Comments on Experimental, Model Errors: Evaluation and Reduction

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Primex Collaboration Meeting: July20,2007

- model errors for coherent, incoherent
- in the future we should use a proton target
- model limitations/ incoherent electron scattering
- cross section comparisons between analyses
- width extraction and error correlations
- cross section scaling: C, Pb comparison

- Models typically treat the nucleus as a static charge and density distribution
- It is really a complex many body strongly interacting system
- This can require more sophisticated treatments
- This is satisfied by Glauber theory
- For inelastic reactions the situation is far more difficult

- **The only simple way out of this complication is to use a proton target**

Model Errors:
Coherent and Incoherent π^0 Production

- We determine the magnitudes of these two processes at large angles $\sim\theta_c$ and $\sim \theta_{inc}$.
- we rely on the calculated ratios

$R_C = \sigma_C(\theta_P)/\sigma_C(\theta_C)$ $\quad\quad$ $R_{onc} = \sigma_P(\theta_P)/\sigma_P(\theta_{inc})$

- We need to estimate δR_C δR_{inc}

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How?

1) Vary the model parameters
2) use different models(incoherent)
3) **Compare the results for C and Pb**

Coherent scattering uncertainties

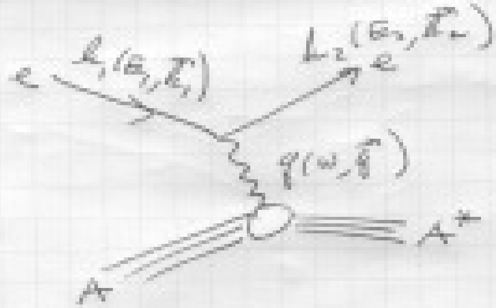
- nuclear density: checked for C, need work for Pb
- $N\pi$ cross section: checked
- **Effect of vector dominance for photons**

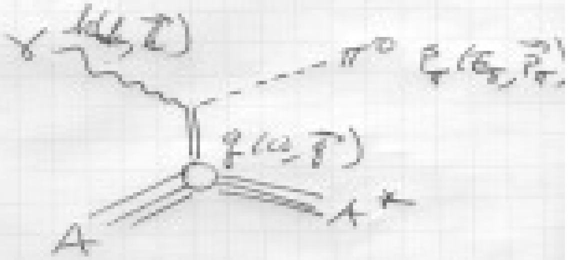
- **This is on a firm theoretical foundation**

Incoherent π^0 Production
This is more difficult to calculate accurately

We should look at inelastic electron scattering for guidance

work in progress with Bill Donnelly





$$\omega = E_1 - E_2 \qquad \omega = k - E_\pi$$

$$\vec{q} = \vec{k}_1 - \vec{k}_2 \qquad \vec{q} = \vec{k} - \vec{p}_\pi$$

$$Q^2 = -q^2 = 4E_1E_2 \sin^2\theta/2 = \vec{q}^{\,2} - \omega^2$$

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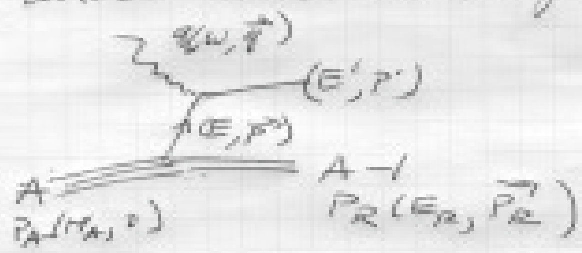
giant resonances.

$$A^* \to (A-1) + N$$

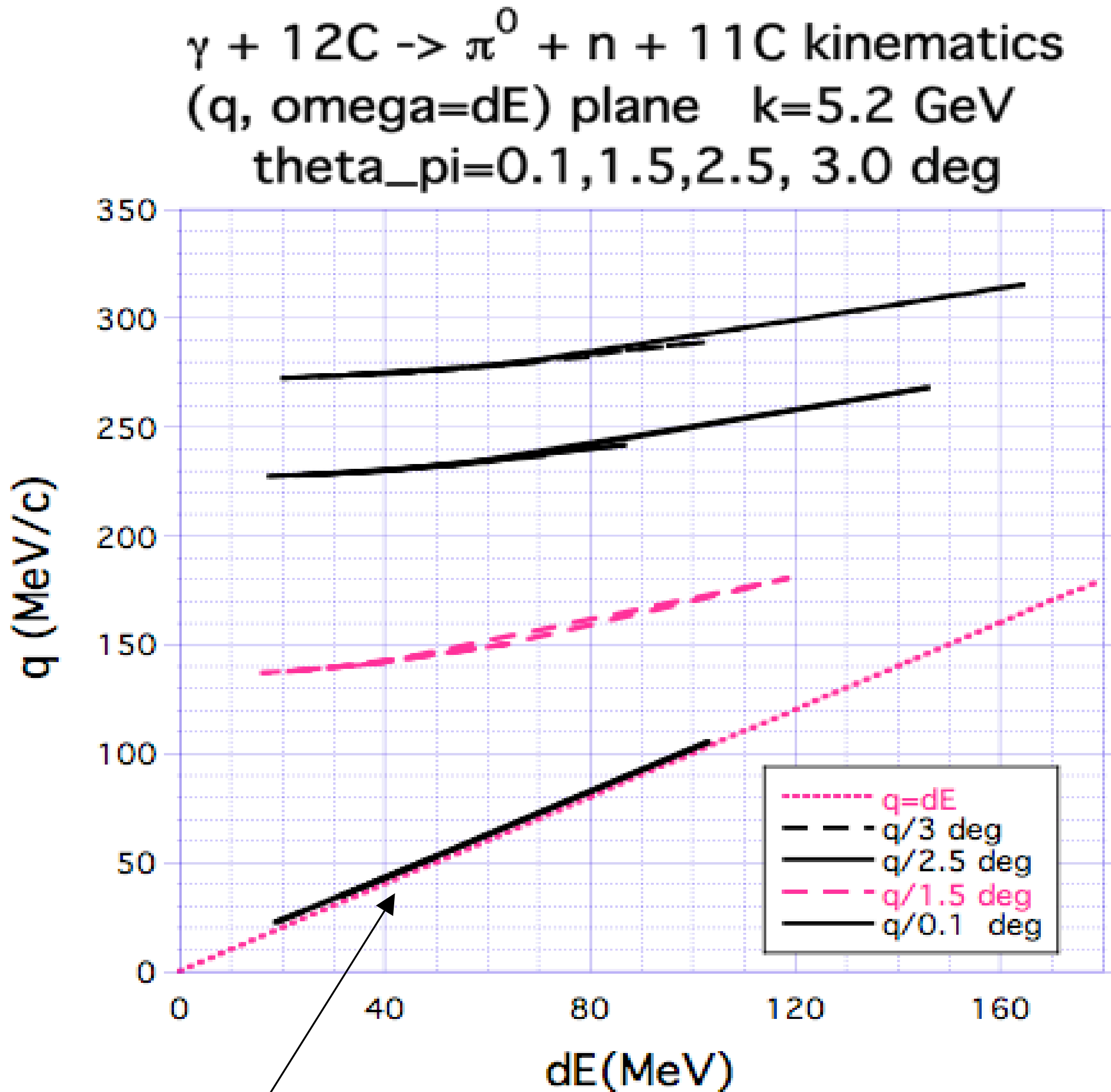
direct emission (impulse approximation)

