ETP FCC meeting - project planning

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Project status

Projects	Status
HNL	Paper in reviewed by JHEP. Received comments and submitted revision
H tautau	xsec: 240 GeV finalized, 365 GeV started (finish in March, paper) CP: reconstruction study ongoing
tau reco	(Lars) transformer tagging on fastsim: works well, not implemented in FCC framework (Gregor) GATr on full sim: works well, but cannot tune Transformer structure
top Vts	First final results frozen for ECFA. Revision ongoing.
top EWK	Sarah can now make stacked histograms from trees No full analysis workflow yet. Did not follow on EFT.
single top at 240 GeV	Rafael can now generate MG samples and make simple histograms. Working on implementing object selection

In-house expertise

Technical tasks	**People with experience**	**expert** (for the scope of FCC studies)
MC Generation	MG (and EFT): Alejandro, Matteo, Rafael, Sofia, Xunwu Whizard, EvtGen: Xunwu	yes
Simulation	FastSim: Alejandro, Matteo, Rafael, Sofia, Xunwu FullSim: Gregor, Xunwu	fastsim yes fullsim no
reconstruction	vertexing, jet clustering, flavor tagging: Sofia, Xunwu explicit tau reco: Aaron, Sofia, Xunwu tau polarimetry: Sofia	yes
FCC analysis workflow	Aaron, Matteo, Sofia, Xunwu (Sarah and Rafael are learning)	yes
combine	Matteo, Sofia, Xunwu	yes
ML	Transformer: Gregor	no, but Jan

Potential project (1/2) - analyses

topic	level	Potential mentor	goal	relevant work
Higgs EFT	master or PhD	Matteo, Sofia	study HVV CP via H->Zgam, gamgam	JHU on HVV CP, MIT on H->Zgam, gamgam
ALPS	master	Matteo, Sofia	search e+e- -> ZA, gamA (A undetected)	FCC-ee has A->gamgam Belle has similar studies https://arxiv.org/abs/2307.06369
flavor violating Z or H decays	bachelor or master	Sofia, Xunwu	check Z/H->uc, ds, db, sb sensitivity Master can do more tagger dev	pheno study https://arxiv.org/abs/2306.17520
FCNC top production	master	Jan, Xunwu	search single top FCNC production at 240 GeV (and/or decay at 365 GeV)	FCC study (no update) CEPC study (no update) Rafael's project
top EWK	master	Jan, Matteo, Xunwu	Add EFT interpretation, and write paper	Sarah's project (if decides for master thesis)
flavor physics	master	Xunwu	for example, Bs->tau tau connect with tau reco dev	B->tau nu H->tau tau

more info at google sheet (not updated)

Potential project (2/2) - technical

topic	level	Potential mentor	goal	relevant work
pion vs photon	bachelor (ML) or master	Jan, Xunwu	ML-based pion vs photon ID in full sim.	Gregor's tau ID
jet flavor tagger	master	Jan, Xunwu	Transformer tagger with full sim	https://arxiv.org/abs/2406.08590 Lars' fast sim tagger Gregor's tau ID
jet clustering	bachelor or master	Xunwu	for multi-jets events, study clustering efficiency and interplay with flavor tagging	top Vts analysis
kinematic fit	bachelor or master	Sofia, Xunwu	tool to improve reco eff and reso, e.g. top reco, tau polarimetry,	tau CP angle reco hadronic top reco
tracking	?	Belle people?	Use GNN for tracking? full sim	INFN, IDEA people

more info at google sheet (not updated)

Student timeline

Member	remark
Sofia	Currently full-time. Switch to CMS this year (TBD)
Alejandro	Starting, part-time, involvement TBD
Aaron	Thesis hand-in by July?
Sarah	Hiwi contract ends in Feb. Expect master thesis around June
Gregor	Thesis hand-in by 04.03
Rafael	Thesis hand-in by mid May?

