



中国科学技术大学
University of Science and Technology of China



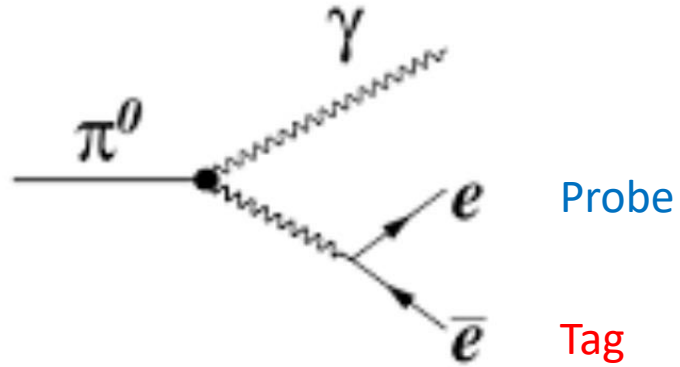
TPC and ITS matching efficiency in central barrel in pp collisions at 13.6 TeV

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ALICE mini-week

Tag-probe method



$$\mathcal{B}(\pi^0 \rightarrow e^+ e^- \gamma(\gamma)) = 1.1836(6)\%$$

The lifetime is $8.5 \times 10^{-17}\text{s}$

- The tag and probe method involves selecting a clean sample of electrons from π^0 Dalitz decay.
- One of the electron (the tag) is well-identified.
- Another electrons (the probe) from same pair is used for the TPC and ITS matching efficiency study.
- The photon converted electrons need to be rejected.

Data and cuts

LHC22o pass4: 528021, 528026, 528036, 528094, 528097, 528105, 528107, 528109, 528231, 528232, 528233, 528263, 528266, 528292, 528294, 528316, 528319, 528328, 528329, 528330, 528332, 528336, 528347, 528359, 528379, 528381, 528386, 528448, 528451, 528461, 528463, 528530, 528531, 528534

Pair cut (default)

$$0 < m < 0.035 \text{ GeV}/c^2$$

Triangle cut (ψ_{pair} and $\Delta\phi$) (to reject photon conversion electron):

Reject pairs with $(\Delta\phi, \psi_{pair})$ in triangle $(0, -0.8)$ $(0, 0.8)$ $(0.12, 0)$

Track cut (default)

$$p_T > 1.0 \text{ GeV}/c, |\eta| < 0.9$$

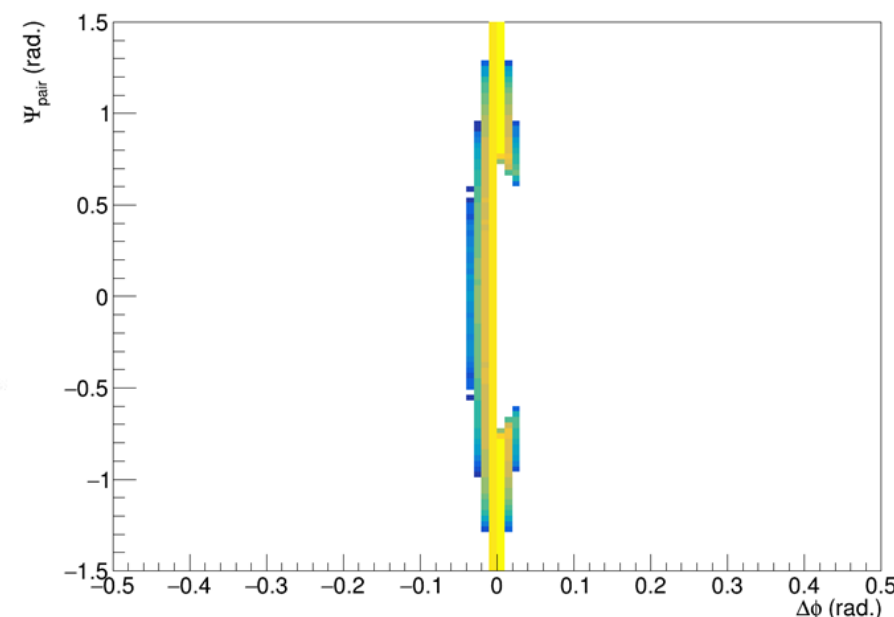
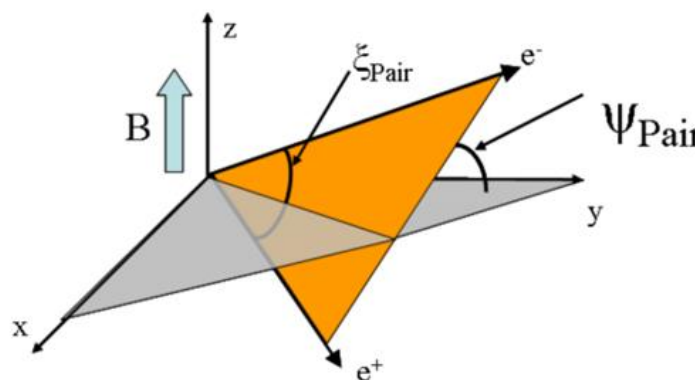
$$\text{TPCncls} > 90, \text{TPCchi2} < 4$$

ITSRequirement: ITSMatch (tag)

