D2 Status

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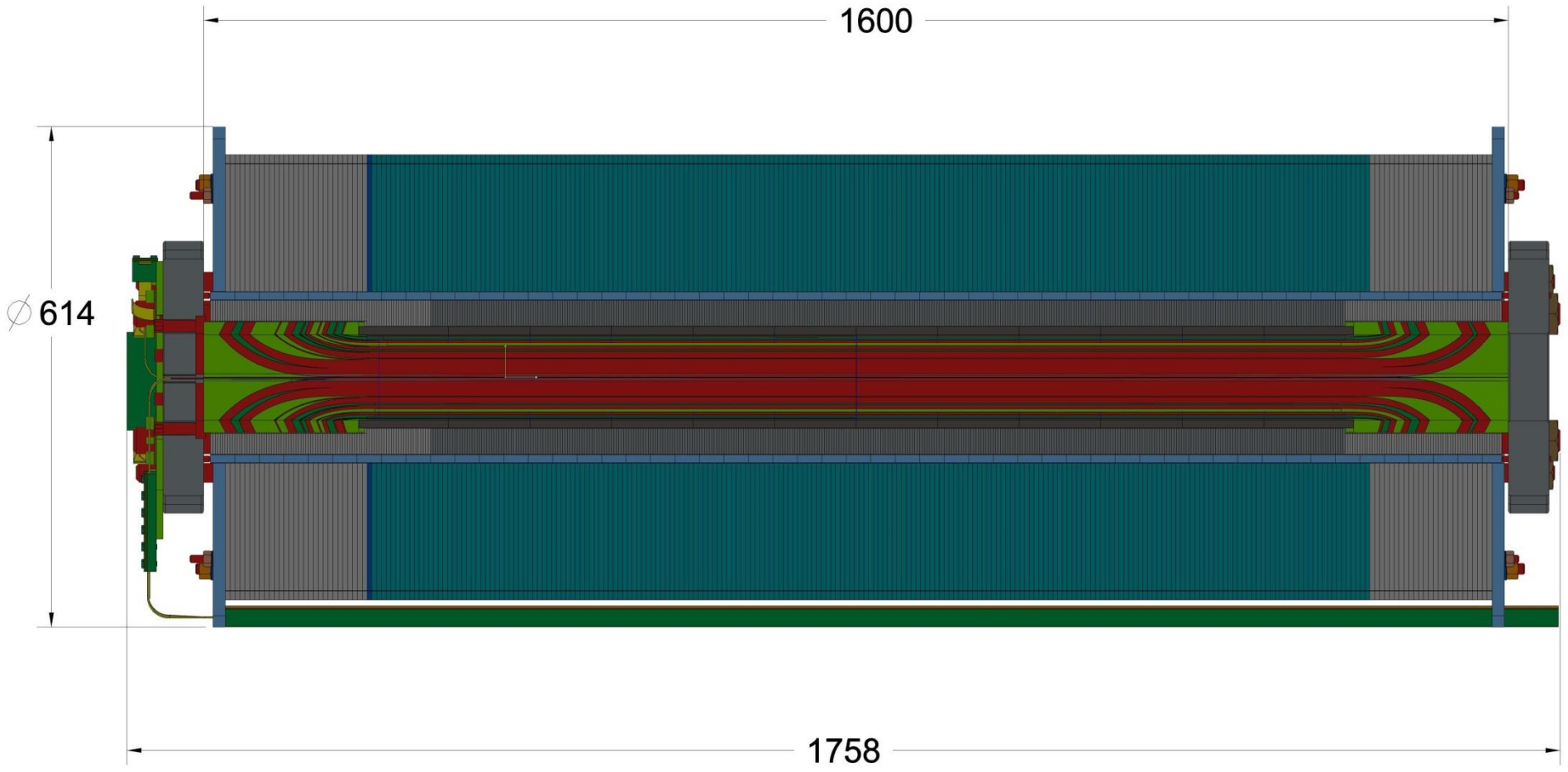
- Presentation of D2 short model (layout, dimensions, interfaces, cables, structure design)
- Magnetic measurement requirements
- Instrumentation table
- QA Hi-Voltage test before transport

The present contract to ASG Superconductors for short model (1.6 m) construction

- The short model is under construction in ASG Superconductors (Genova) with a contract started on Nov. 28 2016 and formally ending on Feb. 28 2018 with delivery to CERN. Presently the delivery date would be end of March (in the best case) or end of April (in the worst). Measures for limiting the delay are going on.

- The construction of D2 short model is based on a Technical Specification issued on March 2016 and completely defined in all parts (missing informations at the time of the writing).

- At the same time INFN Genova is developing the design of the prototype (8 m). Though very similar to short model , modifications are ongoing in the 2D cross section (very small for improving the integral field quality), coil ends (for reducing the peak field), end plate connection side (different function), iron yoke (modification asked by CERN).



