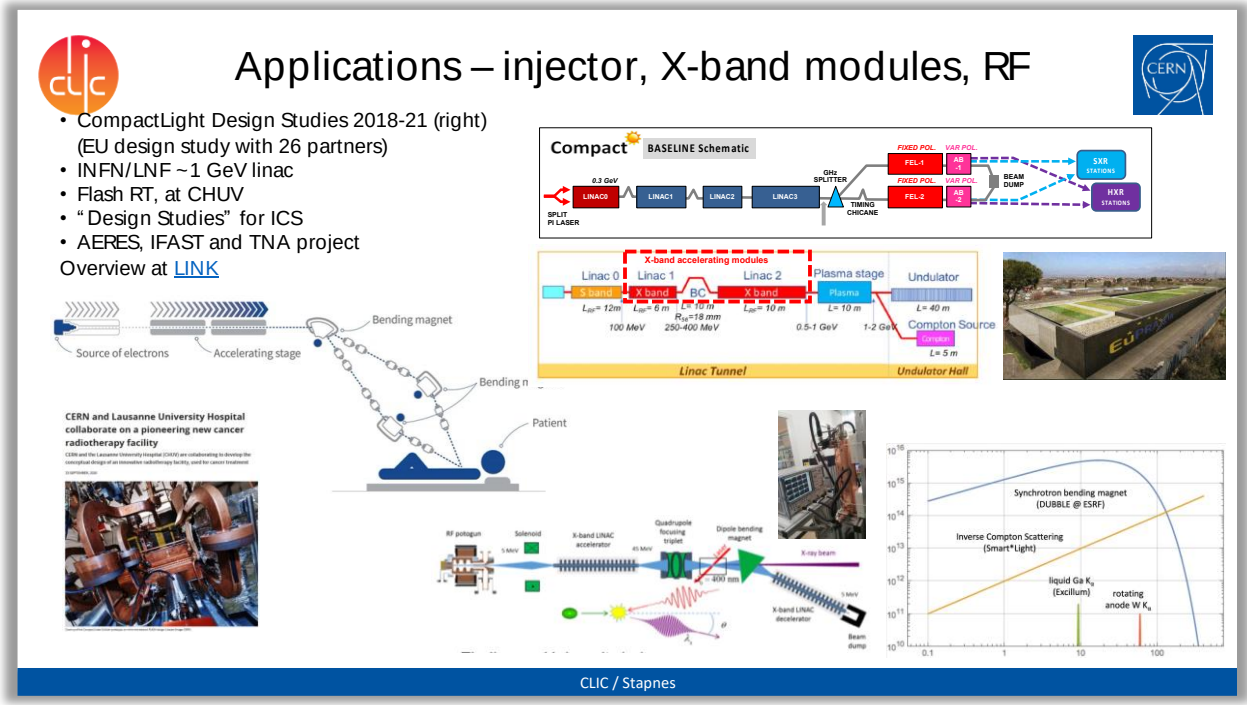
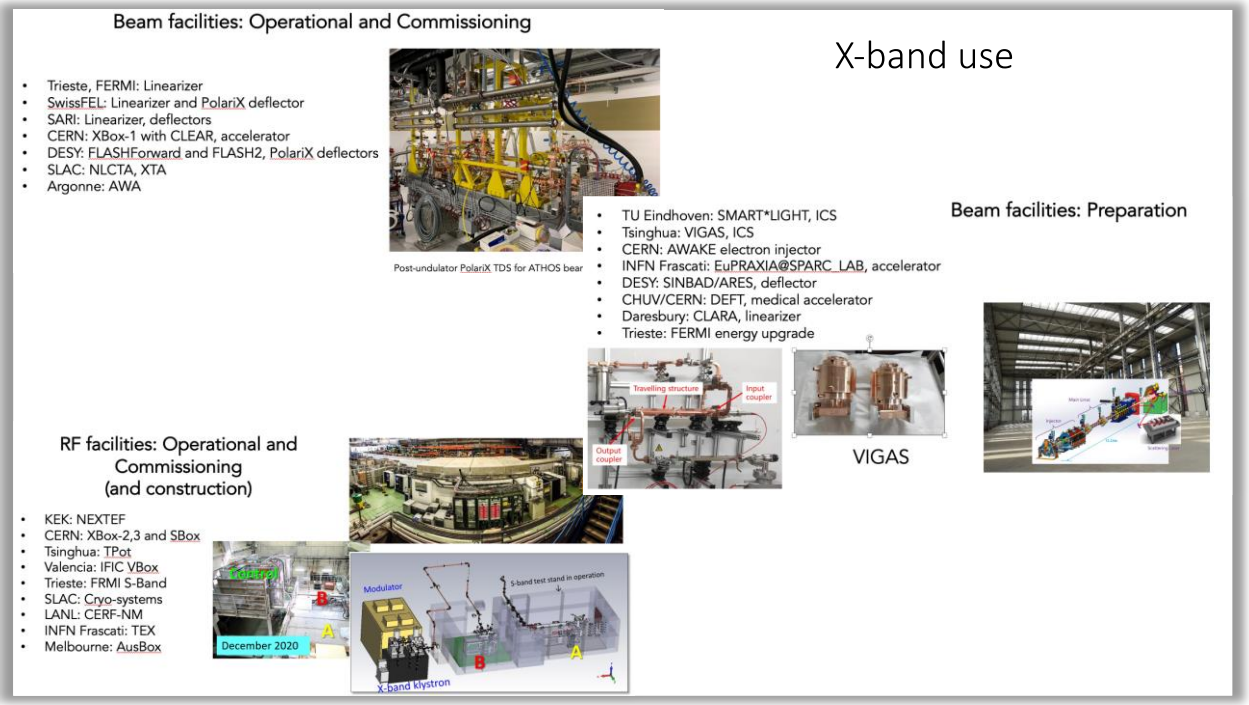
Collaboration

