Instrumentation for the 12 GHz stand-alone test-stand to test CLIC acceleration structures

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CLIC (Compact LInear Collider)

future electron-positron collider in the multi TeV range

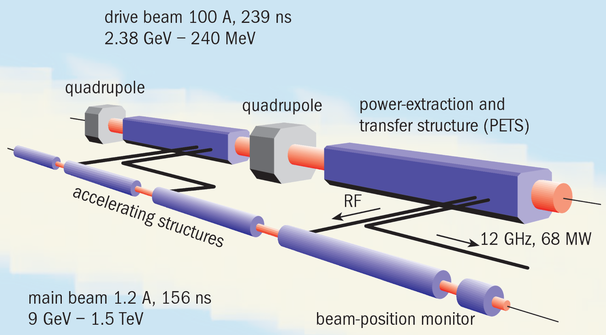
3 TeV center-of-mass energy (< 50 km total length)

TWO-BEAM ACCELERATION

- Drive beam is decelerated in the power extraction structure
- The 12 GHz RF power is transported to the accelerating structure
- Probe (main) beam is accelerated by the extracted power

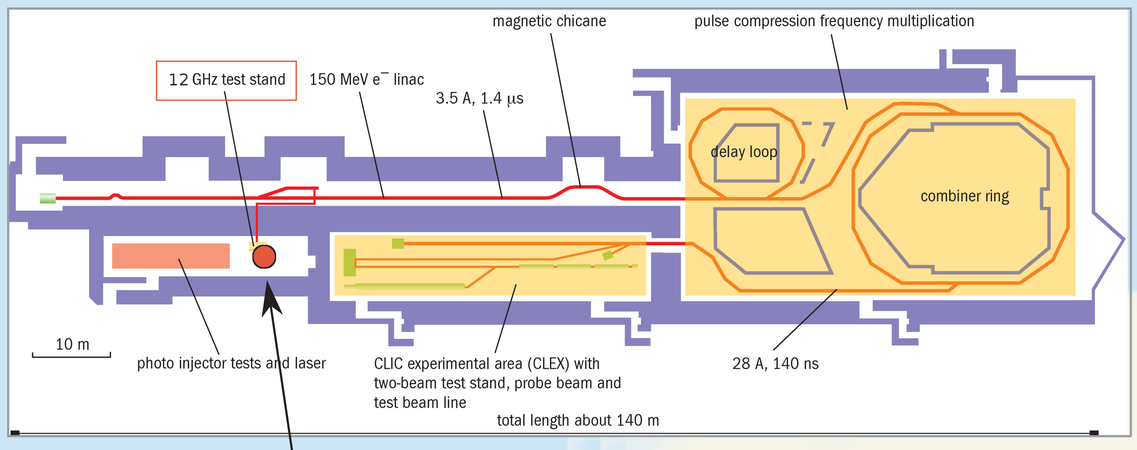
The feasibility of the concept is demonstrated at CTF3:

THE CLIC TEST FACILITY AT CERN



MAIN PARAMETERS

	CLIC	CTF3
C.M. Energy	3.0 TeV	
Peak Luminosity	$2x10^{34}cm^{-2}s^{-1}$	
Main/Probe beam linac		
Energy	1.5 TeV	150 MeV
Bunch freq.	12 GHz	
Rep. rate	50 Hz	0.8 - 5 Hz
Pulse length	156 ns	240 ns
Beam intensity	1 A	0.5 A
Beam size	45x1 nm	0.7 mm
Drive beam		
Energy	2.38 GeV	150 MeV
Bunch freq.	1.0 GHz	1.5 GHz
Beam intensity	100 A	30 A



ACCELERATING STRUCTURES

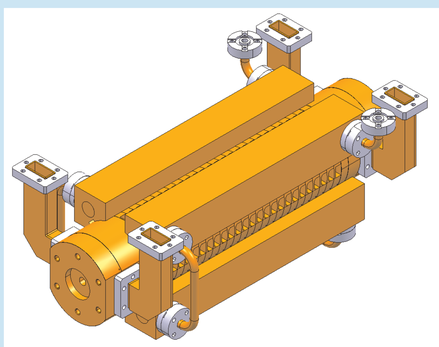
- CLIC beam accelerating structures have to provide an average of 100MV/m gradient (150MV/m achieved in TBTS this year)
- Only room temperature travelling wave structures at high frequency are likely to achieve this gradient.
- Present record is 193 MV/m (at 30GHz with a pulse length of 15ns)

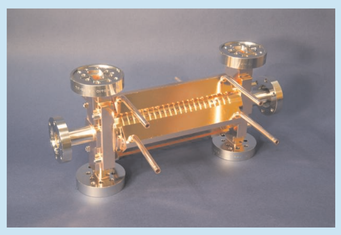
Total number of accelerating structures in future CLIC ~ 140000 !