$$\vec{p} = -\vec{p}_R$$



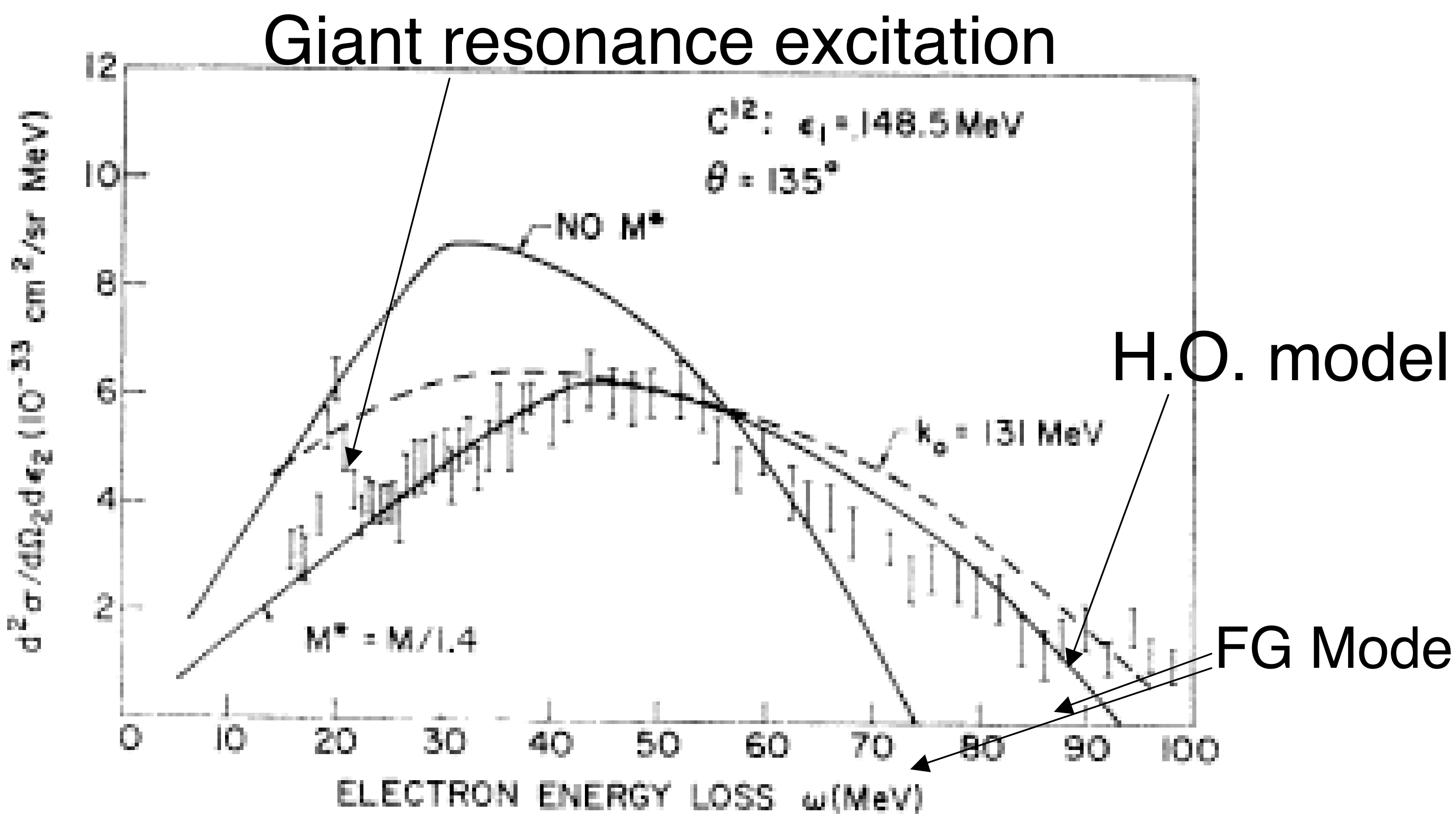
$A(e, e'N)A-1$

$A(\gamma, \pi^0 N)A-1$



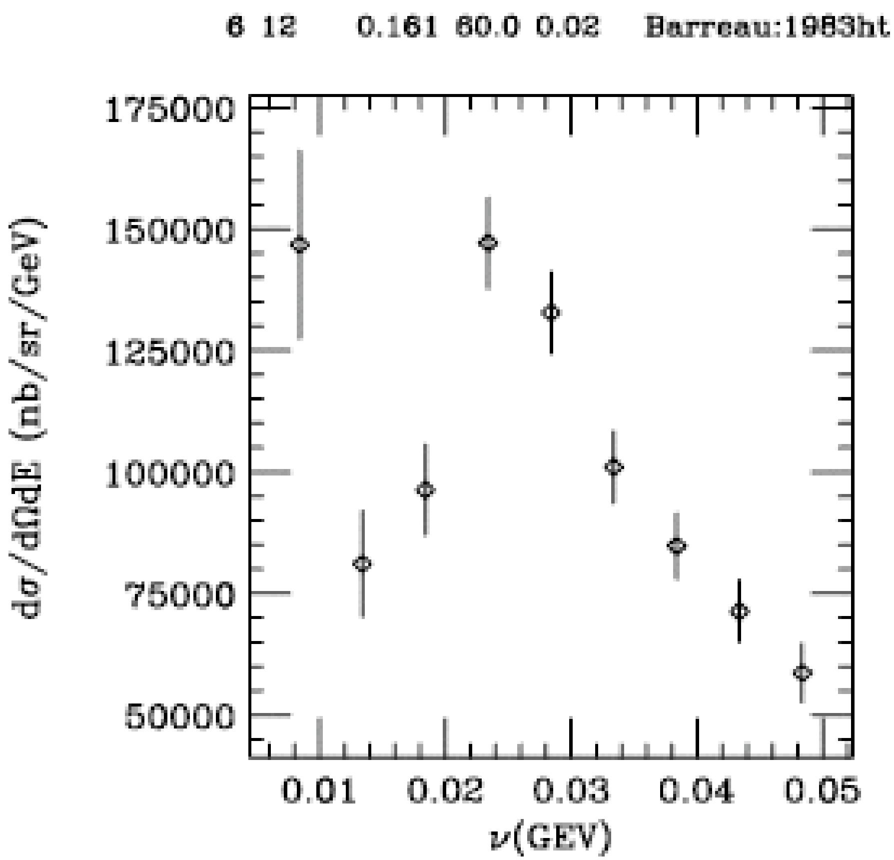
Region of interest (dE< 100MeV, q<100MeV/c)

