

# The Polarized Deuteron Break-up Experiment at COSY

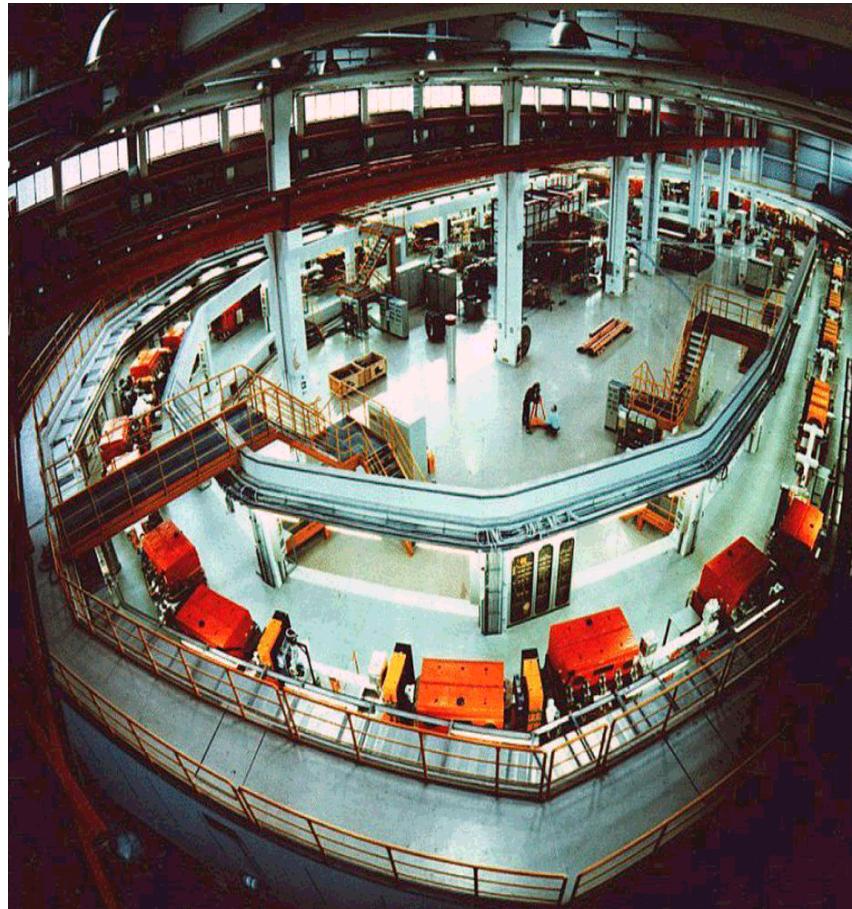
S. Dymov, R. Engels, A. Kacharava, H. Kleines,  
V. Komarov, P. Kravtsov, A. Kulikov, A. Kurbatov,  
B. Lorentz, G. Macharashvili, M. Mikirtytchians,  
V. Nelyubin, D. Prasuhn, F. Rathmann, J. Sarkadi,  
H. Seyfarth, H. Paetz gen. Schieck, E. Steffens,  
H. Ströher, Yu. Uzikov, A. Vassiliev, S. Yaschenko,  
B. Zalikhanov, K. Zwoll, for the ANKE Collaboration

LNP, JINR, Dubna, Russia  
IKP, Univ. zu Köln, Germany  
PI II, Univ. Erlangen-Nürnberg, Germany  
ZEL, Forschungszentrum Jülich, Germany  
PNPI, Gatchina, Russia  
IKP, Forschungszentrum Jülich, Germany

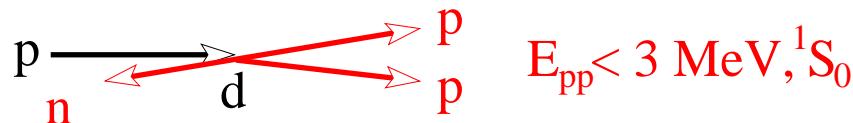
Brookhaven, September 9, 2002

# Outline

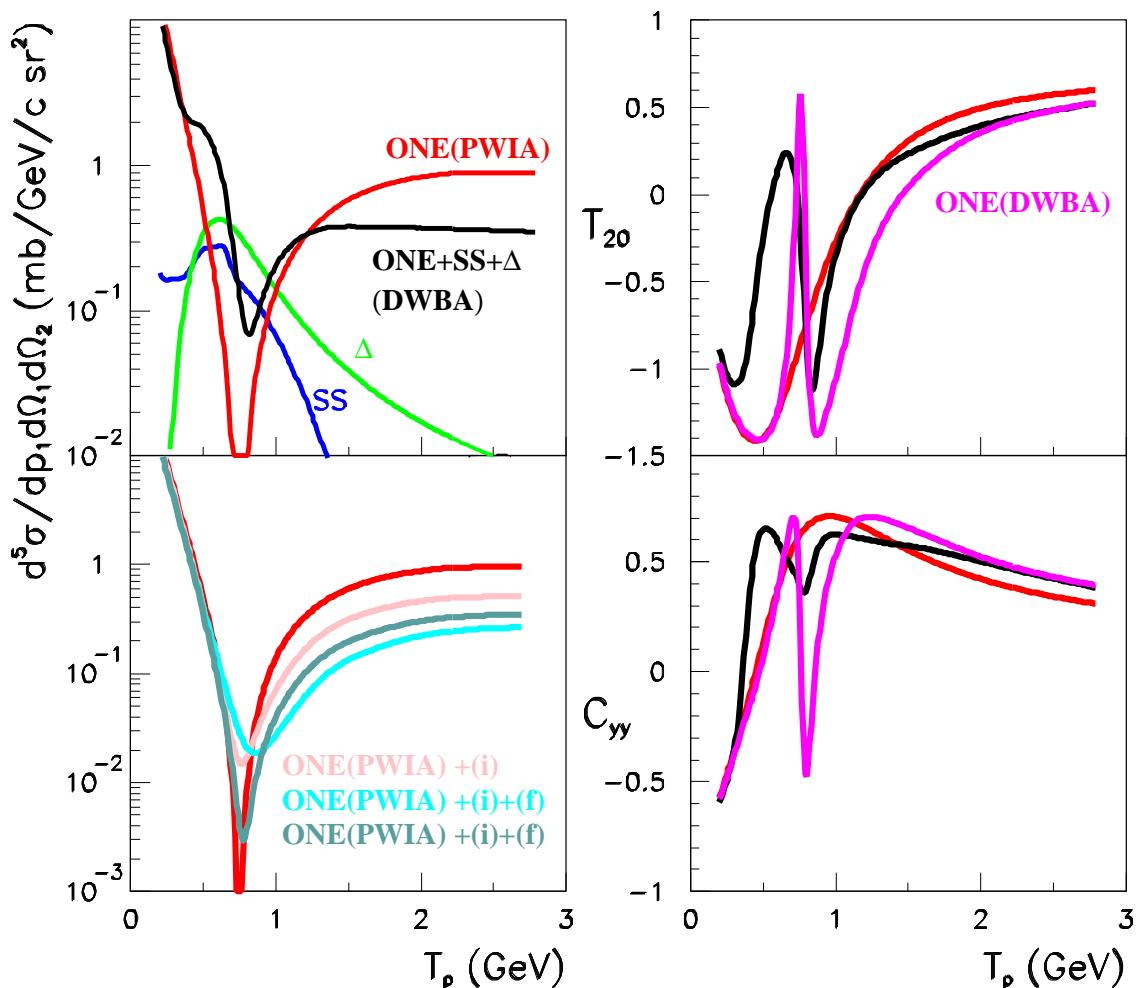
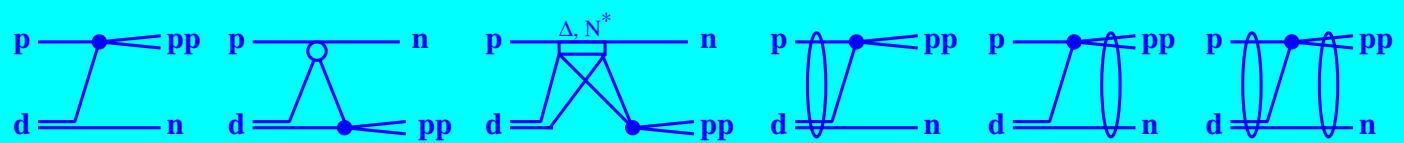
- Motivation
- Experimental Setup
- Data Analysis
- Recent Results
  - Unpolarized Cross section
  - First Polarization Observables
- Current and Future Plans



