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iThemba LABS
Laboratory for Accelerator Based Sciences

Characterization of the 2^+ excitation of the Hoyle state in ^{12}C

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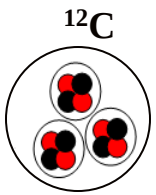
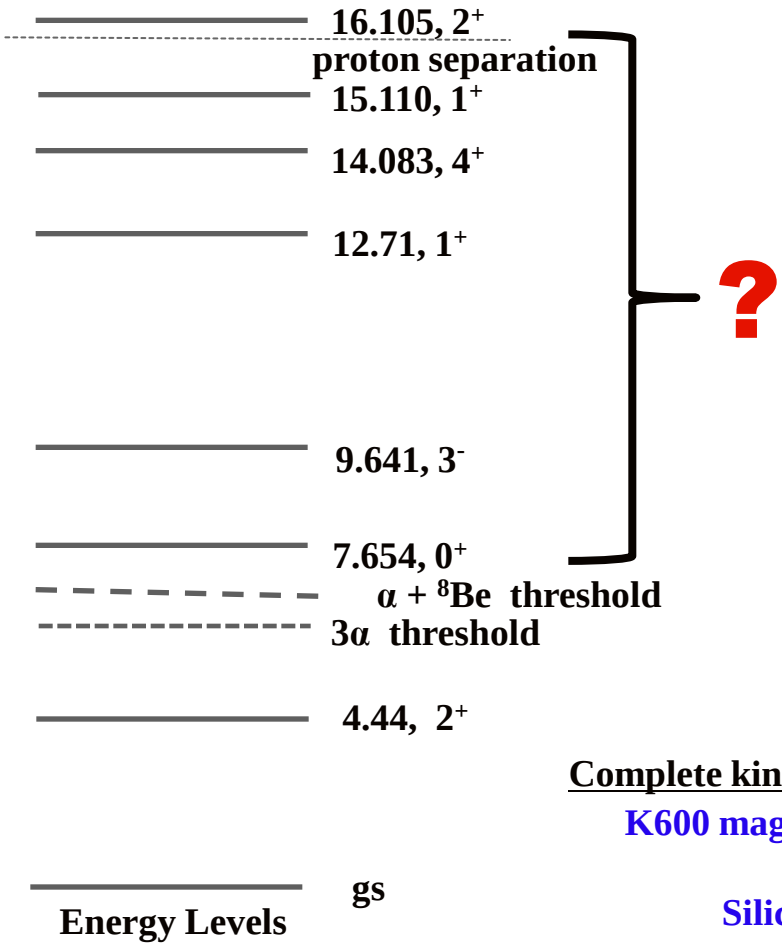
University of Stellenbosch/iThemba Labs

Energy Postgraduate Conference 2013

Overview





Complete kinematics measurement

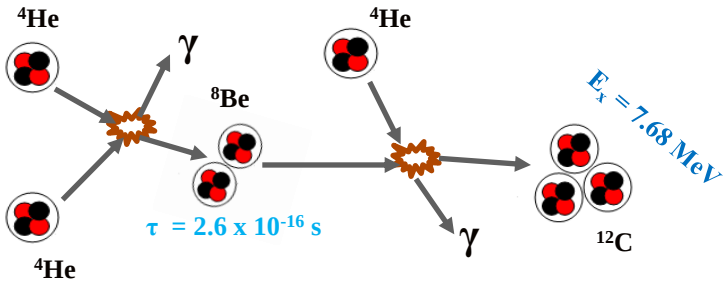
K600 magnetic spectrometer

+

Silicon detectors

Hoyle State

Synthesis of elements inside stars



• This state was found experimentally by (Cook *et. al.* 1957) to be situated at 7.654 MeV.

• It has 0^+ character and was named the "Hoyle state".

