Hadron enrergy and angle resolutions - A study using Monte carlo pions

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Introduction

Iron **CAL**orimeter(ICAL) is a magnetized detector, at the proposed **I**ndia Based **N**eutrino **O**bservatory (INO). To measure the energies of hadrons interacting in the detector, we rely on the total number of hits due to these hadrons. The hits in the detector are used to reconstruct hadron angle also.Here, the studies of resolutions of pion energy and angle as functions of iron plate thicknesses are presented.

Methodology

Code used : INOICAL code - Nov 2011 ; Position : 100,100,0 with smearing of 100,100,100 ; Plate thicknesses : 2.5cm ; 3cm ; 4cm ; 5.6cm
For energy : Direction cosines : 0 0 1 with angle smearing of π for θ and 2π for ϕ.
For angle : Angle smearing of 0 for θ and 2π for ϕ.

Energy Resolution

The distribution of total number of hits for each energy is fitted with a gaussian,for different Fe plate thicknesses.

Mean hit as a function of energy :

$$n(E) = n_0[1 - \exp(-\frac{E}{E_0})]$$

Typically, $E_0 >> E$. This can be approximated by a linear dependence in the 5GeV-15GeV energy range.

$$\frac{n(E)}{n_0} \simeq \frac{E}{E_0}$$

Energy resolution is:

$$\frac{\Delta n(E)}{n(E)} = \frac{\Delta E}{E}$$

To obtain the resolution, this is fitted to an approximate form

$$\frac{\Delta E}{E} = \frac{a}{\sqrt{E}} + b$$

or

$$\frac{\Delta E}{E} = \sqrt{\frac{a^2}{E} + b^2}$$

Ideal case : b = 0.

Angle Resolution

This method uses the actual (x,y,z) positions of hits in the detector.Hits are considered separately in XZ and YZ planes.

- Midpoints $x[i]_{mid}$ and $y[i]_{mid}$ in each layer, are found out and plotted separately in XZ and YZ planes, and fitted with straight lines $z = m_x + c_1$ and $z = m_y + c_2$, with slopes m_x and m_y respectively.
- Using polar co-ordinates, $\tan\phi = \frac{(\frac{m_x}{\cot\theta})}{(\frac{m_y}{\cot\theta})}$;
- $m_x = \cot\theta\sec\phi$; $m_y = \cot\theta\mathrm{cosec}\phi$
- A particular sign of a slope can result from two different quadrants of θ and ϕ. To break this degeneracy an information is supplied. i.e, All events with zlayer[0]<zlayer[l] are UP ↑ (this corresponds to θ in quadrant 1) & and those with zlayer[0]>zlayer[l] are DOWN ↓ (θ in quadrant 2). This inforamtion is put in program and the signs of the slopes are obtained correctly and this corrected slope is used to find ϕ.θ is reconstructed using the information whether the event is upcoming or down going.

Preliminary results

Fig.1 Mean no:of hits (from histogram) vs Energy (GeV)

