FCC-ee News

http://cern.ch/fcc-ee July 2014

Different name, same spirit!

TLEP is now part and parcel of the Future Circular Collider (FCC) design study, that had its kick-off meeting at the University of Geneva on 12th-15th February, and is now known as FCC-ee. The kick-off meeting was the starting point of an international collaboration to carry out a five-year design study of two (and possibly three) accelerators that would fit in a new 80-100 km circular tunnel in the CERN area. The study will be concluded by the delivery of a conceptual design report (CDR) and a cost review for the next update of the European Strategy for Particle Physics, taking place in 2018-2019.

The FCC is aimed at the long-term goal of a high-energy proton-proton collider with a centre-of-mass energy up to 100 TeV (named FCC-hh). It includes the design of a 90-400 GeV high-luminosity, high-precision, e^+e^- machine (named FCC-ee, the former TLEP) as a possible first step. Options for an e-p collider (named FCC-eh) are also examined. Taken together, this complex of machines represents a powerful combination of searches for new phenomena in high-energy physics.

You can check out the FCC Study Mandate, by CERN's Director General, Rolf Heuer.

The starting point

The kick-off meeting assembled more than 350 experts in accelerators and particle physics from all over the world, with particularly high representation from China, Japan, Russia and the US, in addition to the many scientists from European universities and laboratories. The goals of the meeting were to introduce the FCC study, to discuss its scope and organization and to prepare the groundwork to build international collaborations and shape following studies.

CERN's director-general, Rolf Heuer, opened the meeting and presented the main motivations for the FCC. While he encouraged a worldwide collaboration in all areas and an efficient use of the existing efforts and investments, he highlighted the importance of informing about the benefits of this project to society through an comprehensive communication and outreach strategy.

Nima Arkani-Hamed, first director of the Centre for Future High Energy Physics at the Institute of High Energy Physics (IHEP) in Beijing, highlighted the fascinating physics case for circular colliders in a 100 km ring. Christophe Grojean, from the Institut de Física d'Altes Energies in Barcelona, emphasized the importance of the precise measurements that could be made at both the lepton and hadron colliders.

Frédérick Bordry, CERN's director of accelerators and technology, presented the roadmap for CERN, clarifying that Europe's top priority for the next two decades is the exploitation of the LHC. Michael Benedikt, the FCC study coordinator, reviewed the baseline parameters, design challenges and preparations for global collaboration, emphasizing that new partner institutes will be welcome throughout the duration of the study. Yifang Wang, director of IHEP in Beijing, and Stuart Henderson, Fermilab's associate director for accelerators, described the Chinese and US activities for circular colliders and offered their financial and human support to this global enterprise.

After this followed two days of plenary sessions, which surveyed the scope, plan, international situation and design

starting points of the FCC. Seven parallel sessions gave space for feedback, additional presentations and lively international discussions.

FCC-ee's homework

As discussed at the kick-off meeting, there are many experimental, phenomenological and accelerator challenges facing the FCC-ee study. To begin with, a convincing accelerator design needs to be carried out to fulfil the energy and luminosity goals. Likewise, interesting developments will be needed for the detectors to match the physics programme. Finally, the unprecedented precision in Z, W, Higgs and top measurements will also require significant effort in a new generation of theoretical calculations.

The 6th TLEP Workshop

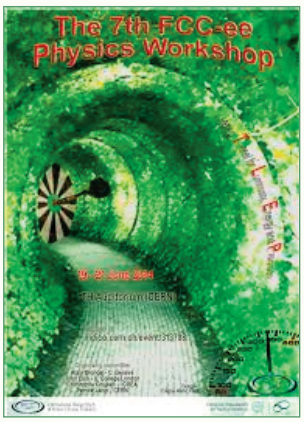
Prior to the kick-off meeting, the 6th TLEP workshop was held at CERN in October 2013. For three days, more than 80 participants from the TLEP community fruitfully discussed the baseline for the design study. The full agenda was structured on parallel sessions dedicated to Physics (Theory and Experiment) and Accelerator studies, as well as various TLEP plenary sessions. Some really promising proposals were made! Check all the material here.

