STI test HRMT-35 and Collimator plans for 2017

Special ColUSM:
Material and design readiness for LS2 productions

2th May 2017

I. Lamas Garcia, on behalf of EN-STI
Presentation Scope

- HRMT-35:
  - Introduction and Goals
  - Experimental Set Up
  - Status and Outlook

- Collimator plans 2017:
  - Tatsuno CFC status and plan
  - Collimators with embedded pipes (HIPing) proposal
  - Collimator surface activities
After dismantling the TDI (10/01/2016), severe damage on the Ti coated surface on the hBN absorbing blocks was found.

The absorbing blocks of the currently installed TDI are made out of Cu sputtered Graphite R4550.

Given the past issues and the general uncertainties on coatings behavior when grazed by a high intensity proton beam, there is a high priority recommendation by the LHC Machine Committee (LMC#256) to test and validate the sputtered Cu performance under the worst impact conditions that the TDI could face.

In order to gain important information for future beam intercepting devices such as TCPPM and TCSPM, other coating configurations (by acting on the subtract and the thickness of the deposited layer) will be tested on low-Z materials such as R4550, 2D Tatsuno CFC and Molybdenum Graphite (MoGr).
HRMT-35: Experimental Set Up

- The HRMT 28 tank and test bench will be used for this experiment
- Modifications will be performed on the jaw configuration in order to host up to 4 different absorbing materials and coating configurations:
  1. SGL Graphite R4550 TDI coating configuration with Cu coating
  2. SGL Graphite R4550 TDI coating configuration with Mo coating
  3. Tatsuno 2D CfC in a TCPPM/TCSPM configuration with Mo coating
  4. Molybdenum Graphite (MoGr) with Mo coating

- HRMT 28 assembly. Prior to the 72 bunches filling restriction, the experiment went exceptionally fine. First results are very promising.
HRMT-35: Experimental Set Up

- **Upper Jaws Stroke**: +/- 30mm.
- **Lower Jaws Stroke**: +/- 30mm.
- **Tank Stroke (5th axis)**: +/- 60mm.
- **Design is compatible with the installation on a standard HiRadMat table:**
HRMT-35: Experimental Set Up

- Measurement methods will be:
  
  i. BPKG right upstream of the jaws in order to accurately monitor the beam position and verify the impact parameter.

  ii. Online visual inspection by means of 4-5 radiation resistant cameras (1 Rad Hard HD camera).

  iii. Thermocouples PT100 to measure the temperature of the jaw frame and the absorbing blocks.

  iv. 2 BLMs to monitor beam losses during alignment of the beam and during grazing impact.
HRMT-35: Status and Outlook

- HiRadMat TB and SB approval in September 2016.

- Section to be added to the safety file describing the installation/assembly procedure in the HRMT 28 tank. It will include time estimates of the various steps, for discussion with HSE/RP for assessing a WDP. Action is on going.

- 2 new jaws for the SGL Gr4550 manufactured.

- Design of the integration of the measurement instruments is done.

- Design of the integration of the other 2 jaws is on going.

- HRMT 28 tank will be at b867 tentatively at the end of June 2017, depending on the outcome of the first 2017 HRMT irradiation slot.


- Experiment scheduled middle of July 2017.
Tatsuno CFC status and plan

- Tatsuno CFC to be considered as a MoGr backup plan for LS2 collimators TCPPM and TCSPM

- Tatsuno CFC AC150 (baked up to 2800deg) is currently used in primary and secondary collimators. However, the grade AC150 is no longer produced.

- Grade FS140 (baked up to 2500deg) has been characterized by EN-MME-EDM (https://edms.cern.ch/document/1750582)

- Thermomechanical Robustness Index higher in FS140 (1943) than AC150 (1372)

- Thermal Stability Index lower in FS140 (28) than AC150 (47)

- Baking temperature is a key factor for the thermal and electrical conductivity (~factor 2 higher if baked up to 2800deg)

L. Bianchi, HiColDEM #11
Tatsuno CFC status and plan

- Tatsuno CFC FS140 baked up to 2500 is being machined for HRMT-35 coating configuration
- Tatsuno CFC FS140 baked up to 2800 small samples for electrical measurements to be dispatched to CERN on 10th of June
- Tatsuno CFC FS140 baked up to 2800 samples for formal characterization (plus material for 4 full TCPPM/TCSPM jaws) to be dispatched to CERN on 18th of July
- Quotation to make entire LS2 production requested. Visit to the company foreseen for 15th of September
- Price is very quantity depending:
  - 4 jaw for TCPP in FS140 baked 2800deg -> 11600 CHF per jaw
  - 10 jaws for TCPP in FS140 baked 2800deg -> 4300 CHF per jaw
Collimators with embedded pipes (HIPing) proposal

- **TIDVG#5 research and prototyping activities with BodyCote and Fraunhofer regarding diffusion bonding between cuprous materials and stainless steel.**

- **Technical Report** ([link](#))

The machined and assembled cooling system demonstrators are hot isostatic pressed at the company Bodycote. The casing is stainless steel (1.4301). The welding material is stainless steel (1.4370). The figure at the left shows the HIP configuration. The applied HIP parameters are a heating and cooling rate of 5K/min and a maximum temperature of 950°C. At 950°C, a holding time of 3h by 100MPa is applied.
Collimators with embedded pipes (HIPing) proposal

- Research is very interesting for Collimators in order to improve the TCC between the back stiffener-cooling circuit pipes-block housing hence increasing the efficiency of the cooling circuit

- Kick-off meeting held on 28th April to design a collimator prototype jaw with embedded pipes (in SS316L) by HIPing

- Jaw TCC will be measured in the dedicated test bench in building 272

- Jaw could be part of a future HRMT test further on
Collimator surface activities

- Preparation for Ready for Operation of 2 TCSP for IP6 (installation YETS17-18)
- Preparation for Ready for Operation of 2 TCTW (installation YETS17-18)
- Any additional crystal collimators are requested?
- Preparation activities for LS2 Collimators production
- Spares cycling tests and maintenance campaign:
  - Non-RP collimators: Phase one spares, TCTP spares, etc.
  - RP collimators currently in b.954
  - Building in point 4 being adapted for RP and non-RP collimator storage
  - Investigation on exploded TCTP#5
Thank you!