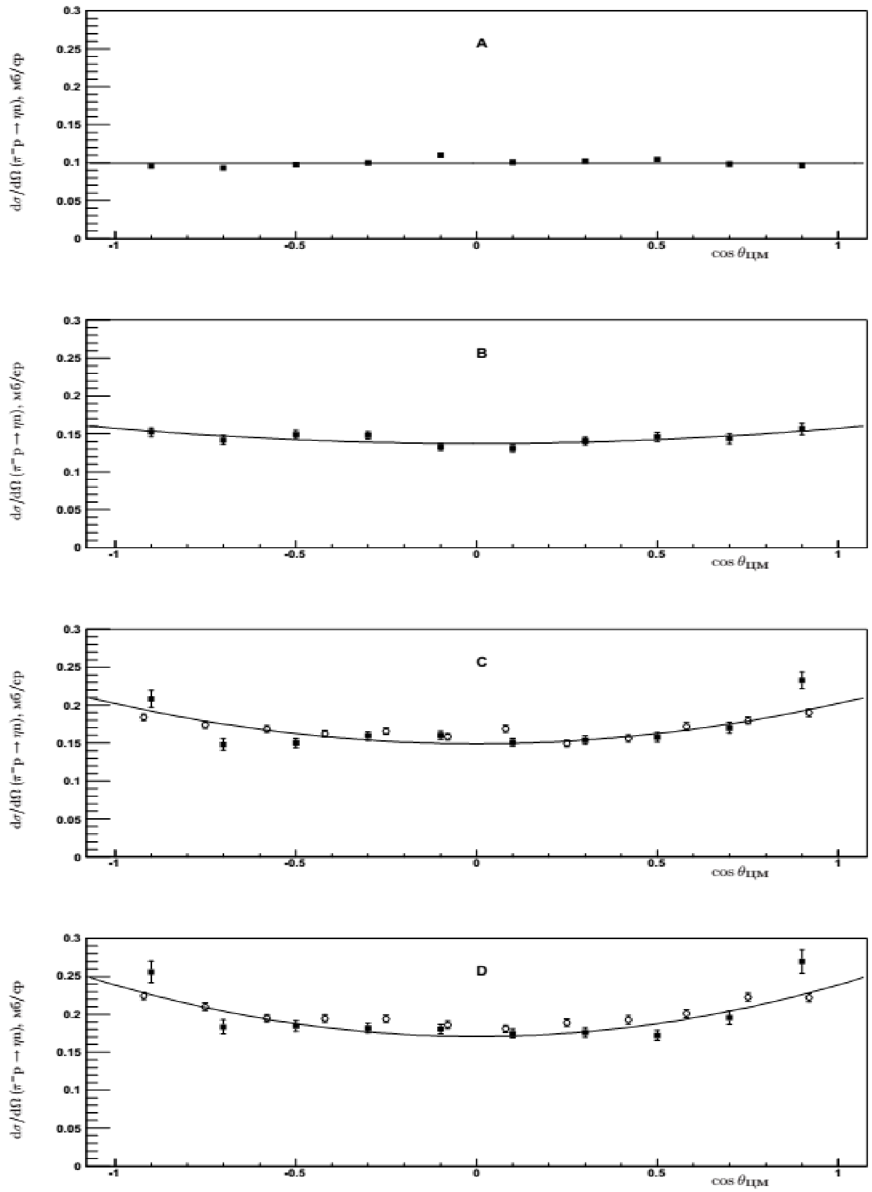
PNPI & EPECUR.



A
B
C
D
dσ/dΩ (π⁻p → ηn), мб/ср
cos θцм

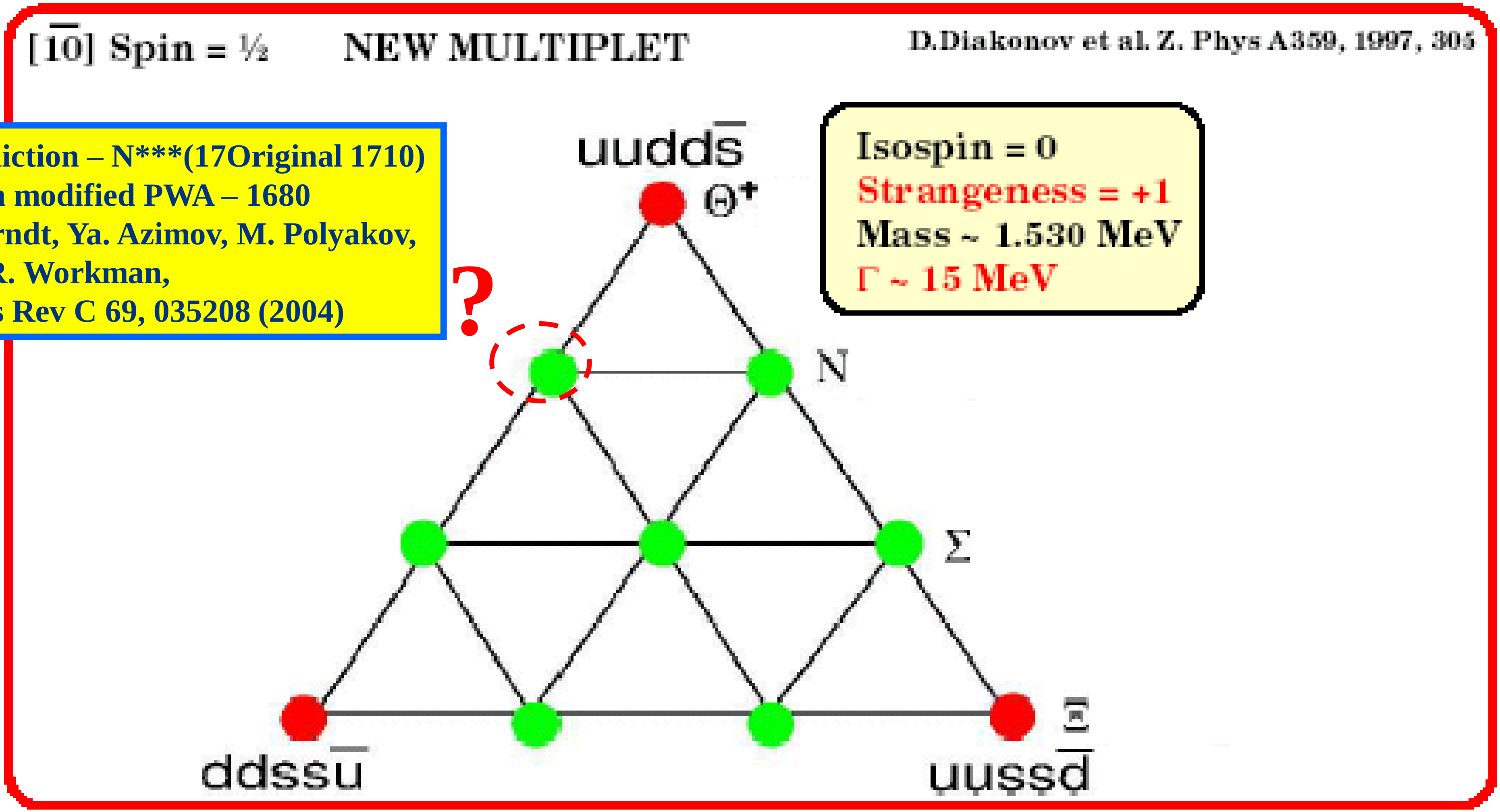
New results on narrow structure in the pion nucleon elastic scattering from the EPECUR experimentn.

I,G. Alekseev, I.G. Bordyuzhin, D.A. Fedin, V.P. Kanavets , L.I. Koroleva,
B.V. Morozov, V.M. Nesterov, V.V. Ryltsov, D.N. Svirida, A.D. Sulimov
ITEP, Moscow

V.A. Andreev, Ye.A. Filimonov, A.B. Gridnev, V.V. Golubev, A.I. Kovalev,
N.G. Kozlenko, V.S. Kozlov, A.G. Krivshich, D.V. Novinsky, V.V. Sumachev, V.I. Tarakanov,
V.Yu. Trautman
PNPI, Gatchina

M. Sadler
ACU, Abilene

Pentaquark antidecuplet



prediction – N***(17Original 1710)
From modified PWA – 1680
R. Arndt, Ya. Azimov, M. Polyakov, IS, R. Workman,
Phys Rev C 69, 035208 (2004)

Why pions? Theory gives weak coupling to πN sector.

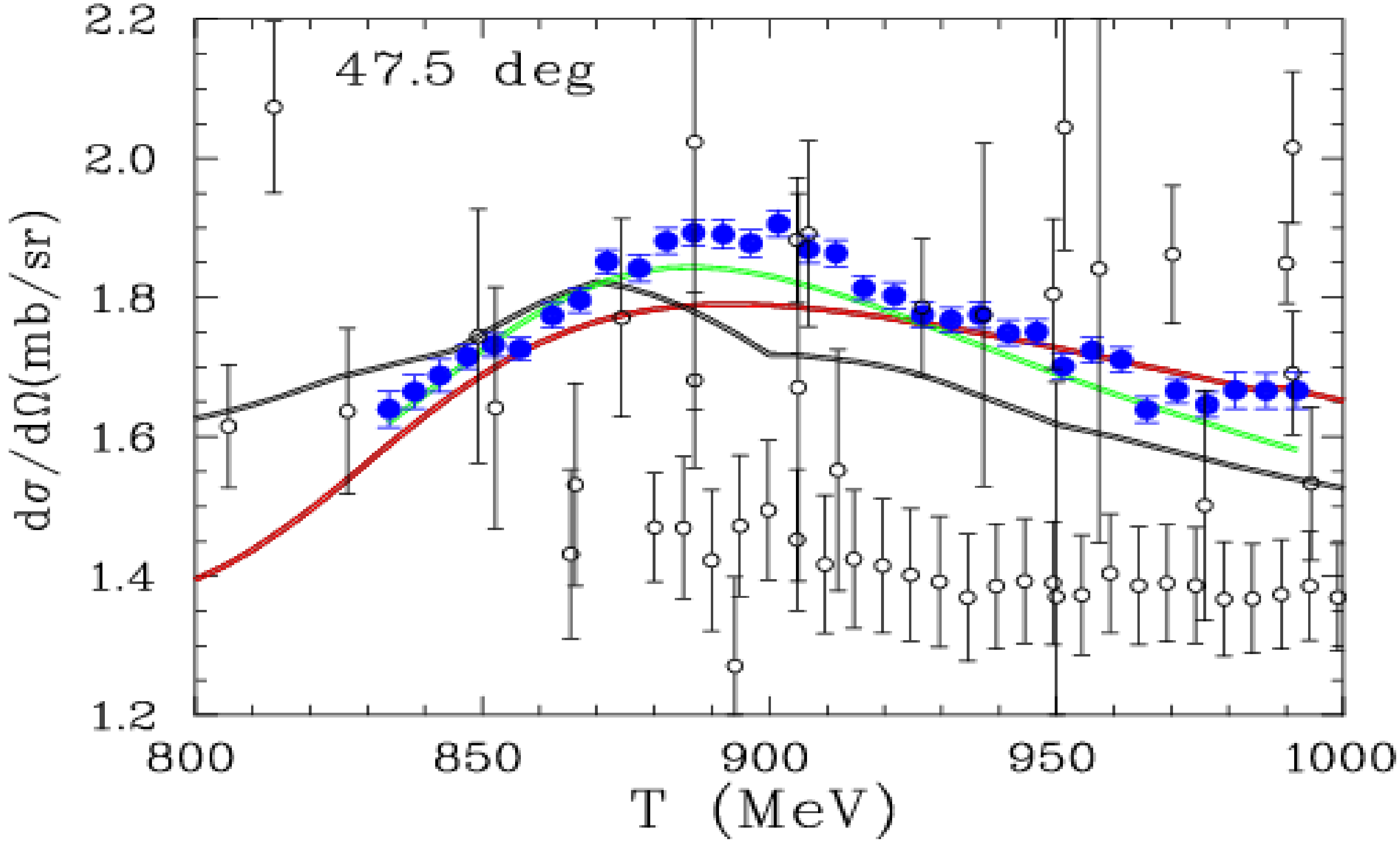
Advantages:

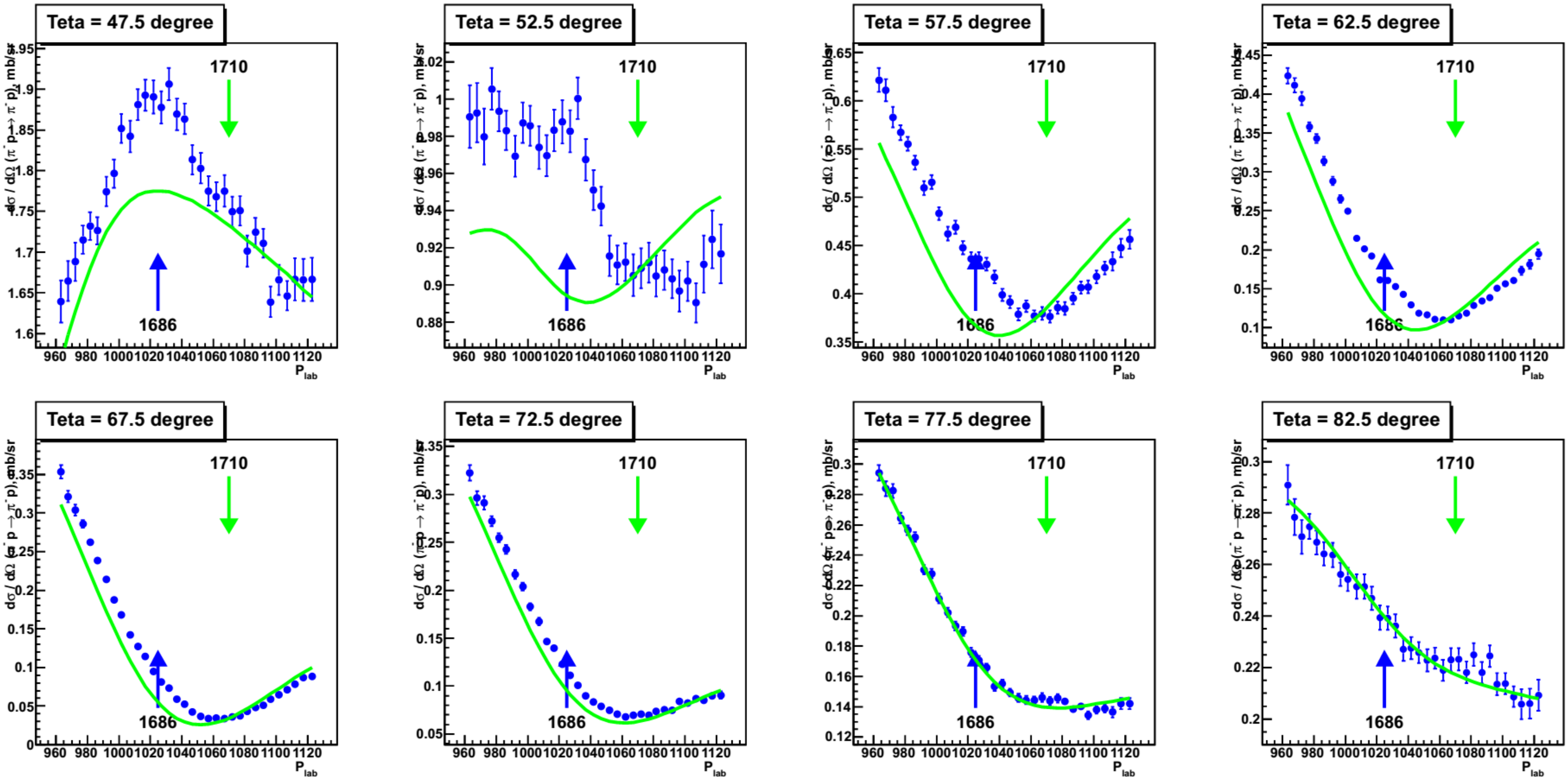
1. The structure of the πN amplitude is much more simpler then in photoproduction

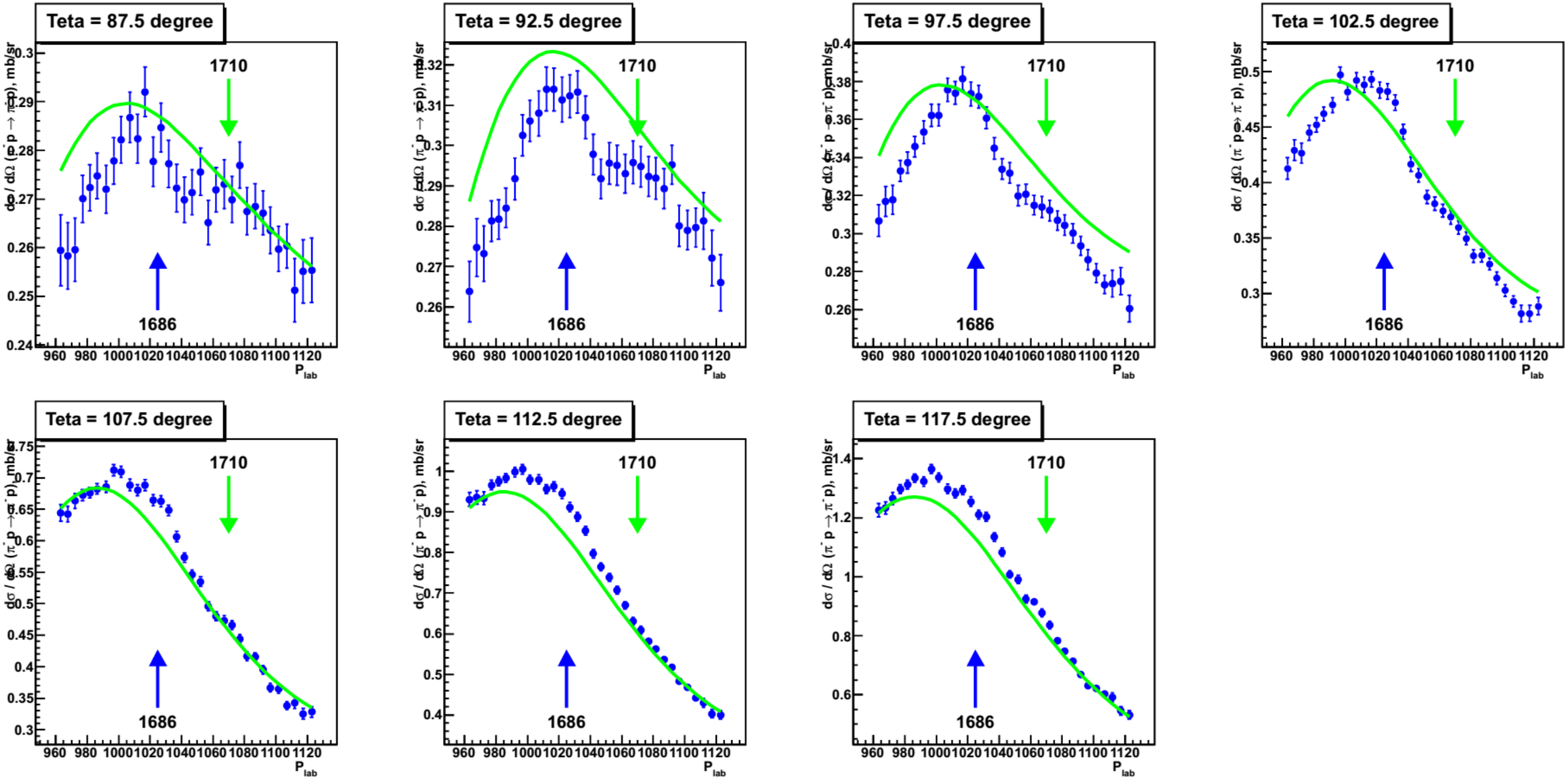
2.The πN partials waves are known very well from phase shift analysis.

3.There is isospin symmetry.

