Calibration Feedthroughs

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DUNE FD Calibration Task Force Meeting
October 5, 2017

Instrumentation & Calibration devices

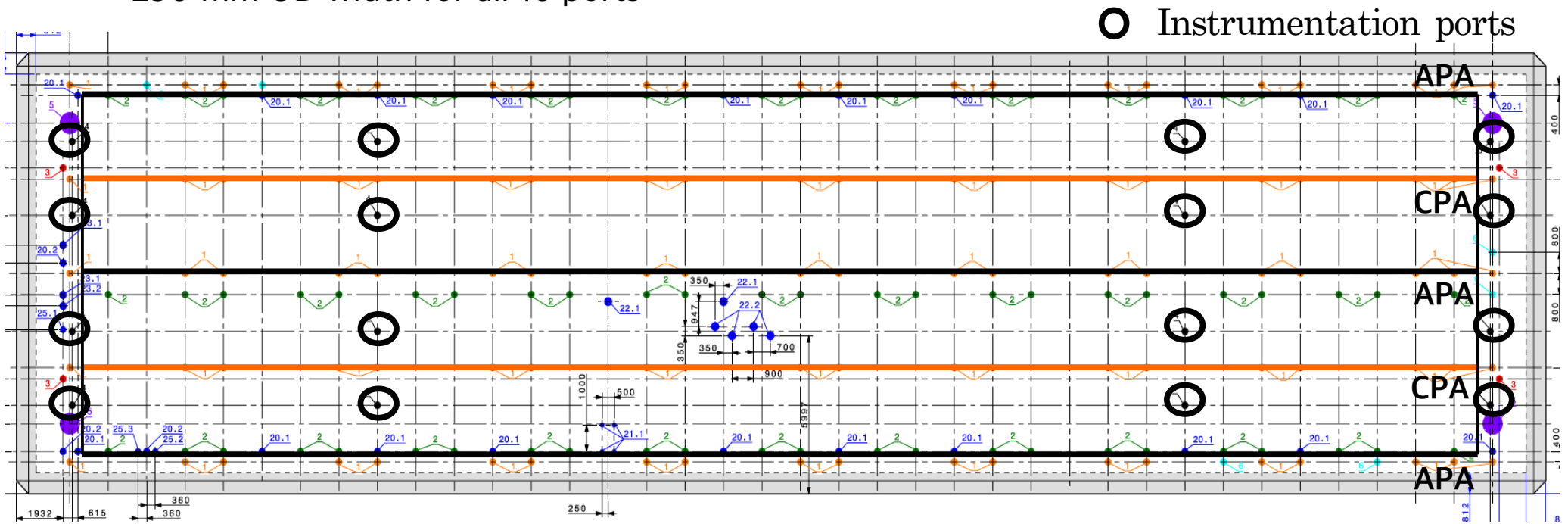
- The following devices are discussed at the Special TB meeting
  - Thermometers
  - Purity Monitors
  - Cameras
  - Radioactive Source Calibration
  - Field Response Calibration
  - Photon System Calibration
  - Laser System (Kendall's talk)
  - Gas analyzers and Liquid level Monitoring
    (currently under LBNF's responsibility, won't touch this in this talk. Talk tomorrow at the Slow Controls Consortium meeting by David M. on this.)

What do we have in our current design?

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
6	Ø250	6	Spare
7	2680x12110	1	Temporary Construction Opening

Pos.	Diameter [mm]	Quantity	Description
20.1	Ø250	20	L+G Ar cool down
20.2		3	Spare
21.1	Ø152	4	G Ar Controled vent
22.1	Ø304	2	G Ar Boil off
22.2		4	G Ar Relief/Safety
23.1	Ø273	2	L Ar Return
23.2		1	L Ar Emergency return
24.1	Ø350	4	L Ar Pump
25.1	Ø219	1	G Ar Purge
25.2		1	G Ar Make up
25.3		1	G Ar Momentum

- 16 instrumentation ports (see open circles in the image below)
- 250 mm OD width for all 16 ports



FT requests Full picture: All needs

(discussed at the Sep. 29 special TB meeting)

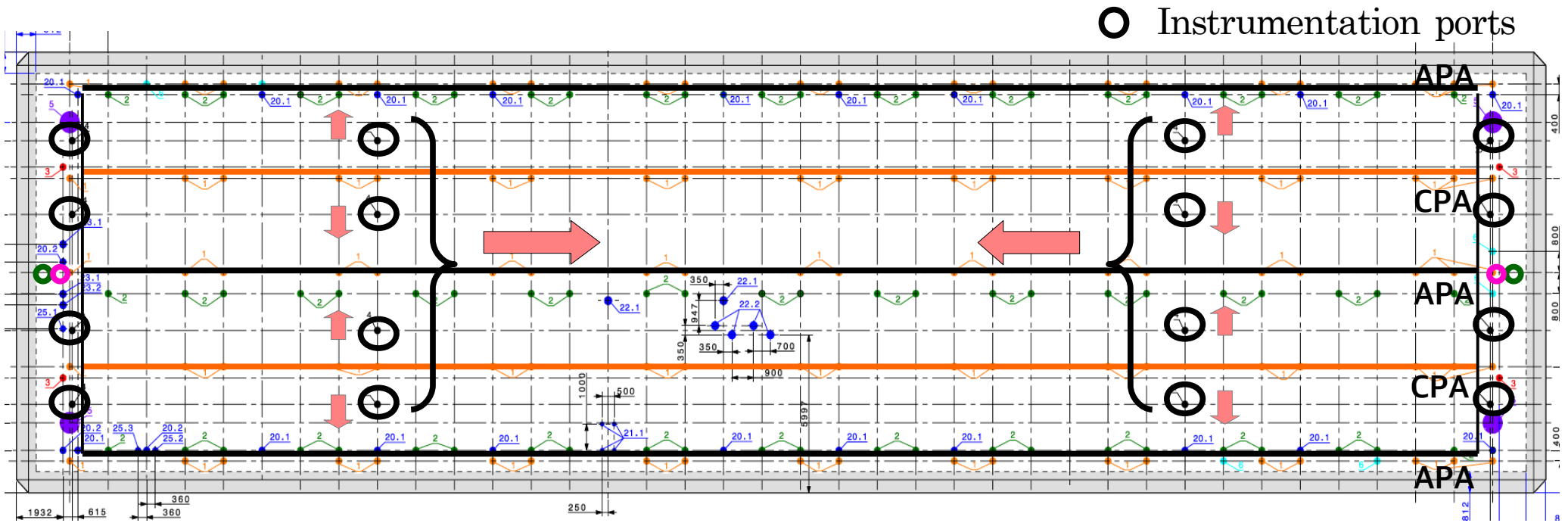
System	Required FT width (minimum)	No. of ports requested
Purity Monitors	160 mm ID	2
Thermometers (Dynamic T-Gradient)	150 mm ID	2
Radio active source and Static Thermometers (Shared)	280 mm ID	4
Cameras	180 mm ID	12
Photon gain monitoring	154 mm ID (5 FTs) 254 mm ID (5 FTs)	10
Field response calibration	200 mm ID	2
Laser system	200 mm ID	20
	Total new requests	**52**
Existing ports Radioactive source Calibration (increase size for 4 inner FTs)	200 mm ID (4 outer FTs) 280 mm ID (4 inner FTs)	16
	Total ports (existing+new)	**68**

