LHCb upgrade: minimum crossing angle from Beam-Beam: Preliminary tracking results

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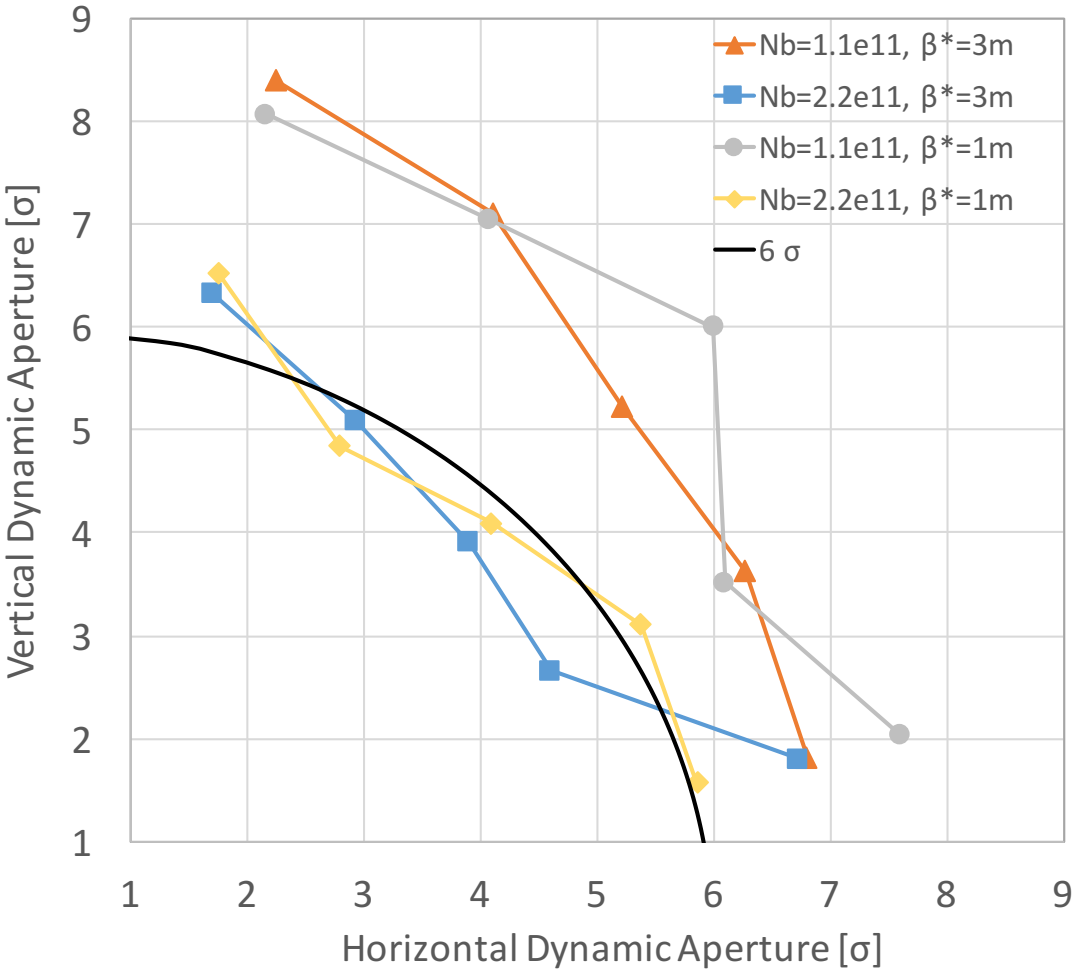
Simulations set-up

- Optics configurations (beam 1):
  - Optics version HLLHCV1.2
  - β* of 15 cm in IR1/5, 10 m in IR2, 3 and 1 m in IR8
  - Tunes of 62.31 and 60.32
  - Crossing (half-)angles: 295 μrad in IR1/5, -170 μrad in IR2, -250 μrad, -200 μrad, -150 μrad and -50 μrad in IR8 (external)
  - LHCb Spectrometer polarity + and –
  - Separation: 0 in IR1/5/8, 2 mm in IR2
  - Chromaticity of 3
  - Multi-pole errors and Landau octupoles switched off
- Emittance 2.5μrad
- Intensities: 1.1×10^{11} and 2.2×10^{11}
- Crab cavities switched off and on

