

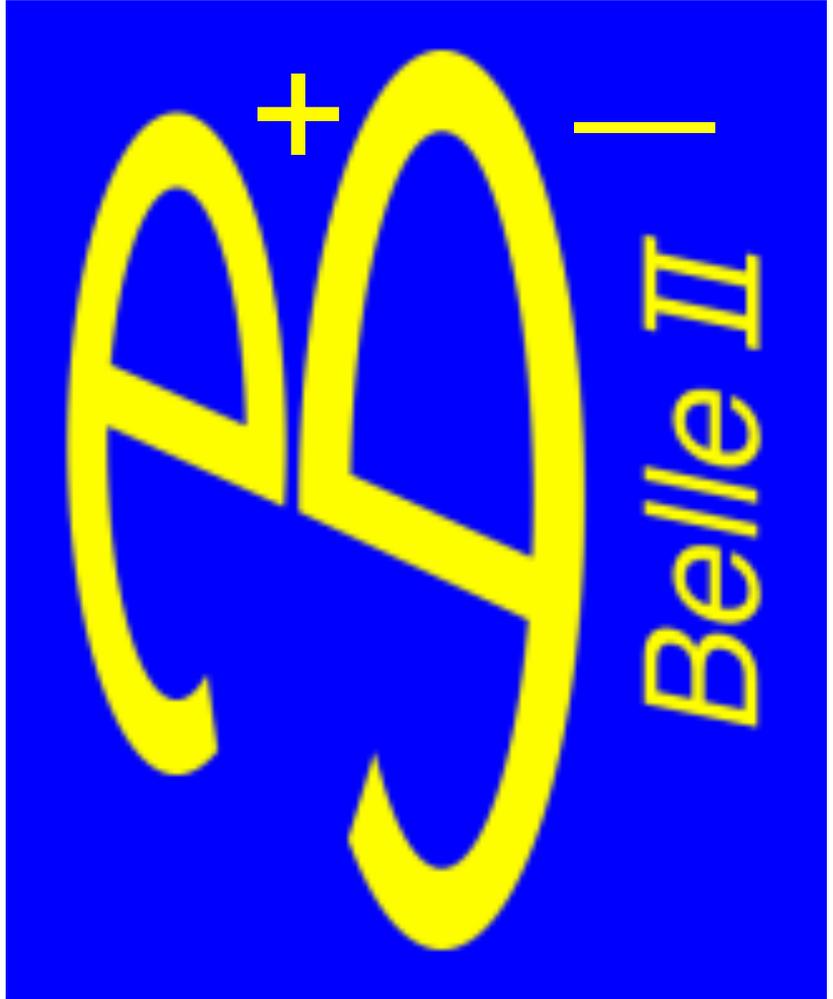
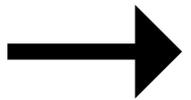
# First data from Belle II

## Lepton Identification Tau Rediscovery

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DESY, September 6th 2018





# Belle II

Located in Tsukuba,  
Japan

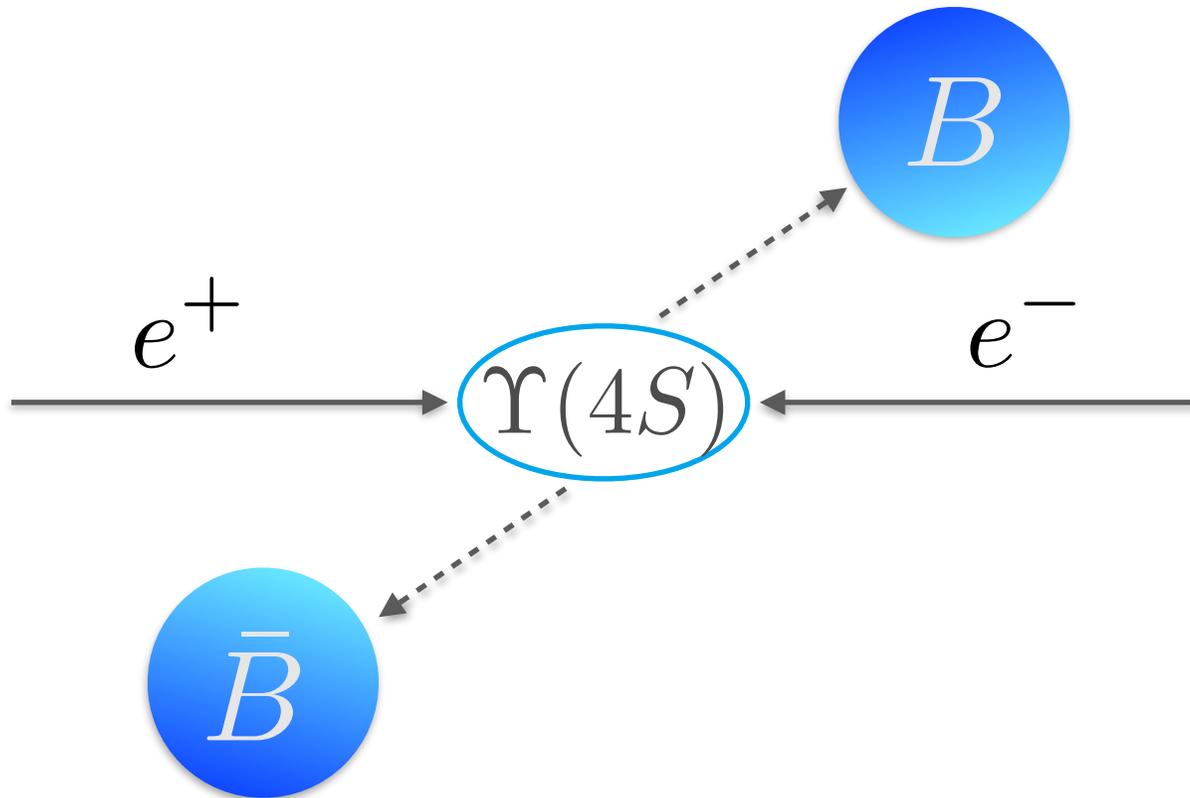
2 hours from Tokyo

Studying mainly :

- Heavy flavour
  - B meson
  - D meson
- $\tau$  physics
- Dark sector and other  
Beyond the Standard  
Model



