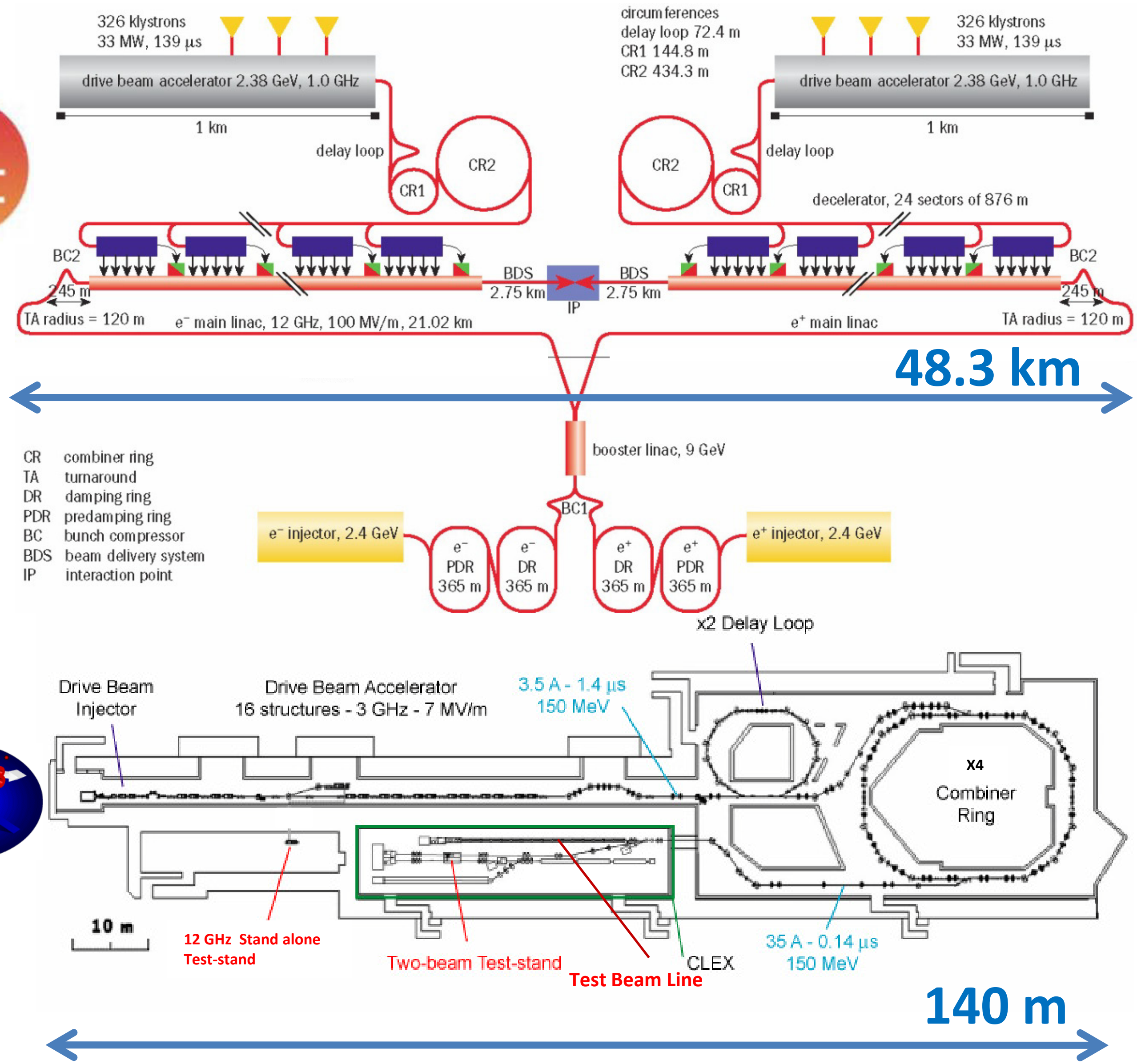
Two-Beam Test Stand Experiments in the CLEX-CTF3 Facility

Wilfrid Farabolini – CEA Saclay
on behalf of the CTF3 team

The CLIC / CTF3 Facility



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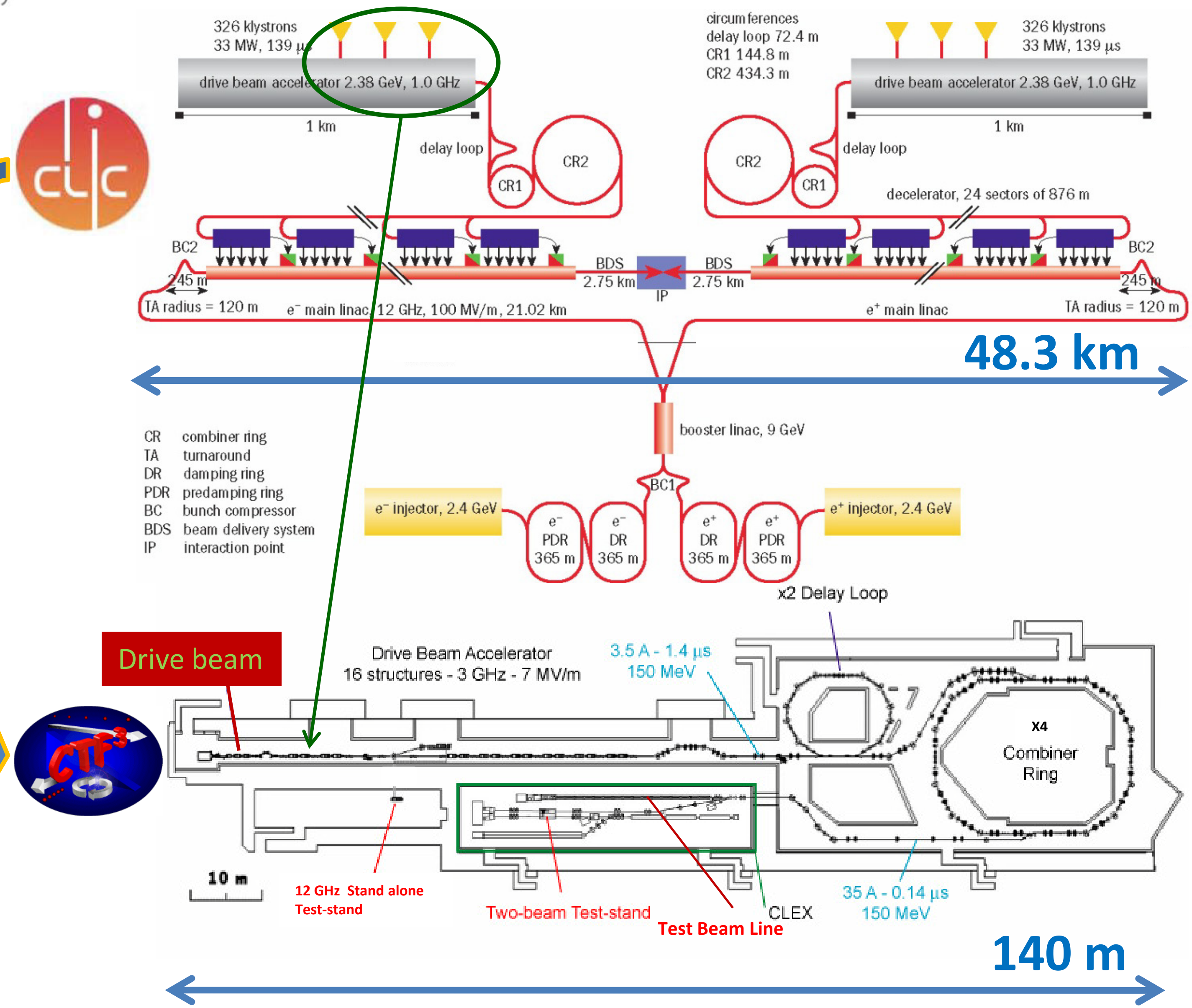

