Analysis of IR8 aperture measurements

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Strategy

Measurement at 450 GeV with hor. crossing bump switched on/off

- Alignment of the TCPs to $4\,\sigma$
- Increase of separation bump until the beam touches the TCTs protecting the triplet
- Opening of the TCTs
- Increase of the separation (2 steps) $\rightarrow$ touch the TCTs again
- Repeating until losses are still seen after the TCT opening

Last configuration before the losses were seen

Hor. crossing bump switched on/off

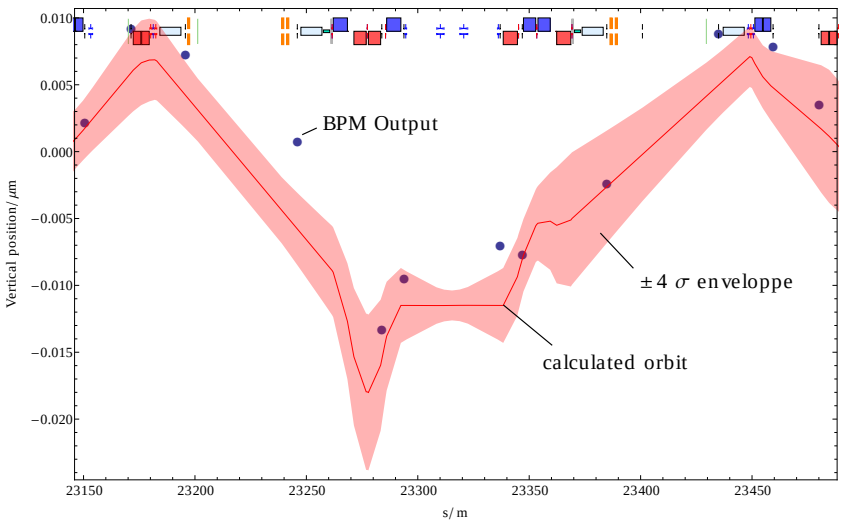
- Use additional bumps by the outer correctors to have independant measurements for B1/B2
- Largest separation before losses were seen (B1&B2) :

$$\Delta y = \pm 11.5\,\mathrm{mm} \tag{1}$$

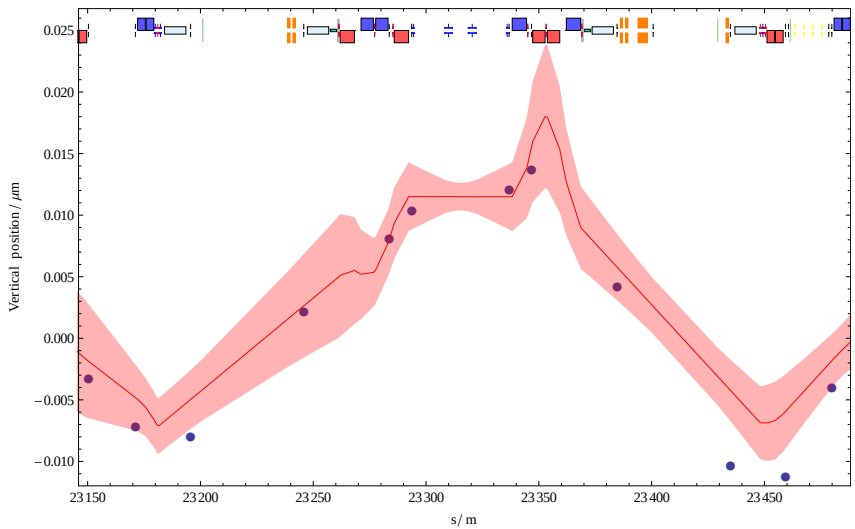
- Compare BPM output with theoretically predicted orbit positions
- Beam enveloppe with worst case emittance $\epsilon_N = 3.5\,\mu\mathrm{m}$ rad

