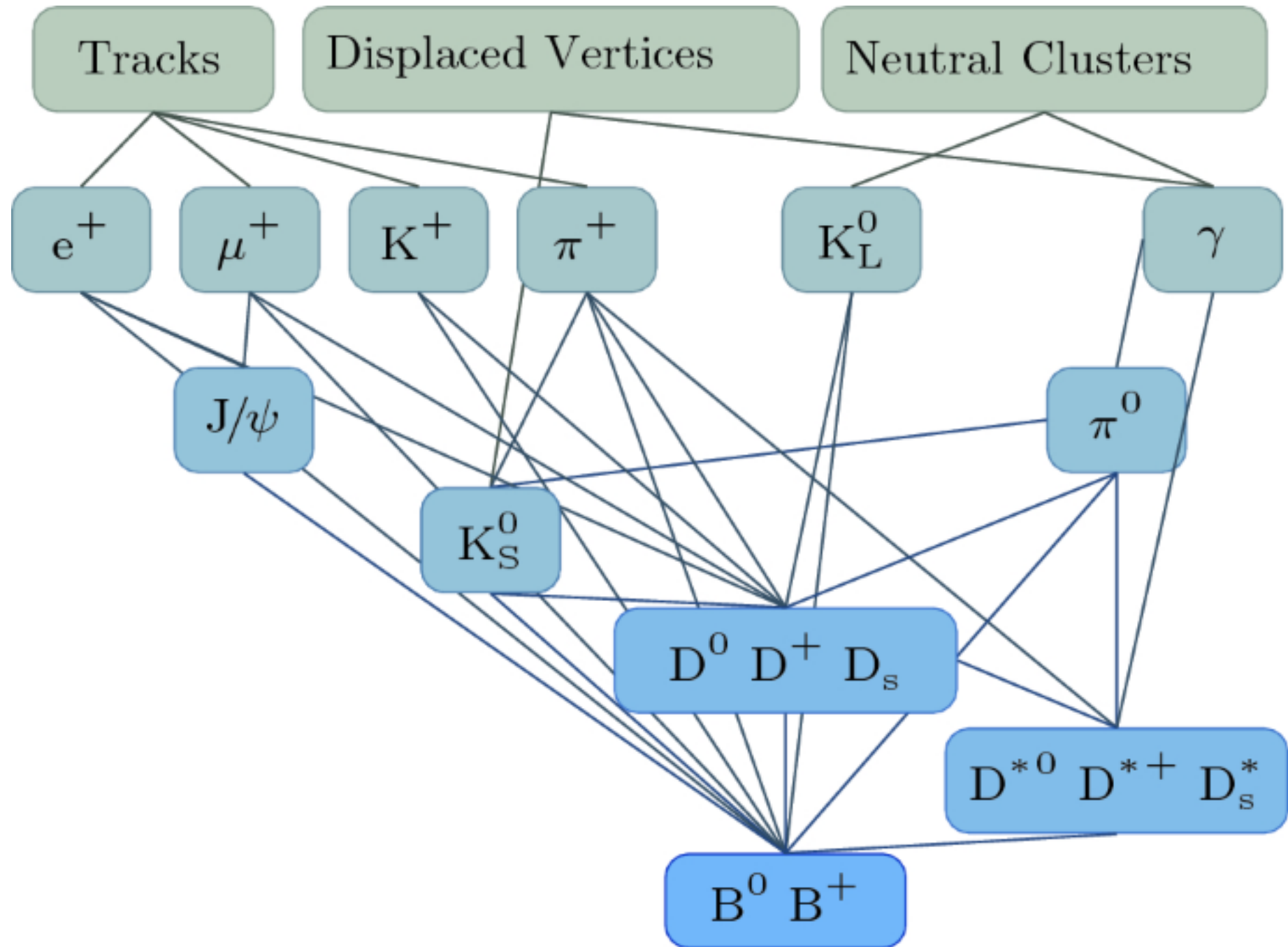
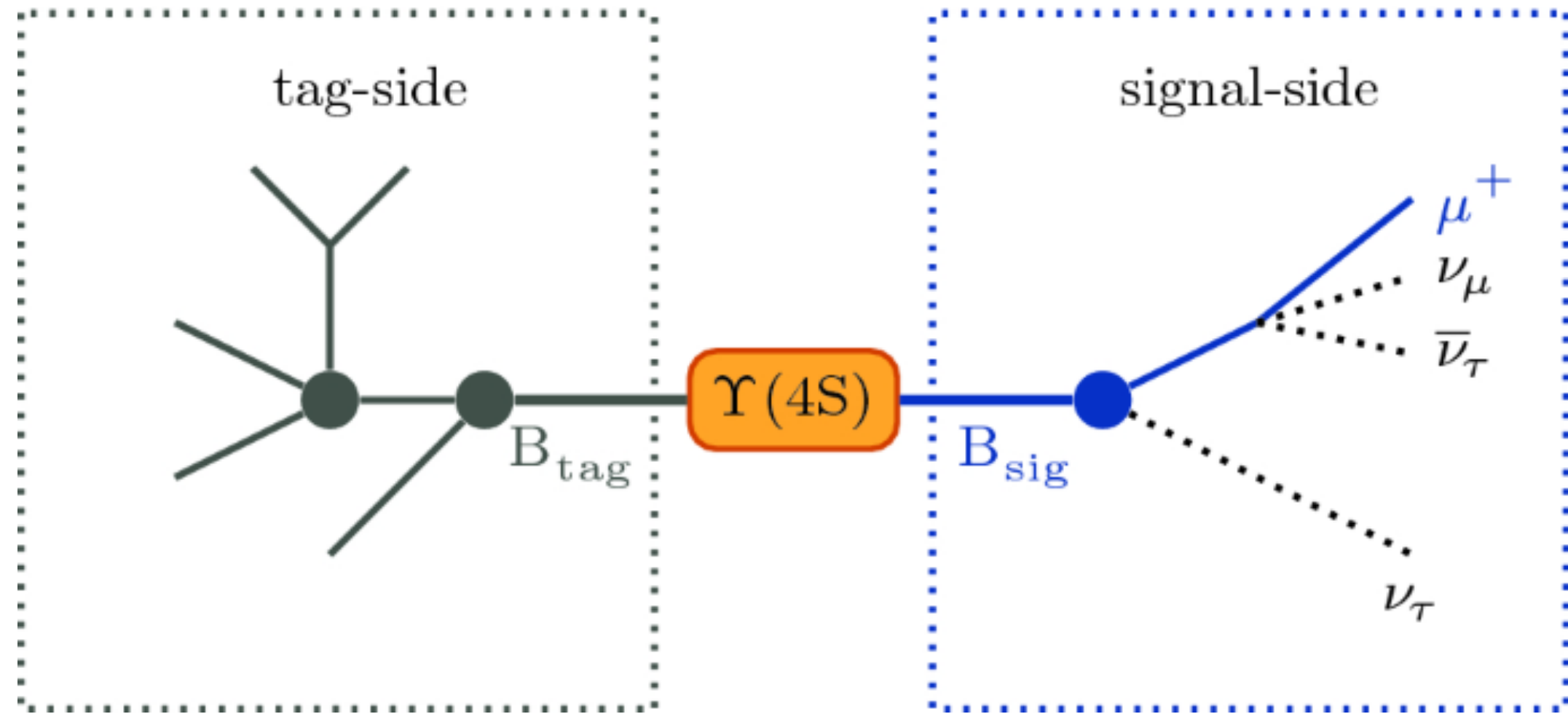


