



# Phase Feed-Forward in CLIC and CTF3

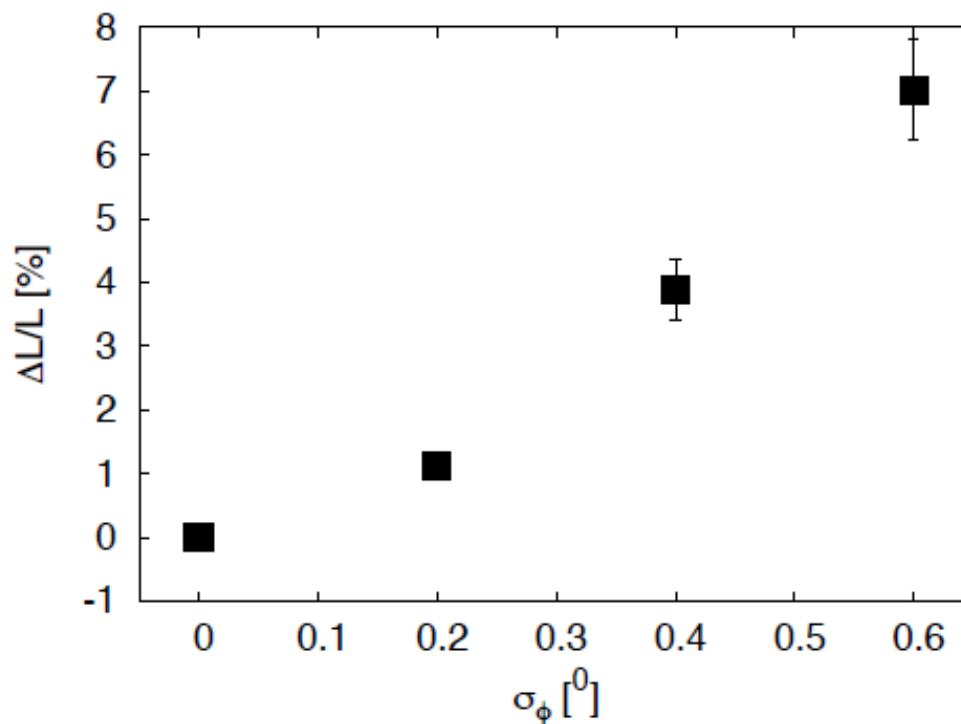
**Piotr Skowroński**

**Daniel Schulte**

**Fabio Marcellini**

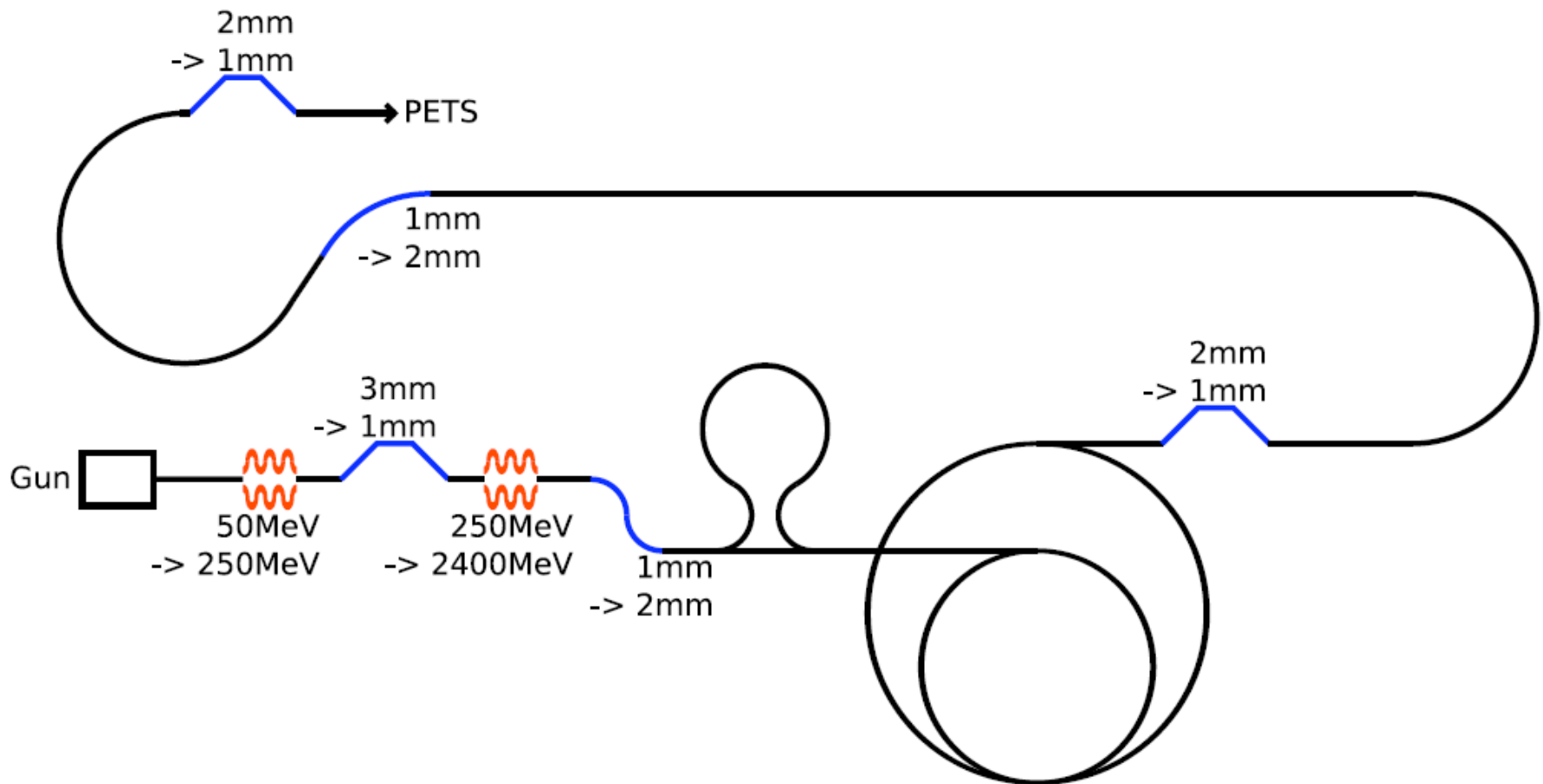
**Alexander Gerbershagen**

- ◆ Simulations show that CLIC luminosity drops by 2% if RF jitters with  $\sigma_\phi = 0.3^\circ$

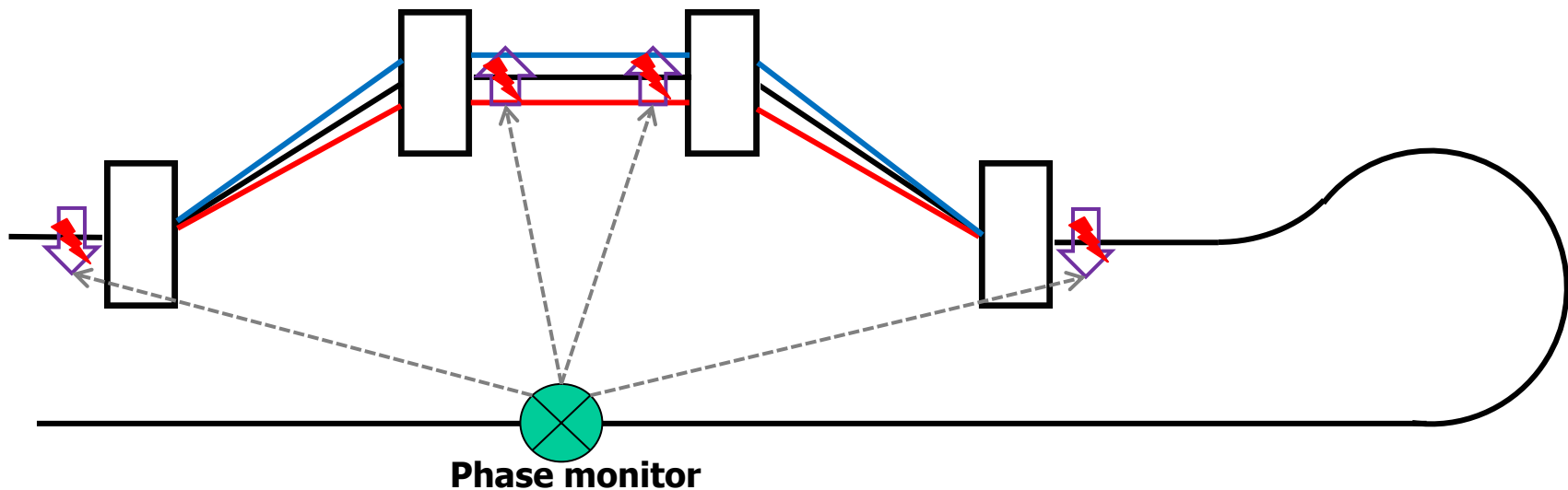




# Drive Beam Compression and Phase Stabilization

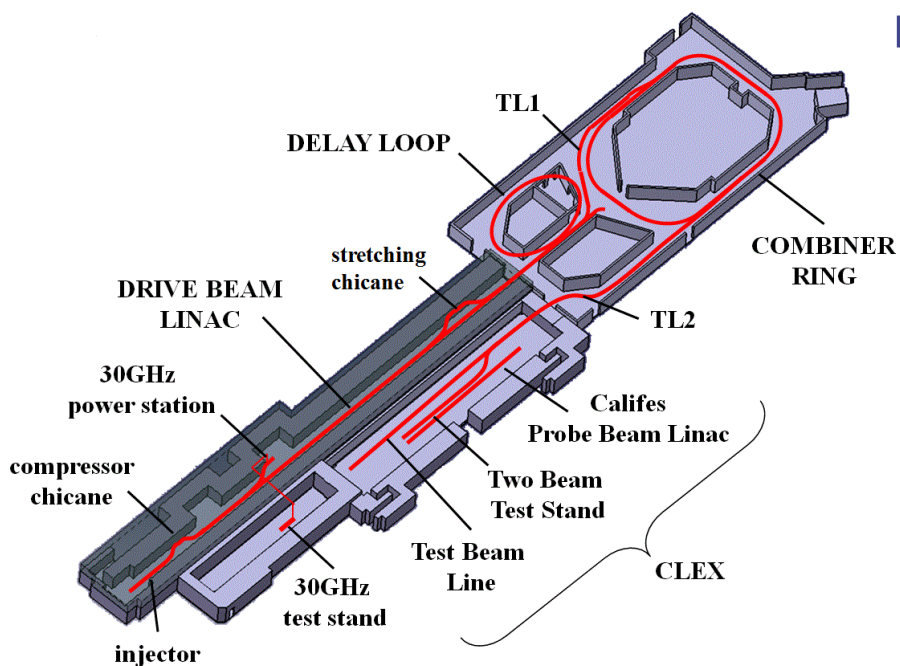


- ◆ Phase Feed-Forward system will increase the drive beam stability and correct phase variation along pulse from  $10^\circ$  (max) to the required  $0.1^\circ$  at 12GHz
  - Measure phase offset before turn around
  - Correct it after turn around
- ◆ The current CLIC design based on a 4-bend chicane, each bend equipped with a fast kicker so the “height” of the chicane is changing, and thus TOF together with it



