Status and plans for Two-Beam Test Stand and Two-Beam module in CTF3

Wilfrid Farabolini

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- Test of the 2 accelerating structures installed in TBTS
  - Energy gain performances
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- Diagnostics tests
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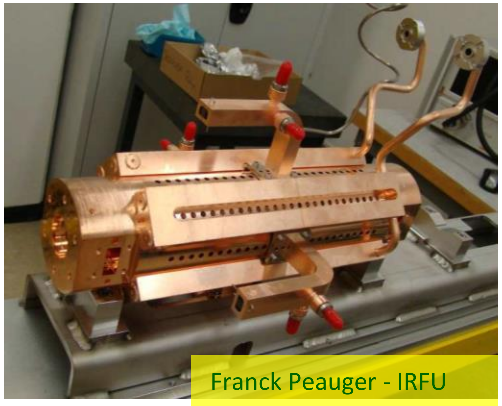
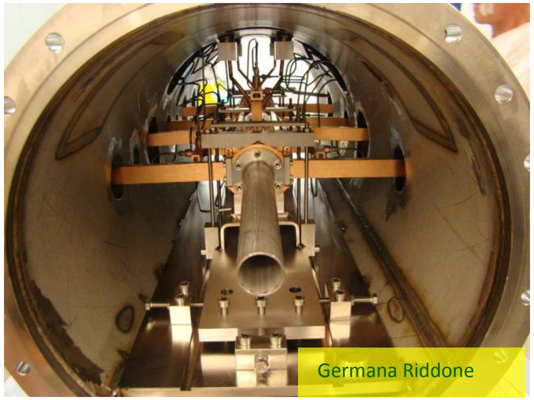
  - Cavity BPMs
  - Diamond detector
  - Cherenkov crystals for spectrometer
  - Coherence length of Optical Diffraction Radiation
- Installation of CLIC module
- Tests planned with the CLIC module

2 Accelerating Structures in the TBTS

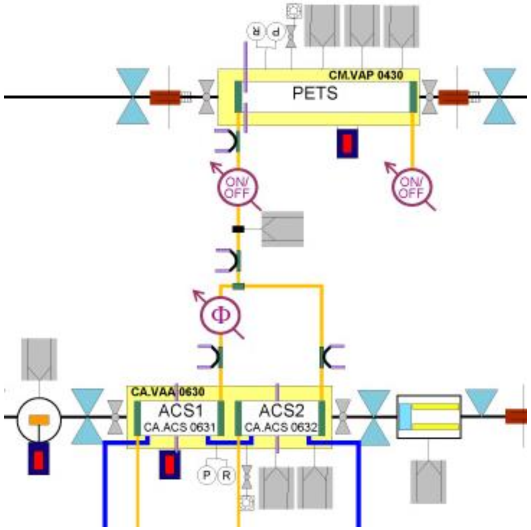


TD24 structure

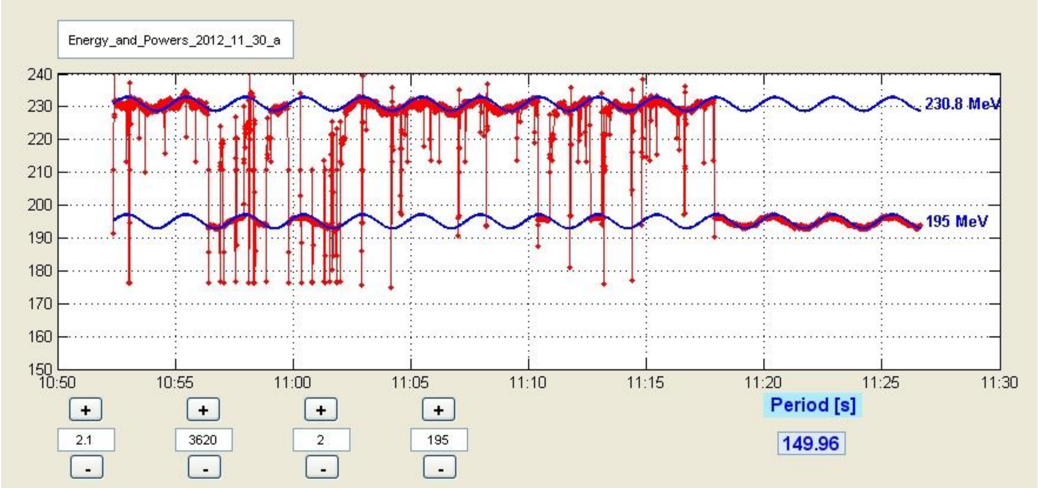


ACS tank

TBTS

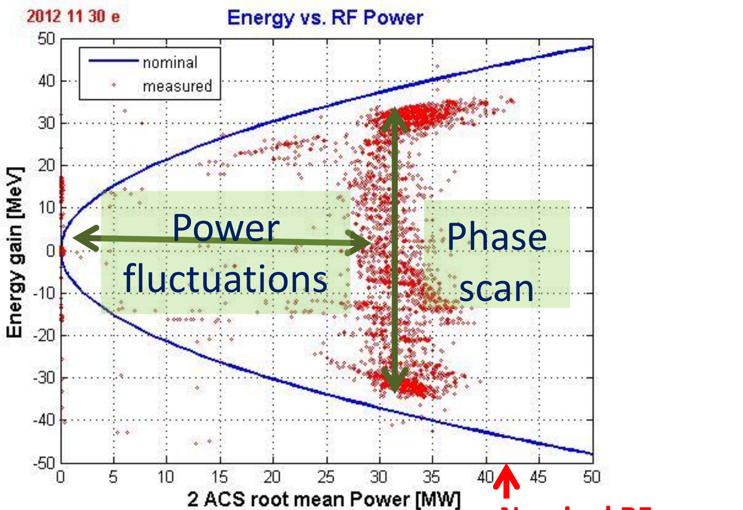


One PETS for 2 structures

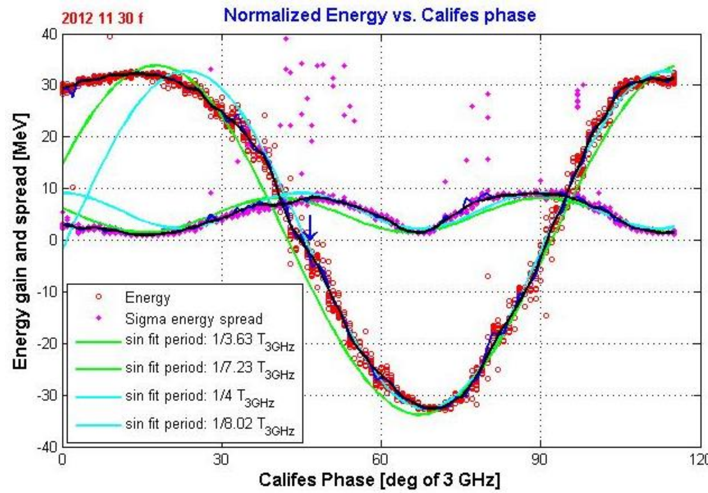


Probe beam Energy with and w/o RF power after phase "optimization"

