Study of the η' meson structure, width and interactions with nucleons at COSY-11

Eryk Czerwiński, Paweł Moskal,
Joanna Klaja, Paweł Klaja
for the COSY-11 collaboration

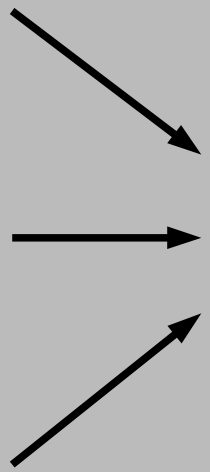
Excited QCD 2010 – Tatranska Lomnica

Overview

1. (Joanna Klaja) structure...
   arXiv:0909.4399 [nucl-ex]

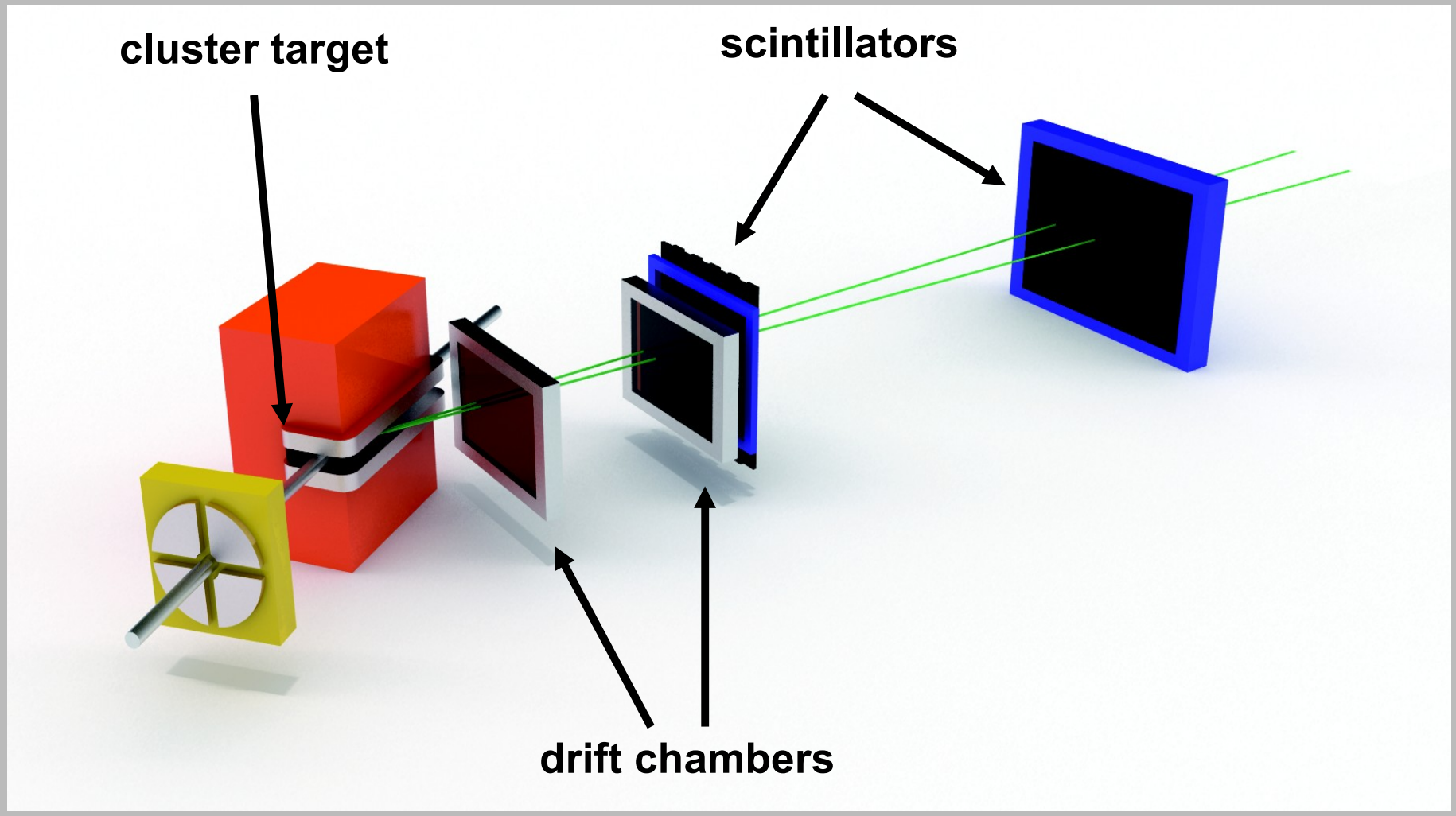
2. (Paweł Klaja) interactions...
   arXiv:0907.1491 [nucl-ex]
   Phys. Lett. B 684 (2010) 11

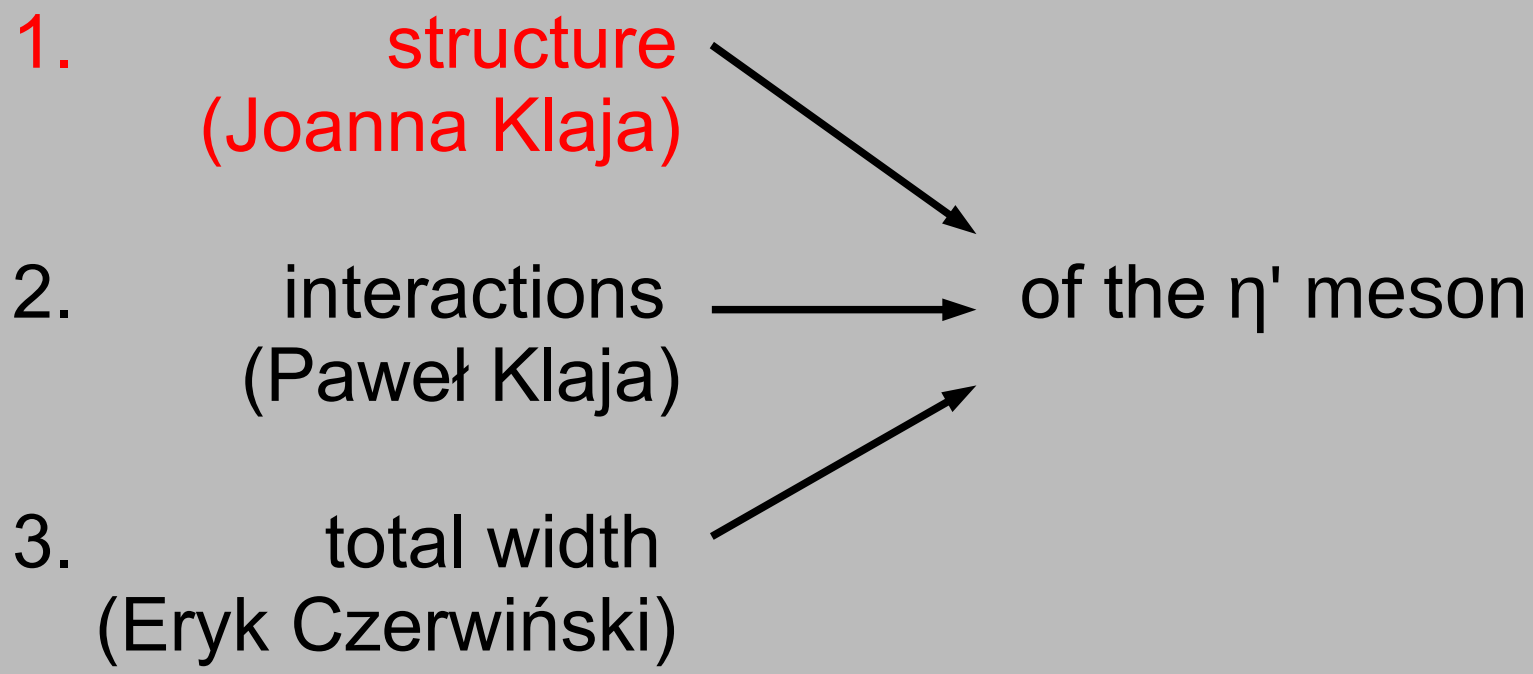
3. (Eryk Czerwiński) total width...
   arXiv:0909.2781 [nucl-ex]



...of the η' meson

COSY-11 detector setup

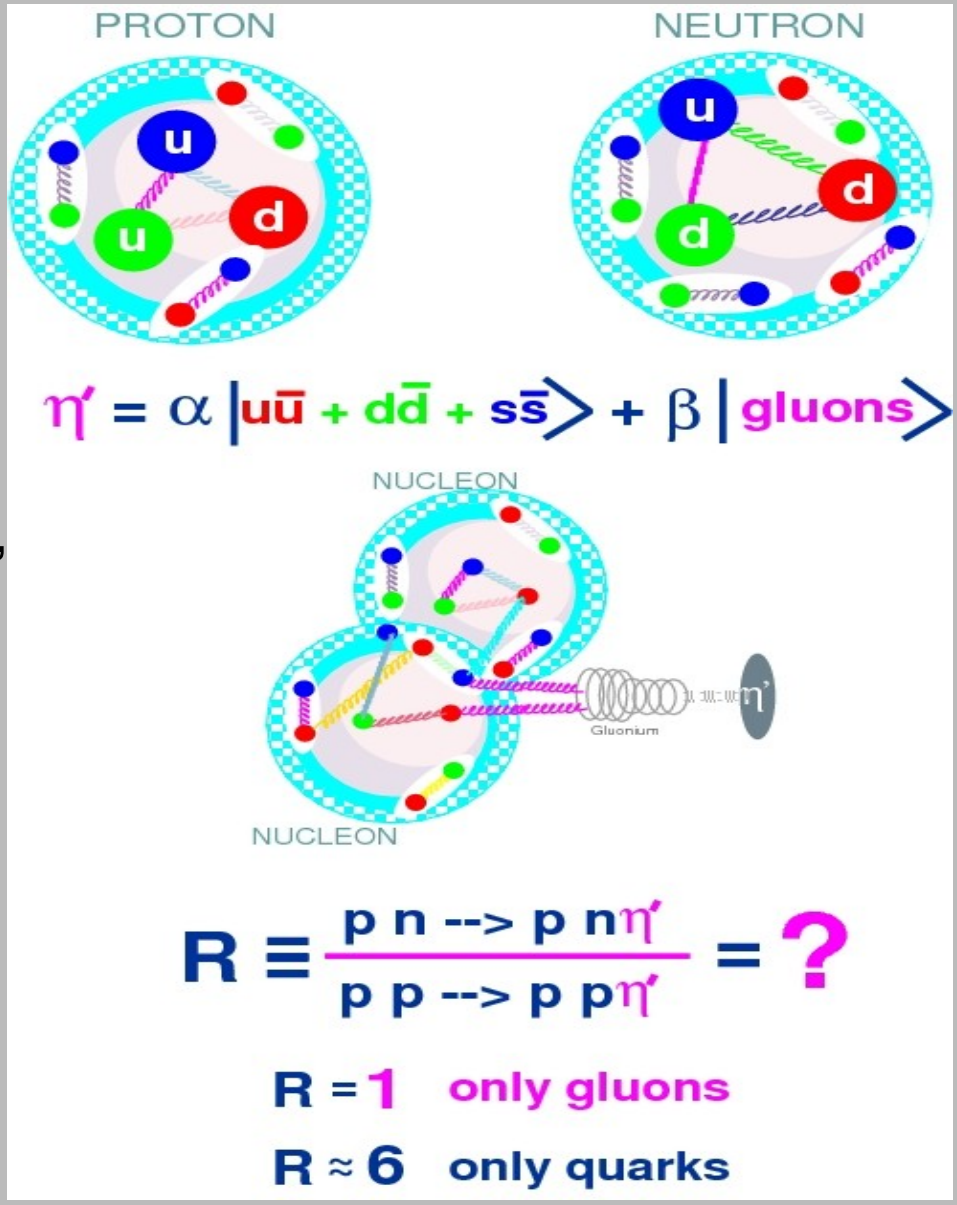



1. structure
(Joanna Klaja)
2. interactions
(Paweł Klaja)
3. total width
(Eryk Czerwiński)
of the η' meson

