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PHOTO-INTERRUPTER AS DISPLACEMENT MEASUREMENT SENSOR CAPABLE OF WORKING AT LOW TEMPERATURES AND UNDER VACUUM.

Daniel Ziemianski

Cracow University of Technology, Institute of Applied Mechanics, al. Jana Pawla II 37, 31-864 Cracow, PL
email: dziemianski@pk.edu.pl

In the context of the Superconducting Proton Linac (SPL) studies at CERN, a wire position sensor is developed. This sensor is designed in order to be tested for its eligibility in the alignment concept based on a stretched wire system. Development and test of the optical wire position monitor capable of working at low temperatures and under vacuum, it has been shown in this work. The test sensor contains three phototransistor type SHARP GP1S56TJ000F. GP1S56TJ000F is a standard, phototransistor output, transmissive photointerrupter with opposing emitter and detector in a case, providing non-contact sensing. For this family of devices, the emitter and detector are inserted in a case, resulting in a through-hole design. This device is unique because it uses position pins to insure accurate placement on the PCB, and has the short profile. The measuring system it was made using MX840A is the 8-channel universal amplifier of HBM's QuantumX data acquisition system and supplemented by the control electronics of his own design. The tests were performed under laboratory conditions at cryogenic conditions (77[K]), the results were presented and discussed.

Keywords: Superconducting Proton Linac, Optical Wire Position Monitor,

1. Introduction

The existing complex of accelerators at CERN is capable to provide the Large Hadron Collider (LHC) with the beam required to reach its nominal characteristics. Higher performance injectors will however be necessary to exceed this limit and maximize the physics reach of the LHC. As a first step, the construction of a new 160 [MeV] H^- linac (Linac4) has started, and the study of a 4 [GeV] Superconducting Proton Linac (SPL) is being pursued in view of submitting a project proposal.

The different options foreseen for increasing the luminosity of the LHC require new injectors that can satisfy the needs of the most demanding scenario [1]. Simplicity and performance margin are necessary features of these new accelerators which are also expected to operate with the very high reliability required to achieve an integrated luminosity per day an order of magnitude larger than nominal.

For the needs of an RIB facility of the next generation, the high power version of the SPL is planned to have an extraction at 2.5 [GeV] which is assumed to fit within the length of one cryomodule. Low field magnets must also be used for extraction and transfer to this facility which requires H^- ions for splitting the beam onto multiple targets. For a neutrino factory, the high power SPL has to be complemented with an accumulator and a bunch compression ring to give an adequate time structure to the beam.

The goal of the SPL study is to prepare for a start of construction of the LP-SPL optimized for PS2 and LHC.

Design and construct a 1⁄2-lenght cryo-module for 4 β=1 cavities (as close as possible to a machine-type cryomodule).

The motivation for this:

- Test-bench for RF testing on a multi-cavity assembly driven by a single or multiple RF source(s).
- Enable RF testing of cavities in horizontal position, housed in machine-type configuration (helium tanks with tuners, and powered by machine-type RF couplers).
- Validate by testing critical components like RF couplers, tuners, HOM couplers in their real operating environment.

2. Goals and Means of the SPL Study

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The most important parameters are hereinafter described:

- enough cavities must designed, built and tested for a reliable assessment of the reasonably achievable gradient,
- a full size prototype cryomodule must be designed and assembled,
- the SM18 test place at CERN must be upgraded to allow for exercising multiple cavities in the prototype cryomodule at the nominal RF power.

2.1 Overview of cavity supporting system

Requirements of the cavity supporting system

- Provide support of components.

