Optimization of the phase advance for precise coupling measurements

Tobias Persson

Outline

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- Study
- Results
  - Simulation
  - Measurements

Motivation

- To minimize the uncertainty of the measurement of coupling.
- In particular interesting for the injection studies since the noise-to-signal is relative high

Introduction to the terminology

In LHC the f1001 is larger than f1010 since Qx-Qy is much closer to an integer than Qx+Qy

- f1001 is related to C- according to:

$$\left|C^-\right| = 4\Delta_Q\left|\overline{f_{1001}}\right|$$

- |C-| is also the same as the closest you can approach the two tunes

$$\left|C^-\right| \equiv \Delta Q_{min}$$

Simulation

- Tracking for Beam 1 at Injection.
- Added noise uncorrelated noise to all BPMs
- Tested with:
  - 1BPM
  - 2BPM (normal)
  - 2BPM (with phase advance close to 90 degrees.)

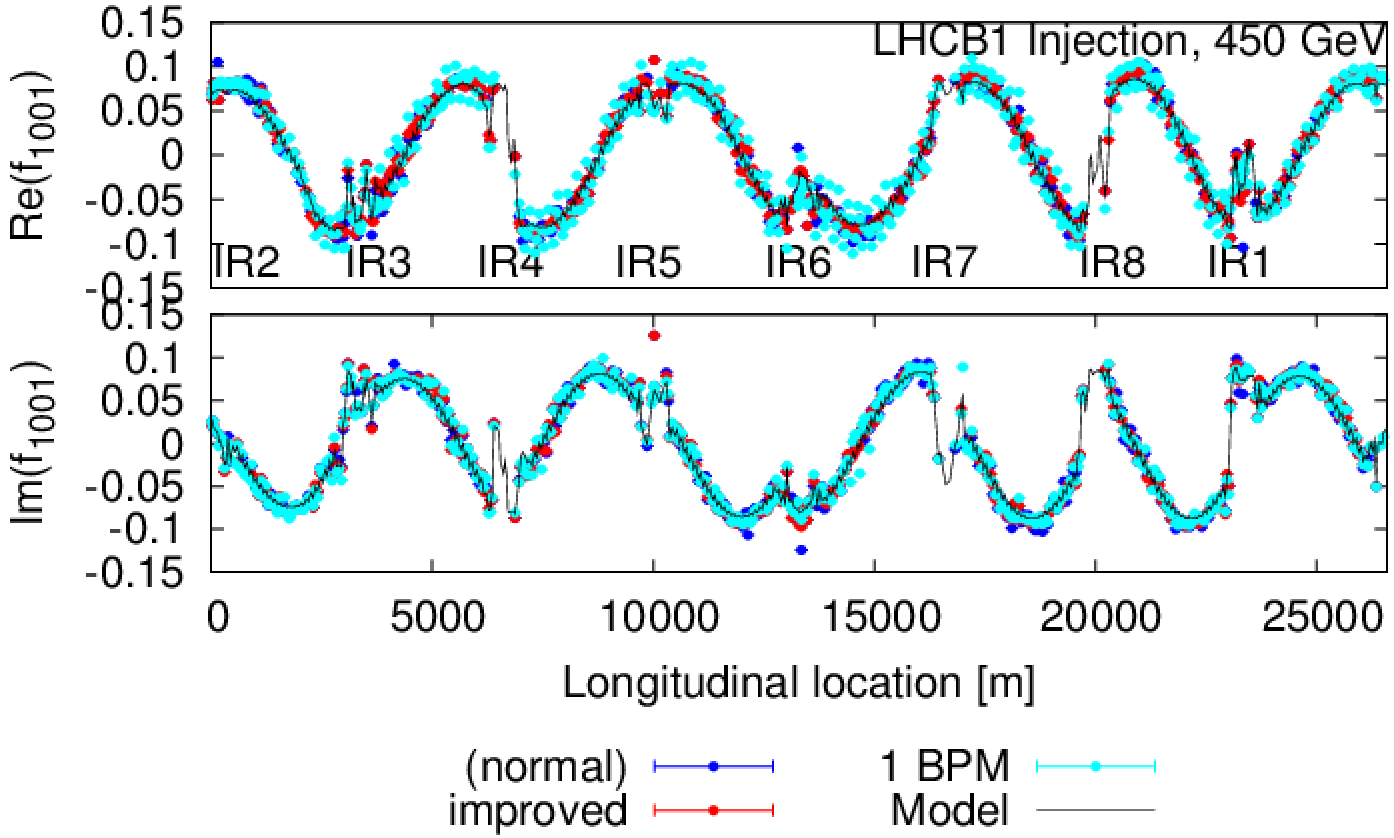
BPM paring

- In the normal algorithm the paring is by taking two consecutive BPMs (i to i+1)
- The optimized tries to pair the BPM so the phase advance is as close to 90 degrees as possible.

