LHC IR Stripline BPM MD Results

Thibaut Lefevre and Drasko Draskovic
on behalf of the BI group

61st HL-LHC WP2 Task Leader Meeting

27.11.2015

Outline

Design of HL-LHC stripline BPMs

- Current status

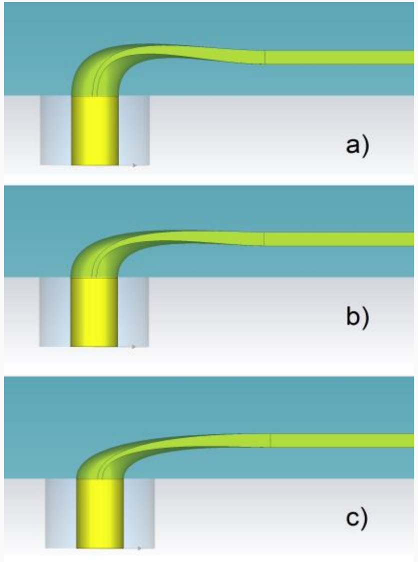
LHC Stripline BPM MD: DOROS vs WBTN in IR

- Overview
- Main results and conclusion

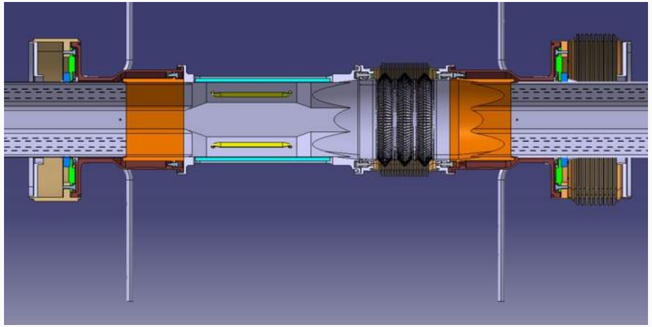
Design of Stripline BPMs for the High Luminosity LHC

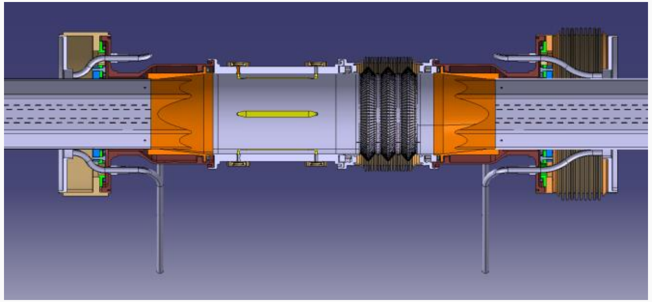
Optimizing the stripline directivity to provide best possible accuracy

- RF simulations showed 7 to 10dB improvement compared to current LHC design (IPAC'15 paper MOPTY053)



Design of Stripline BPMs for the High Luminosity LHC





Mechanical design launched

- Integration of pick-up in the triplet interconnection: two designs being considered (circular and octogonal shape)
- Additional FLUKA simulations are being performed to confirm the need of Inermet absorbers and their dimensions

MD LHC BPM

Goal

- Check the sensitivity of the BPM electronics with two acquisition chain electronics systems, WBTN (Wide Band Time Normalizer) and DOROS (Diode ORbit and Oscillation System) to the position of the BPM with respect to beam encounters.

