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(on behalf of ANKE collaboration)

Spin Physics Inside the COSY Ring

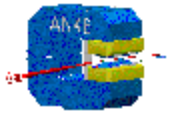
Experimental Program

- Nucleon-Nucleon Scattering
- Pion Production
- Hyperon-Nucleon FSI

Experimental Tools

- Polarization
- Spectator Detection

Introduction: Experimental Program



Motivation:

1. NN Interaction – Fundamental to nuclear physics
2. NN → NNπ – Test of chiral perturbation theory for few nucleon system
3. YN Interaction – SU(3) breaking effects from spin dependence

(talk Ulf-G. Meißner)

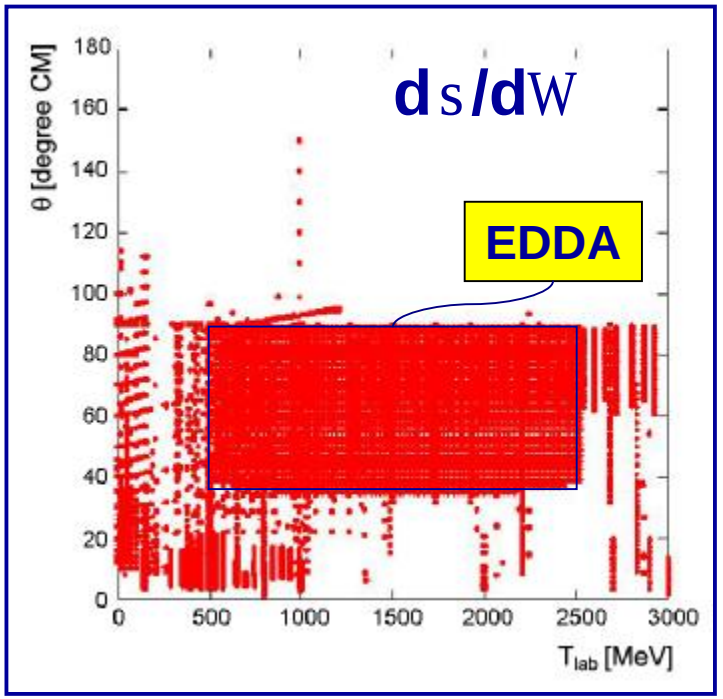
New insights into the strong interaction physics at intermediate energies

Tool: Double polarization (beam/target) experiments by fully exploiting the potential of COSY

NN Interaction: General remarks

- Fundamental for understanding strong interaction
- Characterization requires precise data for Phase Shift Analyses
- pp system well-known up to 2.5 GeV (→EDDA): Majority of data on unpolarized, single, and double polarized observables
- Large impact on PSA > 500 MeV: Significantly reduced ambiguities in I=1 phase shifts

