



Breakup of the 18.2 MeV state in ^{11}Be : New decay modes

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β -decay of ^{11}Li

20.4 $3/2^-$
 ^{11}Li

$Q_\beta = 20.4 \text{ MeV}$
 $T_{1/2} = 8.5 \text{ ms}$

γ & n
97%

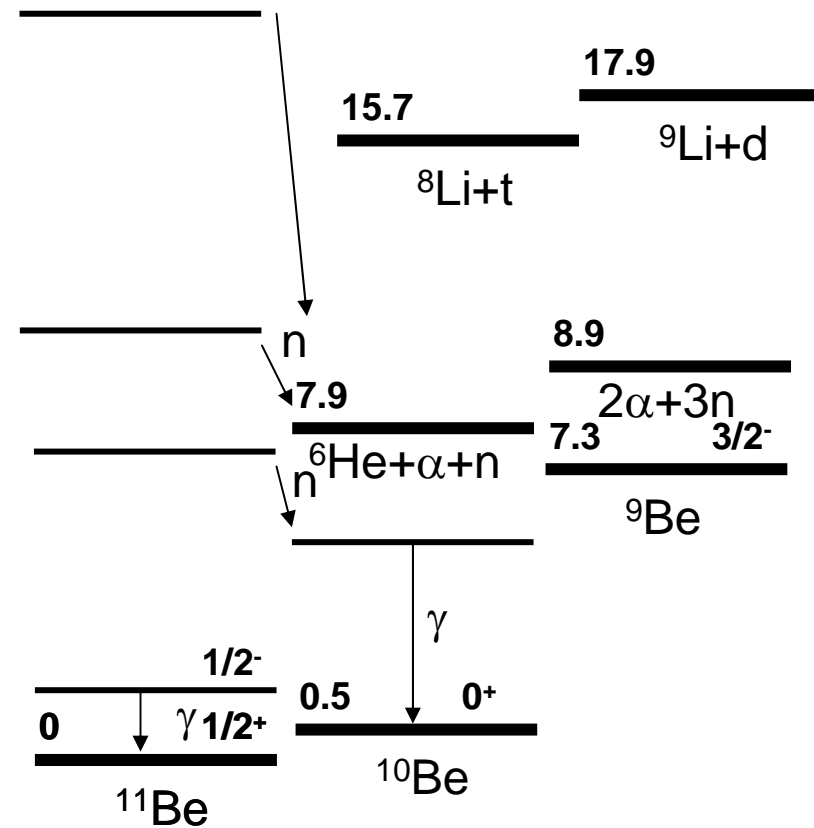
^{11}Be		
$^{10}\text{Be} + n$	0.50 MeV	1974
$^9\text{Be} + 2n$	7.31 MeV	1979

Charged particles (and n)
~3%

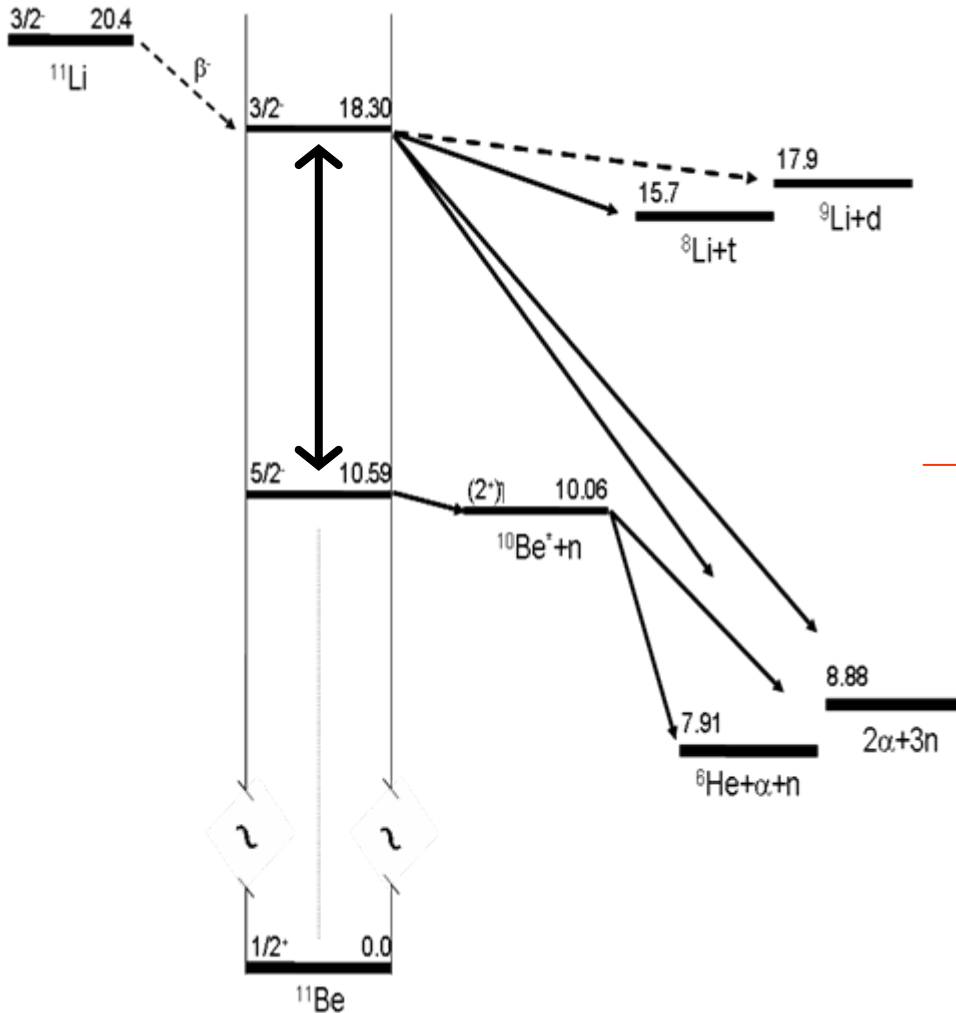
$^6\text{He} + \alpha + n$	7.90 MeV	1980
$2\alpha + 3n$	8.98 MeV	1980

