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

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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,

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

where $N_{\pi\pi}$, N_ρ and $N_{\mu\mu}$ are contributions 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 $\theta_{\pi\pi}$

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

and

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

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. Omitting the constant coefficients, one can write

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

From this we get

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

Solving this system of equations we get

$$\frac{N^h(\varphi) - N^v(\varphi)}{N^h(\varphi) + N^v(\varphi)} = \cos 2\varphi \left[2f_{\pi\pi} - 1 - \frac{1}{\cos 2\psi}\frac{N^h(\psi) - N^v(\psi)}{N^h(\psi) + N^v(\psi)}\right] \tag{16}$$

where $f_{\pi\pi} = N_{\pi\pi}/N$ is the parameter that we need to find from the fit.