- ◆ We want to test the system in CTF3
  - Phase monitor was designed and is being produced in Frascati
  - Frascati will also make the kickers, J.Adams Inst. the pulser
- ◆ But there is no space to have extra 4-bend chicane in CTF3
  - It is difficult to find space even for 2 kickers
- ◆ The most logical place to correct phase is the dog-leg chicane in TL2
  - Phase measurement behind or in the stretching chicane
- ◆ We will be able to correct only the mean phase variation, not variation along the pulse

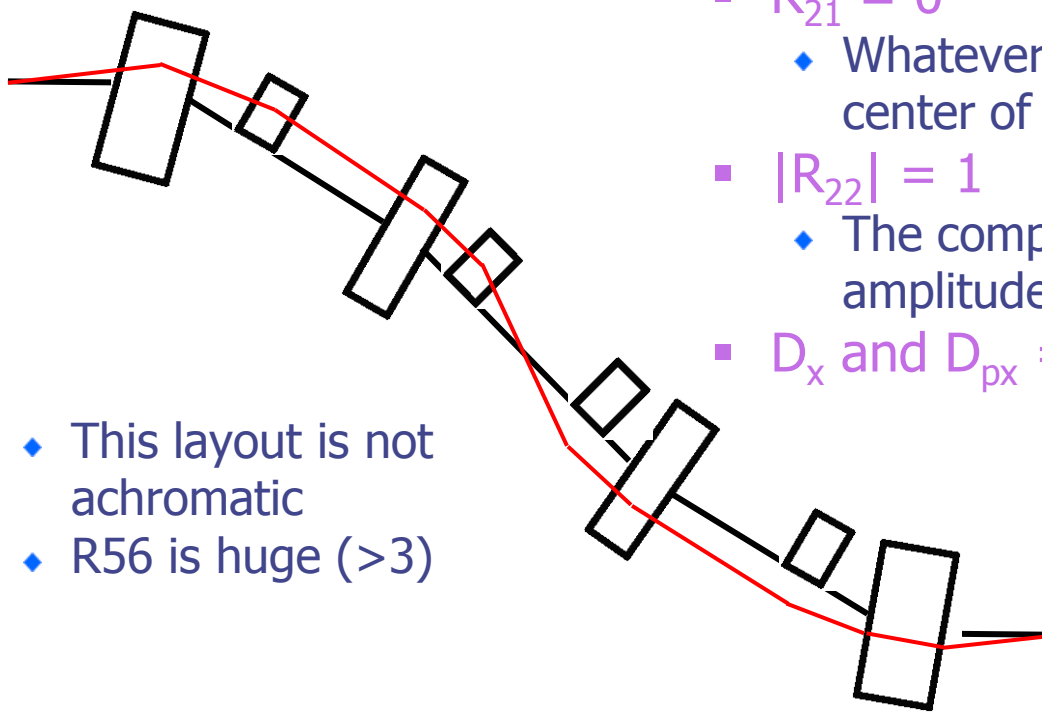
- The phase will be measured on uncombined beam while correction will be done on the recombined one
- **The demonstration of the phase correction along the pulse will be done on not combined beam**



- ◆ I investigate possibility of the system based on 2 kickers

## Requirements:

- Phase correction range 10deg at 12GHz
- Implies TOF correction range of 0.7ms
- $R_{52}$  of at least 0.7 or bigger ( $\sim 1.0$ )
  - ◆ Assuming kicker with 1 mrad range
- $R_{21} = 0$ 
  - ◆ Whatever the kick, the same position at the center of the 2<sup>nd</sup> kicker
- $|R_{22}| = 1$ 
  - ◆ The compensating kick of the same amplitude as the first one
- $D_x$  and  $D_{px} = 0$

