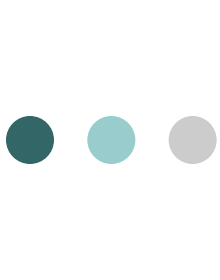
E01-011 Analysis Status and Results

1. Blind Analysis
2. Background Estimation
3. Cross Section

A. Matsumura (Tohoku Univ.)

The 2nd JSPS Core-to-core Seminar on Strangeness Nuclear Physics by Electron beam

Rome, 2009.12.15



1. Blind Analysis

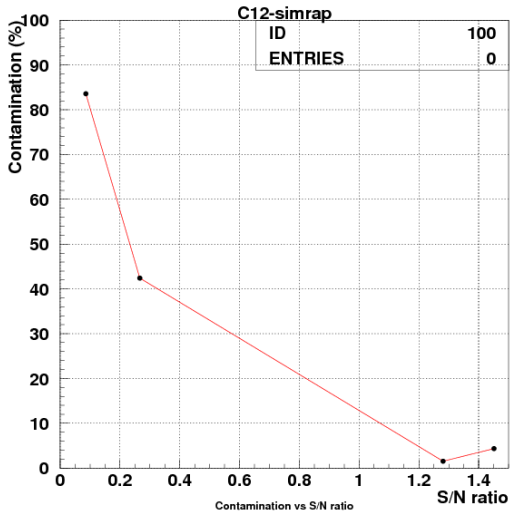
Evaluation of systematic errors depend on the tuning procedure

Absolute mass scale & Linearity

- Blind analysis with **simulation data**
  - CH_2 data : well-known mass
  - ^{12}C data : binding energies and cross sections were arbitrarily changed and hidden from analyzers
  - Reasonable S/N and statistics
  - Full simulation by GEANT
    - TOSCA field map
    - two-arm coincidence
    - Detector resolution
    - Raster effect
    - Sieve slit data for angle tuning

Blind analysis result

Blind analysis result			Assumed in simulation		
Binding energy [MeV]	Yield [counts]	Contamination [%]	Binding energy [MeV]	Yield [counts]	S/N
11.43 (g.s.)	~491	4.4	11.37 (g.s.)	600	1.45
16.70	~191	83.6	16.31	30	0.09
20.35	~142	42.4	20.31	100	0.27
23.32	~407	1.5	23.37	550	1.28



Systematic error ….

