M_x^2 Resolution in $\gamma+p \rightarrow p'+X$

Can we separate eta and omega?
A semi-quantitative assessment.

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The M_x Formula for $\gamma+p \rightarrow p'+X$

$$M_x^2 = 2E_\gamma(M_p - E_{p'} + P_{p'}\cos\Theta) - 2M_pE_{p'} + 2M_p^2$$

with $E_{p'} = \mathrm{sqrt}(P_p^2 + M_p^2)$

At fixed Eg, the relationship between Θ and Pp allows us to determine Mx.

Obviously, the errors on Mx will depend on the errors on Pp, Θ, and Egamma.

The above formula is too complicated for back of the envelope estimates.
The only insights I can glean here are that probably

i. **The error on M_x^2 is going to get worse with increasing Eg**

ii. **The error on M_x^2 is going to get worse with increasing Pp'**

So let's go ahead and simulate it <u>for eta recoils.</u>

Proton Momentum Resolution

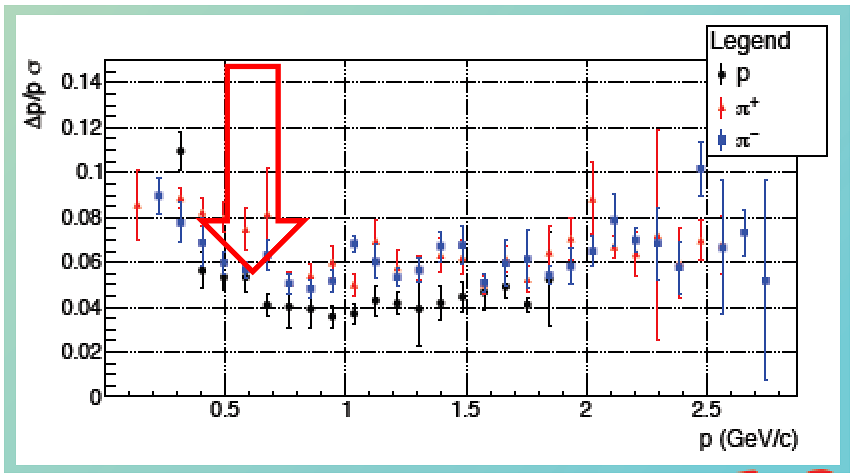
Paul Mattione studied reconstruction resolutions with current data
http://argus.phys.uregina.ca/cgi-bin/private/DocDB/ShowDocument?docid=2838

His fits are honest in that he reports an "rms" for the signal (not just the narrow core).

His resolutions will hopefully improve as corrections are made for wire sagging, etc.

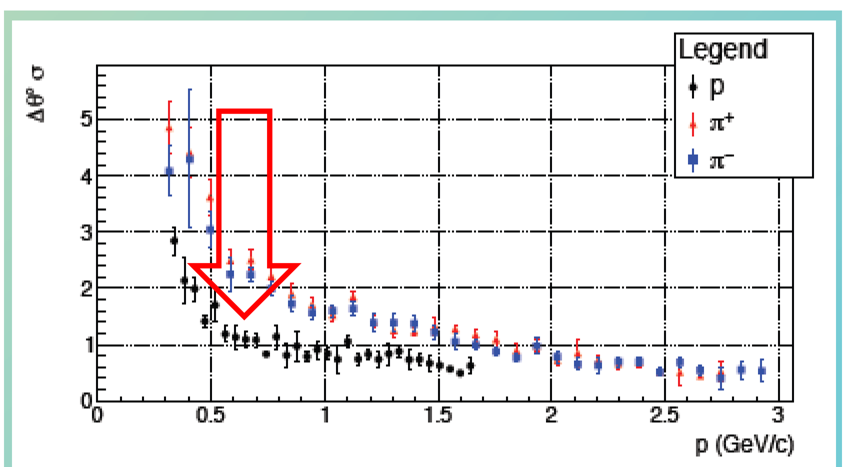
nb: The technique of using $\gamma+p \rightarrow \pi^+\pi^-(p)$ to determine the proton resolution convolutes the pion and proton resolutions (doing this in MC is easy by comparison!) so I assume Paul's resolutions are somewhat over-estimated.

Proton Resolutions



Paul's proton momentum resolution near 0.6 GeV/c is roughly 5%.

