Hen bound states

HPSS 2010

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MOTIVATION AND CURRENT KNOWLEDGE I

η-nucleus quasi bound state

Strong attractive force between η and nucleus

→ new exotic matter

$\eta\,{}^3He$: a- measure scatt. length

$Re(a) < 0$ → bound state

T. Mersmann et. al 2007 : $a = [\pm(10.7 \pm 0.8) + i\,(1.5 \pm 2.5)]$ fm

A. Sibirtser et. al 2004 : $a = [14.3 \pm 0.3] + i\,(0.5 \pm 0.5)]$ fm

Inconsistent and insensitive to sign of Re(a)

MOTIVATION AND CURRENT KNOWLEDGE II

Instead : decay products

If decay through

$N(1535) \nearrow N\eta$ 30-50%

$\searrow N\pi$ 30-50%.

enhancement in $\sigma(\rightarrow N\pi)$ near threshold

M. Pfieffer et. al 2004

too low statistic

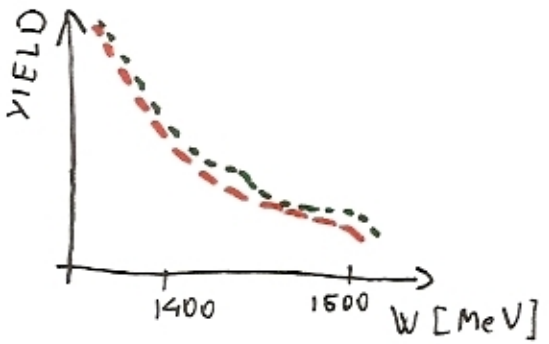
We propose:

Measure $dd \rightarrow p\pi^{-}{}^{3}He$

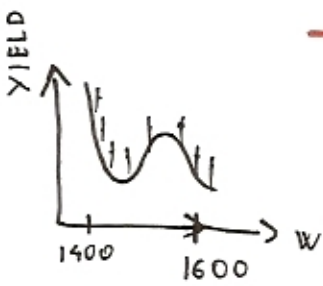
with better statistics and finer binning

