The CLAS Physics Database

for the Physics Analysis of the Experiments with Electromagnetic Probes

V. V. Chesnokov, V. I. Mokeev, B. S. Ishkhanov

CLAS Data and their Impact on Exploration of Strong Interaction

- CLAS detector provided the dominant part of the available data on inclusive, semi-inclusive and exclusive meson electroproduction off nucleons at the invariant masses of the final hadrons W<3.0 GeV and at the photon virtualities Q^2<5.0 GeV^2 and extended the data on meson photoproduction.

- Impressive progress in the studies of the ground and excited nucleon spectrum/ structure has been achieved from the CLAS results (D.S. Carman, K. Joo, V. Mokeev, Few-Body Syst. 61, 29 (2020)).

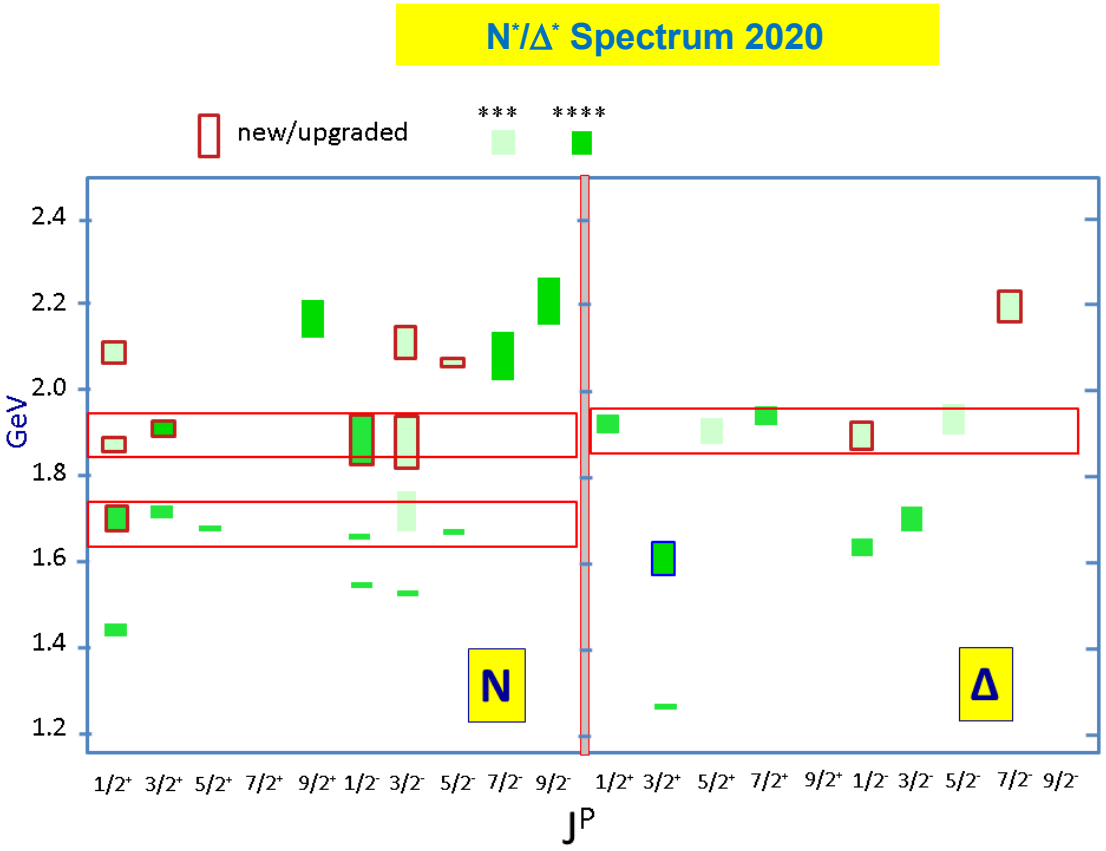
- New results on spectrum and structure of the ground and excited hadrons allow to gain insight into strong interaction dynamics which underlie the hadron generation addressing key open problems on the nature of hadron mass and quark-gluon confinement
  (S.J. Brodsky et al., e-Print: 2006-06802, be published in Int. J. Mod. Phys. E)

- Studies of the hadron spectra and insight into the hadron structure in 1- and 3-dimensions require the combined analyses of a large body of measured observables within a broad kinematic area

→ The Data Bases for physics analyses are needed

Advances in Exploration of the N*-Spectrum

Several new nucleon resonances (``missing" states) have been discovered with the decisive impact of the CLAS open strangeness photoproduction data. A.V. Anisovich et al., Phys. Lett. B782, 662(2018), V.D. Burkert, Few Body Syst. 59, 57 (2018).



Nucleon resonances listed in Particle Data Group (PDG) tables

State N(mass)J^P	PDG pre 2016	PDG 2020*
N(1710)1/2+	***	****
N(1880)1/2+		***
N(1895)1/2-		****
N(1900)3/2+	**	****
N(1875)3/2-		***
N(2100)1/2+	*	***
N(2120)3/2-		***
N(2000)5/2+	*	**
N(2060)5/2-		***
Δ(1600)3/2+	***	****
Δ(1900)1/2-	**	***
Δ(2200)7/2-	*	***

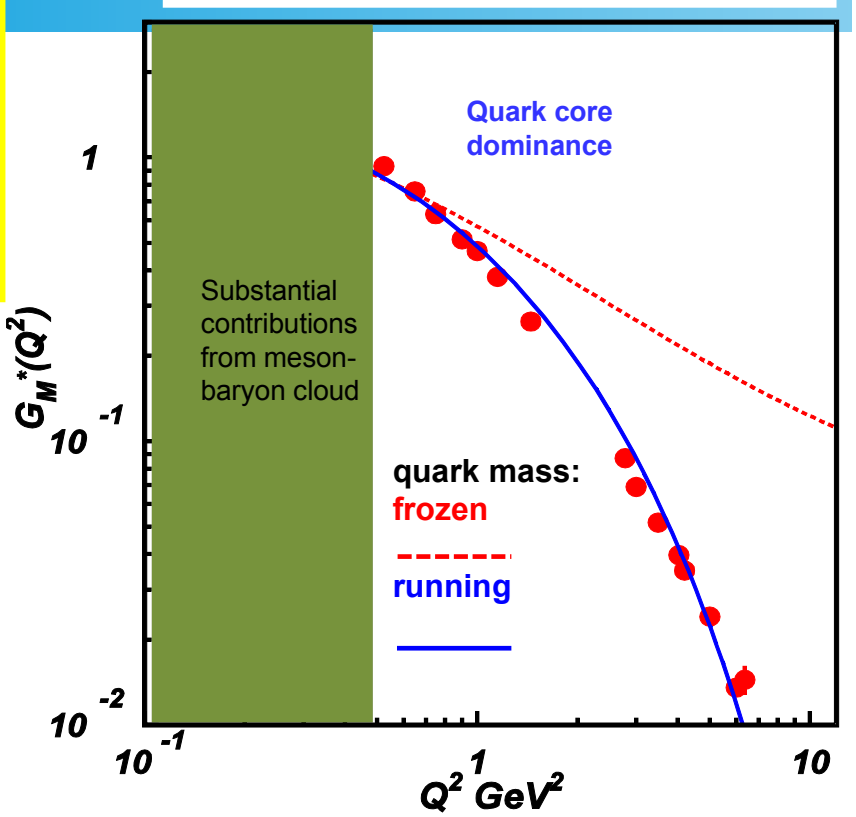
The next step: A description of the exclusive electroproduction data off the proton with the same masses and hadronic decay widths as in photoproduction will support the existence of new baryon states.

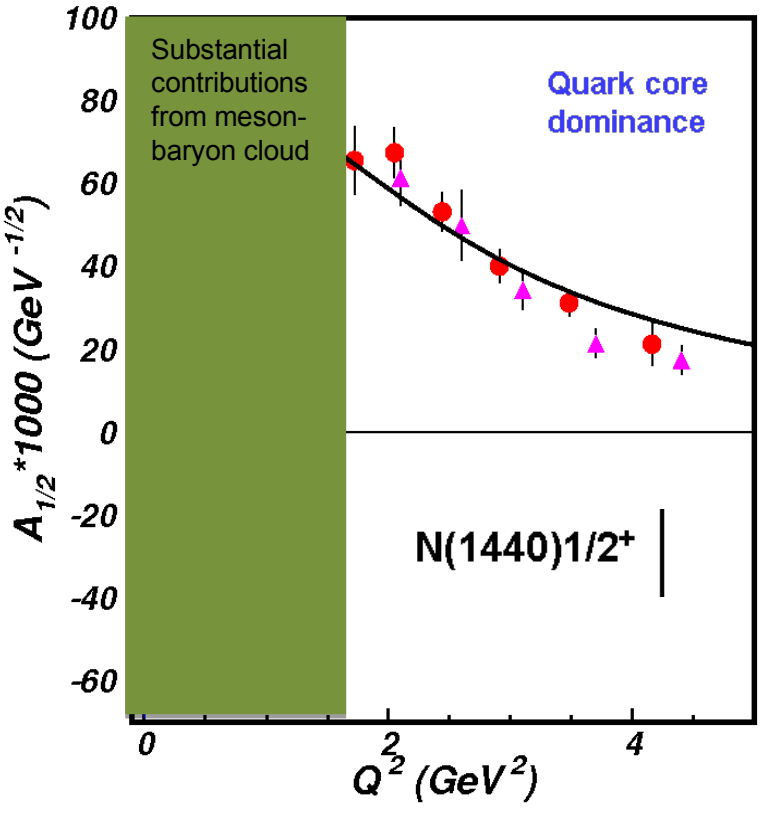
From Resonance Electrocouplings to Hadron Mass Generation

Dyson-Schwinger Equations (DSE):

- J. Segovia et al., Phys .Rev. Lett. 115, 171801 (2015).
- J. Segovia et al., Few Body Syst. 55, 1185 (2014).

