

CALCI NP04 Update

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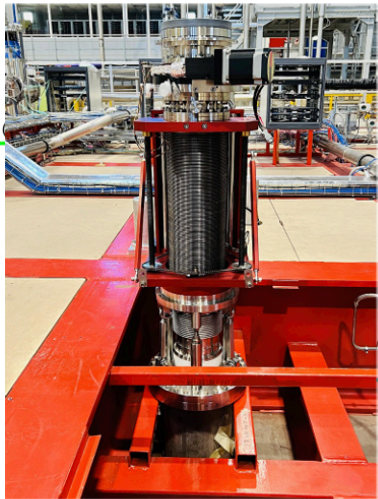
DUNE FD1 Technical Board Meeting
January 10, 2024



CALCI Update

- Change of order to start with NP04 is generally favorable for CALCI subsystems — we have been prepared and waiting for this!
- Great opportunity to test our systems and methods, since many were not tested in PD-HD-1
- IoLaser, PrMs, Bi207 source systems will be installed in NP04 this month and others possibly at a later date
- We have started to actively organize our plans and started discussions on run plan requests
 - Run plans presented here are still evolving, not final yet

Ionization Laser System (IoLaser)



Periscope
1 (P1)



ProtoDUNE laser calibration systems



Periscope 2
(P2) / Endwall



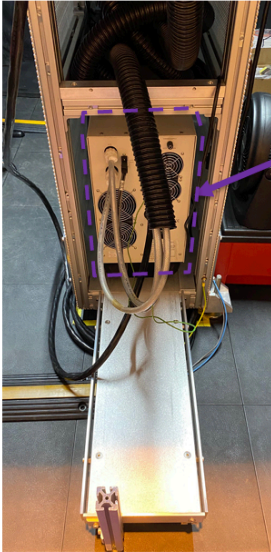
- Two IoLaser systems will be installed on NP04
- Ran practice installation runs several times over the last year with great success

IoLaser Installation Plans

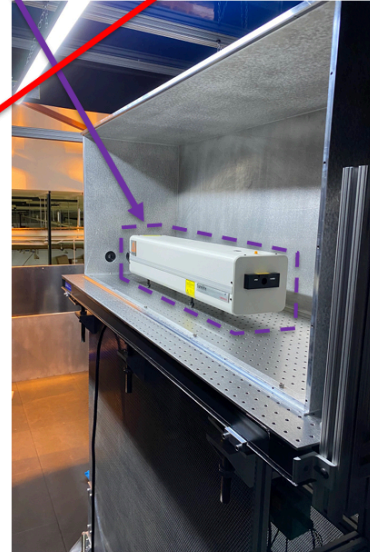
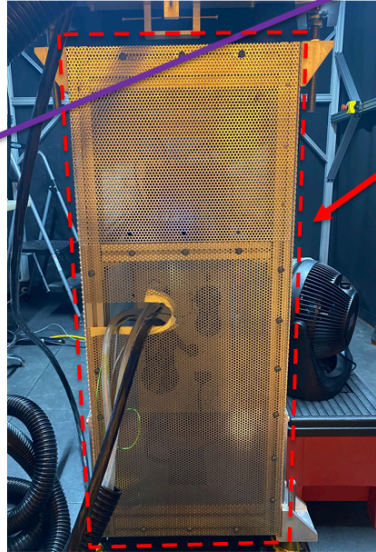
- The Laser beam location systems (LBLS): Pin diode and mirror pads, are already installed in the detector
 - already been using LBLS in periscope testing with green alignment laser
- IoLaser final installation will proceed after NP04 cleaning is finished (currently ongoing)
- Current plans:
 - Jan. 8th-10th: Final preparations for Periscopes 1 & 2
 - Jan. 11th morning: Confined spaces training
 - Jan. 11th -12th: Installation of Periscopes; initial alignment tests
 - Week of Jan. 15th: Assembly and installation of the laser & laser stand
 - Week of Jan. 15th. Purity monitor installation
 - Argon gas purge will happen soon after PM installation
 - Week of Jan. 15th or Collaboration week: Laser interlocks/safety (1st inspection) & Electronics (2nd inspection)