Discussion at the TB meeting

- A lot of these devices involves mainly routing cables, optical fibers
  - Can we use Detector Support Structure (DSS), TPC signal cable ports or Cryogenic ports that are already in the design and can accommodate routing cables (e.g. with a side flange or other design) ?
  - About 100 DSS ports that are all around the detector on APAs and CPAs.
  - Support from David M. (LBNF) and Cryostat engineers that this is feasible
  - A proposal to also design multi-purpose ports that can accommodate multiple devices (e.g. radioactive source, periscopes,…)
- Bottom line: Out of everything requested, explore if DSS, Cable and Cryogenic ports can be used!?
- Laser has special needs, that is understood. The goal was to see if Laser needs can be combined with others - some compromise needed in the requested 20 ports.

Discussion at the TB meeting

- For the Oct. 3rd meeting, we went back with a very minimal proposal
  - 2 dedicated ports for Dynamic T-Gradient Thermometers (Pink circles)
  - 2 dedicated ports for Purity Monitors (Green circles)
  - Spread the instrumentation ports that are in the current design evenly in Z. Move them, to the extent possible, towards the center of the drift - currently they are closer to CPA (40% drift)
  - Everything else needs more exploration

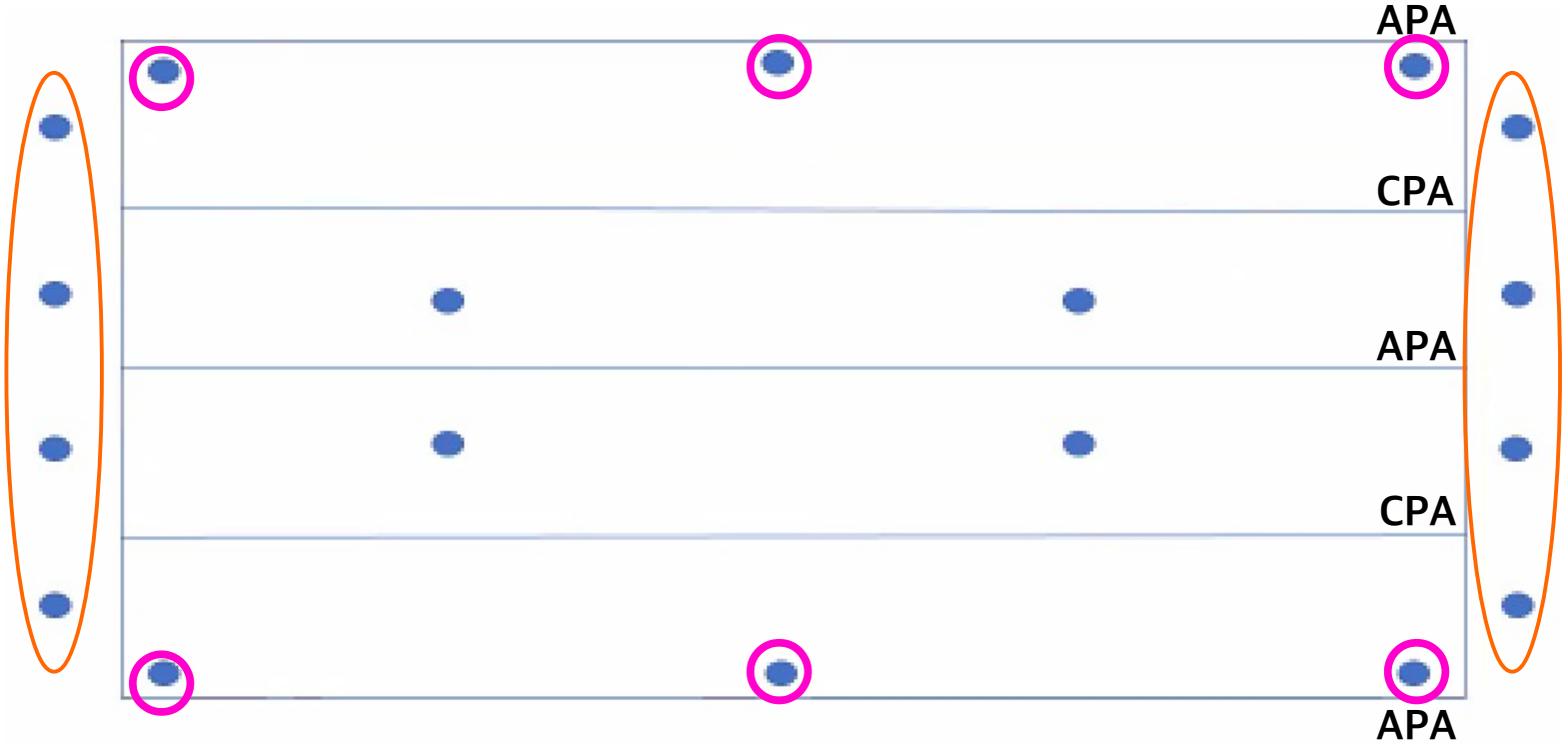


Input from Oct. 3rd meeting
(from Eric James)

System	New ports	From Oct. 3 meeting
Purity Monitors	-	Mount using cable tray (explore)
Thermometers (Dynamic T-Gradient)	-	Mount using cable tray (explore)
Static Thermometers	-	Cryogenic, DSS ports (mount using cable tray?)
Photon gain monitoring	-	DSS ports on top of CPAs
Field response calibration	-	DSS or Cryogenic ports
Radio active source	18 to 20 ports (need to understand how to spread)	Multi-purpose, share
Cameras		Multi-purpose, share
Laser system		Multi-purpose, share

Scenario 1: 18 port arrangement for Radioactive, Cameras & Laser

The ones circled in pink – less flexibility to move due to constraints in those regions