for major peak (S/N > 1),

Accuracy of binding energy < 100 keV

cross section < 5%

for core excited states(S/N <1),

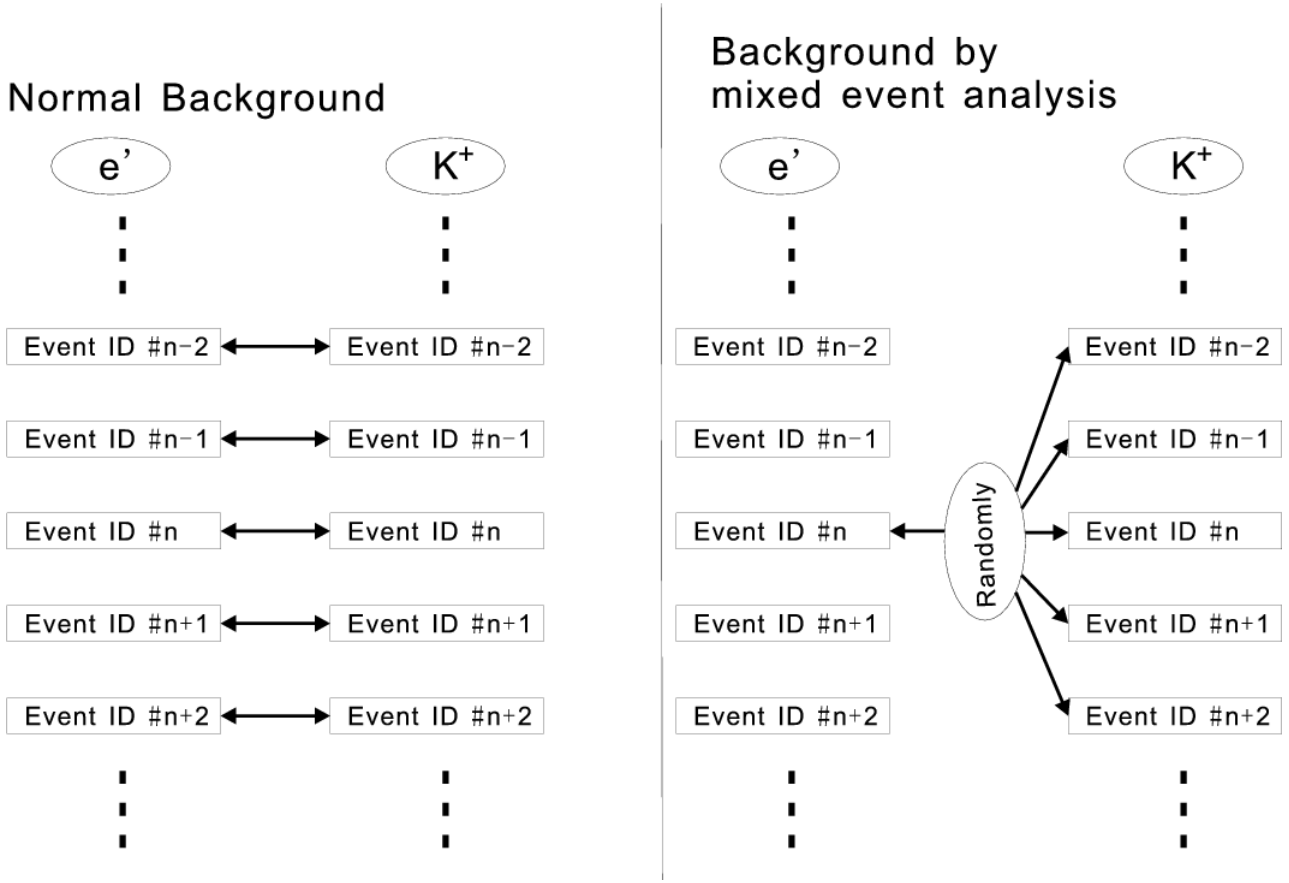
Accuracy of binding energy < 400 keV

cross section < 90 %

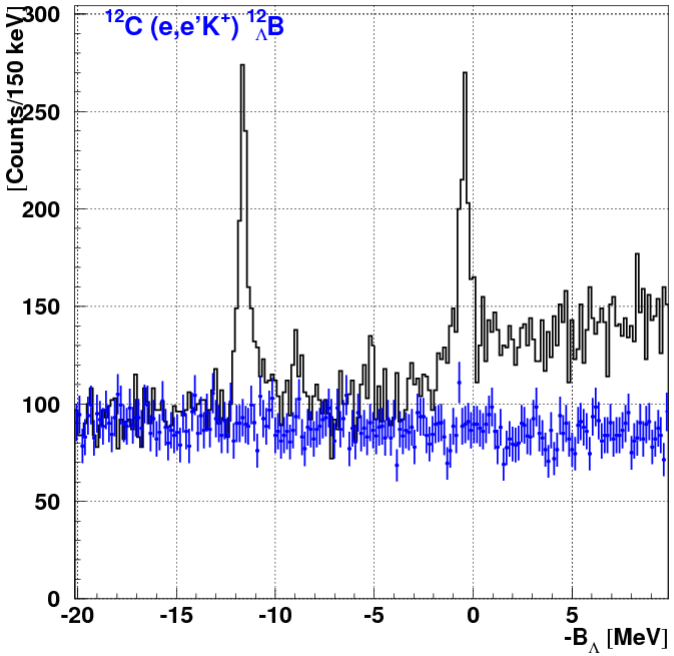
2. Background Estimation

Background estimation by mixed event analysis

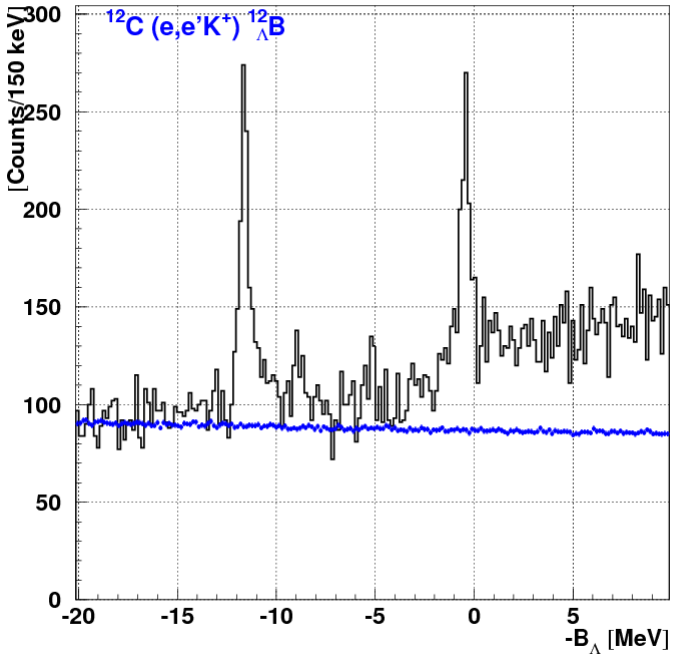
- Background : accidental coincidence between e’ and K^+
- Mixed background → random combination of real data (off gate)



Background estimation by mixed event analysis



Normal Background



Background by
mixed event analysis
(100 times higher statistics)

3. Cross Section

Efficiencies for cross section estimation

Cross section of the (γ^*, K^+):

$$\overline{\left(\frac{d\sigma}{d\Omega}\right)} = \frac{1}{N_T}\frac{1}{N_\gamma}\sum_{i=1}^{N_K}\frac{1}{\varepsilon_{total}\, d\Omega}$$

N_T : # of target

N_γ: # of V.P.

$d\Omega$: solid angle acceptance of HKS

N_K : yield of Λ, Σ^0, or hypernuclear state

$$\varepsilon_{total} = \varepsilon_{htrk} \cdot \varepsilon_{AC} \cdot \varepsilon_{WC} \cdot \varepsilon_{bk} \cdot f_{abs} \cdot f_{decay} \cdot \varepsilon_{etrk} \cdot f_{comp}$$

ε_htrk: ~ 0.96
HKS tracking efficiency
ε_AC: ~0.96
AC cut efficiency
ε_WC: ~0.95
WC cut efficiency
ε_bk: ~0.98
beta cut efficiency
ε_etrk: ~0.88
ENGE tracking efficiency
f abs: ~0.82
Kaon absorption factor
f decay: ~0.35
Kaon decay factor
f comp: ~0.97
Computer dead time factor

