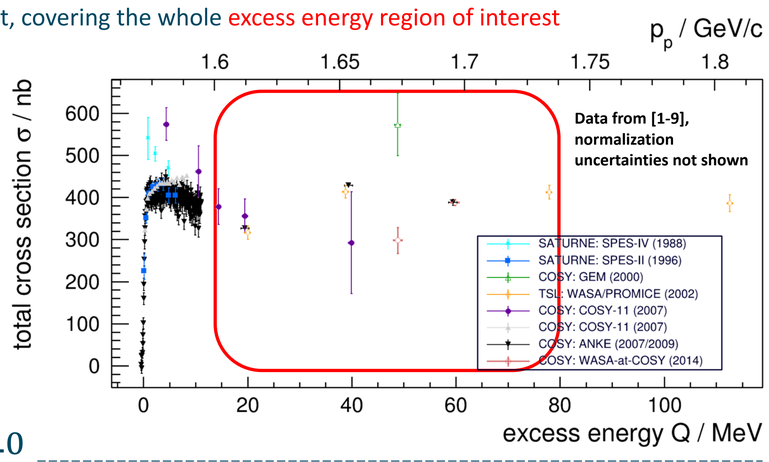
Nils Hüsken, Florian Bergmann, Kay Demmich and Alfons Khoukaz for the WASA-at-COSY collaboration

η- and π^0- production in proton-deuteron fusion to ^{3}HeX with WASA-at-COSY

Motivation

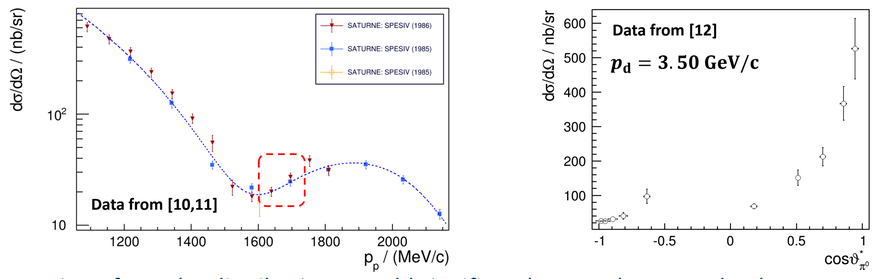
pd → ^{3}Heη

- Production cross section of the pd → ^{3}Heη reaction studied in great detail near threshold
- At intermediate excess energies, data from ANKE and WASA/PROMICE expose a plateau
- Recent WASA-at-COSY results suggest a narrow cross section variation around $Q \approx 48.8$ MeV
- Independent measurement, covering the whole excess energy region of interest
- 15 excess energies, from $Q \approx 13.6$ MeV to $Q \approx 80.9$ MeV with a stepsize of $\Delta Q \approx 4.8$ MeV
- Aim: extract precise total and differential cross sections
- Dataset will allow for stringent tests of theoretical models
- Where does the FSI lose importance?



pd → ^{3}Heπ^0

- Differential cross sections at $cos\vartheta^*_{\pi^0} = -1$ are available in the literature for a broad energy range
- Database on differential cross sections between $cos\vartheta^*_{\pi^0} = -1$ and $cos\vartheta^*_{\pi^0} = +1$ is sparse



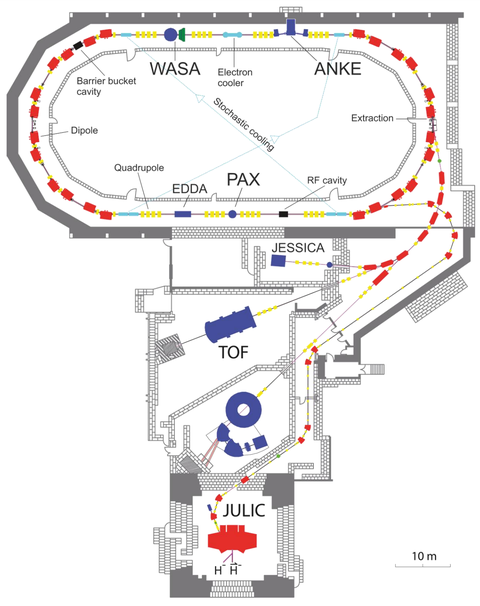
- Extraction of angular distributions would significantly extend current database
- Reliable extrapolation to $cos\vartheta^*_{\pi^0} = -1$ would allow luminosity determination for ^{3}Heη channel

