Updated concept of the CBM dipole magnet. Status of the work.

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Design parameters of the CBM magnet to be realized

Geometry

- Opening angle: ±25° vertically, ± 30° horizontally from the target
- Free aperture: 1.44 m vertically x 1.8 m horizontally, no conical geometry
- Distance target- magnet core end: 1m (STS detector must fit in)
- Total length: 1.5 m
- Space upstream of the magnet: <1 m

Magnetic field

- Field integral within STS detector (along straight lines): **0.972 T*m** -> max. Field ≈ 1 T, depending on the magnet length
- Field integral variation over the whole opening angle along straight lines: ≤ 20% (± 10%)
- Fringe field downstream < reasonable value of the order of 50 to 100 Gauss at a distance of 1.6 m from the target (RICH only)

Operating conditions

- Operates at both polarities
- 100% duty cycle, 3 months/year, 20 years
- No real time restriction on the ramp: 1 hour up ramp
- Radiation damage (<10MG for organics): no problem
- Radiation Energy deposit in the cryosystem: max. 1 W

Design parameters of the CBM magnet to be realized, continued

Assembly

- Field clamps dismountable for MUCH
- Assembly in situ
- Weight restriction: crane 30 tons (including lifting jacks)
- Maximum floor load: 100 tons/m2
- beam height over the floor: 5.8 m

Alignment

- Position accuracy: **± 0.5 mm (changed)**
- Orientation accuracy (roll): ± 0.5 mrad

The requirements given above are mandatory.

Remark: the free aperture was increased from 1.4m (TDR) to 1.44 m. However, the integral field was decreased in order to keep the nominal current the same as in the TDR.

The CBM superconducting dipole will be designed as follows:

- Warm iron yoke (huge vertical and horizontal balks)
- Warm round poles
- Removable field clamps
- cylindrical NbTi coils wound on cylindrical bobbin, cooled with LHe
- Thermal shields cooled with Helium gas (50-80K)
- Two independent cold masses and cryostats (**now not independent**)
- Vertical forces transferred from the coil to the cryostat and finally to the yoke
- Normal conducting leads

Schedule of the following work, November 2019

1. Conceptual Design review, April 2018

- The design of the CBM magnet followed the essential recommendations;

- The magnet design was changed: number of turns, field clamps of the iron yoke.

2. Preliminary Design Review, November 2019 (first?)

- **All 3D drawings will be presented and discussed**
- **Detail design of the coils;**
- **Discussion on the support design: one large or eight small struts;**
- **Cryostat design including HTS current leads;**
- **Cryogenics operation;**
- **Power supply and control system;**

Schedule of the work, November 2019, continued

3. Final Design Review, April-May 2020

- **Manufacturing drawings should be approved**
- **Control of quality procedures**

4. Manufacturing stages

- SC cable manufactured up to March 2020;

- iron yoke (during 2020)

