Search for $\gamma\gamma \rightarrow \pi^0\pi^0$

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Introduction

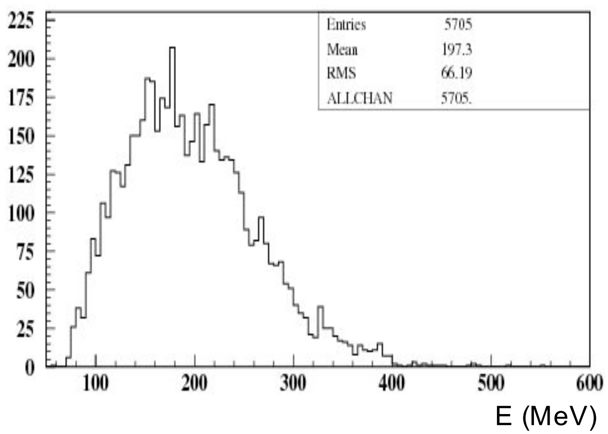
- MonteCarlo (GEANFI) generation of $\gamma\gamma \rightarrow \sigma \rightarrow \pi^0\pi^0$ events
- MonteCarlo generation of backgrounds (ALLPHI)
- Analysis of data taken at 1 GeV
- Conclusions

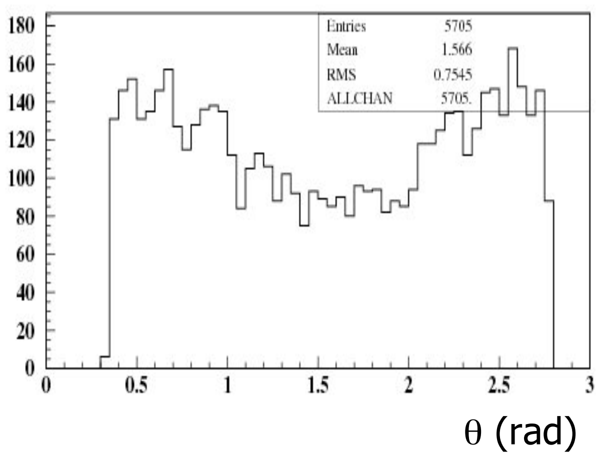
MonteCarlo generation

- 10000 events generated from MC (Breit-Wigner formula)
- Mass and width from BES measurement (m = 541 MeV, Γ = 242 MeV)
- GEANFI full simulation
- Only 4 prompt (< 5 σ_t) neutral clusters with 10 MeV minimum energy
- Polar angle between 20° and 160°: 6100 events
- trigger selected from MC (tskt) bits: 5700 events
- FILFO requirement (MC): 5400 events

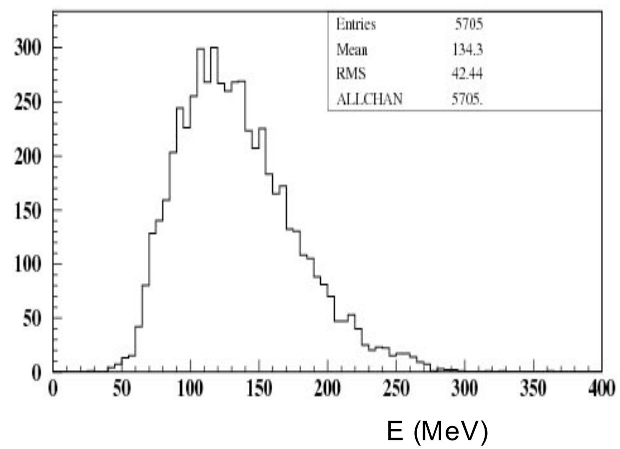
MonteCarlo generation

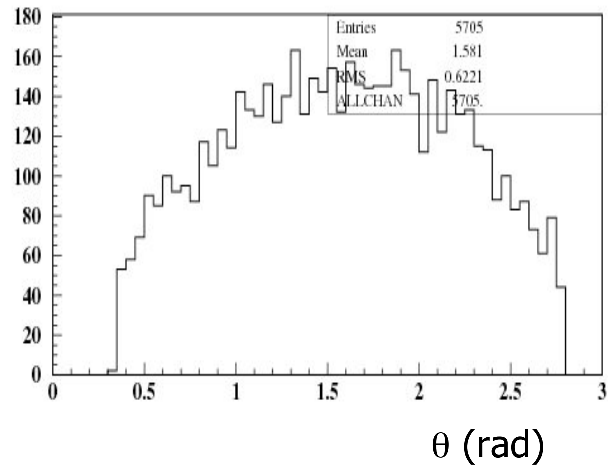
Energy and polar angle (1 Photon)





Energy and polar angle (2 Photon)

