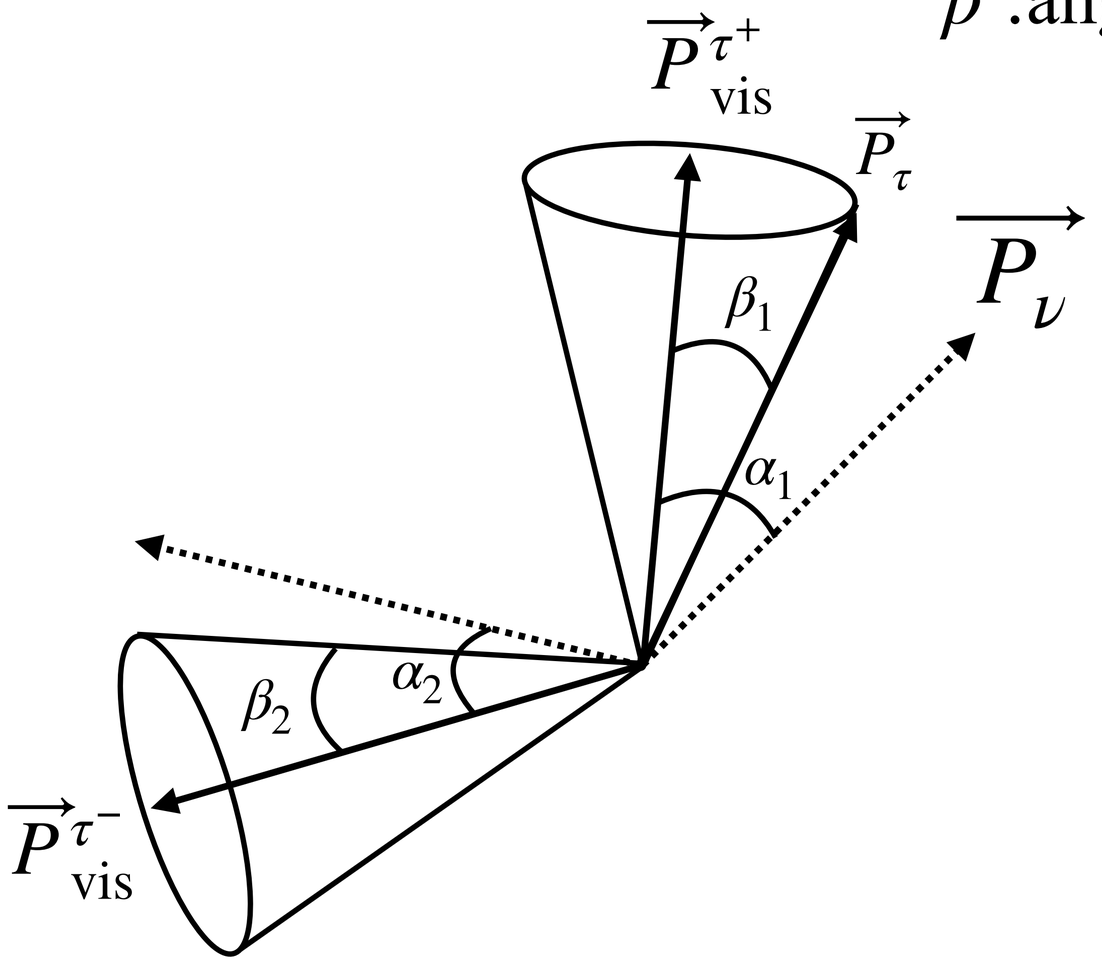
Find tau

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

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



assume:

$$E_\nu = \frac{E_{\text{CM}}}{2} - E_{\text{vis}} \qquad P_\tau = P_{vis} + P_\nu$$

