131.ND.02.07 Calibration Technical Description

Morgan Bonnett - Calibration Lead Engineer

ND-LAr Preliminary Design Review

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Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

U.S. DEPARTMENT OF ENERGY | Office of Science

Outline

- Key Documents (table)
- Design elements & status / CAD model
- Key Analyses / Performance Assessment
- Documentation Tour
- EH&S / Codes & Standards
- Open design issues / Final Design plan
- Summary

Morgan Bonnet (Senior Mechanical Engineer) - University of Hawai'i

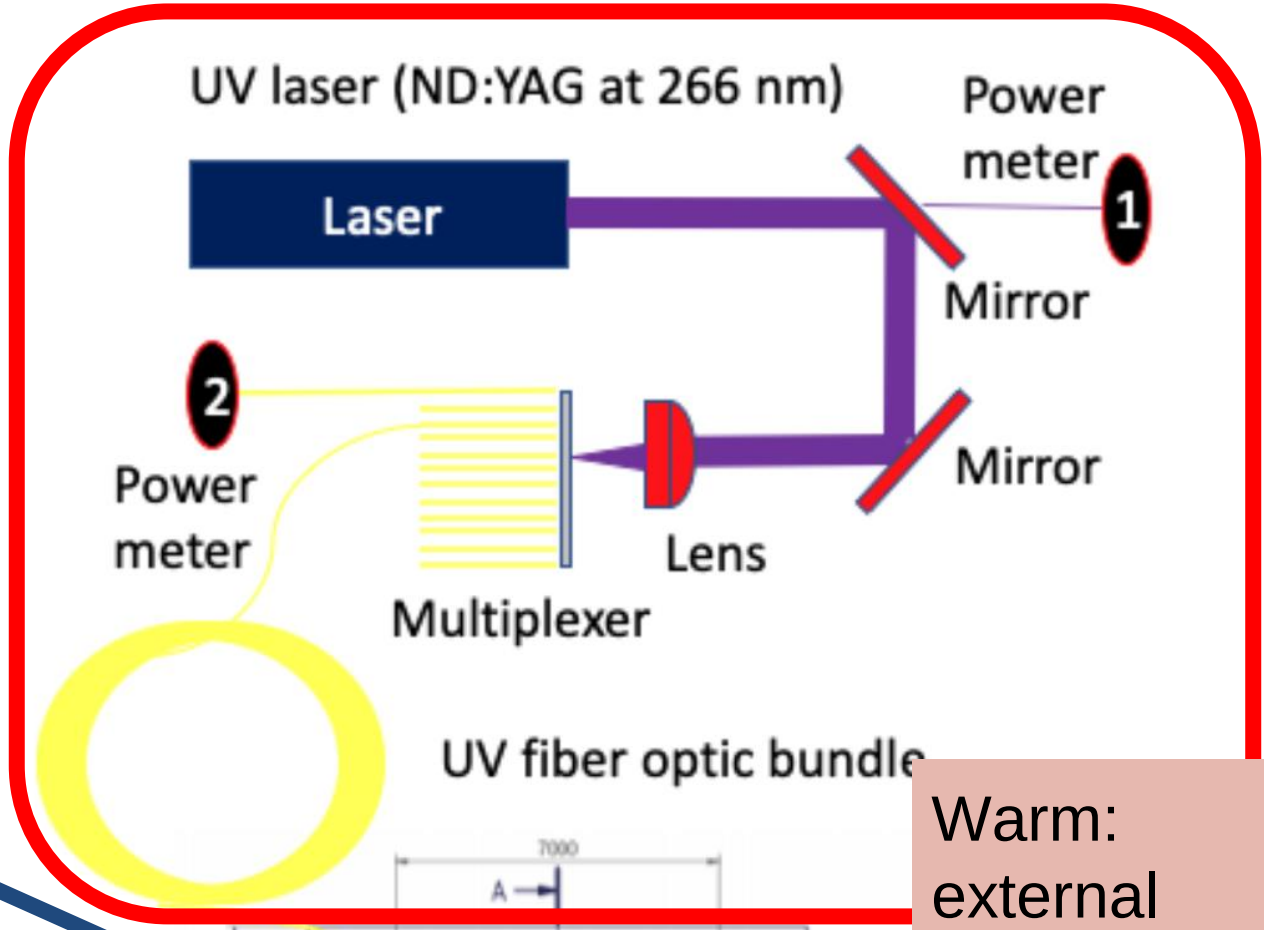
- 2005-2010: Automotive Industry - Engine Control Units Software Development in Germany and USA (Siemens / Continental Corporation)
- 2010 - 2017: Mechanical and Facility Engineer for the NASA Infrared Telescope Facility (U. of Hawaii, Institute for Astronomy)
  - Design, Testing and Commissioning of the **ISHELL** Instrument (high-resolution 1.1-5.3μ Immersion Grating Spectrograph / R~=75,000)
  - Facility and Instrument upgrades
- 2017 - Present: Senior Mechanical Engineer for the U. of Hawaii, Institute for Astronomy:
  - Design, Testing and Commissioning of the diverse instruments:
    - **DL-NIRSP** at the Daniel K. Inouye Solar Telescope (Diffraction Limited Near Infrared Spectropolarimeter)
    - **mxCSM** for the MEES Observatory (Wide-Field Coronal Spectropolarimeter)
    - **Robo-AO2** for the UH-88 and USNO telescopes (Autonomous Laser AO System + Instrument)
  - Facility upgrades at UH-88 / PanStarrs

