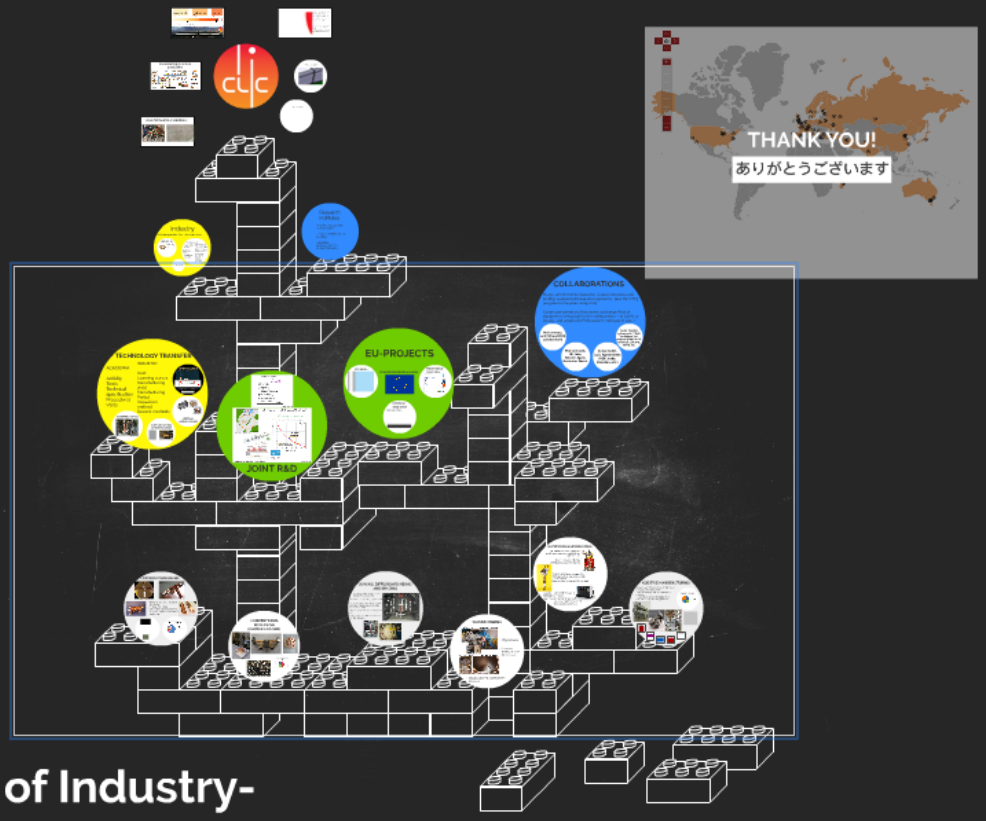
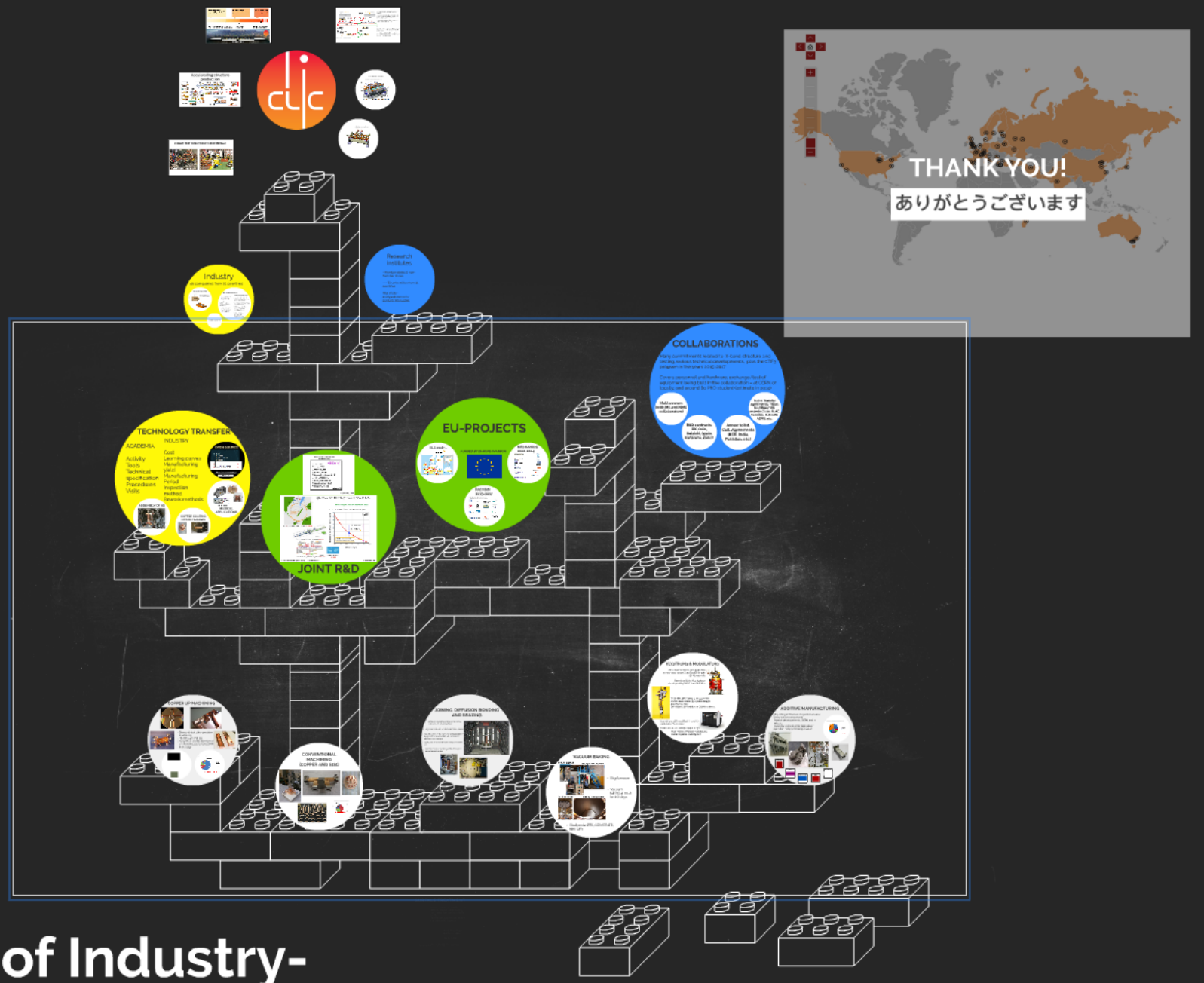
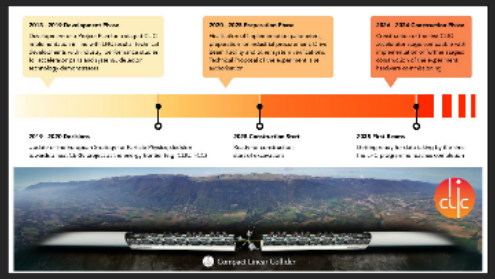


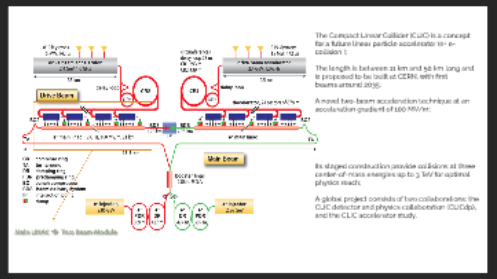
Experience of Industry-Academia cooperation in CLIC



Experience of Industry-Academia cooperation in CLIC

Prezi





The Compact Linear Collider (CLIC) is a concept for a future linear particle accelerator for e-e- collision 1

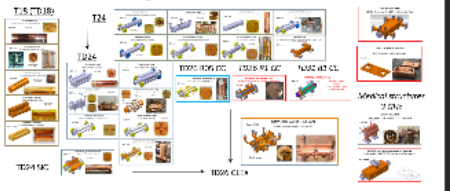
The length is between 11 km and 50 km long and is proposed to be built at CERN, with first beams around 2035.

A novel two-beam acceleration technique at an accelleration gradient of 100 MV/m.

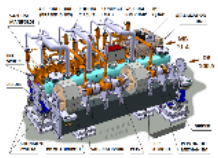
Its staged construction provides collisions at three center-of-mass energies up to 3 TeV for optimal physics reach.