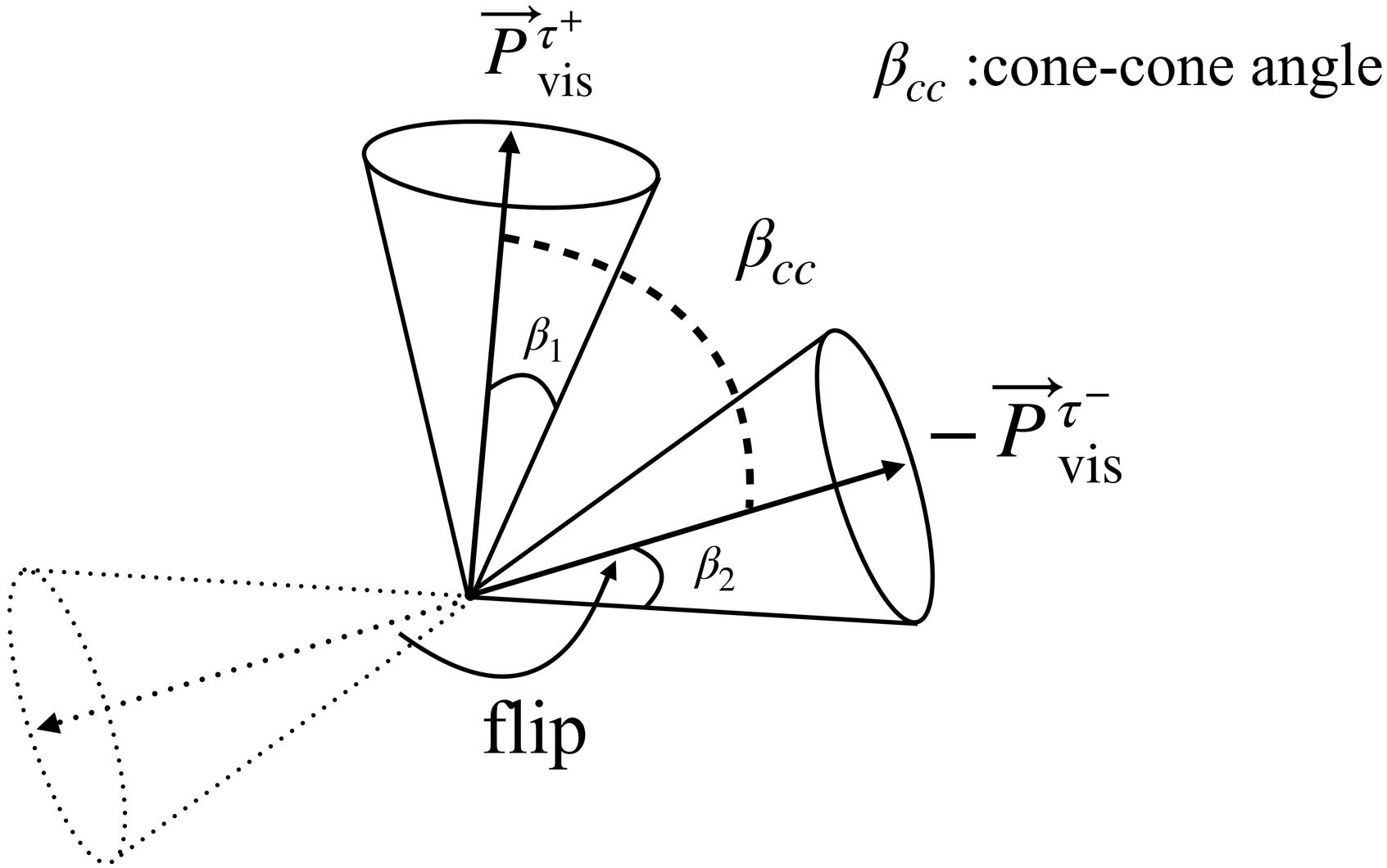
$$E_\tau = \frac{E_{cm}}{2}$$

$$P_\tau^2 = m_\tau^2$$

$$P_{\tau_1} = P_{\tau_2}$$

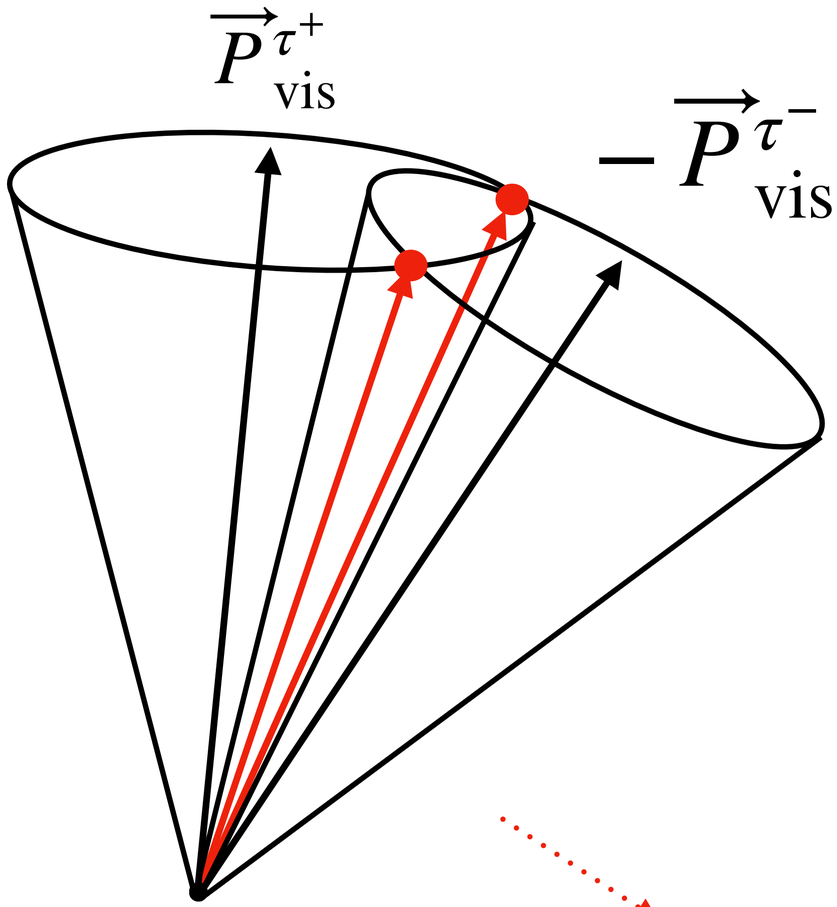
decide β by α

Flip one of tau visible daughter



Find solution

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



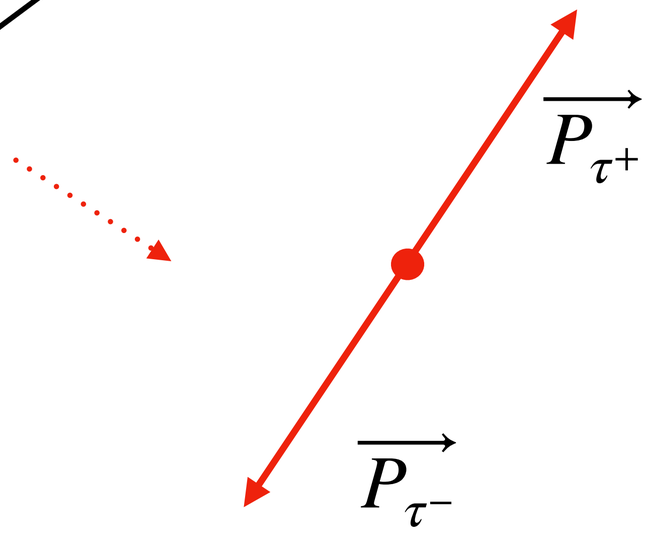
if

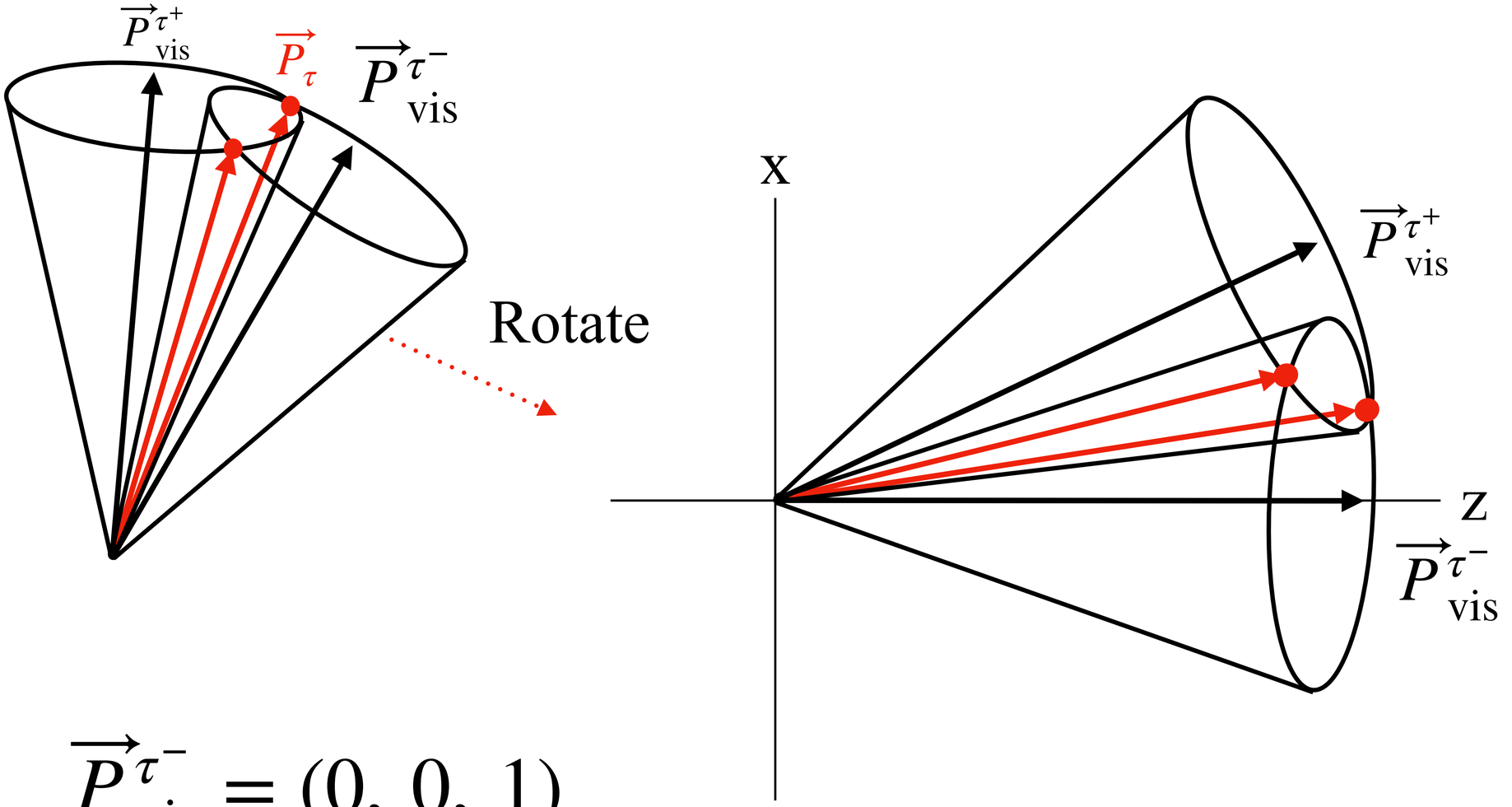
$$\beta_1 + \beta_2 > \beta_{cc}$$

then

2 overlapped points

$\longrightarrow$2 possible solutions

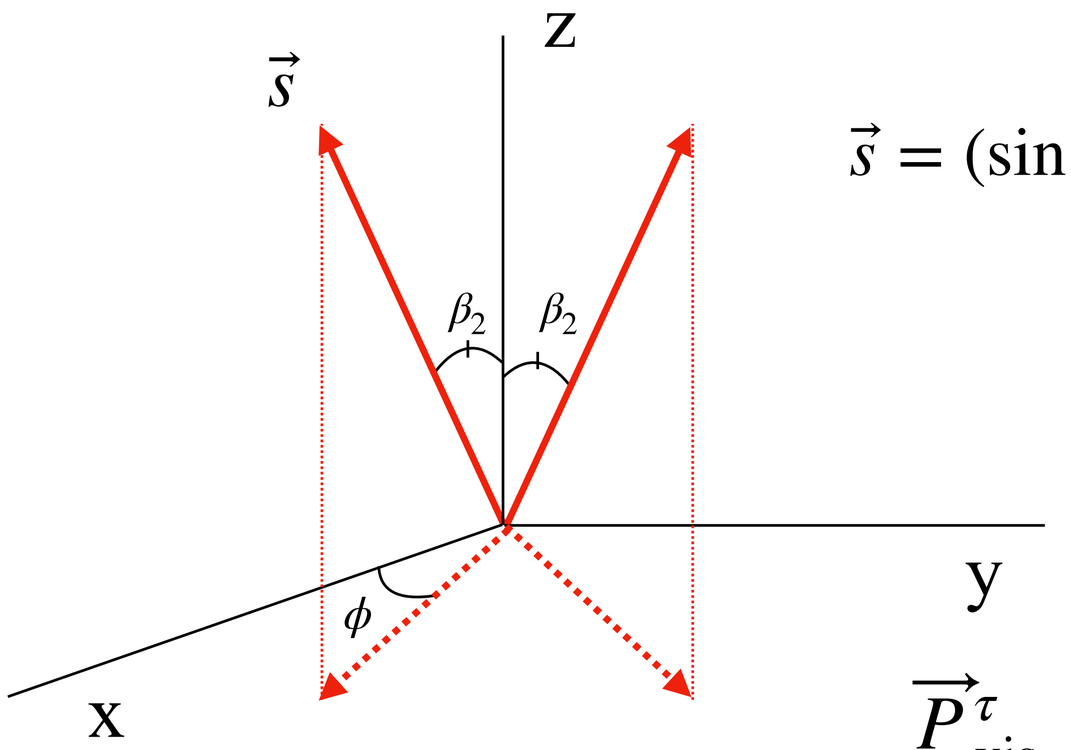




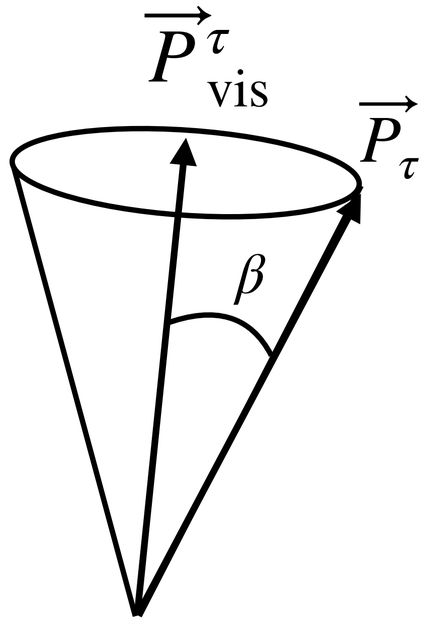
