Physics Studies : Opportunties in SiD

Jan Strube
Tohoku University

Statement of Purpose

Jim, Fujii-san, Tanabe-san, and Tim have set the framework of what we currently have and where we need to go.

This is just a recap to start a discussion

Design Criteria

- Compact design with 5T field
- Robust silicon vertexing and tracking system – excellent momentum resolution, live for single bunch crossings.
- Calorimetry optimized for jet energy resolution
  - based on a Particle Flow approach
  - “tracking calorimeters”
  - compact showers in ECAL
  - highly segmented (longitudinally and transversely) ECAL and HCAL.
- Iron flux return/muon identifier – component of SiD self-shielding.
- Detector is designed for rapid push-pull operation.

These criteria guide the detector optimization

Reminder: ILC Detector Strengths

Well-known initial state

→ energy constraints

→ 4 π reconstruction, not only transverse

Low tracking occupancy

→ high-precision track, vertex reconstruction

→ flavor-tagging, heavy quarks, taus

“Clean events”: low calorimeter occupancy

→ **mass** resolution

→ separation of hadronic gauge boson decays

Opportunities in SiD

To be able to carry out the TDR, we need thorough detector optimization.

For this, we need detailed understanding how parameter changes affect physics output.

We can only accomplish this through sustained effort on some key benchmarks.

This should be supplemented with "volunteer" (= short-term effort) physics studies.

SiD specifics: Tracking

All-silicon tracking:
~ 10 hits for a track

- Redundancy for displaced decays
  - Tracking efficiency vs. displacement
- Resilience
  - what if a ladder fails? -- what about a layer?
- Studies of material budget
- Single BX time stamping in the pixels

SiD specifics: Calorimetry

Compact calorimeters, lower radius than ILD
Current baseline: Digital HCAL

Challenges

- Calorimeter Reconstruction
- Jet Clustering

We have yet to see significant differences with ILD in physics analyses. But we should.

SiD reconstruction opportunities

- Single BX time stamping
  - better vertex purity
  - jet charge / vertex charge
- Particle ID with Silicon Tracker / Calo

color-singlet clustering: Our initial state is a color singlet. Perfect jet clustering could improve error on HHH by 40%

See Junping Tian's talk

Benchmarks

Flagships:

H → cc,gg (include bb as bonus), recoil mass

⇒ vertexing, tracking, jet reconstruction (with hadronic Z)

Higgs trilinear self-coupling:

ZHH production (H→ bb, H → WW)

flavor tagging, particle ID, mass resolution

Further Flagship Analyses

ttbar, ttH:
vertex charge

Direct detection of Dark Matter:
Forward region

EWino production with small mass splitting:
Behavior towards higher energies

Challenge to Analysts

So far, SiD has been successful in meeting the benchmarking requirements for strategic documents.

After completion of the document, the effort usually vanishes.

Moving forward, we have to put a higher emphasis on systematic uncertainties.

⇒ This is the input to detector optimization

Summary

As we steer towards a TDR, we must broaden the base of our physics studies

SiD is a compelling option to deliver the physics we are interested in

Let’s expand the limits of what it can do.

Discussion