Comments for linear photon polarization extractions, Eg cuts and G asymmetries

T. Kageya @ g14 meeting, May 29th, 2024

How to calculate linear photon pol. ?

1. Obtain the coherent edge:

* Take coherant data (distributions of bremsstrahlung electrons) with a diamond crystal radiator. From the scalers on the E-counters of the tagger and record them every 2 seconds.

* Take data with an amorphous radiator

* Divide the coherent by amorphous data(enhancement)-> get the coherent edge

2. Make polarization table on coherent edge and Eg

* Use the coherent bremsstrahlung theory

* Get a table of photon beam pol. on edge and Eg

1. Obtain the coherent edge by a fit to the enhancement distribution for each event group

From ”Determining the Degree of Polarization for Linearly Polarized Photons at CLAS” by Ken and Nick, (March 14, 2012)

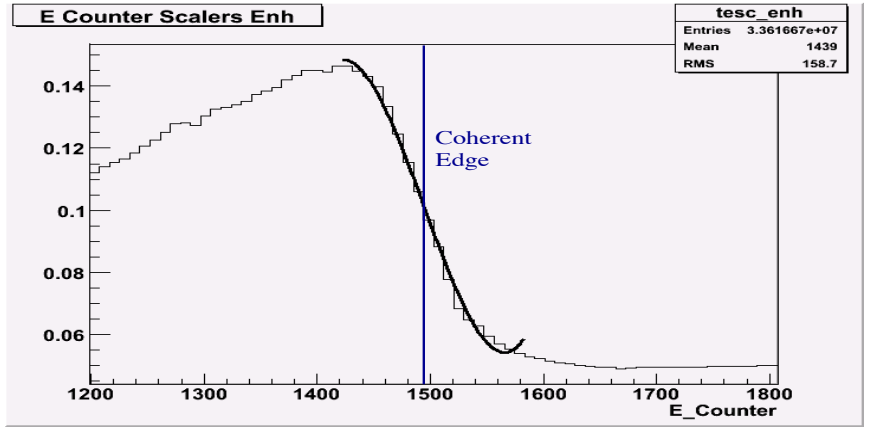


Figure 3: Coherent peak derived from e counter scalers

in the set. This new table is then the default table for the next 2 s period, and is used to look up the degree of linear polarization for any given photon energy.

In general, the data are taken with 2 orthogonal polarization settings (PARA, PERP). Variations in the horizontal and vertical beam profile mean that the shape of the enhancement, and hence the polarization, is different for each of these settings, so different sets of lookup tables need to be made for PARA and PERP or any other azimuthal setting of the polarization plane.

The purpose of this note is to describe in detail the method of generating the polarization tables from the data and explain how to use the information in data analysis. A description of the fitting method follows, and the remaining sections describe how to use the tables in data analysis, and how to produce the tables.

2 Fitting the enhancements.

2.1 The fit function

A table of Coherent Edges on Event groups

Example of a table for 1.8 GeV PARA data Run 69481

#Event Range	Coh Edge	Plane	EPICS Edge
0 - 2778	1788.0	0	1799.7
2778 - 17616	1785.2	0	1802.9
17616 - 31852	1776.5	0	1798.6
31852 - 45339	1780.5	0	1794.2
45339 - 59439	1784.8	0	1797.5
59439 - 73190	1792.8	0	1817.1
73190 - 87531	1795.1	0	1816.1
87531 - 101618	1786.7	0	1812.8
101618 - 115135	1782.4	0	1799.7

Planes are: PARA=0,PERP=1,AMO=2,CHANGING=3

2. Calculate beam pol. with coherent bremsstrahlung theory (CLAS NOTE 2011-020 by Ken)

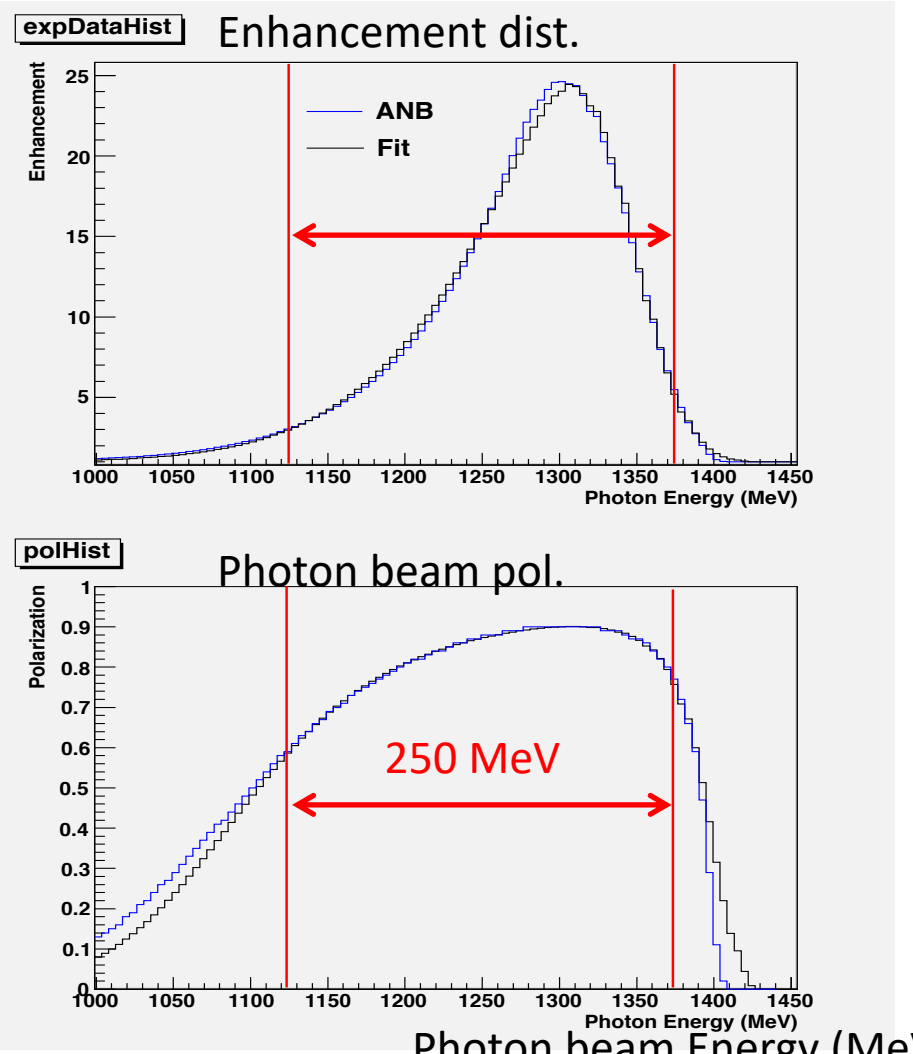


Figure 4: Comparison of fitted data with analytic bremsstrahlung calculation set up to model data from the coherent bremsstrahlung facility at CLAS.

