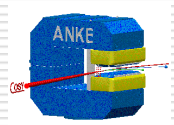
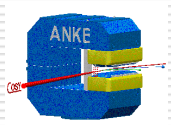


The Polarised Charge-Exchange Reaction

$$\vec{d}+p\rightarrow(pp)+n$$

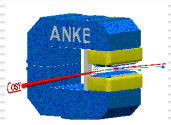
A. Kacharava for the ANKE Collaboration

Outline



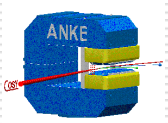
- Motivation
- Test measurement
- np SAID data
- Preliminary results
- Outline

Motivation: *NN* Interaction

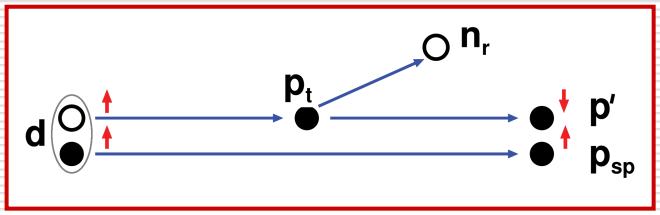


- Characterization of NN interaction requires precise data
  - *pp* system up to 2.5 GeV well-known (…, PINTEX, EDDA)
  - ANKE will provide high-quality data for the *np* (*I=0*) system.
- Remarks:
  1. *Gross misconception within the community that np amplitudes are known to a couple of GeV.* [R. Arndt]
  2. *Measurements of ANY observables at small angle are highly desirable to improve PSAs* [J. Bystricky]
- These measurements can be realized at ANKE-COSY, at higher energies at NUCLOTRON/DUBNA

Motivation: NN Interaction



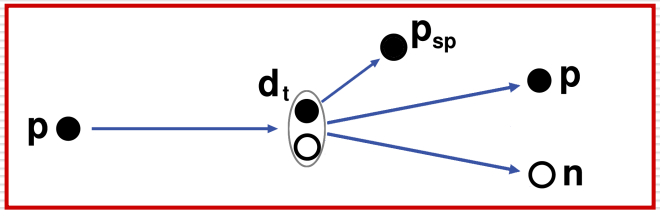
- Spin structure of $np \to pn$ reaction amplitudes
  - Method: CE break-up



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

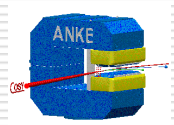
$\vec{\vec{d}}p \to (pp)_{^1S_0}\, n$

- Next Step: Measurement of spin observables for pn system up to 3 GeV
  - Method: Spectator technique



$\vec{p}\vec{d} \to p_{sp}\,(pn)$

Motivation: *np* Scattering Amplitudes



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

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

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

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

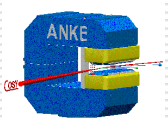
$$\frac{d\sigma}{dt}, T_{20}, T_{22} \Rightarrow |\gamma|^2 + |\beta|^2, |\delta|^2, |\varepsilon|^2 \qquad \text{over a range in } t$$

<u>In collinear kinematics</u> $\Rightarrow$

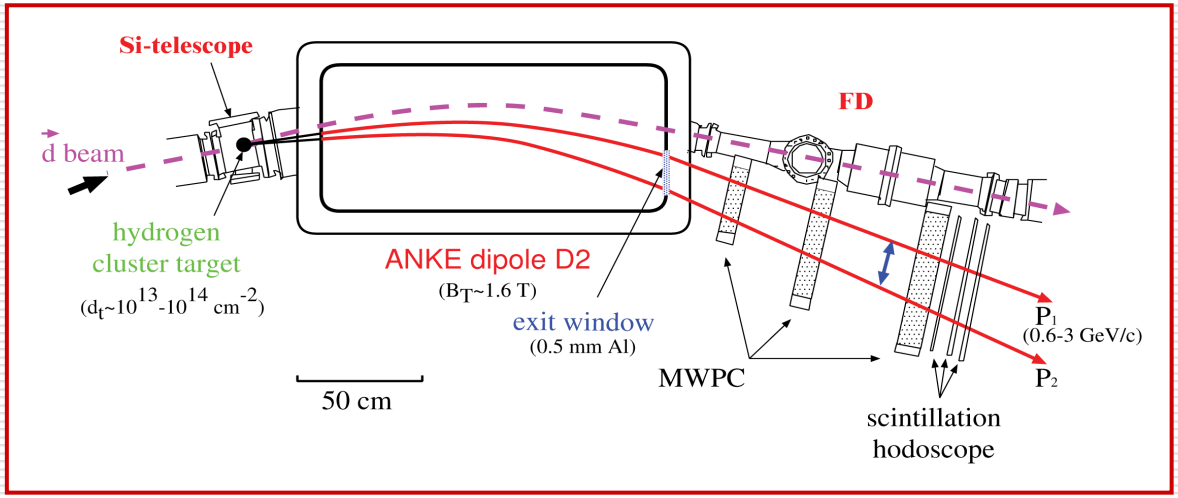
$$I = 2|\beta|^2 + |\varepsilon|^2; \quad IT_{20} = \sqrt{2}\left[|\beta|^2 - |\varepsilon|^2\right] \Rightarrow |\beta|, |\varepsilon|$$

