Planning for Proto-DUNE PD Installation and Cabling at CERN

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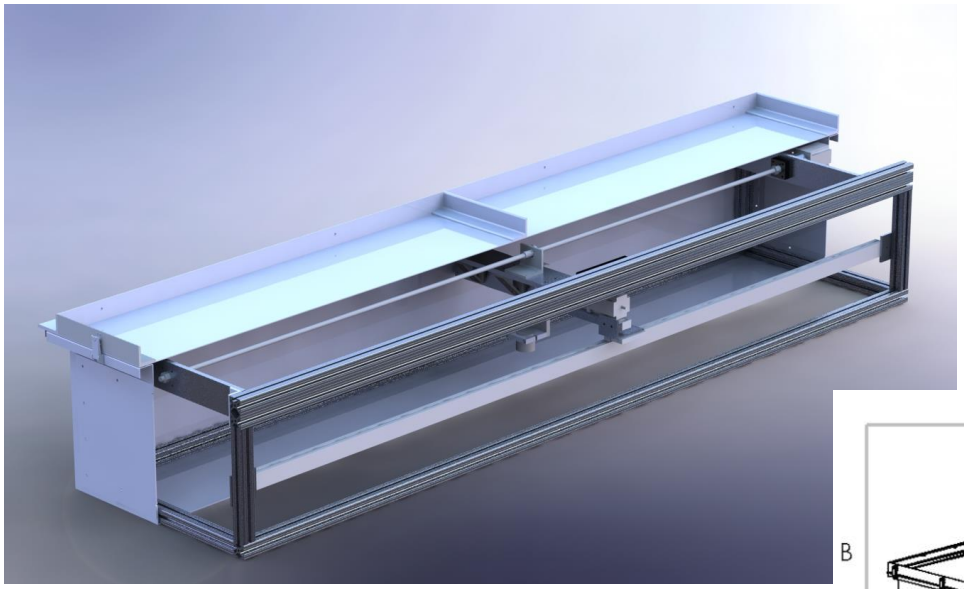
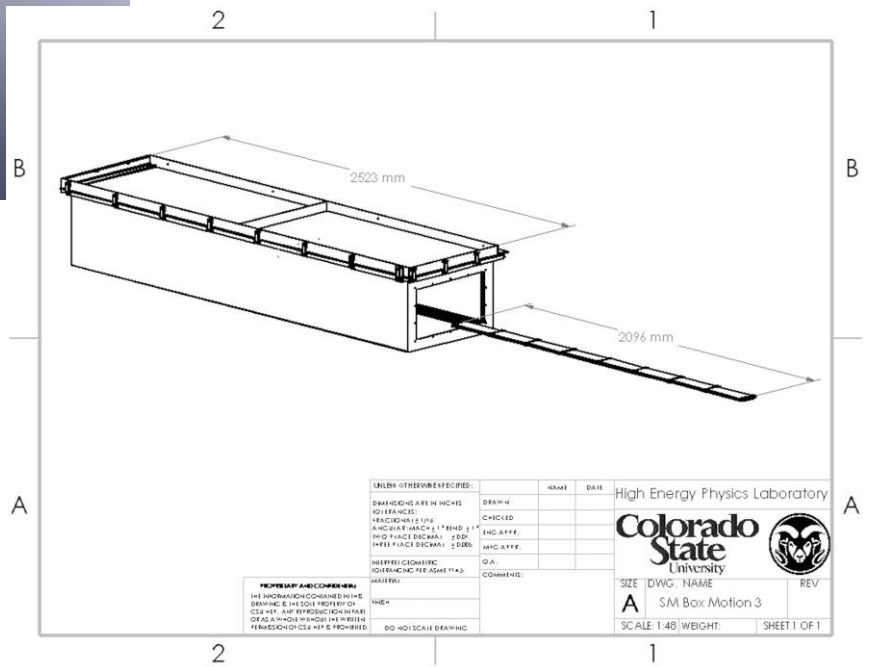
Space requirements for PD installation