Key Documents

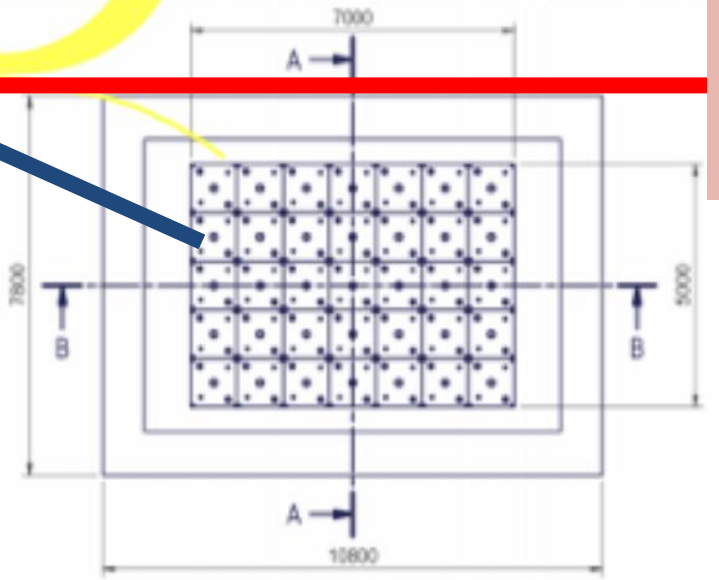
Calibration Documentation	Description	EDMS Link
Calibration Folder	Top level folder for Calibration documentation	https://edms.cern.ch/project/CERN-0000217530
Requirements	Spreadsheet with all ND-LAr requirements, see sheet "Calibration (07)"	https://edms.cern.ch/document/2589287
Internal ICDs	Interface control documents (ICDs) internal to the ND-LAr Consortium	https://edms.cern.ch/project/CERN-0000223195
Analyses	Collection of analyses write-up: FEAs, bench testing, 2x2 prototype evaluations	https://edms.cern.ch/project/CERN-0000230804
QAQC Plan	Subsystem QAQC plan with focus on high-level QAQC test plans	https://edms.cern.ch/document/2617454
Manufacturing Plan	Subsystem Manufacturing plan with focus on manufacturing methods of key items	https://edms.cern.ch/document/2617469
Procurement Plan	Subsystem Procurement plan with focus on procurement management of key items	https://edms.cern.ch/document/2617478
Previous Review Tracking	Spreadsheet with previous review recommendations, see "Calibration"	https://edms.cern.ch/document/2741842
Cost	High-level cost estimate for ND-LAr and subsystems	https://edms.cern.ch/document/2742778
Schedule	High-level "one-pager" schedule for ND-LAr Consortium activities	https://edms.cern.ch/document/2603073
CAD Model (Row Assembly, TPC Assembly)	Solidworks "Pack & Go" and Parasolid exports of CAD models	https://edms.cern.ch/project/CERN-0000230732
Mechanical Component Drawings	Subsystem mechanical component drawings	https://edms.cern.ch/project/CERN-0000230801
Mechanical Assembly Drawings	Subsystem assembly drawing	https://edms.cern.ch/project/CERN-0000230802
Parts List	Subsystem parts list	https://edms.cern.ch/project/CERN-0000230803
Electrical Schematics and Board Layouts	Subsystem electrical schematics and board layouts	NA
Electrical Cabling and Wiring Specification	Specification of electrical cables/wiring	NA
Bill of Materials for Electronics Boards	Bill of materials for electronics boards	NA

Calibration Subsystem Overview

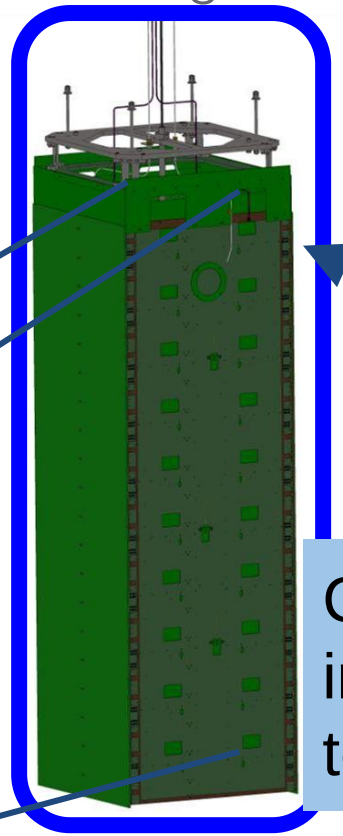
- light injection system on top of cryostat
- fiber guided light illuminates photoelectric targets on cathode inside TPC module
- photoelectric targets on cathode in predetermined locations emit electron clouds after illumination with fiber guided 266 nm laser light
- electrons drift and get collected on anode



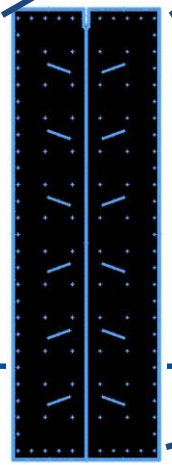
Warm: external to cryostat



ND LAr Top view (not to scale)



