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

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

- 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

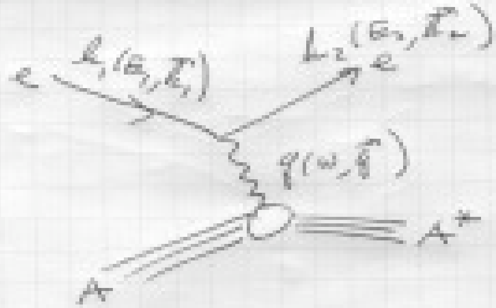
- nuclear density: checked for C, need work for Pb
- $N\pi$ cross section: checked
- **Effect of vector dominance for photons**

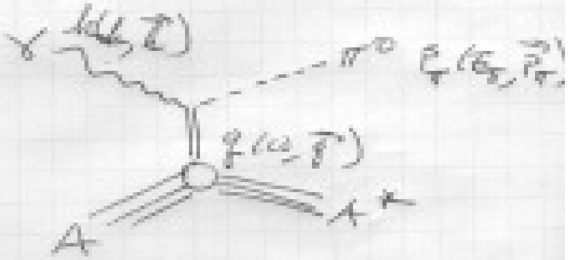
- **This is on a firm theoretical foundation**
- however there are approximations
  that need to be checked

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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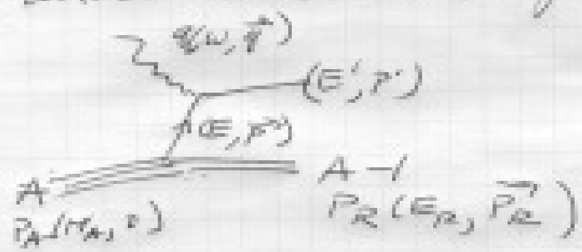
giant resonances.

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

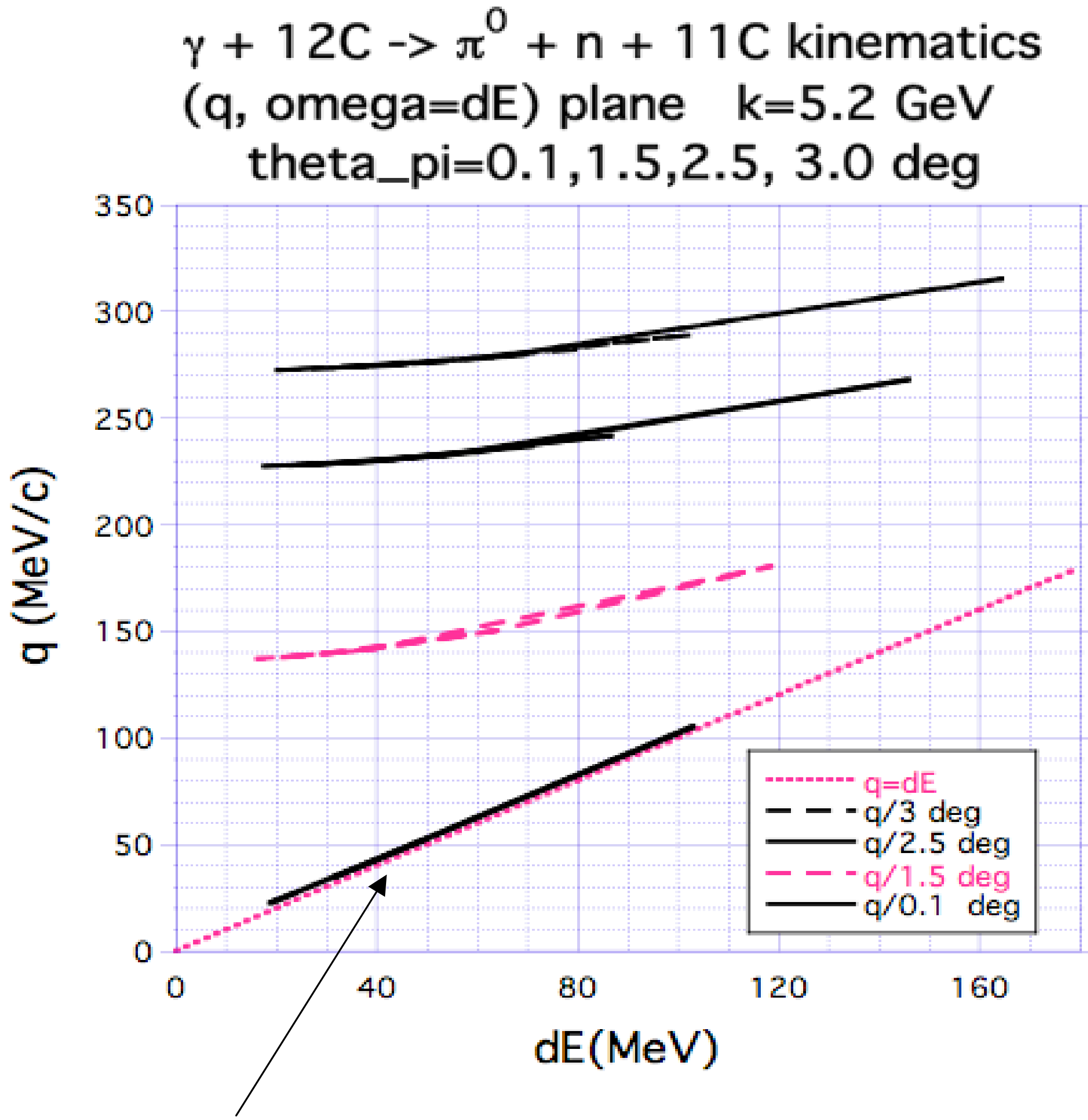
direct emission (impulse approximation)