Charged particles
~0.3%

$^8\text{Li} + t$	15.72 MeV	1983
$^9\text{Li} + d$	17.91 MeV	1996



Charged particle emission



➤ Current knowledge:

➤ Four decay channels

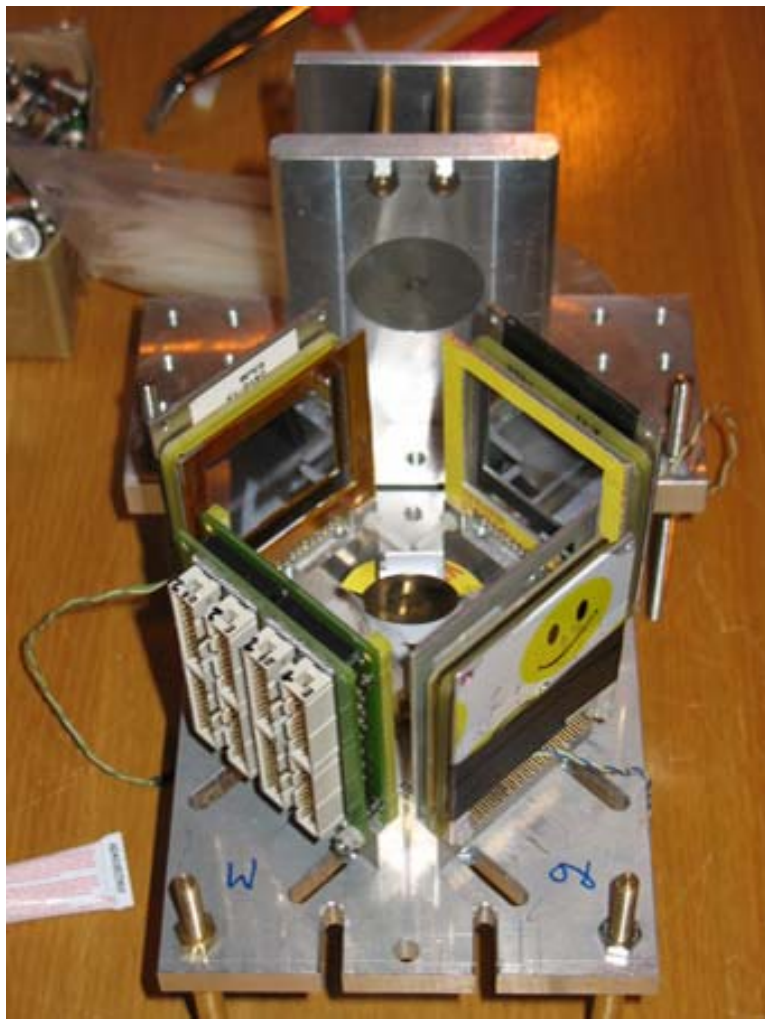
➤ Two states in ^{11}Be : 10.6 and 18.3 MeV.

➤ Theory: SM predicts B(GT) peaks between 15 and 20 MEV. *T. Suzuki and T. tsuka, PRC 56(1997)847*

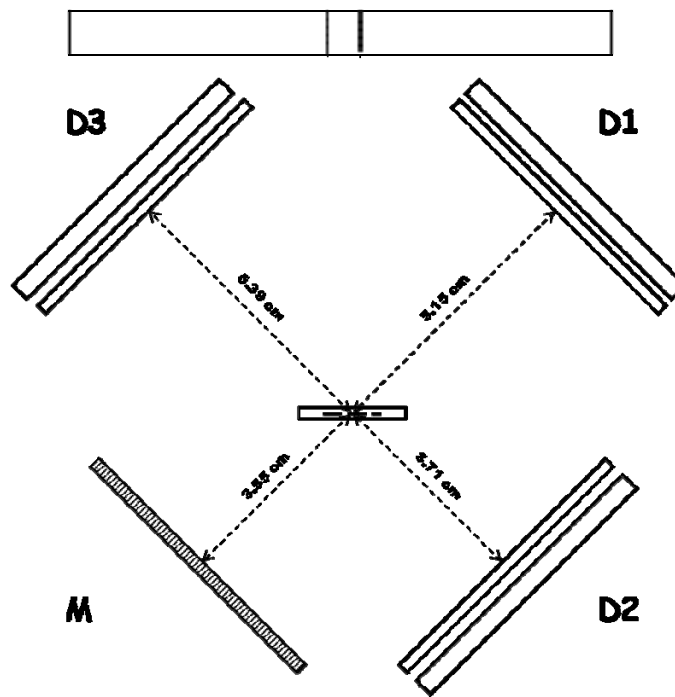
➤ Experiment: γ doppler broadening suggests significant (6%) feeding of states in this region.

