LHC Studies Working Group
Notes from the meeting held on 27 March 2012

The meeting was dedicated to the discussion on the priorities for MD#1 (20-22 April 2012). The slides can be found at the following link:
https://indico.cern.ch/conferenceDisplay.py?confId=183704

1. BI requests (F. Roncarolo)

The request lists studies for all instruments: BCTs (to address non-linearity issues), WCM (calibration), matching monitor (e.g. check detector response), BSRT (orbit bumps and cross-calibration with wire scanners), LDM (transverse beam size dependence), BGI (orbit bumps, inverted polarity to collect ions instead of electrons), BPMs (mapping with bumps for non-linearities, studies of k-modulation, phasing of BPMSW). Note that some of these studies are scheduled during machine commissioning and should be addressed in MD time only if not carried out yet. R. Assmann pointed out that the list is too long for 8 hours, but that some items are outstanding and should be scheduled (e.g. the cross-calibration of the transverse emittance measurement). F. Zimmermann asked about the access required to invert the polarity of the BGI, pointing out that it would be a pity to use MD time for an access. M. Sapinski replied that the access can be carried out at any time, preferably as late as possible (the polarity would be inverted for one BGI only). F. Zimmermann asked if a single nominal bunch would not be better for the k-modulation studies. R. Steinhagen replied that probes would be sufficient to address differences on the two BPMSW acquisition systems.
F. Roncarolo also presented a request for emittance preservation studies. A slot of 8 hours is requested to characterize the emittance growth with different ADT settings at injection and during ramp and squeeze (12 bunches per ring). This MD should be scheduled after the BI MD as calibrated emittance measurements are required.

2. Beam-beam requests (T. Pieloni)

T. Pieloni recalled the request by the experiments to study the effect of transverse offsets in IP1 and 5 on luminosity lifetime. Given that the worry is that a small separation might enhance the emittance growth, the suggestion is to first carry out an end-of-fill study (with ~250 bunches to have the full complement of LR interactions) and to maintain the conditions one/two hours. J. Wenninger recalled that such study is scheduled during the intensity ramp-up. B. Gorini recalled that two options were discussed at LPC, leveling within a fill or comparing two fills with and without separation, and the former option had been preferred. T. Pieloni confirmed that the comparison between two different fills might be harder to understand, and also announced that a pertinent presentation would be given at the LMC on 28 March.
R. Assmann asked whether the study should be done in MD or Adjust mode, B. Gorini replied that for precise luminosity measurements the beam mode should be Stable Beams. M. Zerlauth added that the subject would be discussed at rMPP.
Two beam-beam MD proposals were recalled: leveling with β^* with constant crossing angle at 1 IP as an alternative to leveling by transverse offset (MD request by S.

Redaelli) and an MD to study the long-range beam-beam limit with high intensity 50 ns beams. F. Zimmermann commented that the long-range study could be interesting for defining the crossing angle at smaller β^*. J. Wenninger and R. Assmann pointed out that the machine at the time of the MD would not be ready for 1.7 ppb 50 ns beams. E. Bravin suggested that for the measurement of small emittance variations the wire scanners should be used. M. Sapinski recalled that wire scanner measurements can be carried out at top energy with maximum 50 bunches per ring. J. Wenninger suggested the luminous region size from the experiments as an alternative measurement (despite the fact that the two beam sizes are convoluted). S. Fartoukh suggested a study of the feasibility of the vertical crossing in IP8 at injection (120 μrad might be sufficient, versus the nominal 170 μrad). J. Wenninger replied that for 2012 the vertical crossing is implemented after the squeeze, but that the study is indeed interesting for after LS1.

3. RF request (T. Mastoridis)

This MD focuses on testing a batch-by-batch controlled emittance blow up at injection. The controlled increase in longitudinal emittance should result in reduced transverse emittance blow-up due to IBS at 450 GeV. A new "RF injection sequencer" is to be deployed and tested during the proposed MD: the first injected batch should be captured with the phase loop on, then the phase loop would be opened for the time needed for the blow up; for the next injected batches, capture would be with the longitudinal damper on, to be then turned off for the time needed for the longitudinal blow up; after the blow up is finished, the phase loop would operate on those batches. The hardware and firmware are ready, while the software would be the main innovation to be tested in MD time. G. Papotti asked about the minimum number of bunches required per batch (144 bunches per injection will be operational before MD#1). P. Baudrenghien answered that the maximum available would be best. It was pointed out that the total number of bunches in the machine matters, as beyond ~144 no wire scans would be possible at 450 GeV, and the BSRT scan takes 3 seconds per bunch. F. Roncarolo suggested the option of gating the BSRT on a reduced group of bunches to reduce the scan length. W. Hoefle suggested the option to inject 12 batches of 12 bunches each to allow wire scans throughout the MD. B. Gorini asked whether the bunch length in physics would be different from batch to batch. P. Baudrenghien replied that the controlled blow up during the ramp equalizes the bunch length in physics, and the transverse emittance will be hopefully smaller.

