JLab Hypernuclear Meeting

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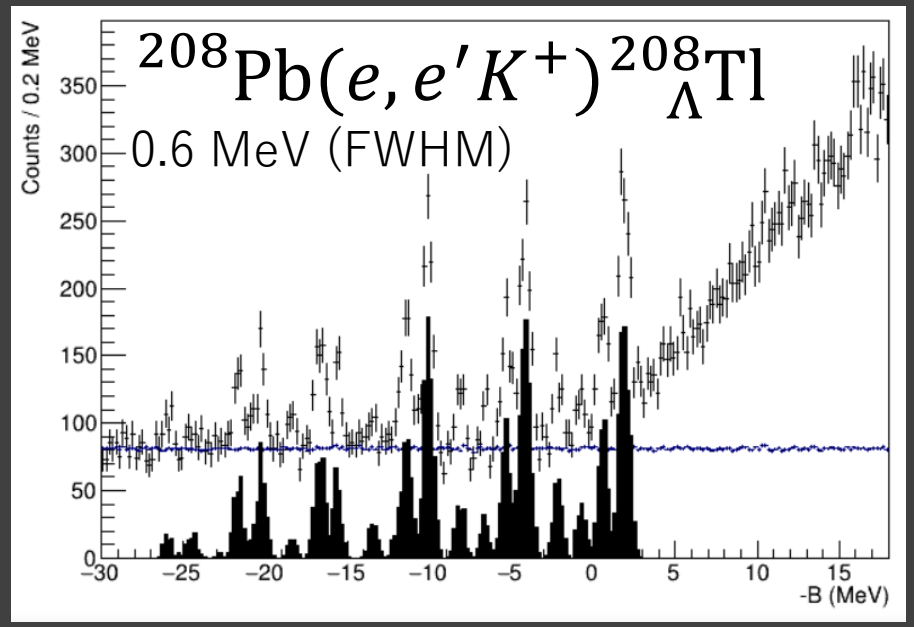
Updated simulation for Pb target

- Horizontal HES-HKS at Hall C
- 20, 30 and 40 days for 25 μA beam on 150-mg/cm^2 Pb
- g.s. ($2s_{1/2}$ hole) has 25 nb/sr
  → The first peak ($2s_{1/2}$ + $1d_{3/2}$ holes) has 50 nb/sr
- Fitting for
  - The first peak (s_Λ low)
  - The fourth peak (p_Λ high)
- Simulation for 1000 times for each condition

c.f.) Previous study on Nov 15, 2023:
https://wiki.jlab.org/tegwiki/index.php/HYP_Pb-exp_20231115

