Observation of the isovector dibaryon resonance-like state with a mass of 2195 MeV/c^2

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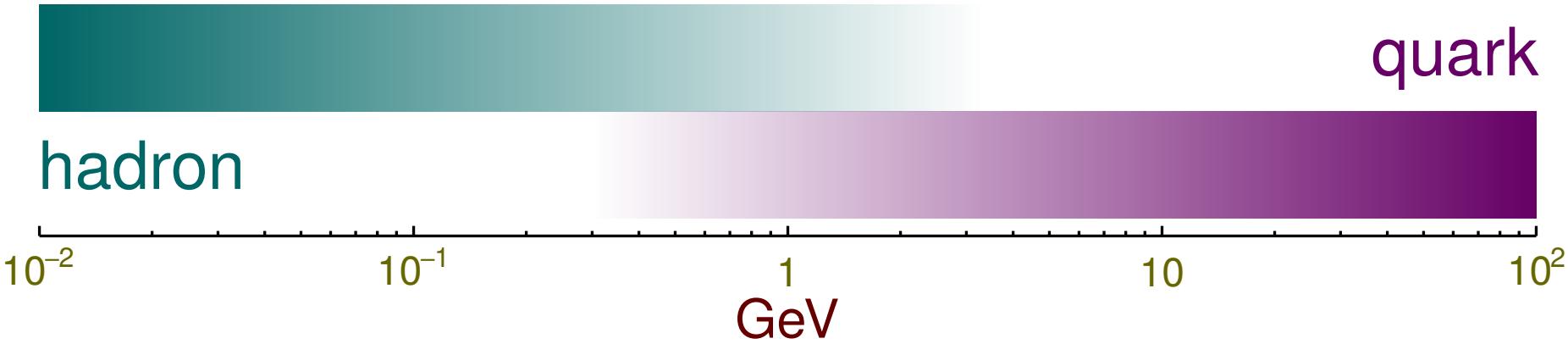
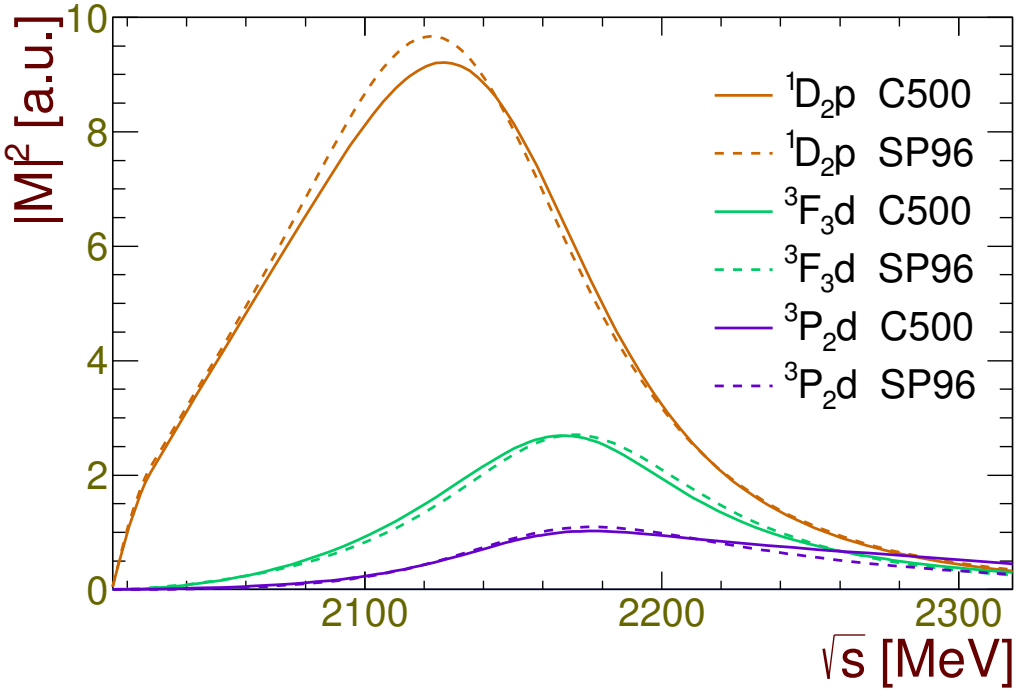
Dibaryon resonance-like states