# B factory 101



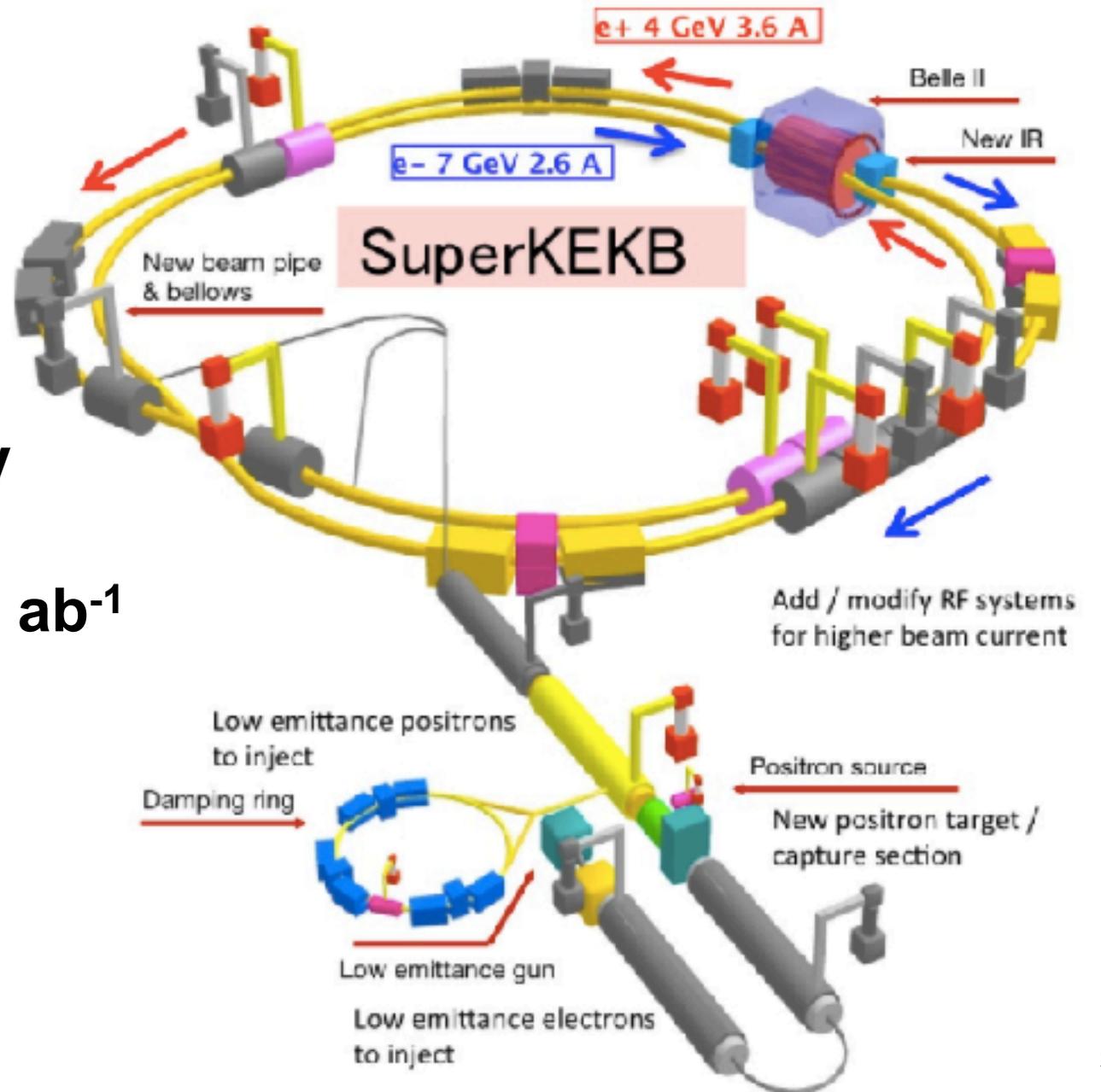
Events	cross section
$\Upsilon(4S)$	1.05
$u\bar{u}$	1.61
$e^+e^-$	300
$\mu^+\mu^-$	1.148
$c\bar{c}$	1.30

