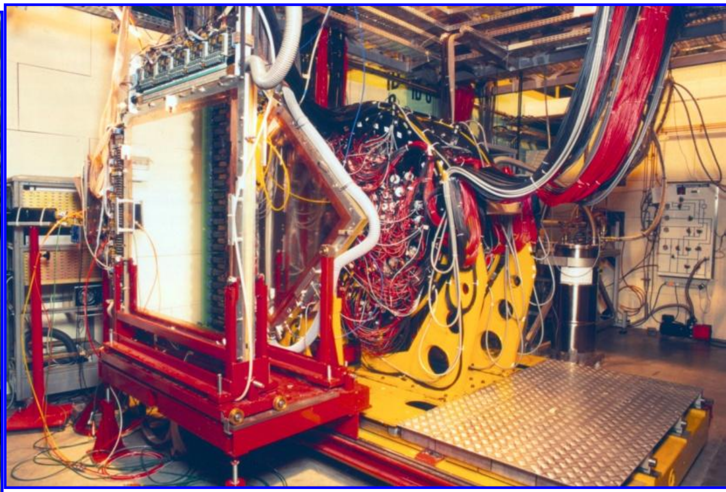
Updates on N*(1685)





Viacheslav Kuznetsov,
In collaboration with Nuclear Physics Group of Catania University
(V. Bellini, F. Mammoliti et al.,) and
Maxim Polyakov

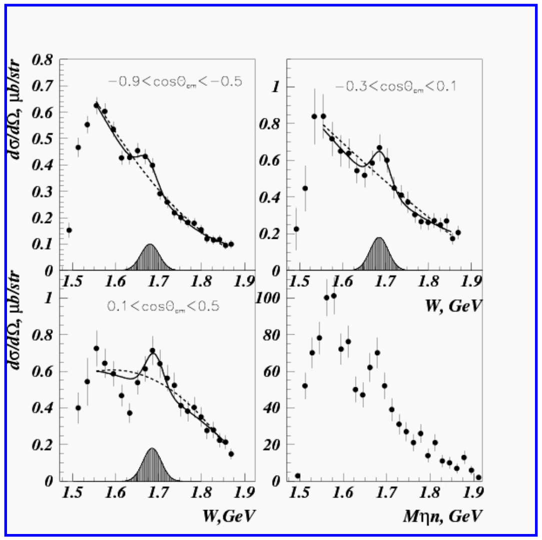
HEPD Session, PNPI, December 26 2016.

Narrow bump-like structure at W=1.68 GeV in quasi-free η photoproduction on the neutron

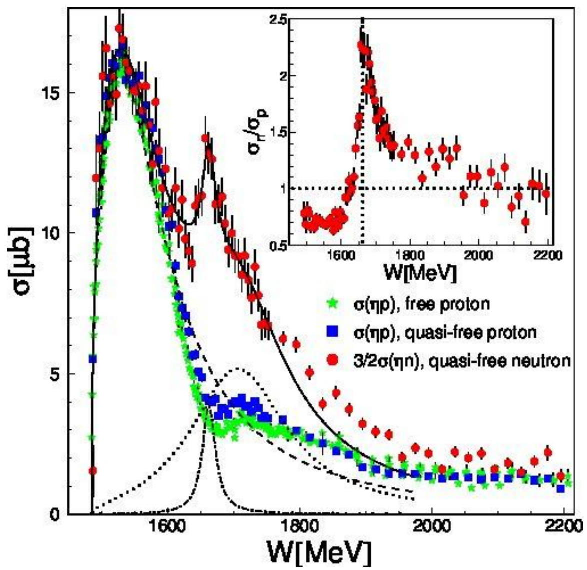
γ + n→η + n

V.Kuznetsov et al.,

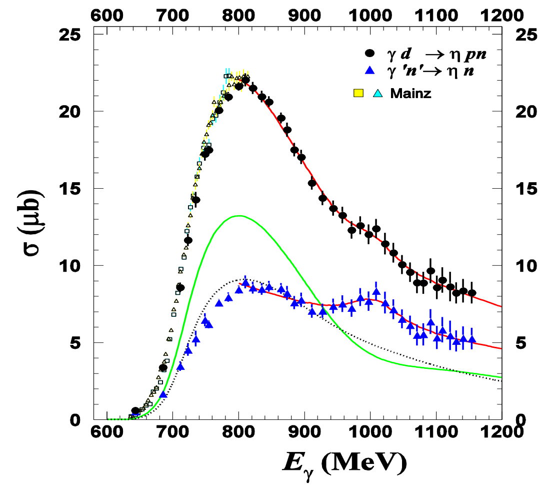
Phys. Lett. B**647**, 23, 2007(hep-ex/0606065)

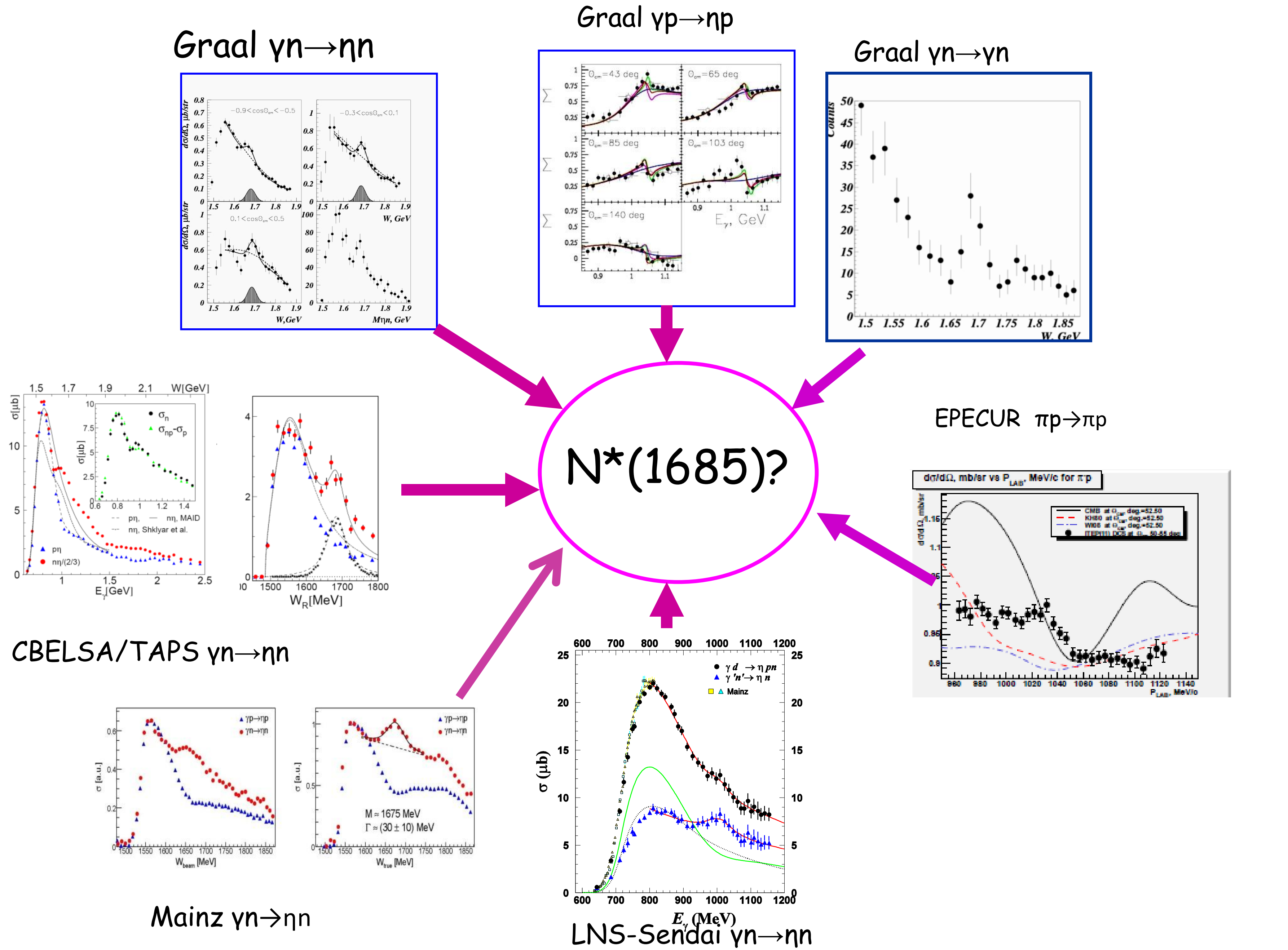


CBELSA/TAPS, J.Jeagle et al,
EPJA **47**, 89 (2011)



F.Miyahara et al., Prog. Theor. Phys. Suppl. **168**, 90, 2007




Graal γn→ηn
Graal γp→ηp
Graal γn→γn
N*(1685)?
EPECUR πp→πp
CBELSA/TAPS γn→ηn
Mainz γn→ηn
LNS-Sendai γn→ηn
M ≈ 1675 MeV
Γ ≈ (30 ± 10) MeV

Putative N*(1685) resonance: Review of observations

Citation: J. Beringer *et al.* (Particle Data Group), PR **D86**, 010001 (2012) (URL: http://pdg.lbl.gov)

$N(1685)\ ?^?$

$I(J^P) = \frac{1}{2}(?^?)$ Status: $*$

OMITTED FROM SUMMARY TABLE

There is a small literature (which we do not try to cover) on this possible narrow state. See KUZNETSOV 11A, MART 11, and the other papers for further references. This state does not gain status by being a sought-after member of a baryon anti-decuplet.

