Budker Institute
of Nuclear Physics
Novosibirsk

The Cryogenic Distribution Box of the SPD Superconductive Solenoid

(Current Design Status)

T.Bedareva, E.Pyata, M.Kholopov, A.Orlova

Budker Institute
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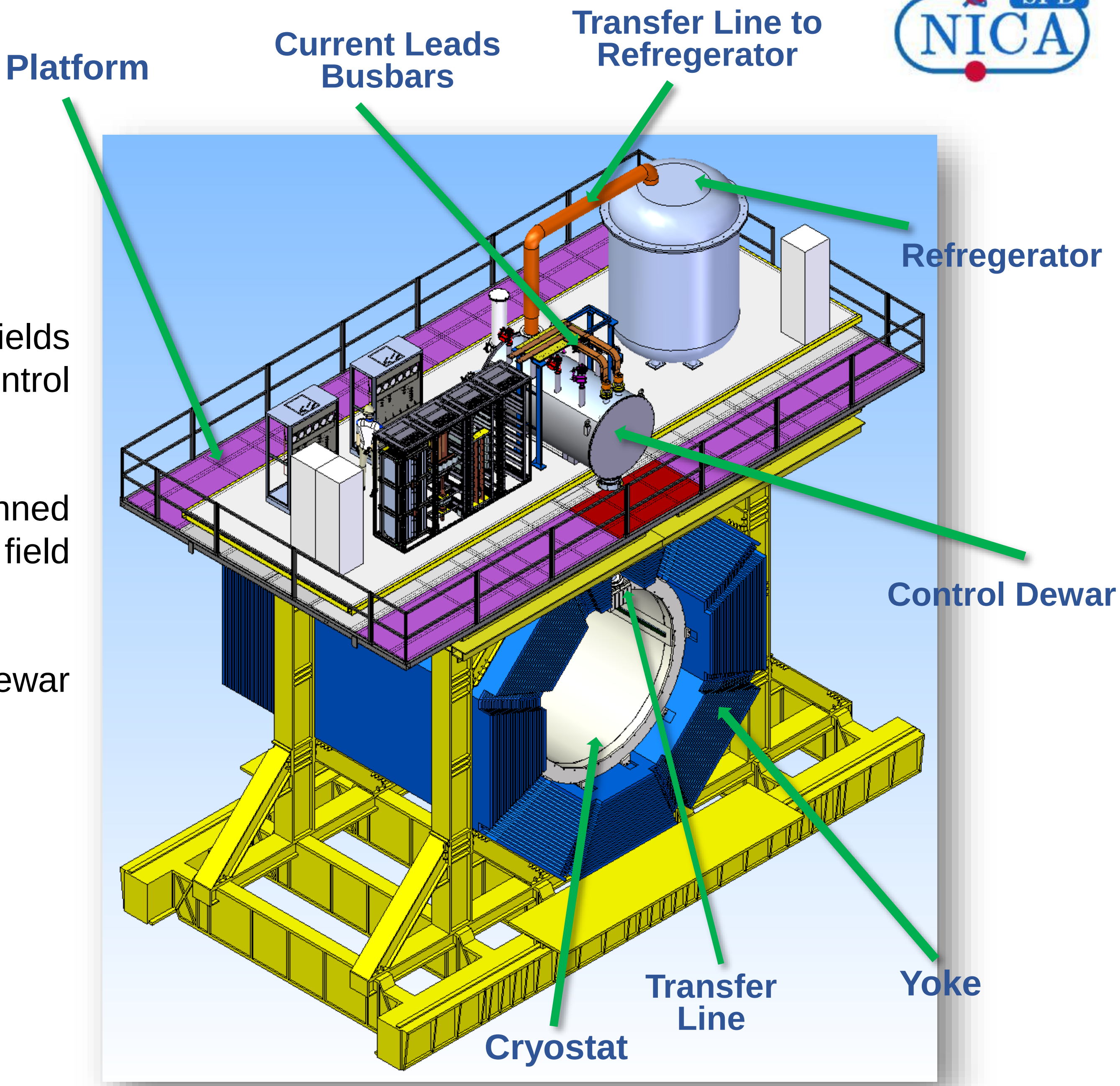
General information

The magnet cryostat with coils, cold mass and thermal shields is located inside the yoke. A distribution box called Control Dewar is located on the top octant of the yoke.

The overall dimensions are determined by the space planned to accommodate the SPD detectors and the magnet field parameters.

The total weight of the cryostat, transfer line and Control Dewar is ~20 t.

The magnetic field along the solenoid axis should be 1.0 T.