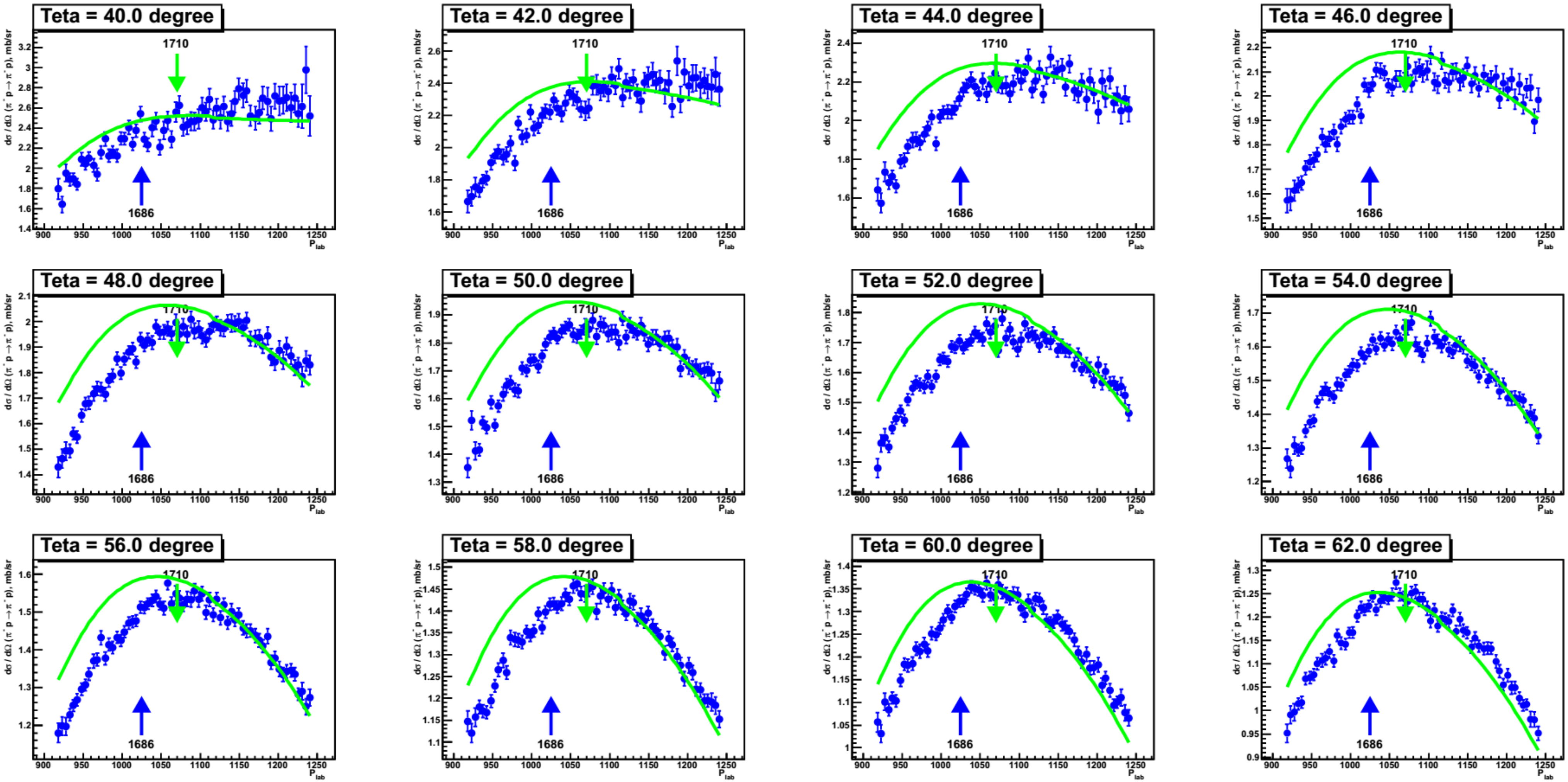
4. The number of free parameters smaller because there is no photocouplings


47.5 deg
dσ/dΩ(mb/sr)
T (MeV)
2.2
2.0
1.8
1.6
1.4
1.2
800
850
900
950
1000

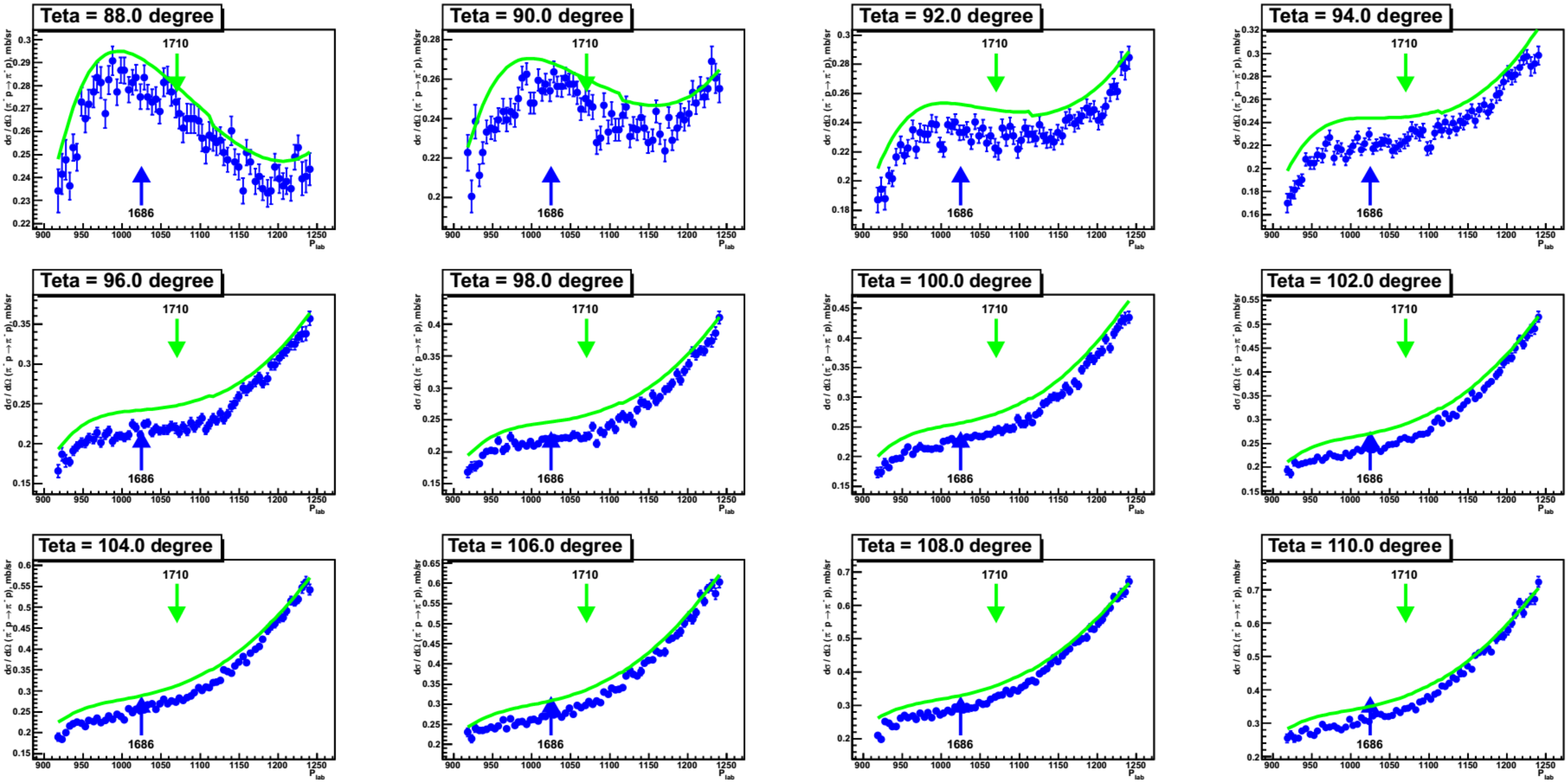

Teta = 47.5 degree
Teta = 52.5 degree
Teta = 57.5 degree
Teta = 62.5 degree
Teta = 67.5 degree
Teta = 72.5 degree
Teta = 77.5 degree
Teta = 82.5 degree
1710
1686
dσ / dΩ (π⁻p → π⁻p), mb/sr
P_lab



Teta = 87.5 degree
Teta = 92.5 degree
Teta = 97.5 degree
Teta = 102.5 degree
Teta = 107.5 degree
Teta = 112.5 degree
Teta = 117.5 degree
1710
1686
dσ / dΩ (π⁻p → π⁻p), mb/sr
P lab



Teta = 40.0 degree
Teta = 42.0 degree
Teta = 44.0 degree
Teta = 46.0 degree
Teta = 48.0 degree
Teta = 50.0 degree
Teta = 52.0 degree
Teta = 54.0 degree
Teta = 56.0 degree
Teta = 58.0 degree
Teta = 60.0 degree
Teta = 62.0 degree
1710
1686
dσ / dΩ (π⁻ p → π⁻ p), mb/sr
P_lab


Teta = 88.0 degree
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Teta = 92.0 degree
Teta = 94.0 degree
Teta = 96.0 degree
Teta = 98.0 degree
Teta = 100.0 degree
Teta = 102.0 degree
Teta = 104.0 degree
Teta = 106.0 degree
Teta = 108.0 degree
Teta = 110.0 degree
1710
1686
dσ / dΩ (π⁻p → π⁻p), mb/sr
P_lab

How we can add resonance and background?

1.Sum of amplitudes $\rightarrow$ *can violate unitarity condition.*

2.Sum of phase shifts $\rightarrow$ *in classical physics it is true for INDEPENDENT sources. Not unique procedure.*

K-matrix approach with effective Lagrangians.

P.F.A. Goudsmit et al Nucl.Phys A575 (1994)673

A.B. Gridnev, N.G. Kozlenko. Eur.Phys.J.A4:187-194, (1999).