$$\overrightarrow{P}^{\tau^-}_{\text{vis}} = (0,\ 0,\ 1)$$

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

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

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

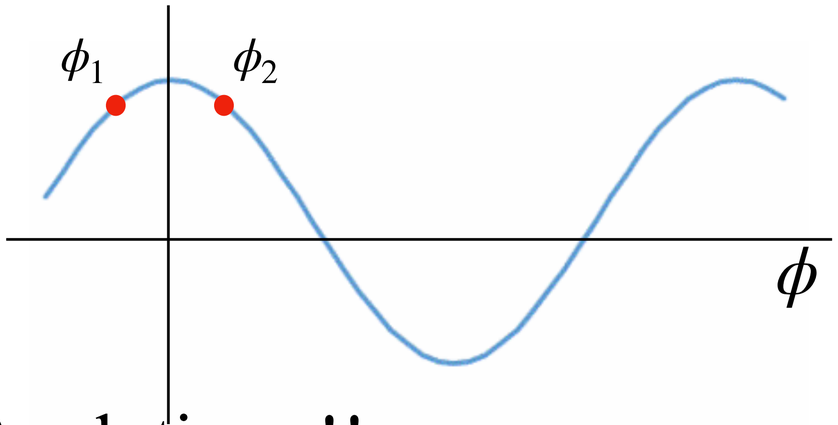
$$\overrightarrow{P}^{\tau^-}_{\text{vis}} = (0,\ 0,\ 1)$$

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

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

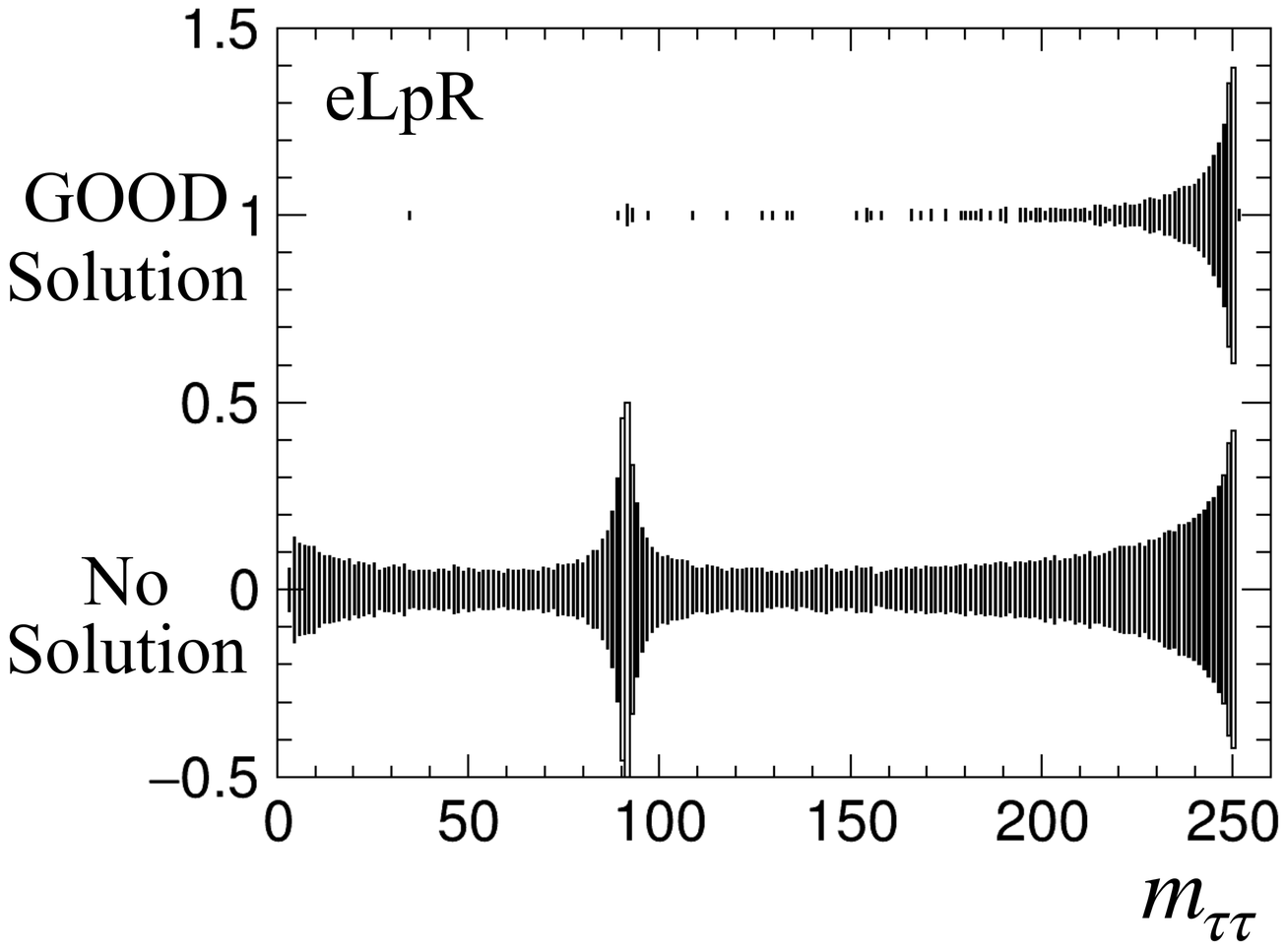
$$\vec{s} \cdot \overrightarrow{P^{\tau^+}_{\text{vis}}} = \sin\beta_2 \cos\phi \sin\theta_{cc} + \cos\beta_2 \cos\theta_{cc} = \cos\beta_1$$