# Super KEKB

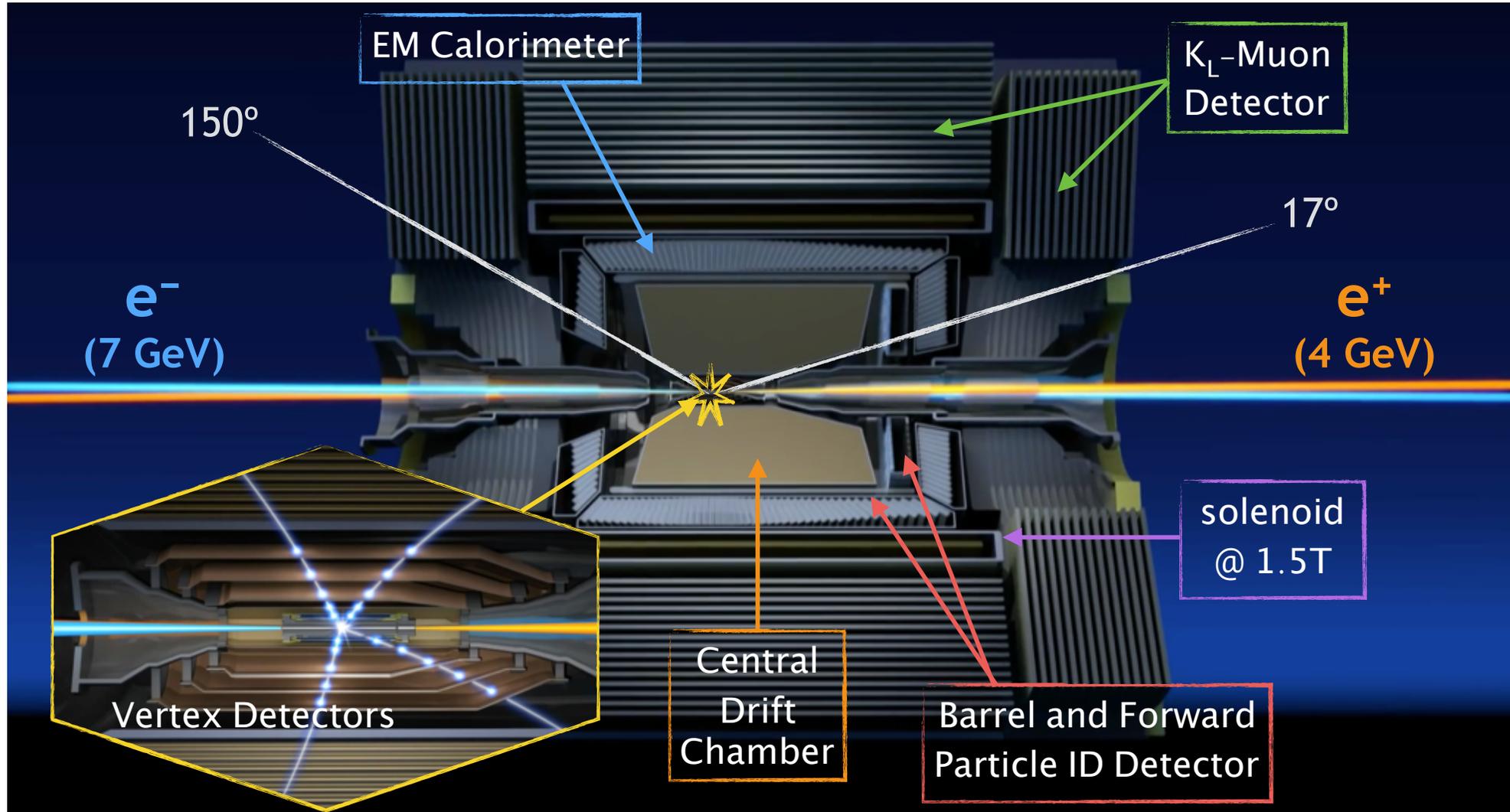
Centre of mass energy: **10.58 GeV**

Expected integrated luminosity: **50 ab<sup>-1</sup>**

Asymmetric e<sup>-</sup>e<sup>+</sup> collider



# Belle II Detector



# Particles

**LEPTONS**

**ELECTRON-NEUTRINO**  
This minuscule bandit is so light, he is practically massless.



**MUON-NEUTRINO**  
Like the other 2 neutrinos, he's got an identity crisis from oscillation.



**TAU-NEUTRINO**  
He's a tau now, but what type of neutrino will he be next?



**ELECTRON**  
A familiar friend, this negatively charged, busy lil' guy likes to bond.



