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Dispersion relation results for VCS at JLab

G. Laveissiere

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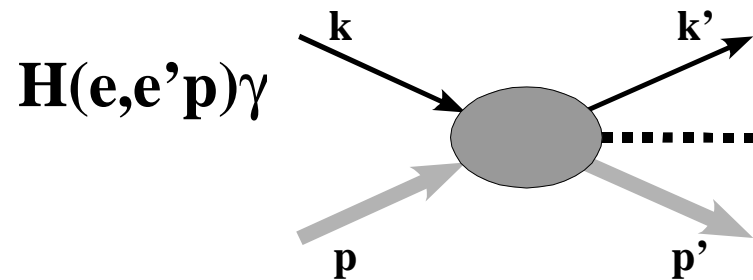
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Virtual Compton Scattering @ Jefferson Lab

Extraction of Proton Generalized Polarisabilities
at $Q^2=1.0$ and 1.9 GeV^2
using a Dispersion Relations formalism

Compton Scattering from low to high momentum transfer
Trento, Italy, April 2003

Electroproduction of photons experiment: analysis below and above π^0 production threshold



$$d\sigma_{exp}^0 = \frac{N_{exp}}{N_{sim}} \times \frac{L_{sim}}{L_{exp}} \times d\sigma_{sim}^0.$$

We need an accurate Monte Carlo simulation in order to obtain the experimental cross section.

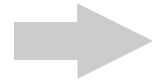
First order Generalized Polarisabilities are not valid in the Δ region.

Low E_γ	Around π^0 threshold	Δ region
Bethe–Heitler + Born	1 st Order GP	Dispersion Relations

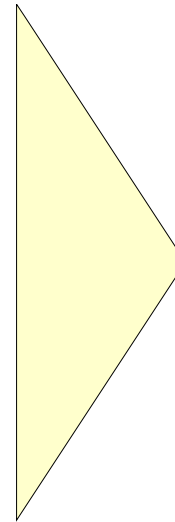
We need a new model to describe the cross sections in the resonance region.

Proton Generalized Polarisabilities extraction above π^0 production threshold

Analyticity
+
Crossing Rules
+
Unitarity

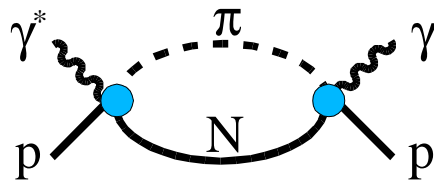


**Dispersion
Relations**



Non-Born
Amplitudes
 \Leftrightarrow
Generalized
Polarisabilities

Intermediate States πN Amplitudes



This formalism has 2 free parameters: the 2 generalized polarisabilities

$$\alpha(Q^2) \text{ and } \beta(Q^2)$$

\Rightarrow valid until the 2 pions production threshold

\Rightarrow related to the structure functions $P_{LL} - P_{TT}/\epsilon$ and P_{LT}

B. Pasquini, M. Gorchtein, D. Drechsel, A. Metz and M. Vanderhaeghen,
Eur. Phys. J. A11 (2001) 185

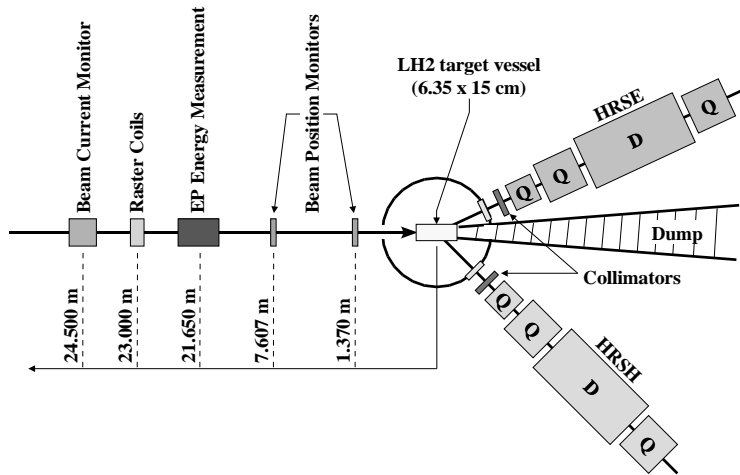
Jlab E93050

Absolute cross sections measurement

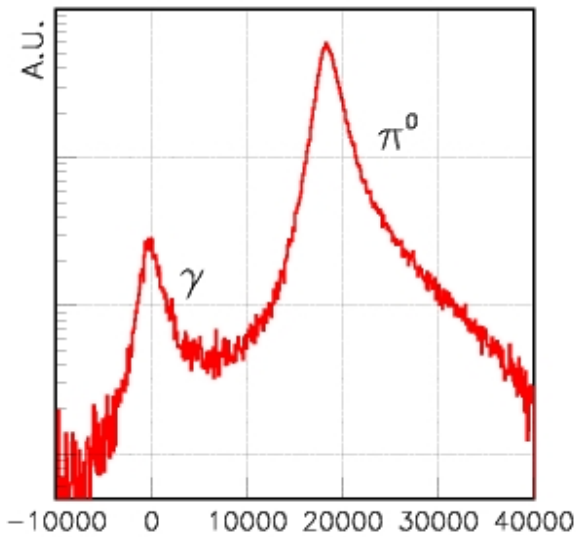
Coincidence e/p

Need good resolution for γ/π^0 separation

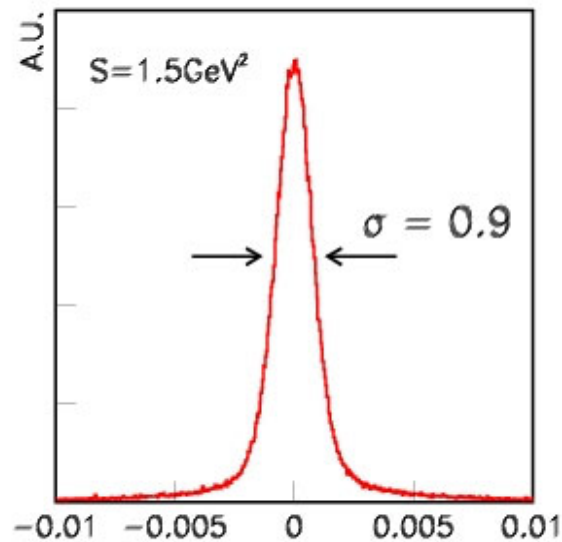
Normalization controlled at low E_γ



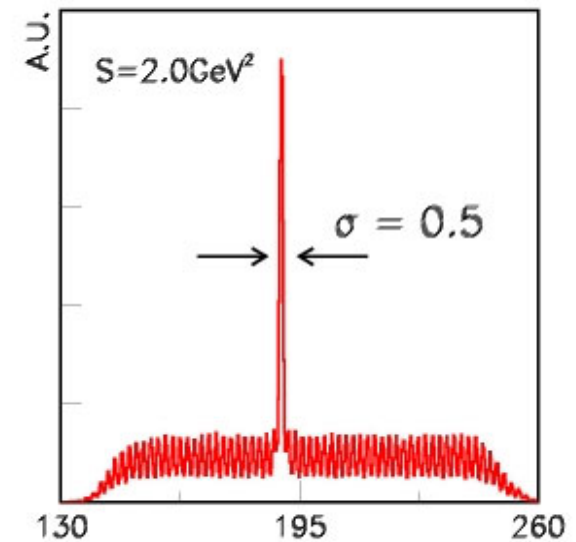
Missing mass (MeV^2)



Vertex Reconstruction (mm)



Coincidence Time (ns)



Analysis

BELOW π^0 THRESHOLD

Low Energy Theorem Analysis \longrightarrow VCS Structure functions

$$Q^2 = 0.923 \text{ GeV}^2 \quad \varepsilon = 0.950$$

$$Q^2 = 1.760 \text{ GeV}^2 \quad \varepsilon = 0.879$$

$$\mathbf{P}_{LL} - \mathbf{P}_{TT}/\varepsilon, \mathbf{P}_{LT}$$

ABOVE π^0 THRESHOLD

Dispersion Relations Analysis \longrightarrow 2 DR Parameters

$$Q^2 = 0.923 \text{ GeV}^2 \quad \varepsilon = 0.950$$

$$Q^2 = 1.760 \text{ GeV}^2 \quad \varepsilon = 0.879$$

$\Lambda_\alpha, \Lambda_\beta$ related to α and β via a dipole form:

$$\alpha(Q^2) - \alpha^{\pi N}(Q^2) = \frac{\alpha - \alpha^{\pi N}}{(1 + Q^2 / \Lambda_\alpha^2)^2}$$