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

Test Measurement: Setup



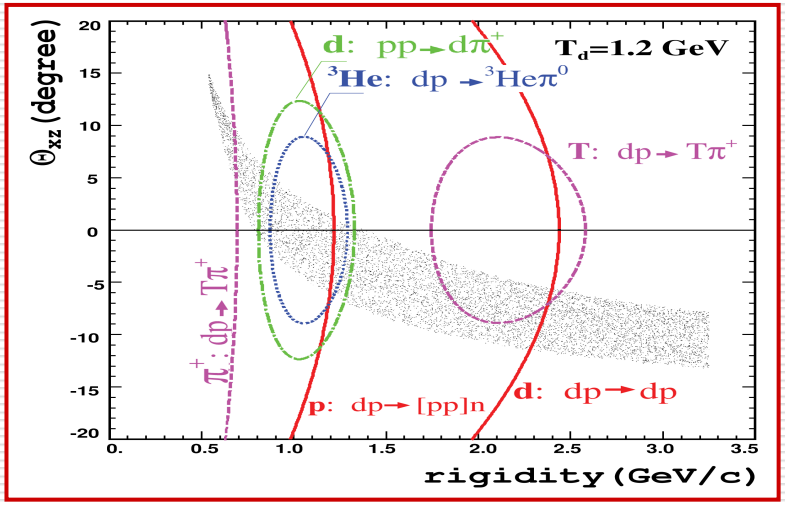
Experimental Setup



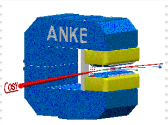
COSY Deuteron Beam $I = 3 \times 10^9 \times f_r$

Spin Mode	Theoretical maximum		Intensity [I]
	P_z	P_{zz}	
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	-1/2	2/3

