

CLAS Collaboration Meeting 2017

JPAC Report

(Summer'17 Edition)

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on behalf of the Joint Physics Analysis Center



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Joint Physics Analysis Center (2013)

Indiana University 

Geoffrey Fox 

Tim Londergan 

Adam Szczepaniak  

Peng Guo 

Vincent Mathieu 

Jefferson Lab 

Mike Pennington 

Victor Mokeev 

Igor Danilkin 

César Fernández-Ramírez 

George Washington University 

Michael Döring 

Ron Workman 

Diane Schott 

Beijing University 

Meng Shi 

Collaborating with: CLAS & GlueX (JLab ), COMPASS (CERN  )
MAMI (Mainz )
BESIII (Beijing )

Code: Faculty / Staff
Postdoc
PhD student

Joint Physics Analysis Center (2017)

Indiana University 

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Emilie Passemar 

Adam Szczepaniak  

Vincent Mathieu 

Andrew Jackura 

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Igor Danilkin 

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Alessandro Pilloni 

Bonn Universität 

Misha Mikhashenko 

Ghent Universiteit 

Jannes Nys 

Collaborating with: CLAS & GlueX (JLab ), COMPASS & LHCb (CERN  ),
MAMI (Mainz ), BESIII (Beijing ), KLOE (Frascati 

CFR, ICN-UNAM

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CLAS Collaboration Meeting 2017

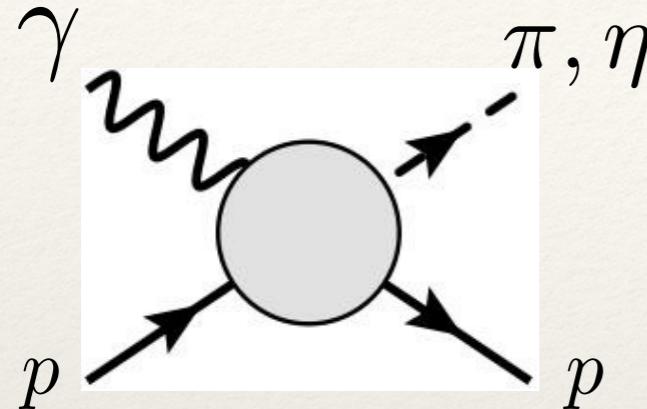
What are we doing?

- ◆ We care for hadron spectroscopy to gain insight on QCD
- ◆ We develop amplitudes following the principles of S matrix theory, *i.e.*
 - ◆ Unitarity, crossing symmetry, analyticity, symmetries
- ◆ Resonances = Poles in the unphysical Riemann sheets

