# Sixtrack 6D bb lens update (Follow up BB meeting 7 Nov)

J. Barranco, T. Pieloni

# Hirata 6D Xsing

- Hirata mentions in his paper a disagreement between his approach and Piwinski's formalism. The main difference is the inclusion of the bunch length by means of slices. To understand the discrepancy he uses two parameters taking into account the luminosity an the beam-beam parameter in the boosted frame. (no dynamical effects included).

$$a = \frac{\sigma_y^*}{\sqrt{2}\sigma_z^*\sigma_{py}^*}$$

$$R_L = \frac{L}{L_0} = \sqrt{\frac{2}{\pi}} a e^b K_0(b)$$

Lumi w/o hour glass reduction or tilt effect

$$b = a^2\left[1 + \left(\frac{\overset{*}{z}}{\sigma_x^*}\tan\phi\right)^2\right]$$

Beam-beam parameter is the boosted frame

$$R_\xi = \frac{\xi_y}{\eta_y} = \int dz^\dagger \rho(z^\dagger)\sqrt{1 + (S/\beta_y^0)^2} \times f_Y(z^\dagger \tan\phi, \sigma_x^*(S), \sigma_y^*(S))$$

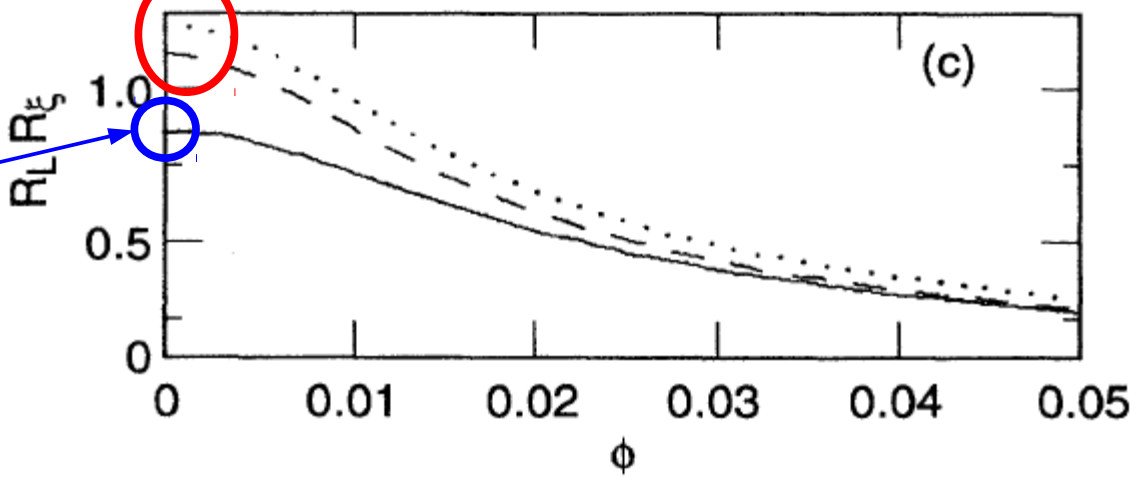
- From the equations above two parameters are important .For R≥1 the hour glass effect is important even for $\phi$=0. For $\Phi$≥1 the tilt effect is important.

$$R = \frac{\sigma_z}{\beta_{x,y}^*} \qquad \Phi = \phi\frac{\sigma_z}{\sigma_x}$$ *Piwinski Angle*

# Hirata 6D Xsing

$R_\xi$>1 for $\phi$=0. Due to hour glass effect the beam-beam interaction is more serious

$R_L$<1 for $\phi$=0. Luminosity is decreased due to the hour glass effect.