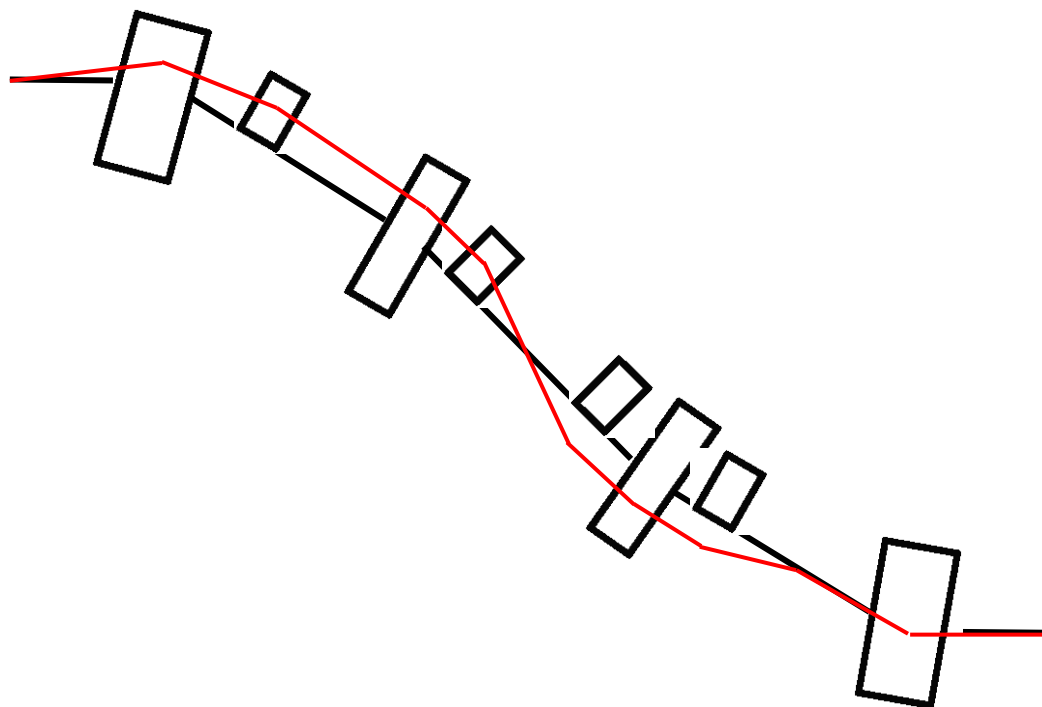
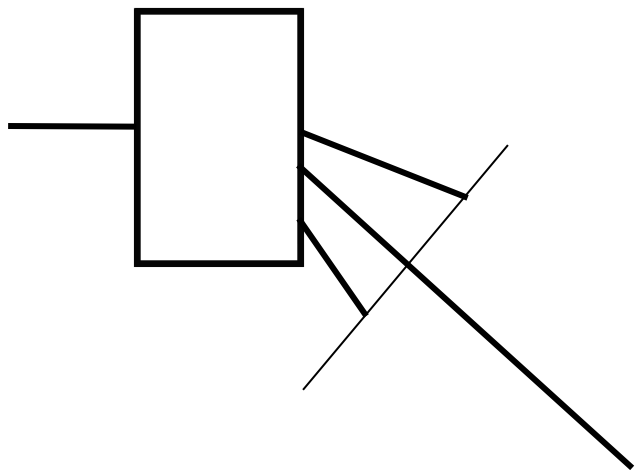


- ◆ This layout is not achromatic
- ◆  $R_{56}$  is huge ( $>3$ )

# 2 kickers setup

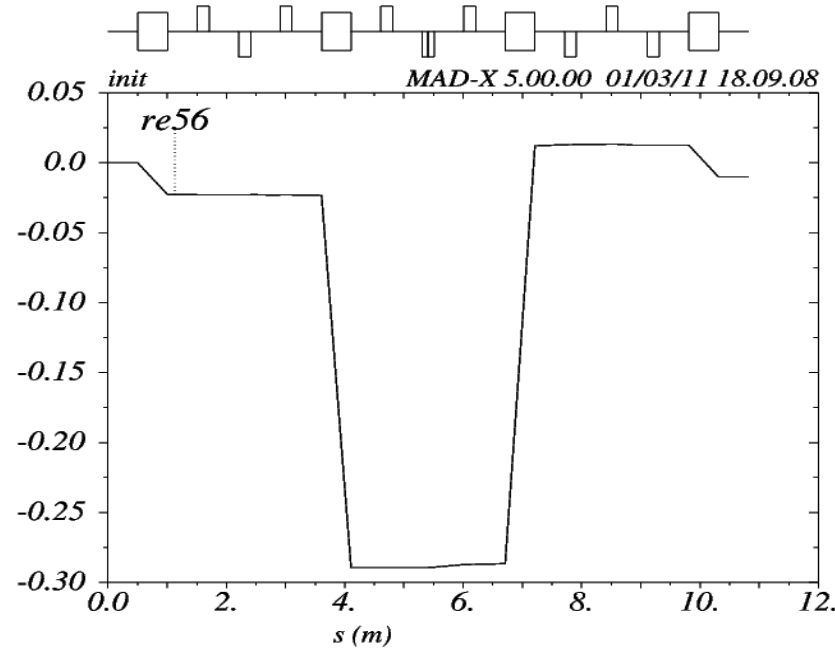
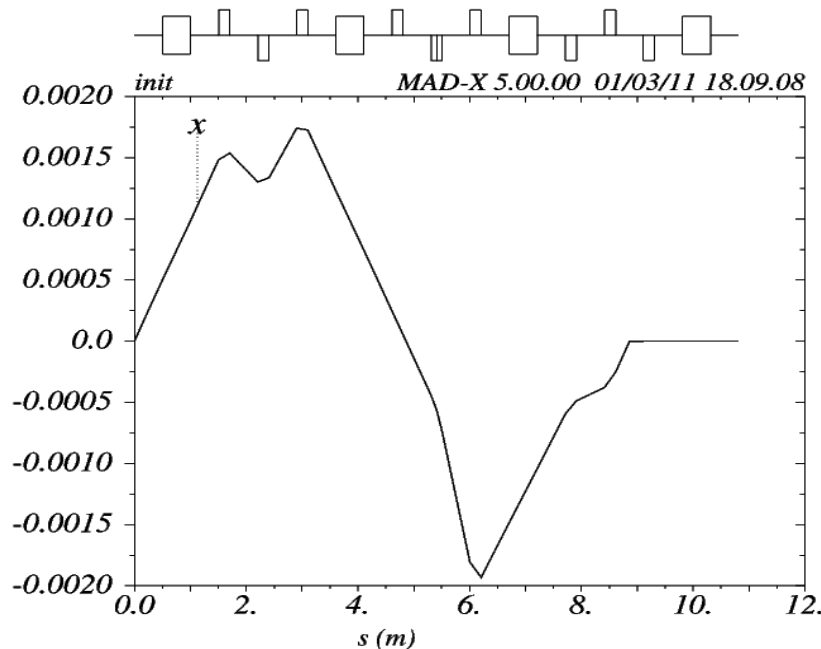
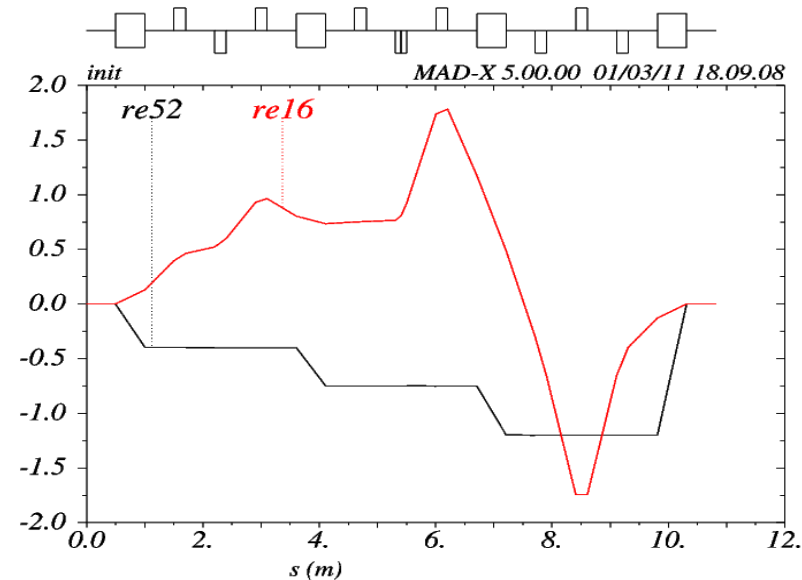
## Basic considerations

