Minutes of the 37th Collimation Upgrade Specification Meeting 11th of April 2014

Participants: C. Adorisio (CA), A. Bertarelli (AB), R. Bruce (RB), F. Carra (FC), M. Fitterer (MF), P. Gradassi (PG), A. Marsili (AM) (scientific secretary), D. Mirarchi (DM), E. Quaranta (EQ), S. Redaelli (SR) (chairman), G. Valentino (GV).
Remote: R. de Maria (RdM), T. Markiewicz (TM) (SLAC), A. Rossi (AR), M. Serluca (MSe). M. Tomut (MT).

Indico event here.

1 GeV Ion Irradiation Experiments on Novel Collimator Materials (M. Tomut)

Slides are available here.

1.1 Summary of the presentation

MT presented the results of the ion irradiation campaign of new collimator materials, which took place in GSI. Two types of ions were used, with energies close to the Bragg peak (4.8 MeV/nucleon). For each test, four samples were irradiated at four different fluences. Different monitoring tools were available on the irradiation bench, including a thermal camera. Post-irradiation tests were carried, including Raman spectroscopy and Scanning Electron Microscopy (SEM), and thermal conductivity.

The samples heat up during each 500 μs peak, then cool down; this is monitored online by the thermal camera, and allows to measure the deterioration of the thermal conductivity with irradiation. MT presented the different tests performed on different samples. The same tests were performed on some samples for high energy deposition by a focused Uranium ion beam. MT presented the different sample holders used in different cases.

One of the most important effects observed is that the Molybdenum Graphite, in transversal orientation, reaches higher temperatures than the other samples. In addition, the maximum temperature reached increases with each ion pulse. Visual observation showed that the sample were deformed after irradiation by high fluences. The time constant of the sample is measured during cooling between two pulses, and also deteriorates. This effect must be explained [**action: MT, FC**].

1.2 Discussion

The different behaviour of the Mo-Gr in transversal orientation was discussed. AB asked about the beam spot size, in case anisotropy in the sample could explain the effect observed. MT answered that the beam spot is bigger than the sample, so this doesn't explain the effect.

AB suggested that the deformation could lead to a bad contact, hence a bad cooling. FC agreed and added that this could create a cycle: bad cooling lead to more heating and more deformation. AB mentioned that it could be due to a swelling of the carbon fibers; it could be checked by weighing the samples after irradiation, showing if their density has changed. MT answered that weighing them was planned and will be done [**action: MT**].

AB asked if the samples have time to cool down. MT answered that their temperature decreases down to 40°C – 50°C, which is the equilibrium temperature.

SR asked what are the next steps needed in the data analysis. MT answered that the next big step is to perform finite element simulations of the thermal conductivity degradation. This might require a common effort in manpower.

MT mentioned that the next irradiation campaign will take place over easter. The following will be in July or August, and then a high energy one in September. Both AB and SR expressed interest in taking part, and asked for the final schedule [**action: MT**].

MT asked if there are any spare MoGr samples for more tests (4 more samples needed per test + a reference one). AB answered that there are some more. EQ will follow this up [**action: EQ**].

2 Status of halo excitation studies at CERN (R. Bruce)

Slides are available in ppt and pdf.

2.1 Summary of the presentation

Small jitters in orbit can cause the tails of the beam to scraped away at the collimators and cause beam dumps. This could be prevented by depleting the tails, that is removing particles from the beam halo faster, leaving the core unaffected. RB presented the halo excitation studies currently ongoing: electron lens, tune modulation and transverse damper narrow-band excitation. Halo removal would be most needed during squeeze, and possibly during collisions. It would also reduce the risks of deflecting beam tails onto sensitive equipment in case of crab cavity failure in HL-LHC. RB explained that no operational tool can be available for the 2015 start up: the immediate goal is to define what needs to be studied in MDs.

Tune modulation adds resonance sidebands around the existing resonance bands. This could be used to extract halo particles without affecting the core particles. However, the tune footprints are different for different bunches in the filling pattern and depending on whether the beams are colliding or separated. RB presented different tune footprints for different conditions, and showed how the resonance sidebands extend further from the original resonance lines when the frequency of the tune modulation is increased. However, it is difficult to find a resonance that would only affect the halo but not the core in any other bunch (depending on the collision scheme). More advanced simulations will be needed to know the strength of each resonance in the machine.

The first considerations about power converters show that no modification would be needed, but the power converter capabilities must still be measured [**action: RB**]. This can be done from the office and does not need a dedicated MD. The magnetic field inside the beam screen must also be measured. SR got confirmation that a spare vacuum chamber is available for measures.

Another option can be to use transverse dampers (ADT) to make a narrow-band excitation. No modifications is needed: the ADTs are installed. Another advantage is the ADT can act on a single beam and a single bunch. However, like tune modulation, very carefully optimised parameters are needed to only affect the halo and not the core, since the method depends on detuning with amplitude.

RB concluded with a comparison with the hollow *e*-lens, which is very promising and acts only on the halo by design. However, it can not be available in the LHC until after LS2.

In conclusion, three techniques for halo excitation were presented, and they should all be studied. MDs will be planned in consequence. A new fellow or PhD student would work on a comparative assessment of these methods.

2.2 Discussion

MF asked about higher resonance orders than the 3rd, which may require less frequency modulation. RB answered that many resonance lines for higher exist – some even already crossing the bunch tune footprint with no notable effect. Finding the relevant ones, which depend on the reality of the machine, will require more detailed simulations and ultimately actual measurements.

3 Updates and Programme for SLAC Rotatable Collimator Tests (G. Valentino)

Slides are available in here.

3.1 Summary of the presentation

GV gave an overview of the tests of the SLAC Rotatable Collimator which took place at CERN. Another point is to prepare the visit of TM at CERN from SLAC. GV presented the time line of different tests and events: the first leakage tests by an external company, then the impedance tests. No leak was found, and the same low-frequency modes were observed as at SLAC and as predicted by simulation. GV clarified that the SLAC RC design is not optimized for impedance.

Controls tests will be performed when TM will be at CERN. GV presented a list of tests, including the standard jaw movement tests but also extra tests including jaw rotation and LVDT calibration.

In conclusion, GV presented the list of RC tests already performed; the ones which will take place during TM's visit at CERN; and future tests.

3.2 Discussion

RB asked if the modes observed during impedance tests are an issue, knowing that the RC was not optimised with respect to impedance considerations. SR answered that it needs to be validated by the impedance team. GV said he should have an answer from the impedance team by the following week [**Action: GV**].

AB asked if there is a protocol for vacuum tests. GV answered that it is the case.

AB asked why the first tests were the ones with air. TM answered that these tests had already been performed at SLAC. It was decided to start by reproducing these tests and transfer knowledge, before performing new tests.