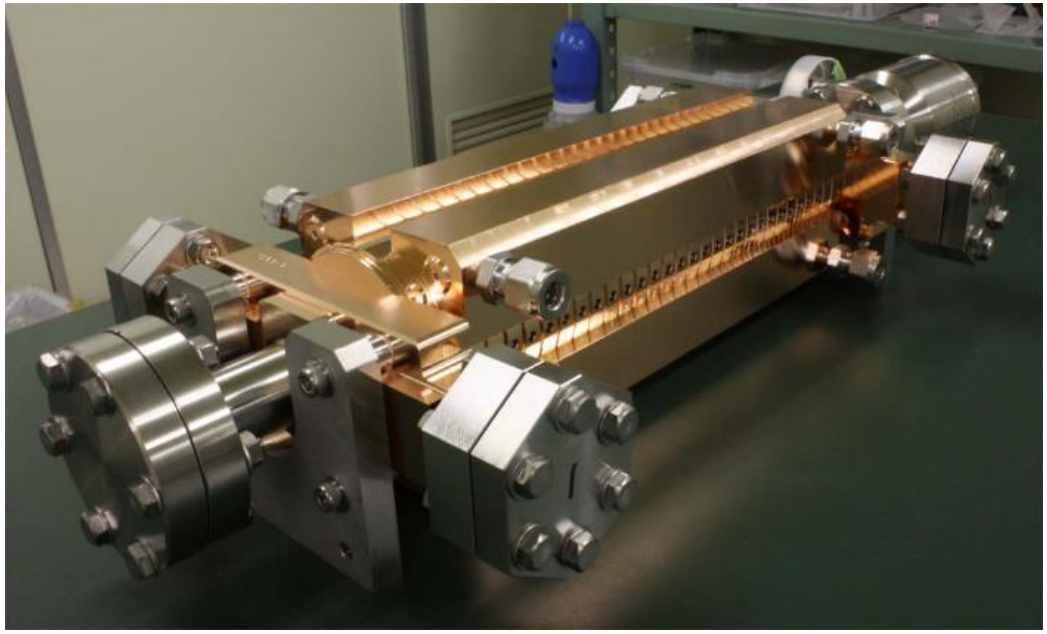
CLIC News

Walter Wuensch, CERN

CLIC accelerating structure

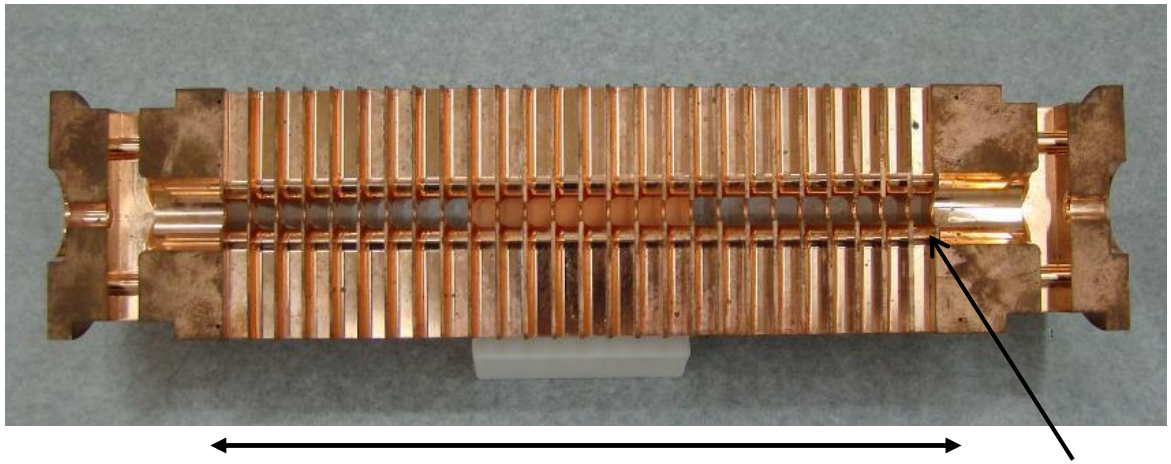
Outside



11.994 GHz X-band
100 MV/m
Input power ≈50 MW
Pulse length ≈200 ns
Repetition rate 50 Hz

HOM damping waveguide

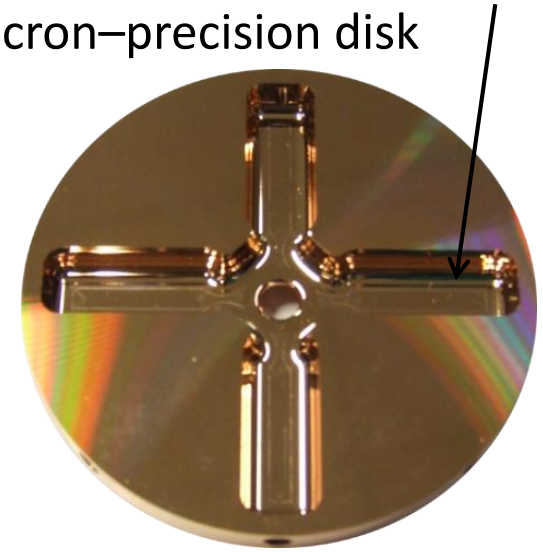
Inside



25 cm

6 mm diameter beam aperture

Micron–precision disk



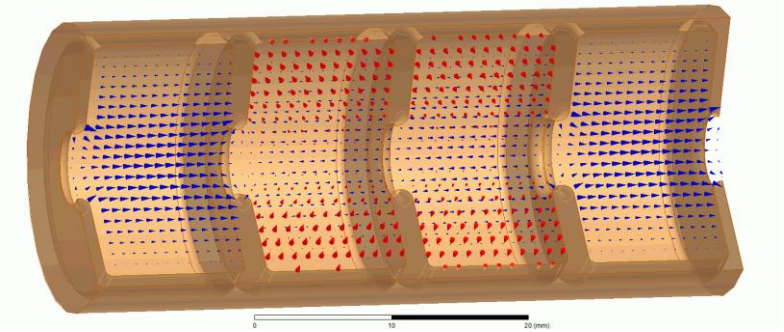
Breakdown rate

CLIC accelerating structure specifications include:

- a gradient 100 MV/m,
- a pulse length 180 ns,
- and breakdown rate, BDR, 3×10^{-7}/pulse/m.

