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HK 11.6

Cascading decays of nucleon and delta resonances with the CLAS detector at JLAB

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Outline

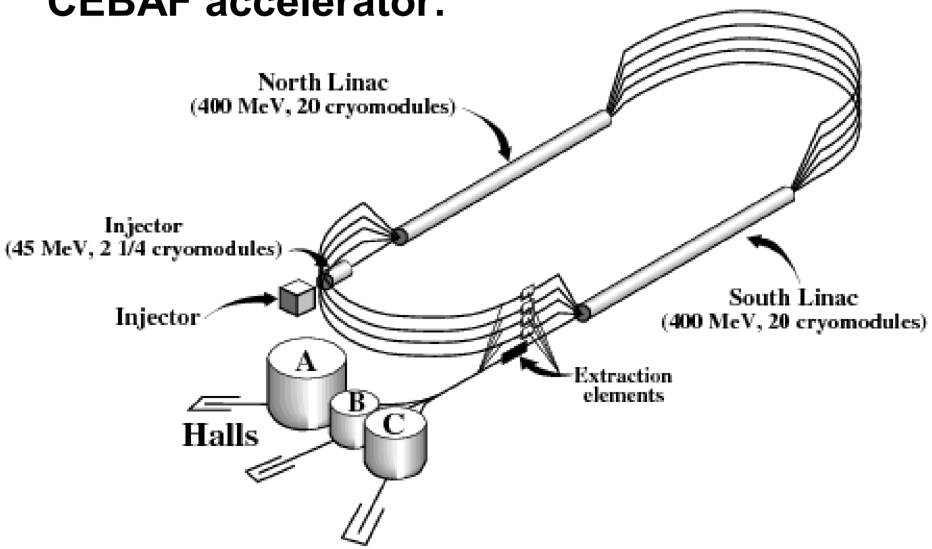
- The CLAS detector at JLAB
- Theoretical predictions
- The analysis model
- Resonance scans
- Oulook

The CLAS detector at JLAB

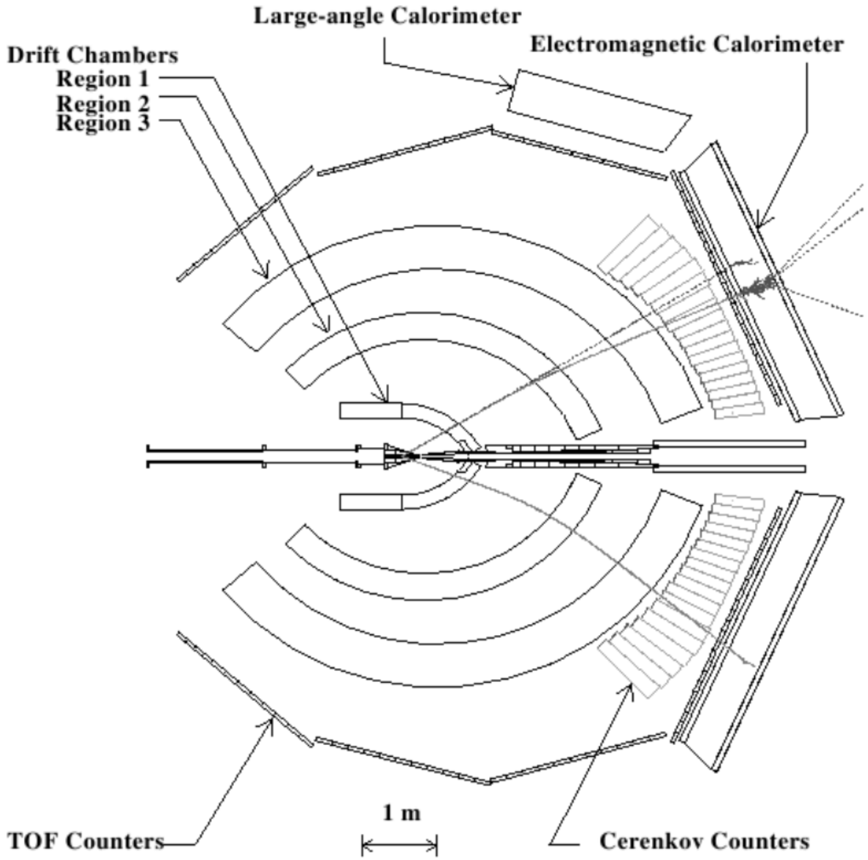
JLAB, Newport News, Virginia

- CEBAF provided a 6 GeV electron beam
- Conversion to a photon beam with a Bremsstrahlung-Tagger in hall B (20% - 95% of E_{e^-})

CEBAF accelerator:



CLAS detector:



Aim of the analysis

Search for cascading baryon resonances produced in the interaction of unpolarized photons with an unpolarized proton target (g11 run of CLAS 6)

i.e. $B^{**} \rightarrow B^{*} m \rightarrow p \ m_1 \ m_2$ with $m_i = \pi, K, \ldots$