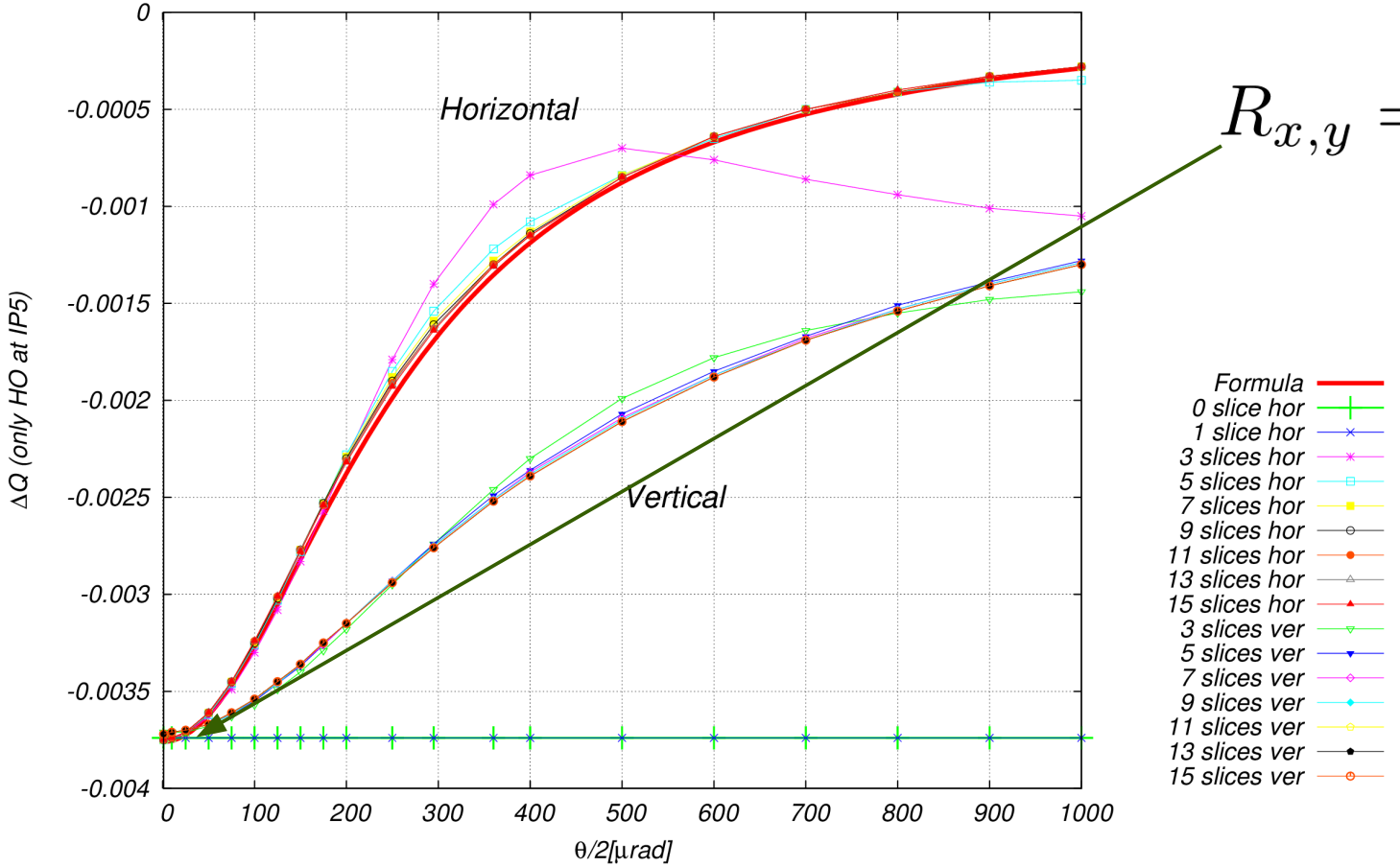

(c) the luminosity reduction factor $R_L$ (solid), the $\xi$ reduction factor $R_\xi$ for $z = 0$ particle (dashed), and the same for $z = \sigma_z$ particle (dotted). Vertical tune $\nu_y$ is 0.15. For the present set of parameters, $\phi = 10$ mrad corresponds to $\Phi = 0.707$.

**Luminosity and beam-beam parameter go in opposite directions for $\phi$=0 !!**

# LHC β*=55 cm

$$\xi_x = \frac{r_0 N_b \beta_x^*}{2\pi\gamma\sigma_{x,\mathrm{eff}}(\sigma_{x,\mathrm{eff}} + \sigma_y)}$$