Fewer resources in the LC studies at CERN wrt 2012-18. High Efficiency Klystron project (Igor cover partly) and CLEAR (Pierre) are separate project with wide scopes, still benefitting the LC studies.
Many Xband project (examples today) in collaborating institutes.
EU projects. I will mention some but also Eurolab (CLEAR and Xboxes) and EAJADE (exchange with Americas and Japan)

Note, changes in fellowship programme (replaced by QUEST and Origin programmes):
https://careers.smartrecruiters.com/CERN/graduates

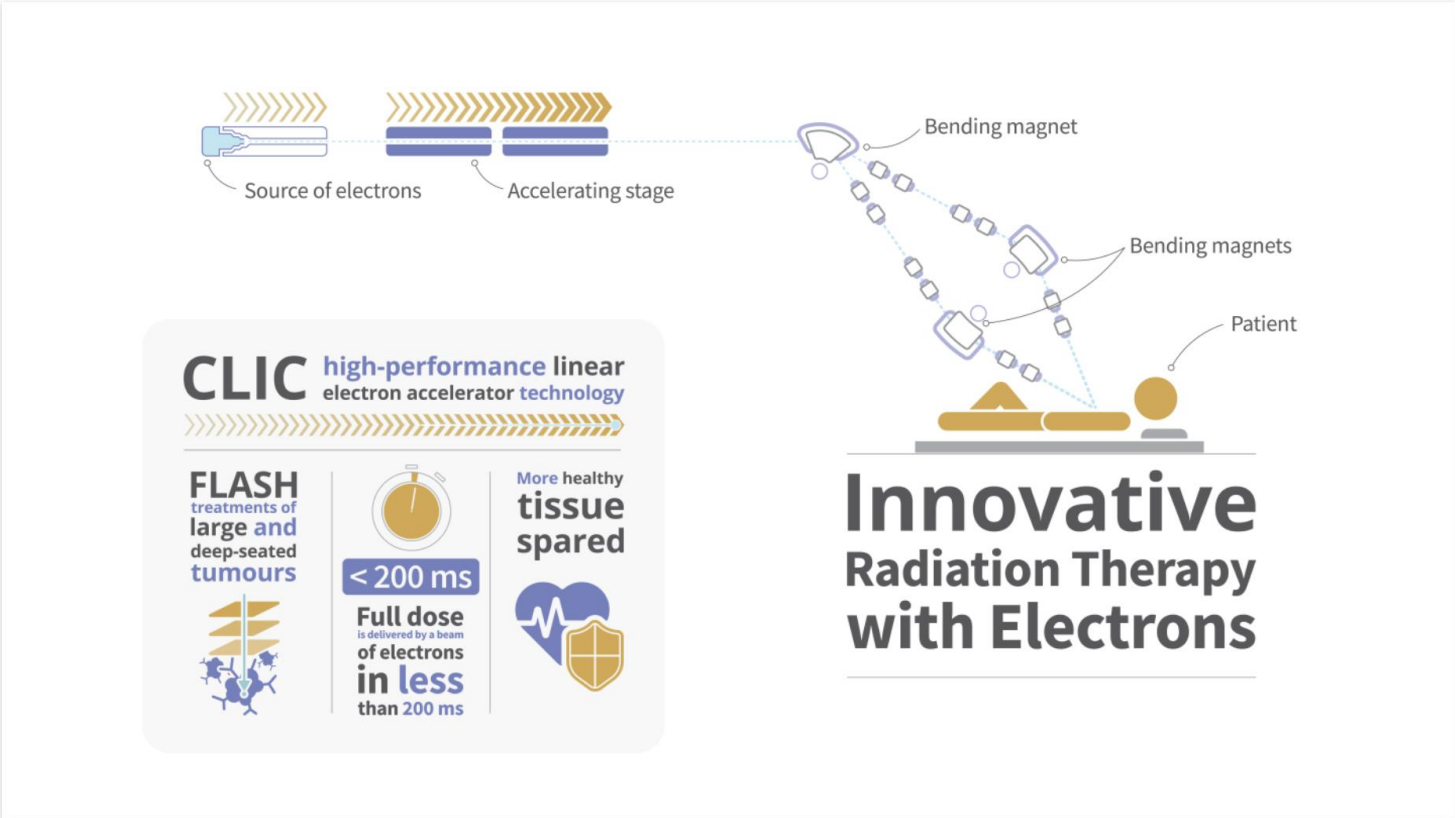




CERN, CHUV and THERYQ join forces for a world first in cancer radiotherapy

CERN, CHUV and THERYQ have signed an agreement for the development of a revolutionary FLASH radiotherapy device