I'll use 5%/sqrt(2) = 3.5%

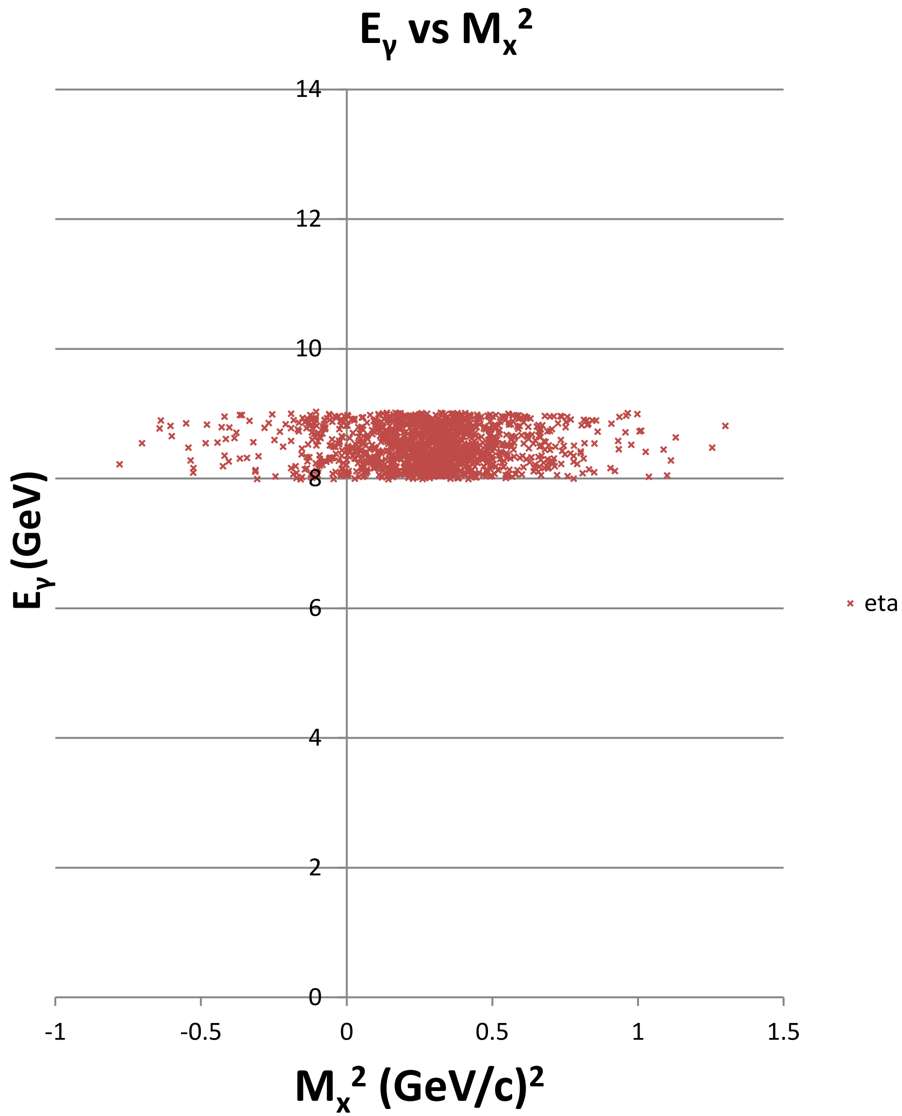


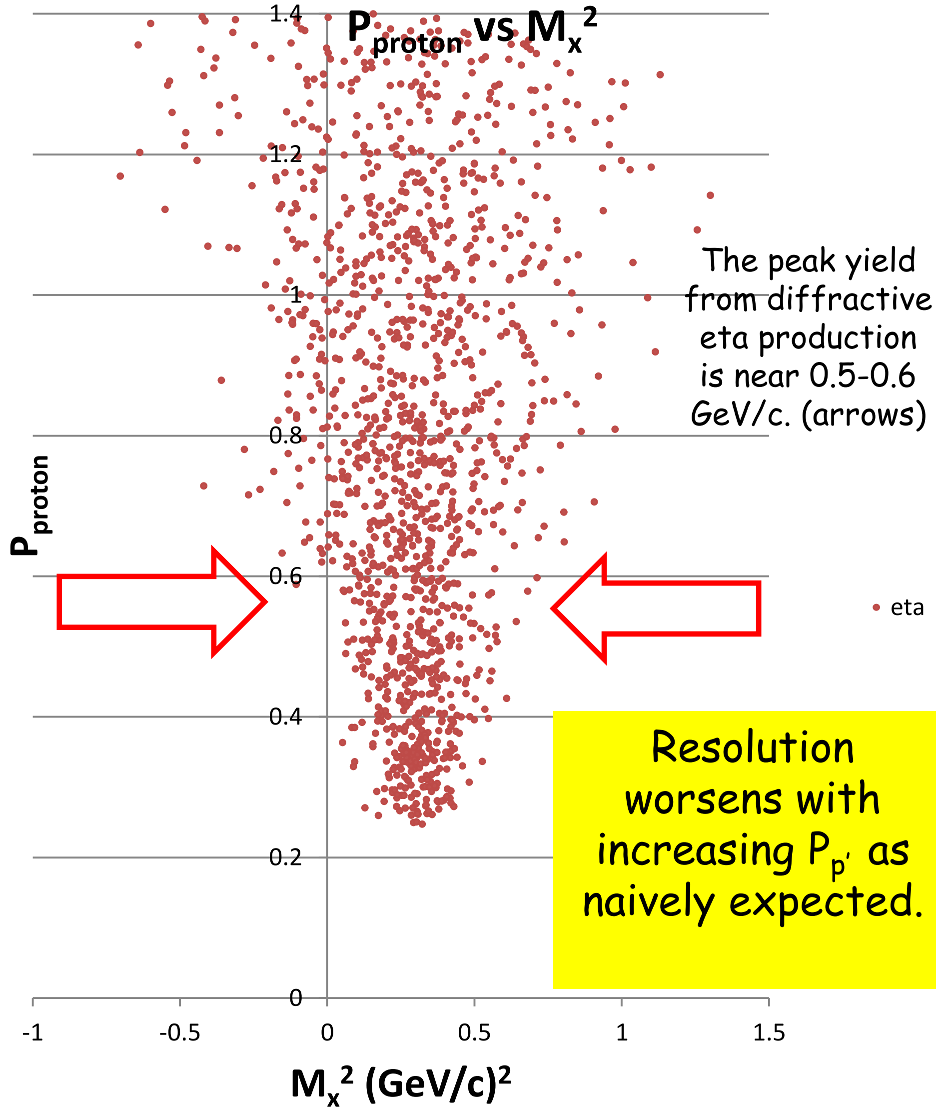
Paul's proton scattering angle resolution near 0.6 GeV/c is roughly 1.2 degree.

