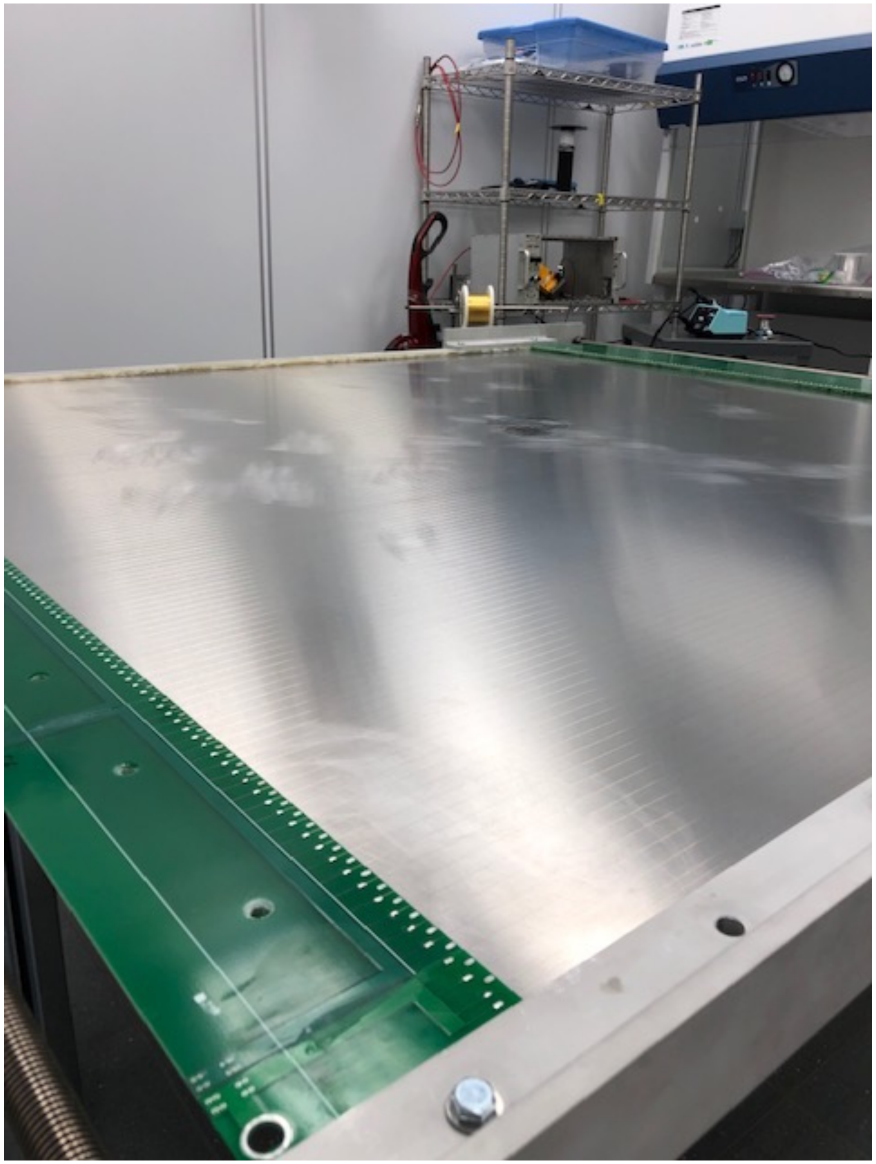
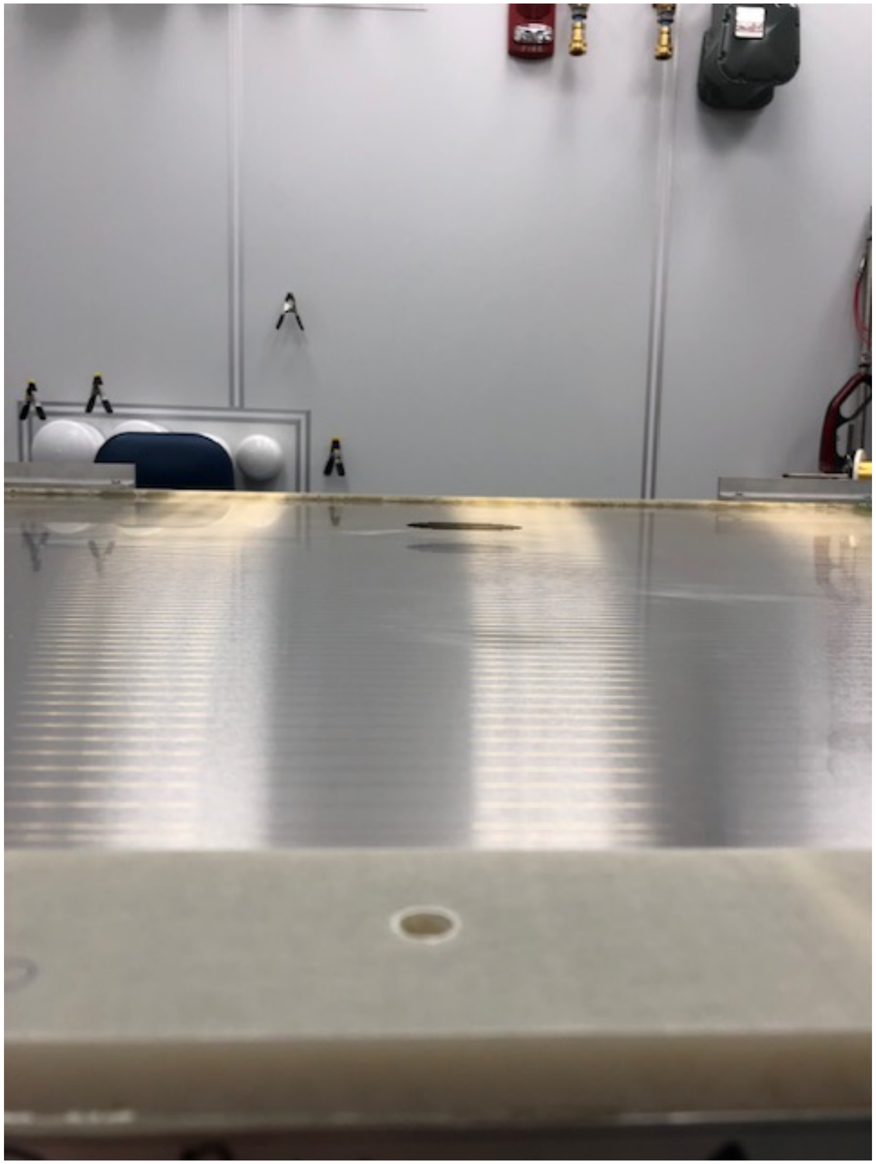
Field wire installation for "Celeborn" is finished





