π^0 Lifetime Extraction from ^{12}C and ^{208}Pb

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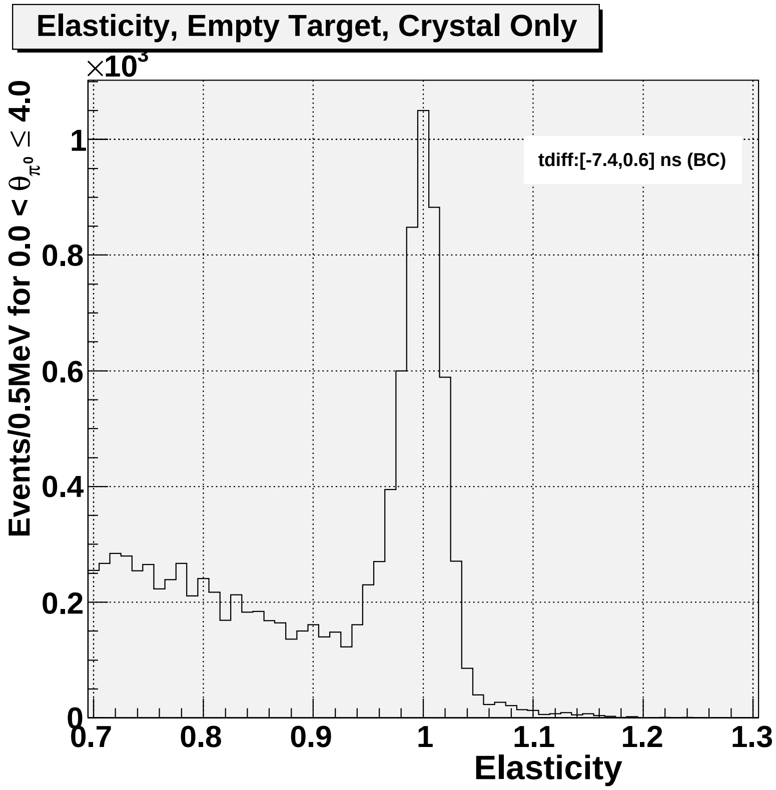
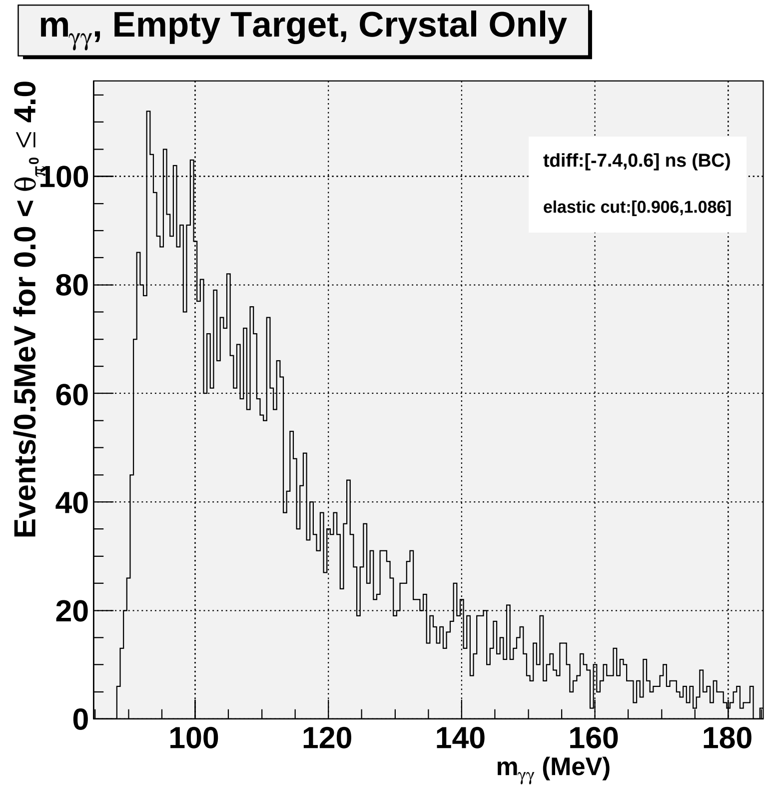
- What's been done recently:
  - Evaluated possible background from non-target sources
  - Analyzed veto false signal occurance for both ^{12}C and ^{208}Pb
  - Perf. simult. combined-parm fits for both targets in various ways
  - New systematic error table, near final
- Very recent Issues which need further considerstion:
  - Accidental contribution to veto false signal?
  - What is the reason for shifted fit at large angles?

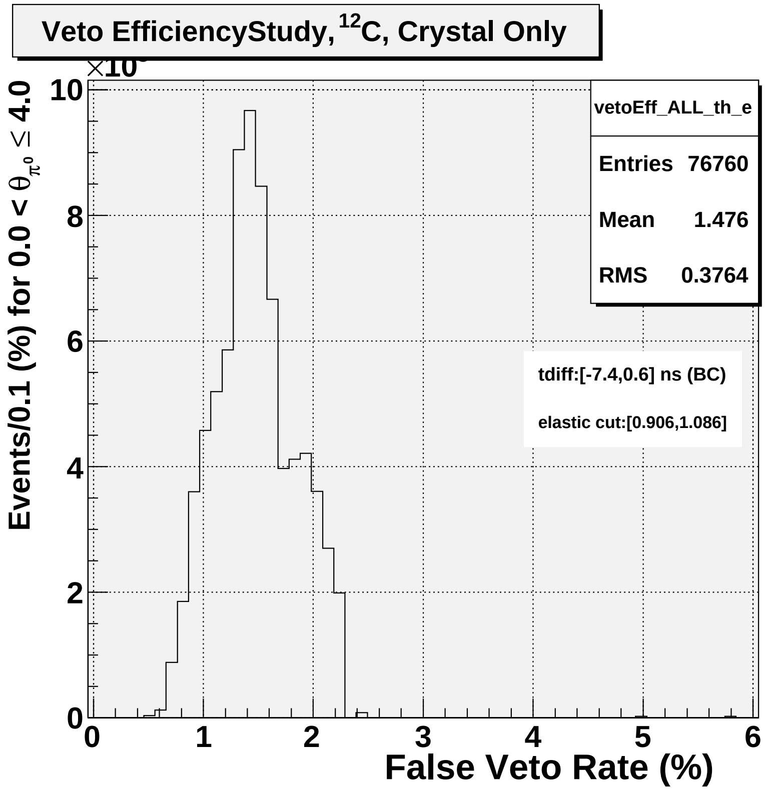
target	$\Gamma_{\gamma\gamma}$	fit (stat) err	syst err	total err
^{12}C:	7.979	0.149(1.87%)	0.174(2.18%)	0.229(2.87%)
^{208}Pb:	7.968	0.142(1.78%)	0.174(2.18%)	0.224(2.81%)
Average	7.97	0.146(1.83%)	0.174(2.18%)	0.227(2.84%)

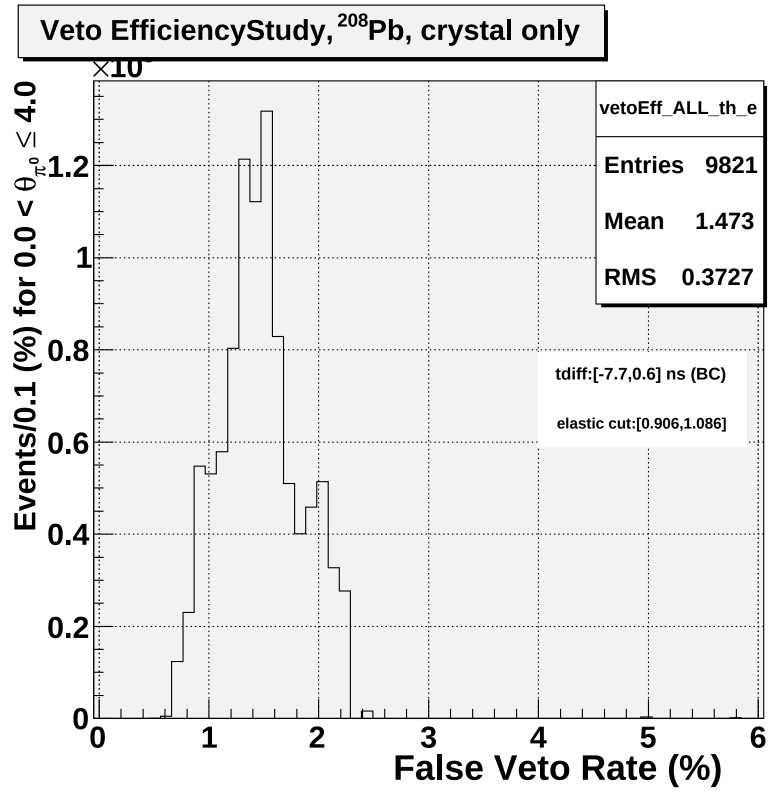
Non-Target π^0 Yield Bkgd (Empty Target Data)



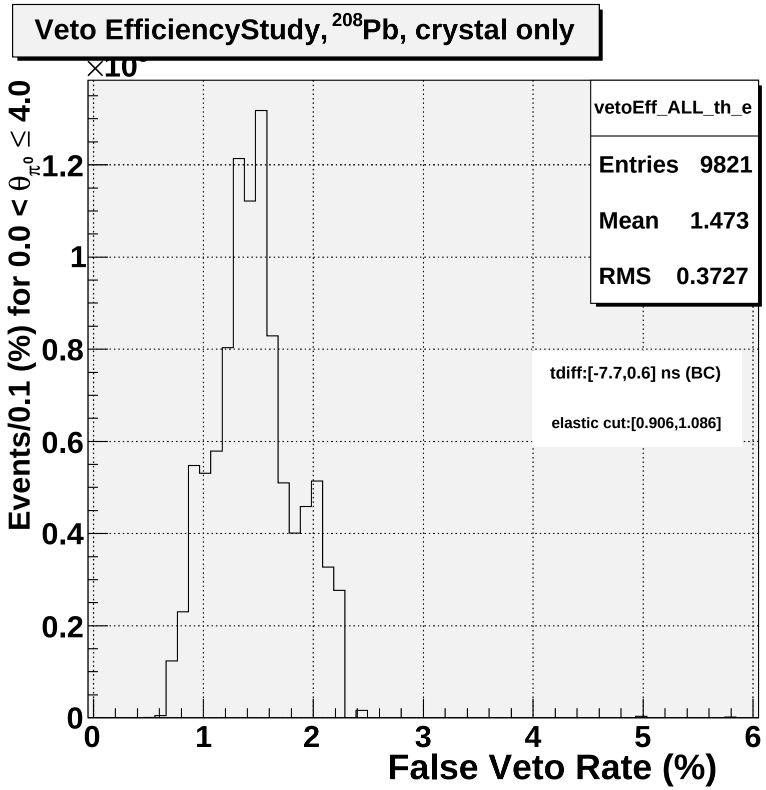


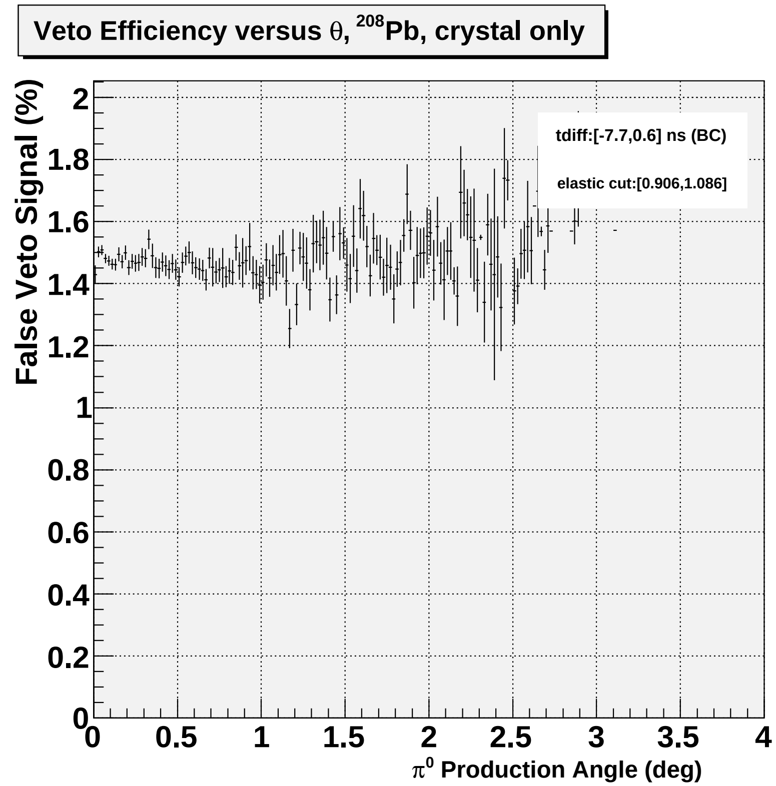
Veto Single γ False Signal Rate, ^{12}C and ^{208}Pb