Cold: internal to cryostat

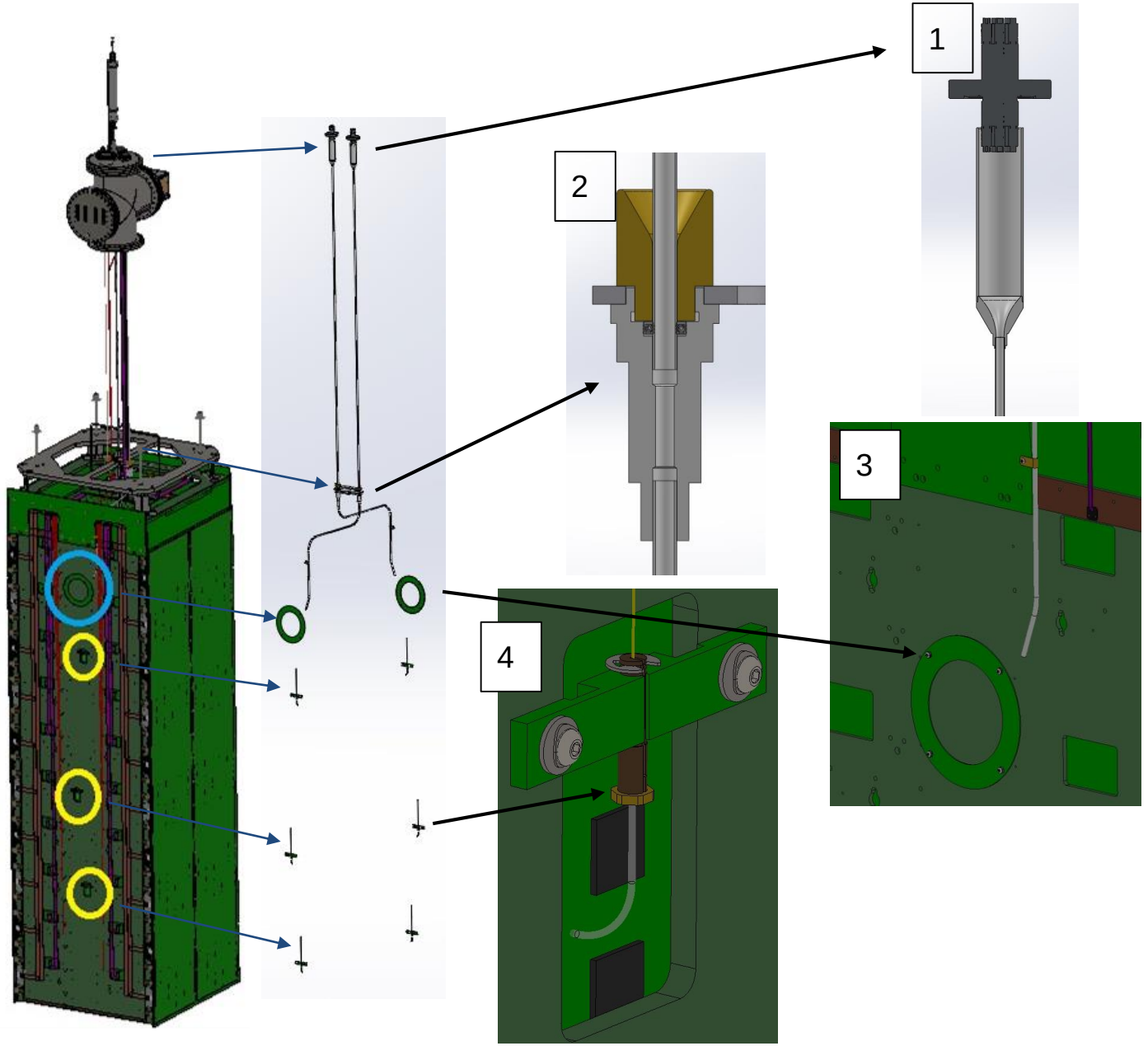


Cathode with photoelectric targets

Calibration Subsystem Overview

The Calibration subsystem inside the cryostat has 4 different elements:

1. Fiber Vacuum Feedthrough and Funnel
2. Frame Interface
3. Fiber Coiling Spool
4. J-Pipe Light Guide Assembly

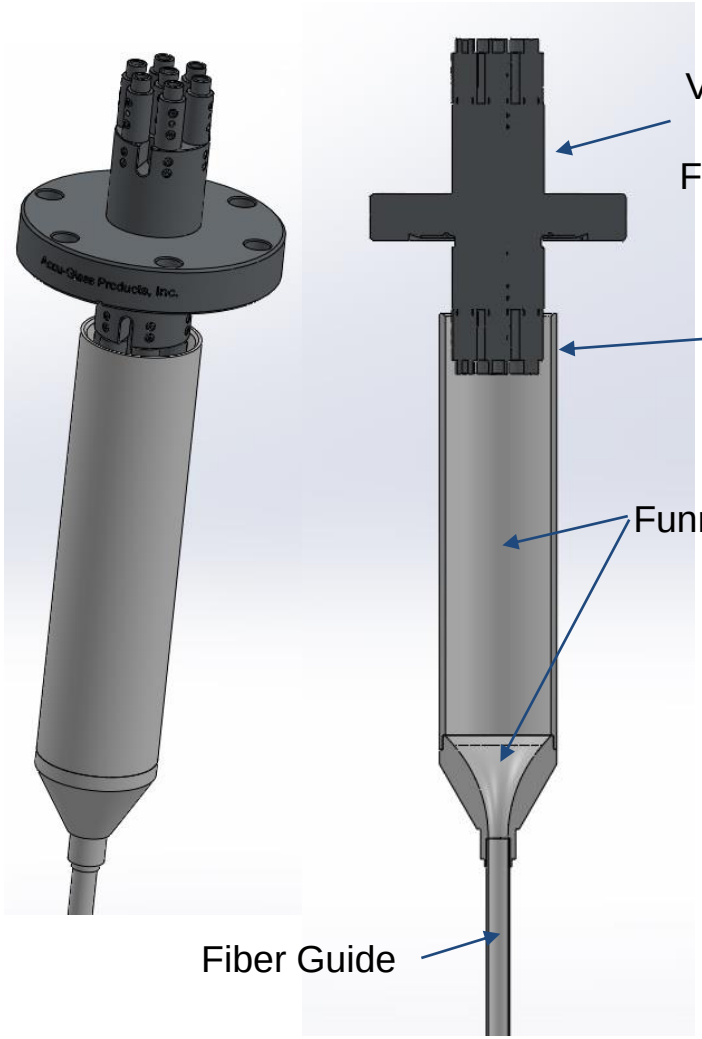


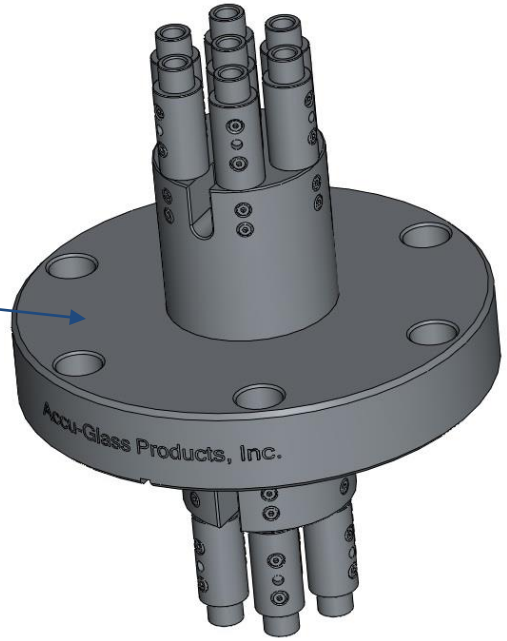
Calibration Subsystem: Vacuum Feedthrough and Funnel

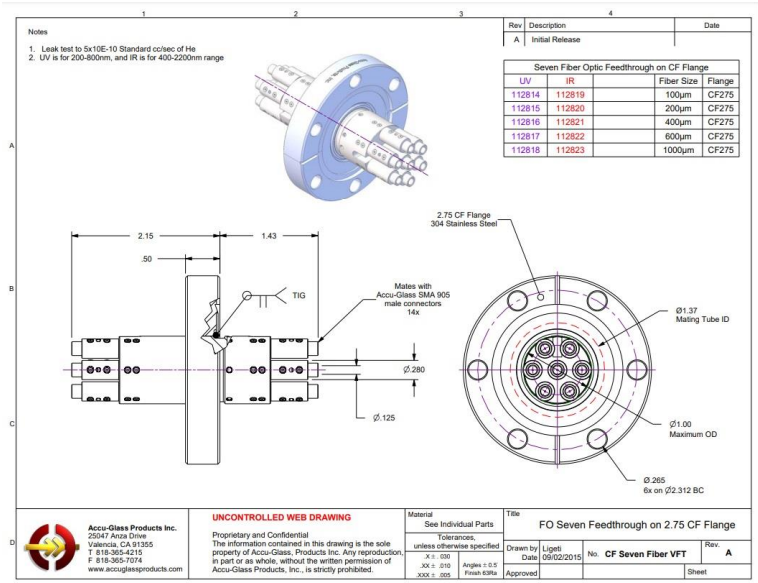
- The Vacuum Feedthrough is an off-the-shelf part from Accu-Glass (P/N# 112815).