# **FEI Calibration study at Belle II**

**Niharika Rout**

# Motivation

- Many interesting missing energy analyses
- Relies on the tagging tools
- **FEI**: heavily used tagging tool at Belle II



Employs over 200 BDTs to reconstruct over 10000 B decay chain

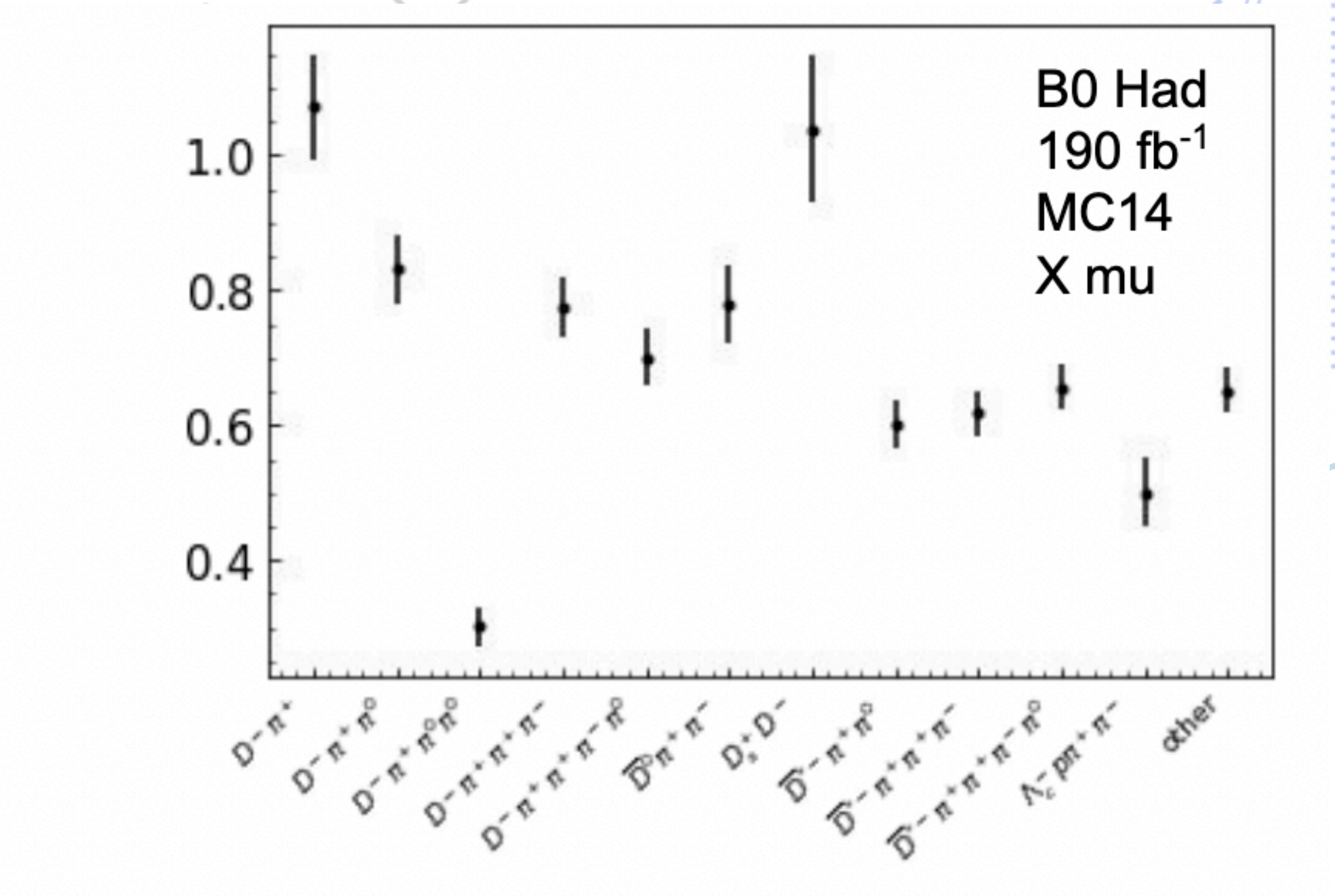