Motivation

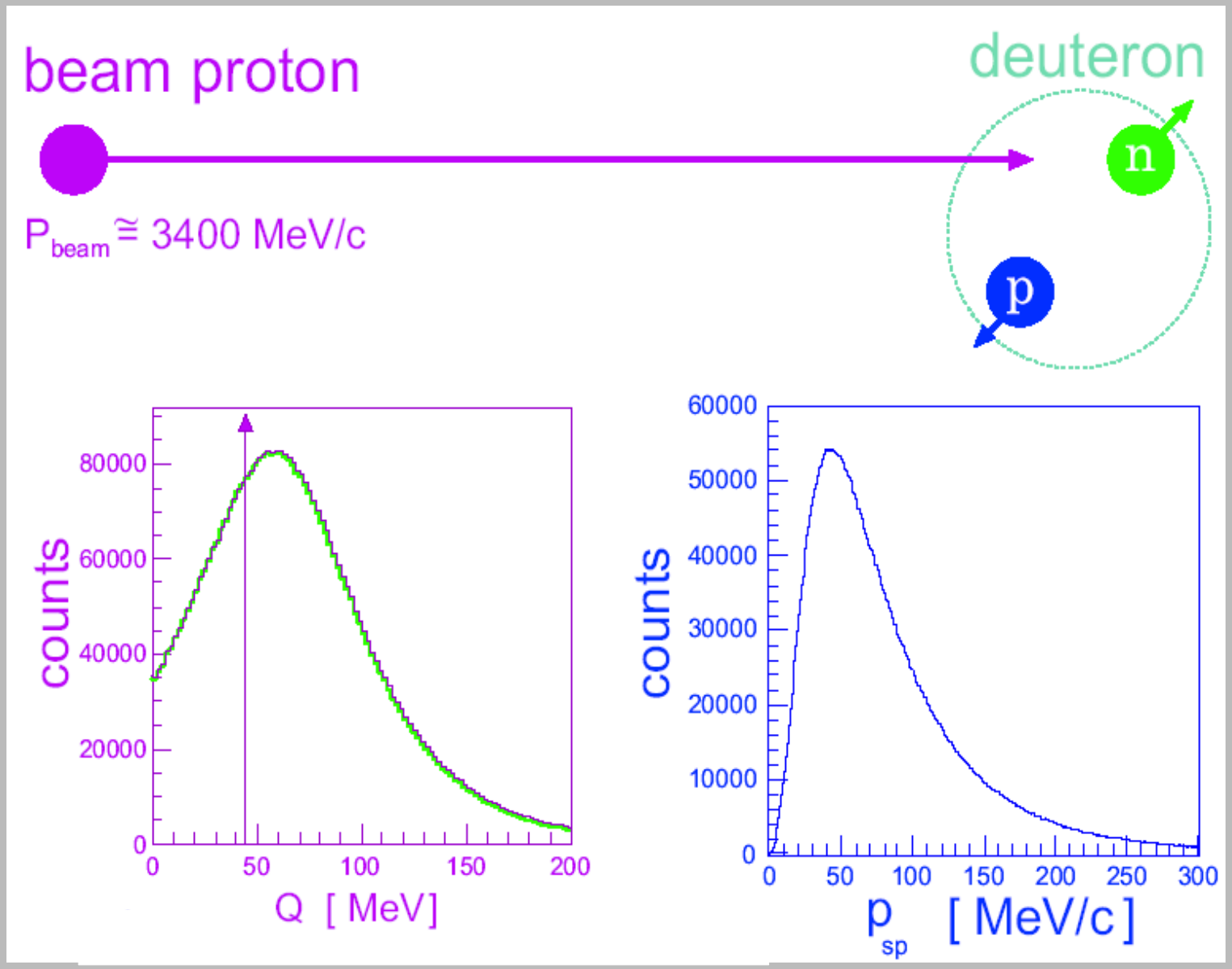
S.D. Bass,
Eur. Phys. J A5 (1999) 17,
E-Print Archive: hep-ph/0006348,
Phys. Scripta T 99 (2002)96

