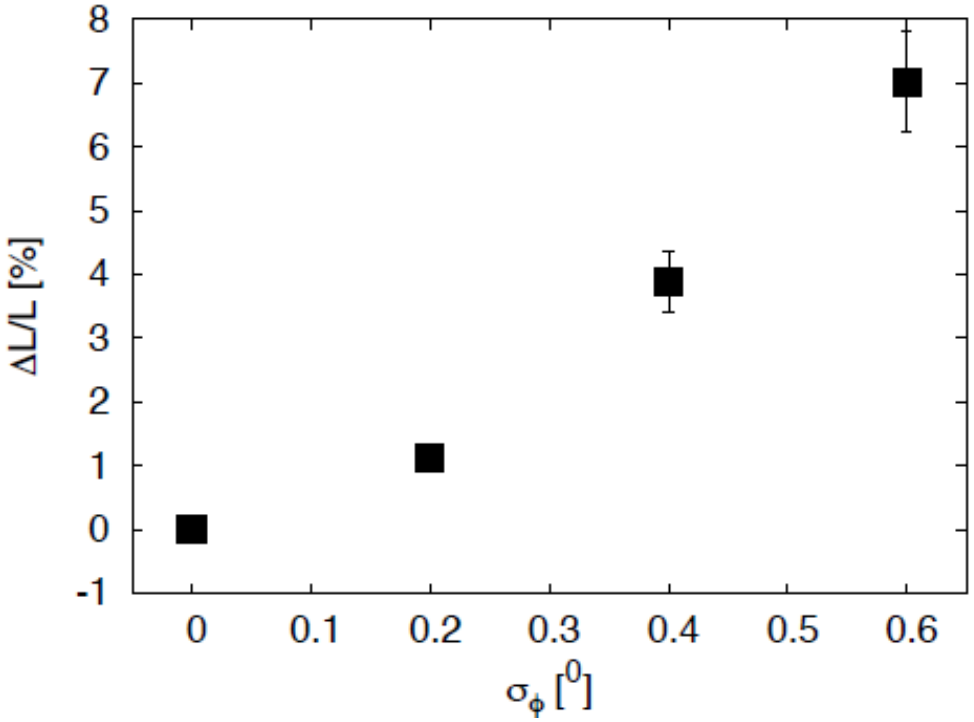
Phase Feed-Forward System

Piotr Skowroński

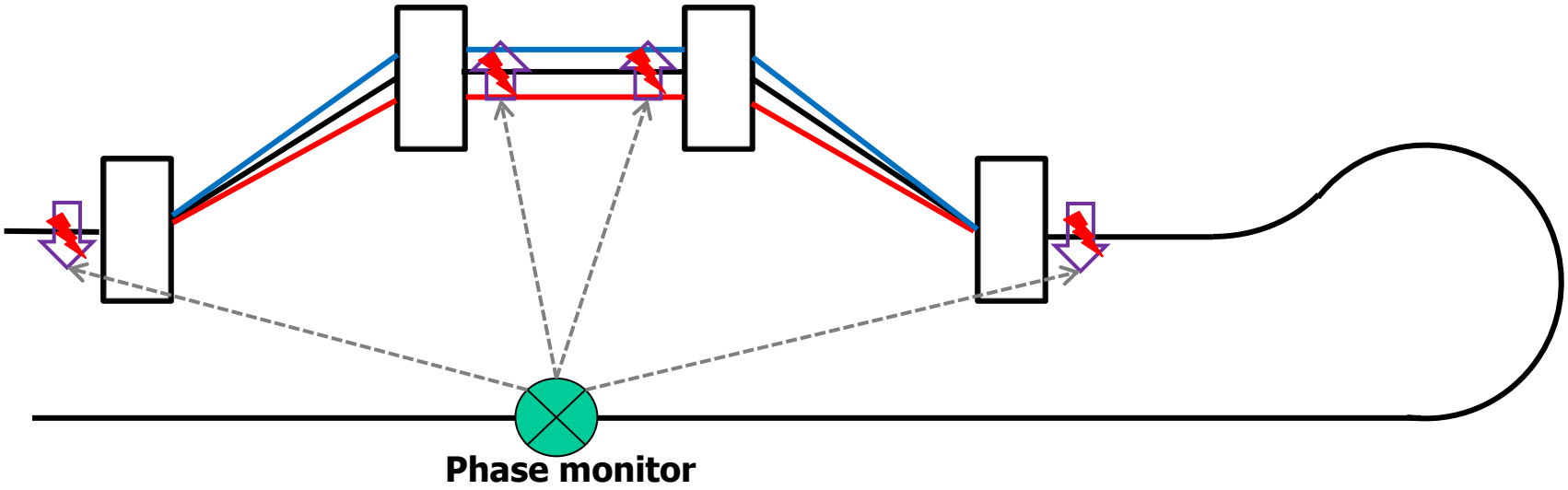
Motivation
Main to Drive Beam Phase Tolerance

