CLIC Decelerator Test Beam Line

International Workshop on Future Linear Colliders 2012

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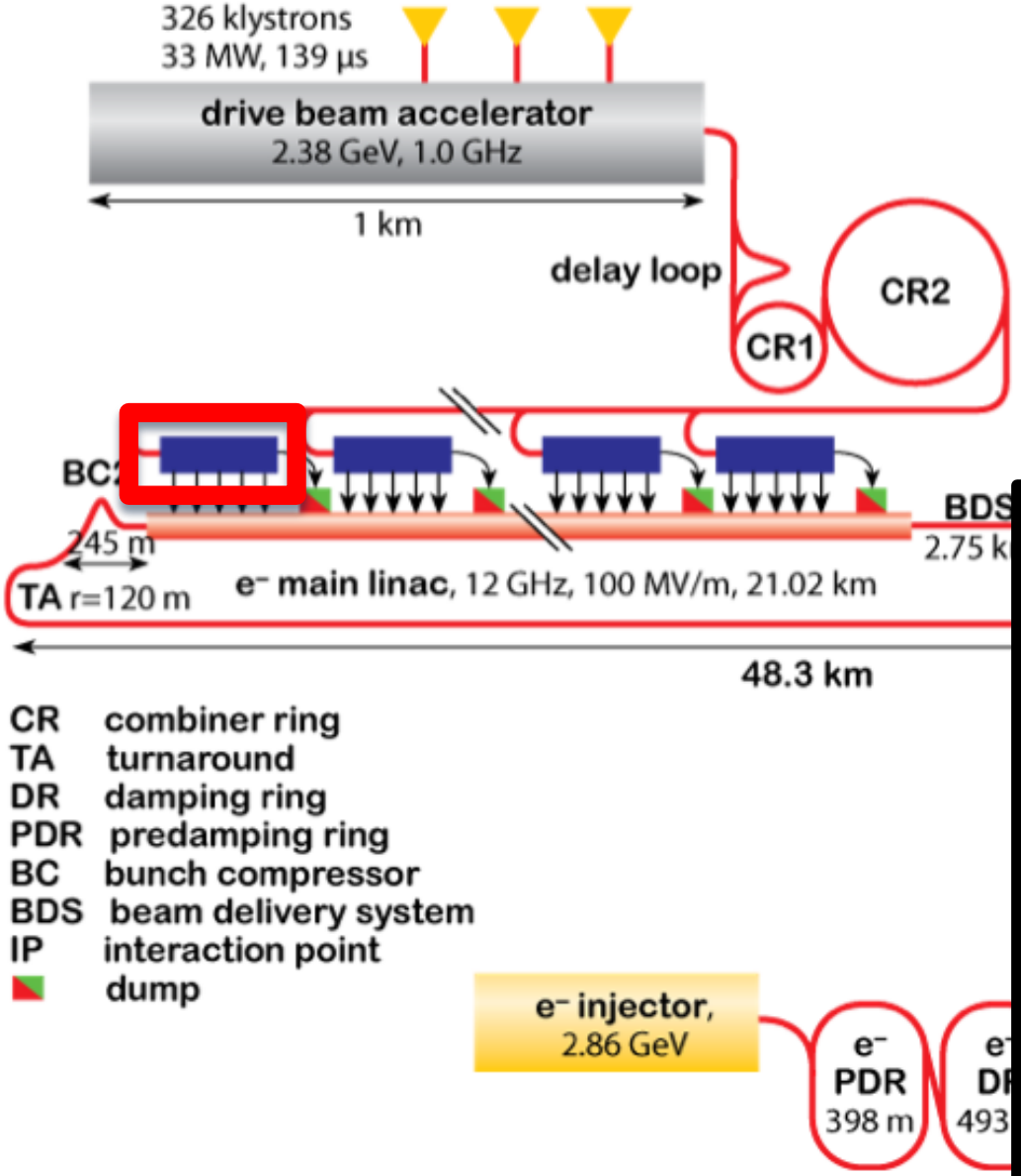
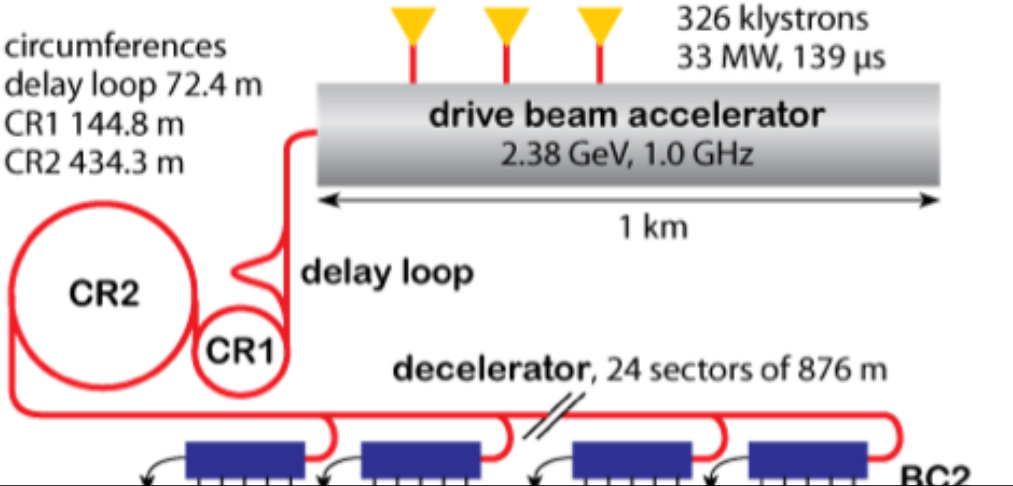
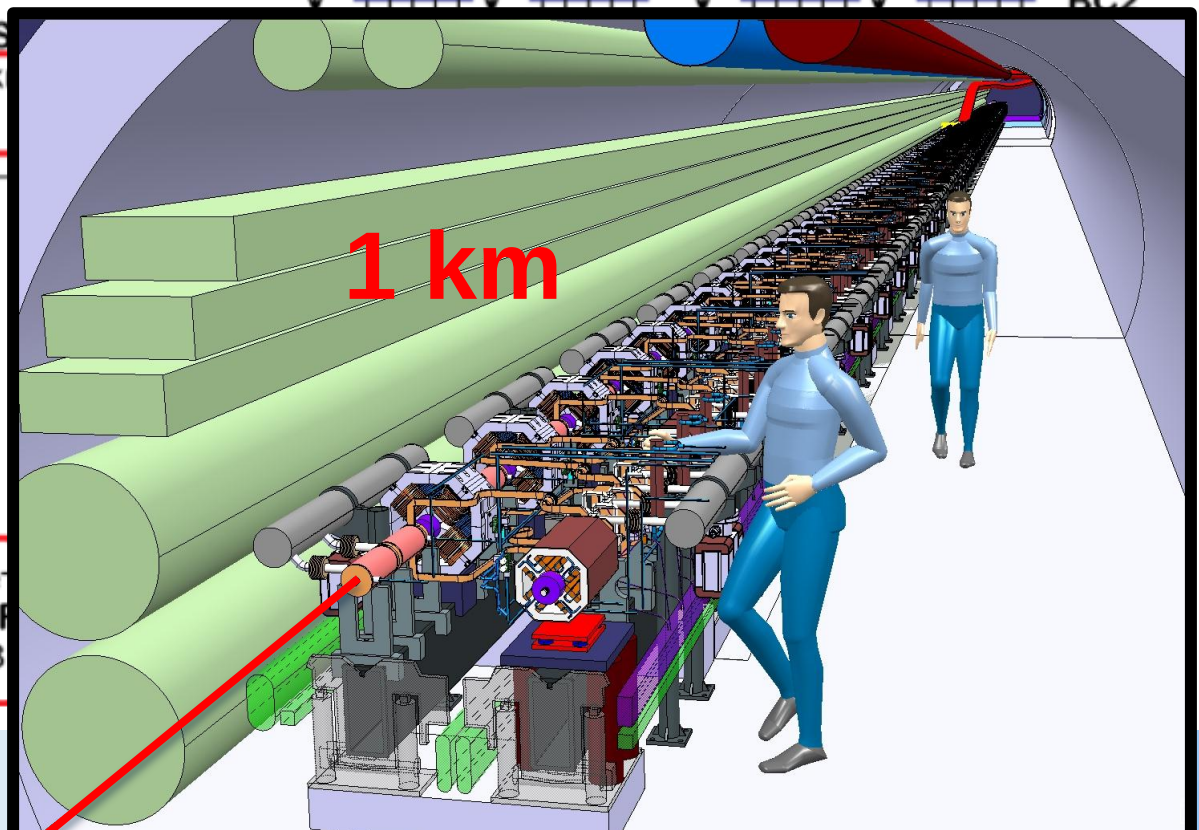
The decelerator



