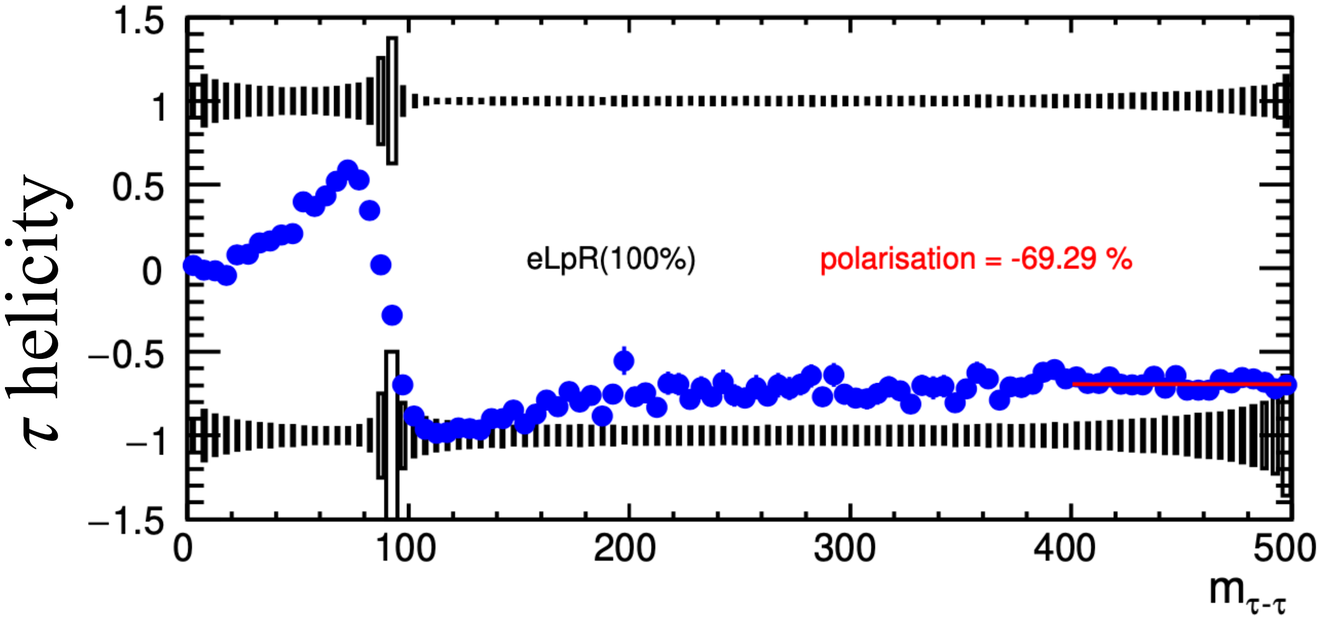
eLpR sample

τ^- is preferred to be left-handed

ν : same direction as τ^-



eRpL sample

τ^- has no preference

left-handed and right-handed

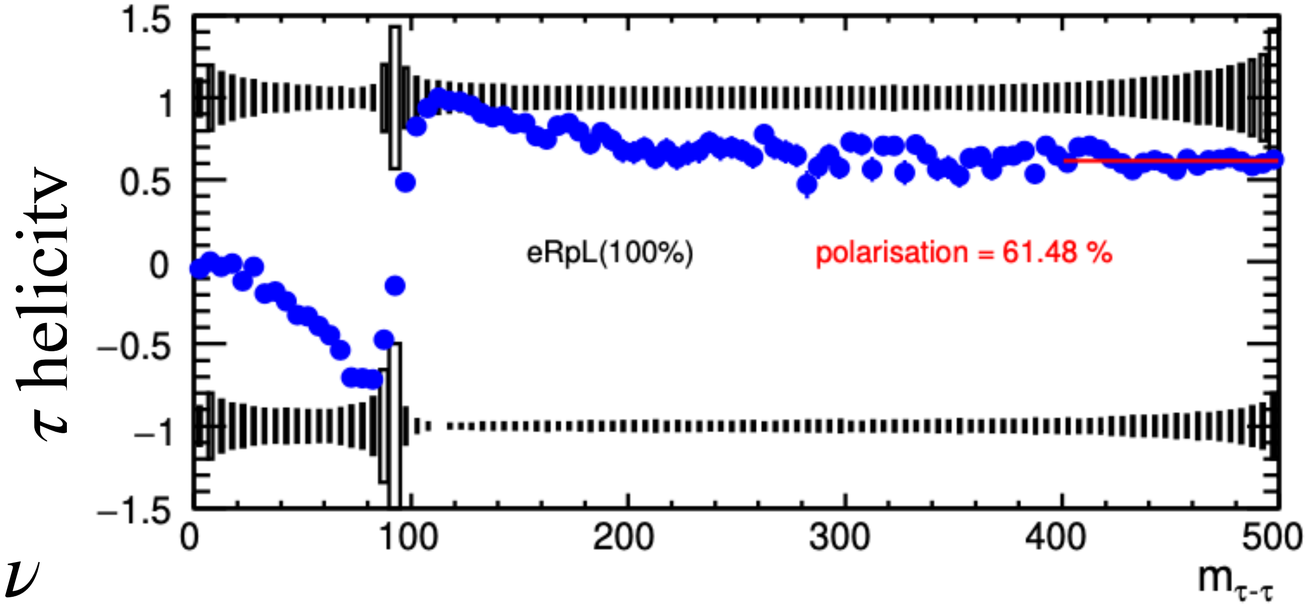
almost 50 % ?

