

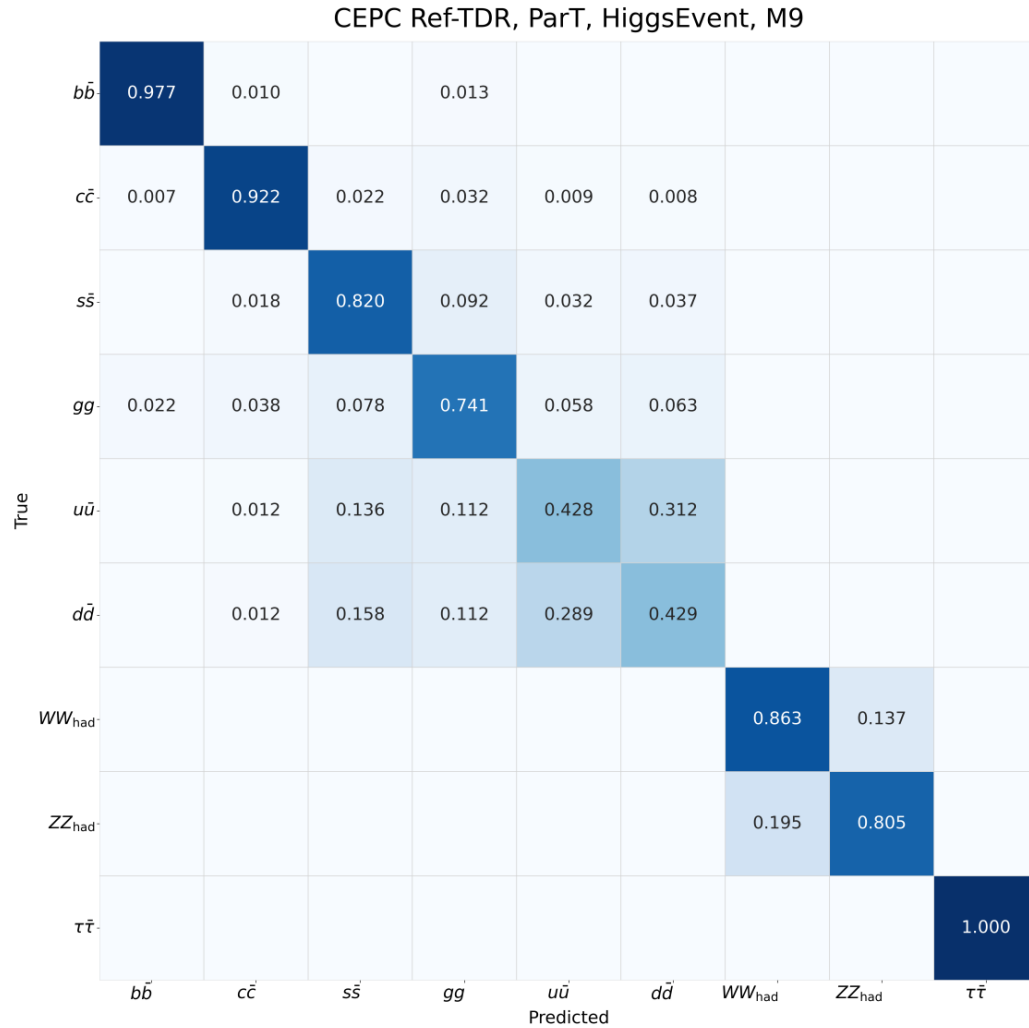


CEPC $H \rightarrow ss$ Brief Look

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$H \rightarrow ss$: The Crown



With Particle Transformer + CEPC 21.6iab data,
We are very close to 5sigma $H \rightarrow ss$ discovery.

This result done in CEPC TDR full simulation, reco ID.

Which scenario?



	Select	Alternative
Generator	Madgraph3.6.3+Pythia8313	Whizard1.9.5+Pythia6.3, Whizard3+Pythia8, Madgraph3+Herwig73
Simulation	Delphes(Fast, intrinsic)	CEPCSW(Full), CEPCSoft(Marlin, Full)
Geometry/Vertex	TDR	CDR
ParT Algo	ParT-ee	PN, ParT, Mi-ParT,
PID	Truth(Ideal)	Reco
Jet/Event level	Event	Jet tagging

Additionally, we need:

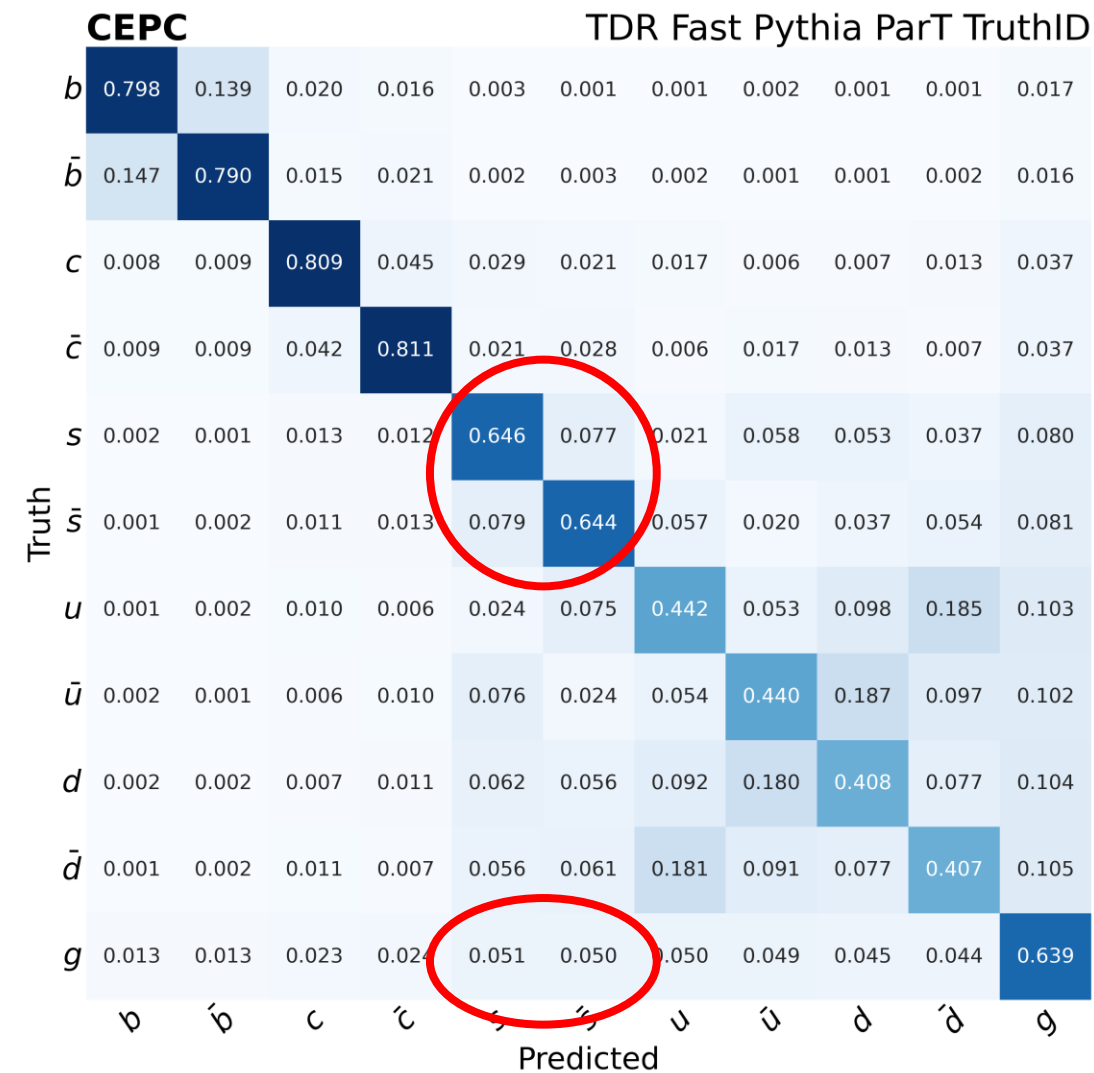
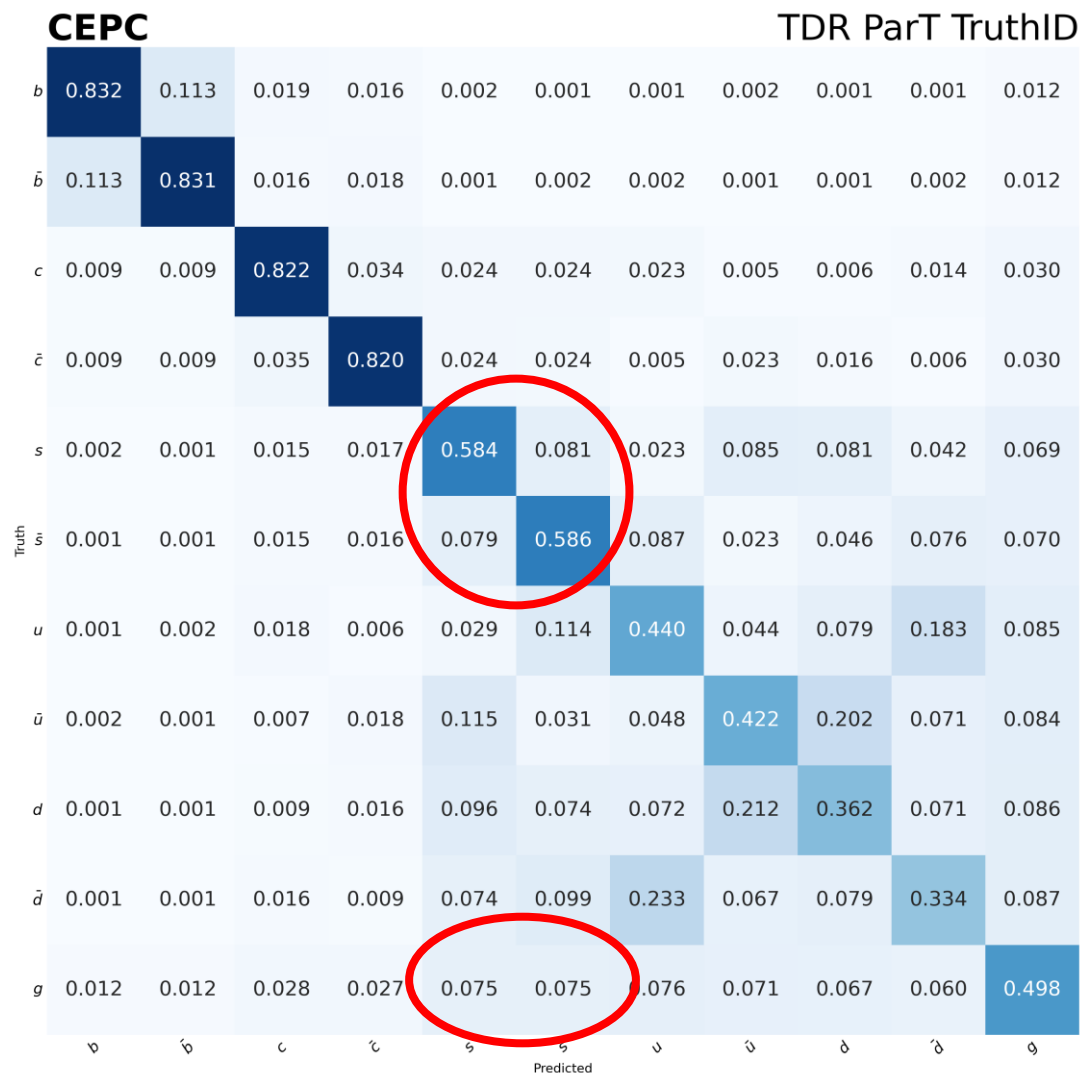
1. All Z final states: ee/mm/tautau/vv, and, most complicated, qq.
2. Include SM backgrounds.
 - For Z(vv)+H(ss), ee->qq, ee->ww/zz->qqqq is easy to separate: but ee->zz->vv+ss.
3. Think about how to disdistinguish from Hss and Hgg. (major background)