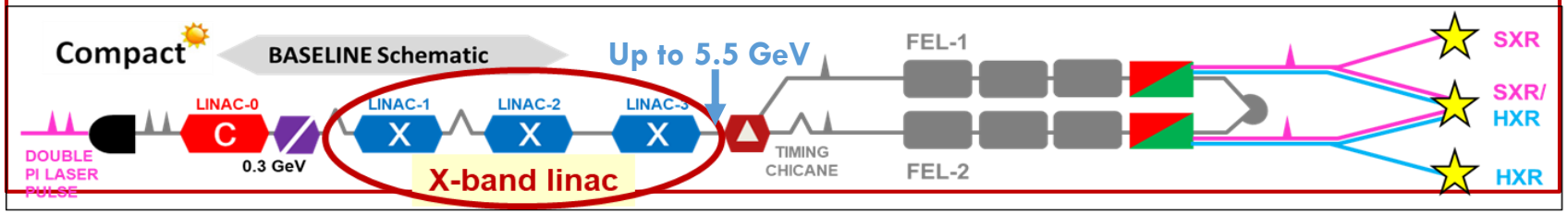
25 NOVEMBER, 2022



The schematic shows the concept of a new revolutionary VHEE FLASH radiotherapy device (Image: CERN)

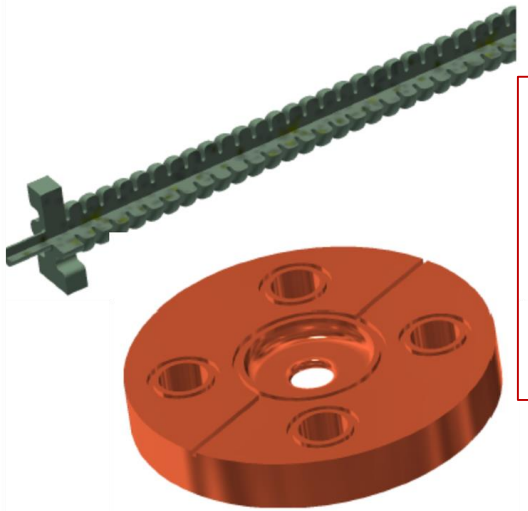
CompactLight (www.compactlight.eu)

A Horizon2020 design study for an innovative, compact and cost effective FEL user facility



Completed at the end of 2021

Parameter	Units	Value		
Frequency	GHz	11.994		
Peak klystron power (100 - 250 Hz)	MW	50		
Peak klystron power (1000 Hz)	MW	10		
RF pulse length (250 Hz)	μs	1.5 (0.15)		
Waveguide power attenuation	%	≈ 10		
Average iris radius a	mm	3.5		
Iris radius a	mm	4.3-2.7		
Iris thickness t	mm	2.0-2.24		
Structure length L_s	m	0.9		
Unloaded SLED Q-factor Q_0		180000		
External SLED Q-factor Q_E		23300		
Shunt impedance R	MΩ/m	85-111		
Peak modified Poynting vector	W/μm^2	3.4		
Group velocity v_g/c	%	4.7-0.9		
Filling time t_f	ns	146		
Repetition rate	Hz	100	250	1000
SLED		ON	OFF	ON
Required klystron power	MW	44	44	9
Average accelerating gradient	MV/m	65	30	30



Two prototypes are being built as part of the I.FAST project to get a full validation of the structure at two RF operating regimes:

i) high gradient/low p.r.r. (60 MV/m @100Hz)

ii) low gradient/high p.r.r. (30 MV/m up to 1KHz)

Task 7.5: CompactLight Prototype Accelerating Structures

Build and test, at low and high RF power, two prototypes of the X-band (12 GHz) accelerating structure designed for the CompactLight project

Two deliverables:

D7.5: Construction of the XLS accelerating structure pre-prototype.
Development of production process and RF tests of the pre-prototype (@TRL 6/7)_December 2023

D7.6: Construction of the XLS accelerating structure full prototype.
Production process analysis and validation, RF tests of the full prototype (@TRL 7)_April 2025

IFAST INNOVATION FUND

Result of projects selection

IIF – projects selected

Permanent magnet solenoid for High efficiency Klystron

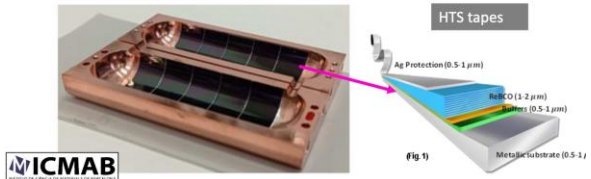
Aim is: to design and build a permanent magnet solenoid for an available klystron. By increasing efficiency of the klystrons, it promises to reduce the operational costs of any accelerator together with the associated carbon footprint.

Name	Institute	kEUR Budget beneficiary	kEUR Budget partner	Total
PM for klystron	CERN	15		115
	ELYTT	100		
HIGHEST	CERN	10		160
	CSIC		50	
	Ceraco		100	
FE cathode	PSI	*100*		200
	VDL	*100*		
KAIO	CNRS	180		200
	CNR	20		
SSPA driven CFA	UU	200		200
msec flash	INFN	40		160
	HZDR		110	
	Piccoli	10		
AM for ion source	INFN	75		100
	CERN	25		
AM vacuum chambers	RHP	75		100
	SBI		25	
TOTALS		**950**	**285**	**1235**

IIF – projects selected

High-Temperature High-Gradient Superconductors

Aim is: to to develop and optimize a 3D coating technology and demonstrate its scalability to make practical RF high power devices. It promises an improvement in Q factor resulting in relevant energy savings for accelerators