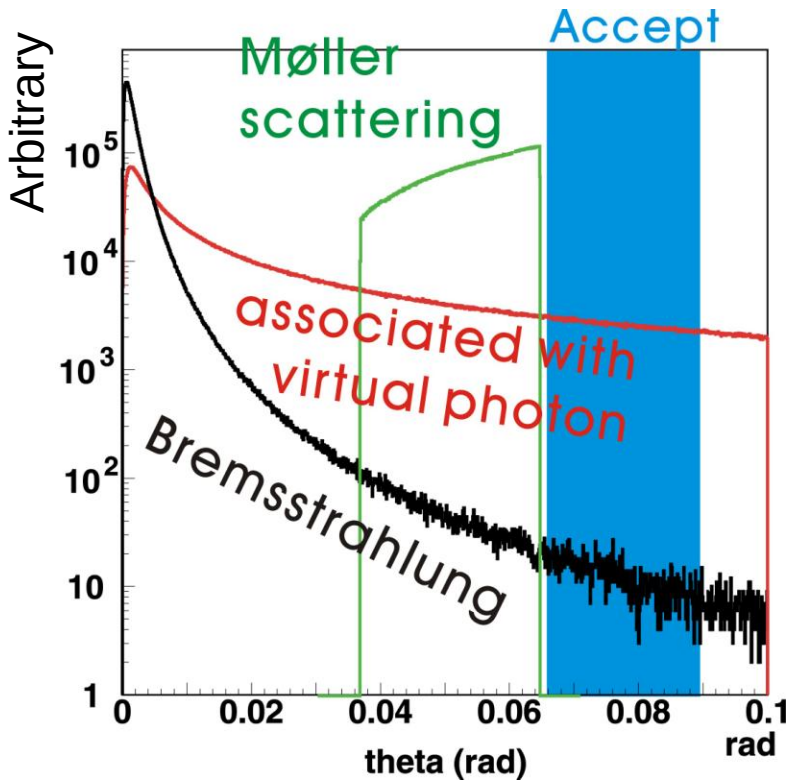
Systematic errors

Systematic error [%]

Target	Thickness	N_γ	dΩ	ε_{total}	*Tune (S/N>1)*		Total
7Li	5	**22**	1	3	5		23
12C	2						22
28Si	5						23

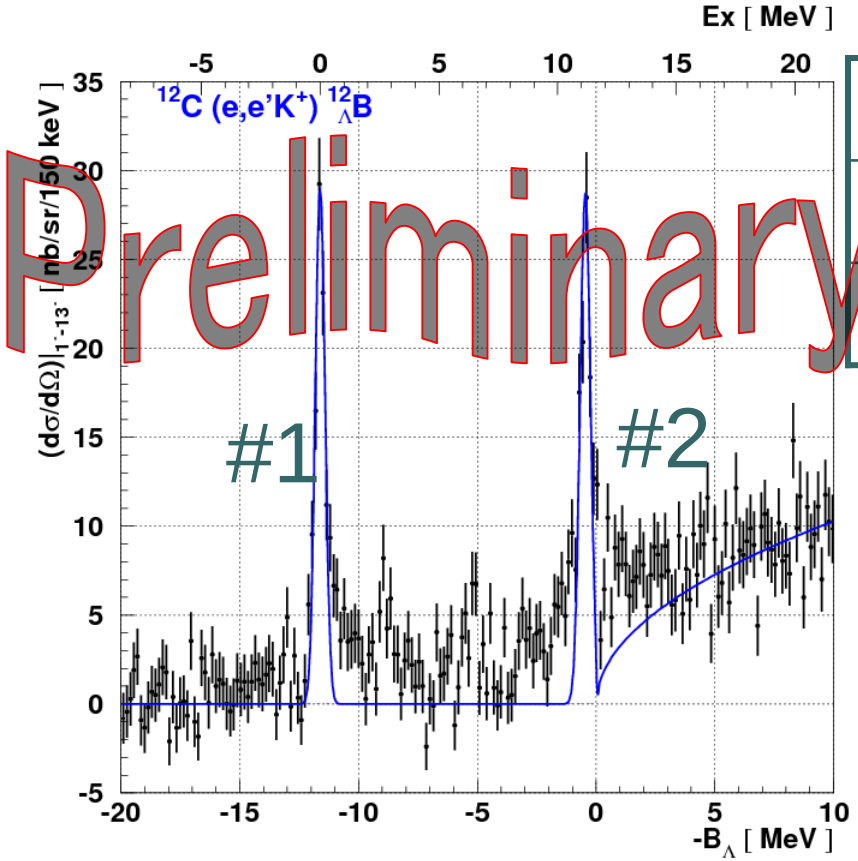
Magnet position is very sensitive to e' detection angle

➔Accuracy of magnet position determine systematic error of Nγ



$^{12}C(e,e'K^+)^{12}_{\Lambda}B$ (preliminary)

Result



ID	Ex [MeV]	$-B_{\Lambda}$ [MeV]	Cross section [nb/sr]
#1	0	-11.6±0.1 (*stat.*) ±0.1 (*sys.*)	96±7 (*stat.*) ±19 (*sys.*)
#2	11.2±0.1 (*stat.*) ±0.1 (*sys.*)	-0.5±0.1 (*stat.*) ±0.1 (*sys.*)	104±7 (*stat.*) ± 22 (*sys.*)