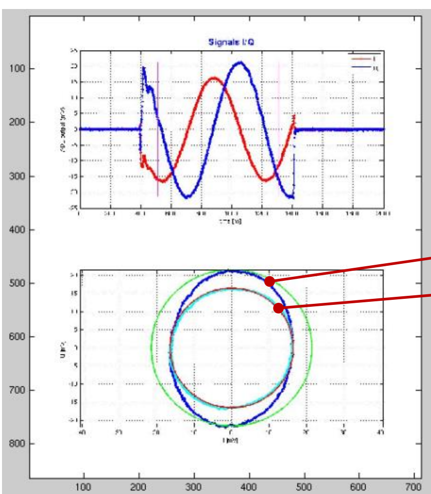
Improvement of RF lines calibration

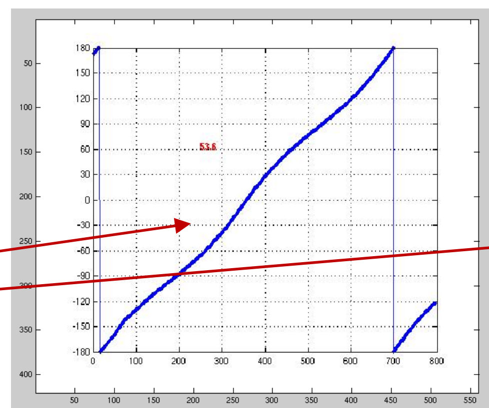


Energy gain figure

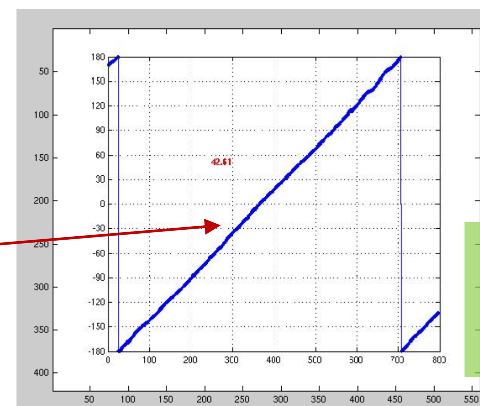


Energy gain and energy spread vs. phase





Phase before I/Q normalization

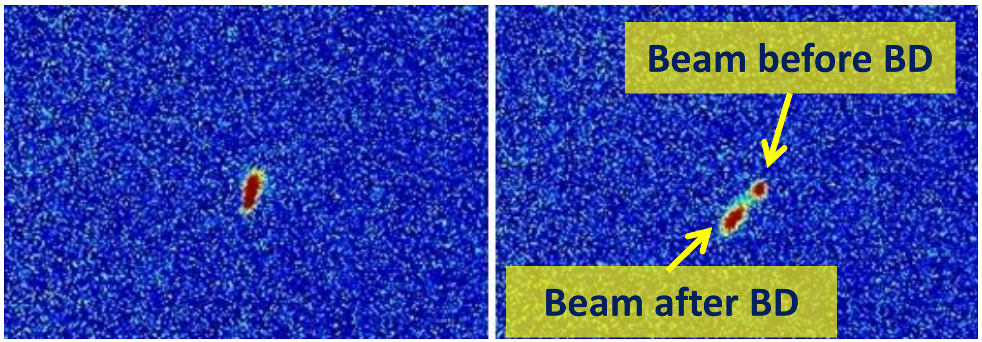


Phase after I/Q normalization

L. Timeo
S. Rey
N. Vitoratou

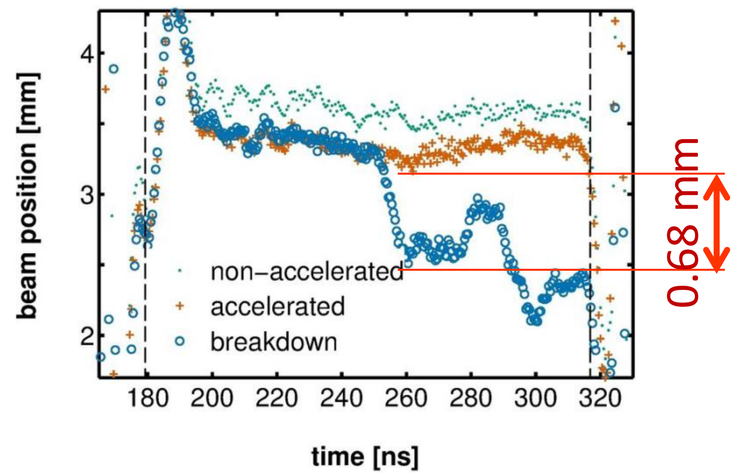
Injection after the 50 dB coupler of a RF calibration signal (1 kW – 11994.2 + 2 MHz)

Beam kick

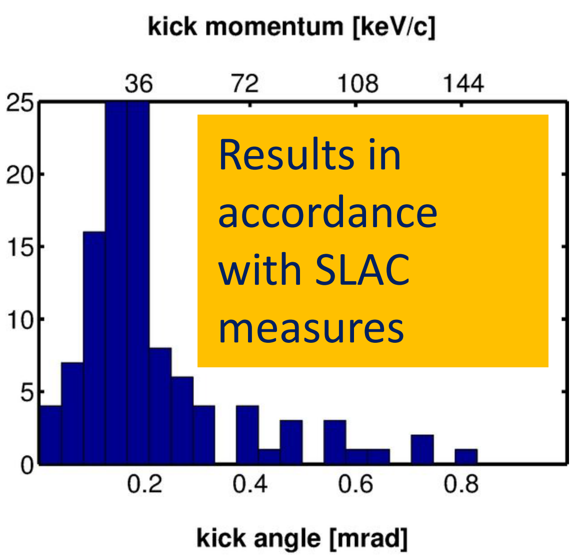


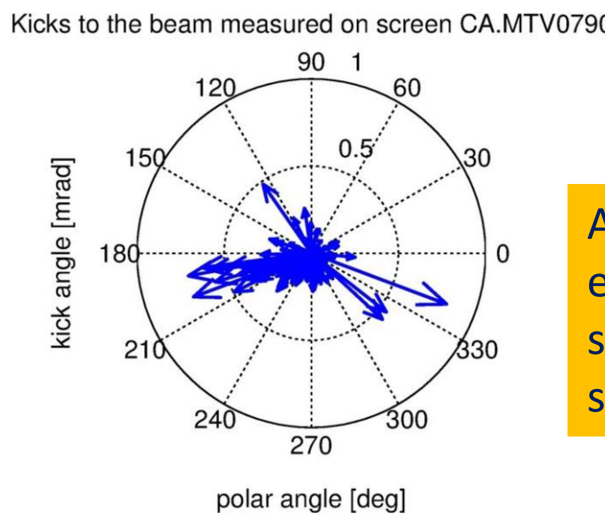
On YAG screen without BD

With BD



Time resolved position on cavity BPM

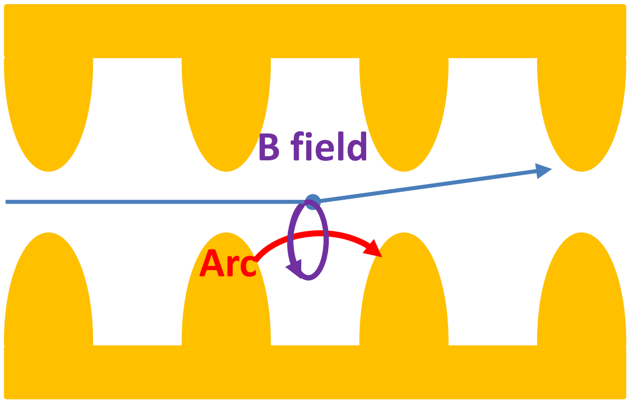




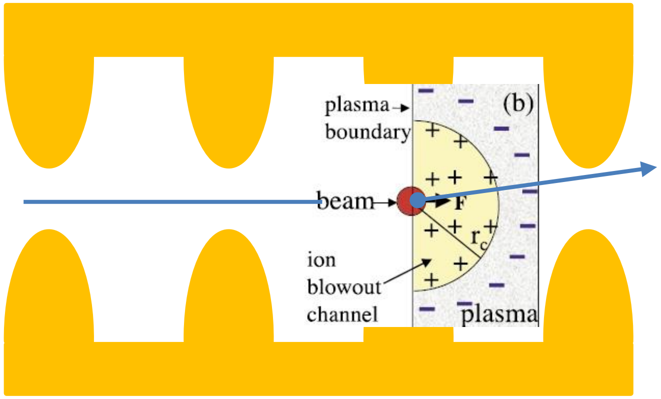
A. Palaia PhD Thesis

Anisotropy not explained but still not enough statistics

2 models for a “single” phenomena



Magnetic deflection by a BD arc of 200 A approx.



Asymmetric blowout of the BD inhomogeneous plasma [*].