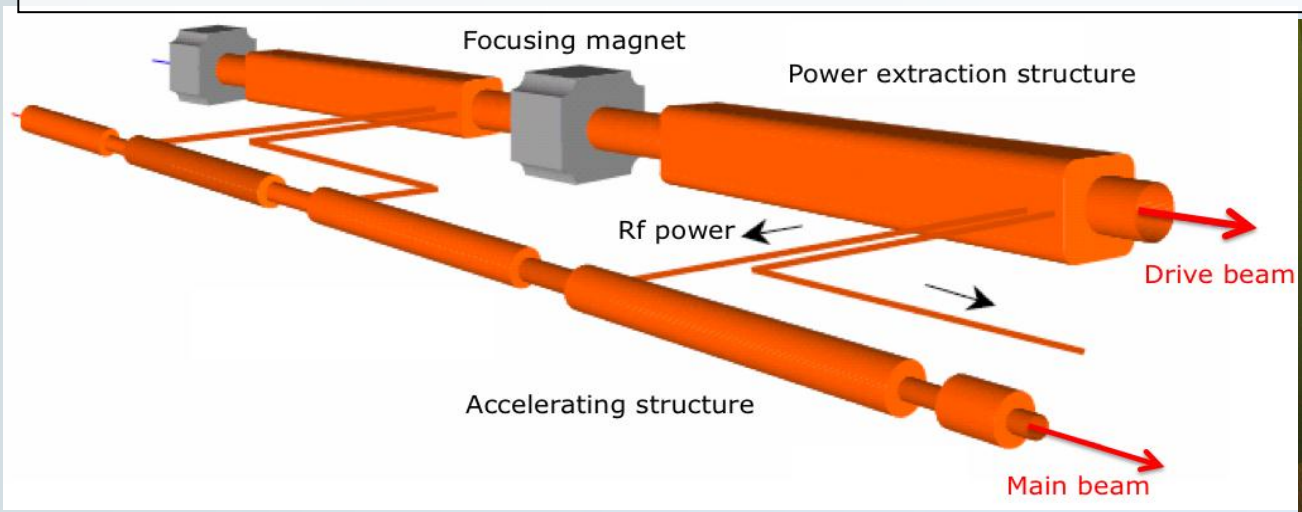


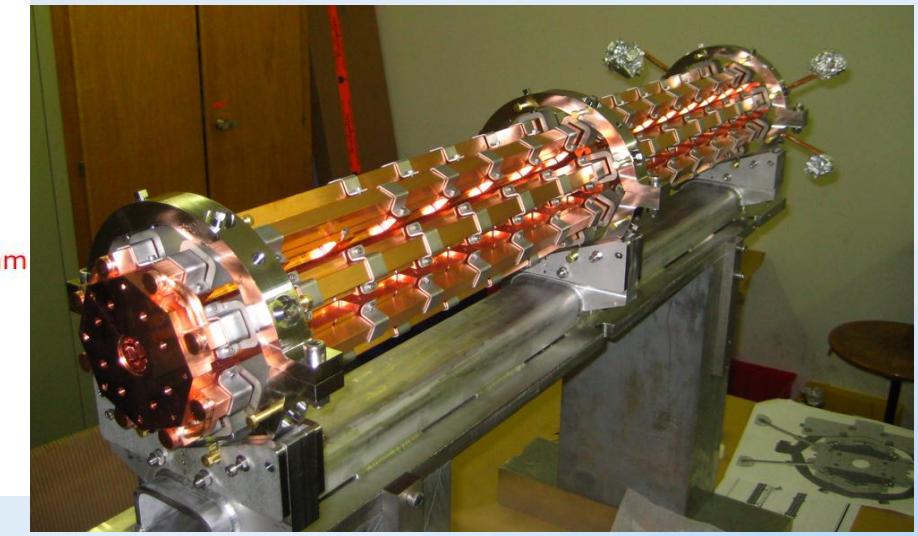


The decelerator

Objective of the drive beam decelerator:

- Produce rf power for accelerating structures, timely and uniformly along the decelerator. **Robust performance of 42 km beam line**.
- Achieving a high energy extraction efficiency, to ensure good machine wall-plug efficiency: baseline is **90% energy extraction** maximum
- Beam must be transported to the end with **very small losse**s
- Drive Beam: **101 A, 2.4 GeV**





1500 x 48 power extraction and transfer structures (PETS) will convert kinetic energy to rf power along 1 km decelerator sectors.

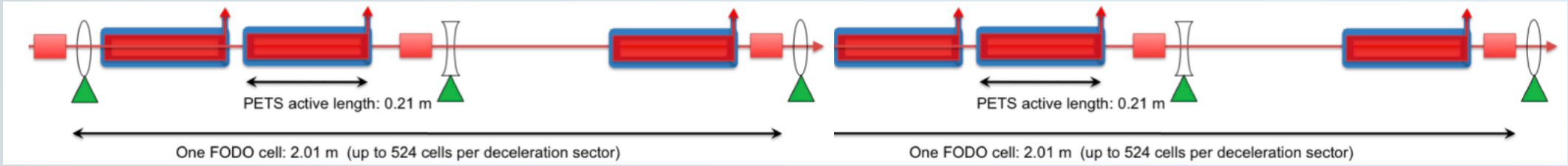
➔ **novel beam dynamic challenges** for the decelerator

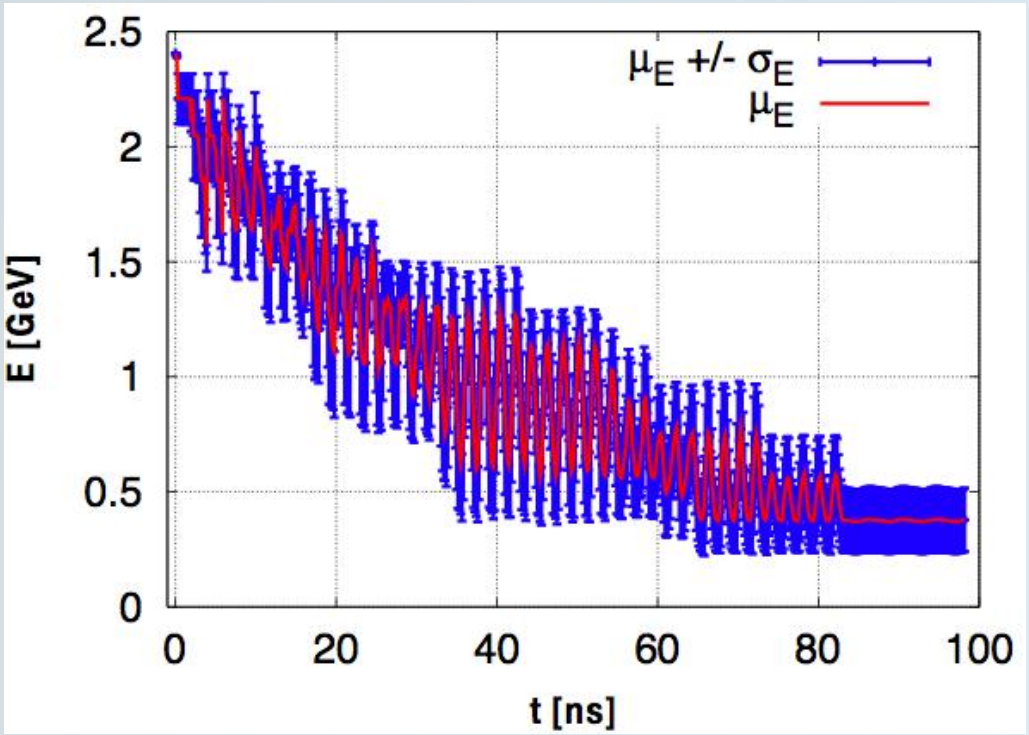
No analogue studies for the ILC – CLIC works from scratch