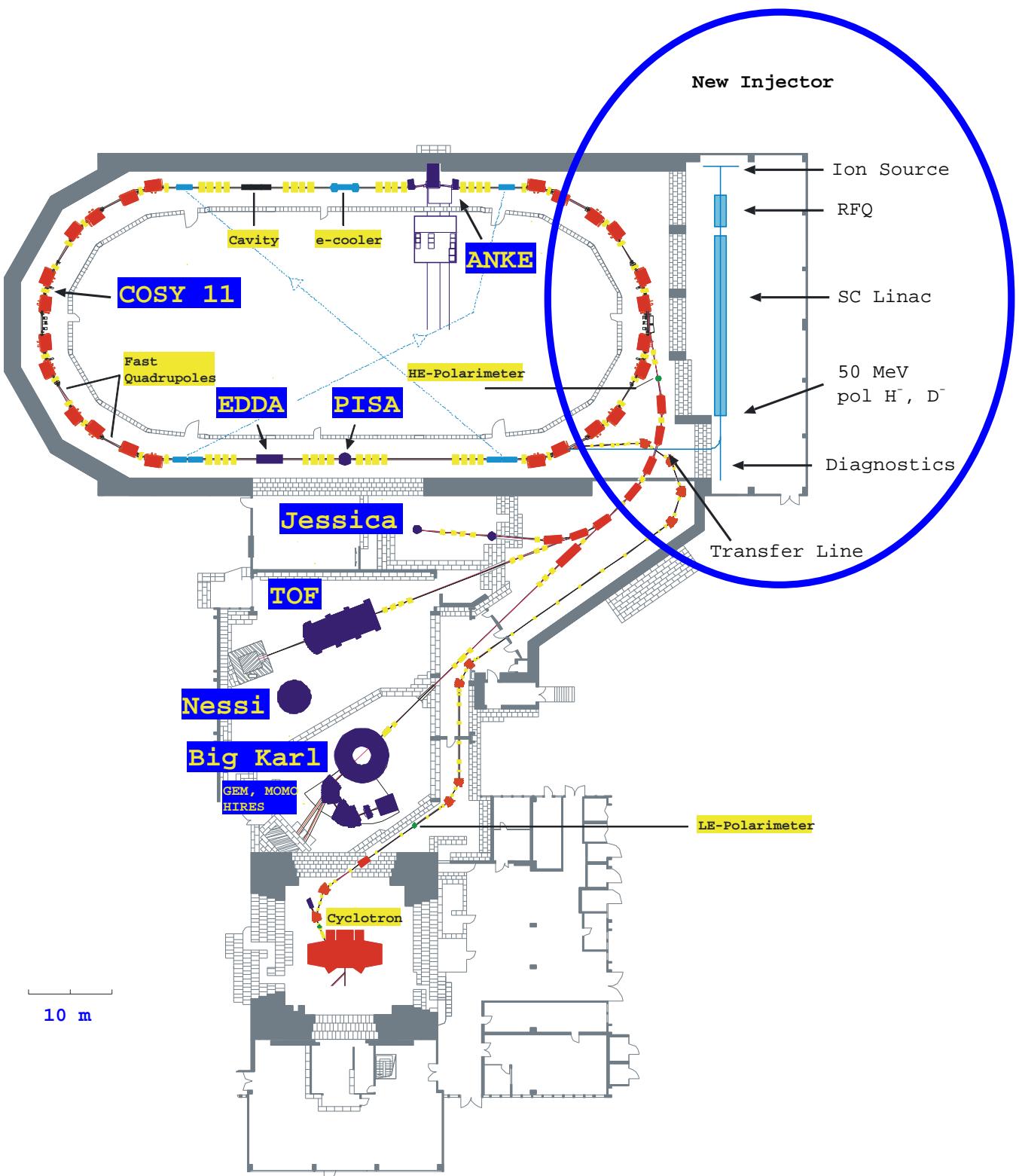
# Why $\vec{pd} \rightarrow pp(0^\circ)n$ ?



- New Experimental Method to Short–Range properties of the NN interaction
- Similar kinematics as in  $pd$ –backward elastic scattering, but with a final  $pp$  pair in  ${}^1S_0$  state!
- Theoretical Predictions for cross sections and spin–observables ( $T_{20}$ ,  $A_y^p$ ,  $C_{yy}$ ). [Yu.N. Uzikov J.Phys.G, 28, B13 (2002)]

