CLIC 2020-25

ALCWS Fukuoka

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on behalf of the CLIC accelerator collaboration

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

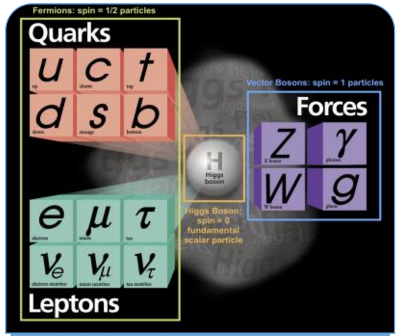
A TDR for CLIC by 2025*

- The CLIC Project Implementation Plan being prepared for the 2019-20 European Strategy Update
- Among the documents prepared are overviews of the collaboration’s plans for next period – the CLIC Preparation Phase 2020-2025*
  - Such overviews are very important for the European Strategy Update and for planning at CERN
  - The collaborative partners plans in the same period are equally crucial – for making a coherent programme for developing “CLIC technologies”

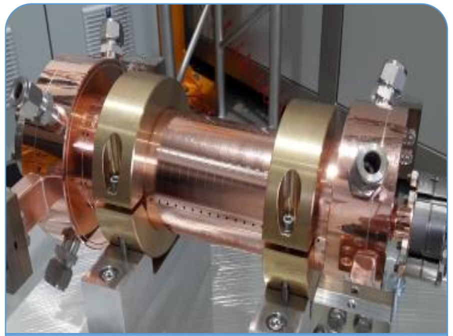
- During 2020-2025* - Towards a CLIC Technical Design Report (TDR)
  - What is needed for a CLIC TDR ?
  - How can we optimize the programme linking to other technology related projects ?

*We have used 2020-26 in our internal budget planning (7 years)

The CLIC project

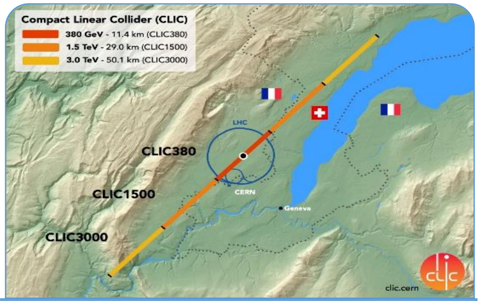


Physics case



Technical implementation and solutions

Organization and community



Industrial basis and future flexibility

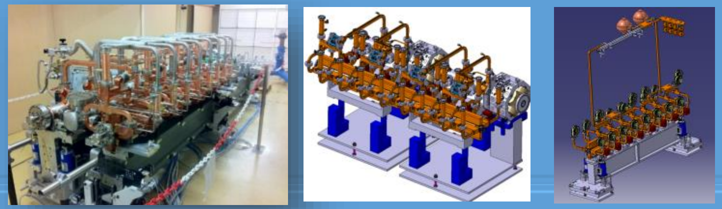
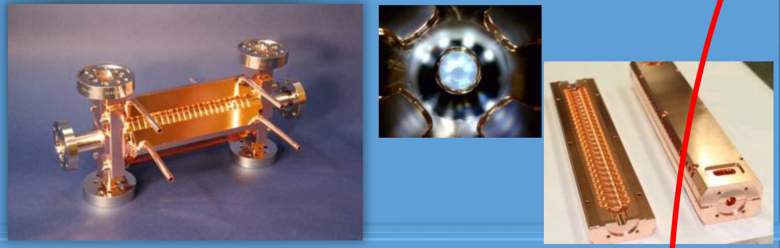
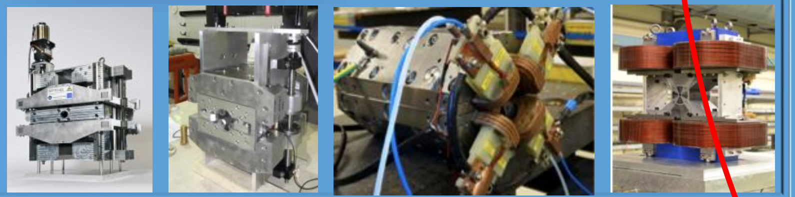
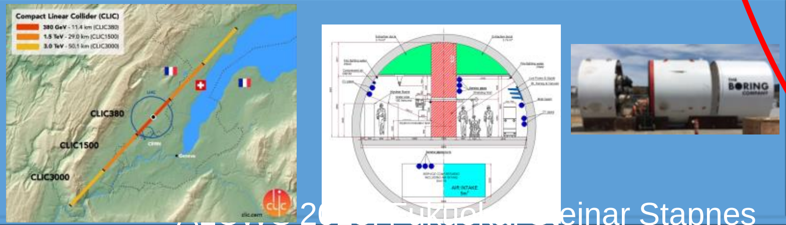
For any next machine the largest challenges are the cost and timescales/size involved ….