N(1685) MASS

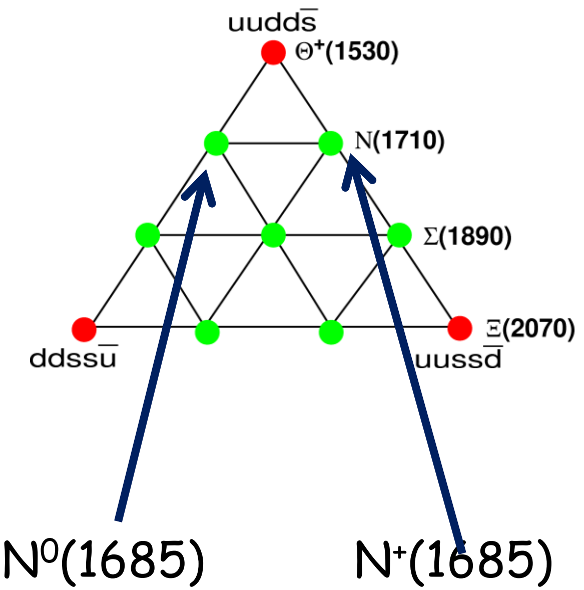
VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
~ 1670	JAEGLE	11	CBTP	$\gamma d \to \eta n\ (p)$
~ 1685	KUZNETSOV	11	GRAL	$\gamma d \to \gamma n\ (p)$
~ 1680	KUZNETSOV	07	GRAL	$\gamma d \to \eta n\ (p)$

N(1685) WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
~ 25	JAEGLE	11	CBTP	$\gamma d \to \eta n\ (p)$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
<30	KUZNETSOV	11	GRAL	$\gamma d \to \gamma n\ (p)$
<30	KUZNETSOV	07	GRAL	$\gamma d \to \eta n\ (p)$

N(1685) REFERENCES

JAEGLE	11	EPJ A47 89	I. Jaegle *et al.*	(CBELSA/TAPS Collab.)
Also		PRL 100 252002	I. Jaegle *et al.*	(CBELSA/TAPS Collab.)
KUZNETSOV	11	PR C83 022201	V. Kuznetsov *et al.*	(GRAAL Collab.)
KUZNETSOV	11A	JETPL 94 503	V. Kuznetsov, M.V. Polyakov, M. Thurmann	(INRM+)
MART	11	PR D83 094015	T. Mart	(U. Indonesia)
KUZNETSOV	07	PL B647 23	V. Kuznetsov *et al.*	(GRAAL Collab.)



Interpretations:

Interference of Known resonances V. Shklyar, H. Lenske , U. Mosel , PLB650 (2007) 172 (Giessen group): A. Anisovich et al. EPJA 41, 13 (2009), hep-ph/0809.3340 (Bonn-Gatchina group); X.-H. Zong and Q.Zhao, Arxiv:1106.2892 and several other publications…

- **Intermediate sub-threshold meson-nucleon state**

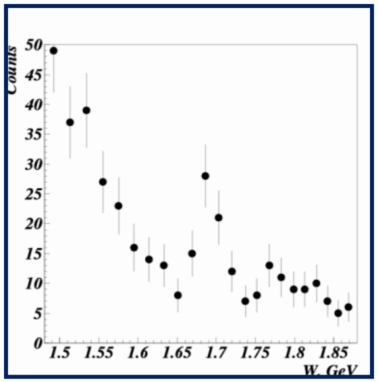
M.Doring, K. Nakayama, PLB683, 145 (2010), nucl-th/0909.3538

Narrow resonance

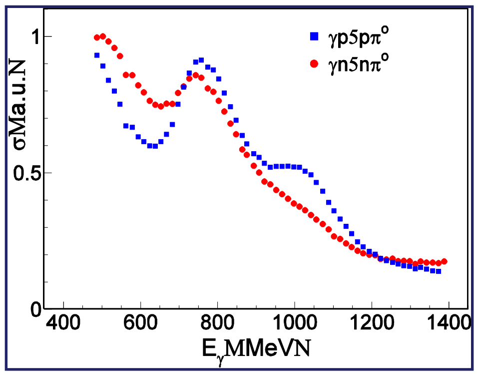
•Y.Azimov, V.Kuznetsov, M.Polaykov, and I.Strakovsky, Eur. Phys. J. A **25**, 325, 2005.
•A.Fix, L.Tiator, and M.Polyakov, Eur. Phys. J. A **32**, 311, 2007.
•K.S.Choi, S.I. Nam, A.Hosaka, and H-C.Kim, Phys. Lett. B **636**, 253, 2006.
•K.S.Choi, S.I. Nam, A.Hosaka, and H-C.Kim, Prog. Theor. Phys. Suppl. **168**, 97, 2008.
•G.S.Yang, H.S.Kim, Arxiv:1204.5644
•Etc…

Questions concerning the interpretation of neutron anomaly in terms of the interference of well-known resonances or as the "cusp effect".

V.Kuznetsov et al., Phys.Rev. C83 (2011) 022201



M. Dieterle et al., Phys.Rev.Lett. 112 (2014), 142001



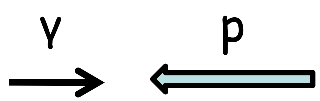
One major challenge for this interpretation is the observation of a narrow enhancement at W~1.68 GeV in Compton scattering on the neutron (γn→γn),

The observation of the peak in Compton scattering on the neutron is in fact makes it questionable the interpretation of the neutron anomaly in terms of interference known resonances of as the cusp effect. It is unclear if these phenomena can generate a peak in eta photoproduction, which is governed by isospin-1/2 resonances, simultaneously genenerate the same peak in Compton scattering, which is governed by isospin-1/2 and isospin-3/2 resonances, and generate neither of peak in pion photoproduction on the neutron, which is governed by the same resonances as Compton scattering.

New Results from the A2@MaMi Collaboration

Measurements of *helicity dependent* $\sigma_{1/2}$ *and* $\sigma_{3/2}$ *cross sections*

L.Witthauer et al., PRL 117, 132502 (2016)



