NPP Update Apr 10

- Generation of the "flat" events for Amptools

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Inputs (see Proposal Appendices)

$$\frac{d\sigma}{dt dm_{\pi\pi} d\phi_\sigma^{cm} d\Omega_\pi^\sigma} = \frac{1}{2(4\pi)^5} \frac{p_\pi^\sigma}{(p_\gamma^{cm})^2 s} |\sum_i \mathcal{A}^i|^2, \quad (25)$$

where the index i runs over the number of resonances or mechanisms included in the calculation. We will assume that we can parameterize each production amplitude as a factorized product

$$\mathcal{A}^i = \mathcal{A}_t(t)^i \, \mathcal{A}_W(m_{\pi\pi})^i \, \mathcal{A}_\tau(\Phi, \phi, \theta)^i. \quad (26)$$

Primakoff

$$\frac{d^2\sigma}{d\Omega_{\pi\pi} dW_{\pi\pi}} = \frac{2\alpha Z^2}{\pi^2} \frac{E_\gamma^4 \beta^2}{W_{\pi\pi}} \frac{\sin^2\theta_{\pi\pi}}{Q^4} |F(Q^2)|^2 \sigma(\gamma\gamma \to \pi\pi)(1 + P_\gamma \cos 2\phi_{\pi\pi}) \quad (8)$$

$f_0(500)$

$$\mathcal{A}_W(m_{\pi\pi}) \sim \frac{m_{\pi\pi}}{2k} \sin\delta_0 e^{i\delta_0} \left(\alpha_1 + \alpha_2 m_{\pi\pi}^2\right) + \cos\delta_0 e^{i\delta_0} \left(\alpha_3 + \alpha_4 m_{\pi\pi}^2\right), \quad (27)$$

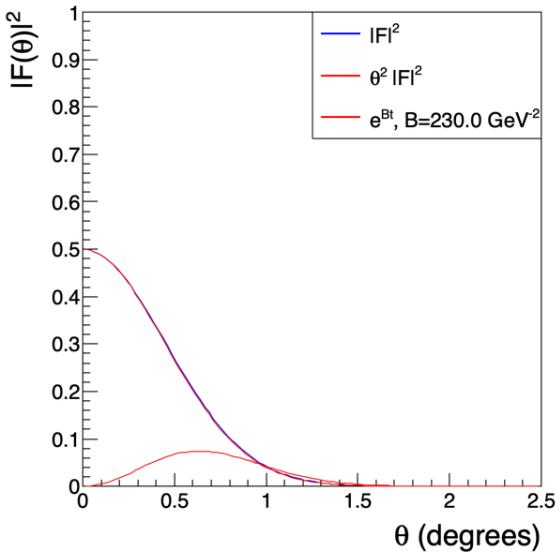
$$\mathcal{A}_\tau \propto (1 + \mathcal{P} \cos 2\phi_{\pi\pi}). \qquad \mathcal{A}_t(t) \sim \text{Strong FF}(\theta_{\pi\pi})$$

Parameterization of strong FF for π^0

$$\frac{d^3\sigma}{d\Omega_\pi} = \frac{d\sigma_P}{d\Omega} + \frac{d\sigma_C}{d\Omega} + \frac{d\sigma_I}{d\Omega} + 2 \cdot \sqrt{\frac{d\sigma_P}{d\Omega} \cdot \frac{d\sigma_C}{d\Omega}} cos(\phi_1 + \phi_2) \qquad (4)$$

where the Primakoff cross section, $\frac{d\sigma_P}{d\Omega}$, is given by equation (3). The nuclear coherent cross section is given by:

$$\frac{d\sigma_C}{d\Omega} = C \cdot A^2 |F_N(Q)|^2 sin^2\theta_\pi \qquad (5)$$



