Results on single-polarized measurements at ANKE with deuteron beam

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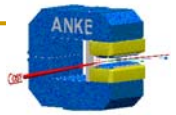
Outline



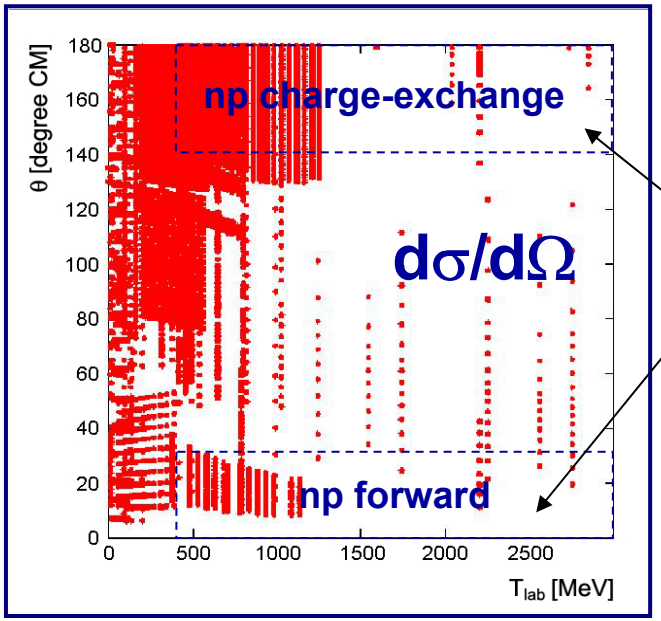
- Introduction
- Experimental set-up
- Beam polarimetry
- Analysing power measurements
- Cross section
- Summary & outlook

Introduction: NN Scattering

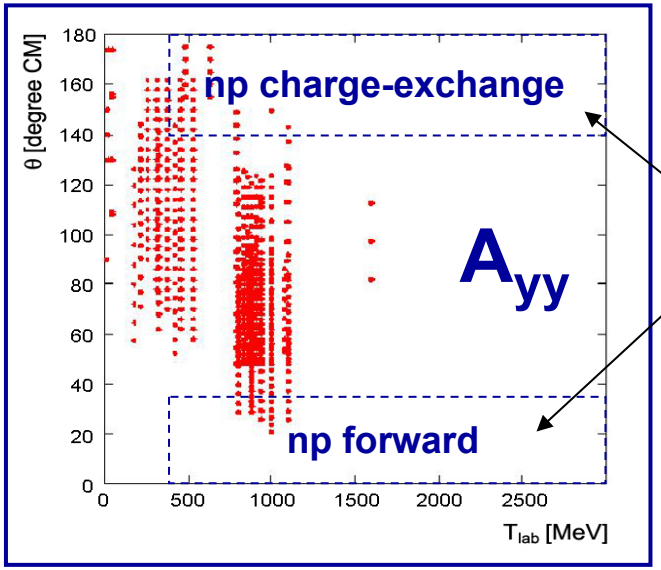
- Characterization requires precise data for Phase Shift Analyses

- Current experimental status of NN data:
  - pp system (I=1) well-known up to 2.5 GeV (EDDA): Majority of data on unpolarized, single, and double polarized observables
  - np system (I=0) poorly known → ANKE will provide high-quality data in forward/backward region

Talks by: Colin Wilkin
Andro Kacharava



ANKE range



ANKE range

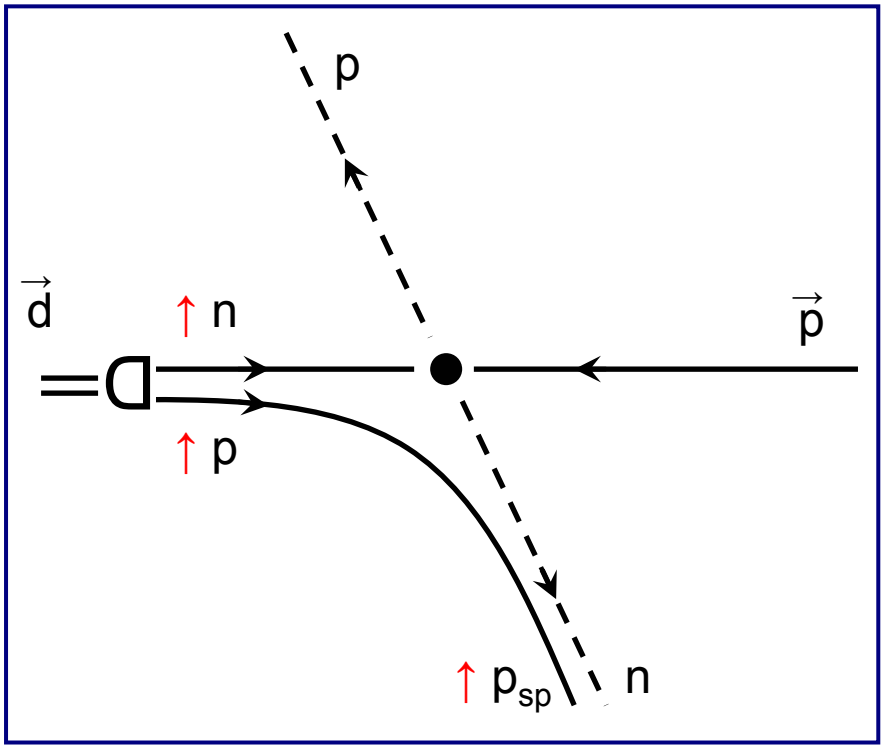
Introduction: np elastic (small angle)