A global project consists of two collaborations: the CLIC detector and physics collaboration (CLICdp), and the CLIC accelerator study.

Accelerating structure production

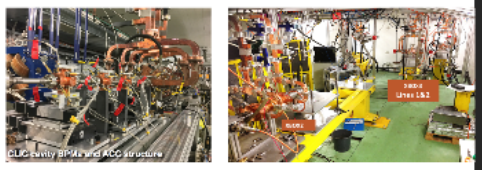


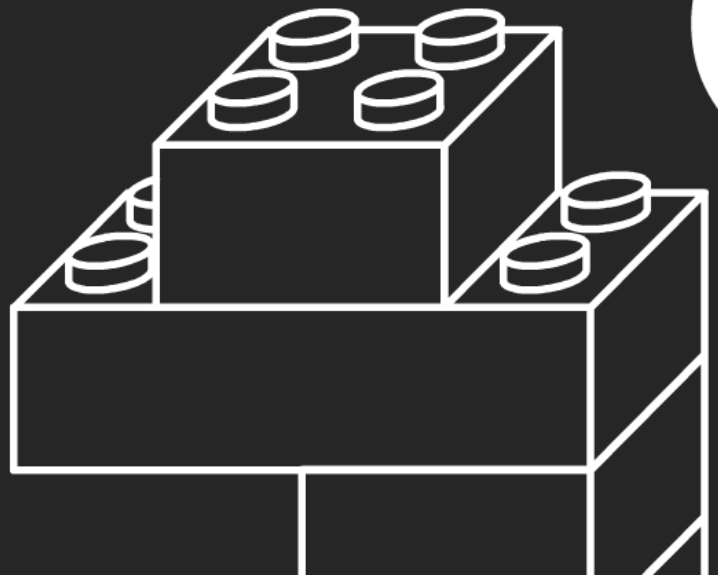
Two-beam module

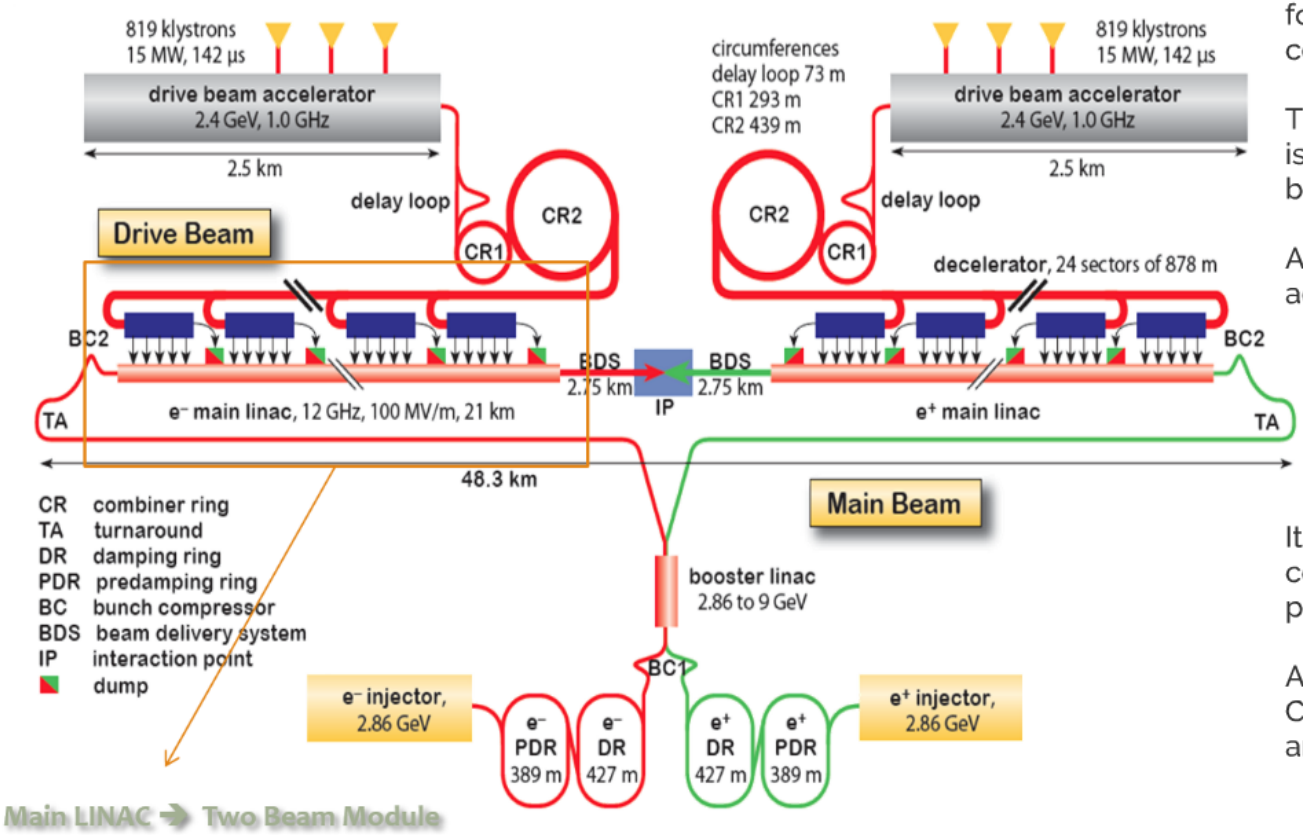


Klystron Module

X-BAND TEST FACILITIES AT CERN (XBOXes)







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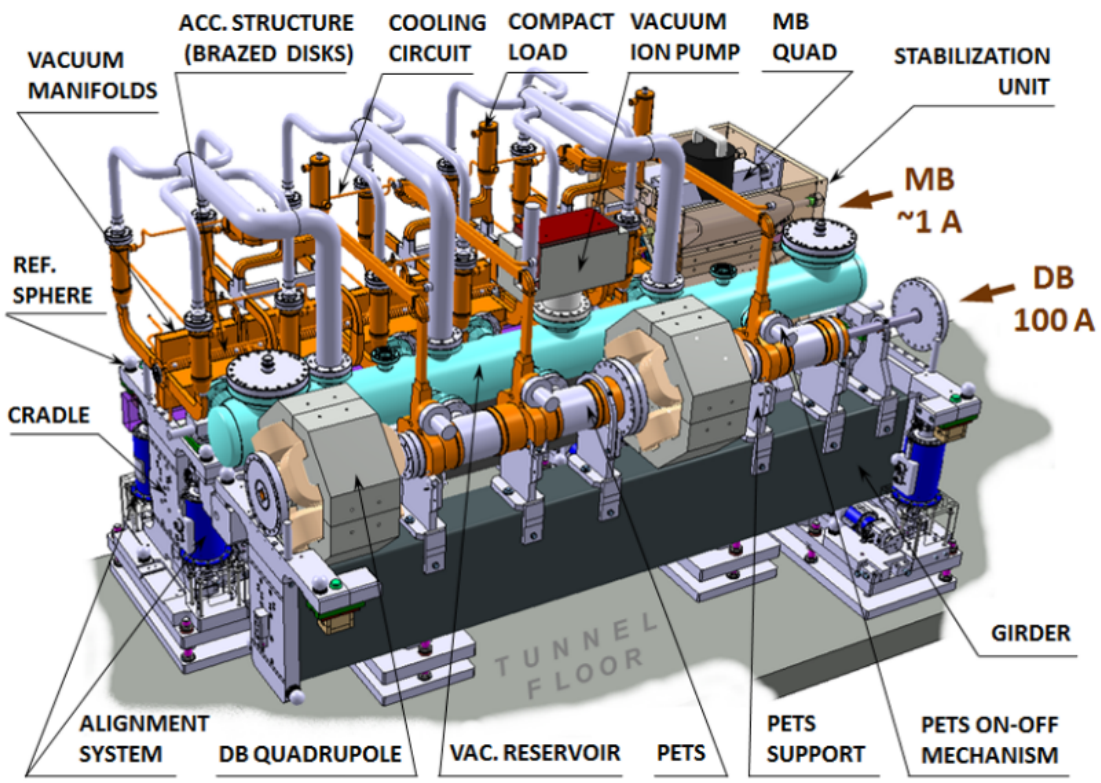
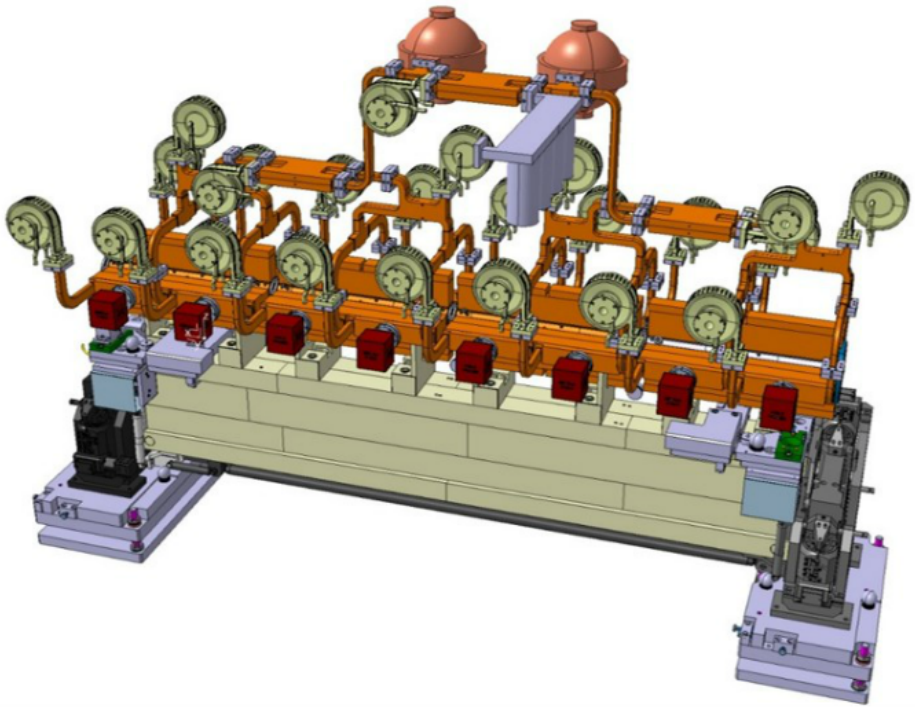


