GW SAID Database

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Outline of the Talk

Work done in collaboration with W.J. Briscoe, D. Schott, and I.I. Strakovsky . Other collaborators: R.A. Arndt, M. Paris, M. Pavan, and L.D. Roper.

- What is SAID ?
- Who uses it ?
- What can SAID do ?
- What is the focus of current SAID activities ?
- What enhancements are planned ?

Scattering Analysis Interactive Dial-in

System (πN , NN) was distributed
through VAX tapes
and could be accessed
through early modem links.

The interface has evolved.

The SAID website

CNS
Center for Nuclear Studies
Data Analysis Center

- CNS DAC Home
- CNS DAC [SAID]
- CNS Home

Partial-Wave Analyses at GW

[See Instructions]

- Pion-Nucleon
- Pi-Pi-N (under construction)
- Kaon-Nucleon
- Nucleon-Nucleon
- Pion Photoproduction
- Pion Electroproduction
- Kaon Photoproduction
- Eta Photoproduction
- Eta-Prime Photoproduction
- Pion-Deuteron (elastic)
- Pion-Deuteron to Proton+Proton

Analyses From Other Sites

- Mainz (MAID – Analyses)
- Nijmegen (Nucleon-Nucleon OnLine)
- Bonn-Gatchina (PWA)

CNS DAC Services [SAID Program]

- The SAID Partial-Wave Analysis Facility is based at GWU.
- New features are being added and will first appear at this site. Suggestions for improvements are always welcome.

Instructions for Using the Partial-Wave Analyses

The programs accessible with the left-hand side navigation bar allow the user to access a number of features available through the SAID program. Contact a member of our group if you are unfamiliar with the SSH version. If you enter choices which are unphysical, you may still get an answer (in accordance with the `garbage in, garbage out' rule). Please report unexpected garbage-out to the management.

Note: These programs use HTML forms to run the SAID code. If unfamiliar with the options, run the default setup first. The output is an (edited) echo of an interactive session which would have resulted had you used the SSH version. If the default example fails to clarify the specific task you have in mind, we can help (just send an e-mail message).

All programs expect energies in **MeV** units. All of the solutions and potentials have limited ranges of validity. Some are unstable beyond their upper energy limits. Extrapolated results may not make much sense.
Increments: The programs will not allow an arbitrary number of points to be generated. As a rule, stay below **100**.

ACKNOWLEDGMENTS

The **CNS Data Analysis Center** is partially funded by the U.S. Department of Energy, and the Research Enhancement Funds of The George Washington University, with strong support from the GW Northern Virginia Campus.

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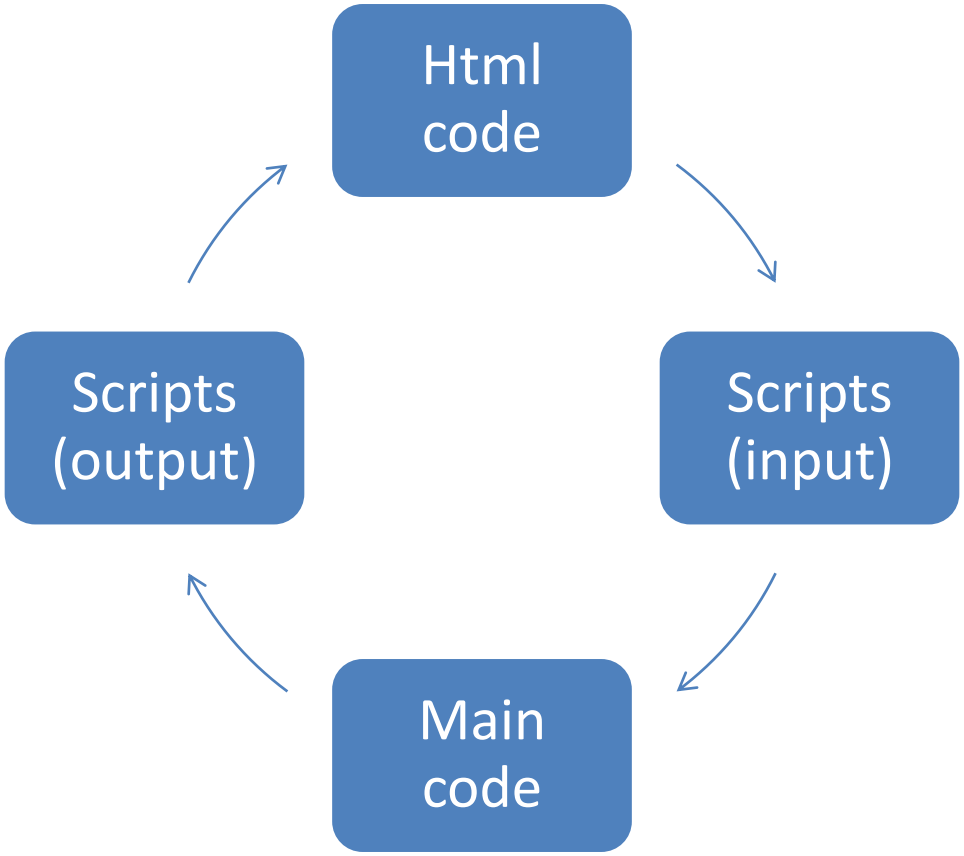
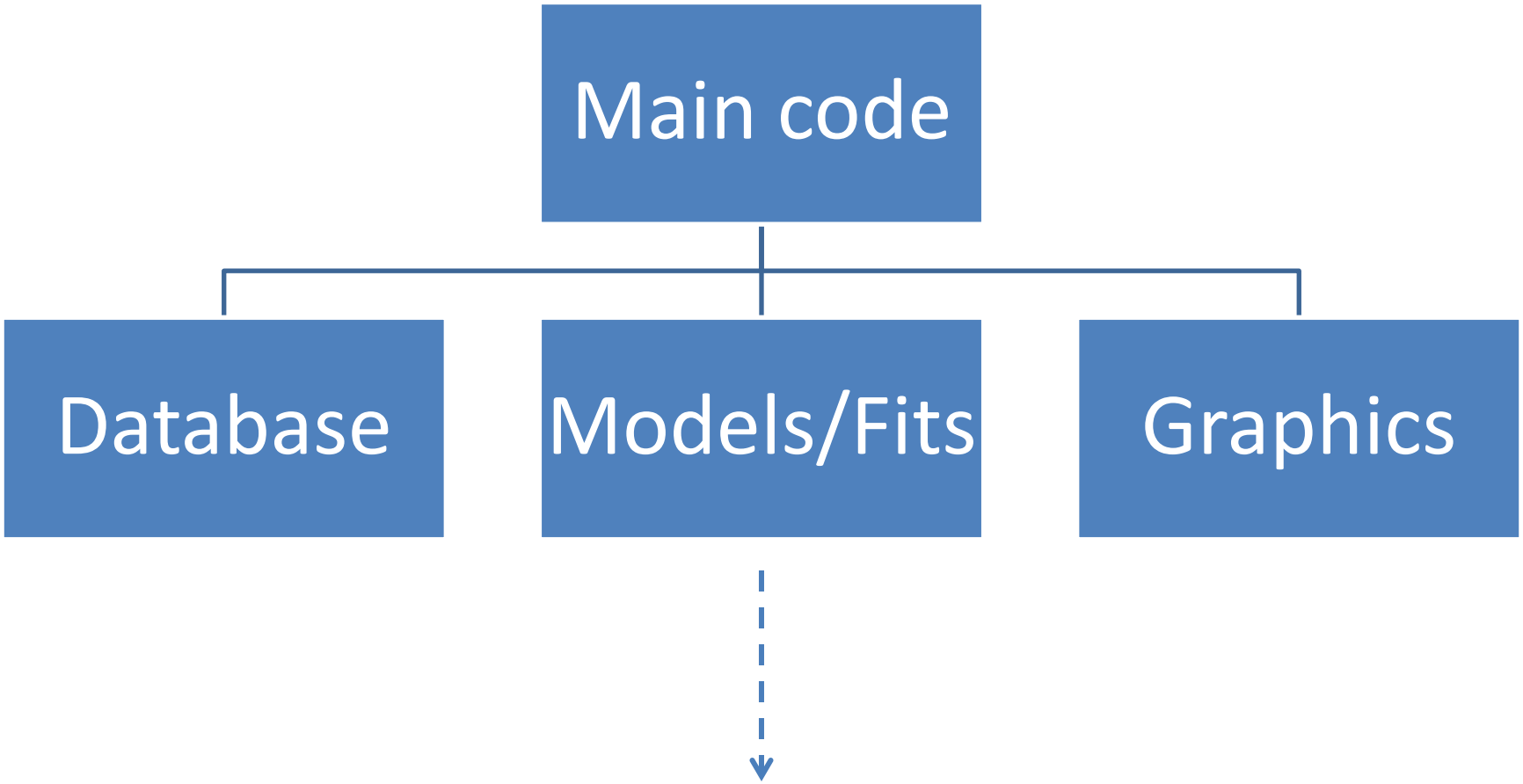
How does the SAID webpage work?

