

Minutes PSB Upgrade WG Meeting 27th August 2015

Participants: O. Berrig, T. Birtwistle, C.Bracco, G.P. Di Giovanni, A. Findlay, V. Forte, R. Froeschl, G.M. Georgiev, M. Haase, K. Hanke, D. Hay, S. Moccia, A. Newborough, S. Pittet, G. Rumolo, W. Weterings.

Agenda (<https://indico.cern.ch/event/440809/>):

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1. Approval of Minutes

- The minutes of the last LIU-PSB WG meeting #155, available [here](#), have been approved.

2. Communications

- **No LIU-PT meeting this morning**
- **LIU-PSB Budget:**
 - The spending is currently at 45% of the allocated money. If a similar trend is kept for the upcoming months, the expected percentage at the end of the year will be of the order of 60%. The WP-holders are invited to make sure the requested money are indeed spent for their respective WP.
- **B245:**
 - The work is progressing well.
 - A. Lopez-Hernandez will report about the progress during the LIU-PSB meeting to be held the 17th September 2015.

3. Follow-up of Open Actions

- All WP-holders are reminded to verify that their group requests for EN-EL have been propagated to G.M. Georgiev.
- A. Findlay on "Make sure that the ECR to clean-up the PSB from the unused pick-ups for is submitted." → A. Findlay reported that the work is ongoing, but it will require an extension of the currently expired deadline.
- D. Aguglia on "Approve document with the functional specifications of the rack space for both the LIU-PSB and the Half-Sector Test in Linac4 addressing the open issues from v0.2." → D. Aguglia was not present at the meeting, but he informed via email that the document should be completed for the beginning of September.
- M. Haase on "Check the integration with G.M. Georgiev and D. Hay and verify the feasibility of the proposed racks layout of the Finement cavities. → M. Haase agreed to present few slides about the final rack layout for Finemet cavities during the next scheduled meeting (3rd September). The action will be closed after the layout has been reviewed and approved in one of the LIU-PSB WG meetings.

4. Requests to EN-EL for LIU-PSB

- G. M. Georgiev showed an updated version of his [Excel file](#).
- Almost all the requests have been received.
- **Couple of missing requests from S. Pittet**, who is working on them, and will shortly provide the needed information.
- **The major missing information is about the rack requests for the WIC system**, as the discussion to finalize the **design is still ongoing**. Nevertheless, a preliminary DIC was submitted and it could be used to start the work.

5. Discussion about the ECR PSB-LJ-EC-0001

- The ECR is available at <https://edms.cern.ch/document/1494503/0.1>.
- Several comments have been received. K. Hanke remarked that the ECR should have also been submitted to all the WP-holders.
- Among the several comments received, **O. Berrig rejected the document** with the following comment:

It has lately been understood, that the betafuncions at the last two pickups in the BI injection line are enormous: https://espace.cern.ch/be-dep/ABP/HSC/Meetings/Fluctuations_on_last_two_pickups_in_BI_injectionline.pptx

The betafuncions are extremely difficult to regulate correctly, basically because there is a design error in the BI injections line - dating from the construction of BI line many decades ago.

We should therefore make a completely new redesign of the BI-line.

- O. Berrig presented few slides about a new proposal for changing the optics of the BI line, see [here](#):
 - Position fluctuations (vertically) in the last two pickups of the BI line have been observed since the beginning of the year:
 - Some measurements indicate that the fluctuations are proportional to the square root of the beta functions. However, some measurements disagree.
 - The fluctuations are not transported down the line according to the optics transport matrix.
 - **One hypothesis is that the fluctuations are caused by an asymmetric transverse distributions that vary from beam to beam and are amplified by the beta functions. The hypothesis also assumes that for the last two pickups the vertical beta functions are greater than what predicted by the MADX model. This may indicate that we do not understand the optics at the end of the BI line.**
- These fluctuations seems to come from the beam and not related to the electronics, cables or any technical feature:
 - Through several tests, the electronics and the cabling of the BPMs seem to work well.
 - Fluctuations within the BPM readings seem to be correlated to a common source. **And the only common source for the BPMs is the beam.**
- In the current BI line, the doublet structure BI.QNO30 and BI.QNO40 is separated from the doublet structure BI.QNO50 and BI.QNO60 by a **long drift**.