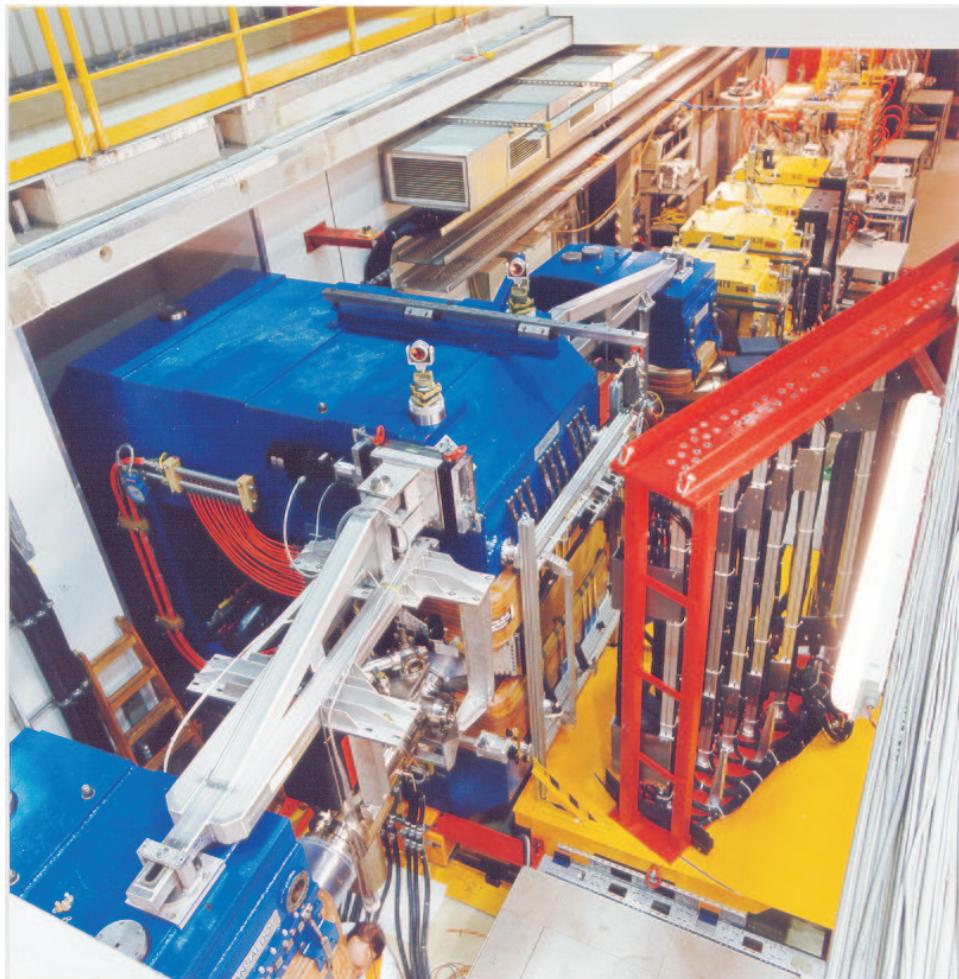
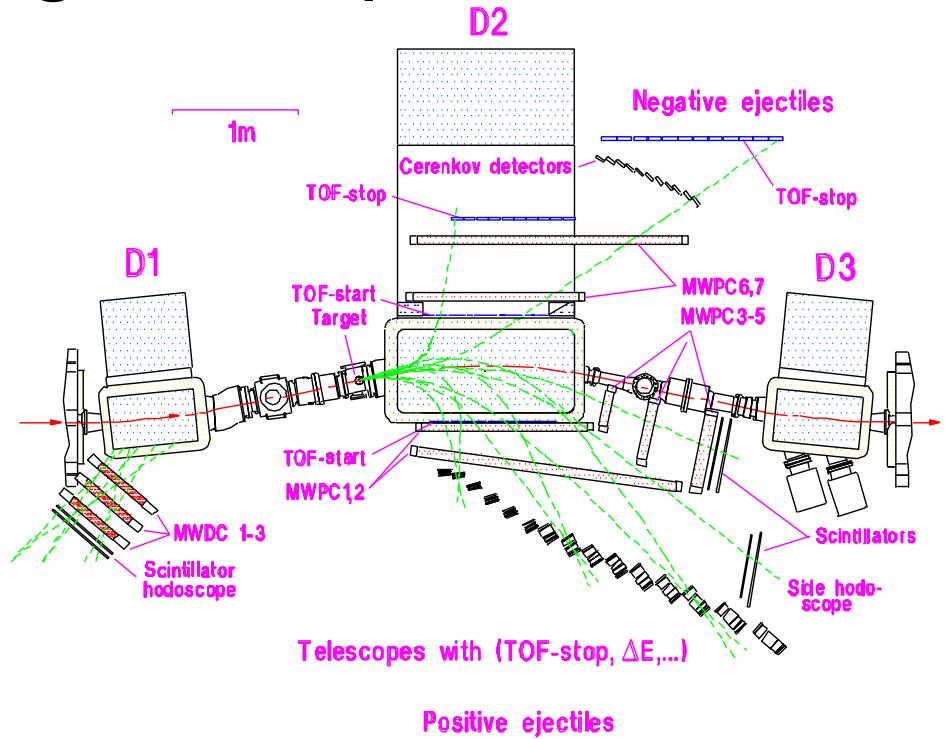


