

WWdiff Focus Topic

discussion of proposed program

ECFA

European Committee for Future Accelerators

ECFA workshops on
e+e- Higgs/EW/Top
factory

Jenny List

2st ECFA Workshop on Higgs / Electroweak / Top Factories

Paestum, 11-13 October 2023



WWdiff: General Motivation & Expert Team

Many thanks to all contributors!

- Constraints on gauge boson interactions = crucial ingredients to global interpretations, be it in SMEFT or in UV complete models
- new physics contributions to aTGCs and Higgs can be closely connected
=> complementary approaches

- coordinated by:
 - Jorge de Blas
 - Alexander Grohsjean
- further members:
 - Patrizia Azzi
 - Tim Barklow
 - Ansgar Denner
 - Wolfgang Kilian
 - JL
 - Frank Siegert

2 meetings sofar:

- July 12
- Sept 25

Previous Studies

for future e+e- colliders

- Theory-level studies (Diehl et al ~2002!), optimal observables: most general set of CP conserving and CP violating triple-gauge boson couplings (28 real parameters!) can be constrained at a centre-of-mass energy of 500 GeV with polarised beams
- Detector-level simulations (Marchesini, Rosca, Barklow ~2011 ff):
 - 500 GeV and 1 TeV,
 - joint extraction of 3 TGCs (LEP parametrisation) and beam polarisations
 - LO MC
 - restricted to $WW \rightarrow \mu\nu uq$ and $WW \rightarrow e\nu uq$
 - 3 TGCs and their covariance matrix passed on to global interpretations, e.g. SMEFT fits
- Extrapolation to 250 GeV (Karl ~2018)
- More recently:
 - statistical optimal observables for all the CP even interactions contributing at LO in SMEFT used in global fits, (but only) based on theory-level distributions (de Blas et al).
 - detailed study of ability to reduce impact systematics by combined fits to differential cross sections of 2f and 4f processes including many nuisance parameters at 250 GeV using LEP parametrisation (Beyer)

Goals

of this focus topic

- Main objective:
understand the full potential of e^+e^- colliders wrt gauge boson interactions,
using the full differential information from W -pair and single- W events
to extract CP even and CP odd couplings,
based on detailed detector simulation with assessments of systematic uncertainties,
at all centre-of-mass energies.
- Also important:
establish the complementarity with HL-LHC and to clarify gain expected at future e^+e^- colliders.

Theory state-of-the-art

of this focus topic

- LEP2 times:
 - differential cross section for W -pair production including W decays only known within the double-pole approximation,
 - implemented in YFSWW and RacoonWW
- Later:
 - complete electroweak $O(\alpha)$ corrections in the SM calculated for some charged-current four-fermion production processes
 - available in unpublished Racoon4f.
 - on top: also the LL ISR effects beyond $O(\alpha)$ in the structure-function approach
- SM extensions like the dimension-six SMEFT:
 - doable thanks to UFO models at LO
 - automated calculation of NLO QCD corrections via the UFO model SMEFT@NLO.
 - automated calculation of NLO electroweak corrections will be completed and available in Madgraph and Whizard (expected to be large at high energies)

To-dos

where you can join!

- full detector simulation WW and single-W processes at all energies
 - event selection - all channels, incl. qqqq
 - reconstruction of decay and production angles and (statistically) optimal observables
 - systematic uncertainties / nuisance parameters
- definition of interface between global interpretations and experimental studies, incl. systematics, nuisance parameters etc
- extension of global interpretations - and the required experimental inputs! - to CP violating couplings
- interplay / combination with HL-LHC - any chance of updated projections?
- simple PR message: which energy scales can we probe with these measurements?

Resources

more than papers

- last ILD qqInu analysis: https://github.com/ILDAnaSoft/ILDbench_WWqqInu
=> Graham Wilson...
- recent MC samples in ILD available at 250 GeV
- available MC samples from other detector concepts?

And now its your turn

time to wake up :)

- questions?
- what is missing?
- volunteers?
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