[A Schematic View]

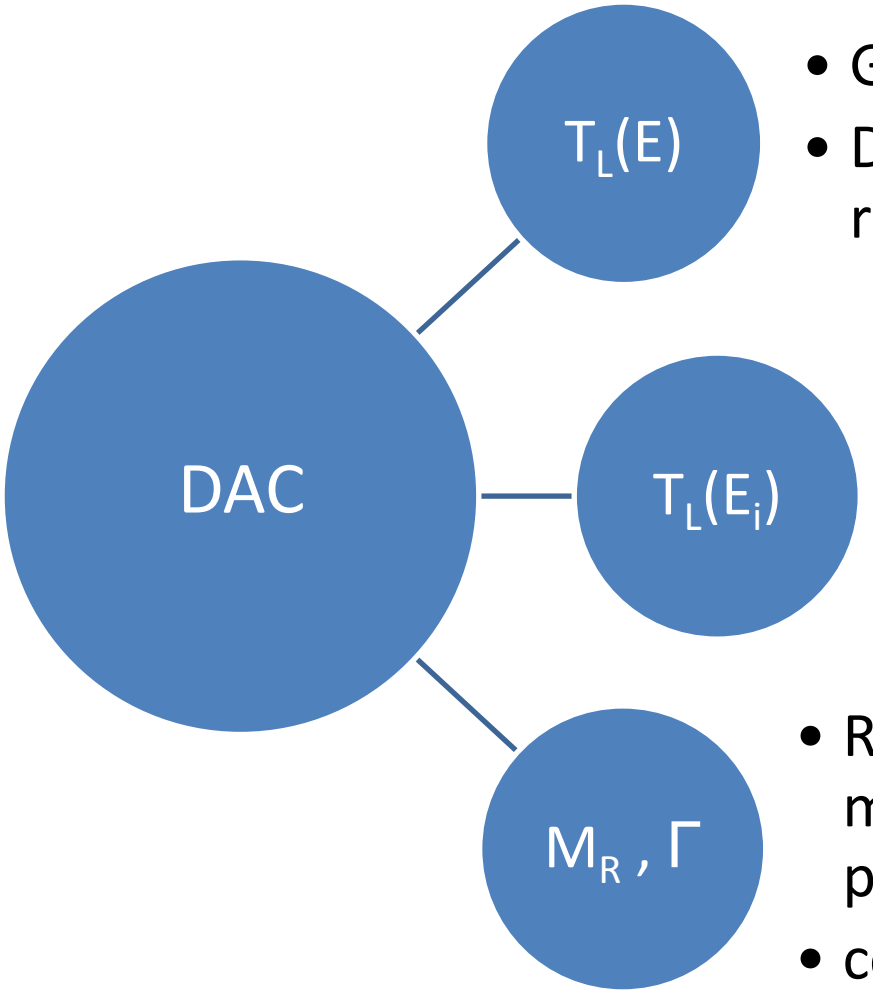
Webpage Flow



SAID Code



SAID Fits



- Global fits
- Dispersion relations

- Single-energy fits
- Global fit constraints

- Resonance mass, width, poles
- couplings

Extensive Comparison Options for both Data and Amplitudes via Web and ssh Access

- Find data types with defined energies, release dates, authors
- Compare fit chi-squared for chosen data and models
- Compare models versus data
- Compare models (predictions) for unmeasured quantities
- Compare model amplitudes
- Locate regions of greatest model deviations
- Explore effect of amplitude changes on model predictions