Build Amplitude → Fit Data → Get Physics

Recent results of interest to CLAS

Finite Energy Sum Rules

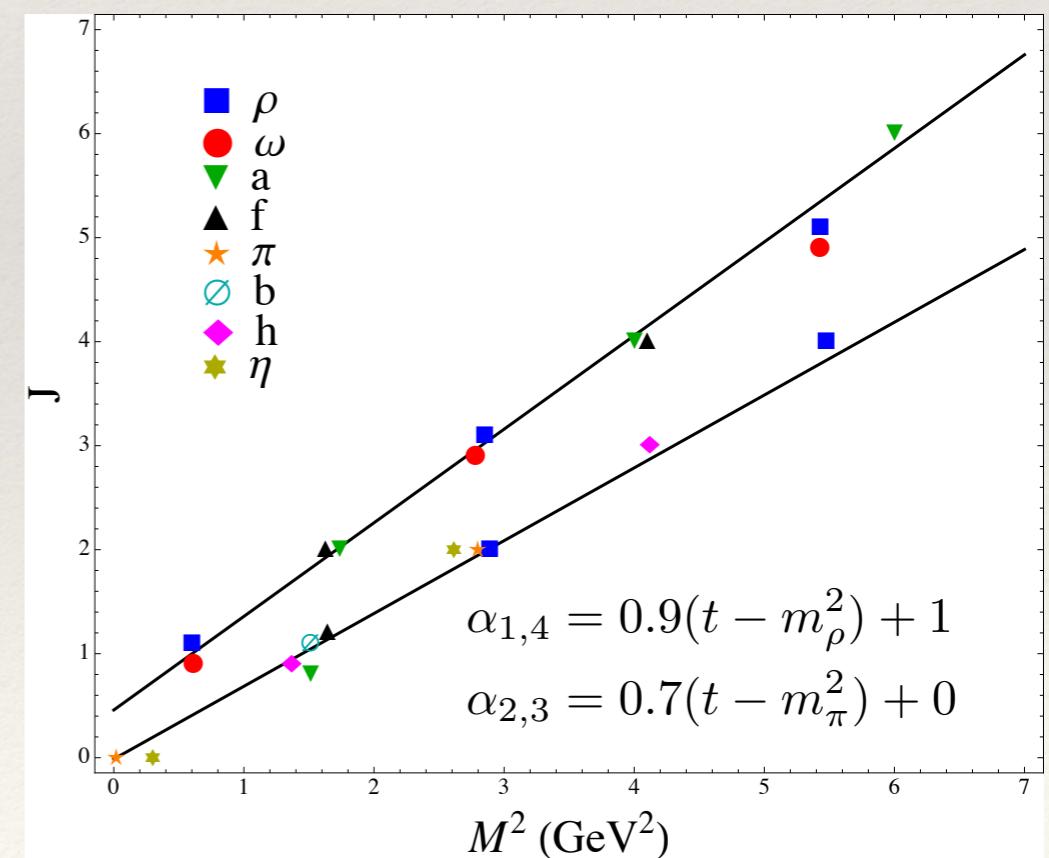
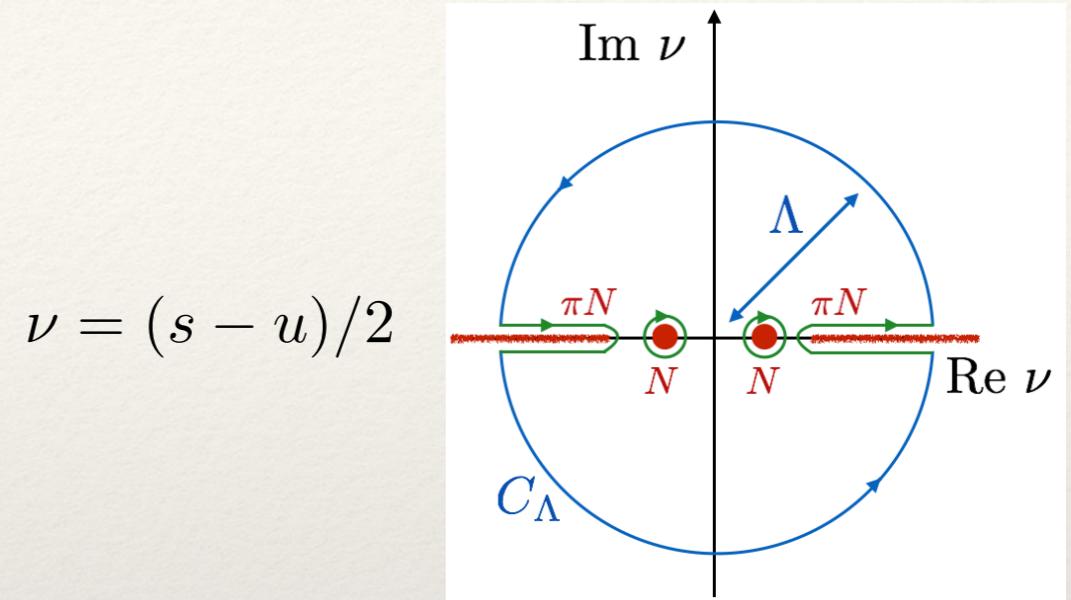


$$\int_0^\Lambda \text{Im } A_i(\nu, t) \nu^k d\nu = \beta_i(t) \frac{\Lambda^{\alpha_i(t)+k}}{\alpha_i(t) + k + 1} + \dots$$

