INAF IASF - Bo

TITLE: **Thermal cycling test of RCA sky load cylinder**

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CHANGE RECORD

Issue	Date	Sheet	Description of Change
0.1	October 2004	All	Draft issue of this document
1.0	April, 2012	All	Final Issue of this document

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1 SCOPE

1.1 Purpose

Purpose of this test is to verify the mounting concept of the RCA sky load cylinder on the Aluminum support at operating temperature (approximately 4K).
Purpose of this report is to describe the test setup and test results.

1.2 Document Overview

In Section 3 the test setup and sensor location are shown.
Section 4 describes the sky load mounting and fixation.
Thermal cycles data are reported in Section 5.
The sample inspection performed after the cycles is reported in Section 6.
Finally some comments and conclusions are drawn in Section 8

1.3 TERMS and ACRONYMS

CF:	Cryo Facility
SUT:	Sample under test

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable documents

2.2 Reference documents

RD 1: Lakeshore DT670 data sheet
RD 2: *The 4KRL cryo facility*, PL-LFI-TES-TN-010

3 Test setup

Test is performed in the IASF-Bo 4K cryo facility, fully described in RD 2. Parts are manufactured by Officine Pasquali.

Stainless steel thermal washers are used to mechanically support and thermally decouple the sky load from the cryo facility cold flange (Fig. 1).

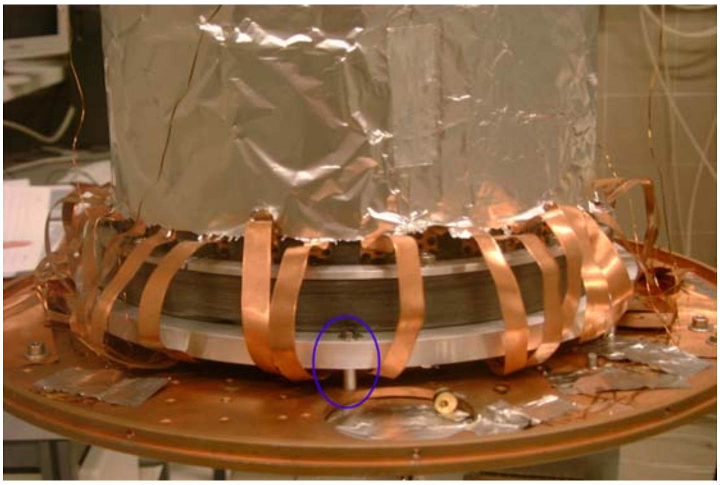

Fig. 1 Sky Load mounted on the facility cold flange. Lateral wall copper slabs links to the Aluminum base and a stainless steel washer (blue circle) are visible.

The thermal strap to the cold flange is provided by a copper slab (0.25 mm thick), fixed to the Aluminum base (Fig. 2).

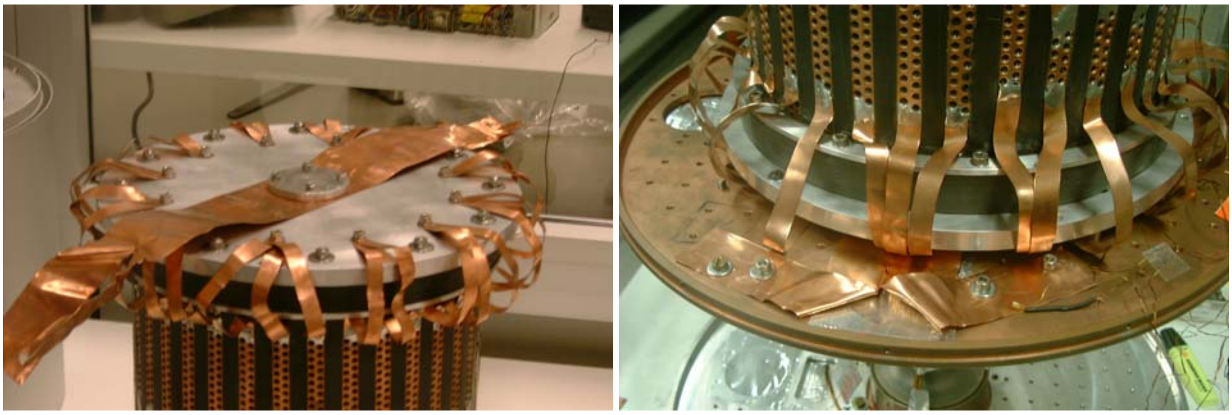

Fig. 2 A wide copper slab is attached to the Aluminum base (left figure) and then fixed to the facility cold flange (right figure).