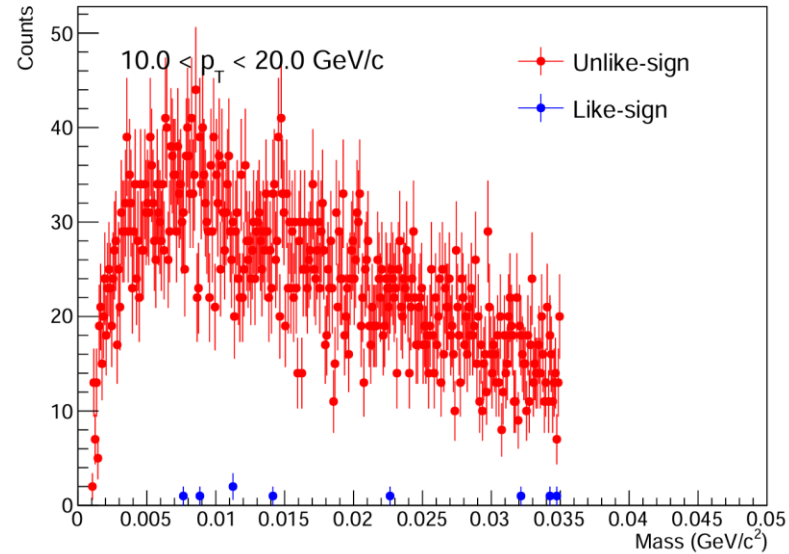
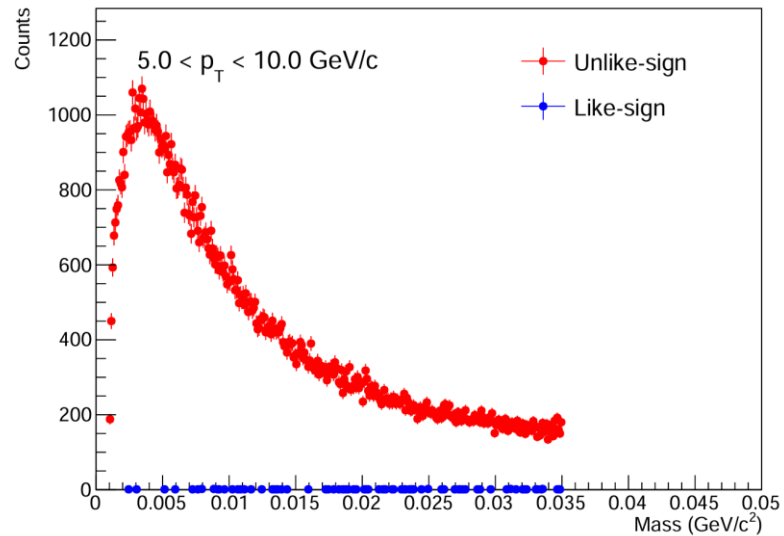
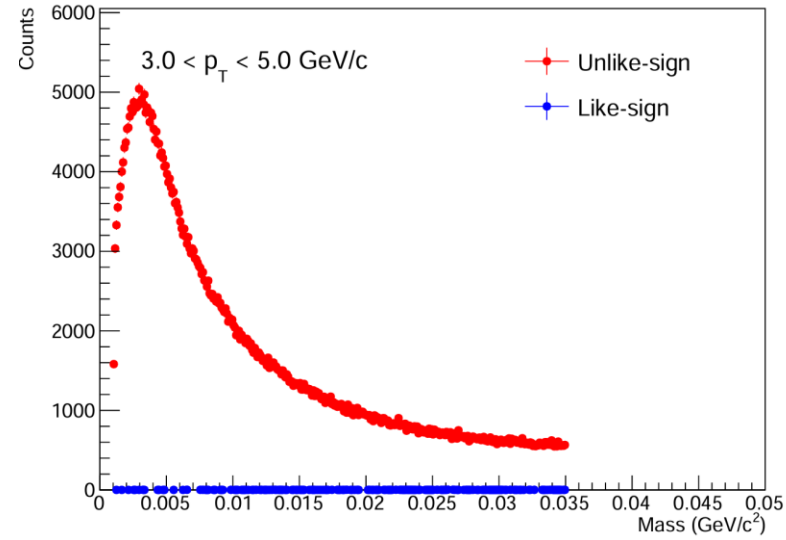
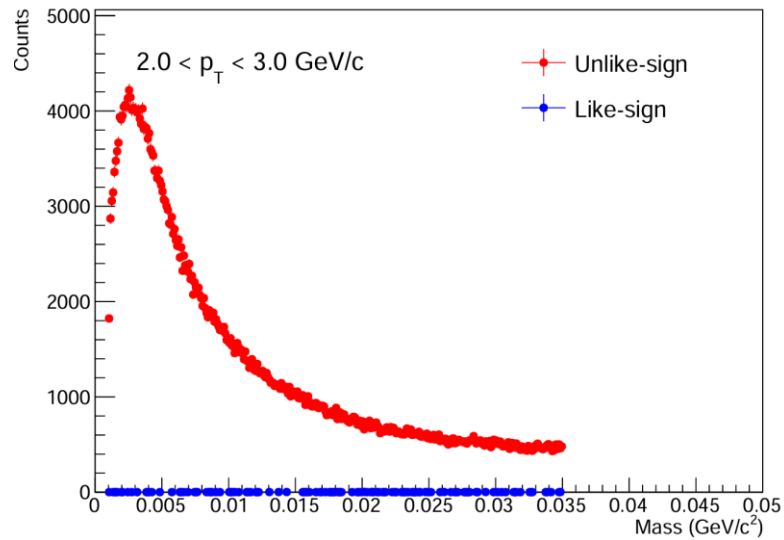
$$-3 < \text{TPCnSigmaE} < 3$$

$$|\text{TPCnSigmaPi}| > 3$$

$$|\text{TPCnSigmaPr}| > 3$$

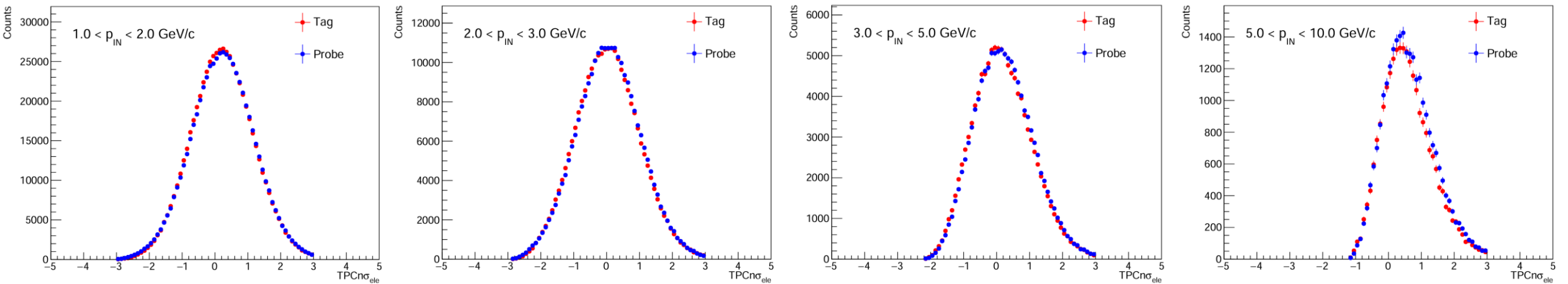


Invariant mass



➤ The purity of pair is high.

PID performance

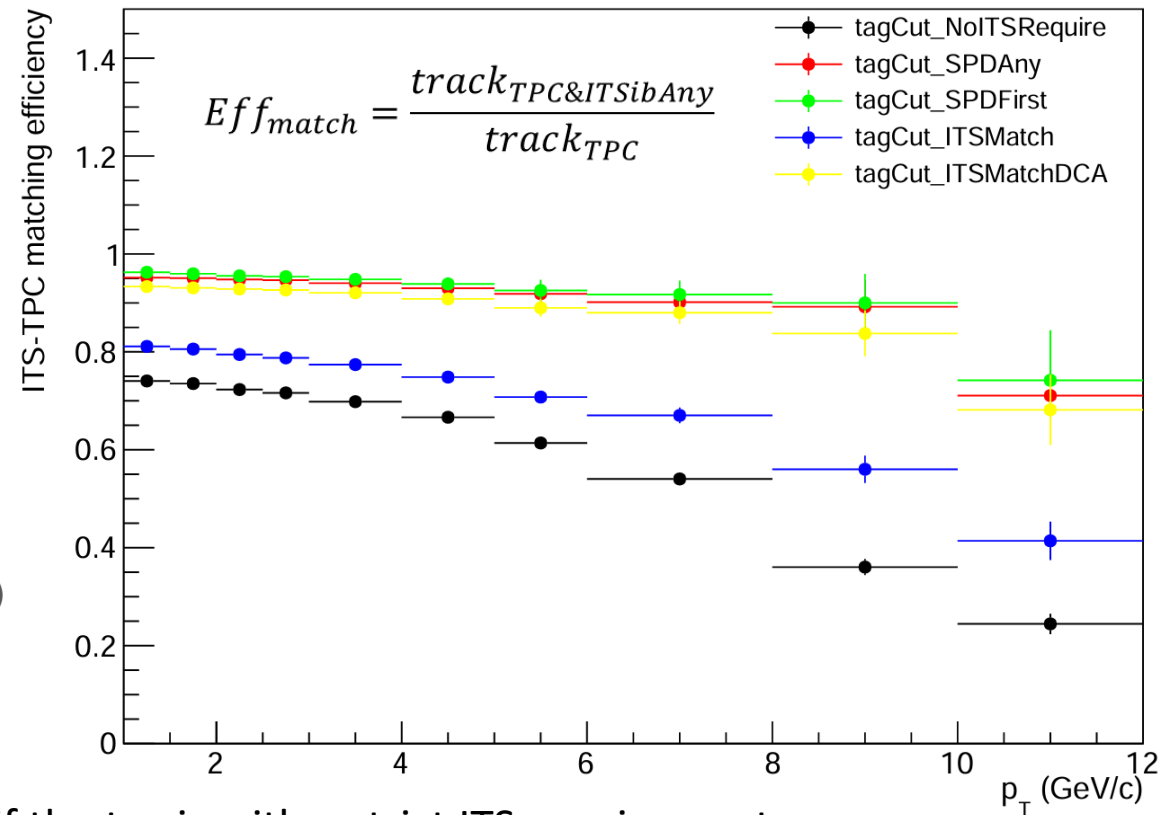


- TPCnSigmaE distribution of tag and probe tracks.
- Electron purity is high after PID selections

ITS-TPC matching efficiency

Tag ITS Requirement with the below:

1. NoITSRequire:
 - No ITS requirement
2. SPDFirst:
 - at least one hit on the inner most layer
3. SPDAny:
 - at least one hit on the first two layers
4. ITSMatch:
 - any hits on the ITS
5. ITSMatchDCA:
 - any hits on the ITS + DCA($|xy| < 0.1$ cm, $|z| < 0.15$ cm)



- The matching efficiency of probe will increase if the tag is with a strict ITS requirement.
 - Correlation of two tracks.
 - Photon converted electrons.
- The ITS-TPC matching efficiency decrease with p_T .
 - Photon converted electrons contamination.
 - ITS clusters shared by two tracks.

