



η production in dd collisions

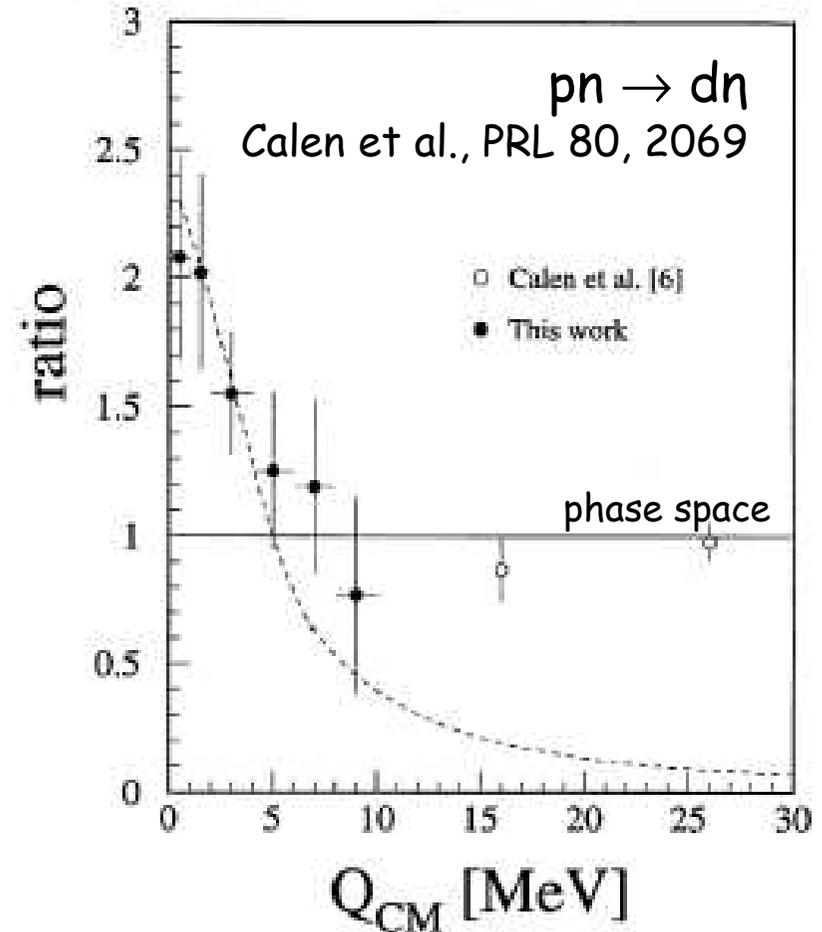
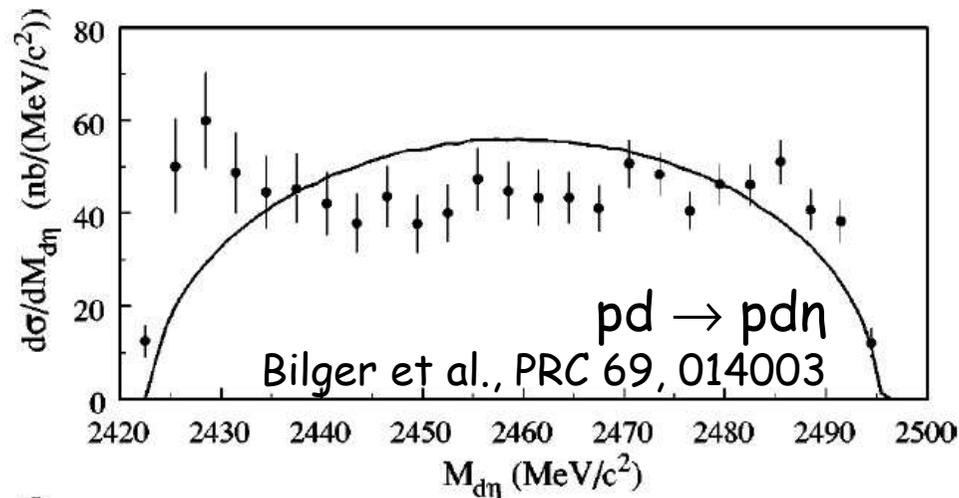
Volker Hejny

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Germany

1st Caucasian-German School and Workshop on Hadron Physics
Tbilisi, 30 August 2004

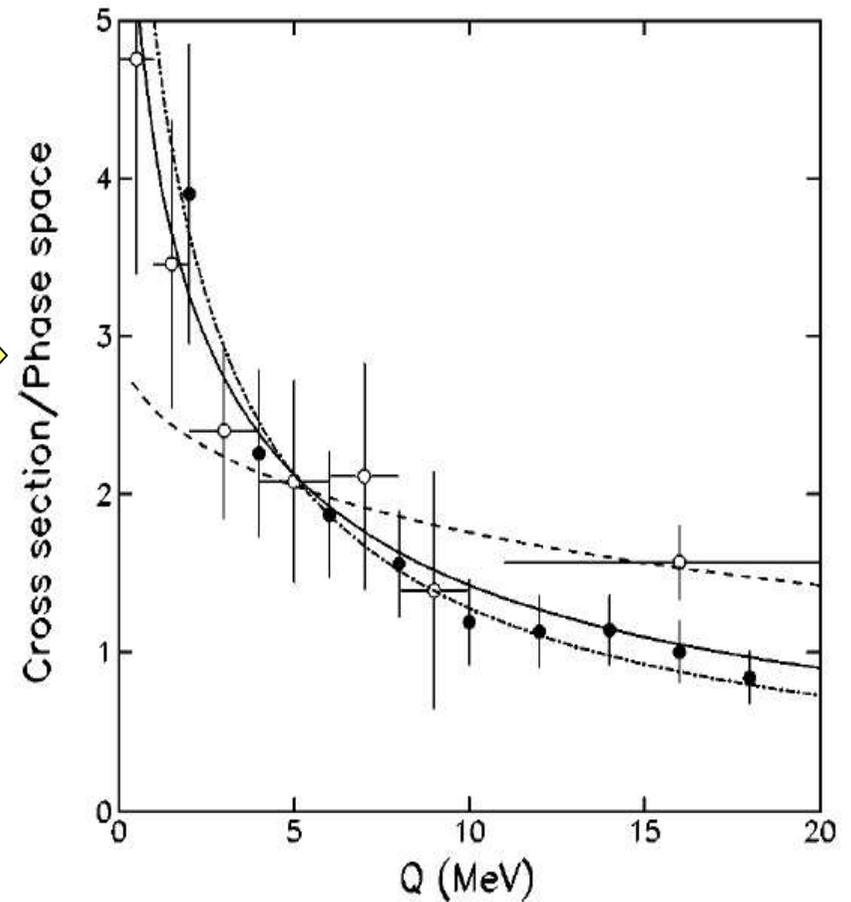
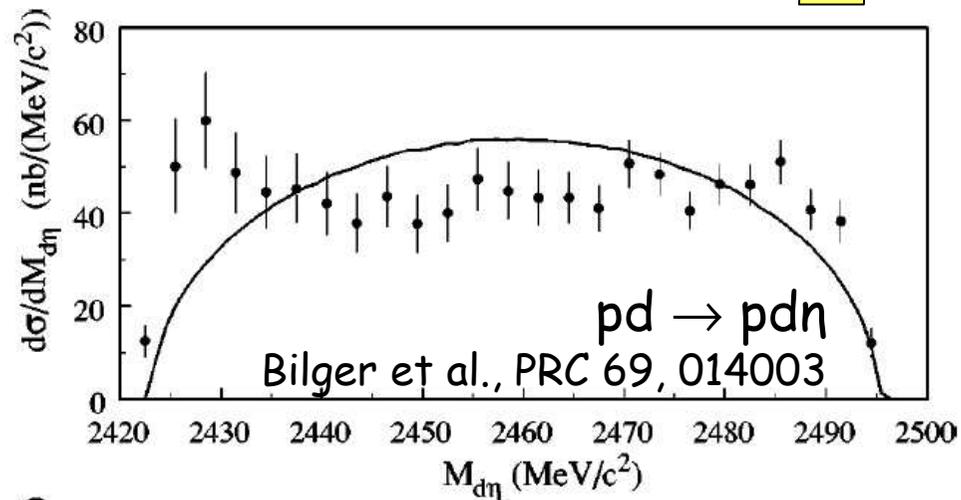
Motivation

