Extraction of the $\gamma\gamma \to \pi^+\pi^-$ contribution

May 9, 2013

Let's assume that N is the flux-normalized unpolarized yield of the events that we selected as the events corresponding to $\pi^+\pi^-$ production. Then,

$$N = \varepsilon_{\pi\pi} N_{\pi\pi} + \varepsilon_\rho N_\rho + \varepsilon_{\mu\mu} N_{\mu\mu} \tag{1}$$

where $N_{\pi\pi}$, N_ρ, $N_{\mu\mu}$ and $\varepsilon_{\pi\pi}$, ε_ρ, $\varepsilon_{\mu\mu}$ are contributions and detection efficiencies of the Primakoff $\pi^+\pi^-$ photoproduction, coherent ρ^0 and coherent $\mu^+\mu^-$, respectively. We know that (or assume that?) for a given E_γ and $\theta_{\pi\pi}$

$$N^{pol}_{\pi\pi}(\varphi) \propto N_{\pi\pi}(1 - P_\gamma \cos 2\varphi) \tag{2}$$
$$N^{pol}_{\rho}(\varphi) \propto N_{\rho} \tag{3}$$
$$N^{pol}_{\mu\mu}(\varphi) \propto N_{\mu\mu}(1 + P_\gamma \cos 2\varphi) \tag{4}$$

and

$$N^{pol}_{\pi\pi}(\psi) \propto N_{\pi\pi} \tag{5}$$
$$N^{pol}_{\rho}(\psi) \propto N_{\rho}(1 + P_\gamma \cos 2\psi) \tag{6}$$
$$N^{pol}_{\mu\mu}(\psi) \propto N_{\mu\mu} \tag{7}$$

We can measure φ- and ψ-dependences $N^h(\varphi)$, $N^h(\psi)$ and $N^v(\varphi)$, $N^v(\psi)$ of the $\pi^+\pi^-$ yields for horizontally and vertically polarized photons. Assuming that the photon polarization degree P_γ does not depend on the polarization state, one can write

$$N^h(\varphi) = \varepsilon_{\pi\pi}(\varphi) N_{\pi\pi}(1 - P_\gamma \cos 2\varphi) + \varepsilon_\rho(\varphi) N_\rho + \varepsilon_{\mu\mu}(\varphi) N_{\mu\mu}(1 + P_\gamma \cos 2\varphi) \tag{8}$$
$$N^v(\varphi) = \varepsilon_{\pi\pi}(\varphi) N_{\pi\pi}(1 + P_\gamma \cos 2\varphi) + \varepsilon_\rho(\varphi) N_\rho + \varepsilon_{\mu\mu}(\varphi) N_{\mu\mu}(1 - P_\gamma \cos 2\varphi) \tag{9}$$
$$N^h(\psi) = \varepsilon_{\pi\pi}(\psi) N_{\pi\pi} + \varepsilon_\rho(\psi) N_\rho(1 + P_\gamma \cos 2\psi) + \varepsilon_{\mu\mu}(\psi) N_{\mu\mu} \tag{10}$$
$$N^v(\psi) = \varepsilon_{\pi\pi}(\psi) N_{\pi\pi} + \varepsilon_\rho(\psi) N_\rho(1 - P_\gamma \cos 2\psi) + \varepsilon_{\mu\mu}(\psi) N_{\mu\mu} \tag{11}$$

From this we get

$$N^v(\varphi) + N^h(\varphi) = 2\varepsilon_{\pi\pi}(\varphi) N_{\pi\pi} + 2\varepsilon_\rho(\varphi) N_\rho + 2\varepsilon_{\mu\mu}(\varphi) N_{\mu\mu} \tag{12}$$
$$N^v(\varphi) - N^h(\varphi) = 2\varepsilon_{\pi\pi}(\varphi) N_{\pi\pi} P_\gamma \cos 2\varphi - 2\varepsilon_{\mu\mu}(\varphi) N_{\mu\mu} P_\gamma \cos 2\varphi \tag{13}$$
$$N^h(\psi) + N^v(\psi) = 2\varepsilon_{\pi\pi}(\psi) N_{\pi\pi} + 2\varepsilon_\rho(\psi) N_\rho + 2\varepsilon_{\mu\mu}(\psi) N_{\mu\mu} \tag{14}$$
$$N^h(\psi) - N^v(\psi) = 2\varepsilon_\rho(\psi) N_\rho P_\gamma \cos 2\psi \tag{15}$$