METHODS

- **FINDING BOUND STATES**



⟹ subtracted from



— 150°- 170° BACKGROUND

— 170°- 180° BOUND STATES

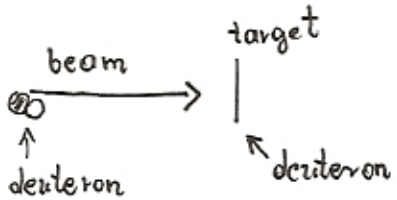
- **THRESHOLD**

$$\sqrt{s} = 4274{,}7 \text{ MeV}$$

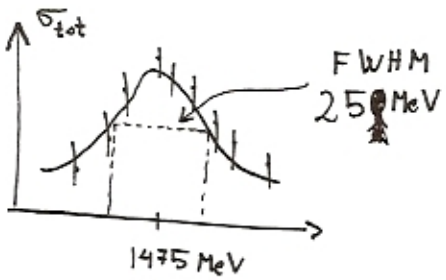
- **BEAM PARAMETERS**

$$E_{dl} = 2996 \text{ MeV}$$

$$p_d = 2336 \text{ MeV}$$

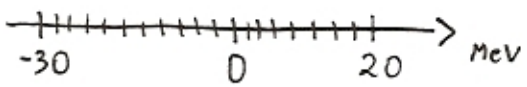


- **PREVIOUSLY EXPERIMENT DATA**

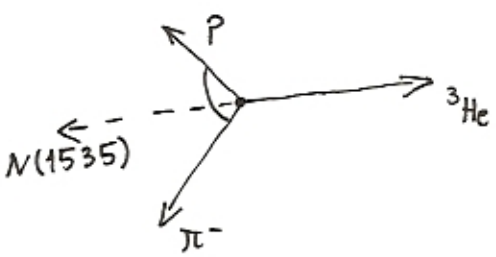


⟹

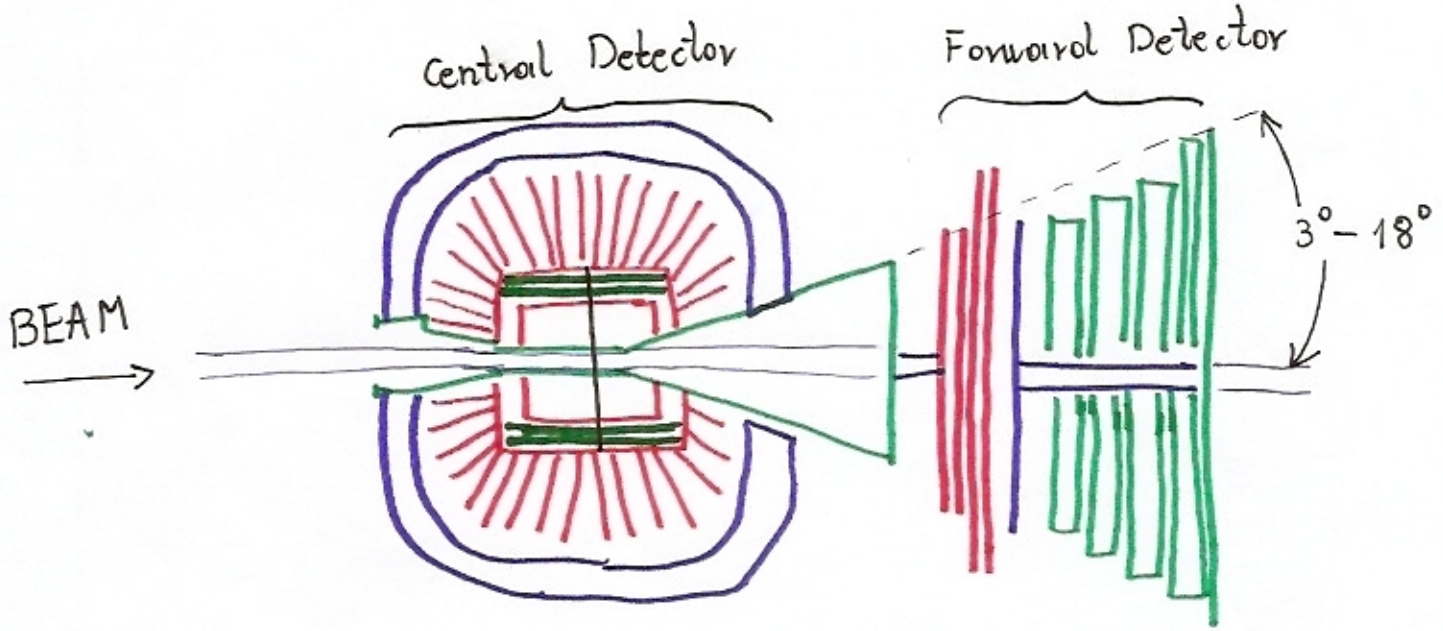
Q-range



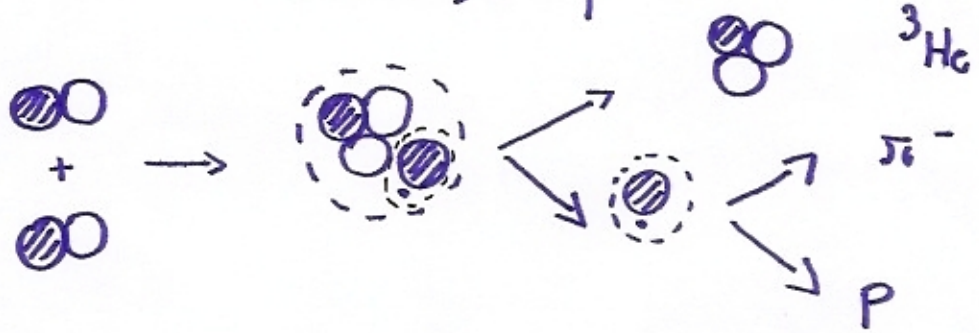
- **DECAY SCHEMATIC**



WASA



$$dd \rightarrow N^* \; {}^3He$$
$$\hookrightarrow \pi^- p$$



particle	case 1	case 2	case 3	case 4
^3He	FD	FD	FD	FD
proton	FD	CD	FD	CD
π^-	FD	CD	CD	FD