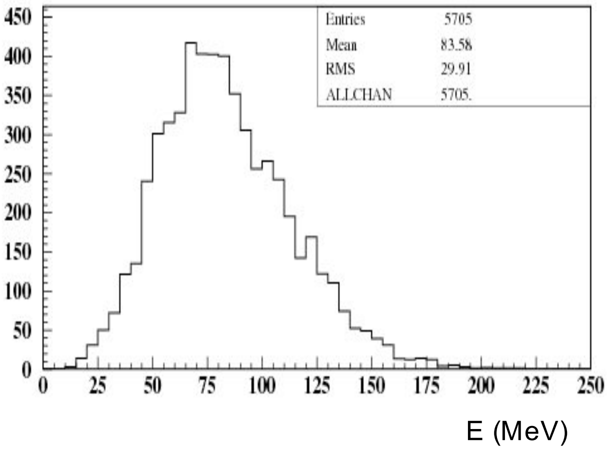


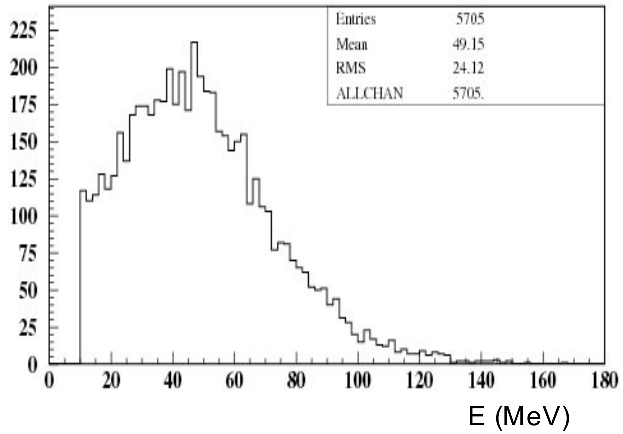


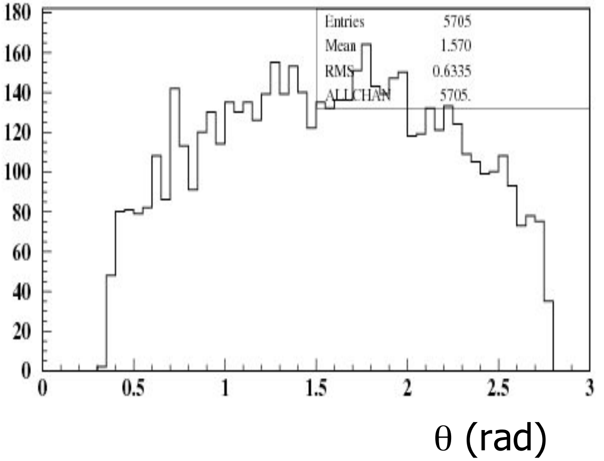
MonteCarlo generation

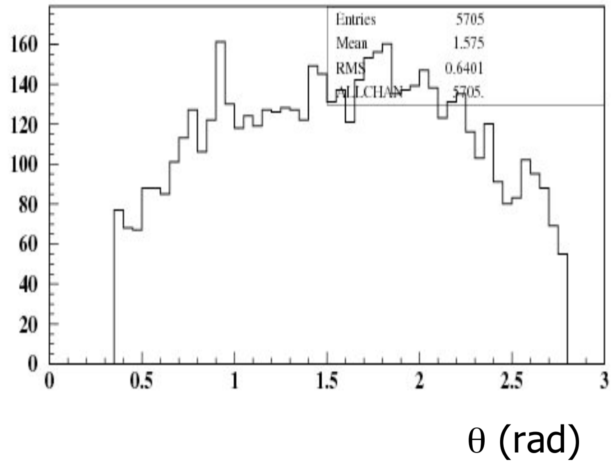
Energy and polar angle (3 Photon)

Energy and polar angle (4 Photon)



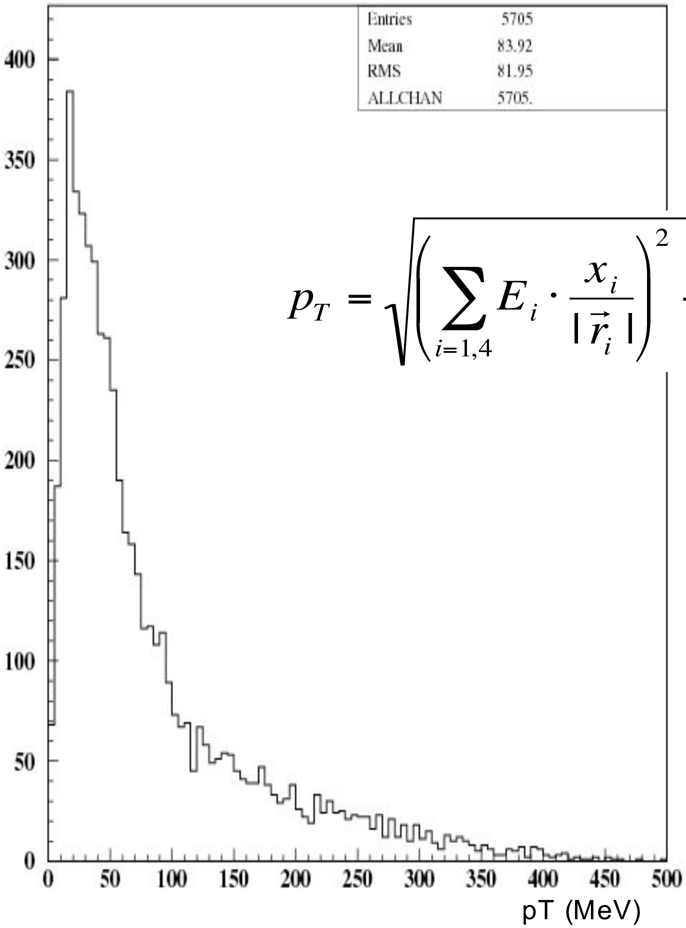




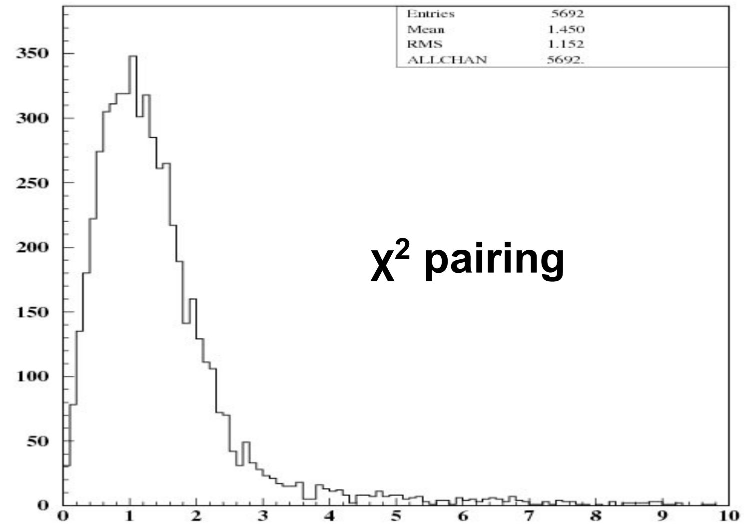


MonteCarlo generation

Transverse momentum P from cluster coordinates



$$p_T = \sqrt{\left(\sum_{i=1,4} E_i \cdot \frac{x_i}{|\vec{r}_i|}\right)^2 + \left(\sum_{i=1,4} E_i \cdot \frac{y_i}{|\vec{r}_i|}\right)^2}$$