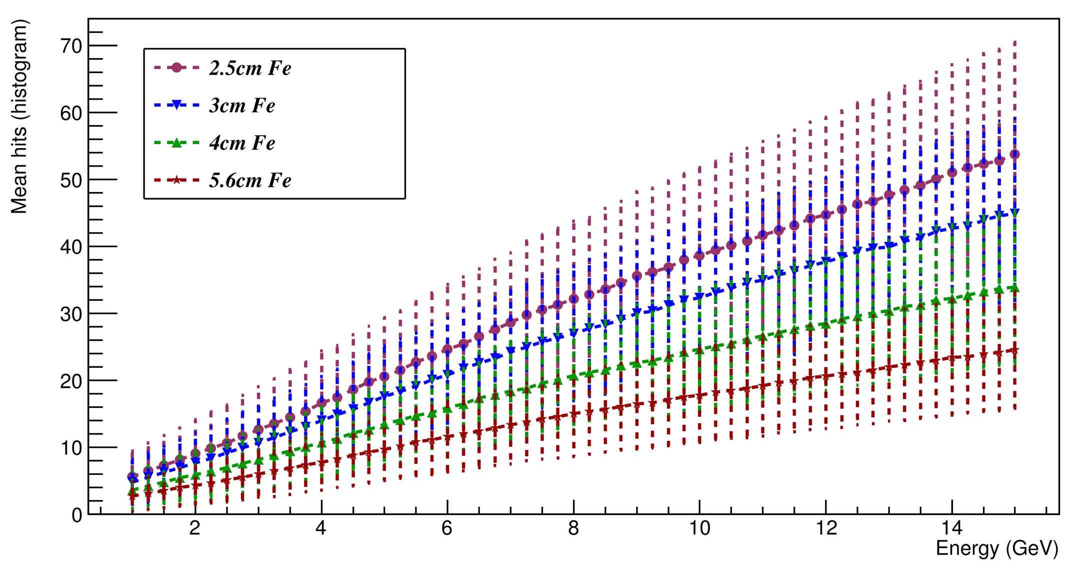
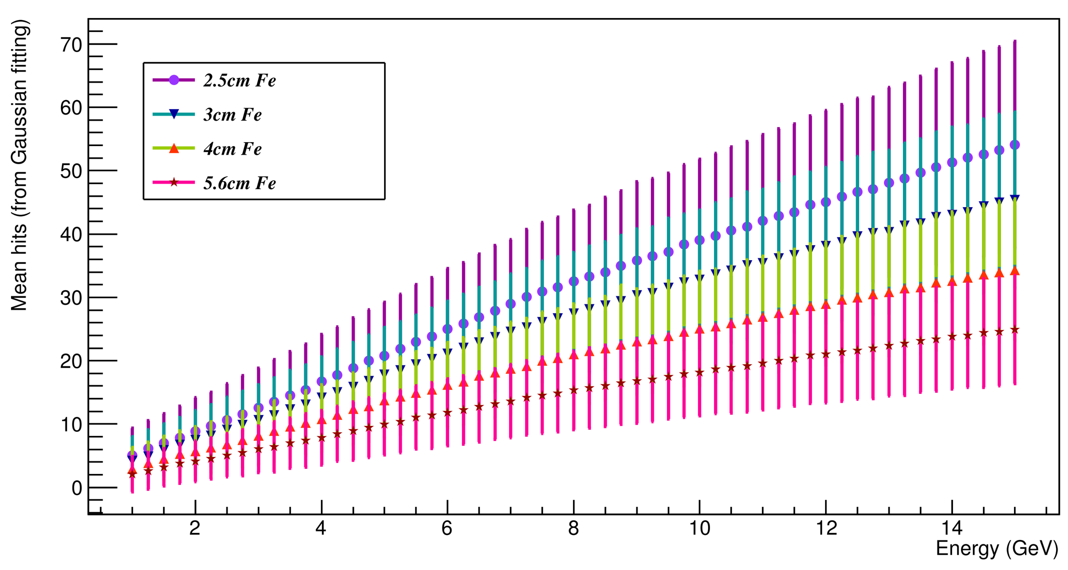


Fig.2 Mean no:of hits (from Gaussian fitting) vs Energy (GeV)



Preliminary results Cont...

Energy resolution by fitting with $\sqrt{\frac{a^2}{E} + b^2}$

Fig.3 $\frac{RMS}{Mean}$ (from histogram) vs Energy (GeV)