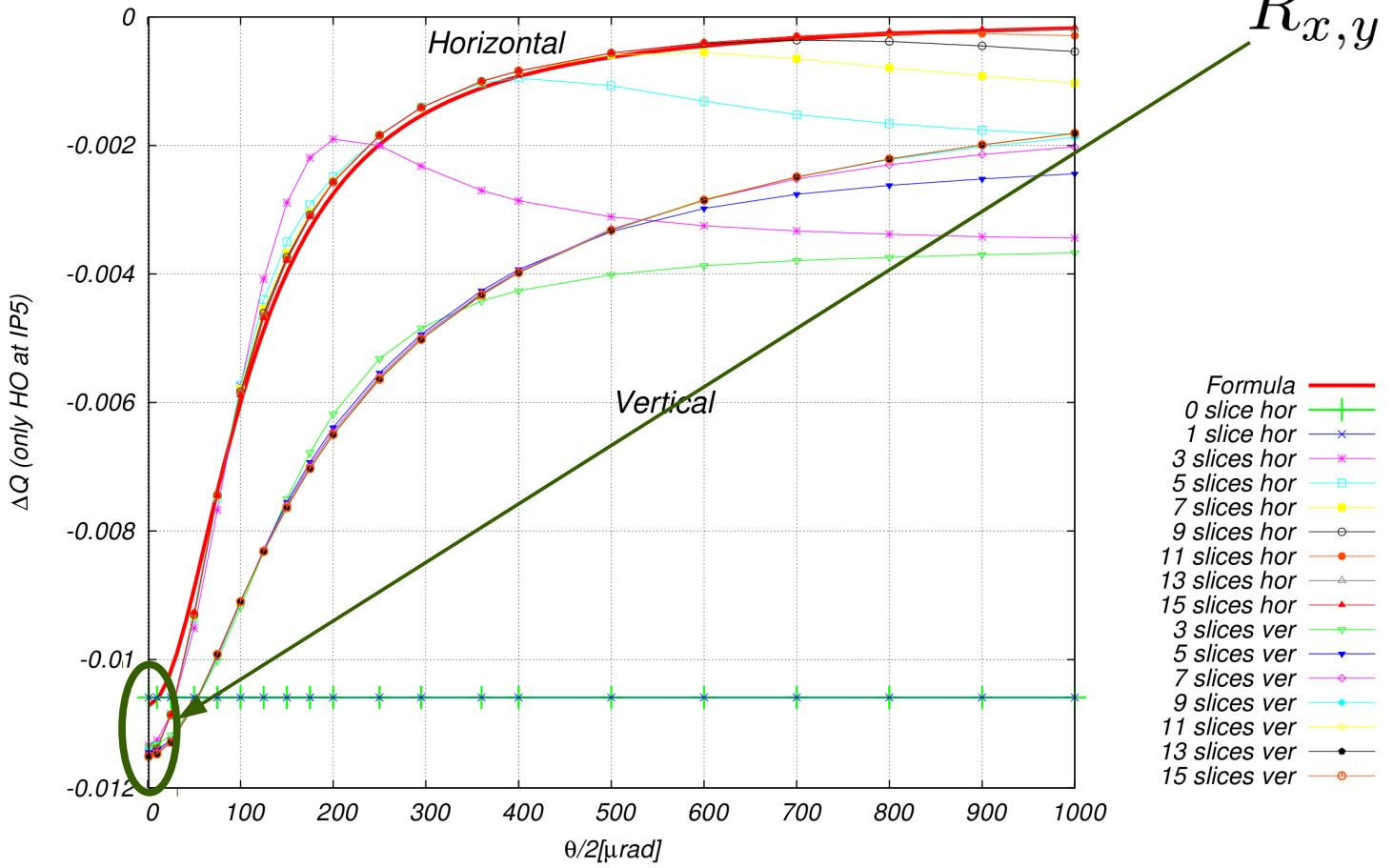
$$\sigma_{x,\mathrm{eff}} = \sqrt{\sigma_x^2 + \phi^2\sigma_z^2}$$