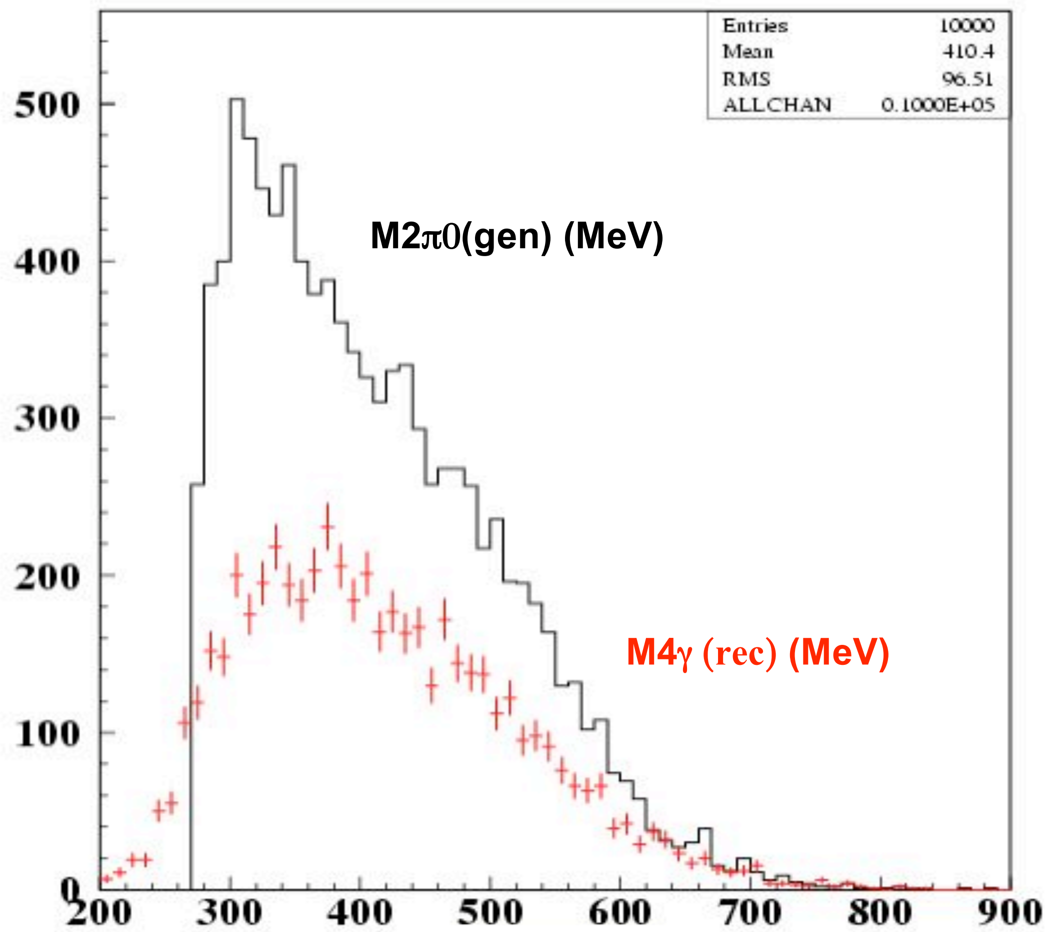
χ^2 pairing

$$\chi^2_{pair} = \left(\frac{M_{ij} - m_{\pi 0}}{\sigma(E_i, E_j)}\right)^2 + \left(\frac{M_{lk} - m_{\pi 0}}{\sigma(E_l, E_k)}\right)^2$$

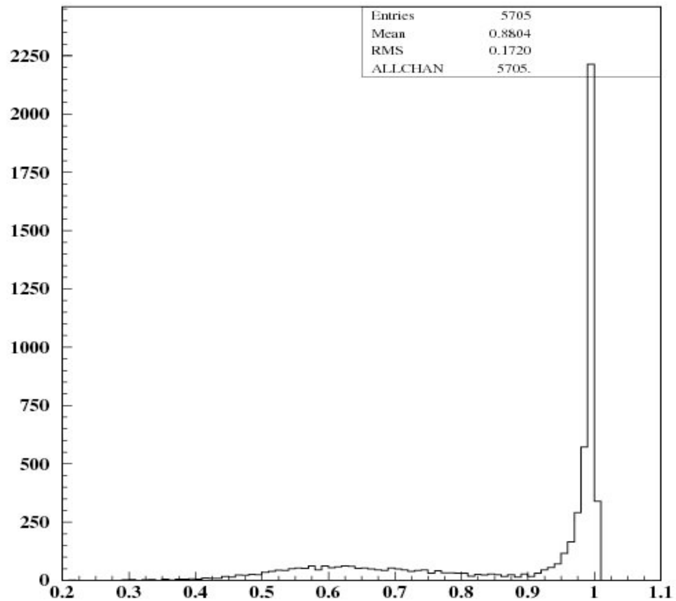
$$\frac{\sigma(E_i, E_j)}{M_{ij}} = \frac{1}{2}\left(\frac{\sigma_{E_i}}{E_i} \oplus \frac{\sigma_{E_j}}{E_j}\right)$$

