Minutes of LIU-PSB Beam Dynamics WG #3 written by D. Quartullo

Participants

S. Albright, F. Antoniou, G. P. Di Giovanni, V. Forte, A. Garcia Tabares Valdivieso, G. Guidoboni, A. Huschauer, E. Koukovini Platia, B. Mikulec, D. Quartullo, G. Rumolo, R. Tomas Garcia , P. Zisopoulos

Approval of minutes

Nothing to mention

A. Garcia-Tabares Valdivieso's talk

Measurements performed from September to December 2017 at 160 MeV

Beam excited through kicker to measure chromaticity at different intensities for the four PSB rings

Measurement principle I: transverse momentum kicks to the beam to induce betatron oscillations to be observed in the BPMs

Measurement principle II: the BPMs record the center of charge of the beam each time it circulates through the ring. Then the analysis can be done in time or frequency domain to obtain the tune

Description and comparison of the two used acquisition methods: Matlab versus Jeroen codes

Studied intensities 125e10 and 250e10 in Ring1: higher resolution using Jeroen's script (e.g. more than one order of magnitude for 125e10). *After having clarified that the same data are used for both methods, G. P. Di Giovanni observes that it is a problem of truncation derived from the choice of using the 'short int' number format to produce more output in a given time. B. Mikulec observes that the alignment of the PUs is not well known and suggests to clarify this resolution problem with BI.*

Slide number 9 showing the summary of the measurements results of optics for different beam intensities in Ring1: good agreement between Matlab and Jeroen methods for tune measurements in x and y planes even if the BPM resolution is factor 2 lower in Matlab.

Tune stability for different intensities shown for Ring1: larger amplitudes in Jeroen's method relative to Matlab

Horizontal and vertical amplitude measurements also performed in Ring2 at 175e10: in the vertical plane a larger number of turns for the oscillation decay is useful for the analysis. It was tried to increase the amplitude of the kick increasing the sextupolar current (small increase observed using 80 A).

Tune stability measurements also for Ring2 at 200e10, 250e10 and 300e10: smaller tune spread than in Ring1, maybe due to an increase of the kick amplitude.

Slides showing the configuration of the AC-dipole measurements and the excitation with tunes .279 and .291.

Work in progress for the beta function reconstruction: the 3-BPM method for phase advance between the BPMs gives different reconstructions. Proposal to use the N-BPM method in order to improve reconstruction. However different additional data have to be provided for the analysis such as BPM misalignment and quadrupolar strength.

Ring 1 shown as example of beta function reconstruction problem: phase beating standard deviation is 1% and beta beating is 5%.

As a conclusion for the talk, it is underlined that a larger number of digits will improve the quality of results. Future plans will include measurements at different tunes.

At the end of the talk S. Albright and the speaker clarify the meaning of the uncertainty of 5% relative to beta beating measurements (also the meaning of the word resolution is clarified). Then F. Antoniou asks if the speaker tried to use Jeroen data for these measurements, the answer is negative. F. Antoniou proposes the speaker to meet with Jeroen and asks if the speaker saw some BPMs which are noisier than others, the answer is negative.

B. Mikulec suggests that before going to BI it should be checked if not truncating the data could improve the quality of the results. G. P. Di Giovanni questions if it is better to push with BI or not. R. Tomas Garcia says that BI have specs and that the current resolution is enough (100 us). In addition he observes that the speaker's measurement were not taken in the best scenario, the data were not the best, and that the results obtained with Jeroen's method will always be a factor of 2 better. S. Albright asks if there could be benefits running the data using Jeroen's script. R. Tomas Garcia answers that it is not clear and maybe not worth, since measurements will be dominated by systematic errors (in any case he proposes to check if Jeroen script is available).

S. Albright asks the speaker if it will be possible to repeat the analysis on the high-precision data before Shutdown, the answer is positive. F. Antoniou asks the speaker if some time will be needed to finalize the tool for data analysis (since some improvements are required), the answer is positive. B. Mikulec asks the speaker if the tool can be used in operation, the answer is that the script is already available in the PSB console.

F. Antoniou asks the speaker if she has some results of measurements using different chromaticities, the answer is negative (work to be continued).

P. Zisopoulos' talk

Exploitation of the new PSB turn-by-turn system for Ring 1 means understanding the system. Quality of measurements depends on the interplay between SNR and physics. For considered data, excitation amplitude is 0.5 mm, according to the speaker it is not enough.

Studying of noise level: autocorrelation technique explained. It is pointed out that this method is more suitable for relative measurements among BPMs

Noise also studied with SVD techniques: this method also gives correction of noise.

The tunes have been accurately measured in about 20 turns mixing BPMs data. At turn 20 the convergence is at 0.00001.

R. Tomas Garcia asks the speaker if the tune jitter could be estimated, the answer is positive.

Optics stability along the cycle for the four different rings at 160 MeV: agreement among BPMs is good. However there is significant spread in Qy, the speaker will try to understand the cause of difference between vertical and horizontal Q. The used data are the same as the ones employed by the previous speaker. The Q-strips were off (flat portion at 160 MeV). *S. Albright pointed out correctly that the four rings could have different intensities. F. Antoniou suggests the speaker to check the intensities in Timber.*

Phase measurements for Ring 1: poor reproducibility of phase advance between BPMs, however that information will be used for beta-beating measurements.

Possible causes for poor reproducibility: shot-to-shot orbit jittering in the BPMs, shot-to-shot variation of the kicker amplitude, asynchronous BPMs (possible presence of lag).

A hint towards BPMs asynchronism comes from large error bars in the reproducibility of the turn-by-turn trajectory.

The statistical jittering of the turn on which the kick is applied was shown, that is the degree of the reproducibility of the transverse position that each BPM recorded at the instance of the kick. The position uncertainty is modulated along the ring, the reason has to be checked. SVD and Statistical Data Cleaning help to reduce the error bars.

Beta-beating study for the four rings: statistical interpretation of the beating information from all the BPMs, huge error bars (poor reproducibility) due to the errors in the phases. On average the beta-beating for Ring 1 is around 5%.

R. Tomas Garcia underlines that a beta-beating below 10% is normal.

F. Antoniou asks the speaker what are the results at extraction energy. The speaker answers that these tests have not yet been done. G. P. Di Giovanni suggests that those could be performed by the end of 2018.

AOB by F. Antoniou:

MD planning for 2018, following important presentations related to the BD WG.

Actions:

- ***repeat the measurements with good phase advance and using the N-BPM method (A. Garcia-Tabares Valdivieso)***
- ***repeat the analysis on the high precision data before Shutdown (A. Garcia-Tabares Valdivieso)***
- ***measurements using different chromaticities (A. Garcia-Tabares Valdivieso)***

- ***test V. Forte's idea to use sextupoles to enhance continual instability and avoid fast oscillation damping; that has to be done one plane at a time since the polarity has to be changed locally (A. Garcia-Tabares Valdivieso)***
- ***verify what amplitude is needed for the excitation kick, instead of 0.5 mm (P. Zisopoulos)***
- ***check absence of shot-to-shot variation in intensity for the four rings (spread in Qy in the optics stability study) (P. Zisopoulos)***
- ***BPMs asynchronism, check synchronization with J. Belleman (new measurements?) (P. Zisopoulos)***