Minutes PSB Upgrade WG Meeting 19th April 2016

Participants: E. Benedetto, T. Birtwistle, M. Cieslak-Kowalska, L. De Mallac, G.P. Di Giovanni, T. Dobers, A. Floriduz, R. Froeschl, G.M. Georgiev, G. Guidoboni, M. Haase, K. Hanke, D. Hay, I. Lamas, B. Mikulec, M.M. Morgenstern, A. Newborough, F.-X. Nuiry, T. Polzin, J. Tan.

Agenda (https://indico.cern.ch/event/514686/):

1. Approval of Minutes

- The minutes of the last LIU-PSB WG meeting #171 have been approved.

2. Communications

- **LIU-PT Meeting:**
  - In the LIU-PT meeting held the 31st March 2016, S. Mataguez presented the updated schedule for the activities in LS2.
  - The minutes of the meetings with EN-STI and BE-BI have been released:

- **LIU and EN-EL Activities:**
  - A dedicated meeting was held between the LIU management and the EN-EL representatives, see https://indico.cern.ch/event/503042/. The minutes are available here.
  - G. M. Georgiev reported that:
    - The LIU-PSB project is generally fine: All pre-DICs have been received to estimate the resources. **The final list should be provided to M. Meddahi by the end of June 2016.**
    - The main issues:
      - **Few activities are not yet registered in PLAN.**
      - Few information, mostly about the **functional position in the machine are missing.** G. M. Georgiev is iterating with T. Birtwistle and J. Coupard to obtain the correct information. K. Hanke encouraged G.M. Georgiev to iterate with the relevant experts in the group and also contact him, if additional support is needed.
    - **BE-BI cabling activities for the EYETS:**
      - **The time estimated for the work of the equipment classified as "priority 1" is about 3 weeks.**
      - EYETS should last approximately 12 weeks and **9 weeks will be dedicated to the decabling activity, which has the highest priority for the EN-EL Group.** K. Hanke commented that, while he understands the need to prioritize work, it is very important to **define a strategy to accommodate the cabling requests of all the**

equipment needed for the possible Linac4 connection by the end of the 2016.

- B. Mikulec reported that **BE-BI requested 1 month of hardware commissioning for the BTMS without beam.** The timeline for the cabling (currently 3 weeks) should also be discussed with J. Belleman to see if enough time is allocated to this activity. **More than 500 cables should be removed for this equipment.** And there will be no way back once the new system is in place.

3. Follow-up of Open Actions

- K. Hanke on "Clarify with all the relevant experts the need for new support for the equipment in the BTP line." → A meeting was held the 6th April 2016. Two options were proposed with comparable costs. In order to finalize the technical decision, precise integration designs are needed. K. Hanke contacted Y. Muttoni and this issue should be followed up at the LIU-PLI meetings. Additionally, it was decided that TE-ABT Group should take care of preparing the ECR for the positioning of the elements in the BTP line. Finally, the money will be taken from the budget of the LIU-PSB management.

4. ECR/SSR for EYETS 2016/2017

- J. Coupard presented the list of ECR/SRR needed for the EYETS in the framework of the LIU-PSB project, see here.

- In order to organize the workload, the 4th March 2016 J. Coupard sent an email to the WP-holders requesting a date for the submission of the ECR or SRR needed for any activity to be carried during the EYETS 2016/2017.
- Several ECRs have been already received and released while some other are under approval.
- The documents for POPS-B are ready and the plan is validate them at the next integration meeting.
- **Several ECRs still missing from BE-BI Group:**
  - Wideband pick-up integration is ongoing and J.M. Lacroix is working on it.
  - **Need a tentative date for the work on the wire-scanner in Section 4L1, the new tune pickup in Section 3L1 and for the new BLM in injection/extraction as well as the PSB rings.**
- **The list of the TE-EPC equipment on surface/underground that must appear in the ECRs will be established soon. S. Pittet presented the complete list of possible activities the 22nd March, see here.**
- **Several SRRs still missing:**
  - For the positioning of the magnets in BT-BTP-BTM lines. K. Hanke asked if this SRR should also include the other equipment which needs new supports. A. Newborough replied that it was agreed that the ECR will be taken care by the TE-ABT Group and for the SRR this information should not be needed.
  - For the positioning of the new PSB scrapers/absorbers, the SRR is ready and the integration is under review. The approval will be launched soon.
  - For the new RF system, the SRR should be prepared by the end of April 2016.