MonteCarlo generation

4 Photon invariant mass



Visible energy / Total energy



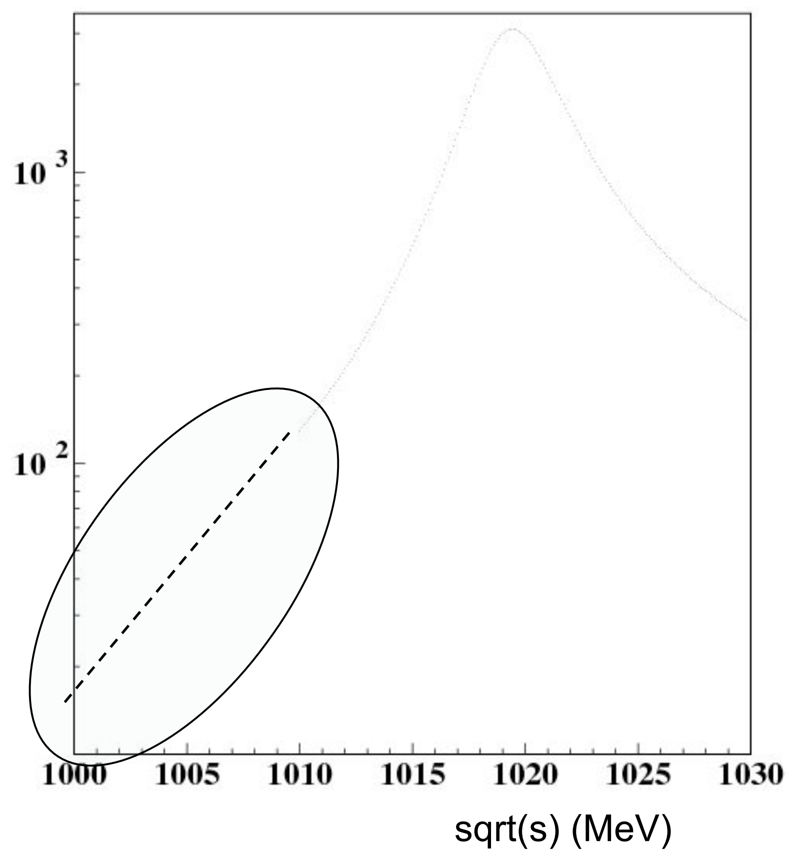
MonteCarlo background

✓ MonteCarlo simulation at Phi energy

✓ Necessity to extrapolate the right cross section for allphys events

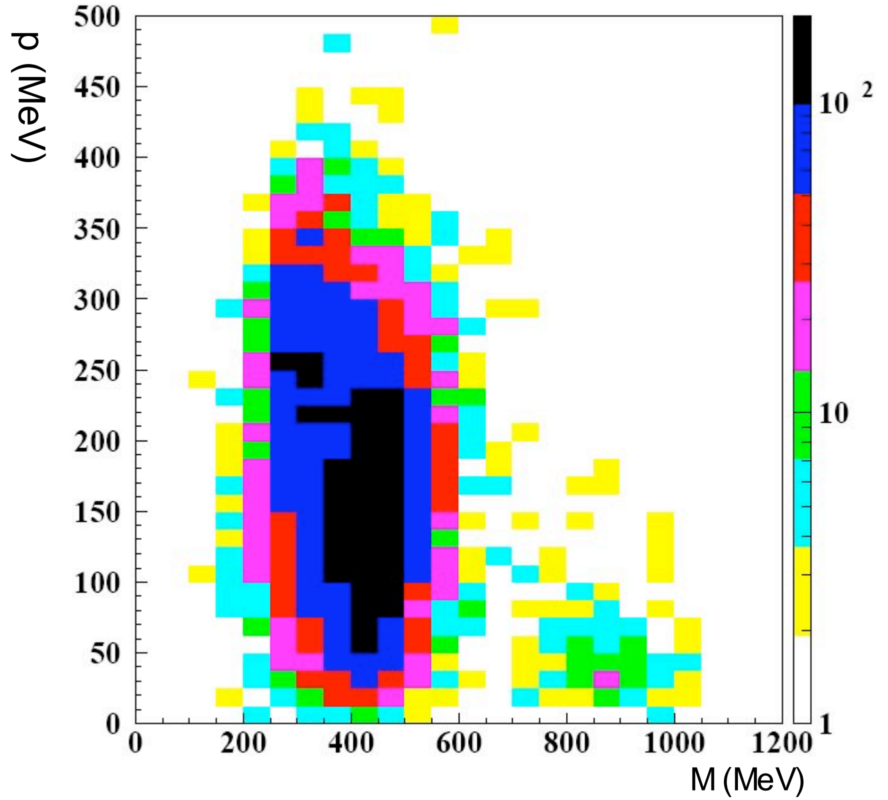
✓ Error in the cross section of Phi decays

Breit-Wigner for Phi resonance

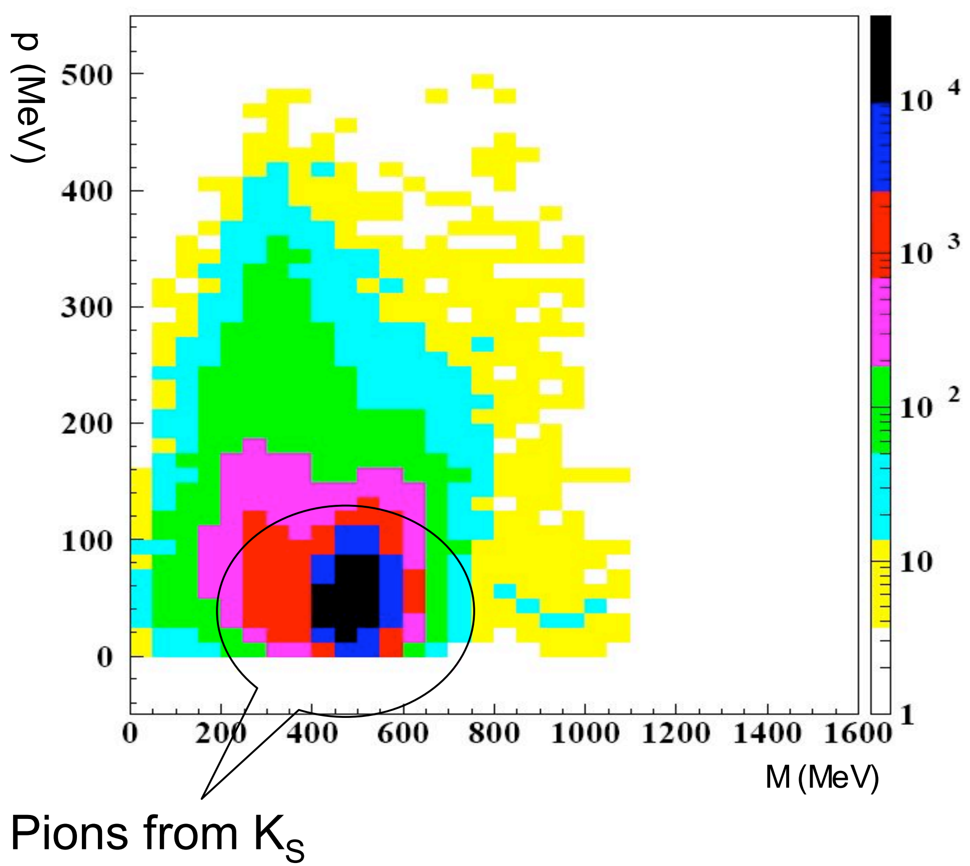


MonteCarlo background

Trasverse momentum vs 4 photon invariant mass ($\omega\pi^0$)



Trasverse momentum vs 4 photon invariant mass (allphi decays except $\omega\pi^0$)