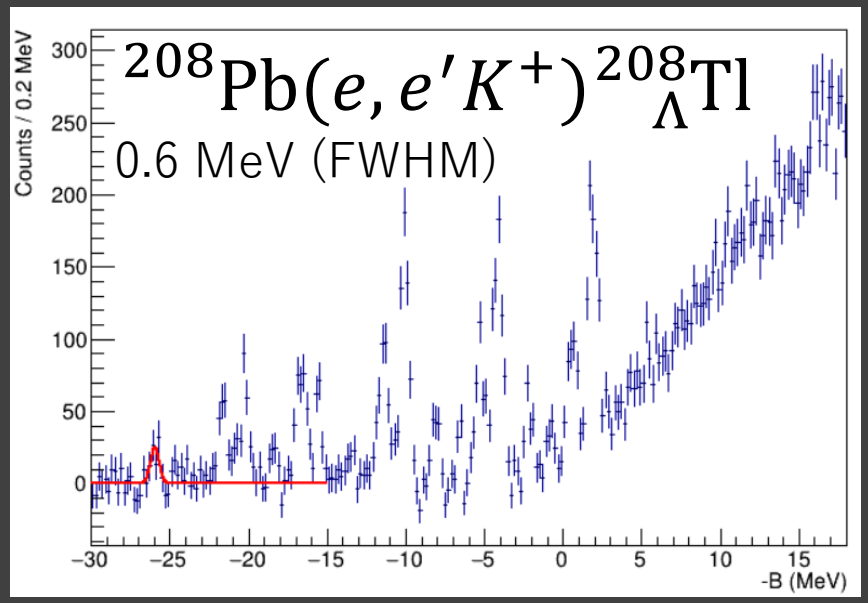
Sample spectra for the simulation

Spectrum generation



150 g/cm^2, 25 μ A, 20 days

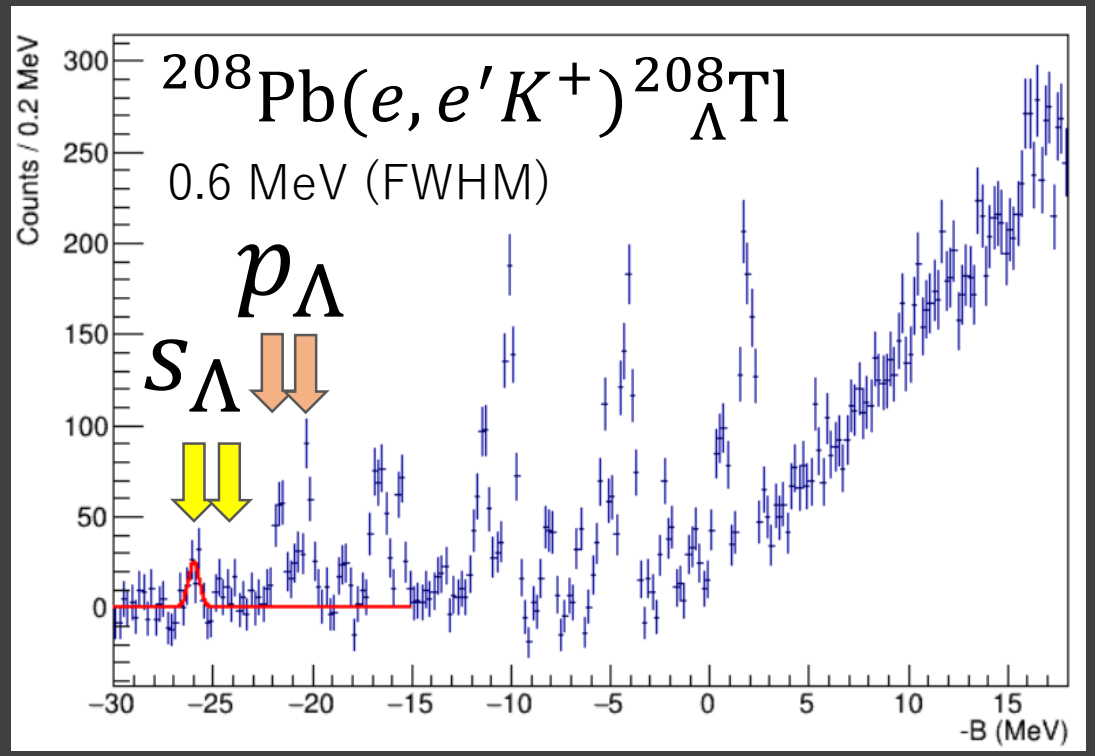
x1000