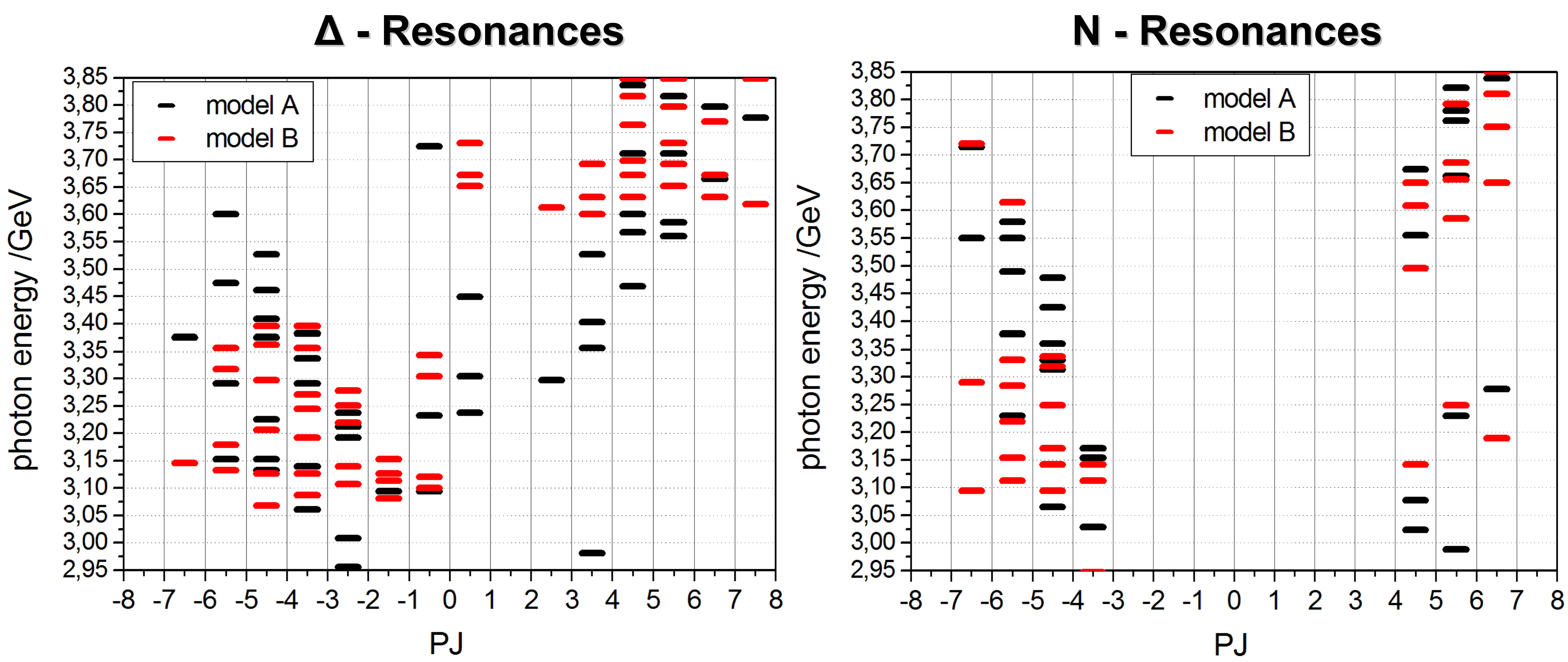
1. Step:

Search for cascading nucleon and delta resonances in events with p $\pi^+ \pi^-$ detected in the final state

a) Optimization of the analysis model in the photon energy range from 3.0 GeV – 3.8 GeV → Well above the production thresholds

b) Extension to the complete photon energy range from 1.6 GeV - 3.8 GeV

Relativistic Quark models of baryons: Predicted Δ and Nucleon resonances for 3.0 GeV < E_γ < 3.8 GeV

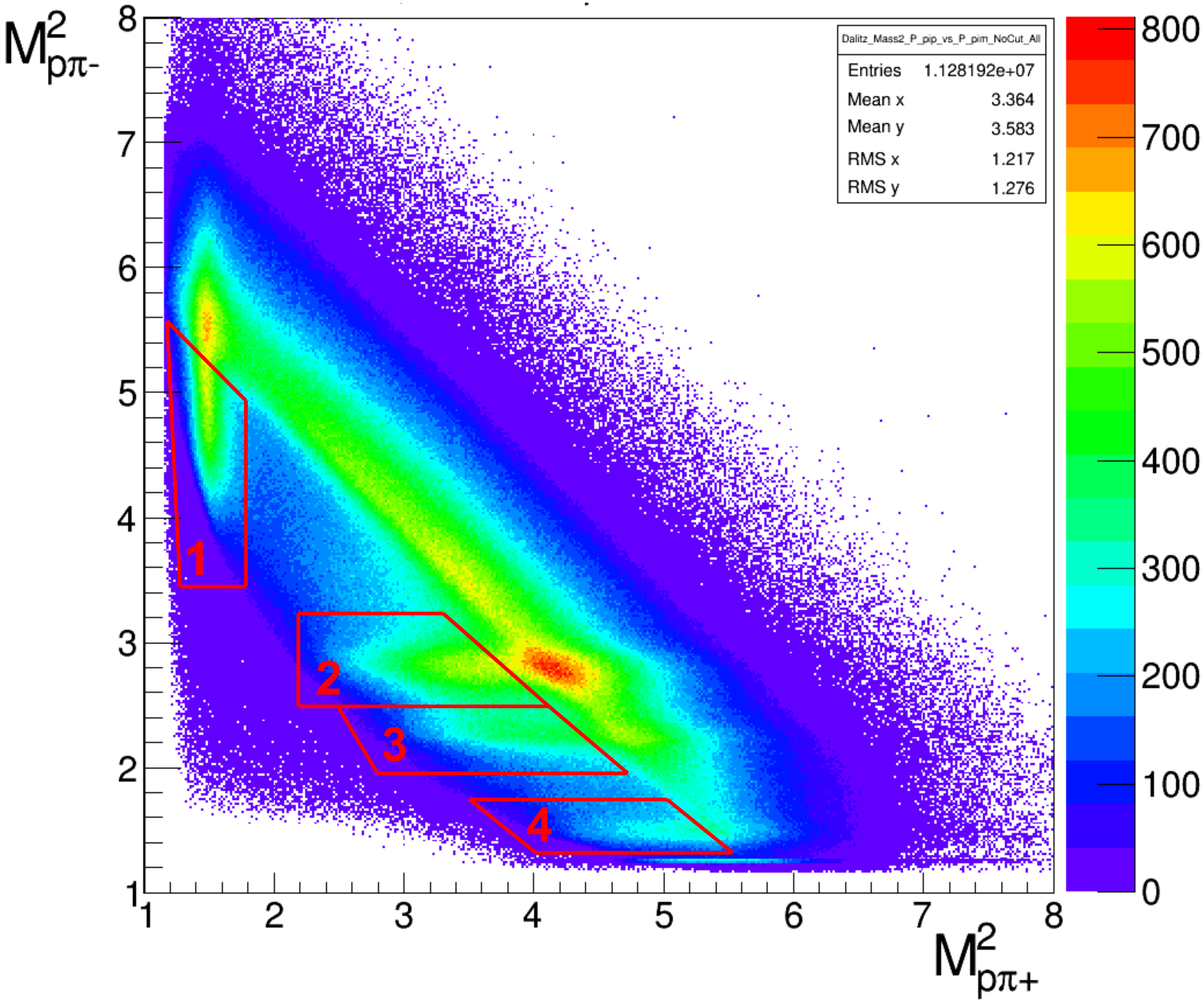


Extracted from U. Löring et al., Relativistic quark models of baryons with instantaneous forces, Eur. Phys. J. A 10, 309–346 (2001)

