

TauFinder 10/9

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Recall

Numbers from
old workflow



```
Total number of true taus matched: 12524  
Total number of reco taus matched: 12617  
Total number of 3-prong reco taus: 1528  
Total number of 3-prong reco taus matched to MC 3 prong: 1440  
Average number of prongs per reco tau matched to 3-prong: 2.392
```

Seeing that an event can have > 1 reco tau, primarily in the 3-prongs

88 of the 93 extra reco taus are from 3P events, $\sim 95\%$

So, this study is done on only the MC 3-prong events

Note: How tau merging works ([link](#))

```
angle = acos((mom_i[0]*mom_j[0]+mom_i[1]*mom_j[1]+mom_i[2]*mom_j[2])/
    (sqrt(mom_i[0]*mom_i[0]+mom_i[1]*mom_i[1]+mom_i[2]*mom_i[2])*
    sqrt(mom_j[0]*mom_j[0]+mom_j[1]*mom_j[1]+mom_j[2]*mom_j[2])));

// Merge if angle between two taus is less than search cone angle
if(angle < _coneAngle)
{
```

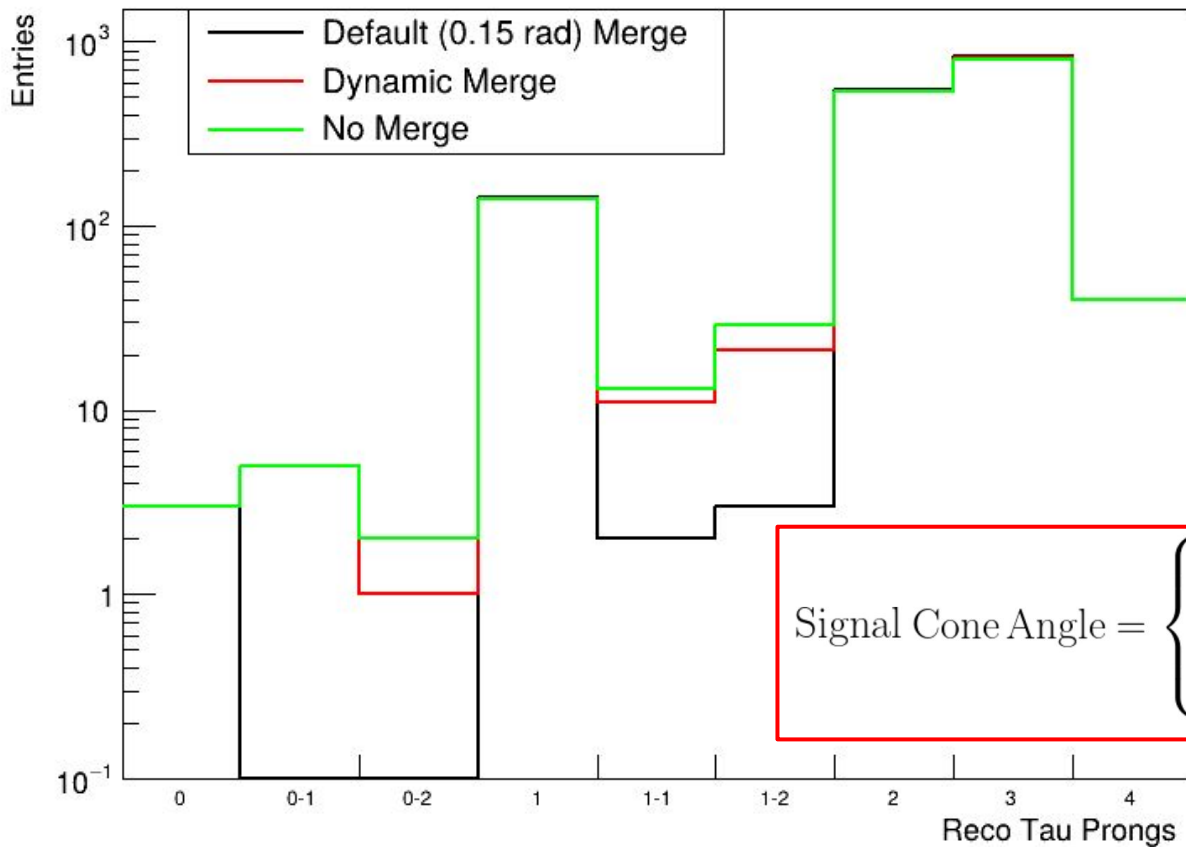
Dynamic merge
replaces
_coneAngle with the
the dynamic cone
value for τ_i
(not necessarily the
max)

$$\theta = \arccos \left(\frac{\mathbf{m}_i \cdot \mathbf{m}_j}{\|\mathbf{m}_i\| \|\mathbf{m}_j\|} \right)$$