ρ^0 background in the CPP experiment

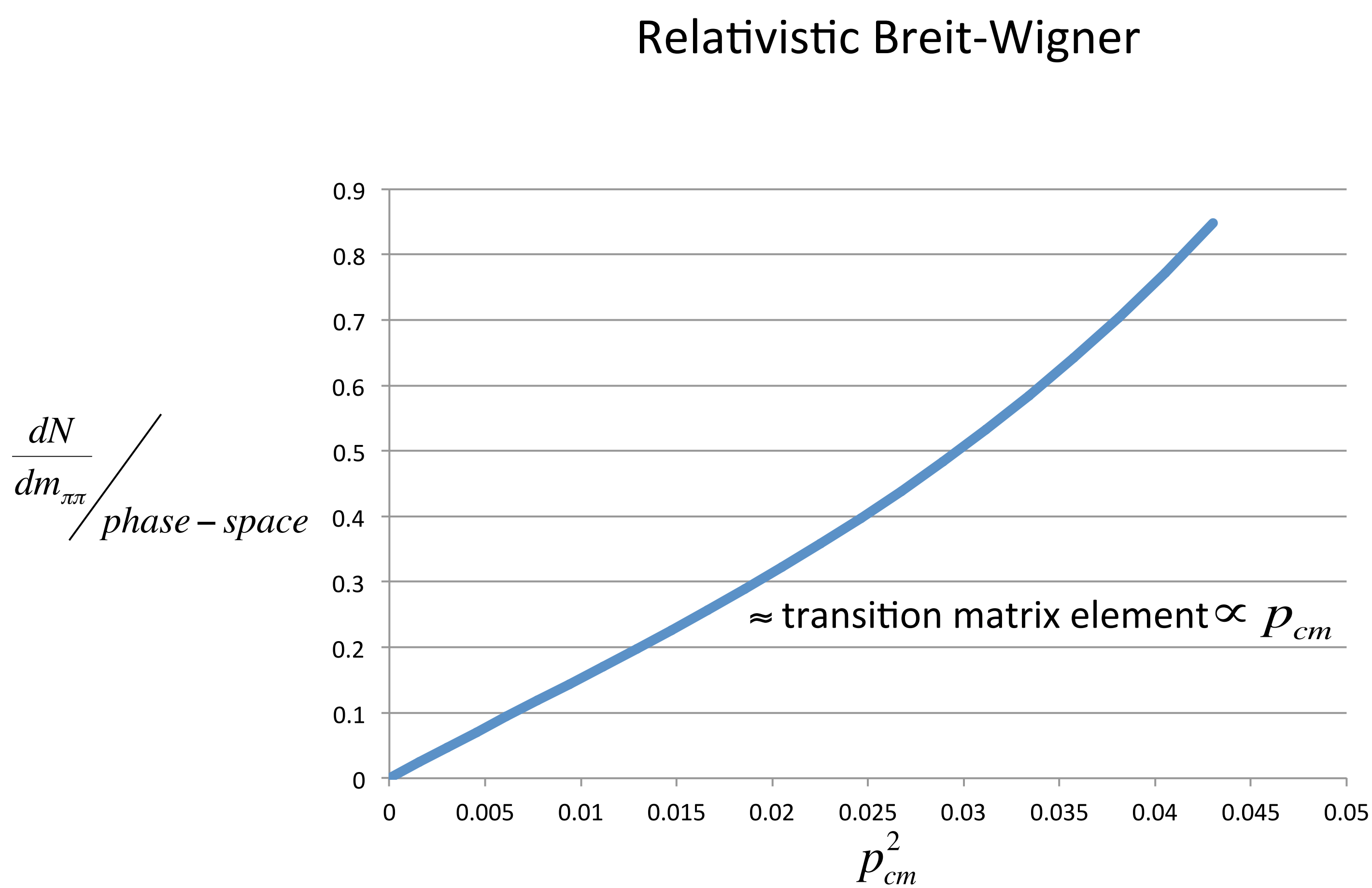
- Resonant ρ^0 term: Relativistic p-wave Breit-Wigner, originally derived by J.D. Jackson. Used in the CPP proposal development. Used by Bulos, McClellan, Alvensleben #2 & #5, and Breitweg (Zeus):

