Agora 2 Summary: Circular e^+e^- Colliders

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U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

Agora 2 Agenda on Circular e^+e^- Colliders (January 19)

SLAC

3:00 PM → 3:05 PM **Welcome & Introduction**
Speaker: Sarah Eno, John Seeman
Agora 2 Introductio... | Agora2_Intro.mp4 | Link to Questions G...

3:05 PM → 3:20 PM **Physics at Circular e+e- Colliders**
Speaker: Alain Blondel (DPNC Université de Genève)
Agora2_Physics.mp4 | Blondel-FCC-Physi...

3:20 PM → 3:35 PM **Future Circular Collider (FCC-ee)**
Speaker: Frank Zimmermann (CERN)
Agora2_FCC-ee.mp4 | Snowmass Agora e...

3:35 PM → 3:50 PM **Circular electron-positron Collider (CepC)**
Speaker: Jie Gao (IHEP)
Agora2_CEPC.mp4 | CEPC Agora-J.Gao-...

3:50 PM → 4:05 PM **Small Circular Colliders (LEP3, FNAL Site FIller)**
Speaker: Eliana Gianfelice (Fermilab)
Agora2_Lep3andFn... | agora_talk.pdf

4:05 PM → 4:20 PM **ERL-based e+e- colliders**
Speaker: Vladimir Litvinenko (Stonybrook University)
Agora2_ERL.mp4 | Aurora2_Litvinenko...

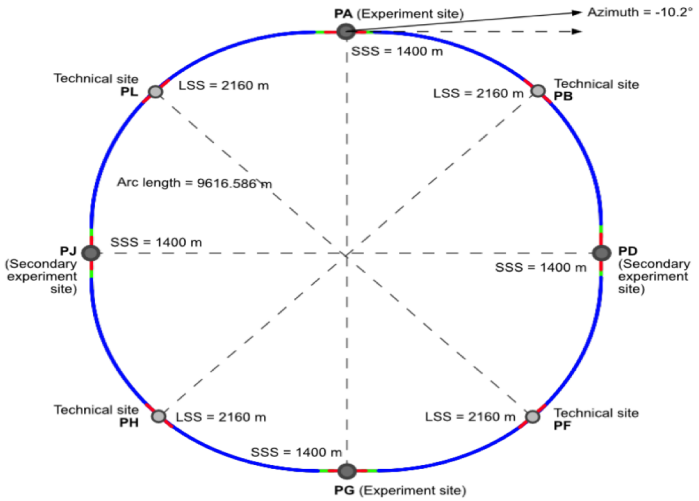
4:20 PM → 5:00 PM **Q&A and Moderated Discussion**
Speaker: John Seeman, Sarah Eno
Agora2_Discussion... | Snowmass Agora 2...

Detailed Q&A responses:

https://docs.google.com/document/d/1jgPcDDpxzwMbdrvqA4KnNC58IDlQmLz_dxRDPu3VUuM/edit?usp=sharing

FCCee Collider

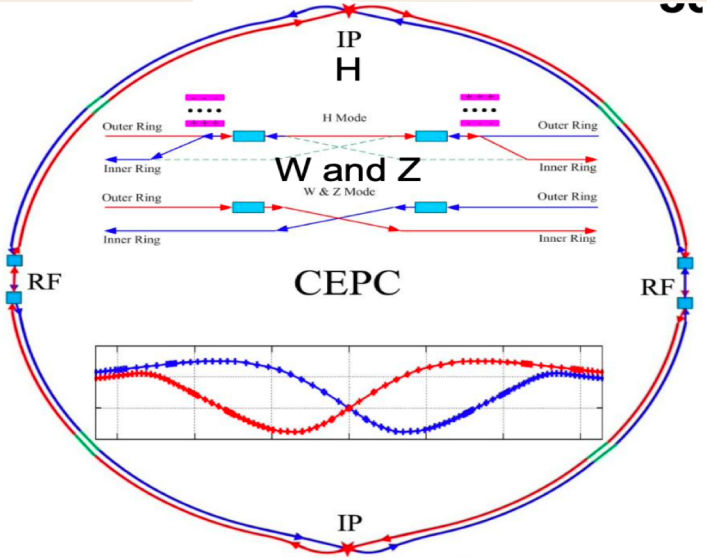
- CME = 91 to 365 GeV.
- Length = 92 km around Geneva.
- Lumi = 180. to 1.25 x10^{34}.
- Adv: Mostly proven technology, >50 yr.
- Adv: Low energy inj on the CERN site.
- Dis: High beam currents at the Z
- Dis: 11 GeV SC RF at ttbar for ring + inj.



- Q1: With start of FCCee after LHC ~2042, why not build FCChh first with lower field dipoles then swap for higher fields?
- A1: Fits the evolution of physics at CERN. Even lower field SC dipoles will take considerable time to develop and the swap time is long.
- Q2: How to reduce the costs?
- A2: More efficient RF power sources, minimize tunneling costs.

