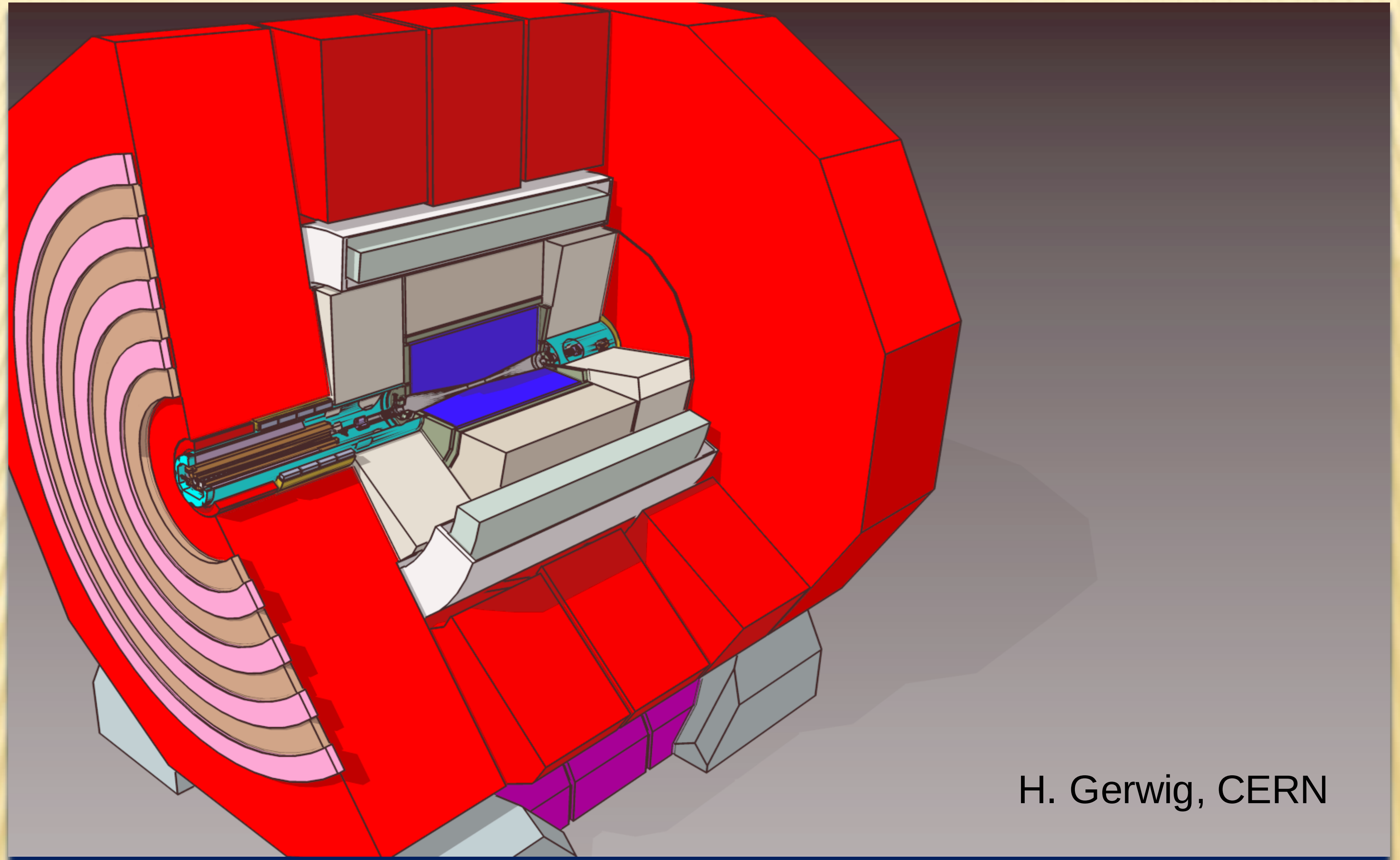
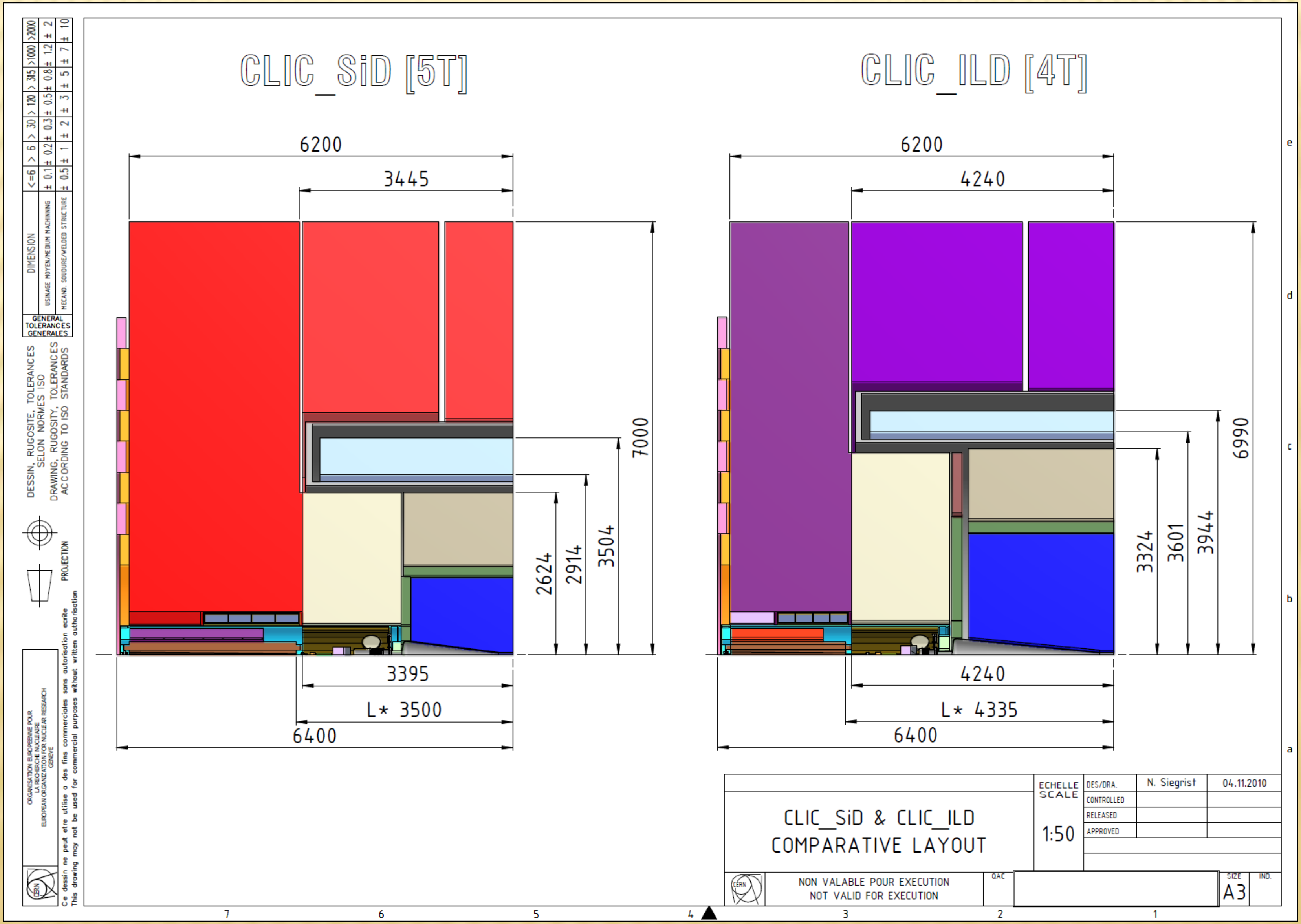


MAGNET SYSTEM AND DETECTOR MOVEMENTS

CLIC DETECTOR GENESIS

- Starting from the ILC detectors
- Adapting to CLIC requirements
- Main Engineering Design drivers are:
  - L* (3.5 m)
  - Nano-stabilisation of final quadrupole (0.15 nm @ 4Hz)
  - Tracking & Calorimeter
  - Magnetic field

THE TWO CLIC DETECTORS IN COMPARISON



COIL PARAMETERS

	Nominal magnetic field (T)	Free bore (mm)	Magnetic length (mm)	Cold mass weight (tons)
CLIC_SiD	5.0	5480	6230	170
CLIC_ILD	4.0	6850	7890	210

CLIC_SiD magnet parameters:

Nominal magnetic field at the IP	5.0	T
Peak magnetic field on the conductor	5.8	T
Free bore diameter	5.5	m
Magnetic length	6.2	m
Ampere.turns	34	MA.turns
Operating current	18	kA
Stored magnetic energy	2.3	GJ
Energy/Mass ratio	14	kJ/kg
Inductance	14	H

Conductor total length: 38 km

For details about transient behavior of the coil after a quench ->LCD Note 2011-007, B. Curé

COIL & CONDUCTOR

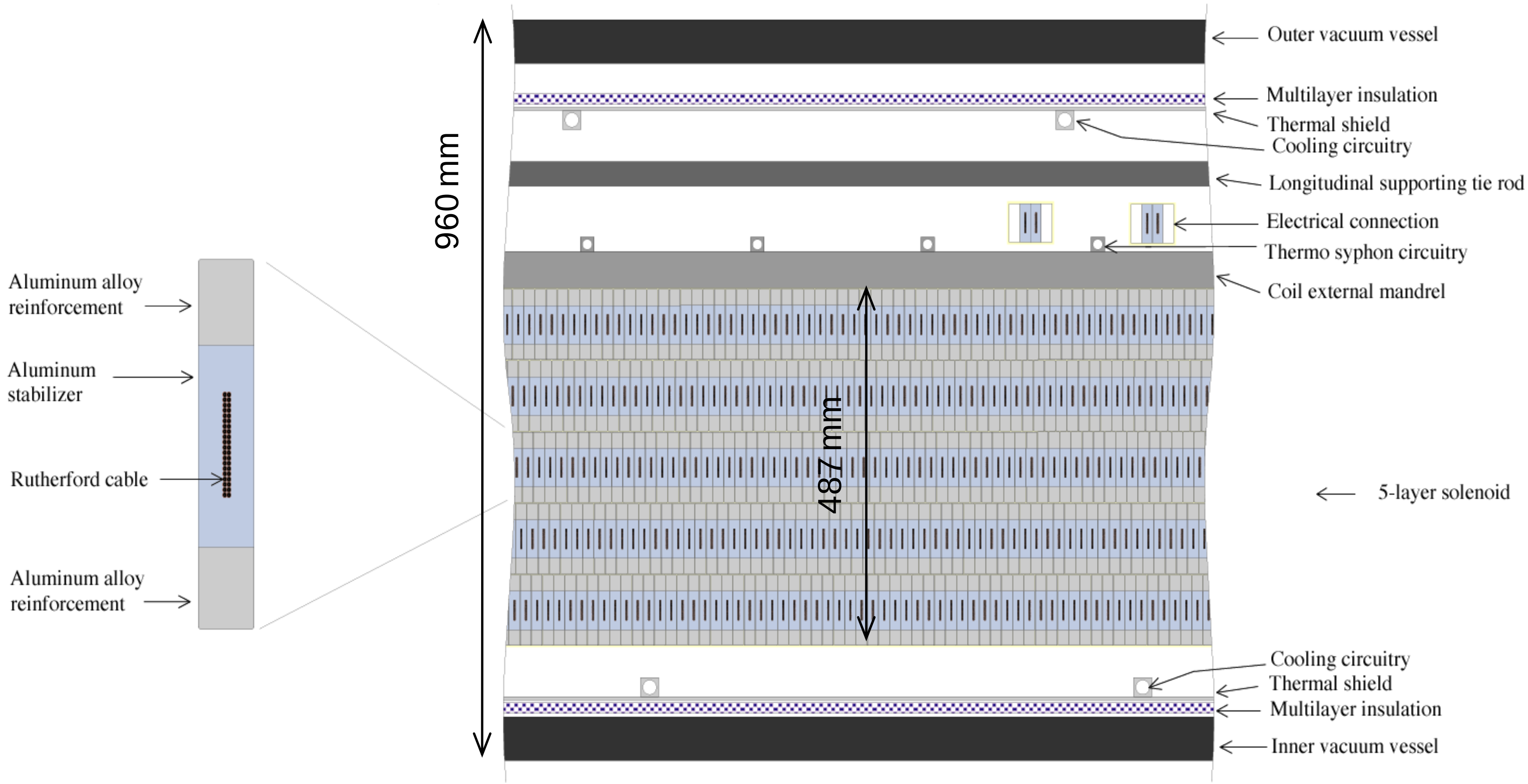
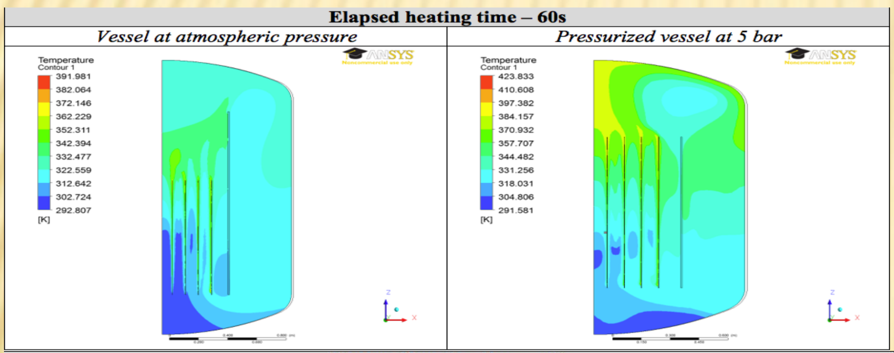
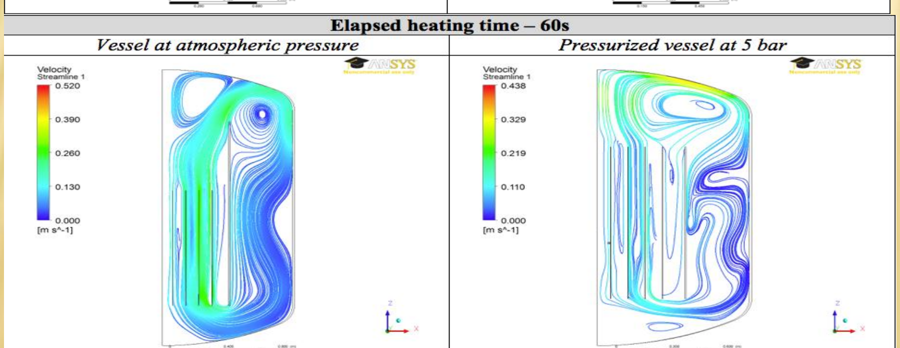