$\Delta(1232)$ REGION

Dispersion Relations Analysis \longrightarrow 2 DR Parameters

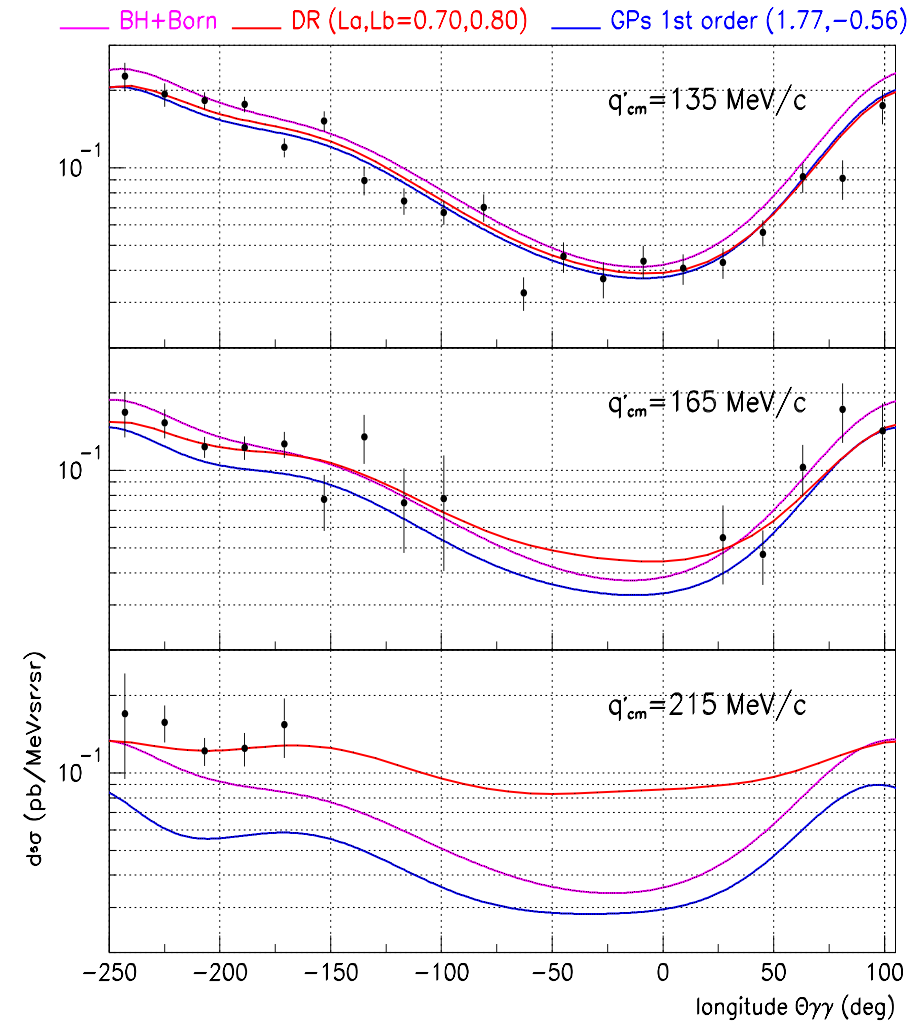
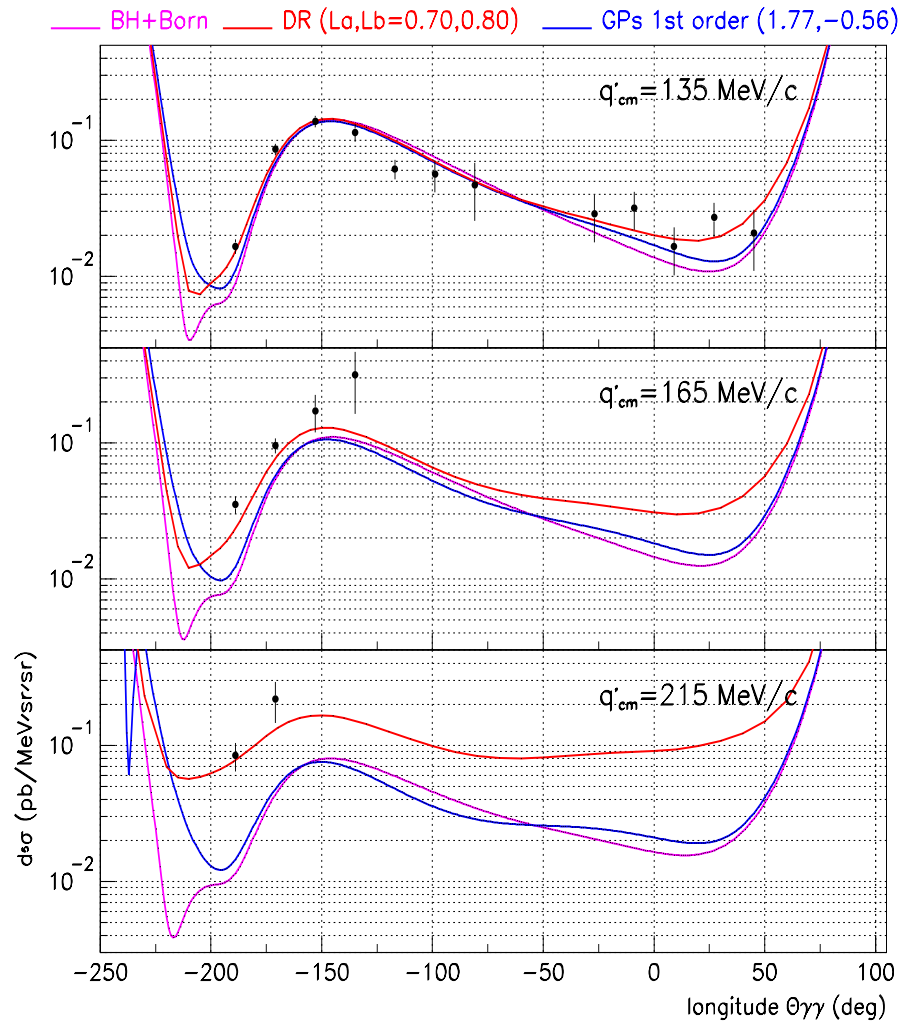
$$Q^2 = 0.923 \text{ GeV}^2 \quad \varepsilon = 0.950$$

