Status update

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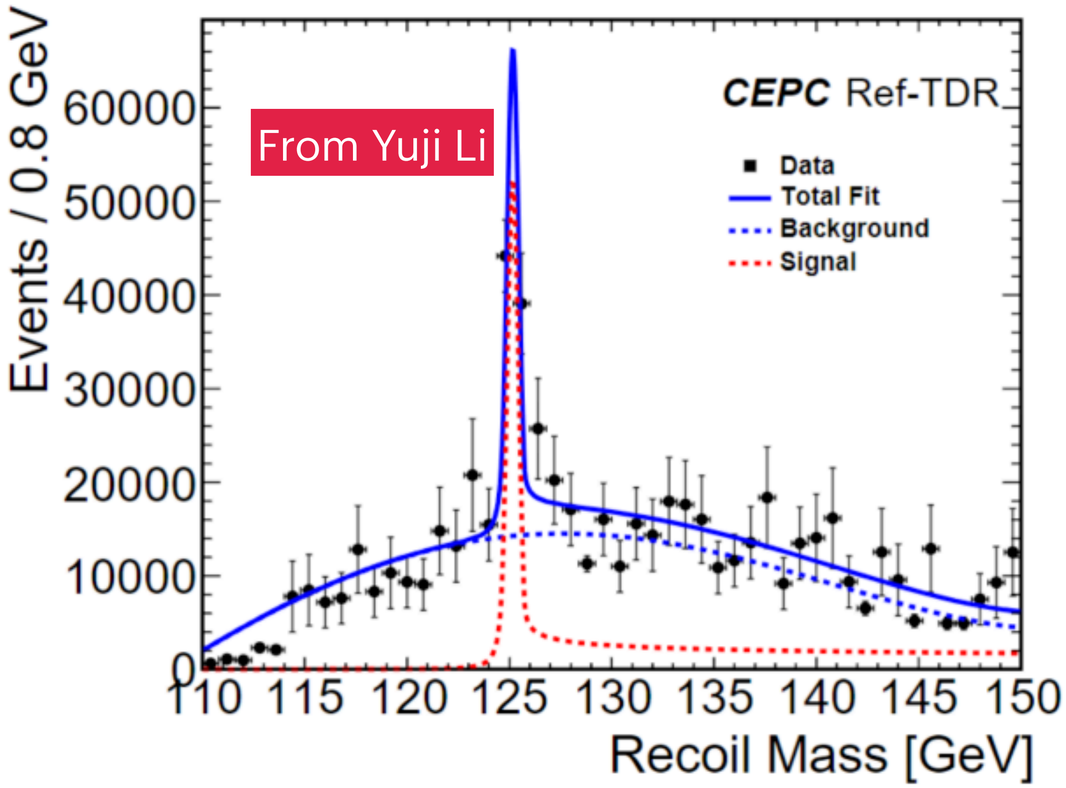
Intro.

- The analysis has a good completeness, thanks to Yuji Li
  - Stat. Err. of mH = 1.7 MeV
  - There is no beam energy spread included, which would contribute to the resolution of the recoil mass spectrum and is an important component of the statistical uncertainty
  - NO systematic uncertainties considered

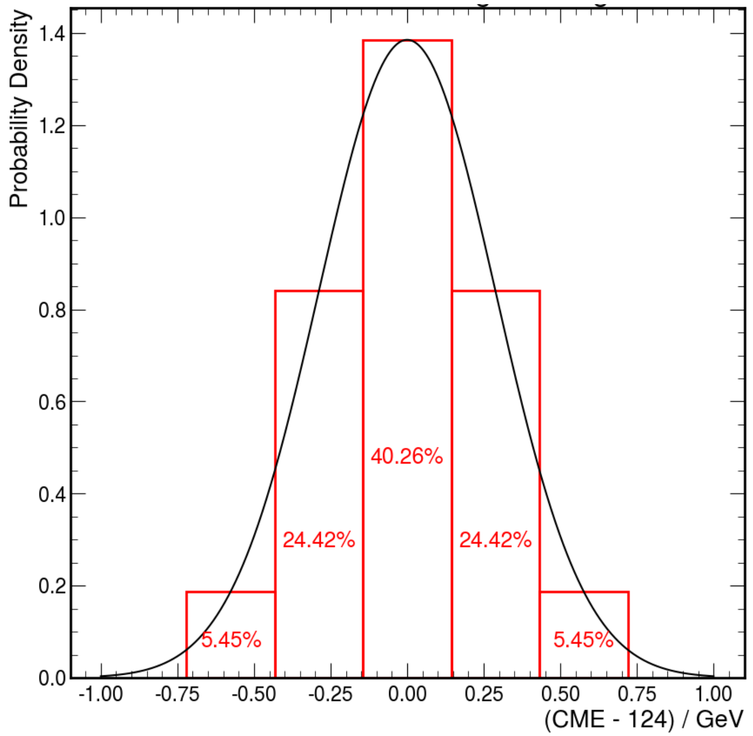
Fitting performance in MuID
Error(mH=125)=1.7MeV