A lot of overlapping resonances are predicted

Overlap may lead to a continuum

Experiment: Identify observable resonances in the Dalitz plot

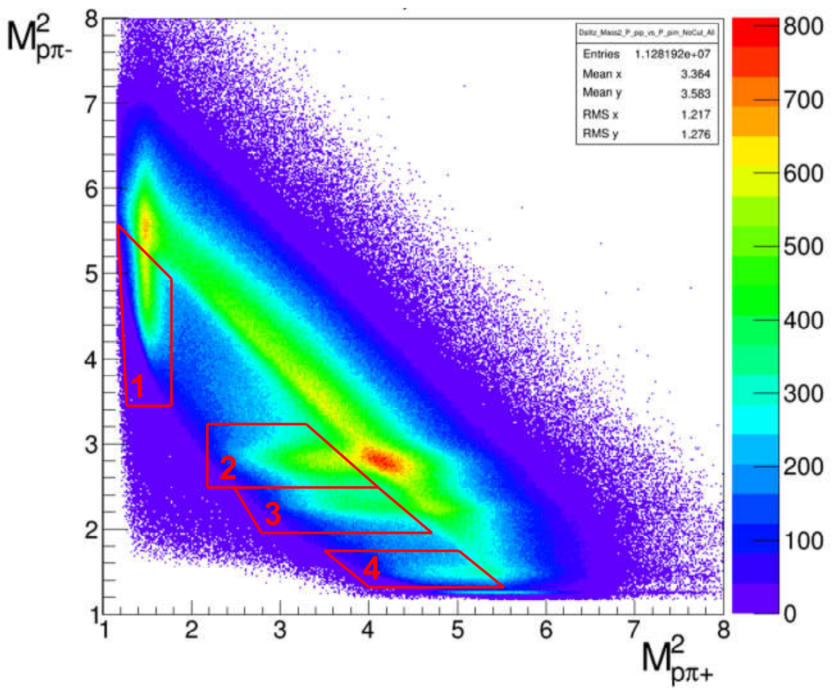


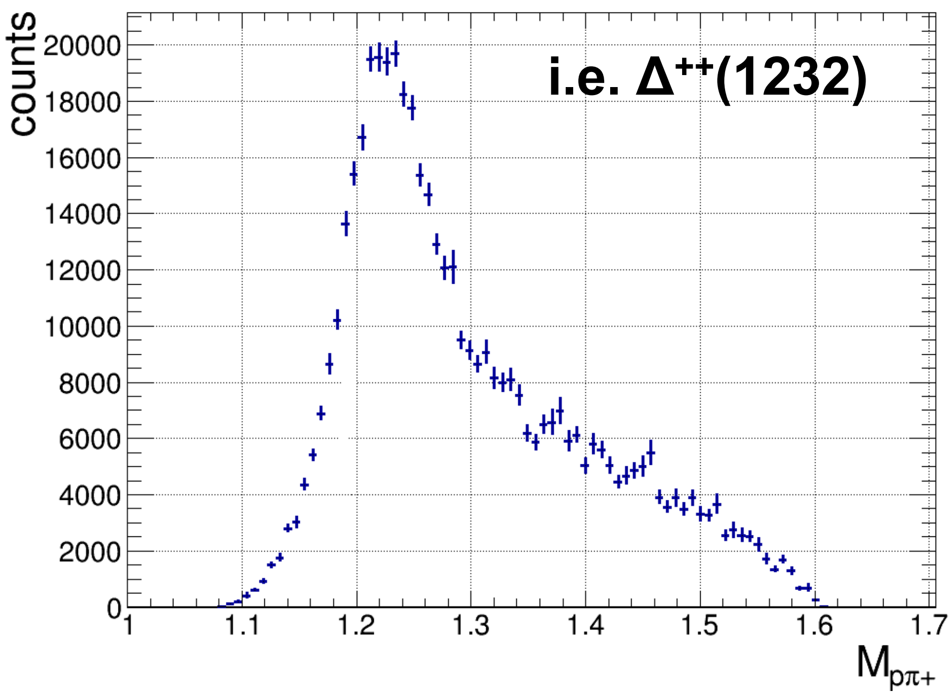
1: $\Delta^{++}(1232)$
2: $\Delta(1600)$
3: $N(1520)$
4: $\Delta(1232)$