  It can pass thru 7 fibers and it uses a standard 2.75 CF flange

- The Funnel helps feeding the fibers into the guiding tube



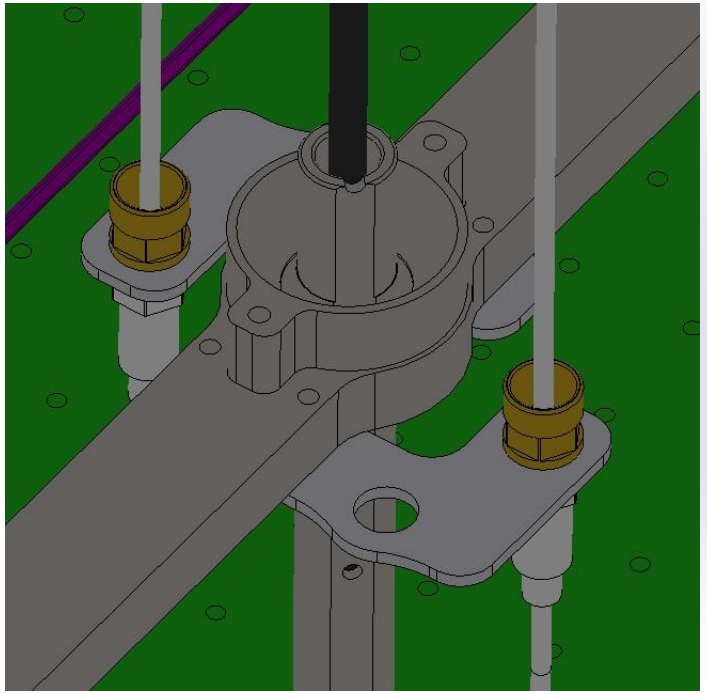


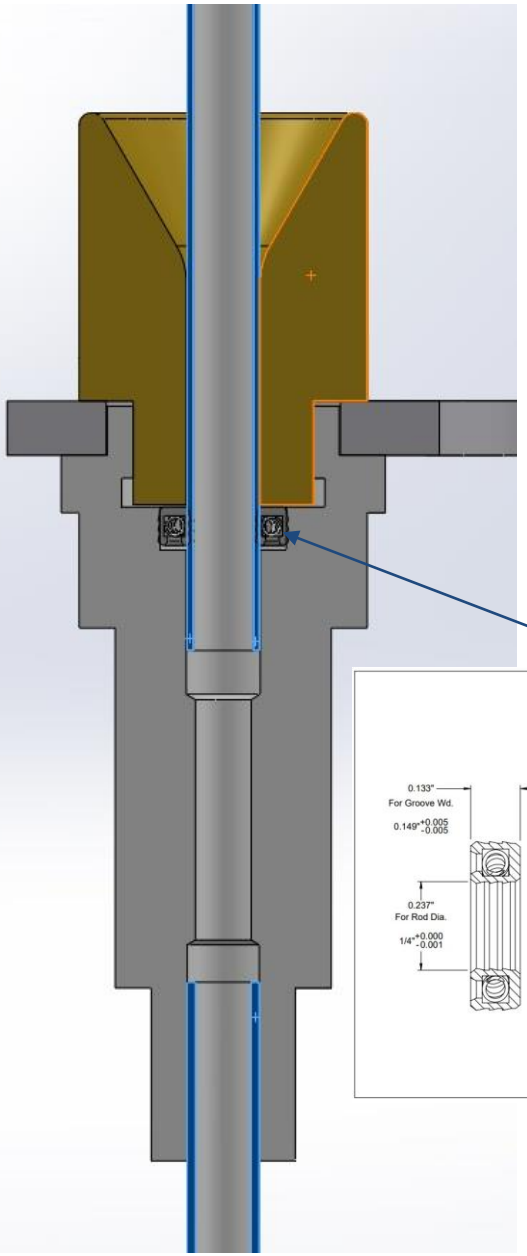


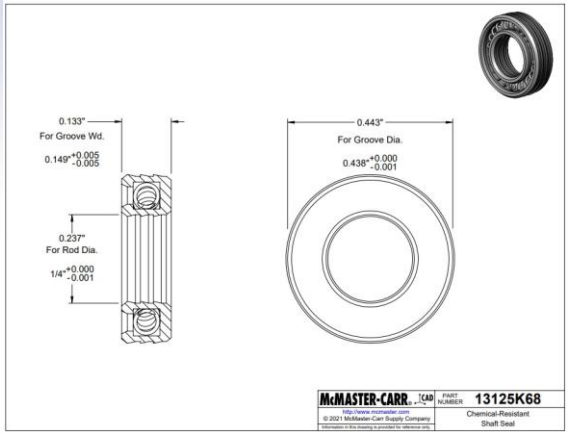
Calibration Subsystem: Frame Interface

The frame interface has 2 functions:

1. It supports the fiber guiding tube via the TPC Module frame
2. It connects the upper part of the guiding tube to the lower part