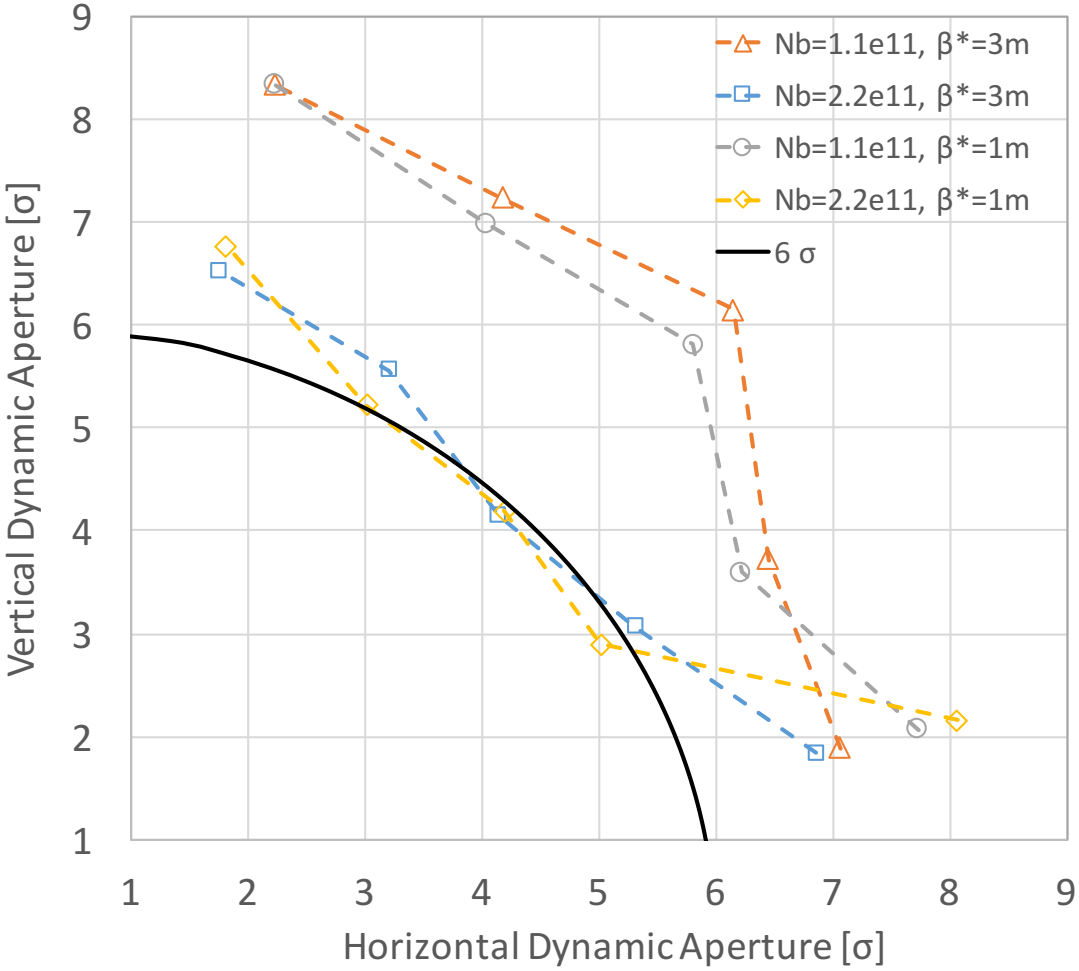
Crabs off - Positive polarity

- Different β* in IR8 does not affect significantly the DA
- Only for high-intensity of 2.2e11, DA < 6 σ



