11/07/01 SNOWMASS J.P. Delahaye

CERN policy

① LHC = unique CERN project

Commissioning : 2006 Payment → 2008

Time is contingency

② Project at CERN after LHC prepared now

- proton intensity upgrade : CNGS, Fixed Target, LHC, ISOLDE
- LHC upgrade : Luminosity, energy
- Multi-TeV e± Linear Collider : CLIC
- Neutrinos upgrade : Superbeam - ν Factory

③ Decision (2008?) depends on World-wide panorama

- Physics results from Tevatron / LHC
- Existence (or not) of Sub-TeV Linear Coll

④ CLIC technology = only realistic candidate for Multi-TeV Linear Collider

- Strong R & D still needed } → 2008
- Convincing validation in Test Facilities }
- Technology possibly available in 2008
- Progress limited by resources available
- Collaborations mandatory
  CTF3 : LAL - LNF - SLAC
  RAL - Strathclyde - Uppsala Uni
- Any body / Laboratory welcome

3.2 Multi-TeV Electron-Positron Colliders

Most of the arguments and motivations for a sub-TeV e^+e^- collider also apply to multi-TeV accelerators of that type. The mass range accessible to search for Higgs bosons or other new particles will be much larger, according to the energy of the accelerator. The potential for discoveries and precision studies at very high energies, comprising novel aspects such as the production of new gauge bosons, of new quarks and leptons and composite Higgs bosons, is therefore much enhanced and extends in many cases beyond that of the LHC.

While a multi-TeV e^+e^- collider offers a greater physics potential, many years of intense R&D are still needed for such a machine. The CLIC design [8], developed and studied at CERN for more than 10 years, offers a promising way to build such a machine in the 3 to 5 TeV range. It is based on a two-beam scheme where intense low-energy electron beams provide the rf power to accelerate the high energy electron and positron beams. It is designed to reach very high accelerating gradients, allowing a much shorter total linac length than other schemes. A test facility (CTF3), currently planned at CERN, is intended to demonstrate the conceptual feasibility of this technique within the next five years.

3.3 Assessments and Comments of the Working Group

The Working Group sees a strong physics motivation for the construction of an e^+e^- linear collider, reaching at least 400 GeV collision energy and exceeding luminosities of 10^{34} cm^{-2} s^{-1}. Flexibility to increase the energy range to significantly higher energies will enhance its capability to study new processes and physics beyond the Standard Model. Justification of an extended energy range will greatly benefit from results obtained at the LHC.

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The Working Group recommends the realisation of an e^+e^- linear collider in the collision energy range from 90 up to at least 400 GeV, with possible extension to higher energies. It is convinced that the decision to construct such a machine should be taken soon,

Promising techniques for a multi-TeV e^+e^- linear collider like CLIC are being developed at CERN but still need significant R&D work before the technical feasibility can be demonstrated. The Working Group recommends the continuation of R&D to show the feasibility of an e^+e^- linear collider in the multi-TeV collision energy range, such as CLIC.

ECFA/01/213
21 September 2001

ECFA EUROPEAN COMMITTEE FOR FUTURE ACCELERATORS

REPORT OF THE WORKING GROUP ON THE FUTURE OF ACCELERATOR-BASED PARTICLE PHYSICS IN EUROPE[1]

EXECUTIVE SUMMARY

The ECFA Working Group on the future of accelerator-based particle physics in Europe has considered the possible options and time-scales for the next major accelerator project, the implications for the current particle physics programme and the strategy that ought to be pursued in the long-term future. Although charged with considering the future for Europe, it has also considered the international context since particle physics is intrinsically international. The Working Group makes the following recommendations:

In the immediate future:

1) the allocation of all necessary resources to fully exploit the unique and pioneering LHC facility;

2) continued support for ongoing experiments, since they promise significant scientific results, provide an optimal physics return on previous investment, and are vital for the education of young physicists;

3) the realisation, in as timely a fashion as possible, of a world-wide collaboration to construct a high-luminosity e^+e^- linear collider with an energy range up to at least 400 GeV as the next accelerator project in particle physics; decisions concerning the chosen technology and the construction site for such a machine should be made soon;

4) an improved educational programme in the field of accelerator physics and increased support for accelerator R&D activity in European universities, national facilities and CERN.

For the long-term:

5) a co-ordinated collaborative R&D effort to determine the feasibility and practical design of a neutrino factory based on a high-intensity muon storage ring;

6) a co-ordinated world-wide R&D effort to assess the feasibility and estimate the cost of a 3-5 TeV e^+e^- linear collider (CLIC), a very large hadron collider (VLHC) and a muon collider; in particular, R&D for CLIC is well advanced and should be vigorously pursued.

