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

The meeting was dedicated to the discussion on the MD priorities for 2012. The slides are at the following link: https://indico.cern.ch/conferenceDisplay.py?confId=174657
An email is attached as annex to these minutes as follow-up of the BLM action from the 8 Dec 2011 meeting.

1. Start of fill MDs (P. Baudrenghien)

P. Baudrenghien supported the idea of "Start of Fill" MDs (SoF) presented by F. Zimmermann at Evian as "End of Fill" MDs are less interesting for the RF studies as the beams are not safe due to the high intensity and as the bucket is full. At the same time, many RF MDs can be performed at injection energy and while injecting nominal batches and with no changes to the rest of the machine. Time slots of 2-4 hours would be very effective for many studies and developments. The beams would be dumped and operation could continue with refill for physics right after. Limits would have to be defined on the accepted deviations from the nominal parameters. A list of possible RF SoF MDs was presented, including: studies of longitudinal stability for batch injection; longitudinal batch-by-batch blow-up studies (potential reduction of the transverse emittance growth caused by IBS); longitudinal damper commissioning; first studies on the voltage modulation around 1 turn (required for 25 ns beam with intensities above 1.1e11 ppb); RF feedback optimization with circulating beam. F. Zimmermann pointed out that the time should be taken from the "floating" MD time, not from physics time. S. Fartoukh pointed out that different studies could be done in parallel on the two rings, P. Baudrenghien recalled that the RF is linked between the two rings, and consequently some studies would need to be dedicated (e.g. chromaticity). B. Dehning supported the idea of SoF studies for BI, e.g. for emittance measurement studies. G. Papotti pointed out that the 5 day MD block can be stressful for some experts involved in many MDs, and spreading out studies that involve minimum changes to the nominal machine configuration could be helpful. R. Assmann concluded that after the discussion, SoF MDs would be treated as floating MDs in order not to draw additional time from physics production. P. Baudrenghien commented that all RF requests seem important for different reasons (for longitudinal impedance, increase in intensity, for 25 ns spaced beams and to prepare for p-Pb) and recalled the request for a ramp with at least 288 25 ns spaced bunches to observe beam loading and possible klystron saturation (preparation for after LS1).

2. UFO Studies (T. Baer)

It was recalled that UFOs might become a limitation especially after LS1 due to the energy increase, that MKI UFOs represent an attractive option to study UFOs and that many positive results were achieved in previous MDs (MKI pulse/UFOs correlation, "faster-than-gravity" UFOs, no UFO observation at MKQs, …). MKI UFO MDs would continue to observe asymmetries between MKIs and to study the possible influence of the electron cloud. No dedicated 25 ns beam UFO studies had been performed yet, but indications of strong UFO activity were derived from parasitic observation (mostly at

the MKI as the observations were at injection energy only). It was generally agreed to the high priority of dedicated studies with 25 ns beams (R. Assmann, B. Dehning, R. Schmidt, J. Uythoven); T. Baer added that the study would be most meaningful at the flat top and with more than only 288 bunches. R. Assmann recalled that abundant dust particles were found in the opened MKI and pointed out that further studies could be performed in the lab and eventually the MKIs could be exchanged, but then the limitation would still be the arc UFOs. J. Uythoven added that no solution has been found yet to improve the solution at the MKIs (no coating is possible). R. Schmidt asked whether the idea of "shaking" the vacuum chamber to produce dust particles had been followed up. T. Baer answered that nothing had been done in that direction yet. S. Fartoukh asked whether the polarity of the kickers could be changed to verify the models. V. Kain answered that this is not possible. F. Zimmermann added that according to the simulations the UFOs are much more likely to move from the top to the bottom of the chamber than vice versa.