- The doublet structure is very good in reducing the beta functions as a small beam size is needed at the septum, BI.SMV10, and at the BI.BVT10 where there are aperture restrictions.
- **When there is a drift the beta function grows in a parabolic way.** The minimum is to be reached at the septum.
- **The settings of the quadrupole are to be regulated precisely, because any error may change the shape of the beta function quite significantly. As said a possible explanation for the current vertical fluctuations is that vertical beta function is in fact quite large in the area of the last two BPMs, while the optics MADX model predicts it to be of the order of 30 m (one should also remember that the MADX simulation does not include space-charge effects).**
- A better understanding of the optics at the end of the BI line is needed:
 - A sensitivity study of the beta-function at BI.QNO60 as function of the strength of BI.QNO40 showed that **by changing the strengths of BI.QNO40 of 10% one can have a beta-function in the vertical plane as high as 200 m**, which could explain the current fluctuation in the last two BPMs.
 - Another source of error could come from the pole face angles of the BI.DIS, BI.SMV10 and BI. BVT10 in the MADX model. If they are not accurate, then the effect will be felt essentially only in the vertical plane and the current estimation of the vertical beta function may be incorrect.
 - **The beam has to arrive to the BI.DIS with an offset of 5.2 mm and this is obtained with a first kick from the BI.DVT30 and in turns using to the quadrupole magnets BI.QNO30 and BI.QNO40.**
 - The BI.QNO30 is a type QF quadrupole, it is de-focusing in the vertical plane. BI.QNO40 is type QD, i.e. focusing in the vertical plane.
 - **Since BI.QNO30 and BI.QNO40 are used to set the offset before the distributor, their strengths are basically locked and one loses two degrees of freedom.** In fact they cannot be used to regulate the beta functions around the SMV10.
 - **Maybe this is not an optimal design:**
 - C. Bracco commented that the solution of creating a bump with quadrupole magnets is quite standard. Probably the reason was due to a lack of strength in the BI.DVT30 to reach the desired offset.
- **New proposed layout:**
 - Add a new defocusing (in vertical plane) quadrupole somewhere between BI.QNO20 and BI.QNO30. Same type as BI.QNO30 and BI.QNO40.
 - **Move BI.DVT30 in front of the distributor, while shifting BI.QNO30 and BI.QNO40 upstream. Increase the distance between the quadrupoles and change their polarities. So one can vary them freely.**
 - **Remove BI.DVT40 and add instead a new de-focusing (in vertical plane) quadrupole in the place of the vacuum pump. The quadrupole is vertically displaced, so it will work as a dipole, replacing the BI.DVT40 functionality.**
 - C. Bracco asked how it would be possible to enter straight at the BI.DIS. → **O. Berrig replied that it is not needed for the beam to enter straight at the BI.DIS. It can come with an angle, then the BI.DIS will kick the beam down and the kick from the quadrupole replacing BI.DVT40 will steer the beam to a straight line.**
- As a separate issue, it was found that the measured horizontal dispersion has opposite sign for the present LT/LTB/BI lines with respect to the MADX convention. **The sign of the BPM conventions in the horizontal plane for LT/LTB/BI line should be inverted.**

- All four BI lines ends with different dispersions. The BOOSTER and the present BI line design have dispersion mismatch (theoretically):
 - As an example, at the end of the BI line 1 $DISP1=0.18$ and $DISP2=0.12$, while they should have been $DISP1=-1.5$ and $DISP2=0$.
 - **K. Hanke commented that the dispersion at the end of the BI line was in fact constructed to be as achromatic as possible, to increase the multiturn injection efficiency and fight against the aperture restriction at the PSB injection septum, so it should stay like this.** Probably this assumption could be revised for the LIU-PSB as there will an H^- injection and there will not be the bottleneck of the septum.
- Some additional recommendation would be:
 - Continue the MD program with the extended kick/response method (i.e. including changing the strengths of the quadrupoles); in order to understand the optics of the last part of the BI line (BOOSTER injection). This should tell us if the model of the BI.DIS/SMV10/BVT10 is wrong or the problem is in the large distance between the pickups.
 - Further study the measurements done by the BI group, and try to understand what features of the beam could create these effects. Possibly new MDs.
 - Verify apertures of the upgrade of the BI line. Do we have enough flexibility to reduce the beta functions where there are aperture limitations? Do we have blown-up beta functions that will create new aperture restrictions?
 - Verify survey of the upgrade of the BI line; especially the 5.2 mm offset and also the levels of the 4 BOOSTER rings.
 - W. Weterings commented that the 5.2 mm offset is only needed to make sure that the beam in ring 3 comes back at the center and he does not understand why a survey is needed. → O. Berrig replied he meant that since BI.QNO30 and BI.QNO40 are needed for the bump and this bump is very delicate, one needs to make sure that the offset is indeed at 5.2 mm.
 - Continue meeting with all interested parties, to talk about changes to the design of the LT/LTB/BI lines.
 - Take action to use the same sign convention in the LT/LTB/BI lines as everywhere else in CERN and compatible with MADX.
 - Write a dedicated program (replacing YASP) to control the injection into the BOOSTER. This program should be able to change the strengths of the BI.DIS, quadrupoles, SMV10, BVT10 and correctors.
- The statement is that **it would be not possible to guarantee that the beam will fit within the apertures of the proposed upgrade, unless the optics is better understood.**

