SUMMARY OF SESSION 3: 2015 COMMISSIONING WITH BEAM

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Abstract

This paper summarizes the discussion that took place during the third session of the LHC Performance Workshop, Chamonix 2014.

INTRODUCTION

The third session of LHC Beam Commissioning Workshop was dedicated to the 2015 commissioning with beam. It included the following presentations:

- "Introduction", by M. Lamont;
- "Experiments' Expectations for 2015", by E. Meschi;
- "Baseline Machine Parameters and Configuration for 2015", by R. Bruce;
- "Optics options for the 2015 LHC run", by M. Giovannozzi;
- "Nominal Cycle and Options", by M. Solfaroli Camillocci;
- "Scrubbing: Expectations and Strategy, Long Range Perspective", by G. Iadarola.

For each presentation of the session, summaries of the discussion that followed the presentations are given.

INTRODUCTION (M. LAMONT)

L. Rossi asked whether synchrotron radiation could be useful for damping at the higher energy. *O. Bruening* recalled that the damping times are about 25 hours in the horizontal plane and 12.5 hours in the longitudinal plane, so slightly too long. *G. Arduini* added that it will be positive for longitudinal emittance, but long fills are needed to profit from it. *J. Jowett* recalled that for ions the phenomena is twice as fast, so rather significant.

EXPERIMENTS' EXPECTATIONS FOR 2015 (E. MESCHI)

R. Alemany commented that concerning the first VdM scan, a crossing angle is applied only in IP1, not in the other IPs. *R. Jacobsson* underlined that it is important to avoid satellites collisions.

A member of the CMAC asked what the expected integrated luminosity is for 2015. *M. Lamont* replied that 10–20 fb^{-1} is the working assumption.

S. Redaelli asked whether the experiments are willing to consider levelling by separation also in IP1/5, as technically it would be easier than β^* levelling. *E. Meschi* explained that with the natural luminosity decay, a short time at high pileup is tolerable. With levelling, on the other hand, the pileup is kept constant during the fill. So, in case of levelling, it is desirable to keep the pileup at an optimized level (lower than maximum acceptable). *S. Fartoukh* added that it is in theory feasible also to level at a non-constant pileup. *L. Rossi* clarified that what is called the peak pileup is in fact the average at the beginning of the fill. He also pointed out that a pileup of 50, with 25 ns beams, gives a luminosity of around $2 \times 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$.

J. Jowett clarified that, concerning the heavy ion run, the only figure for integrated luminosity in 2015 was 0.8 nb^{-1}, quoted at the RLIUP workshop by himself (even though this number is not particularly optimistic).

BASELINE MACHINE PARAMETERS AND CONFIGURATION FOR 2015 (R.BRUCE)

R. Schmidt commented on where to use the additional margins for Machine Protection. He pointed out that the choice might depend on the targeted failure cases: if protection is targeted towards an asynchronous beam dump for example, or to protect the aperture. *R. Bruce* agreed that a detailed discussion could follow concerning where to use the margins.

P. Collier stressed that the available 2 sigma margin is based on various assumptions, which are still to be verified, e.g. the aperture. *R. Bruce* agreed, adding that during commissioning we will see where the margins are needed.

W. Hofle asked why the Design Report 55 cm β^* is not considered. *R. Bruce* replied that the Design Report settings on collimators cannot be used due to the need for increased margins, so in order to consider 55 cm some margins have to be gained elsewhere (e.g. during Run 1 the aperture allowed extra margins). *S. Redaelli* added that it is a complicated parameter space: during Run 1 the aperture was indeed better than expected, the TCT-triplet margin from orbit stability might have been an artefact from instrumentation, the hierarchy in IR7 is driven by impedance needs.

R. Tomas asked why the Design Report bunch length of 1 ns is not considered. *E. Shaposhnikova* recalled B. Salvants presentation and the fact that the limitations concern-

ing heat load are now resolved. *R. Jacobsson* added that from the experiments point of view, a few clear options are needed so that they can be studied. The impact for LHCb is non-negligible and a longer luminous region is generally preferred. *E. Shaposhnikova* added that changes during the fill will be small, at the 10% level, and that synchrotron radiation will shrink the longitudinal emittance, so bunches may become too short.

G. Arduini stressed that the choice of the initial parameters has a strong impact on the later evolution. E.g. the choice of collimator settings will have implications on the next step: tighter settings would allow smaller β^*, and more relaxed settings might ease initial operation but will later require more time to the push performance. *S. Redaelli* agreed. He also added that he prefers not to change the settings of the primary collimators (settings in mm equivalent to TeV). In 2012 they had given origin to loss spikes, and it would be useful to learn about that early on. Anyway, if the TCPs are to stay at nominal settings, others collimators could be opened slightly to relax the operation from the point of view of impedance.