I'll use 1.2 deg/sqrt(2) = 0.85 deg.

For photon beam energy resolution, I used a flat +-30 MeV appropriate for the tagger Hodoscope.

Narrow E_γ Range (8-9 GeV, microscope-like)

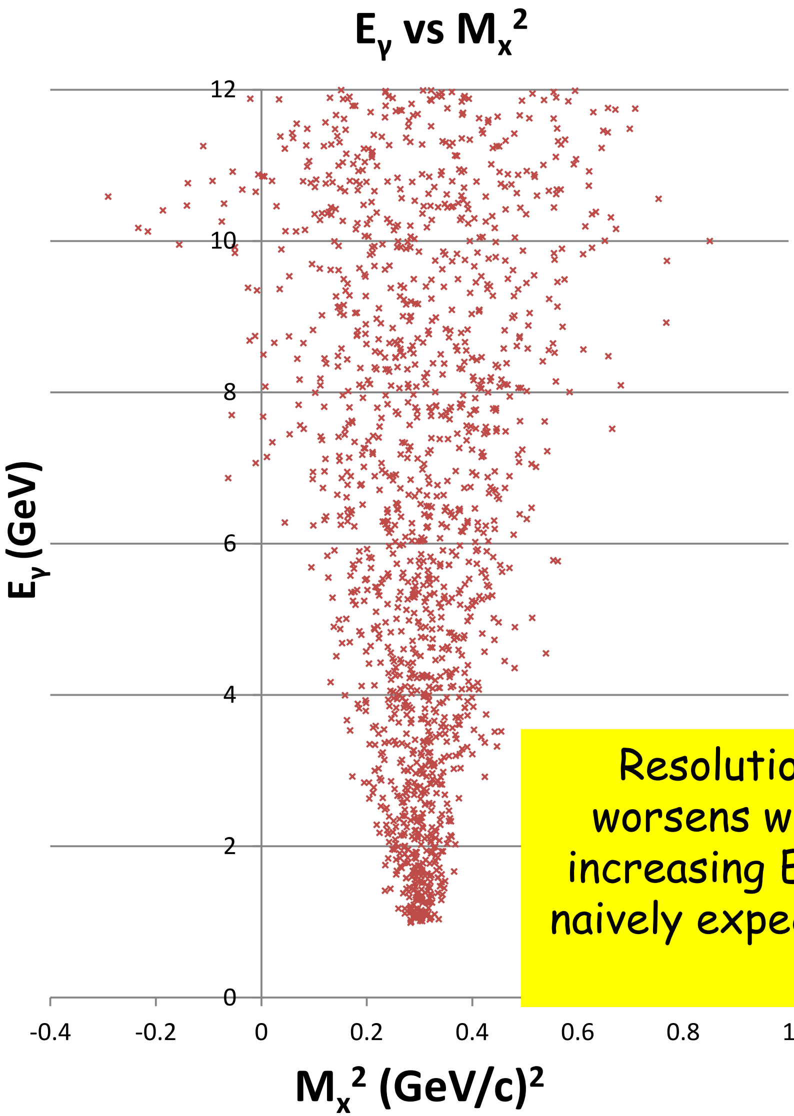