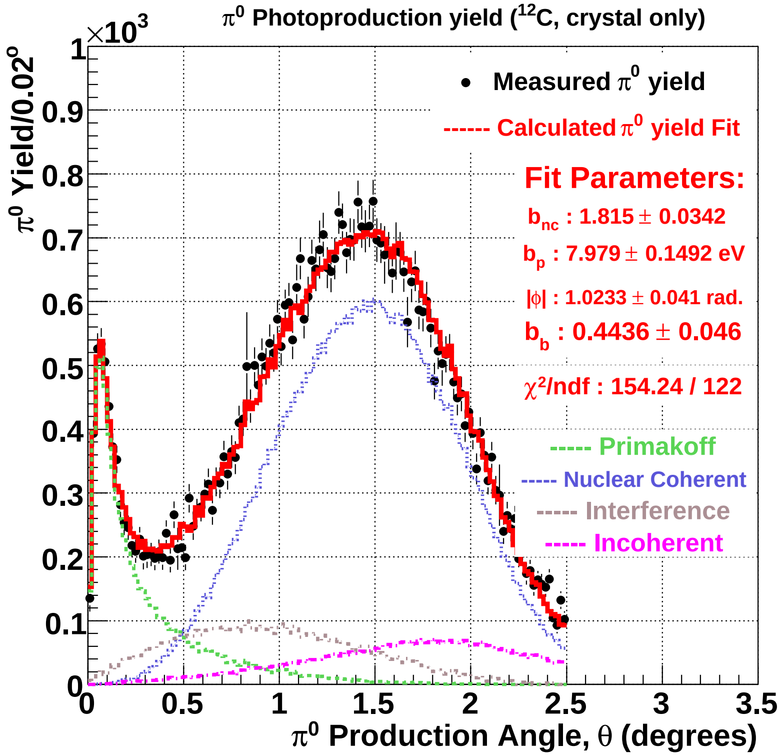


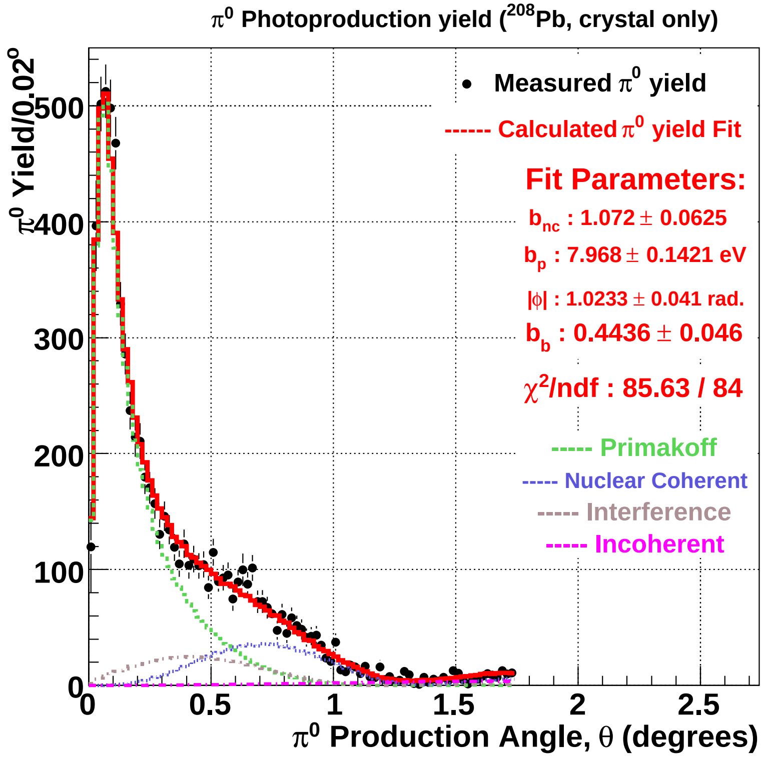
Veto False Signal Rate vs. θ_{π^0}, ^{208}Pb



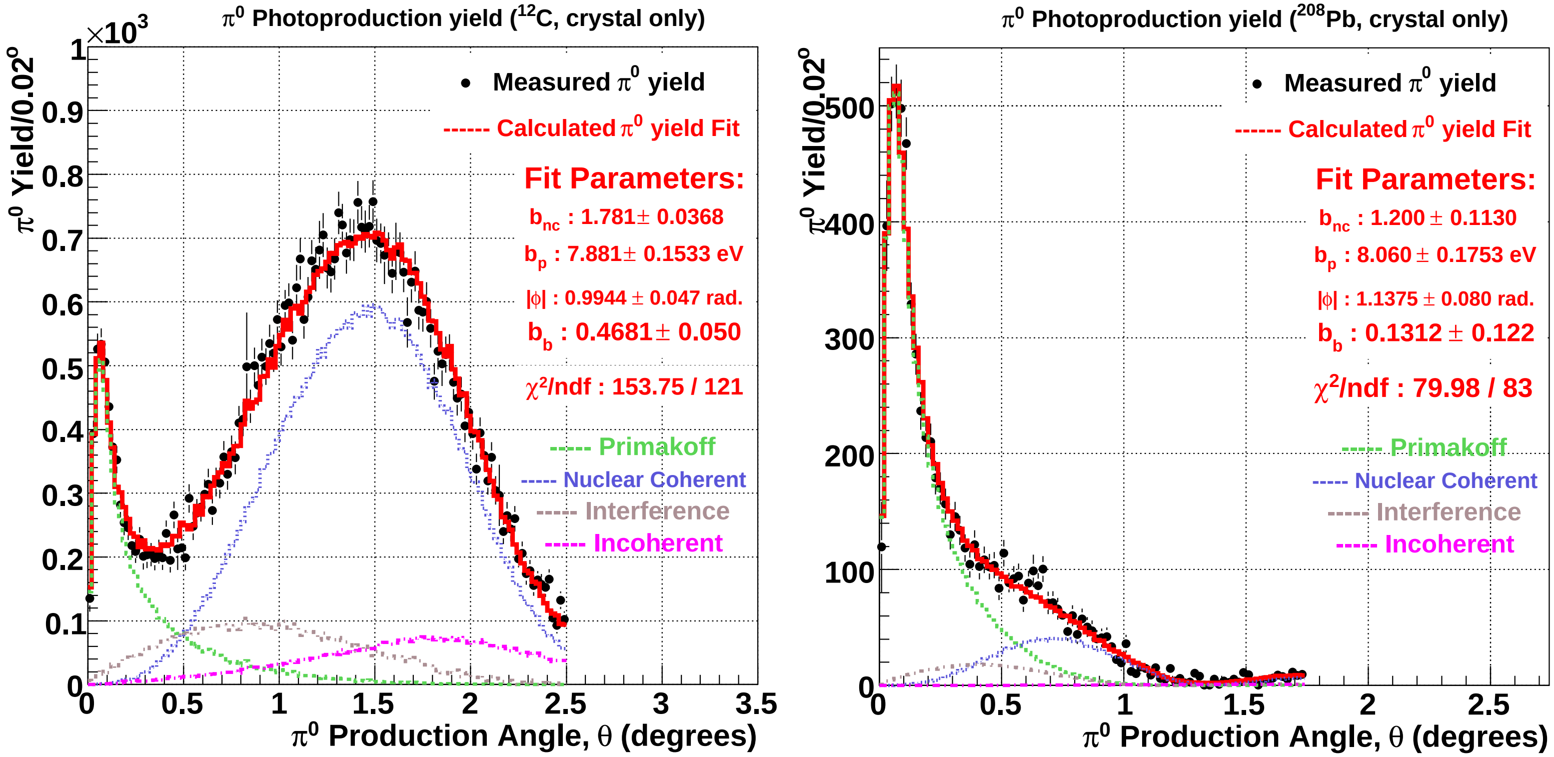


Sample 6 parameter Combined Fits (Indep. $\Gamma_{\gamma\gamma}$)

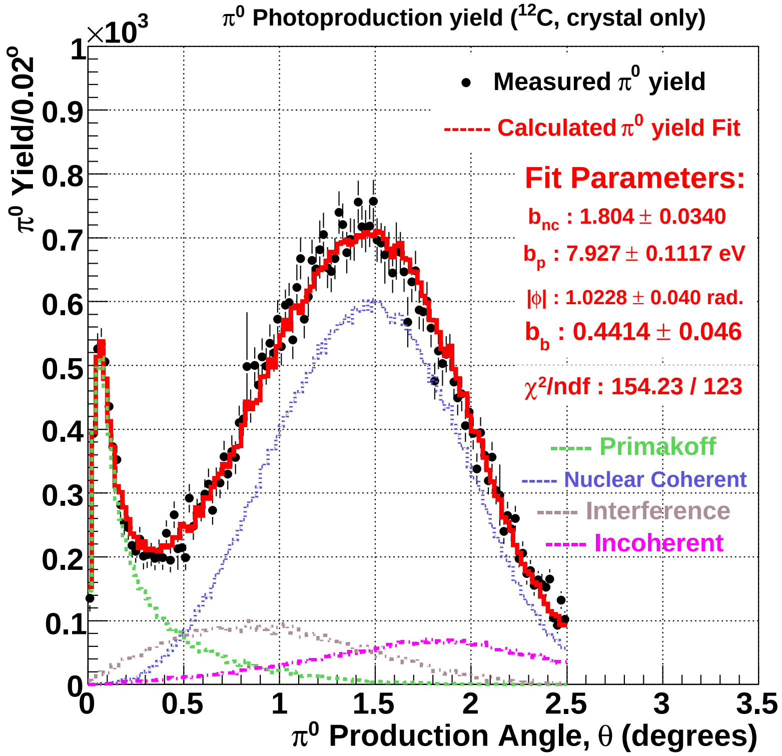


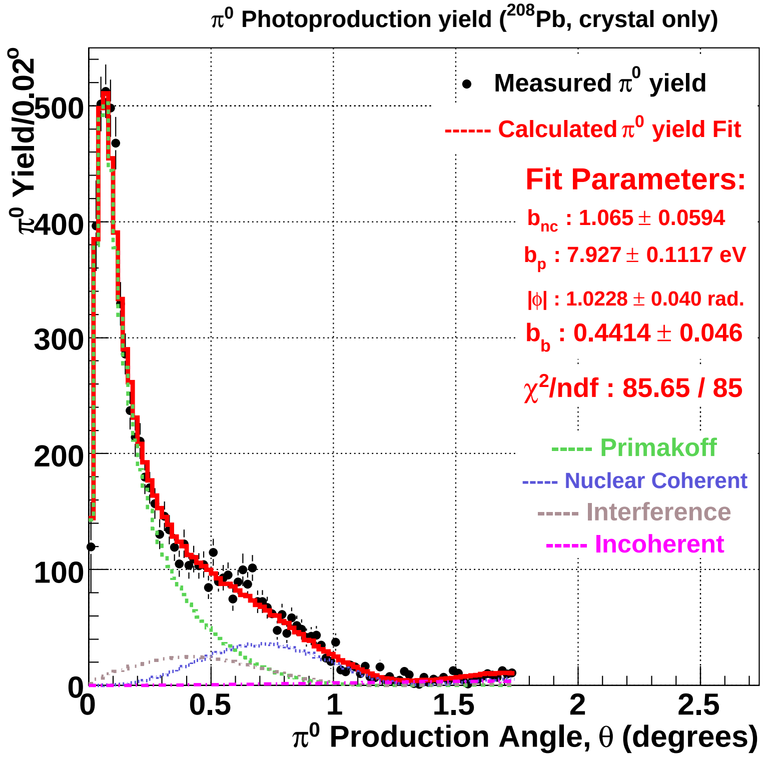


Sample 4 parameter Independent Fits



Sample 5 parameter Combined Fits (Combined Width)