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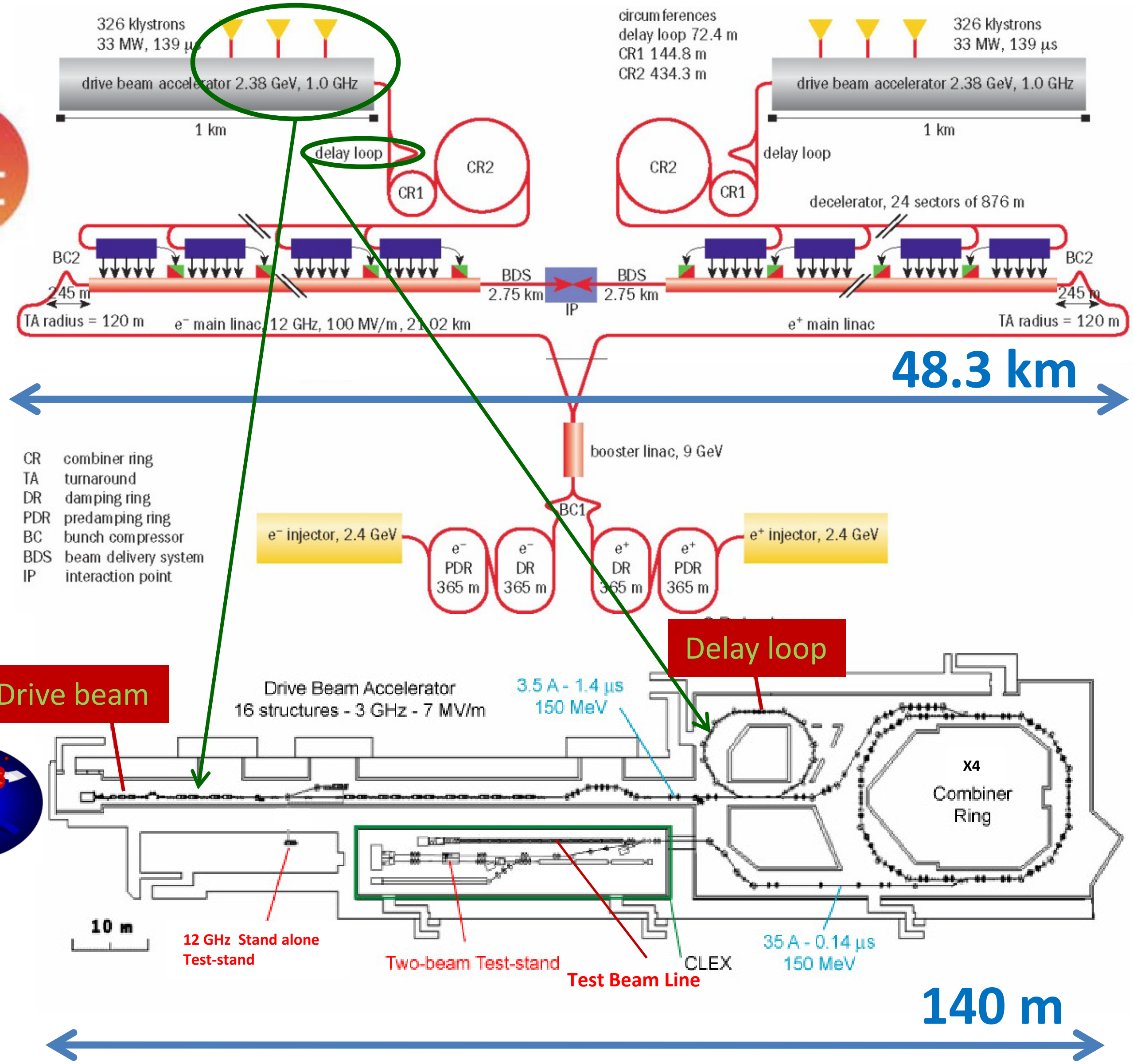