Match efficiency with different DCA

Tag with the below

1. DCA10:

- $|DCA_{xy}| < 0.1 \text{ cm}, |DCA_z| < 1 \text{ cm}$

2. DCA20:

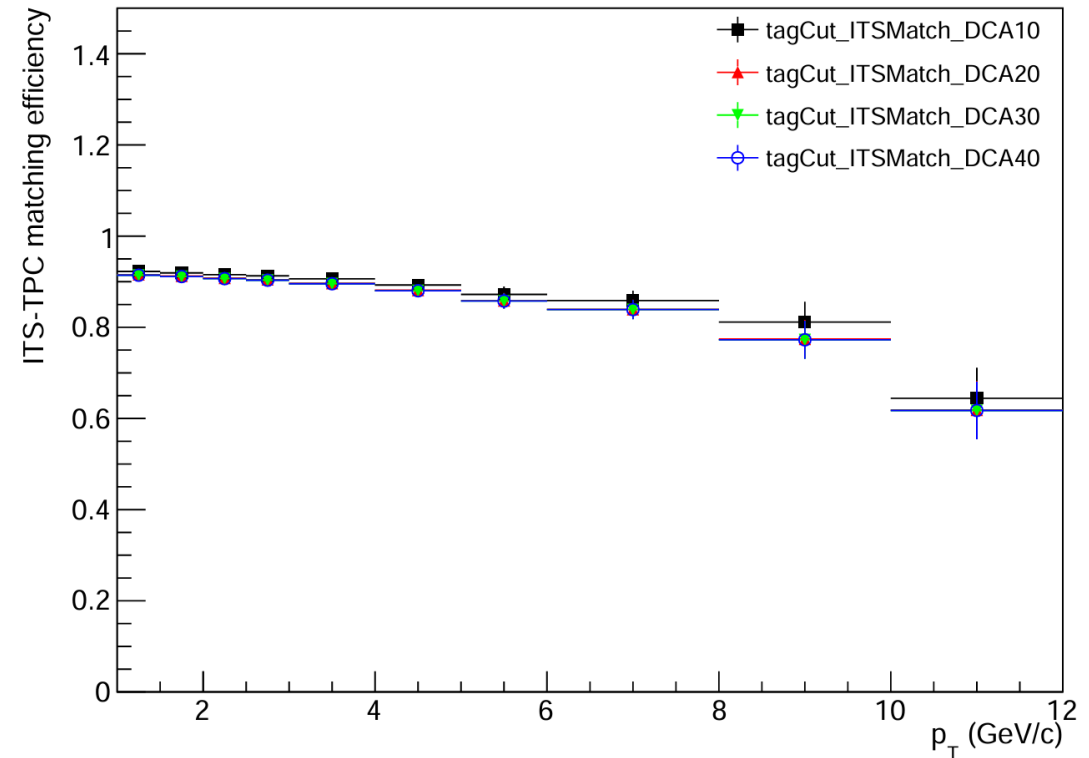
- $|DCA_{xy}| < 0.5 \text{ cm}, |DCA_z| < 1 \text{ cm}$

3. DCA30:

- $|DCA_{xy}| < 1.5 \text{ cm}, |DCA_z| < 1 \text{ cm}$

4. DCA40:

- $|DCA_z| < 1 \text{ cm}$



➤ DCA_{xy} cut on tags will not influence the matching efficiency of probe

Match efficiency with different DCA

Tag with the below

1. DCA01:

- $|DCA_{xy}| < 1 \text{ cm}$, $|DCA_z| < 0.15 \text{ cm}$

2. DAC02:

- $|DCA_{xy}| < 1 \text{ cm}$, $|DCA_z| < 0.5 \text{ cm}$

3.DAC03:

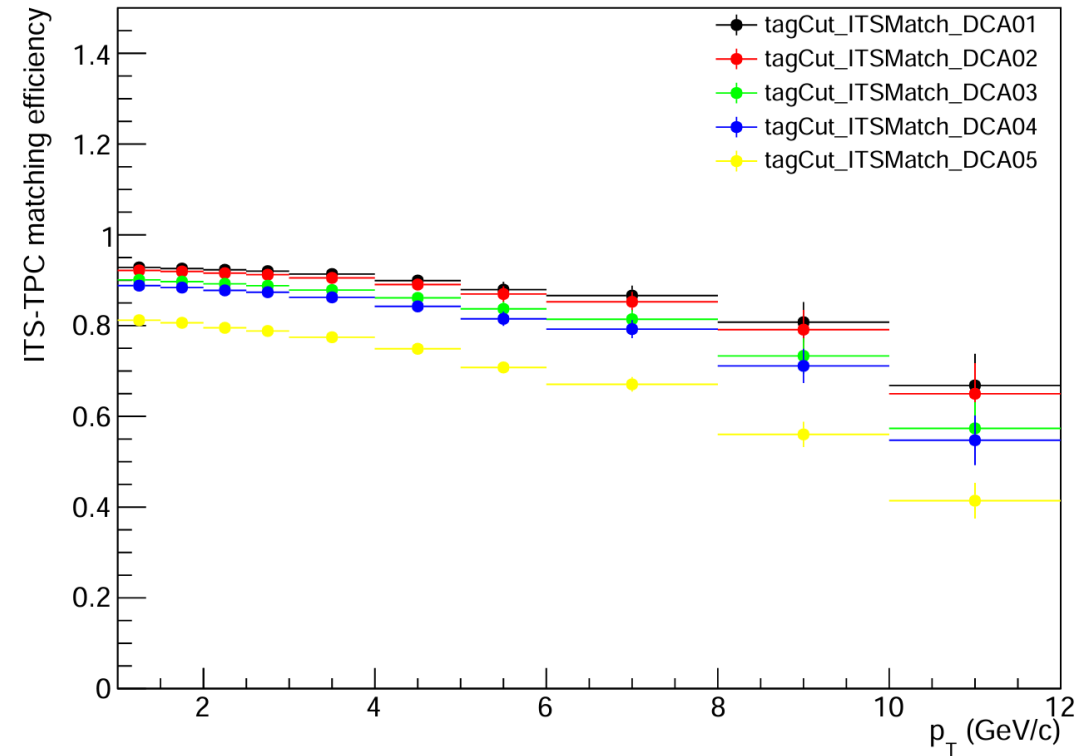
- $|DCA_{xy}| < 1 \text{ cm}$, $|DCA_z| < 2 \text{ cm}$

4.DAC04:

- $|DCA_{xy}| < 1 \text{ cm}$, $|DCA_z| < 3 \text{ cm}$

5.DAC05:

- $|DCA_{xy}| < 1 \text{ cm}$

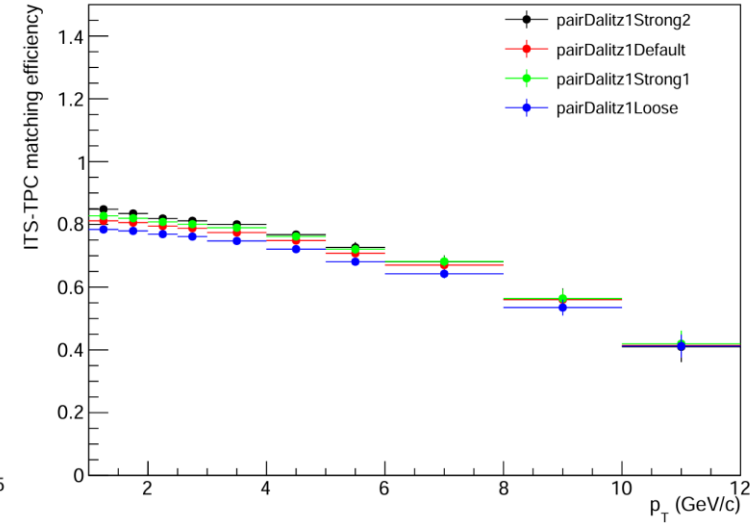
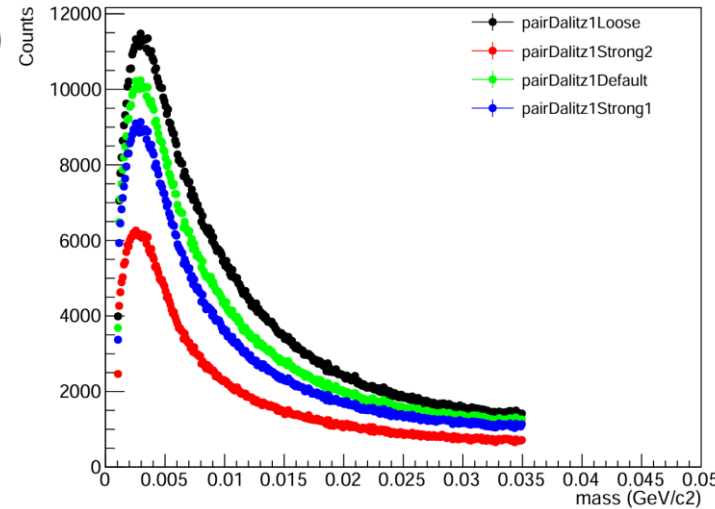


- DCAz cut on tags will influence the matching efficiency of probe.
 - Photon converted electrons.

Matching eff with different triangle cut

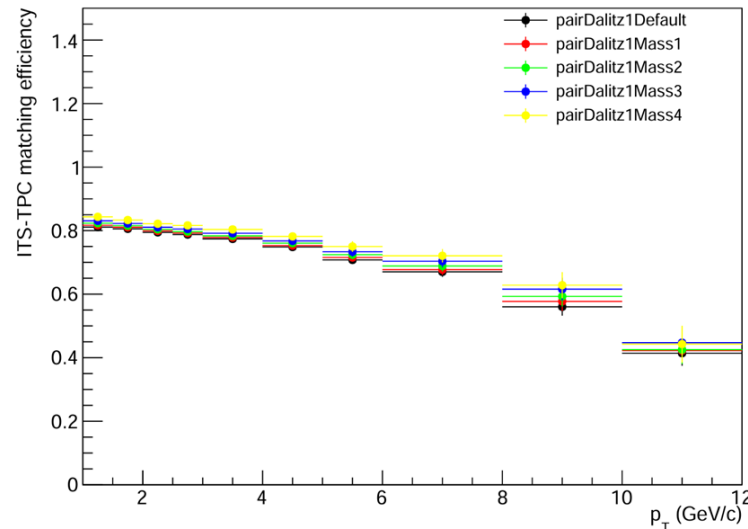
Triangle cut (Reject pairs with $(\Delta\phi, \psi_{pair})$ in triangle)

- pairDalitz1Loose
 - (0,-0.6) (0,0.6) (0.12,0)
- pairDalitz1Default
 - (0,-0.8) (0,0.8) (0.12,0)
- pairDalitz1Strong1
 - (0,-1.0) (0,1.0) (0.12,0)
- pairDalitz1Strong2
 - $(0,-\infty)$ $(0,+\infty)$ $(+\infty,0)$



Mass cut:

1. stand cuts ($m < 0.035 \text{ GeV}/c^2$)
2. Tight cut1 ($m < 0.03 \text{ GeV}/c^2$)
3. Tight cut2 ($m < 0.025 \text{ GeV}/c^2$)
4. Tight cut3 ($m < 0.02 \text{ GeV}/c^2$)
5. Tight cut4 ($m < 0.015 \text{ GeV}/c^2$)

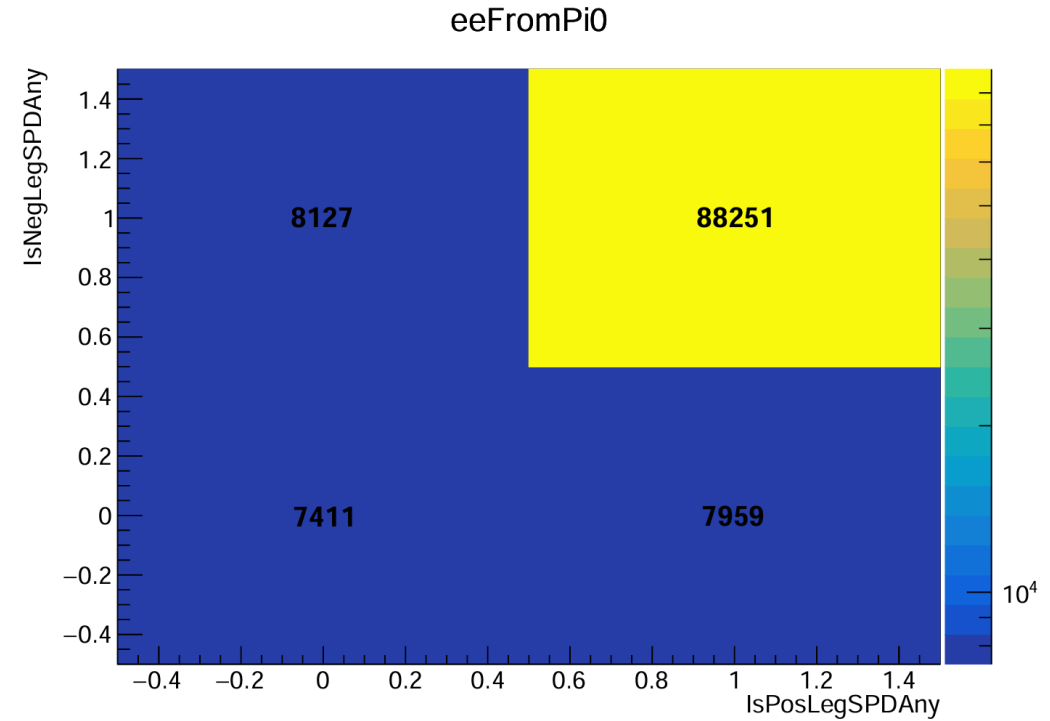
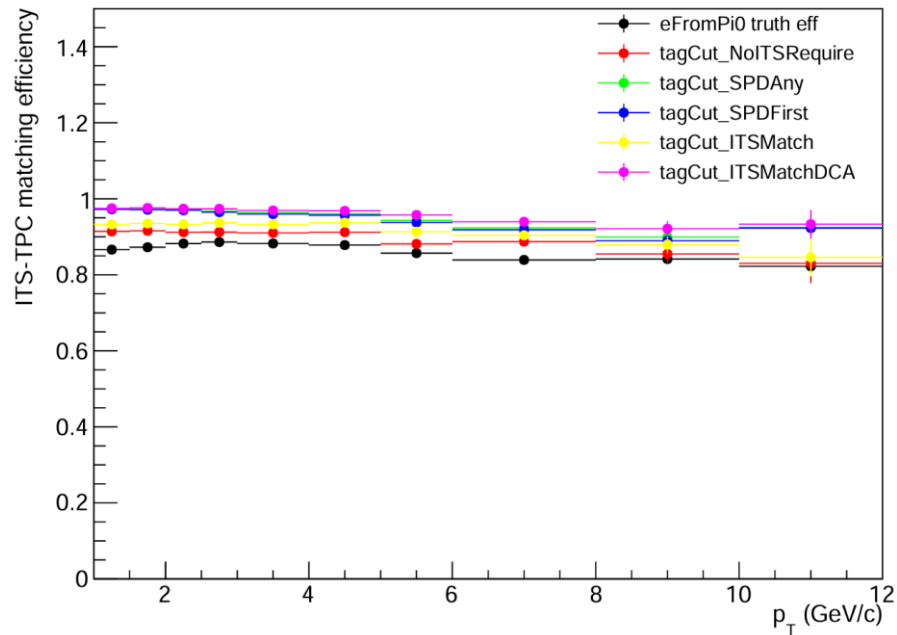