S.D. Bass, A.W. Thomas,
Phys. Lett. B634 (2006) 368



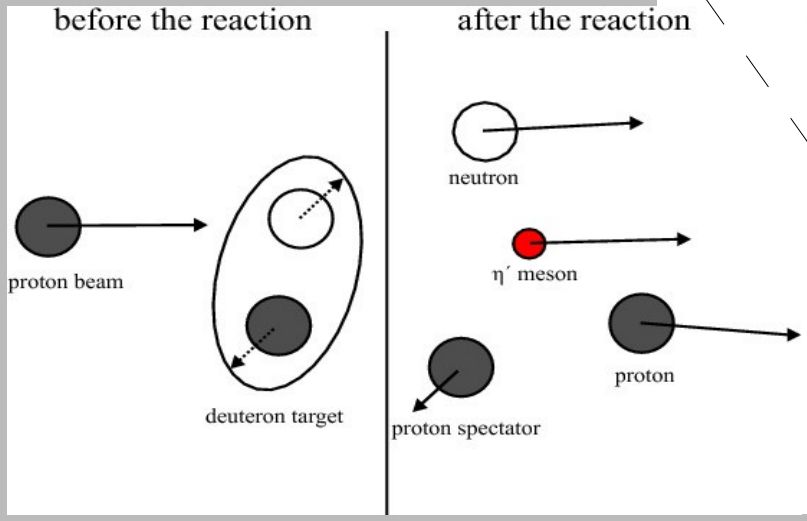
Spectator model

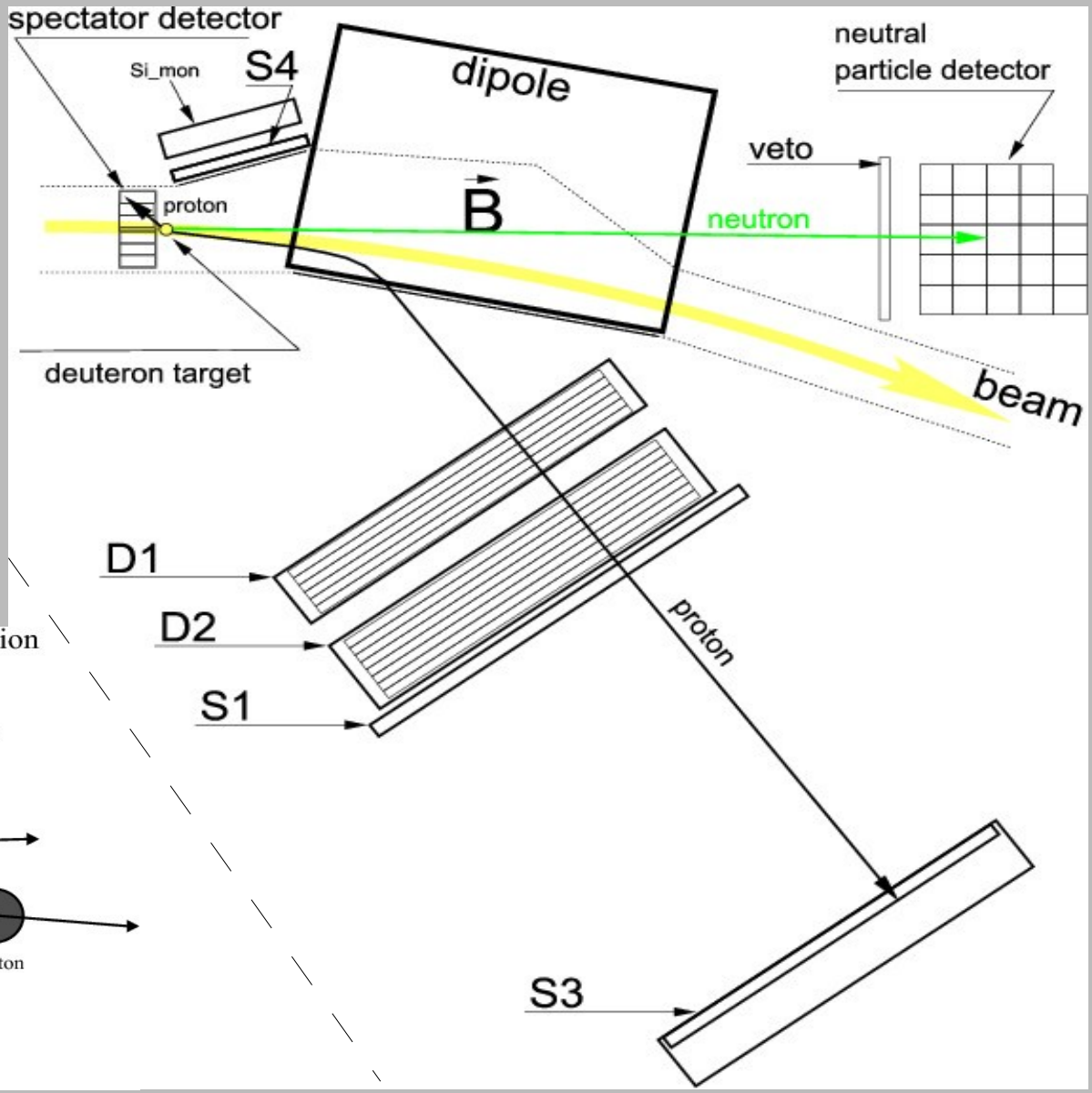
$p\,n \rightarrow p\,n\,\eta'$



Spectator model

$p\,n \rightarrow p\,n\,\eta'$

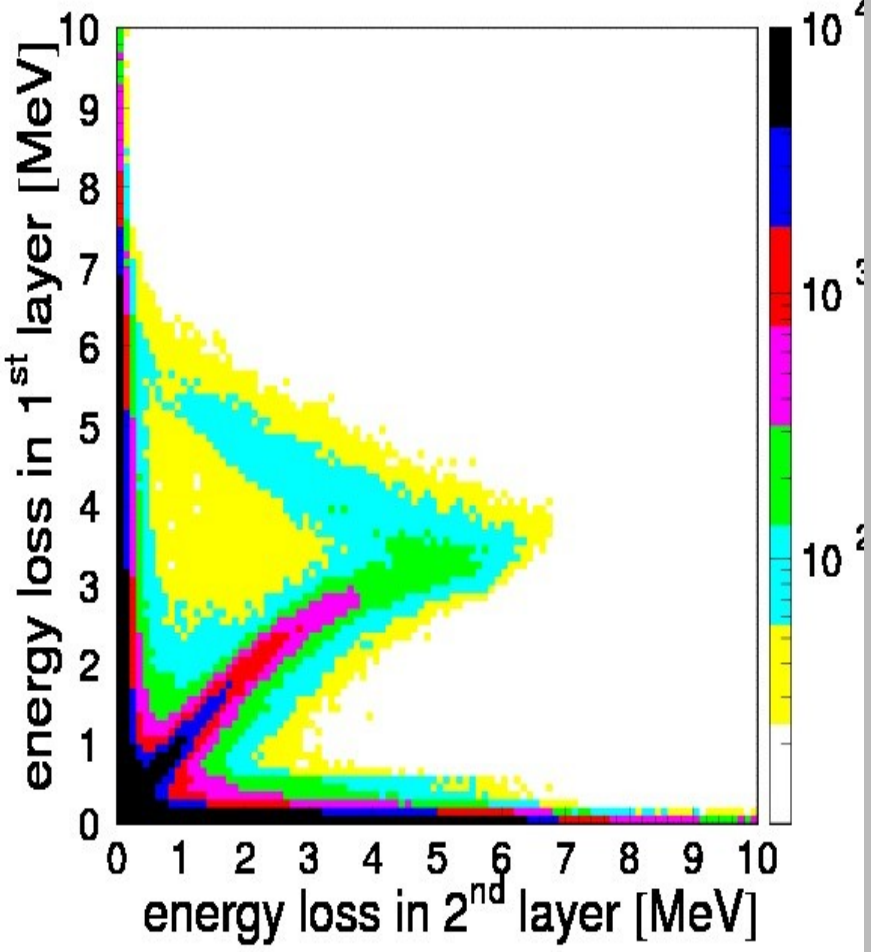




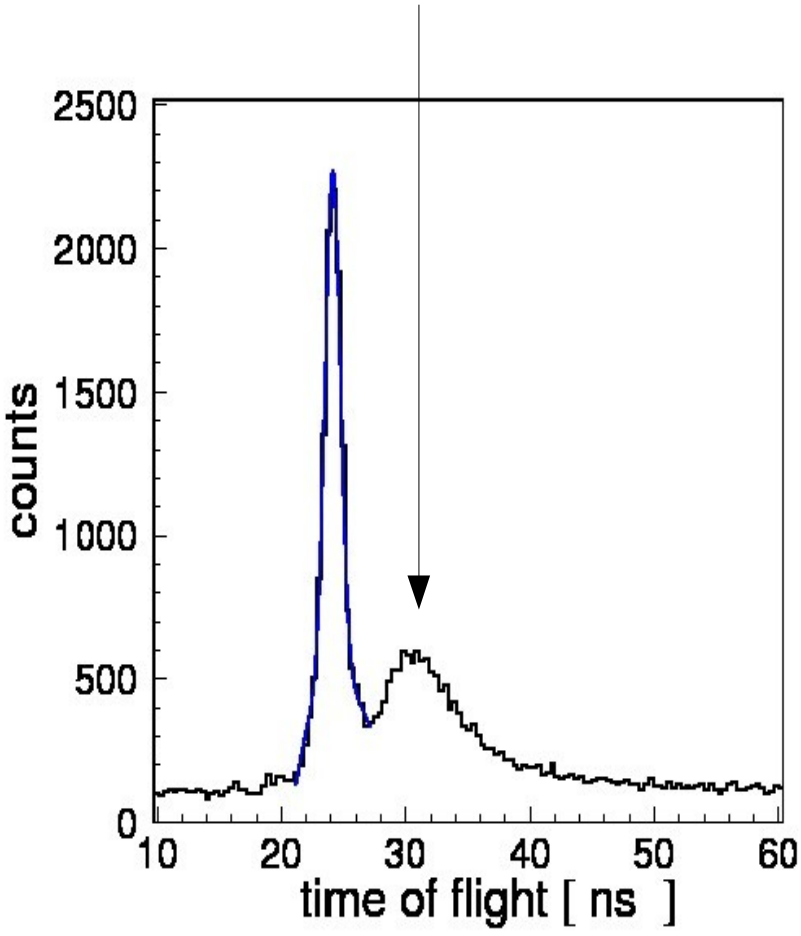
Example spectra

$p\,n \rightarrow p\,n\,\eta'$

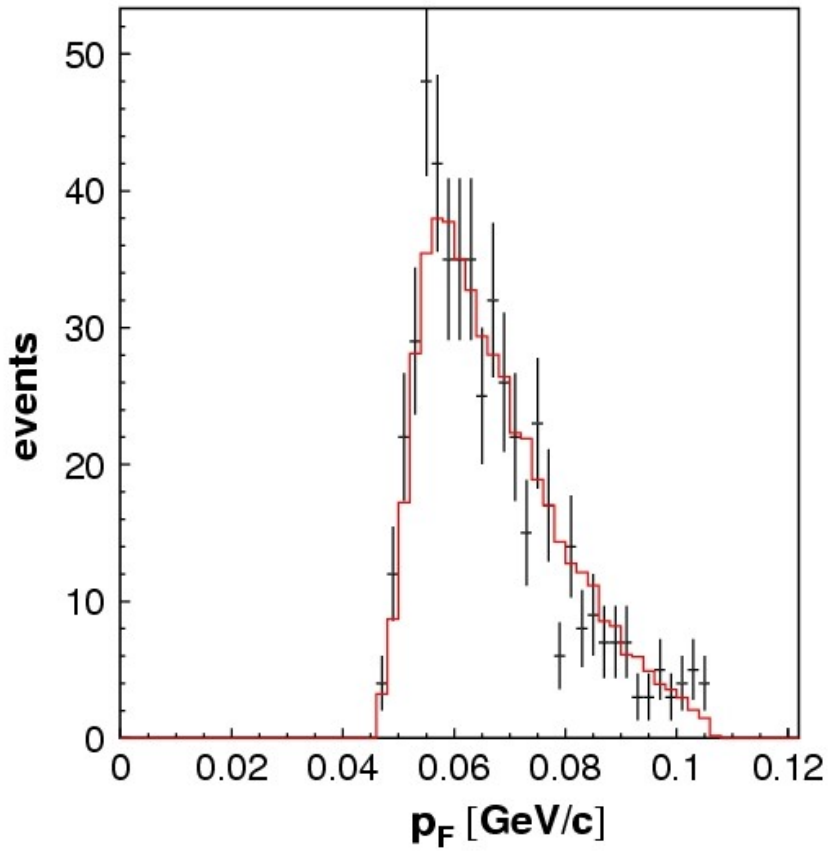
spectator protons

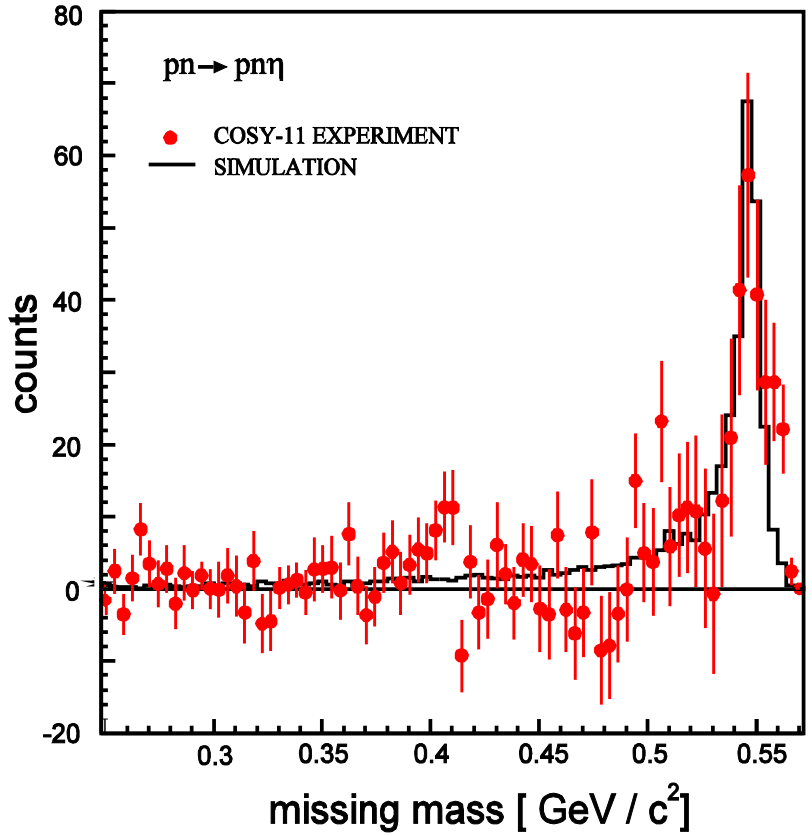


neutrons



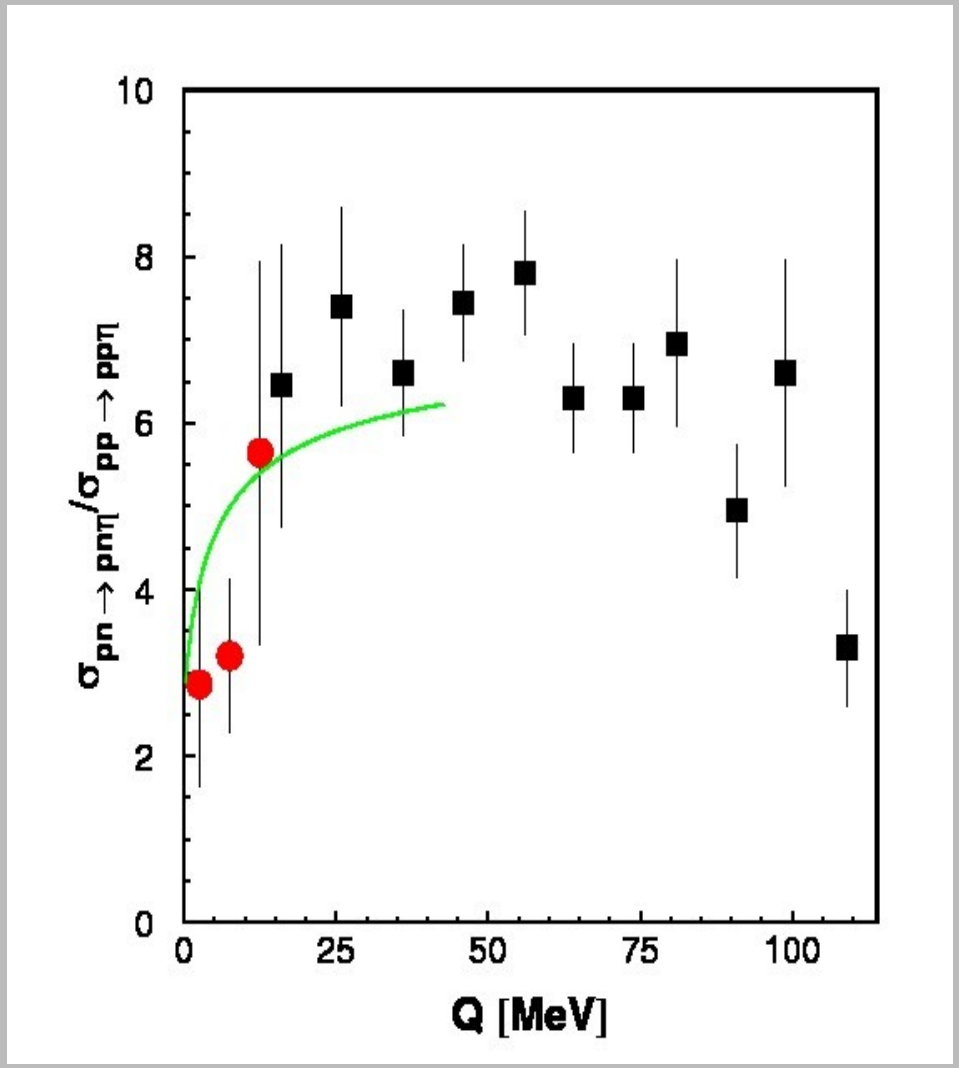
p n → p n η


events
50
40
30
20
10
0
0
0.02
0.04
0.06
0.08
0.1
0.12
p_F [GeV/c]