- In latest model like P8 and H7, s quark has more(>10%) charged kaons in final states than P6.
 - Currently we have Madgraph3.6.3+Pythia8313, with ISR + PDF + LO correction.
 - Very glad to have theoretical contribution!

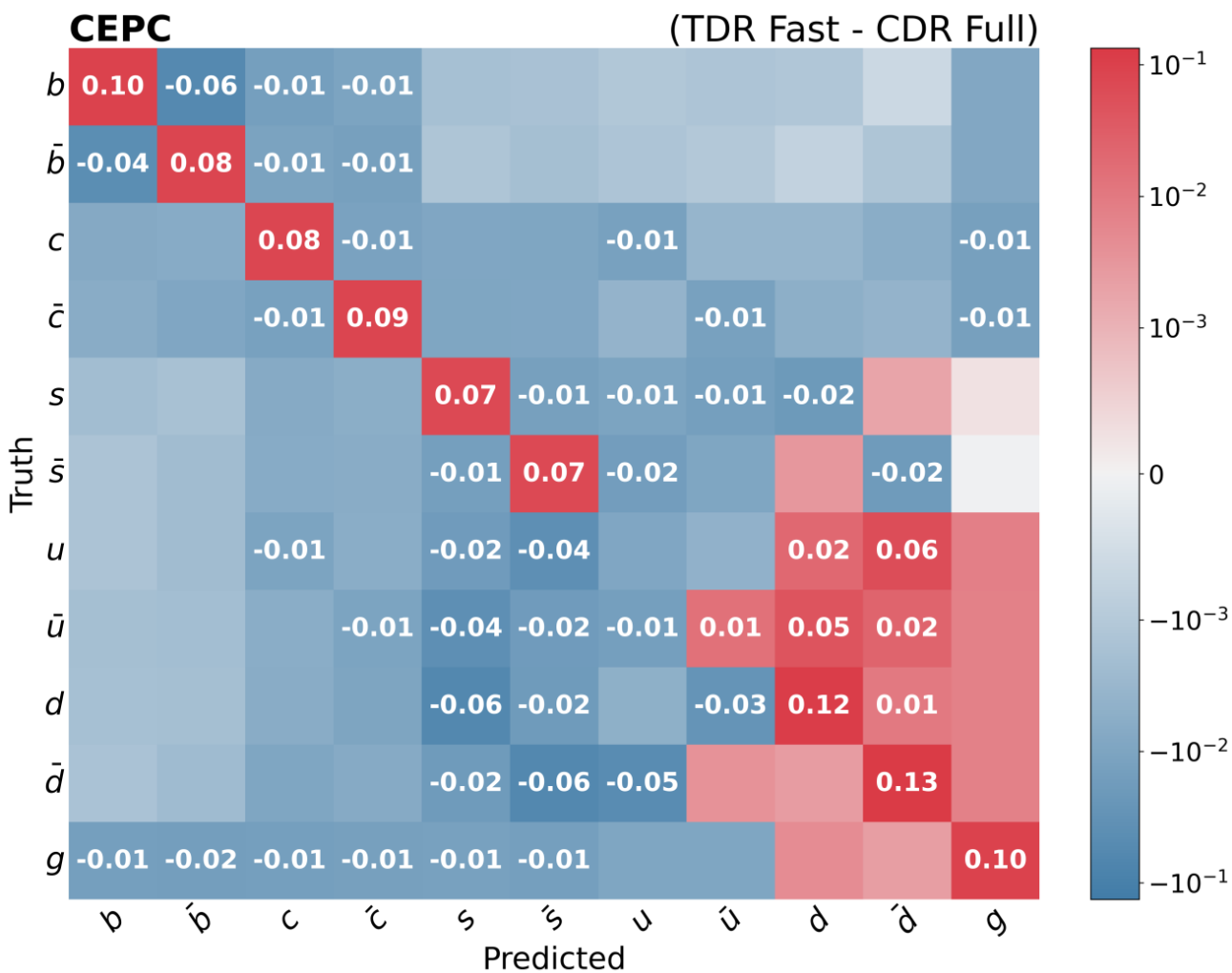
W+Py6 & M+Py8.3



Py8 much better!