Fig. 7.2. Cross section of the solenoid conductor and cut through the coil assembly

COMPACT WATER-COOLED DUMP RESISTOR

- Total stored magnetic energy ≈ 2.50 GJ
- Energy extracted by dumping system ≈ 1.25 GJ
- Solenoid reference current (I) ≈ 20 kA
- Solenoid inductance $L = 2E/I^2$ ≈12.5 H
- Dump resistance (R) ≈ 30 mΩ
- Discharge volt. (wrt ground) ≈ ±300 V
- Peak discharge power ($P_{peak}=I^2R$) ≈ 12 MW
- Discharge time constant (t=L/R) ≈ 416 s





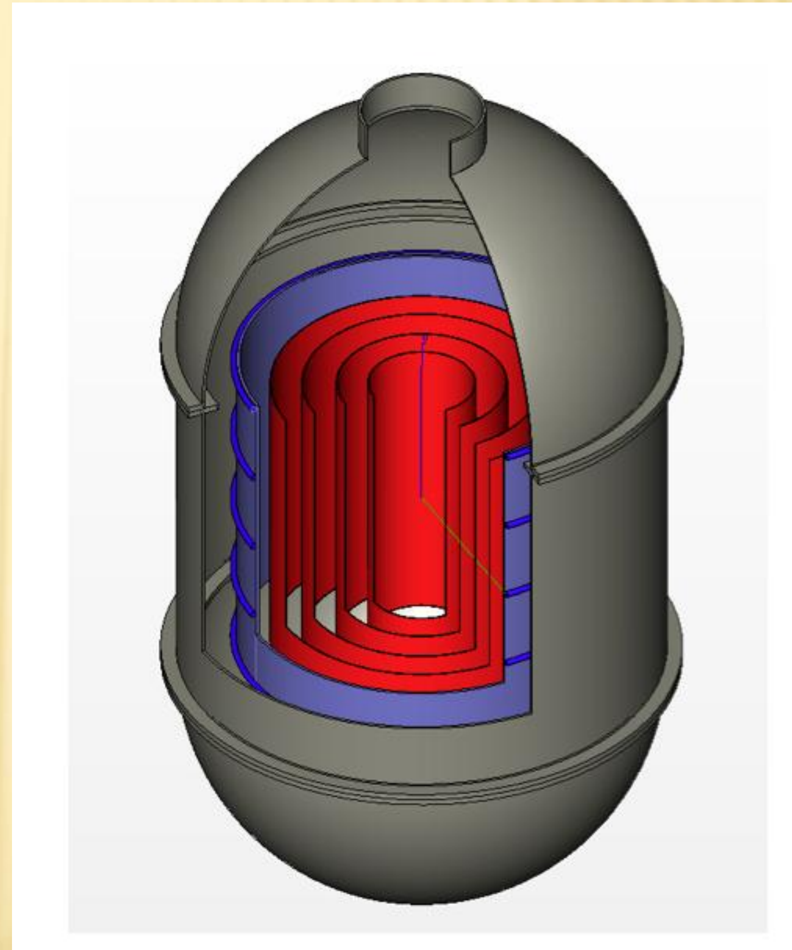
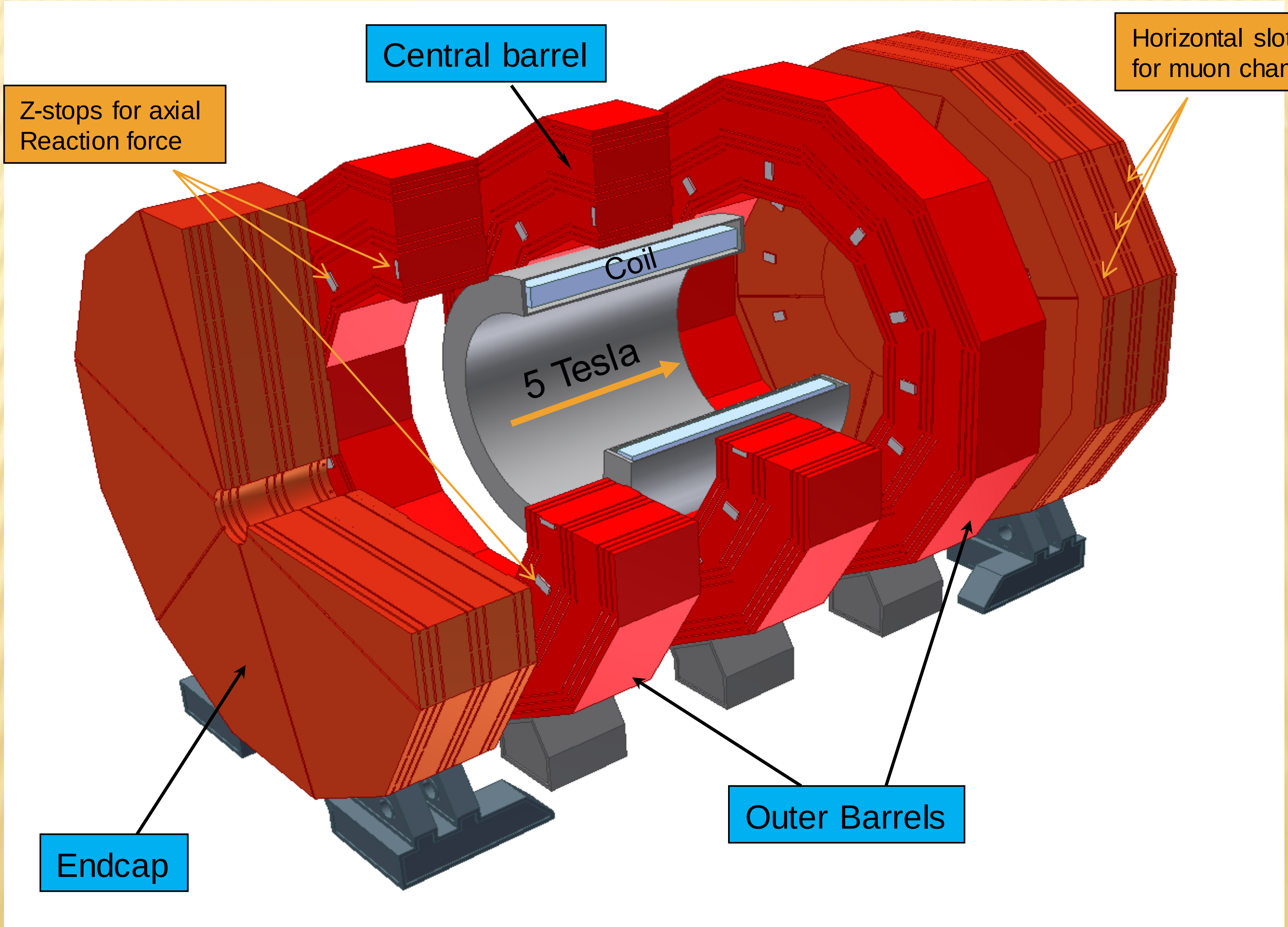
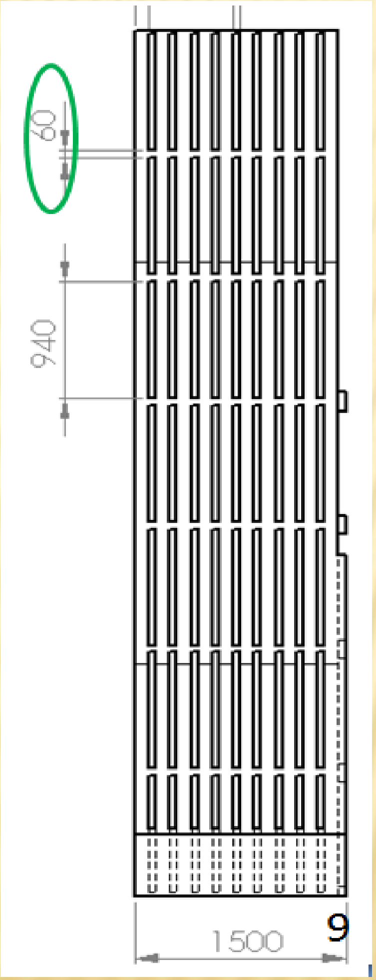


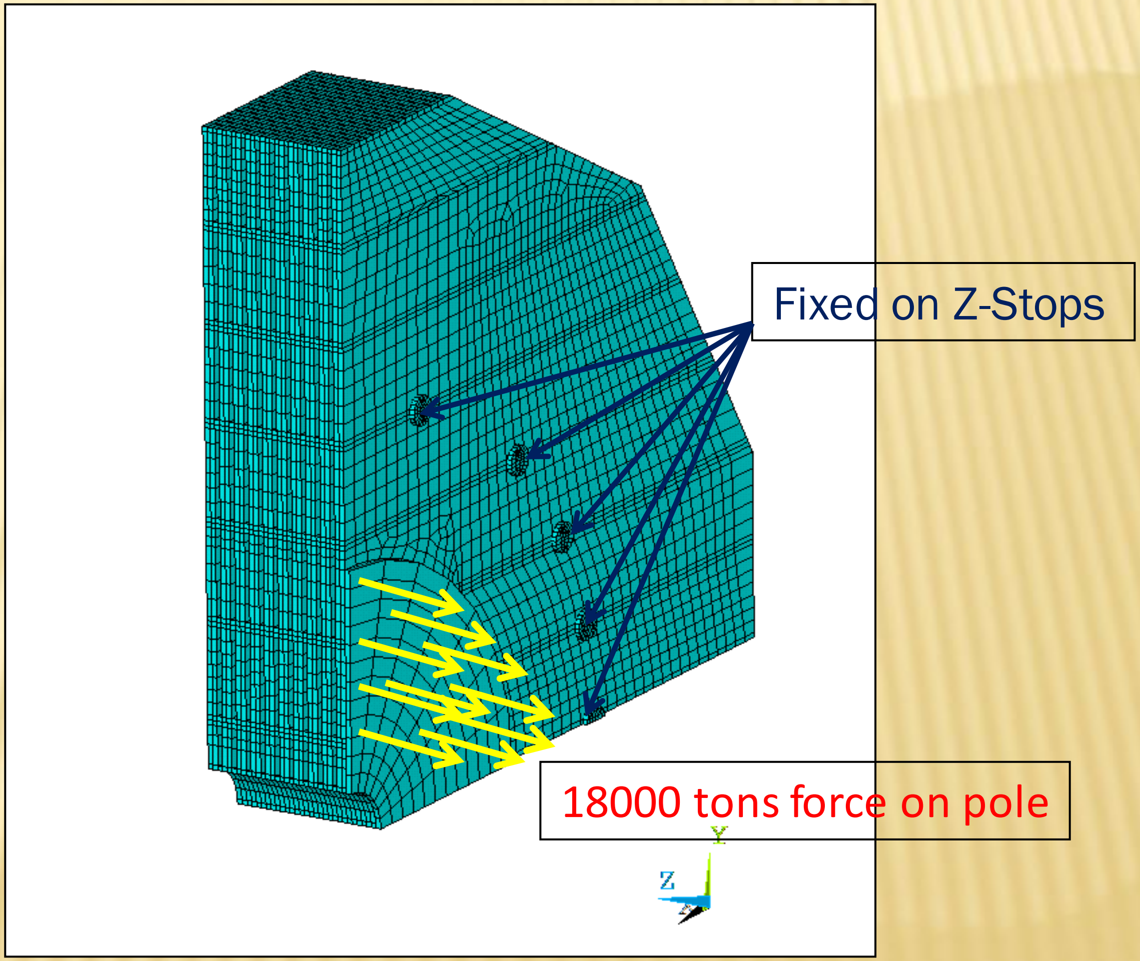
Fig. 7.5. Compact dump resistor for quench protection

