N*(1535) contribution to $pp \to pp\eta'$ and $pn \to d\phi$

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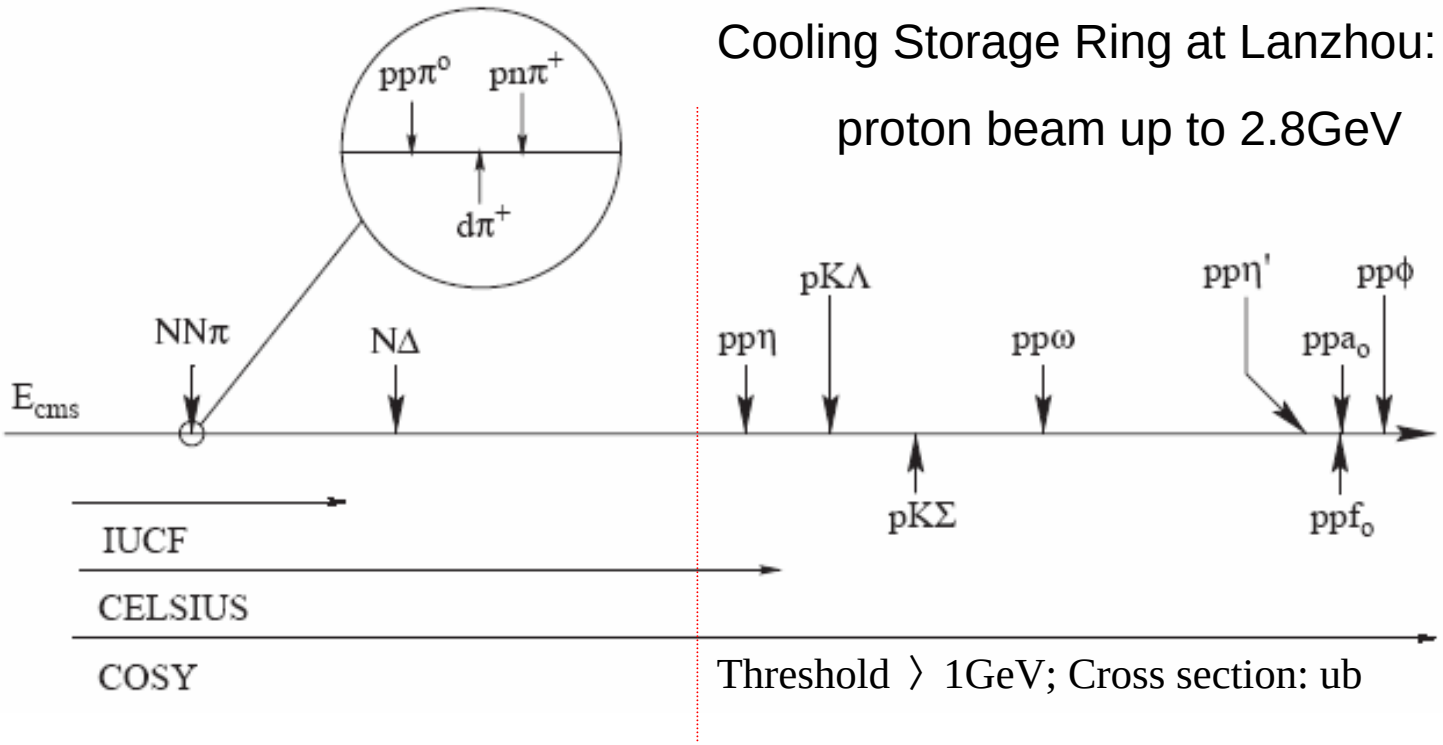
Strangeness Production Process



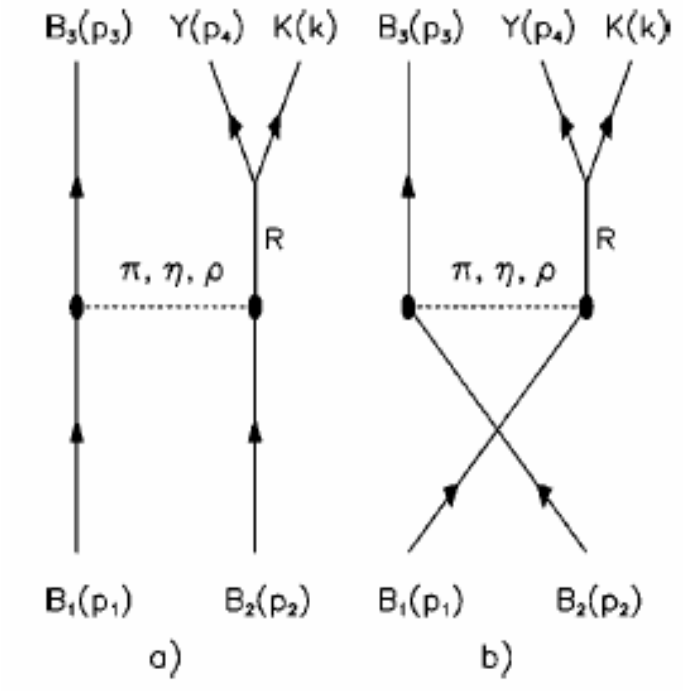
Cooling Storage Ring at Lanzhou:

proton beam up to 2.8GeV

Threshold 〉1GeV; Cross section: ub

C. Hanhart, Phys. Rep. 397, 155, 2004

Phenomenological Model



1. Effective Lagrangians:

   Scalar, Vector, Tensor, PS, PV couplings

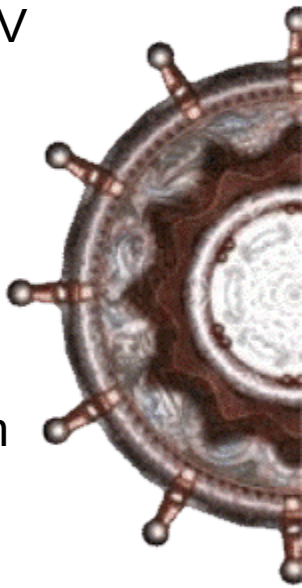
2. Form Factors:

   Bonn model

3. Final State Interaction:

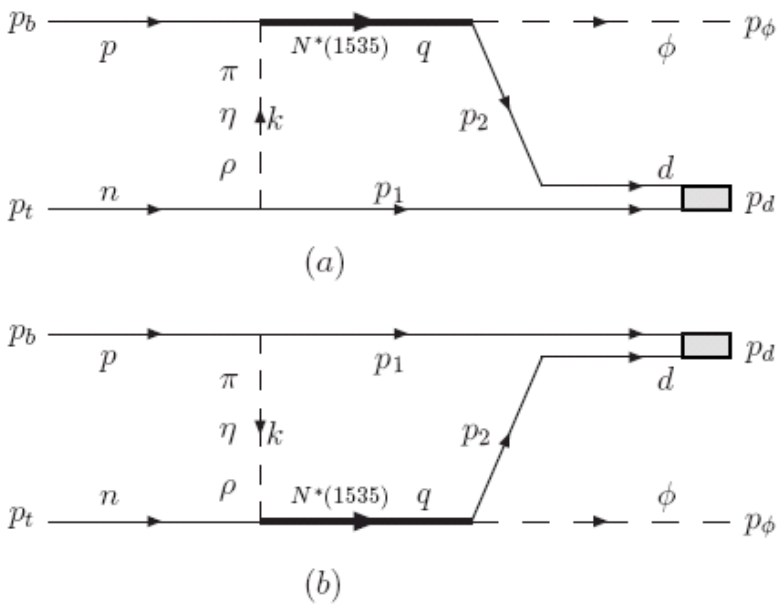
   Watson-Migdal Approximation

   Jost Function $T_{FSI} = \frac{q + i\beta}{q - i\alpha}$



K. Tsushima et al, Phys. Rev. C 59, 369, 1999

Phenomenological Model



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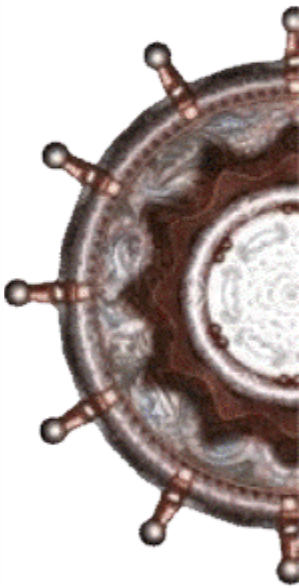
$$\phi_S(Q_R) = \sqrt{\frac{\alpha\beta(\alpha+\beta)}{\pi^2(\alpha-\beta)^2}}\left(\frac{1}{Q_R^2+\alpha^2} - \frac{1}{Q_R^2+\beta^2}\right)$$

$$iS_F^c(p_1)(-i\Gamma_\mu\varepsilon_d^\mu)iS_F(p_2) = \frac{(2\pi)^4}{\sqrt{2}}\delta\left(\frac{p_d\cdot q_r}{m_d}\right)u(p_1,s_1)\phi_s(Q_R)u(p_2,s_2)$$

Model Parameters

TABLE I: Relevant $N^*(1535)$ parameters.

Decay channel	Branching ratios	Adopted branching ratios	$g^2/4\pi$	Cutoff
$N\pi$	0.35-0.55	0.45	0.033	1.3
$N\eta$	0.45-0.60	0.53	0.28	1.3
$N\rho \to N\pi\pi$	0.02 ± 0.01	0.02	0.10	1.3
$N\phi$	–	—	0.13	1.3
$N\eta'$	–	—	1.1	0.8



Ju-Jun Xie, Bing-Song Zou, Huan-Ching Chiang, Phys. Rev. C 77, 015206 (2008);

Xu Cao, Xi-Guo Lee, Phys. Rev. C 78, 035207, 2008.

Role of the N*(1535) in η' production

----Xu Cao and Xi-Guo Lee, Phys. Rev. C 78, 035207, 2008

- 1. Recent experiment:

  $\gamma p \to \eta' p$ N*(1535) and N*(1710)

  CLAS Collaboration, Phys. Rev. Lett. 96, 062001, 2006

- 2. eta-eta' mixing:

  N*(1535) ~ 45-60% ηN

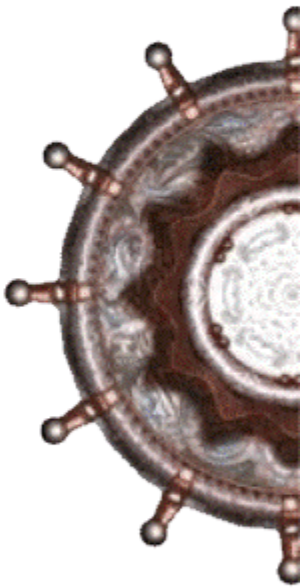
  ~ 35-55% πN

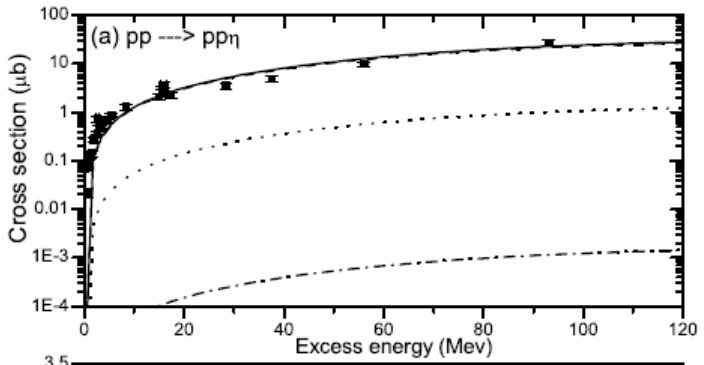
  Particle Data Group, Phys. Lett B 667, 1, 2008

