Cryostat Penetrations
(very critical for this group to start thinking about)

Sowjanya Gollapinni (UTK)

FD Joint Slow Controls & Cryogenic Instrumentation meeting
September 1, 2017

Cryostat Interfaces

- In order to maintain the current schedule, the design of the first cryostat needs to get underway at the beginning of next year
- Input on the initial setup of cryostat penetrations will be received through first week of October (final sign-off in early November)
- From that point on, changes will be made only through formal change control process

Defining Cryostat Penetrations

- Defining cryostat penetrations ties to a bigger problem since one needs to understand the needed calibration systems for DUNE and to some level the instrumentation of devices so accommodations can be made for later in terms of
  - Numbers of feedthroughs
  - Location/Distribution of feedthroughs
  - Width of each feedthrough

Note: at this point we are only defining interfaces not the design of the actual systems

- Calibration Task Force and Cryogenic Instrumentation & Slow Controls Consortium working closely
  - Since it is very relevant for this consortium
  - Kendall and I (TF co-leaders) have been taking input from key stakeholders and holding focused meetings to develop specific questions/studies we would need to address this problem

Possible systems to consider

- Calibration and cryostat instrumentation systems need to be considered to make accommodations with the cryostat penetration design:
  - Thermometry
  - Purity monitors
  - Radioactive source calibration
  - Photon gain monitoring
  - Cameras
  - Laser system
- Keep the no. of penetrations as minimal as possible to reduce heat loads and leaks, but at the same time we want to make sure we can calibrate our detector!
  - Possible scenario: one feedthrough shared b/n multiple systems (e.g. radioactive source & thermometers, or thermometers & PMs)

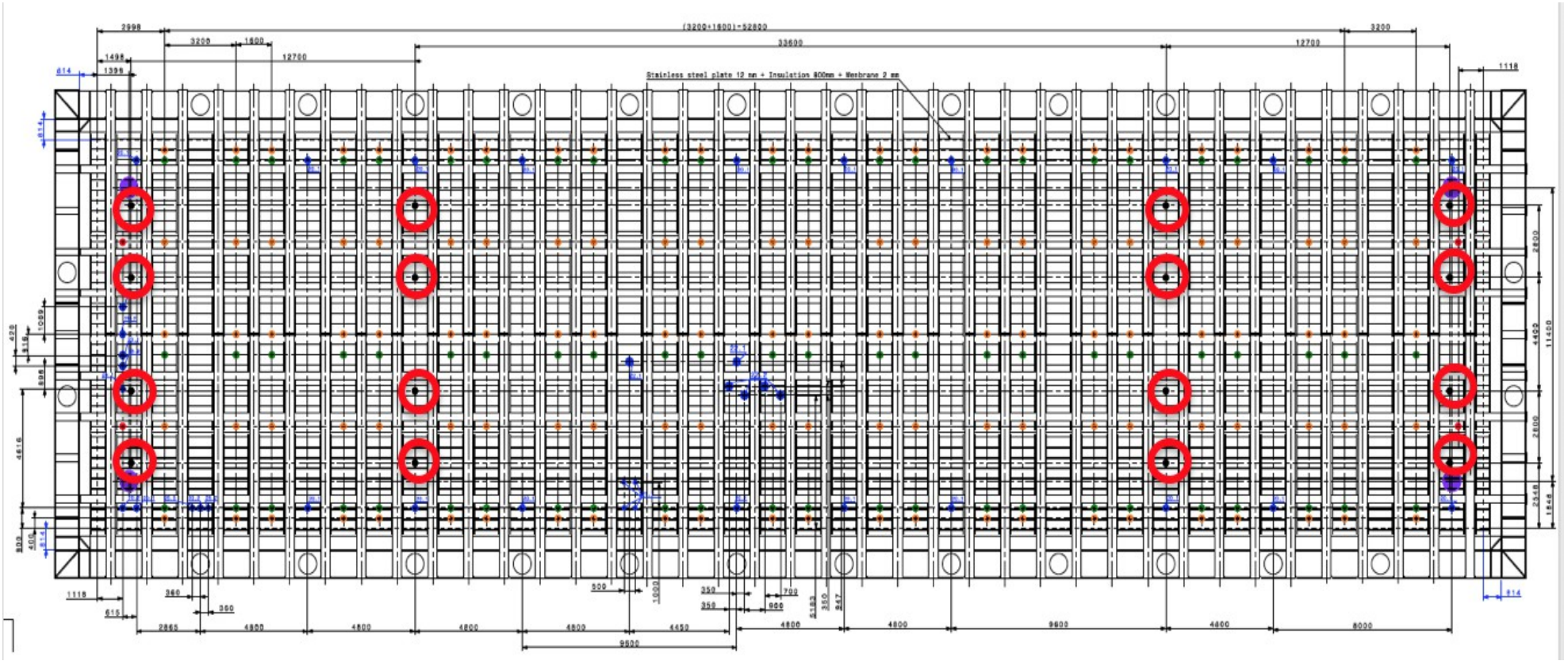
Possible systems to consider

- Calibration and cryostat instrumentation systems need to be considered to make accommodations with the cryostat penetration design:
  - Thermometry
  - Purity monitors
  - Radioactive source calibration
  - Photon gain monitoring
  - Cameras
  - Laser system