- Resonances with baryon number $B = 2$
- Seen in partial wave analysis ($pp \to pp$, $pp \to d\pi^+$)
- Three main resonances: ${}^1D_2$, ${}^3F_3$, ${}^3P_2$ (${}^{2S+1}L_J$ of the pp pair)
- Not observed directly
- Meson-baryon models: states of the nucleon–$\Delta(1232)$ channel
- Quark-gluon models employing also π, σ-meson fields

Why $pp \to \{pp\}_s\pi^0$ channel



- ${}^1D_2$, ${}^3F_3$ — well defined from partial wave analysis
- ${}^3P_2$ — the least intensive, large uncertainties

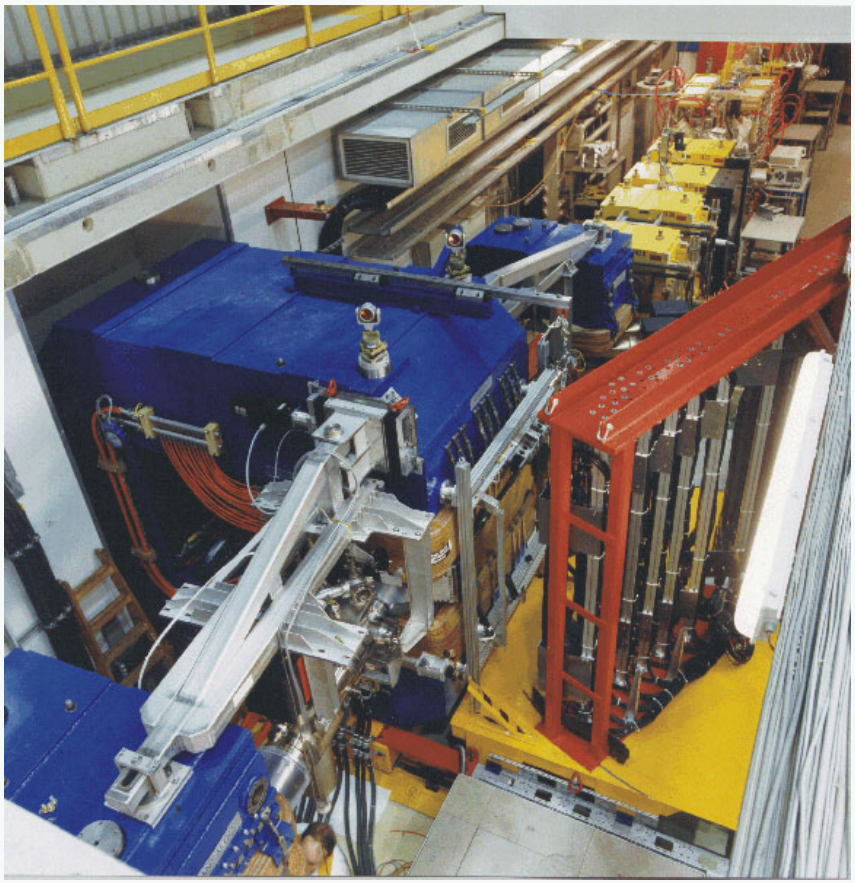
Final proton pairs in the ${}^1S_0$ state

- Forbidden odd (p, $f\ldots$) pion partial waves, forbidden even (S, $D\ldots$) ΔN states
- Of three dominant dibaryon resonances only the least well-defined ${}^3P_2$ allowed