BDR is the fraction of pulses which have a vacuum arc. Breakdown currents and lost acceleration result in lost luminosity on that pulse.

$$\mathcal{L} = H_D \frac{N^2}{4\pi\sigma_x\sigma_y} n_b f_r$$



The three quantities are related to each other: $BDR \propto E^{30}\tau^5$

Testing Capability at CERN

CPI 50MW 1.5us klystron
Scandinova Modulator
Rep Rate 50Hz
Beam test capabilities

Previous tests:

2013	TD24R05 (CTF2)
2013	TD26CC-N1 (CTF2)
2014-15	T24 (Dogleg)

Ongoing test:
Aug2015- TD26CC-N1 (Dogleg)

CPI 50MW 1.5us klystron
Scandinova Modulator
Rep Rate 50Hz

Previous tests:

2014-15	CLIC Crab Cavity

Ongoing test:
Sep2015- T24OPEN

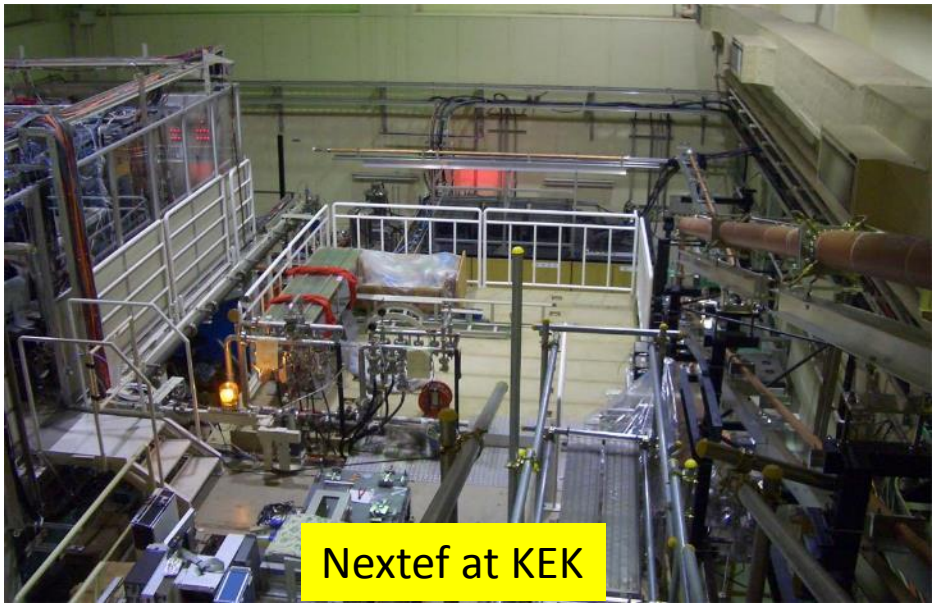
4x Toshiba 6MW 5us klystron
4x Scandinova Modulators
Rep Rate 400Hz

Medium power tests (Xbox-3A):

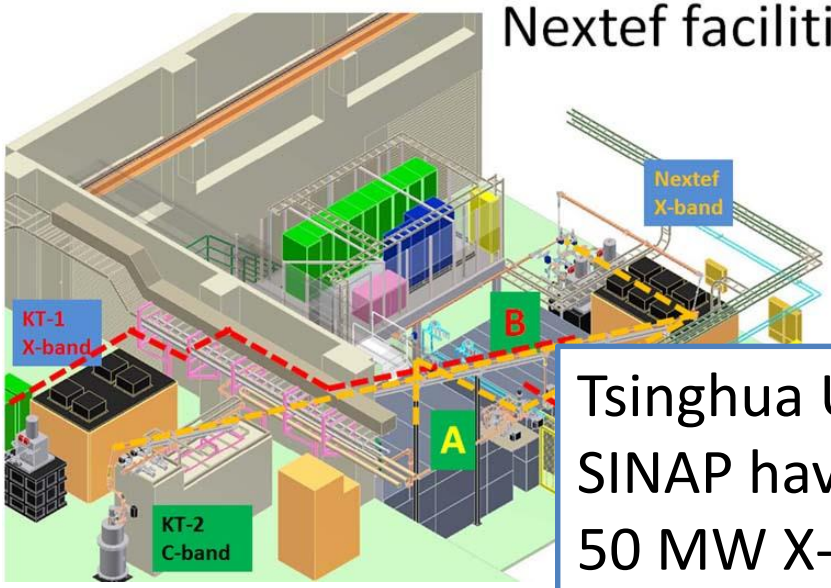
2015	3D-printed Ti waveguide
2015	X-band RF valve

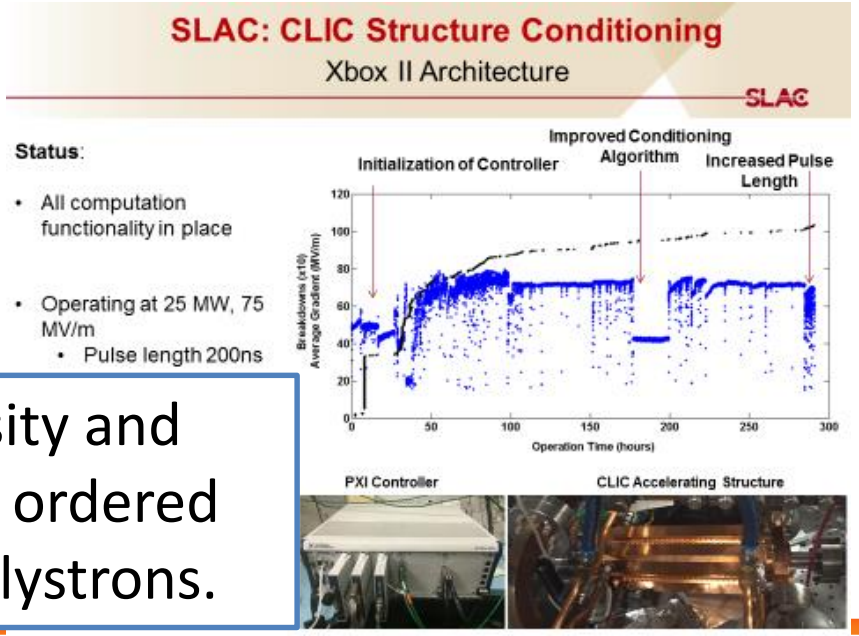
Major increase in testing capacity!