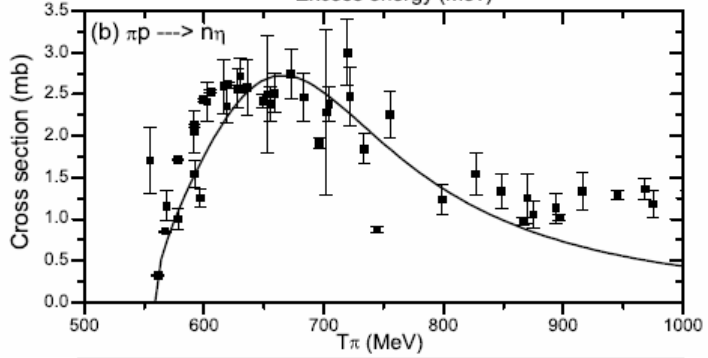
- 3. N*(1535) in Chiral Dynamics:

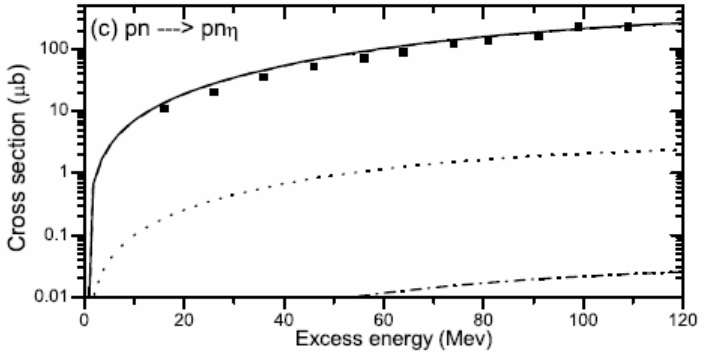
  Couple strongly to strange particles

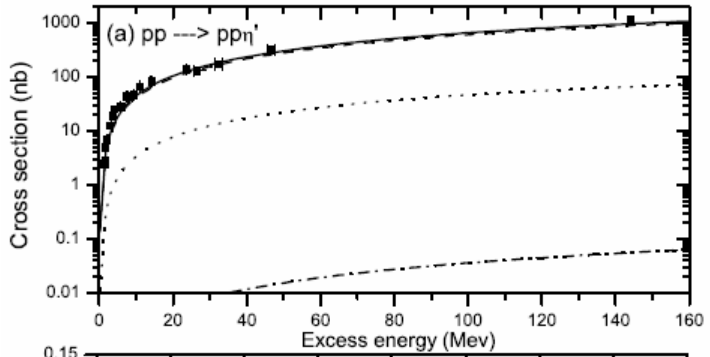
  N. Kaiser, T.Waas, and W.Weise, Nucl. Phys. **A612**, 297 (1997).

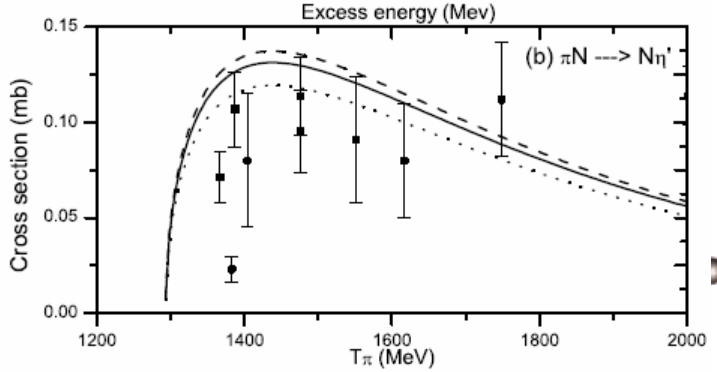


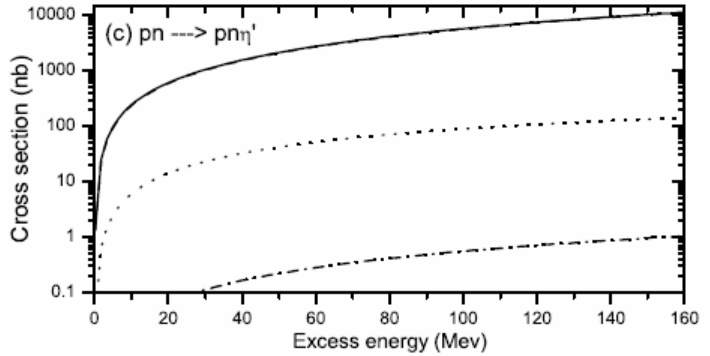

(a) pp ---> ppη
Cross section (μb)
Excess energy (Mev)

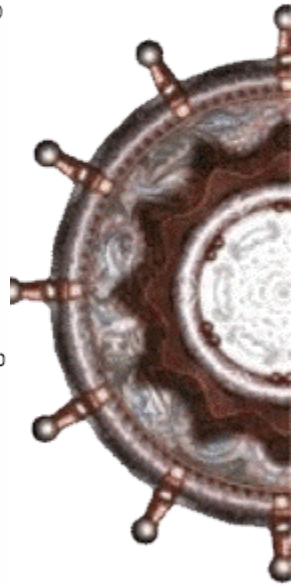

(b) πp ---> nη
Cross section (mb)
Tπ (MeV)