RADES cavity

Name	Institute	kEUR Budget beneficiary	kEUR Budget partner	Total
PM for klystron	CERN	15		115
	ELYTT	100		
HIGHEST	CERN	10		160
	CSIC		50	
	Ceraco		100	
FE cathode	PSI	*100*		200
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AM vacuum chambers	RHP	75		100
	SBI		25	
TOTALS		**950**	**285**	**1235**

CREATE proposal

Compact and **R**esource-**E**fficient **A**ccelerator **TE**chnologies

Horizon Europe Work Programme 2021-2022

INFRA-2022-TECH-01-01

Development of ground-breaking RI Technologies,….. including high tech developments for accelerators

Area of interest:

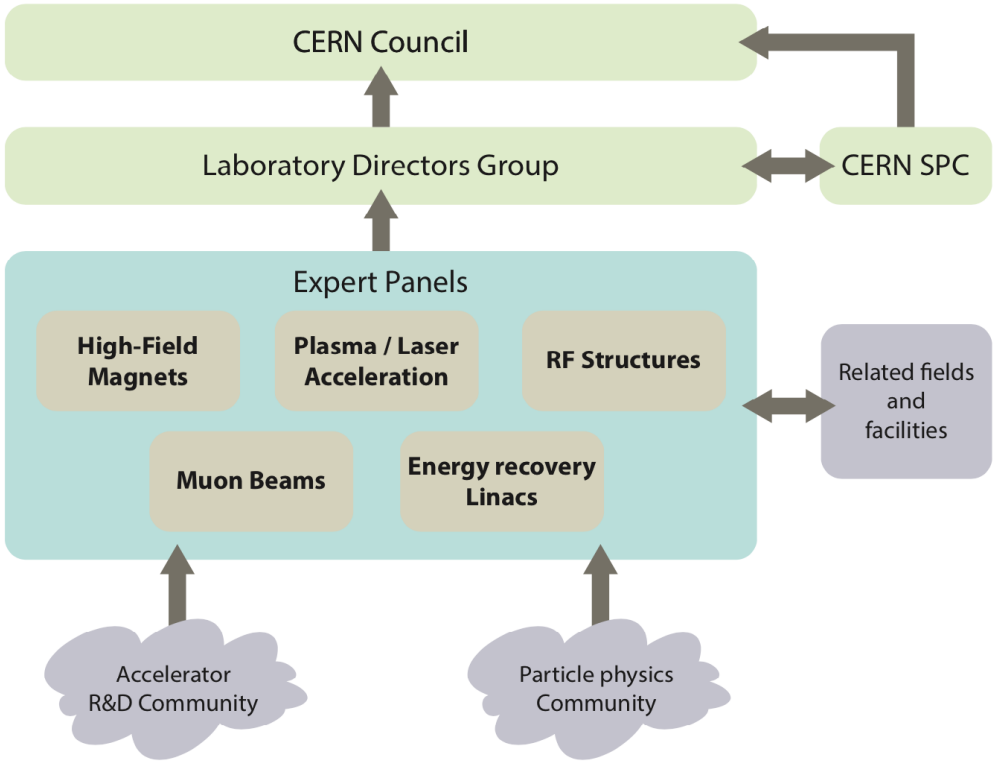
- **Compact & efficient X-band technology for accelerators**
- Compact & efficient plasma accelerators
- Efficient high repetition rate Laser drivers

Prototypes

High efficiency X-band klystron
+
High repetition rate modululator

CREATE received a favorable evaluation, but unfortunately not high enough in the ranking to be funded, given the budget limit of the call. For this reason, it has been put in a "reserve list" to be re-consider if additional funds become available after the completion of the Grant Agreements of the approved projects, beginning of 2023.

Following ESPP recommendation, accelerator roadmaps developed in Europe (with US participation) → approved by CERN's Council Dec. 2021

