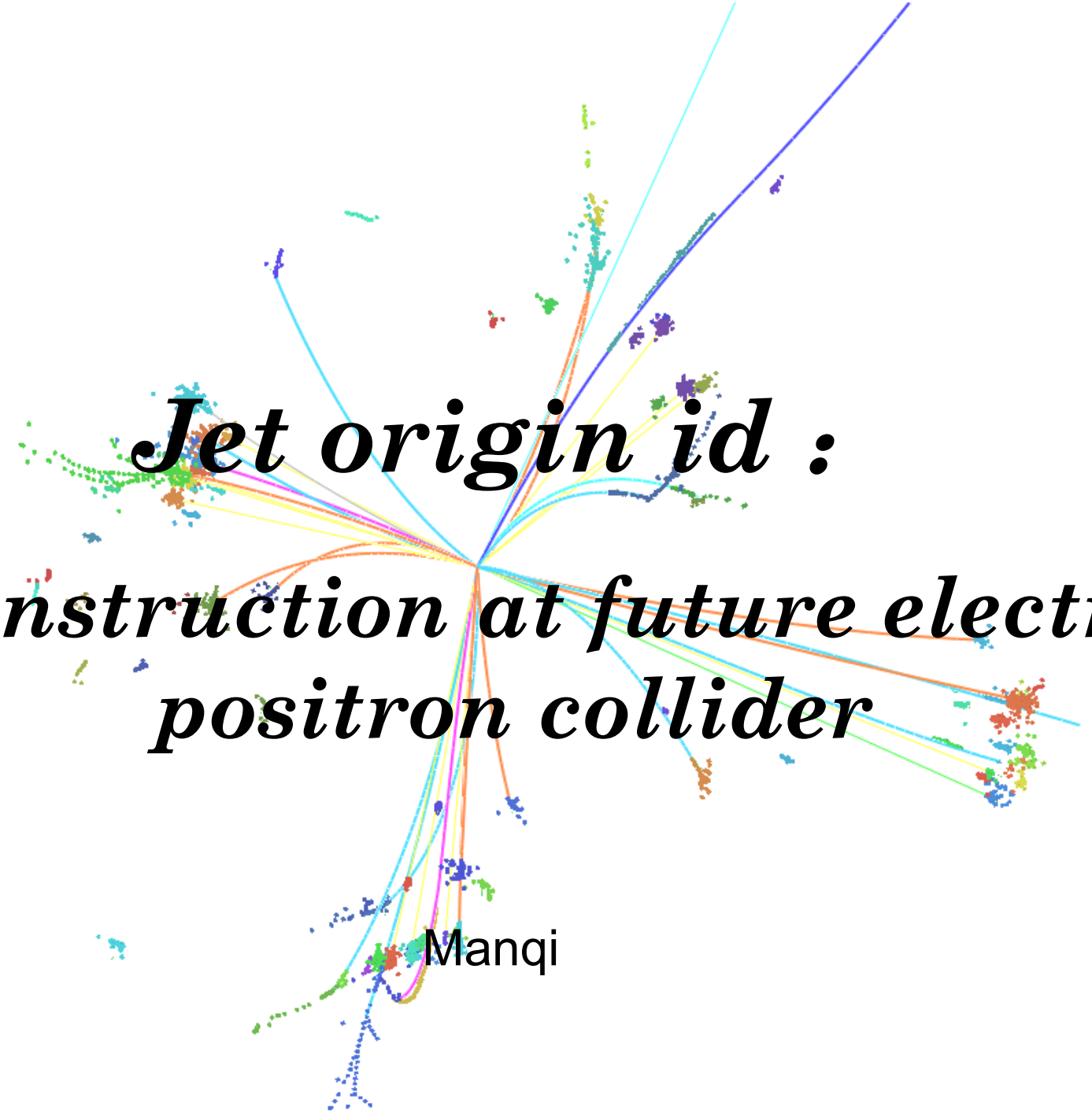
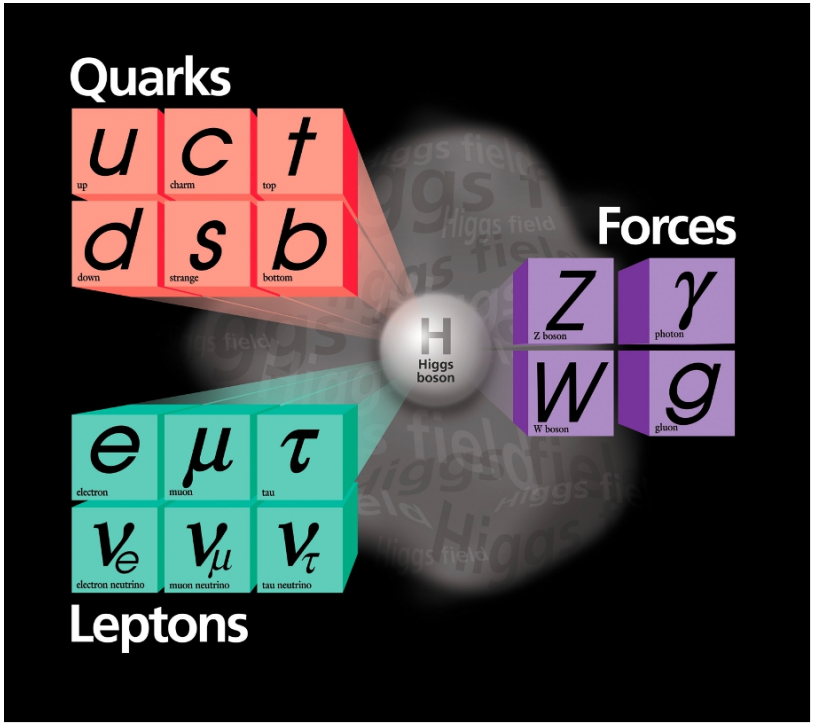


