

Precision calculations for future e^+e^- colliders: targets and tools

S. Abreu, J. Alcaraz, J. Alimena, P. Azzi, D. D'Enterria,
A. Freitas, G. Heinrich, A. Huss, M. Mangano,
M. McCullough, P. Monni, J. Usovitsch, M. Vos

Welcome to the workshop

- The goal of the workshop is to **identify clear theoretical and computational targets** for high-precision predictions of relevance to the programme of future e^+e^- colliders
 - **Week 1 (this week)**: focuses on the **key physics questions** and observables that demand a theory input
 - **Week 2 (next week)**: focuses on modern advancements in **multi-loop calculations** and future applications to match the precision goals
 - **Beyond the workshop**: the programme is not comprehensive, and does not cover other important topics such as Monte Carlo generators and jet physics. These are left for future dedicated events

Welcome to the workshop

- Your input and interactions between participants are essential to optimally identify the theoretical and computational targets and ensure a smooth interface with the field of precision calculations
- The outcome of the first week of the workshop will be collected into a brief digest
 - ▶ This serves as input for the discussions on perturbative techniques during week 2
 - ▶ The resulting document might be posted on arXiv for future reference

Some logistics

- The programme consists of **3-4 talks a day: 40 mins + 20 mins for discussions**
- The mornings are left free and can be used for spontaneous discussions and collaboration work
- Coffee is served every day at **10am and 3pm (2pm on Friday)** in the TH common room (**4/2-011**)
- A small reception will be served at 5pm at the beginning of each week (i.e. today and on Monday June 13) by the CERN main auditorium (**Mezzanine 500/1-201**)
- For any questions or requests, please contact us at fcee-wshop-pc@cern.ch

Programme (week 1): Z pole physics and QCD

TUESDAY, 7 JUNE



12:45 → 13:00 **Welcome**

🕒 15m 📍 4/3-006 - TH Conference Room



13:00 → 17:00 **Talks and discussions: key physics questions and observables**

📍 4/3-006 - TH Conference Room



13:00

Possibilities and precision goals at the Z pole

🕒 40m 📍 4/3-006 - TH Conference Room



The talk will review the physics potential of future lepton (e+e-) colliders at the Z pole, highlighting in particular the electroweak measurements that rely heavily on theory inputs, such as precision calculations. Primary examples are Z-pole measurements of EW parameters, as well as EW precision observables.

Speaker: Patrick Janot (CERN)

14:00

Status of theory calculations for Z-pole observables

🕒 40m 📍 4/3-006 - TH Conference Room



The talk will review the status of theory calculations for Z pole precision observables, and highlight the requirements to match the foreseen experimental precision. Moreover, it will compare the EW pseudo-observables and EFT-parameterisation approaches to carry out precision physics at the Z pole.

Speaker: Ayres Freitas

15:00

Coffee break

🕒 30m 📍 4/2-011 - TH common room (...)

15:30

Possibilities and precision goals for QCD measurements

🕒 40m 📍 4/3-006 - TH Conference Room



The talk will review the physics potential of future lepton (e+e-) colliders at the Z pole, highlighting in particular the QCD measurements that rely heavily on theory inputs, such as precision calculations. Primary examples are Z-pole measurements of the strong coupling constant, hadronic decay rates of W/Z/tau, as well as (multit-)jet measurements.

Speaker: Stefan Kluth (Max Planck Society (DE))

17:00 → 19:00

Reception

🕒 2h 📍 500/1-201 - Mezzanine

Programme (week 1): ISR aspects & top-pair physics

WEDNESDAY, 8 JUNE



10:00 → 11:00

Coffee Break

🕒 1h

📍 4/2-011 - TH common room

12:20 → 17:10

Talks and discussions: key physics questions and observables

📍 4/3-006 - TH Conference Room



13:00

Initial state QED radiation aspects for future lepton colliders

🕒 40m

📍 4/3-006 - TH Conference Room



The talk will discuss the latest progress in the description of QED corrections to the initial state, such as the application and limitations of collinear factorisation to beamstrahlung and YFS approaches. This talk highlights the necessary steps to achieve the precision demanded by future lepton collider experiments.

Speaker: Stefano Frixione (INFN)

14:00

TH colloquium

🕒 1h

📍 4/3-006 - TH Conference Room



<https://indico.cern.ch/event/1124737/>

15:00

Coffee break

🕒 30m

📍 4/2-011 - TH common room (...)