DISCUSSION:

- **K. Hanke commented that the new proposed layout seems a good idea indeed, but unfortunately it comes quite late in time. The baseline design of the optics of the PSB injection line has been frozen. Several groups have already started purchasing components. Moreover the LIU-PSB group has a mandate to be ready for a possible Linac4 connection at the end of 2016. The current ECR should not be stopped because of this.**
- K. Hanke asked C. Bracco if there is any major problem with the aperture for the injection into the LIU-PSB. **C. Bracco replied that the aperture model has been extensively reviewed and of course there are the usual bottlenecks. But the optics have been tuned to minimize the beam in the regions where there are the aperture restrictions. So far, including all the errors and safety margins there is no major showstopper.**

- **A. Newborough added that if needed few more magnets (correctors/quadrupoles) could be purchased** as the process is still ongoing. Moreover as they are meant to work at both 50 and 160 MeV, **the available gradient is increased as well as their field quality. Another solution could be to create the straight offset at 5.2 mm with two correctors and then displace the quadrupole vertically and use them to change freely the beta function.**
- **The ECR will be canceled in order to take several other comments into account. When the ECR is re-issued, it will not be rejected by O.Berrig, but he will flag it as seen with the comment: "Based on the lack of understanding of the BI injection, I believe that it cannot be guaranteed that the beam can be injected into the BOOSTER".**

6. Results from the LV Measurement Campaign

- J. Devine presented the results from the LV measurement campaign, see [here](#).
- Currently there are 3 main projects within the EN-EL group inter-related and centered around the LIU-PSB:
 - B245 for the new MPS, POPS-B.
 - ME25 substation which is currently the power source for the PSB.
 - LV Upgrade for the refurbishment of power converters and switchboards.
- Each projects has an impact on the others, so the coordination is done within the EN-EL group. All the bits of work are planned up until the end of RUN4.
- **B245:**
 - The new B245 will host the new MPS and the new LV substation [ME25C](#).
 - At the moment **the PSB does not have its own dedicated UPS provision.**
 - **This will be added in B245**, with the goal to eventually have a fully redundant system to supply the PSB as a unit, rather than sharing it with other services. K. Hanke asked what the UPS is supposed to supply → J. Devine replied that typically it is for PLC and control elements.
 - The electrical network of B245 is divided in 3 main parts:
 - High voltage for Power Converters, Cooling & Ventilation.
 - ESD for the security system.
 - General Services.
 - In summary:
 - Work will be done on the ESD loads (smoke clearance from CV).
 - Work on the UPS loads and autonomy confirmation.
 - The naming of EBD1/2*25C will have to be confirmed.
 - A detailed electrical design will be done for:
 - Lighting.
 - Small Power.
 - Auxiliary 400 V Circuits.
 - **The budget is to be determined as a function of the above.**
 - **The current schedule foresees the installation works to be completed for start of LS2.**
- **RUN2 48V dc System Upgrade:**
 - **This is an internal system to EL ensure safety.**
 - If there is a failure on the 48V system, it will fail safely.
 - **Some additional space is needed and this work will be carried on during the YETS.**
 - In the long term there is a plan to free more space for the ME25 Upgrade.
- **Booster LV + LIU Upgrade:**