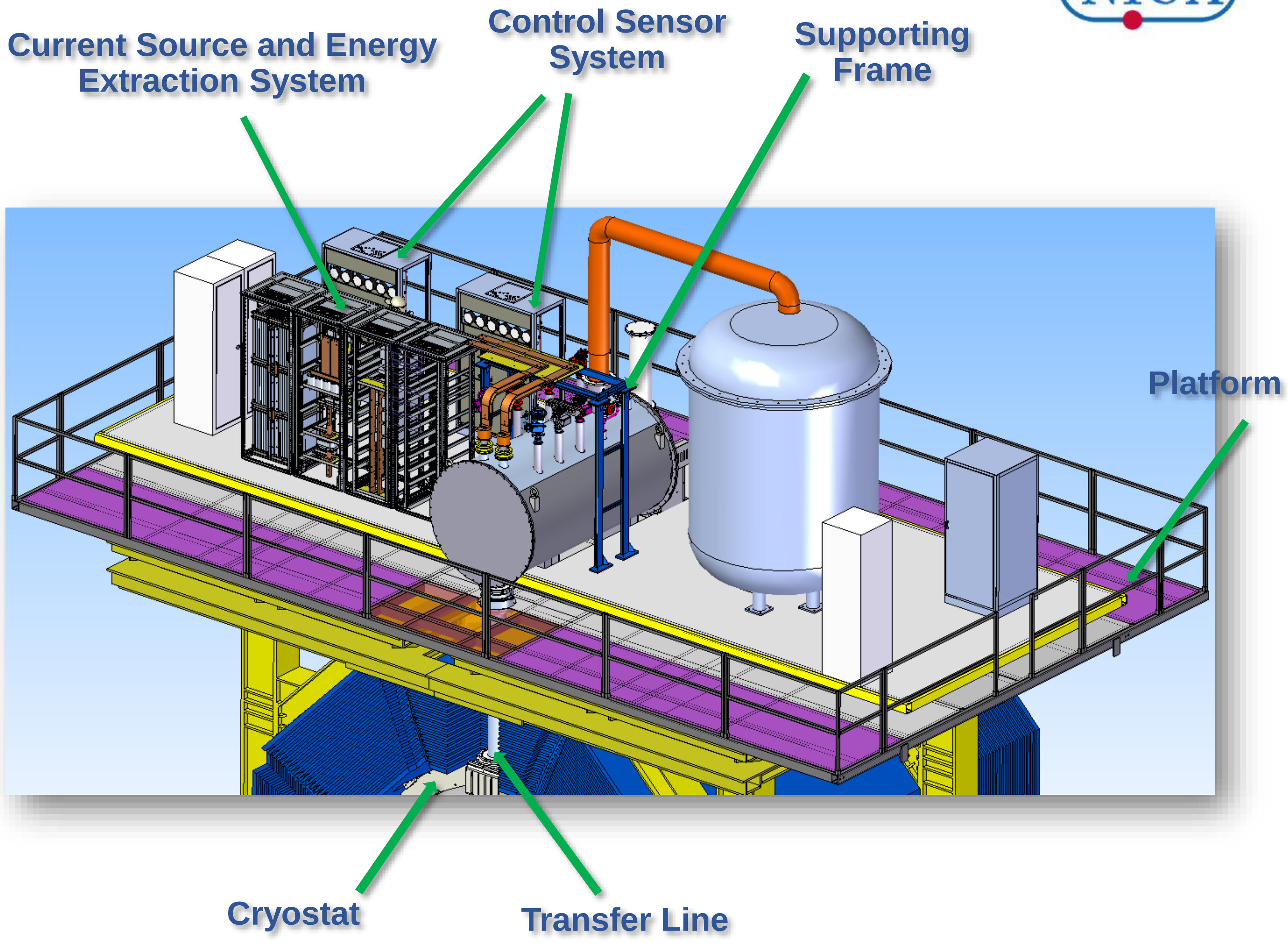


The SPD control Dewar is designed to ensure helium supply to the cryogenic system in accordance with the flow scheme.

The transfer line connects vacuum vessels of cryostat and the control Dewar.

The length of the transfer line depends on the size and configuration of the frame for sliding endcap halves, as well as the type of platform.

The supporting frame is used for current leads copper busbars fixation.



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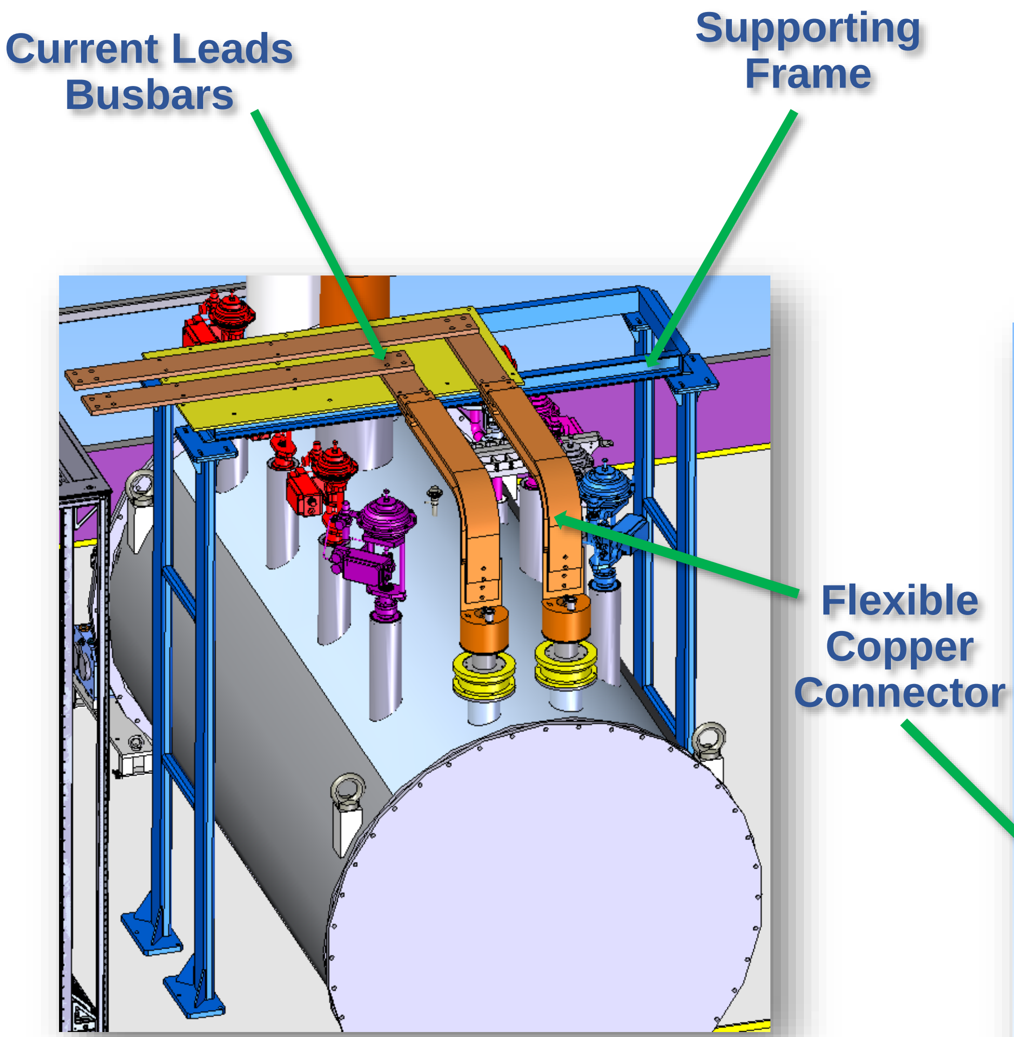
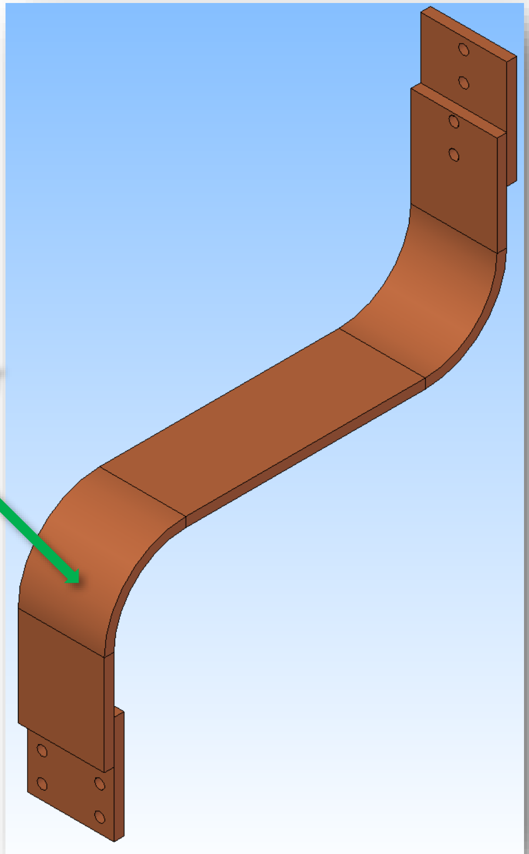
The flexible connector is made of laminated copper foil with high conductivity. Flexible copper connectors are made by press welding, where individual copper strips are fused together under constant current and pressure.