pn→ pnη
COSY-11 EXPERIMENT
SIMULATION
counts
80
60
40
20
0
-20
0.3
0.35
0.4
0.45
0.5
0.55
missing mass [GeV / c^2]

p n → p n η

$$\frac{\sigma(pn\to pn\eta)}{\sigma(pp\to pp\eta)} = 0.5 + A\left(\frac{\sqrt{(\varepsilon_{pp})} + \sqrt{(\varepsilon_{pp}+Q)}}{\sqrt{(\varepsilon_{pn})} + \sqrt{(\varepsilon_{pn}+Q)}}\right)^2$$

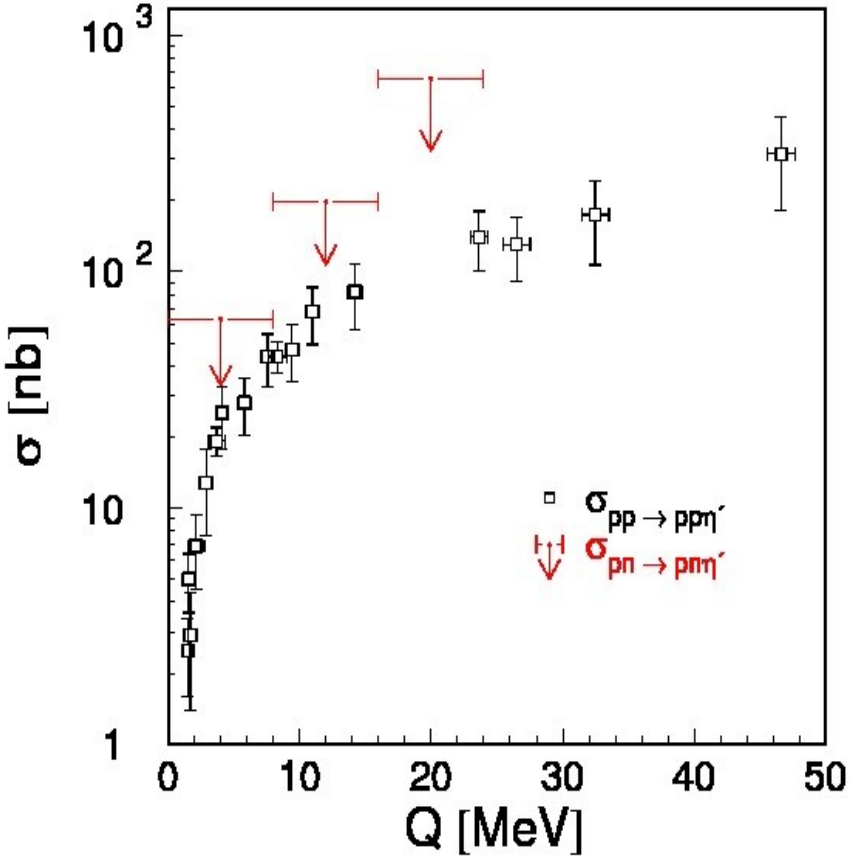


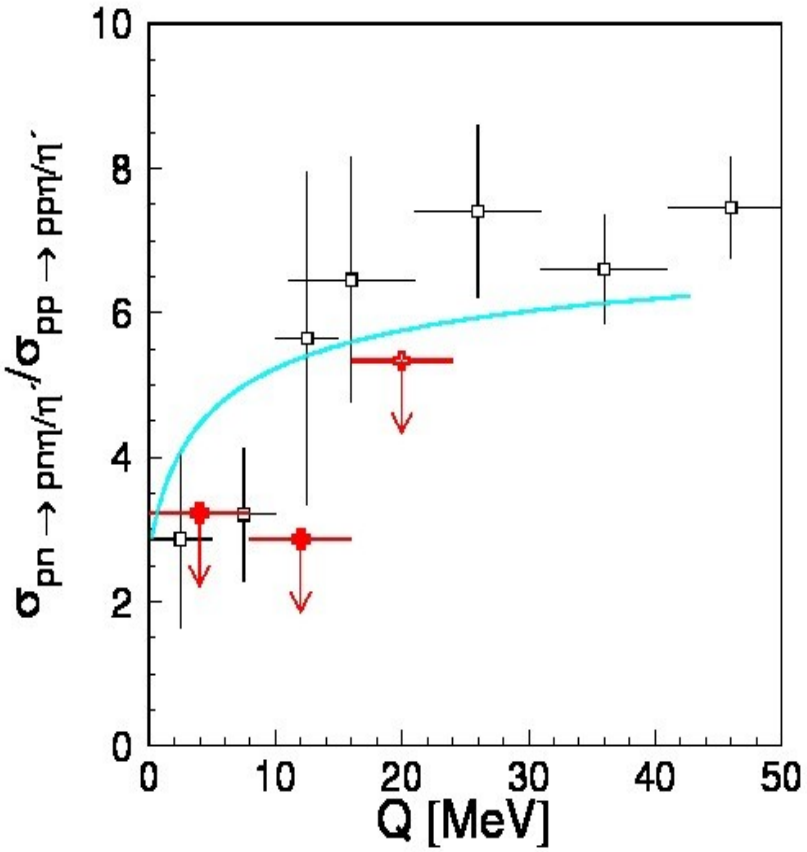
G. Faeldt, C. Wilkin,
Phys. Lett. B382 (1996) 209.
Phys. Rev. C56 (1997) 2067.

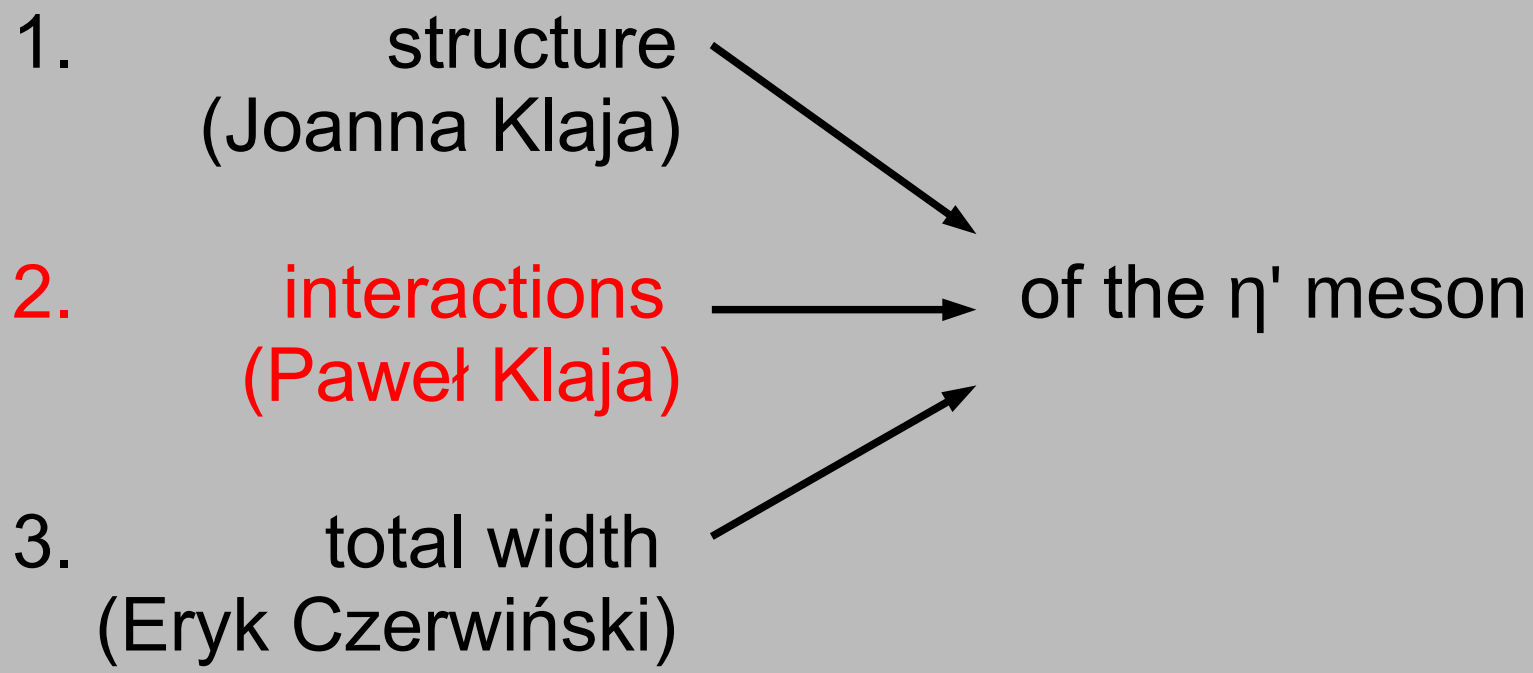
ε_{pp} = 0.68 MeV, ε_{pn} = 2.2 MeV
C. Wilkin, private communication (2008).
A = 6.98 ± 0.63; χ^2 = 1.4; N = 6

P.Moskal, R.Czyzykiewicz at al.
Phys. Rev. C 79 (2009) 015208

Results


σ [nb]
Q [MeV]
$\sigma_{pp \to pp\eta'}$
$\sigma_{pn \to pn\eta'}$


$\sigma_{pn \to pn\eta'}/\sigma_{pp \to pp\eta'}$
Q [MeV]

