Status of the traveling waist studies and future plans

Javier Barranco García, Eduardo Marín Lacoma, Rogelio Tomás

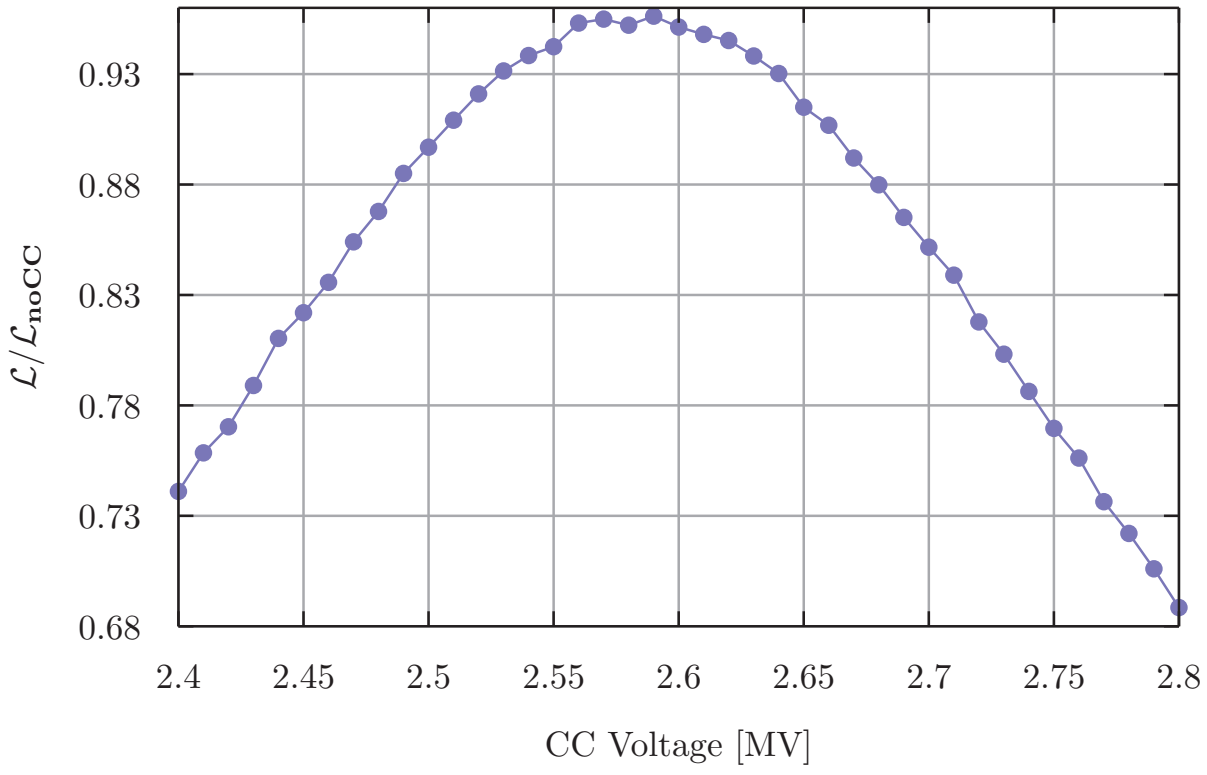
CERN, ABP/CC3

April 26, 2012

Reminder origin of the study

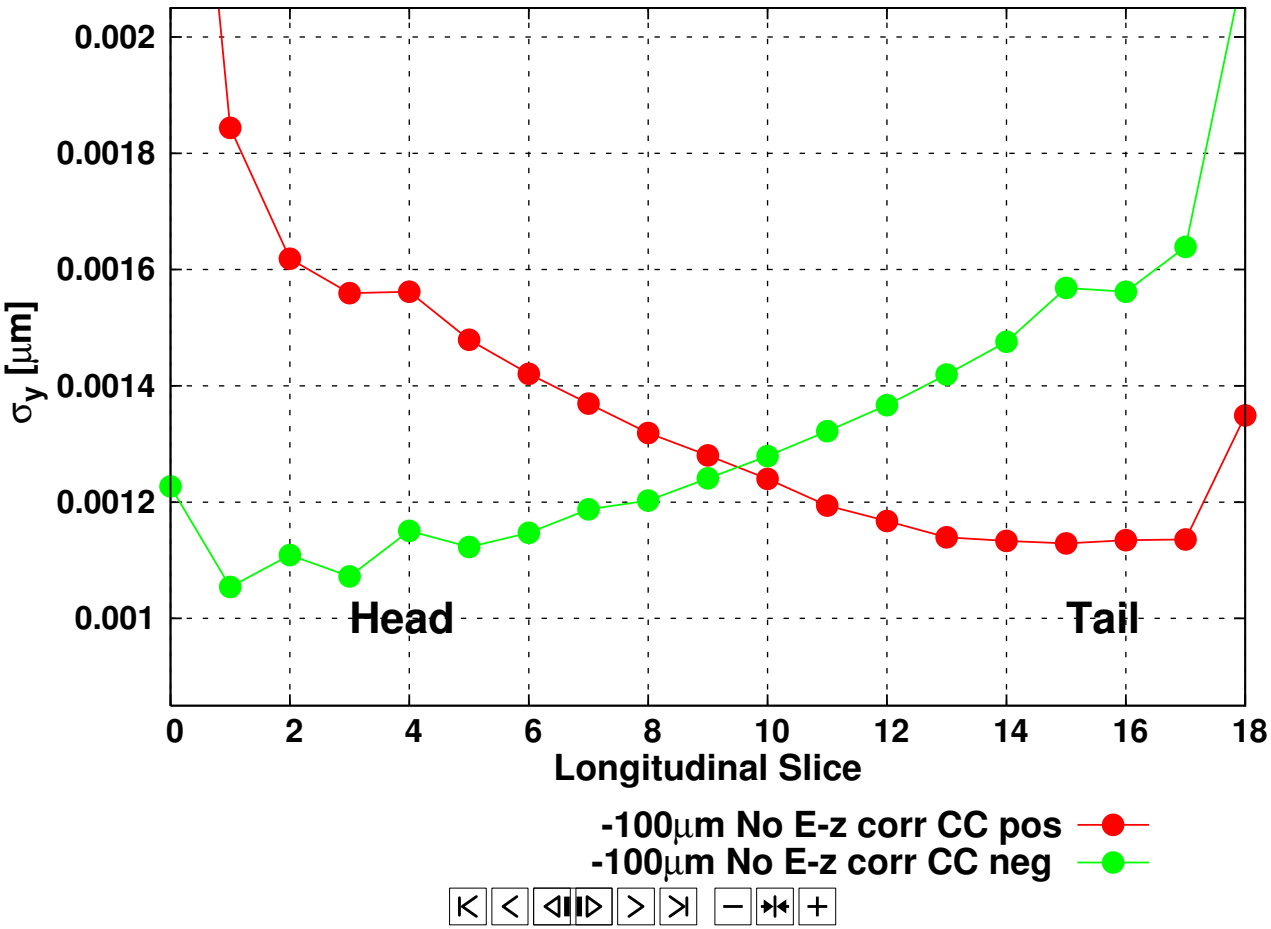
Loss of lumi first pointed out by **I. Shinton** in the 5th CLIC-ILC BDS+MDI meeting.

Maximum luminosity achieved for the expected voltage, previous discrepancies due to wrong value of R_{12}.



Traveling Focus for Different Crossing Angles

The reason for the luminosity loss is explained from the fact that for the current layout the traveling waist goes from tail to head. Simply (in paper) changing the crossing angle fully recovers the luminosity with respect to the head on collisions.