- **The deadline for the ECR/SRR to be finalized (including integration and approval) is set to end August 2016.** The deadline has been defined by the LS2 committee at the beginning of April, https://indico.cern.ch/event/504053/.

- Every WP-holder is requested to contact J. Coupard, if they estimate that their ECR/SRR could not be prepared on time.

5. PSB Beam Absorber/Scraper after LS2

- M. Cieslak-Kowalska presented beam dynamics studies to motivate the need for new absorbers/scrapers in the PSB, see here.

SUMMARY:

- **The aim of the presented study is to support the design of a device to allow a control of the losses in PSB and to localize them in a dedicated area.**
- Motivations for the need of a new absorber/scrapers:
  - **The PSB Injection energy will increase from 50 MeV to 160 MeV.**
  - **A new H- charge-exchange injection scheme will be implemented**
  - **Evaluate doubling the intensity for ISOLDE-type beams, assuming no additional cost/impact on LIU.**
- Three critical scenarios have been investigated:
  - **Collimation of ISOLDE-type beam.** The assumption is to **scrape 6%** of the ISOLDE-type beam.
  - **Full beam impact of the ISOLDE-type beam at the extraction energy of 1.4 GeV.**
  - **Tailoring the LHC-type beam**. The assumption is to **scrape 15%** of the LHC-type beam.
- Proposed positioning:
  - The new absorbers could be place where the BRi.DBSH/V8 bumpers are located, i.e. 2.5 downstream with respect to the current absorbers, WBS. **MADX simulation show that the new position is compatible with the current operation shaving scheme, which should remain operational for LIU-PSB.**
  - **MADX simulation show that the α-function is not zero at the new position, while it is the case for the WBS. This difference does not seem to be an issue, but its impact has to be evaluated.**
  - **The SRR and integration of the new PSB absorber/scraper is being reviewed and the approval will be launched soon.**
- Material:
  - The first proposed material was graphite. **Preliminary studies showed that an absorber made of graphite could localize about 80% of the losses in period 8.**
    - **Graphite seems to be not an optimal material choice for the TE-VSC Group because of out-gassing.** Several other low-Z materials are under study, such as Titanium and Aluminium. The final choice will be a compromise to satisfy STI, VSC, RP, ABP and OP groups.
- **Preliminary results:**
  - The codes used are PTC, for tracking, combined with pyORBIT, for the space charge and particle-matter interactions.
  - The aperture limitations assumed are:
    - **Contain the loss level to 5%, as for the LHC-type beams.**
      - There was a question about the 5% budget for the losses. Generally this budget has been allocated to LHC-type beam, while for ISOLDE-type beam there is no official value. While the exact number for budget of allowed losses of ISOLDE-type beam has to be clarified, assuming a 5% is considered a conservative approach.

        - **Keep the vertical normalized emittance to 6 mm mrad.** This constraint is imposed by the recombination septa, more details available in EDMS 1537199.
    - Preliminary studies show that absorbers in either the old or new positions could localize more than 80% of the losses.
    - Without any absorber the losses are spread all over the machine and amount to 2.5% of the injected beam in the first 5 ms.
    - **The analysis of the beam evolution in the first 5 ms for the ISOLDE-type beam showed that the losses level does not exceed 5%. However a longer tracking, around 20 ms, showed that the integrated beam loss reached more than 10%.**
        - **The limit is due to the aperture restriction at the vertical recombination septa which imposes a vertical normalized emittance of of 6 mm mrad, so the aperture of the WBS cannot be increased.**
        - It was observed that **by reducing the vertical injection offset from 8 mm to 7 or better 6 mm should allow to contain both losses and vertical emittance within the defined constraints.**
- Documentation:
    - The results for the scenarios considered have been summarized in the EDMS document 1578463.
- Next steps:
    - Decision on the material and feedback on the design needed from EN/STI.
    - Optimisation of aperture/thickness as outcome of detailed tracking simulations implying particle-matter interaction.