- Triangle and mass cuts will influence the matching efficiency of probe, but not too much.
 - Some photon converted electrons contamination.
 - Triangle cut can't reject more photon converted electrons.

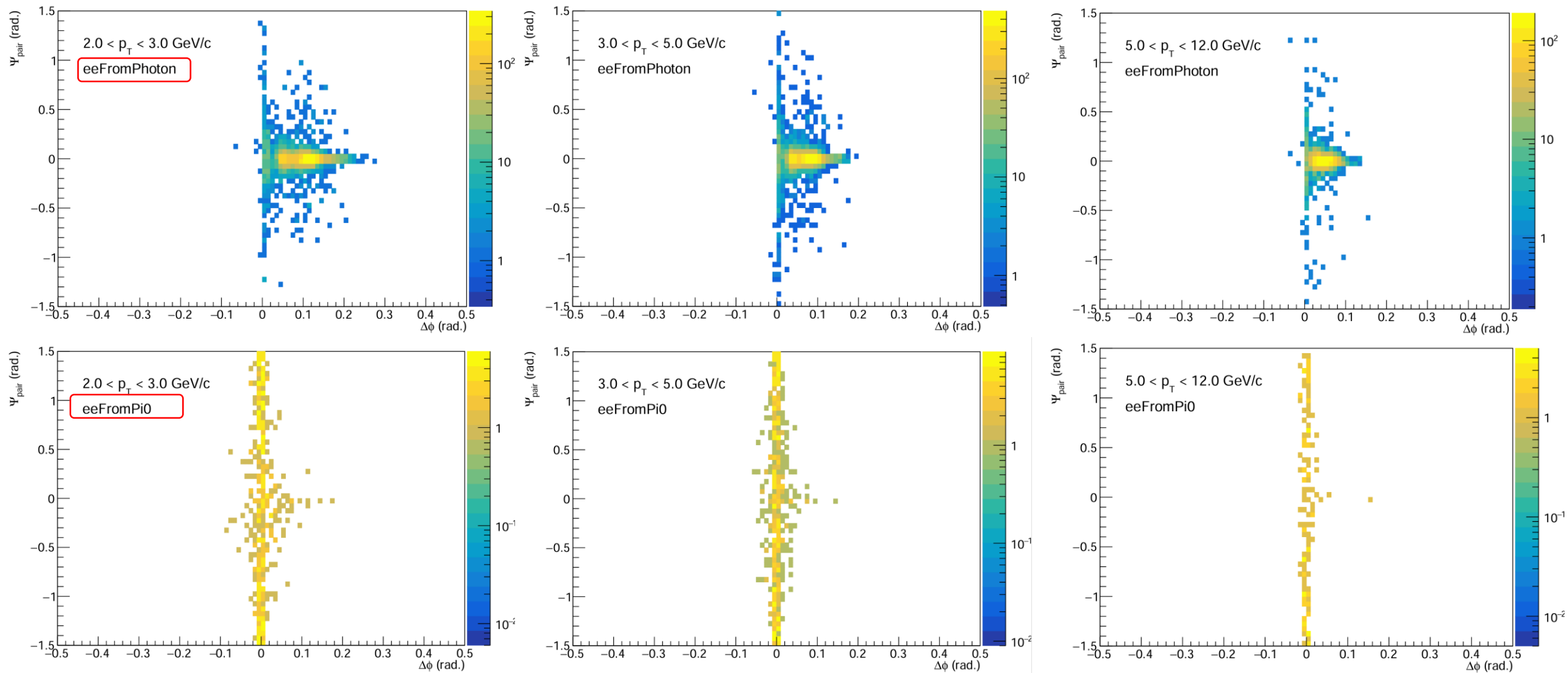
Check in MC

MC: LHC23k2c, GP MC anchored to pass4 HIR data

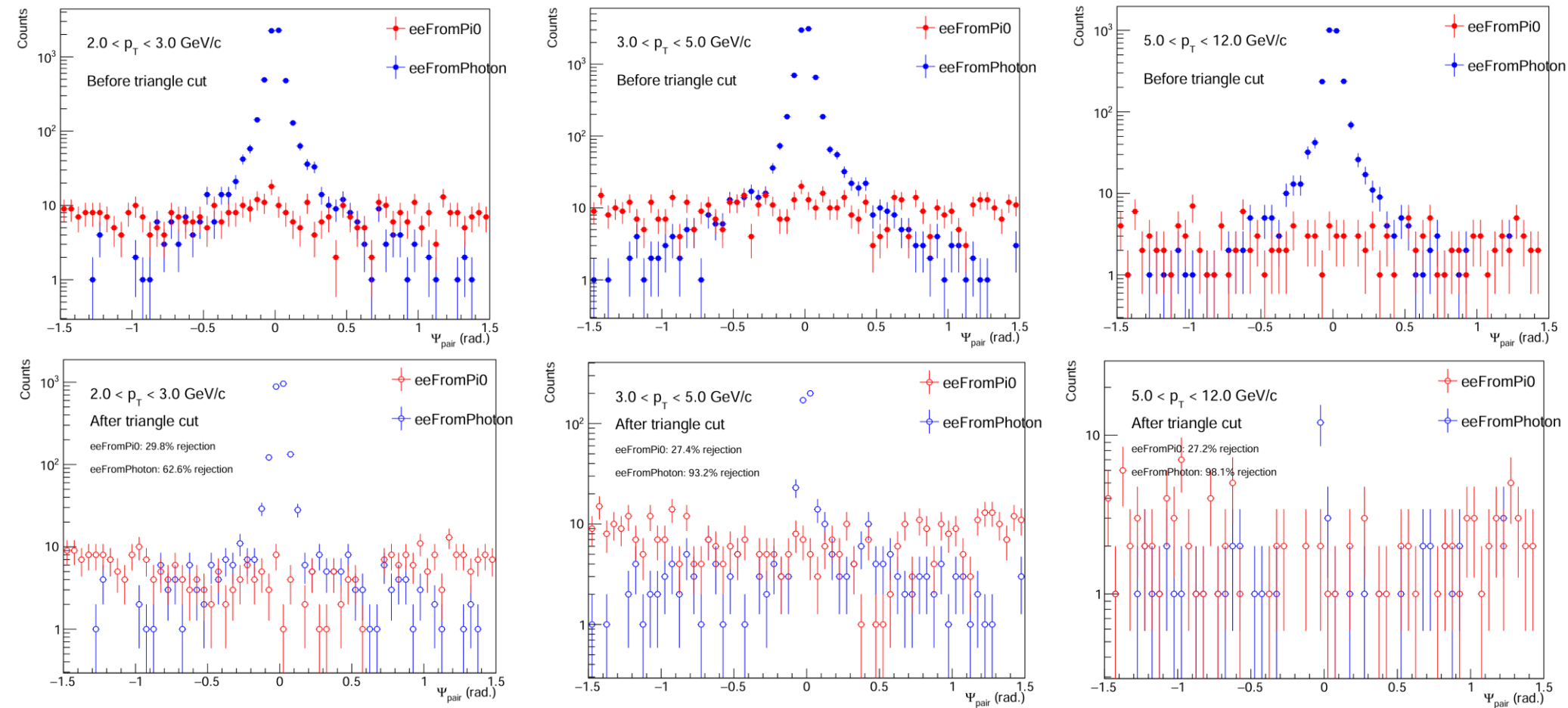
- In MC, the ITS performance shows a strong correlation for the two electrons from Pi^0
 - If the ITS cuts are applied on tag, the probe will be more likely to have ITS hits.