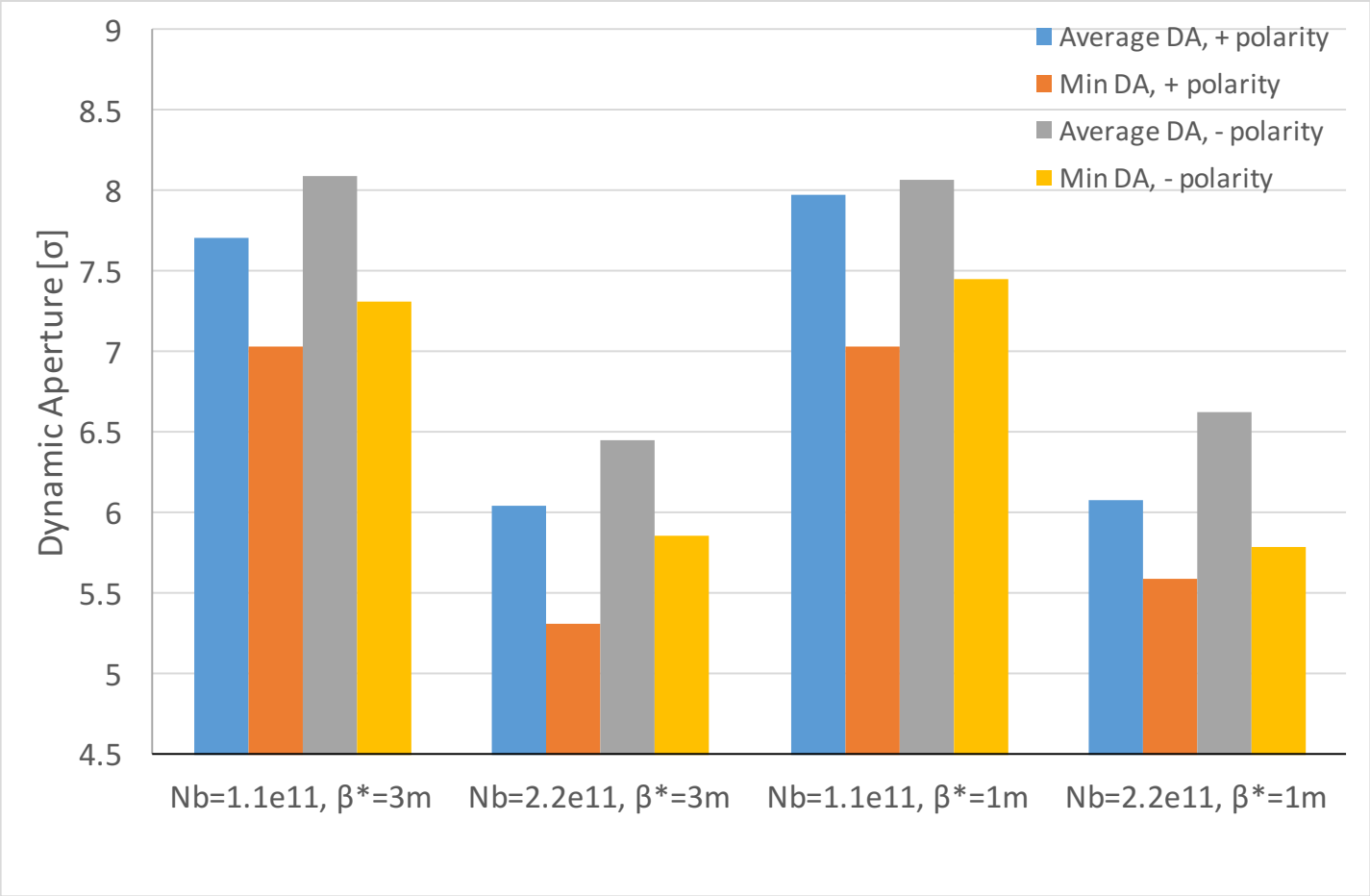
Crabs off – Negative polarity

- Different β* in IR8 does not affect significantly the DA, for negative spectrometer polarity as well
- Only for high-intensity of 2.2e11, DA < 6 σ



