

ProtoDUNE-SP

Schedule and Installation Review

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ProtoDUNE-SP Cryogenic Instrumentation Review - April 26th, 2017

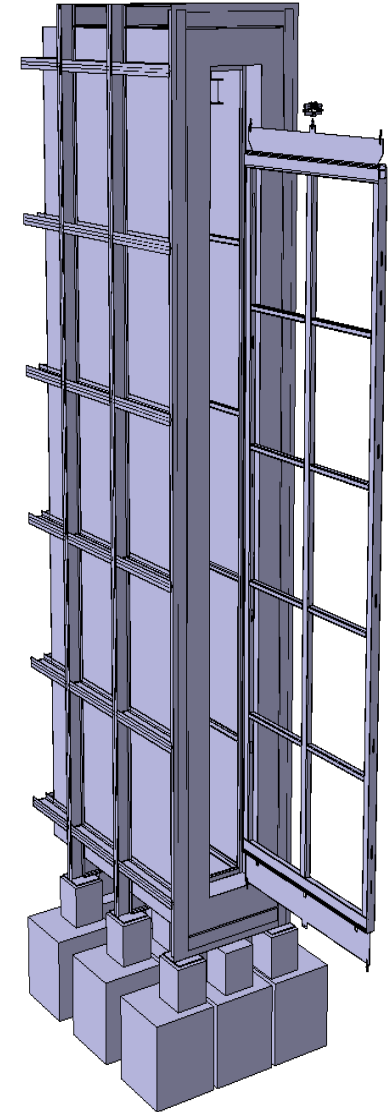
Before to start

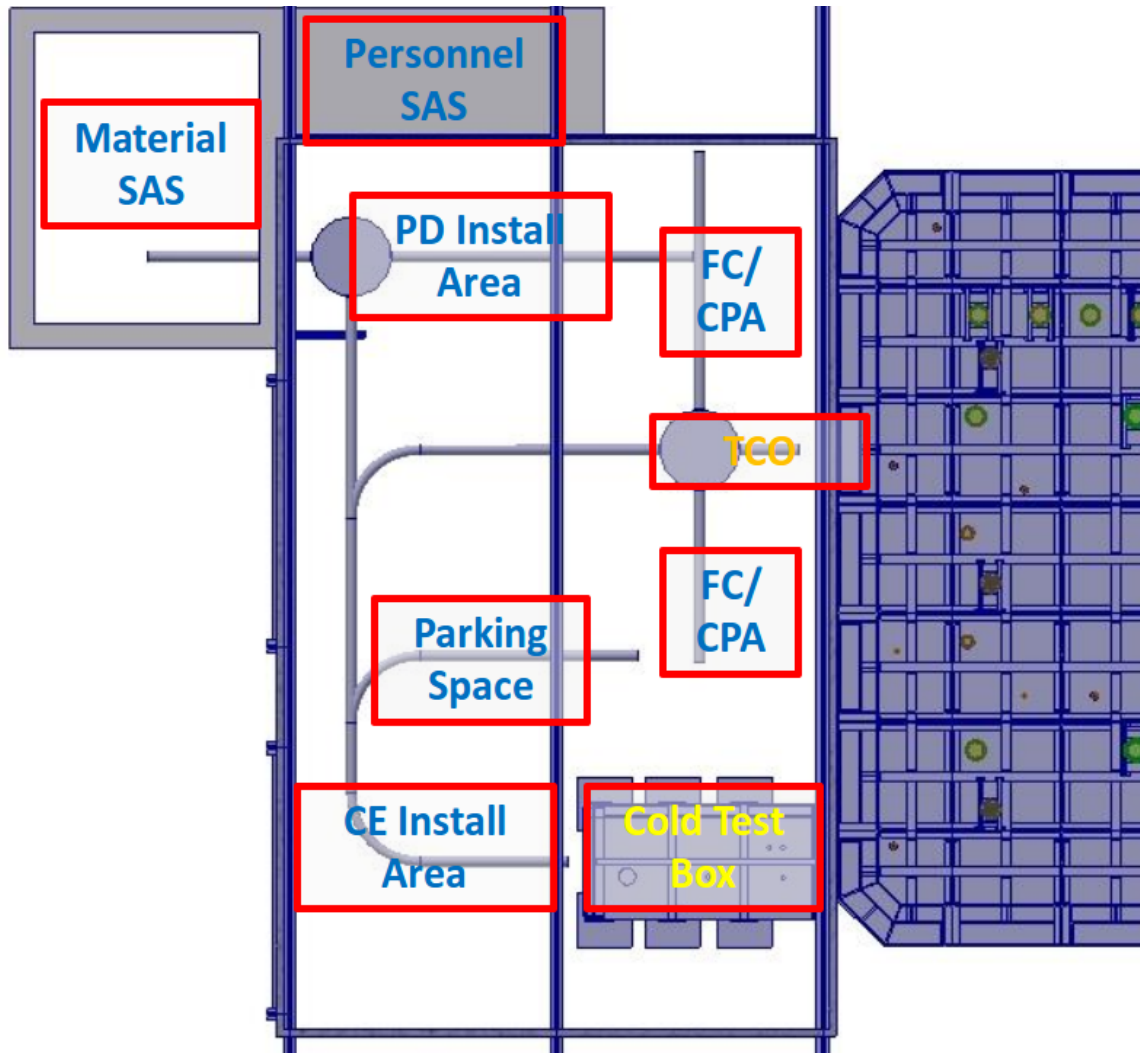
- Schedule still subject to frequent changes, especially to what concern APA delivery
- Taking a conservative approach: activities that can be parallelized are still reported in a sequential order
- For this reason, the final installation date can be considered as a sort of “latest possible date” which we should be able to make even in case of (not too big) problems found along the way