MD LHC BPM

Procedure

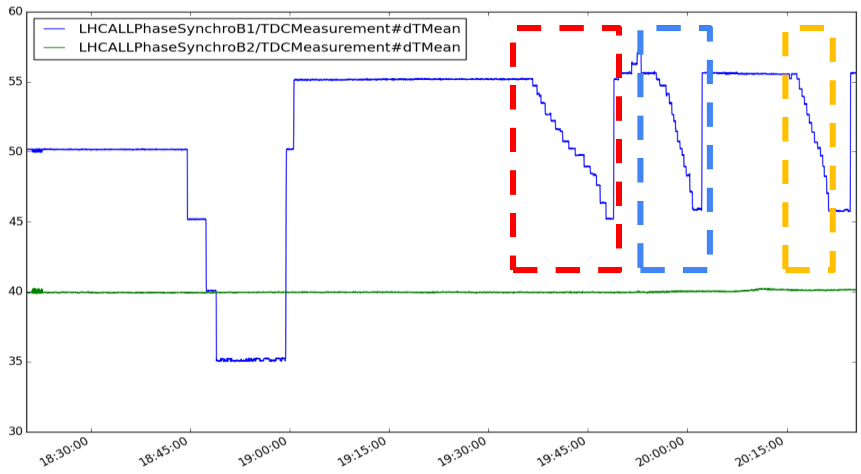
- Check on the oscilloscope the initial readings of the analog sum signals for stripline BPMs in IP1 and IP5 (Left and Right).
- Cogging in large steps (5ns) to find the overlapping position (our reference)
- Proceed with cogging in small steps of 0.625ns.
- Log and live plot the RF parameter #dTMean - the relative time difference between the two beam revolution frequencies B1 and B2, as well as the horizontal and the vertical beam positions for both beams for WBTN and DOROS

MD Three Scenarios

1. Both beams, with the same intensity per bunch, centered in the BPMSW, then adjust the RF cogging to adjust the time overlap between the two beams in the pick-up

2. The same as 1 but with offset in position for both beams (typical separation bumps)

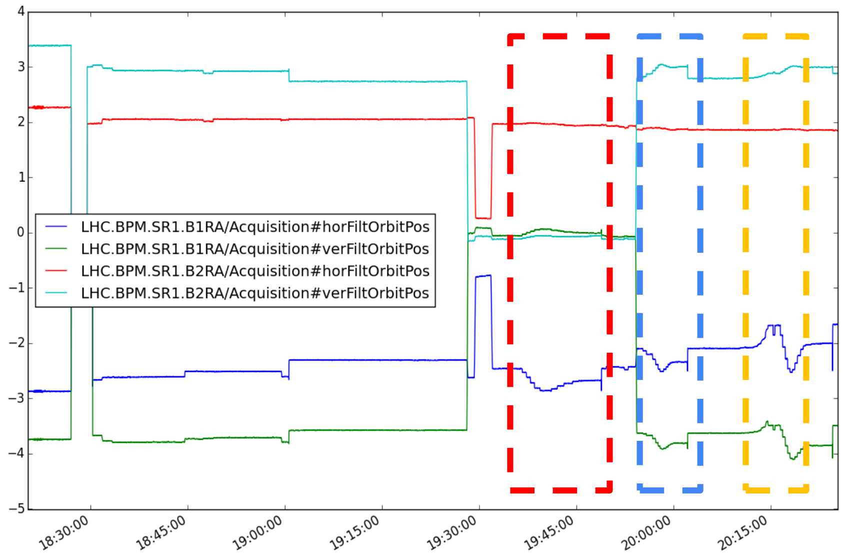
3. The same as 1 but with offset in position for both beams and with factor 2 difference in bunch intensity between B1 and B2