Analytic Bremsstrahlung (ANB) calculation from the Tuebingen Group

Fit to the enhancement dist.

These two agree well within photon energy range (250 MeV) shown by the arrows (down to ~200 MeV from the edge)

A table of event by event photon beam pol. on photon Energy

Example of a table for 1.8 GeV PARA data (Coherent Edge: 1.8 GeV)

#E_Id	Energy	Enh	EnhErr	EnhFit	PFit	PCor	PcorErr	Psmooth
329	1727.4	-1.000	-1.000	6.330	0.771	0.771	0.000	0.758
328	1738.4	-1.000	-1.000	6.467	0.775	0.775	0.000	0.803
327	1749.3	-1.000	-1.000	6.556	0.778	0.778	0.000	0.801
326	1760.3	-1.000	-1.000	6.586	0.779	0.779	0.000	0.789
325	1771.2	-1.000	-1.000	6.548	0.778	0.778	0.000	0.782
324	1782.2	-1.000	-1.000	6.435	0.776	0.776	0.000	0.771
323	1793.1	-1.000	-1.000	6.241	0.772	0.772	0.000	0.758
322	1804.0	-1.000	-1.000	5.969	0.765	0.765	0.000	0.764
321	1815.0	-1.000	-1.000	5.526	0.752	0.752	0.000	0.756
320	1825.9	-1.000	-1.000	5.117	0.739	0.739	0.000	0.789
319	1836.8	-1.000	-1.000	4.666	0.721	0.721	0.000	0.749
318	1847.8	-1.000	-1.000	4.089	0.693	0.693	0.000	0.697
317	1858.7	-1.000	-1.000	3.618	0.664	0.664	0.000	0.612
316	1869.6	-1.000	-1.000	3.166	0.627	0.627	0.000	0.592

At page 10 of Ken‘s CLAS NOTE 2011-020 (to be referred)

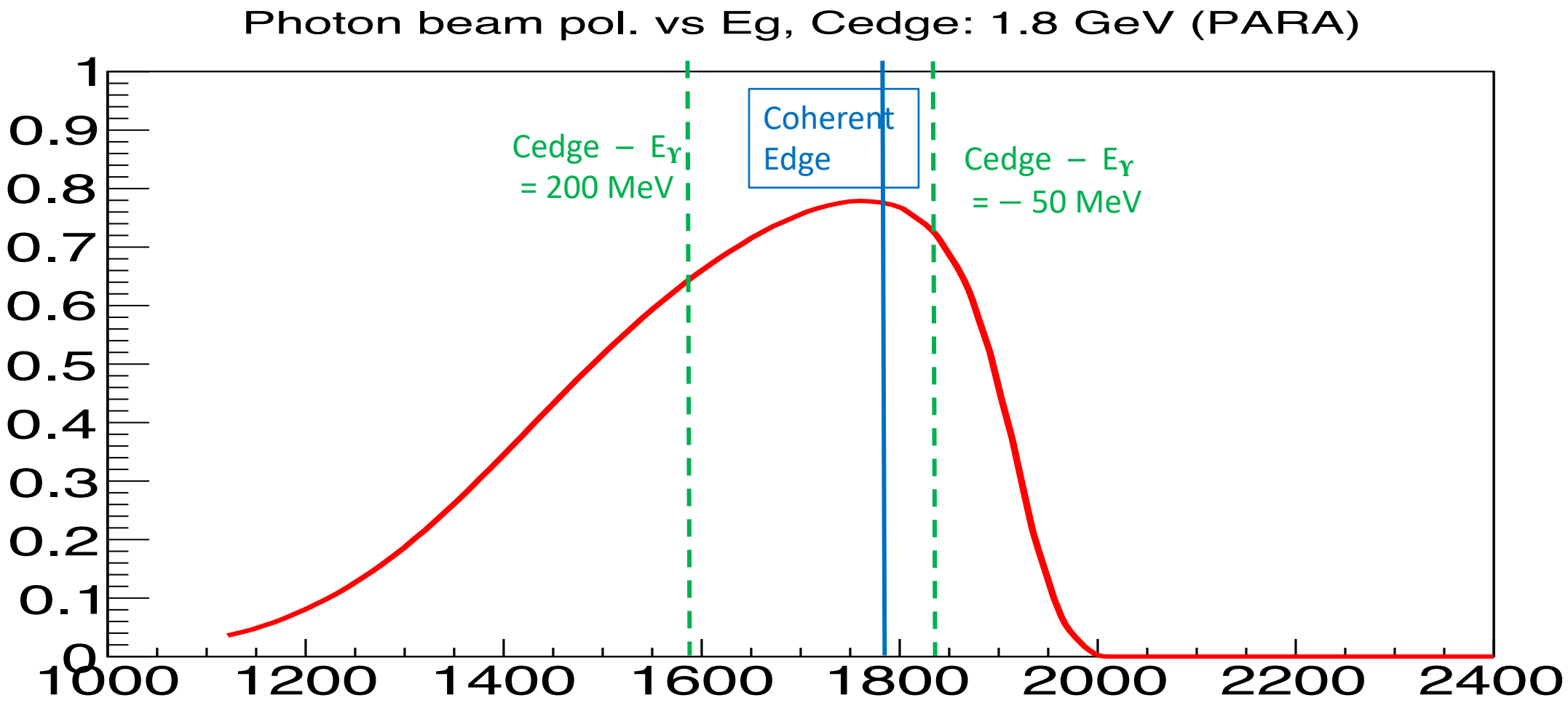
if we restrict ourselves to a window of about 250 MeV around the coherent peak, the agreement between polarization from the ANB calculation that from the fitted data is excellent.