H.O.U. Fynbo et al., NPA736 (2004)39

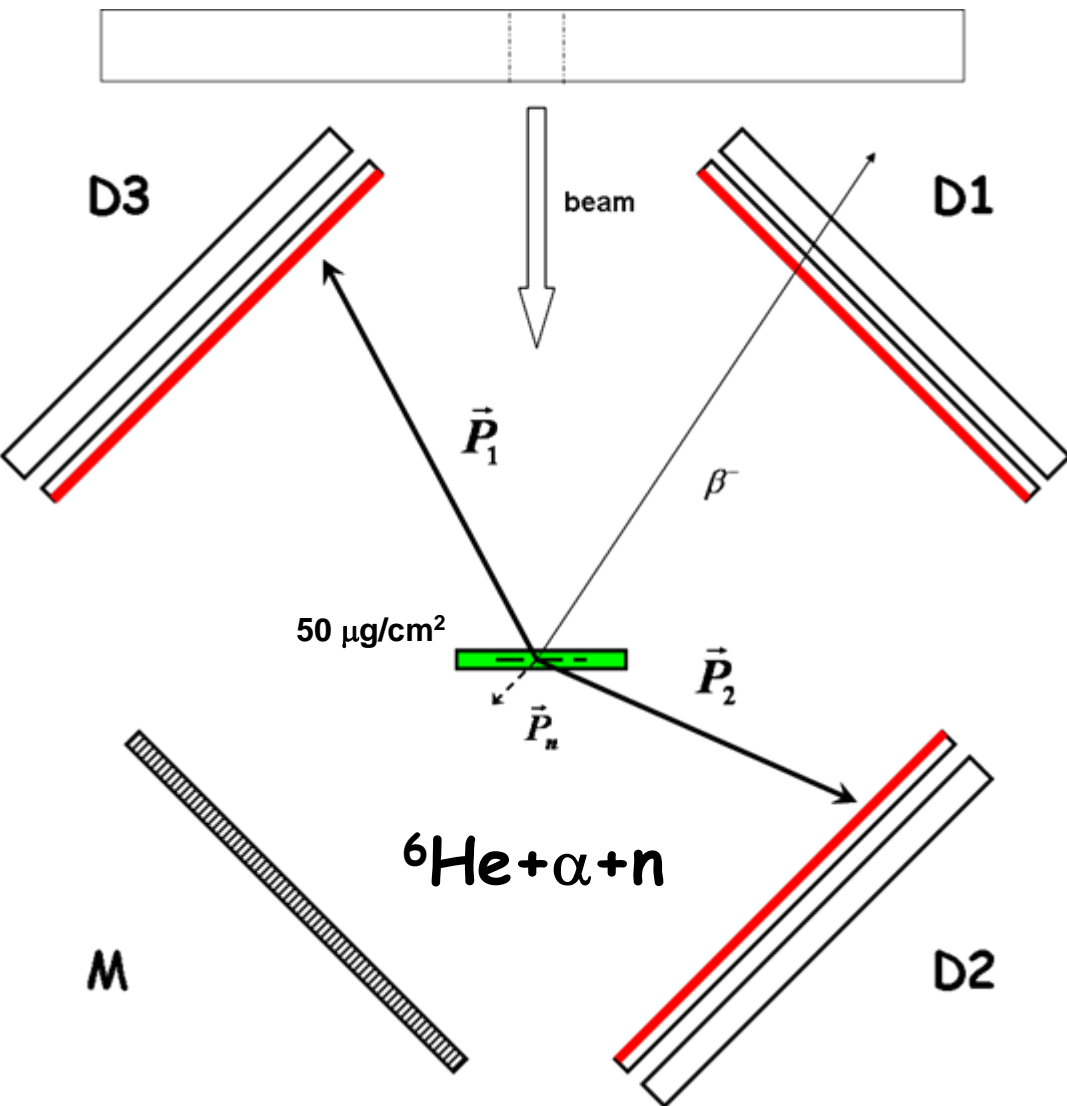
Experimental set-up



- Charged particle detection:
 - 3 DSSSD's + thick silicon pads
 - Compact geometry: $2 \times 4\%$ of 4π and $1 \times 7.5\%$ of 4π



Analysis techniques



Energy & momentum conservation

$$\vec{p}_1 + \vec{p}_2 + \vec{p}_n = 0$$

Momentum reconstruction

Excitation energy of the 1-2 & 1-n systems:

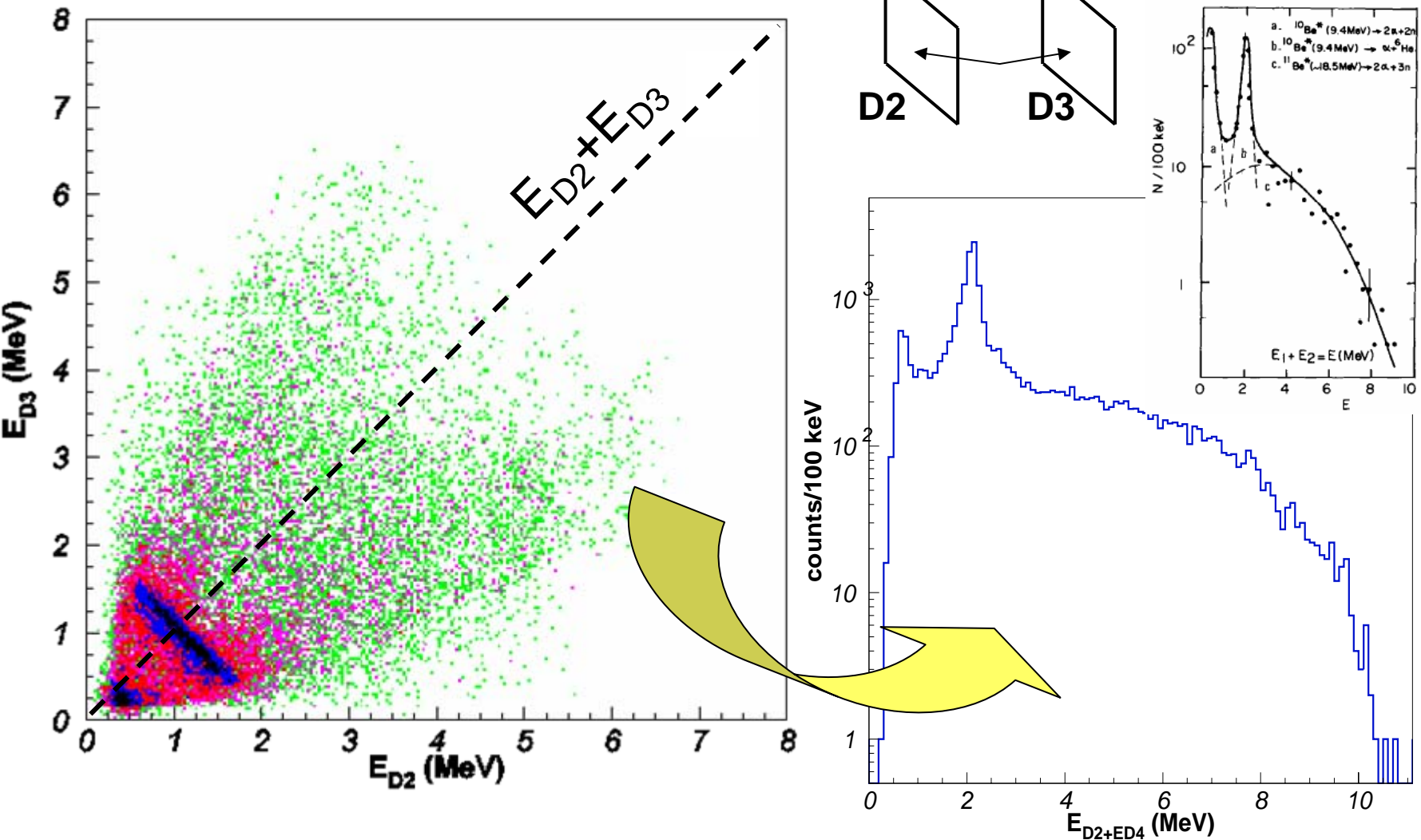
- **Deadlayer** and **carbon-foil** energy losses corrected

- β -background subtraction:

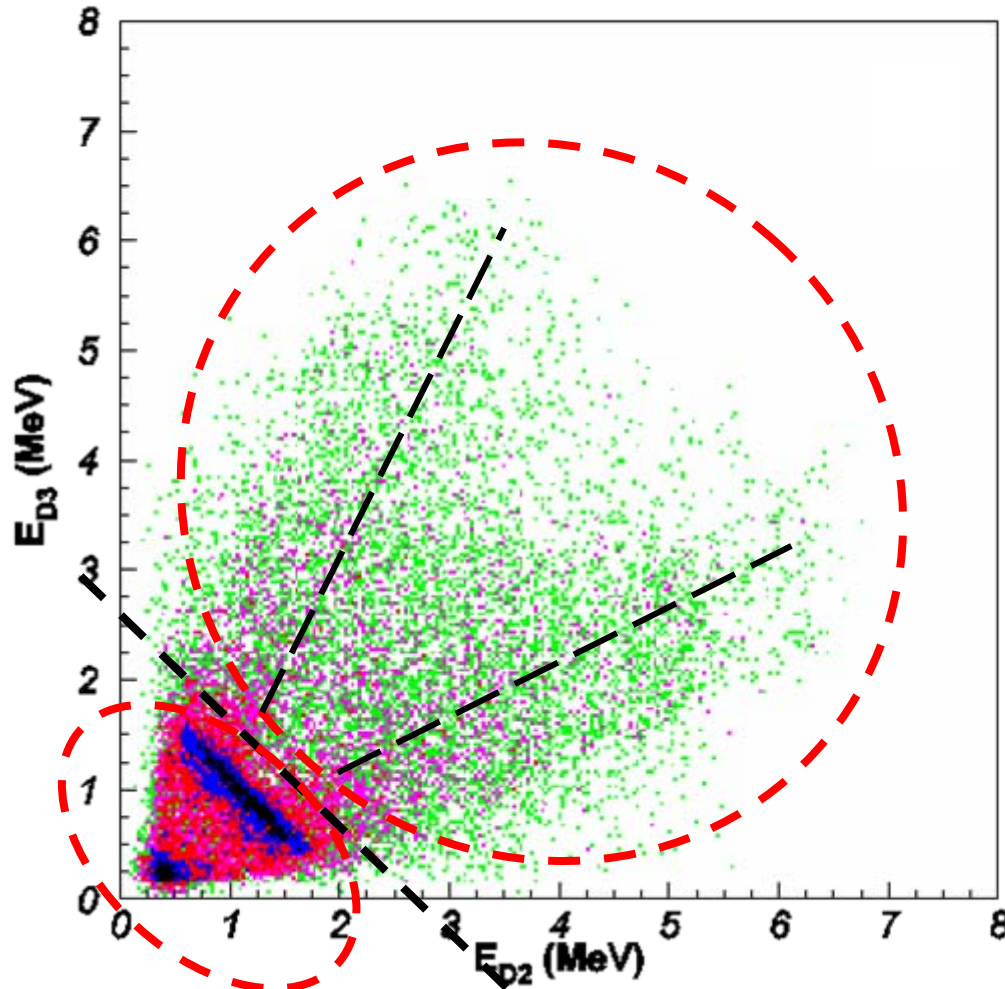
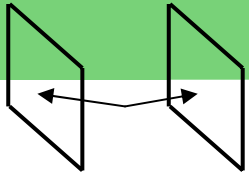
$$E_{\text{front}} - E_{\text{back}} \leq 40 \text{ keV}$$