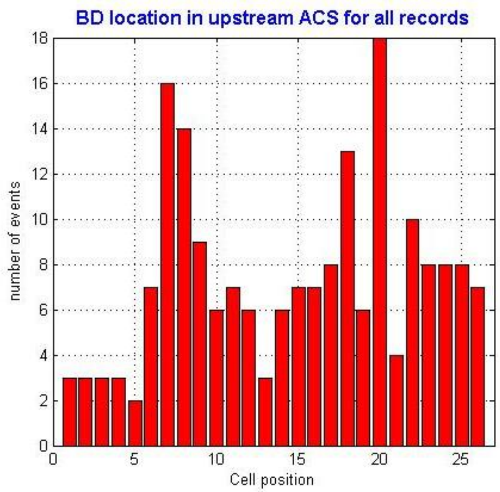
[*] Refraction of e^- beam due to plasma lensing at a plasma-vacuum interface, A.A. Sahai, T.C. Katsouleas, June 16, 2013

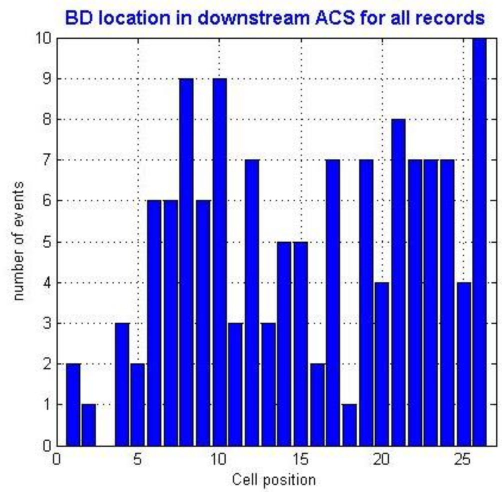
Experiment to discriminate these 2 phenomena (large statistics needed)

- Use a delayed (several μs) probe beam after the BD

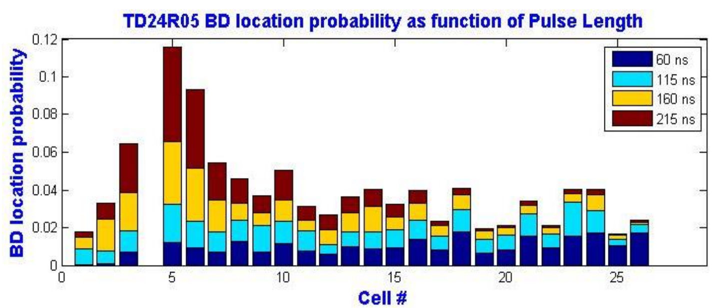
- Send the PB at zero crossing

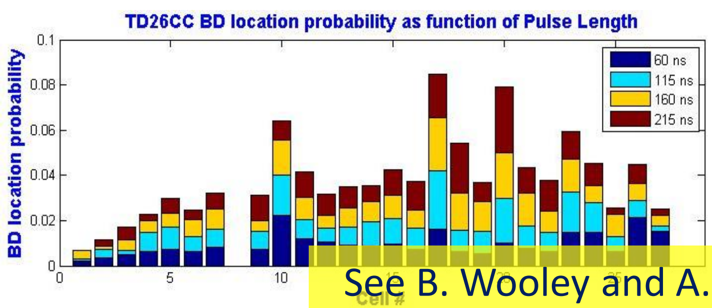
BD statistics studies

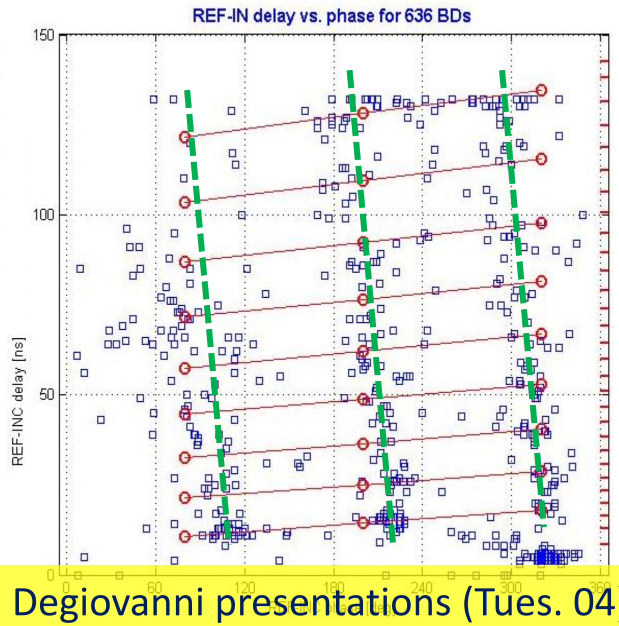


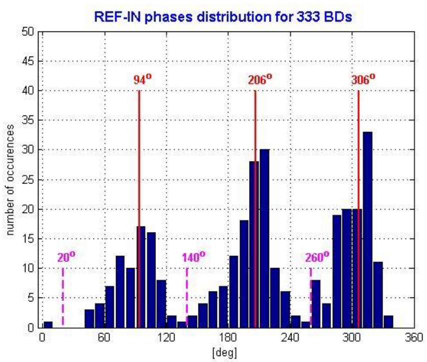


- No hot cell in whatever ACS,
- BD rather evenly distributed in the 2 structures,
- No new data in 2013 since not enough power after conditioning (85 MV/m).





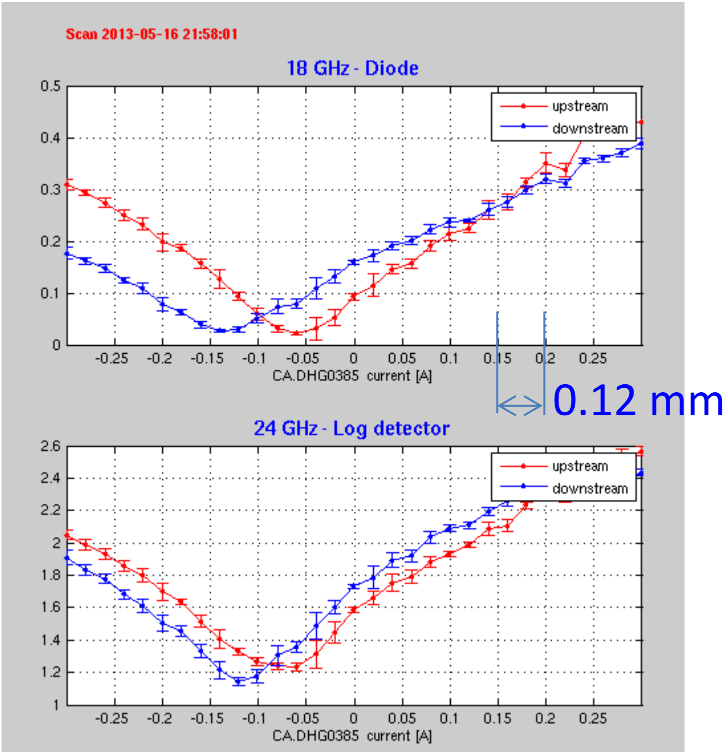




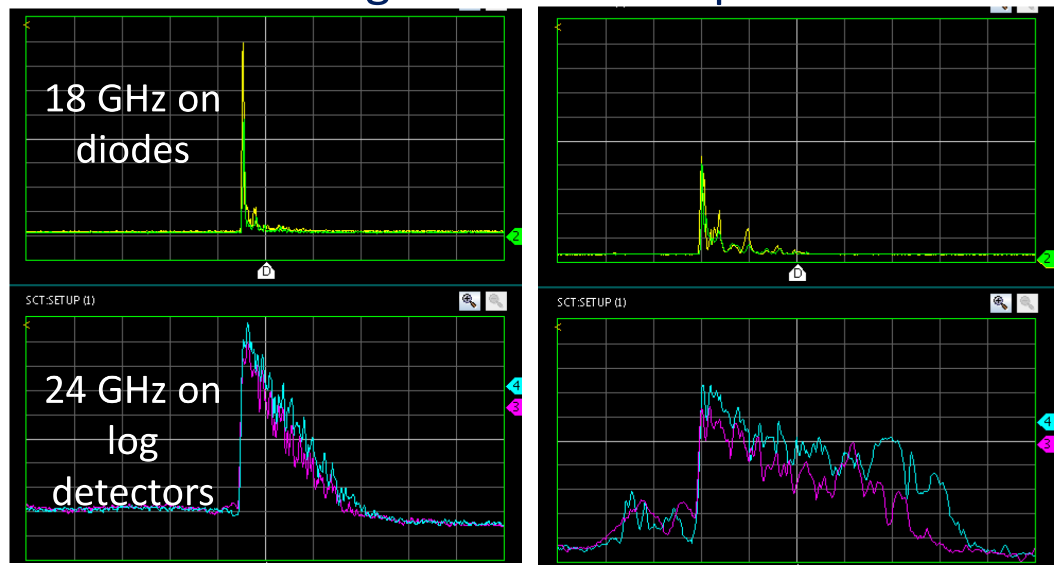
But huge quantity of data generated and analyzed from the X-Box1

See B. Wooley and A. Degiovanni presentations (Tues. 04)

