Indirect measurement of $^{25}Mg(p,\gamma)^{26}Al$ 58 keV resonance

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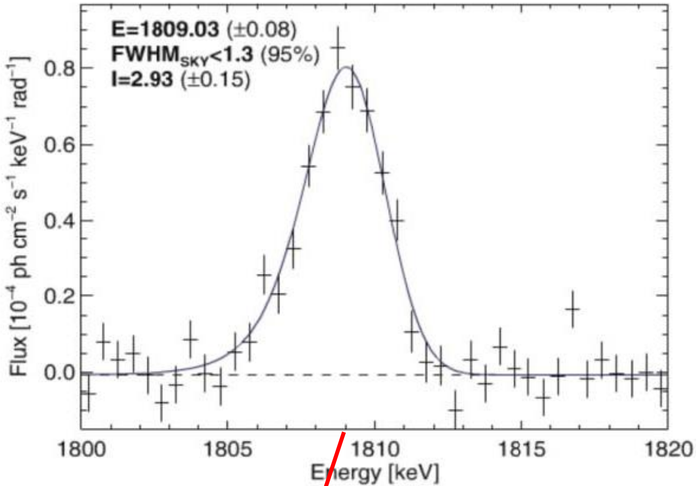
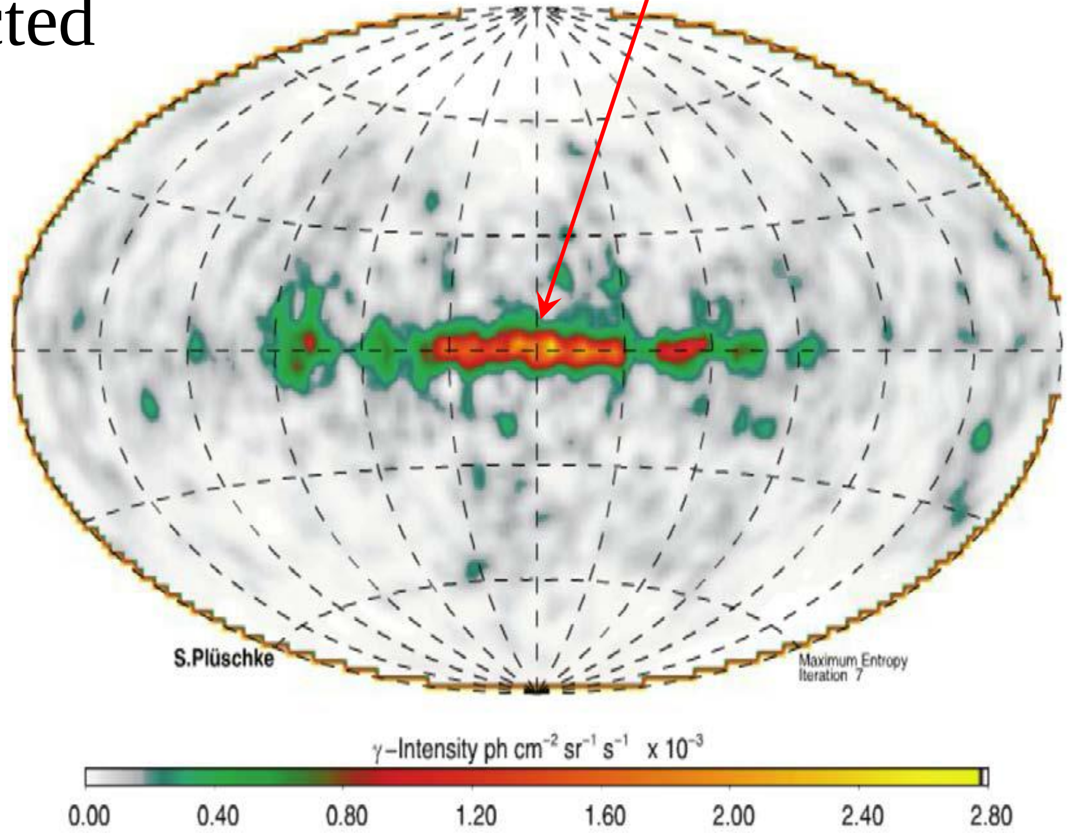
Outline

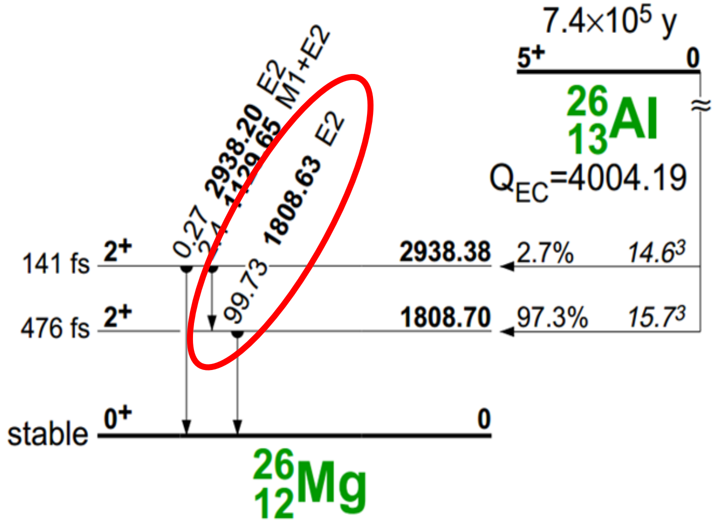
- Introduction
- Status for $^{25}Mg(p, \gamma)^{26}Al$ experiments
- Measurement on Q3D spectrometer at CIAE

Motivation

- Much 1.8 MeV γ-ray have been detected
- ^{26}Al about $3M_{\odot}$ in galaxy
- ^{26}Mg excess in meteorites