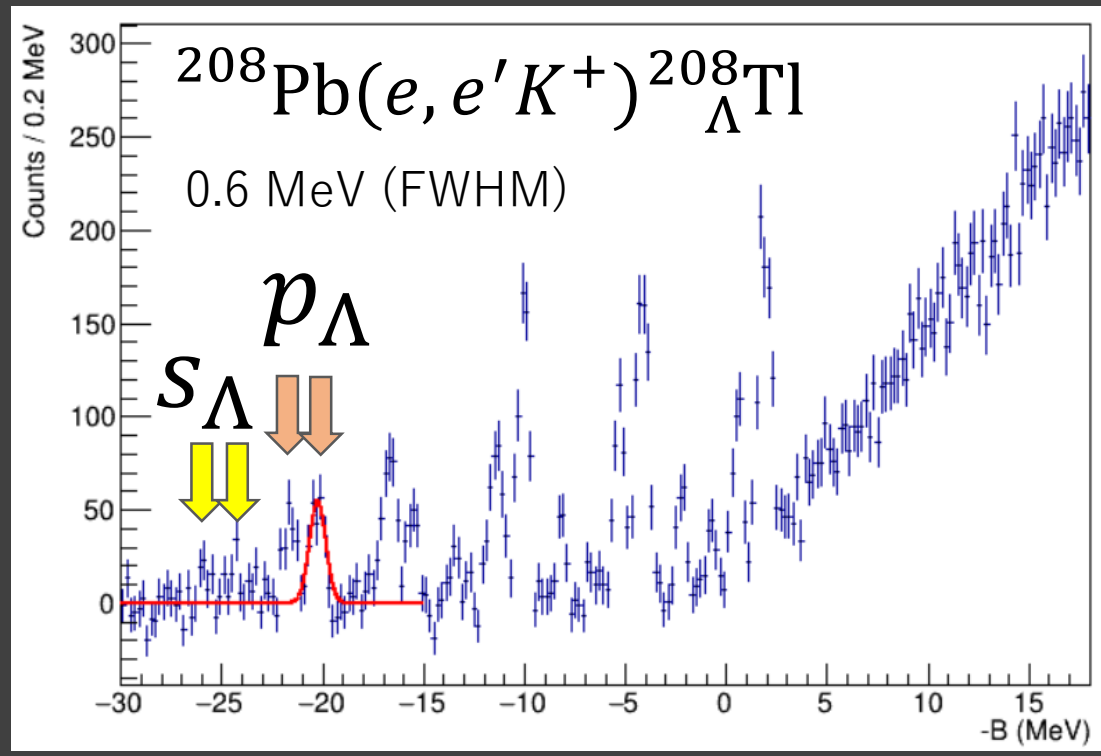
x1000

Fitting → $\Delta B_{\Lambda}^{\mathrm{stat.}}$

Fitting for two peaks



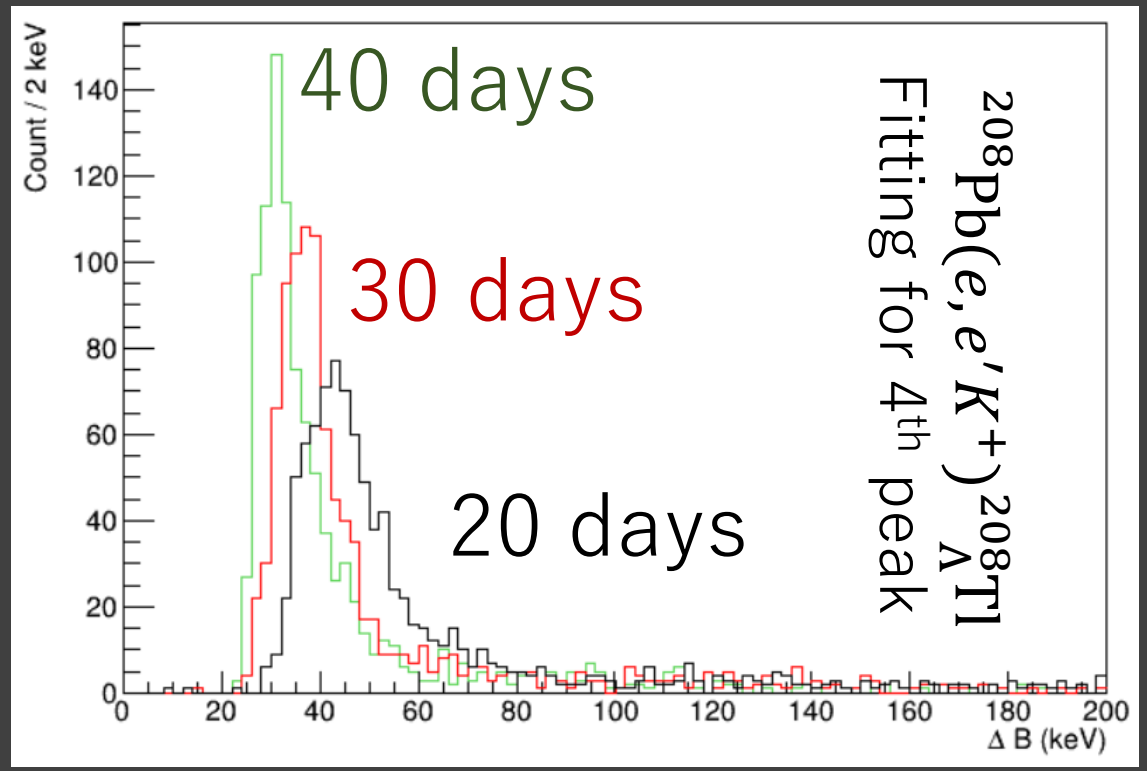
$2s_{1/2}$ + $1d_{3/2}$ holes $\otimes$ s_Λ