Wake Field Monitors study



WFM signals from a PB pulse



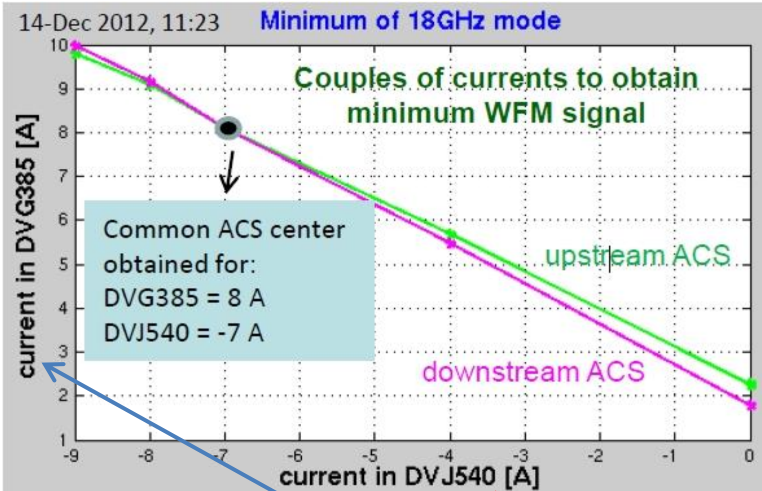
WFM signals without 12 GHz RF power

WFM signals with RF power

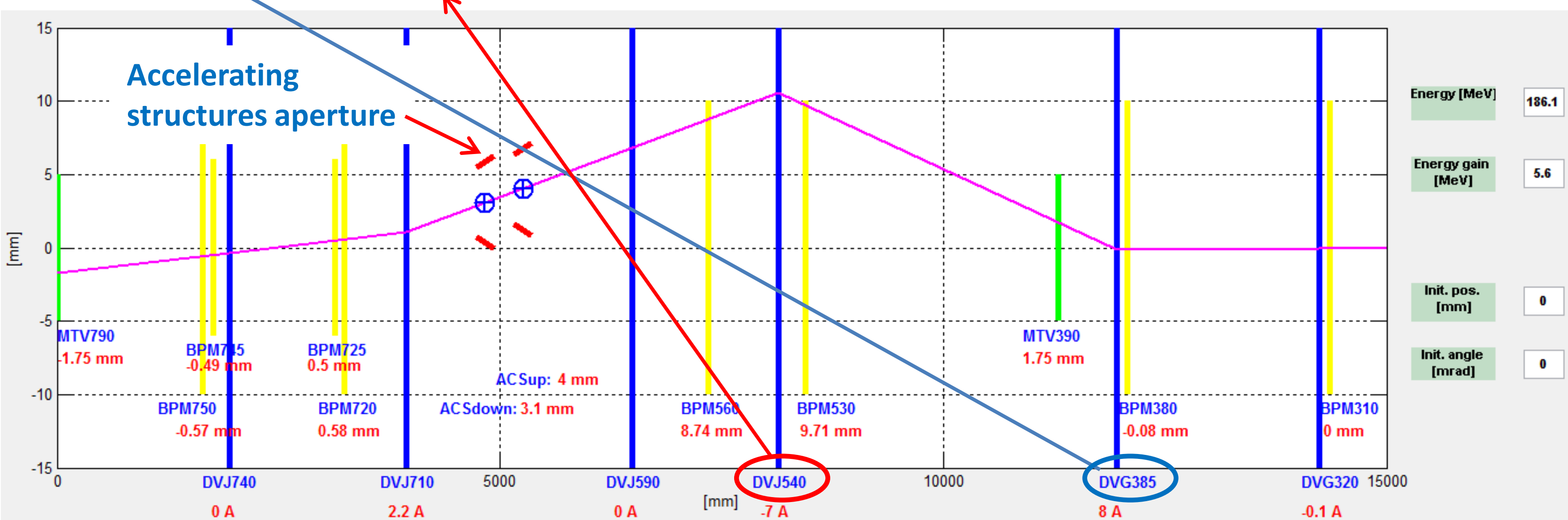
F. Peauger - IRFU

- Two types of WFM installed on the structures : (HOMs: 18 GHz and 24 GHz).
- Resolution already better than 20 μm.
- Robustness with nominal 12 GHz RF power (42 MW) still to be investigated

Re-alignment of the 2 structures



First successful results: realignment of the ACSs tank according to the position delivered by the WFM.
Using corrector is now no longer required to transport the beam through TBTS line.



New acquisition electronics

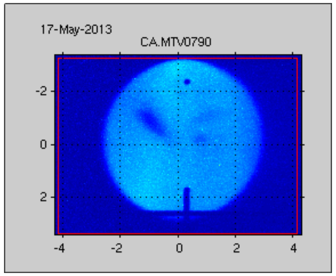
Present log detector PCBs and crate

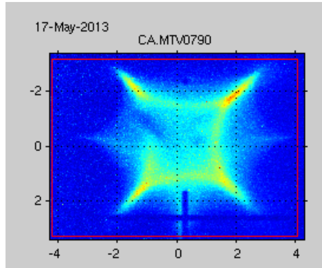
Next PCB (8 channels log detector)

A. Andersson
A. Khan
S. Rey

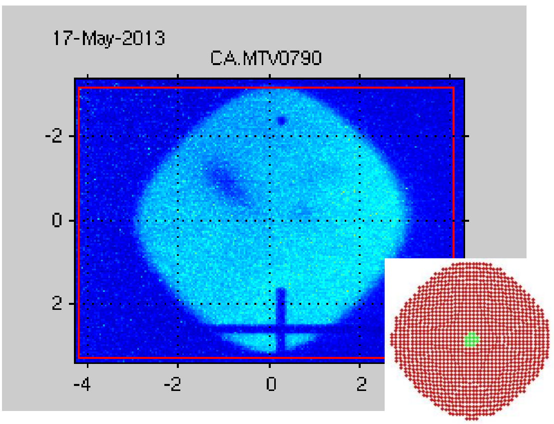
- Based on a novel "log detector" chip still operational at 24 GHz
- New design shared with X-Box2 data acquisition system
- WFM tests to be resumed in February with RF nominal power

Octupolar modes evidences

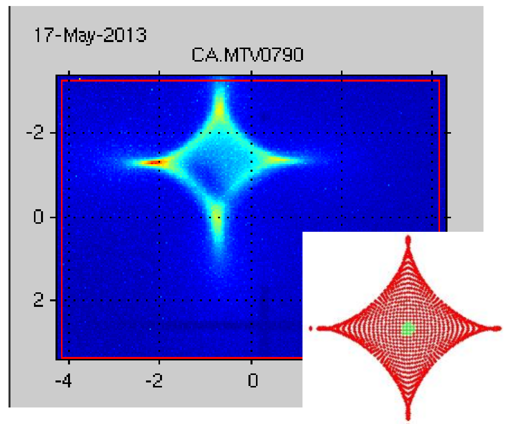




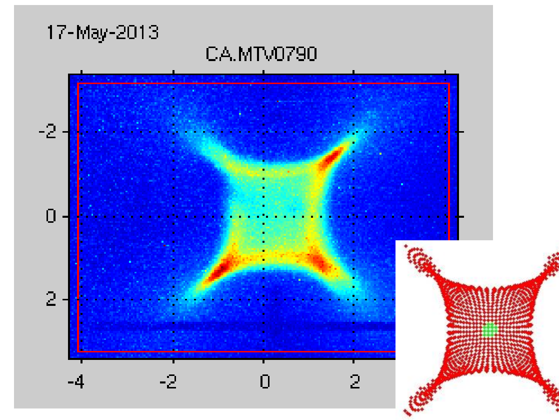
Large beam (Φ > 5 mm) shadowed by the structure, non accelerated (left) and accelerated (right)



For very weak RF power (few MWs, uncertain phase)