Klystron Module



2013 - 2019 Development Phase

Development of a Project Plan for a staged CLIC implementation in line with LHC results; technical developments with industry, performance studies for accelerator parts and systems, detector technology demonstrators

2020 - 2025 Preparation Phase

Finalisation of implementation parameters, preparation for industrial procurement, Drive Beam Facility and other system verifications, Technical Proposal of the experiment, site authorisation

2026 - 2034 Construction Phase

Construction of the first CLIC accelerator stage compatible with implementation of further stages; construction of the experiment; hardware commissioning

2019 - 2020 Decisions

Update of the European Strategy for Particle Physics; decision towards a next CERN project at the energy frontier (e.g. CLIC, FCC)

2025 Construction Start

Ready for construction; start of excavations

2035 First Beams

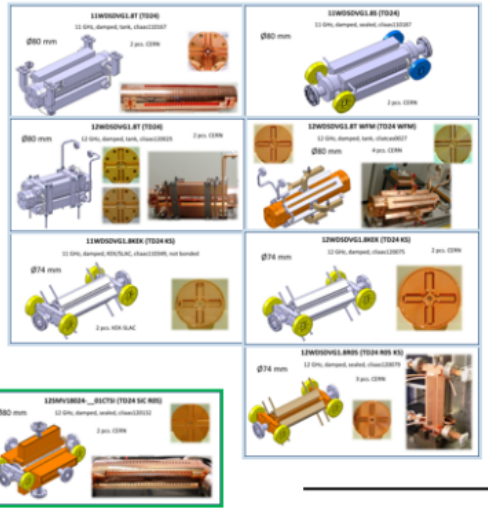
Getting ready for data taking by the time the LHC programme reaches completion

Accelerating structure production

T18 (TD18)