$B^{**} \rightarrow B^{*}\,\pi^{\pm}$
$\rightarrow p\,\pi^{+}\,\pi^{-}$

Analysis procedure

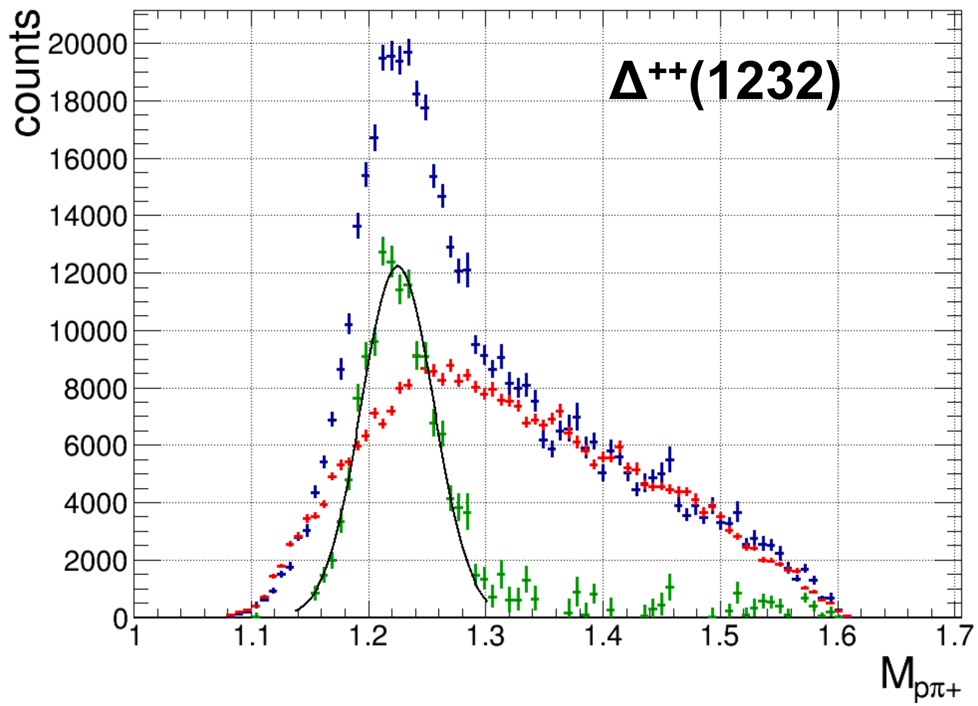
1. Event wise acceptance correction
2. Split the data in 20 MeV wide energy bins and do every analysis step for each of the 40 energy bins
3. Projection of resonance 1 ($\Delta^{++}(1232)$) to „x-axis“ ($M(p\pi^+)$) and 2,3 and 4 (Δ, N) to „y-axis“ ($M(p\pi^-)$)





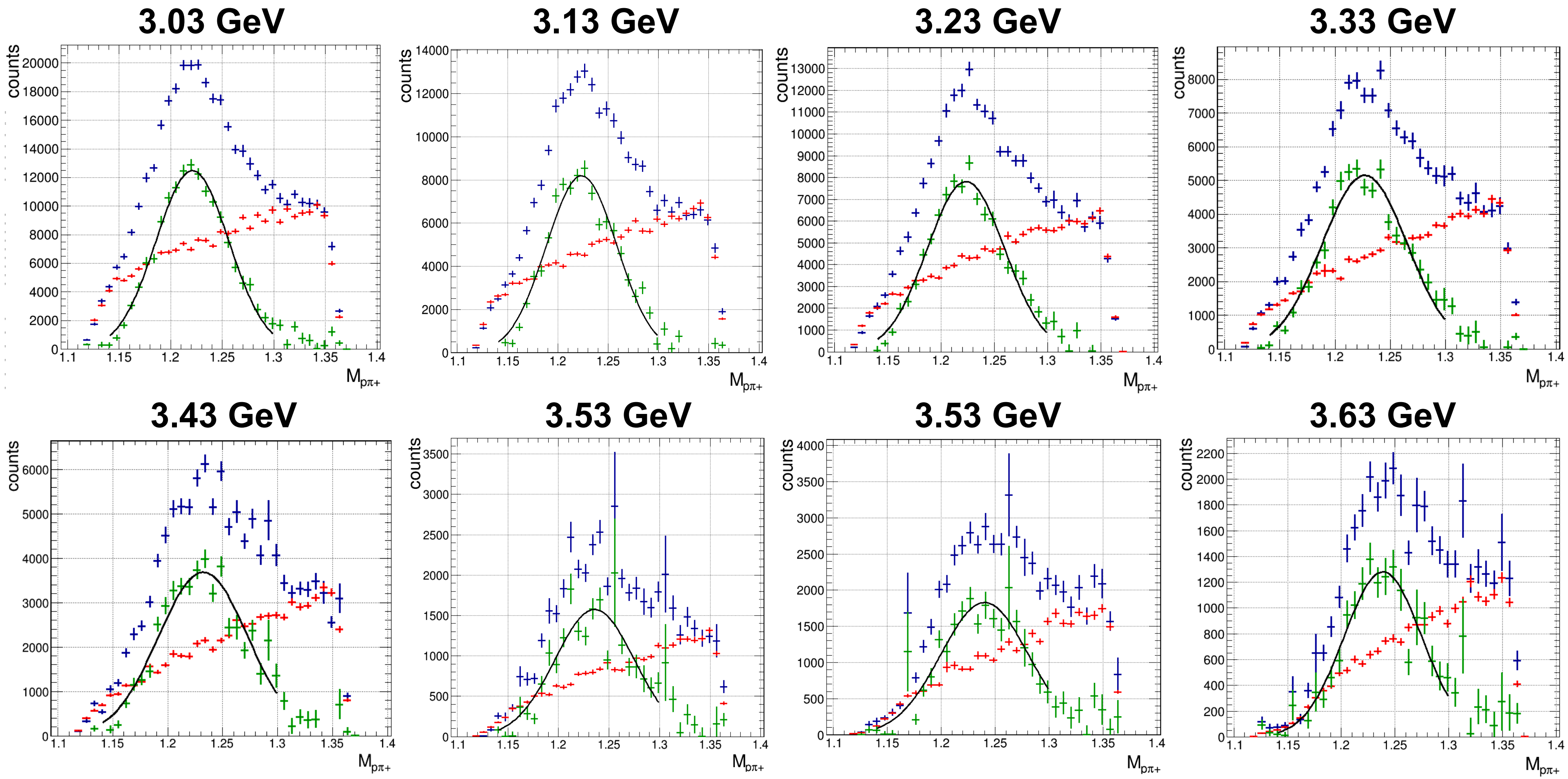
Analysis procedure

4. Simulate phase space events to get an estimation of the background
5. Scale reconstructed and acceptance corrected MC data to fit the experimental background
6. Subtract the MC background from the experimental data
7. Fit the remaining peak (green) with a gaussian distribution
8. The integral of the fit function provides the counts in the specific energy bin
9. Corrected the counts in each energy bin with the experimentally determined photon flux