- **Ideally EN-EL would like to separate users for the LV supply.** It is not convenient from the management point of view to share switchboards across systems. Of course, this is not always possible.
- The system for power converters will stay.
- The system for the new POPS-B will be added to the general services.
- Some machine racks will be separated from the main switchboard.
- A dedicated slice will be there for cooling and ventilation.
- ERD1 for power converters and RF will be separated from the B245.
- Three switchboards for the racks, flagged as obsolete, will be replaced by the end of the YETS. **There will be a new architecture based on the measurement campaign.**
- General services and the safety network (ESD) need some major change, moving from one switchboard to having three, one located in B245. **For the moment this work is not being scheduled and the EN-EL group will do their best to fit it outside any stopping period.**
- **Conclusions:**
 - Significant changes to the single line diagram.
 - Enhanced separation of loads by function/user.
 - Interaction with ME25 modifications.
 - **More than 70% of major user requirements identified**
 - Detailed planning coordination required with EL-CF and users.
- **Measurement campaign (EDMS document 1514166):**
 - Load on **ERD1*25** which supplies the machine network ME25 (55% Power Converters/45% RF):
 - The maximum load measured was about 1500 A, while the maximum foreseen load is about 3200 A.
 - **No possible concern with this switchboard. No major changes foreseen to the distribution.**
 - Load on **EBD1*25** which supplies General Services ME25 (50% Cooling 15% Infrastructure 35% Rack Power)
 - The maximum load measured was about 1600 A, while the maximum foreseen load is about 3200 A.
 - Nevertheless, **the architecture for supplying the rack will be changed to rationalize better the distribution, based on the feedback from the measurement.**
 - Conclusion:
 - **Switchboards currently loaded to 50%.**
 - **First priority is to take care of the ERD and then move to the General services (lighting power, socket outputs, etc, etc).**
 - EBD1.05 and 1.12 supply rack loads, significant spare capacity can be used to meet 30% power increase request.
 - ERD switchboards will continue to be supplied from General Services network.
 - **Enough power capacity cross checked with consumption data.**
 - **Redesign of the architecture to optimize the loads.**
- Next stages:
 - Detailed design of new switchboards (Based on new and existing circuit requirements from users).
 - Space requirements based on switchboard sizes, SRR.
 - Proposal for replacement of AC power distribution infrastructure:

- Overhead distribution to free up space in false floor.
 - Installation independent of cable cleaning campaigns.
 - Requires agreement with users (TE/EPC) for cable routing.
 - Integration within 3D models as the next stage.
- K. Hanke asked about more information about the source of the budget for the presented work → **J. Devine replied that the budget will have to be shared between consolidation and LIU-PSB.** Nevertheless, K. Hanke reminded J. Devine to **respect the cost-to-completion of the current EN-EL budget.**

7. AOB

- The next meeting is tentatively scheduled for the 3rd September 2015.
- W. Weterings reported about a current issue with the ECR for BI.DIS10 (<https://edms.cern.ch/document/1518483/0.1>), where it seems that the adjacent equipment will not be using standard racks, but ones with larger doors as the ones needed for BI.DIS10. Lot of care has to be taken such that people could still open all the doors when the racks are installed.
- A. Findlay reported that work is ongoing for the preparation of the Finemet review.
- D. Hay reported that work is ongoing to clean up the area in BRF2/BAT, mostly done by the BI group, for the 3D scan of the surface. The EPC group should be ready to clean up by next week.
- D. Hay reported that the cost estimation for the work to be done in BRF2/BAT is available. K. Hanke took the occasion to thank S. Pittet for having agreed on charging the expenses on the EPC budget codes.
- S. Moccia reported that he is preparing all the documents needed for the budget of the consolidation work of CV.
- C. Bracco reported that she is currently working on checking the requested precision for the synchronization of the injection kickers and BSWs.
- S. Pittet reported that several functional specifications are being prepared by the EPC group and will be submitted soon.
- R. Froeschl reported that a note to evaluate the **activation of the stripping foil has been released** (<https://edms.cern.ch/document/1513752/1>). It will be circulated among the LIU-PSB WG group. **The estimate for the committed effective dose due to inhalation is 25mSv and for the committed effective dose due to ingestion it is 17mSv. These values are well above the limits for radiation workers as well as above the annual individual dose objective. Therefore protective measures are required to avoid the intake of a foil by the intervening personnel.**