T24

TD24



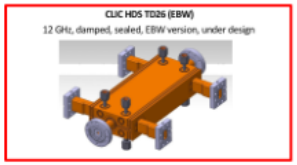
TD24 SiC

TD26 R05 CC

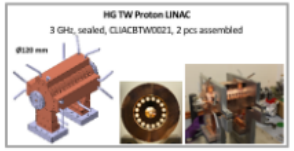
TD26 R1 CC

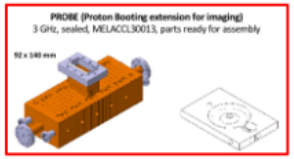
TD31 R1 CC

TD26 CLEX



Medical structures 3 GHz





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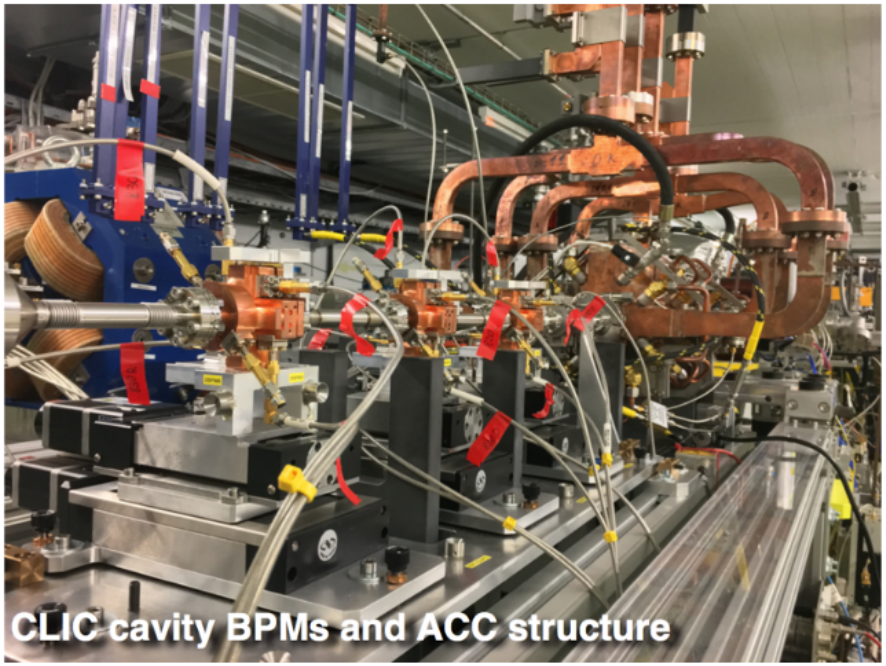
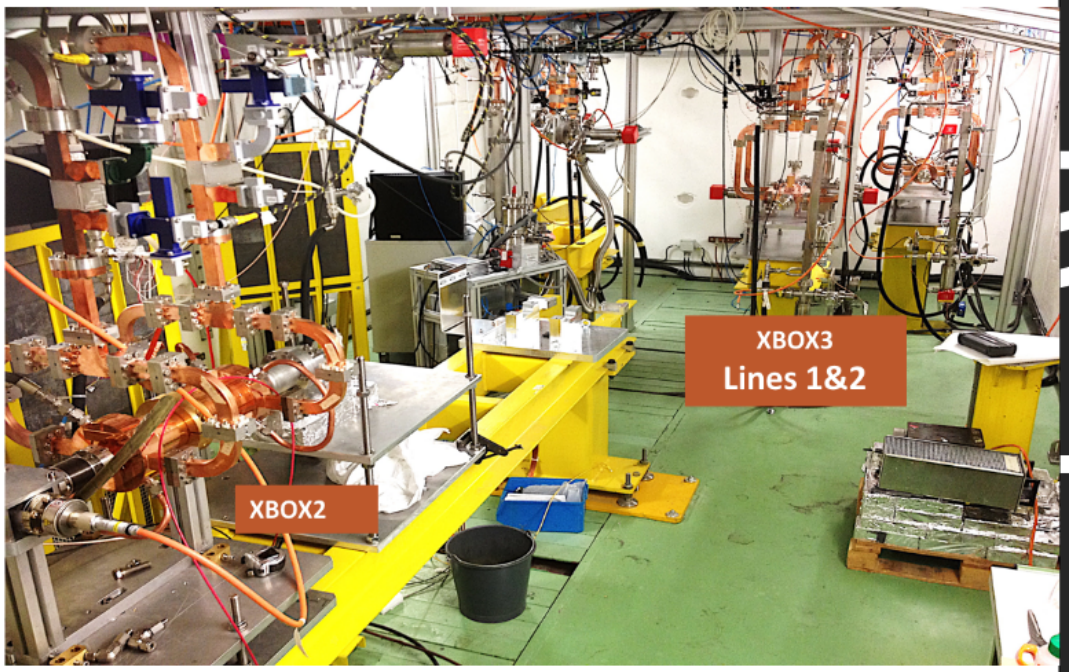
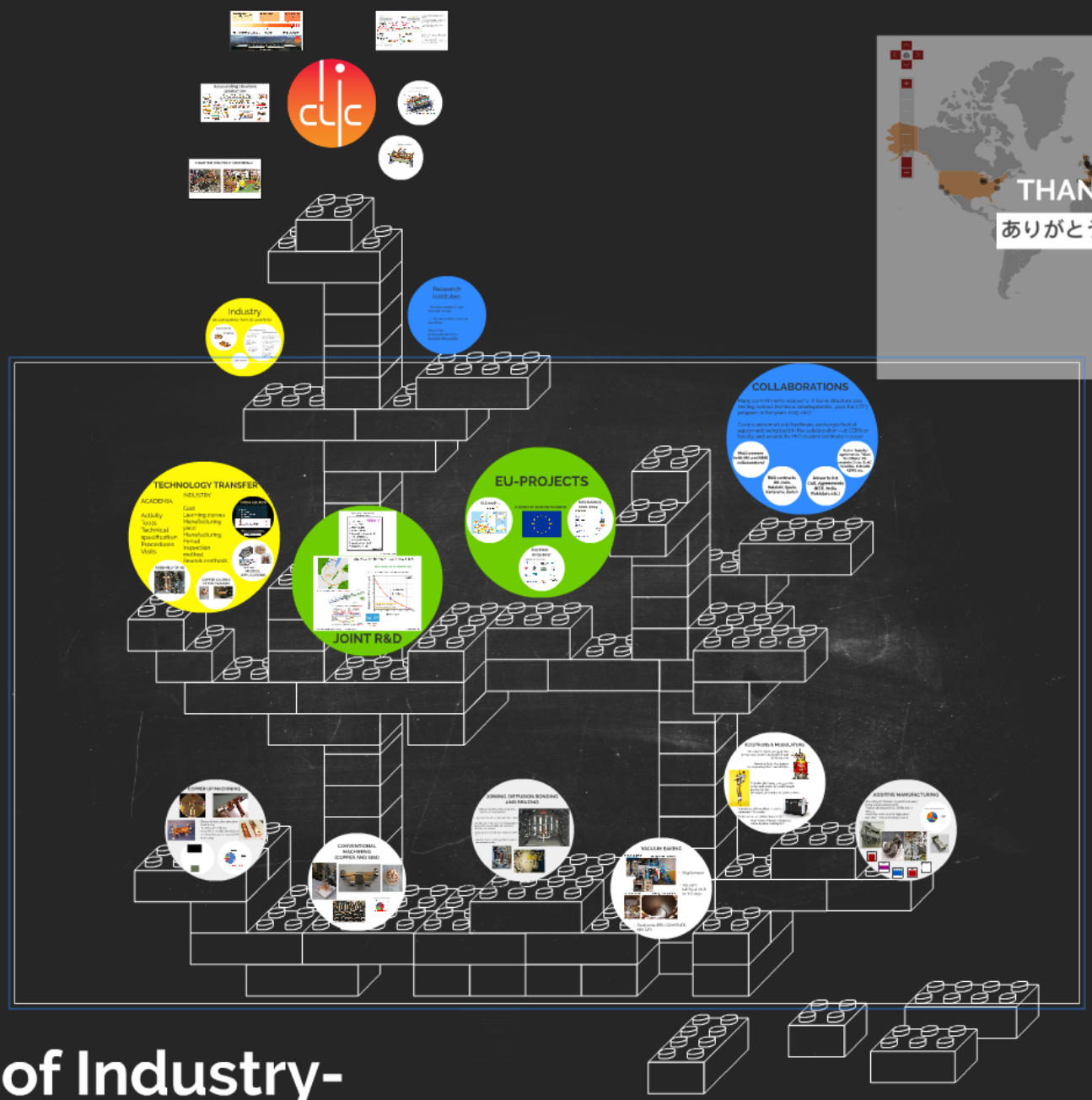






Experience of Industry-Academia cooperation in CLIC

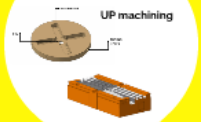
Prezi

Industry

~ 40 companies from 11 countries

QUALIFICATION

UP machining



PROVEN TECHNOLOGIES

- The product exist on the company catalog or can be adapted with a reasonable effort.
- Companies can be included in a call for tender with a technical specification.
- Examples: High voltage modulators, klystrons, ceramics, electronic components, etc.

NEW TECHNOLOGIES

- Done as prototypes at CERN. Technology transfer is generally required from CLIC side.
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DIRECT ORDERS

Research institutes

- Member states & non-member states

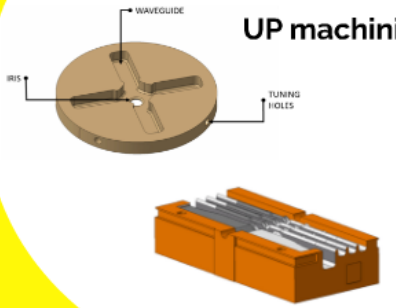
- ~ 70 universities from 31 countries

http://clic-study.web.cern.ch/content/interactive

Industry

~ 40 companies from 11 countries

QUALIFICATION



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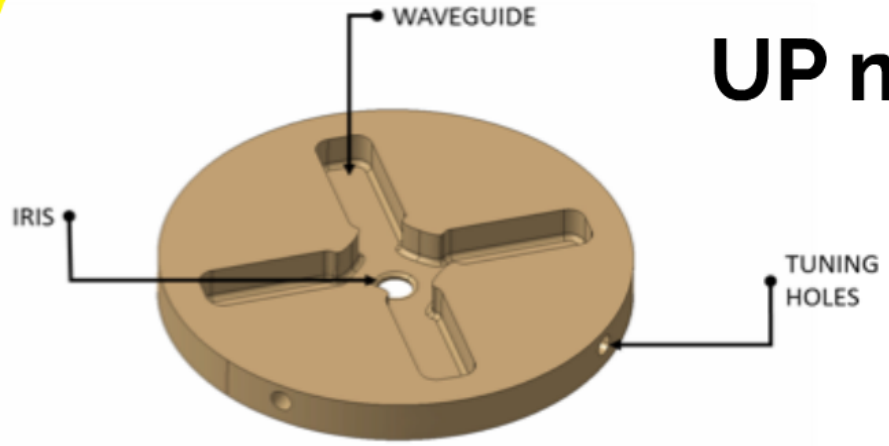