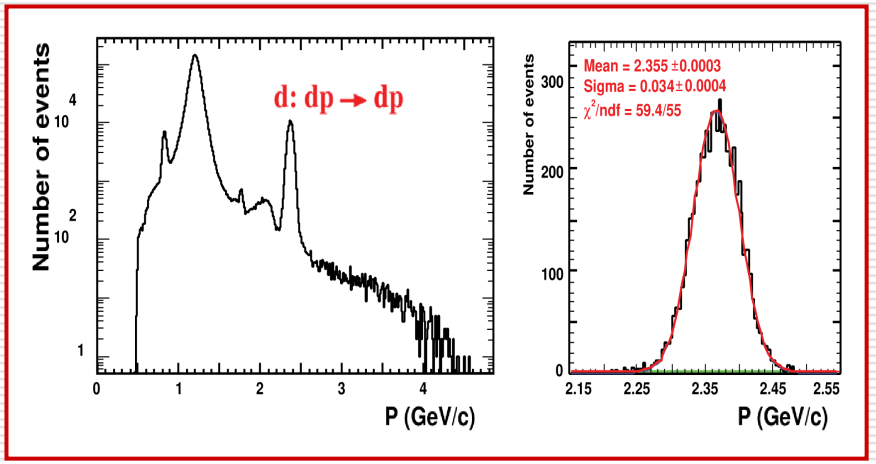
Acceptance

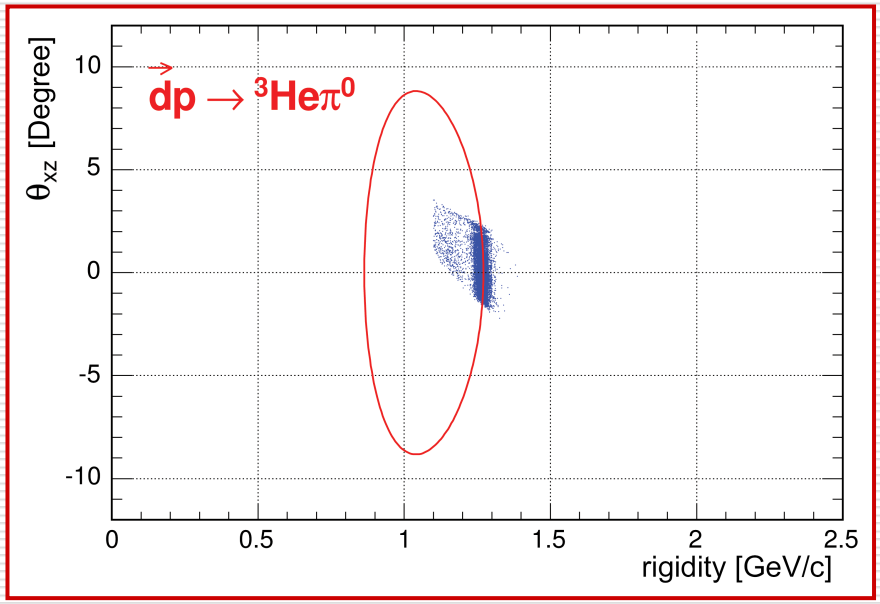


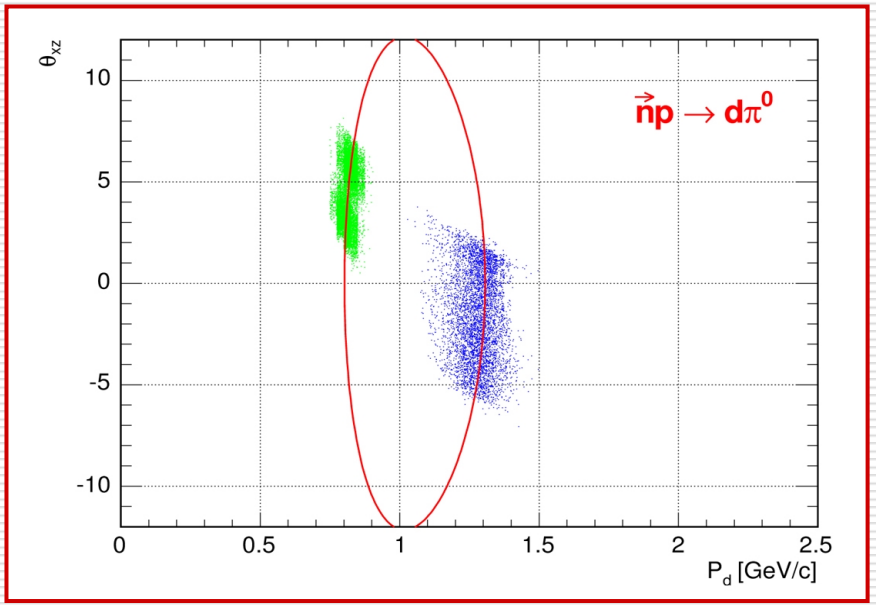
Test Measurement: Identification of *dp* reactions



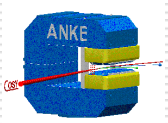
- dp elastic
- $dp \rightarrow {}^3He\pi^0$
- $dp \rightarrow p_{sp}d\pi^0$
- Polarimetry, Luminosity







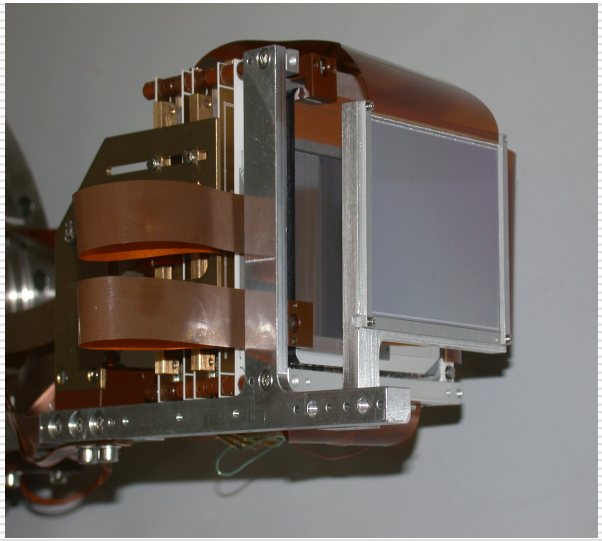
Test Measurement: quasi-free $\vec{p}\vec{p}$ scattering