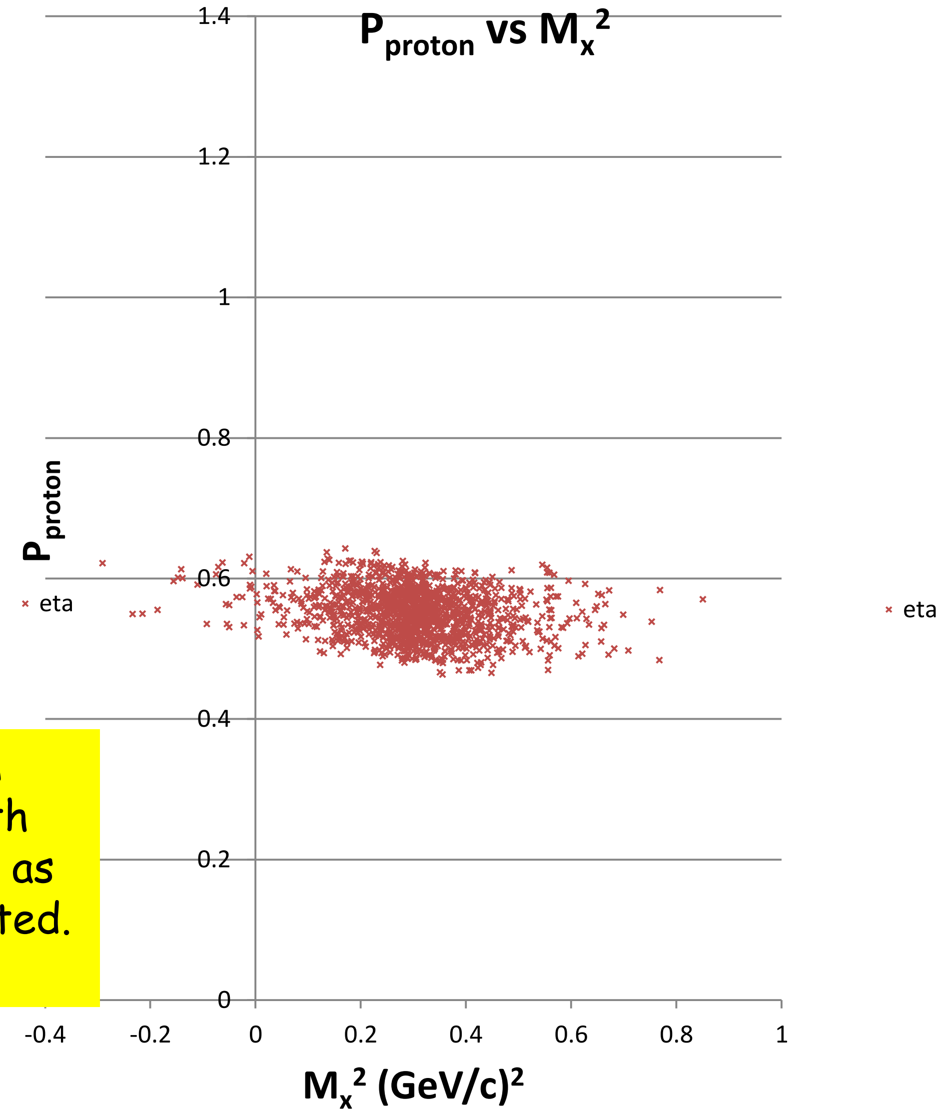


The peak yield from diffractive eta production is near 0.5-0.6 GeV/c. (arrows)

Resolution worsens with increasing $P_{p'}$ as naively expected.

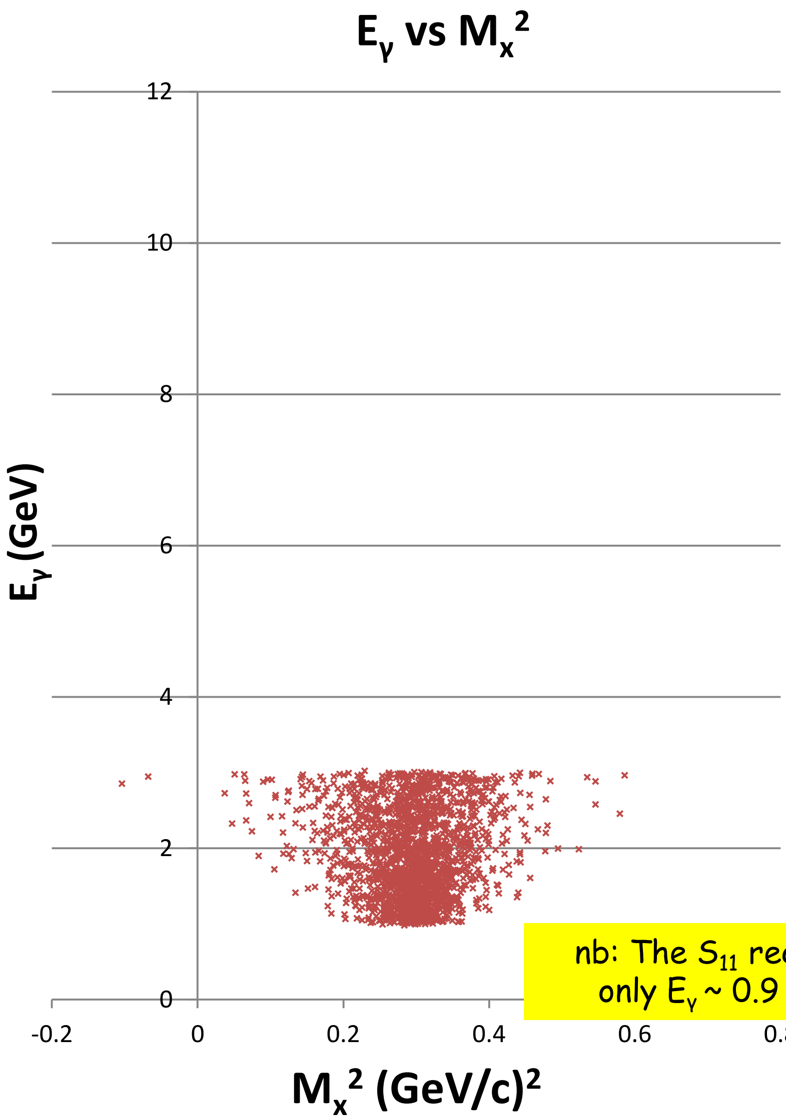
Narrow P_p Range (0.5-0.6 GeV/c)