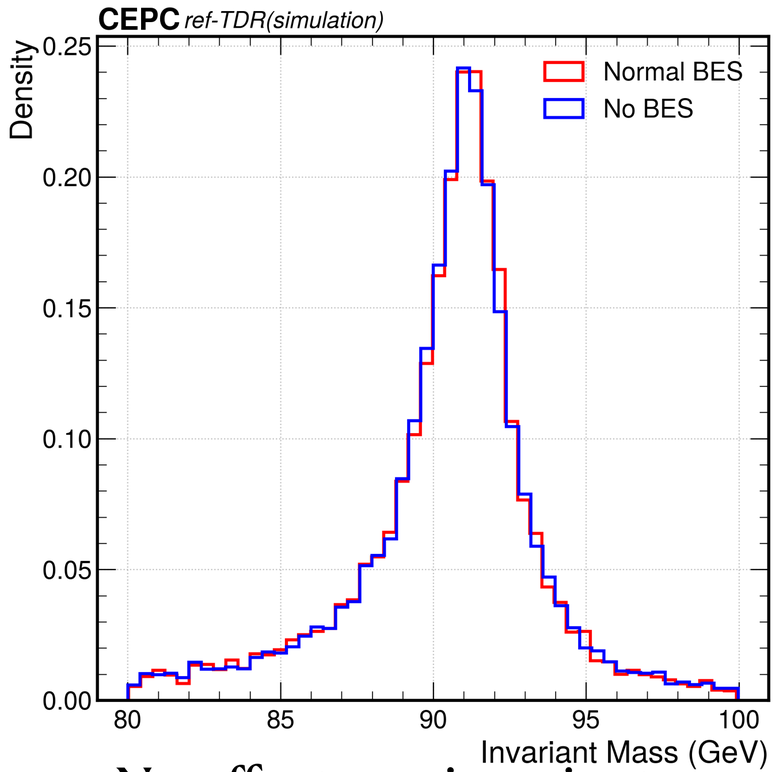
simulation

Beam Energy Spread

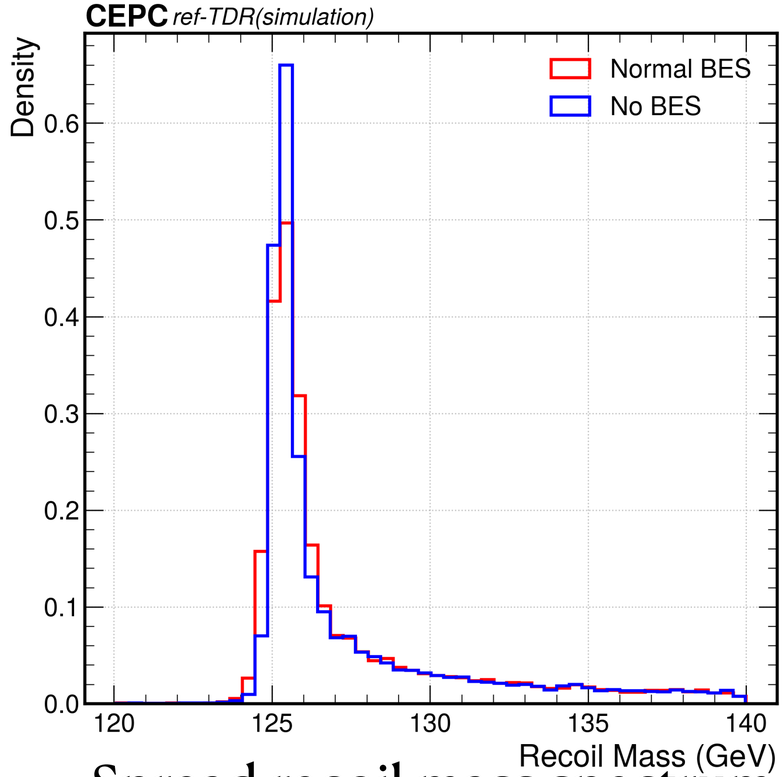
- BES ~ 0.17% at Higgs run
- Normal BES config. : $\sqrt{s} = 240$ +/- 0, 1, 2 $[\frac{\sqrt{2} \times 0.17\% \times \mathrm{BE}}{2 \times \mathrm{BE}}]$ GeV
- mmHX samples are generated with 5 CME points
- Sample events according to the fractions below



Sigma = 0.288 GeV



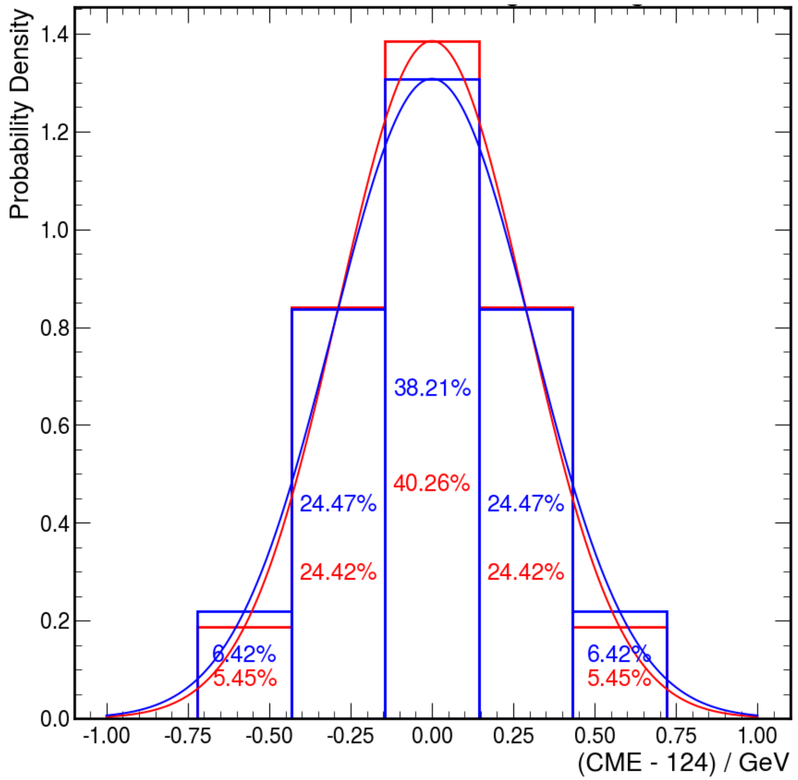
No effects on invariant mass



Spread recoil mass spectrum

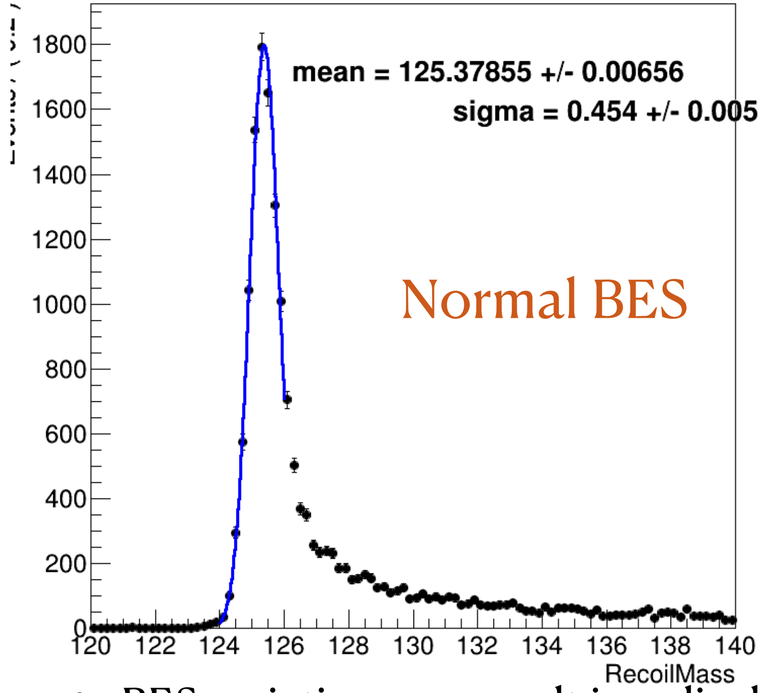
Systematic uncertainties [Beam Energy Spread]

