

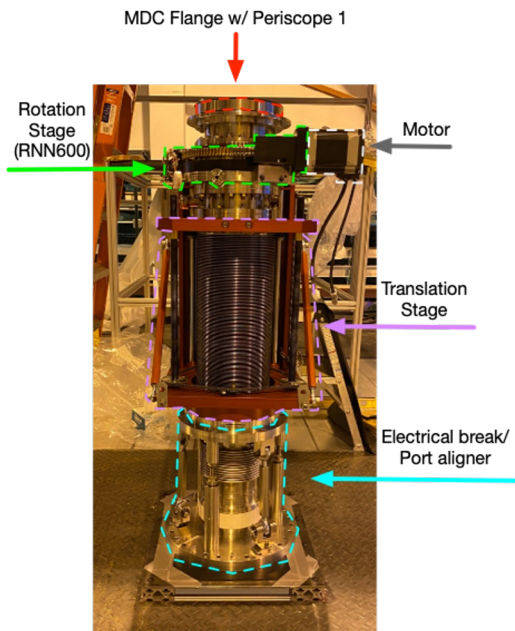
IoLaser Systems at ProtoDUNE-HD

David Rivera for the CALCI Consortium

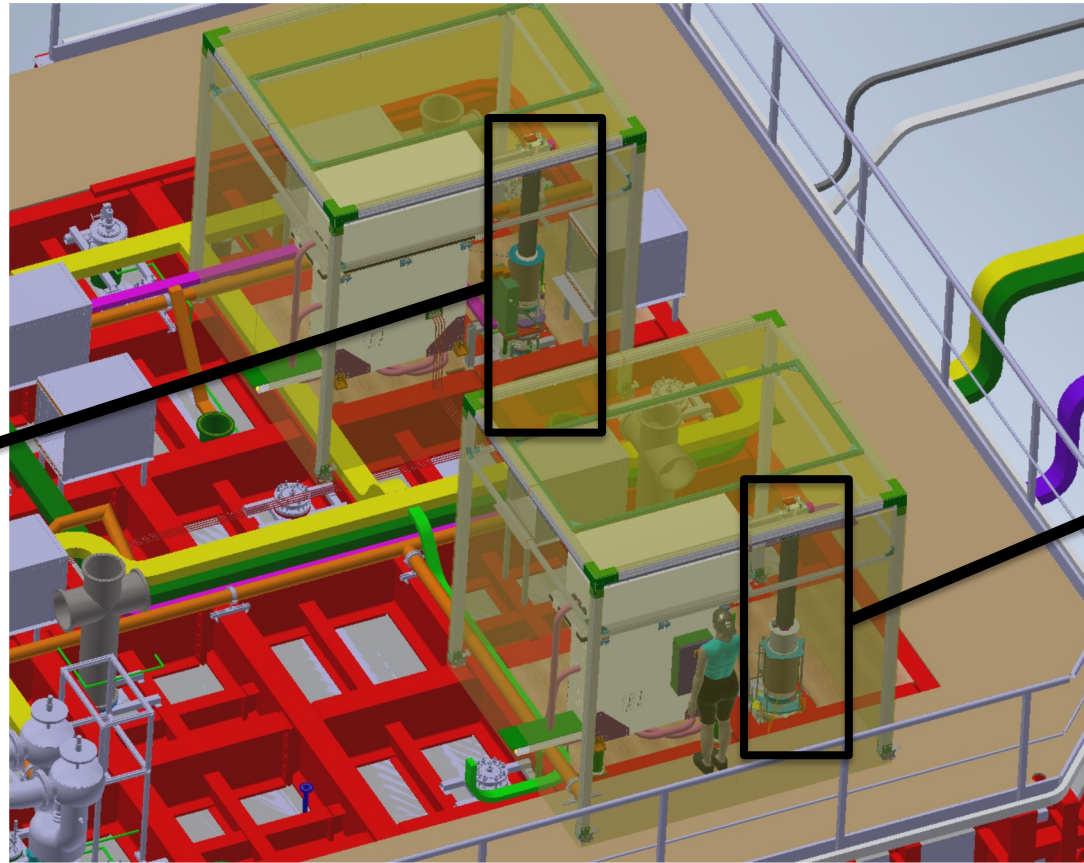
December 22, 2022

Laser system for ProtoDUNE Horizontal Drift (HD)

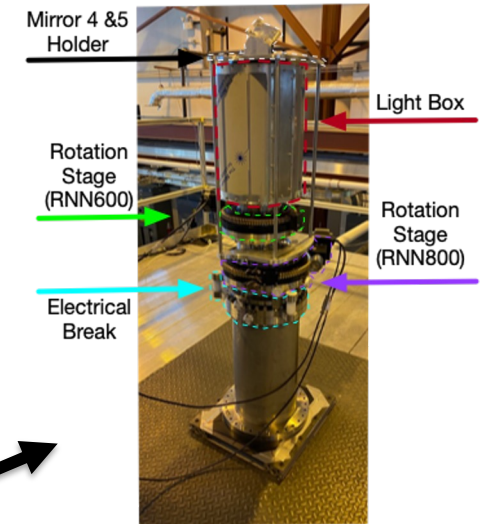
Three degrees of freedom for each periscope including rotations and retractions



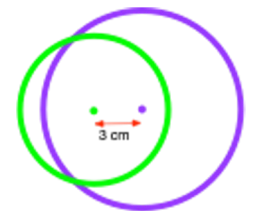
Periscope 1 (P1)