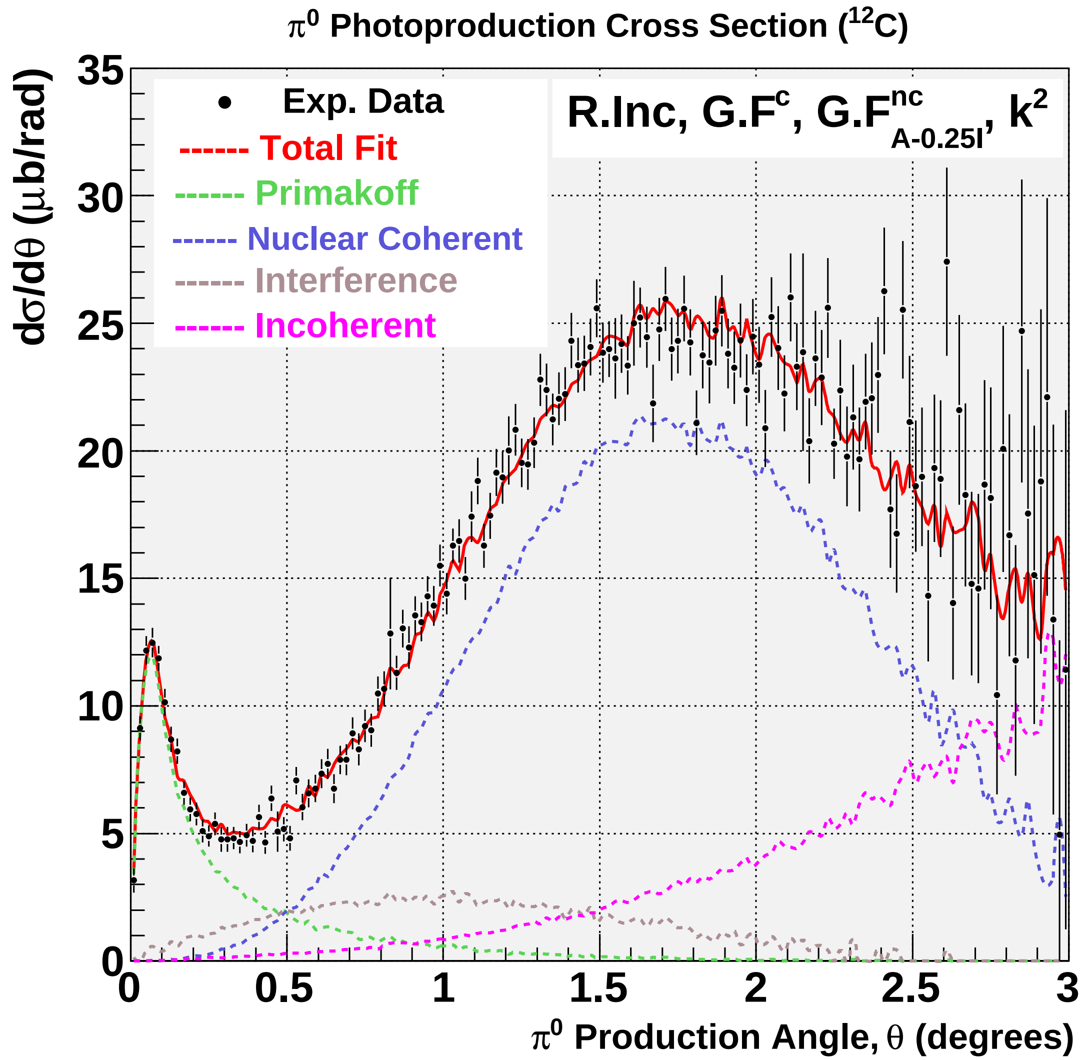




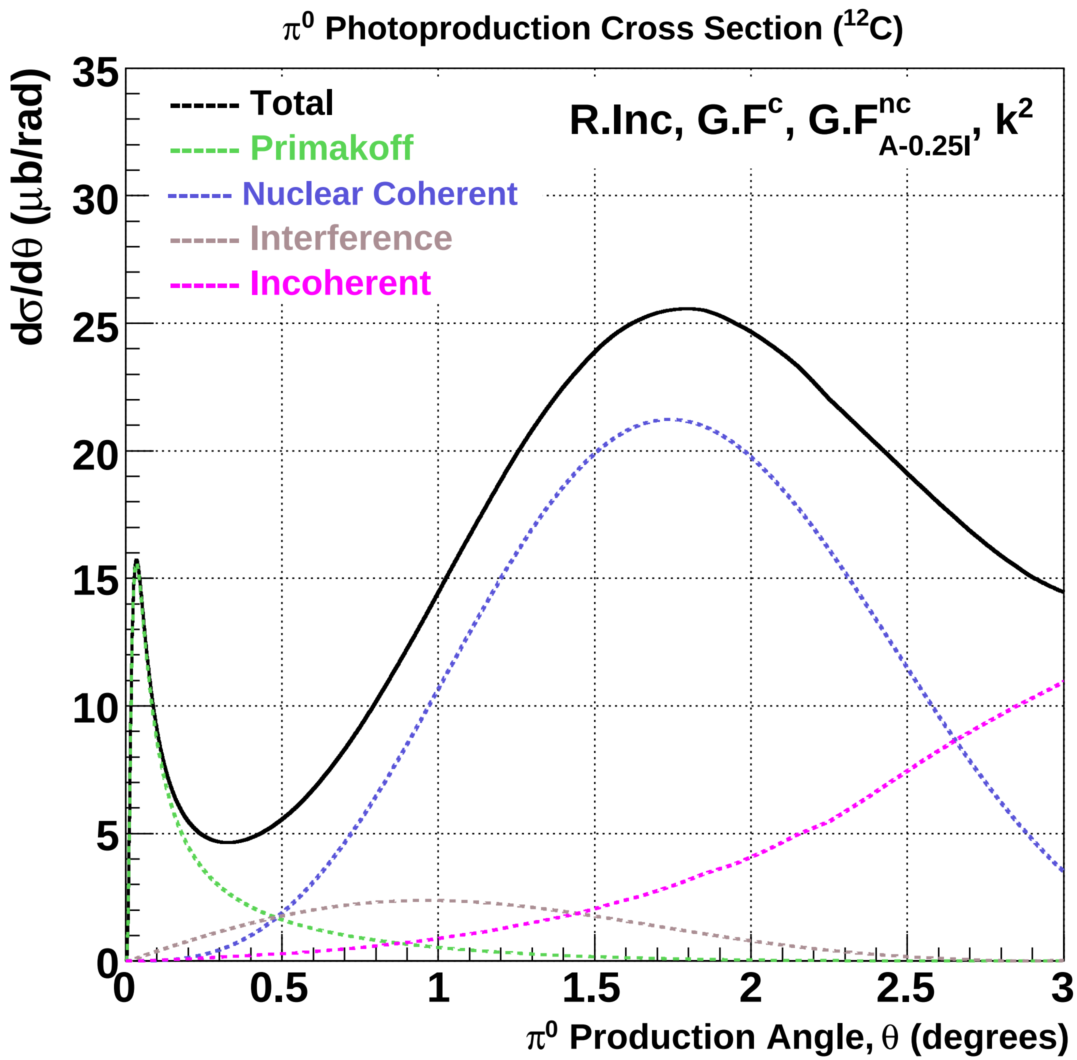
$\Gamma_{\gamma\gamma}$ Fit Parameter Summmary: ^{12}Cand ^{208}Pb

	$\Gamma_{\gamma\gamma} \pm$ fit err in eV (fit χ^2)		
Target	4 Parm Fits	6 Parm Fits	5 ParmFits
^{12}C	7.88 ± 0.15 (1.27)	7.98 ± 0.15 (1.26)	7.93 ± 0.11 (1.25)
^{208}Pb	8.06 ± 0.17 (0.96)	7.97 ± 0.14 (1.02)	7.93 ± 0.11 (1.01)
	$b_{NC} \pm$ fit err		
^{12}C	1.78 ± 0.037	1.82 ± 0.034	1.80 ± 0.034
^{208}Pb	1.20 ± 0.113	1.07 ± 0.063	1.07 ± 0.059
	$\phi \pm$ fit err in radians		
^{12}C	0.99 ± 0.047	1.02 ± 0.041	1.02 ± 0.040
^{208}Pb	1.14 ± 0.080	1.02 ± 0.041	1.02 ± 0.040
	$b_{INC} \pm$ fit err		
^{12}C	0.47 ± 0.050	0.44 ± 0.046	0.44 ± 0.046
^{208}Pb	0.13 ± 0.122	0.44 ± 0.046	0.44 ± 0.046

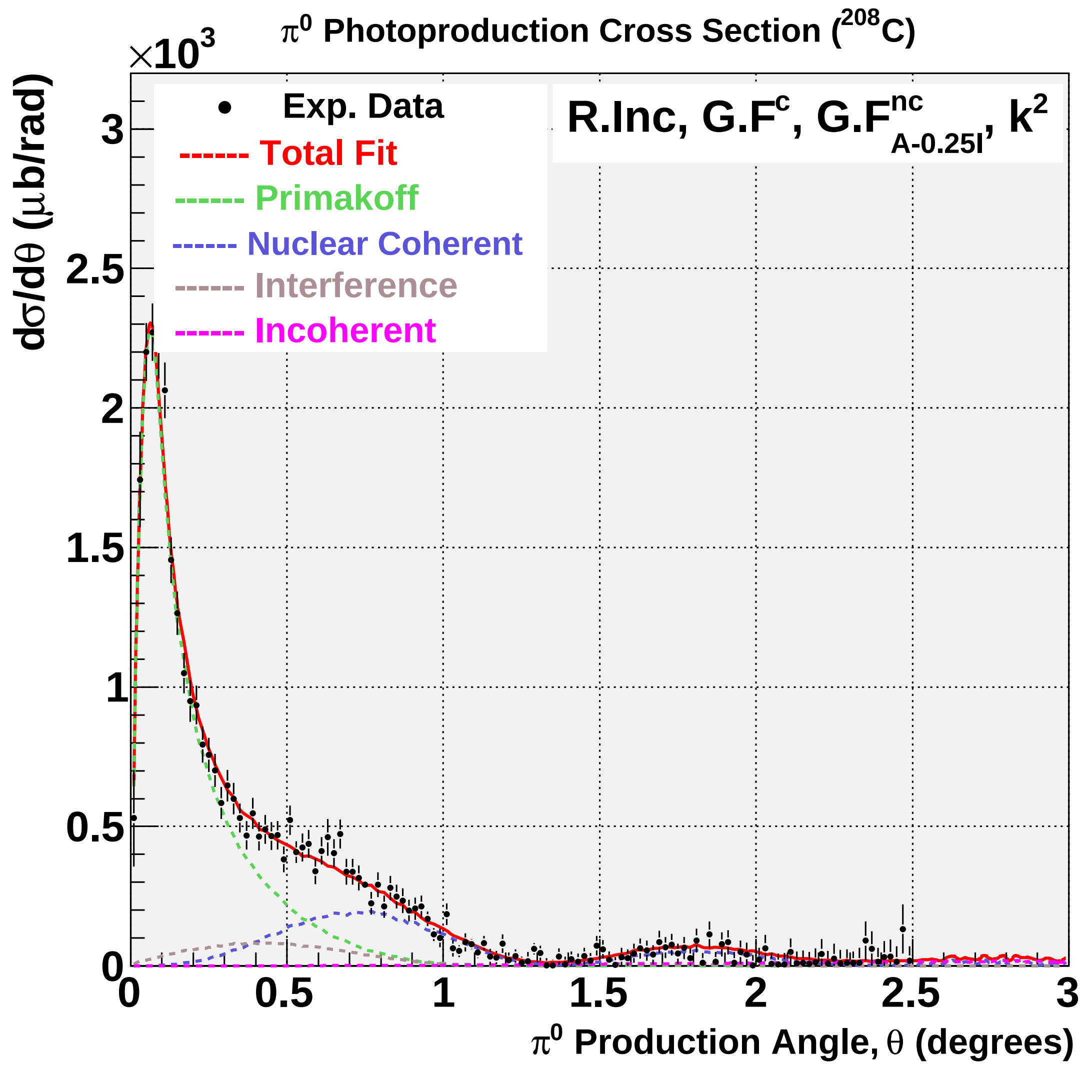
$\gamma(^{12}C, X)\pi^0$ Cross Section (from 4parm Fit)