$$\Gamma = \Gamma_0 \frac{m_\rho}{m_{\pi\pi}} \left[\frac{m_{\pi\pi}^2 - 4m_\pi^2}{m_\rho^2 - 4m_\pi^2} \right]^{3/2} = \Gamma_0 \frac{m_\rho}{m_{\pi\pi}} \left(\frac{k_{cm}}{k_{cm@\rho^0}} \right)^3$$

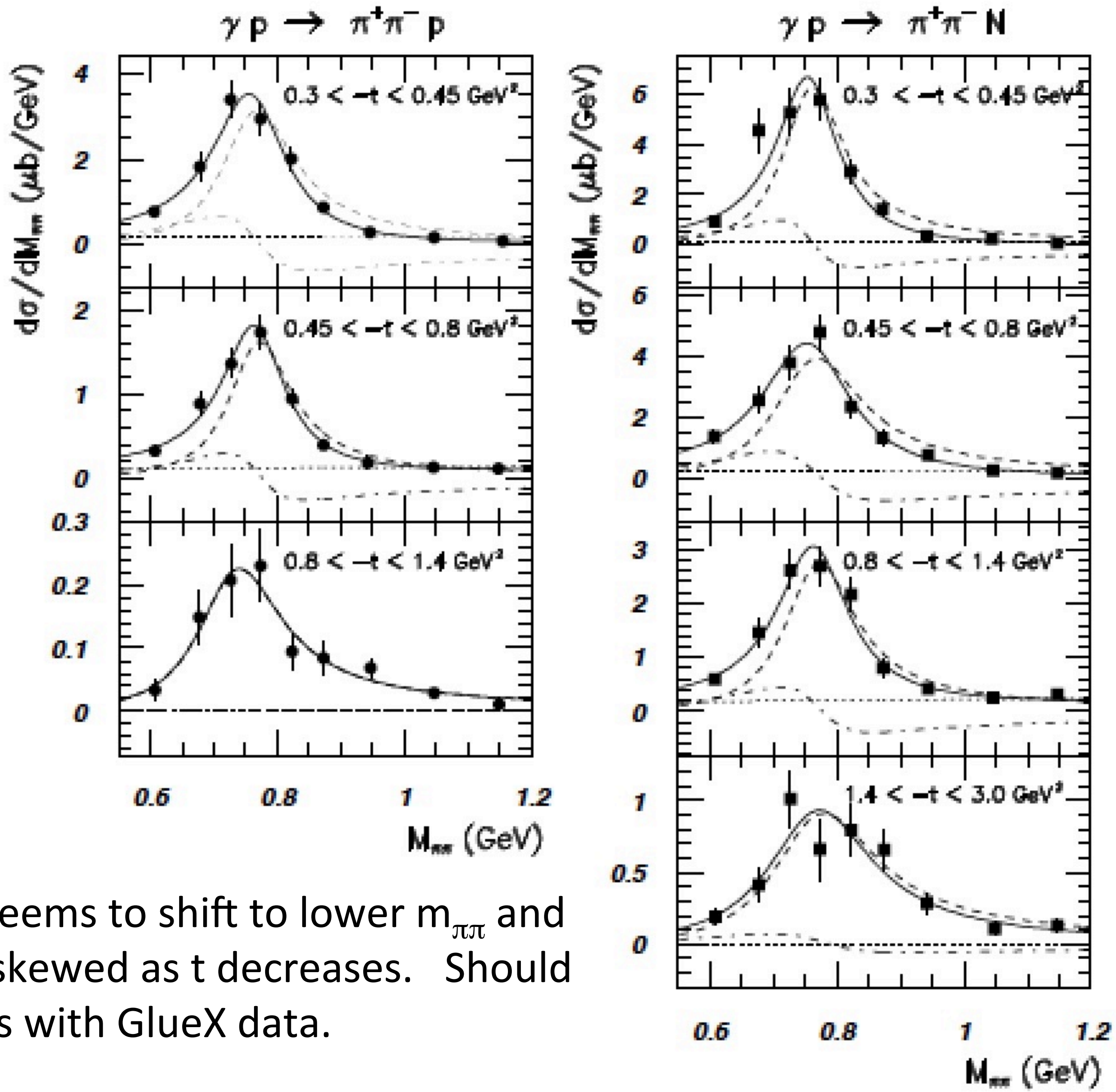
$$\frac{dN}{dm_{\pi\pi}}(m_{\pi\pi})_{RES} = \frac{m_\rho m_{\pi\pi}\Gamma}{\left(m_\rho^2 - m_{\pi\pi}^2\right)^2 + m_\rho^2\Gamma^2}$$