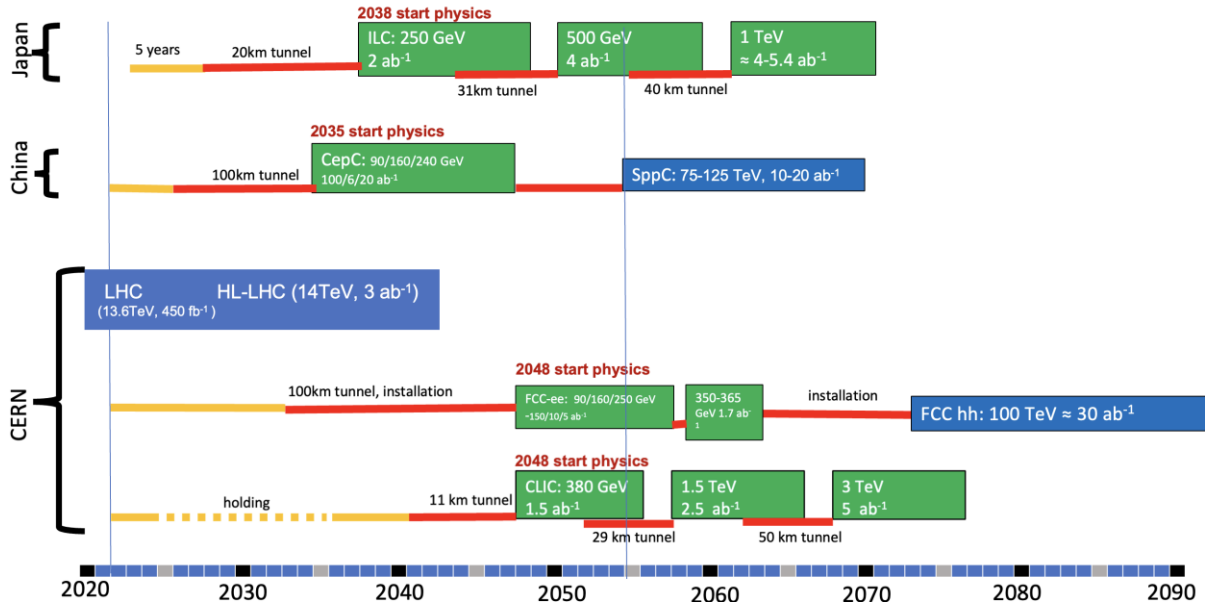


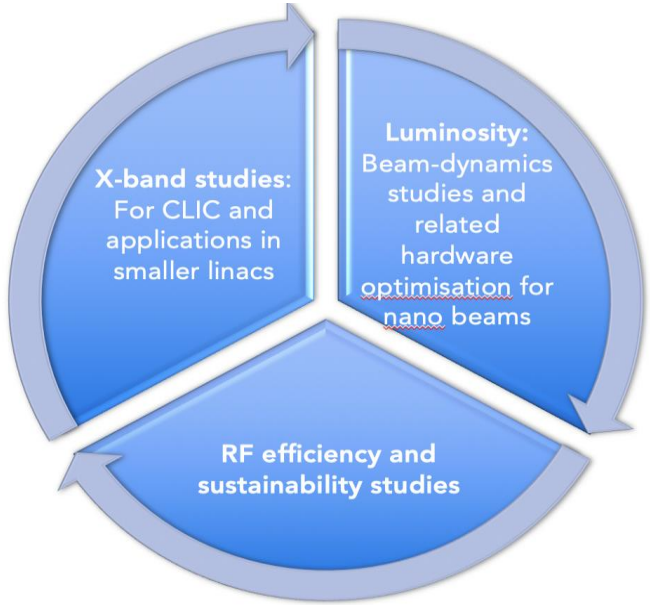
RF panel:

- NC RF, power sources, fundamental processes, test infrastructures, …
- Not clear how to can help the CLIC studies yet but potentially useful longer term

CLIC Project Readiness 2025-26

Project Readiness Report as a step toward a TDR – for next ESPP
Assuming ESPP in 2026, Project Approval ~ 2028, Project (tunnel) construction can start in ~ 2030.



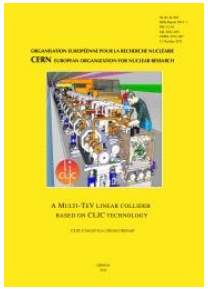
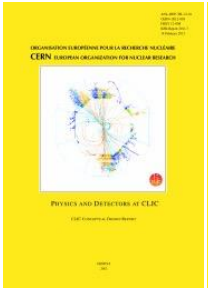
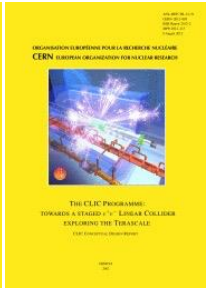


Focusing on:

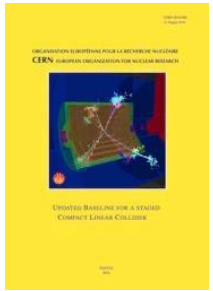
- The X-band technology readiness for the 380 GeV CLIC initial phase - very important part driven by use in small compact accelerators
- Optimizing the luminosity at 380 GeV – already implemented for Snowmass paper, further work to provide margins will continue
- Improving the power efficiency for both the initial phase and at high energies, including more general sustainability studies

Status reports and studies

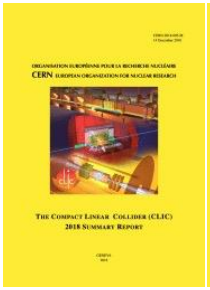
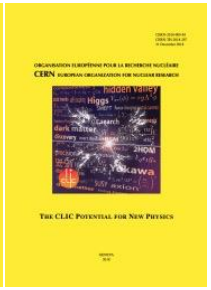
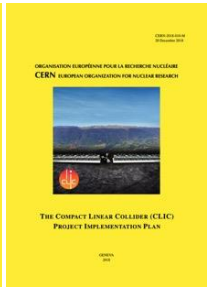
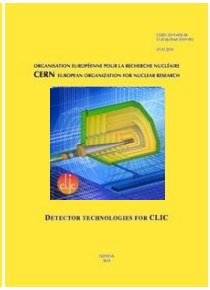
3-volume CDR 2012

Updated Staging Baseline 2016



4 CERN Yellow Reports 2018

Details about the accelerator, detector R&D, physics studies for Higgs/top and BSM

Available at:
clic.cern/european-strategy

Two formal submissions to the ESPPU 2018


Several LoIs have been submitted on behalf of CLIC and CLICdp to the Snowmass process:

- *The CLIC accelerator study: Link*
- *Beam-dynamics focused on very high energies: Link*
- *The physics potential: Link*
- *The detector: Link*

Snowmass white paper:
https://arxiv.org/abs/2203.09186

Broadly speaking: "Updated accelerator part of 2018 Summary Report"

