Pair Production and Hadron Photoproduction Backgrounds at the Cool Copper Collider

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APS April Meeting
3 April 2024

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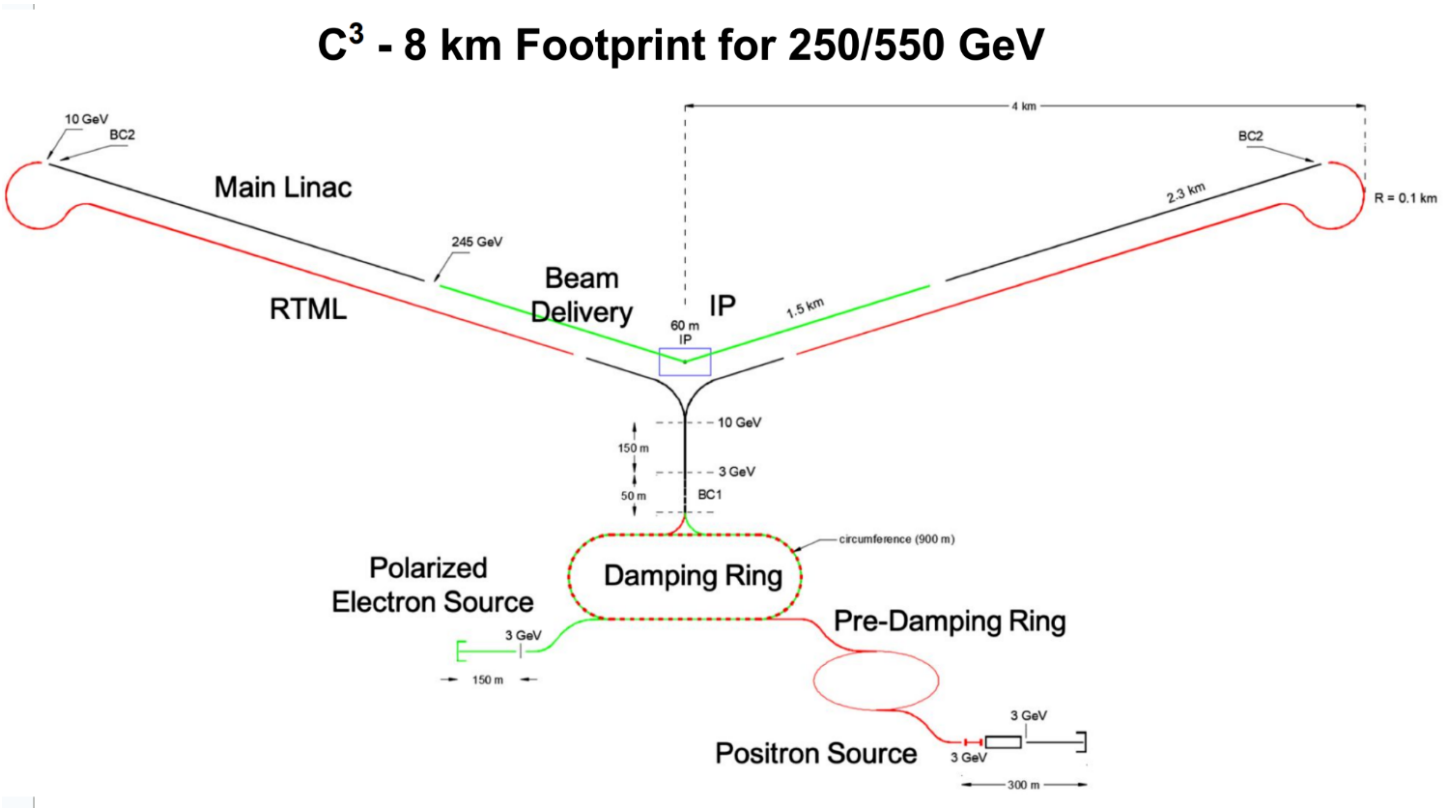
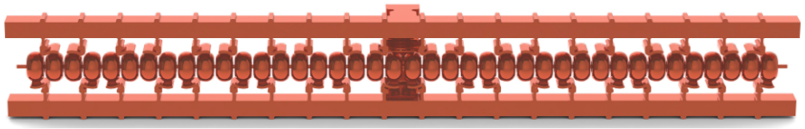
The Cool Copper Collider (C^3)