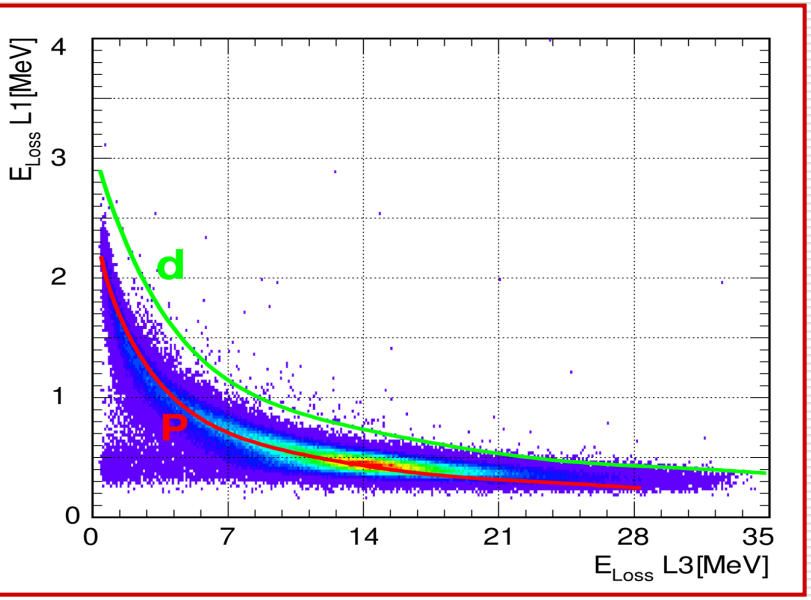


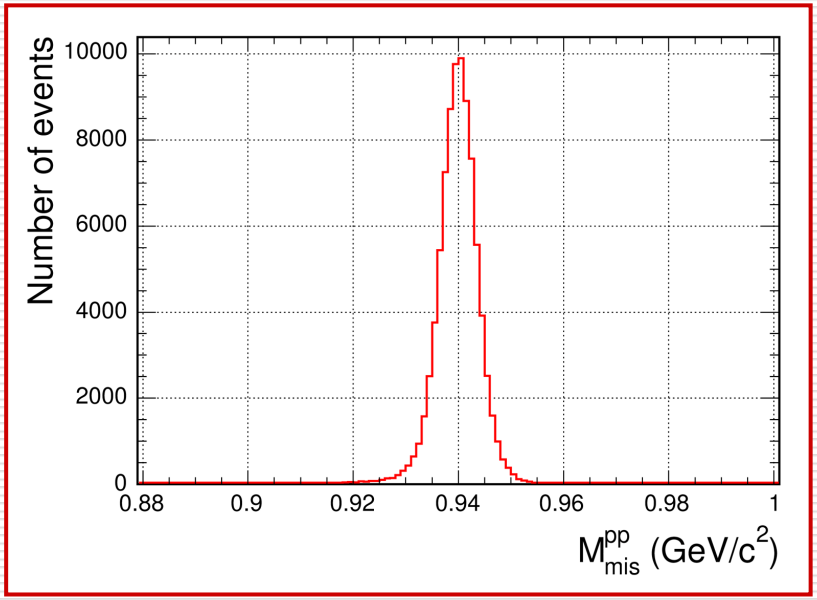
- FD coincidence with Silicon telescope
- P_z via $A_y(\theta)$ from pp elastic

$$\sigma^{\uparrow} = \sigma^{0}\left(1 + \frac{3}{2} A_y(\theta) P_z \cos\varphi\right)$$