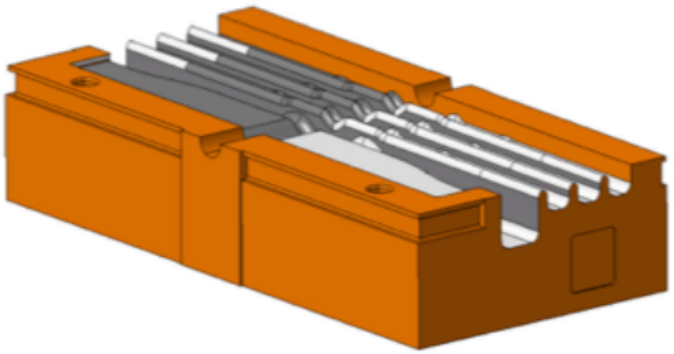

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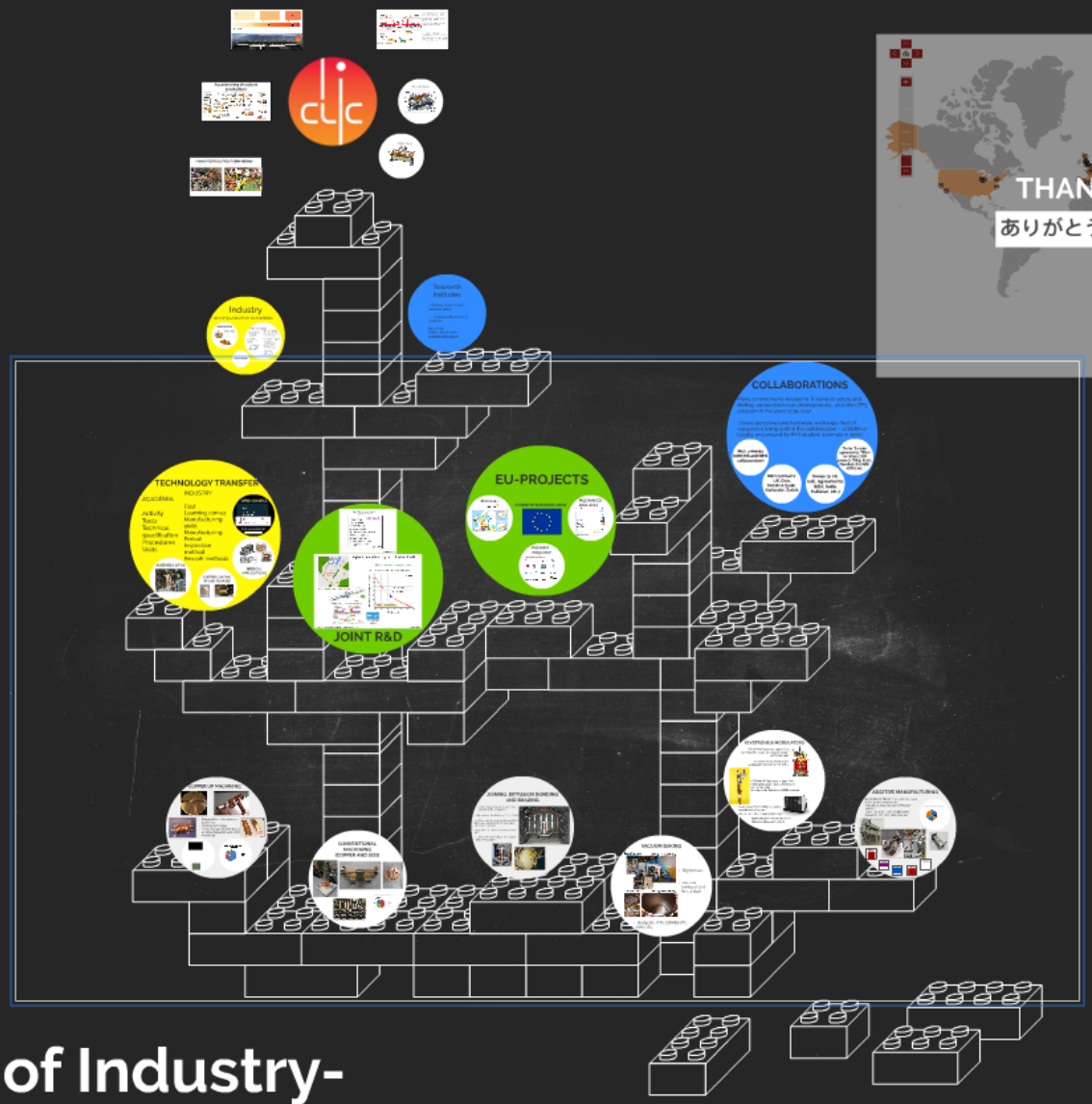

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TECHNOLOGY TRANSFER

ACADEMIA

Activity
Tools
Technical specification
Procedures
Visits

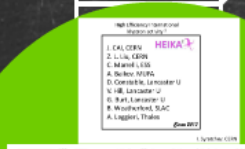
INDUSTRY

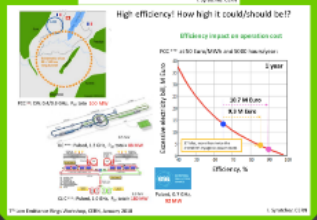
Cost
Learning curves
Manufacturing yield
Manufacturing Period
Inspection method
Rework methods

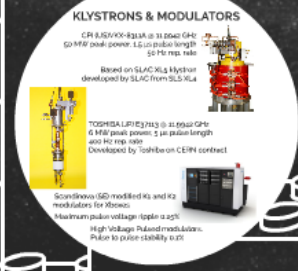
EU-PROJECTS

FUNDED BY EUROPEAN UNION

JOINT R&D







TECHNOLOGY TRANSFER

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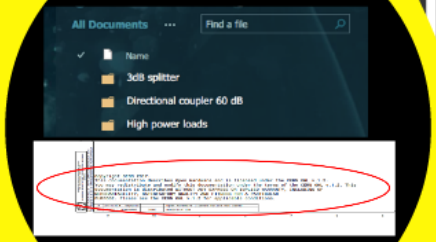
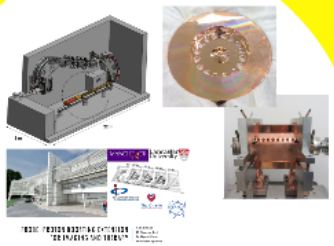
OPEN SOURCE

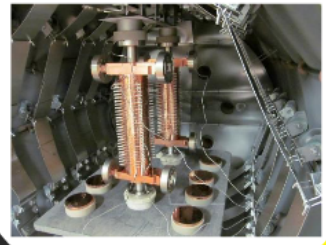


https://www.ohwr.org/

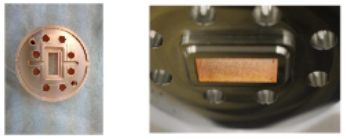
MEDICAL APPLICATIONS



ASSEMBLY OF AS



COPPER COATING OF StSt FLANGES



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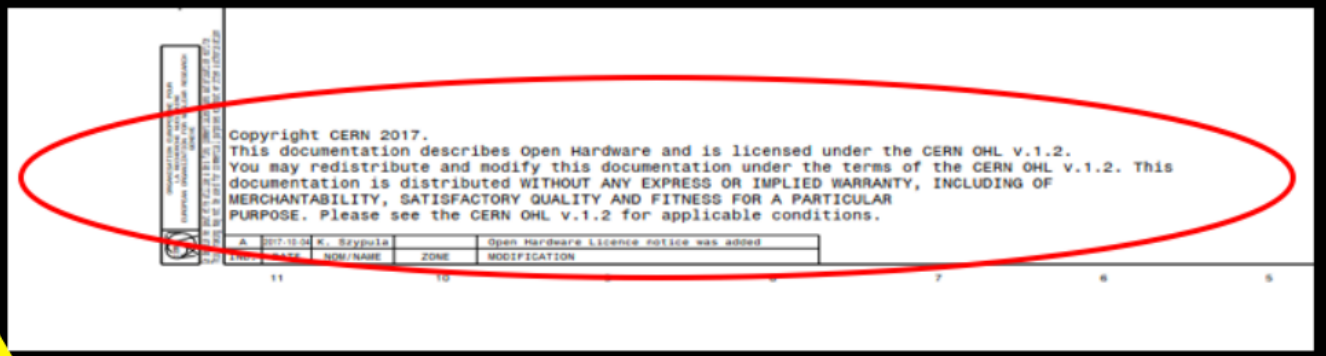


https://www.ohwr.org/

OPEN HARDWARE REPOSITORY

High Efficiency International klystron activity [2]

HEIKA[2]

J. CAI, CERN
Z. L. Liu, CERN
C. Marrelli, ESS
A. Baikov, MUFA
D. Constable, Lancaster U
V. Hill, Lancaster U
G. Burt, Lancaster U
B. Weatherford, SLAC
A. Leggieri, Thales

Since 2013

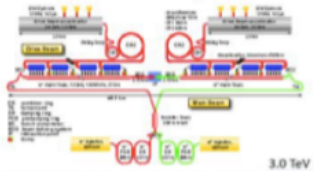
I. Syratchev, CERN

High efficiency! How high it could/should be!?

FCC ^{ee}: CW, 0.4/0.8 GHz, P_{RF} tota 100 MW

0.5 TeV

ILC $^{e+e-}$: Pulsed, 1.3 GHz, P_{RF} total= 88 MW

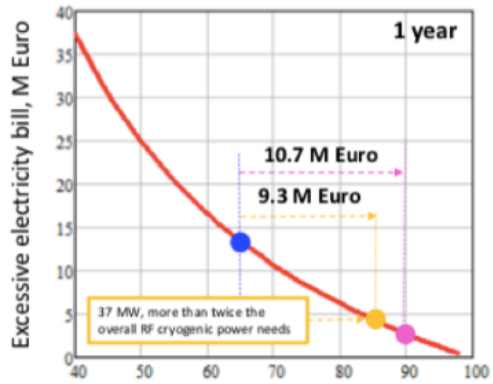


3.0 TeV

CLIC $^{e+e-}$: Pulsed, 1.0 GHz, P_{RF} total= 180 MW

Efficiency impact on operation cost

FCC $^{e+e-}$ at 50 Euro/MWh and 5000 hours/year:



ESS EUROPEAN SPALLATION SOURCE

Pulsed, 0.7 GHz,
92 MW

7th Low Emittance Rings Workshop, CERN, January 2018

I. Syratchev, CERN

JOINT R&D

EU-PROJECTS

XLS 2018-...

