Minutes of 123rd Collimation Upgrade Specification Meeting

Participants: C. Accettura (CA), C. Bahamonde (CB), A. Bertarelli (AB), R. Bruce (RB), F. Carra (FC), M. D’Andrea (MDA) (scientific secretary), P. Fessia (PF), N. Fuster (NF), A. Lechner (AL), M. Modena (MM), N. Mounet (NM), J. Oliveira (JO), S. Redaelli (SR) (chairman), A. Waets (AW).

Remote: J. Molson (JM).

Indico link

Actions from this meeting

- Expected actions on hollow e-lens from WP15 meeting (06/12/2019):
  - Report the outcome of the discussion with survey (S. Redaelli);
  - Release of the HV functional specification (A. Rossi);
  - Provide dimensions of Fermilab modulators for the space reservation (A. Rossi);
  - Provide quench protection system data (S. Redaelli);
  - Provide a maintenance volume for the cathode exchange (D. Perini);

- Other open points and requested actions by WP15:
  - Provide information on crystal collimation system;
  - Provide a list of descoped collimators and slots in LS3;
  - Provide more feedback on the final configuration of IP3 and IP7 collimators;
  - Provide more feedback on the new collimator installations and on which slots will be used for the LS3 layouts, when available;

- Offline discussion with A. Lechner and F. Carra to assess the effects of power deposition on BPMs and determine if they can be considered safe;

- Discuss the results of the future inspection of primary collimators in a dedicated wrap up meeting;

- Repeat the energy deposition calculation once the HL-LHC baseline is confirmed to evaluate the dose on the magnets;

- Evaluate the interest on a potential Cu-coated sample for this year’s irradiation campaign at GSI.

1 Clarification on interfaces to WP15 (M. Modena) [slides]

Summary of the presentation

MM presented the official mandate of WP15, which is to coordinate the integration and (de-)installation of technical equipment during the transition from LHC to HL-LHC. Detailed information and documentation is available in the [WP15 webpage]. After showing a list of the main documents released by WP15 that also affect WP5, MM described the main subjects under WP15 responsibility (budgeting, planning, integration studies, etc.). Some specific activities done for WP5 include integration studies for collimators and hollow e-lens. MM concluded with a list of expected actions on hollow e-lens and other open points (see above).
Discussion

- SR recalled some open points regarding the cabling and space reservation for the control units for Run3, and asked if all the needed input has been received already and if there are any other open actions. PF replied that for the collimators and cables all the information should be already there, but the budget request by some of the WPs needs to be checked;

- MM asked for follow up on the collimator cables, namely if they need to be dismounted and re-installed or if they need to be upgraded. SR replied that the plan is to install the new low-impedance collimators and keep the old TCSGs for the time being, but they will eventually need to be removed. JO asked for more feedback on exactly which slots will be used;

- PF asked for an update on the activities regarding the installation of hollow e-lens. SR replied that the planning is being worked on;

- PF also asked for some initial discussions on plans for crystal collimators. SR replied that the strategy still needs to be consolidated with the new collaborators from Russia, but it will be followed up.

2 Update on beam loads in IR7 collimators (A. Waets) [slides]

Summary of the presentation

AW reported the results of power deposition studies in IR7 LSS collimators, which had not yet been performed for the new HL-LHC baseline layout. The quantities of interest are the total power deposited in the collimator jaws and the peak power density in the absorber blocks. An updated FLUKA geometry for the primaries and the secondaries was used. The HL-LHC baseline used for these studies includes two MoGr primaries (vertical and horizontal) and a CFC one (skew), while all but the first and the third secondaries are MoGr. The results of the simulations performed by E. Skordis for this layout are as follows:

- MoGr primary: 6 kW, CFC skew: 30 kW;
- First secondary CFC: 26 kW (vs. MoGr: 85 kW);
- Second secondary MoGr: 19 kW.

The second secondary (TCSPM.B5) shows the highest difference between the total power in the two jaws, due to neutral particles originating from the primaries. The peak power deposition in the MoGr primaries is of up to 13 kW/cm$^3$, concentrated in the first 10 µm of the jaw. For the secondaries, the peak power deposition is towards the end of the jaw due to showers, and the value decreases by 30% between CFC and MoGr. AW concluded with some results regarding power deposition on BPMs, the largest portion of which is due to shower developments in collimators. In almost all cases, downstream BPMs show the highest peak power deposition, the only exception being on BPMs installed on collimators in close proximity.