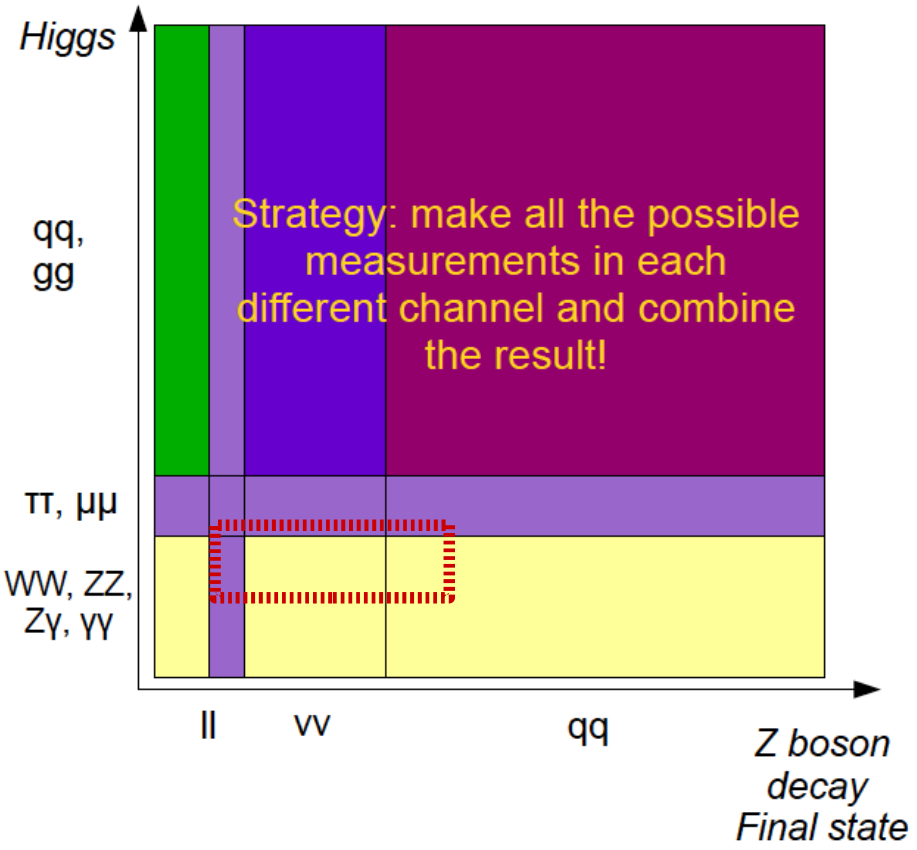
Jet origin id :