- η -nucleus interaction
 - ⇒ large ηN scattering length
 - ⇒ threshold enhancements in $pp\eta$, $pd\eta$, dn , ${}^3,4\text{He}\eta$ final states
 - ⇒ do (quasi-) bound η -nucleus systems exist ?



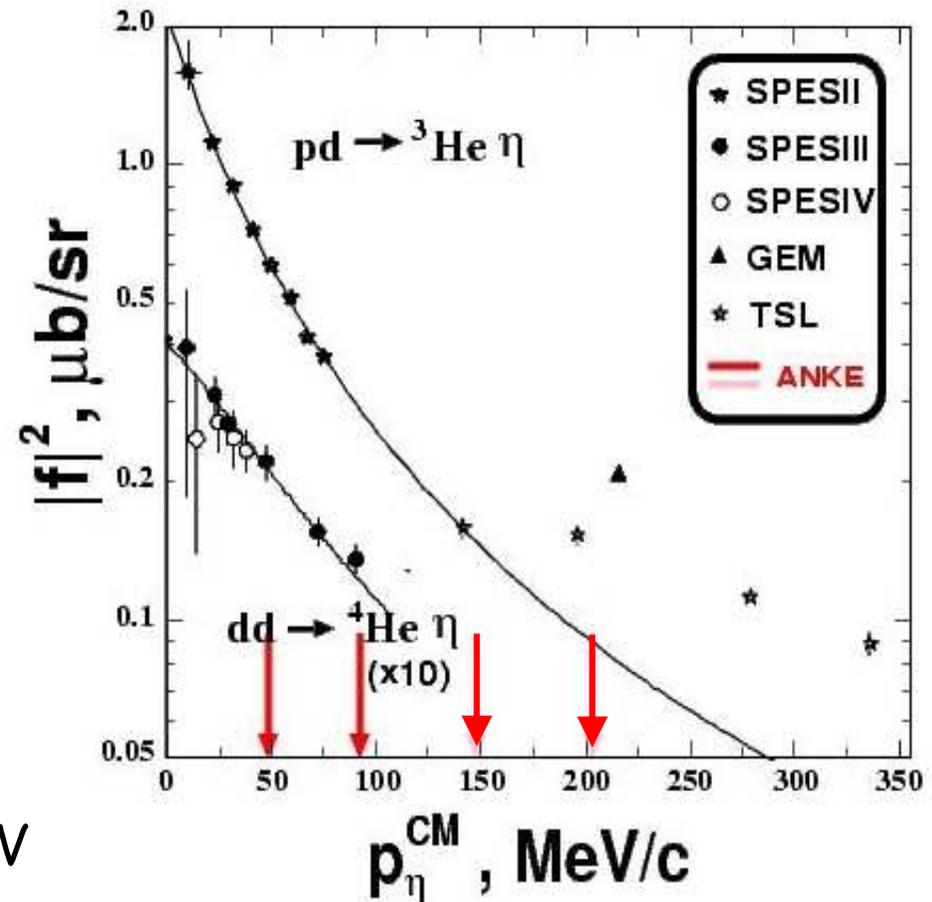
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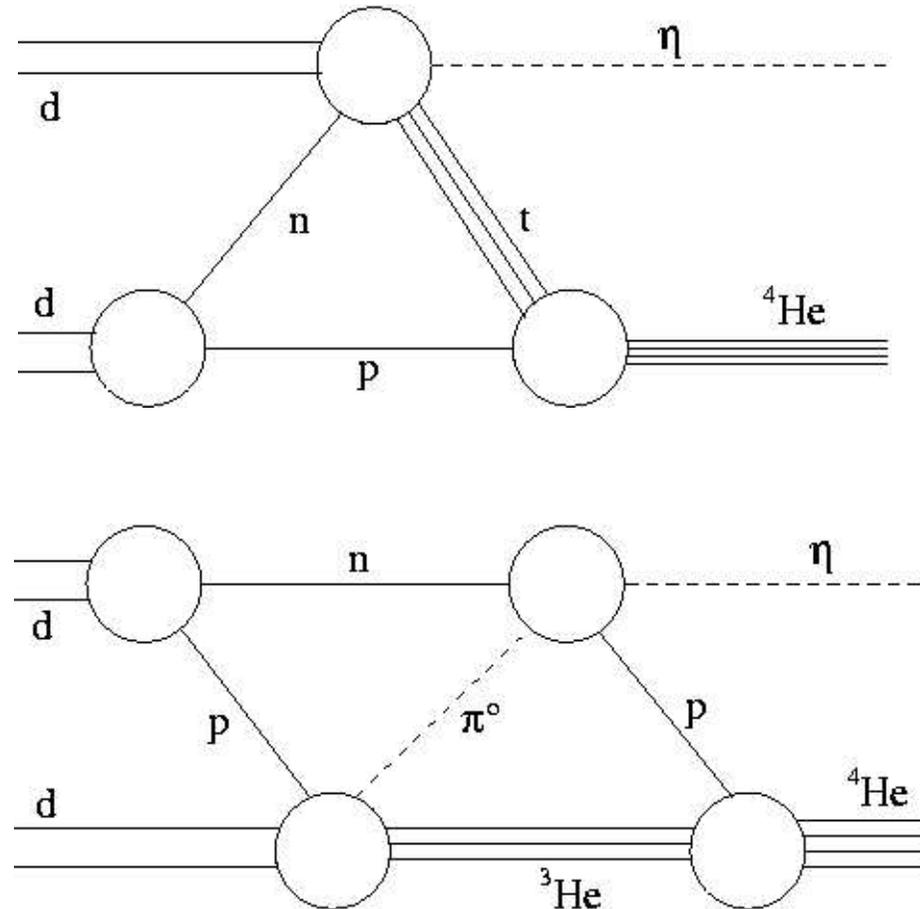
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- η - ${}^3\text{He}$, η - ${}^4\text{He}$: scattering length
 - ⇒ for η - ${}^3\text{He}$: various data sets → next talk see also: Sibirtsev et al., nucl-th/031079
 - ⇒ for η - ${}^4\text{He}$: two data sets from SPES III/IV but: only total cross sections!