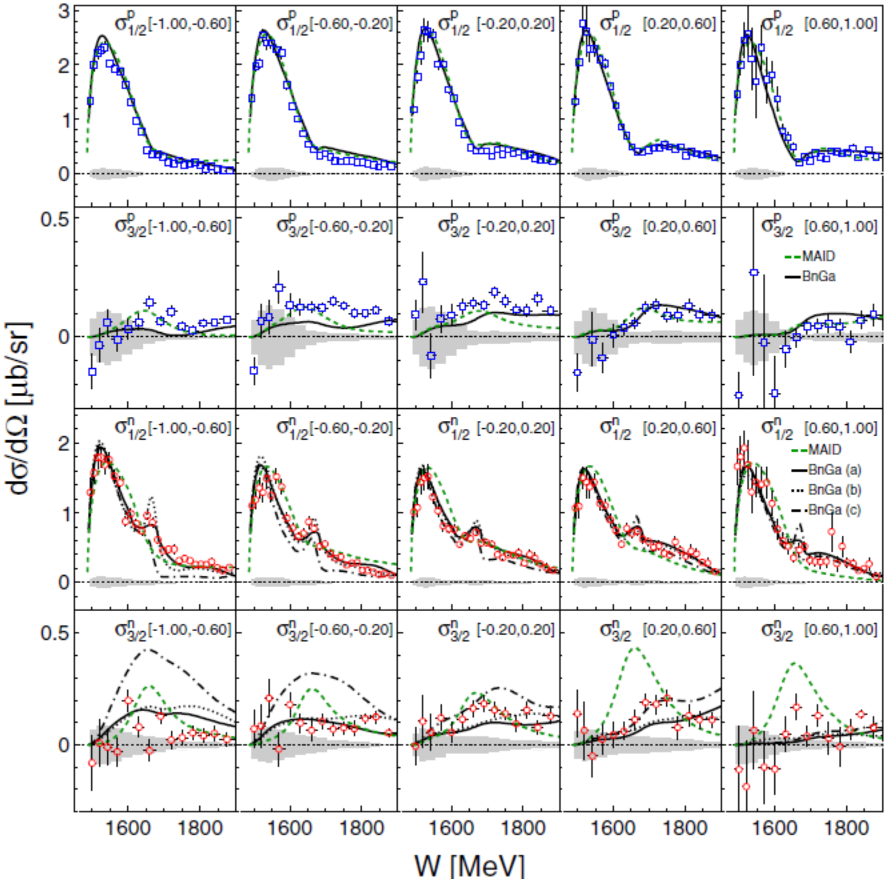
$\sigma_{1/2}$

Includes S11 and P11 waves

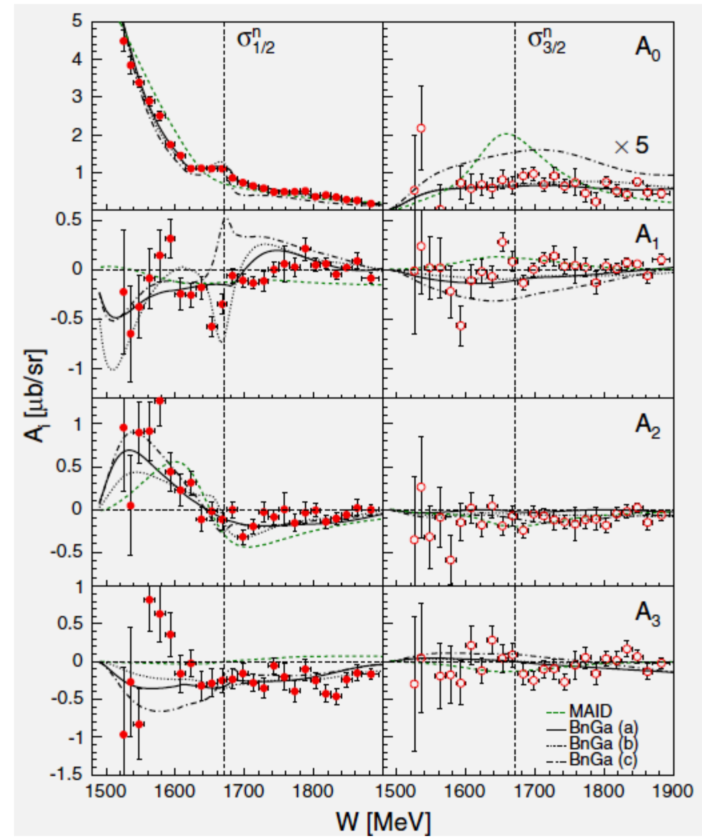
$\sigma_{3/2}$

No S11 and P11 waves

$\sigma_{1/2}$ and $\sigma_{3/2}$



Legendre decomposition



Narrow structure at W~1.68 GeV is generated by the interference of S11 and P11 waves. BnGa solution with the interference of known resonances does not fit the data. *BnGa solution which includes the narrow P11 resonance with the negative $A_{1/2}$ coupling reproduces well the data.*

Search for N*(1685) resonances in

$\gamma p \rightarrow \pi^0 \eta p$

$\gamma p \rightarrow \pi^- \eta n$

$\gamma d \rightarrow \pi^+ \eta n(p)$

$\gamma d \rightarrow \pi^0 \eta p(n)$

$\gamma d \rightarrow \pi^- \eta p(n)$

$\gamma d \rightarrow \pi^0 \eta n(p)$

There are three modes for the reaction

$$\gamma N \to \pi\eta N$$

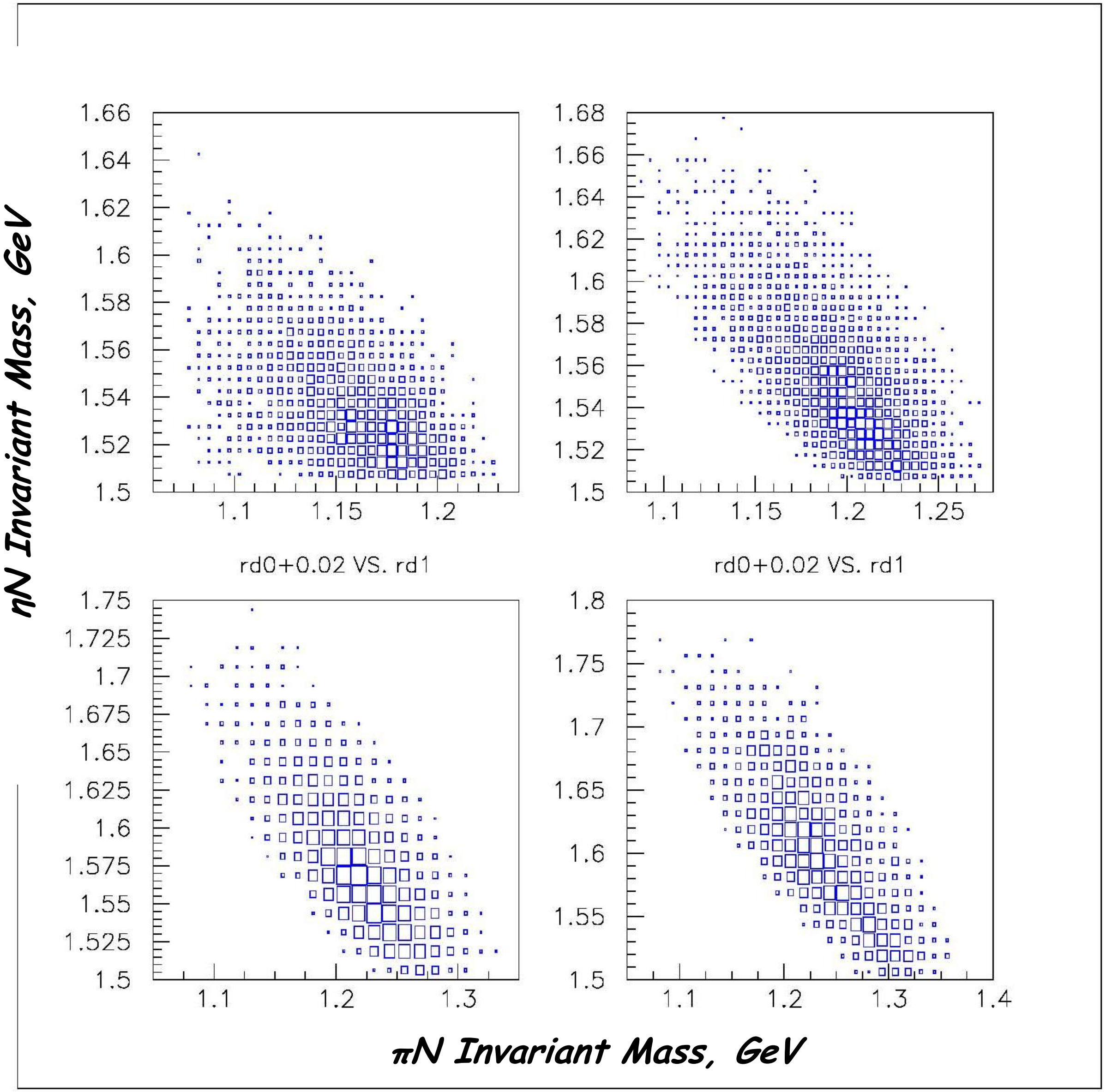
$$\gamma N \to \pi(\eta N) \quad \gamma N \to \eta(\pi N) \quad \gamma N \to (\pi\eta)N$$

The details of the analysis shown below correspond to the
$\gamma p \to \pi^0\eta p$ reaction (as an example).