# New Injector for COSY

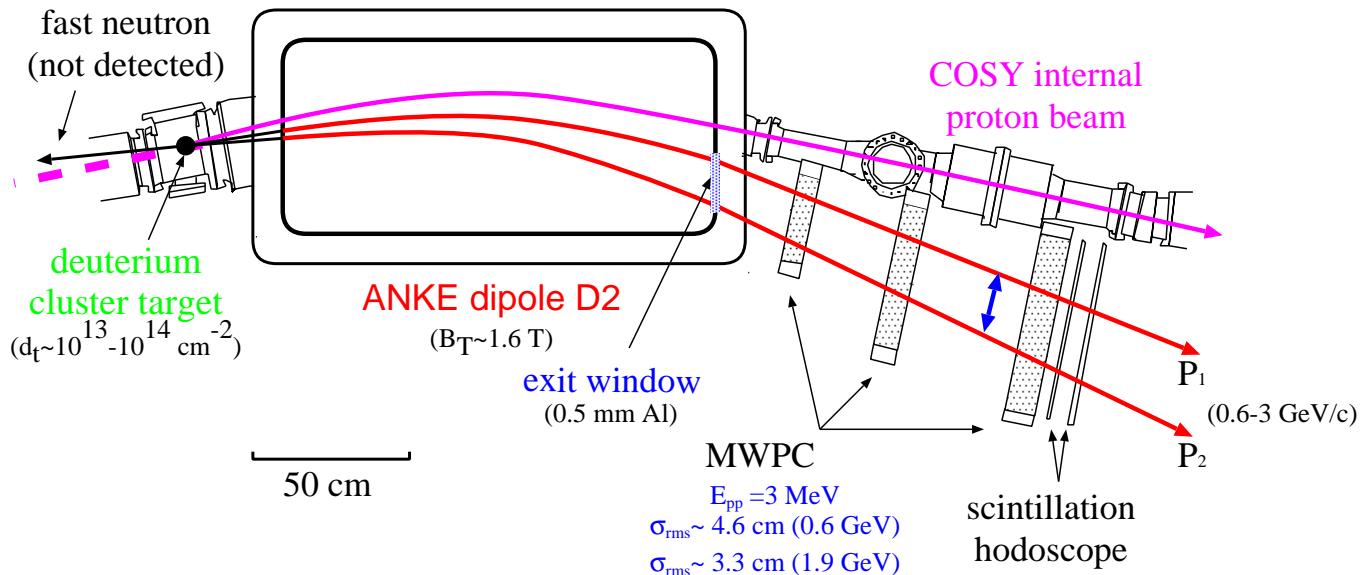


$$T_p = 45 \dots 2600 \text{ MeV} \quad (295 \dots 3400 \text{ MeV}/c)$$

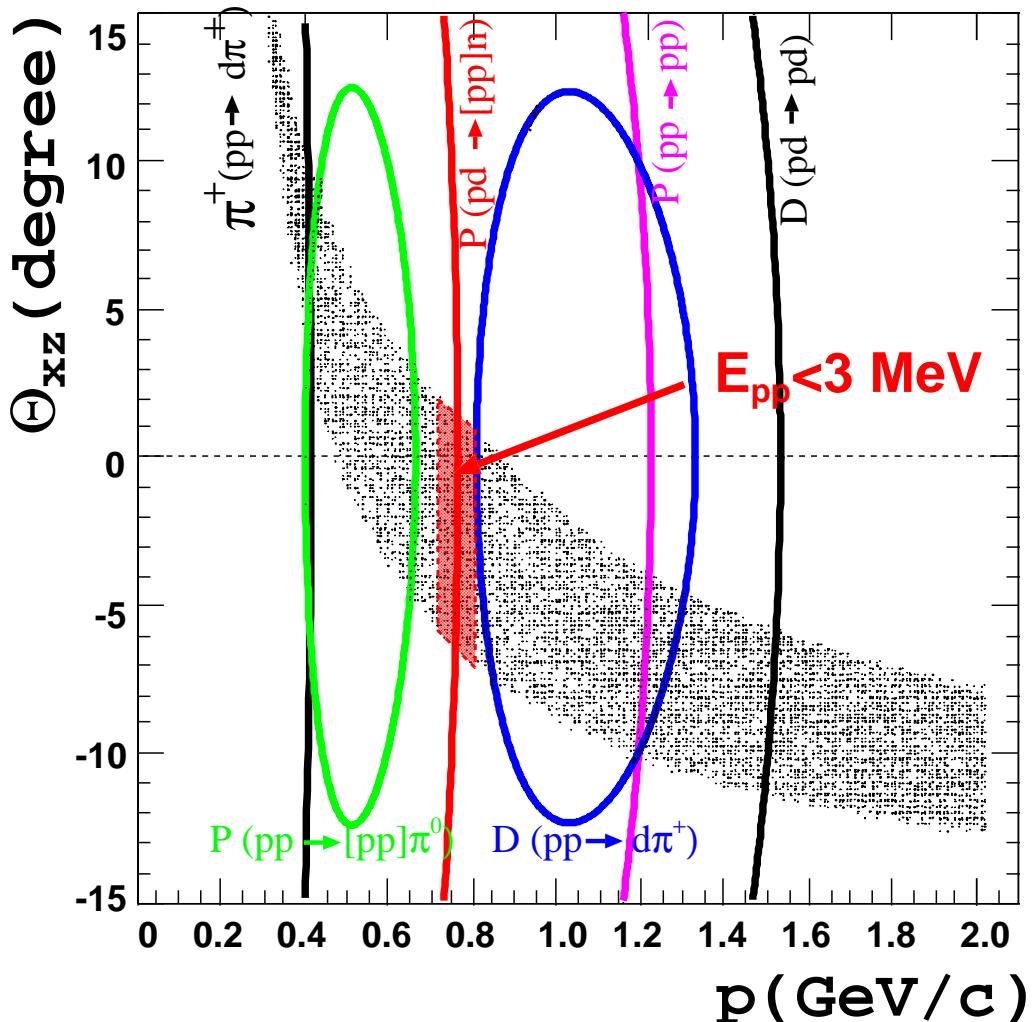
# Magnetic spectrometer ANKE



# Detection System

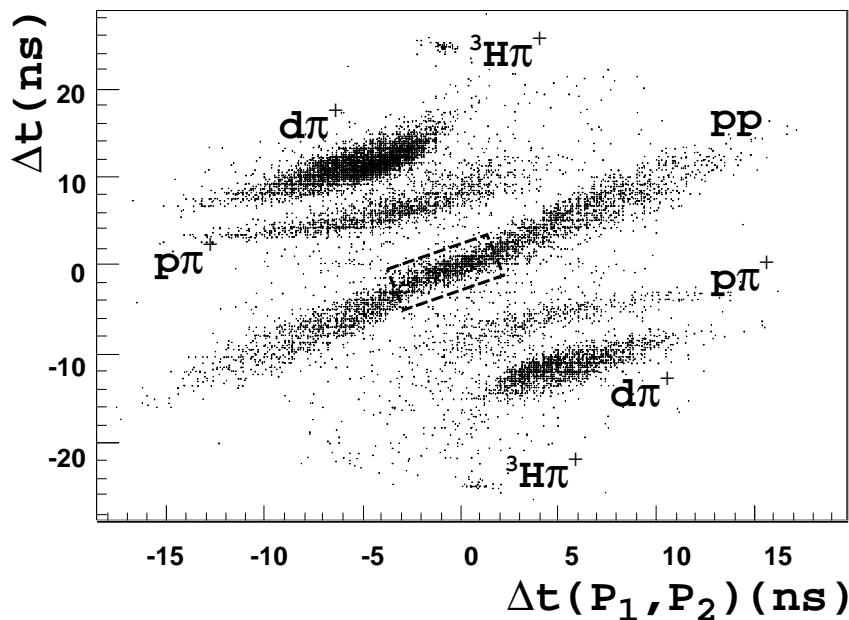
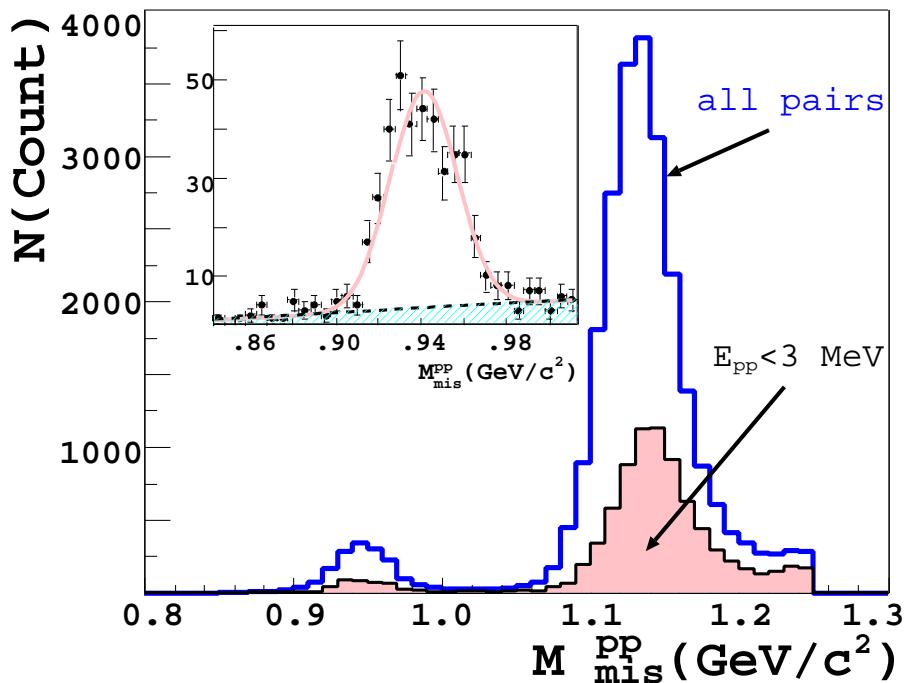


## Acceptance at 0.6 GeV



# Event Identification

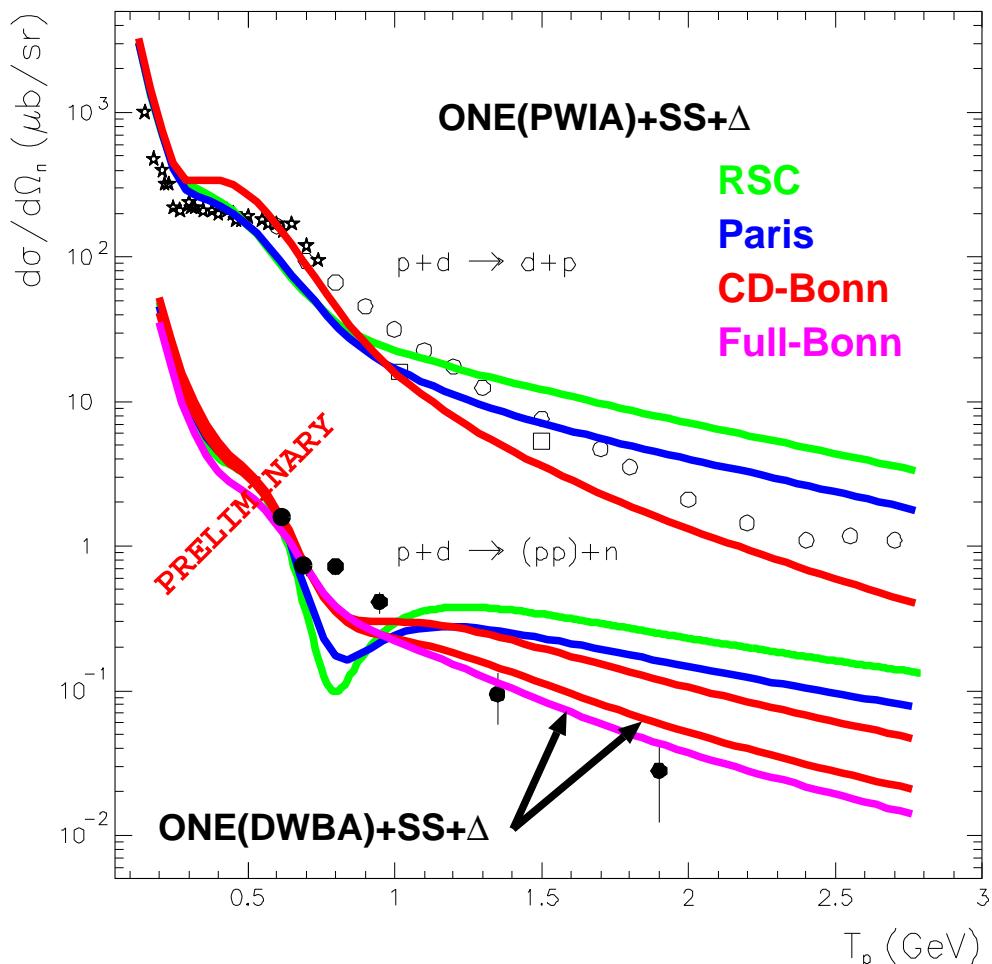
- Unbiased missing mass reconstruction using the measured momenta assuming proton masses.