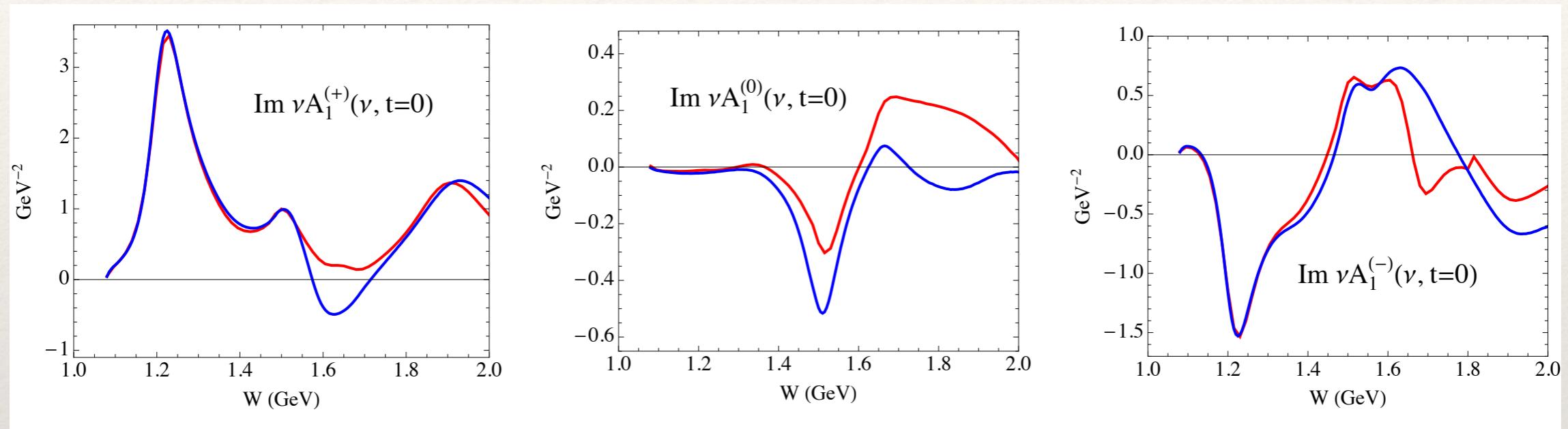
$S_i(t, k)$

High-energy residue prediction
from low-energy data

$$\begin{aligned}\hat{\beta}_i(t) &= S_i(t, k) \frac{\alpha_i(t) + k + 1}{\Lambda^{\alpha_i(t)+k}} \\ &= \beta_i(t) + \mathcal{O}(1/\Lambda)\end{aligned}$$