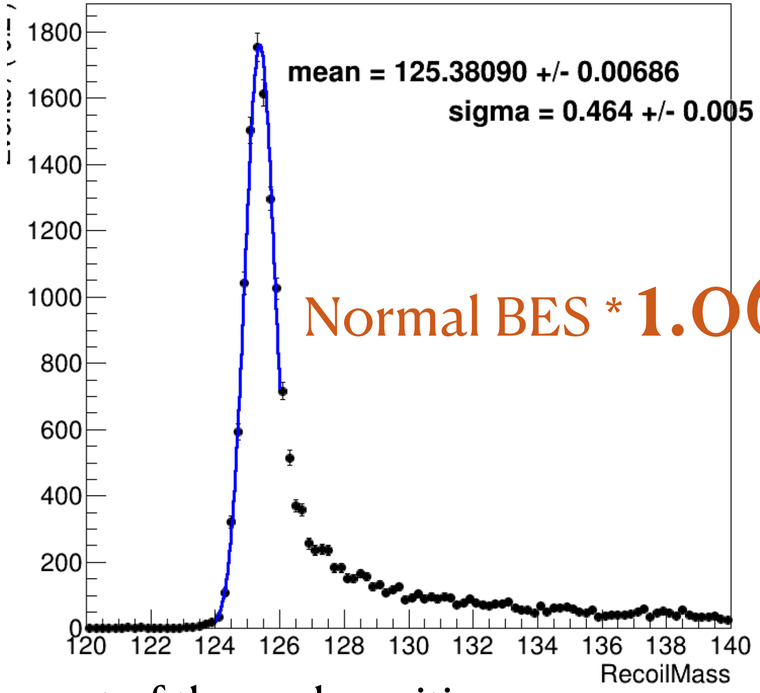
- BES uncertainty ~ 1-6 % [from other place], and should be an input from accelerator
- 1 sigma = 0.288 x 1.06 = 0.305 [blue curve]
- Adjust the sampling fractions to mimic the BSE variation w.r.t. the normal scenario



Sigma = 0.288 GeV

Sigma = 0.305 GeV

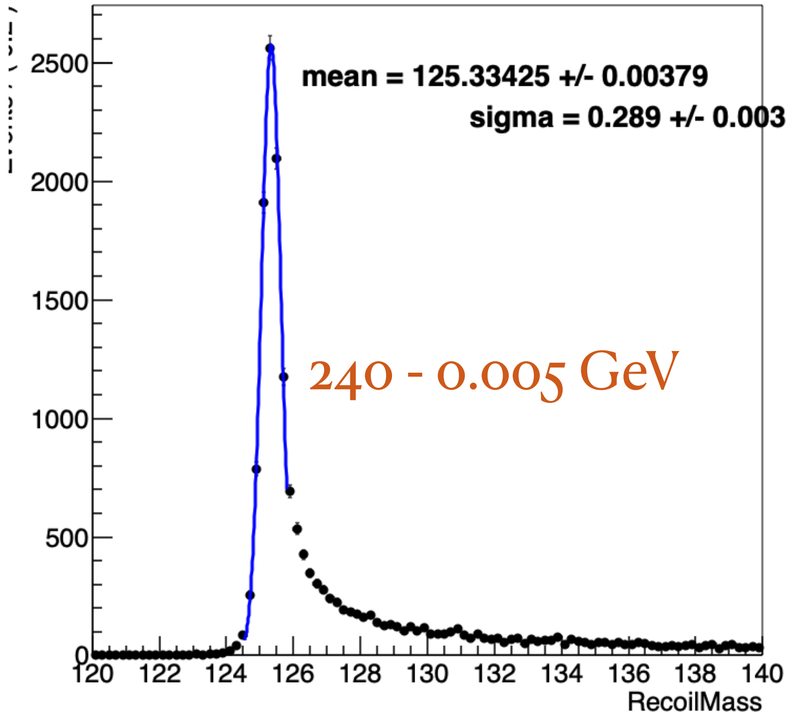


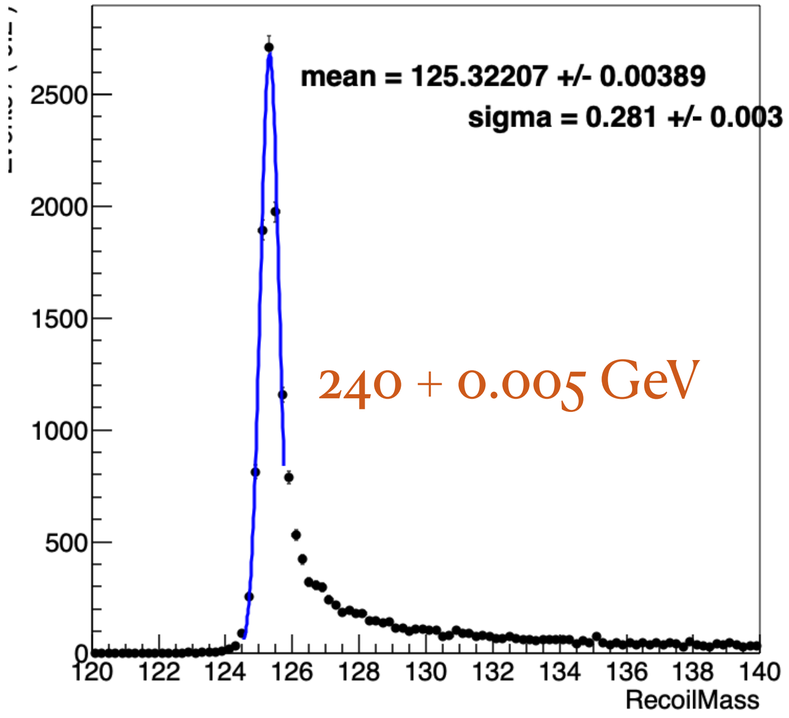


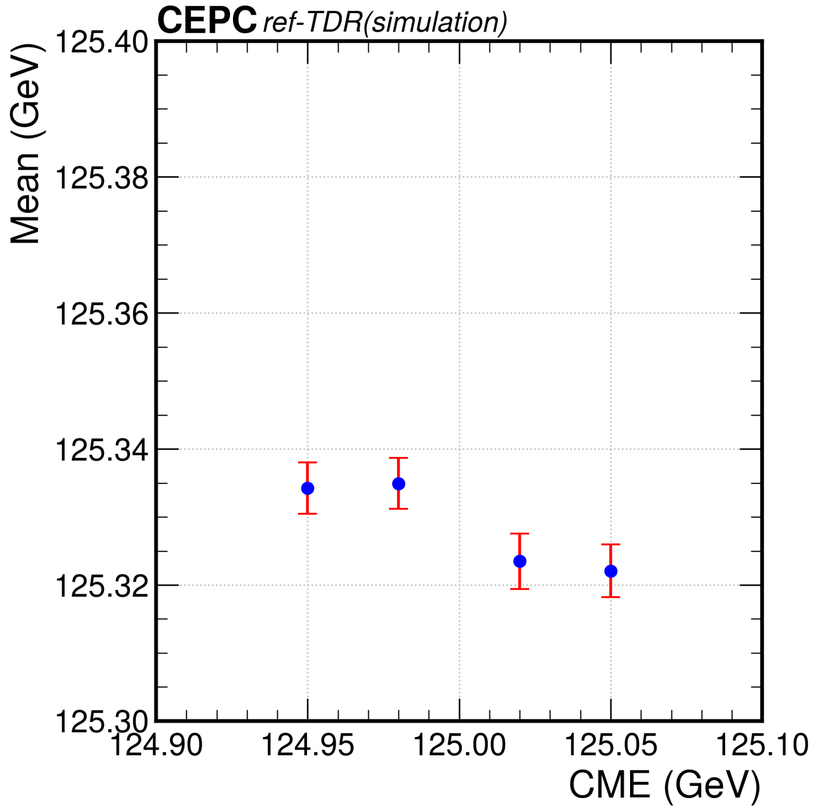
- BES variation may result in a displacement of the peak position
- The fit is challenging, and the relation between δBES $\sim$ δmH is not clearly
- Nonetheless, the impact is likely to be minor [2MeV with the most conservative estimation]