(c) pn ---> pnη
Cross section (μb)
Excess energy (Mev)


(a) pp ---> ppη'
Cross section (nb)
Excess energy (Mev)


(b) πN ---> Nη'
Cross section (mb)
Tπ (MeV)

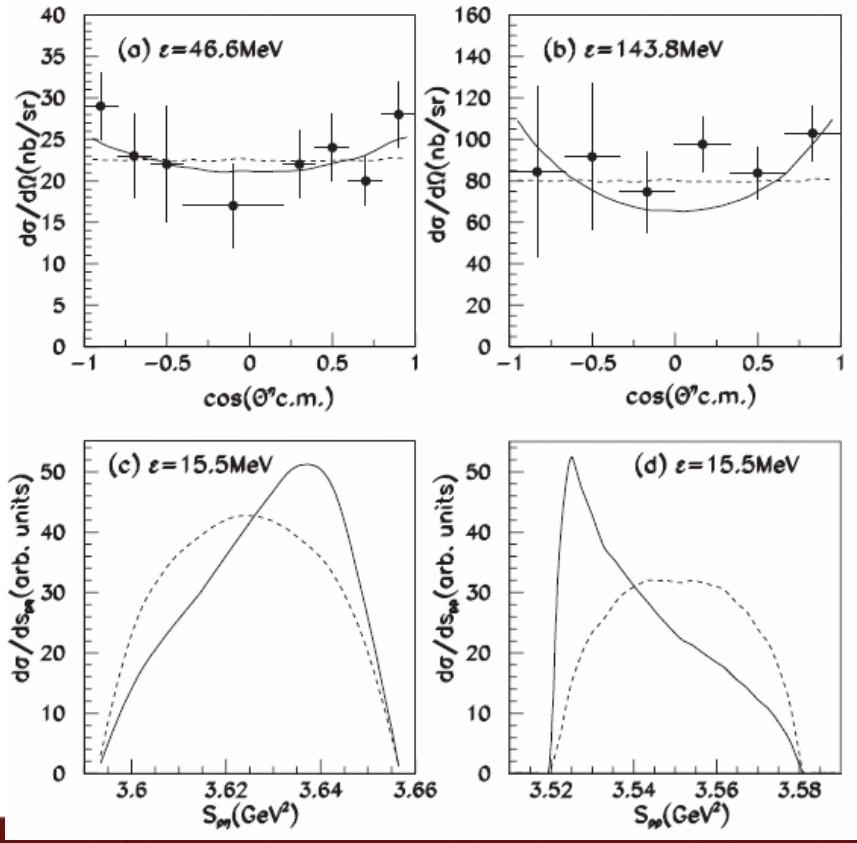

(c) pn ---> pnη'
Cross section (nb)
Excess energy (Mev)