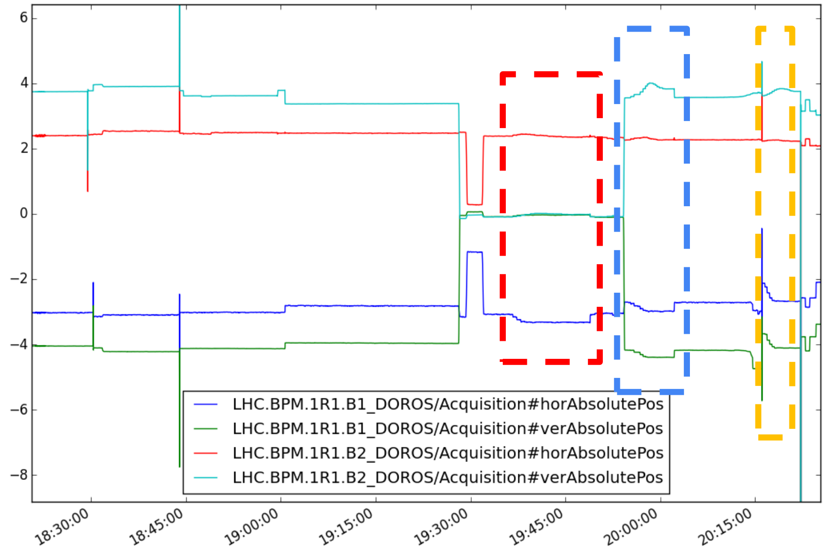


1: Both beams centered 2: Offset in position for beams 3: Same as 2 with 2x difference in intensity

