CLIC programme 2013-2018

- Guidelines and overall goals
- Main activities as re-defined this summer
- Summary and conclusions

Guidelines and overall goals

Goal for next strategy update (2018): Present a CLIC project that is a "credible" option for CERN beyond 2030:

- Physics studies updated taking into account LHC-14 TeV (assume the physics case will be there for an energy frontier machine – i.e. not only the Higgs)
- Physics after LHC programme completion (2030 +)
- Initial costs at around LHC+50% for project construction
- Upgradable in 2-3 stages over a 20-30y period, without major (max 3-4 years) operational breaks, and with upgrade costs contained to 3-5 B/10 years as "determined" by CERN budget when personnel and operation are accounted for

Report at end of next period:

- Documentation according to WBS, EDMS, CDD: documents, drawings, specifications, tender documents, supplier DBs, reports, etc
- Overall project implementation summary report as necessary for the next Strategy Process (do not specify today, and do not invent a report type today – try to avoid CDR size report as last year

Process	VLHC	CLIC	
	200 TeV	3 TeV	5 TeV
squarks	15	1.5	2.5
sleptons		1.5	2.5
Z'	30	20	30
q^*	70	3	5
l^*		3	5
Extra two dimensions	65	20 – 33	30 – 55
$W_L W_L$	30σ	70σ	90σ
TGC (95%)	0.0003	0.00013	0.00008
Λ compos.	130	300	400

In general: need to be co-ordinated with similar "reports/information" and preparation for a possible hadron option, common work in several areas (see later)

Main activities and goals for 2018

Design and Implementation studies:

- Baseline design and staging strategy
- Solid cost basis and more optimized power/energy (aim for 20% energy reduction)
- Proof of industry basis for key components/units, in particular those specific for CLIC
- Comprehensive reliability/robustness/uptime analysis
- Pursue increased use of X-band for other machines/applications (hard to set concrete goal)
- CDR status: not optimized except at 3 TeV and not adjusted for Higgs discovery, not optimized cost, first power/energy estimates without time for reductions, limited industrial costing, very limited reliability studies

System-tests:

- Complete system-tests foreseen for next phase, and comprehensive documentation of the results at CERN (CTF3) and elsewhere
- Strategy for further system verification before construction (XFEL, connected to light-sources, further drive-beam verifications) or as part of initial machine strategy.
- CDR status: CTF3 results initial phase (as of early 2012), ATF and FACET very little, no convincing strategy for further system verification
- Demonstrator of drive beam FE and RF power unit based on industrial capacity – will open for larger facilities beyond 2018 if necessary
- CDR status: Nothing done beyond CTF3

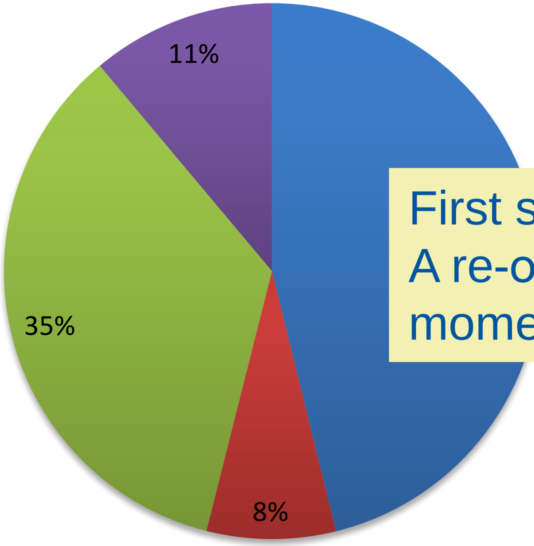
X-band developments:

- Statistics for gradient and structure choice (energy reach) and other X-band elements
- CDR status: Single elements demonstrated – limited by test-capacity

Technology developments:

- Demonstration of critical elements and methods for the machine performance:
  - ✓ DR, main linac, BDS with associated instrumentation and correction methods (combination of design, simulation, system-tests and technologies)
  - ✓ Stability/alignment (locally and over distances)
  - ✓ Module including all parts
- CDR status: alignment/stability partly covered, BBA assumed, wakefield mon. perf. assumed, no complete module

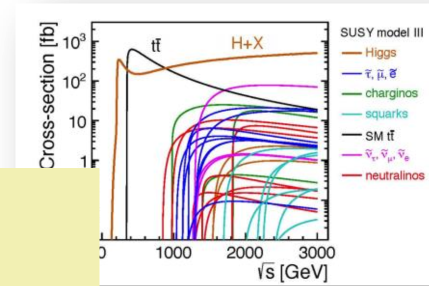
Design and Implementation (9% of overall resources)



- Design, Machine Prot, MDI - covers all areas of the machine, overall design and tools - and documentation, costs mainly students

- qualification of industries. Cost driver for project. Basis for ind. prod.