T. Feuster and U. Mosel Phys. Rec. C 58 457 (1998).

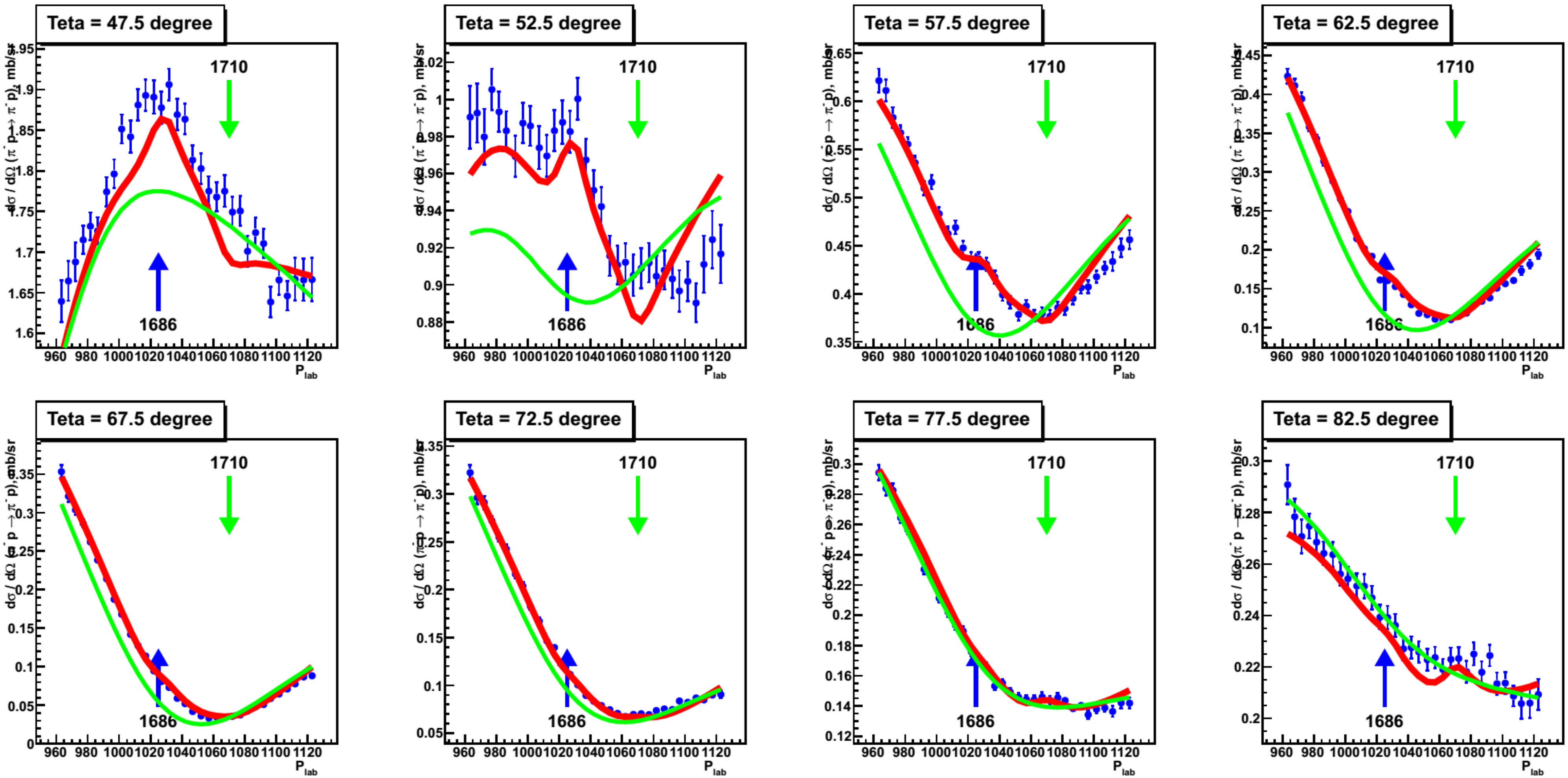
It is assumed that the K-matrix, being a solution of the equation for scattering amplitude, can be considered as a sum of the tree-level Feynman diagrams with the effective Lagrangians in the vertices.

4 resonances in s and u channels and sigma , rho like exchange in t channel.*

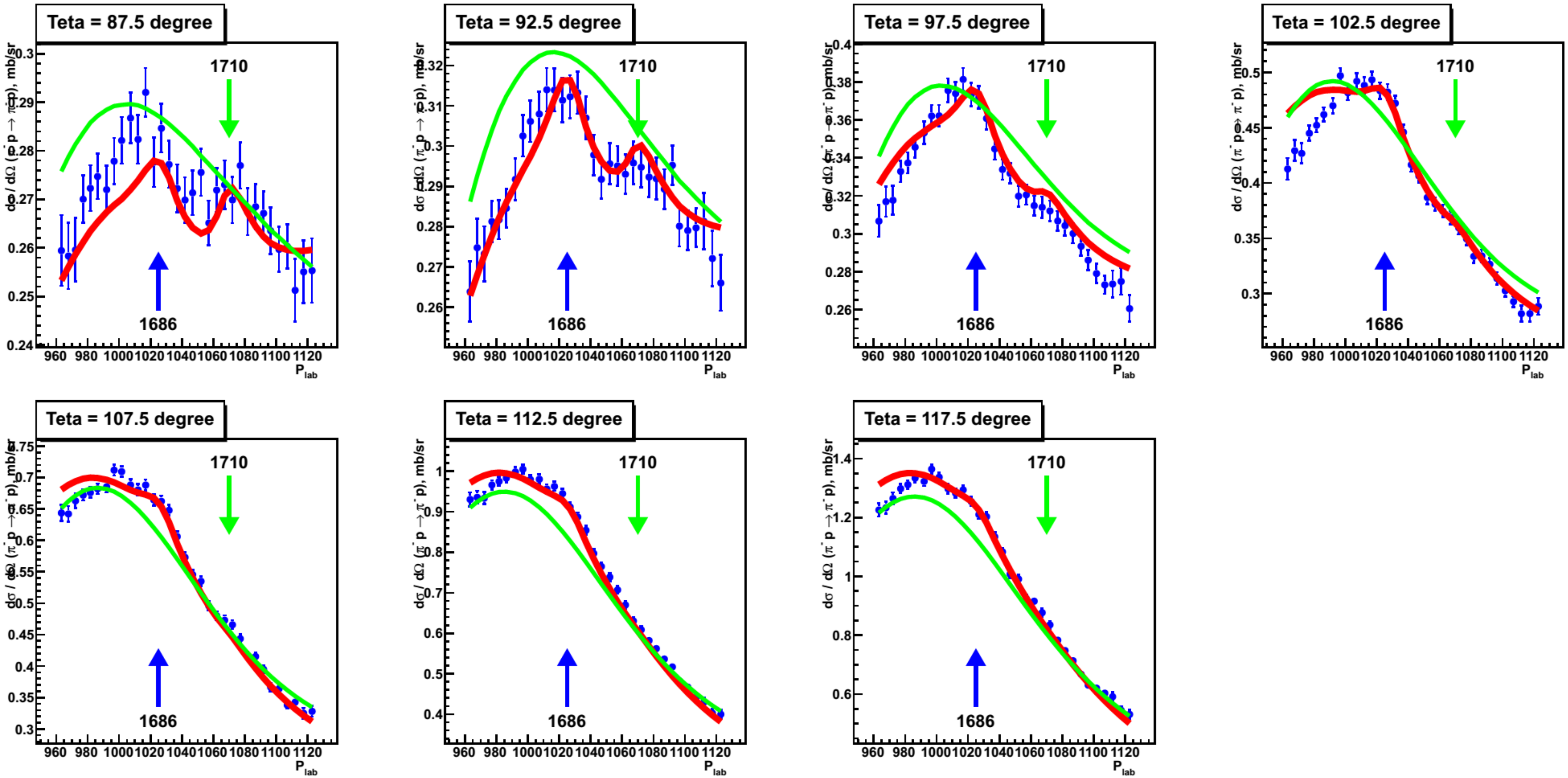
Multichannel:

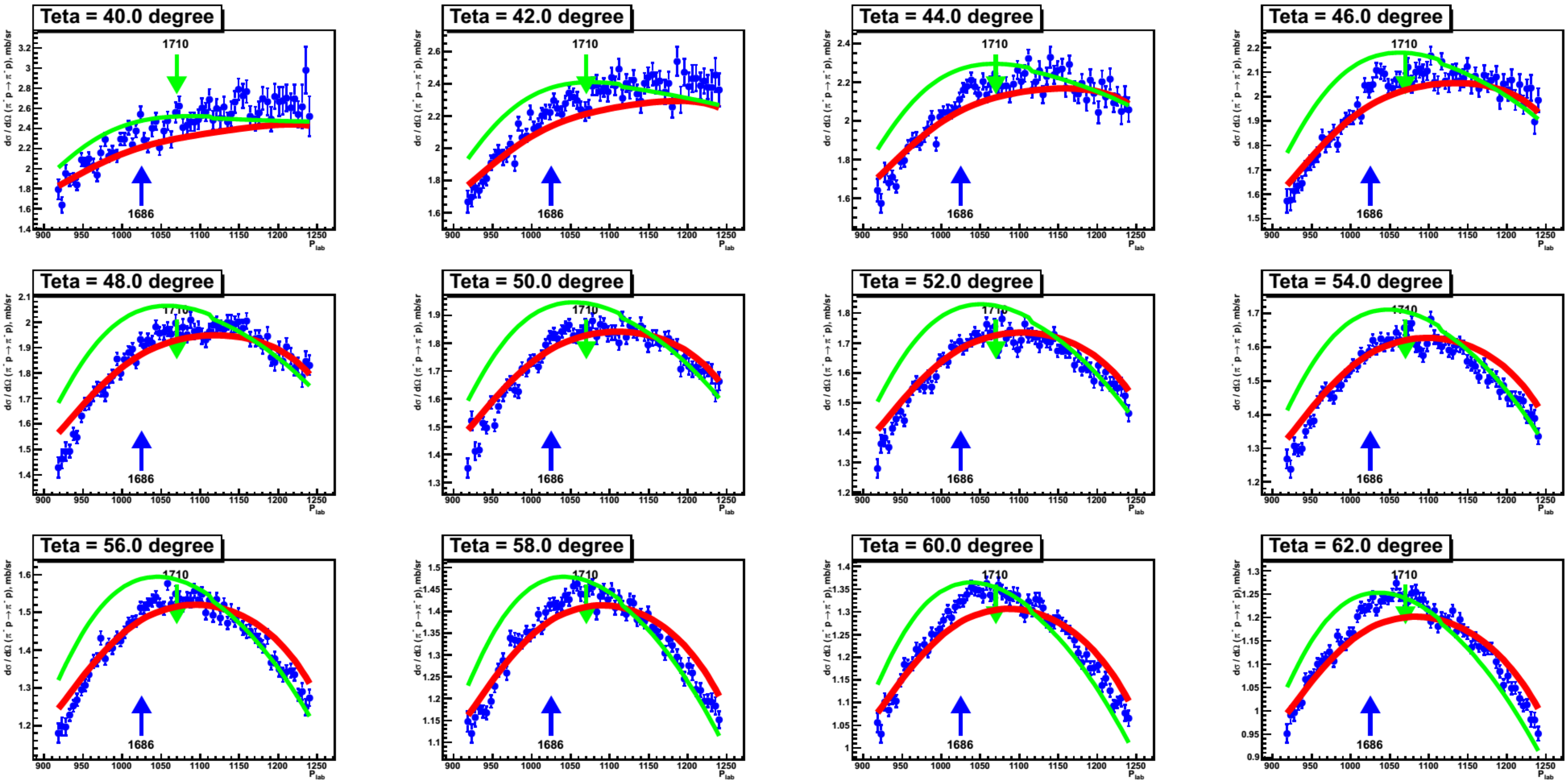
1. *elastic scattering*
2. *two pion production(effective)*
3. *η n production*
4. *K Λ production*
5. *K Σ production*