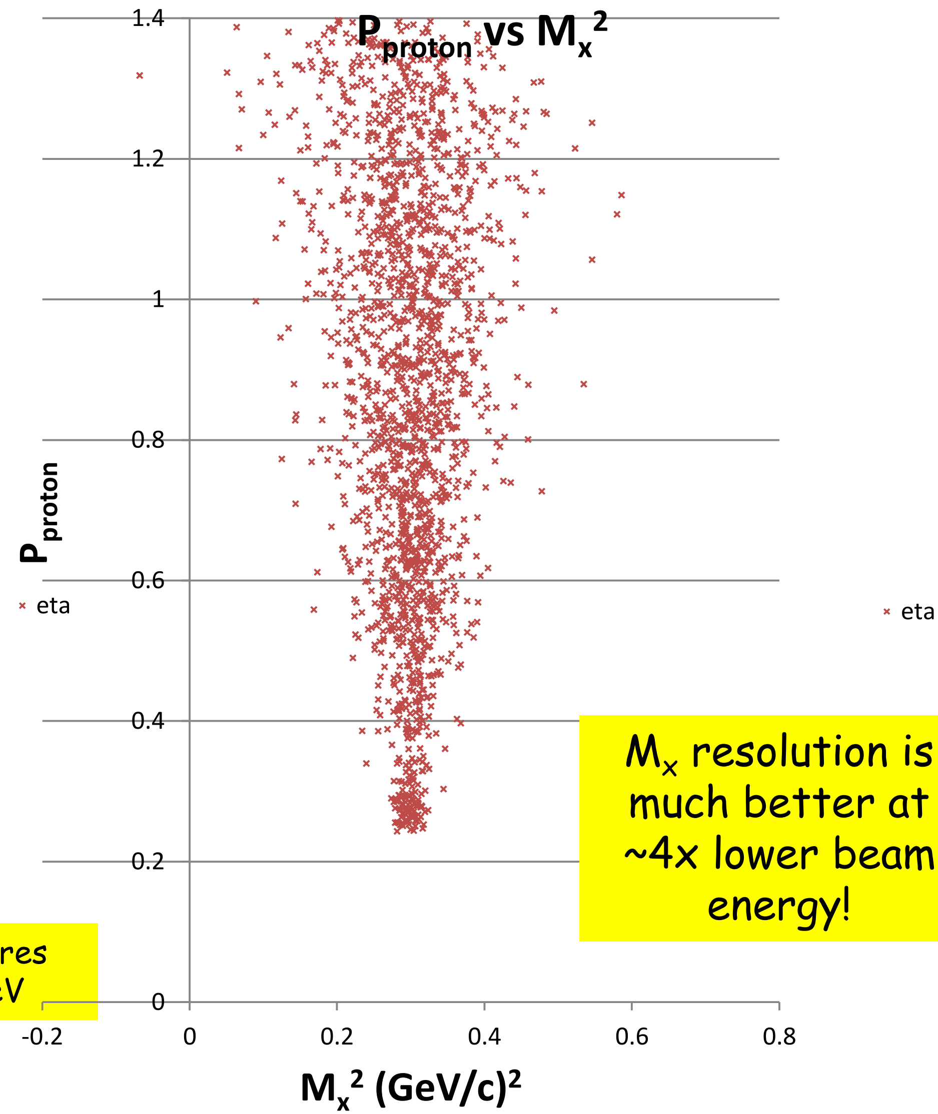


Resolution worsens with increasing E_γ as naively expected.

Narrow E_γ Range (1-3 GeV, “low”)