- technologies of coils impregnation tested, second part of 2020

- tools manufactured

- coils manufactured

- cryostat manufactured in 2021

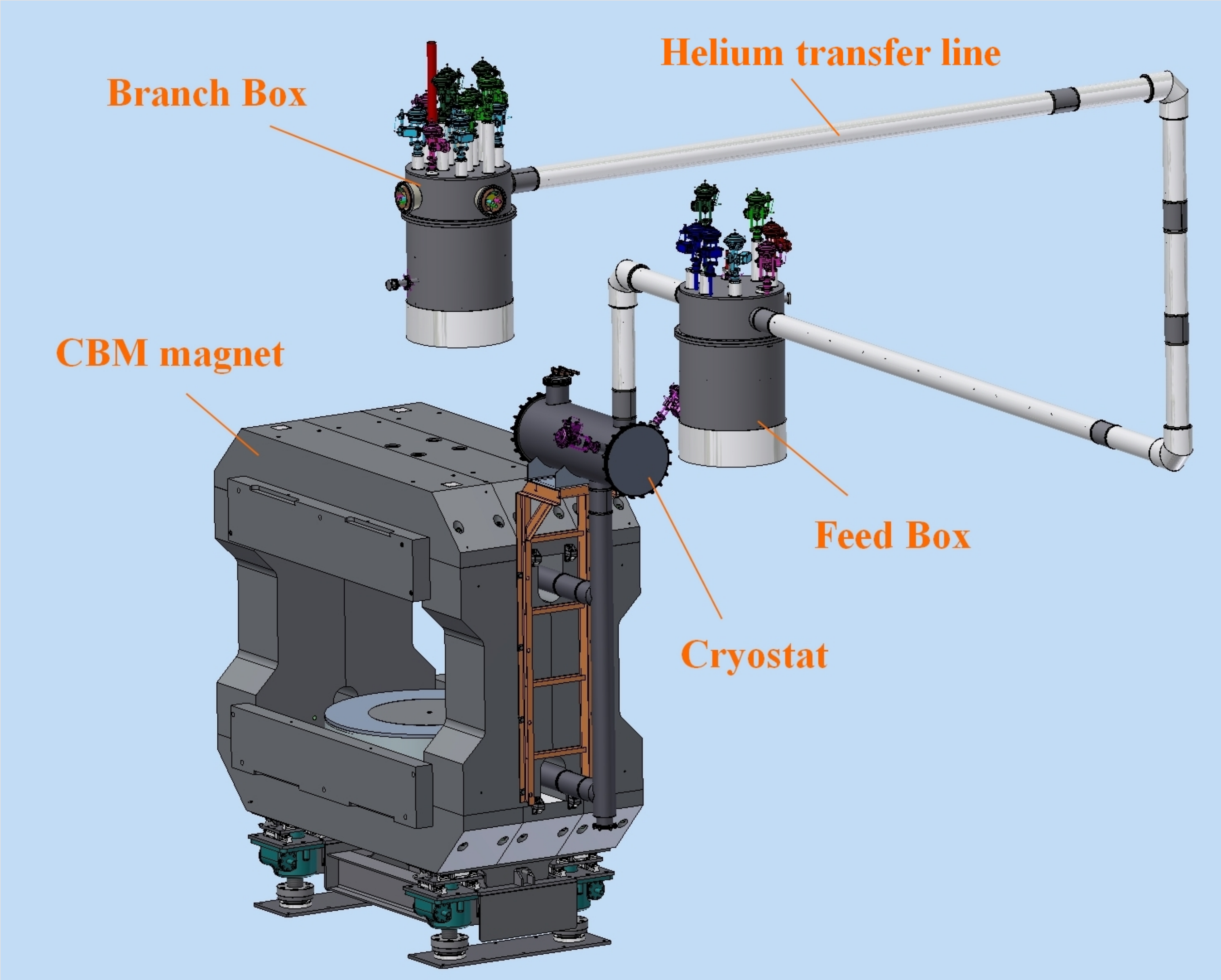
5. Factory acceptance tests in BINP, During 2022

the cryostat will be modified to use LN2 instead of 50 K GHe and a cryocooler will be used for the current leads cooling.

6. Assembling December 2022 – March 2023

7. Cryogenics test in GSI during April – December, 2023

The CBM magnet and cryogenics



The scope of BINP work:

CBM magnet

- **Iron yoke of ~ 150 tons weight**
- **SC dipole coils**

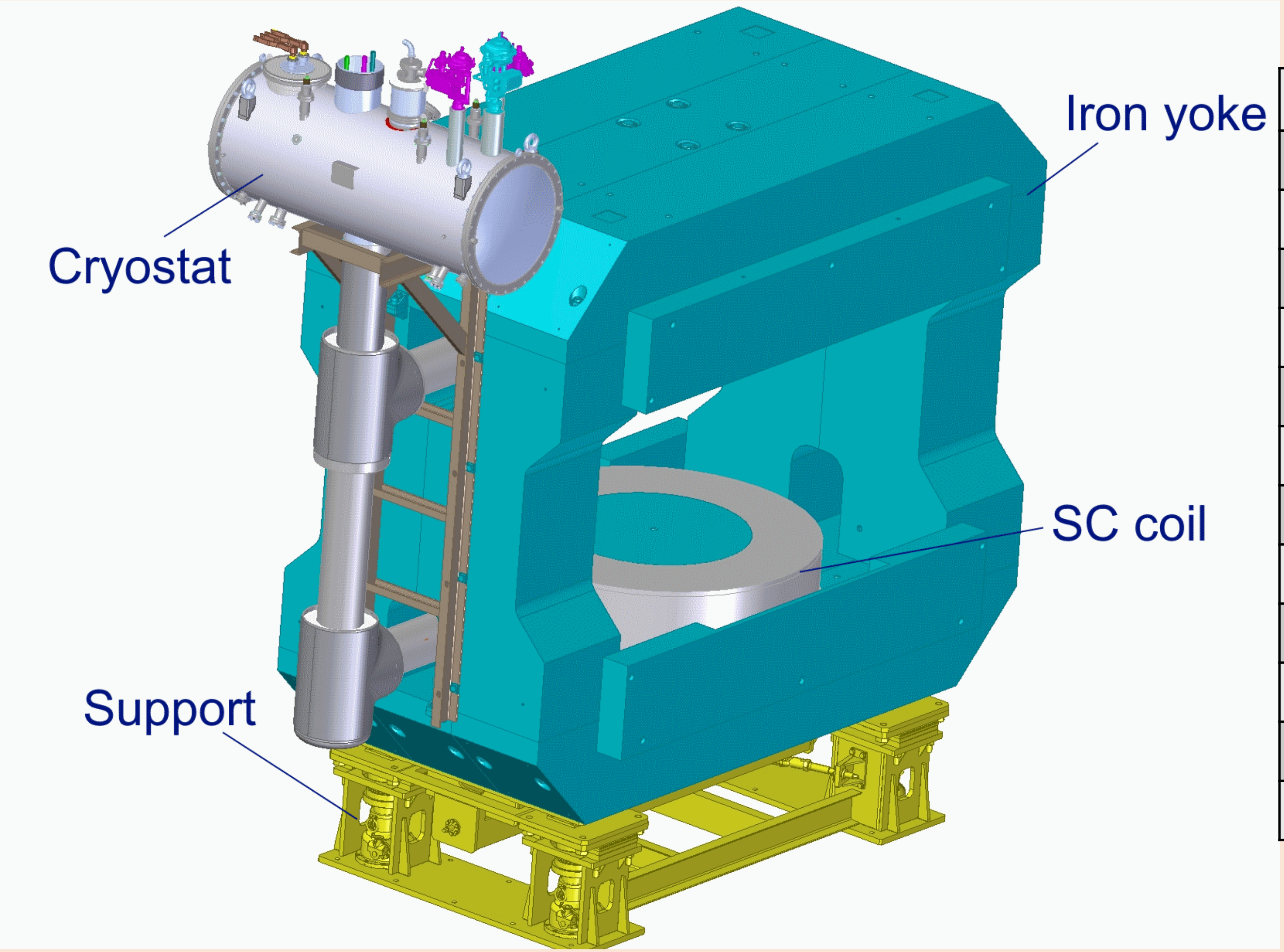
Cryogenics

- cryostat

- Feed Box (control of cooling regimes)

- Branch Box (control of He flows to CBM and HADES detectors)