Reconstruction at future electron positron collider

Manqi

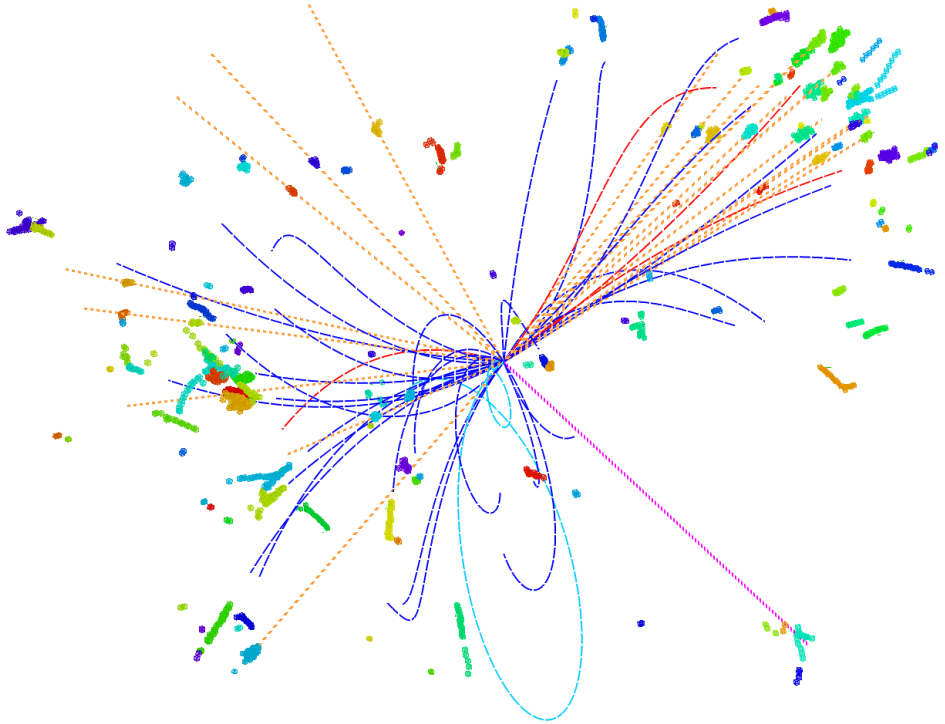
Jets @ CEPC

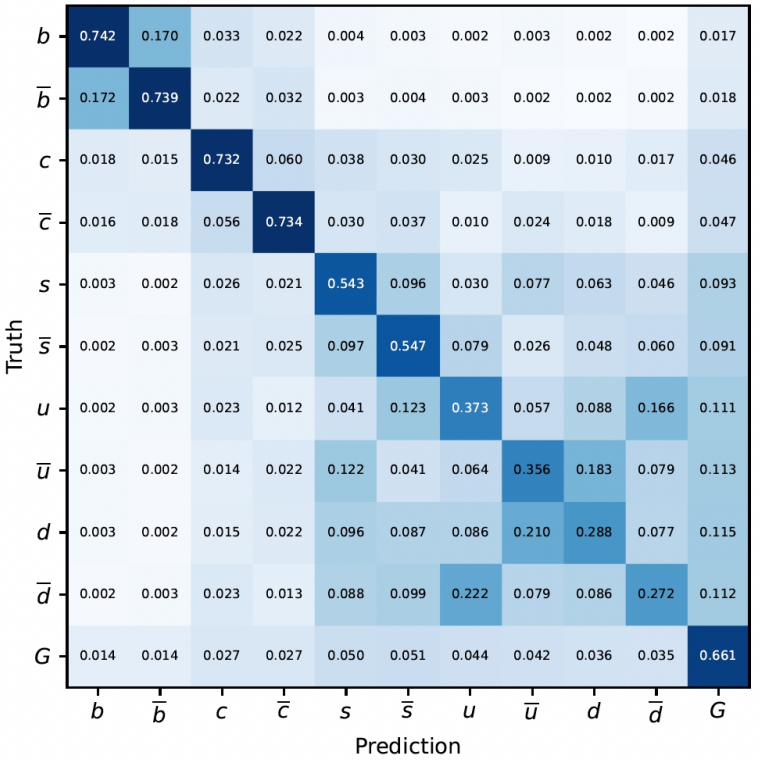




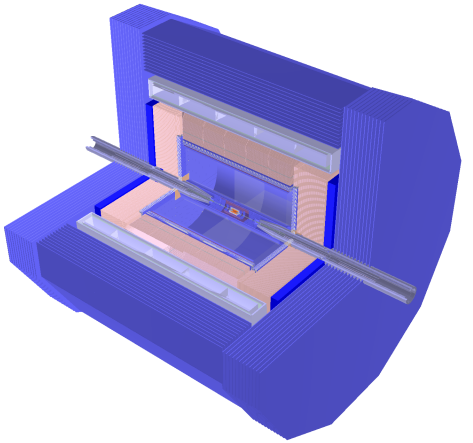
- Massive Four in Standard Model:
  - Z & W: ~ 70% goes to a pair of jets
  - Higgs: ~90% goes to jet final states
  - Top: t → W + B

Identification of all jet species...