- Plot $dN/dm_{\pi\pi}$ divided by the relativistic 2-body phase space:

$$phase - space = 4\pi p_{cm}^2 \frac{dp_{cm}}{dm_{\pi\pi}} = \frac{\pi}{2}\left(m_{\pi\pi}^2 - 4m_\pi^2\right)^{1/2} m_{\pi\pi}$$


Relativistic Breit-Wigner
$\frac{dN}{dm_{\pi\pi}} \Big/ phase-space$
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
$\approx$ transition matrix element $\propto p_{cm}$
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
0.045
0.05
p_{cm}^2

Elastic production ZEUS 1995 Inelastic production



ρ^0 peak seems to shift to lower $m_{\pi\pi}$ and become skewed as t decreases. Should check this with GlueX data.

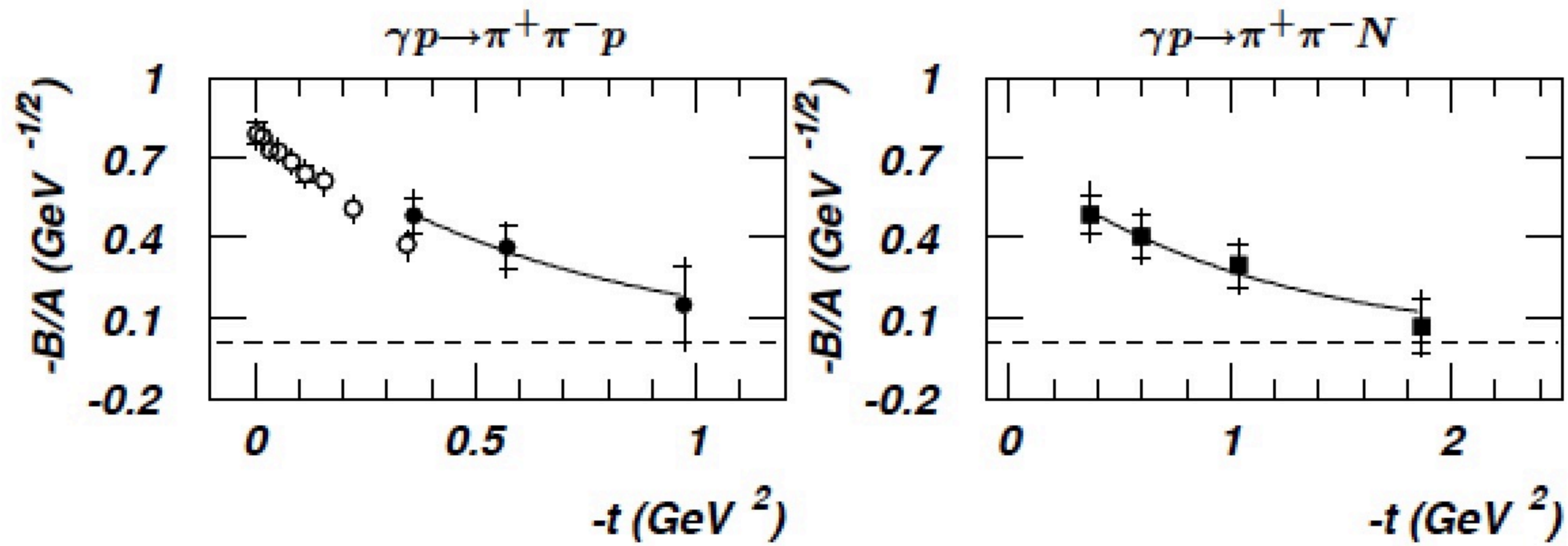
- Non-resonant backgrounds: Breitweg (Zeus) assumes a constant background term that's coherent with ρ^0 electro-production, and an incoherent background

$$\frac{dN}{dm_{\pi\pi}} = \left| \frac{\sqrt{m_{\pi\pi} m_\rho \Gamma}}{m_\rho^2 - m_{\pi\pi}^2 + i m_\rho \Gamma} + B/A \right|^2 + C\left(1 + 1.5 m_{\pi\pi}\right)$$

$$\frac{dN}{dm_{\pi\pi}} = \frac{m_{\pi\pi} m_\rho \Gamma}{\left(m_\rho^2 - m_{\pi\pi}^2\right)^2 + m_\rho^2 \Gamma^2} + 2\, B/A \, \frac{\sqrt{m_{\pi\pi} m_\rho \Gamma}}{\left(m_\rho^2 - m_{\pi\pi}^2\right)^2 + m_\rho^2 \Gamma^2}\left(m_\rho^2 - m_{\pi\pi}^2\right) + \left|B/A\right|^2$$
$$+ C\left(1 + 1.5 m_{\pi\pi}\right)$$

Non-resonant backgrounds

Elastic production ZEUS 1995 Inelastic production



- On a nuclear target would expect the incoherent term C to scale relative to coherent $\rho \to \pi\pi$ as $\approx 1/A$: incoherent term will be small on ^{208}Pb, and we'll neglect it here.