Systematic uncertainties [Centre-of-Mass Energy]

- $\delta\sqrt{s}$ should be at least at MeV level and is an input from accelerator team [For reference, 2MeV is adopted by FCC]
- Visible in the recoil spectra of radiative return events $Z \to \mu\mu\gamma$
- mmHX samples are generated with CME = 240 GeV +/- 0, 2, 5 MeV



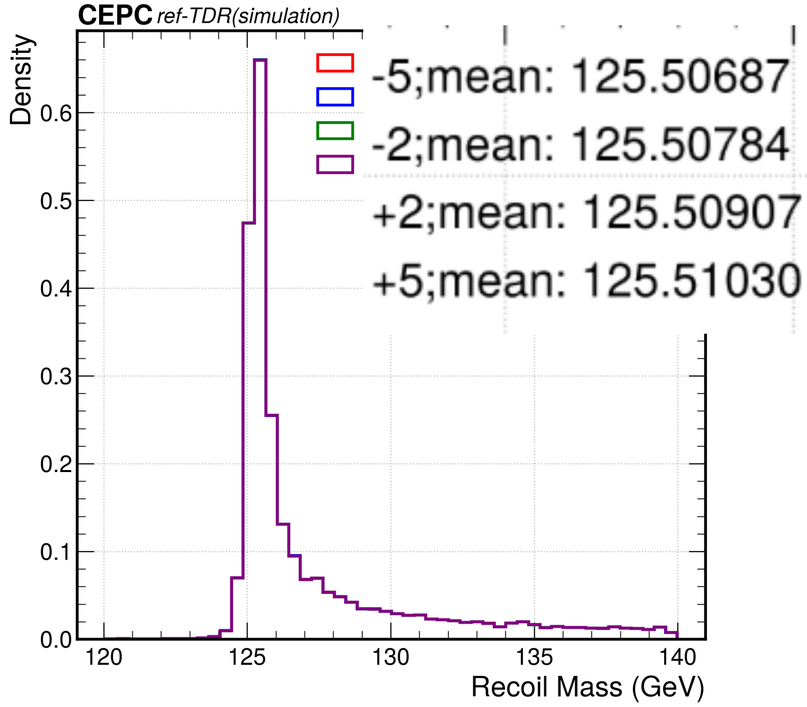


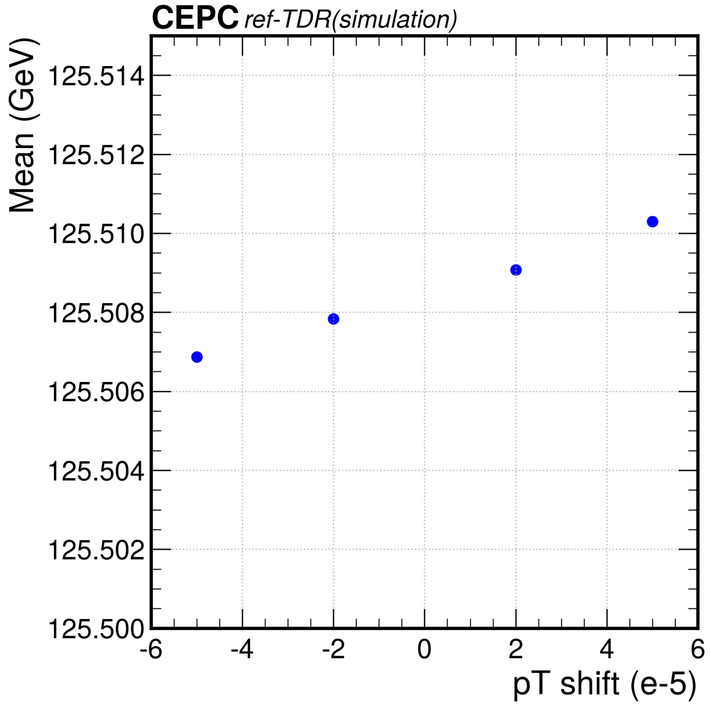


- $\delta\sqrt{s} : \delta m_H \approx 1 : 1$ analytically, but it is difficult to demonstrate this using full simulation
  - Statistics is not enough
  - The function is not very suitable for modelling the spectrum

Systematic uncertainties [Lepton Scale]

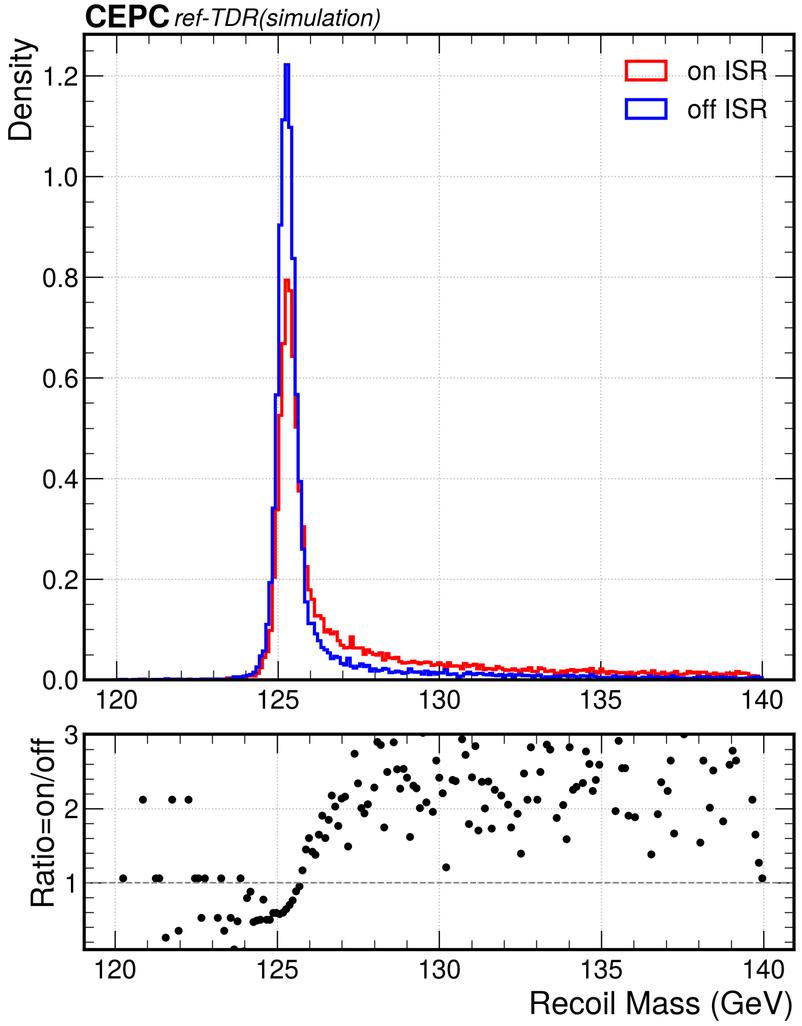
- A large number of radiative return events can be used to monitor the momenta precision,
  - $\delta_{Z_{peak}} = \frac{\sigma_{p_T}}{\sqrt{N}}$, $\sigma_{pT} = 2 \times 10^{-3}$, N=30M ($20ab^{-1}$, radiative return only)
    - Together with Low-Lumi-Z events, δ_{p_T} ~10^{-6} is easily visible from the Z boson
- The bottleneck is the magnet field precision ~ 10^{-5} (from FCC)
- Inject -5, -2 , 2, 5 x 10^{-5} shifts to the muon pT, and check the resulting variations in the recoil mass peak

