Dynamic temperature profiler update

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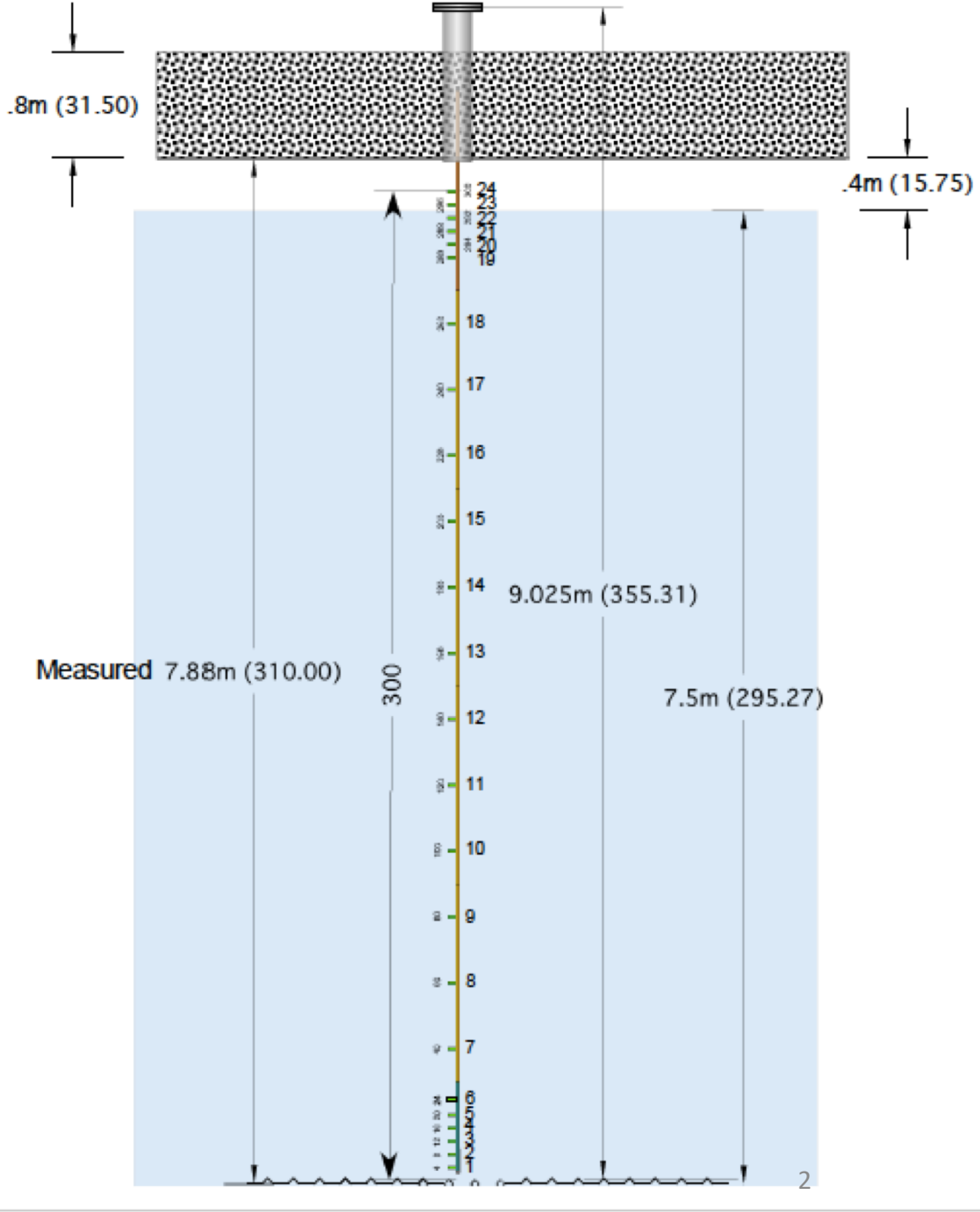
CISC + ProtoDUNE Phone Meeting

