

## LHC-Beam Commissioning Working Group

Notes from the meeting held on  
**27 October 2009**

Present: Carmen Alabau, Ralph Assmann, Rama Calaga, Lene Drosdal, Stephane Fartoukh, Massimiliano Ferro-Luzzi, Kajetan Fuchsberger, Massimo Giovannozzi, Brennan Goddard, Eugenia Hatziangeli, Hitomi Ikeda, Lars Jensen, Verena Kain, Mike Lamont (chair), Yngve Levinsen, Alick Macpherson, Malika Meddahi, Gabriel Mueller, Mario Pereira, Bruno Puccio, Stefano Redaelli, Stefan Roesler, Adriana Rossi, Katarina Sigerud, Ralph Steinhagen, Ezio Todesco, Rogelio Tomas, Frank Schmidt, Marek Strzelczyk, Jan Uythoven, Walter Venturini Delsolaro, Glenn Vanbavinckhove, Jörg Wenninger, Simon White, Daniel Wollmann, Frank Zimmermann.

Excused: Oliver Brüning, Barbara Holzer, John Jowett

### 1. Comments and actions from the last minutes

None.

### 2. News from LMC – Mike Lamont

Summary notes from previous LMC meetings, written by Brennan Goddard or Frank Zimmermann, are available [here](#).

To note:

- Schedule update – Katy Foraz: **Start of the LHC beam commissioning ~ Friday 20<sup>th</sup> November**;
- Technical network security – Stefan Luders: technical network not secured yet. WG formed.

A second sector test will be taking place either:

- **7-8 November**: impact on the HWC to be checked.
- **14-15 November**: Maybe, beam to LHC beam dump as well.

### 3. Dry Run news – Verena Kain

Injection preparation work performed most of last week.

Week 44 program:

- Real time input mapping check for feedback controllers for corrector circuits (Thursday)
- TCDQ tests (Thursday)
- Beam dump arming with BETSsim ramping (needs BIS loop closed)
- Clean up: systems, hardware groups
- Test MKIs in point 8 (needs injection BIS loop)
- Possibly test global incorporation and copy
- CAPTURE test: BLMs and BPMs with concentrators (Wednesday morning)
- BRAN logging (Thursday)
- Wire scanner and synch light application

Link to the more detailed program for this week:

<https://espace.cern.ch/mddb/Activity%20Tracking%20Tool/Activity%20Tracking%20Welcome.aspx?View={593B6E53-F6F9-4485-8646-E7E683D0F681}&SelectedID=54>

Week 45: RF dry run, if involved colleagues are present.

Dry runs will be completed in two week time. Will then be moving to machine check out tests.

#### 4. Status of tune, chromaticity and coupling measurements- Ralph Steinhagen ([slides](#))

Three independent BBQ tune diagnostic are chains available per beam, out of them FTT base acquisition of Q, Q'... –periodic and 'on-demand'- were tested in 2008. PPL based acquisition of Q, Q'... needs to be commissioned in 2009.

To note: Tune viewer GUI further stores a set of machine settings (Q/Q' –reference, trim settings, radial loop, E,...) and enables comparison and re-verification. While there is some automatisation in it, this remains a cross-or sanity check only.

Example of the PLL setup was given –ready for the Q /Q'/C tracking.

Q' through RF momentum modulation based method was addressed. Controllability of Q' relies on the ability to track the tune both accurately and fast. This year it was decided to tackle the LHC Q' measurement in the high accuracy limit. The LHC RF modulation has been tested in collaboration with OP and RF.

#### Summary:

##### a- Base-line LHC Q, Q' and C- diagnostics

- Status Quo: what was available in '08 is also in '09
  - BBQ FFT-based Systems: continuous, on-demand
    - Hardware re-tested, RBAC access maps ...
  - Partially: semi-automated Q' measurement
    - GUI features, cross-checks
- Most features have been tested without beam as part of the dry-runs
- only minor re-commissioning expected (tests), 1-2 half-shifts/beam

##### b- New functionalities/not commissioned items in 2008:

- Tune-PLL (though tested in the SPS) → 2-4 half-shifts/beam
- radial (de-)modulation → continuous Q' measurement → Q'-FB
  - RF radial loop/modulation → 1-2 half-shifts/beam
  - Should be commissioned done prior to first ramp for diagnostic not necessarily FB reasons → 2-4 half-shifts/beam

→ Need real beam to see which functionalities, conveniences & safety features are actually needed for day-to-day operation

Stephane Fartoukh: tune resolution limit? Ralph Steinhagen: based on the SPS experience, the tune resolution can be as low as  $1e-5$  to  $1e-6$ . However, there is no guarantee that this will be the same in the LHC. There are a few effects/uncertainties that need to be verified with beam (see annex of the supporting slides).

Impact of non linearity? When very small excitation are used ( $\sim 1\mu\text{m}$ ), there is no effect from non linearity. Effects appear only if the excitation is done in the 1mm range.

#### 5. LHC injection tests - Round table

##### General comments – Mike Lamont ([slides](#))

Total number of protons:  $9.6e12$  ([slide](#) from Brennan Goddard);  
58% beam efficiency.

Magnet system: E. Todesco: resumed LHC operation for the sector test with the injection settings. The circuits of the dipole were found to be 10 units larger than expected and the current was manually lowered a few hours before the injection test. Marek Strzelczyk: found that one of the magnet parameter had not been properly generated (temperature settings). Concerning Q4-Q6: up to 30 units of difference in the transfer function. This discrepancy was not corrected for the test (single pass).

E. Todesco: Very good reproducibility of the magnets before and after recycling. Jörg Wenninger: looking at the resulting trajectory from YASP, the sectors behaved very similarly as last year; the long term reproducibility looks excellent. Mike Lamont: Note that the 7-8 was not pre-cycling during operation with beam with time.