- Power/cost/schedules/WBS - basis for project implementation and documentation



First step:
A re-optimized machine, see Daniel's talk in a moment

Collaborators: CERN, Ankara, Australia, Novosibirsk, Cornell, Valencia, Frascati, IHEP, JAI, LAL, LAPP, Oslo, RHUL, SYMME, Catalonia, KIT, NIKHEF, EPFL, Aarhus, Shandong, Uppsala

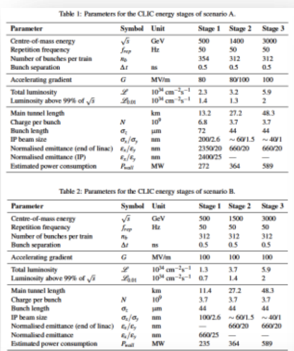
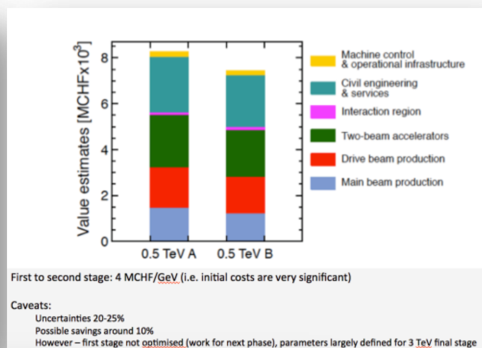


Table 1: Parameters for the CLIC energy stages of scenario A.

Parameter	Symbol	Unit	Stage 1	Stage 2	Stage 3
Centre-of-mass energy	$\sqrt{s}$	GeV	500	1400	3000
Repetition frequency	f_{rep}	Hz	50	50	50
Number of bunches per train	n_b		354	312	312
Bunch separation	Δt	ns	0.5	0.5	0.5
Accelerating gradient	G	MV/m	80	80/100	100
Total luminosity	$\mathscr{L}$	10^{34} cm^{-2}s^{-1}	2.3	3.2	5.9
Luminosity above 99% of $\sqrt{s}$	$\mathscr{L}_{0.01}$	10^{34} cm^{-2}s^{-1}	1.4	1.3	2
Main tunnel length		km	13.2	27.2	48.3
Charge per bunch	N	10^9	6.8	3.7	3.7
Bunch length	σ_z	µm	72	44	44
IP beam size	σ_x/σ_y	nm	200/2.6	~ 60/1.5	~ 40/1
Normalised emittance (end of linac)	ϵ_x/ϵ_y	nm	2350/20	660/20	660/20
Normalised emittance (IP)	ϵ_x/ϵ_y	nm	2400/25	—	—
Estimated power consumption	P_{wall}	MW	272	364	589

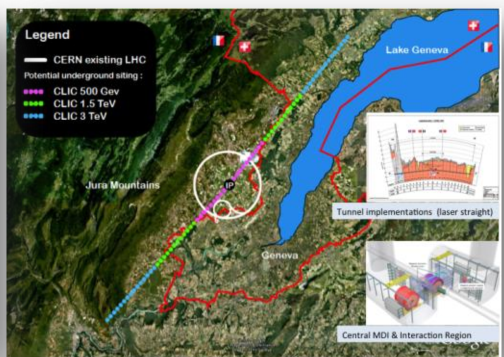
Table 2: Parameters for the CLIC energy stages of scenario B.