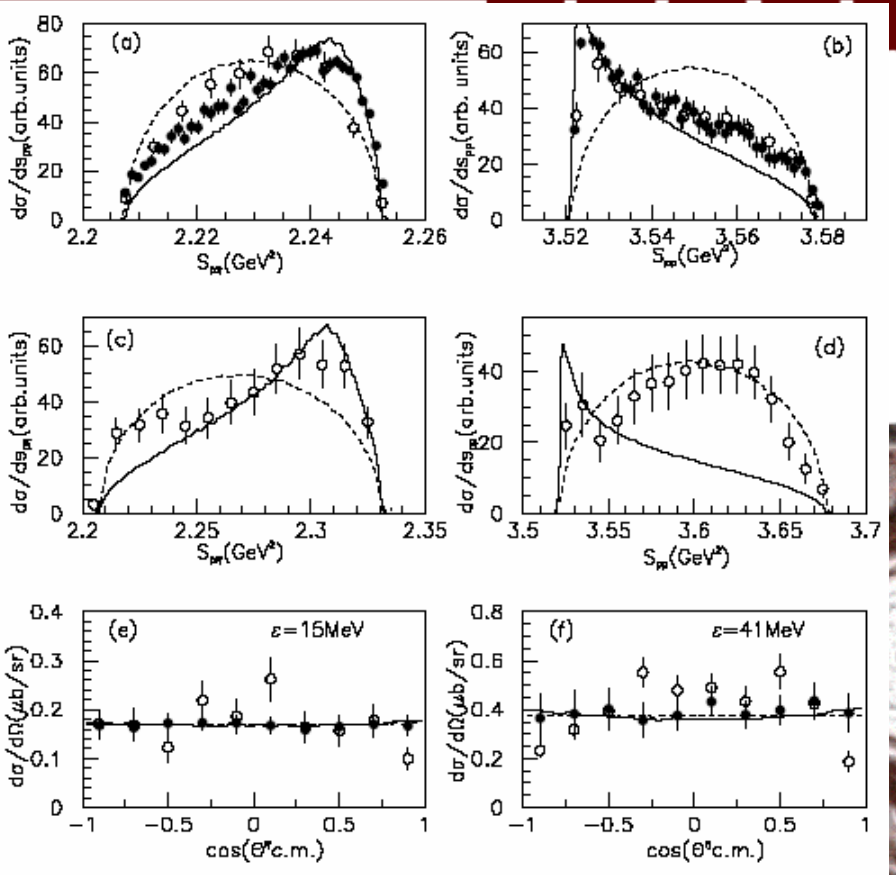


Xu Cao and Xi-Guo Lee,

Phys. Rev. C 78, 035207, 2008

$$pp \rightarrow pp\eta'$$

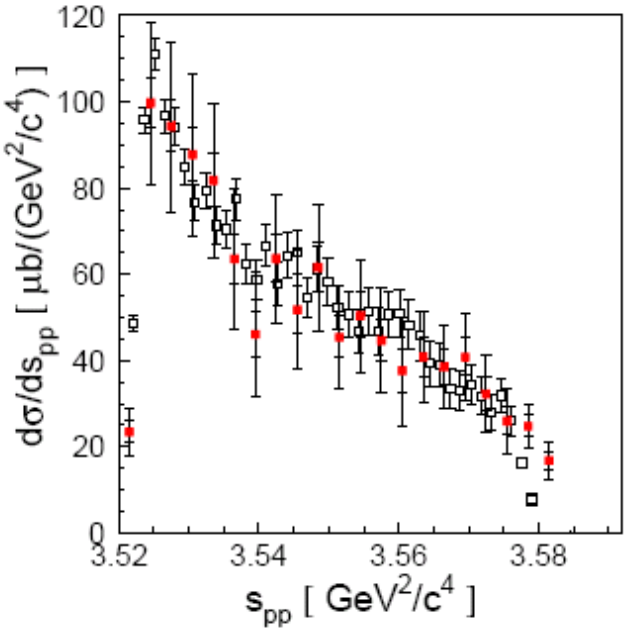


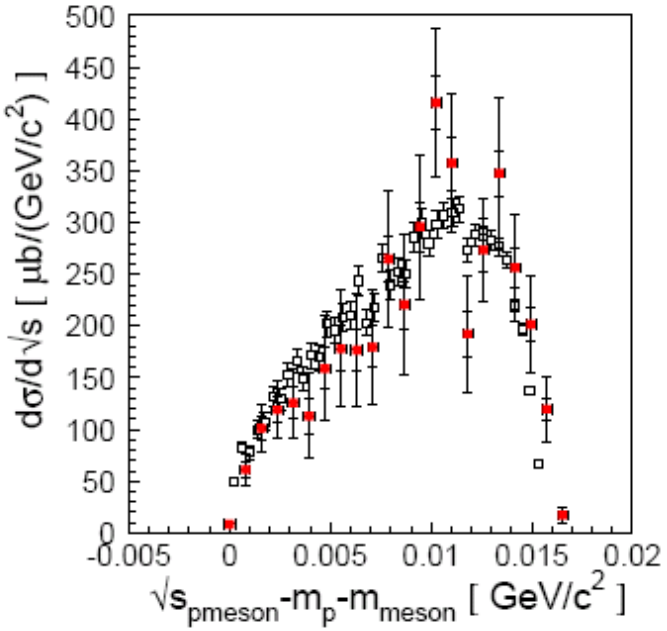


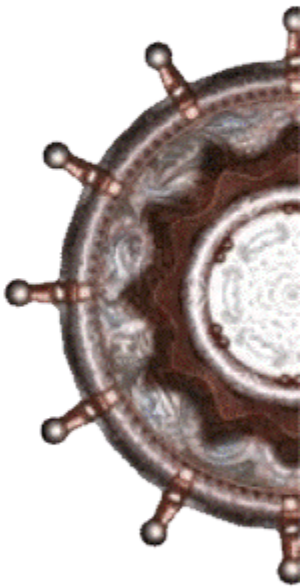
$$pp \rightarrow pp\eta$$

Recent data from COSY-11

--- P. Klaja, R. Czyzykiewicz, P. Moskal, arXiv:nucl-ex/0903.1758







at excess energy of 15.5 MeV

Role of the N*(1535) in η' production

$$g^2_{\eta' NN^*}/4\pi = 1.1 \; ?$$

eta-eta' mixing

$$|\eta\rangle = X_\eta|\eta_q\rangle + Y_\eta|\eta_s\rangle + Z_\eta|G\rangle$$

$$|\eta'\rangle = X_{\eta'}|\eta_q\rangle + Y_{\eta'}|\eta_s\rangle + Z_{\eta'}|G\rangle$$

Simple quark model

$$g_\eta = X_\eta g_q + Y_\eta g_s + Z_\eta g_G$$

$$g_{\eta'} = X_{\eta'} g_q + Y_{\eta'} g_s + Z_{\eta'} g_G$$

5-quark configurations: $qqqs\bar{s}$

B. S. Zou and D. O. Riska, Phys. Rev Lett. 95, 072001, 2005, also Chun-Sheng An's report.

$\gamma p \to \eta' p$

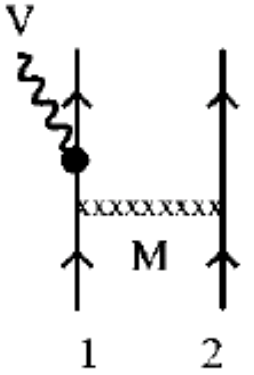
A. Sibirtsev et al, 2003' $g^2_{\eta' NN^*}/4\pi = 0.92$

