FROM COSY to PANDA

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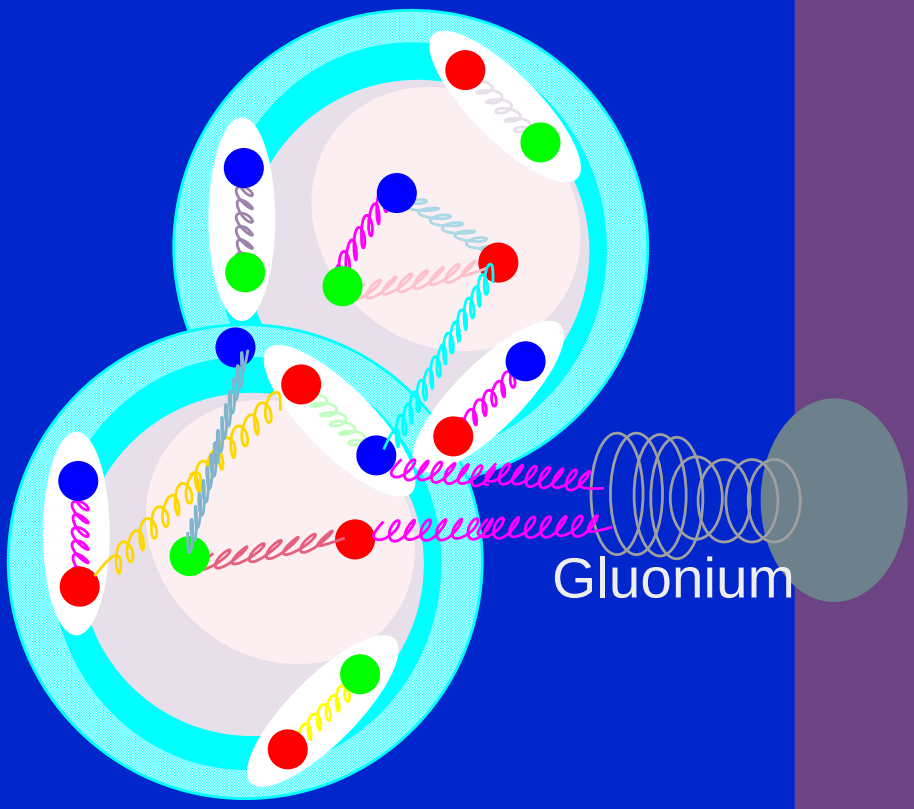


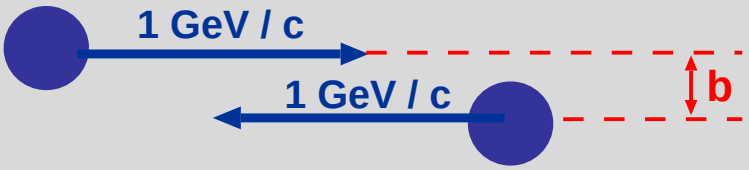
Polish-German Meeting on the New International Accelerator Facility at Darmstadt
Warsaw, 24.11.2003

Threshold works as a filter of quatnum numbers

before reaction

parity conservation
Pauli principle
.....