This type of flexible connectors provides minimal resistance and helps to increase current, lifetime, and reduce downtime.

In addition, these connectors have good mechanical and electrical properties at high temperatures





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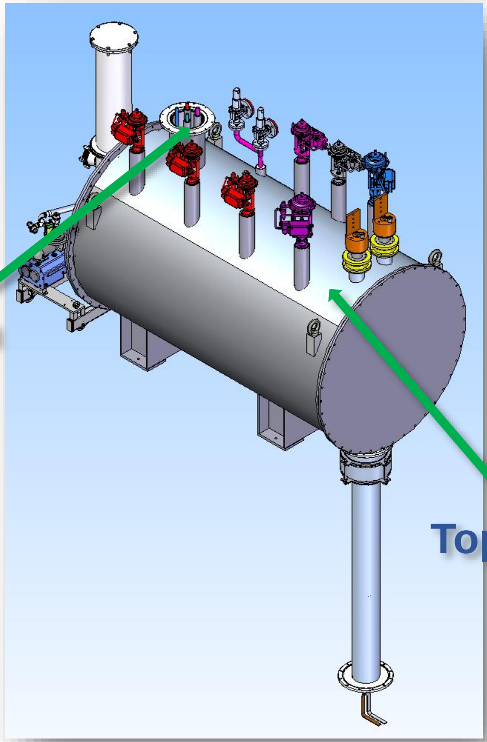
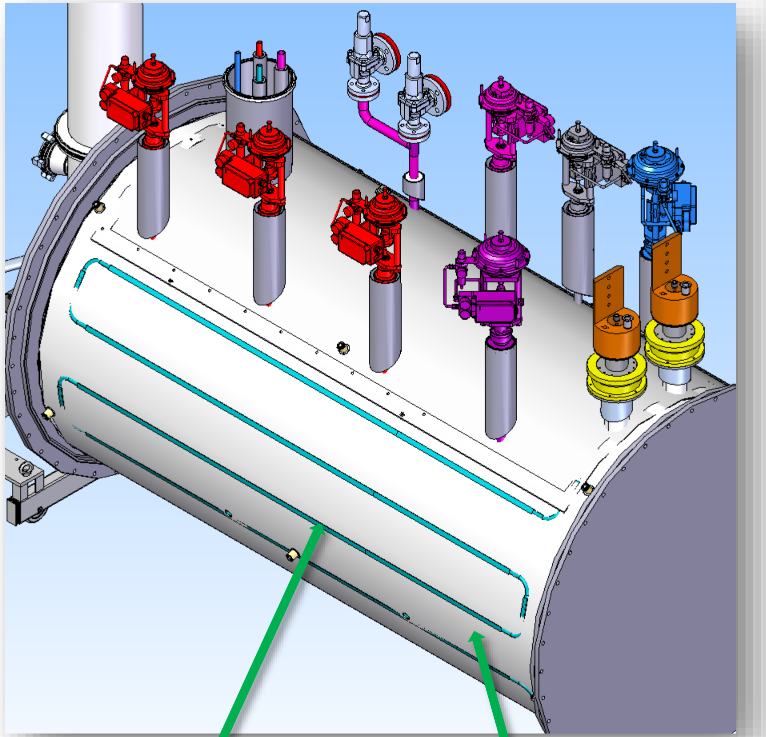
Distribution Box Design

The distribution box includes cryogenic valves, safety relief valves, the 800 liter liquid helium vessel, instrumentation and current leads for solenoid operation.