$\tau \rightarrow \pi\nu$

if τ^- is right-handed

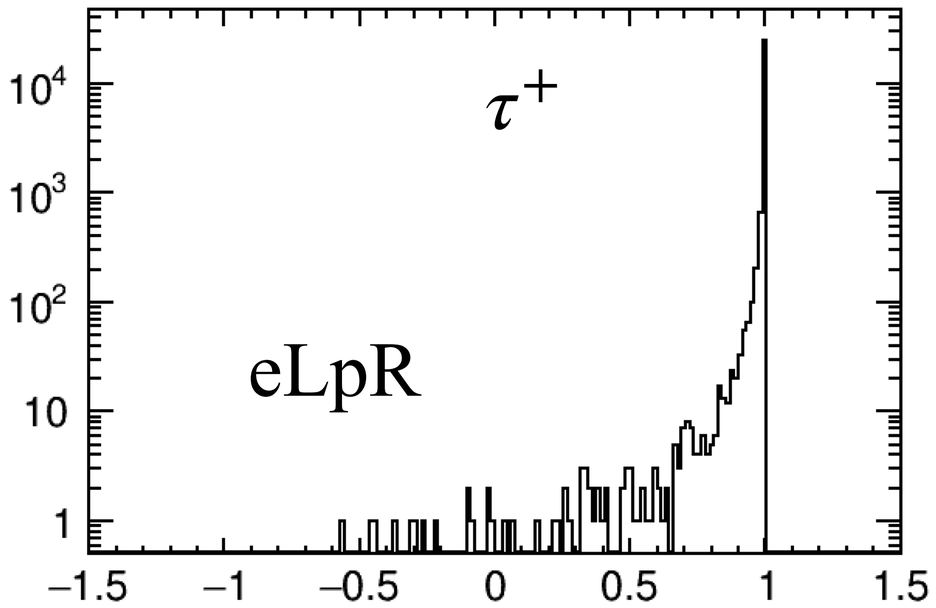
ν : opposite direction as τ^-

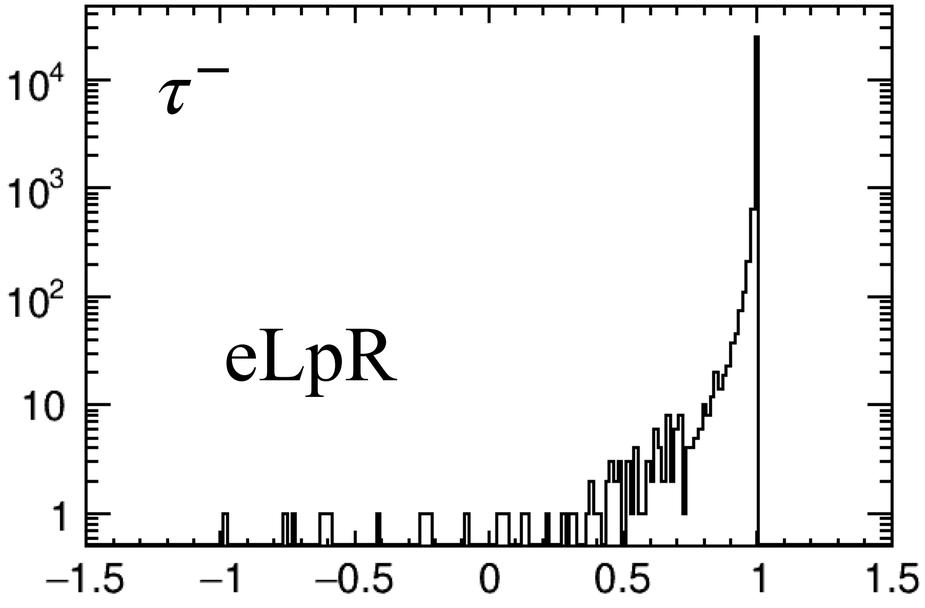
→large angle between τ^- and ν

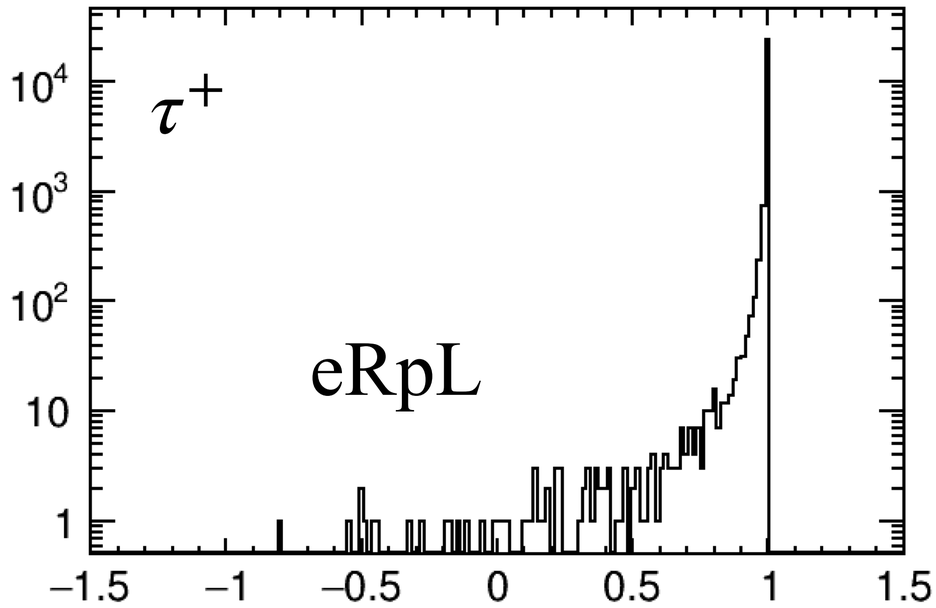


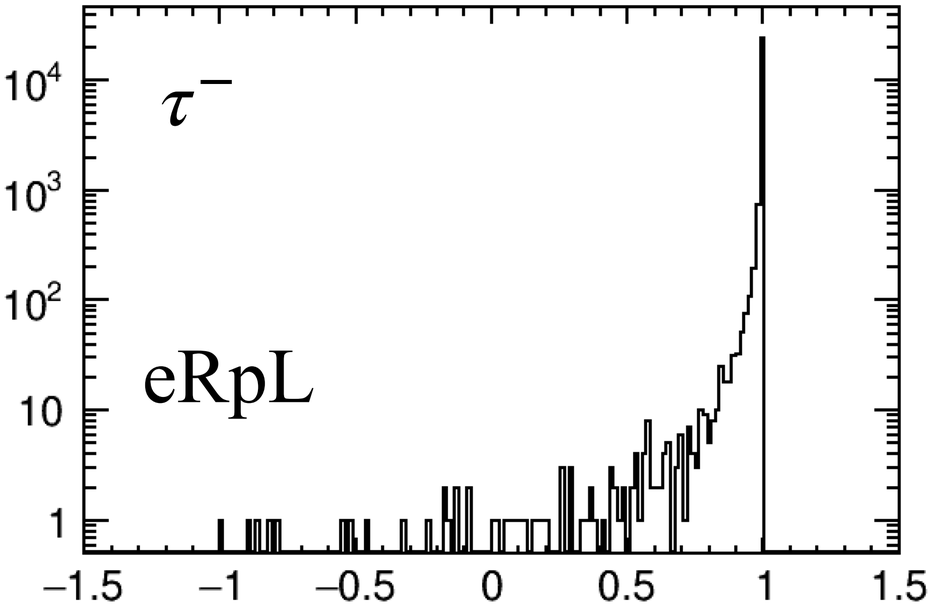
angle: MC τ and neutrino

$\tau \rightarrow \pi\nu$