$$R_{x,y} = \frac{\sigma_s}{\beta_{x,y}^*} = 0.14$$

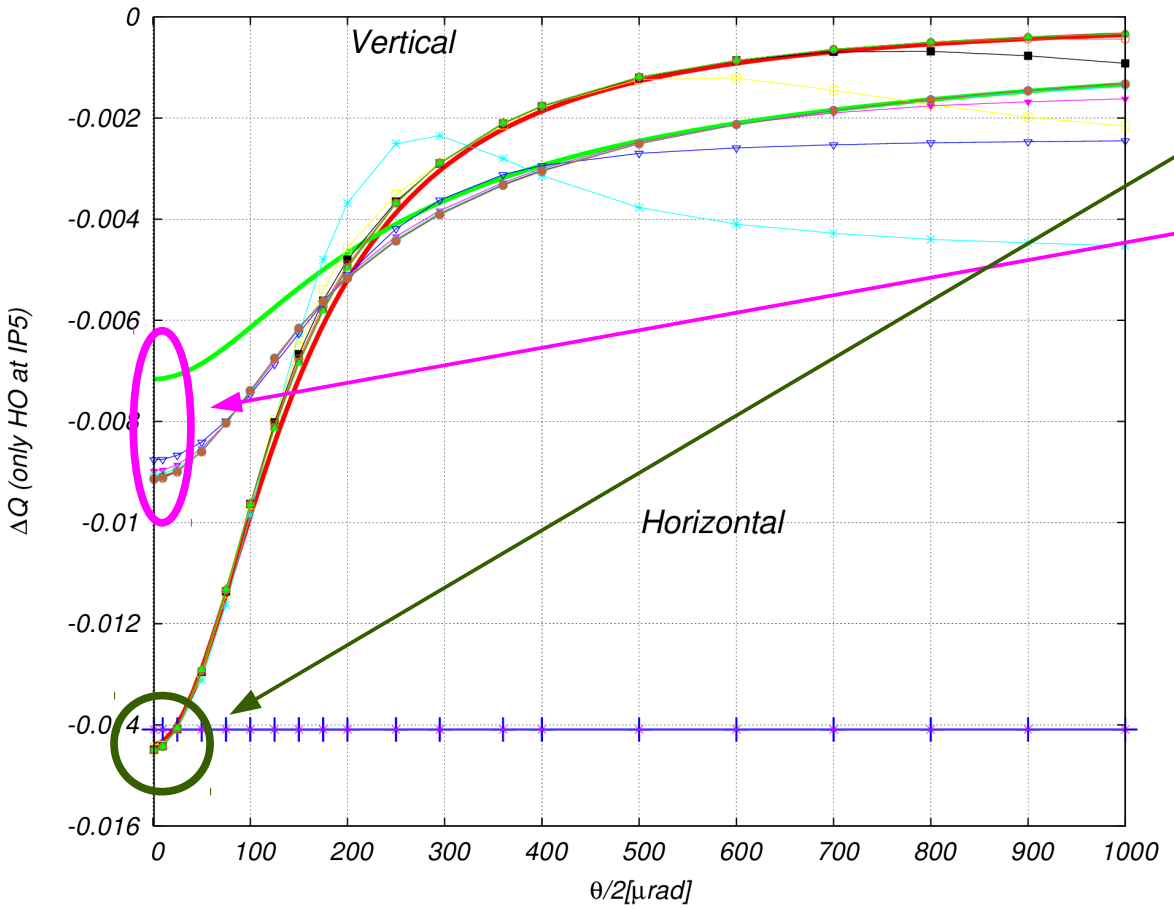
Converging for #slices ≥7

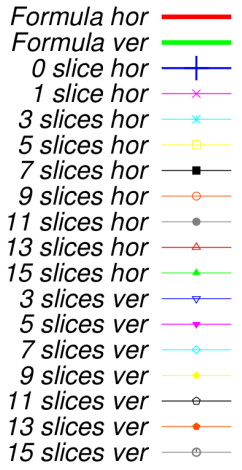
# HLLHC β*=15 cm




$$R_{x,y} = \frac{\sigma_s}{\beta^*_{x,y}} = 0.5$$

