



# Setting Up Simulations of Failure Scenarios for a Crab Cavity in the Nominal LHC

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Crab Cavities (CC's) can recover the geometric reduction of luminosity due to a crossing angle

The transverse kick of a crab cavity can be represented as

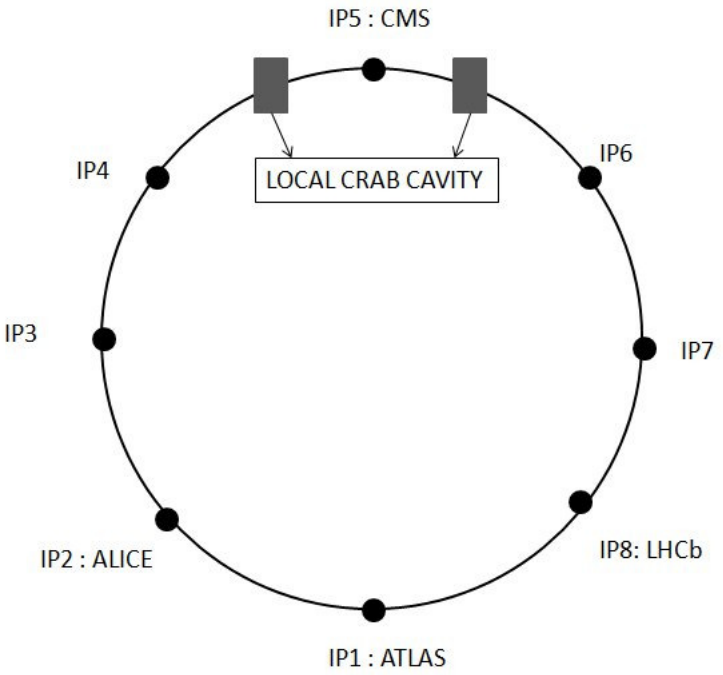
$$\Delta p_x = -\frac{cqV}{E_s}\sin\left(\phi_s + \frac{\omega z}{c}\right) \qquad (1)$$

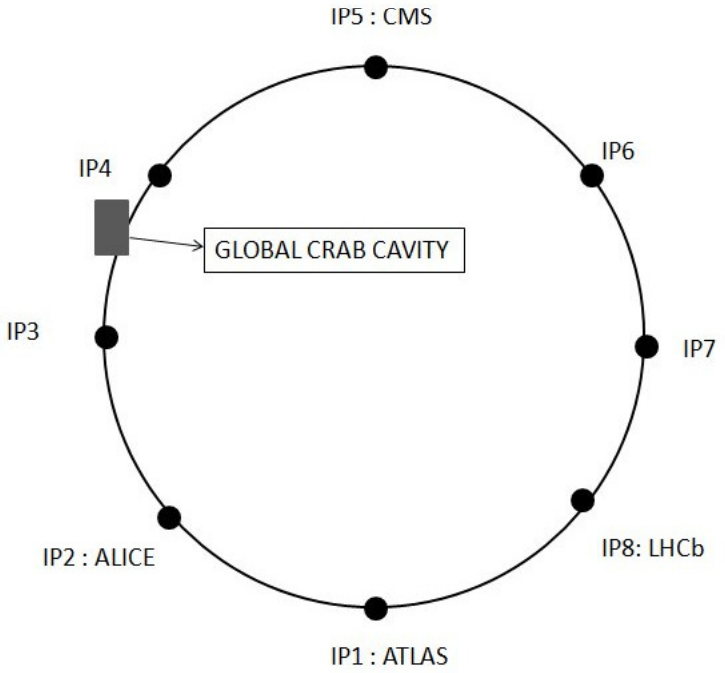
where

$V$ denotes the CC voltage of the CC, $\phi_s$ the synchronous phase, and $\omega$ the crab-RF angular frequency

For the LHC-CC failure scenarios we should consider two different schemes:

- Local Crab Cavity (LCC)
- Global Crab Cavity (GCC)



The simplest case is a single GCC. To simulate a crab-RF failure we vary the crab-RF voltage and the crab-RF phase.