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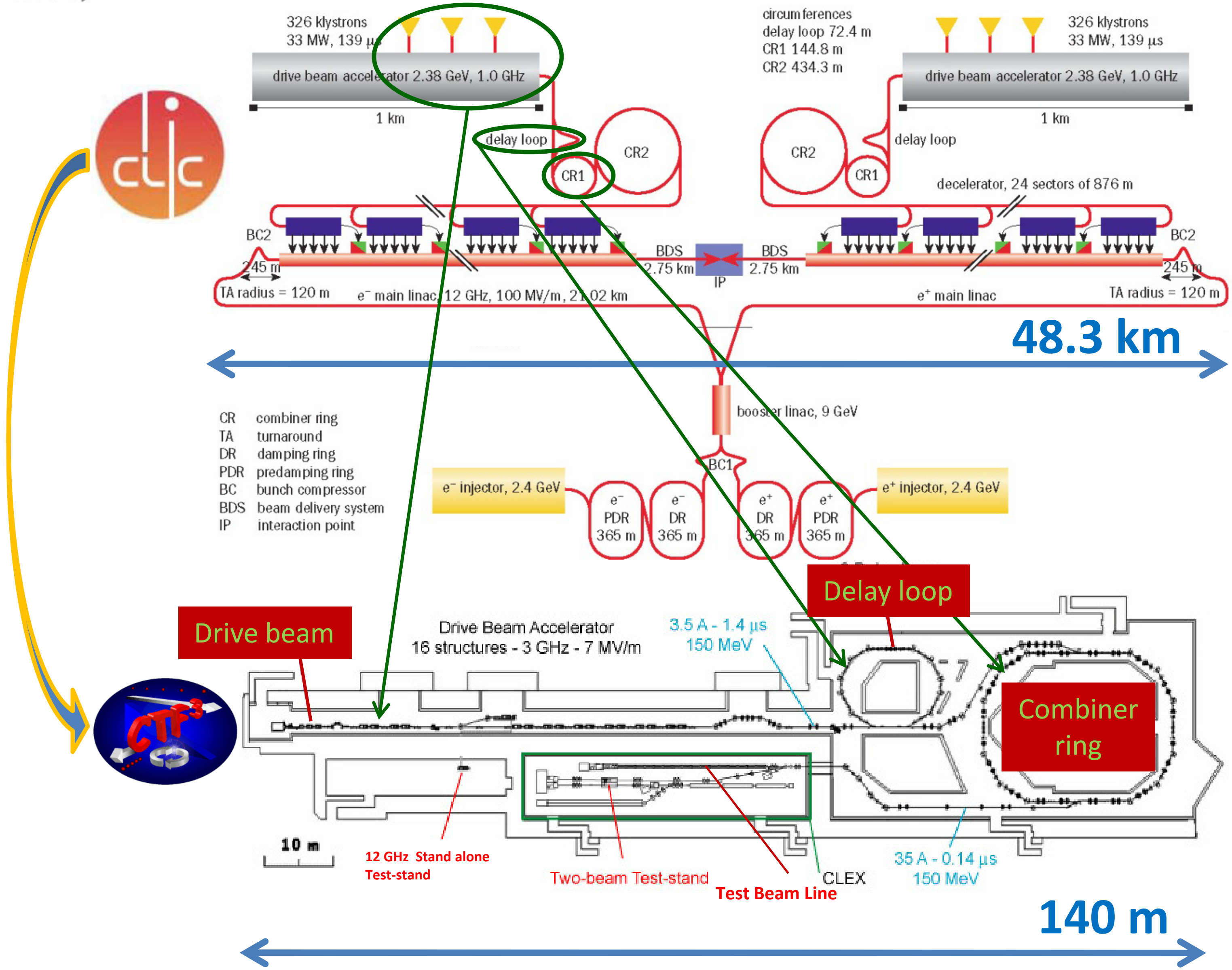
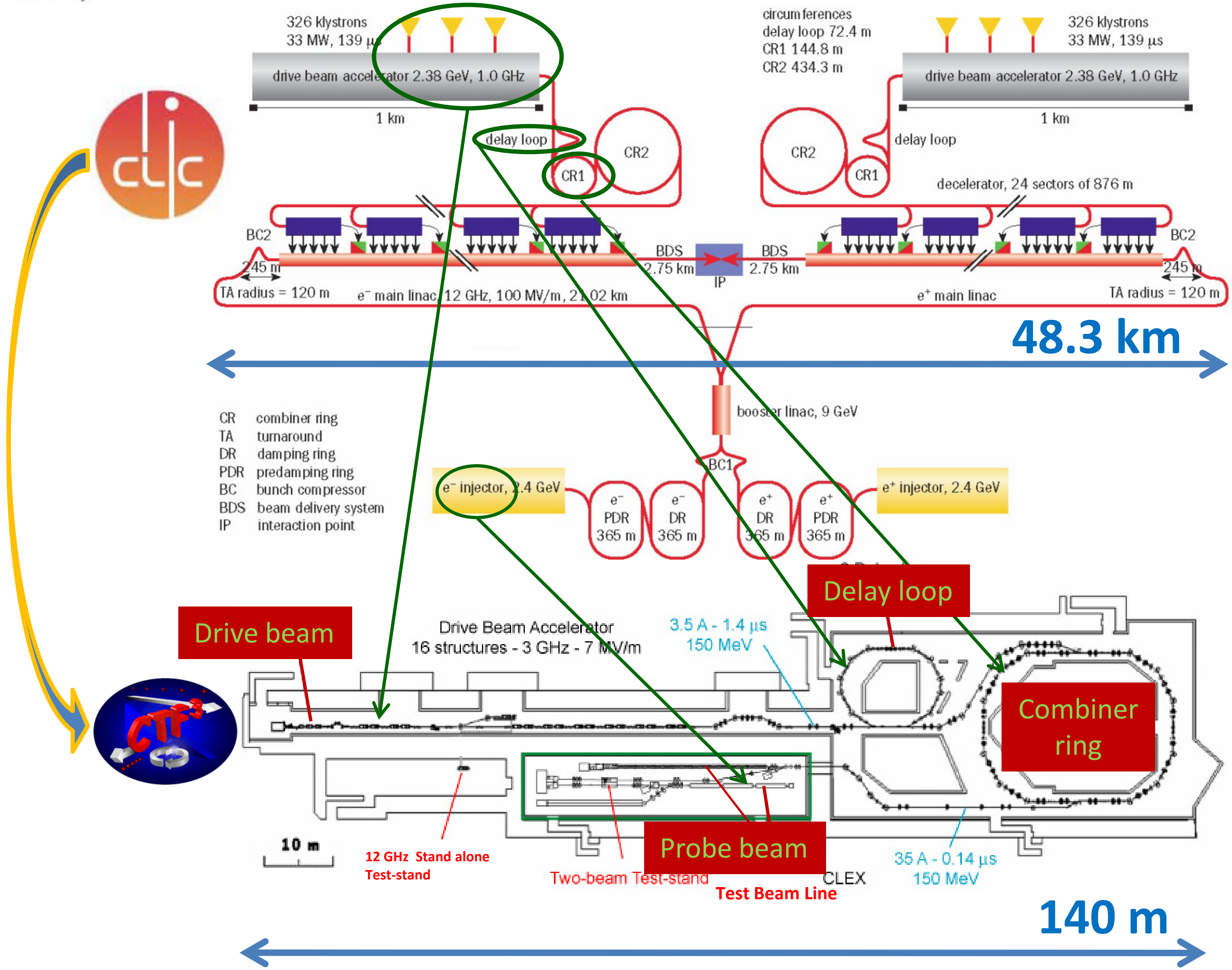
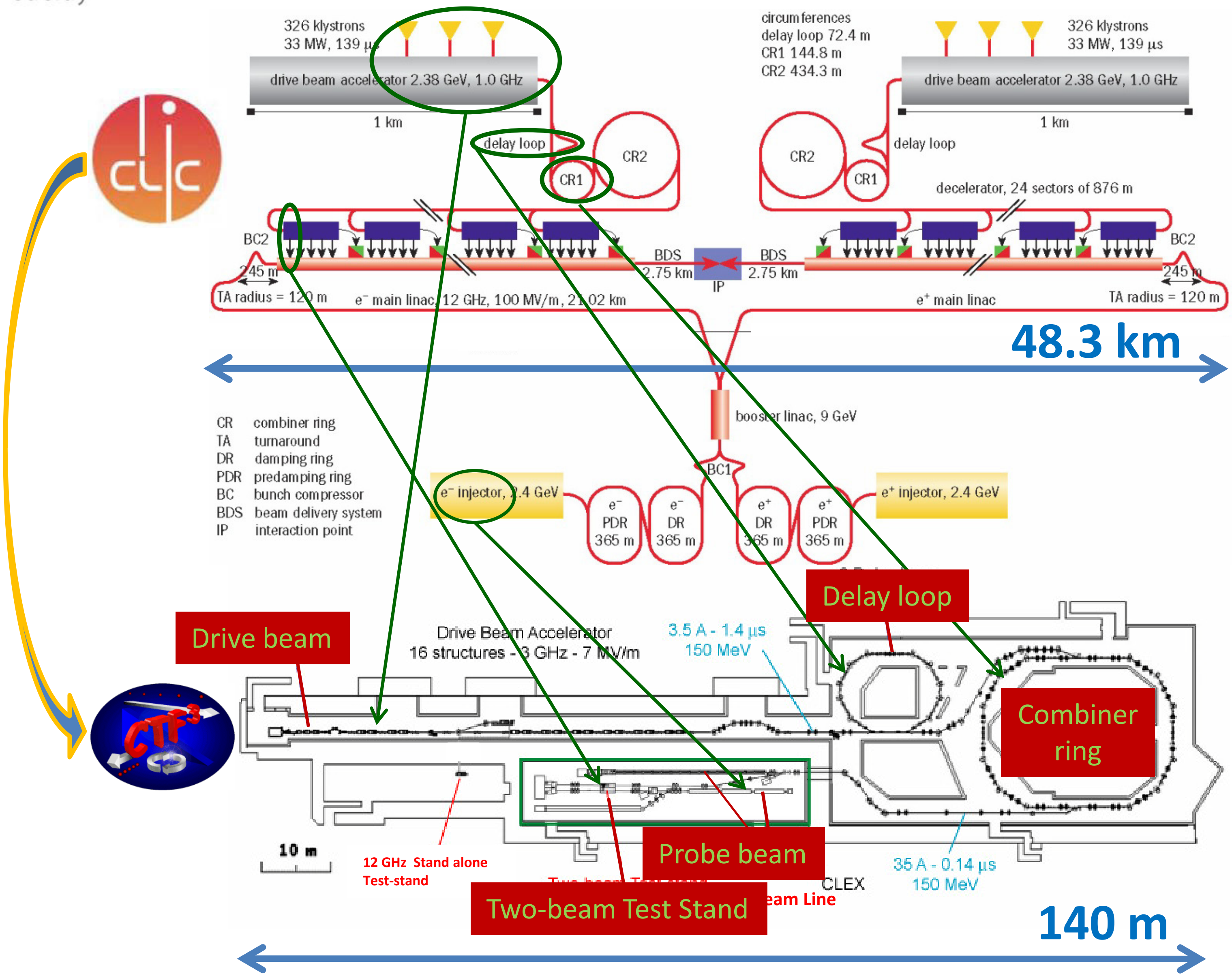