The CLIC project

O. Brunner[a], P. N. Burrows[b], S. Calatroni[a], N. Catalan Lasheras[a], R. Corsini[a], G. D'Auria[c], S. Doebert[a], A. Faus-Golfe[d], A. Grudiev[a], A. Latina[a], T. Lefevre[a], G. Mcmonagle[a], J. Osborne[a], Y. Papaphilippou[a], A. Robson[e], C. Rossi[a], R. Ruber[f], D. Schulte[a], S. Stapnes[a,†], I. Syratchev[a], W. Wuensch[a]

[a]CERN, Geneva, Switzerland, [b]John Adams Institute, University of Oxford, United Kingdom, [c]Elettra Sincrotrone Trieste, Italy, [d]IJCLab, Orsay, France, [e]University of Glasgow, United Kingdom, [f]Uppsala University, Sweden

April 4, 2022

Abstract

The Compact Linear Collider (CLIC) is a multi-TeV high-luminosity linear e^+e^- collider under development by the CLIC accelerator collaboration, hosted by CERN. The CLIC accelerator has been optimised for three energy stages at centre-of-mass energies 380 GeV, 1.5 TeV and 3 TeV [21]. CLIC uses a novel two-beam acceleration technique, with normal-conducting accelerating structures operating in the range of 70 MV/m to 100 MV/m.

The report describes recent achievements in accelerator design, technology development, system tests and beam tests. Large-scale CLIC-specific beam tests have taken place, for example, at the CLIC Test Facility CTF3 at CERN [39], at the Accelerator Test Facility ATF2 at KEK [53, 67], at the FACET facility at SLAC [35] and at the FERMI facility in Trieste [36]. Crucial experience also emanates from the expanding field of Free Electron Laser (FEL) linacs and recent-generation light sources. Together, they demonstrate that all implications of the CLIC design parameters are well understood and reproducible in beam tests and prove that the CLIC performance goals are realistic. An alternative CLIC scenario for the first stage, where the accelerating structures are powered by X-band klystrons, is also under study. The implementation of CLIC near CERN has been investigated. Focusing on a staged approach starting at 380 GeV, this includes civil engineering aspects, electrical networks, cooling and ventilation, installation scheduling, transport, and safety aspects. All CLIC studies have put emphasis on optimising cost and energy efficiency, and the resulting power and cost estimates are reported. The report follows very closely the accelerator project description in the CLIC Summary Report for the European Particle Physics Strategy update 2018-19 [22].

Detailed studies of the physics potential and detector for CLIC, and R&D on detector technologies, have been carried out by the CLIC detector and physics (CLICdp) collaboration. CLIC provides excellent sensitivity to Beyond Standard Model physics, through direct searches and via a broad set of precision measurements of Standard Model processes, particularly in the Higgs and top-quark sectors. The physics potential at the three energy stages has been explored in detail [2, 3, 17] and presented in submissions to the European Strategy Update process.

Submitted to the Proceedings of the US Community Study on the Future of Particle Physics (Snowmass 2021)

[†]Compiled and edited by the CLIC Accelerator Steering Group on behalf of the CLIC Accelerator Collaboration, corresponding author: steinar.stapnes@cern.ch

CLIC Project Readiness 2025-26

Goals for the studies by ~2025, key improvements:

- Luminosity numbers, covering beam-dynamics, nanobeam, and positrons - at all energies. Performance risk reduction, system level studies
  - Substantial progress already documented in Snowmass report and associated references, remains a focus for beamdynamics, nanobeam related technical developments and positron production studies

- Energy/power: 380 GeV well underway, 3 TeV to be done, L-band klystrons
  - In Snowmass report for 380 GeV

- Sustainability issues, more work on running/energy models and carbon footprint
  - Initial studied in Project Implementation Plan (PiP) 2018, just referred to briefly in Snowmass report

- X-band progress – for CLIC, smaller machines, industry availability, including RF network
  - Addressed by establishing improved baseline, CompactLight Design Study very important and many smaller setup. No complete documentation in PiP 2018 or Snowmass report 2022.

- RF design optimization/development – including injectors, R&D for higher energies, gradient (cool/HTS/etc.), optimal beam parameters
  - Links to power, nanobeam and beamdynamics

- Cost update, only discuss changes wrt Project Implementation Plan in 2018
  - Possible impact of sustainability optimization, inflation ?

- Low cost klystron version – reoptimize for power, cost and fewer klystrons

- CLIC versus ILC and C3 (maybe not needed in readiness report) – performances and upgrade scenarios

CLIC towards Readiness Report 2025-26

Tuesday 8 Nov 2022, 11:00 → 13:00 Europe/Zurich

CERN

Videoconference CLIC Implementation Meeting: Design — Join

11:00 → 11:20 **CLIC readiness report 2025-26** — 20m

Main goals for the studies 2022-2025

Speaker: Steinar Stapnes (CERN)

intro-nov22.pdf intro-nov22.pptx

11:35 → 12:00 **CLIC power and RF design studies** — 25m

- brief about 380 numbers
- possible RF studies that can (or cannot) impact these, e.g. injectors, exotic options at multiTeV energies, etc
- later: updating the 3 TeV power estimates

Speaker: Alexej Grudiev (CERN)

CLICpoweranInject... CLICpoweranInject...

12:15 → 12:40 **CLIC beamdynamics studies, luminosity optimisation (TBC)** — 25m

Speaker: Andrii Pastushenko (CERN)

CLIC_meeting_08_... CLIC_meeting_08_...