Important for this consortium
- But will need to interface with other systems and groups (e.g. HV)

- Keep the no. of penetrations as minimal as possible to reduce heat loads and leaks, but at the same time we want to make sure we can calibrate our detector!
  - Possible scenario: one feedthrough shared b/n multiple systems (e.g. radioactive source & thermometers, or thermometers & PMs)

Current design for cryostat penetrations
(only showing the instrumentation ports)



Pos.	Diameter [mm]	Quantity	Description
1	Ø250	120	Support
2	Ø250	72	Cable
3	Ø250	4	High voltage
4	Ø250	16	Instrumentation
5	Ø800	4	Manholes

- 16 instrumentation ports
- 250 mm diameter (current design)

- About 0.5 m clearance on the sides
- About 0.7 m clearance on top from the surface of liquid argon (need to check)

Current systems and requirements

- **Thermometers:** Monitor the detector during cool down; provide information on fluid and gas flow
  - Fixed thermometers vs Dynamic-vertical T-Gradient thermometers for cross calibration. Latter (favored) puts requirements on penetration width
  - How many thermometers? – not clear. Number required to model the fluid flow is not studied
- **Cameras (steerable?):** Not clear where it lives (HV? APA?)
    - Consider this as one system that can be deployed using an instrumentation port. Purpose/requirements need to be defined.
- **Purity Monitors**: Great during commissioning, initial data runs and low purity times
  - No. of purity monitors, requirements on FT width – not studied
  - Can protoDUNE design be extrapolated to DUNE? Not clear.