- Cooled racks for DAQ and computing arrives end of April (next week). Installed in EHN1 in May
- During May - early June, EHN1 infrastructure (network, power, water for cooling) will be completed
- At this point, the Vertical Slice Test stand can be moved to EHN1
- Clean room structure parts arrived mid-April and currently being assembled. Clean Room ready for the first APA by end of May - beginning of June

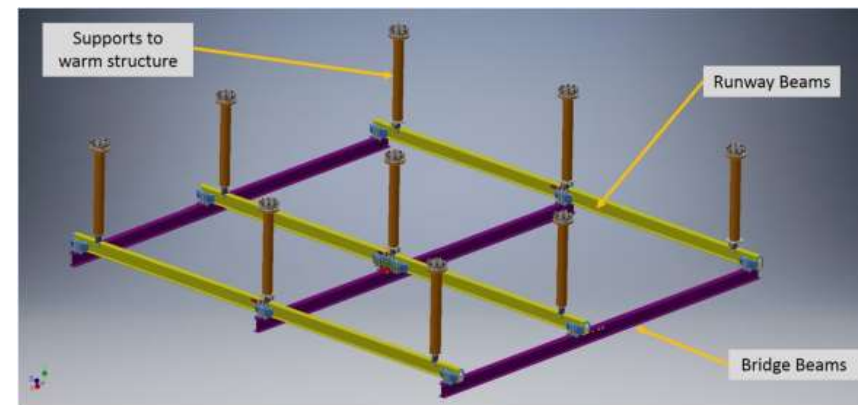


- **APA #1 arrives at CERN! June 22nd**
- Isolated AC distribution (providing power to all the elements on detector ground) will be installed at the beginning of June
- Cryostat membrane will be completed and cleaned by the end of June → if needed, TCO entrance will be temporarily covered to allow for the insertion of the APA in the clean room while the cryostat is being completed/cleaned
- About a month (till ~ 3rd week of July) will be dedicated to APA #1 inspection, PD and CE installation and tests **OUTSIDE** the Cold Box
- Design of Cold Box outer structure has been defined and parts procurement is starting. It will be assembled at CERN and ready to be used by beginning of June.
- The month of June and half of July will be used to test the Cold Box itself: cold cycles and noise studies



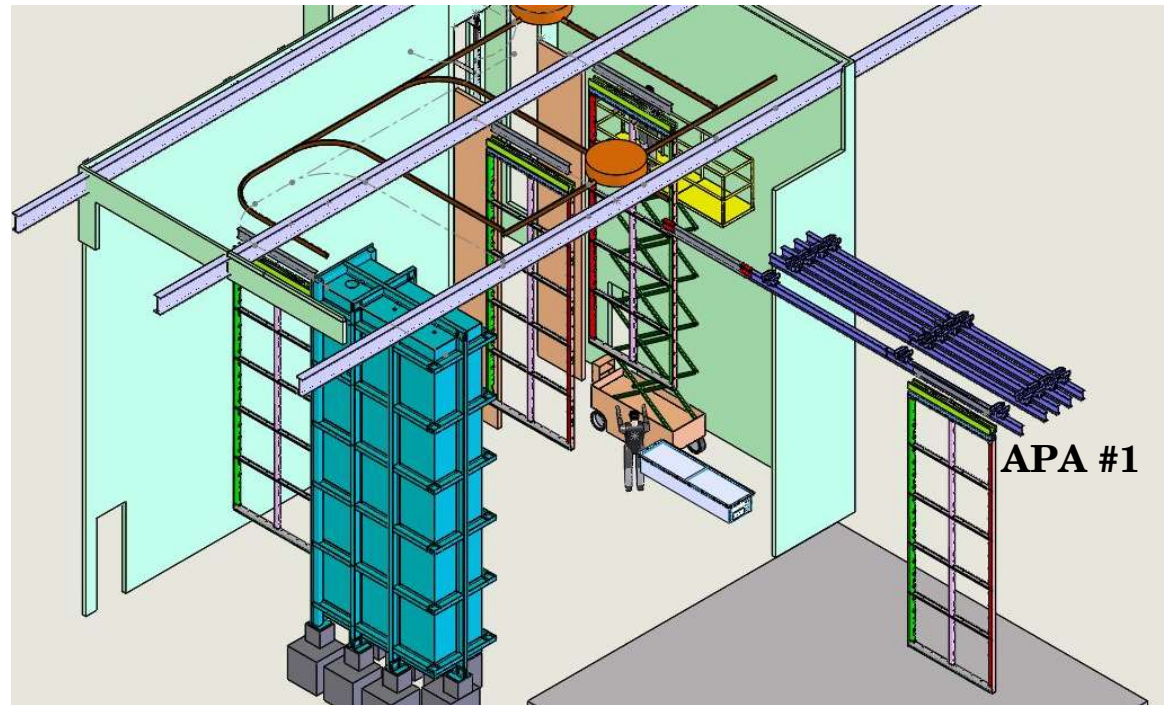


- July 21st – August 17th: warm test of APA #1 in the Cold Box
- While APA #1 is in the Cold Box, the DSS parts should arrive and be installed in the cryostat (~two weeks work between last week of July – mid August)