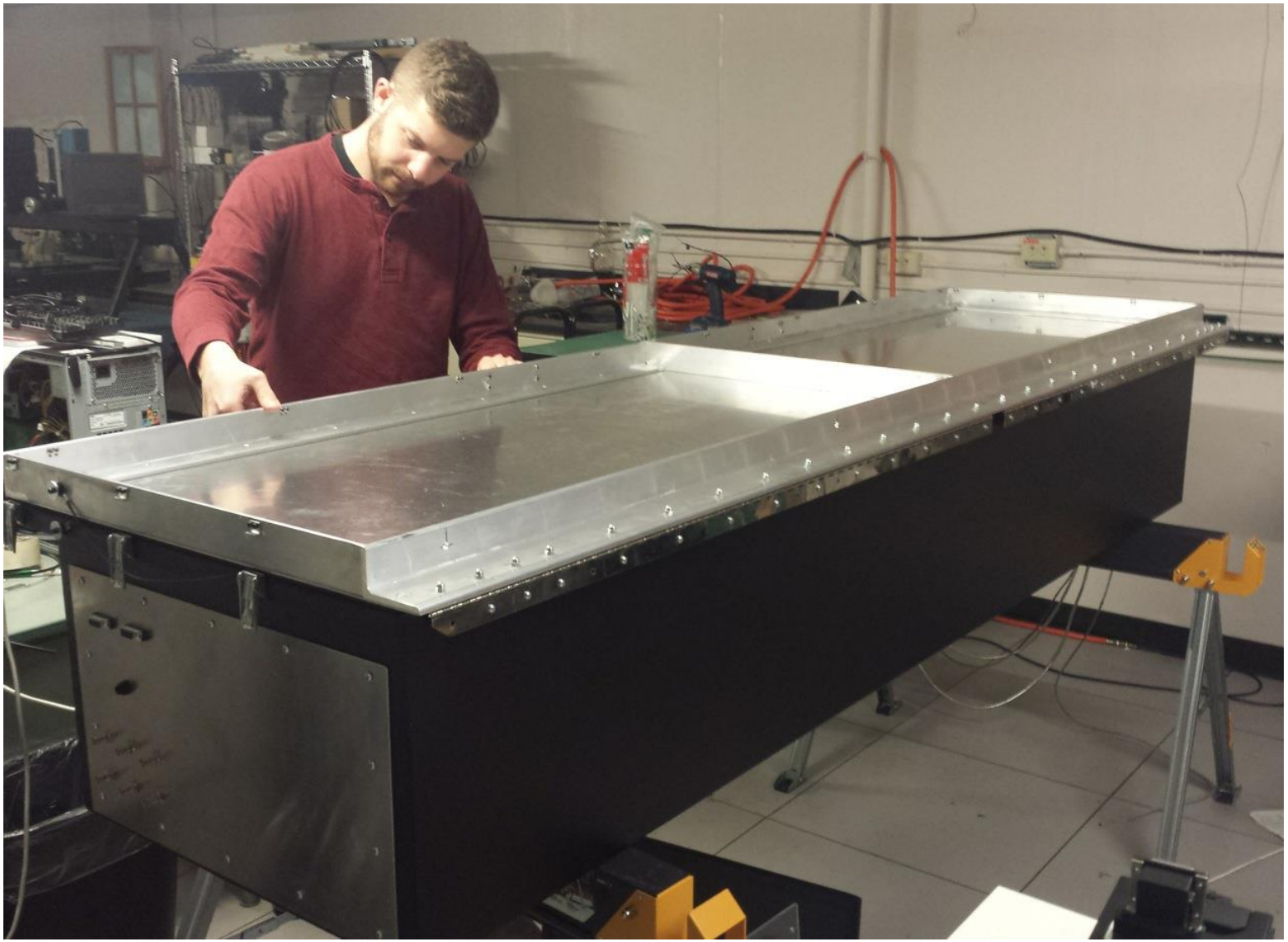
- A PD installation area approximately 2m X 5m is required.
- In addition, the PD test scanner
- The assembly area should be a class 100,000 clean assembly area, with UV filtering (<450 nm) on ambient light.
- Following PD installation, the APAs must be protected from prolonged exposure to unfiltered light at all times.