$\Longrightarrow$ $L = 1$, $S = 1$

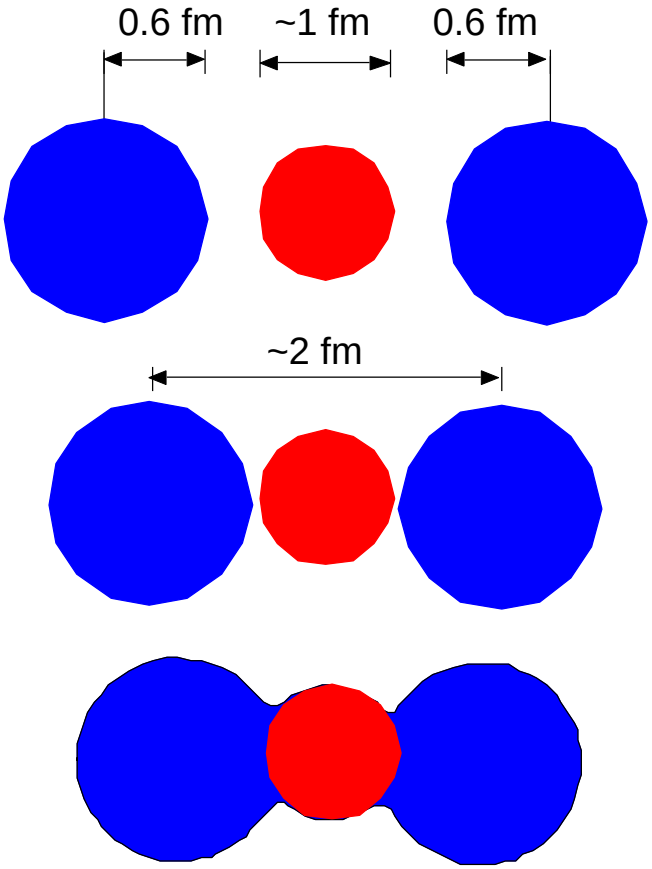


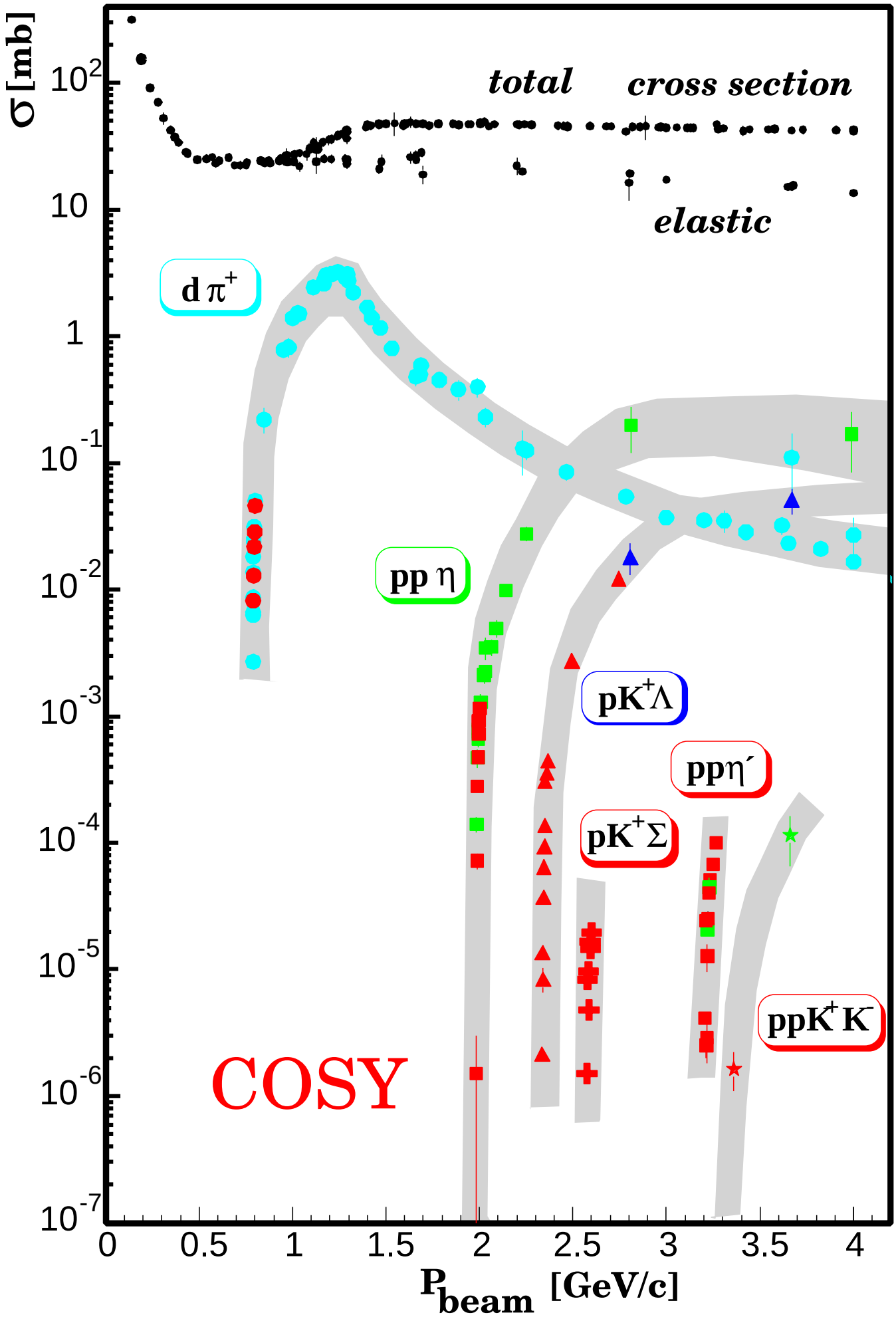
$\Longrightarrow$ collision parameter b ~ 0.2 fm