Check in MC (triangle distribution)



Check in MC (pairDalitz1Default)



- The triangle cuts still left some photon converted electrons.
- The electron from J/ψ can be used to reduce the influence of photon converted electrons.

Tag-probe using J/ψ

Pair cut (default)

$$2.84 < m < 3.2 \text{ GeV}/c^2$$

Track cut (default)

$$p_T > 1.0 \text{ GeV}/c, |\eta| < 0.9$$

$$\text{TPCncls} > 90, \text{TPCchi2} < 4$$

ITSRequirement: ITSMatch (Tag)

$$-3 < \text{TPCnSigmaE} < 3$$

$$|\text{TPCnSigmaPi}| > 3$$

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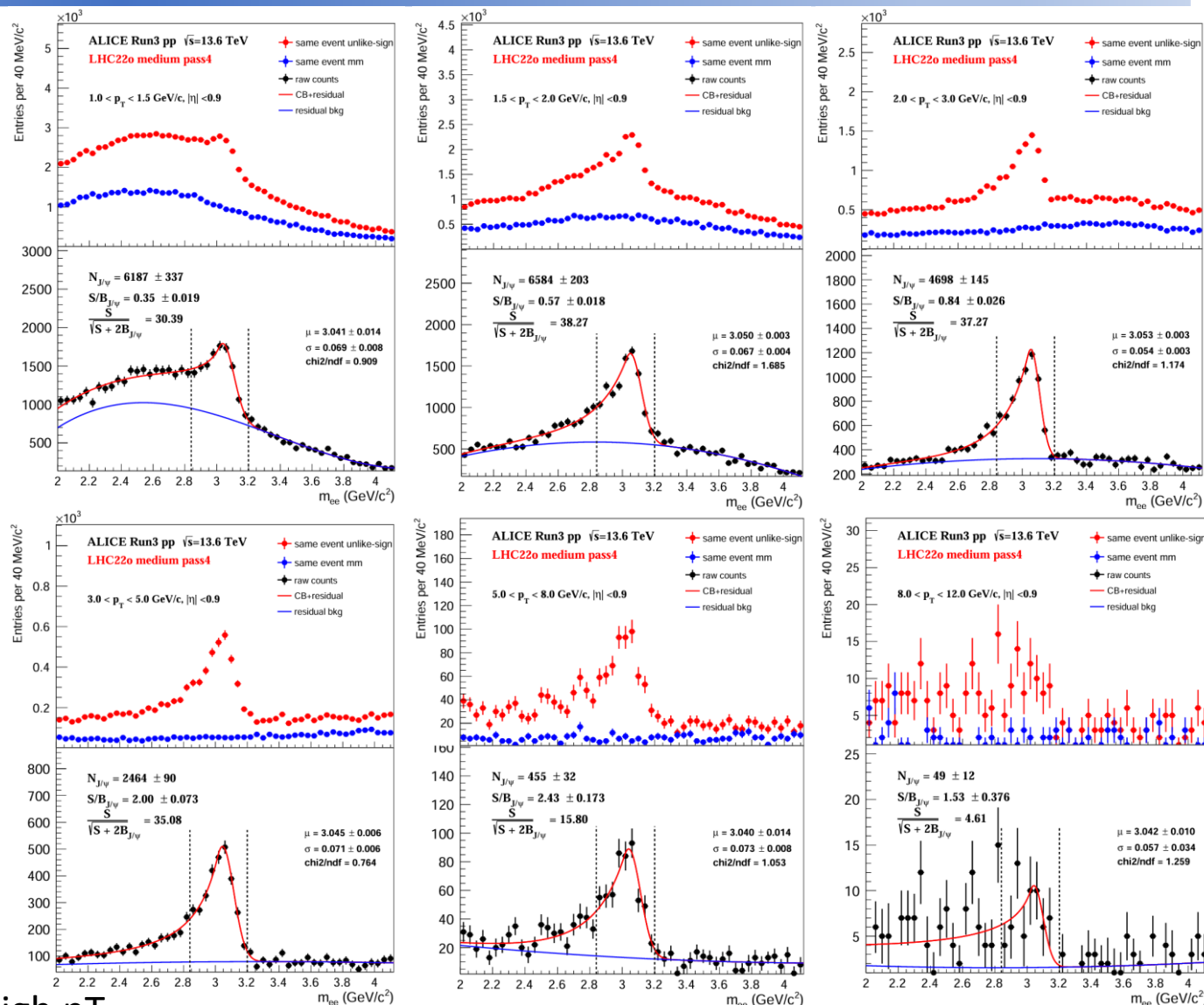
Prefilter cut:

$$p_T > 0.15 \text{ GeV}/c, |\eta| < 0.9$$

$$\text{TPCncls} > 70, \text{TPCchi2} < 4$$

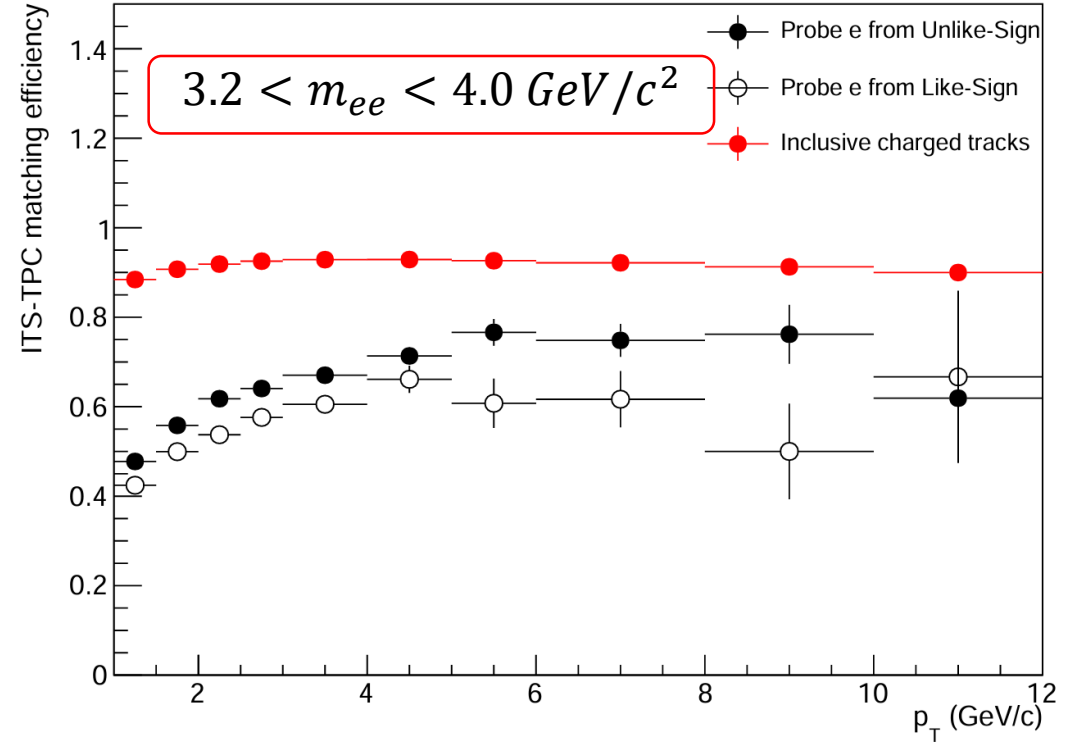
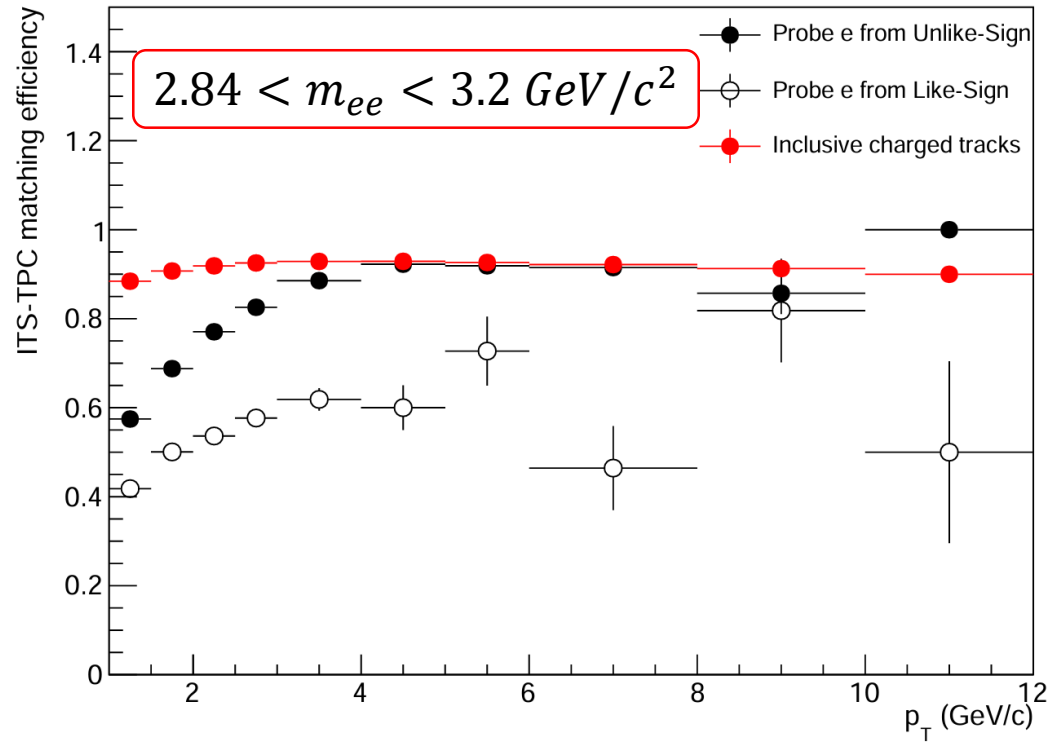
$$|\text{TPCnSigmaE}| < 3$$

$$\text{Exclude } m_{ee} < 0.35 \text{ GeV}/c^2$$



➤ The S/B is ~0.35 in low p_T, but can reach to ~2.43 in high p_T.

ITS-TPC matching efficiency

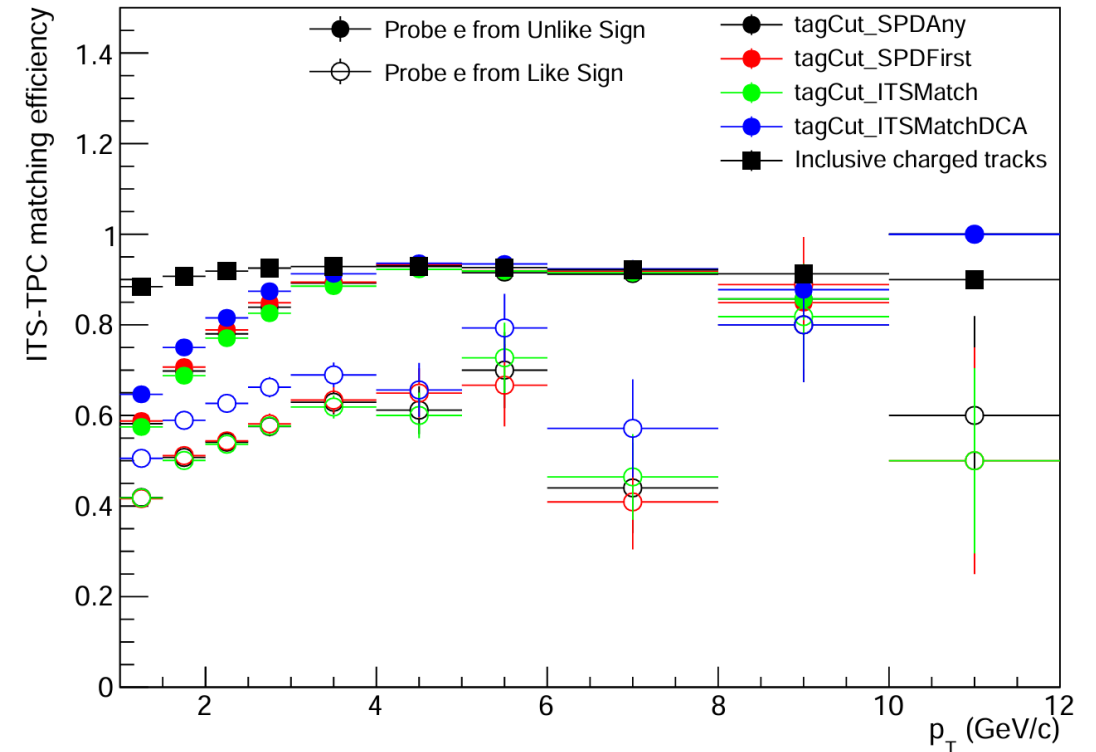


- ITS-TPC matching efficiency of probe e from unlike-sign pair is close to that of inclusive charged tracks.
- Still some photon converted electrons left.

Match eff with different tag cuts

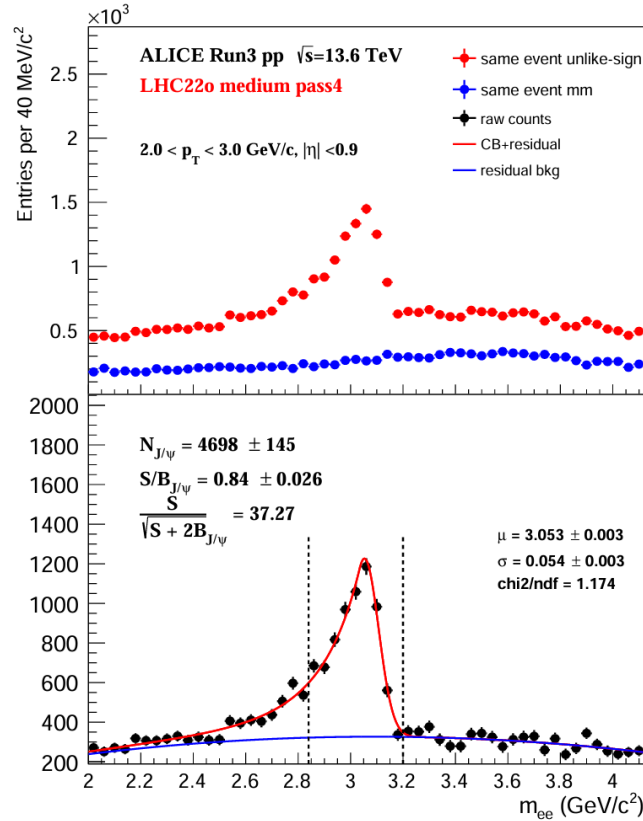
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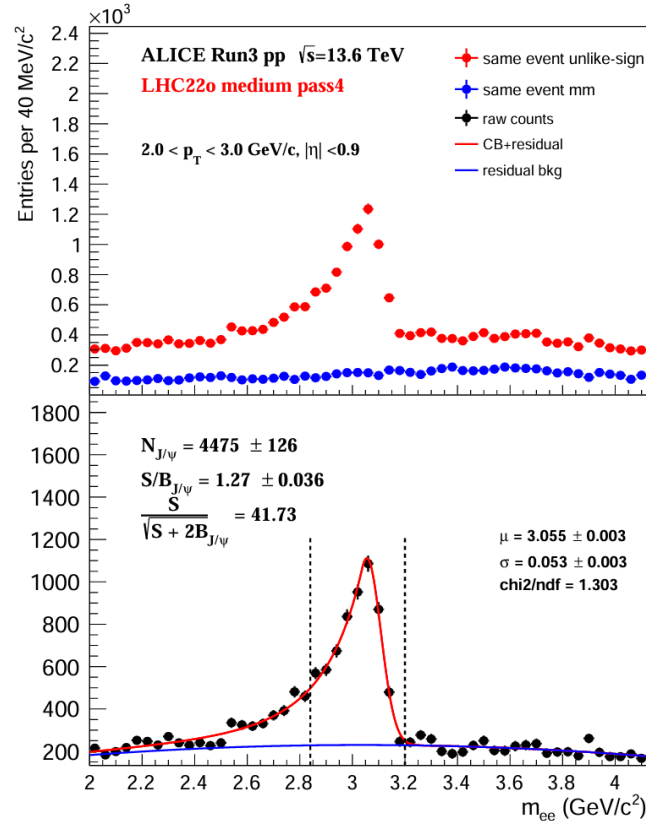