MAGNET = COLD MASS + RETURN YOKE

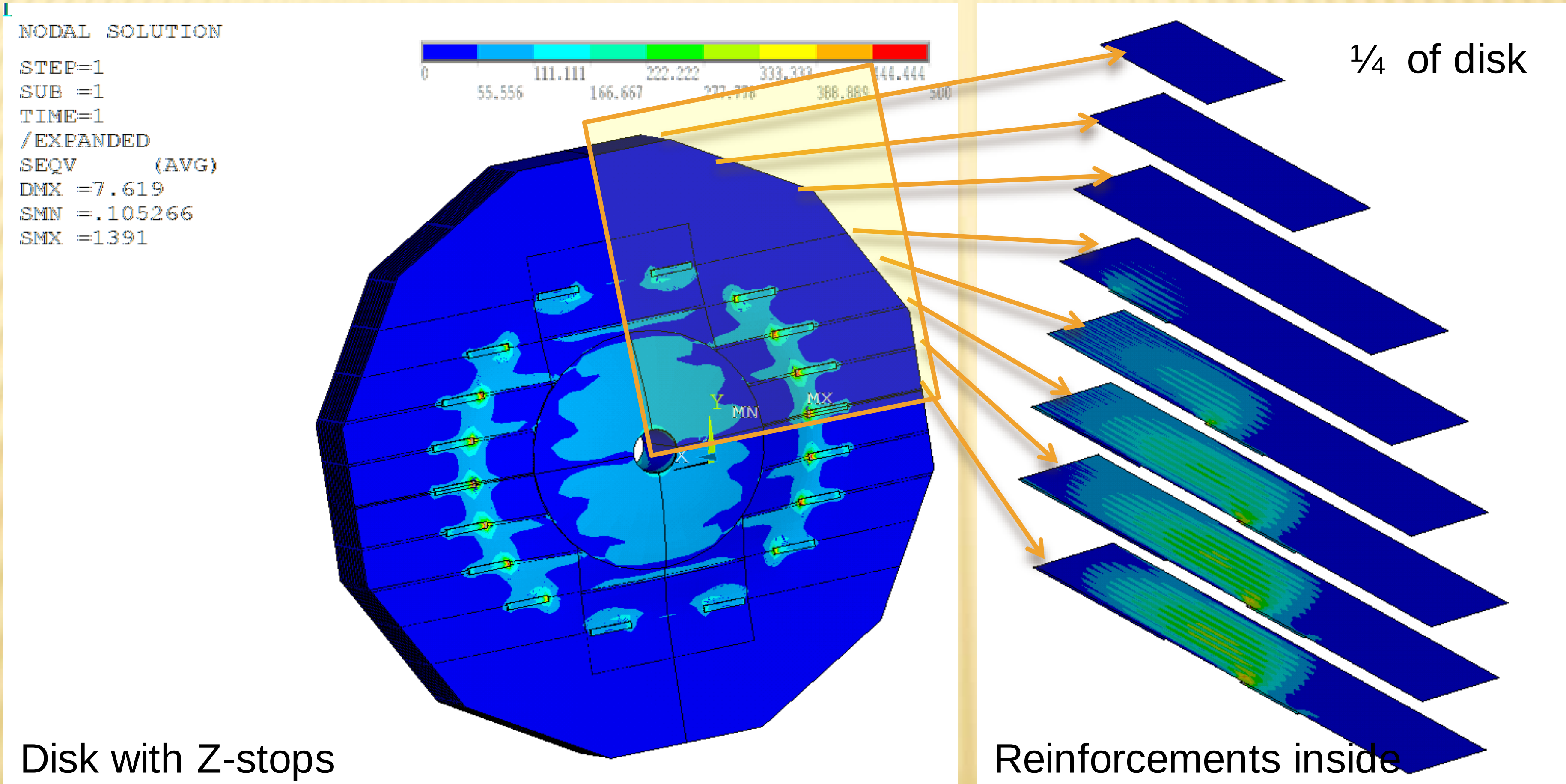


ENDCAP STUDIES





DEFORMATION AND STRESS



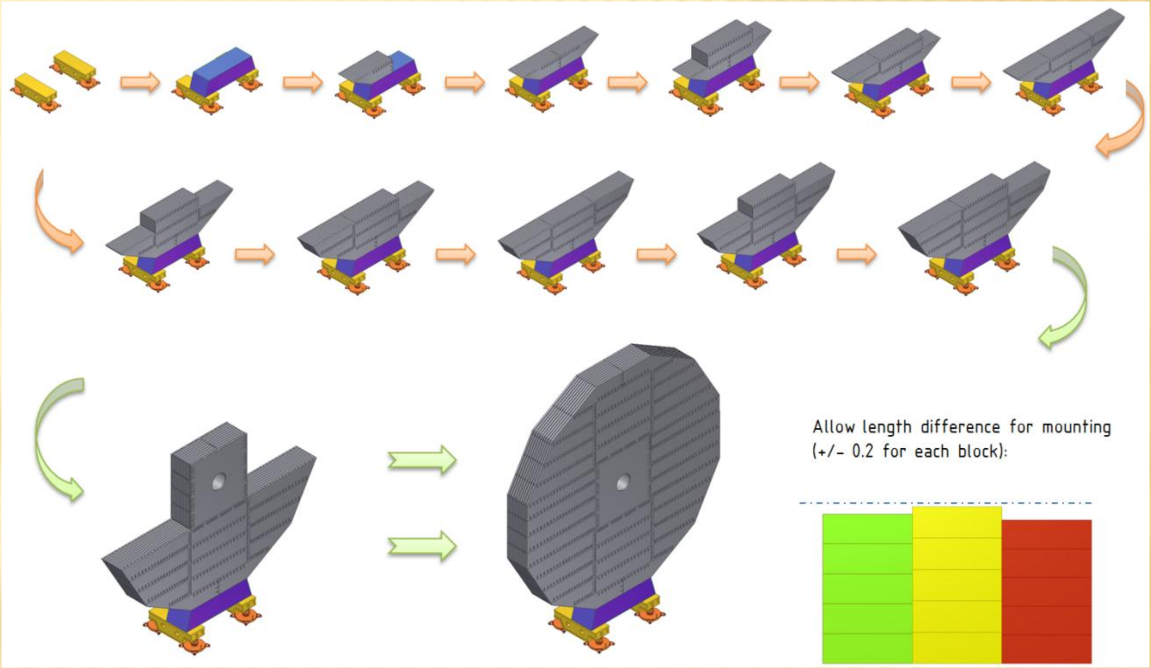
Disk with Z-stops

Reinforcements inside

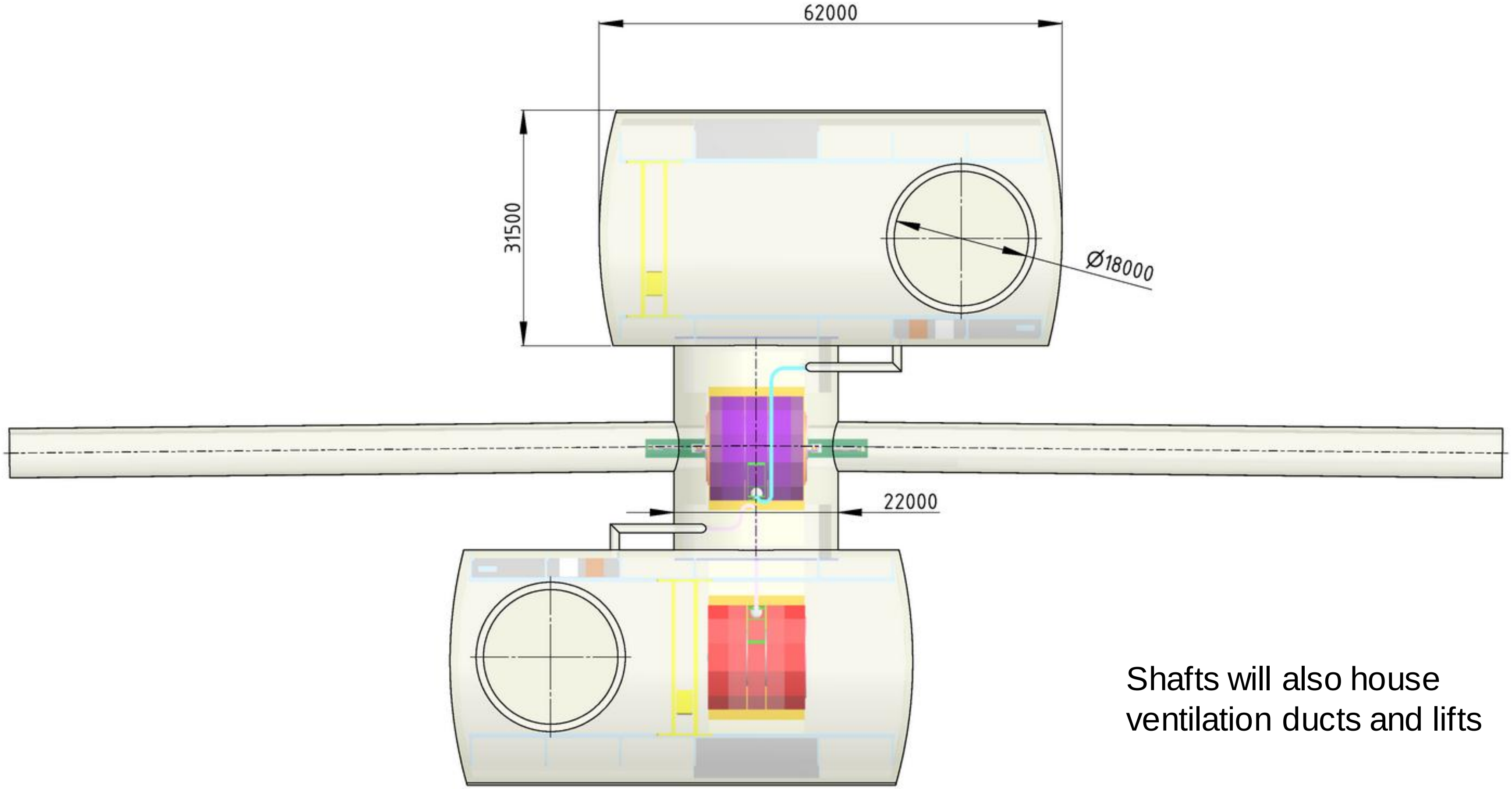
Stresses below 280 MPa – Deformation 7.6 mm

ASSEMBLY TECHNIQUE – HIGH SEGMENTATION

Sub-divide in road transportable units below 40 tonnes,
Avoiding special transport to a maximum, except for central piece