Decelerator beam transport

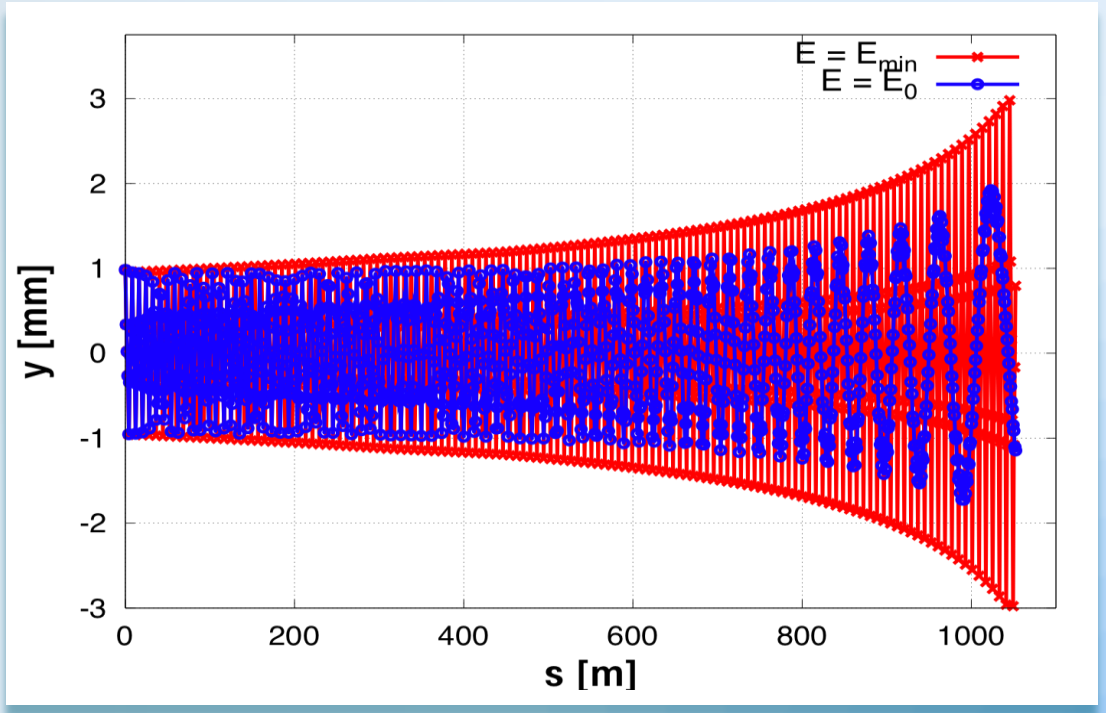
Uniform power production implies that the beam must be transported to the end with very small losses (< 1 % level). We require robust transport of the entire beam through the ~1 km decelerator sectors.

PLACET simulations are the main tool for the decelerator studies.





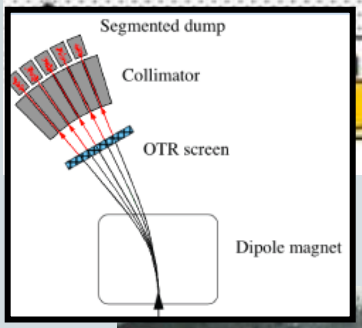
Decelerated drive beam: very high energy spread (factor 10 at the end of the lattice)

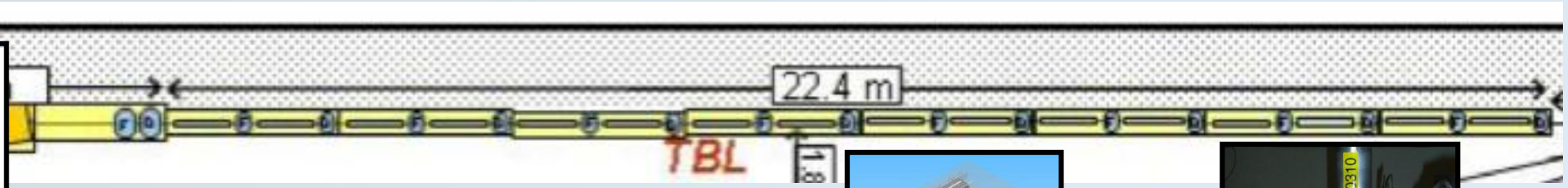


Beam transport along lattice, for ideal injection into a perfect machine : minimum envelope ~ 3 mm