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



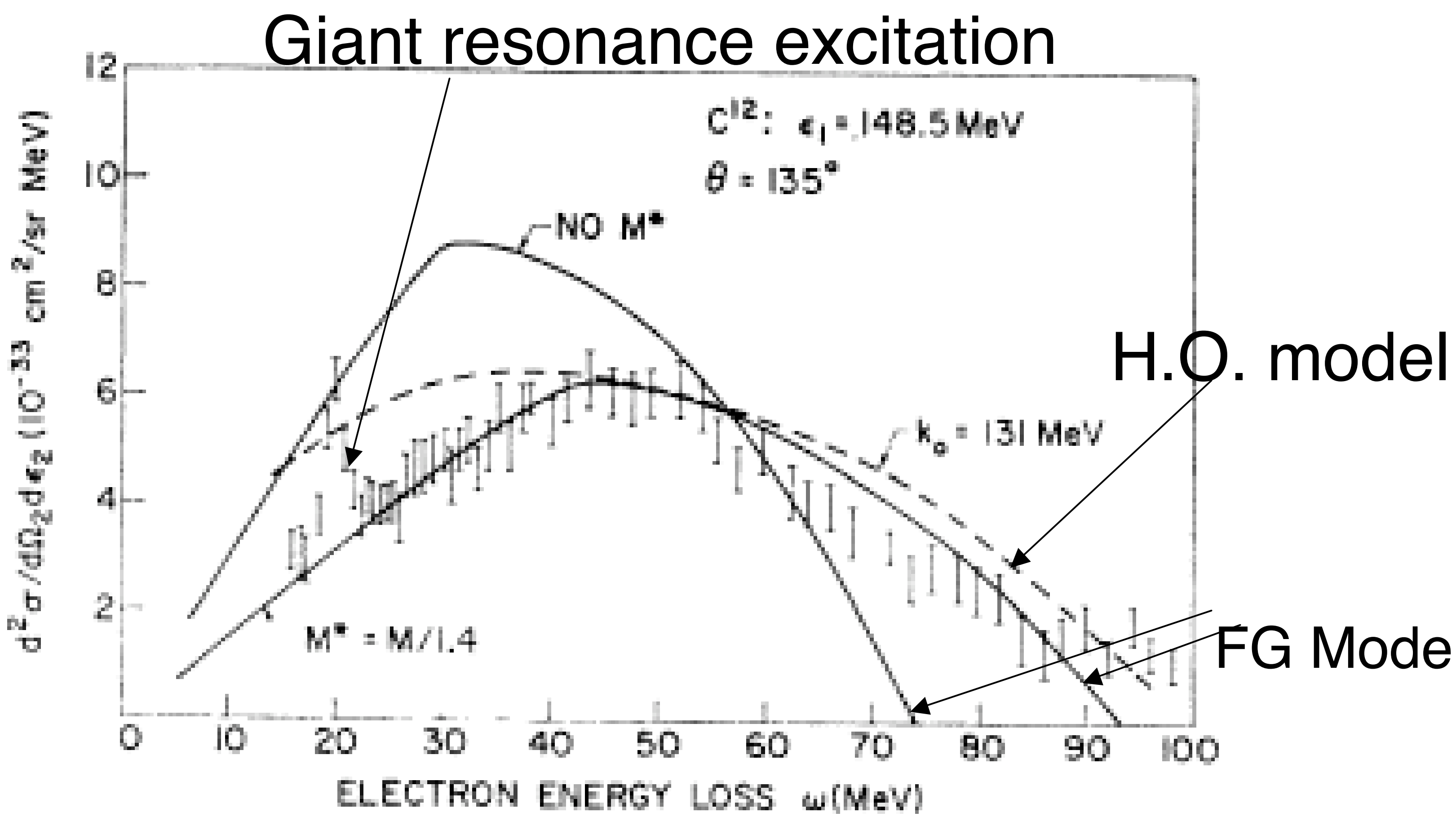
$A(e, e'N)\, A-1$

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



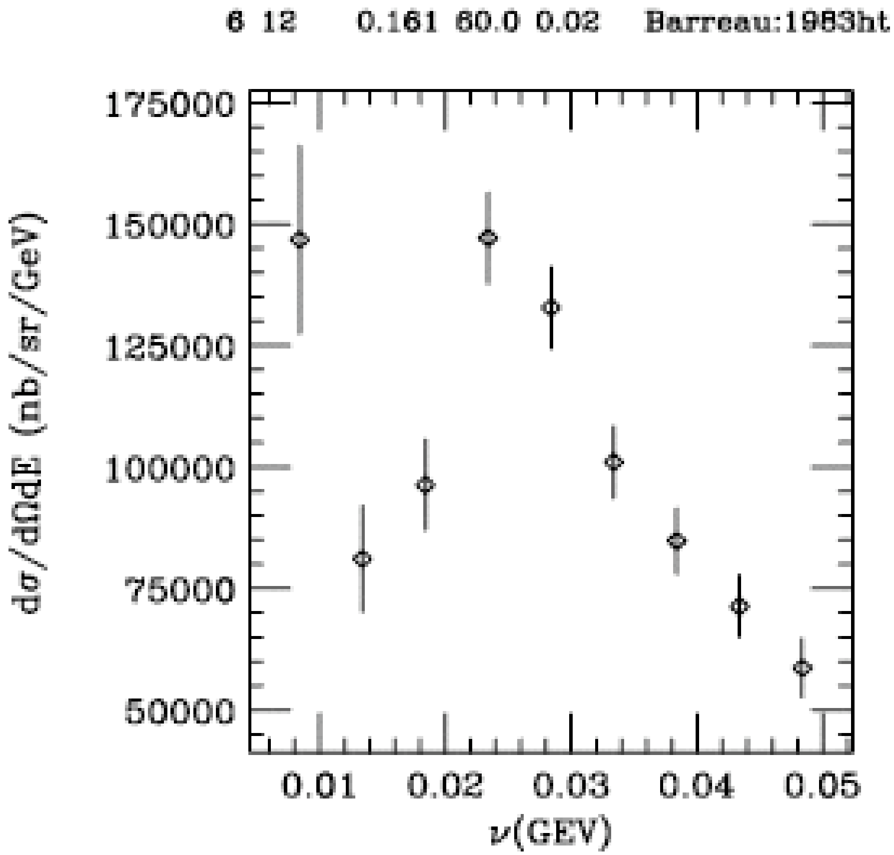
Region of interest (dE< 100MeV, q<100MeV/c)