At page of 4 of Phys. Rev. C **97**, 055202,
“Measurement of the beam asymmetry Σ and the target asymmetry T in the photoproduction of ω mesons off the proton using CLAS at Jefferson Laboratory”

The incident photons reached their maximum polarization within a roughly 200 MeV window below the coherent edge….. The average degree of polarization of the linearly-polarized beam was measured via a fit of the photon energy spectrum using a coherent bremsstrahlung calculation [28, Ken’s CLAS NOTE 2011-020].

Please refer K. Livingston, Nucl. Instrum. Meth. A 603, 205 (2009) in the analysis note

Coherent Edge – E_Υ (MeV) from the table: 1.8 GeV/c (PARA)



On Haiyun's analysis note on Mar. 31st 2021

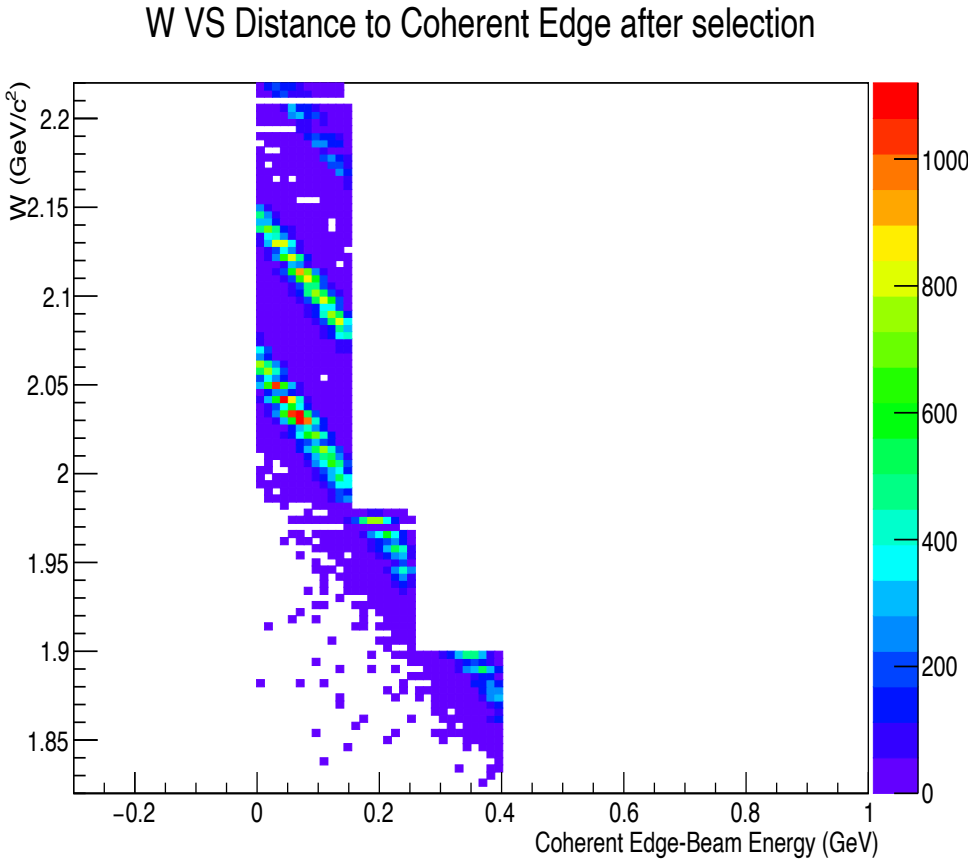
Haiyun estimated gloval factor comparing $\boldsymbol{\Sigma}$ form g14 with g13

W range	factor
1.82 - 1.9	0.81
1.9 - 1.98	0.92
1.98 - 2.06	1.02
2.06 - 2.14	1.07
2.14 - 2.22	1.10

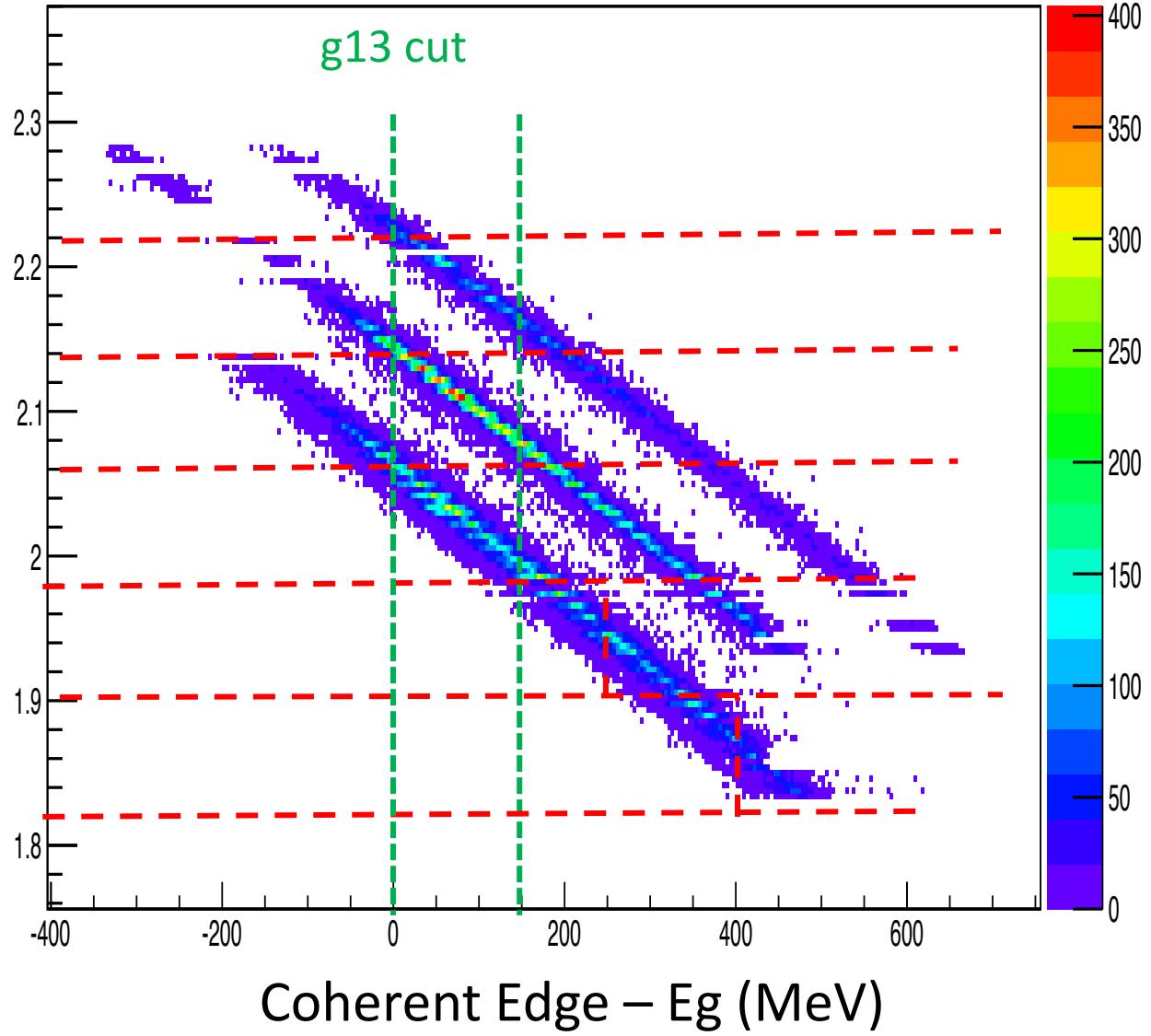
dy reaction assumption.