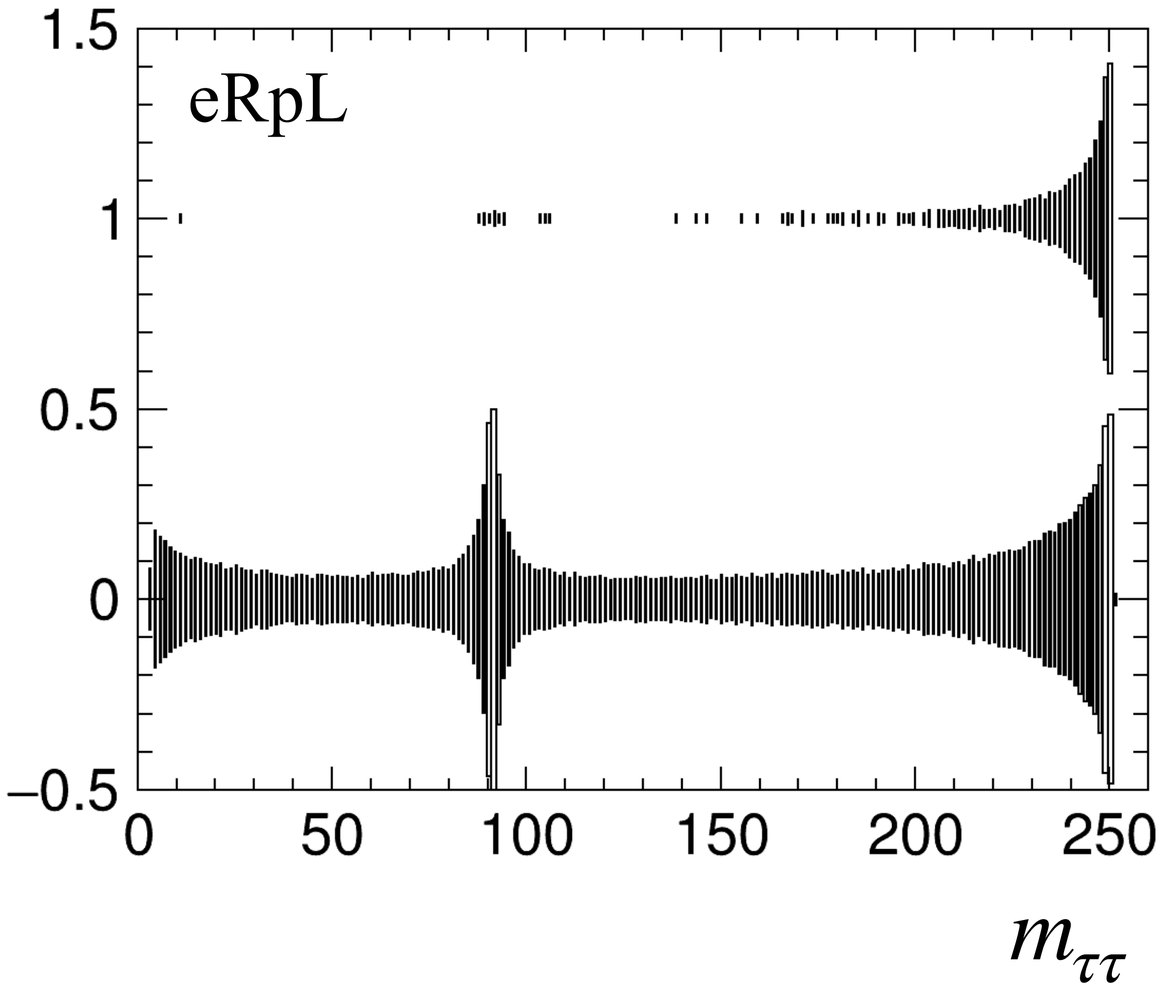
$$\rightarrow \quad \cos\phi = \frac{(1 - \cos\theta_{cc})\cos_{\beta_1}}{\sin\beta_2 \sin\theta_{cc}}$$



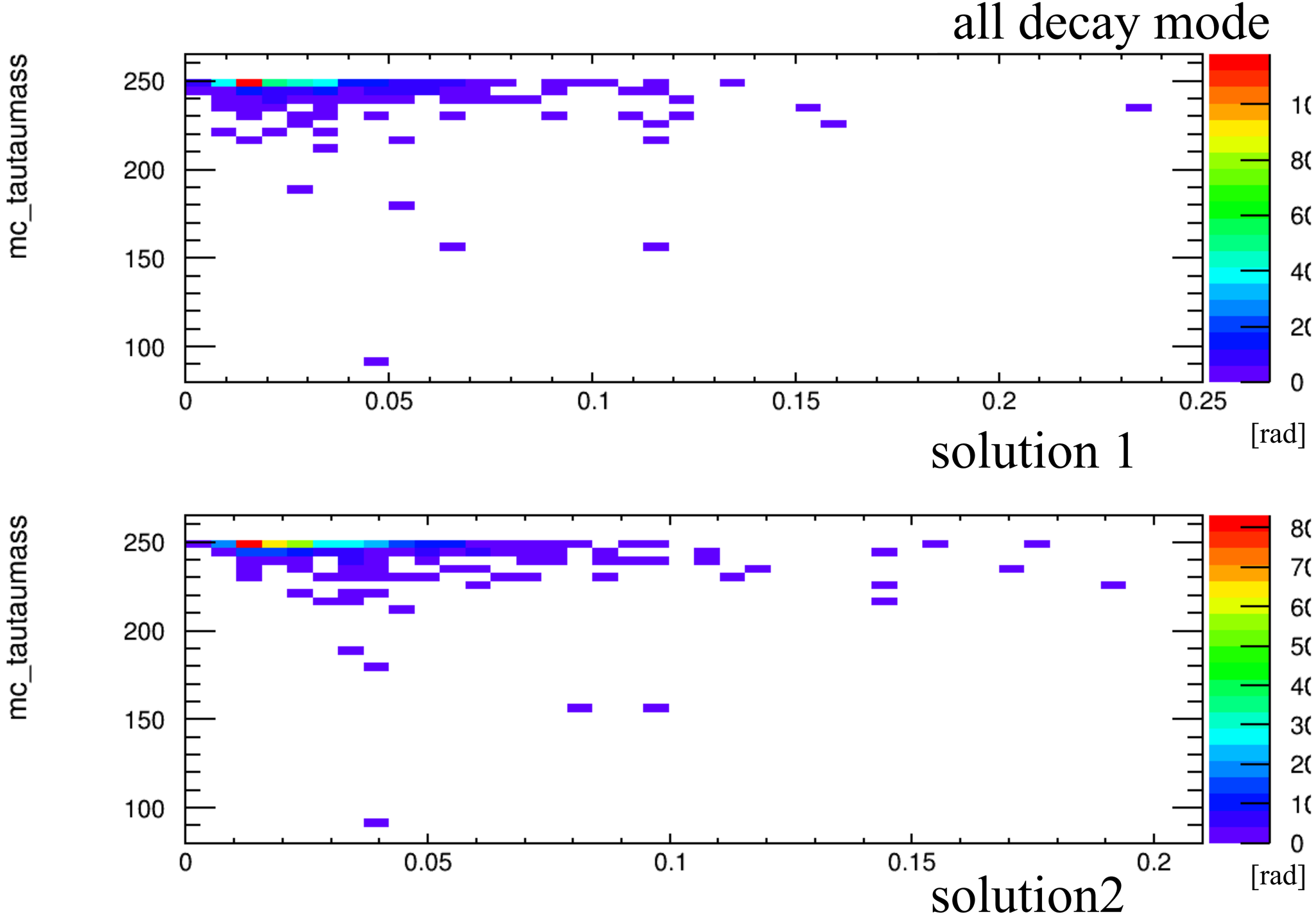
2 solutions !!