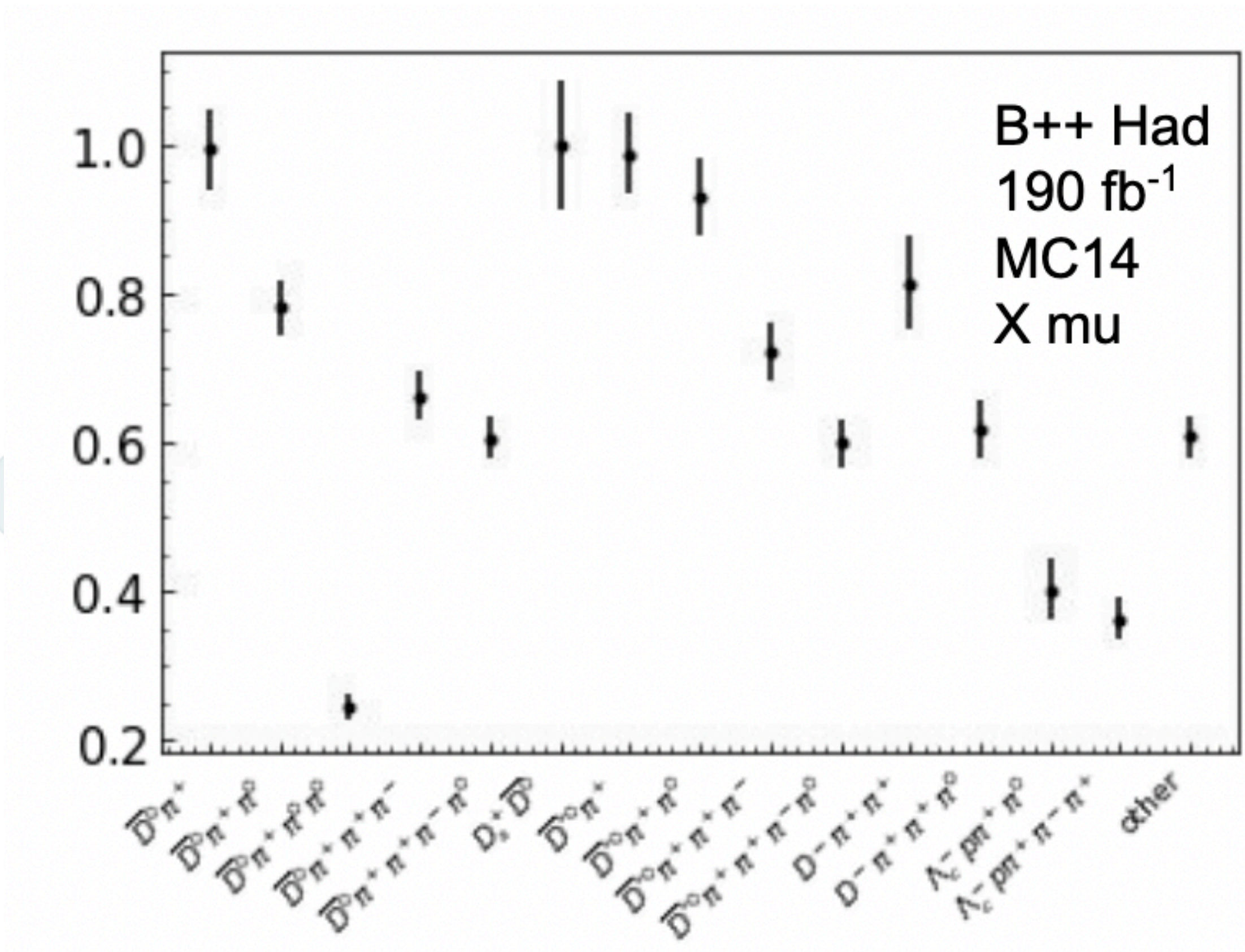
Depends on MC samples for the training of the BDT

Incorrect MC description gives large FEI calibration/correction factor

# Hadronic FEI

- Many interesting missing energy analyses

tag-side [Physics performance@B2GM](#)