The nominal crab voltage is

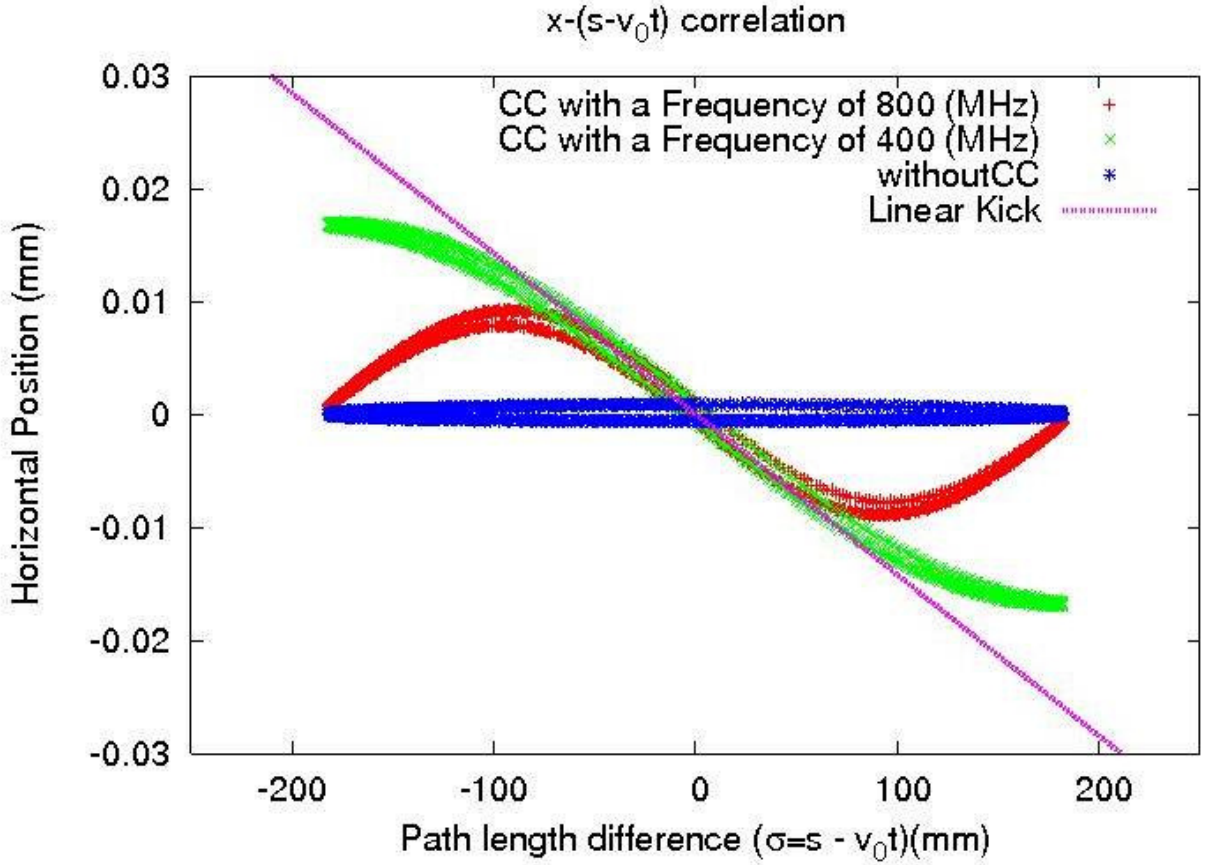
$$V = \frac{cE_s \tan(\frac{\phi}{2})}{q\omega\sqrt{\beta^* \beta_{crab}}} \left| \frac{2\sin(\pi Q_x)}{\cos(\Delta_1 - \pi Q_x)} \right| \qquad (2)$$

*where* $\omega$ *CC angular frequency;* $\Delta_1$ *= the betatron phase difference between the CC and the IP;* $\beta_{crab}$ *= the beta function at the CC and* $\beta^*$ *= the beta function at the IP.*