Where $\mathbf{m}_i$ and $\mathbf{m}_j$ are the momentum vectors for τ_i and τ_j

Multiple reco taus per event under different merge criteria

Different Prong Combinations



Main focus:

- 1p-2p (~30)

Other notes:

- 0 Prong?
- 4 Prong?

As a note

```
if (n_charged > 4 || n_charged == 0)
{
    // Add reco tau to collection which failed number of charged tracks selection
    taucol_nchargedtrks->addElement(reco_tau);
}
```

Current implementation does allow for 4-prong taus, but not sure where the 0-prong are coming from

- [Charge track counting method](#)

Numerically:

Name	# Reco 3P Events	# Reco τ^- Matched to MC 3P
Default (0.15 rad) Merge	1580	1585
Dynamic Merge	1580	1618
No Merge	1580	1629

Most discrepancy in the last column is due to the 1p-1p and 1p-2p
reco tau combinations

Efficiency standpoint

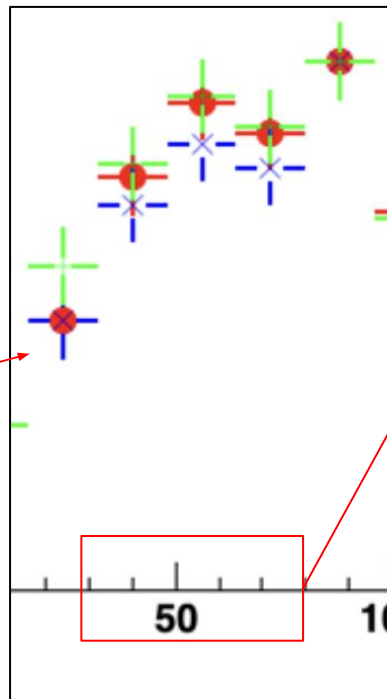
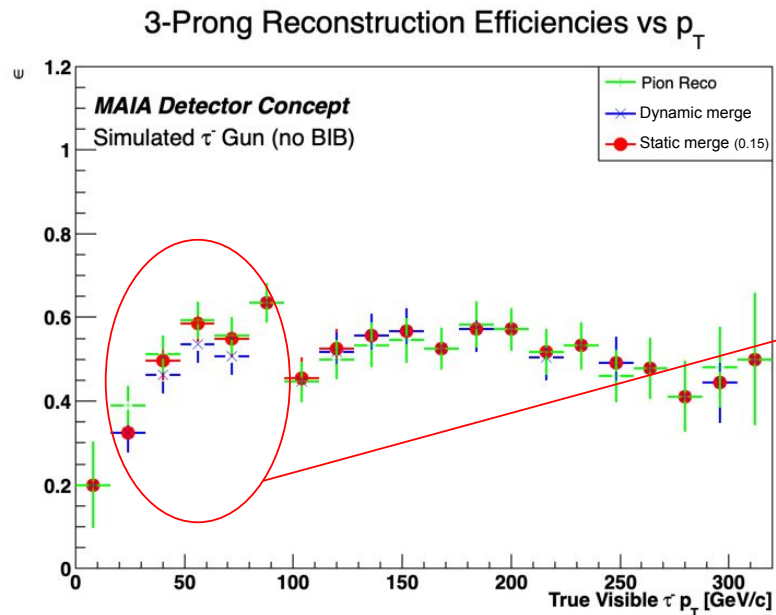
$$\text{Signal Cone Angle} = \begin{cases} 0.3 & p_T \leq 10 \\ \frac{3}{p_T} & 10 < p_T < 60 \\ 0.05 & p_T \geq 60 \end{cases}$$