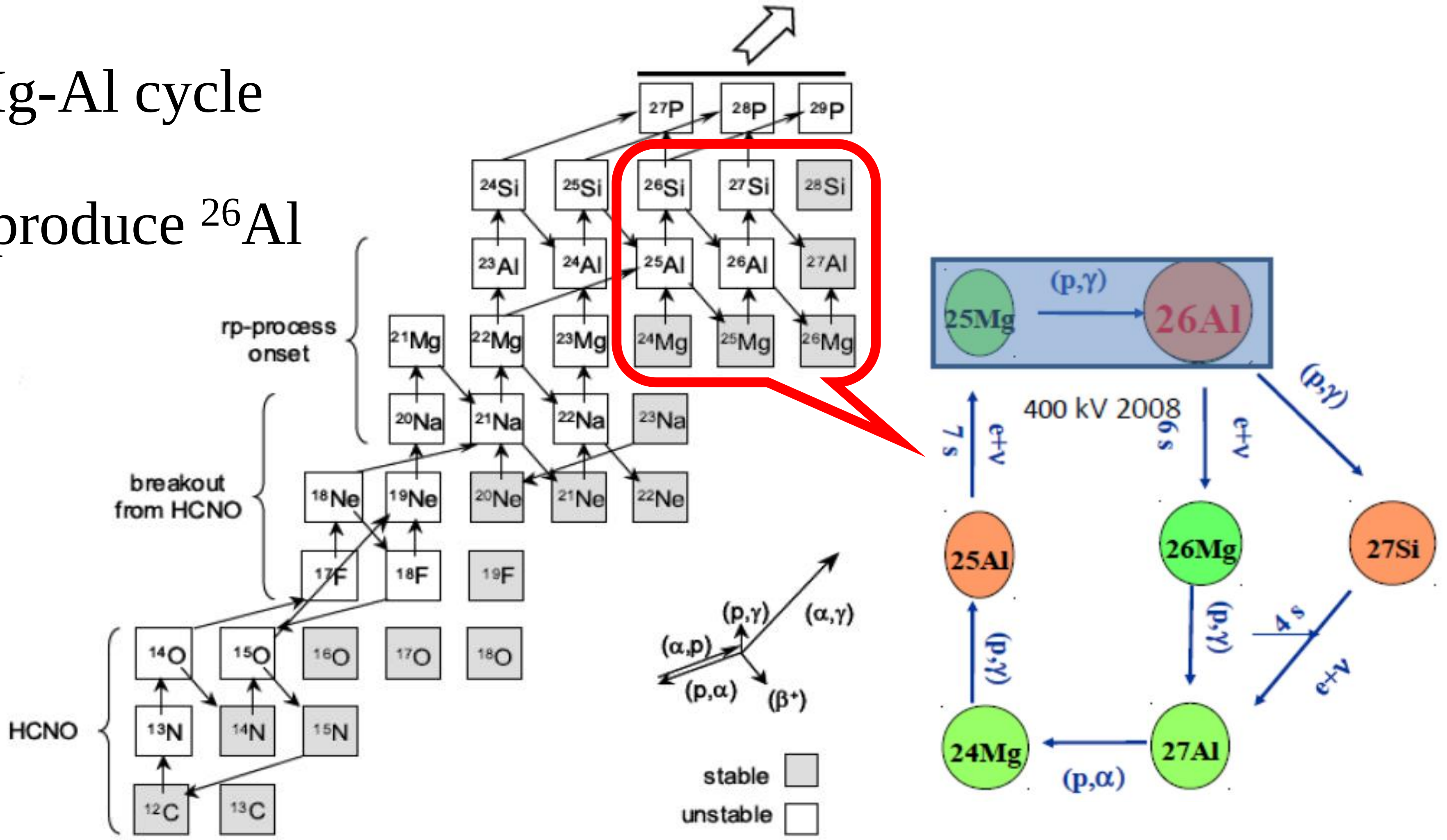




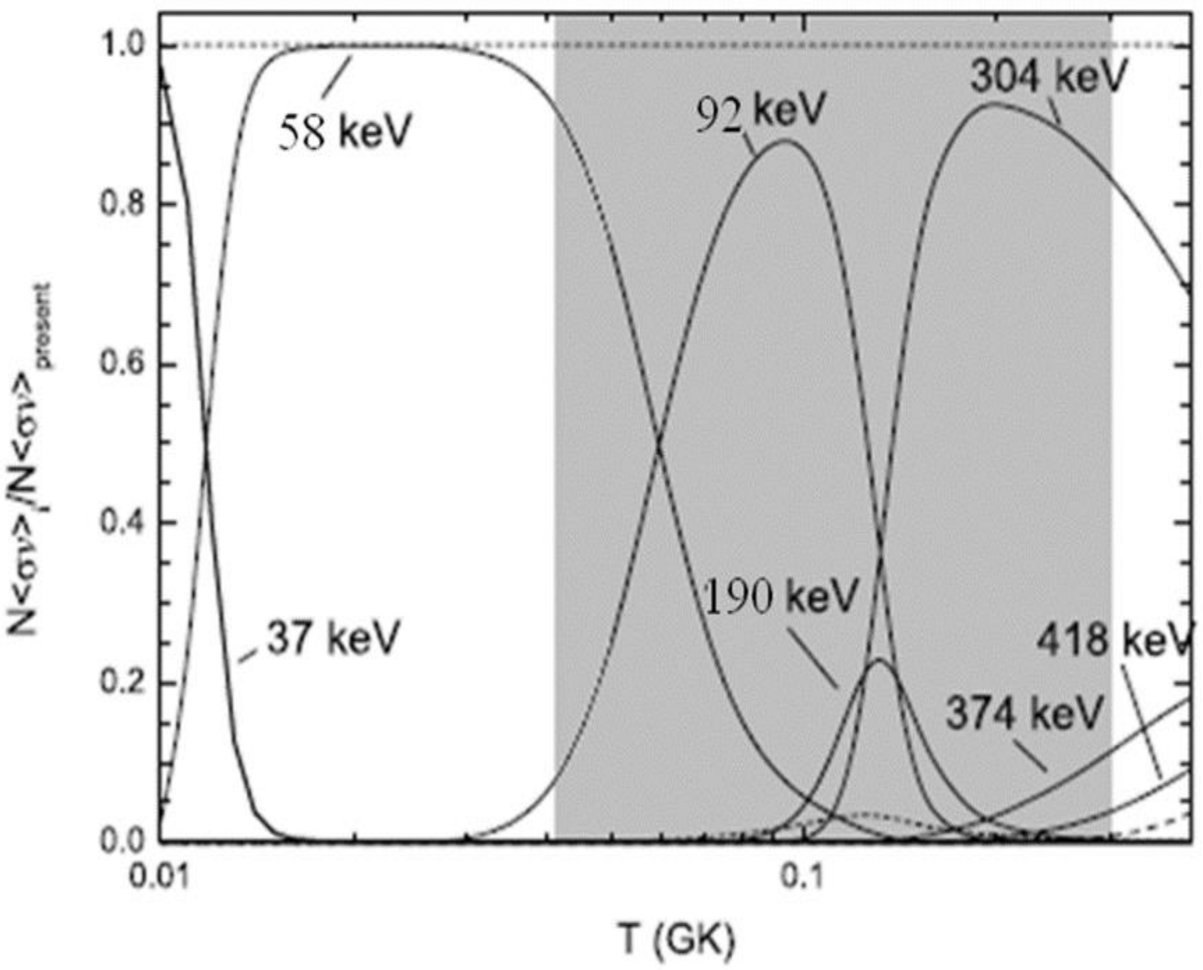
Roland Diehl et al. Nature **439**, 45-47

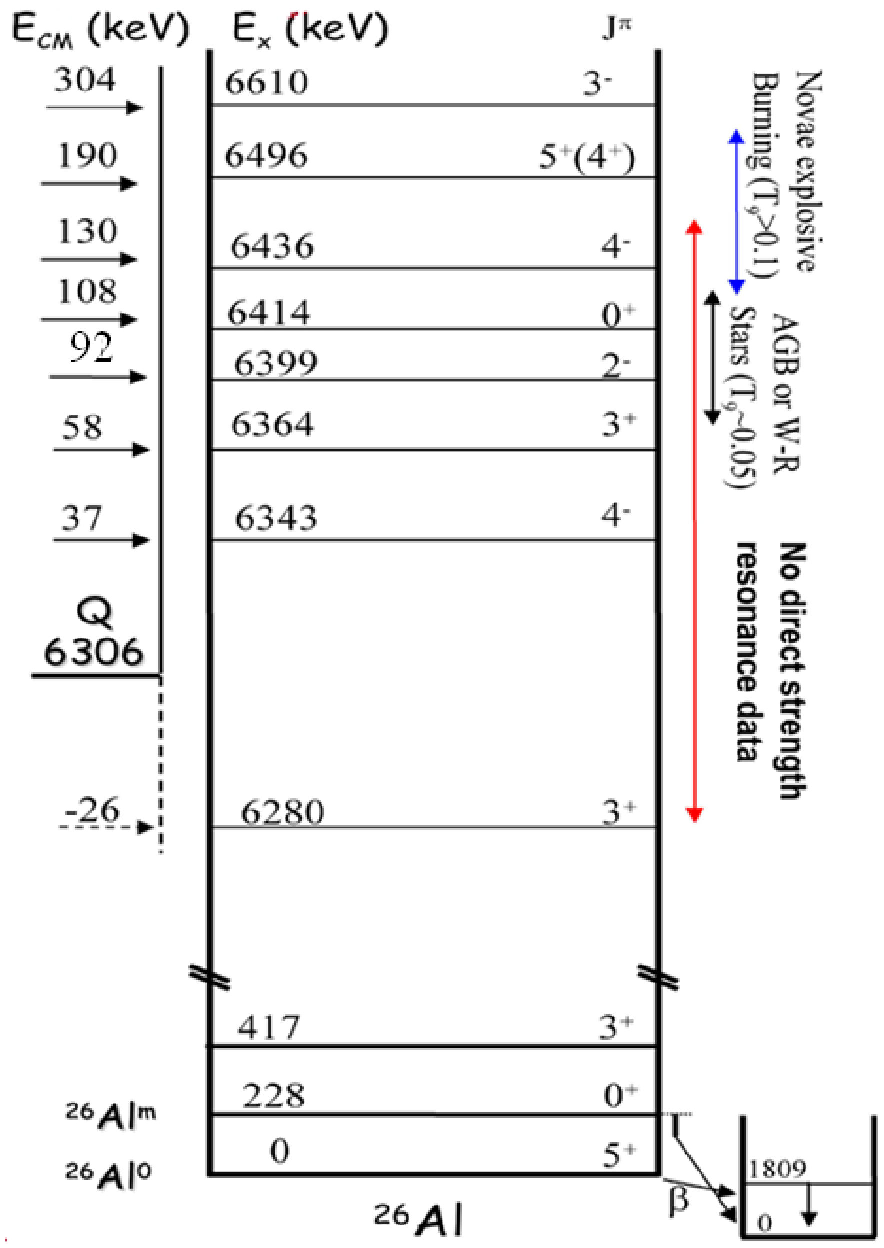
$^{25}Mg(p, \gamma)^{26}Al$

- Key reaction in Mg-Al cycle
- The main way to produce ^{26}Al



Resonance capture for $^{25}Mg(p, \gamma)^{26}Al$





O. Starniero et al., APJ 763 (2013) 100

Direct measurement status of $^{25}Mg(p, \gamma)^{26}Al$

- The direct measurement only reached down to 190 keV
- LUNA successfully measured the 92 keV resonance strength
- No direct data for 58 keV resonance
- JUNA aim to measure at $E_{Lab} < 100$ keV