3.1 Temperature sensor characteristics and location

Most of the temperature sensors used are LakeShore DT670 not calibrated silicon diodes, with accuracy at 4 K of ±0.25K, as reported in RD 1. A calibrated DT670 and a calibrated Cernox CX1050 are used. Their accuracies, at 4 K, are 27 mK for the diode and 7 mK for the Cernox.

Sensor ID	Type	Fixation	Location
A	DT670 (cal)	Al tape	Lateral wall of the cylinder (T-shaped tape in Fig. 3, left)
B	CX1050 (cal)	Al tape	Eccosorb cylinder internal base (Fig. 3, central)
C1	DT670	Screw	Al base (Fig. 3, right)
C2	-	-	Not in use
C3	DT670	Al tape	Lateral wall of the cylinder (straight tape in Fig. 3, left)
C4	DT670	Screw	Cold flange (Fig. 3, right)
D1	DT670	Al tape	Top of the cylinder (Fig. 3, central)
D2	DT670	Al tape	Top of the cylinder (Fig. 3, central)
D3	DT670	Al tape	Top of the cylinder (Fig. 3, central)
D4	DT670	Al tape	Top of the cylinder (Fig. 3, central)

Table 1: Temperature sensor locations

Fig. 3 Sensors locations. Sensors A and C3 are displayed in the left panel, sensors B, D1, D2, D3, D4 in central panel and sensors C1, C4 in the right panel.

4 Sample mounting

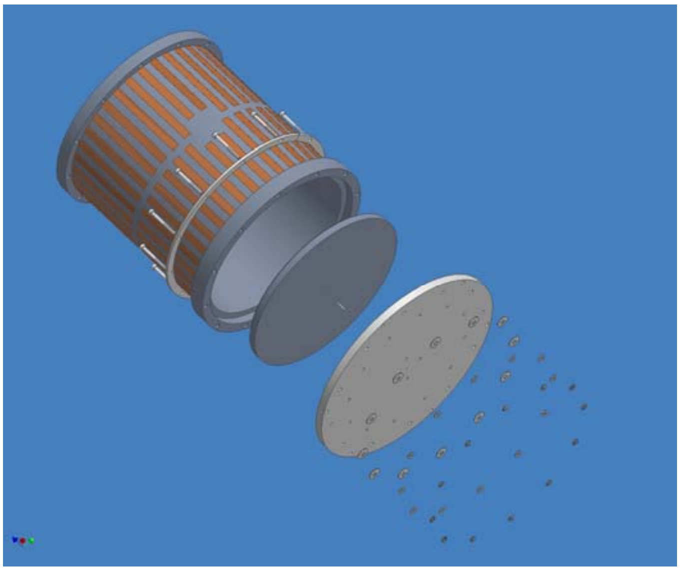

Fig. 4 Exploded view of the load cylinder. The Eccosorb base is hold by the Al base screwed to an Eccosorb step on the bottom of the cylinder wall with the help of disc springs.

The mounting system of the SUT is shown in . The Aluminum flange is fixed with a torque of 0.7 N·m to the Eccosorb base, with three additional disc springs for each screw. An Aluminum foil is mounted on the lateral wall of the cylinder as it will be in the RCA cryofacility operative setup.

5 Thermal cycles

5.1 Cycle 1-2

The test started on October, 12th, 2004 at 16:00. The CF was evacuated using a dry rotative pump. Acquisition of temperature sensor was started at 19:48. Acquisition period was set to 60s.

When a pressure of 1.5E-1 mbar was reached, the cryo-Cooler was started at 19:48. The pump was stopped soon after the start of cooldown.

On October 14th, the cryocooler was turned off at 11:25. Warm-up procedure was started. Cool-down and warm-up data are reported in Fig. 5, while a detail of the temperatures reached is shown in Fig. 6.

The cool down reached a steady state after more than 30 hours, clearly due to the large mass and heat capacity of the sample, compared to the small size of the copper slab used as thermal link. Anyway, a second cycle was performed exploiting the week end soon to come. It started on the 15th at 12:15, the cooler was turned of on the 18th at 10:45. On the 19th At 17:13 the chamber was air filled and opened.

