ILD & ECFA Focus Topics
TwoF and BCFrag/Gsplit

Adrián Irles

AITANA group at IFIC – CSIC/UV

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TwoF and BCFrag/Gsplit

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13 TwoF — EW precision: 2-fermion final states ($\sqrt{s} = M_Z$ and beyond)

Expert Team: Emanuele Bagnaschi, Adrián Irles, Daniel Jeans, Alessandro Vicini

14 BCfrag and Gsplit — Heavy quark fragmentation and hadronisation, gluon splitting and quark-gluon separation

Expert Team: Paolo Azzurri, Eli Ben Haim, Loukas Gouskos, Ayres Freitas, Adrián Irles, Andreas B. Meyer, Simon Plätzer, Andrzej Siodmok, Torbjörn Sjöstrand, Maria Ubiali

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- The unprecedented statistical power provided by future colliders will require a large effort on the control and understanding of systematic uncertainties from theory and experiment. Indeed, the run at the Z pole foreseen by FCC-ee will offer 500 times smaller statistical uncertainties than those of previous measurements [14]. A significant improvement in precision could also be reached at the ILC [20].

- Very challenging measurements at Z-pole, dominated by systematics
  - Polarization (or non-polarization) measurements
  - Luminosity
  - Fragmentation
  - Detector acceptance, flavour tagging, PID performance

ILD activities

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- **e+e- → tautau**
  - D. Jeans et al (IDR, 500GeV, 250GeV in the pipeline)
- **ee→qqbar at 250 GeV (and above). Focus on AFB measurements**
  - T. Suehara et al https://agenda.infn.it/event/34841/contributions/208275/attachments/111331/158807/231011-2f-ecfa-nagae-suehara.pdf
  - R. Poeschl, F.Richard, A.I, J.. Márquez (see Jesus talk tomorrow, ILD paper on its way) ,Okugawa et al
  - Full simulations studies (mu/b/c/s) Focus on flavour tagging, PID, jet-charge measurement
  - Precision physics for indirect BSM searches
  - Assume a revisited precision on Z-couplings to fermions (via GigaZ or RadReturn measurements).
  - Exploiting the ILC/ILD characteristic features: beam polarization, high energy reach, PID, etc
- **PID, flavour tagging**
  - See yesterday session https://agenda.linearcollider.org/event/10211/contributions/53835/
  - And U. Einhaus talk https://agenda.linearcollider.org/event/10211/contributions/53839/

- No current efforts on Full Simulation at **GigaZ**.

Person power, short term activities

Sample production?

- Newer samples using NLO QCD events and/or with different PS tunes (see next topic)
- What about GigaZ samples?

Further detector optimization?

- Acceptance (forward region)
- PID detectors / reconstruction techniques ?
- Person power for physics benchmark analysis?

New topics/analysis opportunities

- Light-quark AFB (thanks to more powerful flavour tagging using PID)

▷**Person power**

- **Tokyo/KEK** → flavour tagging, tau
- **IJCLAB →** squark
- **IFIC** → b/c quark (BSM searches)

BCFrag/GSplit

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14 BCfrag and Gsplit — Heavy quark fragmentation and hadronisation, gluon splitting and quark-gluon separation

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- In the high-precision limit, fragmentation functions will not be universal, i.e. they are expected to depend on observables and initial states. It is argued that the factorisation of the perturbative and non-perturbative parts of the problem is not possible without dedicated tuning of free parameters in the required fragmentation model used.
- High relevance in key measurements
  - Precise study of $h \to gg/b\bar{b}/c\bar{c}$:
  - Precise determination of W -mass and cross section
  - Z-b/c couplings

Target Observables & ILD activities

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Table of observables proposed:

- a) crosscheck model performance
- b) revisit models/tunning using LEP/SLC data
- **c) study full simulation and detector performance**

▷**Open (detector) points**

- Tracker acceptance impact.
- Kaon ID.
- Jet charge measurements → hadronization is a source of uncertainty if not double tagging Is used

▷**ILD recent progresses** on adapting the generation chain

- to use **Pythia8** (facilitating playing with tunning parameters)
- To use **QCD NLO** ee-→qq calculations in Whizard (with PS matching).
- Zhijie Zhao, J. List, M. Berggren https://agenda.infn.it/event/34841/contributions/208079/attachments/111374/158899/ECFA2023-zzj.pdf

Person power, short term activities

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Sample production?

- At 250GeV and higher energy, BCFrag/Gsplit is not the main concern for 2f studies → less urgent to have newer samples, although the QCD NLO would be interesting to be studied (to address QCD correlation uncertainties in AFB)
- But may be for H→ssbar → Samples with different tunes ?
- Z-pole? WW?

▷**Person power**

- **DESY** → Pythia8, NLO QCD
- **TwoF groups**
- **W**