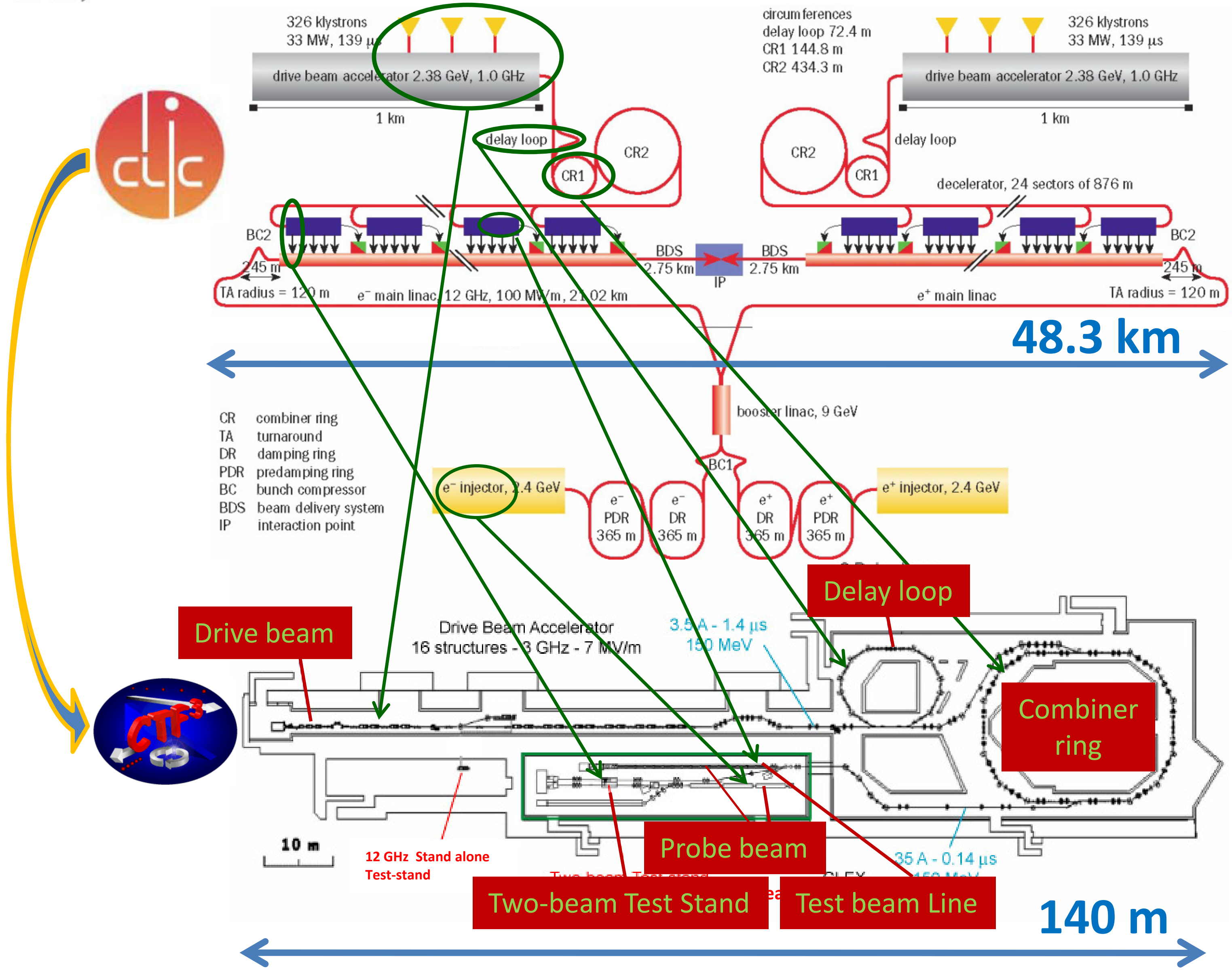
The CLIC / CTF3 Facility



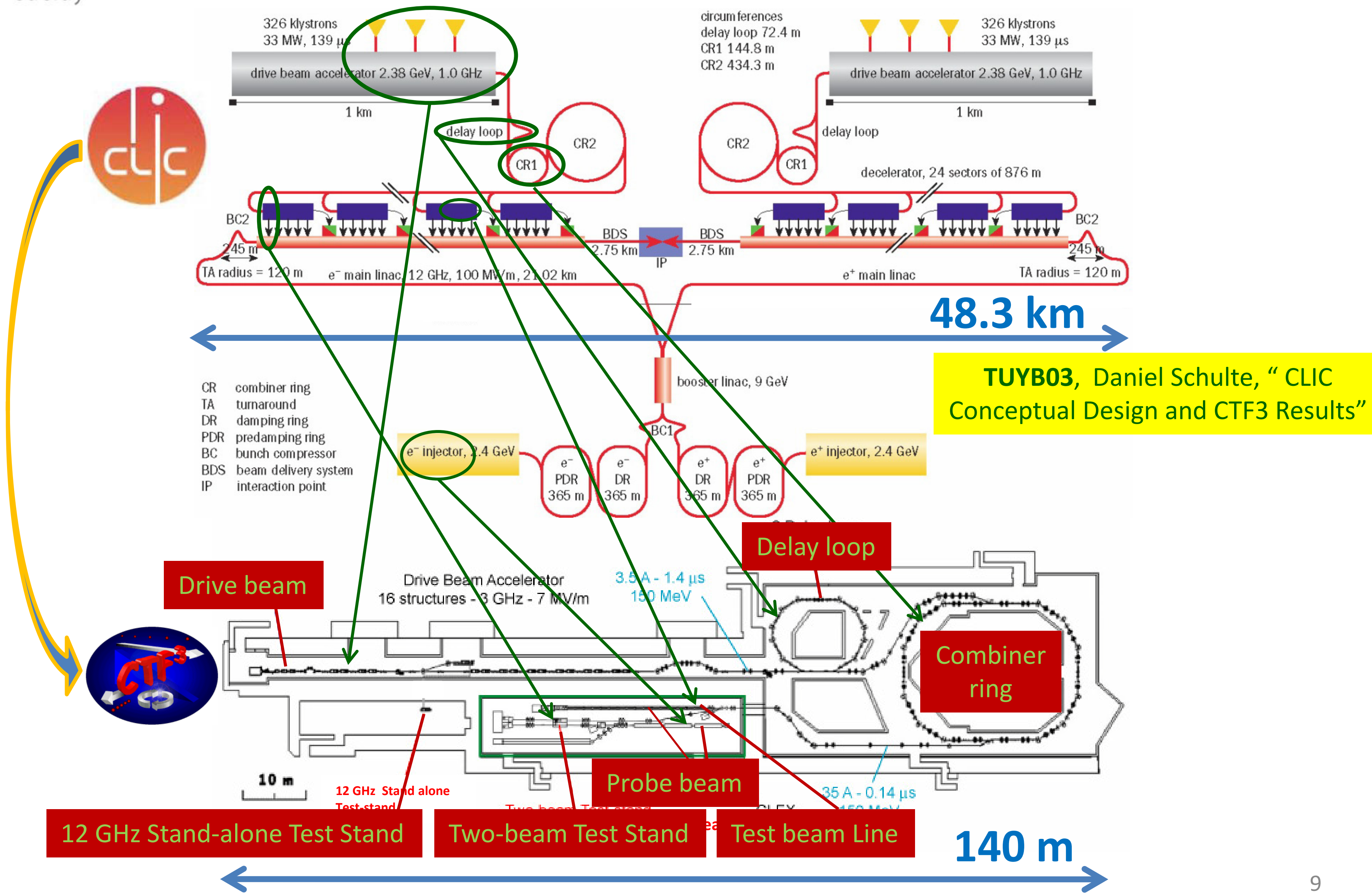
The CLIC / CTF3 Facility



The CLIC / CTF3 Facility

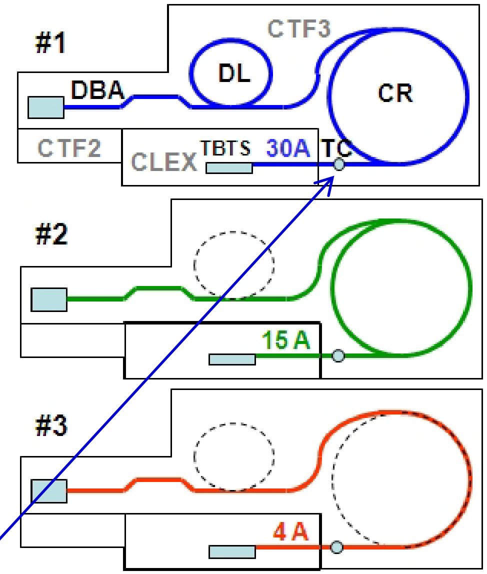


The CLIC / CTF3 Facility



Great Flexibility of the Drive Beam

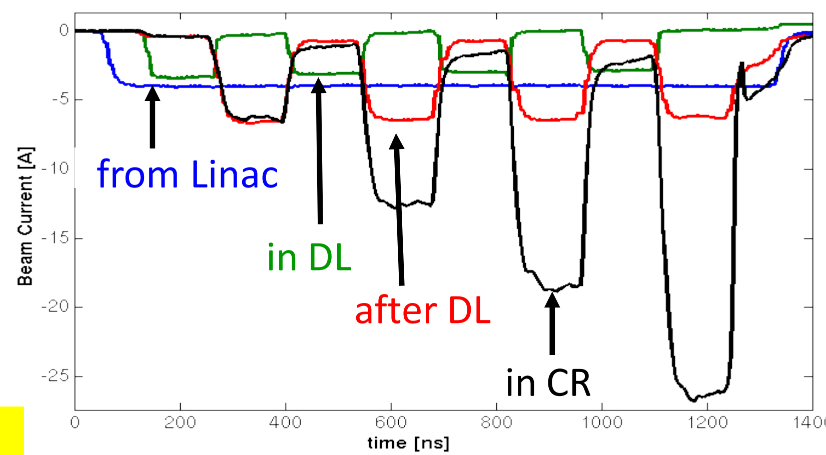
Mode	#1	#2	#3	
Energy	120 **(3)**			[MeV]
Energy spread	2			[%]
Current **(1)**	30	15	4	[A]
Pulse length **(2)**	140	240	1100	[ns]
DBA frequency	1.5	3	3	[GHz]
Bunch frequency	12	12	3	[GHz]
Repetition rate	0.8 **(3)**			[Hz]
PETS power	200	61	5	[MW]



NOTE:
1. PETS length 1 m (0.215 m in CLIC)
2. To adjust the pulse length, a tail clipper (TC) is installed between CR and TBTS.
3. Upgrade possible to 150 MeV at 5 Hz repetition rate.