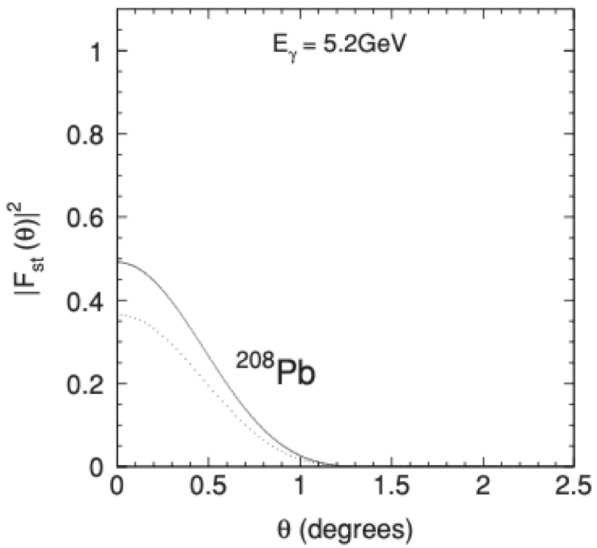
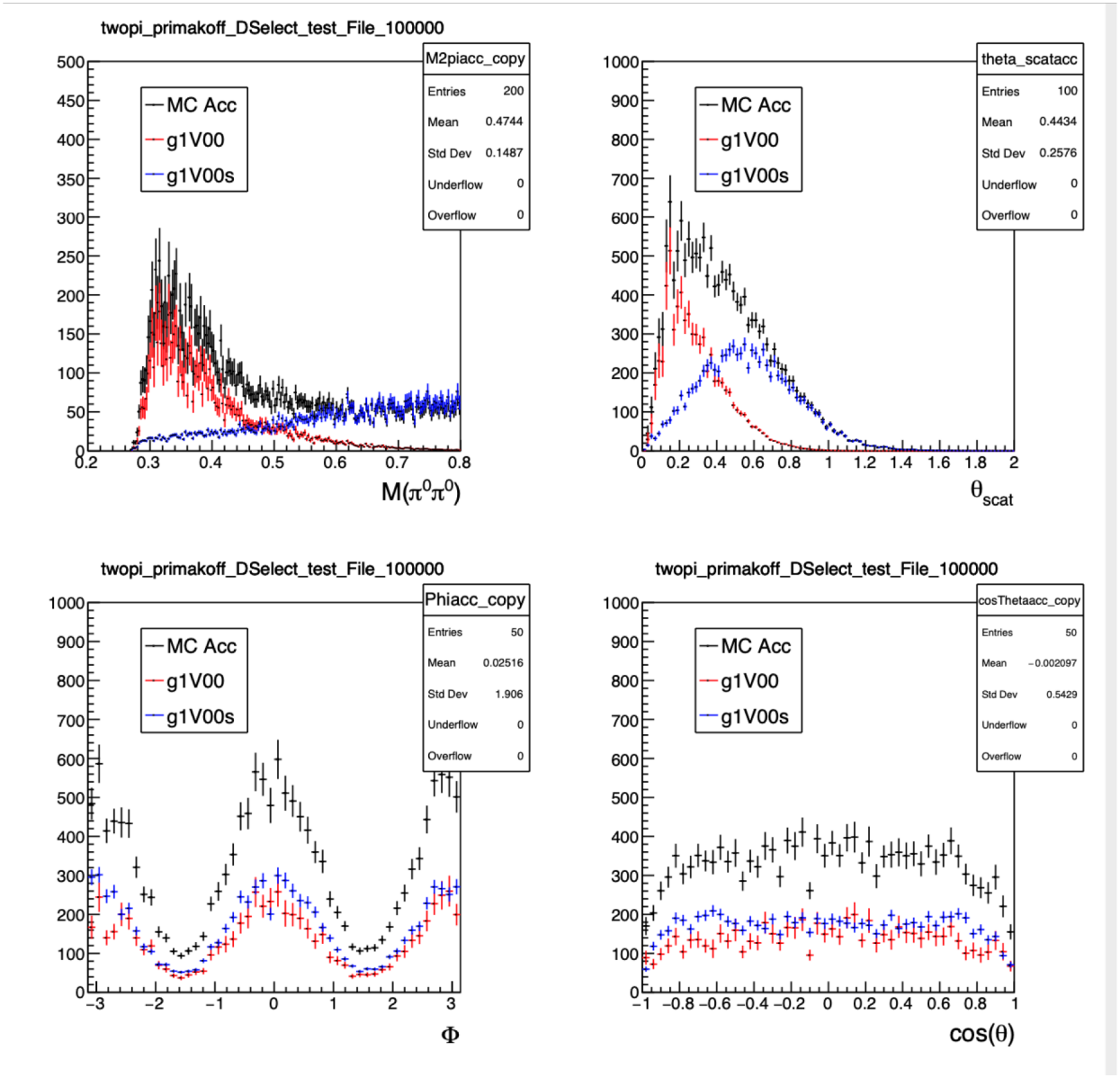


FIG. 6. Square of the strong form factor for lead without shadowing ($w = 0$, solid line) and with maximal photon shadowing ($w = 1$, dotted line).

