LHC Studies Working Group

Notes from the meeting held on 18 October 2011

The meeting was dedicated to the detailed preparation of MD#4 (Oct 30 - Nov 4). The agenda and slides of the meeting can be found at the following link:
https://indico.cern.ch/conferenceDisplay.py?confId=157678

R. Assmann presented the MD#4 draft schedule. The Large Piwinski Angle MD was not presented in this meeting as it had already been introduced previously. G. Arduini presented a request for additional 24 hours for ecloud studies. Possible changes of the schedule will be discussed at LMC on 2011.10.19.

1. Injection stability and losses + Quench margin at injection (C. Bracco)

The injection studies will focus on trying to understand the dependence of the losses on the transfer line steering for both TI2 and TI8. The aim is to defining limits at critical locations (how far the trajectory can go at a given BPM) by progressively worsening the steering and recording the losses. Part of the MD time will be spent in getting 12 bunches up to the TI8 TED. Additionally, a scan of the delay of the SPS MKE4 will be performed to study its effect along the bunch train. R. Assmann pointed out that these studies would be useful for reducing the time spent weekly on transfer line steering.
The quench margin studies will continue on the Q6.L8 (downstream of the TCLIB in IR8). First, data will be taken for the calibration of the BLM at the TCLIB location: as it saturated with 1e10 ppb, this time scraping will be performed. Given that no quench was observed so far with the Q6 at injection current, in this MD the magnet current will be increased until the maximum commissioned value (2300 A, in 200 A steps). Bunches of up to 3e10 ppb will be injected, and if no quench will be observed yet, then the bunch intensity will be increased up to 5e10 ppb. R. Assmann asked whether the Q6 will need to be precycled before the next MD, E. Todesco will provide the information, and added that he estimates that the magnet (which is at 4.2 K) might still be a factor 2 below the quench limit. C. Bracco reminded that in a previous study there seemed to be an indication that the quench limit had been approached.

2. Tune working points (R. Tomas, R. Steinhagen)

A tune working point close to the half integer would allow more space for the beam-beam tune shift. R. Tomas recalled the results of one optics measurement performed with the tune close to the half integer at injection energy: only beam 2 was measured and the β-beating was ~100%. Two different methods were used and gave different results: one based on the phase and one based on the amplitude of the betatron oscillations. Further analysis proved that the phase method was the correct one. Beam 2 corrections might require multiple iterations and beam 1 measurements are not available, it is estimated that at least 3 hours will be needed for optics corrections.
R. Steinhagen presented the preliminary MD program, which will have to be discussed in detail to merge the different MD requests into a coherent program for the allocated time. The optic measurements and corrections will be followed by tune scans with and without collisions. Some loss maps might also be included to exclude fundamental

problems with machine protection. W. Herr pointed out that long-range beam-beam effects cannot be meaningfully studied at injection energy. G. Papotti asked whether a precycle will be needed after the studies, J. Wenninger answered that it is the case in order to leave a clean machine for the next MDs. The time for the precycle is included in the 8-hour slot.

3. TDI vacuum MD (T. Baer)

It has been observed that the vacuum signal at the TDIs increased after a few hours of physics operation at flat top energy, this being possibly due to impedance effects. A reduction of the vacuum activity during coasts was observed on 15/16.10.2011 after opening the TDI gap after injection to +/- 55 mm (compared to the previous +/- 20 mm). E. Shaposhnikova asked why the bunches were slightly longer in the second fill, G. Arduini answered that it had not been intentional and they had been 50-70 ps longer. The TDI vacuum MD aims at studying the TDI vacuum pressure, heat load and temperature dependence on the TDI gap, and measuring the tune shift as a function of the TDI position (information that is useful input to the impedance model). E. Metral pointed out that the studies with one single nominal bunch are the most important. J. Wenninger and R. Assmann pointed out that the TDI can be moved out but not in to avoid making it a primary collimator. R. Steinhagen pointed out that the tune measurement should be optimized for this MD and then set back to physics parameters.
The UFO studies will be carried out in parallel by pulsing the MKIs in a gap in the partly filled machine (beam 1 for UFOs, beam 2 for TDI). The MKQ will also be studied as it is similar to the MKIs but with a different vacuum chamber (metallic coating, while a ceramic chamber is used for the MKIs). A detailed schedule of the MD time is shown in the slides.

4. Proton-lead feasibility test (J. Jowett)

The MD will start with two tests that could not be carried out earlier: RF rephasing with protons and the use of the unlinked radial loops for the two beams. The program then foresees establishing circulating Pb beam for the first time in 2011 (beam 2), followed by protons circulating in beam 1 (unlocking the RF frequencies for the two rings), and studying beam parameters and possible measures to deal with intensity limits, emittance blow-up, etc (e.g. transverse damper, tune changes). If time allows, then higher p intensity or more Pb bunches might be injected, the first Pb ramp might be tried or a ramp of both rings with unlinked frequency programs. More development time on the subject is allocated during ion physics, aiming at ramping both beams, rephasing the RF for proper collision points, squeeze, and possibly collide. J. Wenninger pointed out that during the MD time one Pb bunch should be circulated at the most. After the days of ion commissioning the collimators will have been set up and this limitation can then be released.

