LHC Beam Operation Committee

Notes from the meeting held on 27th September 2011

List of Participants

1. Stability of the LHC Transfer Lines (Verena Kain)

V. Kain presented that out of 1483 injections (>12 bunches) between July and mid of August 2011, 66% were successful. A resteering of the transfer lines was required on average once per week but recently even more often (about every second day). For the TI2 corrections, often the corrector RCBIH.20804 is proposed, which is in phase with MSE and MST. Problematic are the **shot-by-shot trajectory variations** in the transfer lines, which are on average 335µm/102µm (TI2 H/V) and 395µm /94µm (TI8 H/V). MAD-X simulations underlined that the shot-by-shot variations in TI2 can be explained by a **power converter ripple of the MSE in SPS LSS6**. Consequently, a correction should be done on the average trajectory of several injections. V. Kain pointed out that there is a stronger sensitivity to oscillations in TI2 because of two collimators with large dispersion.
Particularly for the horizontal plane of beam 2, the **bunch-by-bunch difference of the injection oscillations exceeds 1mm**. This implicates that the number of injected bunches has a systematic influence on the measured injection oscillations. V. Kain stressed that a correction based on 12bunch injections is thus not optimal for an injection of longer bunch trains. V. Kain presented a guideline for the transfer line correction.

Discussion:

M. Barnes asked to what kick strength variation of the injection kicker magnets (MKIs) the observed 1mm bunch-by-bunch difference corresponds. J. Wenninger and B. Goddard answered that a 1mm oscillation corresponds to a deflection of about 5µrad, which is in the percent level of the total MKI kick.

B. Goddard pointed out that if the MKI waveform is the reason for the bunch-by-bunch variations of the beam 2 injection oscillations, the delay could be adjusted. Via this approach also the 12bunches which are used during setup could be shifted to a more representative part of the waveform.

B. Goddard asked if a bunch-by-bunch trajectory measurement is available in the transfer lines as well. J. Wenninger answered that he assumes that this is principally possible.

S. Farthouk asked if the bunch-by-bunch variations could be explained by longitudinal differences. J. Wenninger underlines that the variations in the transfer lines and LHC are betatron oscillations.

B. Goddard adds that power converter experts are investigating a possible stabilization of the SPS MSE, but that this is rather difficult.

R. Assmann points out that an additional injection collimation 180° upstream of the injection point could reduce the losses at LHC ring BLMs.

2. Beam Induced Heating Assessment on LHC Beam Screens (Laurent Tavian)

L. Tavian explained the control mechanisms of the cryogenics. He pointed out that the instrumentation for the cryogenics system is quite limited, hence a new assessment method was used. Important for the cryogenics control is the rangeability of the valves (= ratio of mass flows with completely open and completely closed valves). L. Tavian presented that **the average rangeability** of 416 valves in the arcs and the dispersion suppressors **is 32 which is below the specified rangeability of 50**. Especially for tight closed valves, a reduced rangeability may introduce significant errors in the cryogenics control.
L. Tavian showed for several fills that **a localized additional transient heating is observed in the arcs and the dispersion suppressor** after the energy ramp. The locations vary between the fills. The transient heat load is smaller for longer bunches.
The maximum heat load for the inner triplet loops is determined by the injections. It is up to a **factor 2 above nominal value and reaches 50% of the local cooling limitation.**

Discussion:

G. Arduini remarked that static heating inleaks influence the analysis and asked how this is taken into account. L. Tavian answered that the design value is assumed but no dedicated measurements were done.

G. Arduini pointed out that the transient heating observations have the characteristics of electron-cloud effects. R. Assmann noted that the energy dependence is rather strong for an electron-cloud effect. E. Metral reminded that electron-cloud also depends on beam size, which is reduced during the ramp.