**MUON**  
A "heavy electron" who lives fast and dies young.

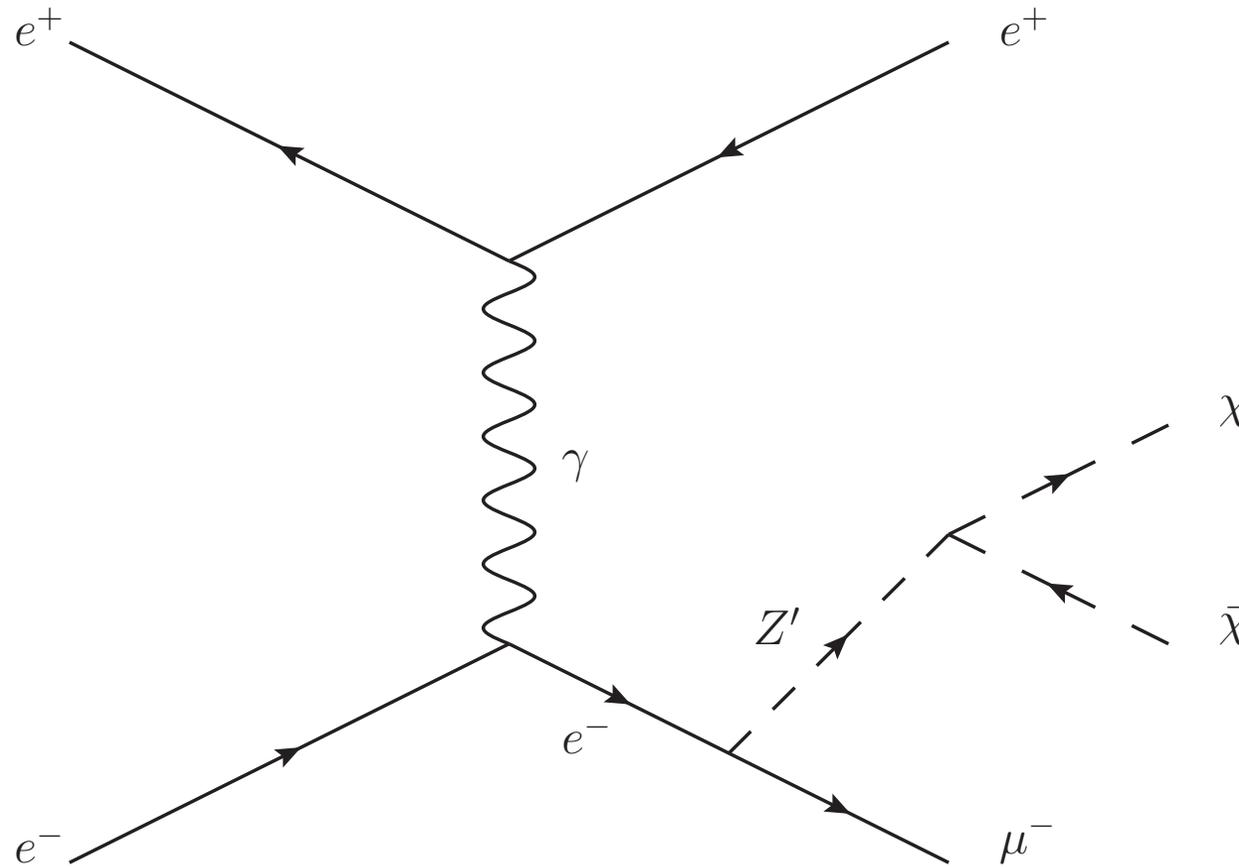


**TAU**  
A "heavy muon" who could stand to lose a little weight.

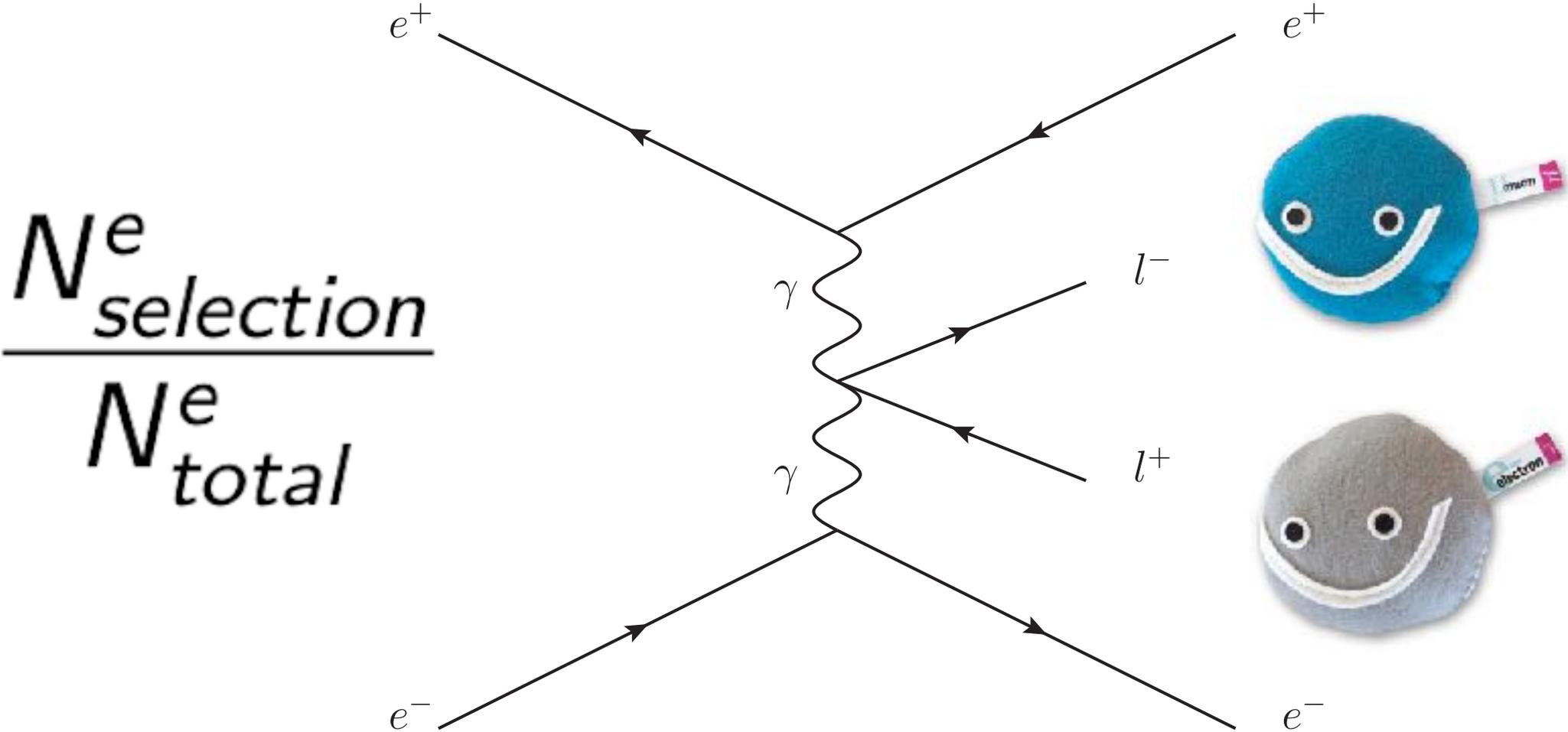


# Why lepton identification?

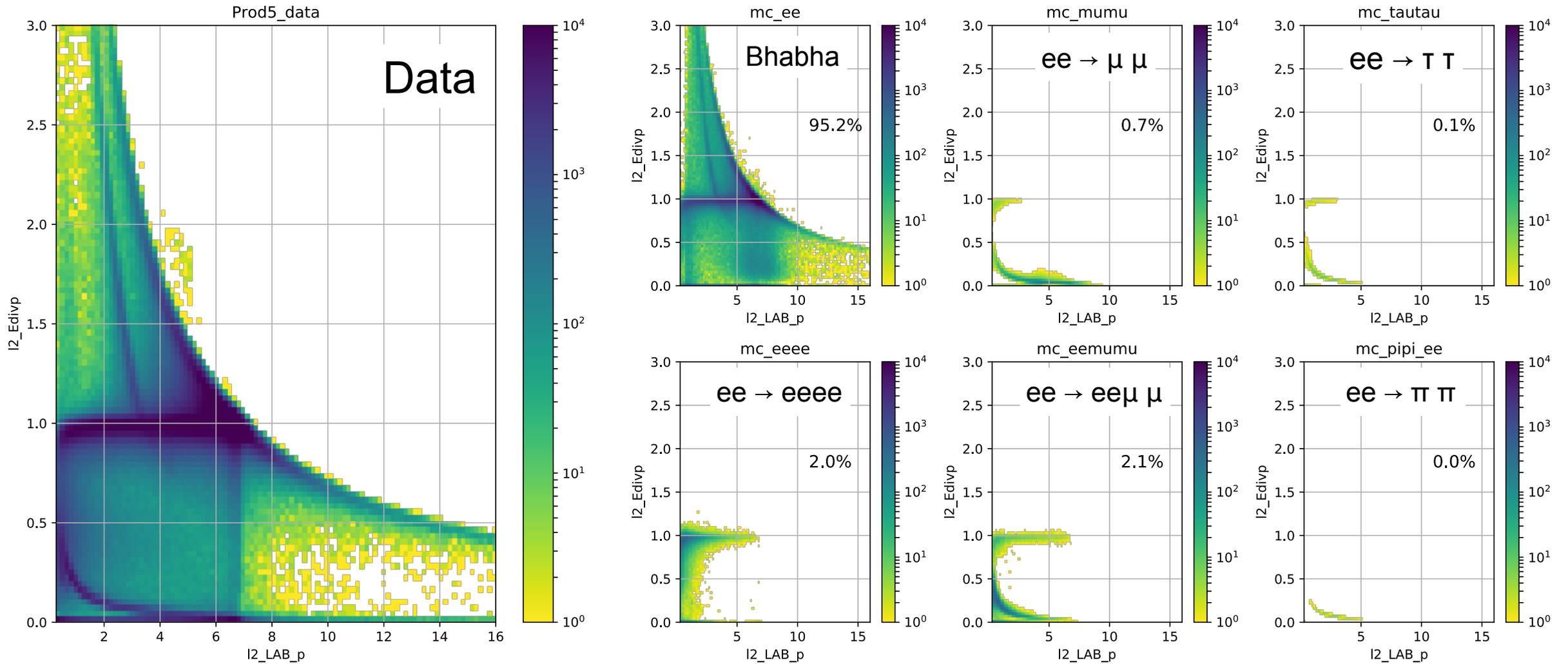
## Lepton Flavour Violating Dark Matter



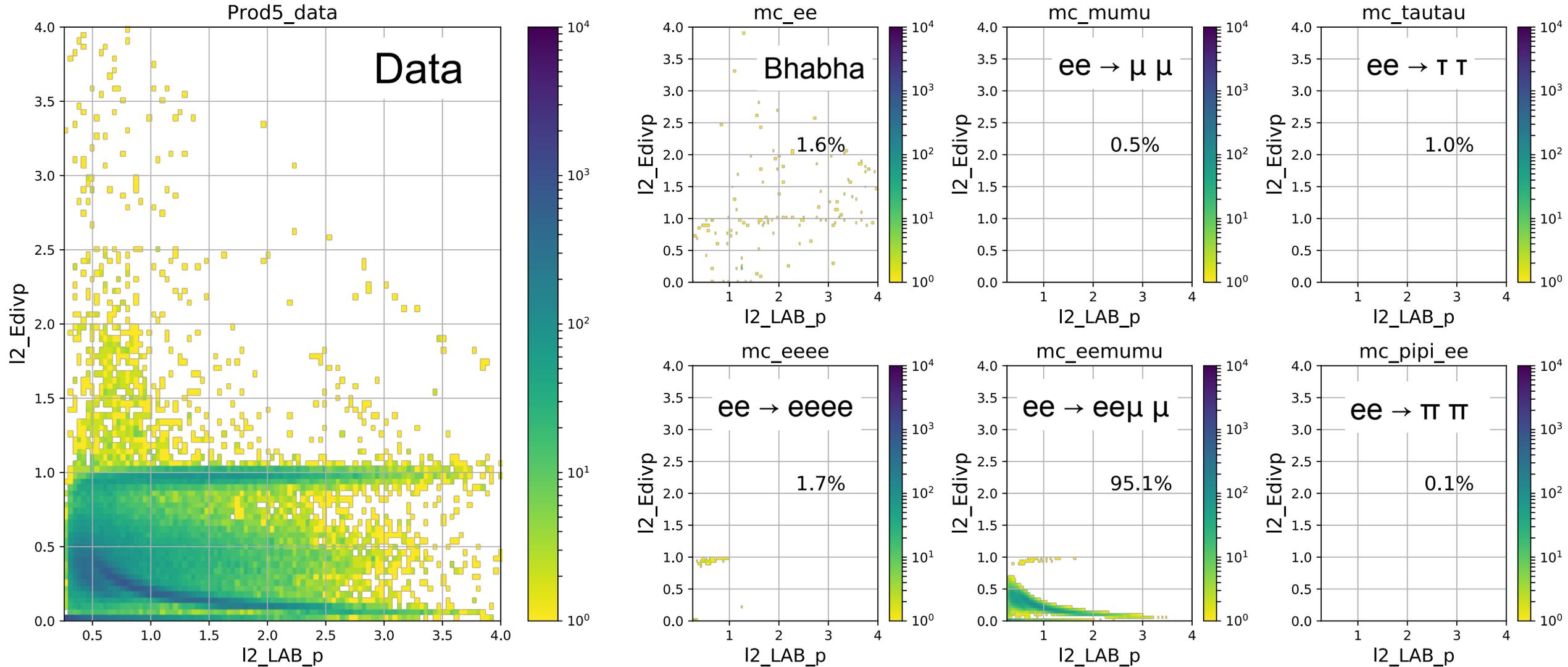
# What is the efficiency of $\mu / e$ selection?



# Data composition before selection



# Data composition after tagging



# LID Calibration

## Calibration procedure:

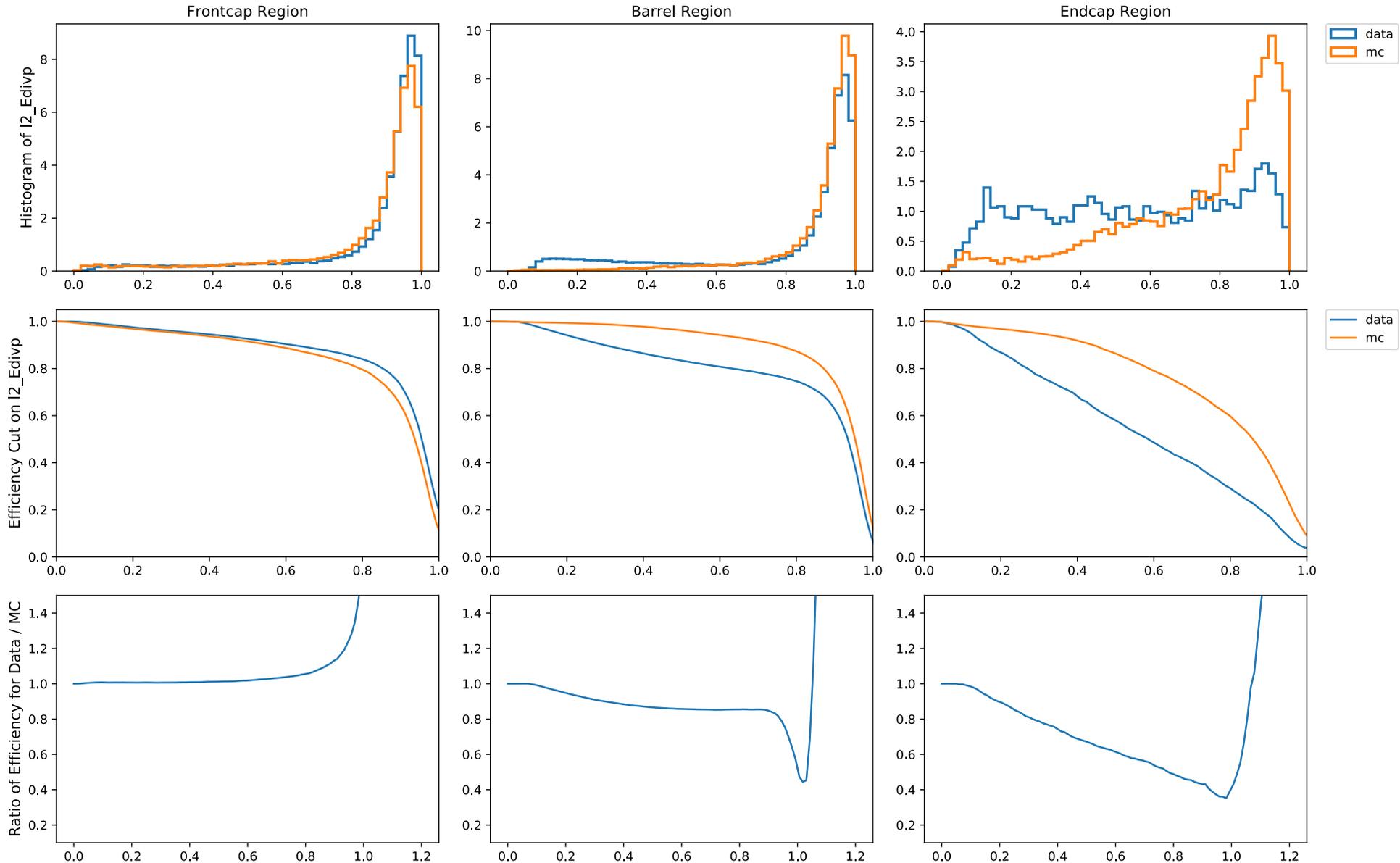
Choose probe particle in detector region