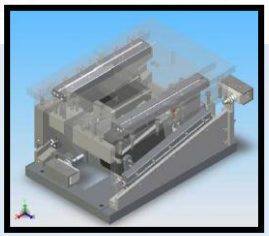
CTF3 Test Beam Line

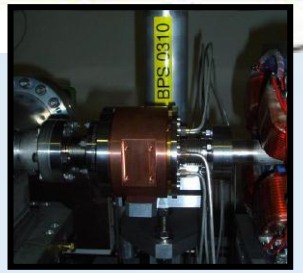
Test Beam Line: **Transport** of the **28 A** CTF3 Drive Beam, while **extracting more than 50% of the energy** using 16 PETS, each producing CLIC level rf power, with **small loss level**.





Optimized segmented dump for complete energy measurement (Uppsala U./CERN)





Quad movers (CIEMAT), ind. BPMs (IFIC ES.)

Test Beam Line – CTF3

Parameter [units]	**Symbol**	**TBL**	**CLIC**
Number of PETS	N_{PETS}	16	1492
Length of PETS [m]	L_{PETS}	0.80	0.21
Initial average current [A]	I_0	28	101
Power per PETS [MW]	P	~138	135
Initial energy [MeV]	E_0	150	2400
Mean energy extracted [%]	η_{extr}	~54	84
PETS sync. freq. [GHz]	f_{rf}	12	12
Number of FODO cells	N_{FODO}	8	524
Length of FODO cells [m]	L_{FODO}	2.82	2.01
Pulse length [ns]	t_{pulse}	140	240
Transient length [ns]	t_{fill}	3	1
Bunch length r.m.s. [mm]	σ_z	1.0	1.0
Init. norm. emittance [μm]	ε_N (x,y)	150	150
Beampipe radius [mm]	a_0	11.5	11.5

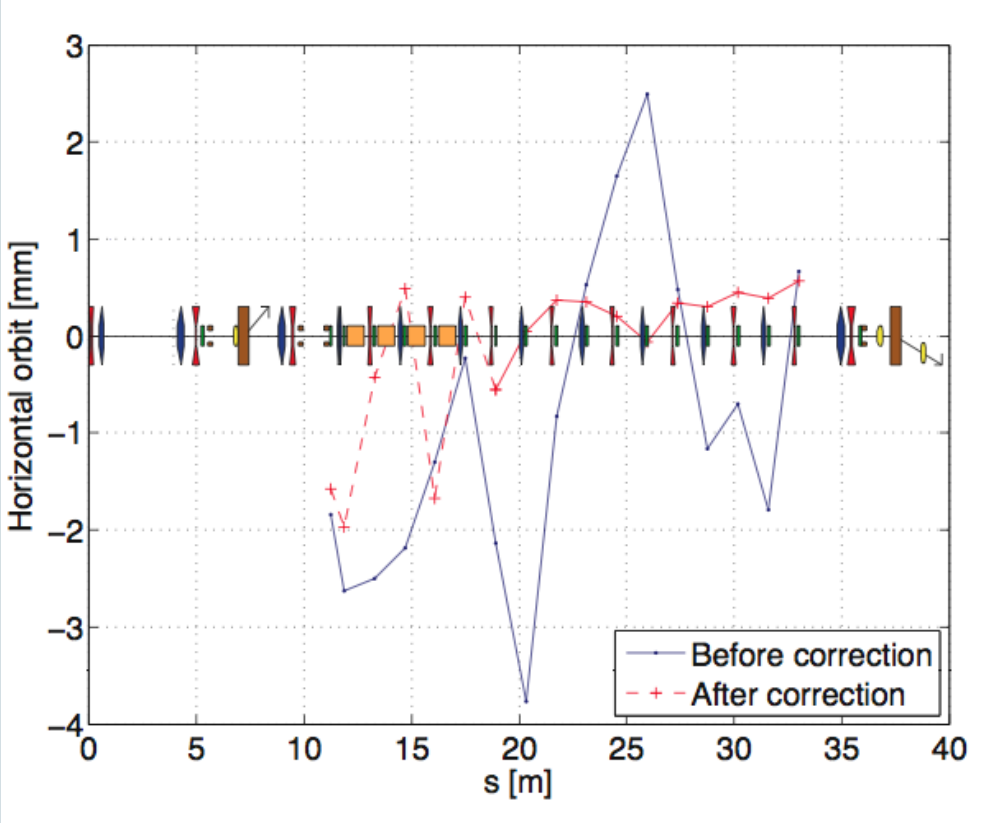
CTF3 Test Beam Line (TBL)