ProtoDUNE laser calibration systems



Periscope 2 (P2) / Endwall



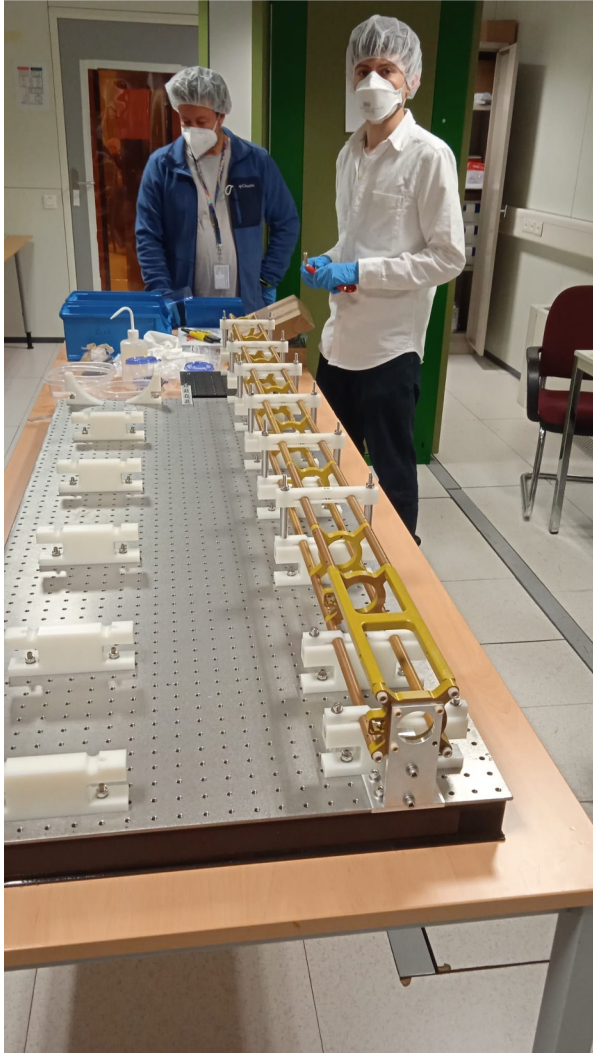
Status

Assembly and installation team consisting of several members from both LIP and LANL

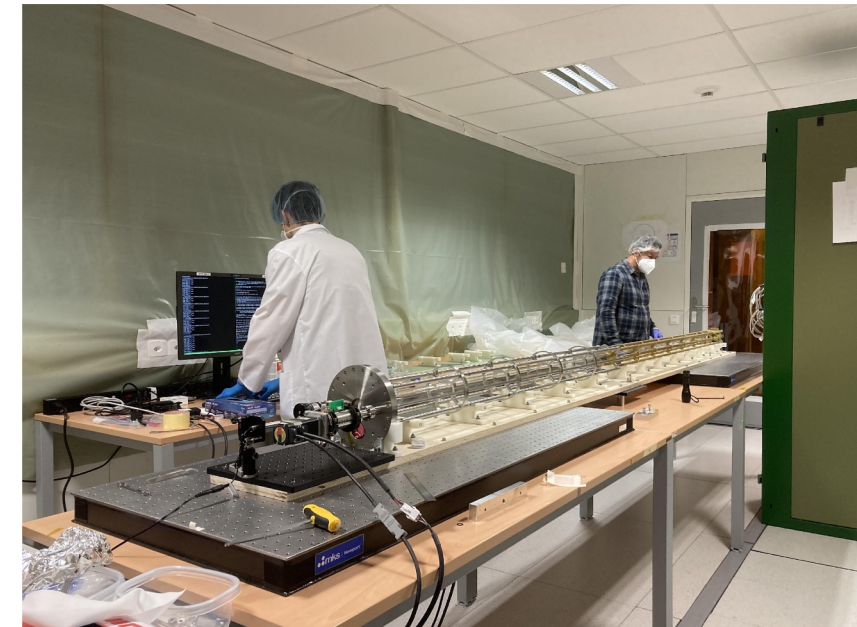
- Feedthrough for End-wall periscope (P2) installed
- Feedthrough for retractable periscope (P1) installed
- P2 fully assembled and installed
- P1 fully assembled and ready for installation
- Removal and storage of P2 complete