$1d_{3/2}$ + $0h_{11/2}$ holes $\otimes$ p_Λ

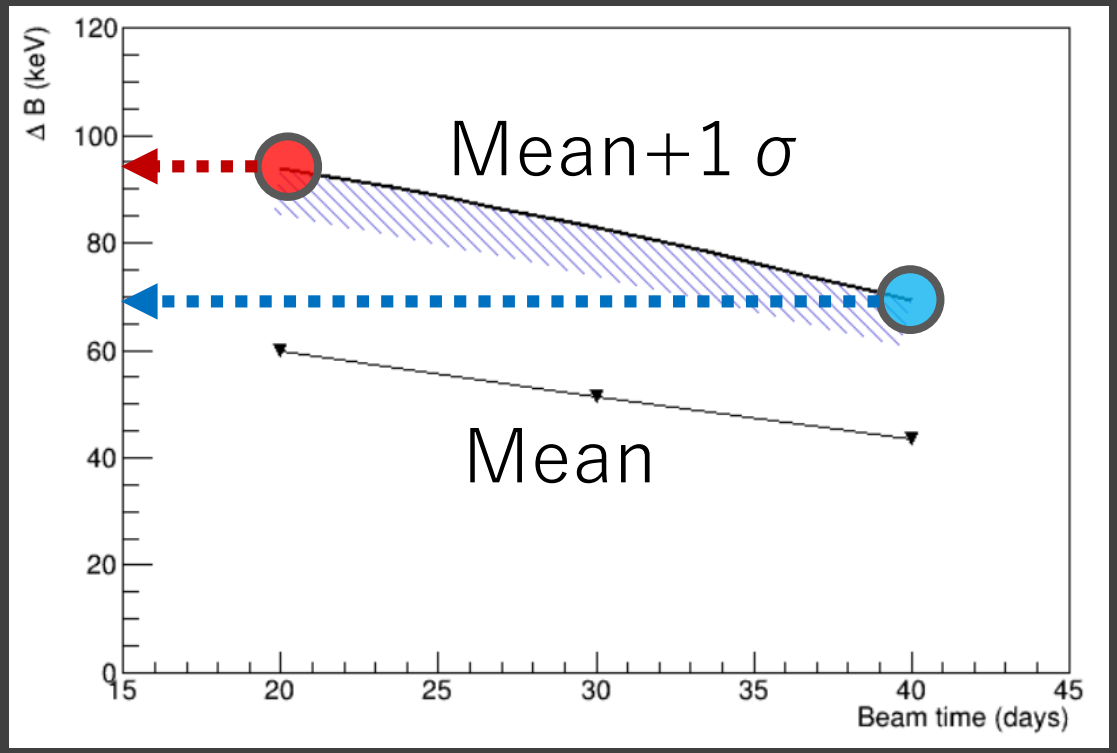
Result of $\Delta B_{\Lambda}^{stat.}$ vs. beam time for the p_{Λ} high (the 4th peak)