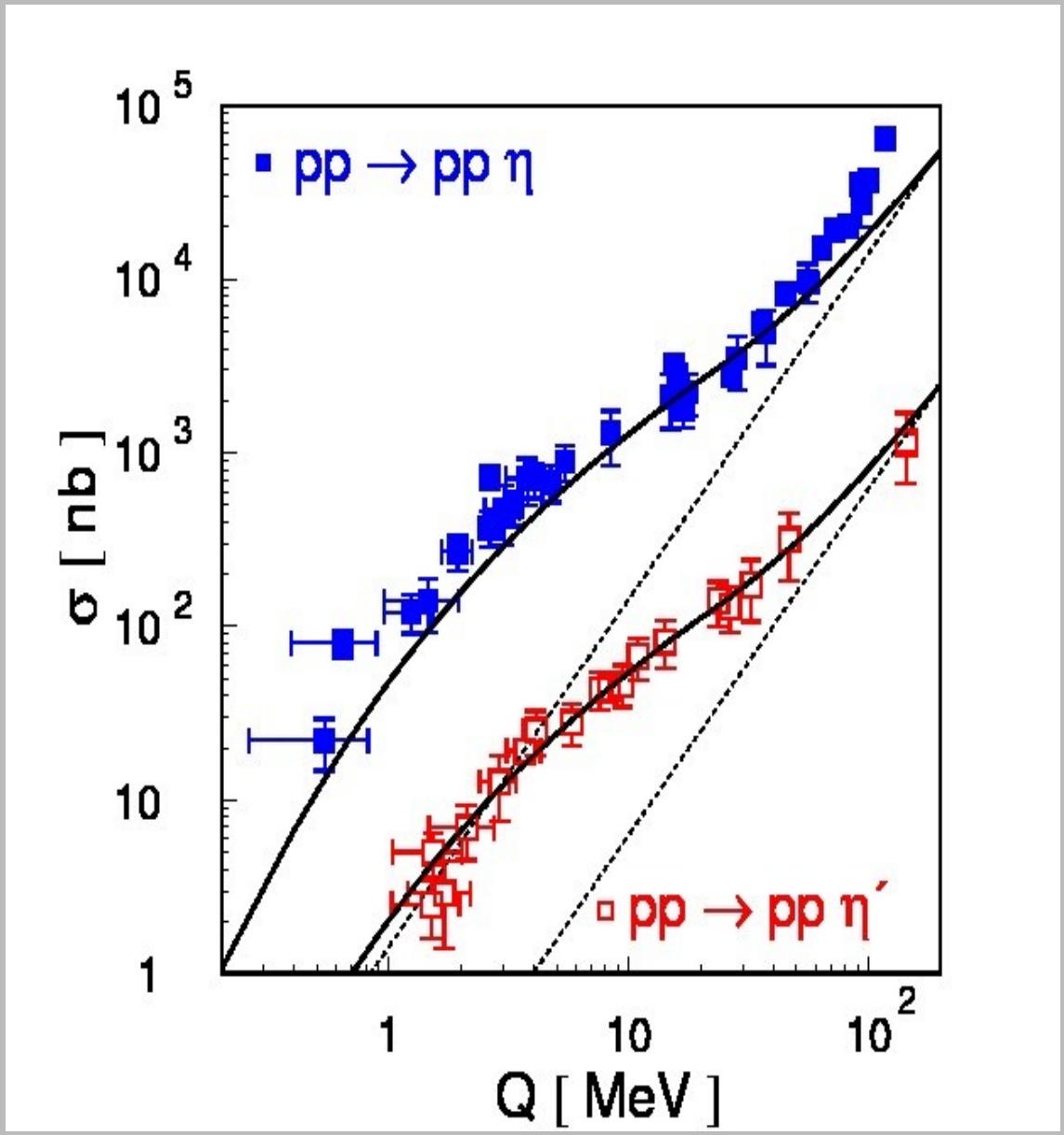

1. structure
(Joanna Klaja)
2. interactions
(Paweł Klaja)
3. total width
(Eryk Czerwiński)
of the η' meson

Motivation

theory:
M. Green, S. Wycech,
Phys. Rev. C 55
(1997) R2167

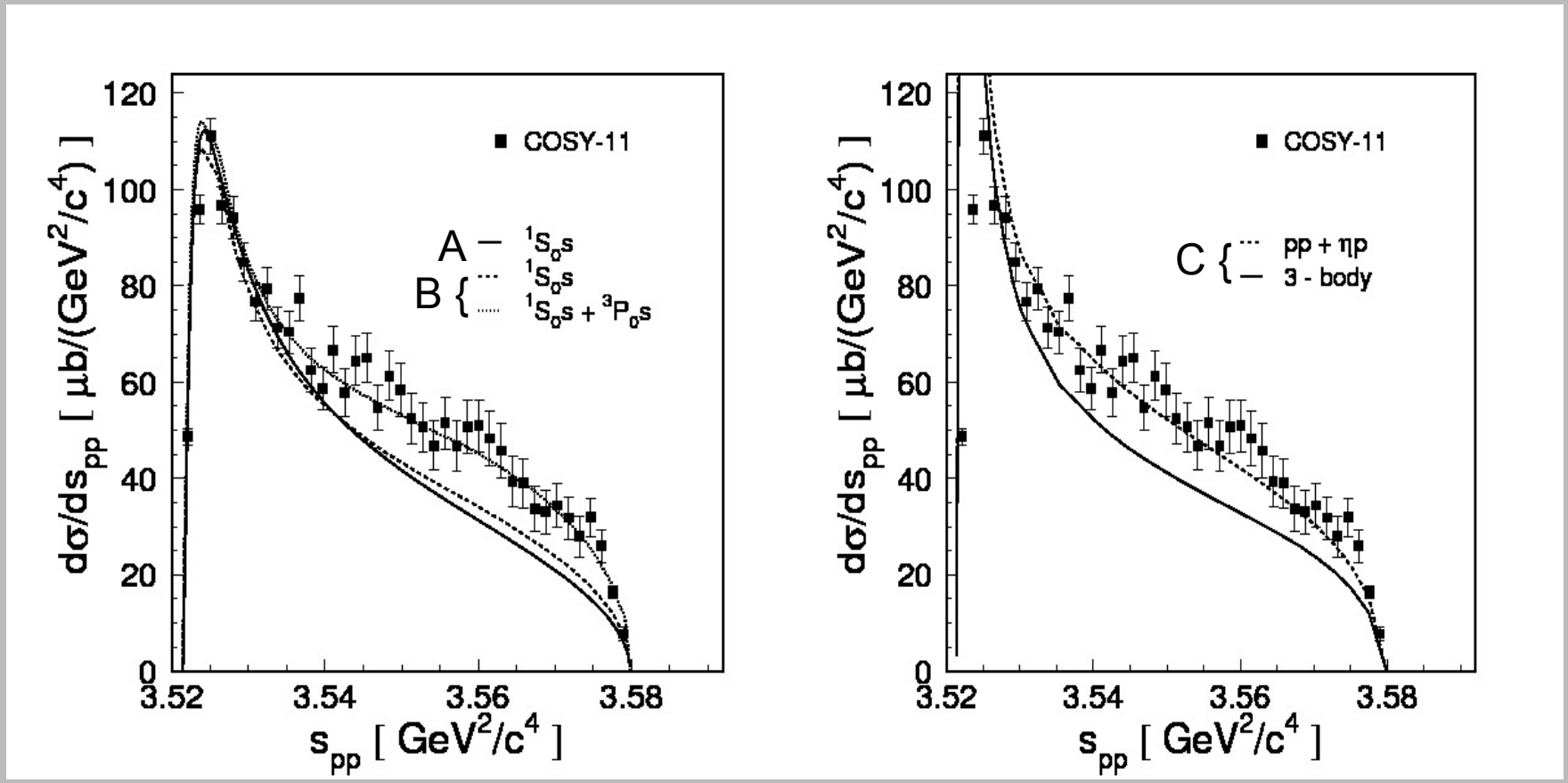
K. Nakayama et al.,
Phys. Rev. C 68
(2003) 045201

A. Fix, H. Arenhövel,
Phys. Rev. C 69
(2004) 014001



p p → p p η

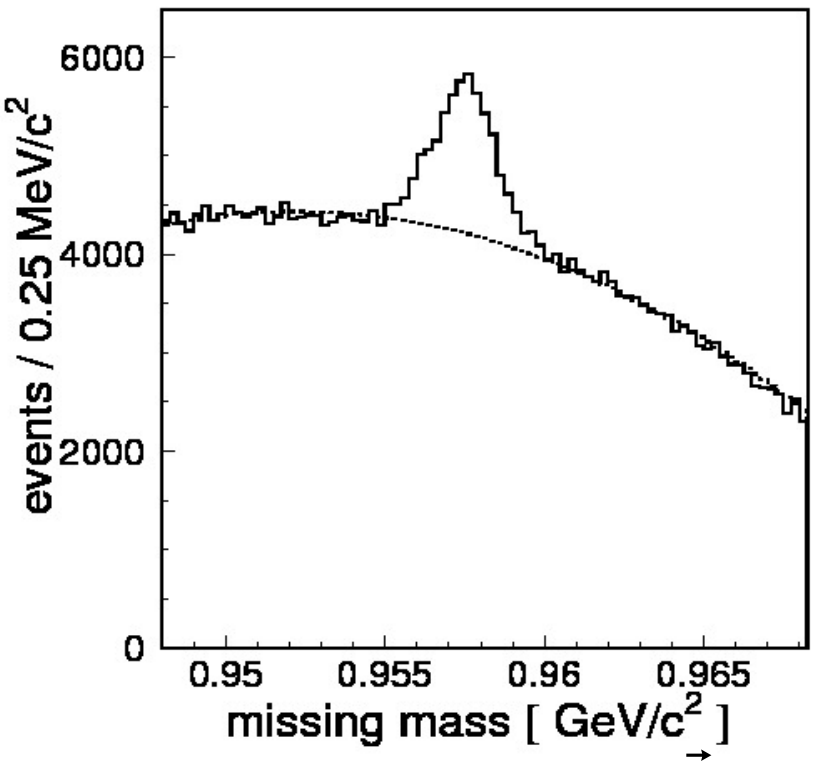
P. Moskal et al., Phys. Rev. C 69 (2004) 025203



A: V. Baru et al., C 67 (2003) 024002
B: K. Nakayama et al., Phys. Rev. C 68 (2003) 045201
C: A. Fix, H. Arenhövel, Phys. Rev. C 69 (2004) 014001