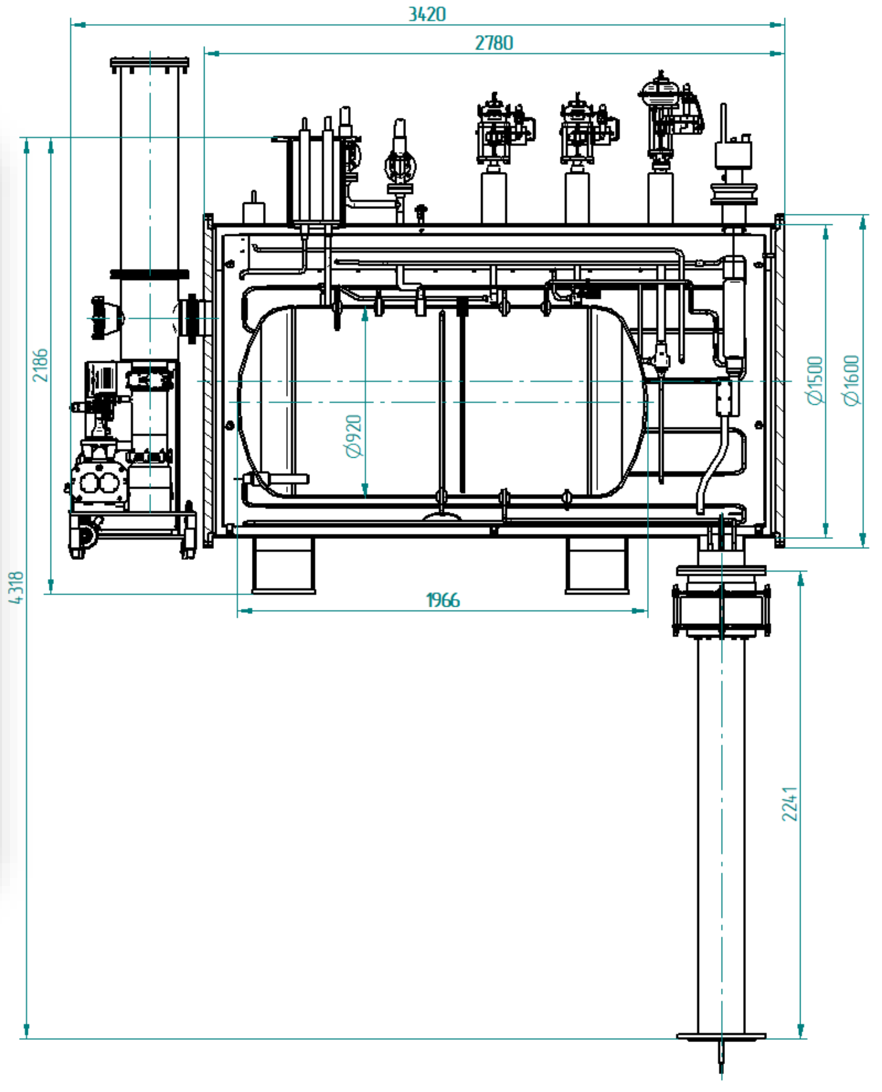
Vacuum Barrier Input

Top Cover



Pipelines 50K

Thermal Shield



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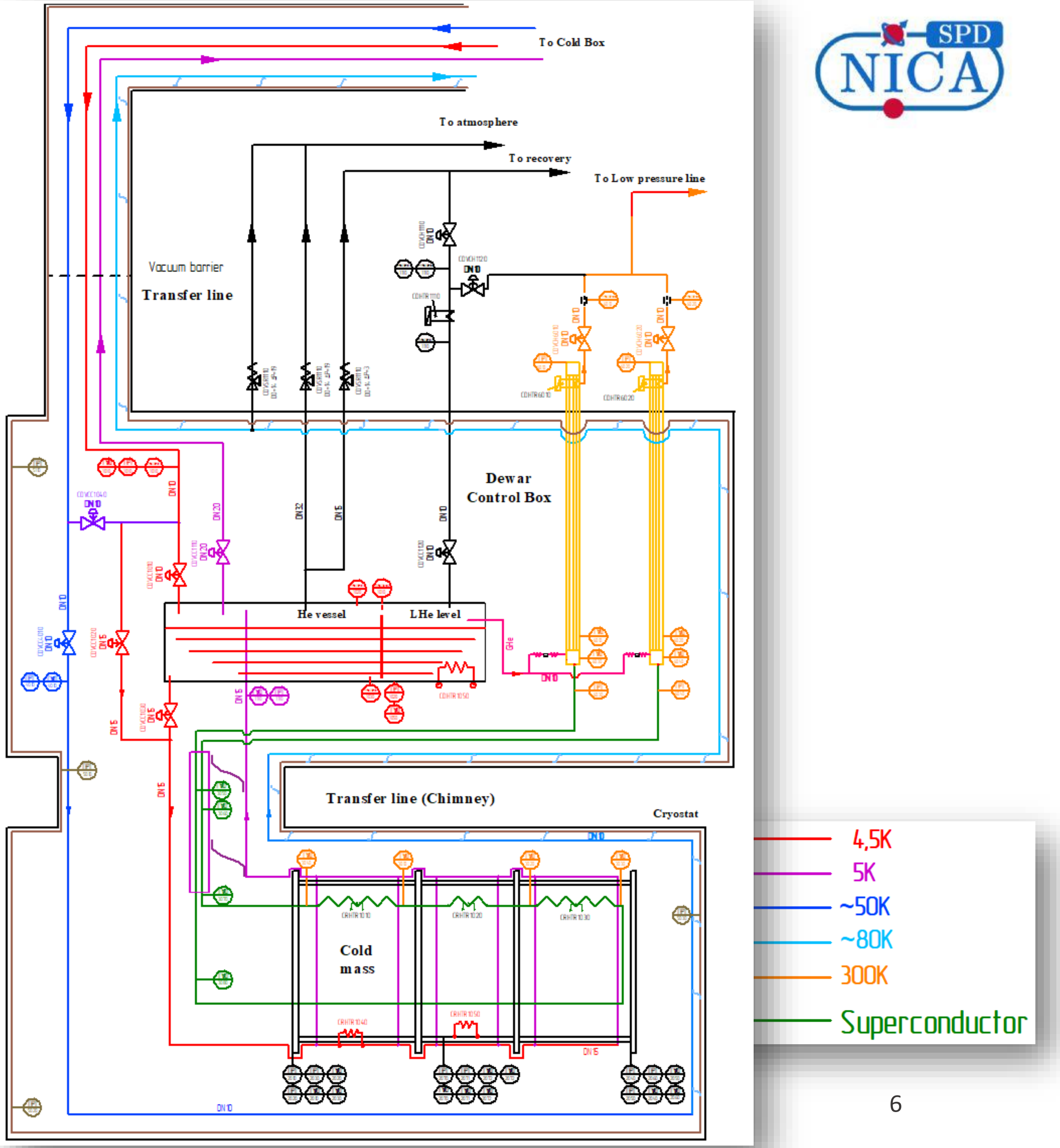
Flow Scheme

The cryogenic system of the cryostat and the control Dewar shall be designed according to the loads resulting in all operating scenarios. The design pressure for all pipelines and the helium vessel is 19 bar absolute pressure (bar-a).

Liquid helium used to cool the cold mass is supplied from the liquefier at a temperature of 4.5 K. Solenoid thermal shields surround the cold internal parts and are cooled by gaseous helium, which flows through serpentine heat exchanger pipes.

The helium stream exits the liquefier at a temperature level of 40 or 50 K and returns to the liquefier after passing the thermal shields at a temperature level about 80 K.
The Process Flow Diagram (PFD) of the SPD cryogenic system has the same principle as for the CMS solenoid (CERN) and PANDA (FAIR).



