Summary of the 2nd LIU-PSB/PS Meeting

Held on Tuesday 1st November 2016

*Agenda (*https://indico.cern.ch/event/579776*)*

1. *Approval of Minutes and follow-up of the previous meeting*
2. *Communications*
3. *PSB RF Bypasses*
4. *PS RF Bypasses*
5. *Plans for the New PSB B-Train during EYETS and BT.BHZ10 BTrain Option*
6. *Status of the LLRF for the New PS B-Train System*
7. *AOB*

PRESENT: S. Albright, M.E. Angoletta, E. Benedetto, Y. Beraud, O. Berrig, T. Birtwistle, F. Boattini, J.-P. Burnet, M. Buzio, H. Damerau, L. De Mallac, G.P. Di Giovanni, J. Double, A. Findlay, R. Froeschl, G. M. Georgiev, M. Gouber-Pace, K. Hanke, J. Hansen, P. Lelong, S. Mataguez, D. Perrelet, D. Quartullo, J.L. Sanchez-Alvarez, F. Sperati, G. Sterbini, J. Tan, F. Tecker.

1. Approval of Minutes and follow-up of the previous meeting

K. Hanke chaired the LIU-PSB/PS joint meeting. The approval of the minutes and the follow up of the actions will be covered in the LIU-PSB and PS meetings.

2. Communications

LIU and HL-LHC Cost & Schedule Review:

- The meeting was held the 17th-19th October, see https://indico.cern.ch/event/542864/.
- The LIU project was well received by the reviewers
- Thanks to both working groups for their contribution to the success of the review.

3. PSB RF Bypasses

- A. Blas presented the status of the RF bypasses for the LIU-PSB, see here.

- The RF bypasses for the PSB cover two main areas:
  - **The injection line.**
  - **The PSB rings.**

- **Injection Line:**
  - The standard collars used inside the ring cannot be used for the injection line, so a new design was needed.
  - The design foresees redundant mechanical fixes for the collars, as well as an easy procedure to exchange them:
    - Fundamental part of the design as the injection line is generally a radioactive area and the operations in this area should be minimized.
  - For this purpose, 24 new collars including 76 new RF-bridges are presently under production. **They should be ready by the end of January 2017.**
    - **K. Hanke** asked if the new RF bypasses could be installed during the EYETS. **A. Blas** replied that **the collars will be ready for an early Linac4 connection and will be installed only at the time of the connection**
  - It will then require 20 man-days on the RF side for installation work and tests.

- **PSB ring:**
  - The collars are made of isolated material. A metallic conductive paint is to be applied.
  - Generally, the ceramic boards break quite often.
  - Until today F. Chapuis (BE-OP-PSB) took care of measuring the RF bypasses in the PSB.
  - **The original request was to be able to sustain the passage of a beam with 2.5E13 protons-per-ring (ppr).**
  - Under this assumptions:
    - For the 4 PSB rings, 128 special vacuum collars should be installed downstream the bendings.
      - About 100 spares without metallic paint and R-C circuit (handled by TE-VSC and P. Demarest) are currently available.
    - About 500 new ceramic circuits should be ordered.
  - **The updated baseline foresees 1.6E13 ppr:**
    - **K. Hanke** remarked that the specification of 2.5E13 ppr was assumed at the time of the design of the beam dump, to make sure that the dump could be design with enough margin for the future.
  - The RF bypasses have to deal with:
    - I_{beam} = 31 A with 1.6E13 ppr.
  - **For the resistor, the specification is to have 0.5 Ohm resistor, as presently installed.**
  - The RF bypasses should sustain:
    - **0.5 W in continuous mode. The RF bypasses presently mounted can sustain 1W.**

        - **The resistor will have to sustain 1150 W in pulsed mode (48 A and 24 V, peak current and voltage for 2.5E13 ppr with a bunch length of 180 ns).**
    - The dimensions of any new RF bypass should be compatible with present setup.
    - **The specifications for the present resistors are unknown.**
        - **In the market resistors meeting the specification required are available.**
        - An example is the pulse proof thick film chip resistor from Vishay.
            - **J. Bent successfully tested the chip in the PS with a peak current of 100 A.**