Compact

FUNDED BY EUROPEAN UNION

MECHANICS 2010-2014

Project Partners

Helsinki Institute of Physics (HIP)
(University of Helsinki)
Coordination

CERN
Scientific Coordination

Lewel Group Oy
Design

Loval Oy
Brazing, Assembly

Mectalent Oy
Machining, Assembly

Metso Minerals Oy
Materials

Tarkmet Oy
Machining

Project's timeline graphics

PACMAN 2013-2017

Network partners

Prezi

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[Project's timeline graphics]

PACMAN 2013-2017

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XLS 2018-...

Compact

FUN

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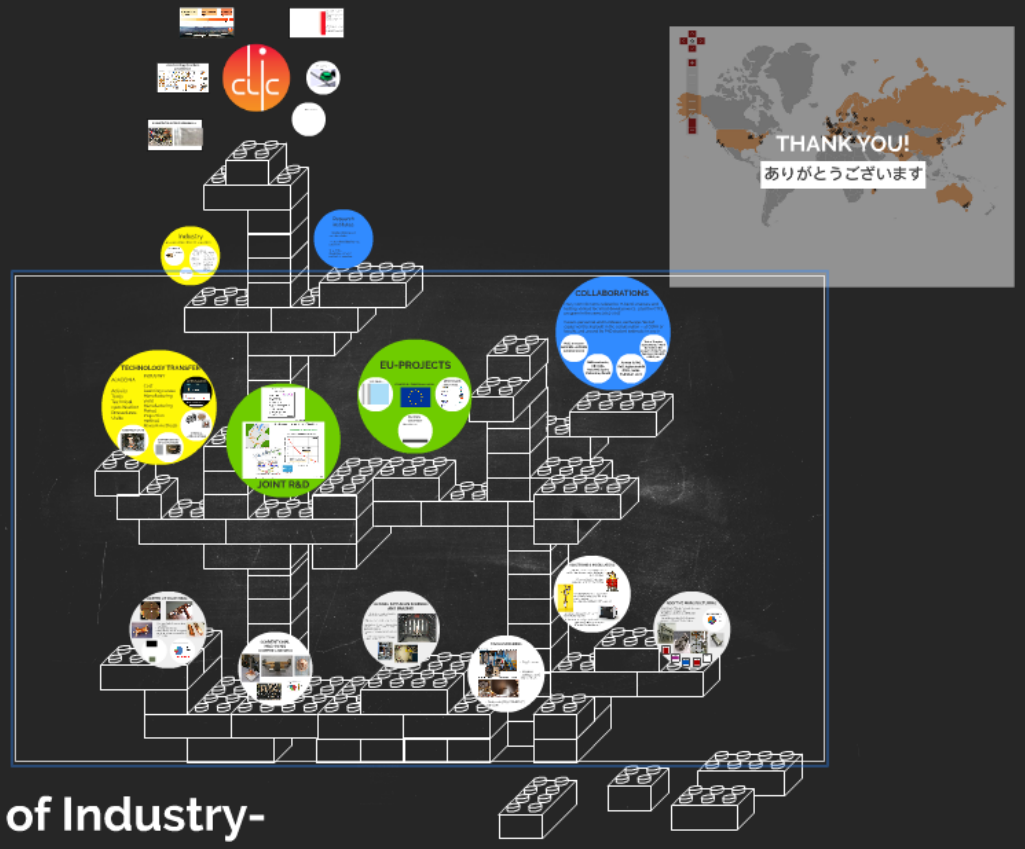
MoU annexes (with MS and NMS collaborators)

R&D contracts, UK, Oslo, Helsinki, Spain, Karlsruhe, Zurich

Annex to Int. Coll. Agreements (KEK, India, Pakistan, etc.)

Techn. Transfer agreements, "Work for Others", EU projects (Tulip, SLAC, Fermilab, EUCARD, AERIS, etc.



Experience of Industry-Academia cooperation in CLIC

Industry

40 companies from 11 countries

Research institutes

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http://cds.cern.ch/collection/Contributions

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COPPER COATING OF SISI FLANGES

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FUNDED BY EUROPEAN UNION

XLS 2010-...

MECHANICS 2010-2014

PACMAN 2013-2017

KLYSTRONS & MODULATORS

COPPER UP MACHINING

JOINING, DIFFUSION BONDING AND BRAZING

ADDITIVE MANUFACTURING

CONVENTIONAL MACHINING (COPPER AND SISI)

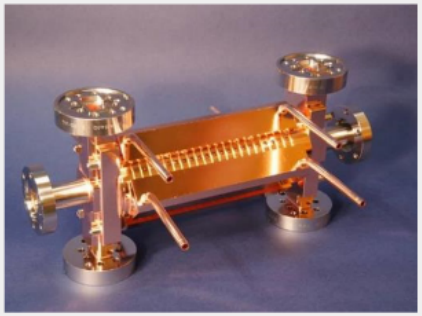
VACUUM BAKING

- Big furnace
- Vacuum backing at 10-8 for 1-2 days
- Bodycote (FR), COMEB (IT), MHI (JP)

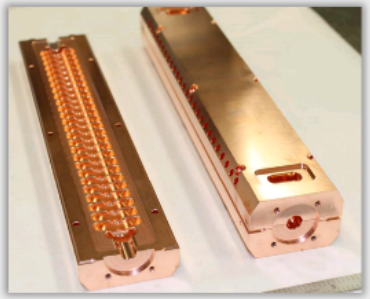
Prezi

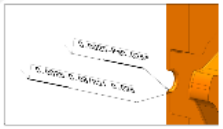
Industry-

COPPER UP MACHINING

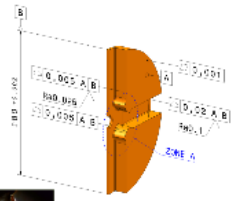


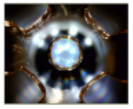
- Diamond-tool ultra-precision machining
- Turning and milling
- Very strict qualification based on visual inspection and CMM metrology

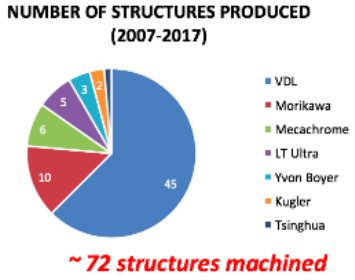


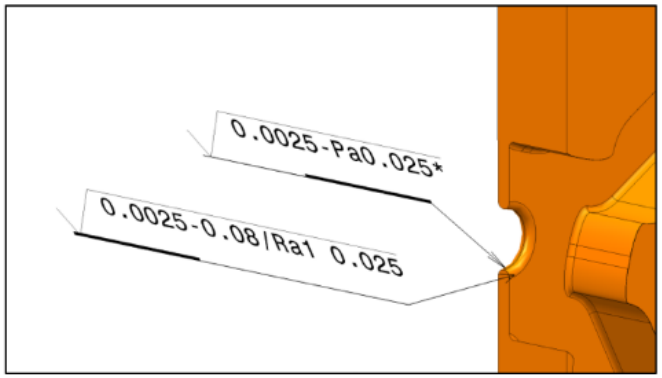


Cell shape accuracy:
zone A - 0.005 mm
zone B - 0.02 mm
Flatness - 0.001 mm
Surface roughness:
zone A Ra 0.025 µm
zone B Ra 0.1 µm