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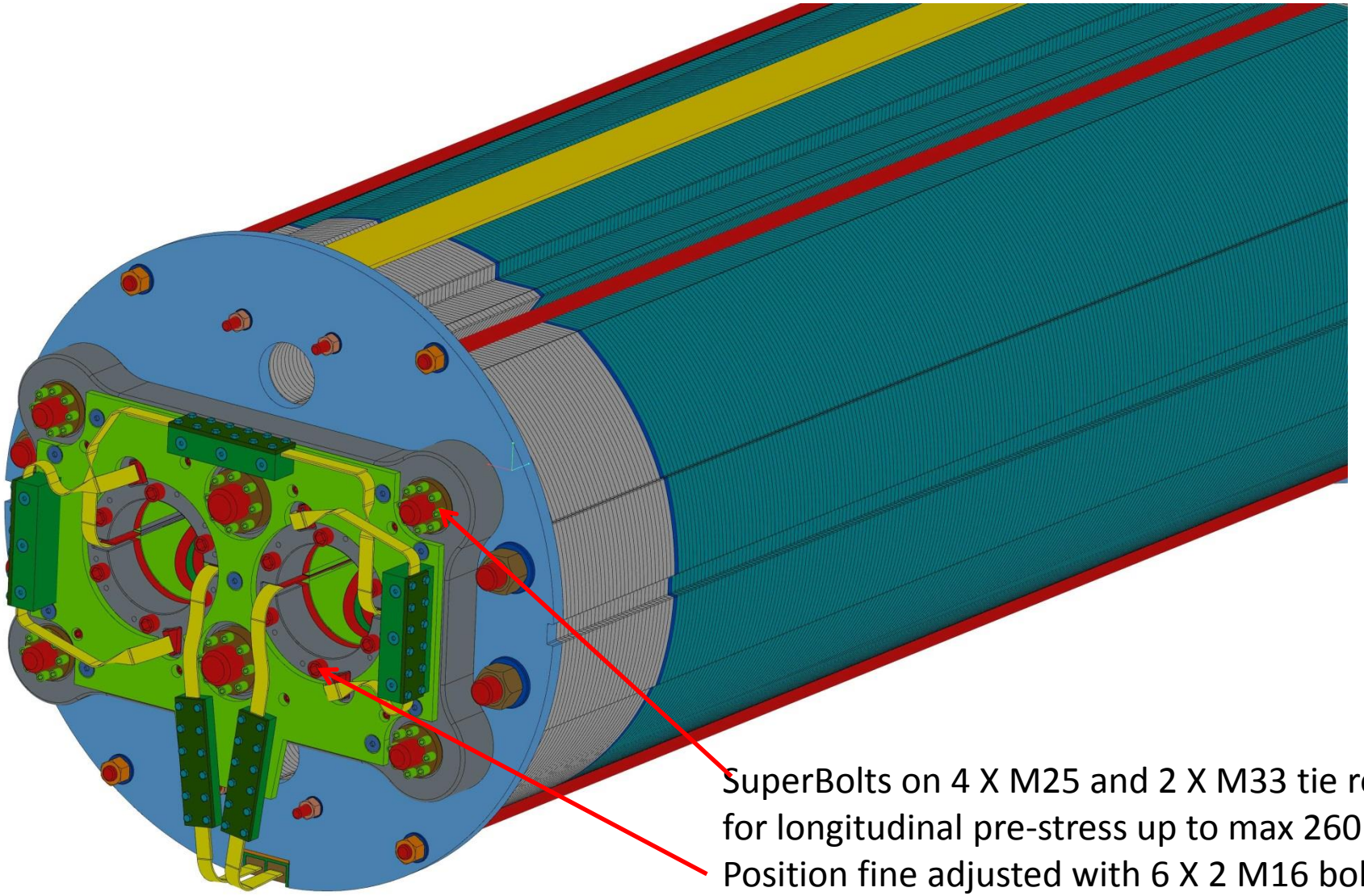
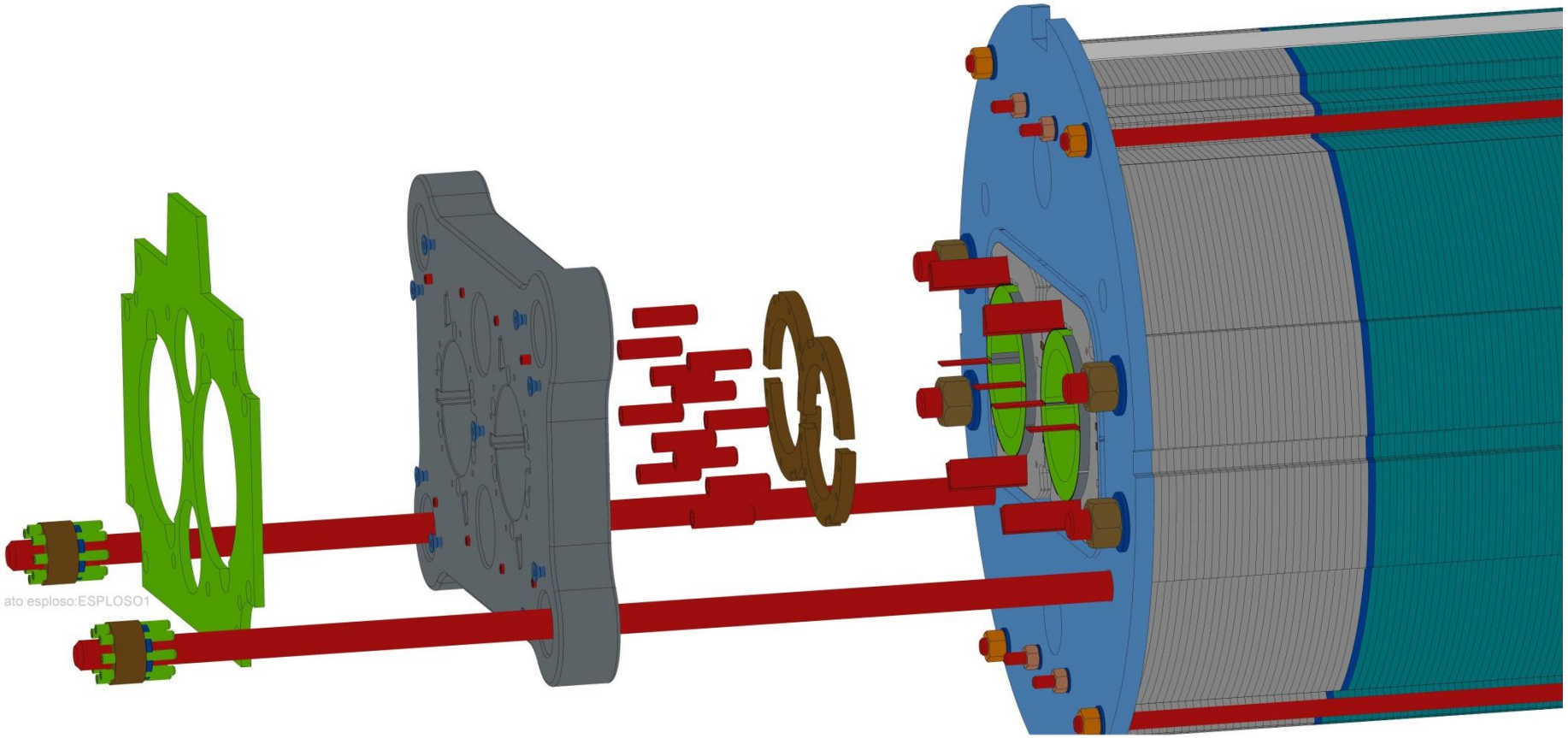