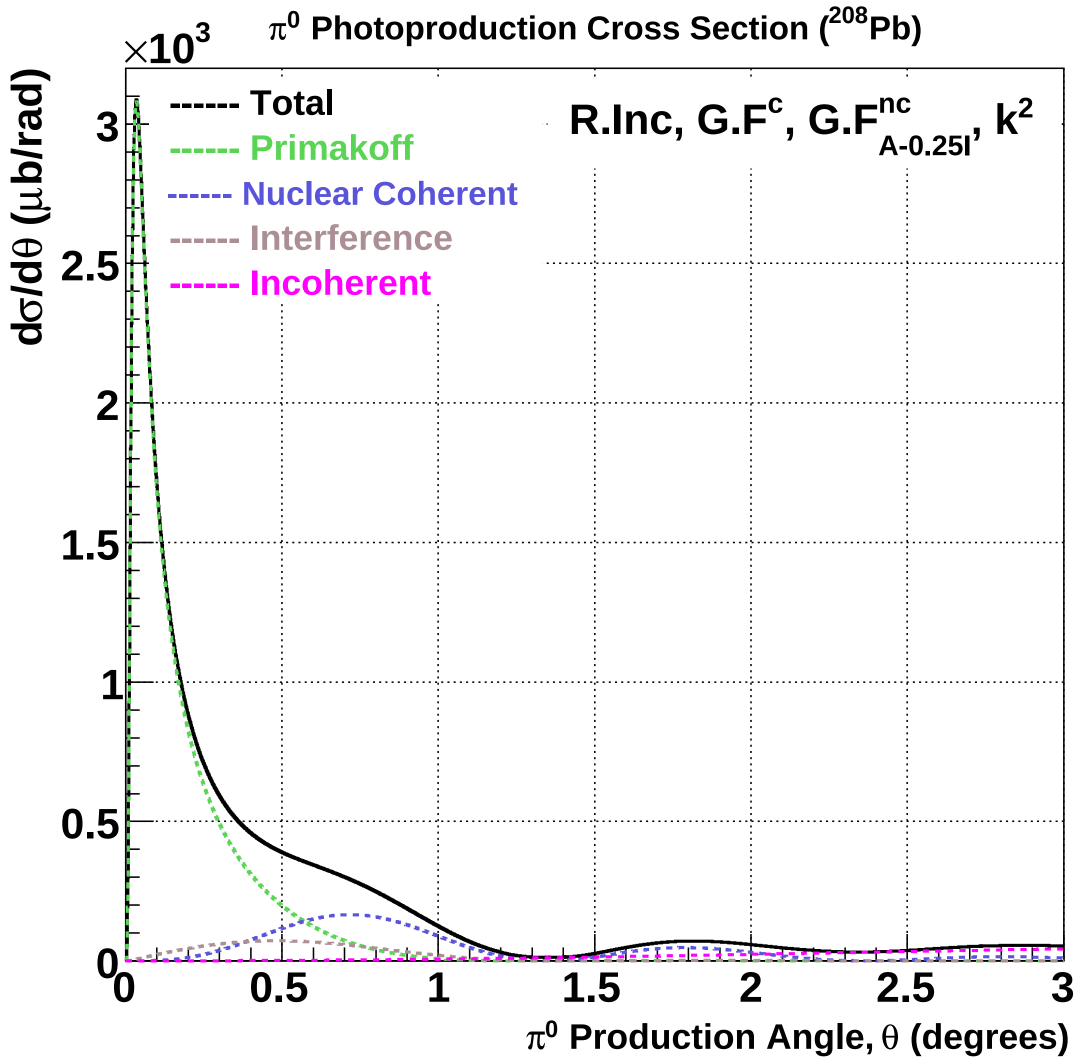
$\gamma(^{12}C, X)\pi^0$ Cross Section (Un-smeared)



$\gamma(^{208}Pb, X)\pi^0$ Cross Section



$\gamma(^{208}Pb, X)\pi^0$ Cross Section (Un-smeared)



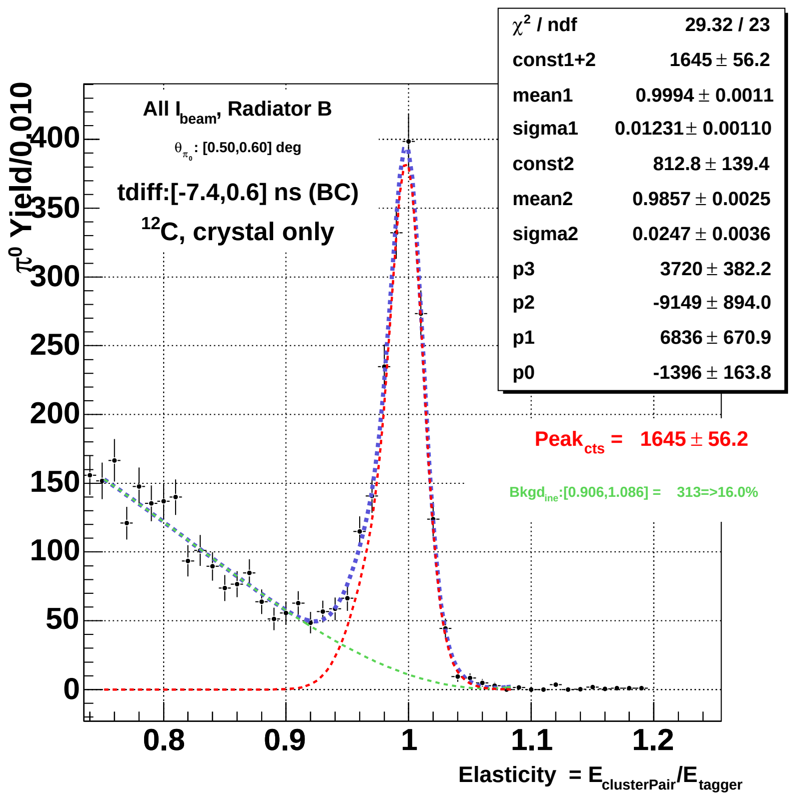
Systematic Error Table, part 1

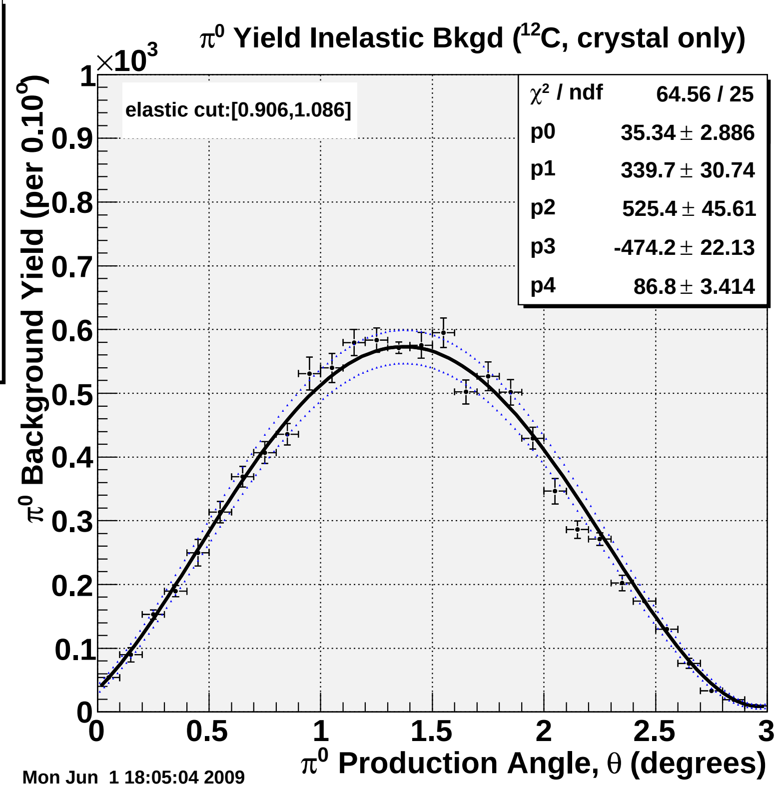
Item	Error (%)
Photon Flux	±0.97
Target Thickness	±0.1
Branching Ratio ($\pi^0 \rightarrow \gamma\gamma$)	±0.03
$\gamma\gamma$ Inv. Mass Fits**	±1.39
Inelastic Bkgd Corr.	±1.10
Timing Accidental Bkgd Corr.	±0.22
ω Bkgd Subtraction (±20%)	±0.26
Tagged Photon Energy	±0.1
Fiducial Acceptance	±0.30
Trigger Efficiency	±0.1

Systematic Error Table, part 2

Item	Error (%)
Timing Cut	$\pm$0.30
Elasticity Cut	$\pm$0.25
Veto Cut	$\pm$0.17
Theory Parameters	$\pm$0.42
Incoherent Shape	$\pm$0.28
Total Quadrature Sum (parts 1 & 2)	$\pm$2.18

Systematic Error: Inelastic Bkgd Correction ±1.10% – 7.79eV < $\Gamma_{\gamma\gamma}$ < 7.96eV





Summary and Future Work

- All past comments and requests have been addressed
- There is no quantifiable empty target π^0 yield for this analysis
- $\Gamma_{\gamma\gamma}$ fit results very stable under various yield Bkgd corrections and theoretical input shapes
- 4 parameter independent fits give ^{12}C and ^{208}Pb widths that differ by 2.25%
- However, 6 parameter fits give very consistent width results between two targets. Why? We think because ϕ is much better controlled for ^{208}Pb fit here
- 5 parameter fits give $\Gamma_{\gamma\gamma}$= 7.927$\pm$0.111eV. Howeve, it is not clear if we can simply combine the ^{12}C and ^{208}Pbstatistics to achieve this 1.4% statisticsl error

target	$\Gamma_{\gamma\gamma}$	fit (stat) err	syst err	total err
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To make the final report we need to:

- Investigate issues–accidental contribution to veto false signal, and shifted fit ditributions
- Re-check our results and finish the write-up
- Address questions and issues brought up at this meeting as well as comments from analysis note reviewers

Extra Slides following this page...