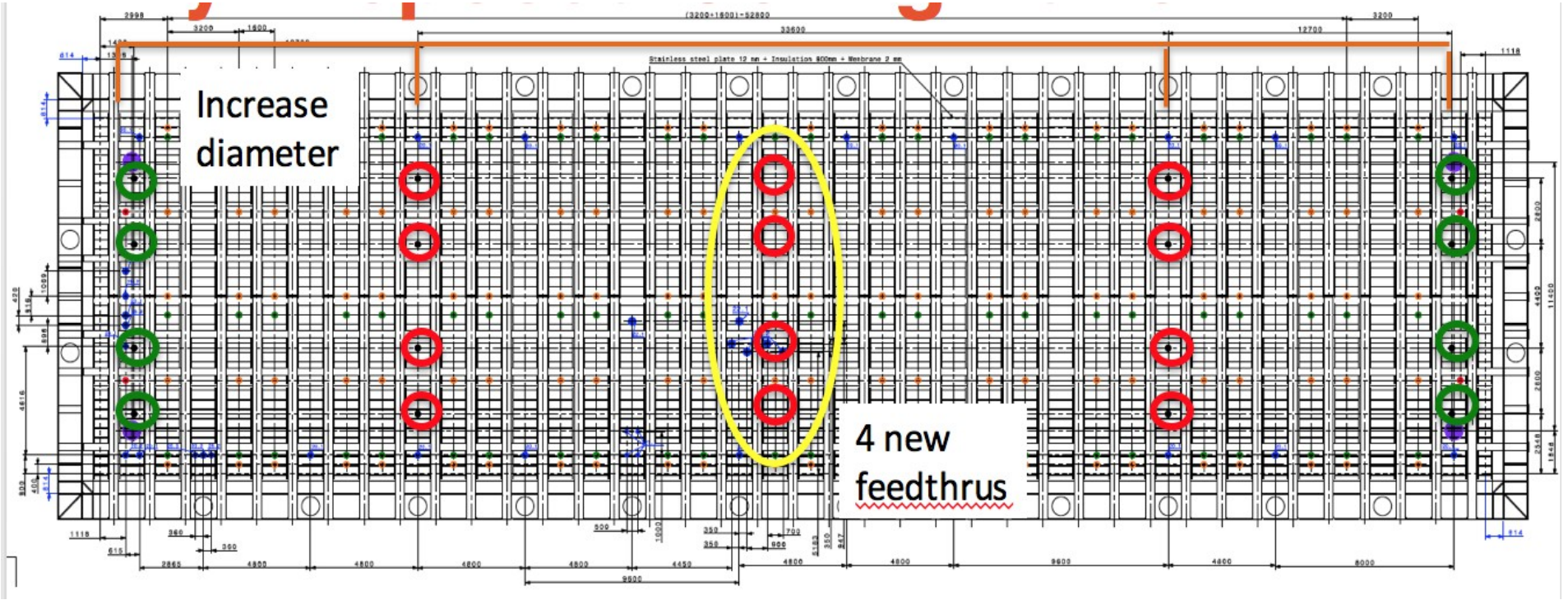
Current systems and requirements

- **Radioactive sources:** Low energy calibration; strong physics motivation
  - Requirement on position resolution and how the current design impacts physics – not clear.
- **Photon gain monitoring:** Light flashing system for commissioning the photon detector and monitoring its relative gain
  - Needs optical feedthroughs for fiber optics. The fibers are fragile and a significant number needed along the plane.
- **Laser system**
  - If we want to do this, will need 16 (?) additional penetrations
  - DUNE has unique challenges, so need studies and well founded arguments that line up with physics requirements

What is clear though: Making instrumentation ports accommodate multiple systems is a good strategy. Needs calculations on the penetration width taking into account various systems.

One proposed design for penetrations – Jim Stewart

(only showing the instrumentation ports)



- **Increase the size of penetrations to accommodate multiple systems:**
  - Change 250 mm → >275 mm (maximum allowed); 300 mm is risky
  - It is not clear what is actually needed based on width requirements from Multiple systems?

- **Adding additional 4 feedthroughs**
  - motivated for Radioactive source calibration to get better position resolution
  - The argument for adding 4 new ports Vs spreading the existing (red) 8 ports need to compared/studied (8 vs 12)

Addressing the FT width question?

- What are the FT width requirements for various systems? (take into account multiple systems will share a single FT)
- **Strategy:** Get the requirements from users from each port and draft a plan.

Charge to various people:

- Radioactive source (Jonathan, Juergen): A table listing the most desirable radioactive sources for DUNE and for each choice what is the required FT size?
- Thermometers (Jelena, Anselmo, Ines): Assuming protoDUNE design can be extrapolated, what is the FT requirement? (take into account fixed vs dynamic vertical T-gradient). Need Fluid flow simulations required to understand no. of thermometers (pursue Eric Voirin, Stephen Pordes)
- Purity Monitors (Andrew, Jianming, Mario): Can protoDUNE model be extrapolated? How many PMs? FT width requirement?
- Need to have discussion on Cameras and Photon gain monitoring

Do we need additional 4 FTs?

(charge to Jonathan, Juergen, Kate, Bob)

- What are the energy and position resolution requirements for DUNE for low energy calibration?
- Position resolution studies comparing 8 vs 12 scenario Vs spreading the 8 over the cryostat center (symmetry important). Strong arguments or studies showing either change is needed?
- Other considerations:
  - How close can one take the source to the field cage? (Jonathan, Bo)
  - Risk factors: Radioactive source can get stuck (well founded concern), what can be done to assess the risk, mock-up tests and considerations in mechanical design? (Juergen)
  - How does this impact other systems? E.g. What accommodations does DAQ have to make in their design? Pre-scale triggers, hardware triggers, special run control etc. (Juergen)
  - Other factors that can impact the design or physics and limit the performance? e.g, field variations, flow patterns etc.

Do we need additional 4 FTs?

(charge to Jonathan, Juergen, Kate, Bob)

- What are the energy and position resolution requirements for DUNE for low energy calibration?
- Position r… the 8 over the … studies showing …
- Other con…
  - How …
  - Risk … ncern), what … ons in mechan…
  - How does this impact other systems? E.g. What accommodations does DAQ have to make in their design? Pre-scale triggers, hardware triggers, special run control etc. (Juergen)
  - Other factors that can impact the design or physics and limit the performance? e.g, field variations, flow patterns etc.

While the additional FTs maybe driven by Radio active source calibration requirements, other systems might require this as well.

Need to think about all possible scenarios Before saying no

Need to be proactive about this...

- Need to finalizing Cryostat Penetrations on a super-short timescale (3 to 4 weeks tops) – so start thinking about this and contribute to the needed studies
  - This is very important for this consortium since we are cryostat Instrumentation group
  - While we can always put in a change request later, we have think the cost/risk factors of doing it now vs later. Earlier is always better!
- The Calibration TF is working full time on this and we will work closely with them
- I am also trying to motivate other consortia leaders to start thinking about this and cross collaborate on defining FT requirements
- I will reach out to more people in this consortium with specific questions/requests

Discussion