- Cross check possible using measured  $\Delta t$ .

# Recent Results of unpolarized cross section

- Measured at incident proton energies  
 $T_p = 0.6, 0.7, 0.8, 0.95, 1.35,$  and  $1.9 \text{ GeV}.$
- Low statistics  $\Rightarrow$  cs averaged over  $\theta_{cm} = 0 \dots 8^\circ.$

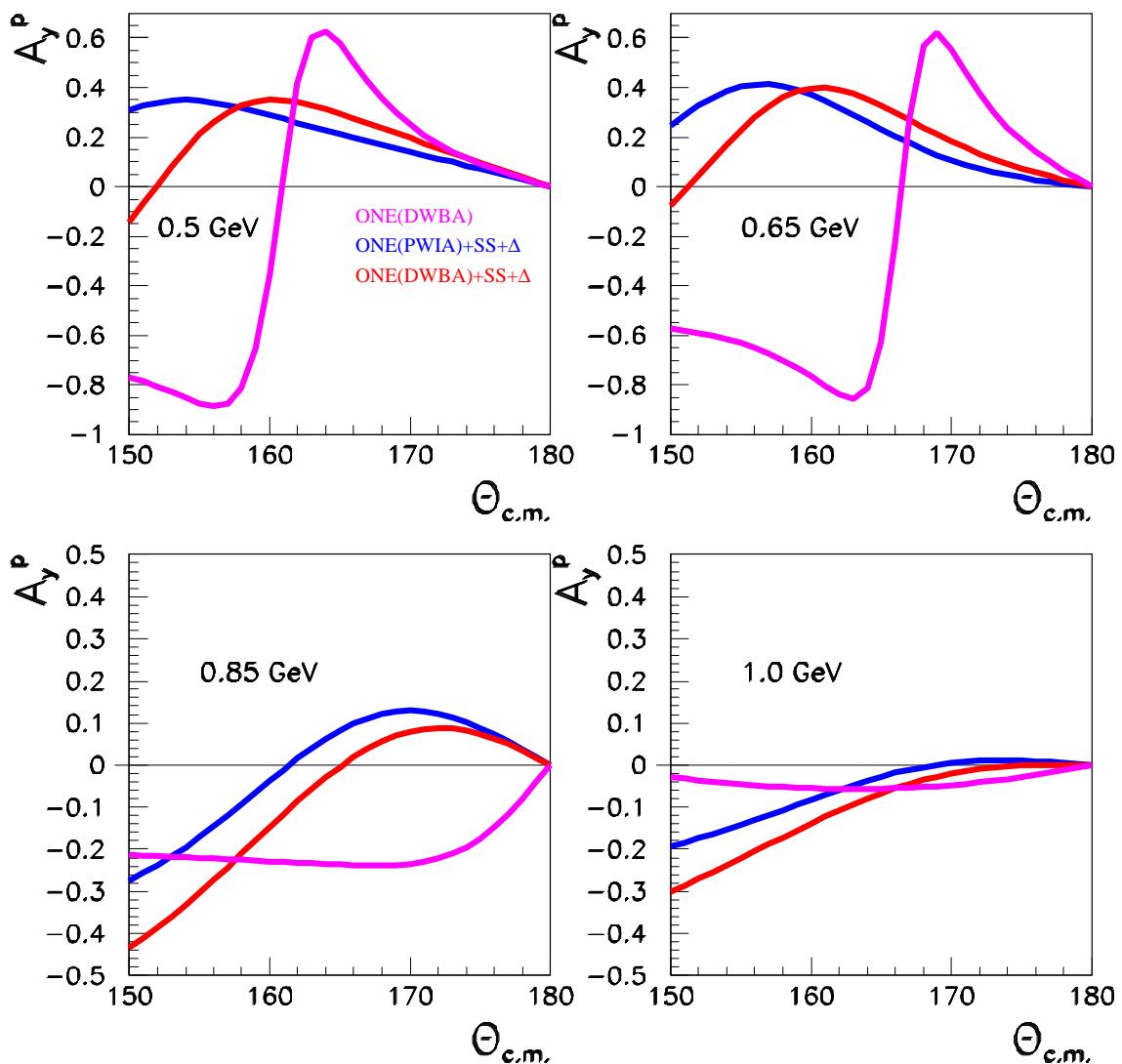


- Luminosity determined from quasi-elastic scattering of protons on deuterons  $\theta_{lab} = 5 \dots 10^\circ:$ 
  - Experimentally impossible to separate elastic and inelastic events.  $\Rightarrow$  Obtained number of counts related to elastic and inelastic terms in diffractive pd scattering. (Cross section calculated via closure approximation of Glauber-Franko theory.)
- $L^{int} \approx (0.7 \dots 1.4) \cdot 10^{34} \text{ cm}^{-2}.$

# First Polarization Observables from ANKE:

## Polarized proton beam incident on unpolarized deuterium cluster target:

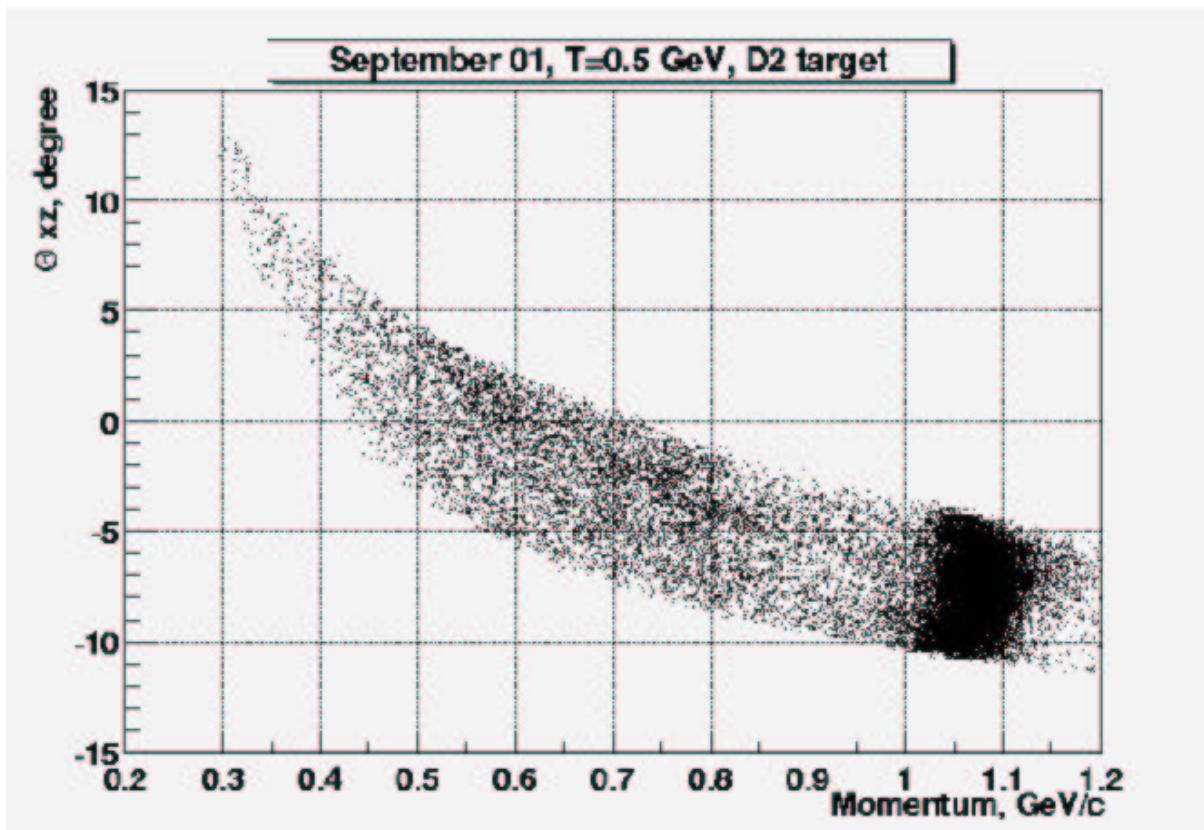
**Goal:** Vector analyzing power  $A_y^p$  of  $\vec{p}d \rightarrow pp(0^\circ)n$  as fct of the neutron scattering angle  $\theta_{cm}^n$  at  $E_{pp} = 3$  MeV