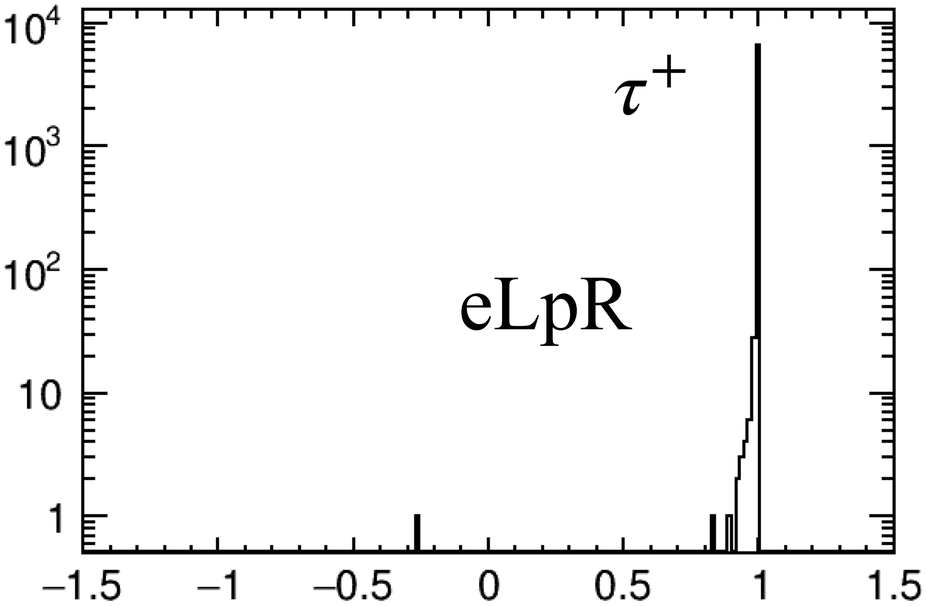


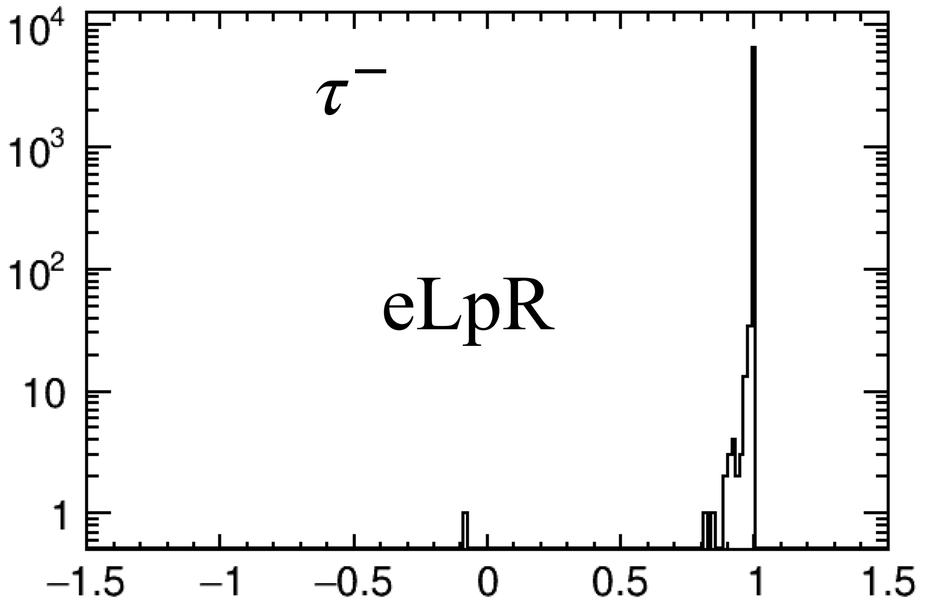


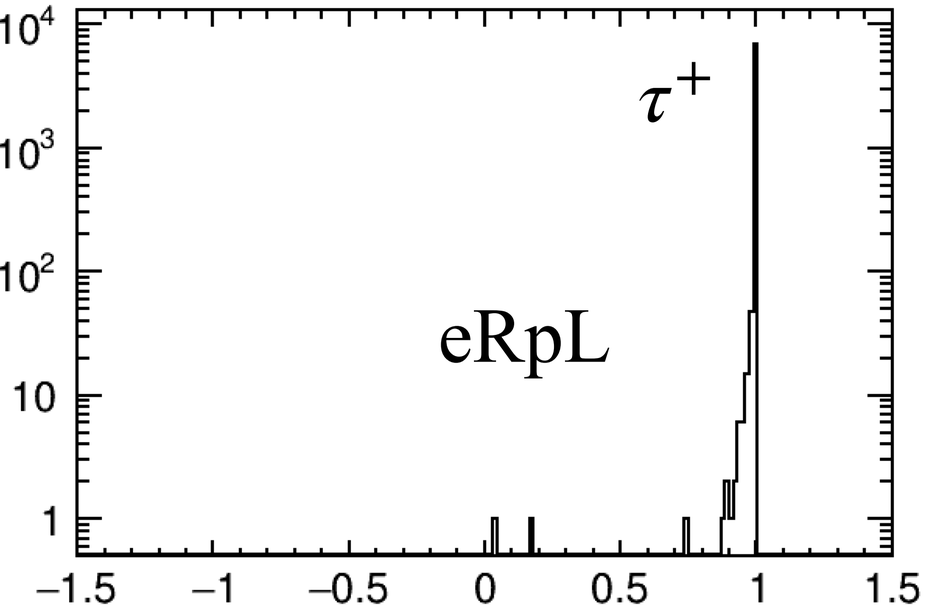


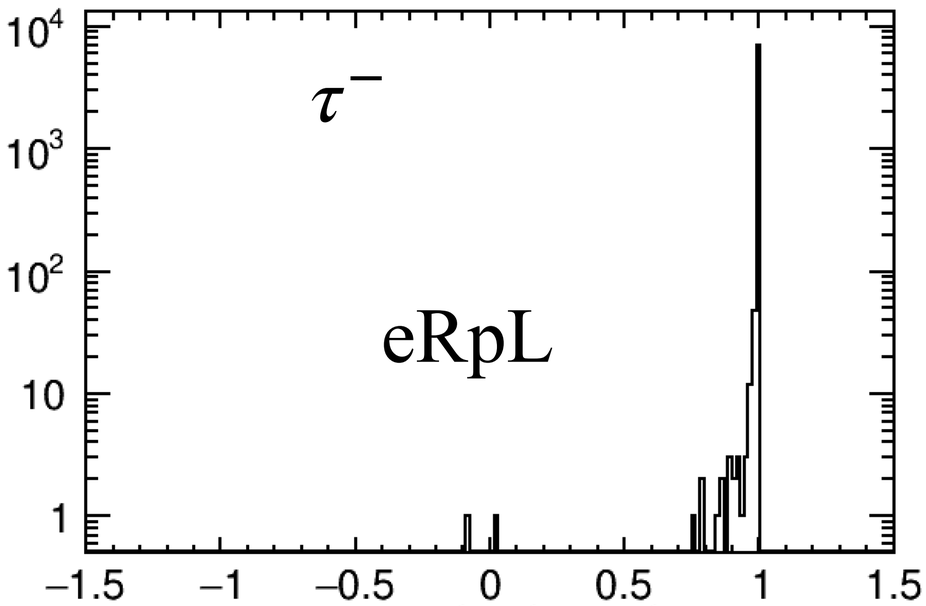


angle: MC τ and neutrino $m_{\tau\tau} > 240$ GeV $\tau \to \pi\nu$





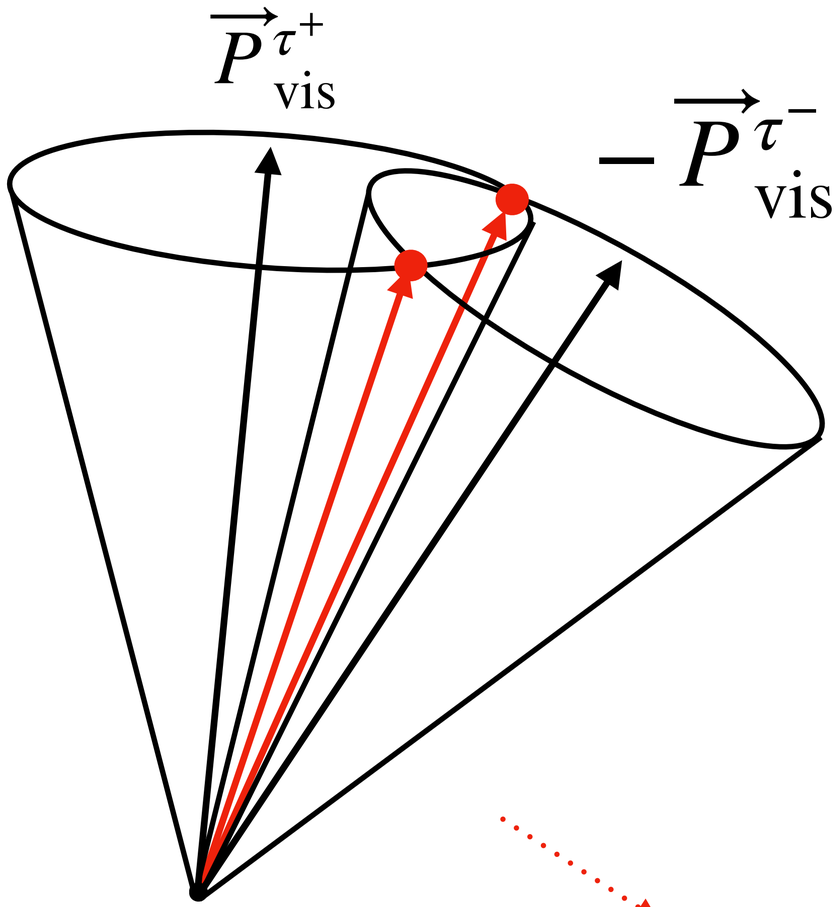




eRpL sample has larger angle between τ^- and ν ?