Experimental setup

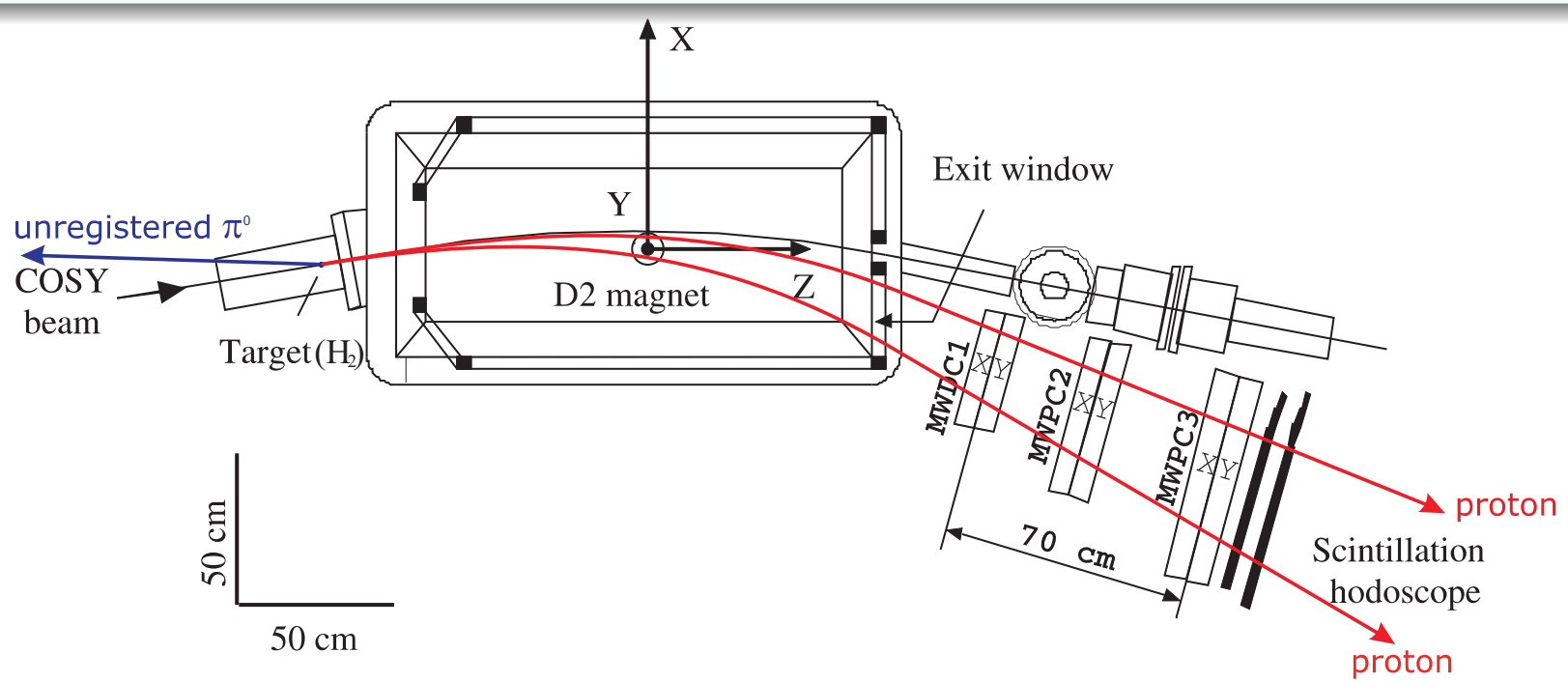
COSY synchrotron

ANKE spectrometer



Experiment

- Forward detector of the ANKE spectrometer
- Transversely polarized proton beam, internal hydrogen target