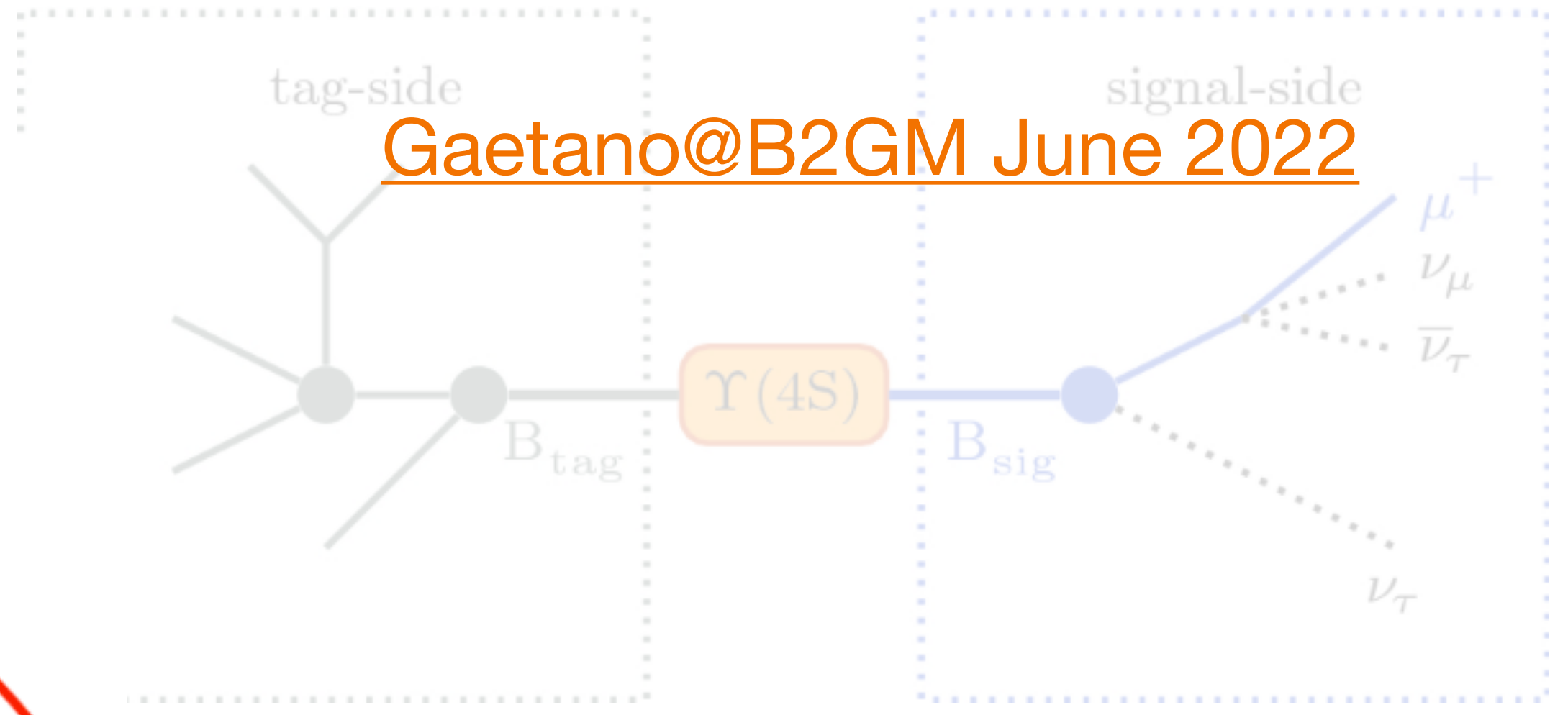
$B^0 B^+$

# Hadronic FEI

- Many interesting missing energy analyses

**Limiting factor :  $\epsilon_{tag} < 1\%$  !**

- Relic
- FEI:



over 200 BDTs to reconstruct over 12 modes out of 36 makes 90% of the total efficiency  $D^{(*)} n\pi$

The results shown later are based on these modes only!

# Method

Partial reconstruction for more statistics!

[Vidya sagar @ BHadronicMeeting](#)

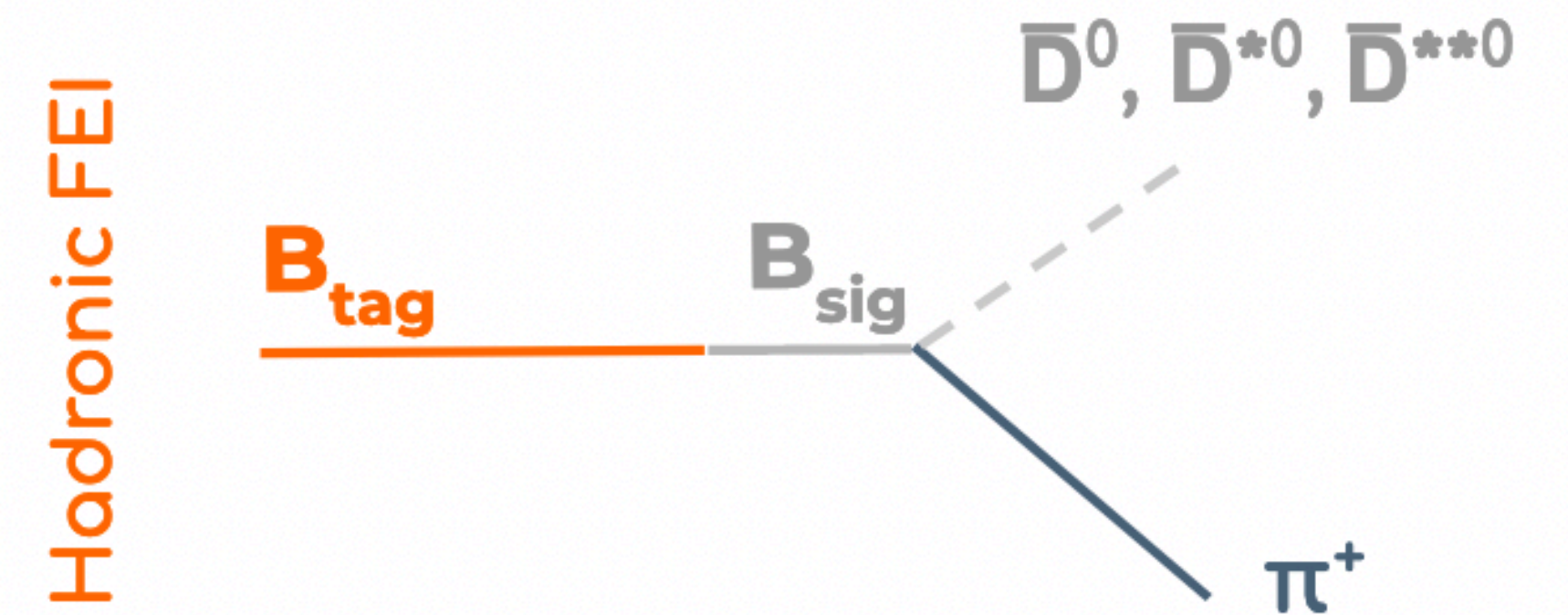
In CM frame of  $\Upsilon(4S)$ :

