Polarized Reflectivity Amplitudes in the $\pi^+\pi^-$ System

$\gamma p \to \pi^+\pi^- p$

Alexander Austregesilo

Amplitude Analysis WG Meeting
December 16, 2020

Polarized Reflectivity

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Polarized Reflectivity Amplitude: GlueX-doc-4094 (M. Shepherd) after PRD 100 (2019) 5, 054017 (V. Mathieu)

- Introduce spherical harmonics rotated to the beam polarization: $Z_\ell^m(\Omega, \Phi) = Y_\ell^m(\Omega) e^{-i\Phi}$
- Intensity can be written as 4 coherent sums with constrains on $[\ell]_m^{(\pm)}$
- Factor $\sqrt{1 \pm P_\gamma}$ absorbed into Z_ℓ^m amplitude

$$I(\Omega, \Phi)/2\kappa = (1 - P_\gamma) \left| \sum_{\ell,m} [\ell]_m^{(-)} \mathrm{Re}[Z_\ell^m(\Omega, \Phi)] \right|^2 + (1 - P_\gamma) \left| \sum_{\ell,m} [\ell]_m^{(+)} \mathrm{Im}[Z_\ell^m(\Omega, \Phi)] \right|^2$$
$$+ (1 + P_\gamma) \left| \sum_{\ell,m} [\ell]_m^{(+)} \mathrm{Re}[Z_\ell^m(\Omega, \Phi)] \right|^2 + (1 + P_\gamma) \left| \sum_{\ell,m} [\ell]_m^{(-)} \mathrm{Im}[Z_\ell^m(\Omega, \Phi)] \right|^2$$

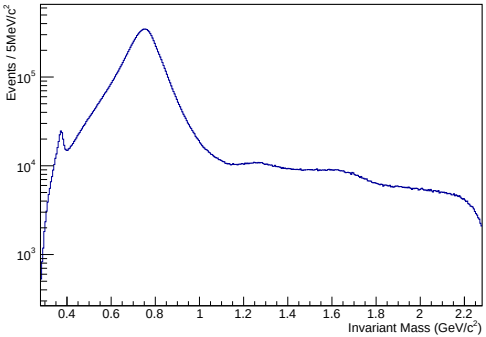
Possible Amplitudes with $\ell < 3, |m| < 2$

- $S_0^+, P_{-1}^+, P_0^+, P_1^+, D_{-1}^+, D_0^+, D_1^+$ and $S_0^-, P_{-1}^-, P_0^-, P_1^-, D_{-1}^-, D_0^-, D_1^-$

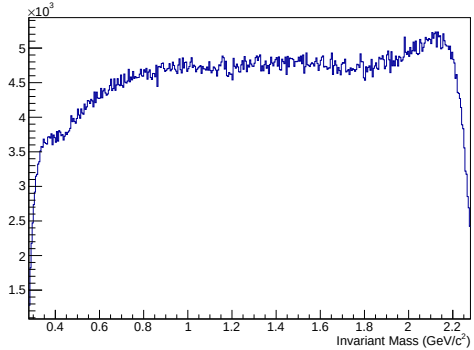
Data Set and MC Simulation

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Data (2017-01, 0°)



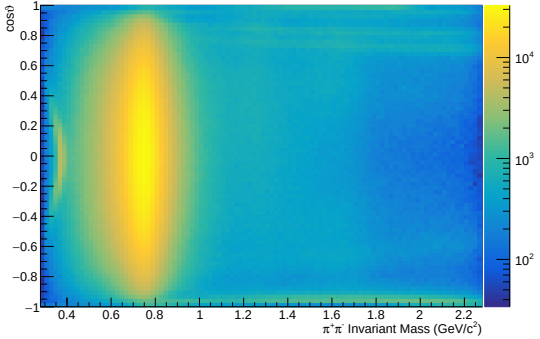
MC (hdgeant4)



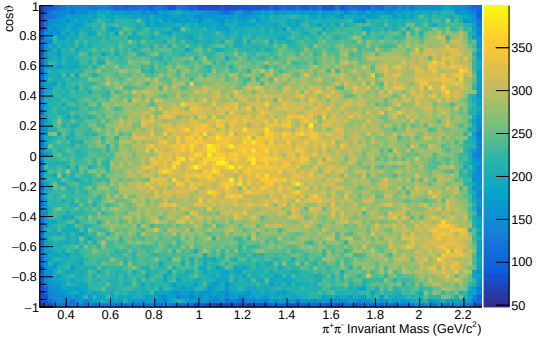
Data Set and MC Simulation

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Data (2017-01, 0°)



