

GSIT MT Internal Note: MT-INT-ErF-2008-001	05.01.2008
Title <i>Space requirement for the SIS300 dipole diode stack</i>	Eric Floch

1 Introduction

This note gives the rough space requirement for the SIS300 dipole diode stack. This information is needed to design the dipole cryostat and define how to suspend the cold mass inside the cryostat.

2 Protection scheme

In the FAIR Technical Report that is written in this moment, the quench protection scheme for the SIS300 dipoles uses dump resistors, cold diodes and quench heaters (Fig. 1).

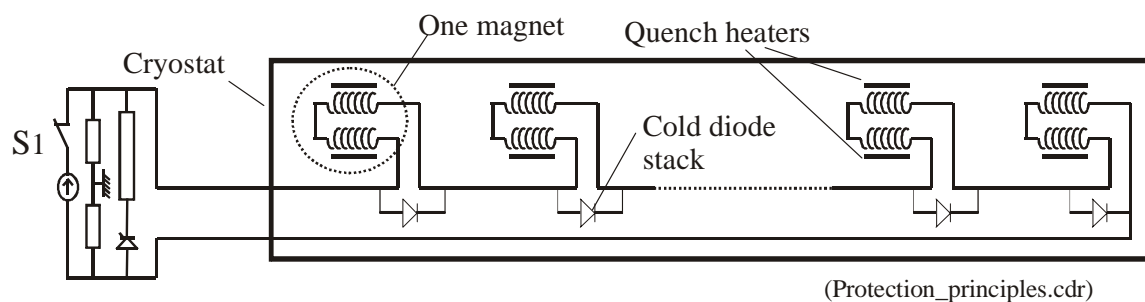


Fig. 1 Schematic of a magnet string protected by dump resistors, quench heaters and diodes.

Measurements done at CERN on LHC type diodes (Table 1) show that the average turn-on voltage of a diode at 4.2 K is 5.7 V.

Table 1 . Measure of the diode turn-on voltage at 4.2 K of 8 LHC diodes (made at CERN by. A. Gharib and D. Hagedorn) The SIS300 dipole circuit.

Vto	sum	min	max	average	sigma
(V)	45.6512	5.5136	5.9296	5.7064	0.1527

Table 2 shows that we need 5 diodes in series for the short dipole and 9 for the long one.

Table 2 Dipole and diode stack turn-on voltages.

SIS300 Dipole	I (A)	L (mH)	V (V)	n° of diodes in series in stack	V _{to_stack 4.2K} (V)
long	8924	22.5	44.62	9	51.3
short	8924	11.25	22.31	5	28.5

3 Space requirements

Fig. 2 shows the dimension of the LHC type diode as produced by Dynex (in England).

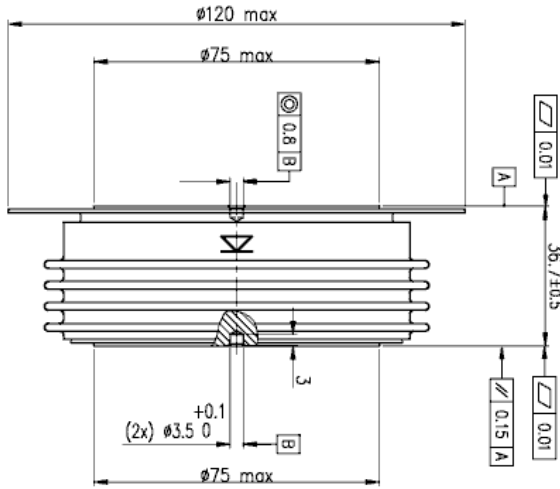


Fig. 2 Dimensions of one LHC type diode.

The forward voltage of LHC diodes was measured up to 2 kGy and $2E14$ neutron/cm². D. Hagedorn (ref 1) studied the behaviour of one 8 diode stack with an extrapolation up to $1E15$ neutron/cm². Using one Cu heat sink (**15 mm thick with a diameter of 120 mm**) between 2 diodes, the maximum wafer temperature is kept below 350 K. We will assume this dimension of heat sinks.

Fig. 3 presents the stack of 8 diodes that was built by Dynex for GSI. 6 of these 8 diodes were irradiated at ITEP (Moscow).

