FDC installation

Timeline, Requirements, Resources

1 Overview

This document describes the plans for the FDC installation and the requirements for each step of the process. The plans are based on the ”re-based” 12 GeV Upgrade schedule and some changes are possible until the schedule is considered final. A FastTrack schedule of the FDC installation, including some other activities directly related to the installation, is shown in Fig.1. A significant part of the installation will be the connection of the detector with signal and Low Voltage (LV) cables. The FDC is the only detector in the GlueX experiment that once inserted in the magnet it is not accessible for service like fixing connectors, pre-amps, improving the grounding. Therefore, during the installation the detector has to be tested completely outside of the magnet with all the cables connected at both sides, detector and electronics, and then inserted in the magnet without disconnecting the cables. 3D renderings of the platform with the installation carts, the racks, and the tooling for the cabling, with the FDC at the initial, intermediate, and final position are shown in Figs.2, 3, 4.

2 FDC installation activities

2.1 Receive and install the FDC assembly on the platform

The FDC assembly (four packages mounted together and installed on a cart) will be ready by the middle of August 2013. To avoid/mitigate corrosion problems on the thin (2 μ) copper layer of the cathodes, we want to minimize the time between the receiving of the FDC in the Hall and the start of the operation of the GlueX detectors inside the magnet when there will be means to keep the humidity inside the magnet low. Therefore, we will keep the FDC in a conditioned area outside of the Hall, until all the infrastructure is ready to start the installation and there are no showstoppers to finish it in time according the the schedule. Thus, before the FDC is moved to the Hall, we require:

- The rails supporting the installation carts to be installed and properly aligned.
- The first downstream installation cart to be in place.
- The rails on the BCAL that support the FDC, CDC, and the mesh to be installed, aligned and attached to the rails of the first supporting cart.
- The two halves of the mesh cylinders to be ready and tested on the first cart.
- The electronics racks and the power for the crates to be installed.
- The cable trays, both on the top of the racks and below the platform to be ready.

- The openings on the platform to access the down trays to be ready and closed.
- The temporary frames to support the top half of the cables running into the top trays, to be installed.

Requirements about the elctronics, LV and HV systems are discussed below.

The FDC will arrive on the second installation cart which will be attached to the first cart (the two main rails have already been aligned) and the detector inserted into the front cart. After that, the rails for the mesh of the second cart have to be aligned and the mesh installed on it. Once the FDC is installed in the front cart, it has to be connected to the gas system and flushed with gas, to minimize the corrosion. If the gas system is not ready by that time, a temporary Nitrogen dewar can be used to flush the chambers. Also, the humidity around the chambers has to be kept as low as possible. For that we require the Hall doors to be kept closed as much as possible. In addition, it is recommended the blower that will supply dry air inside the magnet to be aimed at the FDC during the installation. Before the installation of the cables, all the FDC packages have to be surveyed.

2.2 Connect LV and signal cables to the detector

The numbers of the signal and LV cables per package and in total are shown in Table 1.

Table 1: FDC cable/channel numbers per package and in total separately for strips and wire channels. Spare cables are in brackets.

	Signal cables	LV cables	Channels
Strips per package	108	27 (1)	2,592
Wires per package	24	6 (1)	576
Total per package	132 (4)	33 (2)	3,168
Strips total	432	108 (4)	10,368
Wires total	96	24 (4)	2,304
Total	528 (16)	132 (8)	12,672

The plan is to have all the signal cables on the platform and to label each cable just before attaching it to the detector. Thus we will avoid sorting/searching for the correct cable. The LV cables are not that many and will be labeled in advance.

As seen from the schedule (Fig.1), the bottleneck for the FDC cabling will be the installation of the corresponding electronics. The installation of the crates (together with the modules) finishes after the insertion of the FDC in the magnet, which is not acceptable since, as discussed above, the detector has to be completely tested outside of the magnet with all the cables connected to the electronics. According to the original plan the installation of the crates would start on 10/3/13 and finish on 1/13/14, the time when the FDC will be inserted. We assume that the original plan will hold and the re-based schedule will be corrected. Even if this is the case, the detector will have to be tested concurrently with the installation of the crates. This means that when testing a certain package and the six crates associated with it are not installed, one has to re-arrange all the cables to use the existing electronics. In our opinion this will create even more problems and delays. Therefore, as coordinated with the schedule for the electronics, **we require all the crates** (even without modules) **to be installed in the racks in advance**. Then, even if we don't have modules for a certain package we can use modules from other packages and do the tests.