CEPC e^+e^- Collider

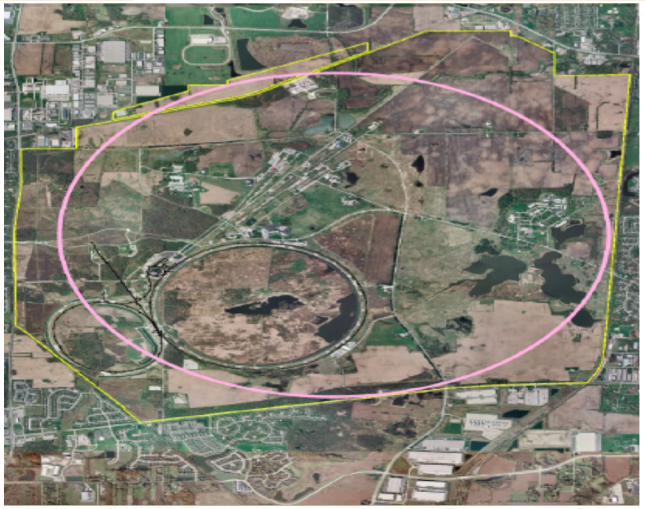
- CME = 91 to 365 GeV.
- Length = 100 km+ inj at a new location.
- Lumi = 115. to 0.5 x10^{34}.
- Adv: Mostly proven technology, > 50 yr.
- Adv: High technology dev'mt underway.
- Dis: High beam currents at the Z.
- Dis: 10 GeV of SC RF for ring and inj.



CEPC collider ring (100km)

- Q1: Does IHEP have a design with 5 kW HOM in cavities?
- A1: HOM damped SC cavities prototypes are in manufacturing.
- Q2: How to reduce the costs?
- A2: More efficient RF power sources and, perhaps, lower tunneling, staffing, and material costs in China.

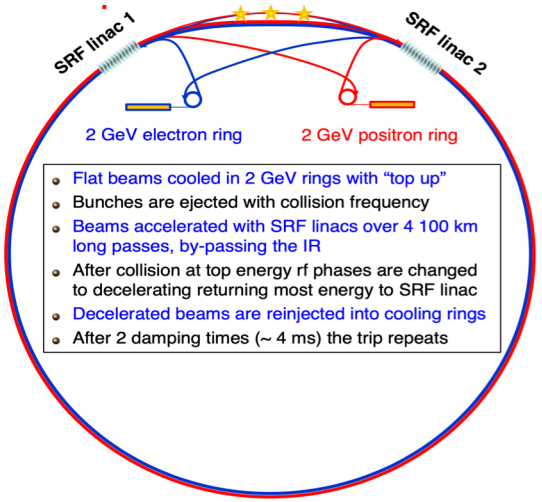
FNAL Site Filler e^+e^- Collider



- CME = 91 to 240 GeV.
- Length = 16 km + injector at FNAL.
- Lumi = 6.3 to 1.0 x10^{34}.
- Adv: Mostly proven technology, > 50 yr.
- Adv: Site exists.
- Dis: Strong synchrotron radiation+power.
- Dis: Early in design phase.
- Q1: Can a low emittance lattice (light sources?) (other than FODO) and adding crab waist schemes raise the luminosity and reduce the beam currents along with the needed wall power?
- A1: Other lattices and IR designs are being considered.
- Q2: How to reduce the costs?
- A2: Make a power efficient design by minimizing the resulting synchrotron radiation and thus the required RF power sources.

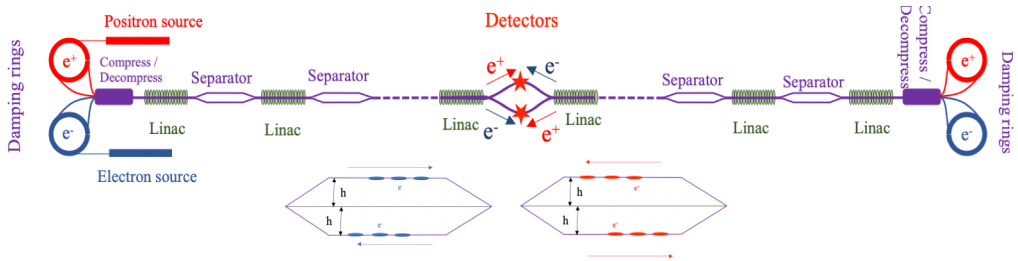
CERC: Circular ERL e^+e^- Collider

- CME = 91 to 600 GeV.
- Length = 100 km + injector.
- Lumi = 94. to 4.4 x10^{34}.
- Adv: Mostly proven technology, > 50 yr.
- Adv: Recycling beam power, e^+, e^- .
- Dis: Efficient particle recovery needed.
- Dis: 150 GeV of SC RF at 600 GeV with HOM damping.
- Q1: Can (up to) three IRs be installed in one straight section?
- A1: Multiple IRs with crab waist designs are under consideration.
- Q2: How to reduce the costs?
- A2: Minimize costs for the large SC RF system, the four ring tunnel transport, and consecutive adjacent IRs.



ReLiC: Recycling Linear e^+e^- Collider

- CME = ~91 to ~3 TeV.
- Length = 20 to 360 km.
- Lumi = 2.1 to 66. x10^{34}.



- Adv: Extendable accelerator from Higgs to TeV.
- Adv: Energy, e+, and e- recovery.
- Dis: Careful particle recovery after strong beam-beam interaction.
- Dis: HOM-beam interactions in SC cavities.
- Q1: How strong can the beam-beam disruption be?
- A1: Somewhere between a traditional linear collider and circular rings.
- Q2: How to reduce the costs?
- A2: Minimize RF power generation sources and chicane lengths.

Circular e^+e^- Collider Summary

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- 1) Circular colliders have 50+ years of development.
- 2) Long tunnels are needed to reduce SR power.
- 3) Almost all of the needed accelerator physics will be tested soon in SuperKEKB and later in the e^- ring of EIC.
- 4) CW damped SC RF at high powers and high beam currents need development and real life demonstrations.
- 5) Strong R&D efforts are crucial in the next few years.