Indirect method for 58 keV resonance

$$\sigma_{exp} = \sum_{l} \mathrm{C}^2 S_p^l \sigma_{DWBA}^l$$

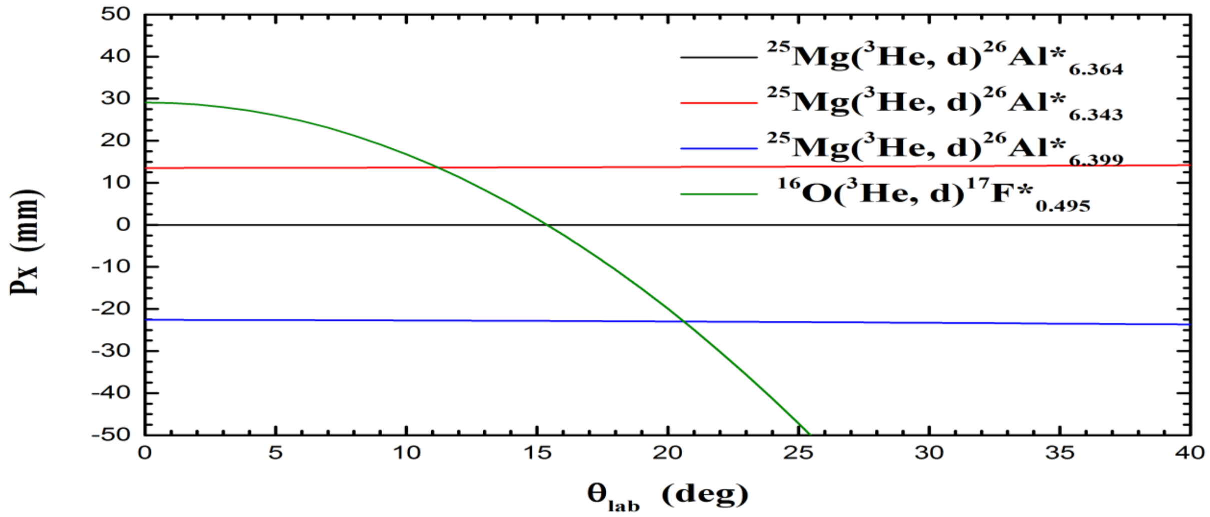
$$\Gamma_p = \sum_{l} 2\frac{\hbar^2}{\mu a^2} P_l C^2 S_p^l \theta_{sp}^2$$

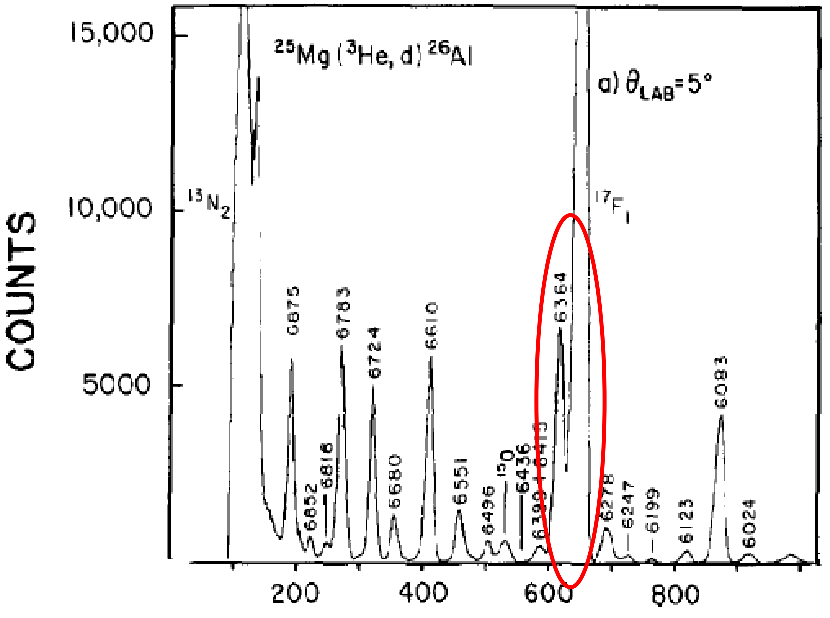
$$\omega\gamma = \frac{(2J+1)}{(2j_p+1)(2j_t+1)} \frac{\Gamma_p \Gamma_\gamma}{\Gamma_{tot}} \xrightarrow{\Gamma_\gamma \gg \Gamma_p} \frac{(2J+1)}{(2j_p+1)(2j_t+1)} \Gamma_p$$

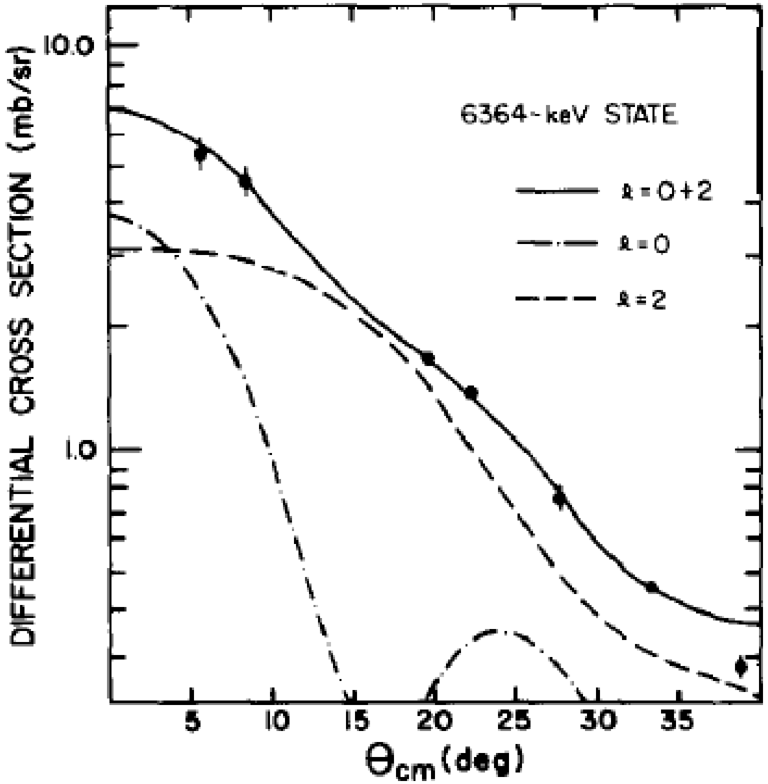
Indirect measurements for $^{25}Mg(p,\gamma)^{26}Al$ 58 keV resonance

S_p		Γ_p(eV)	Ref.
$l = 0$	$l = 2$		
0.19	0.27	6.05×10^{-13}	NPA299(1978)412
0.10	0.27	3.38×10^{-13}	NPA505(1989)384
0.16	0.24	5.08×10^{-13}	NPA507(1990)413

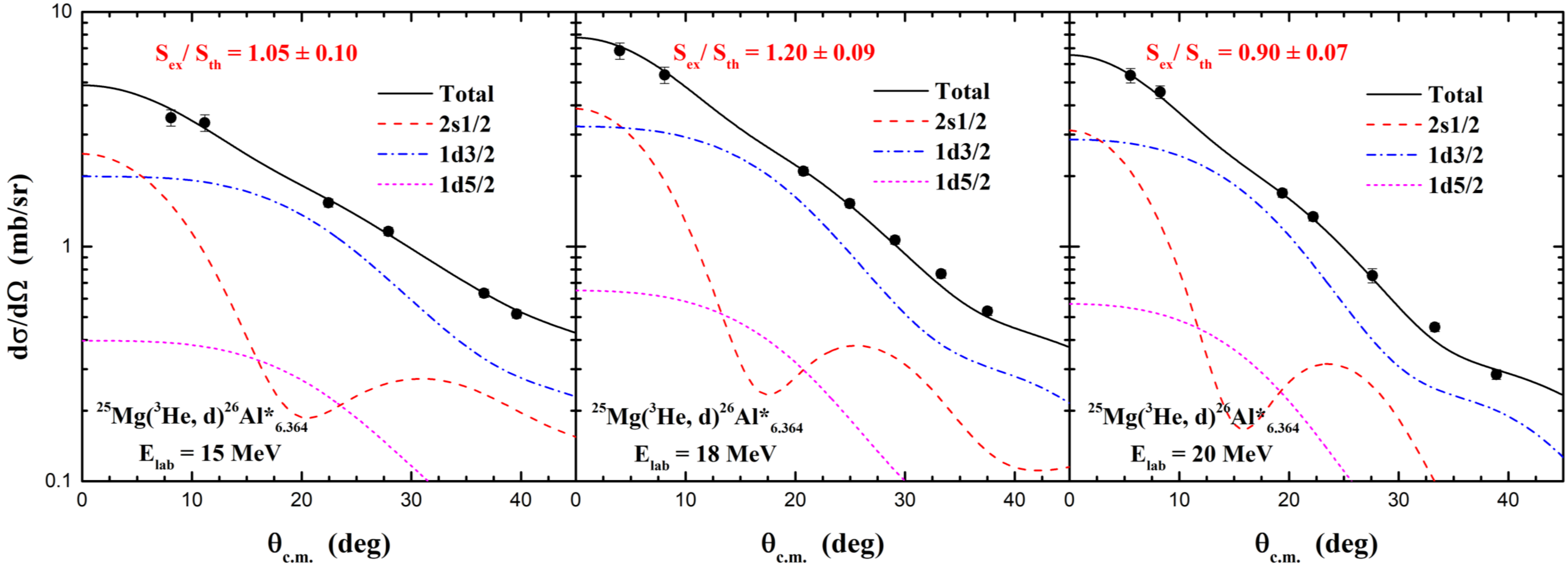
Three $^{25}Mg(^3He,d)^{26}Al$ reaction at E_{lab} = 15, 18, 20 MeV