J. Wenninger suggested to try **a bunch length reduction during stable beams in order to disentangle the bunch length dependency from the energy ramp**. P. Baudrenghien noted that this test would need a dedicated fill, because in the present operational mode there is no margin in RF voltage to reduce the bunch length. G. Arduini pointed out that a **local orbit bump also influences an electron-cloud** and proposed a related test.

R. Assmann suggested to analyze more precisely the exact time, when during the ramp the transient heat load starts in order to correlate this with energy and bunch length.

3. Preparation for 2011 Ions run (Matteo Solfaroli)

M. Solfaroli presented the preparation for the 2011 ion run. Two filling schemes are foreseen: The "nominal" filling scheme with 572 bunches of $7 \cdot 10^7$ ions per bunch separated by 100ns and an "intermediate" scheme with 356 bunches of $10 \cdot 10^7$ ions per bunch separated by 200ns. M. Solfaroli pointed out that the expected luminosities are similar for both filling schemes and proposed to use the intermediate filling scheme which is operationally less challenging. A **squeeze of ALICE to 1m (fallback 1.5m)** will be commissioned with protons (better optics measurement) and an associated aperture measurement is foreseen. **The TCTVs around ALICE will be fully opened** (as approved by rMPP). For ATLAS and CMS the crossing angles of the p-p run will be kept, for **ALICE an external crossing angle of ±140µrad is needed** to compensate the internal crossing angle in order to have zero effective crossing angle at the IP.
M. Solfaroli suggested to do the switch of the ALICE spectrometer polarity at the end of a fill, to use the beam directly for the necessary corrections. ***Amendment: ALICE confirmed that a polarity switch is needed.***
In the upcoming MD block, 2MDs concerning lead ion injection and p-ion operation are foreseen.

Discussion:
S. Fartoukh pointed out that the available aperture in Pt.2 is not necessarily large enough to allow a crossing angle of 140µrad and asked if the full internal crossing angle is needed. ***Amendment: ALICE confirmed that a reduction of the internal crossing angle is not possible.***

M. Zerlauth asked if the **loss maps will be done with the damper.** This would save two cycles. R. Assmann pointed out that this requires the damper experts to be present. **M. Solfaroli will check if this is possible.**

4. Vacuum Observations (Giuseppe Bregliozzi)

G. Bregliozzi presented the recent vacuum observations. He showed that for Pt.2, there are no systematic changes of the vacuum activity before and after Technical Stop 4 (TS4). **High pressures (up to $1 \cdot 10^{-7}$mbar) were observed at VGPB.514.4R2.X (at ID800 recombination chamber 108m right of Pt.2)** but decreased after TS4, despite an increase of bunch intensity. G. Bregliozzi showed that there is a related **conditioning effect for the pressure at the ID800 recombination chamber**. G. Bregliozzi pointed out that the installed solenoids at the beginning of ID800 are obviously not sufficient to reduce electron-cloud effects.
G. Bregliozzi presented that **the pressure at both TDIs increases systematically about 2h after the energy ramp**. An external temperature sensor indicates (with a low measurement accuracy) a correlation of the vacuum peak with the start of a temperature increase.
G. Bregliozzi presented that the pressure in the IRs is dominated by synchrotron radiation. Typically, the pressure increases abruptly at the beginning of

collisions. Especially in CMS there are **large fill-to-fill variations** in the vacuum activity.

Discussion:

G. Arduini asked if the ID800 recombination chamber has a special coating. G. Bregliozzi replied that the chamber is made of stainless steel and has no NEG coating.

M. Ferro-Luzzi asked if the fast transient loss spikes which are observed from time to time have a measurable temporal length. G. Bregliozzi answered that the typical length is a few seconds.

Upcoming meetings:

Tuesday, 11th October: next LBOC meeting (15:30 in 874-1-011).
Tuesday, 18th October: LSWG, planning of MD block 4 (15:30 in 874-1-011).

Monday, 12th December – Wednesday, 14th December: **Evian Workshop 2011**.

Reported by Tobias Baer