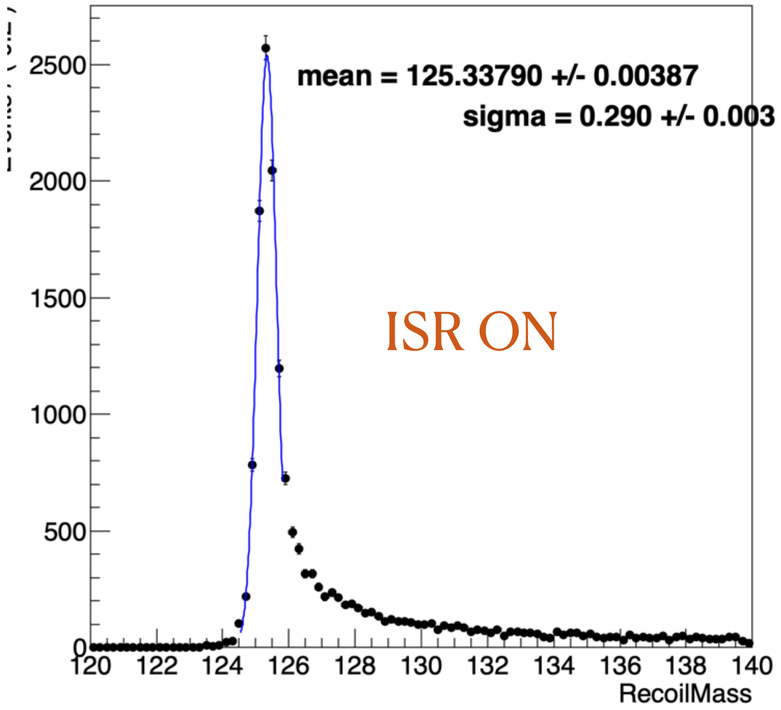


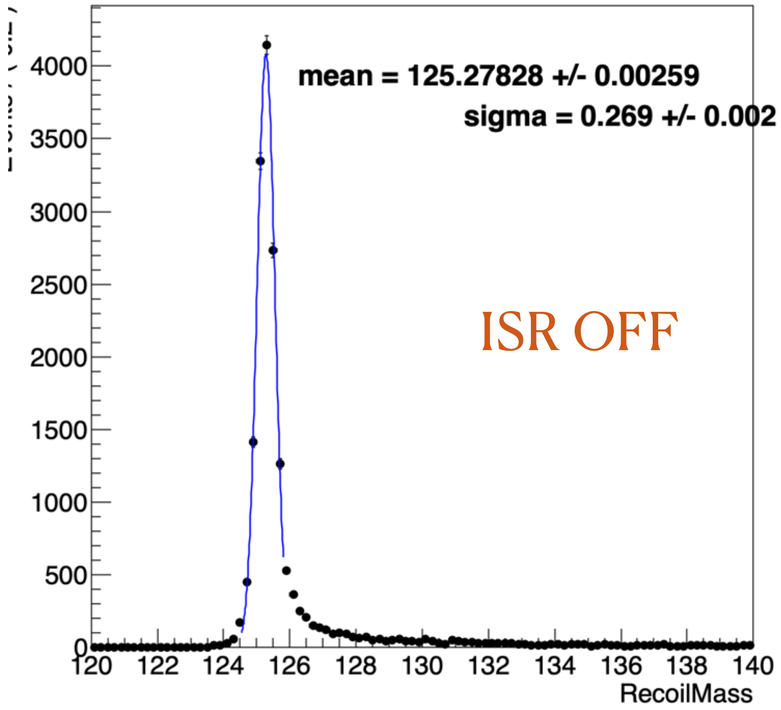


Systematic uncertainties [ISR]

- Turn off ISR in whizard, generate mmHX events at $\sqrt{s} = 240$ GeV
- Check the variation in the recoil mass peak







- With/Without ISR; $\delta m_H \sim 50$ MeV

Summary

- Uncertainty source to mH
  - BES uncertainty < 1MeV
  - CME uncertainty; 1 to 1 propagated to mH; ~ 2MeV
  - Lepton scale; 1 to 1 propagated to mH; ~ 1MeV
  - ISR ~ in progress...

