

## Minutes PSB Upgrade WG Meeting 22<sup>nd</sup> March 2016

**Participants:** S. Albright, W. Bartmann, E. Benedetto, J. Borburgh, L. De Mallac, J. Devine, G.P. Di Giovanni, V. Forte, R. Froeschl, G.M. Georgiev, G. Guidoboni, M. Haase, K. Hanke, B. Mikulec, S. Moccia, M.M. Morgenstern, A. Newborough, S. Pittet, D. Quartullo, J. Tan.

Agenda (<https://indico.cern.ch/event/509724/>):

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### 1. Approval of Minutes

- The minutes of the last LIU-PSB WG meeting #169, available [here](#), have been approved.

### 2. Communications

- **EN-EL Activities:**
  - After the review with the EN-EL Group, the work-breakdown structure has been re-organized and now J. Devine is the WP-holder for both LV and HV workunits.
- **BSW:**
  - The integration work showed that there is **not enough space to place the transformers in the alcove.**
  - Because of lack of space for the cables and difficulties in reaching the transformers for any future intervention, most likely they will have to be placed somewhere outside the tunnel.
  - **This issue is currently under discussion.** In general the work to place the transformers outside is currently not planned in the budget.
- **B245:**
  - A visit of the building was organized.
  - The work is well advancing and probably an another visit will be planned in the future towards its completion.
  - The allocated budget is currently estimated to be sufficient to complete the building.

### 3. Follow-up of Open Actions

- B. Holzer/J. Tan on "Provide specifications for the wire-scanners." → B. Mikulec provided the information from the OP side for the PSB. A new deadline is needed. J. Tan remarked that the section of the specification which concerns the PSB is almost finished. It was anyway decided to keep the action open in order to finalize the specifications of the wire-scanners for the LIU project.

- M. Haase on "Confirm the requirement for CV about the new RF system and in particular about the C16-RF cavity, which was originally foreseen to run on drinking water for ferrite cavities." → The information have been provided to S. Moccia. **Action Closed**
- F. Boattini on "Confirm the requirements for CV of B245 specified in the EDMS documents 1327071 and 1573184." → F. Boattini provided the updated documents to S. Moccia and a meeting is planned to review once again all the requirements. **Action Closed**
- F. Boattini on "Update the schedule of the powering tests foreseen in B245 for the commissioning." → F. Boattini updated the schedule. The EDMS document containing the planning, available [here](#), has been produced using a proprietary format only accessible with Windows. Moreover the plan should be reviewed with D. Hay and J. Coupard to make sure the requested services will be available. **A presentation will be requested to F. Boattini sometime in June 2016. The action will be closed only after the presentation.**
- During a LIU-PT meeting with the EN-STI Group to review the work needed for LIU (<https://indico.cern.ch/event/495745/>) the issue was raised the status of the specification of the H0/H- Dump, <https://edms.cern.ch/document/1293512/0.2>. B. Mikulec mentioned that crucial information, like how many L4 pulses the dump could take without being damaged, is missing. → **Open action for M. Calviani**

Assigned to	Due date	Description
M. Calviani	2016-04-30	Prepare a document for the specification of the H0/H- dump.

#### 4. MD Planning for LIU-PSB

- E. Benedetto presented the list of planned machine development (MD) for the LIU-PSB project in 2016, see [here](#).
- The aim of the presentation is to give a general overview of the questions that the LIU-PSB MD program has to answer to support the decisions still to be made in the LIU-PSB project.
- **The major questions that need to be answered for LIU-PSB are:**
  - **Produce an LHC-type beams with a longitudinal emittance of 2.8 eVs and a bunch length 220 ns, and transfer them to the PS.**
    - **Highest priority for LIU to ease space-charge requirements at PS injection and meet LIU/HL-LHC parameters.** Last year an emittance of 1.8 eVs with a bunch length of 180 ns was achieved.
    - The MD will aim at investigating the blow-up process and reliability with simulation and measurements.
    - Keep investigating the possibility to produce hollow-bunches.
  - **Measure the brightness curve:**
    - Measurements of 2016 performance and benchmark it with simulation.
    - Emittance as a function of injected parameters (working-point, position/angle, KWS slope, L2 current, etc, etc...).
    - **One of the requirements is to understand the fluctuations at the injection BPMs in the BI line.**