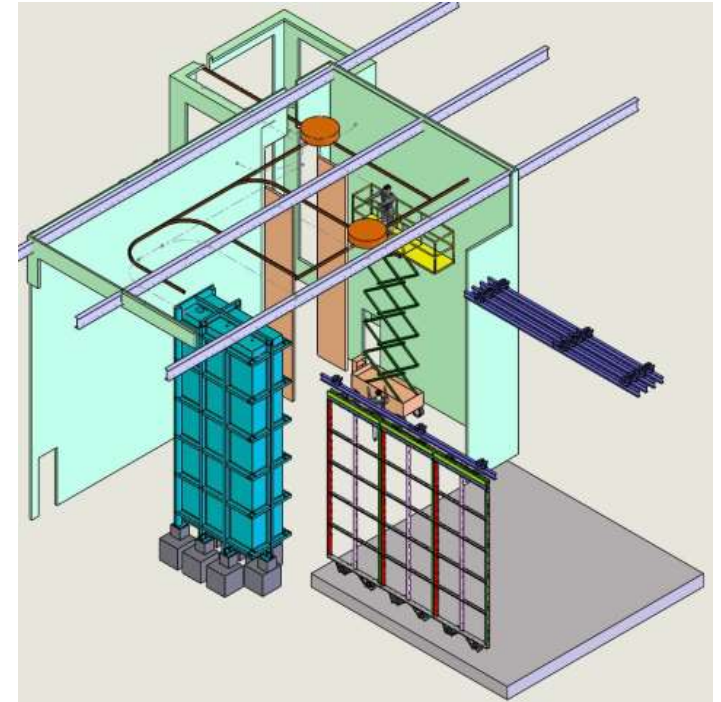


- **APA #2 arrives at CERN! September 6th**
- August 18th – September 14th: cold test of APA #1 in the Cold Box
- Cryogenic piping installation inside the cryostat: ~3 weeks work starting mid July - beginning of August
 - ✓ DSS/cryogenic pipes installation sequence will depend on their respective arrival time
- Once the cryogenic pipes are in place, the installation of temperature sensors on piping, membrane walls and roof can start. **Mid August till end September is a good time window for such installation**
 - ✓ At the beginning, the false floor will be removed to allow installation on the pipes. It will be re-positioned halfway through the job to allow for the use of a scissor lift to install sensors on cryostat walls and roof
- In a similar time frame (end of August – end of September) the installation of the Beam Plug N2 gas supply system can happen on the cryostat roof

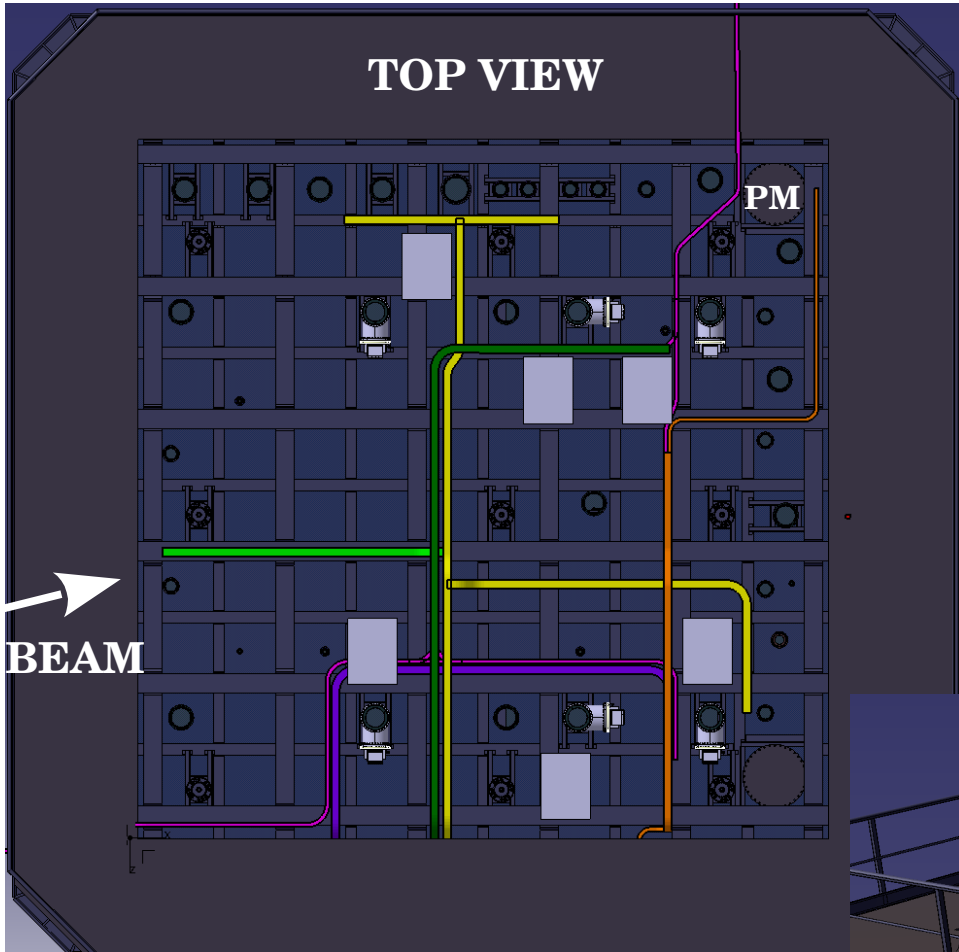
- **APA #3 arrives at CERN! September 27th**
- September 15th – 29th: APA #2 inspection + PD and CE installation
- Tests on APA#1 concluded by mid September: APA ready to be rolled inside the cryostat
 - ✓ By this time temperature sensor installation inside the cryostat may still be ongoing. There should be no problem in completing the installation with the APA already inside and by the TCO. Anyway, to be on the safe side, we may keep APA #1 in the Cold Box till end of September, when the box will be needed for APA #2



