Conduction Cooled HTS Current Leads for the SIS100 Corrector

Magnets

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Abstract – The superconducting synchrotron SIS100 for the FAIR accelerator project requires 137 superconducting corrector magnets: chromaticity sextupoles, steerers and multipole correctors. These corrector magnets are distributed along a circumference of 1083.60 m. The coils of the corrector magnets are individually powered and require all together 244 pairs of current leads with the rated current of 250 A DC. To reduce the heat load to the cold mass of the superconducting ring the current leads will are de-signed by use of the HTS material with a heat sink at the temperature level of 50 - 80 K. Modern 2G HTS tapes with low thermal conductivity and high current density enable a compact design of the current leads cooled entirely by the thermal conduction of the copper parts. The first pair of the current leads has been fabricated and successfully tested at the GSI magnet testing facility. The experimental data are in good agreement with the calculated values. The design of the current leads is presented as well as the measured data.

Conduction Cooled Local Current Leads for the SIS100 corrector magnets

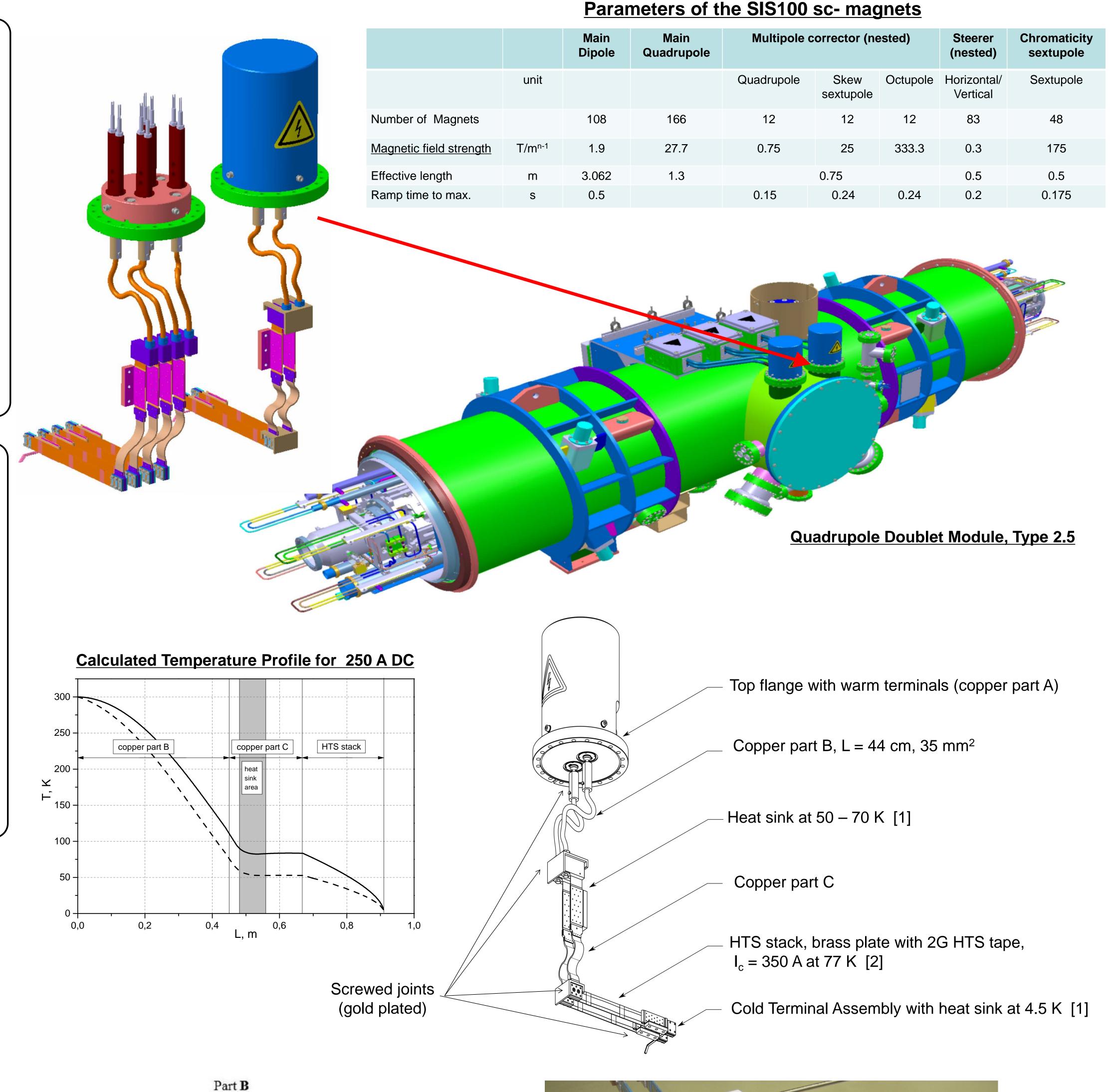
- Operating current up to 250 A DC;
- Pulsed mode operation between 250 A and +250 A at 3
 Hz repetition frequency;
- Short term operation at up to 300 A (magnet training);
- Low heat impacts to the cold mass at 4.5 K and to the thermal anchor;
- Thermal anchor temperature between 50 K and 80 K depending on the location in the tunnel;
- High voltage up to 1.1 kV, no degradation of insulation during long periods;
 Geometrical constrains: length, position of the thermal
- anchor in the cryostat;
 Compensation of the mechanical movement of the
- current lead assembly at cool down and warm up;
 Safe, easy and reliable assembly-disassembly within
- restricted tunnel conditions;
- at least 30 years operation time;