Charged Particle Coincidences

M. Langevin et al.,
NPA 366(1981) 449

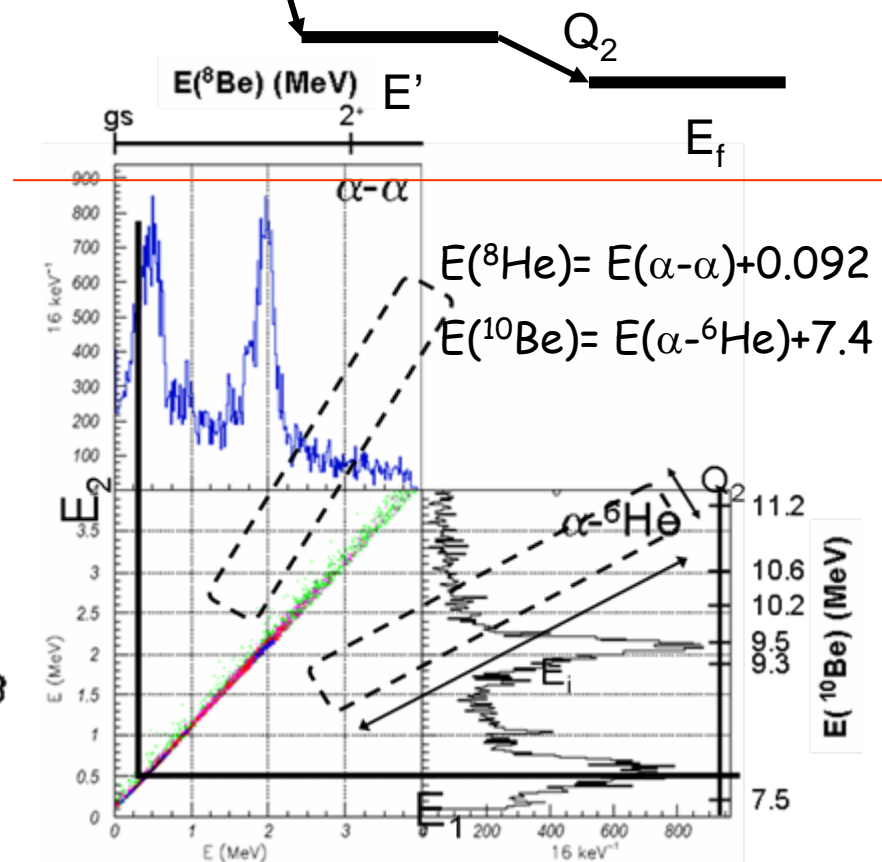


Phase space zones

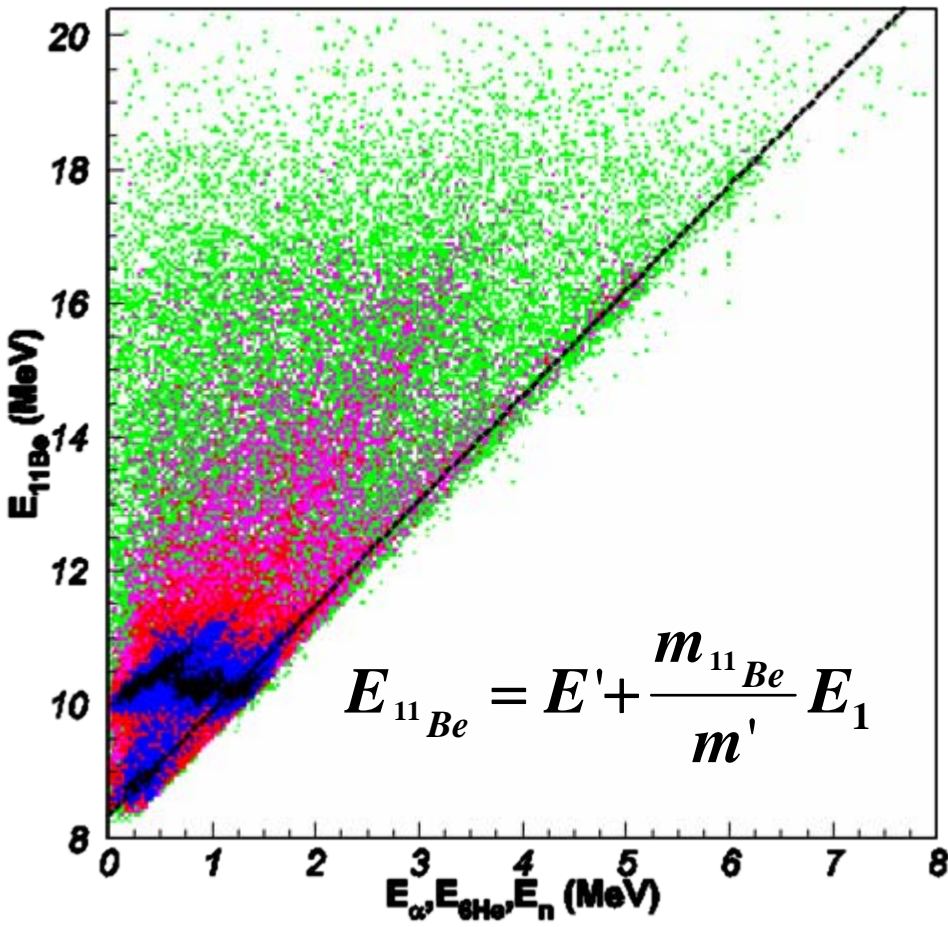
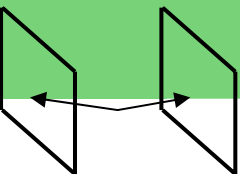


2-body like structure
 ${}^6\text{He} + \alpha + n$ sequential break-up