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

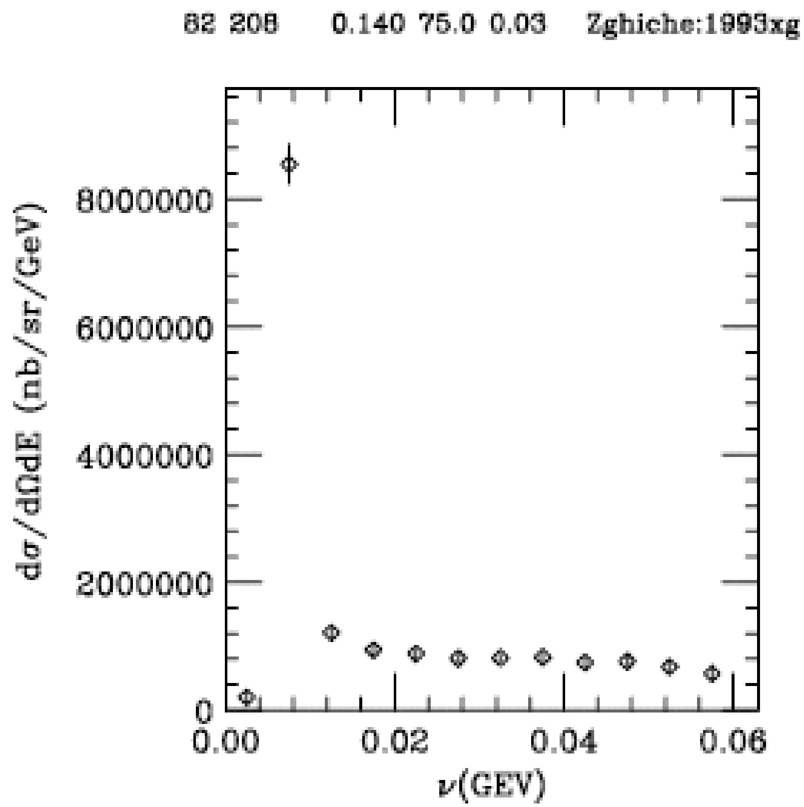


q 265 130 185 MeV/c

C q~150MeV/c



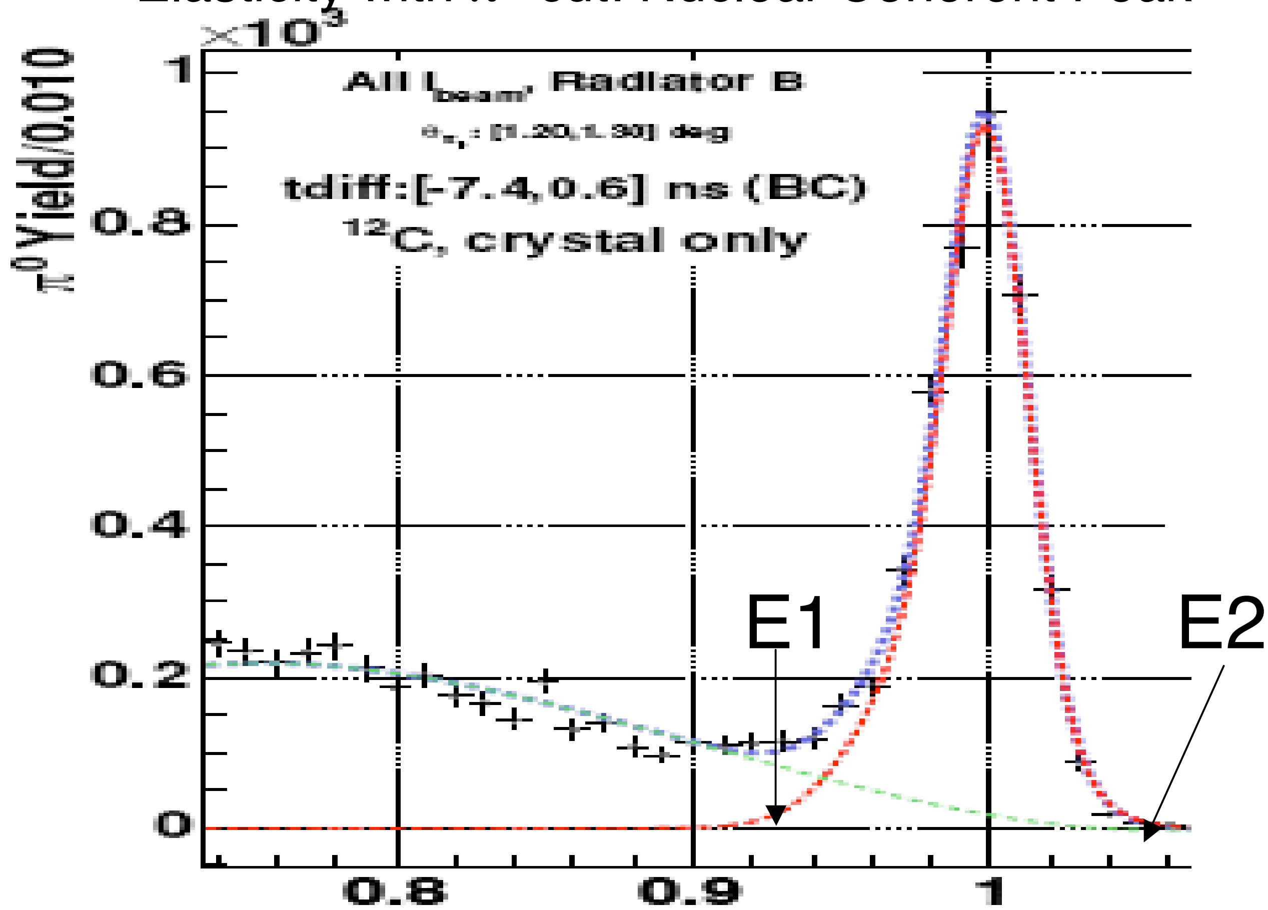
Pb q~ 150 MeV/c



what do we measure?