Assembly

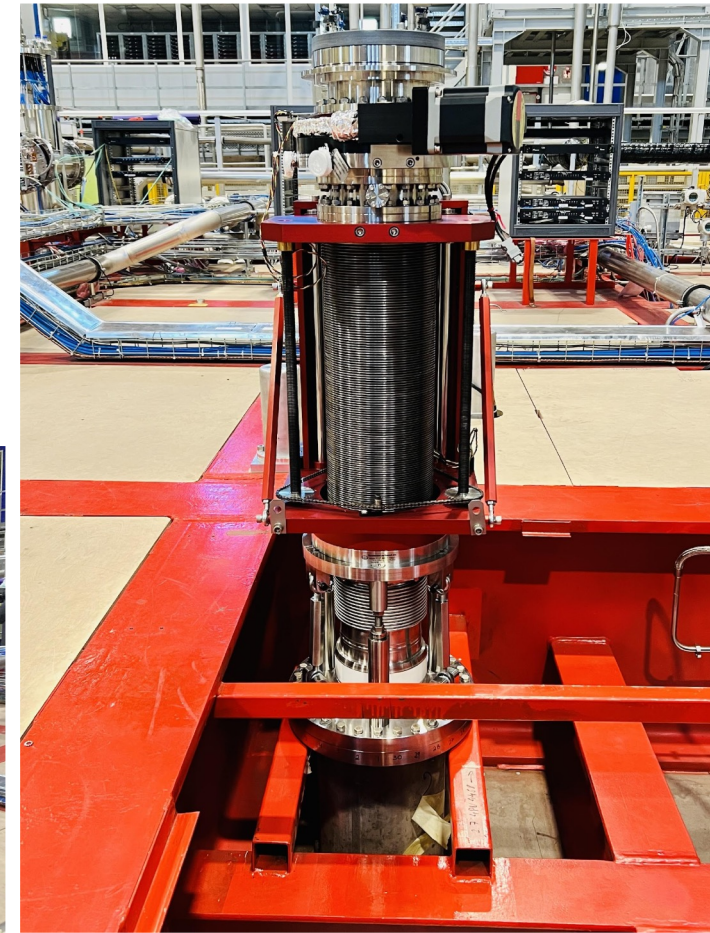


- EHN1 Room 1-Z02 serves as a cleanroom for periscope assembly, tests, and storage
- Steel and Torlon portions for P1 and P2 assembled using optical breadboards and custom-designed bases
- Periscope optics for P2 installed
 - Mirrors and quartz tubes
- Mirrors for P1 installed to do alignment checks



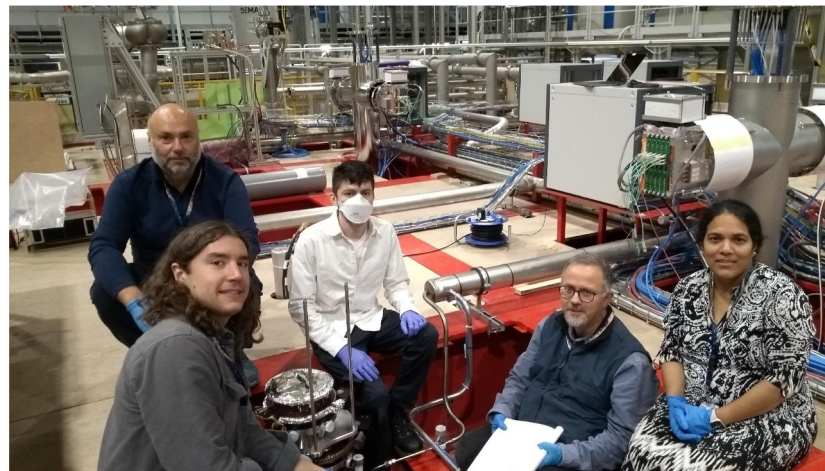
Feedthrough installation (P1)

- Excellent crane-work made this the smoothest installation of the P1 feedthrough yet!
- Many thanks to the craning team!



Completed Nov. 30

Feedthrough installation (P2)