Find solution

$\longrightarrow \tau$-τ is back-to-back



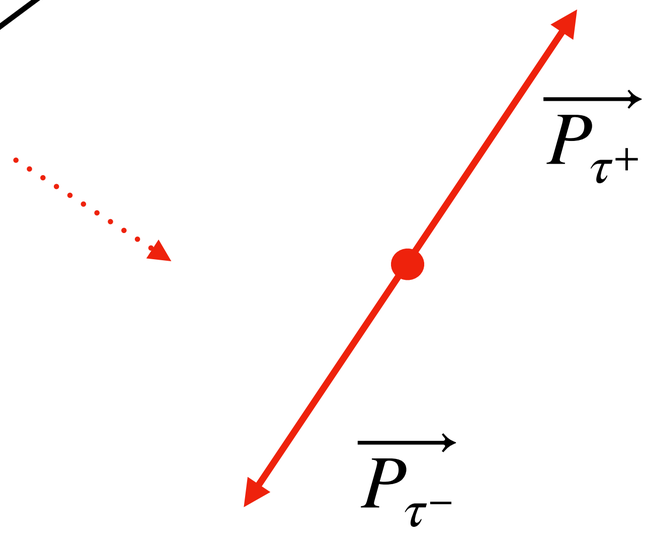
if

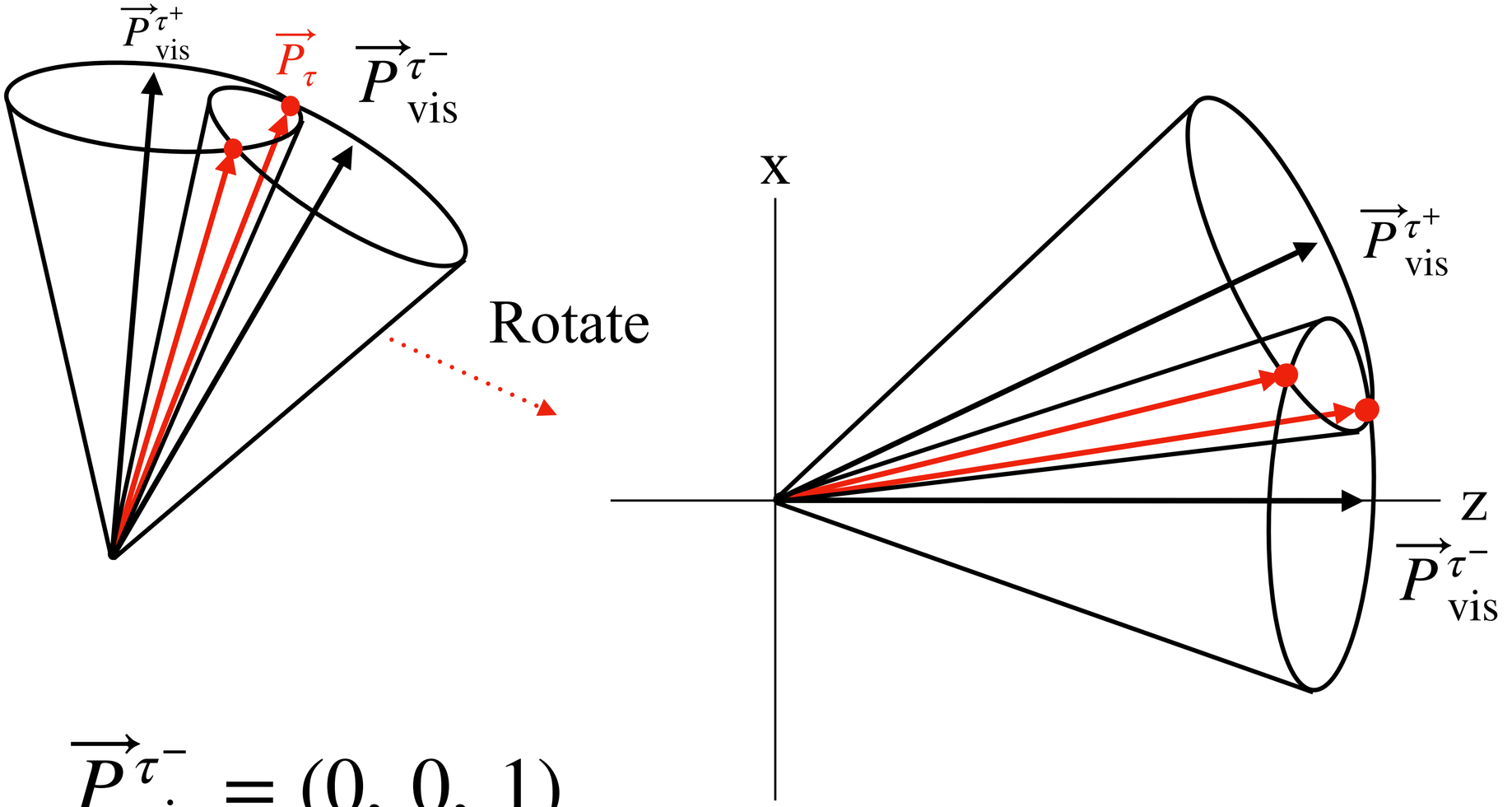
$$\beta_1 + \beta_2 > \beta_{cc}$$

then

2 overlapped points

$\longrightarrow$2 possible solutions

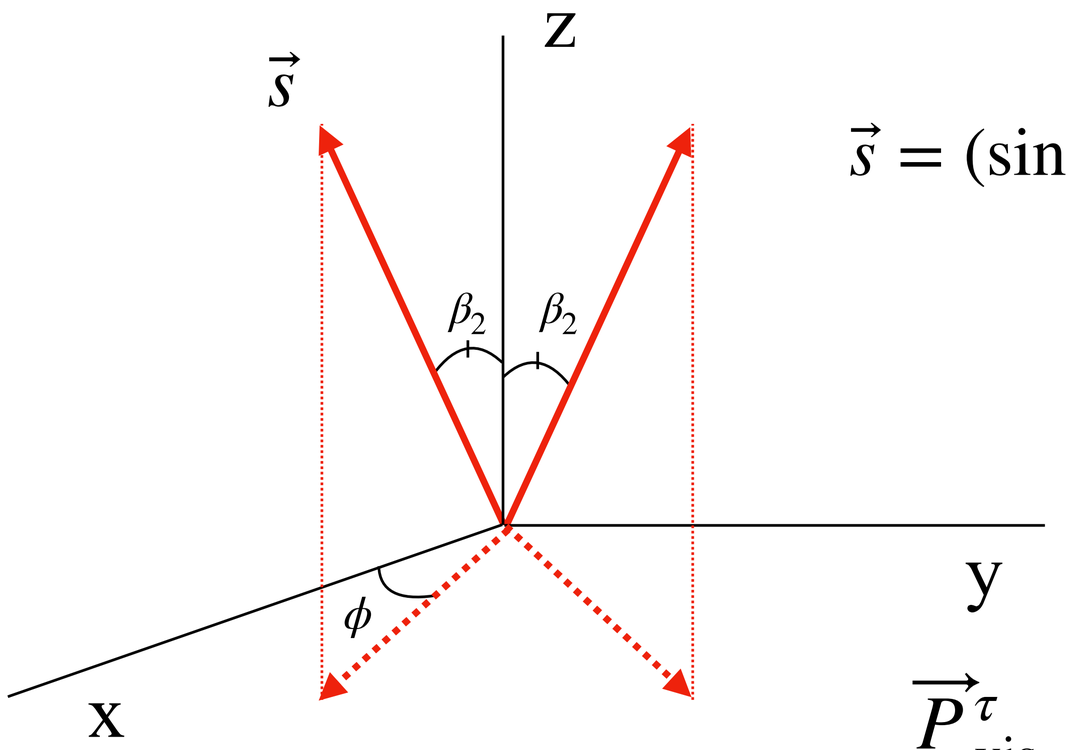




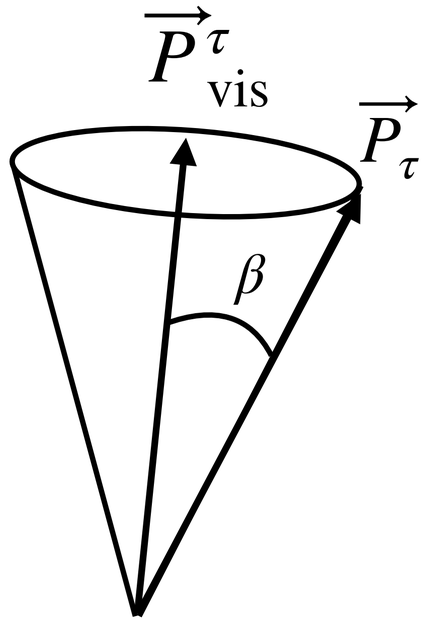
$$\overrightarrow{P}^{\tau^-}_{\text{vis}} = (0,\ 0,\ 1)$$

$$\overrightarrow{P}^{\tau^+}_{\text{vis}} = (\sin\theta_{cc},\ 0,\ \cos\theta_{cc})$$

β_{cc} :cone-cone angle



$$\vec{s} = (\sin\beta_2\cos\phi,\ \sin\beta_2\sin\phi,\ \cos\beta_2)$$



β_1 :angle between $\overrightarrow{P}^{\tau^+}_{\text{vis}}$ and $\overrightarrow{P}_{\tau}$