Key activities for a CLIC TDR in the Preparation Phase will be:

1. Prepare technically for industrial production (examples for cost and power drivers on next slide)
2. Pursue large systems tests (not necessarily at CERN)
3. Final design/parameters, cost/power, schedules, CE/site/infrastructure

Detector and Physics studies not covered

Key technical activities

Now:		Next:
Module (drive-beam, klystron type) baseline		Final modules, from revised designs to industrial modules
Optimized structures and RF components		Finalize industrial structures: increase manufacturability, brazed, halves, conditioning. Use/maintain/operate existing test-stands for testing
High efficiency klystrons and modulators		Efficiency and costs improvements, significant gains possible for efficiency, industrial cost-models and optimization
Magnets design and prototypes		Permanent magnets, longit. variable magnets -> industrial production and cost-optimisation
Civil engineering, infrastructure		Detailed site layout and CE/infrastructure designs

Industrial considerations (example)

Bodycote (FR)
Reuter (DE)
TMD (UK)

SWISSto12 (CH)
3T RPD (UK)
Concept Laser (DE)
INITIAL (FR)
Protoshop (DE)

VDL (NL)
LT-Ultra (DE)
Yvon Boyer (FR)
DMP (ES)
Morikawa (JP)
KERN (DE)

Thermocompact (FR)
BACMI (FR)
Multivalent (NL)

CINEL (IT)
VDL (NL)
BACMI (FR)
CECOM(IT)
Reuter (DE)
Nihon (JP)
COMEB (IT)
Viztrotech (KR)

Thales (FR)
CPI(US)
Toshiba (JP)

Scandinova (SE)
Jema (ES)
Picatron (CH)

General overview (N.Catalan)

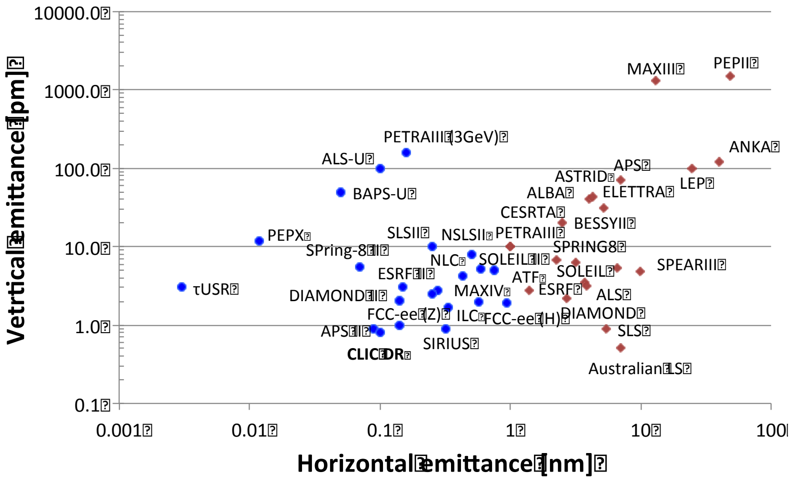
Next phase:

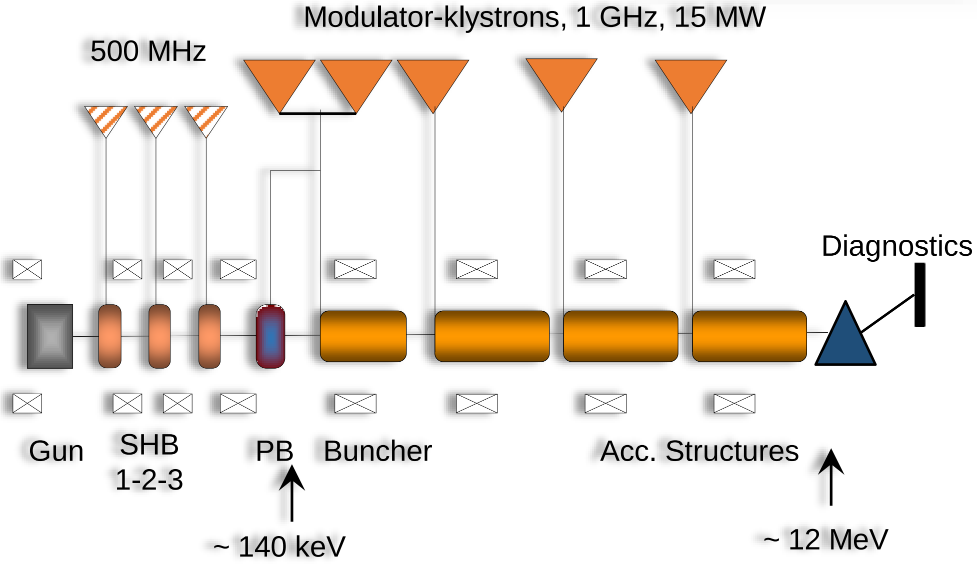
- Qualified companies, technical and commercial documentation, reliable costs (i.e. not first prototype), ideally (small) part of larger market

System tests

Light sources, FACET/FELs for emittance conservation, Final Focus studies (ATF2), Drive-beam Front End facility at CERN

Two examples:



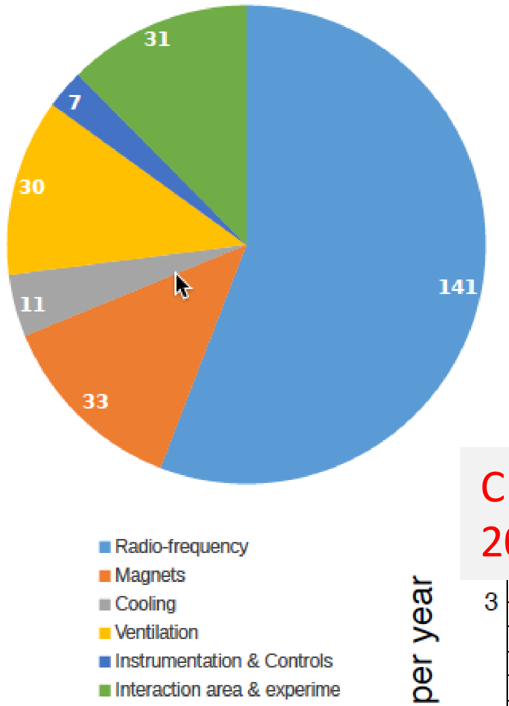


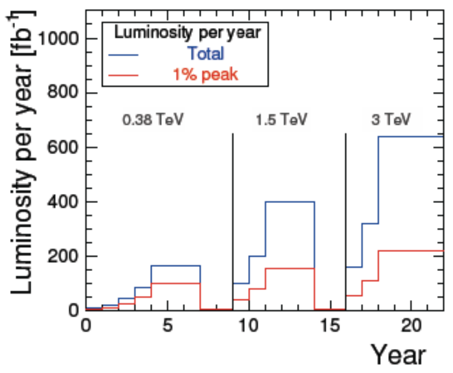
[Summary of design and performances: Daniel Schulte]