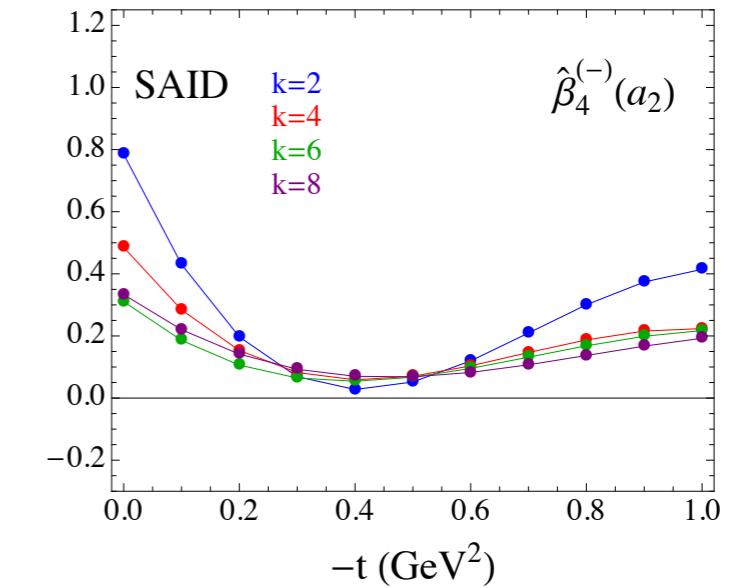
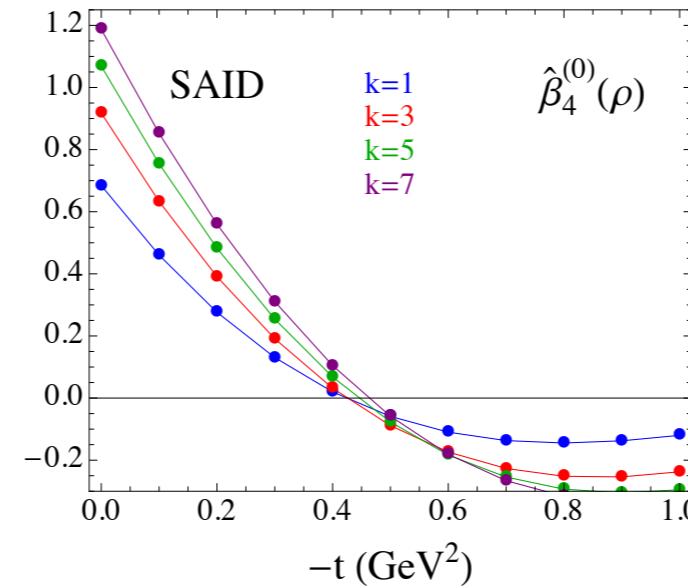
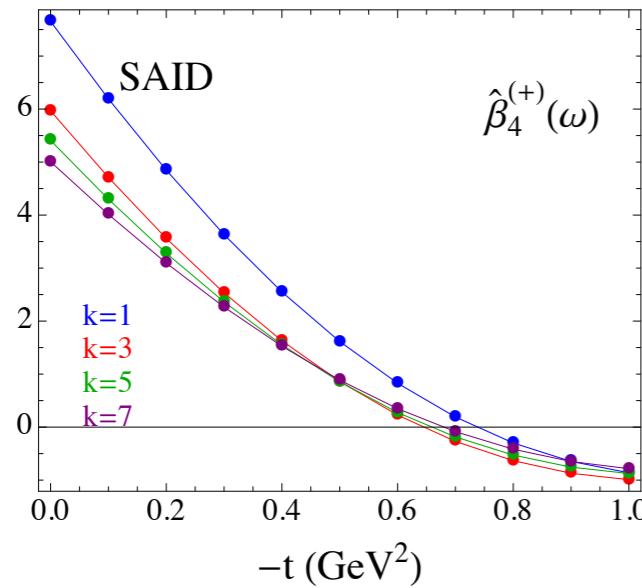
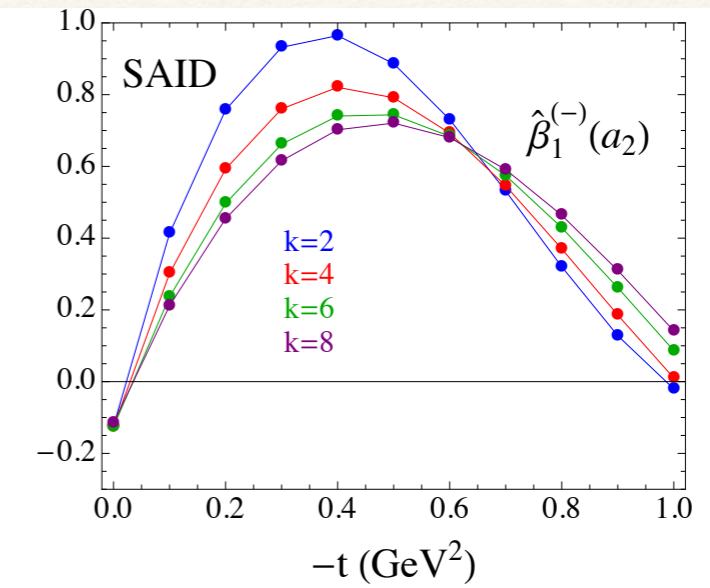
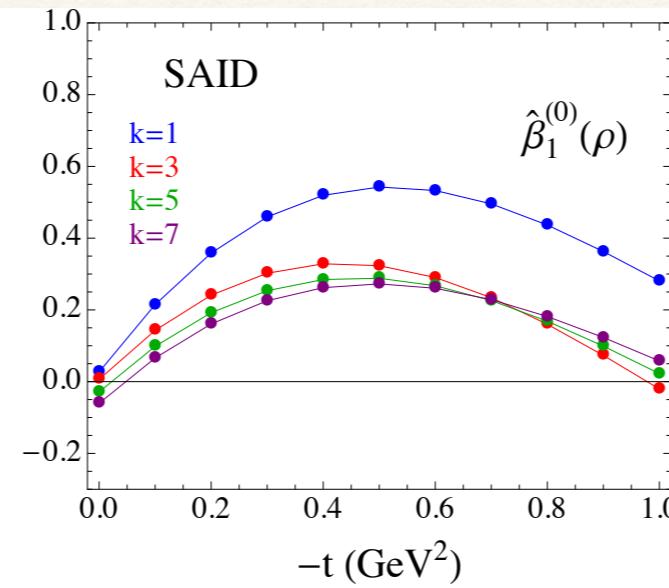
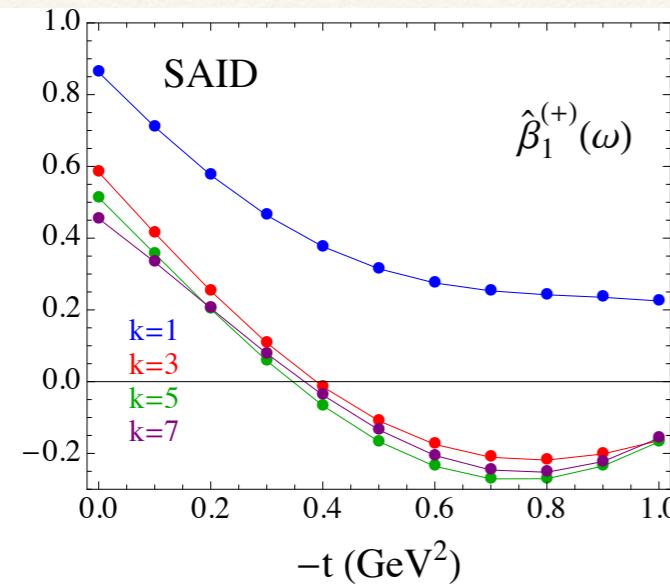
Low-energy amplitudes