1. Newly proposed e^+e^- Higgs factory
2. E_{CM}: 250 GeV $\rightarrow$ 550 GeV $\rightarrow$ TeV-Scale



From ILC to C^3 Parameters

Key Differences in C^3 design against other linear colliders (ILC):

1. Accelerating Technology: Higher gradients - more compact design.
2. Bunch Structure: 2 orders closer $+ \sim 3$ times smaller particle density.
3. Train Structure: higher train rep. freq., one order fewer bunches/train.

Beam and Machine Backgrounds

Various backgrounds originate in the BDS or the IR of C^3

Can deteriorate detector performance:

1. Beam-induced Backgrounds: secondary e^+e^- pairs, $\gamma\gamma \to$ hadrons
2. Machine-induced Backgrounds: halo muon, neutron production

This presentation will focus on the Beam-Induced Backgrounds

e^+e^- Pair Background

1. Beamstrahlung photons produce forward-boosted incoherent e^+e^- pairs
   - Around 10^5 pairs / bunch crossing expected with C^3
   - Most are deflected, but a small fraction reach detector
2. Simulation of background using GUINEA-PIG
   - Interaction w/ detector simulated by Geant4 thru DD4hep - SiD-like

Pair Background Simulation

(Plots here)

- For comparison:
  1. ILC TDR includes all backgrounds, C3 only incoherent pairs
  2. ILC bunch train is 10x longer than C3

Hadron Photoproduction Background

- Beamstrahlung photons can also produce a hadronic background
  1. rate $\sim 10^5$ smaller than the e^+e^- pair background
  2. More central than incoherent pairs, may still impact reconstruction
- PYTHIA used for simulation of processes above $\sqrt{s_{\gamma\gamma}} > 2\ \mathrm{GeV}$
  1. Interfaced w/ detector through Geant4/DD4hep
  2. $\sqrt{s_{\gamma\gamma}} < 2\ \mathrm{GeV}$: Pythia unreliable, use WHIZARD/CIRCE (Slide 10)

Hadron Photoproduction Simulation

(Plots here)

- For comparison:
  1. Only $\gamma\gamma \rightarrow$ hadrons occupancy (Not overlaid with incoherent pairs)
  2. Summed: with incoherent pair occupancy: tail seen in ILC plot appears

Occupancy Results With Pythia

(More plots here)

Further Simulation with CIRCE and WHIZARD

1. $\sqrt{s_{\gamma\gamma}} < 2\ \mathrm{GeV}$: Pythia is unreliable for simulation
2. Alternate workflow: GUINEA-PIG $\rightarrow$ CIRCE $\rightarrow$ WHIZARD
3. Previous simulation from GUINEA-PIG utilized
4. CIRCE: Output successfully tailored for C3 after some consideration
   - CIRCE had a bug when processing low-event GPig data
   - This was fixed in a later release
5. : WHIZARD: Successful simulation with C3 but further modifications needed

Key Takeaways

1. C^3 is a compact, upgradable, and sustainable Higgs Factory proposal
2. Contribution from e^+e^- pairs and $\gamma\gamma \rightarrow$ hadron backgrounds is manageable
3. The ILC is a valid reference for C^3 studies, with $C^3 \sim$ ILC /10.
4. Generation of full hadron background processes is slow but steady
5. Future Steps:
   - Finish hadron background generation
   - Expand data production and investigate further backgrounds
   - Utilize further ILC studies for reexamination within the context of C3

References I