Minutes of the Mini Workshop on the Collaboration on RF WP2

held on 23 July 2021 (09:00-13:00) via Microsoft Teams

Participants:

• BESSY: Alexander Matveenko (AM), …

• ESRF: Jörn Jacob (JJ), Vincent Serriere (VS), Alessandro D’Elia (AD), Simon White (SW), Lee Carver (LC), …

• KEK: Shogo Sakanaka (SS), Naoto Yamamoto (NY), …

• PSI: Lukas Stingelin (LS), …

• SOLEIL: Patrick Marchand (PM), Alexis Gamelin (AG), Fernand Ribeiro (FR), Ryutaro Nagaoka (RN)

Edited by: RN

As a first occasion since the collaboration began in late 2019, a mini workshop was held on WP2 (simulation studies) via videoconference (Microsoft Teams) on 23 June 2021, where the five member labs of the collaboration presented their outputs, which were then discussed along with organizational aspects of the collaboration. The agenda of the mini workshop is appended at the end of this minutes and all the presentation files are accessible in the common disc space of WP2 defined at this mini workshop (<https://gitlab.synchrotron-soleil.fr/PA/workshop/rf-collaboration>).

The mini workshop started from the opening address of PM from SOLEIL, where the scope and the organization of the collaboration were shown with a table summarizing the main objectives of the four defined workpackages. Then in more detail, the goals of WP2 were reconfirmed, consisting of collective beam dynamics studies in the presence of main and harmonic RF systems using several different simulation codes, as well as experimental studies using beam at BESSY and PSI.

A question was raised here on the fact that no official agreement was established so far on the concerned WP2 collaboration. It was decided to address this point during the discussion session at the end.

The second talk was given by LS from PSI entitled, “Simulations of Robinson Instability for SLS and SLS 2.0 with ELEGANT PSI”. The scope of the studies presented was to investigate the impact of the Super-3HC installed in SLS that lengthen the bunch and Landau damps coupled-bunch instabilities induced by the main cavity HOMS, especially when the ring is operated at low beam current. The code ELEGANT was used for the simulation. The effect of the Super-3HC on the AC Robinson stability limit at low current was explored, which was never studied in detail nor measured at the SLS so far. The obtained SLS results were also compared with those of SLS 2.0.

The third talk was given by AM from BESSY entitled, “Transient beam loading with normal conducting harmonic RF system”. Analysis was made on the transient beam loading in BESSY II light source for different ratios of the main to 3rd harmonic RF amplitudes. Measurements of individual bunch arrival times of a typical fill pattern in standard user operation mode with avalanche photodiode and streak-camera were compared with a MATLAB based model simulating the transient beam loading with a point like particle for representing each bunch. The results obtained helped understand the physical mechanism of the observations and it was found necessary to add the main cavity contributions in order to obtain better agreement quantitatively.

The fourth talk was given by NY from KEK entitled, “mbtrack calculation results of bunch lengthening operation at SOLEIL-U ring”. Several calculations have been carried out using mbtrack assuming a passive SC harmonic cavity (HC) in the SOLEIL-U ring. Specifically, the following aspects were addressed and simulation results shown; 1) SOLEIL-U 3/4-filling with harmonic and kicker cavities, 2) single-bunch results with HC, 3) impact of direct RF feedback. For the first point, the transient beam loading (TBL) was evaluated in the ¾ filling which is currently one of the modes of operation at SOLEIL with and without a dedicated kicker cavity that corrects the former and its efficiency was simulated, finding that TBL could be significantly reduced, but not to a sufficient extent. In 2), the beam dynamics was closely followed at 10 and 20 mA single bunch, where beam instability apparently due to longitudinal mode coupling or AC Robinson was observed at 10 mA, and a double hum structure appeared in the bunch structure when the detuning angle of the harmonic cavity was tuned to approach the flat potential condition and beyond. In 3), the direct RF feedback recently implemented in mbtrack was applied in the uniform multibunch and single bunch filling modes, where the efficiency of feedback was examined and compared.

