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# **Motivation**

• Strong, attractive interaction between  $\eta$ -mesons and nuclei  $\rightarrow$  Possible formation of  $\eta$ -mesic nuclei

• Two possible ways to search for mesic nuclei

- $\rightarrow$  Signal below threshold
- $\rightarrow$  Pole near threshold influences cross section above it

• Good Candidate: <sup>3</sup>He $\eta$  system  $ightarrow Q_0 pprox 0.3 \, {
m MeV}$ 

# S-wave FSI-Ansatz

• 
$$\frac{p_i}{p_f} \cdot \frac{d\sigma}{d\Omega} = |f|^2 = |f_s \cdot FSI|^2$$
  
with FSI =  $\frac{1}{1 - i \cdot a \cdot p_f + \frac{1}{2}r_0 a p_f^2} = \frac{1}{(1 - p_f/p_1)(1 - p_f/p_2)}$ 

• Quasi-bound or virtual state?

 $\rightarrow$  Study of A-dependency of the FSI important, especially the light nuclei

 $\rightarrow$  **pn**  $\rightarrow$  **d** $\eta$  ; pd  $\rightarrow$  <sup>3</sup>He $\eta$  ; dd  $\rightarrow$  <sup>4</sup>He $\eta$ ;...

 $\rightarrow$  Gain insight in fundamental interaction between  $\eta$  mesons and nucle-



## **ANKE spectrometer**



- ons

# **The reaction pn** $\rightarrow$ **d** $\eta$

- Investigated via  $pd \rightarrow d\eta p_{sp}$
- Proton acts as spectator particle
- Two beam momenta ( $p_1 = 2.09 \,\mathrm{GeV/c}$  and  $p_2 = 2.25 \,\mathrm{GeV/c}$ )
- ightarrow Data cover excess energies from threshold up to  ${f Q}=90\,{
  m MeV}$
- Acceptance over the whole angular range

#### **COSY – COoler SYnchrotron**

• Provides (un)polarized proton or deuterium beams with momenta of up to 3.7 GeV/c [1]

#### **ANKE–** Apparatus for studies of Nucleon and Kaon Ejectiles

- Cluster-Jet Target serves as internal target
- Forward detector for heavy charged particles like protons, deuterons and He nuclei [2]
- Silicin Tracking Telescopes ("SST") for detection of spectator protons



• Exclusive measurement of meson production

[1] R. Maier, Nuclear Inst. and Methods in Physics Research, A, 1997, Vol.390(1) [2] S. Barsov, Nuclear Inst. and Methods in Physics Research, A, 2001, Vol.462

# **Particle identification**

- Spectator proton in one of the STTs
- Reconstructed and identified via energy loss in two layers



• Deuteron momentum reconstructed via magnetic field



- am energy as if they happened at first one
- Subtraction results in peak at η-mass and shifted nega-



• Apply corrections due to acceptance, fermi motion ...

#### cluster-jet target (p,d) **MWPCs** STT

# Summary & Outlook —

### Summary

- ✓ Spectator protons and deuterons can be identified
- $\checkmark$  Clear  $\eta$  signal in missing mass spectra
- ✓ Approximately 100k  $pn \rightarrow d\eta$  events gathered

## Outlook

- Determination of differential cross sections  $\rightarrow$  **Calculate** limit for s-wave FSI ansatz
- Luminosity





- Steep rise near threshold observed
- Fit data with s-wave FSI ansatz
- $\rightarrow$  **Preliminary** absolute scattering length of  $|\mathbf{a}| \approx 1.2 \,\mathrm{fm}$

→ Calculate scattering length **a**<sub>ηd</sub> → Extract new information on  $a_{\eta N}$ → Influence of N\*(1535) at higher excess energies