Counts



Fitting Error $\Delta B_{\Lambda}^{stat.}$ (keV)

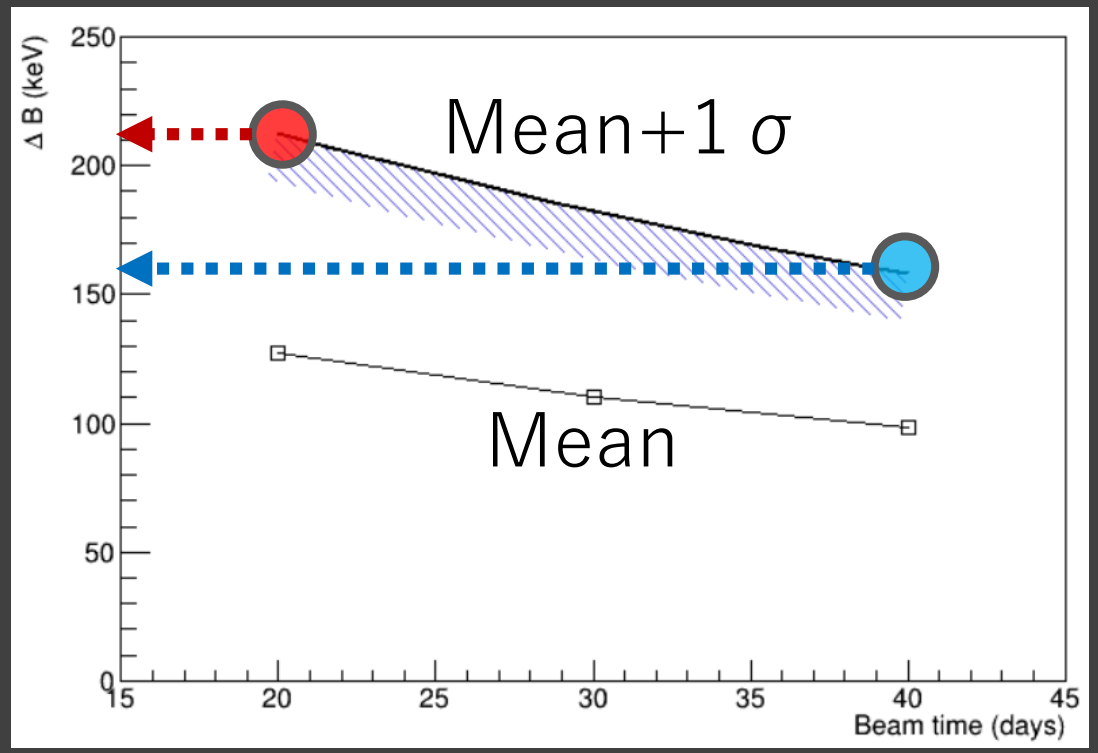
$\Delta B_{\Lambda}^{stat.}$ (keV)



Beam time (days)