Vertical BPM readings at $\pm 11.5\,\mathrm{mm}$

Beam 1

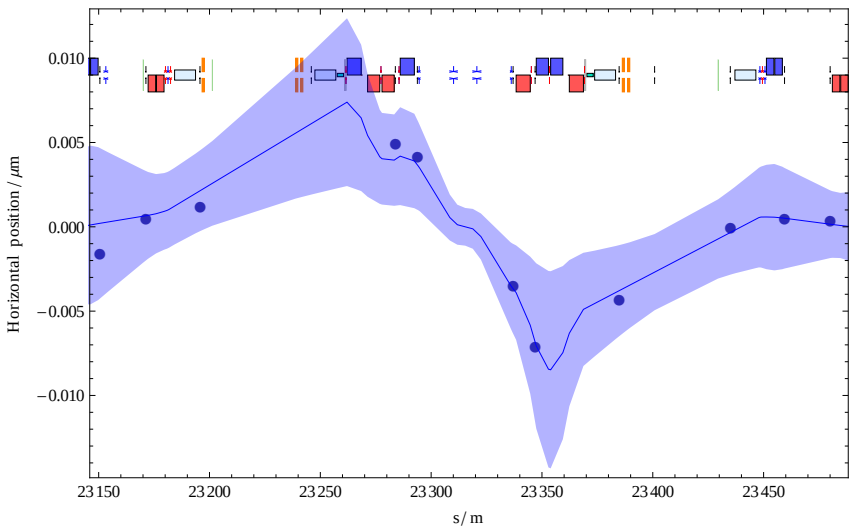


Beam 2

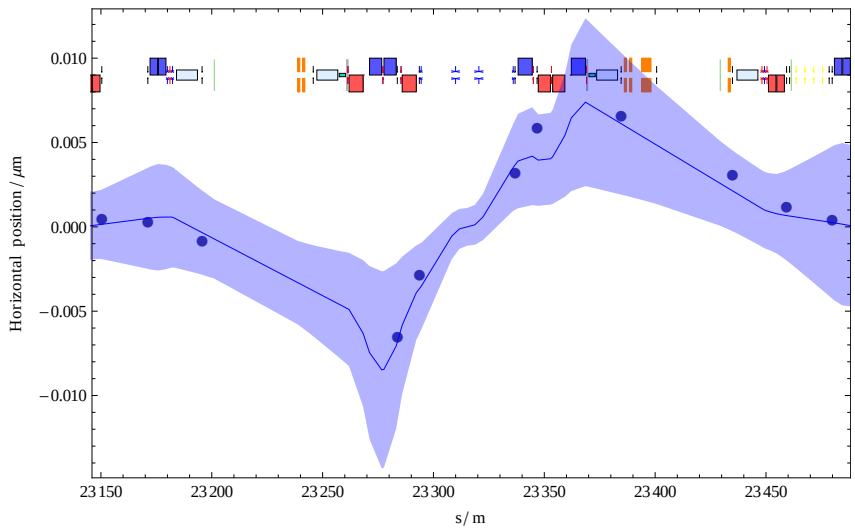


Horizontal BPM readings at $\pm 11.5\,\mathrm{mm}$

Beam 1



Beam 2

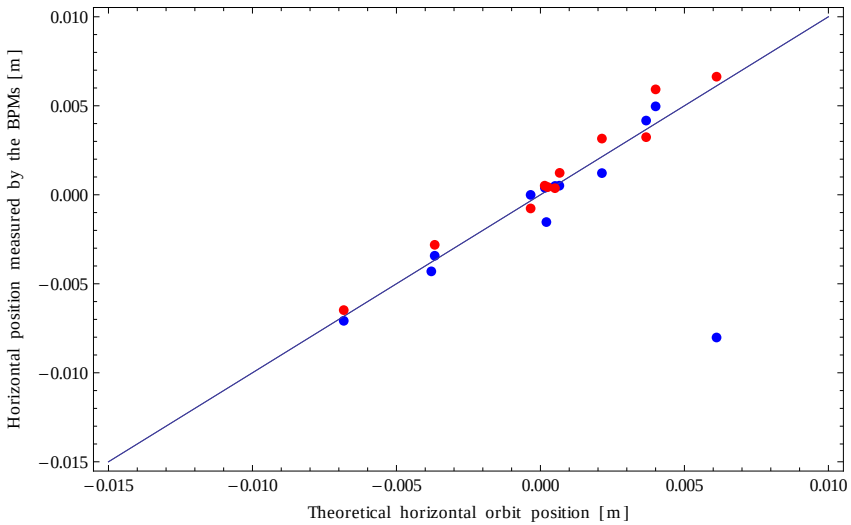


Comparison

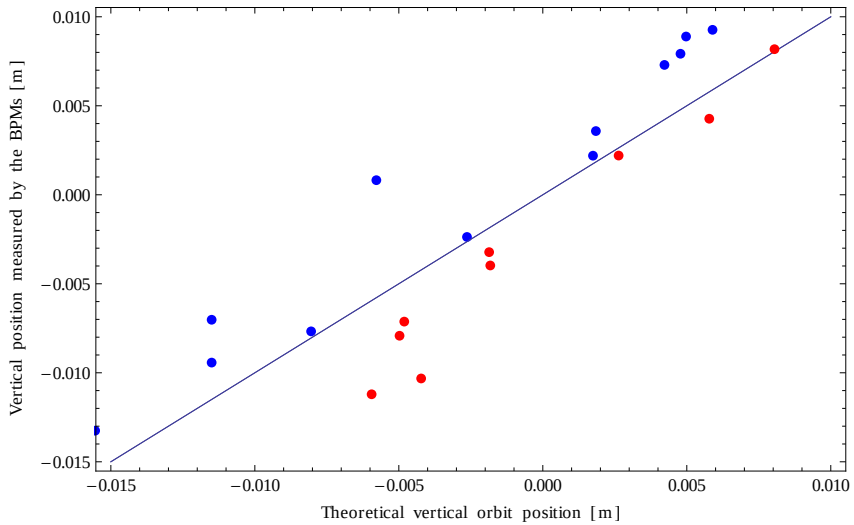
- BPM data in agreement with theoretical bump shape for B2 hor/vert
- Not such a good agreement close to IP8 for B1V
- Non-linearities of the BPMs make results hard to compare

Comparison of BPM measurements with Theory

Horizontal



Vertical



- In horizontal direction good agreement
- In vertical direction large spread
- Better approach : Check non-linearity of the BPMs and select 'good' BPMs for analysis : will be done

Aperture at triplet (Theoretical orbit)

- However, BPM and theoretical bump shape are still similar
- Approach : Use bump shape at 11.5 mm separation
  (last step without losses, with and without crossing bump)
- Largest Y at MCBXV.2R8 : 17.9 mm
- Different models for beam enveloppe ($\epsilon_N = 3.5\,\mu$m rad)

Aperture at triplet (Theoretical orbit)

θ_C Angle [μrad]	X/Y at MCBXV.2R8 [mm]	σ_x/σ_y [mm]	Vert. Aperture $(+2\sigma, 3\sigma, 4\sigma)$ [mm]	Design Aperture [mm]