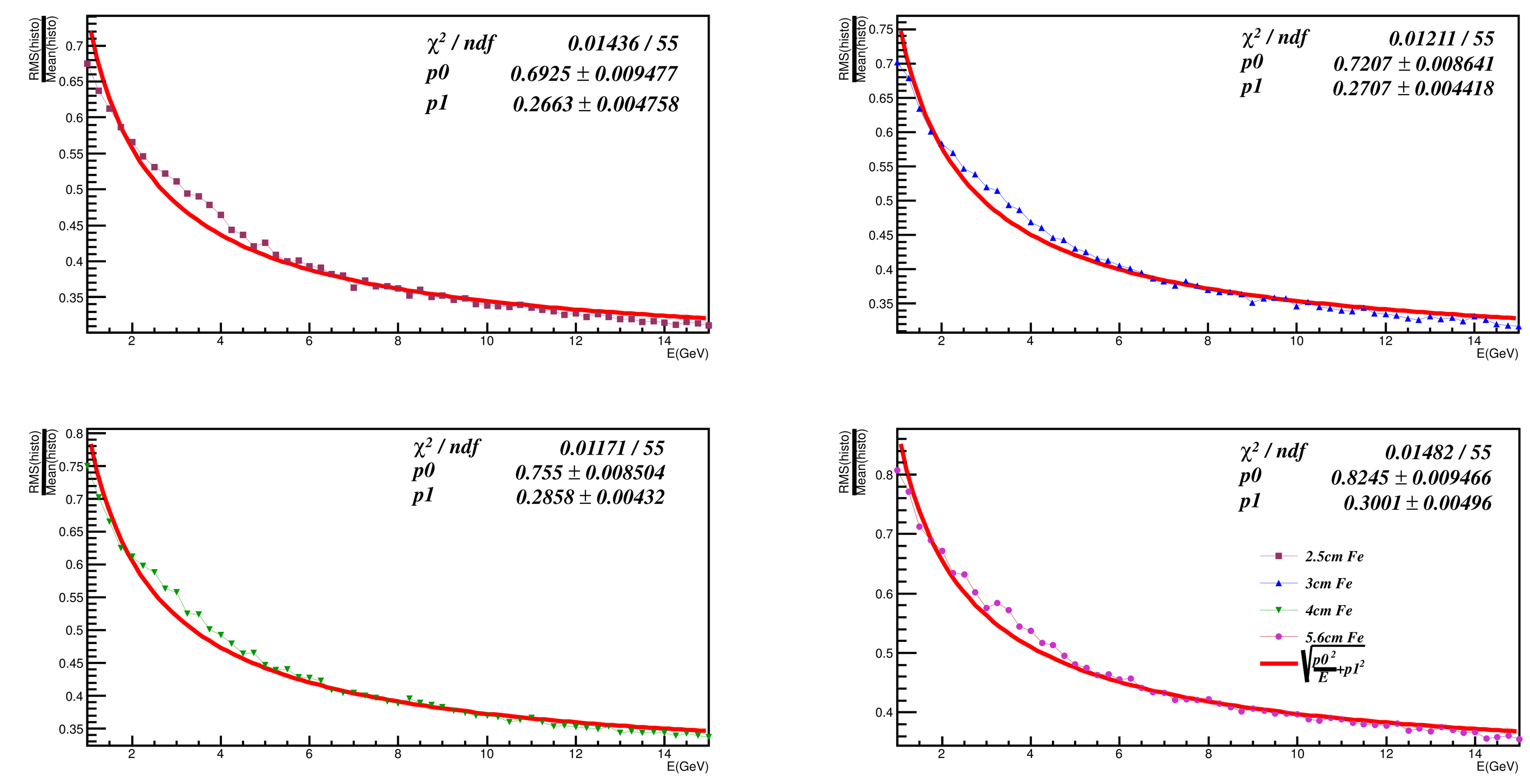


Fig.4 $\frac{\sigma}{Mean}$ (from Gaussian fitting) vs Energy (GeV)