Plot distribution of LID

Plotting efficiency as a function of variable

Take ratio of the efficiencies for data and MC

Repeat for all regions of interest



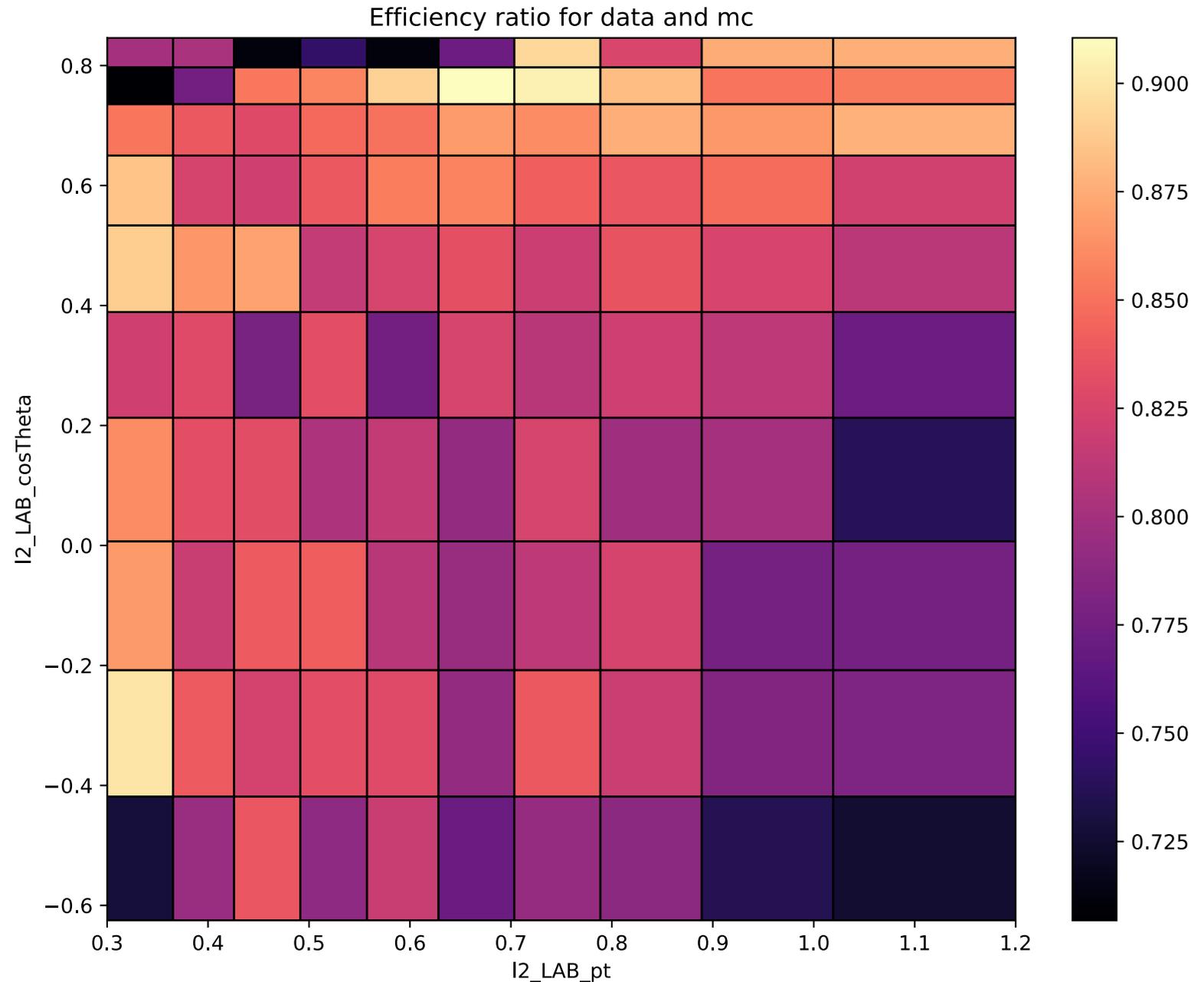
# 2D Mapping

## Mapping the efficiency ratio

LID depends on phase space

We calibrated LID performance in bins of phase space

Overall efficiency of data is 20% less than MC



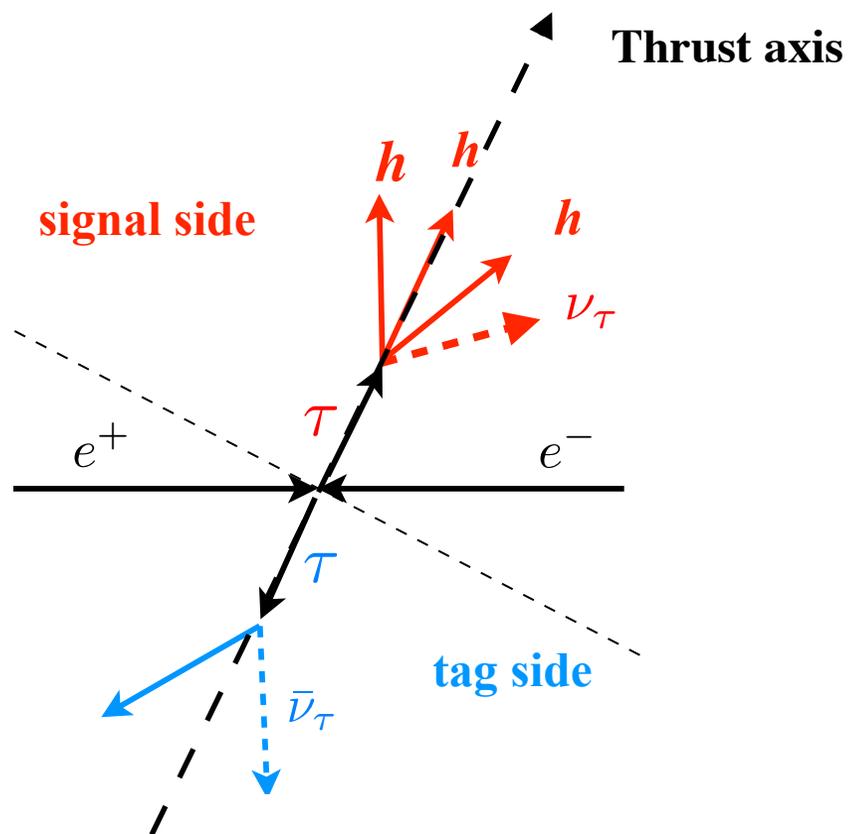
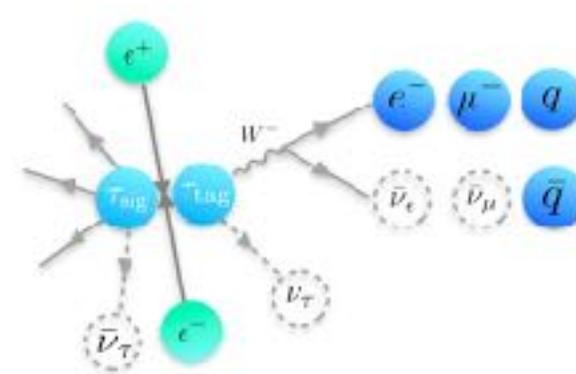


# Rediscovery of tau leptons



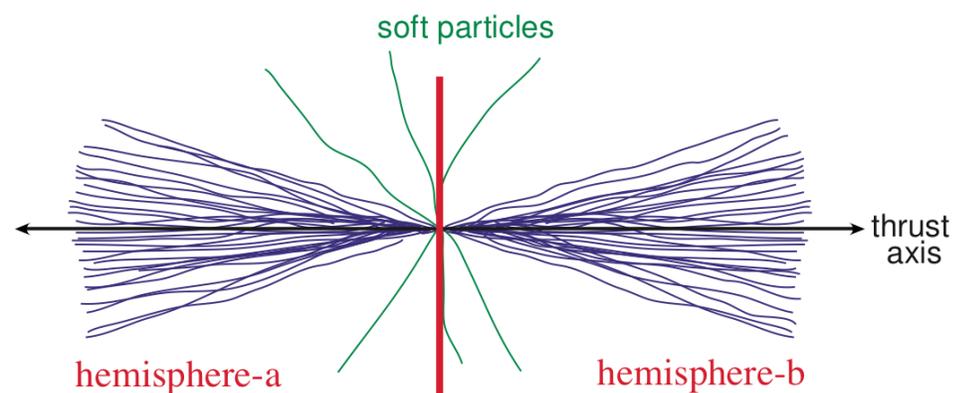
# Tau Studies

- Tau cross section is comparable with one of B-mesons.
- Can be a tool for searching for NP
- Difficult to reconstruct because of neutrinos