"Of course, without the Hoyle state we wouldn't be here." - Prof Morten Hjorth-Jensen (University of Oslo and Michigan State University)

Fred Hoyle British Astronomer 1915 - 2001

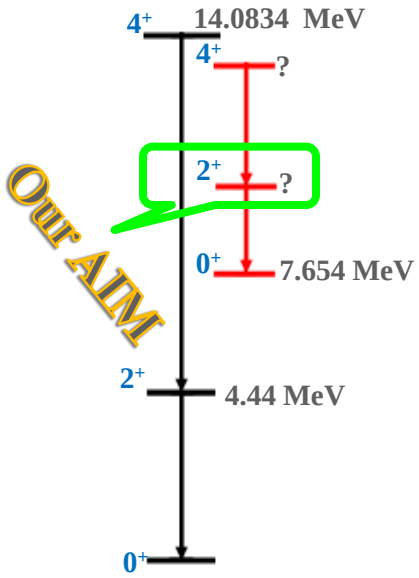
God State?

2^+ excitation of the Hoyle state

- Its structure is not well understood.

rotational band?

- **H. Morinaga, Phys. Rev. 101, 254 (1956)**
  - ✓ **Suggested it Should**

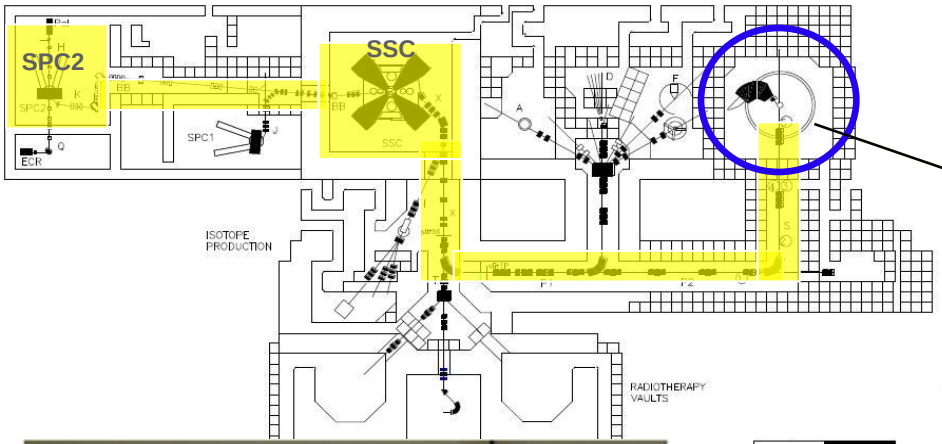


Theoretical Considerations		
Author	**Journal**	**E_x (MeV)**
P. Descouvemont *et al.*	Phys. Rev. C 36, 54	8.400
A. C. Merchant *et al.*	Nucl. Phys. A549, 431	8.954
Y. Funaki *et al.*	Eur. Phys. J. A. 24, 321	9.954
M. Chernykh *et al.*	Phys. Rev. Lett. 98, 032501	9.104

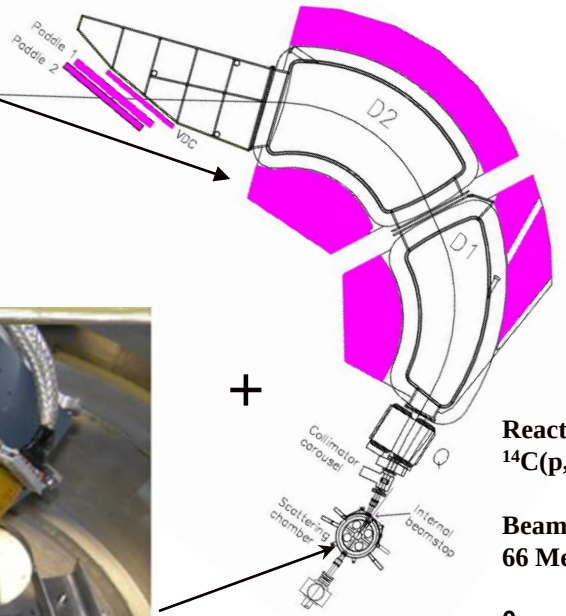
Experimental Considerations		
Author	**Journal**	**E_x (MeV)**
M. Freer *et al.*	Phys. Rev. C 80, 041303	9.600
M. Itoh *et al.*	Phys. Rev. C 84, 054308	9.840
T. K. Rana *et al.*	arXiv:1203.3336v1 [nucl-ex]	9.650
W. R. Zimmerman *et al.*	Phys. Rev. C 84, 027304	10.030

