LHC Beam Operation Committee

Notes from the meeting held on 16th October 2012

Participants

1. Observation of 50Hz Lines in the LHC BBQ System (Riccardo de Maria)

R. de Maria summarized the observations of 50Hz noise in the transverse beam spectra from the band-based tune measurement system (BBQ).

He explained that **similar observations were made at RHIC**, which could be explained by **noise from the main dipole power converters.** This is consistent with the observation that the **50Hz noise in the vertical plane increases with coupling** whereas the noise in the horizontal plane is independent of coupling. **He proposed a similar test for the LHC.**

R. de Maria showed that with the LHC BBQ system, the **50Hz noise is also observed without beam. With beam the the FFT amplitude of the 50Hz lines is increased** though, in particular for the 50Hz lines close to the tune. This leads to the conclusion that **the beam couples to the 50Hz noise**.

R. de Maria elaborated on the shift from injection tunes to collision tunes. He showed that the FFT amplitude of the different 50Hz lines changes during the tune shift. He illustrated that during the tune shift, the tune couples and enhances the 50Hz lines close to the tune.

Discussion:

M. Gasior explained that the noise spectra without beam strongly depend on the installation of the systems, which may account for different observations for the different beams and planes.

E. Chapochnikova asked what the **impact of the 50Hz noise** is. R. de Maria replied that it can lead to **emittance growth,** depending on the amplitude of the noise and its coupling to the beam. R. Steinhagen added that a **related MD** was done, in which the tune was moved intentionally on a 50Hz line for about 10min. **The first preliminary analysis (BSRT data only) did not show an increased emittance growth.**

2. Tune System Parformance with/without Gating (Ralph Steinhagen)

R. Steinhagen explained that there are in total 9 FFT acquisition devices, 6 of them used by operation (one per beam) for **continuous BBQ** (with fixed settings), **on-demand BBQ** (flexible settings, MDs) and **continuous gated** (currently only beam 1). The other three systems are used for development and head-tail measurements. The continuous systems are intended to be used for the tune feedback (controlled by sequencer).

R. Steinhagen elaborated on the working principle of the **(non-gated) BBQ system** and explained that in the case of many circulating bunches **the system naturally gates on a single bunch**, depending on bunch length oscillations, bunch intensity and betatron motion amplitude. This approach is rather **robust** and also ensures that in case of transverse instabilities, the **system automatically gates on any instable bunch.** Nevertheless, this may lead to **mixing of the signal from different bunches** that oscillate with same frequency but different phase.

R. Steinhagen compared the spectra from the gated and non-gated BBQ systems. He showed that during the ramp, **gating the BBQ on the first six bunches together with a reduced ADT gain for these bunches improves the tune signal** (increased amplitude and narrower tune peak width). Due to the narrower tune peak width, in certain cases the **Q_s sidebands can be distinguished from the main transverse tune peaks.** He explained that this allows a **rough measurement of the chromaticity**. Since the FFT amplitude of the Q_s sidebands can be as large as the main transverse tune an **update of the tune tracker** is needed.

R. Steinhagen underlined that the successful tests of the gated BBQ system show that **the system can be used for the tune feedback during the ramp**. A two hour access is needed to install the gated system also for beam 2. Furthermore, setup time for the timing of the systems is needed.

R. Steinhagen elaborated on the **new head-tail monitor system** (cp. LBOC on 11.09.2012) and showed measurements of an instability on 28.09.2012, which occurred during the squeeze at $\beta^* \approx 60$cm. The ratio of the FFT amplitudes for tune peak and revolution frequency is for the 800 MHz acquisition system larger than for the 400MHz acquisition system. This indicates that **the instability is related to an intra-bunch beam motion.**

Discussion:

E. Metral pointed out that higher order intra-bunch instabilities may not be observable with the new head-tail monitor system and underlined the need for diagnostics of intra-bunch motion in time-domain.

J. Wenninger asked on how many bunches can be gated and how fast this can be changed. R. Steinhagen replied that **the gating can be changed within about one turn. There is no limitation on the number of bunches.**

3. Proposal to Change Bunch Length during Physics Fills (Benoit Salvant)

B. Salvant summarized the observations during the end-of-fill test on October 5th: By changing the RF cavity voltage the **bunch length was reduced by about 6%.** This led to a clear (relative) **temperature rise of ALFA detectors and MKI tube. The heat load to the arc beam screens increased by about 14%.** The BSRT temperature measurement shows a slight change of slope with changing bunch length.

B. Salvant presented two proposals of further studies in order to **identify possible limitation before LS1.**

The first proposal is to **reduce the bunch length target after the ramp** during physics fills in small steps. This implies (among others) the **risk of damage to equipment** (e.g. ALFA, BSRT) due to overheating and **potential beam dumps** due to temperature interlocks (e.g. TCT, MKI, TCP).

The second proposal is to study the **impact of flattened bunches with RF noise**. This could **enhance the heating of unknown high frequencies** while decreasing most known problematic sources of heating (disentangle "broadband/narrow band" and "high frequency/low frequency" contributions). A two hour RF test at injection followed by end-of-fill studies would be needed to check the noise.

Discussion:

E. Chapochnikova underlined that for heating normally the bunch length is more important than the bunch shape.

E. Chapochnikova added to the first proposal that the **bunch lengths could also be reduced during collisions only,** to leave the bunch length long during the more critical beam modes (injection, ramp, squeeze). P. Baudrenghien added that at 4TeV, the voltage can be increased from 12MV to 16MV (B1)/15MV (B2). Since the bunch length scales with $\left(\frac{1}{V}\right)^{1/4}$, this implies **a bunch length reduction of only 7% (B1)/5% (B2)**. He noted a third possibility to **increase the voltage at injection**, where larger voltage changes are possible.

M. Zerlauth reminded that also further equipment which is not particularly monitored might heat unexpectedly.

Upcoming meetings:

Tuesday, 30th October 2012 15:30 in 871-1-011: LBOC

Reported by Tobias Baer