SAID
MAID

Provide the left-hand side of the FESR

Residues prediction



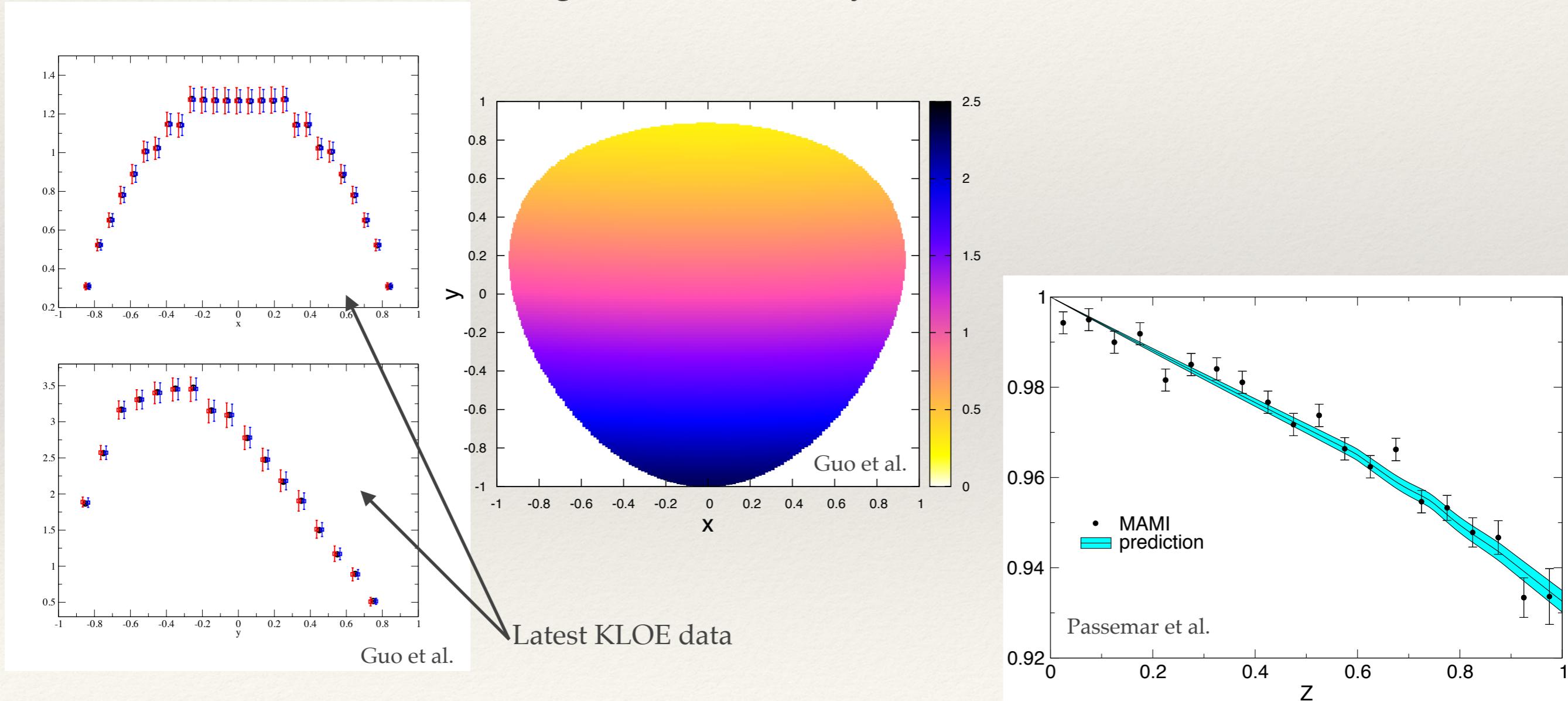
Mathieu *et al.*, in preparation (2017)

$\eta \rightarrow 3\pi$

Two different approaches \Rightarrow model dependencies and systematics under control

