

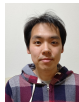
Electroweak Interactions Topical Group

Conveners

Wolfgang Kilian, University of Siegen
Theory



Taikan Suehara, Kyushu University
Experiment



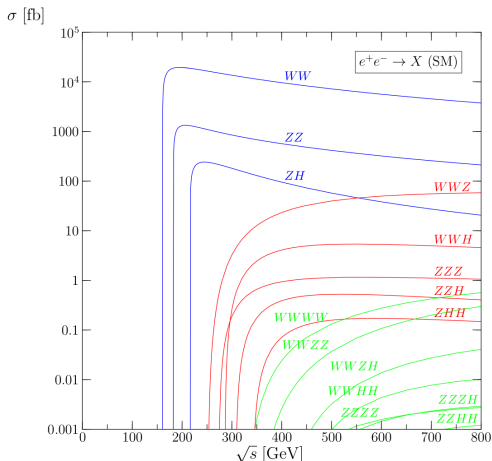
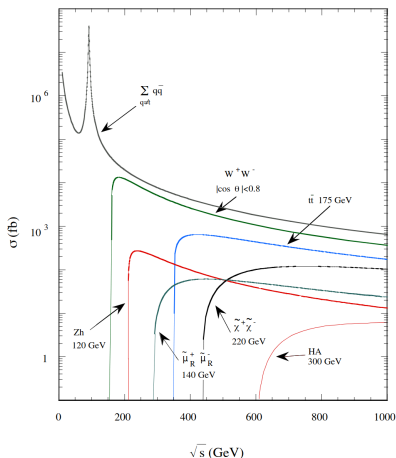
Graham Wilson, University of Kansas
Experiment



The e^+e^- Landscape

ILC: polarized e^- (80%) and e^+ (30%). No trigger needed. Use all decay modes.

Unpolarized cross-sections



Study electroweak physics with 2f, 4f, 6f, 8f. Ranging from the Z-pole to \sqrt{s} conceivably around 1 TeV. Expect ZH, WWZ, WWH, ZZZ, ZZH, ZHH, tt, WWWW, WWZZ, ttH within reach of 500 GeV collider.

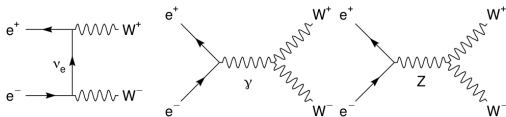
Electroweak Physics Channels

- Di-fermion production, $e^+e^- \rightarrow f\bar{f}$ with $f = e, \mu, \tau, q$ ($q=u,d,s,c,b,t$)
 - Radiative di-fermion production, $e^+e^- \rightarrow f\bar{f}\gamma$.
Especially $\mu^+\mu^-\gamma$, $\nu\bar{\nu}\gamma$ and $q\bar{q}\gamma$.
 - Di-boson production. Mainly 4-fermion final states resulting from WW, ZZ, ZH, but also $Z\gamma$, $\gamma\gamma$.
 - Multiple-boson production. Mainly 6-fermion final states (from WWZ, WWH, ZZZ, ZZH, ZHH), but also $WW\gamma$, $ZH\gamma$, $Z\gamma\gamma$.
 - Other processes. 4f: single Z, (eeZ and $\nu\bar{\nu}Z$), single W ($We\nu_e$). $\nu\bar{\nu}\gamma\gamma$ etc.
 - Quartic boson production
 - Alternative collider modes (e^-e^- , $e^-e^+\gamma$ and $\gamma\gamma$)
- 1 **Zf \bar{f} couplings**
 - 2 **WW γ and WWZ trilinear couplings**
 - 3 **quartic couplings (WWWW, WWZZ, WWZ γ and WW $\gamma\gamma$)**

Z couplings to fermions

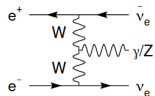
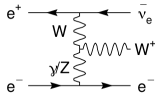
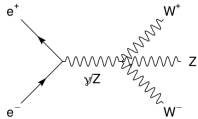
- Study the potential improvements in Z observables from a dedicated Z pole run with polarized beams and line-shape scan. Evaluate detector and accelerator requirements. Key issue: excellent understanding of \sqrt{s} scale.
- Utility of radiative return events for Z physics?
- How can precision Z couplings test BSM models?
- Importance of polarized observables (key asset of ILC)
- How can 2-fermion measurements at the highest energies constrain new physics?
- Are final-state polarization measurements with tau leptons important at the highest energies? Quantify related detector requirements.
- ...

WW program



- Define the ILC experimental program on W boson pair production. What are the key observables and detector requirements?
- What are the various ways to measure the W boson mass at the ILC and ultimate precision? Is a run at threshold well motivated?
- How can one best achieve a precision measurement of the W width?
- Can ILC measure the polarized production amplitudes in a model independent way?
- What BSM models are tested by this program?
- What advances in theory are needed to fully exploit 10^8 WW events?
- Can one fully utilize massive boson reconstruction in hadronic decays?
- ...

Other weak boson processes and generic questions



- What are the ILC capabilities to study the other weak boson reactions including triple-boson, four-boson production and vector-boson scattering?
- Can all the various processes be analyzed coherently with the other EW measurements including in global fits.
- How well can the quartic couplings be isolated and measured?
- Explore the complementarity of the direct multi-boson production with VBS
- Direct CKM matrix element measurements from W decays
- Rare decays of the W
- Lepton universality tests in W decays, Z decays, and tau decays
- Does the Z couple to $uu/dd/ss/cc/bb$ as described in SM?
- Can WW and ZZ be used to learn about color reconnection?
- ...

Concluding Remarks

Relations to other topical groups and task forces

- Almost all of the **task forces** will be very pertinent to EW physics
- Some overlap/cross-talk of course with other groups

Questions

- Many interesting questions to explore
- What interests you? Do you have ideas on complementary topics?

Invitation

We welcome experimentalists and theorists to join:

- share your perspective
- better understand the capabilities of the ILC for electroweak physics
- inform the detector and accelerator design

Recent documentation on physics ideas, SM tests, and the ILC project in Refs. [1, 2, 3]

- [1] K. Fujii et al., [LCC Physics Working Group],
ILC Study Questions for Snowmass 2021, [arXiv:2007.03650](#)
- [2] K. Fujii et al. [LCC Physics Working Group],
Tests of the Standard Model at the International Linear Collider
[arXiv:1908.11299](#)
- [3] P. Bambade et al.
The International Linear Collider: A Global Project, [arXiv:1903.01629](#)