Initial W distributions and vs Coherent Edge – Eg (MeV)

Haiyun's present cuts

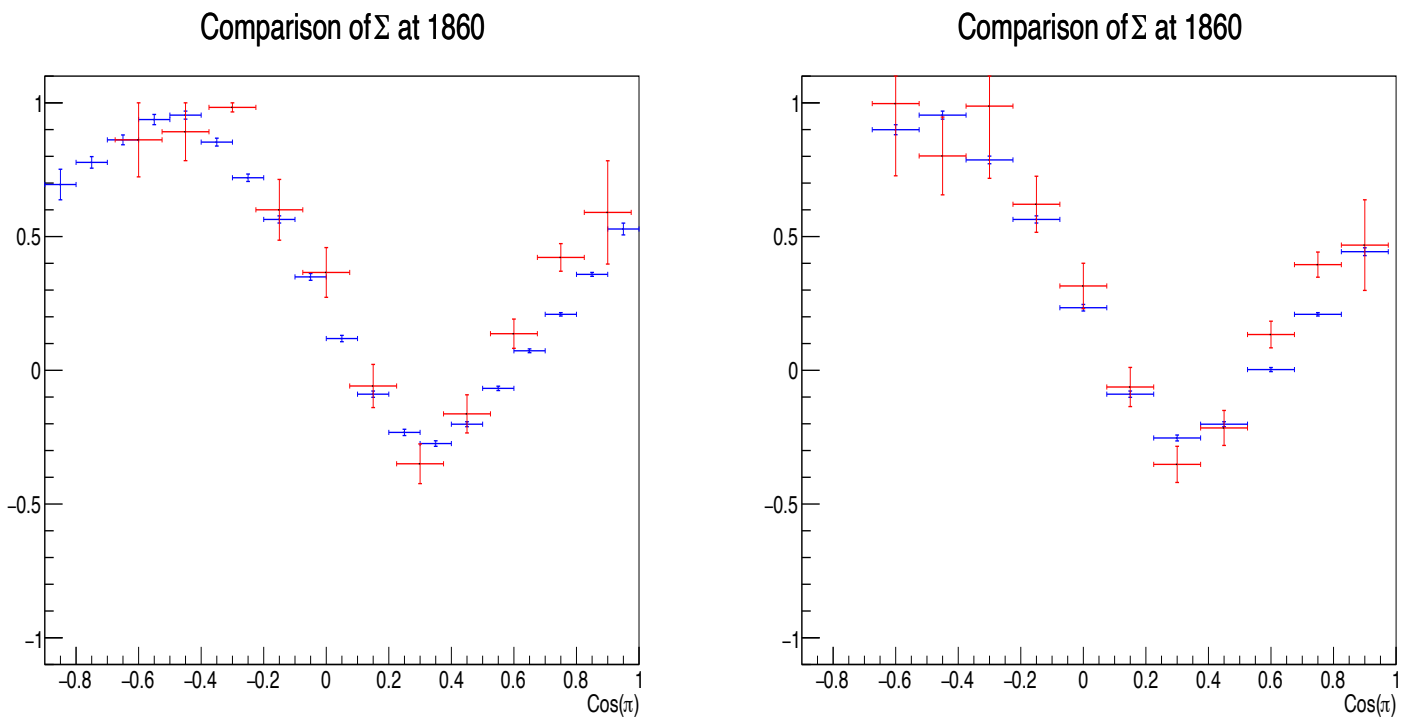


Final W (GeV)