Completed Dec. 1

Periscope 2 installation



Transporting P2
Torlon



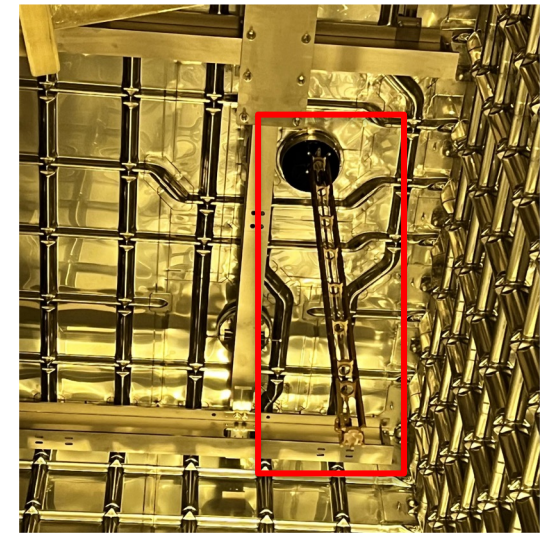
Transporting P2
Steel



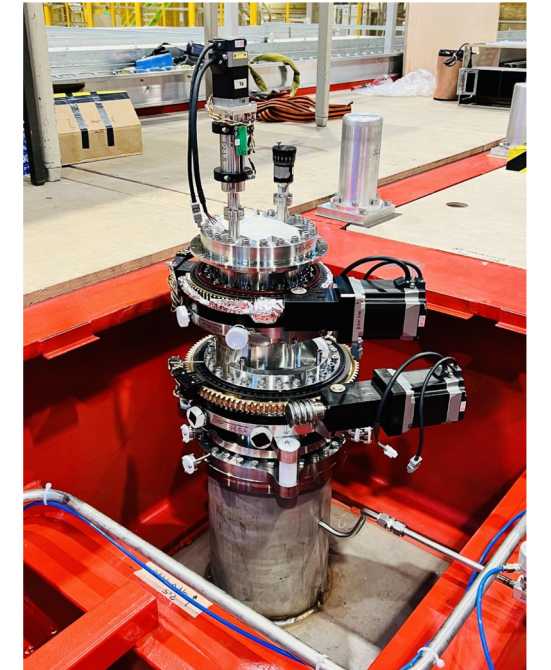
Lowering Torlon
into P2 feedthrough



Connecting P2
Steel and Torlon

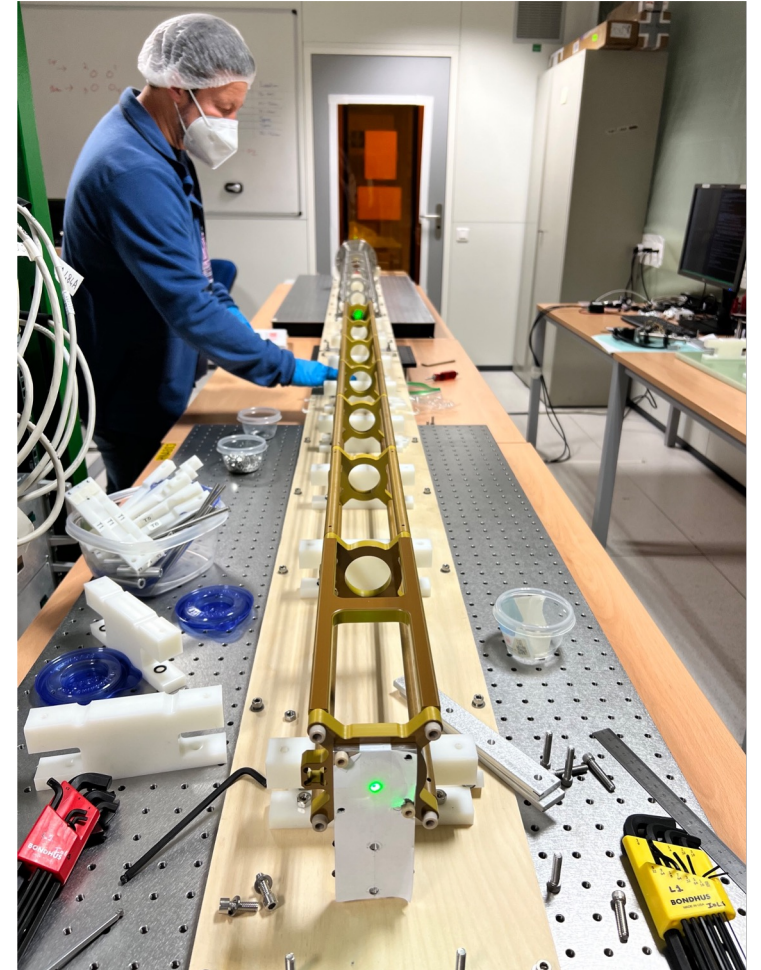


P2 fully installed!



Periscope 1 assembly and tests

- Periscope 1 Steel and Torlon portions fully assembled (completed Dec. 8)
- Straightness evaluated using the horizontal support bases
- Periscope model updated to match measurements
- Periscope is currently staged inside the cleanroom and ready for installation (without quartz tubes)