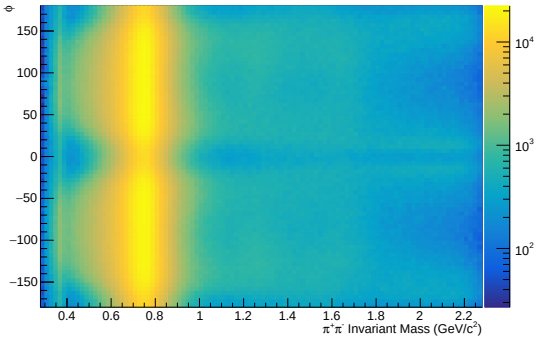
MC (hdgeant4)



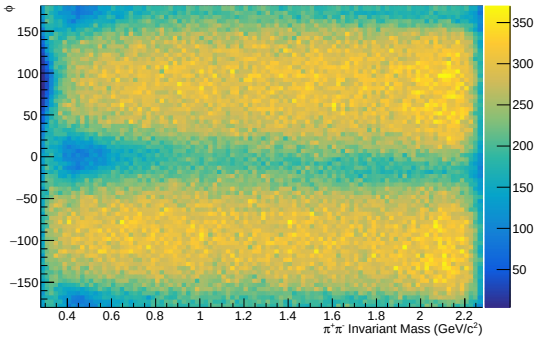
Data Set and MC Simulation

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Data (2017-01, 0°)



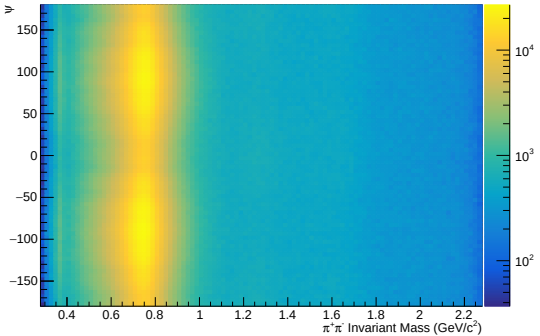
MC (hdgeant4)



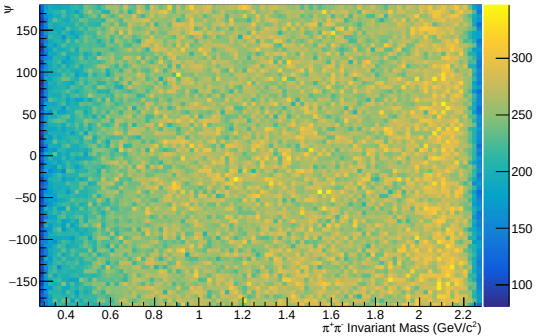
Data Set and MC Simulation

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Data (2017-01, 0°)

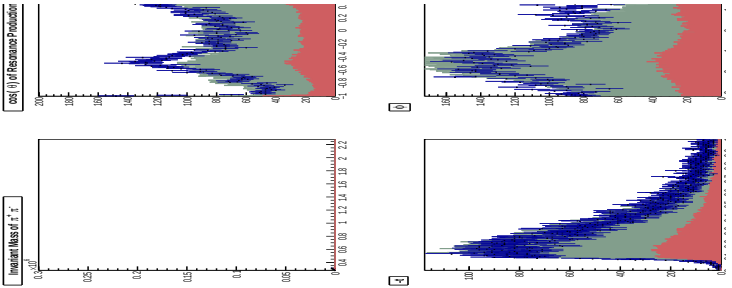


MC (hdgeant4)