Moniz Fermi Gas Model PR1969 $^{12}C(e,e')$

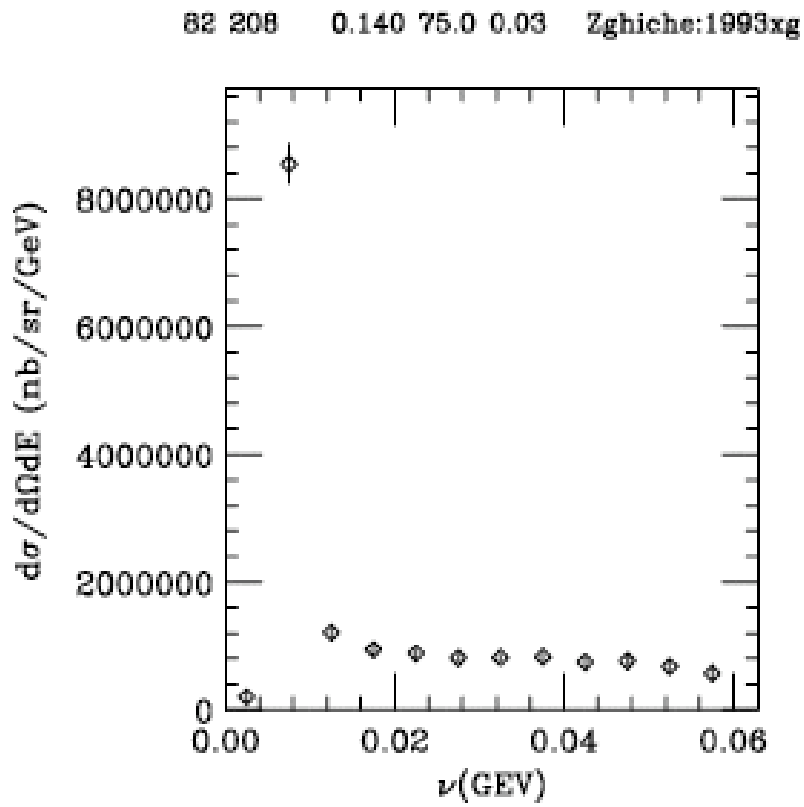


q 265 130 185 MeV/c

C q~150MeV/c



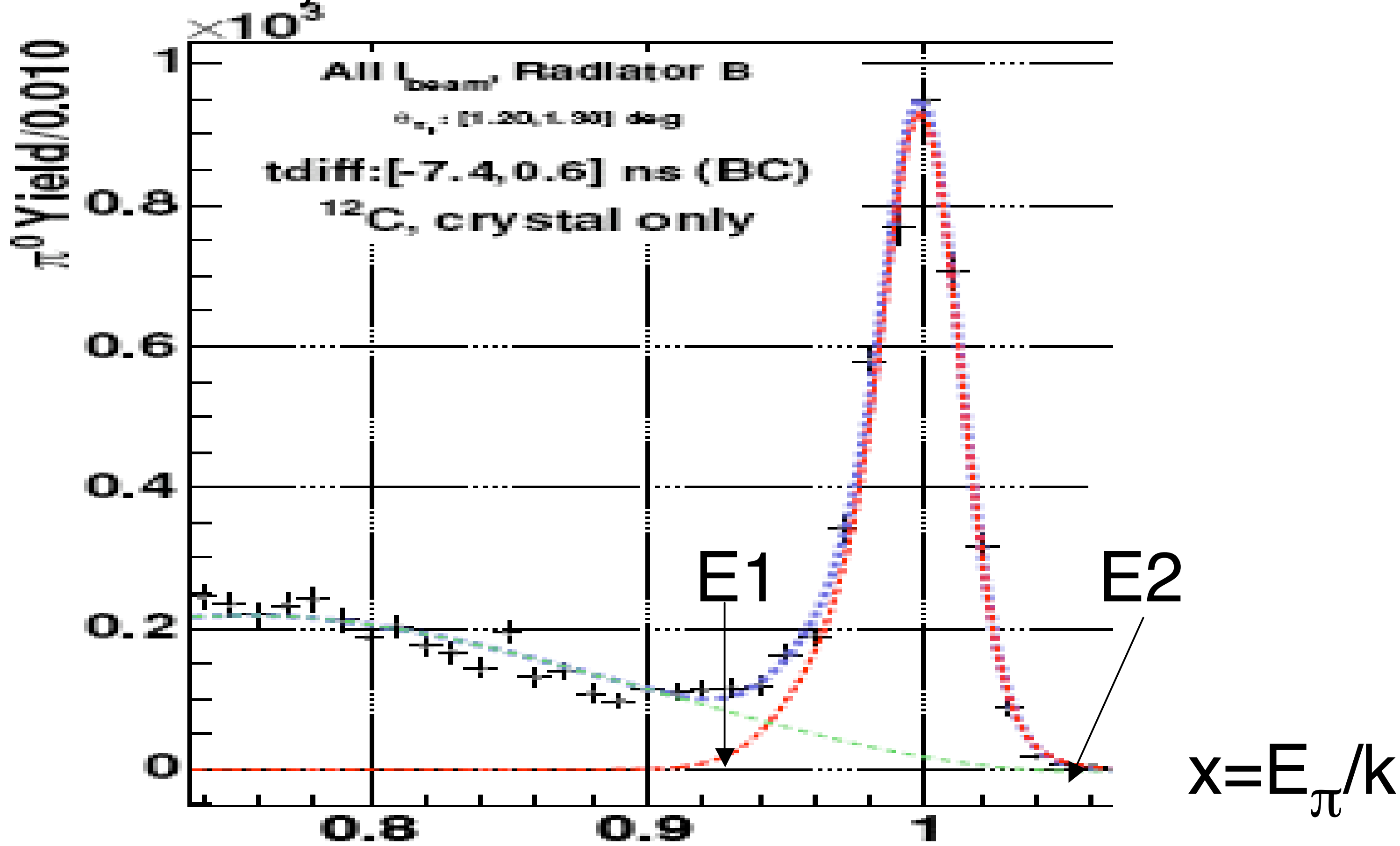
Pb q~ 150 MeV/c



what do we measure?