Experiment

COSY – Cooler Synchrotron

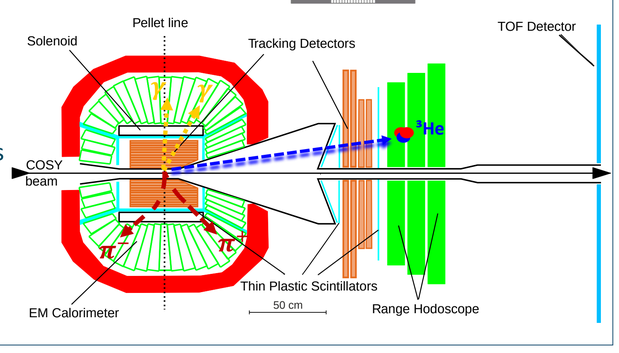
- Provides an (un-)polarized proton or deuteron beam with beam momenta between 0.3 GeV/c and 3.7 GeV/c [13]
- *Supercycle Mode*: Alternating beam momentum with each injection, minimizing systematic effects

SC 0: p / GeV/c	1.60	1.62	1.64	1.66	1.68	1.70	1.72	1.74
SC 1: p / GeV/c	1.61	1.63	1.65	1.67	1.69	1.70	1.71	1.73



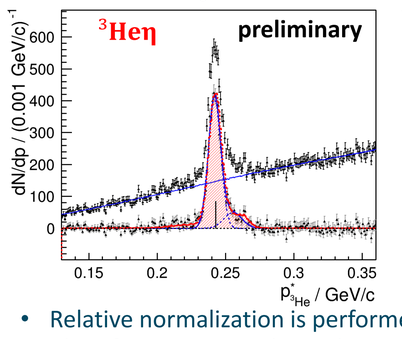
WASA: Wide Angle Shower Apparatus

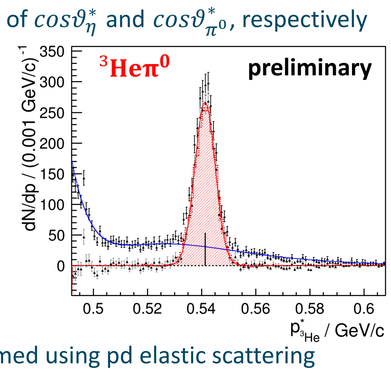
- Frozen hydrogen or deuterium pellets as internal target
- Central detector with a near 4π-acceptance, detecting both charged and neutral particles
- Forward detector optimized for the detection of heavy, charged particles like protons, deuterons or He-nuclei [14]



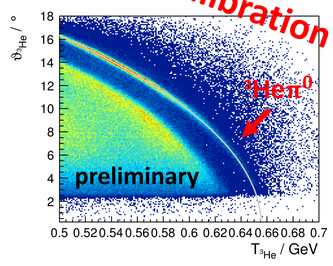
Analysis

- Identify ^{3}He candidates in the FD by their energy loss
- Two particle kinematics allows for a precise fine calibration
- Make use of the missing mass technique
- Spectra of $p^*_{^3\mathrm{He}}$ are fitted in bins of $cos\vartheta^*_\eta$ and $cos\vartheta^*_{\pi^0}$, respectively

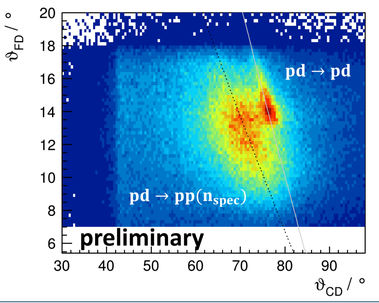


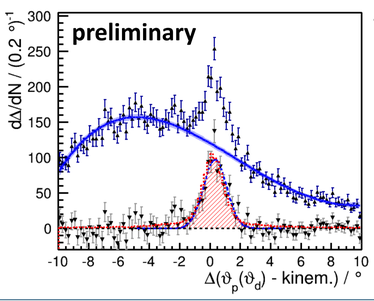


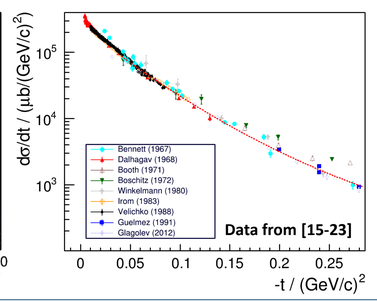
energy calibration



- Relative normalization is performed using pd elastic scattering
- Identification via a relation between polar scattering angles

