5K shield removal experiment in STF cryomodule

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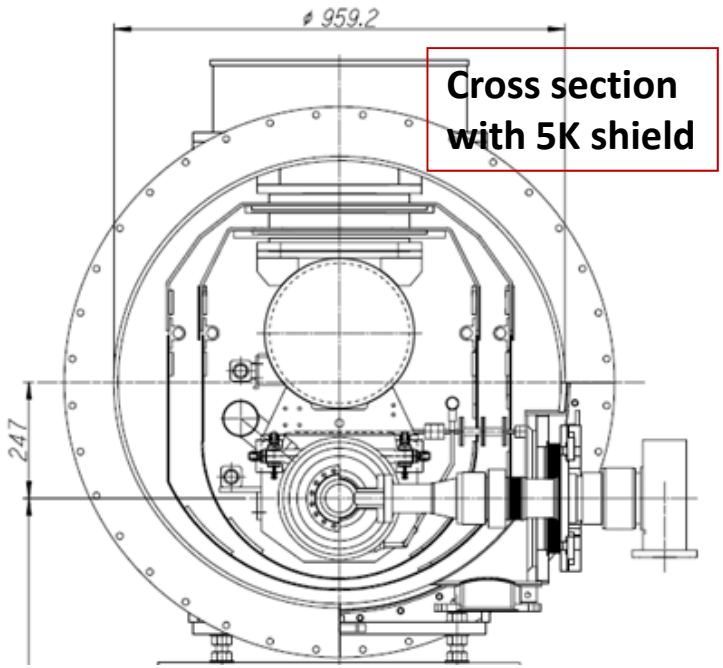
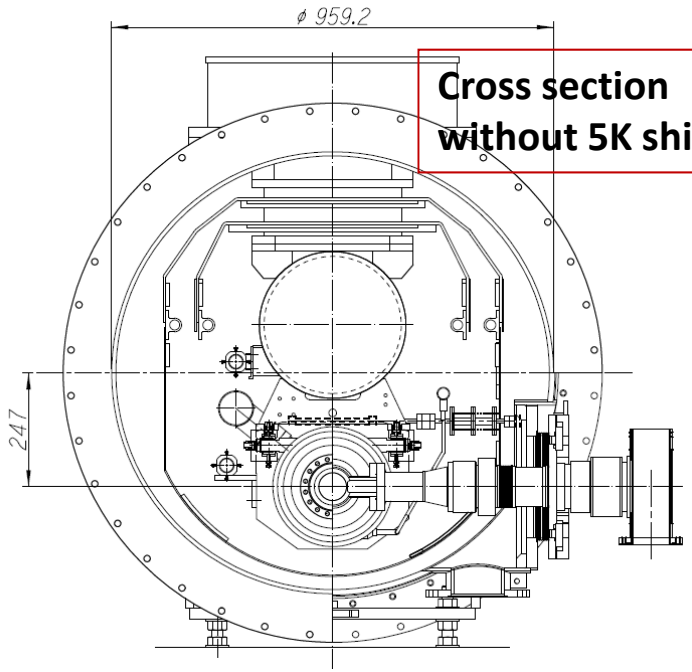
Introduction

SCRF meeting at FNAL (April 2008)

From the study of the balance between the cost of 5 K shield and the operation cost with and without 5K shields , the bridge part of 5K shield can be removed with keeping the plug-compatible design.



Cross section with 5K shield



Cross section without 5K shield

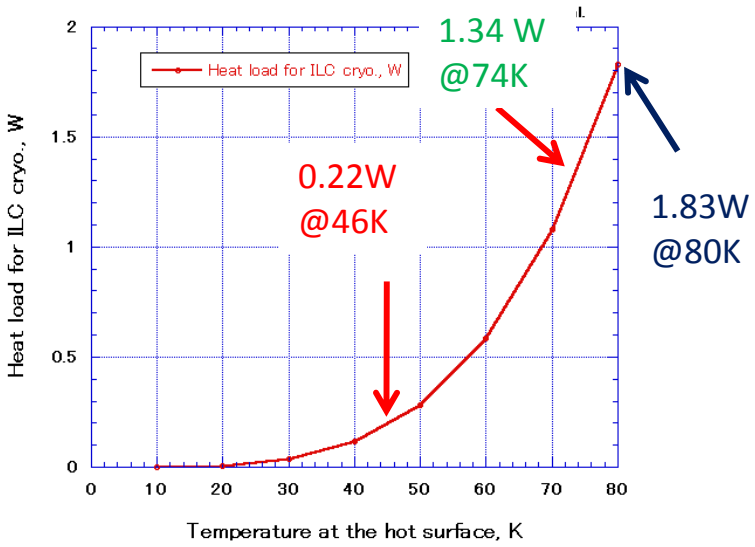
Target : making the effect of 5K shield on the heat load at 2K clear (comparison between heat loads at 2K with and without the 5K shield)

