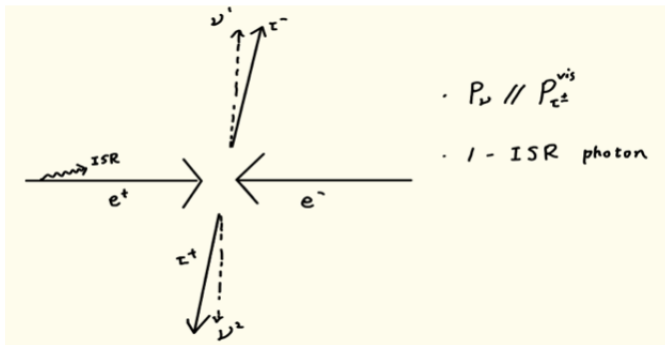


- tau decay mode selection: TMVA \rightarrow too few statistics (~ 5000) for training..?
- Polarisation: calculate the neutrino energy

Neutrino energy calculation



$$\Sigma E = E_\nu^1 + E_\nu^2 + E_{\tau^+}^{vis} + E_{\tau^-}^{vis} + E_{ISR} = 250$$

$$\Sigma P_x = P_{\tau^-x}^{vis} + P_{\tau^+x}^{vis} + P_{\nu x}^1 + P_{\nu x}^2 = 0$$

$$\Sigma P_y = P_{\tau^-y}^{vis} + P_{\tau^+y}^{vis} + P_{\nu y}^1 + P_{\nu y}^2 = 0$$

$$\Sigma P_z = P_z^{ISR} + P_{\tau^+}^{vis} + P_{\tau^-}^{vis} + P_{\nu z}^1 + P_{\nu z}^2 = 0$$

Neutrino energy calculation

$$\begin{aligned}\Sigma E &= E_{\nu}^1 + E_{\nu}^2 + E_{\tau^+}^{vis} + E_{\tau^-}^{vis} + E_{ISR} = 250 \\ \Sigma P_x &= P_{\tau^-x}^{vis} + P_{\tau^+x}^{vis} + P_{\nu x}^1 + P_{\nu x}^2 = 0 \\ \Sigma P_y &= P_{\tau^-y}^{vis} + P_{\tau^+y}^{vis} + P_{\nu y}^1 + P_{\nu y}^2 = 0 \\ \Sigma P_z &= P_z^{ISR} + P_{\tau^+}^{vis} + P_{\tau^-}^{vis} + P_{\nu z}^1 + P_{\nu z}^2 = 0\end{aligned}$$

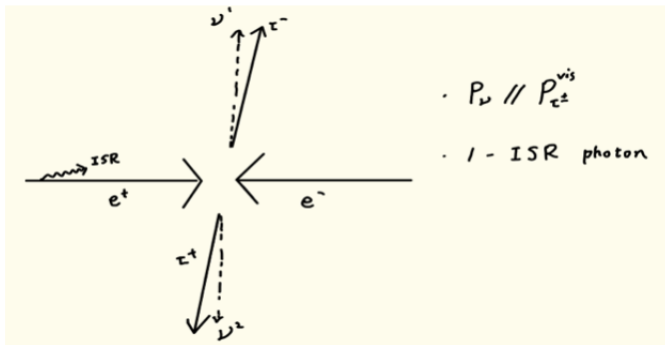
$$E_{\nu}^1 = \frac{P_{\tau^-y}^{vis} + P_{\tau^+y}^{vis}}{P^{-x}P^{+y} - P^{-y}P^{+x}} P^{+x} - \frac{P_{\tau^-x}^{vis} + P_{\tau^+x}^{vis}}{P^{-x}P^{+y} - P^{-y}P^{+x}} P^{+y}$$

$$E_{\nu}^2 = \frac{P_{\tau^-x}^{vis} + P_{\tau^+x}^{vis}}{P^{-x}P^{+y} - P^{-y}P^{+x}} P^{-y} - \frac{P_{\tau^-y}^{vis} + P_{\tau^+y}^{vis}}{P^{-x}P^{+y} - P^{-y}P^{+x}} P^{-x}$$

$$E_{ISR} = 250 - E_{\nu}^1 - E_{\nu}^2 - E_{\tau^+}^{vis} - E_{\tau^-}^{vis}$$

$$P^{\pm i} = \frac{P_{\tau^{\pm i}}^{vis}}{P_{\tau^{\pm}}^{vis}} \quad i = (x, y)$$