Resonance between
 detected particles



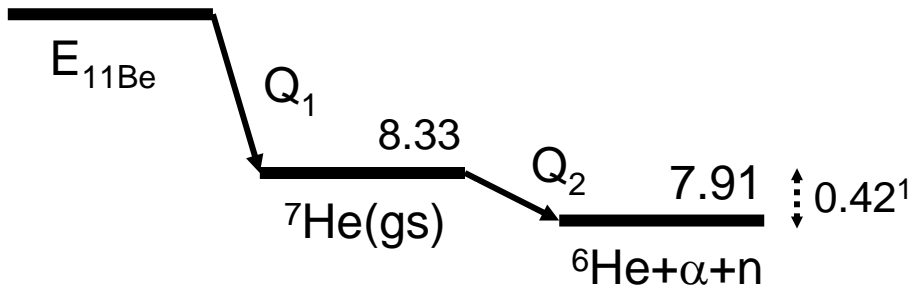
First emitted particle



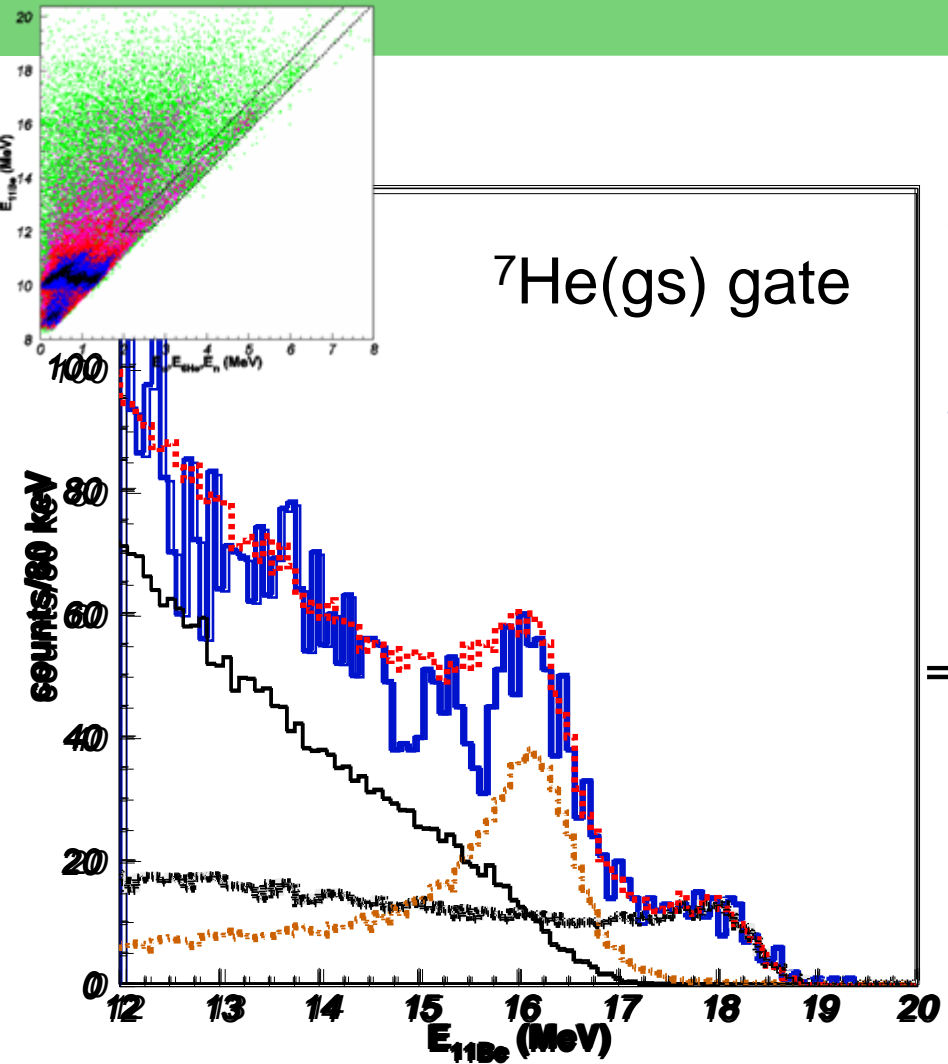
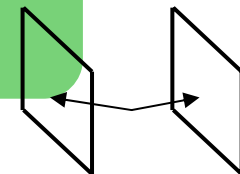
- Sequential 3-body break-up
- First emitted particle: α or ${}^6\text{He}$?