after reaction

at rest

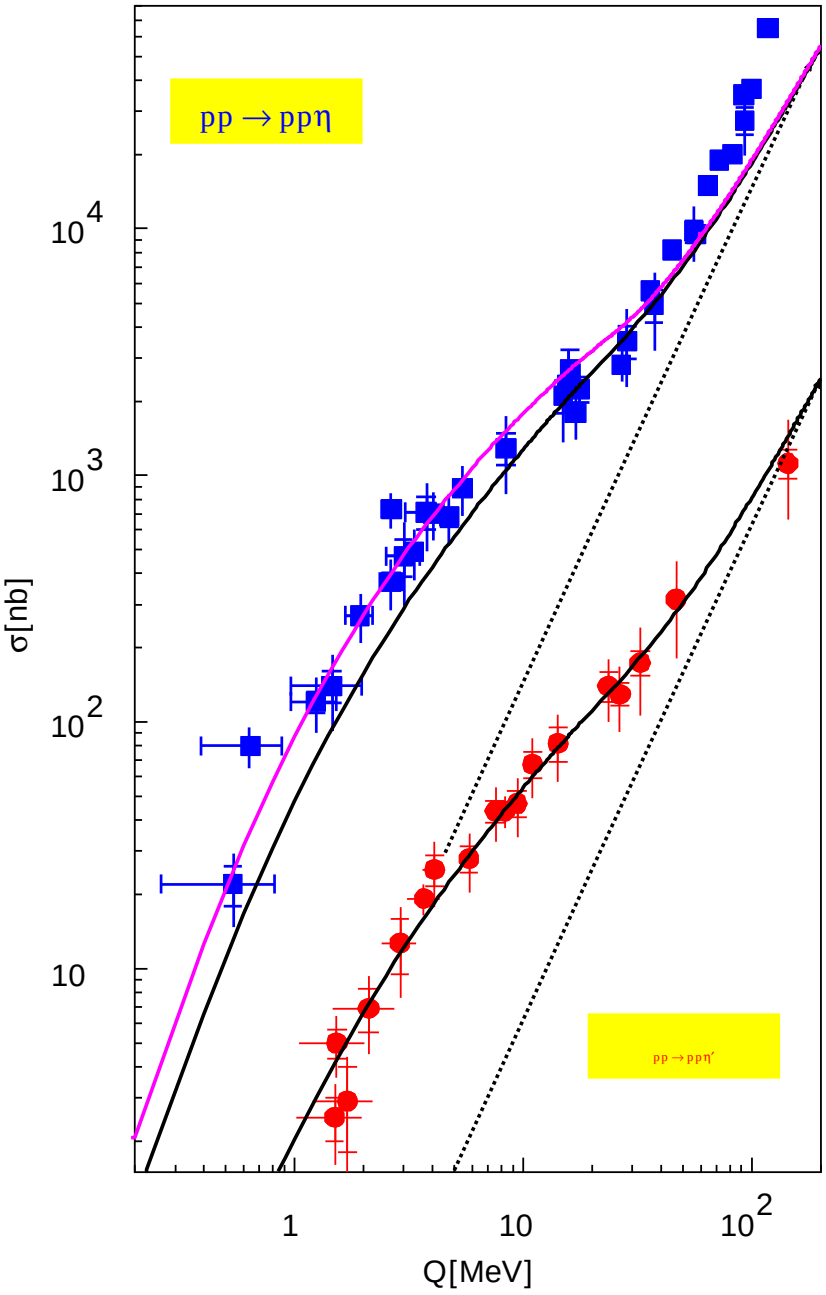
L = 0, I = 0




σ [mb]
total cross section
elastic
d π+
pp η
pK+Λ
ppη´
pK+Σ
ppK+K-
COSY
P beam [GeV/c]