$$\sigma(E_1, E_2; \theta) = \int_{E1}^{E2} \frac{d^2\sigma}{d\Omega_\pi dE} dE$$

Elasticity with π^0 cut: Nuclear Coherent Peak



$x=E_\pi/k$

$$\sigma(E_1, E_2; \theta) = \int_{E1}^{E2} \frac{d^2\sigma}{d\Omega_\pi dE} dE$$

$$= \sigma_{elastic}(\theta) + \sigma_{inelastic}(E_1, E_2; \theta)$$

$$\sigma_{elastic}(\theta) = \sigma_P(\theta) + \sigma_C(\theta) + \sigma_{int}(\theta)$$

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

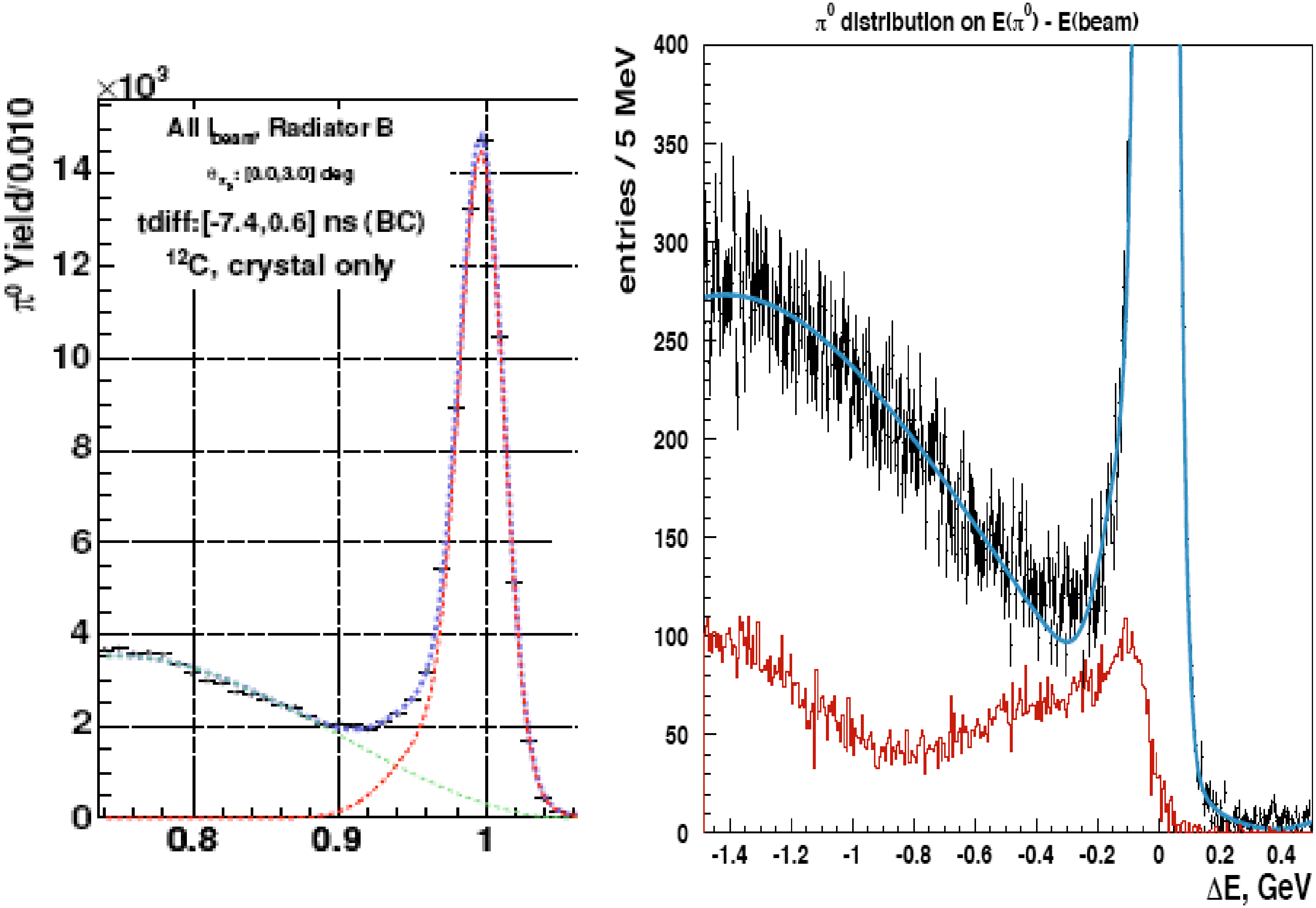


Figure 34: π^0 distribution on elasticity ($E_{\pi^0} - E_{beam}$): black histogram - π^0s observed in the data; red histogram in the bottom - simulated π^0s contribution from ω and ρ decays.

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

♦There should be a way to reduce is analysis scheme dependence of $\sigma(E1,E2:\theta)$

♦ the E2 dependence should plateau:
$\sigma(E1,E2:\theta) \rightarrow \sigma(E1:\theta)$

♦ For small angles $\sigma(E1:\theta)$ will probably plateau
$\sigma(E1:\theta) \rightarrow \sigma(\theta)$
this needs to be tested; compare different analyses

♦ we should compare $\sigma(E1:\theta)$ with and without background subtraction
how different are these for small angles?

