Traveling focusing

Toshiyuki Okugi 2020/11/30 IDT WG2 crab cavity meeting

Crab crossing

Horizontal position difference to compensate the crossing angle of the two beams is generated by using the crab cavity.



- > The horizontal position difference at IP is maximum, when the phase advance between the crab cavity and IP is $\pi/2$.
- Amplitude of the position difference can be controlled by changing the amplitude of the crab cavity.

Traveling Focusing

Focus position is shifted from the bunch head to the bunch tail.





- > The traveling focusing is effective to reduce the hour-glass effect, especially for $\sigma_z > \beta_y^*$. The hour-glass effect is not so strong for ILC250, but we have a few % of the luminosity improvement by the hour-glass effect ($\sigma_z = 300 \mu m$, $\beta_y^* = 410 \mu m$).
- Since a beam is crossing to another beam with smaller beam size, the beam-beam effect is stronger.



Horizontal beam orbit at FD is changed from the bunch head to the bunch tail

> The vertical focal position was shifted from the bunch head to the tail.

	Z	Original		Alternative Waist		shift
Bunch head		$\Delta\sigma_x$ at QF1	$\Delta w_y/\sigma_z$ at IP	$\Delta\sigma_x$ at QF1	$\Delta w_y/\sigma_z$ at IP	Þ
	$+600 \ \mu m \ (+2\sigma_z)$	+1.30 μm	+0.14	+13.1 μm	+1.03	Weak focusing
	$+300 \ \mu m \ (+1\sigma_z)$	$+0.65 \ \mu m$	+0.07	+6.6 μm	+0.51	
	0	0	0	1	0	
Bunch tail	$-300 \ \mu m \ (-1\sigma_z)$	$-0.65 \ \mu m$	-0.07	$-6.6 \ \mu m$	- 0.51	
	$-600 \ \mu m \ (-2\sigma_z)$	$-1.30 \ \mu m$	-0.14	-13.1 μm	- 1.03	focusina
				Crab crossing		. ,

Crab crossing

Crab crossing

Traveling focusing
(almost optimum amount)

But, we cannot change the strength of crab crossing and traveling focusing independently.

Comments

- The concept of traveling focusing and the crab cavity are not originally related. (crab cavity + sextupole) is one of the methods to realize traveling focusing.
- Traveling focusing and crab crossing have different purposes, so it is desirable to be able to adjust them independently.
- It seems to be an accidental coincidence that the waist shift of the traveling focusing with the 7mrad of the crab crossing at s = 77m is exactly matched to the optimum amount. And we could not change the amount of the crab crossing and the traveling focusing independently.
- ➤ In order to make traveling focusing to be independent with the crab crossing, a club cavity must be placed at the virtual IP location. The virtual IP is shifted by the beam optics and the errors. Then, we did not introduce traveling focus in the TDR. We should evaluate the error sensitivities of the traveling focusing for s=77m.
- The current design does not use traveling focus, but 10-15% luminosity increasement, compared to when the beam waist is set on the IP can be expected by shifting the entire beam waist position from the IP.
- Even if the traveling focusing is performed, the increase in luminosity is about a few % to the current design.