- Simulations show that CLIC luminosity drops by 2% if RF jitters with σ_ϕ=0.3°



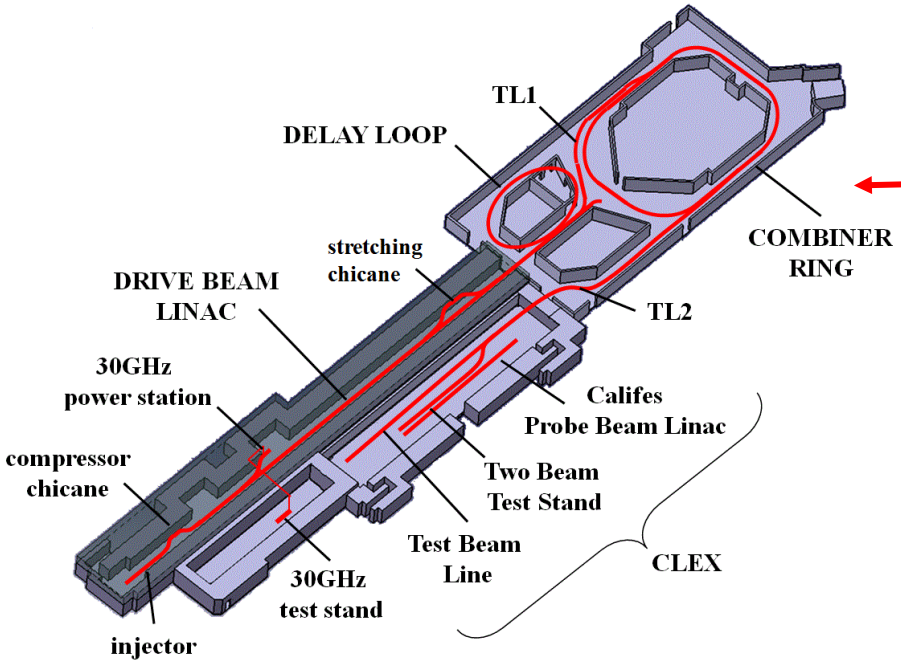
CLIC Phase Feed-Forward System

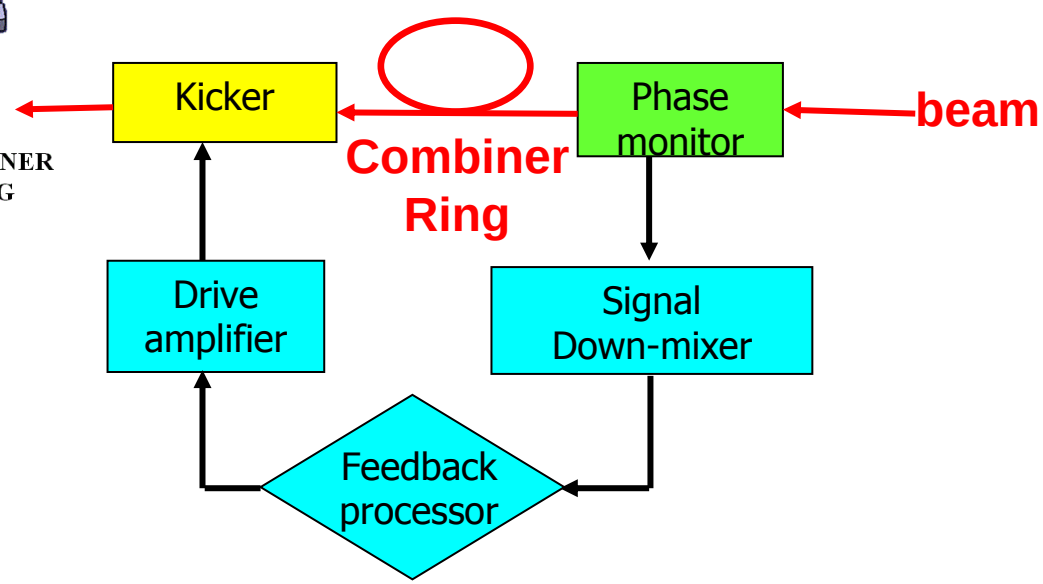
- Phase Feed-Forward system will increase the drive beam stability and correct phase variation along pulse from 10° (max) to the required 0.1° at 12GHz
  - Measure phase offset before turn around
  - Correct it after turn around
- The current CLIC design based on a 4-bend chicane
  - Each bend equipped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