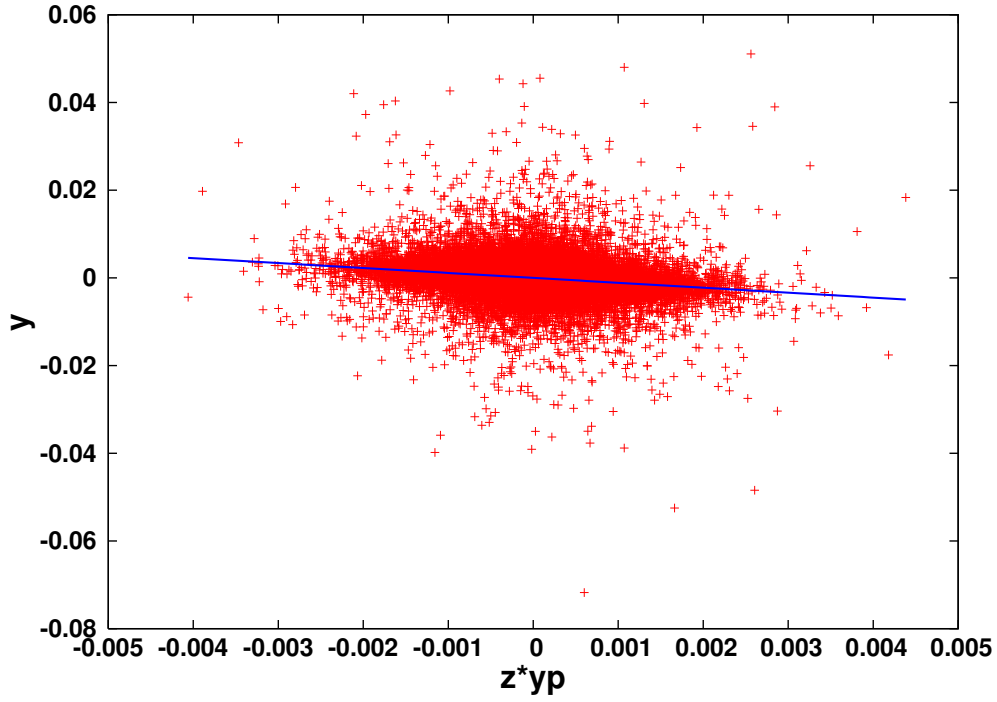


Traveling Waist Analytical Approach

Derived the analytical expression for the traveling waist,

$$\frac{\partial w_y}{\partial z} = \beta^* \sum_i^{\text{sext}} \sum_j^{\text{CC}} R_{12}^{\text{CC}_j\text{-sext}_i} \beta_{x_i} K_{s_i} L_{s_i} \cos\left(2\Delta\mu_y^{\text{sext}_i\text{-IP}}\right)$$

Good agreement with fitting after tracking with PLACET.



