MSWG Meeting #4, 30-August-2019

Present:

S. Albright, M. Barnes, M. Calviani, K. Cornelis, D. Cotte, H. Damerau, M. Fraser, A. Gerbershagen, V. Kain, T. Lefevre, K. Li, E. Lopez Sola, F. Velotti

Agenda:

Link to the Indico Event:

- Approval of minutes – Karel Cornelis
- Main presentations:
    - SPS-BDF prototype target test results – Edmundo Lopez Sola

The minutes from the last meeting were approved.

Main presentations:

SPS Beam Dump Facility target prototype tests results – Edmundo Lopez Sola

The BDF target design was introduced, based on a TZM and W core cladded with Ta2.5W and specified to absorb 320 kW of beam power. The challenging design required experimental validation with a prototype test in view of BDF's ESPP submission. The future conditions (temperature and stress) were recreated with a 400 GeV/c beam of 3-4E12 ppp extracted in a one second spill which was not diluted on the target's front face. The test area in the North Area in front of T6 was described before the timeline and details of the prototype design and tests were presented in detail.

The 3 days of tests with beam delivered over 2.5E16 POT in over 11 hours of accumulated beam time with a maximum beam power of 45 kW deposited on the target. The beam was steered on target using BTV screens up and downstream, with an average beam size of 2.9 x 2.4 mm, close to the 3 x 2.5 mm expected. A trip of the cooling skid pump and interlock after 4 beam impacts gave an interesting signal with high temperature and pressures that will be further investigated in the post-radiation analysis.

The post-irradiation dose rates agree well with RP simulations (approximately 1 Sv/h on contact are expected after 1 year) and dismantling is foreseen in a fully remote fashion with robotics. Water circuit contamination with activation products were detected and probably caused by debris from bronze wheels, justifying the choice to have a separate cooling circuit from the main NA circuit.

A detailed analysis of the data collected during the tests was presented and compared to simulations of the time evolution of the temperature, as well as the maximum temperature reached at different intensities, showing good agreement to 10%. The values attained were in excess of the temperatures expected in the final BDF target. A similar analysis was performed for the measured stress, with a good agreement of 25% with simulation and values achieved in excess of those expected in the final target. The most critical step for the BDF target design validation will be the upcoming Post Irradiation Examination (PIE) where 6 blocks will be examined for the effects of the beam irradiation.

The successful prototype design, construction and operation under the SPS proton beam is a key development for the assessment of the final BDF target.

Discussion:

Strain sensors were discussed, with **E. Lopez Sola** explaining that the difference in electrical resistivity of the sensor returns a calibrated change in position which is used to assess the stress in the material.

A. Gerbershagen asked for clarification on the location of the maximum stress and temperature in the prototype target. **E. Lopez Sola** explained that the maximum temperature occurs along the axis of the beam impact location (roughly in the centre of the prototype). The strain is less evident because the target deforms like a membrane (in a concave fashion) with the maximum stresses being found in a ring around the centre on the target at a radius of about 10 mm. The maximum values reported are inferred from the measured temperature and stress at given instrument locations using the model.

A. Gerbershagen asked for more information about the discrepancy between the simulation and measurement results of the stress during cooldown which are not so well produced. **E. Lopez Sola** explained that although the reason is not known it is likely that beam induced effects with the sensor may be to blame.

K. Cornelis asked if there is any concern to the target's integrity if the beam is not impacting its centre. **E. Lopez Sola** explained that the beam was moved around by some millimetres without issue. **M. Calviani** explained that one is not worried for integrity of the target like for CNGS because the timescale of the beam impact is very different: slow versus fast extraction. Although the BDF target concerns for heating are far more important (high-Z material) the dynamic stresses are far less of a concern.

E. Lopez Sola explained to **T. Lefevre** that the beam on the prototype is not diluted, giving higher temperatures in the core of worst block than expected in the final target. **M. Calviani** explained that this validates the design only for the certain number of cycles tested. The binding between the materials and cladding is the most important aspect and the main objective was to achieve the same level of stress between the two to ensure they do not detach over time.

M. Fraser emphasised that the proposed slow extraction target test facility would be of interest for MD studies and probably many other applications and users. **M. Calviani** explained that although this is to be discussed with management in the future, the budget is already foreseen to move the electronics to the surface in view of a longer-term installation. There was strong support for this idea.