DataSets Analyzed

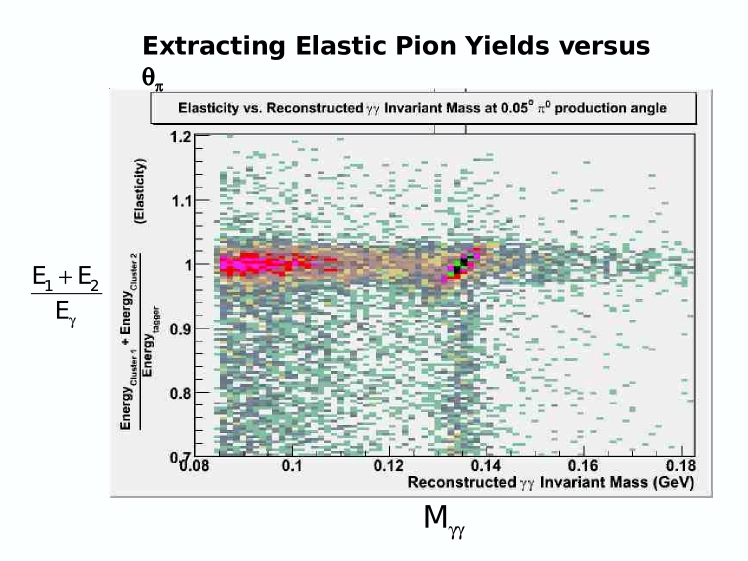
Target	Total Runs	Run Number Ranges
^{12}C	160	4740 – 4768, 4976 – 5059; 5159 – 5242
^{208}Pb	76	4882 – 4913, 5083 – 5114, 5266 – 5330

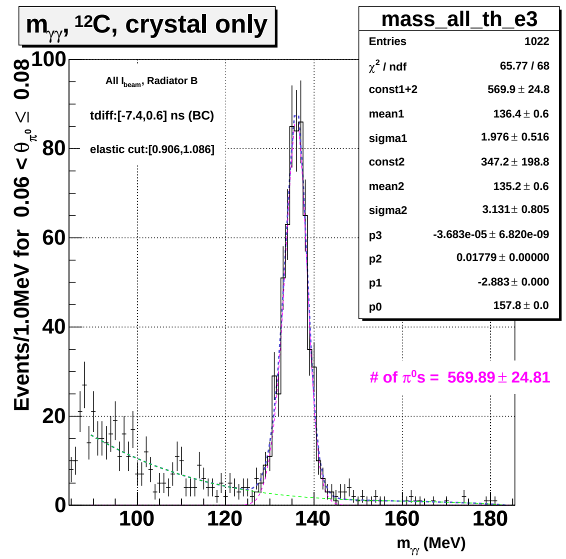
Table 1: Run number ranges used in this analysis for ^{12}C and ^{208}Pb targets. Both sets consist of only radiator B runs.

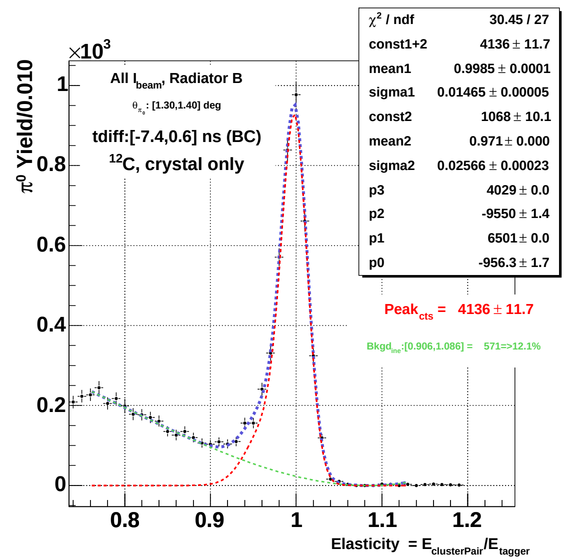
General Cuts and Event Selection

- Accepted $PbWO_4$ hits only (excluding inner and outer-most layer)
- Minimum cluster energy: 0.1GeV
- Best timing candidate selection with tdiff cut: $\pm$4ns

Yield Analysis







- Straight forward yield analysis

–Cuts on timing, invariant mass, and elasticity

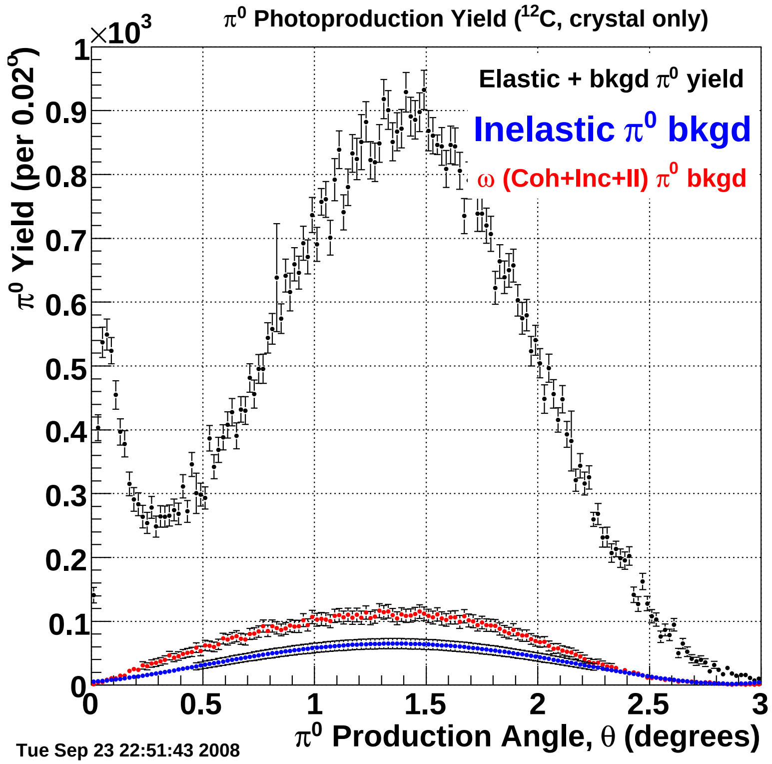
- Backgrounds subtracted:

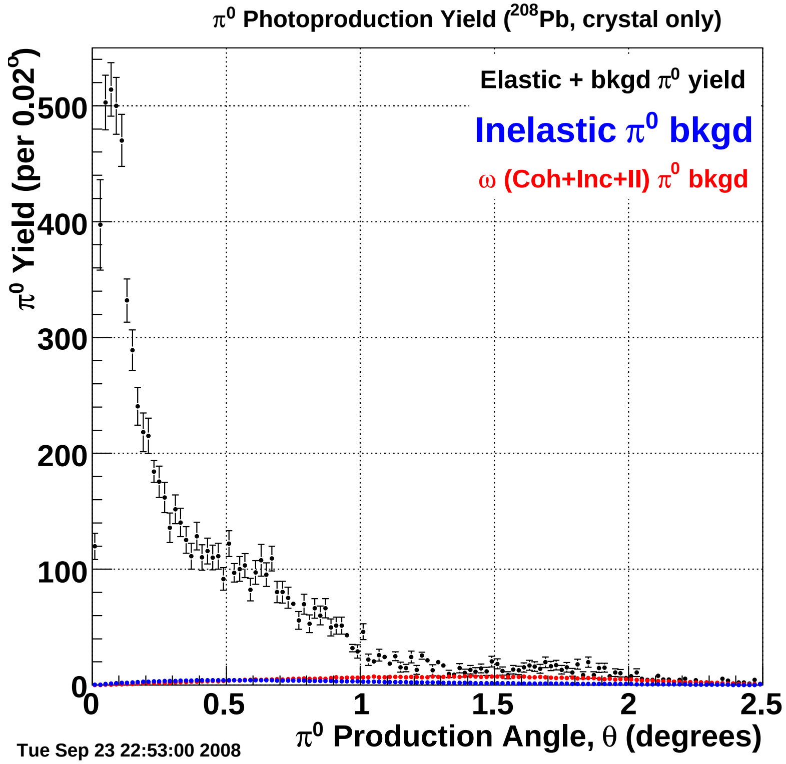
–timing accidentals

–inelastic π^0's

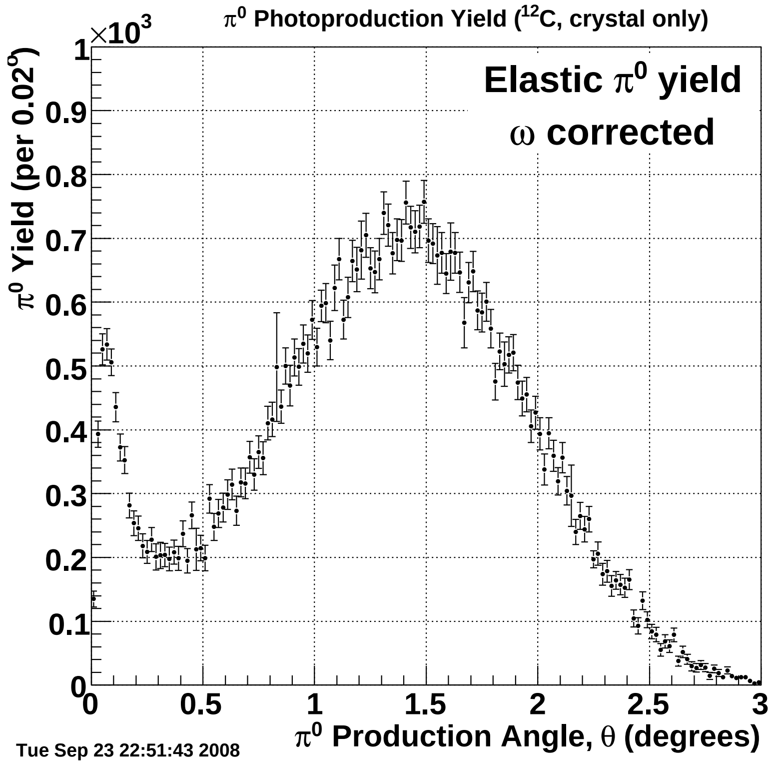
–π^0's from ω decay

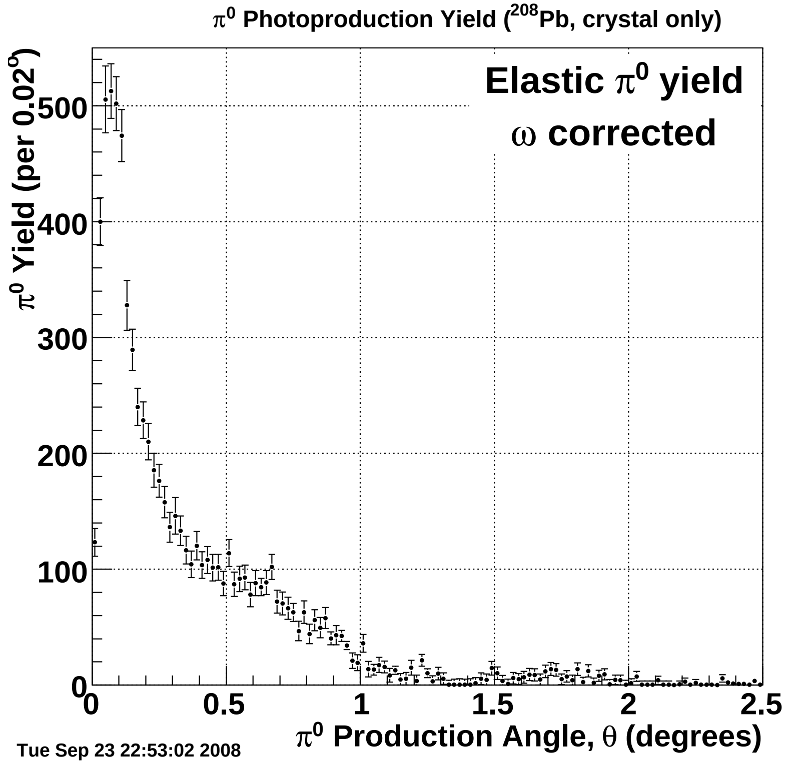
Yields with Bkgds





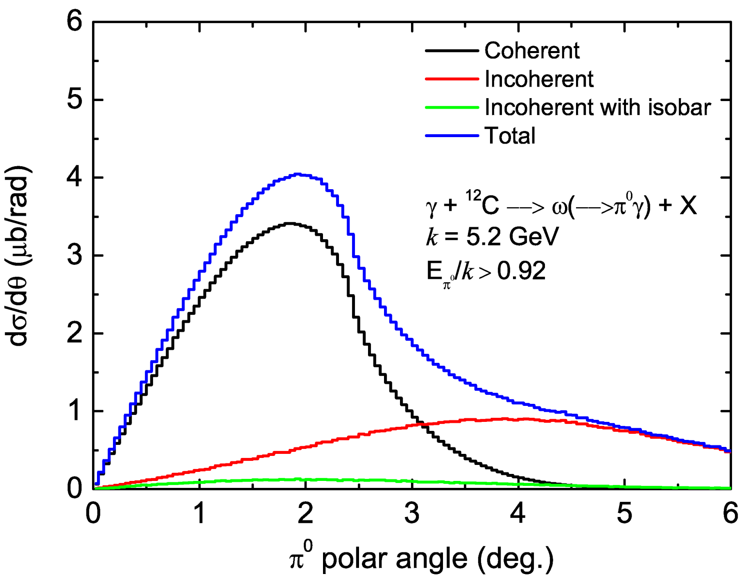
Final Yields

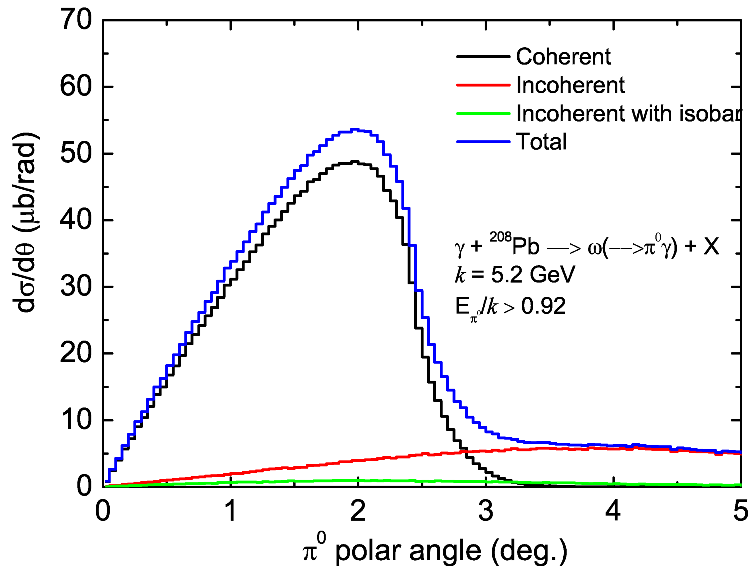




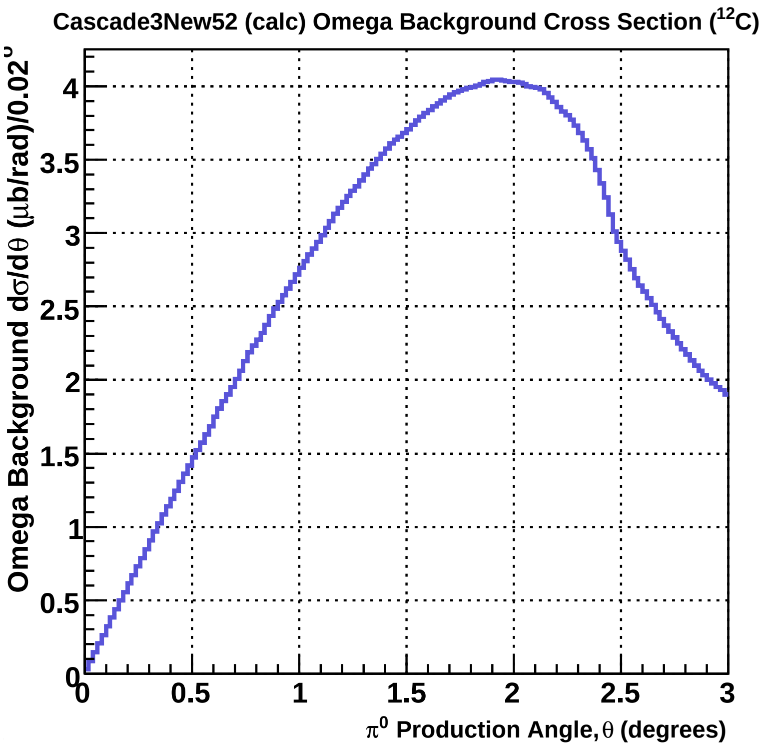
The $\omega \rightarrow \pi^0\gamma$ Bkgd Correction

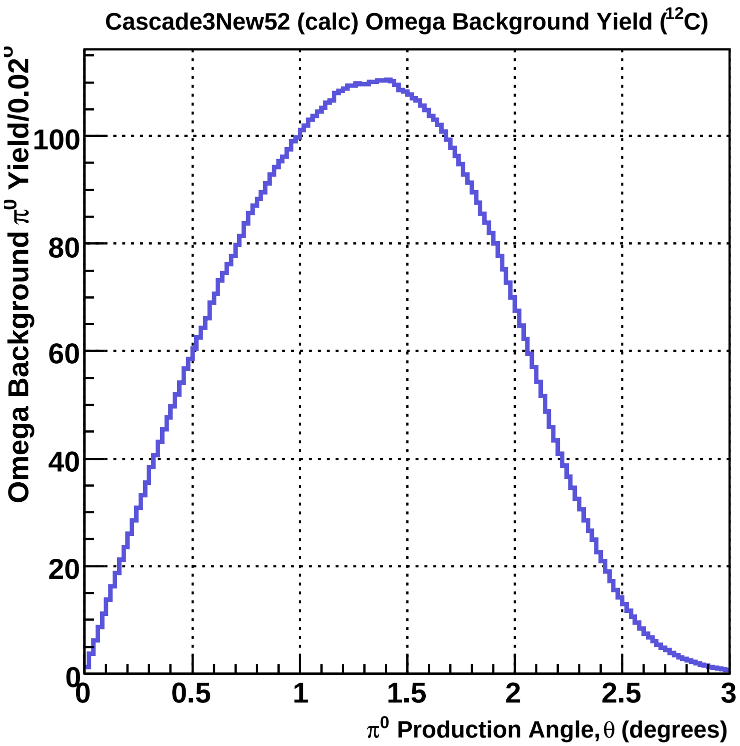
- $d\sigma/d\theta_{\pi^0}$ for $\omega \rightarrow \pi^0\gamma$ taken from T. Rodrigues and implemented in 2 ways
- 1^{st} method: Add omega and incoherent cross sections and use this shape for fitting the data (instead of just incoherent term)
- 2^{nd} method: Convert ω cross section into absolute yield and explicitely subtract it from experimental yield