$$\vec{p}_{B_{sig}} = -\vec{p}_{B_{tag}}$$

$$\vec{p}_X = \vec{p}_{B_{sig}} - \vec{p}_{\pi^+}$$

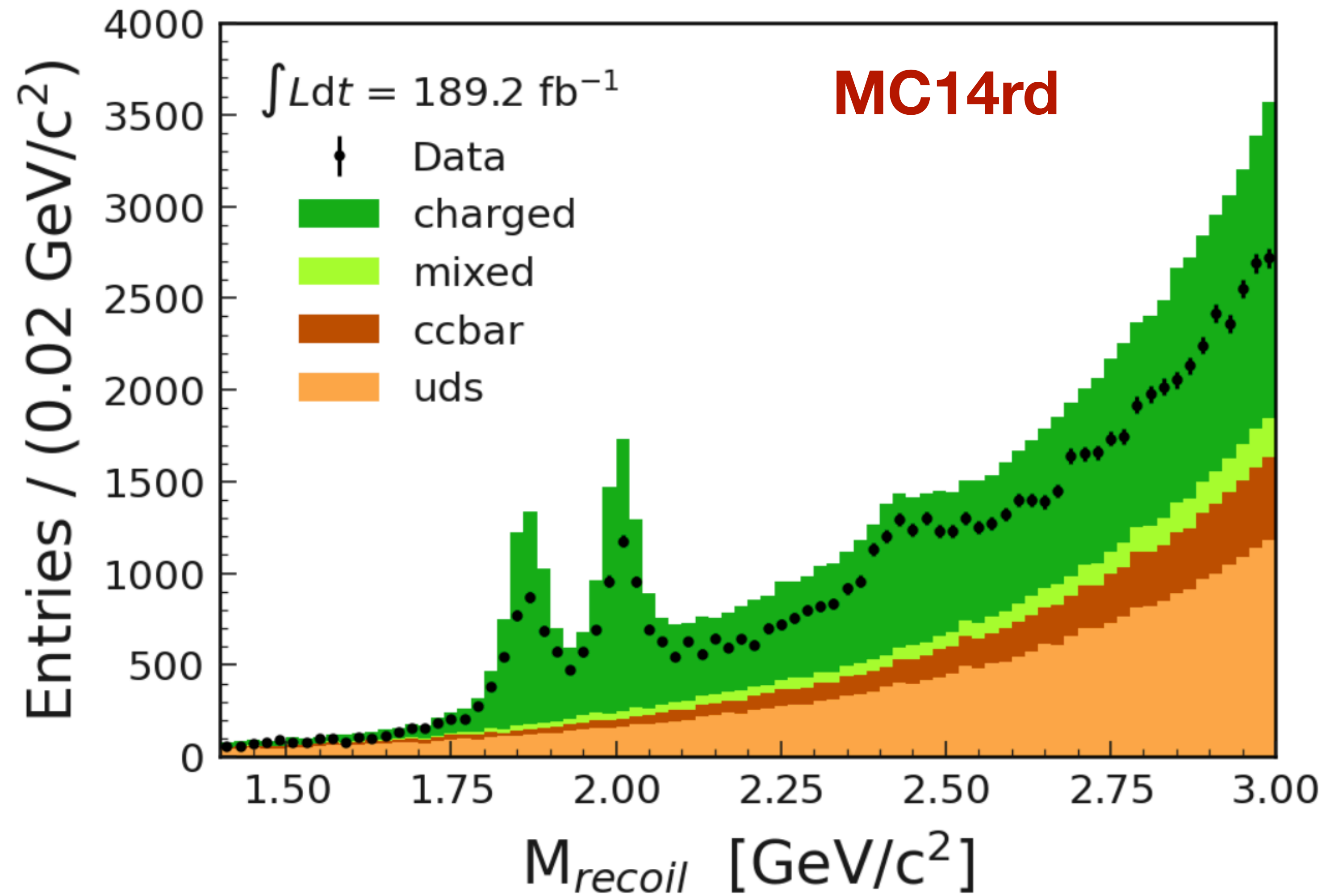
$$E_X = E_{beam} - E_{\pi^+}$$

$$M_{recoil} = M_X = \sqrt{E_X^2 - p_x^2}$$



We can look for  $D^0, D^{*0}$  and even  $D^{**0}$  in the recoil mass of a fully reconstructed B and a  $\pi^\pm$