GOOD solutions



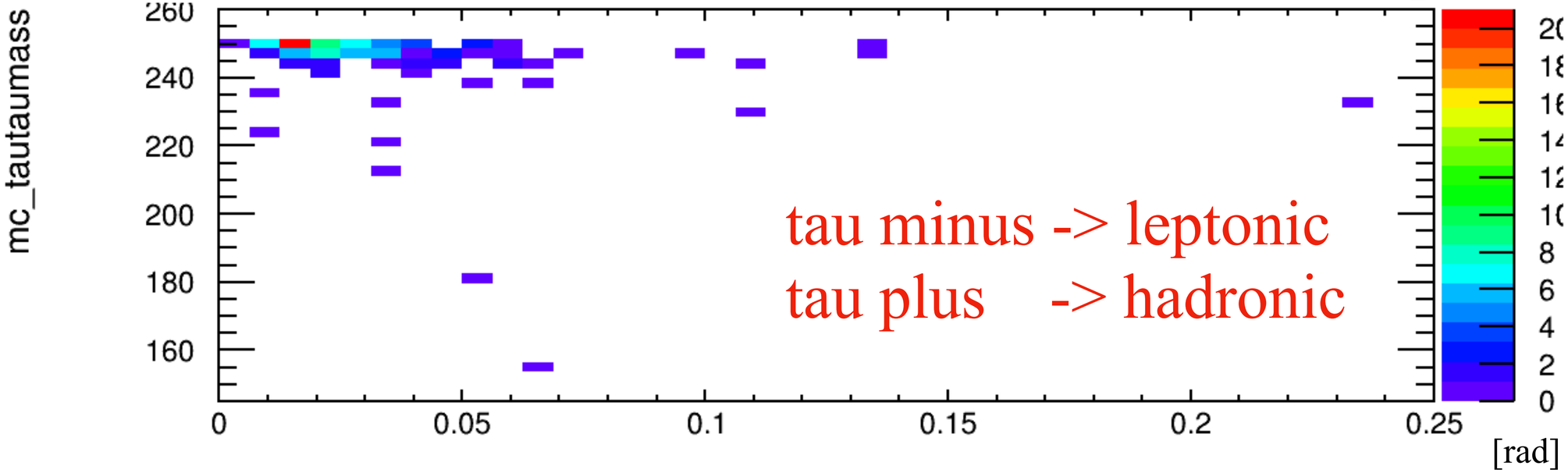


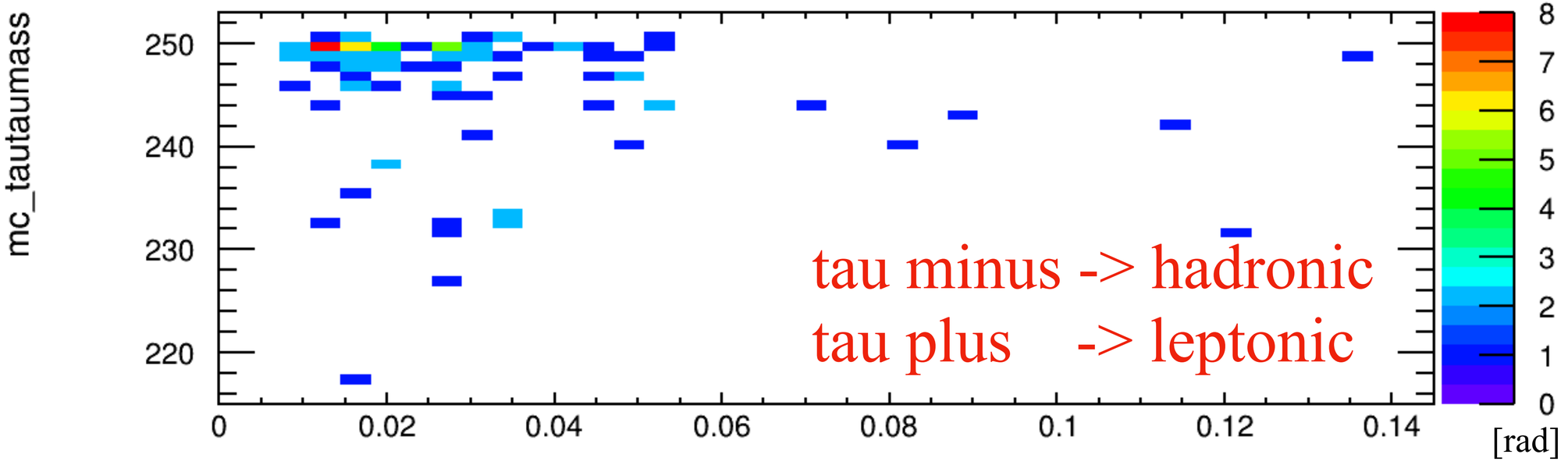
eLpR and eRpL samples: almost same tendency


all decay mode
mc_tautaumass
250
200
150
100
0
0.05
0.1
0.15
0.2
0.25
[rad]
solution 1
mc_tautaumass
250
200
150
100
0
0.05
0.1
0.15
0.2
[rad]
solution2