Neutrino energy calculation



$$\Sigma E = E_\nu^1 + E_\nu^2 + E_{\tau^+}^{vis} + E_{\tau^-}^{vis} + E_{ISR} = 250$$

$$\Sigma P_x = P_{\tau^-x}^{vis} + P_{\tau^+x}^{vis} + P_{\nu x}^1 + P_{\nu x}^2 = E_{CM} \sin \alpha$$

$$\Sigma P_y = P_{\tau^-y}^{vis} + P_{\tau^+y}^{vis} + P_{\nu y}^1 + P_{\nu y}^2 = 0$$

$$\Sigma P_z = P_z^{ISR} + P_{\tau^+}^{vis} + P_{\tau^-}^{vis} + P_{\nu z}^1 + P_{\nu z}^2 = 0$$

Neutrino energy calculation

$$\begin{aligned}\Sigma E &= E_{\nu}^1 + E_{\nu}^2 + E_{\tau^+}^{vis} + E_{\tau^-}^{vis} + E_{ISR} = 250 \\ \Sigma P_x &= P_{\tau^-x}^{vis} + P_{\tau^+x}^{vis} + P_{\nu x}^1 + P_{\nu x}^2 = E_{CM} \sin \alpha \\ \Sigma P_y &= P_{\tau^-y}^{vis} + P_{\tau^+y}^{vis} + P_{\nu y}^1 + P_{\nu y}^2 = 0 \\ \Sigma P_z &= P_z^{ISR} + P_{\tau^+}^{vis} + P_{\tau^-}^{vis} + P_{\nu z}^1 + P_{\nu z}^2 = 0\end{aligned}$$

$$E_{\nu}^1 = \frac{P_{\tau^-y}^{vis} + P_{\tau^+y}^{vis}}{P^{-x}P^{+y} - P^{-y}P^{+x}} P^{+x} - \frac{P_{\tau^-x}^{vis} + P_{\tau^+x}^{vis} - E_{CM} \sin \alpha}{P^{-x}P^{+y} - P^{-y}P^{+x}} P^{+y}$$

$$E_{\nu}^2 = \frac{P_{\tau^-x}^{vis} + P_{\tau^+x}^{vis} - E_{CM} \sin \alpha}{P^{-x}P^{+y} - P^{-y}P^{+x}} P^{-y} - \frac{P_{\tau^-y}^{vis} + P_{\tau^+y}^{vis}}{P^{-x}P^{+y} - P^{-y}P^{+x}} P^{-x}$$

$$E_{ISR} = 250 - E_{\nu}^1 - E_{\nu}^2 - E_{\tau^+}^{vis} - E_{\tau^-}^{vis}$$

$$P^{\pm i} = \frac{P_{\tau^{\pm i}}^{vis}}{P_{\tau^{\pm}}^{vis}} \quad i = (x, y)$$

Neutrino energy calculation

$$E_\nu + E_{\pi^+} + E_{\bar{\nu}} + E_{\pi^-} + P_{ISR} = E_{CM}$$

$$\sin \theta^+ \cos \phi^+ (P_{\pi^+} + E_\nu) + \sin \theta^- \cos \phi^- (P_{\pi^-} + E_{\bar{\nu}}) + P_{ISR} \sin \alpha = E_{CM}$$

$$\sin \theta^+ \cos \phi^+ (P_{\pi^+} + E_\nu) + \sin \theta^- \cos \phi^- (P_{\pi^-} + E_{\bar{\nu}}) = 0$$

