Design and Development of an Octopus Thermometric System for the 704 MHz Single-cell SPL Cavity at CERN

K. Liao*, L. Arnaudon, O. Brunner, E. Ciapala, D. Glenat, W. Weingarten, CERN, Geneva, Switzerland

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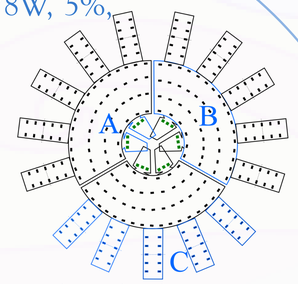
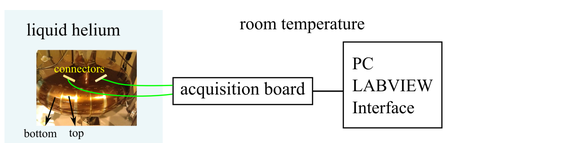
1. INTRODUCTION

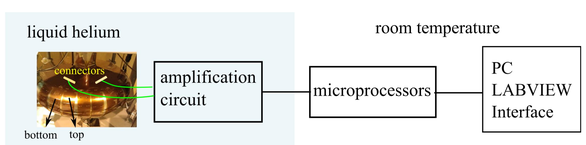
- Thermometric systems have been developed over the past few decades to locate heating or quench spots in superconducting cavities during RF operation.
- The use of carbon resistors as temperature sensors has become popular in these systems ever since mapping the temperature distribution on the cavity surface was first applied at CERN[1].
- The most widely used thermometric systems nowadays are the rigid board based design developed by the Cornel University in 1994.
- At CERN, a newly designed flexible octopus thermometric system for the 704 MHz single-cell SPL cavity is now under development.
- The first prototype is being manufactured and investigations are undergoing for future work.

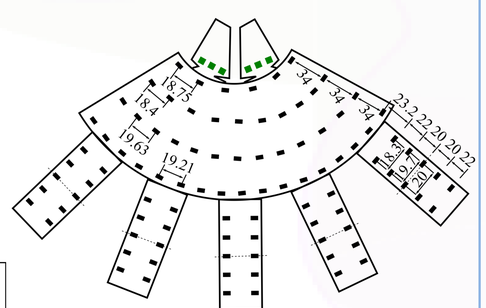
2. DESIGN FEATURES

- An octopus inspired piece, with sensors as suction cups and flexible tentacles to wrap around an object (cavity).
- Thermometers - Allen-Bradley resistors 100 Ω, 1/8W, 5%, $\Delta R/\Delta T \approx 758\ \Omega/K$
- Sensor resolution-
  - A. iris region- diodes 15 mm
  - B. main body resistors- 20 ~ 34 mm
  - C. equator area- max. 23 mm
- Good contact & flexibility – Kapton foil
- Ease of assembly
- A single-cell cavity requires 2 octopuses, 576 resistors and 18 diodes
- Measurement Procedure:



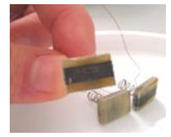




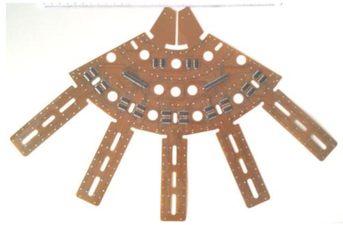


3. HARDWARE

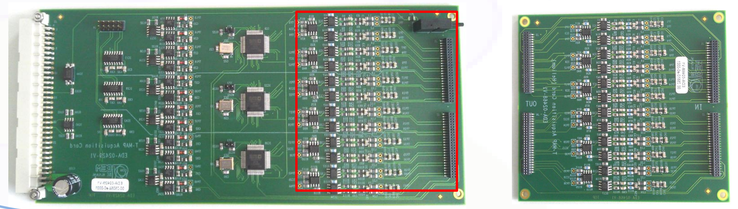
- 1/3 Octopus prototype & sensor fabrication
  - Two versions of sensors to be selected (with and without springs)



  - multiplexer circuit

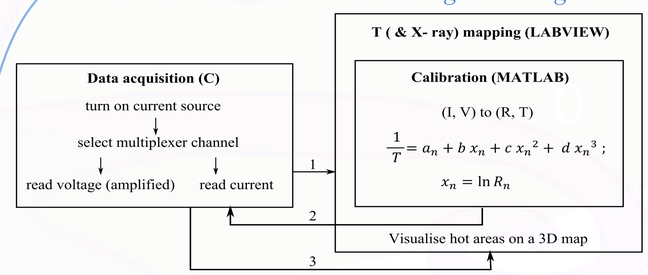


- Electronics for data acquisition
  - A complete acquisition board (left) fitted with 0 Ω resistors to bypass the amplification circuit part (right) when a under liquid helium test is taken.



4. SOFTWARE

- Microprocessor programme: select multiplexer channels and switches on current sources- one reading of voltage on each multiplexer.



- MATLAB programme: construct characteristics curve of each sensor
- LABVIEW: 3D map of the surface temperature
- Optimal mode: the octopus map + second sound localisation result + optical inspection data[2]

5. SUMMARY & FUTURE WORK

- The new octopus thermometric system is now under development with the parts of a prototype 1/3 octopus system already manufactured.
- The system features fast measurement time, high resolution maps, good contact with the cavity and reusability.
- Sensor fabrication and mounting on octopus flexible board are to be completed and tested on the SPL single cell cavity, along with two acquisition boards and software programmes.
- A search for Allen-Bradley 100 Ω resistor replacements as acceptable sensors are to be done.

[1]Ph. Bernard, et al., "Experiments with the CERN superconducting 500 MHz cavity", Nucl. Instr. Meth., 190 (1981), 257
[2]J. Chambrillion, "SM18 Cleanroom and SRF Infrastructure Refurbishment", presentation at SLHiPP-2 (2012)

*KITTY.LIAO @ CERN.CH