- **Investigate the effect of multipoles on beams:**
  - Building a PSB linear and non-linear optic model.
  - Tune scans for loss-maps, LOCO studies, non-linear chromaticity and detuning with amplitude, effect of the half-integer and of the integer on beam.
- **Perform turn-by-turn beam position measurements:**
  - **BTMS commissioning is one of the highest priorities.** Weekly MD sessions already started.
  - AC dipole excitation or Qmeter kicker to characterize the machine, tune ripples, instabilities at 160 MeV.
  - **The full resonance driving terms analysis requires the whole BTMS ready.**
- **Study tail re-population:**
  - For shaved and large emittance (i.e. scraped) beams and validation with simulation.
- **Investigate the instability at C378:**
  - The beam kinetic energy is about 160 MeV.
  - Foresee a study as a function of bunch intensity, bunch length, chromaticity.
  - Record intra-bunch motion with TFB BPM.
  - Validate with simulations.
- **Measure recombination kickers rise time:**
  - **Limitations in bunch length transfer to assess the possibility to transfer a bunch long 220 ns.**
  - **Produce short bunches (long about 10 ns) to probe kicker function.**
  - Inject and dump at 50 MeV and measure risetime using microbunches from the Linac at 200 MHz.
- Concerning the longitudinal studies the additional main directions to cover are:
  - Finemet Reliability Run Studies.
  - Investigate if the operational phase pick-up in 14L4 can be replaced by the phase pick-up in 8L1 for all 4 rings.
  - Investigate methods of measuring the relative phase between C02 and C04 cavities
  - Development/Upgrade of low-level RF.
  - Transverse feedback to test the new digital processing at 160 MeV and at 1.4 GeV.
- Additional studies in the PSB Transfer line involve:
  - Extraction and dump at 160 MeV to check if this could be done for L4 connection commissioning start-up.
  - Validate the simulation for the possible optics changes in the BTM line.
  - BTY optics model validation.
- Beam instrumentation related MD are:
  - Understand the current fluctuations in the injection PUs at the end of the BI line.
  - Measure the energy and energy spread in the injection line via measurements of the time-of-flight of the beam. This MD opens the possibility to optimize the Linac2 debuncher setting.
  - Emittance measurements with the wire scanners along the cycle.
  - Review of the extraction SEM grids: Comparison with wire scanners and review of the optics model.
  - Emittance difference evaluation with different calibration curves obtained in laboratory and with online calibration.



		control racks EN-CV
WU 126816 (Injection)/91573 (2 GeV): Corrector Powering	General strategy to install all power converters to be confirmed. If installed, there will be implications in others WUs (MaxiDisCap/mechanical integration). FGC 3 electronics has to be ready and tested by October 2016. All power chassis to be tested before installation.	EN-EL New false floor structure To be confirmed if WIC is necessary
WU 158193: Booster Injection Quadrupoles Power Converters	Supporting structure. Power converters only if the new magnets and the WIC are also installed.	Integration Supporting structure EN-EL Gateways, starpoints, control racks
WU 91570: Booster MPS	B245: installation of MPS configuration switch (Nov 2016).	Handling EN-HE-HH
WU 91570: Booster MPS	B271: installation of MPS selection switch (Jan 2017).	Handling EN-HE-HH
WU 91570: Booster MPS	Cabling between B245 and B271.	Cabling EN-EL-FC Cable ladders EN-EL-ENP

- Depending on magnet, cables and WIC availability, the work on BI.BVT converters installation and commissioning could be carried out during the EYETS.
- The work on correctors and quadrupoles installation and commissioning cannot be decoupled.
- All the work-units concerning LIU are listed in [http://te-epc-lpc.web.cern.ch/te-epc-lpc/machines/liu-booster/booster\\_injection.stm](http://te-epc-lpc.web.cern.ch/te-epc-lpc/machines/liu-booster/booster_injection.stm).
- **K. Hanke and B. Mikulec commented that it is very difficult to understand which is the work that can be done or not because it depends on the coordination of several activities.**
  - **The TE-EPC group should discuss with the responsible from magnets, WIC and coordinate with D. Hay and J. Coupard to check which work can fit in the EYETS schedule.**
  - **A follow up of the work that could be done should be presented in one of the upcoming LIU-PSB meetings. → Open Action**
- K. Hanke iterated that all the work that can be advanced should be done, provided it fits in the overall planning.
- J. Coupard added that the integration should be completed first.

Assigned to	Due date	Description
J.Coupard, D.Hay, S.Pittet	2016-04-30	Report which is the work that the TE-EPC Group can carry during the EYETS.