In this region:
 $0.05 \leq \text{cone} < 0.15 \text{ rad}$

Biggest drop in efficiency is when the cone shrinks below 0.1 rad

Compared to the default static criteria which is 0.15 rad

Indicates that our cone should always be ≥ 0.1 rad for max efficiency



Redefining the dynamic cone

Before:

$$\text{Signal Cone Angle} = \begin{cases} 0.3 & p_T \leq 10 \\ \frac{3}{p_T} & 10 < p_T < 60 \\ 0.05 & p_T \geq 60 \end{cases}$$

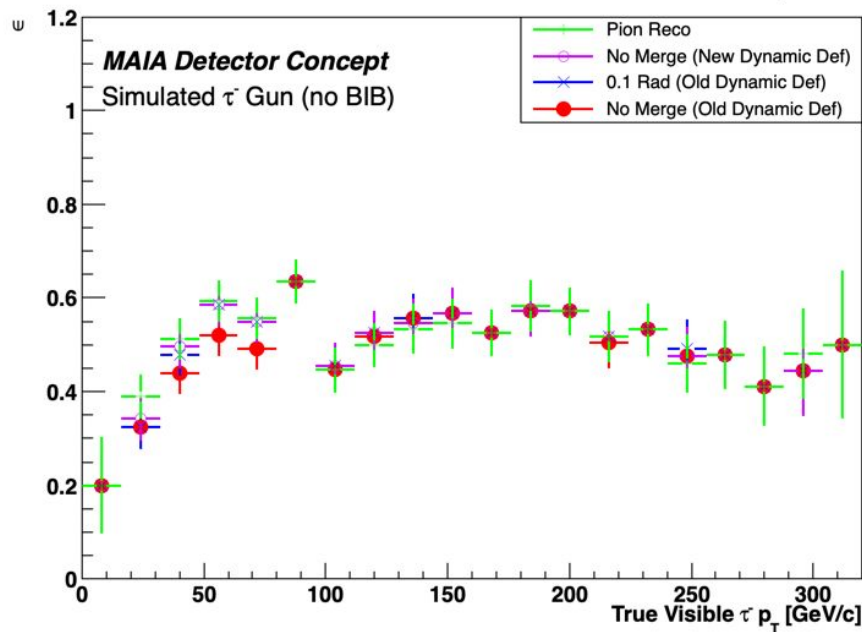
$$0.3 \geq \text{cone} \geq 0.05$$

Now:

$$\text{Signal Cone Angle} = \begin{cases} 0.3, & p_T \leq 20 \\ \frac{6}{p_T}, & 20 < p_T < 60 \\ 0.1, & p_T \geq 60 \end{cases}$$

$$0.3 \geq \text{cone} \geq 0.1$$

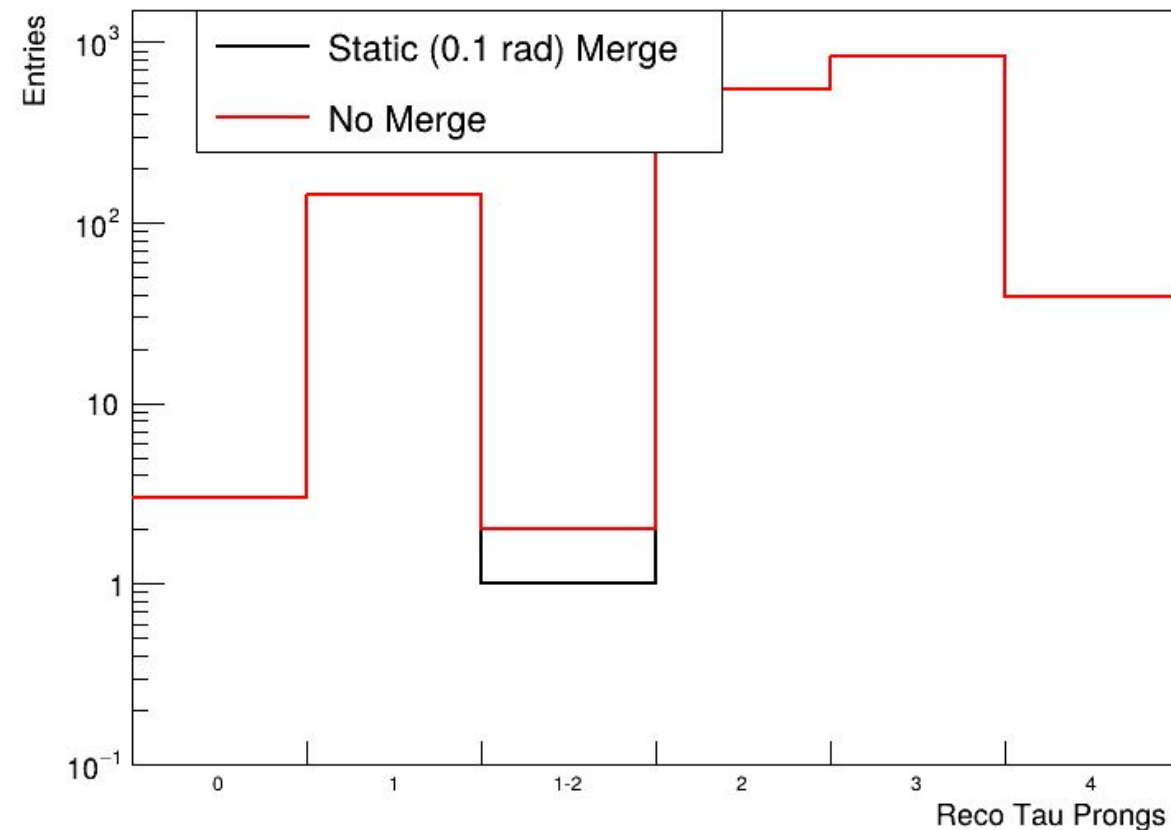
3-Prong Reconstruction Efficiencies vs p_T