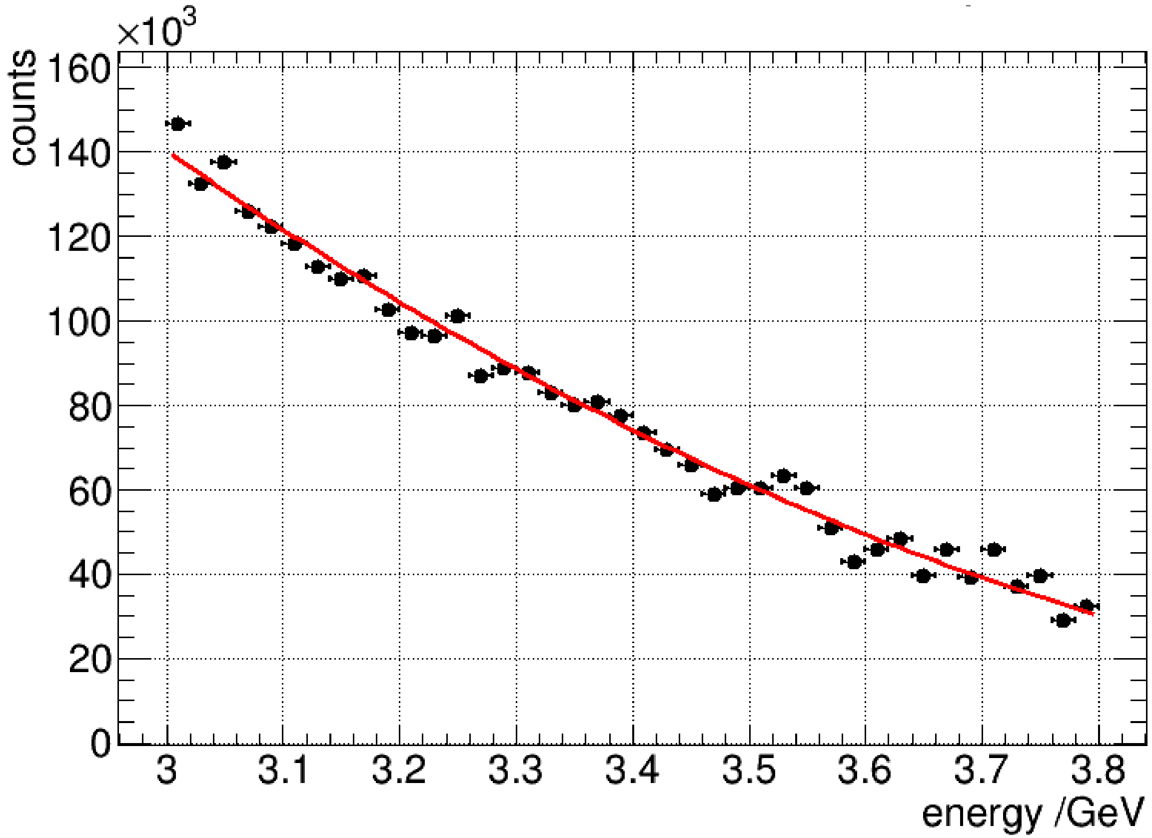
Background subtracted $\Delta^{++}(1232)$ resonance with narrow cut

- For the final extraction a more narrow cut has been applied to the Dalitz plot
  ➔ Allows a better separation of the gaussian distribution