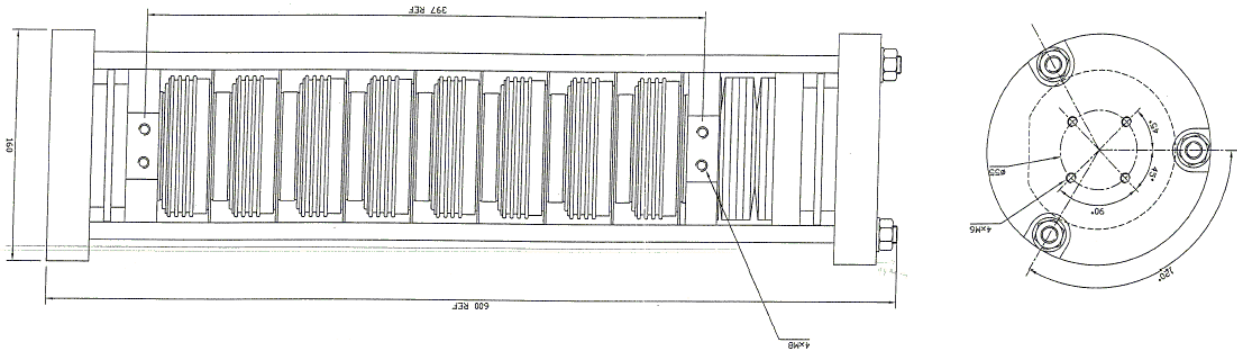


Fig. 3 Stack of 8 diodes that was built by Dynex for GSI.

Table 3 presents the dimensions of the different parts that will be present in SIS300 diode stacks.

Table 3 Dimension of the different parts that will constitute one diode stack.

SIS300 diode stack	thickness or length (mm)	diameter (mm)
diode	36.7	120
Anode or cathode	25.4	110
insulator	25	105
spring guide	20.2	110
1 spring	7.8	100
2 springs	12.8	100
3*2springs	38.4	100
heat sink	15	120
clamp plate	30.2	156

Table 4 shows that the dimensions of the heat sink and clamp plate are not the same than those used in Dynex 8 diode stack.

Table 4 Dimensions of heat sinks and clamp plates in Dynex stack and in SIS300 diode stacks.

"	n° of diodes	heat sink thickness (mm)	heat sink diameter (mm)	clamp plate thickness (mm)	clamp plate diameter (mm)
8 diode from Dynex	8	10.2	75.2	30.2	160.2
SIS300 dipole	5 or 9	15	120	30.2	156

Fig. 4 shows a diode stack of 5 diodes. The stack is covered by a G11CR tube (1.75 mm thick, with an outer diameter of 160 mm). The diode stack is then inserted in the diode box and could be fixed to it with a bayonnette as for LHC dipoles. **We must be able to open the box 3 times** to change the diode stack. Here the diode box is closed with bolts but it could be welded with the possibility of cutting it as for LHC magnets.

