

**WG1-PREC “Precision in theory and experiment”**

**WG1-HTE “HIGGS-TOP-EW and connection with LHC”**

# **MiniWorkshop: Two Fermion Physics at $e^+e^-$**

22nd March 2024

## **Introduction**

PREC: Paolo Azzurri (INFN Pisa), Ayres Freitas (Univ. Pittsburgh), Adrian Irlles (IFIC CSIC/UV), Andreas B. Meyer (DESY)

HTE: Chris Hays (Oxford), Karsten Köneke (Freiburg), Fabio Maltoni (Louvain)

**ECFA Higgs Factory Working Group WG1 on Physics Potential**

# ECFA Higgs/EW/Top Factory Workshop

**Aim:** ...bring together the efforts of various e+e- projects, to share challenges and expertise, to explore synergies and to respond coherently to this high-priority strategy item.

- foster collaboration across projects
- between experimentalists and theorists
- facilitate entry for “newcomers”

**Timeframe:** we aim to provide input in ~2025 to the next European Strategy Update

**Entry point:** <https://gitlab.in2p3.fr/ecfa-study/ECFA-HiggsTopEW-Factories>

# ECFA Higgs Factory Study - WG1 Physics Potential

## Subgroup WG1-PREC “Precision in theory and experiment”

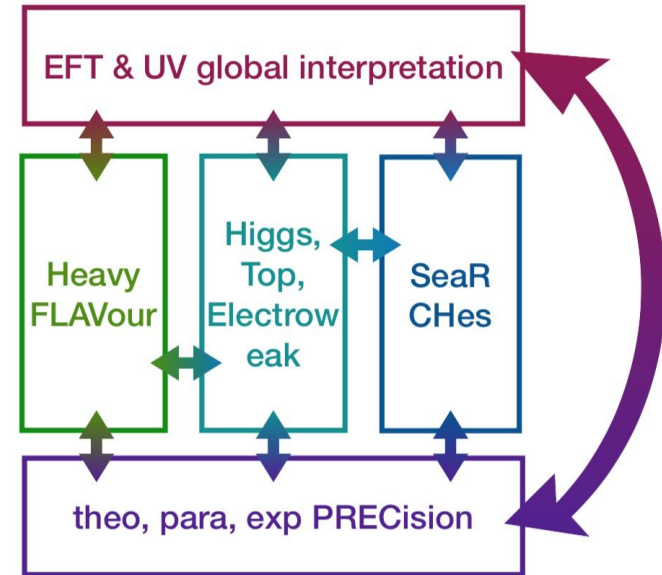
- One of the five subgroups of ECFA-WHF-WG1
- Addressing very high-precision observables

## Topics:

- Precision calculations and theoretical, parametric uncertainties
- Experimental systematic uncertainties

## Interplay:

- Other WG1 subgroups, in particular HTE, FLAV, and GLOB
- Interface with WG2 for object performance, generator and simulation for high-precision measurements



# ECFA Higgs Factory Study - WG1 Physics Potential

## Subgroup WG1-HTE “Precision in theory and experiment”

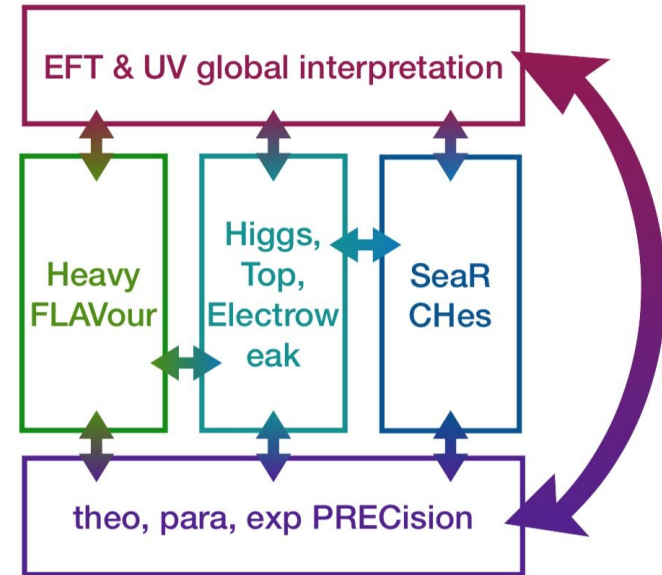
- One of the five subgroups of ECFA-WHF-WG1
- The HTE group studies Higgs/Top/EW physics topics not covered by the Precision and Flavour groups.

## Topics:

- Identify measurements that the HL-LHC can perform in order to increase the physics potential of a future Higgs and top/EW Factory: high-precision inclusive measurements as well as differential measurements, e.g. at high pT.

## Interplay:

- Precision and Flavour groups



# ECFA Higgs/EW/Top Factory Workshop

This meeting is part of a series of mini-workshops.