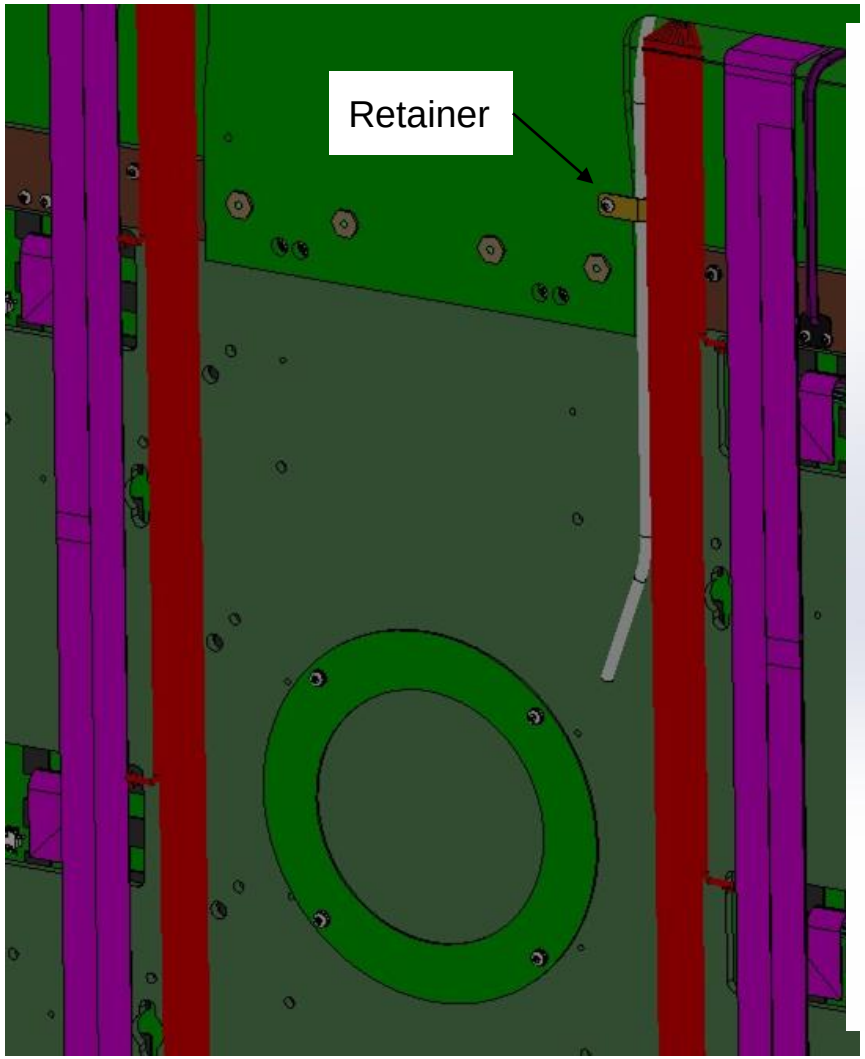


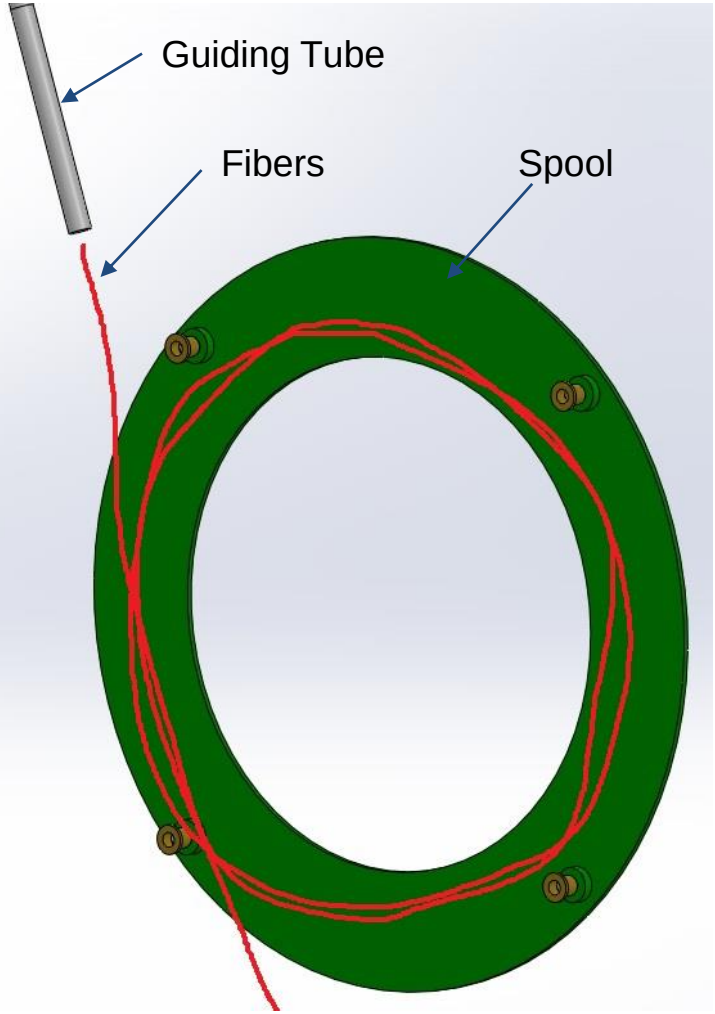




Calibration Subsystem: Fiber Coiling Spool

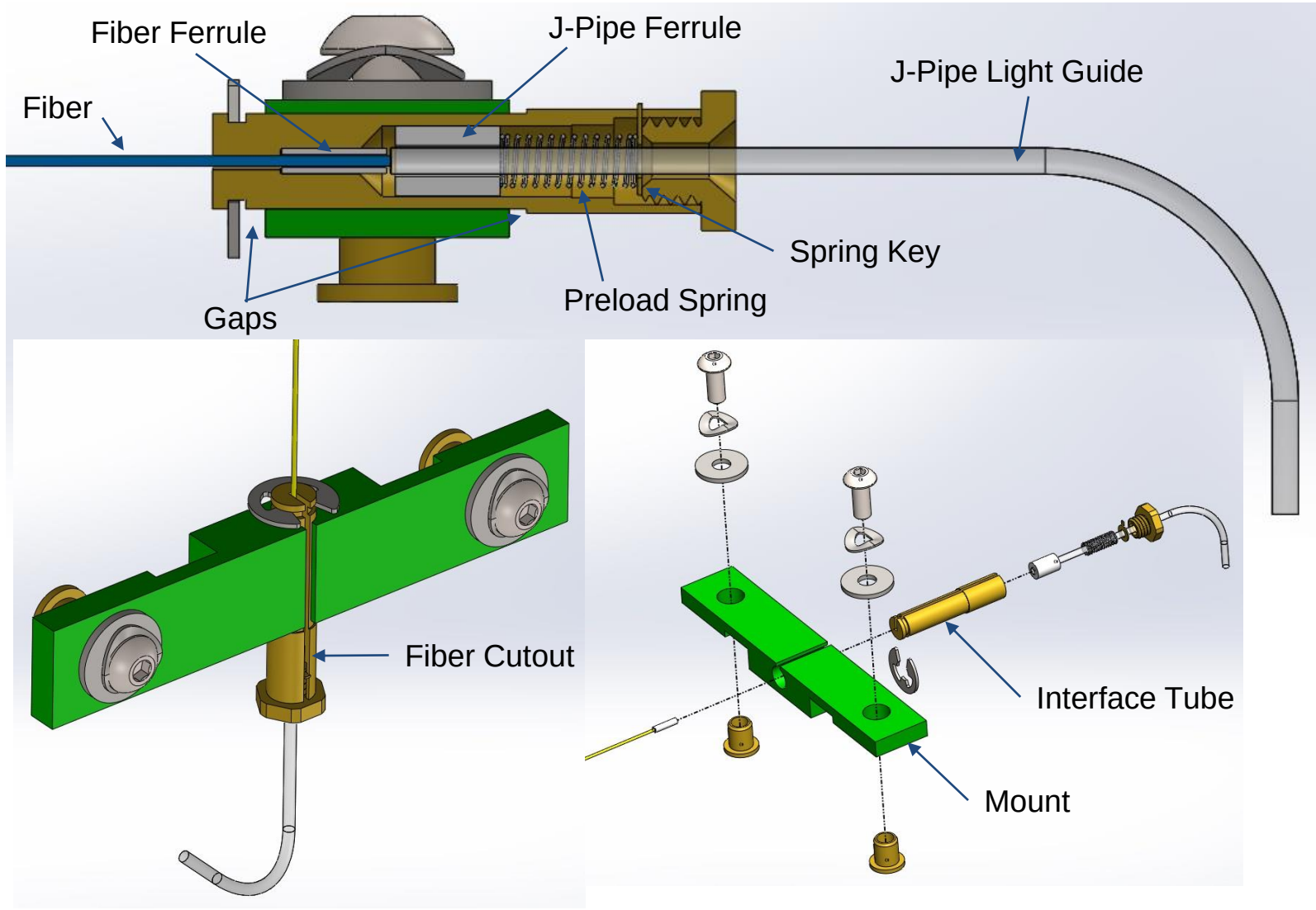
In order to not overconstrain the fibers and to account for fiber length inexactitude, we have implemented a spool that captures the fiber coils within the 4 mounting fasteners.