N→Δ(1232)3/2⁺ magnetic from factor Jones-Scadron convention





DSE analyses of the CLAS data on Δ(1232)3/2⁺ electroexcitation demonstrated that dressed quark mass is running with momentum.

Good data description at Q^2>2.0 GeV^2 achieved with the same dressed quark mass function for the ground and excited nucleon states of distinctively different structure validate the DSE results on momentum dependence of dressed quark mass. $\gamma_v pN^*$ electrocoupling data offer access to the strong QCD dynamics underlying the hadron mass generation.

One of the most important achievements in hadron physics of the last decade in synergistic efforts between experimentalists, phenomenologists and theorists.

Accessing Shear Forces & Parton Pressure

M.V. Polyakov and P. Schweitzer, Int. Mod. J. Phys A 33, 26 1830025 (2018)

Nucleon matrix element of EMT contains:

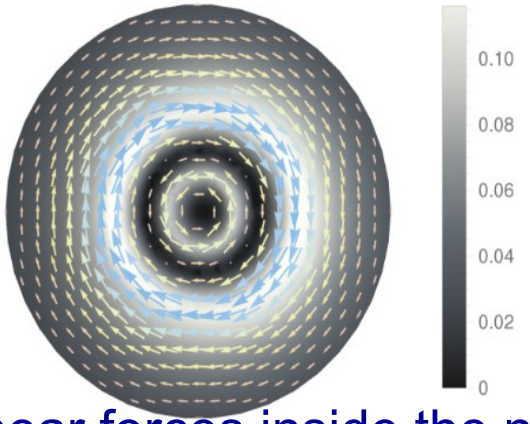
$M_2(t)$: Mass distribution inside the nucleon

$J(t)$: Angular momentum distribution

$d_1(t)$: **Pressure distribution**

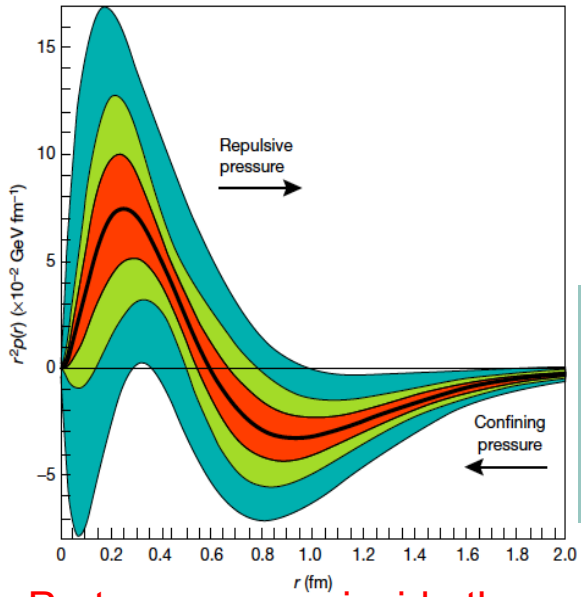
$$\int dx\, x\, [H(x,\xi,t) + E(x,\xi,t)] = 2\, J(t)$$

$$\int dx\, x\, H(x,\xi,t) = M_2(t) + 4/5\, \xi^2\, d_1(t)$$



Shear forces inside the nucleon

Measuring these form factors, we learn about confinement forces



Parton pressure inside the nucleon

V.D. Burkert, L. Elouadrhiri, & F.X. Girod, Nature, 557 396 (2018)

43 Web of Science citations

87 Inspire citations

Summary of Published CLAS Data on Exclusive Meson Electroproduction off Protons in N* Excitation Region

Hadronic final state	Covered W-range, GeV	Covered Q^2-range, GeV^2	Measured observables
π^+n	**1.1-1.38** **1.1-1.55** **1.1-1.7** **1.6-2.0**	**0.16-0.36** **0.3-0.6** **1.7-4.5** **1.8-4.5**	**$d\sigma/d\Omega$** **$d\sigma/d\Omega$** **$d\sigma/d\Omega$, A_b** **$d\sigma/d\Omega$**
π^0p	**1.1-1.38** **1.1-1.68** **1.1-1.39**	**0.16-0.36** **0.4-1.8** **3.0-6.0**	**$d\sigma/d\Omega$** **$d\sigma/d\Omega$, A_b,A_t,A_{bt}** **$d\sigma/d\Omega$**
ηp	**1.5-2.3**	**0.2-3.1**	**$d\sigma/d\Omega$**
$K^+\Lambda$	**thresh-2.6**	**1.40-3.90** **0.70-5.40**	**$d\sigma/d\Omega$** **P^0, P'**
$K^+\Sigma^0$	**thresh-2.6**	**1.40-3.90** **0.70-5.40**	**$d\sigma/d\Omega$** **P'**
$\pi^+\pi^-p$	**1.3-1.6** **1.4-2.1** **1.4-2.0**	**0.2-0.6** **0.5-1.5** **2.0-5.0**	**Nine 1-fold differential cross sections**

- $d\sigma/d\Omega$–CM angular distributions
- A_b,A_t,A_{bt}-longitudinal beam, target, and beam-target asym-metries
- P^0, P' –recoil and transferred polarization of strange baryon

Over 120,000 data points!

Almost full coverage of the final hadron phase space

The measured observables from CLAS are stored in the CLAS Physics Data Base https://clas.sinp.msu.ru/db

Overview

More than 100 experiments,

More than 50 various final states

about 200 various observables measured

List of all experiments available for public access

Please, login to see not published experiments also

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Experiment title	Year	Spokespersons	Final state
E93-006 CLAS experiment	2003	V. D. Burkert, M. Ripani	$\pi^+\pi^-p$
CAA Run E1C	2003	M. Osipenko, G. Ricco	inclusive
EG2000 CLAS	2000	H. Avakian	$\pi + X$
EG2000 CLAS	2000	H. Avakian	π^+n
EG2000 CLAS	2000	H. Avakian	inclusive
E89-042 CLAS Experiment	2003	V. D. Burkert, R. Minehart	π^0p
E89-038 CLAS experiment	1999	V. Burkert, R. Minehart	π^+n
E-89-037 Electroproduction of the P33(1232) Resonance	2002	V. Burkert, R. Minehart	π^0p
EG1	2000	P. Stoler, V. Burkert, R. Minehart	π^0p
E1D and E6A runs CLAS data	2005	M. Osipenko	inclusive
E99-107 CLAS experiment	2005	V. D. Burkert, R. Minehart	π^+n
E99-105	2002	M. Garçon, M. Guidal, E. S. Smith	ωp
E89-004 Photoproduction of Hyperons	2005	R. A. Schumacher	$K^+\Lambda$
E89-004 Photoproduction of Hyperons	2005	R. A. Schumacher	$K^+\Sigma^0$
E89-004	2005	R. A. Schumacher	$K^+\Lambda$
E89-004	2005	R. A. Schumacher	$K^+\Sigma^0$
e6a CLAS experiment	2006	K. Sh. Egiyan, K. A. Griffioen and M. Strikman	p n
g1c CLAS experiment	2006	K. Hicks	$K^{*0}\Sigma^+$
E04-021 CLAS experiment	2004	M. Battaglieri, R. De Vita, V. Kubarovsky	$K^+K^+\Xi(1320)^-$
E04-021 CLAS experiment	2004	M. Battaglieri, R. De Vita, V. Kubarovsky	$K^+K^+\Xi(1530)^-$
g10a CLAS experiment	2007	K. Hicks, S. Stepanyan	φ d
e1-dvcs E06-003	2007	V. D. Burkert, L. Elouadrhiri, M. Garçon, S. Stepanyan	π^0p
Eg1b	2001	S. Kuhn, R. Fersch, P. Bosted	inclusive
g11	2009	M. Battaglieri	$\pi^+\pi^-p$
CLAS Approved Analysis (CAA) of E1-6 experiment	2002	M. Osipenko	π^++X
G11A Run K+Lambda Data	2008	M. McCracken, C. A. Meyer	$K^+\Lambda$
PR-03-113	2004	S. Anefalos Pereira	$K^+\Sigma^-$
g10 CLAS experiment	0	Wei Chen	π^-p
g11a	2004	Biplab Dey, Curtis Meyer	$K^+\Sigma^0$
E2A run CLAS data	2010	M. Osipenko	inclusive

Observables and final states in the CLAS Physics Database

σ	Cross section.
$d\sigma/d\Omega$	Differential cross section.
σ_L	Longitudinal cross section.
σ_T	Transverse cross section.
σ_L/σ_T	Ratio of the longitudinal to transverse cross sections.
σ_{TT}	Interference term.
σ_{TL}	Interference term.
$d\sigma/dt$	Differential cross section over Mandelstam variable t.
$d\sigma/dt'$	Differential cross section over Mandelstam variable t'. $t' = \mathrm{Abs}(t - t_{min})$
$\sigma_{LT'}$	Interference term.
$d\sigma_L/dt$	Longitudinal differential cross section over Mandelstam variable t.
$d\sigma_T/dt$	Transverse differential cross section over Mandelstam variable t.
R_ρ	Ratio of the σ_L/σ_T
F_1	Structure function
F_2	Proton structure function.
F_L	Longitudinal inclusive structure function
$g1$	Polarized inclusive structure function
$g2$	Polarized inclusive structure function
A_{LU}	Beam asymmetry.
A_{lp}	Double polarized asymmetry.
A_{UL}	Target spin asymmetry.
A_{LL}	Asymmetry

inclusive	ppN
semi-inclusive	ppX
	p n
$\pi^+ n$	p+X
$\pi^0 p$	ppn
$\pi^- p$	π + X
$\pi^0 n$	ρ + X
$\pi^- p$	π^++X
$\pi^+\pi^- p$	π^-+X
$K^+\Lambda$	π^0+X
$K^+ \Lambda(1405)$	φ d
$K^+ \Lambda(1520)$	$K^{*0}\ \Sigma^+$
$K^+\Sigma^0$	$K^+ K^+ \Xi(1320)^-$
$K^+ \Sigma^0(1385)$	$K^+ K^+ \Xi(1530)^-$
$K^+\Sigma^-$	π^0d
η p	$K^+ \Sigma^+ \pi^-$
η' p	$K^+ \Sigma^0 \pi^0$
$\varphi(1020)$ p	$K^+ \Sigma^- \pi^+$
φ p	$\gamma_r p$
ρ^0 p	γ p
ω p	$f_1(1285)$
ω d	