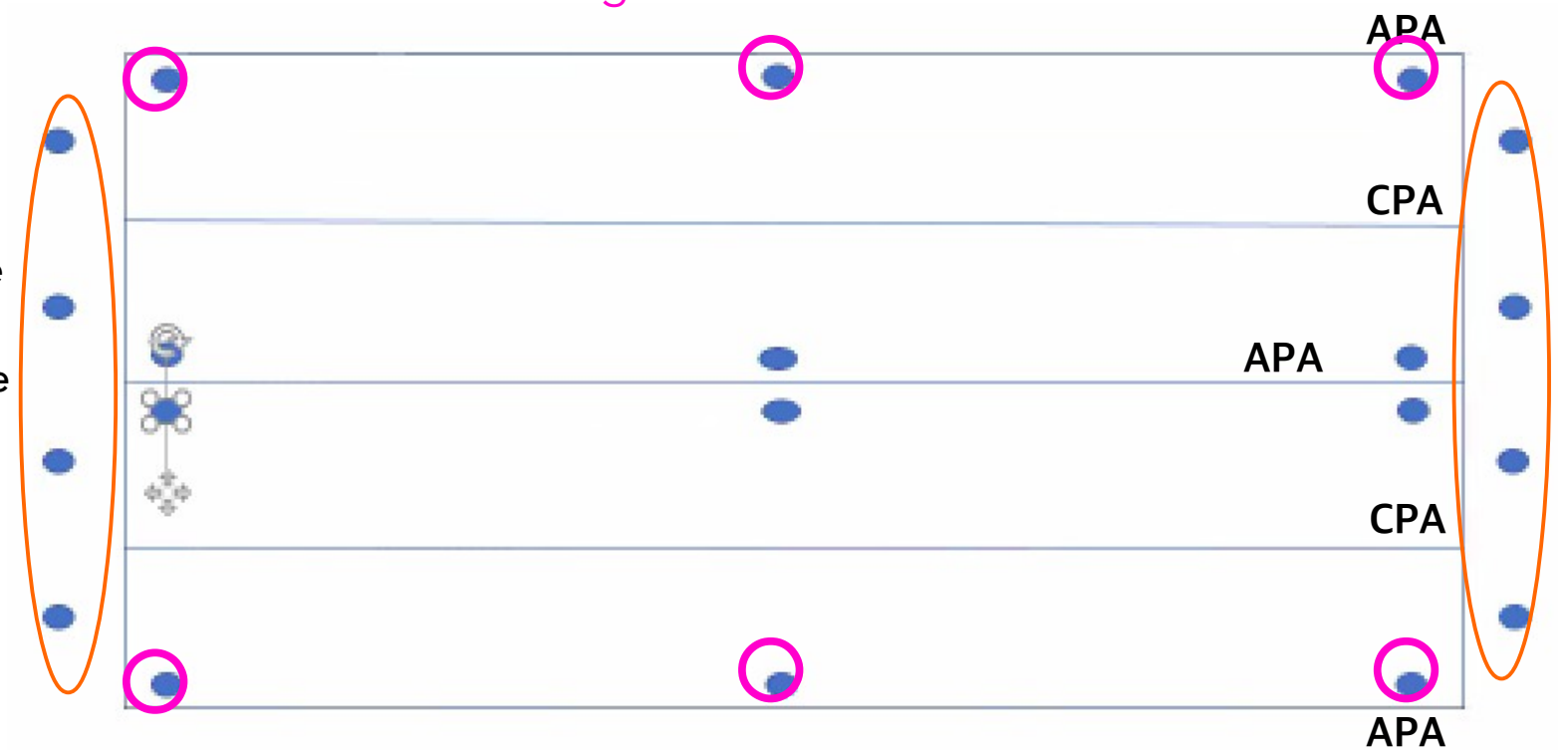
Outside the Field Cage (Radioactive source & Cameras)

Outside the Field Cage (Radioactive source & Cameras)

- Four ports in the central region, not close to APA
  – is that an issue for laser being at 60% of drift close to CPA?

Scenario 2: 20 port arrangement for Radioactive, Cameras & Laser

The ones circled in pink – less flexibility to move due to constraints in those regions

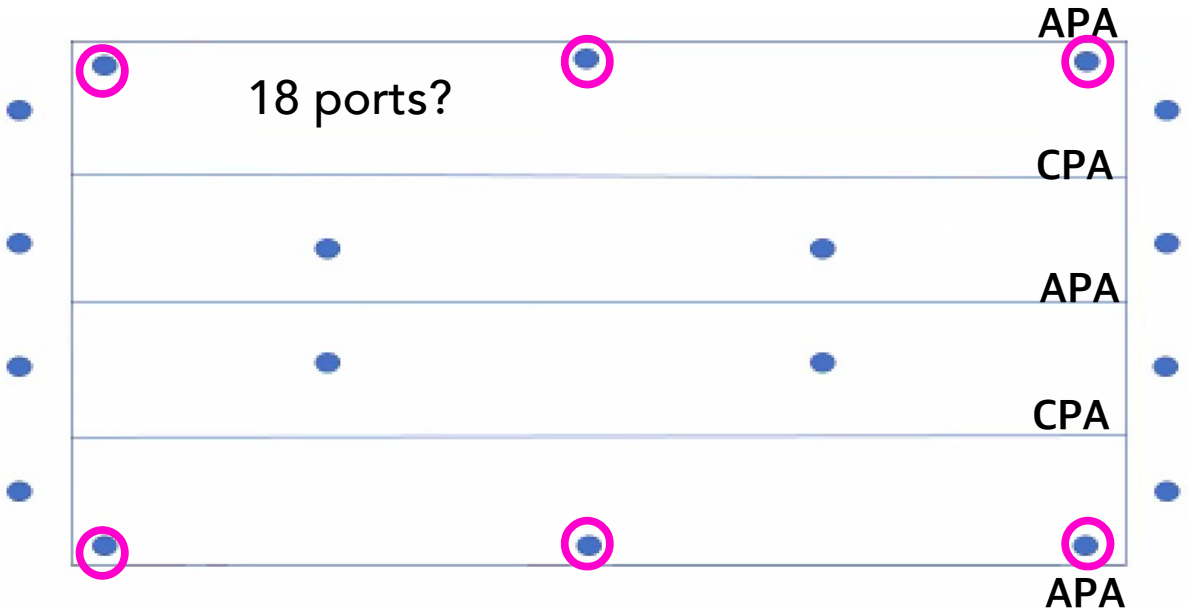


Outside the Field Cage (Radioactive source & Cameras)

Outside the Field Cage (Radioactive source & Cameras)

- This arrangement moves the ports very close to APAs as needed for laser
  – Radioactive source wanted mid-drift. Is that an issue?
- Sampling reduced in Z – one data point for radioactive source

Main question: How to arrange the 4 or 6 ports in the central region?



