



international linear collider

Top/heavy-flavour/QCD

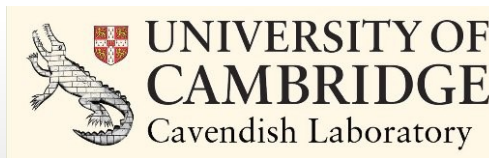
Physics Potential and Opportunities Subgroup (WG3)

A. Irlles^{}, A. Mitov⁺, Hua-Xing Zhu[†]*

^{} AITANA group at IFIC – CSIC/Valencia U.*

⁺ Cavendish Laboratory – Cambridge U.

[†] Zhejiang University



A not comprehensive status report and plans for the group

- ▶ Novel **event-shape/jet/jet-substructure** observables
 - --> strong coupling determination (interplay with top mass studies)
- ▶ **Today this field is dominated by LHC but e+e- will offer excellent ground for these studies**
 - Example LHC NNLO 3 jet calculations (~4 jets at lepton colliders)
- ▶ While many of the new jet observables are **developed for the LHC, e+e- colliders provide excellent ground for understanding their performance/systematics**
- ▶ **Interplay with hadron/nuclear physics community.** Can hadron/nuclear measurements can also be done in e+e- collider (less sensitive to nuclear non-perturbative effects, but with more controllable perturbative predictions) ?
- ▶ Photon-photon physics: hadron distribution amplitudes, jet production in photon-photon collisions, deep virtual compton scattering on a photon target, forward scattering, photon structure function,
- ▶ **High order QCD calculations for heavy flavour b- and charm fragmentation (QCD / Heavy Flavour physics)**

- ▶ The top **threshold scan** provides excellent sensitivity to the mass and other top quark properties
 - Measurement of the top quark mass in theoretically **well-defined mass schemes**
 - Sensitive to: top-quark mass, width, yukawa coupling, strong coupling constant
- ▶ **May need updated experimental studies (with more realistic simulations / tools)**
 - **Optimized MC tools.**

Top-Quark EW couplings (but also b / c / s)

ILC500

- ▶ Many BSM predict sizable deviations in top-EW couplings
- ▶ Several groups working in updated **global fits** with **LEP/Tevatron/LHC** data
 - Fits using **EFT seems to be the trend**
- ▶ All studies show the extraordinary impact of adding the prospects of ILC
 - Even for ILC250 (deviations in the t-b doublet)
 - but ideally ILC500GeV (or similar) → Going **above the top-quark pair production threshold** is crucial for the top-operators
 - The determination of axial terms highly benefit from higher energies

ILC250

- ▶ Many BSM models predict large deviations for the EW couplings for **b/c/s** but usually are not implemented in global fits studies
 - Deviations in these flavours are not observable at LHC
 - Visible at ILC250, ILC500, ILC1TeV... (and would largely profit by having ILC-GigaZ too)
- ▶ Realistic full detector (reconstruction) simulation studies ongoing but using LO MC.

Jet reconstruction (perturb. & not pert. effects)

▶ C-quark pairs

- ▶ High efficient flavour tagging for c-quarks expected at future colliders

▶ Charge measurement

- **Primary method:** identification of Kaons produced D-meson decays → **K-method (requires PID)**
- **Secondary method:** reconstruction of charged mesons → **Vtx-method**

PID is mandatory to reach competitive accuracies

▶ s-quark pairs (in progress)

- Requires PID

▶ B-quark pairs

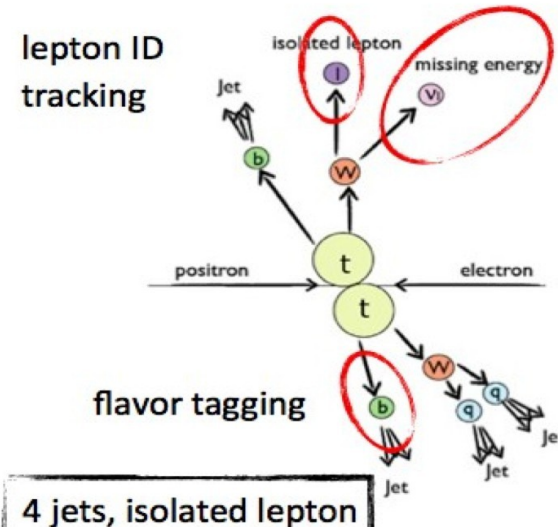
- ▶ High efficient flavour tagging for b-quarks expected at future colliders

▶ Charge Measurement

- **Primary method:** reconstruction of charged mesons → **Vtx-method**
- **Secondary method:** identification of Kaons produced in b-hadron decays → **K-method (requires PID)**

PID is very useful

▶ top-quark pairs... decay before hadronizing



Jet reconstruction (perturb. & not pert. effects)

▶ C-quark pairs

- ▶ High efficient flavour tagging for c-quarks expected at future colliders

▶ B-quark pairs

- ▶ top-quark pairs... decay before hadronizing

Several studies going on that may become crucial for detector (and machine?) optimization
ILC250, ILC500...

of charged mesons → **Vtx-method**

PID is mandatory to reach competitive accuracies

of charged mesons → **Vtx-method**

- **Secondary method:** identification of Kaons produced in b-hadron decays → **K-method (requires PID)**

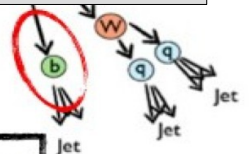
PID is very useful

▶ s-quark pairs (in progress)

- Requires PID

flavor tagging

4 jets, isolated lepton



We are contacting people from the field to give a review on the important topics

- ▶ The **ILC energy program (timeline)** drives the levels of excitement about different topics...
- ▶ **ILC250 GeV is optimal for**
 - **QCD and jet physics studies:** lots of activity on this field but dominated by LHC
 - **b / c /s EW couplings (Z,gamma,Z')**

- ▶ **Next energy point ?**
 - **GigaZ optimal for EW studies (Z couplings, Higgs physics)**
 - **ttbar threshold ? Top-mass is a key parameter**
 - **ILC500 (or 550.. or...?) essential for ttH and top-EW couplings and Higgs Physics**
 - **TeV-ILC ? (BSM searches?)**

Plans

We are contacting people from the field to give a review on the important topics

- ▶ The **ILC energy program (timeline)** drives the levels of excitement about different topics...
- ▶ ILC250 GeV is optimal for
 - QCD and jet physics studies: lots of activity on this field but dominated by LHC
(interplay with precise modeling group)
 - $b / c / s$ EW couplings (Z,gamma,Z') **(interplay with EW group)**
- ▶ Next energy point ?
 - GigaZ optimal for EW studies (Z couplings, Higgs physics)
 - $t\bar{t}b$ threshold ? Top-mass is a key parameter
 - ILC500 (or 550.. or...?) essential for $t\bar{t}H$ and top-EW couplings and **Higgs Physics**
 - TeV-ILC ? (BSM searches?)

**Interplay
with
different
topical
groups**



- ▶ QCD: clear interplay with precision modeling group
- ▶ Higgs – Top quark couplings global fits
 - Interplay with Higgs Properties, EW and Global interpretations groups
- ▶ Heavy quark EW couplings to Z' (and Z/γ at high energies)
 - Interplay with EW group
- ▶ High order calculations (EW, QCD) for top and heavy quarks
 - Modeling and precision theory