Detailed Description

- **The aim of the presented study is to support the design of a device to allow a control of the losses in PSB and to localize them in a dedicated area.**
- Several are the motivations to review the needs in terms of absorber/scrapers to produce the operational beams:
    - **The PSB Injection energy will increase from 50 MeV to 160 MeV.**
    - **A new H- charge-exchange injection scheme will be implemented**
    - **Evaluate doubling the intensity for ISOLDE-type beams, assuming no additional cost/impact on LIU.**

- Three critical scenarios impacting the absorber design have been investigated:
    - Collimation of ISOLDE-type beam. The assumption is to scrape 6% of the ISOLDE-type beam, deposited on one jaw at the injection energy and the beginning of the ramp.
    - Full beam impact at extraction energy. The most critical case is loosing the full ISOLDE-type beam at the extraction energy (1.4 GeV).
    - Tailoring the LHC-type beam. The assumption is to scrape 15% of the LHC-type beam, deposited on one jaw at the injection energy and the beginning of the ramp.
    - The results for the scenarios considered have been summarized in the EDMS document 1578463.

- Proposed positioning:
    - The current PSB absorber/scraper is the window beam scope (WBS) which is located after the bending magnet BRi.BHZ81 and consists of 40 mm thick carbon absorber.
    - **The space freed after the WBS removal would not be enough to accommodate the new design.**

    - **The new operational shaving scheme requires only 2 out of 3 dipole to construct a close bump around the WBS → The space currently occupied by the BRi.DBSH/V8 bumper could be removed.**
    - The BRi.DBSH/V8 bumpers are located 2.5 downstream with respect to the WBS. MADX simulation show that the new position is compatible with the current operation shaving scheme, which should remain operational for LIU-PSB.*
    - **MADX simulation show that the α-function is not zero at the new position, while it is the case for the WBS. This difference does not seem to be an issue, but its impact has to be evaluated.**
    - **The SRR and integration of the new PSB absorber/scraper is being reviewed and the approval will be launched soon.**

- Proposed Material:
    - The first proposed material was graphite:
        - Rescaling the thickness of the current WBS to the expected impact energy, it was found out that 13 cm of material would be needed to stop the beam at 160 MeV.
        - **Additional studies showed that an absorber made of graphite could localize about 80% of the losses in period 8.**
        - **Graphite seems to be not an optimal material choice for the TE-VSC Group because of out-gassing.**
        - Several other low-Z materials are under study, such as Titanium and Aluminium. The final choice will be a compromise to satisfy STI, VSC, RP, ABP and OP groups.

- Aperture limitations:
    - **Contain the loss level to 5%, as for the LHC-type beams.**
    - **Keep the vertical normalized emittance to 6 mm mrad.** This constraint is imposed by the recombination septa, more details available in EDMS 1537199.

- Simulation
    - The codes used were PTC, for tracking, combined with pyORBIT, for the space charge and particle-matter interactions.
    - The model includes:
        - H- injection at 160 MeV, i.e. transverse and longitudinal painting.
        - Injection into accelerating bucket.
        - Chicane decay, i.e. time varying field.
        - Machine apertures based on MADX model.
    - Three cases considered:
        - A scaled WBS at old position. The rescaled (with relativistic βγ) aperture would be 38.18 mm x 22.40 mm (the current WBS aperture is 50 mm x 28.6 mm)
        - A scaled WBS at the new position. The rescaled aperture would be 29.94 mm x 34.15 mm.
        - Lattice without any absorber.

- Results:
    - Preliminary studies show that absorbers in either the old or new positions could localize more than 80% of the losses.
    - Without any absorber the losses are spread all over the machine and amount to 2.5% of the injected beam in the first 5 ms.

        - R. Froeschl asked if it would be not preferable to have the losses more evenly distributed in the machine, more than concentrating in a single area which would be become very hot. While this could be a better choice from an RP point of view, without the window beam scope and a shaving scheme one would lose the handle to tailor the emittance of the LHC-type beams.
    - **The analysis of the beam evolution in the first 5 ms for the ISOLDE-type beam showed that the losses level does not exceed 5%. However a longer tracking, around 20 ms, showed that the integrated beam loss reached more than 10%.**
        - **The limit is due to the aperture restriction at the vertical recombination septa which imposes a vertical normalized emittance of of 6 mm mrad, so the aperture of the WBS cannot be increased.**
        - It was observed that **by reducing the vertical injection offset from 8 mm to 7 or better 6 mm should allow to contain both losses and vertical emittance within the defined constraints.**

- Next steps:
    - Optimisation of aperture/thickness as outcome of detailed tracking simulations implying particle-matter interaction.
    - Decision on the material and feedback on the design needed from EN/STI.
    - Completed the machine and beam modeling with the input above.