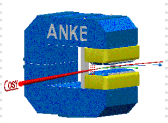
- Luminosity determination



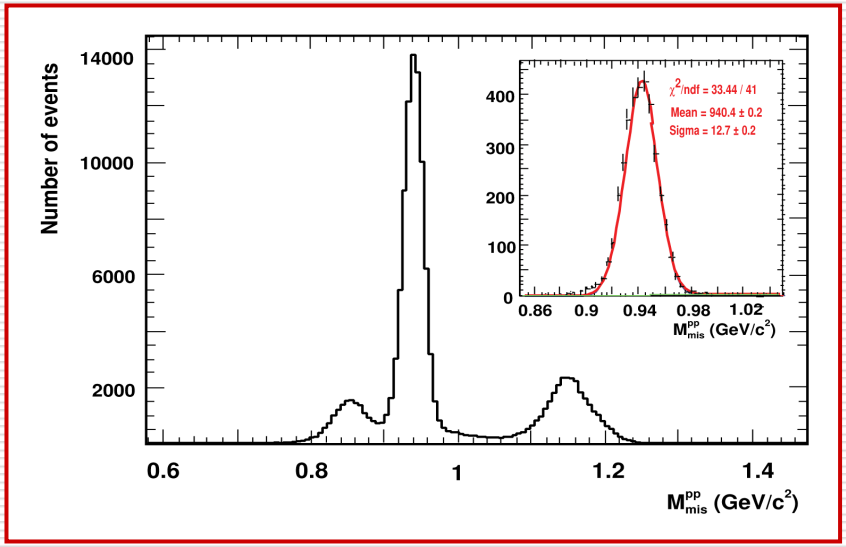


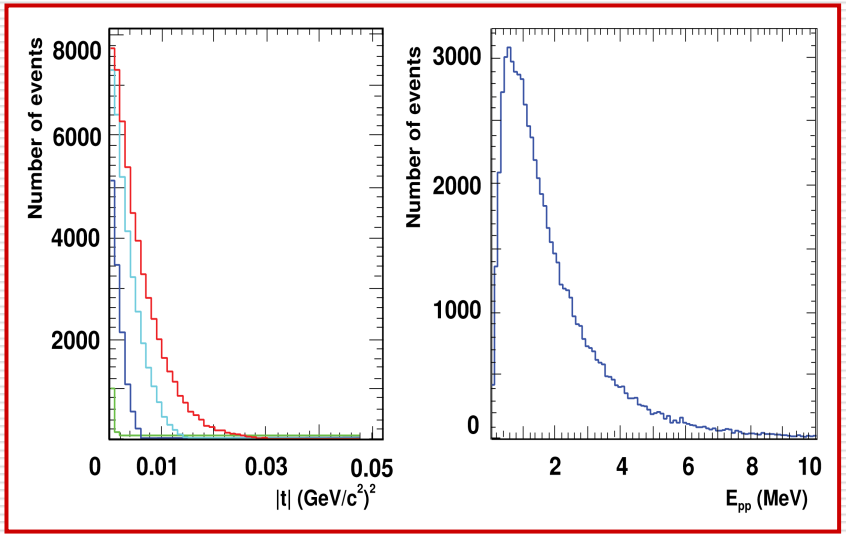


Test Measurement: $\vec{d}p \rightarrow (pp)n$ Charge-exchange

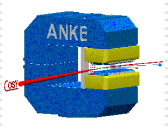


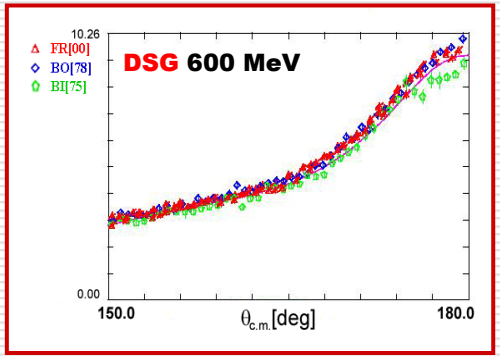
- Reaction identification
  - MWPC information
  - Timing information
- Differential cross section
  (in progress)
  - Acceptance calculation
  - Efficiency estimation
- Monitoring of polarisation