Test equipment of 5K shield performance in STF

Test conditions

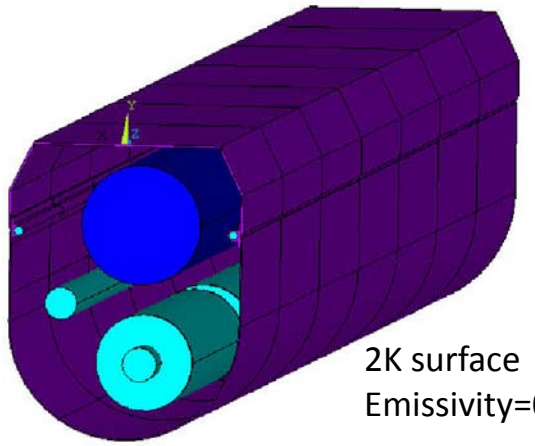
1. 4 dummy helium vessels as same size as the cavity jackets are installed in the STF-Module-B.
2. No input couplers.
3. Penetrations for the input couplers are closed with Al plates.
4. The outer shield (80K) is cooled by LN_2, and the inner shield (5K) is cooled by LHe.
5. Heat load at 2K is measured by the evaporation rate of 2K LHe in the dummy vessel.
6. In the previous experiments, the average temperature of 80 K shield was 86.5 K. For this shield temperature, the difference between the heat loads with and without 5K shield is calculated to be 1.14 W.

For ILC cryomodule geometry,



This calculation includes the geometrical factor of GRP, cavity vessel and LHe supply pipe.

