Can we subtract background in $\pi^0 \rightarrow \gamma X^0$?

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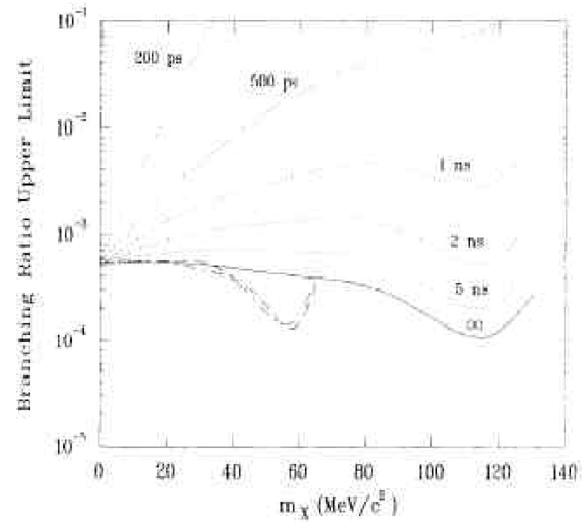
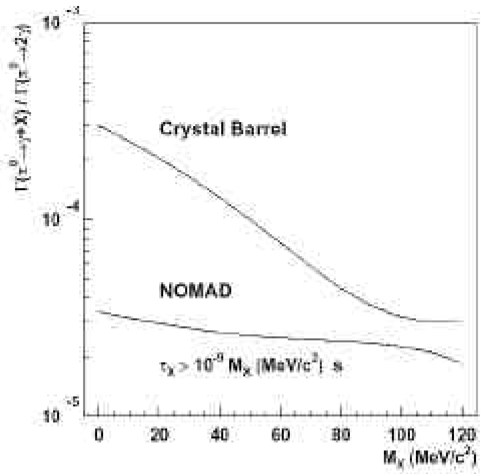
The previous E787 result on $\pi^0 \rightarrow \gamma X^0$ gave $> 2\times10^{-4}$ for the BR upper limit with the limit varying with missing mass



Later, the Crystal Barrel experiment at LEAR did somewhat better, and in 1998, the NOMAD experiment reached ~ 2-3 $\times10^{-5}$ using Primakoff detection of the X^0 through its conversion to a π^0 in the neutrino detector. This may be hard to beat.



This mode basically measures the single photon inefficiency in our detector. The PRL used 1989 data in which the best single photon inefficiency was ~ 2×10^{-4}. According to the Sasaki thesis, the comparable inefficiency in the 1996 version of the detector was $\geq 2\times10^{-5}$. Since our photon detection efficiency has improved since then maybe we could do a little better than NOMAD.

But if we could estimate the background independently, we could probably do considerably better than NOMAD. But HOW?

Here's what our bottom line looked like last time (from PRL 69, 733 (1992)). Note that the limit is obtained as a function of the missing mass squared.

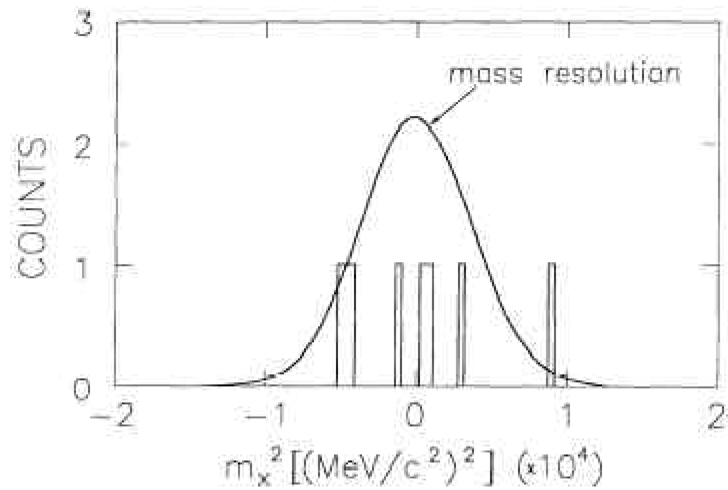


FIG. 2. Invariant missing mass squared for the surviving eight events. The solid line shows the Monte Carlo-expected mass-squared resolution for $m_X = 0$ MeV/c^2.

In an ideal case (perfect resolution), all the background events would be clustered at 0 missing mass. In fact our limit got better as the missing mass rose because of this.

What if we gave up on the missing mass ~ 0 region and used it to measure the photon inefficiency? Then we could estimate the background in the higher missing mass region.

The steps would be the following:

1. Using well-measured (0 missing mass) events, measure ε_γ
2. Using events in which both gammas are observed, find the distribution in energy and direction as a function of measured missing mass
3. Find the weighted ε_γ as a function of missing mass
4. This gives a background estimate to be subtracted