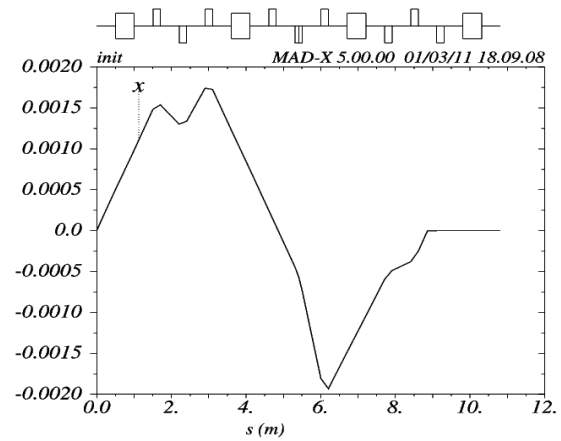
Phase Feed Forward in CTF3

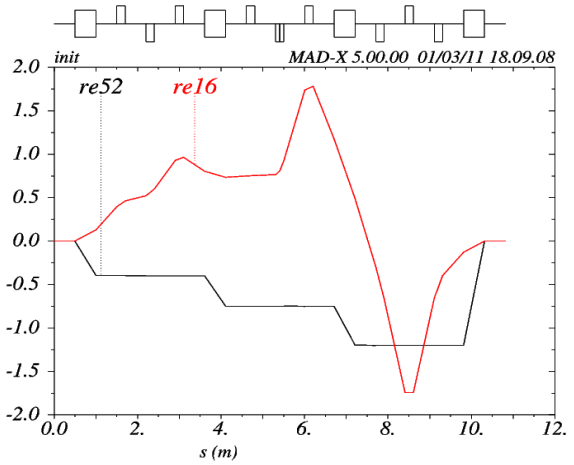
- The implementation is not straight forward and hence a prototype shall be build and tested in CTF3
  - Large bandwidth (60MHz) and power (400kW)
- The chicane design is different from the current CLIC baseline
  - There is no space for extra 4-bend chicane in CTF3
  - 2 kickers placed in the dog-leg chicane of TL2 will do the job
  - Phase measurement behind or inside the stretching chicane
- The demonstration of the phase correction along the pulse will be done on not combined beam





The layout





- R_{52} = 1.2 =>
  1 mrad kick changes path by 1.2 mm
  i.e. phase by 17.3 deg @ 12GHz

CURRENT		PROPOSED	
SX+Q	84	41.7	Quad
Dift	16	17.1	BPI
Q	41.7	41.7	Quad
BPI	17.1	120	KICKER
Q + Corr	64.8	20	Taper
VPI	23.6	6.7	Drift
	247.2	247.2	cm