Motivation

Production mechanisms:

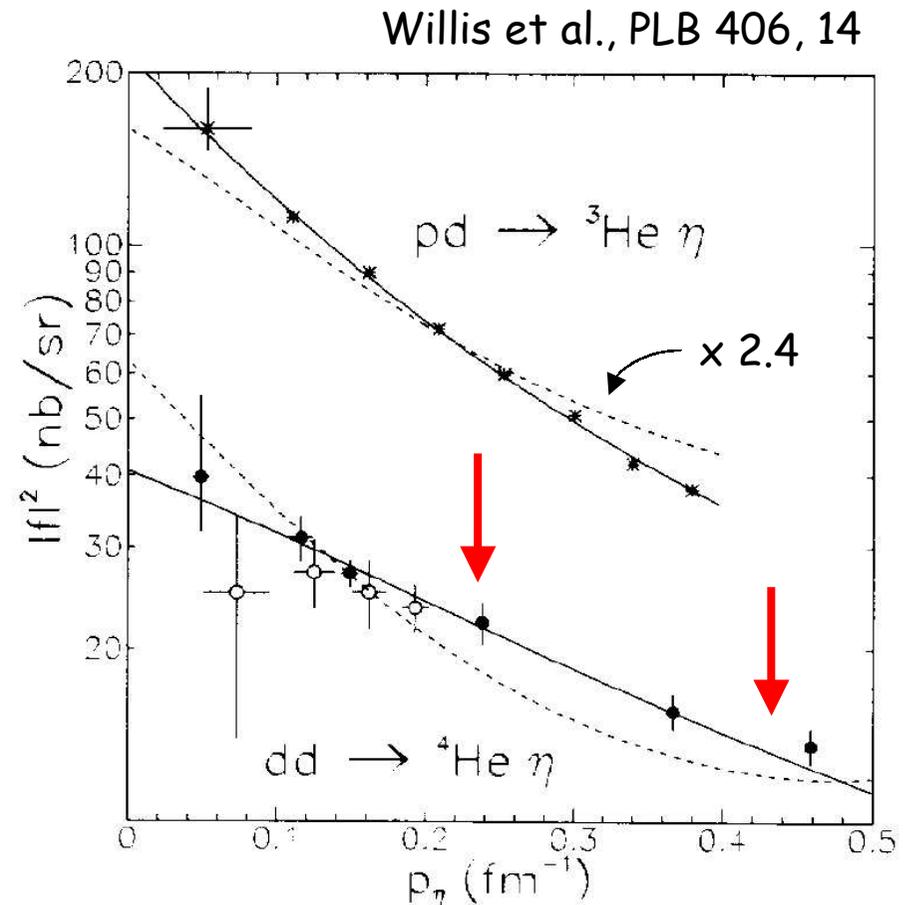
- **Spectator model**
 - ⇒ large momentum transfer
 - ⇒ cross section underestimated
- **Two-step model**
 - ⇒ for $pd \rightarrow {}^3\text{He}\eta$:
 - cross section still too small
 - angular distributions do not match
 - ⇒ for $dd \rightarrow {}^4\text{He}\eta$
 - total cross section ok
 - differential cross sections ?