(ηp) Invariant Mass vs (πp) Invariant Mass

0.9 – 1.2 GeV

1.2 – 1.3 GeV

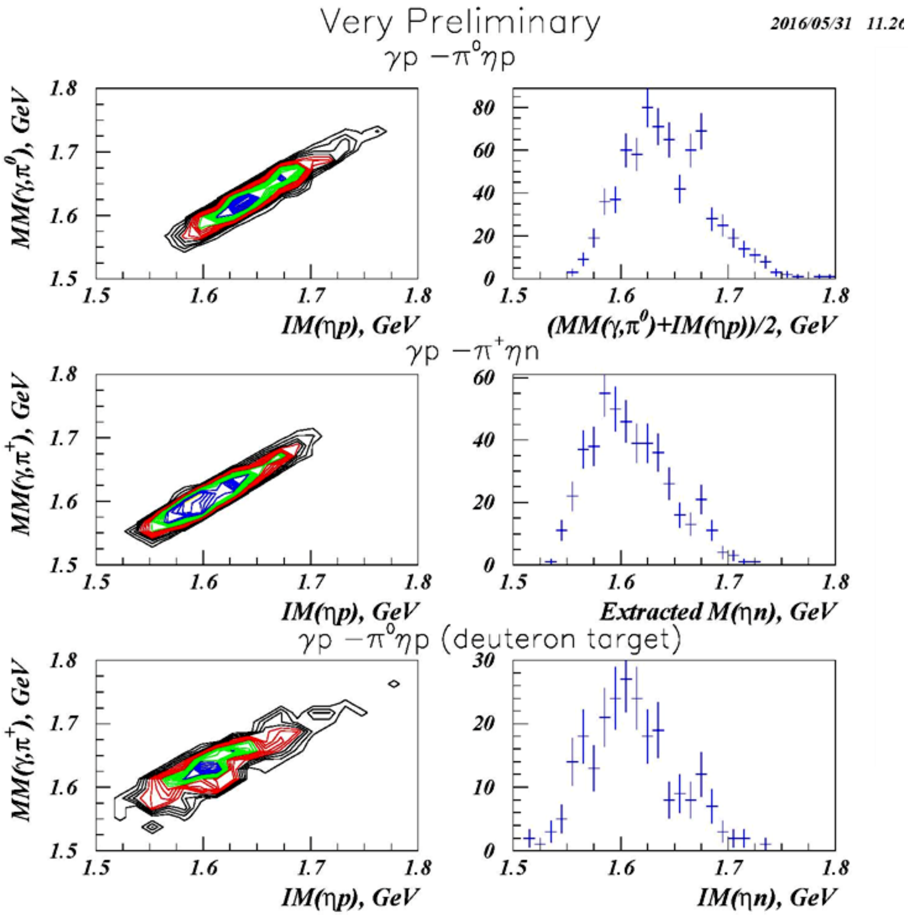


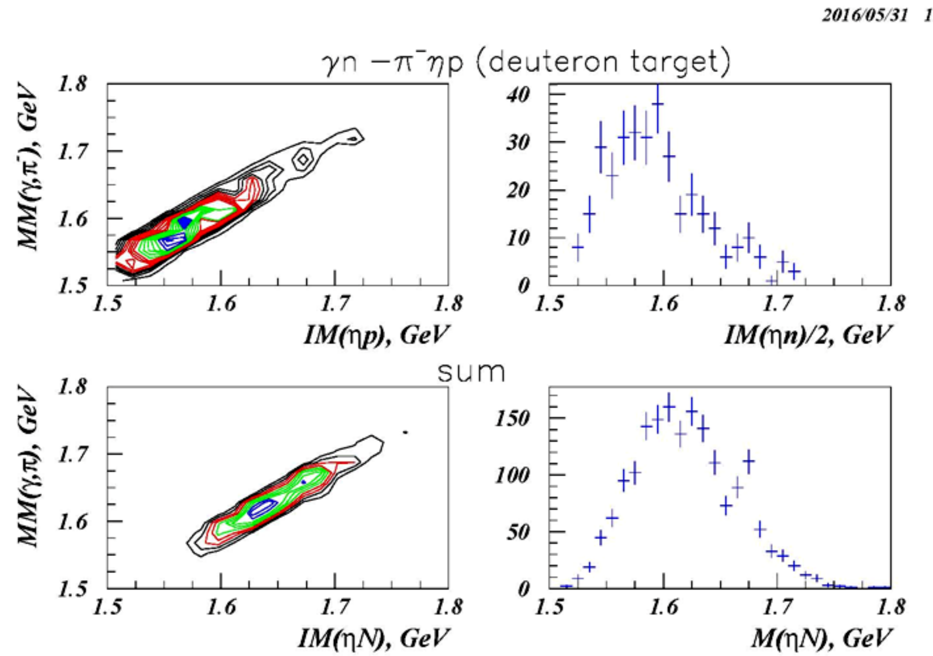
1.3 – 1.4 GeV

1.4 – 1.5 GeV

Region of Interest!

Observation of possible N+(1685) and N0(1685) resonances in γN→πηN reactions

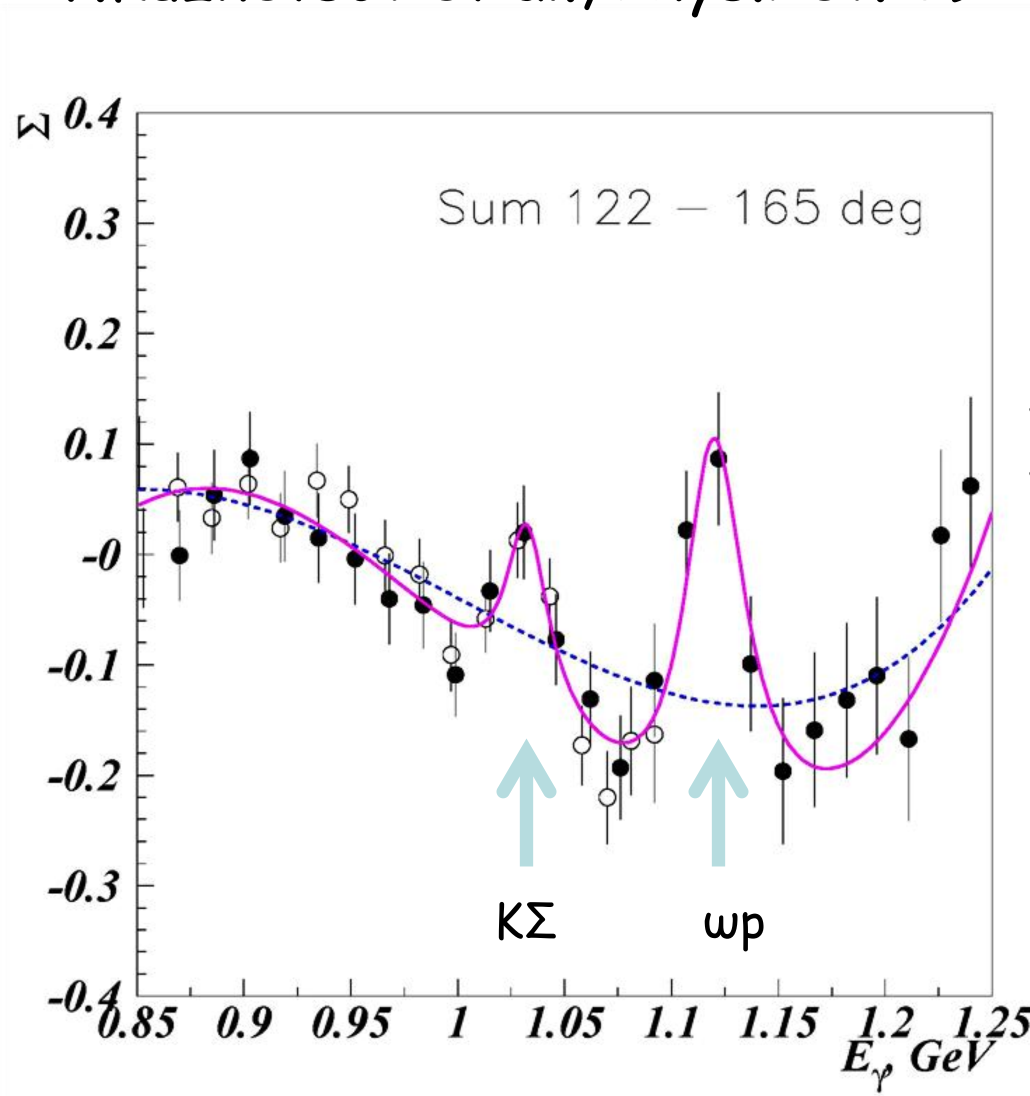




More exotics?