(b) W

From Haiyun's AN
Mar. 31, 2021



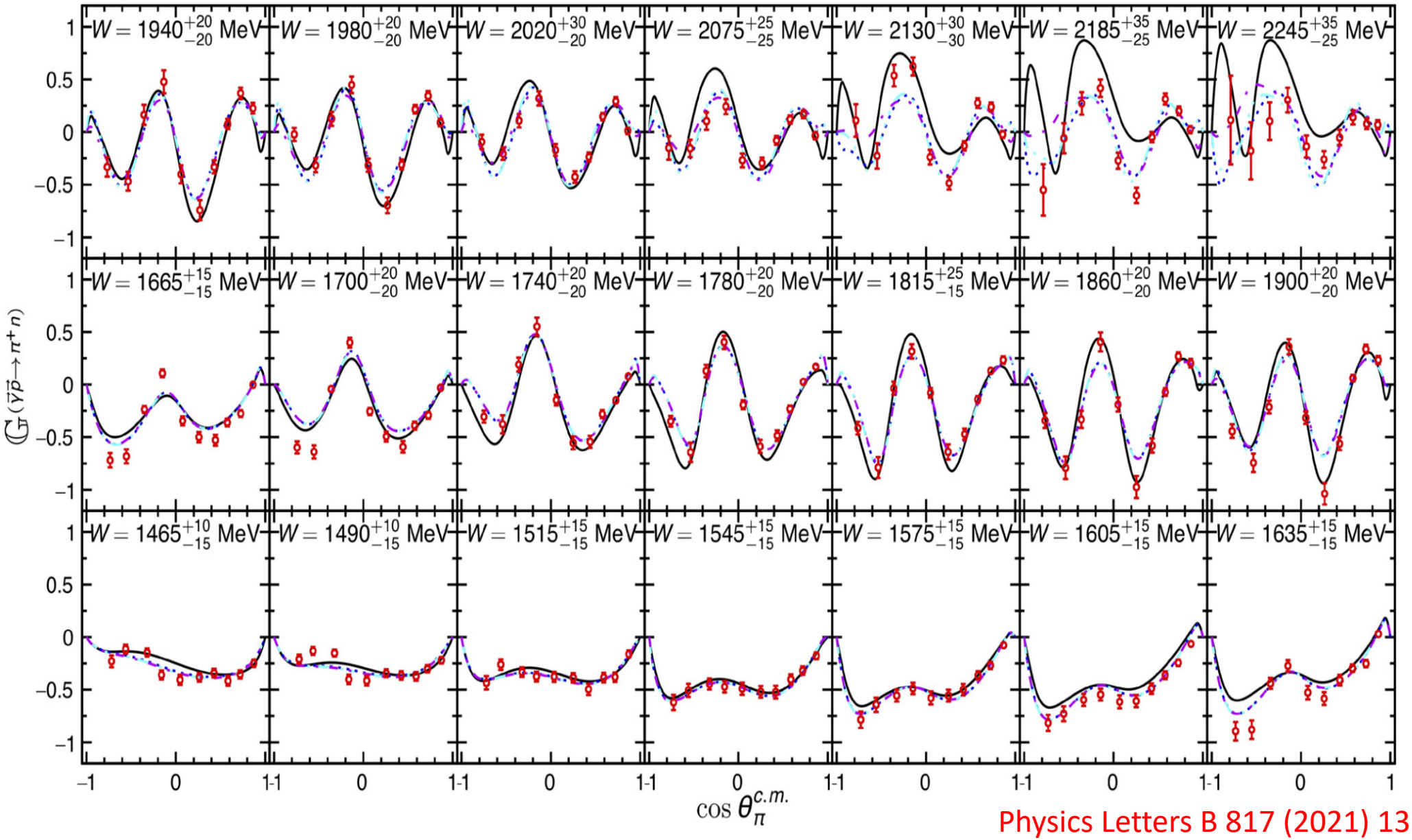
(a) Comparison of Σ in this work (red) with g13 (blue)

(b) Corrected Σ in this work (red) and g13 results (blue)

Figure 34: Fitting global factor by comparing to g13 with W at 1860 MeV. Correction factor 0.81

dash-dotted; see text for details on solutions) are also indicated in the panels (solution 2 not shown). Differences between the four Bonn-Gatchina solutions are only evident at higher W.

G from $\vec{\gamma}\vec{p} \to \pi^+ n$ (g9a)

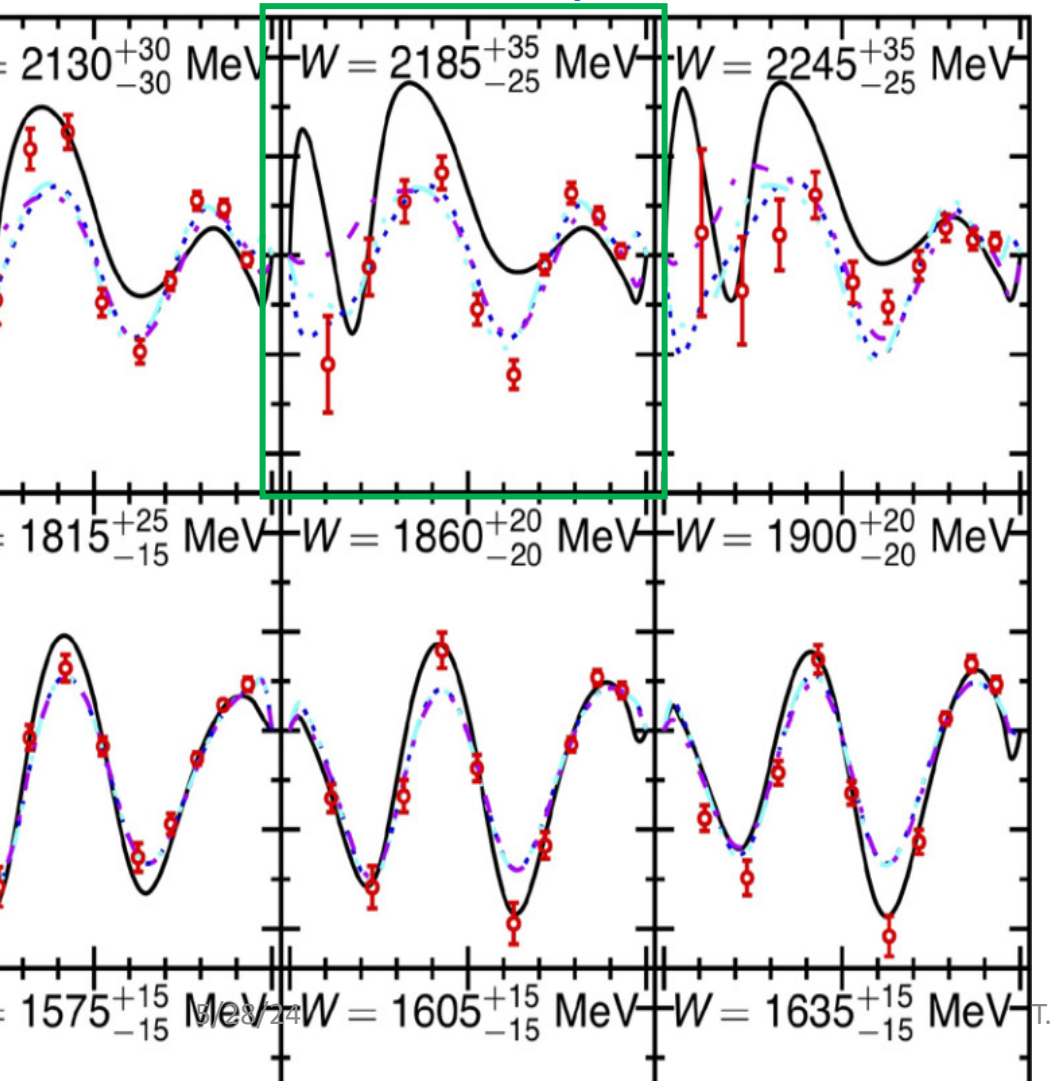


Physics Letters B 817 (2021) 136304

Fig. 5. Double-polarisation observable, $\mathbb{G}$, for the reaction $\vec{\gamma}\vec{p} \to \pi^+ n$ as a function of the pion production angle in the *c.m.* frame. The different panels denote bins in *c.m.* energy W, with the mean values and widths indicated in each plot. The experimental data from this work are shown by the red circle with error bars denoting the