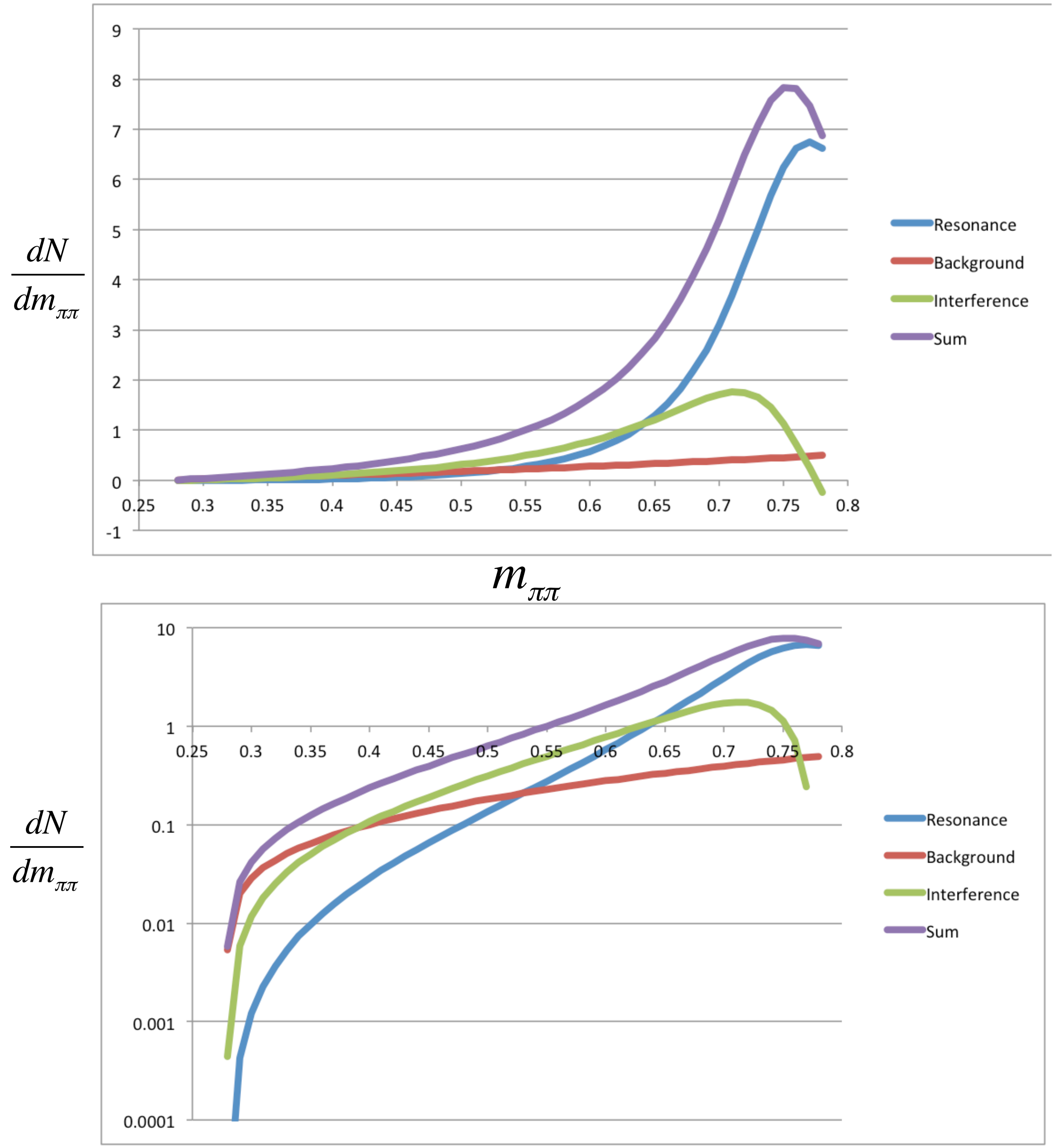
- Breitweg assumed that B/A is a constant, independent of $m_{\pi\pi}$. This can't be correct at low $m_{\pi\pi}$. Based on what we saw for the p-wave Breit-Wigner, make the following assumption,