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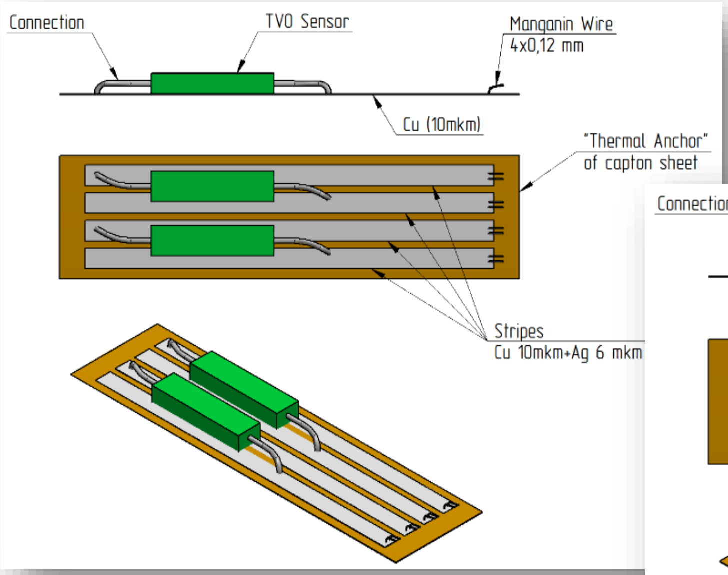
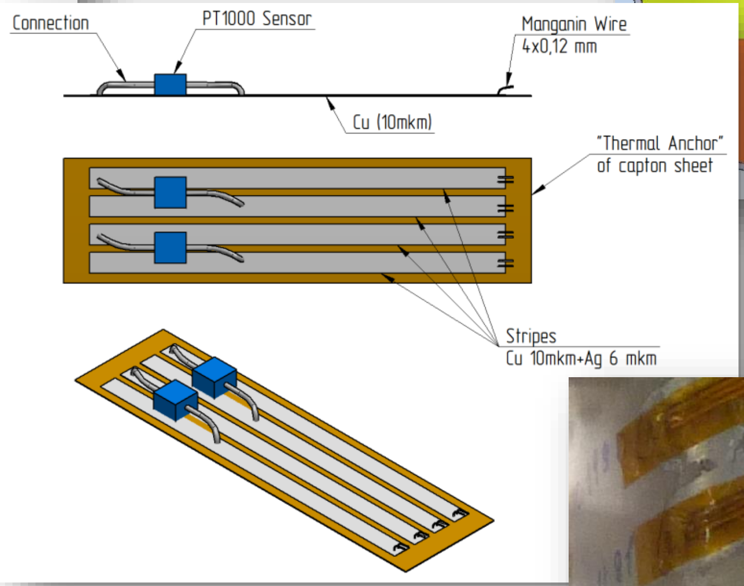
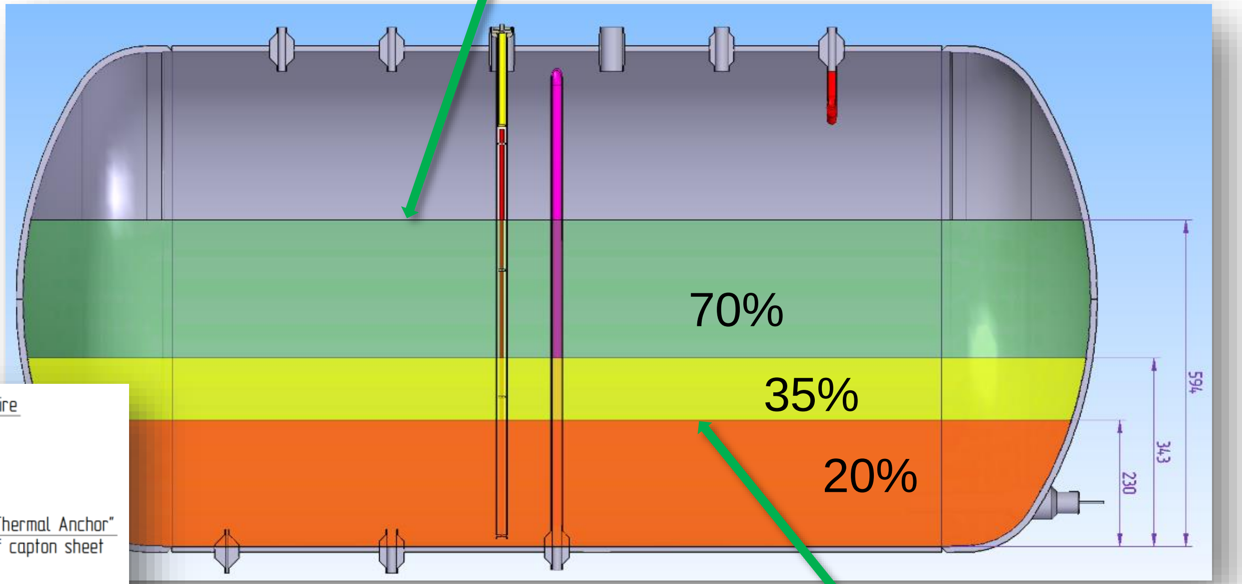
Temperature Sensors TVO and PT1000 Location

The volume of liquid helium in the vessel is 800 litres. The presence of 229 litres in the vessel must be guaranteed.
The maximum LHe level must be less than 594 mm from the bottom of the vessel.
The minimum LHe level must be more than 230 mm..





