
FCC EPOL: introduction and (very brief) overview

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Outline

- Remit of EPOL group, and reminder of baseline E_{CM} calibration strategy
- Achievements up to Midterm Review, and remaining tasks for Final Report
- Conclusions

Remit of EPOL group

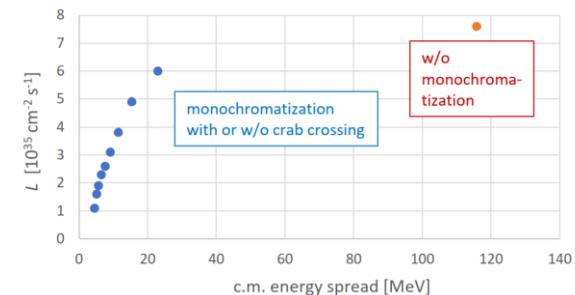
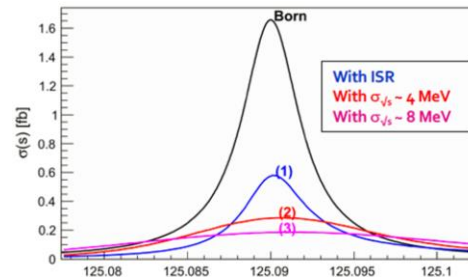
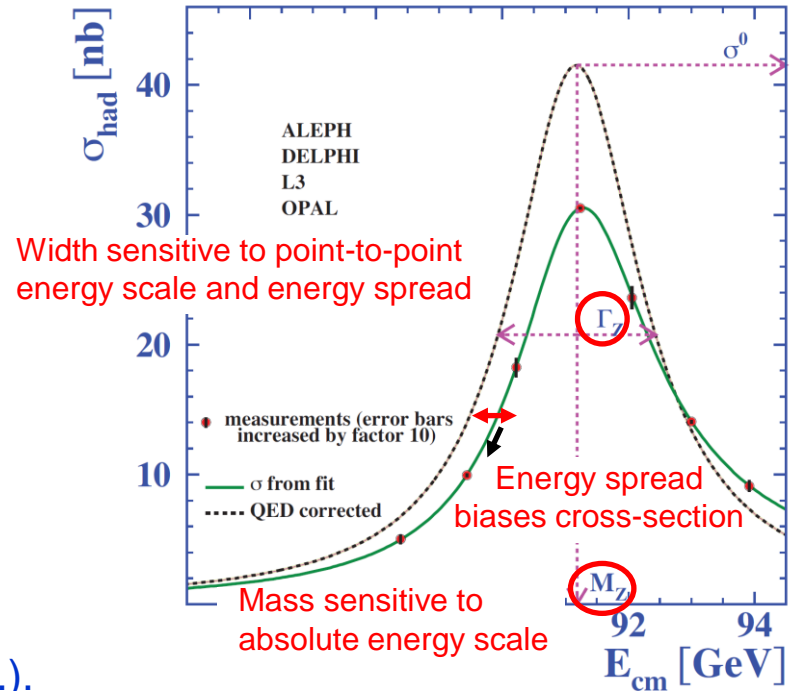
Calibration of E_{CM} , a critical systematic for Z lineshape parameters and W mass. (and needed at higher energies also).

Also needed: measurement of $\sigma_{E_{CM}}$.

Primary tools:

- E_b calibration from resonant depolarisation (RDP), (at least up to WW threshold);
- Measurements from e.g. $e^+e^- \rightarrow f\bar{f}(\gamma)$;
- Measurements needed for IP-specific corrections to go from E_b to E_{CM} (RF sawtooth, dispersion, crossing angle *etc.*).

Investigation of a viable monochromatisation scheme for possible Higgs-pole run (No further discussion today).



Reminder of baseline strategy (Z^0 example)

- Start of fill: inject ~ 120 non-colliding pilot bunches with wigglers on.
- Wait 60-100 mins for polarisation to grow (exact time requirement under study).
- Turn off wigglers and inject physics bunches.
- Perform (essentially) continuous Resonant Depolarisation (RDP) measurements of E_b for both e^+ and e^- pilot bunches (Free Precession Frequency (FSP) measurements a complementary option).
Rely on Sokolov-Ternov effect to replenish polarisation in used bunches.
- Monitor longitudinal polarisation levels in physics bunches (must be \sim zero!); depolarise if necessary.
- Continually adjust f_{RF} to keep beams centred in quads (minimise tide effects).
- Monitor and log all machine parameters ! Track E_b evolution between measurements with model à la LEP.
- Auxiliary procedures and measurements required to suppress and account for dispersion-related IP-specific effects in going from E_b to E_{CM} . Also necessary: corrections for RF sawtooth, measurements of / corrections for crossing angle and energy spread from $e^+e^- \rightarrow f\bar{f}(\gamma)$ events... *etc.*

EPOL ‘requirements’ document: (still evolving) report prepared to accompany Midterm Review