Discussion

- SR pointed out that the baseline used in these studies is still a proposal and is not formally confirmed;
SR noted that it would be interesting to see how the loads on the most exposed collimators translate in terms of deformation. AL pointed out that the total power is what is important for the deformation, and that is reduced by a factor 4. FC confirmed that in first approximation the deformation should also be reduced by a factor 4 in this case;

SR commented that the power deposition on BPMs was qualitatively expected, even though now the actual order of magnitudes are known, and asked if it is safe to assume that none of them is at risk. FC replied that it is a bit difficult to say just by looking at the numbers and this matter should be followed up offline;

FC asked if primary collimators have ever been simulated from a thermomechanical point of view, since the temperature might be quite high and outgassing can become important. SR commented that so far only one primary was taken out in LS1 and the surface showed no damage, but more should be taken out in the near future to inspect their surface and dose. These observations might trigger a simulation campaign. The inspection could be discussed in a dedicated wrap up meeting;

PF noted that once the baseline has been defined, the calculations should be performed again to evaluate the dose on the magnets. AL commented that the main changes affect the collimators themselves, not so much the downstream showers. Still, this is something that could be worth looking into;

SR commented that it should be decided how to close the action to BI, to be followed up offline.

3 DPA and gas production for coated collimators (A. Waets)

Summary of the presentation

AW reviewed what was already presented at the HL-LHC meeting concerning radiation damage on collimators. First he recapped the results of 2018 BLIP irradiation campaign. The simulations were re-done by AW adding the Mo coating to the MoGr and CFC samples, while keeping the same beam distribution and amount of protons on target. Results are in good agreement with previous results by J. Espadanal. The same studies were carried out for the HL-LHC collimators, for which the H and He production with respect to DPA is also evaluated. The results are as follows:

- Primaries: < 0.2 DPA, peak 50 H appm, up to 150 He appm locally, range of several 100 to several 1000 appm/DPA;
- Secondaries:
  - CFC, MoGr bulk: \( \sim 10^{-4} \) DPA, \( \sim 0.1 \) appm, range of several 100 up to several 1000 appm/DPA;
  - Mo coating: \( \sim 10^{-3} \) DPA, < 2 appm, range of several 100 up to \( \sim 1500 \) appm/DPA;
  - When comparing TCSPM.A6 and TCSPM.B5, limited reduction of DPA in coating but 80% reduction in He appm.

Discussion

SR asked if the DPA scales linearly with the density. AL replied that it also changes with the atomic number;
• CA asked if the same threshold energy was considered for CFC and MoGr and if the results are sensitive to the threshold. AL replied that lowering the threshold to zero, the results change by a factor 2, so the order of magnitude stays the same;

• In a discussion with SR, AW, AL, FC and AB it was clarified that while the ratio between DPA and gas production of the BLIP measurements and the collimators fall in the same range, the absolute values for the BLIP tests are much higher. CA also pointed out that according to literature, same ratio but higher DPA is a worse situation.

4 Plans for 2020 irradiation campaign at GSI (C. Accettura)

Summary of the presentation

CA described the plans for the next irradiation campaign at GSI, which will take place at the beginning of April at the UNILAC facility, the same place where last year’s irradiation was performed. CA stressed that irradiation with Ca ion allows to limit the activation of the material, so that the samples can be shipped at CERN after just a couple of months (around June). The main numbers of the new campaign are as follows:

- ∼6 days of beamtime;
- Ca ions of 4.8 MeV/u to keep the same estimated DPA as last year;
- At least 32 samples to be irradiated;
- Two types of bulks (MoGr and CFC) with Mo coating on both;
- One sample geometry (electrical conductivity);
- Two fluences (1·10^{13} and 7·10^{13} ions/cm^3);
- Two values of flux (fluence per unit of time): one will be the same as last year for reproducibility checks, the other an order of magnitude lower;

These tests will allow to test the new grade of MoGr and will cover the same materials that will be irradiated at BLIP this summer, for comparison. Finally, the two different value of flux would allow to investigate the effect of the DPA rate.

Discussion

• SR asked if Cu coating is not considered anymore as a fallback option in case issues arise with Mo coating. AB replied that it could be considered if there is an interest, even though CA added that the plan was to have double the amount of samples of the same material in case something happens to one of them;

• AB asked if a sample with Cu coating would require specific simulation runs for the DPA calculation with FLUKA. AL, AW and CA replied that they were already done in the past. SR pointed out that in the next meeting CB will review the final assessment of the TDI tests where there was a Cu-coated CFC sample.