Laser has a lot on the flange, so this could mean

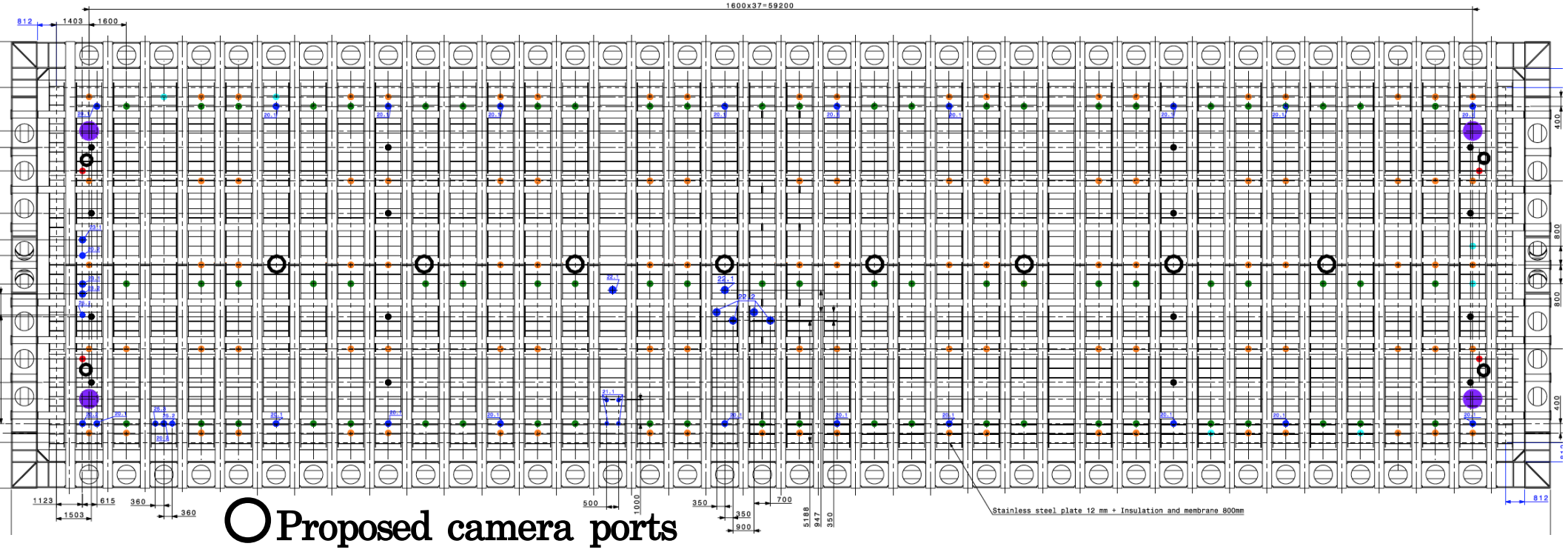
- So, we maybe looking at using cameras/radioactive source during commissioning as needed
- Then Laser takes over these shared ports after that? (except for the ones outside the FC)

Is this reasonable?

Backup

Cameras

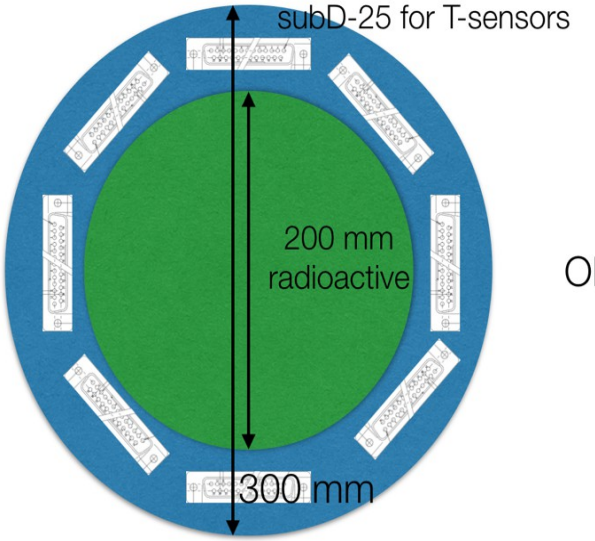
- Inspection Cameras (Steerable Periscope style) - not viable for bottom ground plane
  - Alternate technology option; require dedicated ports right on top of the cameras; possibility for other systems to use as well (e.g. Temp. sensors)
  - Total 12 ports **(Black open circles)** requested: 4 near HV FTs; 8 spread along the central APA for top ground plane (need to be away from the TPC cable FTs for clearance)
  - **FT width:** minimum 150 mm ID
- **Assumptions:** 360 deg rotation; head compact enough to fit b/n middle DSS beam and cryostat ceiling; If the DSS beam too close, will need 2 rows of ports (16 ports) with <180 deg. rotation



Flange designs for shared port b/n radioactive source & Static thermometers

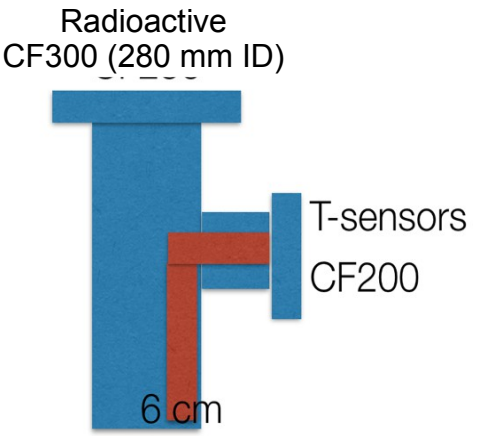
Option 1

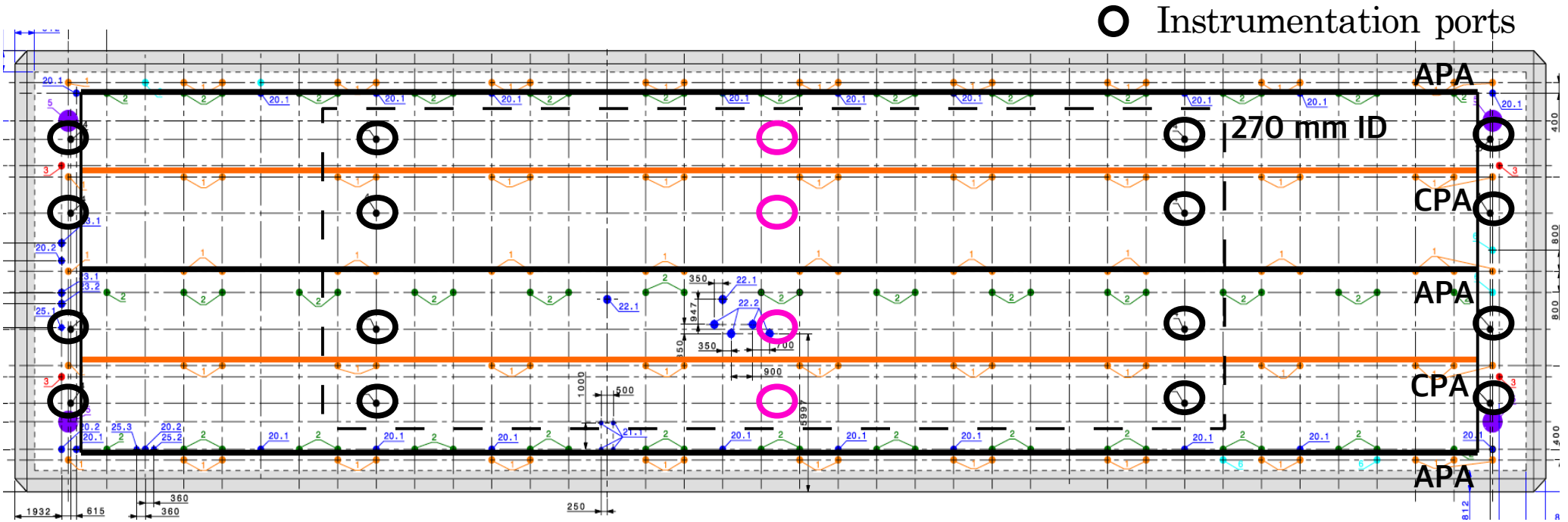
Both images:
CF300 (280 mm ID)