$$\Lambda_\alpha, \Lambda_\beta$$

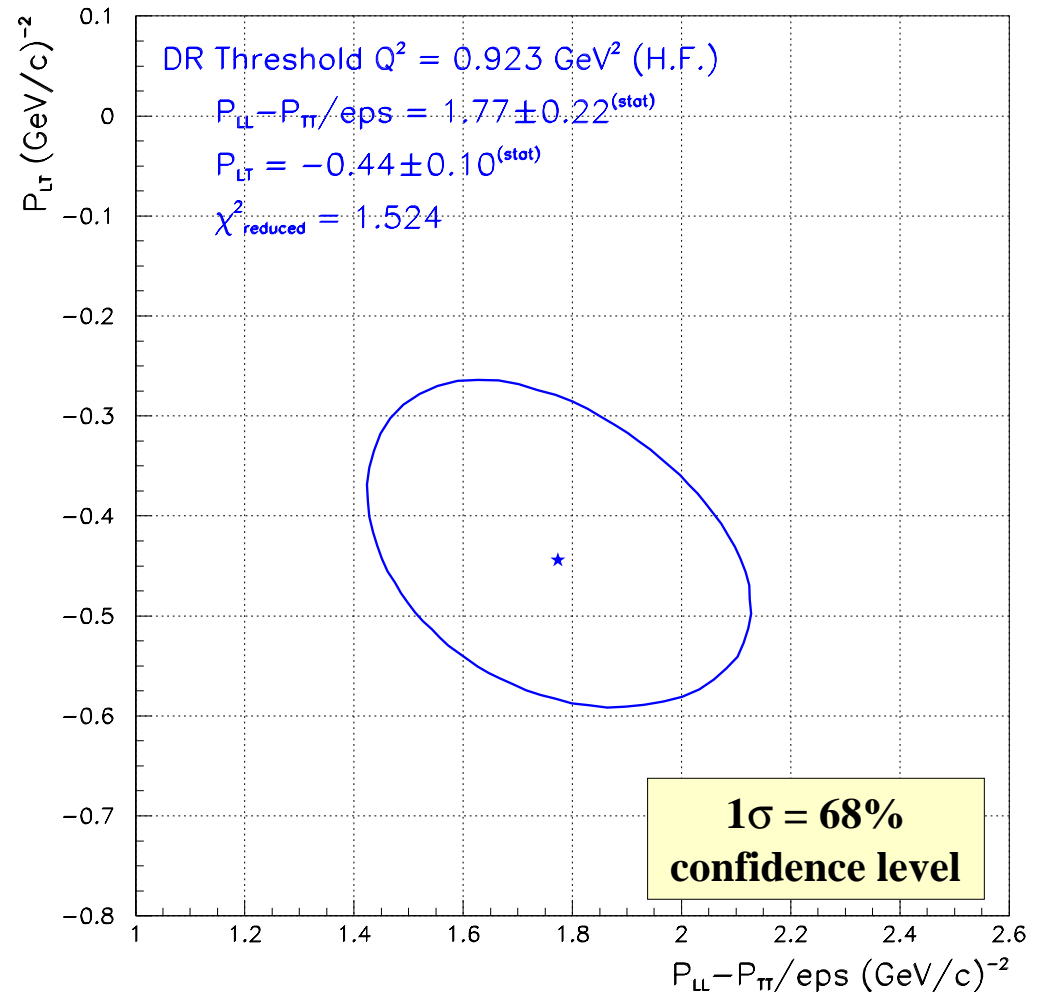
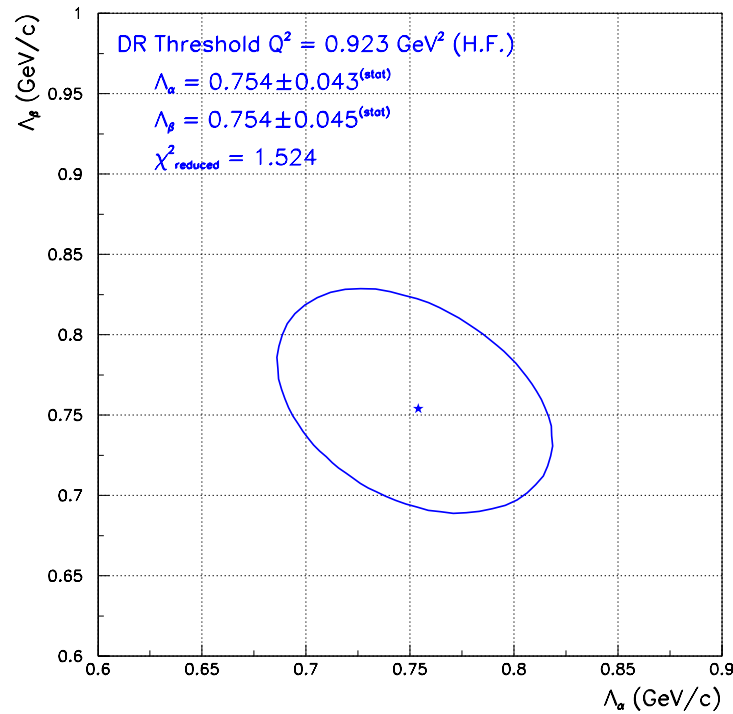
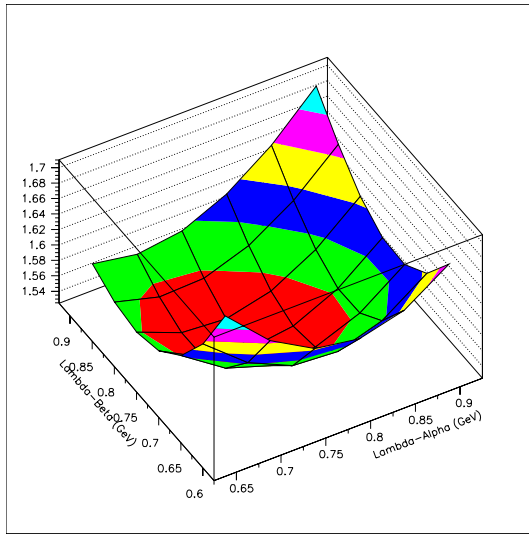
Cross sections at $Q^2 = 0.923 \text{ GeV}^2$ above π^0 production threshold

Lepton Plane

40° Out-Of-Plane



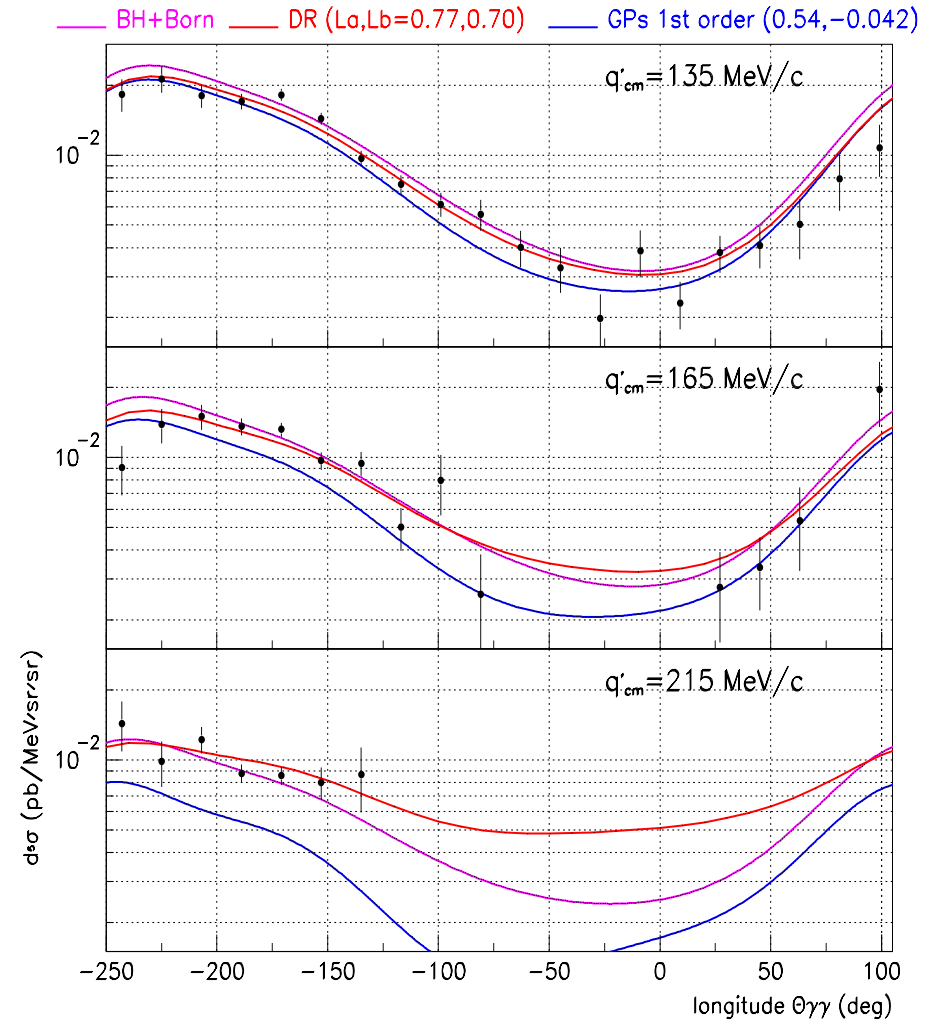
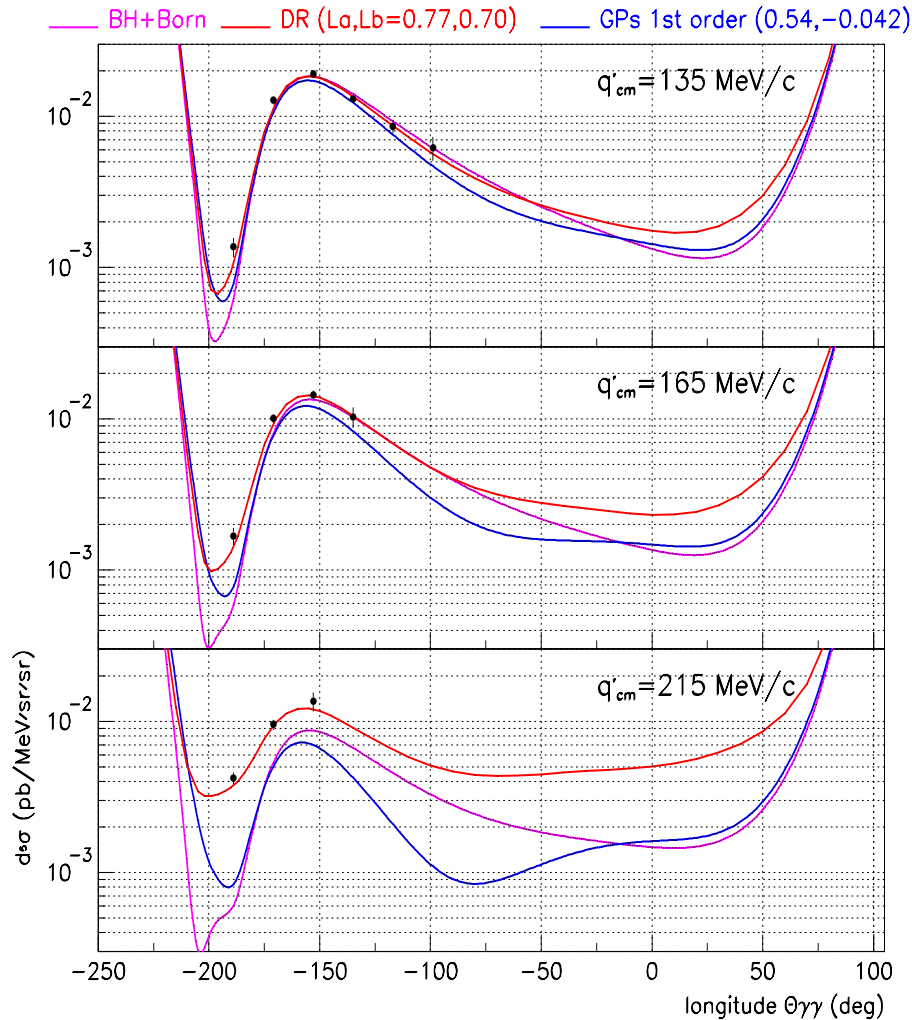
Dispersion relations fit at $Q^2 = 0.923 \text{ GeV}^2$ above π^0 production threshold