The cabling will be done in three successive steps:

- Connection of the cables to the detector.

  It is convenient to work separately on each quadrant and to start with the most upstream package. The LV cables are the most difficult to be connected to the detector, therefore, they will be installed first for the corresponding package and quadrant (8 or 9 cables), laid on the floor and bundled. The procedure for the signal cables is the same except there will be several bundles per package per quadrant. In total per quadrant we will have 4 LV and 16 signal bundles, each with 8 or 9 cables. After the installation of the cables for one quadrant of a package, LV will be applied and the connectivity for all the signal cables will be tested by looking at the noise produced by the preapms. For that **we require the LV system** (at least partially) **to be ready before the start of the cabling**. During the installation the cables will be tied to the mesh cylinder and to the skin between the packages avoiding stress on the connectors. After finishing all the cables, the bundles for each quadrant will be loosely tied in one big bundle.

- Installation of the bundles in the cable trays.

  At the end of the previous step the four big bundles (one per quadrant) will be laying on the platform. The two bundles from the top quadrants will be lifted to the left/right supporting frames and trays on the top of the racks. The two bottom bundles will be inserted in the trays below the racks through the openings in the platform along the sides of the cart rails. At the top and bottom of the racks, the big bundles will be un-bundled, but keeping the individual bundles (with 8 or 9 cables) intact.

- Connecting of the cables to the electronics.

  Now we work bundle by bundle, each of the bundles containing 8 or 9 cables from the same package. It means that these cables will be plugged to one crate or in worst case to two neighboring crates. First, the cables will be un-bundled, then connected to the electronics, service loops made and cables tied to the cable managers, racks and cable trays. In case there's no electronics, one still can run the cables leaving enough length at the end so that each of the cables per module should reach each of the connectors on the module.

  During the cabling at least 20 m from the platform next to the magnet will be occupied and no other activities will be possible at this area.

2.3 Insertion of the FDC into the magnet

After the detector has been completely tested, it will be inserted in the magnet. This operation requires many people working at the same time on the platform. The steps of inserting the FDC are shown in Figs.2, 3, 4. The FDC will be moved in small steps by feeding the cables from the back of the carts. Some temporary cable support might be needed. Once the FDC is out of the front cart and sitting on the rails inside the magnet, the cylinder mesh will be in the front cart, then the rear cart has to be removed. For that the top of the cart will be disassembled, all the cables lifted and the cart will be moved back. At this point, there will be extra cables that will be laid in the bottom and top cable trays. When both the FDC and the mesh are inside the magnet, similar procedure will be done with the front cart. The openings on the floor have to be kept closed at all times except at the positions where the bundles run to the down trays. Once the detector is in its final position, all cables at the face of the magnet have to be attached properly.

3 FDC testing during the installation

As discussed above, the main requirement for the insertion of the FDC into the magnet is the FDC to be completely tested with the full electronics in advance. The tests will be done package by package. The electronics for each package occupies six crates, four with fADC125 modules and two with F1TDC modules, symmetrically to the left and right. The trigger will come from top and bottom scintillator planes that will be moved from package to package. The frame supporting the scintillators can be installed after the first two steps of the cabling (explained above) are finished. The FDC cooling system must be installed in advance and connected with temporary tubing to the packages at their testing position on the platform. The test will be done with the nominal gas mixture of Ar/CO_2 40/60% and for that we need the gas system to be operational. If this is not the case we can use pre-mixed bottles. The main requirements about the DAQ are listed below.

3.1 Trigger

Each FDC package is tested fully with cosmic rays. Two scintillator paddles above and two below the FDC package will provide a trigger for cosmic rays. These paddles are taken from the current test stand in room 126 in the EEL building. This trigger will require some NIM electronics and eight negative HV channels to power the PMTs. In addition it requires HV and LV as well as ADC and TDCs.

The trigger paddles have PMTs on both ends and coincidences are formed between these ends to reduce accidentals. An OR is formed for both the two top and two bottom paddles. The trigger is formed as a coincidence between the top and bottom scintillator paddles. This trigger will be distributed to the other 6 crates as well and to one channel of the trigger crates fast TDC.