β_2 :angle between $\overrightarrow{P}^{\tau^-}_{\text{vis}}$ and $\overrightarrow{P}_{\tau}$

$$\vec{s}\cdot\overrightarrow{P^{\tau^+}_{\text{vis}}} = \cos\beta_1$$

$$\vec{s}\cdot\overrightarrow{P^{\tau^-}_{\text{vis}}} = \cos\beta_2$$

Find ϕ to find 2 solutions

$$\vec{s} = (\sin\beta_2 \cos\phi,\ \sin\beta_2 \sin\phi,\ \cos\beta_2)$$

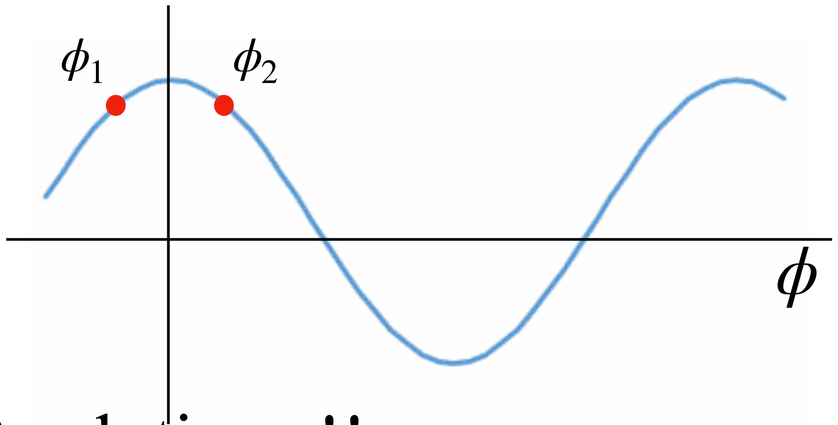
$$\overrightarrow{P}^{\tau^-}_{\text{vis}} = (0,\ 0,\ 1)$$

$$\overrightarrow{P}^{\tau^+}_{\text{vis}} = (\sin\theta_{cc},\ 0,\ \cos\theta_{cc})$$

$$\vec{s} \cdot \overrightarrow{P^{\tau^-}_{\text{vis}}} = \cos\beta_2$$

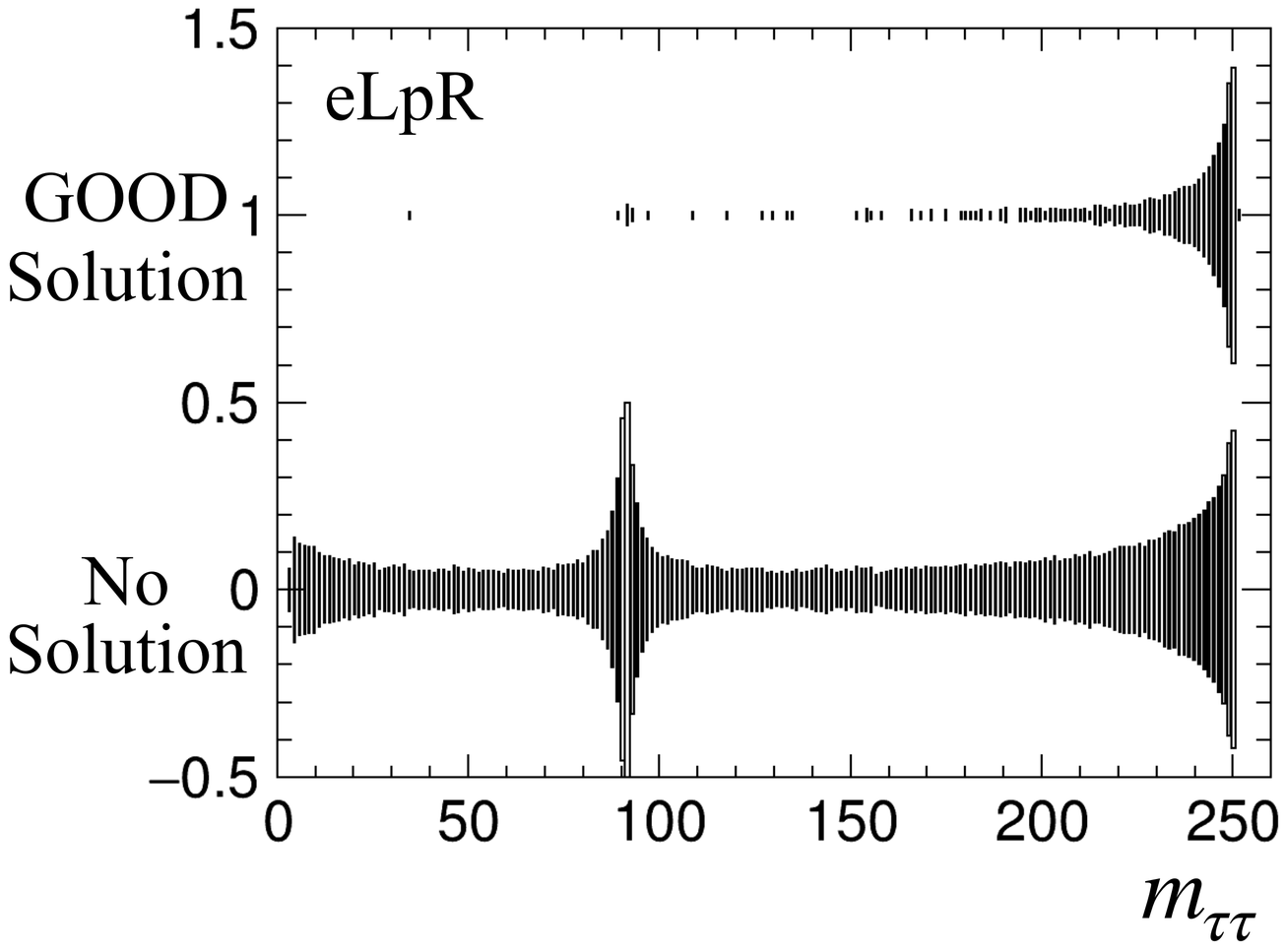
$$\vec{s} \cdot \overrightarrow{P^{\tau^+}_{\text{vis}}} = \sin\beta_2 \cos\phi \sin\theta_{cc} + \cos\beta_2 \cos\theta_{cc} = \cos\beta_1$$

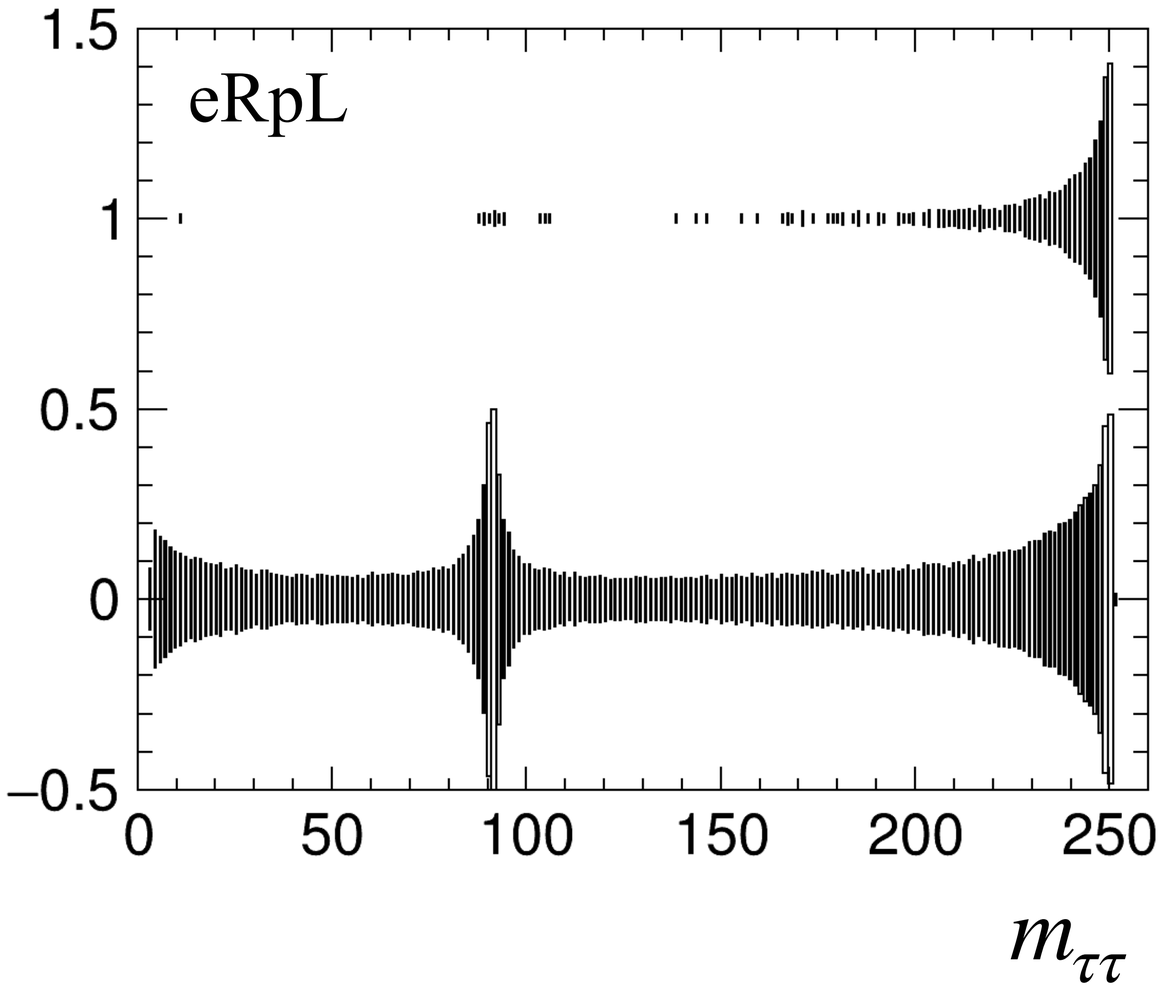
$$\rightarrow \quad \cos\phi = \frac{(1 - \cos\theta_{cc})\cos_{\beta_1}}{\sin\beta_2 \sin\theta_{cc}}$$



