

LHC Beam Operation Committee

Notes from the meeting held on 5th July 2011

List of Participants

1. AOB: Update on the Fidel model – Ezio Todesco

E. Todesco gave a brief update on the Fidel model: End of May 2011, automated trims, depending on the powering history of the magnets were implemented. Since then, **the dependency on the powering history was observed to decay much faster than expected**. Thus, the Fidel model will be updated during this Technical Stop. The updated model will be active from the morning of Saturday, 9th July.

2. Schottky System Status & Results – Mathilde Favier ([slides](#))

M. Favier presented the principle of the Schottky system, its implementation, selected measurement results and known issues.

In the LHC, four Schottky monitors (one per plane and beam) are installed in Pt. 4. They are based on high sensitivity pickup structures which operate at 4.8 GHz. **Tune, chromaticity, emittance and momentum spread** can be determined from fits to the measured spectra. The acquisition can be gated for **bunch-by-bunch** measurements.

M. Favier showed that the dependency of the beam-beam tune shift on the number of collisions is well measurable. **The resolution for bunch-by-bunch tune measurements is 10^{-4} tune units**. Chromaticity measurements were demonstrated but need to be cross-checked.

Limitations are given by coherent longitudinal and transverse oscillations. Especially, for about 30min. after ramp and squeeze no measurement is possible, in case of the ramp this is expected to be related to the longitudinal blow-up. A dependency on the transverse bunch position was identified. For too high bunch intensities, a saturation effect of the electronics was observed.

The measurement for beam 1 horizontal is generally better than for the other three cases, the priority is to understand the reason and to improve the measurement quality to the equivalent levels of B1H. The quality of the spectra for ion beams is higher than for proton beam operation.

Discussion:

W. Hofle asked which **integration time** is needed to obtain the tune measurement precision of 10^{-4} and if this is influenced by the damper. M. Favier answered **about a minute**, depending on the number of bunches to be

measured. R. Jones explained that the damper does not influence the Schottky measurement because it operates at a lower frequency.

G. Arduini asked why the measurement is worse for as long as 30 min. after the end of the ramp since the longitudinal blow-up should be stopped by then. R. Jones answered that this may be due to remaining coherent longitudinal beam motion. In 2010, about 10min. after the ramp a good quality of the Schottky spectrum was regained.

J. Wenninger asked how much orbit excursion is tolerable for a good quality of the measurement. M. Favier showed that from the test during the MD (cf. slide 19) **orbit excursions of about two millimeter are tolerable**, but for excursions of about 5mm the quality decreases significantly. The dependency is different for the four Schottky monitors.

G. Arduini asked about the status of chromaticity and emittance measurement. M. Favier answered that until now changes of chromaticity and emittance were measured and stresses that a cross-calibration is still needed. J. Wenninger reminded that measurements of chromaticity and emittance are automatically logged and could be used for cross calibration. M. Favier commented that the Schottky spectra are logged as well.

R. Jones explained that high quality spectra are essential for the measurement of chromaticity and emittance, since they are calculated from small variations in the width of the Schottky peaks. Hence, also the currently low synchrotron frequency complicates the measurement because the spectral spikes from the synchrotron frequency affect the Fourier analysis.

3. AOB: Double Batch Injection from Injectors

J. Wenninger pointed out that the injectors are **ready to start double batch injection after the Technical Stop**. B. Goddard expressed **machine protection concerns**: How can be ensured that the blow-up in the injectors works correctly and that a **critical limit of beam brightness** is not exceeded? He suggested to work out a start-up procedure and to define limits on emittance/intensity. W. Hofle explained that in the SPS most beams were measured to have a normalized emittance of almost $2\mu\text{m}\cdot\text{rad}$. Normalized emittances of $1\mu\text{m}\cdot\text{rad}$ or less were never observed. He also reminded about known issues with the SPS beam wire scanners. G. Arduini suggested limiting the bunch intensity. J. Wenninger replied that it is not yet decided if the strategy for increasing the luminosity focuses on decreasing the emittance or increasing the bunch intensity first. It was concluded that it could be started with double batch injection limiting initially the intensity to $1.2\cdot 10^{11}$ p/bunch until machine protection issues are clarified. In this case, even accidental reductions of the emittance will not lead to exceeding the transverse density of the ultimate 25 ns beam.