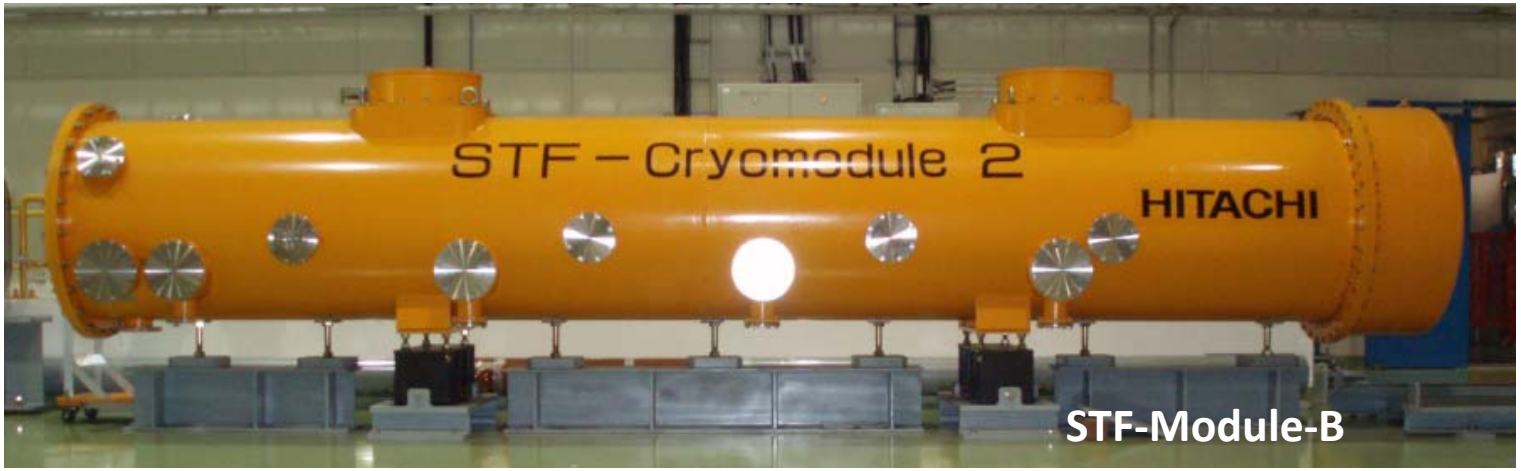
80 K shield surface
Emissivity=0.2



2K surface
Emissivity=0.03

STF-Module B for 5K shield tests

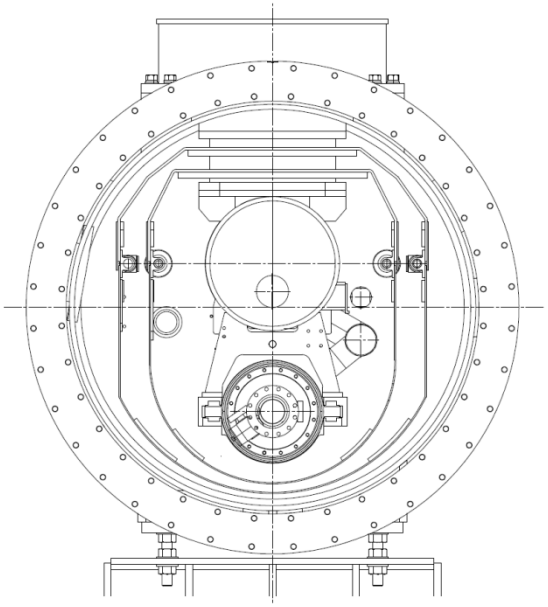
Length of the module-B= 5515 mm
(Module length in the spec. table=11829.6 mm)

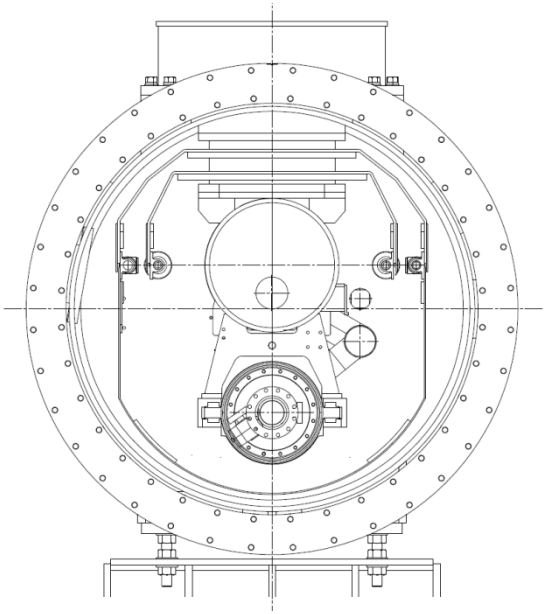


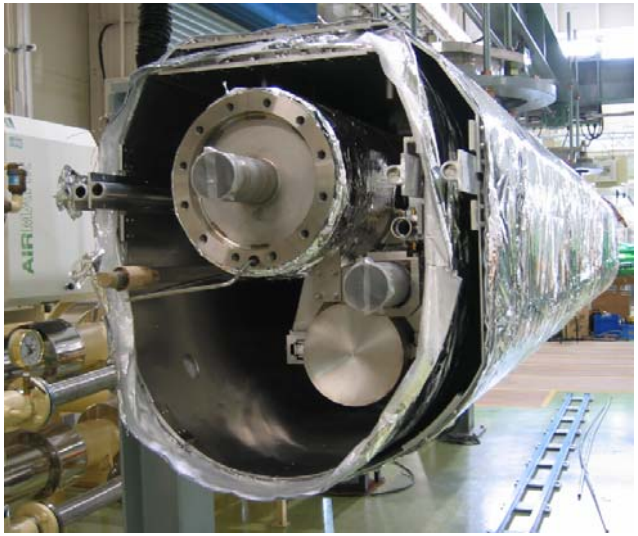
Gas return pipe and liquid helium supply pipe are covered with SI.

Dummy cavity jackets
(helium vessel: SUS and no SI)

STF-Module B for 5K shield tests







With 5K and 80K shield plates

Without lower 5K shield plates

Cryostat ends are covered with the shield plates.