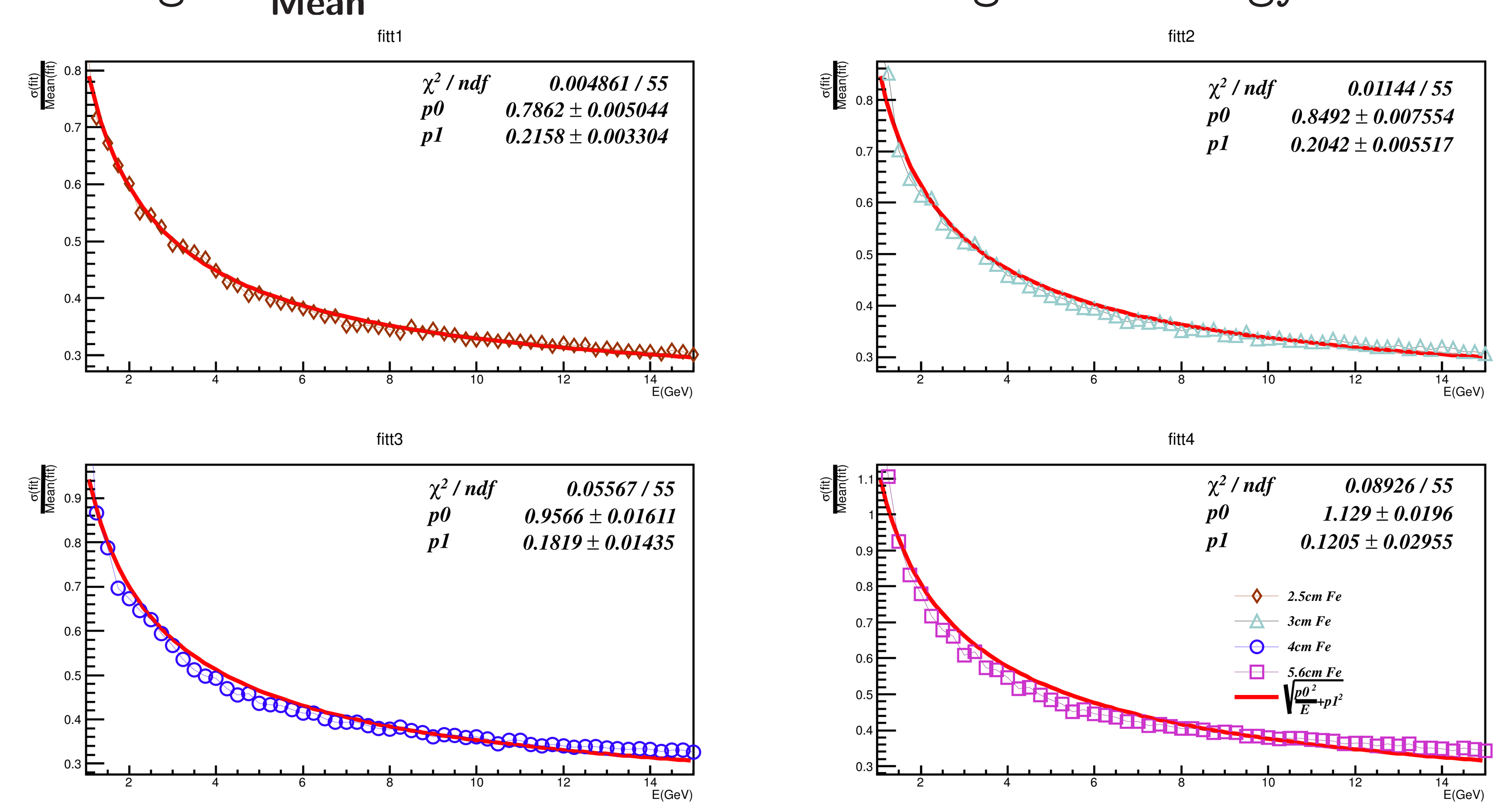
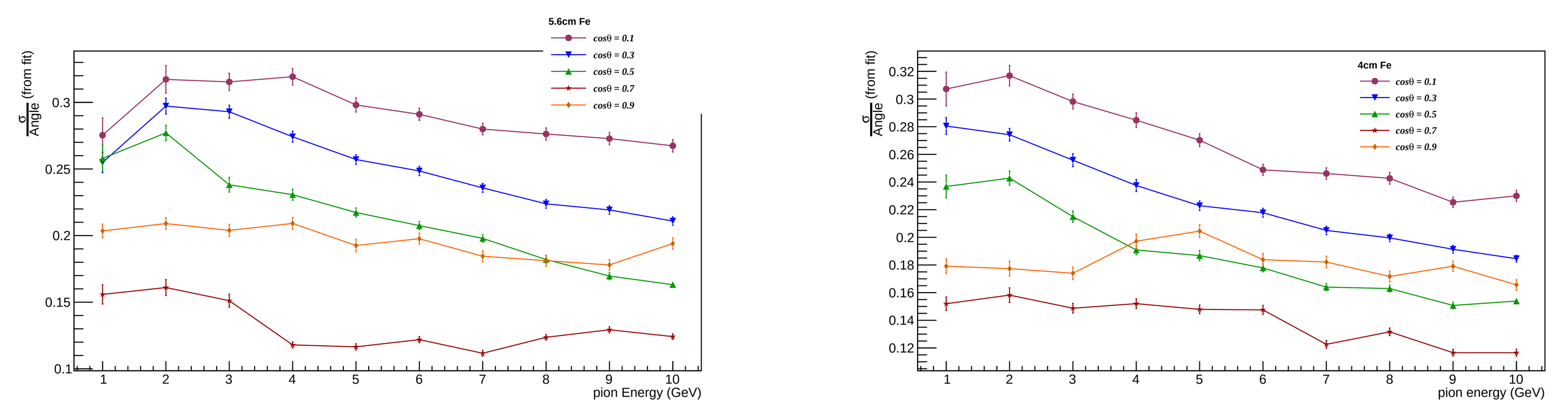


Fig.5 Angular resolution from fitting,for 5.6cm and 4cm respectively.



Conclusions

A study of hadron energy and angle resolutions as functions of Fe plate thicknesses has been done and the above results have been obtained as a preliminary stage.

Acknowledgements

I express my gratitude to M.V.N.Murthy and D.Indumathi,IMSc,Chennai, for the valuable guidances given to me in the works presented here. I also thank Asmita and MoonMoon, TIFR, Mumbai, for their help.

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