3.2 Electronics configuration

- 1 CAEN Main-Frame 1527
- 1 CAEN HV Module 1550P
- 1 CAEN HV Module 1550N
- 1 CAEN HV Module 1733
- 1 LV Main-Frame
- 3 LV Modules power preamplifier cards
- 1 LV Module threshold
- X LV distribution panels
- 12 F1 TDC low resolution
- 1 F1 TDC high resolution (ECL input)

- 36 f125ADC latest version
- 1 NIM crate (for trigger formation)
- 2 NIM coincidence modules (4 channels each)
- 1 NIM logical fan in/out
- 2 NIM Discriminator Module 8 channels
- 1 NIM-ECL converter
- 7 VXS crates with CPU, TI and TD

The concrete configuration of the electronics needs to be assessed based on the availability of electronics components that is installed at the time of the tests and its configuration. The LV main-frame will be located on the north side of the platform. The LV power supply modules will power the distribution panels also located on the north side of the upstream platform. All LV cables from the detectors will run to that location connecting to the distribution panels. As a consequence this requires that all distribution panels are installed as well as the fully loaded LV main-frame. To some extent this is also true for the two HV main-frames, one on the south side and one on the north side of the beam line.

Since the signal cables for both ADC and TDC run to both sides of the beam line the readout electronics needs to be split with half of it on each side. This means 6 F1 TDCs on each side and 18 ADCs on each side. This requires 1 VXS crate for the TDCs and 2 VXS crates for the ADCs on each side for a total of 6 VXS crates. Note that 18 ADCs would fit into a single VXS crate but the current configuration of the setup foresees a smaller load of ADCs per crate. In addition a 7th VXS crate is required that holds the high resolution TDC (trigger time) and acts as master crate and TS.

The readout of 4 crates was tested beforehand in the EEL using the cosmic ray trigger test stand with a fully equipped FDC package.

3.3 Slow control

Some minimal configurations of the slow control systems are needed to do the test. These include:

- controlling HV channels
- controlling LV and thresholds
- gas system control
- cooling system control