November 21, 2019

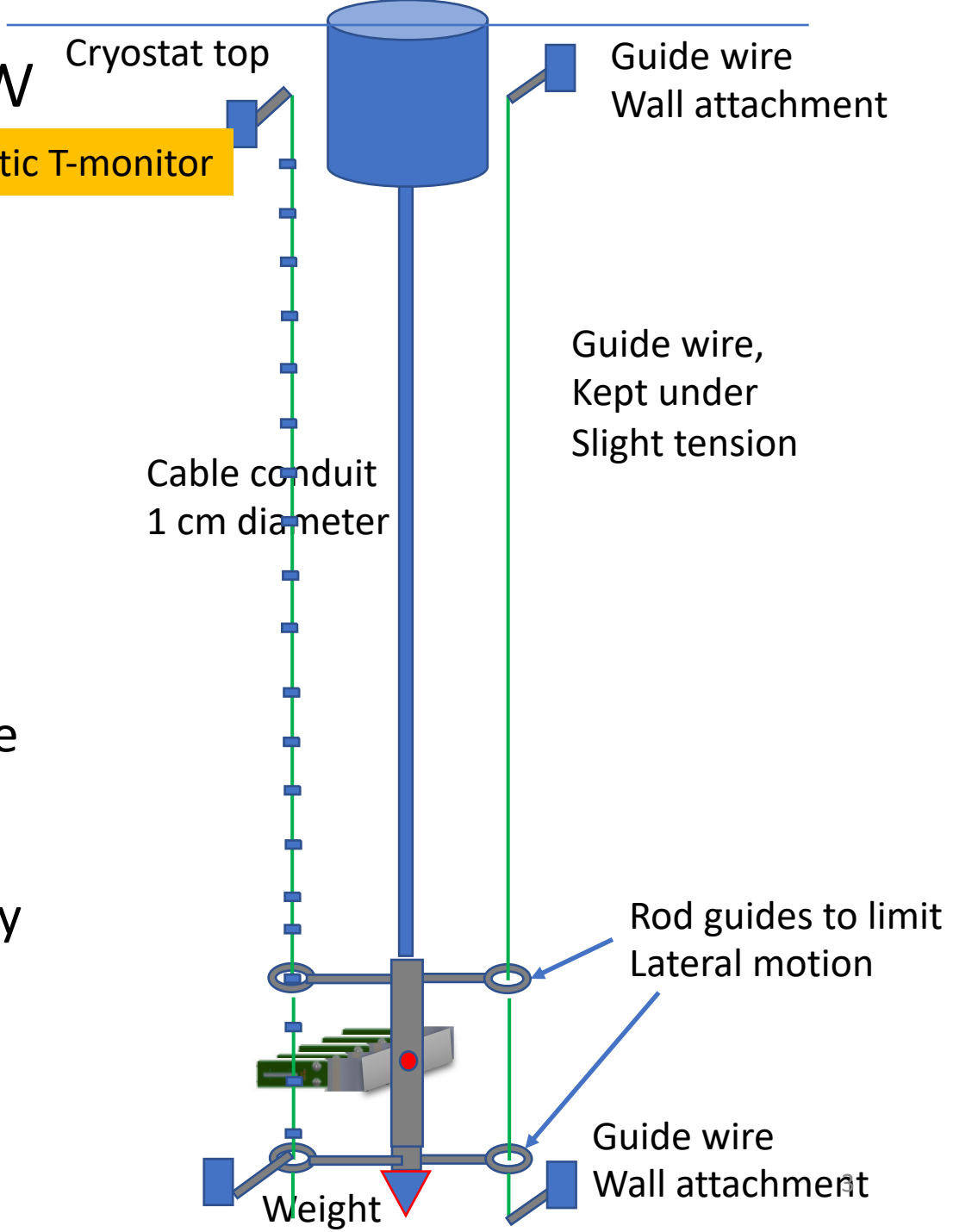
Dynamic Temperature Profiler New Design Motivation

- Current design allows cross-referencing of the sensors in-situ, but the same sensors DO NOT sample the entire height of the detector.
- Issue for calibrating the static sensors as well.
- Due to the high precision requirement for the temperature gradient measurement and adverse effects of the ambient temperature variation that cannot completely be calibrated out, it is desirable to come up with an alternative design that will move the common set of sensors through the entire height of the detector to maximize the measurement precision.