- **APA #4 arrives at CERN! October 17th**
- During the whole month of October, APA #2 and APA #3 are integrated, tested and inserted into the cryostat
- In the first days of November, the first full APA plane is rolled into its final position and cabled up
- The rest of November is dedicated to the assembly and insertion into the cryostat of the first two End Walls
- In the last week of November, the assembly of the first CPA module can start
- As we'd like to read out the APAs in their final position before the drift volume is completed, these months are also a good time to finalize the installation on top of the cryostat: flanges, cable trays, TPC cable routing...



Cable trays layout



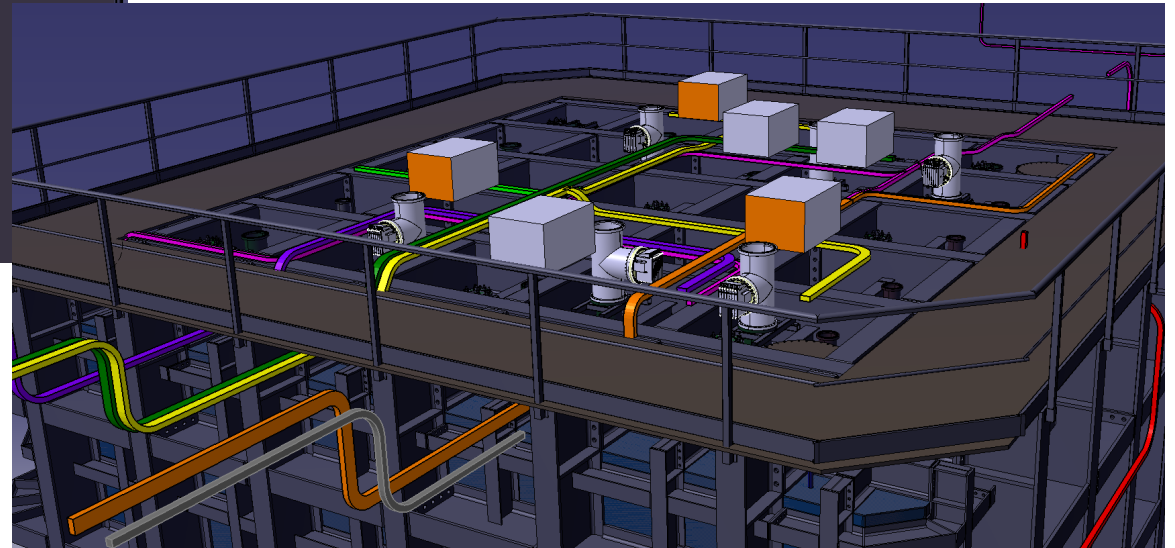
Yellow tray: temperature profile and cryostat temperature sensors

Orange tray: Purity Monitor

Green tray: North APA plane

Purple tray: South APA plane

Pink (!) tray: optical fibers to DAQ and Cold Box



- **APA #5 arrives at CERN! December 6th**
- CPAs are progressively assembled and inserted into the cryostat. Completion of the first drift volume on **January 23rd**. N2 pipe connected to Beam Plug January 24th - 30th
- Temperature monitors on the ground planes have to be installed in this period, during the CPA assembly/installation
- Despite arriving in October, integration of APA #4 starts on January 8th, being the Clean Room occupied by the CPA assembly and installation
- This means that APA #5 will be unpacked and integrated starting January 23nd

REMARK beside assuming the two weeks CERN break, I'm assuming both a serial installation APA1-3 → CPAs → APA 4-6, and a CPA installation happening inside the Clean room, preventing any other activity. Assembly of the CPAs outside the Clean Room and in parallel with the APA 1-3 would allow in principle to have the first drift field completed before Christmas, APA #4 and #5 integration starting on November/December. This could potentially anticipate the installation completion by a few (2-4) weeks

A bit of installation sequence:

End Walls

Top two sections are bolted to the 3rd section



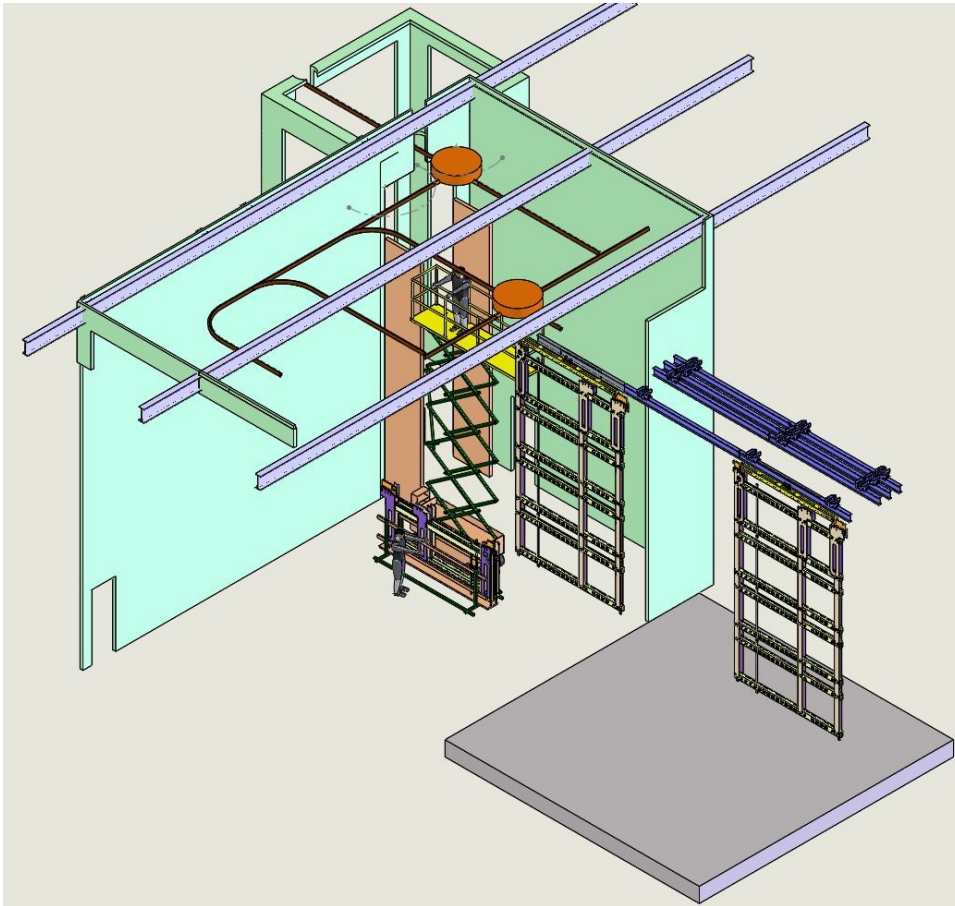
Top three sections are bolted to the last section

The completed end wall is then attached to the transport beam trolley

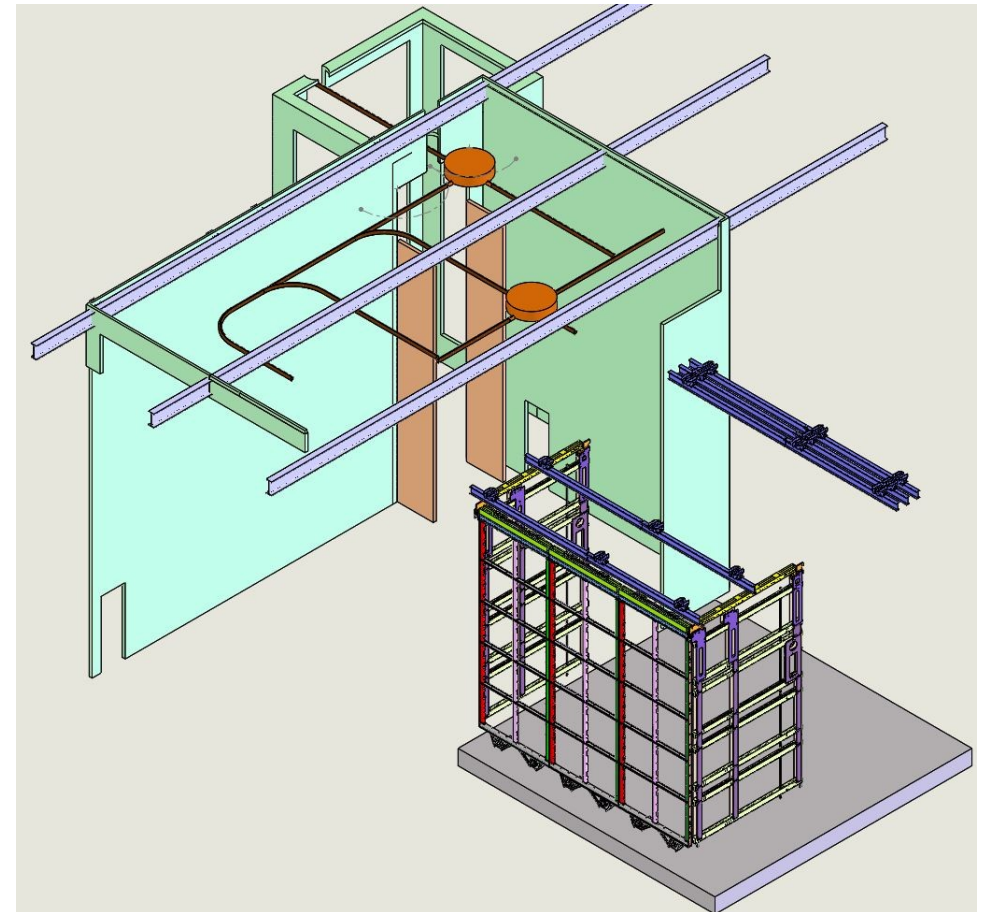


A bit of installation sequence:

End Walls

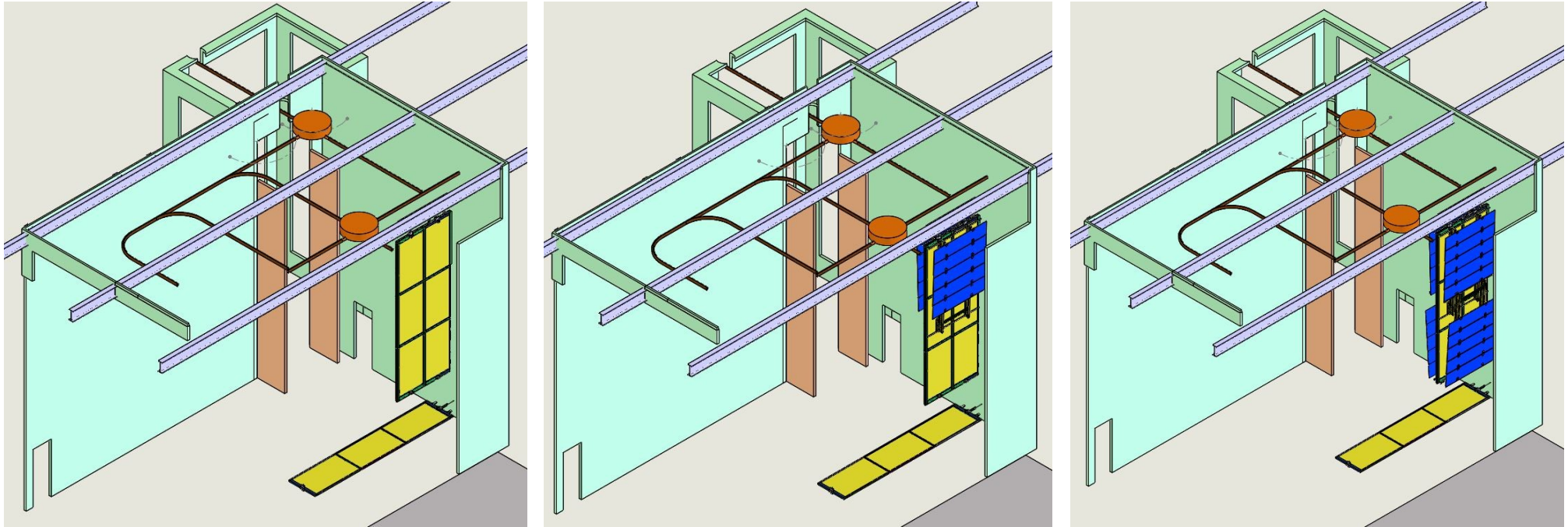


End Walls placed on their bridge beam...



... and rolled into position but not connected yet, waiting for the CPA plane!