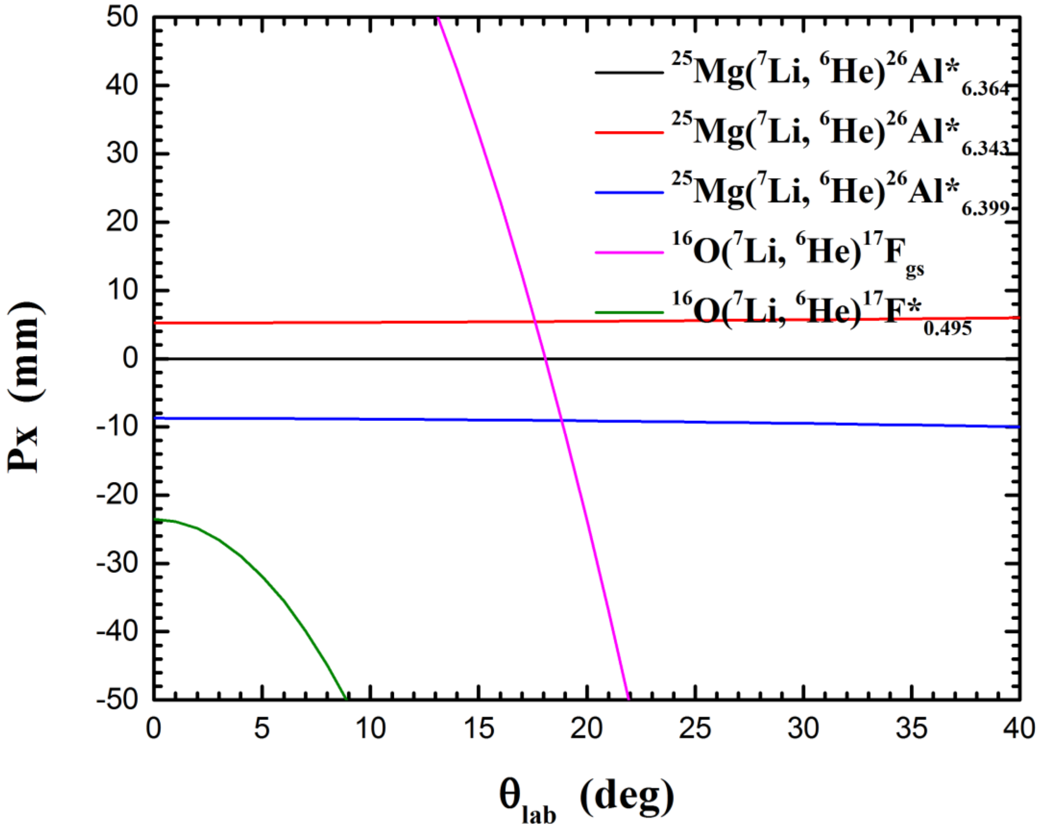
Data reanalysis



			Calculated C^2S		
No.	E_{cal} (MeV)	Ex (MeV)	$2s_{1/2}$	$1d_{3/2}$	$1d_{5/2}$
13	6.29	6.364	0.07	0.14	0.02

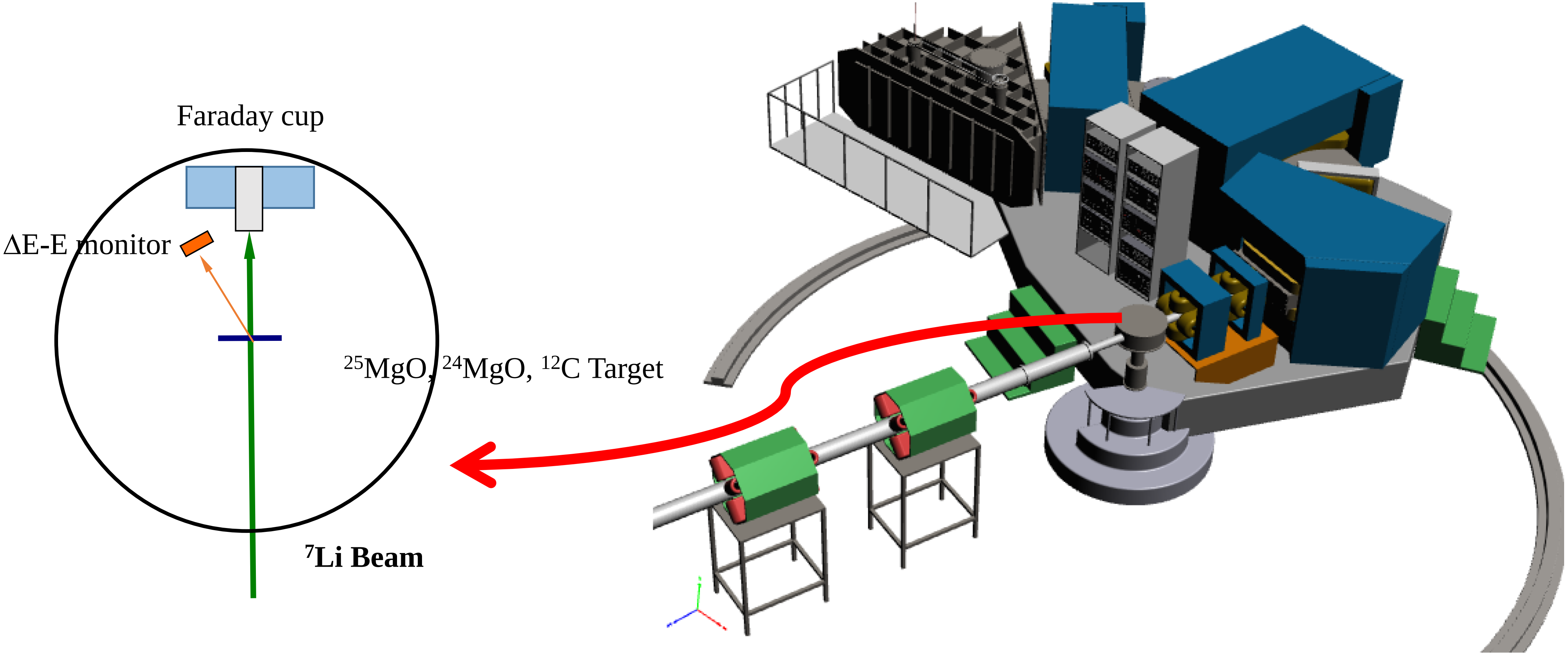
$^{25}Mg(^{7}Li, ^{6}He)^{26}Al^{*}_{6.364}$

- Have not been measured
- Proton spectroscopic of ^{7}Li has been well determined
- (^{7}Li, ^{6}He) angular distribution can be well reproduced by DWBA calculation
- Few interference by other reactions