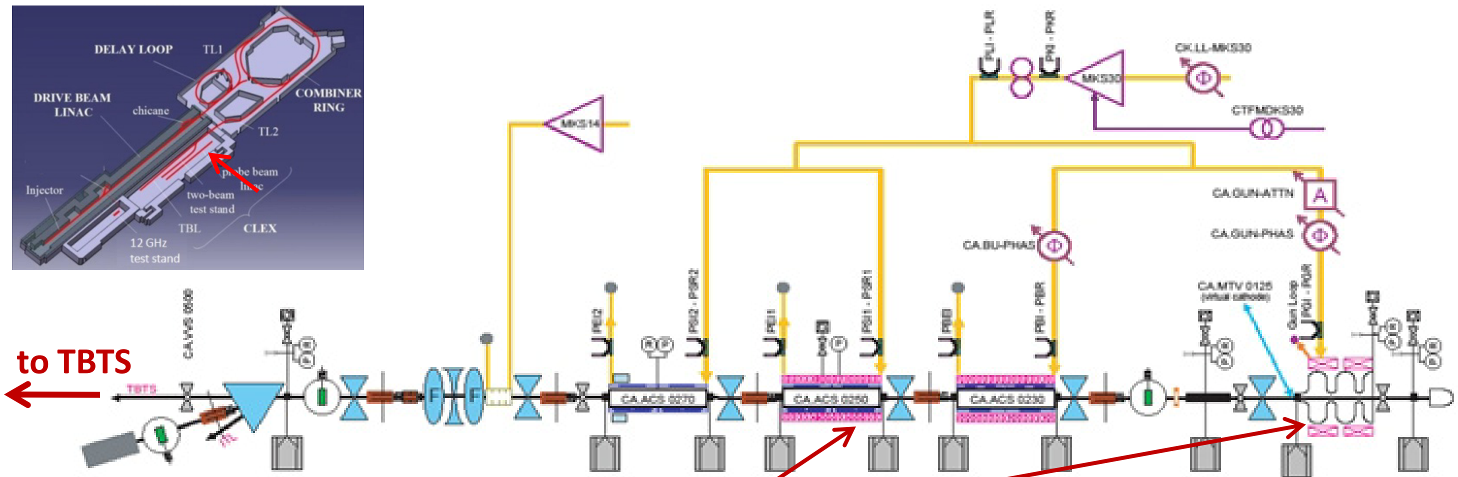
TUPC022, Piotr Skowronski, " Design of the CLIC Drive Beam Recombination Complex "

MOPC150, Marta Csatari, " High Charge PHIN Photo Injector at CERN with Fast Phase Switching"



Currents measured by BPMs

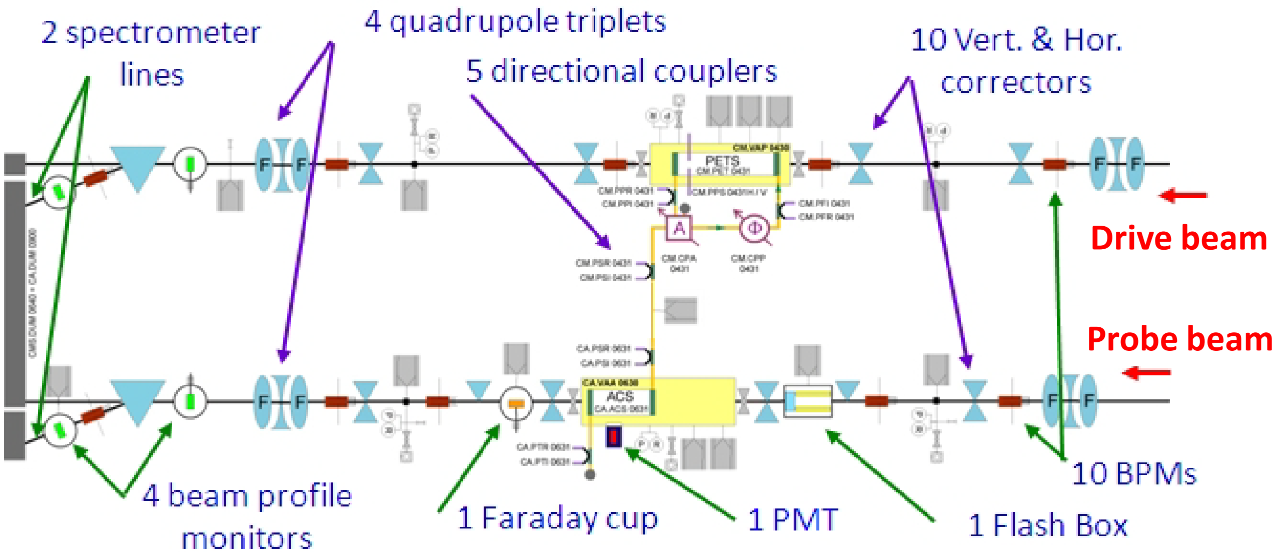
The Probe Beam



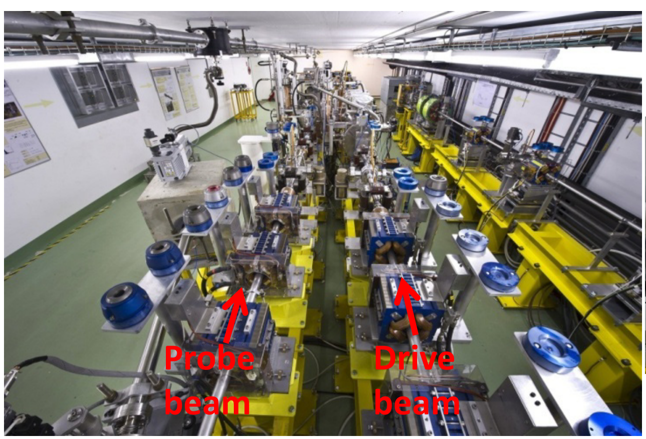
- A standing-wave photo-injector
- 3 travelling-wave structures, the first one used for velocity bunching
- A single klystron (45 MW – 5.5 μs) with pulse compression (120 MW – 1.3 μs)
- A RF network with splitters, phase shifters, attenuator, circulator and couplers

Energy	200 MeV
Energy spread	1% (FWHM)
Pulse length	0.6–150 ns
Bunch frequency	1.5 GHz
Bunch length	1.4 ps
Bunch charge	0.085–0.6 nC
Intensity	
- short pulse	1 A
- long pulse	0.13 A
Repetition rate	0.833 – 5 Hz

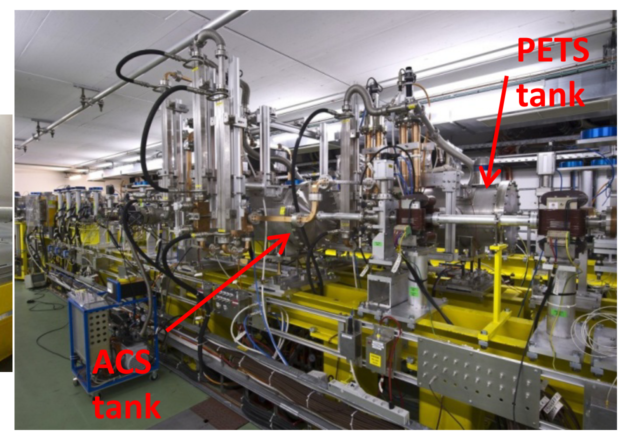
The Two Beam Test Stand



- Two lines hosting vacuum tanks for PETS and for ACS
- A complete set of diagnostics for beam, RF phase / power measurements and breakdown detection