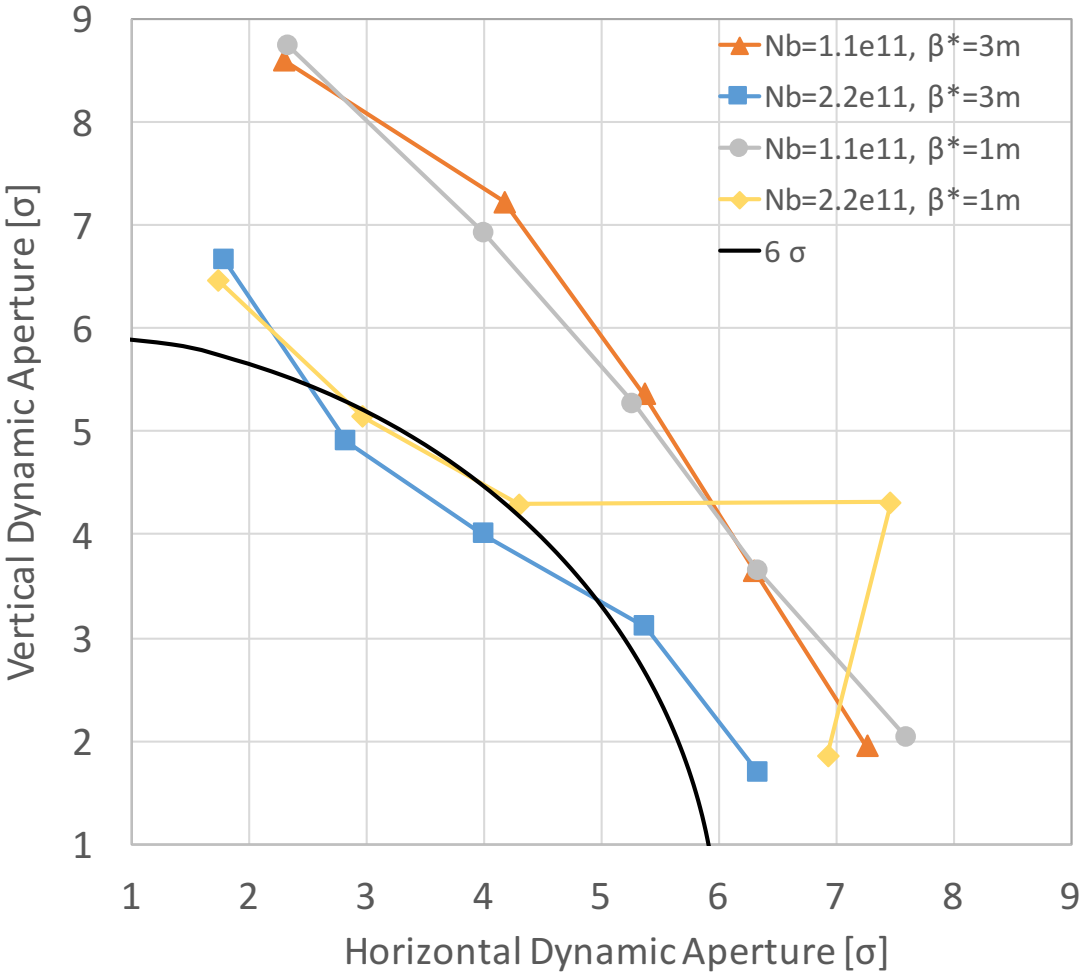
Crabs off - summary

- Overall, slightly higher DA from negative spectrometer polarity (IR8 total crossing angle increase)