X-band test stands at KEK and SLAC



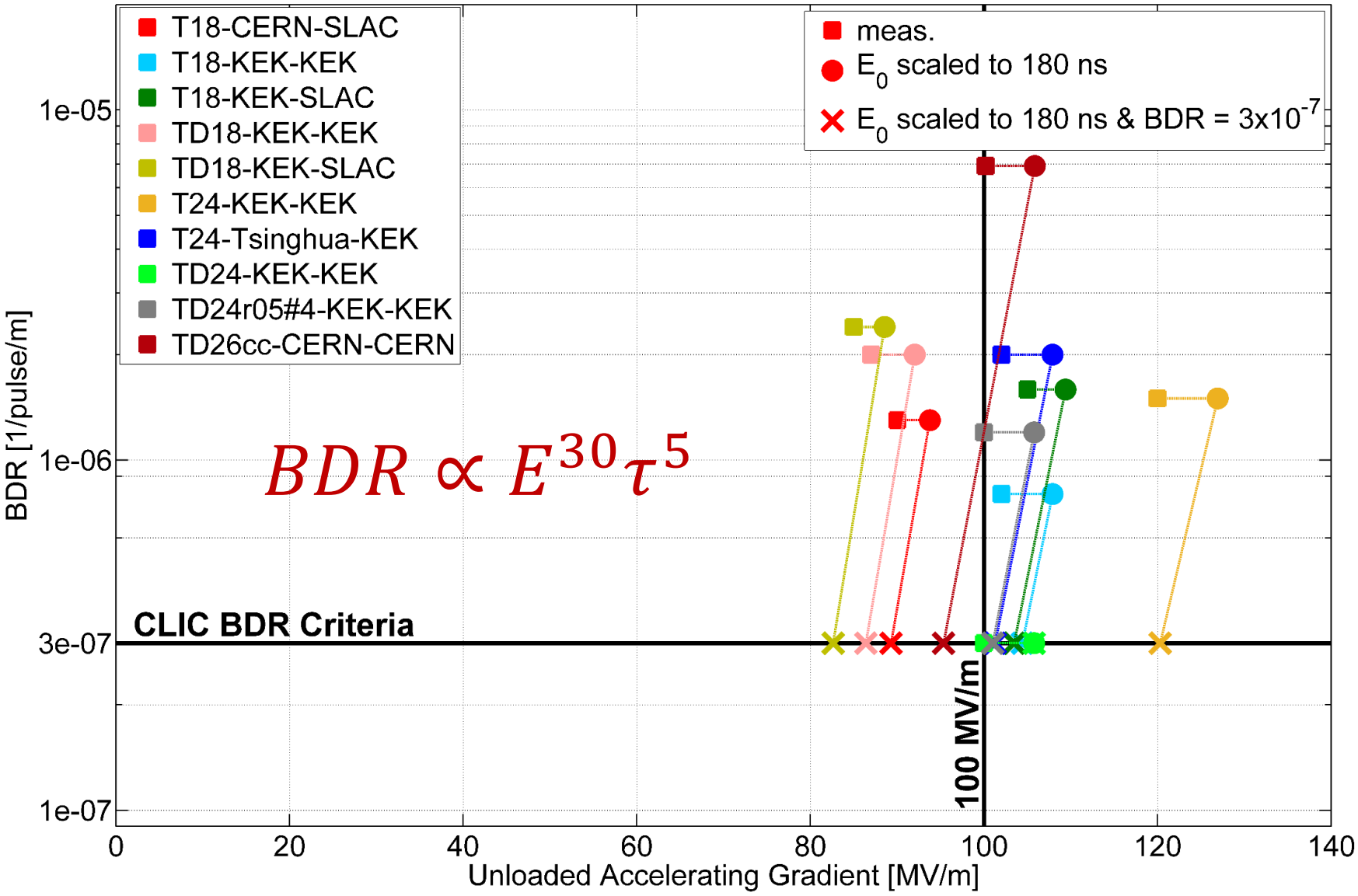
Nextef facilities





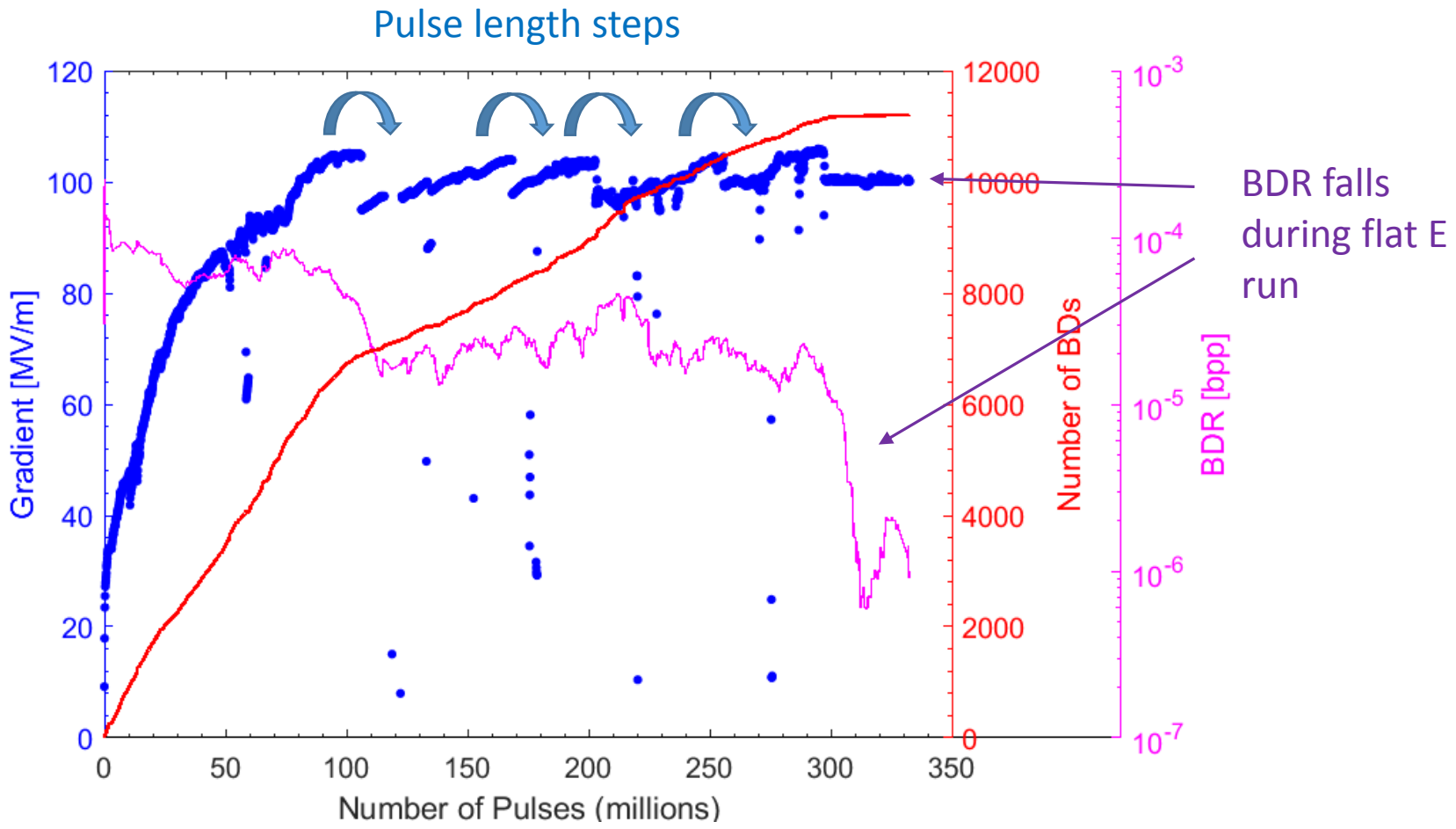
Tsinghua University and SINAP have both ordered 50 MW X-band klystrons.