Experimental Details

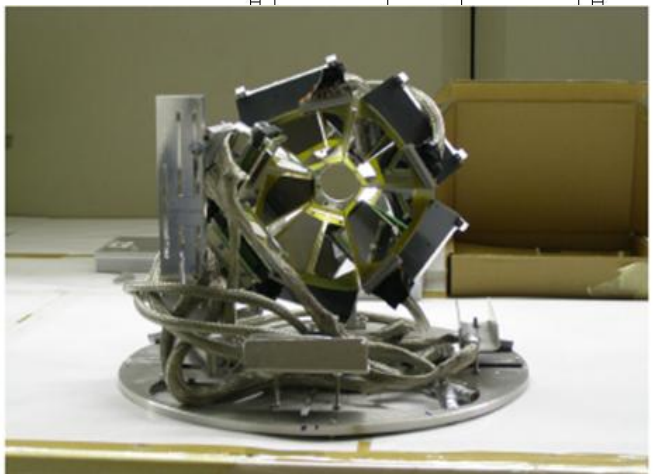
iThemba LABS Cyclotron

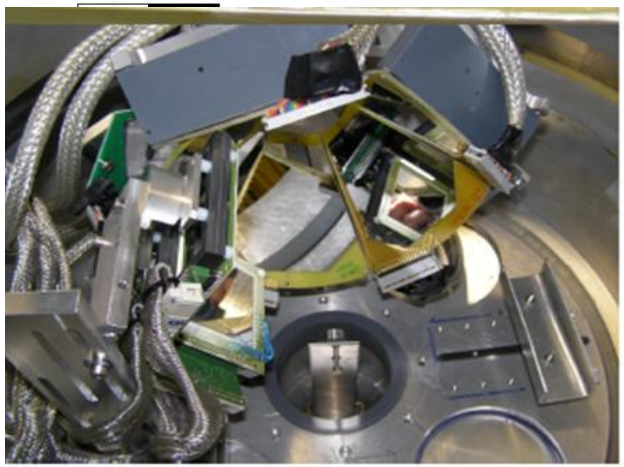


K600 magnetic spectrometer



Array of Silicon Detectors





+

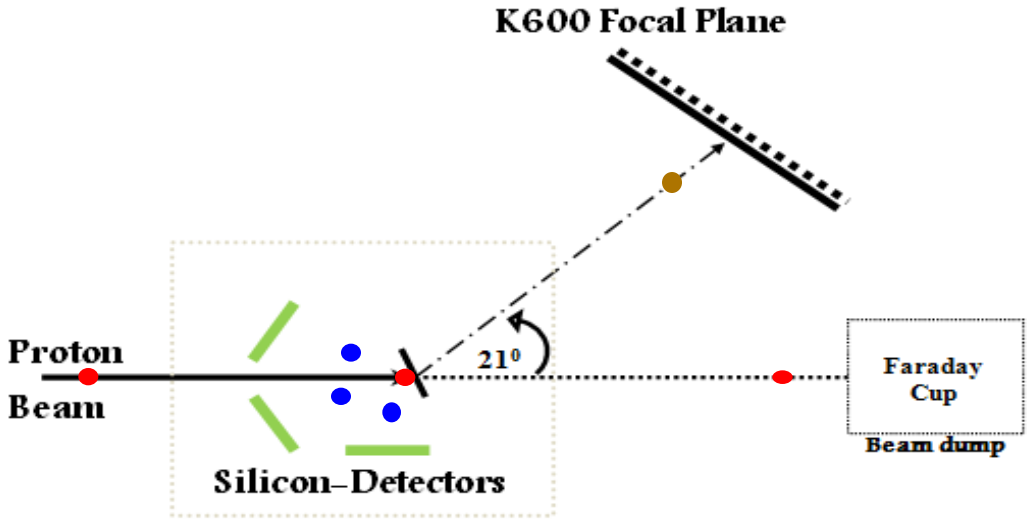
Reaction:
$^{14}C(p,t)^{12}C^*(\alpha\alpha\alpha)$

Beam energy:
66 MeV

$\theta_{lab} = 21^0$

Target:
enriched ^{14}C

Experimental Details



➢We need coincidence of K600 + Silicon Detectors

✓**Complete kinematics measurement**

✓ **K600 spectrometer is used to work out the excitation energy with high energy resolution.**