The central role of CERN in Europe must continue and will be essential as the fulcrum of the long-term future of particle physics. The Working Group considers it essential that, through CERN, Europe should be able to play a key role in the exploration of the multi-TeV horizon that will open in the post-LHC era.

The implementation of these recommendations would ensure a vibrant and exciting programme of investigations into the fundamental structure of matter and maintain Europe's leading role in this pioneering adventure in science.

[1] Address http://web.cern.ch/Committees/ECFA/ (Working Group)

3.4 R&D Accelerator

Although the main objective of CERN is obviously the LHC and its possible upgrading, in parallel a small but significant effort is made to explore options for the post-LHC era. The latter comprises a multi-TeV linear collider and advanced neutrino beams.

CERN's know-how in accelerator physics and technology has also been used for a feasibility study of a synchrotron, associated extraction lines and gantries for a cancer-therapy facility which has been concluded with a detailed conceptual design report in 2000.

Limited resources will severely restrict the amplitude and breadth of the R&D studies for future accelerators. They will not allow much more than an exploration of the possible options and the opportunity to remain in touch with leading-edge accelerator developments around the world.

Collaboration with other European laboratories interested in these topics is being established and contacts have been made with the interested communities in the US and Japan. These collaborations are imperative and provide invaluable help in a number of issues, which otherwise could be studied only superficially.

CERN/SPC/793
CERN/FC/4424
Original: English
28 May 2001

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE

CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Action to be taken		*Voting Procedure*
For recommendation to Council	**SCIENTIFIC POLICY COMMITTEE** 218th Meeting **11 and 12 June 2001**	-
For recommendation to Council	**FINANCE COMMITTEE** 285th Meeting **13 June 2001**	Simple Majority + 70 % of Member States' Contributions Present and Voting
For recommendation to Council	**COMMITTEE OF COUNCIL** 247th Meeting **14 June 2001**	Simple Majority
For Approval	**COUNCIL** 118th Session **15 June 2001**	Simple Majority

THE SCIENTIFIC ACTIVITIES OF CERN AND BUDGET ESTIMATES FOR THE YEARS 2002–2005

Over the years under consideration, the main goal is to finalise the construction of the LHC, while running a restricted scientific programme of high quality.

Council is invited to:

i) approve the overall figures proposed for 2002 to allow for the preparation of the 2002 Draft budget, and

ii) take note of the proposed budget estimates for 2003, 2004 and 2005.

7. SUMMARY OF THE MEDIUM-TERM PLAN

7.1 Scientific Programme

After more than 11 years of successful and efficient operation LEP is being dismantled and will be fully removed before the end of 2001. The analysis of LEP experimental data is expected to continue until 2003. The period 2002-2005 will be characterised by intense construction work towards the commissioning of the LHC by 2005/2006. Despite difficulties encountered by the civil-engineering contractors, the excavation of the caverns is proceeding and every effort is being made to make up for the accumulated delay. The LHC magnet system is now entering its production phase. Construction of the LHC detectors is proceeding according to the revised schedule. The installation of ATLAS is scheduled to start in 2003, CMS and ALICE in early 2004 and LHCb in mid-2004.

The non-LHC scientific programme essentially consists of already approved experiments. Several, such as the NOMAD and CHORUS neutrino experiments, and most of the SPS heavy-ions programme, have reached the end of their data-taking phase. However, two heavy-ions experiments with very specific goals optimized for the SPS are being kept on until 2003. The successful NA48 experiment will further study CP violating K-decay properties in 2002-2003. The CERN scientific programme has been considerably enriched by the introduction of a highly competitive neutrino activity, built around the CNGS facility, and the inception of the very promising TOF neutron facility.

Accelerator R&D is focused on the design and construction of a new test facility CTF3 (CLIC Test Facility 3) in preparation for the post-LHC generation of accelerators.

Full support from { PS division / CERN services / CERN management }

Very motivated and expert team

- Strong recommendation from CTF3 review C[illegible]
- International collaborations (with resource[illegible]

LAL - LNF - RAL - SLAC - Strathclyde - Uppsal[illegible]

October 4, 2001

CTF3 Review

B. Aune (Saclay), H. Henke (T. U. Berlin), R. Siemann (SLAC)

Introduction

CLIC is a multi-TeV linear collider that is a possible future CERN project. Distinctive CLIC features include

- A two-beam configuration to generate the RF power,
- High RF frequency, $f_{RF} = 30$ GHz,
- High accelerating gradient, G = 150 MeV/m.

