# Investigation of the $^{4}$n system by measuring $^{8}$He(p,p$\alpha$)$^{4}$n at large momentum transfer

**Fabia Schindler**

05.10.2017
SFB Workshop
Budenheim

# Do four neutrons form a resonant state?

## Theoretical predictions:

- Sensitive on input of few-body forces
- Experimental information would be a valuable test of state-of-the-art ab-initio theory.

- Recent publications:
  - S.Gandolfi et al. PRL 118, 232501 (2017)
    (Quantum Monte Carlo)
  - K. Fossez et al. PRL 119, 032501 (2017)
    (No-Core Gamow Shell Model)

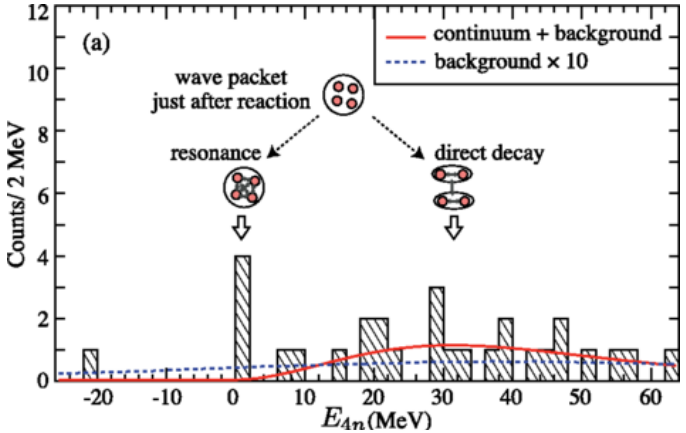
## Our performance:

| | |
|---|---|
| $E_{4n}$ resolution: | 1.6 MeV (FWHM) |
| Statistics: | » 1000 Events (total) |

## Recent Experiment (Kisamori et al.)

- Reaction:
  Double charge exchange:
  $^{8}He+^{4}He \rightarrow {}^{4}n+{}^{8}Be$

- Significance level: 4.9 σ
  → "Nearly discovered"



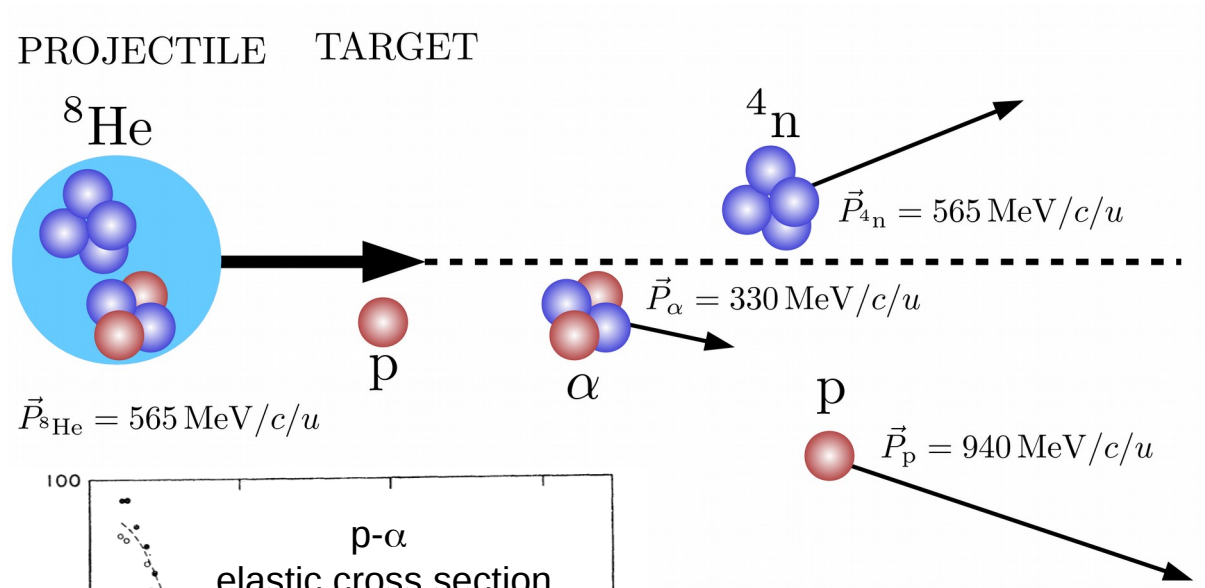

K.Kisamori et al. PRL 116, 052501 (2016)