15:30

Theory aspects in top-pair production ¶

🕒 40m

📍 4/3-006 - TH Conference Room



The talk will review the status of theory calculations for tt production at threshold energies and above at future lepton colliders, and highlight the requirements to match the foreseen experimental precision.

Speaker: Martin Beneke (Technische Universitaet Muenchen (DE))

16:30

Experimental possibilities at and above the top-pair threshold

🕒 40m

📍 4/3-006 - TH Conference Room



The talk will review the physics potential of future lepton (e+e-) colliders at the tt threshold and above, highlighting in particular the experimental targets and those measurements that rely heavily on theory inputs, such as precision calculations.

Speaker: Frank Simon (Max-Planck-Institut fuer Physik)

Programme (week 1): Higgs physics & QCD jet observables

THURSDAY, 9 JUNE



10:00 → 11:00

Coffee Break

🕒 1h

📍 4/2-011 - TH common room

13:00 → 18:30

Talks and discussions: key physics questions and observables

📍 4/3-006 - TH Conference Room



13:00

Experimental constraints on Higgs properties

🕒 40m

📍 4/3-006 - TH Conference Room



The talk will review the physics potential of future lepton (e^+e^-) colliders for Higgs production, e.g. Higgs-strahlung ($e^+e^- \rightarrow HZ$) and VBF ($e^+e^- \rightarrow H\nu\nu$ ($WW \rightarrow H$)), highlighting in particular the experimental targets and those measurements that rely heavily on theory inputs, such as precision calculations.

Speaker: Jenny List (Deutsches Elektronen-Synchrotron (DE))

14:00

Theory precision for Higgs observables

🕒 40m

📍 4/3-006 - TH Conference Room



The talk will review the status of theory calculations for H production, e.g. Higgs-strahlung ($e^+e^- \rightarrow HZ$) and VBF ($e^+e^- \rightarrow H\nu\nu$ ($WW \rightarrow H$)), and Higgs decays at future lepton colliders, and highlight the requirements to match the foreseen experimental precision.

Speaker: Li Lin Yang

15:00

Coffee break

🕒 30m

📍 4/2-011 - TH common room (...)

15:30

Non-perturbative aspects of QCD jet observables ¶

🕒 40m

📍 4/3-006 - TH Conference Room



The talk will review the current understanding of non-perturbative (linear) corrections to final state observables at lepton colliders, such as event shapes and jet rates. The prospects for new calculations needed at future e^+e^- machines should be highlighted in view of the accuracy required at these experiments.

Speaker: Paolo Nason (Max Planck Society (DE))

16:30

Prospects for precision QCD jet calculations

🕒 40m

📍 4/3-006 - TH Conference Room



This talk will review calculations for multi-jet production in e^+e^- collisions; emphasizing the precision targets and prospects for new calculations needed at future colliders, and whether these can be achieved with state-of-the-art technology.

Speaker: Andrea Banfi (University of Sussex)

Programme (week 1): WW physics at and above threshold

FRIDAY, 10 JUNE 📅

| | | | |
|--|---------|--|---|
| 10:00 | → 11:00 | Coffee Break | 🕒 1h 📍 4/2-011 - TH common room |
| 13:00 | → 17:10 | Talks and discussions: key physics questions and observables 📍 4/3-006 - TH Conference Room ✎ | |
| 13:00 | | Precision electroweak physics above the Z pole | 🕒 40m 📍 4/3-006 - TH Conference Room ✎ |
| <p>The talk will review the physics potential of future lepton (e+e-) colliders for EW precision physics above the Z pole, highlighting in particular the experimental targets and those measurements that rely heavily on theory inputs, such as precision calculations.</p> <p>Speaker: Graham Wilson</p> | | | |
| 14:00 | | Coffee break | 🕒 30m 📍 4/2-011 - TH common room (...) |
| 14:30 | | W properties at the pair-production threshold | 🕒 40m 📍 4/3-006 - TH Conference Room ✎ |
| <p>This talk will review the physics potential of future lepton (e+e-) colliders for EW precision physics at the WW threshold, highlighting in particular the experimental targets for the measurement of the W-boson mass and width.</p> <p>Speaker: Paolo Azzurri (Università & INFN Pisa (IT))</p> | | | |
| 15:30 | | Summary of week 1 | 🕒 20m 📍 4/3-006 - TH Conference Room ✎ |

Thank you and enjoy the workshop