List of measurements

Two pion $\pi^+\pi^-$ electroproduction off the proton:

Differential and fully integrated cross-sections, asymmetries

CLAS Physics Database

JLab Search Overview Register Login

E-94-005 CLAS experiment

Spokesperson:
L. Elouadrhiri

Year:
2006

Abstract:
Determination of the ND Axial Vector Tansition Form Factor from the ep -> e' Δ++π-

Publication:
1. *G.V.Fedotov, V.I.Mokeev, V.D.Burkert, L.Elouadrhiri, E.N.Golovatch, B.S.Ishkhanov, E.L.Isupov, N.V.Shvedunov, and CLAS Collaboration* Electroproduction of $p\pi^+\pi^-$ off Protons at $0.2<Q^2<0.6$ GeV^2 and $1.3<W<1.57$ GeV with CLAS // PRC 79, 015204 (2009)

Quantities:
σ dσ/dM(π⁻,p) dσ/dM(π⁺,p) dσ/dM(π⁺,π⁻) dσ/d(−cos(θ(π⁻))) dσ/d(−cos(θ(π⁺))) dσ/d(−cos(θ(p))) dσ/dφ(π⁻) dσ/dφ(π⁺) dσ/dφ(p) dσ/dψ(π⁻) dσ/dψ(π⁺) dσ/dψ(p) A_{π^+} B_{π^+} C_{π^+} A_{π^-} B_{π^-} C_{π^-} A_p B_p C_p

Measurements

◀ prev 1 2 3 4 5 … 8 9 next ▶

ID	Quantity	Beam	Target	Finalstate	Q^2_{min}, GeV^2	Q^2_{max}, GeV^2	W_{min}, GeV	W_{max}, GeV
E62M1	dσ/dM(π⁻,p)	e	p	π⁺π⁻p	0.2	0.25	1.5	1.525
E62M2	dσ/dM(π⁺,π⁻)	e	p	π⁺π⁻p	0.2	0.25	1.5	1.525
E62M3	dσ/dM(π⁺,p)	e	p	π⁺π⁻p	0.2	0.25	1.5	1.525
E62M4	dσ/dφ(π⁻)	e	p	π⁺π⁻p	0.2	0.25	1.5	1.525
E62M5	dσ/dφ(π⁺)	e	p	π⁺π⁻p	0.2	0.25	1.5	1.525
E62M6	dσ/dφ(p)	e	p	π⁺π⁻p	0.2	0.25	1.5	1.525
E62M7	dσ/dψ(π⁻)	e	p	π⁺π⁻p	0.2	0.25	1.5	1.525
E62M8	dσ/dψ(π⁺)	e	p	π⁺π⁻p	0.2	0.25	1.5	1.525
E62M9	dσ/dψ(p)	e	p	π⁺π⁻p	0.2	0.25	1.5	1.525
E62M10	dσ/d(−cos(θ(π⁻)))	e	p	π⁺π⁻p	0.2	0.25	1.5	1.525
E62M11	dσ/d(−cos(θ(π⁺)))	e	p	π⁺π⁻p	0.2	0.25	1.5	1.525
E62M12	dσ/d(−cos(θ(p)))	e	p	π⁺π⁻p	0.2	0.25	1.5	1.525
E62M13	dσ/dM(π⁻,p)	e	p	π⁺π⁻p	0.2	0.25	1.525	1.55

Measurement view

Example:

W-dependence of cross-section *σ*

Reaction:
two pions electroproduction
$\pi^+\pi^-$ off the proton *p*

Q^2 = 0.425 GeV²

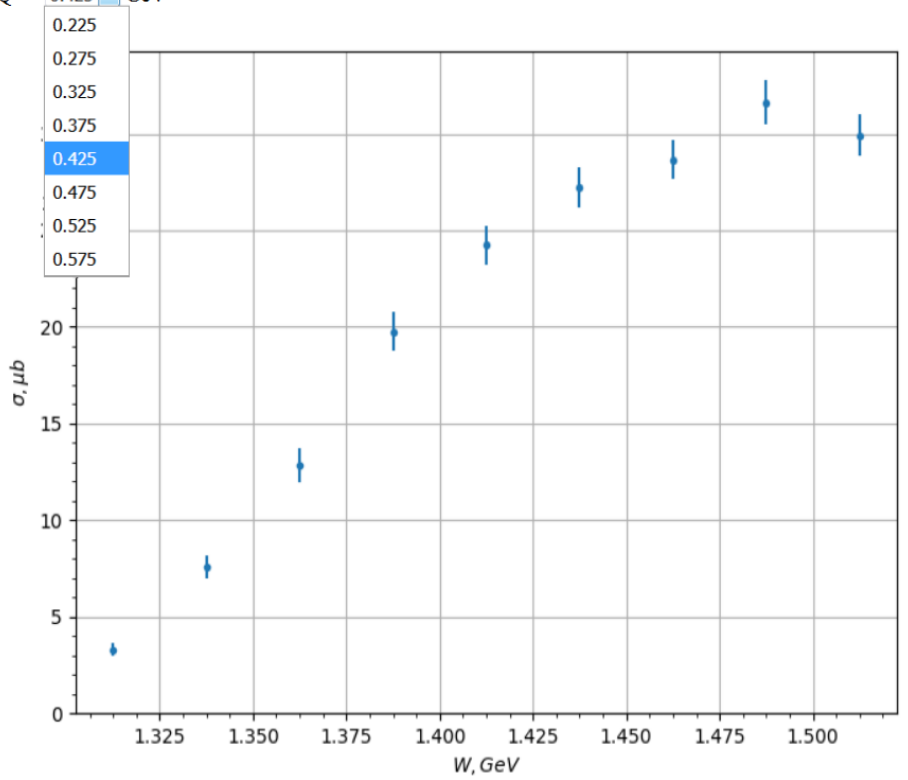
CLAS Physics Database

JLab Search Overview Register Login

Measurement E62M793

Experiment: E-94-005 CLAS experiment
Year: 2006
Spokesperson: L. Elouadrhiri
Reaction: $ep \rightarrow \pi^+\pi^- p$
Polarization: none
Quantity: σ
Q^2: 0.2 — 0.6 GeV^2
W: 1.3 — 1.6 GeV
Publication: *G.V.Fedotov, V.I.Mokeev, V.D.Burkert, L.Elouadrhiri, E.N.Golovatch, B.S.Ishkhanov, E.L.Isupov, N.V.Shvedunov, and CLAS Collaboration* Electroproduction of $p\pi^+\pi^-$ off Protons at $0.2<Q^2<0.6$ GeV^2 and $1.3<W<1.57$ GeV with CLAS // PRC 79, 015204 (2009)

Slice: Q^2 = 0.425 GeV^2



Measurement data

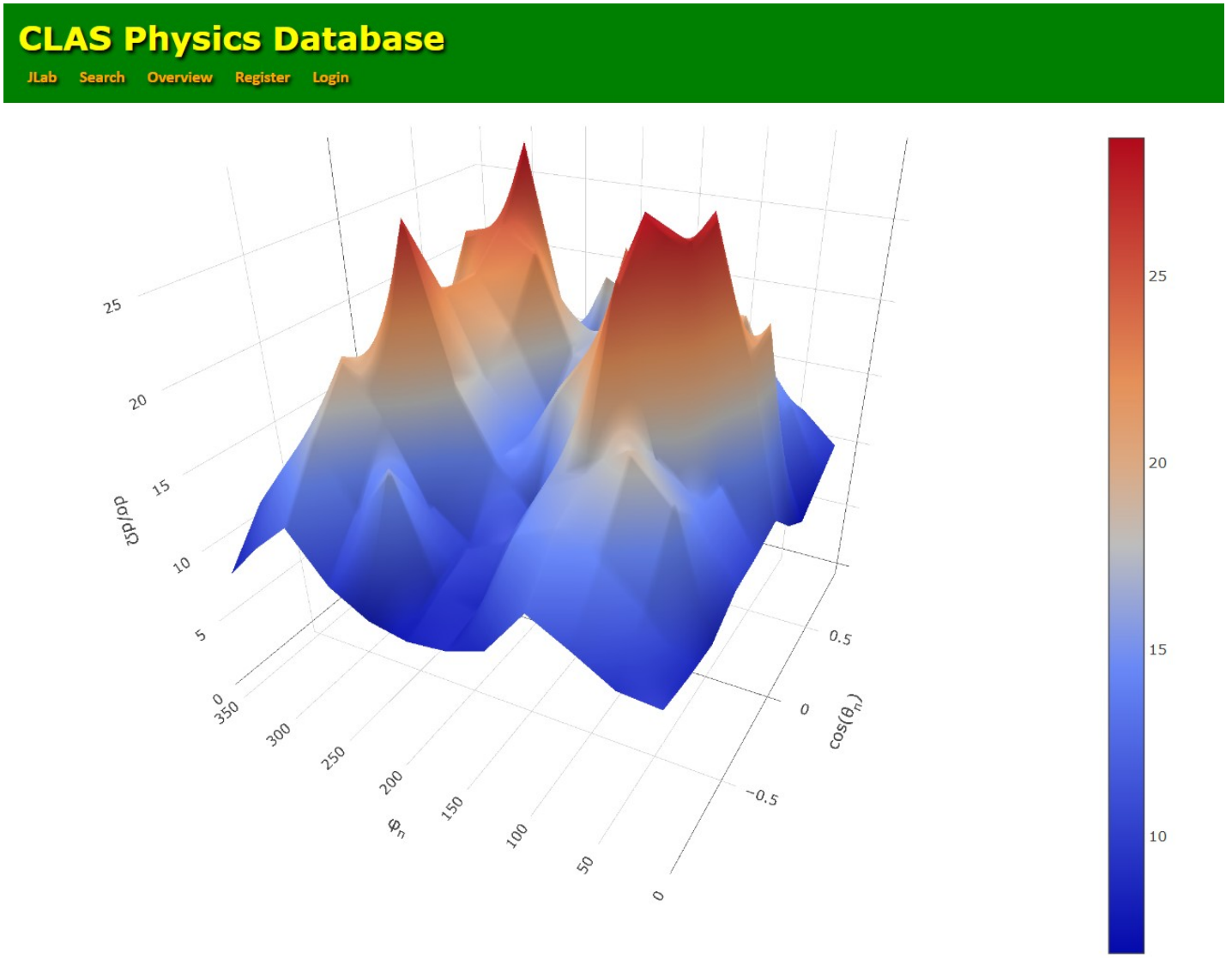
Q^2, [GeV^2]	W, [GeV]	σ, [μb]	uncertainty
0.225	1.5125	44.8273773	1.51808882
0.225	1.5375	40.4969292	1.54815555
0.225	1.5625	42.0923195	1.39615655