CAVERN LAYOUT – TOP VIEW



Shafts will also house ventilation ducts and lifts

Fig. 11.11: Top View with dimensions

CAVERN – FRONT VIEW

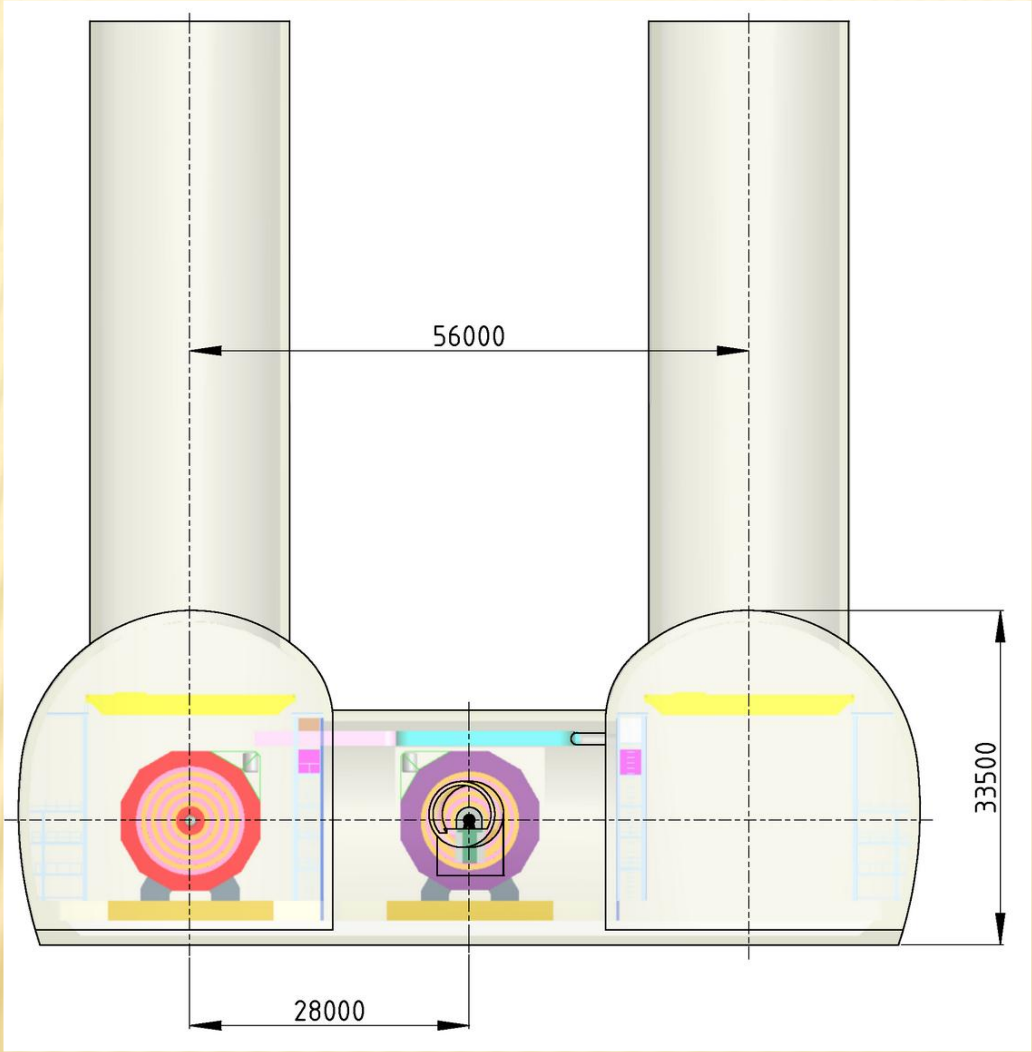
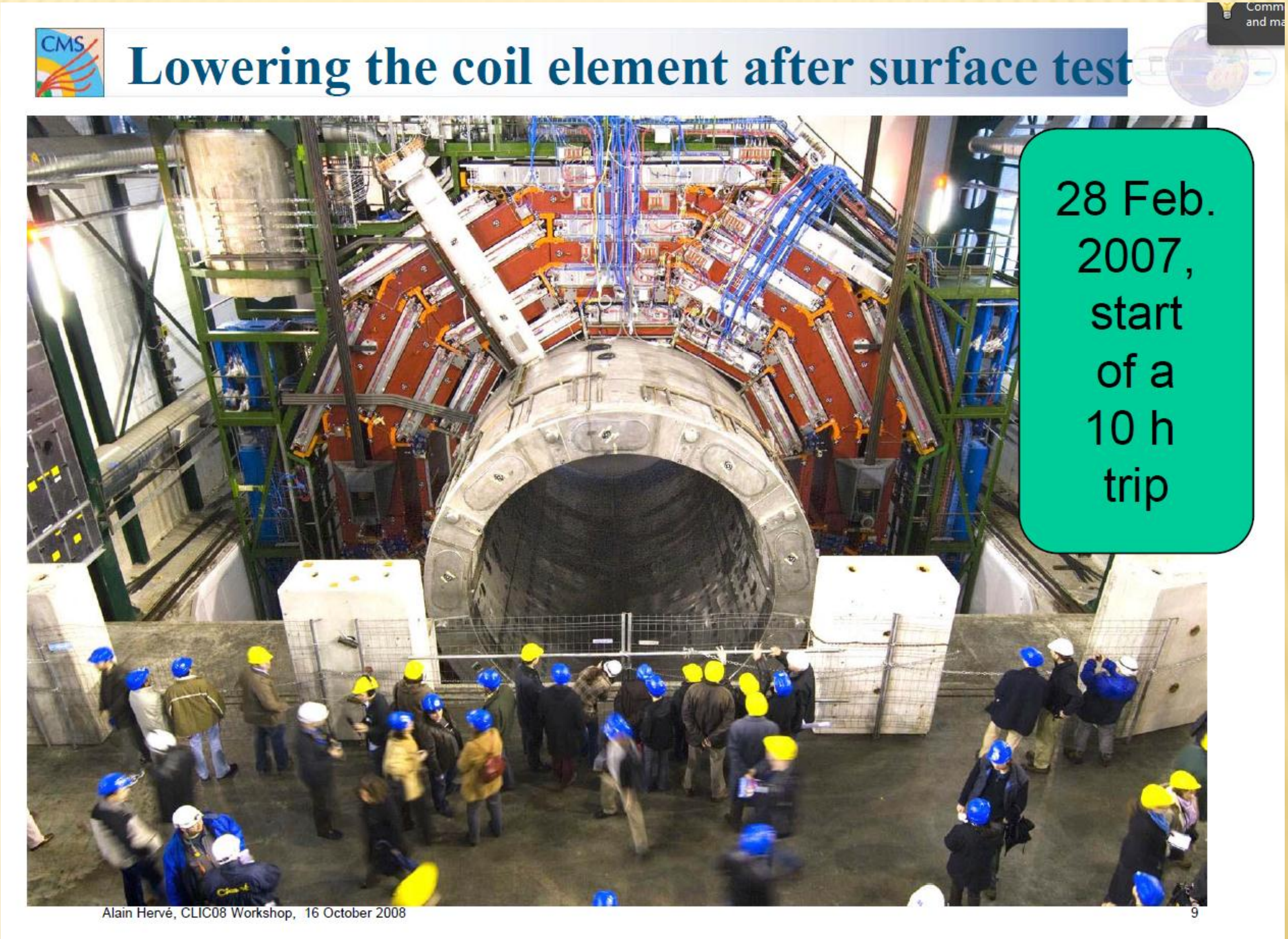


Fig. 11.12

SURFACE ASSEMBLY - TESTING - LOWERING



DETECTOR ON IP – BETWEEN 2 VERTICAL WALLS

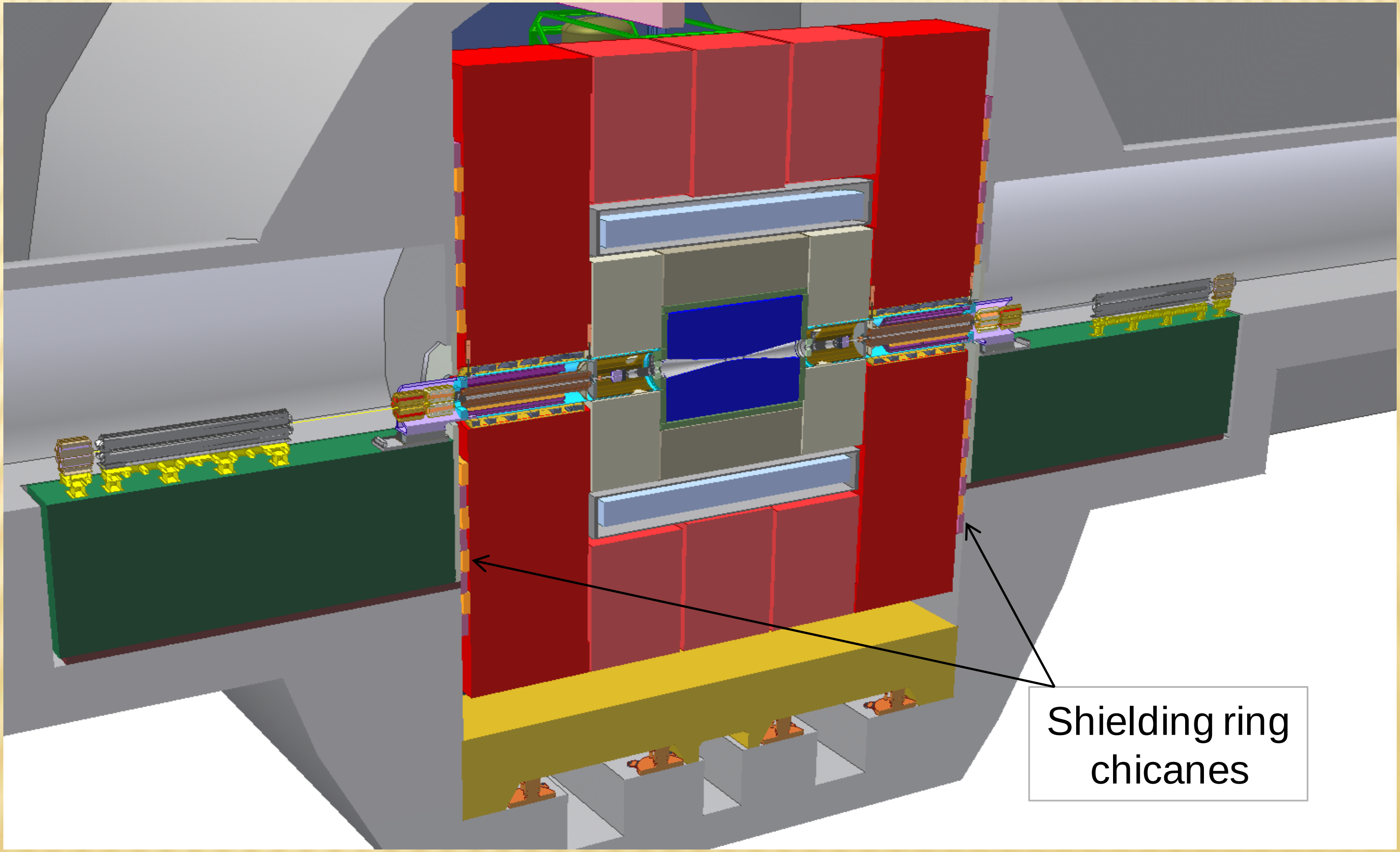


Fig. 11.9: vertical cut through the experiment

RING CHICANE SHIELDING TECHNIQUE

3-D View

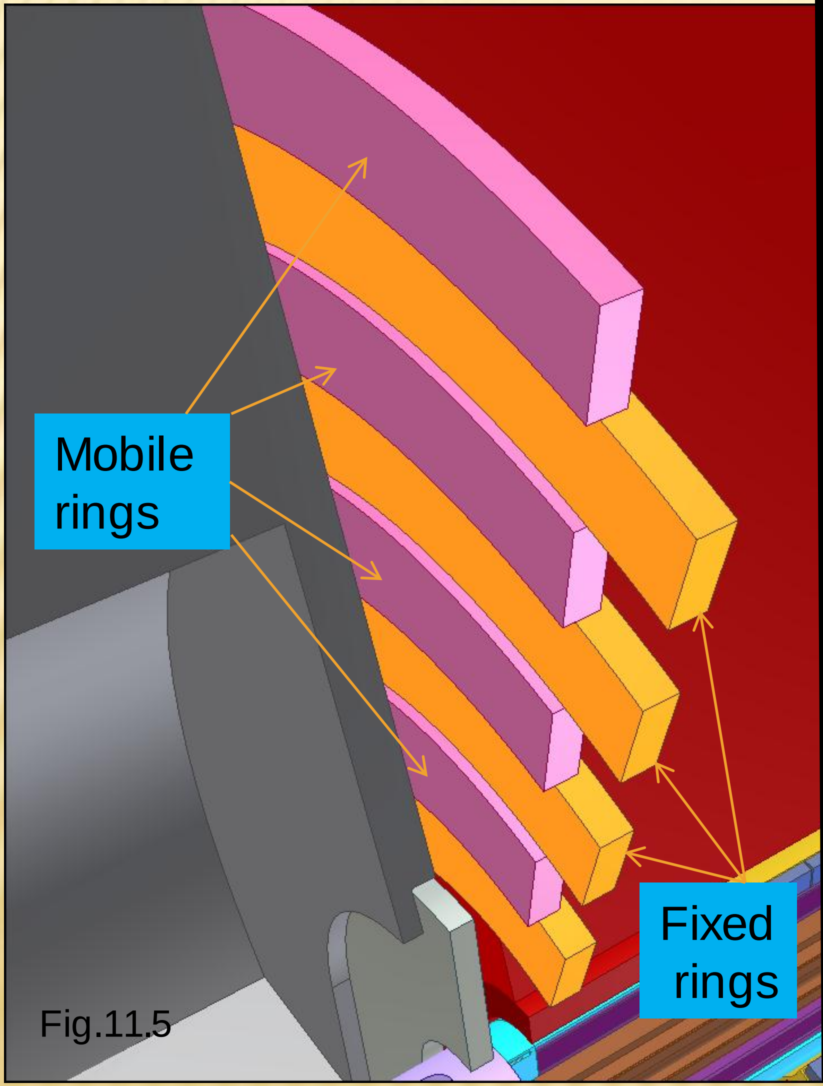
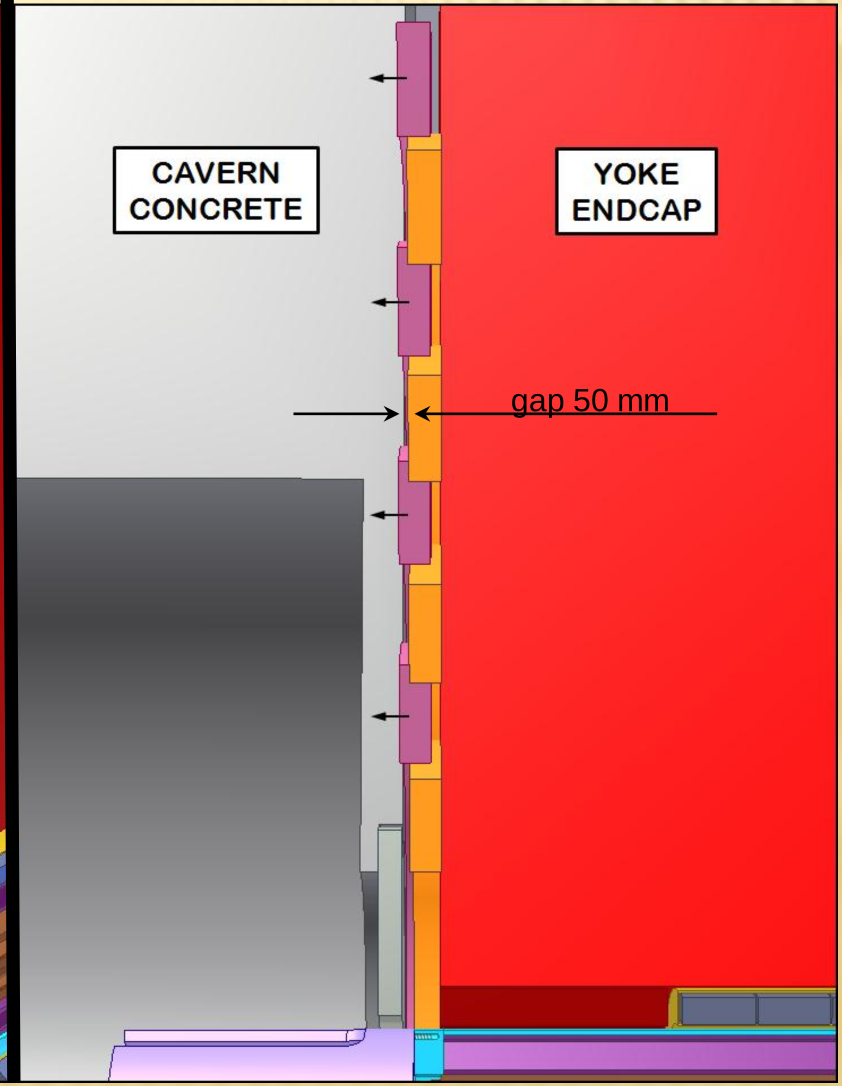
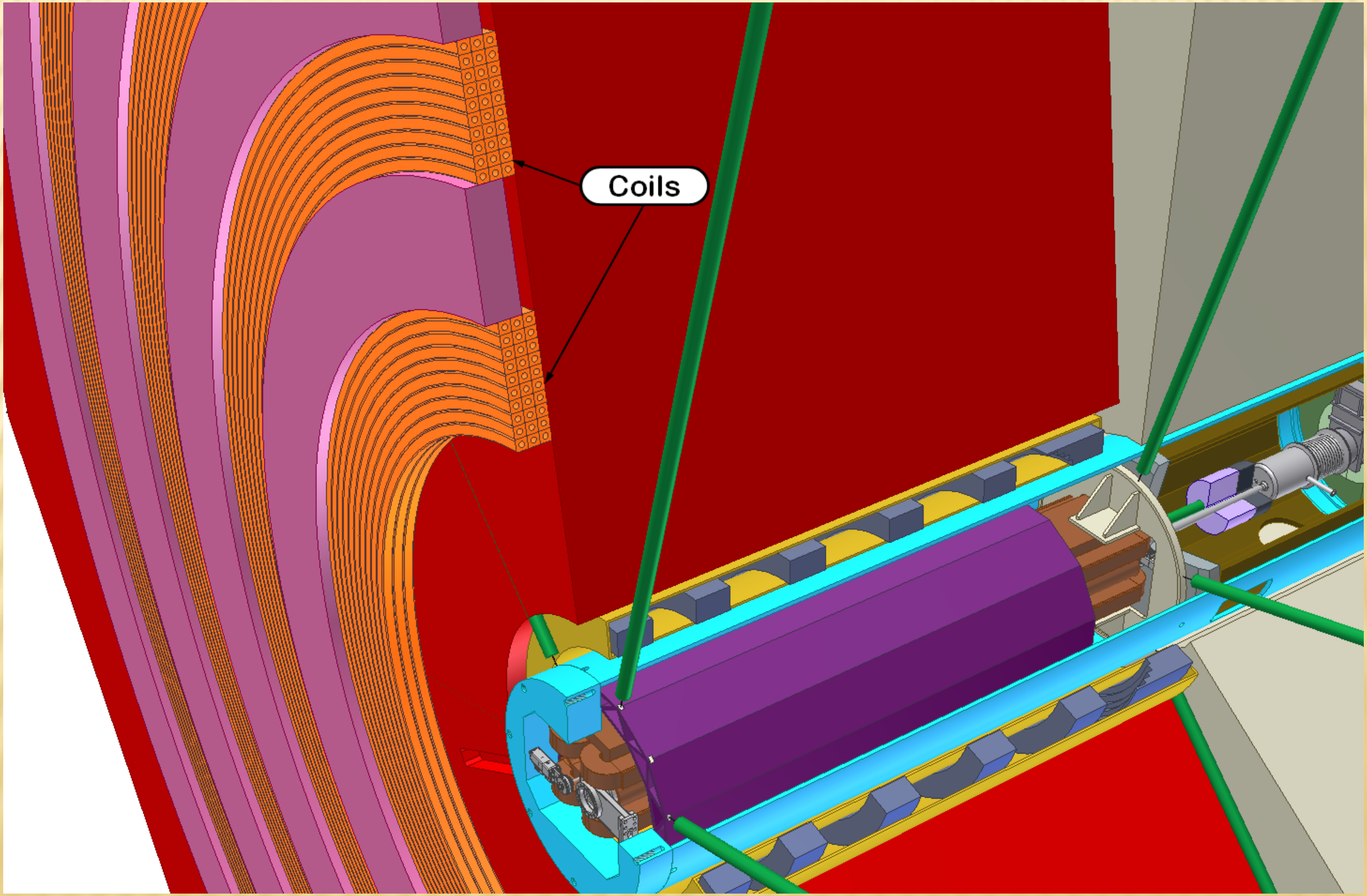


