Actions from the LHC Optics Measurement and Corrections Review

Tobias Persson on behalf of the OMC team

Outline

This presentation will try to summarize the actions and work since the Optics Review not already covered in Andy's talk

- Longer excitation with the AC-dipole
- Improvements of the codes
- The measured optics will be put into LSA
- The new DOROS system
  - Where they will be installed
  - Possible use of the system for optics measurements

More turn-by-turn data

Confirmed that AC-dipole will have a longer flattop

~10 000turns

- Will reduce the time for measurements
  - Need to be implemented
- Or increase resolution

Planed (but not confirmed)

- To increase the number of turns for the BPM
  - Need to modify the concentrator

(Verena Kain before Marek Strzelczyk)

Code improvements

Code improvements(Beta-Beat.src):

- Refactored and cleaned correction scripts and sussix wrapper
  $\rightarrow$ Easier to maintain
- Less crashes by checking input
- Printing helpful messages in case of failures
- Bugfixes

Documentation:

V. Maier

Wiki for general information:

https://twiki.cern.ch/twiki/bin/view/BEABP/OMC

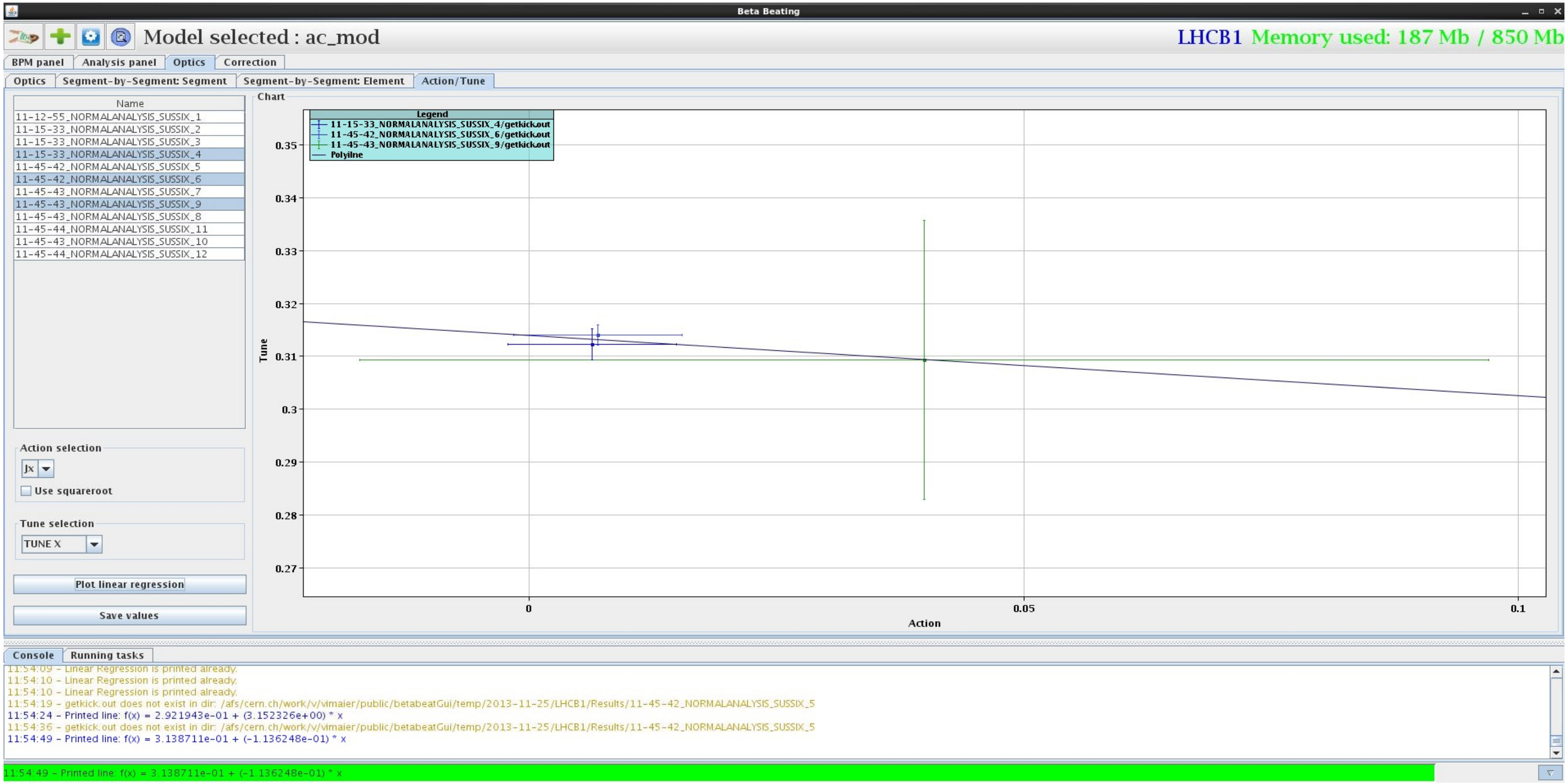
Code documentation:

http://beta-beating.web.cern.ch/Beta-beating/doc/bbeat/

Improvements in GUI

Action/Tune chart:

New chart plotting amplitude detuning



Knob application (LSA?)

We had a meeting about the common requirements for the knob application.

Delphine Jacquet, Matteo Solfaroli Camillocci, Jorg Wenninger, Rogelio Tomas, Tobias Persson; Viktor Maier

The online model

So far we have used the design model

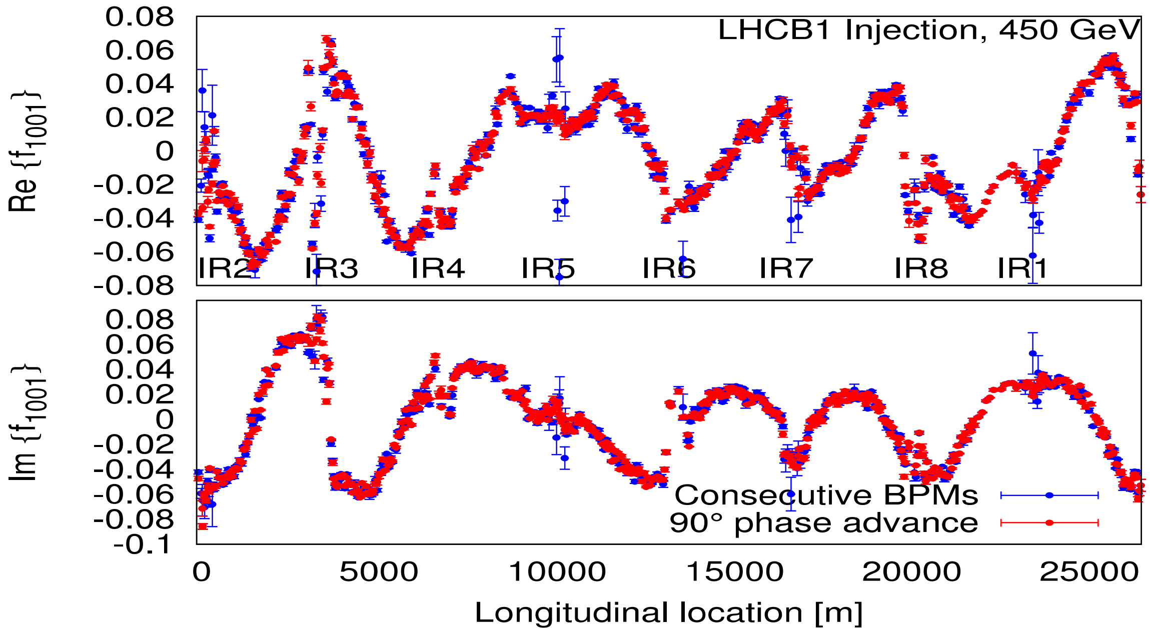
- Things like:
  - Known errors
  - The settings of the quads used for the tune trim and are not in the design model
  - Observed to have an effect
- Can we use the online model in 2015?
- In the future would like to have all the information such as orbit, setting of skew quads as an input to our model, etc.

Improved resolution of the coupling measurements

The coupling measurement is least sensitive to noise when the phase advance between 2 BPMs is 90 degrees.