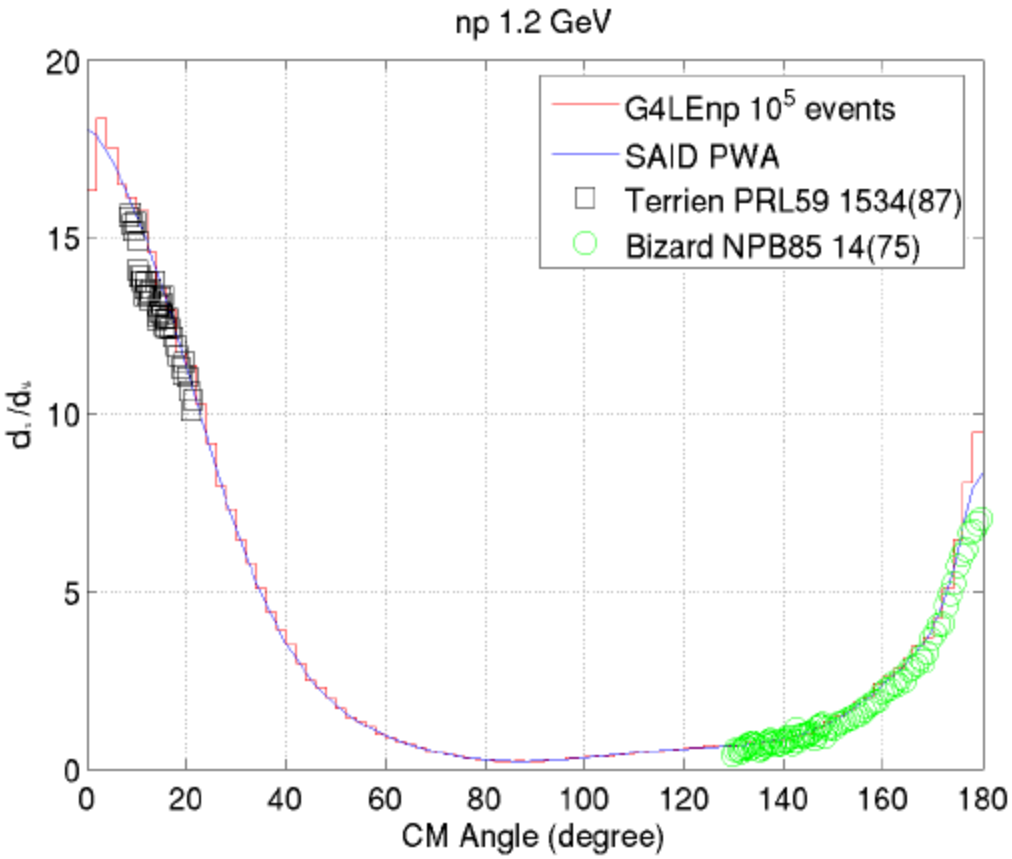
SAID is used by experimentalists planning experiments or considering how preliminary data compare to existing data and predictions. Preliminary fits have been done prior to publication.

Groups doing fits have used some of our single-energy amplitudes as *data* in multi-channel analyses. Comparisons are also made with **SAID** results at the resonance parameter level.

Data Extraction and Processing for Geant4 models

- Hadronic Models for elastic scattering **G4LEnp** and **G4LEpp** were constructed from SAID differential cross sections at energies from 10 MeV to 1.2 GeV (Wellisch-Greeniaus-Jones TRIUMF/UofA).
- Recently we extended the energy range to 5 GeV, the upper limit of the supporting data (Kwan-Jones TRIUMF).
- **G4LEnp** cross section includes charge exchange.
- By default **G4LEpp** omits Coulomb scattering effects and hence can also be used for *n-n* scattering.
- Total cross sections from SAID are not used in Geant4.
- Some MATLAB scripts were developed to provide a semi-automatic procedure for data extraction, integration, normalisation, and generation of C++ code.
- **G4LEnp** and **G4LEpp** are only occasionally found in user applications. The main use is internally in Binary Cascade!

Validation



SAID provides both the model and the validation.

SAID Site Usage (Web and ssh)

Website usage 300-400 hits/month
ssh site usage is less, confined mainly to expert users.

1.	United States	8,570	38.19%
2.	Germany	4,306	19.19%
3.	Japan	1,629	7.26%
4.	Russian Federation	888	3.96%
5.	United Kingdom	675	3.01%
6.	Italy	514	2.29%
7.	China	477	2.13%
8.	France	448	2.00%
9.	Spain	384	1.71%
10.	India	278	1.24%
11.	Senegal	270	1.20%
12.	Sweden	241	1.07%
13.	Canada	239	1.07%
14.	Switzerland	238	1.06%

Example: choose pion-nucleon branch

CNS DAC Home
Pion Nucleon
CNS Home
SAID Start

Analysis Options
Data Base
Observables
Partial Wave Amplitudes
Compare Different Analyses
Compare Fits to Data
3-D Pole Structures

choose option

Pion Nucleon [Overview]

Data Base

The data base contains on the order of 30K data points from
$\pi^-p \rightarrow \pi^-p$, $\pi^+p \rightarrow \pi^+p$ and $\pi^-p \rightarrow \pi^0n$.

Observables

Relations for the observables in terms of amplitudes are given in, for example, Bransden and Moorhouse, The Pion Nucleon System, and G.Hoehler, Pion-Nucleon Scattering, Landolt-Bornstein, Vol. I/9b2.

Partial Wave Amplitudes

The partial wave amplitudes are denoted by $L_{2I,2J}$ with L:angular momentum, I:isospin, and J:total spin.

