Minutes PSB Upgrade WG Meeting 19th January 2016

Participants: J. Abelleira, E. Benedetto, A. Blas, F. Boattini, J. Borburgh, J. Coupard, J. Devine, G.P. Di Giovanni, R. Froeschl, G.M. Georgiev, G. Guidoboni, M. Haase, K. Hanke, J. Hansen, M. Kowalska, S. Moccia, A. Newborough, J.L. Sanchez-Alvarez, L. Sermeus, J. Tan, W. Weterings.

Agenda (https://indico.cern.ch/event/478959/):

1. Approval of Minutes

- The minutes of the last LIU-PSB WG meeting #165, available here, have been approved.

2. Communications

- **Chamonix (http://chamonix-2016.web.cern.ch/):**
  - The last LIU-PT meeting was dedicated to the review of the talk for Chamonix.

3. Follow-up of Open Actions

- E. Benedetto on "Study collimation and losses in the PSB rings" → The action will be closed once the EDMS document describing the absorber in the PSB is submitted for approval. This is expected to happen within the next weeks.

- C. Zamantzas/J. Tan on "Make sure that the SRR or ECR for BLM for the PSB and transfer lines is submitted. The SRR or ECR should include FLAT ionization chambers and ionization chambers to replace ACEMs." → J. Tan reported that the ECR should be issued by the end of March 2016. **Deadline updated.**

- S. Burger/J. Tan on "Submit the ECR for BI.BTV30." → The ECR has been launched, see https://edms.cern.ch/document/1572803/0.1. → **Action Closed**

- B. Holzer/J. Tan on "Provide specifications for the wire-scanners." → J. Tan reported that there is still in preparation and should be available by the end of February. **Deadline updated.**

- S.Moccia/W. Weterings on "Perform air flow measurements in the PSB injection area during the upcoming YETS2015/2016 as an input for the foil exchange procedure." → Measurements were performed in the area where the foil exchange procedure should take place with and without ventilation active. No measurable difference in the airflow could be detected. W. Weterings added that the foil exchange procedure will be performed under a glass box to protect the foil. → **Action Closed**

- S. Moccia on "Check if the TT2 cooling system could be separated from the PSB one." → The current baseline is **to not separate the TT2 cooling system**. The TT2 consolidation is under review at the LIU-PS and it will be investigated if enough resources are available to split the system. → **Action Closed**

- F. Roncarolo/J. Tan on "Prepare a document for approval about the specifications for the H0/H- current monitor electronics." → J. Tan reported that the document is currently under review within the BI Group. The document should be circulated soon within the LIU-PSB working group.

- D. Aguglia on "Approve document with the functional specifications of the power converters for BSW magnets for both the LIU-PSB and the Half-Sector Test in Linac4 addressing the open issues from v0.2" → All comments have been received and addressed, but for some possible issues about handling and transport of the magnets. On the other hand the information is not yet available as several engineering details have to be solved. It was agreed to release the document and once the information are available the document will be updated. The released version of the EDMS document is at https://edms.cern.ch/document/1495860/1.0. → **Action Closed**

- E. Benedetto on "Report about the tests on the 800 W power amplifiers for tune measurements and provide specifications to A. Blas." → Extrapolating the measurements performed in 2015 done by B. Mikulec, R. T. Garcia and A. Garcia-Tabares Valdivieso, a power amplifier of 800 W is considered to be enough to perform linear and nonlinear measurements. → **Action Closed**

- R. Froeschl on "Evaluate the possibility to remove part of the shielding to allow the installation of the new magnets BTM.BHZ10 and BTP.QNO20 for the upgrade of the BT/BTM/BTP lines." → R. Froeschl reported that the RP group received the preliminary information from J.M. Lacroix about how much material has to be removed. The proposed shielding modification is fine for the RP Group. → **Action Closed**

- L. Sermeus/J. Borburgh on "Report about the preliminary results of the measurements campaign on the rise time of the recombination kickers and their impact on the new kicker design." → The measurements done during the YETS 2015/2016 have been presented today, see below → **Action Closed**

- K. Hanke on "Clarify the strategy for the budget allocated to decabling work within the LIU-PSB project." → The official statement is: **"If cables have to be cleaned up the work will not be included in the LIU budget, but, if the cable removal is part of a cable replacement, the budget will have to come from the LIU work-packages concerned".** → **Action Closed**

4. Recombination Kickers Rise Time

- L. Sermeus presented the results of the measurements of the recombination kickers rise time performed during the YETS 2015/2016, see here.