ACS TD24



PETS

Demonstration of Two Beam Acceleration

Raw video of the probe beam spectrum line screen

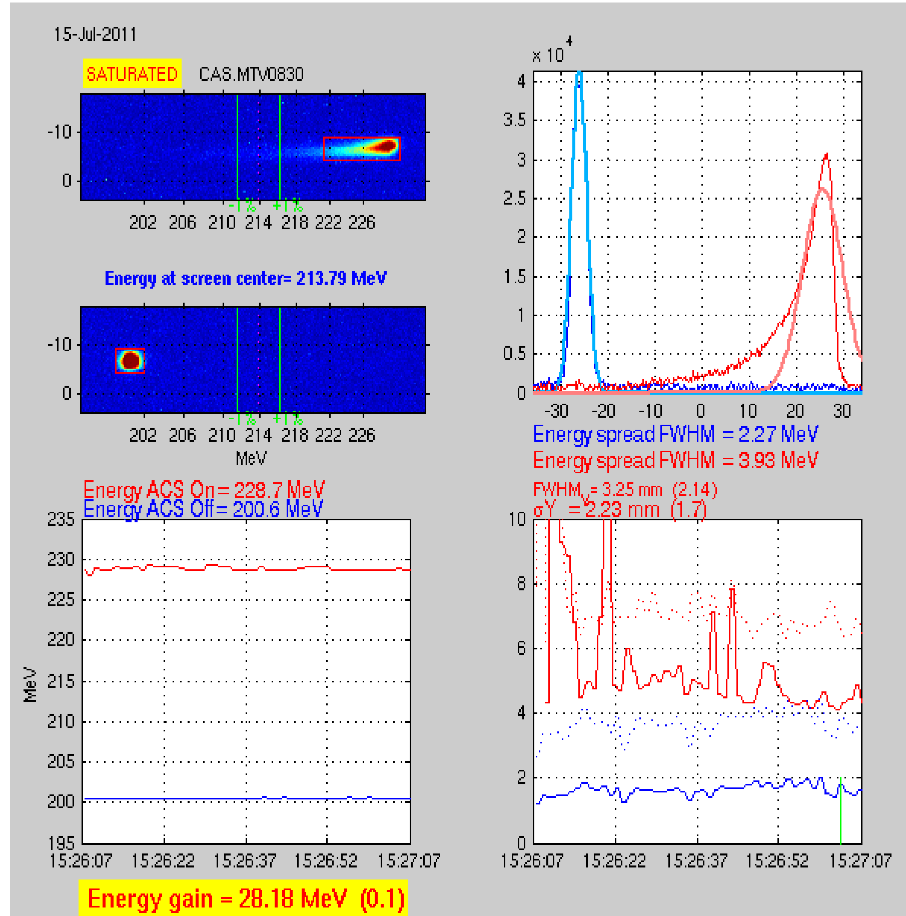
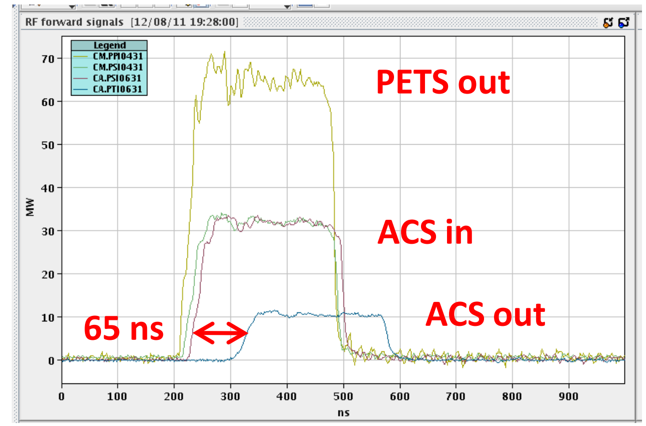


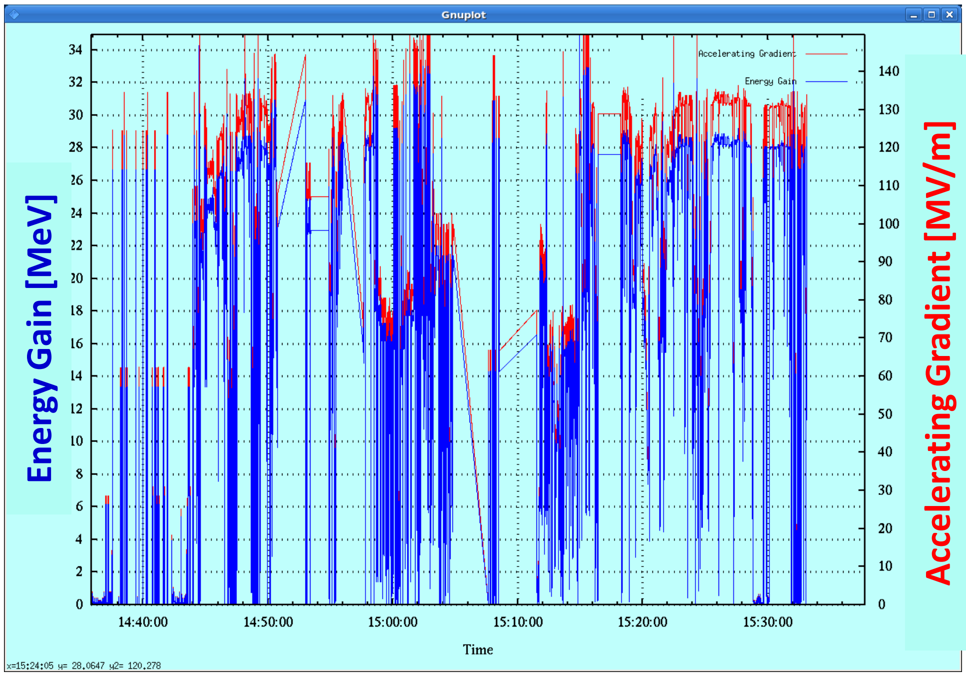
Image processing of the spectrum line screen

- Probe beam repetition rate is twice the Drive beam one
- DB / PB relative timing and phase adjusted to maximize energy and minimize energy spread after ACS
- Probe Beam pulse length 10 to 100 ns
- Drive Beam pulse length 100 to 240 ns