3D plots in the database

Differential cross-section
dσ/dΩ

Reaction:
$\gamma_v p \rightarrow \pi^0 p$

Kinematics:
Q^2 = 0.35—0.45 GeV^2
W = 1.26 GeV



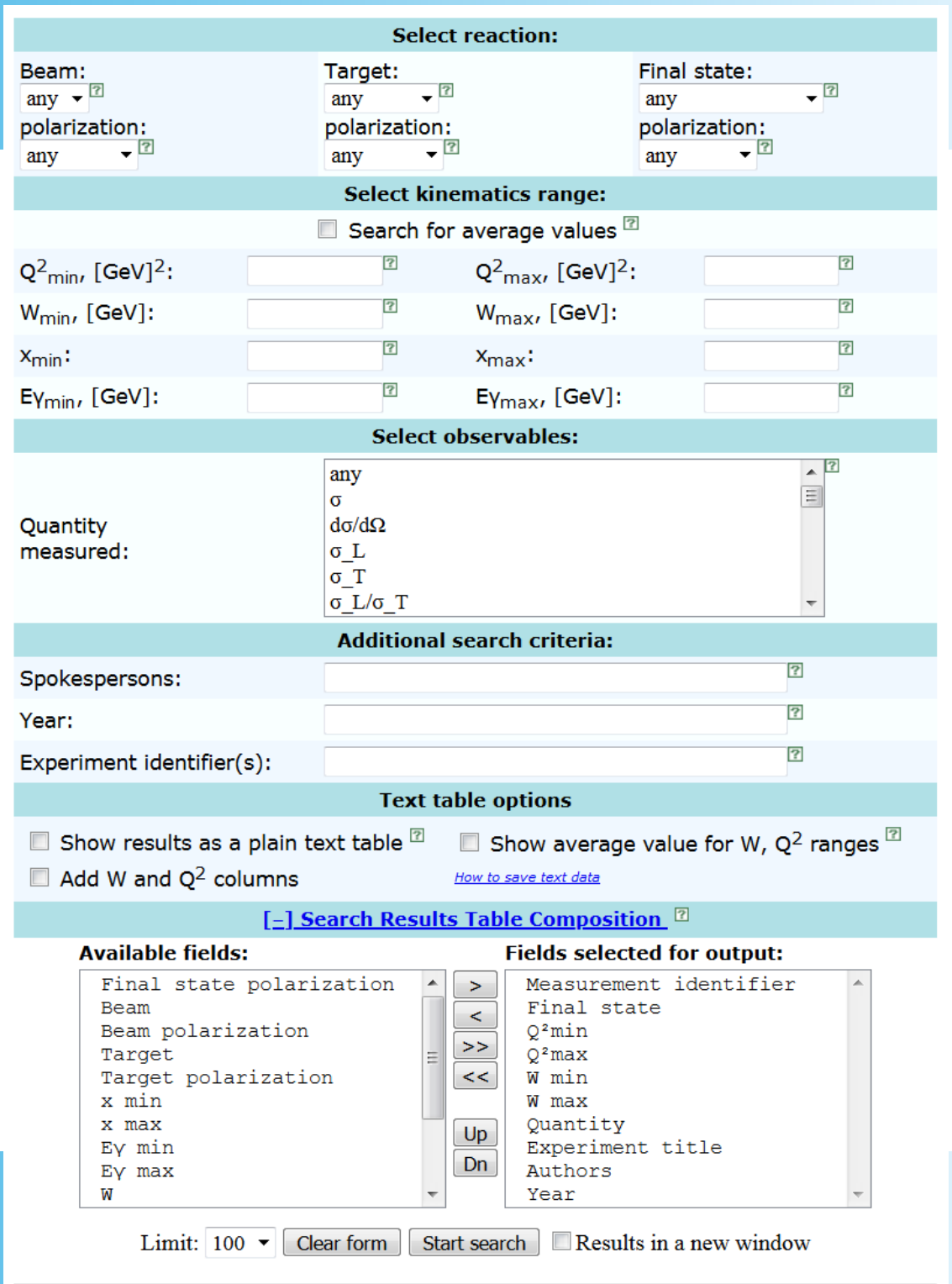
Search of the data

- Reaction
  Beam type (e or γ),
  target (p/n/d/nucleus),
  final state (more than 50 available),
  polarization type of
  beam, target and final state

- Kinematic variables
  (Q^2, W, x_B, E_γ)

- Observable measured
  Cross-sections, structure functions,
  asymmetries

- Bibliography
  Authors, experimet title and year



Data analysis

Example:

automatic differential cross-section fitting of $\pi^0 p$ electroproduction off proton for structure function extraction

$$\frac{d\sigma}{d\Omega} = A + B\cos 2\varphi + C\cos\varphi$$

$$A = \frac{1}{4K_L M_N}\{R_T + \varepsilon_L R_L\}$$

$$B = \frac{1}{4K_L M_N}\{R_{TT}\}d\Phi$$

$$C = \frac{1}{4K_L M_N}\{R_{TL}\}d\Phi$$

$d\Phi$ is phase volume for adron final state,
$4K_L M_N$ is virtual photon invariant flux,
K_L is virtual photon wave vector modulus

Measurement E9M5

You are not logged in.

Experiment: E-89-037 Electroproduction of the P33(1232) Resonance, 2002

Spokespersons: V. Burkert, R. Minehart

Experiment comment: Release 1 - Data replay: recsis prod-1-9. RC and acceptance: aao_rad+MAID98

Publication:

- *K. Joo, L. C. Smith, V. D. Burkert, R. Minehart, I. G. Aznauryan, L. Elouadrhiri, S. Stepanyan, and CLAS Collaboration* Q^2 Dependence of Quadrupole Strength in the $\gamma^* p \rightarrow \Delta^+(1232) \rightarrow p\pi^0$ Transition // Phys. Rev. Let. 88, 122001 (2002)

Quantity measured: dσ/dΩ, mcbn/srad
Differential cross section.
Beam: e, **polarization:** none
Target: p (Z=1, A=1), **polarization:** none
Final state: π^0p, **polarization:** none

Q² : 0.35 — 0.45 GeV²
W : 1.18 GeV
ε : 0.85

Select data slice:
cos(θ$_\pi$) = -0.9 dimensionless

Fit φ dependence:

☑ $A + B\cdot\cos(2\varphi) + C\cdot\cos(\varphi)$

χ^2 = 0.2397

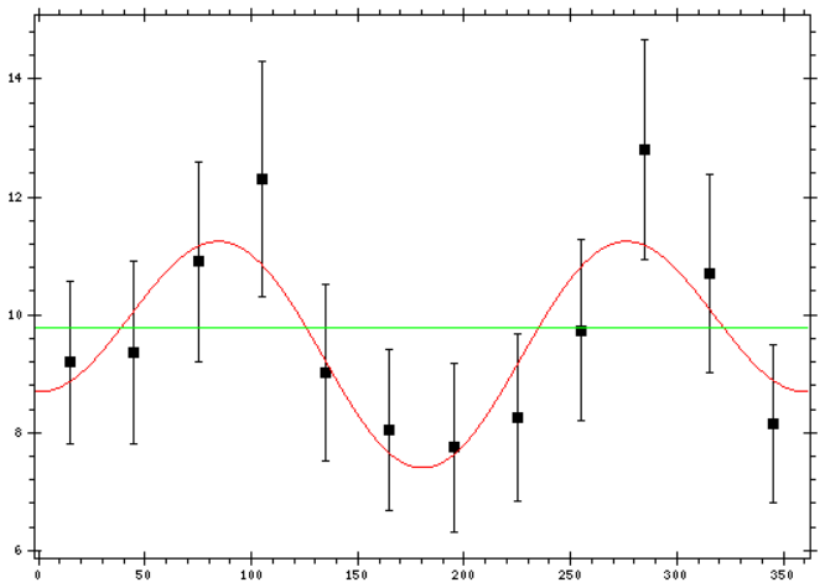
	Value	Uncert
A	9.6295	0.51923
B	-1.5829	0.73168
C	0.64516	0.69222

☐ $A + B\cdot\cos(2\varphi) + C\cdot\cos(\varphi) + D\cdot\cos(3\varphi)$

☑ $\frac{1}{\varphi_{max}-\varphi_{min}}\int_{\varphi_{min}}^{\varphi_{max}}\frac{d\sigma}{d\Omega}\,d\varphi$