New definition
recovers nearly all
lost efficiency

New dynamic definition reco tau combinations

Different Prong Combinations



- Only two 1p-2p events remain (before no merge had ~30)

Other notes:

- No more:
 - 1p-1p
 - 0p-1p
 - 0p-2p

Numerically:

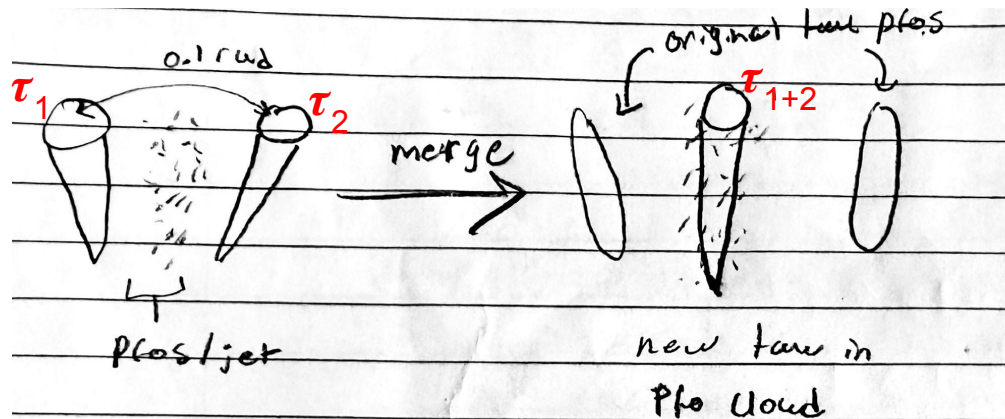
Name	# Reco 3P Events	# Reco τ^- Matched to MC 3P
Static (0.1 rad) Merge	1572	1573
No Merge	1572	1574

- Compared to before we have less reconstructed 3P events
 - Since efficiency did not drop these are likely events that have less than 3 reco prongs
- In the backups there are P_t , Θ , ϕ distributions for the 1p-2p combinations with the new dynamic cone definition

The case for no merging

- With the new dynamic cone definition merging makes hardly any difference (~1 event)
 - Potentially wait to see BIB results
- Madison CMS folks have been critical of the concept of merging taus

My question:



In the code the “position” of the tau is based on its pt

Wouldn't a “merged” Pt change the position of the tau?

Then we could end up with original tau PFOs outside the new cone?