PD Scanner Rendering





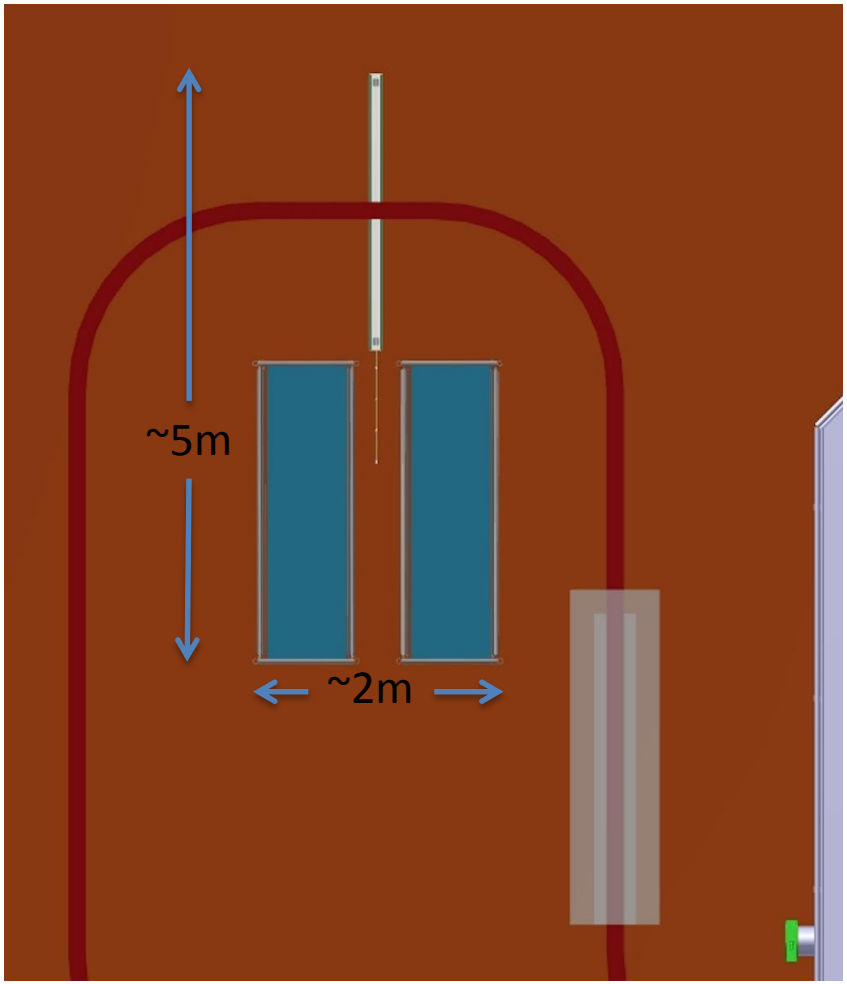
PD Scanner Dark Box

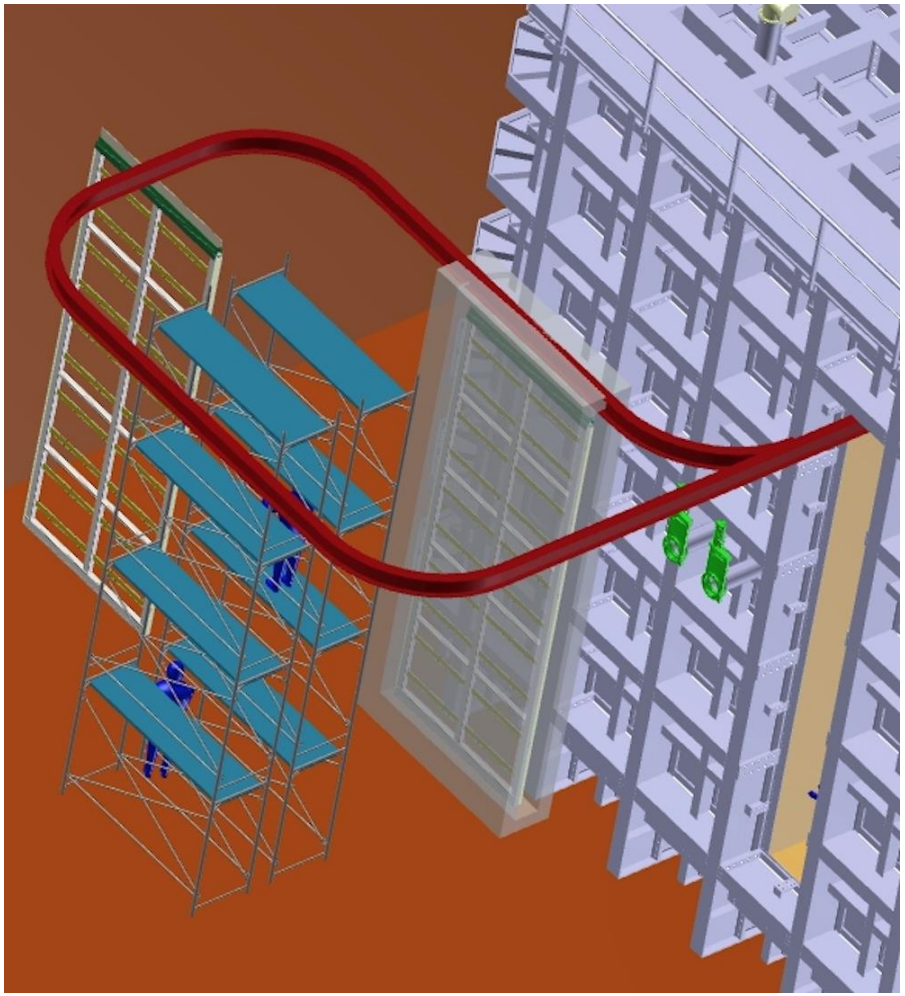


PD Installation in APAs

- Installation of PDs is planned to happen with the APA frames rotated vertically
- Installation follows the following rough outline:
  - PD is tested in PD scanner (while previous installation is occurring)
  - PD “Short haul” cable is pulled through the frame using “Fish tape” positioned in frame during assembly
  - PD to be installed is positioned in “PD lift” and lifted to position.
  - PD is slid into APA frame and fastened into position
  - Short haul cable is connected & connectivity tested at far end of short haul cable.
  - PD installation lift is lowered to ground position and process repeated
  - After 5 PDs are installed in one side of APA, APA is rotated about vertical axis and process is repeated on other side
- No operational (dark) check of the PDs post-installation is planned until they are in the cryostat.