V= 9.07 MV for the chosen location in IR4

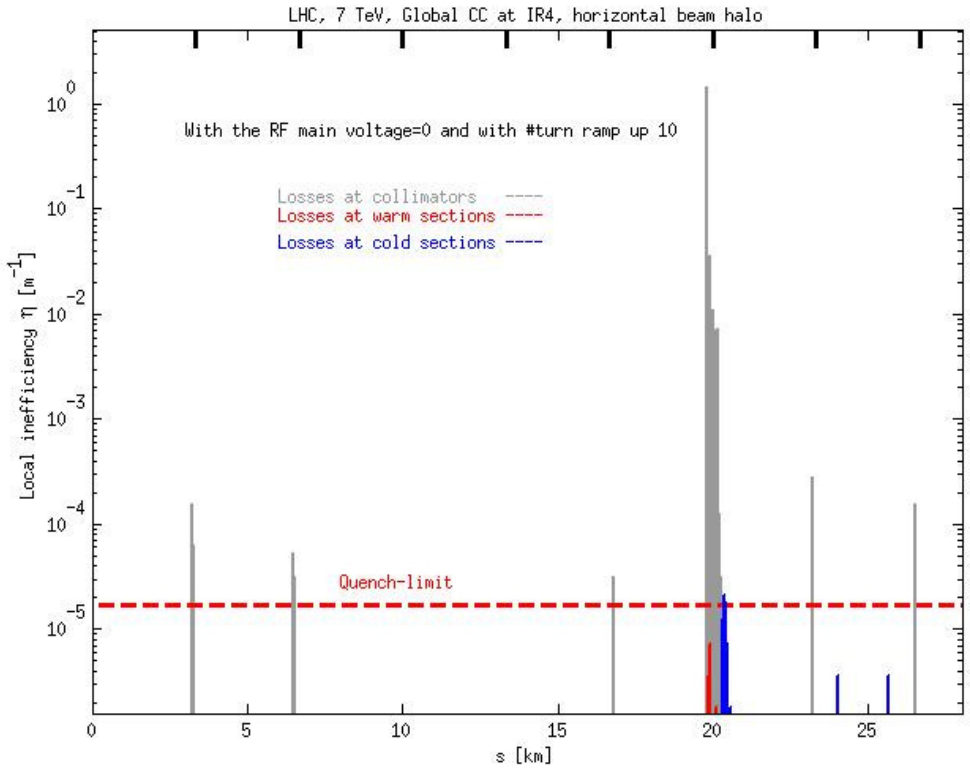
| Parameters | Units | Value |
|---|---|---|
| $Q_x$ | | 64.31 |
| $\beta^*$ | m | 0.55 |
| $\beta_{crab}$ | m | 255.96 |
| $\Delta_1$ | deg | 79.46 |
| $\phi$ | n deg | 16.32 |
| $\omega$ | MHz | 800 |

Check global crab cavity  functioning in Sixtrack.