- ITS requirement on the tag will not influence the matching efficiency of the probe too much.

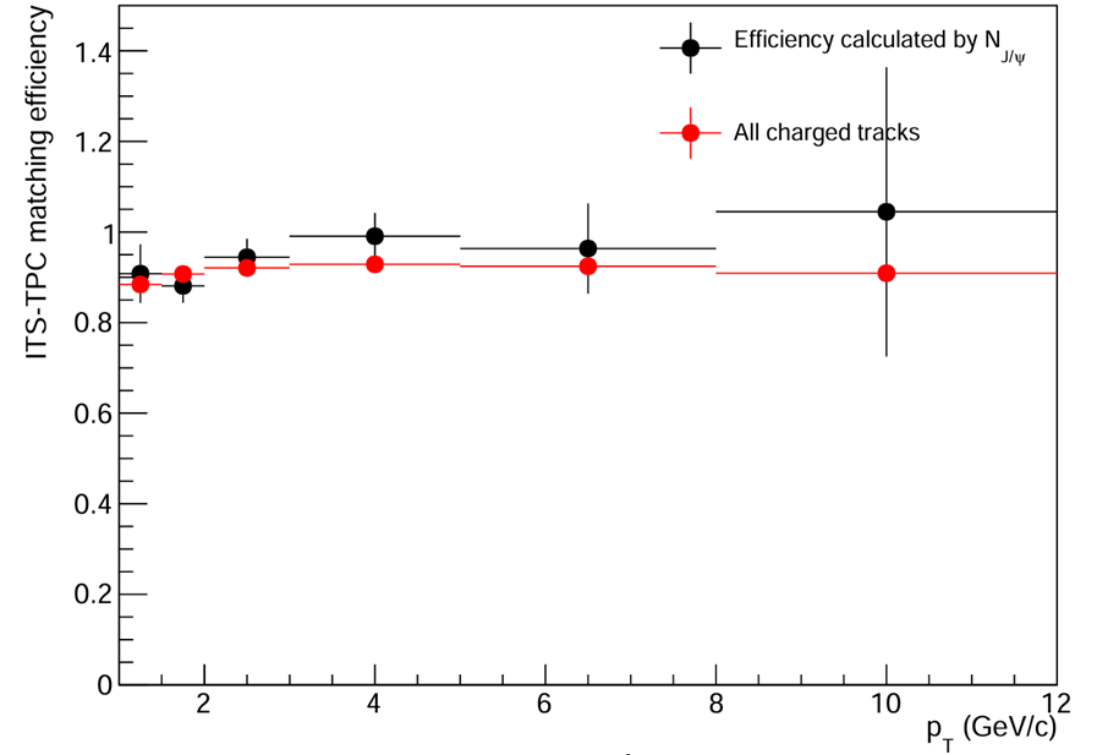
ITS-TPC matching efficiency



Probe w/o ITS requirement



Probe w ITSibAny



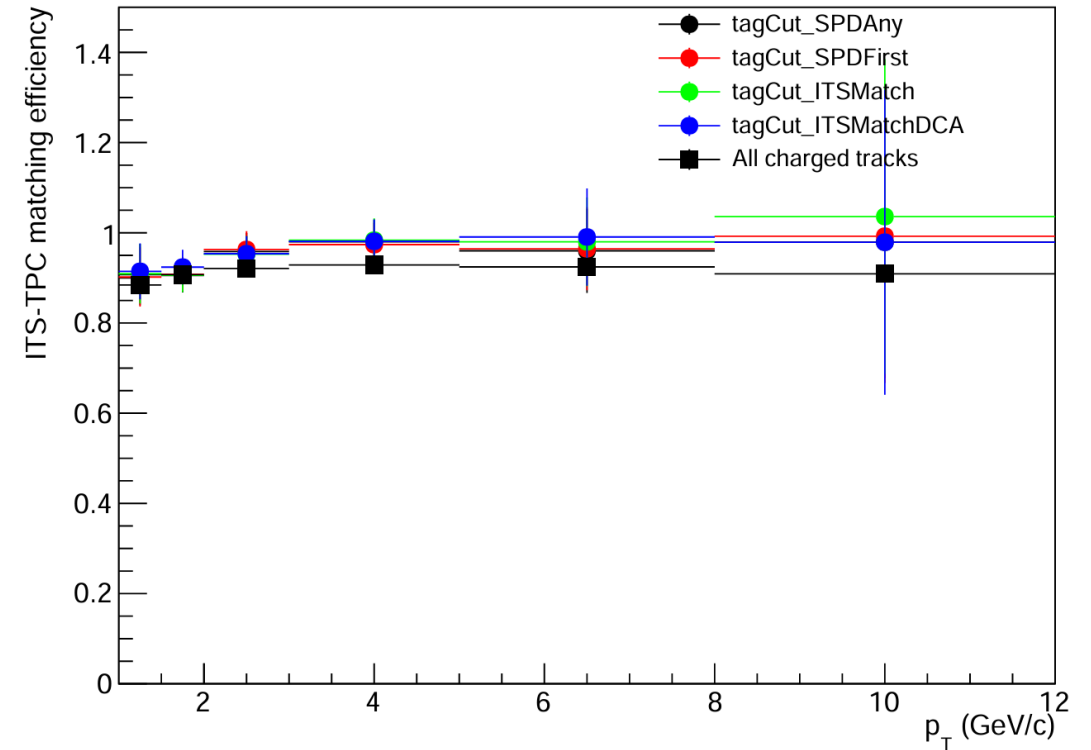
$$eff = \frac{N_{ITSibany}^{Jpsi}}{N_{Jpsi}}$$

- ITS-TPC matching efficiency can be calculated by raw counts of J/ψ by changing the ITS requirement on one leg.
- Will be influenced by the systematic uncertainty of signal extraction.

Match eff with different tag cuts

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- ITS requirement on the tag will not influence the matching efficiency of the probe too much.

Summary

- The ITS and TPC matching efficiencies are systematically checked based on data and MC, using the Dalitz and J/psi decay tag-probe approach.
- The electrons from the Dalitz decay are contaminated by the photo conversion electrons (converted in both data and MC).
- The efficiency from the J/psi tag-probe is compatible with that of inclusive hadrons, as expected.
- To be understood:
 - Why the probe efficiency is slightly dependent on the tag ITS selection.