K. Nakayama et al, 2006' $g^2_{\eta' NN^*}/4\pi = 1.0$

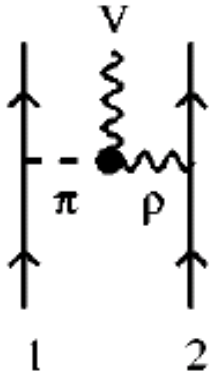
Role of the N*(1535) in $pn \to d\phi$

K. Nakayama et al,

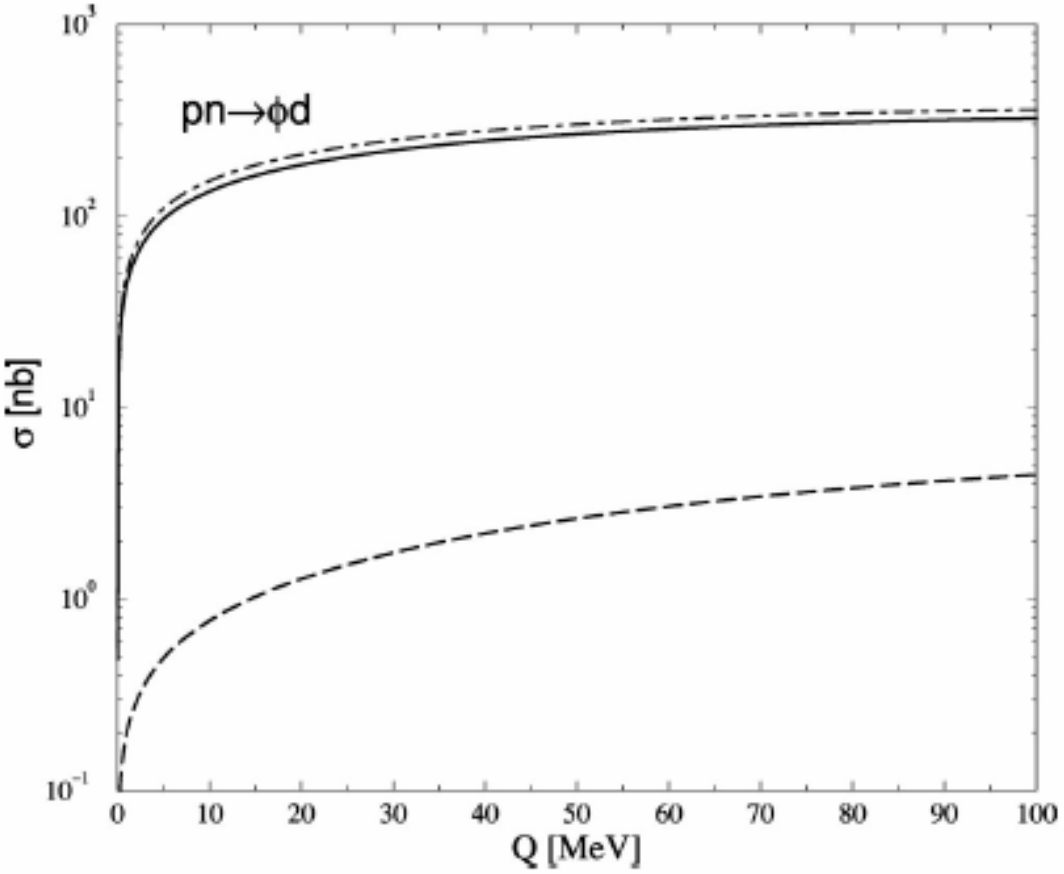
Phys. Rev. C 63, 015201, 2000



Nucleonic current



Mesonic current



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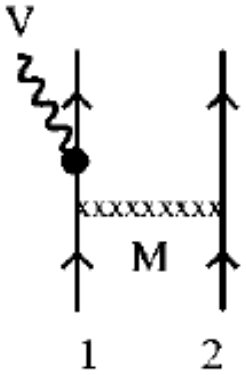
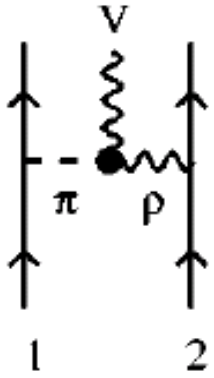
K. Nakayama et al,