*this look OK !*

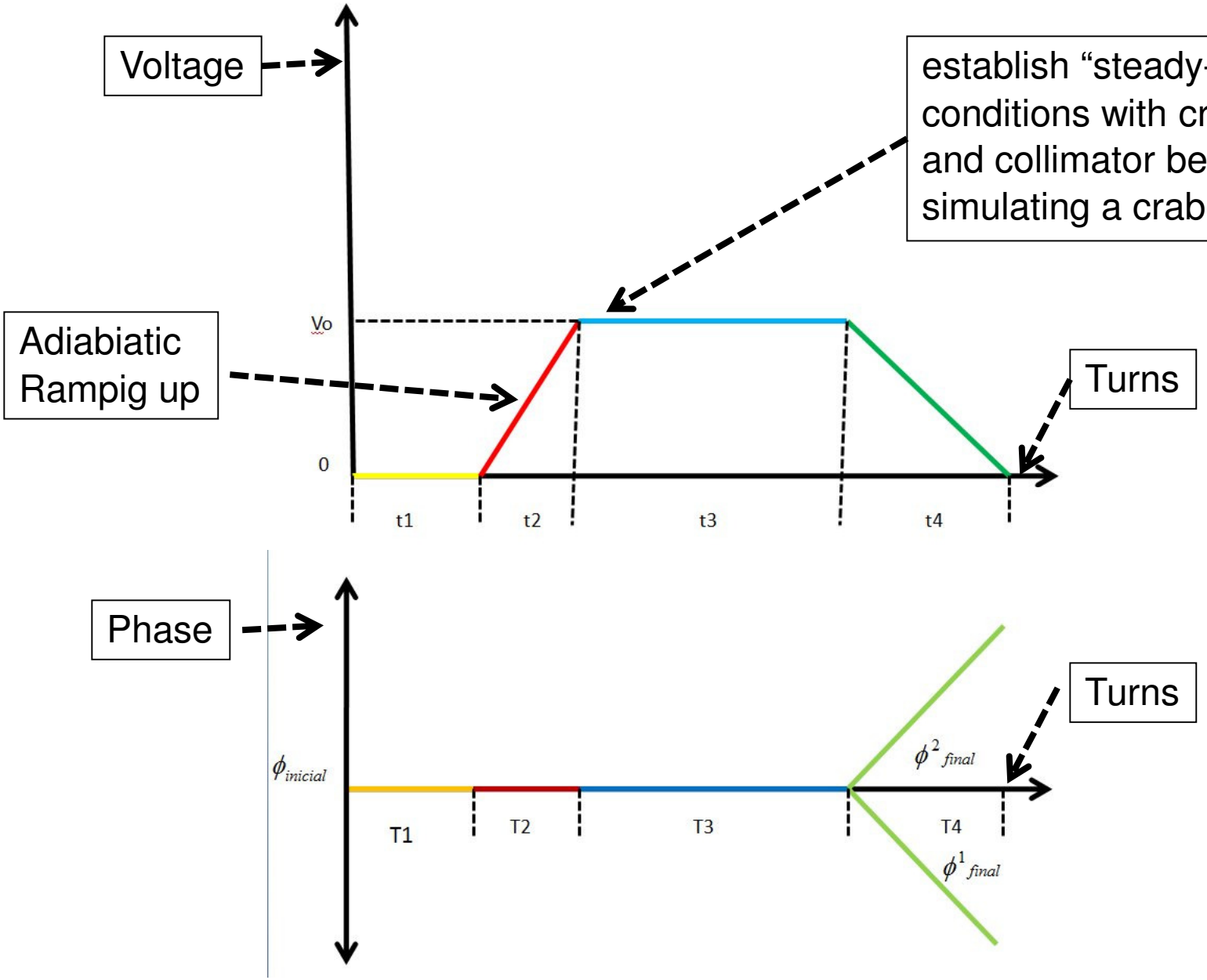
Prior to studying crab failure scenarios, we try to reproduce collimation inefficiency loss maps with crab cavities already performed by Yipeng (PRST-AB). For these tests, typically only a halo close to the primary collimators are tracked.