Data sample

P_{beam} = 3.257 GeV/c

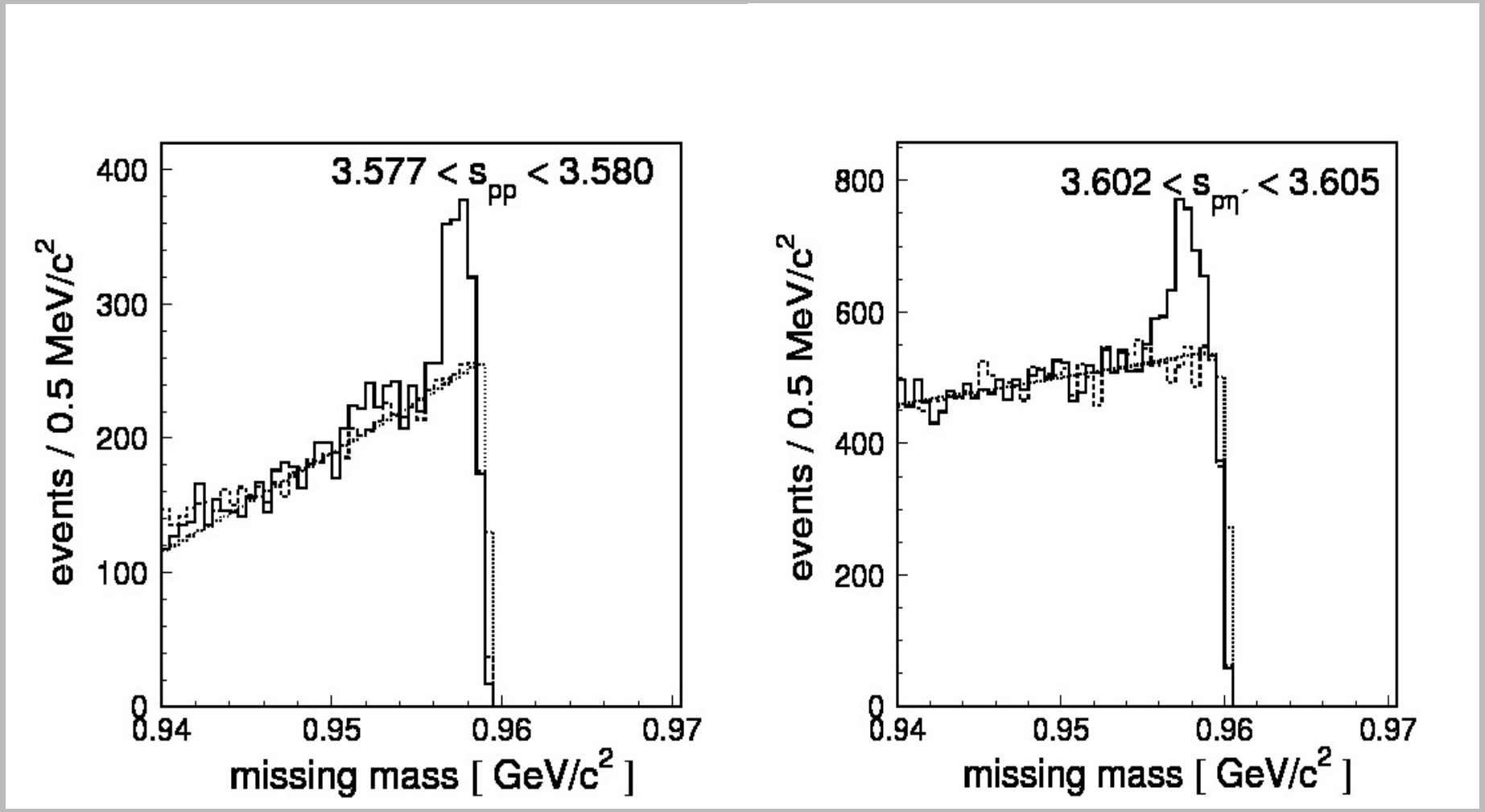


$$m_x^2 = E_x^2 - P_x^2 = \left(E_{beam} + E_{target} - E_1^p - E_2^p\right)^2 - \left|P_{beam} + P_{target} - P_1^p - P_2^p\right|^2$$