ACKNOWLEDGMENTS

The **CNS Data Analysis Center** is partially funded by the U.S. Department of Energy, the Thomas Jefferson Lab, and the Research Enhancement Funds of The George Washington University, with strong support from the GW Northern Virginia Campus.

Pick fits to compare (WI08 vs. CMB)

CNS DAC Home
Pion Nucleon
CNS Home
SAID Start

Analysis Options
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Observables
Partial Wave Amplitudes
Compare Different Analyses
Compare Fits to Data
3-D Pole Structures

Compare Predictions from Different Analyses

Choose a Solution:

(•) Current Solution
( ) KH80 (0.02-10 GeV/c) ( ) KA84 (0.02-10 GeV/c) ( ) CMB (0.3-2.5 GeV/c)

Choose Second Solution:

( ) GW arXiv:1204.2277 (Chew-Mandelstam K-matrix poles included)
( ) KH80 (0.02-10 GeV/c) ( ) KA84 (0.02-10 GeV/c) (•) CMB (0.3-2.5 GeV/c)

Note: Comparisons will be devoid of meaning if either solution is extrapolated beyond its range of validity. The second solution is labeled on the figure and plotted in a light blue colour. Data references may be found using the "Observables" page.

Choose a Reaction Type:

(•) PI+P ( ) PI-P ( ) Charge Exchange

Choose Observables:

( ) Cross Section ( ) P ( ) R (•) A
( ) Total Cross Section ( ) Total Elastic ( ) Total Reaction

Compare fits vs. data for given observable, energy, data range

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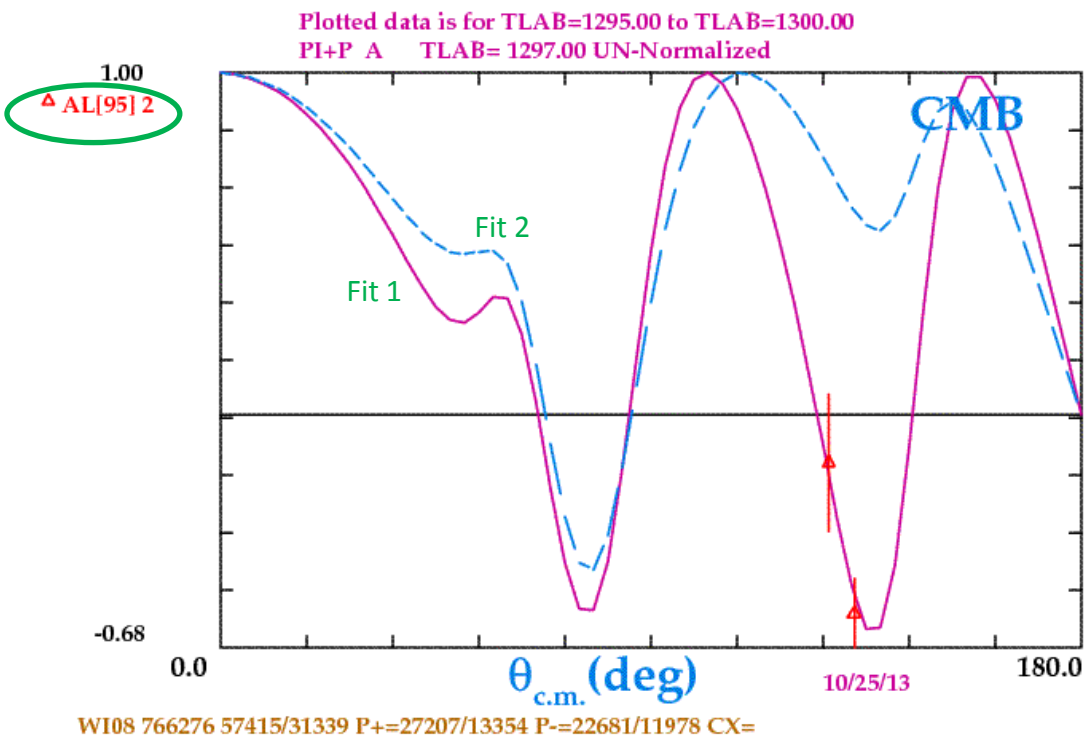
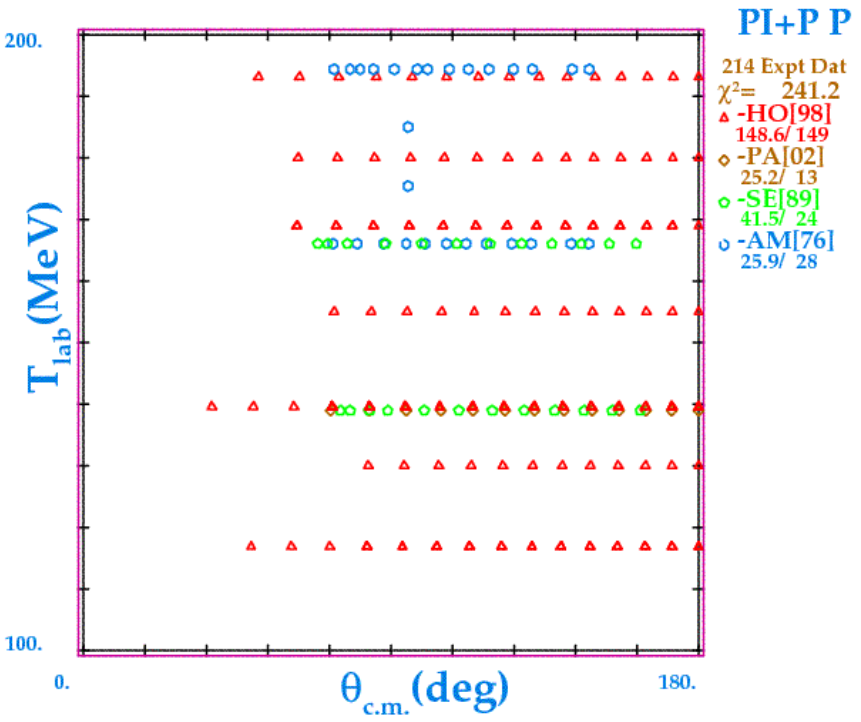
- CNS DAC Home
- Pion Nucleon
- CNS Home
- SAID Start