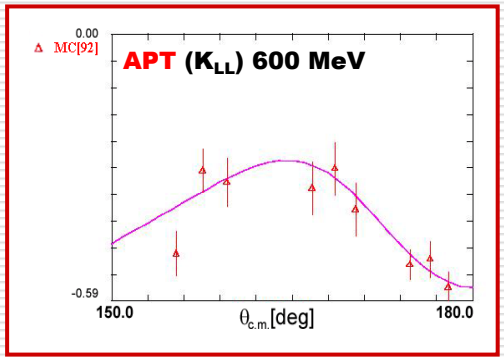


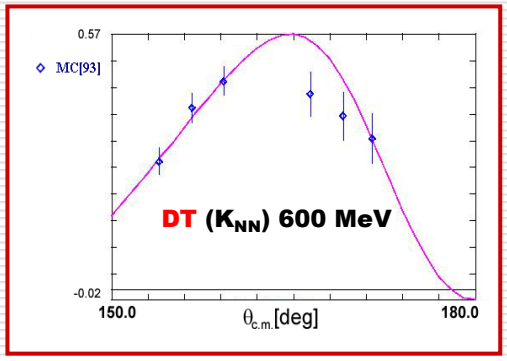


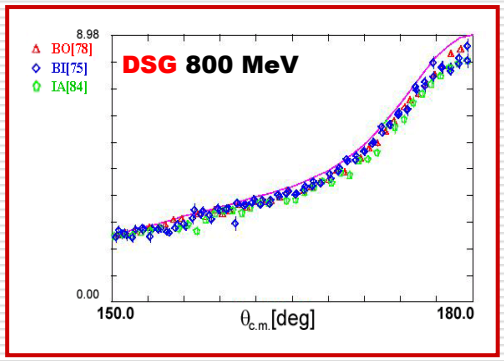
Observables: np SAID data

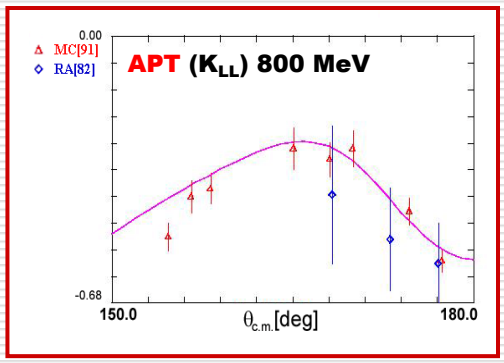


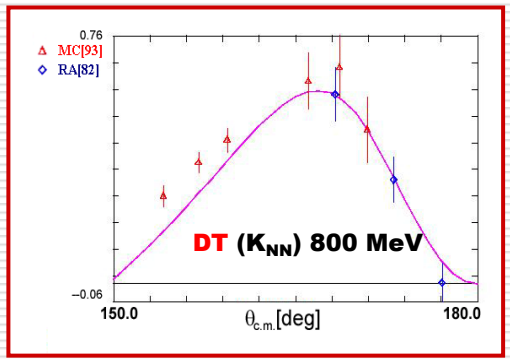


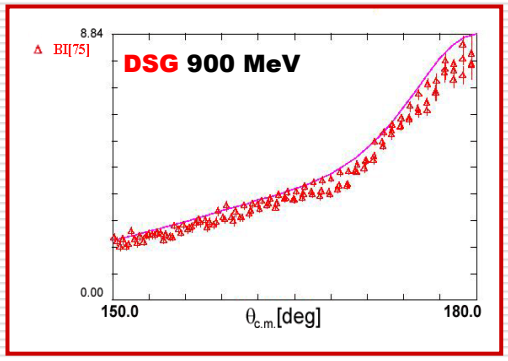


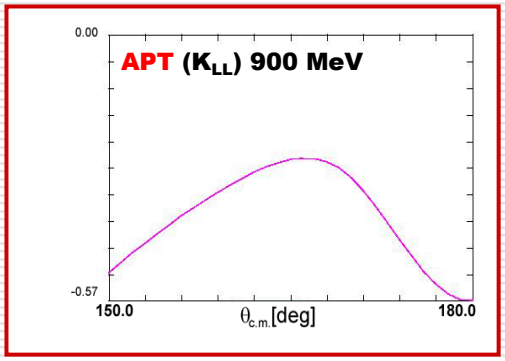


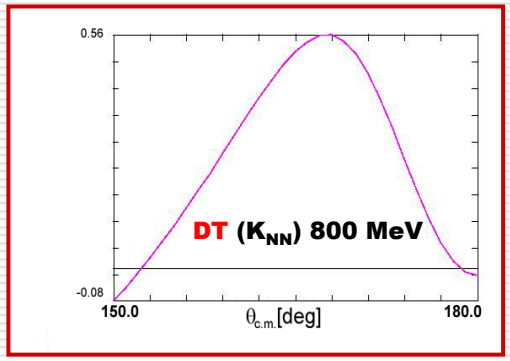












Observables: LAMPF np data

M. McNaughton et al., PRC48, (1991), 2267

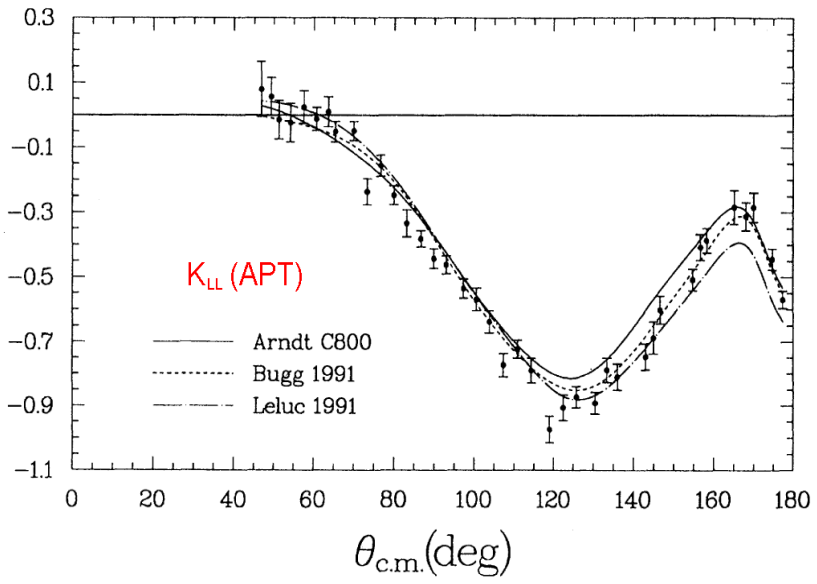


FIG. 4. Spin-transfer observable K_{LL} at 788 MeV compared with recent phase-shift fits by Arndt, Bugg, and Leluc.

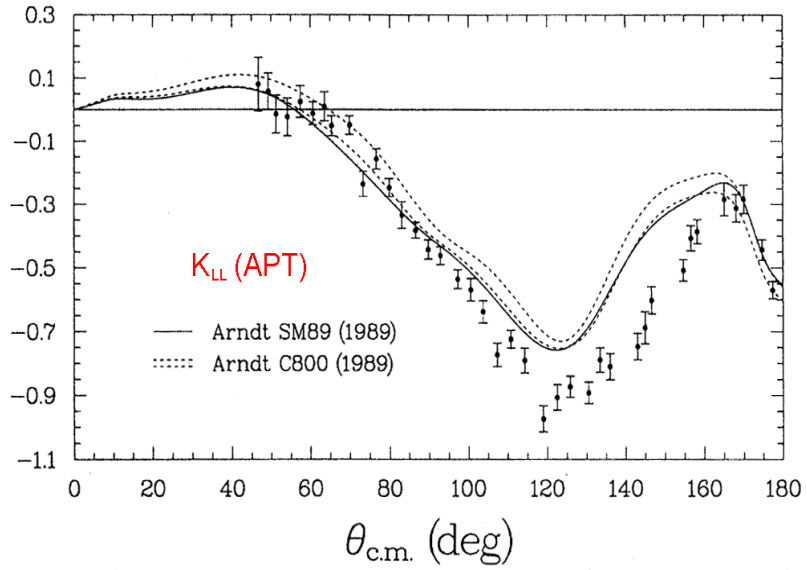
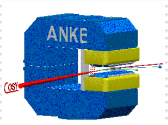
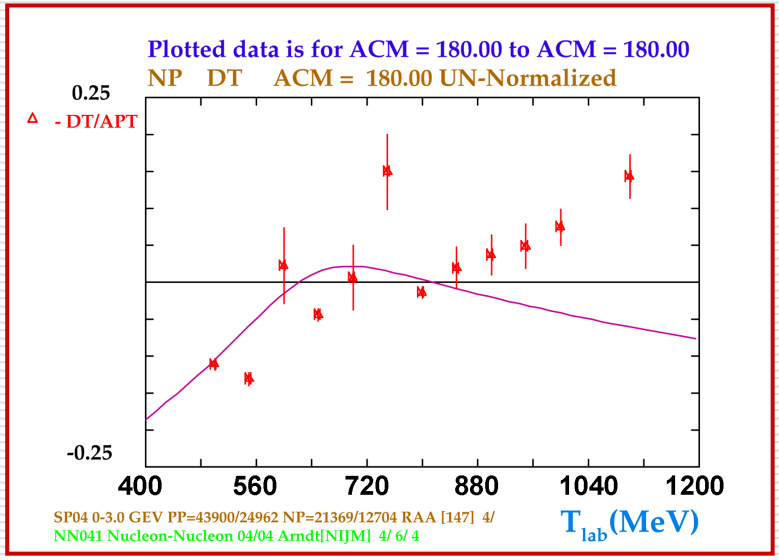
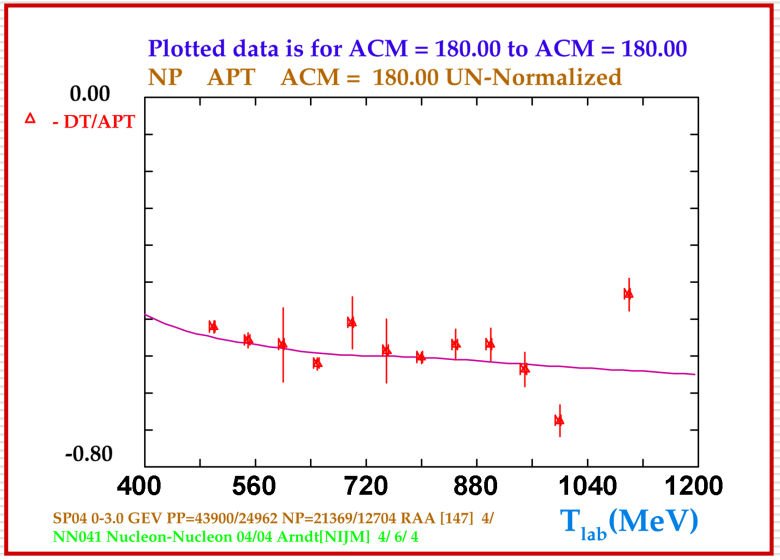