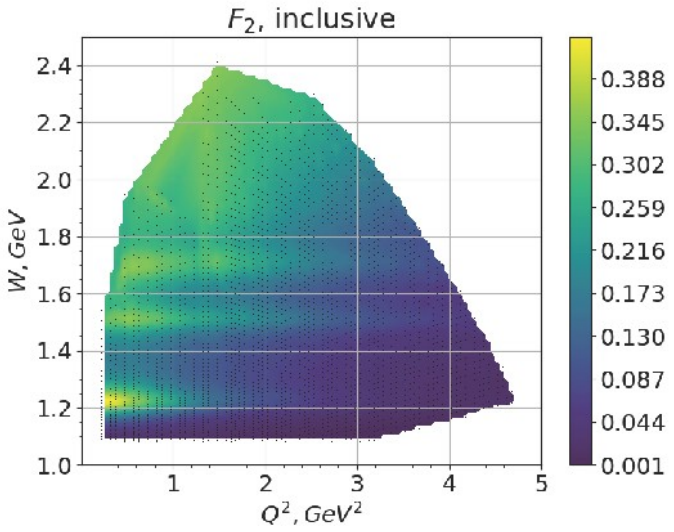
	Value	Uncert
A	9.8	0.3

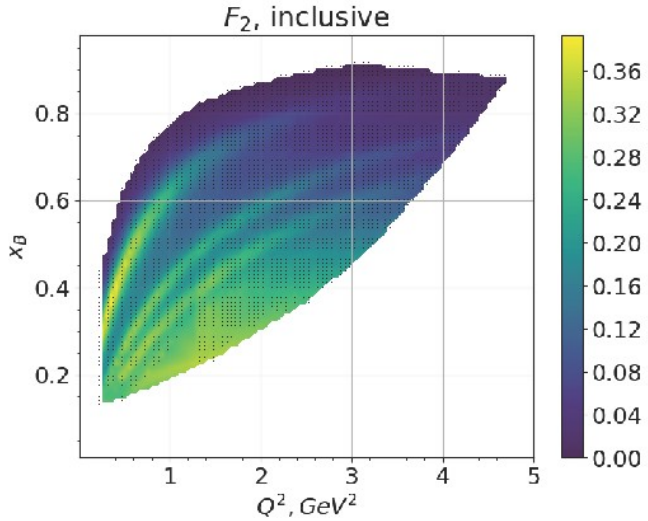
Observable quantity measured (Y axis): dσ/dΩ, mcbn/srad



Parameter (X axis): φ_π, deg

Structure function interpolation





Structure functions and cross-sections

Observable: F1 F2 σ dσ/dWdQ²

Channels: inclusive π^+n π^0p $\pi^+\pi^-p$ $2\pi^0p + \pi^+\pi^0n$ $\pi^+n + \pi^0p + \pi^+\pi^-p$ $K^+\Lambda$ $K^+\Sigma^0$ ηp $\eta' p$

	Abscissa	First	Step	Last
Q², GeV²:		0.8	0.1	0.8
W, GeV:	●	0.97	0.01	2.3

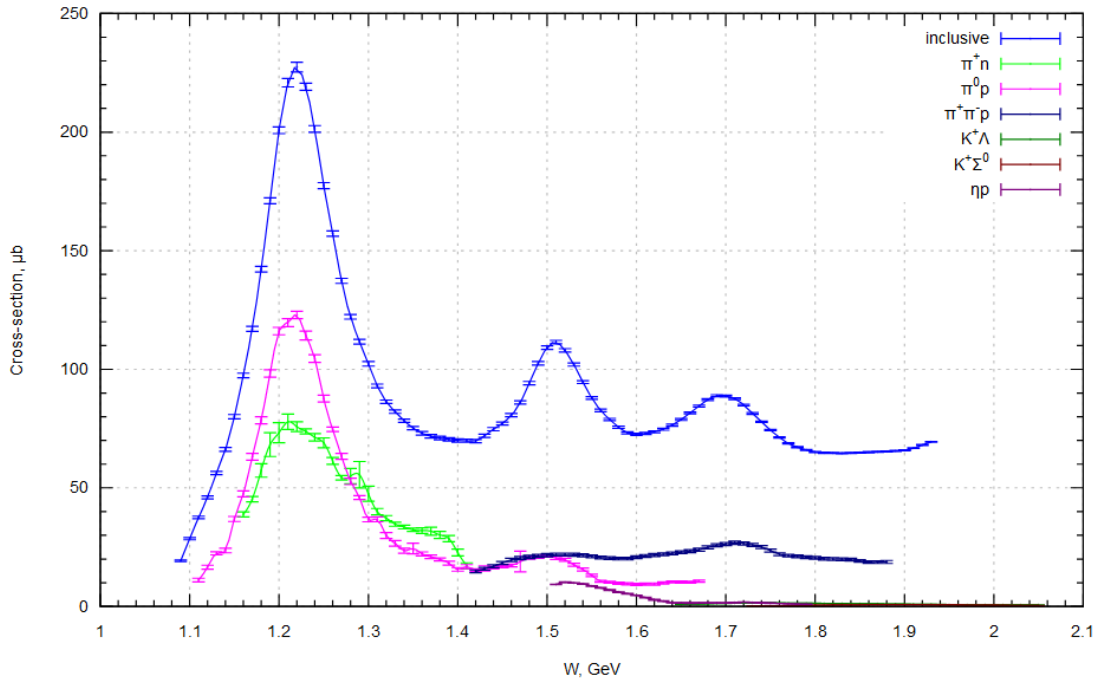
E_{beam}, GeV: 10.6 Calculate σ uncertainty from luminosity

Data set: CLAS data only CLAS and world data Resonant contributions Difference Ratio

Results view: HTML Plot Plot-SVG Text Gnuplot PDF

Plot type: splines lines points

Calculate



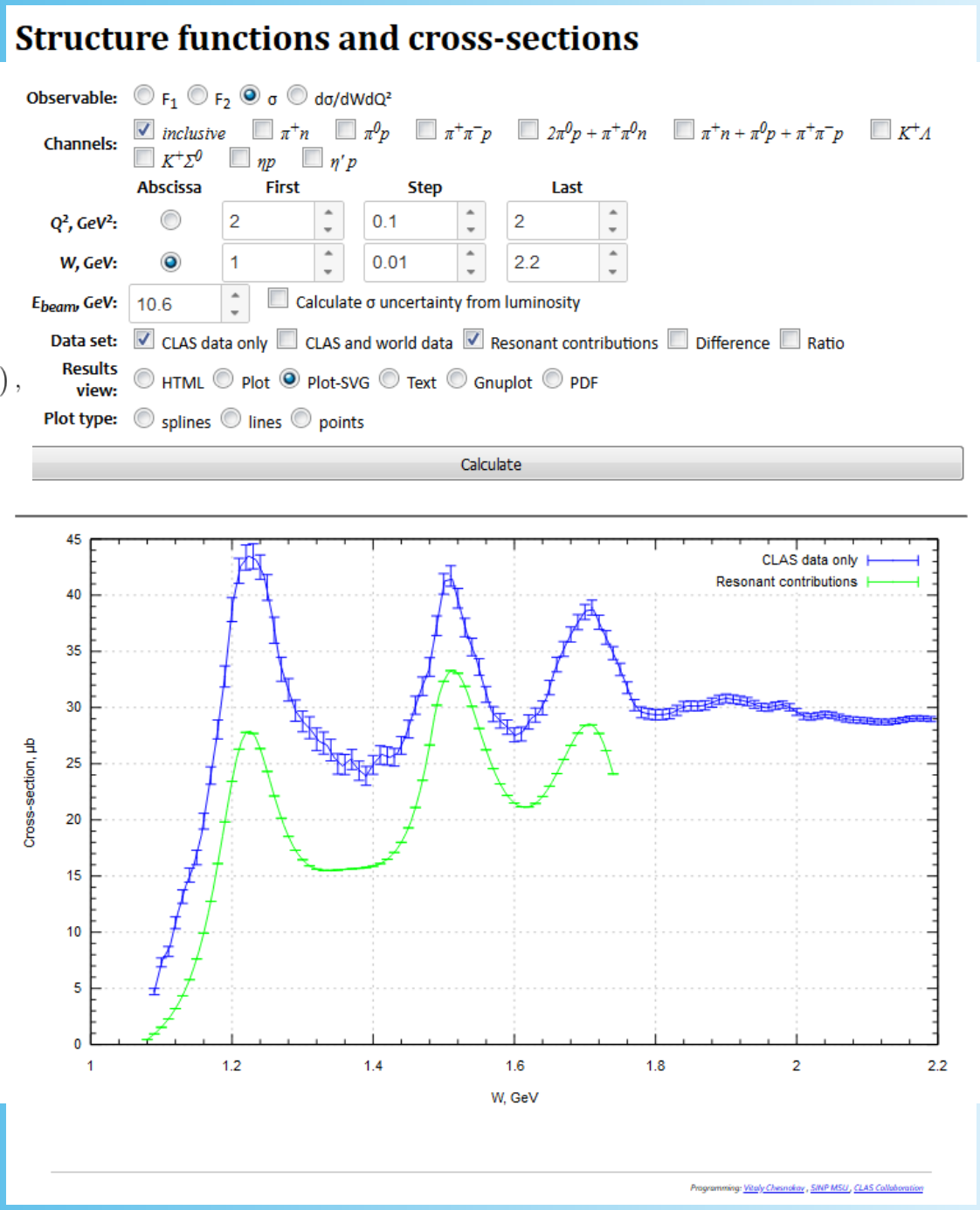
Programming: Vitaly Chesnokov, SINP MSU, CLAS Collaboration