Two narrow (Γ~20 MeV) structures at W~1.68 and W~1.72 GeV in the beam asymmetry data for Compton scattering off the proton at GRAAL

V.Kuznetsov et al., Phys.Rev. C91 (2015) no.4, 042201



W_1 = 1681 ±1 MeV

W_2 = 1726 ±1 MeV

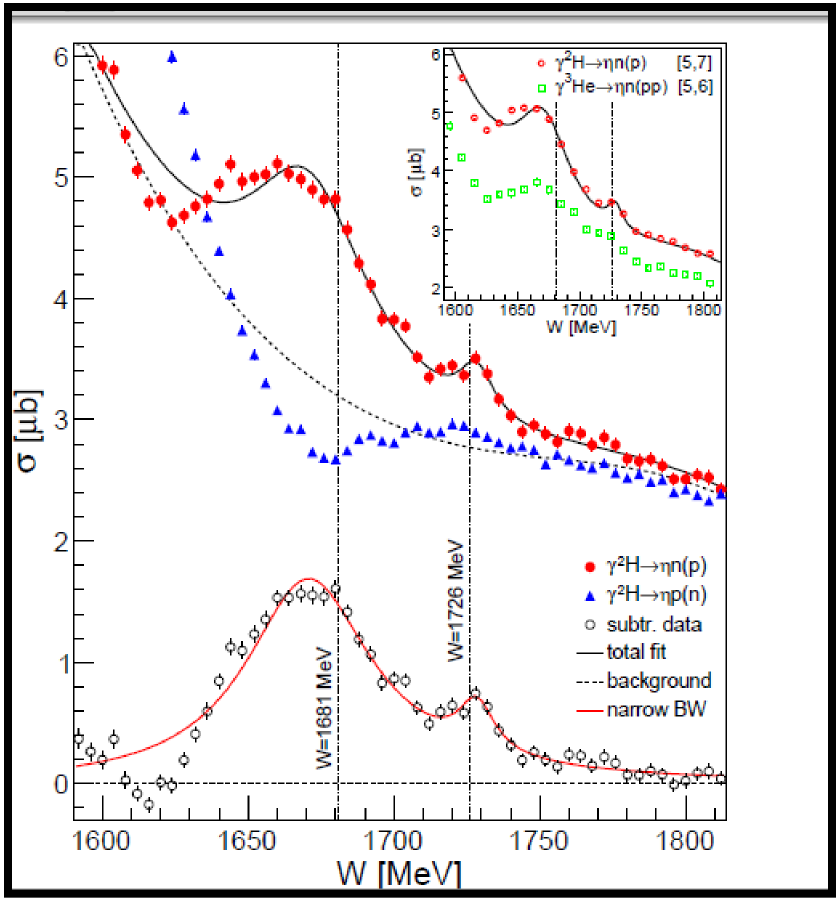
PHYSICAL REVIEW C **92**, 069801 (2015)

Comment on "Evidence for narrow resonant structures at $W \approx 1.68$ GeV and $W \approx 1.72$ GeV in real Compton scattering off the proton"

D. Werthmüller,[1,2] L. Witthauer,[2] D. I. Glazier,[1] and B. Krusche[2]
[1]School of Physics and Astronomy, University of Glasgow, Glasgow G12 8QQ, Scotland, United Kingdom
[2]Departement Physik, Universität Basel, CH-4056 Basel, Switzerland
(Received 8 July 2015; published 11 December 2015)

We comment on the statement by Kuznetsov *et al.* that the structure around $W = 1.72$ GeV seen in the beam asymmetry in Compton scattering off the proton is not observed in the total cross section of η photoproduction on the neutron.

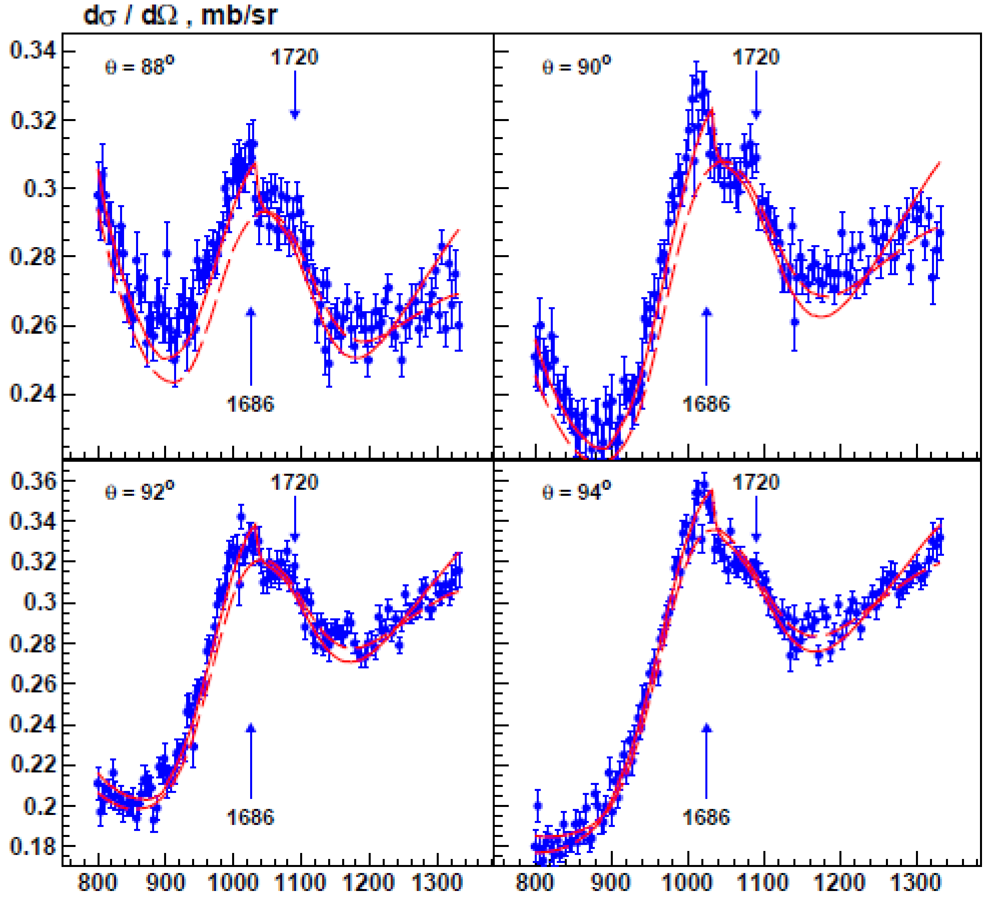
Observation of two narrow structure at W~1.68 and W~1.72 GeV in γn→ηn at A2@MaMiC and CBELSA/TAPS



A. Gridnev et al., ``Search for narrow resonances in πp elastic scattering from the EPECUR experiments"

Accepted for publication in Phys. Rev. C (Rapid Communication)

Talk by N.Kozlenko at this session



Summary

We report on the observation of narrow peaks near $W \sim 1.68$ GeV in the ηN mass spectra from the $\gamma N \rightarrow \pi \eta N$ reactions which may signal a narrow nucleon N^* resonance with the following properties:

Mass 1680±10 MeV

Narrow width $\Gamma < 25$ MeV

$S=0$

$I=1/2$

Strong photoexcitation on the neutron

Tentative Quantum numbers **are** P11

The properties of these resonances coincide well with those expected for the second member of the exotic antidecuplet.

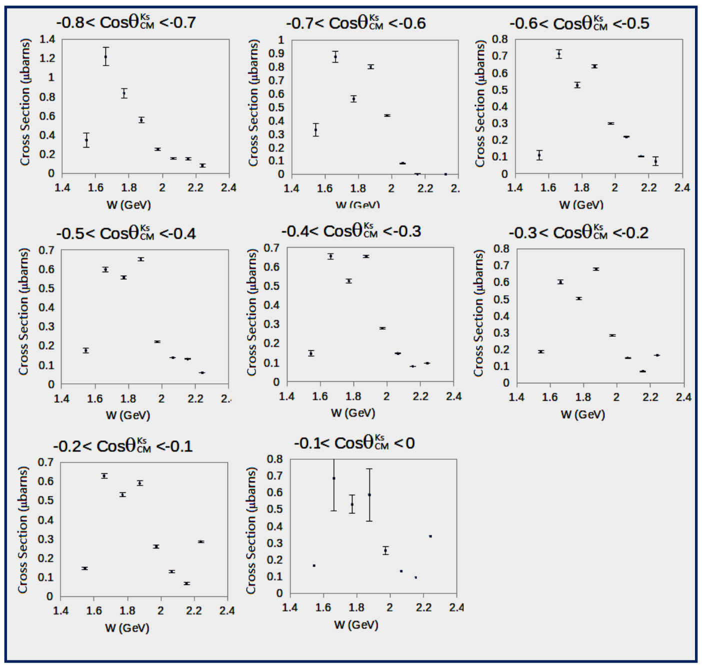
Beyond of this we observe another narrow structure at 1.72 GeV. Its identification requires additional efforts.

