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Design and Manufacturing Assessment of a Multi-purpose Detector for NICA Collider [ID Tue-Mo-Po2.03-10]

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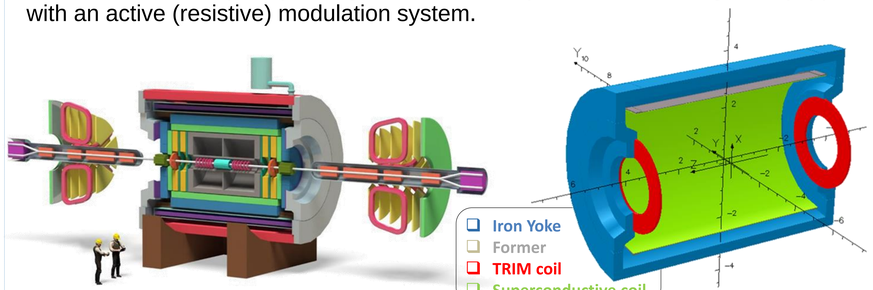
Multi-Purpose Detector (MPD) Magnet

Nuclotron-based Ion Collider state-of-art design involves innovative solutions in superconductive applied technology [1]. Thanks to its consolidated experience, ASG has been directly involved into the program by providing to Joint Institute for Nuclear Research (JINR) a large 0.5 T NbTi superconductive magnet equipped with an active (resistive) modulation system.



[1] Zh. Bunzarov et al., *"Superconducting solenoid magnet for the Multi-Purpose Detector at the NICA facility"*, International Conference on Instrumentation for Colliding Beam Physics, Novosibirsk, Russia. (Febr. 24 – Mar. 1, 2014) and published on Sept. 30, 2014. 2014 JINST 9 C09035

Magnet System

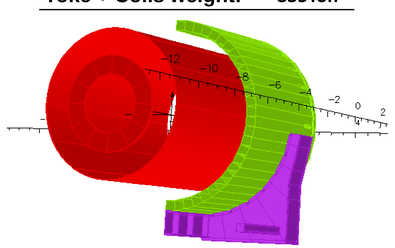
The main components of the MPD are the superconducting NbTi coil and an iron yoke for the flux return.

The cable (custom designed on purpose) is manufactured by coextrusion of stabilizing high-purity aluminum and superconducting NbTi strand.

The coil has an indirect cooling system that consists in a hydraulic LHe circuit welded directly on the coil.

The magnet provides a highly homogeneous magnetic field of 0.5 Tesla in a cylindrical volume (4.6 m diameter, 3.400 m length). Two resistive TRIM coils are installed at the ends of the solenoid to correct and trim the field.

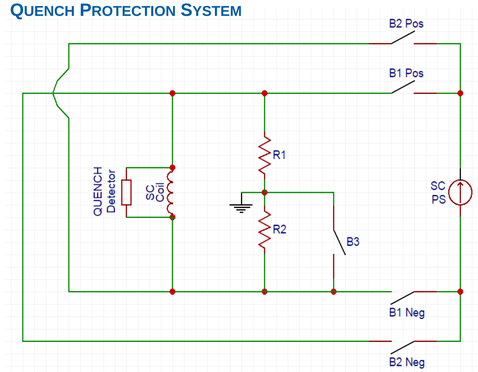
MAIN DIMENSIONS	
SC Coil Ø:	5.2 m
SC Coil lenght:	7.6 m
SC Coil weight:	15 Ton
Cryostat Ø:	5.8 m
Cryostat lenght:	8.1 m
TRIM coil Ø:	3.2 m
TRIM coil depth:	80 mm
Yoke + Coils weight:	≈ 835Ton



Protection System and Polarity Switch

The superconductive regime is guaranteed if the temperature and the magnetic field do not rise up over the respective critical values depending on SC cable. The SC coil is equipped with a protection systems that discharges the **energy stored in the magnet** (**25 MJ**) on a dump resistor composed by two resistors in series, R1 and R2. Closing B3, a fast discharge without quench can be provided discharging the energy on R1.

Quench Protection System



R1 provides to the **fast discharge** of the coil without quench.

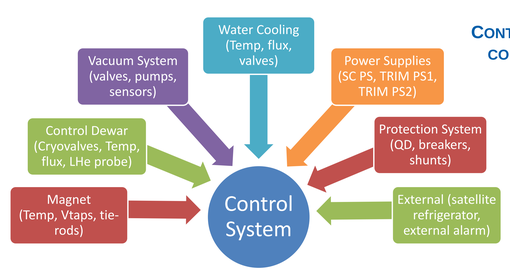
R1+R2 provides the **emergency discharge** of the coil in case of quench or other failures.

B1 and B2 switches the polarity of the system (only at **I = 0 Amp**)

Control System

The MPD Magnet is controlled by a Control System that operates the auxiliary systems, collects the signals from the cryostat, manages interlocks and retroactions, sets the parameters (e.i. SC cable ramp rate, temp threshold, etc.) and switches the operating regimes, including emergencies.

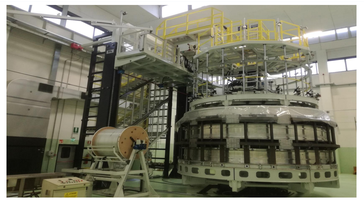
Control System connections



SC Coil Manufacturing

1ST STEP
Cable Insulation And Winding

The NbTi cable was insulated and wounded around three aluminum formers (modules), with vertical axis, using special tools designed on purpose.



2ND STEP
Modules Impregnation

Each module was impregnated with resin into a special oven. VPI process has been selected to get the best thermal, electrical and mechanical performances.

3RD STEP
Cold Mass Assembly

The three modules were tilted to horizontal axis and assembled together, completing the electric and LHe cryogenic circuits.

4TH STEP
Cryostat Assembly

The aluminum thermal shield was installed around the cold mass.
The cold mass was inserted into the vacuum vessel.
The exits (cable and cryogenic) were finished in a chimney on top.

Next Steps
Commissioning

The magnet was pre-tested at ASG Factory to ensure the vacuum tightness, the electrical insulation of superconductive cable and the functioning of all the sensors.
After shipment, the magnet will be installed on site into the iron yoke, all the auxiliary systems will be installed and connected to the Control System and, finally, the magnet will be cooled and ramped to nominal current.