Performance summary at CLIC specifications

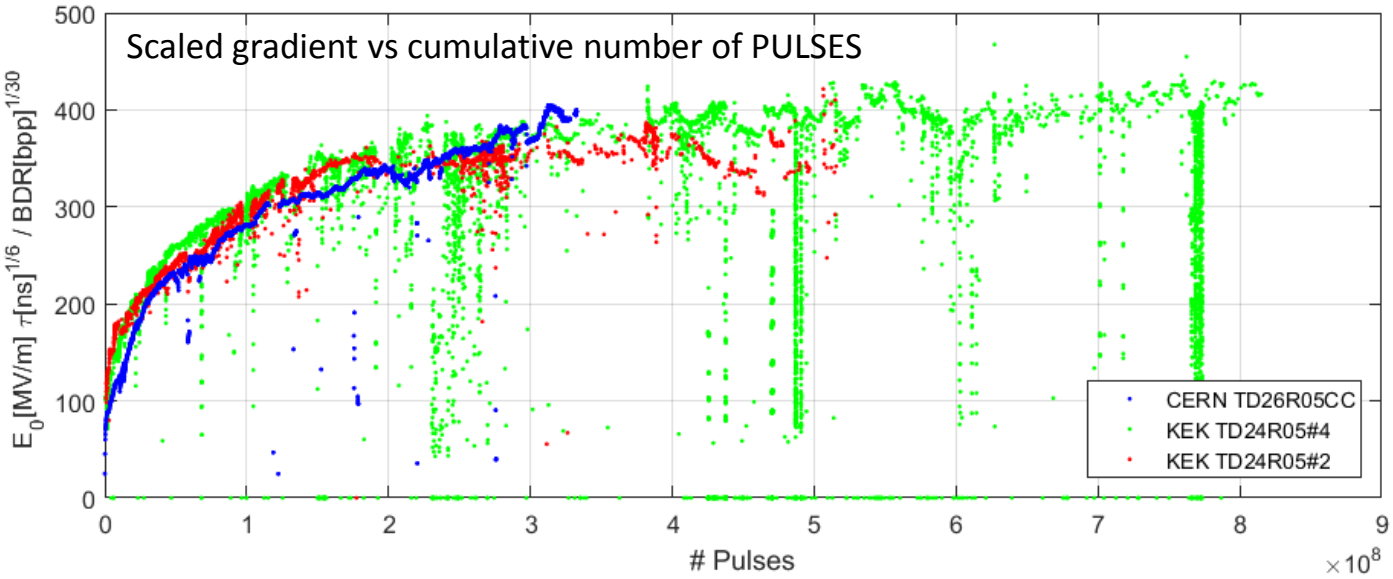


Conditioning

Accelerating structures do not run right away at full specification – pulse length and gradient need to be gradually increased while pulsing. Typical behaviour looks like this:

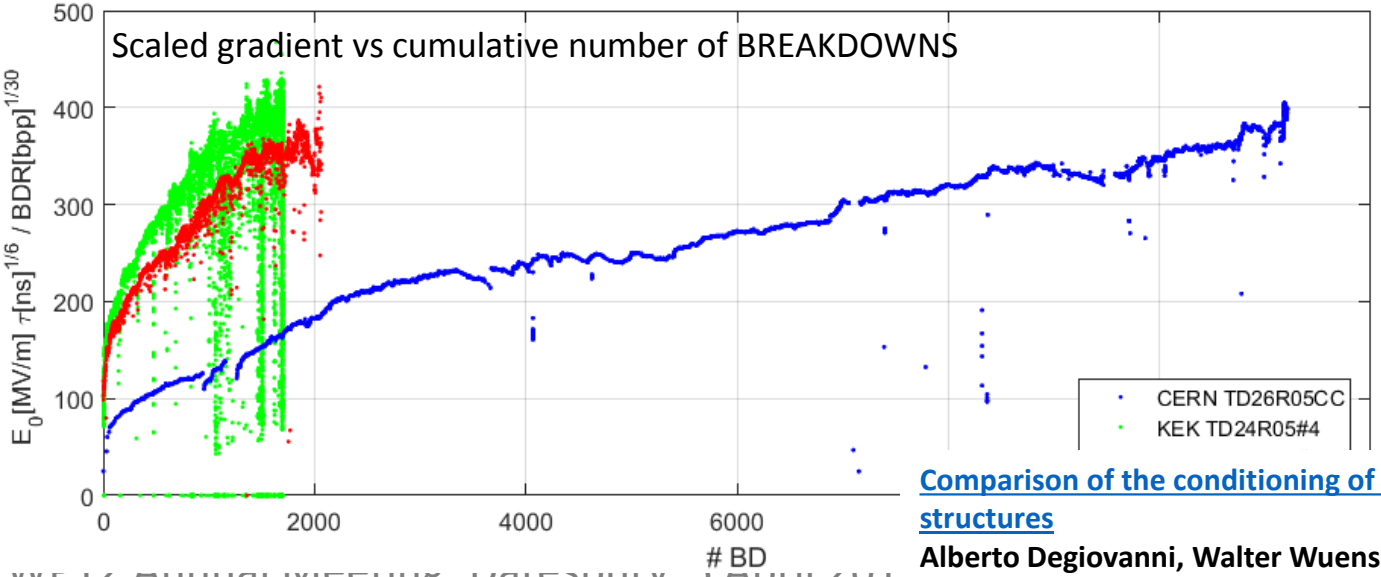


Comparing conditioning



Pulses

$BDR \propto E^{30}\tau^5$

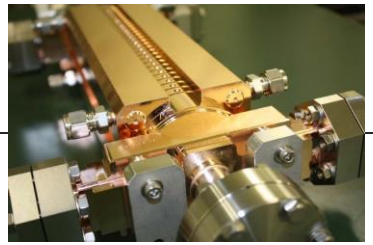


Breakdowns

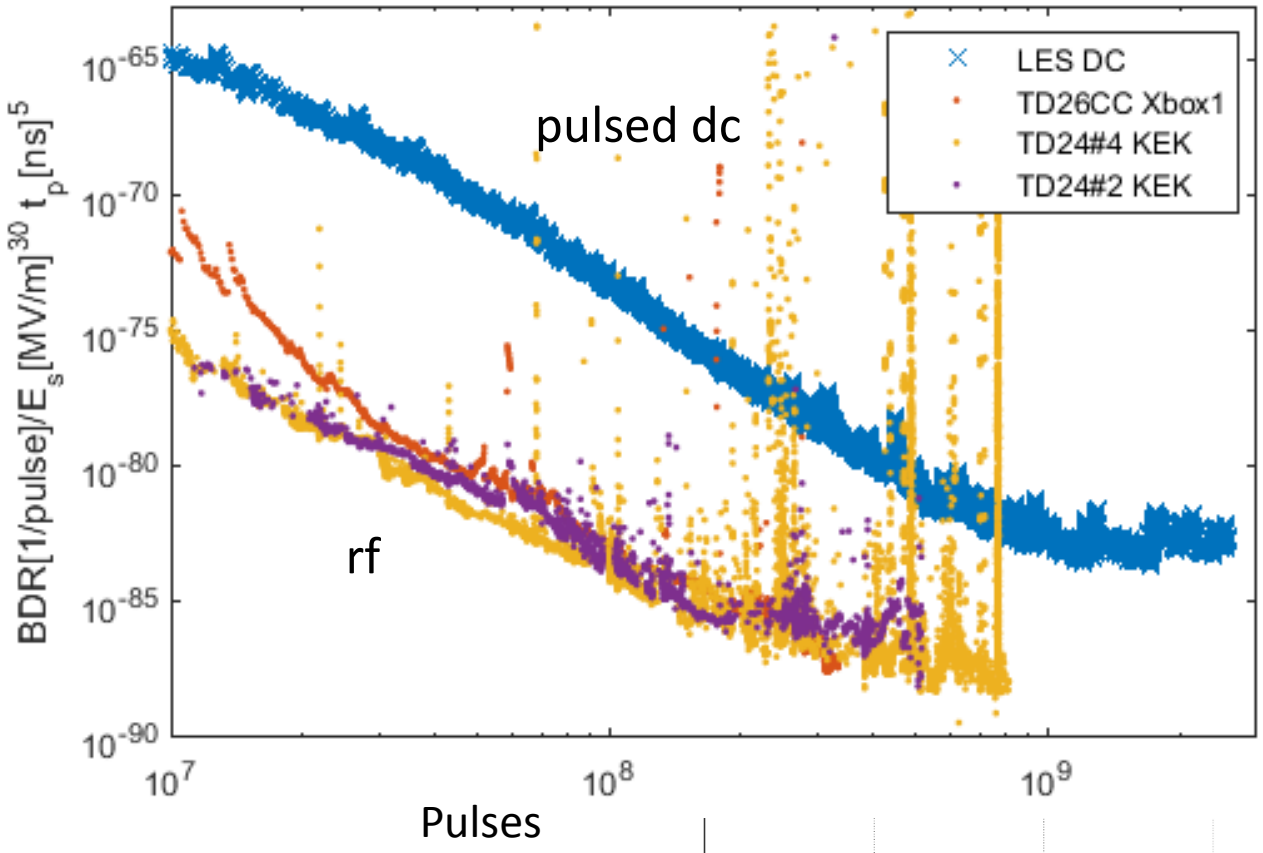
[Comparison of the conditioning of high gradient accelerating structures]