Analysis Options
- Data Base
- Observables
- Partial Wave Amplitudes
- Compare Different Analyses
- Compare Fits to Data
- 3-D Pole Structures

Search for data by short reference



Database Example



Reaction

Observable

T_{LAB}

Angular range

```
 15 PI+P P     at    116.80 Mev A(CM)=    49.13 to    180.00
 HO(98) 3 TRIU  HOFMAN, PRC58, 3484(1998)         Chi,M=  17.443    1.163
N,NE,Nchi=    0.98   0.030     0.63
     A        Obs          Obsx         Err          Dchi
   49.130  0.32059E+00  0.27800E+00  0.22000E-01   0.159E+01
   60.780  0.40404E+00  0.38000E+00  0.20000E-01   0.720E+00
   72.050  0.45291E+00  0.43100E+00  0.22000E-01   0.504E+00
   82.920  0.42573E+00  0.43500E+00  0.19000E-01  -0.102E+01
   93.380  0.33510E+00  0.30600E+00  0.20000E-01   0.105E+01
  103.420  0.23378E+00  0.24400E+00  0.18000E-01  -0.878E+00
  113.060  0.15356E+00  0.16400E+00  0.16000E-01  -0.881E+00
  122.320  0.98415E-01  0.81000E-01  0.12000E-01   0.126E+01
  131.240  0.62377E-01  0.79000E-01  0.12000E-01  -0.151E+01
  139.850  0.39193E-01  0.35000E-01  0.15000E-01   0.217E+00
  148.200  0.24274E-01  0.35000E-01  0.15000E-01  -0.754E+00
  156.340  0.14598E-01 -0.70000E-02  0.13000E-01   0.163E+01
  164.310  0.81873E-02  0.12000E-01  0.15000E-01  -0.267E+00
  172.180  0.36600E-02 -0.40000E-02  0.17000E-01   0.445E+00
  180.000  0.00000E+00  0.48000E-01  0.31000E-01  -0.155E+01
```

Fit chi-squared

A: CM angle
Obs: Calc. observable
Obsx: Expt. Value
Err: Statistical error
NE: Systematic error
N: Best-fit Norm factor

Amplitudes

[magnetic multipole connected to πN D_{13} partial wave]

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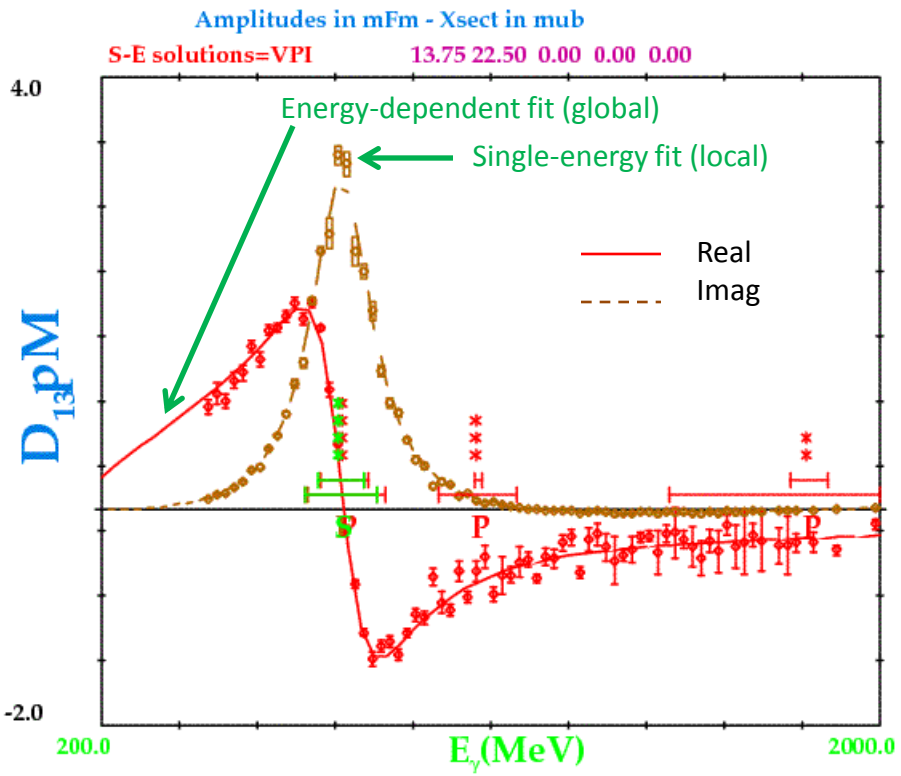
- CNS DAC Home
- Pion Photoproduction ←
- CNS Home
- SAID Start

Analysis Options
- Data Base
- Observables
- Multipole Amplitudes ←
- Change Multipoles
- Compare Different Analyses
- Compare Fits to Data



Numerical values are tabulated following the plot

The SSH Interface

ssh -X said@said.phys.gwu.edu gives you:

```
The following reactions are available under SAID
 nn- Nucleon-Nucleon elastic
 pn- Pion-Nucleon elastic. (includes Pi-N -> Pi-Pi-N)
 pr- Pion photo production
 epr- Pion electro- production
 kn- K+N elastic
 pd- Pion-deuteron -> proton-proton
 pde- Pion-deuteron elastic
 sim- Run Physics Simulations
 demo- Run SAID demo
 show- Look at .PCT file
 cprsol - setup/run comparisons for PR/EPR reactions
Enter the code (eg. NN) of the reaction you want to study->
```

Pick a reaction and follow the prompts

Some Help Available on Website

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CNS DAC Home
CNS DAC [SAID]
CNS Home
TUTORIALS