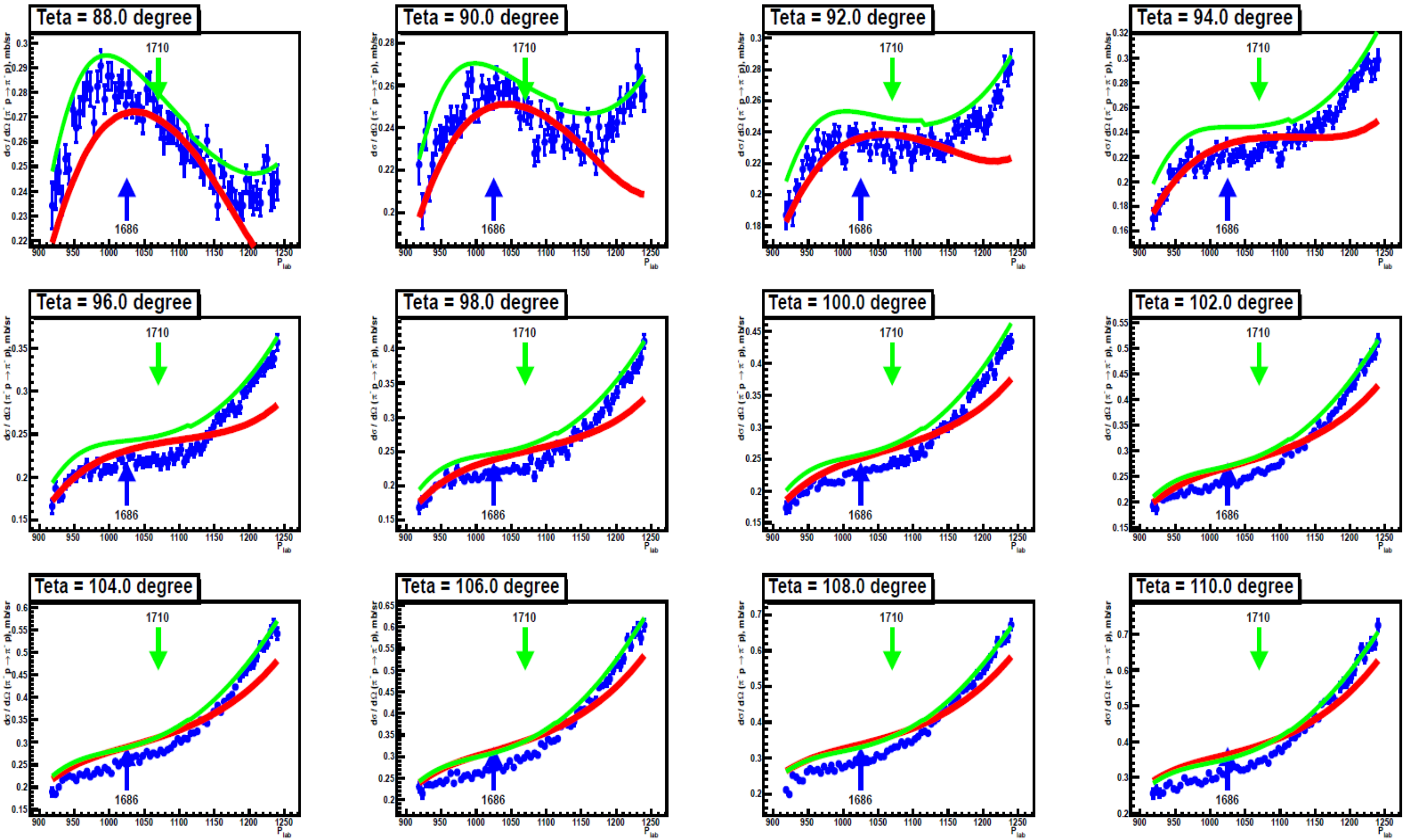
Free parameters → coupling constants.
We concentrate on elastic scattering and treat inelastic channels approximately to save the number of free parameters.
Database:
EPECURE results.
SAID single energy solutions up to 1GeV.
η n total cross section
K Λ differential cross section
K^0 Σ^0 differential cross section
K^+ Σ^+ differential cross section
K^+ Σ^- differential cross section



Teta = 47.5 degree
Teta = 52.5 degree
Teta = 57.5 degree
Teta = 62.5 degree
Teta = 67.5 degree
Teta = 72.5 degree
Teta = 77.5 degree
Teta = 82.5 degree
1710
1686
dσ / dΩ (π⁻p → π⁻p), mb/sr
P_lab
960 980 1000 1020 1040 1060 1080 1100 1120


Teta = 87.5 degree
Teta = 92.5 degree
Teta = 97.5 degree
Teta = 102.5 degree
Teta = 107.5 degree
Teta = 112.5 degree
Teta = 117.5 degree
1710
1686
P_lab
960 980 1000 1020 1040 1060 1080 1100 1120