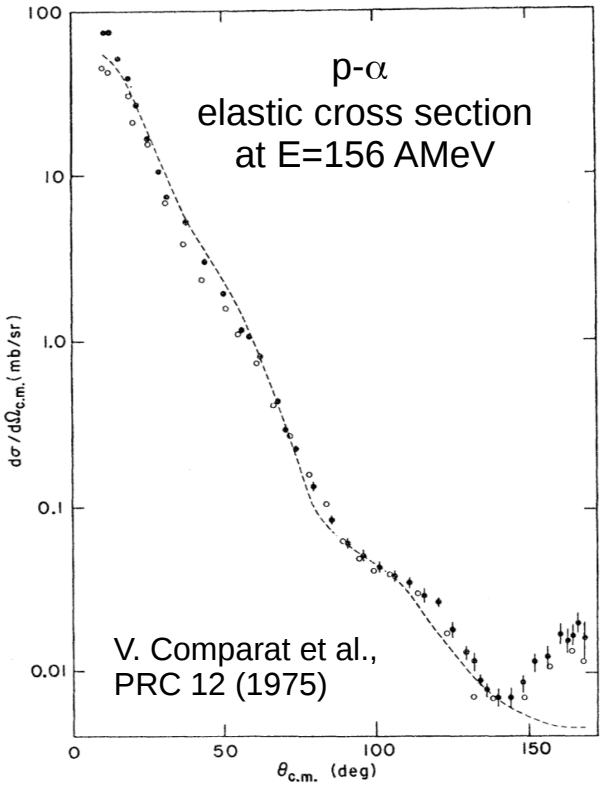
| | |
|---|---|
| Energy: | 0.83 ± 0.65(stat) ± 1.25(syst) MeV |
| Width: | < 2.6 MeV (FWHM) |
| Strength: | ≈ 15 % |

| | |
|---|---|
| $E_{4n}$ resolution: | 2.4 MeV (FWHM) |
| Statistics: | 27 Events (total) |

# Do four neutrons form a resonant state?

**Our Experiment: $^{8}$He(p,pα)$^{4}$n @ 156 AMeV**




- Center of mass angle between α and p: θ = 160º-180º
- Large momentum transfer ≈ 900 MeV/c
  - α: slowed down
  - p: becomes fastest particle
  - $^{4}$n: recoils in $^{8}$He rest frame (momentum of α in $^{8}$He)

  **BUT:** no momentum transfer from reaction

  → α,p,$^{4}$n separated in momentum space

  → no final-state interaction

**Main goal:**

- $^{4}$n energy spectrum via missing mass method
- Measurement of charged particles

**Find possible resonance and determine energy and width**

**In addition:**

- Measurement of neutrons in coincidence
- (3 out of 4 → kin. complete )

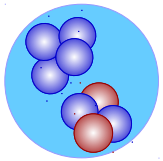
**Study decay properties of $^{4}$n**

# Setup: SAMURAI at RIKEN

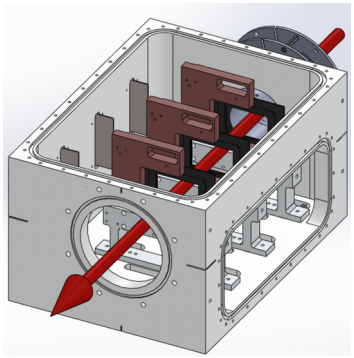
**Upstream detectors:**
Plastic scintillators
Drift chambers