TRIGGER & PARTICLE ID

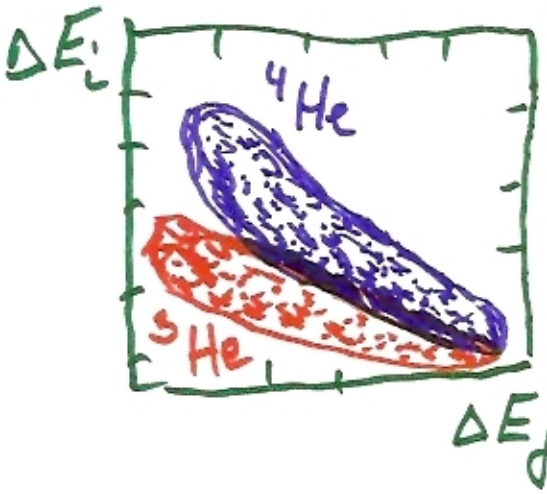
$d + d \longrightarrow \pi^- p\, {}^3He$ in Wasa

TRIGGER:

- 2 particles$^+$ in FD
  $\Delta E_1 >> \Delta E_2$
- 1 in FD & 1 in CD
  (He^{3+}) (p)

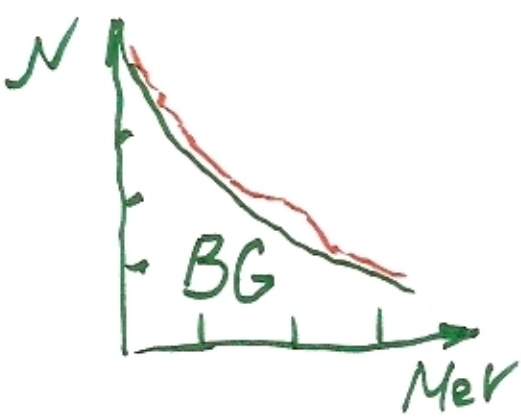
IDENTIFICATION via ΔE-E

- 2D plots in $\Delta E_i : \Delta E_j$ space where i & j are layers of scintillator with diff. thick.

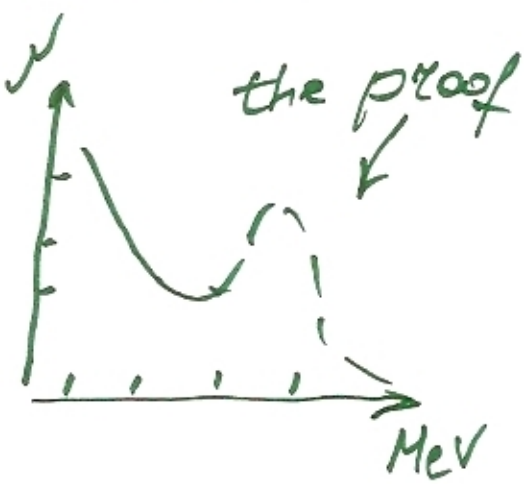


- TOF opportunity
  $\sigma \simeq$ poor
  SMALL DISTANCE BETWEEN LAYERS

LOOKING FOR BOUND STATES:



SUBTRACT →



BEAM TIME: (1)

Luminosity: $\mathcal{L} = \underbrace{n_s dx}_{\#\text{ scatter centers/area}} \cdot N_{in} \cdot f_{rev}$