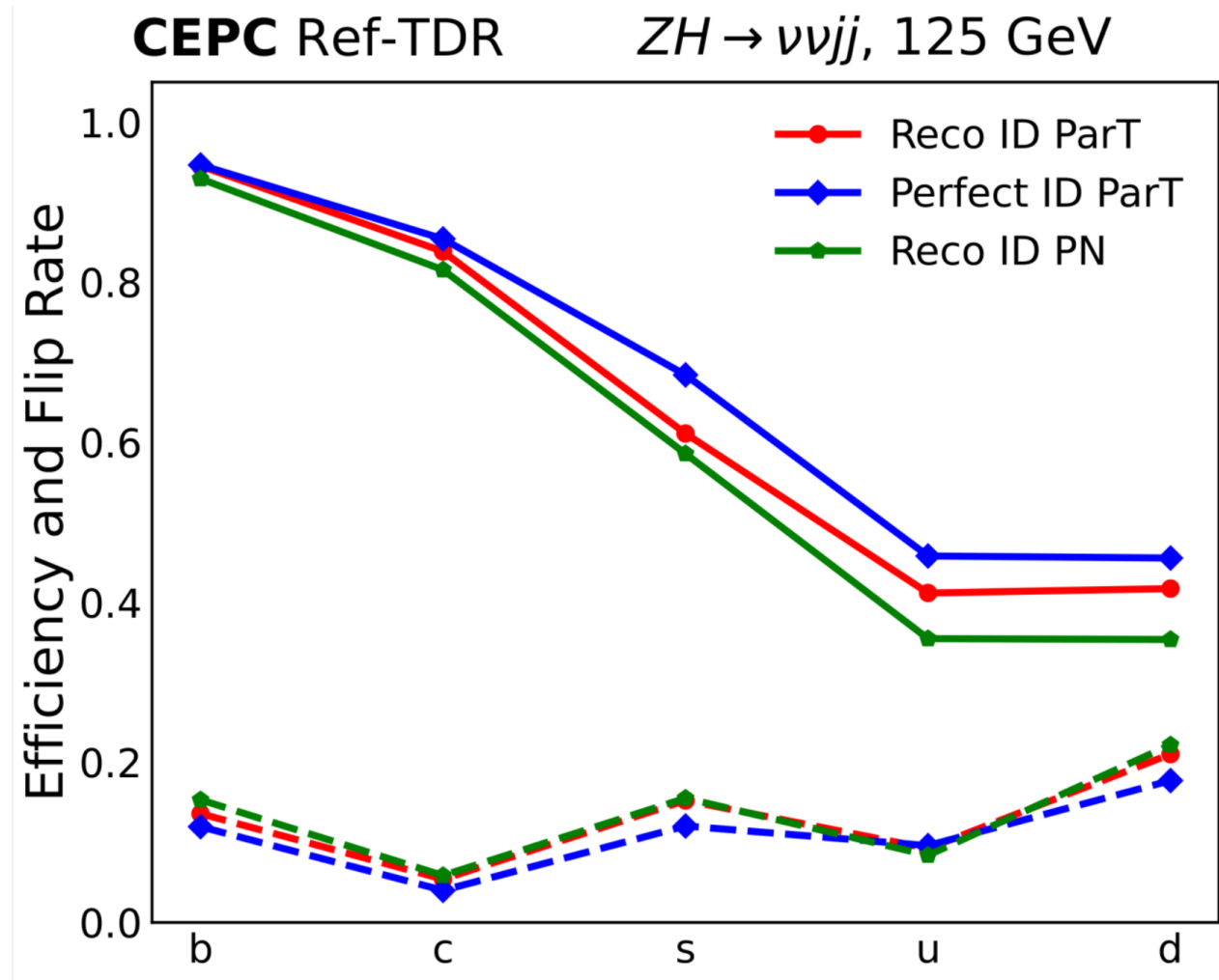


- CEPCSW(Full): <https://code.ihep.ac.cn/cepc/CEPCSW>
- Delphes(Fast): https://code.ihep.ac.cn/zhangkl/delphes_cepc/-/blob/CEPC/cards/delphes_card_CEPC_RefTDR_Intrinsic.tcl?ref_type=heads
 - provide the performance from Hardware part;
 - No shower shape information to use.
 - Performance no big difference but fast is a bit easier to handle.
 - Fast can only truth ID.