Teta = 40.0 degree
Teta = 42.0 degree
Teta = 44.0 degree
Teta = 46.0 degree
Teta = 48.0 degree
Teta = 50.0 degree
Teta = 52.0 degree
Teta = 54.0 degree
Teta = 56.0 degree
Teta = 58.0 degree
Teta = 60.0 degree
Teta = 62.0 degree
1710
1686
dσ / dΩ (π⁻p → π⁻p), mb/sr
P_lab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Teta = 90.0 degree
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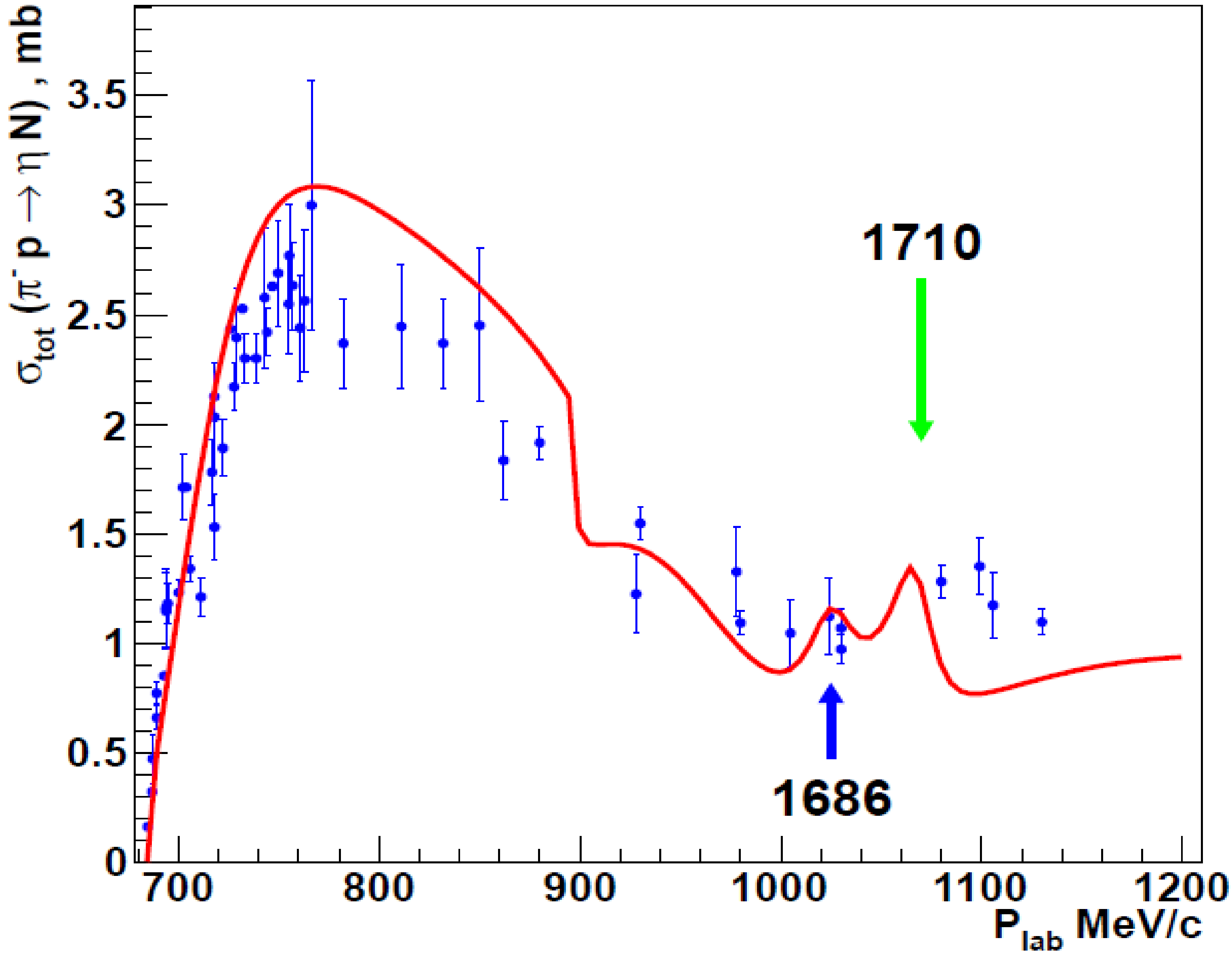
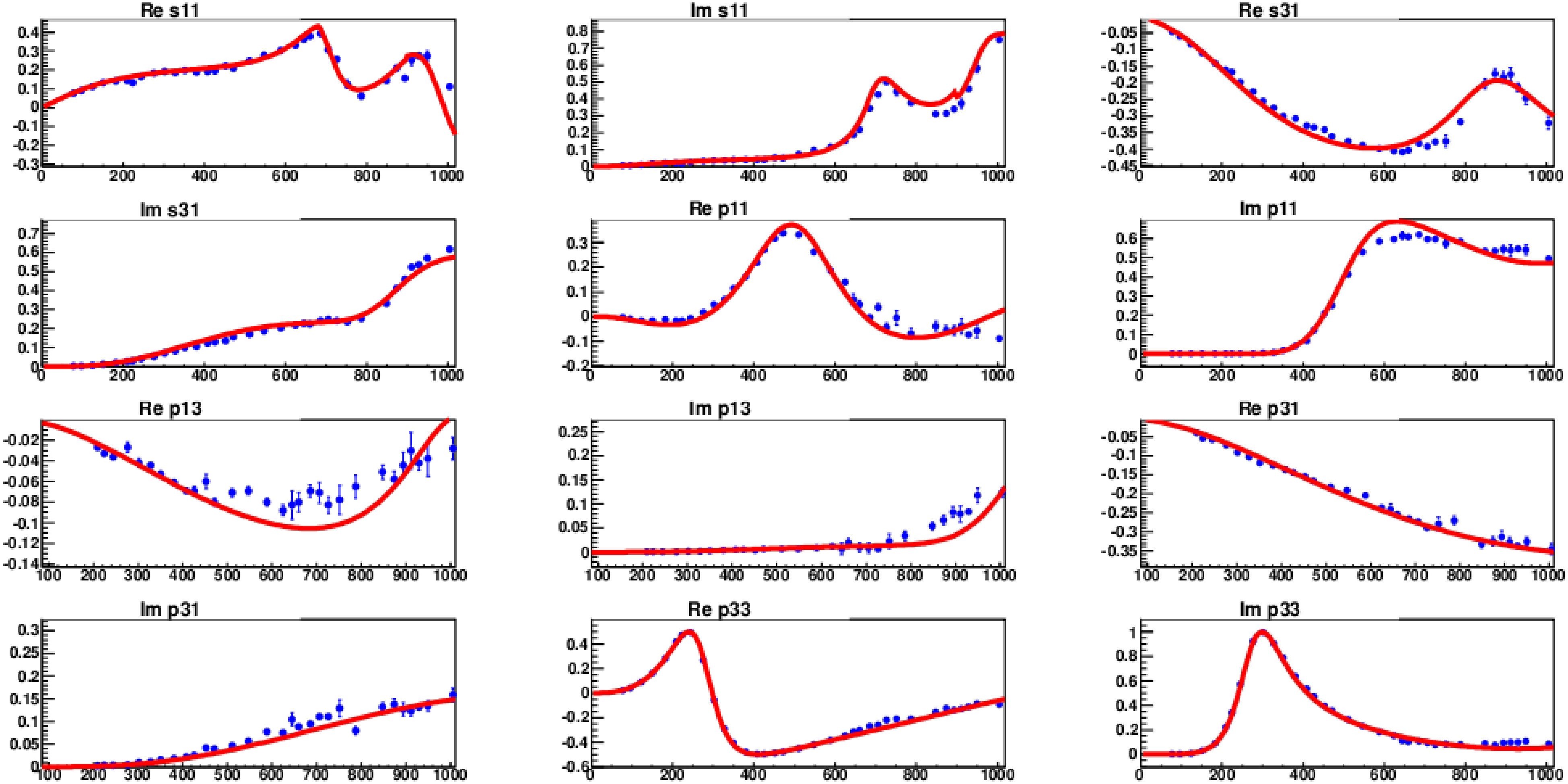
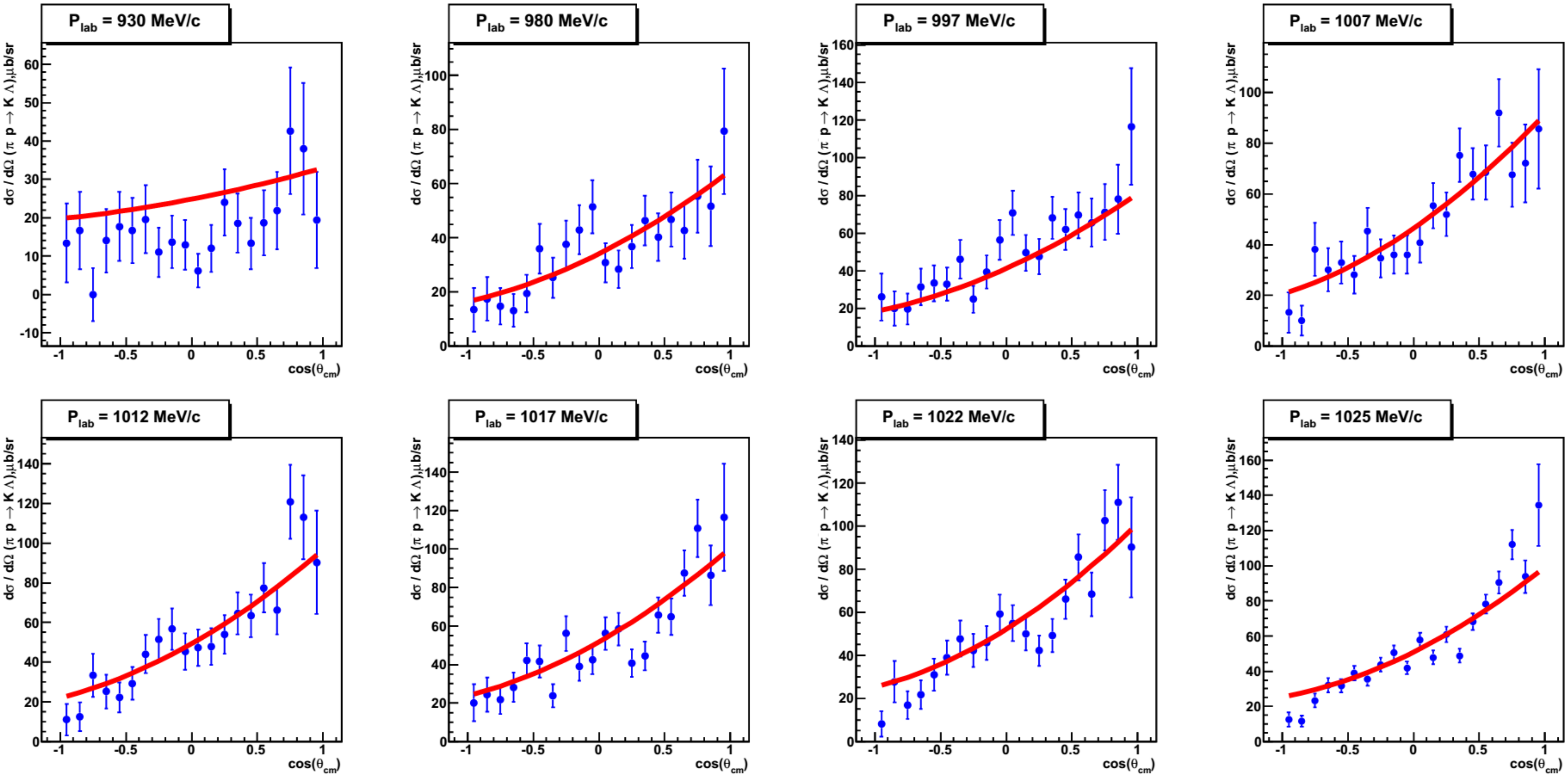
Teta = 94.0 degree
Teta = 96.0 degree
Teta = 98.0 degree
Teta = 100.0 degree
Teta = 102.0 degree
Teta = 104.0 degree
Teta = 106.0 degree
Teta = 108.0 degree
Teta = 110.0 degree
1710
1686
dσ / dΩ (π⁻ p → π⁻ p), mb/sr
P_lab



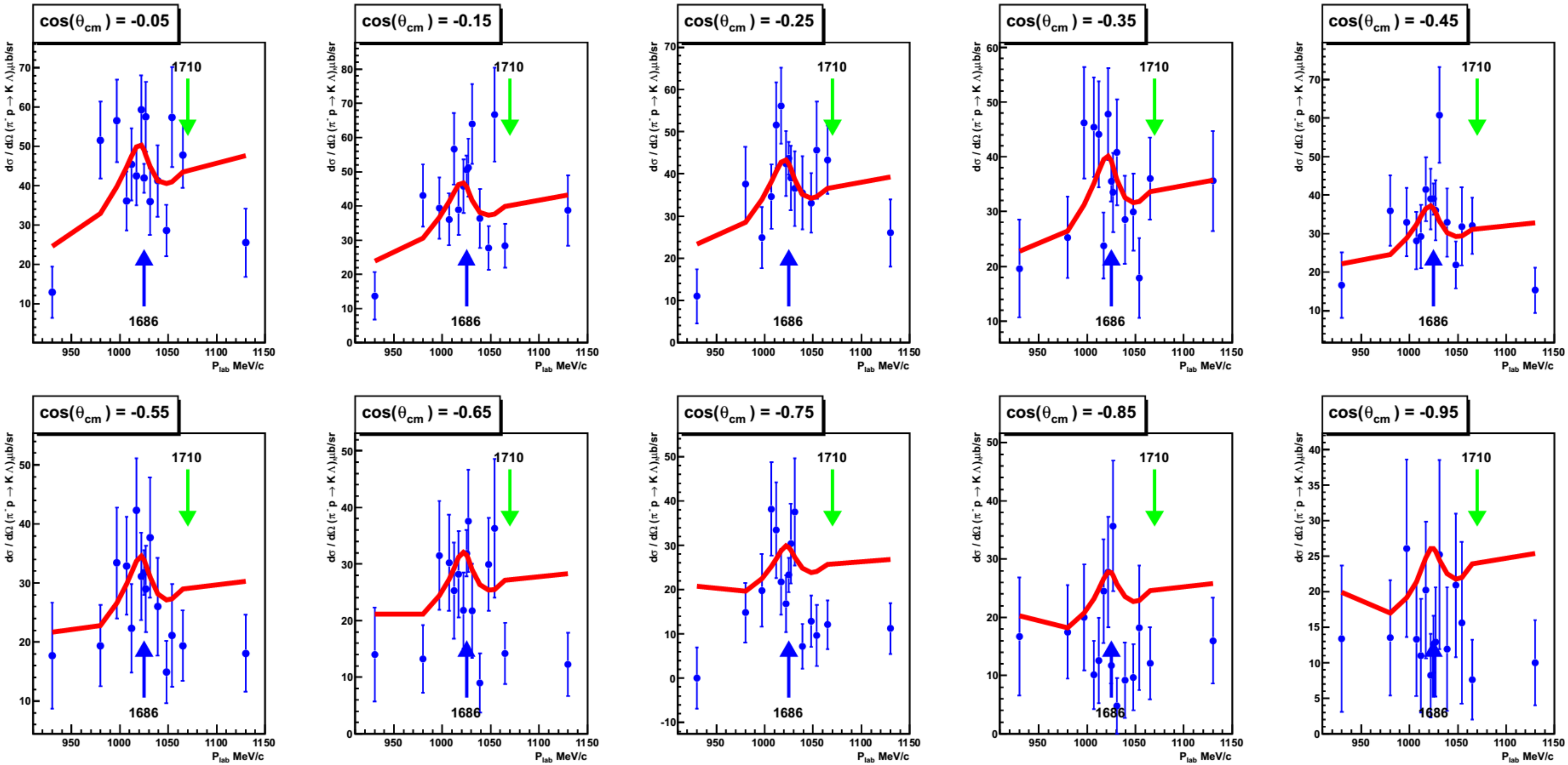
σ_{tot} ($\pi^- p \to \eta N$) , mb
3.5
3
2.5
2
1.5
1
0.5
0
700
800
900
1000
1100
1200
P_{lab} MeV/c
1710
1686