[Y.N. Uzikov, nucl-th/0006067]

ANKE acceptance covers  $\theta_{cm}^n > 166^\circ$ .

# Determination of $P_{beam}$ with a Dipole Spectrometer



Initial luminosity  $\mathcal{L} \approx 10^{29}$ , dropped to  $\approx 10^{28} \text{ cm}^{-2}\text{s}^{-1}$ .  
Stored  $n_{\vec{p}} \approx 1.2 \cdot 10^9$ , dropped to  $\approx 5 \cdot 10^8$ .

- For relative luminosity selected via  $\Delta E$ :

$$-1^\circ \leq \theta_{xz} \leq 1^\circ \text{ and } 0.42 \leq P_p \leq 0.72 \text{ GeV/c.}$$

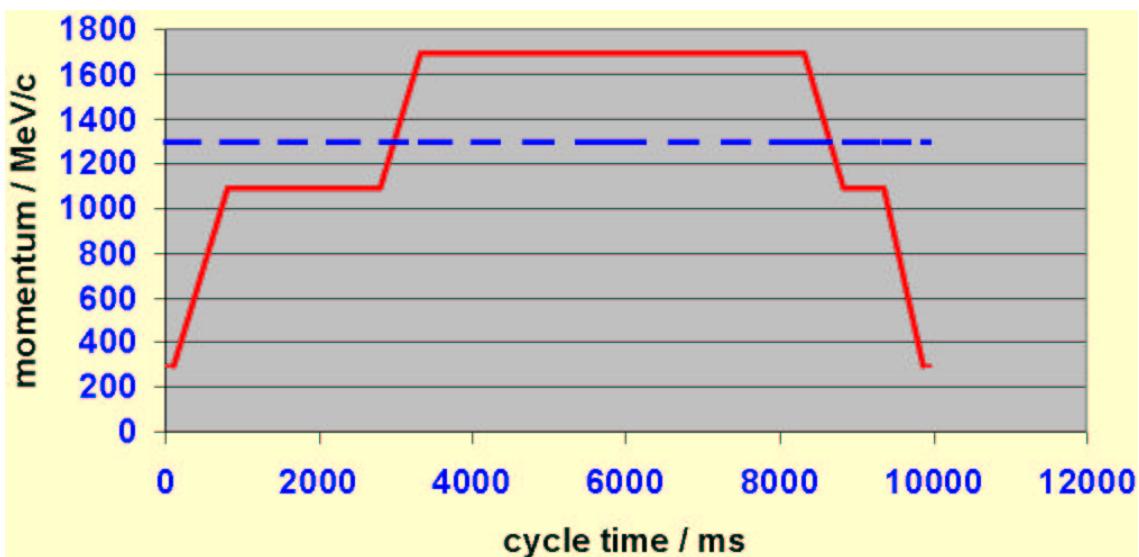
- Asymmetry from forward protons:

$$5^\circ \leq \theta_{xz} \leq 10^\circ \\ 1.04 \leq P_p \leq 1.1 \text{ GeV/c} \\ + \Delta E \text{ to get rid of } d's.$$

# COSY Cycle

Take data at **two** energies:  $T = 500$  and  $1000$  MeV

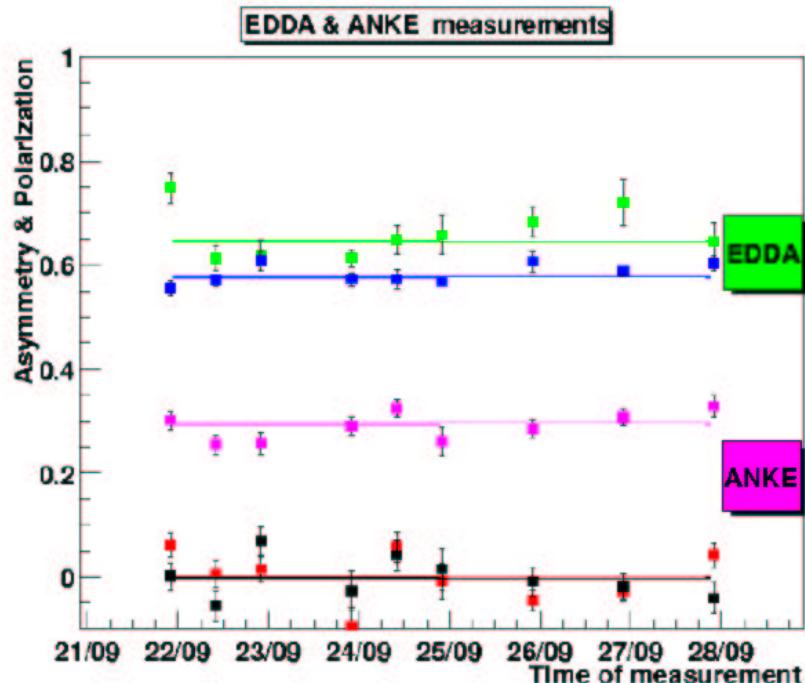
- Calibrated pol. meas. at EDDA for  $T > 700$  MeV!
- EDDA targets tolerate only  $n_{proton} < 5 \cdot 10^8$   
⇒ **two** identical cycles (same excitation of magnets)
  1. ANKE data taking
  2. EDDA polarization measurement
- Resonances at  $0.5 \dots 0.7$  GeV well understood in COSY.
- Two modes of polarization measurements:
  1. During ramp between  $0.7 - 1.0$  GeV
  2. On Flattop at  $1.0$  GeV



# Results of Polarization Measurement with EDDA and ANKE

Asymmetry

$$\varepsilon(\uparrow, \downarrow) = \frac{N_{\uparrow}/\mathcal{L}_{\uparrow} - N_{\downarrow}/\mathcal{L}_{\downarrow}}{N_{\uparrow}/\mathcal{L}_{\uparrow} + N_{\downarrow}/\mathcal{L}_{\downarrow}}$$