WBTN

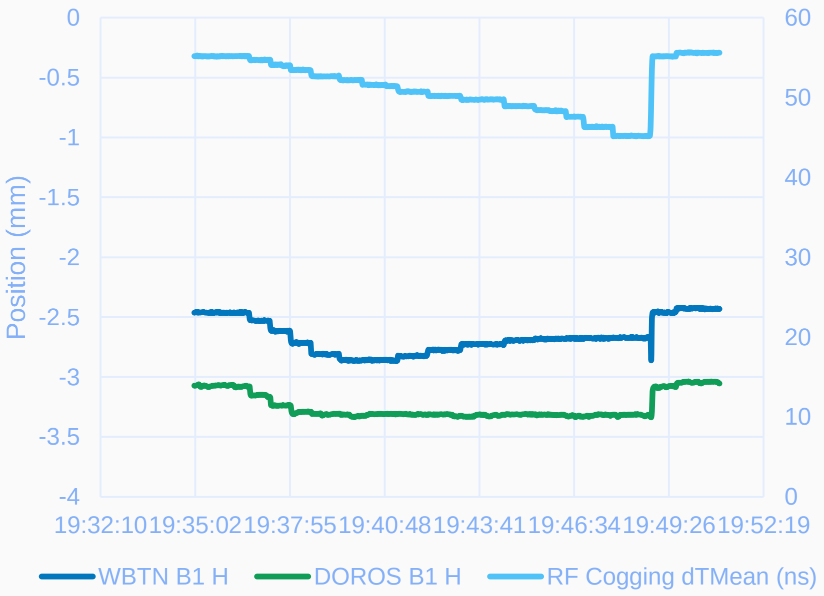
DOROS



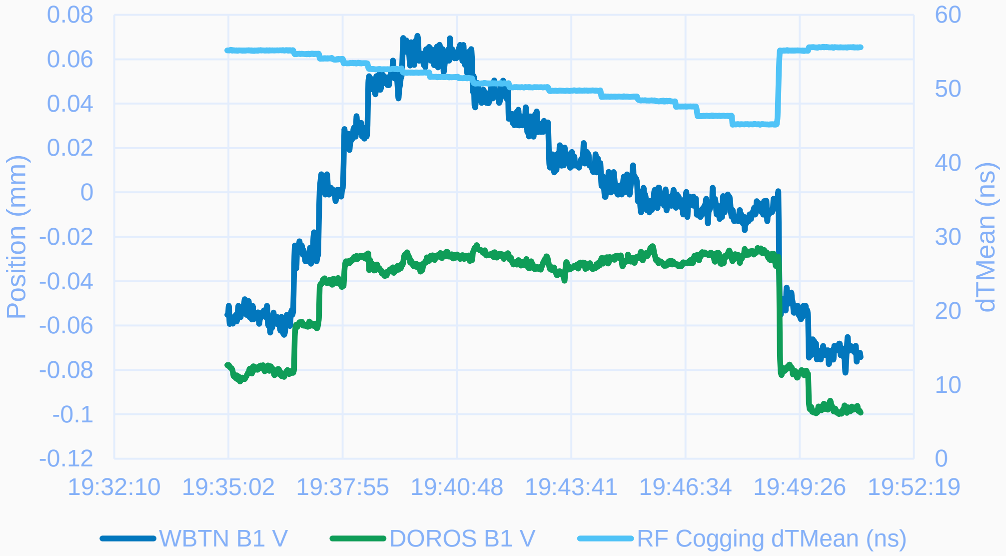


1: Both beams centered **2: Offset in position for beams** **3: Same as 2 with 2x difference in intensity**