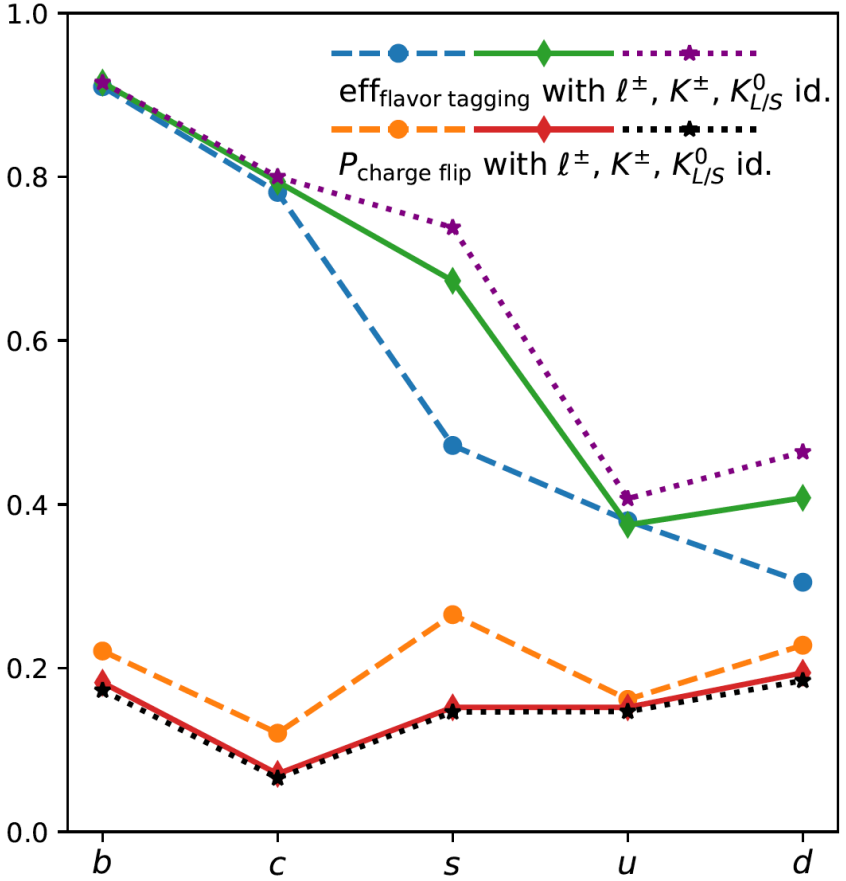


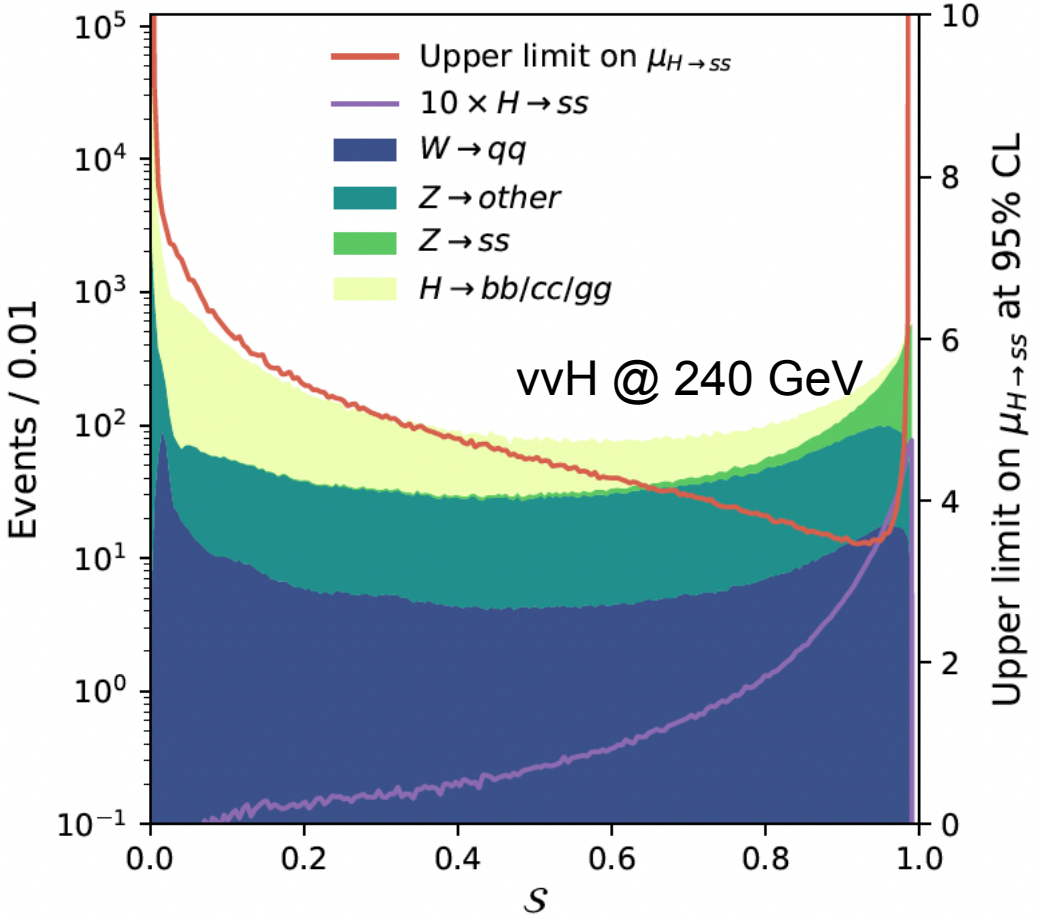


- **Jet origin identification: 11 categories (5 quarks + 5 anti quarks + gluon)**
- Full Simulated vvH, Higgs to two jets sample at CEPC baseline configuration: CEPC-v4 detector, reconstructed with **Arbor + ParticleNet (Deep Learning Tech.)**