OR

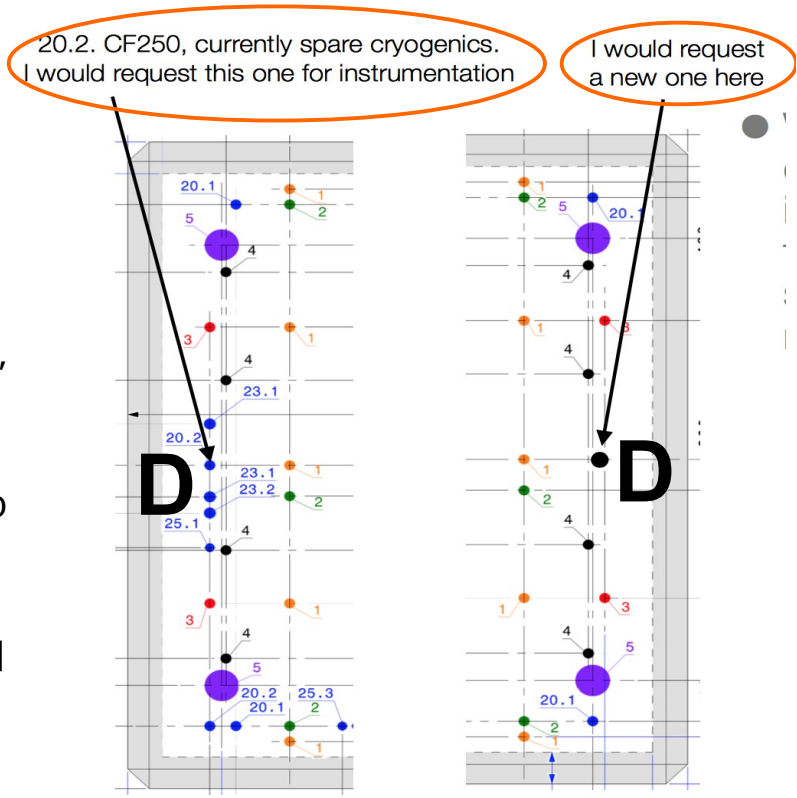
Option 2

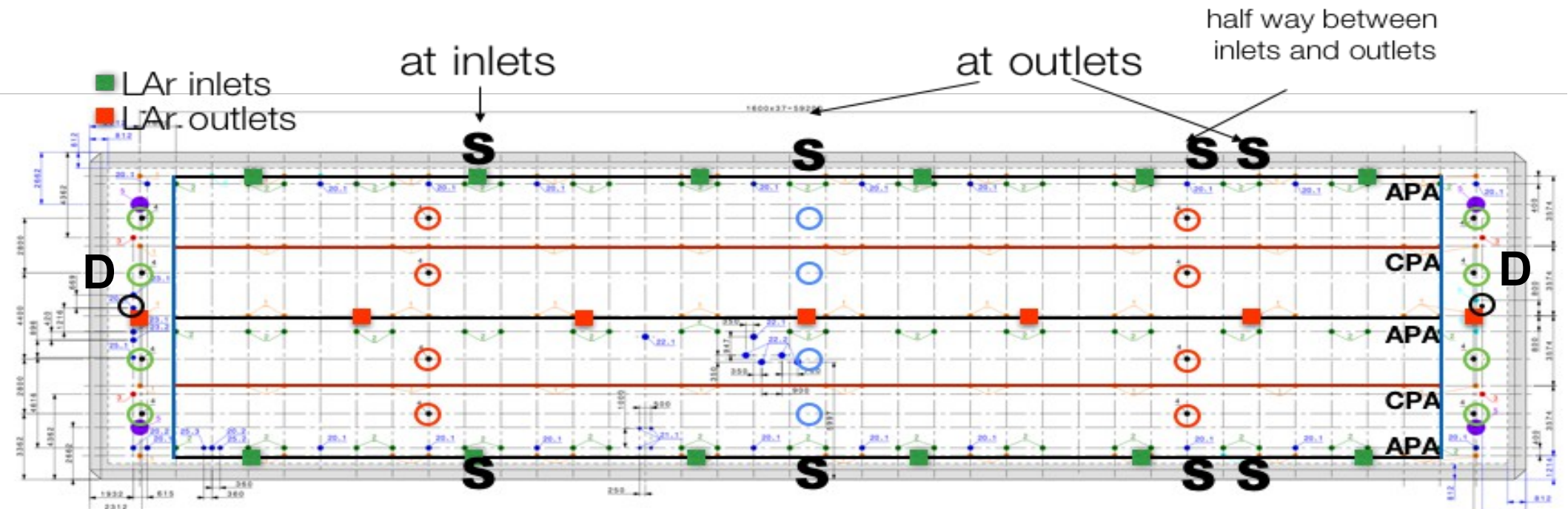




Proposal for Thermometers
Static (S); Dynamic (D)