Comparison between 1st and 4th peaks

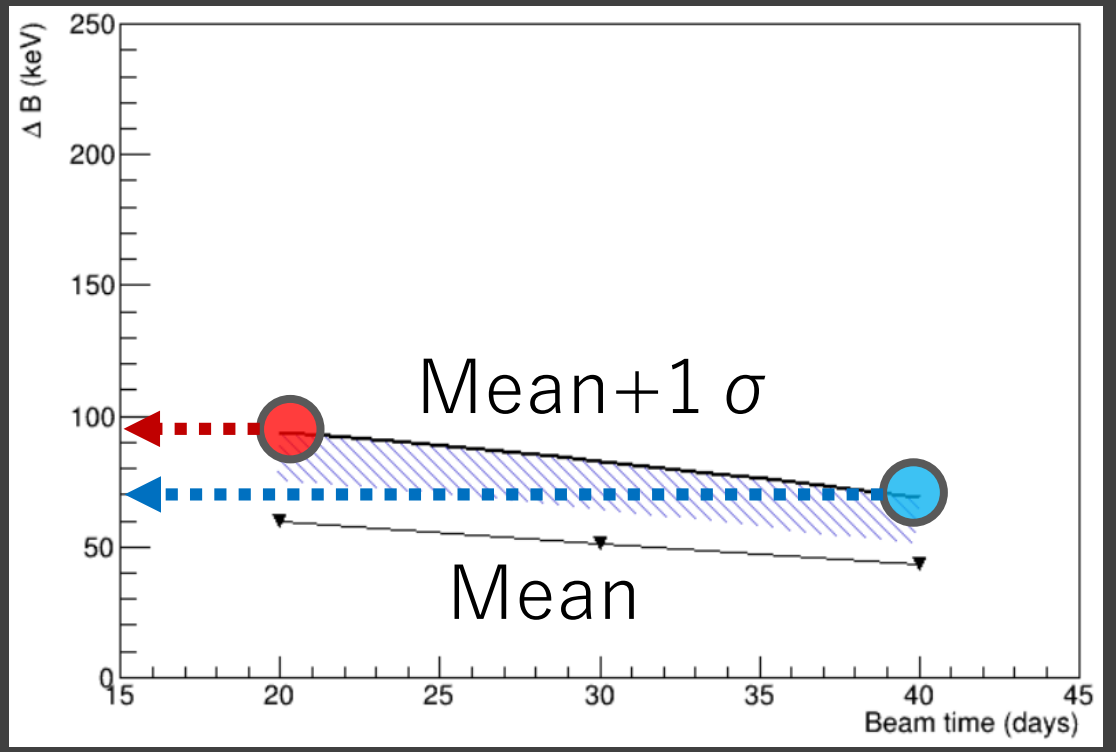
The 1st peak (s_Λ low)



$\Delta B_\Lambda^{stat.}$ (keV)

Beam time (days)

The 4st peak (p_Λ high)



$\Delta B_\Lambda^{stat.}$ (keV)

Beam time (days)