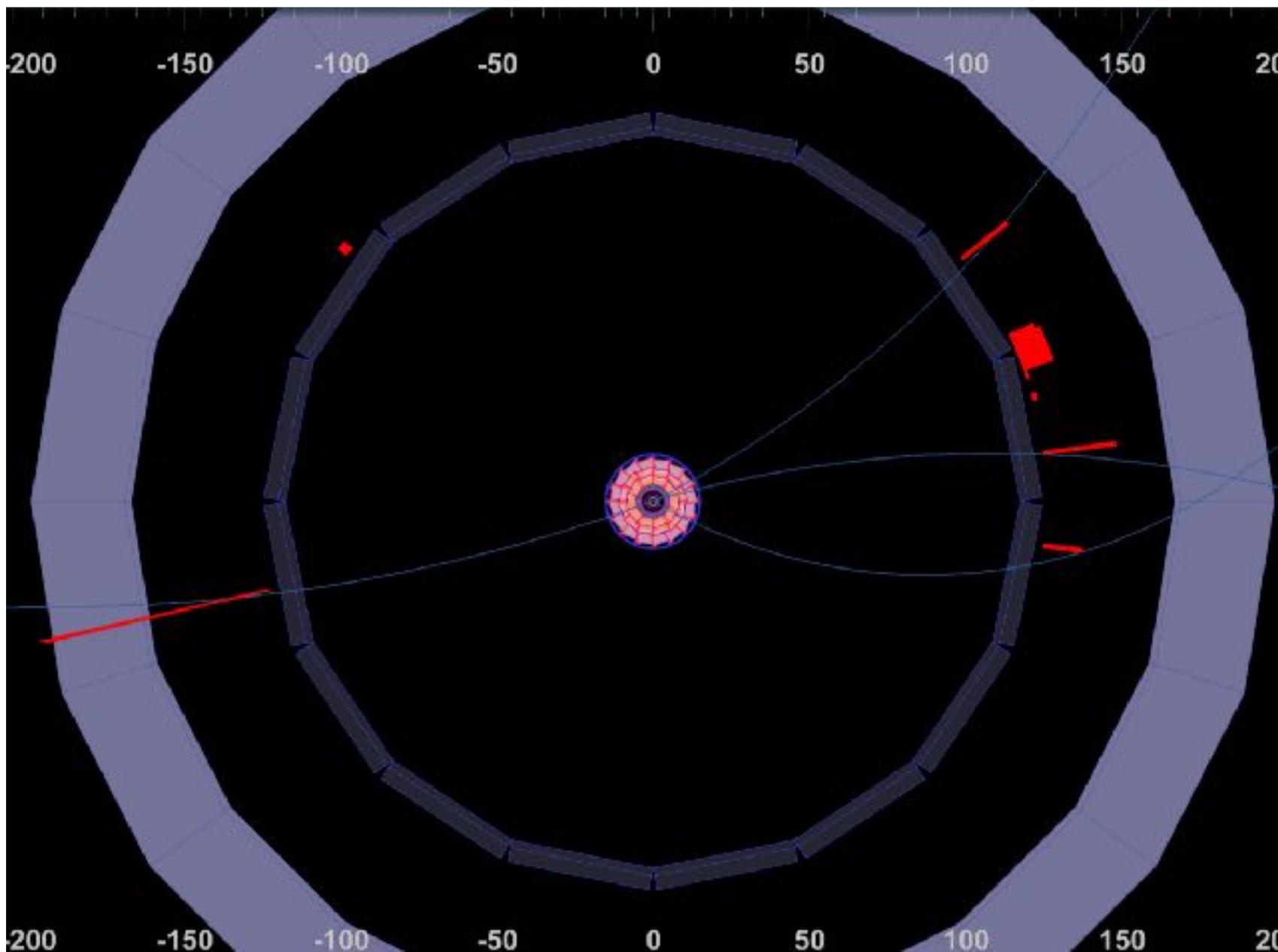


Thrust axis is maximising the jet event shape variable:

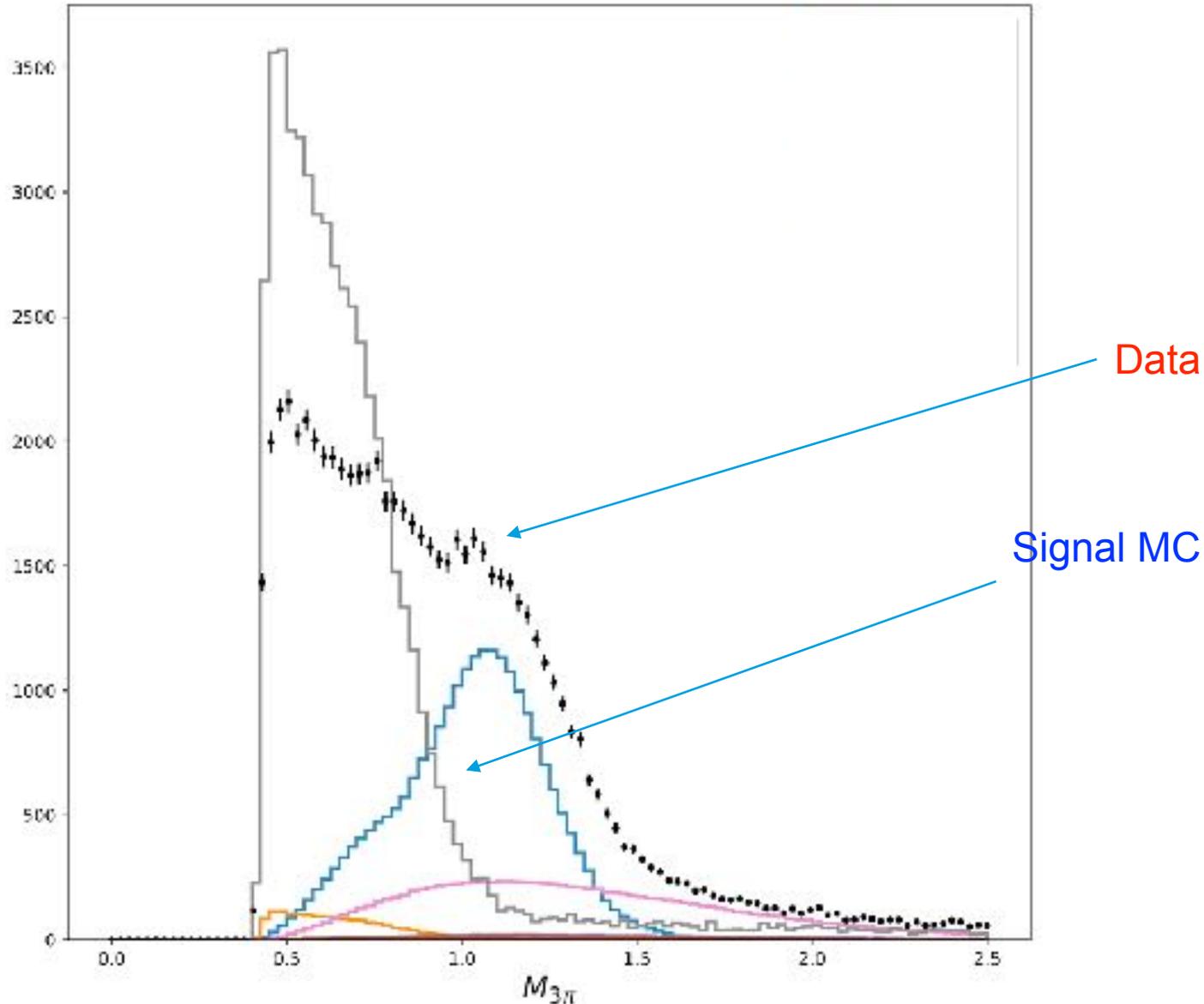
$$\mathbf{T} = \sum_h \frac{\vec{P}_h \cdot \hat{n}}{|P_h|}$$