Guo *et al.* PRD 92 (2015) 054016 , PLB 771 (2017) 497

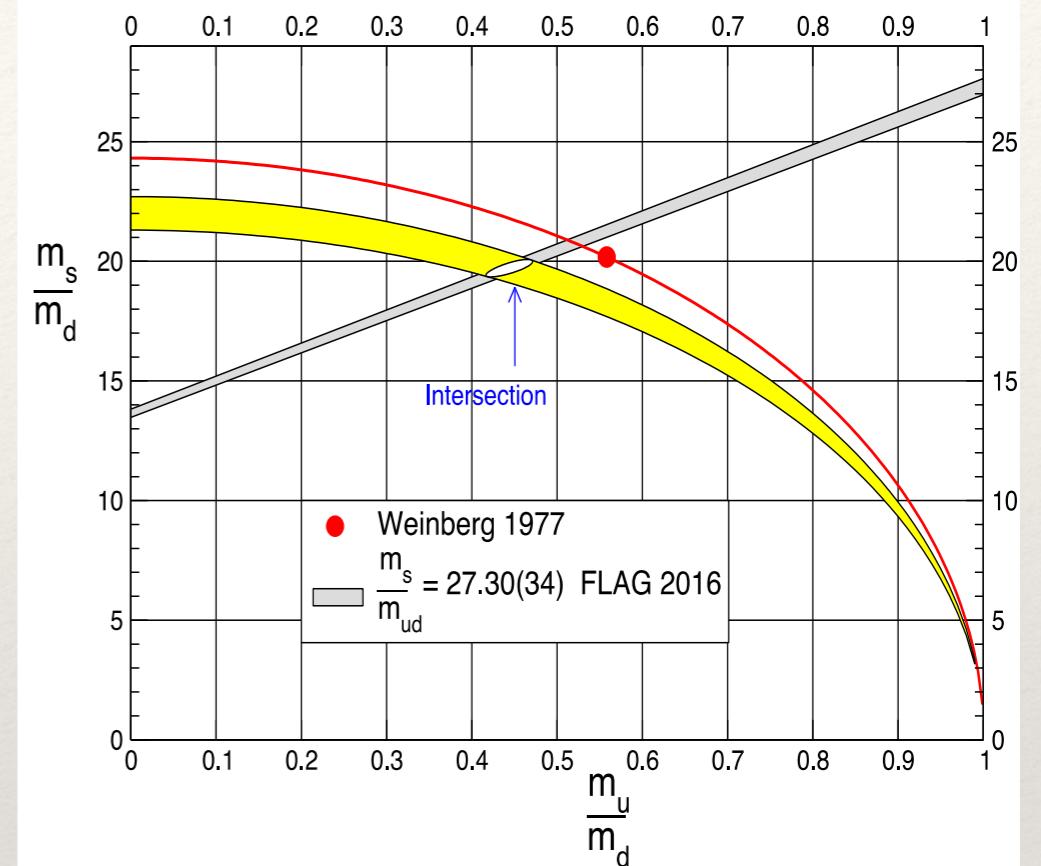
Colangelo, Lanz, Leutwyler, Passemar, PRL 118 (2017) 022001



Quark mass ratio

Matching ChPT to the dispersive amplitude
we can obtain the quark mass ratio

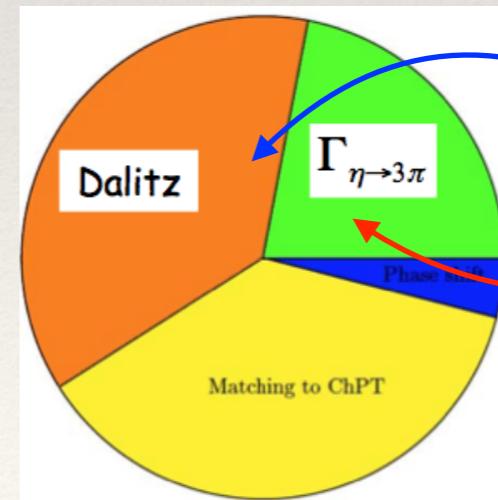
$$Q^2 = \frac{m_s^2 - m_{ud}^2}{m_d^2 - m_u^2} \quad m_{ud} = \frac{m_u + m_d}{2}$$