SUMMARY:

- Measurements of the kicker rise time in the BT recombination line performed during the YETS 2015/2016.
- **BT1,4.KFA10:**
  - The rise time at 50 kV for the nominal (2-98)% was measured to be 134 (138) ns for BT1.KFA10 (BT4.KFA10).
  - The required performance for LIU-PSB are a (2-98)% rise time of 104 ns, so **the current KFA10 are out of the LIU-PSB specifications**.
  - Ripples are visible but it is within the predefined specification of +/- 2%.
  - The current ferrite type installed in the kickers is assumed to be 4L1.
  - Simulation with Pspice predicts a improvement in the rise time performance using the ferrite-type 8C11.
  - On the other hand, current simulation cannot completely reproduce the measurements.
- **Current planning to resolve the issues with the BT1,4.KFA10 rise time:**
  - A new vacuum tank with magnets equipped with better ferrite type, 8C11 or CMD5005 should be ready in 2017.
  - **Meanwhile, several tests in the laboratory are planned on a KFA20 spare. This spare is already equipped with CMD5005 and will be set in the same configuration as KFA10. These test should help refining the Pspice equivalent circuit and simulate the improvements needed to reach the specification.**
  - **If the rise time can not be met, a solution would be to split the magnets in two and build two new generators to supply them. Currently one generator supplies two magnets in parallel.**
    - **This choice assumes SF6 cables can be bought.**
    - **This option is not presently funded nor staffed.**

- **BT2.KFA20:**
  - The rise time at 27 kV for the nominal (2-98)% was measured to be 94 ns.
  - **The measured rise time is within the specification of LIU-PSB.**
  - The ripples observed are more pronounced with respect to the measurements performed on BT1,4.KFA10.
  - In simulation there is an overshoot not present in the measured waveforms.
  - **While the measurements comply with the LIU requirement, the nominal voltage at 2 GeV is 36.5 kV, and the maximum available voltage is 37 kV.**
    - **W. Bartmann is looking into the optics model to relax the requirements on BT2.KFA20%ENDCOLOR → This change should have negligible impact on LHC-type beams, while it may affect the high intensity beams. This is to be studied in more details.**
  - If the new KFA10 is within specification, the KFA20 could then be reconfigured the same way to avoid magnet breakdowns. → **Currently no LIU workunit exists for this task**.

- **It was agreed to review the status and progress concerning the recombination kickers at the end of June 2016. By this time more tests should have been carried out and the understanding improved.**

Detailed Description

- The presented results are a follow up of the measurements done in 2015 on the BT1,4.KFA10, see here.
- The measurements were done using a scope with a 200MHz bandwidth and 13 bits resolution (for the measurements presented in 2015 the resolution was 8 bits).
- **The baseline for the rise time is (2-98)%.**
- **BT1.KFA10:**
    - The rise time at 50 kV for the nominal (2-98)% was measured to be 134 ns.
    - Ripples are visible but it is within the predefined specification of +/- 2%.
    - Simulation with Pspice predicts a rise time of **122 ns with ferrite 4L1 (which is assumed to be the present ferrite type installed in the kicker)** and 109 ns with ferrite 8C11.
    - **The measured rise time is out of the specification for LIU, which is requested to be 104-105 ns**
    - Simulation predicts a measurable improvement by changing the ferrite.
    - **A. Blas remarked that the current simulation code does not seem to reproduce the measurements observed in data.**
        - L. Sermeus explained that indeed the model is not perfect. For instance it is not frequency dependent.
- **BT4.KFA10:** * The rise time at 50 kV for the nominal (2-98)% was measured to be 138 ns, 4 ns higher than BT1.KFA10.
    - Simulation with Pspice predicts a rise time of **107 ns with ferrite 4L1 (which is assumed to be the present ferrite type installed in the kicker)** and 104 ns with ferrite 8C11.
    - The measured rise time at 50 kV for the nominal (2-98)% is 138 ns.
    - **A similar level of disagreement between data and simulation as in the BT1.KFA10 case is observed.**
- **Plan to resolve the issues with the BT1,4.KFA10 rise time:**
    - A new vacuum tank with magnets equipped with better ferrite type, 8C11 or CMD5005 should be ready in 2017.
    - **Meanwhile, several tests in the laboratory are planned on a KFA20 spare. This spare is already equipped with CMD5005 and will be set in the same configuration as KFA10. These test should help refining the Pspice equivalent circuit and simulate the improvements needed to reach the specification.**
        - If the tests are proven to be effective, one could also rearrange the present Tx-PFL pairs to reduce mismatches during the EYETS.
        - Last, one could cut new transmission cables from the PFLs which are longer than necessary (or install new transmissions cables, if available) for a better matching.
    - **If the rise time can not be met, a solution would be to split the magnets in two and build two new generators to supply them. Currently one generator supplies two magnets in parallel.**
        - **This choice assumes SF6 cables can be bought.**
        - **This option is not presently funded nor staffed.**