# M<sub>recoil</sub>



Signal window of  $D^{(*)}$

$D^0$

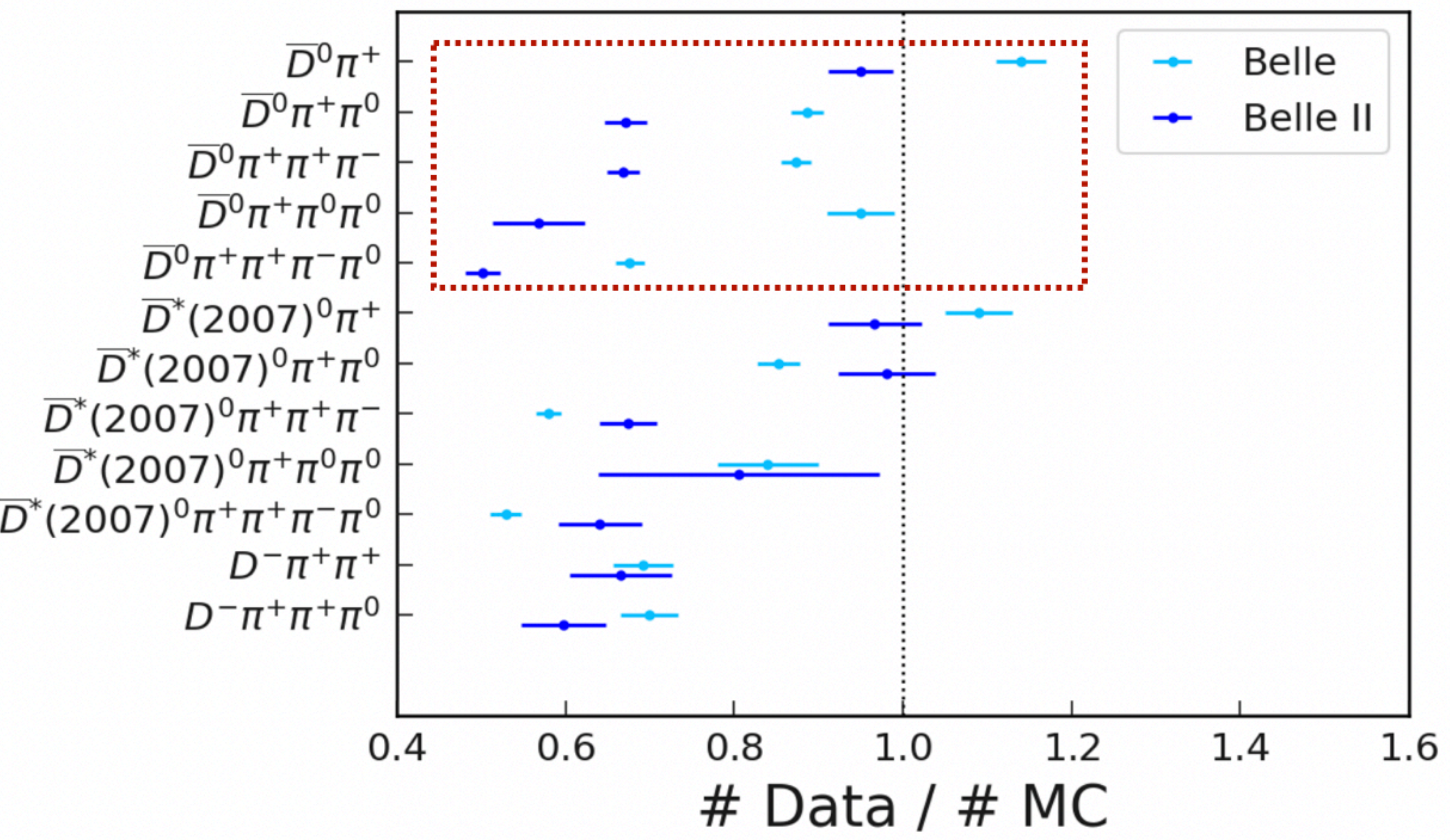
$M_{recoil}$	Data/MC
[1.84, 1.88]	0.64
[1.82, 1.90]	0.66
[1.80, 1.92]	0.70