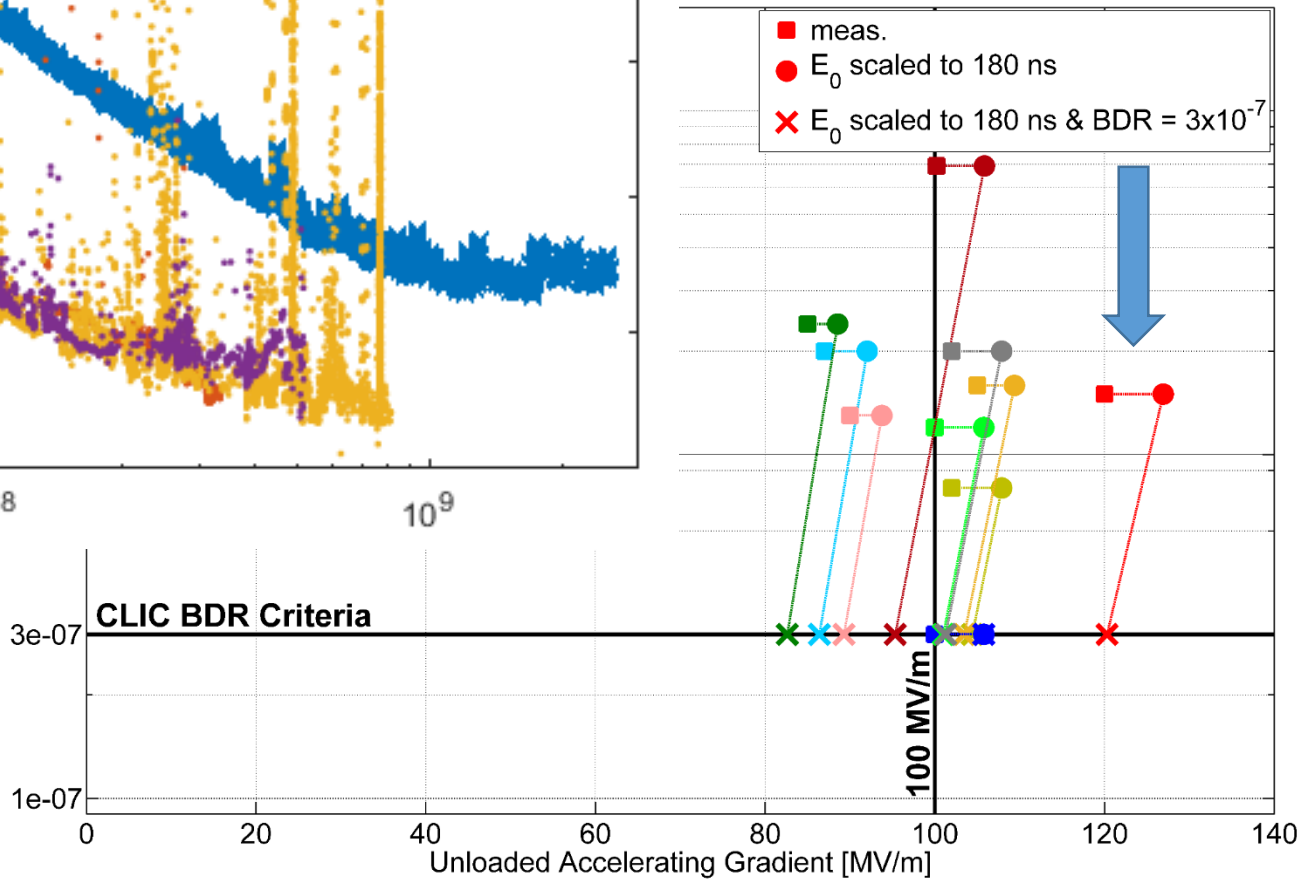
Alberto Degiovanni, Walter Wuensch, and Jorge Giner Navarro
Phys. Rev. Accel. Beams 19, 032001 (2016) - Published 4 March 2016