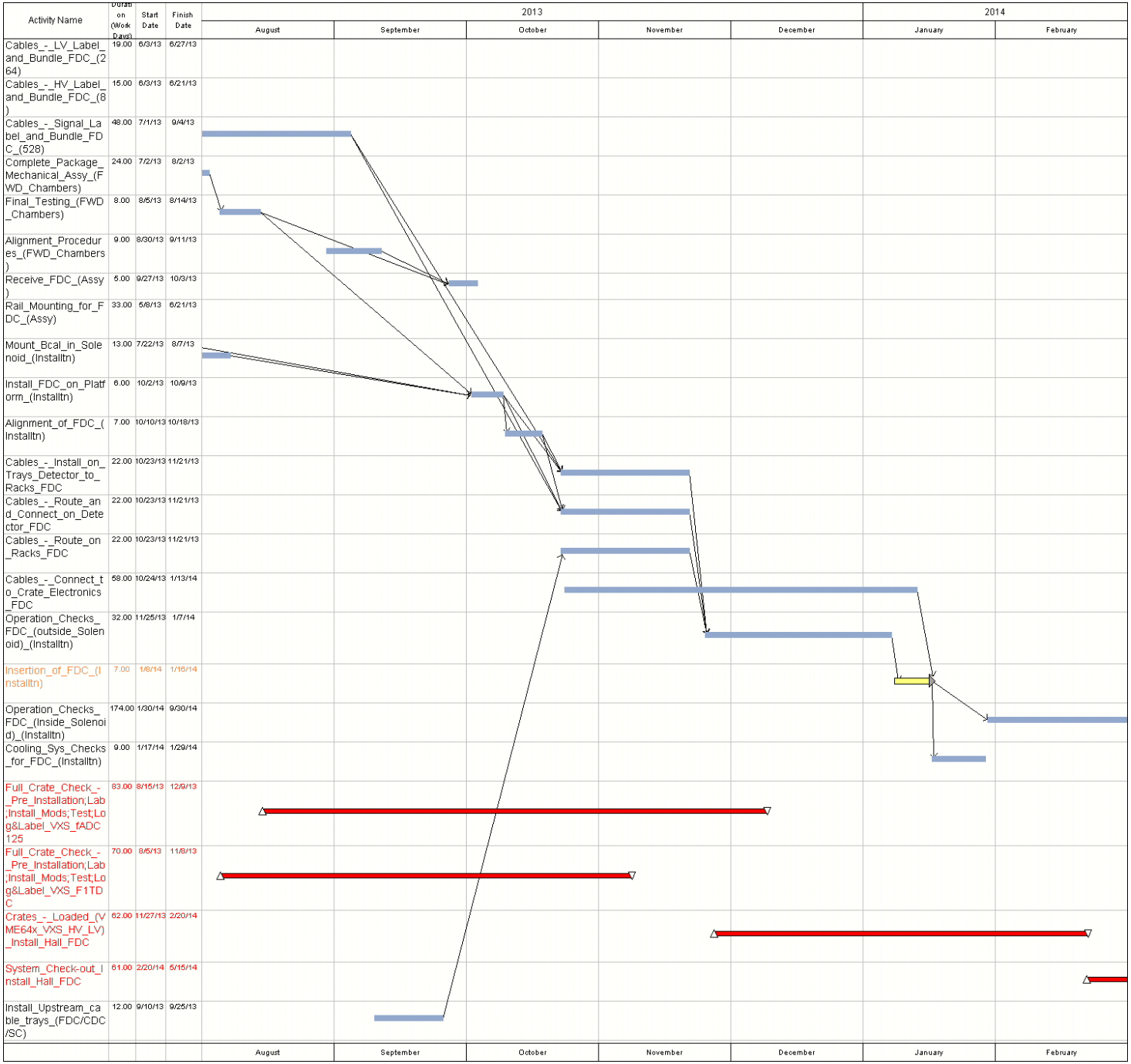

Figure 1: FDC installation schedule. Critical tasks related to the FDC electronics installation are shown in red.