Next steps:

- Update the charge track cuts?
 - Shouldn't reconstruct 4p or 0p taus
- Setup on the OSG machines, support with BIB
- Relative isolation (E_{iso}/p_T)
- Check reco Pi^0 daughters (a colleague mentioned seeing a neutron + photon pair reconstructed frequently)
- See if 4p events are also a result of electrons (Giacomo's suggestion)

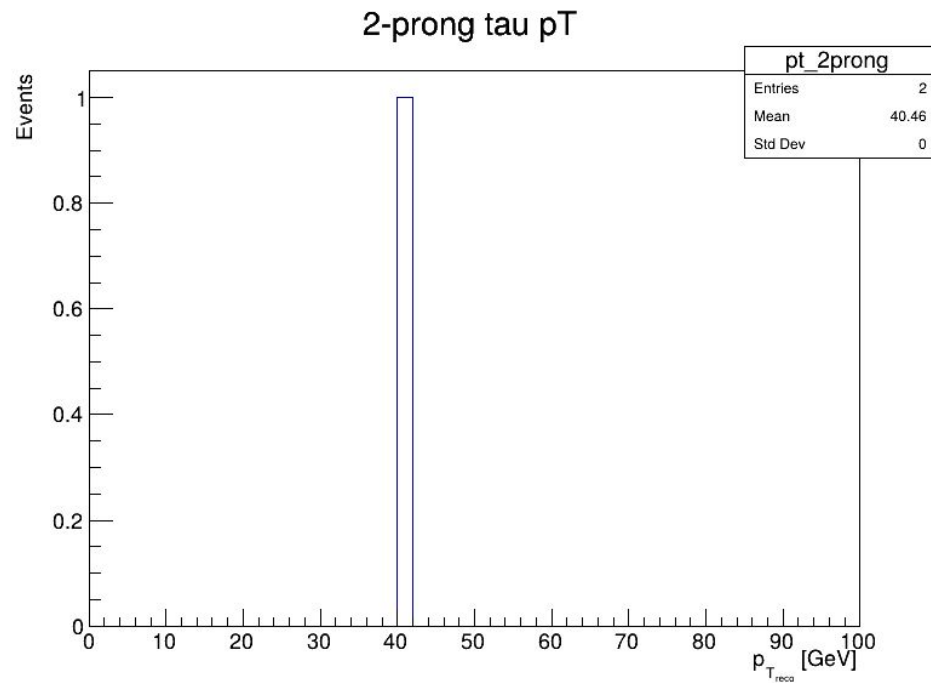
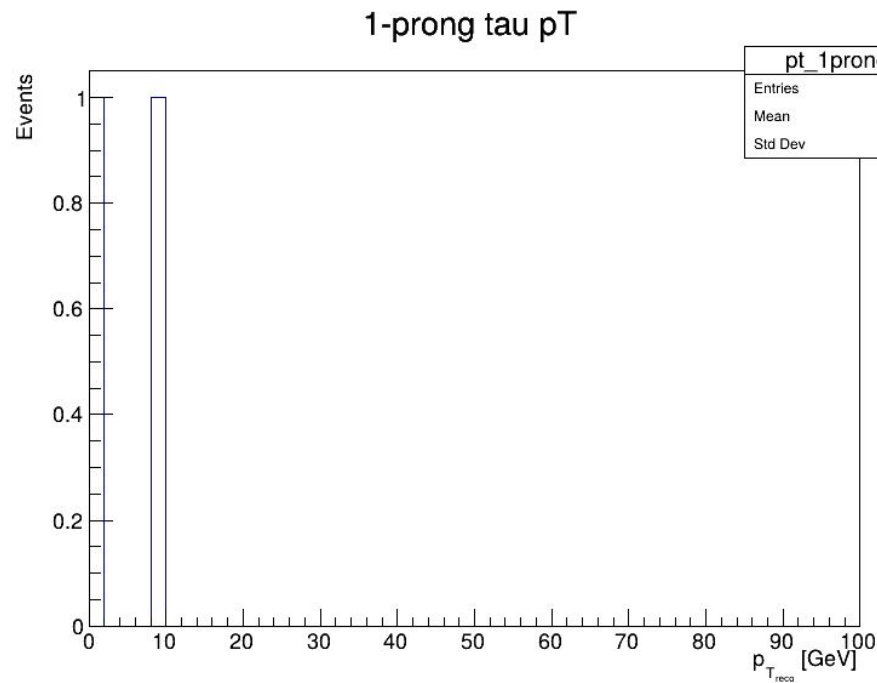
Thank you!