SuperBolts on 4 X M25 and 2 X M33 tie rods
for longitudinal pre-stress up to max 260 kN
Position fine adjusted with 6 X 2 M16 bolts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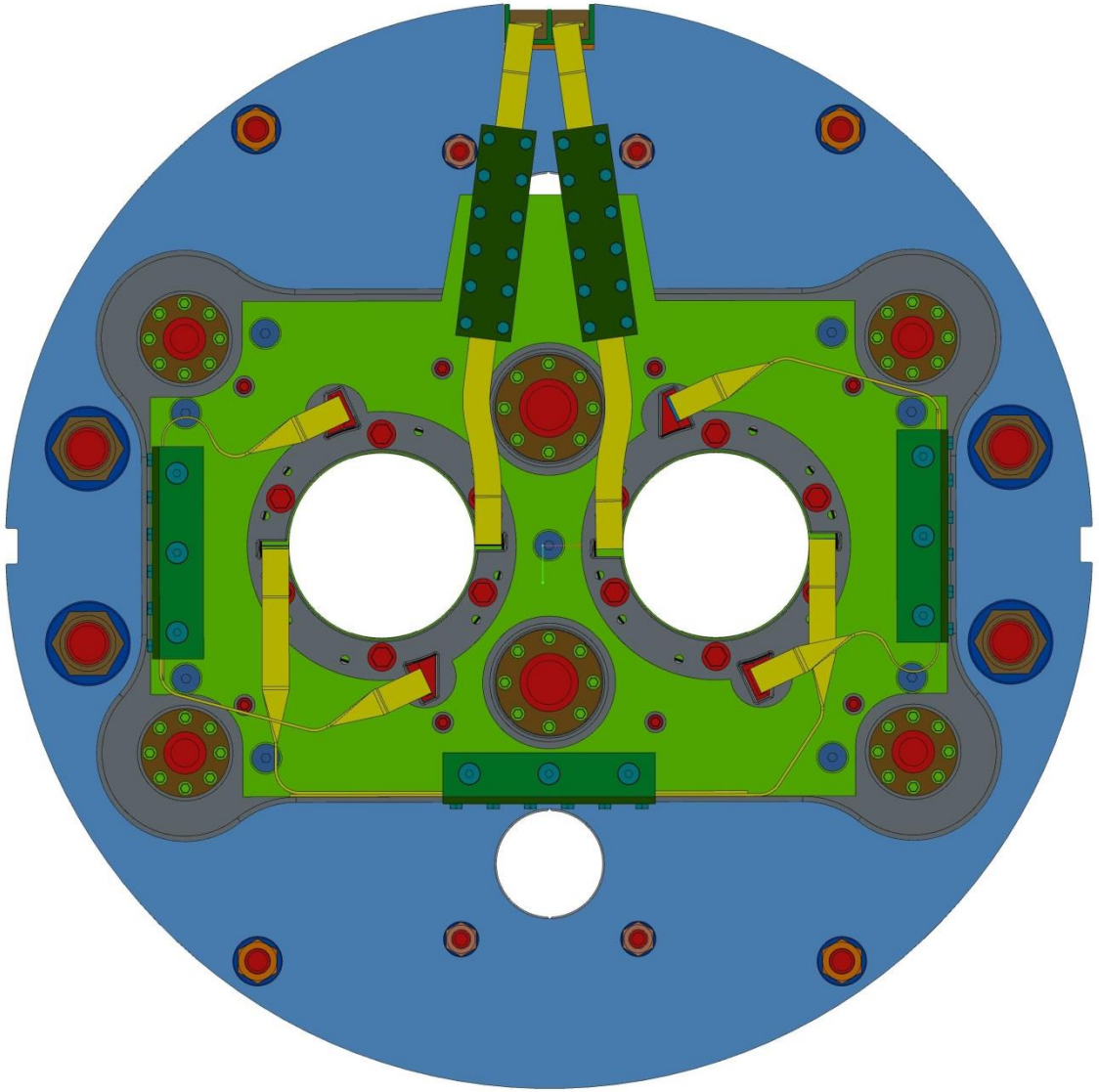
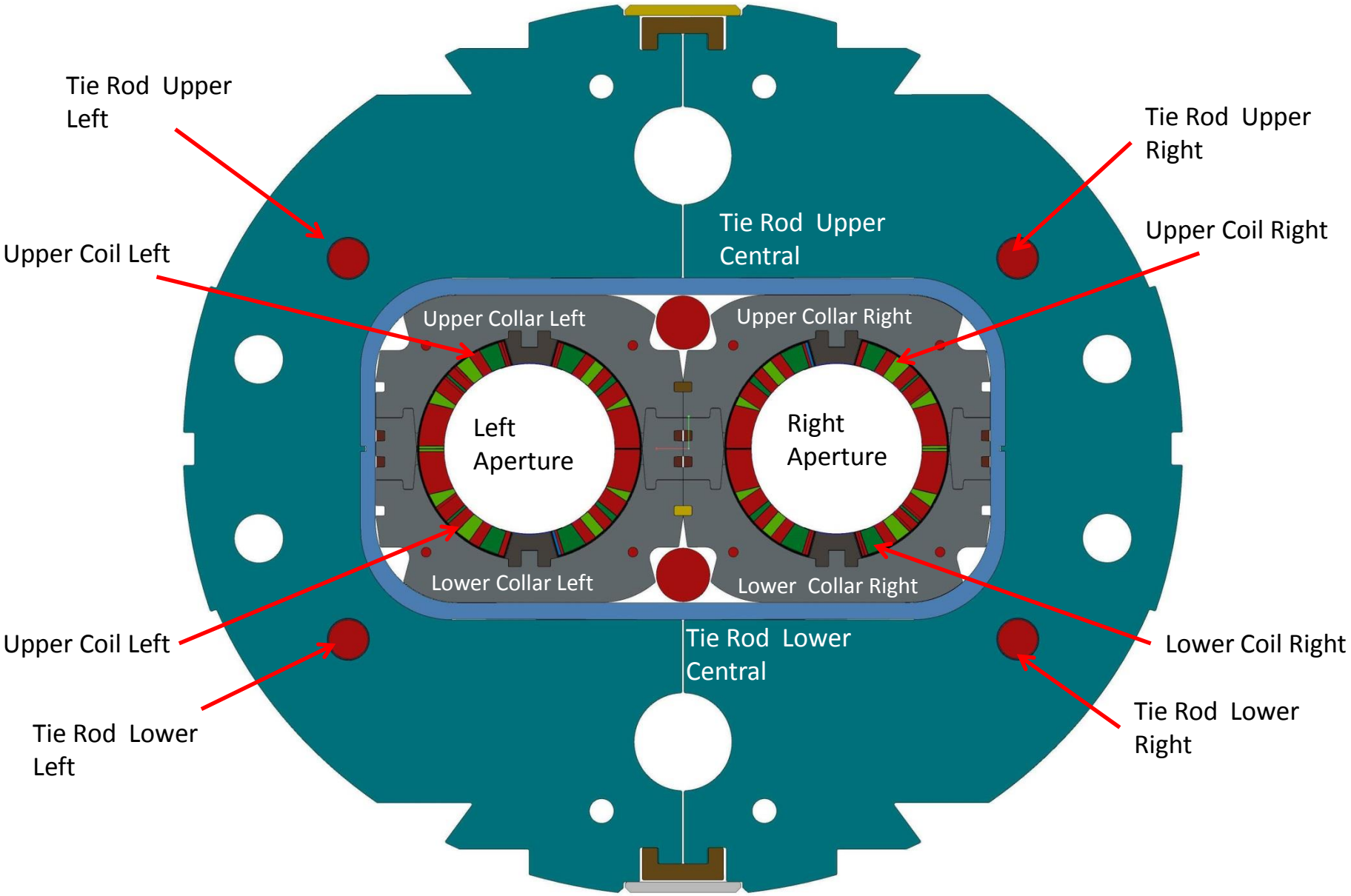
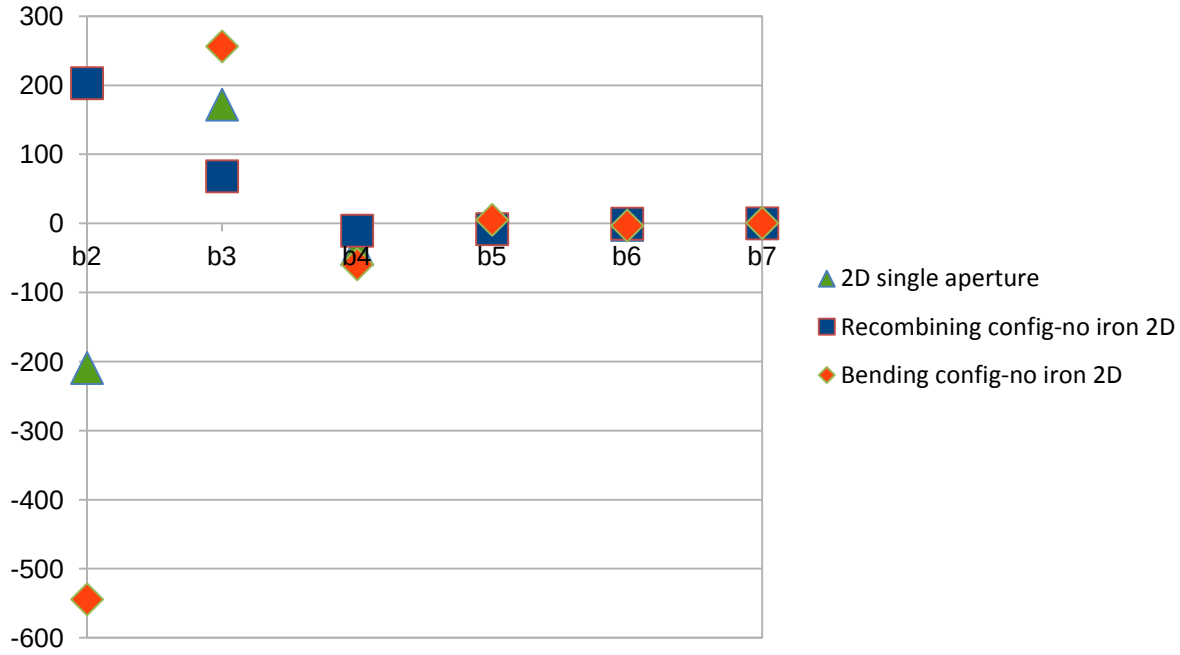