Resonant contributions

$$\sigma^R_{T,L}(W,Q^2) = \frac{\pi}{q^2_\gamma}\sum_{N^*}(2J_r+1)\frac{M_r^2\Gamma_{\rm tot}(W)\Gamma_\gamma{}^{T,L}(M_r,Q^2)}{(M_r^2-W^2)^2+M_r^2\Gamma^2_{\rm tot}(W)},$$

$$\Gamma^T_\gamma(W=M_r,Q^2) = \frac{q^2_{\gamma,r}(Q^2)}{\pi}\frac{2M_N}{(2J_r+1)M_r}\left(|A_{1/2}(Q^2)|^2+|A_{3/2}(Q^2)|^2\right),$$

$$\Gamma^L_\gamma(W=M_r,Q^2) = 2\frac{q^2_{\gamma,r}(Q^2)}{\pi}\frac{2M_N}{(2J_r+1)M_r}|S_{1/2}(Q^2)|^2,$$

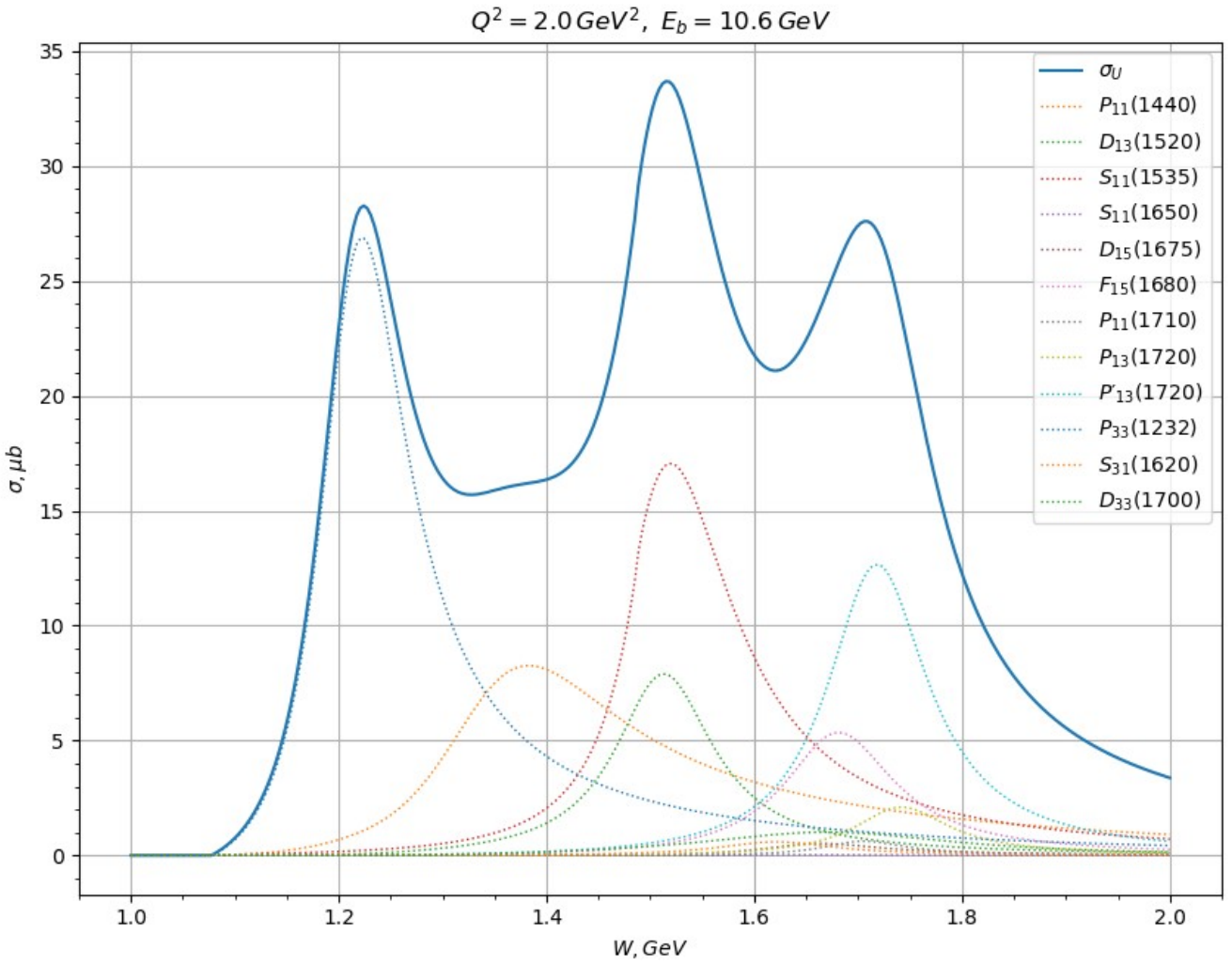


Resonant contributions

Contributions of individual resonances to unpolarized inclusive cross-section

Calculated for

Q^2 = 2.0 GeV²
E_b = 10.6 GeV



Internet links

CLAS Physics Database

https://clas.sinp.msu.ru

Structure functions and cross-sections of inclusive and exclusive reactions

https://clas.sinp.msu.ru/strfun

Resonant contributions to inclusive cross-sections of pion electroproduction off the nucleons

https://clas.sinp.msu.ru/res

CLAS Analysis Framework

https://clas.sinp.msu.ru/fw

List of reaction models used and kinematical range covered

CLAS Analysis Framework

Start Models Groups Interpolate

Reaction models for description of Nπ electroproduction off nucleons

Name	Author	Description	Channels	Q^2, GeV^2	W, GeV	θ, deg
maid	D. Drechsel, L. Tiator	MAID approach for evaluation of Nπ observables in the resonance region	$\pi^+ n$, $\pi^0 p$, $\pi^- p$, $\pi^0 n$	0 — 5 bin size: 0.1	1.1 — 2.0 bin size: 0.02	0 — 180 bin size: 10
GK	P. Kroll, S. Goloskokov	Approach for DVMP studies	$\pi^+ n$, $\pi^0 p$	TBD	TBD	0 — 180

Calculation of differential cross-sections from helicity amplitudes

$$\frac{d\sigma}{d\Omega} = \frac{d\sigma_T}{d\Omega} + \varepsilon\frac{d\sigma_L}{d\Omega} + \sqrt{2\varepsilon(1+\varepsilon)}\frac{d\sigma_{TL}}{d\Omega}\cos\varphi + \varepsilon\frac{d\sigma_{TT}}{d\Omega}\cos 2\varphi + h\sqrt{2\varepsilon(1-\varepsilon)}\frac{d\sigma_{TL'}}{d\Omega}\sin\varphi$$

$$\frac{d\sigma_T}{d\Omega} = R_T^{00}\frac{p_m}{k_\gamma^{cm}}$$

$$\frac{d\sigma_L}{d\Omega} = R_L^{00}\frac{p_m}{k_\gamma^{cm}}\frac{Q^2}{\omega_\gamma^2}$$

$$\frac{d\sigma_{TL}}{d\Omega} = R_{TL}^{00}\frac{p_m}{k_\gamma^{cm}}\frac{\sqrt{Q^2}}{\omega_\gamma}$$

$$\frac{d\sigma_{TT}}{d\Omega} = R_{TT}^{00}\frac{p_m}{k_\gamma^{cm}}$$

$$\frac{d\sigma_{TL'}}{d\Omega} = R_{TL'}^{00}\frac{p_m}{k_\gamma^{cm}}\frac{\sqrt{Q^2}}{\omega_\gamma}$$

$$R_T^{00} = \frac{1}{2}(|H_1|^2 + |H_2|^2 + |H_3|^2 + |H_4|^2)$$

$$R_L^{00} = |H_5|^2 + |H_6|^2$$

$$R_{TL}^{00} = \frac{1}{\sqrt{2}}(H_5^* H_1 - H_5^* H_4 + H_6^* H_2 + H_6^* H_3)$$

$$R_{TT}^{00} = -H_1^* H_4 + H_2^* H_3$$

$$R_{TL'}^{00} = \frac{1}{\sqrt{2}}(-H_5^* H_1 + H_5^* H_4 - H_6^* H_2 - H_6^* H_3)$$

p_m is absolute value of meson three-momentum, ω_γ stands for the photon energy in the CM-frame, k_γ^{cm} is the photon equivalent energy in the CM-frame:

$$\omega_\gamma = \frac{W^2 - Q^2 - M_B^2}{2W}$$

$$k_\gamma^{cm} = \frac{W^2 - M_B^2}{2W}$$

$$p_m = \sqrt{E_m^2 - m_m^2}$$

$$E_m = \frac{W^2 + m_m^2 - M_B^2}{2W}$$

The repository structure

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Model *maid* data

Author:
D. Drechsel, L. Tiator

Description:
MAID approach for evaluation of Nπ observables in the resonance region