Cool down and warm up curves of the second cycle are shown in Fig. 7, low temperature data are shown in Fig. 8.

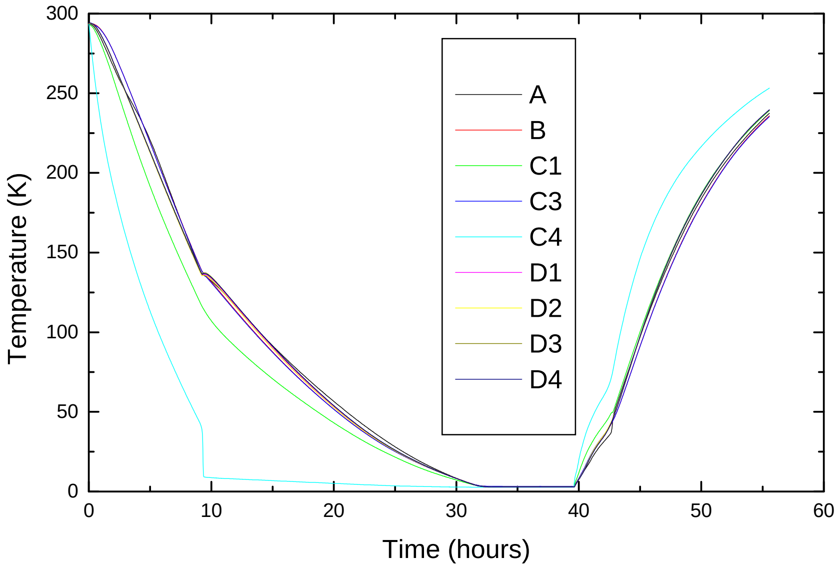

Fig. 5 Cool down and warm up data for the first cycle

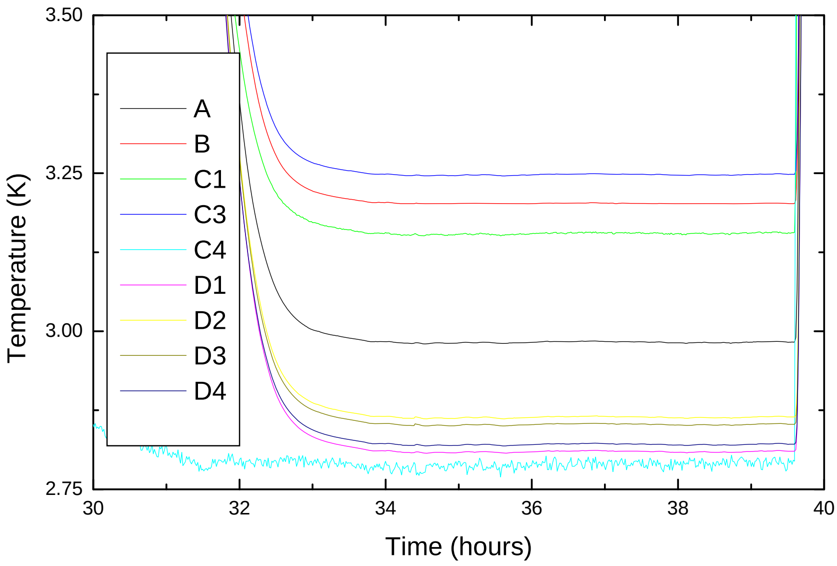

Fig. 6 Low temperatures reached in the first cycle.