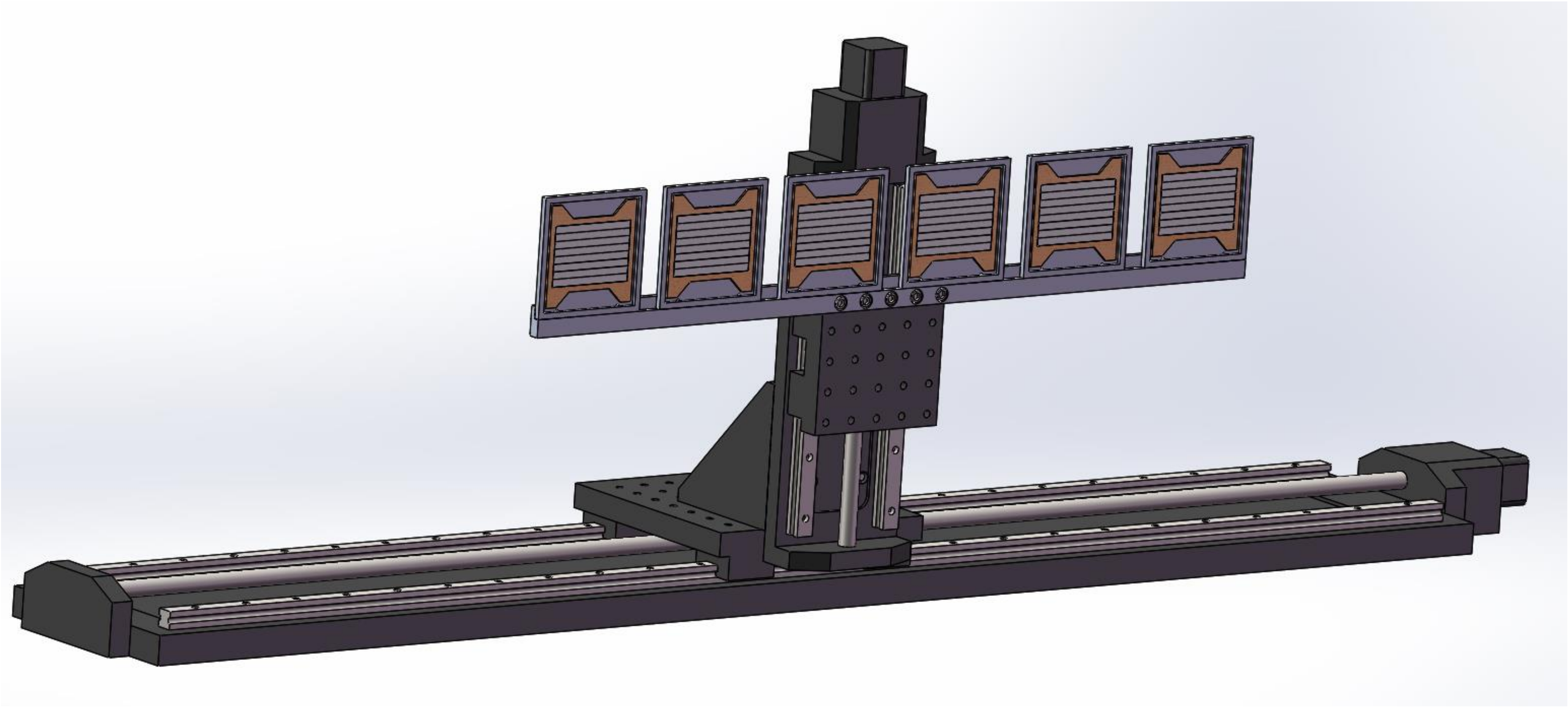


E_{lab} = 31.5 MeV

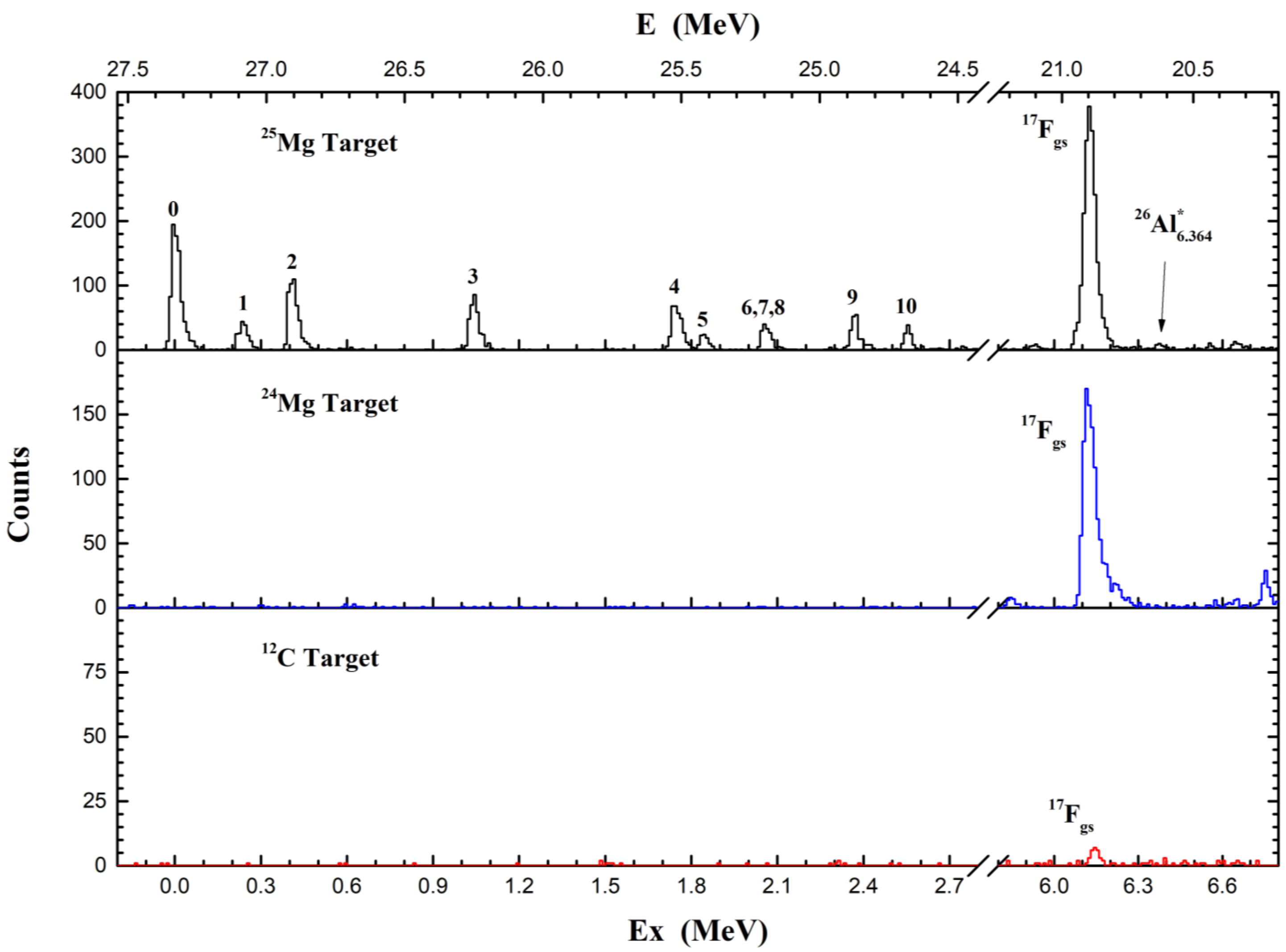
Setup on Q3D

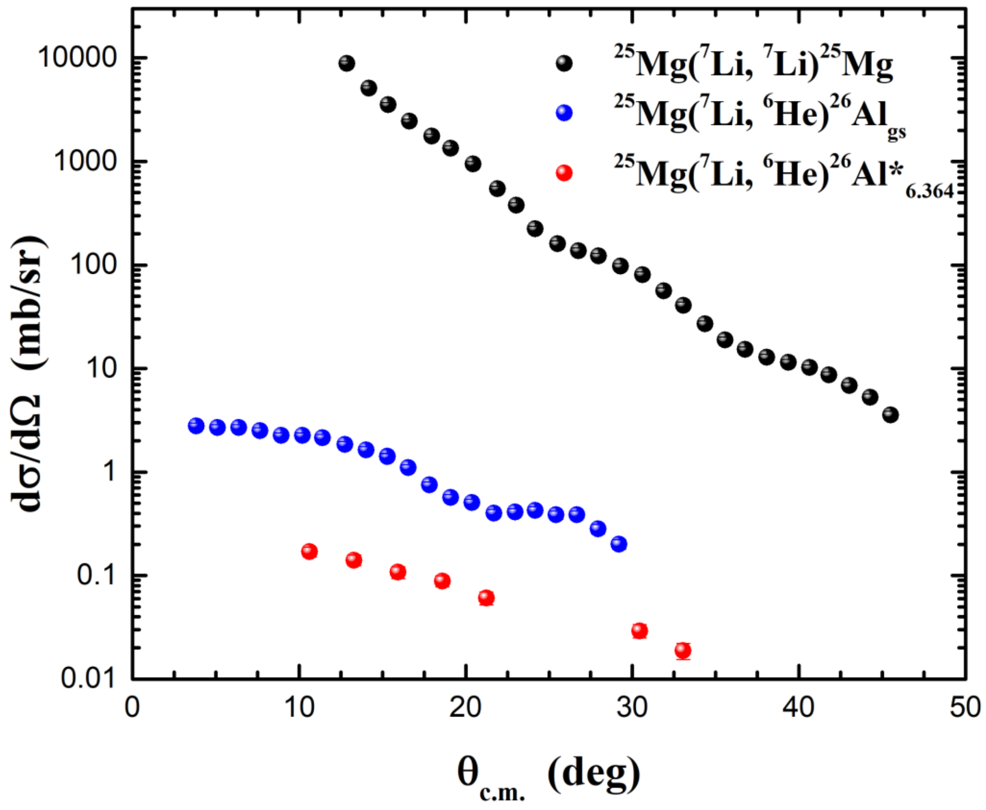