- ◆  $R_{52}$  is changed only by bends
  - It is connected to rotation of reference frame
- ◆  $R_{52}$  disappears whenever dispersions disappear
  - Could not find analytical formula in any textbook
  - If we want to keep the beam dispersion free after the chicane the second kicker should be placed inside the chicane



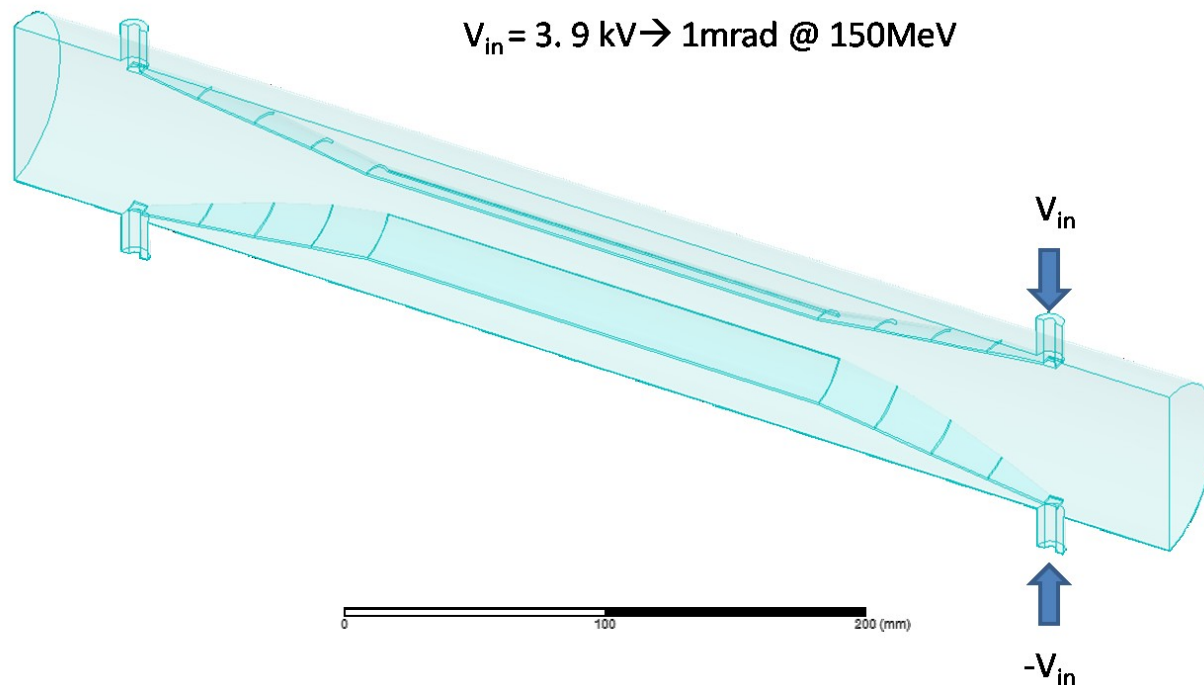
# 2 kickers setup

- ◆  $R_{52} = -1.2$  at the 2<sup>nd</sup> kicker
- ◆ Dispersions = 0
- ◆  $R_{56} = 0$
- ◆ Max kick (1 mrad) gives orbit change smaller than 2mm