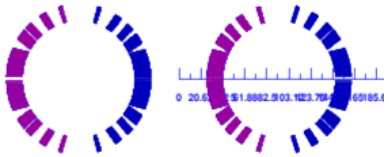

Tie Rod Upper Left
Tie Rod Upper Right
Tie Rod Upper Central
Upper Coil Left
Upper Coil Right
Upper Collar Left
Upper Collar Right
Left Aperture
Right Aperture
Lower Collar Left
Lower Collar Right
Upper Coil Left
Lower Coil Right
Tie Rod Lower Central
Tie Rod Lower Left
Tie Rod Lower Right

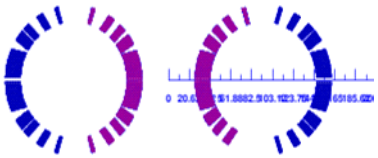
Magnetic Measurements

Magnetic measurements. ASG is equipped with a system based on rotating coils (QUIMM Measuring System provided by CERN) used since the construction of LHC. This system has been used during the construction of SIS300 prototype. ASG will use a 60 mm diameter mole, which can be considered an acceptable tool for D2 (field quality specified on 70 mm diameter) for multipole up to 5^{th} . The length of the mole is 600 mm, adequate for the 1.6 m long coil with about 1 m straight section. ASG is in contact with CERN for an external calibration of the system (an internal calibration procedure is still existing involving a quadrupole magnet). INFN considers this system suitable for checking the field quality during the construction; namely: a) After collaring a single aperture; b) After integrating the two apertures inside the Al sleeves; 2) After integration in the iron yoke. Simulations have been done for predicting the expected field multipoles during these intermediate tests. During the construction the measured values will be compared with expectations for providing feedback to ASG about the successful completion of a construction step.