Clear signal with about 17000 events corresponding to the pp → ppη' reaction

Example spectra

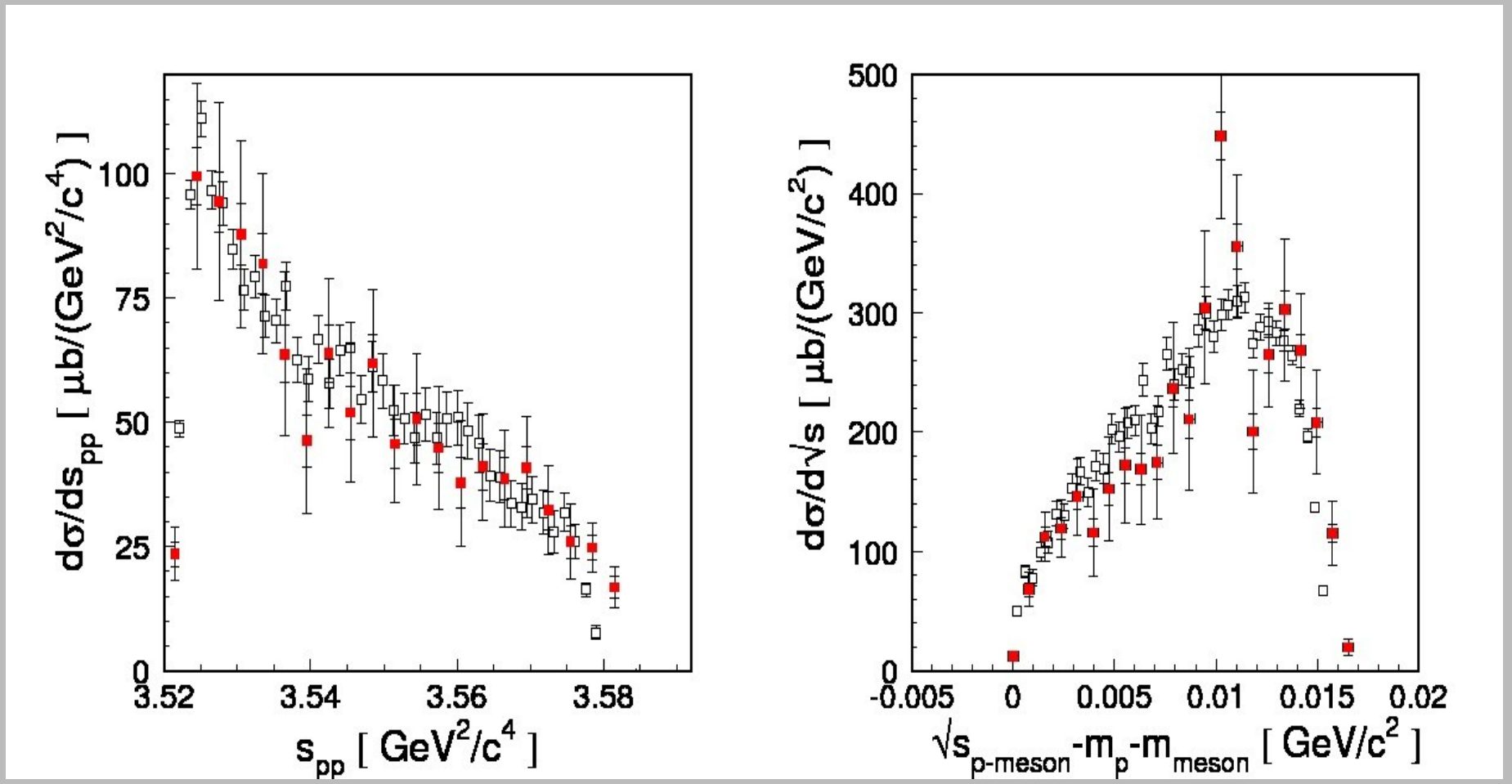
$p\,p \rightarrow p\,p\,\eta'$

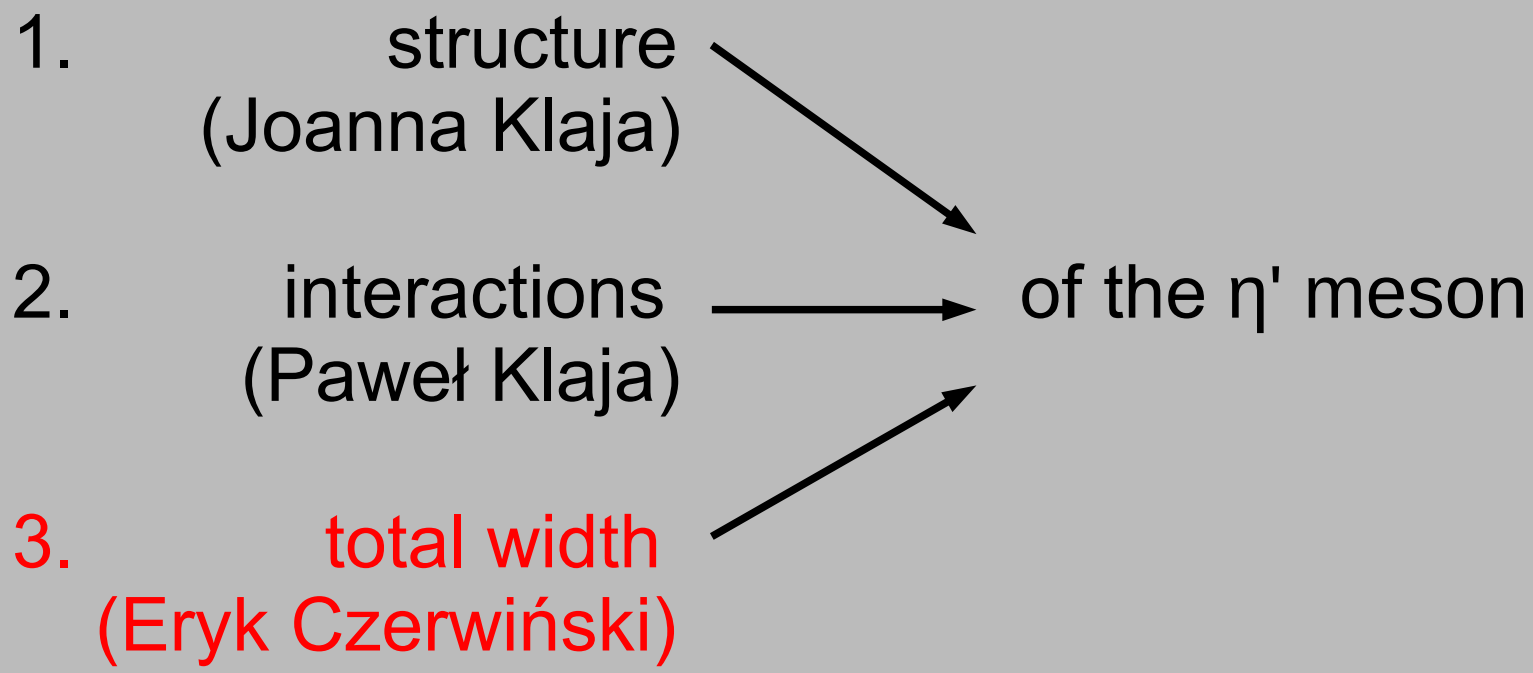


Results

pp → ppη P. Moskal et al., Phys. Rev. C 69 (2004) 025203

pp → ppη' P. Klaja, Phys. Lett. B 684 (2010) 11




1. structure
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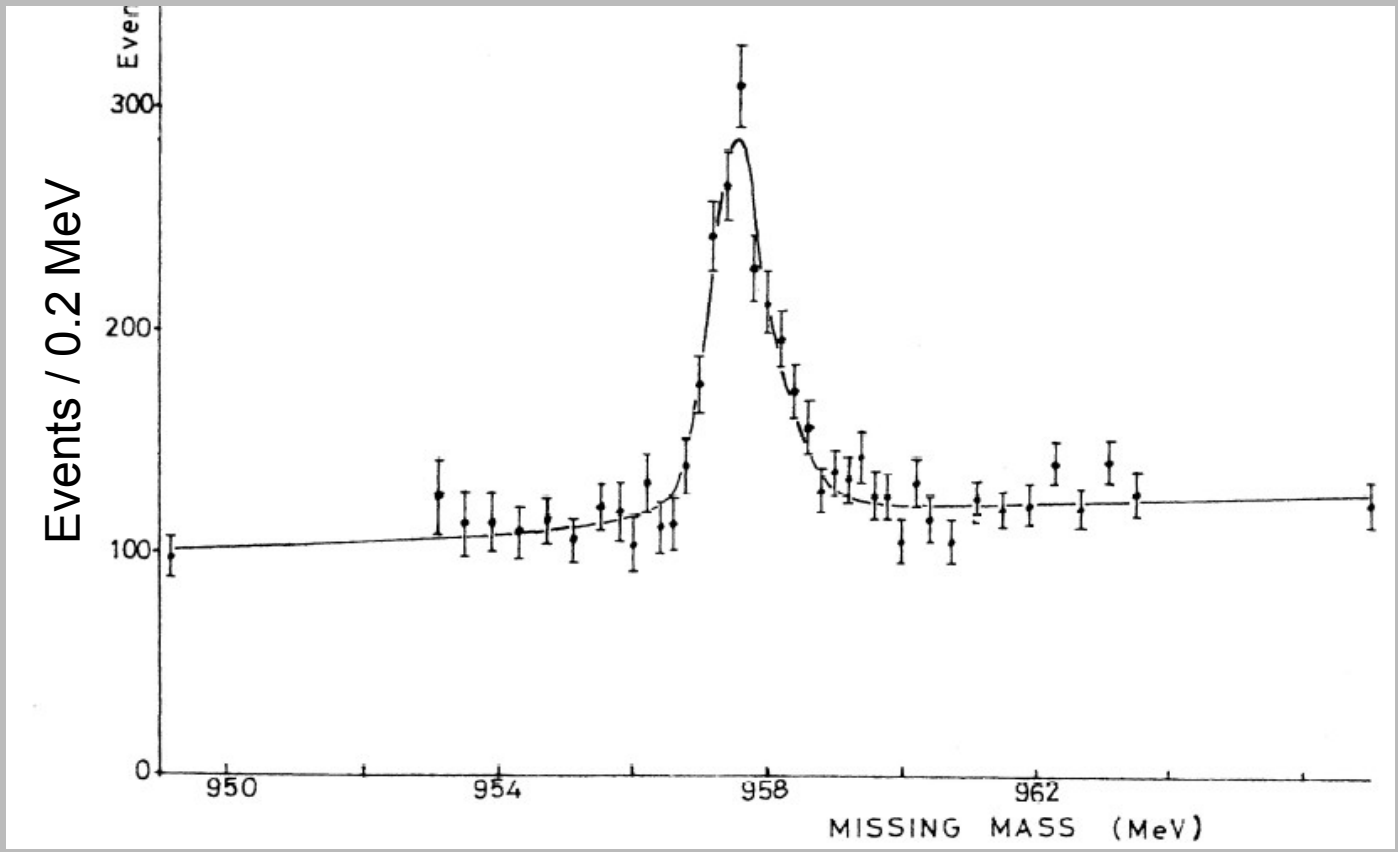
of the η' meson

Previous measurements

$\pi^- + p \rightarrow n + X$ NIMROD 0.28 ± 0.10 MeV/c^2



D. M. Binnie et al., Phys. Lett. B 83 (1979) 141

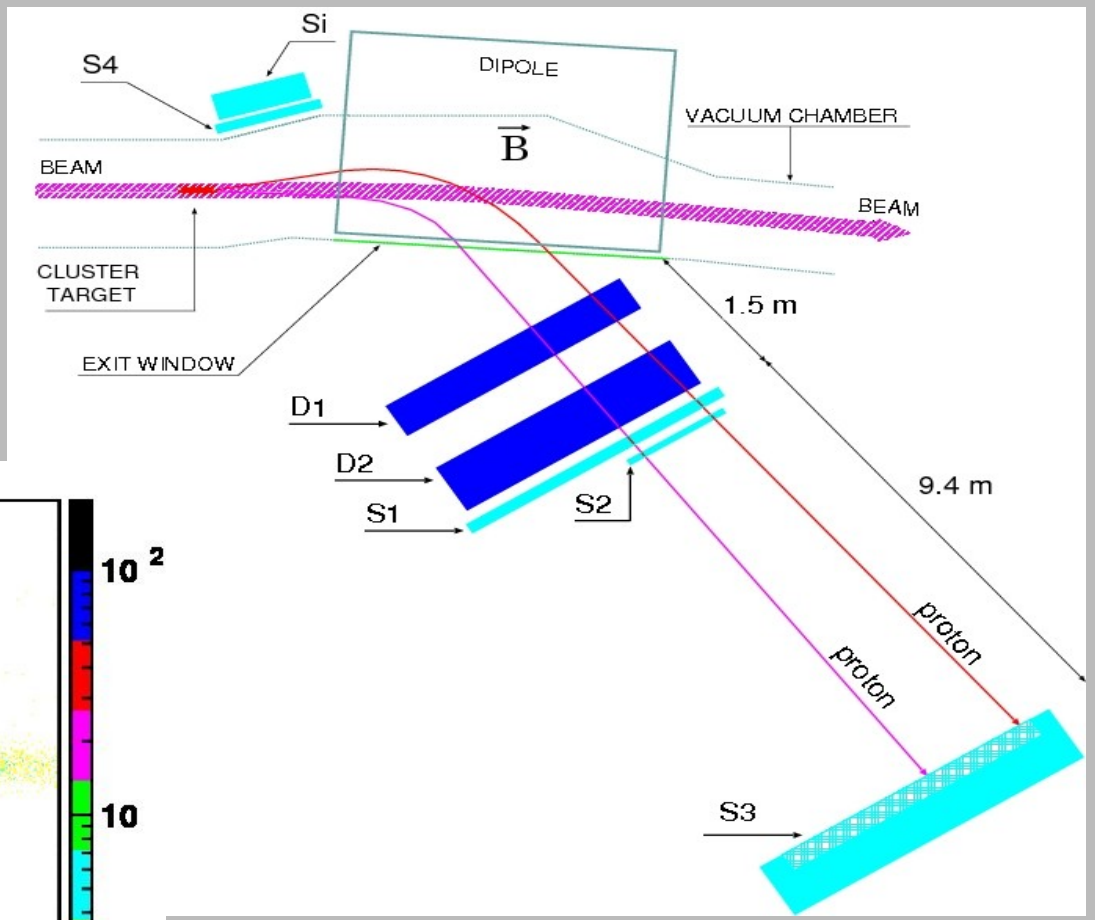
Previous measurements

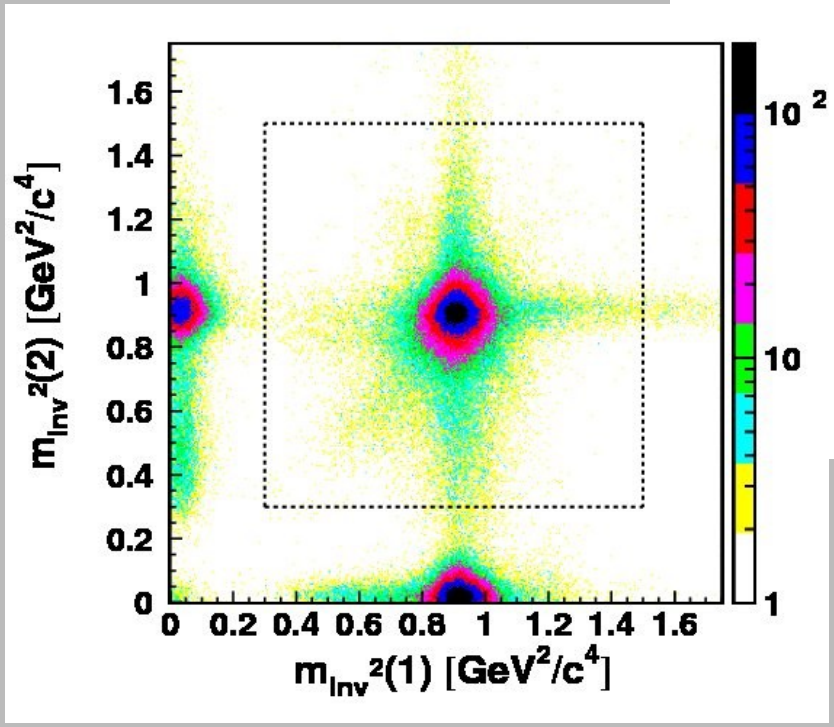
$\pi^- + p \rightarrow n + X$ NIMROD 0.28 ± 0.10 MeV