AmpTools configuration file

```
# sum includes s-wave and p-wave production of pi+pi-
sum Primakoff Aplus
sum Primakoff Aminus

genmc Primakoff ROOTDataReader treeFlat_gen_2pi0_primakoff_test_flat_100000_amptools.root
accmc Primakoff ROOTDataReader treeFlat_DSelector_Z2pi0_trees_test_flat_100000_amptools.root
data  Primakoff ROOTDataReader treeFlat_DSelector_Z2pi0_trees_test_signal_100000_amptools_InTime.root
bkgnd  Primakoff ROOTDataReader treeFlat_DSelector_Z2pi0_trees_p1_signal_100000_amptools_OutTime.root

define Bgen 20.0
amplitude Primakoff::Aplus::g1V00 TwoPiAngles_primakoff phipol polFrac 0 0 flat
amplitude Primakoff::Aplus::g1V00 TwoPiWt_primakoff 9.6 0.028 Bgen 1 2
amplitude Primakoff::Aplus::g1V00s TwoPiAngles_primakoff phipol polFrac 0 0 flat
amplitude Primakoff::Aplus::g1V00s TwoPiWt_sigma 1.29 0. 1 2
amplitude Primakoff::Aplus::g1V00s TwoPitdist 50. Bgen 1 2

amplitude Primakoff::Aminus::g1V00 TwoPiAngles_primakoff phipol polFrac 0 1 flat
amplitude Primakoff::Aminus::g1V00 TwoPiWt_primakoff 9.6 0.028 Bgen 1 2
amplitude Primakoff::Aminus::g1V00s TwoPiAngles_primakoff phipol polFrac 0 1 flat
amplitude Primakoff::Aminus::g1V00s TwoPiWt_sigma 1.29 0. 1 2
amplitude Primakoff::Aminus::g1V00s TwoPitdist 50. Bgen 1 2

initialize Primakoff::Aplus::g1V00 cartesian 1.0 0.0 real
initialize Primakoff::Aplus::g1V00s cartesian 14.0 0.0

constrain Primakoff::Aplus::g1V00 Primakoff::Aminus::g1V00
constrain Primakoff::Aplus::g1V00s Primakoff::Aminus::g1V00s
```

Fitted decomposition / $M_{\pi\pi}$ and $\theta_{\pi\pi}$



Summary

- Generated 10k events
  - "flat" files with B=230 GeV-2
  - "signal" = Primakoff+f0(500)
- Used AmpTools to fit the distribution
- Show the decomposition for the two amplitudes g1V00 and g1V00s

Backup

References

- PRIMEX web page at
  - https://www.jlab.org/primex/
- Gevorkyan et al., Phys Rev C 80 (2009) 055201

Strong form factor

γ A -> π^0 A

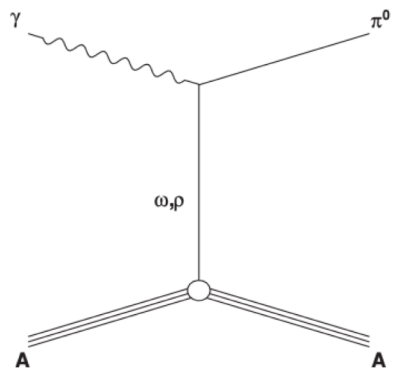


FIG. 2. Pion photoproduction in the strong field of a nucleus.

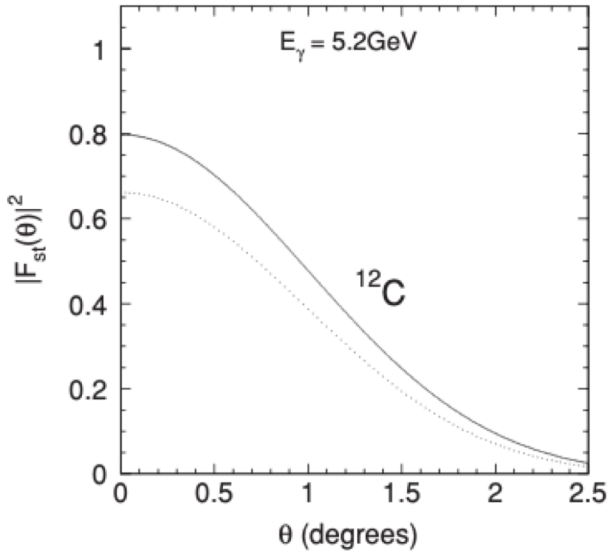


FIG. 5. Square of the strong form factor for carbon without shadowing ($w = 0$, solid line) and with maximal photon shadowing ($w = 1$, dotted line).