Partial-Wave Analyses at GW
[See Instructions]
Pion-Nucleon
Pi-Pi-N
Kaon(+)-Nucleon
Kaon(-)-Nucleon
Nucleon-Nucleon
Pion Photoproduction
Pion Electroproduction
Kaon Photoproduction
Eta Photoproduction
Eta-Prime Photoproduction
Pion-Deuteron (elastic)
Pion-Deuteron to Proton+Proton

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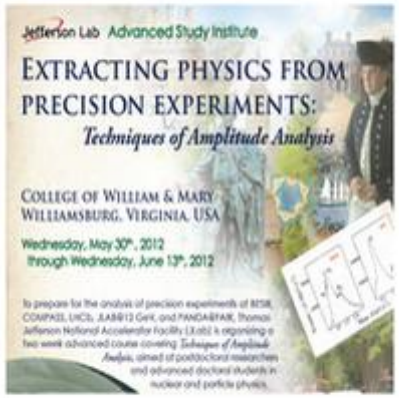
Data Analysis Center

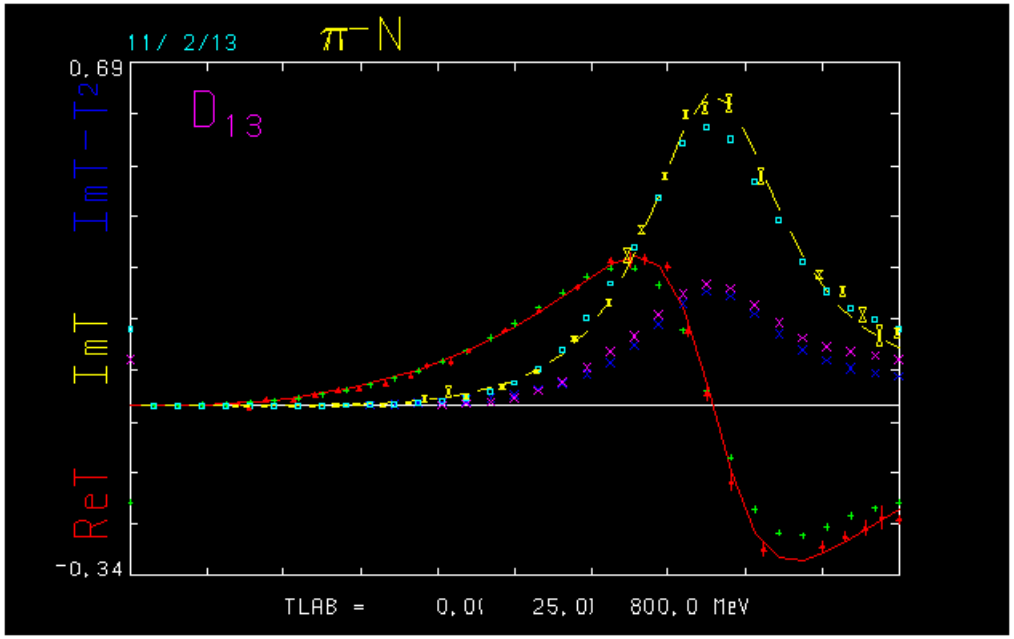


SAID Web Tutorials
Webpage overview
SAID SSH Tutorials
SSH Overview
SSH Comparisons
Model Tutorial

Compare πN Amplitudes (WI08 vs. KA84)

red/yellow
lines

green/blue
symbols



Explore Fits vs. Data

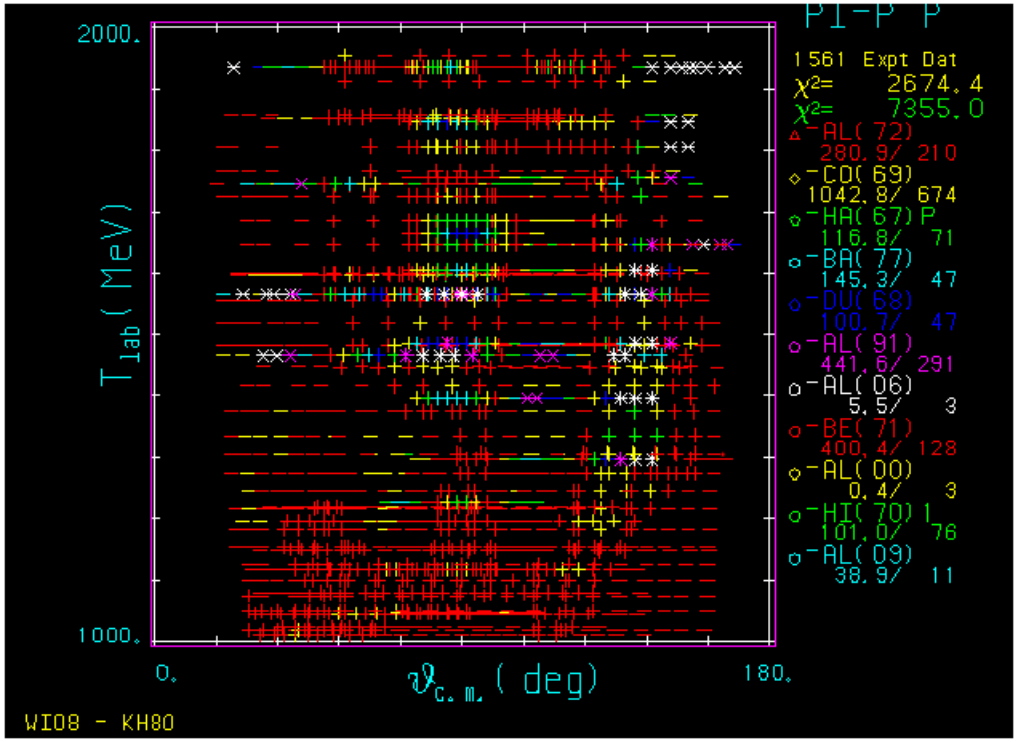
Plot:

($Sol_1 - Sol_2$)/err

for existing data

Color coded (rainbow)

Red(small)→Blue(large)



Projects on the Horizon

- Incorporation of JLab, Mainz, Bonn pseudo-scalar meson photoproduction data (proton/neutron targets)
  (unpolarized, single- , double-polarization observables)