5. 25 ns ecloud observations (G. Arduini)

The results of the 25 ns floating MD were presented: some time was spent for initial setup, then reference measurements were taken and finally up to 1020 bunches were accumulated in ring 1. In ring 2 the limitation was the pressure on MKI8, for which the interlock was raised to 2.5x10-9 mbar. Observations of increase in heat load, decrease in vacuum pressure, emittance blow-up and RF stable phase shift are available. In particular it was noted that after the 25 ns floating MD it is possible to inject more than 1.4e11 ppb with no important vacuum instability. This constitutes the motivation to request another period of ~24 h before the end of the p+ physics run to test potential effects on high intensity 50 ns operation. This newly requested period aims also at exploring the operation with ~2000 25 ns spaced bunches and improve the understanding of the vacuum dynamic behaviour in the machine. This would provide vital input for the operation in 2012. The time would be allocated to setup injection, then accumulate up to 2100 bunches, observing vacuum and heat load, and taking reference measurements. J.M. Jimenez supported the proposal stressing that additional information is required to be able to give a reasonable estimate for the length of the 2012 scrubbing run (the collected data shows hints that scrubbing could be 10 times faster than foreseen). He also recalled that there are no vacuum measurements in the arc, and the only estimates for ecloud there come from the heat load, for which more measurements are needed to estimate how quickly the arcs can be scrubbed. R. Assmann stressed the difficulty of scheduling 3 extra shifts on the subject, which would require the cancellation of other studies. L. Evans supported the additional studies, recalling that scrubbing was already planned in the design report. R. Assmann proposed to re-discuss the priorities at the next LMC (19 October) where the schedule will be presented for approval, and proposed also to get at least part of the time from physics in view of the importance of the results on the decision for the 2012 running scenario. J.M. Jimenez recalled also that the SEU rates are proportional to the integral pressure over the machine: if the vacuum pressure will be at 1e-7 mbar for the whole machine, it is likely that the SEU rates will increase and some systems might show problems.

6. Long-Range beam-beam with 25 ns beams (X. Buffat)

The studies on limitations from LR effects will continue with 25 ns spaced beams, and similarly to previous MDs the crossing angle in IR1 and 5 will be collapsed in steps (followed by the TCTs) until lifetime drops and losses will be observed. This test would allow estimating a parameter set for (possible) running with 25 ns spacing in 2012. One 72-b train per ring colliding in IP1 and 5 is needed. Another test can be performed in parallel by adding one train per ring colliding only in IP8: the test of a 20 degree (HV) crossing plane in IP8. This setting would make LHCb polarity changes transparent for operations and would allow LHCb to take data with both polarities with 25 ns spaced beams. A change of crossing angle in both planes is required for this MD, and an MPP document is under preparation. R. Assmann stressed that the 20 deg crossing angle setting would allow saving time in the future. W. Herr added that the V crossing angle would be added first, and that then (part of) the H crossing angle would be taken out.

7. Beam instrumentation (A. Rabiller)

The MD time is divided in 6 periods with different beam conditions. The BSRT/WS measurements at the flat top now have highest priority and will be carried out first (2

12-b trains, including orbit bumps). After rampdown, Inj&Dump will be performed for the direct dump BLM calibration, followed by Circulate&Dump for the Matching Monitors and then emittance blow-up dependence on chromaticity studies. Next closed orbit bumps for BSRT and BPMs are foreseen. The rampdown is now included in the MD time, and the machine will be left at injection level by the BI team. A list of actions to be carried out before the MD starts was presented, in order to improve efficiency during MD time. L. Ponce pointed out that the time it takes to change the SPS supercycle and retune beam parameters should not be forgotten. J. Wenninger recalled that in case of important orbit bumps and non-setup beams, masks are needed in the SIS and he should be informed beforehand. J. Wenninger and R. Assmann disagreed with R. Steinhagen and suggested not to create the orbit bumps at the TCTs as proposed. R. Assmann asked when the BSRT absolute calibration would be available, A. Rabillier answered that although the relative measurements are fine, more understanding of some phenomena is needed before the absolute values can be trusted. J. Wenninger also noted that in case Circ&Dump with more than 1.2e10 ppb is required, the approval of all 4 experiments would be needed so that the procedure should be started as soon as possible.