np forward

deuteron beam: $\vec{d}\vec{p} \rightarrow p_{sp}\,(np)$

deuteron target: $\vec{p}\vec{d} \rightarrow p_{sp}\,(pn)$

d beam: up to 1.1 GeV for np
d target: up to 2.8 GeV for pn



dp observables: $d\sigma/d\Omega$, T_{20}, T_{22}, $A_{y,y}$, ...

quasi-free

np observables: A_y, A_{yy}

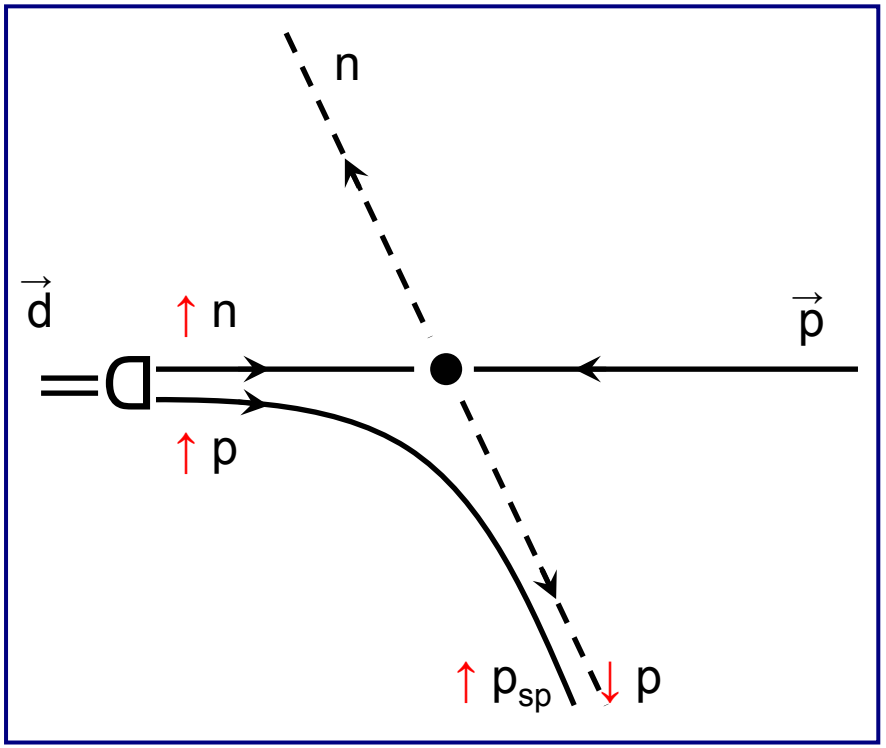
Introduction: np elastic (large angle)

np charge-exchange

deuteron beam: $\vec{d}\vec{p} \rightarrow (pp)_{^1S_0} n$

deuteron target: $\vec{p}\vec{d} \rightarrow (pp)_{^1S_0} n$

d beam: up to 1.1 GeV for np
d target: up to 2.8 GeV for pn



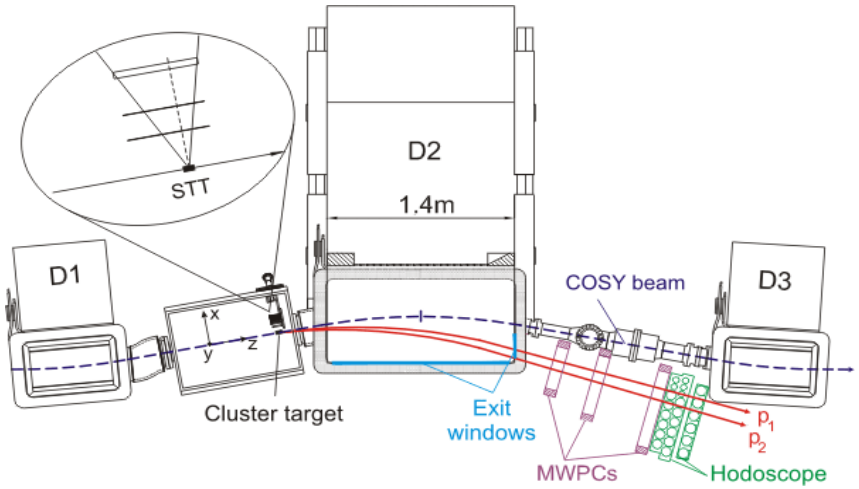
dp observables: $d\sigma/d\Omega$, T_{20}, T_{22}, $A_{y,y}$, ...