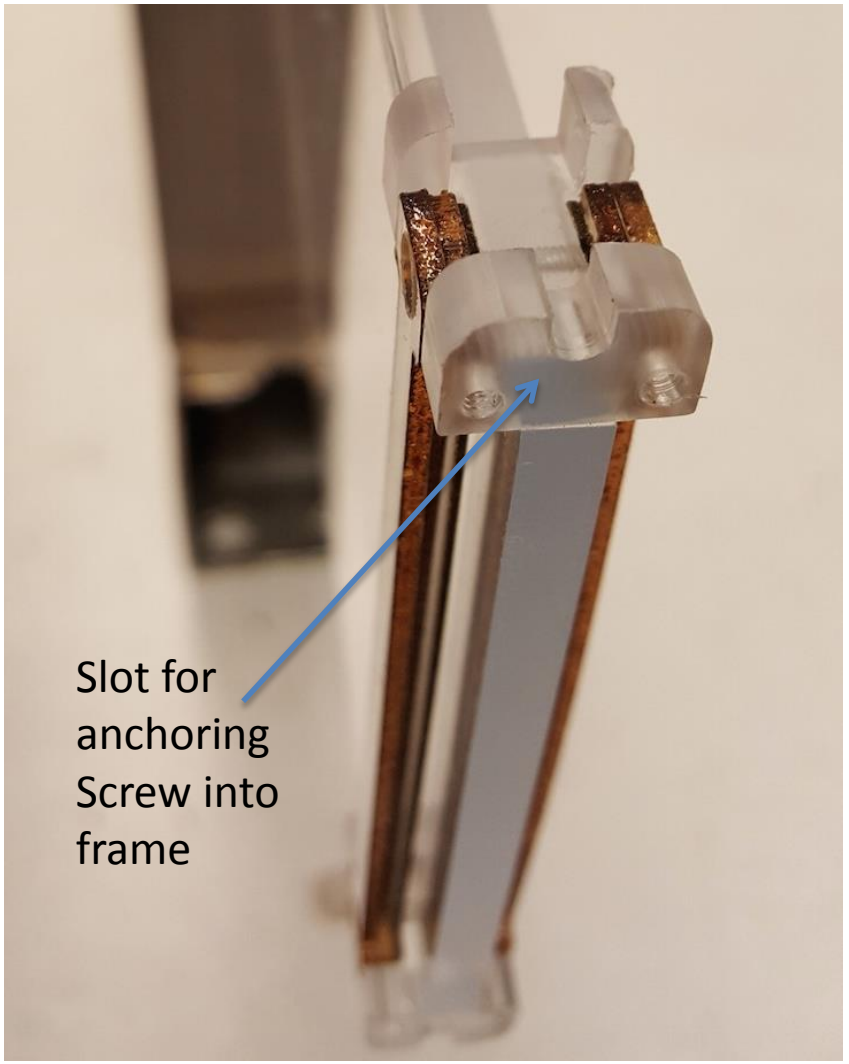
PD Installation in APAs





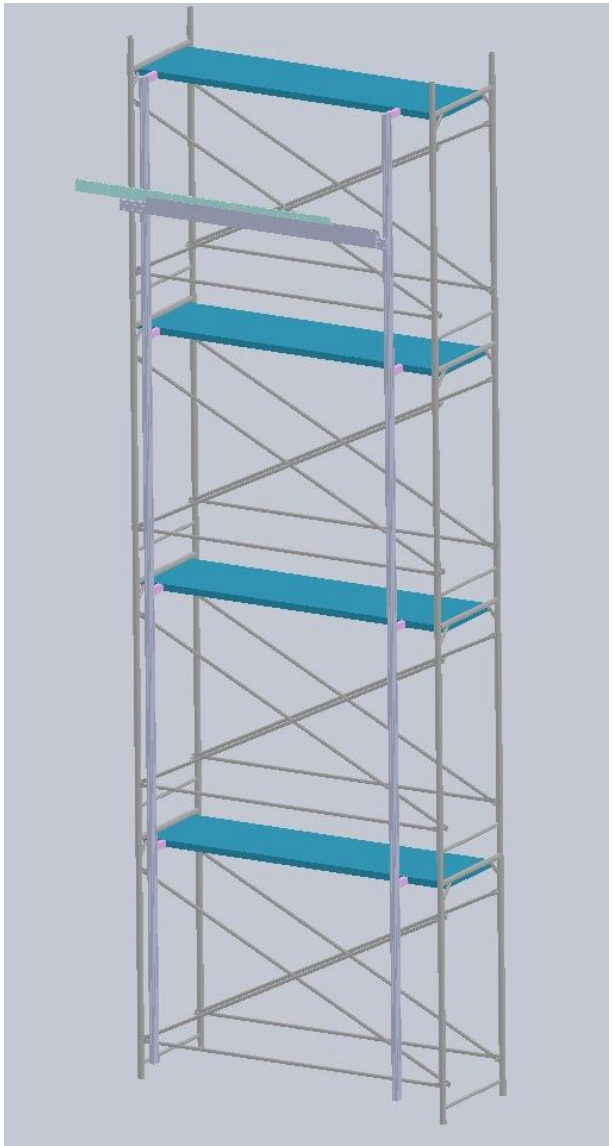
Plan view in cleanroom

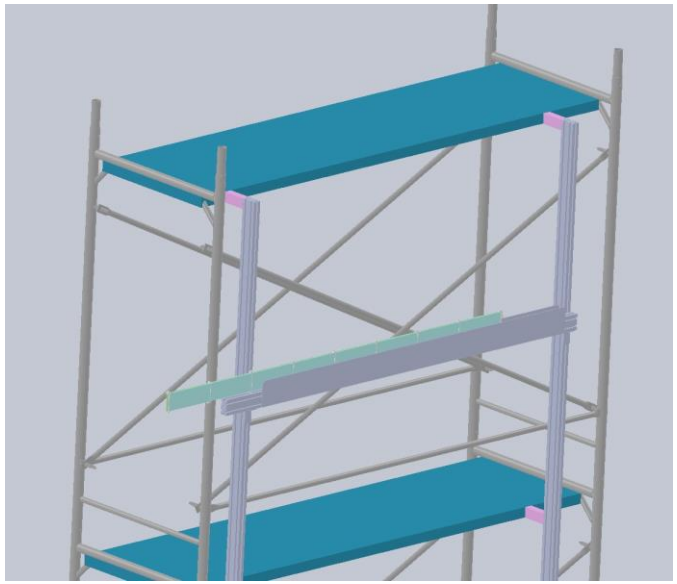
PD being inserted into vertically-oriented APA

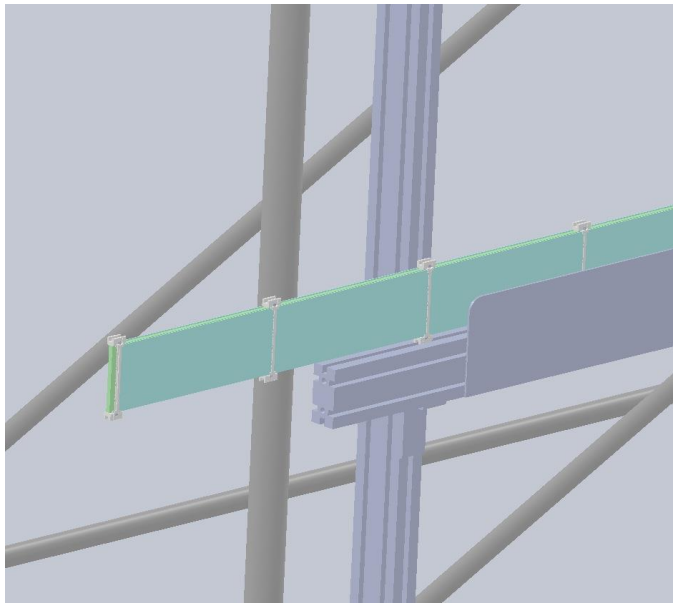


PD Installation “Elevator”

- “Elevator” is fabricated from extruded slotted aluminum bars (“80/20 extrusion”) with a horizontal vertically-adjustable insertion tray.
- Elevator is supported by a scaffolding separate from the one occupied by installation personnel to minimize vibration during installation.