- ◆ Fabio Marcellini has prepared blueprint of a device with the following parameters
  - 1 mrad kick with 4 kV
  - Length of the electrodes 412 mm
  - Aperture 40 mm
  - Circular nine with inner diameter of 74 mm





# Summary



- ◆ Solution with 2 kickers is feasible
- ◆ Currently we investigate
  - Integration of kickers
  - Strength of available quads
  - Optics matching to the rest of the line
  - **Pulsar feasibility**
    - ◆ Amplitude – voltage range from -4 to +4 kV
      - This would give 30 deg correction range
      - Half of it would also do
    - ◆ Bandwidth – ideally the same or better as the phase monitor
      - The current prototype has 30ns response time
      - Igor promises that the new design will deliver 3-5ns
      - Alexander simulations show that at least 10ns is required for CLIC

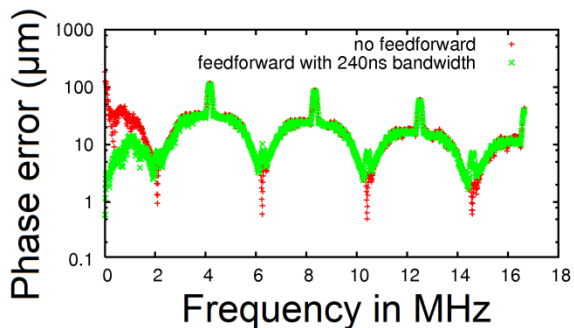


# Total phase error and feed forward averaging time

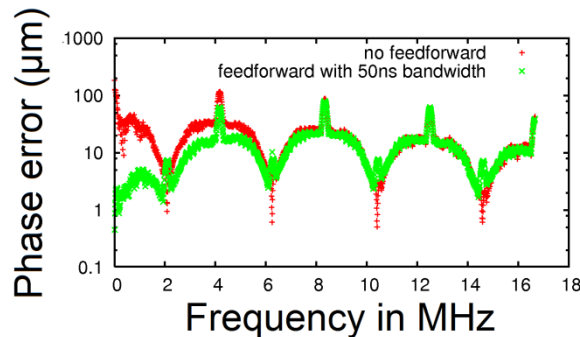


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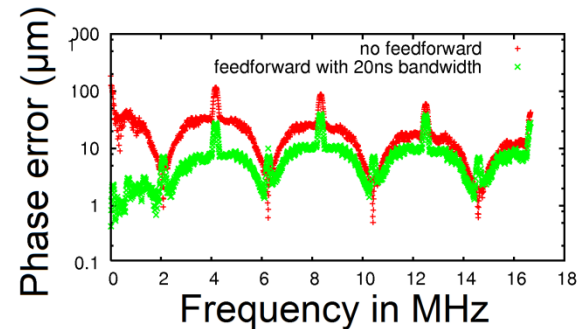
240ns



