# Machine integration for FCC-hh, FCC-ee and HE-LHC

ID: 2AMSP43

Authors: Fani Valchkova-Georgieva with input and support from the Integration Work Group

The Future Circular Collider (FCC) study aims at developing conceptual design for a post-LHC particle accelerator research infrastructure in a global context, with an energy significantly above that of previous circular colliders as LHC and SPS. An electron machine will also be considered as a possible intermediate first step (FCC-ee). The study benefits from earlier work done in the context of TLEP. FCC-ee is capable of very high luminosities in a wide center-of-mass ($E_{CM}$) spectrum from 90-to 350 GeV.

The HE-LHC itself must fit the existing LHC tunnel with a diameter of 3.8 m. The HE-LHC shall provide proton-proton collisions at an energy of about 27 TeV in the center of mass. The integrated luminosity of the HE-LHC over about 20 years of operation should exceed 10 $ab^{-1}$ . The target energy requires FCC dipole magnets with a field of 16 Tesla. The HE-LHC also incorporates novel elements from the HL-LHC such as crab cavities and low-impedance collimators.

CERN's Integration Office is in charge to study and integrate the machine and services equipment within the new FCC machine tunnel and other underground structures. After additional investigating the FCC-hh and FCC-ee machine tunnel layout has been modified to 5.5 m inner diameter. The new tunnel has a circumference of 97.75 km (Figure 1), almost four times the size of the present LHC. Eight main arc pieces will be interleaved with eight straight sectors and four shorter arcs.

The cross section of HE-LHC machine tunnel (Figures 2.1, 2.2) shows the position of the magnets cryostat with an overall diameter (including reinforcement ring, flanges, bellows, ... ) of 1.2 m and the cryogenic distribution line with an overall diameter of 0.83 m. Service elements comprise different line for helium, raw and demineralized water, a duct at the ceiling for smoke/He extraction, a leaky feeder, and trays for power and control cables.