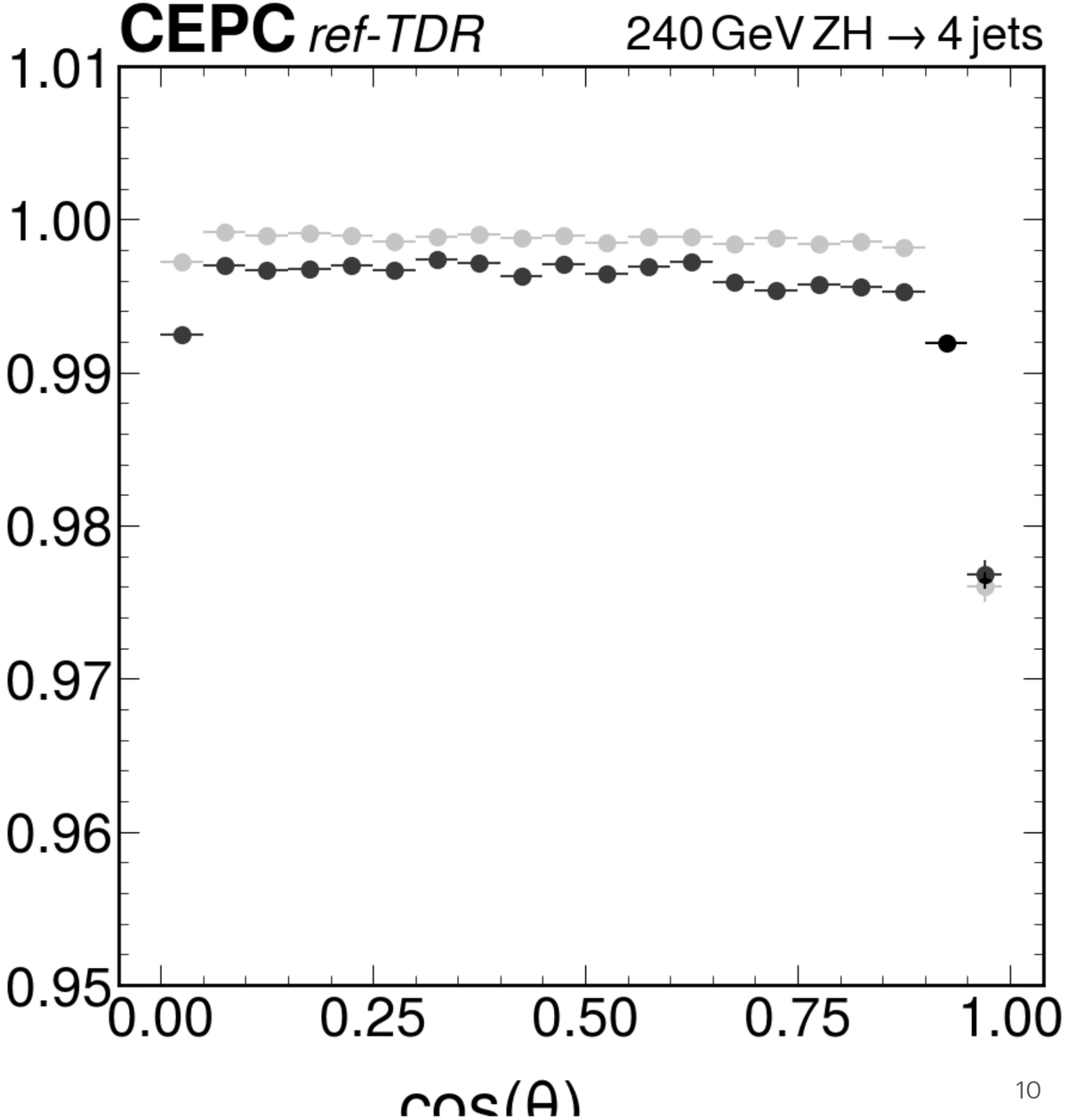
- This study only propagates the sources of uncertainties to the recoil mass spectra
  - These sources need to be verified against the accelerator TDR

- Some expectations cannot be clearly observed with full simulation
  - The fit is challenging. A clear bias is observed in the fit
  - Need larger statistics

Summary

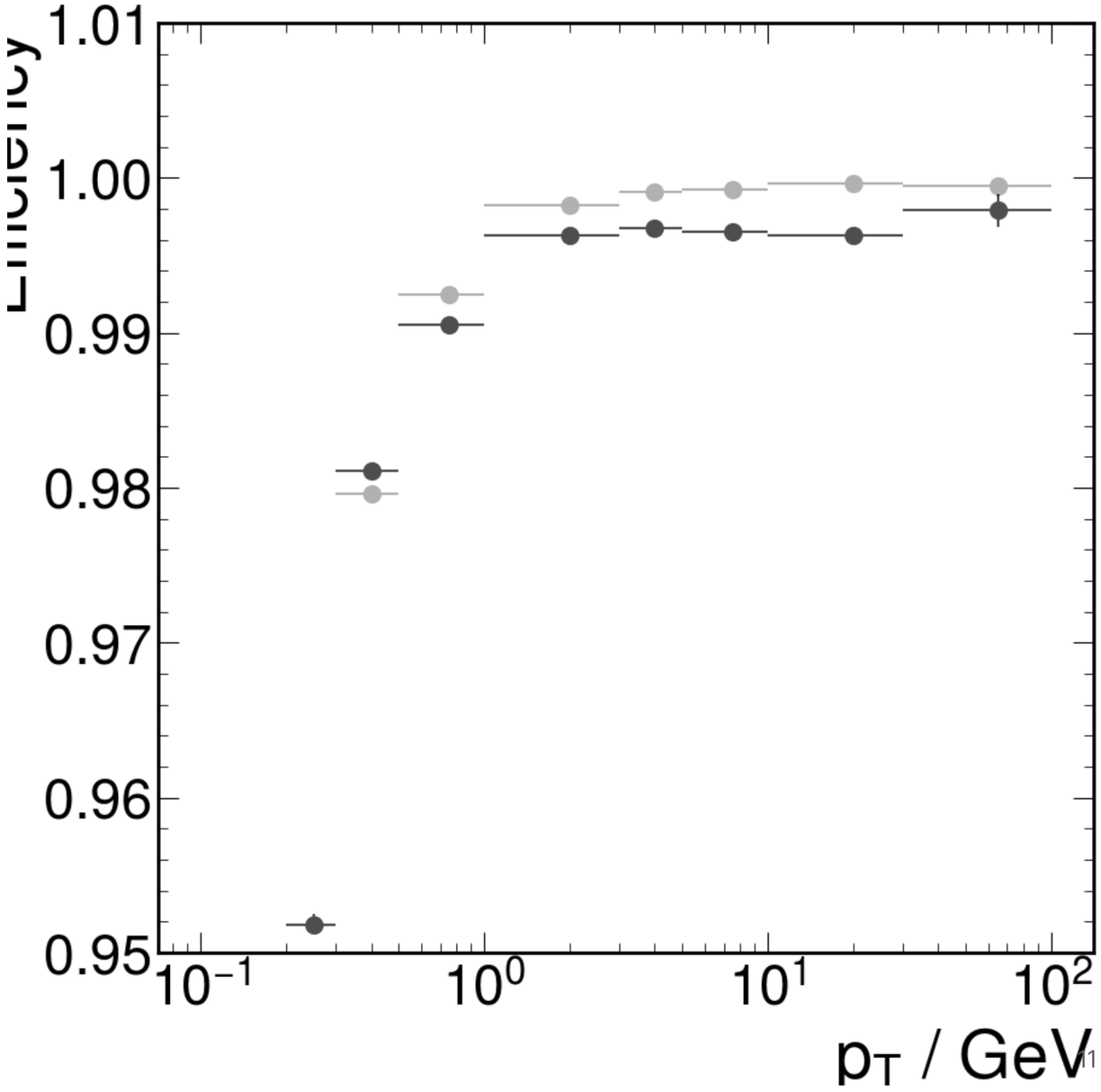
resolution/purity			
trk momenta	< 0.2% for 1-100 GeV		
Impact parameter	100-3 um for both d0 and z0 in barrel	10-3 um for d0 and z0 in endcap	
vertex	Primary, 2-3.5 um, as a function of Nrk	Secondary, transverse < 5 um, longitudinal < 30 um	
photon energy	2%-0.3%, for genE 1-100GeV		
Jet energy	5%-6%, vary as energy and polar angle		
BMR	4%-6%, for barrel and endcap		
PID (From current TDR, NOT up to date)	mu	e	K
	[>10GeV, 100%], [<10GeV, 90-99% for E/B]	[>20GeV, 100%], [<20GeV, 90% for E/B]	~75% for best WP
jet-tagging (BDT)	c, uds mis-id. as b	b, uds mis-id. as c	
	2.23%, 0.24% for 80% WP	13.6%, 13.9% for 80% WP	