**Target:**
Liquid hydrogen
d=5cm
t=357.5 mg/cm$^2$

Incoming $^8$He
E=156 AMeV



**Silicon tracker:**



Thick target
↓
Precise vertex reconstruction needed

B=1.25 T

$^4$n
E=156 MeV

Unreacted $^8$He
E=156 MeV
Bρ=7.5 Tm

Drift chamber

Plastic wall

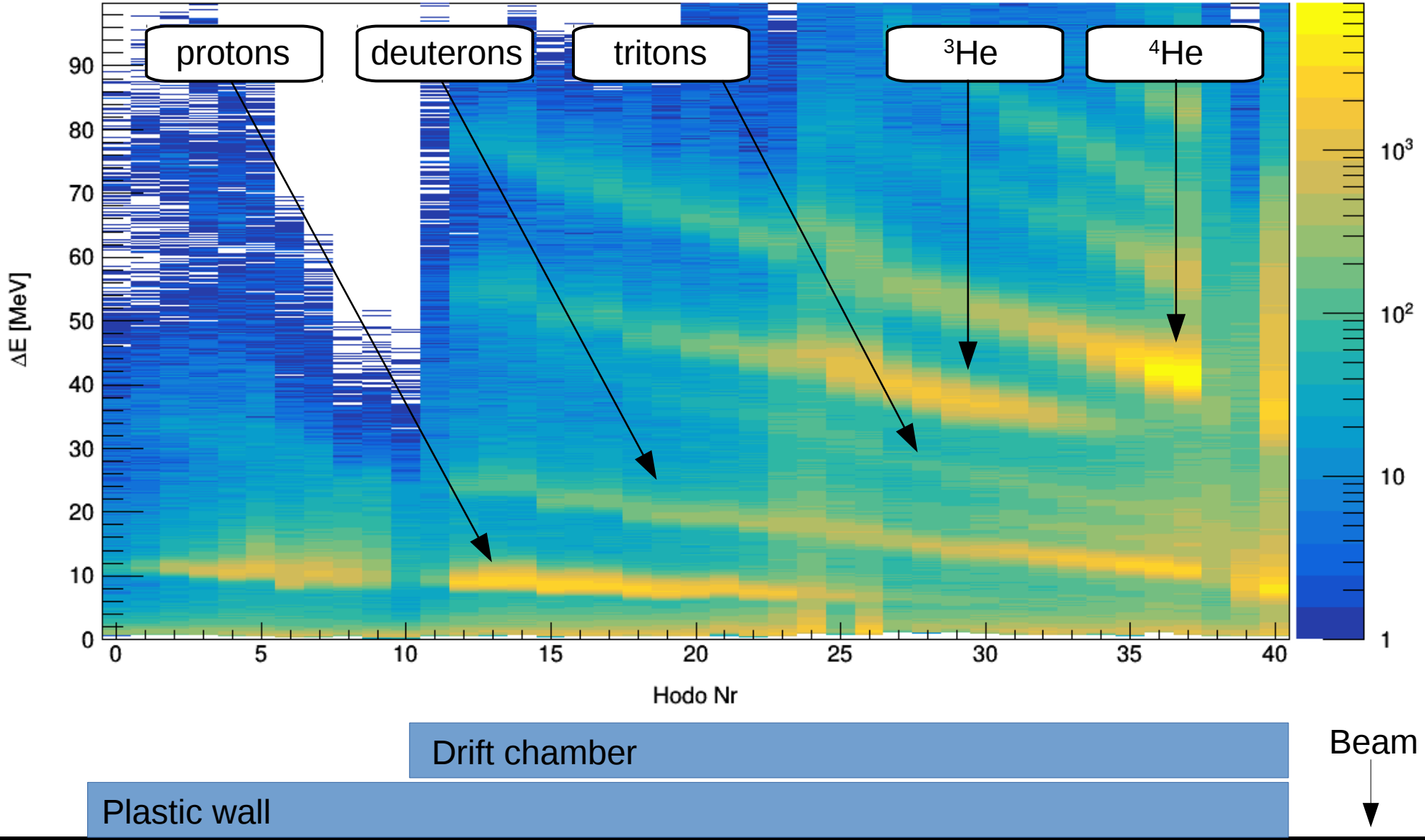
Slow $^4$He
E=55 AMeV
Bρ=2.2 Tm

Fast **protons**
E=400 MeV
Bρ=3.2 Tm

**Neutron detectors:**
NeuLAND (R$^3$B)
NEBULA

# ! News !

- Experiment was done… and a success! (26.06-02.07)
- Detectors and people are back home.
- Teaser: Preliminary fragment ID from plastic-wall data:



# Thank you for your attention!