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Channel	Q^2, GeV²	W, GeV	cos θ	H_1, GeV^{-1}	H_2, GeV^{-1}	H_3, GeV^{-1}	H_4, GeV^{-1}	H_5, GeV^{-1}	H_6, GeV^{-1}
π^+n	0.0	1.1	1	0j	-0.268-0.00922j	0j	0j	0.195+0.00302j	0j
π^+n	0.0	1.1	0.985	-0.0197-0.000387j	-0.264-0.0092j	0.00432+3.58e-05j	0.0298+0.000716j	0.193+0.00299j	-0.0202-0.00038j
π^+n	0.0	1.1	0.94	-0.0373-0.000752j	-0.252-0.00912j	0.0163+0.000136j	0.058+0.00143j	0.186+0.00292j	-0.0375-0.000745j
π^+n	0.0	1.1	0.866	-0.0513-0.00107j	-0.236-0.009j	0.0334+0.000294j	0.0836+0.00215j	0.175+0.00282j	-0.0498-0.0011j
π^+n	0.0	1.1	0.766	-0.061-0.00135j	-0.217-0.00882j	0.0527+0.000502j	0.106+0.00287j	0.163+0.00267j	-0.0565-0.00142j
π^+n	0.0	1.1	0.643	-0.0665-0.00155j	-0.197-0.00858j	0.0716+0.000745j	0.126+0.00358j	0.149+0.0025j	-0.0582-0.00171j
π^+n	0.0	1.1	0.5	-0.0682-0.00167j	-0.179-0.00829j	0.0881+0.000996j	0.145+0.00428j	0.136+0.0023j	-0.0558-0.00197j
π^+n	0.0	1.1	0.342	-0.0667-0.00171j	-0.162-0.00792j	0.101+0.00123j	0.161+0.00498j	0.122+0.00208j	-0.0505-0.00219j
π^+n	0.0	1.1	0.174	-0.0626-0.00168j	-0.146-0.0075j	0.11+0.00145j	0.177+0.00566j	0.109+0.00186j	-0.0434-0.00238j
π^+n	0.0	1.1	0.0	-0.0566-0.00158j	-0.132-0.00701j	0.115+0.00162j	0.193+0.00631j	0.0964+0.00163j	-0.0354-0.00252j
π^+n	0.0	1.1	-0.174	-0.0491-0.00141j	-0.119-0.00645j	0.116+0.00173j	0.207+0.00694j	0.0844+0.0014j	-0.0271-0.00263j
π^+n	0.0	1.1	-0.342	-0.0408-0.0012j	-0.106-0.00583j	0.112+0.00176j	0.222+0.00752j	0.0728+0.00118j	-0.0191-0.00271j
π^+n	0.0	1.1	-0.5	-0.0322-0.000967j	-0.0926-0.00513j	0.105+0.00171j	0.235+0.00805j	0.0616+0.000974j	-0.0115-0.00276j
π^+n	0.0	1.1	-0.643	-0.0237-0.000724j	-0.0788-0.00438j	0.0934+0.00158j	0.247+0.00852j	0.0508+0.000781j	-0.00484-0.00279j
π^+n	0.0	1.1	-0.766	-0.0159-0.000487j	-0.0643-0.00358j	0.079+0.00138j	0.258+0.00891j	0.0403+0.000602j	0.000845-0.0028j

Reaction cross-section

Calculation example:

φ-dependence of differential cross-section for π+ electroproduction off proton

Q^2 = 0.5 ГэВ²
W = 1.2 ГэВ
cos θ = -0.5

And beam energy

E_b = 10.6 ГэВ

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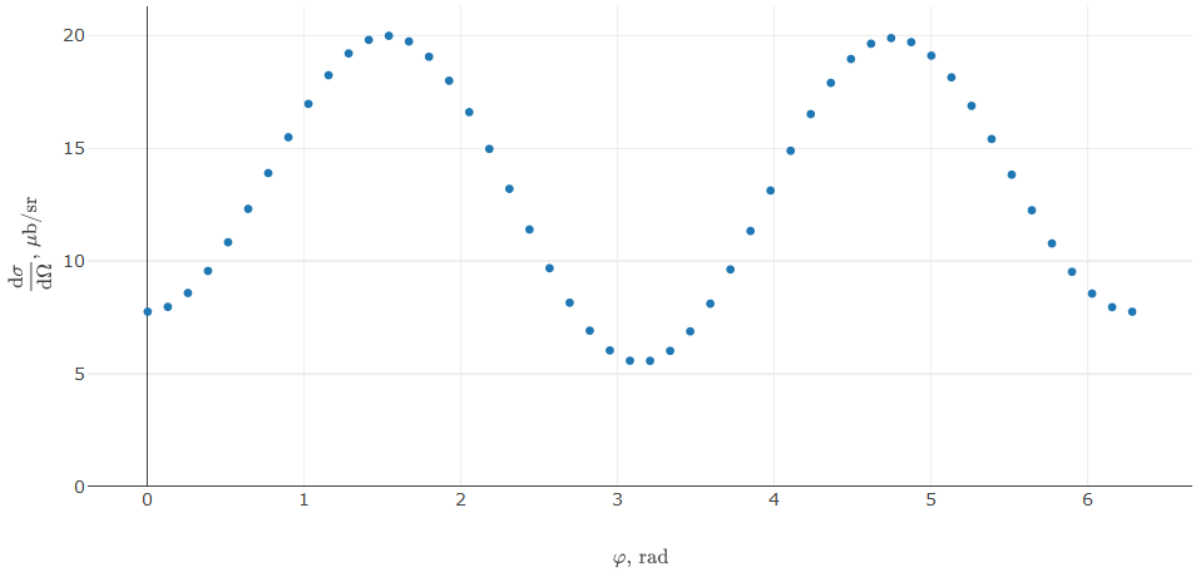
Differential cross-section

Model	Channel	Q^2, GeV²	W, GeV	cos θ	x_B	E_b, GeV
maid	$\pi^+ n$	0.5	1.2	-0.5	0.472	10.6

H_1, GeV^{-1}	H_2, GeV^{-1}	H_3, GeV^{-1}	H_4, GeV^{-1}	H_5, GeV^{-1}	H_6, GeV^{-1}
-0.0731-0.0883j	-0.107-0.078j	0.137+0.153j	0.0472+0.0325j	0.000645-0.000795j	0.00129+0.000358j

R_T^{00}, μb/sr	R_L^{00}, μb/sr	R_{TT}^{00}, μb/sr	R_{TL}^{00}, μb/sr	R_{TL}^{00}, μb/sr
14.825937614252918	0.0011050202381007782	-7.890168906357977	0.023279441696396386	0.023991781418785843

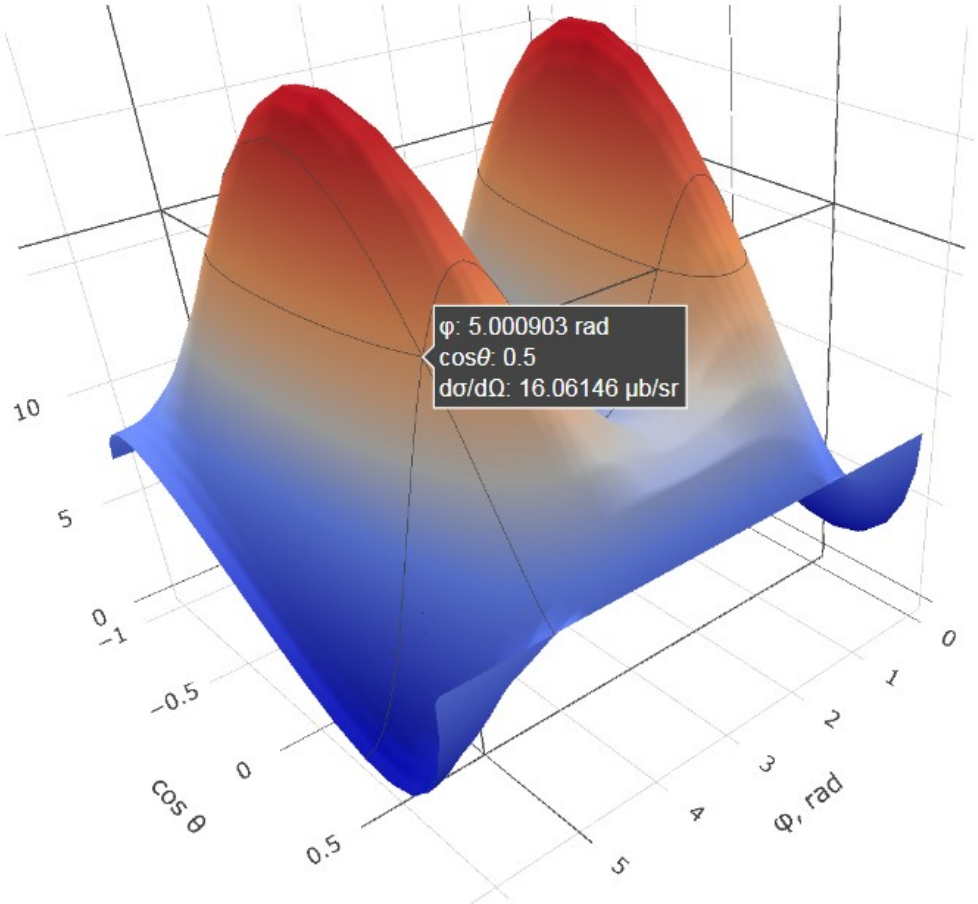
$\frac{d\sigma_T}{d\Omega}$, μb/sr	$\frac{d\sigma_L}{d\Omega}$, μb/sr	$\frac{d\sigma_{TT}}{d\Omega}$, μb/sr	$\frac{d\sigma_{TL}}{d\Omega}$, μb/sr	$\frac{d\sigma_{TL'}}{d\Omega}$, μb/sr
12.515235625597306	0.7551342936017441	-6.66044371412306	0.5591237914921284	0.5762327106667019