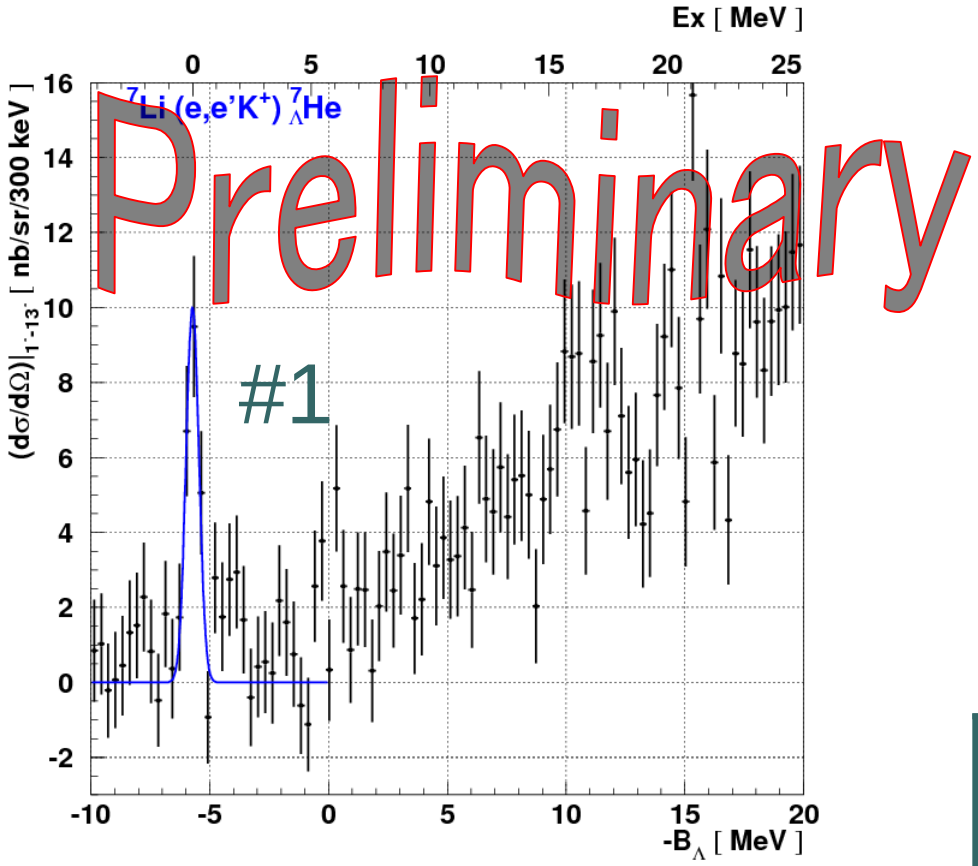
Resolution : ~480 keV (FWHM) for g.s.
Data taking : ~30 hours w/ 30 μA

Theory by Sotona *et. al.*
($1.3 < E\gamma < 1.6$ GeV, $1 < \theta_K < 13$ deg.)

J^{π}	Ex [MeV]	Cross section [nb/sr]		
		SLA	C4	KMAID
1^-	0	19.7	22.8	20.7
2^-	0.14	65.7	82.0	43.0
2^+	10.99	48.3	56.9	38.0
3^+	11.06	75.3	107.3	68.5

^{7}Li(e,e'K^{+})$^{7}_{\Lambda}$He (preliminary)

Observation of $^{7}_{\Lambda}$He w/ good statistics



Result

ID	-B_{Λ} [MeV]	Cross section [nb/sr]
#1	-5.7±0.2 (*stat.*) ±0.2 (*sys.*)	22±3 (*stat.*) ±3 (*sys.*)