Detector array on focal plane

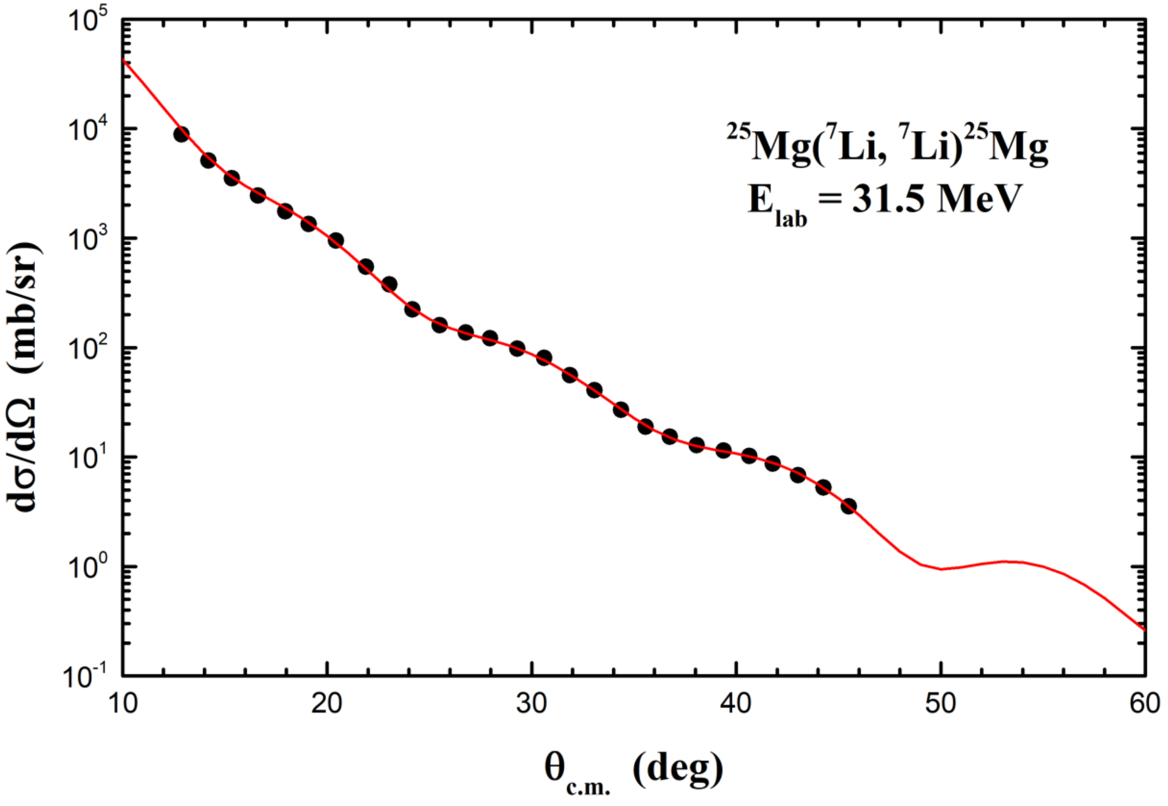


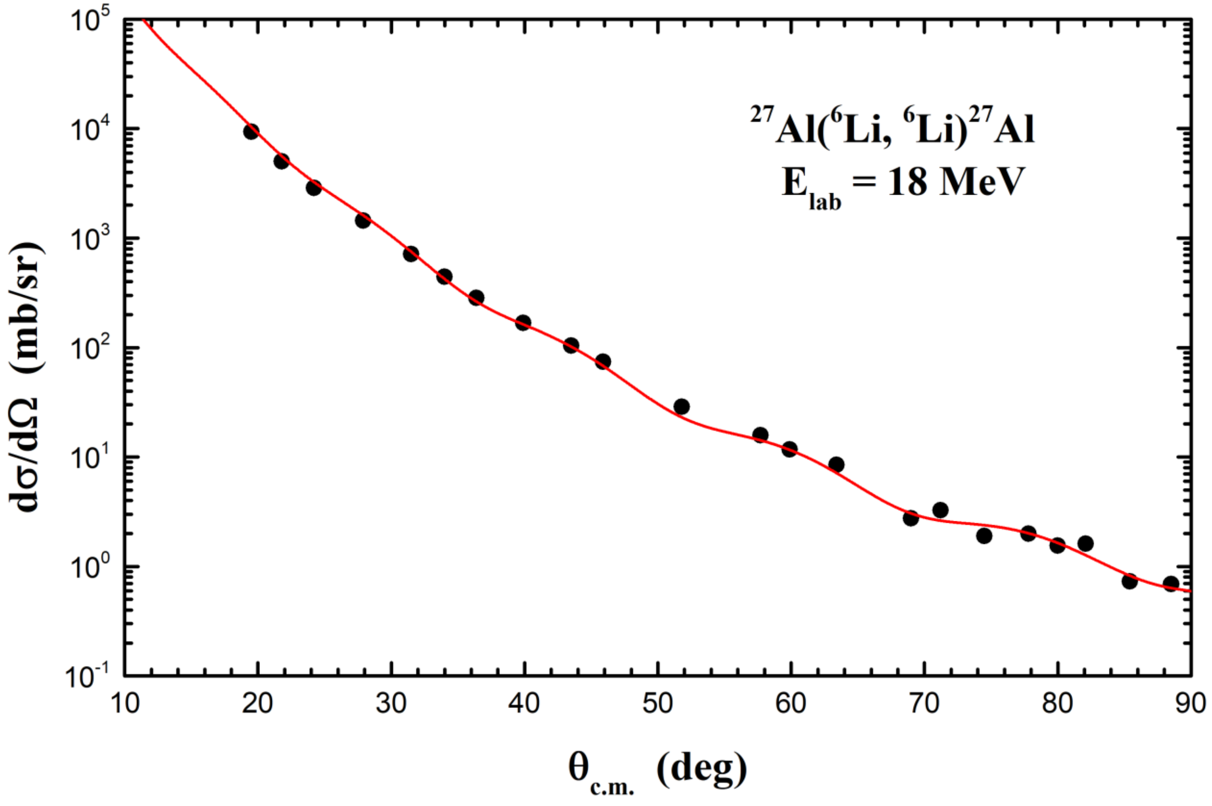
Typical spectra and angular distributions