Fig.11.5

Side View



CLIC_ILD: RING CHICANE AND COILS



VACUUM SECTORISATION

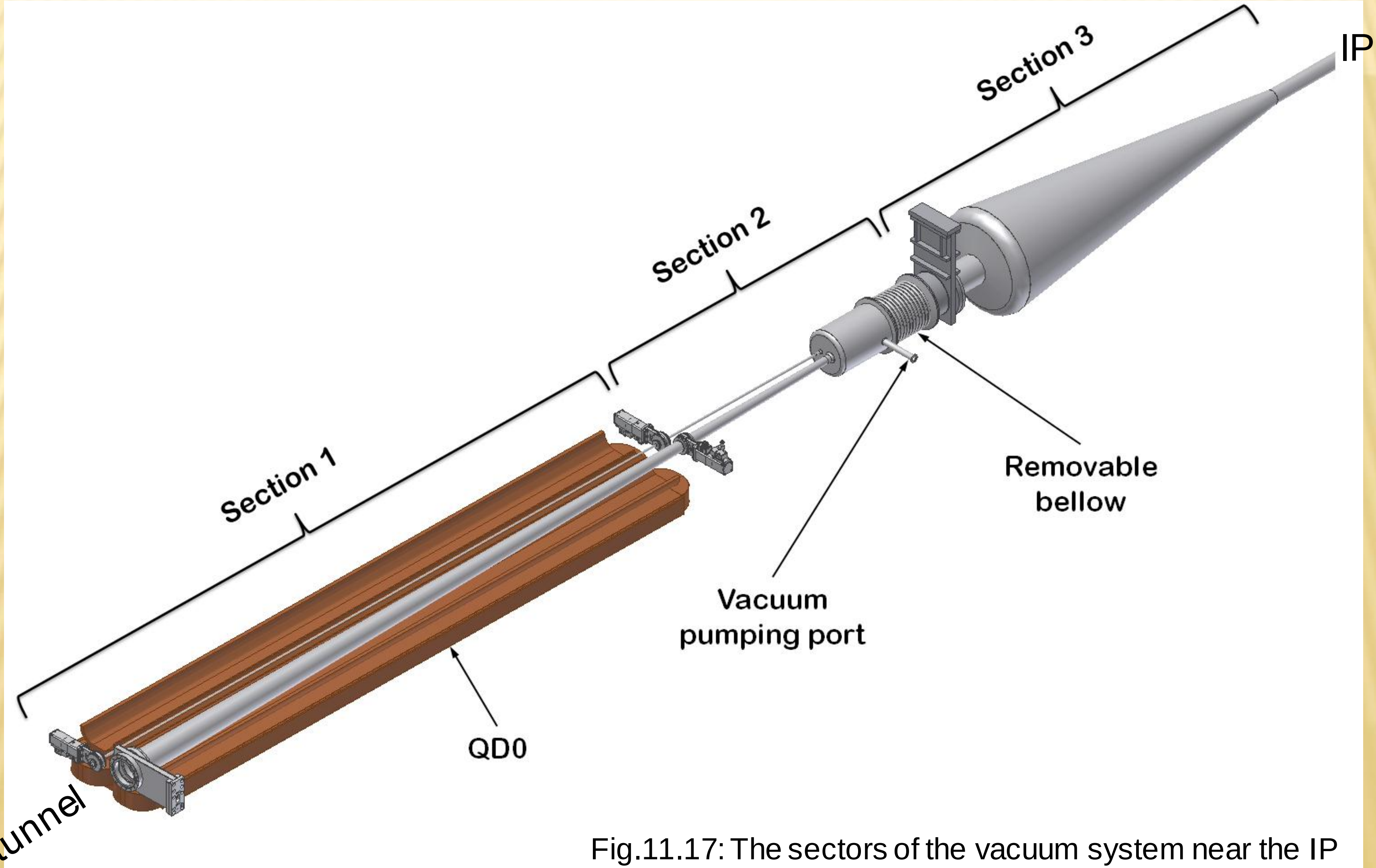
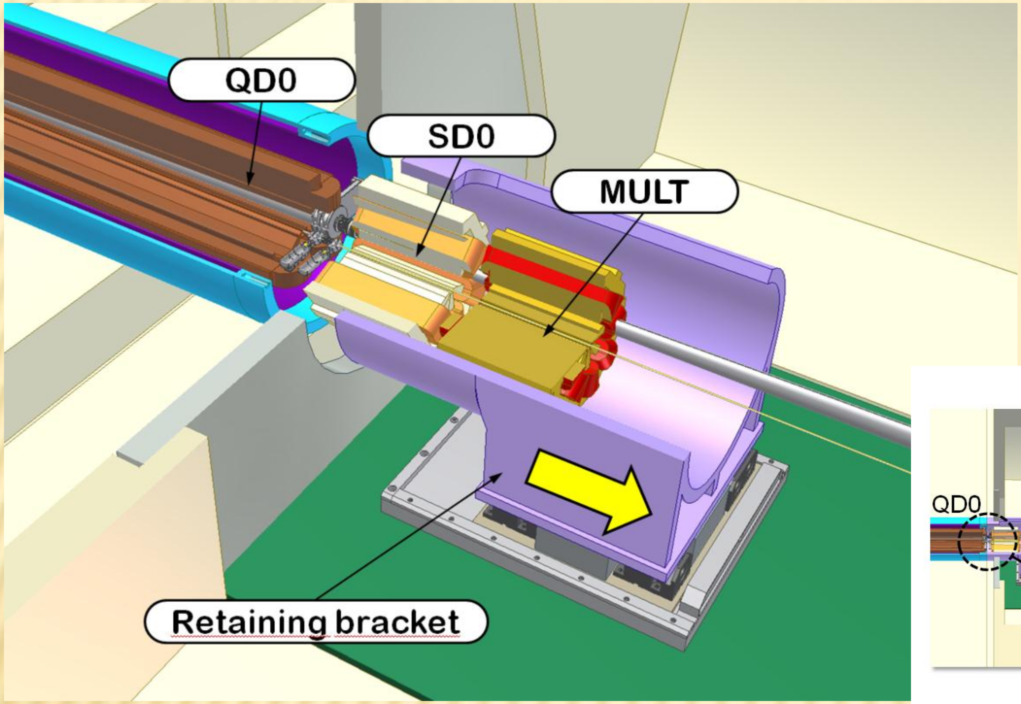
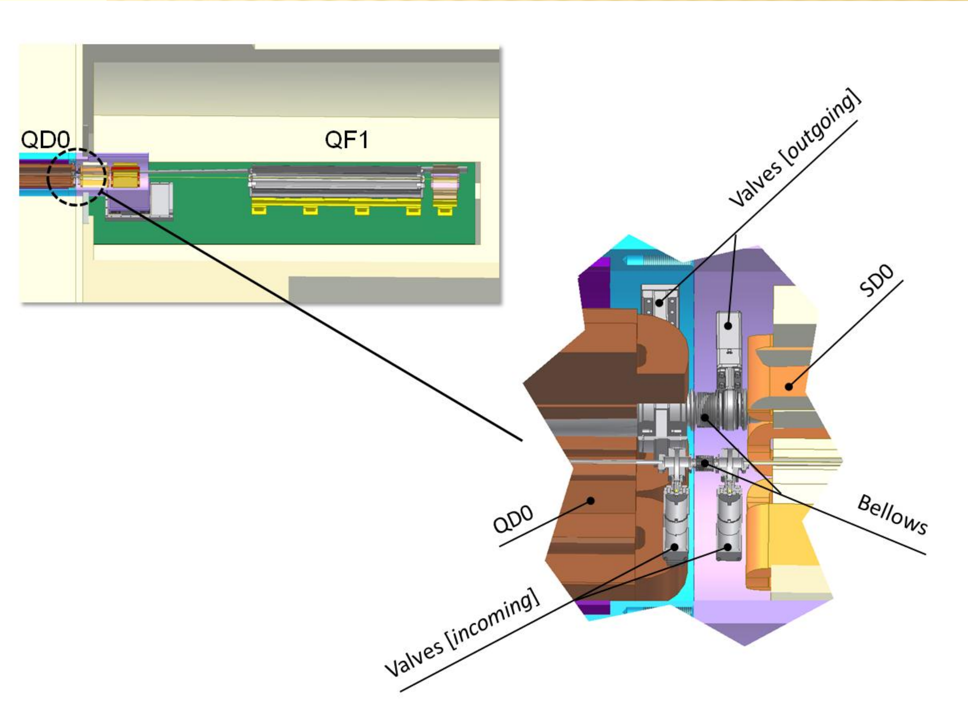


Fig.11.17: The sectors of the vacuum system near the IP

DISCONNECTION FROM BEAM





SEQUENCE:

- QD0 support tube is held by jacks in the end-cap
- SD0 and MULT hold by special tool
- Retaining bracket is unbolted and pushed back
- Access to bellows is free
- Taking out bellows
- Free to move to garage position