At zero-crossing (rising RF power side), 25 MW

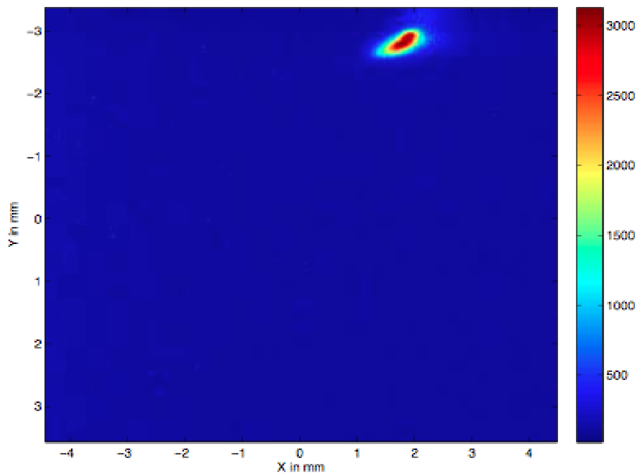


At zero-crossing (falling RF power side), 25 MW

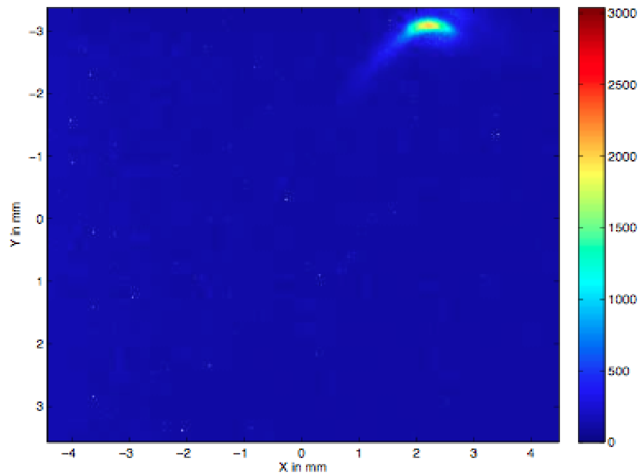
Effect of the disks symmetry (HOM damping waveguides) already foreseen but not significant for a well centered small size beam (green beamlets on the simulation).

"Multipoles of the accelerating field and the beam distortion in TBTS", Alexej Grudiev, 29/05/2013 **CLIC RF Structure Development Meeting**

Beam shape and coupling



(a)



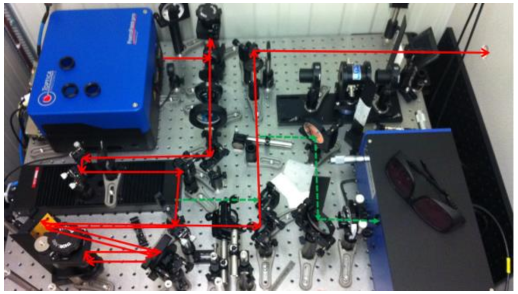
(b)

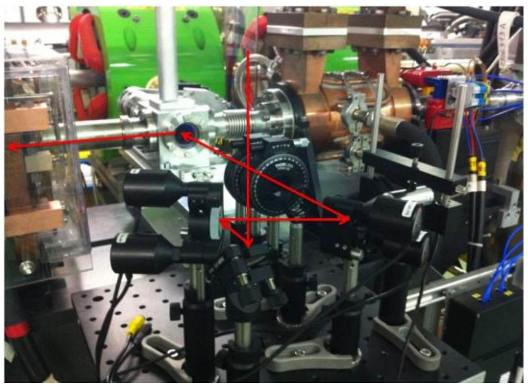
Figure : Image of the probe beam for a non-accelerated (a) and accelerated case (b). A change of the beam position as well as of the size and the x-y-correlation is visible.

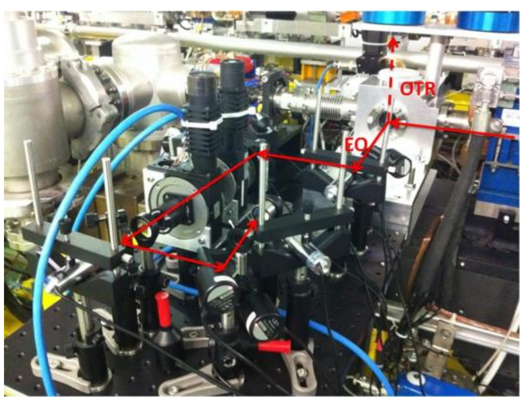
Question: How does the RF influence the beam transversely?

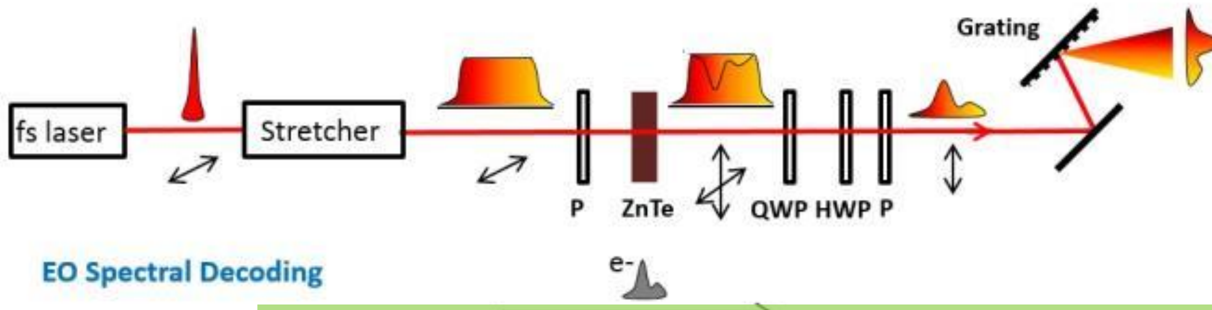
"Measurement of transverse coupling in the TBTS, Christopher Borgmann, 22. October 2013, **CLIC/CTF3 Exp. Verification meeting"**

Electro Optical Sampling

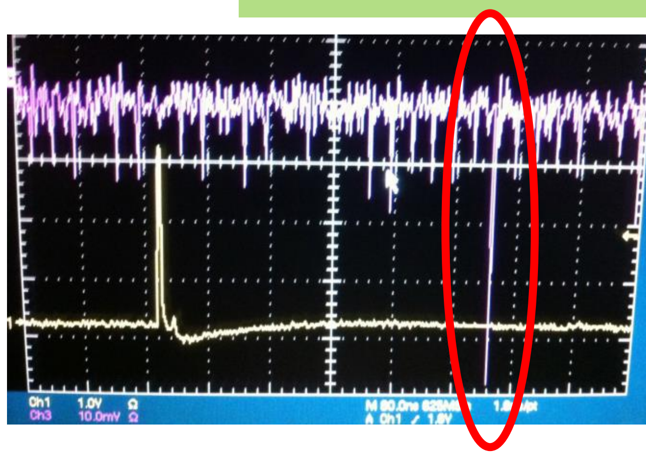








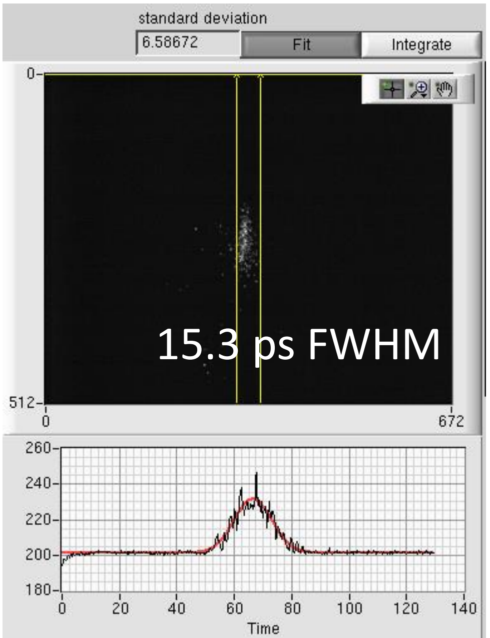
Rui Pan (PhD student), Electro-Optical Bunch Profile Measurement at CTF3 IPAC'13 MOPME077.



