UNIVERSITÄT BERN

AEC ALBERT EINSTEIN CENTER FOR FUNDAMENTAL PHYSICS

ArgonCube

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π^0 studies with ArgonCube 2x2 in NuMI

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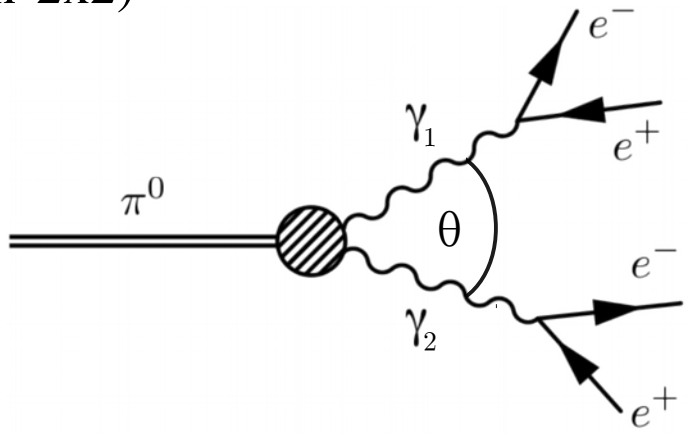
Motivation

Calibrating electron energy scale using $\pi^0 \rightarrow \gamma + \gamma$ events (which are contained in 2x2)



Total π^0 energy goes into showers (back-to-back γ's in CM frame)

→ Angle between γ's allows for π^0 kinetic energy reconstruction:

$$E_{tot,\pi^0} = m_{\pi^0} \cdot \sqrt{\frac{2}{((1-\alpha^2)\cdot(1-\cos(\theta)))}} \qquad \alpha = \frac{|E_{\gamma_1} - E_{\gamma_2}|}{E_{\gamma_1} + E_{\gamma_2}}$$

$BR(\pi^0 \rightarrow \gamma + \gamma) \approx 0.988$

Questions to be Answered

- Reconstruction of Pi0 mass (using natural units):

  $m_{reco,\pi^0} = \sqrt{E_{tot}^2 - |\vec{p}_{\pi^0}|^2} = 134.97$ MeV + Bias

  → In general, depends on the energy deposits contained in 2x2!

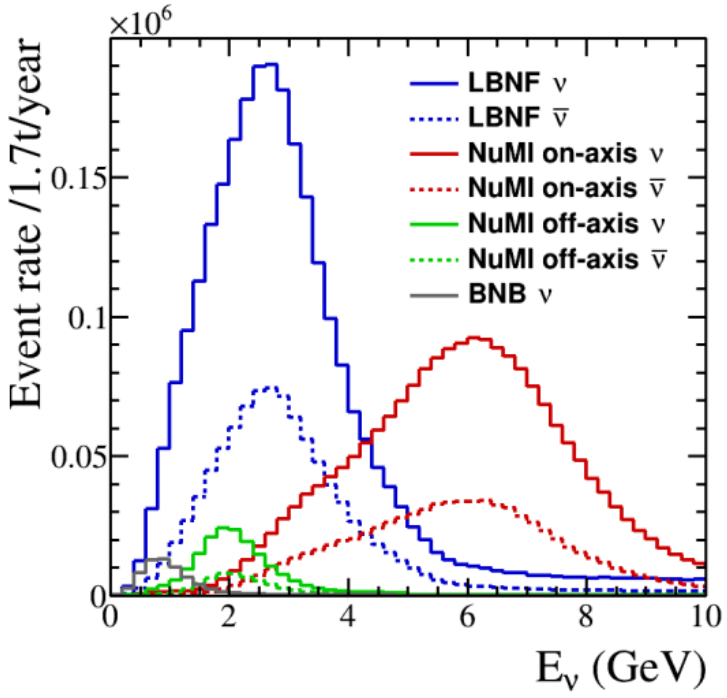
- Determine the Bias as a function of the *fraction of contained energy (*)* in 2x2

  In order to keep Bias low: **What is the needed fraction of contained energy?**

- **How big will be the π^0 production rate (with this constraint)?**

(*) Defined in Backup Slide

Event Rates in NuMI ND Hall



→ What is the expected event rate of π^0 induced showers which could be used for the electron scale calibration?

Backup

$$\text{Fraction of Contained Energy} \overset{\text{def}}{=} \frac{\text{total energy in 2x2}}{\text{total energy of } \pi^0}$$

$$= \frac{\sum \text{Energy Deposits in 2x2} + \sum E_{tot} \text{ of particles remaining after shower}}{E_{tot} \text{ of } \pi^0}$$

$$\geq \frac{\sum \text{Energy Deposits in 2x2}}{E_{tot} \text{ of } \pi^0}$$

Lower limit for the fraction of contained energy

Note: Detector efficiency not taken into account

$$\text{Fraction of Contained Energy} \overset{\text{def}}{=} \frac{\sum \text{Energy Deposits in 2x2 Active Volume}}{E_{tot} \text{ of } \pi^0}$$