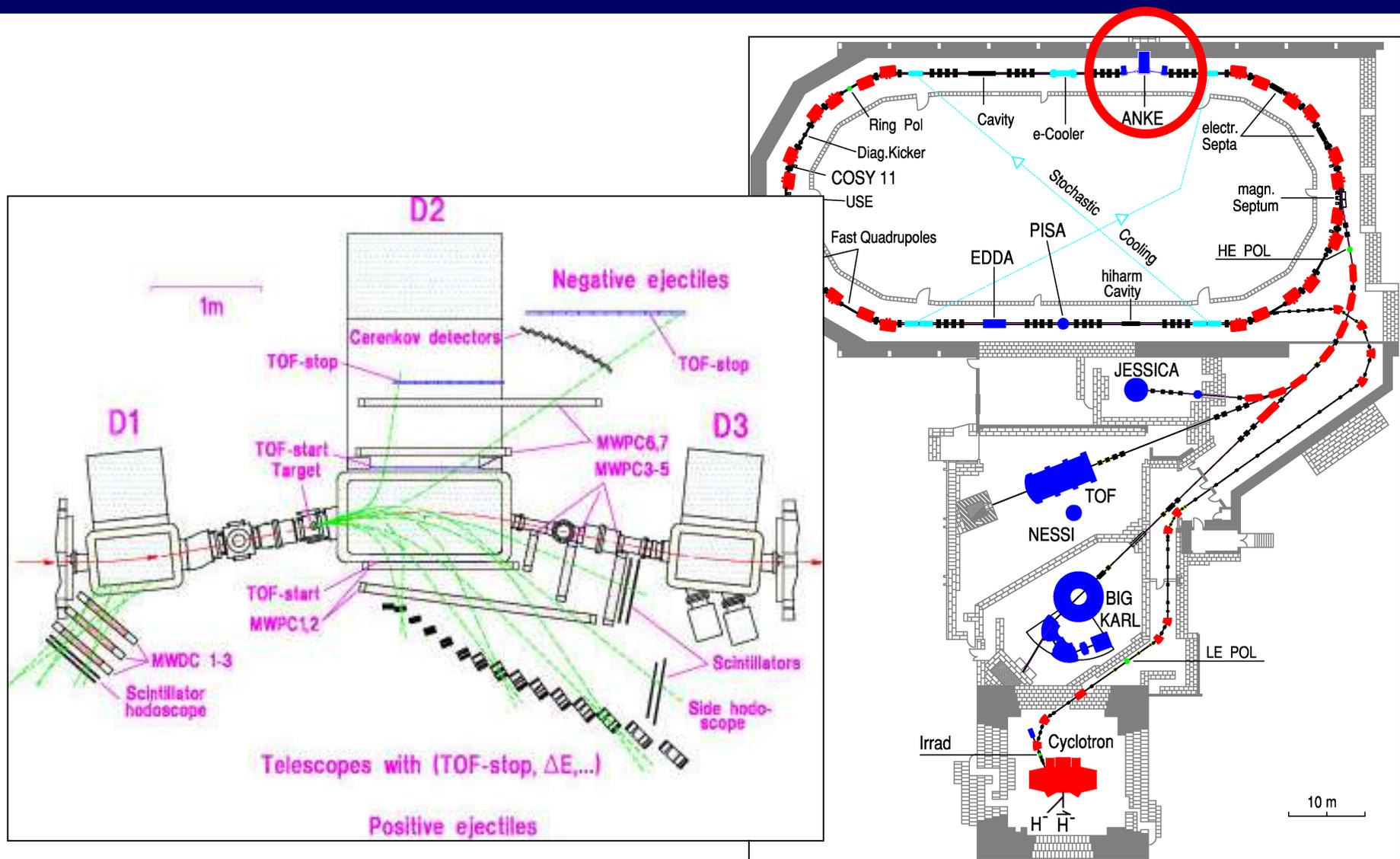
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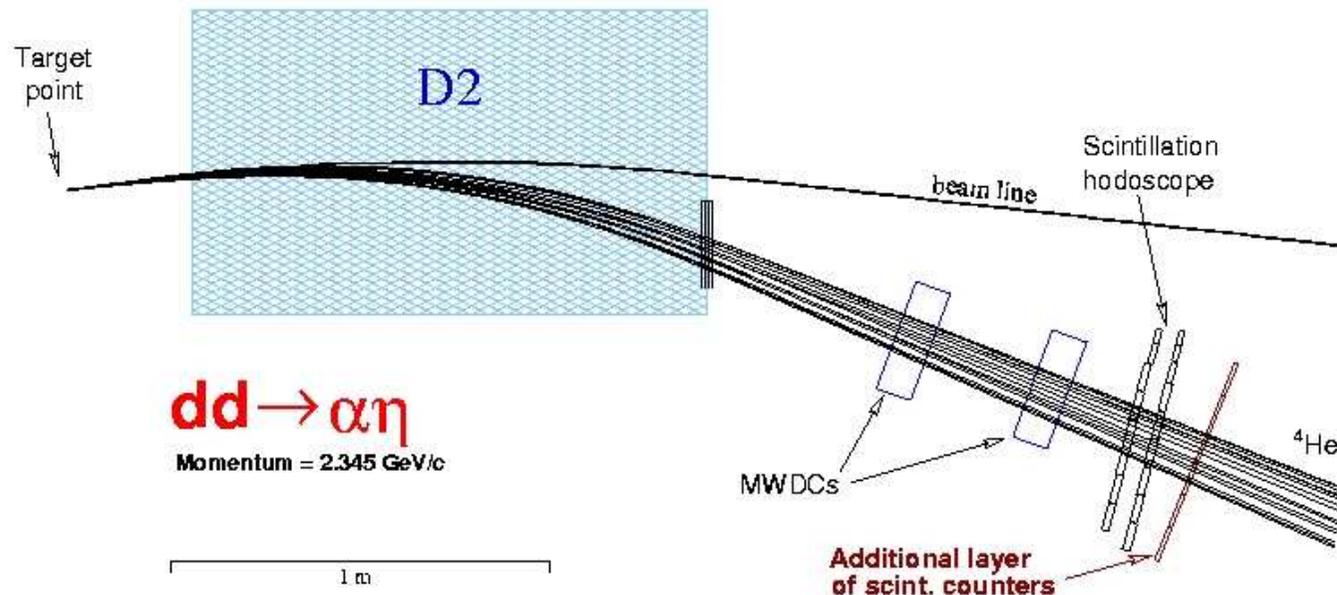
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ANKE at COSY



dd \rightarrow $^4\text{He}\eta$ at ANKE

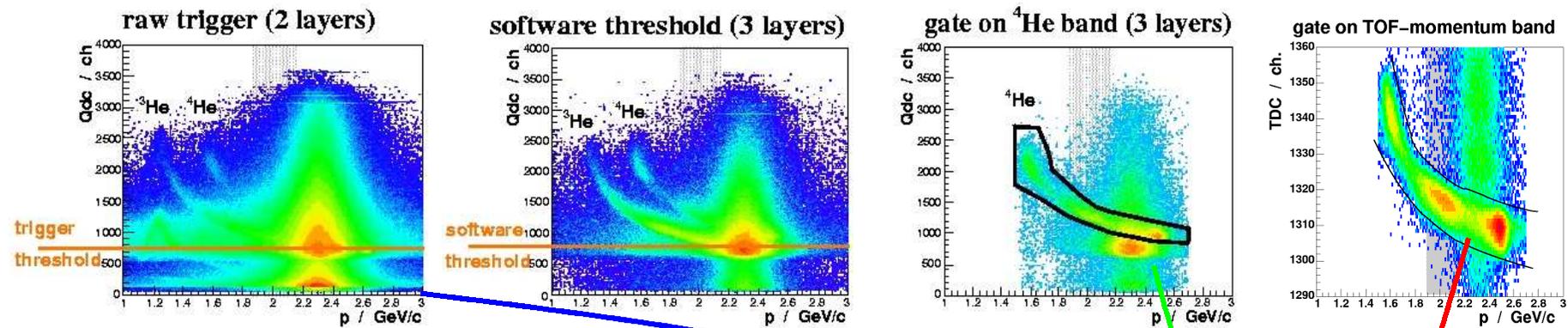


Data taken at $Q \approx 2 \text{ MeV}$, 7 MeV , 22 MeV and 42 MeV

- Missing mass technique
- $Q < 7 \text{ MeV}$: 100% acceptance, $Q < 80 \text{ MeV}$: full polar acceptance