CTF3 is a test facility that is part of the CLIC development and is a collaboration between CERN, INFN Frascati, LAL Orsay, RAL Didcot, SLAC, Strathclyde UK, and Uppsala University. CTF3 would test the underlying concepts of the RF power generation by experimentally demonstrating several critical aspects including high efficiency energy transfer from low frequency RF to the Drive Beam and frequency multiplication using a delay loop and a combiner ring. Thirty GHz RF would be produced at the end of the Drive Beam linac in the Initial Phase and with the beam from the combiner ring in the Nominal Phase. This power can be used to test accelerating structures and RF components to establish the feasibility of the CLIC accelerating gradient.

Specific CTF3 goals are

- Fully beam-loaded operation of the Drive Beam Accelerator
- Phase coding of bunches and bunch interleaving
- Control of bunch length and energy spread
- Production of 30GHz RF power at nominal CLIC requirements
- Provide a test facility for CLIC RF components

Principal Findings and Recommendations

CTF3 or an equivalent facility is imperative for the development of CLIC. The actual technical choice of CTF3 is based on existing buildings and components. Under the given boundary conditions collaborations are vital for the project. INFN (Frascati) is taking responsibility for the transfer lines, delay loop and combiner ring, which are major, essential parts of CTF3.

The CTF3 concept is sound, and it takes advantage of existing buildings and hardware to realize substantial savings. The project is staged intelligently with three stages that explore the various CTF3 goals with increasing demands on performance.

The project is technically demanding, but there are no insurmountable problems. Resources and schedule look possible but tight. We believe that, because of the technical demands, several years of commissioning and operation will be required after the completion of the installation.

CLIC is critically dependent on developing the processes, materials, techniques, etc. that firmly establish the feasibility of the high acceleration gradient. The RF power from CTF3 will be available for testing major CLIC components, but high power RF experiments need at least one fully dedicated and continuously available test stand. Either a dedicated power source or new collaborations devoted to understanding gradient limits are necessary soon for a timely and systematic exploration of the many issues that must be resolved.

Comments on Technical Solutions

Injector: A thermionic gun and bunchers have been designed with requirements on current magnitude and stability that are at the upper limit of what is possible. If the stability is not achievable right away, a feedback solution is foreseen. In parallel an RF gun is under design. It would allow for a better bunch structure and lower emittance. The main challenge is the drive laser. There is encouraging progress on that, and planned experiments should allow a choice between these two injector options.

Linac: A slotted iris structure with higher order mode damping and detuning (SICA) was chosen, and the first high power tests were positive. The 3 GHz power generation relies on existing klystrons, modulators, and modified LIPS pulse compression. The RF system will require sophisticated temperature and phase control. The linac would be operated fully beam-loaded to demonstrate high efficiency, but full beam-loading is not necessary for high power RF generation. Comparison between FODO, doublet and triplet optics showed best emittance preservation and smallest jitter amplification in the case of triplets.

Transfer lines, delay loop and combiner ring: All of these devices are isochronous, and parameters have been chosen but they are not final. They make use of existing magnets and are being designed to fit within the footprint of the available building. Work on the RF deflectors is in progress, and no major problems have been encountered. A novelty is the use of wigglers in the rings for path length control. The requirement on the low frequency impedance in the combiner ring, $Z/n = 0.4\Omega$, is low but possible with a smooth vacuum chamber and a minimum number of vacuum chamber transitions.

Longitudinal phase space manipulations: Very short bunches will create coherent synchrotron radiation in the rings and degrade the emittance. Bunches, which are compressed in the linac to reduce energy spread, must be lengthened before they are injected into the delay loop and compressed again after the combiner ring. This will be demanding and requires sophisticated diagnostics.

Staging of the project: A Prelimary Phase, which has already started, makes use of the existing linac, a new gun, and EPA ring with a modified lattice. It will allow the first demonstration of beam combining with factors of 3, 4 and 5 at low current. It will also allow first experiments on deflectors, on coherent synchrotron radiation effects, and bunch length and phase monitors. In a second stage, the Initial Stage, the new linac will be installed and will have a test stand for high power RF experiments. High power RF test stands will be invaluable for CLIC, and this test stand should remain operational during installation, commissioning and operation of the full CTF3 facility. The combiner ring, delay loop, CLEX experimental area and a probe beam will be added in the Nominal Phase, which is the third and final stage.

Probe beam and CLEX experimental area: CLIC needs 240 MW/m for 130 nsec at a repetition rate of 100 Hz. This would give 150 MeV/m accelerating gradient in the main linac. The CLEX test stand is intended for power generation, testing of waveguide components and accelerating structures at nominal parameters, study of breakdown phenomena at 30 GHz and other RF frequencies, and determining the ultimate possible gradient. A 200 MeV probe beam will serve for verification of RF parameters, measuring of wake effects, and the CLIC beam-loading compensation scheme.