Conferences

- Corfu for future accelerators 27 April - 4 May, https://www.physics.ntua.gr/corfu2025/fa.html
- CEPC workshop 5-8 May, Barcelona, https://indico.ifae.es/event/2054/
- Higgs Pairs, 11-17 May, Isola d'Elba, https://www.pi.infn.it/hh2025/
  - 15'+5' FCC overview looking for speaker
- FCC week, 19-23 May, Vienna, https://indico.cern.ch/event/1408515/
- Higgs and Effective Field Theory, 2-6 June, CERN, https://indico.cern.ch/event/1487697/
- European Strategy Symposium, 23-27 June, Venice Lido https://agenda.infn.it/event/44943/
- EPS-HEP 2025, 7-11 July, Marseille, https://www.eps-hep2025.eu/
- Higgs Hunting 2025, 15-17 July, Paris, https://indico.ijclab.in2p3.fr/event/11484/

backups

Higgs summary

FCC-ee + HL-LHC

Coupling	HL-LHC	FCC-ee (240–365 GeV) 2 IPs / 4 IPs
κ_W [%]	1.5*	0.43 / 0.33
κ_Z [%]	1.3*	0.17 / 0.14
κ_g [%]	2*	0.90 / 0.77
κ_γ [%]	1.6*	1.3 / 1.2
$\kappa_{Z\gamma}$ [%]	10*	10 / 10
κ_c [%]	–	1.3 / 1.1
κ_t [%]	3.2*	3.1 / 3.1
κ_b [%]	2.5*	0.64 / 0.56
κ_μ [%]	4.4*	3.9 / 3.7
κ_τ [%]	1.6*	0.66 / 0.55
BR_{inv} (<%, 95% CL)	1.9*	0.20 / 0.15
BR_{unt} (<%, 95% CL)	4*	1.0 / 0.88

Table 1: Relative uncertainty (%) on $\sigma_{ZH} \times \mathcal{B}(H \to XX)$ and $\sigma_{\nu_e\bar{\nu}_e H} \times \mathcal{B}(H \to XX)$, as expected from the FCC-ee data at 240 and 365 GeV from the CDR.

$\sqrt{s}$	240 GeV		365 GeV	
Integrated luminosity	10.8 ab^{-1}		3.0 ab^{-1}	
Channel	ZH	$\nu_e\bar{\nu}_e$H	ZH	$\nu_e\bar{\nu}_e$H
H → any	±0.36		±0.6	
H → bb	±0.20	±2.1	±0.35	±0.6
H → cc	±1.5		±4.4	±7.1
H → gg	±1.3		±2.5	±3.2
H → W^+W^-	±0.8		±1.8	±2.1
H → ZZ	±3.0		±8.5	±4.7
H → $\tau^+\tau^-$	±0.6		±1.8	±2.1
H → $\gamma\gamma$	±6.1		±13	±16
H → Zγ	??	??	??	??
H → $\mu^+\mu^-$	±13		±28	
H → invisible	< 0.2		< 0.4	

In MTR and current FSR, taken from 1905.03764 (Global fit)

CDR configuration (5 ab^{-1} for 2 IPs, 7.2 ab^{-1} for 4 IPs)

CDR table scaled to latest FCC-ee lumi

Higgs summary

(**WIP**) latest FCC-ee expectations

Table 2: Relative uncertainty (%) on $\sigma_{ZH} \times \mathcal{B}(H \to XX)$ and $\sigma_{\nu_e\bar{\nu}_e H} \times \mathcal{B}(H \to XX)$, as expected from the FCC-ee data at 240 and 365 GeV from current studies.

$\sqrt{s}$	240 GeV		365 GeV	
Integrated luminosity	10.8 ab^{-1}		3.0 ab^{-1}	
Channel	ZH	$\nu_e\bar{\nu}_e$H	ZH	$\nu_e\bar{\nu}_e$H
H → any	±0.59(0.36)		±1.48(0.6)	
H → bb	±0.21(0.20)	XX	±0.41(0.35)	±0.67(0.6)
H → cc	±1.65(1.5)		±3.13(4.4)	±3.49(7.1)
H → ss	±105(NA)		±356(NA)	±290(NA)
H → gg	±0.80(1.3)		±2.21(2.5)	±2.66(3.2)
H → W^+W^-	±1.1(0.8)		±3.18(1.8)	±5.36(2.1)
H → ZZ	±3.1(3.0)		??	??
H → $\tau^+\tau^-$	±0.66(0.6)		±1.8	±2.1
H → $\gamma\gamma$	±3.1(6.1)		±13	±16
H → Zγ	NA	??	??	??
H → $\mu^+\mu^-$	±11(13)		±26(28)	
H → invisible (upper limit)	< 0.02		< 0.04	
H → invisible (rel. unc. to SM)	±27		±75	