## 6. PSB-PS Magnets Specifications Update

- W. Bartmann presented an update about the PSB-PS magnet specifications for the LIU, see [here](#).
- The talk aimed at describing the existing specifications and included a proposal for a **distinction between LHC and HI beams**.
- **Up to now high-intensity (HI) beams have been used to define the good-field-region (GFR) and LHC beam requirements to define the field homogeneity.**
- The field homogeneity which has been always assumed is of  $1e-4$  rms, which implies a maximum value of  $\pm 2e-4$ .
- The proposal is to **distinguish field quality depending on the beam type**.
  - **Use the field homogeneity requirement only for LHC beam size: the goal is to optimize LHC-type beams for emittance growth.**
  - **Accept higher field inhomogeneities for HI beams as long as they fit into the acceptance: The goal is to optimize HI-type beams for losses, and not emittance growth.**
- B. Mikulec pointed out that a recent development of the Multi-Turn-Extraction beam, which is a HI-type beam, is to have small vertical emittance, of the order of  $4 \mu\text{m}$ , and actually control the emittance growth. The reason is an aperture restriction in the vertical plane in the SPS. → **W. Bartmann replied that he could check the emittance growth of the MTE-type beam. → Open Action**
- **LHC-type beams:**
  - Main focus is to minimize emittance growth.
  - The setting for LHC-type beam is fine, as agreed in review on 24<sup>th</sup> September 2015, see [here](#).
  - The assumption made were to have balances random errors in both planes:
    - Many small/medium error sources in vertical plane.
    - One strong error source in horizontal plane.
- **HI-type beams:**
  - The integral of  $\Delta B/B$  for the large GFR is allowed to be  $5e-4$  rms (maximum value at  $\pm 1e-3$ ) for both BT.BHZ10 and BT.BVT10/20.
  - Together with other recombination error sources leads to steering error of 0.4 (horizontal) and 1.6 mm (vertical). The values found are compatible to the assumed orbit tolerance of 1.5 mm in the PS ring (due to the bump).
  - The aperture bottleneck at PS injection when bump is fully on (collapses after 500 turns) is 33 mm radial aperture.
    - For the acceptance calculation:
      - 2 mm for alignment errors are subtracted.
      - 3 mm for the orbit already included in beam size.
    - **Fit 3.3 sigma horizontally of HI beam at 1.4 GeV (worse case scenario)**. This is generally higher than the standard 3.0 sigma required.

- **The bottleneck would be also in the vertical plane, but the new septum will have increased vertical aperture and 4.1 sigma could fit in the acceptance.**
  - **The beam size changes by 0.8% due to optics mismatch after filamentation has taken place.**
  - **Most of the acceptance reduction comes from mis-steering errors due to optics mismatches, more than emittance growth.**
- The horizontal/vertical emittances assumed in the calculations are:
    - HIE-ISOLDE: 13/6  $\mu\text{m}$ .
    - HI (PS): 10/5  $\mu\text{m}$ .
    - LHC: 2/2  $\mu\text{m}$ .
  - The horizontal/vertical GFR are:
    - **BT.BHZ10:**
      - HIE-ISOLDE: +/- 51.5/51.5 mm.
      - LHC: +/- 19/21 mm.
    - **BT.BVT10:**
      - HIE-ISOLDE: +/- 26/16 mm.
      - LHC: +/- 12/10 mm.
    - **BT.BVT20:**
      - HIE-ISOLDE: +/- 48/15 mm.
      - LHC: +/- 21/10 mm.
  - If the new specification is agreed upon, the specification table in magnet design reports should be updated.
  - Also it would be good to add tolerances for as-built and as-measured.
  - E. Benedetto asked which is the  $\Delta p/p$  assumed:
    - **W. Bartmann replied that he used the value, provided by G. Rumolo, of 1.07e-3 for LHC beam and 1.35e-3 for HI beam.**
    - E. Benedetto mentioned that **for LIU the target would be an higher  $\Delta p/p$ . K. Hanke asked to make sure with G. Rumolo about the correctness of the used inputs. → Open Action**
  - A. Newborough commented that the requirement seems fine for BT.BHZ10. The TE-MSG Group would need some more time to assess if the requirements are fine for BT.BVT10/20 as well.

Assigned to	Due date	Description
W.Bartmann	2016-07-30	Report about the emittance growth of the MTE-type beam in the framework of LIU project.

Assigned to	Due date	Description
G.Rumolo	2016-04-03	Clarify the value of $\Delta p/p$ which should be used in the LIU-PSB related simulations.

## **7. AOB**

- The next meeting is planned for the 5<sup>th</sup> April 2016.
- J. Borburgh reported that he prepared a safety file for the PSB extraction are. Some information from the TE-EPC Group are missing and could only be provided by the end of the year. K. Hanke mentioned that in general there is some confusion about the status of the safety files and I. Kobzeva will be invited to present in one of the upcoming LIU-PSB meeting.
- G. M. Georgiev reported that, in view of a possible Linac4 connection at the end of 2016, the complete list of the cable requests should be provided by end March 2016 to the LIU management. K. Hanke proposed to present few slides about the status of the requests at the next LIU-PSB meeting.