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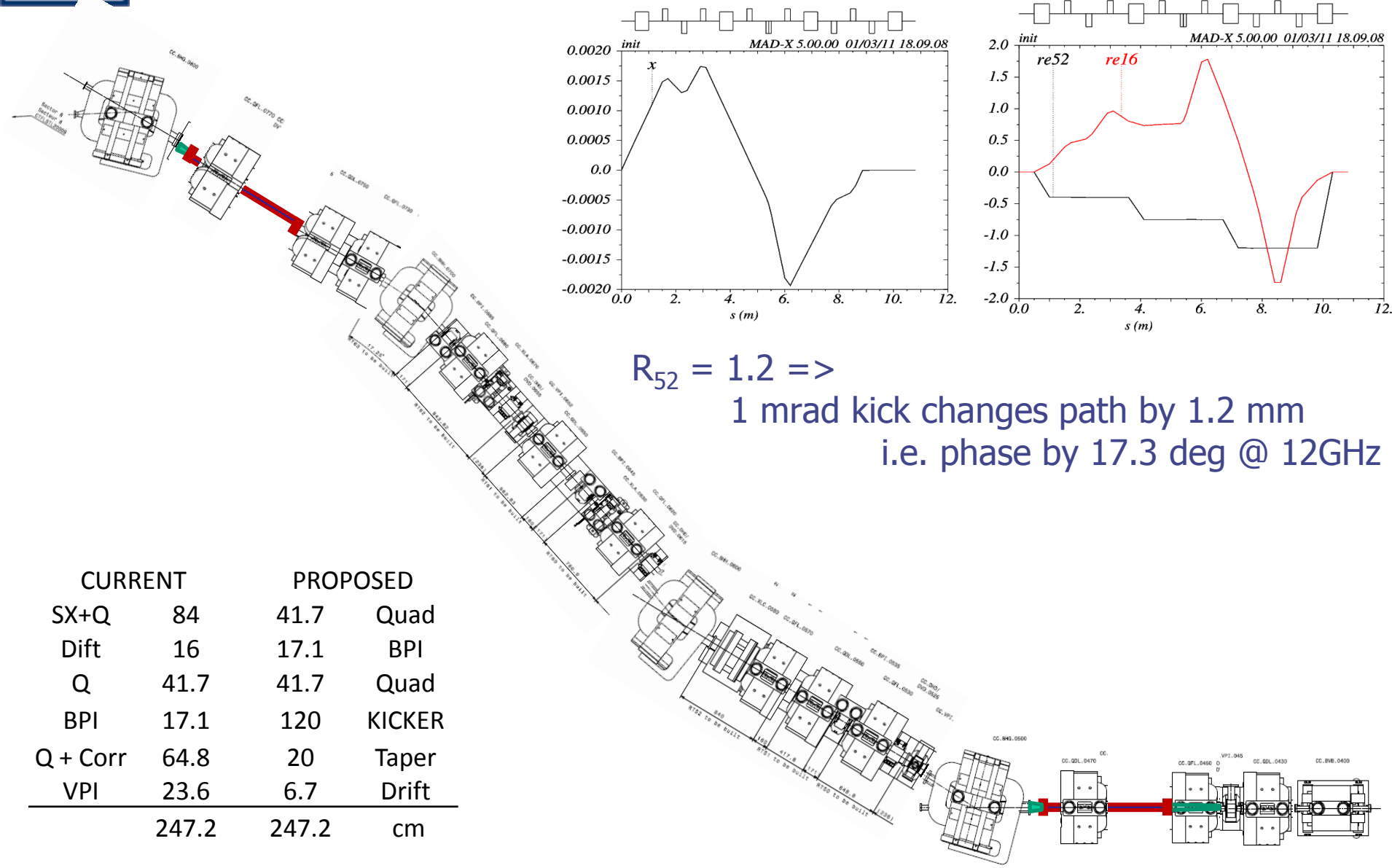

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The components

- The phase monitor based on choke mode cavity was designed and is being produced by LNF Frascati, Italy
  - First one shall arrive soon to CERN for the first tests
- Its read-out electronics will be made at CERN
- Frascati also has designed and started fabrication of the kickers
- The pulser's R&D is carried out by John Adams Institute / Oxford University, UK
  - Staging approach will be applied
    - First version with reduced capabilities in terms of power and band width
    - Following version(s) will eventually deliver full capabilities
- First version of the system to be completed during winter shutdown 2012/2013

The budget

WP: CTF3-002 Drive Beam phase feed-forward and feedbacks	Purpose/Objectives/Goals: Understand sources of drive beam phase jitter, develop and test feed-forward system to stabilize drive beam phase (performance, risk)	Deliverables	Schedule
Drive Beam phase monitors	Understand sources of drive beam phase jitter. Used in feedbacks and feed-forward test.	Drive Beam phase monitor prototype, phase monitor small series (2-3), electronics and acquisition. M budget: 0.5 MCHF	Monitor proto: 2011 – 4Q Monitor series: 2013 – 2Q
Feed-forward kickers	Required to demonstrate feed-forward performance.	Two strip-line kickers. M budget: 0.75 MCHF	2012 – 4Q
Feed-forward pulsers	Required to demonstrate feed-forward performance.	Fast amplifiers for the two kickers. Fast electronics. M budget: 1.25 MCHF	2013 – 4Q ?
Infrastructure and operation	Required for testing.	Cabling, infrastructure, controls, operational support. M budget: 0.5 MCHF	Distributed 2012-2016
Link to other WPs/activities: This WP depends on WP CTF3-001			
Lead collaborator(s): INFN/LNF, Oxford Un./J. Addams, CERN: BE/RF, BE/BI, BE/ABP, BE/OP…			