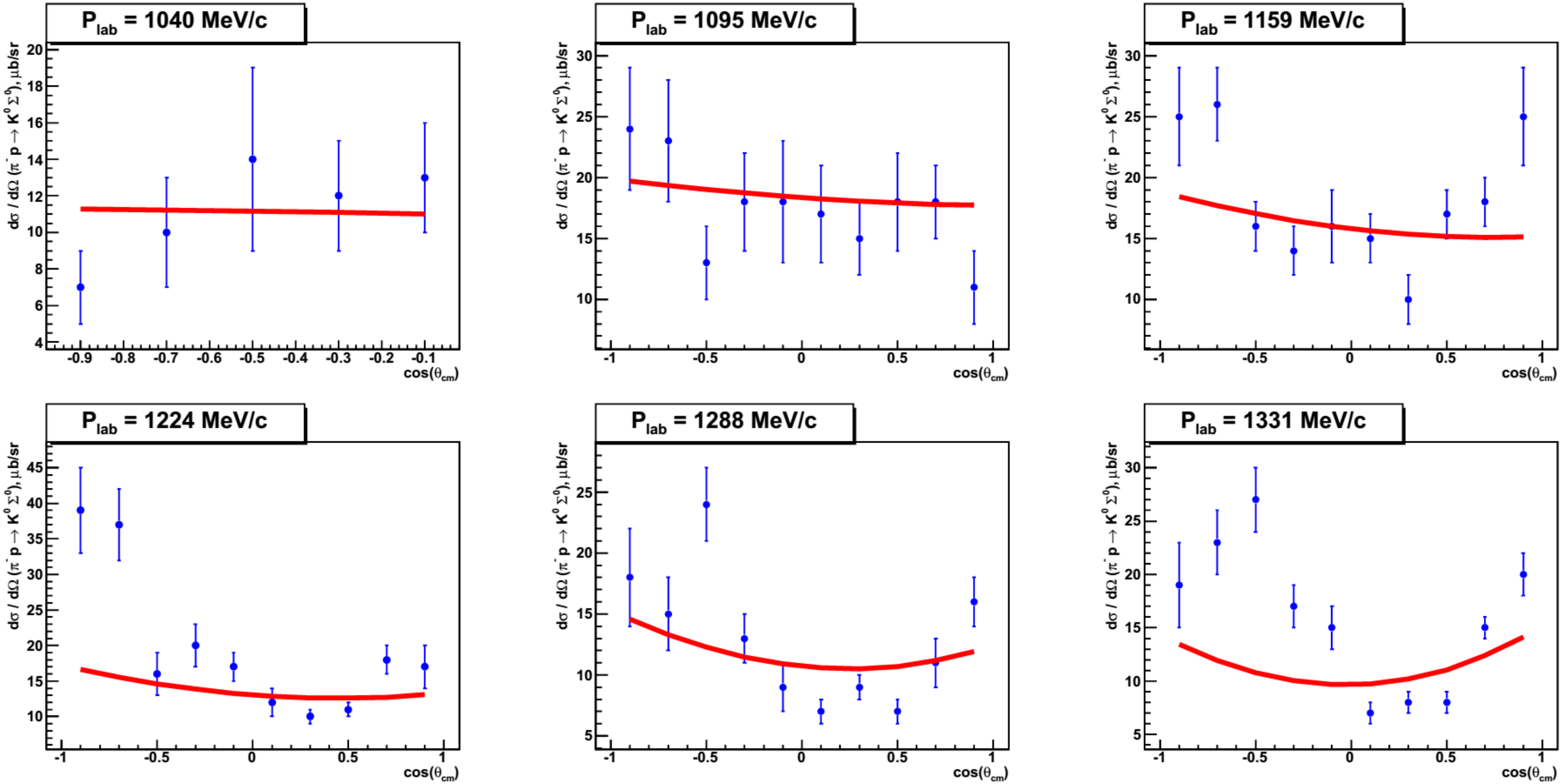
I


Re s11
Im s11
Re s31
Im s31
Re p11
Im p11
Re p13
Im p13
Re p31
Im p31
Re p33
Im p33

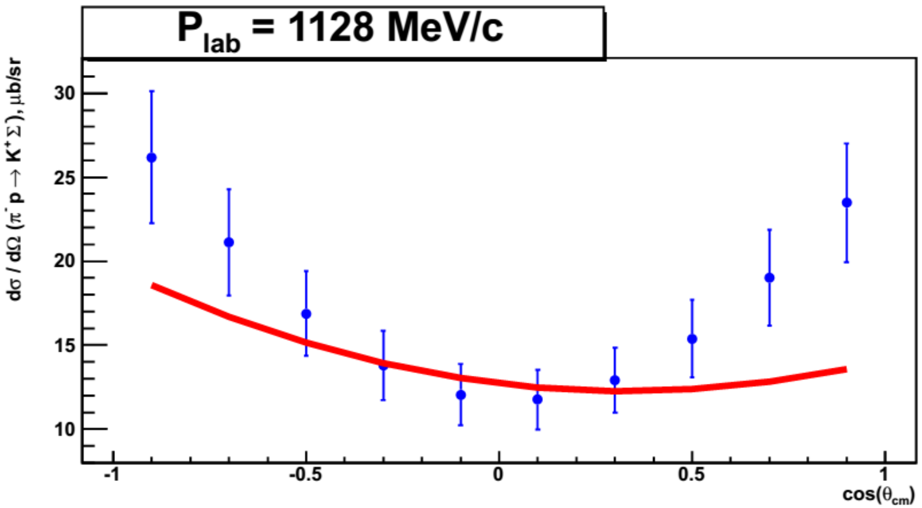


P_lab = 930 MeV/c
P_lab = 980 MeV/c
P_lab = 997 MeV/c
P_lab = 1007 MeV/c
P_lab = 1012 MeV/c
P_lab = 1017 MeV/c
P_lab = 1022 MeV/c
P_lab = 1025 MeV/c
dσ / dΩ (π⁻ p → K Λ),μb/sr
cos(θ_cm)

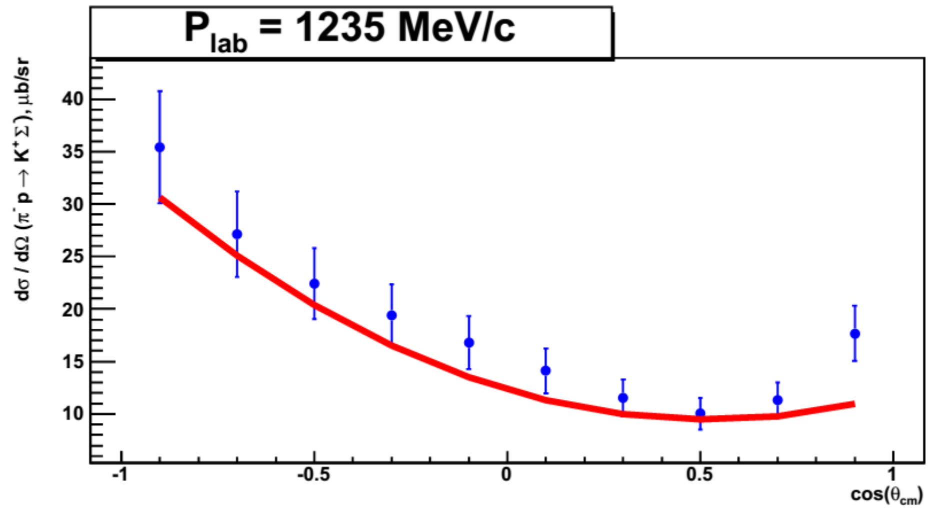

cos(θcm) = -0.05
cos(θcm) = -0.15
cos(θcm) = -0.25
cos(θcm) = -0.35
cos(θcm) = -0.45
cos(θcm) = -0.55
cos(θcm) = -0.65
cos(θcm) = -0.75
cos(θcm) = -0.85
cos(θcm) = -0.95
1710
1686
dσ / dΩ (π⁻ p → K Λ) μb/sr
Plab MeV/c



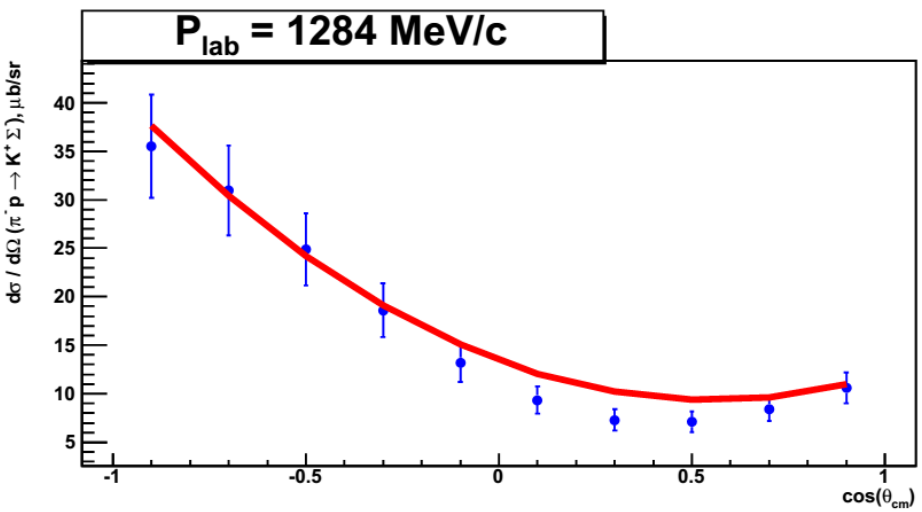
P_lab = 1040 MeV/c
P_lab = 1095 MeV/c
P_lab = 1159 MeV/c
P_lab = 1224 MeV/c
P_lab = 1288 MeV/c
P_lab = 1331 MeV/c
dσ / dΩ (π⁻p → K⁰Σ⁰), μb/sr
cos(θ_cm)