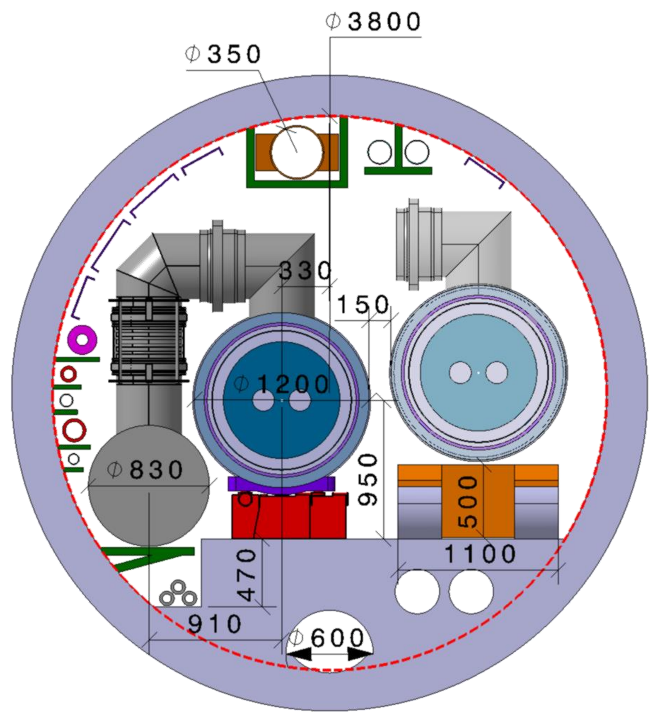



Figure.2.1. 3.8 m HE-LHC 3D, dipole, transport vehicle

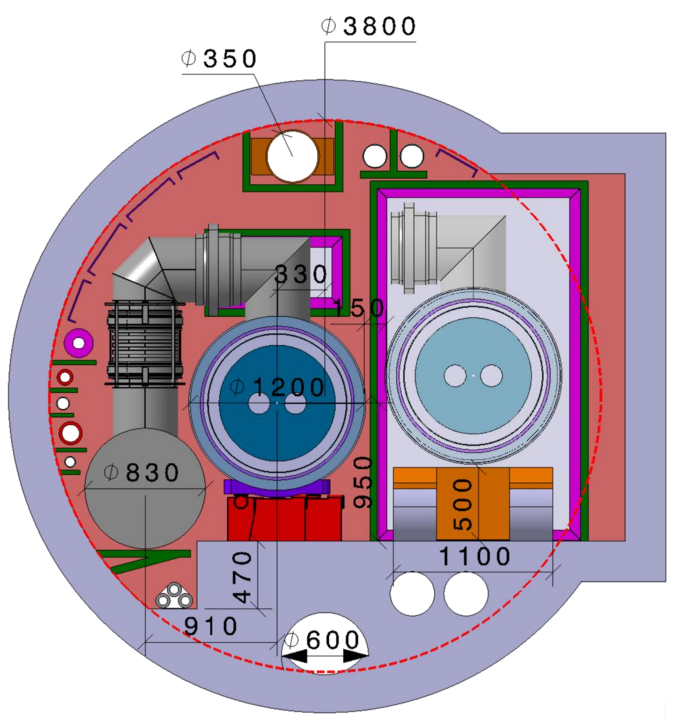