solution 1

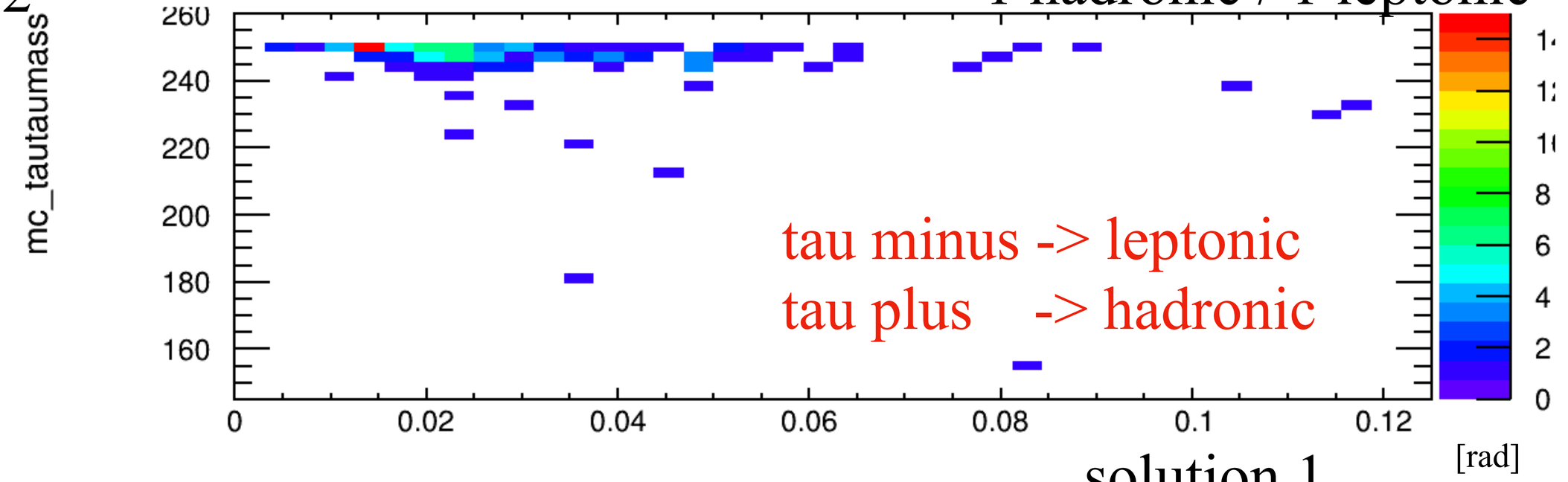
1 hadronic / 1 leptonic



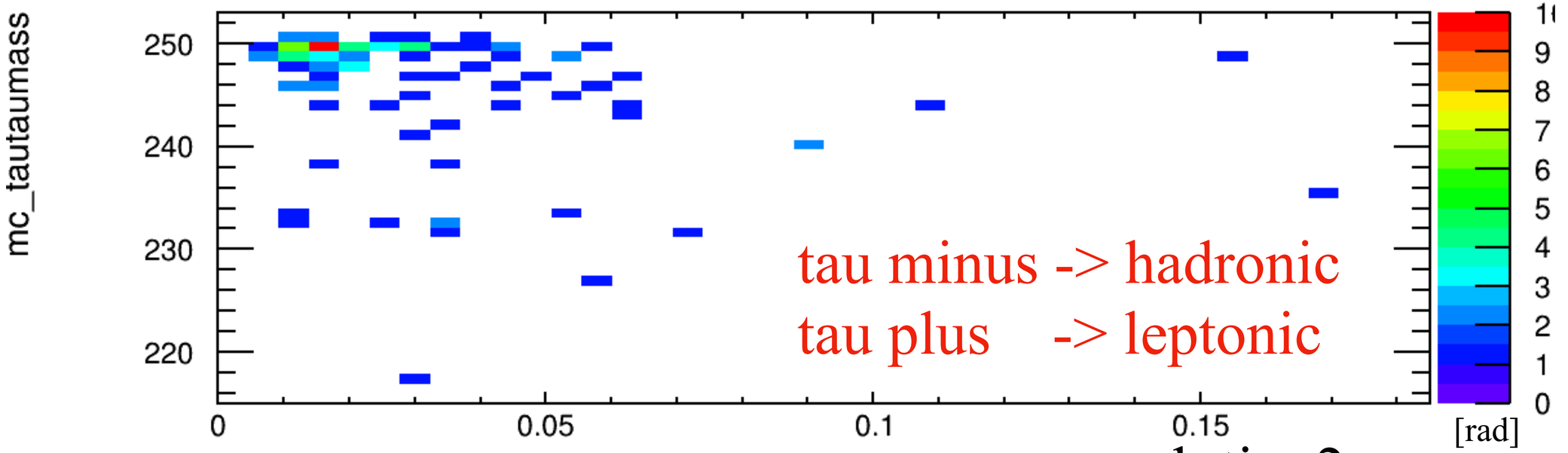


solution 2

1 hadronic / 1 leptonic



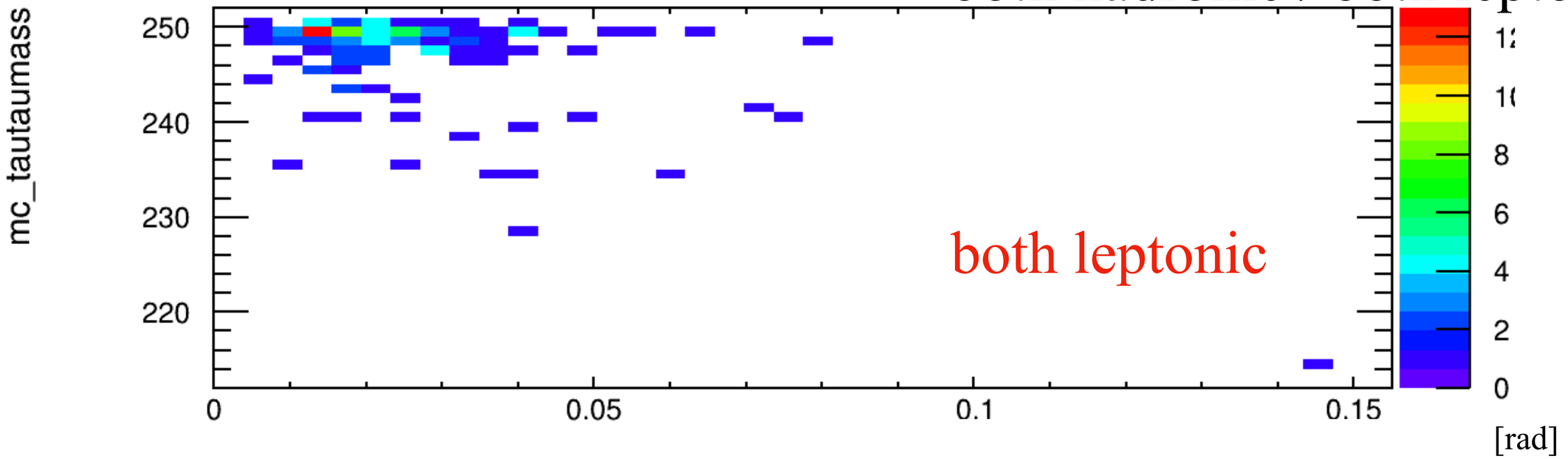
solution 1

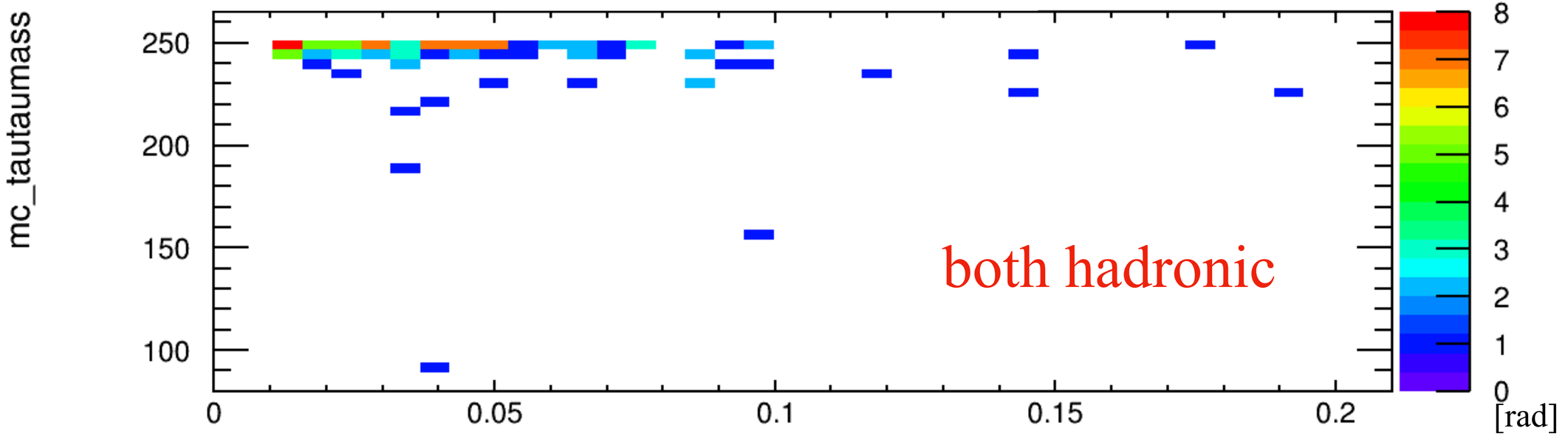


solution2

solution 1