- **In conclusions:**
    - **Given the lower specified intensity of 1.6E13 ppr, it is proposed to first test the current existing RF bypasses in the PS to check if they can sustain the current required by the LIU.**
        - The PSB RF bypasses will be installed during the EYETS in the PS machine.
        - If the test is successful, a full exchange of the RF bypasses is not needed.
        - If it is not the case, **resistors are available in the market which could meet the required specifications.**
            - **About 500 new ceramic boards will have to be ordered.**
            - **About 50 man-days of work will have to be invested in upgrade of the PSB rings. The estimation does not include work which may be required from the TE-VSC Group.**
                - The work could be advanced whenever necessary.

- **K. Hanke** asked if the expenses for the RF bypasses are budgeted in the LIU-PSB Baseline.
    - **A. Blas replied that this work is not budgeted in. So far the expenses have been covered with the budget allocated for the transverse damper.**
    - **K. Hanke** proposed to wait for the results of the measurement to decide on the budget and try to find the additional resources (LIU or CONS) to cover the expenses.
      → **Open Action in LIU-PSB**
- **J. Hansen** asked if there are contact problems if the contact surface is not polished. **A. Blas** explained that no problem is expected since the new bypass uses a different principle.

4. PS RF Bypasses

H. Damerau presented the PS RF Bypasses status, see here.

Differently from the PSB there are no activities foreseen for LIU PS. The presentation described the present status.

To avoid current loops induced by the main magnet ramp (2.3 T/s) the PS vacuum chambers are isolated by ~200 flanges. On the other hand, to reduce the coupling impedance seen by the beam each flange as to guarantee electrical continuity in the frequency range of the beam induced current. For this reason, RF bypasses are used. This allows to reduce from 40 to 1 Ohm the coupling impedance at 1 MHz.

The PS RF bypasses consist of two topologies:

1. Damped coupling capacitors. Out of the ~155 installed the majority (~150) has a renovated circuitry. The ~5 non-renovated ones are referred as 'pince type' bypasses.
2. Short circuit bypass (~45 installed).

During each YETS, the PS RF bypasses are checked by **J. Bento** (BE-RF-FB).
One critical point of topology 1 is the average and peak power on the circuit components. With typical TOF beams the induced voltage can go beyond 100 V with peak power of 27 W but average power in the cycle below 10 W. The most demanding beam in terms of average power is, for the moment, the high intensity SPS Fixed Target (~10 W).

A summary table with the LIU beams and future beams scenario was presented concluding that the present RF bypasses are expected to be compatible with the LHC-type beams after the LIU upgrades. In term of reliability no resistor failure was observed since 2009. The SS48 vacuum leak in 2016 was mostly due to a bad contact of the old 'pince type' bypass. An additional series of spares is in production and, possibly, new bypasses can be considered for higher-intensity fixed target beams.

5. Plans for the New PSB B-Train during EYETS and BT.BHZ10 BTrain Option

- M. Buzio presented the plans for PSB B-Train during the upcoming EYETS (2016/2017) and the proposal for the field control of the BT.BHZ10, see here.

5.1 Status of the new FIRESTORM B-Train

- The renovation of PS, SPS, LEIR and AD B-trains was approved and budgeted in July 2016 as a Consolidation Work Unit.
- Feedback of new system to RF and POPS (in PPM mode) are in preparation for the PS.
- **PSB system: The final routing of the high-current leads above the reference magnet in B265 has to be discussed/agreed with TE-EPC.**
- The functional specification are currently documented in (EDMS 1685695) and are being finalized. **Several topics are still under discussion.**