TBL line in CLEX

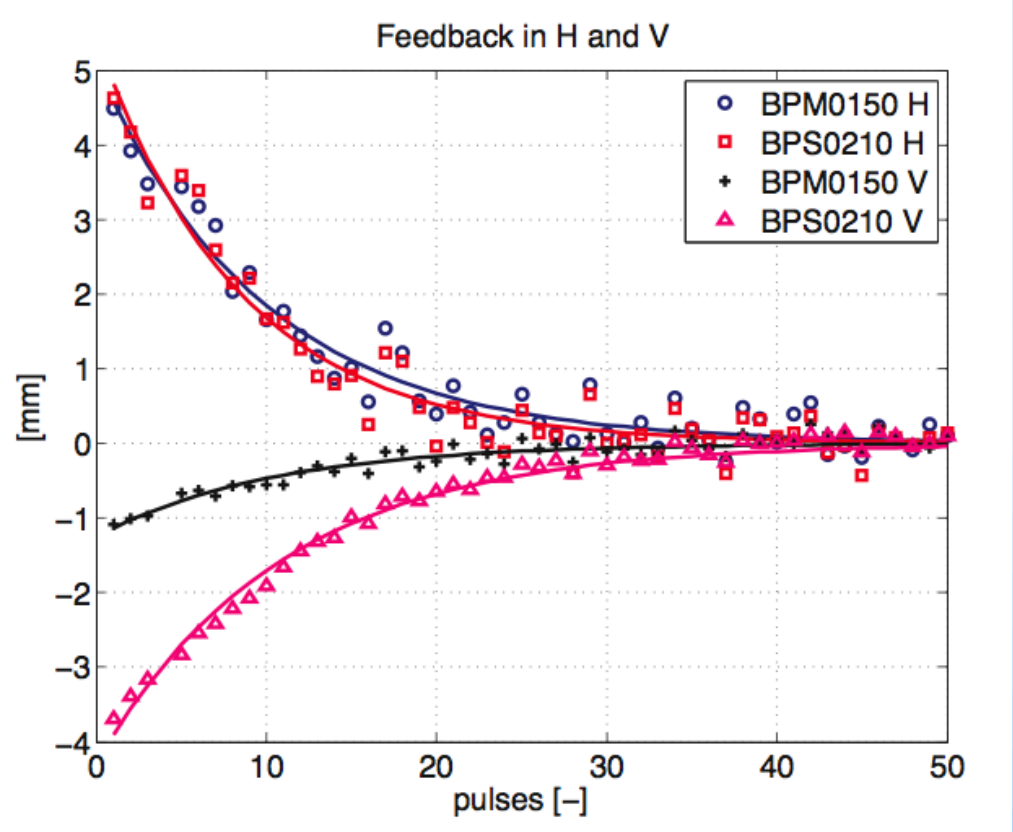
S. Doebert, R. Lillenstol

Automatic orbit control in the TBL

Advanced beam-based alignment is required to robust performance of the CLIC decelerators. Automatic orbit control algorithms have been tested successfully in TBL. Slow feedback leads to well-damped final orbit after ~10 pulses.



Automatic orbit control in TBL. 2013: plans to test dispersion-free steering schemes.

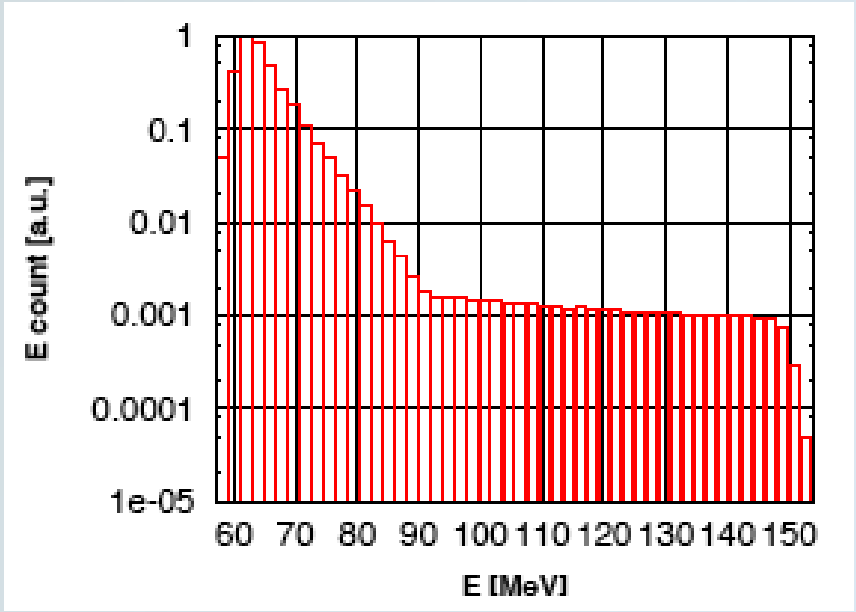


Good convergence of orbit control with a slow gain (G=0.1).