$$\frac{m_{11Be}}{m'} = \frac{11}{7} \quad \alpha + {}^7\text{He}$$

$$E' = 8.33 \text{ MeV} \quad E' \rightarrow {}^7\text{He}(gs)$$



^{11}Be excitation spectrum



Resonances \rightarrow R-Matrix Lorentz shapes

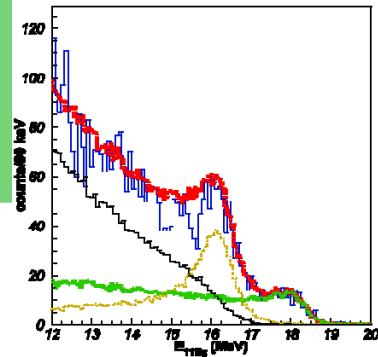
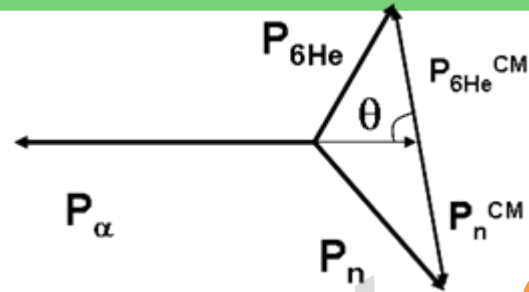
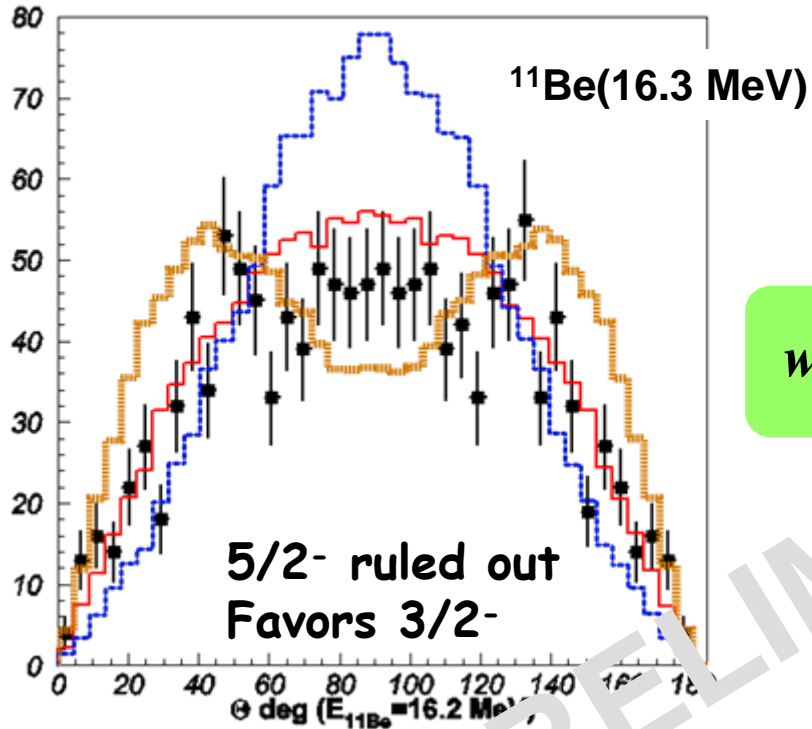
Multiple channel Monte-Carlo simulation:

$^7\text{He}+\alpha$
 $2\alpha+3n$

E_0 (MeV)	γ^2 (MeV)	Γ (MeV)	BR (%)
18.30(5)	0.1(1)	0.93(10)	0.120(2) ¹
16.30(5)	0.1(1)	1.04(10)	0.079(2) ¹