Field quality- warm test without iron







Our previous experience with DISCO_RAP (SIS300)

ASG

Position	magnet center	magnet center	magnet center 500 mm	magnet center -500 mm	magnet center 1000 mm	magnet center 1000 mm	magnet head all mole inside	magnet head all mole inside	magnet head half mole inside	magnet head half mole inside
measured magnetic field (gauss)	100.65	100.64	100.64	100.64	100.62	100.64	86.92	87.03	35.69	36.1
current	+20 A	-20 A	+20 A	-20 A			+20 A	-20 A	+20 A	-20 A
b1	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04
b2	-0.79	2.11	0.31	0.75	1.11	-0.64	0.97	-1.90	-1.72	6.33
b3	4.95	4.63	5.19	5.02	4.97	4.85	-17.67	-18.19	-48.54	-53.12
b4	0.91	1.33	1.14	1.29	1.34	1.37	1.33	1.18	1.55	0.84
b5	-1.63	-1.64	-1.66	-1.69	-1.82	-1.85	-2.22	-2.19	-3.68	-3.31
b6	0.26	0.40	0.30	0.45	0.39	0.53	0.18	0.43	-0.48	0.91
b7	-0.26	-0.18	-0.23	-0.18	-0.31	-0.25	-0.94	-0.87	-1.89	-1.58
b8	-0.11	-0.08	-0.09	-0.04	-0.08	-0.03	-0.15	-0.07	-0.23	0.09
b9	0.07	0.10	0.08	0.11	0.06	0.09	-0.17	-0.13	-0.46	-0.44
b10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
b11	0.39	0.34	0.37	0.35	0.37	0.35	0.26	0.25	0.14	0.17
b12	0.14	0.16	0.15	0.18	0.13	0.16	0.02	0.08	-0.08	0.13
b13	-0.07	-0.07	-0.08	-0.08	-0.07	-0.08	-0.08	-0.08	-0.17	-0.10
b14	0.06	0.10	0.06	0.10	0.05	0.09	0.00	0.05	-0.10	0.07
b15	-0.04	-0.05	-0.04	-0.04	-0.04	-0.04	-0.05	-0.04	-0.09	-0.02
a1	0.05	0.27	0.12	0.15	0.17	0.07	0.20	0.02	-0.13	1.23
a2	0.57	0.83	1.26	1.42	0.27	0.34	-1.47	-2.22	-0.98	-14.83
a3	-0.82	-1.13	-0.33	-0.53	0.04	-0.13	1.31	0.93	4.81	1.39
a4	-1.05	-0.93	-0.75	-0.70	-0.66	-0.60	-1.34	-1.17	-3.17	-1.95
a5	-0.09	-0.15	-0.06	-0.07	0.20	0.19	0.24	0.27	-0.76	0.50
a6	0.18	0.11	0.34	0.25	0.38	0.28	0.20	0.11	-0.47	-0.74
a7	0.10	0.02	0.07	-0.01	0.11	0.02	0.20	0.14	-0.08	0.05
a8	0.20	0.17	0.19	0.20	0.20	0.20	0.12	0.14	-0.25	-0.31
a9	-0.16	-0.10	-0.19	-0.17	-0.16	-0.15	-0.08	-0.04	-0.13	0.00
a10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
a11	-0.09	-0.11	-0.10	-0.10	-0.11	-0.10	-0.10	-0.08	-0.05	0.08
a12	-0.09	-0.09	-0.06	-0.09	-0.06	-0.09	-0.07	-0.11	-0.08	-0.18
a13	0.02	0.00	0.02	0.00	0.02	-0.01	0.05	0.01	0.09	0.01
a14	0.11	0.06	0.13	0.09	0.12	0.09	0.15	0.10	0.13	0.06
a15	0.08	0.09	0.09	0.07	0.09	0.07	0.11	0.09	0.04	0.05

Sensors: What specification says

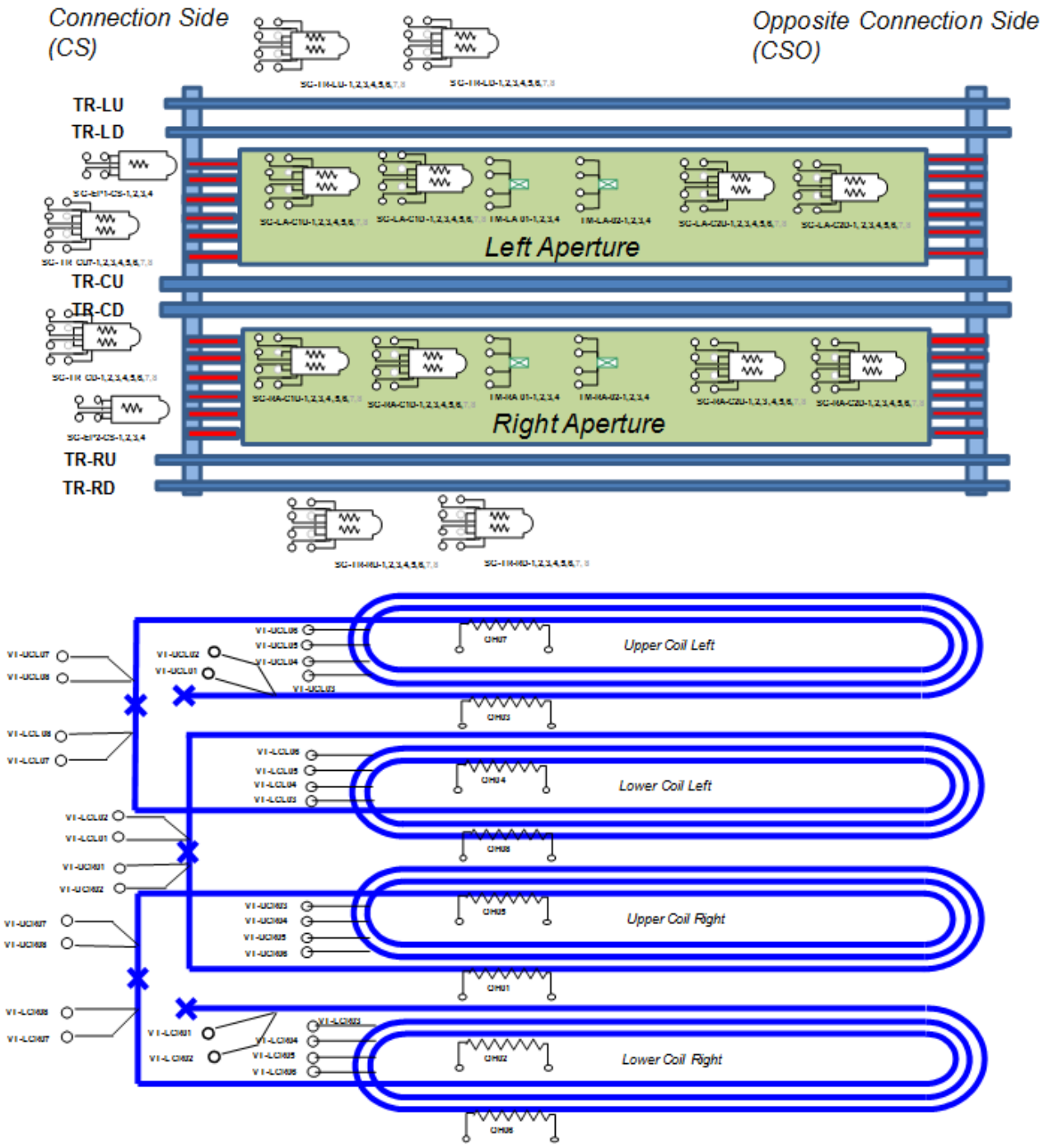
1) **Sensors.** The model shall be equipped with a number of sensors (thermometers, strain gauges and voltage steps). The precise location of each sensor will be provided by INFN at the start of the contract. To the aim to give a quotation, the sensors to be applied and tested are: a) 4 thermometers (CERNOX type); b) 10 strain gauges; 16 voltage steps.