The CBM magnet and main parameters

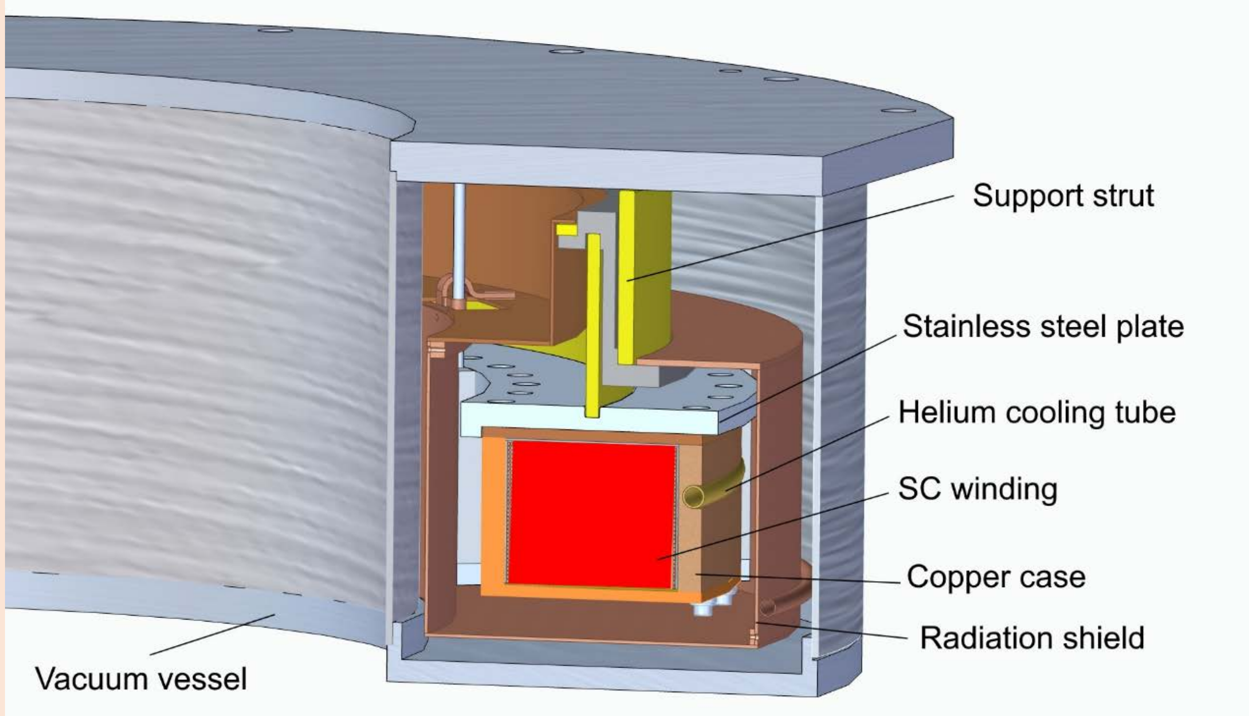


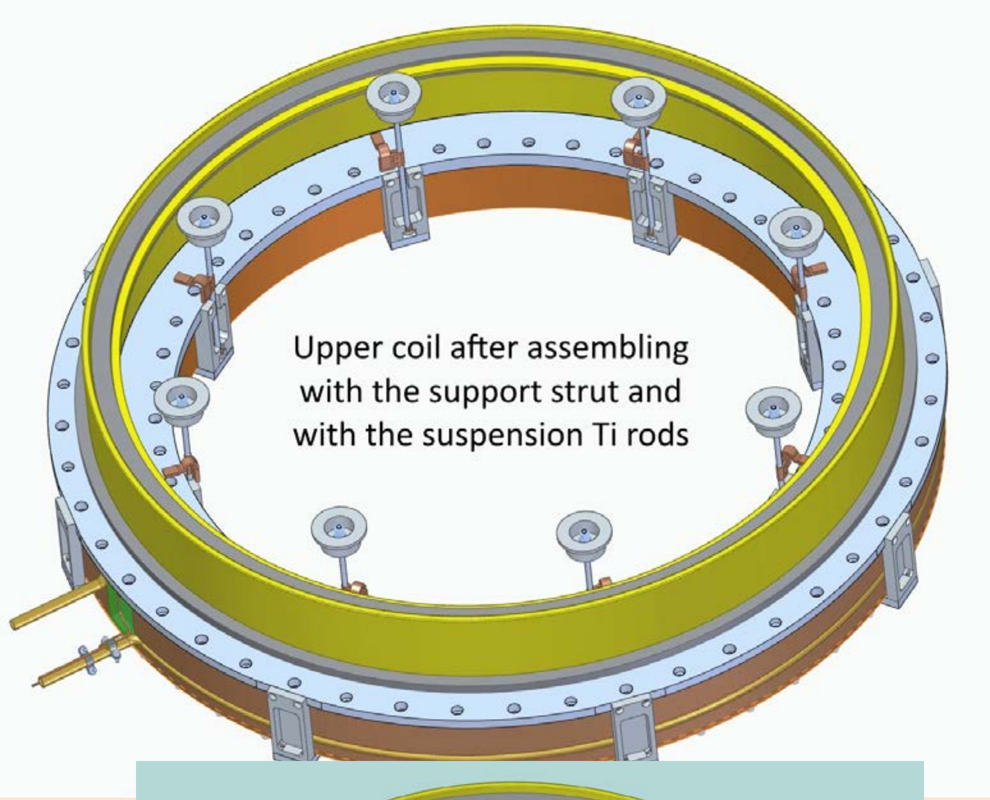
The support may adjust positioning and rotation of the iron yoke.