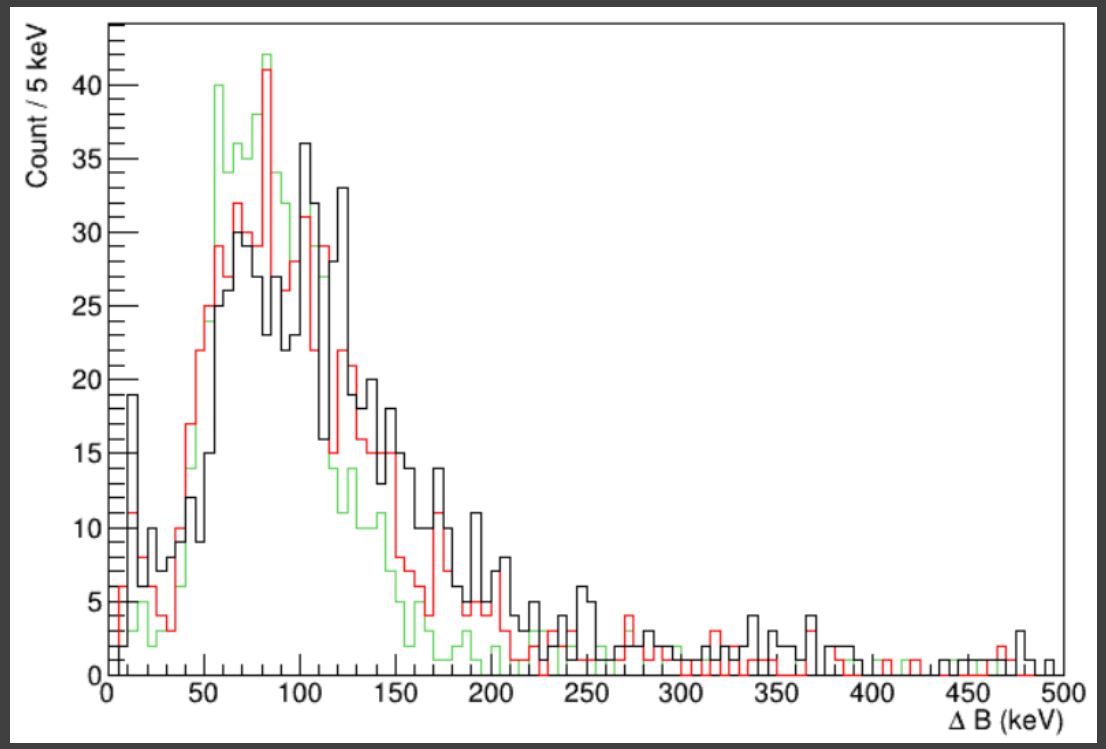
Summary

- Simulation conditions were updated
- S/N looks better than before
- 20 vs. 40 days (25 μA on 150-mg/cm^2 ^{208}Pb)
  - s_Λ low ($2s_{1/2}$ + $1d_{3/2}$ holes $\otimes$ s_Λ): $\Delta B_\Lambda^{\mathrm{stat.}} = 210 \rightarrow 160$ keV
  - p_Λ high ($1d_{3/2}$ + $0h_{11/2}$ holes $\otimes$ p_Λ): $\Delta B_\Lambda^{\mathrm{stat.}} = 95 \rightarrow 70$ keV