Total Cross Section for η and η′ Production

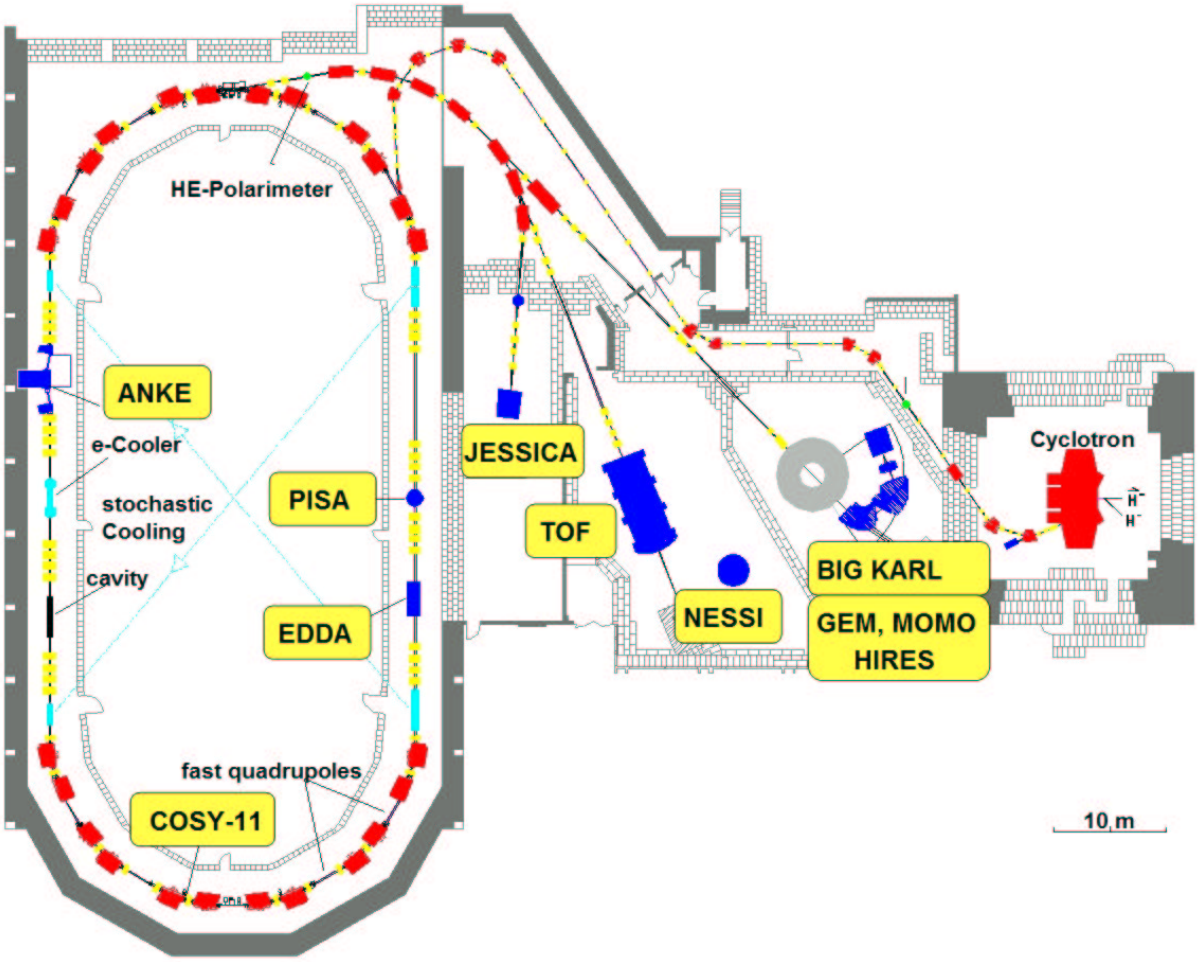
Energy Dependence

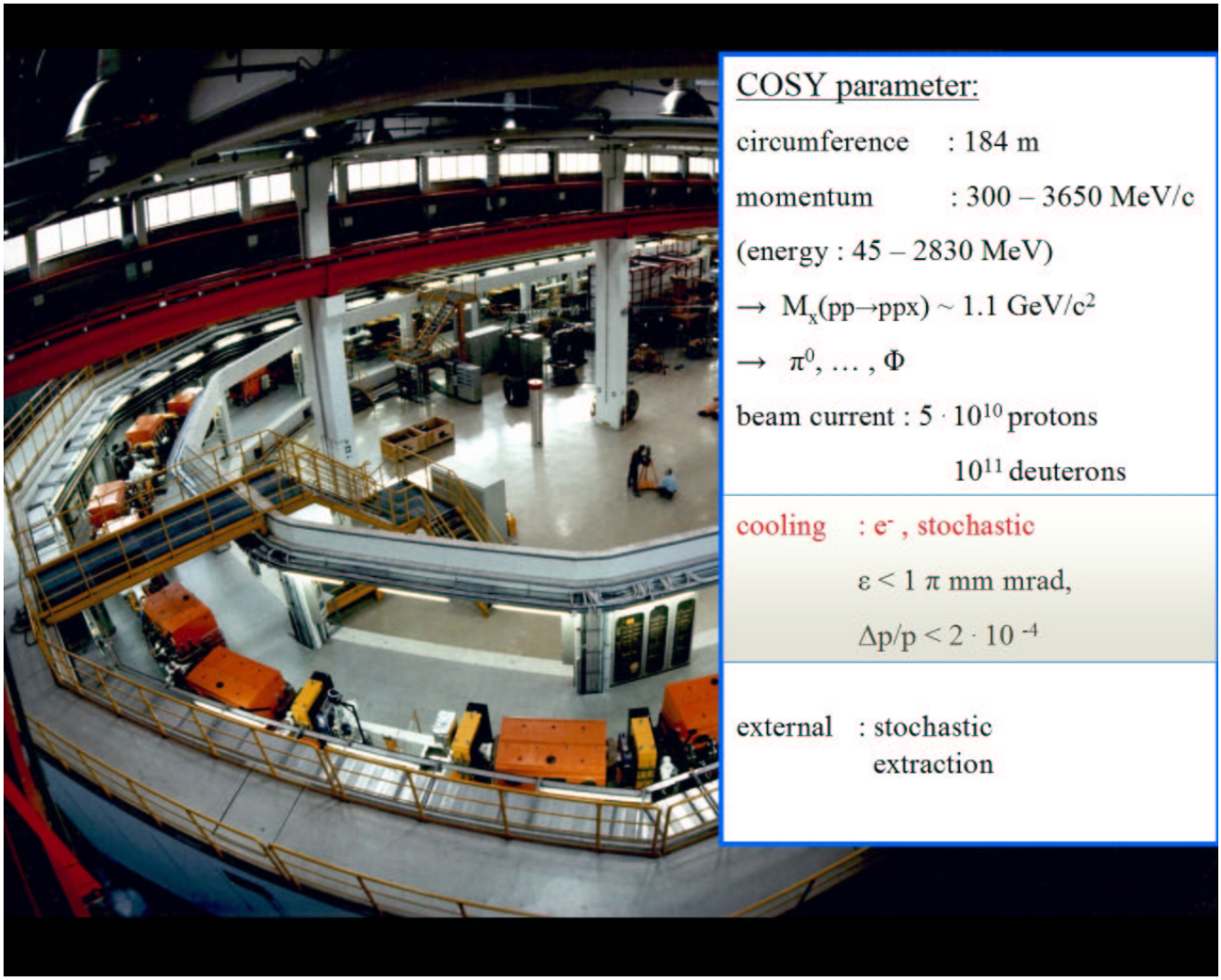


phase space (arb. norm.)

+ pp FSI ($^1S_0$, Coul)

+ pη FSI
$a_{p\eta}$ = +0.7fm + *i* 0.4fm
$r_{p\eta}$ = -1.5fm - *i* 0.24fm
(A.M.Green, S.Wycech, PR C55 (1997) R2167)


HE-Polarimeter
ANKE
e-Cooler
stochastic
Cooling
cavity
PISA
EDDA
fast quadrupoles
COSY-11
JESSICA
TOF
NESSI
BIG KARL
GEM, MOMO
HIRES
Cyclotron
H-
H-
10 m



COSY parameter:

circumference : 184 m

momentum : 300 – 3650 MeV/c

(energy : 45 – 2830 MeV)

