Minutes of the LHC Beam Operation Committee

13th March 2018

Participants, Indico

J. Wenninger presented an update on the commisioning plan. The opening of the CMS vacuum valves have been delayed by 3 days, the first beam was delay by 4 days. The first test of the high β at injection will be performed mid-may. The outcome will determine whether the low energy high β run at low energy can be performed later on at injection energy or rather at 900 GeV. The VdM scan session was delayed to after TS1 and will be followed by the 90 m β^* run at 6.5 TeV. The optics for the high β run will be based on the ATS injection optics. The baseline bunch spacing is 100 ns, the feasibility of using a 50 ns beam is under study. VdM scans will be performed using identical settings as in 2017. X. Buffat asked whether the collimator gaps can be reduced in order to avoid the instabilities observed when performing the scans of ALICE and LHCb. J. Wenninger answered that it is possible since a validation is needed in any case.
The beams needed for the VdMs as well as the 100 ns or 50 ns beams for the 90 m β^* run should be ready from the injectors by week 24.
The last powering checks will be performed during week 12, week 13 will be dedicated to the global machine checkout with first beams down the TL reaching ALICE and LHCb by the 29th of March. ALICE would like to be informed of the beam presence in order to take data, however they do not request dedicated time. The machine checkout will be finished during week 14 with the beam commissioning starting on the 5th of April.
Since sector 12 was not warmed up to temperatures as high as initially foreseen it is expected that a sufficient conditioning can be recovered faster, therefore the scrubbing run was reduced to 24h. Non-BCMS 25 ns beams will be needed. E. Bravin asked whether the exposure of sector 12 to the gas sublimating from 16L2 during the warm up could have affected the conditioning of the surface and therefore would require more scrubbing time. J. Wenninger answered that a significant level of uncertainty remain, therefore some flexibility will be needed in case of issue.
The detailed plan of the shifts are available on the LBOC webpage and will be updated dynamically.
A good fraction of the cycle was copied from last year's : A faster ramp function (PPLP) will be used and the last squeeze segments from last year will be merged. The details of the implementation of β^* levelling down to 27/25 cm will be discussed during the next LBOC.
In order to reduce the leakage of the dispersion due to the crossing angles to the rest of the machine and in particular at the BSRT, it is proposed to use bumps in the arcs as prepared by S. Fartoukh. G. Trad insisted that the improvement of the systematic error on the emittance measurement will be significant. The dispersion suppression is done in the arcs neighbouring the IPs and therefore does not impact the dispersion a the roman pots.
Crossing angle antilevelling in IP8 was considered but not retained since the complications are significant for a minor improvement of the integrated luminosity.
W. Hofle asked if RF experts are needed to capture the beam during the injection test over Easter. W. Bartmann answered negatively since there is no need for capture in the LHC.
8:30 meeting have already re-started, while currently focused on hardware commissioning by Easter the topic will change to beam commissioning.
B. Salvant asked whether 8b4e beams will be requested for commissioning. J. Wenninger answered that there is a request for a high intensity 8b4e beam for MDs only. B. Salvant asked what would be the time scale of the preparation needed if this scheme would be needed for unforeseen reasons. No clear answer were provided.

W. Hofle mentioned that some time should be dedicated to test the electron cloud measurement setup by injection and detection of RF signal in the beam pipe in IR4, in order to exclude possible interference with other devices such as the ADT.

S. Vlachos presented the status and plans for the Beam-Gas Vertex detector. A demonstrator of this technique was installed in B2 in view a full deployment in the HL-LHC. The system is composed of a volume within which neon is gas is injected at a pressure between 10^{-8} and 10^{-7} Torr, the result of the beam gas interactions are measured by a set of fast scintillators for triggering and two scintillating fibre plates for tracking. The trigger system has a resolution in the order of 1 ns which allows for an accurate measurement of the ghost charge.
The operation of the system was difficult in 2017, proper data is therefore available only for a few fills. The reproducibility of the alignment of the detectors components was tested and seem sufficient, however the resolution of the vertex detection affects significantly the reconstructed beam size and therefore can not be used as direct measurement. However, it is possible to exploit the correlation between tracks arising from the same event to reconstruct the beam size. A correction of about 10% based on Monte-Carlo simulations is introduced in order to correct for imperfections of the detector.
In this demonstrator, the tracks are reconstructed based on the position measured at two plates, representing a significant limitation. The full implementation will feature more plate.
The resolution increases with the acquisition time as expected thanks to the increased statistics. Above 1 minute of integration time, the resolution saturates at around 4 μm, corresponding to 2.3% of the beam width.
At injection and top energy, the BGV and the BSRT are in good agreement, the resolution of the BGV is slightly higher.
The measurement during the ramp improved significantly over the year with the experience in the operation of the device. The latest measurement performed during the 2.5 TeV ramp are in good agreement, assuming a constant β function. S. Redaelli said that some of the variations might be explained by variations of the optics. S. Vlachos said that if these variations are known he can take this effect into account in the comparison of the measurement with expectations. A. Rossi asked about the impact on the beam mouvements on the time scale of the acquisition. J. Wenninger answered that usually the orbit jitter is significantly smaller than the beam size.
The bunch by bunch resolution is currently limited by the amount of beam-gas interaction and the DAQ bandwidth resulting in limit at about 15%. An improved acquisition allowing for longer integration time will be implemented in the full system. A change from neon to argon gas would also allow to increase the number of tracks and therefore the resolution for the same gas pressure.
E. Bravin said that the signal from the BGV could be used in operation to significantly improve the BSRT calibration strategy. S. Vlachos said that the reproducibility should be sufficient, but the systems needs to be operated on longer time scale to evaluate its stability.
The estimations presented here assume round beams at the BGV, in principle the vertical and horizontal beam sizes can be disentangled using further processing of the correlation between tracks.
Currently significant post-processing is needed and the data cannot be provided online, a delay of about a day can be envisaged. The procedure is however not automatic and the CPU power is not yet large enough to generate data continuously. With the present hardware it takes about 10 minutes to treat 1 minute of data. Knowing these limitations, S. Vlachos asked for feedback on possible usage of this data for the operation of the LHC.

- E. Bravin said that a calibration of the BSRT based on the beam average given by the BGV in the different phases could become very useful, potentially saving the time of dedicated calibration fills. For that purpose it would be useful to gate the system such as to exclude the first 12 bunches which usually have very different emittances w.r.t. the rest of the beam. The separation between the horizontal and

vertical plane is also crucial.

- E. Bravin suggested to upload the result of the post-processing of the data to an accessible location when available, following the same model as the Massi files.
- G. Trad mentioned that the resolution has to be below 5% of the beam size in order to improve the knowledge of the emittance w.r.t. the BSRT measurement.
- Since the system cannot be operated continuously, targeting the cycle from the beam mode PRERAMP to a few minutes into STABLE BEAM would cover the most critical parts of the cycle.
- C. Schwick asked whether the data could be use during VdM scans. S. Vlachos answered positively but larger integration times will be needed due to the reduced number of bunches.

The deployment of the full system on the two beams is currently planned for run 4. Depending on its impact on operation it could be anticipated to run 3.

Reported by X. Buffat