Longer term operation



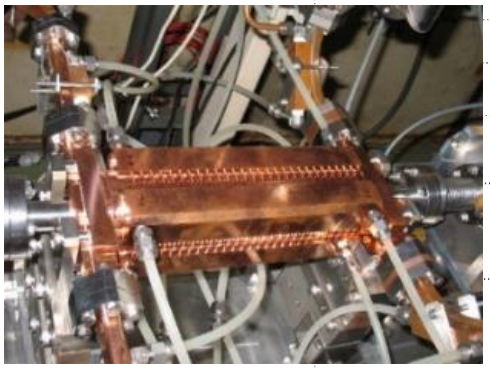
Long term evolution of BDR

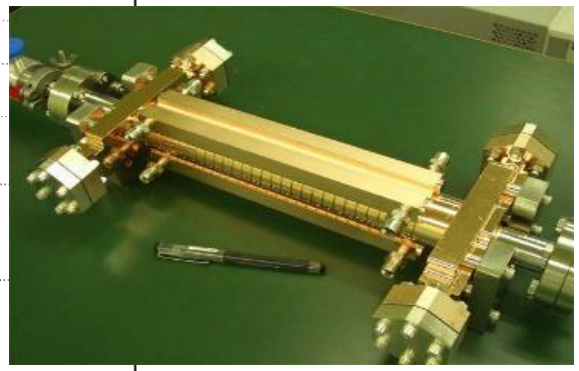




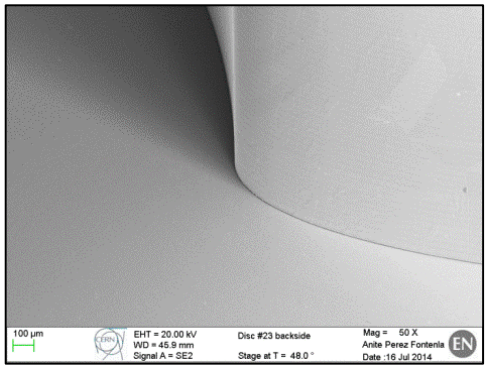
Gradient Perspectives

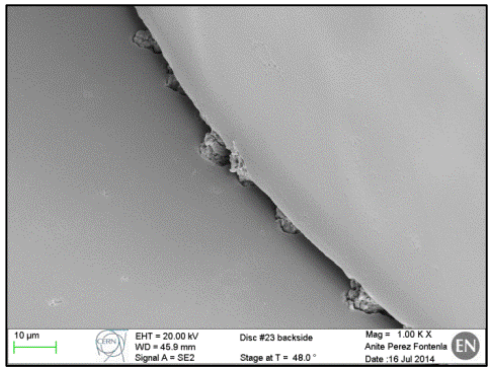
damped (mostly) ← → un-damped

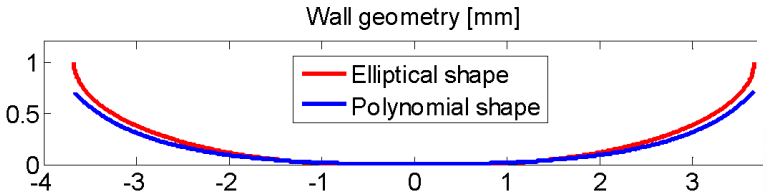


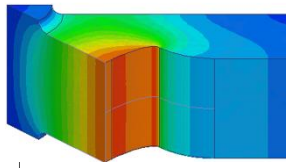


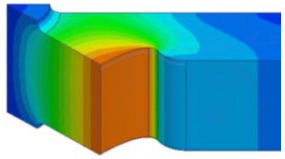
New baseline structure: major objective







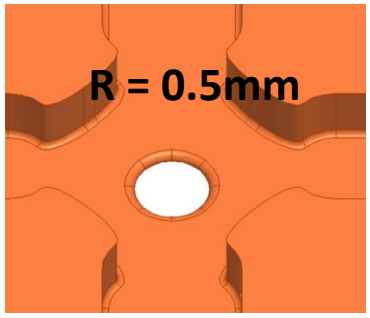


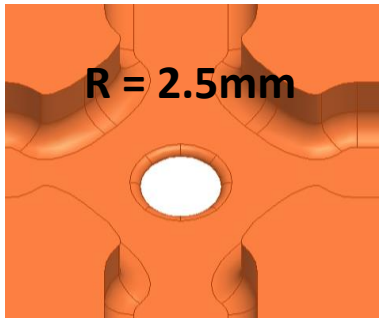


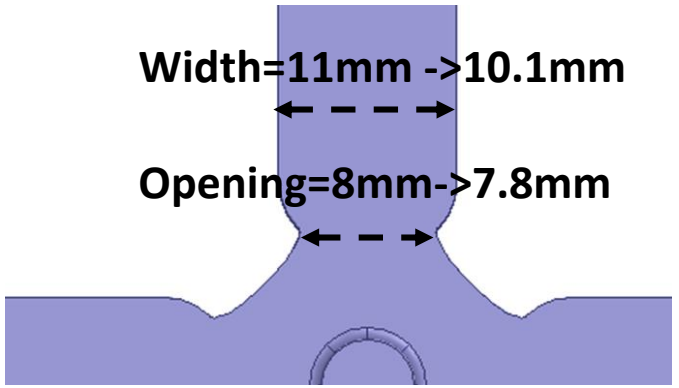
Analysing results and re-optimizing CLIC, we have a new baseline structure.

We expect to get to 120 MV/m unloaded, closing the gap we expect from beam loading.

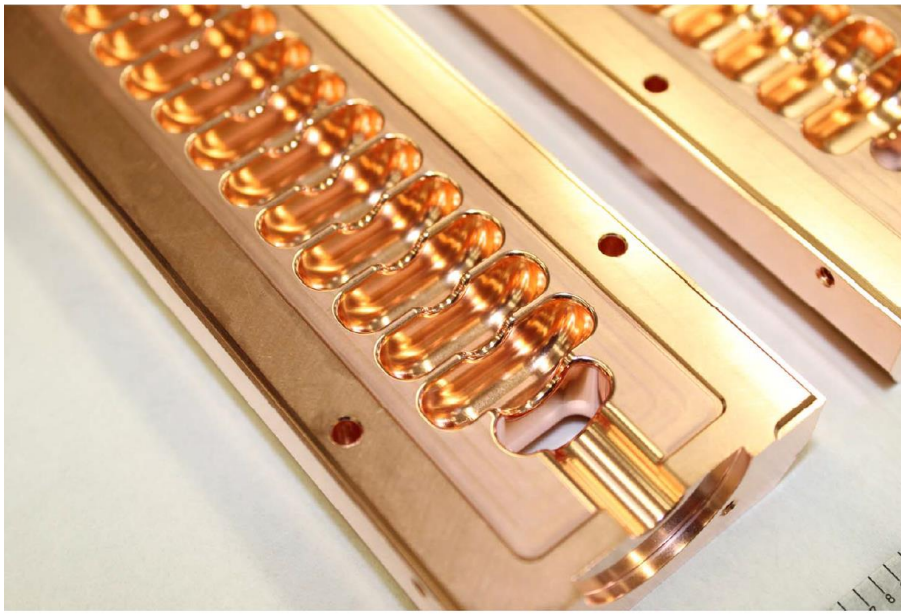
Mechanical design done. To be built and tested.