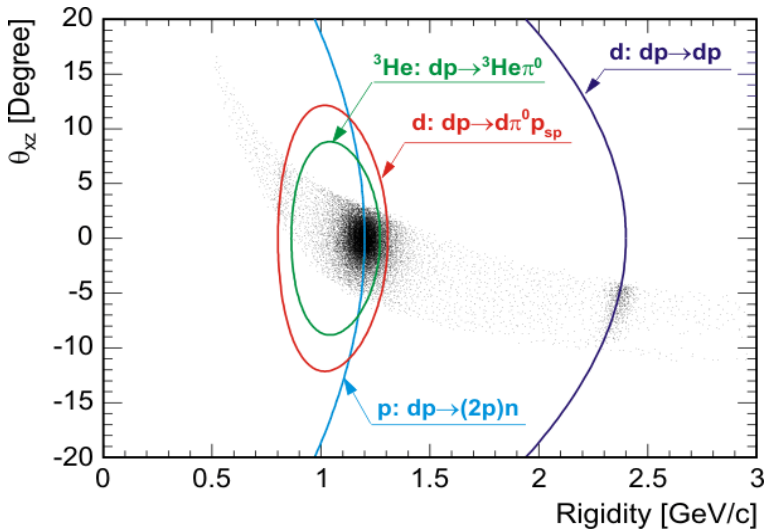
quasi-free

np observables: A_y, A_{yy}, D_{yy}, $A_{xy,y}$, ...

Experimental setup

ANKE



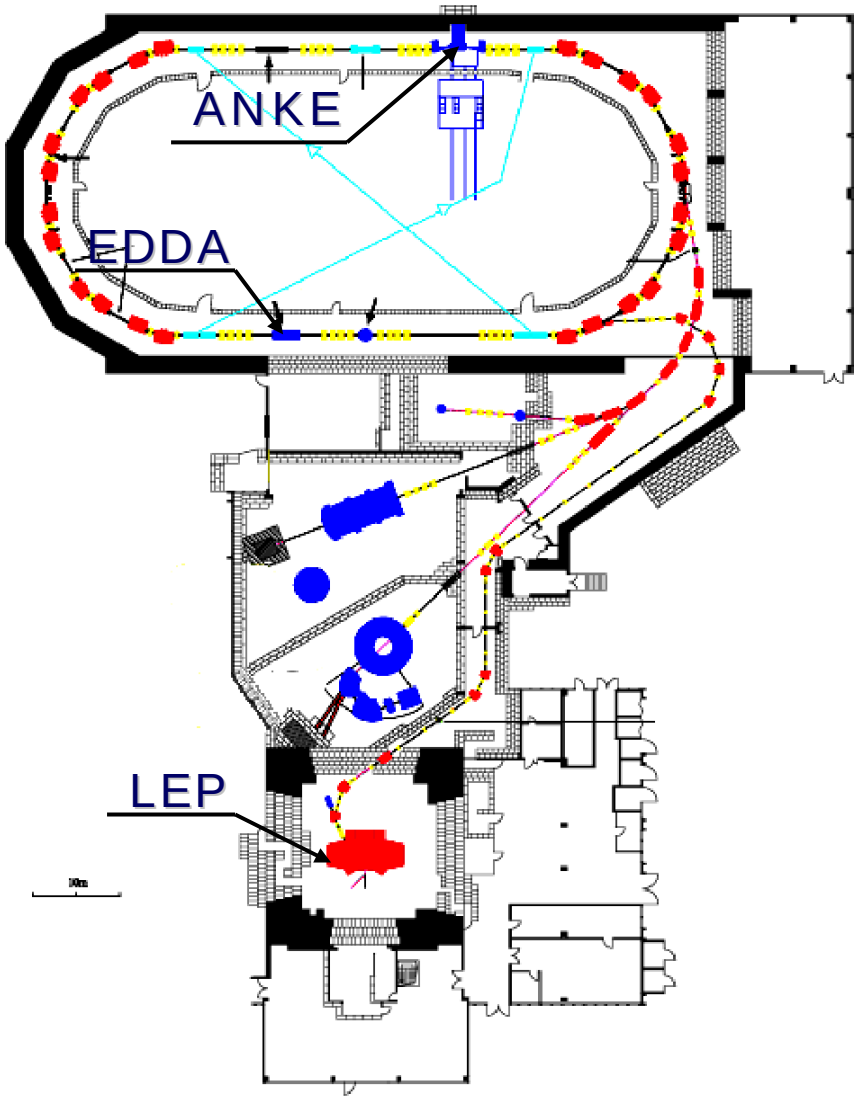


Source

- Polarized deuteron beam
- T_d = 1.2 GeV; P_d = 2.4 GeV/c
- N_d ~ 3 x 10^9

Spin mode	P_z ideal	P_{zz} ideal	Intensity [I_0]
0	0	0	1
1	-2/3	0	1
2	+1/3	+1	1
3	-1/3	-1	1
4	+1/2	-1/2	2/3
5	-1	+1	2/3
6	+1	+1	2/3
7	-1/2	-1/2	2/3