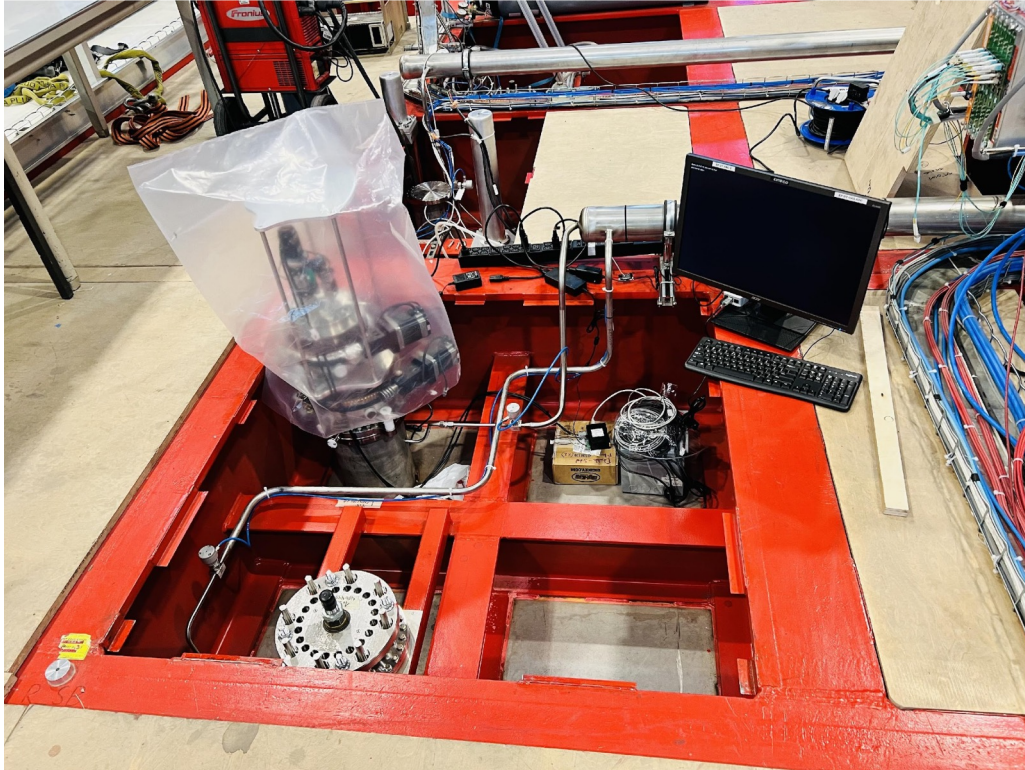


Installation

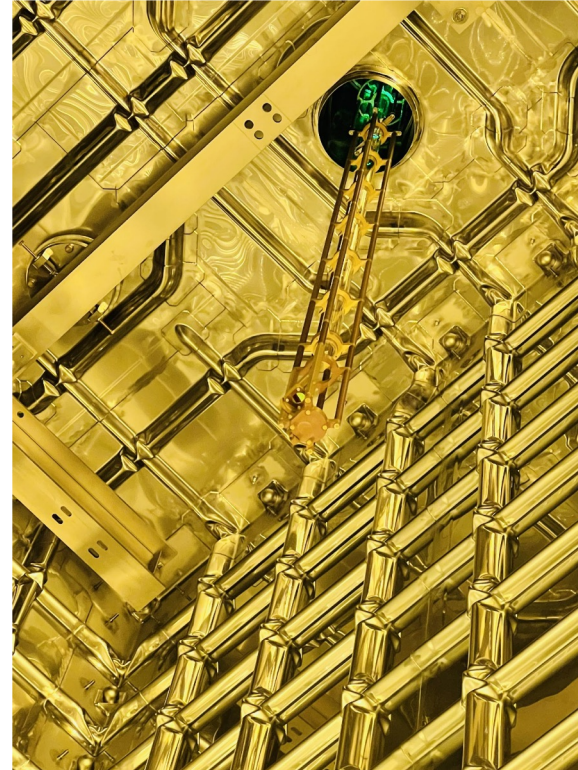
- The end-to-end installation process has been *extremely valuable* and has set precedence for future streamlined installations
- In order to preserve the cleanliness of the periscopes (especially the UV/Visible mirrors and Quartz tubes and windows), P1 and P2 will be stored in custom crates and re-installed closer to commissioning time or as needed for system integration tests
 - UV laser can melt dust deposited on the optical surfaces and would, in turn, affect the energy profile



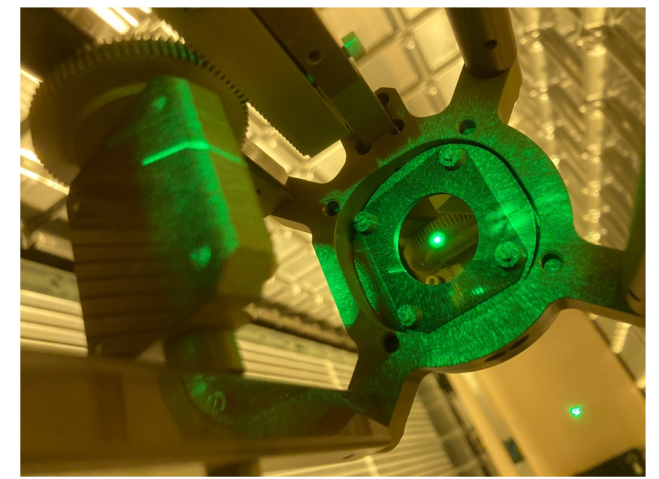
Alignment tests



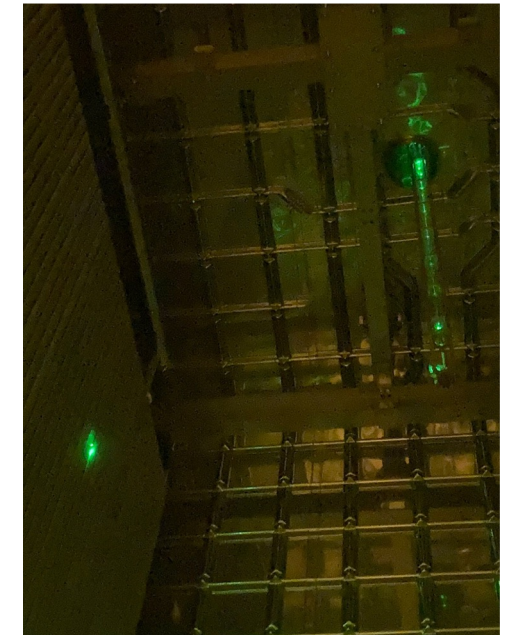
Alignment tests for P2 are ongoing



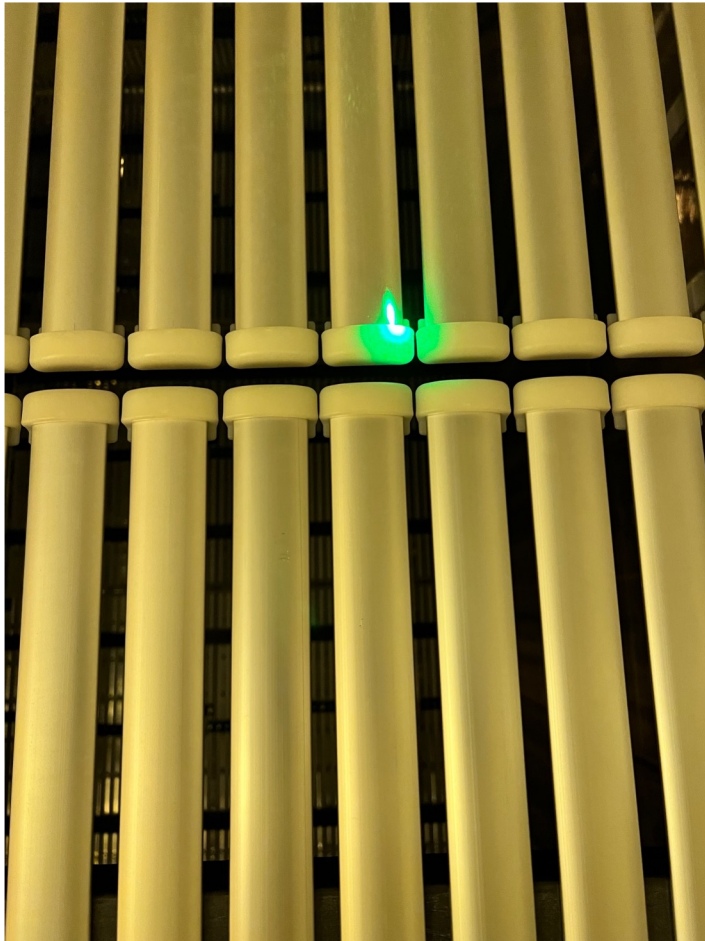
Hitting the field cage for the first time with the alignment laser!