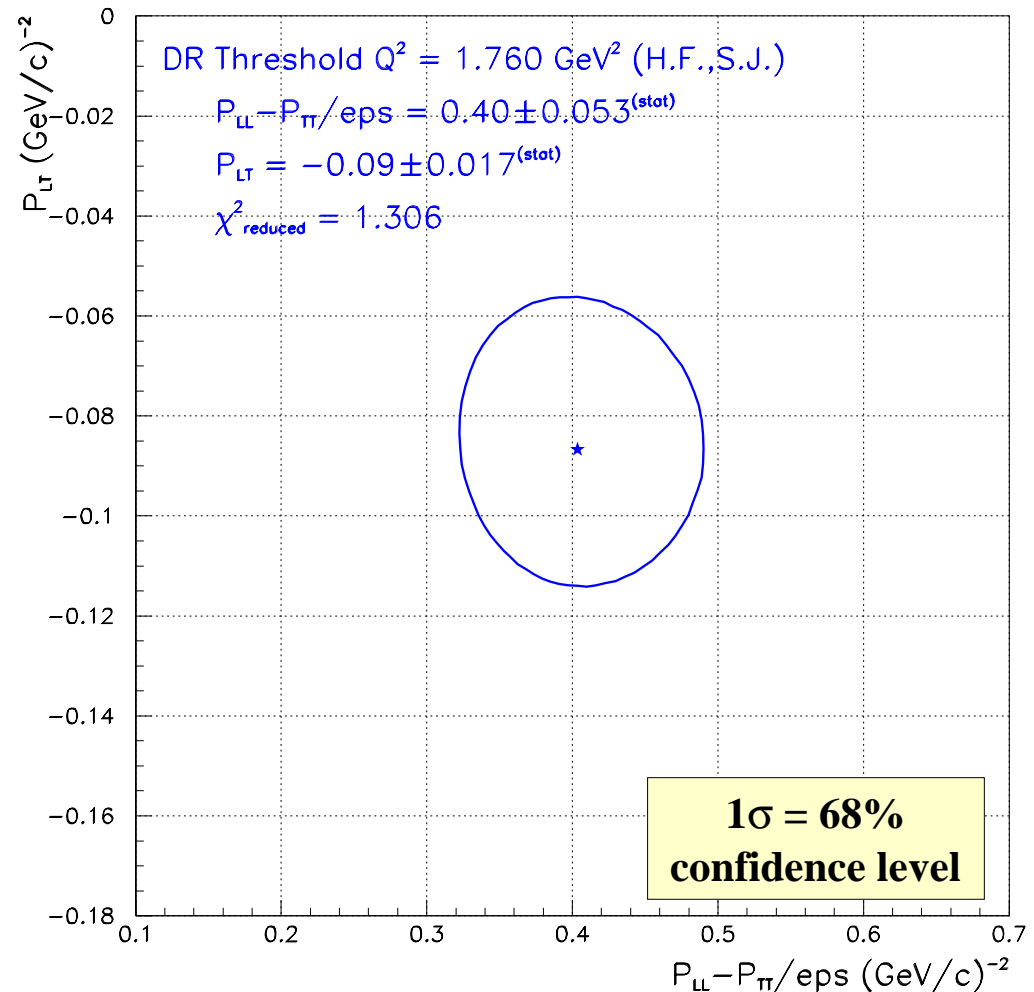
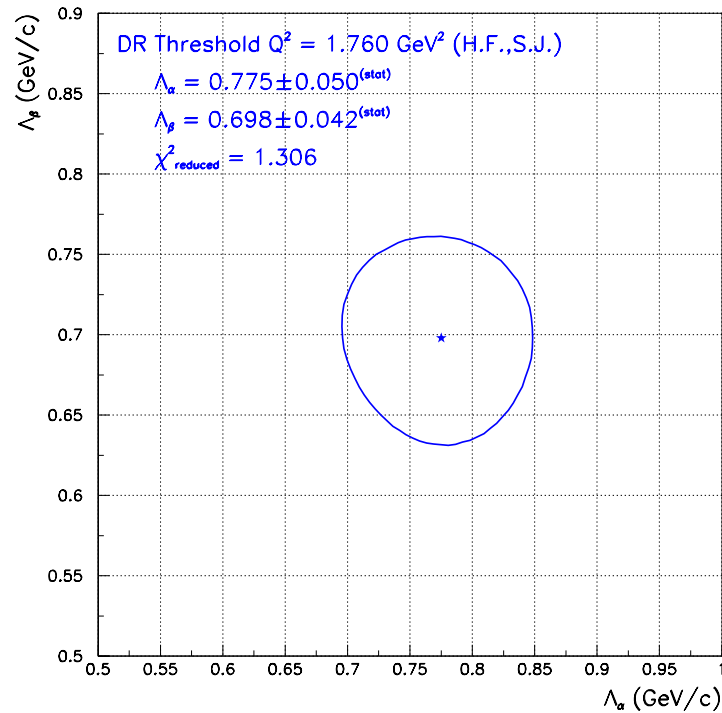
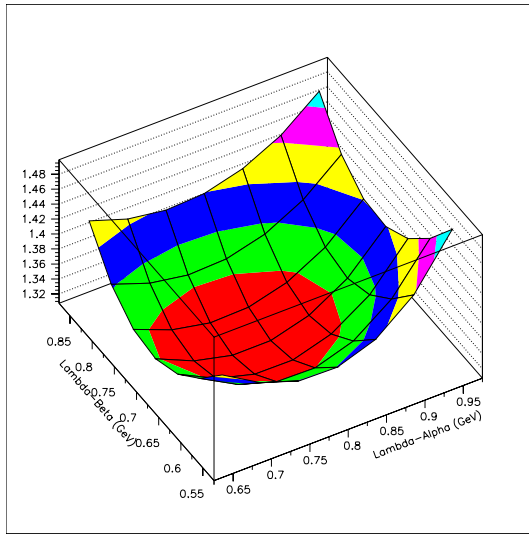
Cross Sections at $Q^2 = 1.760 \text{ GeV}^2$ above π^0 production threshold