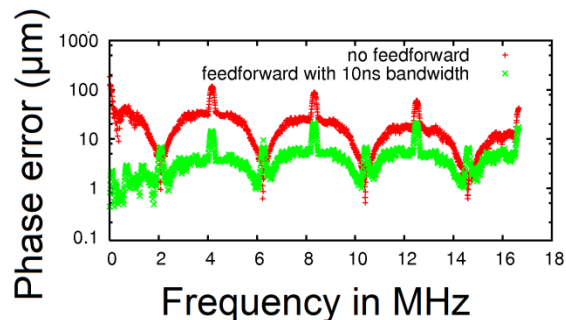
50ns



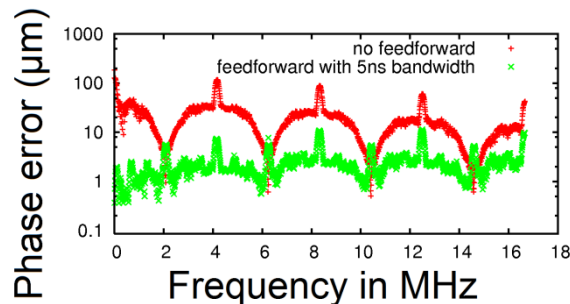
20ns



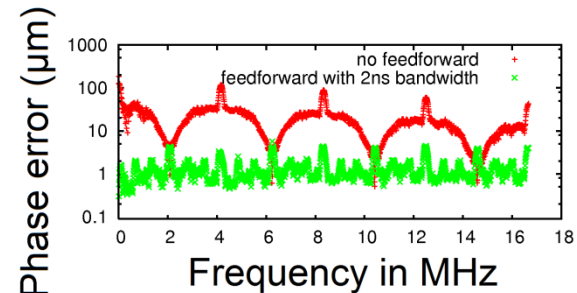
10ns



5ns



2ns



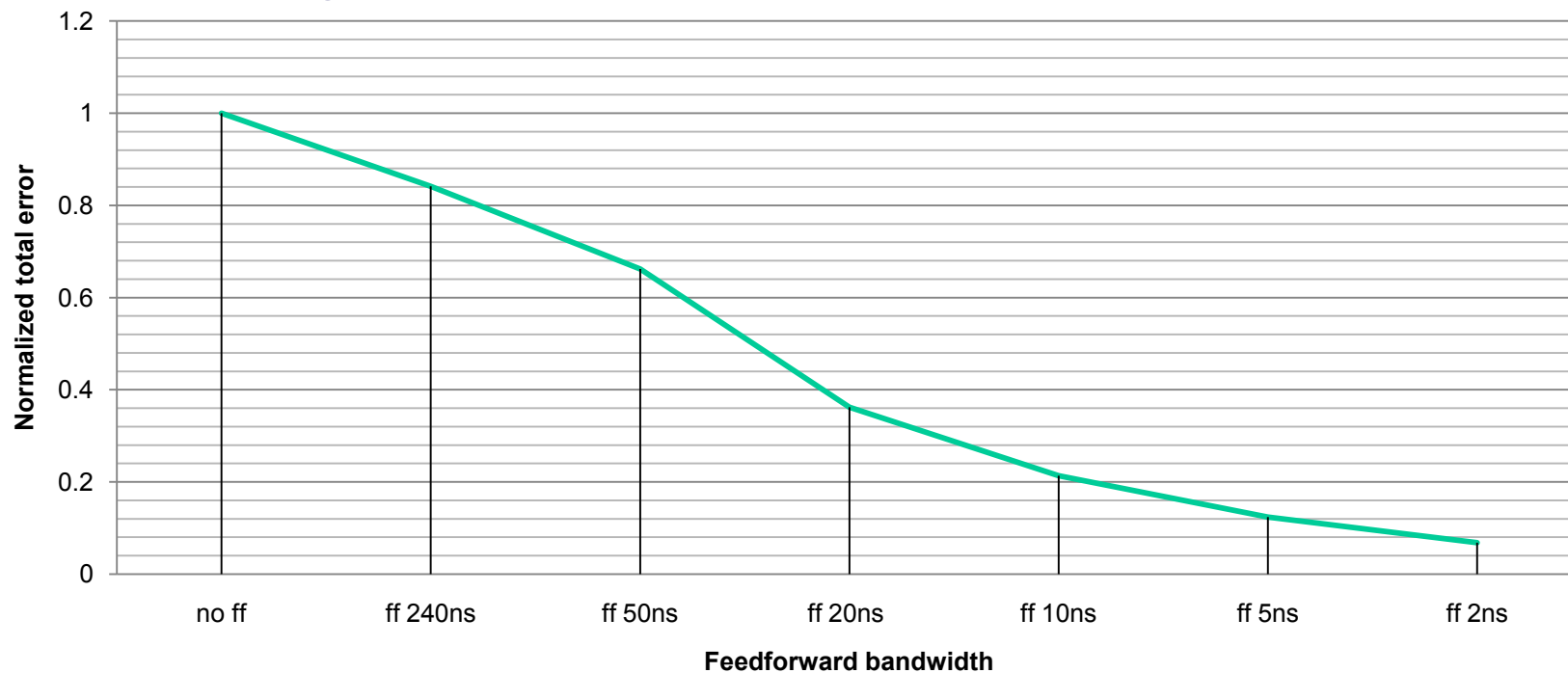
Horizontal axis: frequency of phase error for beam before recombination  
Vertical axis: phase error after phase feed forward



# Total phase error and feed forward averaging time



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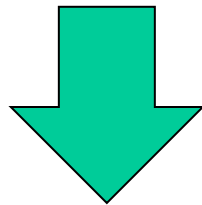
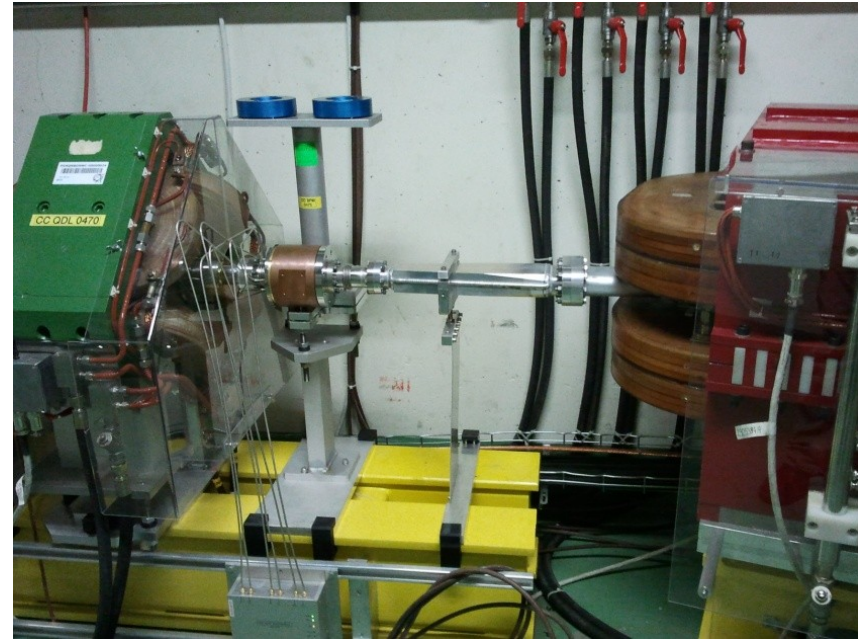
Feedforward averaging time	no ff	ff 240ns	ff 50ns	ff 20ns	ff 10ns	ff 5ns	ff 2ns
Normalized total error	1	0.8416	0.6617	0.3621	0.2137	0.1236	0.0679
Absolute total error ( $\mu\text{m}$ )	19.196	16.219	12.752	6.9779	4.1182	2.3816	1.3089



# Backups slides



- ◆ It is not an issue
  - In the best case only the vacuum chamber inside the bend needs to be reworked
  - Eventually BPM0475 would need to be moved to another location