4. Satellites for ALICE – Massimiliano Ferro-Luzzi ([slides](#))

M. Ferro-Luzzi explained how the filling schemes are designed and that in the last physics fill 39 pairs of bunches were colliding in ALICE. To limit the pile-up, **ALICE favors to achieve the same luminosity with more colliding bunches**, which on the contrary would result in less collisions in IP1/5 or IP8. M. Ferro-Luzzi suggested **collisions of main bunches with satellite bunches in ALICE**. In the suggested scheme, dedicated main-satellite collisions in ALICE are created by **increasing the gap between two PS trains from 225ns to 250ns**. M. Ferro-Luzzi showed an analysis based on the fills 1900 and 1901 which showed that the **intensities of the satellite bunches is sufficient to exceed a luminosity of $5 \cdot 10^{29} \text{cm}^{-2} \text{s}^{-1}$** but expresses ALICE's worries that the fluctuations in the intensity of the satellite bunches may result in fills with too low luminosity.

B Goddard asked if this could implicate requests for larger intensities of satellite bunches. M. Ferro-Luzzi replied that if the intensity of the satellite bunches is controllable, changes of the satellite intensities might be requested. J. Uythoven asked how the intensity of the satellite bunches will change with double batch injection. J. Wenninger replied that the satellite intensity is likely to change but it is not clear which changes can be expected.

W. Hofle asked if the satellite bunches have a pattern. M. Ferro-Luzzi replied that the satellites are distributed over all buckets. V. Kain commented that concerning the injection, satellites between the batches (which are coming from the PS) are not critical. High injection losses are due to satellite bunches before the first PS train and after the last. These satellite bunches originate in the SPS.

M. Ferro-Luzzi noted that D. Jacquet already prepared the SPS train patterns with 250ns gaps. J. Uythoven explained that for the kickers, only slight adjustments of the MKI pulses are needed. Tests with slight shifts were already done in the past. No interference with the abort gap keeper is expected.

M. Ferro-Luzzi presented a scenario for the intensity ramp up after the Technical Stop: **One test ramp with pilots → one physics fill with single bunches → one physics fill (about 3 hours) with 48 bunches → one physics fill (about 3 hours) with 264 bunches (only single PS train injections in the SPS) → one physics fill with 840 bunches → physics fills with 1380 bunches.**

ALICE could test the main-satellite bunch collisions in the 48 and the 264b fills. From 840b fill on the 250ns gaps between the PS trains are needed.

Discussion:

J. Wenninger pointed out that the long intermediate intensity fills are useful to understand the intensity dependency of the UFO rate. He asked how to proceed after the 264b fill if ALICE does not inform immediately about the test results. M. Ferro-Luzzi replied that as long as ALICE does not clearly state that this solution is not viable, one should continue as planned. This way, multiple changes of the scheme are avoided.

M. Ferro-Luzzi pointed out that in the new 1380b filling scheme no space remains for the probe bunch. It will be injected in RF bucket 3601 and cleaned away by the injection cleaning or being overinjected by the first 144b train.

J. Wenninger expressed worries that if the achieved luminosity of main-satellite bunch collisions is too low, ALICE wants to go back to main-main bunch collisions. G. Arduini pointed out that there might be fills with low satellite intensities which would result in low luminosity for ALICE. J. Wenninger reminded that the TCTs in Pt. 2 are centered with respect to the luminosity leveling bump. **It has to be clarified if a setup of the respective TCTs in Pt. 2 would be needed**, in case the new scheme is kept and the bump is removed.

5. AOB

J. Wenninger reminded that for the weekend after the Technical Stop, several machine protection experts are not available (J. Wenninger, R. Schmidt, M. Zerlauth, J. Uythoven).

6. Upcoming meetings:

Tuesday, 12th July: LSWG meeting. Discussion of last MD block.

Tuesday, 19th July: LSWG meeting. Preparation of next MD block.

Tuesday, 26th July, next LBOC meeting (15:30 in 874-1-011).