# HLLHC β*=30/7.5 cm

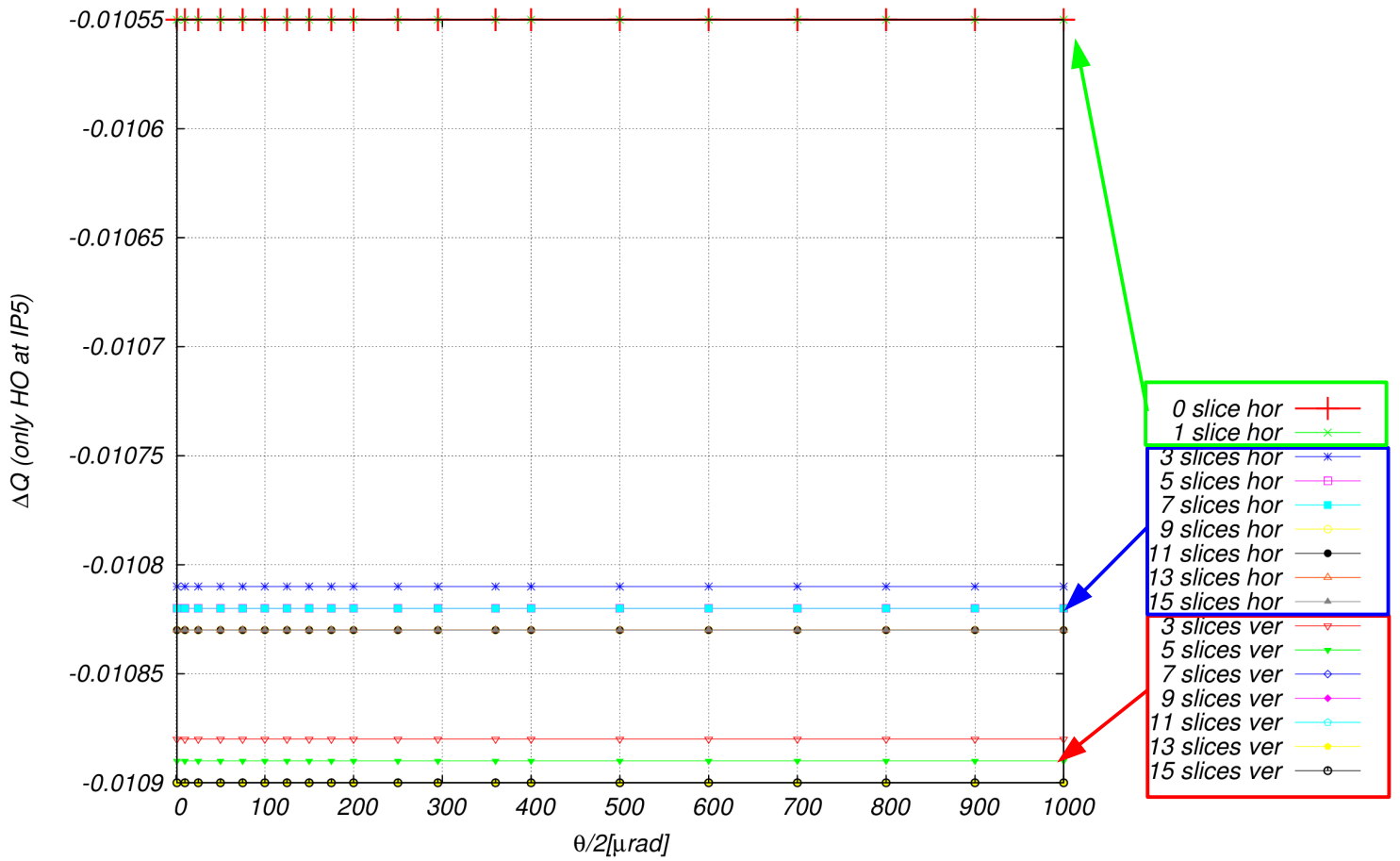



$$R_x = \frac{\sigma_s}{\beta_x^*} = 0.25$$

$$R_y = \frac{\sigma_s}{\beta_y^*} = 1.0!!!$$

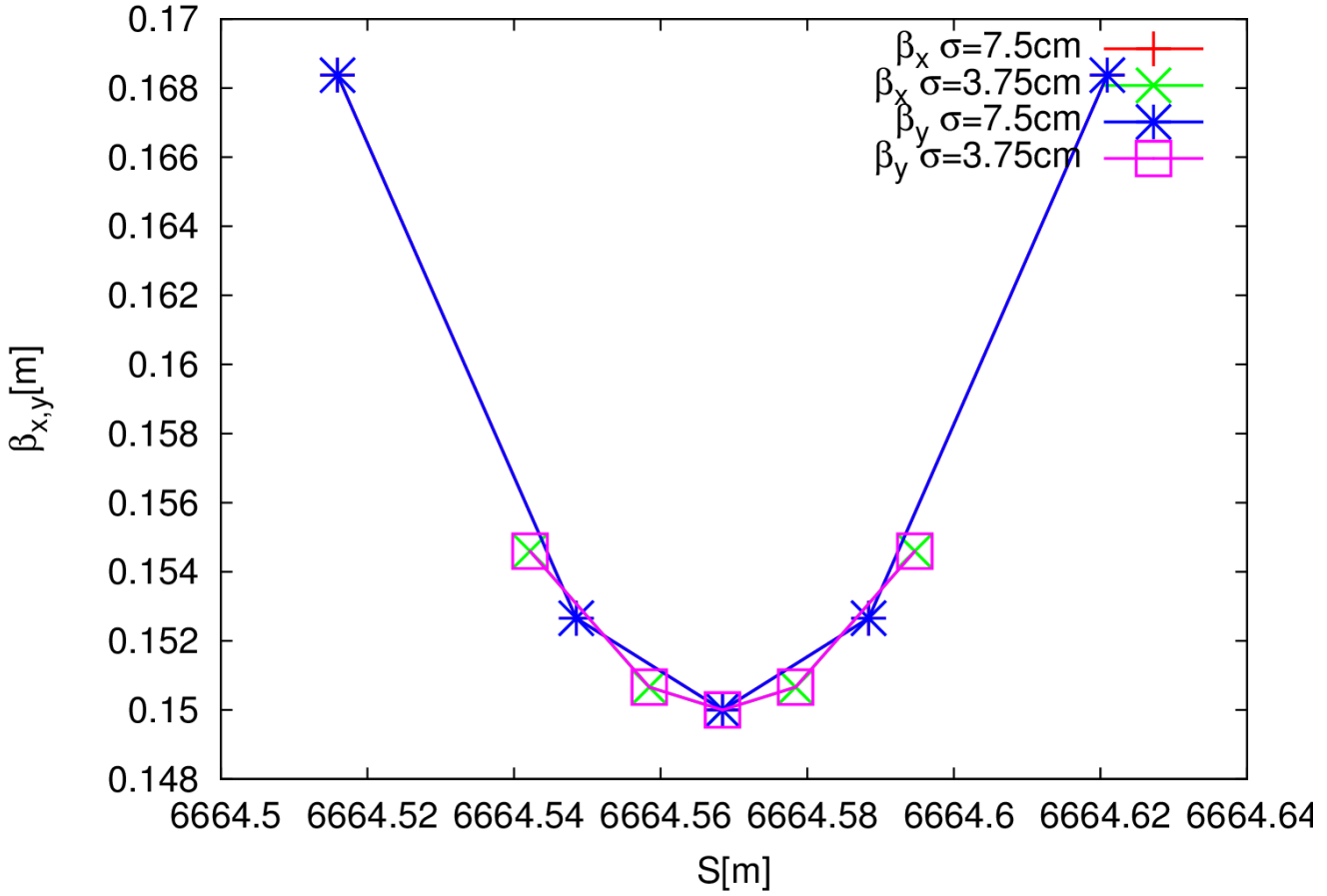
# Crab Crossing HLLHC β*=10 cm