Backups

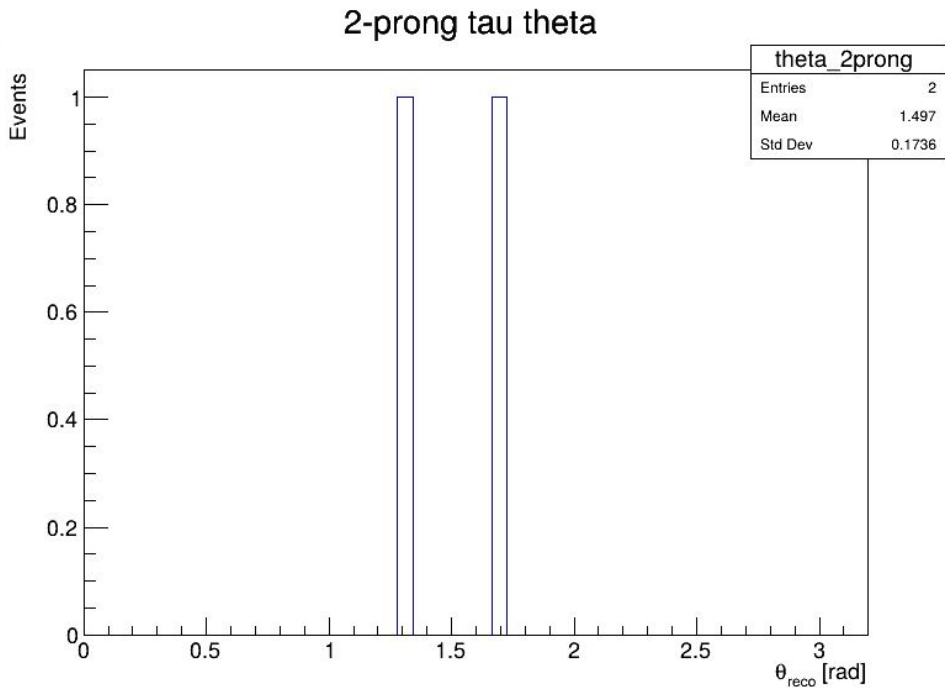
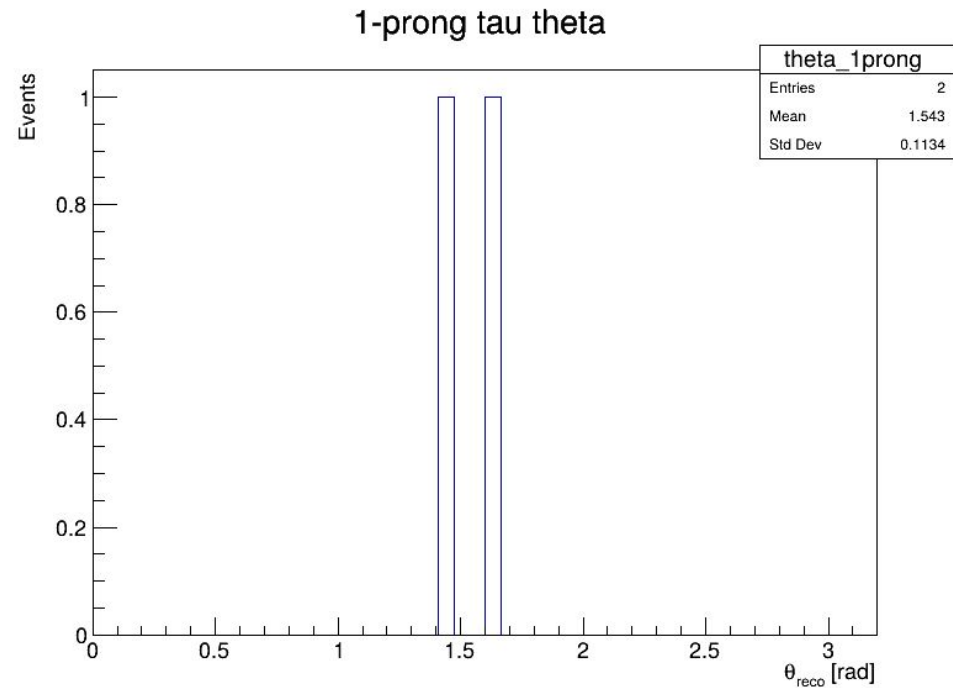
New dynamic cone missed 1p-2p combinations (table comparison)