❑ **Offline analysis K600 software + SimSort (P. Papka)**

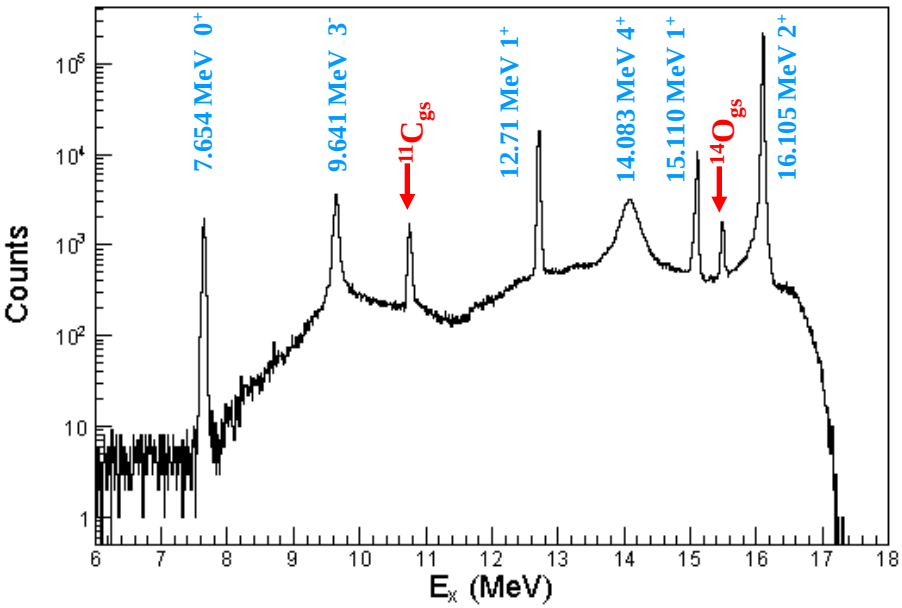
✓Choose the coincidence of interest t~~p~~, t~~pp~~, and t~~ppp~~

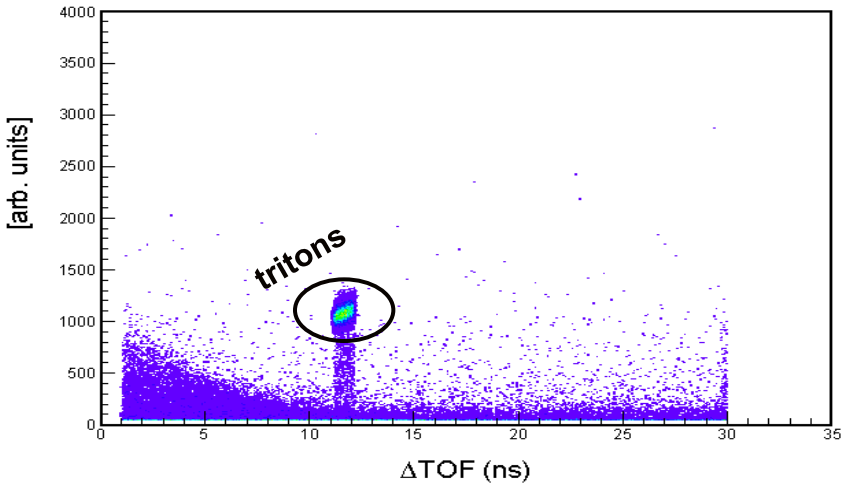
~~p~~ - charged particle (α)

We use the missing momentum technique to reconstruct the 3rd particle (α)