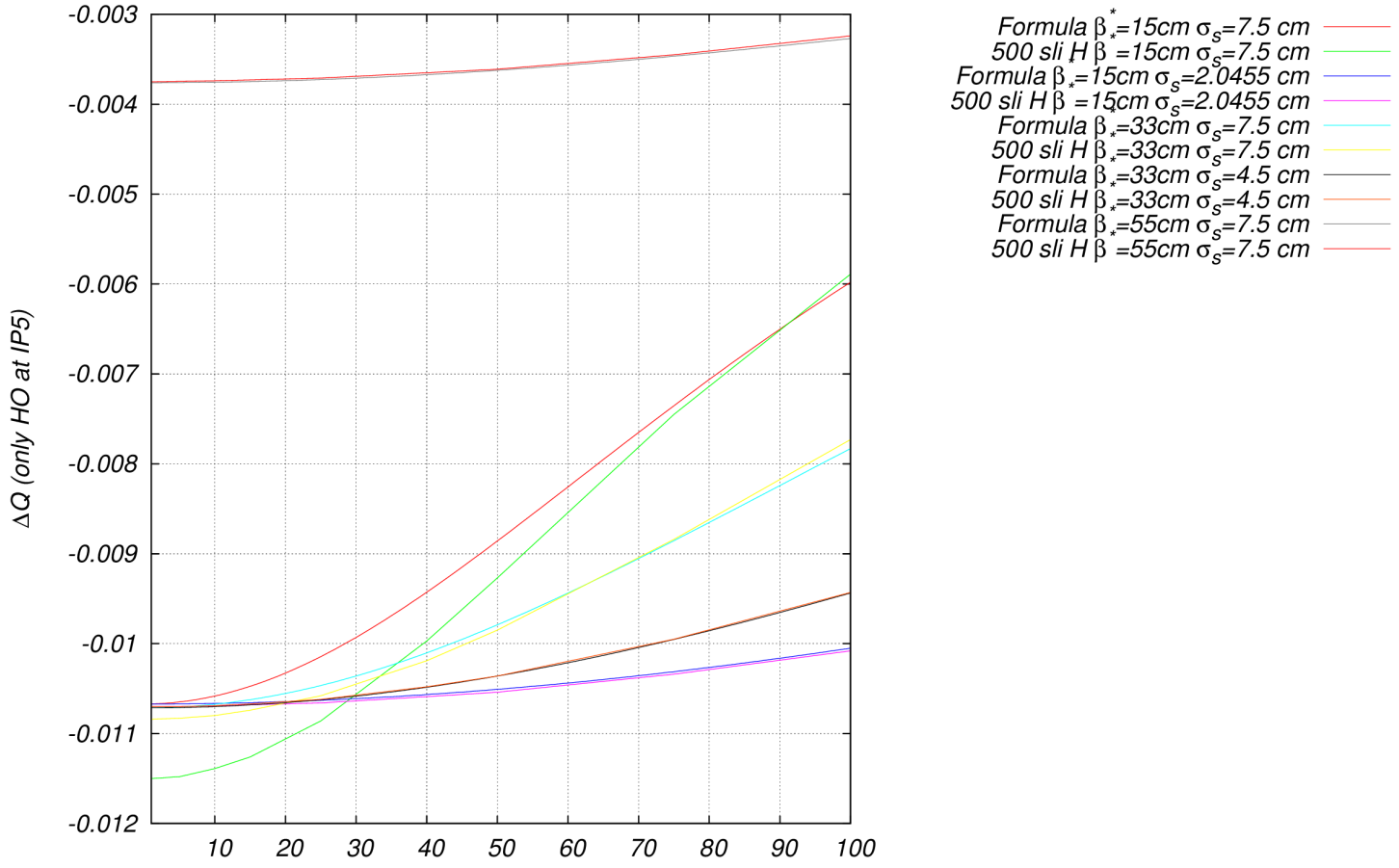

Still to better understood, first discussion could be due to the position of the slices/charge.

# 6D slicing vs bunch length

Location and beta function of the slices for different bunch lengths.