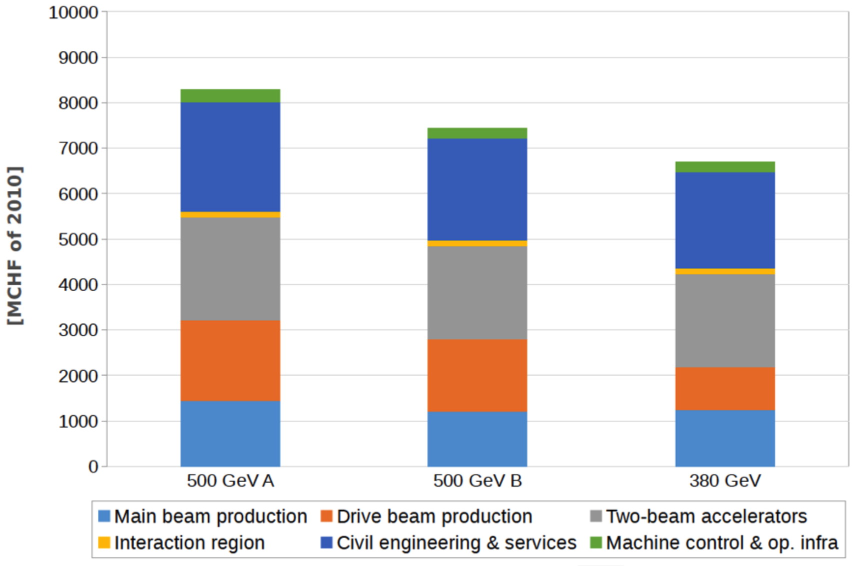
Cost and Power

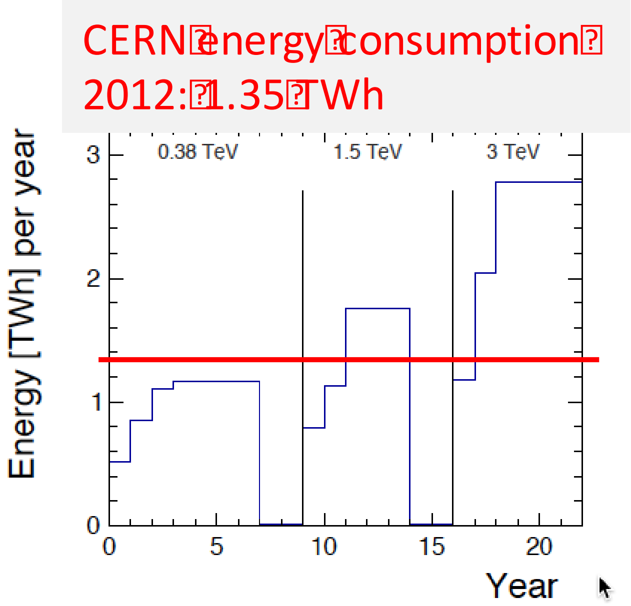
Table 11: Value estimate of CLIC at 380 GeV centre-of-mass energy.

	Value [MCHF of December 2010]
Main beam production	1245
Drive beam production	974
Two-beam accelerators	2038
Interaction region	132
Civil engineering & services	2112
Accelerator control & operational infrastructure	216
Total	6690









A cost of ~6 BCHF and power ~200 MW are “reasonable” values
→ Focus TDR work on modules, RF and CE for costs; for power RF and magnets

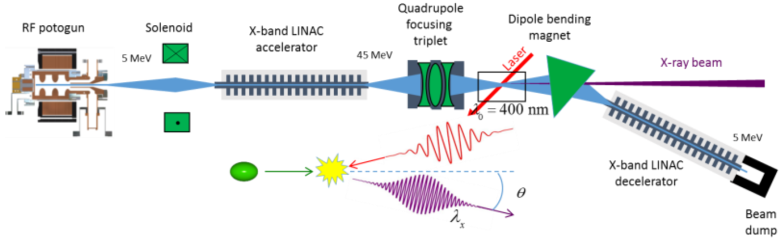
Collaboration

Today the CLIC project preparation is a very collaborative effort

In next phase the potential is even larger:

- Increasing use of X-band technologies in other projects
- XFEL Design Study
- Additionally: Medical applications (proton and very high energy electron therapy)

INFN Frascati advanced acceleration facility
EuPARXIA@SPARC_LAB



Eindhoven University led
SMART*LIGHT Compton Source

Status of applications

X-band technology

Eindhoven	Compact Compton source – 100 MeV	6 MW	Design and procurement
CERN	CLEAR – 50 MeV (from Xbox-1)	50 MW	Design and preparation
Frascati	XFEL, injector to plasma - 1 GeV	4(8)x50 MW	CDR
Collaboration	CompactLight – 6 GeV		Design Study
CERN	LDMX – 3.5 GeV	24x50 MW	Proposal under discussion
Groningen	1.4 GEV XFEL Accelerator 1.4 GeV		NL roadmap
CERN	CLIC – 380 GeV	5000x50 MW	CDR