$$\frac{d\sigma}{d\Omega_\pi} = \int_{E1}^{E2} \frac{d^2\sigma}{d\Omega_\pi dE} dE$$

Elasticity with π^0 cut: Nuclear Coherent Peak

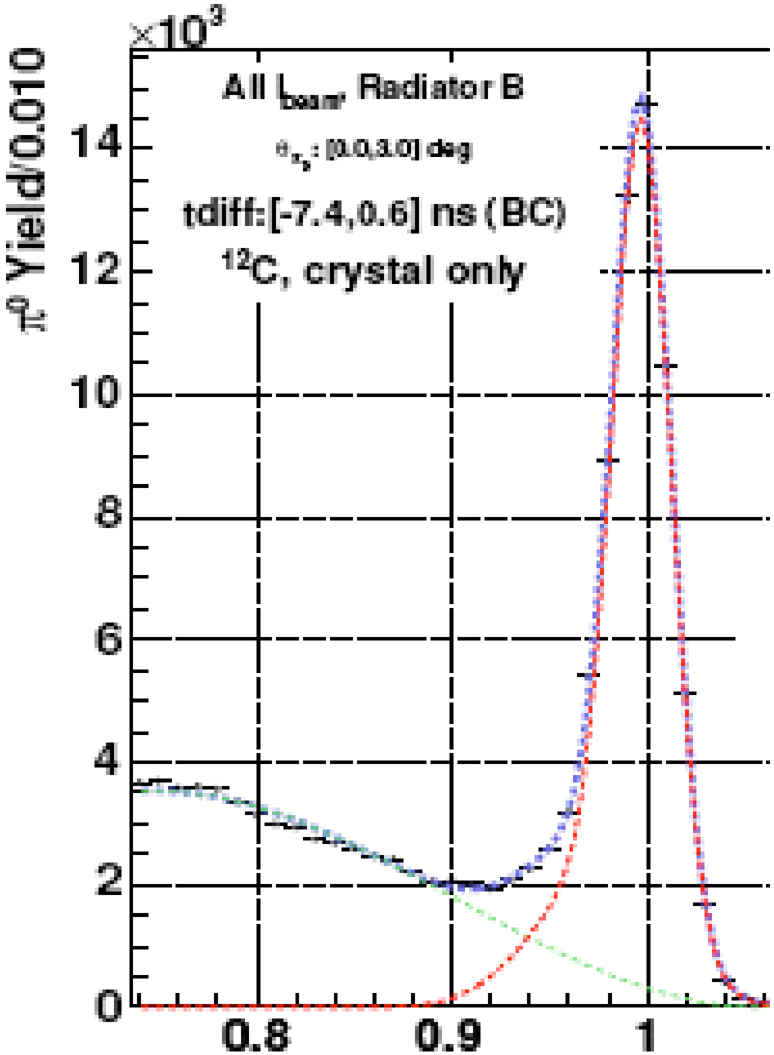


$$\frac{d\sigma}{d\Omega_\pi} = \int_{E1}^{E2} \frac{d^2\sigma}{d\Omega_\pi dE} dE$$

$$= \frac{d\sigma_{elastic}}{d\Omega_\pi} + \int_{E1}^{E2} \frac{d^2\sigma_{inelastic}}{d\Omega_\pi dE} dE$$

$$\frac{d\sigma_{elastic}}{d\Omega_\pi} = \frac{d\sigma_P}{d\Omega} + \frac{d\sigma_C}{d\Omega} + 2 \cdot \sqrt{\frac{d\sigma_P}{d\Omega} \cdot \frac{d\sigma_C}{d\Omega}} cos(\phi)$$

- **These quantities are extraction dependen**
- **This is due to our finite energy resolution**
- **We cannot separate some of the coherent and incoherent**