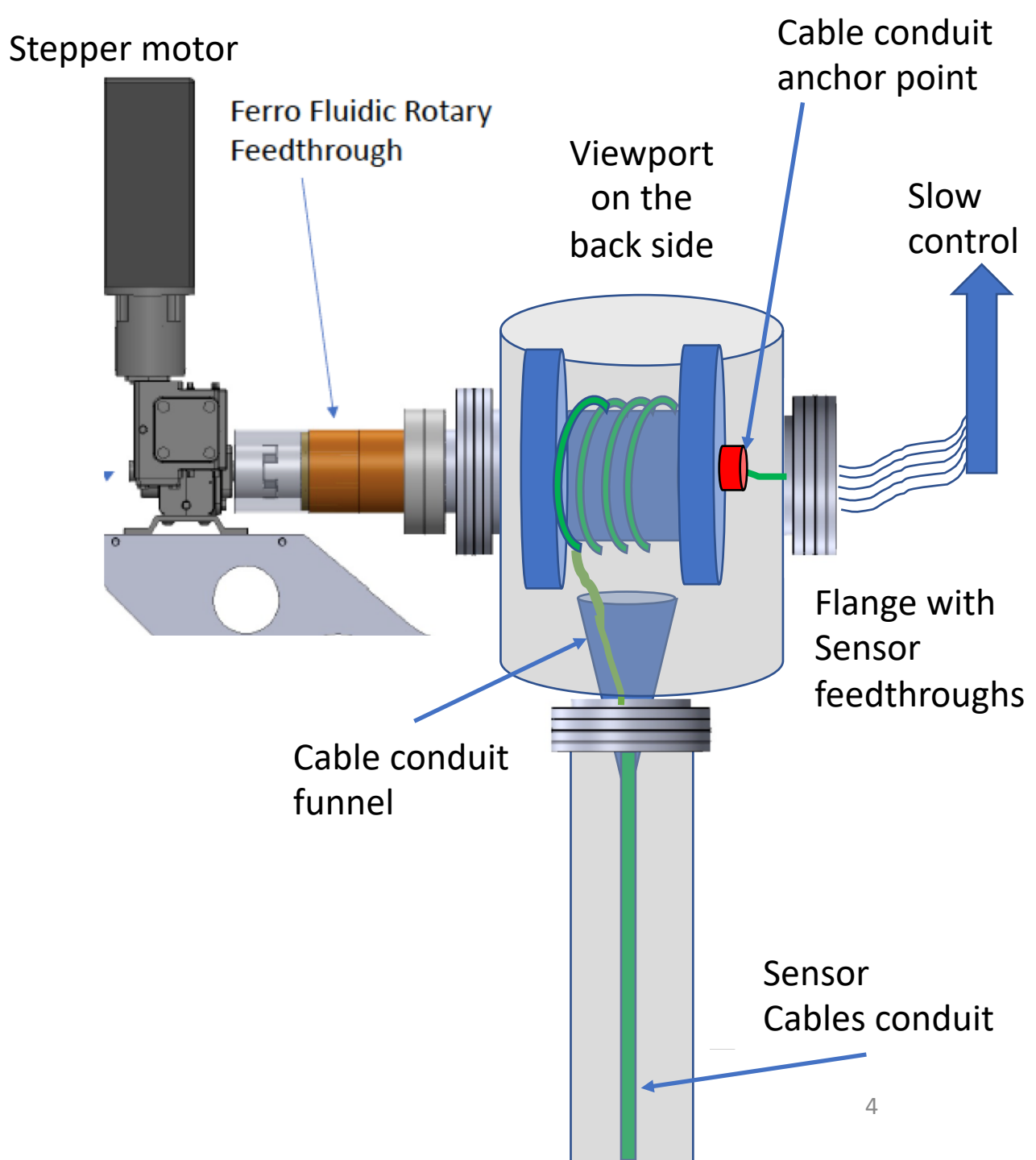
Temperature Profiler Overview

- Consists of movable array of 5 sensors and static temperature sensor array next to it.
- 5 sensor attached to a single point on the cable.
- Cable moves up and down over the entire cryostat height ~14 m.
- Weight attached to the bottom of the cable minimizes lateral motion.
- Two guides, one on each side of the movable sensor array restrict lateral swing.
- One of the guides serves as a static temperature array with sensors spaced every 25 cm over the entire TPC height and protective net to allow guide to move smoothly.



Motion mechanism

- Use similar motion mechanism as before
- Stepper motor drive
- Ferrofluidic seal to transfer the rotary motion to the spool
- **Drawings and step file of the motor drive received from Cary.**