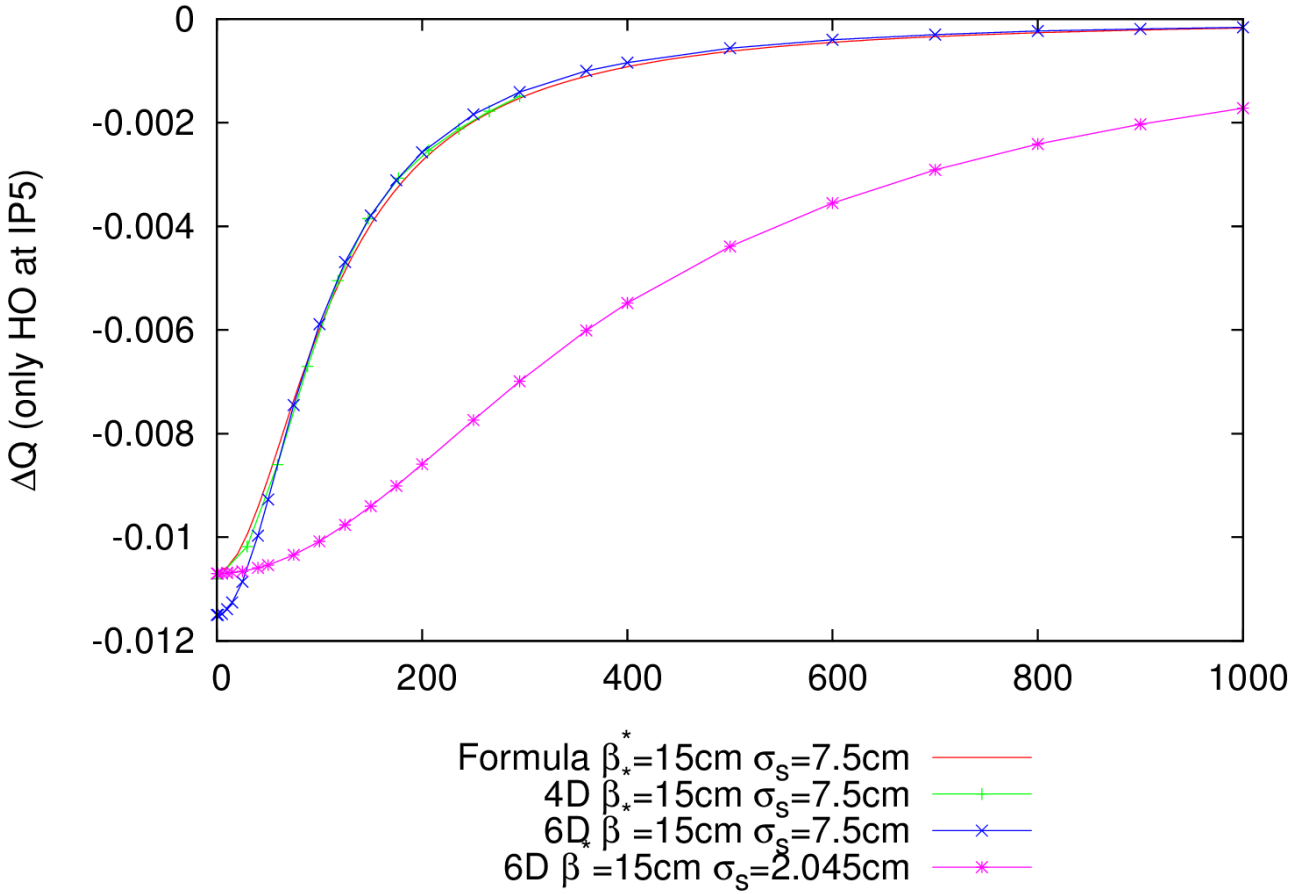


# 6D tune shift vs $\sigma_s$

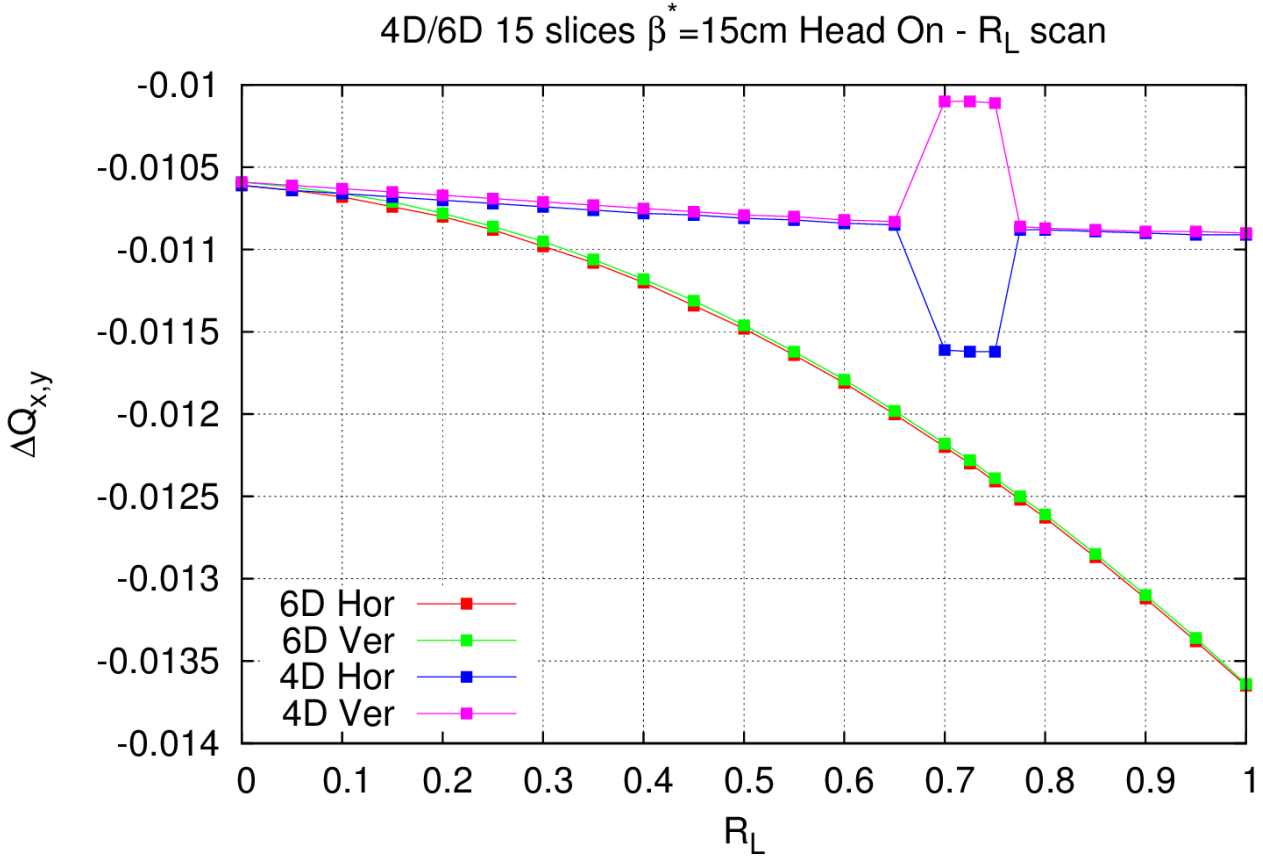



For a given β* the hour glass effect could be compensated with a certain bunch length.