Very valuable to have the floor and elevator for visual confirmation and for validating the alignment methods in this new environment



Alignment tests

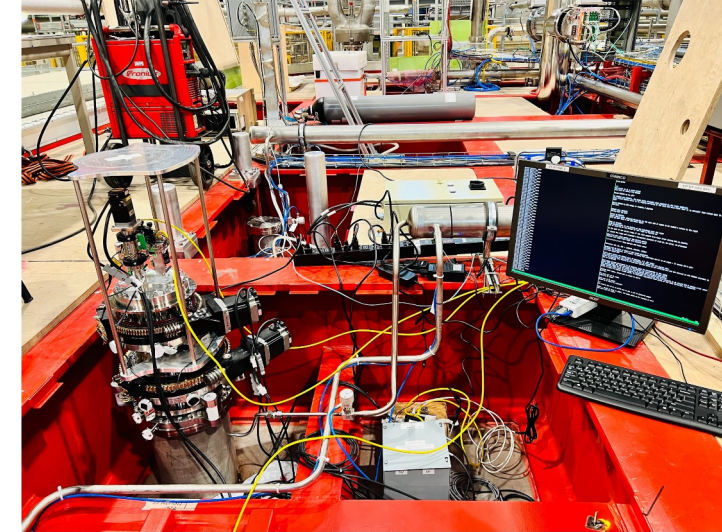


- Performing detailed scans and studies to measure the positions of various reference points
 - Field cage bar gaps must be well understood for P2
 - P2 roughly aligned w/ one of the Pindiode boxes
 - Checked rough position of LBLS mirror mounted on DS field cage



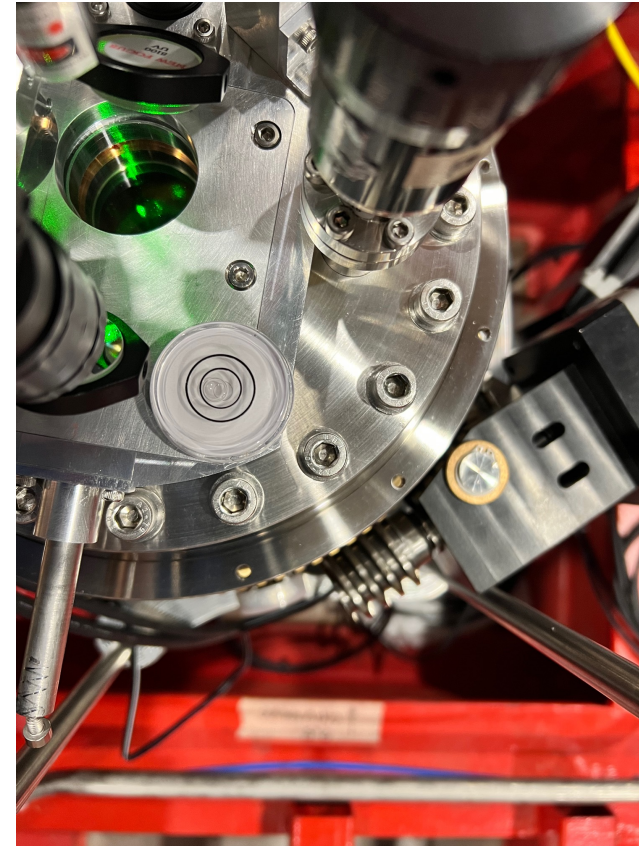
Electrical distribution tests

- Test of the electrical distribution system for P2
 - Power cables routed by Xavier ready to connect on the periscope end
 - Tests included UPS's in the IoLS rack, the junction boxes receiving the power, and the Power Distribution Unit (PDU) that will power the laser system instrumentation