2 solutions !!

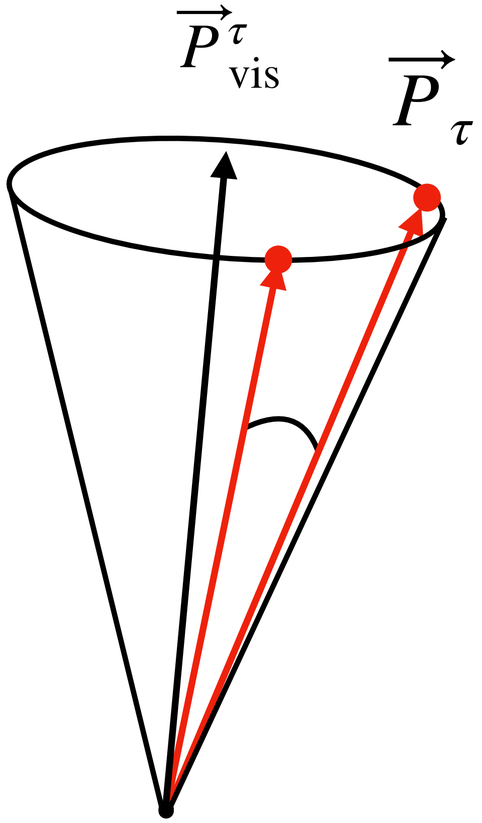
GOOD solutions

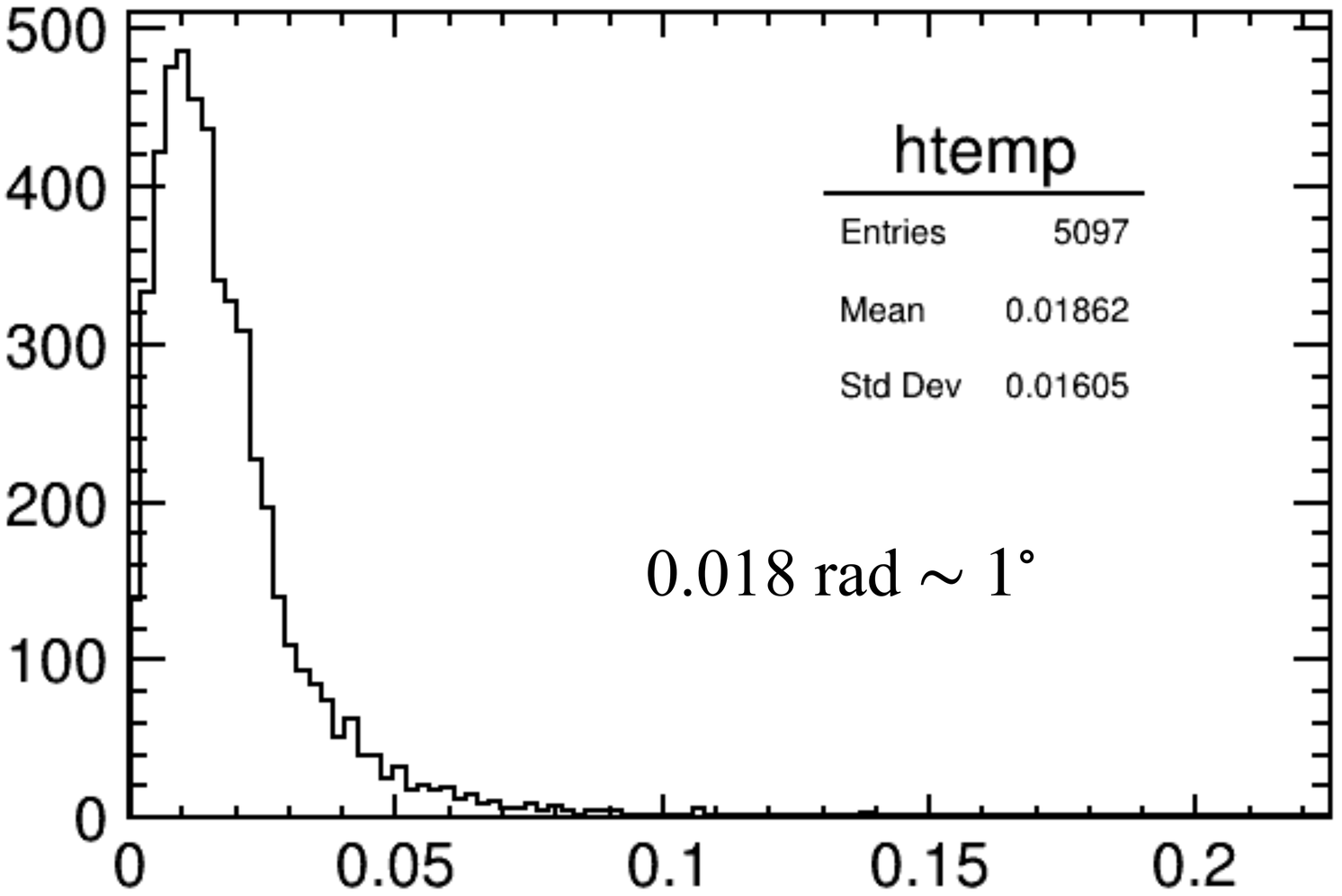




eLpR and eRpL samples: almost same tendency

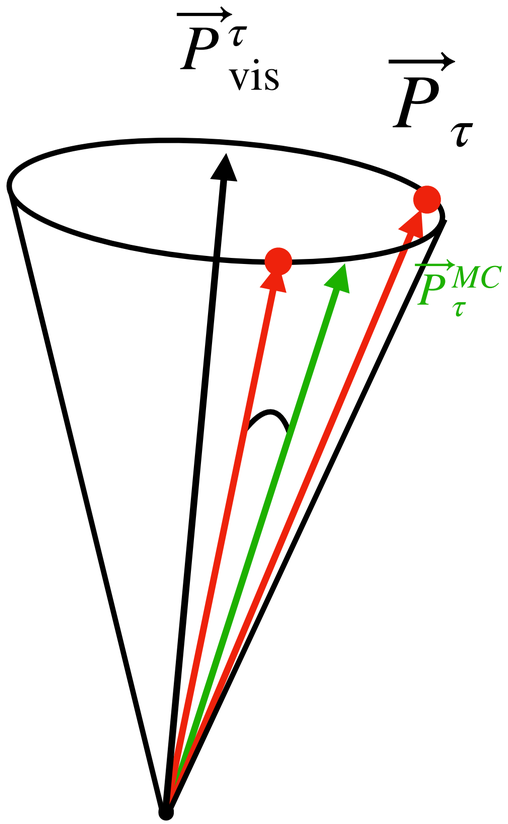
angle between 2 solutions

