Minutes PSB Upgrade WG Meeting 5th July 2016

Participants: M. Calviani, L. De Mallac, G.P. Di Giovanni, A. Floriduz, R. Froeschl, G. M. Georgiev, M. Haase, I. Lamas Garcia, B. Mikulec, M. Morgenstern, T. Polzin, L. Soby, J. Speed, W. Weterings.

Agenda (https://indico.cern.ch/event/546929/):

1. Approval of Minutes

- The minutes of the LIU-PSB WG meeting #175 have been approved.

2. Communications

- **LIU-PT Meetings:**
  - Last meeting relevant for LIU-PSB was held the 30th June 2016, available here.
  - There was an open point concerning non-radioactive waste:
    - S. Kleiner presented an overview of the CERN-wide inventory and present issues.
    - A template to be filled by the groups will be provided by mid September.
    - **The inventory will only concern the LIU project**: The LIU project is responsible for checking that LIU equipment have not been forgotten in the equipment group inventory.

- **Cost & Planning Review:**
  - Planned for Fall 2016.
  - The current baseline has been closed the 1st July 2016. **A new baseline is in progress**
  - The LIU management needs updated budget profiles in particular for 2016 and 2017.
  - **The work-package holders are requested to provide updated budget profiles by the end of August.**

- **Linac4-PSB 160 MeV Connection Readiness Review:**
  - Planned for the 30th August 2016.
  - The aim is to derive a comprehensive plan to execute the Linac4 to the PSB connection for 160 MeV operation, if needed.
  - Review all details of the plan to make sure nothing is forgotten and prepare a list of associated risks.

3. Follow-up of Open Actions

- Today the original agenda drafted a review of the EN-STI activities within LIU-PSB project. Nevertheless, the speakers requested to postpone the presentations to a later time, but for the latest results on the thermo-mechanical simulations of the new PSB scrapers/absorbers.

- **All actions assigned to EN-STI have been postponed to September 2016.**
  - A.Perillo on "Find an alternative solution for the vacuum window at the exit of BTM".
  - D. Grenier on "Report about the validation certificates for the LIU-PSB dumps".
  - D. Grenier on "Report about the status of the beam stopper certification for the 160 MeV/2 GeV operations".
  - M. Calviani on "Prepare a document for the specification of the H0/H- dump".
  - As a consequence also the action for K.Hanke and B. Mikulec on "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" will be postponed to September 2016.

- J.Tan/C.Zamantzas 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." → L. Soby reported that the SRR/ECR should be provided **by end July 2016**.

- B. Holzer on "Provide specifications for the wire-scanners." → L. Soby reported that a first draft of the specifications should be provided **by end July 2016**.

- J.Coupard, D.Hay, S.Pittet on "Report which is the work that the TE-EPC Group can carry during the EYETS." → L. De Mallac reported that the TE-EPC should meet on Wednesday 6th July to discuss the activities to do during EYETS.

- K. Hanke/B. Mikulec on "Clarify with all the relevant expert the need for new support for the equipment in the BTP line." → B. Mikulec reported that the needs have been clarified and now the action is in the hand of B. Riffaud. **The action can be closed** and **another one open for B. Riffaud to prepare a solution accommodating the different requests.**

Assigned to	Due date	Description
B.Riffaud	2017-01-30	Provide proposal for the support of the equipment in the BTP line.

4. Cabling Commitment for LIU-PSB during EYETS

- G. M. Georgiev presented the list of priorities for the cabling campaign during EYETS, see here.

- Status of decabling/cabling requests for the PSB:
  - **5765 cables (out of about 12300) have been declared obsolete:**
    - 2860 cables will be removed.
    - 2905 cables will be replaced.
  - **2881 new cables have been requested for installation.**

- **In order to accommodate the maximum number of requests, EN-EL Group plans to work in 2 shifts during the EYETS, including the holiday break and on Saturdays.**

- The planned activities were divided in two blocks:

- **Priority 1 (P1) activities to be performed first.**
- **Priority 2 (P2) activities to be carried during EYETS, if time allows.**

- **Original Planning for P1 Activities:**
  - **Decabling of the cables labeled (and tested as) obsolete during the last shutdown in 2015/2016.**
  - Additional **removal of 484 short cables to replace the electronics of the turn-by-turn BPMs in the PSB rings.**
  - **Installation of 241 new cables, only after decabling:**
    - **Turn-by-turn BPMs in the PSB rings**: 224 cables to be pulled. **P1**
    - **Prototype of the new wire-scanners in period 4 and 11**: 12 cables to be pulled. **P1**
    - **Wide-band BPM in BTP line: 5 cables to be pulled**. **P1**
  - **Timeline: 2.5 weeks working in 2 shifts.**
  - **Cabling of POPS-B between B245 and B271**. This cabling work does not conflict with other activities since it is outside the tunnel.