Event #	1p reco pt	2p reco pt	1p reco theta	2p reco theta	1p reco phi	2p reco phi
0	1.22	40.46	1.429	1.324	0.871	1.015
1	9.31	169.44	1.656	1.671	0.923	0.849

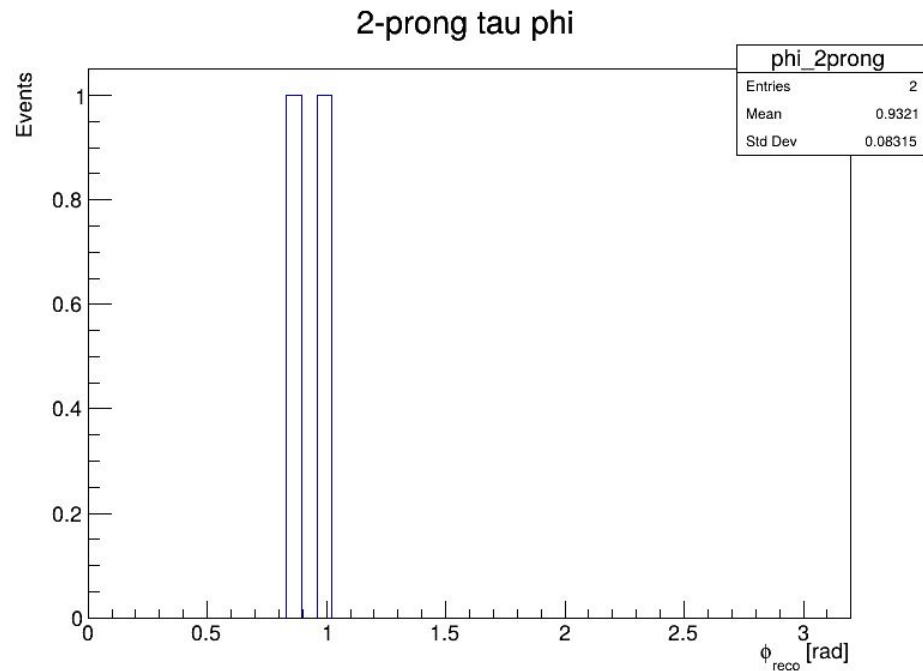
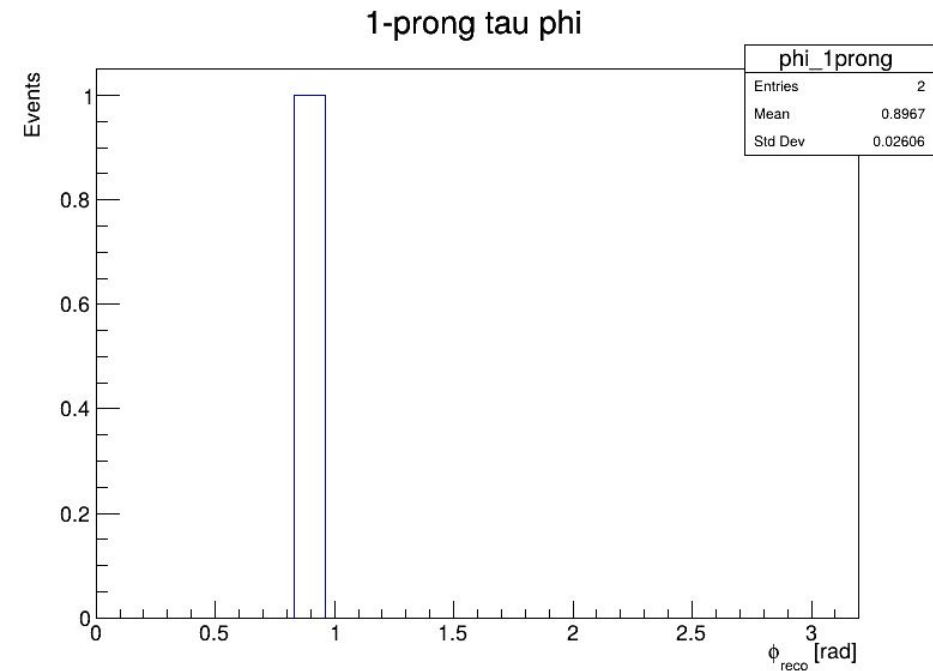
New dynamic cone missed 1p-2p combinations (Pt dist)