12:55 → 13:00 **Next meeting - close** — 5m

- Project meeting with Xmas drink Wednesday December 7th 1330-1730

CLIC Project Meeting #43

Wednesday 7 Dec 2022, 13:30 → 19:30 Europe/Zurich

60/6-015 - Room Georges Charpak (Room F) (CERN)

Videoconference

CLIC Project Meeting #43 — Join — 60/6-015

13:30 → 13:40	**Introductions, goals for 2025**	10m	60/6-015 - Room Georges Cha...
	Speaker: Steinar Stapnes (CERN)		
13:45 → 14:00	**Report from Melbourne**	15m	60/6-015 - Room Georges Cha...
	Speaker: Matteo Volpi (University of Melbourne (AU))		
14:05 → 14:20	**INFN/LNF update**	15m	60/6-015 - Room Georges Cha...
	Speaker: Dr Fabio Cardelli		
14:25 → 14:40	**SmartLight Eindhoven**	15m	60/6-015 - Room Georges Cha...
	Speaker: Otger Jan Luiten		
14:45 → 15:00	**ATF plans and opportunities**	15m	60/6-015 - Room Georges Cha...
	Speaker: Dr Angeles Faus-Golfe (IJClab IN2P3 CNRS-Université Paris-Saclay (FR))		
15:05 → 15:20	**Sustainability studies for CLIC and ILC**	15m	60/6-015 - Room Georges Cha...
	Speaker: Dr Benno List (Deutsches Elektronen-Synchrotron (DE))		
15:25 → 15:45	**Coffee Break**	20m	60/6-015 - Room Georges Cha...
15:45 → 16:00	**CERN X-box/band update**	15m	60/6-015 - Room Georges Cha...
	Speaker: Marçà Boronat (CERN)		
16:05 → 16:20	**High Efficiency klystron update**	15m	60/6-015 - Room Georges Cha...
	Speaker: Igor Syratchev (CERN)		
16:25 → 16:40	**CLEAR report and plans**	15m	60/6-015 - Room Georges Cha...
	Speaker: Pierre Korysko (University of Oxford (GB))		
16:45 → 17:00	**HTS coated acc. structures**	15m	60/6-015 - Room Georges Cha...
	Speaker: Sergio Calatroni (CERN)		
17:05 → 17:20	**C^3 studies**	15m	60/6-015 - Room Georges Cha...
	Speaker: Emilio Nanni		
17:25 → 17:30	**AOB and close**	5m	60/6-015 - Room Georges Cha...
17:30 → 19:00	**CLIC Christmas Drink**	1h 30m	500/1-201 - Mezzanine

25th CLIC Collaboration Board

Wednesday 7 Dec 2022, 11:00 → 12:00 Europe/Zurich

4/S-030 (CERN)

Gerardo D'Auria (Elettra Trieste) , Gerardo D'Auria (Elettra Trieste) , Gerardo D'Auria

Videoconference

25th CLIC Collaboration Board — Join — 4/S-030

11:00 → 11:05 Welcome — 5m

- Approval of the minutes of last meeting
- Approval of the agenda

11:05 → 11:10 Collaboration Issues and Status — 5m

- Collaboration status
- EU projects

Speaker: Steinar Stapnes (CERN)

11:10 → 11:25 Recent achievements and plans towards 2025-26 — 15m

- Brief highlights from prev. years
- X-band technology applications and spread
- Goals for 2025
- Connection to LDG roadmap activities and other projects (ILC and C3)

Speaker: Steinar Stapnes (CERN)

11:30 → 11:55 Collaboration updates. Around the table, news and relevant updates from collaborating institutes — 25m

- orally or one slide

Speaker: - all

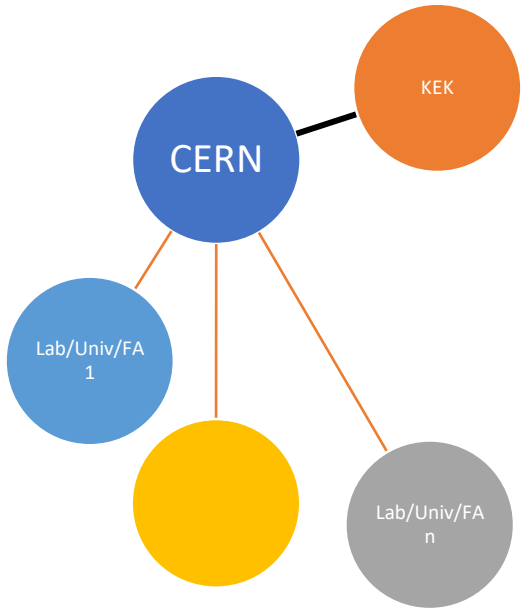
11:55 → 12:00 Next CB meeting, option of CLIC days in autumn 2023, AOB and close — 5m

2023

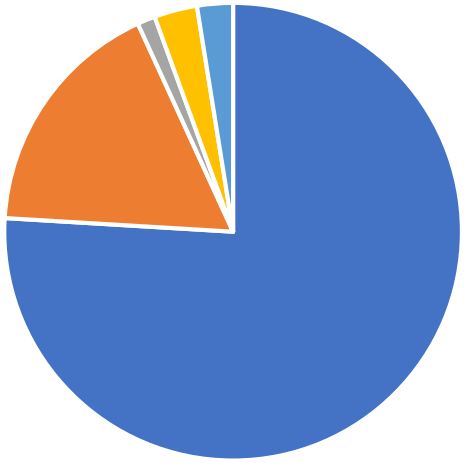
Next CLIC Project Meeting in April
2-3 days meeting in Sept/Oct including CB