Trk Efficiency



- The same gen-events with different SW release
  - tdr.25.3.6: dashed
  - tdr.25.5.0: solid
- The same code for plotting

Trk Efficiency



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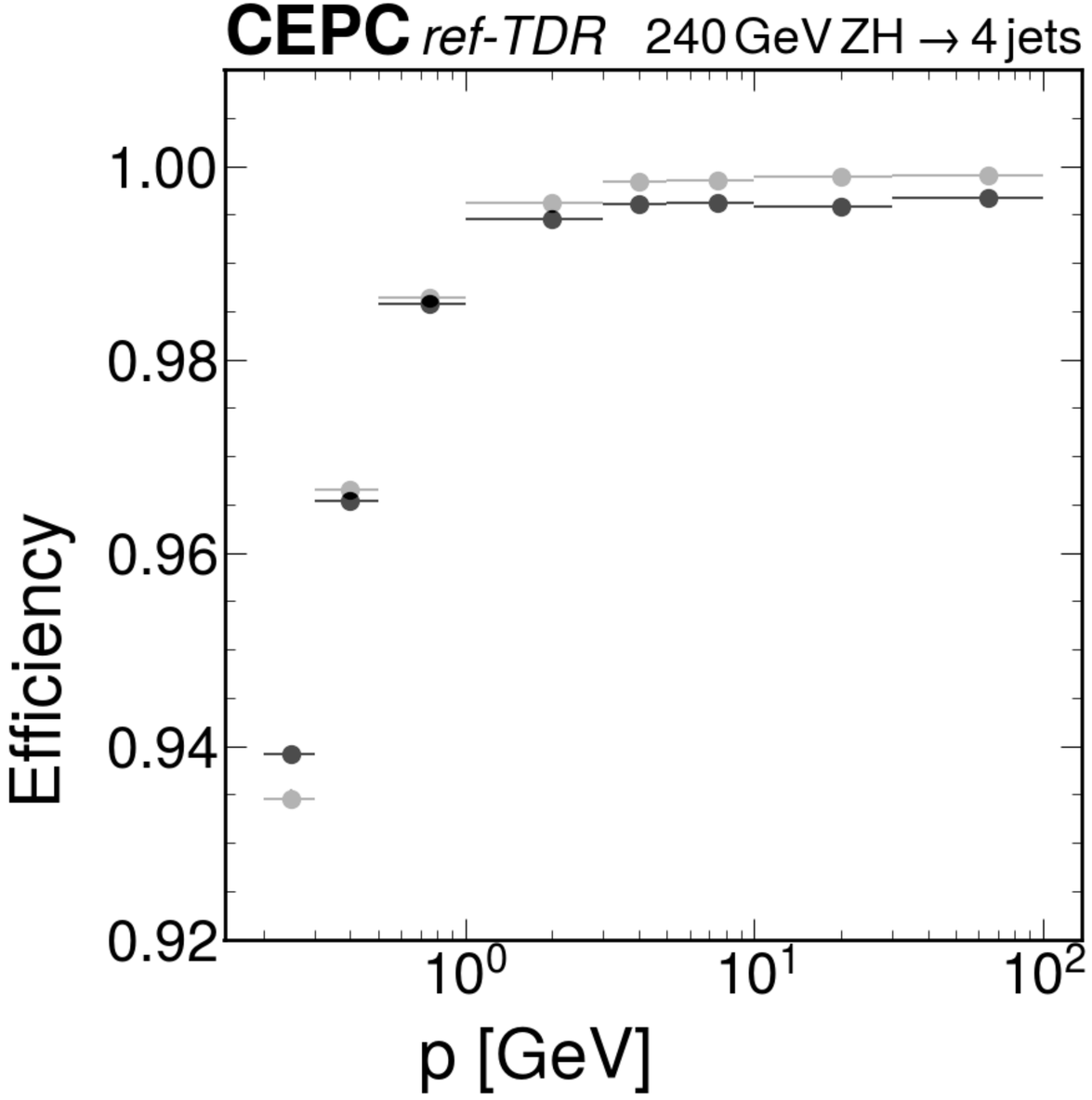

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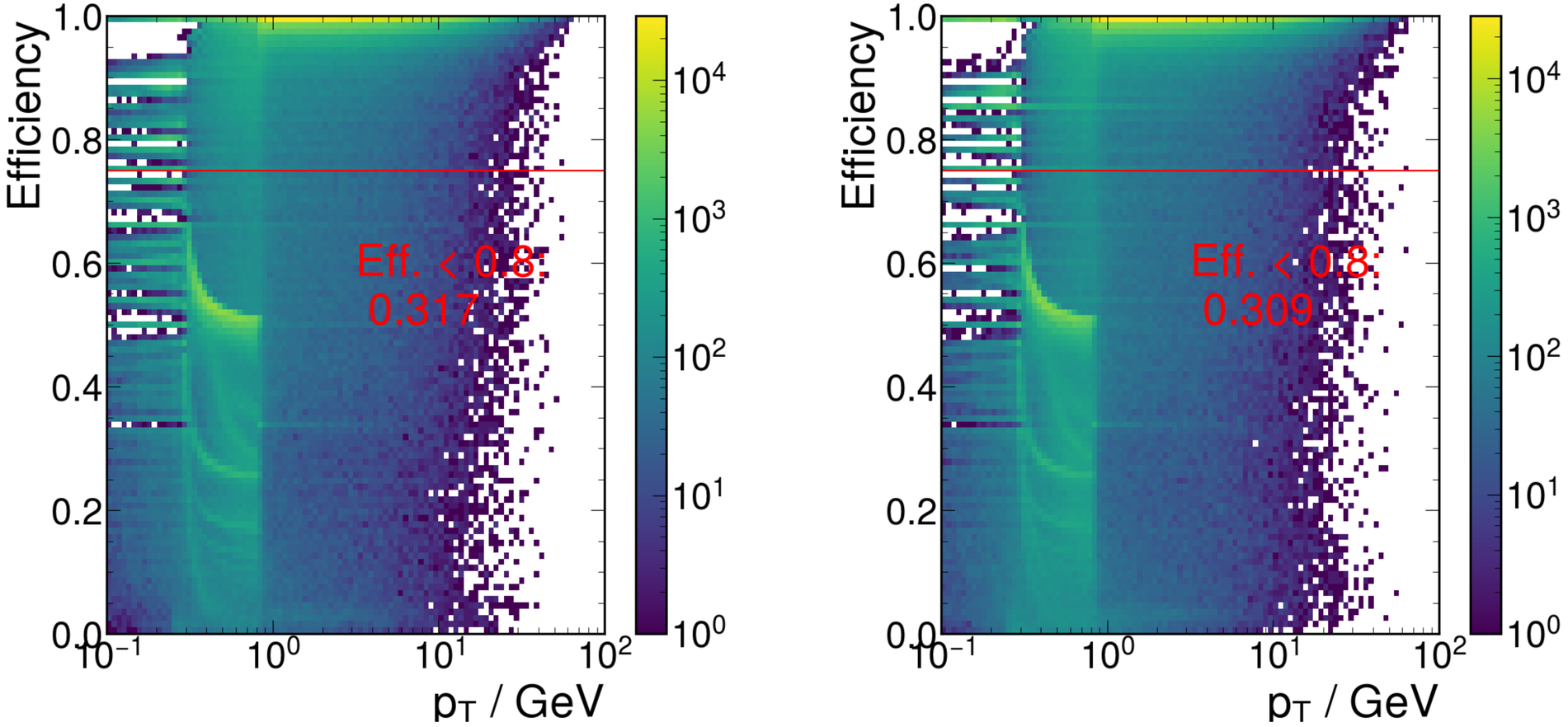