Deployment off center from the flange and through the cross if flange is shared

- This design enables deployment off center from the flange with engagement of additional pulleys
- Pulleys do not need to rotate but should be of the material that minimizes friction as the cable conduit moves over them
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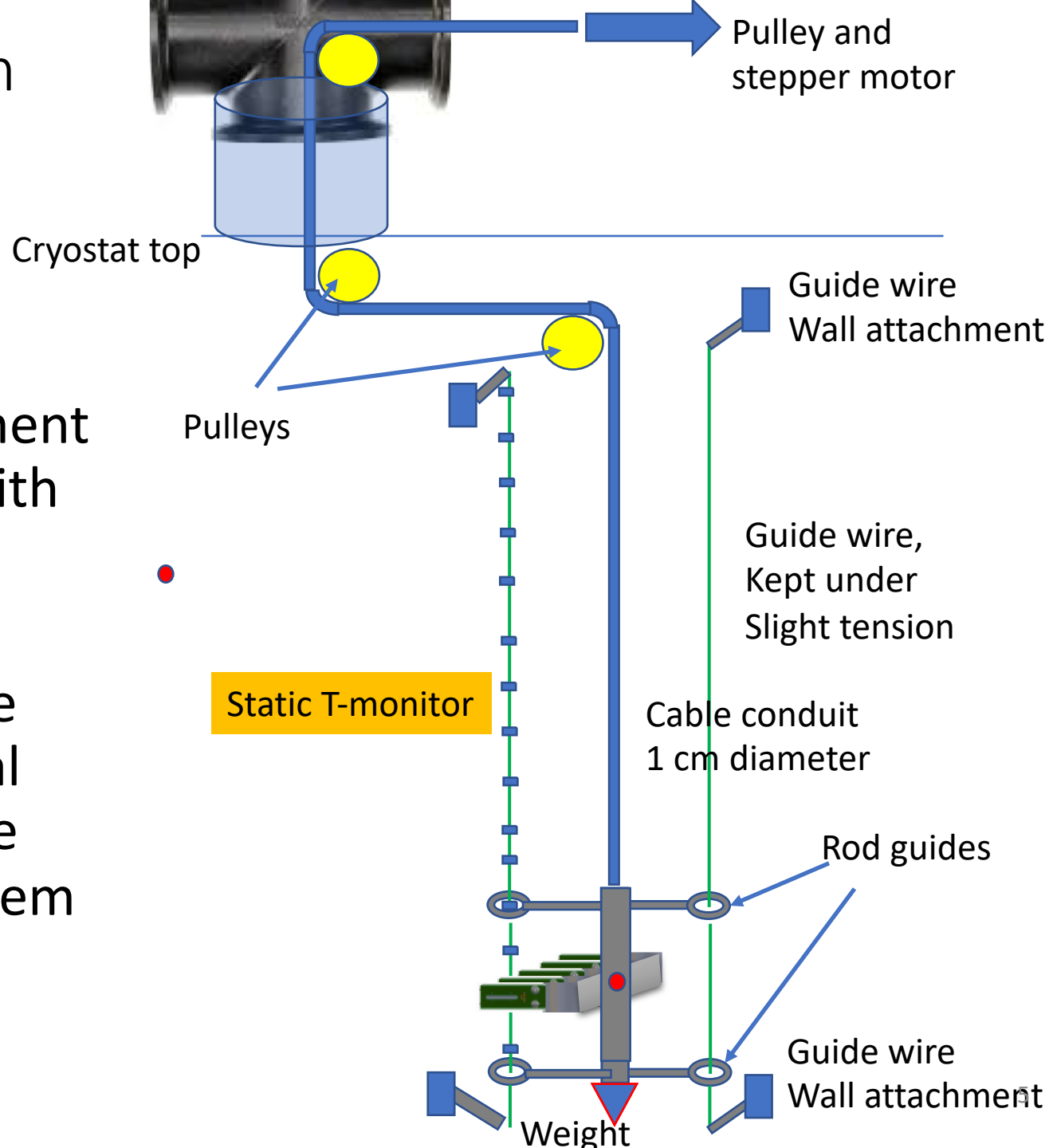
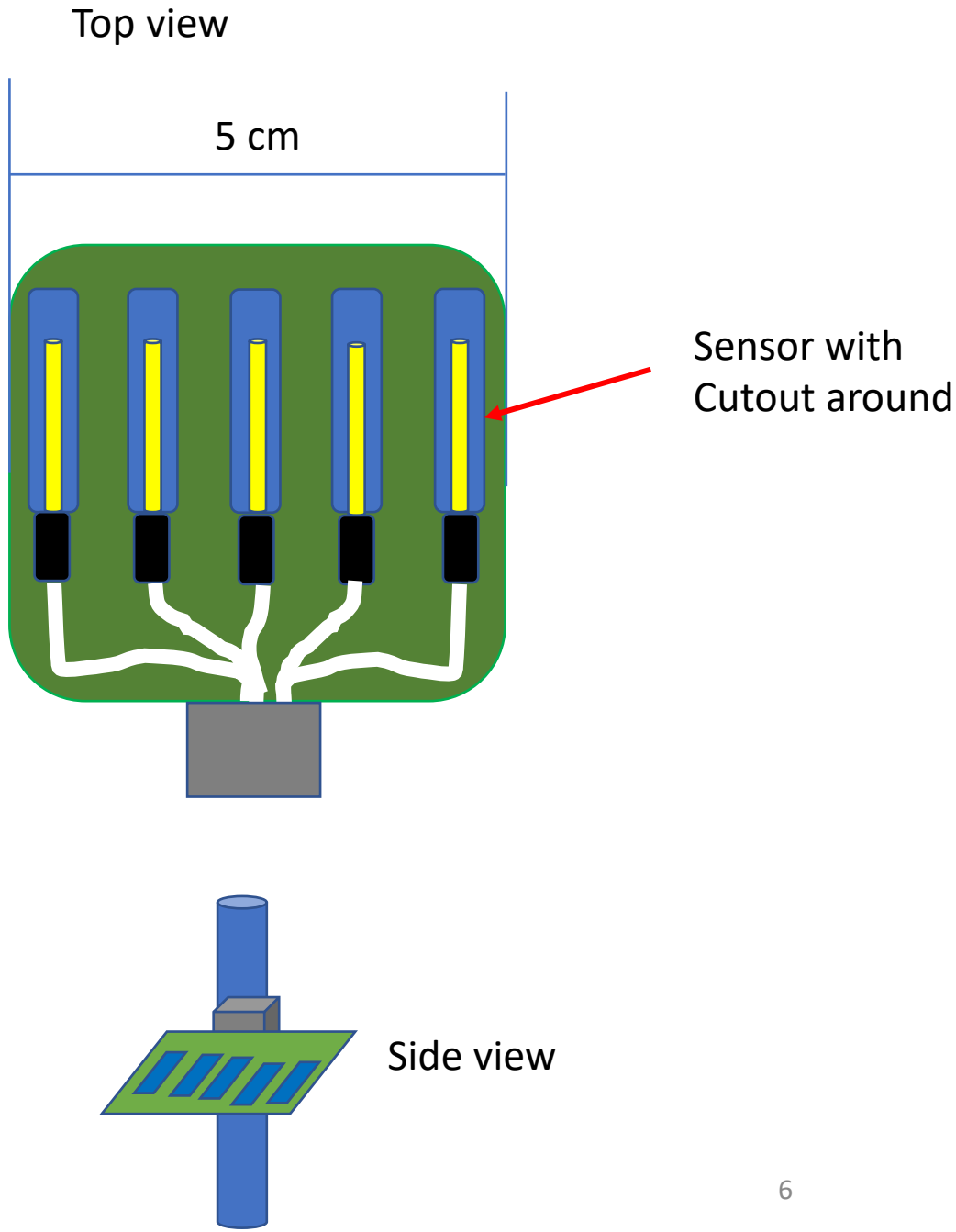