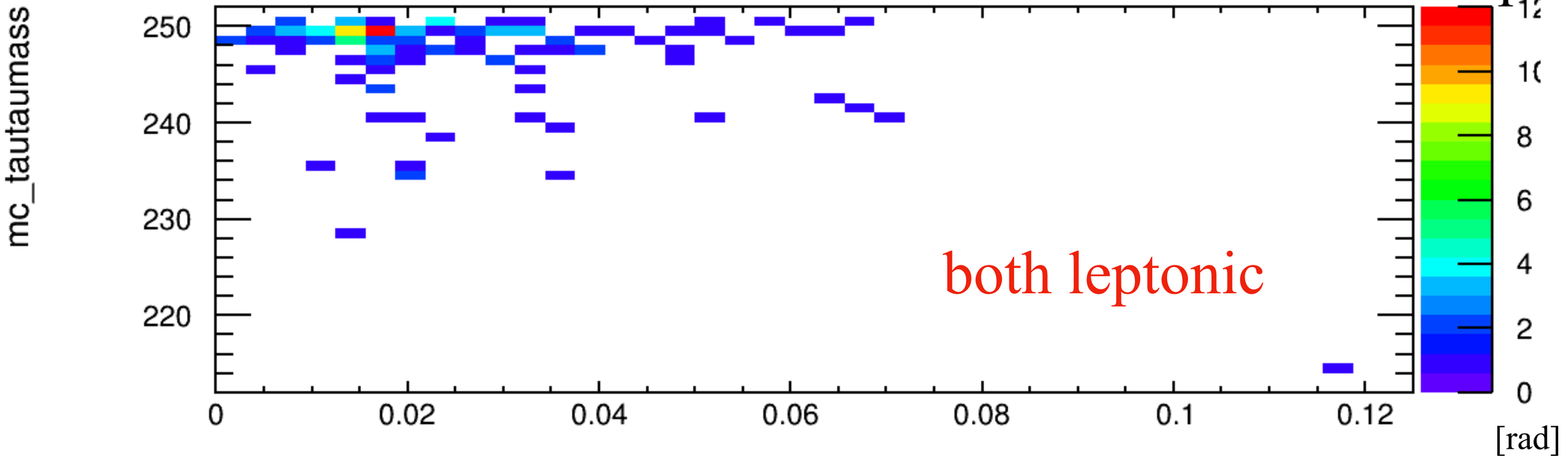
both hadronic / both leptonic

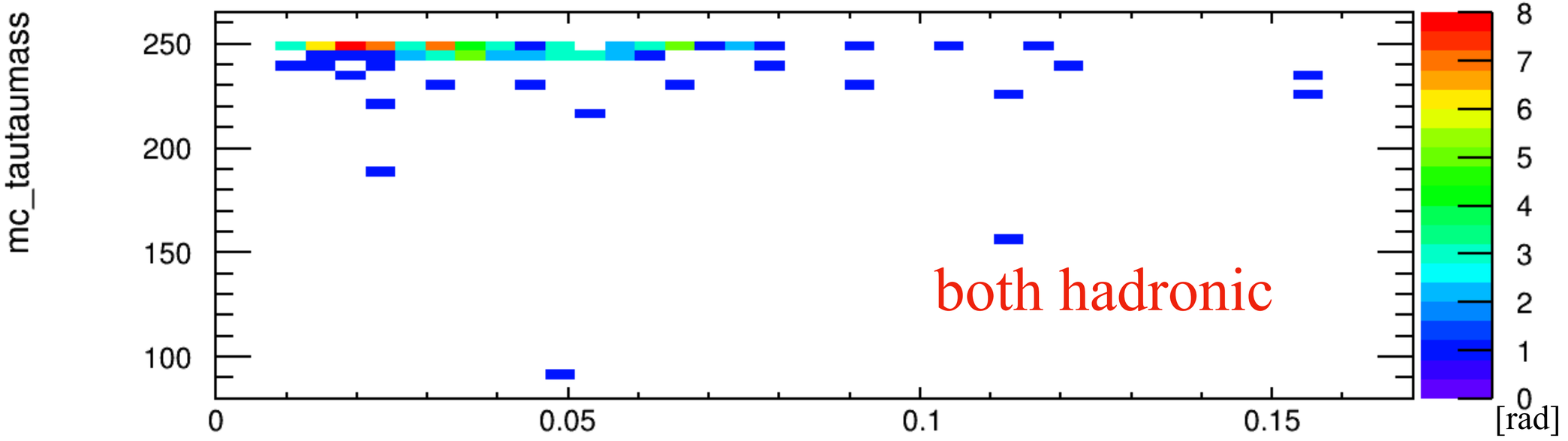




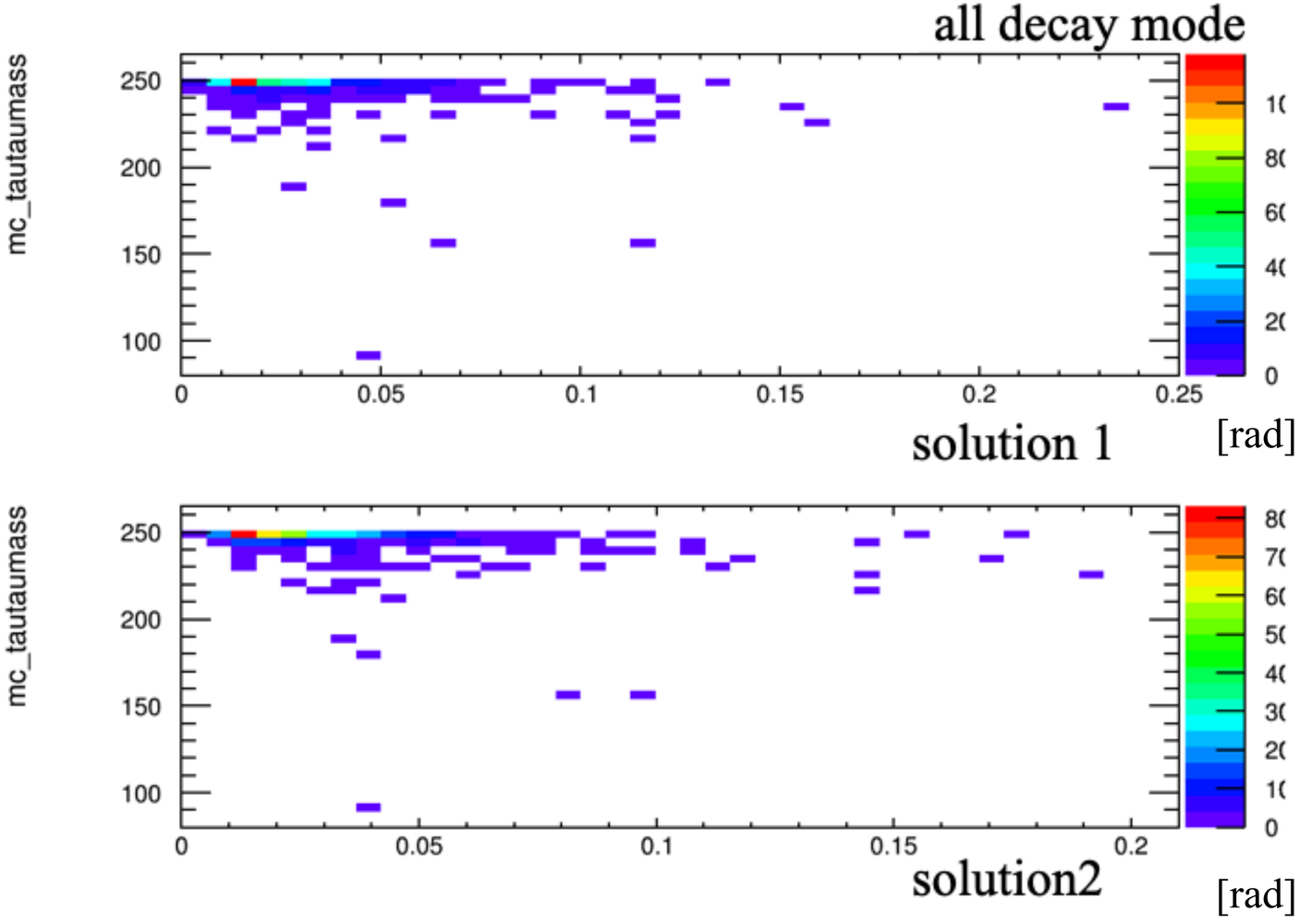
solution 2

both hadronic / both leptonic

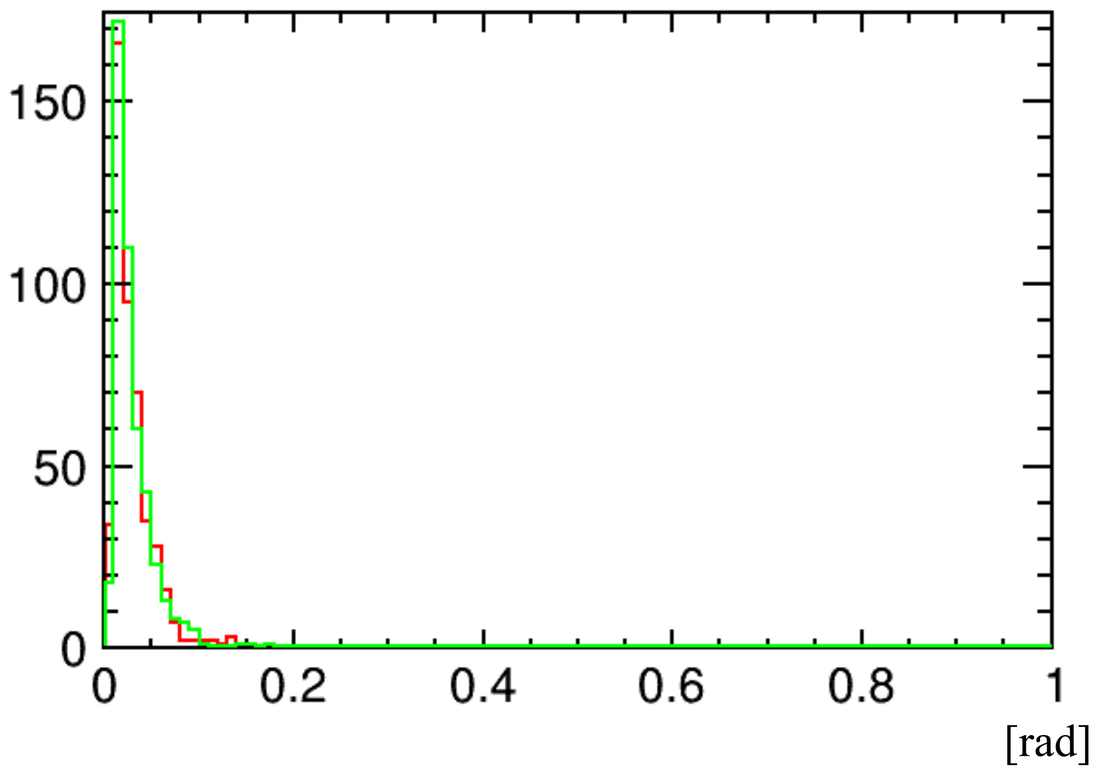




projection X ($m_{\tau\tau} > 240$ GeV)