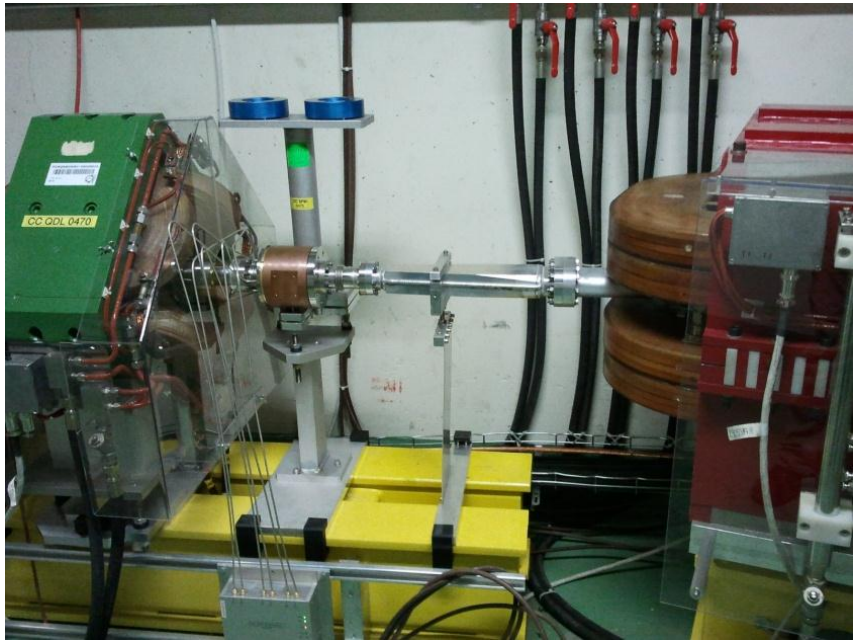
Resources:	2011	2012	2013	2014	2015	2016	Total
Material (kCHF):		500	900	1100	300	200	3000
Personnel (FTE):		4	4	4	4	4	20

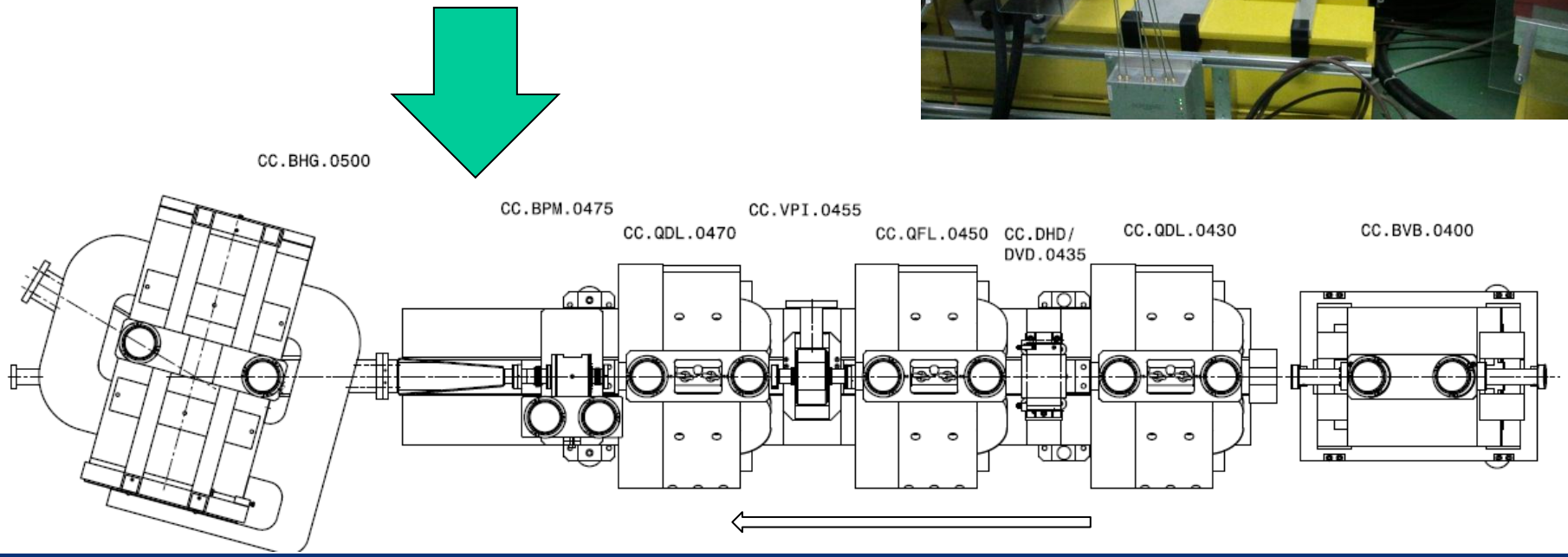
Work plan reviewed with INFN-Frascati & Oxford and updated. Need to check total resources and repartition with collaborators.