- **EYETS has been extended by a week, so new requests could be accommodated:**
  - **Watchdog BR.TMD8L1**: 10 cables to be removed and 24 new cables to be pulled. **P1**
  - **BLMs (2 FLAT-ICs per PSB section)**: 96 new cables to be pulled. **P2**
    - **According to the current estimations, only 80% of the new cables could be installed.** If time allows, all cables will be pulled.
    - Theoretically, **68 cables are marked as obsolete but will stay in place as the system is not ready for a complete replacement**. B. Mikulec remarked the importance to keep these cables as a decision to remove the old BLMs is not yet done.

- **Priority 2 Activities. In order of priority:**
  - **BLMs in BI line**: 26 new cables to be pulled. **P2**
  - **Diamond BLMs in the injection region**: 40 new cables to be pulled. **P2**
  - **BLMs in BT-BTM-BTP lines**: 60 new cables to be pulled. **P2**
  - **B. Mikulec mentioned that as for the BLMs in the transfer lines, the old cables should not be removed**. For instance the design of the BLM supports is not yet finalized. G.M. Georgiev confirmed that the cables will not be removed during the EYETS.

- All remaining requests needed for a **complete Linac4 connection will be ready for execution.**
  - **Most of the material should be received before the end of the year and the remaining parts by March 2017.**
  - G.P. Di Giovanni asked if this implies that all cables needed for Linac4 will be purchased this year. **G.M. Georgiev confirmed that the cables will be purchased this year. The money will be transfered to the BC 54253 from the different WU this year.** This concerns the new baseline in preparation for end of August 2016.
  - G.M. Georgiev added that a memorandum will be circulated within the groups requesting work to confirm the list of cables and associated costs.

- **G. M. Georgiev reported he recently received additional urgent requests for installation of few cables from TE-ABT which are not within the LIU project:**
  - **A. Prost requested 4 new cables to be pulled.**
  - **F. Cordobes Dominguez requested 4 new cables to be pulled.**

    - The execution time would be 1 day in 1 shift (1/2 day with 2 shifts).
    - The cabling requests were declared urgent by TE-ABT. On the other hand, **G.M. Georgiev requested a formal assignment to be either a priority 1 or 2.**
    - After the meeting, B. Mikulec contacted the requesters and the **cables are needed for the electro-valves of the septa BESMH, BT1/BT4SMV10 et BTSMV20. The cables provider stopped producing 48V electrovalves used for the septa.** The electrovalves will have to be replaced by the standard types at 220V, implying a change in cables and connectors for compatibility reasons. This year several interventions were done on the septa and, as a result, the spares available for a repair in the current configuration do not allow future changes in case of problems. **These cabling requests are essential for 2017 operation and should therefore be priority 1.** This means that likely less than 80% of the BLMs cables will be pulled (according to the theoretical planning)

- B. Mikulec asked if a formal presentation of the cabling interventions in the PSB has been requested by the IEFC. G.M. Georgiev replied that an official presentation has not been demanded yet.

- G.M. Georgiev mentioned that there are still **issues in recruiting enough people supervising the cabling activities in the PSB tunnel during the whole period.**
    - G.M. Georgiev added that an official call for help to all groups requesting new cables will be sent around.
    - W. Weterings asked what is the role expected of the supervisor. G.M. Georgiev replied that the supervisor needs to make sure that the safety rules are followed and helps with the machine functional positioning of the equipment, since most of the workers will be external contractors.
    - **B. Mikulec asked if it would be enough to provide a supervisor with a phone number or the supervisor presence is requested all the time. The experience from last year showed that most of the time the supervisor presence was not needed. To be clarified.**

5. PSB Beam Scrapers/Absorbers: Thermo-Mechanical Simulations

- I. Lamas Garcia presented the status of the thermo-mechanical simulations for the PSB beam scrapers/absorbers, see here.