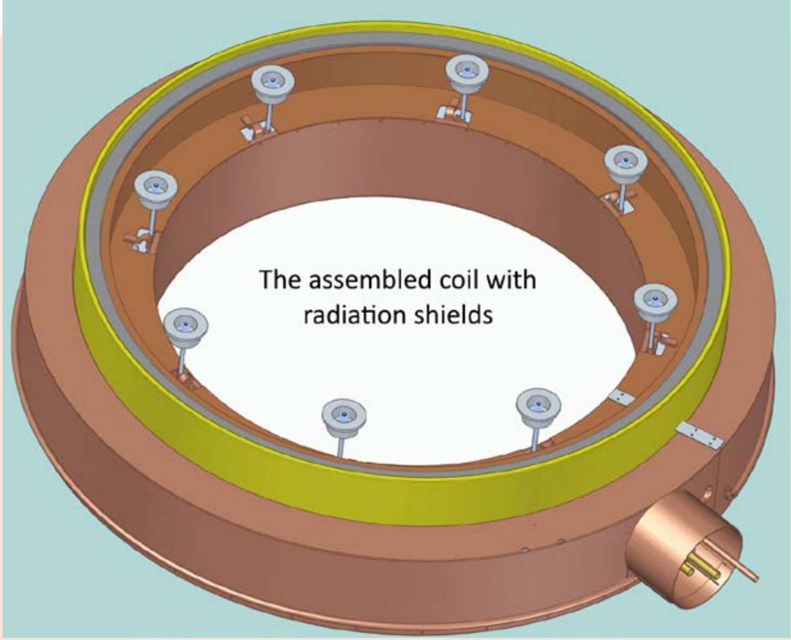
Main parameters of the CBM magnet	
Magnetic field integral along 1 m about the center, T*m	1.02
Maximal magnetic field on the coils, T	3.6
Inner diameter of the SC winding, m	1.396
Vertical distance between the poles, m	1.44
Operating current, A	666
Number of turns per coil	1716
Number of layers	32
Stored energy, MJ	5.0
Coils cold mass, kg	3600
Operating temperature, K	4.5
Inductance at operating current, H	21
Vertical force acting on the coils toward the iron yoke, MN*	3.0

The red figures is what was changed since May 2018.