Fit in 40 MeV$/c^2$ Mass Bins

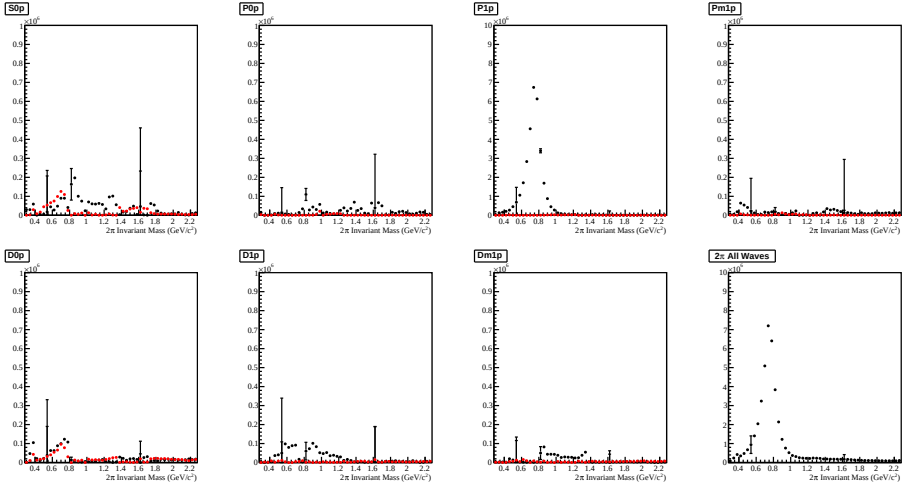
Jefferson Lab
Thomas Jefferson National Accelerator Facility



Intensity Distribution

Full Waveset (positive and negative reflectivity)

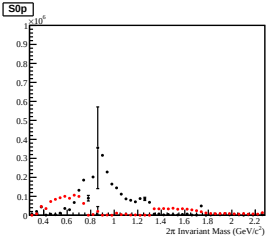
Jefferson Lab
Thomas Jefferson National Accelerator Facility

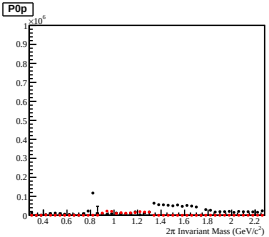


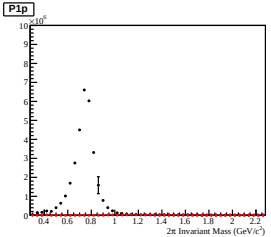
Intensity Distribution

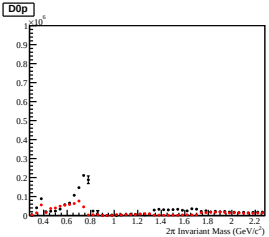
$m \geq 0$ Waveset (positive and negative reflectivity)

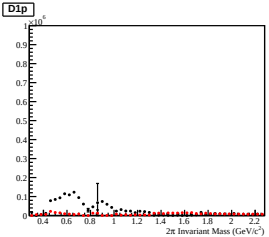
Jefferson Lab
Thomas Jefferson National Accelerator Facility

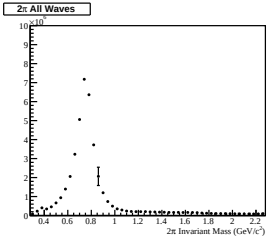








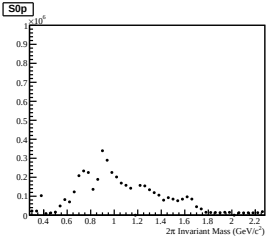


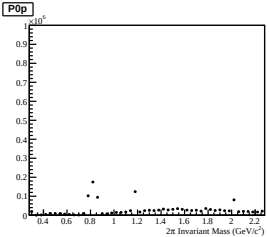


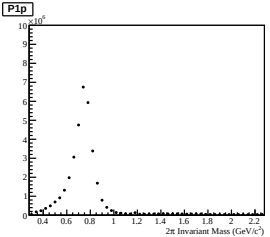
Intensity Distribution

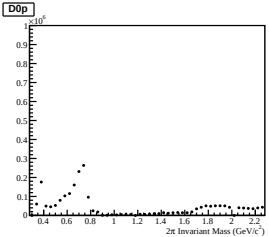
Full Waveset (only positive reflectivity)

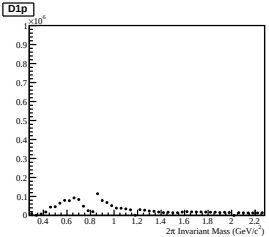
Jefferson Lab
Thomas Jefferson National Accelerator Facility