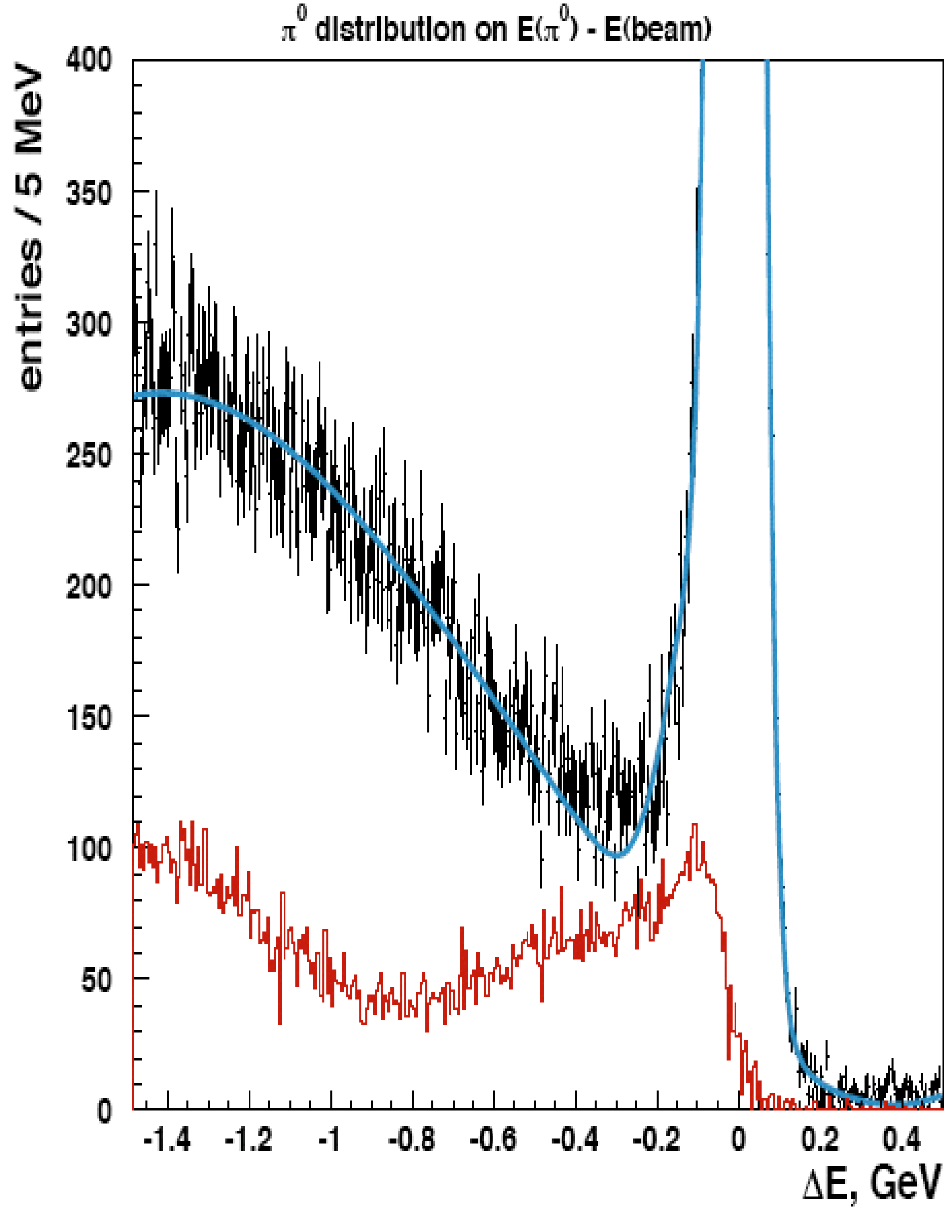


Figure 34: π^0 distribution on elasticity ($E_{\pi^0} - E_{beam}$): black histogram - π^0s observed in the data; red histogram in the bottom - simulated π^0s contribution from ω and ρ decays.

- Due to analysis differences the different methods should not have the same cross sections
- However they should give the same width!

- There is a method to reduce the difference between analyses
- This is the integral method
- By integrating the cross section to ~0.2^0 to ~ 0.3^0 we will get most of the Primakoff yield and have only ~2% to ~5% interference background
- This should reduce differences due to energy
- and angular resolution
- This is the comparison we should make between the different extracted cross sections
- In addition it should reduce the dependence of the extracted width on the incoherent cross section
- this comes from the off diagonal elements in the error matrix

Why is the Pb data so critical?

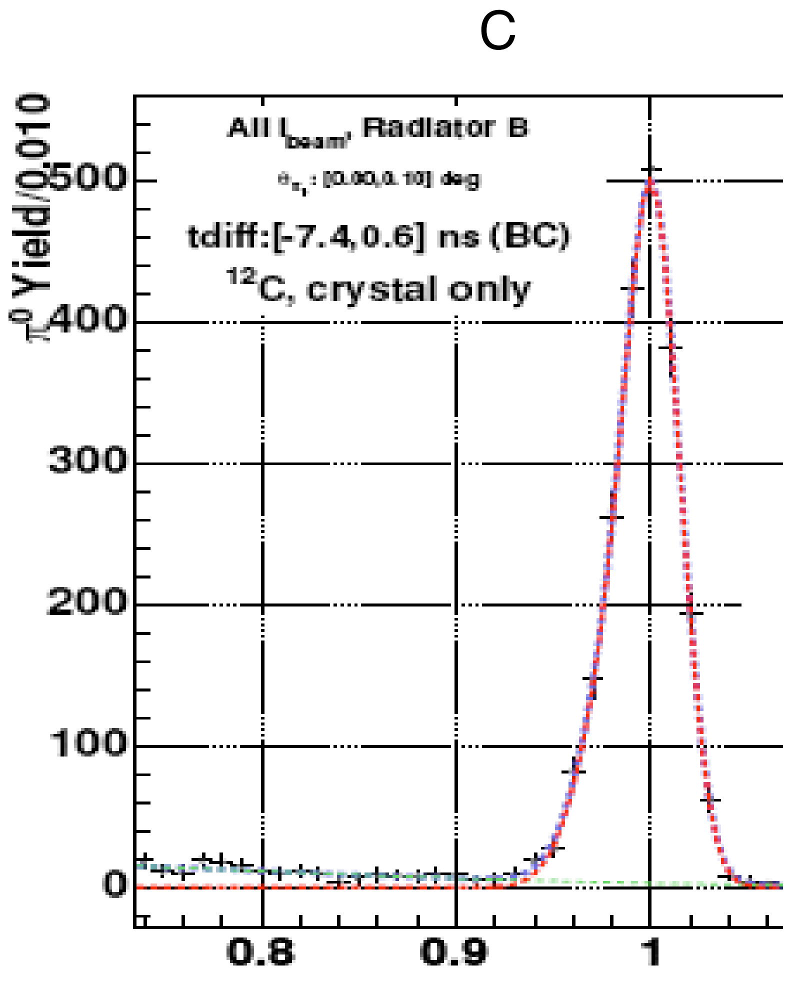
Cross section scaling

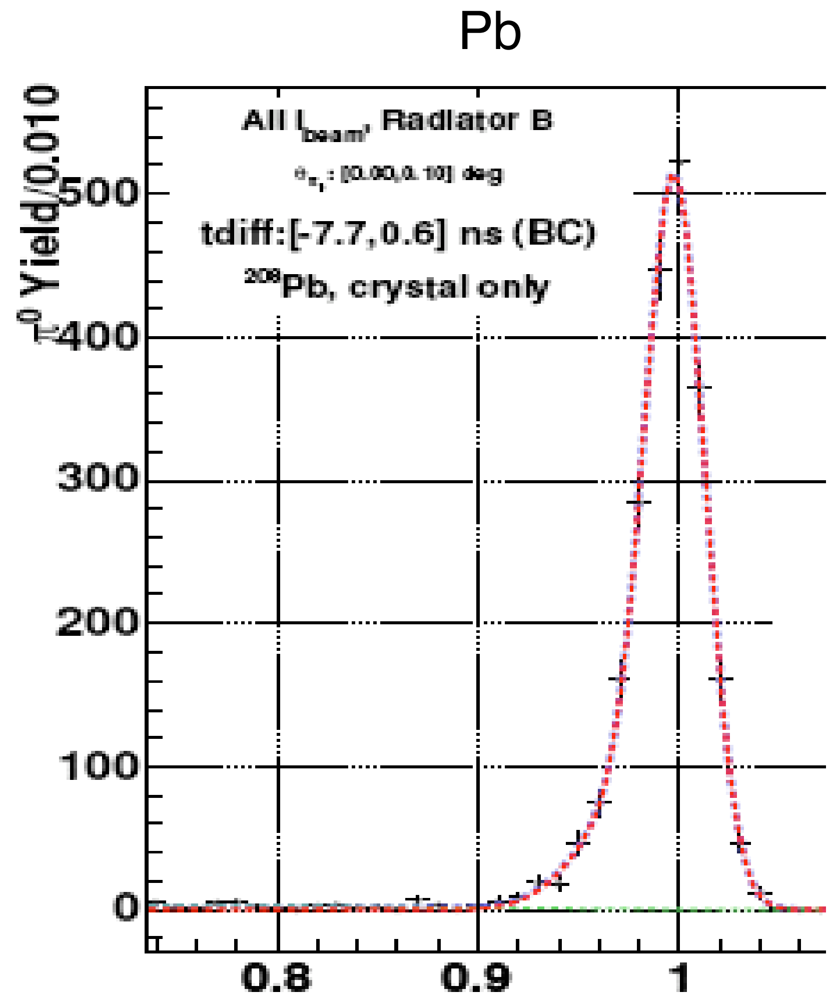
Cross Section	No FSI	With FSI
Primakoff	Z^2	Z^2
Coherent	A^2	$\sim A$
Inerference	ZA	$\sim Z\sqrt{A}$
Incoherent	A	$\sim A^{2/3}$?