- **Introduction:**
    - The increase in beam energy and intensity expected with the LIU-PSB upgrade will lead to potentially more harmful losses and requires mitigation measures including the study of a new collimation/scraping system.
    - Any new PSB scraper/absorber will replace the current window beam scope (WBS) installed in section 8L2.
    - The scraper/absorber will be the major aperture restriction in the machine and should localize the beam losses in Period 8 and limit the activation of the remaining installed machine equipment.
    - Official released documents:
        - Functional Specification: EDMS 1578463.
        - Space Reservation Request: EDMS 1612378.

- Two scenarios analyzed in simulation and presented today:
    - **SCENARIO 1:**

        - Scraping at low energy, **160 MeV**.
        - Beam losses in scraper assumed to **6% of an ISOLDE-type beam**, 2e13 protons per ring.
        - The pulse period is 1.2 s and the losses are integrated over 20 ms yielding 4e11p/ring/s.
        - Beam size: σ_X = 10.81 mm, σ_Y = 12.00 mm.
    - **SCENARIO 2:**
        - **Direct impact at top energy at 1.4 GeV for an ISOLDE-type beam.**
        - Intensity at 2e13 protons per pulse per ring lost within 1 turn (applied during 240 ns).
        - Beam size: σ_X = 5.64 mm, σ_Y = 5.43 mm.

- Thermo-mechanical simulations performed for 2 different absorbing materials:
    - **Graphite (SGLR4550).**
    - **Titanium (Ti6Al4V).**

- **Geometrical assumptions:**
    - **Smaller mask (worst case scenario for the absorber) with a squared aperture of 74 mm for each side. The mask is 130 mm thick. The diameter will be 180 mm with a housing of stainless steel (SS316LN) of 200 mm.**
    - Heat only dissipated via radiation of the surface.
    - **Vacuum tank is assumed to be a black body cavity at room temperature.**
        - W. Weterings commented that such an assumption maybe optimistic and the emissivity of the tank should probably be included in the simulation.

- **SCENARIO 1:**
    - **Results for Graphite (SGLR4550).**
        - Thermal steady state:
            - Maximum temperature reached is about 42 degrees Celsius.
            - **Homogeneous distribution around the location hit by the beam.**
            - The evolution of the maximum temperature during 48 hours of beam operation with ISOLDE assuming 40% of the supercycle is filled shows a plateau reached around 42 degrees Celsius.
        - Thermal transient state:
            - The temperature distributed homogeneously along the area hit by the beam after one pulse reaching a maximum temperature of about 22 degrees Celsius.
            - Additionally the temperature is homogeneously distributed in the mask.
        - Transient structural state:
            - **Equivalent stress after 1 pulse scraped reaches a pressure of 3.13 MPa, which can be considered negligible, and it is mostly located between the Graphite mask and its housing.**
            - **The stress is rather symmetric thanks to the good thermal conductivity of the material.**
            - Equivalent stress after 10 pulse scraped reaches a pressure of 3.17 MPa, which is not very different from the case with 1 pulse:
                - **Thanks to the thermal conductivity of the material the temperature is quickly dissipated inside the Graphite** and before the next pulse arrives the temperature almost reaches its starting temperature baseline.

- **Results for Titanium (Ti6Al4V):**
  - Thermal steady state:
    - **Maximum temperature reached is about 77 degrees Celsius.**
    - The maximum temperature is higher than the Graphite because the energy deposition is higher due to the higher density of Titanium with respect to Graphite.
    - **The temperature increase is localized in the area hit by the beam because if the higher density of the Titanium.**
    - The evolution of the maximum temperature during 48 hours of beam operation with ISOLDE assuming 40% of the supercycle is filled shows a plateau reached around 77 degrees Celsius.
  - Thermal transient state:
    - The temperature distributed homogeneously along the area hit by the beam after one pulse reaching a maximum temperature of about 22 degrees Celsius, compatible with Graphite.
    - The reason for the compatibility between the increase of intensity in the two material is due to the higher energy deposit being compensated by the higher density in Titanium.
    - **The maximum in temperature is nevertheless reached quicker in Titanium than Graphite.**
  - Transient structural state:
    - **Equivalent stress after 1 pulse scraped reaches a pressure of 4.64 MPa and the distribution is less symmetric with respect to Graphite.**
    - Once again most of the stress is located between the mask and the housing.
    - Equivalent stress after 10 pulse scraped reaches a pressure of 6.73 MPa. In this case the temperature is not as quickly dissipated as inside the Graphite before the next pulse arrives. The asymmetry of the stress is even more pronounced after several pulses.
- Comparative measurements for SCENARIO 1 for maximum energy densities at 160 MeV:
  - About 3.5 J/cm^3/pulse for Graphite scrapers.
  - About 7 J/cm^3/pulse for Titanium scrapers.