3. Quench studies (A. Priebe)

A. Priebe recalled that previous tests on C14R2 successfully quenched the magnet by provoking losses over about 5 s (further statistics would be appreciated). A 3-corrector bump is needed for B2V and Geant4 simulations are available which are in good agreement with the experimental data. A new MD is requested to produce steady state losses over 1 minute which would be useful to calibrate the corresponding BLM thresholds (R. Steinhagen proposed the use of the orbit feedback to produce these losses). The MD would be divided in two phases: first a magnet quench at 4 TeV from which a BLM threshold could be derived, then operation with losses at 90% of the threshold. Additional BLM, mobile BLMs, RadMons and QPS equipment would be installed for this study. These studies would provide useful input also for the LHC upgrade and for future magnet technologies. B. Holzer asked how many quenches are planned for this MD, A. Priebe answered that only 1 quench is foreseen and that only half a cell is affected. R. Schmidt recalled that quench matters should be treated with extreme care, e.g. the possible decision to run at 4 TeV/beam in 2012 is based on the fact that no quenches happened in 2011. He also recalled that some sectors are known to be better than others, e.g. S56 was chosen for the 2011 HWC diode tests as it is known to be safe up to 5.8 TeV. S. Fartoukh asked about the reason for a V bump on beam 2. A. Priebe answered that both beams and planes would be theoretically interesting, but only B2 had been available in that first successful MD in 2010. M. Sapinski added that the V bump is safest due to the fact that with an H bump also the dipole had quenched in 2010 (not only the quadrupole). S. Fartoukh suggested the chosen location to be in S34, which was rebuilt after the 2008 incident, B. Dehning answered that it would be preferable not to change the location. R. Schmidt recalled that running at 4 TeV might be slightly different from 3.5 TeV. R. Assmann pointed out that the test could be done towards the end of the year to avoid jeopardizing the physics yield. D. Wollmann added that some 4 TeV operational experience would be available by then. R. Schmidt asked how much overhead for recommissioning would be required to repeat the test at 3.5 TeV in 2012. V. Kain answered that for high intensity this would not be negligible. B. Holzer recalled that the experiments are interested in a lower energy run, in which case the study could be combined.

4. Heavy ion MD requests (R. Verstegeen)

The main results of the 2011 MD were recalled: the p-Pb feasibility test, (injection, ramp, cogging), the ALICE polarity reversal (through small long-range separations), the BFPP mitigation, and the Pb collimation quench test (quite successful despite not quenching the magnet). The preliminary requests for 2012 were recalled: the continuation of the p-Pb feasibility test (crucial to plan the physics program, to be performed as soon as Pb is available); the continuation of the Pb collimation quench test; the possible extension of the BFPP technique to e.g. IR7 and IR3. It was also recalled that the p-p cogging is a prerequisite for the p-Pb MD. B. Holzer asked for which energy the p-Pb test is foreseen, R. Verstegeen answered that she is running simulations for 3.5 and 4 TeV but 2.5 TeV could also possibly be requested by the experiments, and recalled that higher energy is easier as the frequency offset between the two rings is smaller.

5. Injection and dump MDs (C. Bracco)

C. Bracco recalled the list of MD requests for 2012 and pointed out the importance of all: beam losses at injection with 288 bunches; protection from long devices (TCDQ/TCT checks), to be combined with collimation studies on asynchronous dump during beam based setup at 450 GeV and end of fill studies during aperture measurements with squeezed optics; impedance and beam induced heating of TCDQ and TDIs; quench limits at injection and with wire scanners; injection matching and emittance preservation; Q20 optics beam extraction, transfer and injection (could be partly done during LHC downtime); transfer line stability (done during commissioning and later in the year). R. Assmann questioned the importance of the TDI impedance studies as long as the TDIs are non conform to the design specification (beam screen made of copper instead of stainless steel, and structurally deformed). C. Bracco confirmed that a new beam screen is needed. E. Metral recalled the importance of RF heating studies and the effect of the bunch length on the MKI temperature.

6. Proposed priorities for 2012 (R. Assmann)

R. Assmann recalled that all MD notes concerning 2011 studies should be published and uploaded on the LSWG webstite. Then, he presented the preliminary list of highlights/goals for 2012 MDs to be presented in the Chamonix workshop:

- Establish reliable nominal injection. Injection limitations (TL stability). Improvements (Q20).
- 2808 bunches of 25ns at injection: 2808 x 1.2e11
- Ramp 1 batch, 288b (25ns) for peak current within 3 μs → demonstrate 200 kW klystron power. Ramp as many batches as possible.
- Understand longitudinal impedance in LHC. Advance voltage modulation and blow-up. Test longitudinal damper.
- Understand beam-beam emittance growth due to transverse noise.
- Flat beams with standard optics as an option to increase luminosity in 2012 and reach 5e34 lumi after LS1, before HiLumi upgrade.
- Understand LR beam-beam limit for 25ns.

