Future ee colliders

PPAP community consultation summary

Matthew Needham

Submissions

- Three future collider submissions related to ee options
  - CEPC
  - FCCee
  - ILC
- For hadron and eh options, plus FCCglobal plan see Monica's talk

The CEPC Input to the Particle Physics Advisory Panel[1]

Adrian Bevan[a], Véronique Boisvert[b], Daniela Bortoletto[c], Jens Dopke[d], Brian Foster[c], Harald Fox[e], Yanyan Gao[f], Tim Jones[g], Roy Lemmon[h], Bill Murray[i], Fabrizio Salvatore[j], Craig Sawyer[d], Ian Shipsey[c], Jaap Velhuis[k], Trevor Vickey[l], Iacopo Vivarelli[j]

a) contact person representing Queen Mary University London
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c) contact person representing University of Oxford
d) contact person representing STFC RAL and STFC Particle Physics Division
e) contact person representing University of Lancaster
f) contact person representing University of Edinburgh
g) contact person representing University of Liverpool
h) contact person representing STFC Daresbury Lab
i) contact person representing University of Warwick
j) contact person representing University of Sussex
k) contact person representing University of Bristol
l) contact person representing University of Sheffield

12 institutes signing the contribution

CEPC: context

- 100 km circular e+e- collider proposed for China
- Operation at 3 centre-of-mass energies: Z peak, WW threshold, 240 GeV (Higgs factory)
- $5B project
- CEPC Conceptual Design Report published in 2018
- 1100 signaturies from 24 countries
- Decision on construction could come as soon as 2022
- Accelerator construction to take 5 years with running in 2030s

CEPC: UK interests and plans

- UK holds roles on the International Advisory Committee
- Opportunities for UK involvement in Accelerator R&D
- International collaborations starting to form on Calorimetry and Tracking
  - UK has leadership in the tracker and potential to utilize and build-on existing expertise in commercial CMOS silicon pixel technology from ATLAS/ALICE /mu3e
  - Dual readout calorimeter with high efficiency and 1 ns timing planned. R&D needed in collaboration with industry for low-cost SiPM
  - TDAQ work building on generic R&D work in AIDA2020

CEPC: take home

From
the contribution

International collaborations have started on CEPC detector R&D, on the tracking detector and the calorimeter, with contributions from many UK institutes, including Bristol, Edinburgh, Lancaster, Liverpool, Oxford, Queen Mary University London, STFC RAL PPD and Daresbury lab, and Sussex. Dr Harald Fox was chosen as the international contact for the CEPC tracker. QMUL and Lancaster have contributed significant computing resources to the CEPC simulation. Sussex has contributed significantly in test beam and simulation for the R&D of a dual-readout calorimeter of one of the CDR detectors.

The UK participation during the R&D phase in the next 3-5 years can focus on two main aspects, accelerator studies to explore the intellectual and industrial opportunities, and detailed detector R&D in key subsystems to identify challenges and opportunities for the UK industry and academia. Both can be pursued in collaboration with other electron-positron collider projects.

PPAP roadmap input: FCC-ee

Physics strengths and R&D opportunities for UK particle physics

October 2020

Submitted on behalf of FCC-UK[1] (representing: Birmingham, Bristol, Cambridge, Cockcroft, Daresbury, Durham, Edinburgh, Glasgow, Imperial, John Adams Institute, King's College, Lancaster, Liverpool, Manchester, Oxford, QMUL, STFC Rutherford Appleton Laboratory, Royal Holloway, Sheffield, Southampton, Sussex, UCL, Warwick)

22 institutes signing the contribution

FCCee: Context

- The recent update of the European Strategy for Particle Physics (ESPPU) identified an electron-positron Higgs factory as the highest-priority next collider and recognised the importance of R&D towards a future hadron collider of the highest achievable energy
- FCCee is the e+e- option for the FCC program at CERN
- Operation at centre-of-mass energies from 90 to 350 GeV
- Timeline
  - 2021-25 Physics studies
  - 2025/2026 TDR
  - 2028 Project approval
  - 2030 - 2037 tunnel construction
  - 2040 First collisions