PDG 0.205 ± 0.015 MeV

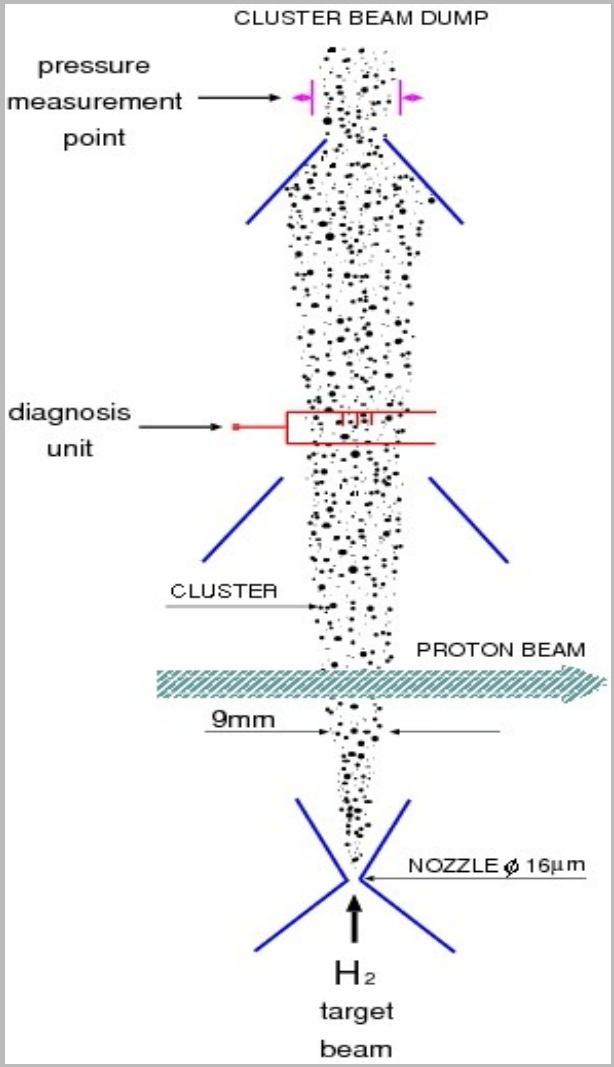
Principle of the measurement

$p\,p \rightarrow p\,p\,\eta'$

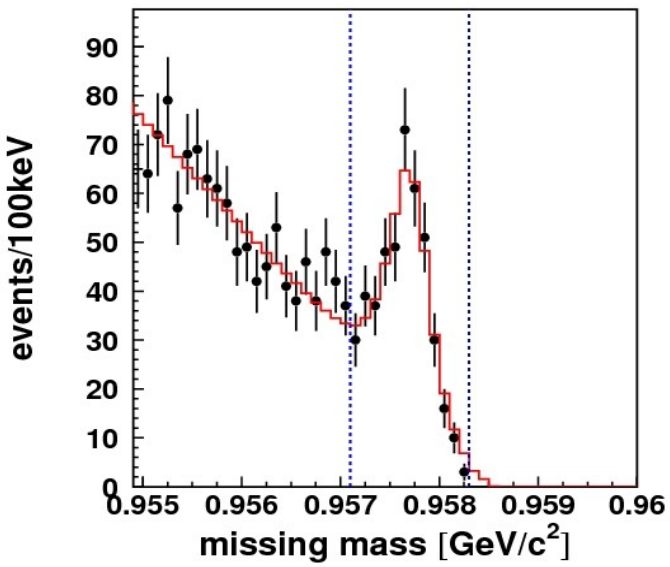




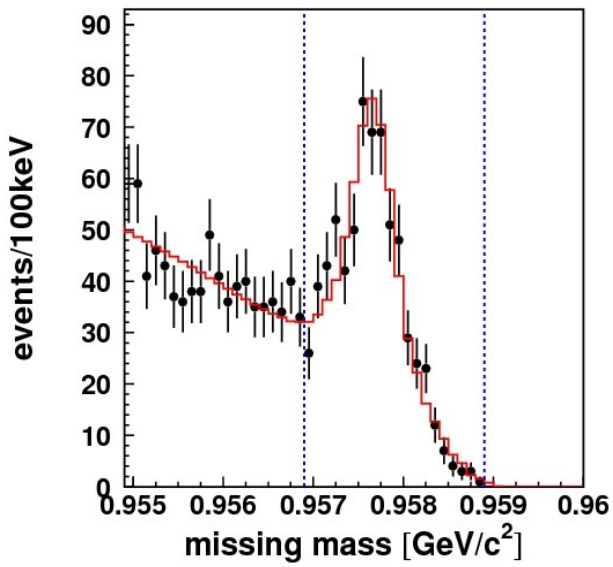
Diagnosis unit – wire device



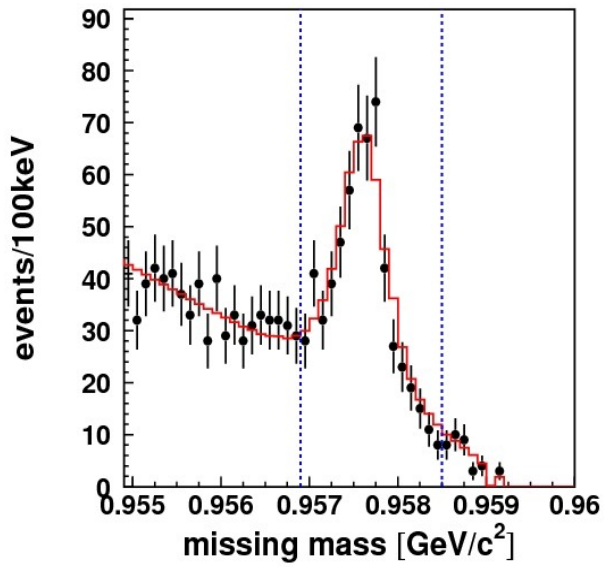
Q = 0.8 MeV



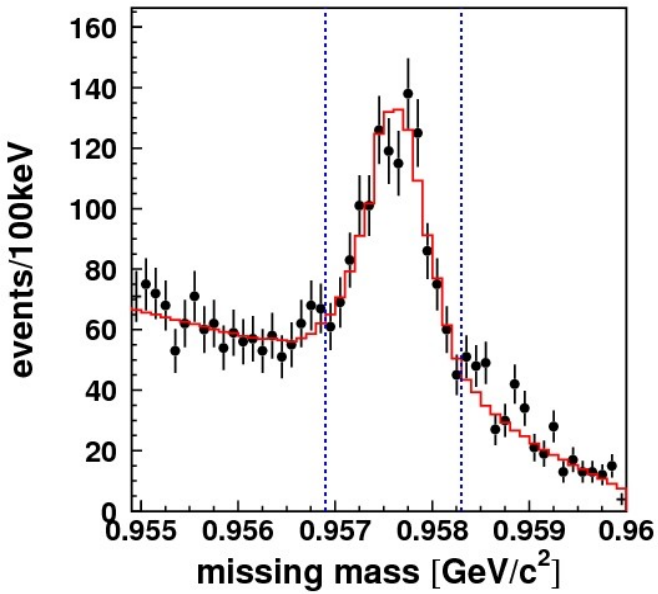
Q = 1.4 MeV



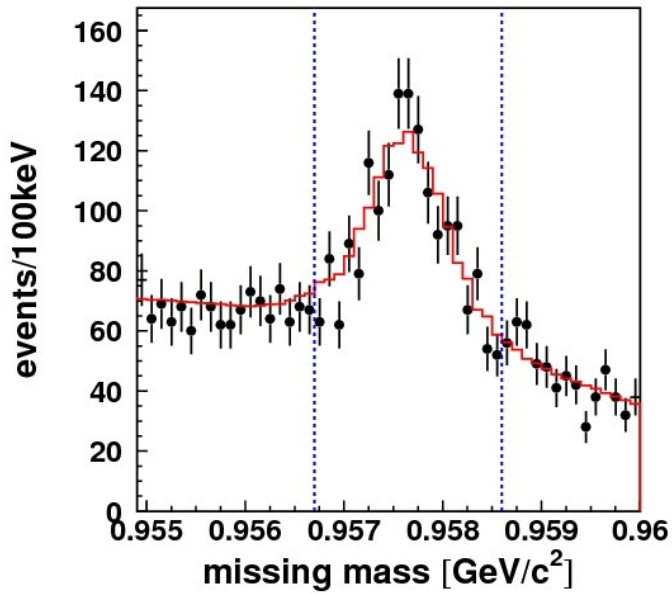
Q = 1.7 MeV



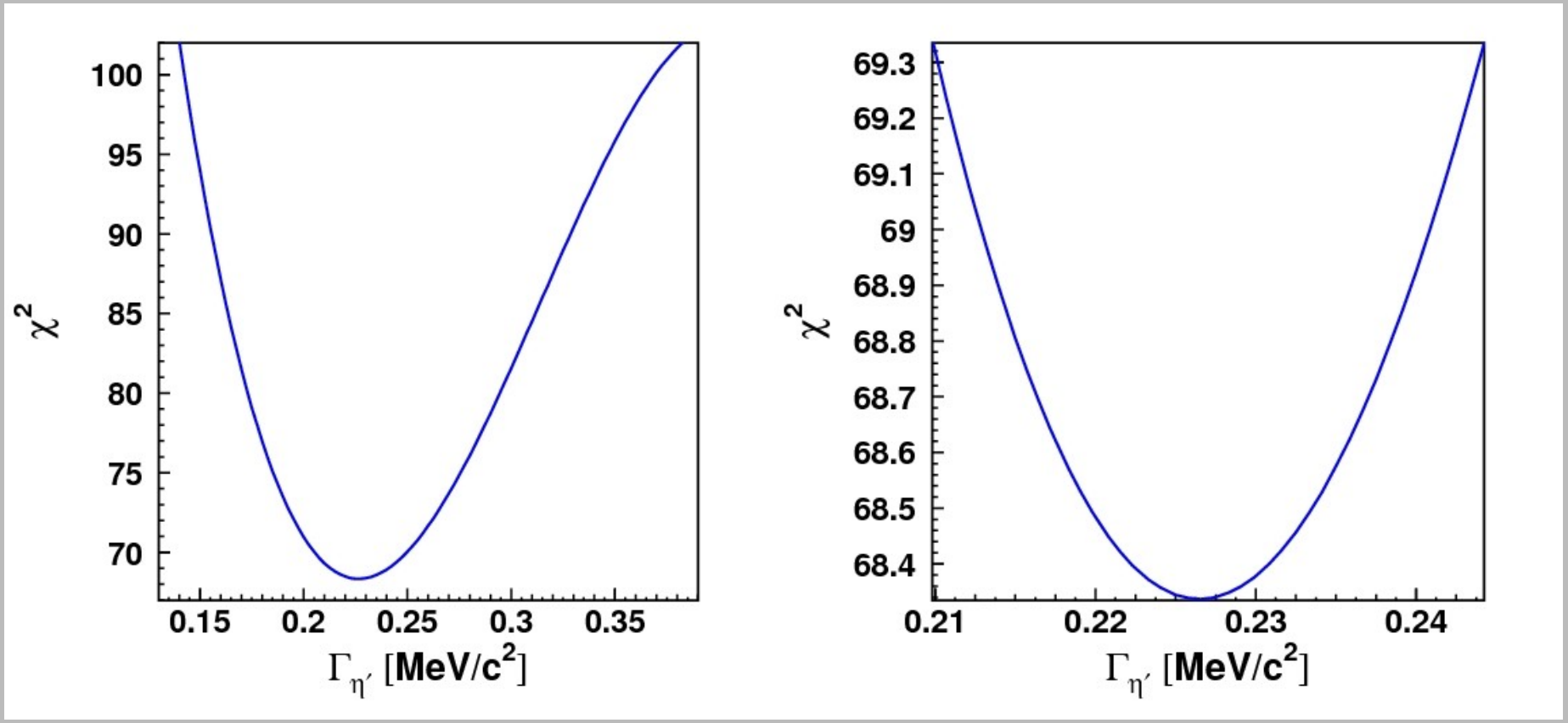
Q = 2.8 MeV



Q = 4.8 MeV



Results



$$\Gamma_{\eta'} = 0.226 \pm 0.017(\text{stat.})\ \text{MeV}$$

Systematic error

parameters contribution to the systematic error	MeV
map of the magnetic field	0.007
target position	0.006
background subtraction method	0.006
ranges of missing mass, where χ^2 was calculated	0.005
bins width	0.004
absolute beam momentum	0.003
final state interaction (FSI) between protons	0.003
effective target width	0.002
position and orientation of the drift chambers	0.001
TOTAL	0.014

Result

$\Gamma_{\eta'}$ = 0.205 ± 0.015 MeV PDG

$\Gamma_{\eta'}$ = 0.28 ± 0.10 MeV NIMROD

$\Gamma_{\eta'}$ = 0.226 ± 0.017(stat.) ± 0.014(syst.) MeV COSY-11

Ende

The End

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