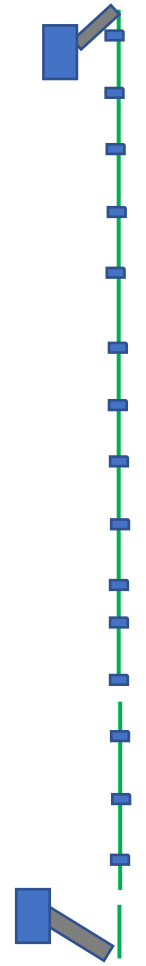
Sensor Board Design Overview

- Set of 5 sensors, closely spaced
- Attached to the rod that moves along the entire 14 m height of the detector
- While 1 sensor would suffice, 5 sensors are placed for redundancy and to account for potential failures.
- Sensors placed on a common PCB carrier rod.
- Use connectors (like in a static profiler) to connect sensors to cables.



Static temperature profiler design

- Design will heavily rely on the static profiler experience from ProtoDUNE
- Place sensors every 25 cm for a total of ~56 sensors.
- Requires dedicated flange with electric feedthroughs.
- Sensors will be surrounded by Faraday cage that will also ensure smooth motion of guides across array.
- May require wire tensioner to eliminate sagging of the carrier (no design details yet).



Design status and implementation

- Need engineering work to produce a more technical conceptual design and integrate it with the DUNE module 3D model
- Three options currently being pursued (no dedicted engineering funds available)
  - 1) Hawaii machinist Roger with engineering experience can work on the design, but not integration with DUNE 3D model – free of charge
  - 2) Hawaii engineer Christian Miki who works for another faculty may be available to work on it part time –experienced user of SoidEdge, thus, can perform integration with the cryostate model – moderate cost
  - 3) ANL engineer Victor Guarino may be available to do engineering work – higher cost

Uodated Cost of Dynamic + Static T-gradient Profiler

Item	Cost ($) (dynmic)	Cost ($) (static)
Materials, total	30,000	15,000
Prototyping	15,000	2,000
Shipping, crating	5,000	5,000
Engineering	60,000	0
Travel	9,000	0
Total (for 2 units)	149,000	44,000

The total cost estimated at $200k for 2 systems of combined dynamic and static monitor.

Future steps

- Critical part: integration of the combined static and dynamic array in the 3 d model.
- Combine existing motion mechanism design with the fishline system
- Identify suitable anchor points for the guidewires
- Identify whether there is a need for the off-axis installation with the respect to the dedicated flange.

Sensor rod motion mechanism

- 5 sensor cables grouped together inside cable conduit
- Cable conduit has 1 cm diameter
- Cable conduit contains thin (1.5 mm diameter) stainless steel cable to avoid cable sagging
- Cable conduit and the stainless steel cable is attached to the top of the sensor rod to eliminate stress on the cables (Chinese fingers or some similar system)
- Cable conduit flexible and perforated to eliminate gas pockets.
- Weight on the bottom of the sensor rod keeps the cable conduit under tension (also account for buoyancy in LAr).
- Guide wire limits the upward motion of the sensors. Motor current is limited.
- Guide wire near the static array.