- **BT2.KFA20:**
  - The layout is different with respect to BT1,4.KFA10 and the **magnets is already equipped with CMD5005 ferrite blocks.** The magnets are charged with the PFLs.
  - The rise time at 27 kV for the nominal (2-98)% was measured to be 94 ns.
  - **The measured rise time is within the specification of LIU-PSB**
  - The ripples are more pronounced with respect to the measurements performed on BT1,4.KFA10.
  - Pspice simulation can reproduce the ripples, but it **predicts a rise time of 83 ns, which is not in agreement with the measurements**
  - **In simulation there is an overshoot not present in the measured waveforms.**
  - **While the measurements comply with the LIU requirement, the nominal voltage at 2 GeV is 36.5 kV, and the maximum available voltage is 37 kV.**
    - **W. Bartmann is looking into the optics model to relax the requirements on BT2.KFA20%ENDCOLOR → This change should have negligible impact on LHC-type beams, while it may affect the high intensity beams. This is to be studied in more details.**
  - **Additional plans to improve the performance of the BT2.KFA20 rise time are:**
    - Improve matching of cables in order to reduce the amplitude of the two measured ripples.
    - Improve filters (mainly on the main switch) to reach 100% earlier.
  - If the new KFA10 is within specification, the KFA20 could then be reconfigured the same way to avoid magnet breakdowns. → **Currently no LIU workunit exists for this task**.

- **It was agreed to review the status and progress concerning the recombination kickers at the end of June 2016. By this time more tests should have been carried out and the understanding improved.**

5. Status of the Optics of the PSB Extraction Lines

- J. Abelleira presented the updated status of the optics of the PSB extraction lines for the 2 GeV upgrade, see here.

SUMMARY:

- **New optics has been produced for LHC-type and FT-type beams, keeping the constraints from gradients and GFR in the new quadrupoles as specified in previous reviews.**
- **The relative emittance increase for LHC-type beams at PS injection due to optics mismatch has been reduced from about 5% to 2%.**
- **The relative emittance increase for FT-type beams at PS injection due to optics mismatch is now at the level of 9% in the horizontal plane.**
  - Nevertheless, **the new FT-type optics shows a small increase in terms of beam size and so there should be no impact due to beam losses in the line.**
  - In the LIU project there is no emittance growth budget associated to high intensity beams.

- **Beam Stopper, BTP.STP10:** A document describing the input parameters for the FLUKA simulation is currently under approval, see https://edms.cern.ch/document/1557914/0.1.

- **Impact of the new optics on BTY line:**
  - The optics for BTY is the same used for sending the beam to the dump.

    - No major effect, but a rematching may be needed at the end of the line.

- **Repository:**
    - The code is currently available on afs at "/af/cern.ch/eng/ps/cps/TransLines/PSB-PS/2015/cmd/PSB-PS-LIU-proj/LIU_PSB-PS_transfer_lines