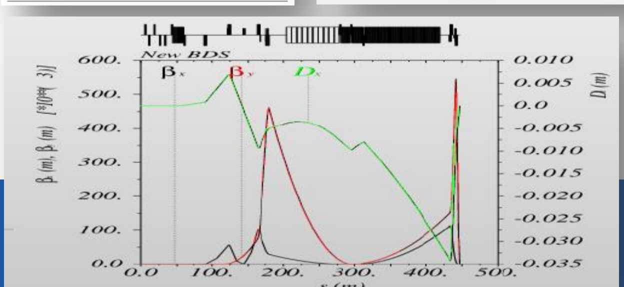
Parameter	Symbol	Unit	Stage 1	Stage 2	Stage 3
Centre-of-mass energy	$\sqrt{s}$	GeV	500	1500	3000
Repetition frequency	f_{rep}	Hz	50	50	50
Number of bunches per train	n_b		312	312	312
Bunch separation	Δt	ns	0.5	0.5	0.5
Accelerating gradient	G	MV/m	100	100	100
Total luminosity	$\mathscr{L}$	10^{34} cm^{-2}s^{-1}	1.3	3.7	5.9
Luminosity above 99% of $\sqrt{s}$	$\mathscr{L}_{0.01}$	10^{34} cm^{-2}s^{-1}	0.7	1.4	2
Main tunnel length		km	11.4	27.2	48.3
Charge per bunch	N	10^9	3.7	3.7	3.7
Bunch length	σ_z	µm	44	44	44
IP beam size	σ_x/σ_y	nm	100/2.6	~ 60/1.5	~ 40/1
Normalised emittance (end of linac)	ϵ_x/ϵ_y	nm	—	660/20	660/20
Normalised emittance	ϵ_x/ϵ_y	nm	660/25	—	—
Estimated power consumption	P_{wall}	MW	235	364	589

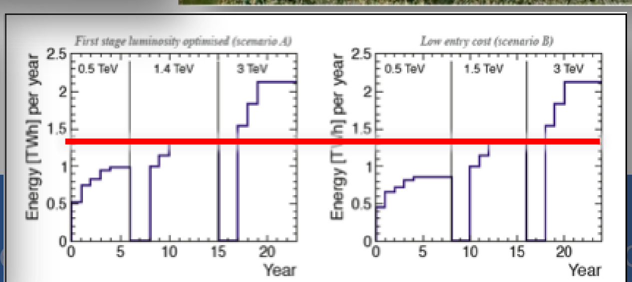


First to second stage: 4 MCHF/GeV (i.e. initial costs are very significant)

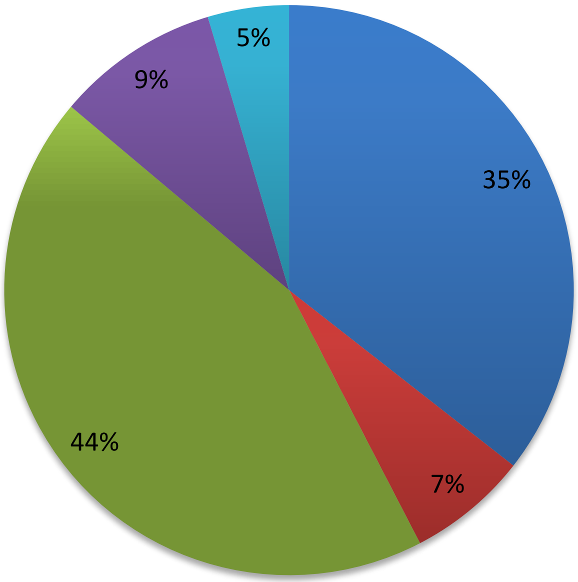
Caveats:
Uncertainties 20-25%
Possible savings around 10%
However – first stage not optimised (work for next phase), parameters largely defined for 3 TeV final stage