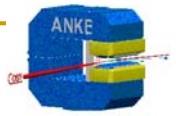
Beam polarimetry: LEP & EDDA



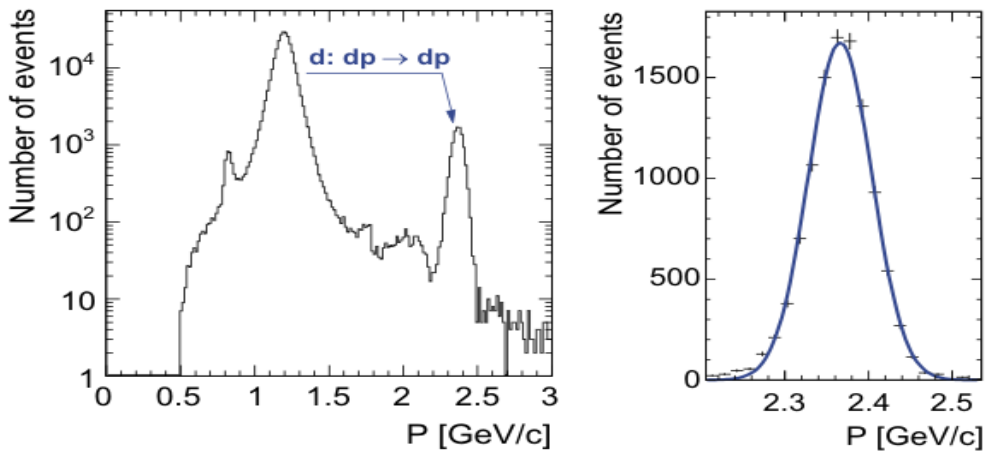
- Low Energy Polarimetry
  - T_d = 76 MeV
  - dC → dC
  - $A_y(40°) = 0.550 \pm 0.025$ ~ KVI
- EDDA
  - T_d = 270 MeV
  - dp → dp
  - A_y, A_{yy} (65°-95°) ~ RIKEN

$P_z \approx 75\ \%$ $P_{zz} \approx 60\ \%$

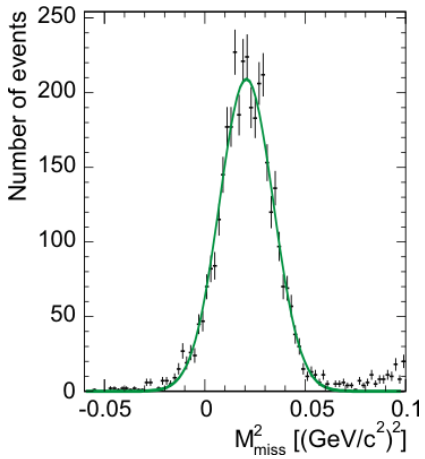
Beam polarimetry: Reaction identification