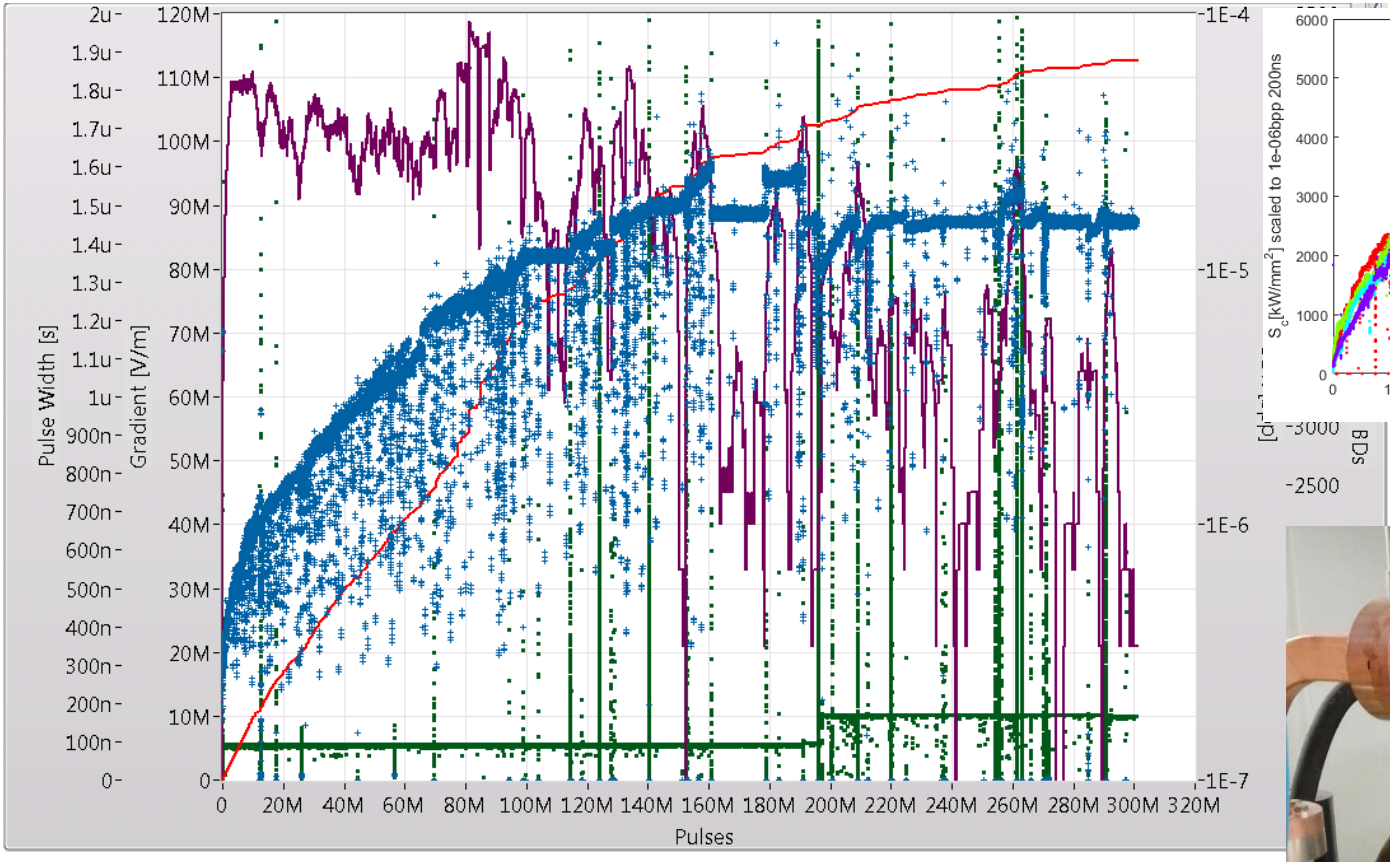
Symmetry plane structures

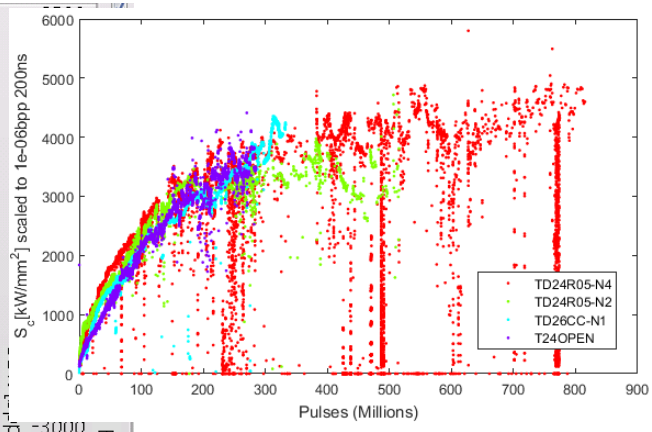


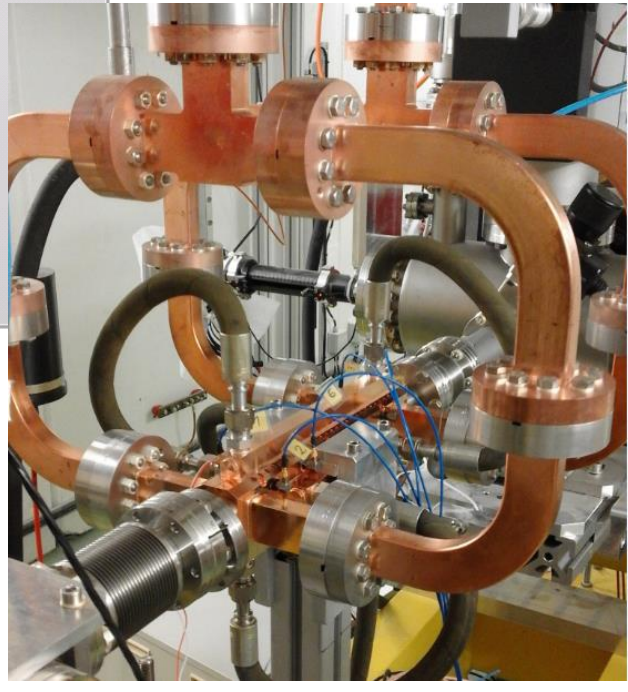
vs.

Structures in parts along symmetry planes have **significant potential advantages - cost, joining, heat and chemical treatment, materials.** Does require 3-D micron precision milling which is now possible.
Early tries with quadrants yielded unsatisfactory results, but don't believe this was end of story. We're back!

Structure in halves – testing in XBox-2





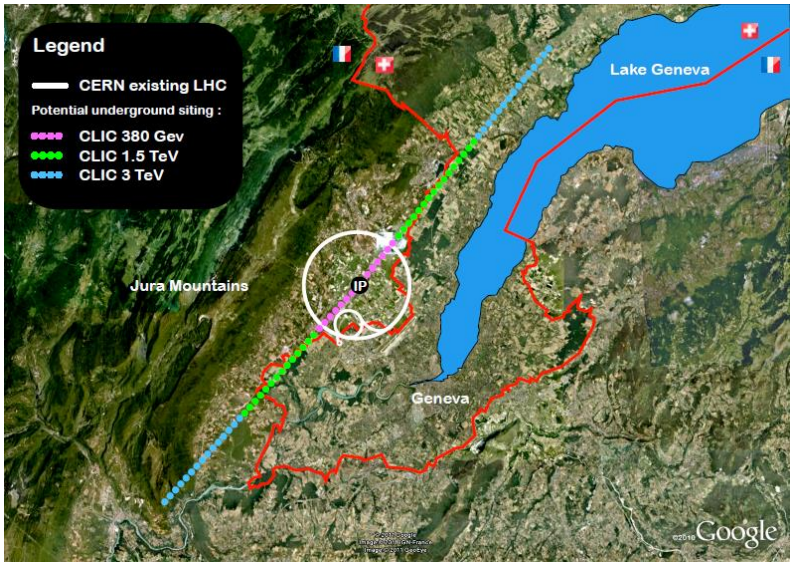


CERN design and high-gradient testing, SLAC fabrication.

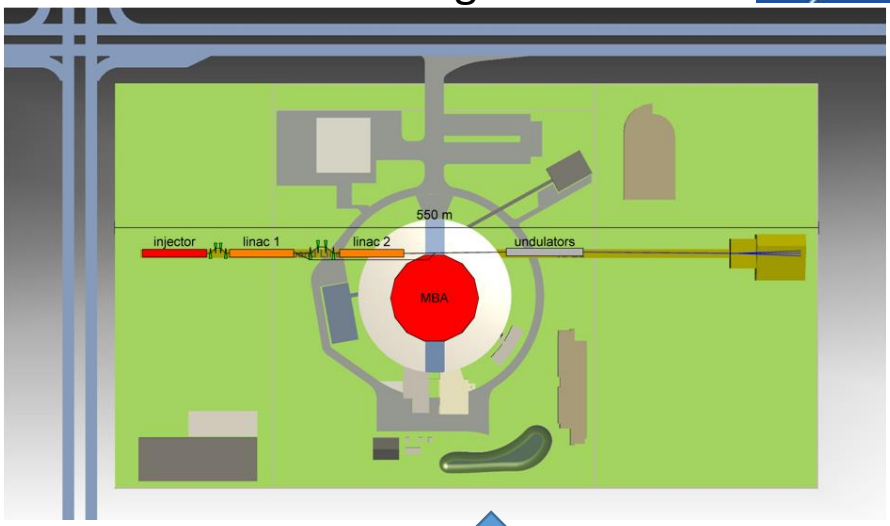
Hard copper version under preparation.