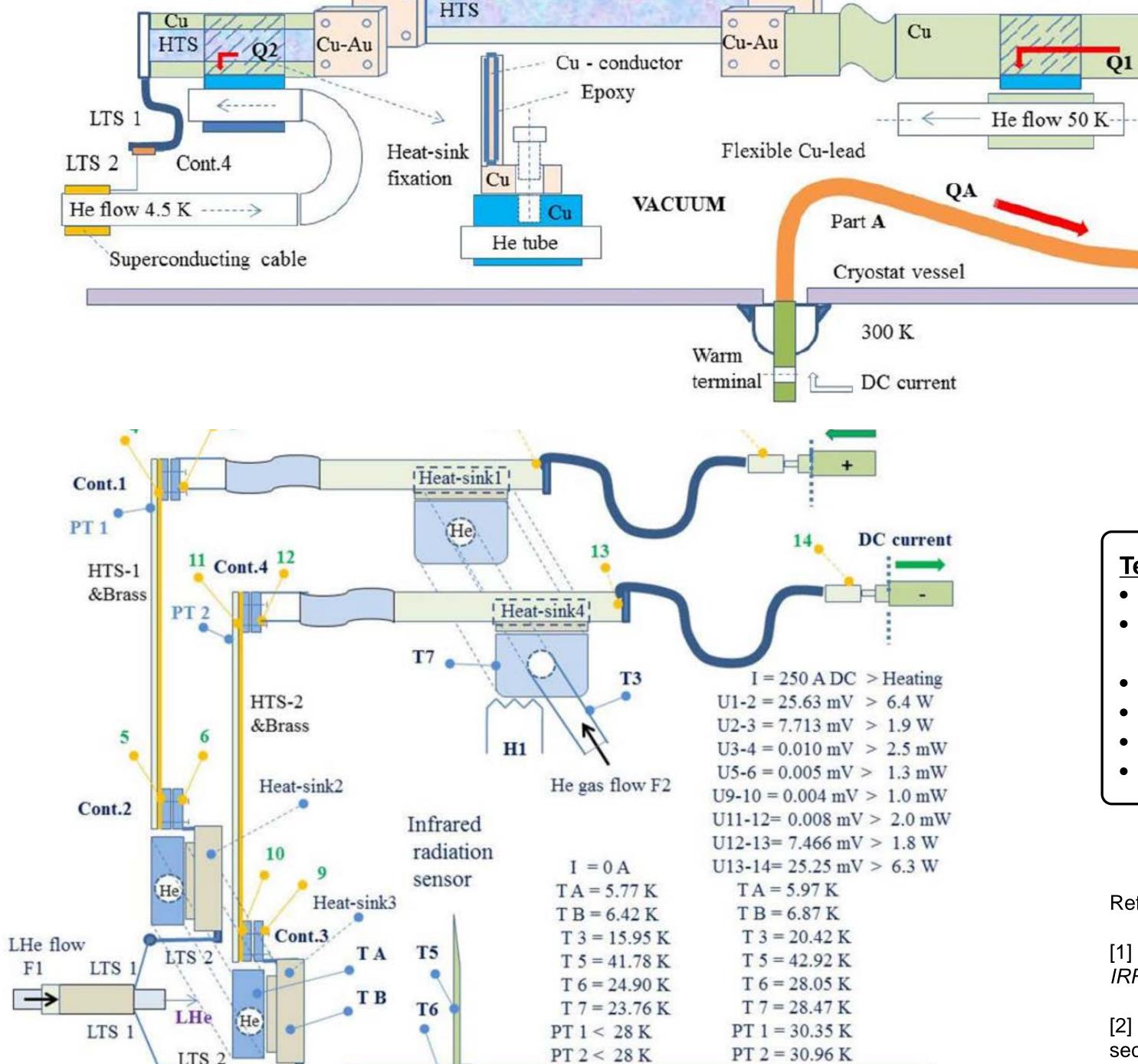
I = 0 A	I = 250 A DC
8.5 W	14.0 W
0.1 W	0.2 W
	8.5 W

Cont.3

Part D

Heat-sink 2





Part C

Cont.2

Brass

Testing of the Current Lead Prototypes

- Testing of performance of the HTS stacks and screwed gold-plated joints in liquid nitrogen;
 - Testing of the assembled current leads with cold terminals for corrector magnets at GSI magnet test facility
- Reliable operation at 250 A DC and 300 A pulsed currents;
- Heat generation in screwed Au-plated joints: 1.0 -1.3 mW at 4.5 K and 2.0 -2.3 mW at 50 K;
- No degradation of the contact resistances after several assembling/disassembling cycles;
 Tests in assembled quadrupole doublet module are scheduled for middle of 2018;

References:

Cont.1

Cu-Au

Heat-sink 1

[1] V. Datskov, A. Bleile, G. Hess and E. Fischer, "SIS100 HTS Local Current Leads - Cryogenic Performance", *Proc. of the 14th IRR International Conference Cryogenics 2017.*

[2] S. Lee, V. Petrykin, A. Molodyk, S. Samoilenkov, A. Kaul, A. Vavilov, V. Vysotsky and S. Fetisov, "Development and production of second generation high T_c superconducting tapes at SuperOx and first tests of model cables", *Superconductor Science and Technology*, vol. 4, no. 4, 2014.