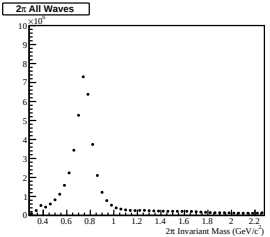








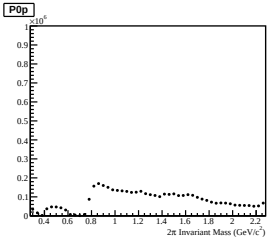


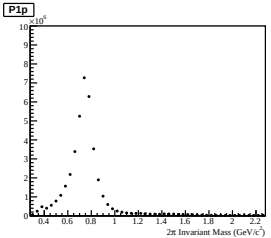


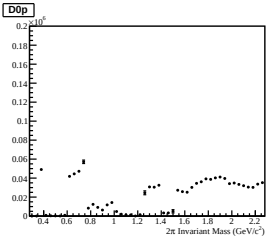
Intensity Distribution

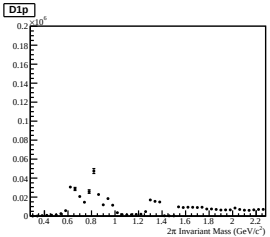
No S-Wave

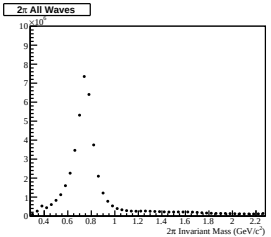
Jefferson Lab
Thomas Jefferson National Accelerator Facility





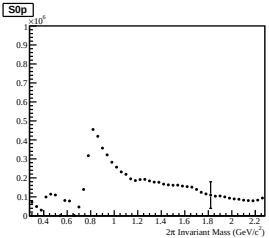


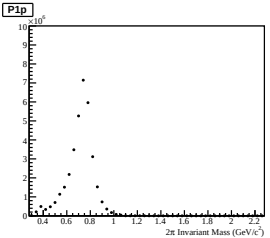


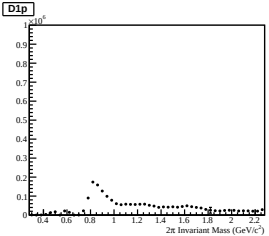


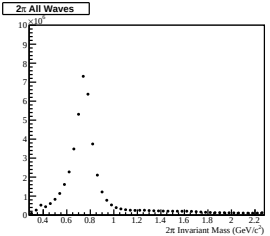
Intensity Distribution

No $m = 0$ Waves





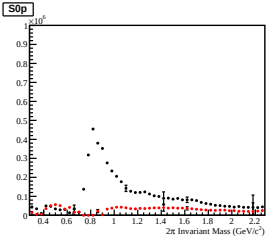


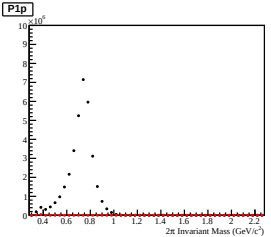


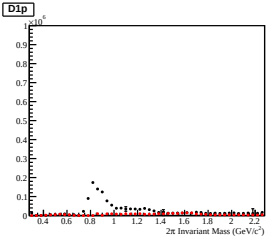
Intensity Distribution

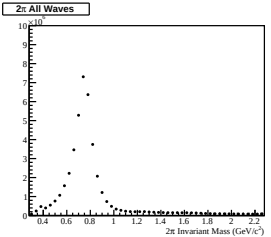
No m=0 Waves (positive and negative reflectivity)

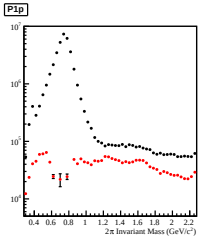
Jefferson Lab
Thomas Jefferson National Accelerator Facility

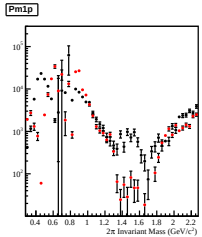


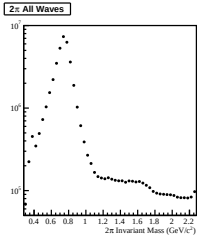







P1p
2π Invariant Mass (GeV/c²)


Pm1p
2π Invariant Mass (GeV/c²)


2π All Waves
2π Invariant Mass (GeV/c²)

Outlook

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Possible Strategies:

Top-Bottom Approach

- Start with all possible partial waves and remove insignificant ones
- By intensity, some definition of goodness-of-fit, by eye?

Bottom-Up Approach

- Start with dominant waves, add smaller ones step by step
- By intensity, some definition of goodness-of-fit, by eye?