Performance with different PID scenarios & H→ss measurements



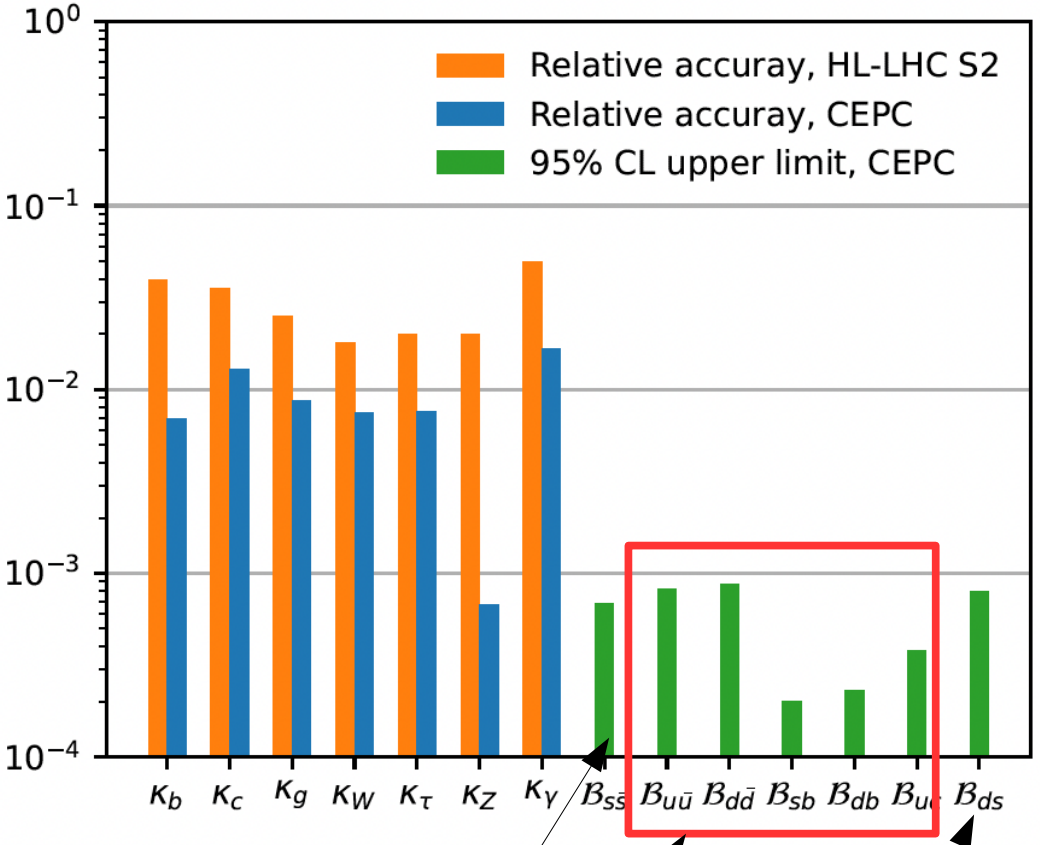


Flavor tagging: type that maximize {L_q + L_q_bar, L_g}

If quark jet: jet charge ~ compare {L_q, L_q_bar}

Remark: current jet flavor tagging efficiency & jet charge flip rates are projections of the 11-dim arrays produced by Jet origin id

Benchmark analyses: Higgs rare/FCNC



Improved by ~3 times

Improved by 1-2 orders of magnitudes

Presumably... firstly quantified

TABLE I: Summary of background events of $H \to b\bar{b}/c\bar{c}/gg$, Z, and W prior to flavor-based event selection, along with the expected upper limits on Higgs decay branching ratios at 95% CL. Expectations are derived based on the background-only hypothesis.

	Bkg. (10^3)			Upper limit (10^{-3})						
	H	Z	W	$s\bar{s}$	$u\bar{u}$	$d\bar{d}$	sb	db	uc	ds
$\nu\bar{\nu}H$	151	20	2.1	0.81	0.95	0.99	0.26	0.27	0.46	0.93
$\mu^+\mu^-H$	50	25	0	2.6	3.0	3.2	0.5	0.6	1.0	3.0
e^+e^-H	26	16	0	4.1	4.6	4.8	0.7	0.9	1.6	4.3
Comb.	-	-	-	0.75	0.91	0.95	0.22	0.23	0.39	0.86

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[59] J. de Blas et al. Higgs Boson Studies at Future Particle Colliders. *JHEP*, 01:139, 2020.

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For H->bb, cc, gg: results in 20 – 40% improvement in relative accuracies (preliminary)...