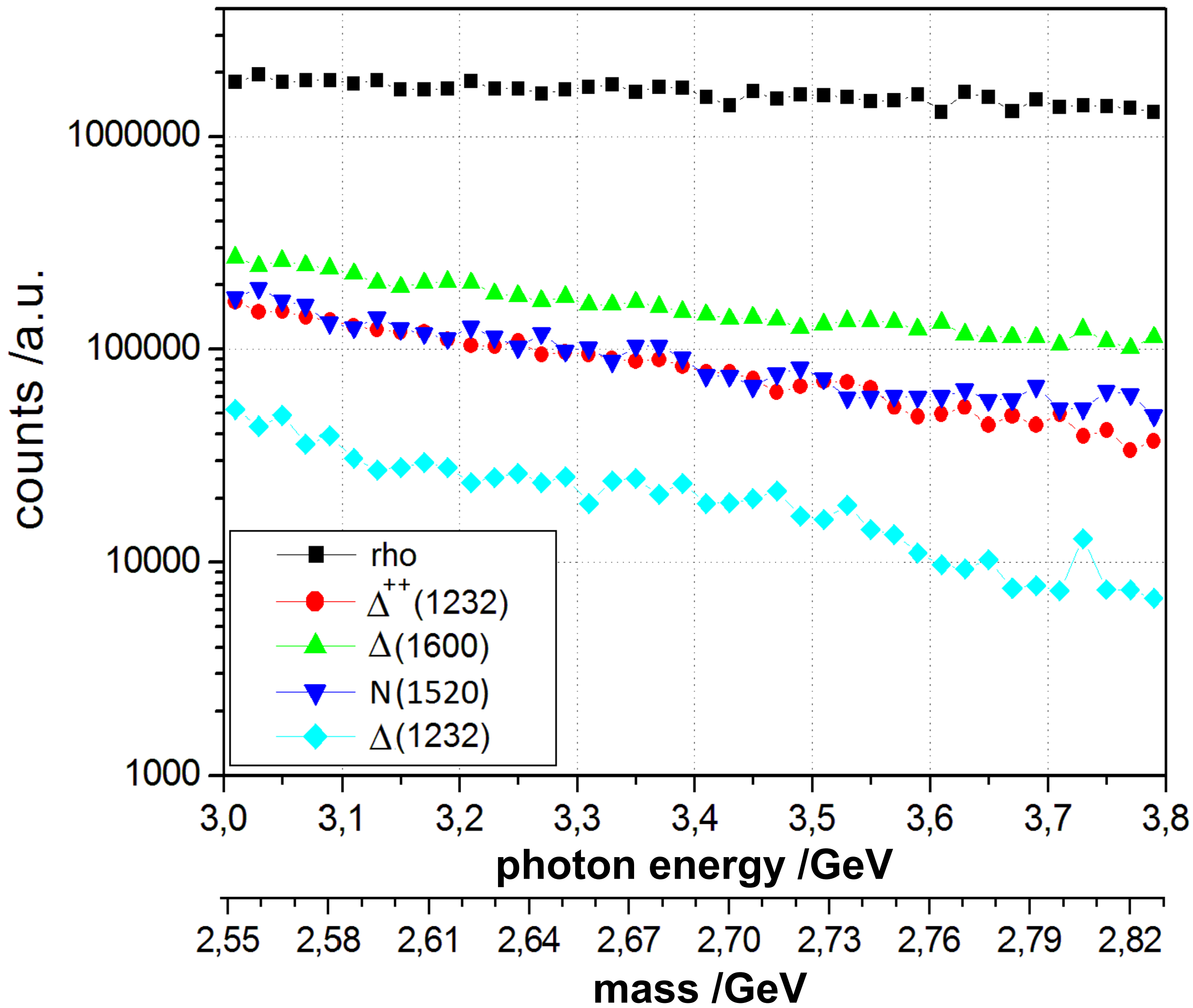
$\Delta^{++}(1232)$ excitation function

- The integral of the fit provides one point for each of the 40 energy bins
- A photon flux correction based on the tagger efficiency has been applied



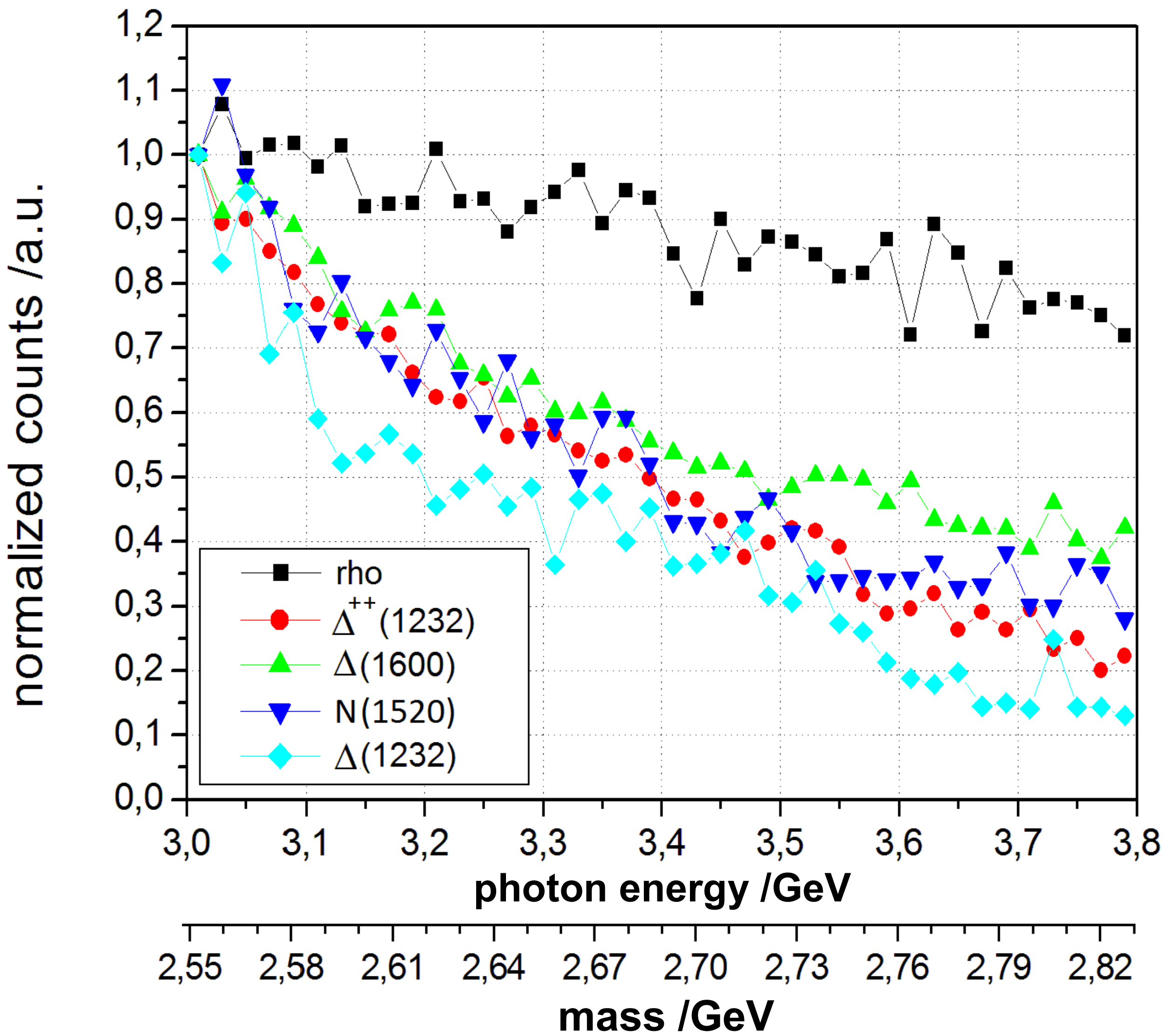
- Same procedure applied to all resonances and for comparison also to the ρ meson

Delta / Nucleon excitation functions



Ratio of the excitation functions

(normalized to 3.0 GeV)