The 7th FCC-ee Physics Workshop

Following the 6th TLEP Workshop and the FCC kick-off meeting, a vigorous 7th FCC-ee Physics Workshop was held at CERN from the 19th to the 21st June 2014. More than 50 participants from the FCC community and from the linear collider projects gathered at CERN to discuss the outline to make the FCC-ee dream come true.

The afternoon of the 19th June was dedicated to presenting the road towards FCC-ee, as well as updating the experimental and software proposals that have been studied. There were also presentations of news about the energy and precision capabilities of the collider and the performance possible for realizing the full physics potential of the machine.

The morning of the 20th June was focused on the phenomenology of FCC-ee physics and the common benchmarks within the FCC-hh. These general discussions were followed by a series of afternoon talks concerning the studies carried out within the different specific FCC-ee experimental working groups – Higgs physics, QCD and gamma-gamma, flavour physics, precision measurements of the EW parameters, detector designs, online software and computing, and search for new physics. With the new theoretical emphasis on the precise measurements of the 'invisible widths' of the Higgs and Z particles as opportunities to reveal the production of dark matter, it was fitting that the experimenters are discovering the power of the Tera-samples of the Z boson, whose 20% branching fraction into neutrinos make it potentially a (heavy) neutrino factory.



The morning of the 21st June was devoted to presentatios of the achievements of the accelerator study group – including the exciting news that ideas for crab waist crossing could increase the luminosity at the Z peak energies by up to a factor of 8! In view of the previous days findings, this was just what the doctor ordered. Machine-detector interface issues such as luminosity and energy measurements, as well as beam-beam effects, were presented.

Alain Blondel's motivating final talk was aimed at summarizing the important progress achieved since the last workshop. The FCC-ee community can be proud that all the top-level conveners have now been nominated and are getting down to work. A huge software effort has been undertaken and we have benefited from the fruitful collaborations with e^+e^- linear collider colleagues. Moreover, it has been proven that the complementarity with the hadron machine is not just words and we have great prospects in the quests for dark matter, the cosmological baryon asymmetry and neutrinos. Thanks to the committed work of all the members of the FCC-ee community, the immense potential offered by this high-luminosity e^+e^- Z, W, H and t factory is now more than evident.

ICFA and the FCCs

Since the 71st International Committee for Future Accelerators (ICFA) Meeting, which took place at DESY in February, "*ICFA supports studies of energy frontier circular colliders and encourages global coordination*". You can find the official statement here.

There will be an ICFA Advanced Beam Dynamics Workshop on High Luminosity Circular e+e- Colliders for a Higgs Factory (HF2014) from 9th to 12th October 2014 in Beijing, China. This workshop will discuss future large circular e^+e^- colliders that would serve as Higgs factories and will be concentrating on CEPC and FCC-ee accelerator physics.

First Look at the Physics Case and baseline parameters

The TLEP Design Study Working Group published the "First Look at the TLEP Physics Case" in December 2013. The paper concisely presents an initial assessment of some of the relevant features of the FCC-ee physics potential, to serve as a baseline for the more extensive design study that is now being carried out.

Similarly, the latest version for the baseline parameters of the lepton collider at the various centre-of-mass energies (Z peak, WW threshold, HZ cross-section maximum and top-pair threshold) is now published and available here.

A happy family

The FCC-ee experimental, phenomenological and accelerator conveners lists are now complete! Do not hesitate to contact any of the experts or check their study scope in the FCC-ee website:

1. **Experimental Studies:** A. Blondel, P. Janot.
   - WG1: Electroweak Physics at the Z pole: R. Tenchini.
   - WG2: Di-boson Physics and W mass measurement: R. Techini.
   - WG3: H(126) Properties: M. Klute, K. Peters.
   - WG4: Top Quark Physics: P. Azzi.
   - WG5: QCD and γγ Physics (joint exp/th): D. d'Enterria.
   - WG6: Flavour Physics (joint exp/th): S. Monteil.
   - WG7: New Physics: M. Pierini, C. Rogan.
   - WG8: Offline Software: P. Janot, F. Gianotti, B. Hegner.
   - WG9: Online Software: C. Leonidopoulos.
   - WG10: Experimental Environment: N. Bacchetta.
   - WG11: Detector Designs: A. Cattai, G. Rolandi.