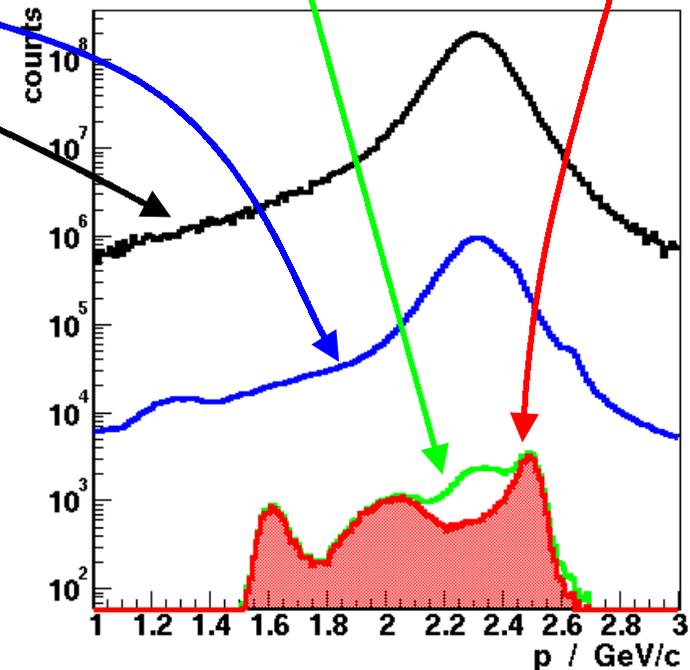
\Rightarrow data analyzed by A. Wrońska

Event selection: $dd \rightarrow {}^4\text{He} X$



Minimum Bias
Trigger

- $L = 5 \times 10^{30} \text{ s}^{-1} \text{ cm}^{-2}$
- Total particle flux in Forward: ca. $7 \times 10^5 \text{ s}^{-1}$
- Trigger rate ca. 2500 s^{-1}

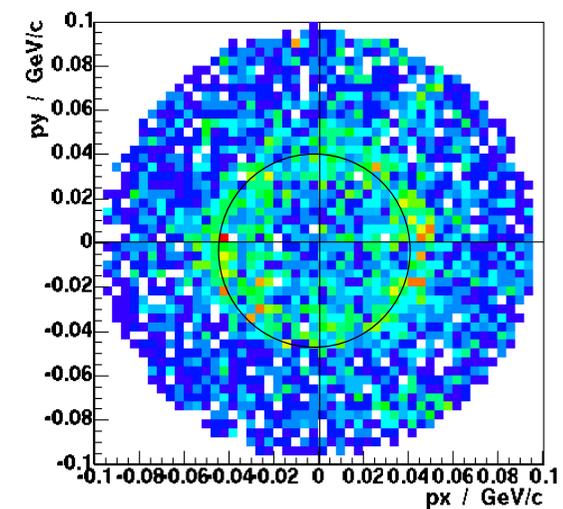
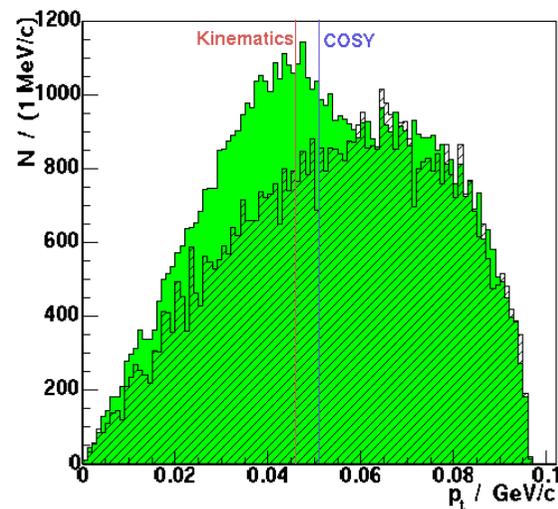
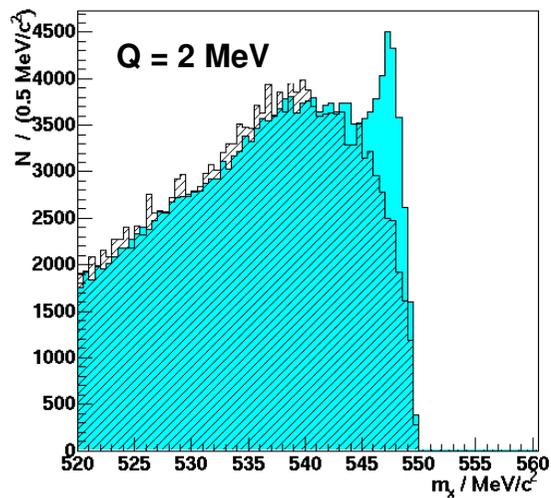


Reaction identification

✘ Missing Mass

✘ Transverse Momentum
→ information on p_{beam} !

✘ p_y versus p_x
at $p_z = 0$



Total cross section

- **Background subtraction:**
 - ⇒ data taken at $Q \approx -2$ MeV
 - ⇒ kinematically scaled to measured beam momenta