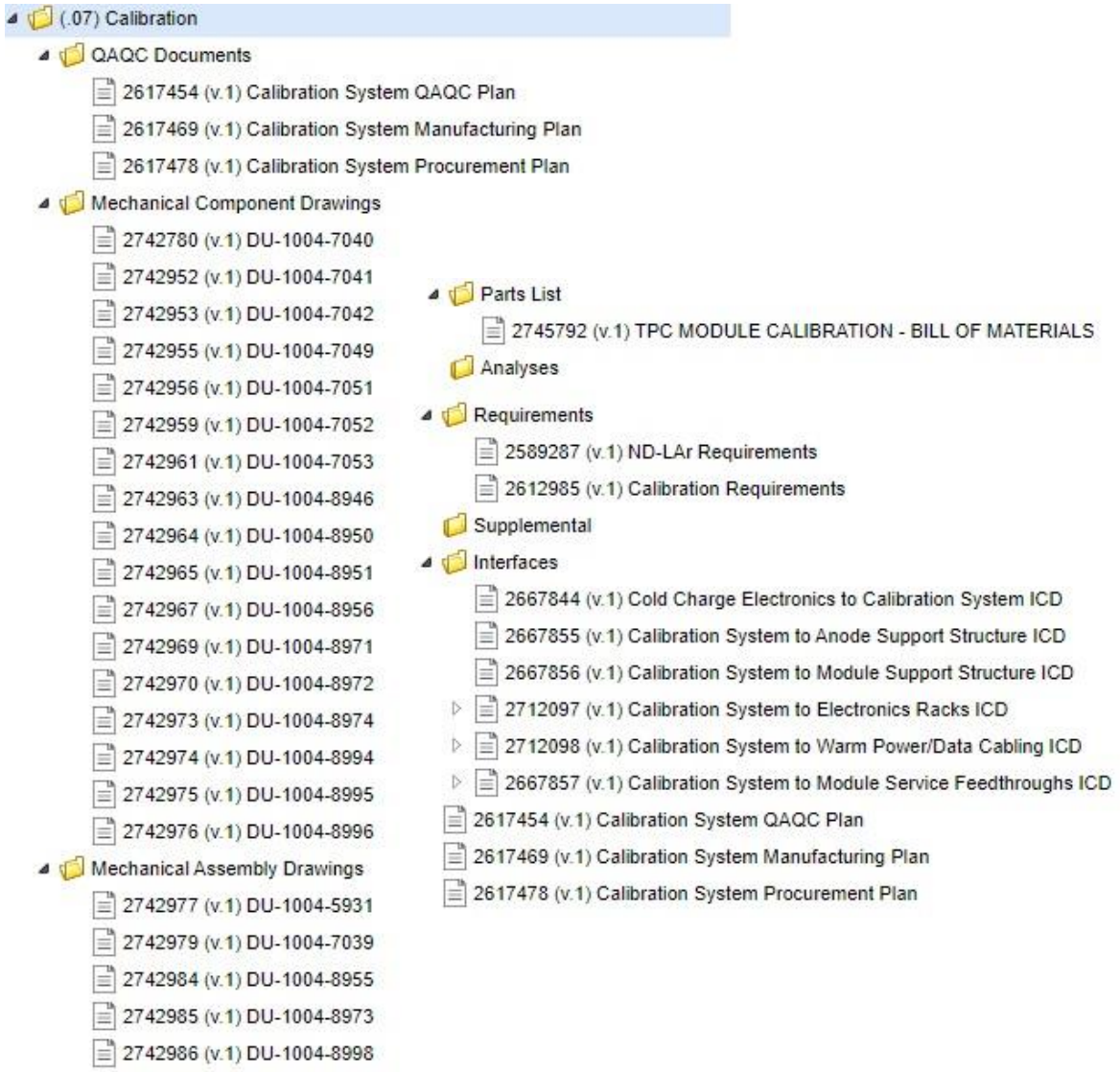


Calibration Subsystem: J-Pipe Light Guide Assembly

- Due to the large minimum bending radius of the fiber, it is necessary to use a J-Pipe Light Guide if we want to inject the calibration light perpendicular to the TPC Board.
- To insure contact at all times the J-pipe is preloaded against the fiber with a spring.
- The interface tube is free to translate in its mount to account for CTE differences



Documentation Tour



Mechanical Component Drawings:

https://edms.cern.ch/project/CERN-0000230801

Mechanical Assembly Drawings:

https://edms.cern.ch/project/CERN-0000230802

Parts List (Bill of Materials):

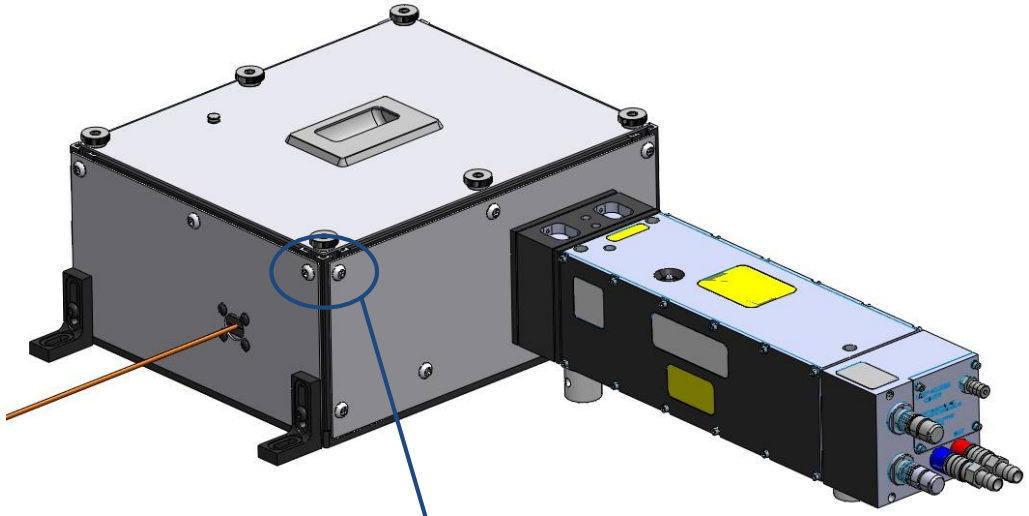
https://edms.cern.ch/project/CERN-0000230803

