To: R. Edwards, and M. Pennington

From: Rory Miskimen

Subject: Theory TAC report on pion polarizability proposal PR12-13-008

This memo is in response to the theory TAC report on the pion polarizability proposal.

Regarding point (b) on page two of the report, indeed there was a mistake in my reading of the literature on this subject, and the C.M. angular distributions *are not isotropic*. Fig. 1 below shows a calculation by Barbara Pasquini for the angular distributions. In this calculation, Pasquini et al. make a partial wave expansion of the amplitude taking into account the unitarized Born contribution for the S-wave contribution. For higher partial waves they take vector-meson contributions, the Born contribution and the contribution from the $f_2$ resonance. For your convenience I'm attaching a couple of theory papers on this calculation. The second paper on "Fixed-t subtracted dispersion relations…" , Fig. 7 shows plots of the angular distributions at energies above 600 MeV.

The Pasquini calculation shows that in $\gamma\gamma \to \pi^+\pi^-$ the sensitivity to the polarizabilities comes in through a term that goes as $\alpha-\beta$ in the S-wave contribution (see Eqns. 45-47 in "Polarizability of the pion: … ") . The forward and backward peaks in the cross section result from pion pole amplitudes (Born terms), where there should be no sensitivity to the polarizabilities.

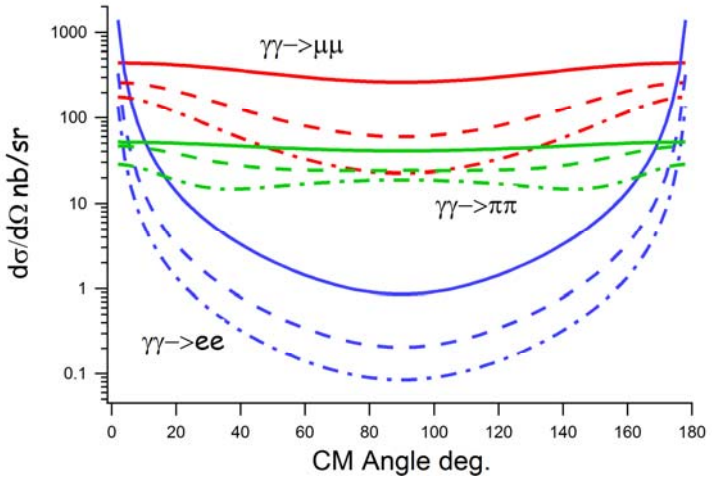


Fig. 1. The red curves are for $\gamma\gamma \to \mu^+\mu^-$, the green curves for $\gamma\gamma \to \pi^+\pi^-$, and the blue curves for $\gamma\gamma \to e^+e^-$. The solid, dashed, dash-dotted curves are for C.M. energies of 300, 400 and 500 MeV.

Fig. 2, 3, and 4 below show angular distributions at C.M. energies of 300 MeV, 400 MeV, and 500 MeV, along with an estimate of our projected data points. At energies from threshold up to about 500 MeV the distributions are approximately flat over much of the solid angle. The figure shows that our proposed measurement has good reach in $|\cos\theta|$ compared to the old Mark II data; we should be able to obtain useful data from $-.9 < \cos\theta < .9$, compared to $\pm 0.6$ for Mark II.

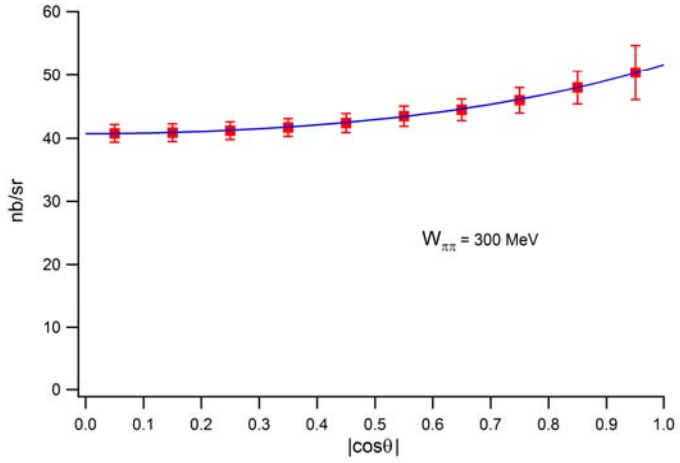


Fig. 2. Angular distribution and projected data points at C.M. energy of 300 MeV.

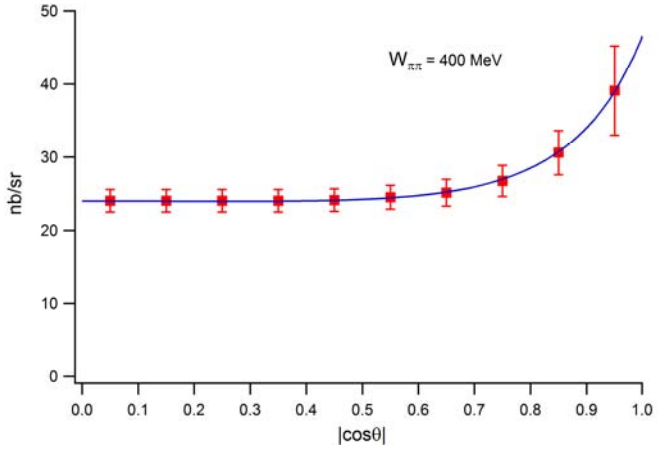


Fig. 3. Same as Fig. 2, but for 300 MeV.

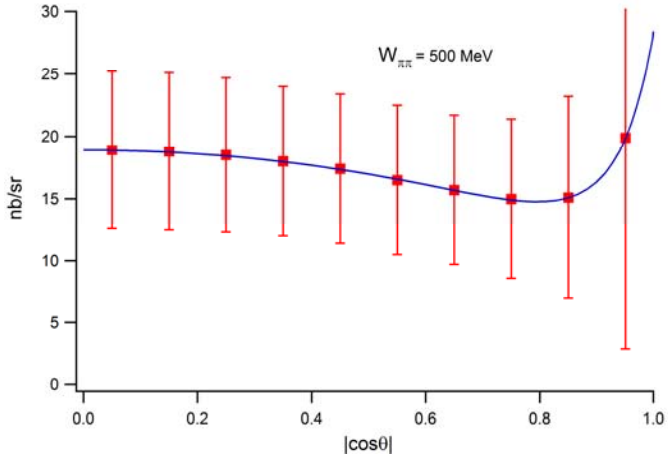


Fig. 4. Same as Fig. 2, but for 500 MeV.