CERN	XBox-1	50 MW, 12 GHz	Operational (later to CLEAR)
	Xbox-2	50 MW, 12 GHz	Operational
	XBox-3	4x6 MW, 12 GHz	Operational
KEK	NEXTEF	2x50 MW	Operational
Tsinghua	Later energy upgrade for Compton	50 MW, 12 GHz	Commissioning
Trieste	CTF	45 MW, 3 GHz	Operational
Valencia		2x10 MW, 3 GHz	Commissioning
Frascati		50 MW, 12 GHz	Procurement
Shanghai		50 MW, 12 GHz	Procurement
Melbourne, ALS		2x6 MW, 12 GHz	Proposal submission
SLAC	NLCTA		Operational (I think)

Trieste	Linearizer for Fermi	50 MW	Operational
PSI	Linearizer for SwissFEL	50 MW	Operational
	Deflector for SwissFEL	50 MW	Design and procurement
DESY	Deflector for FLASHforward	6 MW	Design and procurement
	Deflector for FLASH2	6 MW	Design and procurement
	Deflector for Sinbad	tbd	Planning
SINAP	Linearizer for soft X-ray FEL	6 MW	Operational
	Deflectors for soft X-ray FEL	2x50 MW	Procurement
Daresbury	Linearizer	6 MW	Design and procurement
Tsinghua	Linearizer for Compton source	6 MW	Planning
SLAC	LCWS linearizer		Operational
	LCWS deflector	50 MW	Operational

Beyond being a collaboration for CLIC, many groups have their own X-band facilities and components (see overview)

Left: EU Design Study for X-Band FELs 2018-2020: http://compact-light.web.cern.ch

In the CLIC preparation phase:
Take advantage of the widespread use of electron linacs, and rapidly increasing use of X-band → increase collaboration

Preparation Phase planning

The main activities needed for a TDR are quite clear, keywords: costs/power, industrial activities, final parameters, site preparation, detector and physics studies

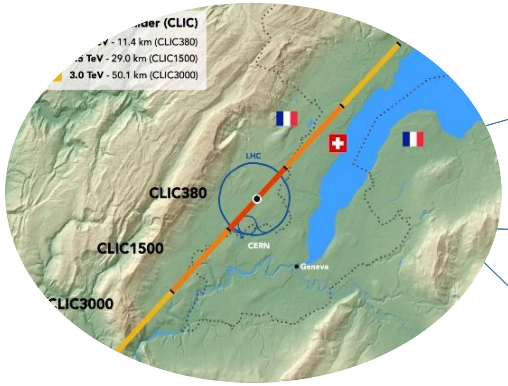
Concerns: Drive-beam facility, ATF2 or similar, resources

The way forward depends very strongly on the collaboration – for each item/study needed for the TDR: Combine CERN resources, collaboration activities, industrial interests and educational programmes

Examples:

- Klystron modules – if done for FEL projects outside CERN the CERN efforts can be less
- Permanent magnets – if industry interested (for use outside CLIC), or other projects use on a short timescale, we need to participate and not carry such a programme
- If a country would like to establish a training or exchange programme with CERN for electron linacs/X-band we will put into the planning matching funds
- Network of X-band testing facilities – rely strongly on activities outside CERN