MAGNET SERVICES FLEXIBLE LINES

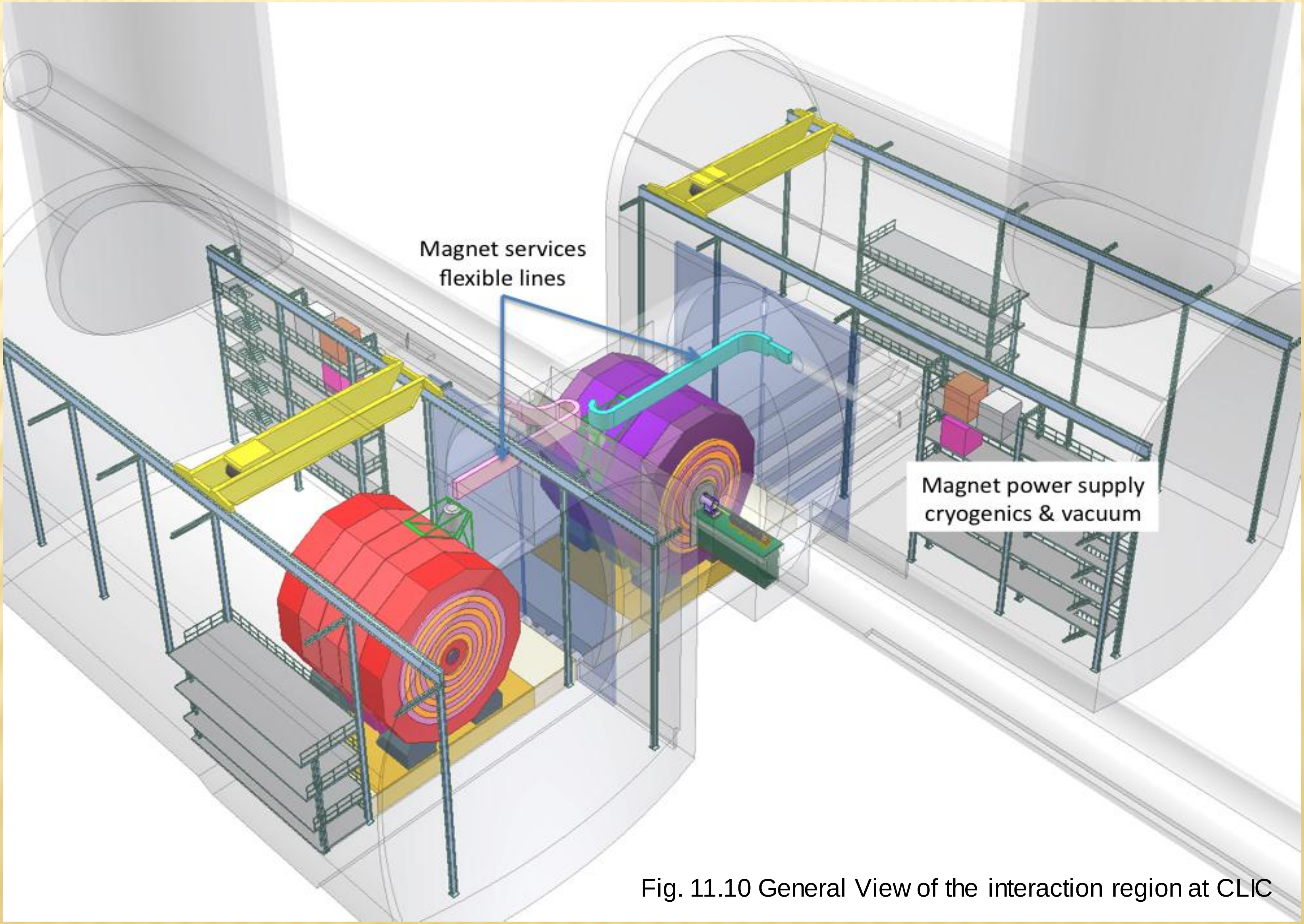
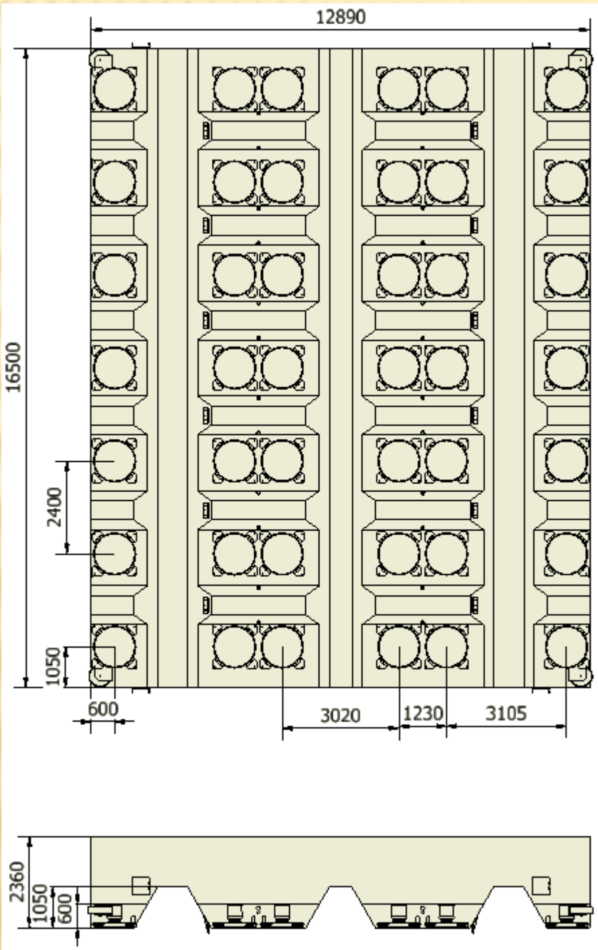


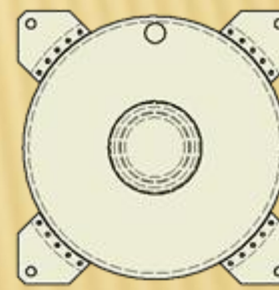
Fig. 11.10 General View of the interaction region at CLIC

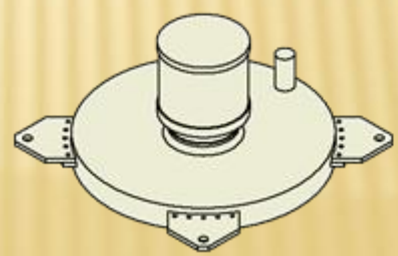
MOVING PLATFORM



Same type of platform for both detectors.
Weight of a detector up to 14 000 [t]

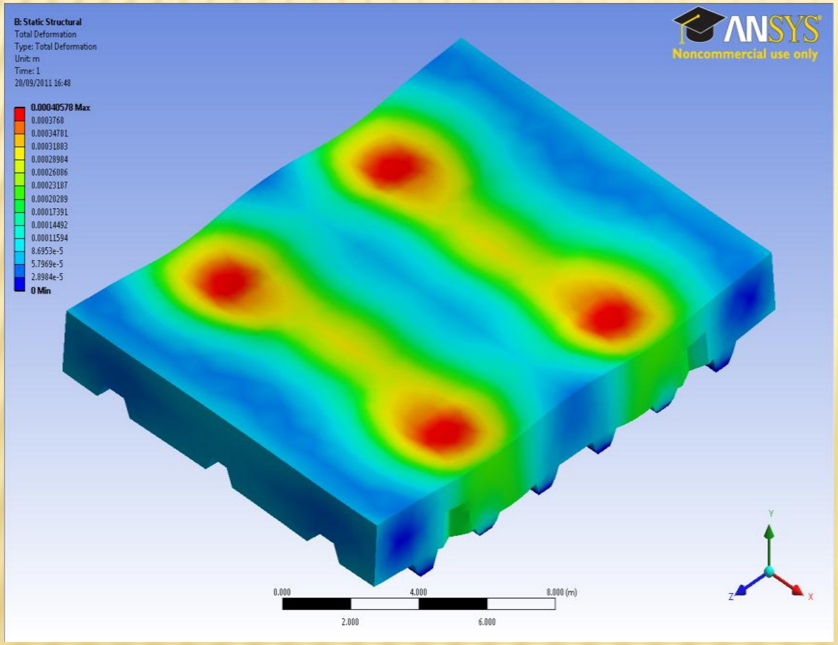
Possible weight of platform + detector: 16 000[t]
1 Airpad weight capacity: 400[t]
Number of airpads: 40

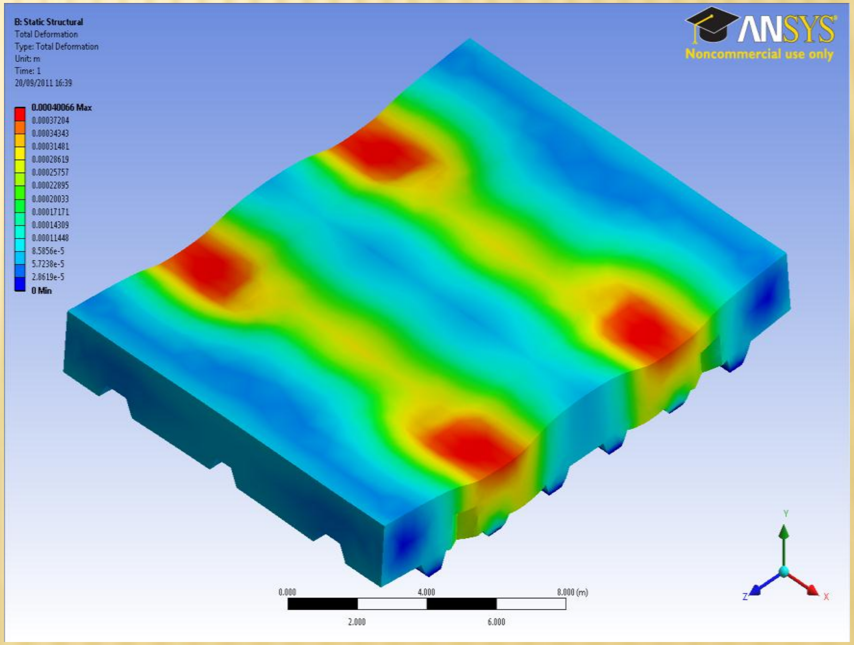




DEFORMATION

- Detector closed
- Opening started

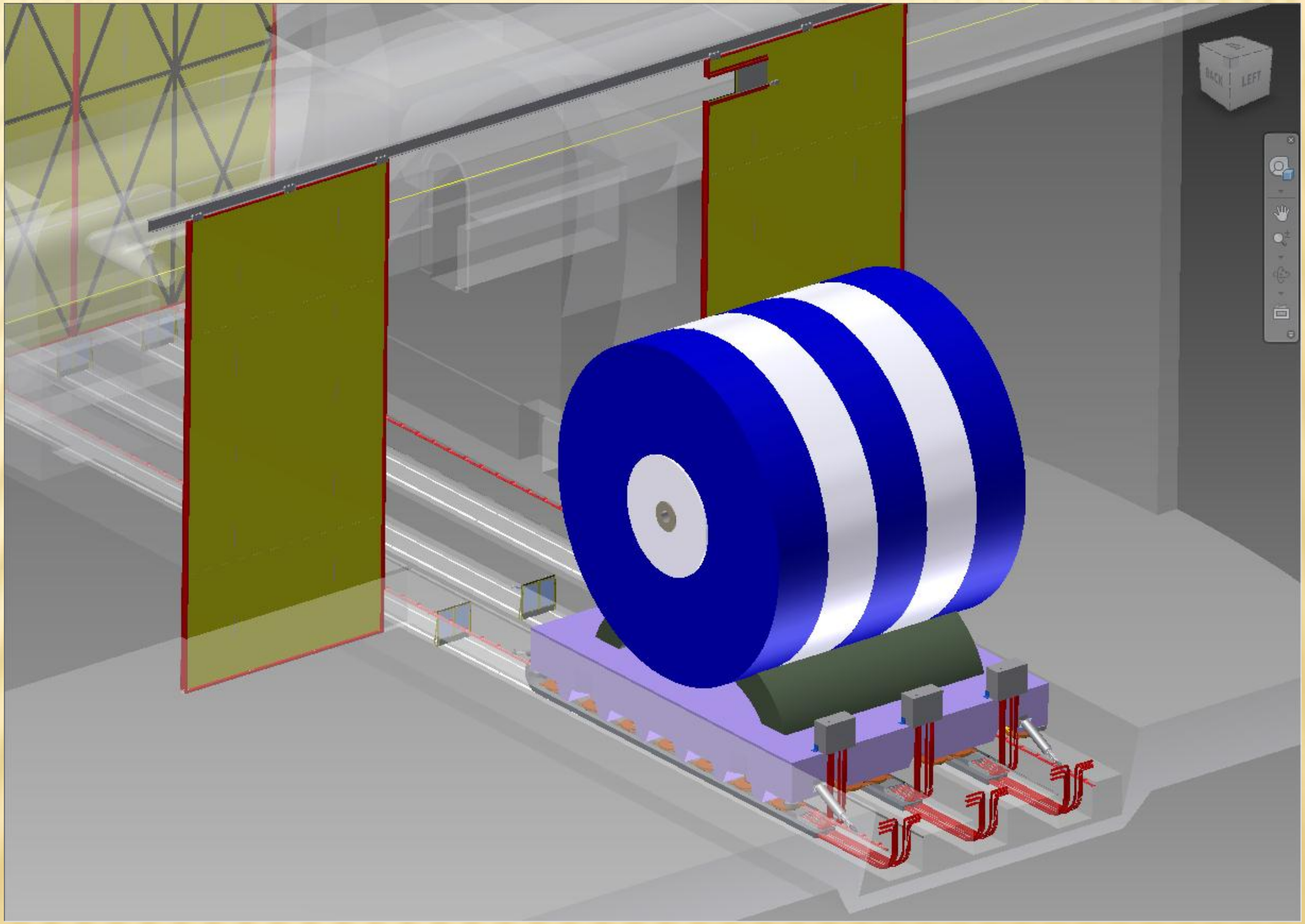




- Deformation in both cases 0.4 [mm]