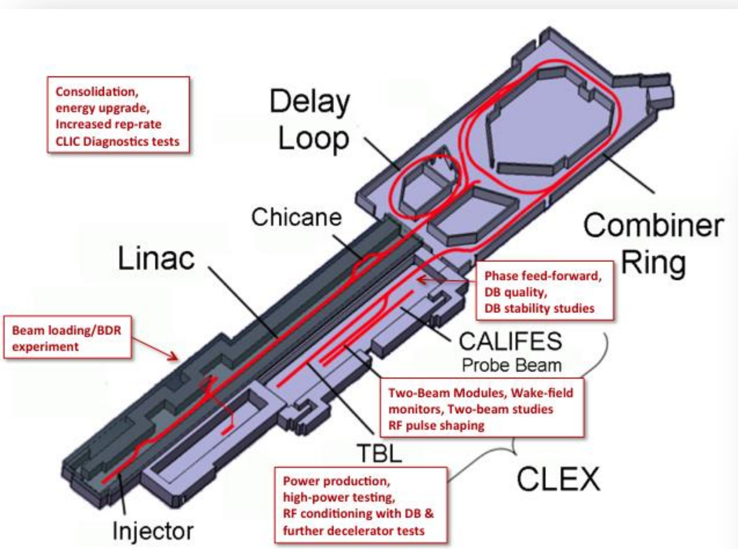


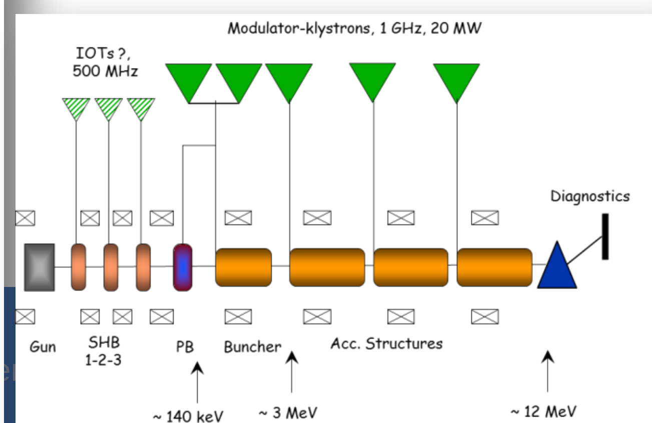
System-tests at CERN and outside (27% of overall)

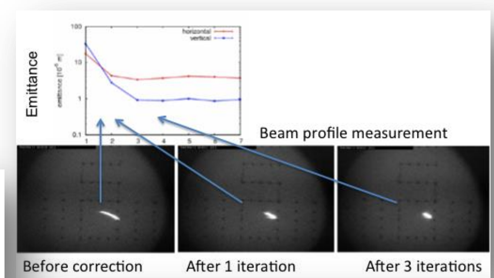


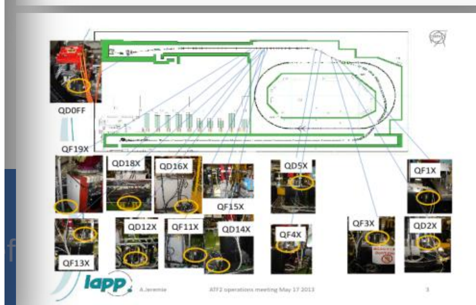
- CTF3 Consolidation & Operation (stop planned end 2016) for the next period, studies of re-use of equip. and site
- Drive Beam performance and feedback/forwards, drive beam decelaration and power prod., two beam mudule tests, instr. tests
- Drive-beam front end including injector studies (critcal parts of the first part of drive beam complex and power units)
- Modulator development, magnet converters, also to become part of Drivebeam FE system

Collaborators: IAP-Russia, Valencia, Frascati, IPM, JAI, Oslo, Uppsala, CEA, LAL, CIEMAT, RRCAT, LAPP, RHUL, SLAC, NCBJ







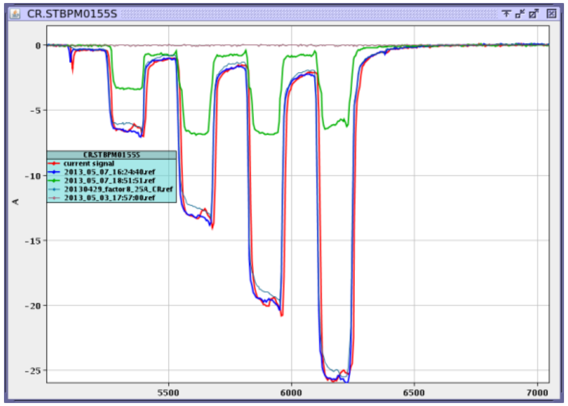


Recent CTF3 Results

- Operation with 8 times combination now routine
- New feedbacks added to improve phase stability