$$B/A \propto p_{cm}^{N} \times \sqrt{phasespace}$$

with N=0, 1, 2, … Fix the amplitude at the ρ^0 peak to be B/A = 0.7 GeV$^{-1/2}$

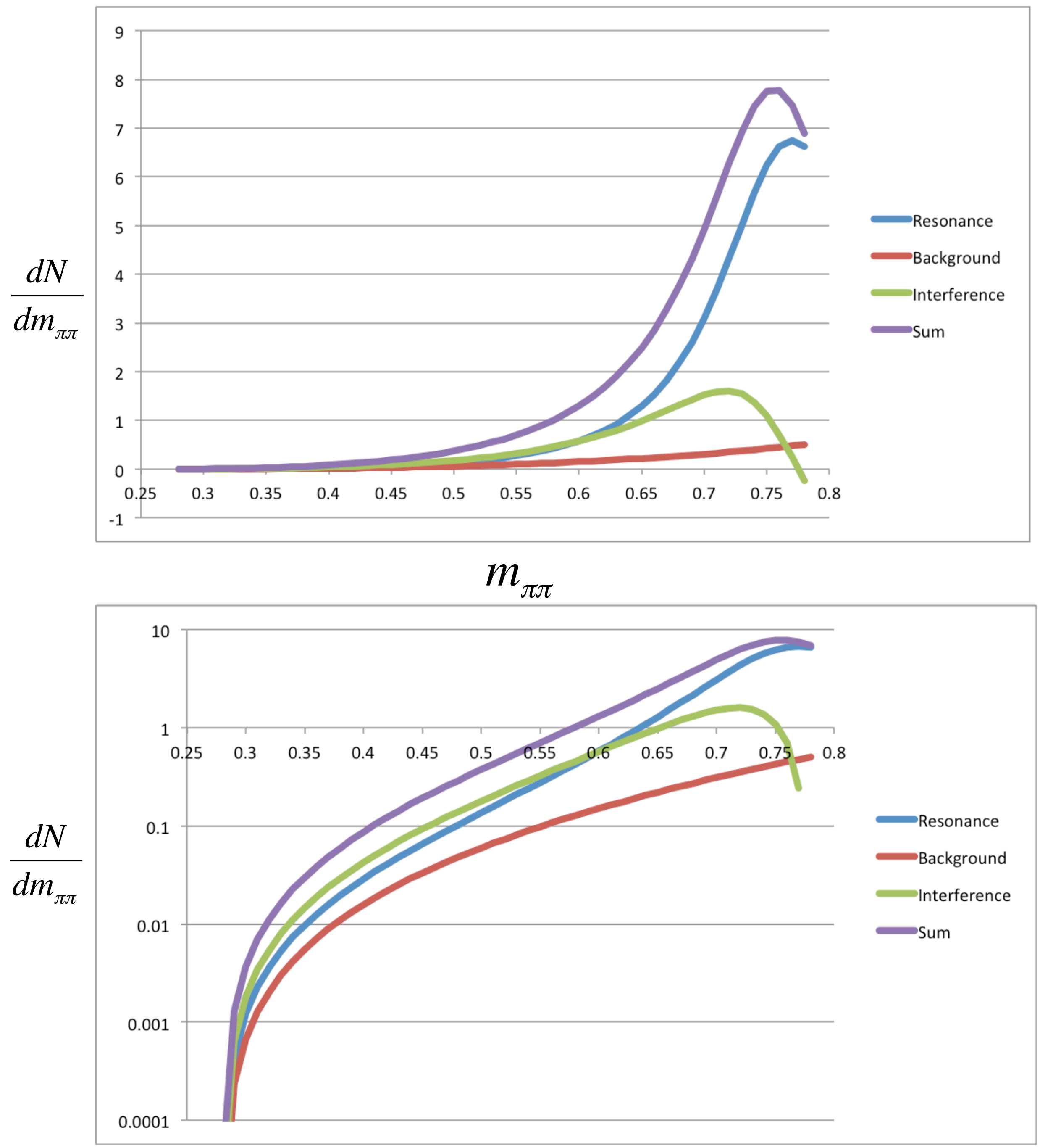
$$B/A\left(m_{\pi\pi}\right) = 0.7 GeV^{-1/2} \left(\frac{p_{cm}}{p_{cm@\rho}}\right)^{N} \sqrt{\frac{phasespace}{phasespace@\rho^0}}$$