CC.BHG.0500

CC.BPM.0475

CC.QDL.0470

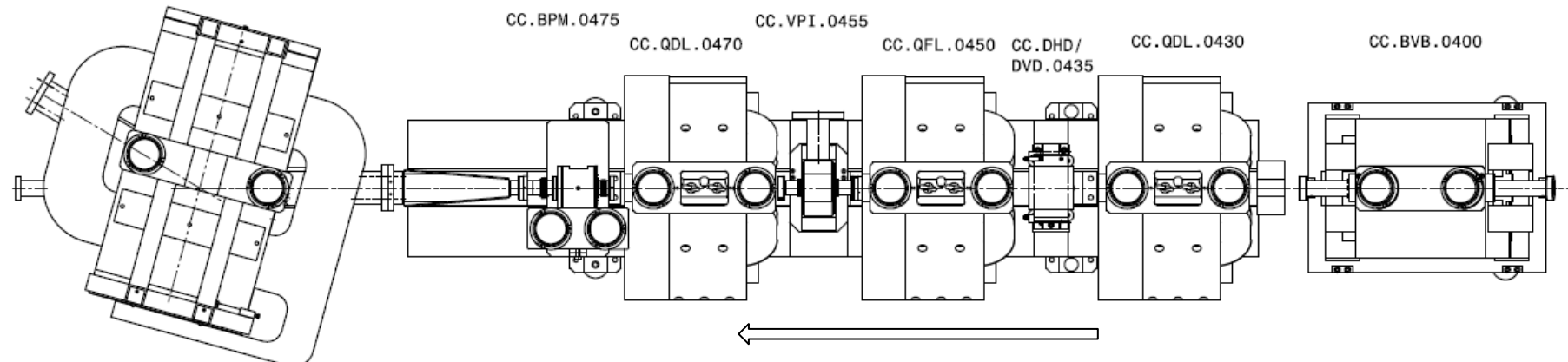
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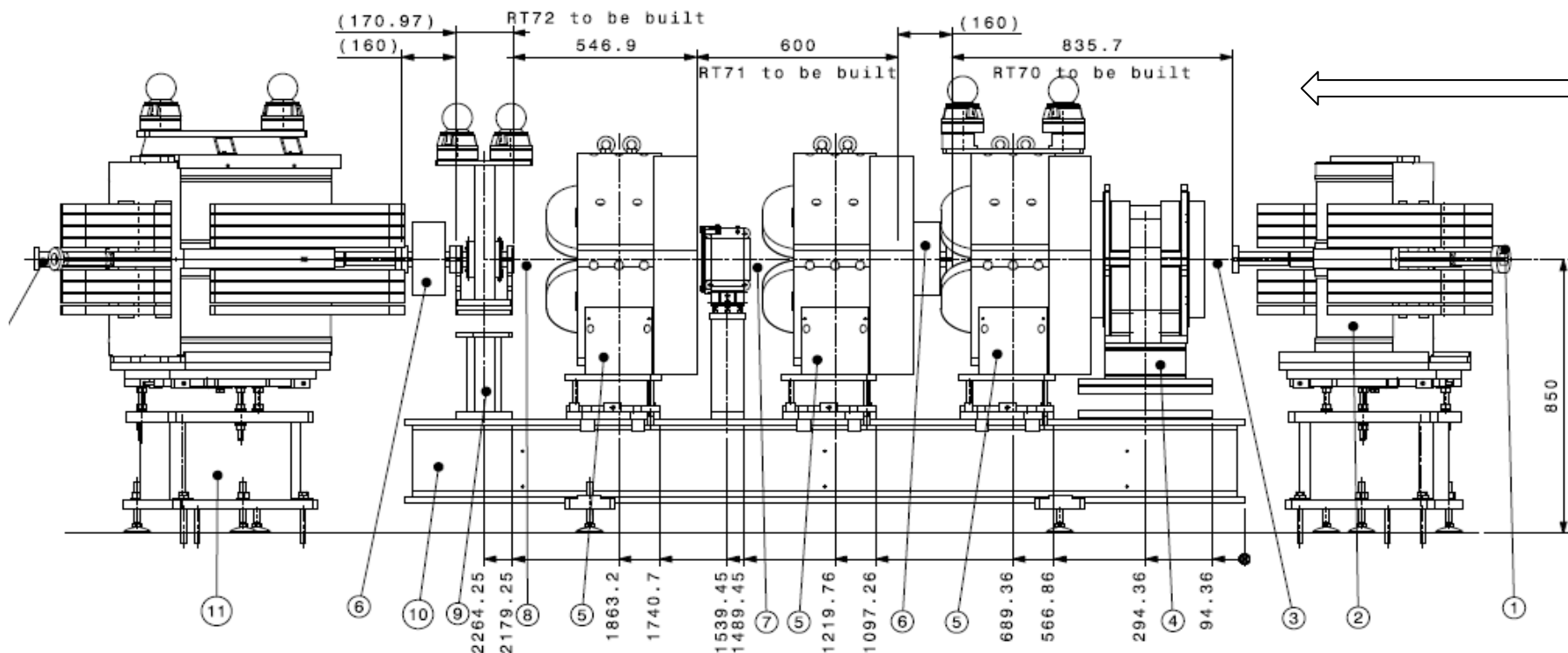
CC.DHD/  
DVD.0435

CC.QDL.0430

CC.BVB.0400



- ◆ More detailed study is needed to find 50cm space for the kicker before the last bend
  - Most probably some element reshuffle will be needed
  - Change of quad polarity, or installation of bi-polar power supplies will be needed





# The prototype phase monitor issue



Fabio Marcellini