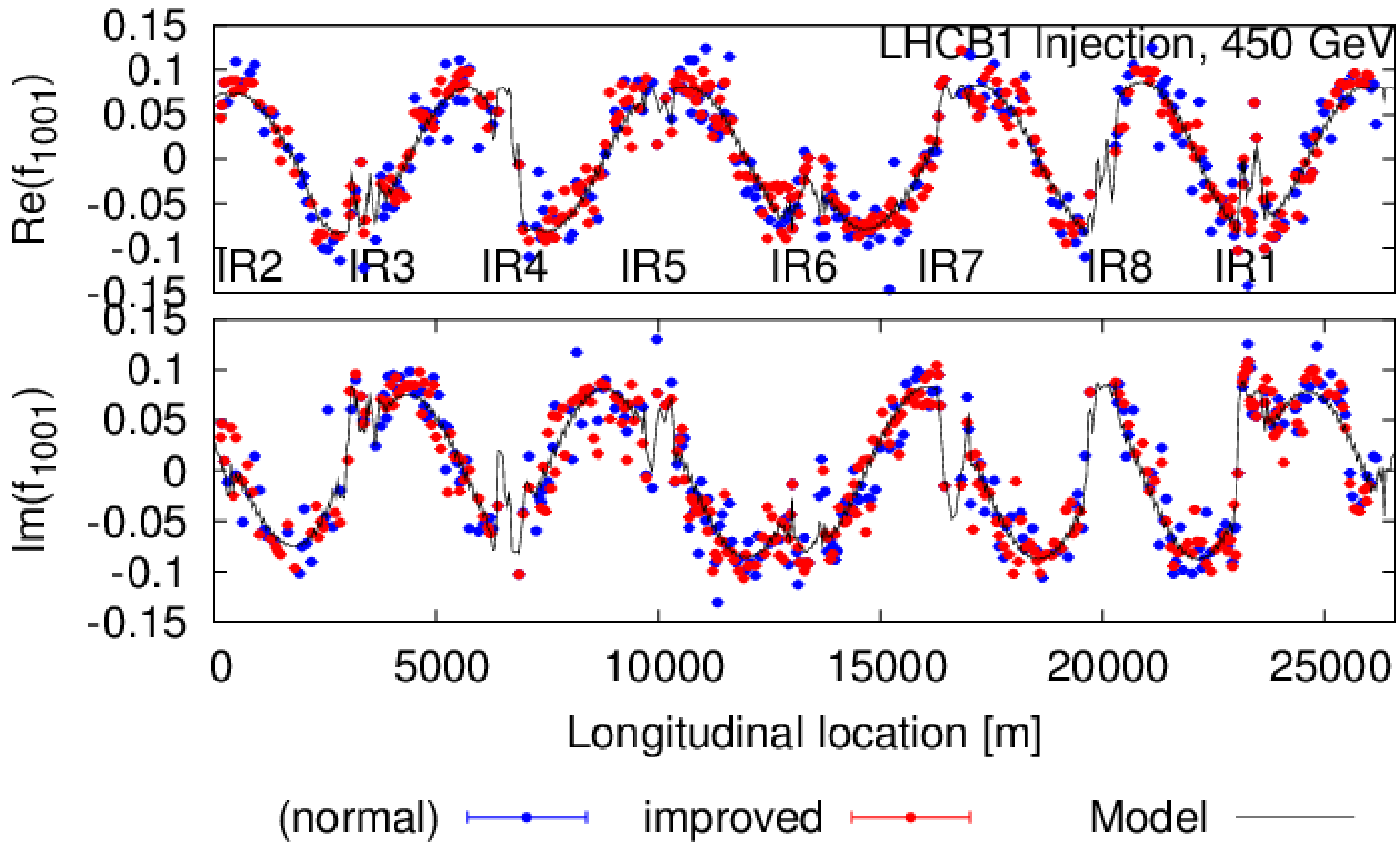
Algorithm

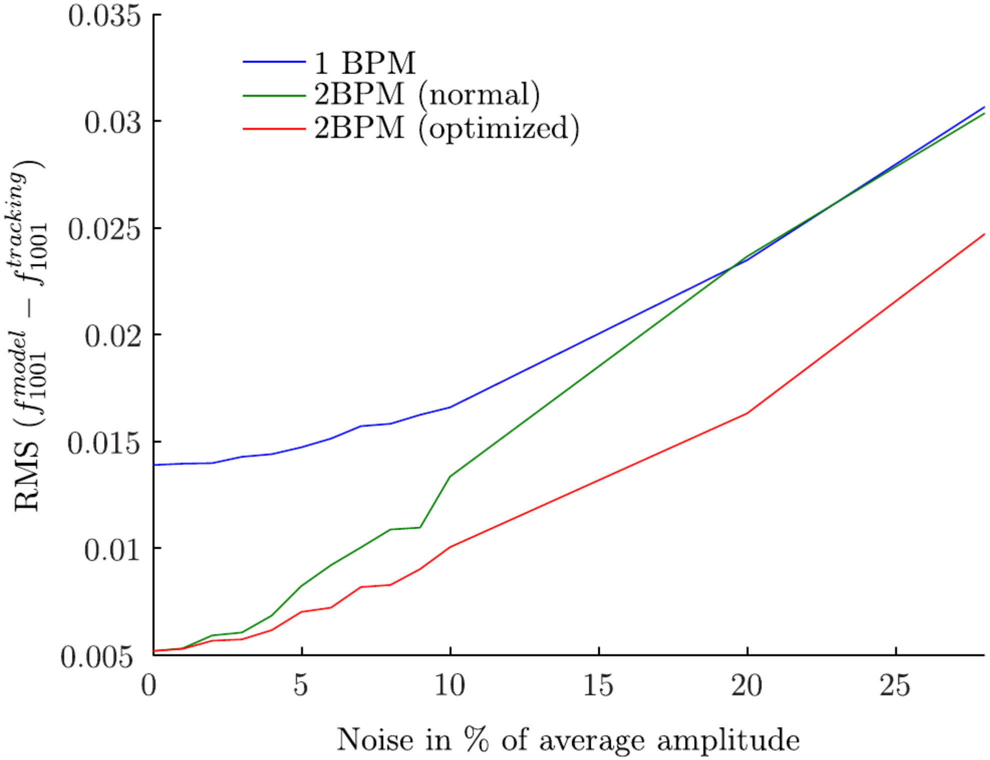
1. Look up to 4 BPMs away (in the model) and chose the one with closest to 90 degree phase advance in the horizontal plane.
2. Makes a list of the pairs.
3. In case the correspondent BPM is not in the measurement it falls back to the normal solution(BPM i+1).

Simulation (added noise)