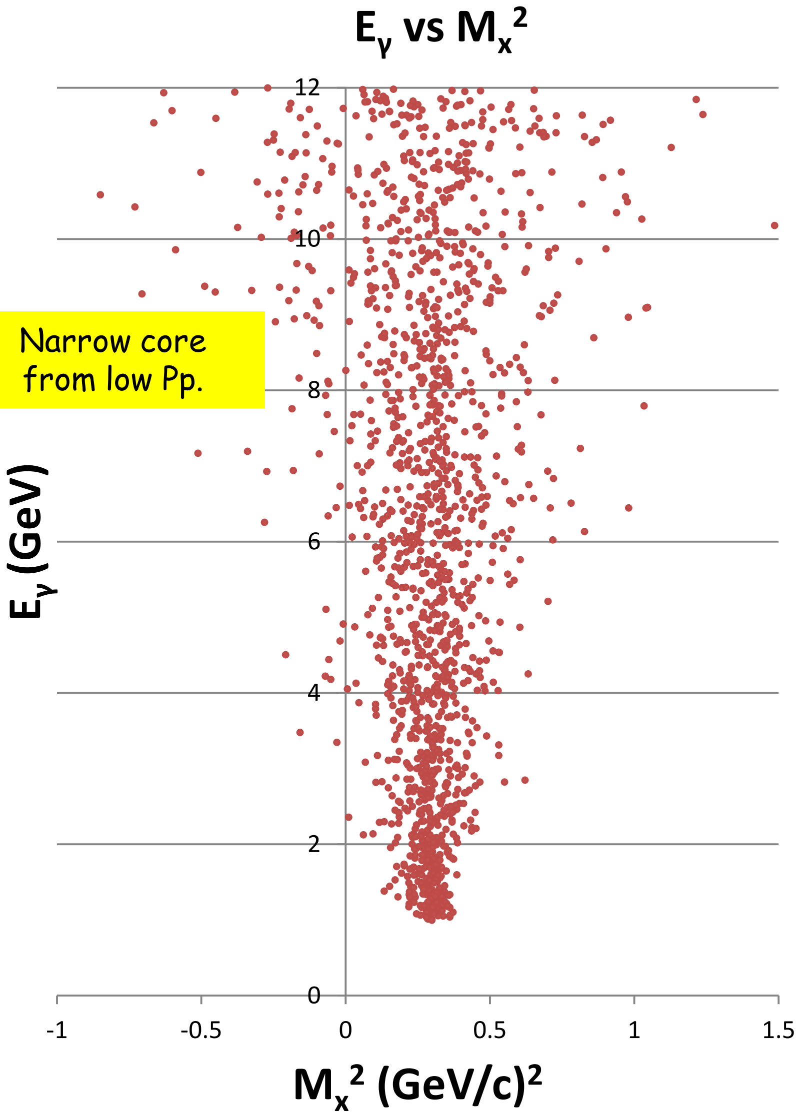


nb: The S_{11} requires only $E_\gamma \sim 0.9$ GeV

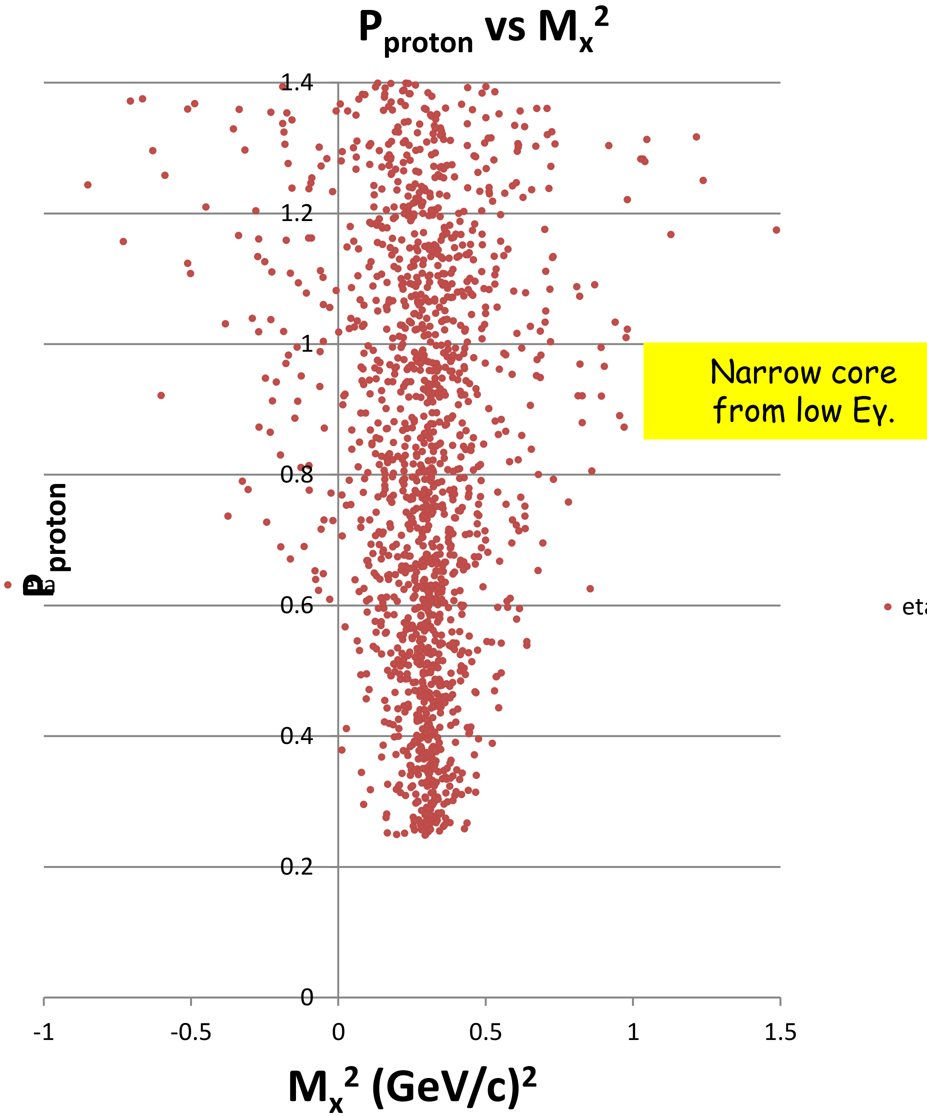


M_x resolution is much better at ~4x lower beam energy!

Broad E_γ and P_p Range



Narrow core from low Pp.



Narrow core from low Eγ.

To Do

1. Is dP or dΘ most critical for determining the Mx2 resolution?
   (and does dEgamma matter at all?)

2. Actual reconstruction almost certainly correlates dP and dΘ. See if it matters.

3. Further applications:

i. simulate omega mass to see if an efficient veto is possible to clean up the eta region,

ii. simulate eta' mass to see how good the resolution is for Mmeson ~ Mproton

iii. simulate mass = 1600 MeV to see how good the resolution is for a hybrid candidate
(this mass is also not far from the S11)

Summary

Mx2 resolution appears to scale almost linearly with Egamma and Pproton.
(See slide 5 for the microscope energy range.)

Mx2 mass discrimination near the eta looks excellent for Egamma < 6 GeV.
(For 5.8 GeV data, this is qualitatively consistent with Simon's Mx plots, and with Jane's effective use of the omega veto.)

