LHC Beam Operation Committee

Notes from the meeting held on 27th March 2012

List of Participants

1. First Optics Measurements 2012 (Ewen Maclean)

E. Maclean presented the results from the first optics measurements and corrections done in 2012.

At **450GeV**, the coupling was corrected locally using the 2011 knobs**. The beta-beating was corrected globally from 30-40% to 5-10%** using MQM, MQT and MQTL. The normalized horizontal dispersion-beat was corrected globally from $0.04\sqrt{m}$ to $0.01\sqrt{m}$.

At 4TeV and $\beta^* = 60$cm, the initial beta-beating was up to >90% due to optics errors in IR1 and IR5. **The beta-beating was reduced to ≈20% with local corrections only and to ≈5% with additional global corrections** (MQM, MQT). The normalized horizontal dispersion-beat was reduced from $0.08\sqrt{m}$ (beam 1) and $0.05\sqrt{m}$ (beam 2) to $0.01\sqrt{m}$ by local and global corrections.

For **$\beta^* = 70$cm**, the local corrections from flat top and the linearly scaled global corrections are implemented. An optics measurement at $\beta^* = 70$cm showed that the beta-beating is ≈5%.

Discussion:

R. Bruce noted that the beta beating in the IRs seems to be very large. E. Maclean replied that also the measurement error in the IRs is very large. For a precise determination of the optics in the IRs, a dedicated optics measurement using e.g. quadrupole k-modulation would be needed. R. Tomas pointed out that the beta-beating in the triplet is with a few percent relatively small.

T. Baer asked how the optics corrections are compared to the 2011 corrections. E. Maclean and R. Tomas pointed out that the beta-beating in IR1 and IR5 is very different from 2011. Thus, in 2012 the triplet quadrupoles are used for local correction, as well.

S. Fartoukh asked about the chromaticity change related to the dispersion correction. J. Wenninger answered that within the measurement error of about 2 unites, no change of chromaticity was observed.

2. 2012 Aperture Measurements - Preliminary Results (Stefano Redaelli)

S. Redaelli explained the method for global aperture measurements and elaborated on the improvements: **In 2012 the transverse damper is used to blow up selected bunches in a very controlled way** (compared to blow up by 3rd order tune resonances in 2011) in order to generate constant losses at the global aperture limitation. Then a collimator is successively closed until the collimator becomes the global aperture limitation. By this approach, the aperture of the global bottleneck can be absolutely measured.

At 450GeV, the measured global aperture is between 11.5σ (B1 H) and 13σ. The locations of the global aperture bottlenecks are the same as in 2010 and 2011 (see slides). S. Redaelli pointed out **that the measured aperture successively decreased in the last years by about 0.5 - 1σ per year**. In 2012, a **beam based measurement of the shift of the center of the aperture was performed and shifts of up to 800µm (B1 V) were found**.

At 4TeV and $\beta^* = 60$cm, the measured global aperture is between 11.0σ and 12.0σ (separated beams). The global bottlenecks are as expected in the triplets of IR1 and IR5. S. Redaelli pointed out that **the horizontal global aperture limitation for beam 2 was against expectations found in IR1** (separation plane) and not in IR5.

Additional local aperture measurements were only performed at a suspicious vacuum valve in IR7. No unexpected limitation was found.

S. Redaelli concluded that **the measured apertures are sufficient for operation at $\beta^* = 60$cm (assumption 10.5σ).** Further global and local aperture measurements (including off-momentum measurements) are foreseen.

Discussion:

R. Assmann reminded that **the design aperture (n1=7) corresponds to 8.4σ at 450GeV and concluded that the measured aperture at injection is 30 - 50% above design.** He also stressed that there is a **margin of 0.5σ between the measured aperture and the assumed values for the β^* determination**, which could allow for a further reduction of β^*.

J. Wenninger pointed out that the probe beam reference orbit which was used for the aperture measurements is very similar to the reference orbit for nominal intensity.

M. Lamont asked if local aperture scans in IR1 and IR5 are foreseen. S. Redaelli answered that the apertures in IR1 and IR5 were in principle already measured when doing the global aperture measurements. Concerning the unexpected beam 2 H bottleneck in IR1, an additional aperture measurement with symmetric orbit scans at the MQX is foreseen, though.

S. Fartoukh pointed out that the off-momentum aperture at $\beta^* = 60$cm could be limited by the spurious dispersion and underlined that it should be measured. R. Assmann replied that machine protection considerations (especially asynchronous beam dump) are the main motivation for the aperture measurements. The momentum deviation is typically $< 10^{-3}$. For beta*=60 cm, S. Fartoukh further commented, that the off-momentum TCT and triplet aperture

can change by a couple of sigma at a Δp of one permil, due to the spurious dispersion from crossing angle (typically a 1-2 mm orbit in the triplet at 0.001) and off-momentum beta-beating (20-30% at one permil).

Upcoming meetings:

Tuesday, 3rd April 2012 15:00 in 871-1-011: LBOC (afterwards LSWG)

Reported by Tobias Baer