- Include/fit new πN and NN data (WASA, EPECUR)

- Add new strangeness channels:

  $K^- p \rightarrow K^- p,\ K^0 n,\ \Lambda \pi\ ,\ \Sigma \pi$ (in progress)

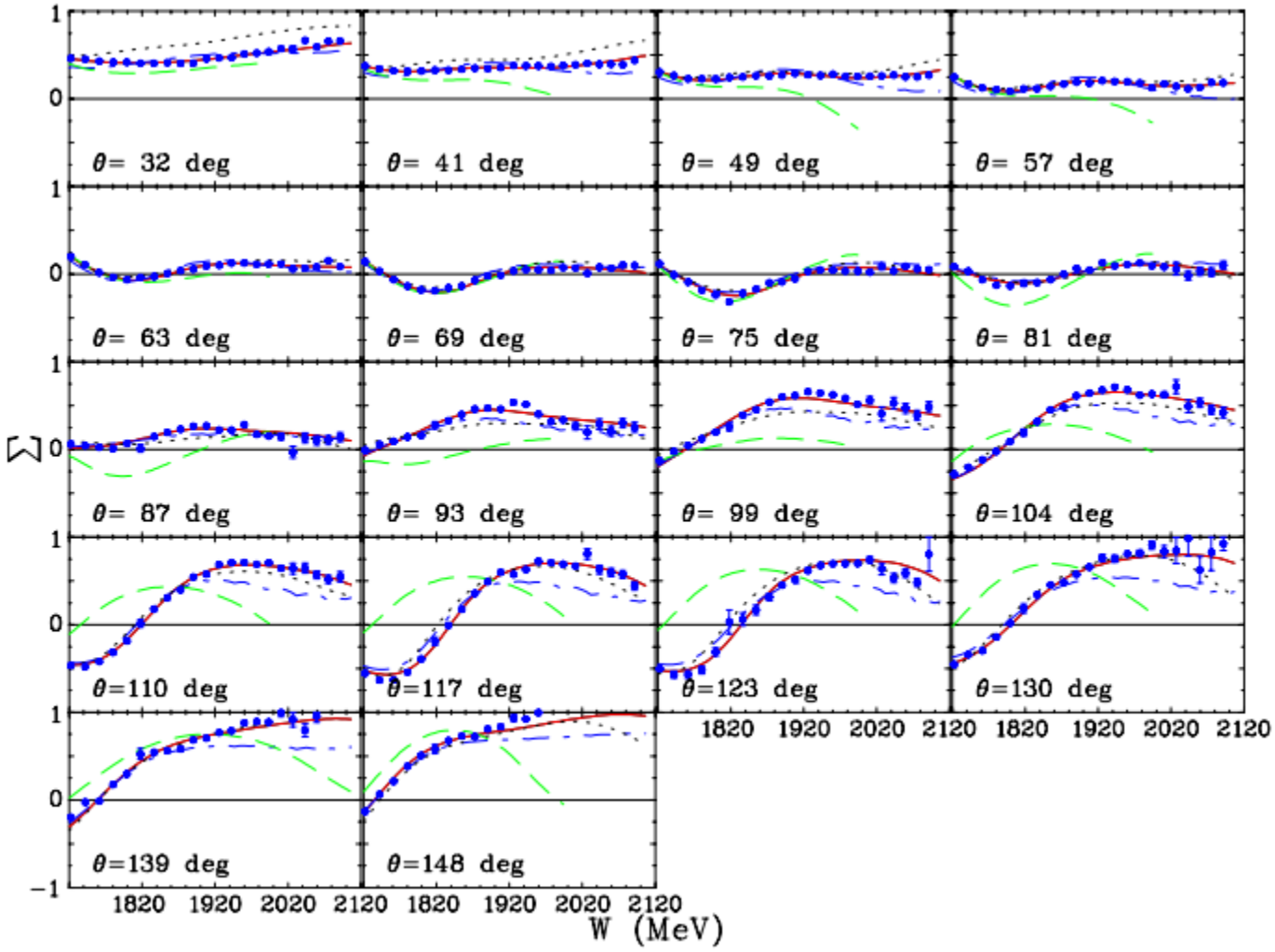
  $\pi N \rightarrow \Lambda K\ ,\ \Sigma K$

- Attempt to link resonance – higher energy parameterizations
  (matching to Regge fits, exploring FESR constraints)