IoLaser Installation Plans

- Arrived at CERN: one UV laser, a laser stand, and a laser box to CERN



Laser Power Supply mounted and loaded into laser stand



Laser head inside the laser box. Access panel open (left). Fully enclosed (right)



- Assembly and installation of the laser and one laser stand will be carried out in the week of Jan. 15th
- This will allow the laser safety/interlocks inspection and approvals to proceed

IoLaser Run Plans

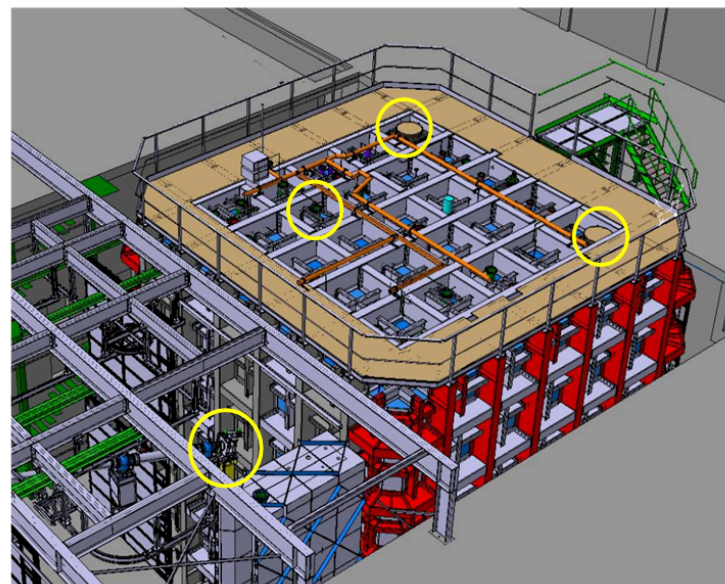
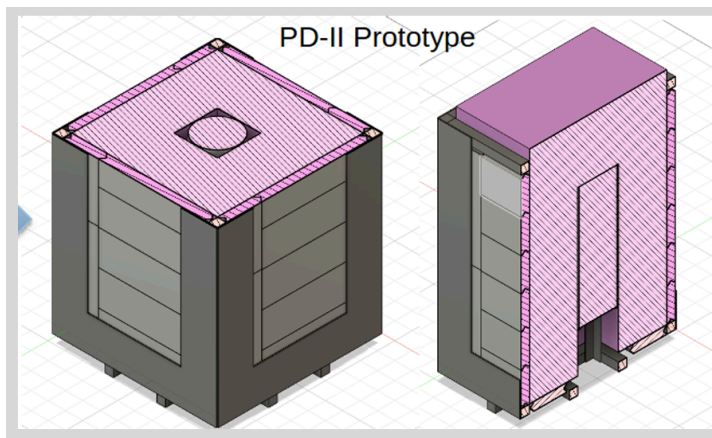
- Teams from LANL and LIP at CERN starting Jan. 8th to 27th
 - LANL: David (PD), Sowjanya
 - LIP: Vladimir, Wallison (student), Jose
- We will plan future trips as the filling and commissioning schedule evolves
- Run Plans currently under development
 - Alignment tests in Air/GAr with LBLS (HV/DAQ/LAr not needed)
 - Alignment tests in LAr with LBLS (no HV/DAQ needed; low purity is fine; but bottom portion of the periscope should fully submerge in the liquid - will require some liquid level monitoring with slow controls)
 - UV laser tests in LAr (need all systems in place; high purity and HV achieved)
 - Need to coordinate with PDS during laser runs; implement interlocks b/n laser and liquid level/PDS