- G.P. Di Giovanni raised the question about the 5% budget for the losses. Generally this budget has been allocated to LHC-type beam, while for ISOLDE-type beam there is no official value. E. Benedetto replied that while the exact number for the losses of ISOLDE-type beam has to be indeed clarified, assuming a 5% budget for the losses is at least a conservative approach.

6. PSB Beam Absorber/Scraper after LS2

- F.-X. Nuiry reported about progress on the design of the new PSB beam absorber/scraper, available here.

SUMMARY:

- The aim of the talk is to review the current design of the PSB beam absorber/scrapers.
- Planning:
    - **Selection of the best target material** to match the requests of mechanical, RP and vacuum compatibility. Deadline: **Mid June 2016**.
    - **Design of the mechanism**, selection of the best technology for the linear movement. Deadline: **End of 2016/Beginning of 2017**
    - **Equipment production and testing.** Deadline: **2018**.
    - **Equipment delivery.** Deadline: **LS2, end of 2019**.
- Positioning:
    - **The new PSB absorber/scraper will be installed in place of the BRi.DBSH/V8 where 520 mm flange-to-flange will be available.** In the current WBS position only 185 mm are available for the absorber and this is not enough physical space for the system as currently designed.
- Present proposed design:
    - The system is still under discussion, but the **general idea is for it to be composed by 4 large fixed masks, one per ring. Four additional masks, smaller in size, could be**

inserted. Each ring will have an **independent inserting movement of the smaller masks.** The estimation for the thickness of each mask is about 13 cm.
    - The system will include 4 actuators for the linear movement, vacuum flanges, a vacuum pump and bellows at the entrance and the exit. **The mask insertion will not be ppm:The idea is to use the bigger masks for commissioning purposes and, only later, insert the smaller masks for beam operation.**
    - **E. Benedetto mentioned that the impedance of the new equipment has to be properly estimated. As soon as a realistic design is available, even if preliminary, it should be provided to ABP Group. → Open Action**
- Preliminary results:
    - Simulation results assuming an **ISOLDE-type beam at 160 MeV, with an intensity of 2e13 ppp and a repetition rate of 0.9 s. K. Hanke and B. Mikulec recommended that the next simulation should include the correct repetition rate of 1.2 s and assume that 40% of supercycle is filled with ISOLDE-type beams.** F.-X. Nuiry mentioned that the simulation will be updated and that a repetition rate of 0.9 s can be anyway considered a conservative assumption.
    - The core of the absorber was assumed to be made of graphite with a support of stainless steel.
    - **The thermal simulations were performed for the steady state, as specified in EDMS 1537199. Nevertheless, a similar approach may lead to a design or a material selection much more constraining than it should be. The plan is to launch transient thermal simulations to see after how many cycles/hours a steady state temperature is reached, if it is ever reached.**
    - About **6% of the beam is assumed to be lost in a localized area of the absorber.**
    - **The maximum temperature reached is about 383° C.**
    - The heat in localized in a small area followed by a cool down degradation around. **The maximum difference in temperature for the part of the scraper which is hit by the beam is less than 50K, so no high stresses are expected for the equipment.**
    - **Currently waiting for feedback from the TE-VSC Group to confirm that the maximum temperature of 383° C is acceptable.** K. Hanke asked if J. Hansen, as contact person for TE-VSC within the LIU-PSB project is aware of the request. F.-X. Nuiry confirmed that J. Hansen has been informed. K. Hanke proposed to organize a meeting to sort out the pending decision about the material and the design. → **Open Action**
- EDMS 1578463 is currently labeled as engineering specification, and, given the ongoing discussion, it would be preferable to **change it to a functional specification.** The engineering specification will follow once the pending decisions about material choice and design are sorted out.

Assigned to	Due date	Description
F.-X.Nuiry	2016-09-30	Provide the preliminary design of the PSB scrapers to ABP Group for the evaluation of the impedance.

Assigned to	Due date	Description
K.Hanke, B.Mikulec	2016-05-30	Organize a meeting with the relevant experts from STI, VSC, RP, ABP and OP to review the material choice for the new PSB absorbers/scrapers.

Detailed Description

- The aim of the talk is to review the current design of the PSB beam absorber/scrapers.

- The starting point for the design is EDMS 1578463, which describes several specifications for the absorber/scraper.
- The first point raised is that the specification assumes a repetition rate of 0.9 s. K. Hanke confirmed that this has to be change to the canonical basic period of 1.2 s.