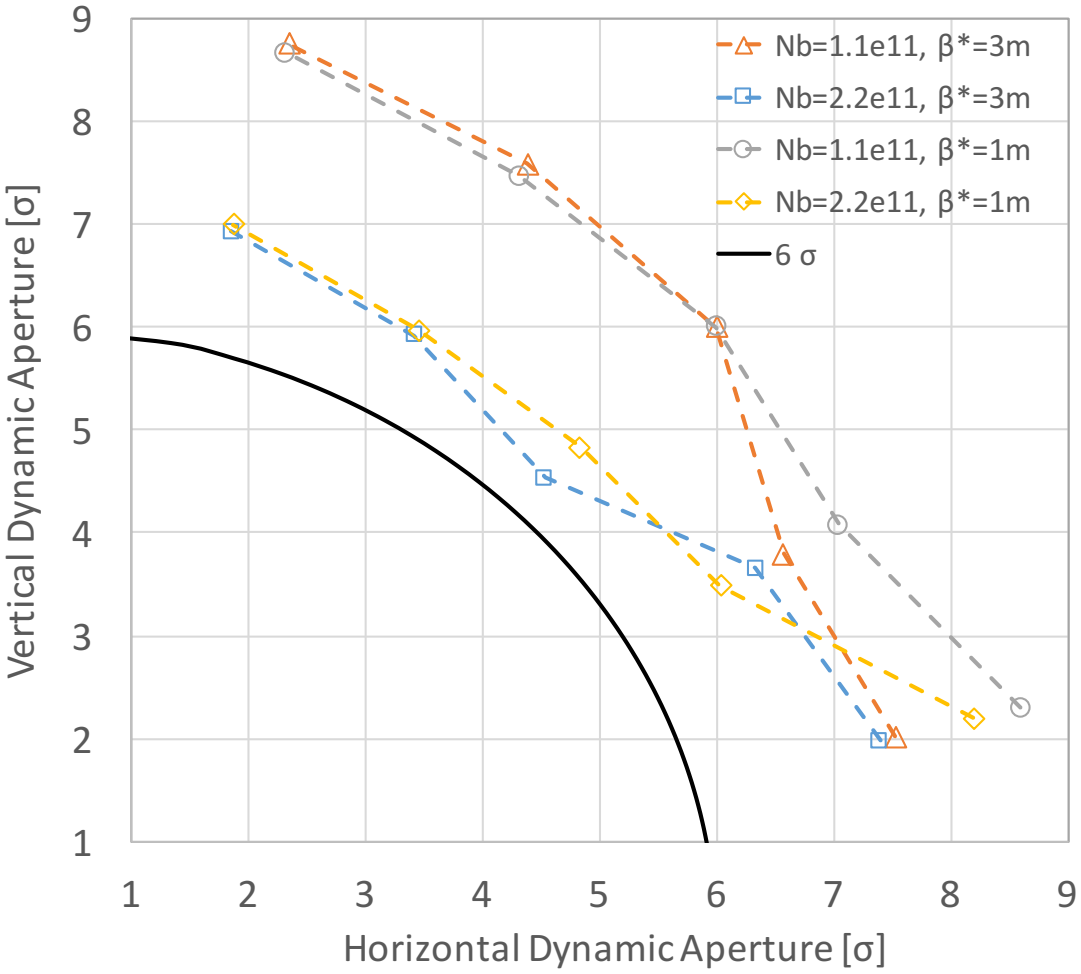
Crabs on - Positive polarity

- Minor impact on DA for crab-cavities switched on



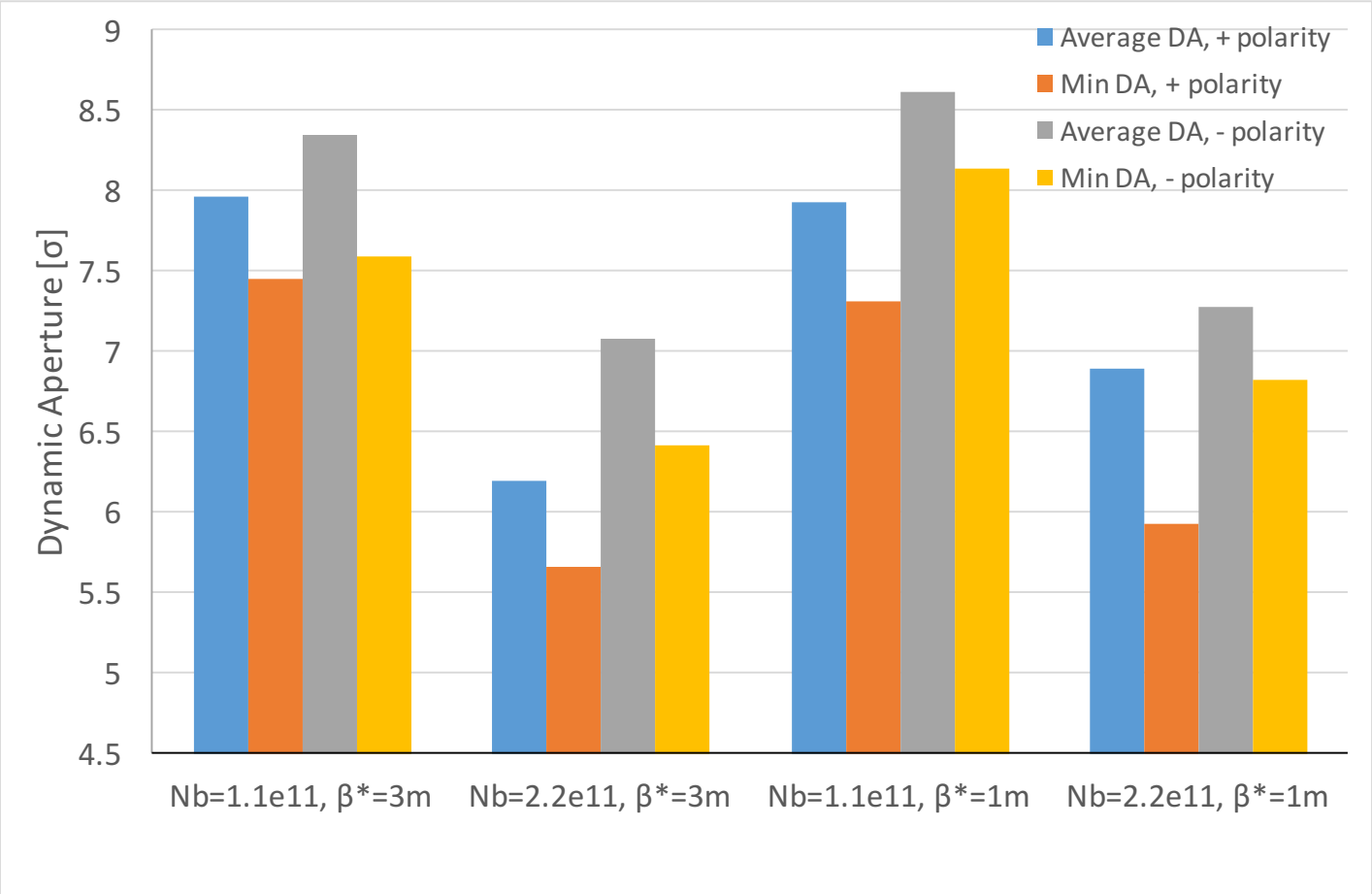
Crabs on– Negative polarity

- For negative spectrometer polarity, DA> 6 σ for all intensities



