Beam Instrumentation in the HL-LHC

Thibaut Lefevre on the behalf of the BI group

HL-LHC Vacuum Related Issues – 5th March 2013

Overview on BI in HL-LHC

WP 13	Task/Description
13.2	Cryogenic BLMs
13.3	Radiation Hard Electronics for the BLM system
13.4	**Fast Wire Scanners**
13.5	**New Interaction Region BPMs**
13.6	Luminosity Monitors
13.7	**Diagnostics for Crab Cavities**
13.8	**Upgrade to Synchrotron Light Monitor**
13.9	**Halo Diagnostics**
13.10	**Beam Gas Vertex Detector (BGV)**
13.11	**Long Range Beam-Beam Compensator** - Task in collaboration with EN/STI
13.12	*Second Undulator Per Beam* possibly

No impact on Vacuum

Upgrade of exsiting instruments for HL-LHC

New Designs for HL-LHC

WP 14	Task/Description
14.XX	**Beam Instrumentation for Transfer & Dump Lines**

Collimator BPMs

Other BI activities

Improvement of existing diagnostics

- **Beam Gas Vertex detector**
  - Relying on beam interaction with rest gas
  - Currently under study and full implementation foreseen by LS2
- **New Fast wire scanners**
  - Design being finalised
  - Implementation in PS and SPS first
- **Upgrade of SR monitors**
  - Issues with extraction mirror
- **Add. Collimator BPMs**
  - First design installed during LS1
  - Possible improvements foreseen for LS2 and LS3 installations

Other BI activities

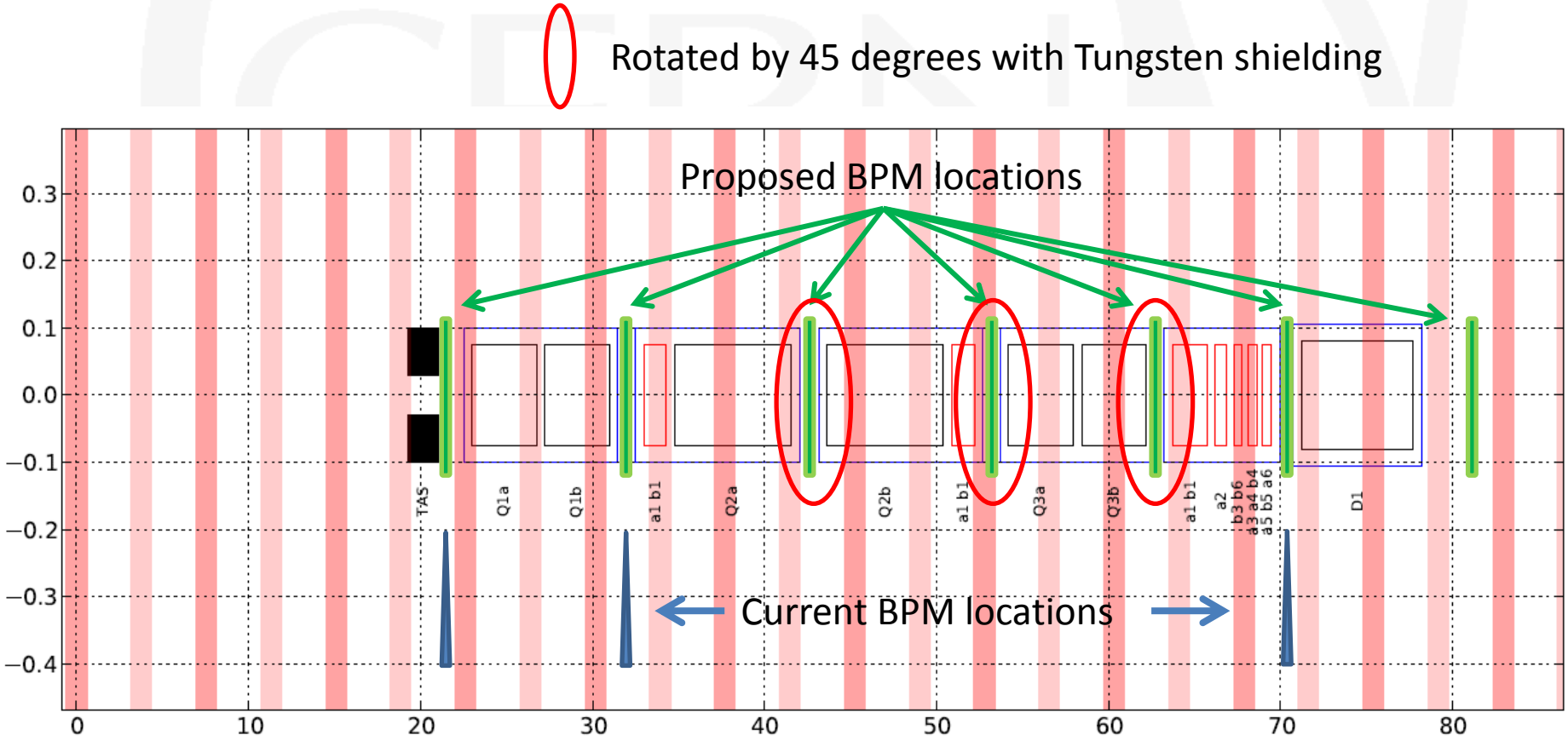
HL-LHC specific instruments

- **BBLR compensators**
  - Wire in collimator – studied with EN-STI
  - Study of e-beam options
- **Diagnostic for crab cavities**
  - New Head-Tail pick-ups to measure the crabbing (Collaboration with RHUL in UK)
  - Need to work on functional specification