4. UFO-like losses with the ADT (A. Priebe)

The possibility to create losses in the UFO timescale with the ADT was investigated on 26 March, and turned out to be very promising. Two methods were tested on the probe beams: a coherent excitation (ADT feedback in open loop), and a sign swap of the feedback loop. The ADT can provide high losses (beyond the BLM saturation level of 23 Gray/s) and the losses have a slightly different time distribution (showing multiple peaks that are not present in UFO events). It was concluded that the ADT could be used for the 2012 quench tests, and that more studies are required before then. R. Assmann suggested further studies to understand the height of the signal in the absence of BLM saturation. M. Sapinski speculated that judging from the shape,

the signal would not have been much higher than saturation. W. Hoefle and D. Valuch pointed out that also slower losses can be generated, adding that the pilot is a narrowband resonator due to the reduced tune spread and that the method to flip sign is the worst case scenario. T. Baer pointed out that the UFO signal is "cut" after the beam dump. J. Wenninger and R. Assmann recalled that the collimation system is designed for multiturn losses and that phase-space coverage is not guaranteed in such fast scenarios. They wondered whether the excited beam could miss the primary collimator and hit elsewhere, e.g. a TCT, and added that the machine protection implications should be studied. M. Zerlauth recalled that in an MPP meeting it had been decided to limit the ADT hardware so to avoid this type of fast losses. W. Hoefle indicated that the transverse oscillation of the bunch can increase of up to 1 sigma in 3 turns.

5. Collimation request (G. Valentino)

G. Valentino presented a request of 8 hours of MD time for the collimation team as a follow-up of the ongoing commissioning. The time would be dedicated to developing new techniques for improving further the setup time (already reached: full alignment of 86 collimators completed in 10 hours compared to 18 hours in 2011) and investigating the effects of tight collimator settings on the beam at 4 TeV (intensity and impedance issues). R. Assmann hinted that some observations (e.g. instabilities) from commissioning should be reproduced. F. Zimmermann asked whether the impedance team is involved in the study and S. Redaelli answered positively.

6. Impedance studies (E. Shaposhnikova)

This MD focuses on the measurement of the LHC longitudinal effective resistive impedance. The related phase shift was measured in May 2011 and significant deviations from the predictions (based on the existing impedance model from N. Mounet's PhD thesis) were found. During the MD, more data would be acquired as only small ranges in bunch length (<20%) and intensity (fluctuations) were covered in 2011. Single bunches with different longitudinal emittances and intensity would be injected in both rings. Note that other measurements are possible in parallel (e.g. transverse blow-up, peak-detected Schottky for longitudinal incoherent frequency shift with intensity for the reactive part of impedance). The request is for 2 hours at injection, but if more time were available, the study would profit from an energy ramp. The phase shift would be important information for comparison to phase shift from electron cloud and heating from other elements. F. Zimmermann asked what component of the resistive impedance is dominant (resistive wall from the arcs or collimators). E. Shaposhnikova answered that at low frequency the resistive part is dominant, at high frequencies many elements are, including collimators. F. Zimmermann pointed out that the measured impedance seems 10 times smaller than expected. E. Shaposhnikova answered that the shown results are preliminary and based on a small dataset, so more checks should be carried. P. Baudrenghien asked about the big bunch-to-bunch differences in the predicted phase shift. E. Shaposhnikova answered that it is due to the fact that the model is frequency dependent and bunches have different bunch length.

7. ADT developments (W. Hoefle)

W. Hoefle recalled that already in Chamonix 2012 a few proposals were presented to address the issue of the compatibility with the BBQ tune measurement (e.g. a lower ADT gain for the first 12-bunch train and the feasibility of a tune measurement from the residual ADT pick-up signal). It was also pointed out that in physics operation the damper gain is lowered in preparation for the ramp to allow enough BBQ signal for the tune feedback, and that the damping times were not yet optimized across beams and planes. Another proposal is then to verify whether a higher gain in the ramp could possibly cure the measured emittance blow-up (a higher BBQ signal amplitude implies more residual beam oscillations, which potentially lead to blow-up). D. Valuch already prepared new features on the ADT in view of these developments (new memory blocks for quasi-continuous observation, e.g. 8 bunches times 2048 turns, and bunch-selective gain modulation in the digital part of the feedback loop). During the MD time, one more intense bunch would be the "witness" bunch (zero ADT gain, to verify improvements on the BBQ signal), while 7 additional bunches would have different gains. The beam would be ramped to 4 TeV, the request is for 6 hours. Note that the entire machine would be in nominal operation except for the ADT gain. Wire scanner measurements are required throughout the MD. R. Assmann pointed out that all the proposals seem important, and that the most important is the interference with the tune signal, while the emittance preservation would be a second order priority. R. Steinhagen confirmed that the BBQ data is logged, so that data can be analyzed after the MD session. R. Steinhagen also proposed to run without the tune feedback and maximum damper gain to observe the tune. N. Mounet recalled that during the snapback the chromaticity can be negative, and this might allow beam instabilities in the absence of the ADT risking to trigger a beam dump.

L. Norderhaug Drosdal recalled the importance of the transfer line studies, out of which some items will be carried out during the machine commissioning. B. Goddard sent the injection MD priorities via email after the meeting, the slide can be found attached to the Indico webpage. Highest priority is given for the study of beam losses at injection (288b injection, new BLM checks, ...).
S. Redaelli recalled a list of aperture studies of which some items might remain after commissioning. R. Assmann agreed, highlighting the need to understand why the aperture bottleneck is found in IR1 instead of IR5 in b2h for β^*=60 cm.

The next meeting will be held in 874-1-011 on 3 April 2012 at 15:30 and will be devoted to the detailed presentation of each study scheduled in MD#1.

Giulia Papotti

List of participants

ASSMANN	Ralph Wolfgang	BE-ABP-LCU
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Excused: M. Giovannozzi.