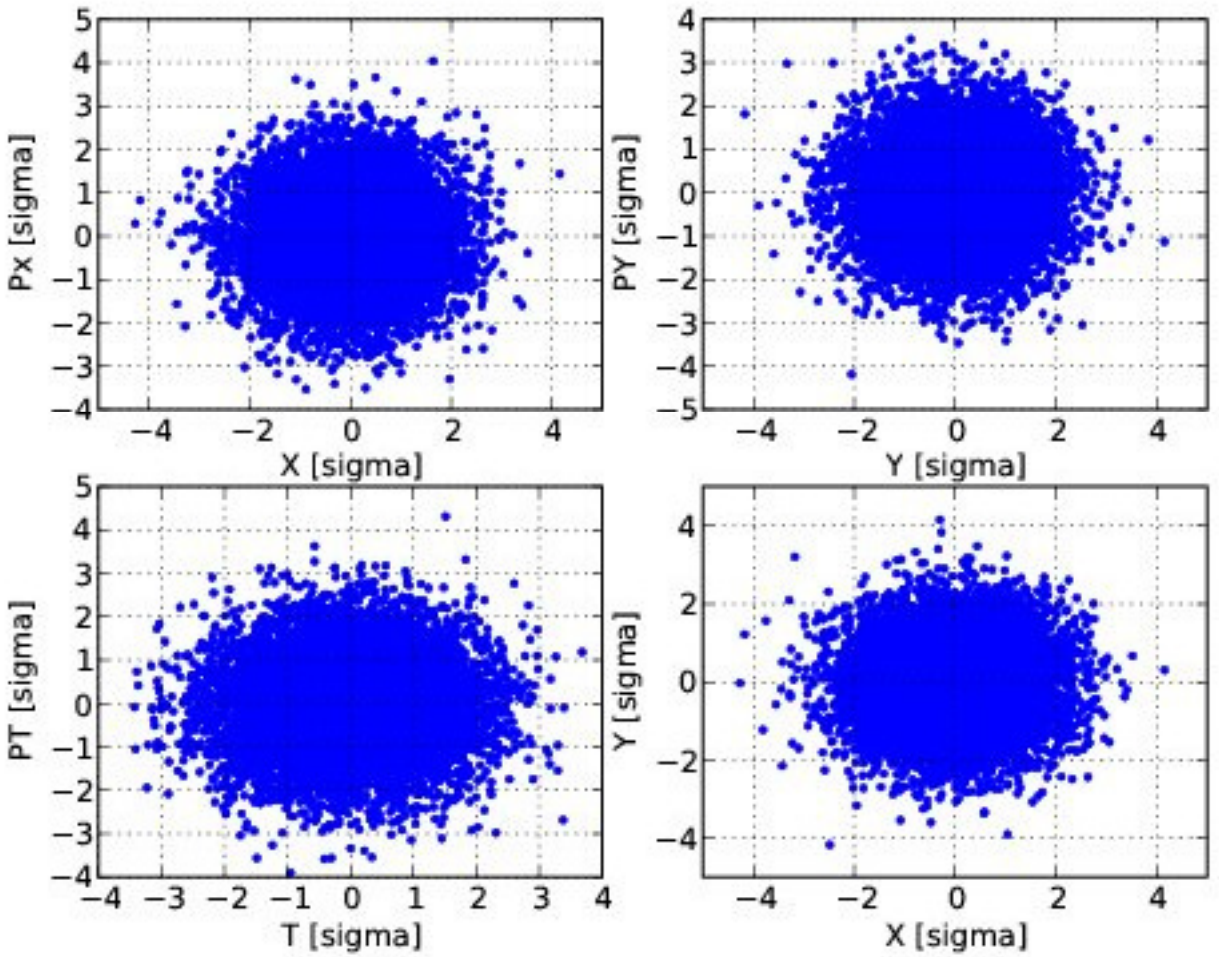

Its in agreement with the previous results too.

For failure scenarios, we will perform tracking on a full bunch with different distributions.