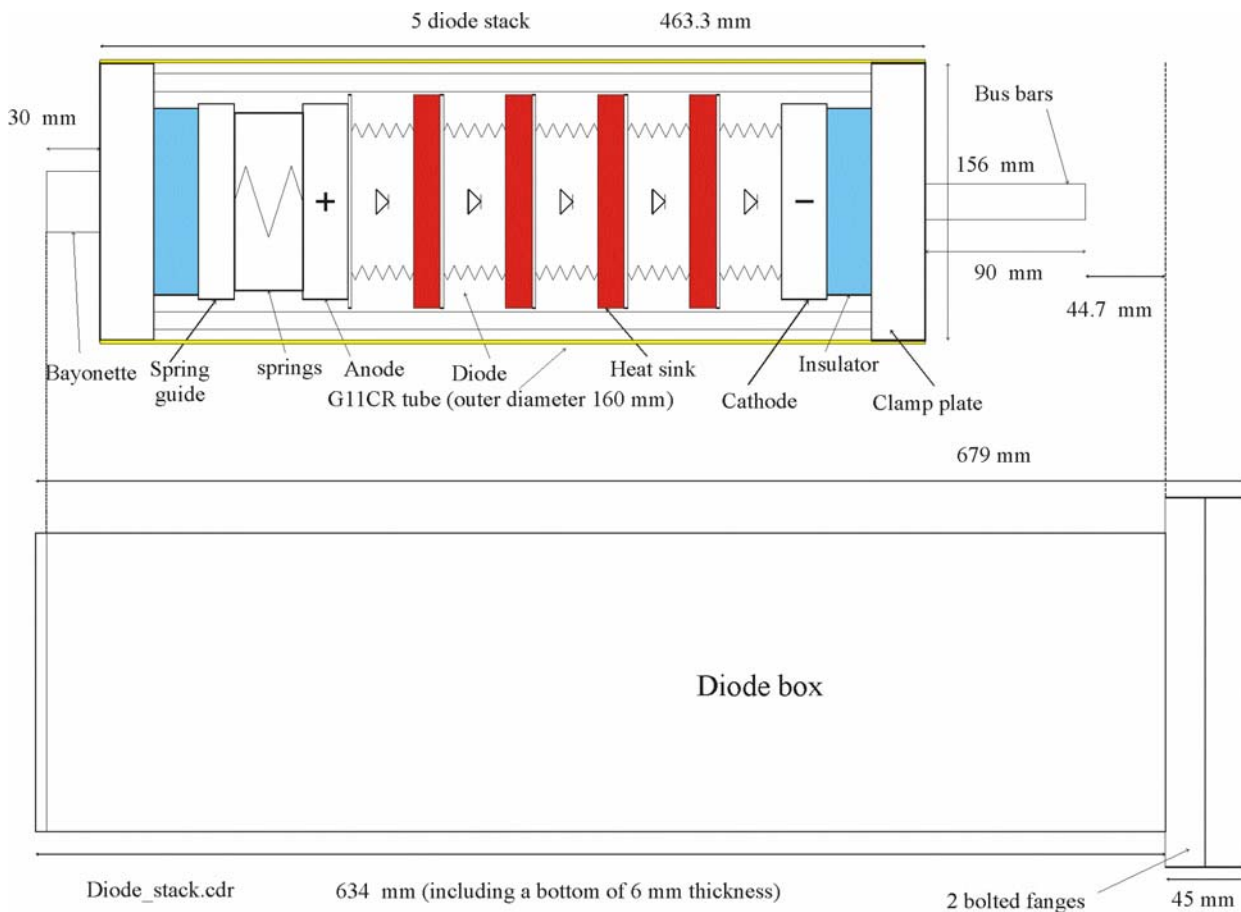


Fig. 4 Dimension of one stack with 5 diodes.

Fig. 5 shows a diode stack of 9 diodes.