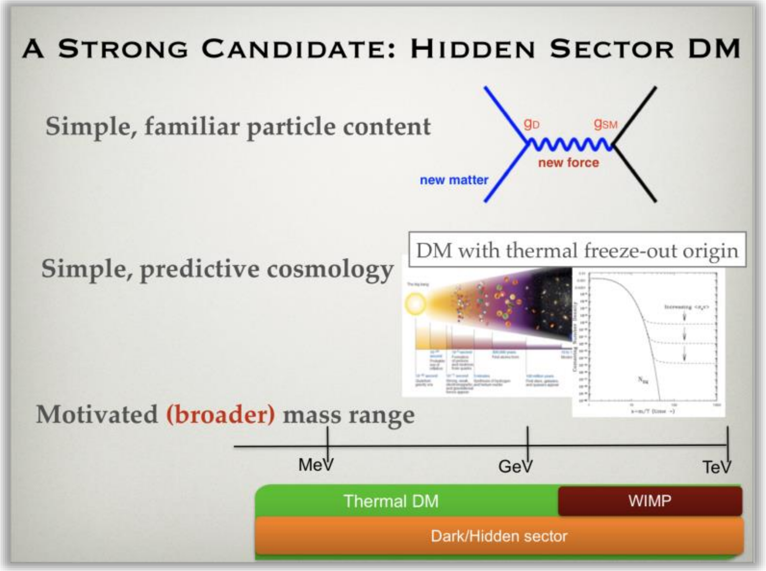
  - need to be creative -

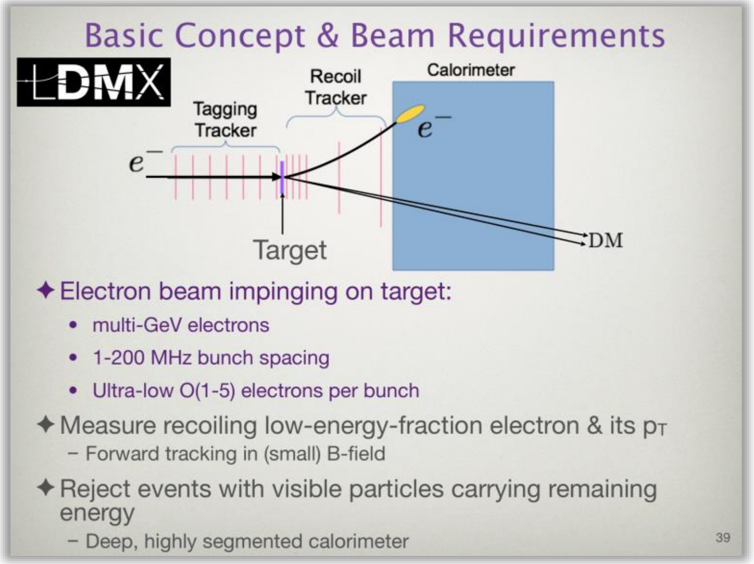


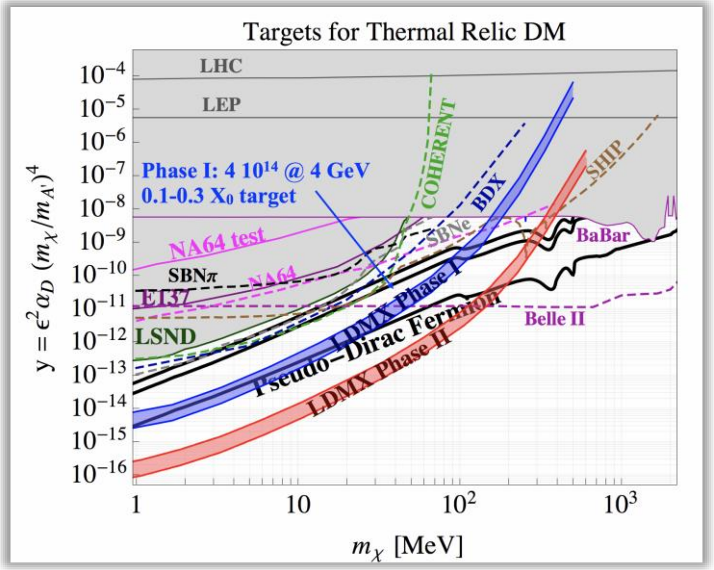
The CLIC studies are CERN hosted

- Creating matrix with key partner contributions 2020-25
- ILO overview of technologies