Next step

- Jet origin id:
  - Not only critical for Higgs measurements, but beneficial for all measurements with jets – weak mixing angle, flavor, etc.
  - “World leading performance of tagger”, “A game changer and opens new horizon for precision flavor studies at all future experiments.”
- Next steps:
  - Apply to Particle Flow Reconstruction, in progress
- General question from Reconstruction
  - Categorization (identification),
  - Grouping (Clustering),
  - Evaluation.

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Jet-Origin Identification and Its Application at an Electron-Positron Higgs Factory

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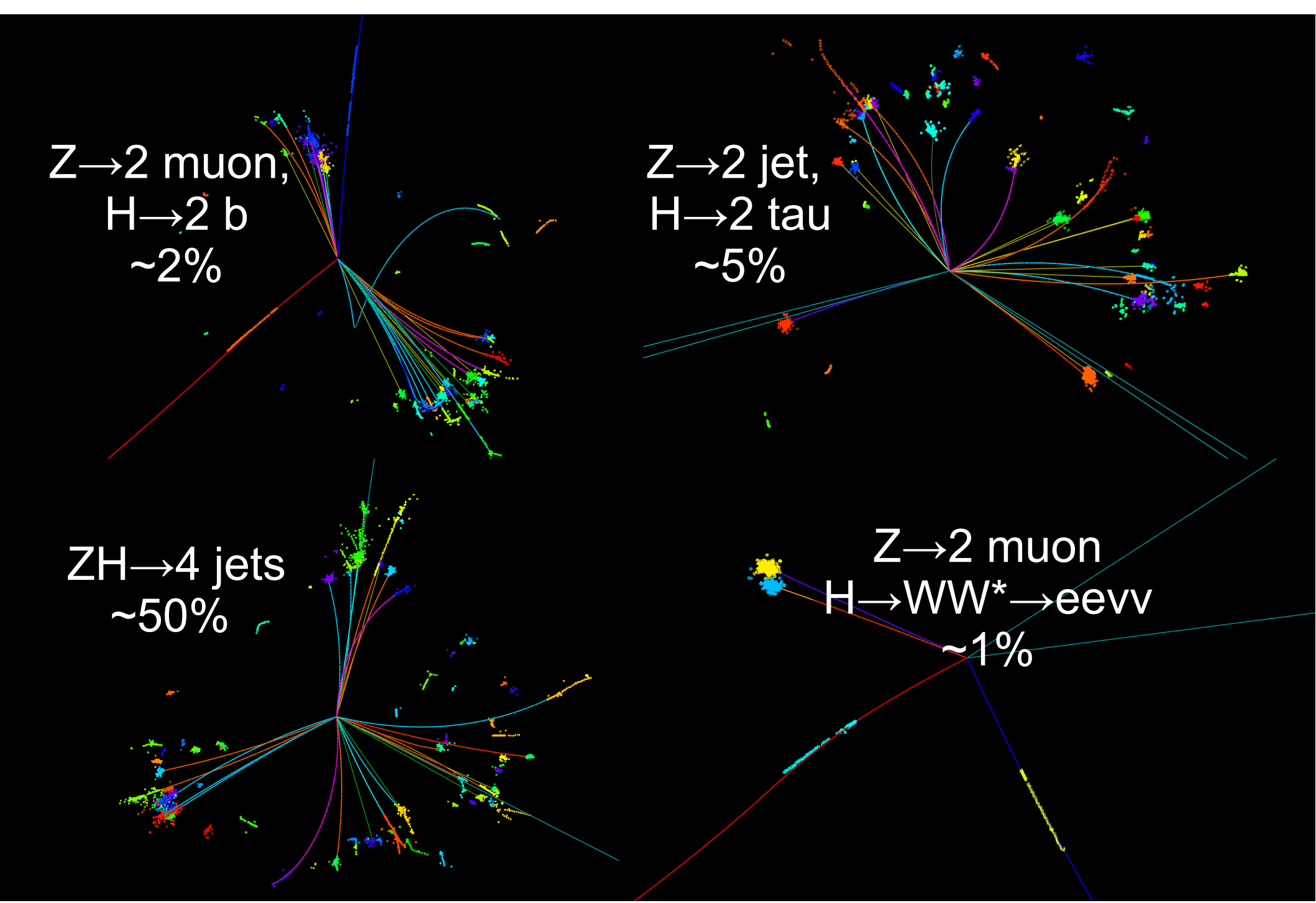
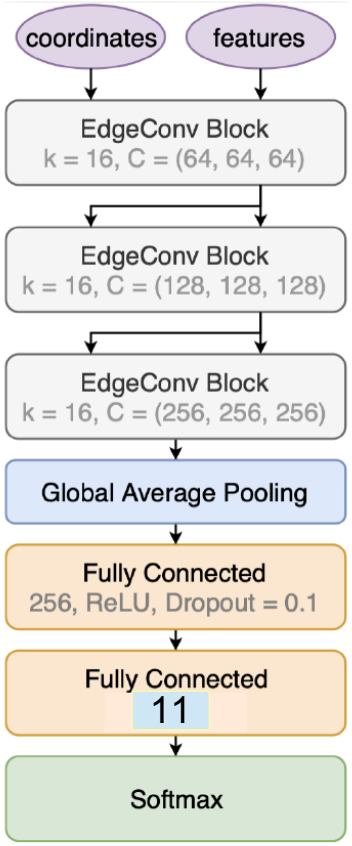
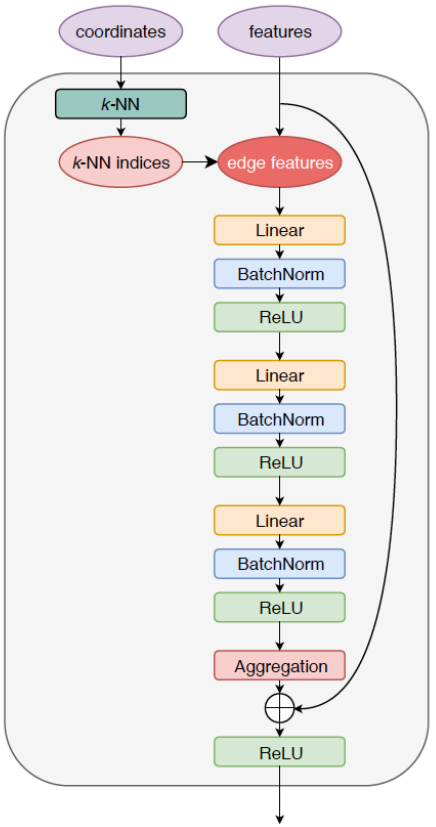
Back up