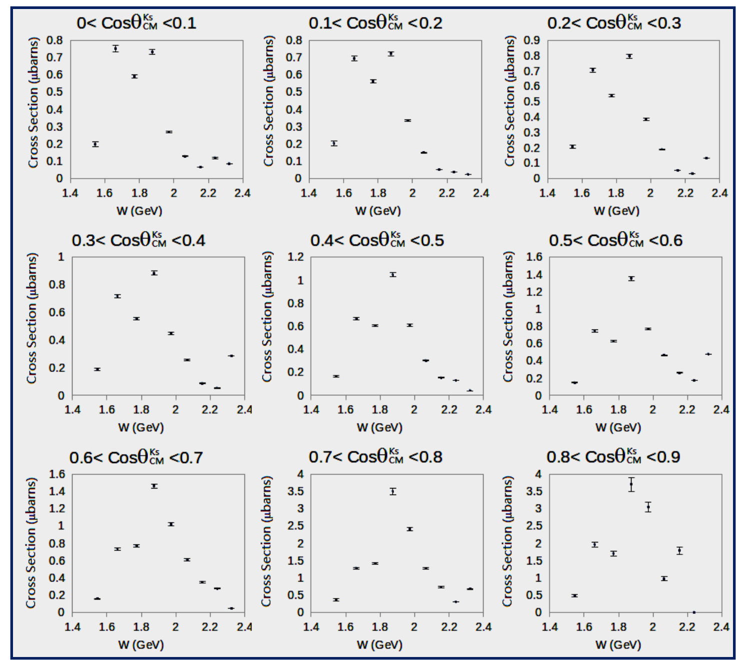
Thanks for your attention!

Preliminary data on $\gamma n \to K^0_s \Lambda$ from CLAS

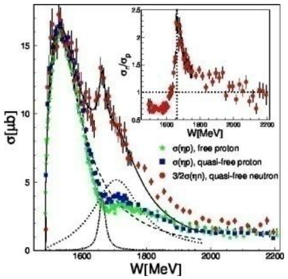
Talk of Taylor at NSATR2013 Workshop

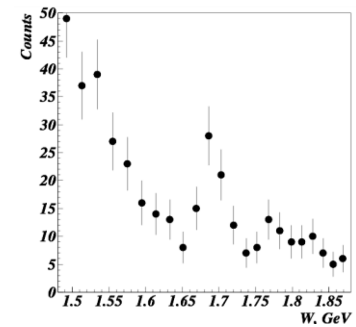
Peak at 1.7 GeV!

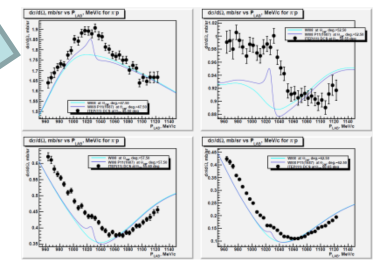




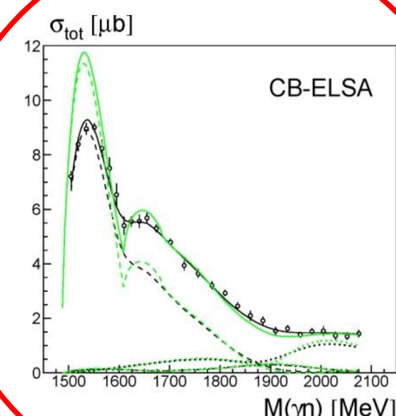
Interference of known resonances



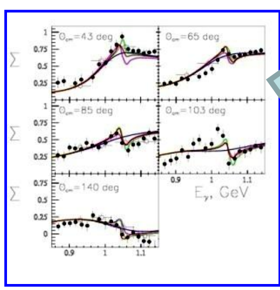




Real width is more narrow

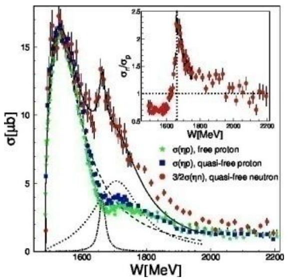


Unlikely can be seen in Compton and pion scattering as these reactions are governed by other resonances

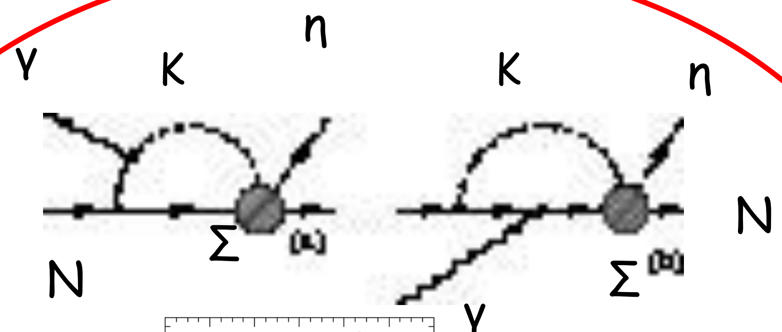


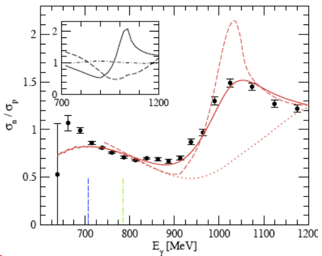
Doesn't explain the structure on the free proton

Cusp effect: open questions

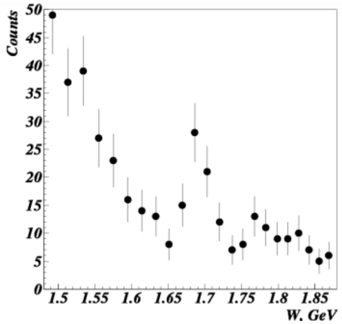


Real width is essentially more narrow





Unlikely can be seen in Compton scattering



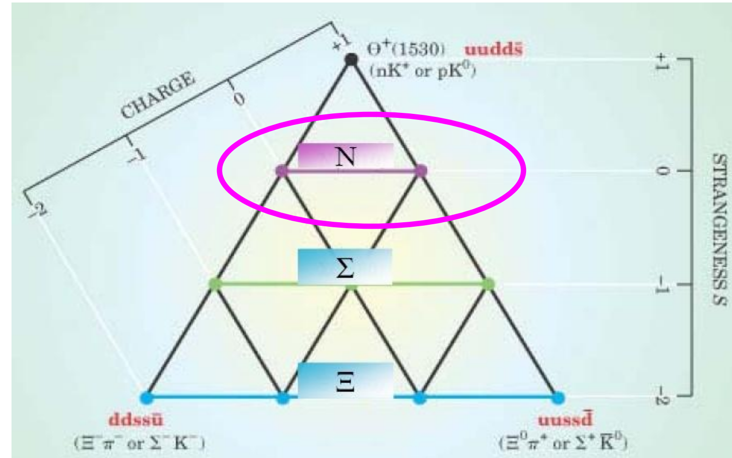
Why it is not seen in π^0 photoproduction on the neutron and on the proton while it is seen in $\pi^- p \to \pi^- p$?

Why there is no similar peak corresponding to the virtual KΛ ?

Properties of tentative N(1685)

- M=1685±10 MeV
- Γ≤30 MeV
- Isospin ½
- S=0
- Strong photoexcitation on the neutron and suppressed (~100 times) photoexcitation on the proton
- Suppressed decay to πN final state

Expected properties of the second member of the χQM antidecuplet [10,1/2-]



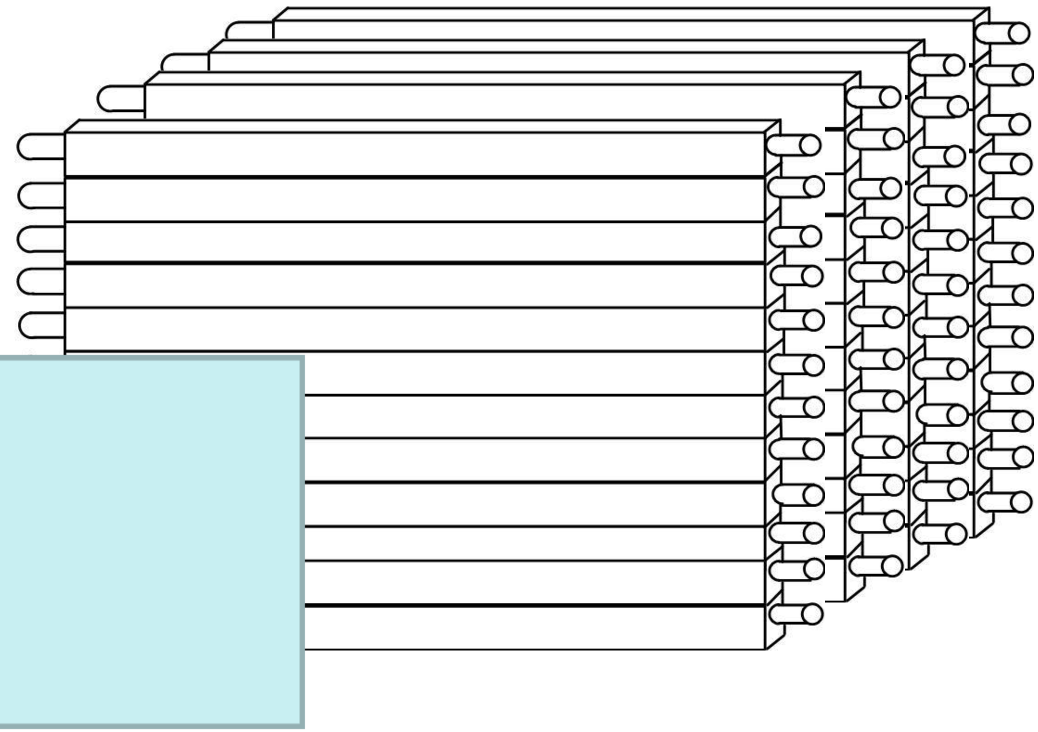
- M= 1650 – 1690 MeV
- Γ≤30 MeV
- Isospin ½
- S=0
- Strong photoexcitation on the neutron and suppressed (~100 times) photoexcitation on the proton
- Quantum numbers P11