T [GeV]	$P_{beam}^{\text{EDDA}}$
0.7	$0.645 \pm 0.009$
1.0	$0.577 \pm 0.001$

Asymmetries measured at ANKE at  $\theta_{xz} = 9 \dots 10^\circ$

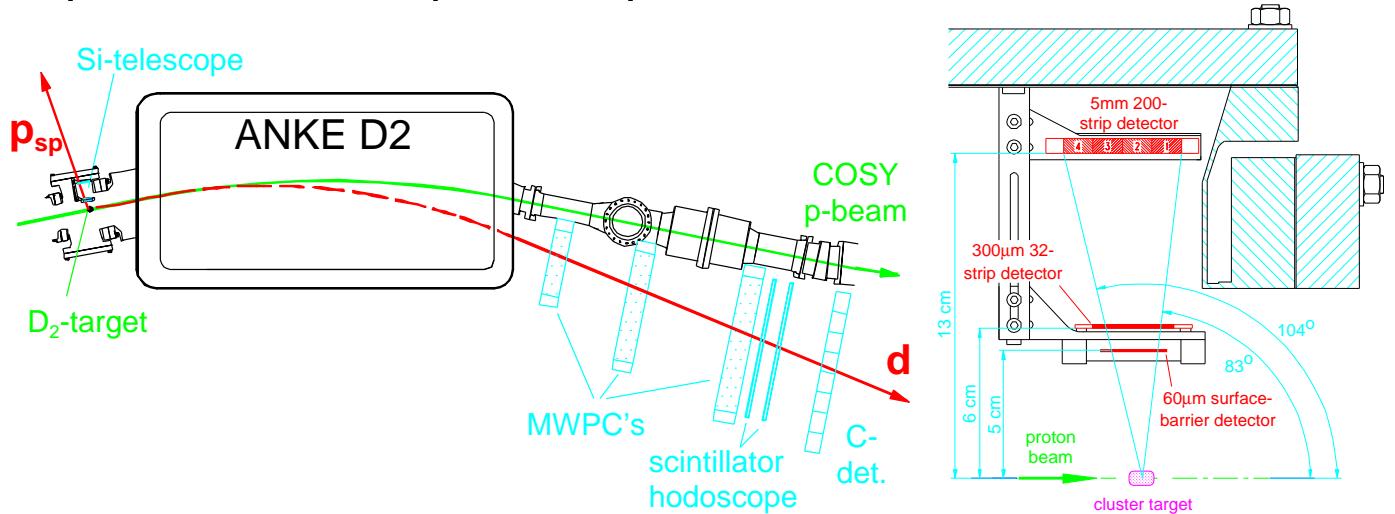
T [GeV]	$\varepsilon(\uparrow, \downarrow)$	$[\varepsilon(\uparrow, \uparrow) + \varepsilon(\downarrow, \downarrow)]/2$
0.5	$0.294 \pm 0.006$	$-0.002 \pm 0.009$

Effective analyzing power

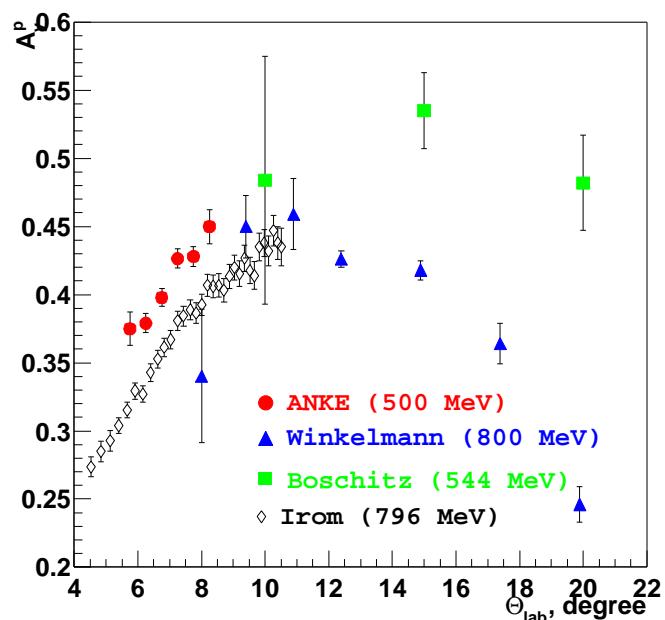
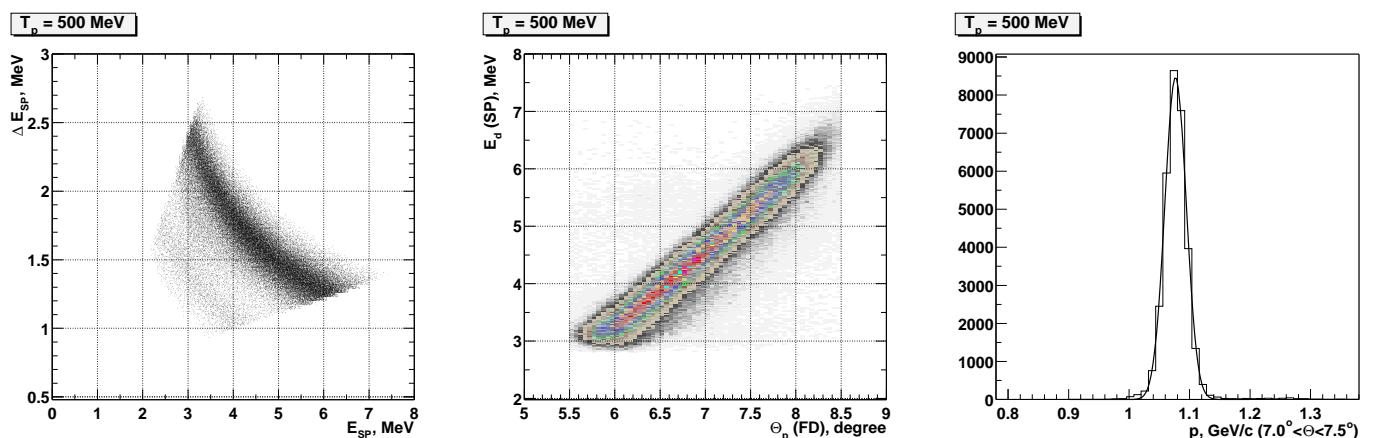
$$A_y^{\text{eff}}(9 \dots 10^\circ) = \varepsilon(\uparrow, \downarrow)/P_{beam}^{\text{EDDA}} = 0.456 \pm 0.011.$$

# *pd* elastic $A_y$ at 500 MeV

## Experimental Setup with Spectator Detector

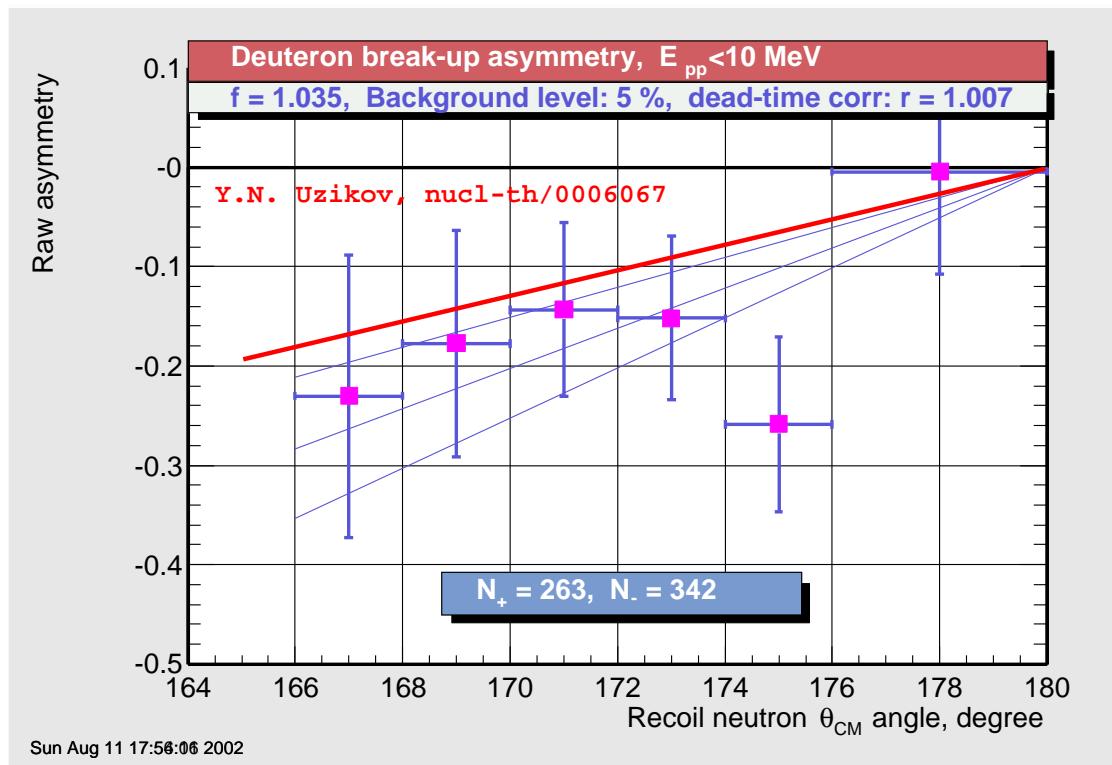


(R. Schleichert, I. Lehmann, A. Mussgiller, S. Merzliakov)