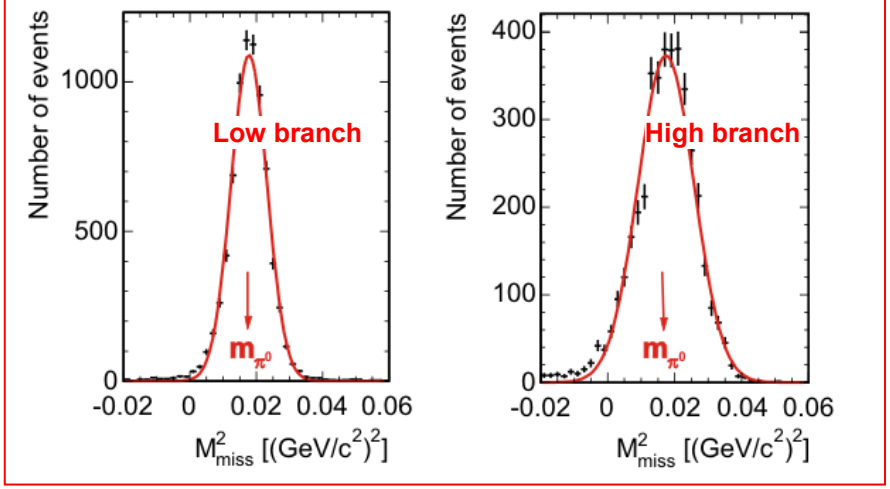
dp → dp



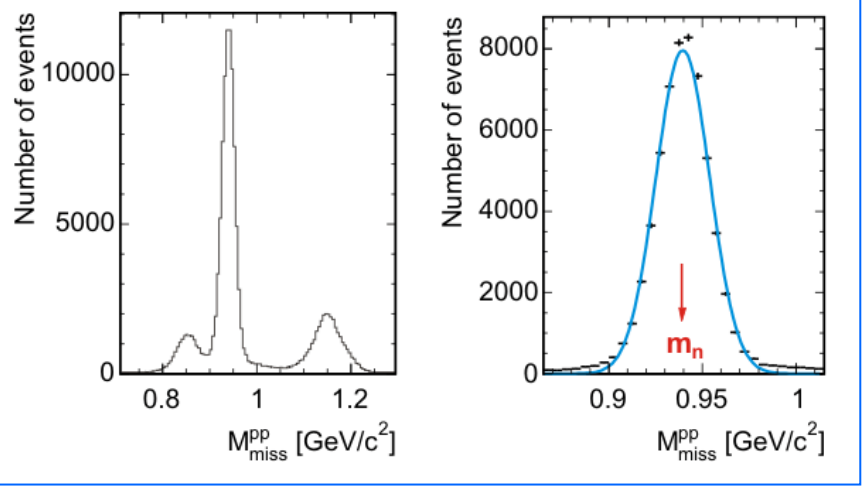
dp → ^{3}Heπ^0



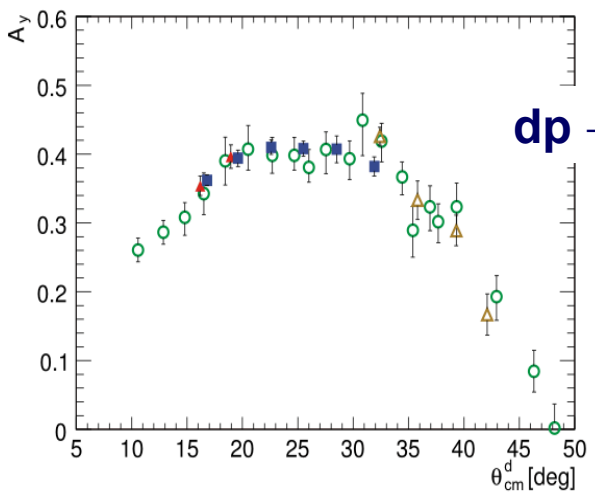
dp → dp_{sp} π^0

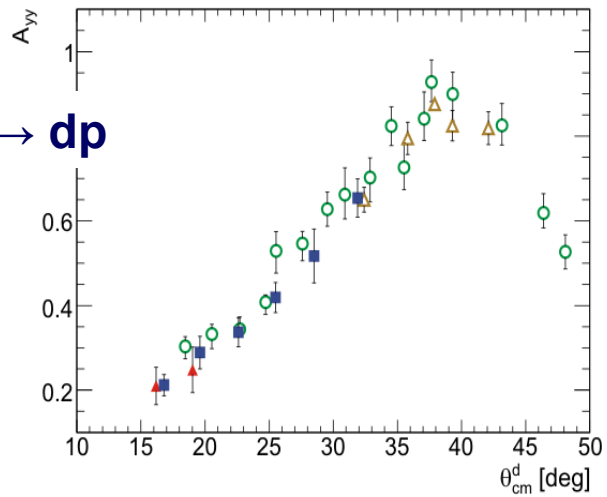


dp → (pp)n

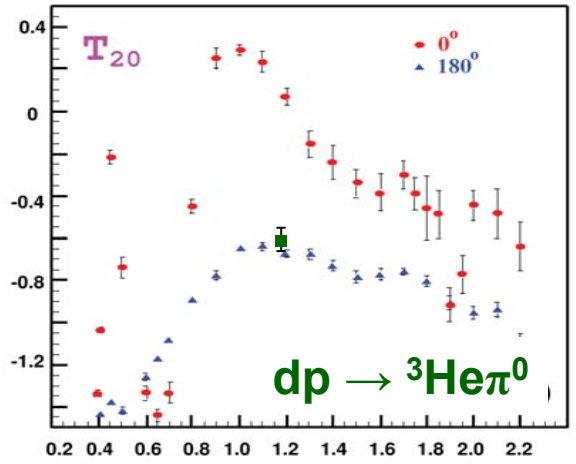


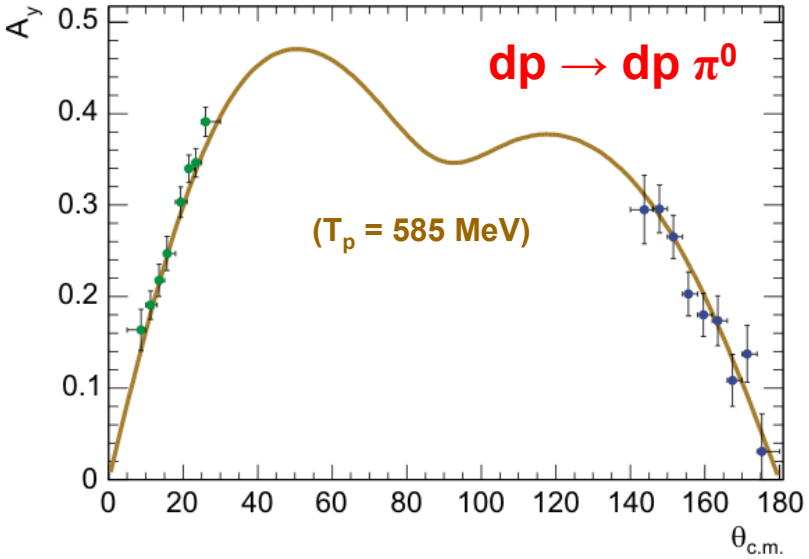
Beam polarimetry: Results