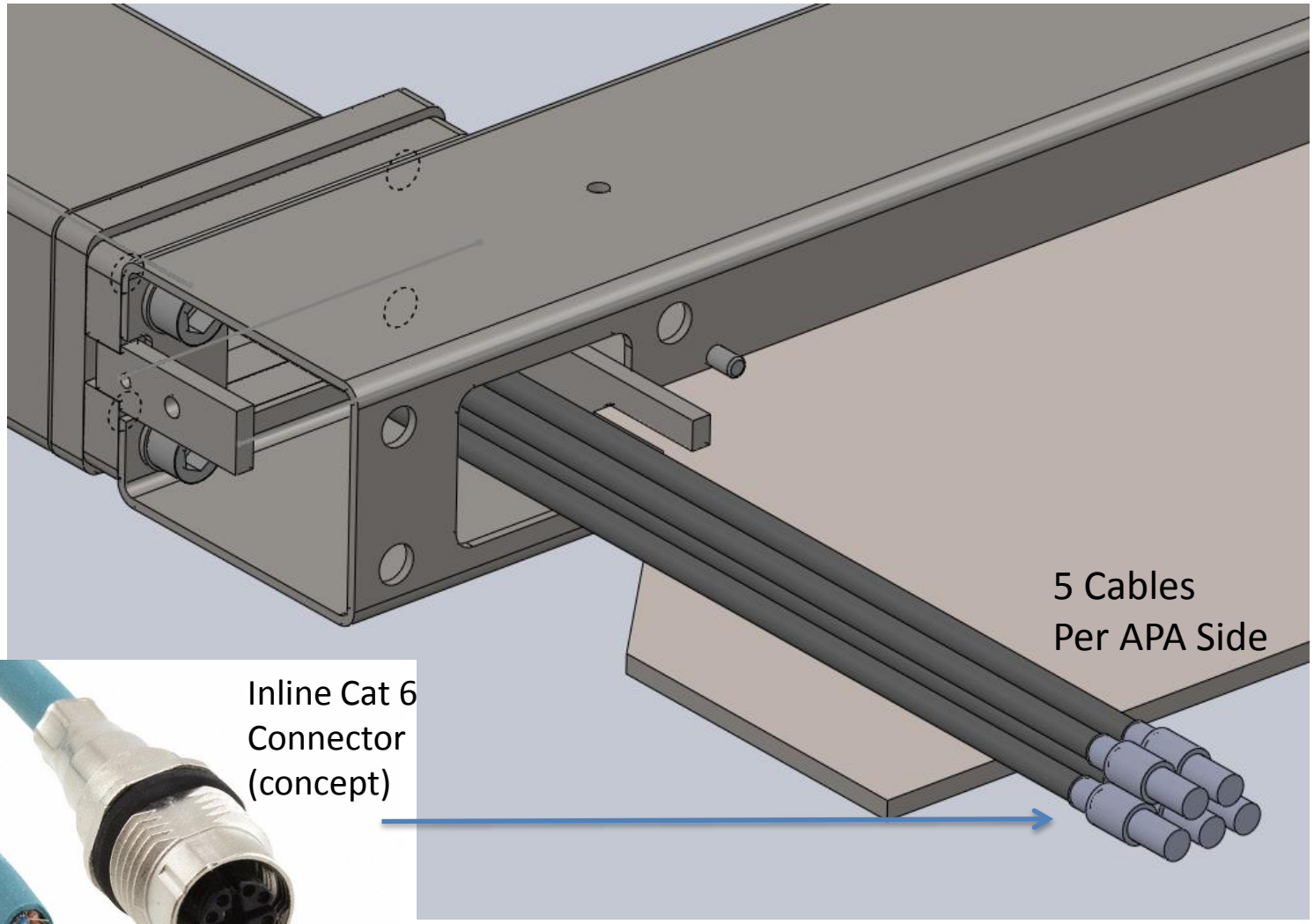




PD Cabling

- PD cabling will occur concurrently with APA cold electronics installation.
- Each APA will have 10 Cat-6 PD cables to connect (5 in each of the APA side tubes)
- Connecting of PD modules to long-haul cables and through the cryostat feed throughs should occur as early in the process as possible.
- Immediately upon connection continuity checks to the SiPMs must be made.

PD Cabling



Inline Cat 6
Connector
(concept)

Conclusions

- The majority of PD components are scheduled to arrive in March through June 2017
  - CERN help will be needed to receive the equipment
  - We will require something like 4m X 4m for storage until we are ready to install
- PD installation into the APAs will require a clean, light-filtered area approximately 2m X 5m
  - APA oriented vertically during installation
- The PD group will send over a test scanner to allow us to re-test all APAs prior to installation
  - Testing & installing a single PD will require ~ 2 hours
  - Installing the PDs in a single APA will require 5 days
- Approximately 3 people will be required to install PDs
  - 1 scientist (Post-doc level)
  - 1 expert technician (PD specific)
  - 1 local (CERN-supplied) technician

Shipping to CERN (initial estimates)

- Shipping
  - PD components will begin to arrive at CERN in March 2017, with most components on-site by June 2017
  - The PD modules will ship to CERN in 6 crates, approximately 85cm X 85cm X 250cm, weighing ~ 200 kg
    - 10 PDs + 1 spare per crate?
  - Electronics (24 modules?) will ship to CERN a currently unspecified number of containers, but the total volume should be ~ 2 or 3m^3
  - Cables will ship in 6 crates (1 per APA) ~ 85cm X 85cm X 85cm, weighing ~ 100kg each
  - PD QC scanner will ship in a crate ~ 1.2m X 1.2m X 3m, weighing ~250kg
  - Help will be required from CERN to receive, store and transport the crates on site
  - PD components will need to be stored in a dry, environmentally-controlled area
- No on-site assembly or fabrication of PDs is expected at this time