A graphical tour of recent issues

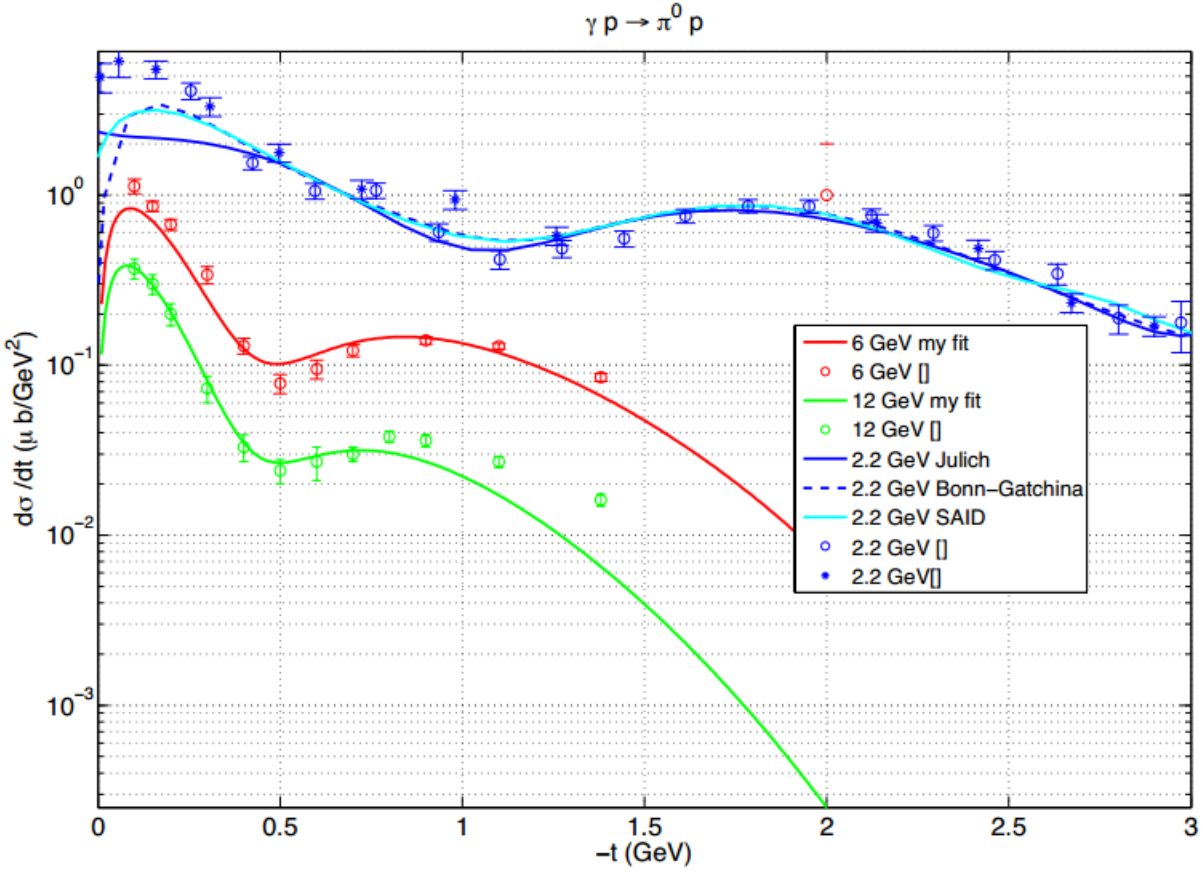
$\pi^+ n$ photoproduction Σ data from CLAS

M. Dugger et al., submitted to PRC



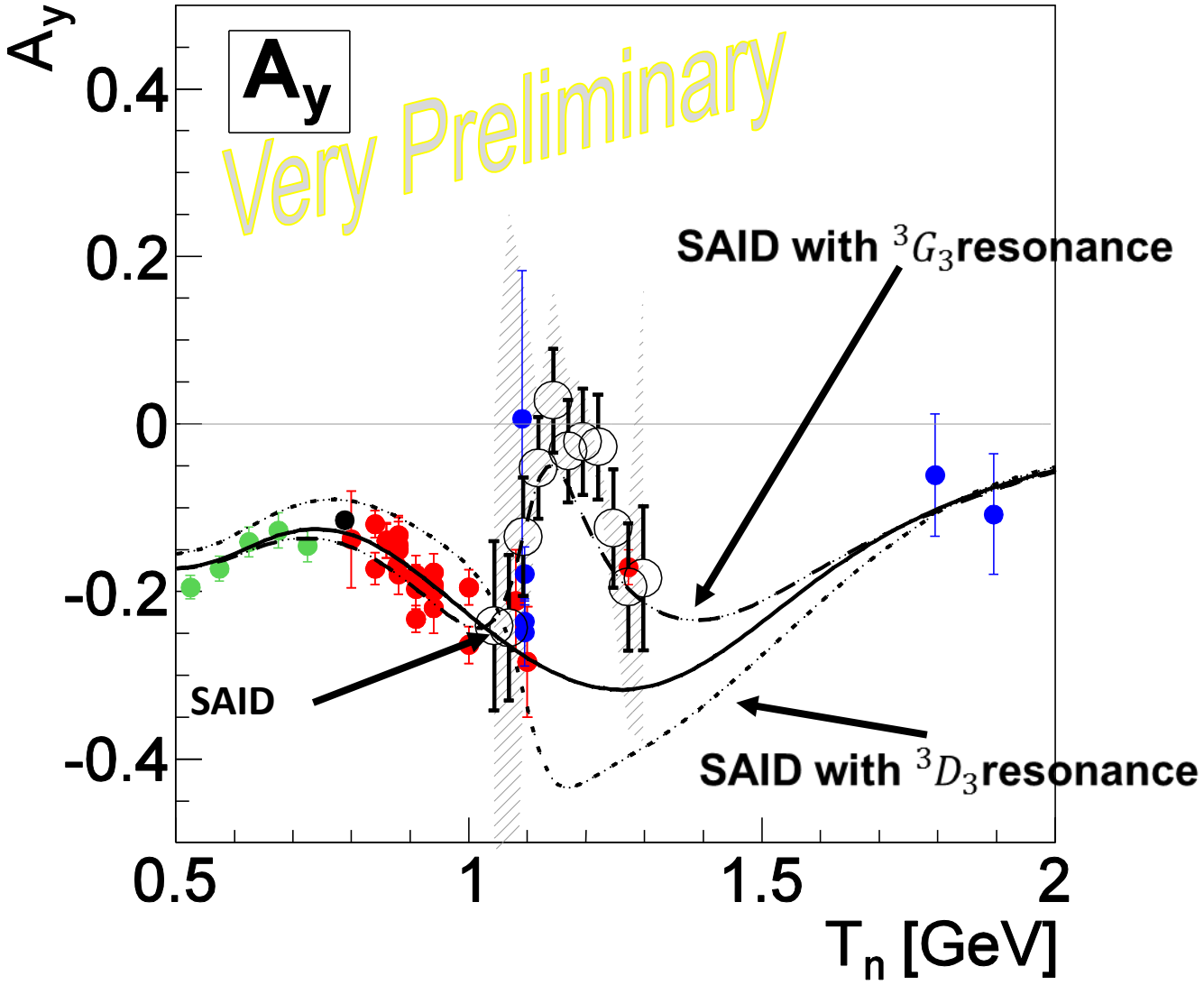
Comparison: Resonance vs. Regge Regions

V. Mathieu, JPAC working group



WASA-at-COSY np data

M.Bashkanov, Baryons 2013



EPECUR data

D. Svirida, Baryons 2013