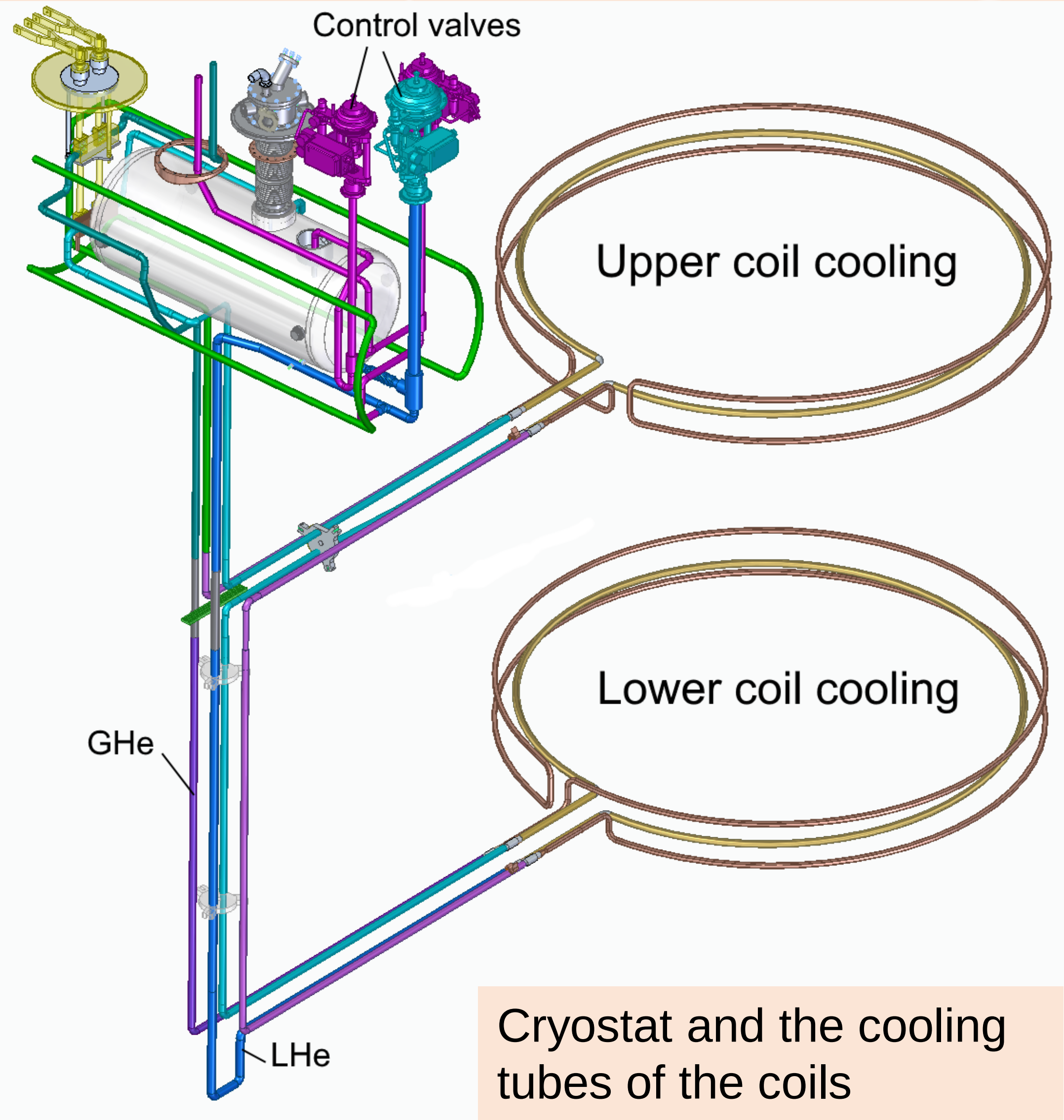
The design of the coil







Cryostat and cooling

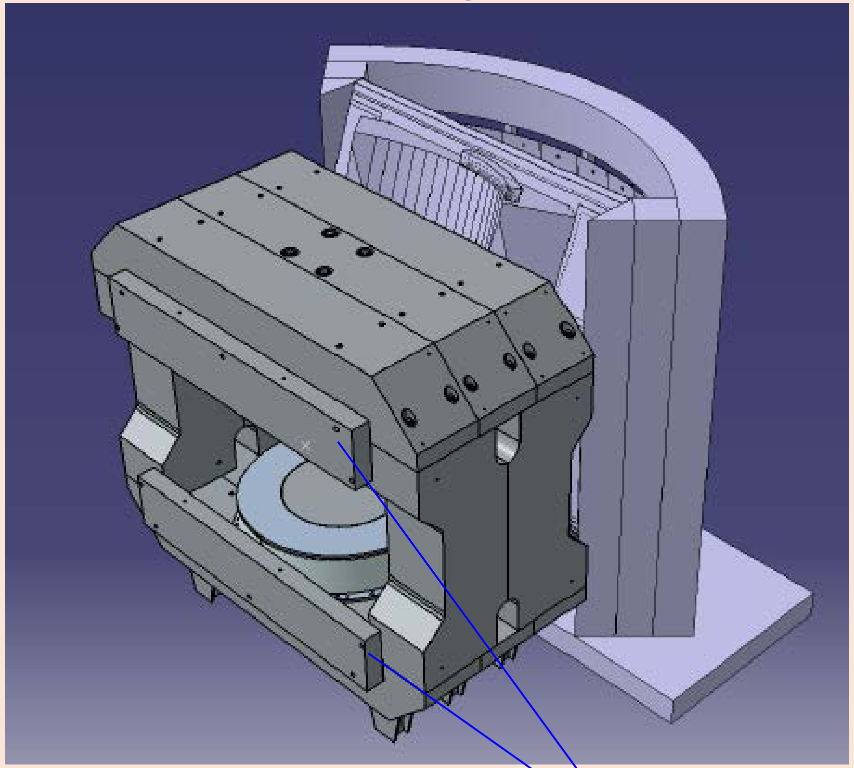


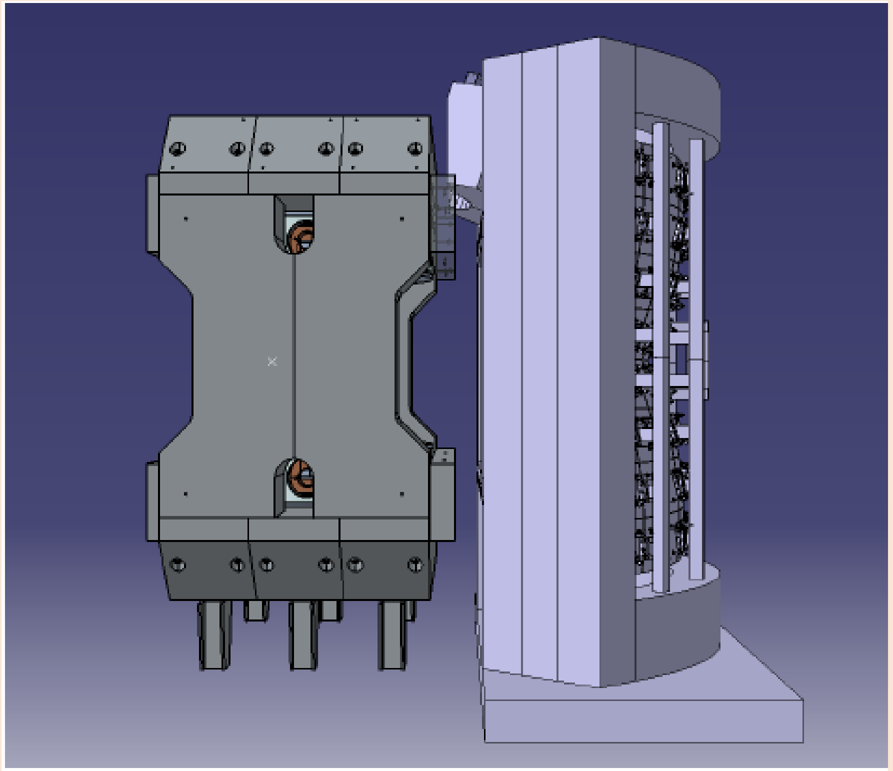
Cryostat and the cooling tubes of the coils

The liquid helium is accumulated in the LHe vessel of 180 l volume. The J-T valve is used for liquefying the helium entering the cryostat at 4.6 K at 3 bar.
The coils are connected in serial by tubes with liquid helium. The helium flow is pushed by density difference between the vertical channels of the helium flow loop. This is a thermosyphon cooling method. The peculiarity of this design is that the coils as serially connected. The horizontal part of the loop is relatively large, about 14 m. The thermosyphon cooling estimations show that the vapor quality (x) at the outlet of the cooling loop is less than 0.1 that is quite low. The stable thermosyphon flow works with x up to 0.8 value.
The horizontal tubes inclination and a 5 W heater are foreseen for stabilization of the He flow.
The cooling down of the system will be realized by forced flow of helium of 50 K temperature.

Interfaces with other systems 1

The RICH detector is placed close to the magnet. Stray magnetic field is reduced by the field clamps. The field clamp were adjusted to the needs of the magnet. The suppression of the stray filed should be done by the RICH detector design.