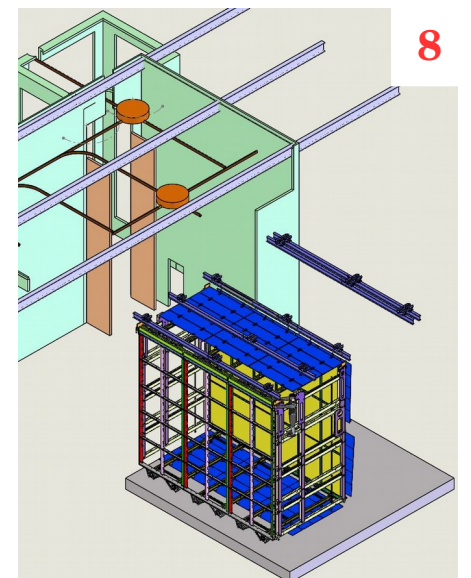
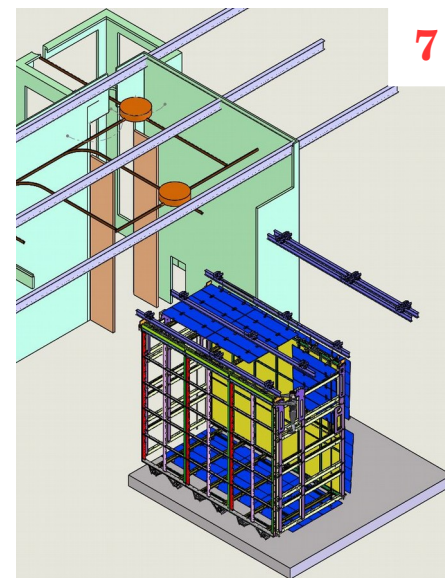
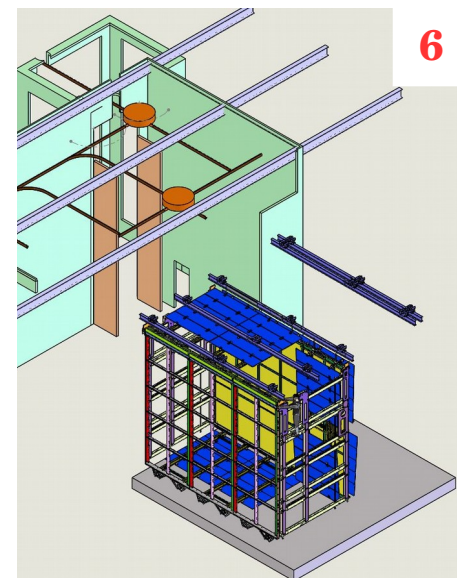
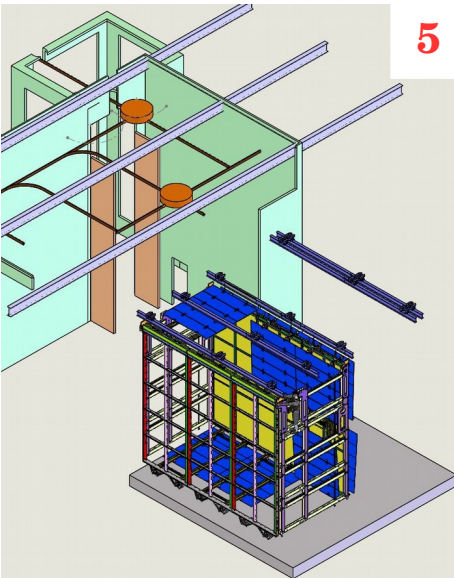
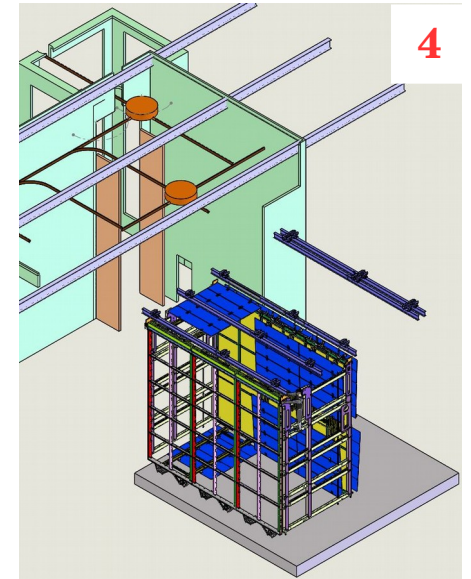
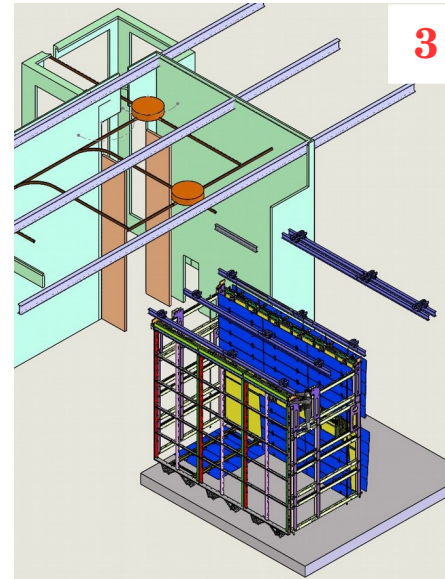
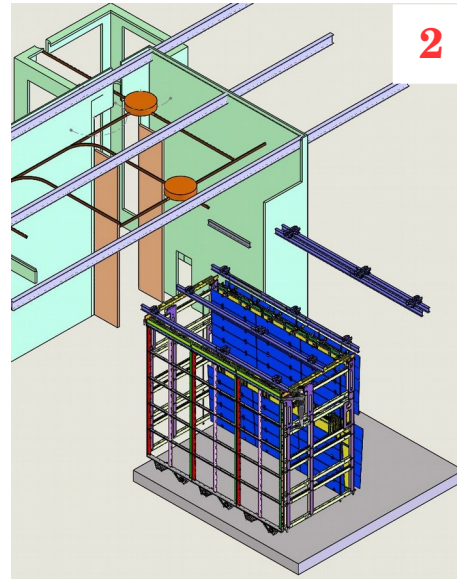
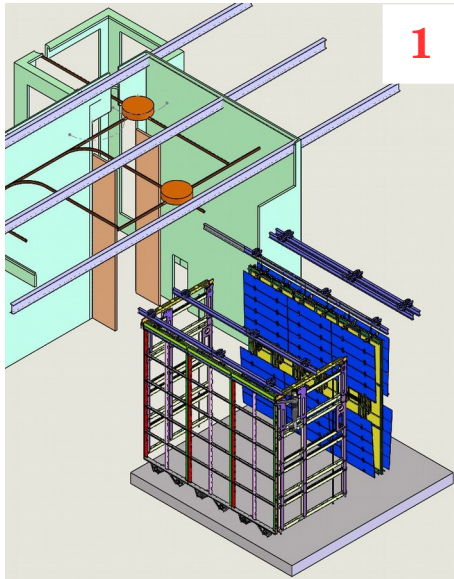
CPAs