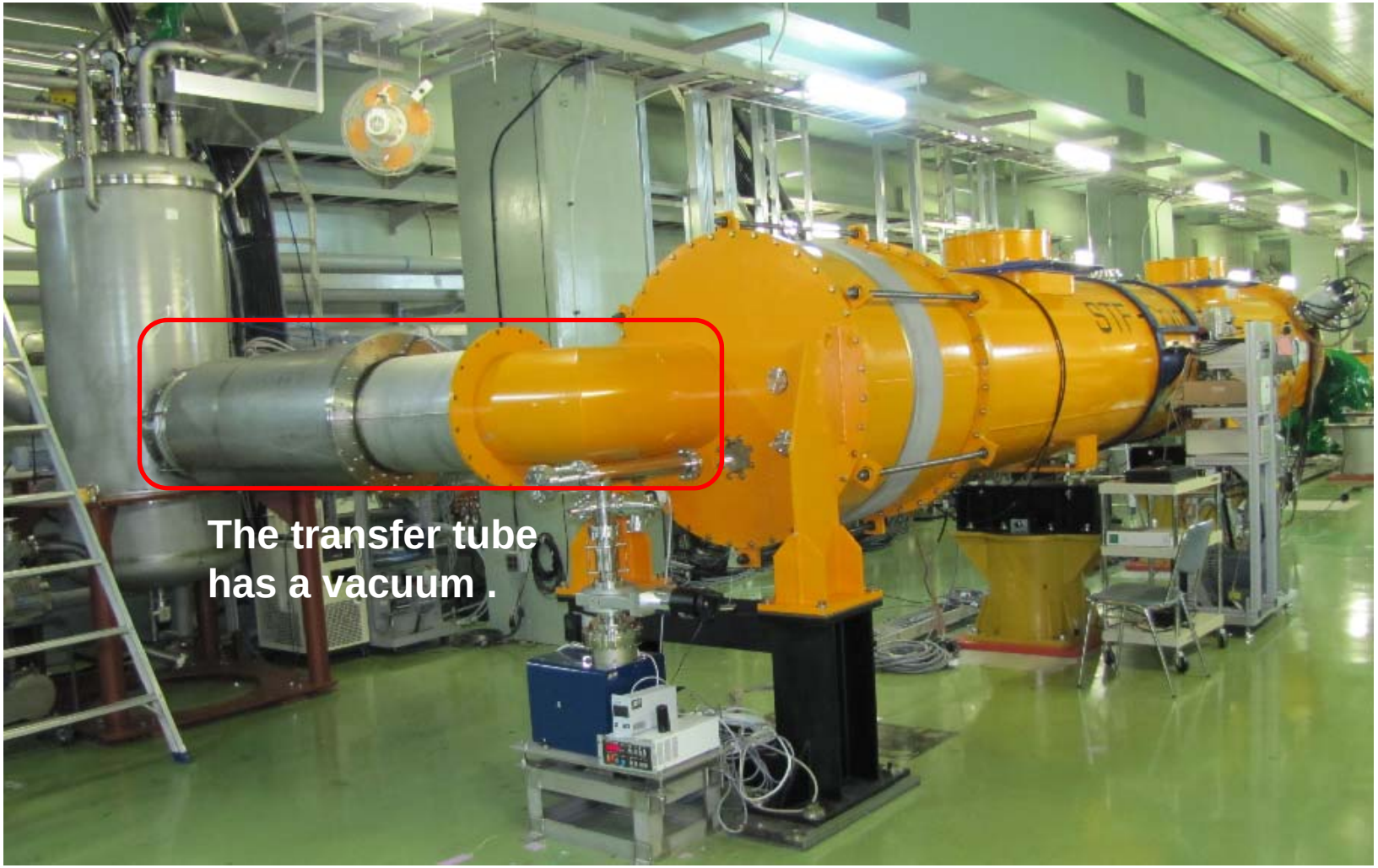
Test results of 5K shield performance in the STF cryomodule

The cold test with 5K shield : June 15 ~ July 3
The cold test without 5K shield : August 25 ~ September 11

Date	LHe Level, %	5K shield temp., K	80K shield temp., K	Pressure, kPa	Evaporation rate, g/s	Heat load, W	ΔQ (W)
June 30	77	4.82	84.3	2.87	0.132	3.04	0.8
Sept. 11	77	4.51	84.2	2.86	0.167	3.86	
June 30	63	4.81	84.9	2.86	0.051	1.11	0.8
Sept. 8	71	4.51	84.0	2.84	0.083	1.91	

The measured heat loads enclosed with red lines included the heat load along the transfer tube between the cryomodule and 2K cold box.
The heat loads enclosed with blue lines excluded the heat load along this tube by decreasing liquid helium level.

The difference of heat loads with and without 5K shields is about 0.8 W for STF cryomodule.


The transfer tube
has a vacuum .

Summary

1. Thermal performance tests of 5K shield in the module were performed from June to September.
   - The difference of heat loads at 2K with and without 5K shields was 0.8 W for the 6 m STF cryomodule.
2. In order to understand the results, we are calculating the thermal radiation heat loads for the STF cryomodule with the 3D model by ANSYS.