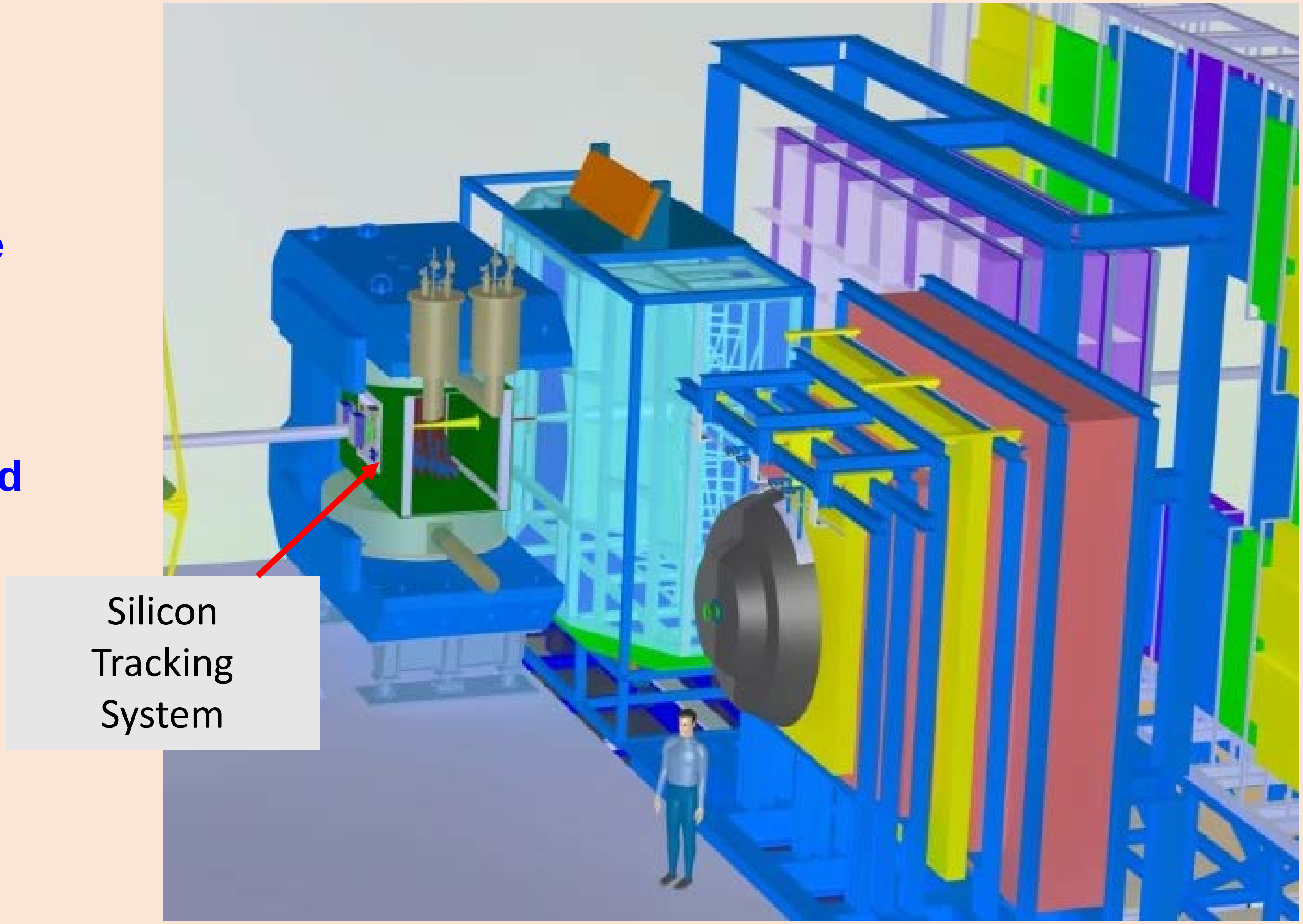
field clamps

Interfaces with other systems 2

The Silicon tracking system is placed inside the magnet.

It needs:

- **1440 mm of vertical gap between the poles;**
- **The magnet including the iron yoke should be rotated around vertical axis;**
- **The rails should be placed by the lower coil.**



Status of BINP work on the CBM magnet

- **The design of the coil, cryostat and the cryogenics will be presented for the discussions and for improvements.**
- **The design of the CBM magnet was slightly changed from CDR. The calculations of new design will be presented and discussed.**
- **The bare SC cable will be manufactured in November 2018 as first test part and finished in March 2019.**
- **Test place in BINP will be ready in the 2020.**
- **Subcontractor for manufacturing of the iron yoke is working.**
- **The rest tasks may be discussed during this meeting.**
- **The schedule is very tight now. Most of the questions must be discussed with final decisions in close weeks.**