Proposal for an Additional BPMs in the PSB Transfer Lines

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Additional BPMs

1. Additional BPM in the BI line.

2. Additional BPM in the BTP line.
Additional BPM in BI: Motivation (I)

- Injection in the PSB is a delicate process which includes steering, minimizing losses and **slicing the beam**.

- With the available instrumentation a full diagnostic of the beam slicing process is challenging:
  - Only 1 BPM, **BI.BPM30** between quadrupoles before the DIS and slits at the entrance/exit of DIS/SMV.
  - The commissioning mostly relies on minimizing the losses by checking the BLMs level and the OASIS signals from the slits which is very time consuming.

- Difficult to validate simulations, understand the reason why a setting may or does not work:
  - Most of the commissioning relies on the PSB operators experience and trial-and-error method.
Additional BPM in BI: Motivation (II)

• We would like to put forward the proposal for an additional BPM to be installed in the BI line to increase the available diagnostic tools.

• There is available space between the distributor, DIS10, and the septum, BI.SVM10.

• The optimal position would be as close as possible to SMV10:
  • Where the beam vertical displacement is maximum, +25 mm/-60 mm at the entrance of SMV10.
  • The beam size (ellipse half axis) at the entrance of SMV10 for LIU beams is estimated to ~6/5 mm in H/V.
  • The value might change by < 3% if moving the BPM 3 m upstream wrt the SMV10 position.
  • The envelope (without mechanical tolerances) is calculated to be ~22/15 mm in H/V.
  • Beam size and envelope calculated using the fully matched optics:
    • $\beta_X$ at the entrance of BI.SMV10 can vary by a factor 2 (larger than nominal).
    • $\beta_Y$ at the entrance of BI.SMV10 can vary by a factor 4 (smaller than nominal).

• Expected resolution to be 0.1 mm.
• Desired accuracy to be 0.5 mm.
BPMs for LIU-PS injection instrumentation

• New Y chamber for LIU in MU41 was installed during this EYETS. The chamber has a port for a BTV right upstream the septa, however there is no BPM included contrary to the original ideas (Meeting 26.4.2017).

• Solution:
  • The recently installed Y chamber will not be modified.
  • **Missing BTP.BPM60 will be installed as close as possible to the Y chamber. It can be in either vacuum sector.**
  • BTP.BPM30 will be installed 90 deg upstream of the septum exit, between QN050 and 55.

C. Hessler’s presentation at the LIU-PSB WG #197 (https://indico.cern.ch/event/652026/)
Cost estimates (from BE-BI)  

**Additional BPM in BI line:**
- Drawing office: 20 kCHF
- Production (1+1 spare): 15 kCHF
- Cables+ADCs: 15 kCHF

**TOTAL**: 50 kCHF

**Additional BPM in BTP line (see LIU-PSB meeting 197):**
- Ceramic chambers x2: 10 kCHF
- Ferrite cores x2: 5 kCHF
- Cables: 5 kCHF

**TOTAL**: 20 kCHF

**Manpower**: 1 man-month (BE-BI-PI section)
Supporting Slides
Accuracy, Precision, Resolution

- Very often confused in day-to-day language
- **Accuracy:** also called trueness of measurement
- **Precision:** how well can I reproduce my measurements
- **Resolution:** smallest possible difference in successive measurements

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Ex: BPM: Mechanical and electrical offsets, gain factors influence the accuracy, various noise sources or timing jitter influence the precision, ADC resolution can limit the resolution.
Beam-size/Beam-envelope in BI line

Formulas used in C. Bracco’s calculations:

• **1-sigma beam size** is $\sqrt{\text{emittance} \times \beta \times 1.2 + \text{dispersion}^2 \times \text{rms\_momentum\_spread}^2}$

  The factor 1.2 is used to take into account a 20% difference in beta function wrt nominal.

• **The 4-sigma beam envelope** (important for aperture studies) is calculated as:

  $4\times\sqrt{\text{emittance} \times \beta \times 1.2} + \text{dispersion} \times \text{max\_momentum\_spread} + \text{rms\_orbit\_displacement}$