$D^{*0}$

$M_{recoil}$	Data/MC
[1.98, 2.02]	0.66
[1.95, 2.05]	0.71
[1.92, 2.10]	0.73

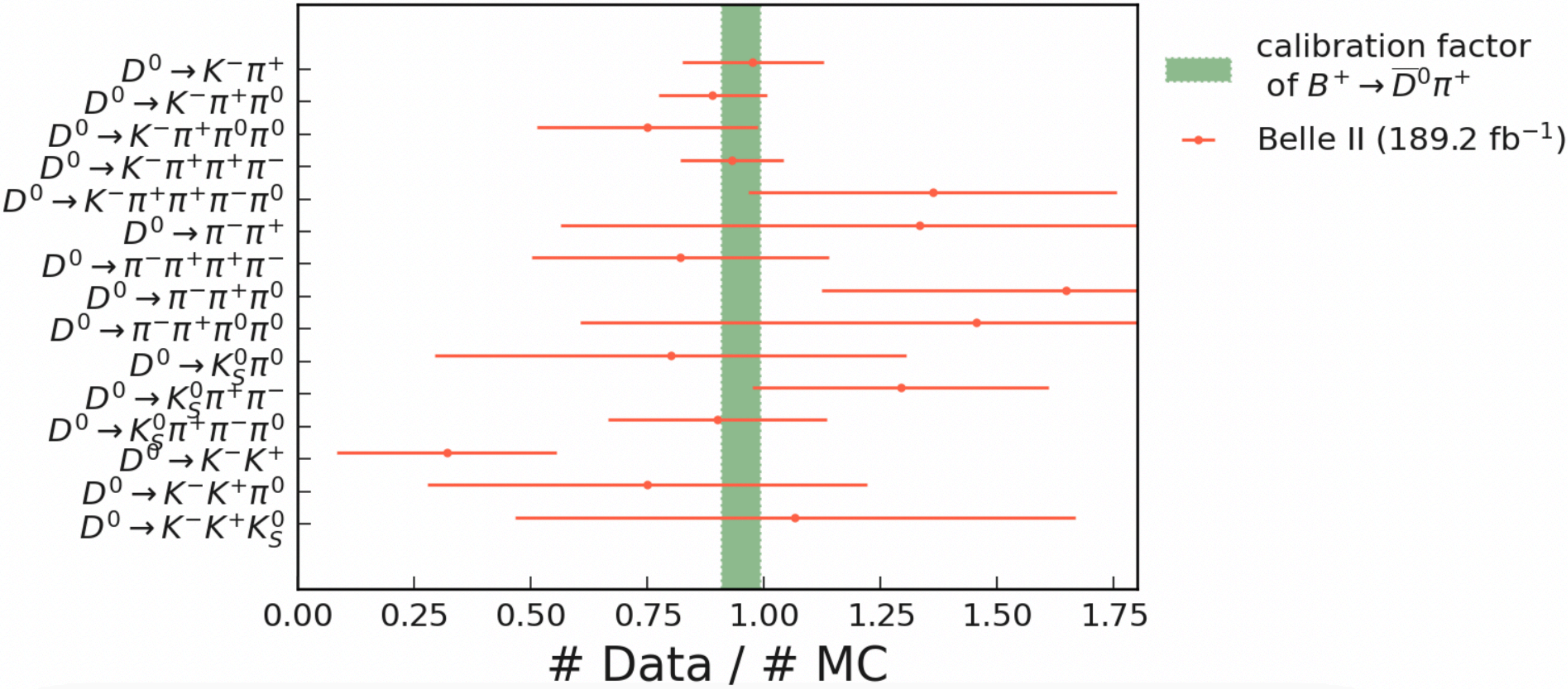
Overall calibration factor obtained using this method  $\sim 0.65$

# FEl: mode by mode



- Belle calibration factor is  $\sim 0.8$
- **Belle II: 0.65; why so low at Belle II?**
- Most of the differences are in  $D^0 n \pi$  channels