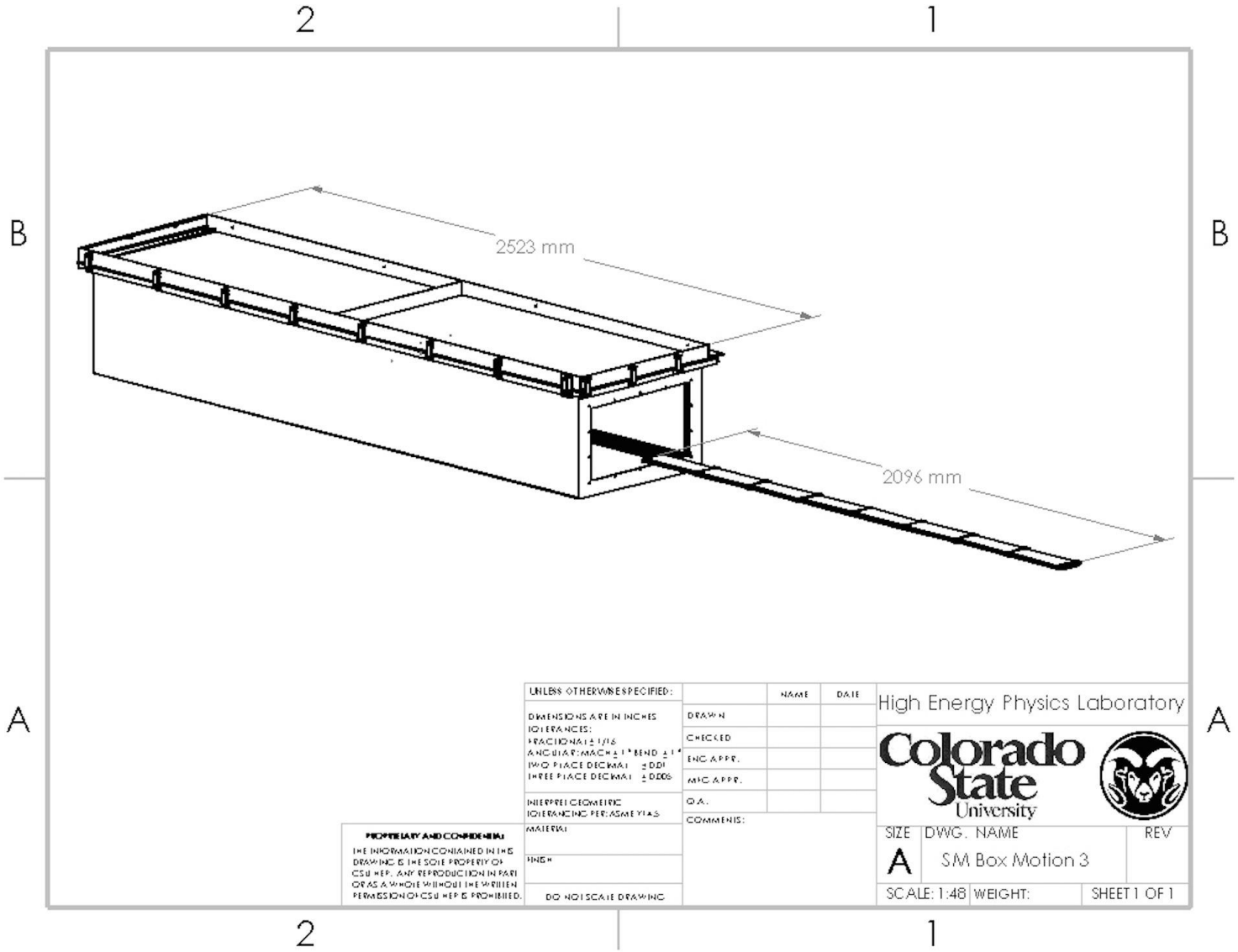
Labor Requirements for PD installation/QC

- 3 persons will be required for installation of the PDs
  - 1 scientist (Post doc)
  - 2 technicians (1 PD expert, 1 CERN technician for local support)
- Allowing for inefficiencies and our uncertainties remaining for vertical APA installation, perhaps as many as 5 days are required to install the PDs in 1 APA (2/day).
- In addition, materials handing support to receive, store and transport components. Intermittent scientist and technician support will be required during APA installation into the cryostat to confirm cable connectivity while action can be taken to rectify problems (perhaps 1 hour total following APA installation).