We have recently revised the need for instrumentation and we have now a proposal including:

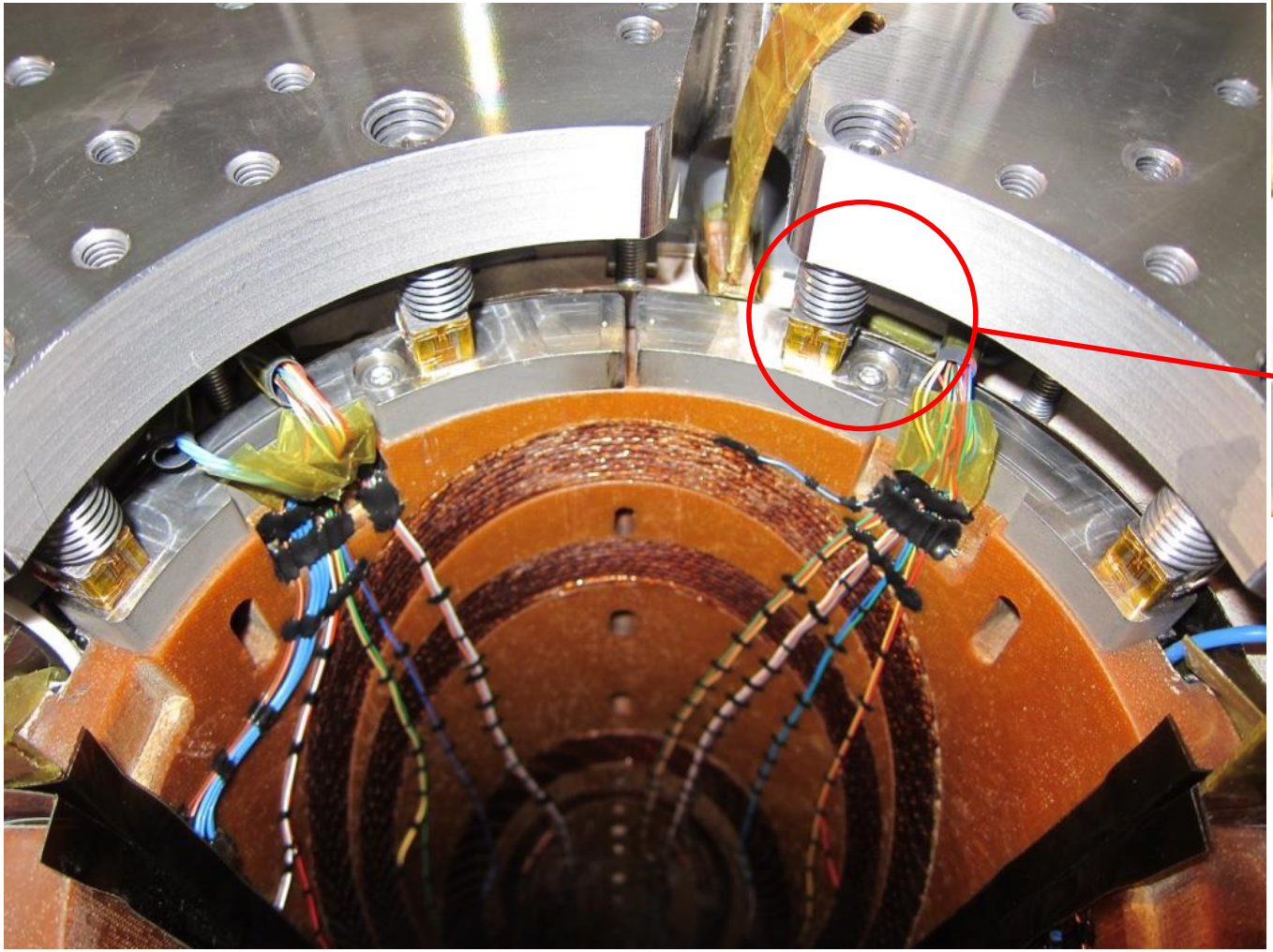
a) 4 thermometers (Cernox)
b) 30 Strain gauges
c) 32 Voltage taps

If the bullets used for homogenizing the axial pre-stress were involved, further 12 strain gauges would be used.