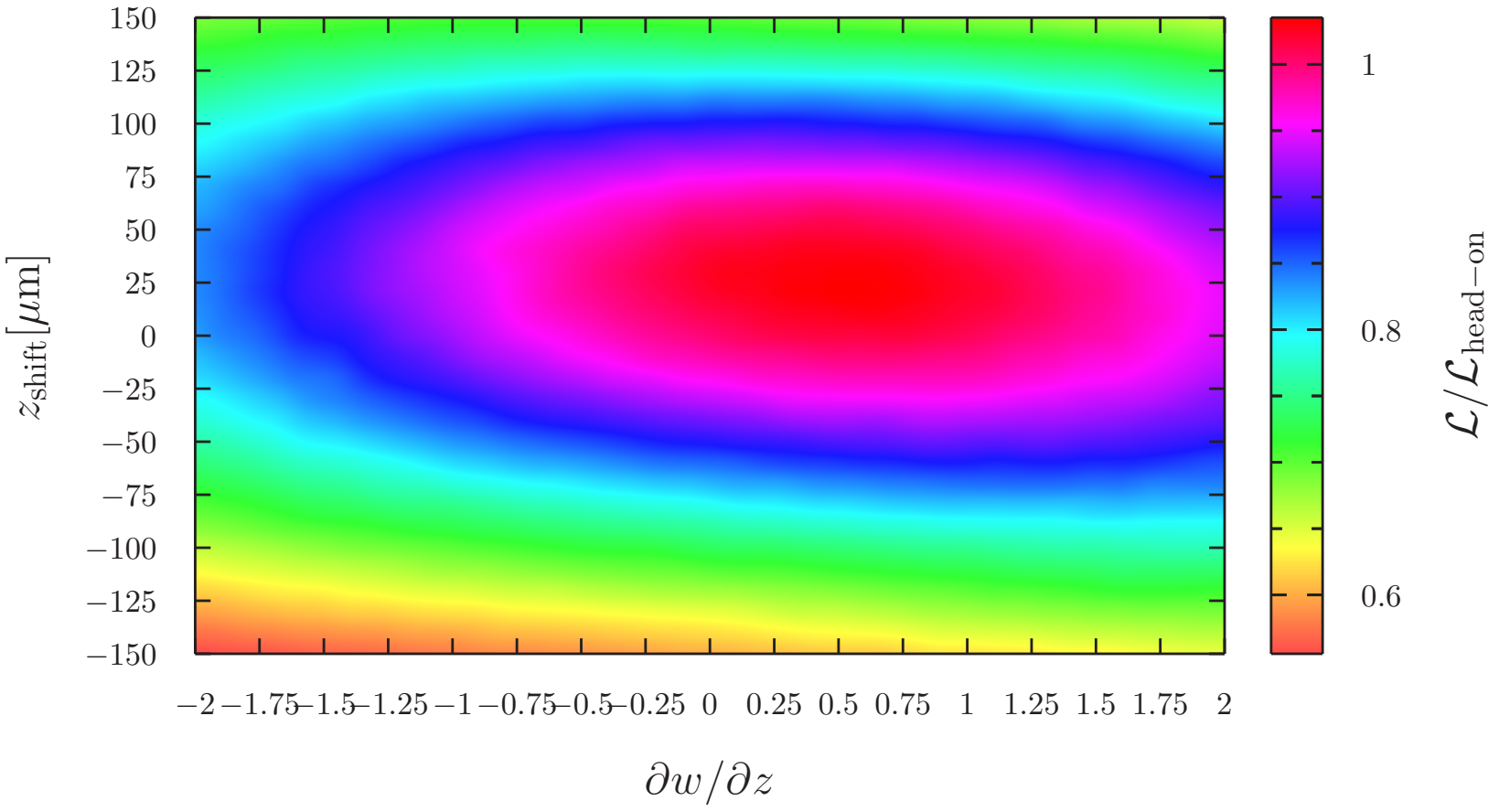
Exploring Possible Solutions

1. New locations for the CC (con: single klystron for both CC placed at the IP). Two locations found where the optics almost cancelled the traveling waist effect.

Case	$\Delta\sigma_x$[%] (MAPCLASS)	$\Delta\sigma_y$[%] (MAPCLASS)	$RE_{12}^{CC\text{-}IP}$[m] (MADX-PTC)	V_{CC} [MV] (P-GP)	$\partial w/\partial z$ [-] (P-GP)	$\mathcal{L}/\mathcal{L}_0$[%] (P-GP)
1a	0.05	0.50	10.33	5.68	-0.15	99.5
1b	6.80	0.15	17.86	3.31	-0.70	97.6
2	4.0	0.90	23.54	2.54	-1.01	96.2
3	0.3	0.04	-13.05	-4.58	0.20	99.5

2. 2 CCs with different polarity. Proposed by A. Seryi but not very elegant.
3. Change of the crossing angle for $\theta_c/2 = 10$ mrad $\rightarrow \theta_c/2 = -10$ mrad. Civil engineering reviewed, no major problems included. Recovers up to 99.7%.

Traveling Focus and Waist Shift



Nominal CC location $\Rightarrow \dfrac{\partial w}{\partial z} \approx -1.2 \longrightarrow \Delta\mathcal{L}/\mathcal{L}_{\mathsf{headon}} \approx -9.5\%$ (v_10_01_25)

Nominal CC location $\Rightarrow \dfrac{\partial w}{\partial z} \approx -1.2 \longrightarrow \Delta\mathcal{L}/\mathcal{L}_{\mathsf{headon}} \approx -5.0\%$ (v_10_10_11)

Conclusions & Future Plans

- Currently finishing a paper documenting the study and main results.
- For the version v_10_01_25 waist displacement to $1\sigma_z$ needed. Now $\Delta w = -2\mu$m. As rule of thumb any future BDS design should have the waist at 1 sigma (44μm) before the IP and correct evolution of the traveling waist ($\partial w/\partial z < 0$) for our sign convention. Beam size optimization with MAPCLASS does not leave much room for lumi increase with traveling waist.
- In general all tolerances studies should be revaluated with the crab cavity as any orbit in the final sextupoles would affect the traveling waist.
- On a different subject, plans to implement an improved Simplex (quasi gradient method). In discussion with Barbara.