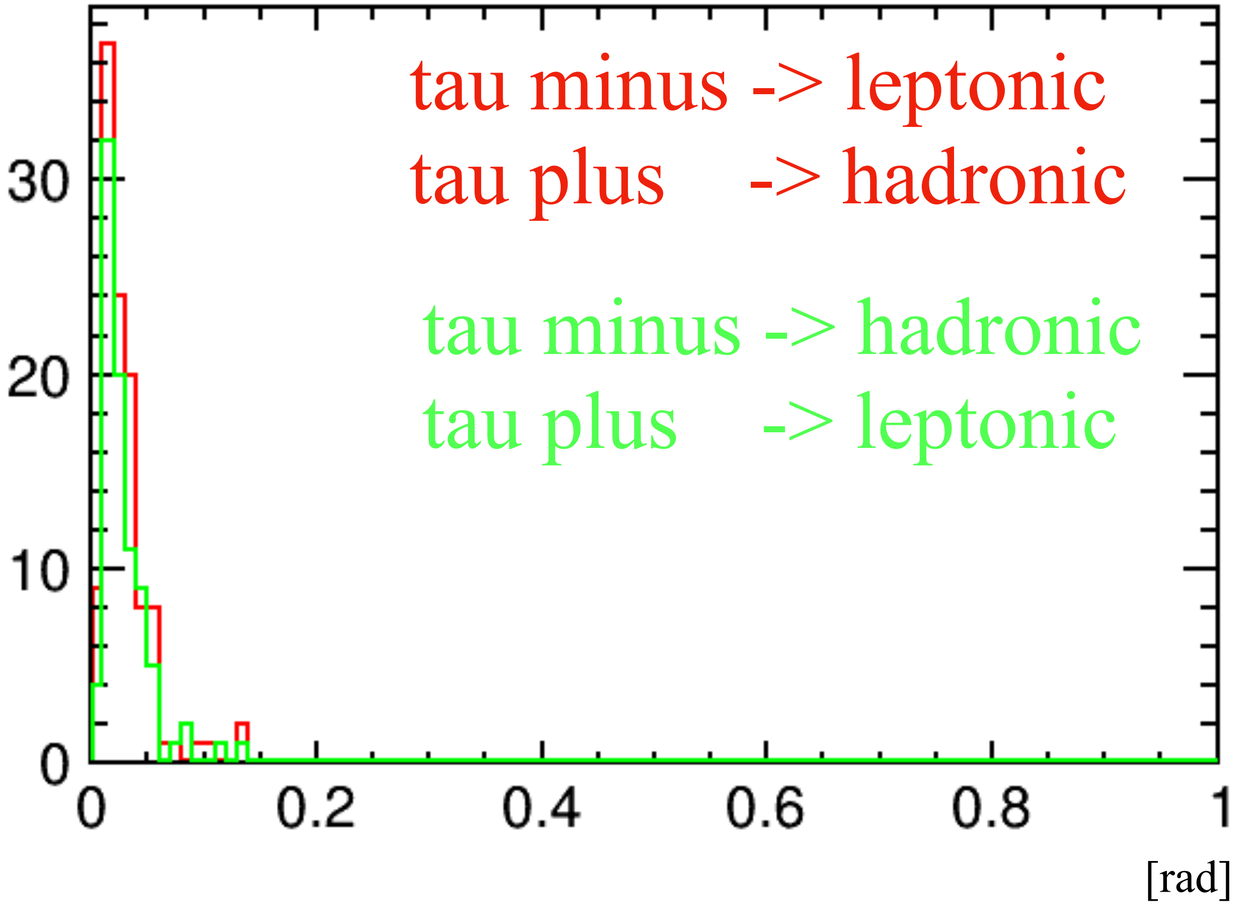
all decay mode



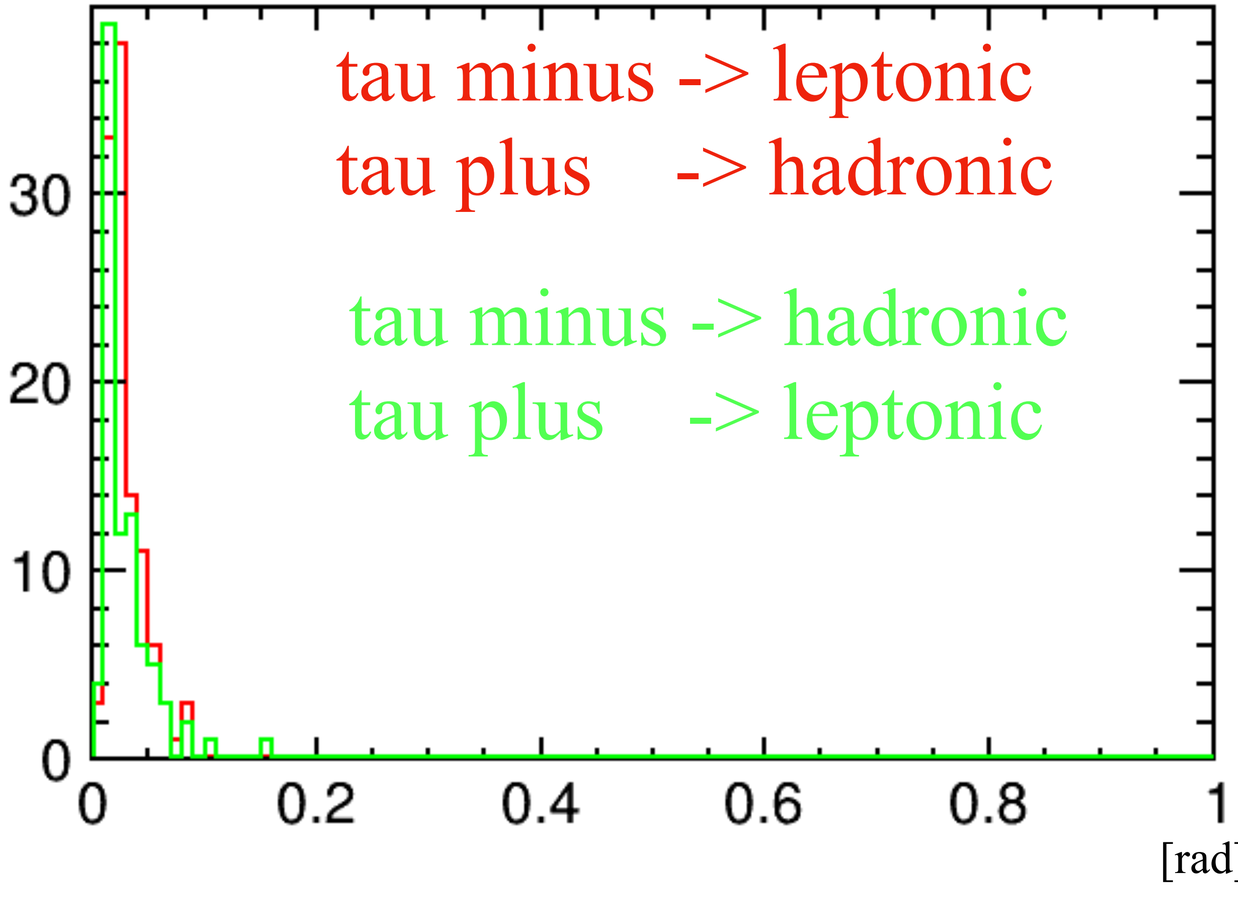
projection X ($m_{\tau\tau} > 240$ GeV)

1 hadronic / 1 leptonic

solution 1

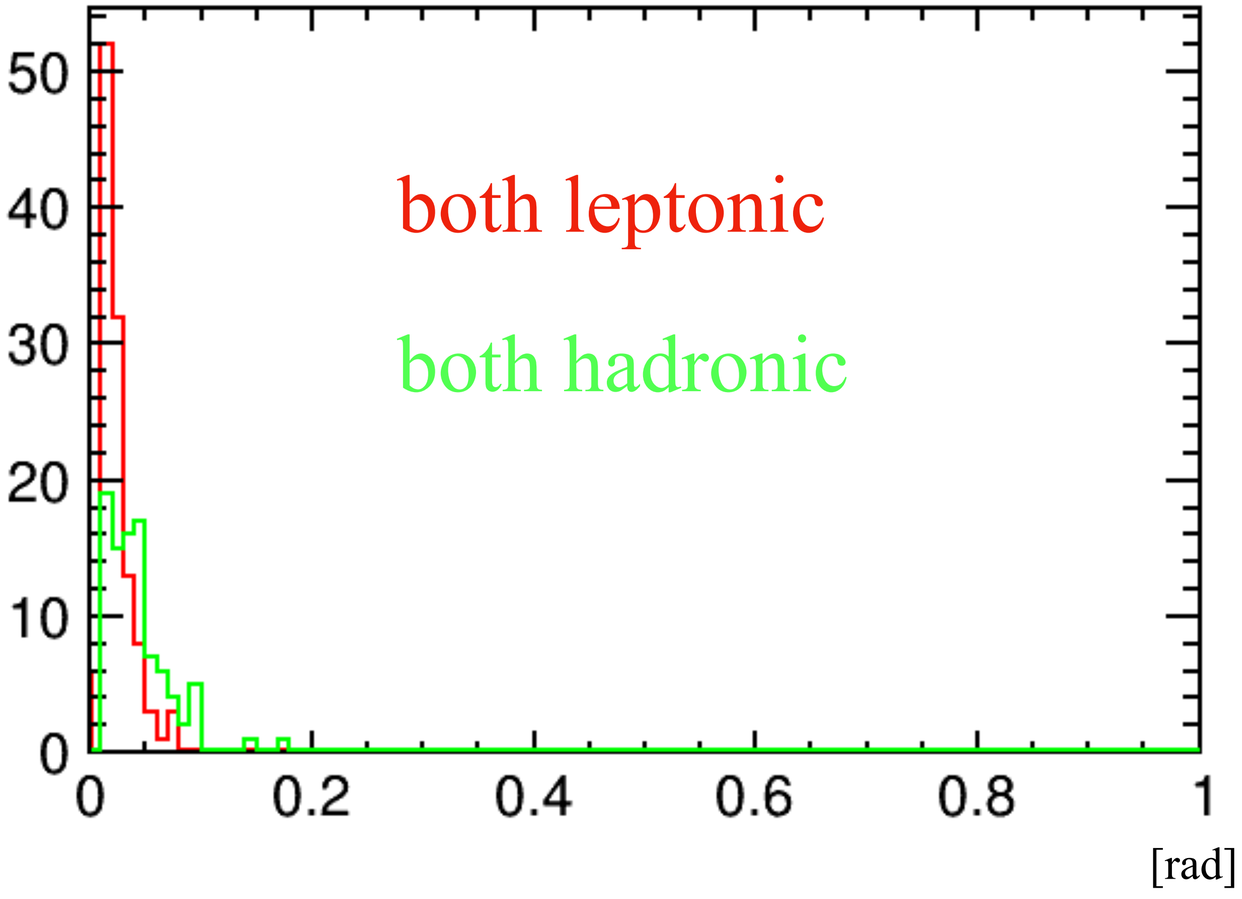


solution 2



projection X ($m_{\tau\tau} > 240$ GeV)

solution 1



solution 2