→ $M_x(pp \rightarrow ppx) \sim 1.1$ GeV/c^2

→ $\pi^0, \ldots, \Phi$

beam current : $5 \cdot 10^{10}$ protons

10^{11} deuterons

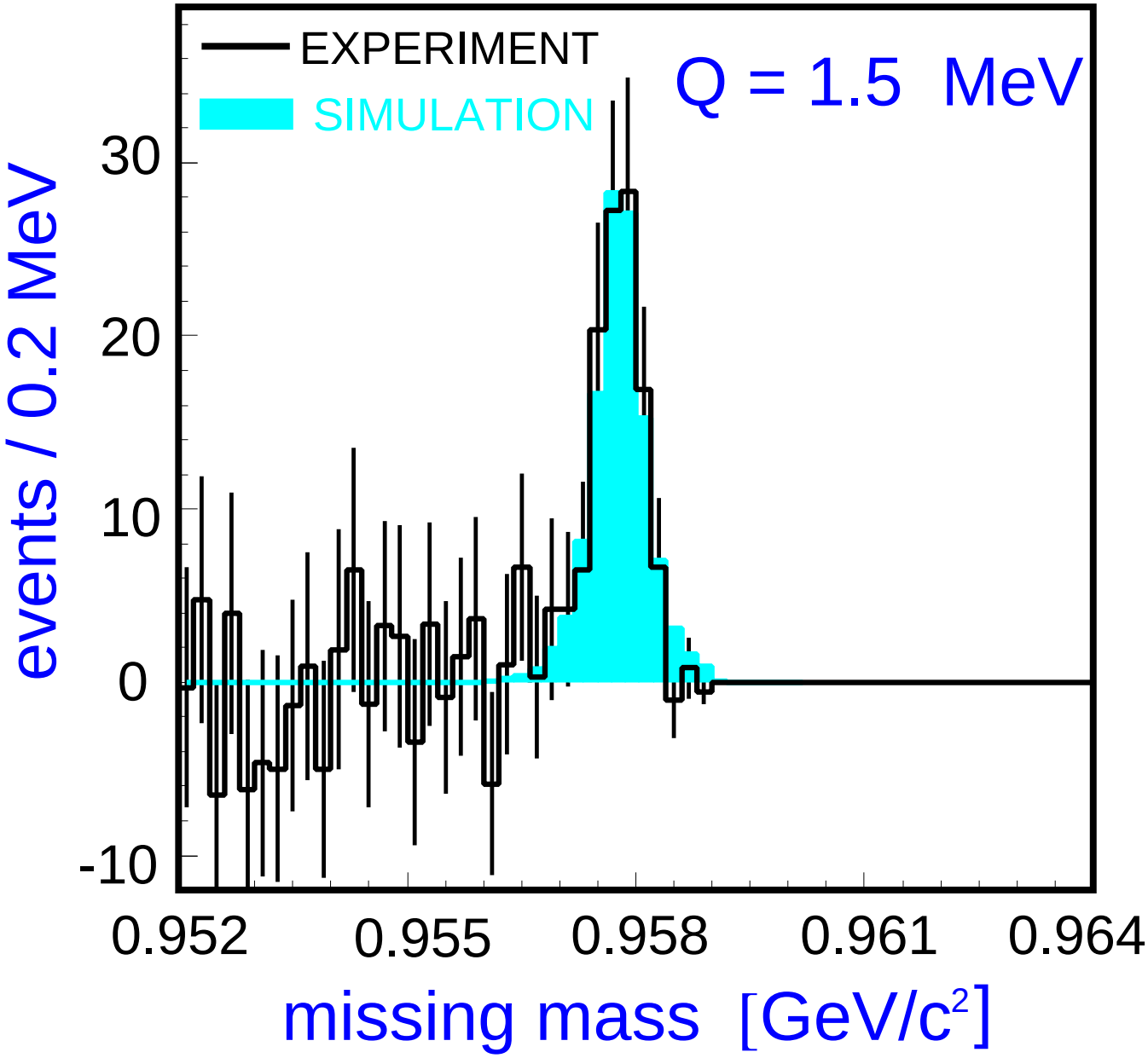
cooling : e^-, stochastic

$\varepsilon < 1\ \pi$ mm mrad,

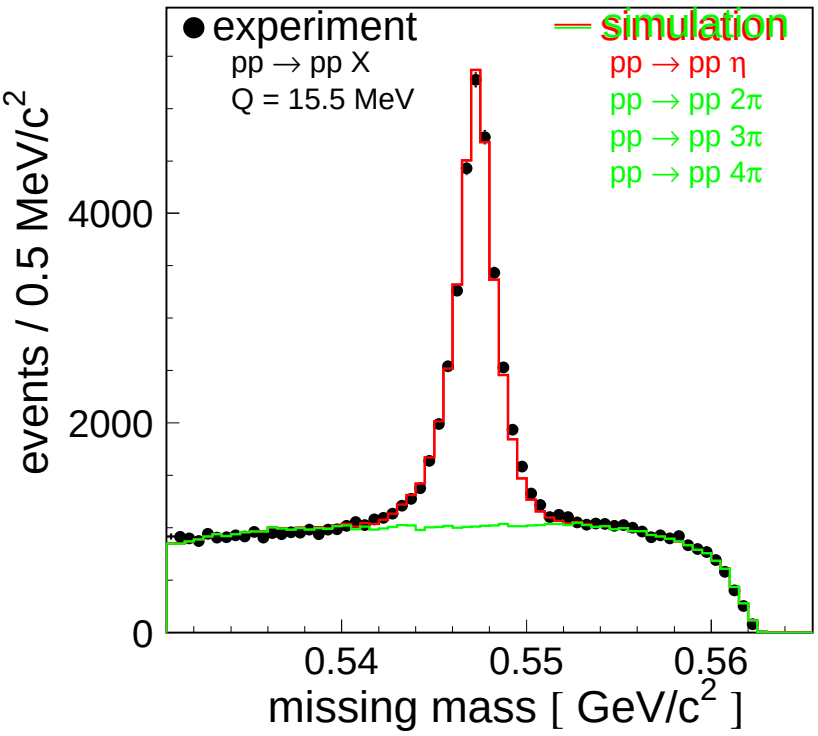
$\Delta p/p < 2 \cdot 10^{-4}$

external : stochastic extraction

p p --> p p η'