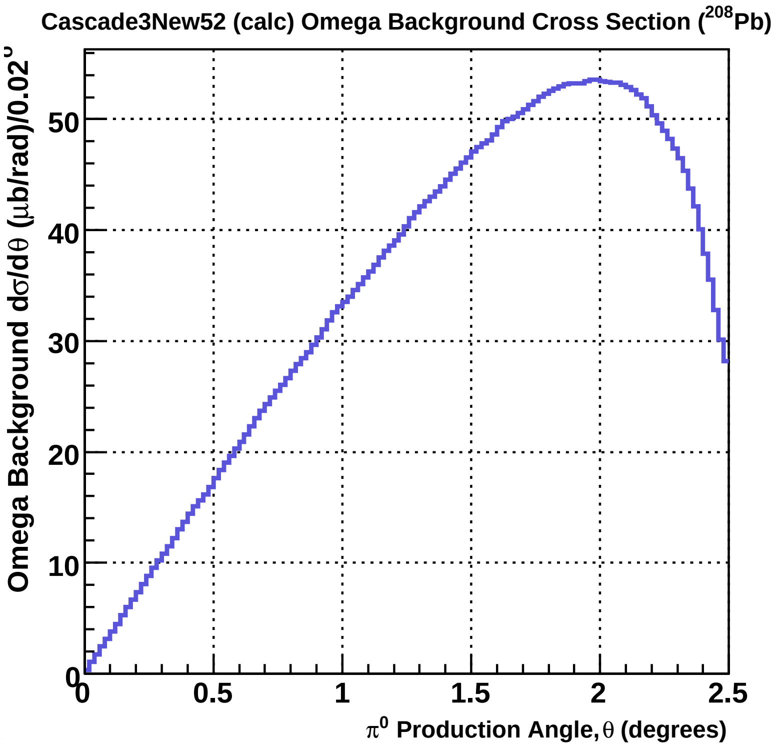


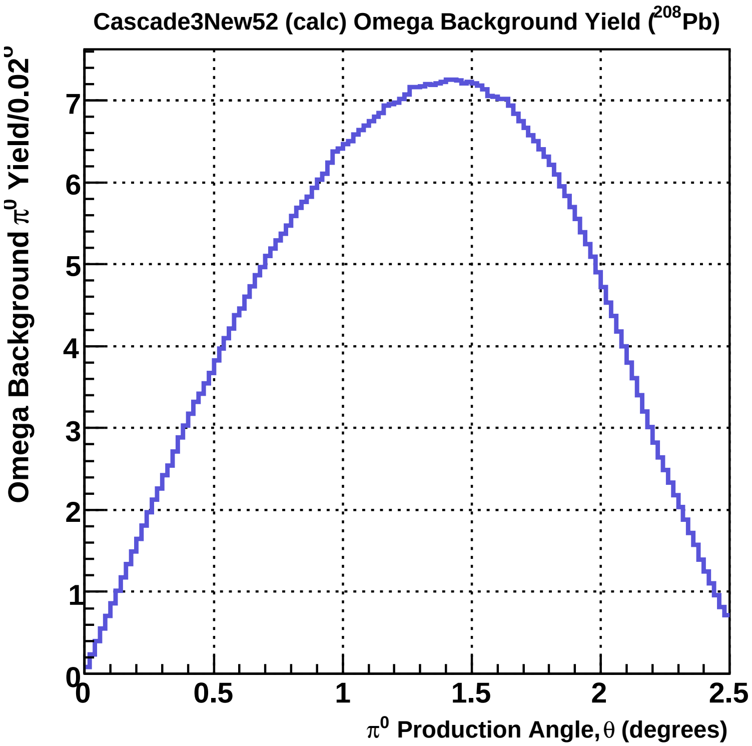
ω Cross Section and Yield for ^{12}C





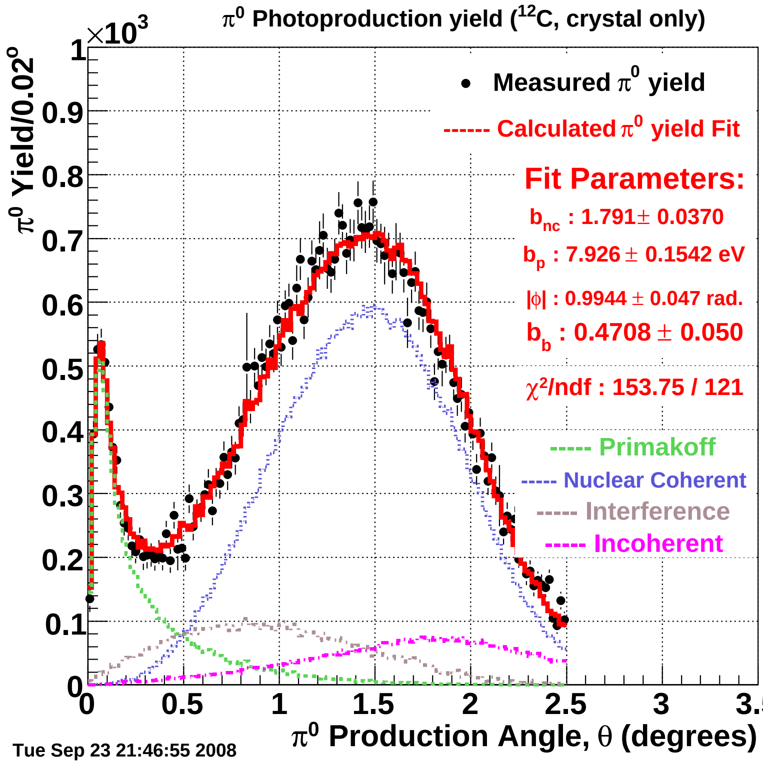
ω Cross Section and Yield for ^{208}Pb

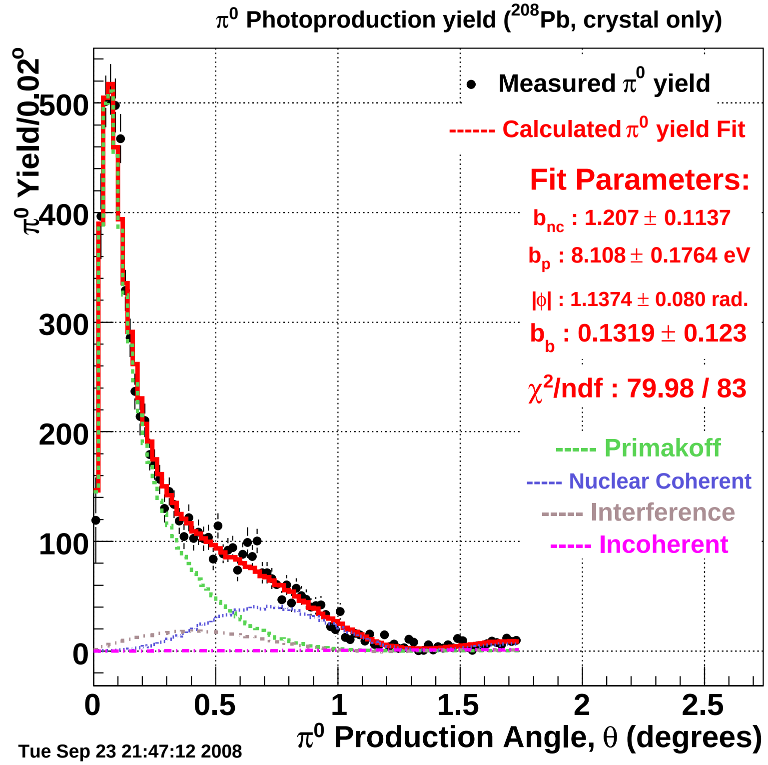




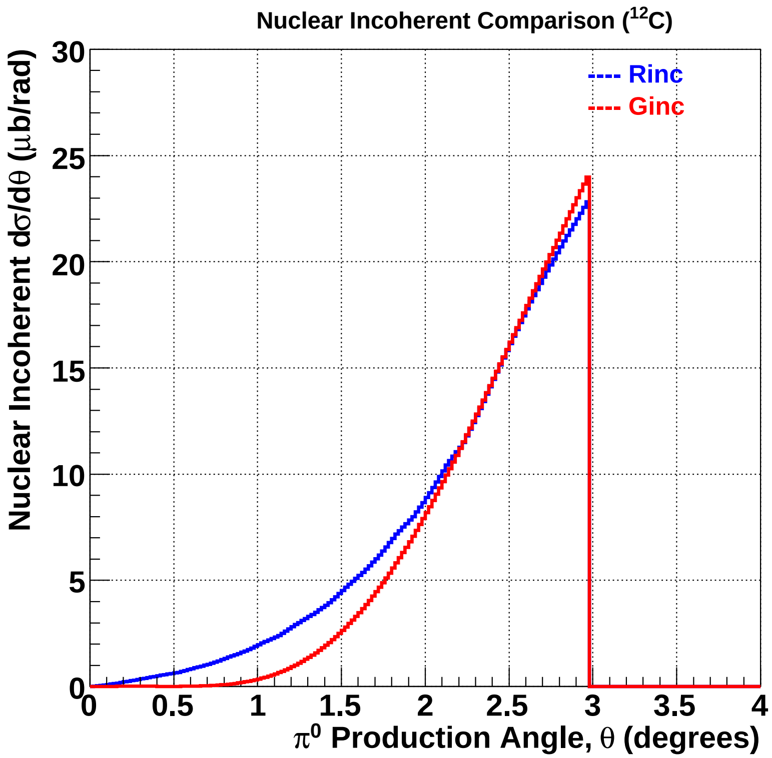
Sample Fits Using ω-Corrected Yield (2^{nd} Method)