Allows measuring

- Differential cross section $d\sigma/d\Omega$
- Vector analyzing power A_y

Fitting functions

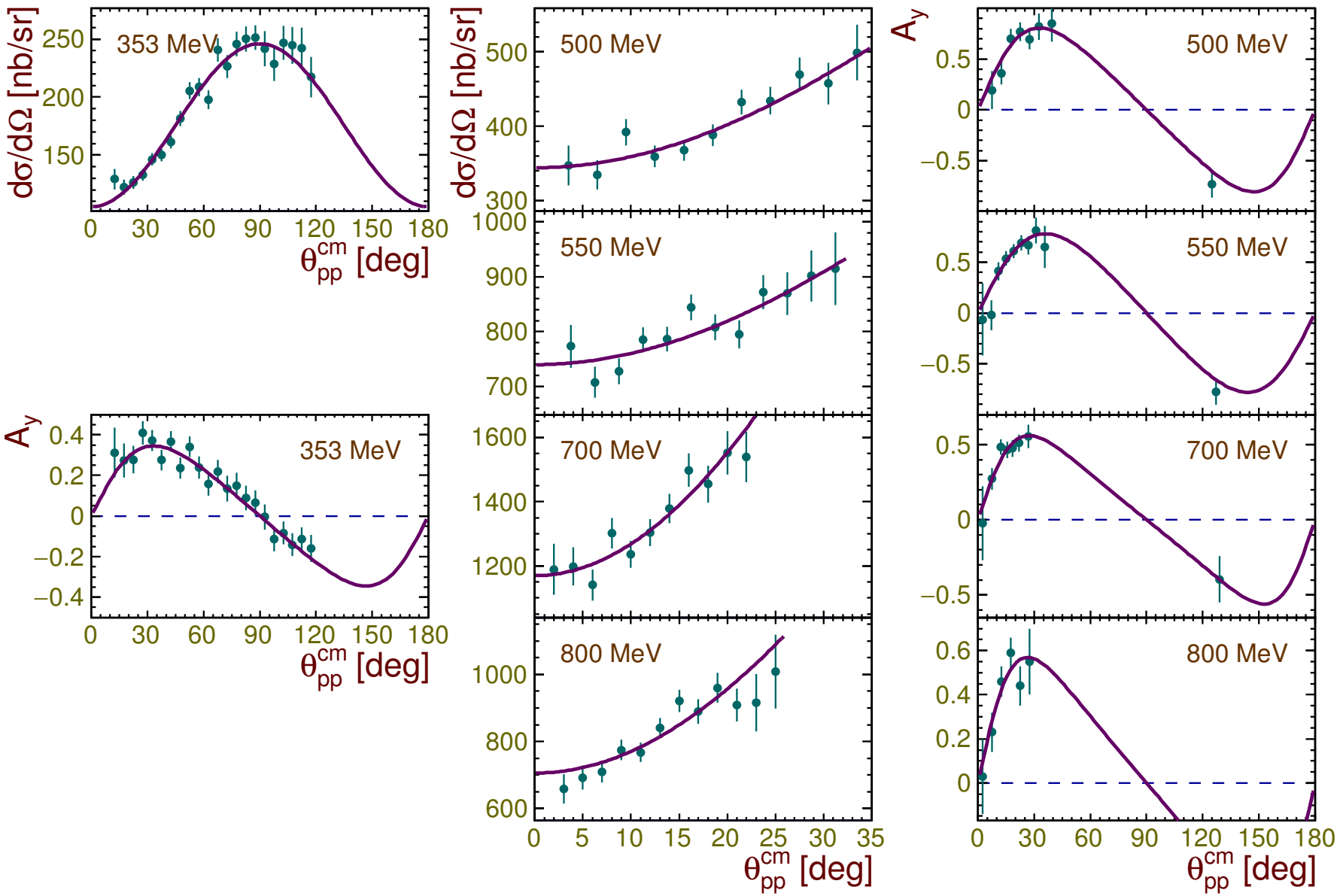
$$\frac{d\sigma}{d\Omega} = \frac{k}{4p}\left(a_0 + a_2\cos^2\theta_\pi + a_4\cos^4\theta_\pi + \ldots\right)$$
$$A_y\frac{d\sigma}{d\Omega} = \frac{k}{4p}\sin\theta_\pi\cos\theta_\pi\left(b_2 + b_4\cos^2\theta_\pi + \ldots\right)$$