pp elastic data-base



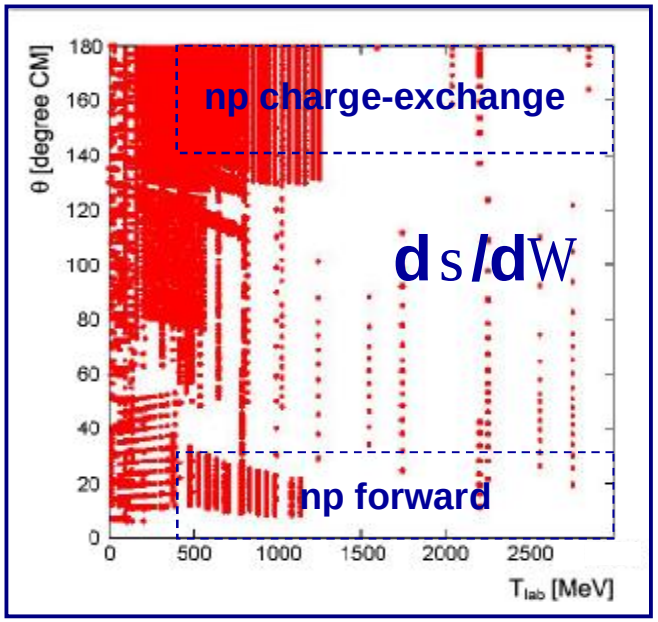
NN Scattering: np elastic data-base

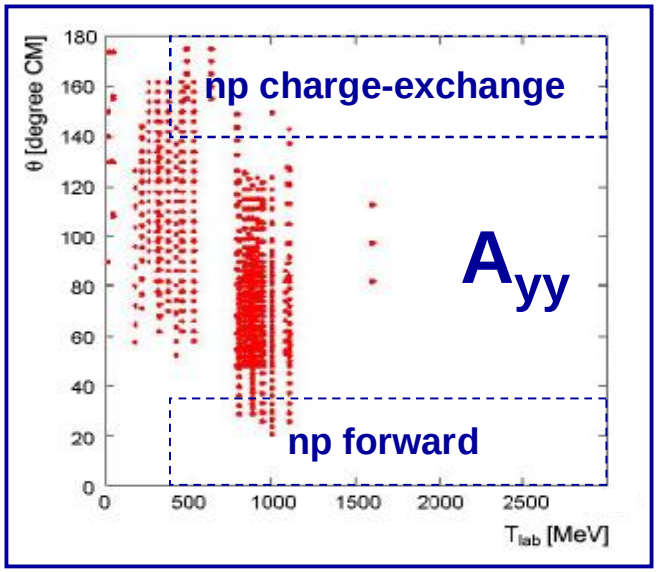
- Current experimental status of np data:

  §*R. Arndt:*

  - *"Gross misconception within the community that np amplitudes are known to a couple of GeV"*
  - *"np data above 800 MeV is a DESERT for experimentalists"*

- np system poorly known → ANKE will provide high-quality data in forward/backward region





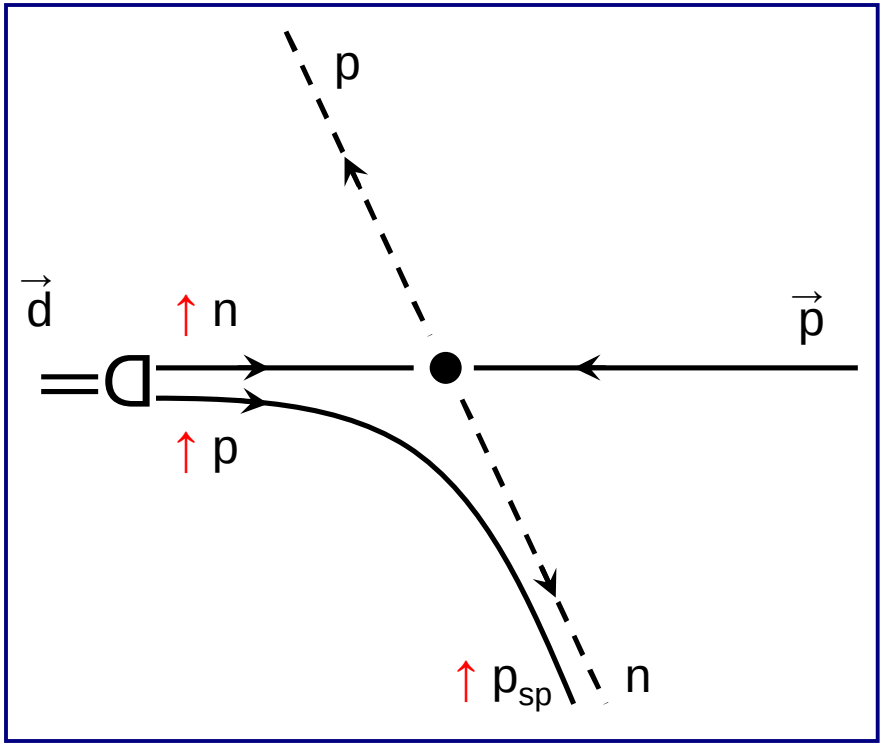
NN Scattering: np elastic at ANKE

Deuteron beam:

$\vec{d}\vec{p} \rightarrow p_{sp}(pn)$ **(forward np)**

Deuteron target:

$\vec{p}\vec{d} \rightarrow p_{sp}(pn)$ **(forward pn)**



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

quasi-free

np observables: A_y, A_{yy}

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

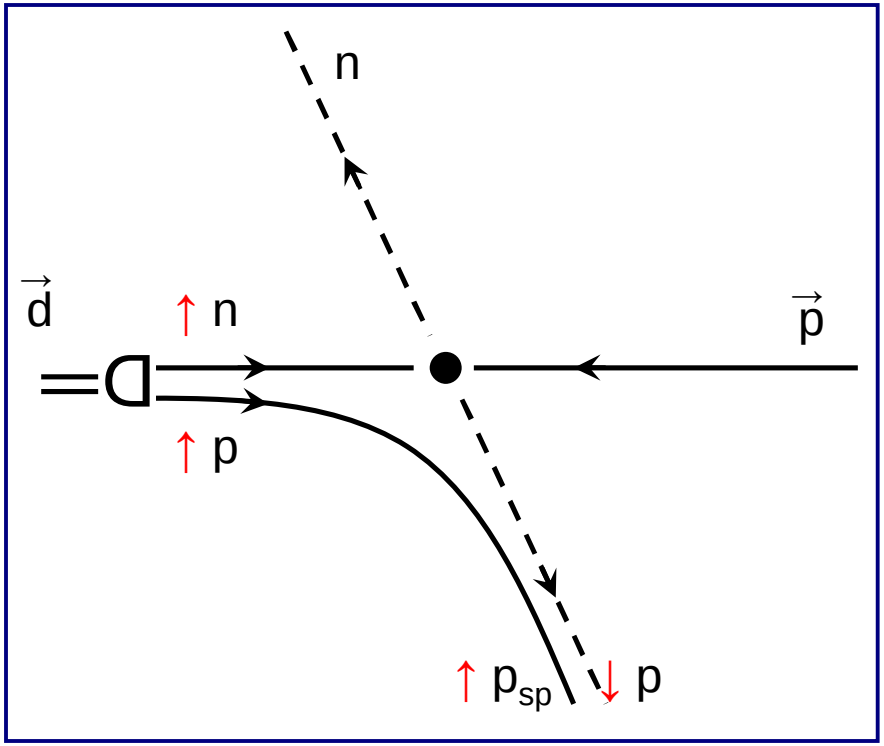
NN Scattering: np elastic at ANKE

Deuteron beam:

$\vec{d}\vec{p} \rightarrow (pp)_{^1S_0}\, n$ **(charge-ex. np)**

Deuteron target:

$\vec{p}\vec{d} \rightarrow (pp)_{^1S_0}\, n$ **(charge-ex. pn)**



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

quasi-free

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

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

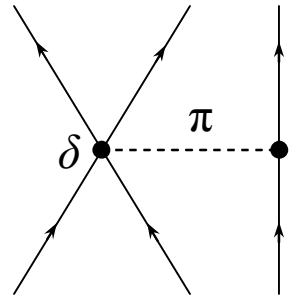
Pion Production: Motivation

Derive chiral three-body force from pion production

- Very different kinematics, but same d : consistency check of ChPT for NN → NNπ
- Model-independent extraction from ANKE data

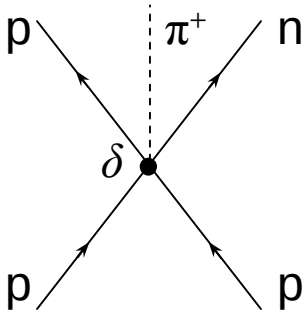
$\vec{p}\vec{d} \rightarrow p_{sp}pp\pi^-$ ⟶

Role of 4Nπ contact term



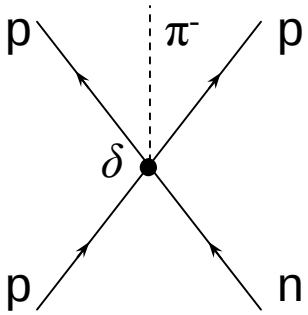
pd elastic

RIKEN, KVI, ...