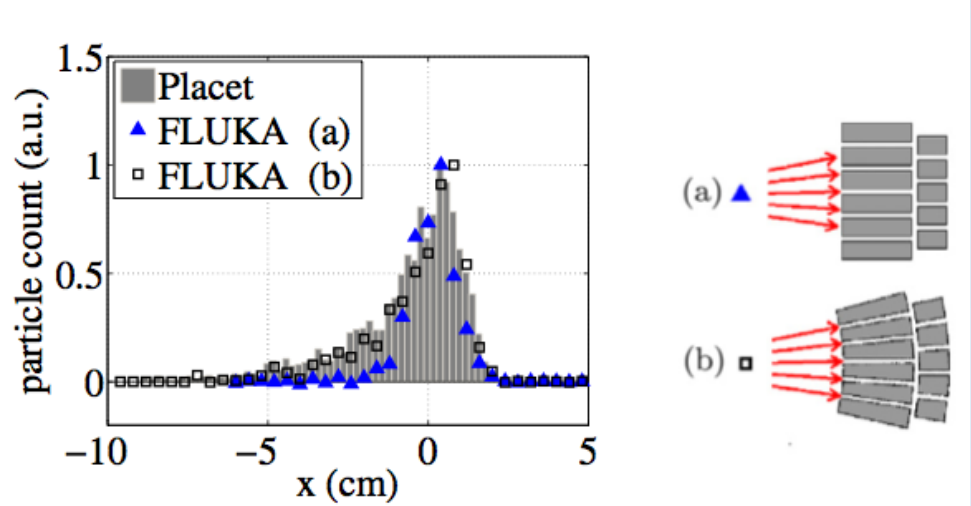
G. Sterbini, IPAC'12

Segmented dump spectrometer

To measure the large energy spread decelerated beam in TBL, a segmented dump spectrometer has been specially constructed (M. Olvegaard, Uppsala University).



Energy histogram after full deceleration in the Test Beam Line



Concentric geometry of the segmented dump (b) ensures good resolution of the energy profile.

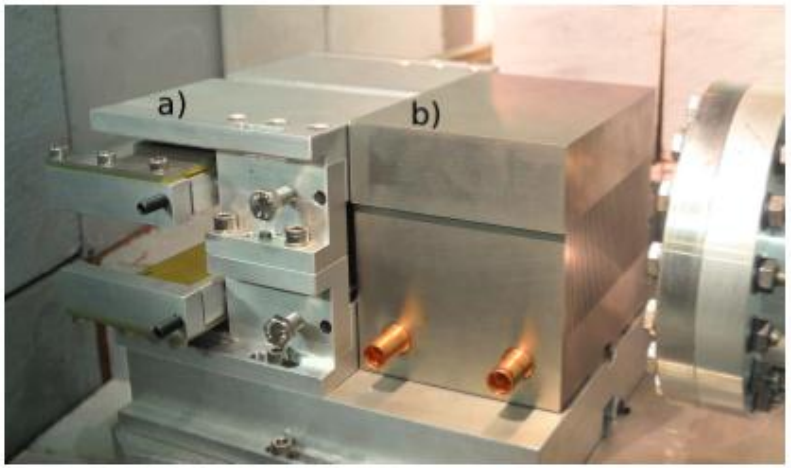
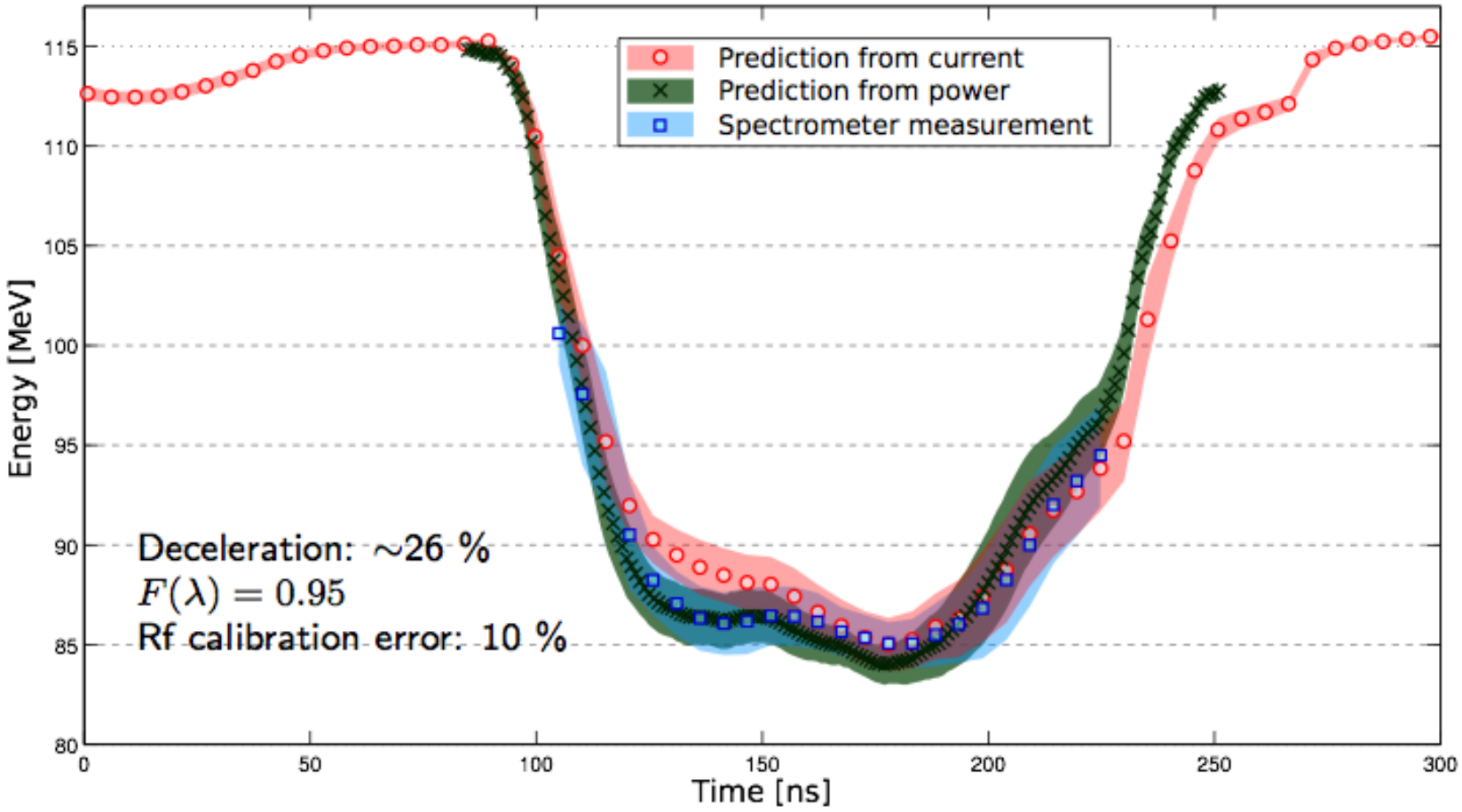