- The integral method should reduce the dependence on the quasi elastic
- 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

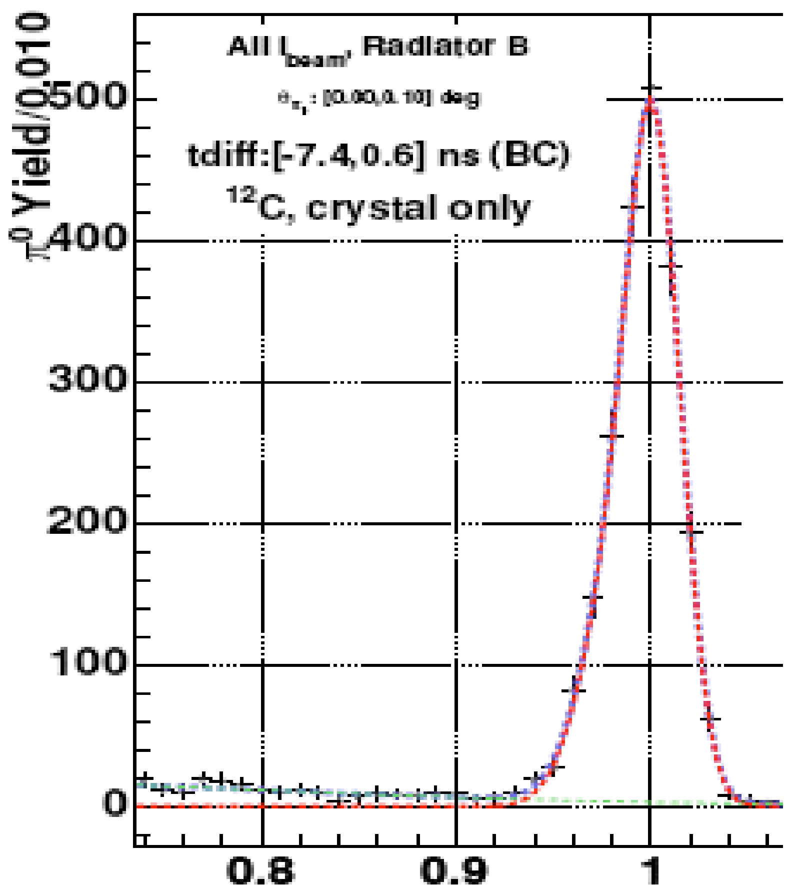
Cross Section	No FSI	With FSI
Primakoff	Z^2	Z^2
Coherent	A^2	$\sim A$
Inerference	ZA	$\sim Z\sqrt{A}$
Incoherent	A	$\sim A^{2/3}$?

Pb/C ratios

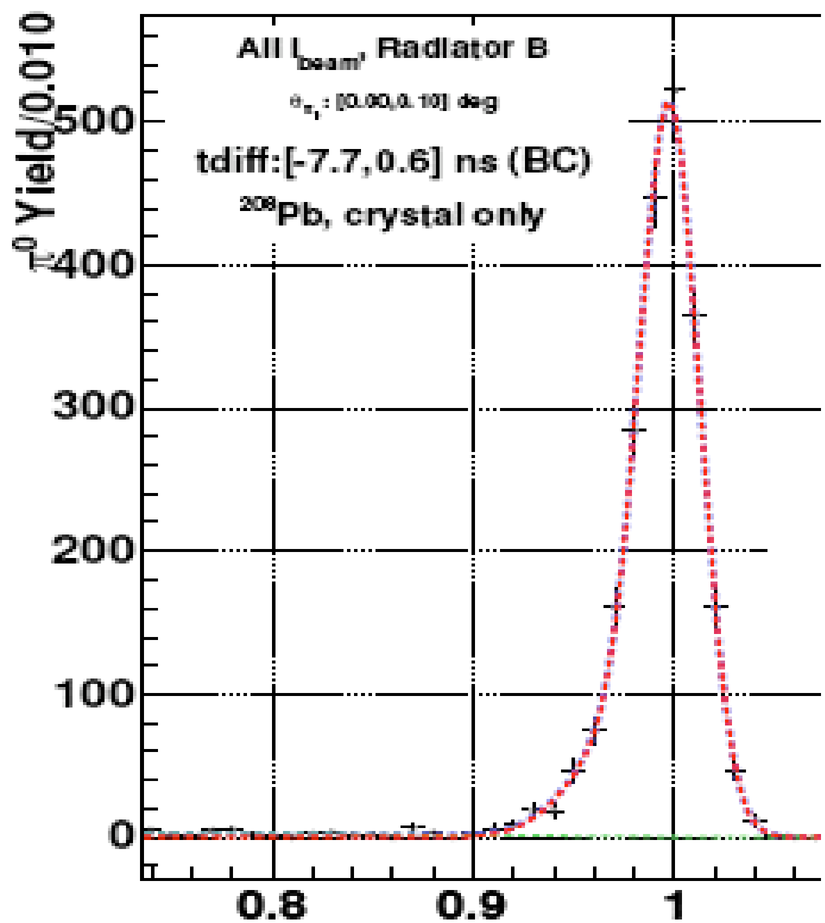
Coherent/Primakoff	9.3%
Interference/Primakoff	31%
Incoherent/Primakoff	3.6%