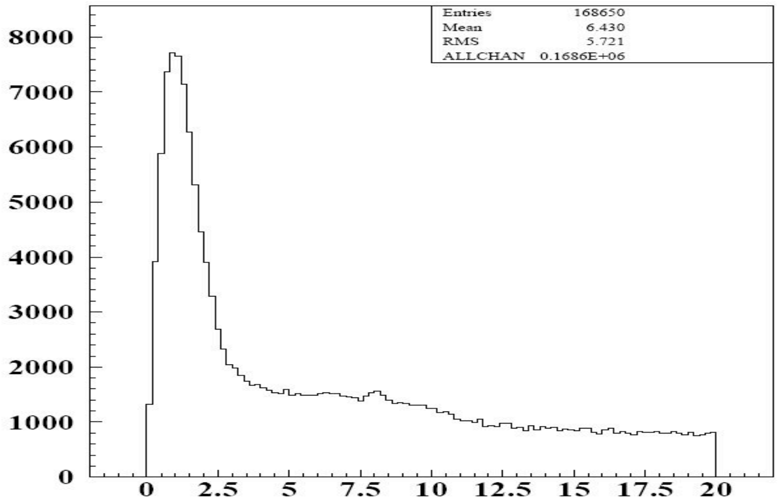


Data analysis

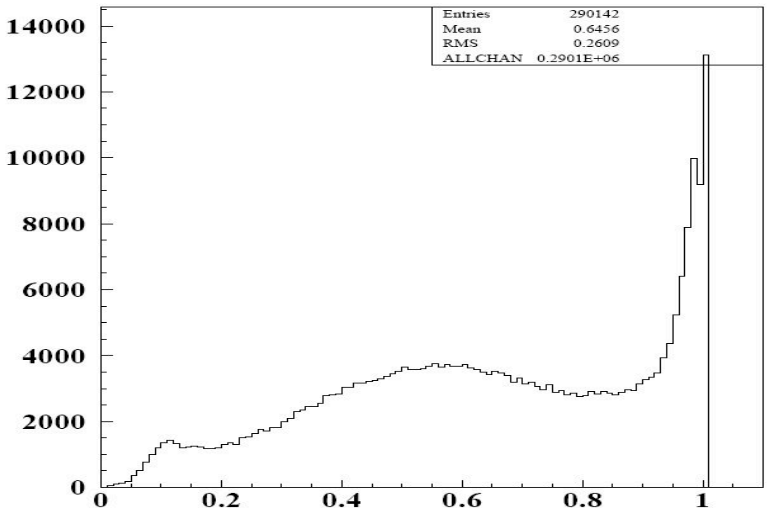
- **12 pb^{-1} of reconstructed data (ufo) at 1 GeV**
- **Only 4 clusters (neutral) “prompt”, with a minimum energy of 10 MeV.**
- **Polar angle between 20° e 160°.**