Figure.2.2. 3.8 m HE-LHC 3D, dipole, compartment wall, transport vehicle

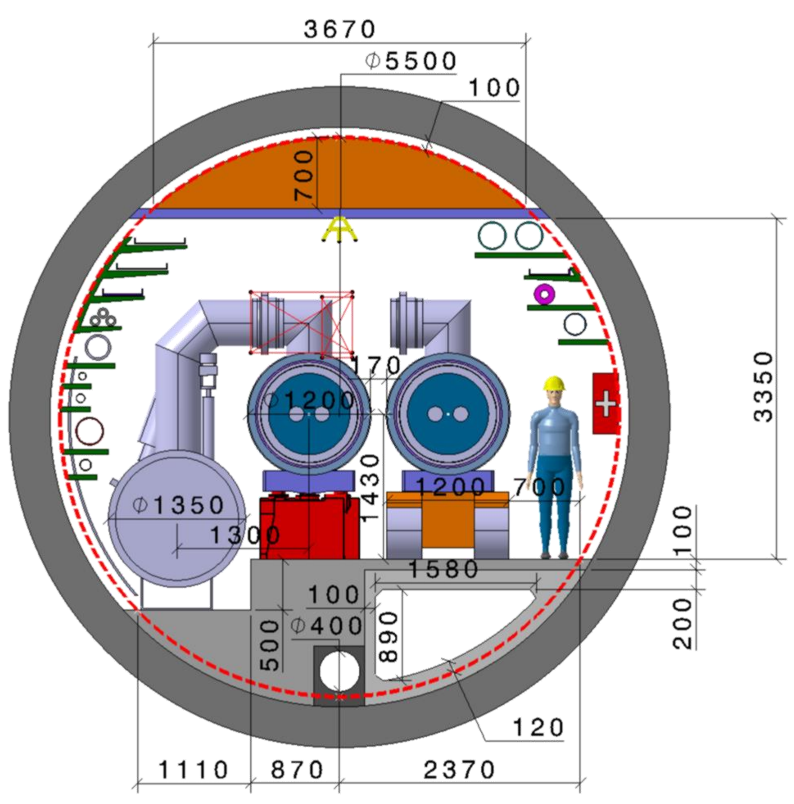