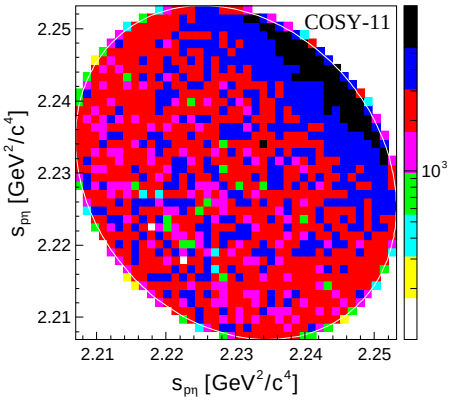
$\Gamma_{\eta'} \cong 0.2$ MeV


experiment
pp → pp X
Q = 15.5 MeV
simulation
pp → pp η
pp → pp 2π
pp → pp 3π
pp → pp 4π
events / 0.5 MeV/c2
4000
2000
0
0.54
0.55
0.56
missing mass [GeV/c2]

ppη Final State

Dalitz Plot

Experiment

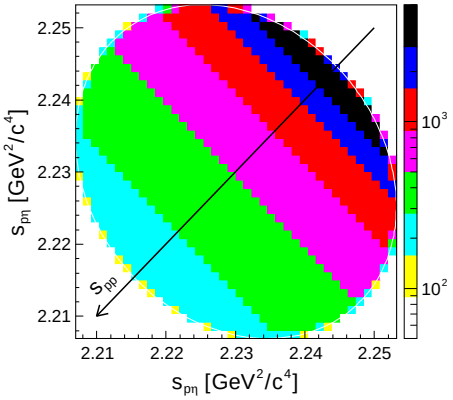


$pp \rightarrow pp\eta \quad Q = 15.5\text{MeV}$

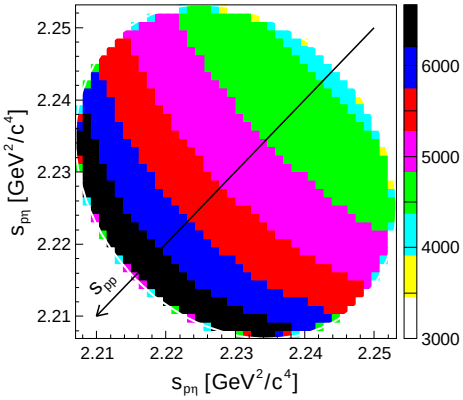
P. Moskal et al., nucl-ex/0307005,
submitted for publication