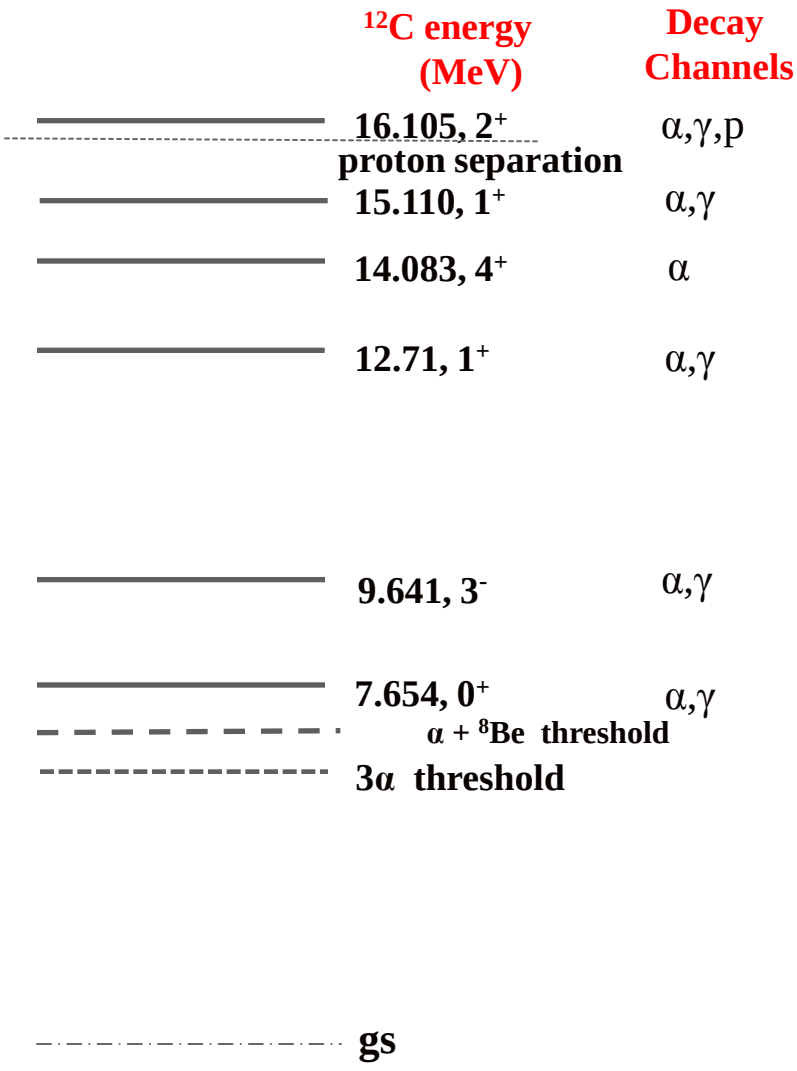
Analysis and Preliminary Results

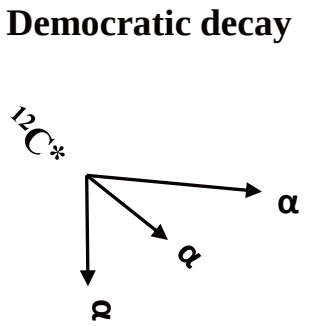
- Spectrometer Analysis
  - ✓ $^{14}C(p,t)^{12}C$