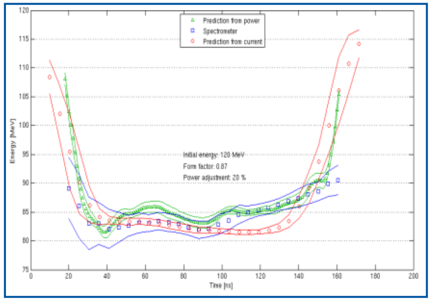
Goal is to achieve

- $\varepsilon_x = \varepsilon_y \cong 150$ µm also for factor 8, currently ε_x=550µm due to orbit error
- Charge stability $\sigma_Q \approx 10^{-3}$ for factor 8



- Deceleration increased from 30% to 35%
- Decelerator BPM prototype tested (stripline, LAPP)
- Good understanding of the optics

Goal is to reach 40% deceleration



Feed-forward to correct drive beam phase

Phase monitors successfully tested

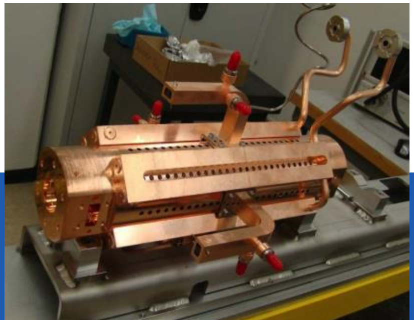
Goal:

- Install kickers and amplifiers (FONT5) in summer
- First tests in autumn

INFN Frascati

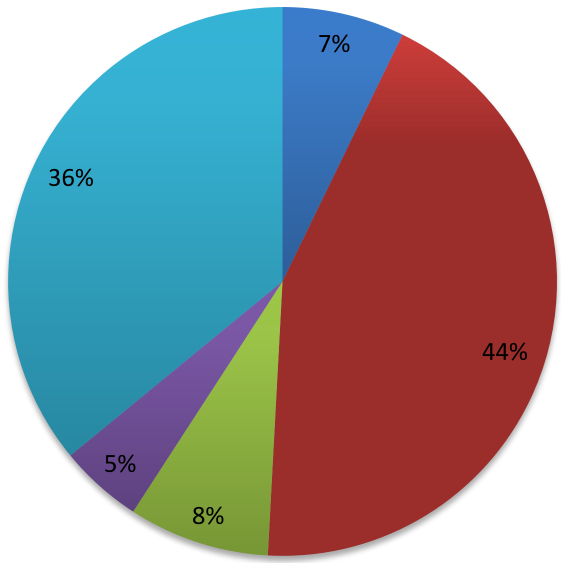
JAI/Oxford

- Structure with wake-monitor installed in TBTS
- Resolution is very good

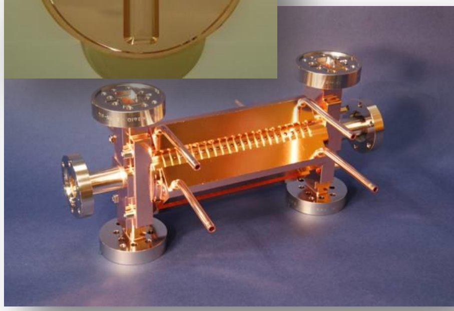


CEA IRFU - Saclay

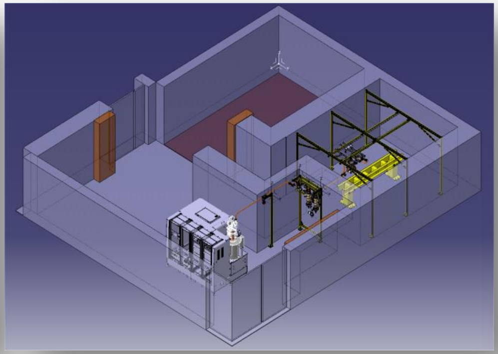
X-band activities (25% of overall)

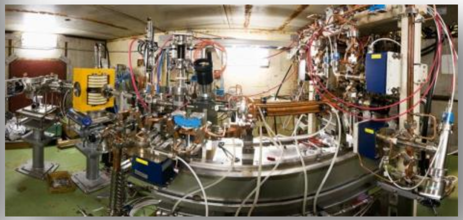


- X-band Rf structure Design and basis High Grad R&D
- X-band Rf structure Production (development and statistics)
- X-band Rf structure High Power Testing, including KEK and SLAC
- Novel RF unit developments, R&D for future, link to other R&D projects
- Creation and Operation of x-band High power Testing Facilities, core of programme

