Minutes of the 95th WP2 Meeting held on 30/05/2017

Participants: S. Antipov, G. Arduini, X. Buffat, R. Corsini, D. Gamba, P. Hermes, M. Giovannozzi, S. Kostoglou, E. Metral, Y. Papaphilippou, D. Pellegrini, G. Skripka, R. Tomas, F. Van Der Veken.

General Information (G. Arduini)

The minutes of the previous meeting have been circulated. Gianluigi summarises the outcomes of the previous meeting.

Dario reports a study performed by Sofia in which some larger DA tune space is found close to the half integer. Rogelio adds that some tests were done in the past, the orbit corrections were harder, but looked feasible. Yannis stresses the need of including errors and corrections in simulations. Gianluigi suggests remaining focalised on the current tune setting, refining the work on LHCb, and trying to get a working baseline before exploring radical alternatives. We will take this up later in fall-winter. **Action: Gianluigi, Massimo, Rogelio, Yannis to analyse this option at a later stage.**

LHC and HL-LHC DA studies with field errors at injection for proposing DA targets (P. Hermes)

Pascal explains that DA is used to specify field quality, but collimation systems are based on minimum lifetime, without a clear connection between the two of them. In addition the number of turns for the tracking is limited by computing power and accuracy.

Gianluigi wonders what could be the limits. Yannis reports some approaches alternative to brute force tracking that may allow tracking for more turns (e.g. Cremona map). Massimo stresses that the numerical accuracy at some point becomes an issue, a possibility to verify this is by backtracking. For many turns Boinc becomes inadequate as the job needs too much time from a single volunteer CPU (which can be taken down at any moment), one would like to split the jobs with checkpoints to reduce the failure rate. GPU do not really help with the number of turns, but just with many particles. Gianluigi wonders if there are studies concerning the numerical noise. Massimo reports some old studies but he adds that this feature is no longer available in Sixtrack, although with a dump of the particles coordinated and a reversed lattice it should be possible to perform some tests. Davide asks if the same information obtained with long term tracking could be extracted by densely populating the phase space. Massimo replies that this is possible to some extent, but the extrapolation introduces uncertainty. Sergey ask to which accuracy the model is known, indeed it seems that a very long tracking may diverge from the machine and at some point it may be no longer significant. Massimo replies that the uncertainties in the model are taken into account by tracking with different magnetic machine realizations.

Pascal reports the existence of scaling laws for the extrapolation of the DA for large number of turns and to extract the DA value from the beam losses. The simulated DA as function of the number of turns is shown and fitted with the DA scaling law which reproduces the trend very well.

Pascal shows octupoles and chroma scans of DA extrapolated at 30 min for the two beams at injection. An island of low DA is reported for Beam2. Dario suggests checking the tracking data as it may be due to computational issues.

Knowing the DA value one can extract the total loss of intensity assuming a given beam profile. A Gaussian distribution however gives unrealistically small losses.

Pascal considered a Levy-Student distribution which allows for higher tails, but it has an additional free parameter. The beam fraction at an amplitude larger than a given value is shown as function of the two parameters which control the shape of the distribution. The parameters are then tuned according to the measurements performed by F. Burkhart in his PhD thesis which showed that between 1.9% and 3.6% of the transverse profile is beyond 4 sigma amplitude. The total losses over 30 min are plotted in the chroma-octupole space resulting in much more realistic values compared to the Gaussian case.

The DA scaling with the number of turns is then used to compute losses, loss rate and lifetime as function of time. The exercise is repeated for two seeds (a good and a bad one) giving results compatible or below the specification for the lifetime. More detailed statistical analysis is going to be performed.

The same technique has been applied by Frederik for the HL-LHC case.

Several steps are identified in order to improve this first analysis, in particular it will be important to take into account the emittance evolution (IBS and SR) and to benchmark with measurements. Gianluigi asks if the measurement done by Florian at injection were done with high intensity; indeed with low intensity one could reduce the impact of the IBS. Massimo suggest including the IBS model, Yannis replies that it can be provided.

Gianluigi points out that the tails of the injected beam can be scraped from the SPS. He suggests scraping down to very small amplitudes with low intensity beams in order to check the injection process (losses and potential mismatch) and the development of tails. This could also be interesting for ABT.

Yannis asks about the longitudinal shape, which has an impact on the IBS evolution. Scanning of the initial momentum and convolutions of the longitudinal distribution looks possible. Yannis stresses that the Levy-Student distribution is a re-parametrisation of the q-gaussian already in use for estimations of the transverse profiles.

Xavier asks how it is foreseen to extrapolate the emittance growth. Massimo explains that this could be done by evaluating the losses outside the DA boundaries, which allow fixing the shape of the beam distribution.

Sergey asks if the estimations of DA limited at 90000 turns are applicable at 30 min. Massimo replies that measurements were performed validating the scaling laws. In general the different fit parameters for the various seeds can change radically, however the result in specific time intervals tend to be more stable. Massimo also adds that synchrotron motion and other noise sources can result in a negative asymptotic DA, where no point in the phase space is endlessly stable; however, even in this case, a large part of the phase space could remain available for the required time.

Gianluigi summarises that it would be important to determine what is the DA that corresponds to a given beam lifetime:

- In the presence of beam-beam the beam lifetime should be significantly larger than the burn-off lifetime (this is varying from 20 to 10 hours during the fill for the nominal luminosity), not to affect significantly the luminosity lifetime.
- In the absence of beam-beam (injection to collision) the lifetime should be comparable to other mechanisms (e.g. beam-gas) and in any case it should be in the range of few tens of hours from operational experience (at least in the design phase).

Action: Massimo and Yannis to come up with possible targets based on these considerations.

Yannis notes that the DA simulations are performed for a given momentum offset, while the number of particles at this momentum amplitude is generally small. As there is some correlation between DA and momentum offset (especially for large chromaticity), the convolution with the momentum distribution should be considered.

Round Table

Elias reports that some instabilities have been recently observed in the LHC, but there are still no accurate emittance measures, neither in the SPS. Xavier comments that extrapolating from the BSRT is not straightforward also due to the non-linear calibration factors.

Gianluigi asks if at flat bottom in the SPS the emittance measure is feasible, Yannis reports that the switch to bunch-by-bunch acquisition has introduced noise.

Xavier comments that full octupole current still allows being within the error bars of the stability thresholds although this could be on the edge for pessimistic emittances. Gianluigi suggests providing the required octupole settings as a function of the brightness.

Elias reports a more uniform heat load in the different sectors. Rogelio asks if this is jeopardising the 50 ns test. Gianluigi stresses that one has to wait for some conditioning to take place in order to see the evolution of the SEY.

Sergey points out that the Schottky detectors could also provide emittance measurements, but for the moment they seem to be far from ready.

Reported by Dario, Gianluigi and Rogelio.