Error sources

$$Q = 21.6 \pm 1.1 \quad [\text{Guo et al. (2017)}]$$

$$Q = 22.0 \pm 0.7 \quad [\text{Passemar et al. (2017)}]$$



Can be investigated
& reduced at
GlueX, JEF, CLAS

Pentaquark Photoproduction

- ◆ We need independent confirmation of the LHCb signal
- ◆ J/ Ψ photoproduction on the proton is a perfect reaction for an independent confirmation (if the pentaquark couples strongly enough to the photon)
- ◆ The pentaquark signal should be clearly visible with the current experimental resolution at CLAS
- ◆ If P_c is confirmed, we need to:
 - ◆ Study the electromagnetic properties
 - ◆ Look for the other members of the P_c multiplet

Bijker, arXiv:1705.10252

Bijker, F-R, in preparation (2017)

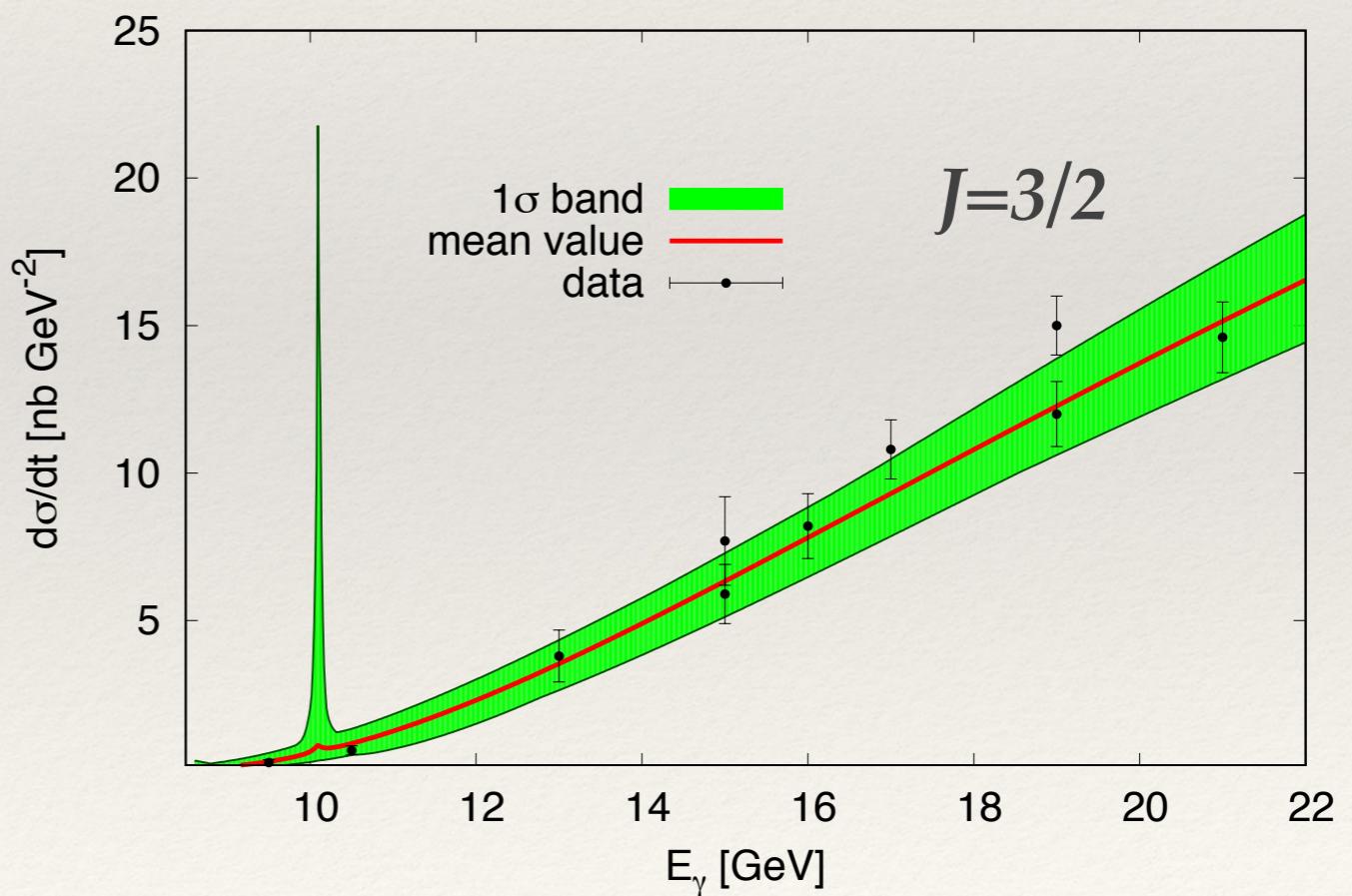
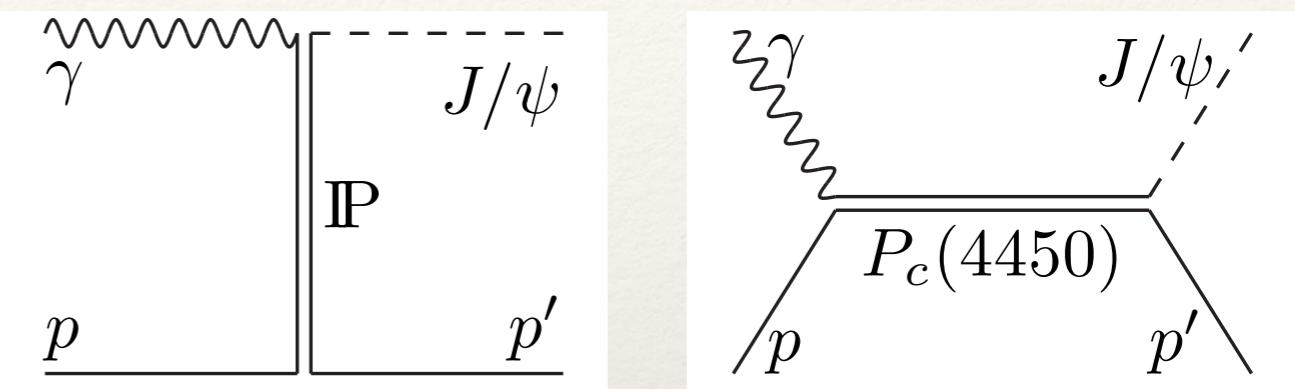
Pentaquark Photoproduction