The fifth talk was given by AG from SOLEIL entitled, “Simulation results for SOLEIL upgrade”. In this presentation tracking results using the new python version of mbtrack “mbtrack2” in the course of development were shown for the RF system planned for SOLEIL upgrade. First the simulation results with superconducting 3rd harmonic cavities assuming a uniform filling pattern were shown, followed by comparing them with the case in which the impact of non-uniformities with variable gap lengths and with a typical filling pattern, measured in the present SOLEIL ring. Then in the second part of the talk, an alarming reduction in the current threshold of the main cavity HOM-driven coupled bunch instability due to the harmonic cavity that resulted in the simulation studies was shown, demonstrating the theoretical predicted effect (due to lowering the synchrotron frequency) that harmonic cavities may not necessarily increase the threshold current thanks to Landau damping. Following this presentation, the methods of calculating the beam lifetime were discussed, where it was agreed that, within the frame of WP2, calculation methods have to be validated by tests with beam in actual machines.

The sixth talk was given by JJ from the ESRF giving a short intervention introducing the DC Robinson instability excited with an active harmonic cavity, in anticipation of future simulation results, as normal conducting active harmonic cavities are foreseen for the ESRF-EBS and as no one addressed this point in this workshop. It was shown by integrating the equation of synchrotron motion that the beam is found to become unstable already at very low current, due to the DC Robinson instability. That was also shown by multi-bunch tracking, using mbtrack, reported by NY at the ESRF (spring 2019, link: <https://gitlab.synchrotron-soleil.fr/PA/workshop/rf-collaboration>/Presentations\MiniWorkshop\_23\_06\_2021\N.Yamamoto\_mbtrack\_01Feb2019.pdf).

At the end of the presentation session, PM from SOLEIL made a summary talk overviewing the obtained simulation results for SOLEIL-U along with a list of items to study in the next steps. He also showed the list of studies to be made in the frame of WP2 collaboration both numerical and experimental (at BESSY and PSI) for its updating.

In the remaining time of the discussion session, nearly one hour was spent in discussing some of the points presented in the contributed talks, as well as issues surrounding the collaboration in WP2. Regarding the official agreement, a round table discussion was made each of the five labs expressing its view, where it was commonly agreed that no official agreement would be needed for collaborative simulation studies. All the WP2 members should reasonably judge if acknowledgement is needed in the event of publications when a certain simulation tool developed by others is used. However, it was also agreed that each lab will confirm this idea with its Division Head.

It was commonly agreed that cross checks of simulation results are very important and should be made using available codes wherever possible, and in particular in between mbtrack (mbtrack2) and elegant. The ESRF colleagues (LC and SW) reported that they are currently using PyAT and PyHeadtail and developing the latter to be able to treat multibunches.

Regarding the sharing of presentation files, simulation inputs and outputs, creation of a common disc space was discussed. SW proposed the use of git repository upon his positive experience using it, which was accepted by all participants. AG then volunteered quickly to prepare it and distributed the link: <https://gitlab.synchrotron-soleil.fr/PA/workshop/rf-collaboration>

Finally, regarding the frequency of such workshop, it was commonly agreed that we leave it flexible and communicate with each other when we consider useful to organize another workshop sharing the new outcomes of the studies.

Programme of the Mini Workshop on the Collaboration on RF WP2 held on 23 June 2021

09h00 – 09h05: Opening remarks (Patrick Marchand)

09h05 – 09h45: Simulations of Robinson Instability for SLS and SLS 2.0 with ELEGANT PSI

Lukas Stingelin (PSI)

09h45 – 09h50: Questions/comments

09h50 – 10h05: Transient beam loading with normal conducting harmonic RF system

Alexander N. Matveenko (BESSY)

10h05 – 10h10: Questions/comments

10h10 – 10h50: mbtrack calculation results of bunch lengthening operation at SOLEIL-U ring

Naoto Yamamoto (KEK)

10h50 – 10h55: Questions/comments

10h55 – 11h00: Pause

11h00 – 11h40: Simulation results for SOLEIL upgrade

Alexis Gamelin (Synchrotron SOLEIL)

11h40 – 11h45: Questions/comments

11h45-11h55: Short intervention by Jörn Jacob (ESRF)

DC Robinson instability with an active harmonic cavity, in anticipation of future simulation results

11h55 – 12h00: Questions/comments

12h00 – 13h00: Discussions/Closing remarks (by all participants)