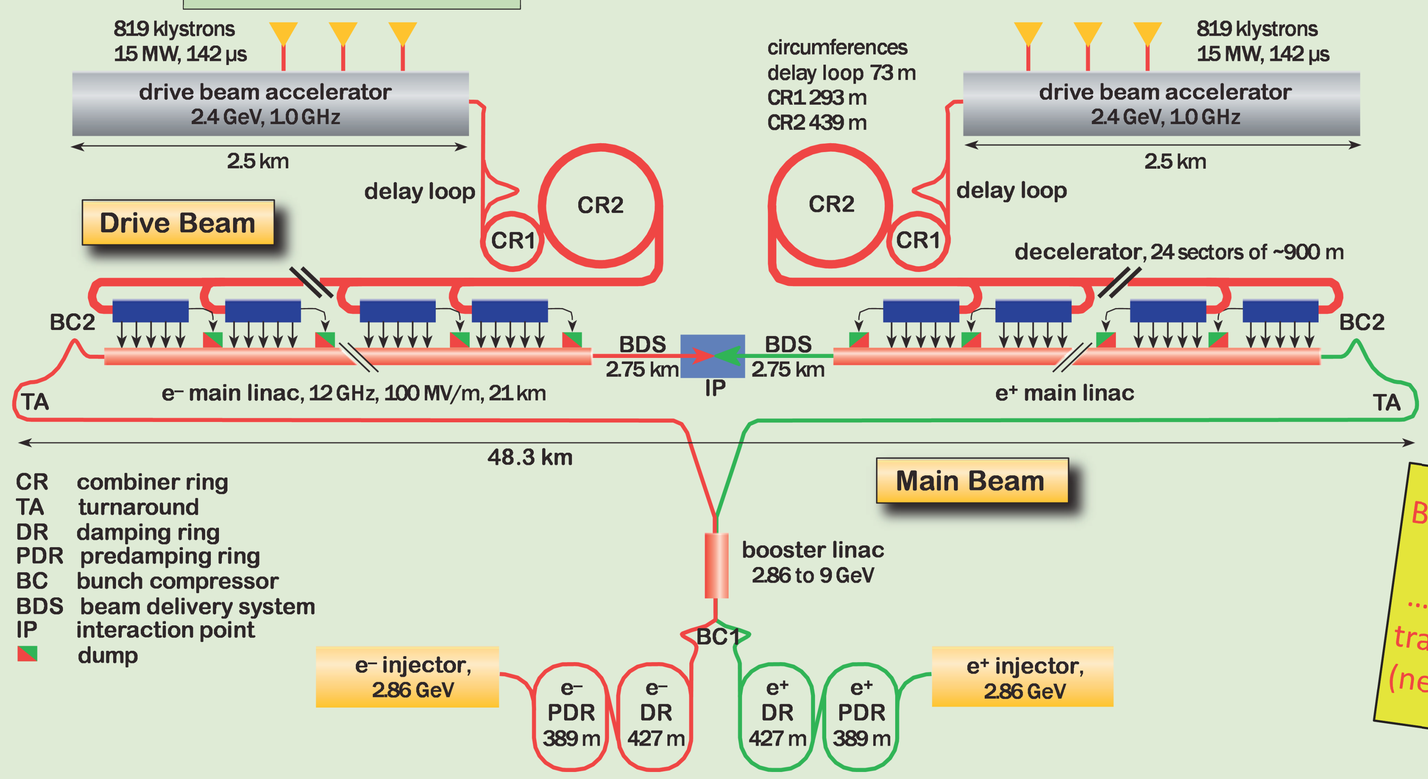
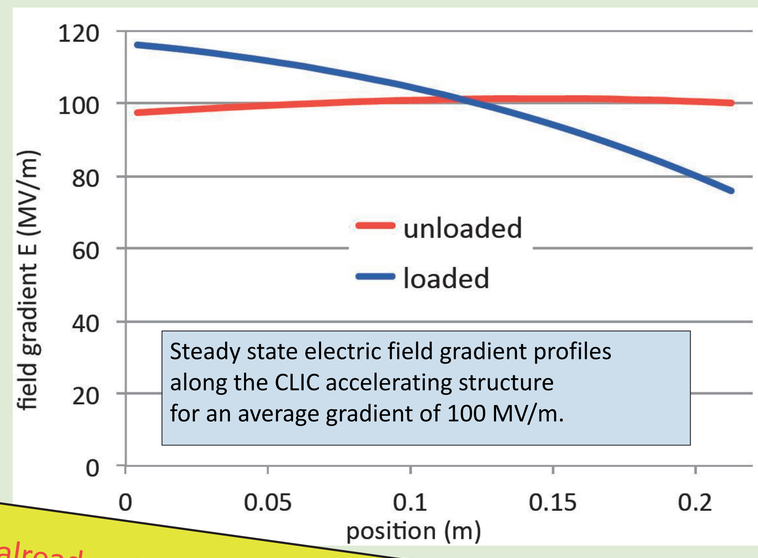
An Experiment for RF Breakdown Measurements in Beam Loaded CLIC Accelerating Structures

J.L. Navarro Quirante[1], R. Corsini[1], M. Dayyani Kelisani[1], S. Doebert[1], A. Grudiev[1], O. Kononenko[1,2], S. Lebet[3], G.Riddone[1], A. Solodko[1,2], I.Syratchev[1], F. Tecker[1], W. Wuensch[1]

[1] CERN, Geneva, Switzerland, [2] JINR, Dubna, Russia, [3] INEO, St. Genis-Pouilly, France

Introduction





BD rate already achieved without beam!!! but...

