CLIC overview

R. Tomás for the CLIC/CTF3 collaboration

- May 8th, 2009
Goal of the CLIC study

<table>
<thead>
<tr>
<th>Centre of mass energy</th>
<th>3 TeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luminosity (in 1% energy)</td>
<td>$2 \times 10^{34}$ cm$^{-2}$s$^{-1}$</td>
</tr>
</tbody>
</table>

With current parameters:

<table>
<thead>
<tr>
<th>Number of $e^\pm$ per bunch</th>
<th>$3.7 \times 10^9$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bunch separation</td>
<td>0.5 ns</td>
</tr>
<tr>
<td>Main linac RF frequency</td>
<td>12 GHz</td>
</tr>
<tr>
<td>Number of bunches per train</td>
<td>312</td>
</tr>
<tr>
<td>Repetition frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Proposed site length</td>
<td>48.3 km</td>
</tr>
<tr>
<td>AC to beam power efficiency</td>
<td>6.8 %</td>
</tr>
<tr>
<td>$\gamma \epsilon_x / \gamma \epsilon_y$</td>
<td>660/20 nm</td>
</tr>
</tbody>
</table>
The CTF3 – CLIC world wide collaboration

Ankara University (Turkey)
BINP (Russia)
CERN
CIEMAT (Spain)
Cockcroft Institute (UK)
Gazi Universitelle (Turkey)
IRFU/Saclay (France)
Helsinki Institute of Physics (Finland)
IAP (Russia)
IAP NASU (Ukraine)
Instituto de Física Corpuscular (Spain)
INFN / LNF (Italy)
J. Adams Institute, (UK)
JINR (Russia)
JLAB (USA)
KEK (Japan)
LAL/Orsay (France)
LAPP/ESIA (France)
NCP (Pakistan)
North-West. Univ. Illinois (USA)
Oslo University (Norway)
PSI (Switzerland),
Polytech. University of Catalonia (Spain)
RRCAT-Indore (India)
Royal Holloway, Univ. London, (UK)
SLAC (USA)
Uppsala University (Sweden)
Friendly rivalry  
Nature 456,422, 27 Nov. 08

“The spirit of collaboration in the race to define the LHC’s successor sets an example for large projects. The future for high-energy physics is decidedly mixed...”
and in fact...

Number of titles including CLIC or CTF3

Counts

EPAC02  PAC03  EPAC04  PAC05  EPAC06  PAC07  EPAC08  PAC09
The CLIC CDR should address the critical points:

- Accelerating structures at 100 MV/m.
- Power Extraction and Transfer Structures (PETS).
- Generation of the 100 A drive beam with 12 GHz bunch frequency,
- meeting the phase, energy and intensity stability tolerances.
- Main beam low emittances.
- Stabilization of main quads. to 1nm and FD quads to 0.15nm (freqs >4 Hz).
- Machine protection.
Damping Rings

326 klystrons
33 MW, 139 μs

Drive beam accelerator 2.38 GeV, 1.0 GHz

CR1
144.8 m
CR2
434.3 m

Circumferences
delay loop 72.4 m
decelerator, 24 sectors of 876 m

1 km

BC2

245 m

TA radius = 120 m
e⁻ main linac, 12 GHz, 100 MV/m, 21.02 km

BDS
2.75 km

IP

BDS
2.75 km

ta radius = 120 m
e⁺ main linac

48.3 km

Booster linac, 9 GeV

CR combiner ring
TA turnaround
DR damping ring
PDR predamping ring
BC bunch compressor
BDS beam delivery system
IP interaction point

e⁻ injector, 2.4 GeV

e⁻ PDR 365 m
e⁻ DR 365 m
e⁺ DR 365 m
e⁺ PDR 365 m
e⁺ injector, 2.4 GeV
The emittance challenge

with severe collective effects: intra-beam scattering, fast-ion instability and e-cloud.
e-cloud mitigation

Carbon coating with SEY < 1 developed in CERN being tested in SPS and CESR-TA (summer 09).
Negligible longitudinal phase space deformation in the RTML at 8 GeV.
Drive beam complex

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interaction point

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CLEX is where the high intensity beam (drive beam) transfers its energy to the main beam.
CTF3 - $\times 4$ combination in CR!
Power extraction demonstrated @ 3 A. Enhancement by power recirculation in the PETS.
CTF3 - Next steps

- 28 A by recombination in delay loop and CR
- Two beam acceleration (PETS + 12 GHz structures)
- Stability of decelerated beam
- PETS on-off
- RF feedback R&D
Accelerating cavity tests

Demonstration of CLIC specifications with a CLIC-like structure without damping.
Beam Delivery System

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33 MW, 139 μs

drive beam accelerator 2.38 GeV, 1.0 GHz

1 km
delay loop

circumferences
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IP

Booster linac, 9 GeV

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e− injector, 2.4 GeV

e− DR 365 m
e− PDR 365 m

e+ DR 365 m
e+ PDR 365 m

e+ injector, 2.4 GeV

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## Vertical IP beam sizes and chromaticities

<table>
<thead>
<tr>
<th>Project</th>
<th>Status</th>
<th>$\sigma_y^*$ [nm]</th>
<th>$\xi_y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFTB</td>
<td>Measured</td>
<td>70</td>
<td>17000</td>
</tr>
<tr>
<td>ATF2</td>
<td>Commissioning</td>
<td>37</td>
<td>19000</td>
</tr>
<tr>
<td>ILC</td>
<td>Design</td>
<td>6</td>
<td>15000</td>
</tr>
<tr>
<td>ILC low power†</td>
<td>Proposed</td>
<td>4</td>
<td>30000</td>
</tr>
<tr>
<td>CLIC</td>
<td>Design</td>
<td>1</td>
<td>63000</td>
</tr>
</tbody>
</table>

† [WE6PFP082](#)  

CLIC, again, the most challenging.
ATF2 layout

Final Focus

S-band Linac

High Energy Accelerators Research Organization (KEK)
ATF2 ultra-low $\beta$ proposal

- In CARE/ELAN-2008-002 a squeeze of the ATF2 IP $\beta$-functions by a factor of 4 was proposed to prove CLIC chromaticity,
- $\sigma_y \approx 20$ nm, $\xi_y \approx 76000$.
- Beneficial for the ILC project, more in particular for the ILC low power option.
- The future superconducting FD for ATF2 should extend the ultra-low $\beta$ R&D.
QD0 has to be stabilized to 0.15 nm for frequencies above 4 Hz.
0.15 nm, small as a H$_2$O molecule!
Active stabilization studies

0.13 nm reached in laboratory, the challenge remains to prove 0.15 nm within the detector.
A possible concept for the CLIC QD0

T. Mihara, Y. Iwashita, M. Kumada and C.M. Spencer

(Superconducting QD0 is not excluded but subnanometer stabilization of coil adds a challenge)
Frequency can be 4 GHz or 12 GHz, biggest challenge is phase stability of $0.008^\circ$ and $0.025^\circ$, respectively.
CLIC schedule

- 2010: CDR.
- 2015: TDR, technical designs and final cost.
- 2016: project approval?
- 2023: 500 GeV CLIC first beam.
- 2026: 3 TeV CLIC first beam.
Summary

• Excellent progress towards the CLIC CDR,
• but lots of work still to be done.
• Challenging work and tight schedule!
Thanks to the outstanding contributions from the growing international collaborations:

See you in CLIC09 workshop,
October @ CERN.