

Minutes of the LHC Beam Operation Committee

20th March 2018

Participants, Indico

Jorg Wenninger presented an [Update on the Startup](#):

The powering tests are completed ahead of schedule. Some cryogenic plant tests are foreseen for next Wednesday and Thursday, eventually spilling to Friday morning. The machine checkout will therefore start around mid-next week. CMS valve opening is expected on Thursday and until then no LBDS tests could be carried out.

The transfer lines tests, down to the downstream TED, are advanced from Thursday to Tuesday afternoon (keeping Thursday as a buffer in case of problems).

The official “first beam” date is kept unchanged on Thursday 5th of April.

Week 12:

Handshake and signal exchange tests with the experiments are planned for Thursday; LBDS BETS validation, machine cycles and heat runs will take place throughout the weekend.

Week 13:

LBDS UPS tests, connection of LBDS to BIS loop are planned for Monday, however it is possible they get shifted earlier to Friday 23rd March.

On Thursday, the BIS loop and the LBDS will be armed and machine protection tests are planned for the following 2 days.

By Friday evening, the conditions should be very close to having beam in the LHC.

Week 14:

The first injections are expected around Easter Monday. The experiments are also aware that this may happen earlier on Easter Sunday. In fact, the management agreed that if everything is ready, beam could circulate over Easter with a ‘best effort’ support provided by the various groups especially RF, BI and ABT.

Most probably on Tuesday and Wednesday access will be granted to the LHC to sort out eventual problems arising over the weekend.

In case of good progress over Easter, the official ‘first beam’ could be anticipated to Wednesday and beam commissioning would then start.

Over Easter, the proposal is to have a pilot bunch at injection and possibly at FlatTop (without squeezing). Since the activities with pilot at injection are limited, nominal bunch will also be injected to advance with the commissioning (no ADT setup is required over Easter's weekend).

S. Redaelli asked about the collimators alignment and the settings for the first ramp with pilots. J. Wenninger replied that B. Salvachua who will be on shift could perform the needed a first alignment and the setup of collimators coarse settings for the first ramp.

Michi Hostettler presented [a proposal for the implementation of \$\beta^*\$ leveling](#).

The proposal implementation for 2018 operation would rely on the 'Lumi server' used to send trims to move between optics match points similarly to what is done for the crossing angle levelling commissioned in 2017. This will avoid changing the resident beam process, thus resulting lighter than the normal squeeze. The Lumi server will take care of orchestrating the PC, OFB and collimators trims.

An overview of the β^* levelling, commissioned in MDs last year, was given: the telescopic squeeze from 40 cm to 30 cm back and forth was fully demonstrated. The orbit control was near perfect with ~ 200 eigenvalues and unitary gain for the OFB (these settings will then be used for the commissioning in 2018). In fact, the luminosity optimization performed throughout the squeeze and un-squeeze indicate that head on collisions were basically preserved (less than 2 microns parasitic beam separation). It is worth mentioning that also the non-telescopic unsqueeze from 40 cm up to 1m was successfully tried.

The commissioning plan of the β^* anti-levelling in 2018 will be similar to what was done for the crossing angle leveling in 2017: parasitically during intensity ramp-up at end of fills and gradually shifting it back to earlier in the fills. It will not be triggered by the experiments request, but rather driven by machine margins following iso-dynamic aperture curves.

The levelling in 2018 will consist of the IP separation for ALICE and LHCb (and optionally for ATLAS and CMS if pile up is too high), the crossing angle anti-leveling and the beta* anti-leveling.

Two options are proposed to combine the last leveling techniques in a fill:

A) Starting with anti-leveling with crossing angle from 160 μ rad down to 140 μ rad. Switching to β^* anti-leveling from 30 cm down to 25 cm when the bunch intensity is between 1 and 1.1 10^{11} (eventually with an intermediate step to 27 cm). Finally, reducing again the crossing angle down to 130 μ rad when the bunch intensity is lower than 0.9 10^{11} prot.

B) Anti-leveling with crossing angle from 160 μ rad all down to 130 μ rad and then switch to anti-leveling with β^* leveling from 30 cm down to 25 cm when the bunch intensity is below 0.95 10^{11} protons (eventually with an intermediate step to 27 cm).

The crossing angle anti leveling, in 2018, will take place continuously along the fill in steps of 1 μ rad from 160 to 130 μ rad.

The preferred option is option B as disentangling the two techniques allows freely pushing back easily the β^* leveling from the end to earlier in the fill.

E. Bravin asked whether in terms of integrated luminosity there is preference between the two proposed options. M. Hostettler affirmed that both options are expected to produce the same integrated luminosity.

J. Wenninger recalled that in 2017 we had to stop at 140 μrad crossing since the beams started colliding in the triplets. E. Metral suggested to run some simulations to check whether this would be the limit also this year with the new β^* and beam emittances.

S. Redaelli asked next what would be the separation at $\beta^* = 25\text{cm}$ and crossing angle of 140 μrad for BCMS beams and consequently what would be the maximum bunch intensity for such configuration. Because waiting for the aperture to be OK to start un-squeezing will maybe lengthen the fill time beyond optimal.

Y. Papaphilippou replied that at 130 μrad , with BCMS beams of 2.5 μm emittance, the beam beam separation is estimated to 7σ , a good number to operate with for $\beta^* = 25\text{ cm}$ and at lower intensity of around $9 \cdot 10^{10}$.

G. Trad asked if there is a preferred leveling option that is favored by the forward physics; J. Wenninger replied that since no calibration will take place until TS1, both options are OK. C. Schwick added that option A may lead the experiments to request more data for the calibration.

M. Hostettler asked if an intermediate step at $\beta^* = 27\text{ cm}$ is needed or leveling down directly to 25 cm is possible. J. Wenninger prefers to have the intermediate step.

S. Redaelli proposed, if there are no objections, to do these 2 commissioning of $\beta^* = 25\text{ cm}$ with both crossings at 140 and 130 μrad .

C. Schwick asked if the crossing angle anti-leveling relies on a feedback or feedforward mechanism, and M. Hostettler explained that the beam intensity will be used for the feedback to maintain constant DA evaluating it every 60 seconds to decide if a further step of 1 μrad reduction is accepted.

B. Petersen wanted to know the impact of ATLAS and CMS asking at the start of SB for different targets of instantaneous luminosities on the leveling options. J. Wenninger replied that since this would take place only for few days (around 10 days) it is not worth the complication of having asymmetric crossing angles between IPs, therefore no β^* anti-leveling will be done but just separation leveling.

S. Redaelli asked how to avoid having a step of β^* reduction triggered at a wrong point of crossing angle resulting in an unprotected/not commissioned situation. M. Hostettler replied that an option could be enforcing matching rules on the value of the crossing angle when trimming between match points from the Lumi server. M. Solfaroli proposed having the SIS take care of this, however according to J. Wenninger it is complicated and needs several considerations before implementing it.

Finally, R. Bruce replying to a question from E. Metral confirmed that as last year, also for the configuration in 2018, the impedance drivers among the collimators are still unchanged (primary and secondary collimators) since the change in the TCTs and TCDQ settings do not have a notable influence on the total impedance.

Reported by G. Trad