... RF beam loading changes field profile in travelling waves (TW) accelerating structure (never measured)

- **CLIC (Compact Linear Collider)** is a **multi-TeV** high luminosity **e⁺ e⁻ linear collider** project.
- CLIC relies on the **two beam acceleration concept:** 12 GHz RF power for acceleration of the **"main beam"** is generated decelerating a high current **"drive beam".**
- Acceleration in CLIC is based on **normal conducting** travelling wave accelerating **cavities** working at a gradient as high as **100 MV/m.**
- **CLIC luminosity is limited by RF breakdowns (BD)** which produces beam deflection.
- Maximum Breakdown Rate (BDR) allowed = $3\ 10^{-7}$ BD/(pulse m) for operation at 3 TeV.

Test Area Installation

- Experiment installed in the CLIC Test Facility CTF3 at CERN
- Reused existing beam line branching off mid-linac
- 12 GHz CLIC accelerating structure installed

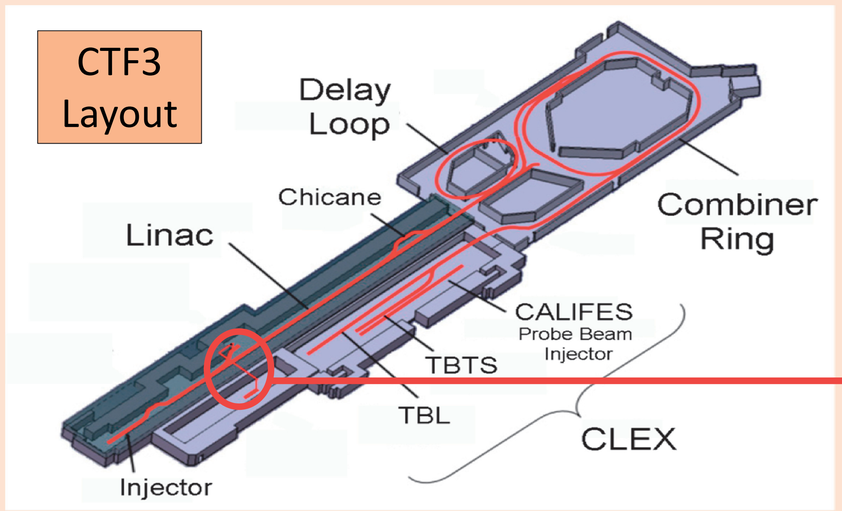
First stage (finished):

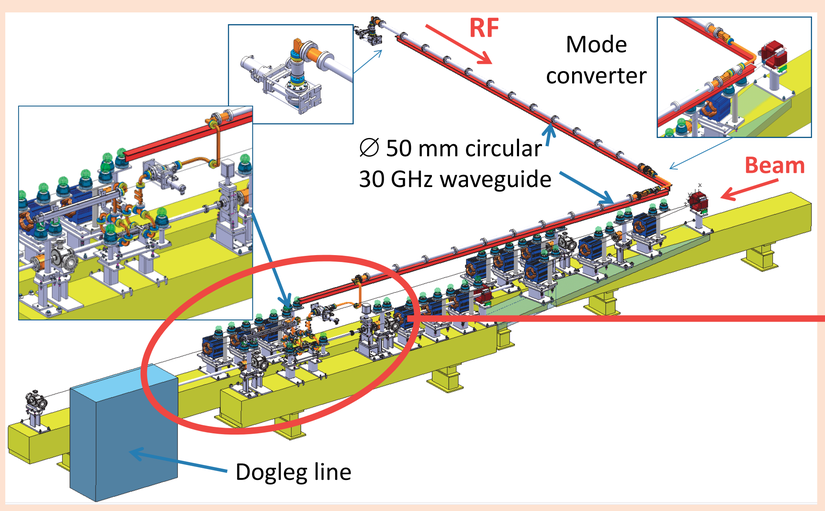
- structure equipped with RF loads
- no connection to 12 GHz klystron
- establish beam transport
- observe beam induced RF signals

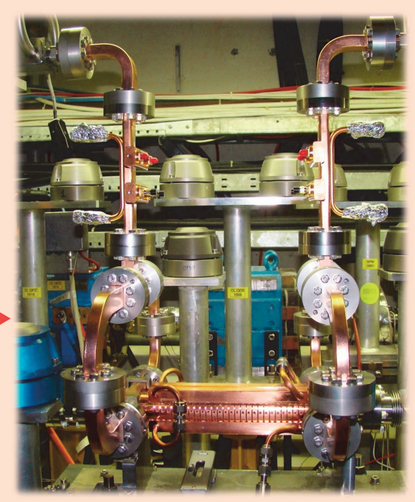
Second stage (January 2014):