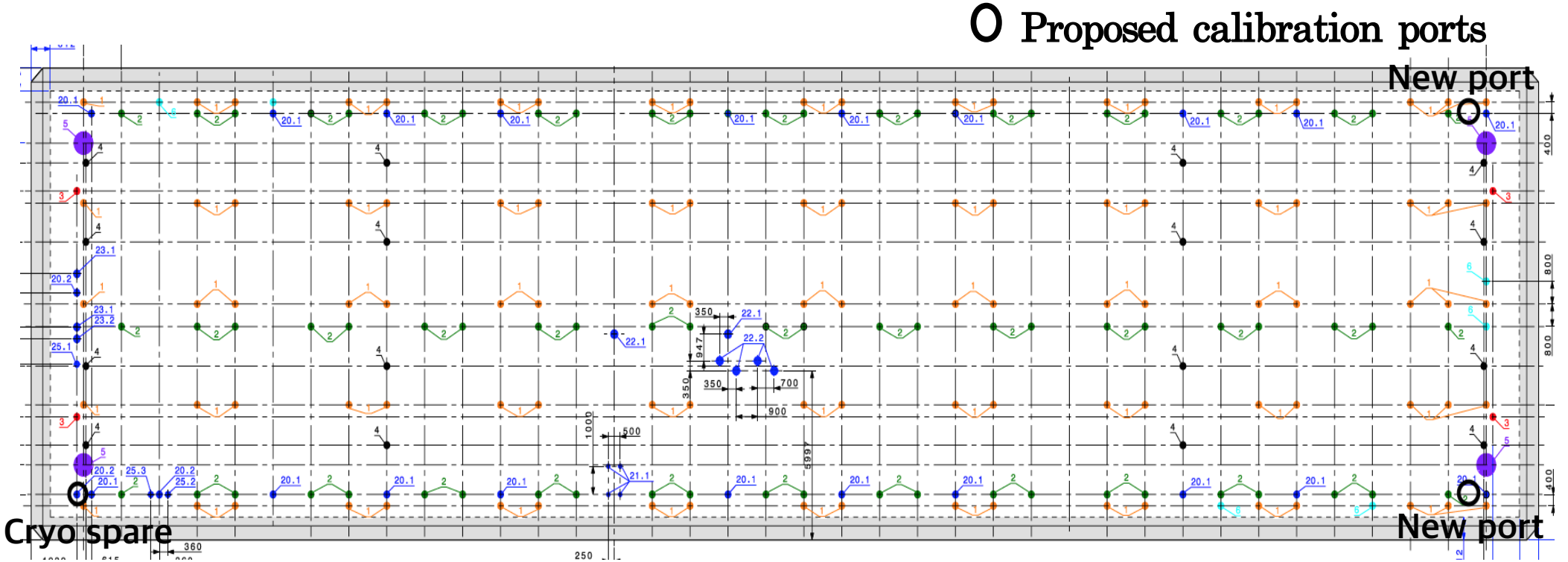
- Requesting Cryo spare 20.2 be made an instrumentation port (black, **D**) - looking into E-field & possible shielding
- Request a new port (250 mm OD) on the other side of Z (black, **D**)
- The central (Blue, **S**) column of 4 FTs are strongly requested as is the Z=0 plane where most variations are shown by CFD; Also without the central column, you have a blind spot
- For the FTs that are on the TPC (red and blue 12 "**S**" ports), increase the size of the ports to 280 mm ID so it can be shared between radio active and static (**S**) thermometers with the flange design discussed before





Field Response Calibration

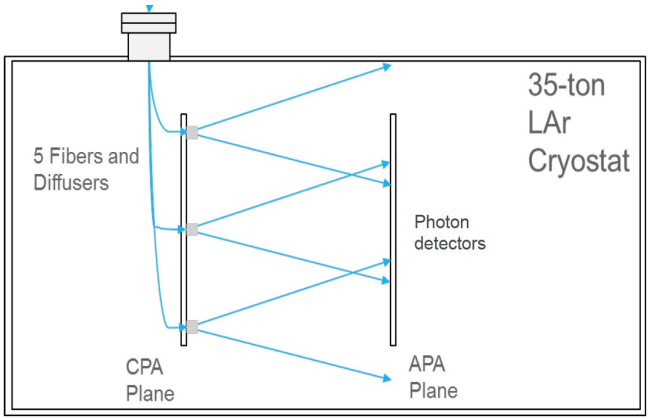
- Current Proposal
  - Proposal for 2 devices for DUNE, placed at two different vertical locations behind two different APAs. Reduces the risk that one APA doesn't work or had bad performance
  - Supporting structure for the device need to be installed as well at both locations
  - Requested FT width: 200 mm ID (minimum)
  - The location of the 20.2 cryogenic spare port (black) on the bottom left is also suitable if we request that to be an instrumentation port.
- Below are the FT locations requested (open black circles) on the penetration map.



Photon System Calibration

(contact points: Ranjan, Zelimir)

- Motivation
  - Verify photon gain monitoring and timing resolution; Monitor stability
  - Useful during commissioning and test photon system
- Design
  - Light Diffusers on one side of CPA1 and on two sides of CPA2
  - Optic fibers for HV signal; highly insulating optic fibers (tested, see backup)
  - Each CPA side is split into 45 cells with optical fiber feeding into each cell. For 3 sides of CPAs this results in 135 (45*3) individual penetrations
  - But, the fiber can be grouped together to reduce the number of overall FTs required



- For safety purposes for HV, it would be good for the FT to be right on top of the CPA plane; sharing port is also risky; secondary reasons: avoid bending of fibers, routing of long cables

https://indico.fnal.gov/getFile.py/access?contribId=3&resId=0&materialId=slides&confId=15243 (Ranjan)

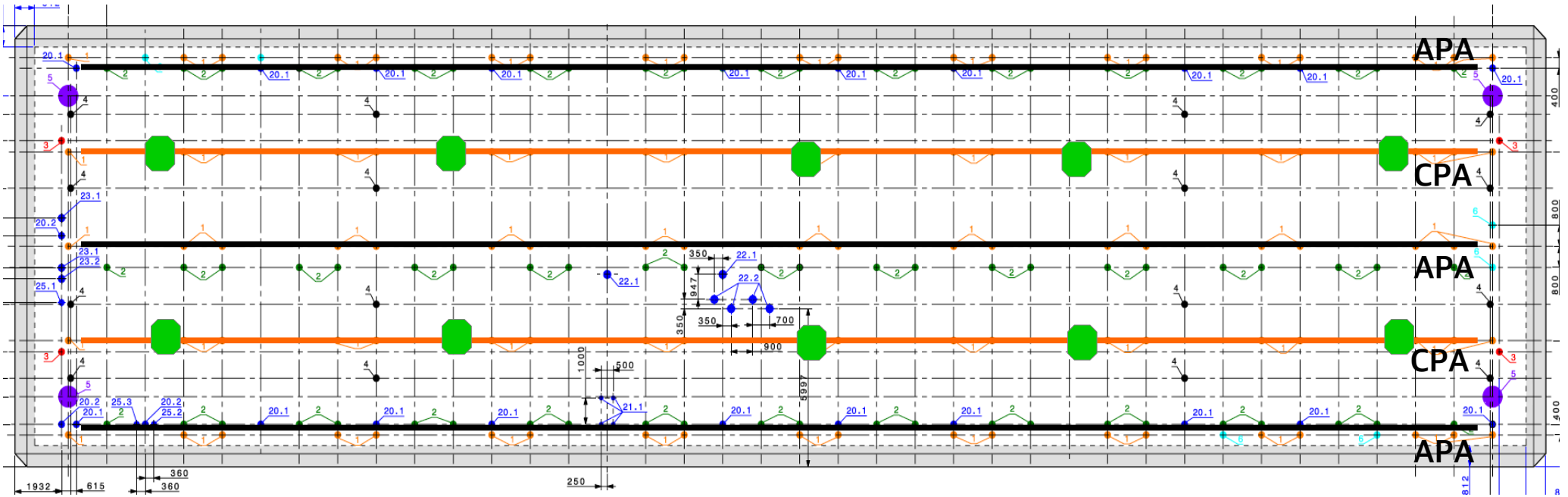
Photon System Calibration

(contact points: Ranjan, Zelimir)