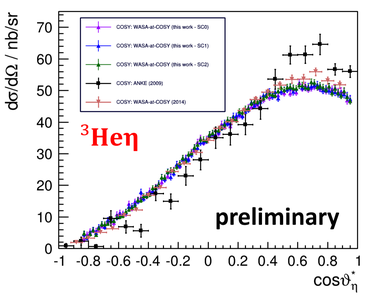


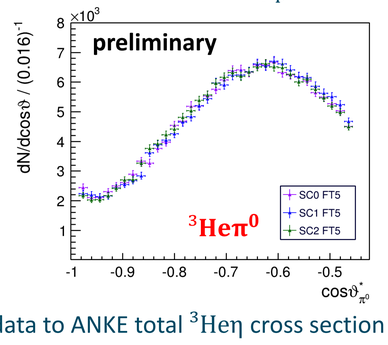


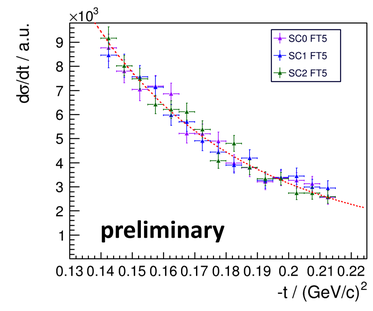


Results

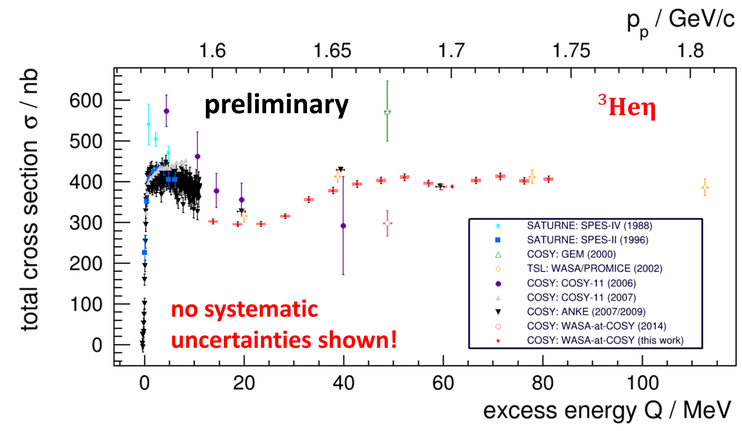
- Excellent agreement between three measurements at $p_p = 1.70$ GeV/c for all three reactions

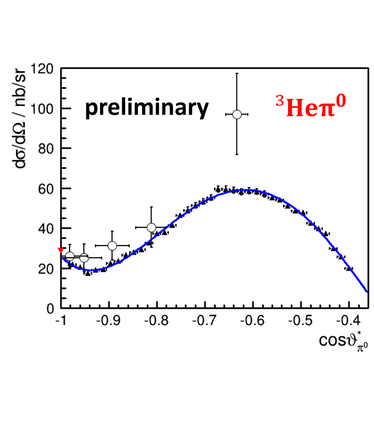






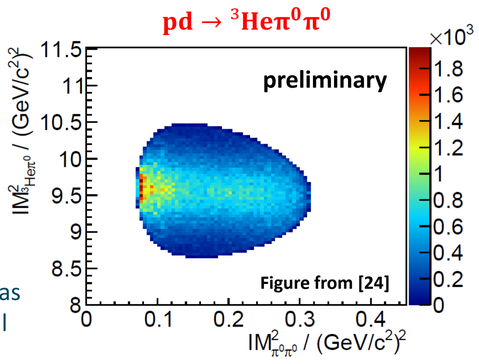
- Normalize $p_p = 1.70$ GeV/c data to ANKE total ^{3}Heη cross section of 388.1 nb
- Relative normalization, using pd elastic scattering in the interval $0.14\ (GeV/c)^2 < -t < 0.215\ (GeV/c)^2$, assuming $d\sigma/dt$ to be independent of p_p





Summary & Outlook

- New pd → ^{3}HeX data available for 15 momenta between $p_p = 1.60$ GeV/c and $p_p = 1.74$ GeV/c
- Total cross sections of the reaction pd → ^{3}Heη can be extracted with small statistical uncertainties
- Differential cross sections of the single pion production will substantially extent the available database
- **Important:** Study of systematic uncertainties remains to be done!
- **Outlook**: Apart from η- and single-pion production, it was shown that multi-pion production can be studied as well in great detail [24-26]



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Questions?

Contact:
n_hues02@uni-muenster.de