e *c.m.* frame. The different panels denote bins in *c.m.* energy *W*, by the red circle with error bars denoting the total uncertainties. tted, solution 3 cyan dash dotted-dotted, and solution 4 magenta rences between the four Bonn-Gatchina solutions are only evident

g9a G $(\gamma \vec{p} \rightarrow \pi^+ n)$



Haiyun's analysis note on Mar. 31st 2021

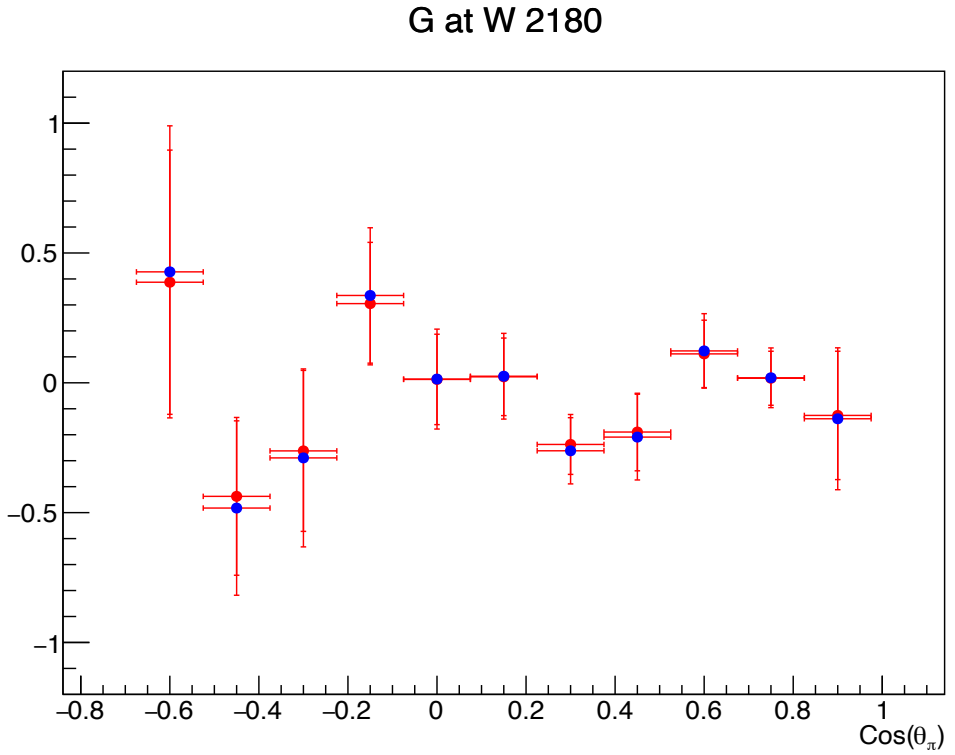
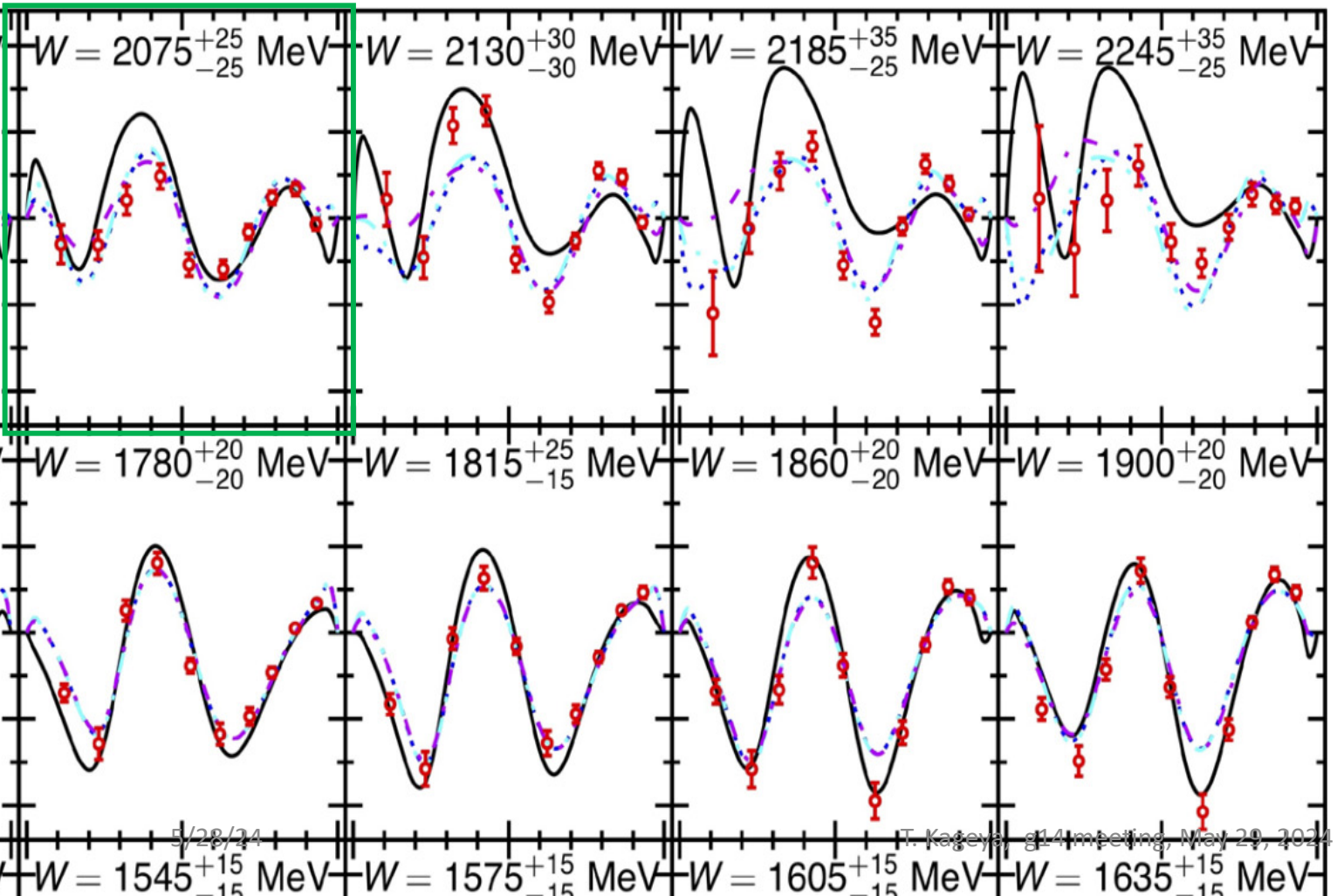


