (3 days)
- Cosmics Data taking with Special conditions: (5 day)
 - ASIC configuration scanning -> Charge response (1 day)
 - LRS configuration scans : Threshold, LED timing, keyhole position cable
 - Low energy run (4 hours)
 - HV test higher than Nominal Cathode potential
 - LEAD blocks to make showers
 - Zero recirculation test

Studies and plots needed for FDR

Please think about what studies need to be preformed and who is going to do this

Examples:

- PDE study for full size Light collection modules ?
- Light readout threshold study? (in MeV)
- Light readout dynamic range study? (in p.e)
- LRS DAQ limit of event rate, threshold, file size
- LRS SiPM gain uniformity and stability.
- LRS timing resolution of ADC
- LRS LED keyhole study
- Electron lifetime study
- F18 radioactive source study
- Field uniformity study?
- Charge readout threshold study ?
- Data transmission Efficiency, packet loss?
- Pixel response uniformity study ?
- MIP Study dq/dx
- CRS configuration scan study
- Anticorrelation LY vs E field, dq/dx vs Efield
- Laser calibration -> Light coverage from injection point
- etc

What data and how much do you need to perform this study?

Special requests?

- Subsystem round table for input and requests
- Special operation requests
 - Special cooldown rate?
 - Special HV ramp rate? -> 16V/s
 - Special Interlock condition LAr level? ->
 - Warning: @ 10 cm above TPC,
 - Action for HV off @ 5 cm above TPC top,