5.2 B-Train Plans during the EYETS (2016/2017)

- **The proposal is to install a FIRESTORM B-train prototype for the PSB:**

- In order to perform the installation of the prototype, **rack space is needed:**
  - Racks 373 and 375 are available:
    - There is a module, a Philips PM6654 high resolution time counter, which seems un-used. **The proposal is to remove it. K. Hanke asked M. Buzio to provide the information to D. Hay who in turn will check if the module can be safely removed. → Open Action in LIU-PSB**
  - Half of the rack 376 is empty. **The request would be to use for the prototype installation as well. K. Hanke asked M. Buzio to provide the information to D. Hay. → Open Action in LIU-PSB**

- **Reference Magnet. The proposal is:**
  - Do not modify ring3.
  - **Install an integral coil, two short coils for fringe and centre field measurements, as well as two NMR markers and a probe in ring 4.**
  - **Install an integral coil and two FMR markers in ring 2.**
  - **Keep the short coil in ring 1 as a spare for ring 4.**
- **Cabling work is needed** :
  - **11 new cables are required to be pulled from to B361-1-018 to the rack 373.** If possible, **pull these under the false floor after de-cabling intervention.**
  - **Additional cables, outside the reference magnet enclosure, are needed.**
  - **Klaus Hanke** commented that this is a quite late request. Moreover there could be constraints in lifting the false floor. **He proposed to M. Buzio to urgently prepare a DIC and send it to G.M. Georgiev. → Open Action in LIU-PSB**

- **Proposed tests before the end of the year**
  - **Requiring beam:**
    - Unplug supposedly unused sensors during operation. Time estimated: 1 hour.
    - Split existing coil cables, try operation with simultaneous input to existing B-train and additional DAQ.
    - **K. Hanke and G.P. Di Giovanni** recommended to request official MD time for similar tests. As perturbation could be expected it would be important to request them as dedicated MD. → **Open Action in LIU-PSB**
  - **Without beam**, but with the **magnet cycling:**
    - Check of the existing sensor outputs, signal and noise level.
    - Interventions during the shutdown, requiring removal of the protection covers on the magnet:
      - Check the existing signal cables under false floor.
      - Check position and clearance of existing sensors.
      - Installation of new mechanical supports, sensors and cables.
      - Installation and cabling of rack electronics (may be completed during the 2017 run).
      - **K. Hanke urged M. Buzio to send all the information to D. Hay and J. Coupard so that the tests could be scheduled in for the EYETS.** It is important to remark that the planning for EYETS is rather tight

already. Moreover it is not obvious that intervention requiring lifting the false floor or pulsing magnets could be performed at any time or at all. → **Open Action in LIU-PSB**

5.3 BT.BHZ10 Field Control

- The BT.BHZ10 the dipole allows switching destination ISOLDE/DUMP or PS.
- For LIU-PSB one magnet will be installed and another one prepared as a spare:
  - The call for tender is about be placed and the vacuum chamber design is being finalized.

- Cycling conditions:
  - **Random switching between +/-1.4 GeV and +/-2.0 GeV.**
  - **The rise time and the plateau are 0.5 s.**
  - **A peak non-uniformity of 2E-4 is allowed** in a 38x42 mm^2 good field region (GFR) center on the nominal beam path.

- **Several options were presented to meet the required specifications and a Multi-sensor analogic feedback looks like the best trade-off between accuracy and cost.**
  - In this way one would be able to monitor possible change of shape of the B field.
  - The main issues raise from the very high precision requested and the front-back asymmetry.
  - The cost is estimated to be **about 30 kCHF, requiring 0.5 FTE**.
  - Preliminary tests carried out on MedAustron dipoles are encouraging. Additional tests in preparation.
  - There is a CERN-wide interest in developing an adequate solution as cheaply as possible, in view of similar applications for the transfer lines in the fixed-target areas

- **Discussion:**
  - **K. Hanke asked if the costs for the BT.BHZ10 field control have been budgeted in the LIU baseline. M. Buzio replied that this is not the case.**
  - **A. Blas** asked in case option 5 will be implemented where the 0.5 FTE will come from. **M. Buzio** mentioned this should come from the TE-MSC Group. **J.P. Burnet commented that this solution may require more than 0.5 FTE.**
  - **J.P. Burnet proposed to consider the option to fully cycle between -2.0 and +2.0 GeV and whenever the +/- 1.4 GeV is required this would be reached going down from the maximum. This would be the cheapest solution which does not require much work. M. Buzio** said he looked into this solution but he does not have the data in this presentation. **K. Hanke** proposed to organize a meeting between a restricted number

of expert to look at all options, including **J.P. Burnet**'s proposal, and decide if this is indeed the optimal solution. → **Open Action in LIU-PSB**