2. **Phenomenology Studies**: J. Ellis, C. Grojean.
   - WG1: QCD and γγ Physics (joint exp/th): P. Skands.
   - WG2: Precision EW calculations: S. Heinemeyer.
   - WG3: Flavour Physics (joint exp/th): J. Kamenik.
   - WG4: Model Building and New Physics: A. Weiler.
   - WG5: Global Analysis, Combination, Complementarity: J. Ellis.

3. **Accelerator Studies**: J. Wenninger, F. Zimmermann

Notable Talks and Posters

On the accelerator side, see F. Zimmermann's review on challenges for future circular colliders at the IPAC'14 conference in Dresden. A notable talk was given by Fabiola Gianotti at the LHCP workshop on 6 June 2014 on Opportunities and Prospects of Future High Energy Colliders. We were well represented at the ICHEP conference in Valencia, with two posters and four physics talks. Links to these and more can be found from the FCC-ee web page, 'events/past talks'.

Software catch up

When it comes to developing a software environment for FCC, the idea is to propose a 'turn-key' solution that covers most of the post-LHC experiments' needs, providing R&D for future HEP software and taking advance of the group members' experience in the LHC projects. In this sense, FCC is adopting a pragmatic stance with initial simple building blocks that foresee software gradually growing in sophistication.

As for the software framework, Gaudi is one of the more attractive options, since it combines simplicity, flexibility and completeness and is usable in C++ and Python. The most feasible option for the data model, one of the essential pieces when it comes to efficiency in the development and runtime, could be LCIO. Regarding the detector description, FCC has started trying out DD4HEP, that covers the entire lifecycle of an experiment. The simulation of events is to be carried out using Delphes, for which tutorials are taking place. Finally, assessment is still to be done regarding reconstruction and analysis: more manpower is needed!

Delphes 3.0. released

The version 3.0 of the Delphes fast-simulation code was recently presented. For those who are not familiar with it, Delphes is a C++ framework that performs a fast multipurpose detector response simulation. The simulation includes a track propagation system embedded in a magnetic field, electromagnetic and hadron calorimeters, and a muon identification system. More information is available here.

A tutorial based on the release 3.2.1. was held at CERN at the beginning of May. The first part consisted on an introduction to Delphes' technicalities applied to FCC needs, covering topics such as the installation setup, code running, modular structure and configuration file. Attendees could then profit from a hands-on session with examples especially designed to manage FCC events. Further details about the tutorial can be found here.

Twiki pages

A set of twiki pages have been created and are accessible from the working group pages in the FCC-ee website. These twiki pages are intended to gather all the technical information about the working groups concisely in one site to ensure all collaborators keep updated!

Design study: more than 400!

As we write these lines, 434 subscribers from around the world have already signed up the FCC-ee design study team! A warm welcome to all our new subscribers! If you still have not joined us and are willing to do so, do not hesitate another minute - click here to register!

New Twitter account

Keep updated about FCC-ee news and anecdotes and share an enriching debate with us by following FCC-ee on Twitter: http://twitter.com/TLEP_FCCee

Upcoming events

Set your agendas - FCC-ee has lots of events coming soon! The first FCC international collaboration board meeting is taking place on the 9th and 10th September. As already mentioned, the ICFA Advanced Beam Dynamics Workshop on High Luminosity e^+e^- Colliders (HF2014) will be held from the 9th to the 12th October 2014 in Beijing, China. Likewise, the 8th FCC-ee Physics Workshop will take place from the 27th to the 29th October in Paris, and the Pisa group has volunteered to organize the 9th one at the beginning of 2015. A general FCC Workshop is being considered for April next year.

Keep track!