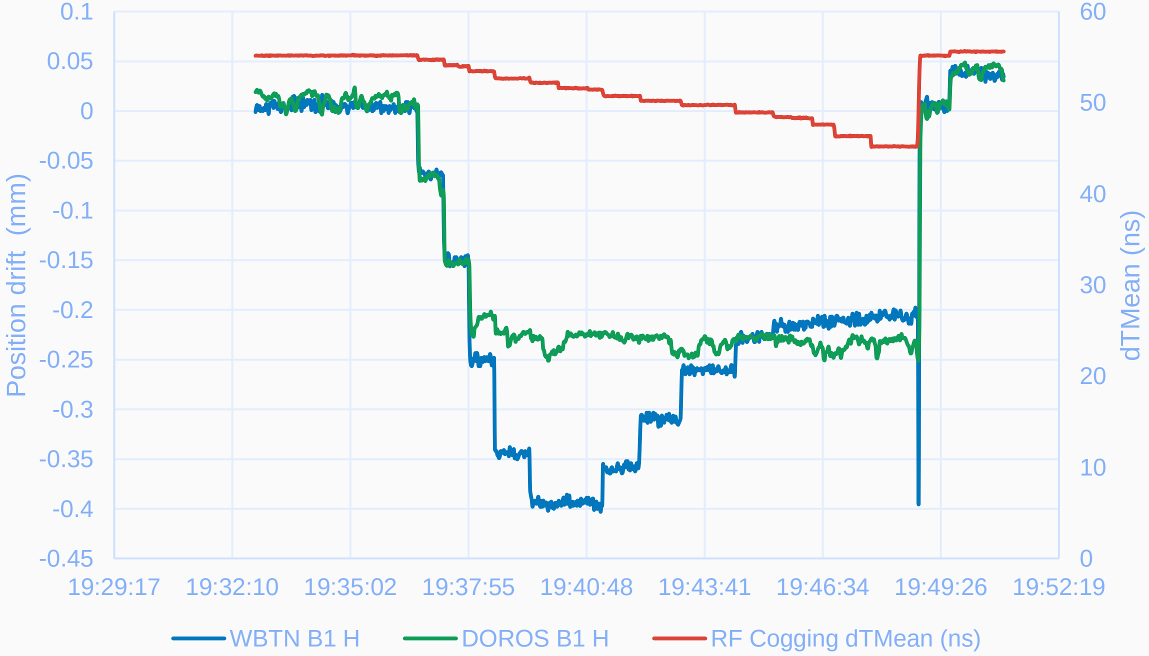
P1 Scenario 1, horizontal plane



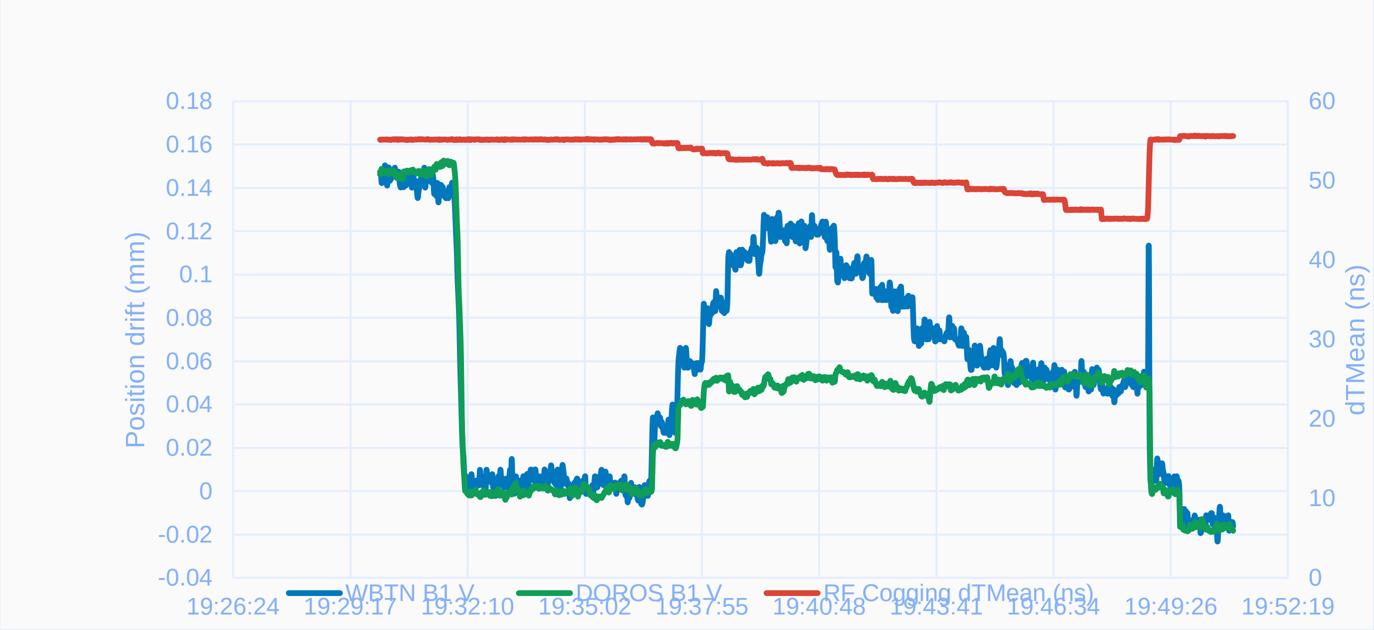
P1 Scenario 1, vertical plane



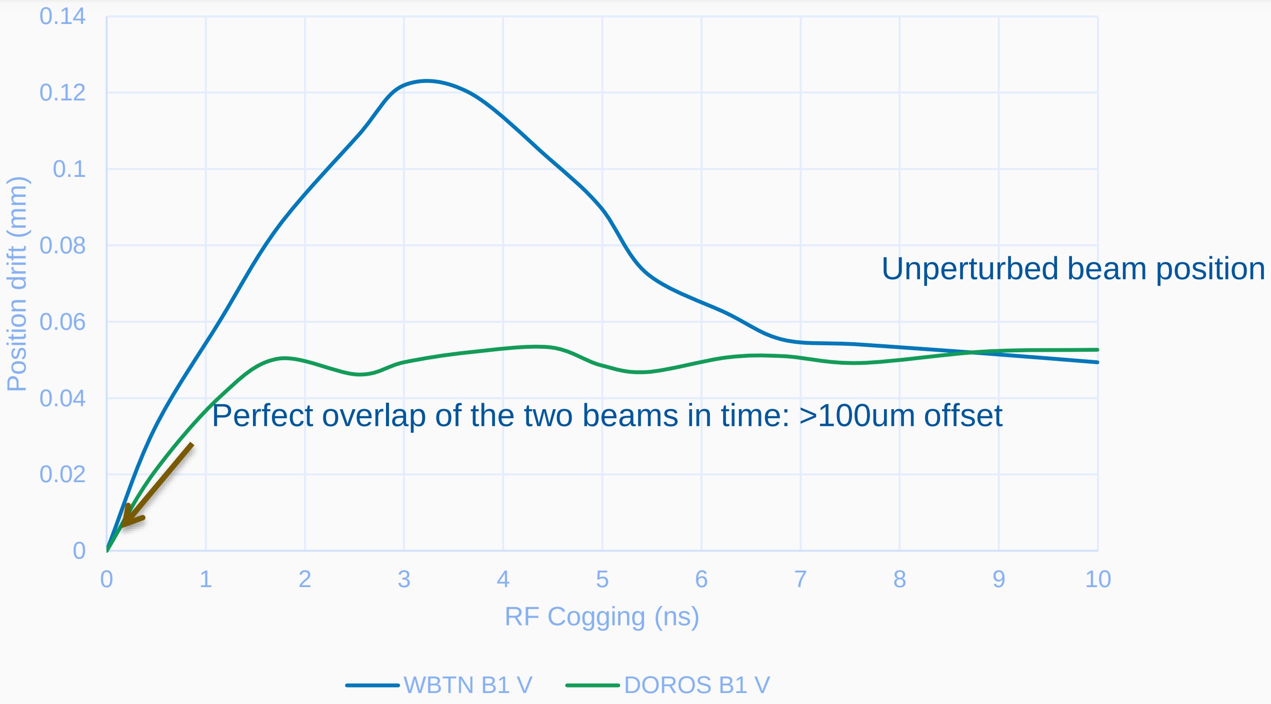
P1 Scenario 1, horizontal position drift