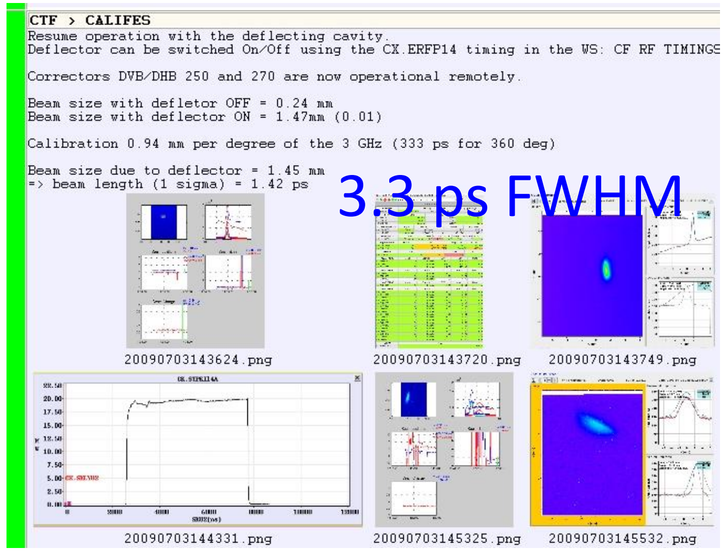
See S. Mazzoni talk "Beam instrumentation developments at CTF3", This WS, Tues 17:30

A laser pulse (top trace) is visible 420ns after the trigger signal (RF), bottom trace. Evidence for a depolarisation induced by the E-O crystal

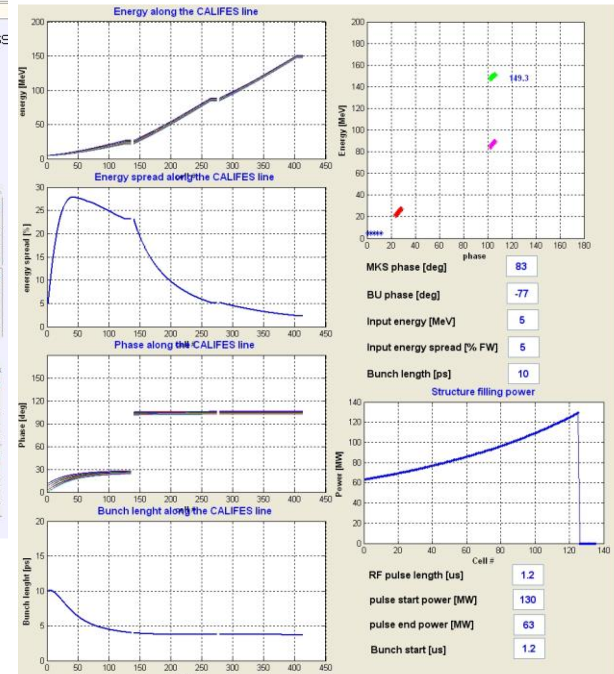
Short bunches no longer achieved



Streak Camera



CTF3 logbook 3 July 2009

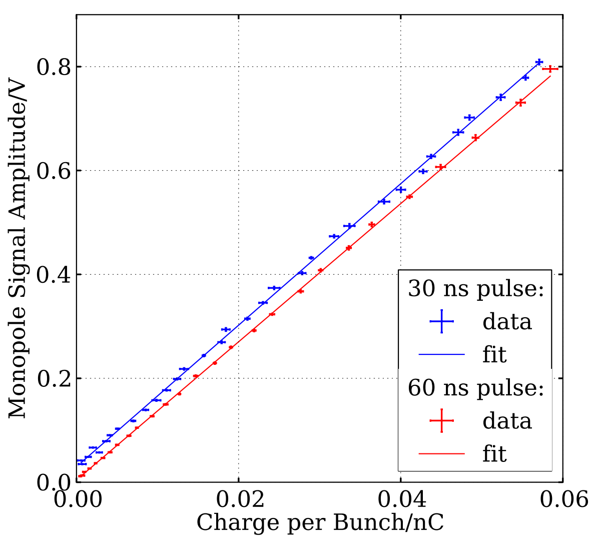


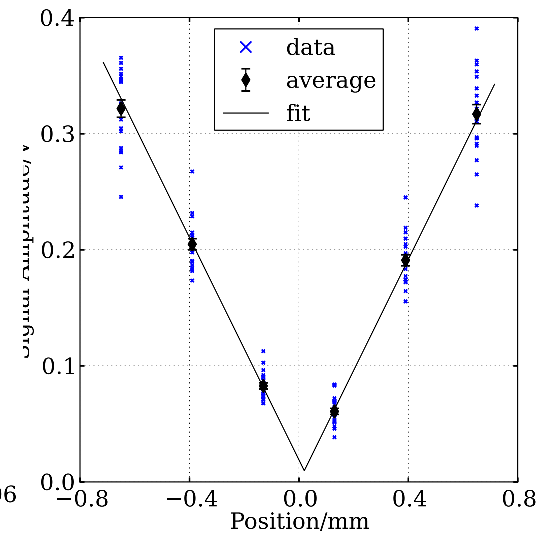
Particles tracking model

- Despite the phase shifter for setting the first LIL structure in velocity bunching, bunch length is always longer than 15 ps FWHM
- Before phase shifter installation, 3.3 ps bunch length was measured with the deflecting cavity.
- To be solved urgently (particles tracking model, RF pulse compression phase…)

Cavity BPMs

- BPM required to measure orbit with 50 nm and 50 ns resolutions.
- 15 GHz stainless steel prototype cavity BPM installed in CALIFES.
- Two cavities: Position (dipole) and reference (monopole).
- Beam tests last spring.
- No motor control to vary beam position, used corrector magnets.



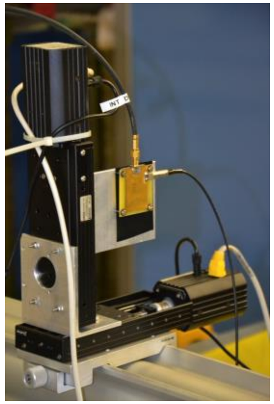


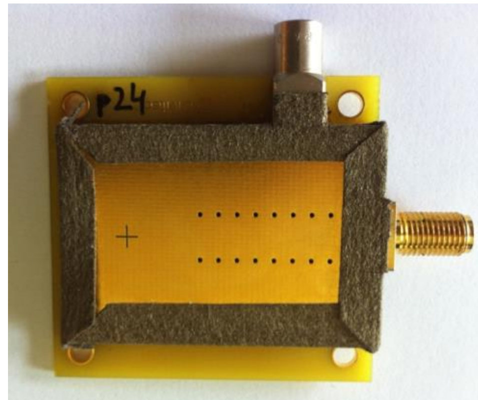
F. Cullinan , J. Towner

See S. Mazzoni talk "Beam instrumentation developments at CTF3", This WS, Tues 17:30

Other diagnostic tests in preparation

Diamond detector

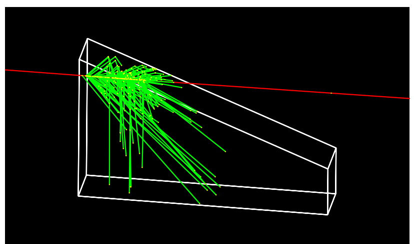




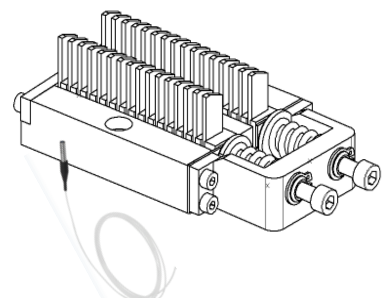
F. Burkart, O. Stein (TE-MPE-PE)
E. Nebot Del Busto (BE-BI-BL)

Very low and well calibrated bunch charge requested (10^5 e^-)