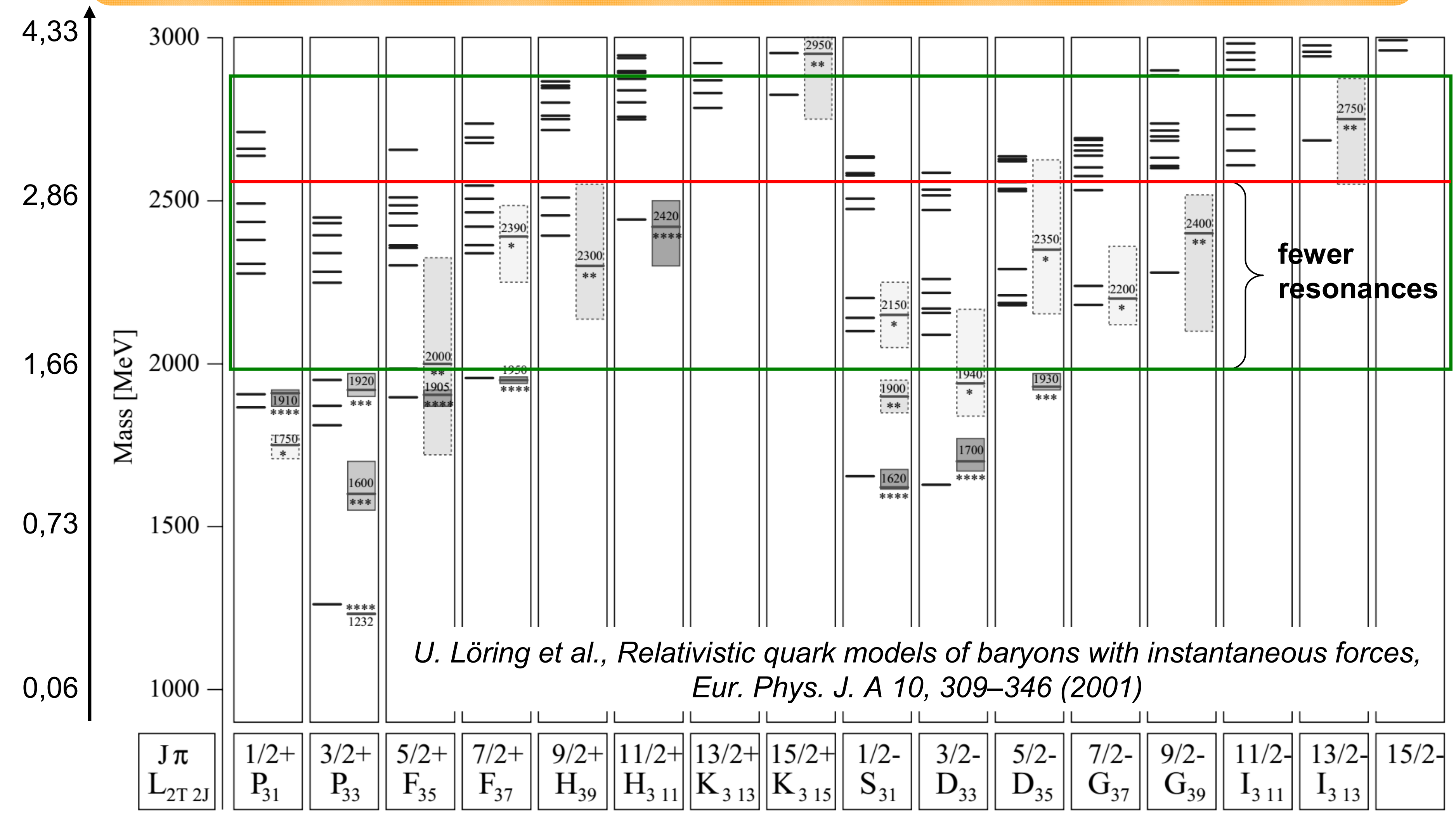


No resonances can be clearly identified in the energy range from 3.0 GeV to 3.8 GeV

Reasons:

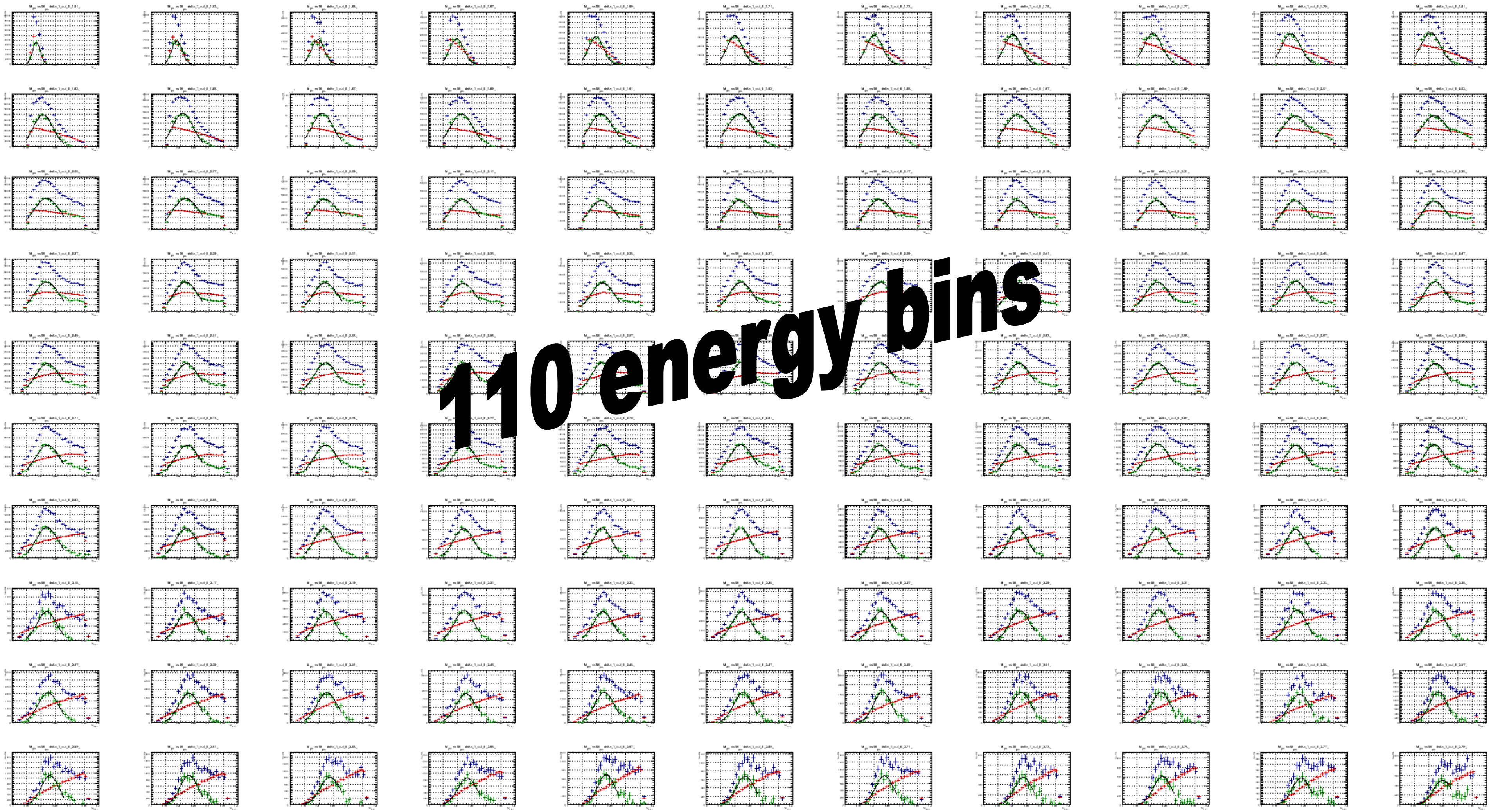
- High density of the predicted resonances leads to a continuum
- Resonance width is increasing with energy
  ➔ Resonances are expected to have a width of several hundreds of MeV