# Event Display



# ... if only 4 tracks in event...



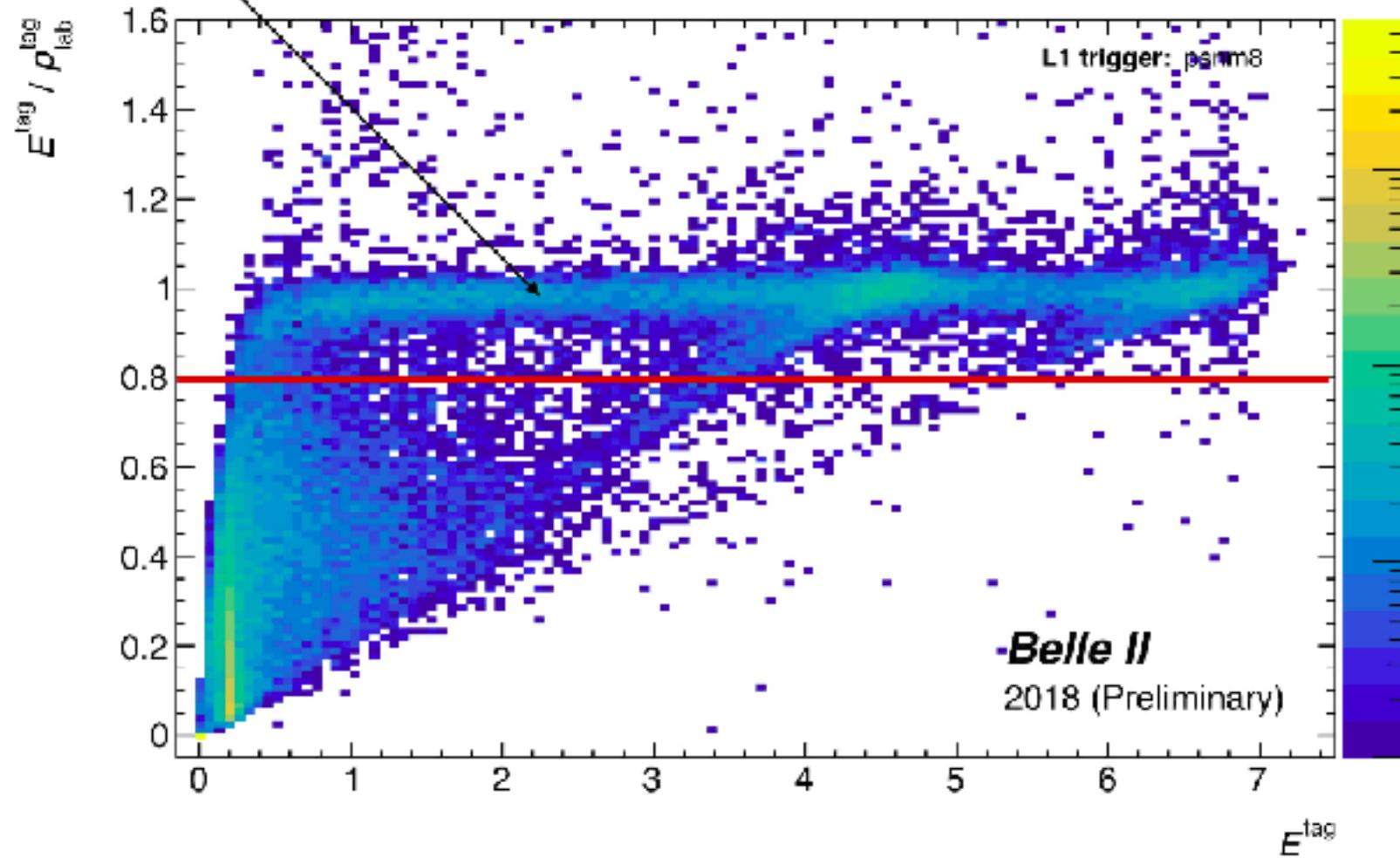
## Background

- $e^+e^-\gamma$
- $\mu^+\mu^-\gamma$
- $e^+e^-e^+e^-$
- $e^+e^-\mu^+\mu^-$
- $q_i\bar{q}_i$  (u,d,s,c)
- $B\bar{B}$

# E/p

Cut the electrons/positrons

- plot from Petar -

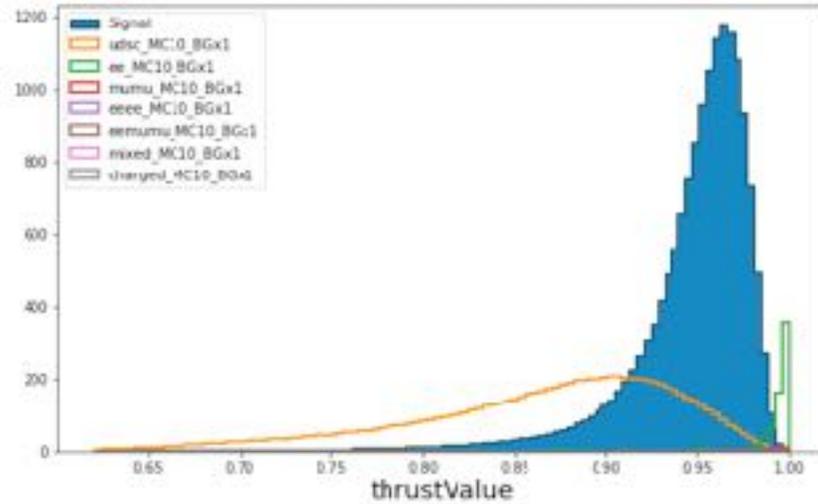


# Figure of Merit

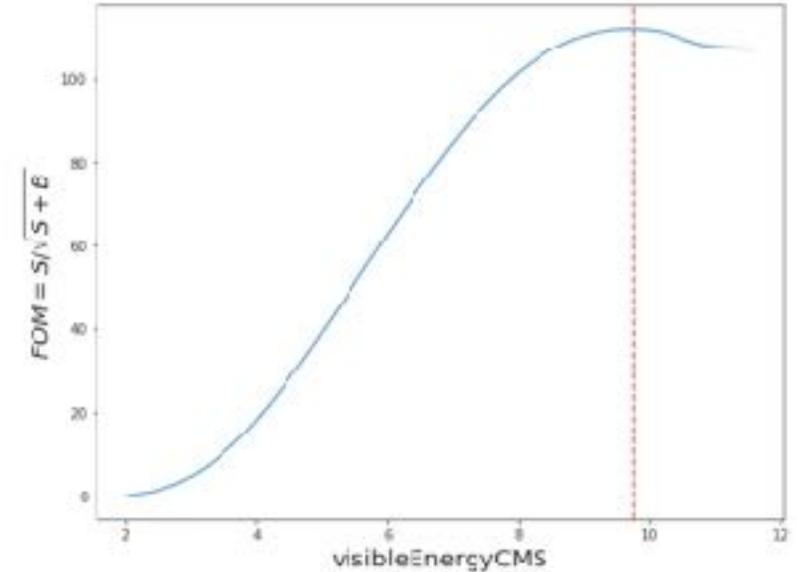
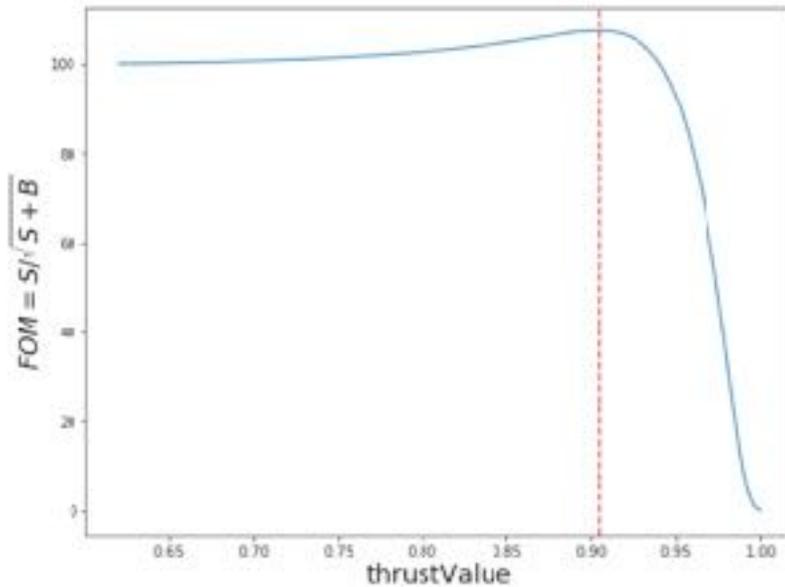
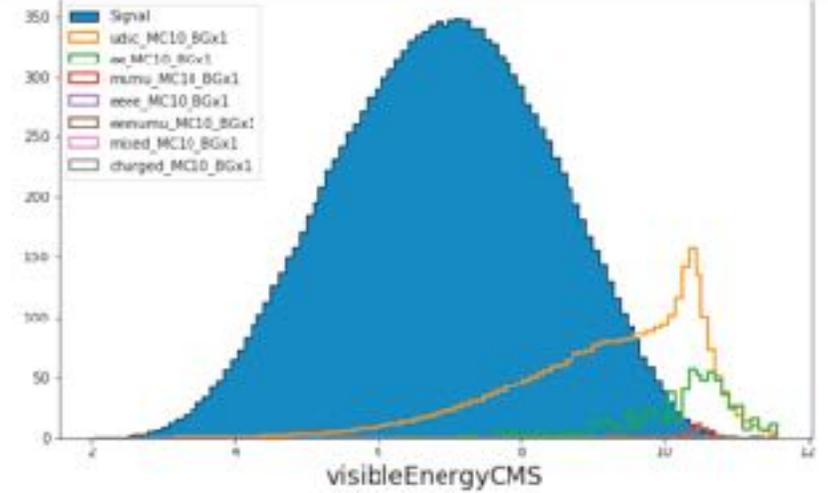
Thrust