Elasticity with π^0 cut : Primakoff Peak

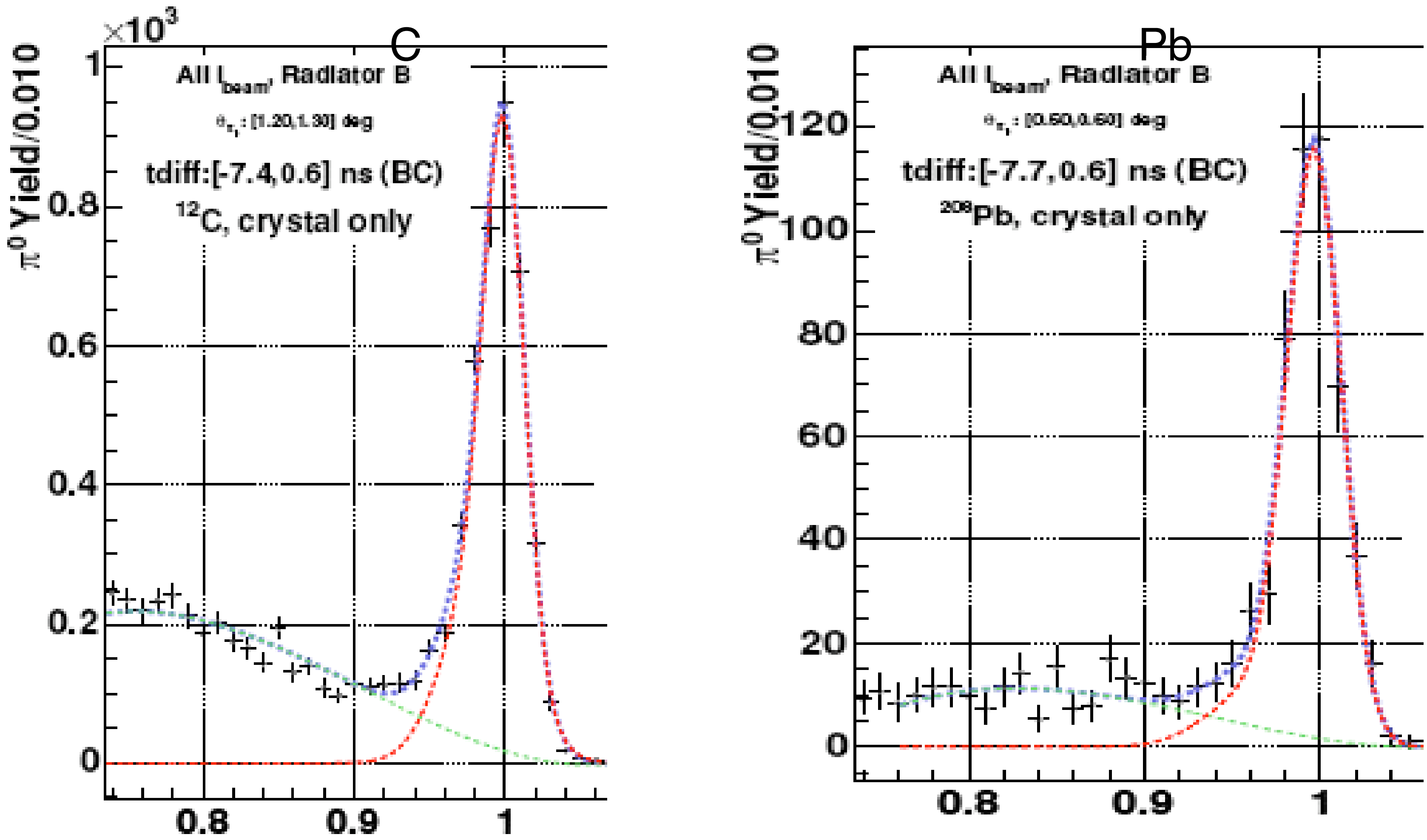
C



Pb



Elasticity with π^0 cut: Nuclear Coherent Peak