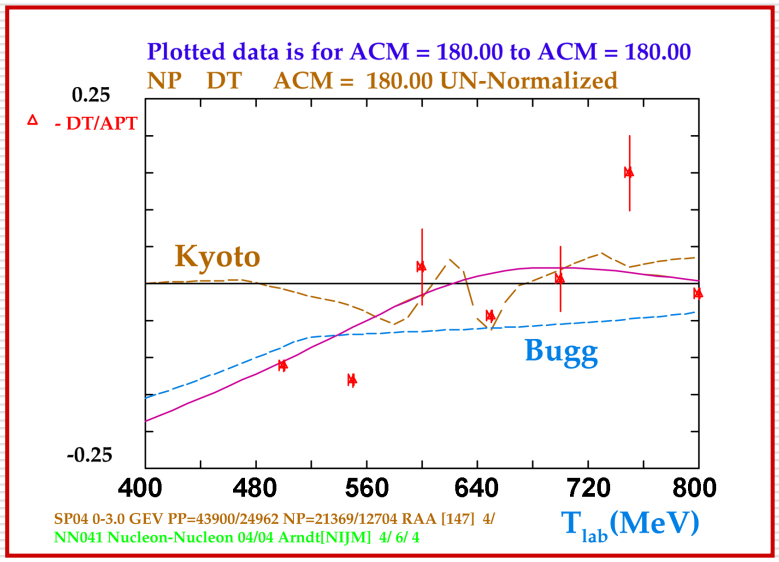
FIG. 7. Spin-transfer observable K_{LL} at 788 MeV compared with Arndt's phase-shift predictions: C800 (single energy) and SM89 (energy dependent). The pair of dashed lines shows the error corridor for the C800 solution.

