Cryogenic Tests of Ceramic Feedthroughs for SIS100 BPM

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Introduction

Due to the cryogenic environment in which the Beam Position Monitors (BPMs) will be used at SIS100 synchrotron special attention has to be turned to the BPMs' signal feed-throughs (FT) [1]. Present design considers titanium based, N-Type FTs isolated with Al_2O_3 ceramics and welded into CF-16 flange. In a temperature range between room temperature and 4.2 K the requirements for the FTs are threefold: i) high mechanical stability, ii) vacuum-tightness even after many cold-warm cycles, iii) good and stable electrical connectivity. These features were tested in 10 cold-warm cycles in the temperature range given above.

Methods and Results

Fig. 1 shows the test setup: Five N-type (FT) were mounted to a sixfold CF-16 crosspiece that was installed in a bath cryostat having a volume of 30 l. The free flange of the crosspiece was connected via a long stainless-steel pipe to a He leakage detector installed close to the cryostat. All M4 bolts (A4-80 stainless-steel) used at the flanges were fastened with a final torque of 2.6 Nm. One pair of spatially opposing FTs was electrically connected inside the crosspiece via a titanium rod equipped with spring contacts typically used in banana-connectors. This formed a 50 Ω transmission line with an intended impedance mismatch in the crosspiece center. The electrical connection between the two interconnected FTs and a Network Analyzer (NWA) was done by semiflex Tensolite coaxial cables. The quality of the electrical connectivity was measured using Time Domain Reflectometry (TDR) based on the analysis of the synthetic time domain signals measured by means of NWA [2]. Temperature monitoring was done

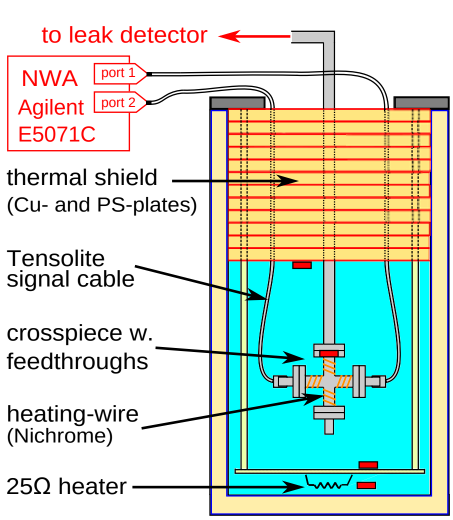

Figure 1: Cryogenic test setup

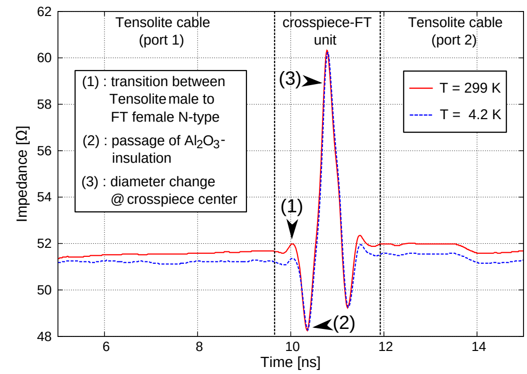

Figure 2: TDR signals at room and LHe temperature

by four resistive temperature sensors depicted in Fig. 1 by red boxes. The cryostat was equipped with a 25 Ω resistive heater for removing residual LN_2 left over from precooling. A Nichrome heating wire wound around the crosspiece was used to accelerate cold-warm cycling so that the average duration of a cycle could be reduced to less than 2 h. He leak rate monitoring was performed during the whole test. Since the crosspiece was immersed into LHe any leaks at the FT that could possibly occur should be immediately registered in the leakage detector. TDR measurements were done first at room temperature and have been repeated after LHe was filled into the cryostat to cool down the crosspiece to 4.2 K. Fig. 2 compares two TDR measurements made at 299 K and 4.2 K in one of the 10 cold-warm cycles. The characteristic points (1), (2) and (3) on the plot correspond to the electrical connections within the crosspiece-FT unit. In the crosspiece-FT region both TDR signals are highly congruent which proves that electrical connections between rod and FTs do not change with temperature. Moreover, this connection is even better if compared to the left and right part of the plot, where the cryogenic cables' passage between the outside and the inside of the cryostat is strongly effected by the temperature changes. Thus, it can be stated that the solution proposed here results in a stable and reproducible electrical connectivity under cryogenic conditions. Comparing Fig. 2 to the measurements made in the remnant cycles, the pointwise deviations of the impedance curves are below ± 0.05 Ω in the significant region of the crosspiece-FT unit. Furthermore, within ten cold-warm cycles, the crosspiece-FT unit did not exhibit any leaks maintaining a He leak rate in the order of 5×10^{-10} mbar · l/s. However, a slight loosening tendency of about 11 % of the initial torque was measured at the bolts used for flange mounting. The usage of foldable washers might be necessary.

References

[1] P. Kowina et al., *Proc. EPAC'06*, Edinbourgh, p.1022

[2] see e.g. www.home.agilent.com, Application Note 1287-12

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