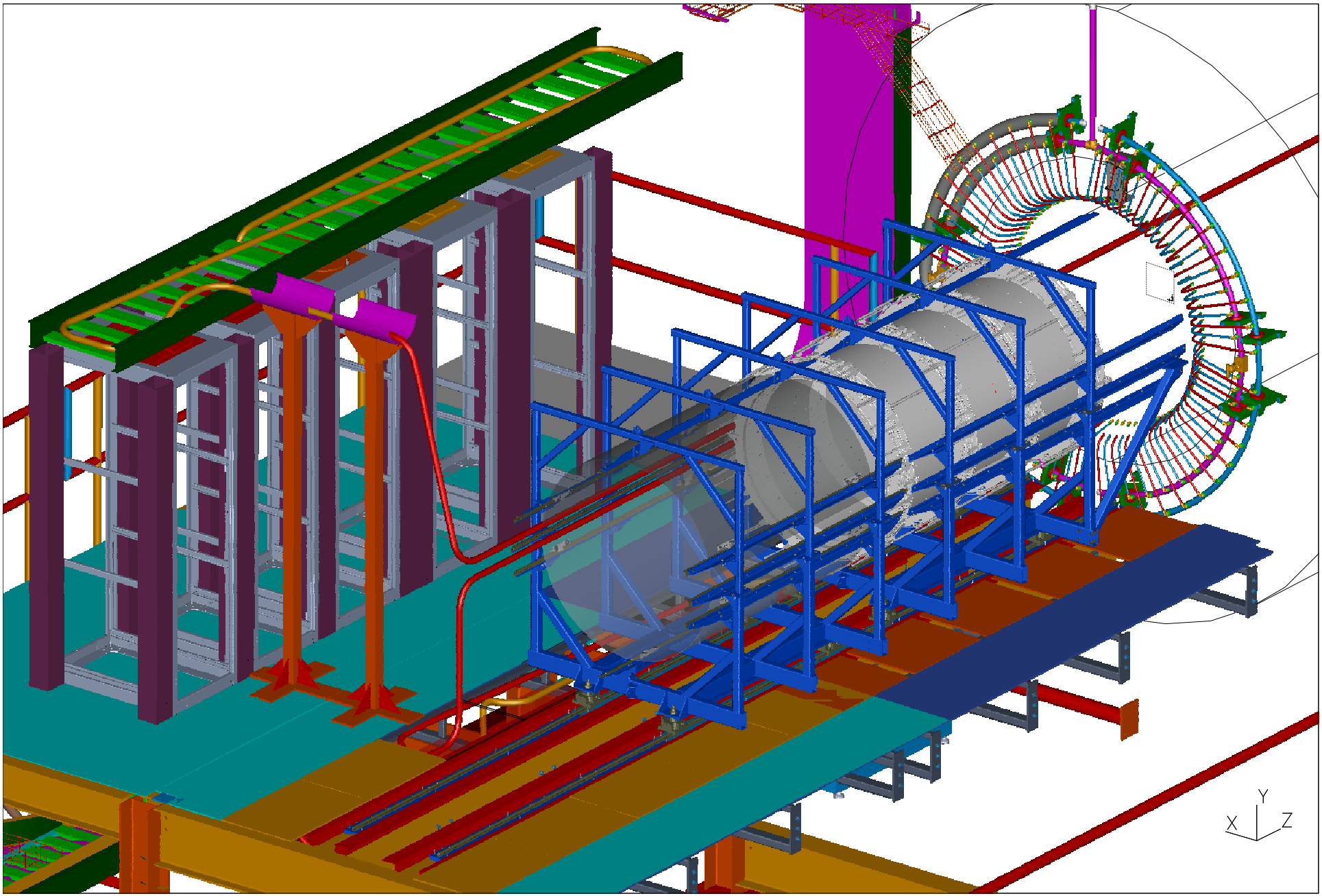

Figure 2: Cable installation: initial FDC position

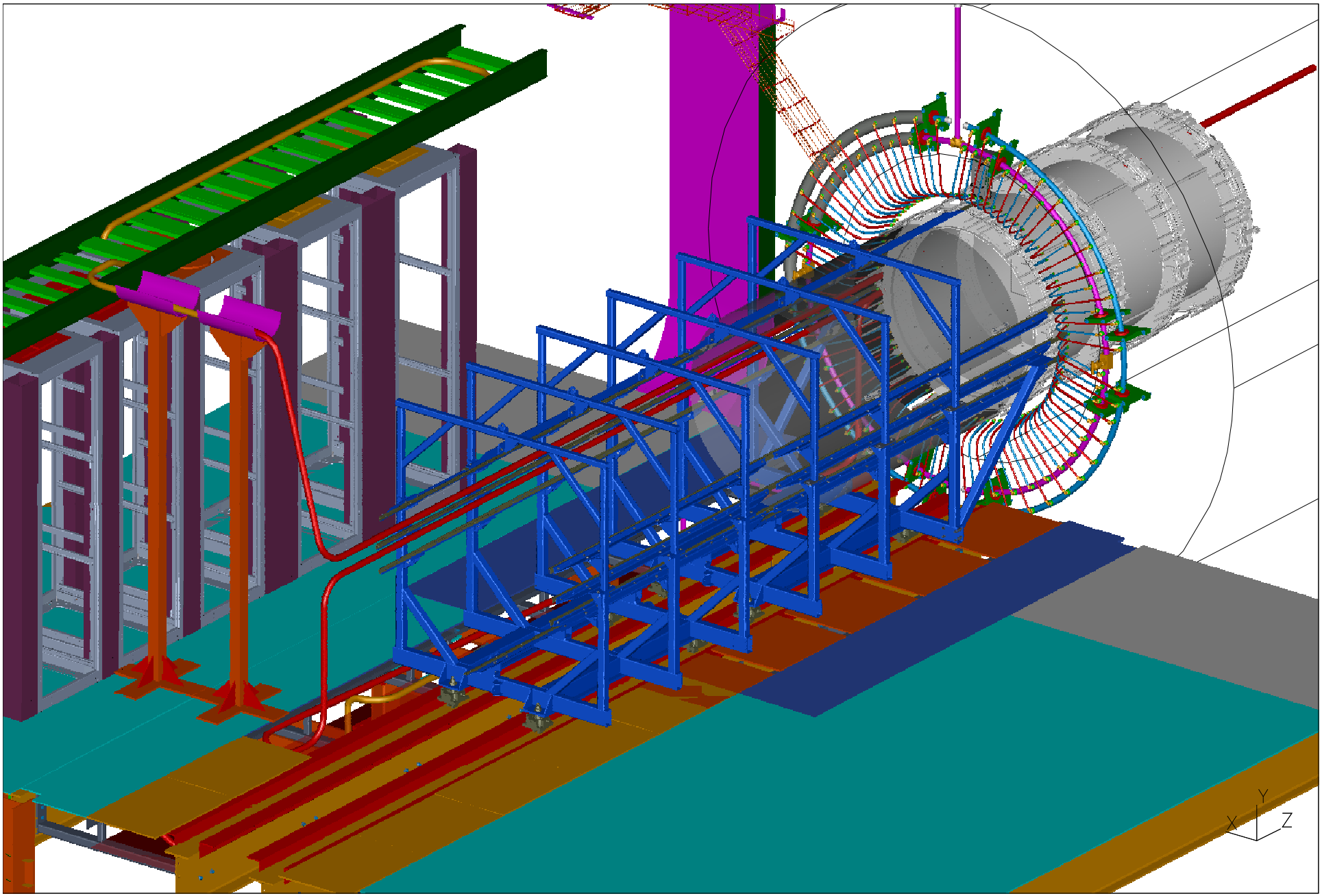