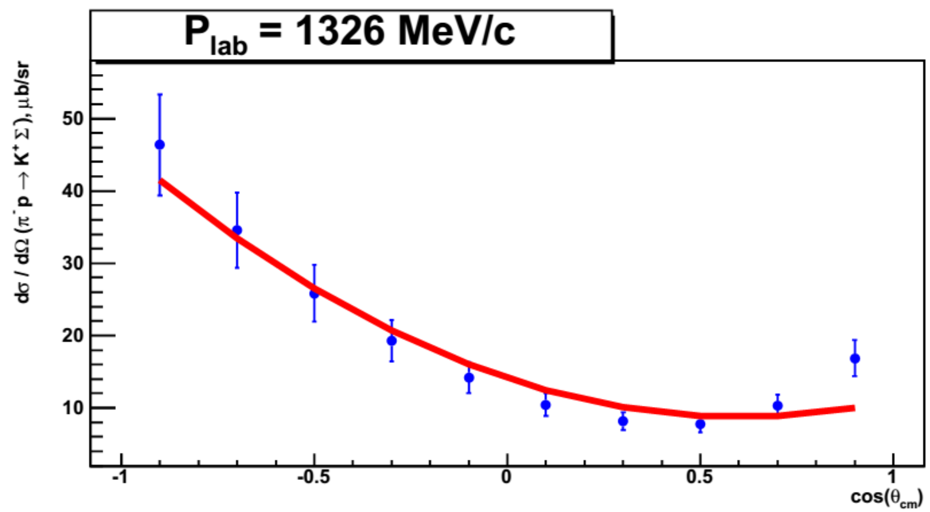
P_lab = 1128 MeV/c
dσ / dΩ (π⁻p → K⁺Σ), μb/sr
cos(θ_cm)



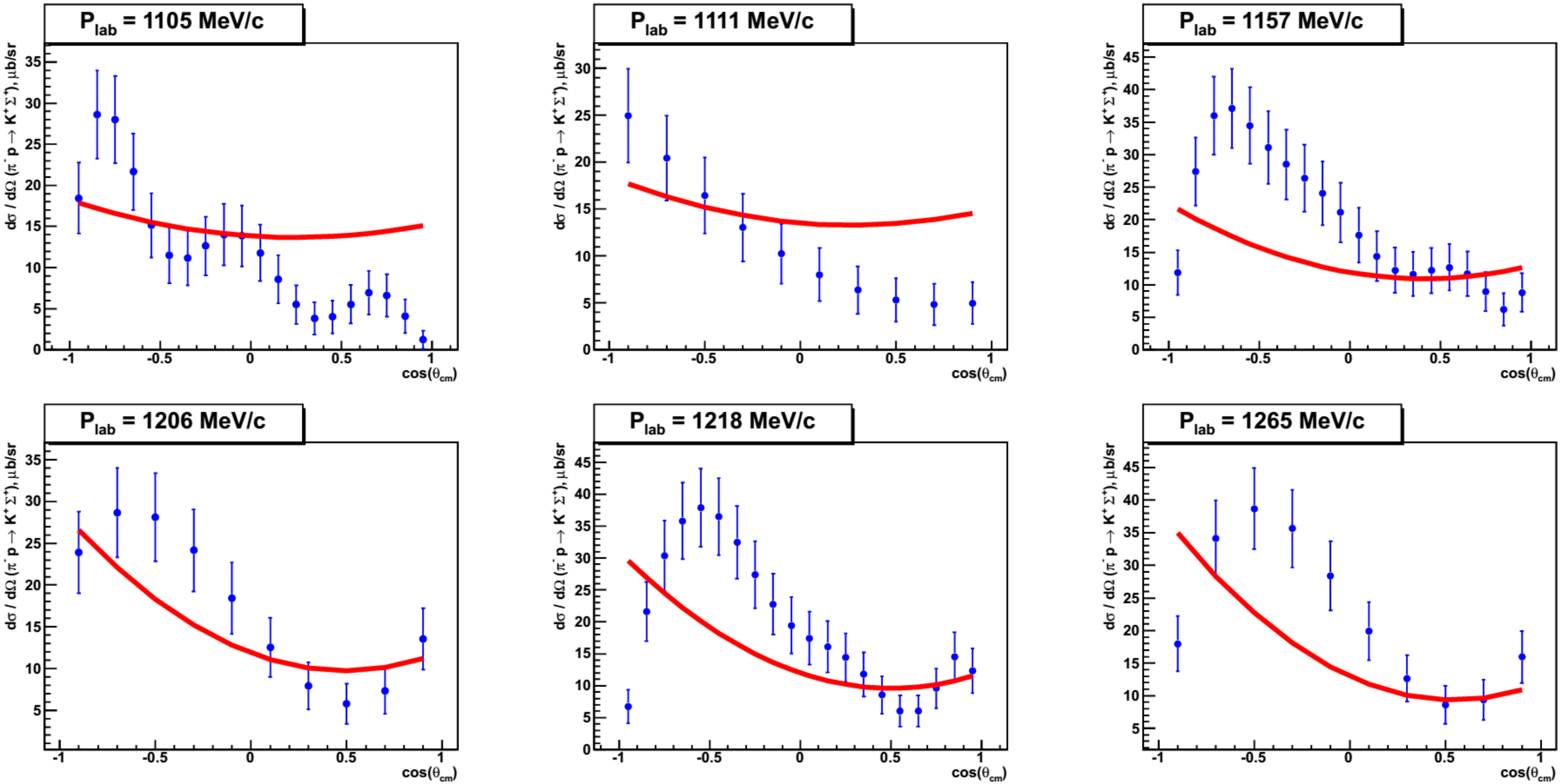
P_lab = 1235 MeV/c
dσ / dΩ (π⁻p → K⁺Σ), μb/sr
cos(θ_cm)



P_lab = 1284 MeV/c
dσ / dΩ (π⁻p → K⁺Σ), μb/sr
cos(θ_cm)



P_lab = 1326 MeV/c
dσ / dΩ (π⁻p → K⁺Σ), μb/sr
cos(θ_cm)



P_lab = 1105 MeV/c
P_lab = 1111 MeV/c
P_lab = 1157 MeV/c
P_lab = 1206 MeV/c
P_lab = 1218 MeV/c
P_lab = 1265 MeV/c
dσ / dΩ (π⁻ p → K⁺ Σ⁺), μb/sr
cos(θcm)

Very preliminary

S11

$M=1686(1.5)$

$\Gamma_{tot}=18.2\ MeV$

$\Gamma_{el}=0.1\ MeV$

$\Gamma_{2\pi}=10.0\ MeV$

$\Gamma_{\eta n}=8.0\ MeV$

$\Gamma_{K\Lambda}=0.1\ MeV$

P11

$M=1710(2.0)$

$\Gamma_{tot}=25.0\ MeV$

$\Gamma_{el}=0.25\ MeV$

$\Gamma_{2\pi}=10.0\ MeV$

$\Gamma_{\eta n}=5.1\ MeV$

$\Gamma_{K\Lambda}=0.25\ MeV$

$\Gamma_{K\Sigma}=9.0\ MeV$

$M=1686 \quad S11 \rightarrow P11 \rightarrow \chi^2 \uparrow 15\%$

$M=1710 \quad P11 \rightarrow S11 \rightarrow \chi^2 \uparrow 25\%$

Another explanations (for η photoproduction)

1.Interference effects.

Interference of well-known resonances

Interference of S11(1650) and P11(1710) .

V. Shklyar, H. Lenske , U. Mosel , PLB650 (2007) 172 (Giessen group)

Interference of S11(1535) and S11(1650) .

A. Anisovich et al. EPJA 41, 13 (2009) (Bonn-Gatchina group);

We not found such solution

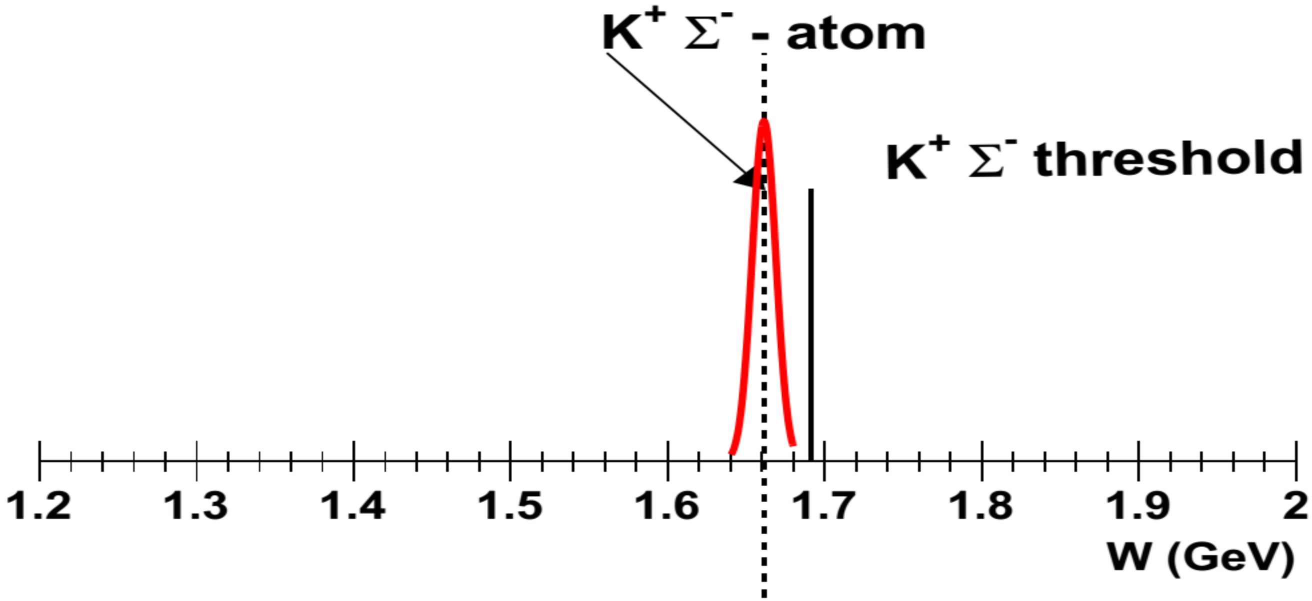
2.Cusp effect

M.Doring, K. Nakayama, PLB B683:145 (2010)

We are working on this possibility

The electromagnetic effects.

π^- p elastic , γ n $\rightarrow \eta$ n



Experimental check:

$$\pi^- p \rightarrow elastic, \;\; \eta\, n, \;\; k\,\Lambda.$$

Isospin symmetry

$$\pi^+ n \rightarrow elastic, \;\; \eta\, n, \;\; k\,\Lambda.$$

Благодарю за внимание!