- **Absolute normalization:**

- ☑ to $dd \rightarrow {}^4\text{He}X$

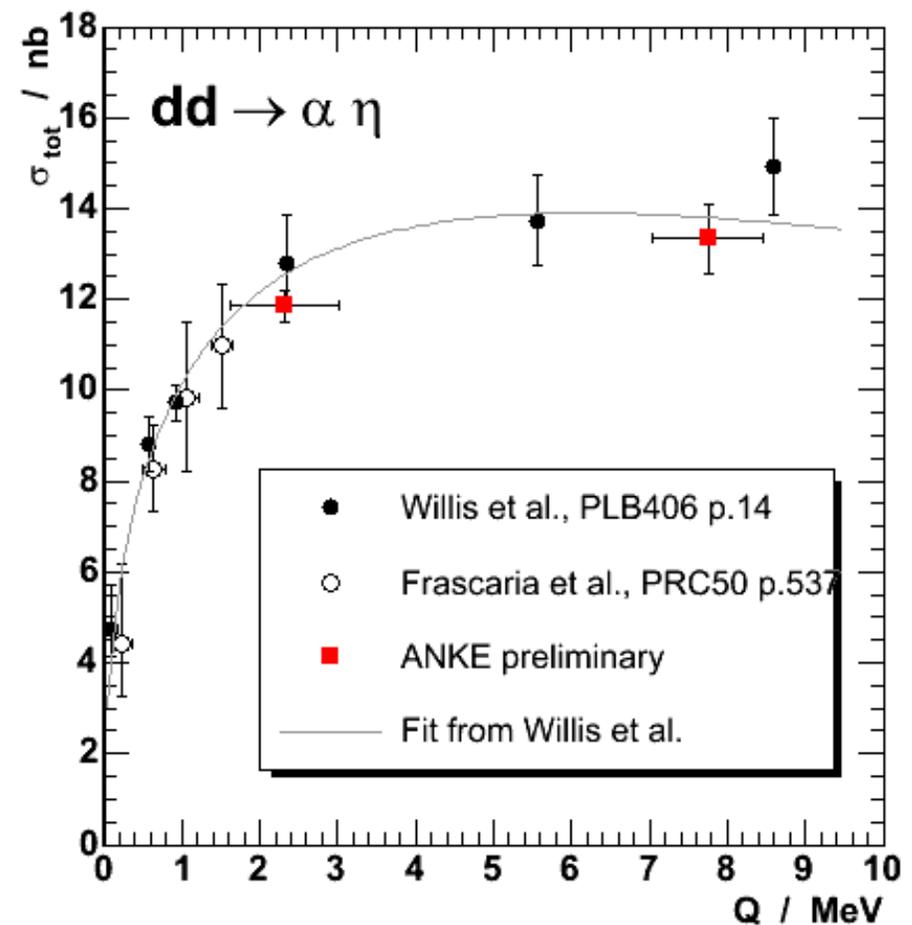
J.Banaigs *et al.*, Nucl. Phys. **B105** (1976) 52