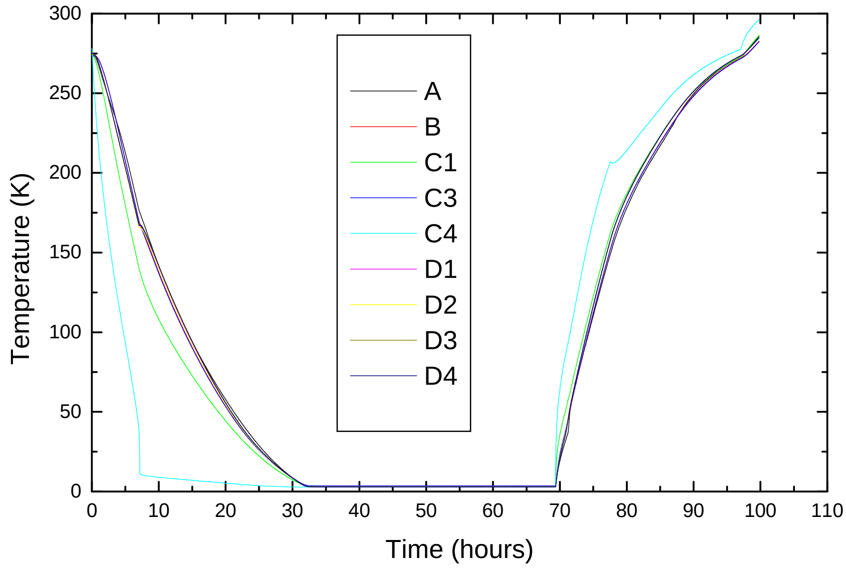

Fig. 7 Cool down and warm up data for the second cycle

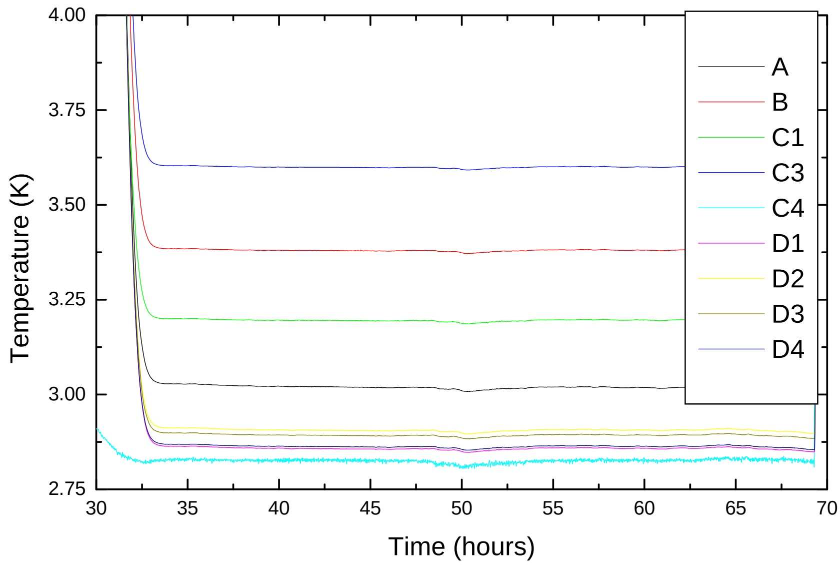

Fig. 8 Low temperatures reached in the second cycle.

5.2 Cycle 3

On October, the 19th at 17:13 the cryofacility was opened, a brief visual inspection showed no relevant change of the sample. Three additional copper thermal strap, from the cold flange to the Aluminum support, were mounted and then the facility was closed at 18:48. The pump was started. On October, the 20th at 7:05 the cooler was turned on.

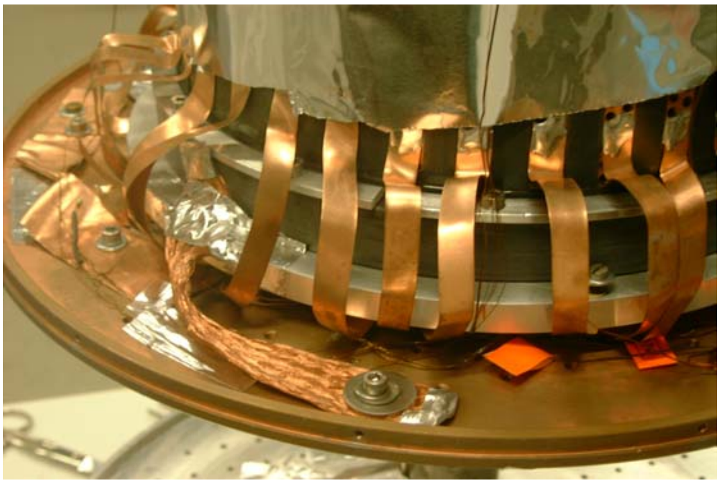

Fig. 9 Detail of one of the three thermal straps added in the third cycle

As evident from Fig. 10 and Fig. 11, with this change the cooldown was more efficient.