Pion orbital momenta $\ell \leqslant 2$, new parametrization

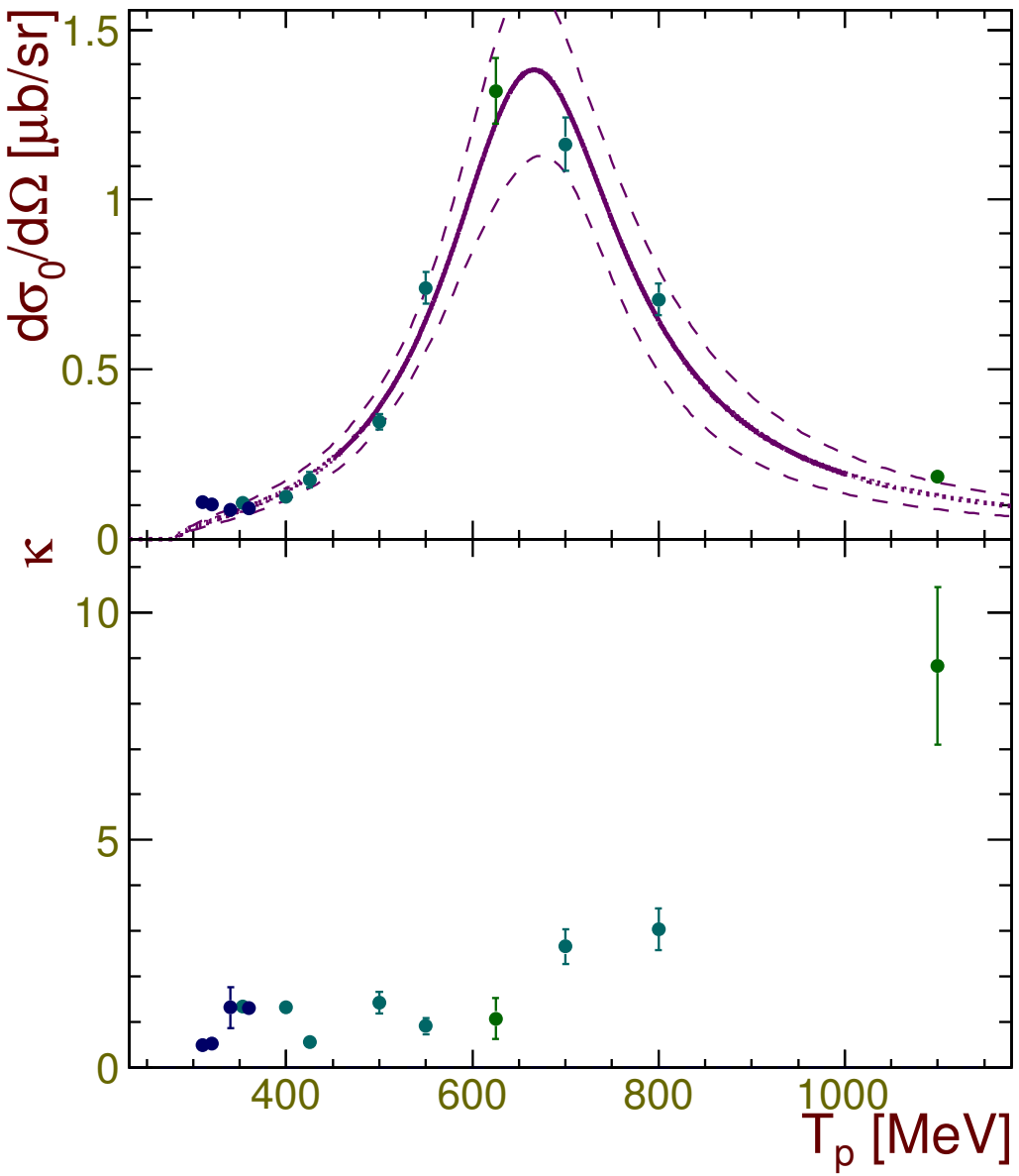
$$\frac{d\sigma}{d\Omega} = \frac{d\sigma_0}{d\Omega}\left(1 + \kappa\sin^2\theta_{pp}\right)$$
$$A_y = \frac{A_y^{\max}\sqrt{1+\kappa}\sin 2\theta_{pp}}{1+\kappa\sin^2\theta_{pp}}$$