EPECUR (if repaired)

π^-p -> ηn and **π^-p -> $K\Lambda$**

at the energies around ~1020 MeV/c
Signal and properties of N*(1685)

New Time-of-Flight detector for neutrons and charged particles (under construction at PMPI)



Four separate layers each made of 16 counters covering altogether an active area of 80x80 cm. Veto counter at the front. Expected TOF resolution for minimum-ionizing particles <80 ps

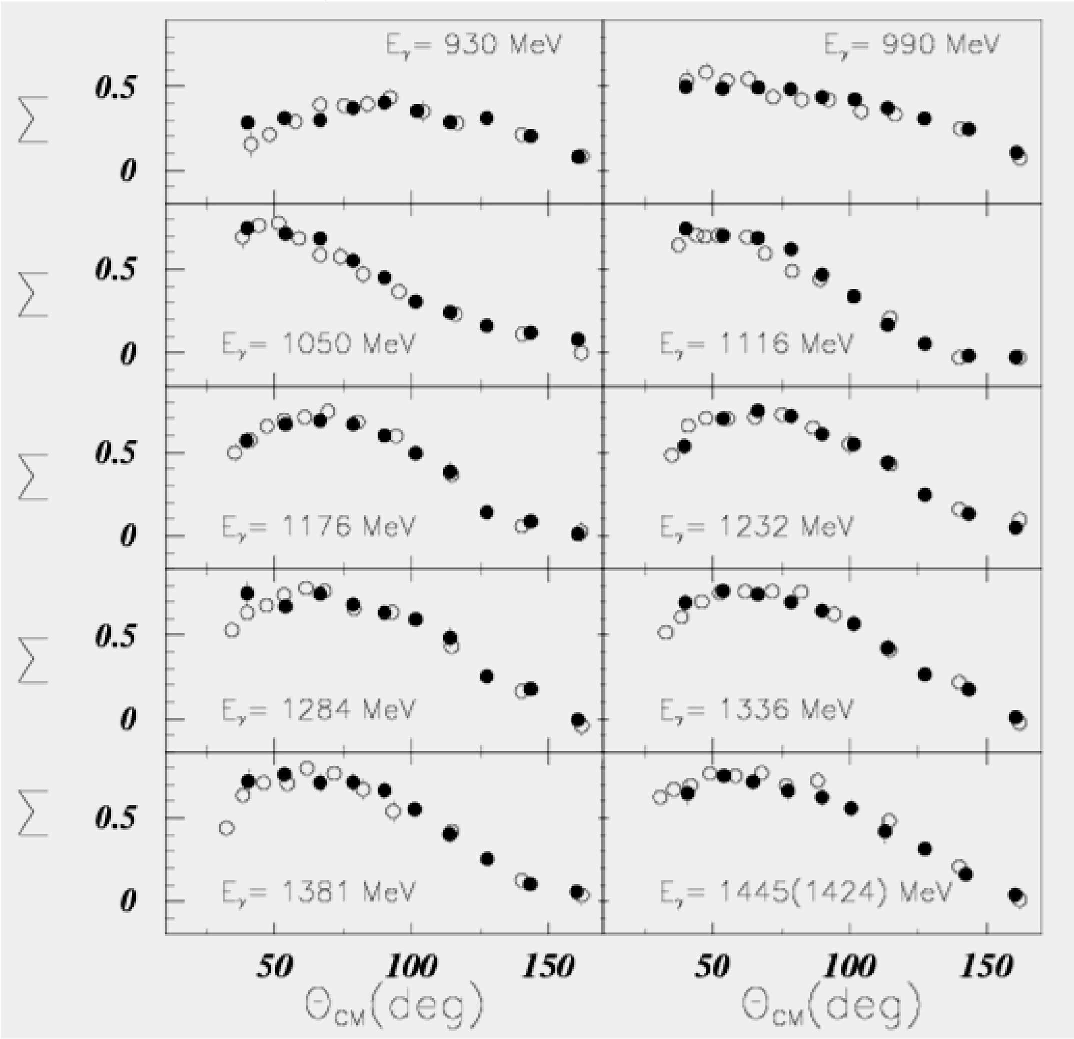
Thank you for your attention!

Comments on O.Bartalini *et al.* (by the GRAAL Collaboration (?)) ``Measurement of eta photoproduction on the proton from threshold to 1500 MeV", Nucl-ex:0707.1385.

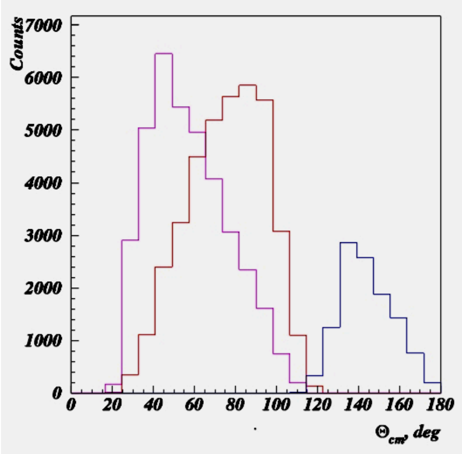
Data analysis has been performed by A.Lleres, LPSC Grenoble.

Authors claimed no evidence for a narrow N(1670) state in beam asymmetry and cross section data for eta photoproduction on the proton.

Comparison of O.Bartalini et al.(black circles) with the old GRAAL publication V.Kuznetsov, πN News Letters, **16**, 160(2002) (open circles) (angular dependences)

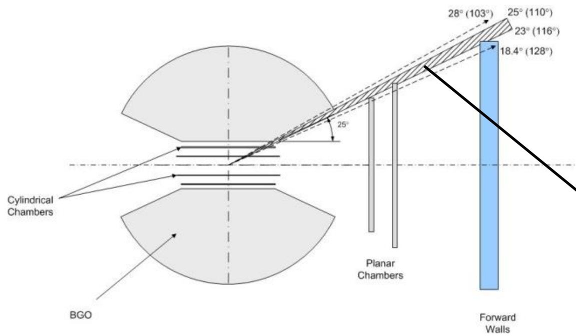


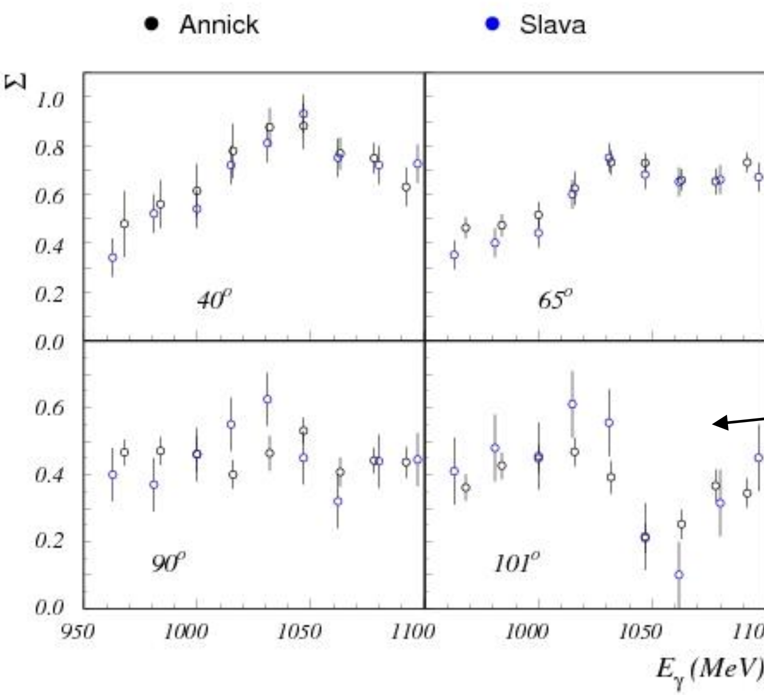
Despite the triple increase of statistics, new data are less accurate at forward angles! The reason is that events in which one of the photons from η→2γ decay is detected in the forward wall, are excluded from data analysis