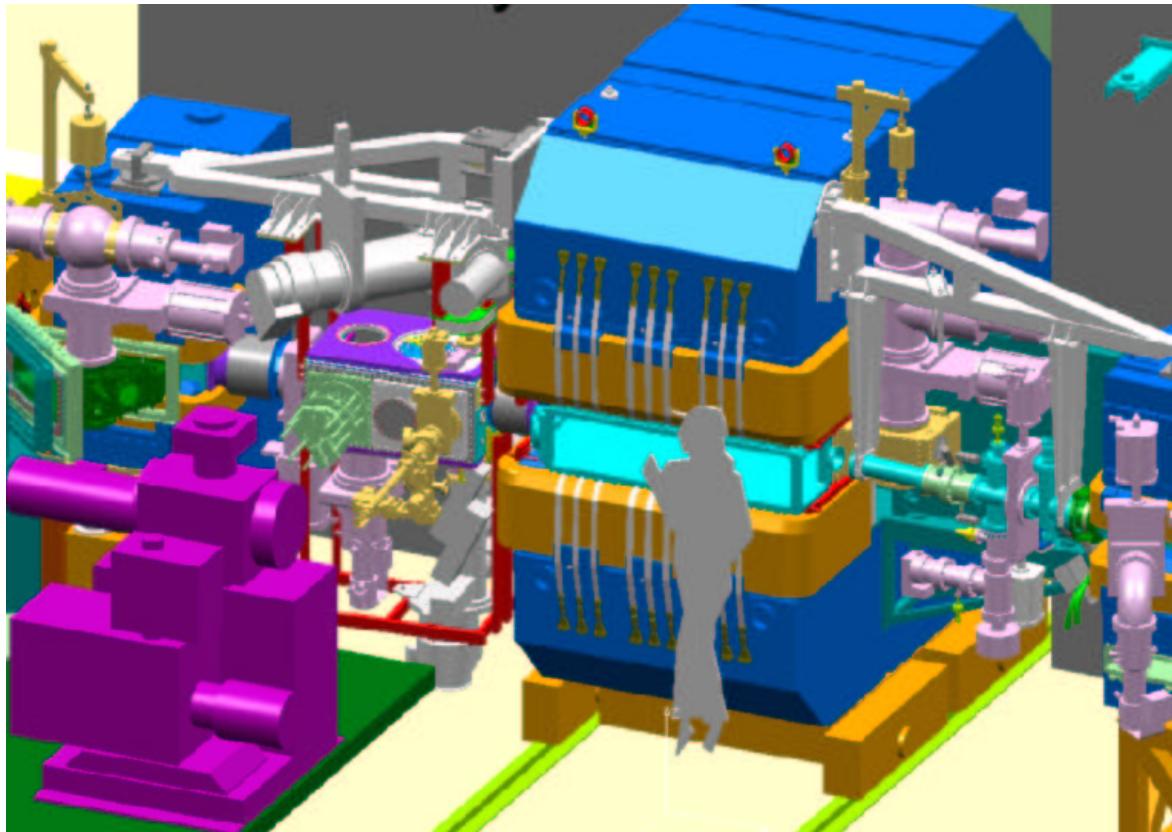
# First glance at $A_y^p$ from $\vec{p}d \rightarrow pp(0^\circ)n$

- $T_p = 500$  MeV
- $P_{beam} = 0.6$ , measured at EDDA

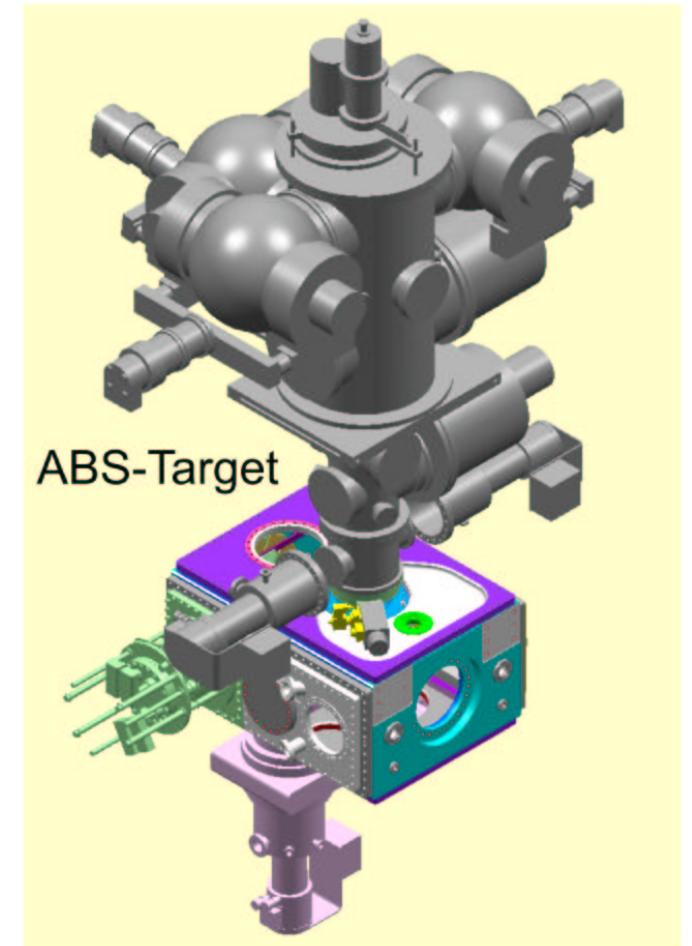


# Future: Polarized Internal Storage Cell Target for ANKE

Target Chamber, Differential Pumping & Beam Position Monitoring System



Forschungszentrum Jülich



ABS-Target

Zentralabteilung Technologie

# Summary

- Measurement of Unpol. cross section of  $pd \rightarrow pp(0^\circ)n$  at six beam energies:  $T_p = 0.6, 0.7, 0.8, 0.95, 1.35$ , and  $1.9$  GeV. (Publication in preparation)
  - Theoretical estimates of cross sections and spin observables (Yu.N. Uzikov).
- First Exp't with polarized beam at ANKE
  - $P_{Beam}$  measured at EDDA!
  - $pd$ -elastic scattering at ANKE with spectator counter suitable to determine  $P_{Beam}$ !
  - Measurements at  $T_p = 500$  MeV:
    - \*  $\vec{pd}$ -elastic  $A_y^p(\theta_{lab} = 5 \dots 10^\circ)$ .
    - \*  $\vec{pd} \rightarrow pp(0^\circ)n$   $A_y^p(\theta_{cm} = 166 \dots 180^\circ)$ .
- Polarized Internal Storage Cell Gas Target in preparation.
  - ABS up and running ( $7.4 \cdot 10^{16}$  atoms/s [2 HFS]).
  - Lamb-shift Polarimeter for Target polarization.
  - First cell studies underway.