Applications of X-band acceleration

CLIC

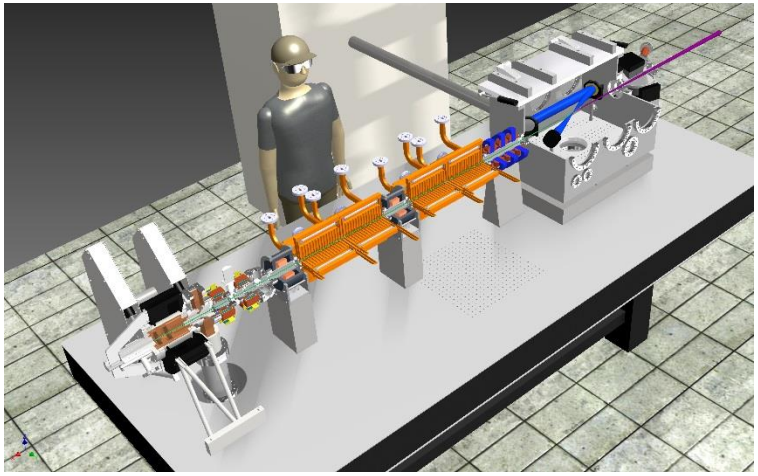


Australian Light Source



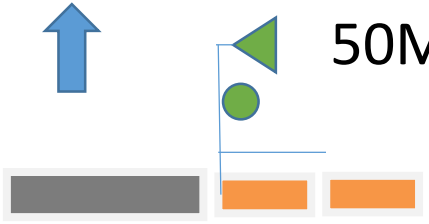
Linear collider - TeV

XFEL – 1 to 10 GeV



Thompson/Compton source – few 100s MeV

50MW



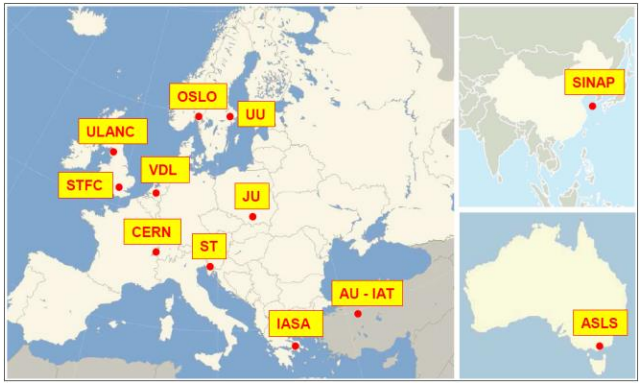
Smart*Light, NL

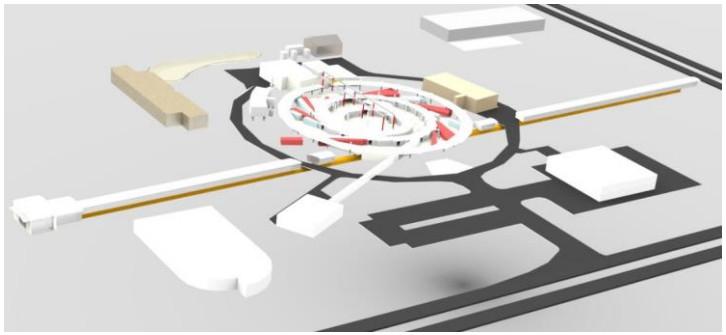
Compact Compton source few 10s MeV

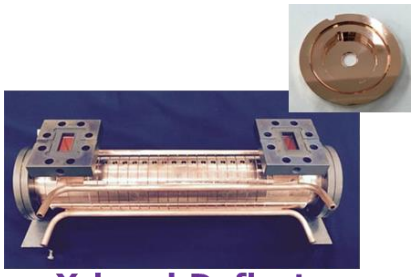
Tsinghua, China

Selected collaborations on applications of X-band and high-gradient

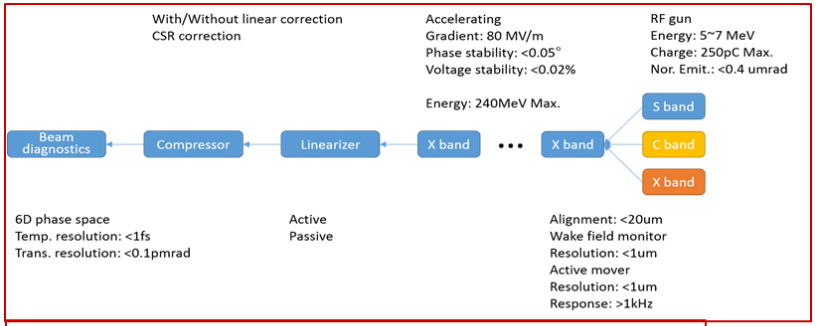
- XbFEL H2020 design study to be resubmitted in 2017.
- XBox3-B to Australian light source, Monash University proposal.
- X-band deflector and accelerating structure testing for X-band option for XFEL at SINAP.
- X-band linearizer system with Fermi@Trieste and SwissFEL







X-band Deflector

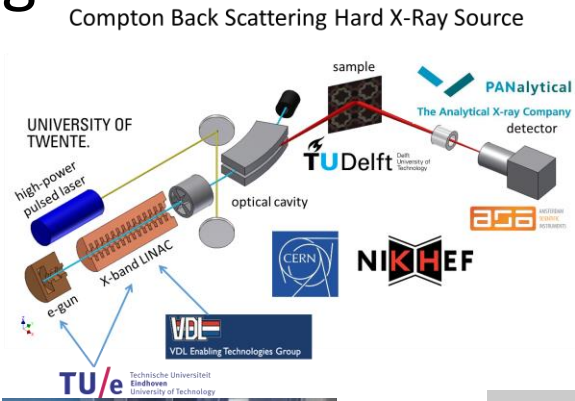


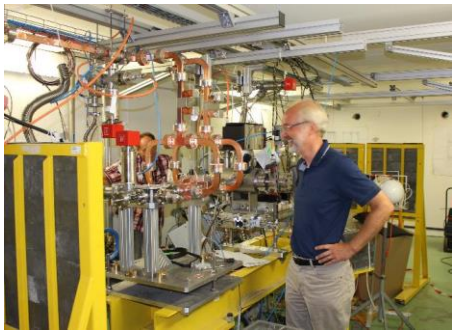
X-band Accelerator Test Facility plan at SINAP

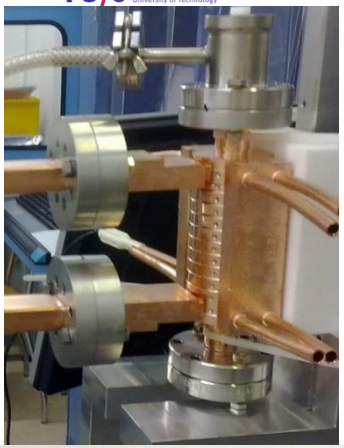
Selected collaborations on applications of X-band and high-gradient - continued

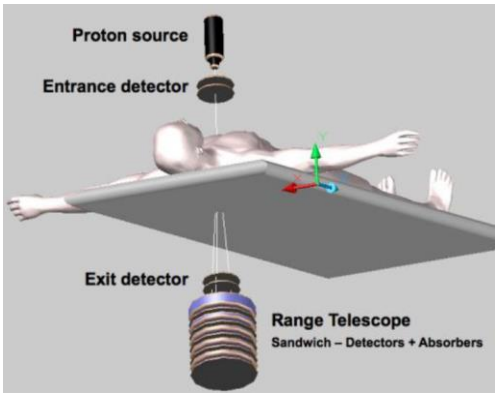
- Trans-National Access for Xboxes in Aries (EUCARD3) proposal.
- SMART*Light, Dutch proposal for compact Compton X-ray source.
- Transverse deflector based on 50 MW klystron for SINBAD at DESY.
- X-Band Thompson source energy upgrade at Tsinghua University.
- Medical linac structures – TERA/KT and Lancaster/Cockcroft.

We gain experience with help and resources of other projects! For example XFEL-type accelerating structures are similar in gradient and iris aperture to CLIC 380 GeV structures.









HG2016

International Workshop on Breakdown Science and High Gradient Accelerator Technology (HG2016)

6-8 June 2016
Argonne National Laboratory
US/Central timezone

https://indico.hep.anl.gov/indico/conferenceDisplay.py?ovw=True&confId=963