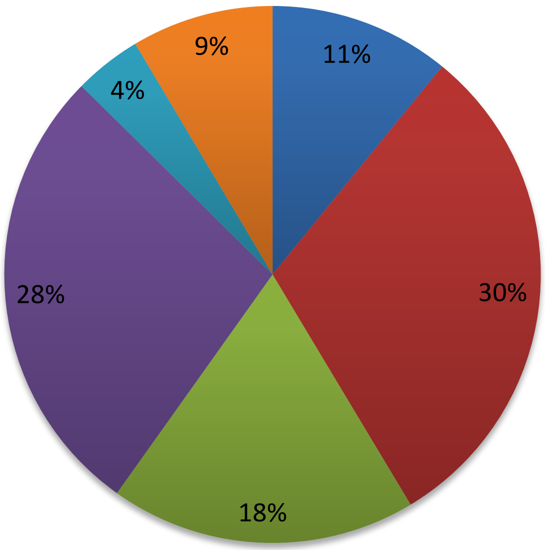


Collaborators: CEA, Helsinki, Valencia, IHEP, KEK, SLAC, Lancaster, Manchester, Oslo, PSI, Trieste, Tsinghua, Uppsala, Dubna,Tartu, Groningen, Jerusalem, EPFL, METAS, SACLAY, Sandia, Shanghai, TERA



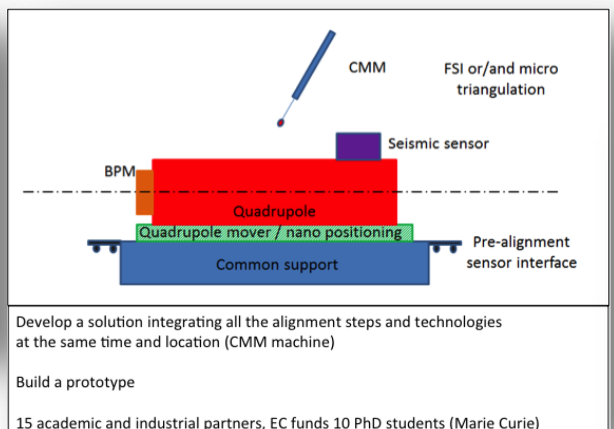


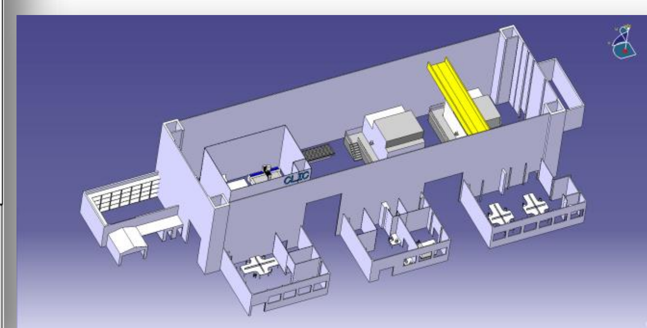
Technology developments (24% of overall)



- Pulsed, SC and warm magnets: Damping Rings Superconducting Wiggler and Kicker Development
- Survey & Alignment, Stability, Magnet development, including PACMAN hardware
- Beam Instrumentation and Control
- Two-Beam module development, for lab and CTF3 measurements
- Vacuum systems and studies (and finalise minor collimator studies)
- Creation of a "CLIC technology center@CERN" - bat 156

Collaborators: Brussels, CEA, CIEMAT, Dundee, Helsinki, Frascati, JAI, KIT, LAPP, LNBL, NTUA, PSI, SLAC, Cornell, Daresbury, Symme, Dubna, Minsk





Summary and Conclusions

Programme towards next Strategy Update is defined and optimized

Can be executed according to CERN MTP resources 2013-18:

- Re-work list of critical items for the project, and re-prioritize accordingly
- Need to close down CTF3 end 2016 and reduce or cut short several activities
- CTF3 programme and Drivebeam FE "transfer" clarified, module 1st and 2nd generation better defined, test-setup planning and structure prod. Planning updated, PACMAN support included, bat 156 and space clarified, technology transfer, power/energy studies and UK-CERN beyond mid 2014 all accounted for

There are several potential areas for common work with future hadron options (site/cost/power/schedules/WBS and general project development, possibly some technical studies, physics and detector technology) – to be exploited