- Large Piwinski Angle test.
- ATS optics: β^*<40 cm, pile-up of 100, ... Collimation for β^*=40 cm and flat beams.
- Non-linearities: What do we really need for upgrade specifications?
- Chromatic limits in LHC and collimation/MP: When do we need an ATS optics?
- Collimator setup 9 times faster (with 9 Hz). Test of 7 TeV collimation settings → ultimate efficiency.
- Optics: Establish a beta* of 500m.
- Additional data for UFO's at MKI's. Highest priority: ramp as many 25ns bunches as possible and observe.
- Experimental benchmark on 7 TeV quench limits: Quench test on C14R2 at 4 TeV.
- Noise properties of ADT with FB on and off. Emittance growth. Optimization of ADT in ramp.
- Compatibility tune and ADT: Residual tune signal in damper signal. ADT Q/Q' diagnostics compatibility.
- Understand transverse impedance limits of the LHC and limitations in octupole and ADT stabilization.
- Understand beam heating effects. Done?
- Limitations in BI. Lessons for improvements in LS1.
- Automatic K modulation for beta*.
- RF for proton-lead MD.
- Understand Pb intensity and luminosity limitations and mitigation (orbit bumps).

E. Metral stressed the importance of studying the heating effects, studies of impedance localization, studies of beam stabilization by octupoles and by beam-beam.
S. Fartoukh commented that, at constant mechanical aperture in the inner triplet, flat optics can be an alternative to round optics when the β^* aspect ratio is substantial of the order of 3 to 4, that is a β^* of 30cm/1.2m in the H/V plane in order to be competitive with the round optics with β^* of 60 cm which is targeted in 2012 and will a priori saturate the triplet aperture. Under these conditions the product of the β^* in H and V planes is the same, and the gain of luminosity actually comes from a mitigation of the geometric loss factor, that is a gain of the order of 10-15% for the nominal collision β^* of 55 cm of the LHC. In all cases, the smaller β^* in the plane perpendicular to the crossing plane seems out of reach without deploying ATS like optics, a fortiori if the starting point would be a round β^* of 40 cm after LS1, i.e. a targeted flat optics of 20/80 cm. B. Holzer added that the necessary optics will be prepared only if needed.
R. Tomas suggested to add the half integer tune optics studies to the list, stressing that some results have already been achieved in 2011.
R. Tomas also pointed out that below 1m β^* at 4 TeV the triplet non-linearities might need correction, and the question came up of which correctors will be available during the 2012 run. T. Baer answered that the list had been presented at the latest LBOC meeting (Tue 24 Jan 2012).
S. Fartoukh supported the large Piwinski angle studies as useful also for after LS1, not only for the LHC upgrade.
R. Verstegeen recalled that during the p-Pb MD the injection and ramp of many bunches against many bunches was not reached in 2011, and stressed its importance for 2012.

R. Schmidt stressed that all quench data and simulations should be put together for extrapolations to 7 TeV.

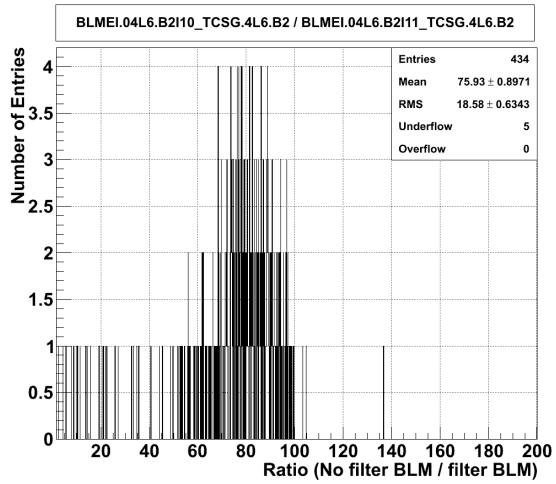
The next meeting will be held after the Chamonix LHC Performance Workshop (6-10 Feb 2012), invitations and agenda will be sent in due time.

Giulia Papotti

Annex, follow-up of action from previous minutes:
"TCLIB BLM with RC filter that showed a reduction factor smaller than expected"

From A. Nordt, from the BLM team:

"A few more details about one BLM with a filter where we see a much smaller reduction in signal than expected.
"This BLM (06L8@TCLIB B2I11) had a big filter until 26th of Nov. 2011 and with such filter we expect a reduction in signal amplitude by a factor of 180. However taking into account the cable length (100-140m), we expect roughly a factor 80.
"But: we see only a factor of 20. In Nov. the filter was rechecked and found to be correct and for testing reasons we increased the filter and installed a 10 times bigger filter.
"Then we would expect a factor of signal amplitude reduction of 800 (taking cable length into account already). However we see only a reduction by ~40-50.
"Attached you can see 4 plots, 2 histograms and 2 graphs for the TCLIB monitor and a TCSG monitor in L6, where all is as expected.
"Shown is the ratio between non filter and filter BLM (both are located at the same dcum). I use RS01 (40musec) and I plot all losses at these monitors as measured during 2011.
"For the TCLIB Graph plot you see that there are no values in the beginning of the year...simply because the monitor was installed in summer only for a quench test. And in the end of the year you can see the 'jump'-->exchanged the big by 'super-big' filter.
"I would like to point out, that it is not yet understood why this BLM gives a smaller ratio. We checked several times the filter, the capacitor etc.. Also a malfunctioning monitor can be probably excluded because the HV modulation data show no non-conformities.
"I will meet with Bernd and Ewald (probably next week) in order to understand this behavior correctly and to take a decision, whether this BLM stays or whether we exchange it. "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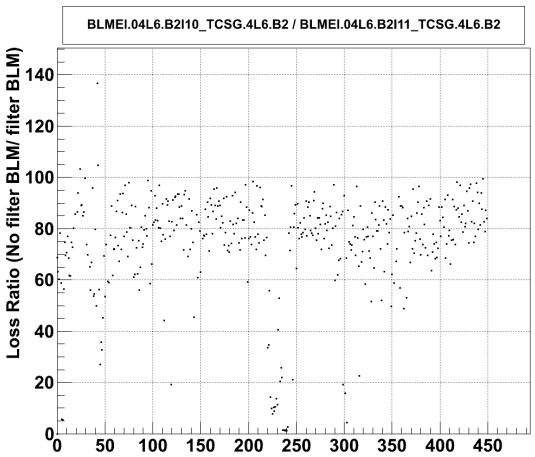
RMS 18.58 ± 0.6343
Underflow 5
Overflow 0
Number of Entries
Ratio (No filter BLM / filter BLM)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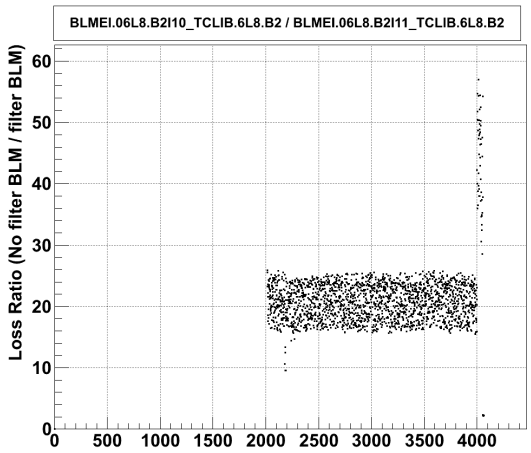
Loss Ratio (No filter BLM/ filter BLM)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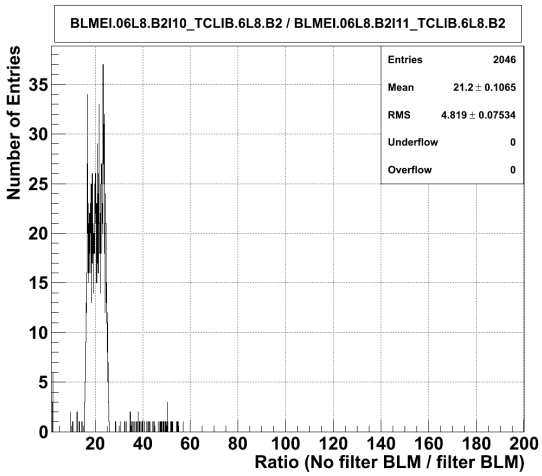
Loss Ratio (No filter BLM / filter BLM)


BLMEI.06L8.B2I10_TCLIB.6L8.B2 / BLMEI.06L8.B2I11_TCLIB.6L8.B2
Entries 2046
Mean 21.2 ± 0.1065
RMS 4.819 ± 0.07534
Underflow 0
Overflow 0
Number of Entries
Ratio (No filter BLM / filter BLM)

List of participants

ASSMANN	Ralph Wolfgang	BE-ABP-LCU
BAER	Tobias	BE-OP-LHC
BAUDRENGHIEN	Philippe	BE-RF-FB
BHAT	Chandrashekhara	BE-ABP
BRACCO	Chiara	TE-ABT-BTP
BRUCE	Roderik	BE-ABP-LCU
CALAGA	Rama	BE-RF-BR
DE MARIA	Riccardo	BE-ABP-LCU
DEHNING	Bernd	BE-BI-BL
DROSDAL	Lene Norderhaug	BE-OP-LHC
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NEBOT DEL BUSTO	Eduardo	BE-BI-BL
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SCHMIDT	Rudiger	TE-MPE-PE
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VERSTEEGEN	Reine	BE-ABP-LCU
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Excused: G. Arduini, M. Giovannozzi, S. Redaelli.