BPMs in the HL-LHC Insertion Regions

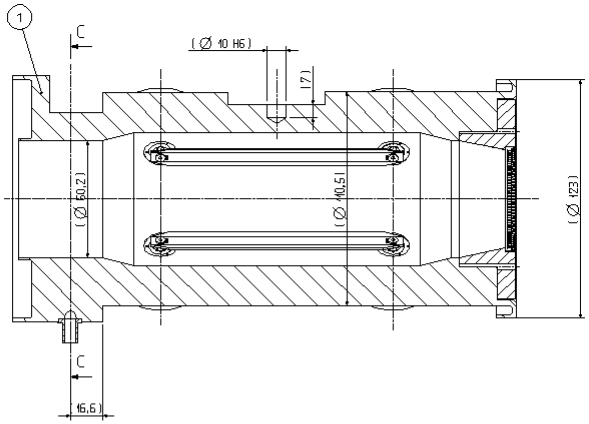
HL-LHC Experimental Insertion BPMs

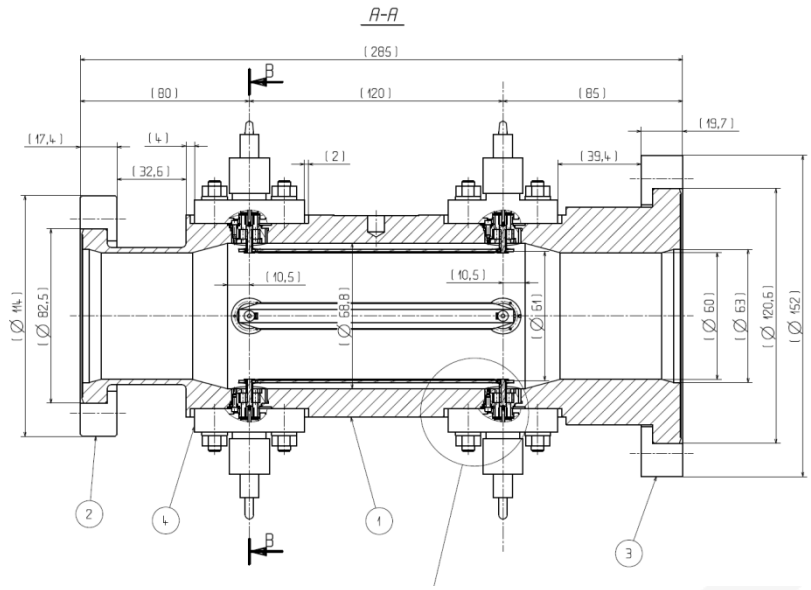
- **HL-LHC Experimental Insertions – Proposed BPM Layout**



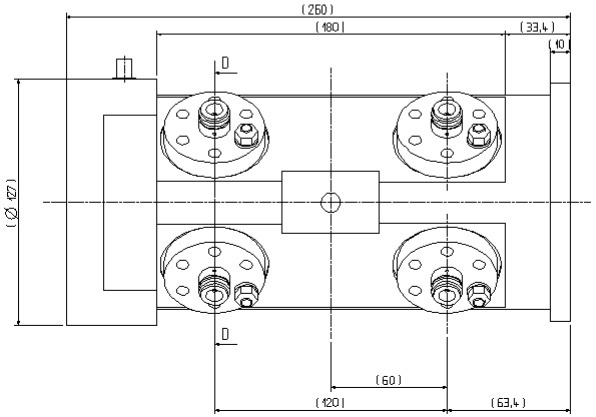
HL-LHC Experimental Insertion BPMs

- **New strip-line BPMs: Aperture & Length to be defined**
  - Aperture
    - NOT related to length
    - Can adapt the same BPM for any aperture
    - Larger aperture ⇒ less signal & lower final resolution
  - Length
    - 220mm minimum for cold stripline BPM
    - 285mm minimum for warm stripline BPM





BPMSW – Warm BPM in front of Q1



BPMS – Cold BPM in Q2

HL-LHC Experimental Insertion BPMs

- **New design started with a Fellow (D. Draskovic – Jan 2014)**
  - 140mm aperture strip-line BPMs
  - Investigating new strip-line geometries to improve Pick-up directivity in order to achieve the required resolution
    - Space constrains versus resolution to be investigated
  - Hor. & vert. Inermet shielding and need to rotate the BPM by 45 degrees
    - Impact on BPM sensitivity
    - Quantify the emission of secondary particles
  - Copper coating or C-coating

HL-LHC Experimental Insertion BPMs

- **RF design completed by mid 2015**
- **Mechanical design by end 2015**
  - Including Integration in Cryostat
- **Prototype (and beam test) by mid 2016-2017**
- **Launch production in 2018**

HL-LHC Experimental Insertion BPMs

- **Impedance simulations on-going (Benoit and Nicolas)**
  - Finalizing the number and position of BPMs
  - Strong impedance from BPMs located at large beta value
    - Trade-off between impedance and beam tuning
    - Possibly using other BPM design than strip-line with a lower impedance (i.e. Button pick-up) but limited usage

Conclusions

- **BI activities have been defined and the work is starting**
  - Need to work on functional specifications for all devices requested
- **Special BPM design with Inermet shielding and appropriate cooling which should provide a better resolution than the existing design**
  - Several design necessary for Q1 and Q2 due to the thickness of the shielding
- **No (add.) critical issues for vacuum identified so far**
- **Few specific requirement impacting on vacuum quality**
  - i.e. Gas vertex detector