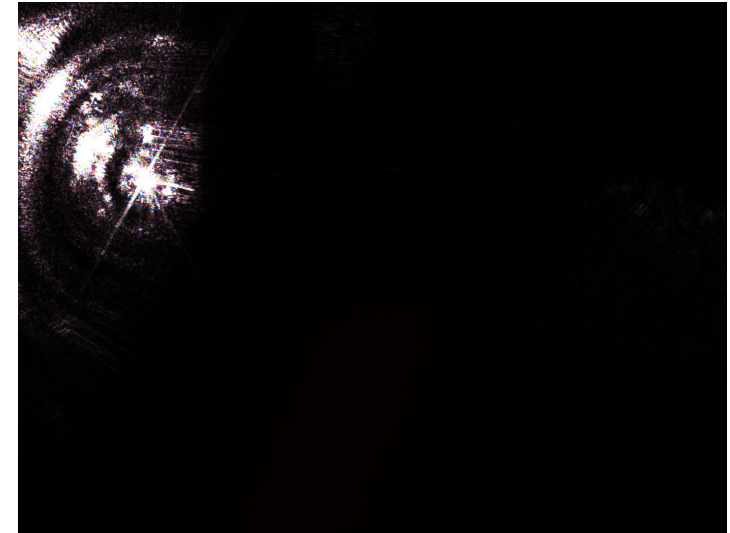
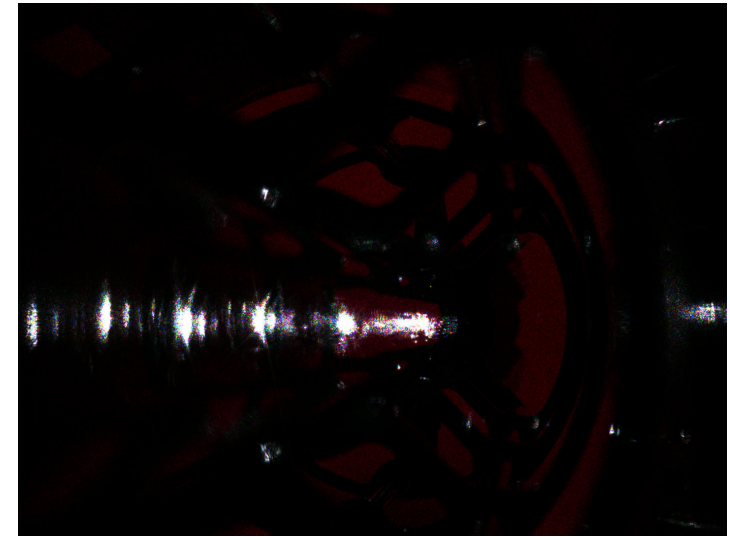
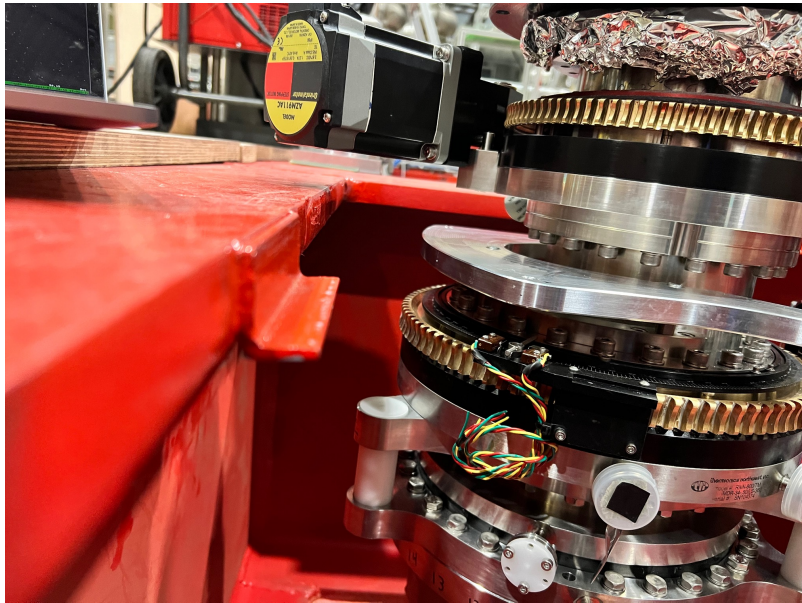
P2 feedthrough

- Unable to trace a vertical line w/ P2 when pointing at a known reference (the field cage or the membrane wall)
 - A small ~ 1 degree tilt can be observed when driving the stage for the linear motor
 - Preliminary tests suggest that it is the P2 feedthrough onto which the periscope is mounted which is not level w/ the field cage
 - P1 feedthrough has a port aligner feature, which can compensate for small tilts like this
 - May need something similar for P2
- More tests will be performed



Additional tests

- Clearance tests of P2 from RNN800 rotation
- Camera alignment tests



Camera view for aligned beam when looking down

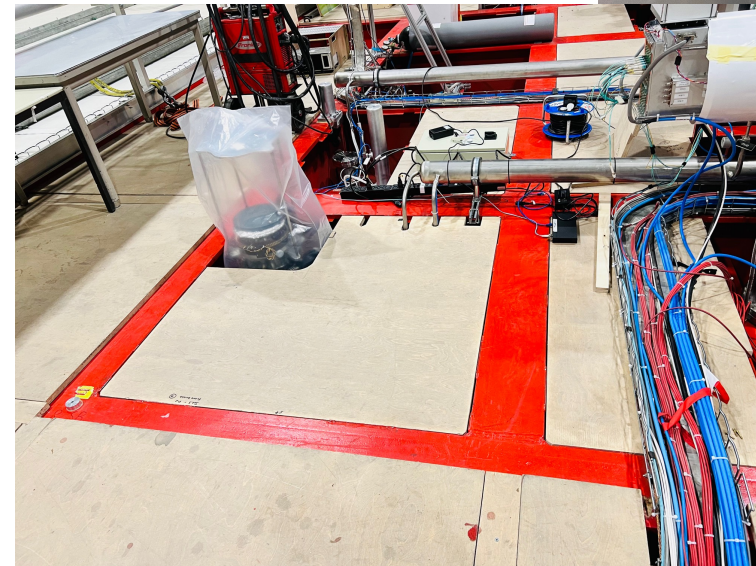
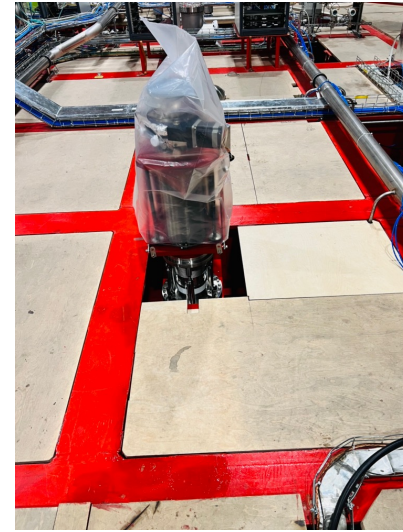
Periscope 2 removal