Figure.3.1. 5.5 m FCC-hh 3D, dipole, cryogenic jumper, transport vehicle

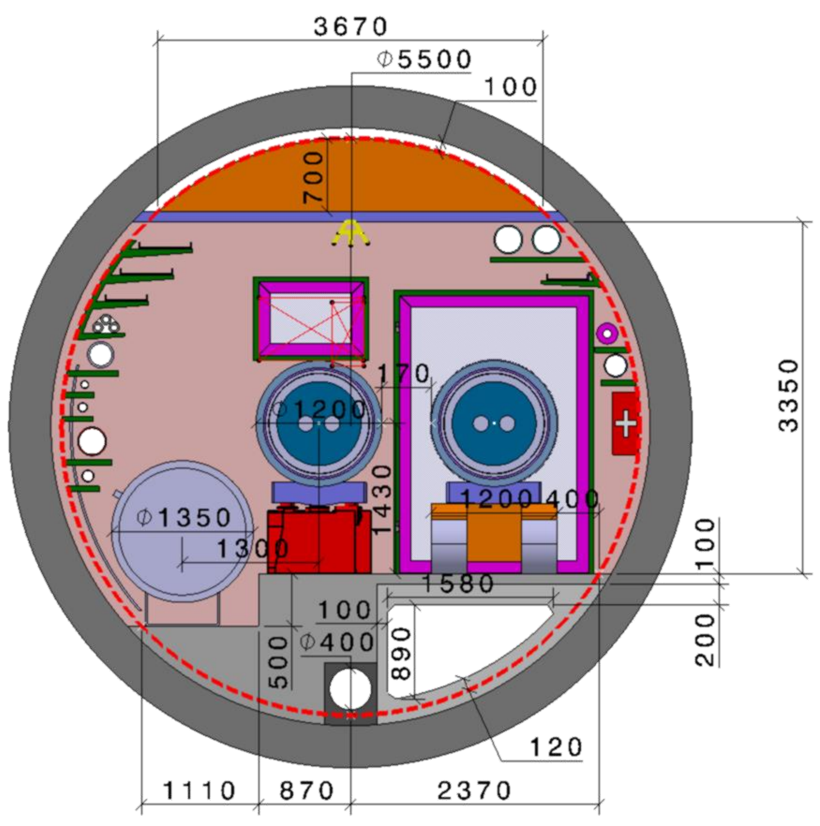
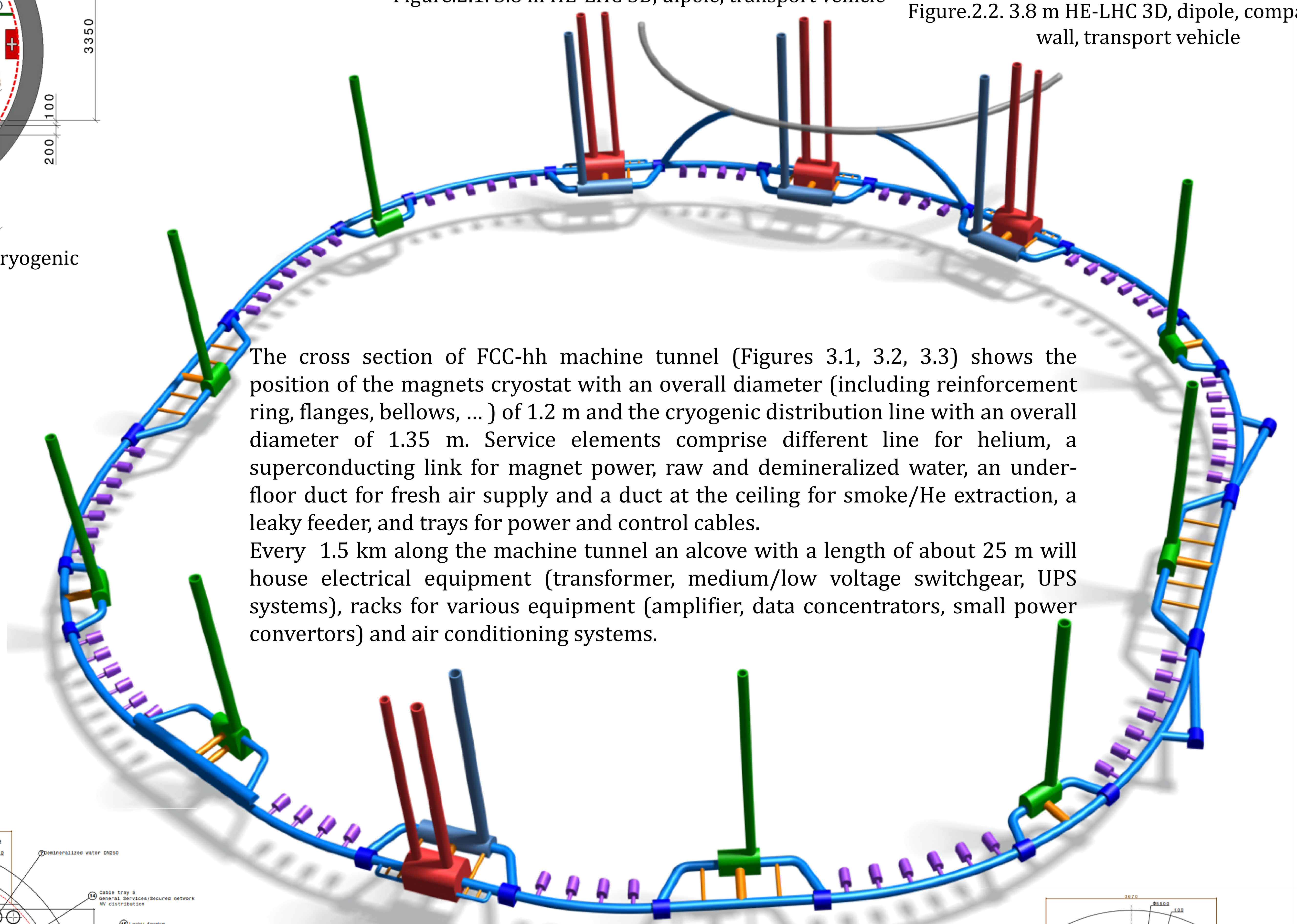