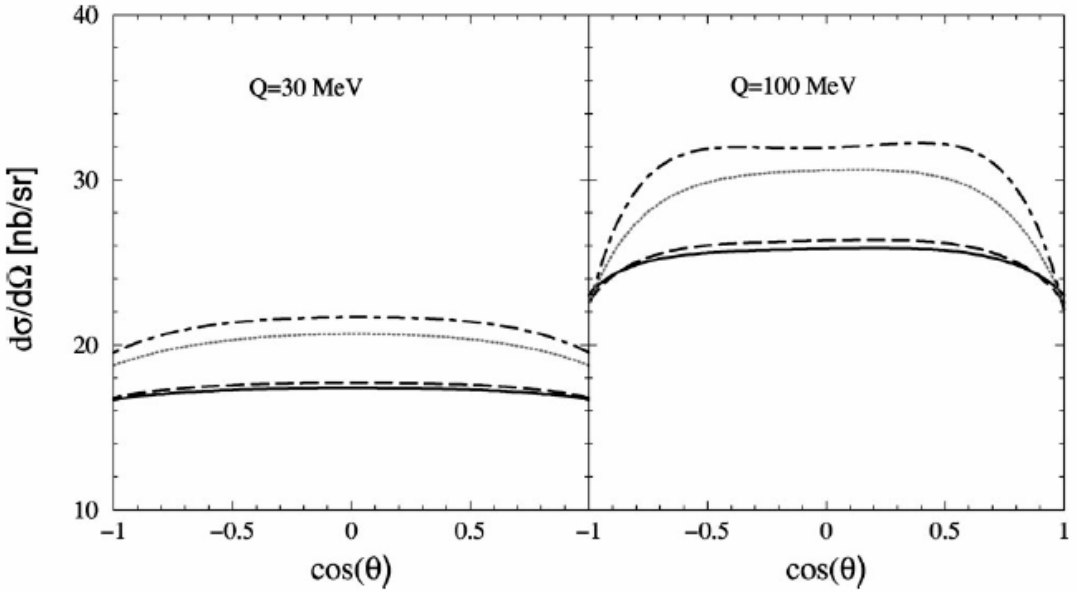
Phys. Rev. C 63, 015201, 2000



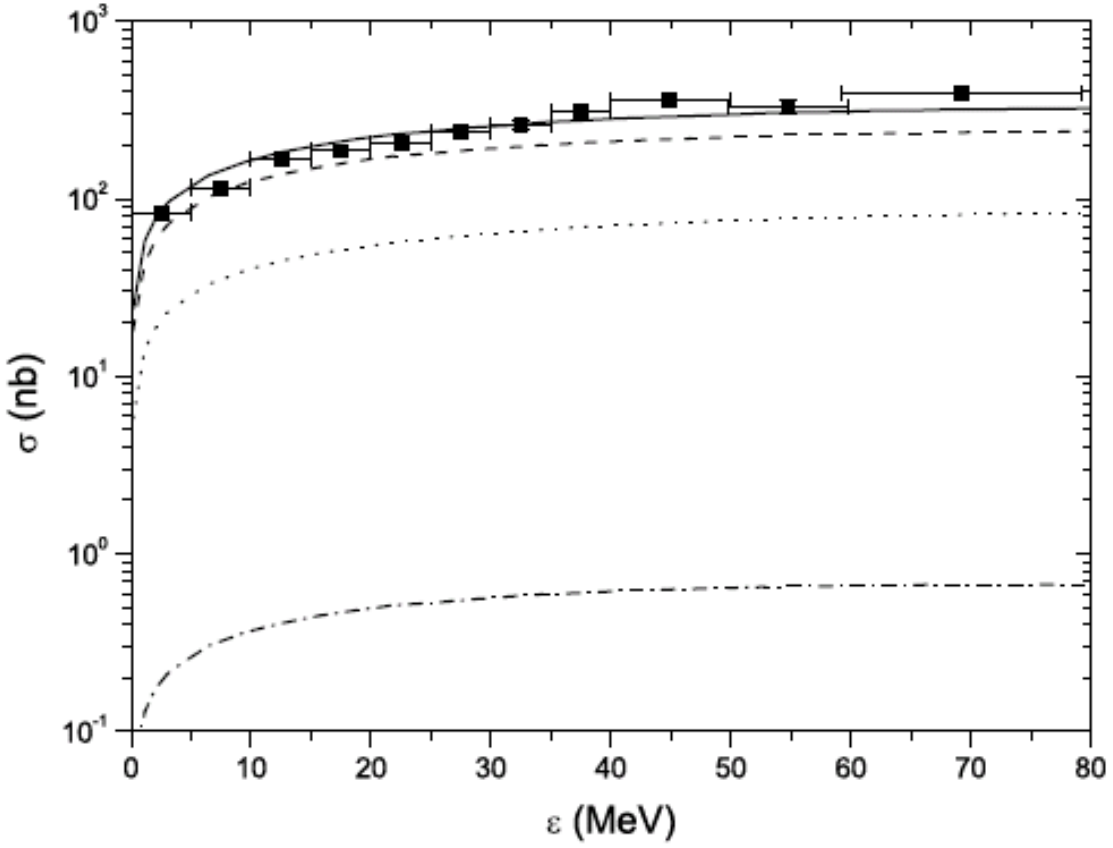
Nucleonic current



Mesonic current



Role of the N*(1535) in $pn \to d\phi$



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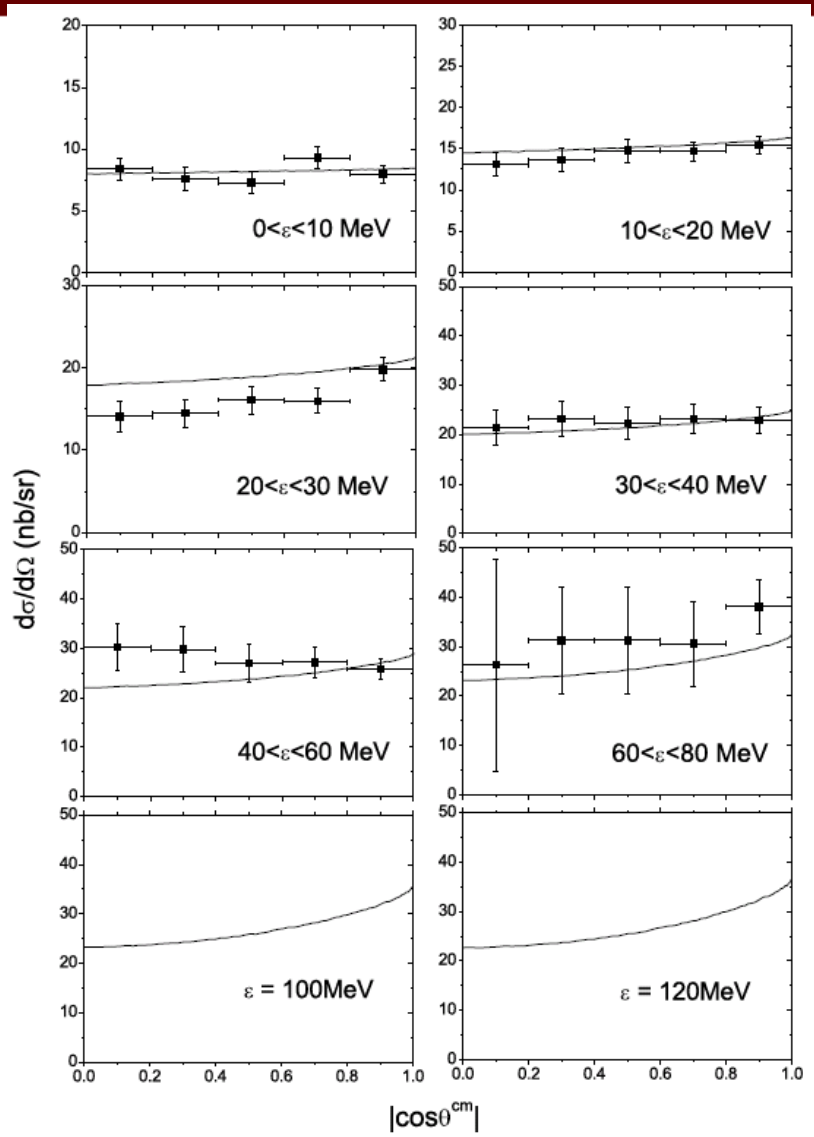