Figure 3: Cable installation: intermediate FDC position

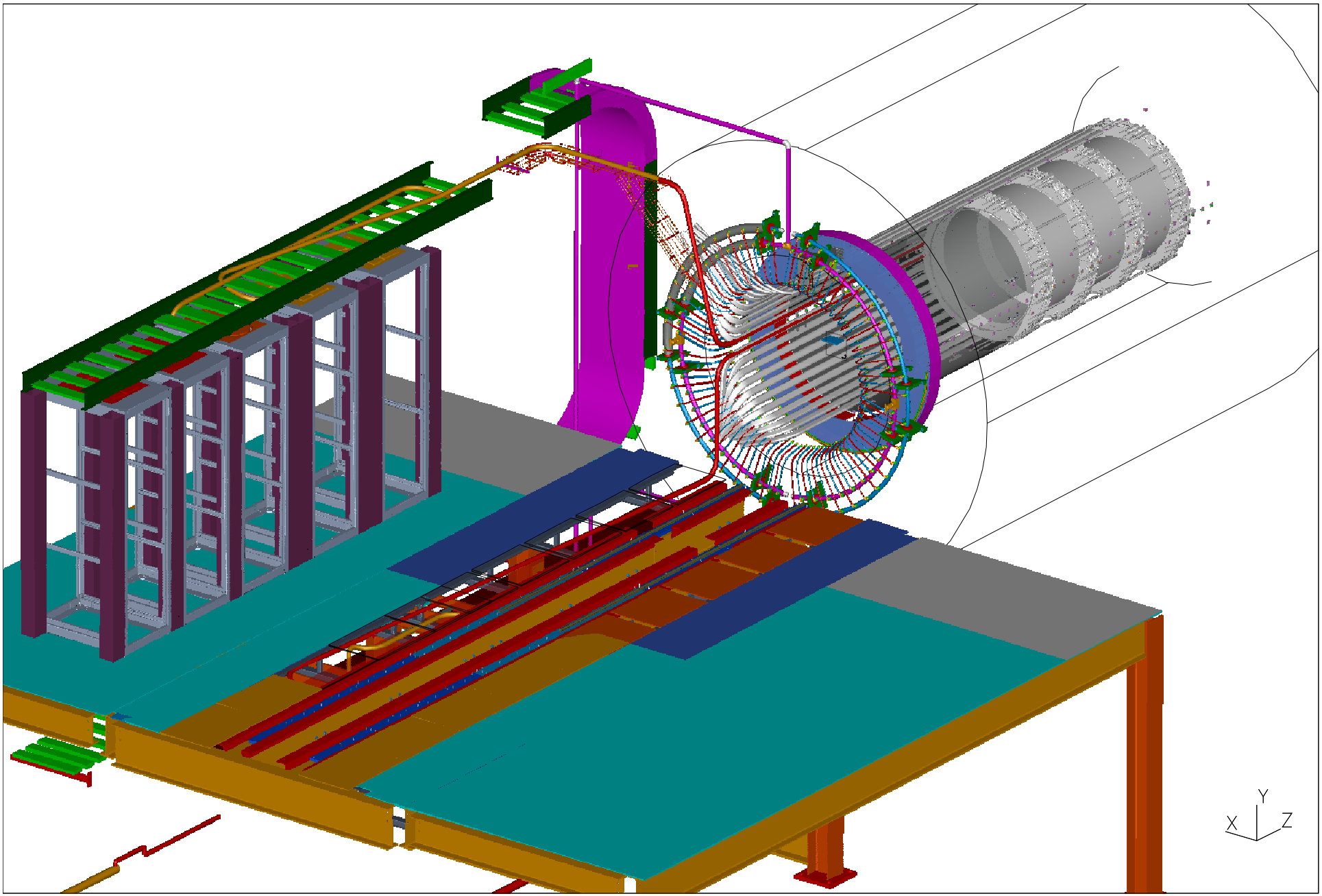

Figure 4: Cable installation: final FDC position.