Cell shape accuracy:

zone A - 0.005 mm

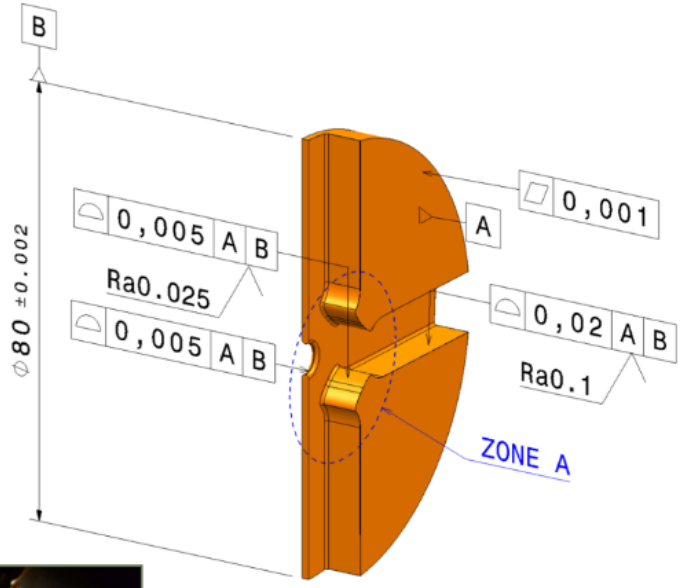
zone B - 0.02 mm

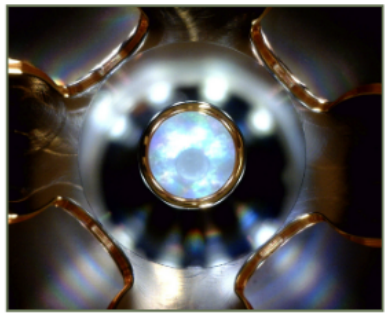
Flatness - 0.001 mm

Surface roughness:

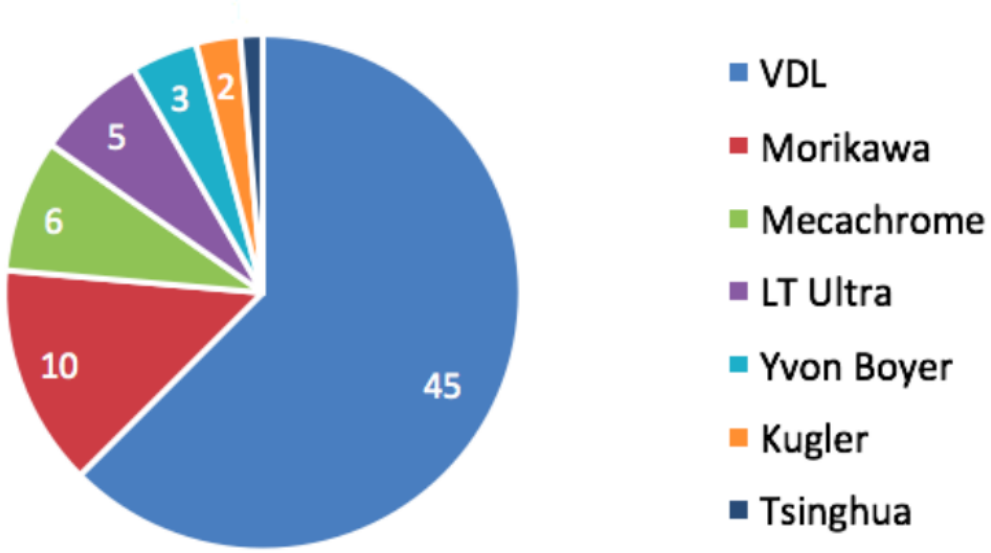
zone A Ra 0.025 μm

zone B Ra 0.1 μm



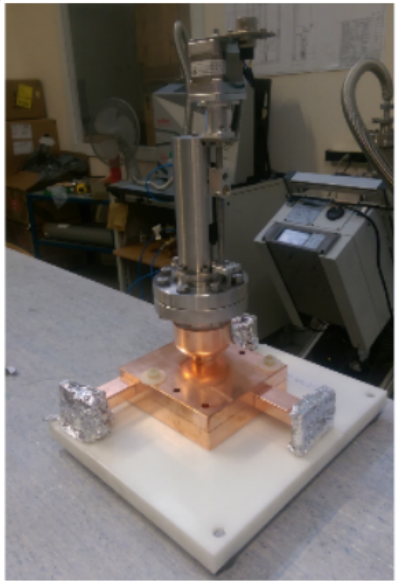


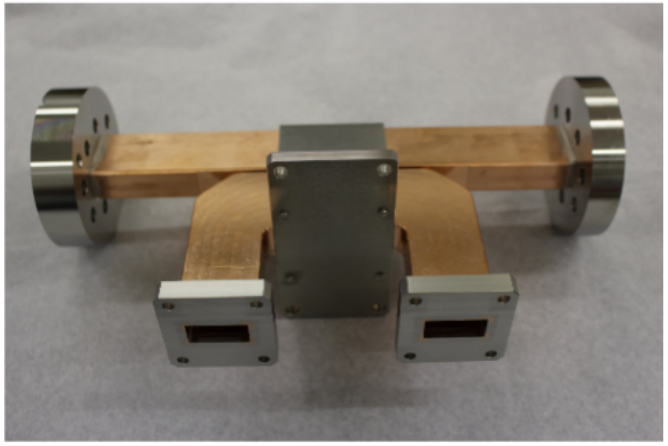
NUMBER OF STRUCTURES PRODUCED (2007-2017)

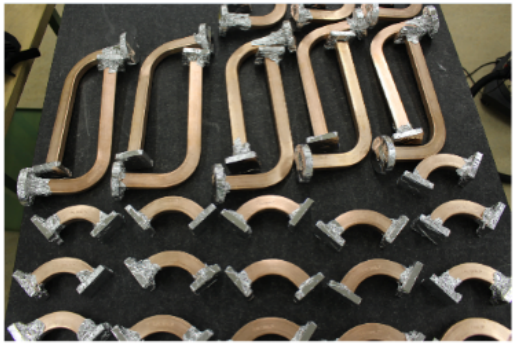


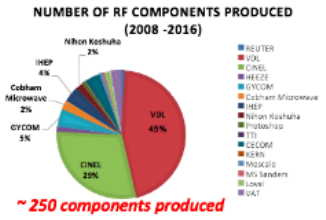
~ 72 structures machined

CONVENTIONAL MACHINING (COPPER AND StSt)

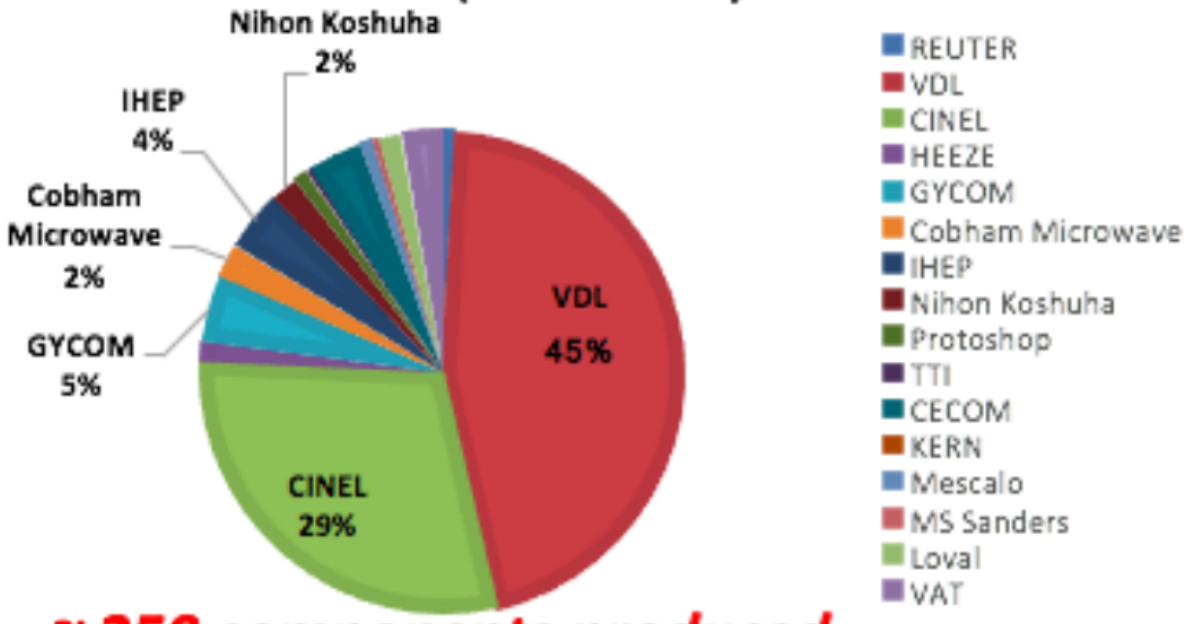








NUMBER OF RF COMPONENTS PRODUCED (2008 -2016)