Left hand side (Beam 1)				
-181	4.09/-17.97	0.7/1.5	20.8/22.3/23.8	24
0	0/-17.97	0.7/1.5	20.8/22.3/23.8	24
Right hand side (Beam 2)				
$+181$	4.09/-17.97	1.5/0.7	20.0/21.5/23.0	24
± 0	0/-17.97	1.5/0.7	20.0/21.5/23.0	24

Aperture at triplet (Interpolated orbit)

- Bump interpolation by using the BPM data (all BPMs) and magnet configuration

θ_C Angle [μrad]	Y at MCBXV.2L8 [mm]	σ_x/σ_y [mm]	Vert. Aperture $(+2\sigma, 3\sigma, 4\sigma)$ [mm]	Design Aperture [mm]
Left hand side (Beam 1)				
-181	4.09/18.51	0.7/1.5	21.5/23.0/24.5	24
0	0/18.51	0.7/1.5	21.5/23.0/24.5	24
Right hand side (Beam 2)				
-181	4.09/18.80	1.5/0.7	20.2/20.9/21.6	24
0	0/18.80	1.5/0.7	20.2/20.9/21.6	24

Summary & Conclusions

- Two approaches for the analysis
- Theoretical bump shape and $4\,\sigma$ distance to aperture :

$$a_V(\text{left}) = 23.8\,\text{mm} \qquad a_V(\text{right}) = 23.0\,\text{mm} \tag{2}$$

- Interpolated bump by BPM readings :

$$a_V(\text{left}) = 24.5\,\text{mm} \qquad a_V(\text{right}) = 21.6\,\text{mm} \tag{3}$$

- Second methods suffers from BPM non-linearities
- Can increase precision by not using very non-linear BPMs
  $\rightarrow$ Note