- The same gen-events with different SW release
  - tdr.25.3.6: left
  - tdr.25.5.0: right
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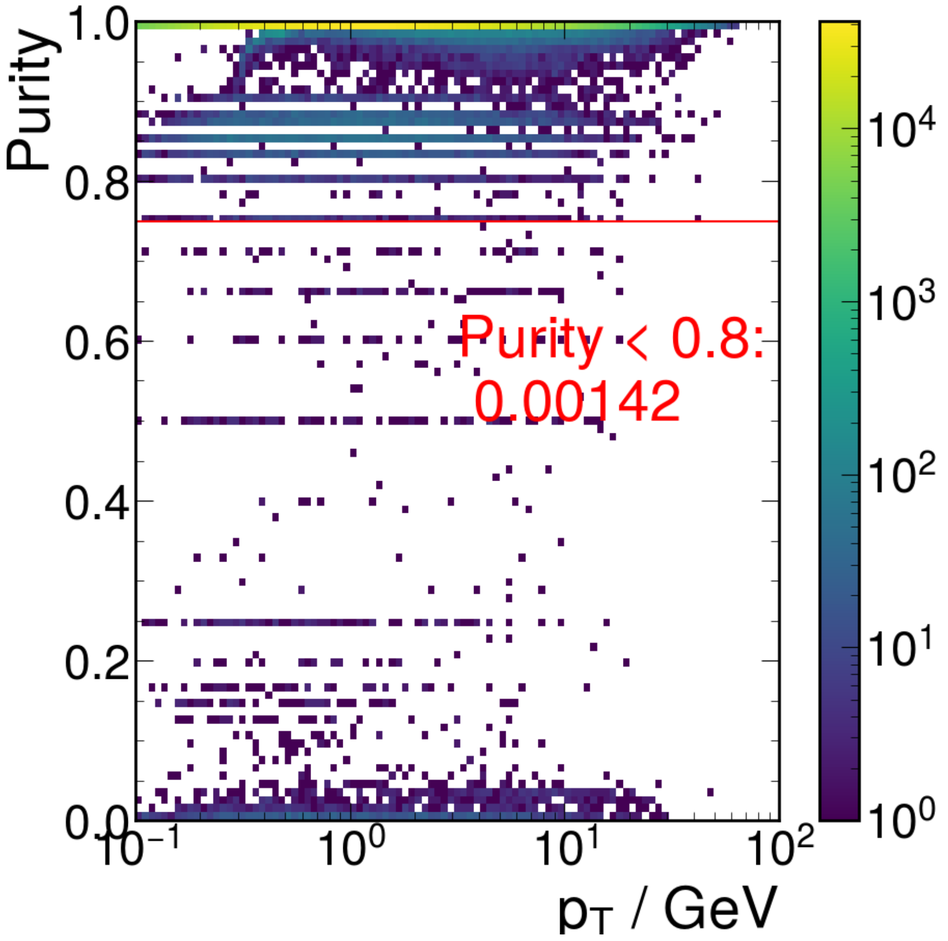

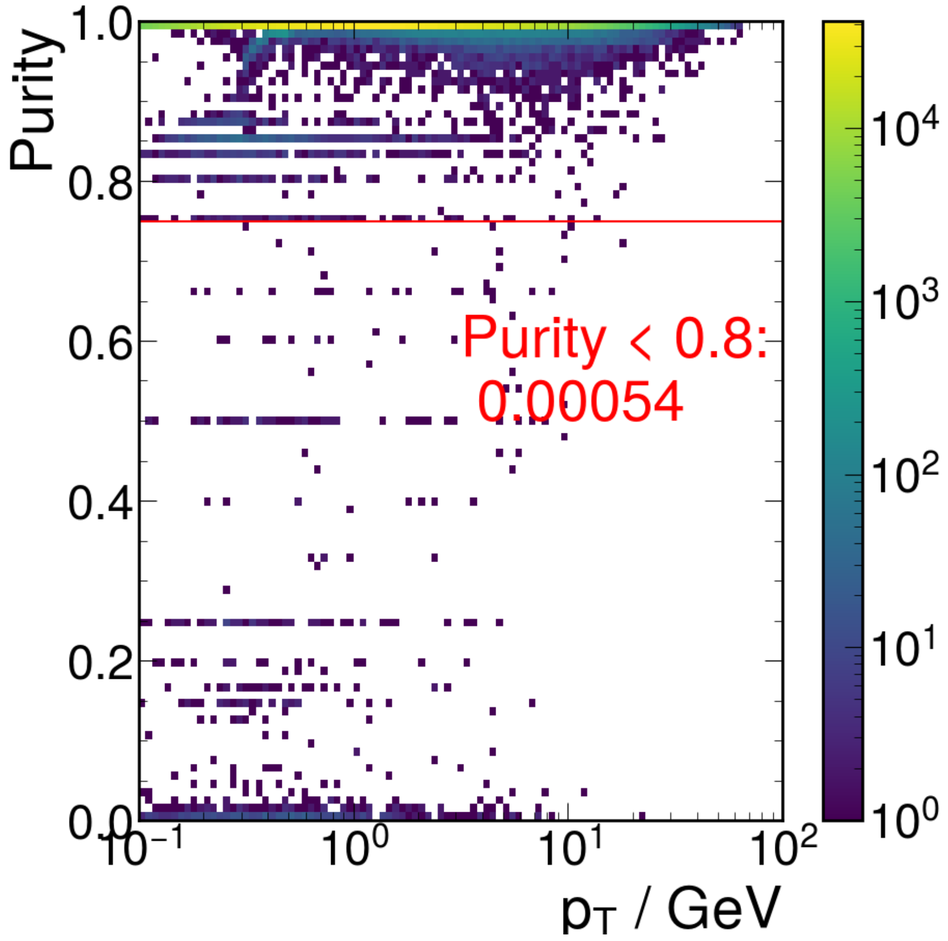

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