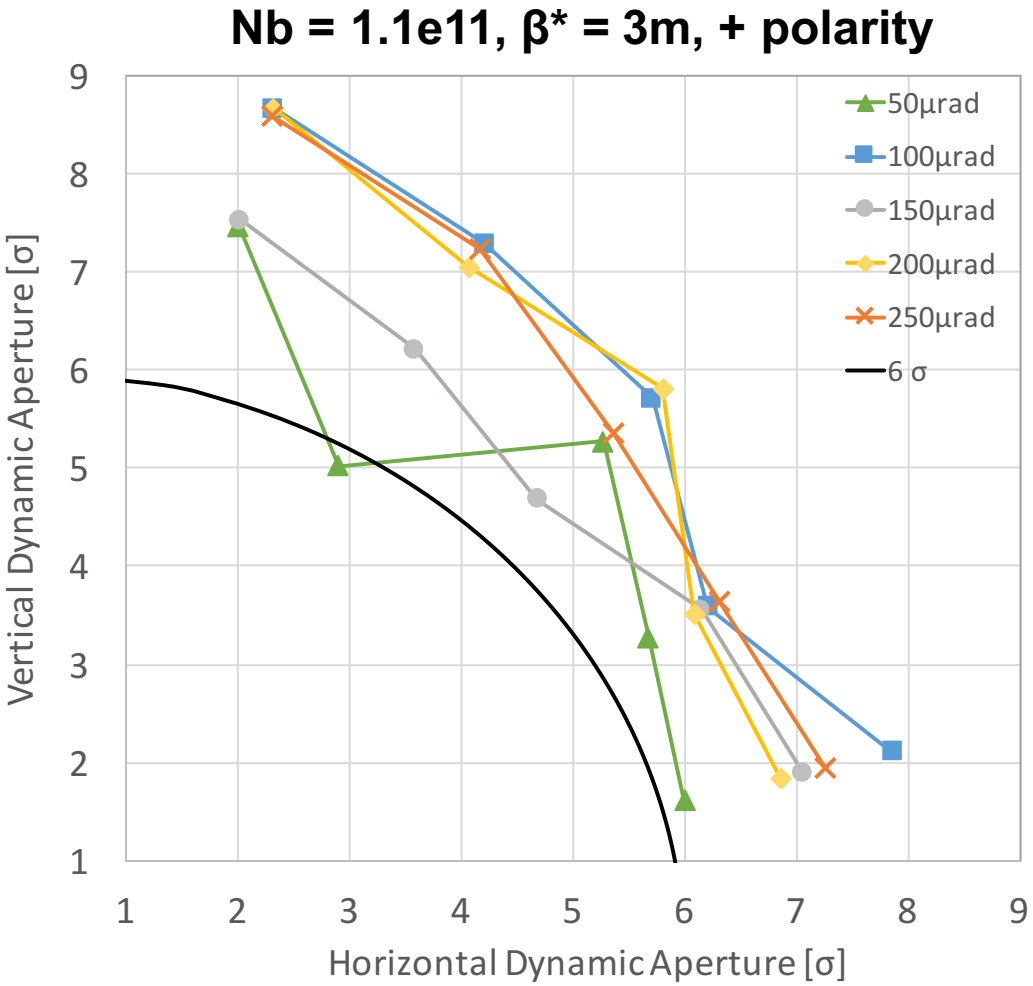
Crabs on - summary

- Overall higher DA (average and minimum) for negative polarity



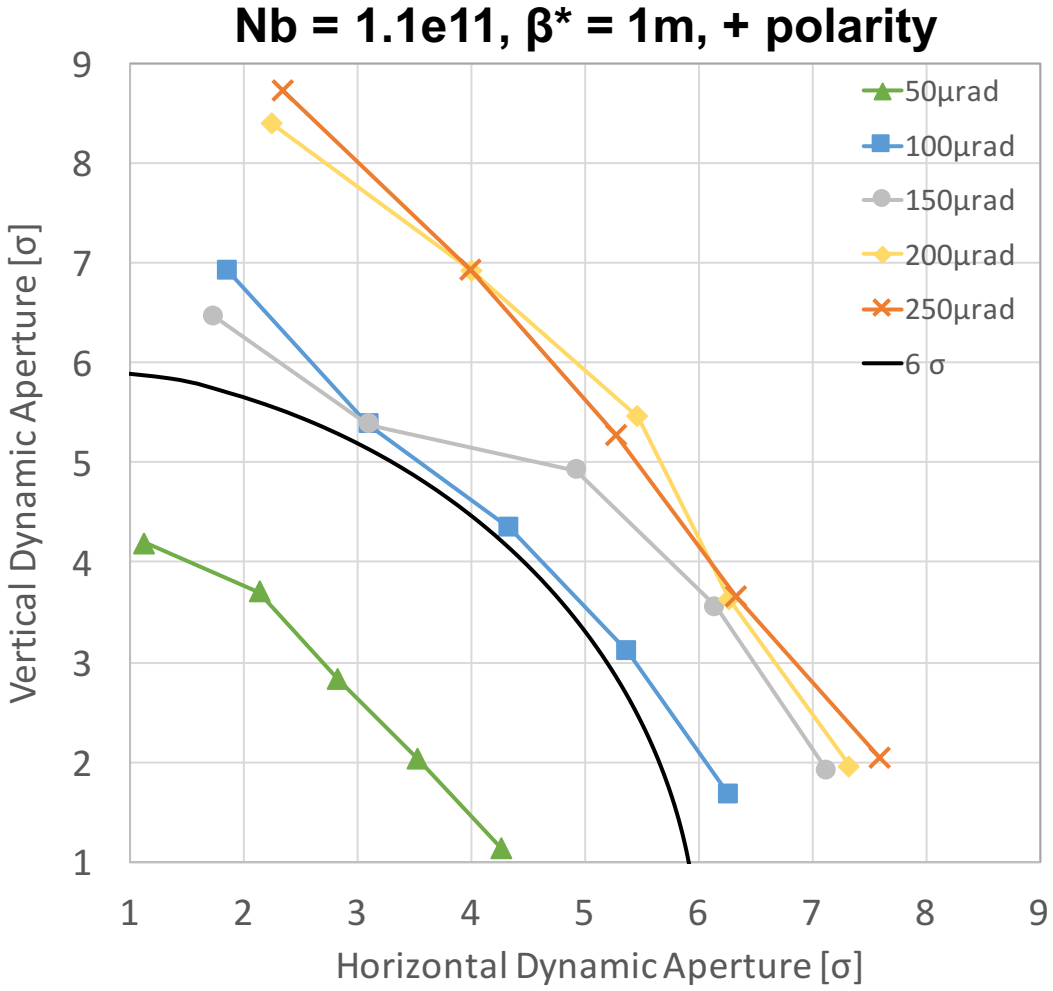
Crossing-angle scan

- Clear degradation of DA below -150 μrad, getting better for -100 μrad and worse for -50 μrad (following