$$\cos \theta^+ (P_{\pi^+} + E_\nu) + \cos \theta^- (P_{\pi^-} + E_{\bar{\nu}}) \pm P_{ISR} \cos \alpha = 0$$

unknown

$E_\nu, E_{\bar{\nu}}, P_{ISR}$

Neutrino energy calculation

$$E_\nu + E_{\pi^+} + E_{\bar{\nu}} + E_{\pi^-} + P_{ISR} = E_{CM}$$

$$\sin \theta^+ \cos \phi^+ (P_{\pi^+} + E_\nu) + \sin \theta^- \cos \phi^- (P_{\pi^-} + E_{\bar{\nu}}) + P_{ISR} \sin \alpha = E_{CM}$$

$$\sin \theta^+ \cos \phi^+ (P_{\pi^+} + E_\nu) + \sin \theta^- \cos \phi^- (P_{\pi^-} + E_{\bar{\nu}}) = 0$$

$$\cos \theta^+ (P_{\pi^+} + E_\nu) + \cos \theta^- (P_{\pi^-} + E_{\bar{\nu}}) \pm P_{ISR} \cos \alpha = 0$$

constraints

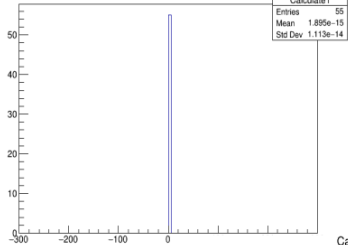
$$m_\tau^2 = (E_{\pi^+} + E_\nu)^2 - (E_{\pi^+} + E_\nu)^2$$

$$m_\tau^2 = (E_{\pi^-} + E_{\bar{\nu}})^2 - (E_{\pi^-} + E_{\bar{\nu}})^2$$

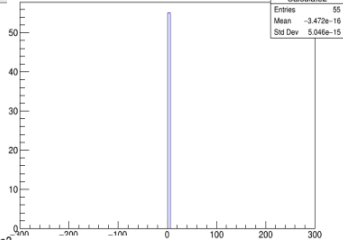
unknown

$E_\nu, E_{\bar{\nu}}, P_{ISR}$

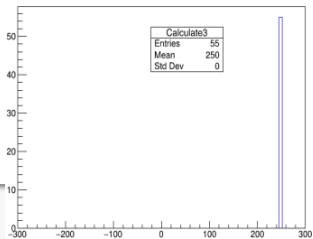
Calculate1



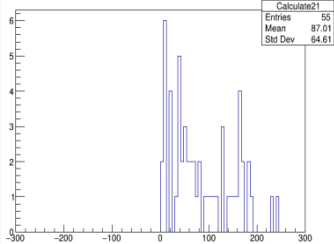
Calculate2



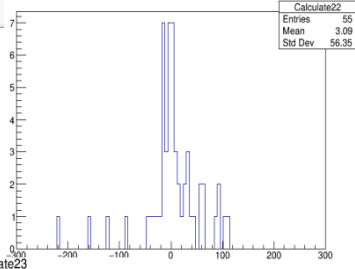
Calculate3



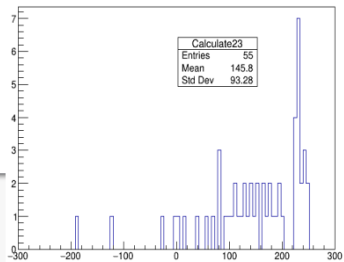
Calculate21



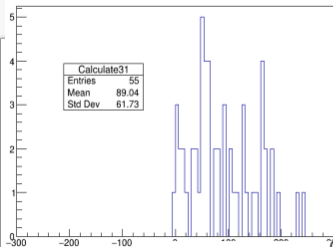
Calculate22



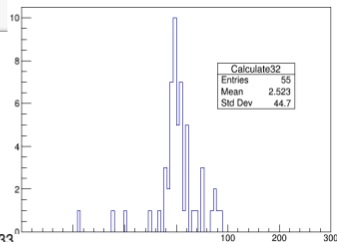
Calculate23



Calculate31



Calculate32



Calculate33