Current limitation is

RF BREAKDOWN

(max. breakdown rate for CLIC $<10^{-7}$)





NEW 12 GHZ TEST STAND

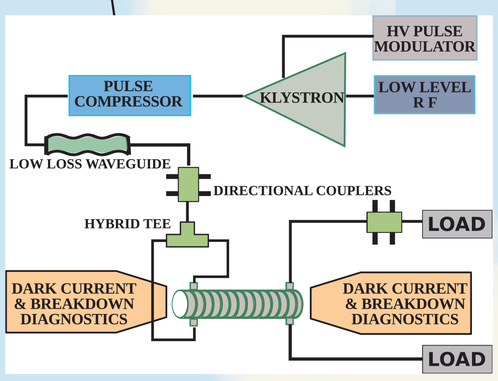
Most effective way to achive high statistic data on breakdown physics

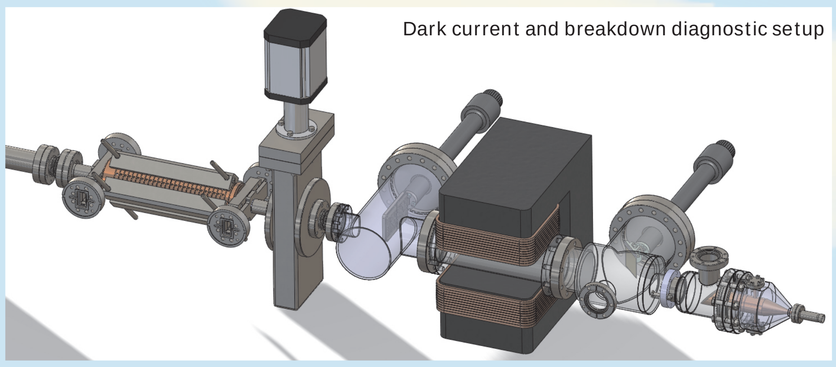
Solid state HV Modulator
(Scandinova)
XL5 X Band Klystron
(SLAC)

HV:	450 kV
Current:	335 A
RF frequency:	11.9942 GHz
Peak RF power:	50 MW
RF pulse length:	1500 ns
Pulse rep. rate:	50 Hz

RF TESTS:

- the conditioning of the structure
- measurement of the breakdown rates at different power levels
- detection of dark current and light emissions directly relevant to breakdown physics
- measurement of dynamic vacuum due to breakdowns and dark currents





Dark current and breakdown diagnostic setup

RF BREAKDOWN

(RF initiated surface plasma process)

Direct effects:

- heavy reflections back to the RF source
- a cut-off of the transmitted power
- a collapse of the accelerating field inside the structure
- possible stimulation of transverse fields which can give a transverse kick to the passing beam

Accompanying effects:

- the ejection of electrons and ions out of the structure
- light and X-rays emission
- surface damage

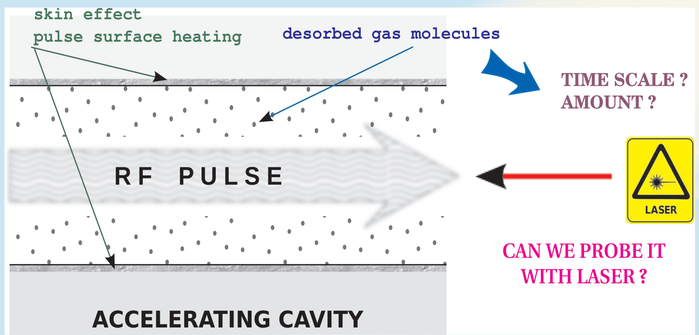
DYNAMIC VACUUM

Very difficult to measure

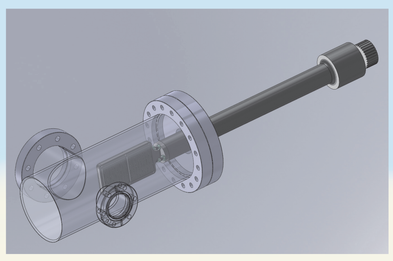
During the 240 ns RF pulse pressure changes in a small volume faster than sampling of the vacuum gauges

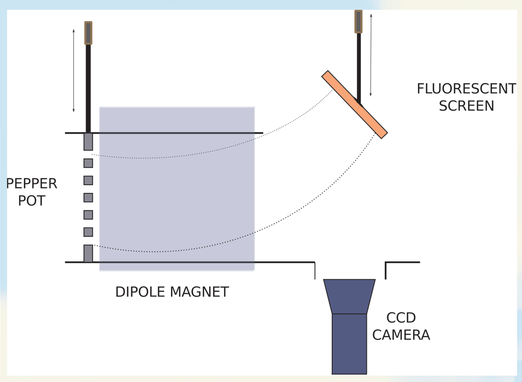
Idea ⇒ Laser-based system:
(collaboration with Helsinki Univ.)

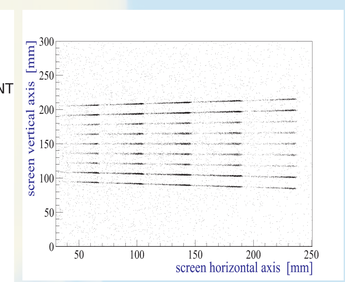
- Widening of a mode-locked short laser pulse
- Spectroscopy (emission, absorption, Raman)
- Detection of refraction changes



Idea of pepper-pot spectrometer







GEANT4 simulation

DARK AND BREAKDOWN CURRENT:

Spatial and energy distributions of the emitted electrons ?

Idea ⟹ pepper-pot with an external magnetic spectrometer

Fast (single shot) measurement of the area occupied by the exiting electrons in the phase-space together with energy determination

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