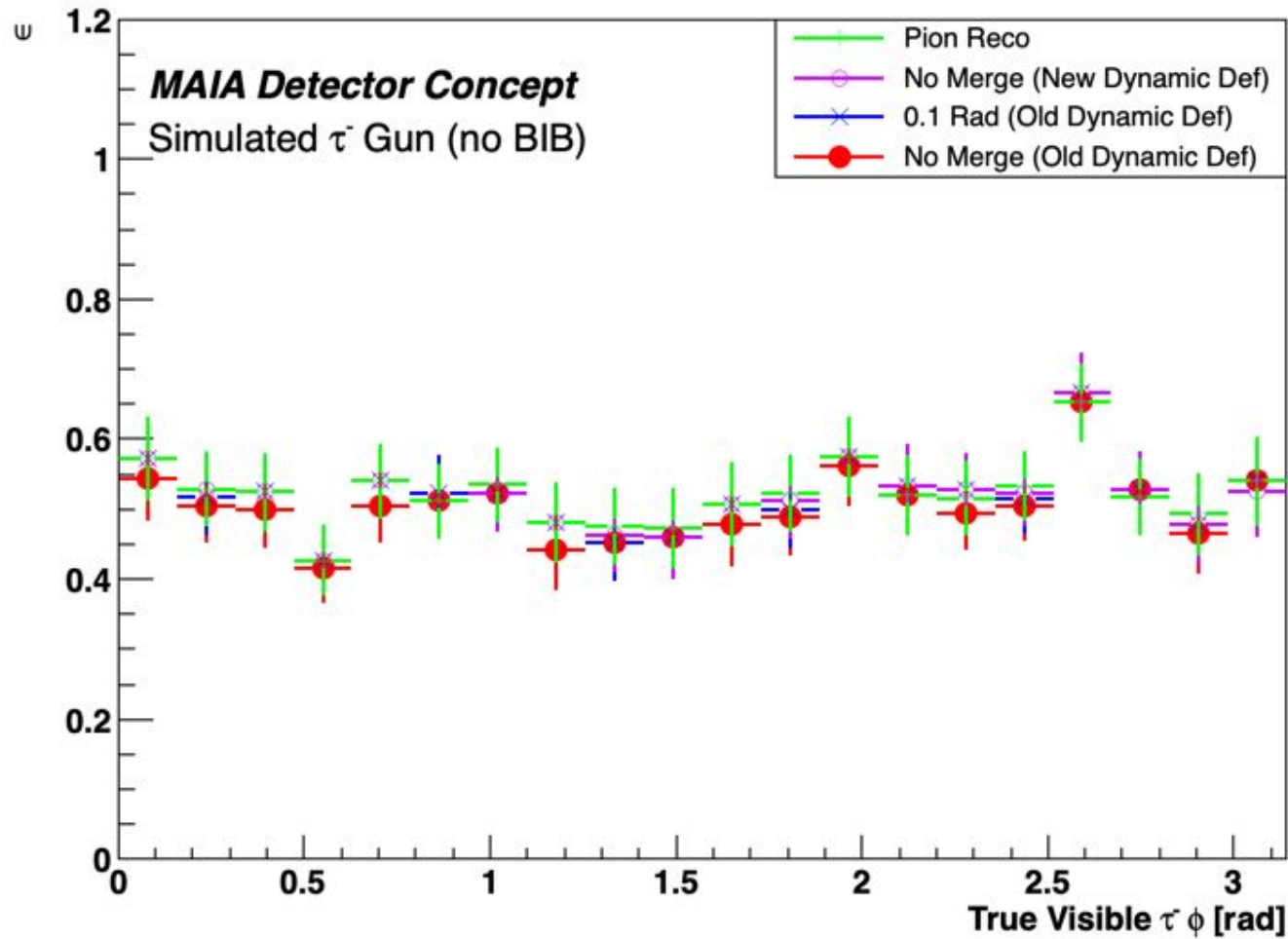
New dynamic cone missed 1p-2p combinations (Θ dist)



New dynamic cone missed 1p-2p combinations (ϕ dist)



3-Prong Reconstruction Efficiencies vs ϕ



3-Prong Reconstruction Efficiencies vs θ