Data analysis

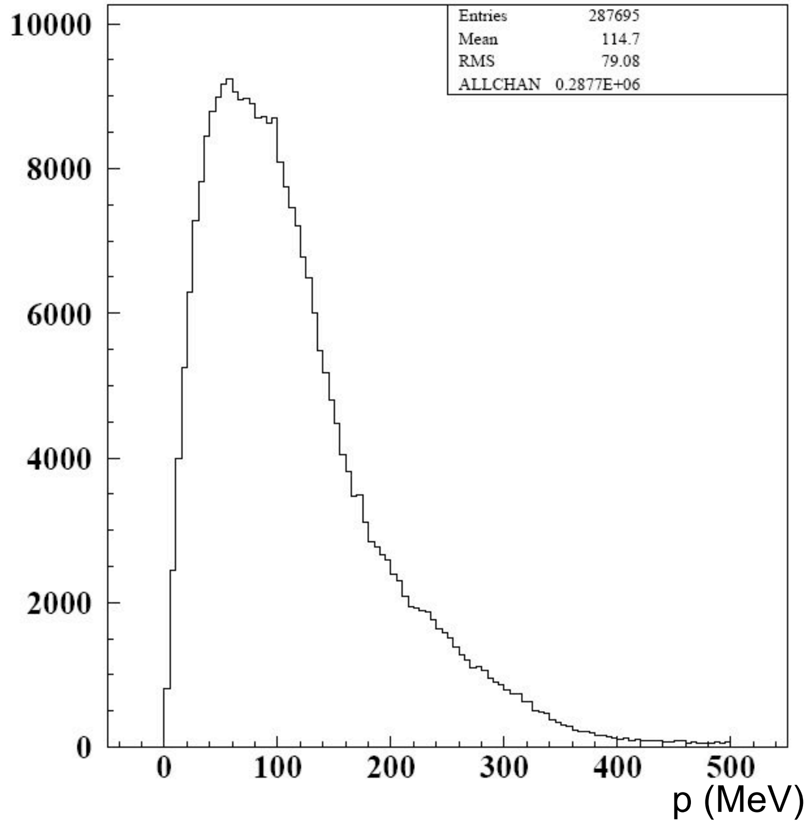
χ^2 pairing



Visible energy / Total energy

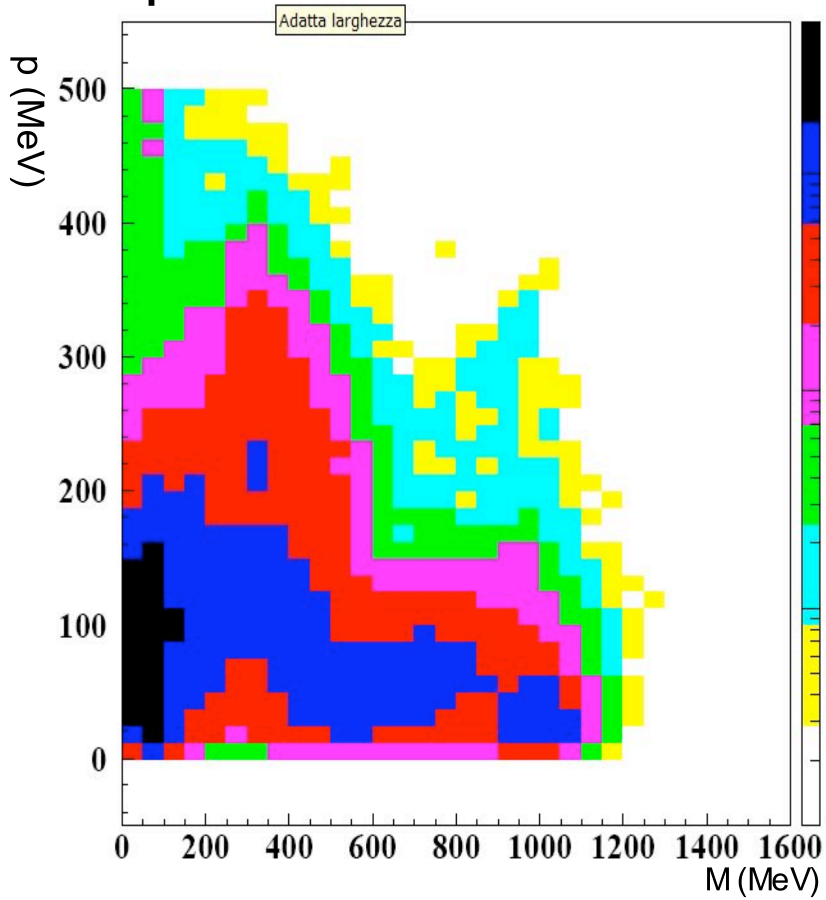


Trasverse momentum

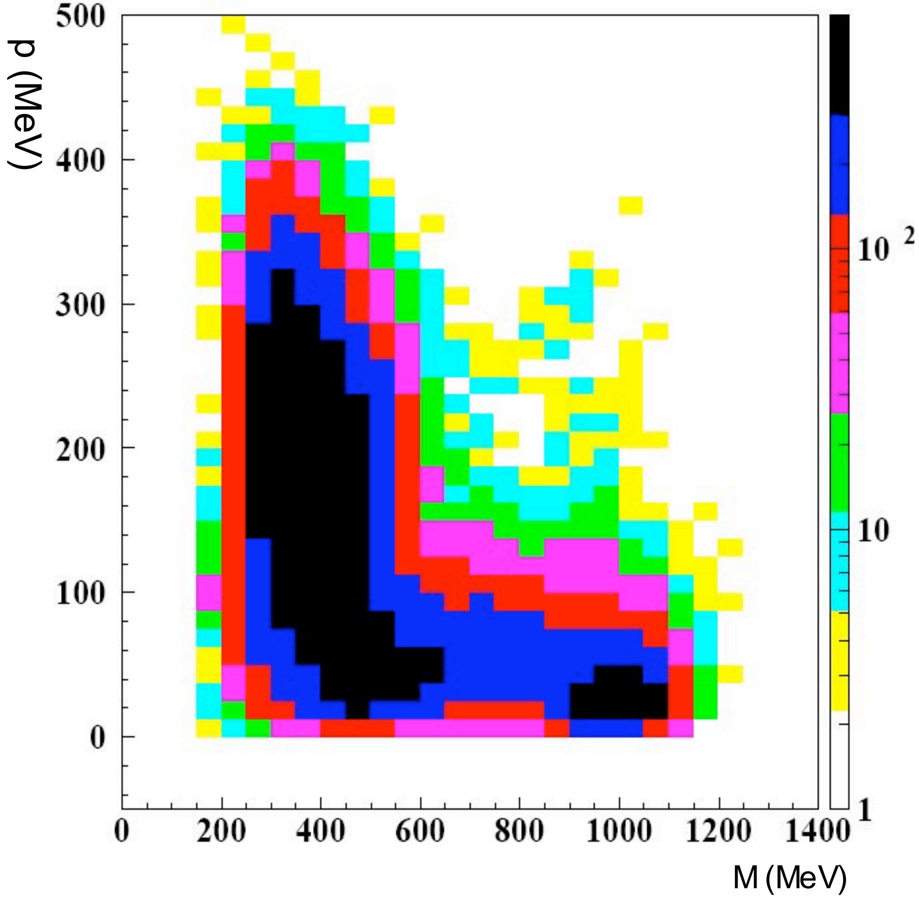


Data analysis

Trasverse momentum vs. 4 photon invariant mass

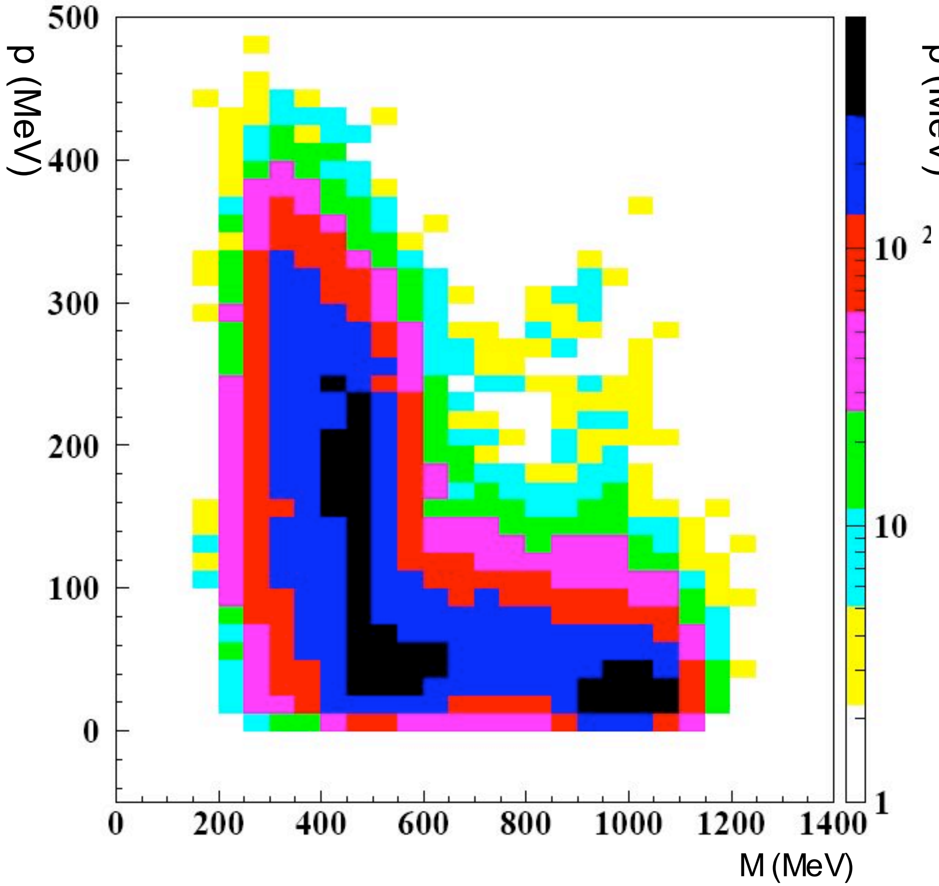