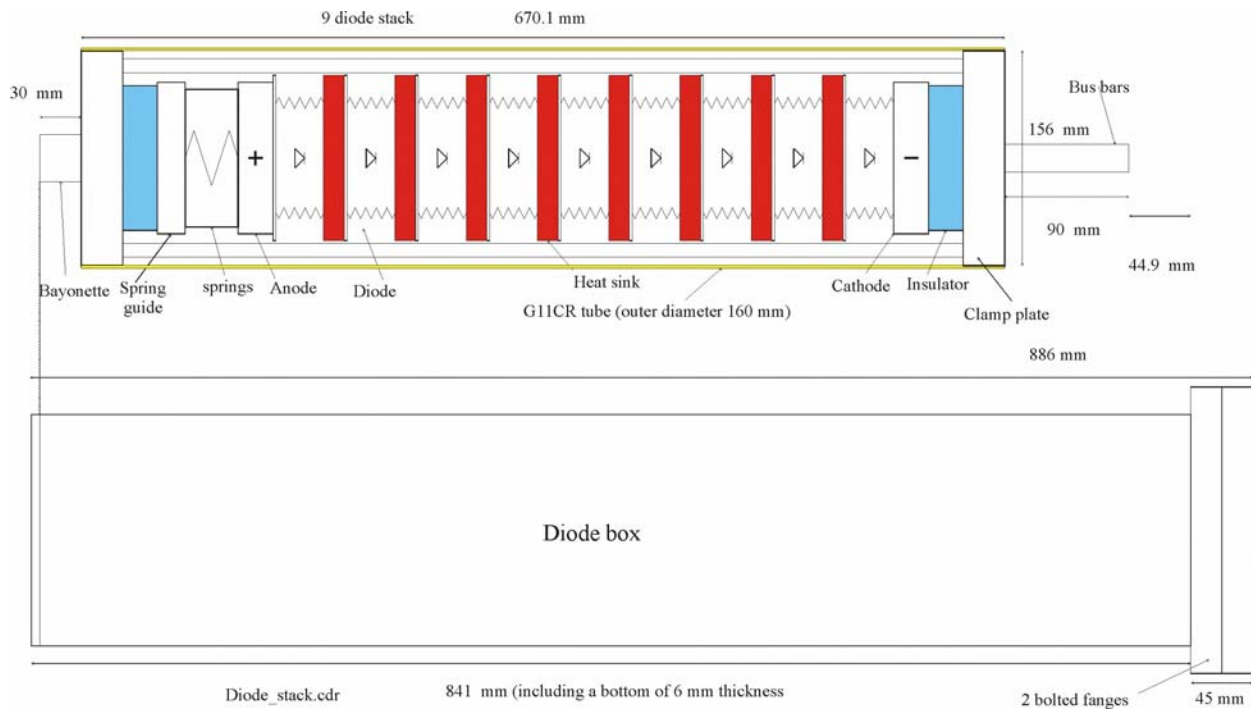


Fig. 5 Dimension of one stack with 5 diodes.

Fig. 6 presents how the diode box could be attached to the cold mass end cap. We must have the possibility to change the diode stack, which means the thermal shields and cryostats of two neighbor magnets must be at least 960 mm distant. This rough sketch gives a cryostat outer shell with an outer diameter of 858 mm.

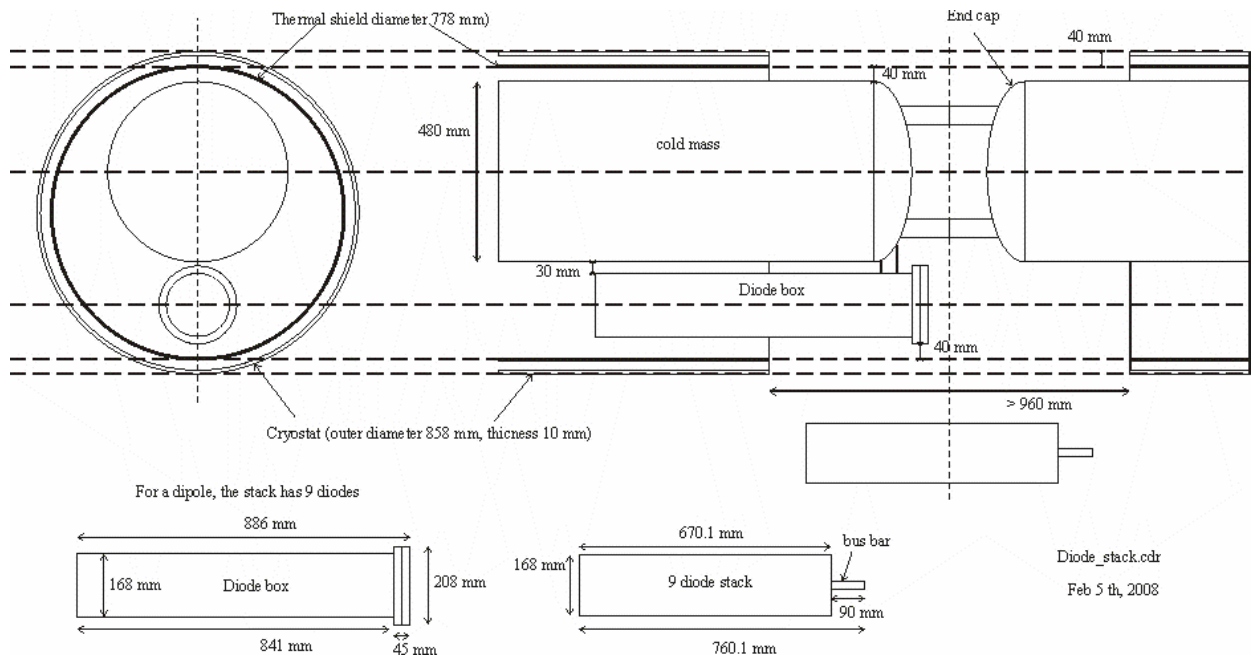


Fig. 6 Approximate dimension of the cryostat and approximate place of the diode stack.

references

ref 1 D. Hagedorn. "Expected irradiation effects on the by-pass diodes for the SIS 300 magnets with single-layer coils and heat-sink dimensioning". November 2007.

Private files on my documents

- This document: Diode_space_requirement_Feb08.doc
- SIS300D_characteristics.xls (dimensions of diode stack)