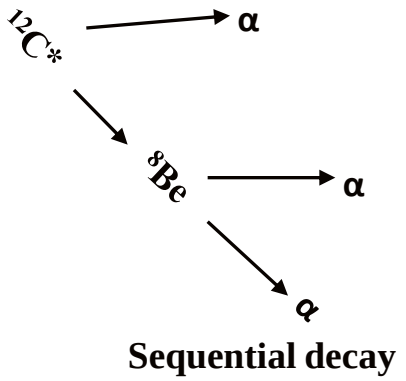




Analysis and Preliminary Results

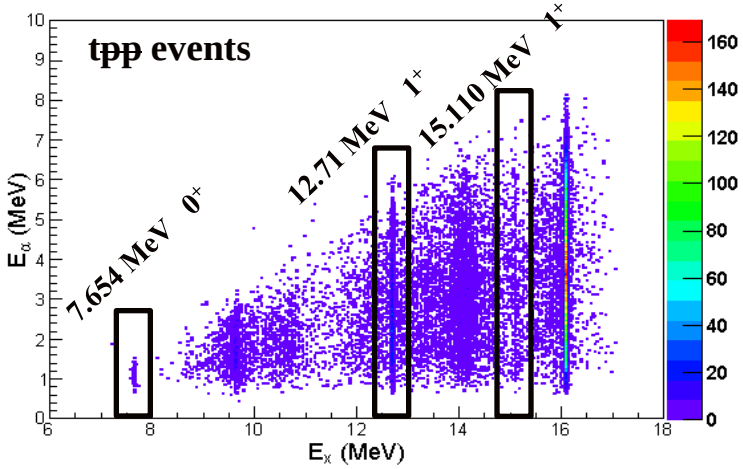


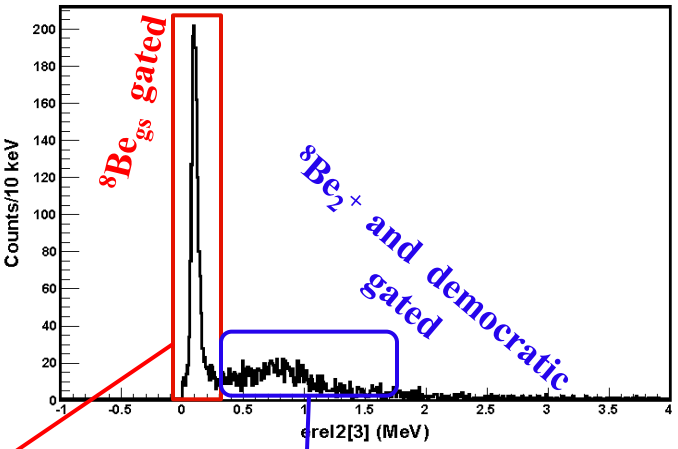


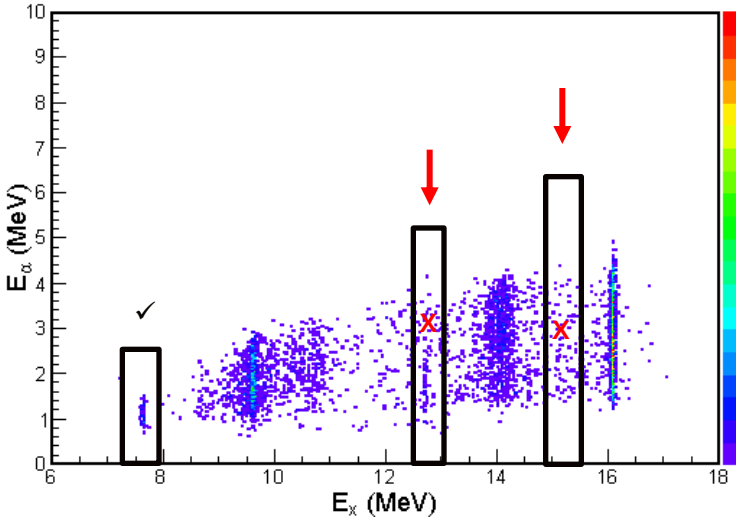


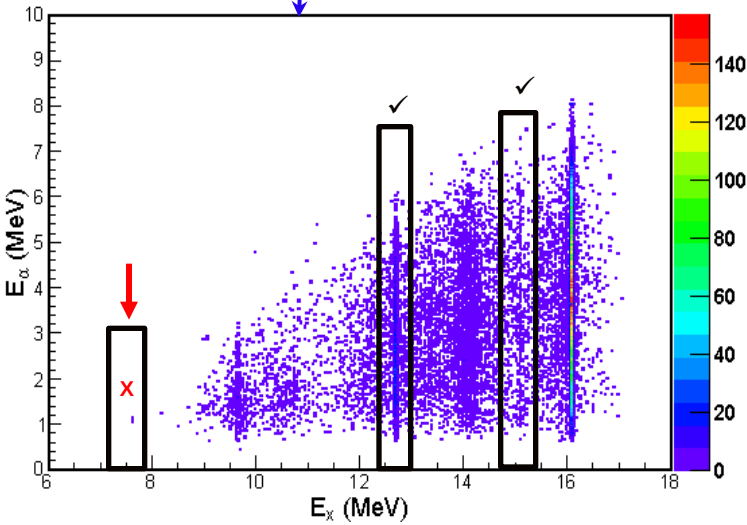
Analysis and Preliminary Results

- **What do we know?**









Conclusion and Outlook

- ✓ $^{14}C(p,t)^{12}C$ Complete kinematics measurement was successfully conducted.
- ✓ Preliminary results support other published results on known ^{12}C states.
- ✓ Next step is to zoom in the E_x ~10 MeV region.
- ✓ Complete data analysis to be finished soon.
- ✓Results will be compared with the Monte Carlo Simulations.

すべてのありがとう

Thank you All