Sensor type and number	Id	Position	Wires
Voltage tap n1 to n8	VT-LCM01 to VT-LCM08	Lower Coil High	8
Voltage tap n9 to n16	VT-UCM01 to VT-UCM08	Upper Coil Right	8
Voltage tap n17 to n24	VT-LCML01 to VT-LCML08	Lower Coil Left	8
Voltage tap n25 to n32	VT-UCML01 to VT-LCML08	Upper Coil Left	8
Strain Gauge n1 n2	SG-TR-RU-1,2,3,4,5,6,7,	Tie-Rod High Upper	6
Strain Gauge n3 n4	SG-TR-RD-1,2,3,4,5,6,7,8	Tie-Rod High Down	6
Strain Gauge n5 n6	SG-TR-LU-1,2,3,4,5,6,7,8	Tie-Rod Left Upper	6
Strain Gauge n7 n8	SG-TR-LD-1,2,3,4,5,6,7,8	Tie-Rod Left Down	6
Strain Gauge n9 n10	SG-TR-CU-1,2,3,4,5,6,7,8	Tie-Rod Contral Upper	6
Strain Gauge n11 n12	SG-TR-CD-1,2,3,4,5,6,7,8	Tie-Rod Contral Down	6
Strain Gauge n13 n14	SG-RA-C1U 1,2,3,4,5,6,7,8	Collar 1 Upper Right Aperture	6
Strain Gauge n15 n16	SG-RA-C1D 1,2,3,4,5,6,7,8	Collar 1 Down Right Aperture	6
Strain Gauge n17 n18	SG-RA-C2U 1,2,3,4,5,6,7,8	Collar 2 Upper Right Aperture	6
Strain Gauge n19 n20	SG-RA-C2D 1,2,3,4,5,6,7,8	Collar 2 Down Right Aperture	6
Strain Gauge n21 n22	SG-LA-C1U 1,2,3,4,5,6,7,8	Collar 1 Upper Left Aperture	6
Strain Gauge n23 n24	SG-LA-C1D 1,2,3,4,5,6,7,8	Collar 1 Down Left Aperture	6
Strain Gauge n25 n26	SG-LA-C2U 1,2,3,4,5,6,7,8	Collar 2 Upper Left Aperture	6
Strain Gauge n27 n28	SG-LA-C2D 1,2,3,4,5,6,7,8	Collar 2 Down Left Aperture	4
Strain Gauge n29 n30	SG-EP1-CS 1,2,3,4	End Plate 1 Connection Side	4
Thermometer CERNOX n1	TM-RA-O1 1,2,3,4	Coil Right aperture	4
Thermometer CERNOX n2	TM-RA-O2 1,2,3,4	Coil Right aperture	4
Thermometer CERNOX n3	TM-LA-O1 1,2,3,4	Coil Left aperture	4
Thermometer CERNOX n4	TM-LA-O2 1,2,3,4	Coil Left aperture	4
Quench Heater n1 to n8	QH01 to QH08	2 per coil	16
Total 44 sensors 432 VT			Total 150 wires

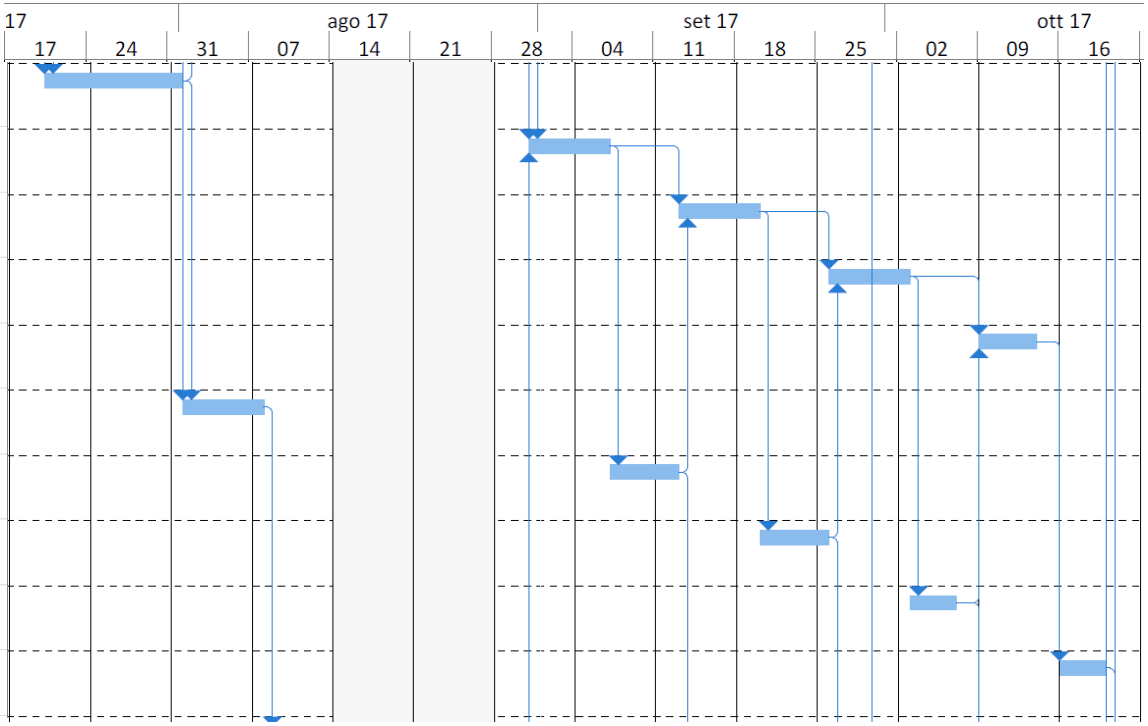


Same solution of D1 for bullet “gauges”?



Schedule for short model construction – Winding and curing

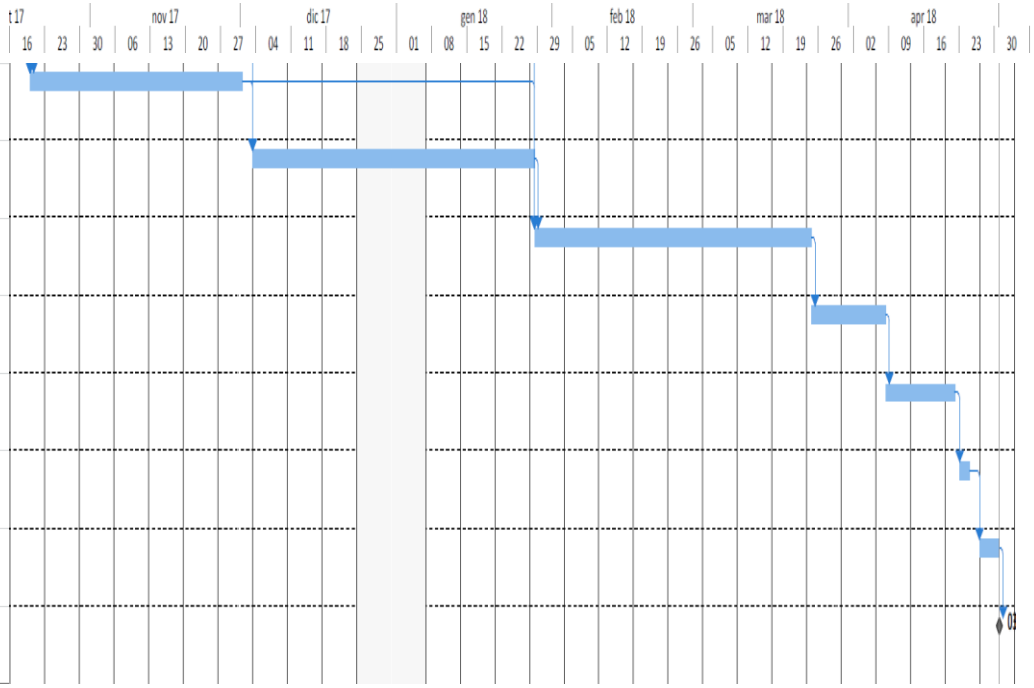
Winding of dummy 1st coil	8 g	gio 20/07/17
Winding coil #1 of 1st aperture	5 g	gio 31/08/17
Winding coil #2 of 1st aperture	5 g	mer 13/09/17
Winding coil #1 of 2nd aperture	5 g	mar 26/09/17
Winding coil #2 of 2nd aperture	5 g	lun 09/10/17
Curing of dummy 1st coil	5 g	mar 01/08/17
Curing coil #1 of 1st aperture	4 g	gio 07/09/17
Curing coil #2 of 1st aperture	4 g	mer 20/09/17
Curing coil #1 of 2nd aperture	4 g	mar 03/10/17
Curing coil #2 of 2nd aperture	4 g	lun 16/10/17