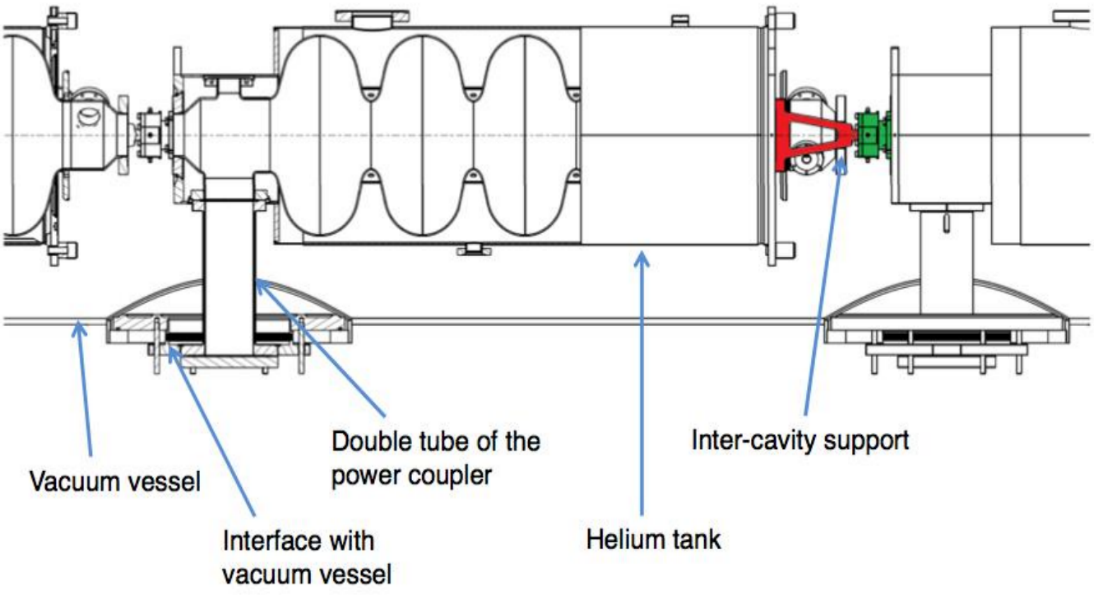

Figure 1: Short cryomodule schematic layout

- Guarantee cavity alignment during entire life cycle.
- Minimize thermal load.

2.2 Aims Investigate

- Cavity position stability and alignment.
- Sensitivity of cavity adjustment.

- Thermo-mechanical position stability.
- CD/WU transients.
- Thermal profiles on coupler (rescaling).
- Active control of T on coupler.
- Optical Wire Position Monitor.

3. Optical Wire Position Monitor (OWPM)

Cavity position monitoring specs:

- Static position or slow movements: absolute movements (x,y,z) of each of 4 cavities during steady state operation and cool-down/warm-ups (300-2 [K]).
- Vertical range: 0-2 [mm].
- Precision: <0.05 [mm].
- Resolution : <0.01 [mm].
- Possibly vibration measures (0-1 [kHz]).

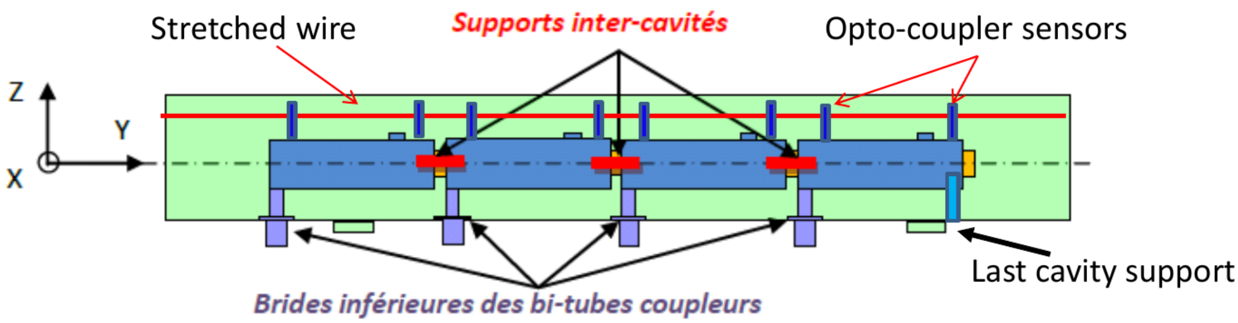

Figure 2: Overview of cavity supporting system

3.1 Photo-interrupter as displacement measurement devices

GP1S56TJ000F is a standard, phototransistor output, transmissive photointerrupter with opposing emitter and detector in a case, providing non-contact sensing. For this family of devices, the emitter and detector are inserted in a case, resulting in a through-hole design. This device is unique because it uses position pins to insure accurate placement on the PCB, and has the short profile.