European Organisation of an ILC programme

- Focus on priority and time-critical WPs for ILC (2-4 years) – ITN (ILC Technology Network)
- CERN plays coordinating role
- KEK contribution to the material cost is essential
- Main contract for flow of funds between CERN and KEK*
  - CERN-KEK ILC IDT agreement already extended by 2 years
  - Amendments/modifications would be needed for ITN
- Subsequent contracts* – similar to what is done for other studies for future colliders – between CERN and European Labs in the cases where money flow is needed (limited number)
- Establish a distributed Project Office, administratively anchored to CERN, to follow up the work.
- Aim to involve CERN personnel, fellows, PJAS within the current LC resource planning at CERN (in many cases using long term collaborative links and common studies between CLIC and ILC)



Materials ~4 MCHF



*Additional collaboration agreements between KEK and FA/countries might be very beneficially, where these activities are recognised directly

The European activities, and resources

European presentation of ILC studies, distributed on five main activity areas:

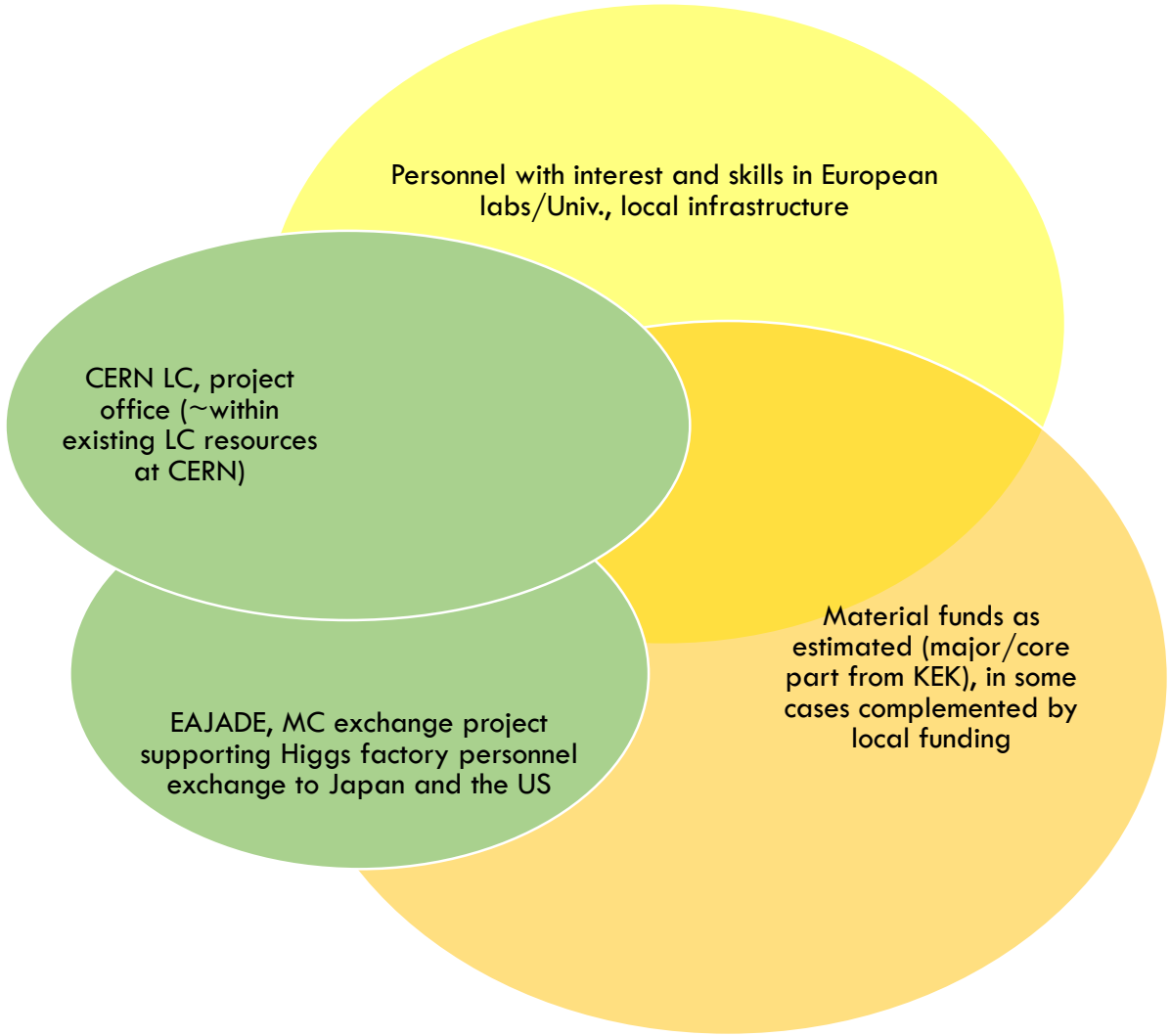
A1 with three SC RF related tasks
- SRF: Cavities, Module, Crab-cavities
- Might want to split into 3 separate WPs

A2 Sources
- Concentrate on undulator positron scheme, consult on conventual one (used by CLIC and FCC-ee)

A3 Damping Ring including kickers
- Low Emittance Ring community

A4 ATF activities for final focus and nanobeams
- Groups active in ATF (including new ones)

A5 Implementation including Project Office
- Dump, CE, Cryo, Sustainability, MDI, others (many of these are continuations of on-going collaborative activities)



EAJADE: Information at LINK