Predicted Δ resonances for the complete energy range
(relativistic quark model)

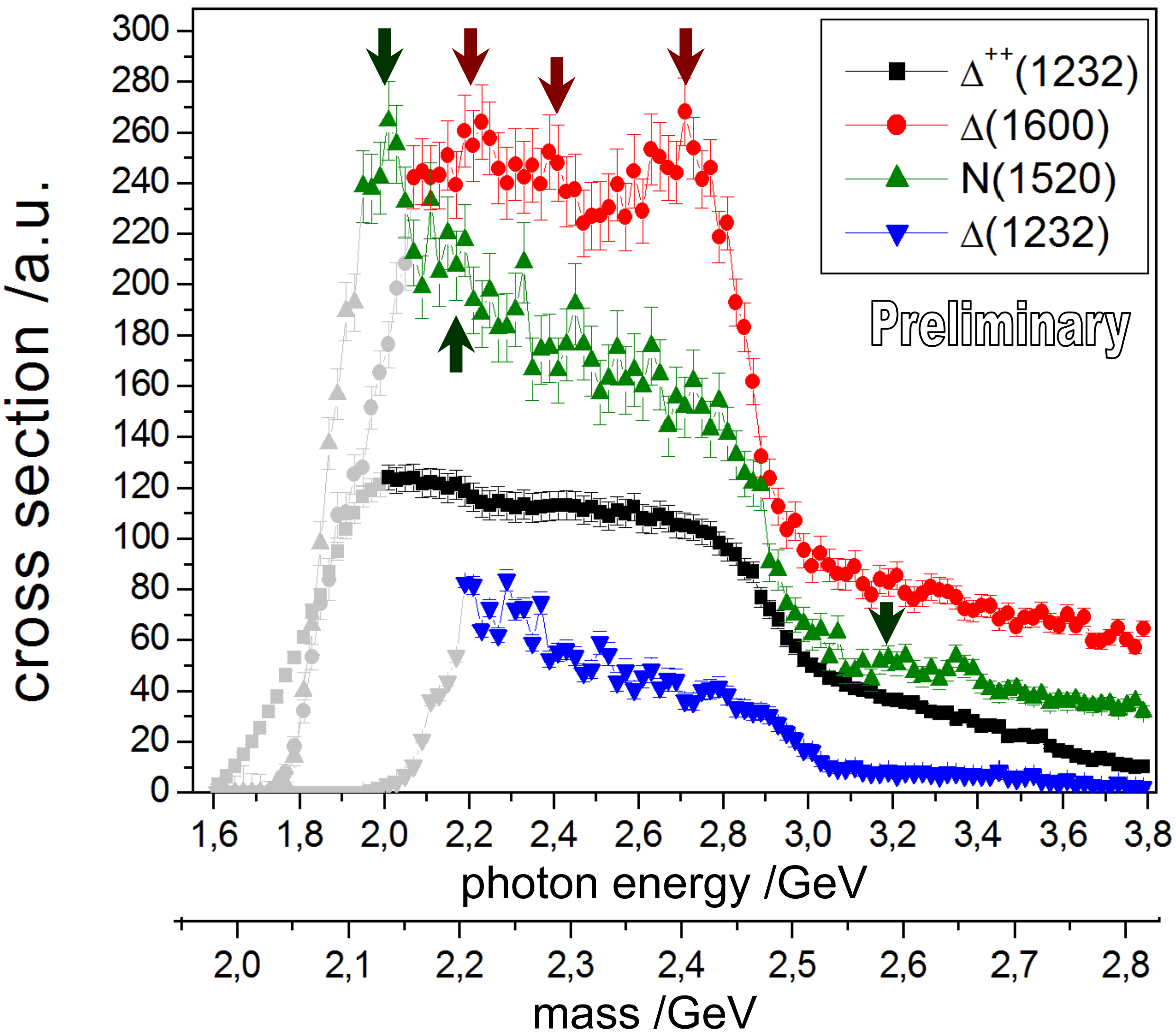


U. Löring et al., Relativistic quark models of baryons with instantaneous forces, Eur. Phys. J. A 10, 309–346 (2001)

Resonance scan for the energy range from 1.6 GeV – 3.8 GeV



Excitation function for the energy range from 1.6 GeV – 3.8 GeV



For Δ

Known resonances exist e.g. at masses of 2.20 GeV, 2.30 GeV and **2.42 GeV**

(widths ~ 300 – 500 MeV)

→ Bumps in the red curve

For N:

Known resonances exist e.g. at masses of **2.19 GeV**, 2.22 GeV and 2.60 GeV

(widths ~ 300 – 800 MeV)

→ Bumps in the green curve

Conclusion and Outlook

- Energy range above 3 GeV provides only a continuum (large number of overlapping and wide resonances)
- Resonance scan over the complete energy range shows promising structures below 3 GeV (angular distributions etc. have to be studied to verify their nature)
  - Resonances are more narrow
  - Less resonances which overlap
- Search for resonances with **strangeness content**
  - Expected to be significantly more narrow

Thank you for your attention!

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