Cherenkov crystals for spectrometer

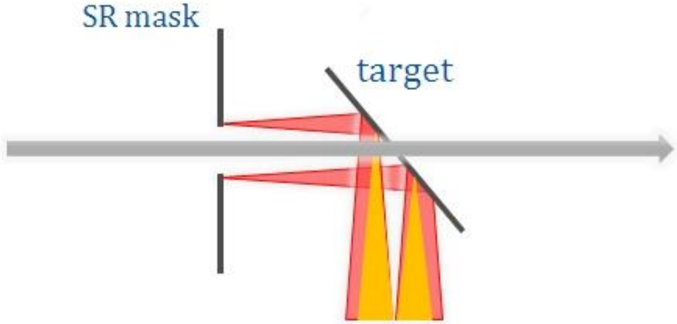


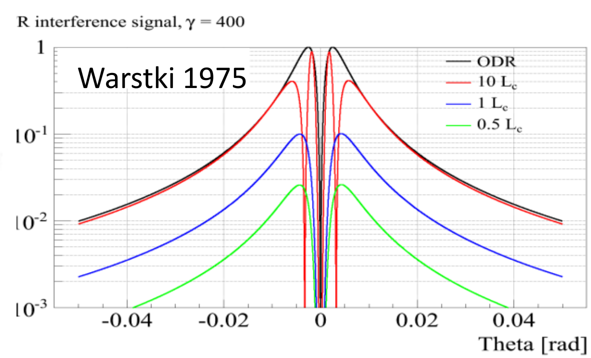
GEANT simulations by A. Apyan



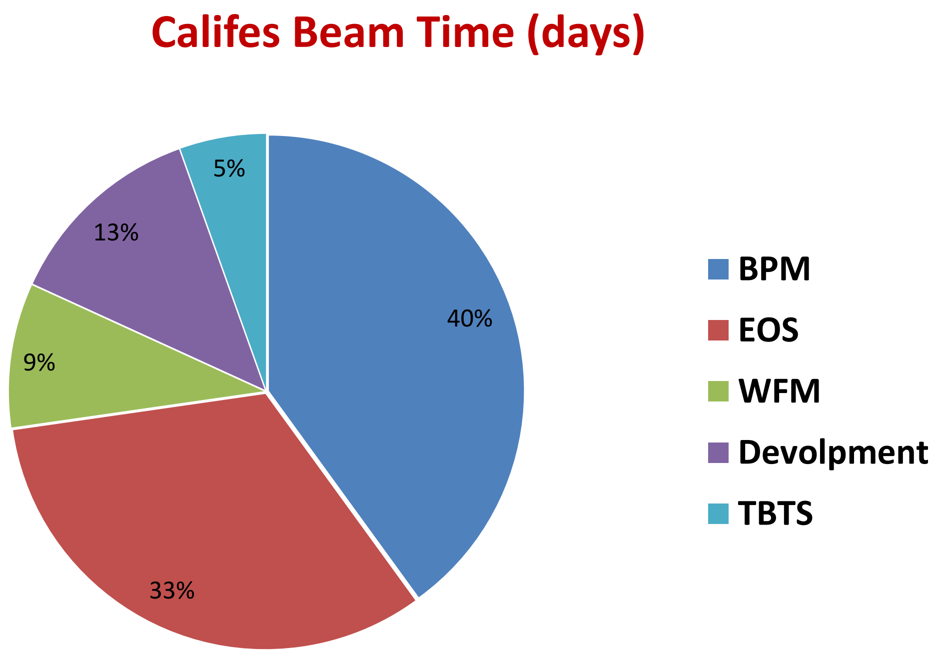
See S. Mazzoni talk "Beam instrumentation developments at CTF3", This WS, Tues 17:30

Coherence length of ODR light





CALIFES beam time use in 2013

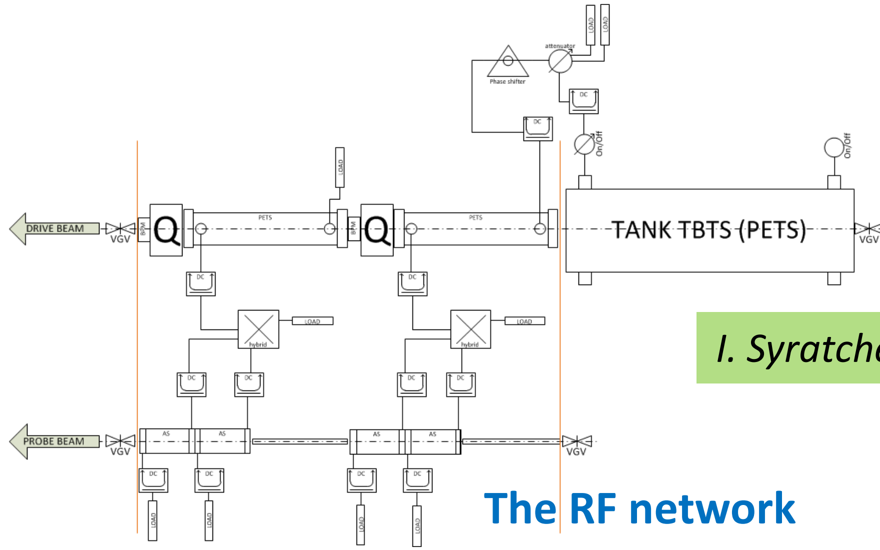


- Cavity BPM : 22 days
- EOS : 18 days
- WFM : 5 days
- CALIFES development : 7 days
- TBTS acceleration: : 3 days

Beam interrupted from June 2013

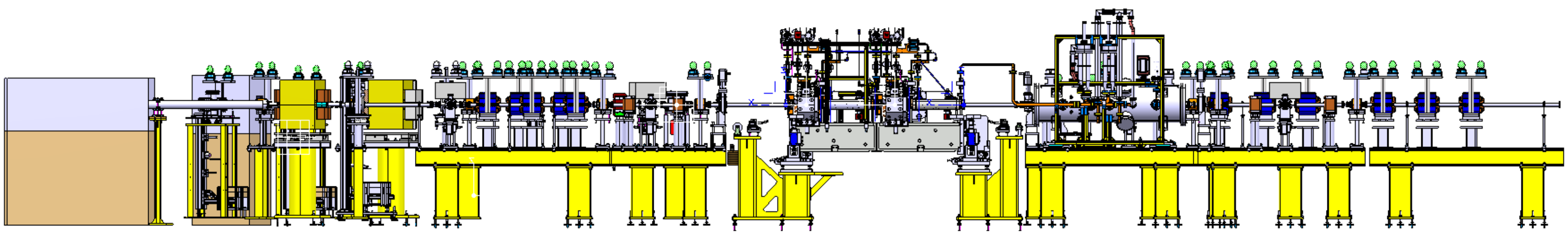
Installation of the CLIC module

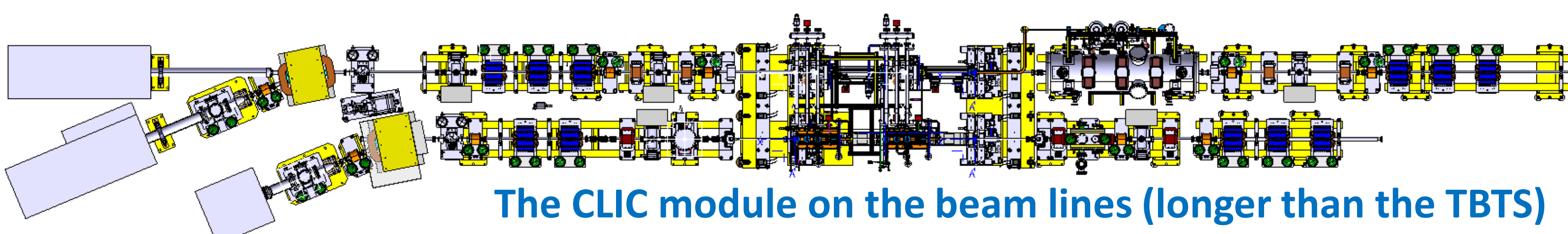
The CLIC module in the lab



The RF network

I. Syratchev

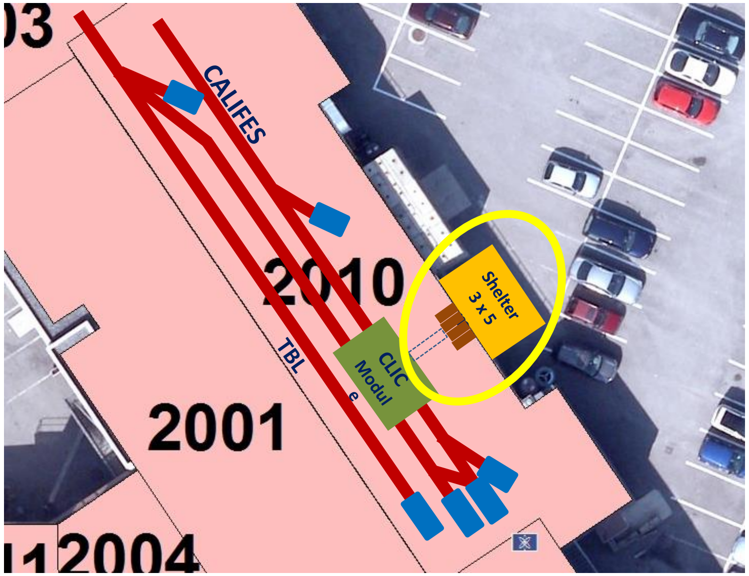




The CLIC module on the beam lines (longer than the TBTS)