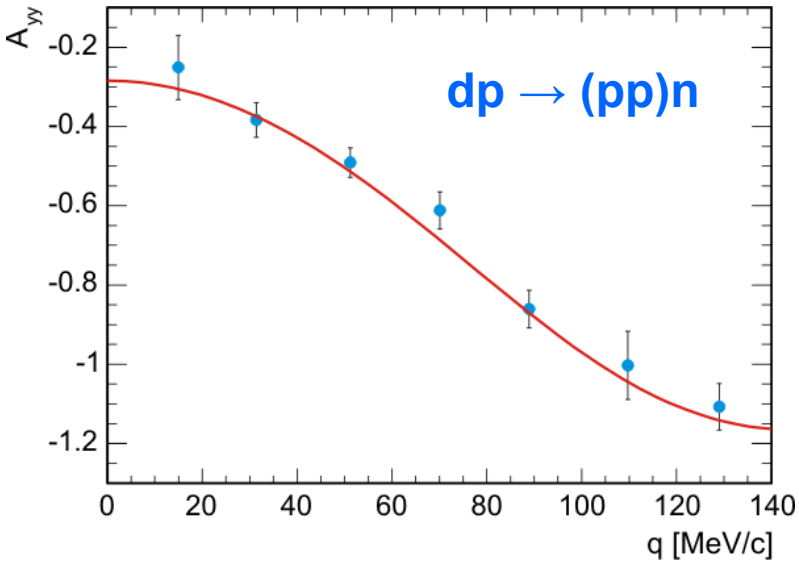




dp → dp





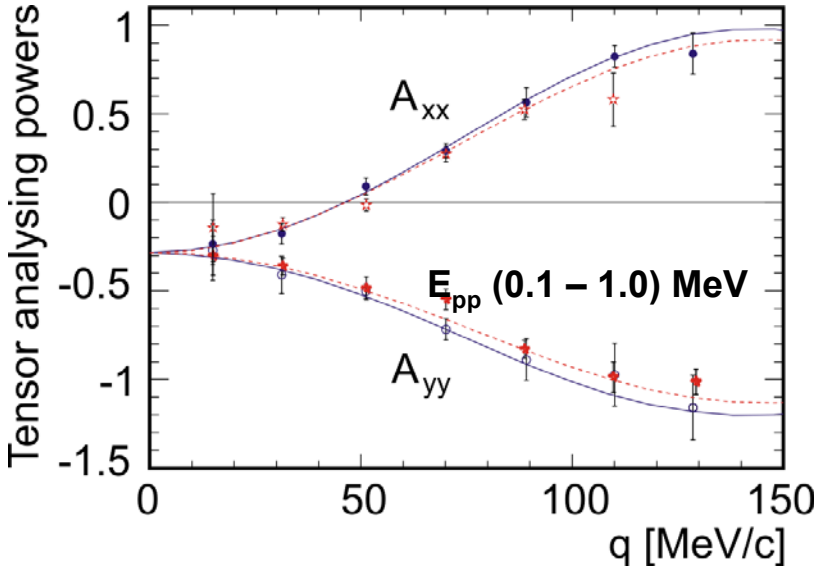


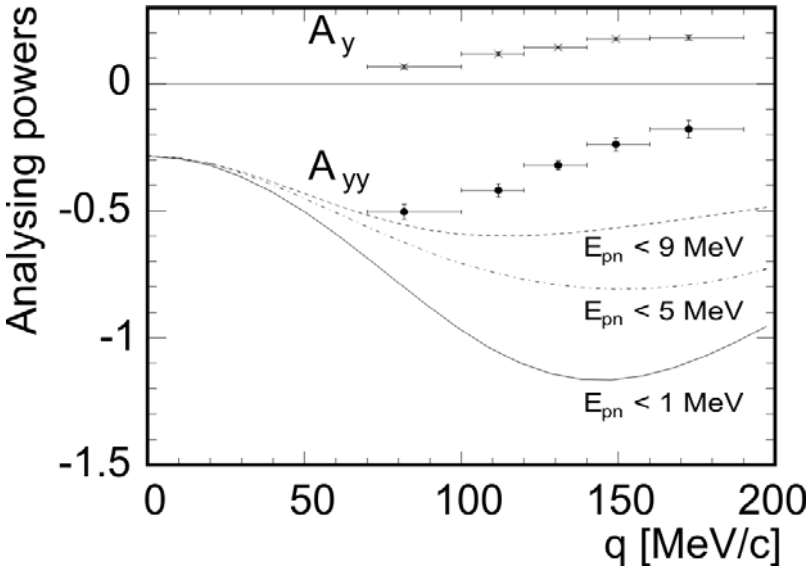
Depolarization less then 4%

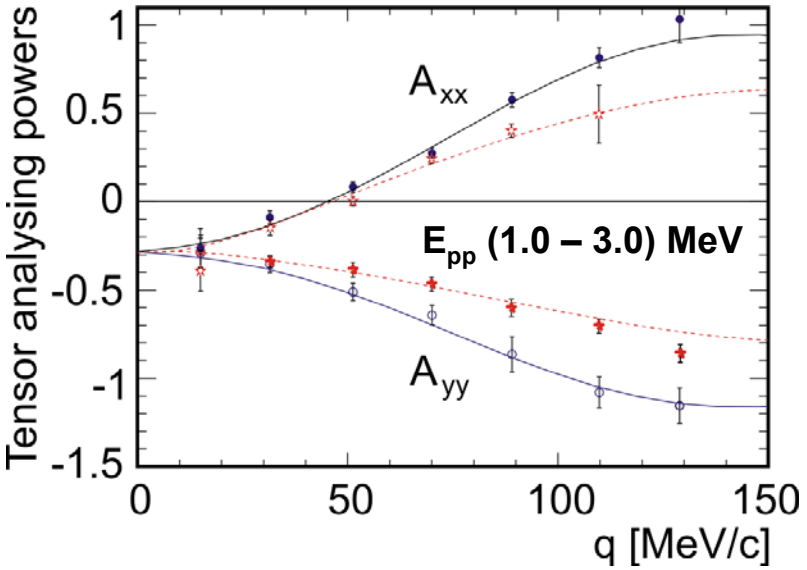
Published: Phys. Rev. ST Accel. Beams 9, 050101 (2006)

Analysing power measurements

- dp → (pp)n
- dp → (pn)p



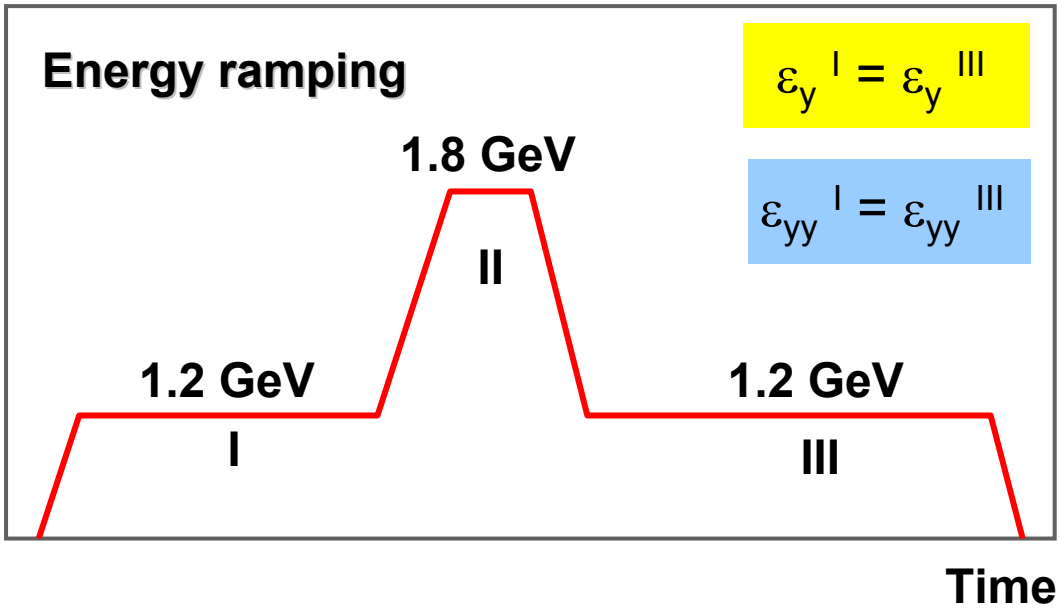