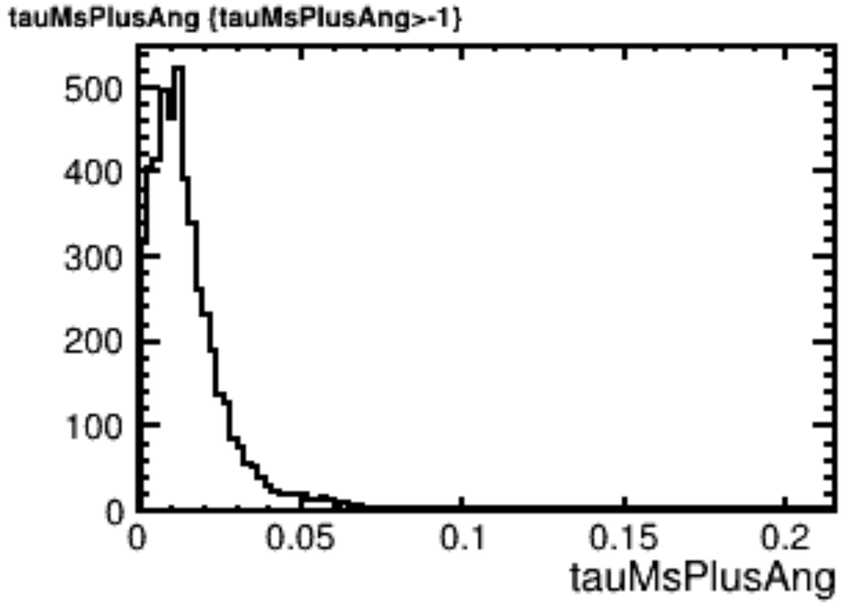


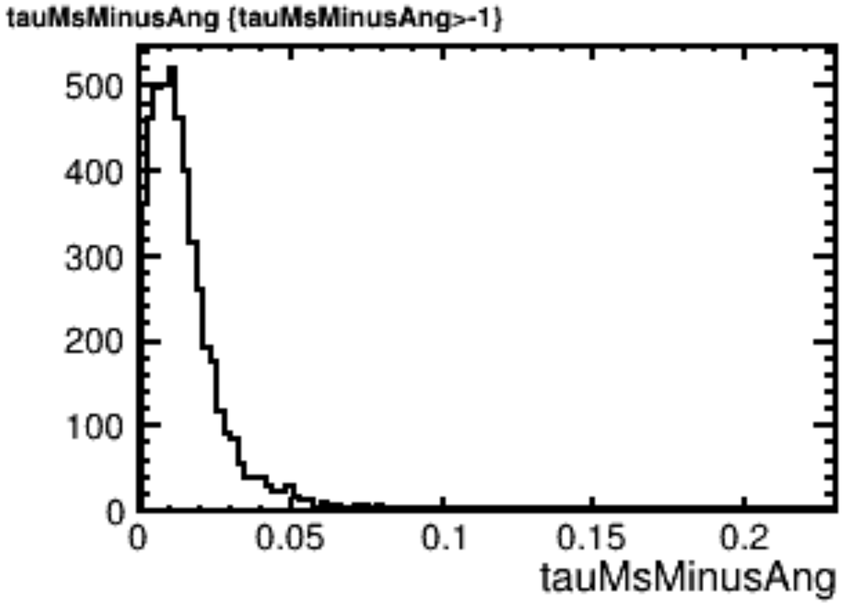


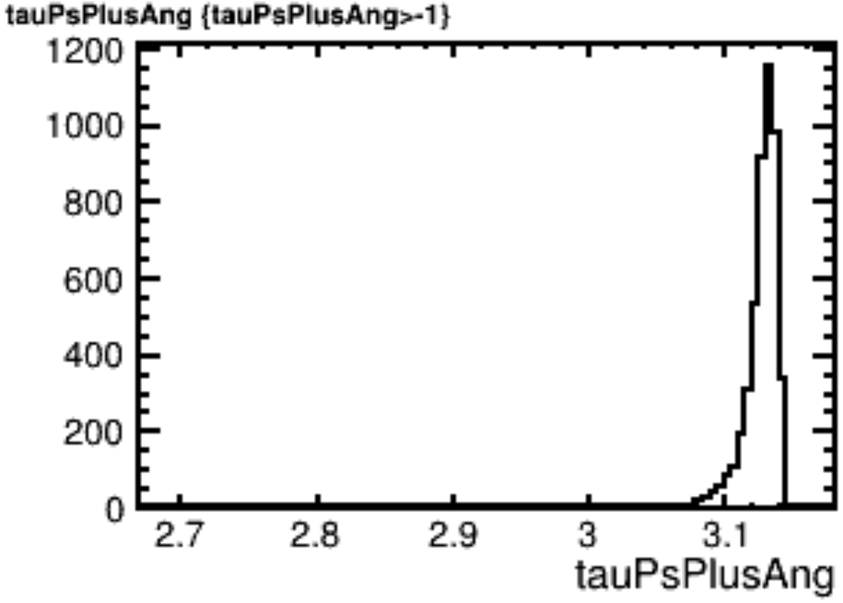
angle between 2 solutions is very narrow

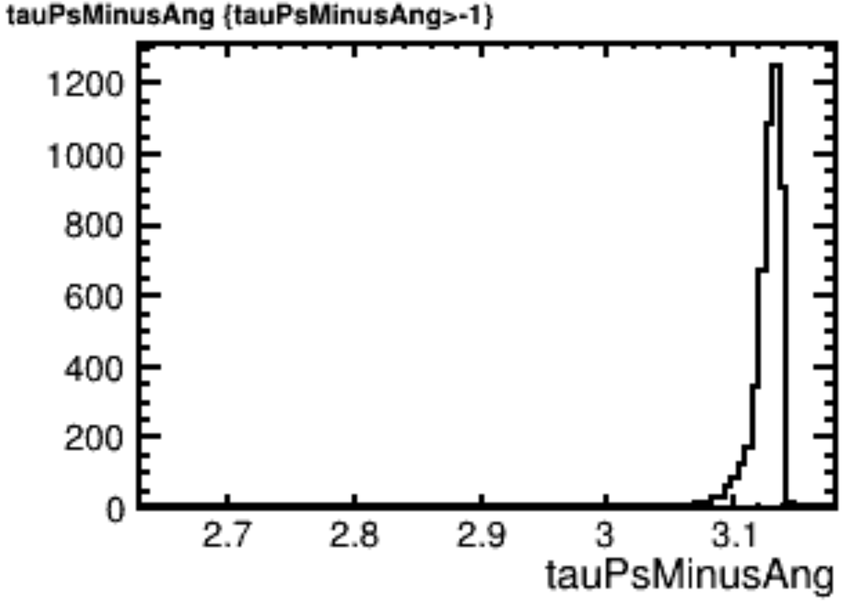
angle between MC tau and reconstructed tau