$pn \to d\phi$

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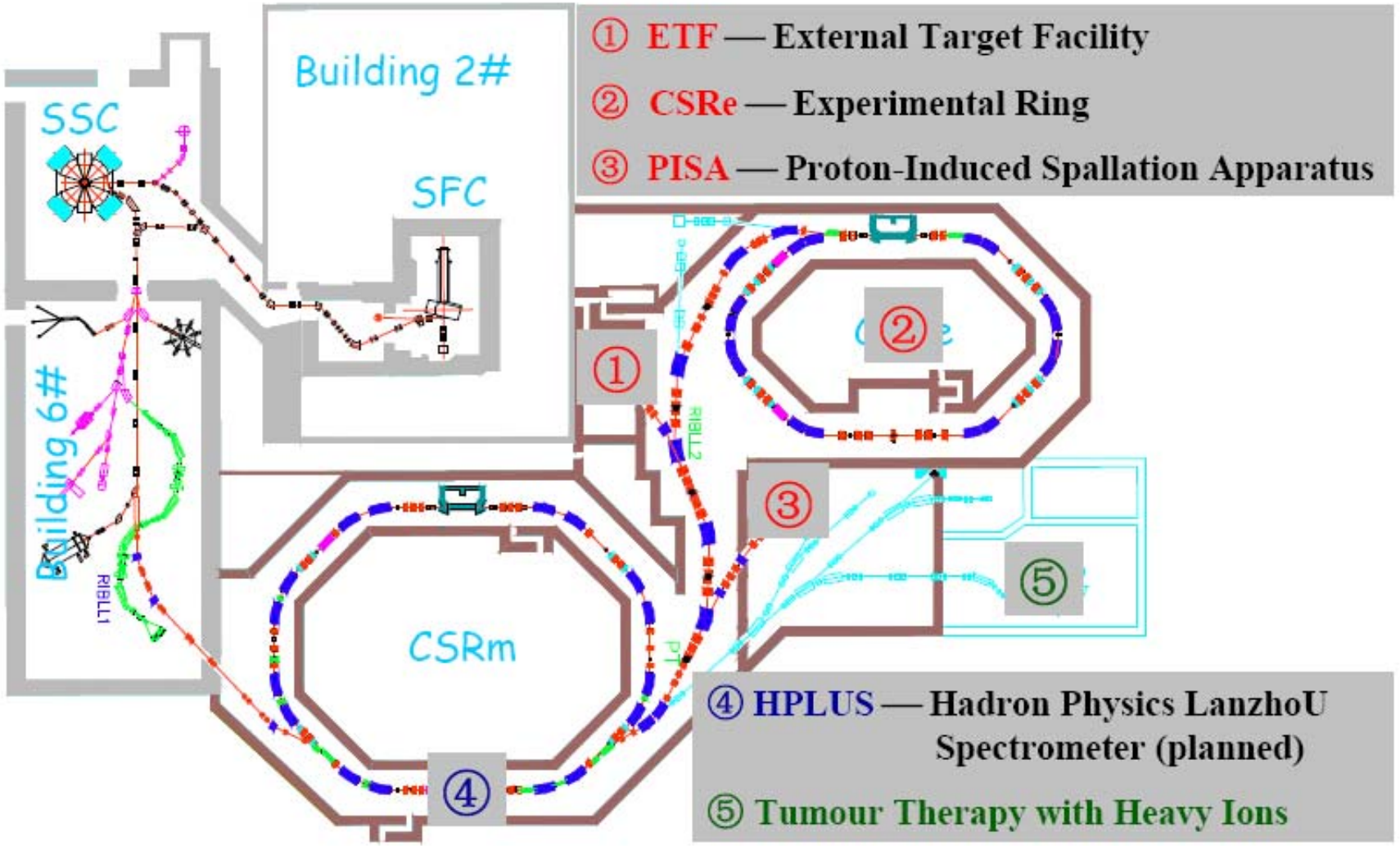
in preparation

Other S11 resonance can not be excluded!

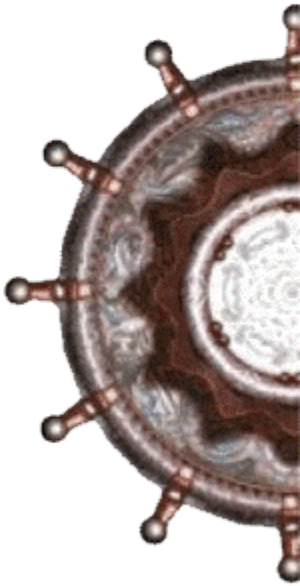
Experiments at CSR

Hushan Xu STORI08’



Summary

- Role of the N*(1535) in strange meson production in nucleon-nucleon collisions
- The internal structure of N*(1535)
- Further measurements at COSY and CSR



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- Thank you……