N=0



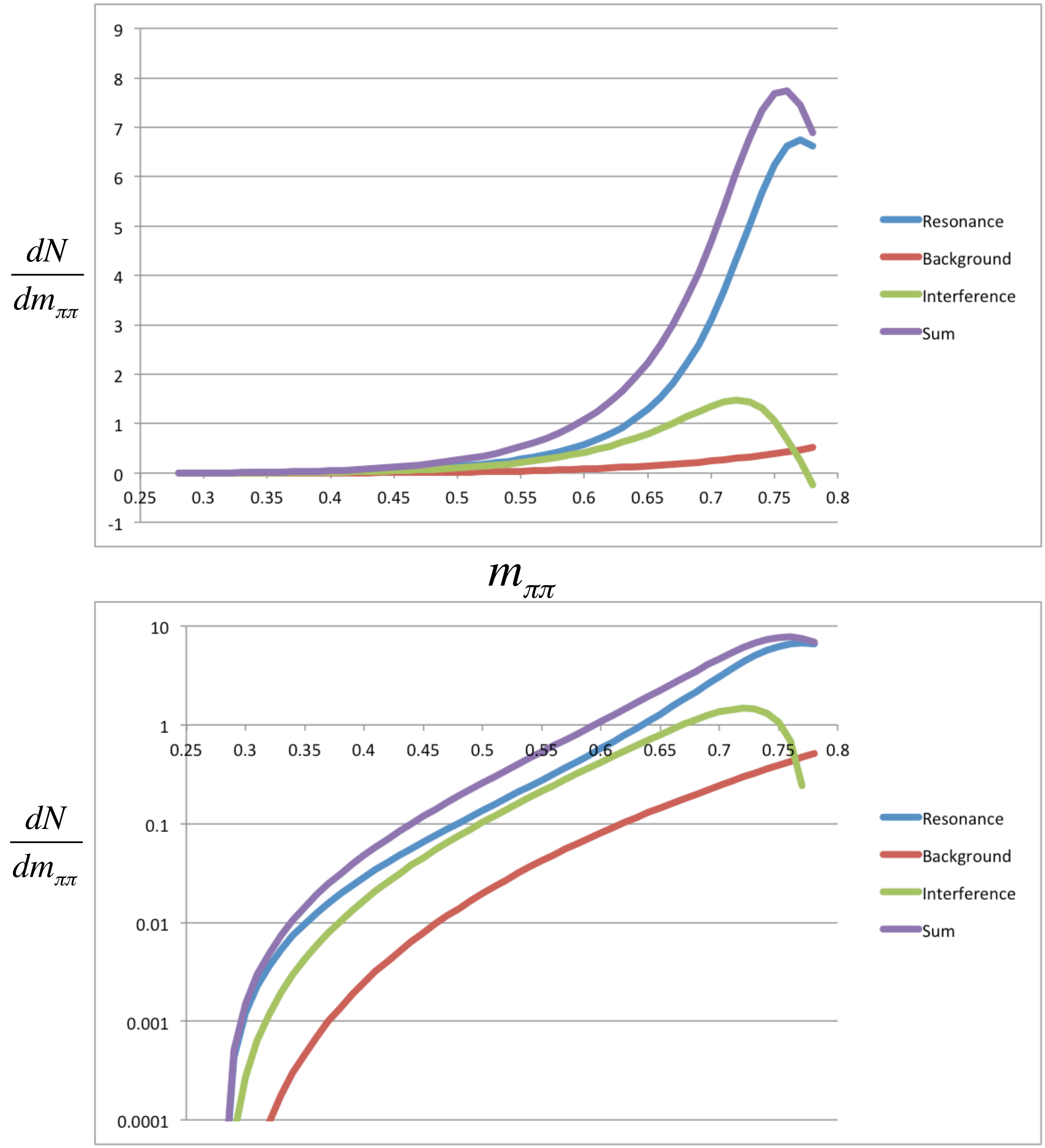
dN/dm_ππ
m_ππ
Resonance
Background
Interference
Sum
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
-1
0
1
2
3
4
5
6
7
8
9
10
0.1
0.01
0.001
0.0001