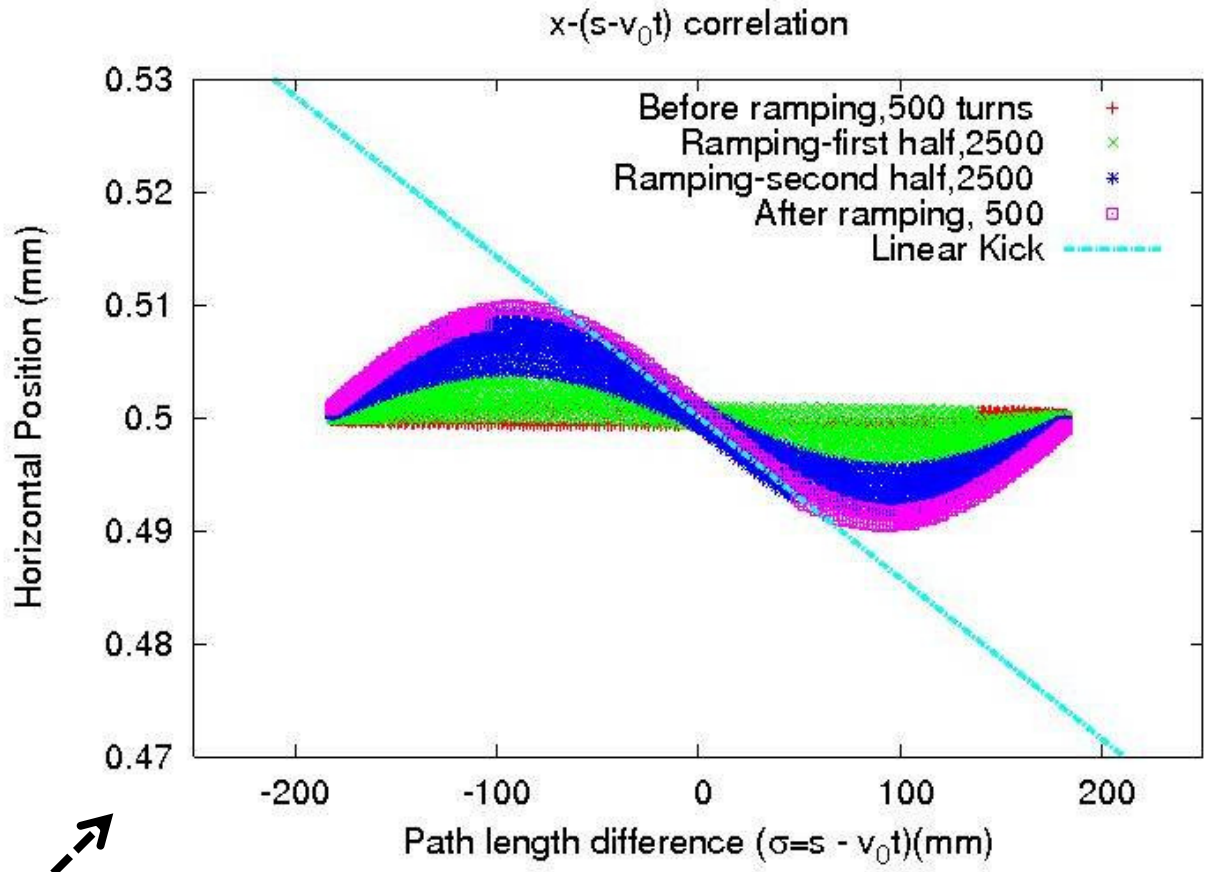
# simulation set up for changing CC voltage and phase



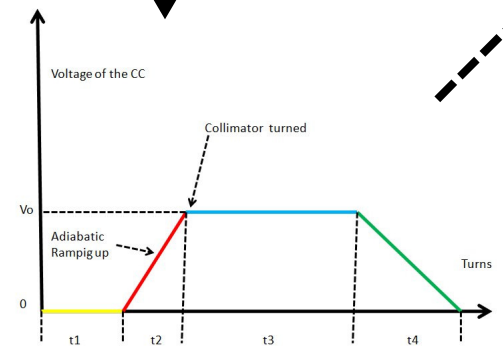
Example of initial particle distribution used as input for Sixtrack