Solving this system of equations we get

$$\frac{N^v(\varphi) - N^h(\varphi)}{N^v(\varphi) + N^h(\varphi)} = \left[\frac{4\varepsilon_{\pi\pi}(\varphi) N_{\pi\pi}}{N^v(\varphi) + N^h(\varphi)} + \frac{\varepsilon_\rho(\varphi)}{\varepsilon_\rho(\psi) P_\gamma \cos 2\psi} \frac{N^h(\psi) - N^v(\psi)}{N^h(\varphi) + N^v(\varphi)} - 1\right] P_\gamma \cos 2\varphi \tag{16}$$

This equation means that for extraction $N_{\pi\pi}$ we need to use a 2d fit. In the case of the ε not depending neither on φ nor on ψ, the Eqn. (16) simplifies to the form

$$\frac{N^v(\varphi) - N^h(\varphi)}{N^v + N^h} = \left[2\varepsilon_{\pi\pi} f_{\pi\pi} + f'_\rho - 1\right] P_\gamma \cos 2\varphi \tag{17}$$

$$\frac{N^h(\psi) - N^v(\psi)}{N^h + N^v} = f'_\rho P_\gamma \cos 2\psi \tag{18}$$

$$f_{\pi\pi} = \frac{N_{\pi\pi}}{N^v + N^h} \tag{19}$$

In this case, we cat extraction the $\pi\pi$ contribution from the 2 1d independent fits (17) and (18).

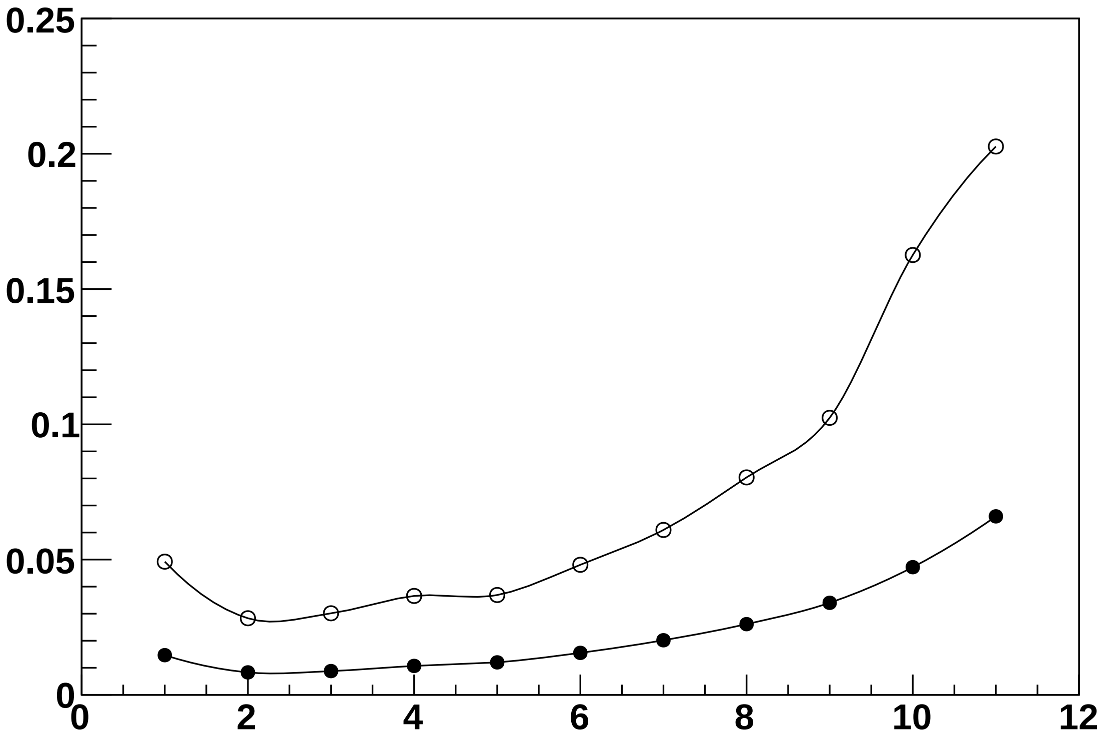

Fig. 1: Ralative error for the extracted $f_{\pi\pi}$ as a function of $W_{\pi\pi}$. Open circles: contribution of $N_{\mu\mu} = 10N_{\pi\pi}$, Close circles: no $\mu\mu$