Figure 43: Corrected (blue) and uncorrected (red) *G*with W at 2180 *MeV*

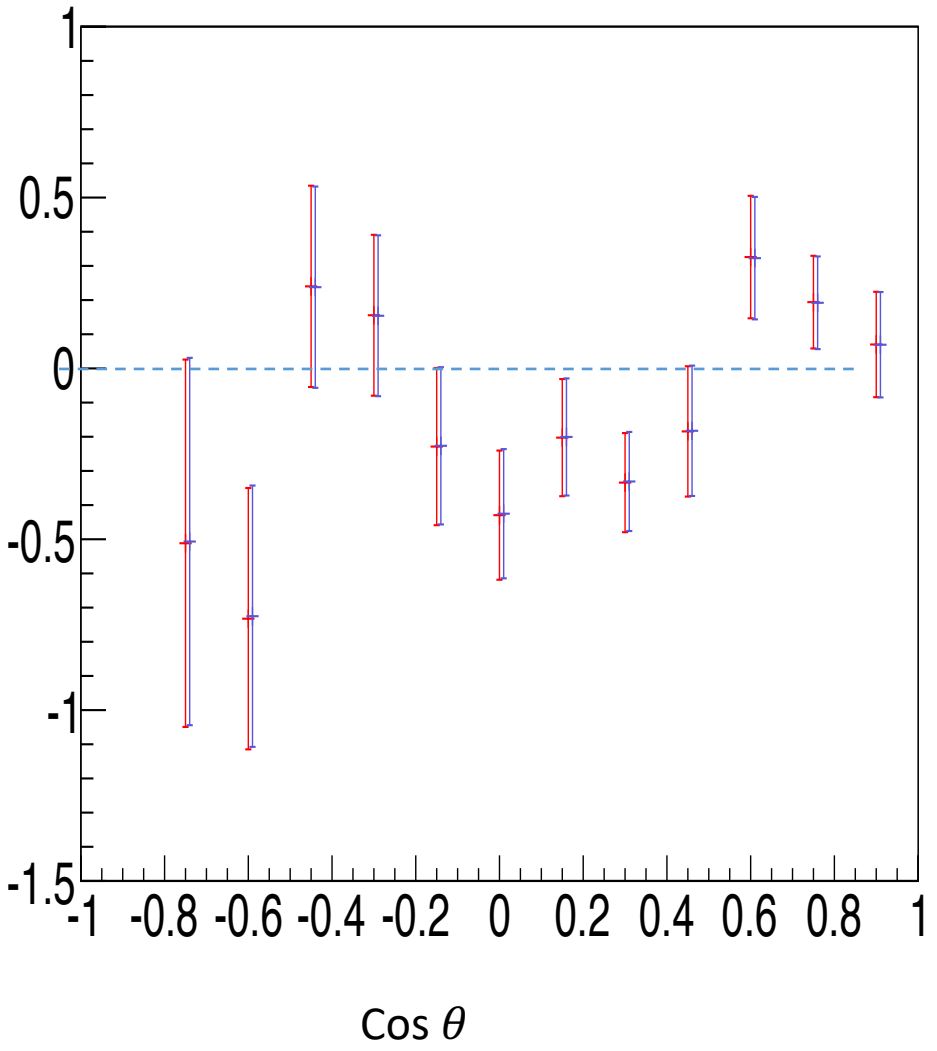
$\cos\theta_\pi$

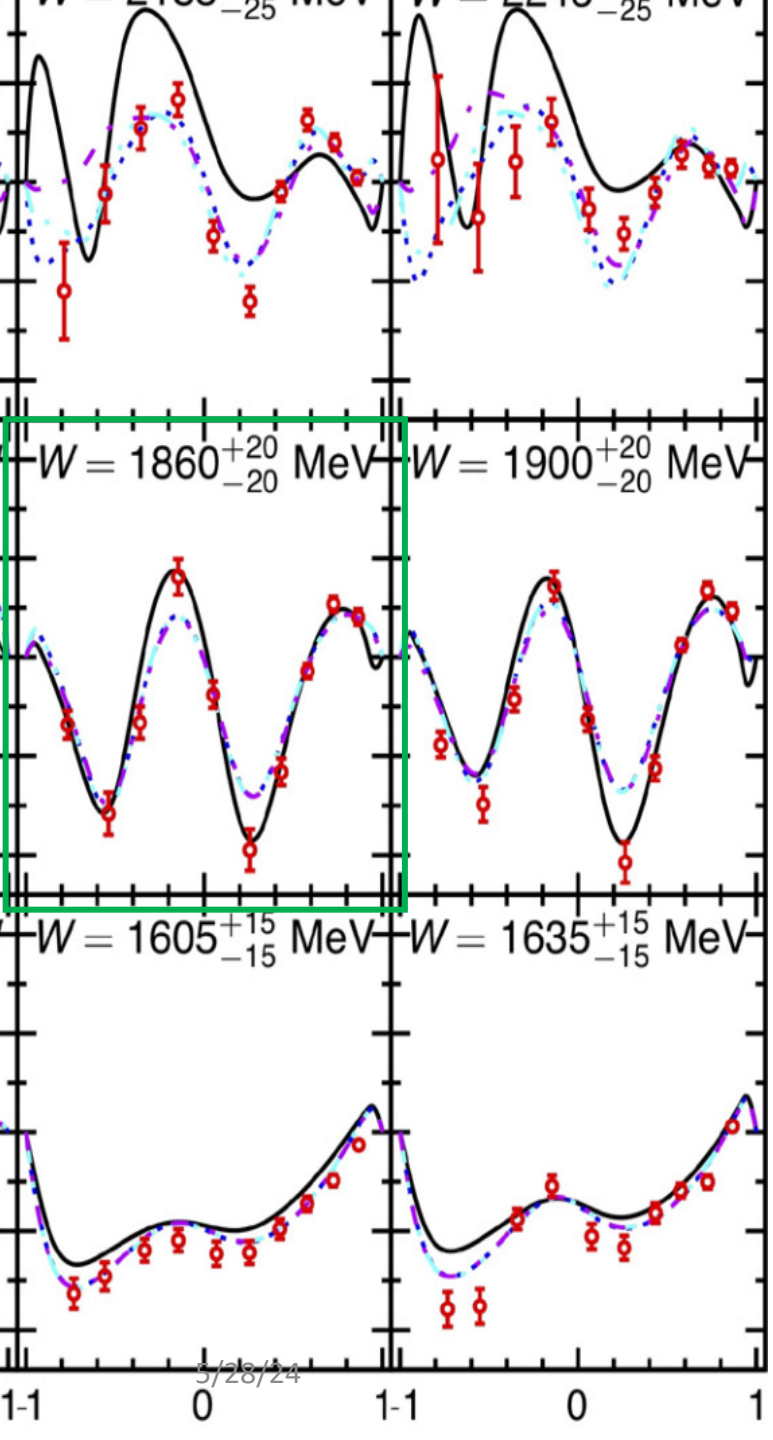
action of the pion angle in the *c.m.* frame. The different panels denote bins in *c.m.* energy *W*, ta from this work are shown by the red circle with error bars denoting the total uncertainties. olutions (solution 1 - blue dotted, solution 3 cyan dash dotted-dotted, and solution 4 mage (solution 2 not shown). Differences between the four Bonn-Gatchina solutions are only evid