IoLaser Run Plans

- Once alignment tests are done and as high purity is achieved
 - Beginning of data taking: two, 8hr-days (1 per periscope) to determine that aiming of the lasers is consistent with the charge readout data.
 - End of data taking: repeat the same, two 8hr-days, for final checks on the detector and for comparison over time
 - During beam running:
 - ~4 hr long calibration runs each day (ideally)
 - ~2-4 hr long calibration runs every few days (minimally)
- *Plans will be refined in the coming days - not a final plan*
- DAQ and slow controls interfaces actively being worked on in parallel and we will restart some of those discussions as the hardware installation gets behind us

Pulsed Neutron Source (PNS)

- Plan to do two tests in NP04
 - one with modified LANL DD-generator (ThermoFisherMP320) on top of a cryostat roof feedthrough port
 - one with the new DD-generator (Starfire n-Gen310) at the beam plug (remains to be discussed; alternate location: roof port)
- The LANL DD-generator is upgraded with new shielding and controls (SD Mines, UC Davis) but high rate cannot be tuned down.
 - However, still useful to take new data to compare to PD-HD-1 and validate shielding and controls.
 - Should arrive at CERN in February
 - Will also be tested in PD-VD cold box tests

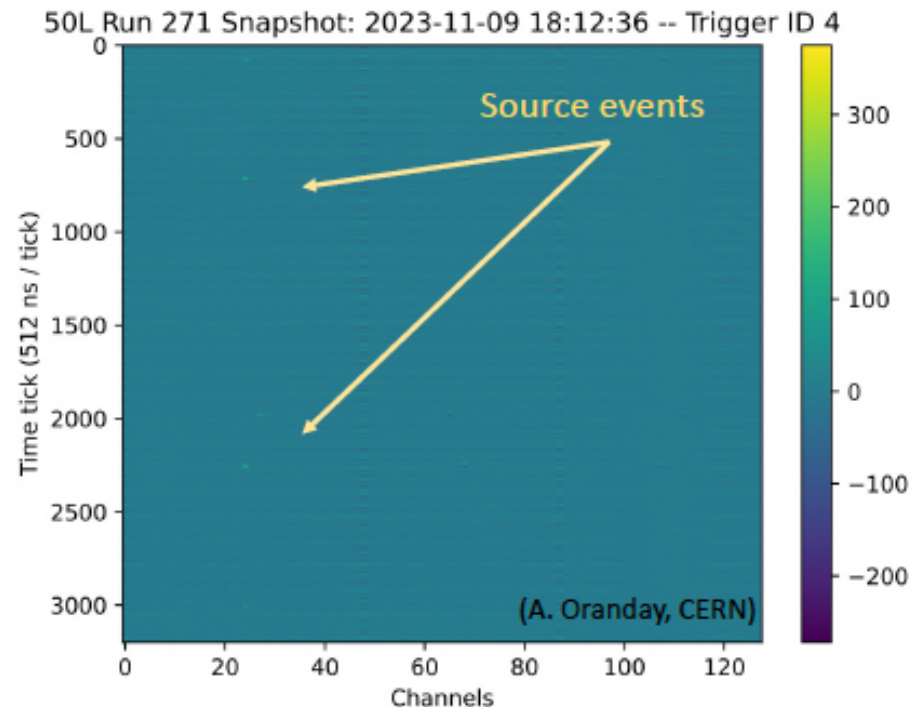
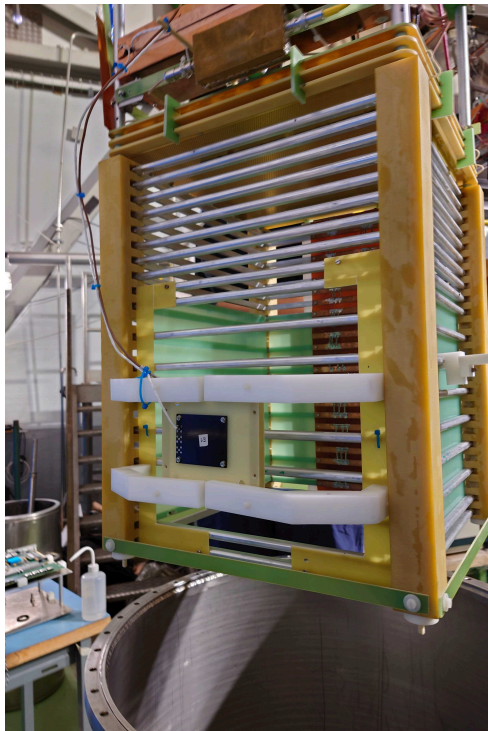