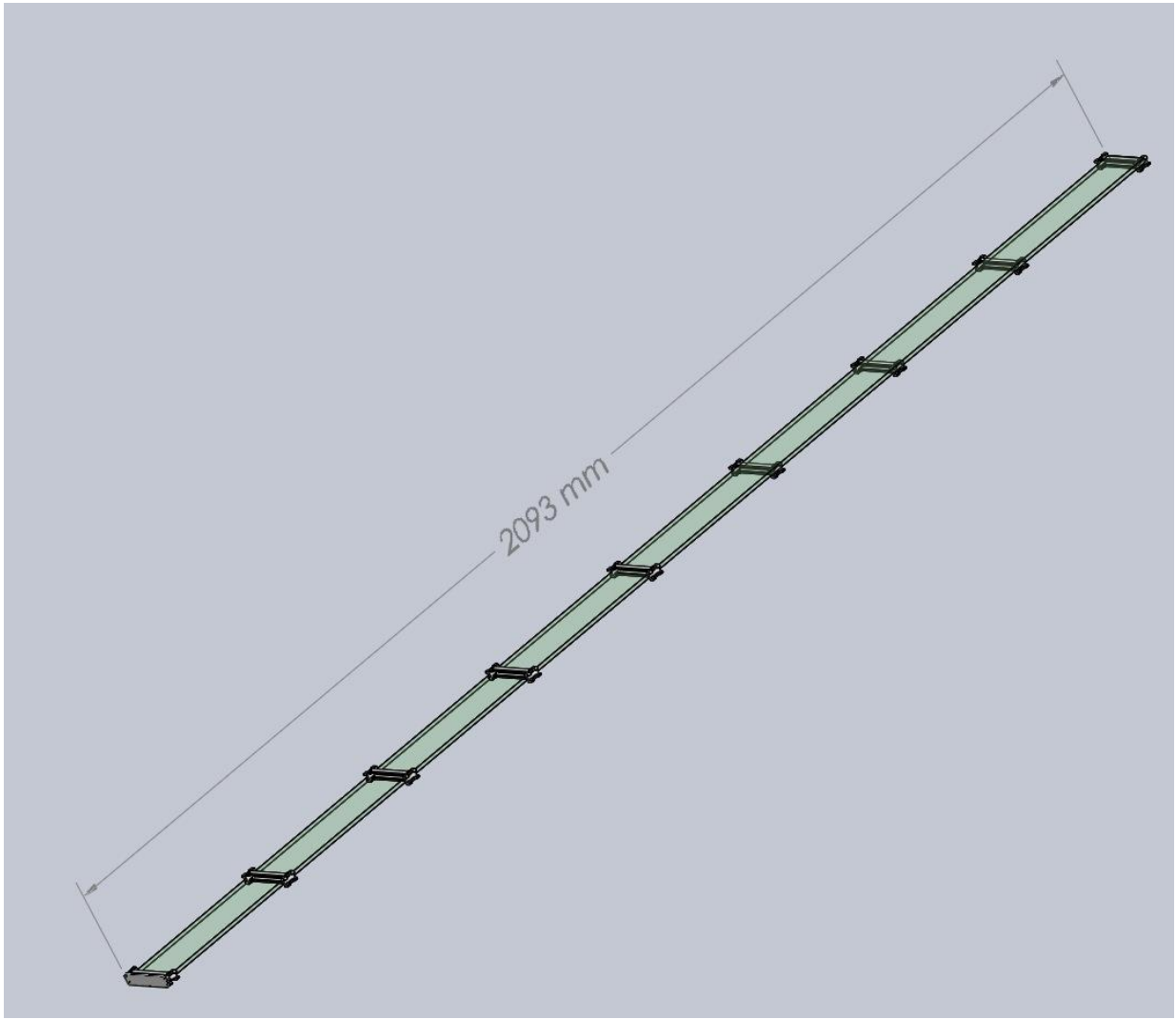
Special Testing Tools

- The PD group will ship a dark box/automated scanner to CERN
  - The dark box requires approximately 2.5m X 0.7m floor space, 0.45m tall (sits on table)
  - Needs ~2.5m space in front for sliding in PD module
- The automated scanner will require some space (~ 0.8m X 2m) desktop space for stand-alone DAQ
- All PD modules will undergo final checkout in the scanner box (inside the clean room) immediately prior to installation
- The scanner contains an automated moving scanner head which is planned to illuminate the PD module under test with a VUV spot
  - Scanner head will generate VUV light using gaseous argon, with either laser ionization or alpha source activation.
  - CERN safety procedures for handling small radioactive check sources (100 kBq Po 210) and/or UV lasers (power currently unspecified) need to be checked.