~ 250 components produced

JOINING. DIFFUSION BONDING AND BRAZING

- Diffusion bonding and brazing with a protective H2 atmosphere.
- High vacuum <10-5 mbar; >15% H2; > 1000
- Qualification of the oven involving pollution tests and an observation with scanning electron microscope
- Bodycote (FR), Reuter (DE), TMD (UK), MHI (JP)
- Electron-beam-welding of hard copper under investigation

VACUUM BAKING

Pumping group

Baking oven (outside)

- Big furnace
- Vacuum baking at 10-8 for 1-2 days

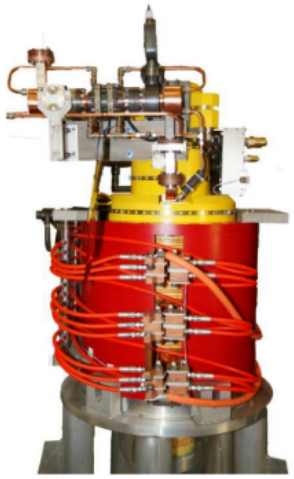
Structure support

Baking oven (inside)

- Bodycote (FR), COMEB (IT), MHI (JP)

KLYSTRONS & MODULATORS

CPI (US)VKX-8311A @ 11.9942 GHz
50 MW peak power, 1.5 µs pulse length
50 Hz rep. rate



Based on SLAC XL5 klystron
developed by SLAC from SLS XL4

TOSHIBA (JP) E37113 @ 11.9942 GHz
6 MW peak power, 5 µs pulse length
400 Hz rep. rate
Developed by Toshiba on CERN contract

Scandinova (SE) modified K1 and K2
modulators for Xboxes

Maximum pulse voltage ripple 0.25%

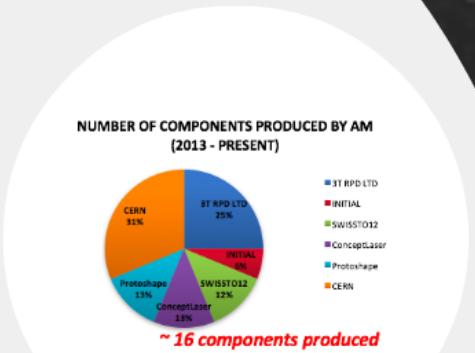
High Voltage Pulsed modulators.
Pulse to pulse stability 0.1%

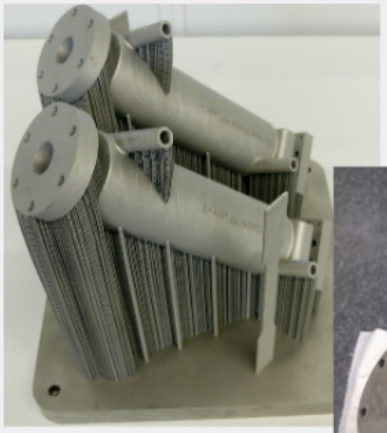
ADDITIVE MANUFACTURING

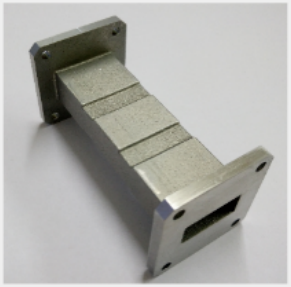
3D printing in Titanium for parts like loads or low power components

Parallel development at CERN and in industry

Currently under test for high power operation. Very promising results!







Swissto12

3T RPD

ConceptLaser

Initial

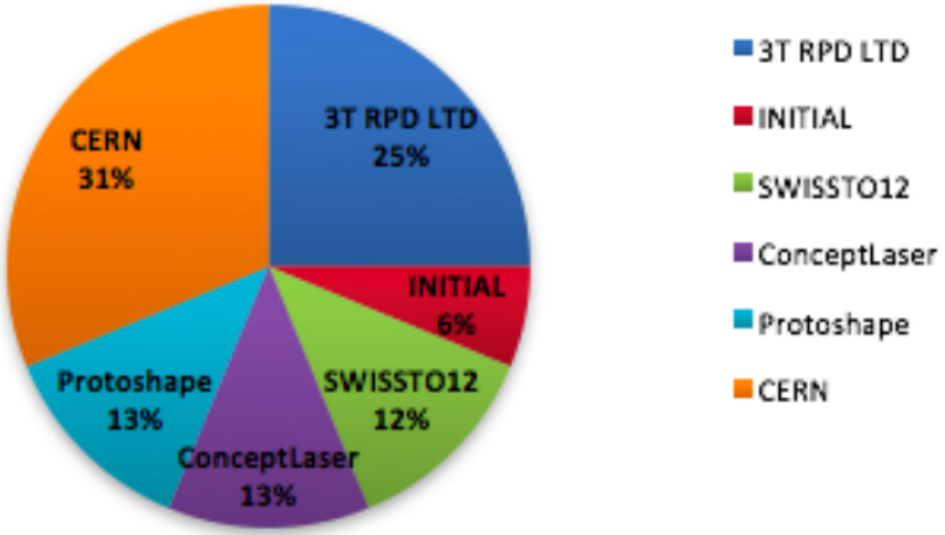
ProtoShape

ProtoShape GmbH

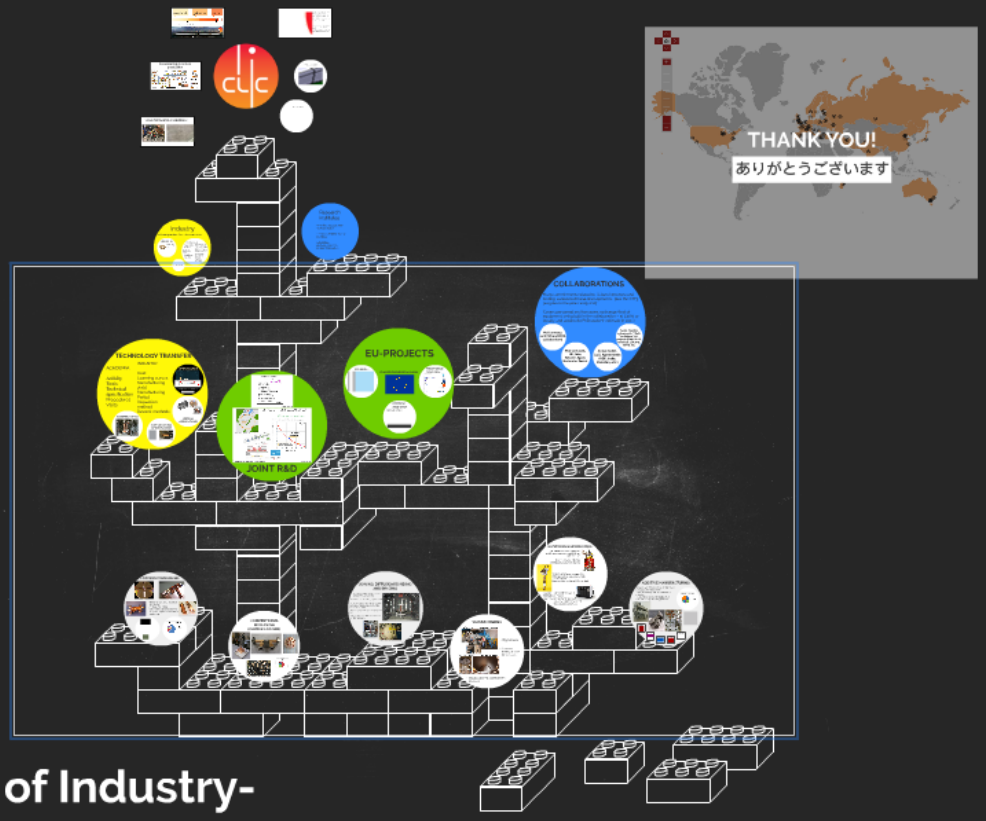
Prezi

as

NUMBER OF COMPONENTS PRODUCED BY AM (2013 - PRESENT)



~ 16 components produced



Experience of Industry-Academia cooperation in CLIC


THANK YOU!
ありがとうございます
Prezi