Pb/C ratios

Coherent/Primakoff	9.3%
Interference/Primakoff	31%
Incoherent/Primakoff	3.6%

Elasticity with π^0 cut : Primakoff Peak





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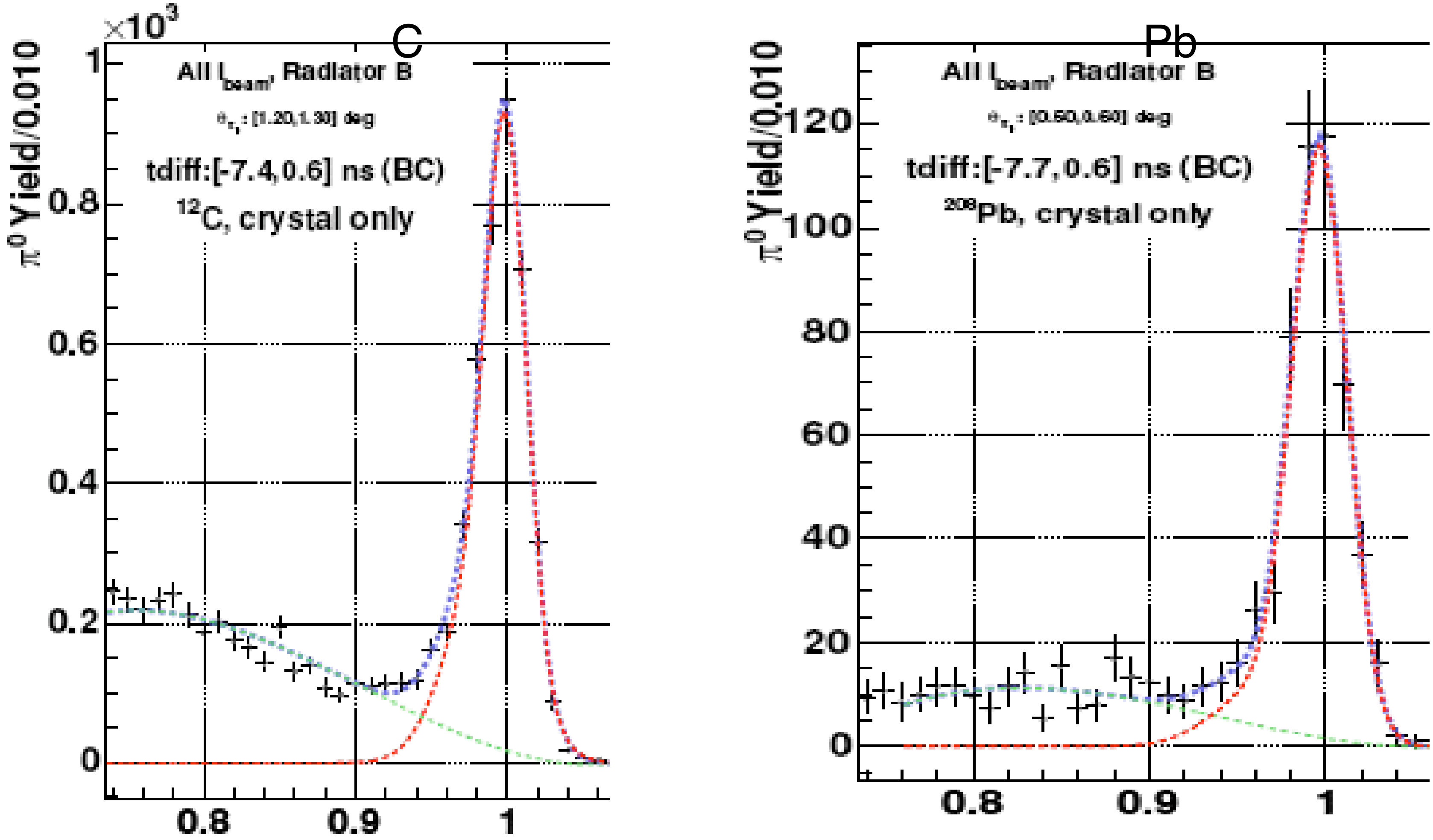