EXPERIENCE WITH CMS PLUG – 2.2 M THICK

CAVERN DOORS AND SERVICES

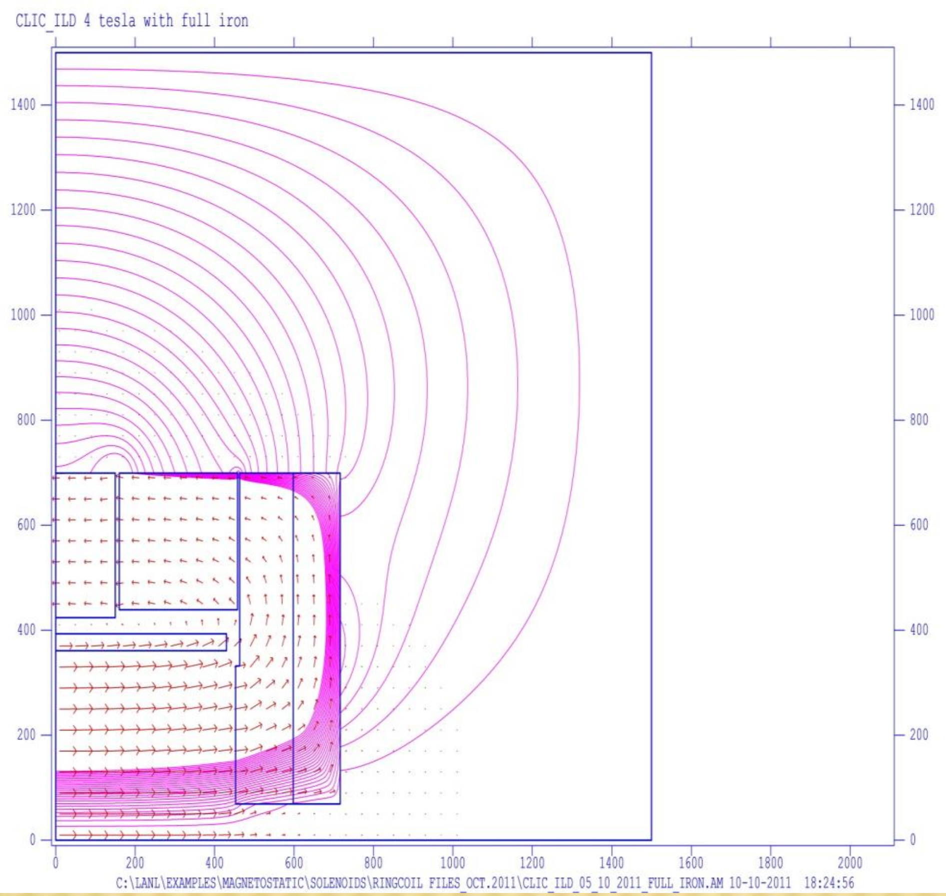


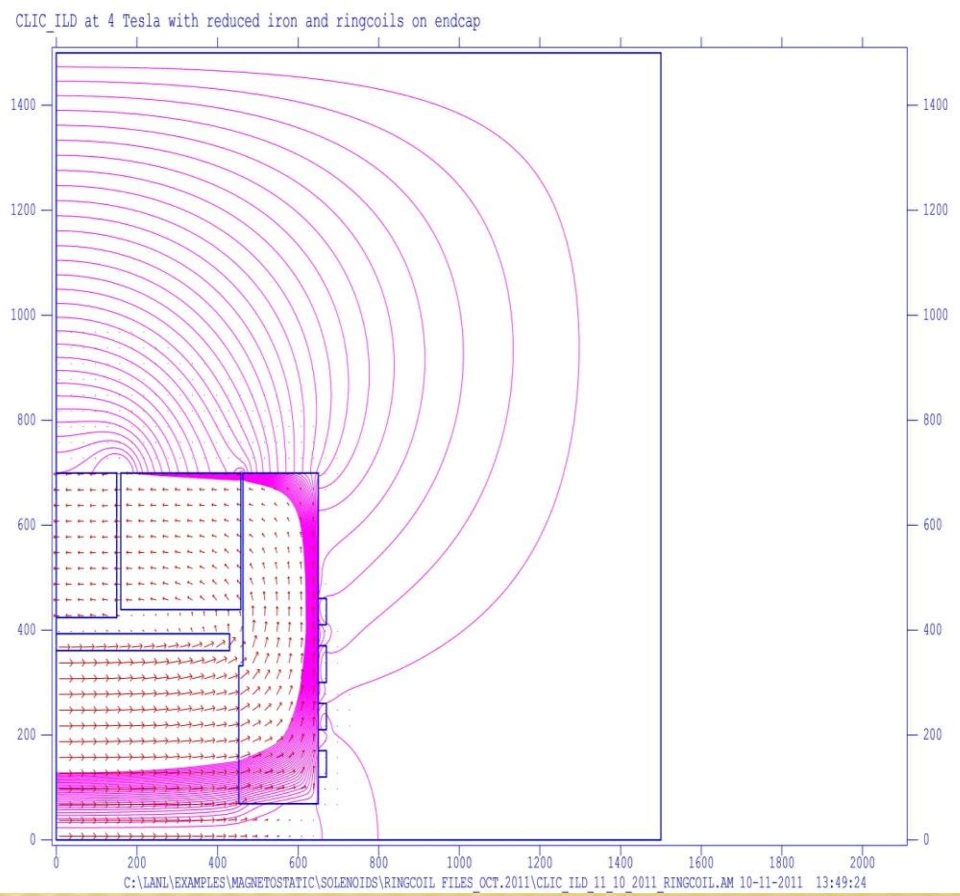
SUMMARY

- Two CLIC detectors in push-pull mode
- The studies show that the challenges in terms of detector movement, high magnetic field and short L* are manageable
- Services can be designed such that they follow the movement of the detector on a platform

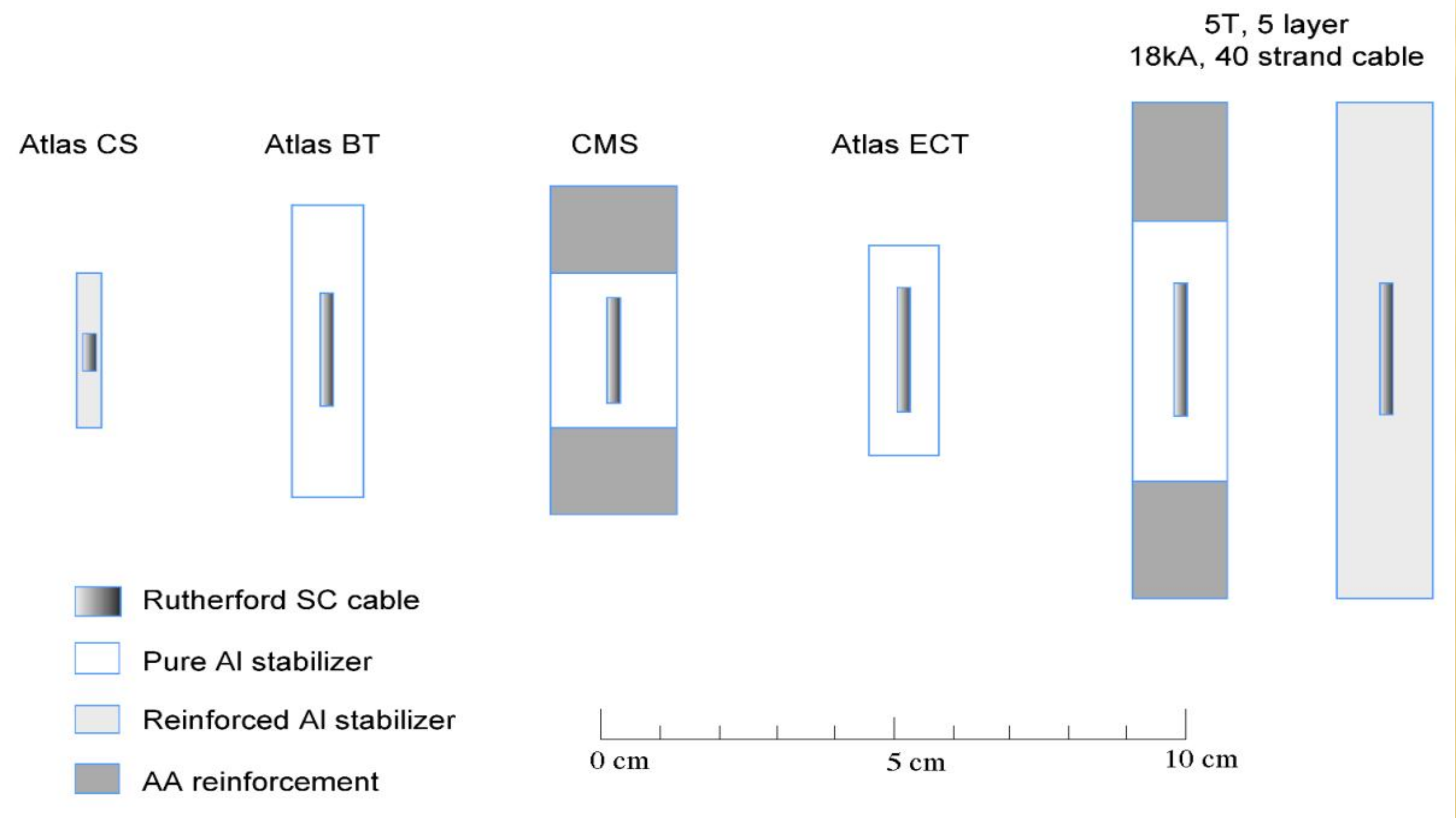
BACK-UP SLIDES

CLIC_ILD FULL IRON AND WITH RING-COILS





SUPERCONDUCTOR OPTIONS



POWERING LINES : FLEXIBLE HTS BUS-BARS

Despite the fact that during push-pull, the detector magnet is obviously off, a permanent connection of the solenoid power supply to the coil current leads would save precious time and avoid risks associated with manipulation. This line shall be able to carry 20kA in a self-field of about 0.6T, over a length of some 60m. A flexible resistive line would take too much space in the cavern and have a significant voltage drop ΔV (in addition to the power dissipated $P=\Delta V x I$).

CERN is actually developing the design of a semi-flexible, vacuum insulated, HTS (MgB_2) line for the LHC upgrade.
The characteristics of this powering line are the following:

- *Nominal current: 110kA at 20K and 0.8T*
- *Maximum current: 130kA at 20K and 0.8T*
- *Cooling: GHe, from 5 to 20K*
- *Length: 100m*
- *Vacuum envelope: Φ90mm*
- *Minimum bending radius: 1.5m*

POWERING LINES : FLEXIBLE HTS BUS-BARS

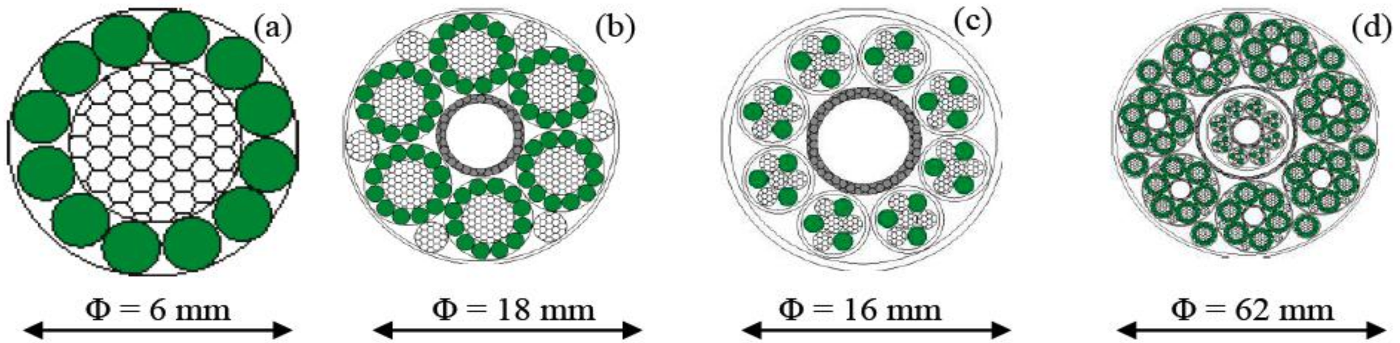


Figure 1. Layout of: 3 kA cable (a), 14 kA cable (b), group of 8 × 0.6 kA cables (c), configuration of 7 × 14 kA, 7 × 3 kA and 8 × 0.6 kA cables (d). The MgB_2 is shown solid, the copper is shown hatched.