Pulsed Neutron Source

- Starfire generator was procured last year and successfully operated and tested at SD Mines
 - Rate can be tuned down to \sim Hz — a better match for DUNE DAQ
 - Very important to test this as it will be the candidate generator for DUNE-FD; will arrive at CERN at a later date due to shipping logistics
- Data taking requests:
 - all PNS runs with no beam, nominal HV and high purity
 - Minimal request: 20- 40 hrs with LANL generator on top of a roof port
 - Ideal request: in addition to minimal, 20- 40 hrs with Starfire generator on the beam plug (alternative: roof port)

Bi-207 Source Plans

- Tests with 50L CERN test stand continue successfully
 - Source placed on the cathode, new FEMB card, using DUNE-DAQ software readout etc.
 - Progress on simulation and data analysis studies in parallel
 - Involved institutes: CERN, LIP, LANL, Boston



Bi-207 Source Plans

- Two sources will be installed in NP04 this month (likely already installed) through the manhole using a tripod (not scaffolding)
- One source will be installed on the cathode
 - near the bottom or at a height reachable by human
- Second source will be installed either near the anode or at another location near the cathode
 - both scenarios are useful for calibration
- Install sources in the same volume as the (particle) beam and laser and in the downstream corner where we will have coverage by two laser beams
- Using data triggered via cosmics will be enough, but, would be useful to have a few runs of pulsed/random triggers in the dedicated region only, to test possible run method for FD.



Bi207 source installation sequence

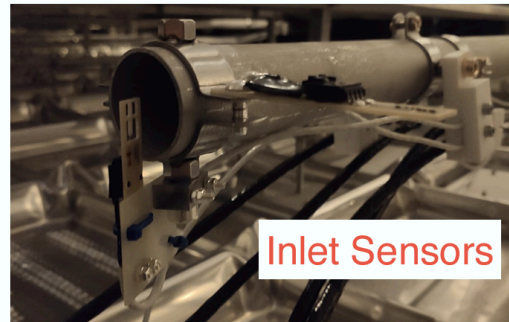
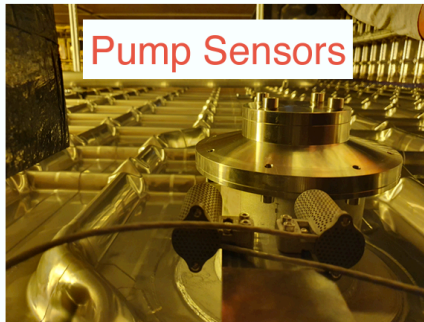
Radioactive Source Deployment System (RSDS)

- Install RSDS system (without source) to test the deployment system and related mechanics (lead: SD Mines)
- A PD-HD-II port for RSDS deployment <40 cm away from FC will be suitable — needs to be discussed and finalized
- Materials for RSDS prototyping have been acquired
 - Source end of the RSDS system has been machined
 - All materials successfully finished cryogenic testing
 - Mock up testing of the RSDS deployment system underway at SD Mines high bay lab
- Source-based testing plans outside NP04 are also underway
 - Cf-252 source with Delrin moderator is a good option for RSDS demonstrator tests
 - RSDS tests with Cf-252 underway at SD Mines and at an underground location at SURF to demonstrate proof of principle physics measurements
 - Future plans include deploying the system exterior to a small LArTPC e.g. CSU or LArPix or ND prototypes