- connect to 12 GHz klystron by modified existing low-loss RF transfer line
- almost all necessary RF components fabricated
- condition the CLIC accelerating structure with RF
- measure RF breakdown rate without and with presence of the beam

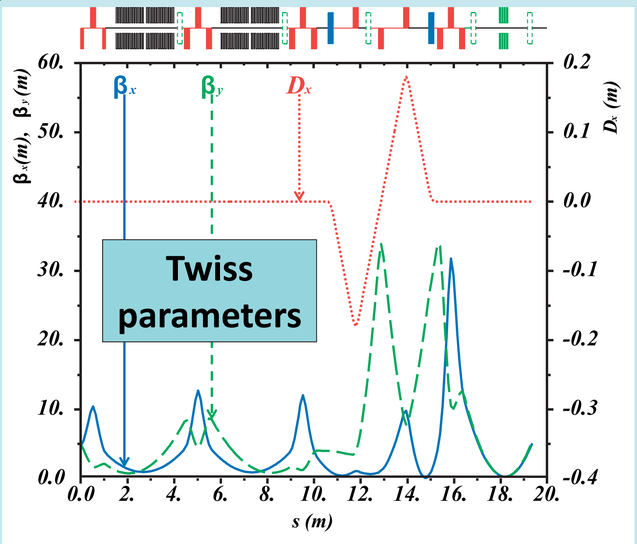
=> **For the first time, breakdown rate with beam-loading will be measured.**







Beam Optics Design



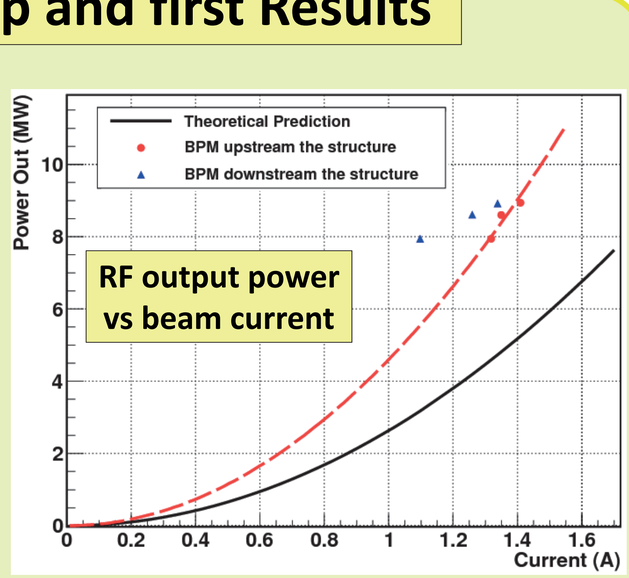
- Beam optics design to achieve full beam transmission inside the structure using MAD-X and OPA
- optimized for tapered accelerating structure (6.3 to 4.7 mm diameter) => beam waist towards downstream end
- optimized longitudinal placement of an 8 mm aperture collimator upstream the structure

Beam properties:

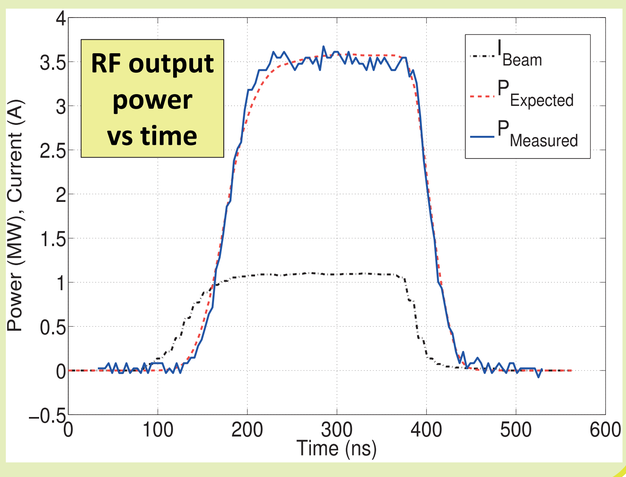
- Electron beam at 132 MeV/c
- Beam current 1.2 A
- Pulse length up to 250 ns

Experimental Setup and first Results

- RF pulse compression in Linac set up for higher RF power
- Linac optics rescaled
- Twiss parameters measured downstream in the linac
- Optics rematched based on this measurement
- beam transmission of 85-95% achieved



- RF signals measured for several levels of beam current
- Calibration error of ~2.5 dB in power (on total 80-90 dB)



- Time evolution of produced power (scaled) at the structure output fits the analytical model

Conclusion

- 1st Dedicated experiment to **measure** the **breakdown rate in presence of beam-loading**.
- **Beam transport** through the structure **established** and the RF signal acquisition set up.
- **Further work** foreseen on signal **calibration** and on optimization of the **beam transport**.
- Structure **connected to** 12 GHz **klystron from January 2014** and RF conditioning will start.

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