$^1S_0 \rightarrow {}^3S_1p$

IUCF



$(^3S_1 - {}^3D_1) \rightarrow {}^1S_0p$

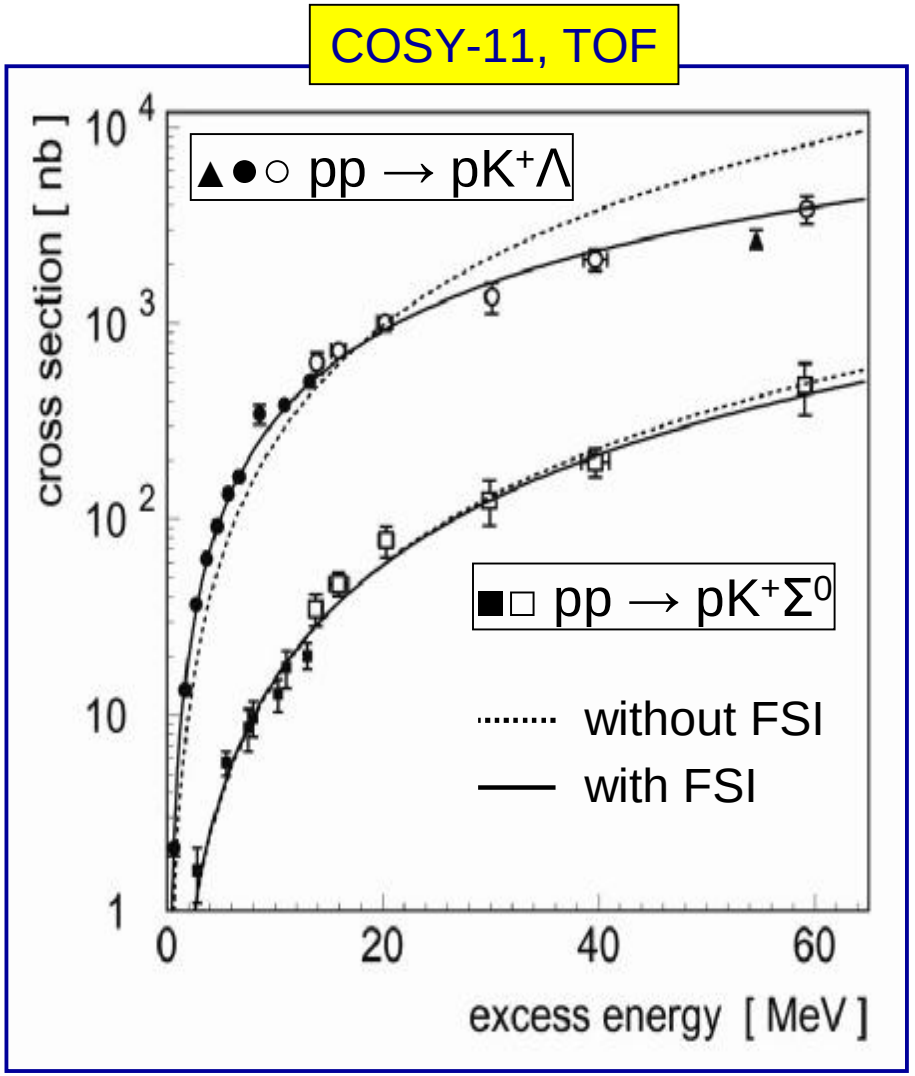
(unknown)

YN Interaction: Selected result

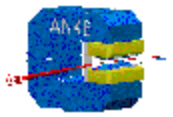
Importance of Final State Interaction:
$pp \rightarrow pK^+\Lambda$, $pp \rightarrow pK^+\Sigma^0$

- Incoherent sum of $^3S_1$ and $^1S_0$ FSI with unknown relative strengths

- Spin dependence of FSI unknown
  C. Hanhart, Phys.Rep. 397 (2004)



YN Interaction: Scattering length



Spin/isospin dependence of $pN \rightarrow (N\Lambda)\, K^+$

- Both needed:

  $\vec{p}\vec{p} \rightarrow (p\Lambda)\, K^+$ TOF

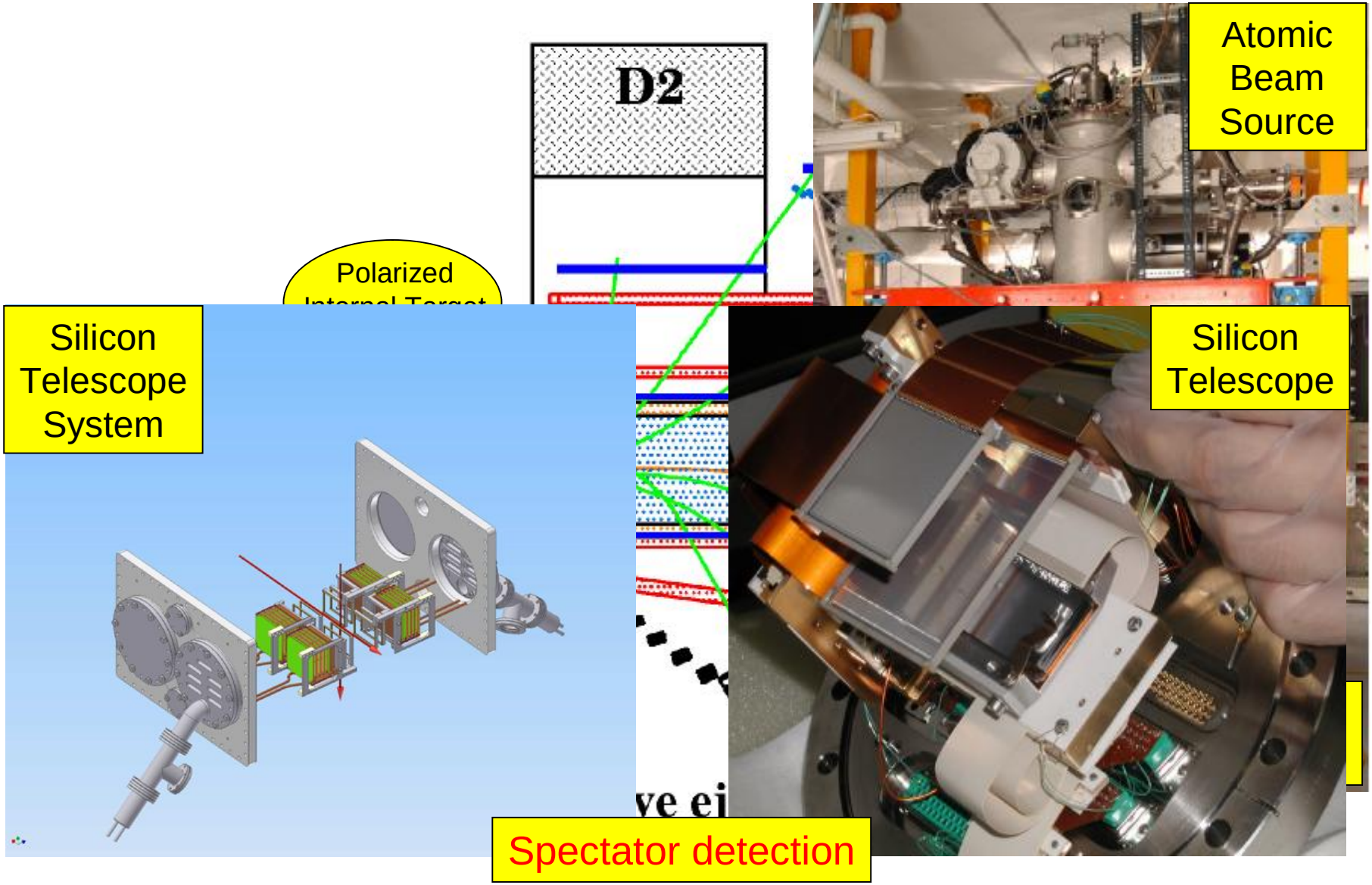
  $\vec{p}\vec{n} \rightarrow (n\Lambda)\, K^+$ ANKE $\Rightarrow$ via spectator detection

- ANKE is well equipped to provide:

I_0	–	unpolarized cross section
A_{yy}	–	transverse spin-correlation
(D_{yy}	–	spin-transfer parameter)

- $N\Lambda$ triplet final state can be isolated unambiguously from ~ $ds\,(\uparrow\uparrow)/dm^2_{N\Lambda}$

Experimental Tools: ANKE Set-up



Conclusion

Existing experimental tools at ANKE-COSY

þ pursue a **Unique Spin Physics Program**

Single and Double Polarization Experiments

- $(\vec{p}\vec{n})$ þ **NN interaction**
- Pion Production in NN Collisions þ **3N forces**
- YN Interaction þ **SU(3) symmetry breaking**

The COSY SPIN physics program will find a natural continuation in the HESR SPIN physics (i.e. PAX)

(talk Frank Rathmann)