Backups slides

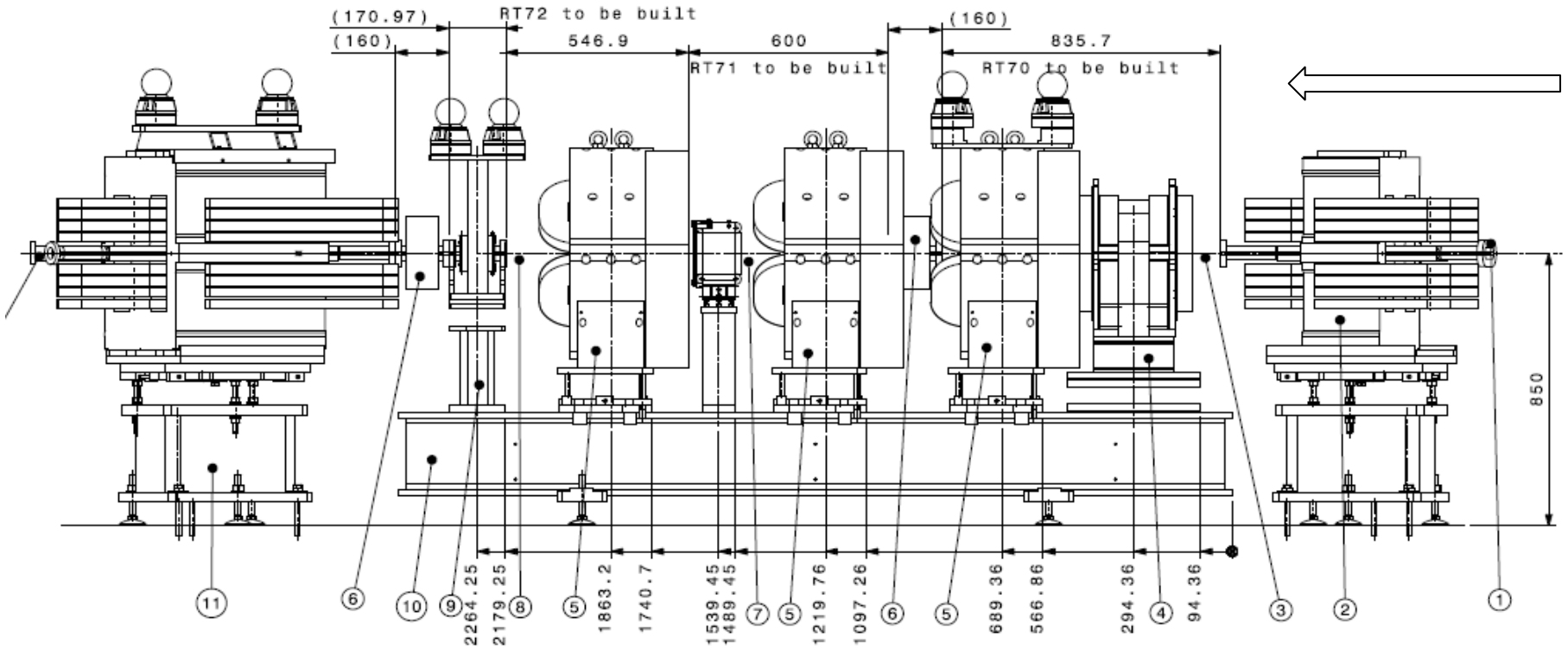
Space for kicker 1

- 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





Space for kicker 2

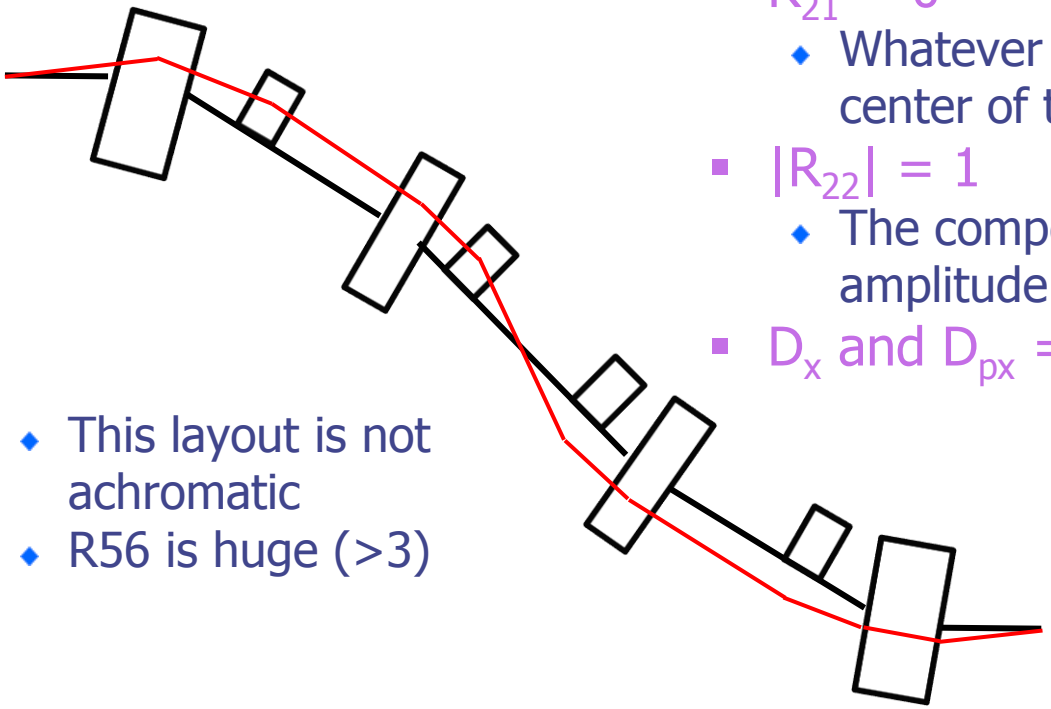


System based on 2 kickers?

- I investigate possibility of the system based on 2 kickers

Requirements:

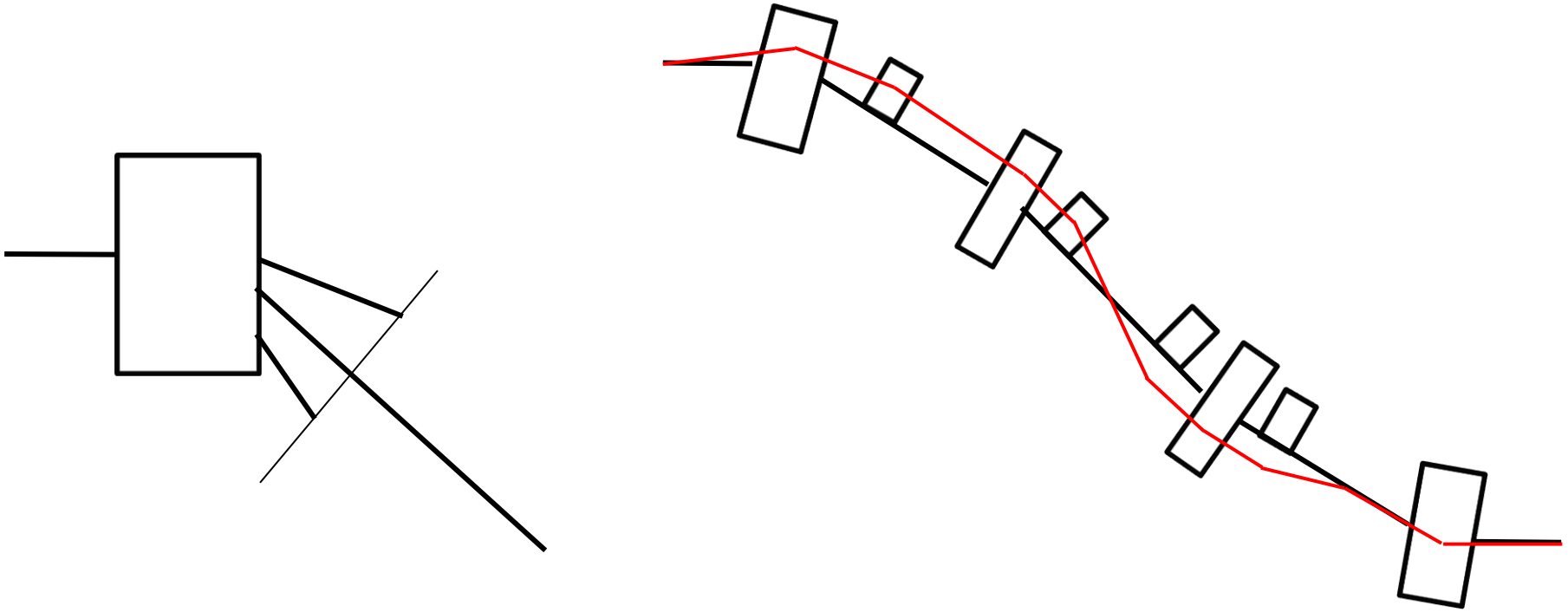
- Phase correction range 10deg at 12GHz
- Implies TOF correction range of 0.7ms
- R_{52} of at least 0.7 or bigger (~1.0)
  - Assuming kicker with 1 mrad range
- $R_{21} = 0$
  - Whatever the kick, the same position at the center of the 2nd kicker
- $|R_{22}| = 1$
  - The compensating kick of the same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