Lepton Plane

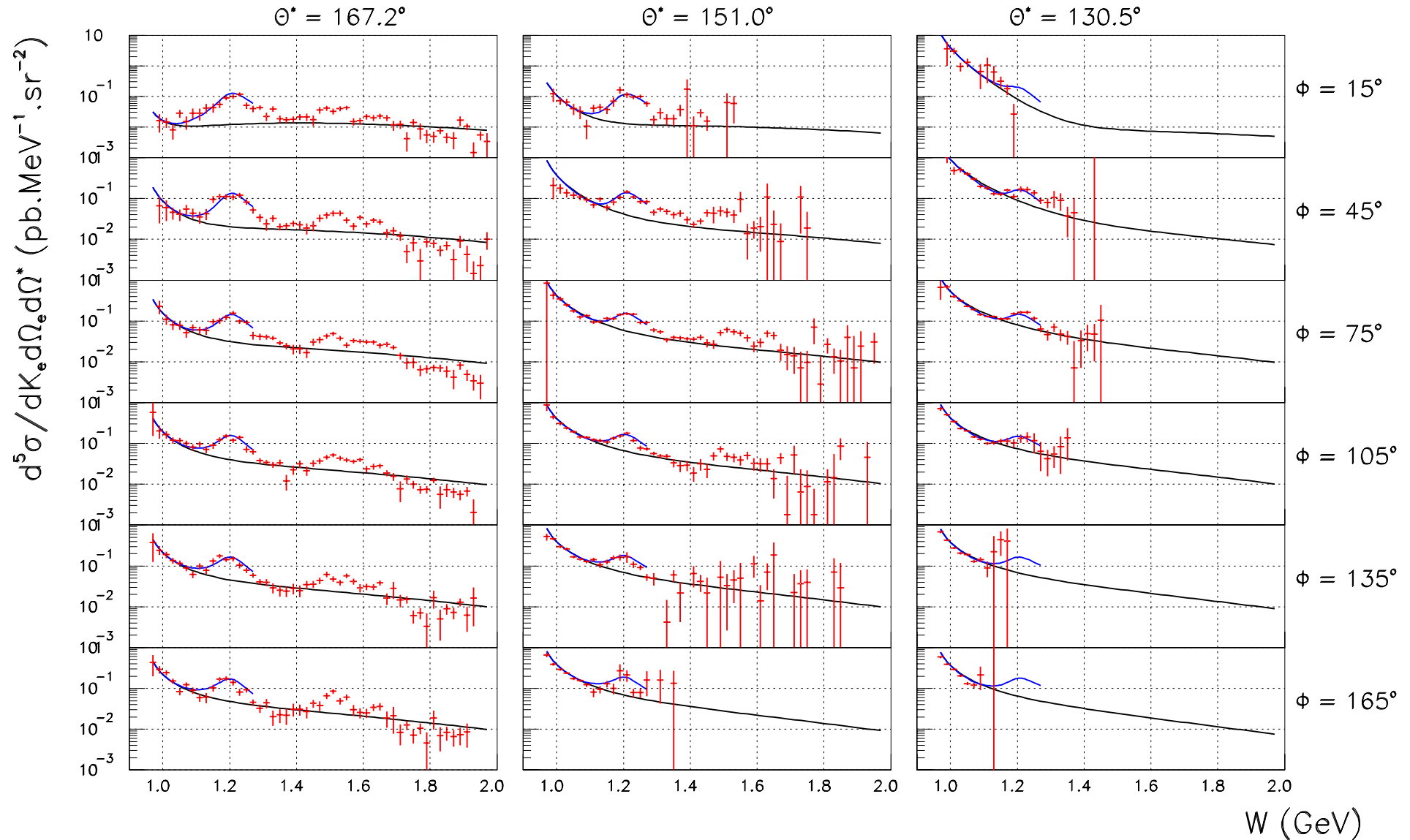
40° Out-Of-Plane



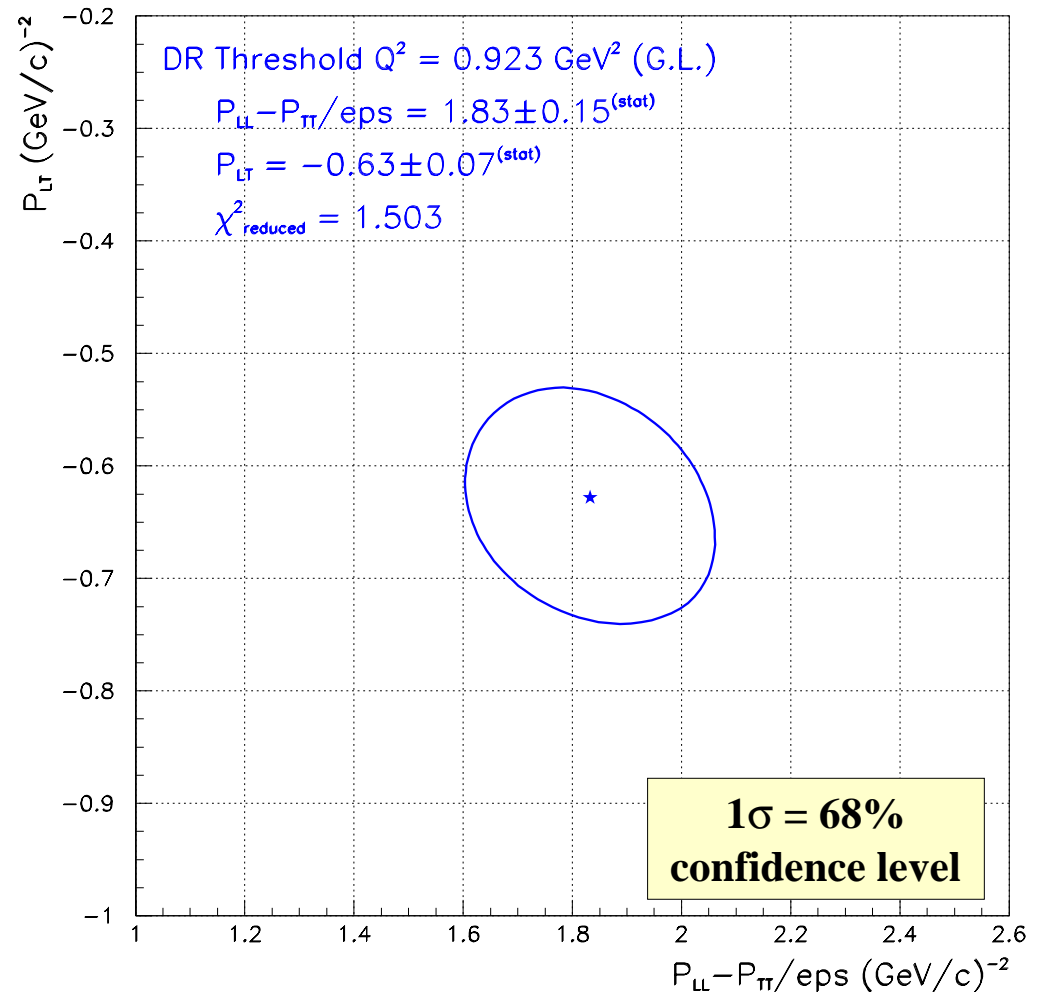
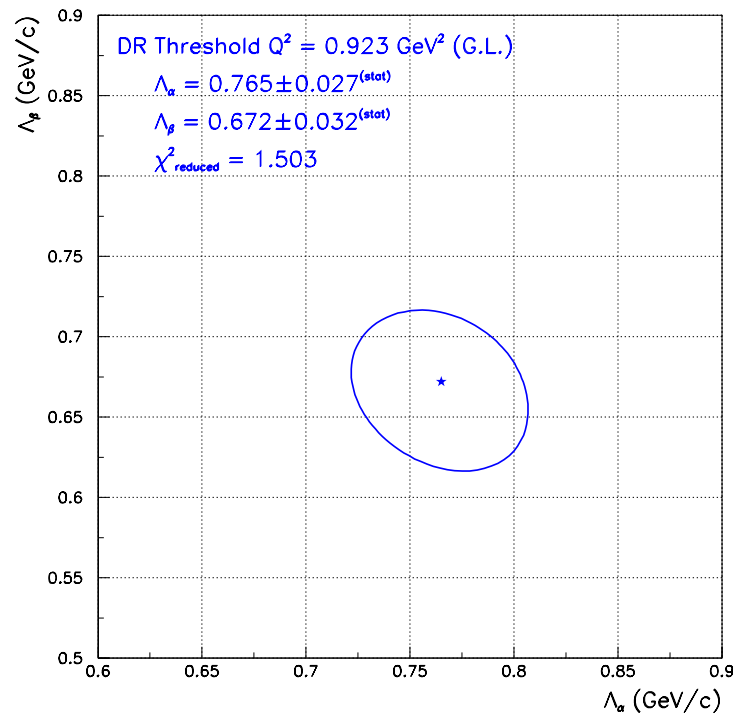
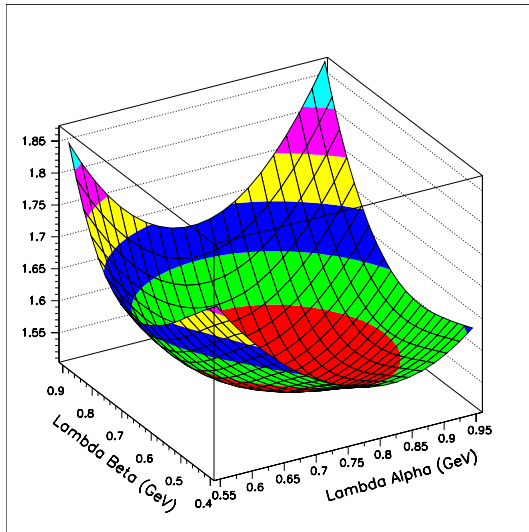
Dispersion relations fit at $Q^2 = 1.760 \text{ GeV}^2$ above π^0 production threshold