P1 Scenario 1, vertical position drift



P1 Scenario 1, vertical position drift



Significant difference in response

DOROS

The offset for DOROS is gradually decreasing as the two beam signals do not overlap in time, and after a Δt of 3ns, the DOROS reading does not change anymore. Then, at this stage one can consider that DOROS electronics is processing the beam signals with no crosstalk from the other beam.

WBTN

The WBTN chain has a more complex behavior.

After a Δt of 3 ns, the WBTN offset changes sign and it needs more than 6 ns of time separation to consider that the WBTN electronics processes the signals with no crosstalk

Comparison of the BPM reading absolute change (range) due to cogging (in mm)

P 1

	Scenario 1		Scenario 2		Scenario 3	
	H	V	H	V	H	V
WBTN B1	0.213	0.073	0.252	0.200	0.494	0.324
DOROS B1	0.249	0.053	0.278	0.222	0.225	0.199

P 5

	Scenario 1		Scenario 2		Scenario 3	
	H	V	H	V	H	V
WBTN B1	0.116	0.098	0.239	0.126	0.563	0.219
DOROS B1	0.128	0.103	0.387	0.139	0.532	0.218

Comparison of the BPM reading absolute change (range) due to cogging (in mm)

- The maximum beam offsets measured by both systems is very similar. It corresponds to the case where the beam signals are perfectly overlapping in time and there is no way for the electronics to separate the signals induced by both beams.

- With both beam separated in position, the measured errors become larger (up to 10%).

- When two beams have different bunch intensities, i.e. scenario 3, the measured error on the lower bunch intensity becomes proportionally larger, i.e. twice larger for 50% lower bunch intensity.

Δt acceptable time (ns)

	Scenario 1	Scenario 2	Scenario 3
WBTN B1	6.82	6.68	6.47
DOROS B1	2.53	2.95	2.75

Conclusion

Conclusion (1/2)

- When the two beams propagate at the same time in the pick-up, DOROS and WBTN show similar beam offsets. These offsets become larger when the beams have opposite positions in the vacuum chamber.
- If one beam has a larger intensity than the other, its contribution to the measurement of the other beam is significantly larger. Offsets up to 500um have been measured in such conditions.

Conclusion (2/2)

DOROS

DOROS demonstrates that for temporal offset larger than 3ns, its position reading is not influenced anymore by the presence of the other beam.

WBTN

The WBTN electronics would need more than 7ns of temporal offset in order to avoid any contribution from the counter propagating bunch.

Discussion