→ Instead of consecutive, 2 BPMs with phase advance close to 90 degrees are chosen to reconstruct the coupling

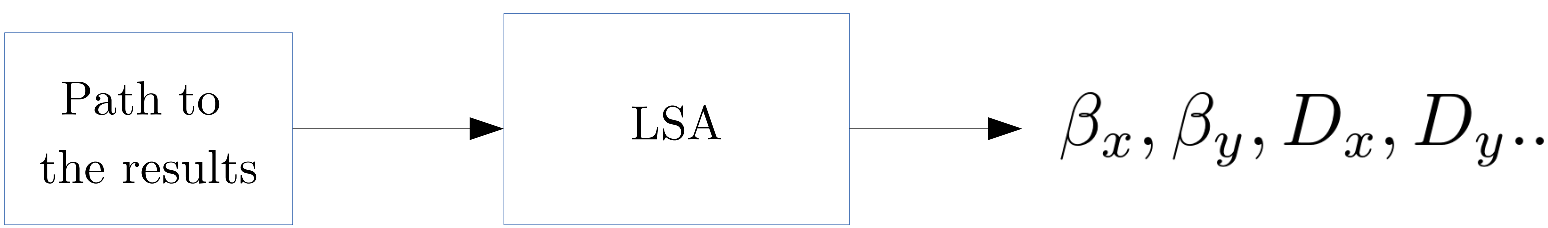
- Reduces the error bars with a factor ~2 in real data
- Consistent with results from simulation



LSA

(R. Tomas, V. Maier, V. Kain, D. Jacquet)

The measured optics will go into LSA where it will accessible for the users



Towards online measurement of the coupling

Goal:

To provide an online measurement of the phase and amplitude of the coupling with the possibility to minimize it online

Background:

During end 2012 we implemented a software for measuring the coupling based on the injection oscillations. It was used in normal operation. However, only works at injection.

We tried to use the BBQ turn-by-turn data

- Partially successful, after extensive post processing. However it was hard due to missing synchronization between horizontal and vertical plane
- The BBQ is not optimized for phase measurements

Marek Gasior is working on a new system called DOROS

DOROS (Diode Orbit and Oscillation)

A few BPMs and collimator will be equipped with electronics which will provide a more precise measurement

The test in the lab indicates that it is possible to achieve precise phase measurement with a beam excitation of ~10μm (see presentation from Marek Gasior during the OMC review)

https://indico.cern.ch/contributionDisplay.py?contribId=12&confId=246159

Locations for the “new” BPMs

The preliminary information is:

The BPMs closest to the collision IPs will be equipped

- Eventually it might be that all the BPMs close to IPs will be equipped.
- BPMSA.7R1.B1 and BPMSA.7L1.B2 will be equipped (our request) will explain later

Collimators at Q4 (TCTP(V/H).4, Left for B1 and right for B2) will be equipped

- Horizontal and vertical plane will be separated with 1m in longitudinal direction.

What can we use it?

- Online coupling measurements
  - With the goal to provide online measurement of the phase and amplitude of the coupling.
    - It will most likely need some transverse excitation of the beam
  - If successful it could be turned into a feedback for all energies in the future

- Improved resolution for the optics measurements during commissioning and MD periods
- Monitoring of the phase advance during e.g squeeze and ramp