Acceleration performances

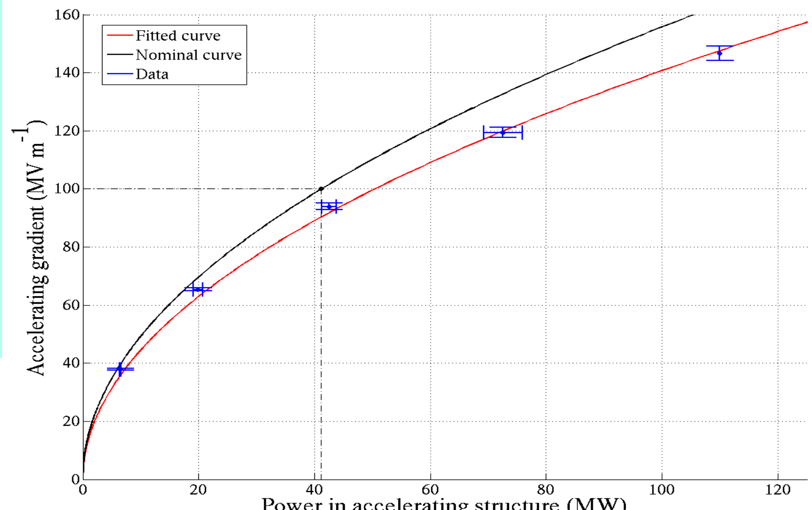


RF power signals



Data logging of energy gain

Javier Barranco

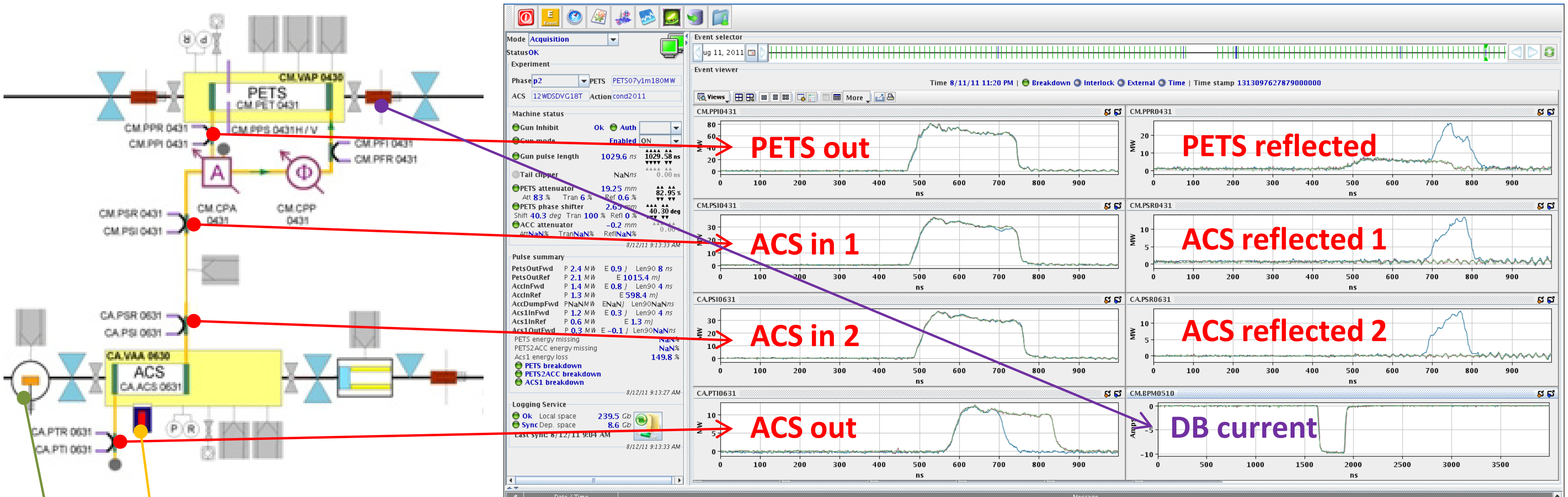


Tobias Persson

ACS accelerating gradient vs. RF Power in

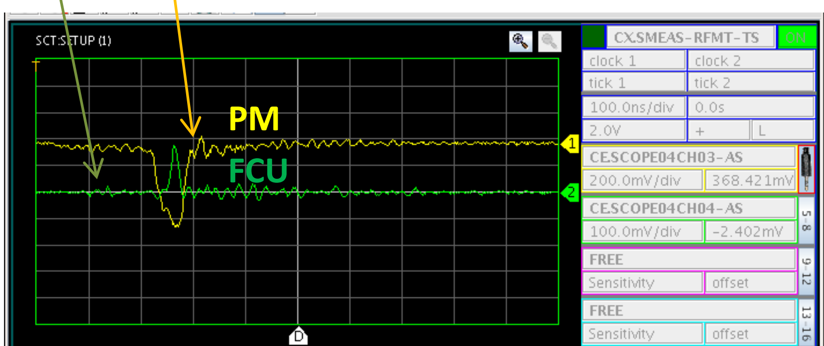
TUPC021, Piotr Skowronski, " The CLIC Feasibility Demonstration in CTF3"

Breakdown Detection



RF power pannel

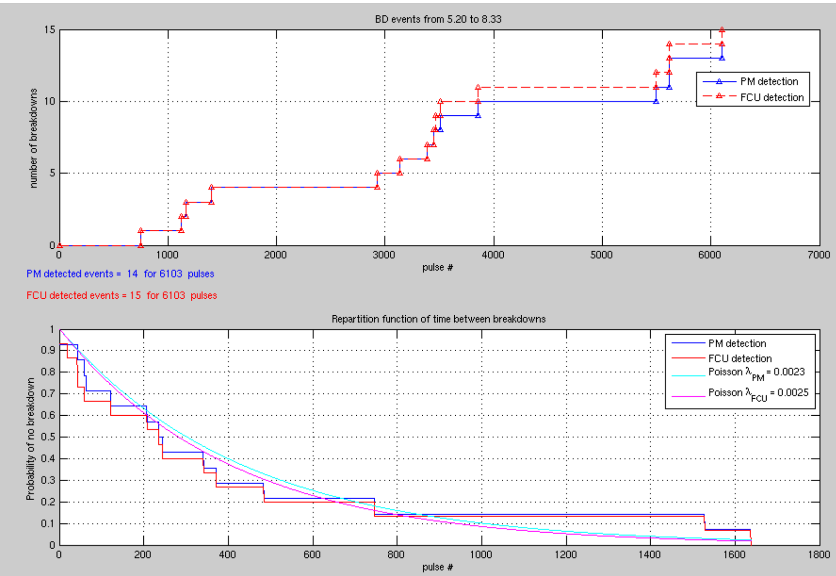
Alexey Dubrowskiy



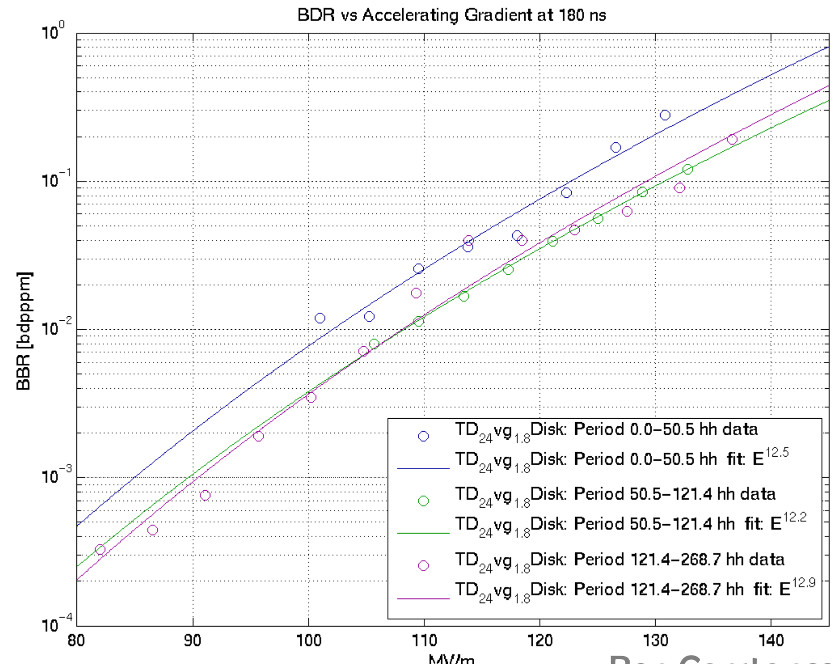
Photomultiplier and Faraday cup signals during BD

- Logical analysis of the RF signals allows to attribute breakdown either to the PETS, to the waveguide network or to the ACS
- PM detection of X-rays and Faraday cup current are typical of ACS breakdowns
- Flash box will allow to analyze electron and ions current produced during breakdown.

Breakdown Rate



ACS breakdown count vs. RF pulse number and repartition law of RF pulse number between BD



Ben Constance

Breakdown rate vs. accelerating gradient for various periods of time.

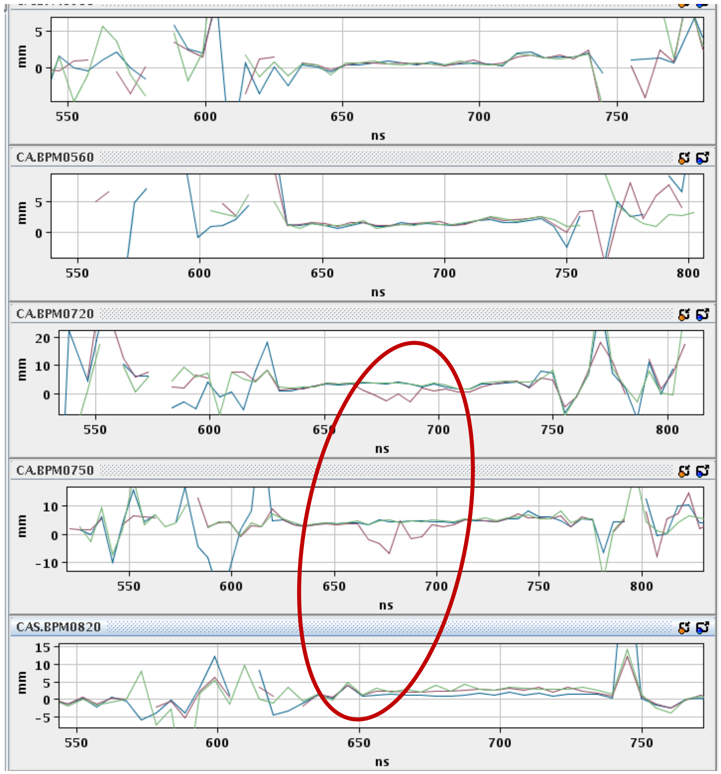
- Long automatic runs over night allow recording some statistics about breakdowns
- The positive effect of RF conditioning can already be observed despite the low DB repetition frequency
- The dedicate place for ACS conditioning will be the Stand-alone Test Stand powered by an X-band klystron of 45 MW pulsing at 50 Hz (to be started soon in CTF2 premises)

TUPC13, Marek Jacewitcz, " Instrumentation for the 12 GHz Stand-alone Test Stand to Test CLIC Accelerating Structures"