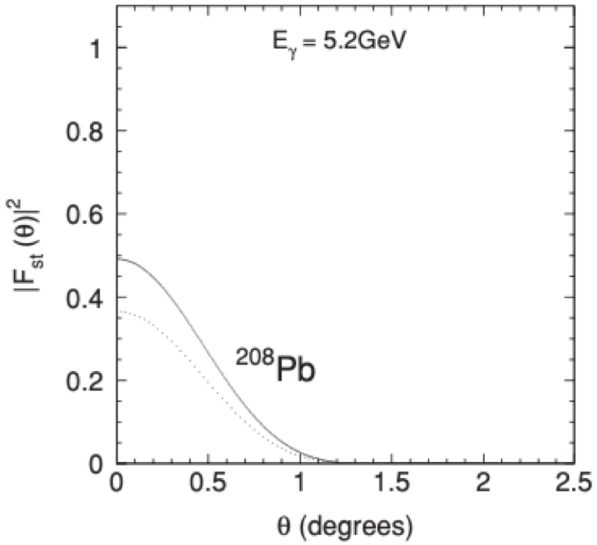


FIG. 6. Square of the strong form factor for lead without shadowing ($w = 0$, solid line) and with maximal photon shadowing ($w = 1$, dotted line).

E&M form factor

γ A -> π^0 A

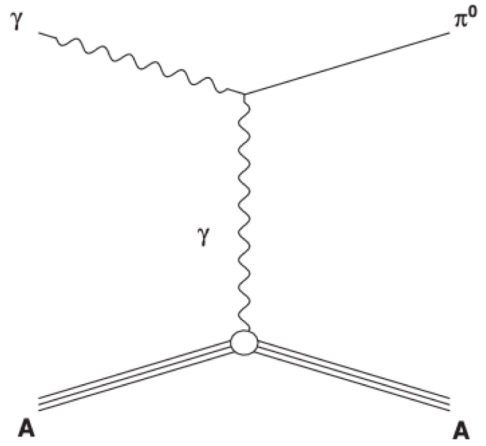


FIG. 1. Pion photoproduction in the nuclear Coulomb field.

PHYSICAL REVIEW C **80**, 055201 (2009)

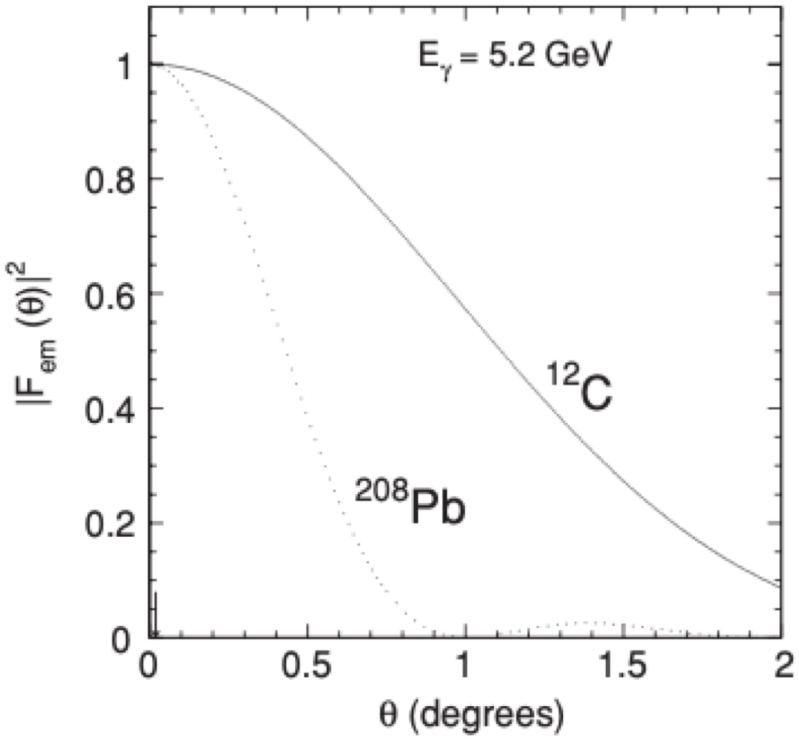


FIG. 3. Square of the electromagnetic form factor for carbon (solid line) and lead (dotted line). The arrow at $\theta_\pi = 0.02^\circ$ indicates the location of the Primakoff peak for the two nuclei.