MT25
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Optimization, Design and Operation Assessment of a Multi-Purpose Detector for NICA Collider (ID #861)

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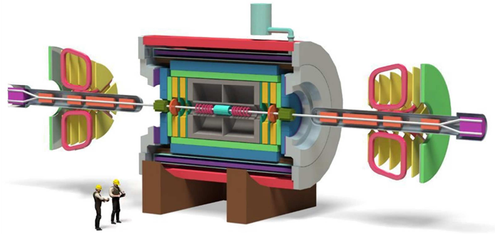
Multi-Purpose Detector (MPD) Magnet

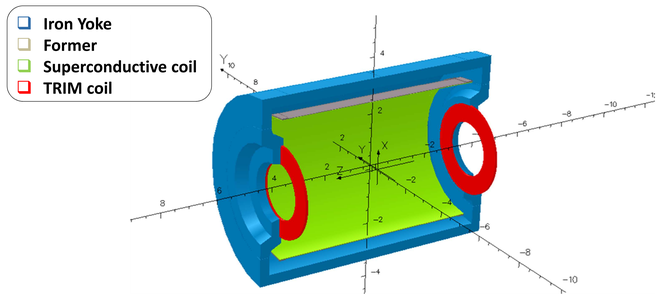
Nuclotron-based Ion Collider state-of-art design involves innovative solutions in superconductive applied technology [1]. Thanks to its consolidated experience, ASG has been directly involved into the program by providing to Joint Institute for Nuclear Research (JINR) a large 0.5 T NbTi superconductive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



[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

Low Field Magnet

The main component of the MPD is a superconducting solenoid magnet with a superconducting NbTi coil and an iron yoke for the flux return.
The magnet provides a highly homogeneous magnetic field of 0.5 T in a cylindrical volume (4596 mm diameter, 3400 mm length) to ensure the transverse momentum resolution within the range of 0.1-3 GeV/c at NICA.

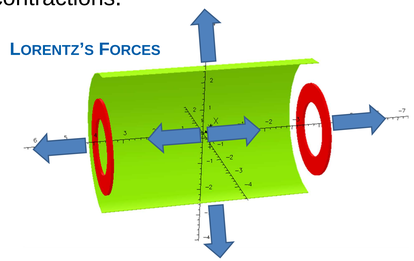


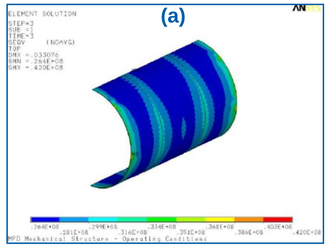
Correction to the main field is provided by two resistive copper coils (TRIM coils) which can be individually tuned in current to reach the requested homogeneity.

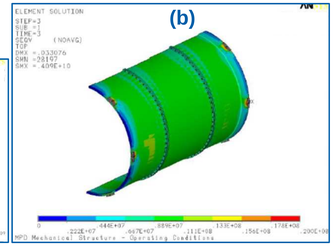
Magnetic Forces and Mechanical Stresses

A relevant aspect of the design is the evaluation of the mechanical stresses on the coils and on the mechanical structure. The stresses are generated by magnetic forces (Lorentz's Forces) and by thermal contractions.

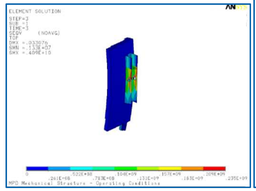
Lorentz's Forces





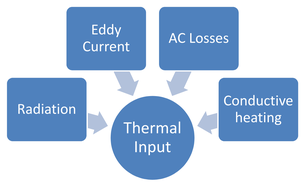


Mechanical stresses on the SC coil (a) and on the mechanical structure (b)

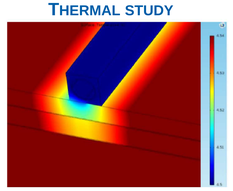


Thermal Design

In order to optimize the thermal design of the magnet, different aspects must be considered: Radiation, Eddy Current, AC losses and Conductive Heating (wire, tie-rods, current leads …).



Thermal study



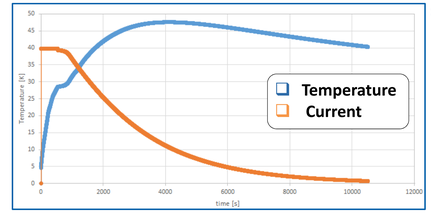
The following items have been coupled:

- He cooling circuit
- Thermal anchoring system
- Multi-layer insulation
- Thermal shield
- Optimized current leads

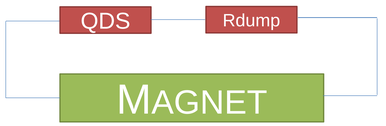
Quench

The superconductive regime is guaranteed if the temperature and the magnetic field do not rise up over the respective critical values.
If a superconductive coil quenches it is important that it discharges in a reasonable time avoiding that the coil temperature increases up to too high values at which a damage can occur to the wire. In order to avoid this phenomenon, superconductive coils are equipped with protection systems that discharge the energy stored in the magnet on a dump resistor.

Current and Temperature trend



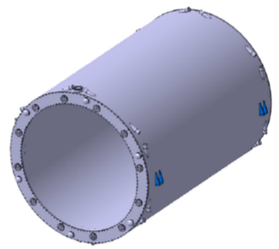
Quench Protection System



Production

ASG has been directly involved in the whole construction of the MPD magnet, from the design to the production.

Design



Production