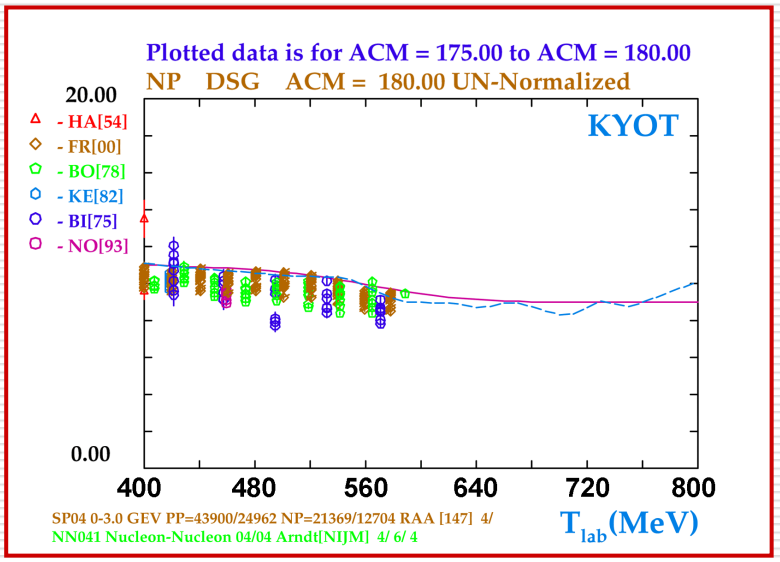
np SAID data: Error analysis









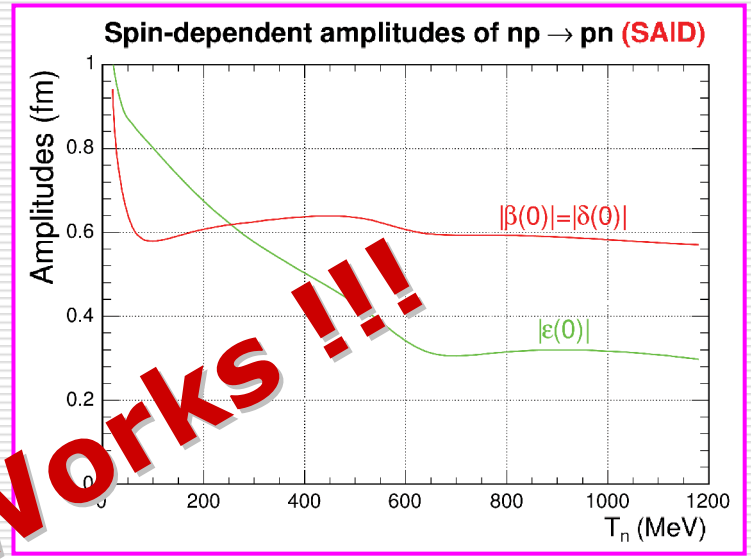


Results: Spin dependent amplitudes

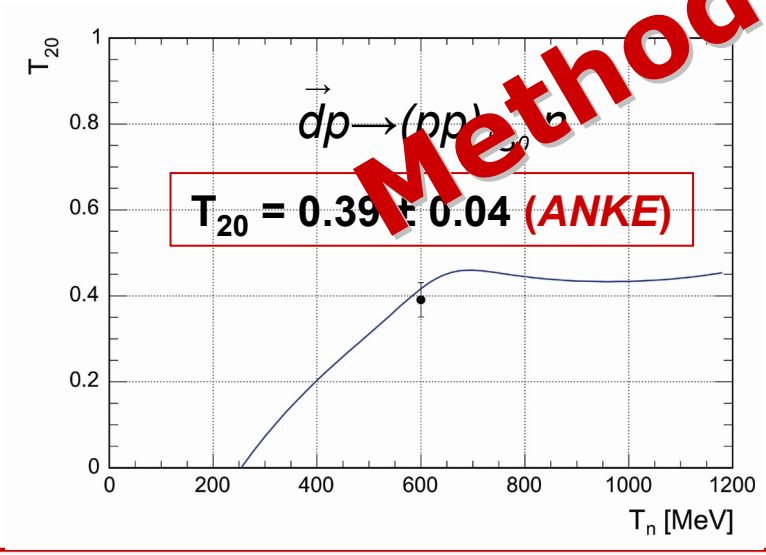
$$4|\varepsilon(0)|^2 = DSG(1 + APT - 2DT)$$

$$4|\beta(0)|^2 = DSG(1 - APT)$$

DSG, DT, APT from SAID



$$T_{20} = \sqrt{2}\,\frac{|\beta(0)|^2 - |\varepsilon(0)|^2}{2|\beta(0)|^2 + |\varepsilon(0)|^2}$$



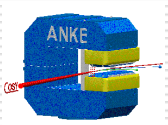
Method Works !!!

$$\frac{|\beta(0)|}{|\varepsilon(0)|} = 1.86 \pm 0.15 \qquad (ANKE)$$

$$\frac{|\beta(0)|}{|\varepsilon(0)|} = 1.79 \pm 0.27 \qquad (SAID)$$

Value from SAID WI00
Error from R. Arndt SE-Solution

Outlook: Polarized internal target

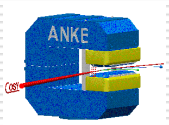


Foreseen ANKE Experiments requiring a PIT:

1. charge-exchange breakup $\vec{d}\vec{p} \rightarrow (pp)_{^1S_0}\, n$
2. np elastic scattering $\vec{p}\vec{d} \rightarrow p_{sp}(pn)$
3. Deuteron breakup $\vec{p}\vec{d} \rightarrow (pp)_{^1S_0} n$
4. Additional ideas (η meson, Parity of $\theta^{+,}$ …)

Strategy: Begin commissioning of PIT using high rate reactions that can be easily identified (e.g. CE).

Outlook: Beam time (2005)



TWO weeks to determine np→pn amplitudes at THREE energies: T_d=1.8, 2.0, and 2.2 GeV with polarization export from the calibrated energy T_d=1.2 GeV.

ONE week for a test measurement using a polarized deuteron beam incident on storage cell filled with unpolarized gas (H_2, N_2) at T_d=1.2 GeV.