Model for J/Ψ photoproduction

Pomeron + Resonance

- ❖ High-energy dominated by Pomeron exchange
- ❖ Resonance added as a Breit-Wigner
- ❖ We assume vector meson dominance (we do not know the em couplings)

Hiller Blin *et al.*, PRD 94 (2016) 034002
F-R, Hiller Blin, Pilloni, arXiv:1703.06928



Webpage

<http://www.indiana.edu/~jpac/>

- ❖ Codes and documentation can be downloaded
- ❖ Codes can be run online

The screenshot shows a web browser window displaying the JPAC homepage. The URL in the address bar is <http://www.indiana.edu/~jpac/>. The page features a header with logos for Indiana University Bloomington, Jefferson Lab, and The George Washington University. Below the header, the title "Joint Physics Analysis Center" is displayed, along with navigation links for HOME, PROJECTS, PUBLICATIONS, and LINKS. A banner at the bottom of the header section acknowledges support from the U.S. Department of Energy and the National Science Foundation. The main content area is titled "NEWS". Under this section, there are three categories: "Photoproduction", "Hadroproduction", and "Light meson Decay", each listing several links to specific pages.

NEWS
ABOUT JPAC

indiana.edu

Indiana University Bloomington

Jefferson Lab

THE GEORGE WASHINGTON UNIVERSITY

Joint Physics Analysis Center

HOME PROJECTS PUBLICATIONS LINKS

U.S. DEPARTMENT OF ENERGY

National Science Foundation

JPAC acknowledges support from DOE and NSF

NEWS

Photoproduction:

1. High energy model for η' beam asymmetry photoproduction: $\gamma p \rightarrow \eta' p$ page
2. High energy model for η photoproduction: $\gamma p \rightarrow \eta p$ page
3. High energy model for π^0 photoproduction: $\gamma p \rightarrow \pi^0 p$ page
4. High energy model for J/ψ photoproduction: $\gamma p \rightarrow J/\psi p$ page

Hadroproduction:

1. Pion-nucleon scattering:
 - Amplitudes $\pi N \rightarrow \pi N$ amplitude page
 - Finite energy sum rules $\pi N \rightarrow \pi N$ FESR page
2. Kaon-nucleon scattering: $\bar{K}N \rightarrow \bar{K}N$ page

Light meson Decay:

1. η meson into three pions: $\eta \rightarrow 3\pi$ page
2. vector meson into three pions: $\omega, \phi \rightarrow 3\pi$ page

Summary

- ◆ JPAC keeps producing results on amplitude analyses
- ◆ Several projects of interest to CLAS
 - ◆ FESR as high-energy constrains on the resonance region
 - ◆ $\eta \rightarrow 3\pi$
 - ◆ Pentaquark electro- and photo-production
 - ◆ If confirmed, it opens an exciting opportunity for CLAS
- ◆ All goes to the webpage, take advantage!