P. Collier highlighted that if Collide&Squeeze or β^* levelling are to be used operationally, a robust orbit feedback is needed in operation first so that the beams can be kept reliably in collisions with negligible separation. *J. Wenninger* suggested to test C&S and R&S during commissioning, and postpone the decision of whether to use them operationally to later. Indeed though, the first ramps should be simple, then e.g. R&S could be prepared in parallel.

G. Arduini added it is very difficult to qualify the feasibility of the C&S in MD, as the reproducibility on longer time scales is needed. *P. Collier* replied that he would not rely on reproducibility only, but on a robust feedback, which he considers a prerequisite for operation. A 1-sigma separation between the colliding beams can easily give stability issues. *J. Wenninger* recalled that once the LHC is in high intensity operation, changes are slow. Some experience should be gained with few bunches during commissioning, or parasitically with LHCb. *S. Redaelli* added that C&S is not exactly operationally the same as β^* levelling: C&S profits from additional flexibility and shorter validation period.

OPTICS OPTIONS FOR THE 2015 LHC RUN (M. GIOVANNOZZI)

R. Bruce commented on the comparison of the β^* reach for the nominal and ATS optics: the two optics are not fully equivalent. He recalled that for ATS an extra margin of 1 sigma is needed between the TCDQ and the TCTs. This effectively reduces the β^* reach (which can possibly be recovered with oval beams). *M. Giovannozzi* agreed that the ATS optics needs to be studied further, both in simulation and with beam studies.

M. Lamont asked when the validation for option-med will be presented at the LMC (including the change of tune). *M. Giovannozzi* replied in a month or two, and added that also the aperture with collision tunes needs to be proven to be as good as with injection tunes.

M. Deile stressed that injection at higher β should be pursued, as it could be useful not only in 2015, but also in the later runs (until LS3 there will be requests for high β runs). *M. Giovannozzi* recalled that injection at 30 m is probably already at the limit. *J. Wenninger* added that with an injection β of 30 m, the gain would be around 15 minutes per cycle. But the investment in commissioning the different injection optics would be gained back only with 2–3 weeks of running, so it might not pay off overall. Also, every year revalidation would be required. *H. Burkhardt* added that on the plus side it would simplify the high β runs, e.g. concerning the tune change (which would be smaller).

NOMINAL CYCLE AND OPTIONS (M. SOLFAROLI CAMILLOCCI)

P. Collier asked whether any improvement is possible on the main quadrupole precycle which at present are the limiting factor in length. *L. Bottura* said that the task will be taken up by the FiDeL team. *E. Todesco* replied that a precycle to lower current would change the tune decay. This might be ok if the tune feedback system can take care of that. *M. Lamont* pointed out that from the hardware commissioning one cold gain better estimates for the decay constants (the ones used at present are very conservative). *M. Solfaroli* added that in the longer term new power converters might be useful. *R. Tomas* also recalled the option to precycle the MQXs to lower current (with implicaations on β beating).

SCRUBBING: EXPECTATIONS AND STRATEGY, LONG RANGE PERSPECTIVE (G. IADAROLA)

P. Collier asked about the effectiveness of the doublet scrubbing in the quadrupoles. *G. Iadarola* replied that it is similar to the nominal beam, and that the enhancement is mostly in the dipoles.

W. Zeuner asked why a second scrubbing exercise is not an option. *G. Iadarola* replied that if improvements are seen while scrubbing, it will be carried on. Later improvements in scrubbing will happen while producing luminosity, with physics fills. The change to the other schemes (8b4e or 50 ns) will be done only if they would give much better performance.

L. Tavian worried that operation with doublet beams might saturate the cryogenic cooling capacity: 250 W/half cell is close to the local limit due to the size of the valve, but might not be fully available if operating with two beams (then we might be limited globally from the cryogenic plant itself, at 200 W/half cell. *G. Iadarola* recalled that the strategy was to check online with the cryogenics operator and inject only enough to get to the bottleneck, and when the new beam could be coped with.

G. Arduini stressed the importance of the online diagnostics tools to optimize the scrubbing strategy. While little improvement was seen on the quadrupoles, the transition between the different phases is given by the dipole improvements. Doublet beams are more efficient, so they should be used as soon as possible. *G. Iadarola* added that in 2012, had the doublet beam been available, it would have been used on the last day of scrubbing.

P. Baudrenghien pointed out that the bunches at injection are short due to the mismatched capture, chosen to reduce capture losses, but this could be changed. *E. Shaposhnkova* added that at injection the maximum voltage available should be used, as the momentum spread should be high. *G. Iadarola* mentioned that the batch-by-batch blow up to increase the bunch length could be used.

R. Schimdt wondered whether a higher density of beam loss monitor could be useful at some particular location in the machine. The discussion will be followed up offline.

S. Fartoukh asked whether simulations off-axis were performed in the quadrupoles. *G. Iadarola* replied negatively. He recalled that for the triplet, electrons are guided from the field lines. In quadrupoles, similarly, there is a trapping mechanism.