total crossing angle, which passes from -15 to +35 and finally +85 μrad)
- Only for crossing angle of 50μrad, DA close to 6σ



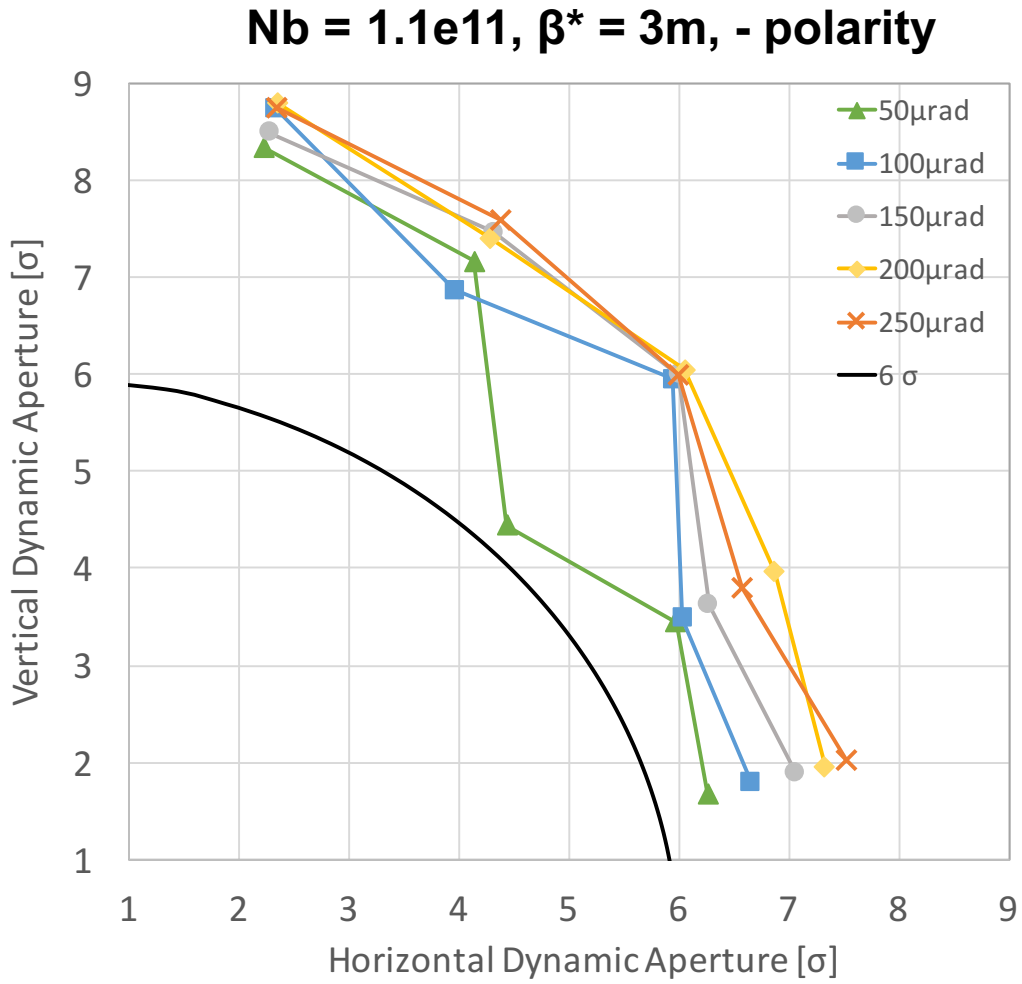
Crossing-angle scan

- Clear degradation of DA below -150µrad
- For crossing angle below -100µrad, DA < 6σ