$$FOM = \frac{S}{\sqrt{S+B}}$$

Visible Energy

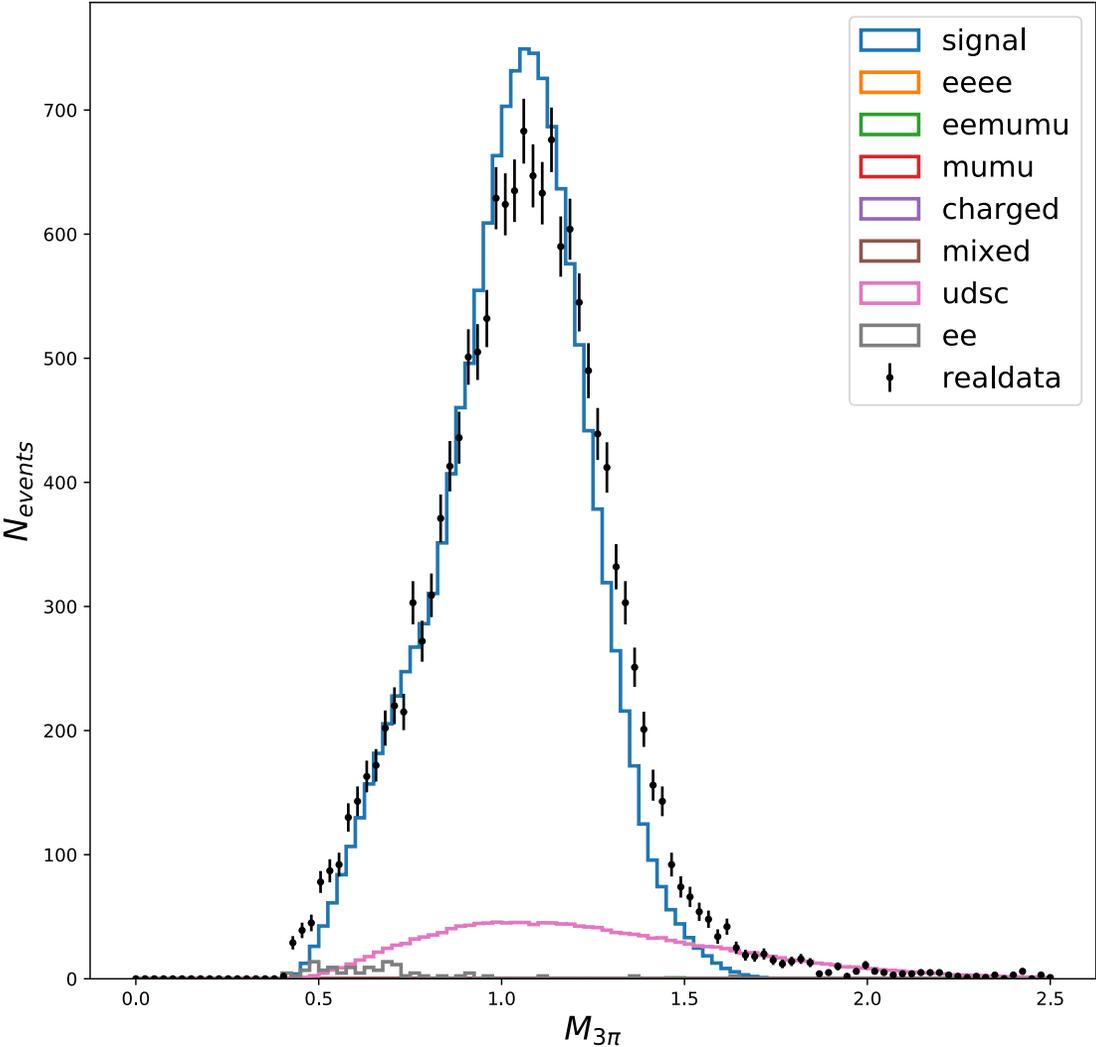
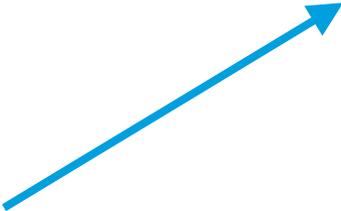
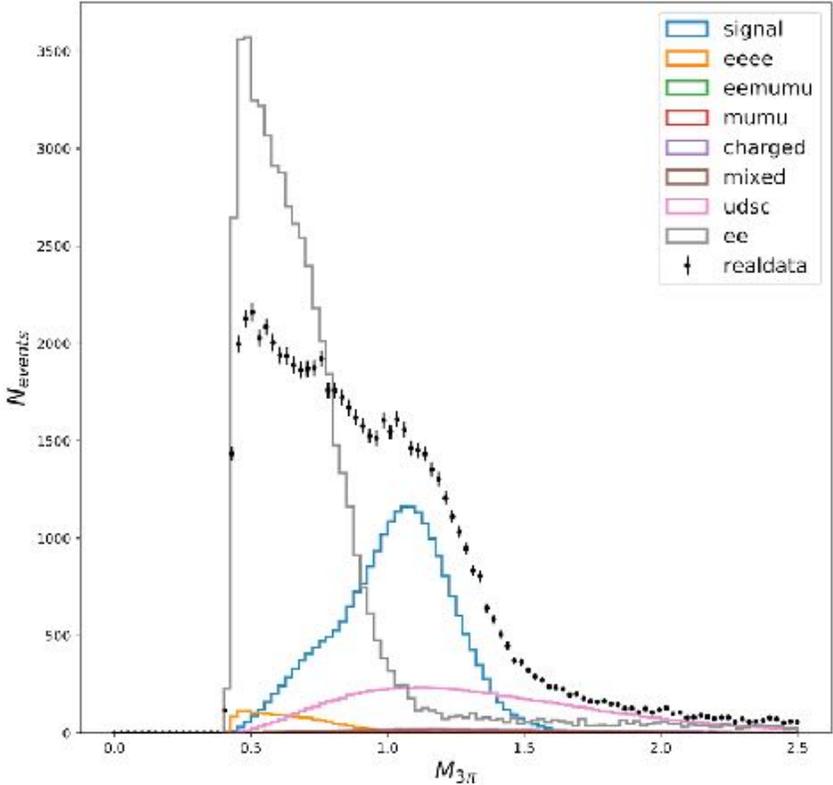


S - number of signal events  
B - number of background events



# BG suppressed!

Finalised of tau candidates selection



# Final Remarks