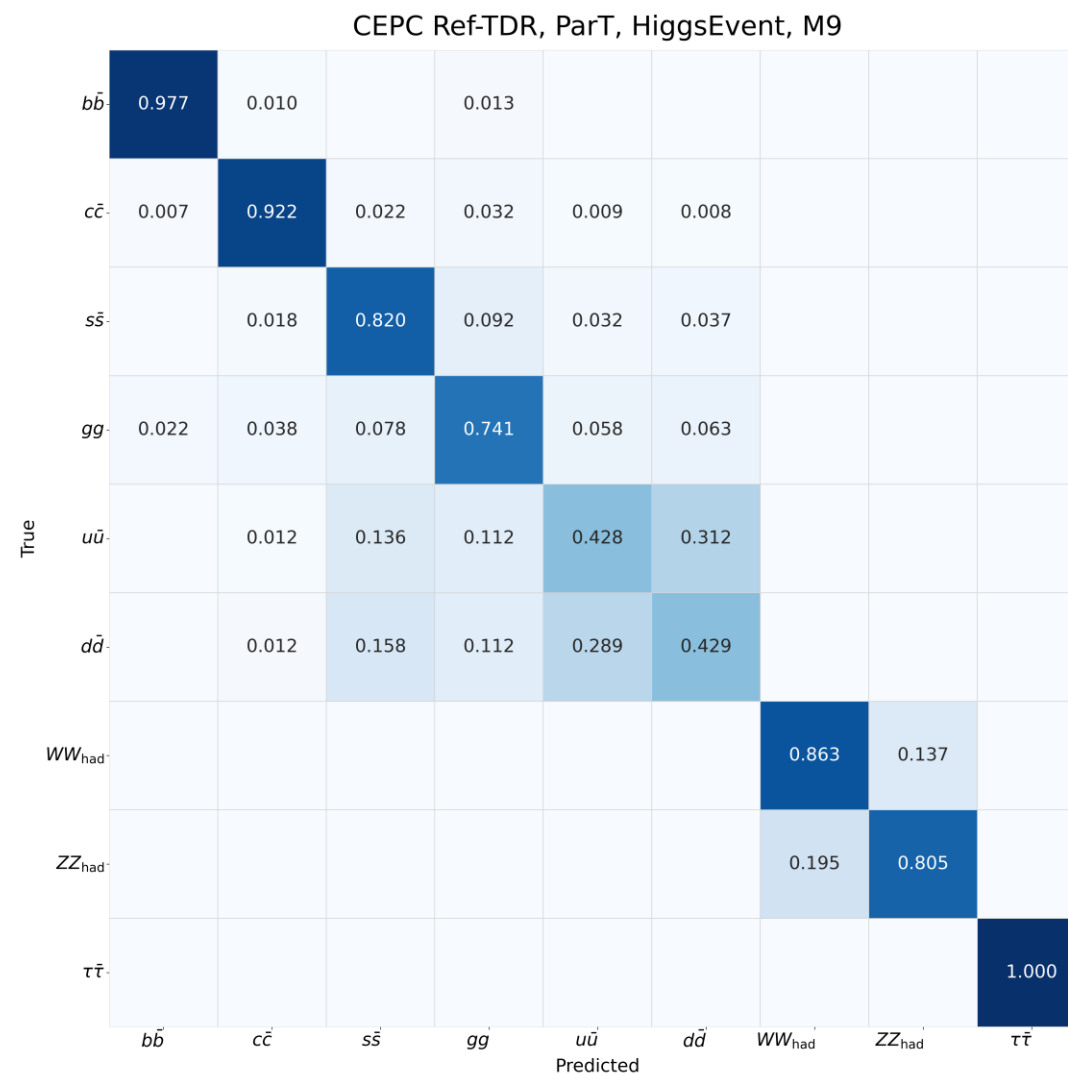
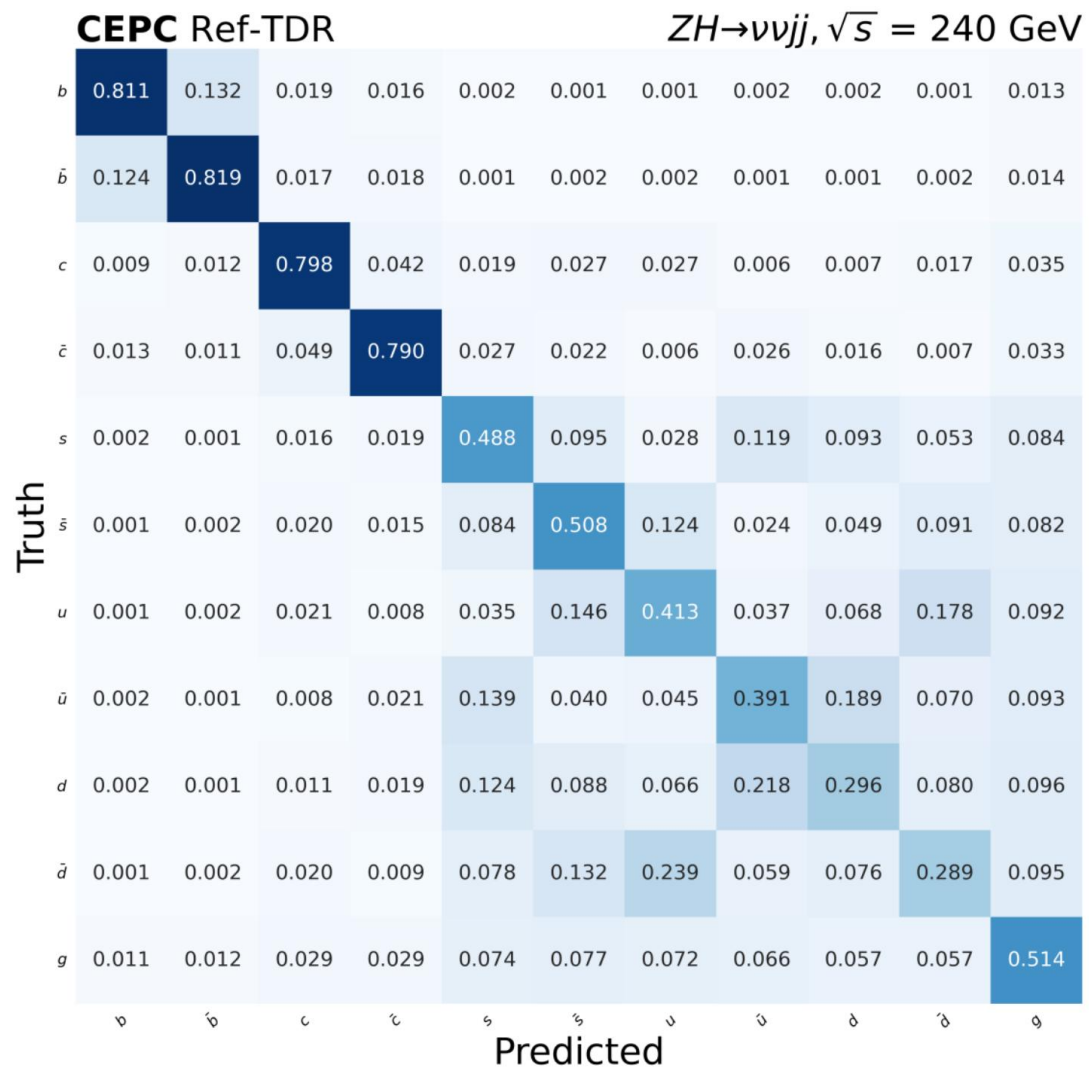
- TDR $\gg$ CDR $\sim 10\%$. Should use TDR.
- Mainly from vertex detector performance.
- Impact parameters essential.
- Can test one more aggressive vertex if needed.