Current FT Proposal

- For CPA1 - diffusers only on 1 side, combine 9 fibers into 1 FT. This results in 5 FTs
  - FT width: 6” or 153 mm ID
- For CPA2 - diffusers on both sides, combine 18 fibers into 1 FT. this results in 5 FTs
  - FT width: 10” or 254 mm ID

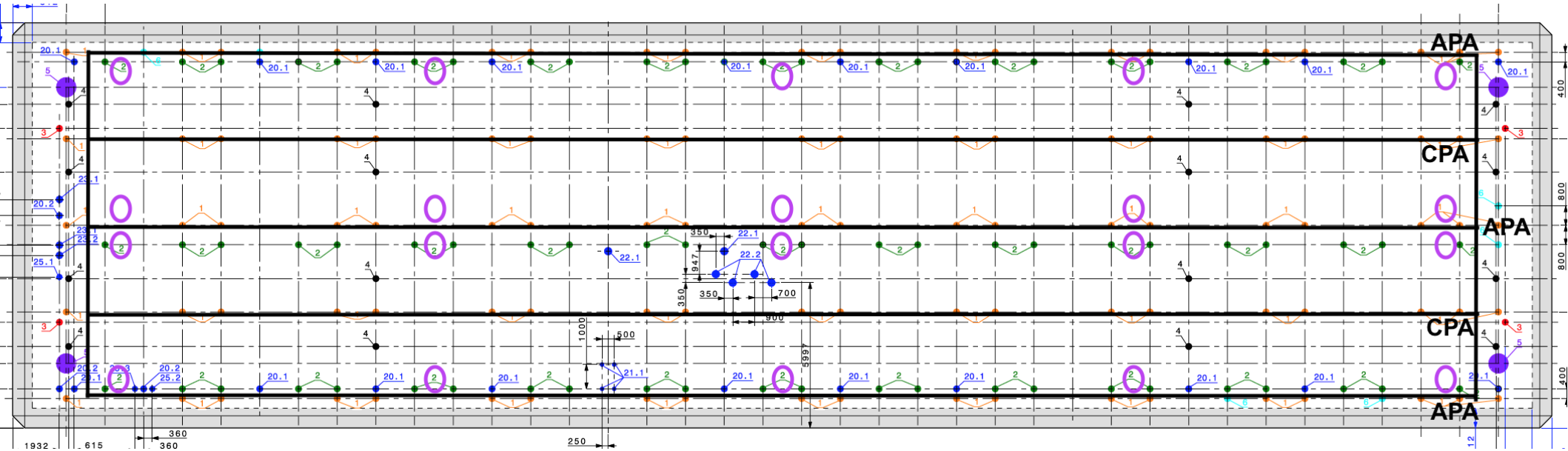
- The proposed locations for Photon System FTs are drawn on the penetration map below (green octagons)



Laser System

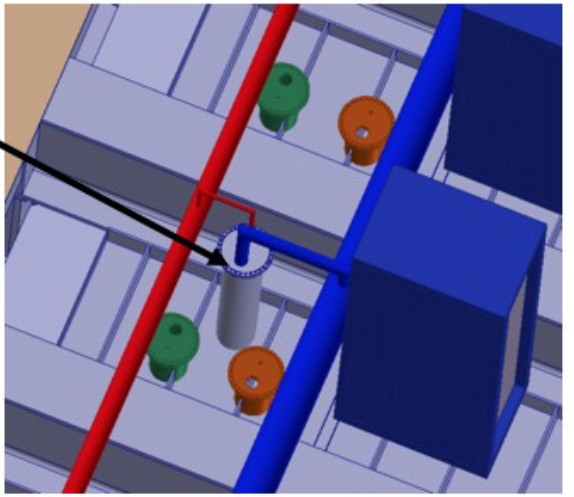
(contact point: Igor/Michele)

- A detailed talk after this talk on Laser
- SBND design is considered as the default choice
- The ovals in magenta show requested dedicated FTs (total 20 FTs) for laser
- FT width: 200 mm ID is required
- Because of the steerable head and other support structure that goes on the flange, the laser ports cannot be shared with other systems. So, we need 20 dedicated ports for Laser

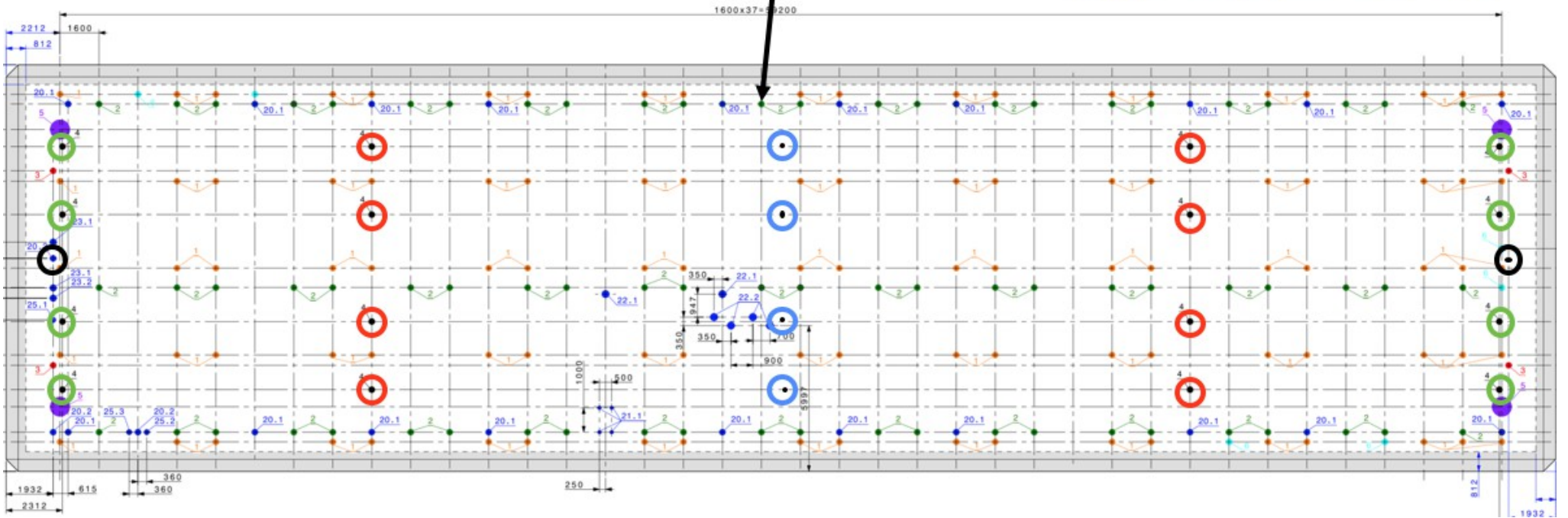


Ports for static T-gradients

- We should ask whether we can use the blue ports near the side APAs (see image) with a side port
- This may relax a bit our needs, but I would ask anyway for at least two ports in the middle area. The detector is too big and certainly we want instrumentation there: T-sensors, cameras, etc