Published: Physics Letters B 637 (2006) 170 - 175

Beam polarimetry: Polarization export

- Polarized deuteron beam at 3 energies
- Calibration of the beam polarization of arbitrary energy
- Super cycle: T_d = 1.2 GeV, 1.8 GeV.



Results

$\varepsilon_y^{\ I} = -0.213 \pm 0.005$

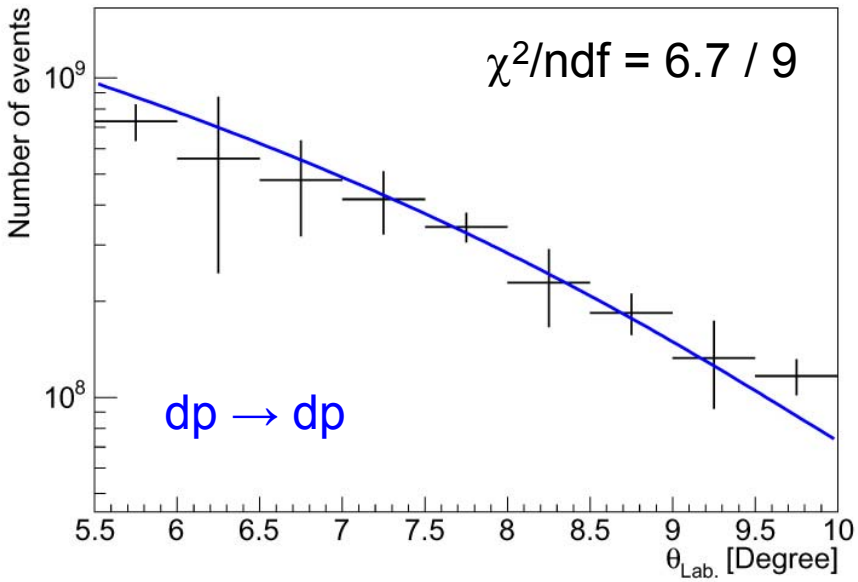
$\varepsilon_y^{\ III} = -0.216 \pm 0.006$