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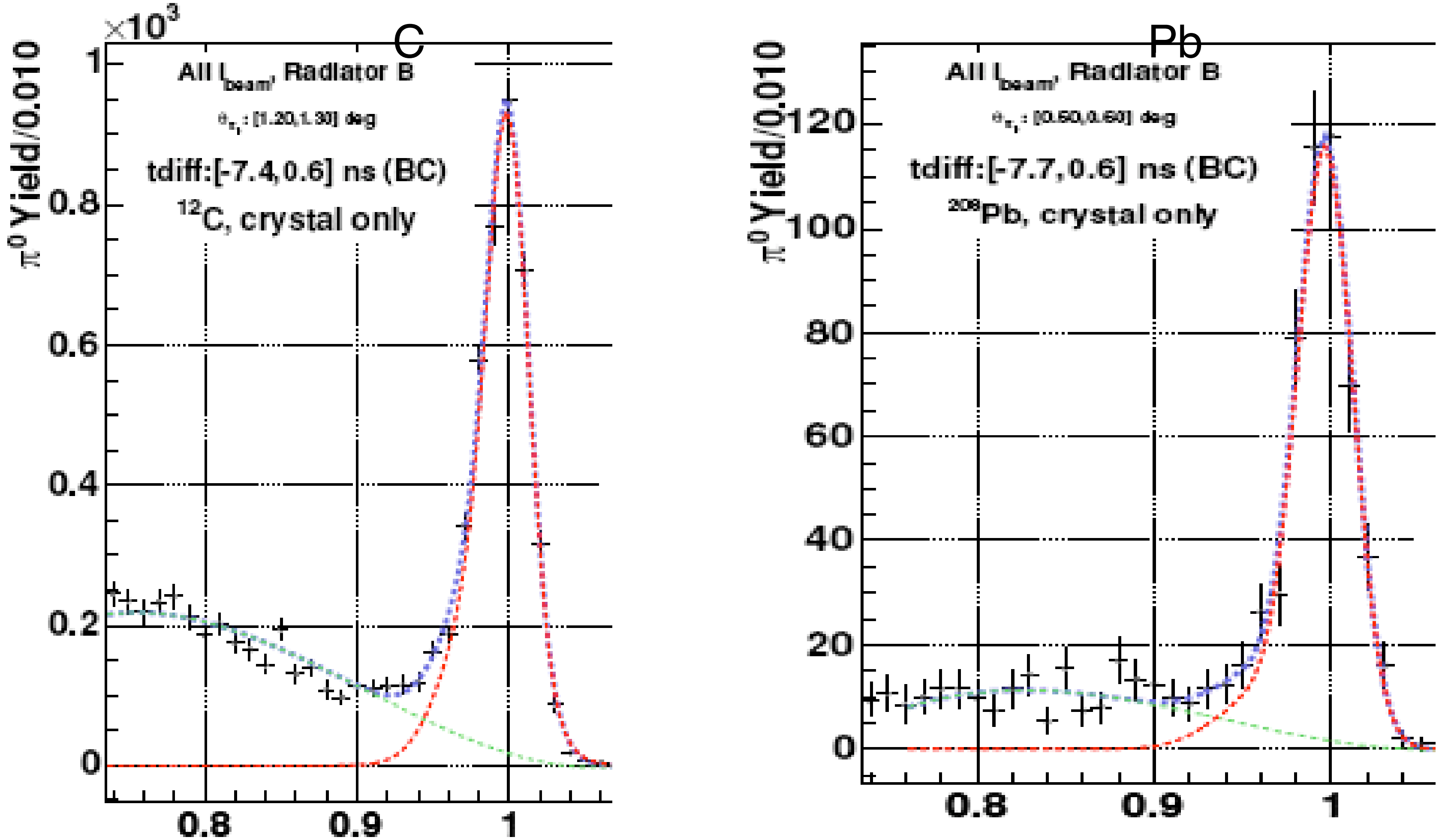
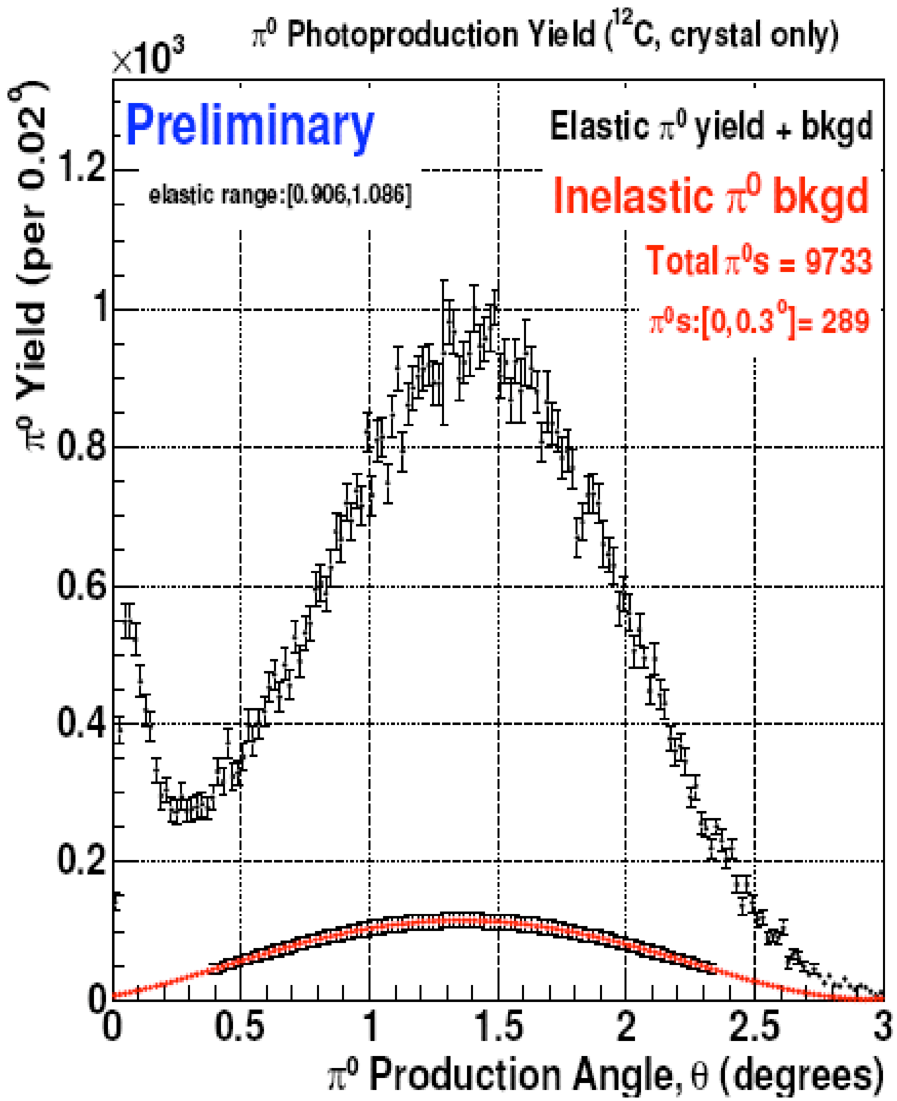
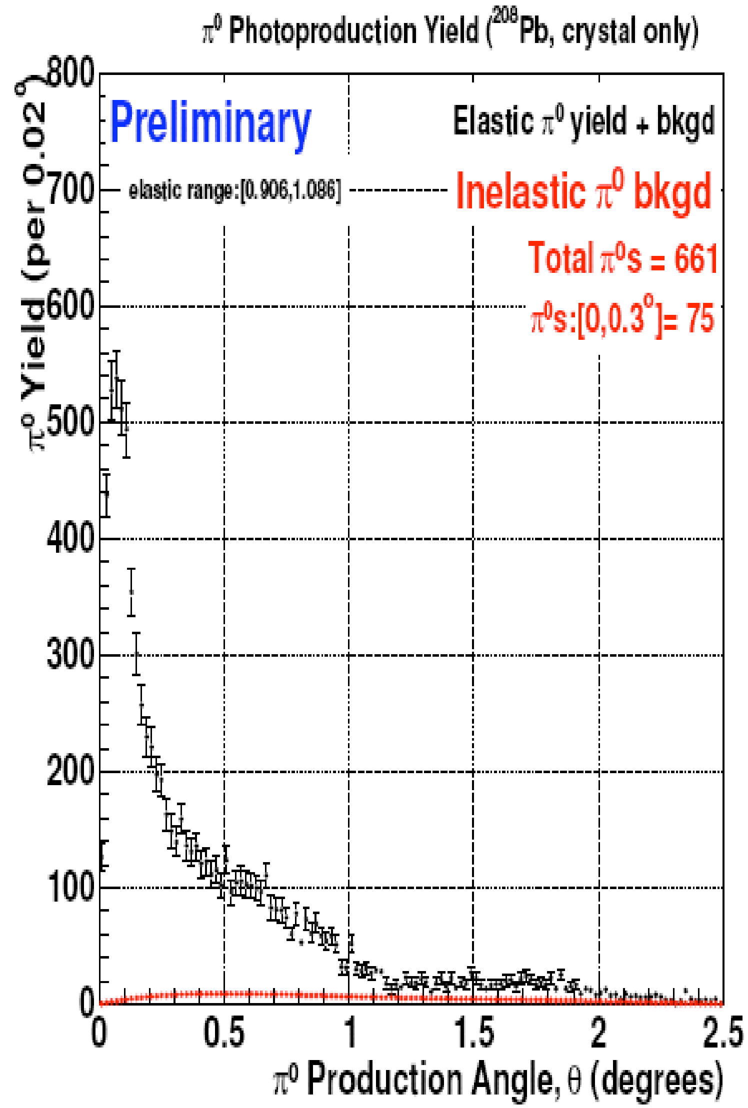