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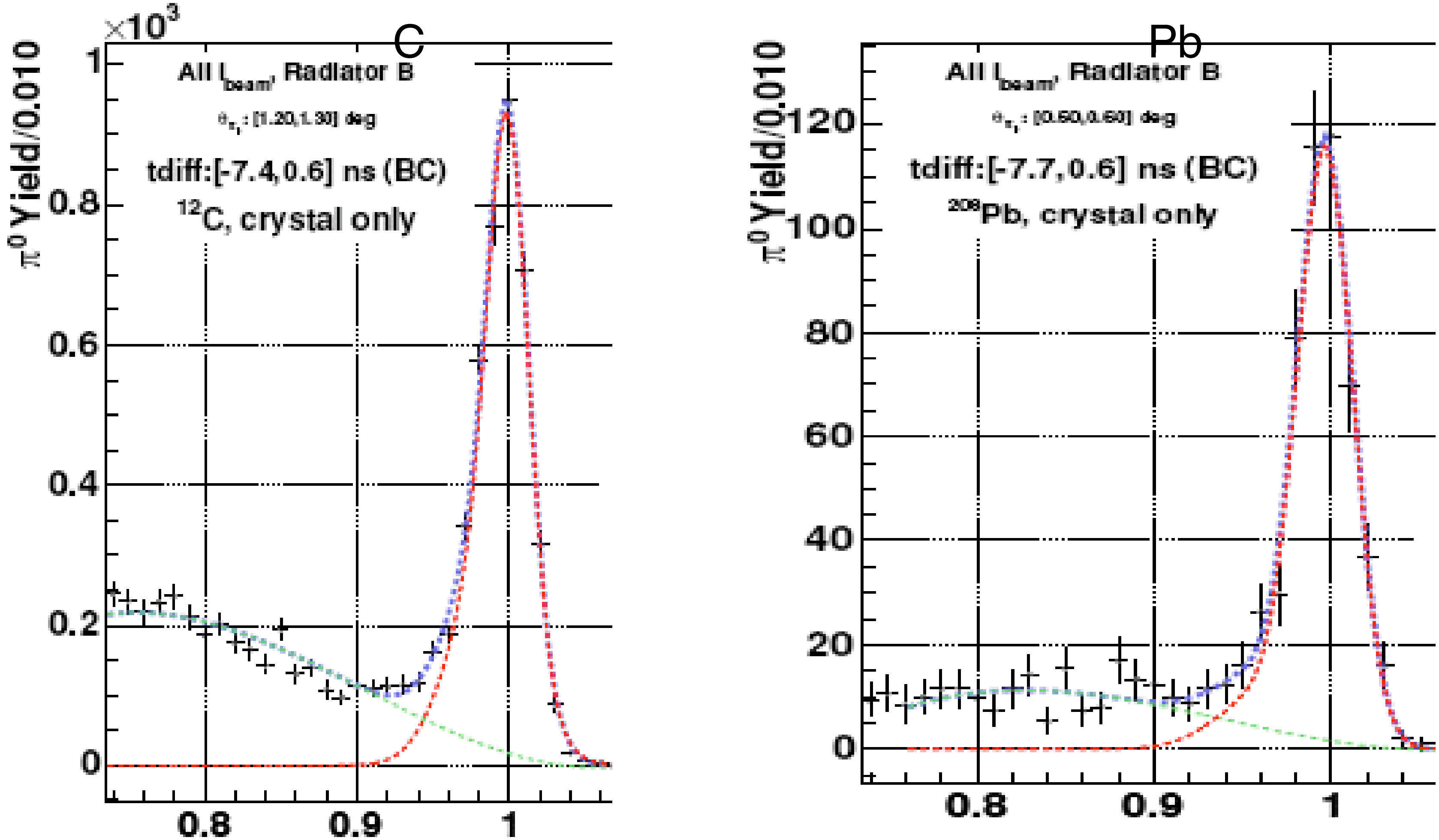
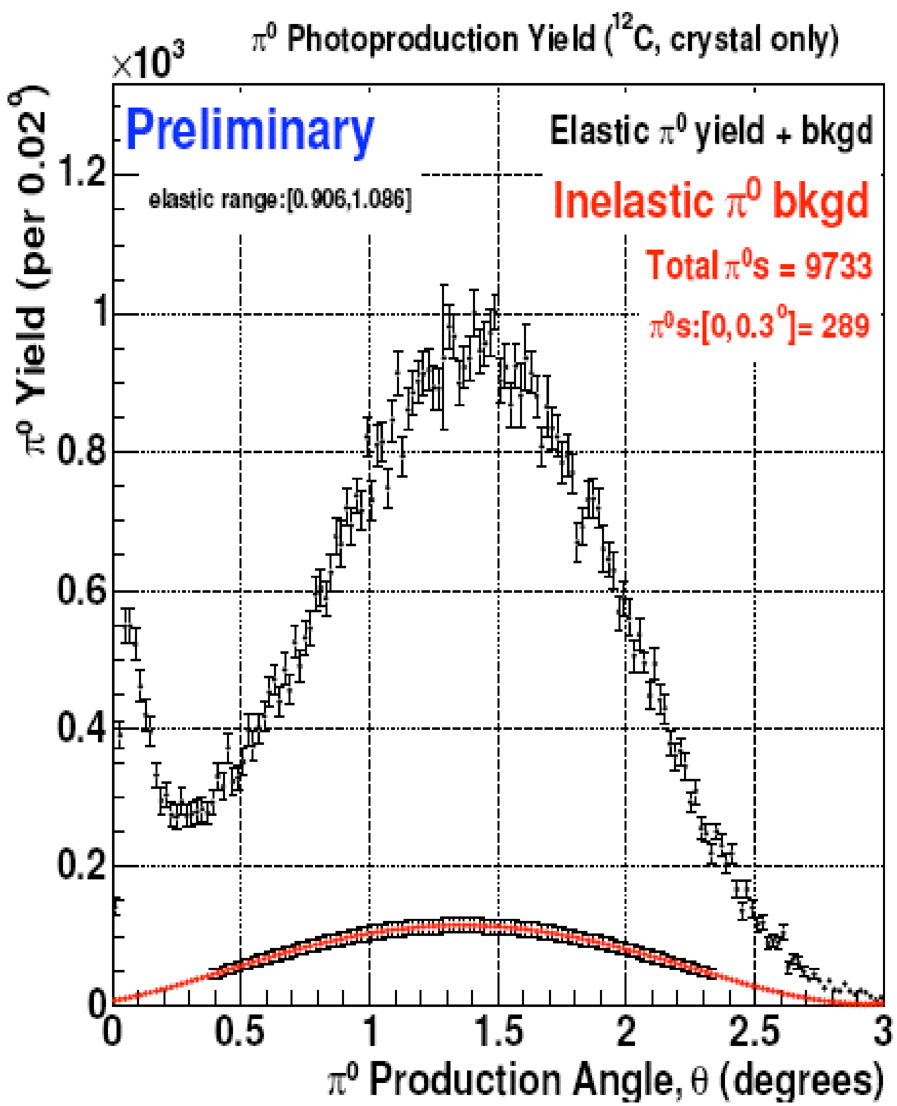
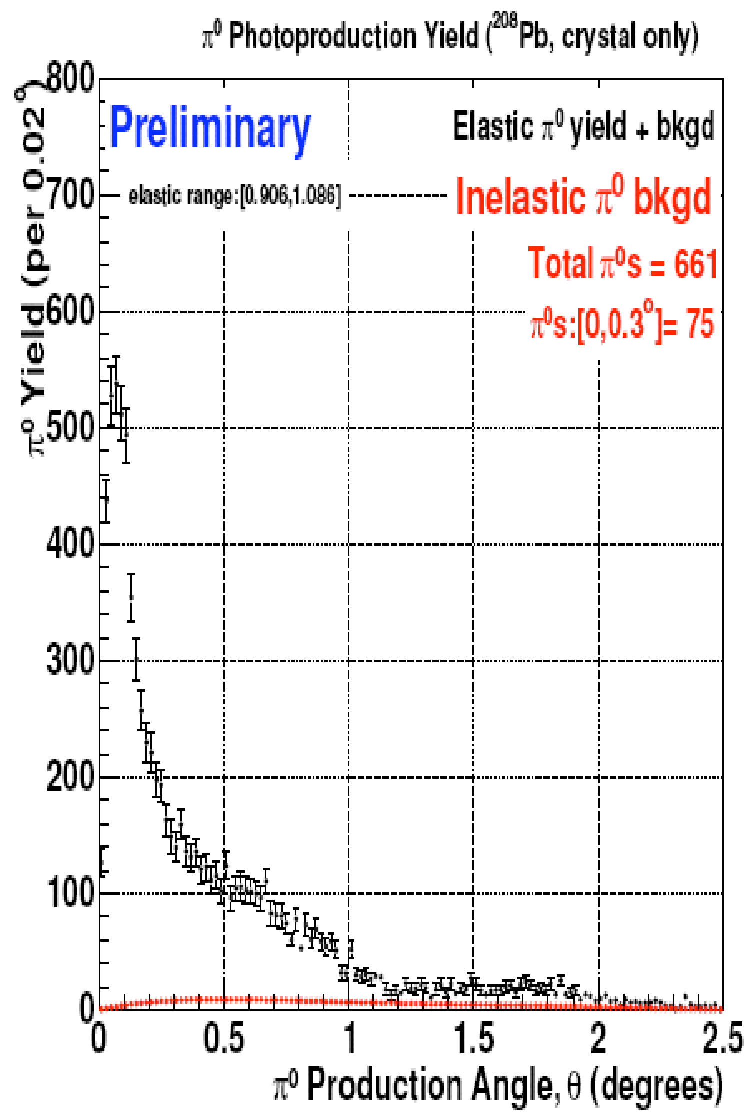