3-D plot of differential cross-section

Differential cross-section

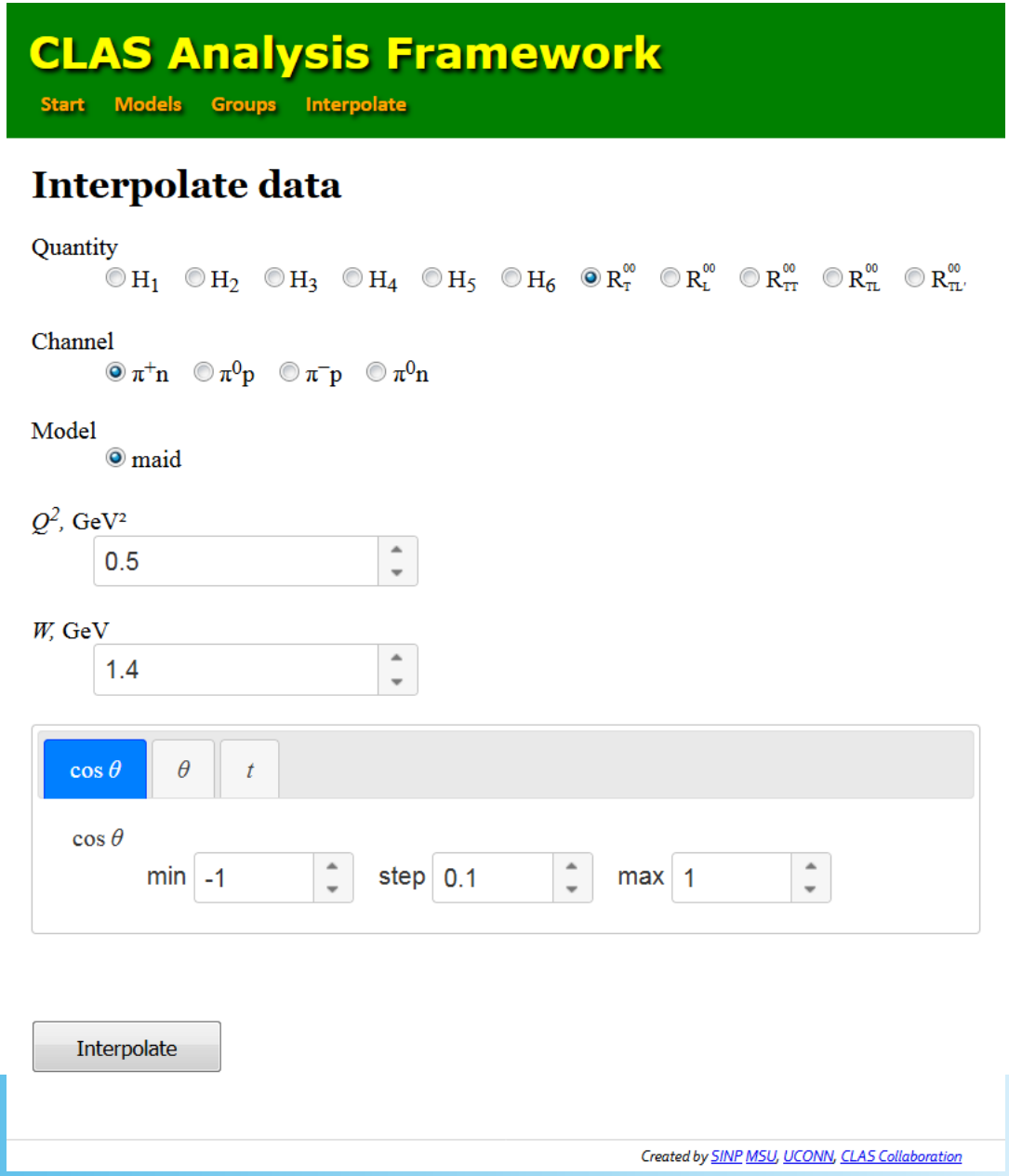
Channel	π^+n	Model	maid	Q^2, GeV²	0.5	W, GeV	1.2	E_b, GeV	10.6



Data interpolation

Form to specify interpolation parameters:

observable, channel, model, Q^2, W, grid cos θ or θ or t



Amplitudes interpolation results

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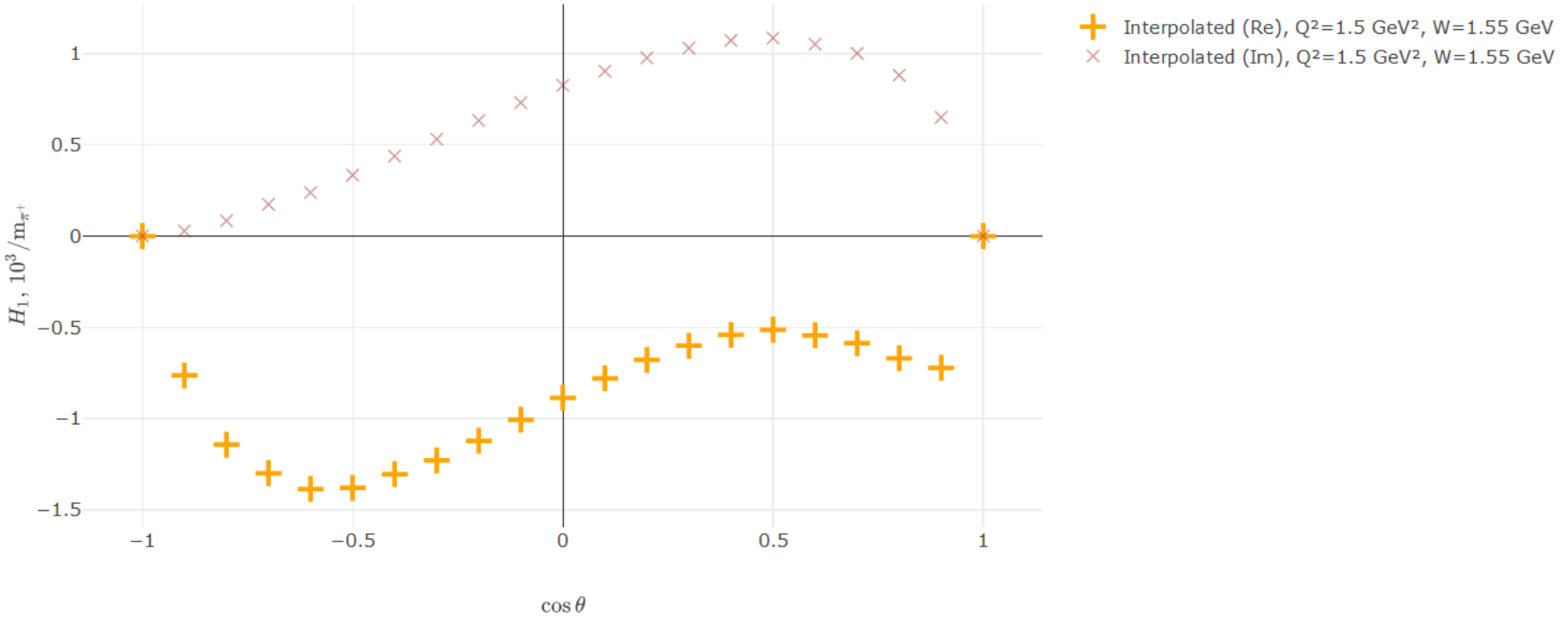
Interpolation results

Channel	π^+n	Model	maid	Q^2, GeV²	1.5	W, GeV	1.55



Interpolation results comparison

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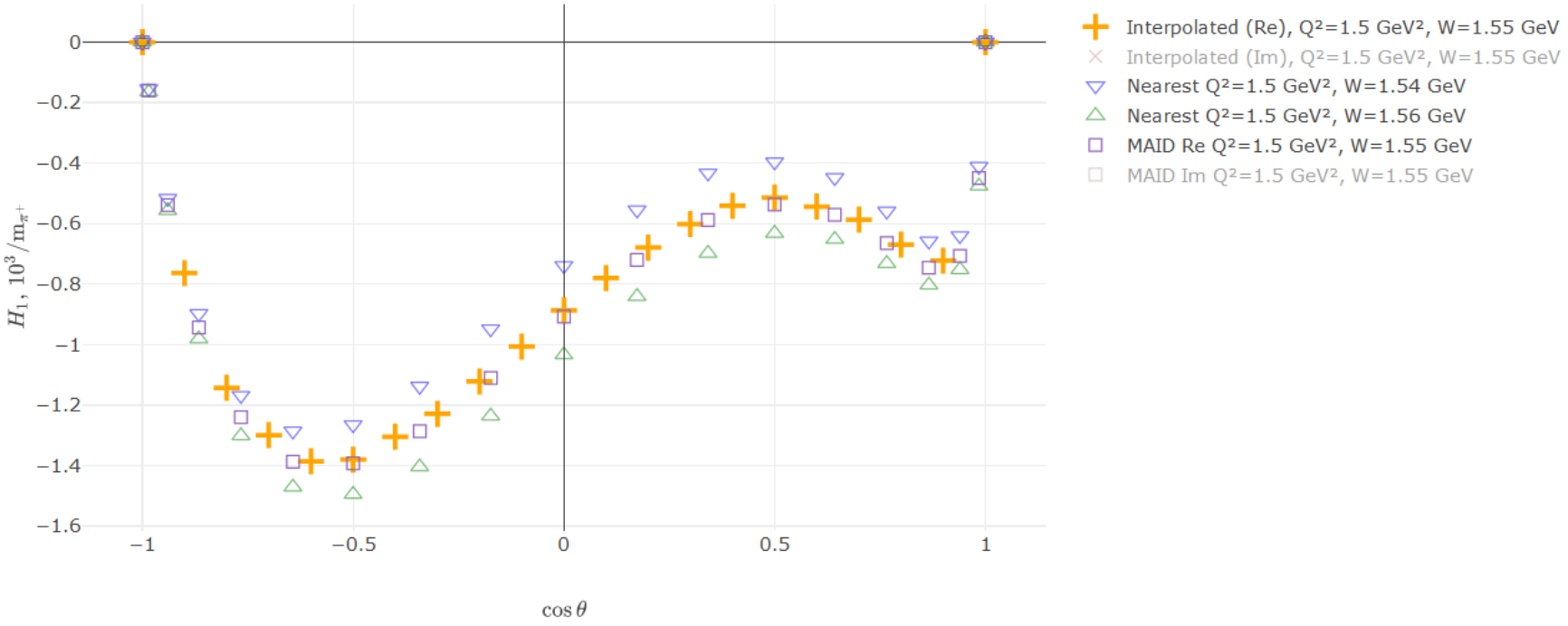
Interpolation results

Channel	π^+n	Model	maid	Q^2, GeV²	1.5	W, GeV	1.55



Interpolation results comparison for the structure function

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Interpolation results

Channel	π^+n	Model	maid	Q^2, GeV²	1.5	W, GeV	1.55