- ☐ to $dd \rightarrow {}^3\text{He}n$

G.Bizard *et al.*, Phys. Rev. **C22** (1980) 1632

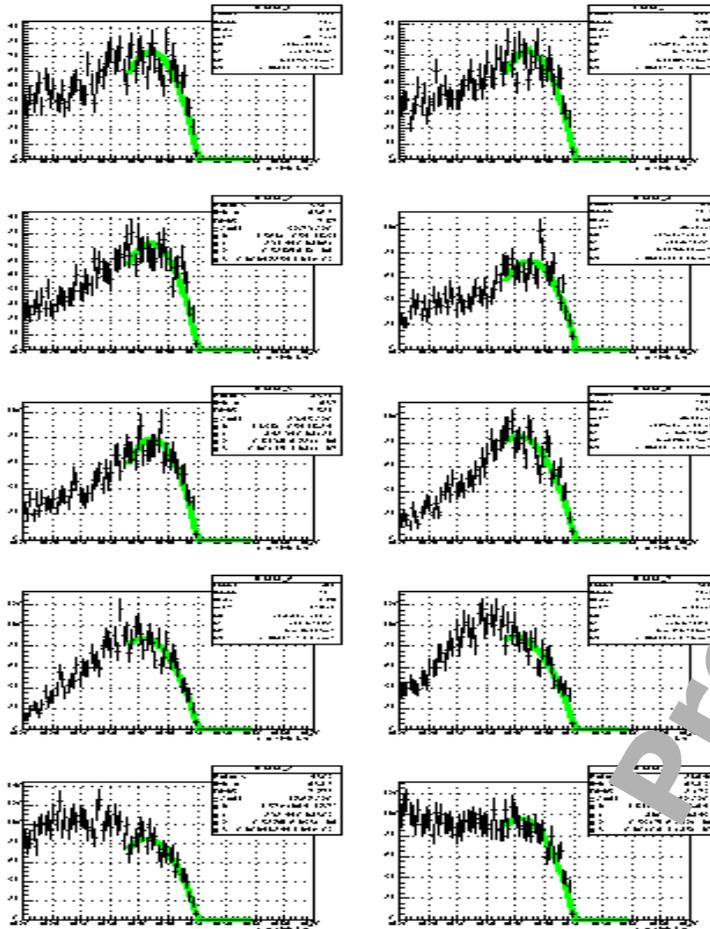


used by Banaigs *et al.*
Willis *et al.*
Frascaria *et al.*

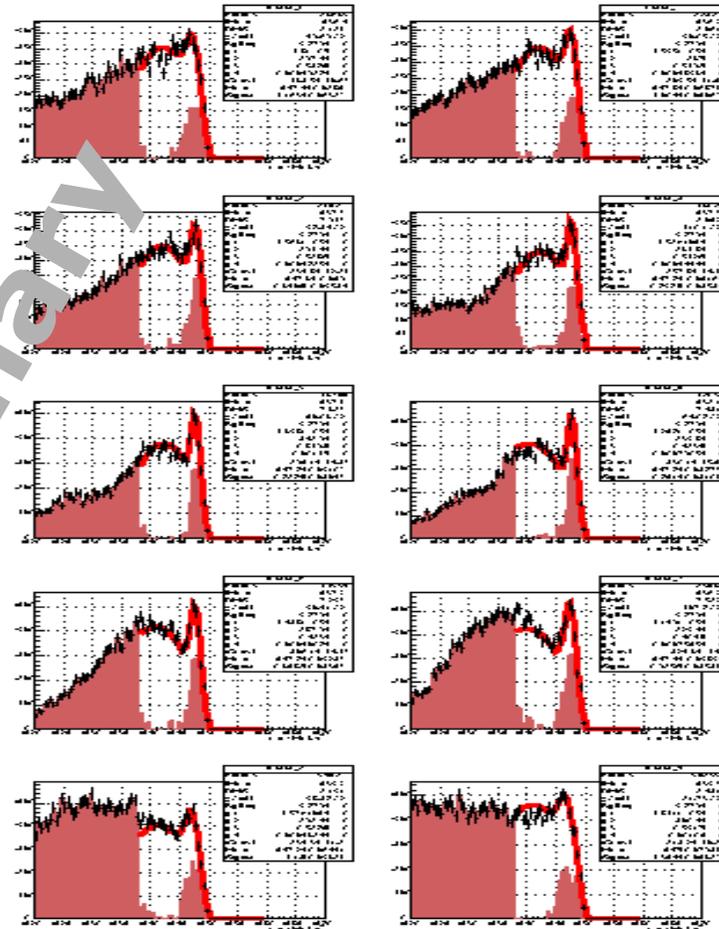


Extraction of angular distributions

1. Fit background **shape**
in $\cos\theta$ bins

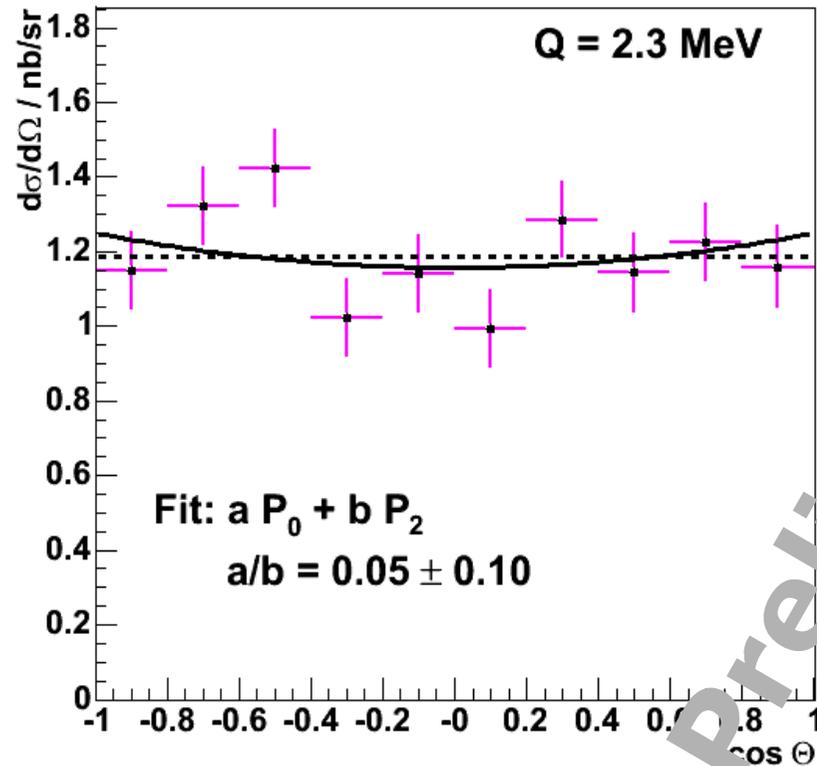


2. Fit background **amplitude**
and peak parameters

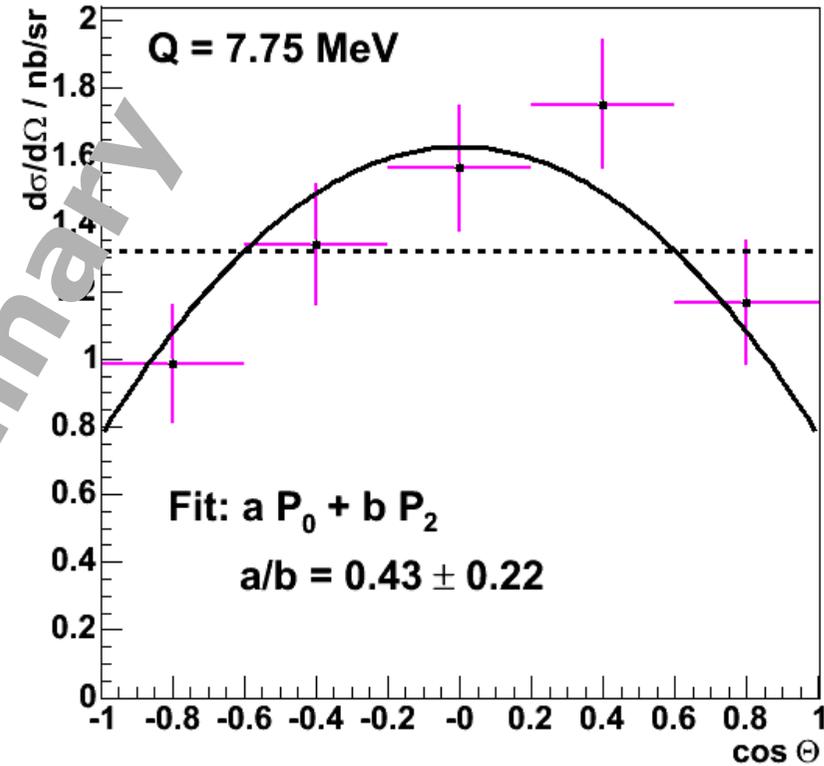


Preliminary

(Preliminary) Results

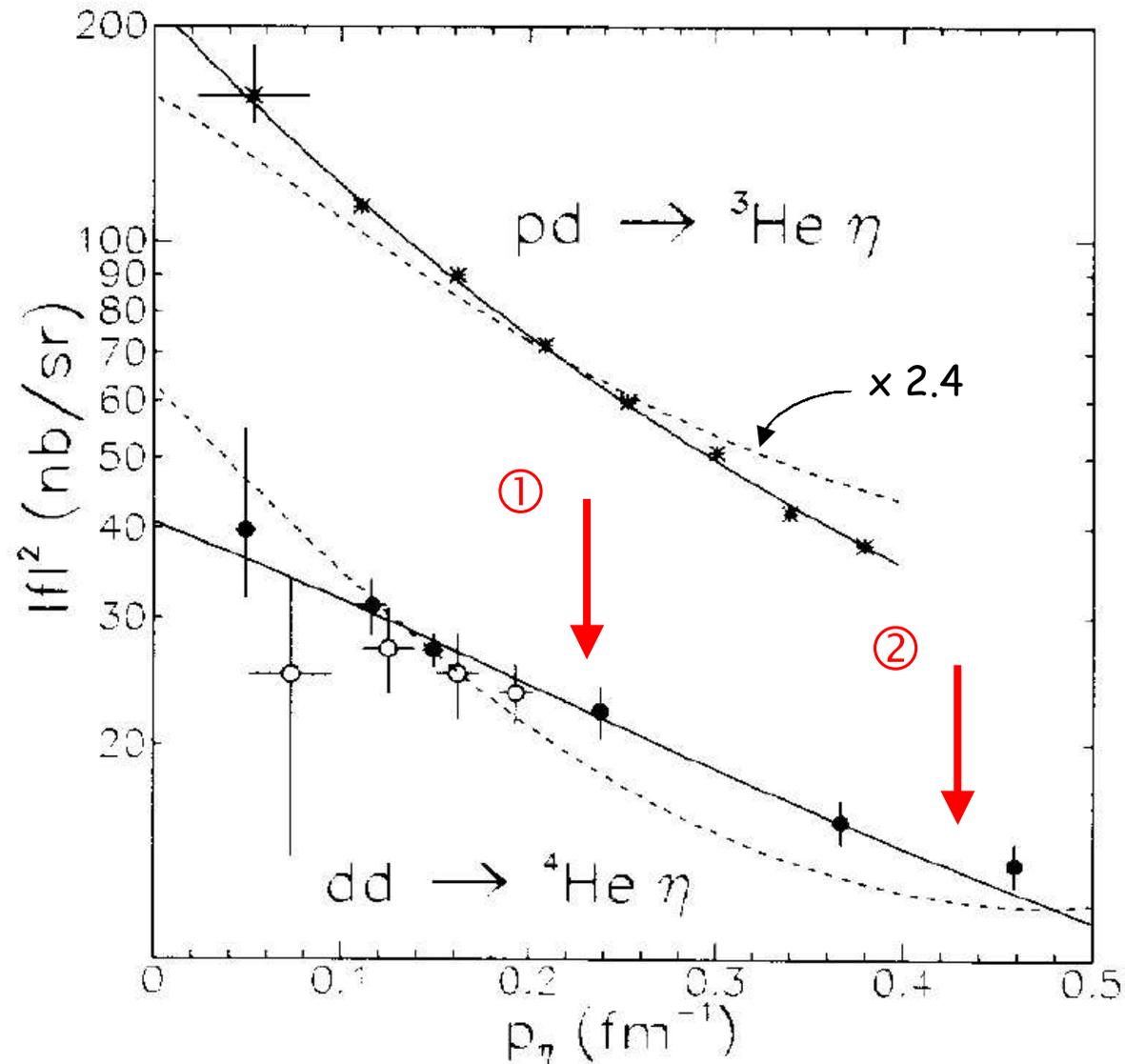


Consistent with
pure *s*-wave



Higher partial
waves (*p, d* ?) contribute

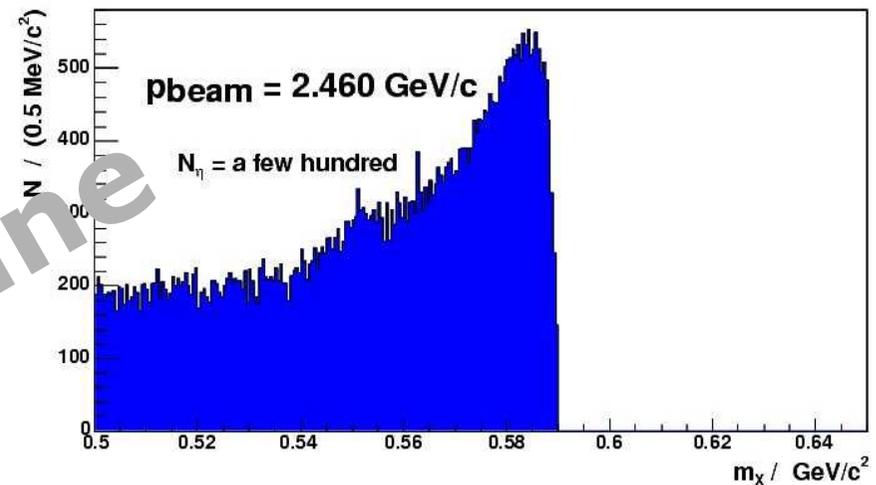
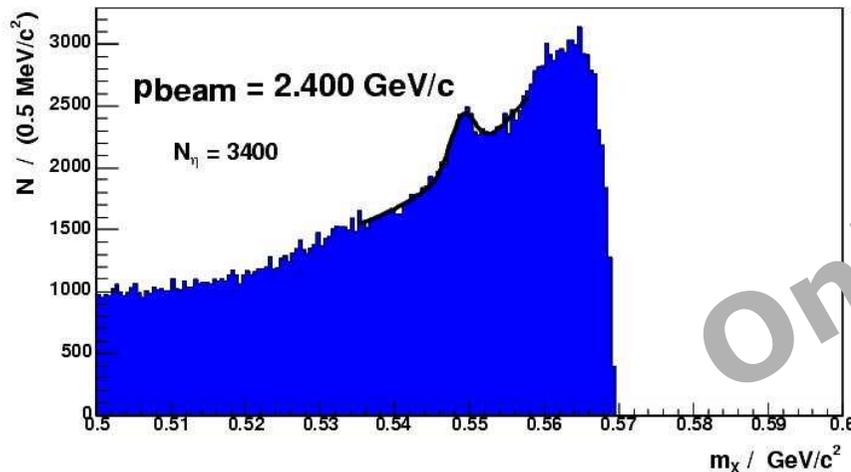
What does this mean?





To be done ...

- 2 more energies in queue (Nov. 03)
 - ⇒ modified setup (MWDC → MWPC)
 - ⇒ $Q = 22 \text{ MeV}$
sufficient statistics for angular distributions
 - ⇒ $Q = 42 \text{ MeV}$
only total cross section possible





Summary / Outlook

- **Open questions concerning $dd \rightarrow {}^4\text{He}\eta$**
 - is there a ${}^4\text{He}\text{-}\eta$ bound or quasi-bound state?
 - what is the dominant production mechanism?
- **Reaction measured with ANKE at COSY close to threshold**
 - clean identification of $dd \rightarrow {}^4\text{He}X$
- **(Preliminary) total and differential cross sections at $Q=2.3$ MeV and 7.75 MeV**
 - σ_{tot} consistent with existing data
 - contribution of higher partial waves at $Q = 7.75$ MeV
- **Data for $Q=22$ MeV and $Q=42$ MeV taken (Nov. 03)**
 - expected results: total cross section
differential cross section for $Q=22$ MeV
- **Measurements with polarized beam in progress by GEM**
 - first test run in December '03 at $p = 2.4$ GeV/c ($Q = 22$ MeV)
 - next: $p = 2.5$ and 2.8 GeV/c (i.e. $Q = 57$ and 161 MeV)