Cross sections at $Q^2 = 0.923 \text{ GeV}^2$ in the Δ resonance region



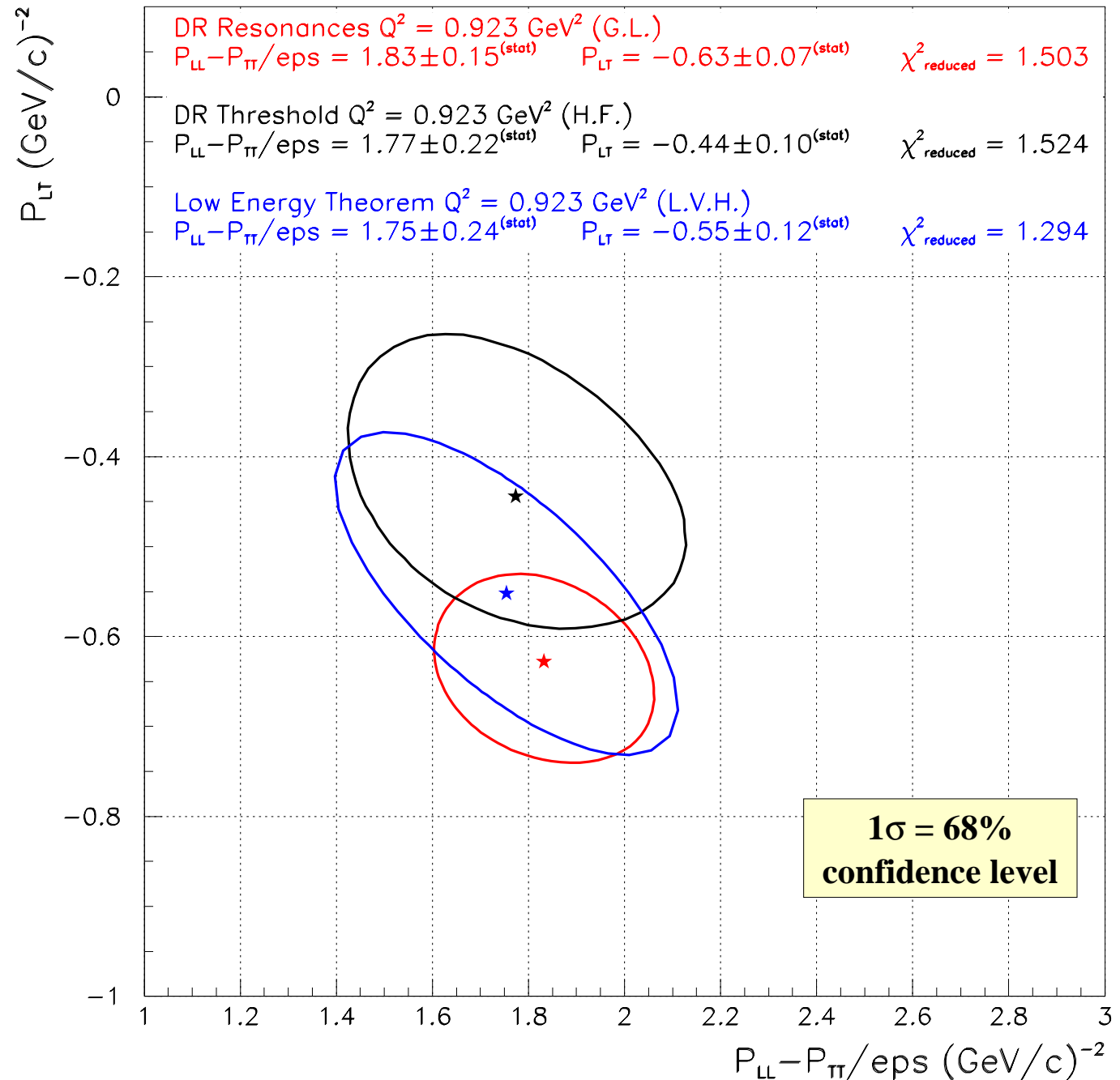
Dispersion relations fit at $Q^2 = 0.923 \text{ GeV}^2$ in the $\Delta(1232)$ region