Trasverse momentum vs. 4 photon invariant mass, cut on $\chi^2 < 4$

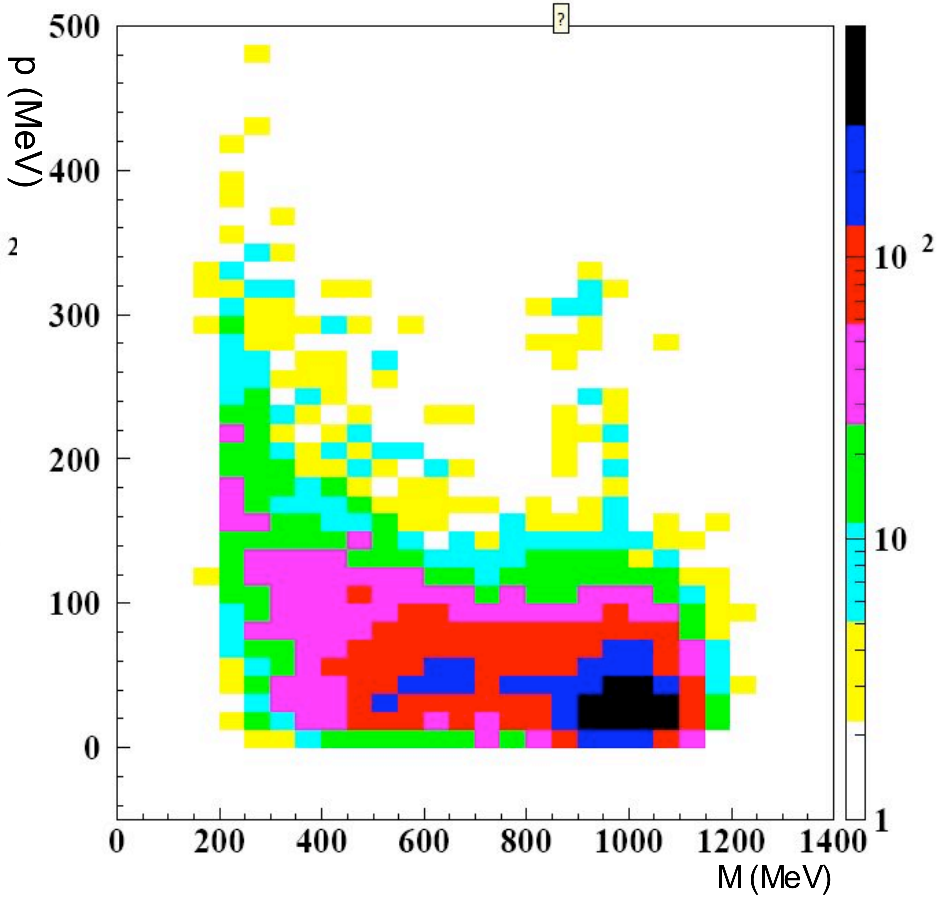


Data analysis

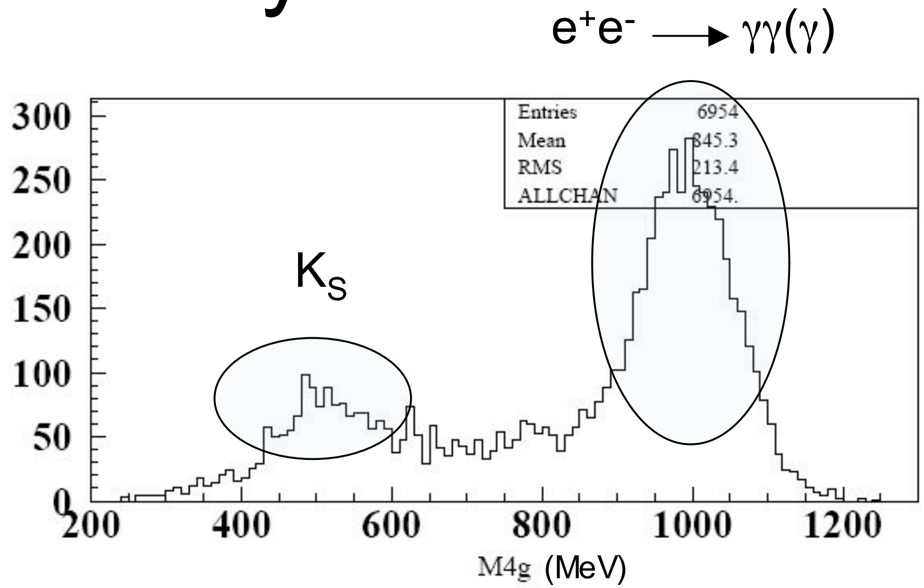
Trasverse momentum vs. 4 photon invariant mass, cut on $\chi^2 < 4$, r > 0.6



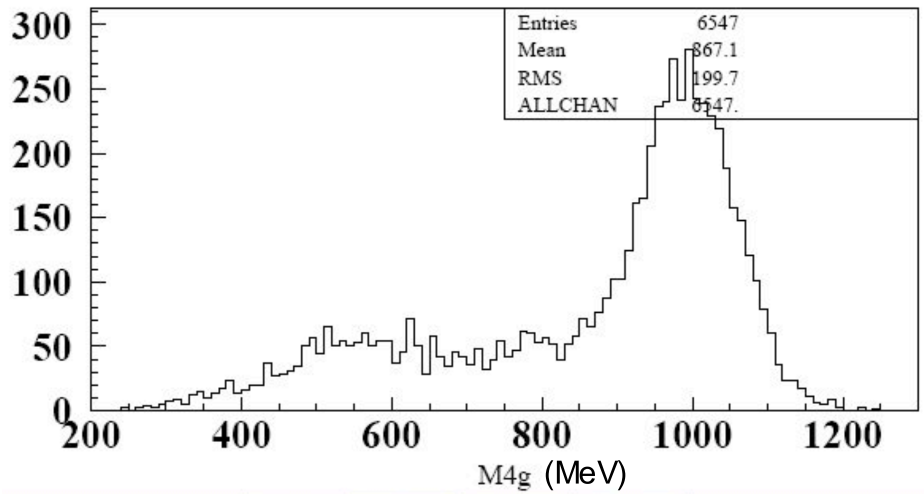
Trasverse momentum vs. 4 photon invariant mass, cut on $\chi^2 < 4$, r > 0.6, no tracks