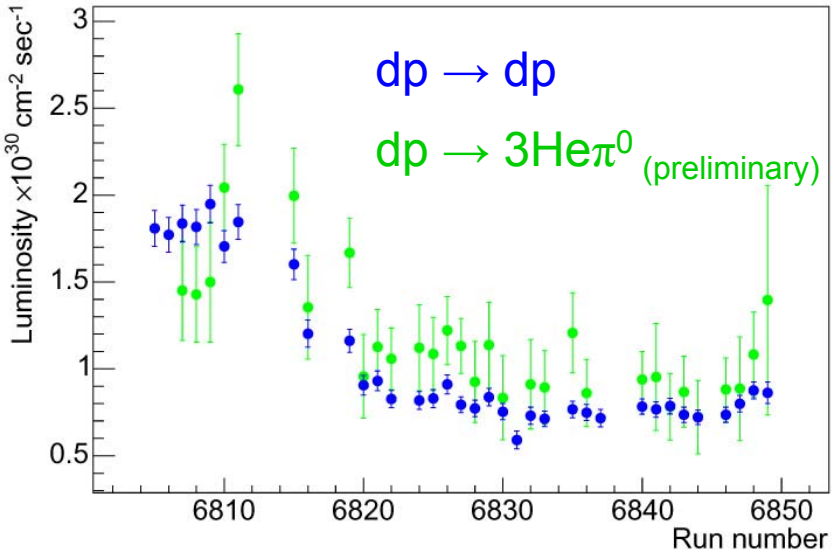
$\varepsilon_{yy}^{\ I} = 0.057 \pm 0.003$

$\varepsilon_{yy}^{\ III} = 0.059 \pm 0.003$

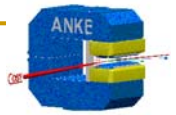
Luminosity

- dp → dp
  - Cross Section from KEK
- dp → ^{3}Heπ^0
  - Cross Section from SATURNE
- dp → dpπ^0 *(in progress)*
  - Cross Section from SAID





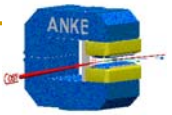
Summary & Outlook



- Polarisation standard at 1.2 GeV
- Polarisation at higher energy
- Analysing power measurements are done
- Cross-section in progress
- 2 publications are published

- Higher beam energy (up to 2.3 GeV)
- Double polarized dp→(2p)n reaction

Introduction: np amplitudes



$$\vec{d}p \to (pp)_{^1S_0}\, n$$

$$I = |\gamma|^2 + |\beta|^2 + |\varepsilon|^2 + |\delta|^2 R^2, \quad R = \frac{S^+(k, q/2)}{S^-(k, q/2)}; \qquad \frac{d^4\sigma}{dt d^3k} = \frac{1}{3} I\left[S^-(k, q/2)\right]^2;$$

$$IT_{20} = \frac{1}{\sqrt{2}}\left[|\gamma|^2 + |\beta|^2 + |\delta|^2 R^2 - 2|\varepsilon|\right]^2; \qquad IT_{22} = \frac{\sqrt{3}}{2}\left[|\gamma|^2 + |\beta|^2 - |\delta|^2 R\right]^2;$$

$$IC_{y,y} = -2\Re(\varepsilon^* \delta) R; \quad IC_{x,x} = -2\Re(\beta^* \varepsilon); \quad IC_{z,z} = -2\Re(\delta^* \beta) R.$$

$$\frac{d\sigma}{dt}, T_{20}, T_{22} \Rightarrow |\gamma|^2 + |\beta|^2, |\delta|^2, |\varepsilon|^2 \qquad \text{over a range in } t$$

Bugg, Wilkin; NP A467(1987) 575

In collinear kinematics $\Rightarrow$

$$I = 2|\beta|^2 + |\varepsilon|^2; \quad IT_{20} = \sqrt{2}\left[|\beta|^2 - |\varepsilon|^2\right] \Rightarrow |\beta|, |\varepsilon|$$

$$IC_{y,y} = -2\Re(\varepsilon\beta^*); IC_{xz,y} = -3\Im(\beta\varepsilon^*) \Rightarrow \cos(\varphi_\varepsilon - \varphi_\beta)$$