Kick Measurement during Breakdown

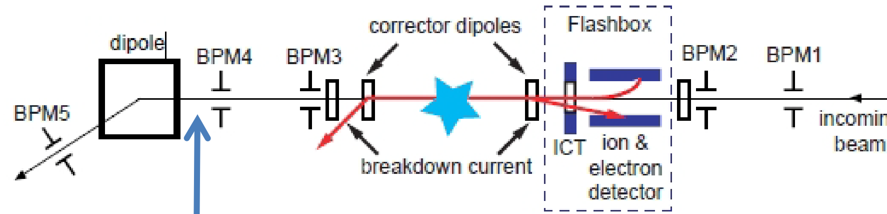
BPMs before ACS

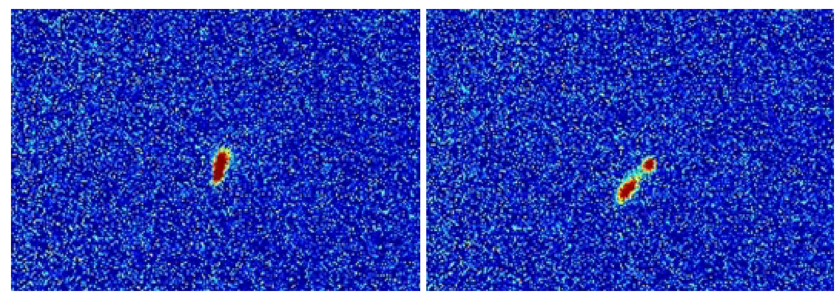
BPMs after ACS



Volker Ziemann

Possible kick recorded during a breakdown





Andrea Palaia

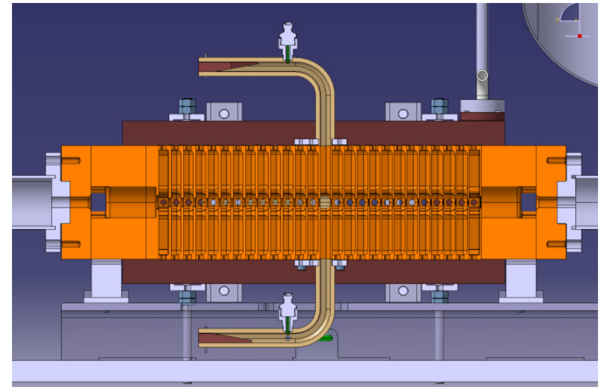
Beam without BD

Beam with BD
Kick : 0.2 mrad

- During a breakdown, in addition to energy default, the beam is likely to receive a transverse kick.
- It is important for the CLIC design to quantify this effect.
- BPMs are foreseen for this experiment but are presently affected by noise that limits their resolution.
- However kicks effects have been recorded using a beam profile monitor

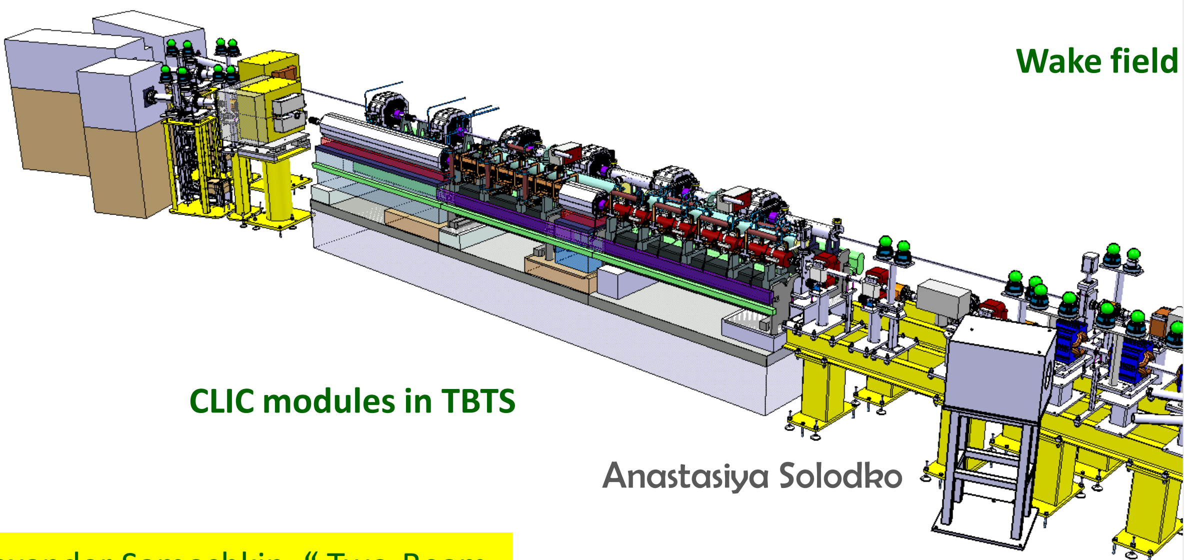
Future Experimental Program

- PETS On-Off mechanism (will replace external recirculation)
- ACS integrated Wake field monitors
- Installation of the 3 types of CLIC modules



Franck Peauger

Wake field monitor on ACS



CLIC modules in TBTS

Anastasiya Solodko

TUPC008, Alexander Samoshkin, " Two-Beam Module for the CLIC Conceptual Design and Related Experimental Program"

Conclusion

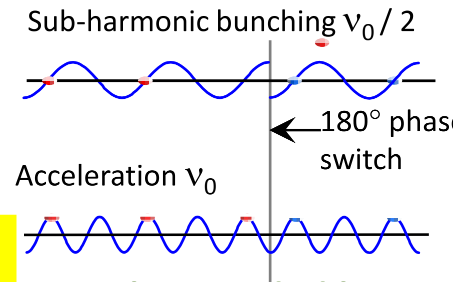
- Two beam acceleration has been achieved.
- Conditioning and breakdown studies are progressing.
- Beam kick studies have started.
- CTF3 is well under way to demonstrate the essential CLIC feasibility studies.

Many thanks to the CERN and collaborating institute teams
and for your attention

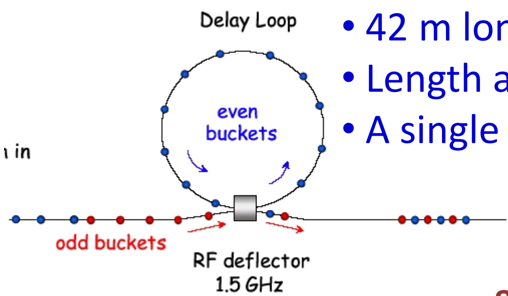
The CTF3 Drive Beam Generation

- Thermo-ionic gun
- Sub harmonic bunchers at 1.5 GHz with phase coding
- 8 klystrons at 3 GHz with pulse compressors
- 16 fully loaded accelerating structures (120 MeV – 4 A)
- 2 chicanes

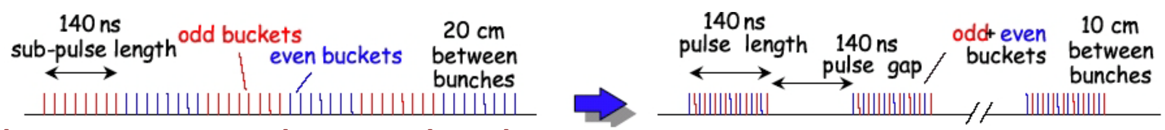
MOPC150, Marta Csatari, " High Charge PHIN Photo Injector at CERN with Fast Phase Switching"



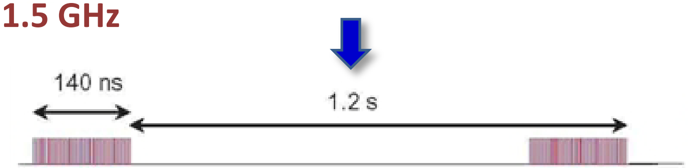
Phase coded beam



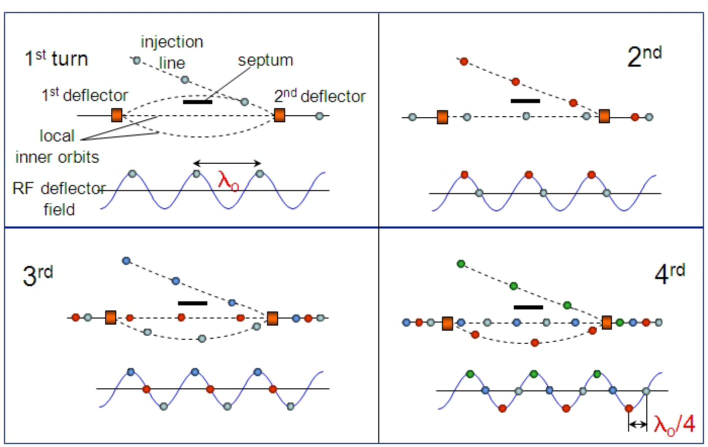
- 42 m long : 140 ns
- Length adjustable by a wriggler
- A single deflecting cavity at 1.5 GHz



8 pulses – 4 A – 20 cm between bunches: 1.5 GHz



1 pulse – 32 A – 2.5 cm between bunches: 12 GHz



- 84 m long
- Length adjustable by a wriggler
- 2 deflecting cavities at 3 GHz
- An extraction kicker