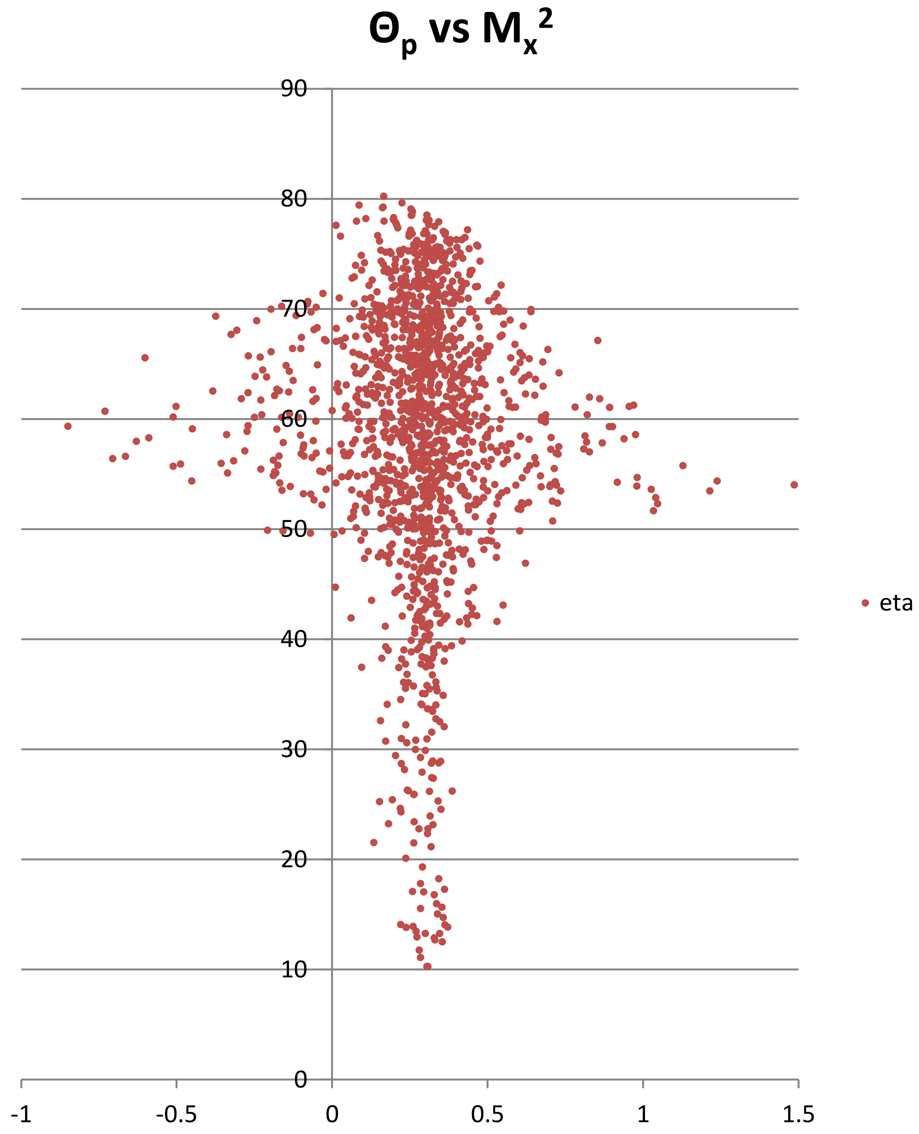
For Egamma > 6 GeV, the mass discrimination near the eta is becoming marginal at the Pp where diffractive eta yield peaks (0.5-0.6 GeV/c)
(Consistent with Sascha's simulation in the JEF proposal.)
(I doubt we can make an efficient omega veto for JEF ….)

For Egamma > 6 GeV and higher –t (or Pproton), the mass discrimination near the eta is bad.
(The omega veto could only be used with high eta inefficiency.)

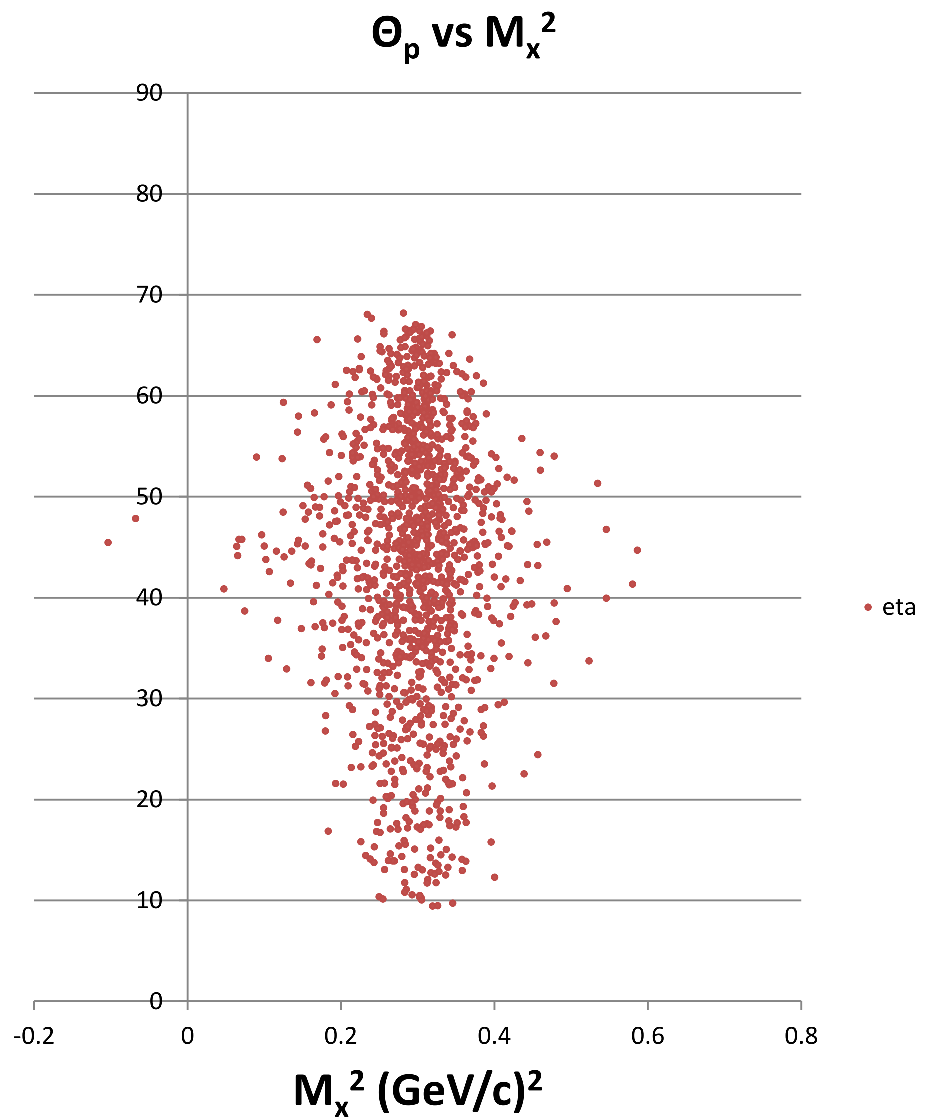
nb: plotting Mx2 without binning in these two variables, especially Egamma, will result in a narrow peak on a much broader peak. Even plots made for the limited energy bite of the microscope will have a weak narrow core from very low Pp events.

