Contents

1. Scope

I. This document defines design principles for components supplied with liquid helium by the central helium refrigerators.

- Cryo-magnetic modules within superconductive particle accelerators
- cryogenic supply systems
- cryogenic transport systems
- cryogenic current lead boxes
- auxiliary cryogenic systems within superconductive particle accelerators

II. This document is not related to experimental areas, with their independent cryogenic supply (via their own cryogenic refrigerator or dewar supply). The handling of the supply by dewars filled by the central helium liquefier is described in a separate document [1].

2. Definitions

The interfaces between the different cryogenic systems are described in a special document [2].

3. Codes and Standards

I. Arbitrary Text

II. Arbitrary Text

4. Design Remarks

The volume of liquid helium should be kept as small as possible to reduce the amount of helium inventory for safety and operational reasons.
All helium-bearing components should have plane surfaces and avoid steps to achieve a low pressure drop in the helium system during operation. All changes in diameter (for example at branching of smaller flows) the junction should be chamfered. All soldering/ welding should be made in such a way to prevent soldering/ welding material to form into the flow cross section and to lower the free flow area.
The capillary tubes for pressure measurements should have some extra length to lower the heat load; a fast response of the measurement is secondary. For all connections between ambient and the 4K level it has to be proven, that the probability of thermoacoustic oscillations (Taconis Modes) is unlikely.

4.1. Cool-down

To achieve a maximum cool down speed, the mass located on the 4K level should be reduced to the functional required minimum.
To avoid accumulation of residual gases during cool down, each volume has to be designed in that way that during purging a defined helium flow can be feed through. In addition lowering the pressure of the component to 10^4 Pa (.1 bar) should be possible
To achieve short durations during cool down and/ or warm up operation the system will be operated with helium at a higher than operation pressure. The maximal operating pressure of the compressors will be used to increase the helium flow rates. Therefore all components should resist this pressure. (Special protected area may be discussed). The design should follow the technical guidelines [5]. In addition the valves, especially for Joule- Thomsen- valves, the cool- down characteristic has to fit to the cool down requirements. If not a parallel cool- down valve should be foreseen.
For the design it has to be demonstrated by calculations that during cool-down each line may be cooled down individually, even if this scheme is not possible from the piping scheme. Therefore components should resist the stress due to 300K temperature difference. If the design can not cope with this requirement, individual demands may be specified between the FAIR officer and the supplier in due consideration of the local cooling scheme. For the length compensation lyra compensators should be preferred, where ever space and functionality allows.

4.2. Design heat load

The heat load onto the liquid helium supply has to be minimized by interception of the heat load by the shield cooling return and/or the return of the evaporated helium at low temperatures as often as possible. In addition the heat load onto the shield temperature level should be concentrated onto the return.

I. For each component the design heat load onto the different temperature levels is defined in the detailed specification.

II. If this design heat load is exceeded during the preparation process for the component the necessity has to be demonstrated and the higher heat load may be accepted by the responsible FAIR officer.

III. If an excess of the heat load of more than 10% is determined during the acceptance tests the supply will have to cover the additional energy costs during the operation time of the machine. The following efficiencies for the different temperature levels are assumed independent from the real operating conditions.

4K supply – 5K return	250 W/W
4K supply – ambient return	29 kW/W
50K supply – 80K return	25 W/W
50K supply – ambient return	3 kW/W

4.3. Measurement and Control system

The complete cryogenic system will be operated by a single control system, supervised from the central control room. The control system will be provided by BEL [3]. The information about the required control loops/ algorithm has to be provided in the defined from (BEL document). All I/O units have to fulfil the form factors and bus protocol specified by BEL [4].

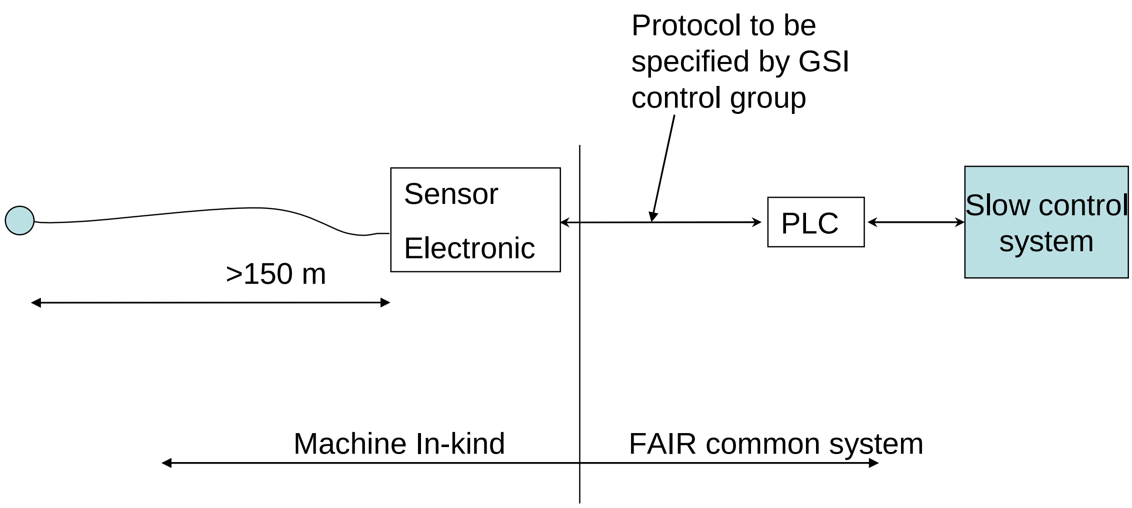

Figure 1: schematic sketch of the interface between the measurement hardware and the control system

For radiation reasons it should be possible to place the sensor up to 150 m fare away from the sensor electronic.

For more details pay attention to the technical guidelines:

5. References

[1] Technical Guideline: Supply of liquid helium by dewars
[2] Common Specification: Cryogenic
[3] Common Specification: Slow control system
[4] Technical Guideline: Protocol and form factors
[5] Technical Guideline: Pressurized vessels