Physics with e-beams, example LDMX





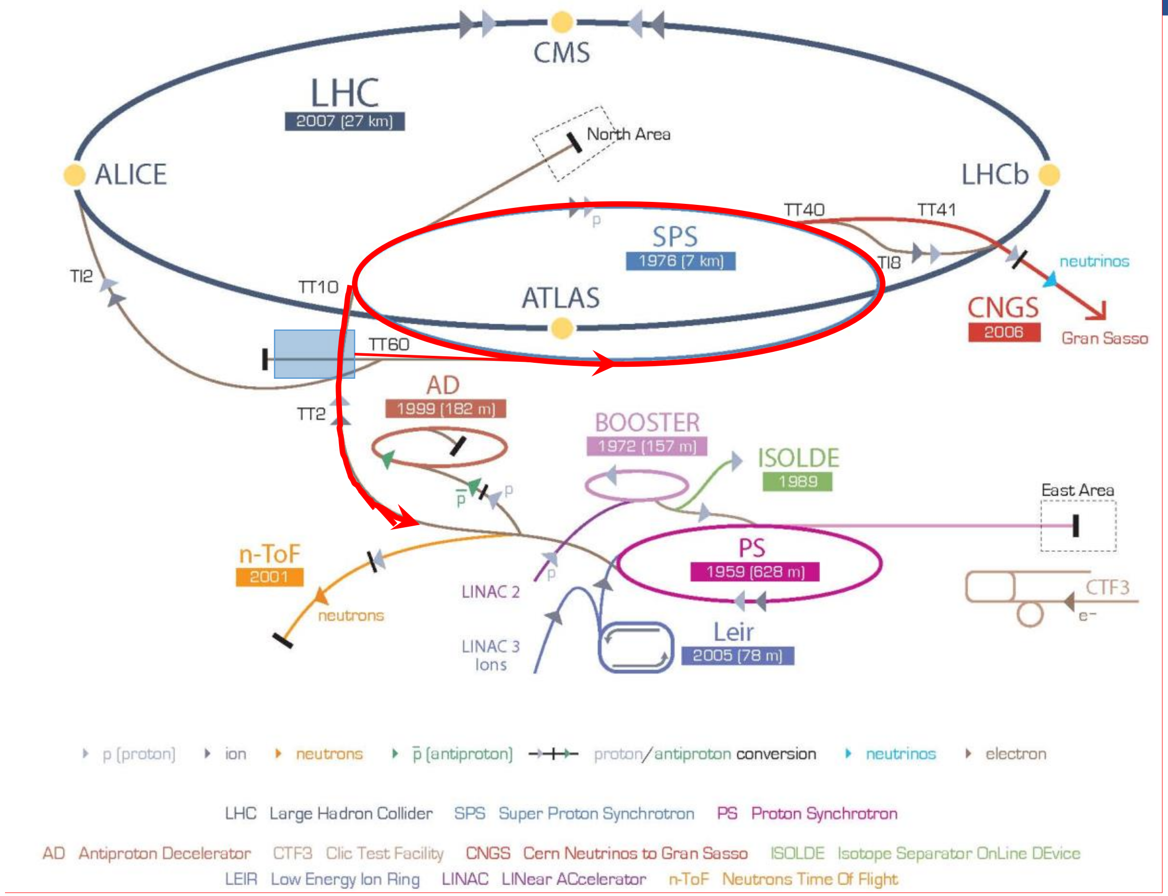


[Talk by P. Schuster](#)
“Physics Beyond Colliders” Nov 21, 2017

X-band linac at CERN in next phase ?

Accelerator implementation at CERN of LDMX type of beam (Physics Beyond Colliders)

X-band based 70m LINAC to ~3.5 GeV in TT4-5:
- Fill the SPS in 1-2s (bunches 5ns apart) via TT60
- Accelerate to ~16 GeV in the SPS
- Slow extraction to experiment in 10s as part of the SPS super-cycle
- Experiment(s) considered by bringing beam back on Meyrin site using TT10



Beyond LDMX type of beam, other physics experiments considered (for example heavy photon searches)

Acc. R&D interests: Overlaps with CLIC next phase (klystron based), FEL linac modules, e-beams for plasma, medical/irradiation/detector-tests/training, impedance measurements, instrumentation. positrons and damping ring R&D

While being strategized

Look at common areas in all scenarios – consider key topics or facilities 2019-2023

Cover all existing **existing** agreements with (INFN, UK, Spain, etc) that go into 2020, it also covers CompactLight obligations, ARIES transnational access, LCC

Also consider the key developments needed for eSPS

Wait and see budget 2019-2023
LC design team
Nanobeams and related system tests ATF, DR, etc
CLEAR
High Eff Klystrons/modulator and test-areas, module
Xbox operation and test-structures
Gun and positron studies (AWAKE, CLEAR, Compact Light, eSPS)

From the CLIC workshop end January – 230 participant

Summary:

Previous talk: The CLIC collaboration is on track to present a Project Implementation Plan and provide input to the European Strategy Update:

- 380 GeV drivebeam baseline, klystron option, both upgradeable in stages to 3 TeV

This talk: Plans for next period 2020-2025 will be a part of ESU documentation – a collaborative plan with focus on industrial pre-series including agreements with main collaboration partners where X-band projects, or other core technologies, are put into use in the same timeframe

Current planning for the phase 2019-2023 focusing on minimum "must do"

Construction can start ~2025+ with completion ~2035