Monte Carlo Simulation

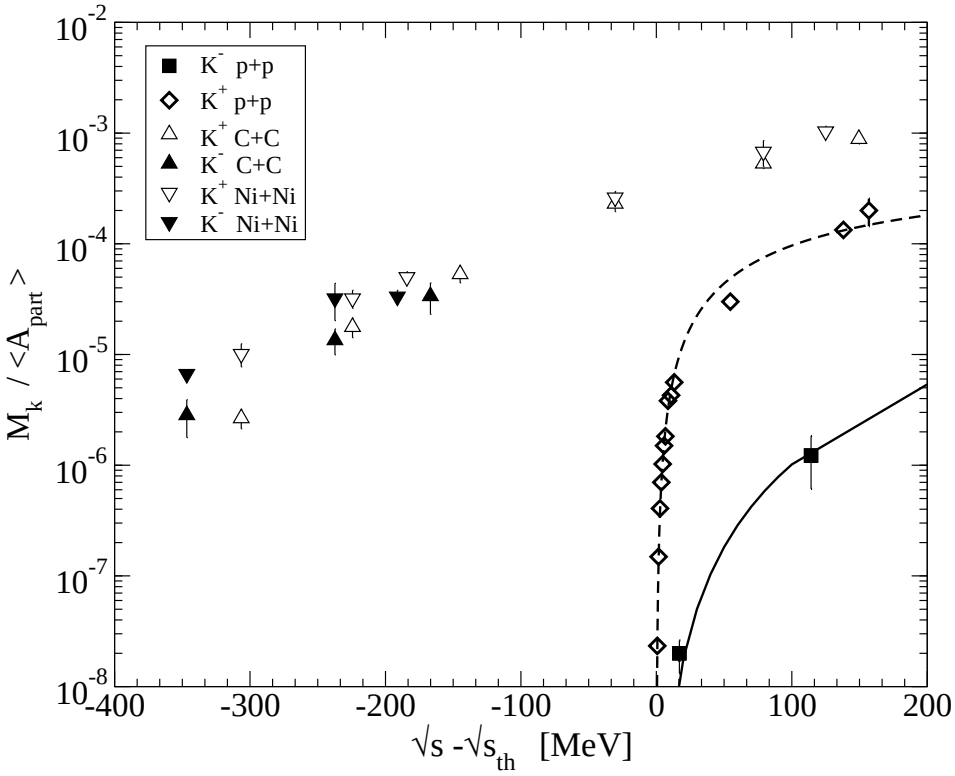
Phase space + $^1S_0$ pp FSI



Phase space + pη FSI*



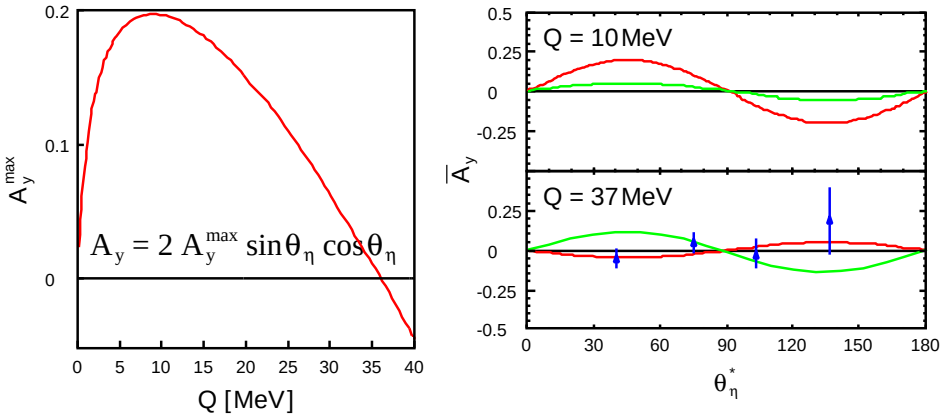
*$a_{p\eta}$ = 0.7fm + *i* 0.3fm


K- p+p
K+ p+p
K+ C+C
K- C+C
K+ Ni+Ni
K- Ni+Ni
M_k / <A_part>
√s -√s_th [MeV]
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
10^-8
-400
-300
-200
-100
0
100
200

More Selective Clues to

$S_{11}(1535)$ excitation Higher Partial Waves

Analysing Power for $\vec{p}p \to pp\eta$



- COSY-11 Q = 40 MeV
  P. Winter et al., Phys. Lett. B 544 (2002) 251
- $S_{11}(1535)$ excitation ρ exchange
- $S_{11}(1535)$ excitation π, η exchange
  + mesonic currents + nucleonic currents

Higher Partial Waves ⇔ Interference of Amplitudes

e.g. $(PsPp) \to A_y \propto \sin\theta_\eta \cos\phi_\eta$

$(SsSd) \to A_y \propto \sin\theta_\eta \cos\theta_\eta \cos\phi_\eta$

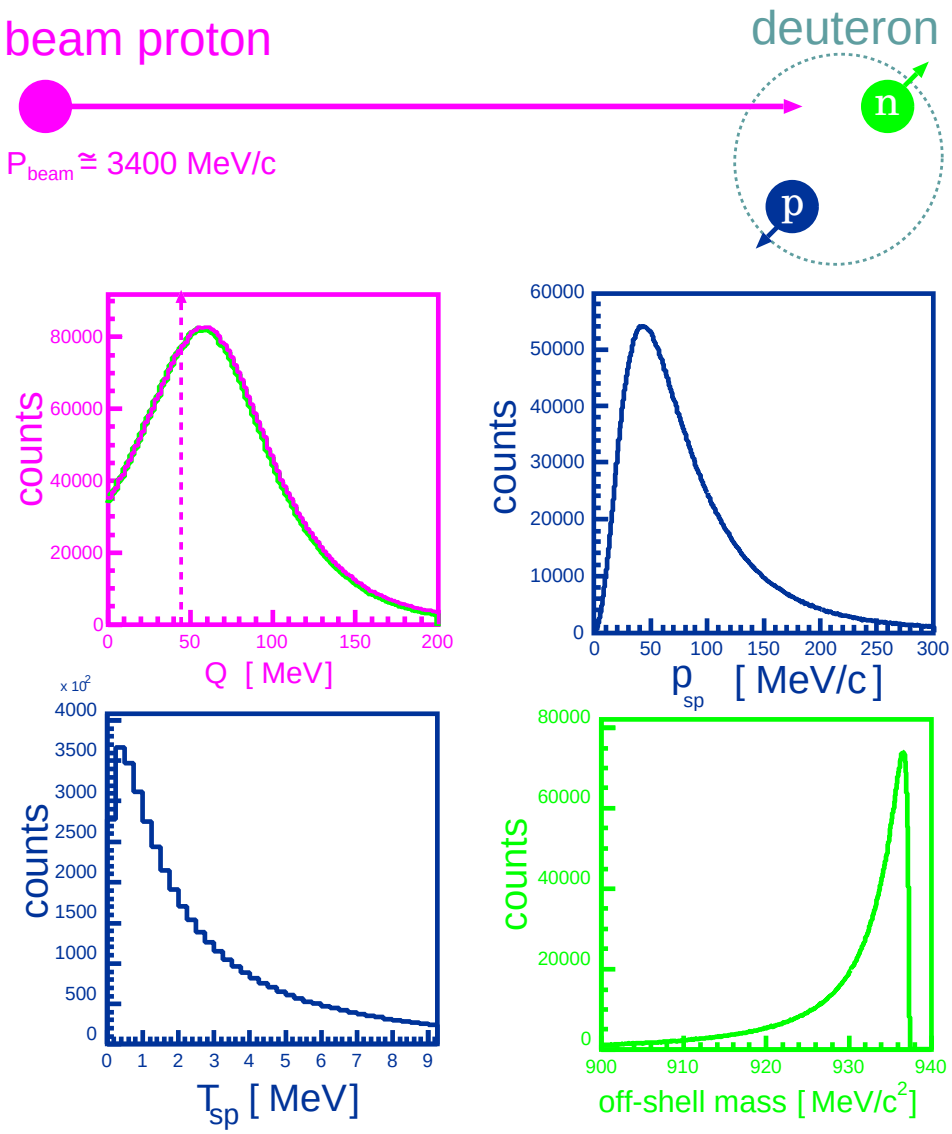
(Published) Experimental Results:

No discrimination between ρ and π, η exchange (yet)

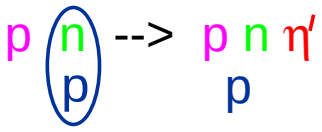
Interference Terms (PsPp), (PpPp), (SsSd) compatible with zero