- 3 sections are assembled together on a flat table, then lifted with a hoist as a single module
- 2 modules are connected together once vertical to form a pair, which has about the same dimensions of an APA

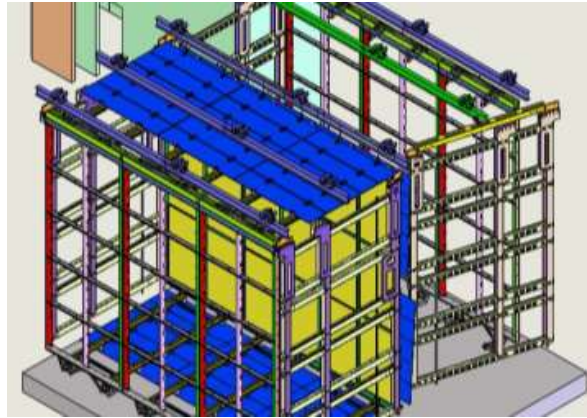
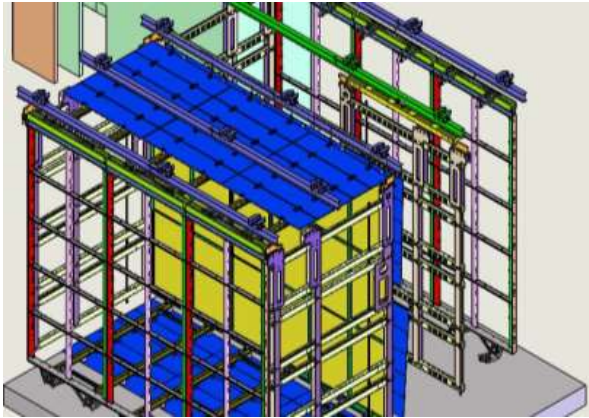
- Once a pair is formed, field cages are connected to it
- Top field cages are connected first, than the bottom ones
- Connectivity tests performed before installation in the cryostat

CPAs

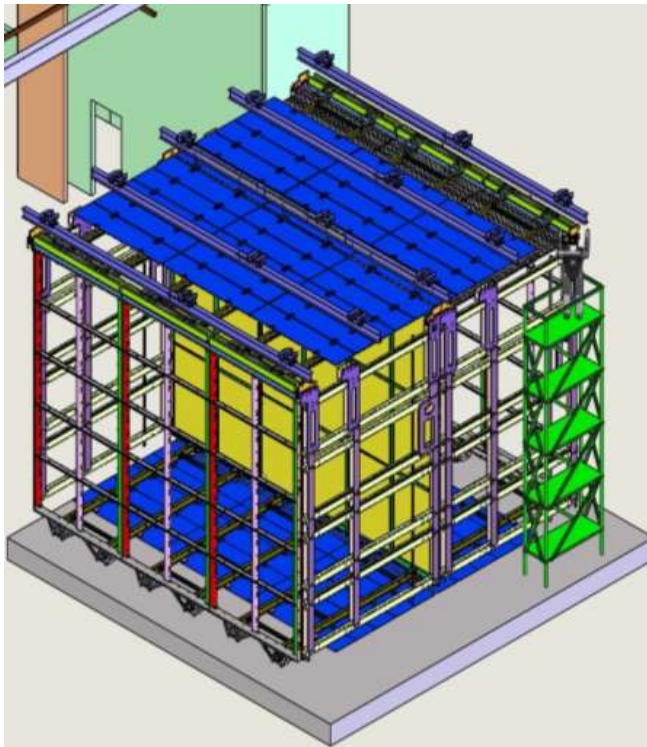


- **APA #6 arrives at CERN! February 21st** (*working on speeding this up*)
- At the beginning of February, APA #4 goes in the cryostat and APA #5 in the Cold Box.
- End of March, APAs 4-6 are moved into place and cabled
- March 28th – April 11th, the last two End Walls are assembled and inserted
- **April 12th – 19th TCO closing. Start working on a confined space regime**
- Attachment of the End Walls and deployment of the field cages for the second drift volume proceed till May 10th
- Once the TPC is completed, the purity monitors and the two temperature profiles (as well as the HV feedthrough) can be installed **starting May 11th**
- **Installation completed: May 18th**

A bit of installation sequence: last drift volume



- Once the TCO is closed, the last two End Walls are set in place and connected



- Field cages are deployed, first bottom and then top, for each section
- Field cages deployed moving from upstream towards downstream, like for the first volume
- Once TPC is completed, lift/and or scaffolding is taken away through the manhole

- As said at the beginning, this schedule has been realized taking a conservative approach. We could gain a few weeks by assembling CPAs outside the Clean Room and installing them in between APAs 1-3 installation
- At the same time, the end-of-installation date is presently mostly driven by the late arrival of APA #5 and #6 in particular. For this reason, we are investigating possibilities to speed up the construction and delivery process
- In any case, the best time window for the installation of temperature sensors inside the cryostat (cryogenic piping, walls, roof) is during the months of August/September
- Temperature monitors for field cage ground planes are best to be placed during the field cage-CPA assembly in the Clean Room
- Purity Monitors and temperature monitors have to be installed once the TPC is completed, as last thing before sealing up the cryostat → May 2018

Calendar view