Preliminary draft 08:32 31 August 2023

31 August 2023

Accelerator and physics requirements for the calibration of the collision energy

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Keywords: EPOL, BI

Abstract

The Future Circular Collider (FCC) technical and financial Feasibility Study (FS) includes a work package on Energy Calibration, Polarisation and Monochromatisation (EPOL), which is concerned with the precision determination of the centre-of-mass energy at the e^+e^- machine, FCC-ee. To achieve this goal it is proposed to use resonant depolarisation and possibly spin precession measurements, in conjunction with precise measurement by the detectors of the energy spread and other parameters with physics events. Beam diagnostics, provided by polarimeters and beam-position monitors, play an essential role in monitoring the polarisation level and controlling numerous beam parameters at the interaction point. Specific items of accelerator equipment include polarisation wigglers and depolarising RF-kickers. The target is to achieve a precision commensurate to the remarkable statistical precision achievable in the physics experiments. The possible monochromatisation of colliding beams in view of a measurement of the $e^+e^- \rightarrow H(125)$ process is also being studied, with the specific requirements of this procedure under investigation.

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Builds on work presented in [\[arXiv:1909.12245\]](https://arxiv.org/abs/1909.12245), which was prepared for the CDR.

Tasks for remainder of Feasibility Study

- Ensure sufficient polarisation in optics, including HSM studies at Z & WW
- Procedure, systematics and ultimate precision on RDP & FSP measurements
- Inform studies through series of measurements at KARA (and other accelerators)
- Arrive at full conceptual design of polarimeter, including infrastructure
- Full costing of EPOL related items
- Wigglers vs polarisation ring (injecting polarised e^-/e^+ increasingly attractive possibility – is it feasible ?)
- Requirements on depolariser and agreement on depolarisation procedure for pilot and physics bunches
- Deepen understanding of IP-specific corrections, in particular dispersion and offset effects
- Improve understanding of input from experiments, e.g. effect of higher-order corrections and detector resolutions *etc.* in $e^+e^- \rightarrow f\bar{f}(\gamma)$ studies
- Establish feasibility and expected performance of monochromatisation scheme for electron Yukawa run

Tasks for remainder of Feasibility Study

Dedicated talks on several of these items today...

Y. Wu

- Ensure sufficient polarisation in optics, including HSM studies at Z & WW
- Procedure, systematics and ultimate precision on RDP & FSP measurements

W. Hofle

- Requirements on depolariser and agreement on depolarisation procedure for pilot and physics bunches

- Inform studies through series of measurements at KARA (and other accelerators)

J. Keintzel

- Deepen understanding of IP-specific corrections, in particular dispersion and offset effects

- Arrive at full conceptual design of polarimeter, including infrastructure

- Full costing of EPOL related items
- Wigglers vs polarisation ring (injecting polarised e^-/e^+ increasingly attractive possibility – is it feasible ?)

R. Kieffer

- Improve understanding of input from experiments, e.g. effect of higher-order corrections and detector resolutions *etc.* in $e^+e^- \rightarrow f\bar{f}(\gamma)$ studies

A. Faus-Golfe,
Tuesday morning

- Establish feasibility and expected performance of monochromatisation scheme for electron Yukawa run

Plus invited talks from the EIC (D. Gaskell, G. Hoffstaetter) & on polarised positron production (J. Grames). Also lessons from LEP & summary of next steps (E. Torrence).

Overview of sessions

13:30 → 15:00 **Joint effort PED & accelerators: EPOL (i)**

Convener: Guy Wilkinson (University of Oxford (GB))

13:30 **Introduction and overview**

Speaker: Guy Wilkinson (University of Oxford (GB))

13:50 **Polarized positron production**

Speaker: Joseph Grames (Massachusetts Institute of Technology (MIT))

14:10 **Experiments at existing facilities**

Speaker: Jacqueline Keintzel (CERN)

14:30 **The EIC polarimeter, and lessons for the FCC**

Speaker: Dave Gaskell (Thomas Jefferson National Accelerator)

15:30 → 17:03 **Joint effort PED & accelerators: EPOL (ii)**

Convener: Jacqueline Keintzel (CERN)

15:30 **Simulation polarization studies at the FCC**

Speaker: Yi Wu (EPFL - Ecole Polytechnique Federale Lausanne (CH))

15:48 **Polarized electrons at the EIC, and lessons for the FCC**

Speaker: Georg Hoffstaetter de Torquat (Cornell University)

16:06 **The FCC polarimeter**

Speaker: Dr Robert Kieffer (CERN)

16:25 **First thoughts on the FCC depolarizer**

Speaker: Wolfgang Hofle (CERN)

16:43 **Lessons from LEP, and final steps towards the Final Report of the Feasibility Study**

Speaker: Eric Torrence (University of Oregon (US))

Somebody is missing ?

Alain Blondel, a driving force behind EPOL studies, and the FCC-ee as a whole, sends his best wishes for the meeting from Georgia.



Conclusions and outlook

A baseline plan for meeting EPOL-related requirements was established in CDR, and refined for Midterm Report of FS. Key issues are now being investigated in more detail, with aim to have realisable solutions in place for Final Report.

Help very much welcome ! EPOL issues may be limiting systematics of many of the flagship measurements of the FCC-ee precision programme.

Sign up to e-group fcc-ee-PolarizationAndEnergyCalibration@cern.ch
Meetings can be found under <https://indico.cern.ch/category/8678/>

Jacqueline will summarise these two sessions on Friday morning.

Backups