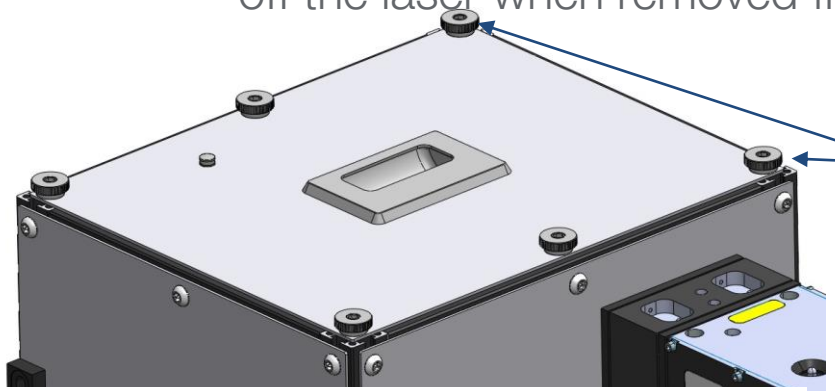
Internal ICDs:

https://edms.cern.ch/project/CERN-0000223195

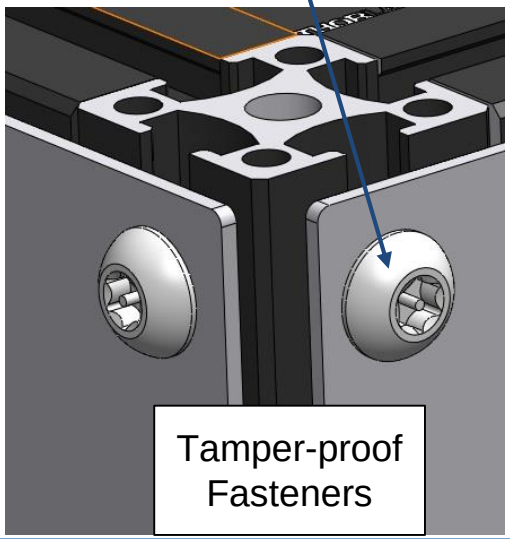
ESH Codes and Standards: Laser Safety

- The Laser module is attached to the box from the inside.
- All the panels have tamper-proof fasteners except the top one.
- The top panel (cover) has a limit switch that shuts off the laser when removed from the box.

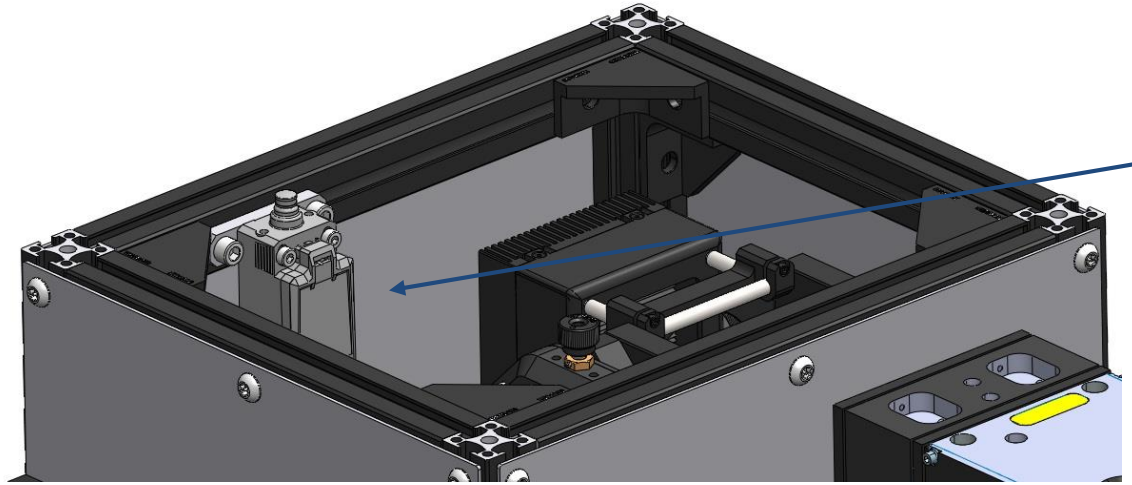




Thumb Screws



Tamper-proof Fasteners



Safety Limit Switch

Open Design Issues / Path to FSD & FDR

Current preliminary design status:

- Confirmed individual design elements work in test benches (see previous talk)
  - Target mounting, photoelectrons in vacuum, light injection

To solve prior to FSD:

- Demonstrate integration of design elements in SingleCube
  - Key aspect: photoelectrons transported in LAr
- Optical fiber routing and J-pipe integration

No anticipated design issues to be resolved after FSD but before FDR

- Modular design elements and local, SingleCube test stands available

Summary

Status

- Individual design elements work as designed in test benches
  - Target mounting, photoelectrons in vacuum, light injection
- Integration of design elements in SingleCube to be demonstrated
- Finalize design of optical fiber routing and interface with J-pipe

Final Design Phase

- Verify system level performance (FSD)