Detailed Description

- In the latest review, held the 24th September 2015 and available here, **a significant optics disagreement for the different 4 BT lines was observed. The reason behind the impossibility to fully match all the 4 BT-BTP lines is due to the different weak focusing of the vertical dipoles.**
- The mismatch in the horizontal betatron function and in the vertical dispersion **results in a relative emittance growth bigger than 5%, which is out of the specification given for LIU.**
- **The new rematching aims at minimizing the overall emittance growth from the 4 rings at the same time, instead of fully matching only one ring.**
- In the new rematching procedure, the **new (longer) magnetic length were used. It was not the case for the optics model presented in September 2015.**
- Both the optics for LHC-type and Fixed-Target-type (FT-type) beams were probed.
- **The major constraint was to keep the maximum good field regions (GFR) and gradients for the quadrupole magnets to the same level specified in previous reviews** → This turned to be a complicated task due to the interplay between longer magnets and beam divergence at the entry/exit of the magnets.
- **LHC-type optics:** The new optics predicts a **maximum relative emittance growth of 1.34% (mostly from ring 3) due to horizontal betatron mismatch and 2.38% (mostly from ring 1) due to the vertical dispersion mismatch.**
- **FT-type optics:** The new optics predicts a **maximum relative emittance growth of 3.18% (mostly from ring 3) due to horizontal betatron mismatch and 8.36% (mostly from ring 1) due to the vertical dispersion mismatch.**
- If one compares the results with the ones presented in September 2015:
    - **The total (4 rings) relative emittance growth for the LHC-type optics goes from 2.3 (5.4) % to 1.4 (2.4) % in the horizontal (vertical) plane**
    - **The total (4 rings) relative emittance growth for the FT-type optics goes from 2.0 (8.9) % to 5.2 (1.79) % in the horizontal (vertical) plane**
        - **The main reason behind the relative emittance growth in the FT-type optics is the constraint to maintaining the GFR at the level specified in previous reviews.**
        - **On the other hand, the figure of merit for the FT-type optics is the losses and not the total relative emittance growth. In this case, the beam envelopes only grow by 3.4 (0.8)% in the horizontal (vertical) plane. Even with the beam envelope growth, simulation shows that there will be negligible effect on the foreseen beam losses.**
        - The losses would get higher instead if one uses the LHC-type optics on the FT-type beam, in the attempt to recover the total relative emittance growth.
        - G.P. Di Giovanni asked if it is possible to use the new LHC optics for LHC-type beam and instead the old one presented in September 2015 for the FT-type beam. J. Abelleira replied that it should not be needed to do it as the figure of merit for the high intensity beam is the losses and the beam envelope does not show any increase in losses. There is no budget of total relative emittance growth associated with the FT-type beam in the LIU project.

Moreover the results shown in September 2015 should be reviewed using the new magnetic length before deciding.

- **Beam Stopper, BTP.STP10:**
  - A document describing the input parameters for the FLUKA simulation is currently under approval, see https://edms.cern.ch/document/1557914/0.1.

- **Impact of the new optics on BTY line:**
  - Used the latest BTY model, under development.
  - The optics for BTY is the same used for sending the beam to the dump.
  - No major effect, but a rematching may be needed at the end of the line.

- **Repository:**
  - The code is currently available on afs at "/af/cern.ch/eng/ps/cps/TransLines/PSB-PS/2015/cmd/PSB-PS-LIU-proj/LIU_PSB-PS_transfer_lines

6. Quadrupoles Trims for 2 GeV Operation and Tunes at Extraction

- E. Benedetto presented slides about the trims of the quadrupole for the 2 GeV beam operation and discussed the tunes at extraction, see here.

SUMMARY:

- The input for the current values were taken from A. Newborough from the presentation showed in November 2015, available here.
- **The higher the trim applied, the lower would be the resulting working point (WP)**. Therefore going higher in WP is generally feasible by means of reducing the trim current.
- **For the nominal trim current the values of the WP are calculated to be Qx/Qy=4.18/4.17.**
- **There is good margin provided by the quadrupole magnets to keep a similar working point as of today and there is good flexibility in varying the WP at extraction.**
- A remark is that it will not be possible to lower than Q=4.10 at extraction, but it should not be needed.
- **Need to update the "Q editor" application to take into account the new MPS, as the new inner and outer coils will be powered independently.**

7. AOB

- The next meeting is planned for the 9th February 2016.
- E. Benedetto reported that the simulation of the brightness curve has been finalized and presented at the LIU PSB injection meeting, see https://indico.cern.ch/event/469742/.
- A. Newborough reported that during the YETS 2015/2016 both QFO72 and BHZ62 were lifted because of a suspected vacuum leak. The leaks did not seem to be related to the magnets. The magnets have been pulsed and the coils are not moving.
- S. Moccia reported that there was a discussion to remove few pipes running with drinking water in the injection region. The work to perform such a removal will start next week.
- K. Hanke reported that the disconnection campaign for the obsolete cables is progressing well. The first tests with the relative hardware were fine. Another set of tests will start soon. In total about 3000 cables have to be disconnected during this YETS 2015/2016.
- M. Haase reported that the support platform in BRF2 is ready and the work can be started.
- G.M. Georgiev reported that the estimation for the DC cables for the LIU-PSB has been done and the work amounts to about 500 kCHF. K. Hanke replied that it should be included in the current baseline for 2016.