LHC Beam Operation Committee

Notes from the meeting held on 10th July 2012

Participants

1. Status of Beam Gas Ionization Monitor (BGI) – M. Sapinski (slides)

M. Sapinski explained the BGI operational principle and gave a detailed overview of the hardware and its subsystems in the LHC and SPS. The cards for the high voltage controller are produced at CERN and are used also for the wire scanners (at present one spare is available for the WS and no spare for the BGI). A problem was encountered when moving to the linux CPU. The problem was fixed reducing the frequency of the image reading.
Instabilities and communication problems were observed in the HV system; mitigations were put in place but any operation on HV is forbidden when high intensity beam is present in the machines.
Some issues are present in the SPS for what concerns the powering of the correctors used to generate the orbit bump at the BGI and a short-circuit was found in a vertical corrector. Improvements in the powering system logic are foreseen for LS1 and the vertical corrector will be replaced during TS3.
A serious problem in the imaging system prevents measurements in the vertical plane for Beam 1 in the LHC; this will be fixed during LS1.
The software is under development: two fixed displays and an expert application are already available and new manpower will work on image processing, fitting and automatic gain control.
The BGI fitting procedure takes into account only the beam core; examples showed that it is relatively stable even if in some cases the bottom line seems to be affected by the grid wires. The BGI is calibrated on the BSRT signal (linear correction). Inconsistencies were measured during the energy ramp and could be due to a non-Gaussian point spread function, space charge and magnetic field effects. More data for cross-calibration and work on the model are needed.

Discussion:

B. Holzer commented that it might be useful to change the voltage during beam operation to optimize the signal.
M. Sapinski answered that this could induce instabilities in the beam and eventually a dump. The tuning of the signal should be performed using the camera and not the voltage.

J. Wenninger asked B. Holzer if BGI was used at DESY.
B. Holzer confirmed it.
M. Sapinski commented that ion and not electron beams were used at DESY for the imaging. Moreover, much larger and less sensitive beams had to be measured there.
V. Kain asked if ions would give a better resolution also in the LHC.
M. Sapinski replied that space charge effect would become stronger with ions.

T. Baer asked how the grid wires affect the measurements of the beam tails.
M. Sapinksi explained that at 3-3.5 TeV the wires start emitting electrons; as a consequence the tails appear and this complicates the emittance measurements during the energy ramp. The option of removing the wires is taken into account since they have the main aim of avoiding spurious emissions but this effect is less problematic than the tails.
M. Sapinski concluded saying that a student in Paris is performing studies to develop a correct calibration model and his PhD thesis will be soon available.

2. Optics and Aperture Calculations for p-Pb in Physics Conditions. – R. Versteegen (slides)

R. Versteegen presented on optics and aperture calculations for the future p-Pb run in the LHC. She explained that operation at the same energy (4Z TeV) implies having collisions between off-momentum beams. The effect of off-momentum trajectories on beam-beam separation and on n1 (aperture) was evaluated to define the main luminosity parameters (β*, crossing angle and bunch spacing). The studies were done considering unequal beam sizes for p and Pb beams and for equal β* in IP1, IP2 and IP5. A full analysis with β* varying from 1 m to 0.6 m (0.1 m steps), net half crossing angle in IP2 (external bump + ALICE spectrometer) of +/-60 μrad and 0 μrad, and a bunch spacing of 100 ns or 200 ns was performed and is summarized in the CERN-ATS-Note-2012-051. Only the most relevant cases were presented in this meeting. A β* of 0.8 m and a half crossing angle of -60 μrad (negative spectrometer polarity) in IP2 give results similar to those for the 2011 on-momentum Pb-Pb run. Moreover, a β* of 0.8 m in IP1 and IP5 determines an n1, for off-momentum beams, equivalent to the actual one (0.6 m β* and on-momentum beams). A bunch spacing of 200 ns is preferable in order to reduce long-range beam-beam effects.
A β* of 3 m was considered for LHCb but aperture calculations indicate that some margin exists to further reduce it.

Discussion:

R. Bruce commented that the collimator tight settings might allow operation with a β*<0.8 m.
J. Jowett explained that this is not excluded a priori but aperture measurements are needed.

B. Schmidt asked if there is any estimate on how small the β* could be in IP8.
R. Versteegen answered that this was not yet calculated.
J. Jowett commented that chromatic effects have to be considered but 2-1 m might be achievable.
S. Redaelli pointed out that the aperture measurements should be done also in IR8 since this region was never measured.

3. Update on Plans for the First p-Pb run – J. Jowett (slides)

J. Jowett presented an update on the plans for the p-Pb run explaining that the final decisions depend on the physics priorities established by the LPC.
The present baseline foresees using the parameters presented in R. Versteegen's talk (0.8 m b* in IP1, IP2 and IP5, 3 m β* in IP8, -60 mrad crossing angle in IP2 and 200 ns bunch spacing). A beam switch (from p-Pb to Pb-p) and an ALICE polarity flip should be performed in the middle of the run. Some tests with protons and an MD with p-Pb have to be carried out before the physics run.
ALICE has the priority for this run: a luminosity of up to $\sim 10^{29}$ cm^{-2} s^{-1} could be achieved and bunch 1 – bunch 1 collision should be possible in IP2 thanks to the RF re-phasing. It must be checked whether this is transparent for BI, the experiments and the logging.
The filling scheme has to provide some non-colliding bunches in ALICE, ATLAS and CMS and collisions in LHCb, even if this has a lower priority.
Dedicated aperture measurements have to be performed to check if there is any restriction preventing to go beyond 0.8 m β*, possibly as far as 0.6 m in three IPs.
If the RF frequencies are locked before the squeeze, tertiary and IR3 collimators have to be adjusted during squeeze and then again after the beam switch. The option of locking the frequencies after the squeeze could avoid this, saving on set-up time, and should be considered.
J. Jowett showed the preliminary results of simulations on proton and ion beam evolution during collision (simulations of M. Schaumann). A very slow decay of the luminosity is predicted but beam-beam effects, induced by the different beam sizes, are conceivable and are not included in the model.

Discussion:

B. Holzer asked if LHCb needs the 'tilted crossing' as for the p-p run.
B. Schmidt answered that this is not needed for p-Pb and that the 'classical' horizontal crossing plane is fine. He added that a smaller β* (2 m?) would be appreciated.
** Comment after the meeting: LHCb is interested in flipping the polarity (in the shadow of ALICE) during the p-Pb run.

B. Holzer pointed out that an unequal size of the colliding beams could be a real problem, he asked if it could be envisaged to have asymmetric β*?
J. Jowett answered that this would require a new optics and is extremely complicated, better to think of emittance blowup or lower bunch intensity.

P. Baudrenghien asked the reason for the emittance reduction at 4 TeV predicted by the simulations.
J. Jowett answered that it is induced by synchrotron radiation and it is a very slow process (130 hours damping time).

P. Baudrenghien commented that performing the squeeze without locking the frequencies is not a problem.
After the meeting it was however realized by J. Wenninger that when the frequencies are not locked during the squeeze, the common region BPMs will not work, which

implies that there is no orbit control possible in the triplet region during the squeeze. This may not be acceptable due to the tight tolerances, and it may make the conditions in collision not reproducible.

D. Manglunki reminded that p-Pb will be ready in the SPS by the end of August.

J. Jowett added that the test physics will presumably be performed in the second half of October right after the MD week.

4. Next meeting

Tuesday, 24/07/2012: **LSWG meeting (15:30 in 874-1-011)**.