- Planning:
  - **Selection of the best target material** to match the requests of mechanical, RP and vacuum compatibility. Deadline: **Mid June 2016**.
  - **Design of the mechanism**, selection of the best technology for the linear movement. Deadline: **End of 2016/Beginning of 2017**
  - **Equipment production and testing.** Deadline: **2018**.
  - **Equipment delivery.** Deadline: **LS2, end of 2019**.

- Positioning:
  - **The new PSB absorber/scraper will be installed in place of the BRi.DBSH/V8 where 520 mm flange-to-flange will be available.** In the current WBS position only 185 mm are available for the absorber and this is not enough physical space for the system as currently designed.

- Present proposed design:
  - The system is still under discussion, but the general idea is for it to be **composed by 4 large fixed masks, each per ring. Then 4 additional masks, smaller in size, could be inserted. Each ring will have an independent movement.**
  - The current estimation for the **thickness of each mask is 13 cm.**
  - The system will include 4 actuators for the linear movement, vacuum flanges, a vacuum pump and bellows at the entrance and the exit.
  - The design of the tank of the equipment BRi.BCW8L1 is similar to what is currently foreseen for the scrapers.
  - J. Tan asked if the device to insert the smaller masks is expected to be a ppm device. B. Mikulec replied that the mask insertion will not be ppm. E. Benedetto added that the idea is to use the bigger masks for commissioning purposes and later on insert the smaller masks for beam operation.
  - E. Benedetto recommended to make sure that the impedance of the new equipment is properly estimated. As soon as a realistic design is available, even if preliminary, it should be provided to ABP Group, who will assess the additional impedance to the PSB machine. → **Open action**

- Preliminary results:

- Simulation results assuming **an ISOLDE-type beam at 160 MeV, with an intensity of 2e13 ppp and a repetition rate of 0.9 s.**
- While the repetition rate is to be corrected in the updated simulations, an assumption of 0.9 s is conservative for the steady state analysis, i.e. energy deposition per pulse.
- The core was assumed to be made of graphite (to be review in light of the ongoing discussion with the TE-VSC Group) with a support of stainless steel.
- Through the analysis of the effect of contact pressure and the roughness the material, it was observed that it is not crucial to have good contact thermo-coefficient.
- About **6% of the beam is assumed to be lost in a localized area of the absorber** and the temperature equilibrium is analyzed all over the block to define the heat extraction model.
- The simulation is assumed to be rather conservative.
- **The thermal simulations were performed for the steady state, as specified in EDMS 1537199. Nevertheless, a similar approach may lead to a design or a material selection much more constraining than it should be. The plan is to launch transient thermal simulations to see after how many cycles/hours a steady state temperature is reached, if it is ever reached.**
- **The maximum temperature reached is about 383° C.**
- The heat in localized in a small area followed by a cool down degradation around. **The maximum difference in temperature for the part of the scraper which is hit by the beam is less than 50K, so no high stresses are expected for the equipment.**
- **Currently waiting for feedback from the TE-VSC Group to confirm that the maximum temperature of 383° C is acceptable.** K. Hanke asked if J. Hansen, as contact person for TE-VSC within the LIU-PSB project is aware of the request. F.-X. Nuiry confirmed that J. Hansen has been informed. K. Hanke proposed to organize a meeting to sort out the pending decision about the material and the design. → **Open Action**
- B. Mikulec recommended that to assume in the simulation that 40% of the cycle is filled with ISOLDE-type beam. F.-X. Nuiry replied that this could be done at the same time when the repetition rate is updated to 1.2 s.

- K. Hanke asked if the equipment was expected to be ready for the early Linac4 connection, as the design seems to be still preliminary. F.-X. Nuiry replied that the plan is not to install this equipment at the end of 2016, but during LS2. B. Mikulec confirmed that the original plan was not to install the system during the EYETS 2016/2017.
- G.P. Di Giovanni commented that the EDMS 1578463 is currently labeled as engineering specification, and, given the ongoing discussion, it would be preferable to change it to a functional specification. The engineering specification will follow once the pending decisions about material choice and design are sorted out. K. Hanke seconded the proposal.

7. AOB

- B. Mikulec reported that few meeting were already organized to define the planning of the HST installation and commissioning. Some issues have to be clarified and in particular some responsibilities assigned to people. Additional meeting are planned to sort out this issues.
- The next meeting is planned for the 3rd May 2016 and it will be the first joint LIU-PSB/PS to review the B-Train system.