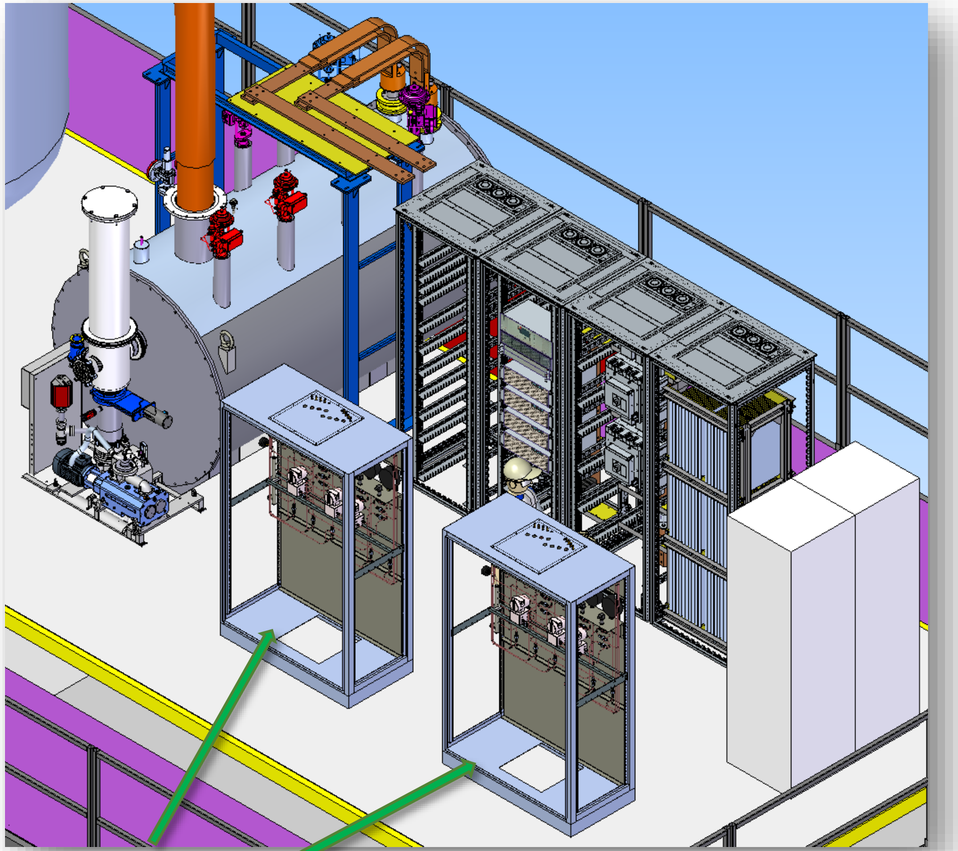
Maximum LHe Level

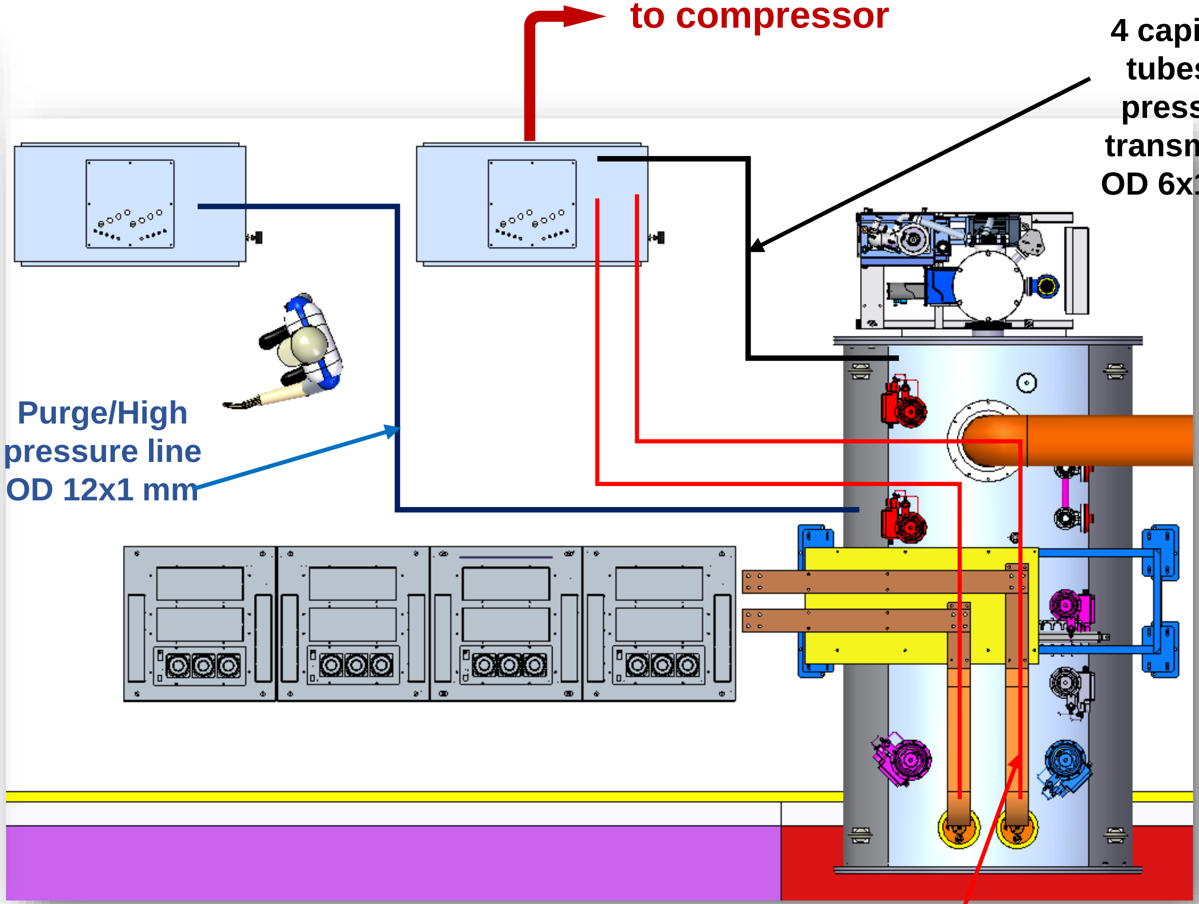


Minimum LHe Level

For temperature monitoring, TVO sensors and PT1000 sensors are planned to use for elements of the cryogenic distribution box.