Figure 18: Picture of the segmented beam dump (a) installed in the beam line with a water-cooled collimator in front (b).

Spectrometer successfully installed and commissioned at the end of the TBL in 2011 (results: next slide).

Correspondence deceleration and power

Measurements from spectrometer has very good agreement with deceleration estimated from power readings and current readings :



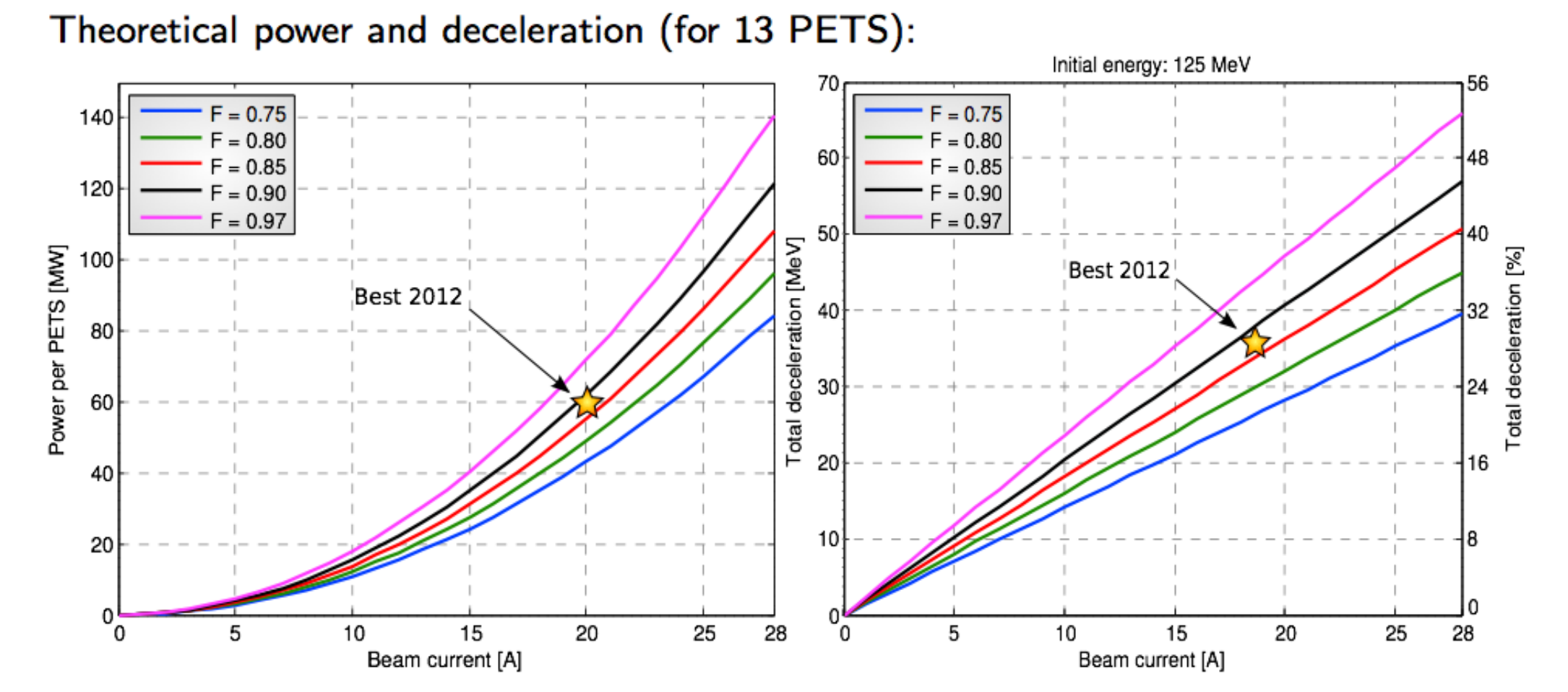
Experimental verification of the CLIC decelerator with the Test Beam Line in the CLIC Test Facility 3

Presented at IPAC'12

R. Lillestoel, IPAC'12

Goal for TBL run 2012-2013

So far in 2012, **29% deceleration has been shown**. Goal for 2012 + spring 2013 is to demonstrate the TBL target of 50%.



Ideal beam for TBL : Reliable, stable, reproducible 28 A beam with a high form factor and a square pulse.

R. Lillestoel