Figure.3.2. 5.5 m FCC-hh 3D, dipole, compartment wall, transport vehicle



The cross section of FCC-hh machine tunnel (Figures 3.1, 3.2, 3.3) shows the position of the magnets cryostat with an overall diameter (including reinforcement ring, flanges, bellows, ... ) of 1.2 m and the cryogenic distribution line with an overall diameter of 1.35 m. Service elements comprise different line for helium, a superconducting link for magnet power, raw and demineralized water, an under-floor duct for fresh air supply and a duct at the ceiling for smoke/He extraction, a leaky feeder, and trays for power and control cables.

Every 1.5 km along the machine tunnel an alcove with a length of about 25 m will house electrical equipment (transformer, medium/low voltage switchgear, UPS systems), racks for various equipment (amplifier, data concentrators, small power convertors) and air conditioning systems.

Figure.1 FCC-hh schematic 3D model (Courtesy of Angel Navascues)

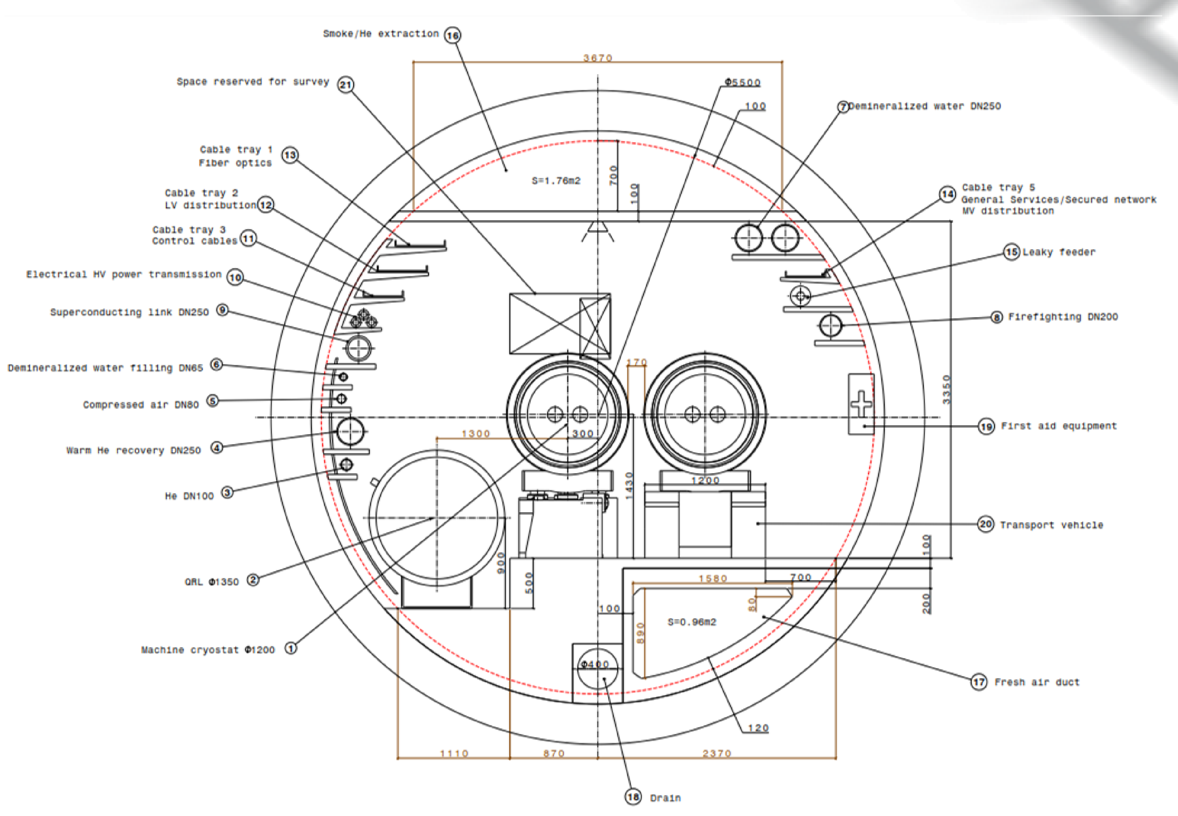


Figure.3.3. 5.5 m FCC-hh 2D, dimensions, explanations

The cross section of the FCC-ee machine tunnel (Figures 4.1, 4.2) shows the position of the $e^+/e^-$ ring and Booster ring. Service elements comprise different line for raw and demineralized water, an under-floor duct for fresh air supply and a duct at the ceiling for smoke/He extraction, a leaky feeder, and trays for power and control cables.