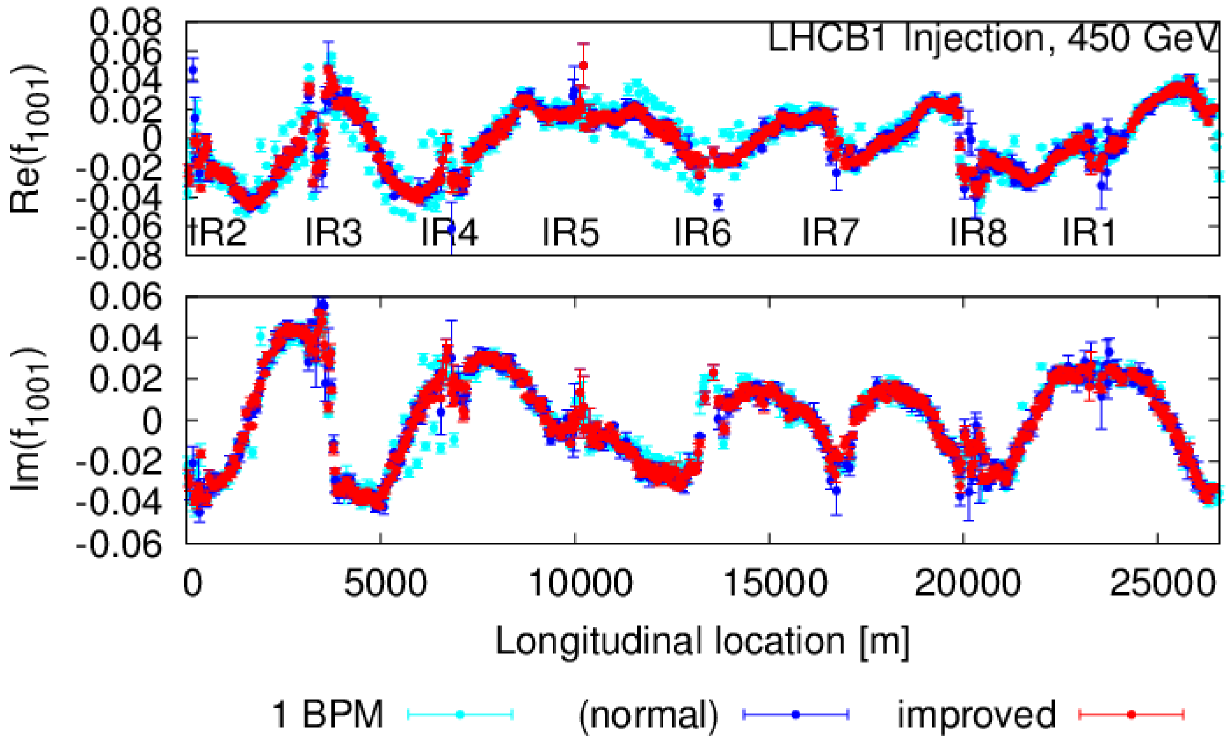


Simulation (more noise)



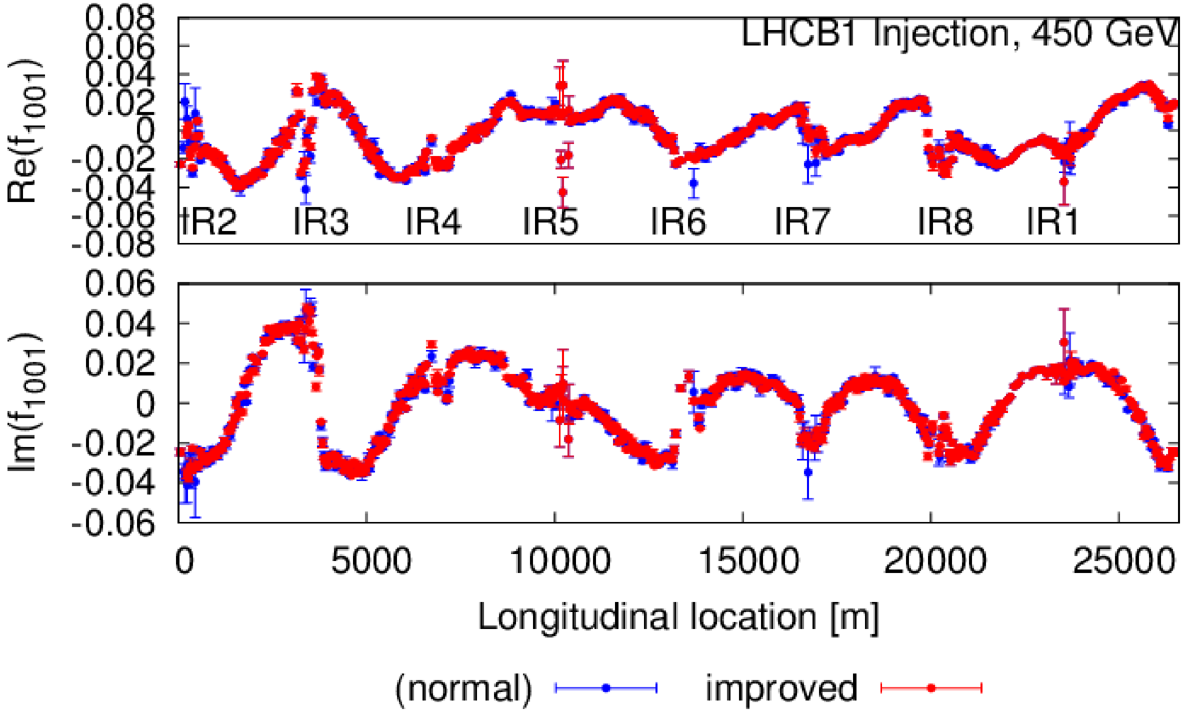

1 BPM
2BPM (normal)
2BPM (optimized)
RMS $(f_{1001}^{model} - f_{1001}^{tracking})$
Noise in % of average amplitude
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
5
10
15
20
25

Injection kick data



Normal, RMS = 0.00401
Improved, RMS = 0.00226

Ac-dipole injection



Normal, RMS = 0.00301
Improved, RMS = 0.00206

Conclusion and outlook

- Paring of the BPM can improve the accuracy of the measurement
- It is crucial to use a 2BPM approach for a good measurement of the coupling
- I Would like to continue to see if we can find an optimum SVD-cut to further increase the accuracy of the coupling and phase measurements
  - Anyone looked into this before?