Pb/C ~ 0.5; implies coherent omega contribution

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

Urgent tasks

1. Pb data analysis
2. Evaluate σ(E1,E2: θ)
3. Integral analyses: reduce dependence on quasi-elastic?
4. Model studies, errors
5. Contribution of giant resonance states? (AB,TWD)

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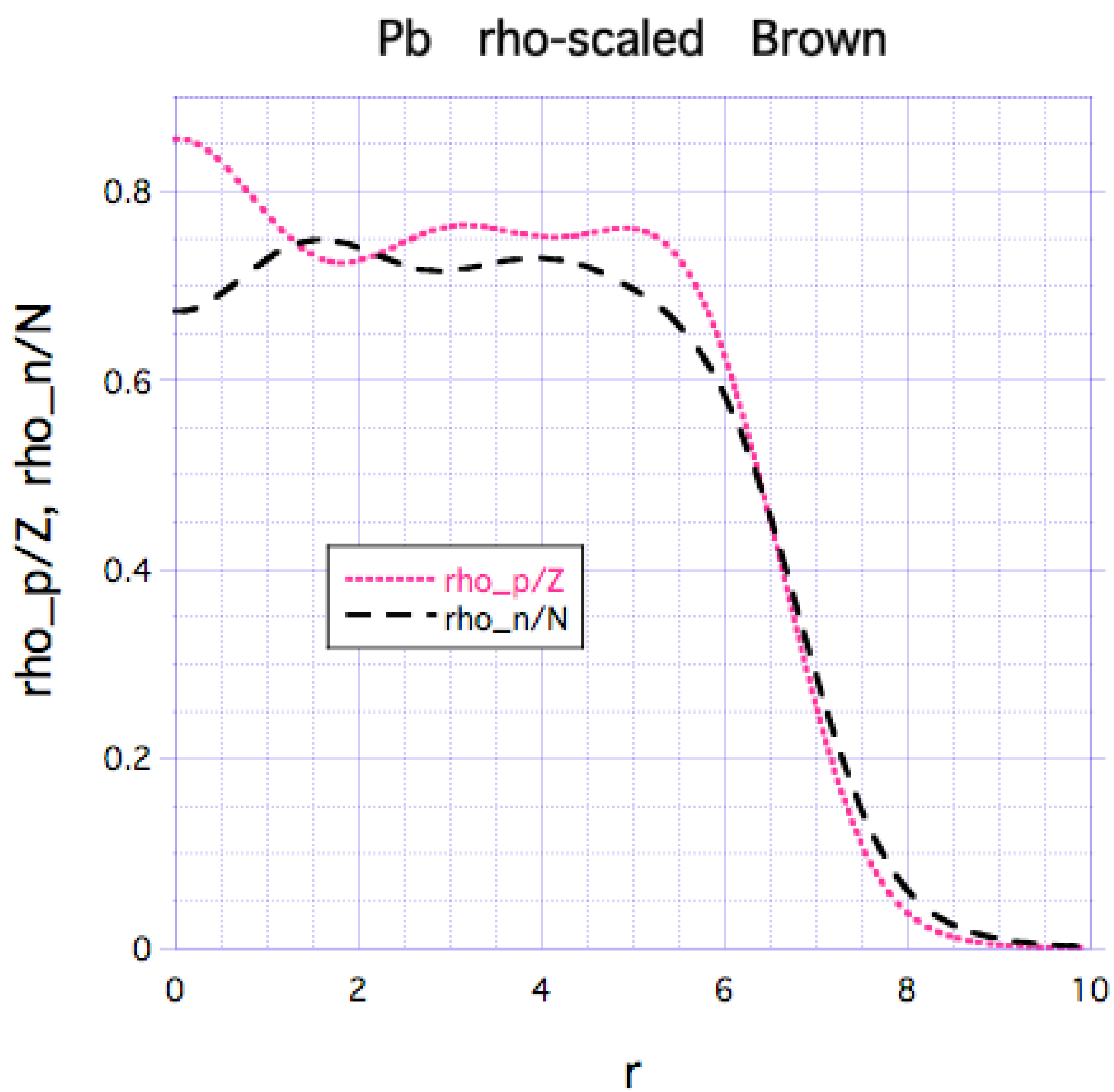

Pb rho-scaled Brown
rho_p/Z, rho_n/N
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
r
rho_p/Z
rho_n/N