- CEPCSW FinalPID provide reasonable PID performance. But:
 - Hardware: limited when $pt < 1$ GeV; Most small tracks in jet do not have enough information for PID.
 - Software: Imperfect reconstruction.
 - Difference $\sim 10\%$ in s jet tagging.



- ParT > PN ~3%.
- ParT-ee (optimized for CEPC with $\cos \theta$ instead of $\Delta\eta$ for ee colliders)
 - Performance similar with Normal ParT and Mi-ParT.
- Other techs in training like double embeds...
 - Small contribution. ~1-2%.

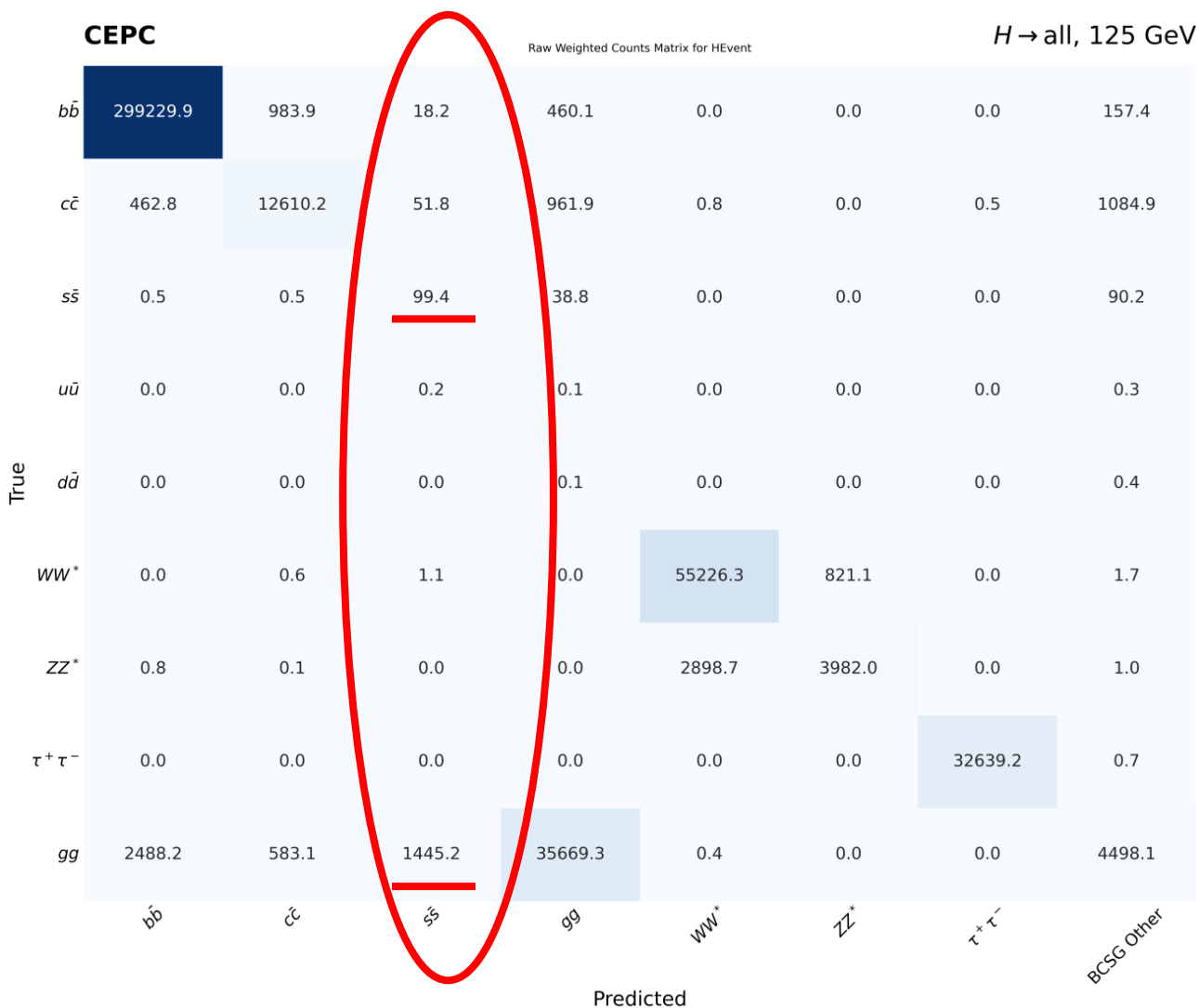
Training with same data. Event/Holistic approach to find ss much better to find 2 individual s jets.



This metric 0.6226 should be best in current all cases.

		CEPC				TDR Fast Pythia ParT TruthID						
Truth	b	0.798	0.139	0.020	0.016	0.003	0.001	0.001	0.002	0.001	0.001	0.017
	$\bar{b}$	0.147	0.790	0.015	0.021	0.002	0.003	0.002	0.001	0.001	0.002	0.016
	c	0.008	0.009	0.809	0.045	0.029	0.021	0.017	0.006	0.007	0.013	0.037
	$\bar{c}$	0.009	0.009	0.042	0.811	0.021	0.028	0.006	0.017	0.013	0.007	0.037
	s	0.002	0.001	0.013	0.012	0.646	0.077	0.021	0.058	0.053	0.037	0.080
	$\bar{s}$	0.001	0.002	0.011	0.013	0.079	0.644	0.057	0.020	0.037	0.054	0.081
	u	0.001	0.002	0.010	0.006	0.024	0.075	0.442	0.053	0.098	0.185	0.103
	$\bar{u}$	0.002	0.001	0.006	0.010	0.076	0.024	0.054	0.440	0.187	0.097	0.102
	d	0.002	0.002	0.007	0.011	0.062	0.056	0.092	0.180	0.408	0.077	0.104
	$\bar{d}$	0.001	0.002	0.011	0.007	0.056	0.061	0.181	0.091	0.077	0.407	0.105
	g	0.013	0.013	0.023	0.024	0.051	0.050	0.050	0.049	0.045	0.044	0.639
		b	$\bar{b}$	c	$\bar{c}$	s	$\bar{s}$	u	$\bar{u}$	d	$\bar{d}$	g
		Predicted										

Current trial



- $H_{gg} \sim 300$ times of H_{ss} .
- By optimizing WP (previous confusion matrix choose $P(\max)$), $Z(\nu\nu) \sim 40\%$ precision H_{ss} expected.

Next steps for IHEP...



- Include SM backgrounds.
- Move to Zee/Zmm/Ztautau.
- Try with ACSI and Zqq.