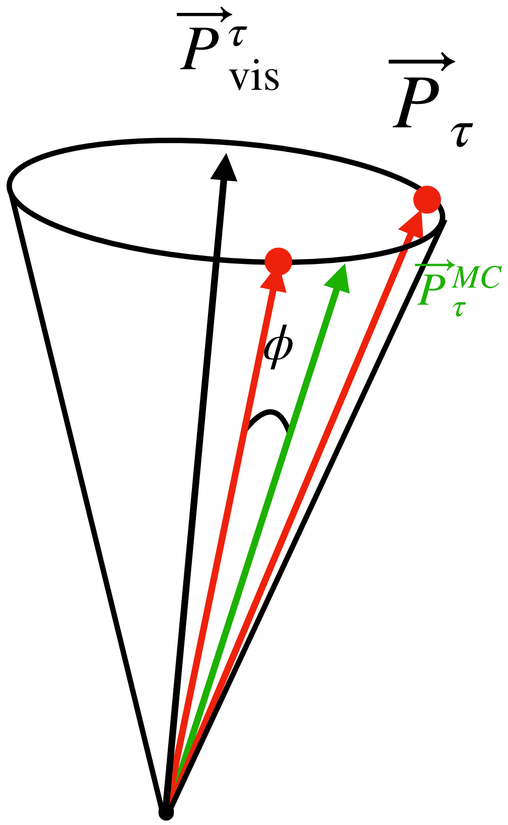


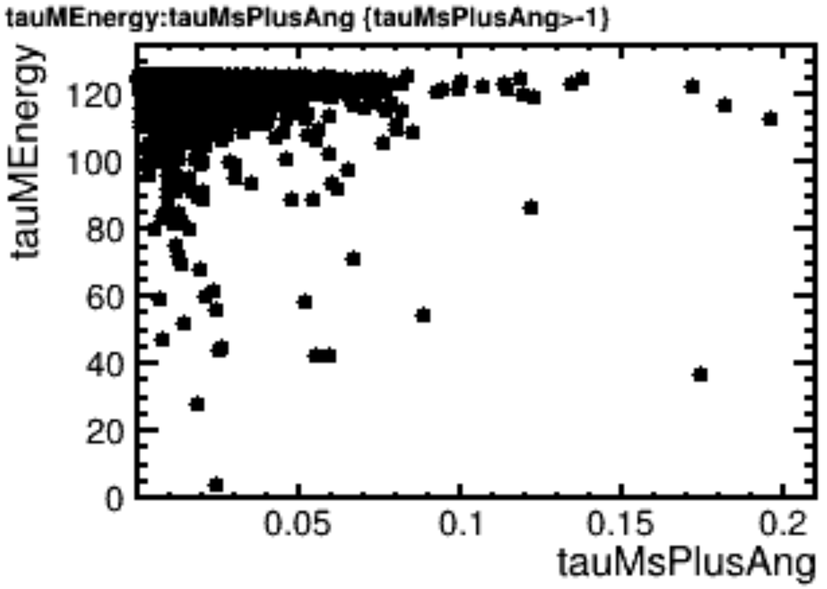


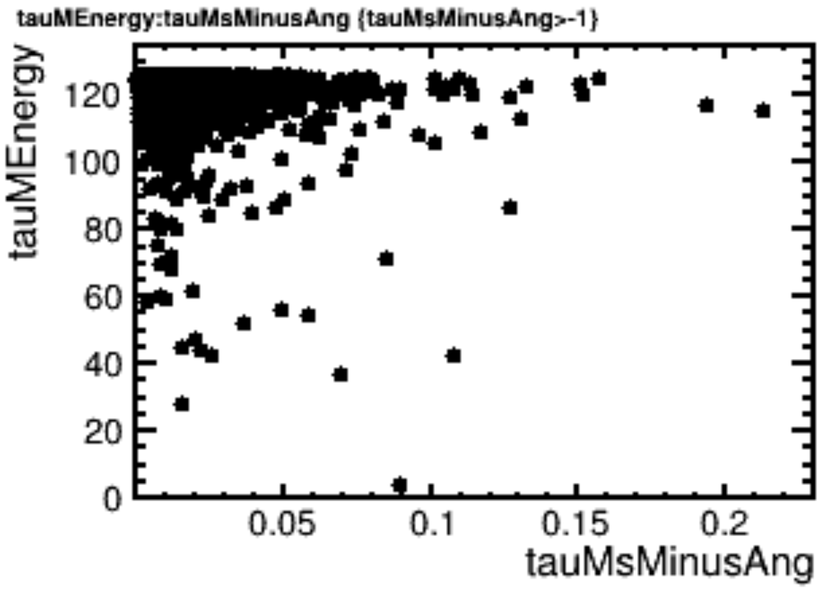


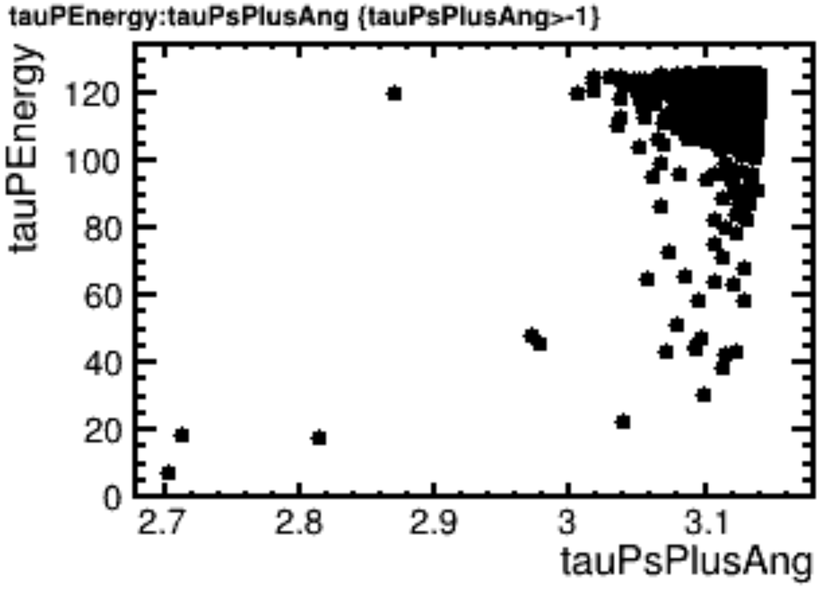
angles of τ^+ are $\sim \pi$ rad because of flip

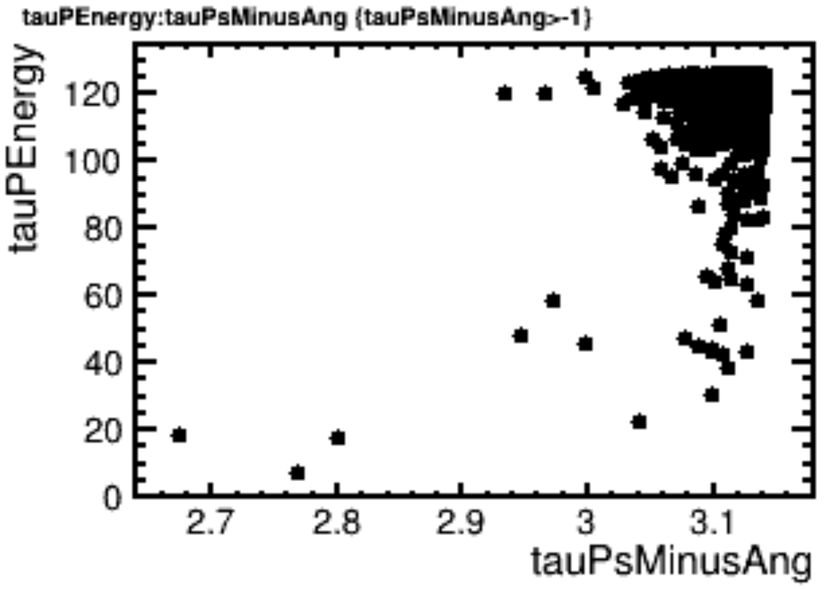
angle between MC tau and reconstructed tau vs tau energy











Plan

Look at

- both tau decay hadronically / leptonically
- 1 hadronic decay and 1 leptonic decay

tau decay mode selection

if $m_{\tau\tau} > 240$ GeV cut are applied, BDTG Ranking result is strange…

investigate why this happens

```
BDTG                  : Ranking result (top variable is best ranked)
                      : ---------------------------------------------
                      : Rank : Variable         : Variable Importance
                      : ---------------------------------------------
                      :    1 : MC_tautauInvMass : 1.316e-01
                      :    2 : TM               : 1.223e-01
                      :    3 : PGM              : 1.185e-01
                      :    4 : NG               : 1.067e-01
                      :    5 : GM               : 9.906e-02
                      :    6 : GamEneMax        : 7.878e-02
                      :    7 : NCHG             : 7.248e-02
                      :    8 : ChPiEneMax       : 7.182e-02
                      :    9 : MinAngPiGam2     : 6.600e-02
                      :   10 : MinAngPiGam1     : 5.370e-02
                      :   11 : MaxEneGamAngPi   : 4.360e-02
                      :   12 : GamEneMin        : 3.560e-02
```

```
BDTG                  : Ranking result (top variable is best ranked)
                      : ---------------------------------------------
                      : Rank : Variable         : Variable Importance
                      : ---------------------------------------------
                      :    1 : NG               : -nan
                      :    2 : GM               : -nan
                      :    3 : PGM              : -nan
                      :    4 : GamEneMax        : -nan
                      :    5 : GamEneMin        : -nan
                      :    6 : ChPiEneMax       : -nan
                      :    7 : MinAngPiGam1     : -nan
                      :    8 : MinAngPiGam2     : -nan
                      :    9 : MaxEneGamAngPi   : -nan
                      :   10 : TM               : -nan
                      :   11 : NCHG             : -nan
                      :   12 : MC_tautauInvMass : -nan
```