- **G. Sterbini** asked what kind of jitter is allowed and if option 5 will provide results within the requested tolerances. K. Hanke will contact W. Bartmann to make sure M. Buzio is provided with the correct specifications.
- **G.M. Georgiev reminded that, whichever the option chosen, a cabling request is to be provided to EN-EL Group.**
  - **M. Buzio** mentioned that it is still to be decided where the electronics would go.
- **G. Sterbini** asked about the possible 1.4 GeV and 2.0 GeV at the PS. **K. Hanke** replied that this is currently not a scenario for POPS-B. **G. Sterbini** added that nevertheless all the injection equipment in the PS was designed keeping this possibility in mind. **K. Hanke** confirmed that this was indeed case, but the current plan is not to inject 1.4 GeV protons in the PS. To be seen.

A more detailed review is available here.

6. Status of the LLRF for the New PS B-Train System

D. Perrelet presented the status of the LLRF for the new PS B-TRAIN System, see here.

The BTRAIN is the main input used to determining the f_{rev} open-loop (h1) applied to the beam control. Within the framework of the BTRAIN renovation, BE-RF-FB designed and commissioned a new PS LLRF revolution frequency program.

The old frequency program HW uses the asynchronous B_{up}/B_{down} blocking levels that are converted using 2 NIM modules (EEPROM based). The two modules are respectively used for proton and ions beams.
The new frequency program HW uses a FPGA to convert the B in f_{rev}. The proton/ion conversion is done using a PPM scaling factor. The system uses the White Rabbit protocol for the input. In this WR word the new BTRAIN and the old B_{up}/B_{down} is delivered and the system can select in PPM between these two available BTRAINs.

In addition, the new BTRAIN has a two-fold distribution (operational and a spare new BTRAIN). The spare one is distributed in the Prevessin RF Laboratory for developing and test purpose. The two BTRAINs are also published via a FESA class (not in a real time streaming).

The new frequency program setup uses BE-CO and BE-RF standard hardware. It is fully PPM and remotely controlled.

The details of the mathematical expression used for the B field to the frequency conversion were presented with particular attention to the scaling factor (for protons and ions) and the effective value of the BTRAIN considered to compensate saturation effect and integrated magnetic length effects.

M. Buzio suggested that one could envisage to distribute the "corrected" BTRAIN directly to all users (RF, BI and EPC) to maintain the consistency. **H. Damerau** commented that the applied corrections are based on effective models but a physical model would be preferable before implementing a general solution.

The details of the FESA class publishing the information of the f_{rev} program was described together with its operational deployment (working set, samplers, DIAMON and LASER console connection, INSPECTOR panel, JAPC/Matlab subscription).

The results of comparison between the old and new frequency program, that uses the old BRAIN information (transmitted with the WR), were compared for ions and protons. The new WR transmission show a limited latency error that does affect the beam.
Since the 2nd August 2016 the new frequency program LLRF is in operation for all users (fully validated with beams).
In addition, protons were accelerated using the new BTRAIN as input for the frequency program (with POPS regulated on the old BTRAIN).

D. Perrelet informed that some work is still needed to adapt and use the new Bdot for the stable phase program but the system is ready for test with POPS regulating on the new B (FMR) measurement system. The long term maintainability (synthesis tool dependences) has still to be assessed together with a clarification of operational responsibility and support (TE, CO, RF and OP).

7. AOB

- Next LIU-PSB meeting is scheduled for the 8th November 2016.
- Next LIU-PS meeting is scheduled for the 15th November 2016.

Minutes reported by G. Sterbini and G.P. Di Giovanni