- **SCENARIO 2:**
  - **The conclusions are qualitatively similar to the results obtained for SCENARIO 1.**
  - **The transient thermal state simulation shows an increase in temperature up to about 26 degrees Celsius for Graphite and about 31 degrees for Titanium.**
  - **The transient thermal stress simulation reports an increase in pressure up to 18 (31) MPa in Graphite and up to 26 (62) MPa in Titanium after 1 (10) direct impact(s) of an ISOLDE beam at 1.4 GeV.**
  - Once again **the temperature distribution looks rather symmetric for Graphite, while clear asymmetries in the distribution can be observed with Titanium.**
  - **B. Mikulec mentioned that, following S. Gilardoni's request, scenario 2 has been updated to 2 GeV to account for a possible future upgrade of ISOLDE**.
    - I. Lamas Garcia replied that the simulation will be then updated. Nevertheless the conclusions will remain very similar.
- Comparative measurements for scenario 2:
  - Maximum energy densities:
    - About 16 J/cm^3/pulse for Titanium scrapers.

        - About 7 J/cm^3/pulse for Graphite scrapers.
    - Energy carried by escaping particles:
        - About 89% for Titanium (1.24 GeV/proton) → about 4.0 kJ/pulse.
        - About 95% for Graphite (1.33 GeV/proton) → about 4.3 kJ/pulse.
        - **Independently from the chosen material, one should check the consequences for the downstream equipment.**
        - B. Mikulec commented that downstream of the PSB absorber, there is one of the main quadrupole magnet, so **the effect of the escaping particles hitting this equipment should be checked with FLUKA simulation as well.**

- **Timeline. Major milestones:**
    - Thermal simulation ongoing.
    - Detailed 3D design to be completed by 07/2017, included integration.
    - ECR to be submitted by 09/2017.
    - Start procurement of raw material and components in 02/2018.
    - Assembly test in 12/2018.
    - Installation and commissioning in LS2 (2019-2020).
    - Ready for operations in 2020.

- **Conclusions:**
    - Given the current results of the thermo-mechanical simulations **EN-STI would recommend the use of Graphite (SGLR4550) as absorbing material.**
    - **Temperatures and stresses reached for both scenarios shown, are well below the mechanical material limits.**
    - Furthermore, the mechanical behavior of Graphite improves with temperature.
    - SGL is a validated CERN supplier of high quality Graphite, as an example used on several BIDs in LHC, with a controlled purification process.
    - **Vacuum acceptance should not represent a problem and the integration of a cooling system can be avoided.**
    - **Simulations should be finalized for the last in the functional specification, SCENARIO 3.**

- R. Froeschl commented that when addressing scenario 3 (LHC-type beam produced by shaving) one should better combine it with scenario 1 for the long term simulation because ISOLDE may request beam while LHC is filling.

- M. Calviani and I. Lamas Garcia commented that Graphite is installed in the LHC complex without major issues:
    - The general guideline is that if the temperature stays below 50 degrees Celsius the material is compliant with operations of vacuum.
    - **W. Weterings mentioned that he recollects the issue with Graphite is with the impossibility to perform standalone bake out with Graphite. W. Weterings also suggested to account for the possibility to bake out the equipment in the final design. * B. Mikulec recommended to complete the simulation of all scenarios. Once the results are available, a meeting will be organized with J. Hansen to discuss the final material choice.**

6. AOB

- **HST:**
    - B. Mikulec mentioned that Linac4 will stop the 100 MeV commissioning today. The RP Group will enter in the tunnel tomorrow at 8.00 a.m. and then the equipment could be dismantled from the girder to start the installation of the HST.
    - **Several issues with connecting the H0/H- monitor inside the BSW4 chamber, but a temporary solution has been found and more permanent solutions will have to be found for the future.**
- Next meeting is scheduled for the 19th July 2016.