g9a G. ($\gamma \vec{p} \rightarrow \pi^+ n$)



Tsuneo's analysis ($2.06 < W < 2.14$)





g9a G

$(\vec{\gamma}\vec{p} \rightarrow \pi^+ n)$

Haiyun's analysis note on Mar. 31st 2021

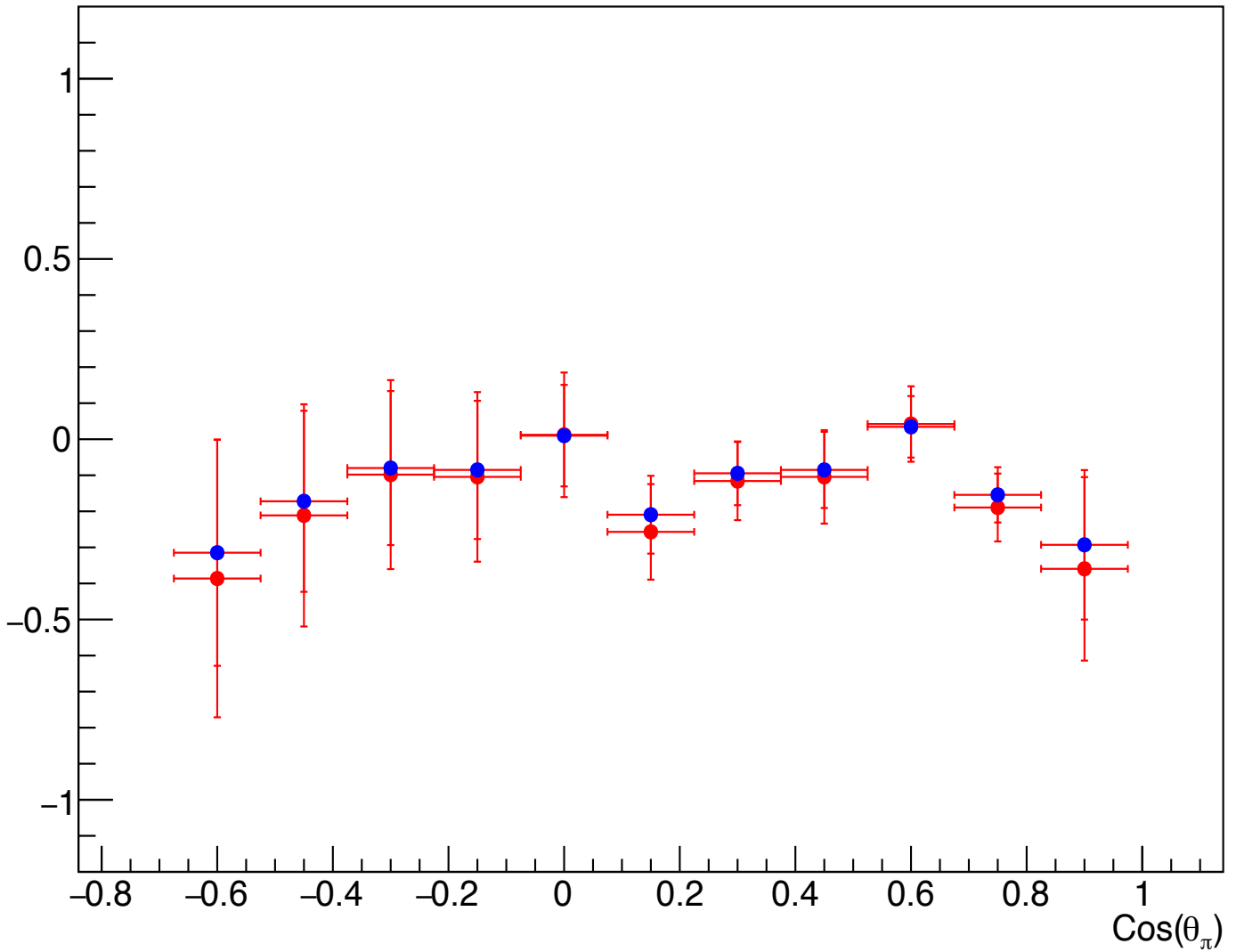


Figure 39: Corrected (blue) and uncorrected (red) G with W at 1860 MeV

Final W vs Coherenct Edge – Eg (1.8, 2 & 2.2 GeV (Gold1 & Last1-3, PERP));

Suggested W bins and cuts