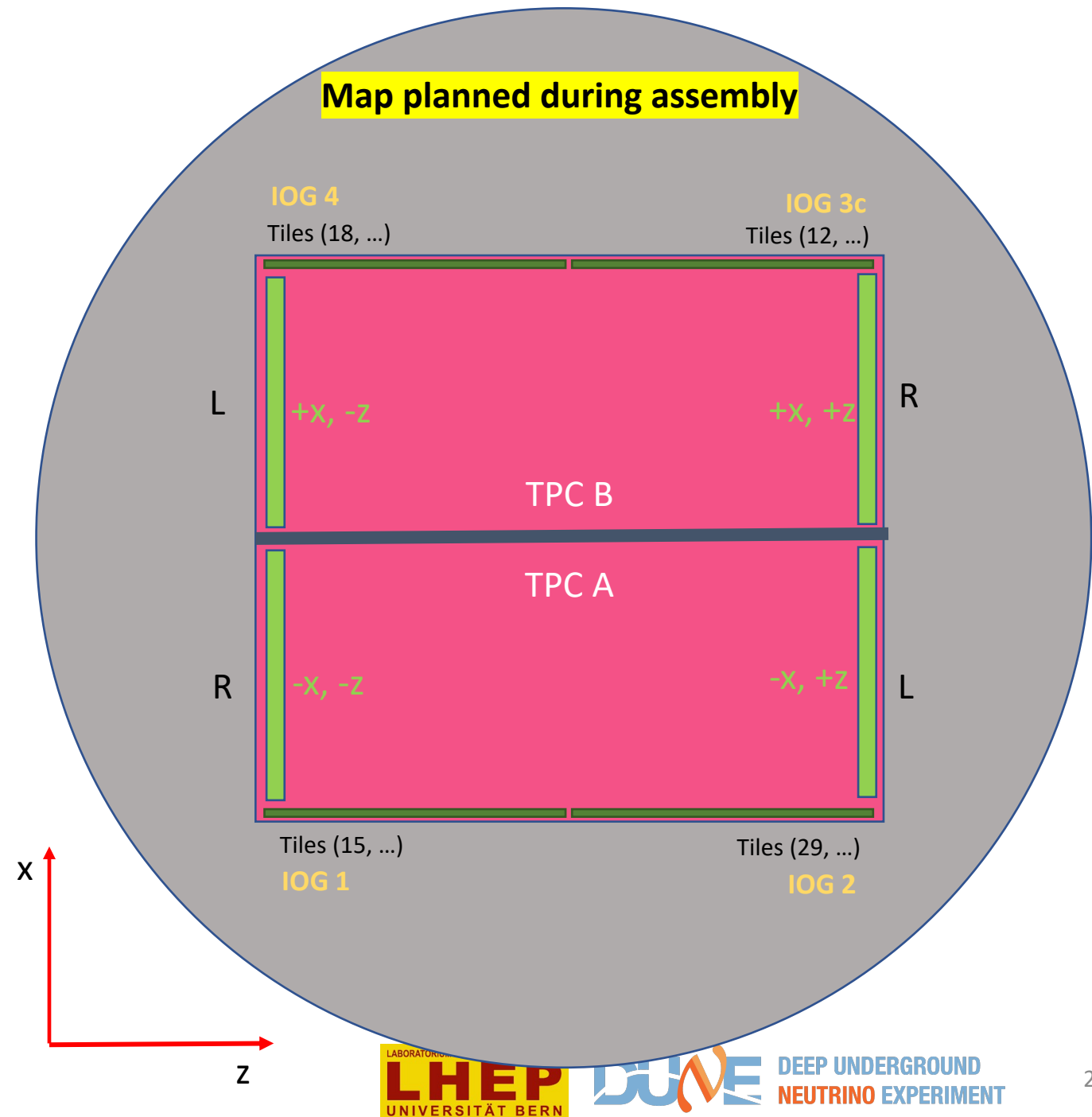
Thanks



Geometry Definition During assembly

- The Light readout tile positions and geometry map is based on this definition of geometry
- After the return ground short of TPC B, the charge readout saw correlations to what they called TPC 1
- After the F18 source pointing to the corner of TPC A, the charge readout saw the signal in TPC 2
- Jaafar confirmed that cold cables of Anode A is wrongly connected to the io group 3 and 4 and vice versa.
- During cabling the information of cold cable id and feedthrough cold connector id is not inserted in our spreadsheet -> (quote: we can work this out later!)

Add to Lessons learnt



Module Map Document created by Rob during assembly

- The module Map was intended to record every physical component in the FSD module
- For each charge tile we can record:
 - Cold data cable #,
 - Cold power cable #
 - feedthrough cold data connector #,
 - Feedthrough cold power connector #
 - Pacman #

This was not fully inserted in our spreadsheet ->
(quote: we can work this out later!)

ÄÜÄ TPC / TPC 0 Further from the loading dock area This TPC has targets for charge calibration glued to the cathode			
Left Field Cage / Global +z	Anode		Right Field Cage / Global -z
Mapping as if you are inside the module looking at the anode, your back at the cathode. This is the field cage on your left side. Pos 1 is on top, Pos 10 is on the bottom / Mapping as if there were a beam from the windows to the lab entrance: +z is defined as downstream in the beamline, or towards the lab entrance	Mapping as if you are inside the module looking at the anode, your back at the cathode. Pos 1 is on top, Pos 10 is on the bottom		Mapping as if you are inside the module looking at the anode, your back at the cathode. This is the field cage on your right side. Pos 1 is on top, Pos 10 is on the bottom / Mapping as if there were a beam from the windows to the lab entrance: -z is defined as upstream in the beamline, or away from the lab entrance
Pos. 1 Left	Pos. 1 Left	Pos. 1 Right	Pos. 1 Right
Light Tile Type: ACL	Charge Tile # 29	Charge Tile # 15	Light Tile Type: ACL
Light Tile # 4.01	Cold Power Cable # 2-1	Cold Power Cable # 1-1	Light Tile # 4.04
Close to Charge Tile # 29	Cold Data Cable # 21	Cold Data Cable # 31	Close to Charge Tile # 15
Cold PCB Board # 020	Warm Power Cable #	Warm Power Cable #	Cold PCB Board # 001
Cold Cable # 01-02	Warm Data Cable #	Warm Data Cable #	Cold Cable # 01-01
FT Data Input # 20	Pacman #	Pacman #	FT Data Input # 1
FT Data Output # 4	Readout channel #	Readout channel #	FT Data Output # 1
Warm Cable # 4			Warm Cable # 1
VGA # 4			VGA # 1
ADC # 1			ADC # 0
ADC Board Sum # 27			ADC Board Sum # 0
ADC Local Channels # 56,57,58,59,60,61			ADC Local Channels # 0,1,2,3,4,5
ADC Global Channel #			ADC Global Channel #
ADC Sum Channels #			ADC Sum Channels #

Add to Lessons learnt

Geometry Observed in data

- Consequence is mirroring with respect to y axis: $x \rightarrow -x$ and $z \rightarrow -z$.
- Hence the geometry file used to flow the files is incorrect.
- How are we going to address this?
 - LRS map is correct, and we want to keep it
 - CRS can correct the geometry multiple ways:
 1. Change the PACMAN IP, assigned to IO Groups
 2. Change geometry file definitions
 - > Packet plotting scripts
 - > Flow files