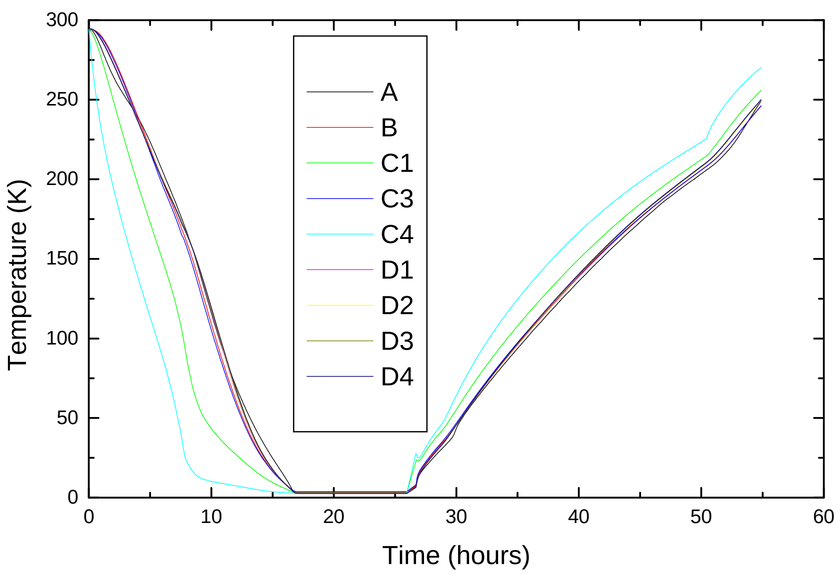

Fig. 10 Cool down and warm up data for the third cycle

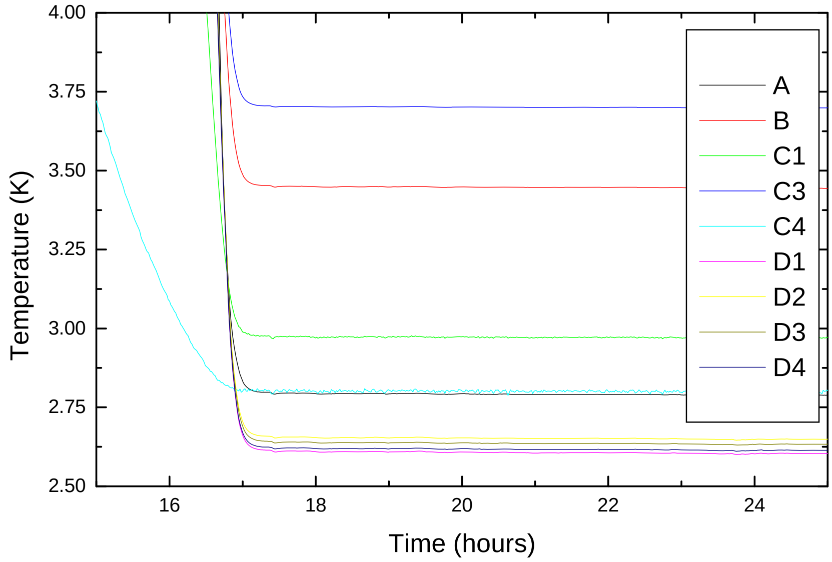

Fig. 11 Low temperatures reached in the third cycle

6 Visual inspection

A detailed visual inspection was performed after the third cycle.
The Aluminum tape on the sensors mounted on the lateral wall of cylinder was found detached in the low part (Fig. 12).
The load was demounted from the cryochamber. No change was found, no cracks or flake were observed (Fig. 13).

Fig. 12 Aluminum tape on the lateral wall sensors was found slightly detached.

Fig. 13 No change was observed in the load base.

7 Check of the screw torques

The screw torque was checked and it was found less than 0.6 N·m for all the fixing screws of the Aluminum base.

8 Conclusions

The sky load performed three thermal cycles successfully, showing that the new mounting philosophy can be used with no structural damage.
The relaxation of the screw torques suggests the mounting of an additional disc spring for each screw which would let us to increase the torque to 1 N·m.
Temperature data show the need of a good thermal strap conductance in order to optimize the cooldown time.
Steady state temperature homogeneity is good for the sensors mounted on top of the cylinder.
Sensors C3 and B show temperatures outside the typical accuracies.
This could be explained with the worsening of the fixation for the C3, while the use of the calibrated sensor for the B channel would not let us to univocally explain that difference.