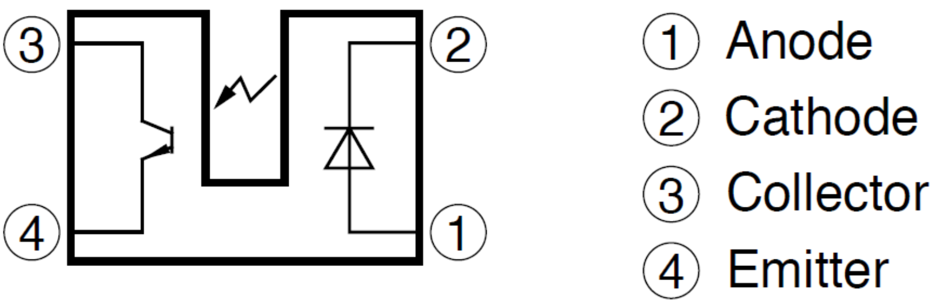

Figure 3: Sharp GP1S56TJ000F

3.2 Validation test at 77 [K]

The results of validation test in liquid nitrogen.

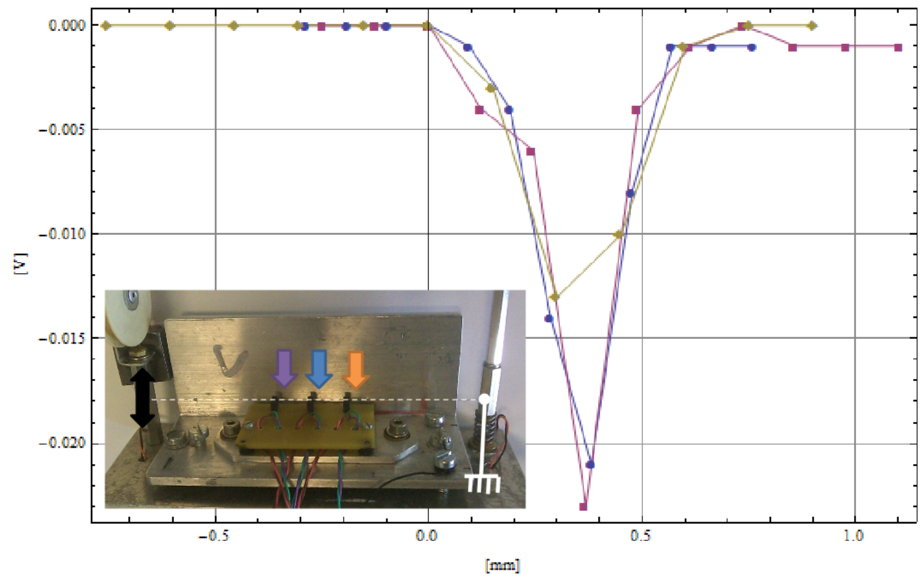

Figure 4: liquid nitrogen validation test

4. Conclusions

- The proposed solution is very interesting.
- Usin the proposed solution as a measure of displacement is unfortunate.
- Usin the proposed solution as a motion detector seems to be a great idea.
- Usin the system in an environment filled with liquid nitrogen and the present form is impossible.
- Usin the system in real life will require the use of performance or dedicated postprocessing filters.
- As it stands the tests exclude the usefulness of the system.
- It seems necessary to repeat the test after designing and building a system resistant to thermal deformation, and can change displacement inside the cryostat.

REFERENCES

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