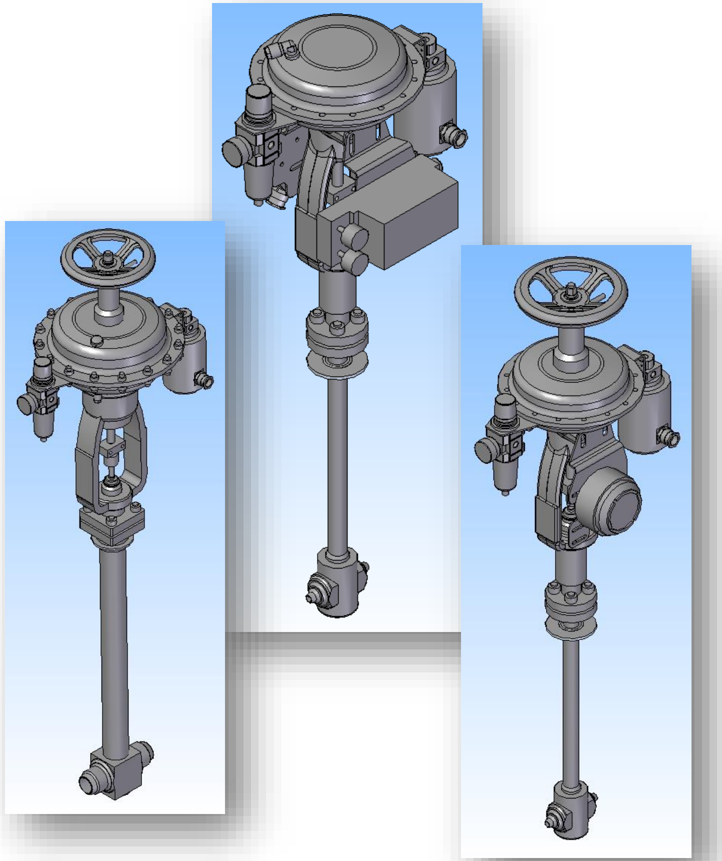
Sensor Connection Diagram

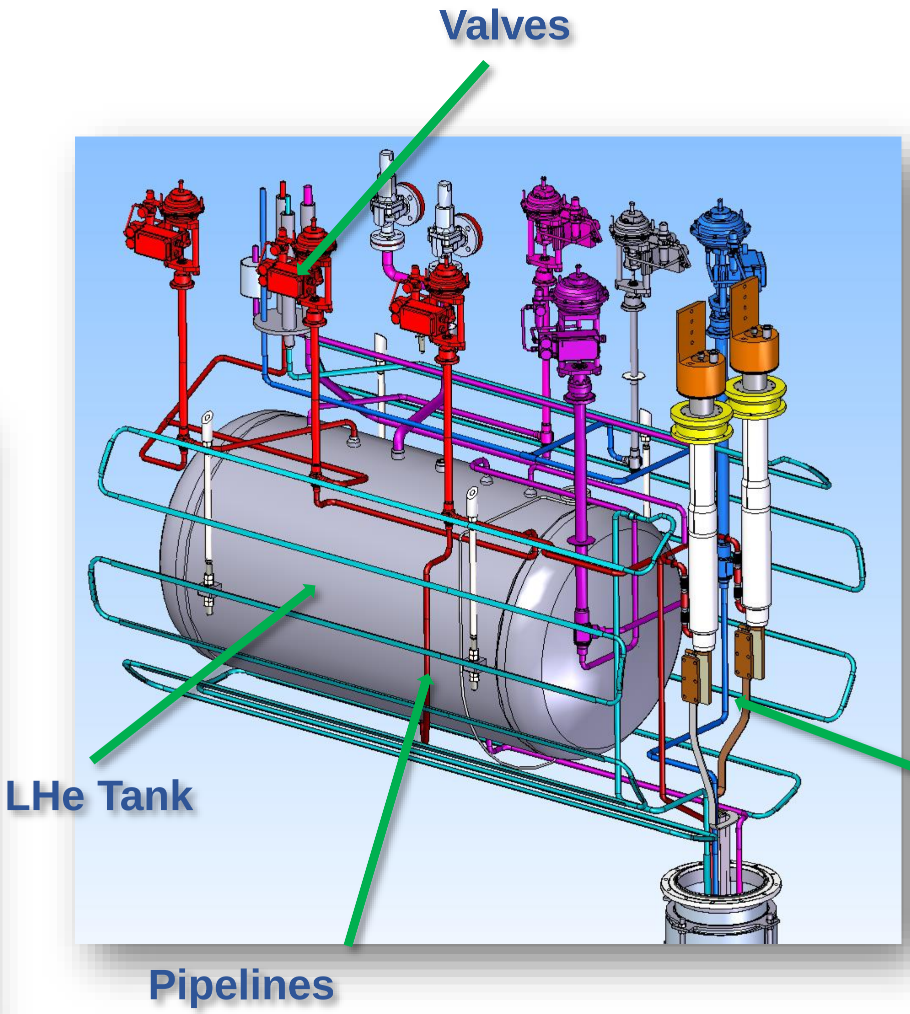


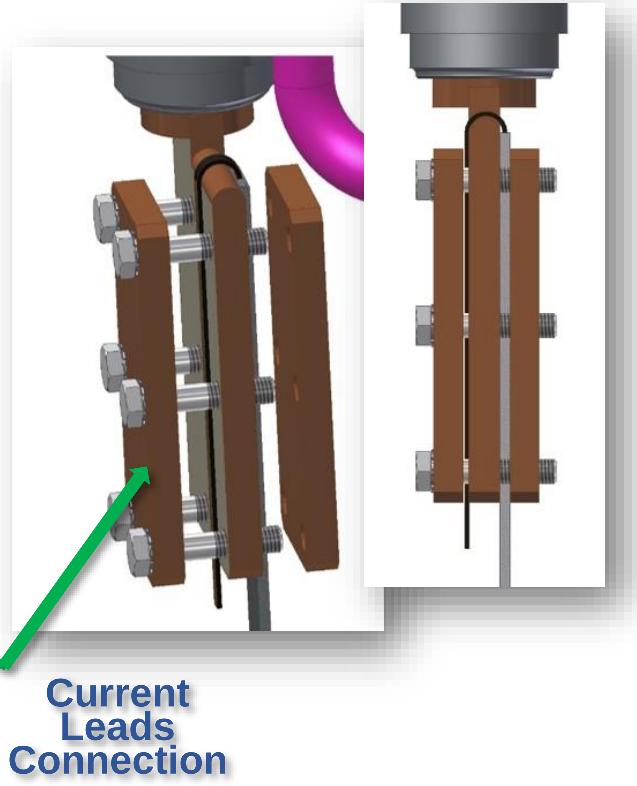


Control Sensor System

The sensors will be connected by using capillary tubes and signal cable





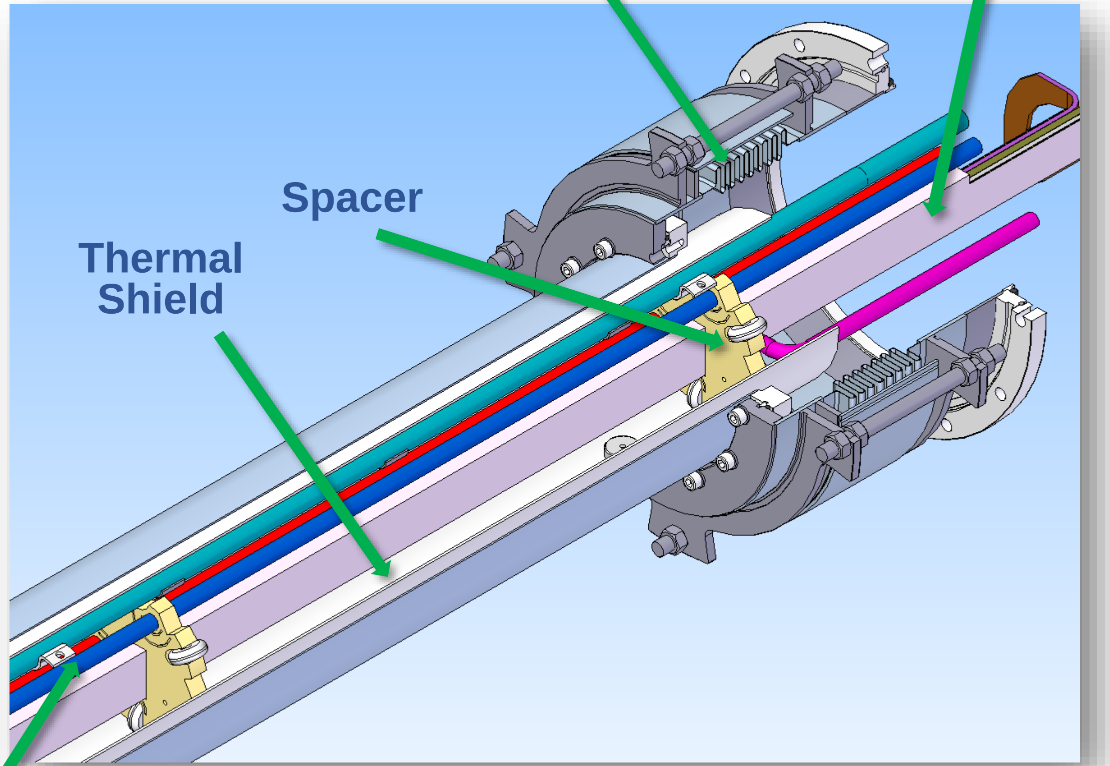


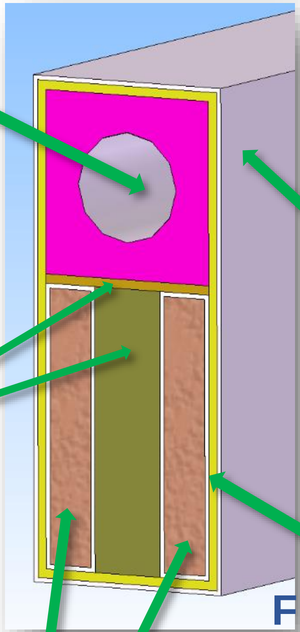
For the distribution box, it is assumed to use valves made by LG Automatics (Russia).

Connection of the SC conductor to the current lead terminal. The surface of the terminal is tin plated with tin solder to avoid potential between copper and aluminum. Spring washers are used. Rutherford cable is soldered with a minimum length of 150 mm.

Transfer Line Design

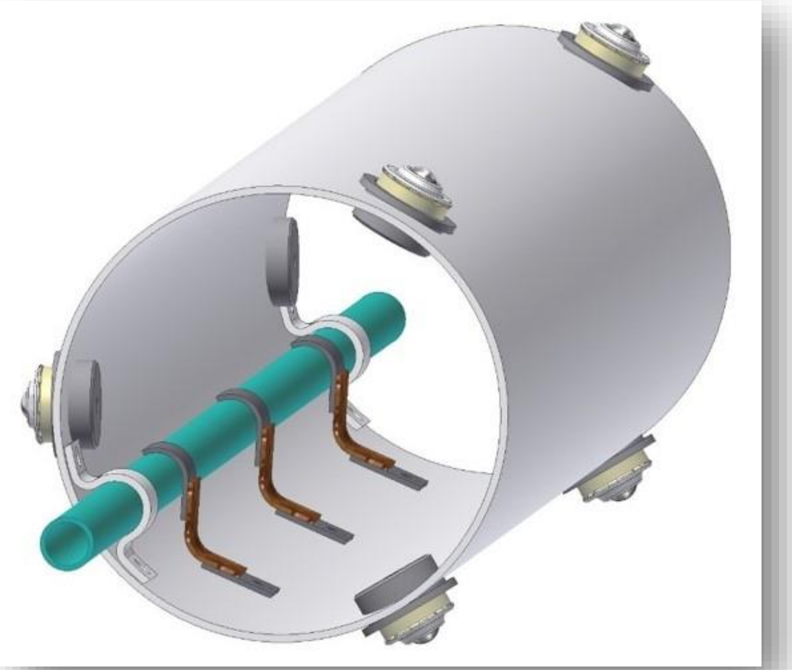