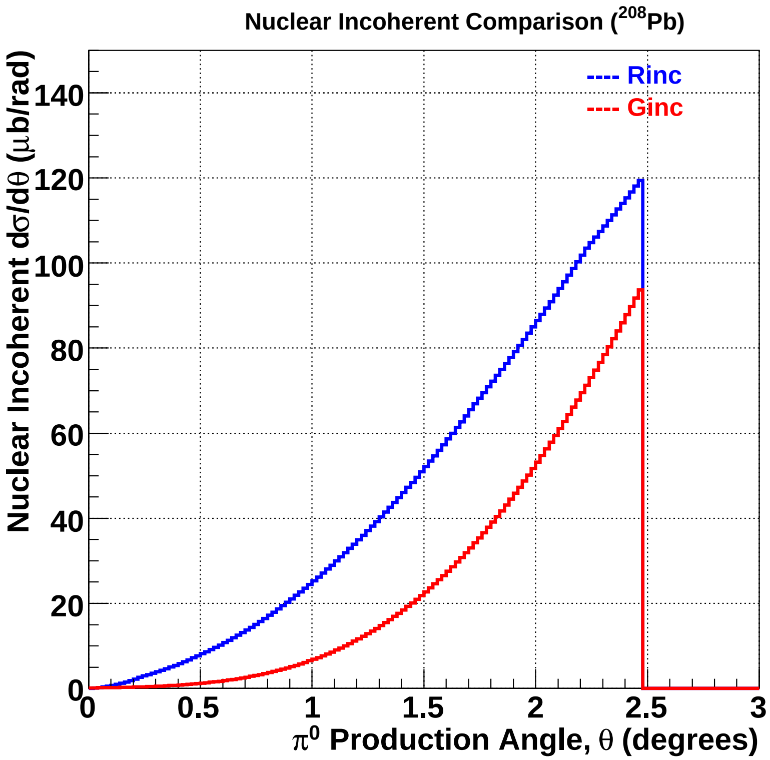
Rinc:$\psi = \frac{1}{4}$:omb



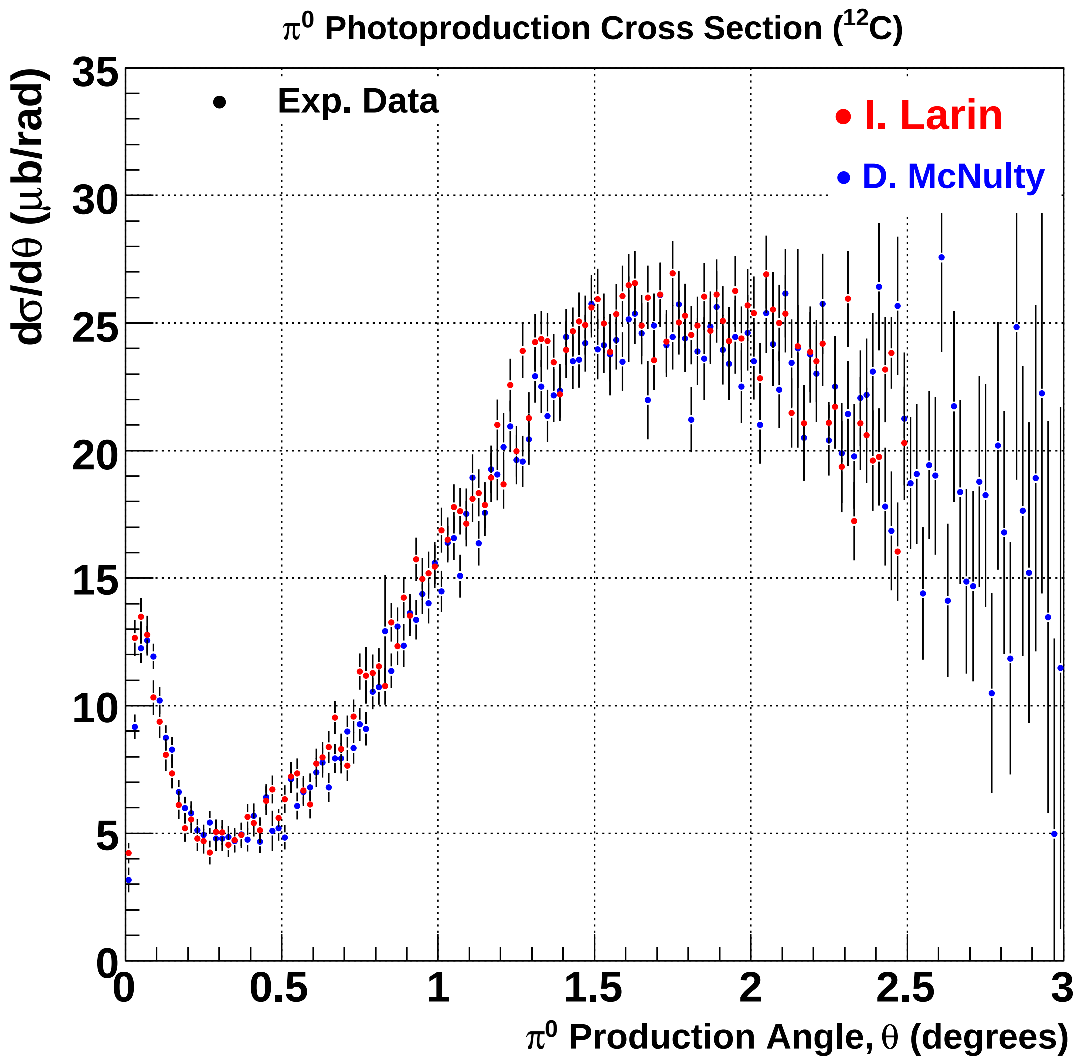


Incoherent Cross Sections

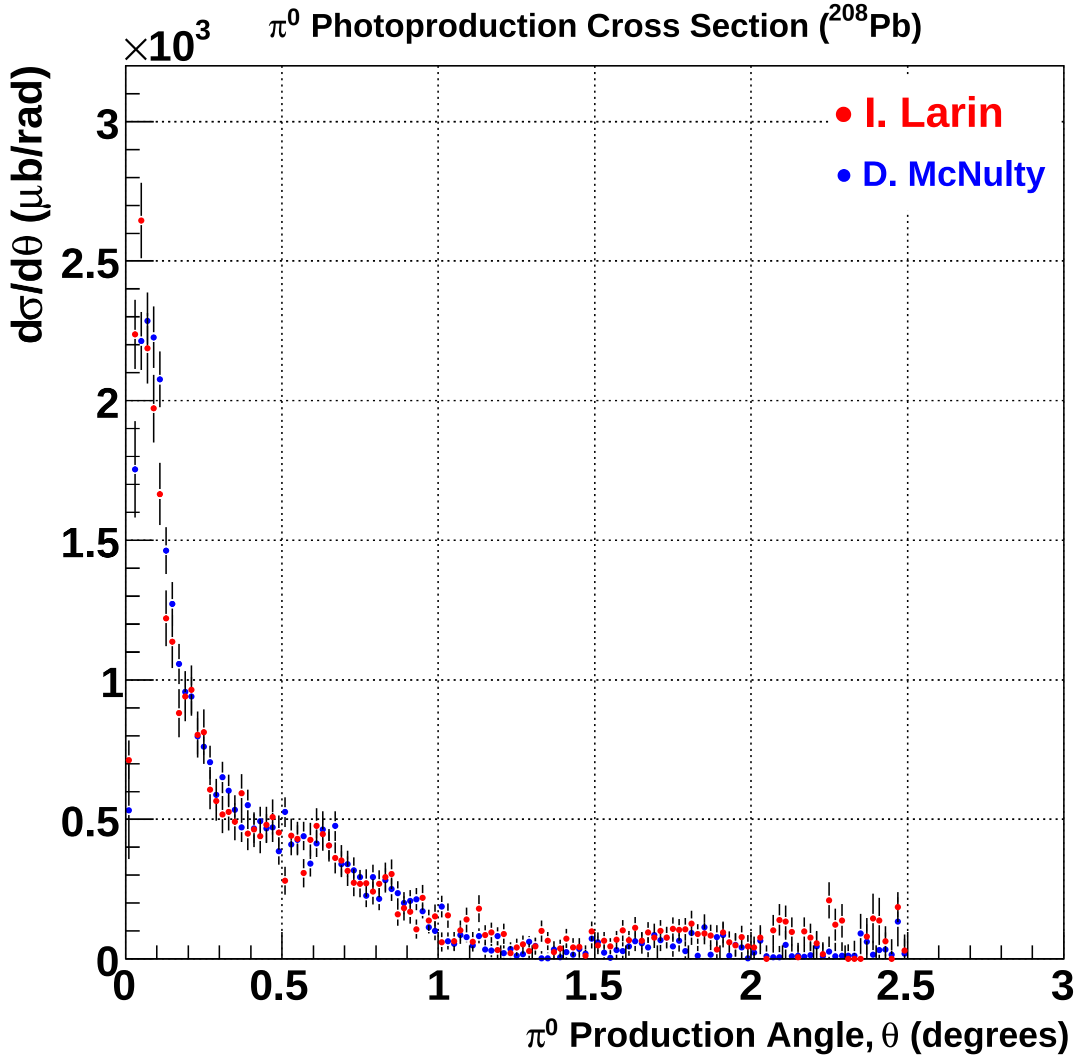




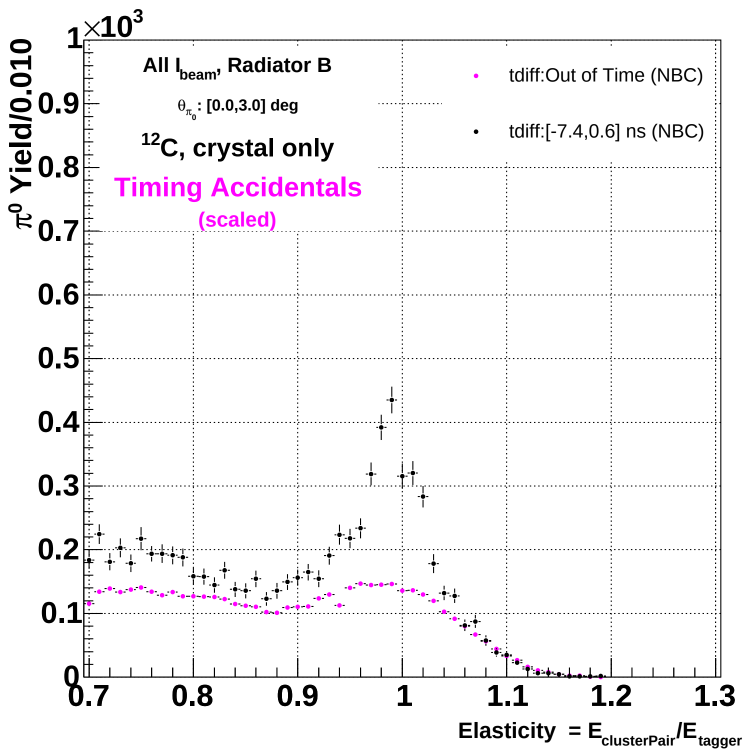
$\gamma(^{12}C, X)\pi^0$ Cross Section (Group Comparison

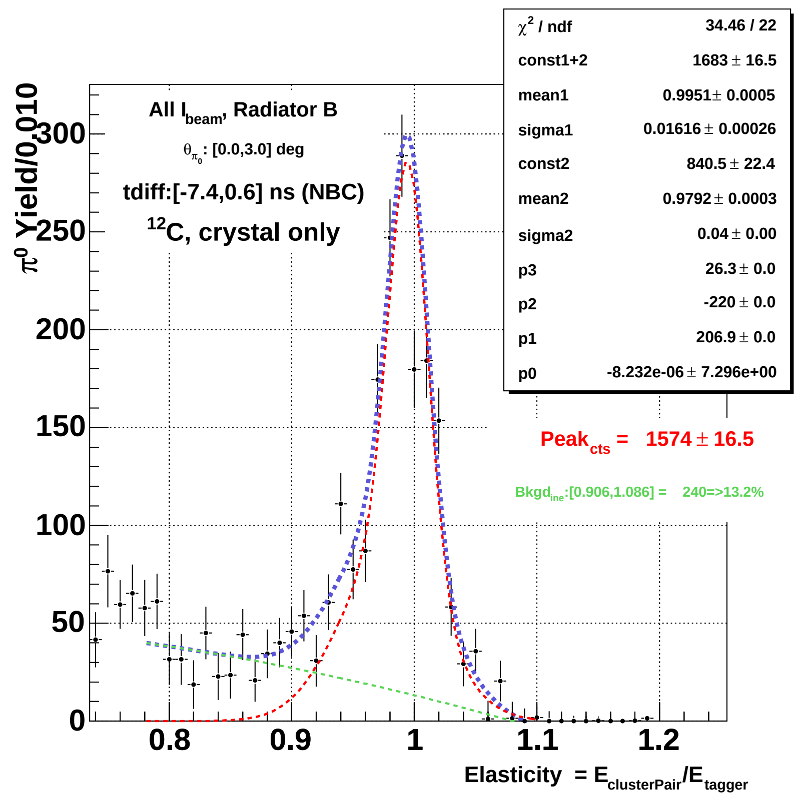


$\gamma(^{208}Pb, X)\pi^0$ Cross Section (Group Comparison)



Systematic Error: Timing Cut/Event Selection $\pm 0.30\%$



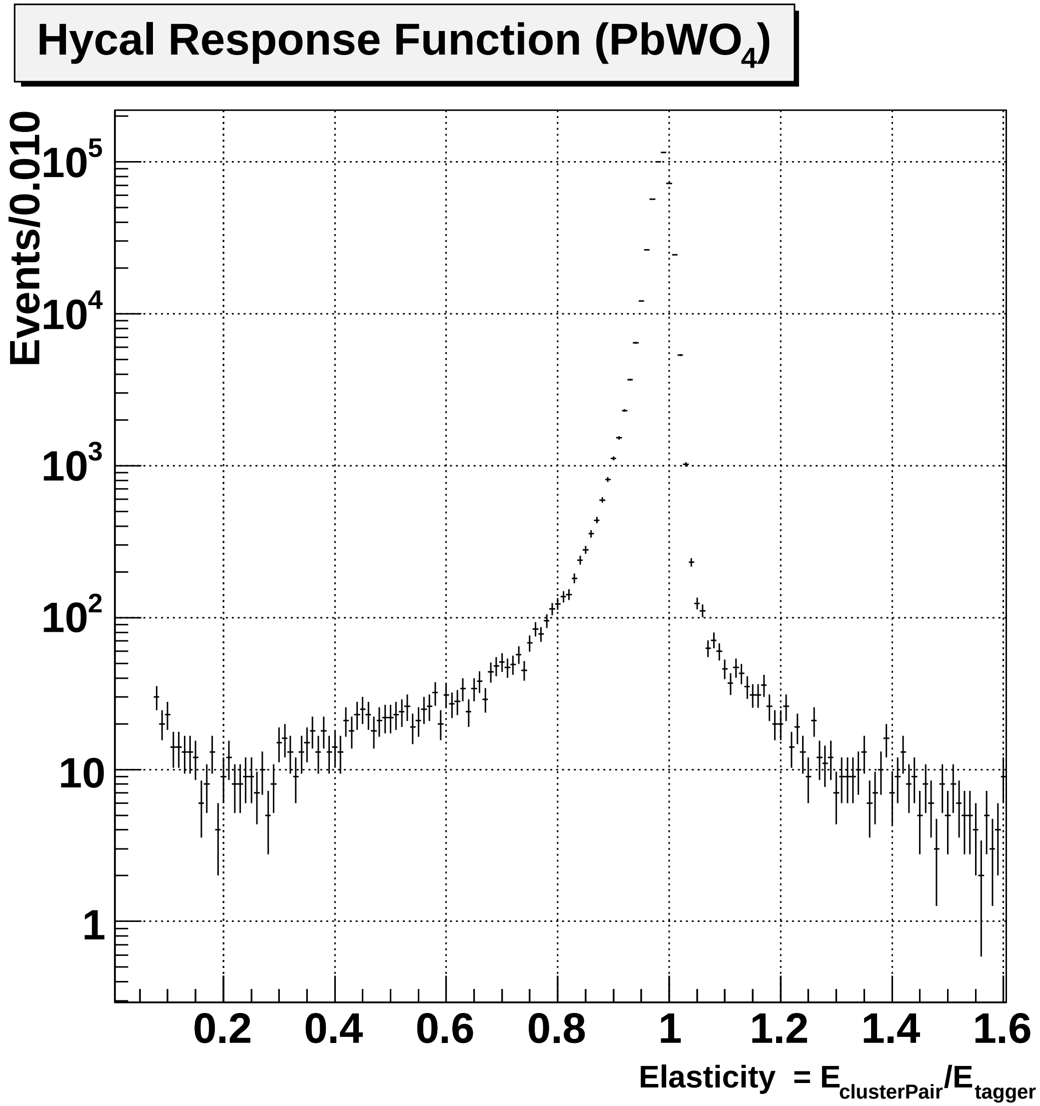


Systematic Error: Timing Cut/Event Selection $\pm 0.30\%$

Target Used	BC Fit Peak Cts: π^0's	NBC Fit Peak Cts: lost π^0's	BC Selection Cut Efficiency	Corresponding Efficiency Losses (%)
^{12}C	63924 ± 335	1574 ± 17	0.975 ± 0.0028	2.5 ± 0.3
^{208}Pb	9085 ± 107	105 ± 10	0.989 ± 0.0033	1.1 ± 0.3

Table 2: Summary of timing candidate selection efficiency for ^{12}C and ^{208}Pb

Systematic Error: Elasticity Cut ±0.25%



Systematic Error: Elasticity Cut $\pm 0.25\%$

Elasticity Cut Range	Events Lost (%)
$[0.876, 1.116]$	1.07 ± 0.16
$[0.886, 1.106]$	1.22 ± 0.17
$[0.896, 1.096]$	1.42 ± 0.18
$[0.906, 1.086]$	1.69 ± 0.20
$[0.916, 1.076]$	2.07 ± 0.22
$[0.926, 1.066]$	2.63 ± 0.25
$[0.936, 1.056]$	3.52 ± 0.28
$[0.946, 1.046]$	5.07 ± 0.34

Table 3: Table of elasticity cut ranges and corresponding efficiency losses