

LHC Beam Operation Committee

Notes from the meeting held on 20th November 2012

Participants

1. Recent Simulations on Beam-Beam Effects and Some Measurements (Tatiana Pieloni)

T. Pieloni presented an update on simulations and observations of beam instabilities. She explained that all long-range beam-beam interactions become effective during the squeeze from about $\beta^*=3\text{m}$ onwards. Since many parameters (intensities, β -functions, filling scheme, transverse emittances, etc.) are relevant, the system is very complex and not necessarily reproducible.

T. Pieloni presented a new 6 dimensional model (by S. White), which coherently combines beam-beam interactions and impedance effects. She showed that **head-tail modes can couple** (and result in instabilities) under combined effect of beam-beam and impedance, mainly depending on beam-beam parameter, transverse separation and number/strength of long-range interactions. This may explain some of the observed instabilities in the LHC. **The instabilities can be mitigated very effectively by the transverse damper (dipole modes only) or increased octupoles current and chromaticity. The system stabilizes when taking into account head-on collisions as well.**

T. Pieloni reminded that currently a very reproducible instability is observed at the end of the squeeze in the vertical plane of beam 1 only. Typically, only the **last bunches of each train become unstable**. She explained that **with a small tune split, the instability should move to bunches with more long-range interactions. Instability observations from recent fills with different tune splits seem to confirm this.**

T. Pieloni underlined that head-on collisions should stabilize the beams. Nevertheless, in fill 3195 **an instability during stable beams with full head-on beam-beam effect was observed.**

Discussion:

R. Steinhagen pointed out that **the instability at the end of the squeeze is only observed in the vertical plane of beam 1 but not on beam 2, which may indicate that the effect is not beam-beam related.** T. Pieloni replied that quadrupolar modes may be involved, which cannot be detected with the ADT. R. Steinhagen replied that also with the BBQ (bandwidth $>3\text{GHz}$), no oscillations are observable on beam 2.

A. Burov pointed out that **with the high damper gains which are currently used, coherent dipolar beam-beam modes can be excluded.**

2. Recent Observations on Bunch Length Splitting in LHC Beam 1 (Michi Hostettler)

M. Hostettler elaborated on the bunch-by-bunch transverse emittances (from luminosity) at beginning of stable beams. He showed that **many bunches of beam 1 have systematically larger emittances as a result of the instabilities observed during the squeeze. This effect is increased since TS#3** (more bunches with higher emittance).

M. Hostettler explained that, starting from stable beams, **a splitting of the bunch length is observed. The splitting increases throughout stable beams.** He pointed out that the bunch length splitting is only observed for fills with selective transverse blow-up.

He showed that there is a **clear correlation between emittance increase and bunch length splitting.** This leads to **two separated regions, where bunches with larger transverse emittance have a shorter bunch length.**

Discussion:

Elena Shaposhnikova suggested that bunches with larger transverse emittance have consequently increased beam losses, which may result in a reduced bunch length.

3. Performance Evolution vs Machine Parameters in the last 3 Weeks (Gianluigi Arduini)

G. Arduini showed that as for the transverse emittances and bunch lengths (see presentation by M. Hostettler), there are **two groups of bunches with different specific luminosities.** He showed a comparison of operational settings with average, maximum and maximum-minimum specific luminosity at the start of the fills of the last weeks. Whereas the average specific luminosity is relatively stable, **the spread of the specific luminosities clearly increased in the last fills.**

G. Arduini concluded that the instabilities during the end of the squeeze (which are expected to account for the selective transverse emittance blow-up) are limiting the specific luminosity.

Discussion:

S. Fartoukh argued that if beam-beam effect alone would be responsible, smaller emittances should reduce the effect. W. Hofle suspected that bunches that are well stabilized maintain a small transverse emittance, while bunches that the ADT cannot stabilize blow-up until they are stabilized by octupoles.

S. Fartoukh proposed to lower the vertical tune of beam 2 instead of beam 1.

Upcoming meetings:

Tuesday, 4th December 2012 15:30 in 871-1-011: LBOC