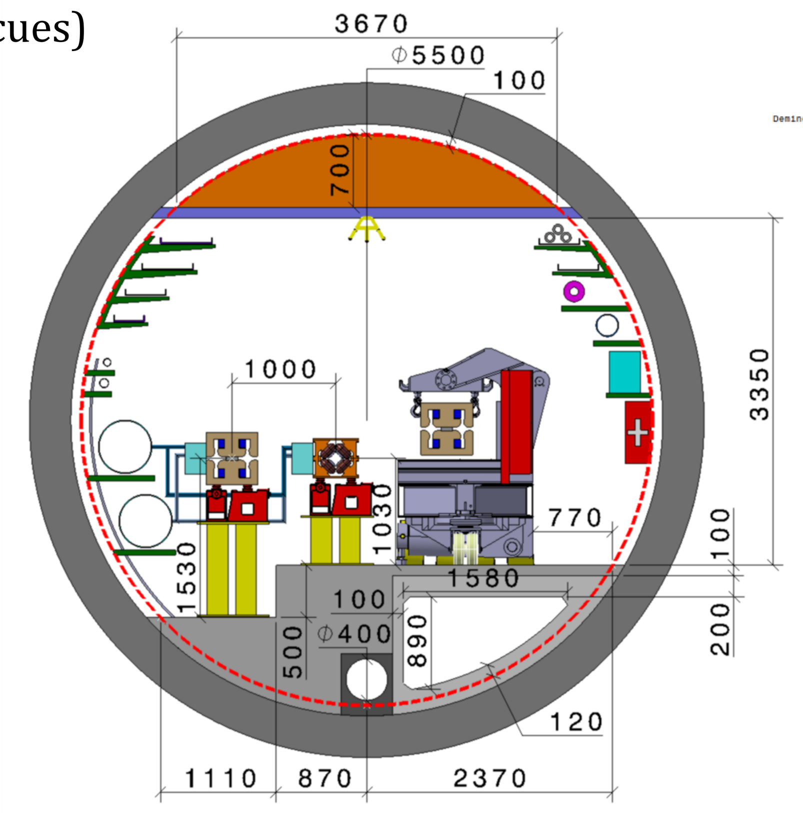



Figure.4.1. 5.5 m FCC-ee ring and booster ring 3D, quadrupole, transport vehicle

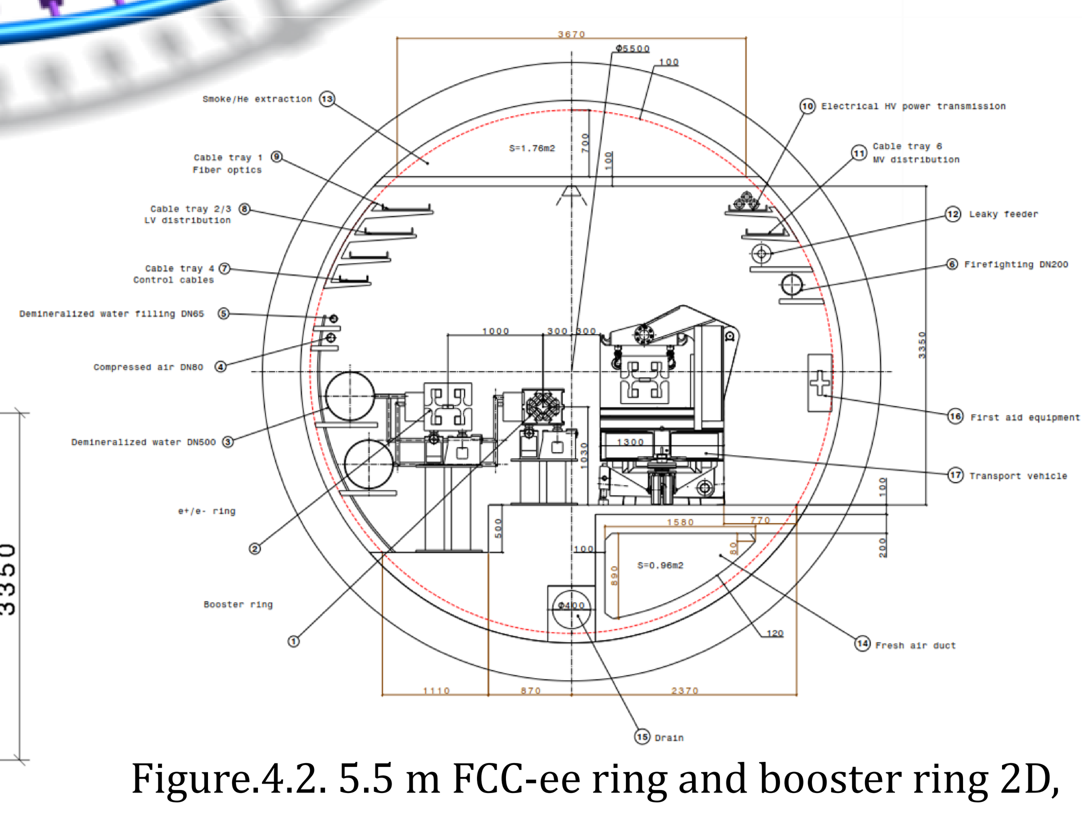


Figure.4.2. 5.5 m FCC-ee ring and booster ring 2D, dimensions, explanations