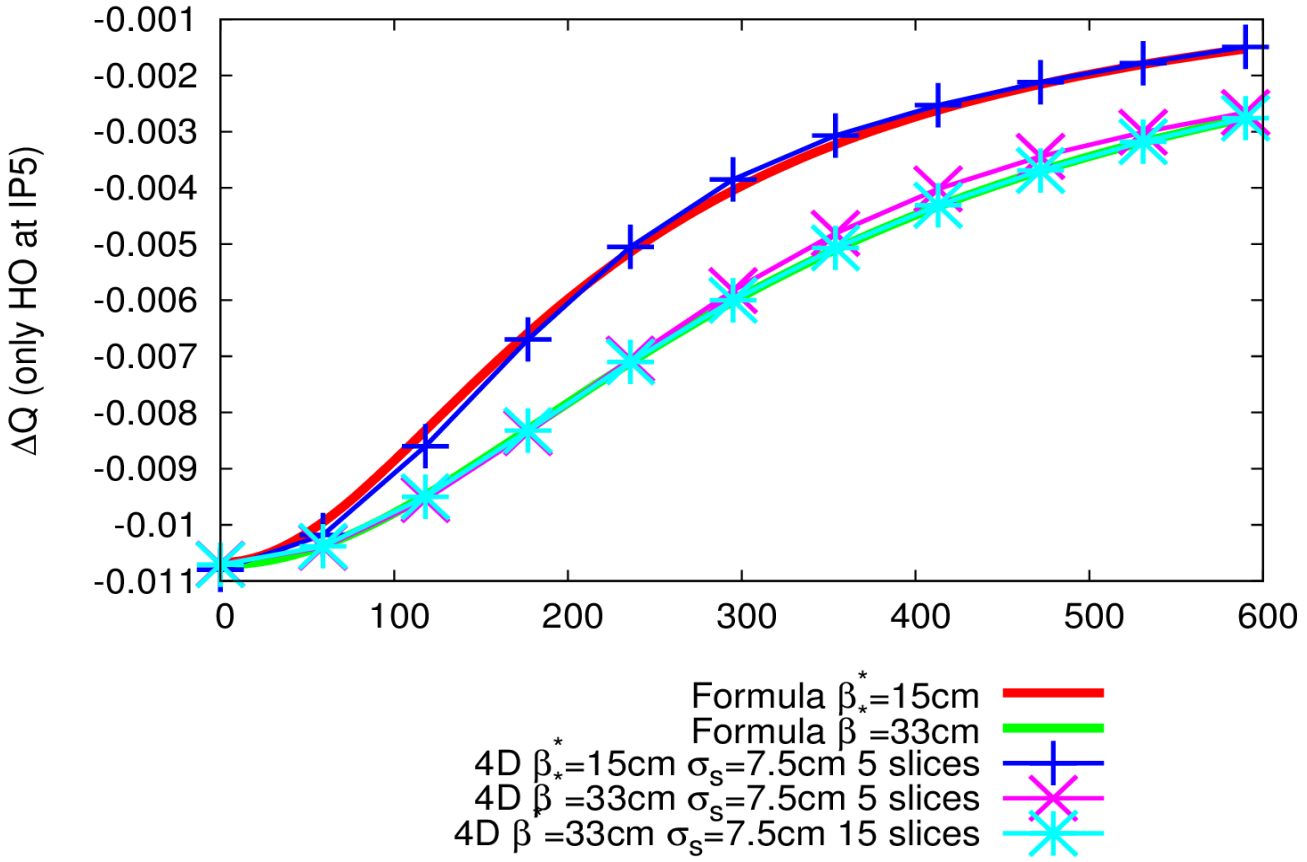
# 4D vs 6D tune shift



# 4D vs 6D tune shift



# 4D tuneshift




4D shows very good agreement with analytical formula when using enough number of slices.