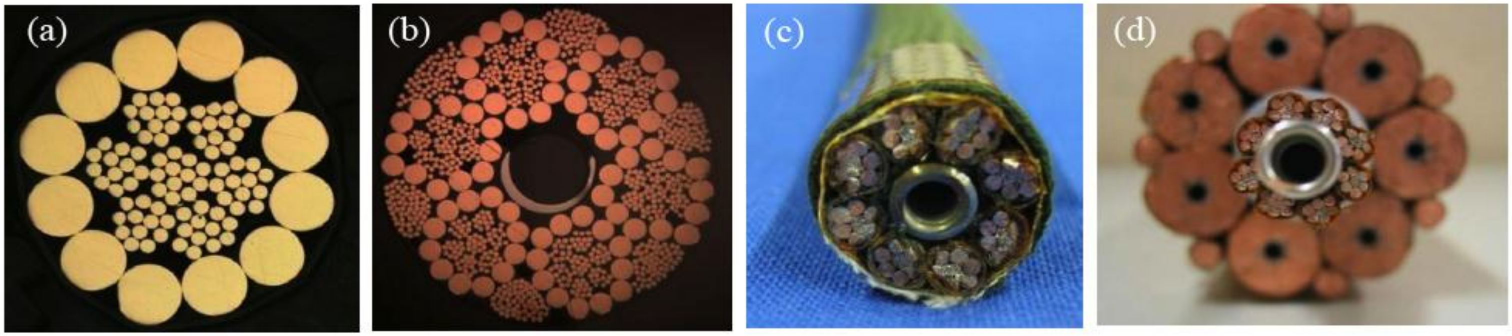
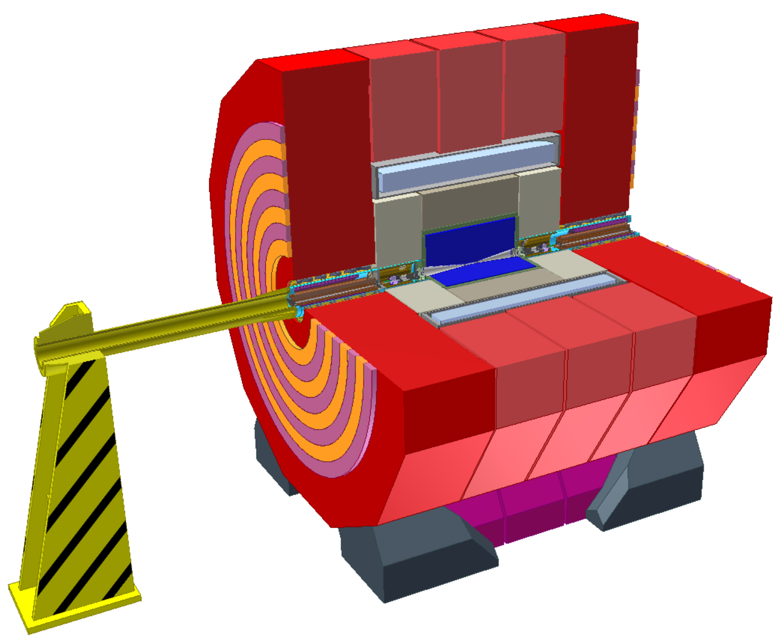
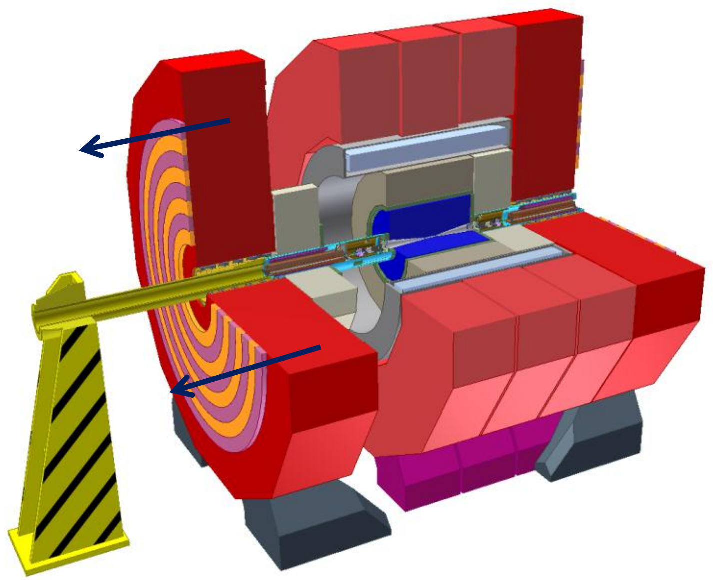


Figure 2. Mock-up of: 3 kA cable (a), 14 kA cable (b), group of 8 × 0.6 kA cables (c), configuration of 7 × 14 kA, 7 × 3 kA and 8 × 0.6 kA cables (d). The external diameter of each assembly is reported in Figure 1.

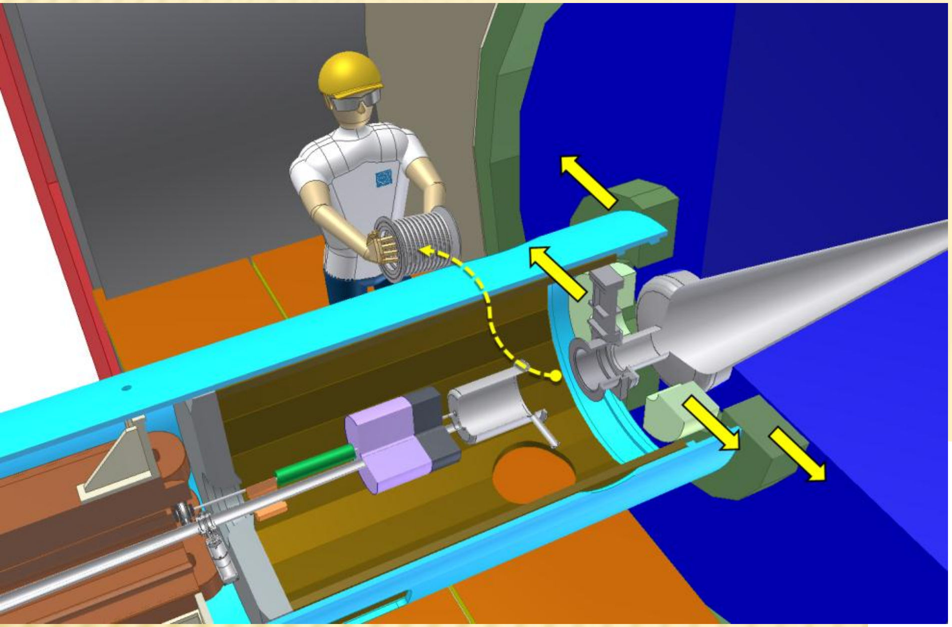
OPENING THE DETECTOR IN GARAGE POSITION

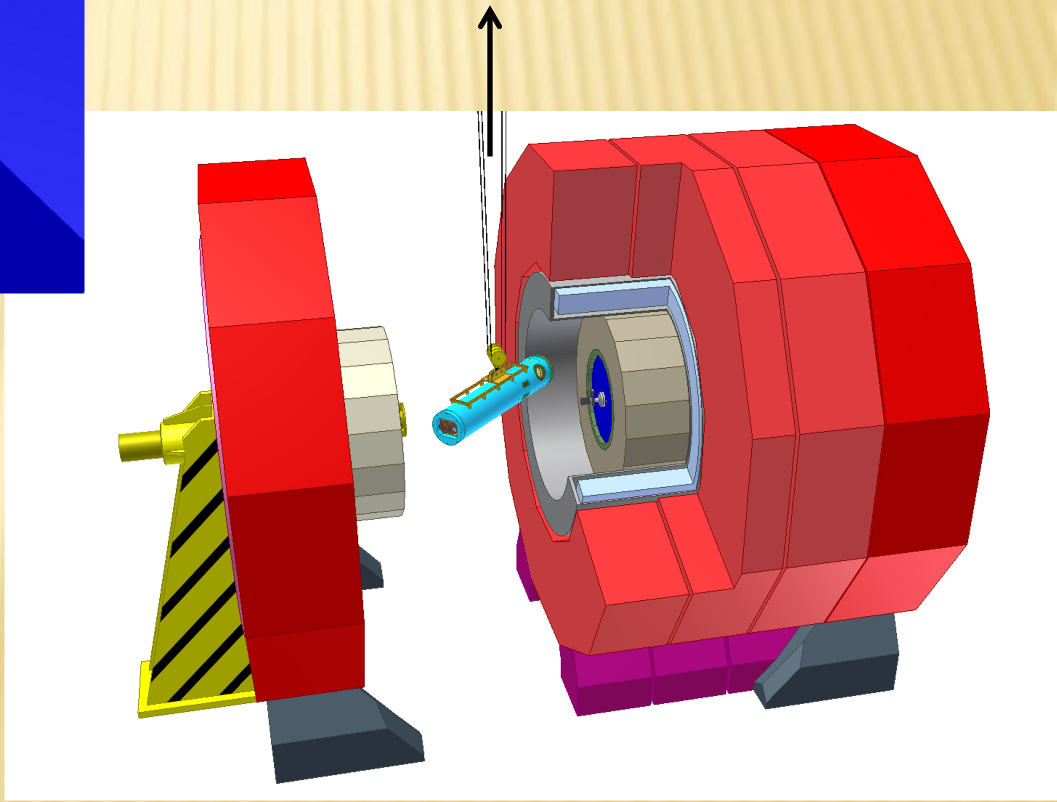


Installing extraction tool

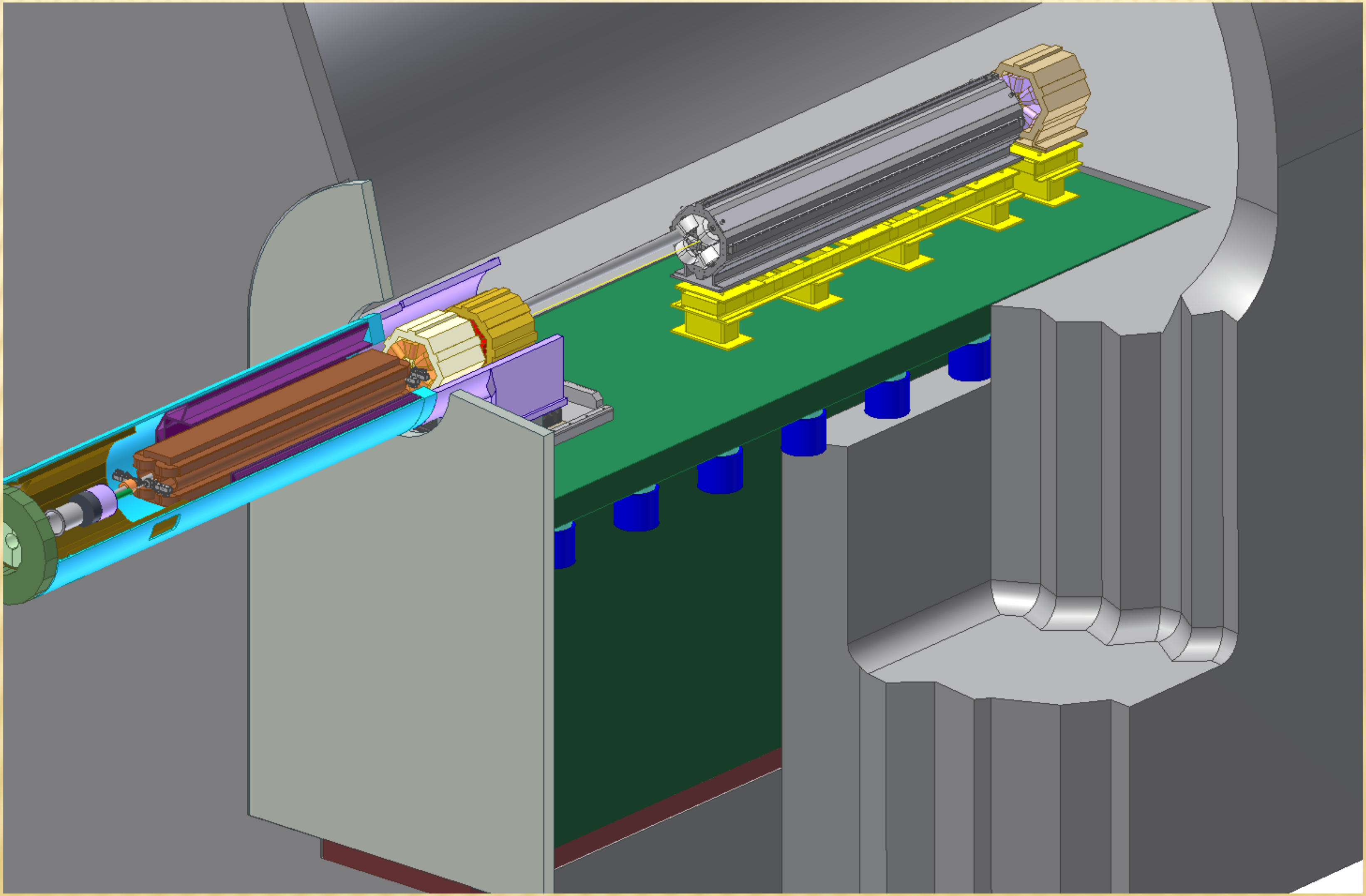


SEPARATING VERY FORWARD PART FROM INNER DETECTOR





PRE-ISOLATOR WITH FF MAGNETS



MUON LAYER ARRANGEMENT