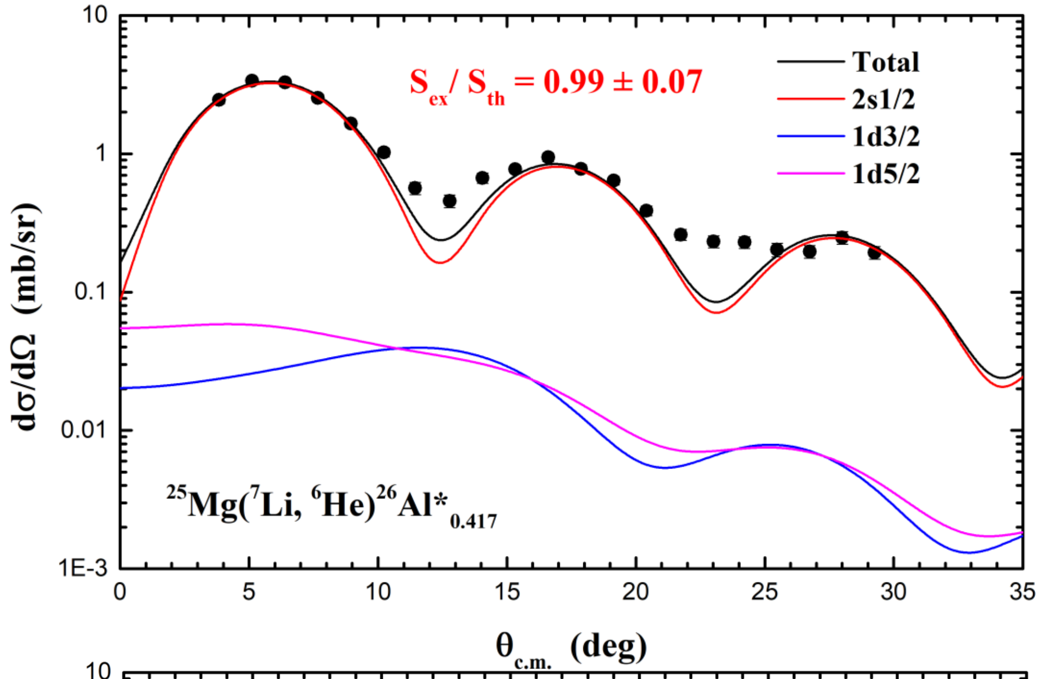
Elastic scattering fitting



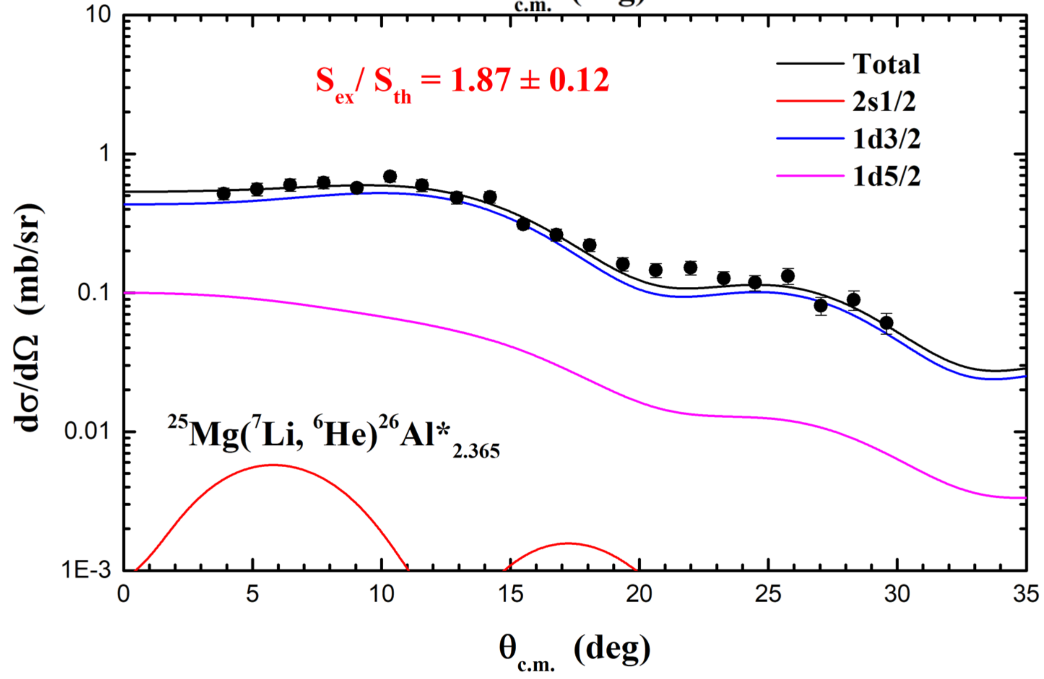


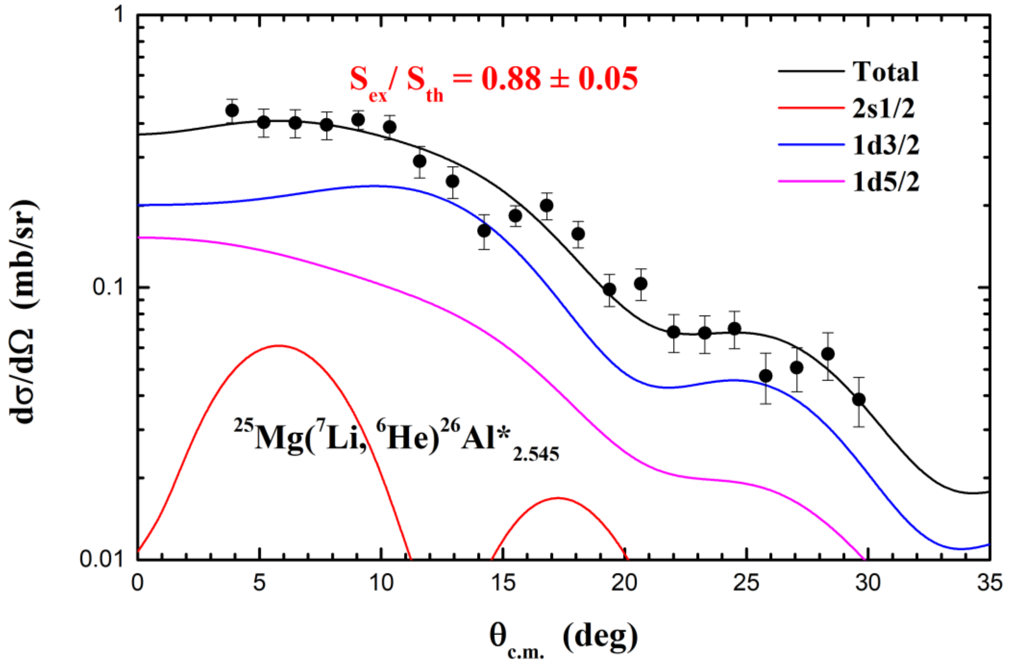
	U_V	r_R	a_R	W_V	r_I	a_I	r_C
$^{7}Li + ^{25}Mg$	100.5	1.315	0.46	28.3	1.210	1.10	1.0
$^{6}Li + ^{27}Al$	64.6	1.042	0.64	14.7	1.029	1.17	1.0

DWBA analysis for 3^+ states

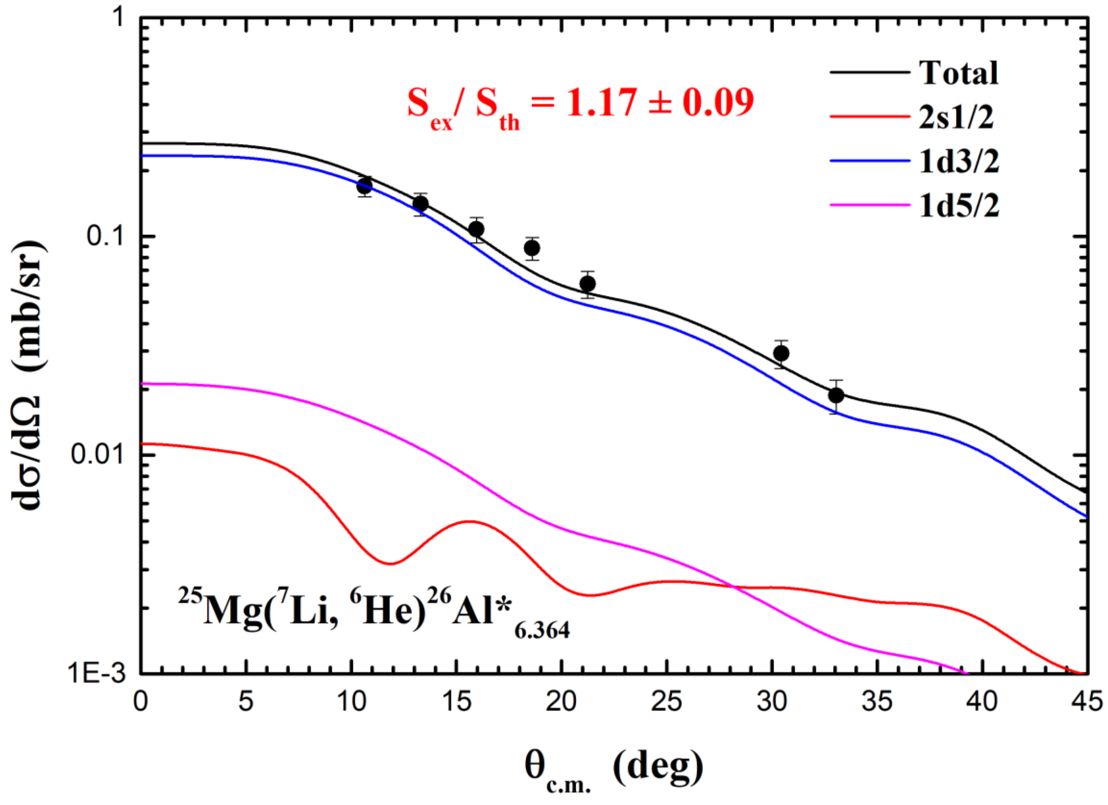


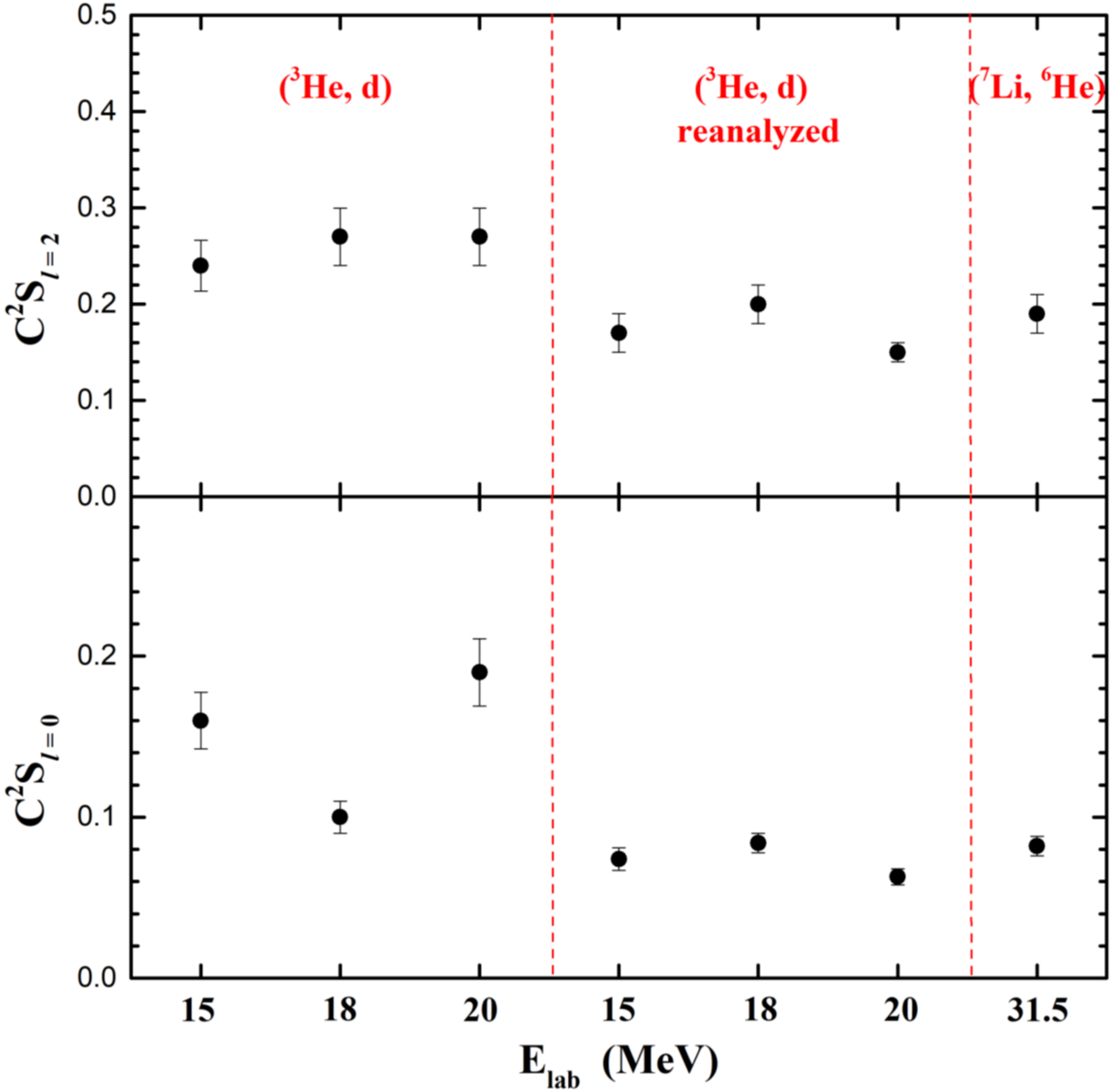
			C^2S		
No.	E_{cal} (MeV)	Ex (MeV)	$2s_{1/2}$	$1d_{3/2}$	$1d_{5/2}$
1	0. 404	0. 416	0. 32	0. 014	0. 020
2	2. 033	2. 365	0. 0007	0. 097	0. 019
3	2. 278	2. 545	0. 018	0. 094	0. 063