Z→2 muon,
H→2 b
~2%
Z→2 jet,
H→2 tau
~5%
ZH→4 jets
~50%
Z→2 muon
H→WW*→eevv
~1%

Particle Net: IO





Variable	Definition
$\Delta\eta$	difference in pseudorapidity between the particle and the jet axis
$\Delta\phi$	difference in azimuthal angle between the particle and the jet axis
$logp_T$	logarithm of the particle's p_T
$logE$	logarithm of the particle's energy
$log\frac{p_T}{p_T(jet)}$	logarithm of the particle's p_T relative to the jet p_T
$log\frac{E}{E(jet)}$	logarithm of the particle's energy relative to the jet energy
ΔR	angular separation between the particle and the jet axis $(\sqrt{(\Delta\eta)^2+(\Delta\phi)^2})$
d0	transverse impact parameter of the track
d0err	uncertainty associated with the measurement of the d0
z0	longitudinal impact parameter of the track
z0err	uncertainty associated with the measurement of the z0
charge	electric charge of the particle
isElectron	if the particle is an electron
isMuon	if the particle is a muon
isChragedKaon	if the particle is a charged Kaon
isChragedPion	if the particle is a charged Pion
isProton	if the particle is a proton
isNeutralHadron	if the particle is a neutral hadron
isPhoton	if the particle is a photon

Table 3. The input variables used in ParticleNet for jet flavor tagging at the CEPC.

- Output: likelihoods to different categories