8. Combined ramp and squeeze (N. Ryckx)

This MD aims at proving the feasibility of performing part of the squeeze during the energy ramp (operational: squeeze at constant energy). Settings have been prepared (and dry-run for the quadrupoles and orbit correctors) to achieve β^*=3.5 m in IP1 and 5 and β^*=3 m in IP8 at the end of the ramp (at ~3m the optics correction take place), effectively gaining 400 s in the functions length. Optics measurements would be performed during the ramp (dynamically) and at the flat top. Simulations done with MADX online predict up to 10% β-beating at around 5 m, corrections were prepared to reduce this beating. The first ramp is invested in measuring the coupling and for the optics measurements at the flat top. A second, and possibly third, ramp will start at collision tunes and measure the chromaticity during the ramp. The machine will be kept flat (crossing and separation bumps collapsed for all IPs). The AC-dipole, the OFB and the QFB are requested for the MD. E. Todesco wondered whether the gain in time justifies the effort, given that the ramp will have to be fully recommissioned after LS1.

9. Achromatic Telescopic Squeezing scheme (S. Fartoukh)

After a dry run for the verification of the settings (squeeze to 10 cm in a few stop points, check knobs), two MDs are foreseen. In the first, both IP1 and 5 will be squeezed to the ‘pre-squeeze’ value of 40 cm. In a first ramp, the main parameters and the optics will be corrected (pilot bunches), in a second ramp (nominal bunches) the collimators will be set up. In the second MD, IP1 and IP5 will be squeeze to 10-15 cm to validate the ATS scheme (pilot bunches). The detailed breakdown of the foreseen actions is available in the slides. J. Wenninger asked how much aperture is available at 40 cm, S. Fartoukh answered 9.4 nominal σ, assuming no β-beating.

10. Quench margin at 3.5 TeV (D. Wollmann)

This MD aims first at creating 500 kW peak losses at the TCPs in IP7 for beam 1, then at creating 500 kW constant losses for 5-10 s at the TCPs in IP7 for both beams, and finally at assessing the quench margin in the IP3 DS. Two methods are proposed, the traditional 3rd order resonance one and one that profits from the recent ADT developments to perform blow up on selected bunches. A breakdown in 3 or 4 ramps per method is presented in the slides. It should be noted that the ADT blow-up was tested only at 450 GeV. A detailed MPP document will have to be prepared for this MD (BLM threshold changes in IP7 and 3, agreement on maximum allowed intensities). J. Wenninger pointed out that on 17 October a ramp was lost due to the high voltage of the BLMs, suggesting checking with B. Dehning whether this could be a limitation. E. Todesco requested a list of the magnets that are expected to quench (with copy to L. Bottura). D. Wollmann answered that previously the highest losses were observed at the Q8 and Q11. G. Papotti asked whether this can be combined with the wire scanner/quench MD, which otherwise cannot be carried out.

11. Non linear dynamics (M. Giovannozzi)

M. Giovannozzi presented an update on the program since the previous LSWG. A 2-hour access is required to fix the AC-dipole (was giving a variable kick strength): luckily this was be done before the MD block. Additionally, for machine protection issues, the MKA should be enabled/disabled before/after the MD (requiring a 1 hour precycle). The MD aims at benchmarking simulations for the long term developments, e.g. for HL-LHC. It is planned to have two sets of studies in parallel on the two beams. A single pilot bunch in ring 1 will be blown up with the ADT and the intensity decay recorded while scanning over MCDs and MCOs. In ring 2, the MKA will be used to determine directly the dynamic aperture (might be cancelled if MKA not available or too time consuming to set it up). The results will be used to cross-correlate with the data previously acquired for ring 1. Additionally driving terms and detuning measurements will be performed. For both MDs the collimators will all be opened, except for the primaries (to be kept at 12 σ).

12. Longitudinal beam stability (E. Shaposhnikova)

During this MD more data will be acquired on the long lasting dipole oscillations after injection and on the loss of Landau damping as a function of longitudinal emittance, beam energy and intensity. In the first part, multi-bunch beam will be used to study dependence of longitudinal stability on emittance and voltage at injection. This study will also explore a parameter set that would be useful for the SPS low γ_t and for the study of the onset of coupled-bunch instability (by lowering the RF feedback gain). In the second part, 8 nominal bunches will be ramped (different emittances extracted from the SPS). The main difference from the previous studies is that the phase loop will be turned off during the ramp, after having damped the injection dipole oscillations: this will allow identifying the instability mode (quadrupole, observed May 2010 or dipole mode, observed in August 2011).

Next meeting to be held on 8 November, to discuss the results of MD#4.

Giulia Papotti

List of participants

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AQUILINA	Nicholas	TE-MSC-MDA
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EVANS	Lyn	PH-UCM
FARTOUKH	Stephane	BE-ABP-LCU
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HAGEN	Per	TE-MSC-MPT
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