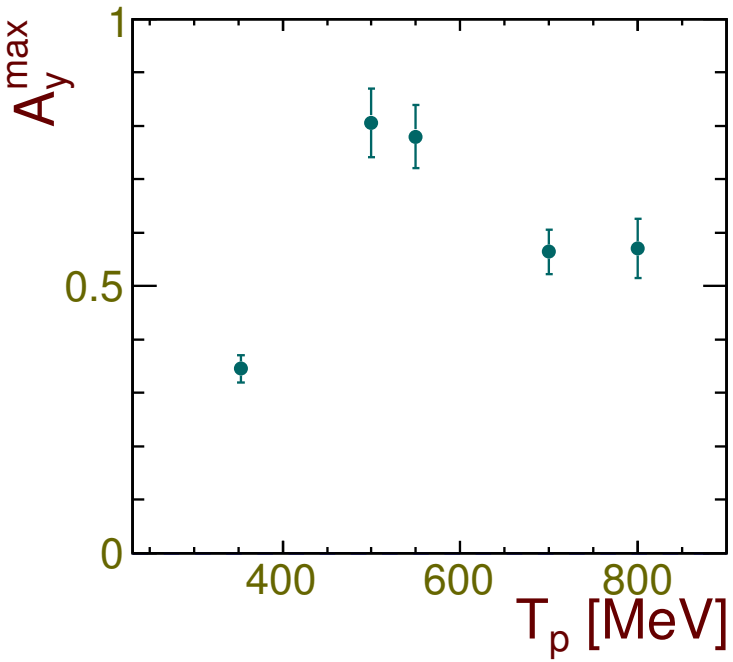
- $d\sigma_0/d\Omega$ — cross section at 0 angle
- κ — cross section angular slope
- $A_y^{\max}$ — maximal analyzing power

Measured cross section $d\sigma/d\Omega$ and analyzing power A_y



Energy dependence of fit parameters





new ANKE data
published ANKE data
published WASA data
Breit-Wigner fit
68% confidence interval