Comparison of structure functions

3 different
analysis

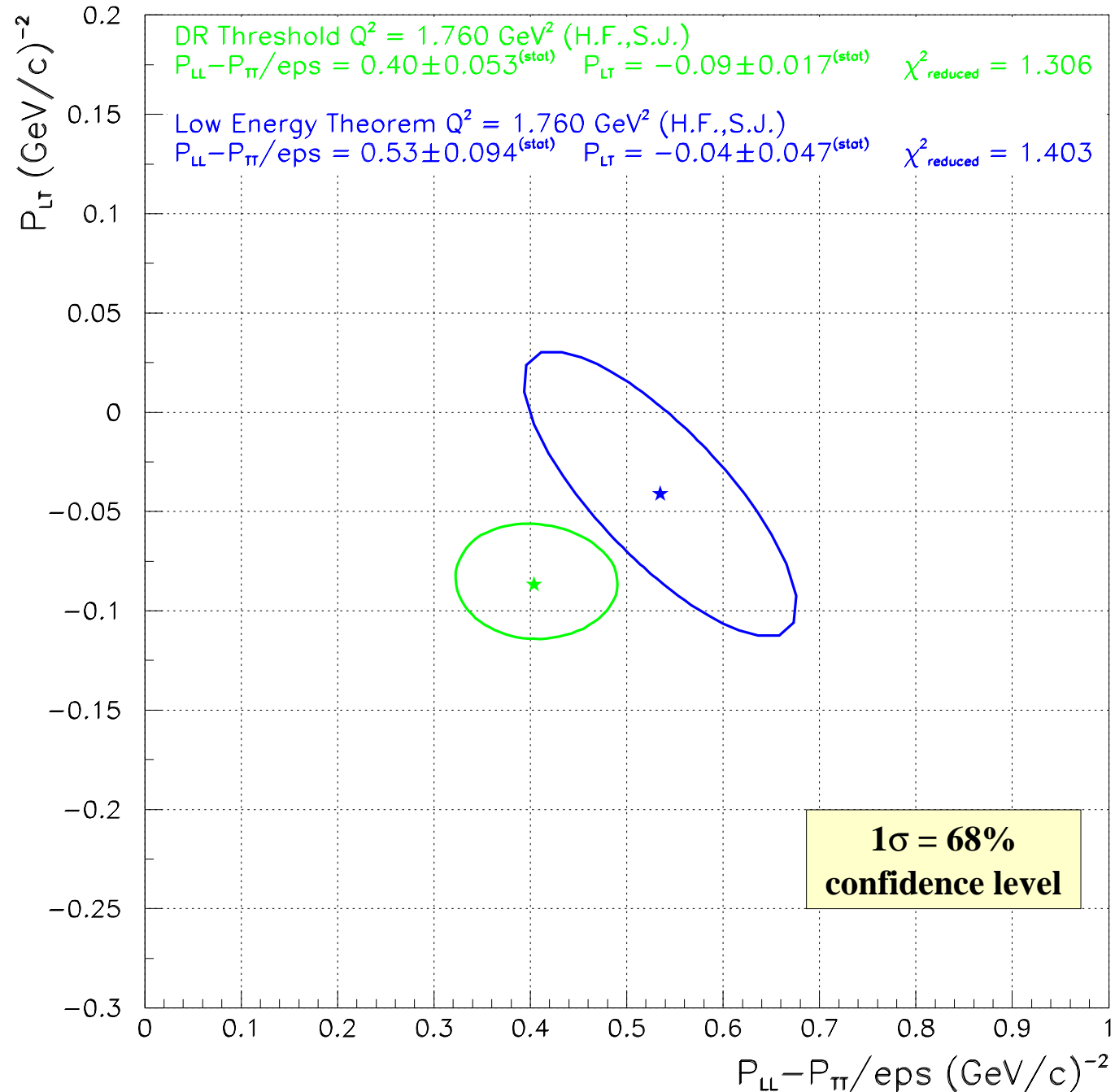
$Q^2 = 0.923$
 GeV^2



Comparison of structure functions

LEX and DR analysis

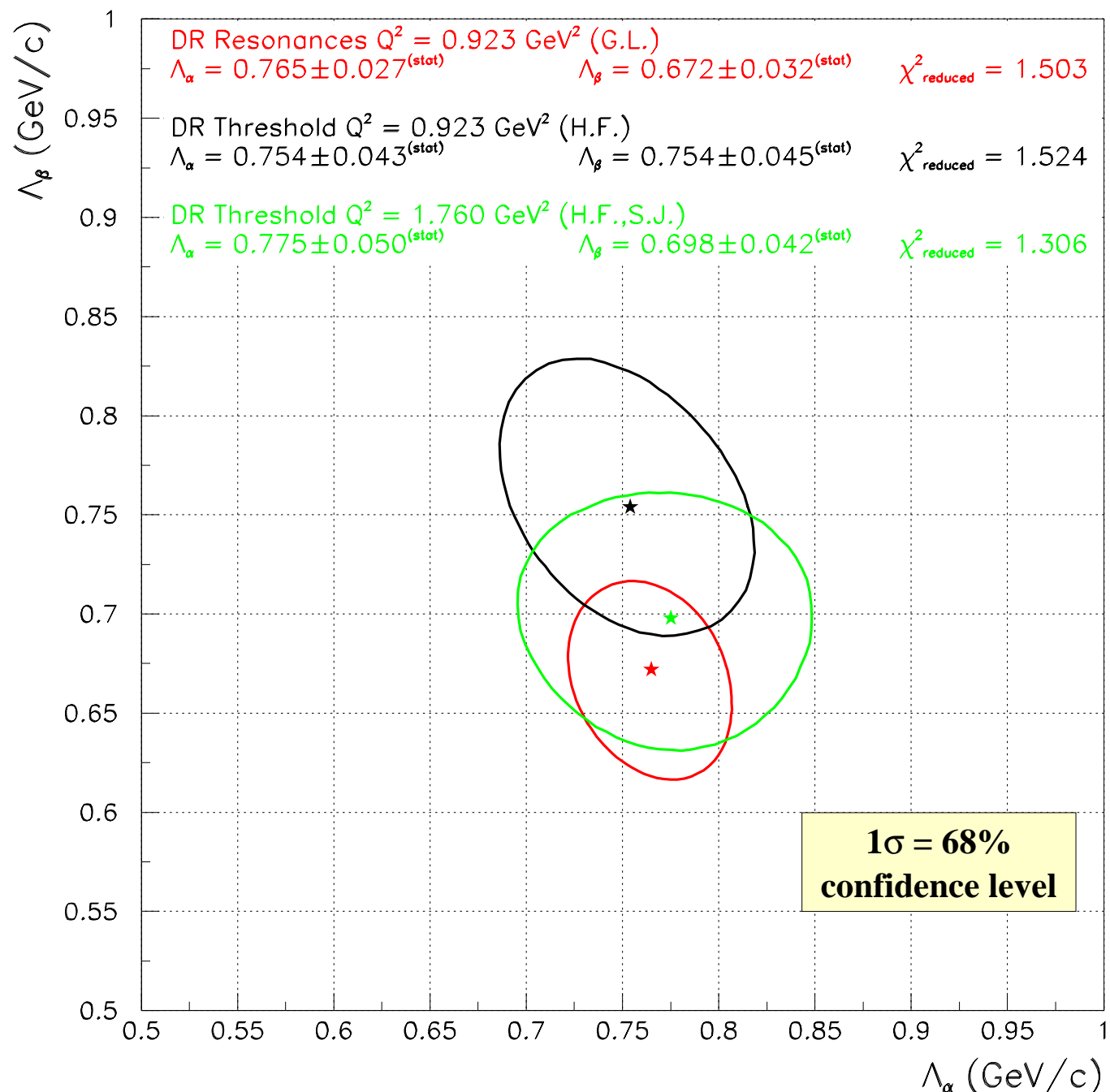
$Q^2 = 1.760$
 GeV^2



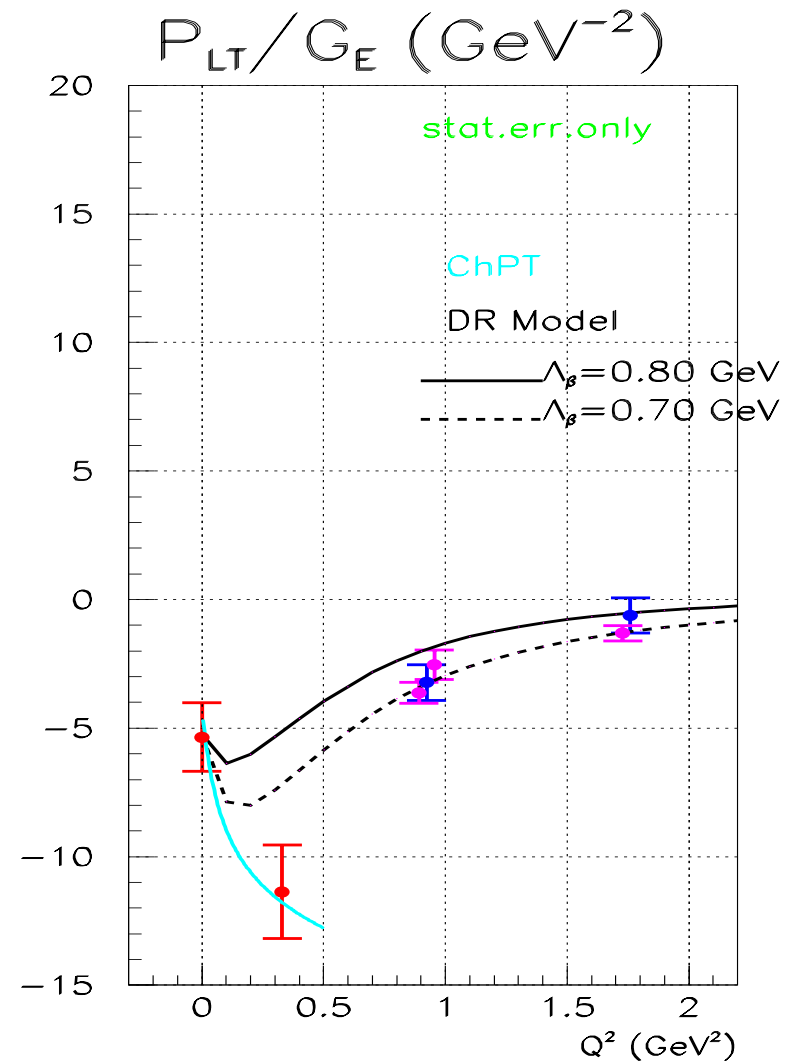
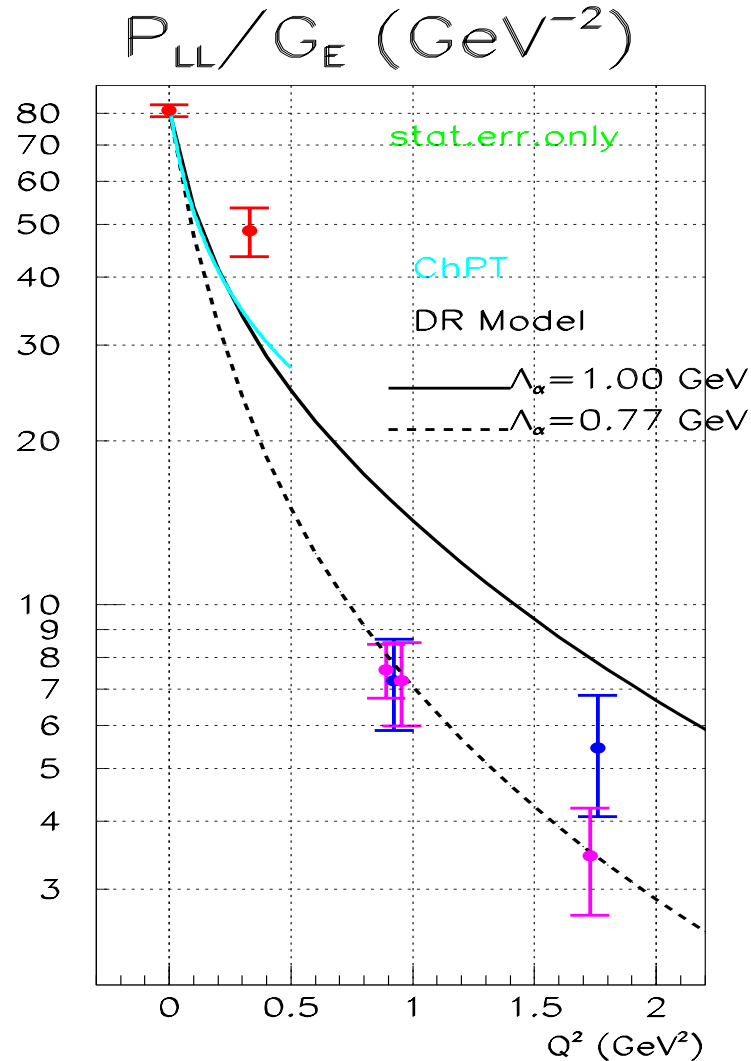
Comparison of dispersion relations parameters

3 different analysis

Dipole form is
pretty good !!



Summary



proton EM Form factors = parametrization of Brash et al.