- This layout is not achromatic
- R56 is huge (>3)

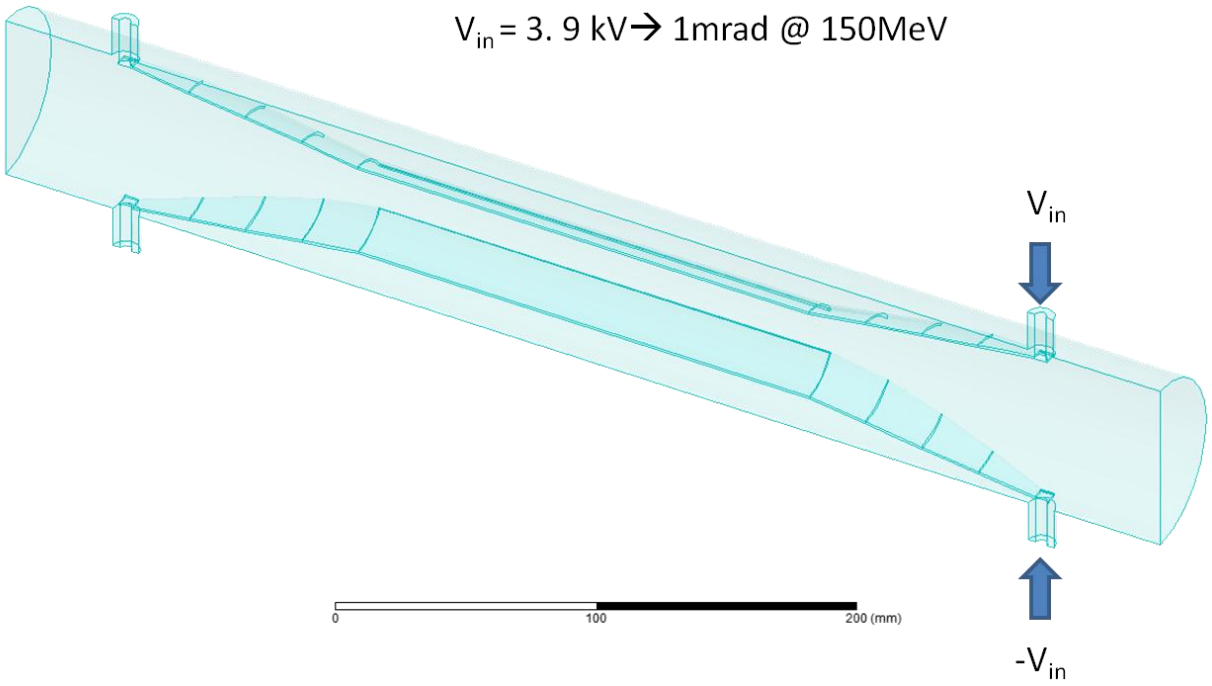
2 kickers setup
Basic considerations

- The figure of merit is R_{52}, which relates kick (the 2nd variable) with the trajectory length (the 5th variable)
  - R_{52} is changed only by bends
    - It is connected to rotation of reference frame
  - R_{52} disappears whenever dispersions disappear
    - If we want to keep the beam dispersion free after the chicane the second kicker should be placed inside the chicane



Kicker Parameters

- 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 pipe with inner diameter of 74 mm



Timeline

Monitor

- Design based on choke mode cavity
- The first fabricated monitor about to arrive to CERN
- Tests in lab, tests with readout electronics
- When successful installed in the machine
- The following 2 devices installed initially behind the first one to form a string for accuracy and resolution determination
- In final setup one monitor left in place, one put before the correction chicane, the last one behind
- Mechanical design completed, ready for fabrication