Data analysis



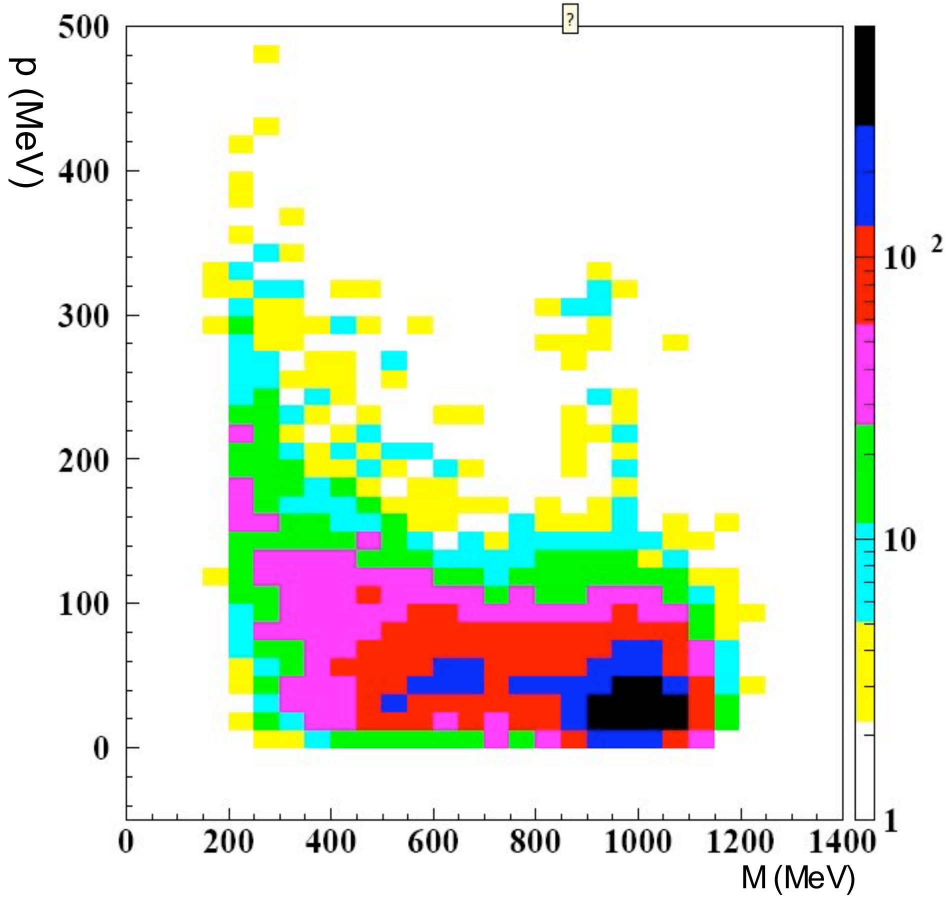
4 photon invariant mass, cut on $\chi^2 < 2.5$, missing pT <50 MeV, no tracks



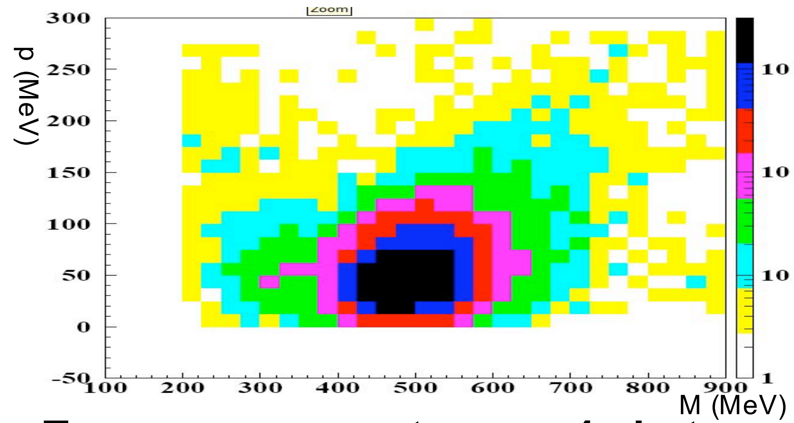
4 photon invariant mass, cut on $\chi^2 < 2.5$, r > 0.7, missing pT <50 MeV, no tracks

Conclusions

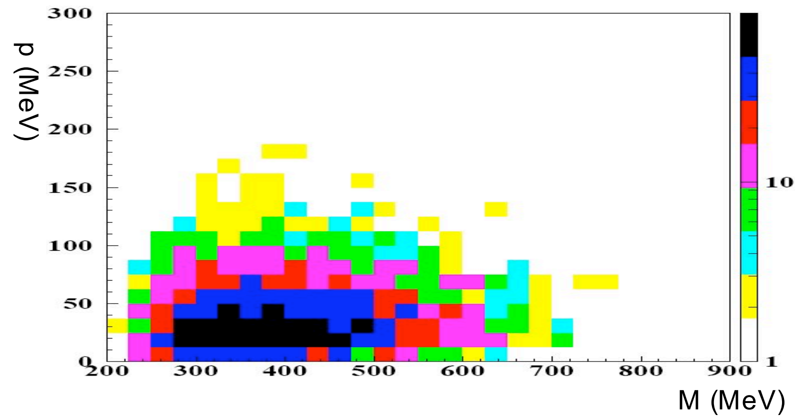
Trasverse momentum vs. 4 photon invariant mass, cut on $\chi^2 < 4$, r > 0.6, no tracks, DATA



Trasverse momentum vs. 4 photon invariant mass, cut on $\chi^2 < 4$, r > 0.6, no tracks, MC ALLPHYS



Trasverse momentum vs. 4 photon invariant mass, cut on $\chi^2 < 4$, r > 0.6, no tracks, MC SIGMA



Conclusions

✓ **Strong K_S background component. We can avoid this component through the arrival times of the clusters not "prompt". The time of arrival of K_L particles (either neutral or charged) to reach the calorimeter is more than 50 ns, while the arrival time of a prompt cluster is less then 10 ns.**

✓ **We have to calculate the QED $e^+e^- \rightarrow \gamma\gamma(\gamma)$ contribution at 1 GeV (long low mass tail)**

✓ **Expectations based on $\Gamma_{\sigma\gamma\gamma}$ coupling ~ 4 keV estimate about 500 events of sigma from 12 pb^{-1} of UFO**