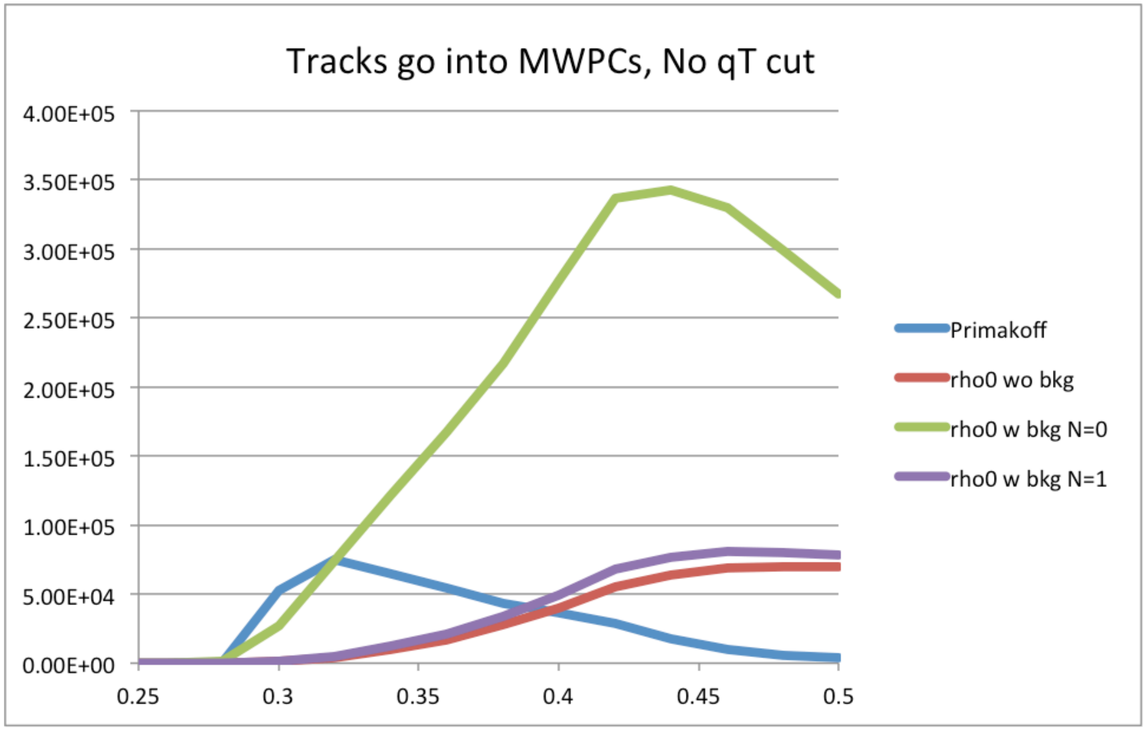
N=1

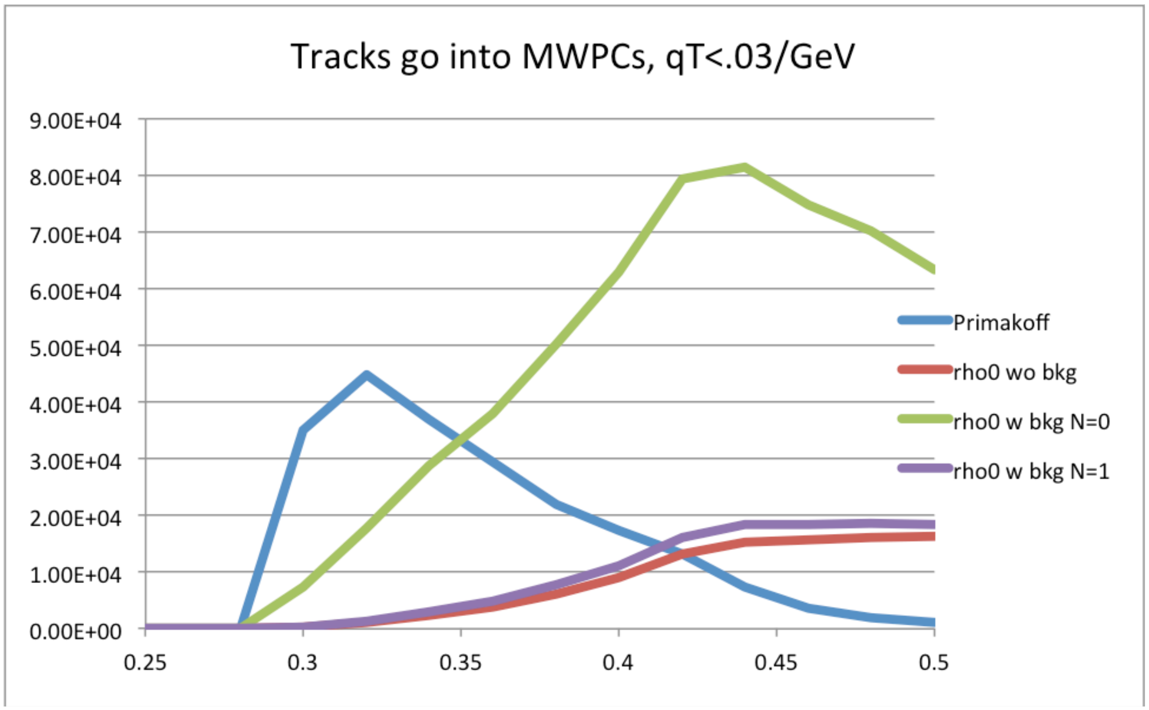


$\frac{dN}{dm_{\pi\pi}}$
9
8
7
6
5
4
3
2
1
0
-1
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
Resonance
Background
Interference
Sum
$m_{\pi\pi}$
$\frac{dN}{dm_{\pi\pi}}$
10
1
0.1
0.01
0.001
0.0001
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
Resonance
Background
Interference
Sum

N=2




Tracks go into MWPCs, No qT cut
4.00E+05
3.50E+05
3.00E+05
2.50E+05
2.00E+05
1.50E+05
1.00E+05
5.00E+04
0.00E+00
0.25
0.3
0.35
0.4
0.45
0.5
Primakoff
rho0 wo bkg
rho0 w bkg N=0
rho0 w bkg N=1


Tracks go into MWPCs, qT<.03/GeV
9.00E+04
8.00E+04
7.00E+04
6.00E+04
5.00E+04
4.00E+04
3.00E+04
2.00E+04
1.00E+04
0.00E+00
0.25
0.3
0.35
0.4
0.45
0.5
Primakoff
rho0 wo bkg
rho0 w bkg N=0
rho0 w bkg N=1

Comments on the N=0 case:

- This corresponds to a constant matrix element with no dynamics
- Seen in a few cases in low/medium energy nuclear physics, noted as contact interactions, spin operator interactions
    1. Nuclear beta decay
    2. Kroll-Ruderman term in charged pion photoproduction $\gamma p \rightarrow \pi^+ n$

- Is contact interaction in $\gamma A \rightarrow \pi^+ \pi^- A$ on a spin-zero nucleus physical ?