¹Normalized to $^7\text{He}+\alpha$ channel of M. Madurga et al., in preparation

Spin and Parity

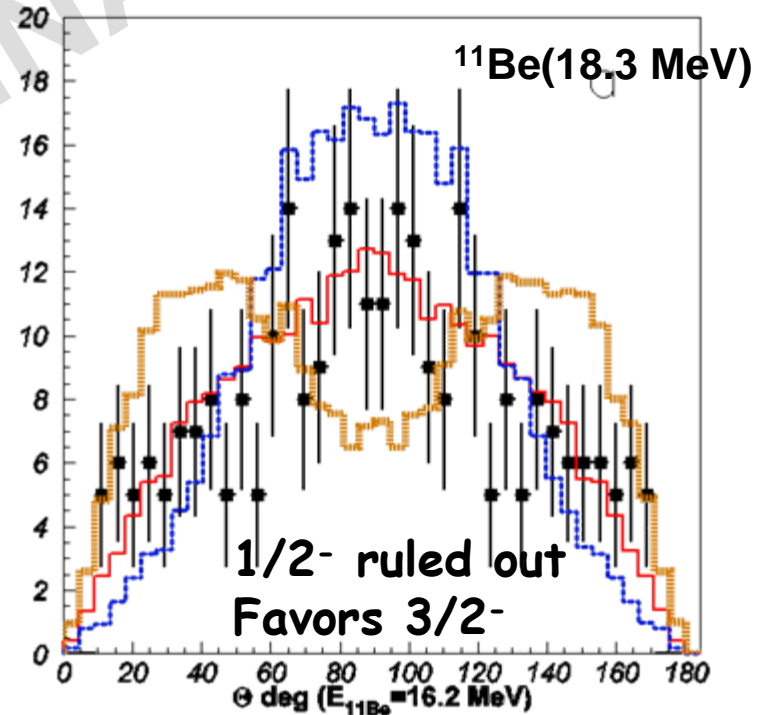


$$w(\theta) = 1 + \frac{1}{2} A_2 \cdot (3 \cos^2 \theta - 1)$$

$$A_2 = \begin{cases} -0.714 & (5/2^-) \\ 0 & (3/2^-) \\ +1 & (1/2^-) \end{cases}$$

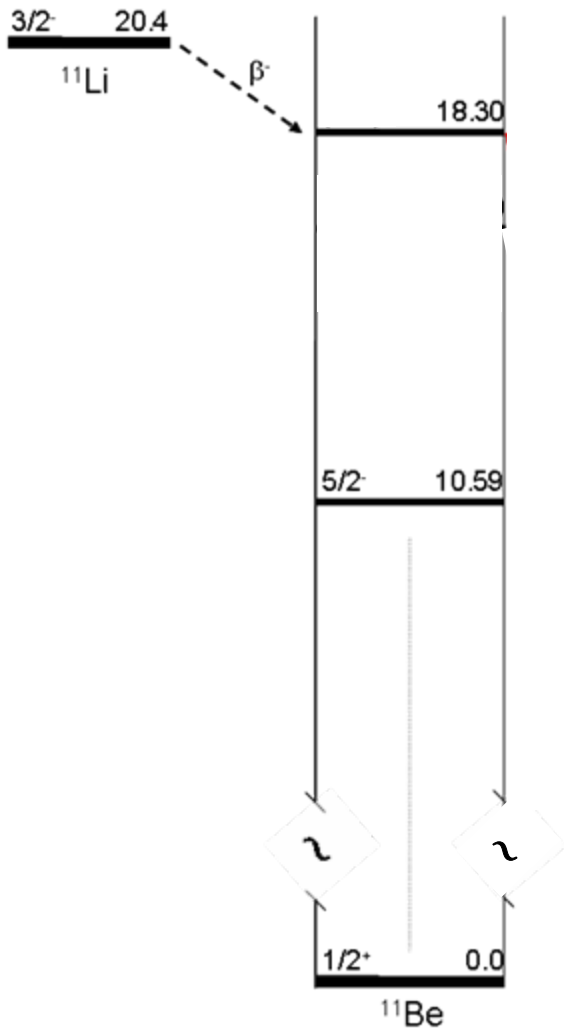
5/2- ruled out
Favors 3/2-

- DATA
- 3/2-
- - - 5/2-
- 1/2-



1/2- ruled out
Favors 3/2-

Summary & Outlook I



- ^{11}Li β -delayed spectrum studied in coincidence.
- Evidence of a new decay channel: $^7\text{He}(\text{gs}) + \alpha$.
- Two states in ^{11}Be involved in this channel.
- Spin and parity from angular correlations.

Summary & Outlook II

Breakup study of highly excited states in ^{11}Be fed in β -decay with a setup for charged particles with high granularity and angular coverage.

- ✓ For the states that break in 3 particles, the setup allows the complete kinematics study.
- ✓ This study indicates that $^7\text{He}+\alpha$ channel plays a role in the breakup of the ^{11}Be levels in the unknown region between 10.6 and 18.3 MeV
- ✓ The $^7\text{He}+\alpha$ channel probes the region where SM calculations of the ^{11}Li β -decay expect the $B(\text{GT})$ distribution to peak.

Sensitivity to halo distortion of $B(\text{GT})$?

- ✓ Alpha emission from ^{11}Be states hints intrinsic cluster structure

Thanks



M. Alcorta, M.J.G. Borge, L.M. Fraile, A. Perea, O. Tengblad, M. Turrion.



U. Bergmann, C.Aa. Diget, H.O.U. Fynbo, H.B. Jeppesen, O. Kirsebom, S. Hyldegaard, K. Riisager.



J. Cederkäll, B. Jonson, T. Nilsson, G. Nyman, E. Tengborn, K. Wilhelmsen.



J.C. Angelique, A. Bută, J.M. Daugas, E. Lienard, F. Marechal, M. Marques, V. Meot, F. Negoita, F. Perrot, O. Roig.