G. Riddone, D. Gudkov (BE-RF-PM)

Preparation work has started in CLEX



A shelter on the car park to host the new equipments

A trench cut for the cables

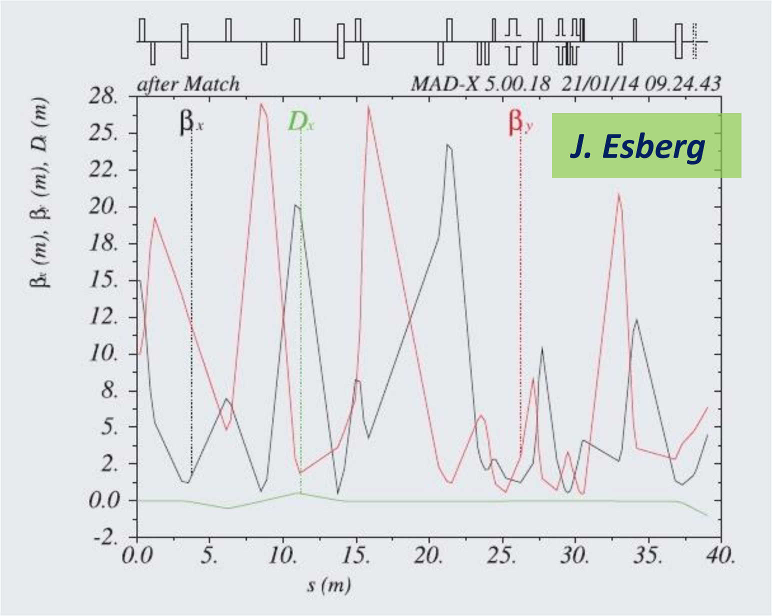
External wall drilled according to RP requirements

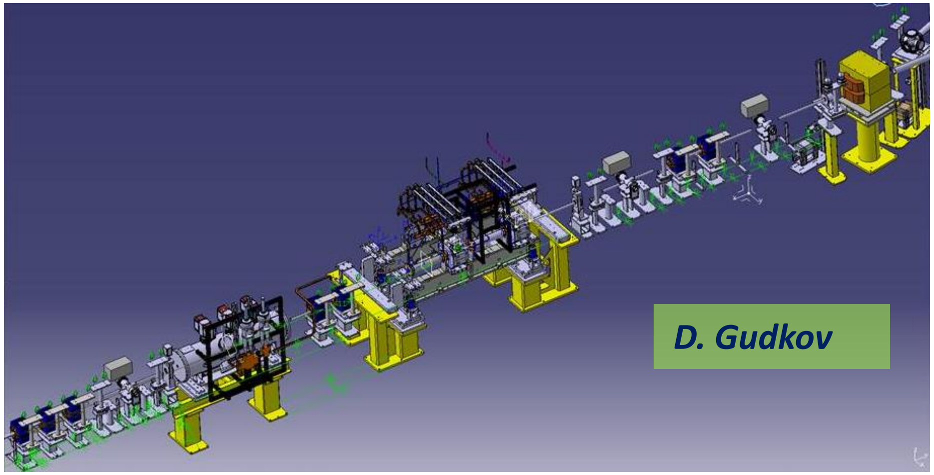
TBM T0@CLEX Cabling Summary

System	Racks for electronics: Shielded bunker	Racks for electronics: CTF3 gallery	Cable Type	Quantity	Ø (mm)	Starting (S) and End (E) Points: TBM	Starting (S) and End (E) Points: Shielded bunker	Starting (S) and End (E) Points: Outside Shelter	A
Pre-alignment	Sensor conditioning crates (19"x 3U x 380mm)	3 x 43 U (3 racks)	Rad-hard Muller MULRA	40	4	S		E	640
			Rad-hard Muller MULRA	6	4	S		E	96
			MCA8	20	7.7	S		E	1185.8
			MCA8	6	7.7	S		E	355.74
			MCA8	12	7.7	S		E	711.48
			NG18	12	16.5	S		E	3267
RF			LDF2-50	22	12				3168
			ethernet	1	5				25
			command for stepping m	4	10				400
			control and Limit switch	4	12				576
									0
									0
BI		1 rack		2	10	S		E	200
									0
									0
									0
									0
									0
Vacuum		6 rows	NG4 (4 conducteurs de 1	2	8.7	S		E	151.38
			TCA3 (triaxial haute tens	2	7	S		E	98
			DIODE: SVA3 (triaxial ha	6	9.7	S		E	564.54
			NEG: [illegible]	[illegible]	[illegible]	S		E	937.5
									0
									0
Magnet									0
									0
									0
									0
									0
									0
Cooling		2 x 43 U (2 racks)	Temperature sensors	30	5	E		S	750
			Supply pipe - SAS#1	1	15	E		S	225
			Supply pipe - SAS#2	1	15	E		S	225
			Supply pipe - PETS	1	15	E		S	225
			Supply pipe - DBQ#1	1	15	E		S	225
			Supply pipe - DBQ#2	1	15	E		S	225
			Return pipe - SAS#1	1	15	S		E	225
			Return pipe - SAS#2	1	15	S		E	225
			Return pipe - PETS	1	15	S		E	225
			Return pipe - DBQ#1	1	15	S		E	225
			Return pipe - DBQ#2	1	15	S		E	225
									14640 mm^2

Cable list established

Beam dynamic study with the CLIC module





- 2 additional quads required between the PETS tank and the CLIC module
- Powering, sensitivity to errors and uncertainties studied

See J. Esberg talk “Two-beam module layout and optics”, This WS, Wed 11:30

Schedule of the installation

Redrawing the line to accommodate the CLIC module	✓
Cables and crate reservations -> new premises	✓
Study of the new beam optics	✓
Drawing and manufacturing of all the elements	✓
Civil Engineering works	✓
Shelter installation and equipment on the car park	
Remove the TBTS tanks	2nd June
Storage inside CLEX of all reusable equipments	
Remove the girders and the feet	
Remove the cables trails and pipes	
Replace the PETS tank	
Install the CLIC module and the new girders with their equipments	
Vacuum chambers connections and leak tests	
Re-cabling of all the equipments and tests	
Connection to the shelter and tests	15th Sept.

Test planned with the CLIC module

- Module program:

R. Corsini

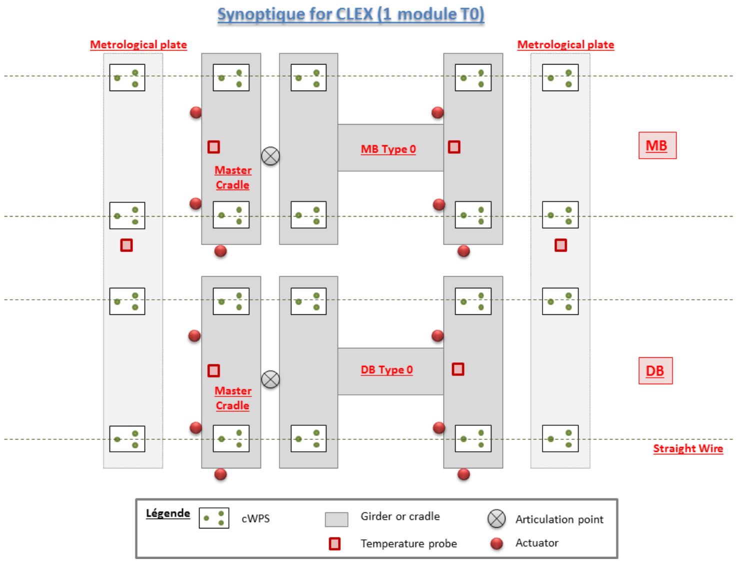
  - Basic RF behaviour (system conditioning, breakdown cross talks…).
  - Basic two-beam acceleration (energy gain, set-up with beam and phasing…).
  - Active alignment and stabilization, in presence of radiation and EM noise.
  - Alignment and fiducialization - WF monitors vs. BPMs.
  - Phase drifts studies (thermal effects, losses…)

Conclusion

- Despite a CALIFES beam interruption since June, the year 2013 has been pretty busy
  - Growing interest from the beam diagnostics community
  - Consolidation of the existing systems
  - Preparation of the CLIC module installation
- The first half of 2014 will be dedicated to complete the essential experiments with the TBTS (WFM, Nominal accelerating gradient…) and to deliver beam for testing the diagnostics already installed.
- The second half will see the challenging CLIC module installation and commissioning.

Specific pre-alignment tests foreseen on the CLEX

- Alignment of the girders (when there is no beam)
  - Control of the metrological data (impact of the transport test)
  - Alignment of the girders (with respect to the existing beam)
  - Absolute measurement (comparison between cWPS sensors and AT401 tracker)
- Test of the Degree of freedoms
  - Actuators displacement (5 D.O.F on 1 mm range)
  - Test of the Articulation Point (transfer of 2 D.O.F)
- Validation of equipment performance in radiation and high EMC noise
- Pre-alignment versus beam alignment
  - Follow up of the data
  - Comparison between sensors alignment and beam data



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