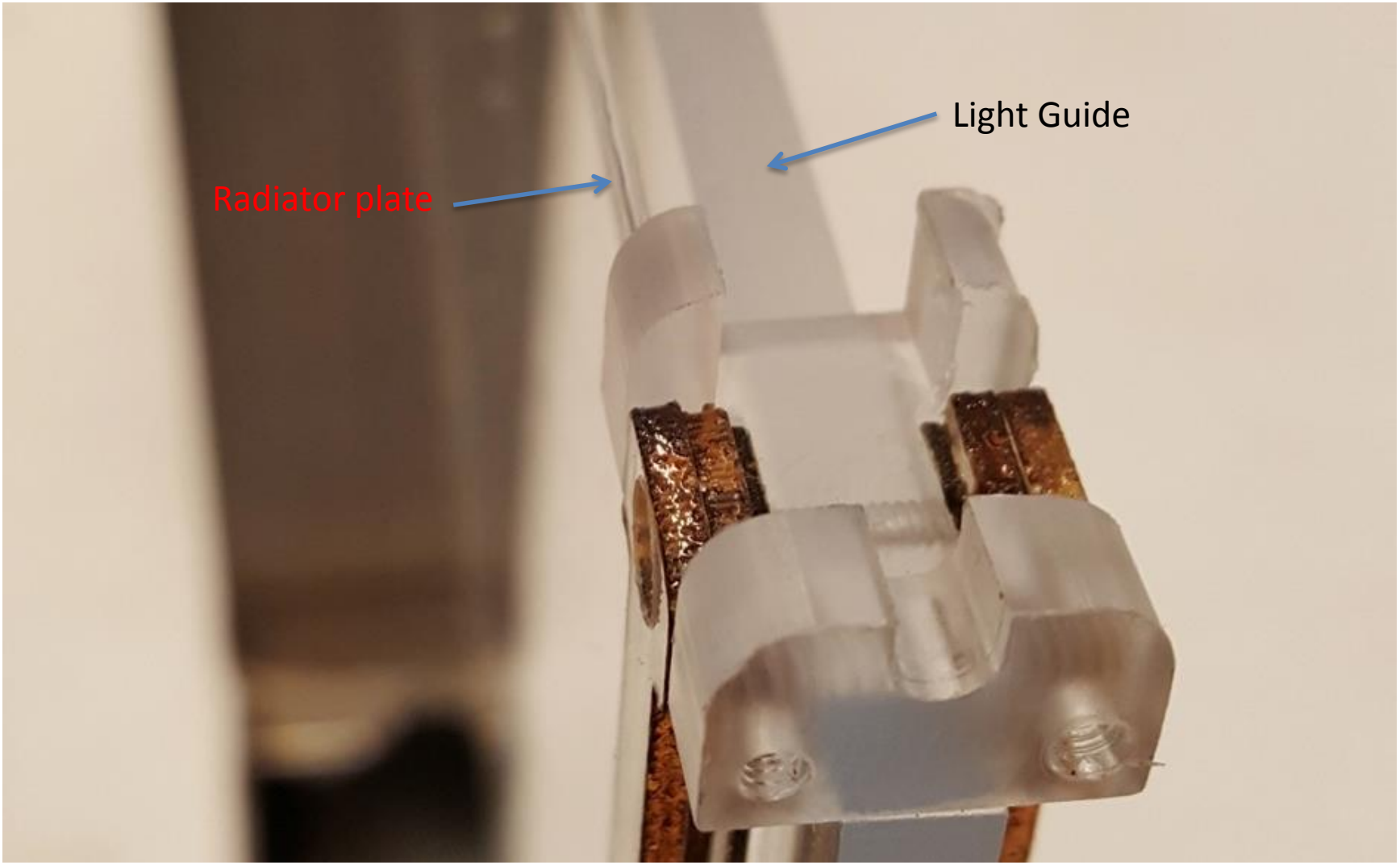
PD Scanner showing PD



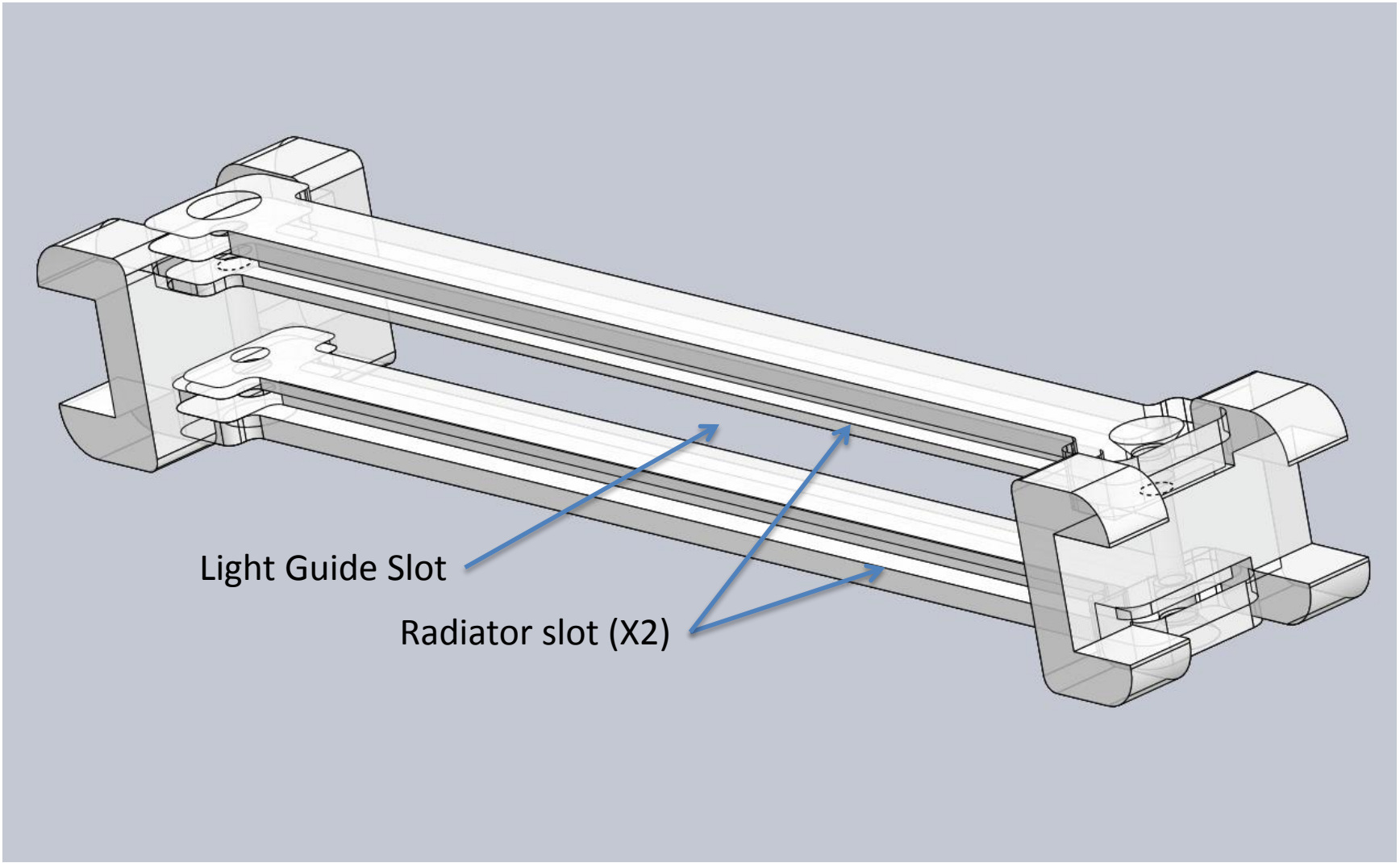
PD Module



Radiator Plate & Light Guide



Radiator Support/Installation Guide



Rail Mounting