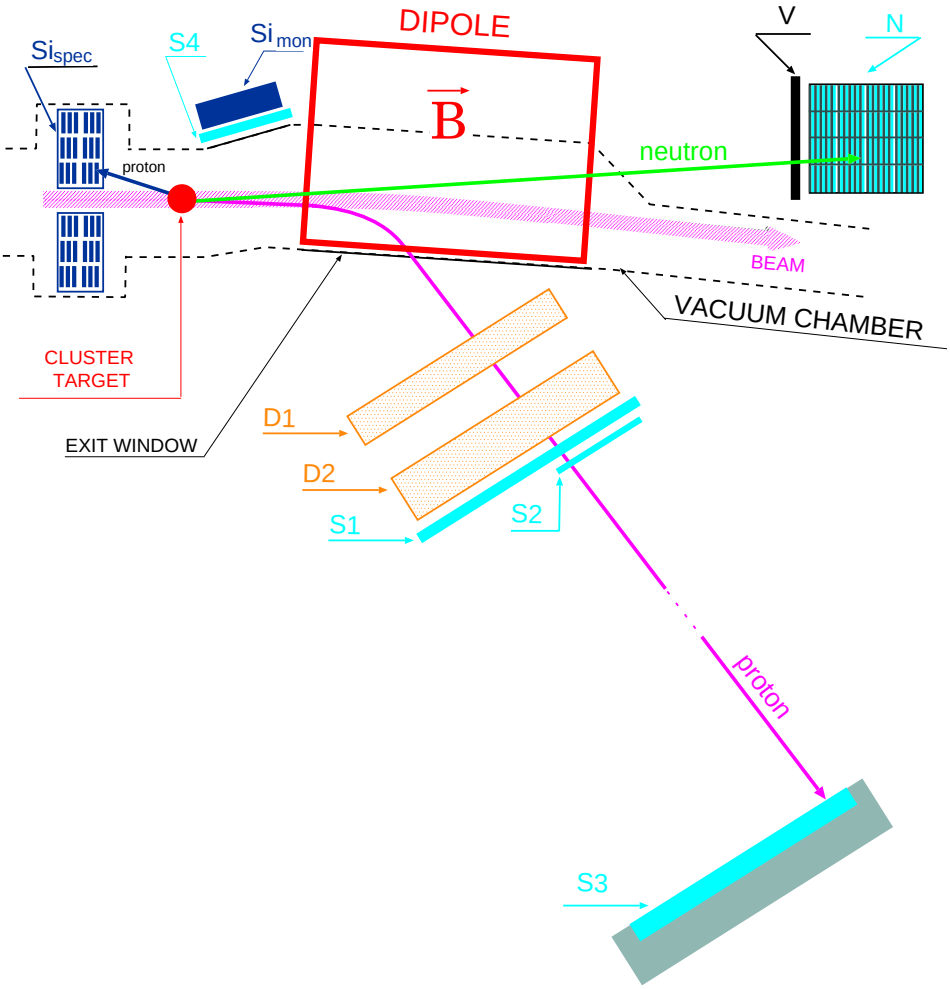
Experimental Programme: Energy Dependence of A_y^{max}

The momentum of both nucleons inside a deuteron is measured for each event !

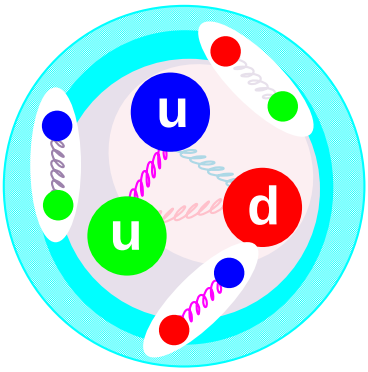


COSY-11 DETECTION SETUP

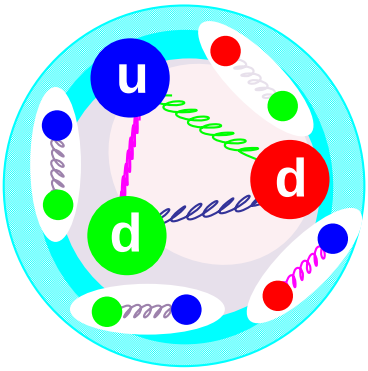




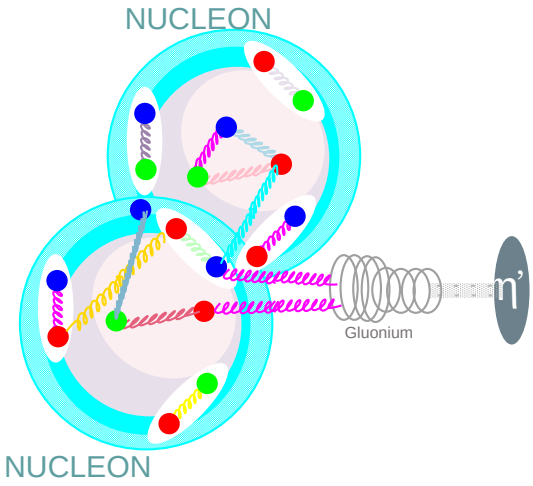
PROTON



NEUTRON



$$\eta' = \alpha \left| u\bar{u} + d\bar{d} + s\bar{s} \right\rangle + \beta \left| \text{gluons} \right\rangle$$



$$R \equiv \frac{p\ n \dashrightarrow p\ n\eta'}{p\ p \dashrightarrow p\ p\eta'} = ?$$

$R = 1$ only gluons

$R \approx 6$ only quarks