Pion decay kinematics

- In the pion rest frame:

$$p^* = \frac{m_\pi^2 - m_\mu^2}{2m_\pi} \approx 30 MeV/c$$

$$E^* = \frac{m_\pi^2 + m_\mu^2}{2m_\pi} \approx 110 MeV/c$$

- Boost into the laboratory frame for $\beta_\pi \rightarrow 1$:

$$E_\mu \approx \gamma_\pi (E^* + p^* cos\theta^*)$$

- For two extreme cases:

a) $cos\theta^* = +1$, Muon emitted in the same direction (in the pion rest frame) as pion:

$$E_{\mu_{max}} = \gamma_\pi (E^* + p^*) = \gamma_\pi m_\pi = E_\pi$$

b) $cos\theta^* = -1$, Muon emitted in the opposited direction (in the pion rest frame)

$$E_{\mu_{min}} = \gamma_\pi (E^* - p^*) \approx 0.57 E_\pi$$

- Summary: The muon momentum p_μ from the pion's decay on flight with momemtum p_π ranges between $0.57 p_\pi$ and p_π if all angles are accepted

- Example: $p_\pi = 2GeV$, then $\gamma_\pi = 14.32$. In the laboratory frame muon's p_t is limited to $p_t = p^* sin(\pi/2) = p^* \approx 30MeV/c$ This would correspond to the largest muon's angle in the laboratory frame which is $tg\theta_{max} = \frac{p_t}{p_L}$. For $\theta^* = \pi/2$, $E_\mu = \gamma_\pi E^* = 14.32 * 0.11 = 1.6GeV$. Hence $\theta_{max} \approx arctg(0.03/1.6) \approx 1^\circ$ which will be probably accepted by T11 optics. Thus from 2 GeV pions we'll have muons with the momenta from $1.14GeV$ to $2GeV$