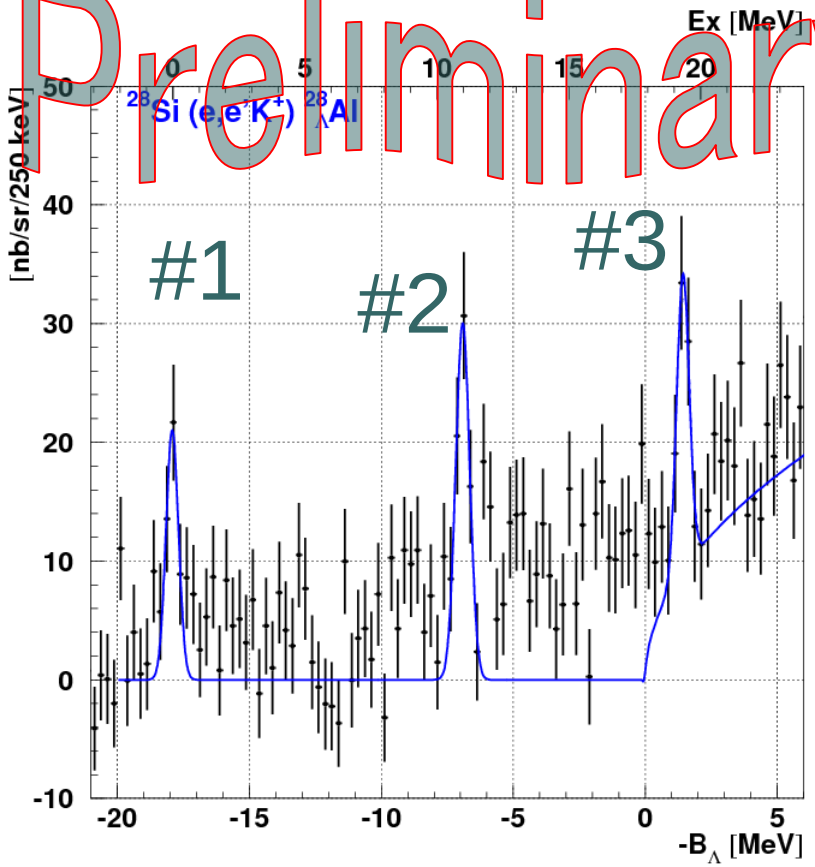
Theory by Sotona *et. al.* (Cross section)
by Hiyama *et. al.* (-B_{Λ} : w/o CSB)
($1.3 < E\gamma < 1.6$ GeV, $1 < \theta_{K} < 13$ deg.)

J^{π}	-B_{Λ} [MeV]	Cross section [nb/sr]		
		SLA	C4	KMAID
$1/2^{+}$	-5.36	13.2	16.2	9.7

Resolution : ~510 keV (FWHM) for g.s.
Data taking : ~30 hours w/ 30 μA

^{28}Si(e,e'K$^+$)$^{28}_{\Lambda}$Al (preliminary)

Preliminary



Resolution : ~520 keV (FWHM) for g.s.
Data taking : ~30 hours w/ 30 μA

Result

ID	Ex [MeV]	-B$_{\Lambda}$ [MeV]	Cross section [nb/sr]
#1	0	-17.9±0.1 (*stat.*) ±0.3 (*sys.*)	50±10 (*stat.*) ±12 (*sys.*)
#2	11.0±0.1 (*stat.*) ±0.3 (*sys.*)	-6.9±0.1 (*stat.*) ±0.3 (*sys.*)	79±13 (*stat.*) ± 18 (*sys.*)
#3	19.3±0.1 (*stat.*) ±0.3 (*sys.*)	1.4±0.1 (*stat.*) ±0.3 (*sys.*)	56±7 (*stat.*) ± 8 (*sys.*)

Theory by Sotona *et. al.*
(1.3 < Eγ < 1.6 GeV, 1 < θ$_K$ < 13 deg.)

J$^{\pi}$	Ex [MeV]	Cross section [nb/sr]		
		SLA	C4	KMAID
2$^+$,3$^+$	0	92.1	112.7	71.76
4$^-$	9.42	134.9	167.7	117.5
3$^-$	9.67	91.3	109.1	58.5
4$^+$	17.6	148.4	184.7	135.1
5$^+$	17.9	139.1	167.1	89.9

Summary

- Systematic errors depend on optics tuning procedure were carefully evaluated using detailed Monte Carlo simulation data
  - < 100 keV (B.E.) and 5% (Cross section) for major peak (S/N<1)
- Statistical fluctuation of background is almost negligible thanks to mixed event analysis
- Efficiencies for cross sections were estimated

- Estimation of efficiencies for a new calibration is in progress