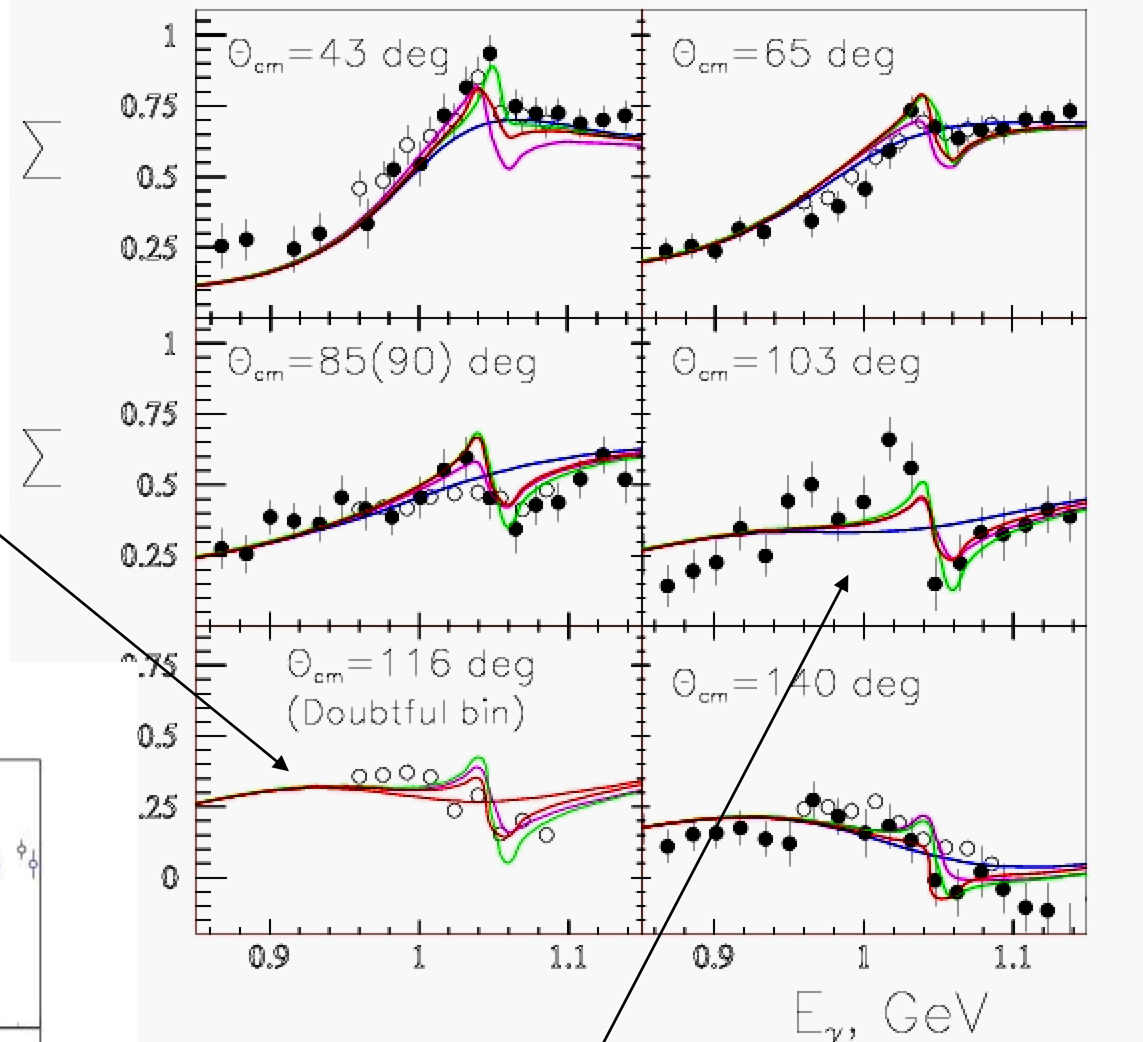


γp→ηp Yield for different types of events

Comparison of O.Bartalini et al. (open circles) and our results (black circles). Main difference is at 103/116 deg.







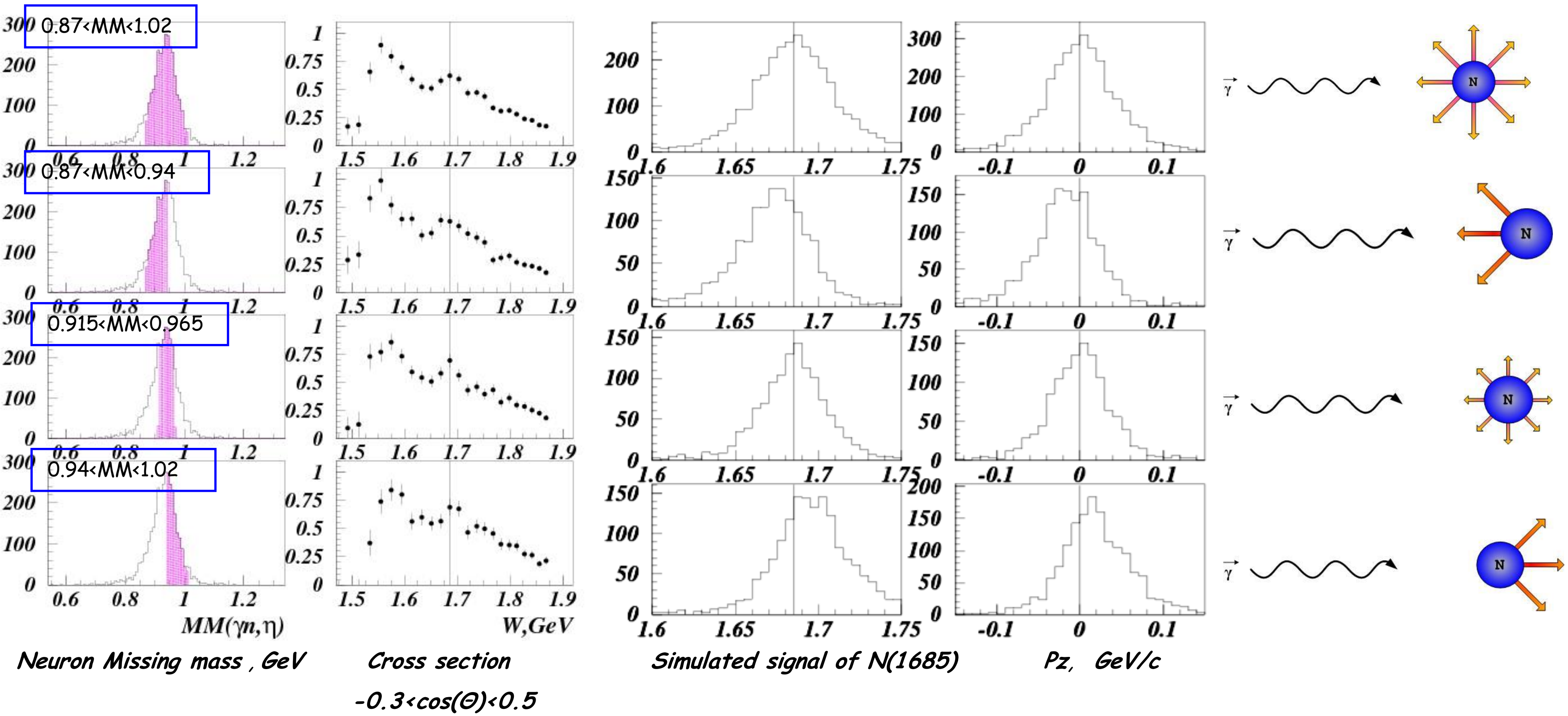
The same dip structure at 103 deg!

Comparison wilh preliminary results done by A.Lleres (A.Lleres, private communication (E-mail from Feb 5, 2007)).

γn→ηn cross section with different cuts on the neutron missing mass

Experimental Data

Simulations



The width and the position of the peak in the γn→ηn cross section are affected by the cut on the neutron missing mass!