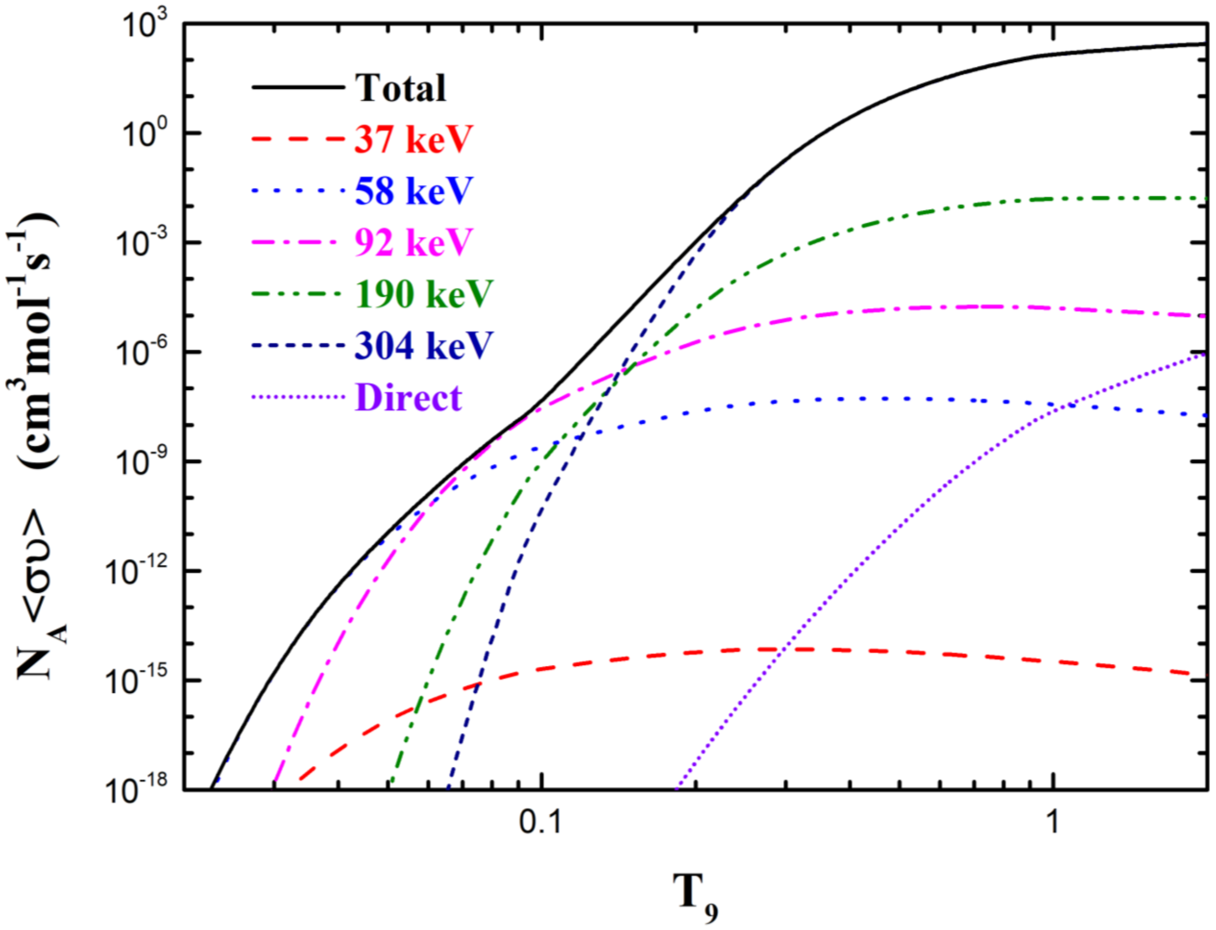


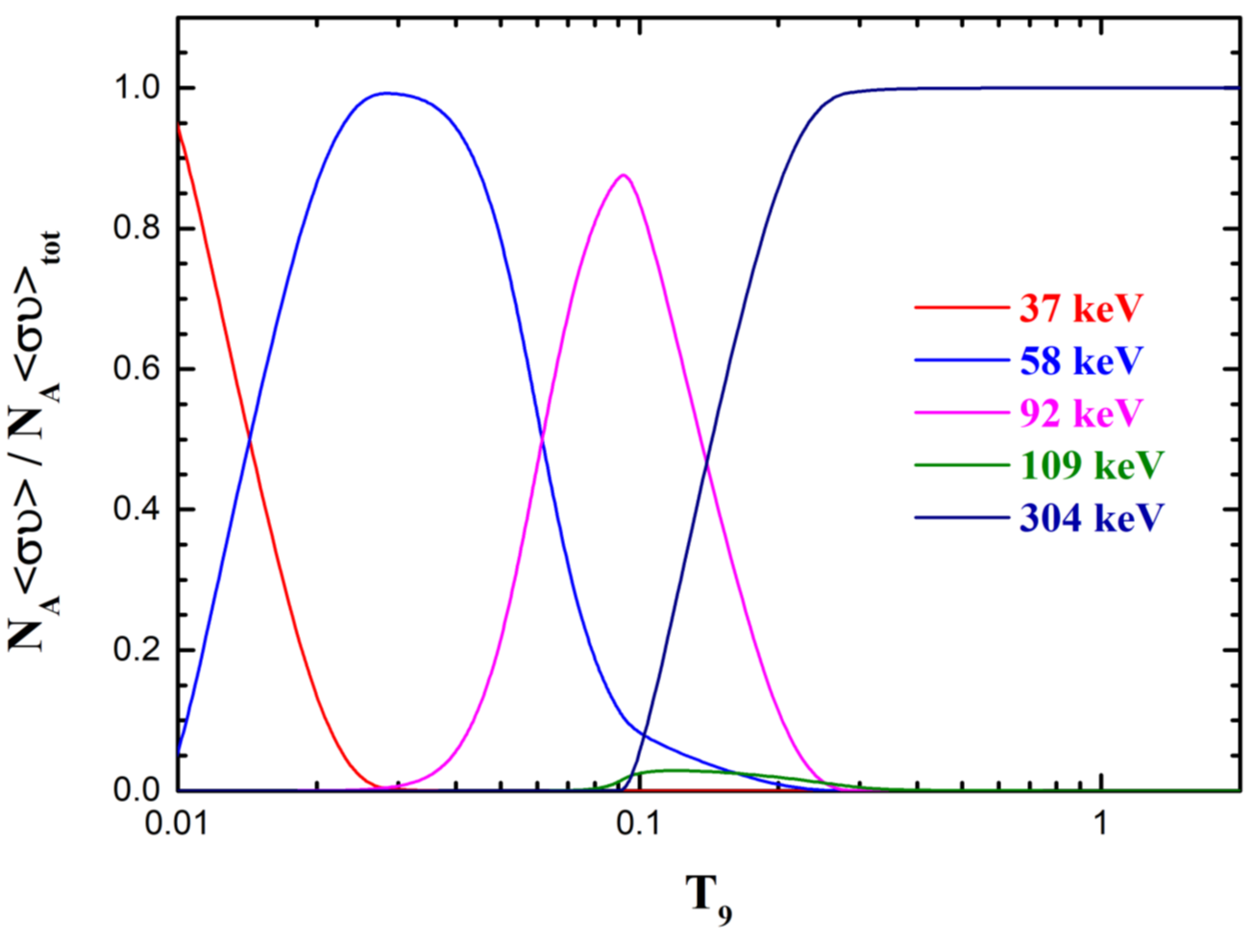
Proton spectroscopic factor of 6.364 MeV excited state





Astrophysics $^{25}Mg(p,\gamma)^{26}Al$ reaction rates





Summary

- For verify the divergence, the $^{25}Mg(^{3}He, d)^{26}Al$ reaction has been reanalyzed and $^{25}Mg(^{7}Li, ^{6}He)^{26}Al$ has been measured at Q3D
- The proton spectroscopic factor of $^{26}Al^{*}_{6.364}$ has been determined
- The astrophysics $^{25}Mg(p, \gamma)^{26}Al$ reaction rates have been calculated