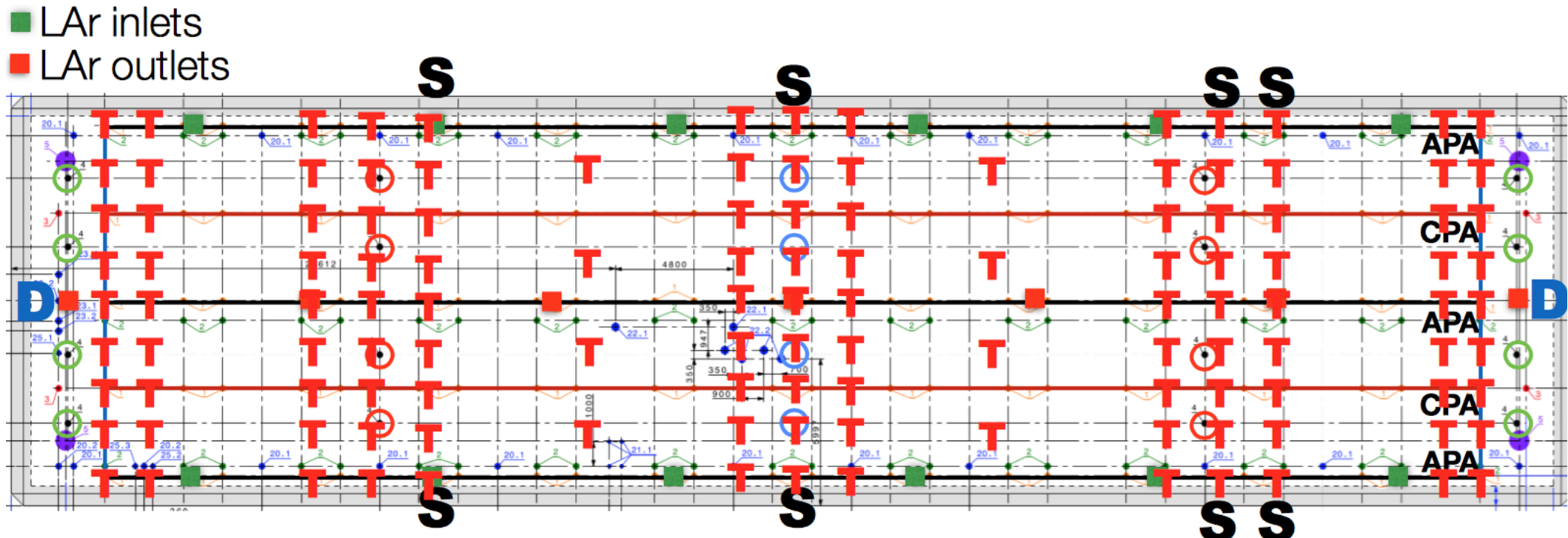


instrumentation ports
previously requested instrumentation ports
new request



Top and bottom grids

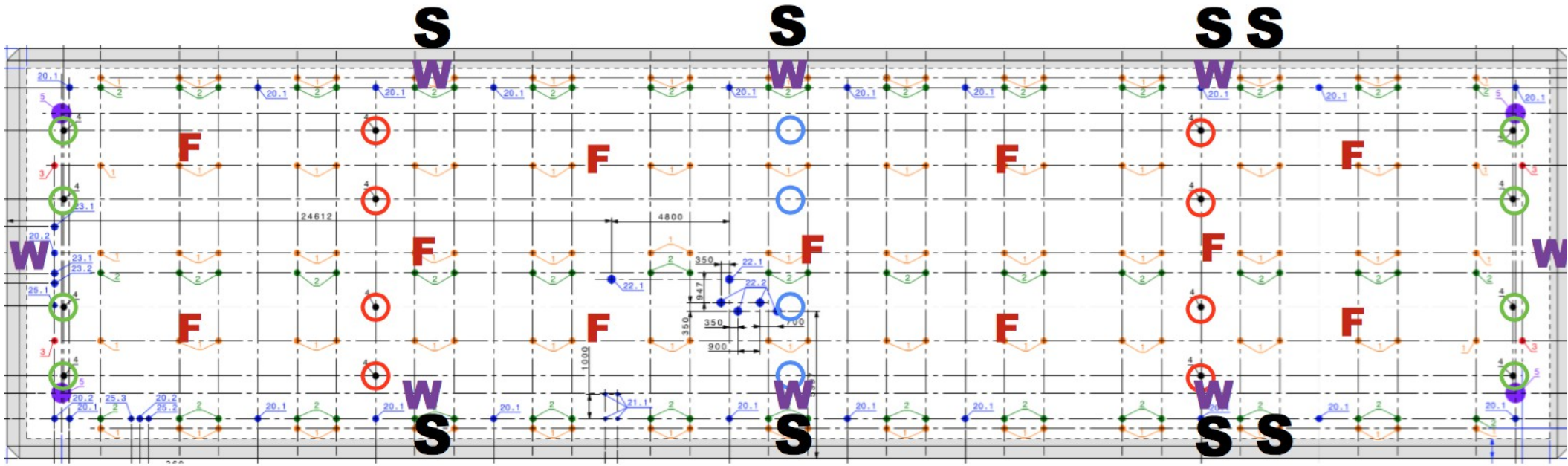
- We should foresee a grid of high precision sensors at top and bottom to complement the T-gradient monitors and contribute to the 3D map
- Those would be below and above the ground planes, as in ProtoDUNE
- It is important to have measurements in all four drift volumes
- Below un upper limit for the number of sensors: 250 sensors (125 for bottom and 125 for top)
  - This is just to confirm that the current ports are OK



Membrane sensors

- We also need a number of standard sensors on the membrane to monitor the cool-down and filling processes (vertical array of ~10 sensors).
  - No special locations needed. We can use existing ports
  - To discuss with experts how many arrays we need
  - Use the Static T-gradient structure to route cables
- And some sensors on the floor to check the presence of LAr everywhere when filling begins. To discuss with experts how many we need

F= floor sensors **W= array of wall sensors**



Option 2 closer look

- Only free space (inner diameters) shown in picture
  - CF300 (280 mm inner diameter)
    - 200 mm used for radioactive sources
  - Lateral port (CF200) for T sensors