COSY: $\mathcal{L} = \frac{5 \cdot 10^{14} \frac{\text{deuterons}}{\text{cm}^2}}{\text{WASA}} \cdot 10^{10} \frac{\text{deuterons}}{\text{deuterons}} \cdot 1.5 \cdot 10^{6} s^{-1}$

$$\mathcal{L} = 7.5 \cdot 10^{30}\ cm^{-2} s^{-1}$$

π detected: $N_{det} = \mathcal{L} \cdot \sigma \cdot T \cdot D$

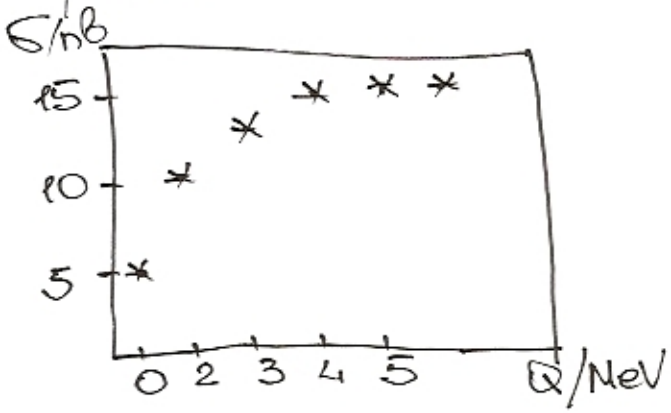
$D = \varepsilon_p \cdot \varepsilon_{^3He} \cdot A_p \cdot A_{^3He}$

ε_p = 90%, $\varepsilon_{^3He}$ = 90%, A_p = 0.8, $A_{^3He}$ = 2/3

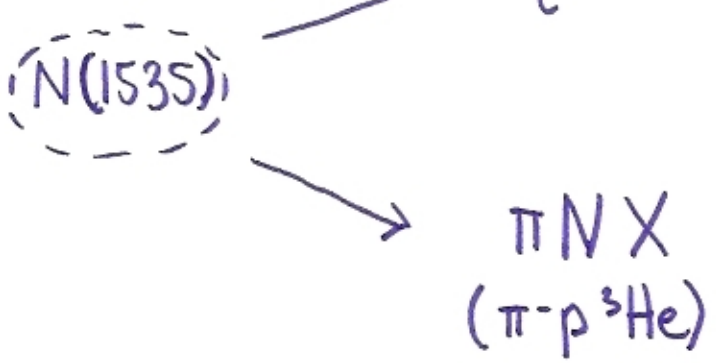
$$N_{det} = 3.24 \cdot 10^{10} \cdot \sigma \cdot T$$

σ?

A. Wrońska et al: Near-threshold η-meson production in the $dd \to {}^4He\,\eta$ reaction



$\sigma = 15$ nB



BEAM TIME (2)

desired stat. accuracy: $\frac{\sigma}{\sigma_{error}} = 10\ \%$

Background!!! Non-resonant production

$dd \rightarrow p\pi^- {}^3He$

M. Pfeiffer et al: Photoproduction of η-Mesic ^3He

$\sigma_{signal} / \sigma_{bg} = 1/4$

$$\frac{N_{tot} - N_{bg}}{\sqrt{N_{tot} + N_{bg}}} = 10 \quad ; \quad N_{tot} = 1.25\, N_{bg}$$

$$\Rightarrow \underline{N_{bg} = 3600}$$

$$T = \frac{N_{bg}}{3.24 \cdot 10^{10} \cdot 6} \approx 5 \text{ hours/Bin}$$

! Duty factor $\approx 1/2$

$$\Rightarrow \underline{T \approx 10 \text{ hours/Bin}}$$

bins: 40

$T \approx 17$ days

TRIGER adjustment + unexpected....

4 days

$$\boxed{T = 21 \text{ days} = 3 \text{ weeks}}$$