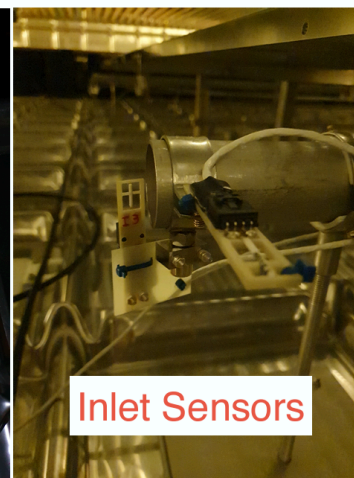
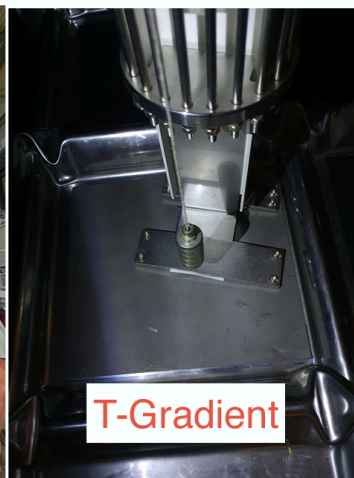


Temperature sensors

- Almost all 159 sensors to be used in PD-HD have been already installed and commissioned during summer 2023 by IFIC
 - Missing one sensor in pipes and 6 on PrMs (installed next week)



Gas Array

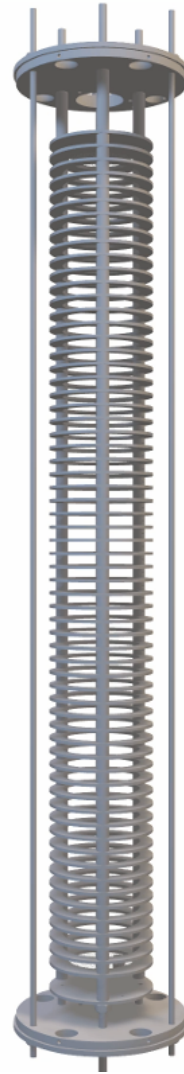


Temperature sensors

- In general, these can run and collect data independently of other systems - no special coordination/planning needed
- It is highly desirable to have a small period (half day or so) without recirculation, to allow the sensors to equalize and benchmark the ex-situ cross-calibration
 - This would also provide another data point for constraining CFD simulations
- If possible, another run period with a different recirculation regime (pumps at half speed) would further constrain CFD simulations

Purity Monitors

- PD-HD-II will reuse 2 of the 3 PrMs from PD-HD-1
 - A new long purity monitor (75 cm) will be installed as the middle PrM.
- The three PrMs are stored in the long pipe and waiting for installation in the cryostat
 - Storing PrMs in a vacuum environment helps preserve the performance of the photocathode.



Purity Monitors

- **Week of Jan. 15th** is planned for Purity monitor installation
- Purity Monitor team from UC Irvine on the ground at CERN already preparing for installation
- The overall data taking plan for the NP04 purity monitors (PrM) is very similar to PD-HD-1 runs:
 - during beam days: only a few measurements per day
 - outside beam days: 3-5 times a day or more if needed
 - each measurement only takes a few minutes
 - the PrMs can be operated remotely, and all at the same time
- The exact time of each measurement will always be coordinated with the PDS system

General Takeaway

- Several of our systems are already installed (Temp. Sensors, LBLS systems) and others (IoLaser, PrMs, Bi207) will be installed this month
- With PNS and RSDS, need to restart discussions and understand port availability; installation will happen after January
- Timeline is tight — it will be crucial to plan everything well ahead of time and also to be present at CERN and have flexibility as the schedule evolves
- Very short runtime makes it challenging to organize all the needed measurements
- We are categorizing our data taking needs in terms of ideal Vs minimal requests — still refining them and they will evolve over the next few days