BI WP13 Meeting #7 2018

WP13 #7 meeting (https://indico.cern.ch/event/755408/) on Monday 1 October in room 866-1-A04.

Agenda:
14:00-14:10 Approval of minutes and previous actions
14:10-14:40 Requirements for the HL LHC BPM system, R. De Maria
14:40-15:00 Specifications for the HL LHC BPM system, M. Wendt
15:00-15:25 Status of luminosity monitor design for HL-LHC¶, M. Palm
AOB

Minutes of the previous meeting at https://indico.cern.ch/event/744123/

Approval of minutes and previous actions:
Minutes from the previous meeting were approved.
ACTIONS:

- HEL-BPM no progress so far
- CRYO-BPM: Lucio asks to present conclusions at TCC
- TE-VSC for WP13: still outstanding contribution required for HEL and sectorisation valves for BGC (Adriana and Ray). Rhodri said that HEL is not in the baseline, should not be part of the document.

Requirements for the HL LHC BPM system, Riccardo de Maria:
Riccardo said that he started the specs document, based on the present document for LHC. (LHC-BPM-ES-0004 rev 2.0 , 2002).

- List of measurements type: bunch-by-bunch, turn-by-turn or closed-orbit mode.
- Beam parameters (updated for HL, including doublets, even if not baseline)
- Position of BPM fixed, so no specs.
- Collimation system: at LHC time the doc referred to BPM in collimation regions, now they are embedded in the collimation and they have different reading system (DOROS), to be checked if ok for HL or should be improved.
- Range and beam positions: ABP should distinguish between what is needed for pilot and full beam.
- Precision: chapter 5.5 (old document) talks about uncertainties more than precision. + xtrue is true w.r.t. which reference frame?
  - Originally it was the magnetic centre of the quadropoles, then it became the centre of the beam screen. ABP has to decide what they want where.
  - Today there are uncertainty on crossing angle, this comes from the fact that we should centre w.r.t. magnetic centre of triplets and triples have misalignment. We should be able to distinguish between BPM and alignment errors.
  - In arc more important to optimise for aperture. Maybe for triplets we should foresee different kind of calibration (alignment?). We start from centre of electrodes and then we can add corrections. Note that ABP assume orbit stable throughout the cycle.
- $$x_{measured} - x_{true} = \Delta + kx_{true} + \psi y_{true} + \sum_{k=2}^{\infty} \sum_{j \le k} \alpha_{kj} x_{true}^{k-j} y_{true}^{j} + \varepsilon$$

  Uncertainties come from electronics and alignment mainly. Would be good if BI could tell ABP number goes where.

- Requirements from Jorg and Rogelio not clear, because they rely on the reduction of uncertainties thanks to reproducibility and averaging out many measurements.
- Table 6: Linearity of 100um with 4% stability is what is ultimately required
- Requirements for bunch-by-bunch measurements are not reached at the moment, to be checked (BI) what we actually can do.
- Systematic errors reduce quality of measurements more than random errors. Difference between the 2 beams should be constant if the beam does not move.
- New document:
- The FWHM bunch length is the one optimised by the RF (not with Gaussian distribution). The old 4sigma should also be there if longitudinal feedback is not on.
- For reproducibility, the time scale is specified with the measurement type.
- Colour noise more dangerous than white noise, but less if away from the tune.
- Reproducibility more important than accuracy.
- Resolution for orbit mode better at triplets than at arcs. Local error does not propagate with beta function, but error in the machine does.
- Sensitivity on bunch pattern?
- RJ proposes a dedicated meeting (WG) with JJ, Manfred, Rhodri, Riccardo, Rogelio, Jorg to be organised after the annual meeting with the aim of finalizing the specification document by mid 2019.

ACTION BI: Need to look at what is achieved wrt original specs. For modes that are used by the machine

Technical specifications for the HL LHC BPM system, Manfred Wendt

Manfred showed what he plans to present at the HL-LHC 8th collaboration meeting:

- Status quo, limitation and issues with the present WBTN BPM system
  - Maintenance, spares, dynamic range, doublets
- Translate requirements to technical specifications
- Discuss the upgrade boundaries set by hardware infrastructure and machine environment
  - Fibres, tunnel locations, radiation levels
- Present the signal processing layout to be tested for the LHC interlock BPMs
  - Time multiplexed electrode signal processing
- Present a realistic signal processing scenario for the LHC BPM upgrade
  - Rad tolerant electronics: go to digital with rad tol.
- Discuss measurement options, some beyond the scope of beam position measurements
  - Quadrupolar moments, IQ-signal processing (time/phase information, e.g. bunch crabbing)

Rhodri commented that the last subject could be dealt separately in small audience.
It should be shown what we lose when going to doublets scheme.
No clear requirements for doublets, and location of measurements (for the moment only in P6).
Doublets should be protected by orbit errors. Gianni is not sure that d are needed. Not in the baseline/

Read-out? Doros on collimators, time multiplex on interlocks and integrated . . . On others. We should make an inventory and a status/comparison.

We do not want to give up some functionalities like bunch by bunch? YES, then systems like Libera not possible.

Status of luminosity monitor design for HL-LHC, Marcus Palm

- BRAN measures luminosity around IPs = proportional to the secondaries produced by neutrons in the TAN and reacting in the BRAN.
- For HL-LHC measurements based on Cherenkov radiation, testing now with either fused silica or Al-coated mirror (active area = size of the mirror).
- Results from silica. Signal = ATLAS meas. Initially a loss of signal with time was observed (over 2016) now stable. Gains still goes down this year but not due to degradation of silica but due to PMT.
    - Effect of radiation visible on ATLAS ZDC (Zero Degree Calorimeters) rods (actual material not known).
    - Transmission measurements on rods took out this year show visible range ~ unaffected.
- Aluminium mirrors: put at different heights. The one giving the highest signal is the same that degraded the most, and the degradation continuous so probably not good solution for HL. Reflectivity measurements to be done at the end of the year to establish weather is the mirror that degrades or the reflectivity in the tube.
    - Can we think of different material but Al? For UV maybe gold . . . But again to be checked what degrades.
- In HL only 50mm in-between beam pipes (100mm presently). For H Xing the peak is not visible, so luminosity measured will change during crossing scans. Since the BRAN is there to optimise beam crossing (= when beam is moving), it is difficult, few urad at IP may change things by few mm, we need to put numbers. We should be able to find a calibration/scaling, since during beam scan, the crossing angle does not change.
- Could we move the rods? Very hot area
- Dynamic range ~ 4-5 orders of magnitude, should be ok.
- Simple but reliable system
- Low and high sensitivity config
- Lab test needed to calibrate and establish distance of PMT
- In LS2 we will build 2 prototypes to be installed in run 3
- Readout not mentioned . . . Present system could be used, if more channel