The transfer line connects the vacuum volumes of the cryostat and the control Dewar. The transfer line has an outer diameter of 219.1 mm and the wall thickness of 2 mm. It contains the superconducting busbars, direct and return pipes for gaseous and liquid helium flows and measurement wiring. All components are surrounded by a thermal shield.

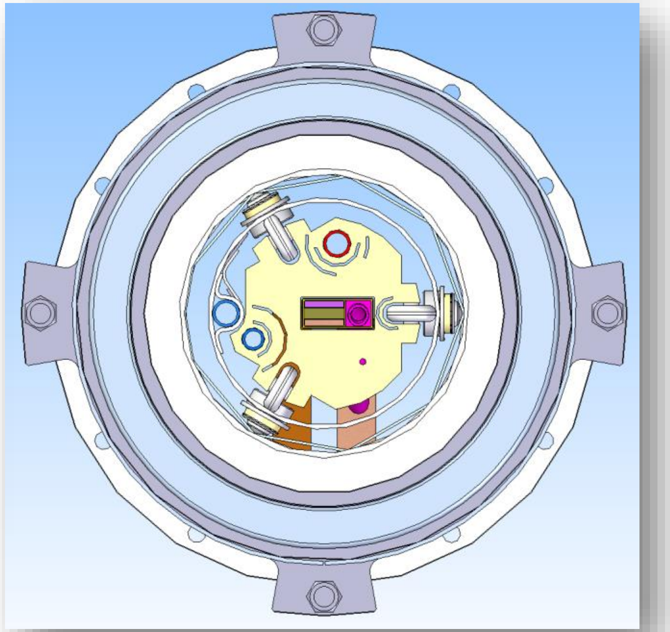




The busbars going to the magnet are not cooled and this is a high risk of quench or even too high temperature for the SC.
The proposed by BINP design provides the temperature regime of the conductor.
In order to validate this design, several tests need to be performed.

The 80K pipe should be fixed to the transfer line thermal shield and for this thermal bridges are installed every 350-400mm.





The figures show of the transfer line’s thermal shield with thermal bridges and transfer line cross section.

Thank you for your attention!