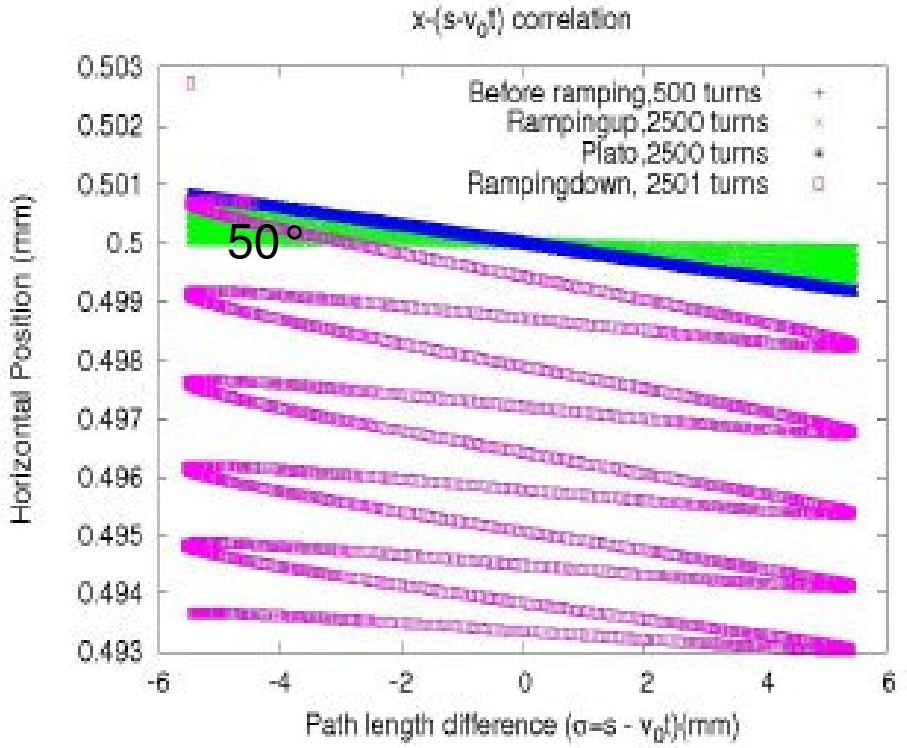
# Check of Voltage Ramping

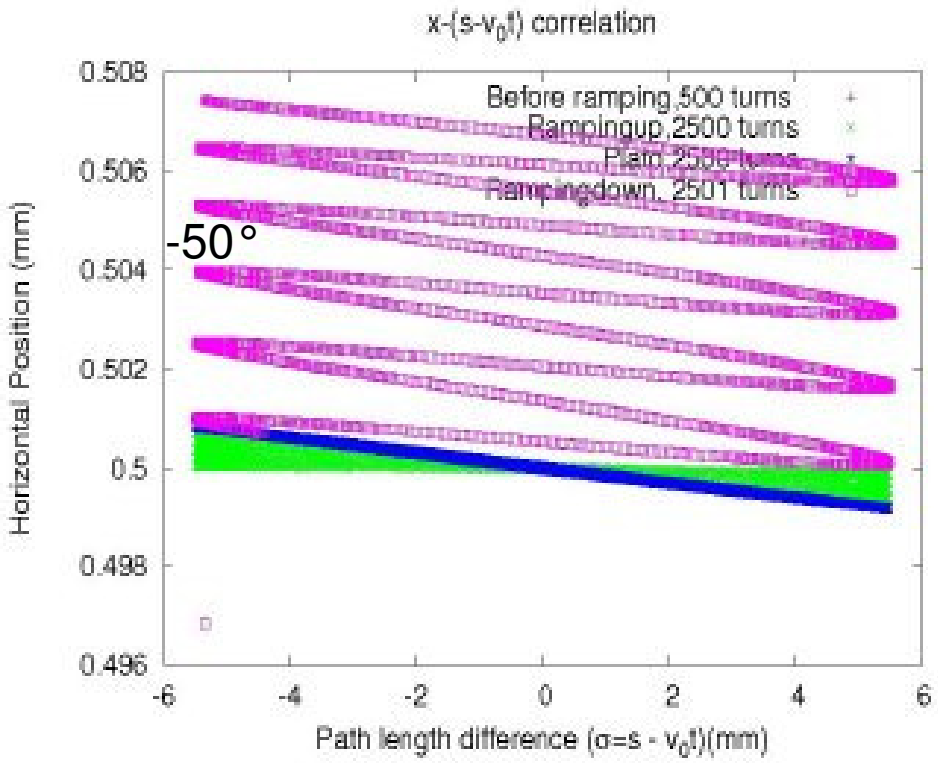


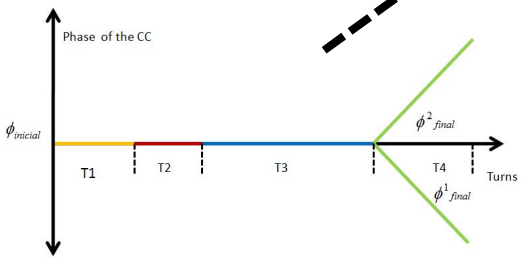

Change of the CC voltage



# Check of Phase Ramping




Change of the CC phase

A CC phase change steers the beam at the IP as expected

# Future work….

- Scan the change of the phase.
- Scan the change in the number of turns of the phase change.
-The study in an upgrade scenario.
- Implement to the LCC.
- Use the RF signals from KEK'B cavities like input on SixTrack.

Thanks for your attention