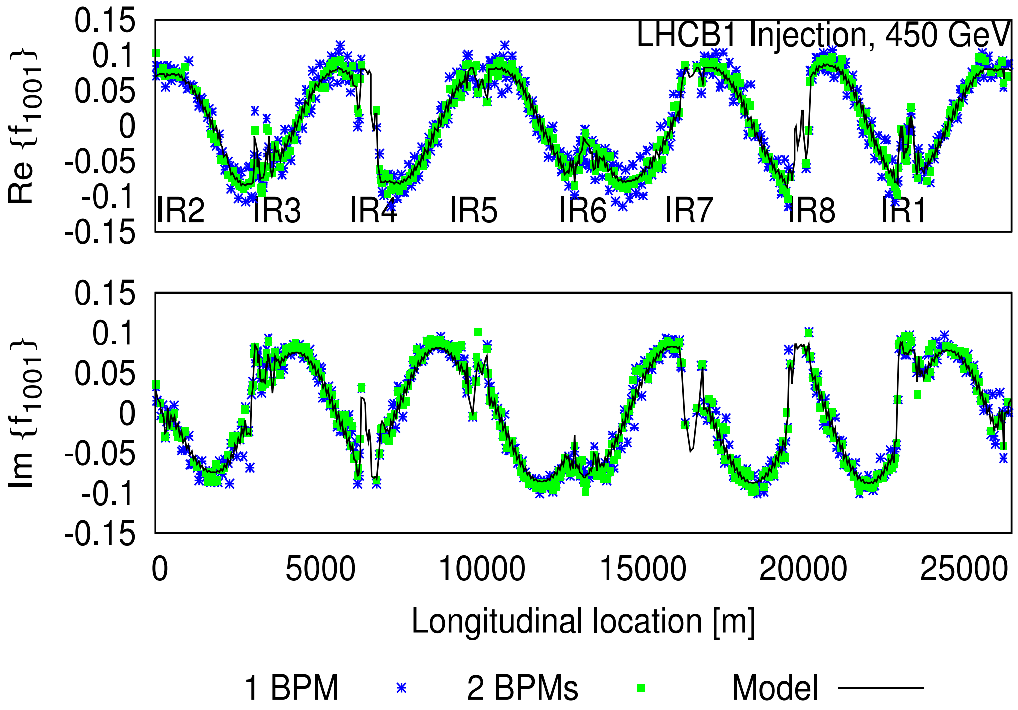
How to measure the coupling

In order to measure both the f_{1001} and f_{1010} (difference and sum) we need to have have at least two synchronized BPMs.

- The sensitivity to noise is dependent on the phase advance between the two BPMs (90 degrees is the optimal)
- Under assumption that f_{1001} is dominant (which is the case in normal operation) it is possible to measure the f_{1001} with a single BPM with a systematic error of ~10%

1BPM vs 2BPM

- Tracking 1000 turns
- The skew quads are used to reproduce a measured coupling situation (including f_{1001} and f_{1010})
- No noise has been added



Reconstructing the coupling

The ideal situation would have been to have several pairs of BPMs with

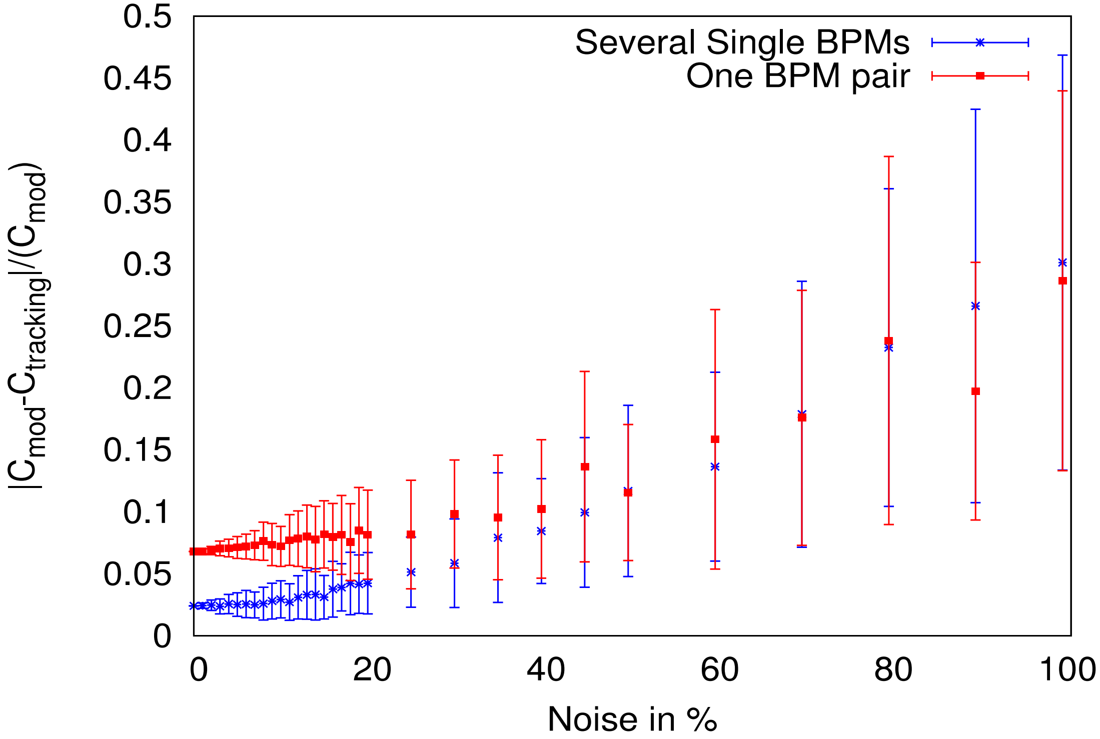
- Phase advance close to 90 degrees
- Large beta-functions
- Stripline BPMs (easier to install the system and better resolution)