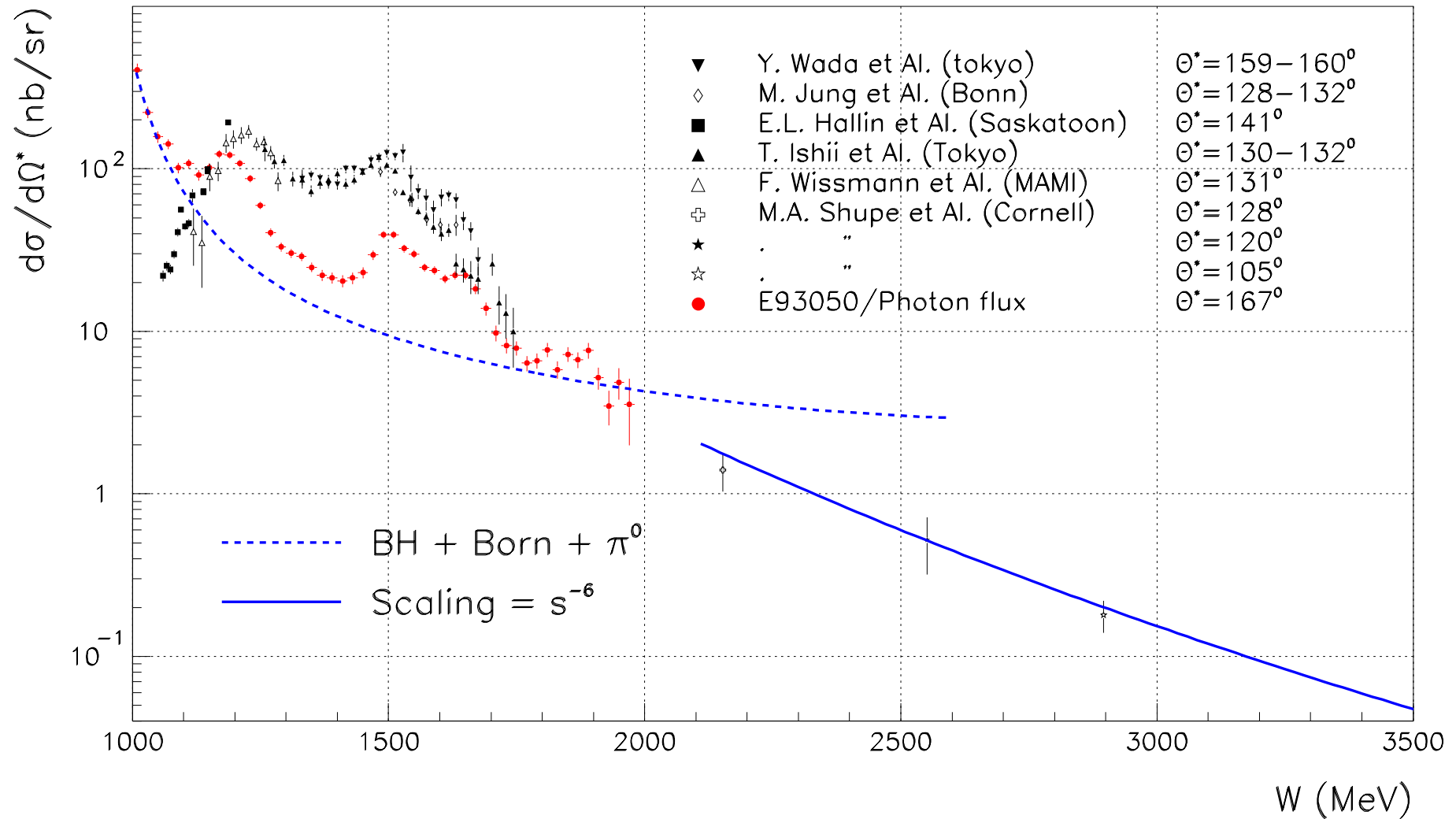
exp. point at $Q^2=0.00$ / (RCS) V.Olmos de Leon et al., Eur.Phys.J.A10 (2001) 207

exp. point at $Q^2=0.33$ / VCS (Mami) J.Roche et al, Phys.Rev.Lett.85 (2000) 798

exp. point at $Q^2=0.92$ and 1.76 / VCS JLab E93050 LEX analysis

exp. point at $Q^2=0.92, 0.92$ and 1.76 / VCS JLab E93050 DR analysis

VCS / RCS Comparison



Cross sections of the same order (Q^2), Identical Resonances VCS follows « scaling »?