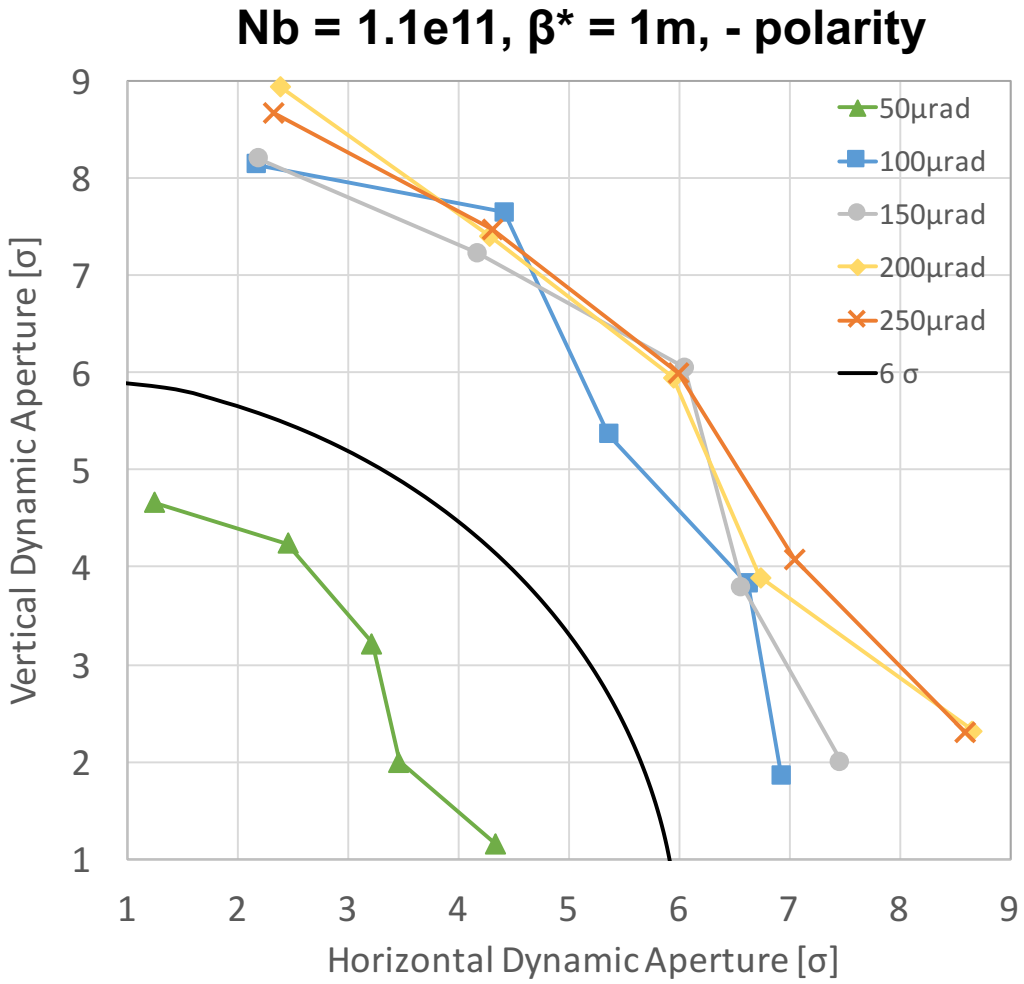
Crossing-angle scan

- DA not affected until external crossing angle of 50 μrad, (i.e. -185 μrad of total crossing angle)
- Only for crossing angle below 50 μrad, DA close to 6σ



Crossing-angle scan

- Clear degradation of DA below 100 μrad (total crossing angle of -235 μrad)
- Finner scan is needed to identify the limit



Summary – next steps

- Mild impact on DA between β* of 3m and 1m in IR8
  - For both spectrometer polarities and the nominal external crossing angle of 250 μrad
  - For both nominal and peak intensities,
  - With and without crab cavities
  - DA always above 6 σ, for nominal intensity
- Negative polarity provides always higher DA, due to total crossing angle increase
- Crossing angle scan:
  - From the preliminary analysis, there is an important DA degradation when external crossing angle is reduced to below 100 μrad (especially for positive polarity)
- Next steps:
  - Missing cases (for 2.2e11, β* = 2m), alternative crossing scheme
  - Inclusion of other non-linearities (octupoles, multi-pole errors)
  - Detailed beam dynamics analysis with other indicators

Thanks for your attention