In reality we are limited to the given locations and request the system to be installed on a few positions where stripline BPMs are located

  - As we will see this is sufficient

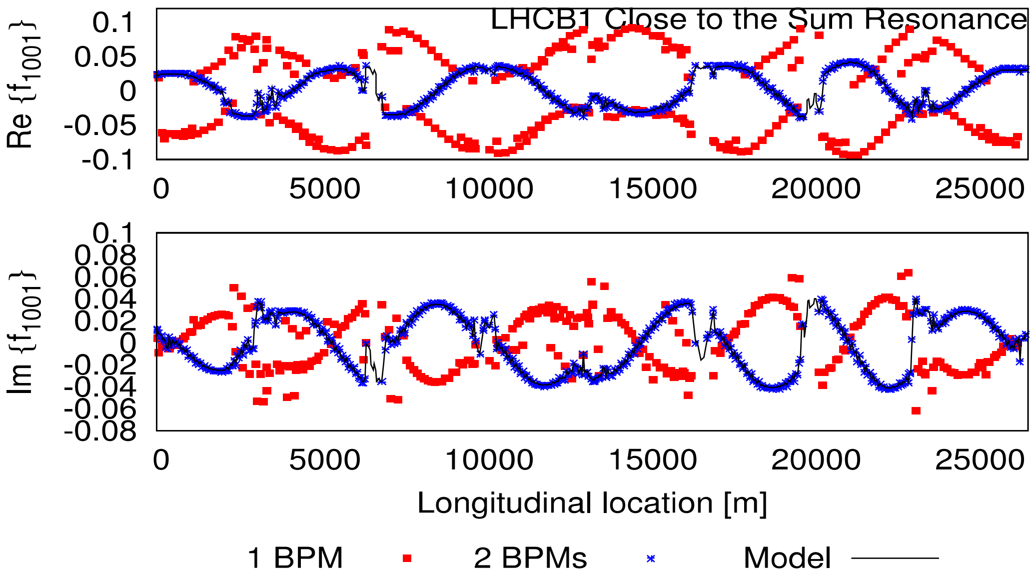
Comparison between a system utilizing 2 BPMs to a system based on all DOROS BPMs

- Tracking 1000 turns
- The skew quads are used to introduce coupling.
- The optimal setting of the knob is calculated from the model.
- The difference between the optimal setting and the found from tracking is compared for different noise levels.



Tunes closer to the sum resonance

- Tracking 1000 turns
- The skew quads are used to introduce coupling
- The fractional tunes are here changed to Qx=59.42 and Qy=64.47 (close to sum integer)



In order to be able to measure in this configuration we asked to equip BPMs close to Q7, which gives good phase advance to the BPM at Q1 (at least at injection)

Improvements for the optics measurements

The DOROS will provide precise measurement in the interaction regions

At the moment it is foreseen that we receive the phase and amplitude information from the tune and coupling peak (not Turn-by-Turn data)

- We need to modify our codes to be able to handle this.

Summary of the progress

The AC-dipole will be able to excite the beam for more turns

Improvements of the code

- Reliability
- Maintainability
- Improved resolution of the coupling

Investigation of the use of the DOROS system

- It will provide improved precision for the optics measurements in critical regions
- Online coupling measurements based on all of the DOROS BPMs (in normal operation). However, most likely needed to chirp the beam.

Actions/follow-ups

- Follow up that all the turns can be recorded
- Implement splitting of Turn-by-Turn files
- Investigate to which extend we can use the online model and implement the necessary changes on our side
- Implement so our codes can take the phase and amplitude information from DOROS
- Write the software for the online coupling measurements application
  - There is a new fellow from February that will do/help with the implementation

Backup slides

1BPM vs 2BPM

- Tracking 1000 turns
- The skew quads are used to introduce coupling (f_{1001} ~0.1)
- The difference is between tracking and the coupling calculated from the twiss averaged over 30 times for each noise level
- The difference between the optimal setting and the found from tracking is compared for different noise levels.
- Normal is here ~45 degree and optimal is ~90 degrees