FCCee: UK interests and plans

- Recent FCCee-UK kickoff meeting
- UK interests in:
  - CMOS technology for tracking building on UK's existing strength and expertise
  - Calorimetry: UK has had leadership in the CALICE project since its inception and more recently led development of dual readout technology
  - Trigger/DAQ
  - ParticleID (exploiting FCCee as a flavour factory)
  - Accelerator R&D

FCCee: take home

From
the contribution

It is crucial that the UK HEP community has a very strong engagement in these studies in order to place ourselves in a position to claim central roles in detector building, civil construction, and optimise the "juste retour". This is particularly important given that starting with the project construction, the UK is expected to be contributing a large monetary amount, of the order of tens of £M per year for more than a decade.

The priority for the initial, 5-year period will be on Physics studies, software/computing development, phenomenological work for measurement projections, and detector/accelerator R&D. Aspects of this R&D work will require involvement with industry. We provisionally expect a ramping up from an initial 10 FTE to approximately 20 FTE by the time of the CDR/TDR submission.

UK participation in the International Linear Collider

Submission to the PPAP 16/10/20

LCUK Collaboration [1]

(*Contacts: P.N. Burrows, A. Robson*)

[1] The LCUK consortium includes 22 UK groups, whose ILC interests are listed in Annex 1.

Birmingham, Bristol, Brunel, Cambridge, Daresbury, Durham, Edinburgh, Glasgow
Imperial College, Lancaster, Liverpool, Manchester, Open University, Oxford, QMUL
RAL, RHUL, Sheffield, Southampton, Sussex, UCL, Warwick

ILC: UK interests and plans

- First phase of the ILC. Higgs factory at 250 GeV, later phases expanding reach to 1 TeV
- Cost of first phase machine $5B
- ILC TDR completed in 2013
- February 2020 the Japanese Government signaled its interest in hosting the ILC in Japan
- August 2020 an ‘International Development Team’ (IDT) was set up by ICFA, tasked with setting up an ILC ‘Pre-lab’ by 2022 ‘EOIs’
- 2022- 2025 Preparation phase. Complete R&D, design and preparatory work for setting up the ILC Laboratory. LOIs ~ 2023, TPs 2026
- Construction could start by 2026, with running by 2035

ILC: UK interests and plans

- UKRI infrastructure bid submitted to UKRI in April 2020 and attached to the contribution
  - Identifies scope and scale of UK investment in the preparation and construction phase
  - For the Preparation Phase, an IAC investment of order £30M plus 80 staff years on the accelerator, and £10M plus 50 staff years on the detector is laid
- Silicon Tracker, Calorimeter, and DAQ/data-handling are areas where UK has leadership and considerable, internationally leading expertise
- Possible accelerator contributions, building on existing work and expertise (e.g. LCABD collaboration, work for ESS)
  - ~10 % of cryomodules
  - UK expertise in, e.g. the Beam Delivery System, Damping Rings, and Positron Source offers the prospect of both intellectual and technical leadership

ILC: Take home

From
the contribution

Timeframe	ILC project phase	ILC activity	UK actions
2020-21	IDT	Identify remaining technical issues and potential project partners for Preparation Phase. Set up ILC 'Pre-lab' hosted by KEK.	Engage with IDT. Identify relevant technical areas and opportunities for UK participation in Preparation Phase, and resources required.
2022-25	Preparation ('Pre-lab')	Complete R&D and design/preparatory work. Prepare formal international agreements for contributions to the Construction Phase via the ILC Laboratory.	Contributions to ILC final R&D and design. Identify areas of leadership and responsibility and the resources required for delivery in the Construction Phase. Negotiate terms of agreement with ILC Laboratory for UK deliverables.
2026-35	Construction ('ILC Laboratory')	Construction of accelerator and detector, managed through the ILC Laboratory.	Production and delivery of UK agreed contributions to the accelerator and detector.
>2035	Operation	Commissioning and physics running	Physics exploitation.

Possible UK actions commensurate with this timeline and project phases are indicated in the final column of the table. We recommend that PPAP note the timeline and the UK actions that are required in order to secure a leading role in the ILC project