RP: Stefan Roesler: LSS3 and LSS7 are now Simple Controlled Radiation Areas with the exception of localized areas around TCLA.6R3 and TCLA.D6L7 which are posted as Limited Stay Areas.

Injection region: Brennan Goddard ([slides](#))

a- Work status:

	TI 2 / B1	TI 8 / B2
Injection region setup	Done	Done
MKI waveform measurement	Done	
TDI setting up	Basic	
TCDI setting up & checks		H only
Injection region aperture	H and V	H only

b- Injection region setup:

- Went very well for B1 on Friday night -should try to 'sequencer' drive this next time.
- B2 on Sat night more problematic -will use the experience to update the procedure.

c- Aperture measurements performed:

- A TI2/P2 injection region looks fine. Physical limits as expected around  $\pm 8 \sigma$  at MSI.
- TI8/IP8 aperture may have a problem between MSI and Q5...

Need to complete this P8 measurement, with high priority

d- TCDI setting up:

Made centering scans for all the 6 jaws of TCDIH in TI8. Centering scans agreed very well with YASP (<01.mm) except for 88121 (0.4 mm error)

TCDI setting up checking vs protection of the LHC: scanned TCDIH with upstream bump ('failure') at different phases. Measures beam loss on IR7 collimators as a function of the bump amplitude. Set beam to  $6\sigma$  offset then scanned transmission with IR7 collimators. A lot of data to be analysed. To be done as well for off-momentum beam.

e- MKI waveform protection. Found about 2% overshoot (specs is +- 0.5 % ptp). Need to repeat with more sampling and at a falling edge.

f- TDI checks: Put TDI IN beam at 'tight' settings to protect downstream against likely losses from moving beam around with MKI kick and scanned each TDI jaw across beam Procedure to ensure ALICE fully off to be reviewed. Ralph Assmann: Possible indication of a jaw misalignment, to be investigated.

Massimiliano Ferro-Luzzi: How to improve the emittance values to approach the nominal specs. Mike Lamont: Must try in the injector chain to **produce the nominal emittance**.

Aperture checks: Stefano Redaelli: Performed aperture scan in the arc and IP3. Compared to last year, could measure the whole insertion region. Could fit  $10-11\sigma$  through the arc ( $+3\sigma$  of the beam itself). So preliminary results indicate no problem in the aperture. In the arc, Q11.R2 was the bottleneck in both planes for a few phases - expected in the vertical plane, tbc. Stephane Fartoukh: if the beam is off-momentum, Q6 is the aperture bottle neck. Otherwise there is more aperture in the arc.

Polarity test, sector 23 – 78: Rama Calaga ([slides](#))

Revisited 2008 measurements to investigate several specific issues and candidates from HW, alignment and beta beat measurements. Checked relevant orbit corrector polarities and find good agreement between MADX and measured trajectories.

Summary of the measurements performed:

Circuits	Sector 23 2008	Sector 23 2009	Circuits	Sector 78 2008	Sector 78 2009
QT11.R2	Wrong	Fixed	QT11.L8	Misalign (?)	Fixed
Q4.R2	$\beta$ -beat	No Response	QT13.L8	Inconclusive	OK (?)
Q6.R2	$\beta$ -beat	OK	Q5.L8	Suspicious	OK
Q6.L3	Hardware	Inconclusive	QT5.R7	Suspicious	OK (?)
MQS.23	Wrong	Wrong	MQS.78	Wrong	Fixed
MSS.23	Not tried	Not tried	MSS.78	Wrong	Inconclusive
SF[1,2].23	OK	Not tried	SF[1,2].78	OK	Inconclusive
SD[1,2].23	Not tried	Not tried	SD[1,2].78	OK	Inconclusive
KOF.23	Not tried	Not tried	KOF.78	OK	Not tried
KOD.23	Not tried	Not tried	KOD.78	Inconclusive	Not tried

Fixed: Either in LSA or due to "updated" MADX convention

(?): Polarity OK but amplitude or phase discrepancy

Sextupole & higher order: dp/p too small, all results inconclusive

Kick response measurements and dispersion: Kajetan Fuchsberger ([slides](#))

Kick response measurements in TI2+LHC: phase advance is in agreement with model (ignore data at BPMS.2). Some checks to be done at the end of the sector 3.

Jörg Wenninger: we do observe BPM offset from particle spray. Ralph Assmann: effect on the LHC feedback system to be studied. Jörg Wenninger: should maybe remove these pick-ups (close to collimators) from the feedback system.

Kick response measurements – TI8 only: big improvement after the rematching of the optics, taking now into account the idea of Stephane Fartoukh of a b3 in the MBI (and a resulting feeddown b2 through x misalignment).

Stephane Fartoukh: in the LHC, the phase advance discrepancy most probably comes from the systematic b2 of the dipole.

LHC corrector polarity checks: list of results shown.

Dispersion: TI8+LHC+S78: dispersion more in agreement with model after the rematching. Initial conditions (Dx, Dpx) can explain the remaining beating.

To Note: similar preliminary observation in TI2+LHC+S23.

LHCb spectrometer: Jörg Wenninger. Consists of 4 magnets with no focusing element in between. Need to find a "physical" solution to correct for the non-closure of the bump (which is about 1% at full field at injection). Ezio Todesco: The model of the spectrometer magnet is also being updated and available.

6- A.O.B. –

**DAILY LHC pre-operation meeting at 17:00 CCC conference room.**

Next meeting

**Tuesday 3rd November 2009, 15:30, 874-1-011.** Agenda will be sent in due time.

Malika Meddahi.