## Previous workshops organized by WG1-PREC

- high-precision measurements: <https://indico.cern.ch/event/1129966/> (8 March 2022)
- parametric uncertainties:  $\alpha_s$  <https://indico.cern.ch/event/1131344/> (10 March 2022)
- parametric uncertainties:  $\alpha_{\text{QED}}$  <https://indico.cern.ch/event/1173700/> (14 July 2022)
- collision energy <https://indico.cern.ch/event/1206598/> (2 Nov 2022)
- luminosity <https://indico.cern.ch/event/1218043/> (16 Dec 2022)
- cross section lineshapes <https://indico.cern.ch/event/1271343/> (14 April 2023)
- Z-couplings measurements <https://indico.cern.ch/event/1339326/> (13 November 2023)

## Previous workshops organized by WG1-HTE

- [Z-pole physics](#) on *September 23, 2022*.
- [Higgs/EW physics at 125 & 160 GeV](#) on *February 10, 2023*.
- [Higgs/EW physics at 160 & 240 GeV](#) on *May 12, 2023*.

# ECFA Higgs/EW/Top FOCUS TOPICS

Focus topic document <https://arxiv.org/abs/2401.07564>

<https://gitlab.in2p3.fr/ecfa-study/ECFA-HiggsTopEW-Factories/-/wikis/FocusTopics>

Focus topics are specific areas in which the ECFA study could reach significantly beyond the state-of-the-art understanding of the physics potential of future e+e- colliders.

The topics do not aim to comprehensively map the physics program of a future Higgs factory. Instead, they should serve to:

- complete the current overall picture where (most) necessary;
- give guidance to people who would like to contribute to the ECFA study;
- highlight processes particularly suitable for studying the interplay of the three working areas of the ECFA study: physics potential, analysis methods, and detector performance.

The topics are also meant to create new engagement and collaboration.

# ECFA Higgs/EW/Top FOCUS TOPICS

Focus topic document <https://arxiv.org/abs/2401.07564>

Table 1: Overview of focus topics and relevant centre-of-mass energies. Energies applicable to the considered topic are indicated with '✓'.

Topic	Lead group	Relevant $\sqrt{s}$ [GeV]				
		91	161	240–250	350–380	$\geq 500$
1 HtoSS	HTE			✓	✓	✓
2 ZHang	HTE (GLOB)			✓	✓	✓
3 Hself	GLOB			✓	✓	✓
4 Wmass	PREC		✓	✓	✓	✓
5 WWdiff	GLOB			✓	✓	✓
6 TTthres	GLOB (HTE)				✓	✓
7 LUMI	PREC	✓	✓	✓	✓	✓
8 EXscalar	SRCH			✓	✓	✓
9 LLPs	SRCH	✓	✓	✓	✓	✓
10 EXtt	SRCH				✓	✓
11 CKMWW	FLAV		✓	✓	✓	✓
12 BKtautau	FLAV	✓				
13 TwoF	HTE (PREC)	✓	✓	✓	✓	✓
14 BCfrag and Gsplit	PREC (FLAV)	✓	✓	✓	✓	✓

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

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

<https://gitlab.in2p3.fr/ecfa-study/ECFA-HiggsTopEW-Factories/-/wikis/FocusTopics/TwoF>

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 previous measurements. A significant improvement wrt LEP/SLC in precision could also be reached at the ILC and CepC.

Very challenging and exciting TwoF program at **Z-pole**, dominated by systematics.

- Polarization (or non-polarization) measurements
- Luminosity
- Fragmentation
- Detector acceptance, flavour tagging, PID performance...

but program also at **higher energies** (HZ threshold and above)



# Today:

**3:00 PM** → 3:10 PM **Introduction**

**Speakers:** Adrian Irlen (IFIC CSIC/UV), Andreas Meyer (DESY), Ayres Freitas, Paolo Azzurri (Universita & INFN Pisa (IT))

🕒 10m

**3:10 PM** → 3:40 PM **Status of Jet Origin Id studies**

**Speaker:** Manqi Ruan (Chinese Academy of Sciences (CN))

🕒 30m

**3:40 PM** → 4:10 PM **tau polarization studies**

**Speaker:** Daniel Jeans (High Energy Accelerator Research Organization (JP))

🕒 30m

**4:10 PM** → 4:40 PM **tau reconstruction challenges**

**Speaker:** Mogens Dam (University of Copenhagen (DK))

🕒 30m

**4:40 PM** → 5:00 PM **discussion**

🕒 20m

# Links

## Email list

For future WG1-PREC events, please subscribe here, and/or forward the link to interested colleagues:

<http://simba3.web.cern.ch/simba3/SelfSubscription.aspx?groupName=ecfa-whf-wg1-prec>

(this link and email list also works for non-cern accounts)

## WG1 portal page on indico

<https://indico.cern.ch/event/1044297/page/23971-wg1-group-activities>

## WG1 seminars and events

<https://indico.cern.ch/category/14055/>

## WG1 twiki page

<https://gitlab.in2p3.fr/ecfa-study/ECFA-HiggsTopEW-Factories>

# ECFA Higgs/EW/Top Factory Workshop

**2 large ECFA-Higgs/Top/EW factory workshops**

**2022- DESY** <https://indico.desy.de/event/33640>

**2023 - Paestum** <https://agenda.infn.it/event/34841>

**2024 - Paris (9-11 October, tba)**