Pb/C ~ 0.5; implies coherent omega contribution

Yields and Backgrounds with π^0 cut: C and Pb





Why is the Pb data so critical?

The best way we have to determine the model error is to extract the pi0 width from C and Pb and see what the difference is

We cannot finalize/publish our results before we have done this

This is the most urgent task of the Primex group

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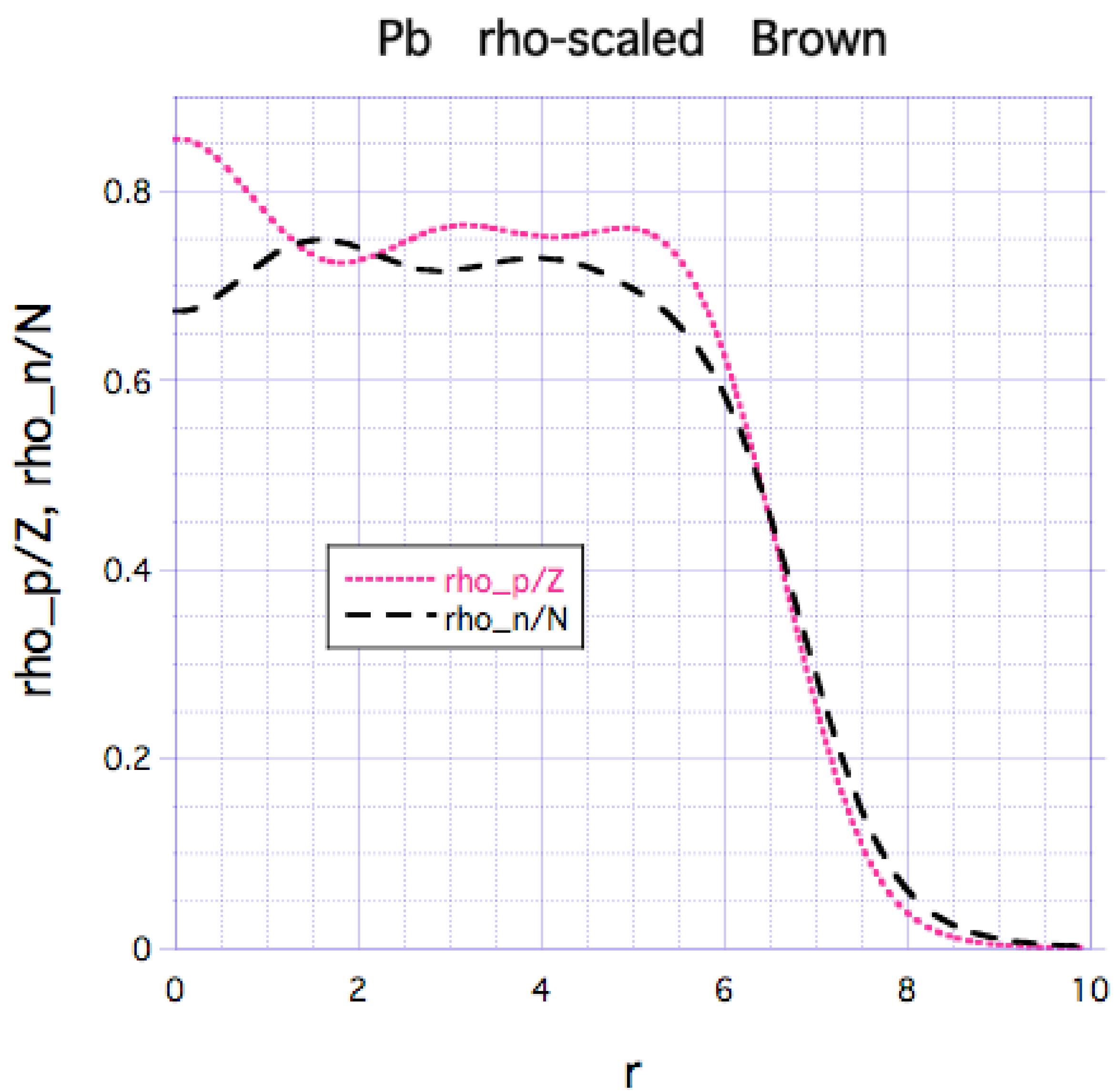
Pb rho-scaled Brown
rho_p/Z, rho_n/N
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
r
rho_p/Z
rho_n/N