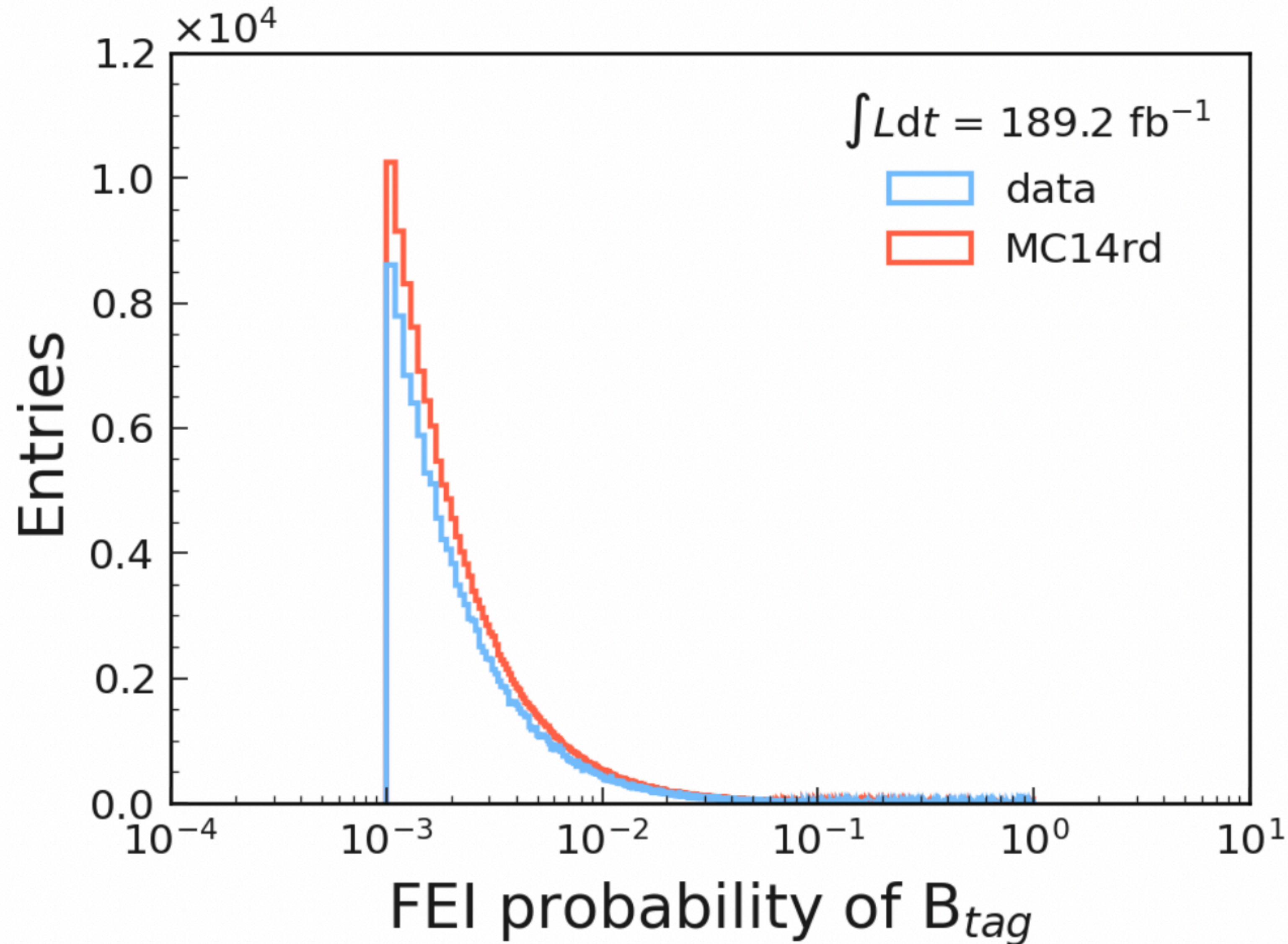
# Further investigations



Looked at calibration factors at D-level; nothing suspicious!



# Further investigations



- FEI probability is used in the BCS selection along with pion momentum
- Data-MC comparison looks fine

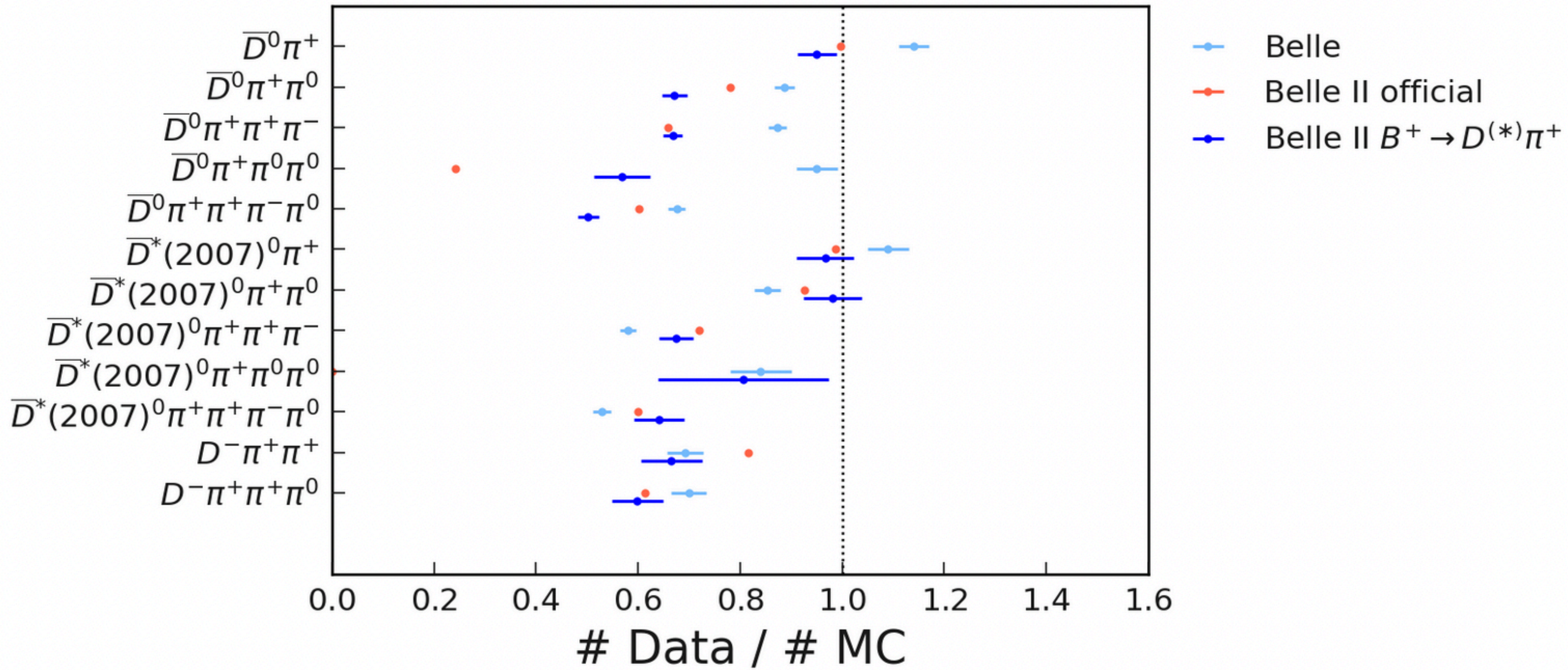
# Branching ratio check

Mode	Belle (%)	Belle II (%)
$D\pi\pi^0$	1.76	1.74
$D\pi\pi^0\pi^0$	1.69	1.56
$D\pi\pi\pi$	1.12	1.38
$D\pi\pi\pi\pi^0$	3.54	3.42

[BELLE2-NOTE-PH-2022-002](#)

- The difference in the calibration factor for  $D\pi\pi\pi$  makes sense (~30% difference in BR between Belle and Belle II)
- Need to study other 3 modes!

# Comparison with official values



# Next steps

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- Closer look at recoil mass and intermediate resonances for these three modes
- Side-by-side comparison of the above distributions with the Belle dataset