Extras

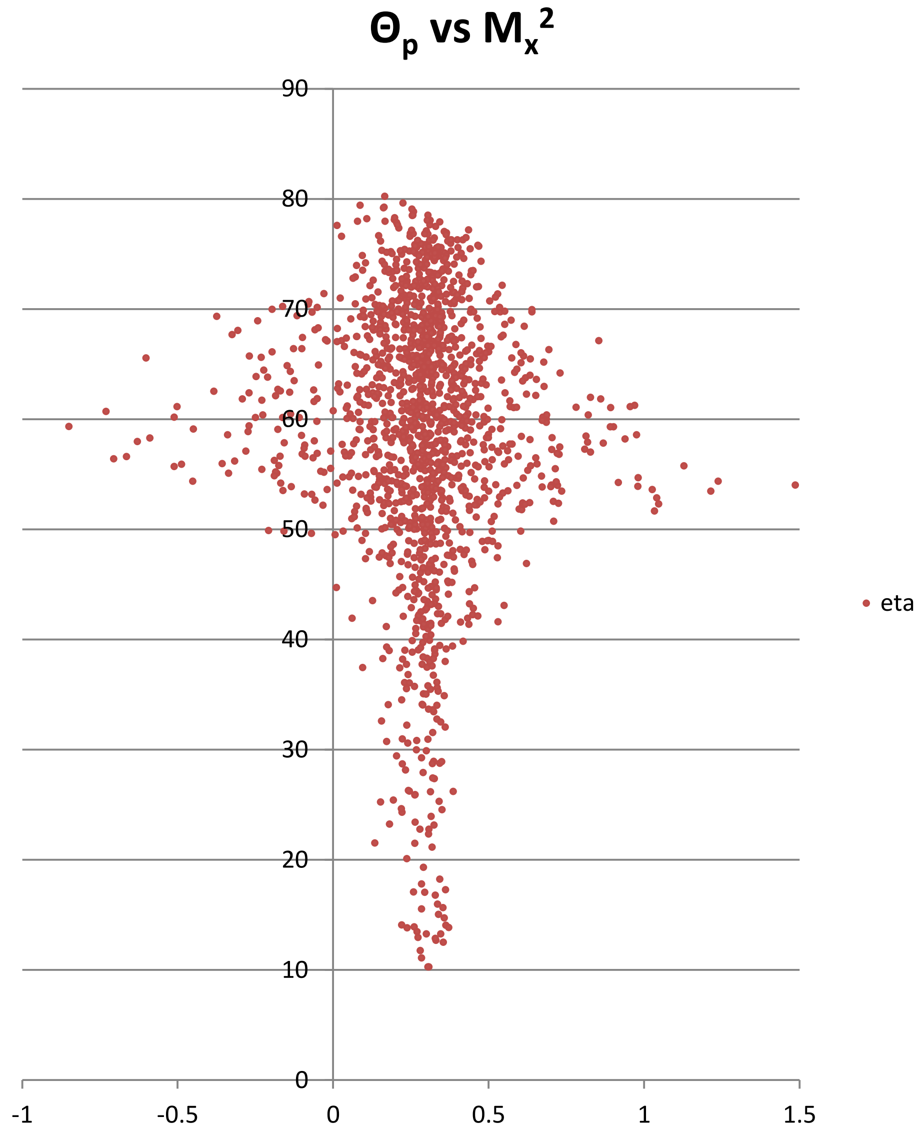
Narrow E_γ Range (8-9 GeV, microscope-like)



Narrow E_γ Range (1-3 GeV, "low")



Broad Everything Range



Narrow P_p Range (0.5-0.6 GeV/c)