Further analysis

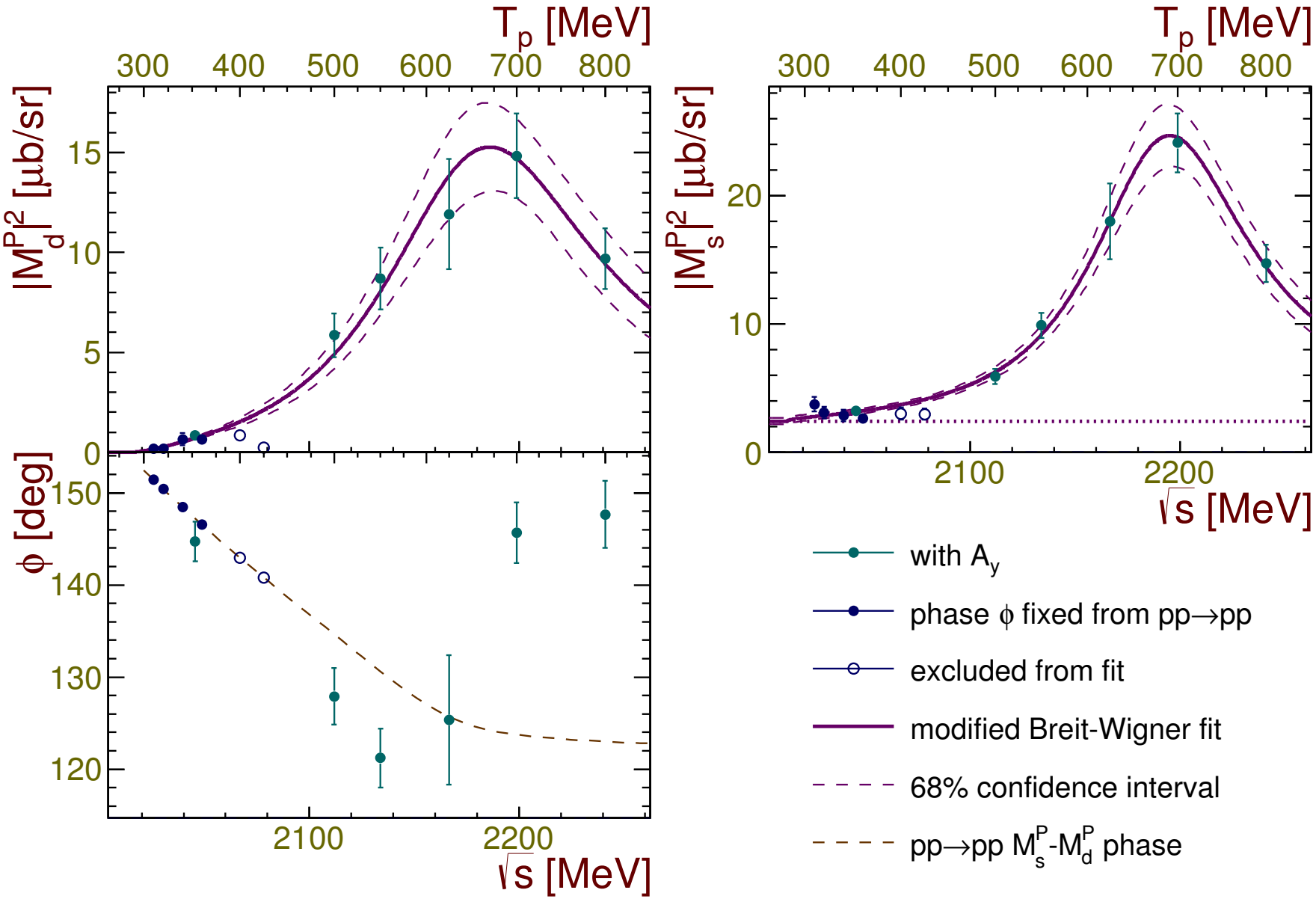
Features of the data

- Resonance peak in $d\sigma_0/d\Omega$
- $d\sigma/d\Omega$ angular dependence: minimum at zero angle
- Slowly varying angular slope parameter κ
- Large analyzing power

Partial wave analysis

- $\ell \leqslant 2$ — three possible transitions:
  ${}^3P_0 \to {}^1S_0 s$, ${}^3P_2 \to {}^1S_0 d$, ${}^3F_2 \to {}^1S_0 d$
- Model:
  - Two main transitions ${}^3P_0 \to {}^1S_0 s$, ${}^3P_2 \to {}^1S_0 d$
  - ${}^3F_2 \to {}^1S_0 d$ and higher momenta neglected

Partial waves energy dependence



Summary

- Comparable ${}^3P_0 \to {}^1S_0 s$ and ${}^3P_2 \to {}^1S_0 d$ amplitudes, peak in $d\sigma_0/d\Omega$, positive slope κ and large A_y originates from their interference
- ${}^3P_2$ resonance parameters:
  $E_R = 2195 \pm 8$ MeV$/c^2$, $\Gamma = 134 \pm 22$ MeV$/c^2$
  with $\chi^2/\mathrm{ndf} = 8/6$
- Indication on resonant behaviour in ${}^3P_0 s$, parameters:
  $E_R = 2199 \pm 5$ MeV$/c^2$, $\Gamma = 94 \pm 11$ MeV$/c^2$,
  $c_{\mathrm{bg}} = 2.4 \pm 0.2$ μb/sr
  with the $\chi^2/\mathrm{ndf} = 6.5/6$
- Article in preparation

Thank you