- Removal of P2 on Friday, Dec. 16
- Reverse process as the installation



Final status

- P2 was safely stored away inside crates
- Crates are wrapped in clean plastic and stored away in the cleanroom for now
- P1 is still on the horizontal table where tests can be conducted
- Feedthroughs are covered and protected



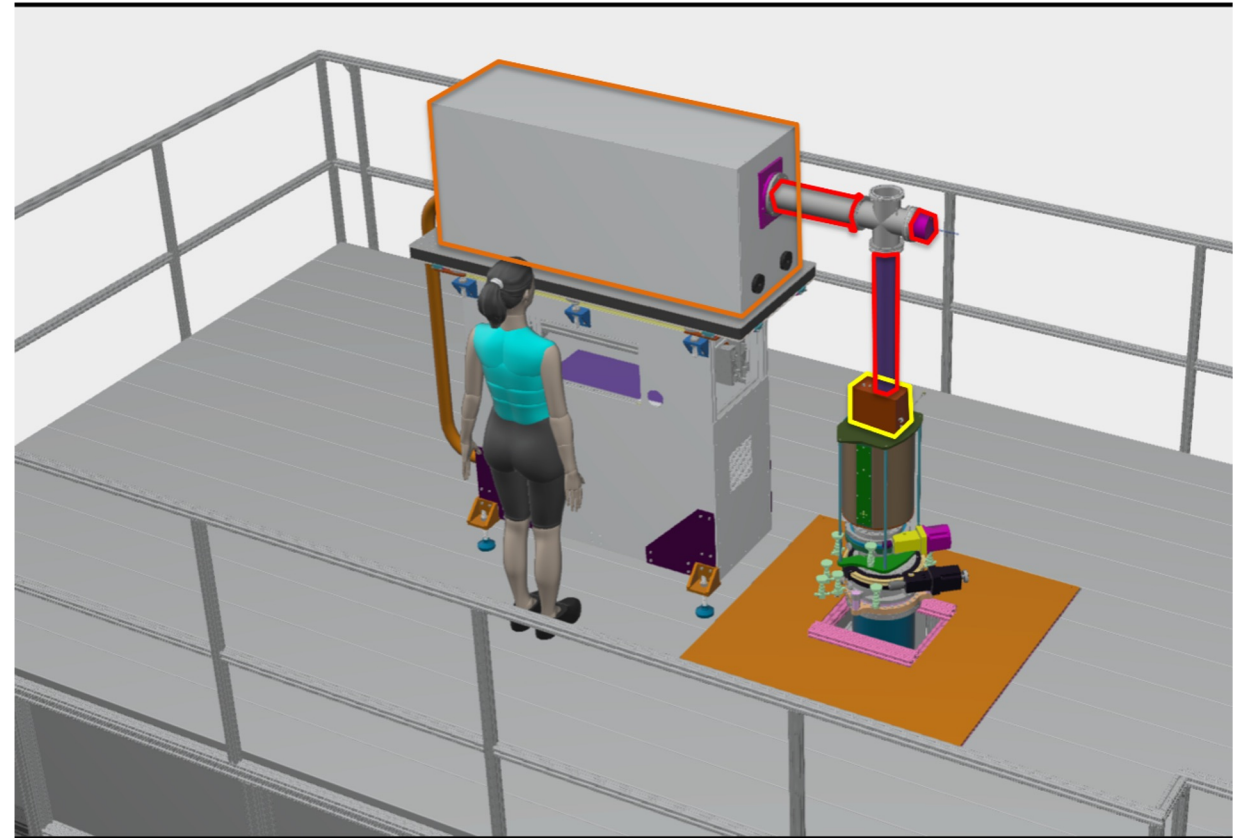
Next steps (near term goals)

Air tests

- Detailed tests of P2 using Class 2, alignment laser mounted directly on the periscope
 - Confirm that no mechanical interferences exist for the feedthrough during rotation
 - Align beam using external camera system (verify visually)
 - Drive the motorized stages in order to hit reference targets with visible laser (Pindiodes and LBLS mirrors) inside the cryostat (verify visually)
 - Update the models accordingly
- Uninstall P2
 - ~~Remove quartz tubes~~
 - Separate Steel and Torlon portions and store inside storage crates
- Install P1 onto its feedthrough in the fully retracted position
- Verify the clearance into the field cage while slowly driving the translation stage
 - Adjust the port aligner if needed
- Repeat the detailed alignment tests for P1
- Uninstall and store P1 Steel and Torlon

Next steps

- Ship remaining parts of the laser system
- Assemble and install laser tents for P1 and P2
- Assemble and install the laser systems:
 - Interlock safety system
 - Electrical components and control devices
 - Optical setup for guiding and conditioning the UV and alignment lasers
 - Cable routing and shielding
- Integrate w/ the Slow Controls and DAQ
- Final periscope installations
- Commission



THANK YOU

Many thanks to the coordinators at EHN1 for the support throughout the last weeks (and beyond)!

- Daniela Macina, Johann Poirot, and Filippo Resnati

Backup

- The IoLS systems fall under the category of Slow Controls
- During normal operations, the Calibration Interface Boards (CIBs) will run a slow controls server and listen for configurations and run commands. They will then communicate w/ the peripheral devices in their corresponding laser system. This includes:
 - The laser itself (Continuum SL I-10)
 - Optical devices for laser conditioning (e.g. laser attenuator)
 - Raspberry Pi 4, which communicates w/ the motor drivers
 - Pindiode readout boards
- Some additional devices (e.g. cameras), will only be needed during alignment procedures

Communication lines