The late starting of the practice coil winding is due to the delivery of the copper wedge .
We are pushing for re-organising the production of copper wedge and start winding beginning o July.

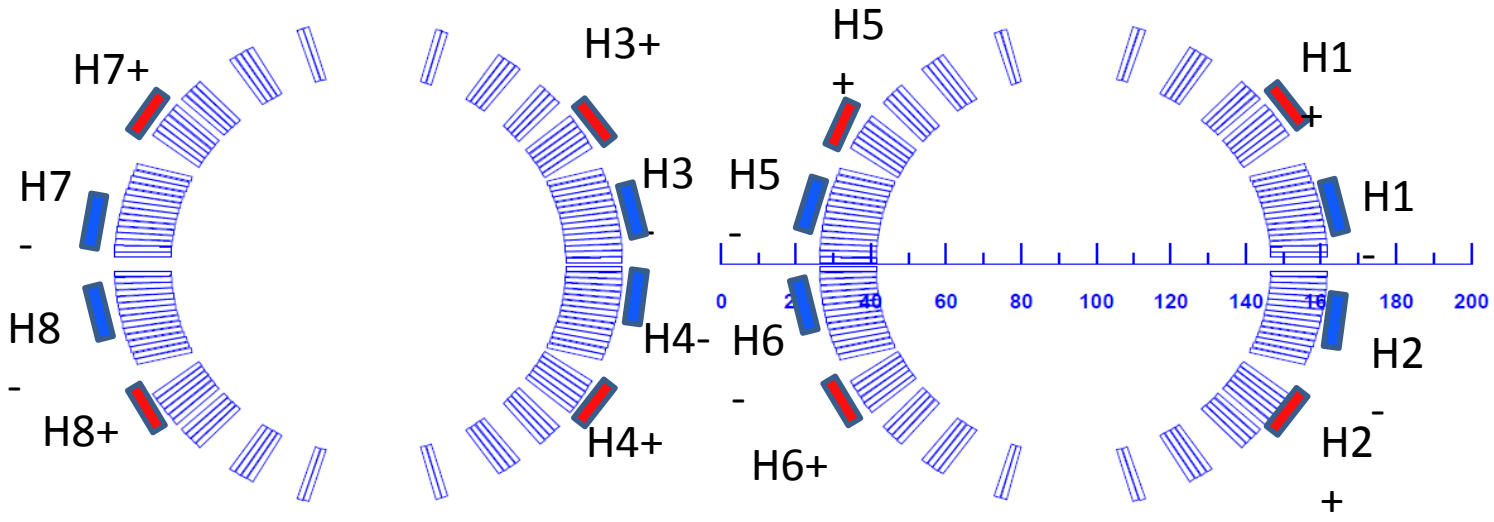
Schedule for short model construction – Completion

Collaring of first aperture	30 g	ven 20/10/17
Collaring of second aperture	30 g	lun 04/12/17
Model assembly and yoke completion	40 g	mar 30/01/18
Model completion	10 g	mar 27/03/18
Final tests	10 g	mer 11/04/18
Packing	2 g	gio 26/04/18
Shipment	3 g	lun 30/04/18
Delivery	0 g	gio 03/05/18



HEATERS LAY-OUT

8 circuits formed by 2 heaters each. One heater in the HF zone and the second in the LF. Only 4 circuits are used (1,6,3,8). The voltage is 900 V per each circuit



- Two **0.025** mm thick stainless steel strips bonded in between two layers of poly-imide
- Part of the strips are covered with copper (**0.005** mm thick).
- A single strip has a **width of 15 mm (red strip) and 20 mm (blue strip)**
- The pattern is **120 mm ss** and **400 mm copper** for red strips and **150 mm ss** and **370 mm copper** for blue strip.
- The covered surface **is 0.028 m²** (per strip)
- For the 8 m long D2 magnets the resistance of a single strip is **2.91 Ω**
- The two strips are connected in series (**$R_{circuit\ total}$= 7.13 Ω)**
- With 900 V (± 450 V) the peak current is **126 A → 92 to 150 W/cm²**

Standard and failure scenarios

Operating mode	Max temperature (K)	Peak voltage to ground (V)	Peak turn-to turn voltage (V)
Standard Two circuits per aperture One circuit per pole Working : 1,6,3,8→ All poles quenches	260	140	39
Fail 1 One circuit fails Three working : 1,3,6 → Three pole quenches	280	587	43
Fail 2 Two circuits fail Two working 1,3 → One pole per aperture quenches	*340 (tbc)*	*580(tbc)*	*64(tbc)*
Fail 3 Two circuits fail Two working 3,8 → One aperture quenches	340	830	78

Electrical tests: Specifications

- **Electrical test.** A verification of the integrity of the electrical insulation and impedance of various circuits shall be performed. Three steps are scheduled in the electrical acceptance tests during the manufacture of the collared coils: (i) after curing (polymerization) of the poles, (ii) after collaring, and (iii) after integration of the iron lamination. The measurements to be performed includes coil electrical resistance, complex impedance at different frequencies and ground insulation up to 5 kV (with minimum resistance to ground of 1 MΩ). The quench heaters integrity and ground insulation (3 kV) shall be tested elsewhere;