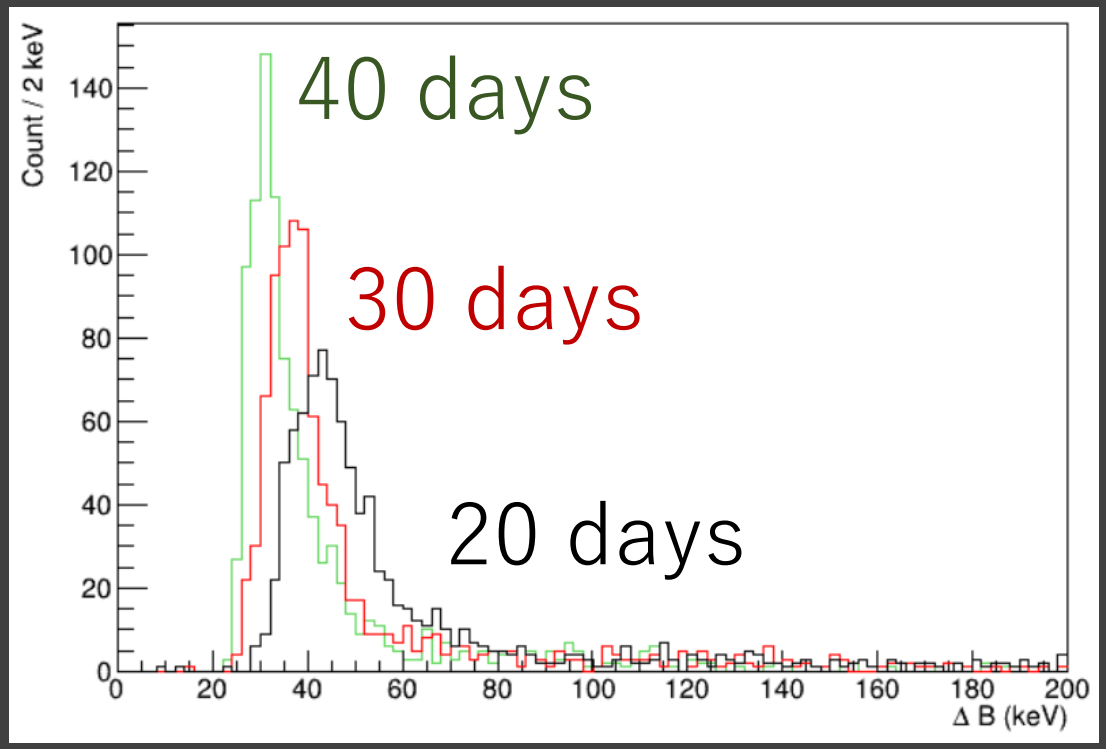
Backup

Simulation result

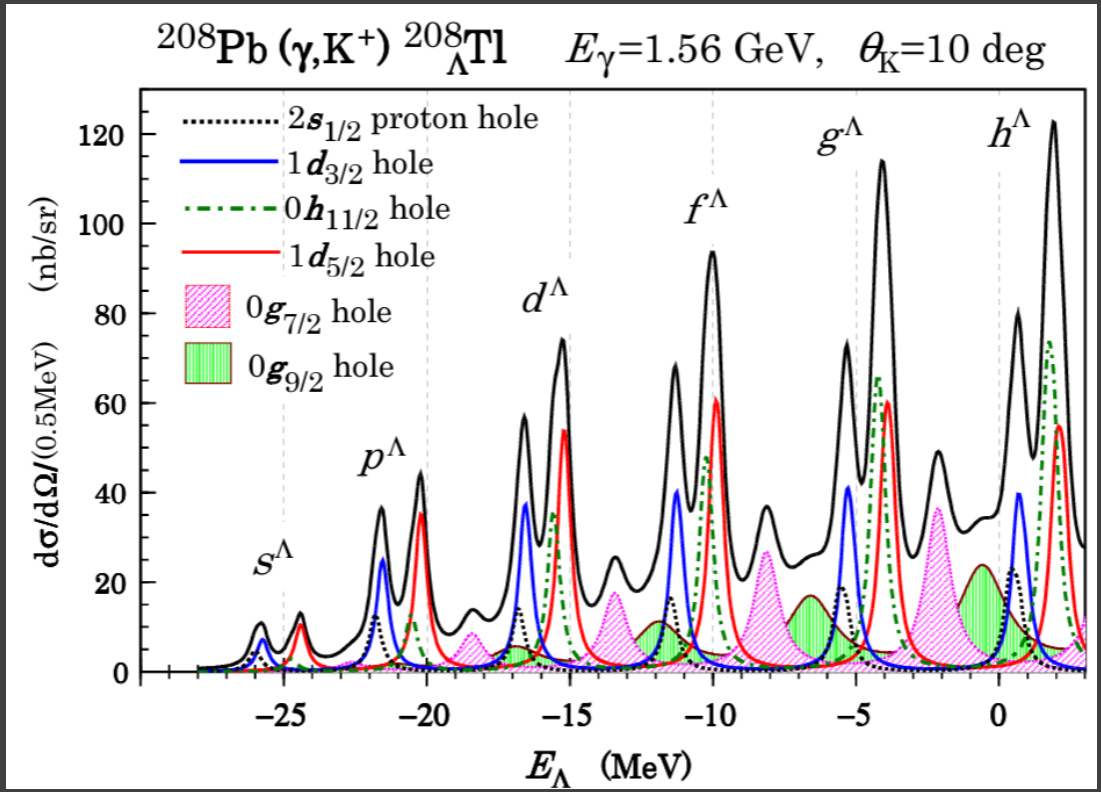
The 1st peak (s_Λ low)



The 4st peak (p_Λ high)



Theoretical calculation (^{208}Pb→$^{208}_{\Lambda}$Tl)



T. Motoba, JPS Conf. Proc. 17, 011003 (2017); https://doi.org/10.7566/JPSCP.17.011003

Table III. Calculated cross sections for the ^{208}Pb$(\gamma, K^+)^{208}_{\Lambda}$Tl reaction at E_γ=1.56 GeV and $\theta_K^{\rm Lab}$= 5 and 10 deg. Each entry (nb/sr) is for the 1p-1h multiplet $[(n\ell j)_{\rm p}^{-1}(n\ell j)^\Lambda]_J$ summed up over $j^\Lambda = \ell \pm 1/2$ and J.

	θ_K = 5°							θ_K = 10°				
	$0s^\Lambda$	$0p^\Lambda$	$0d^\Lambda$	$1s^\Lambda$	$0f^\Lambda$	$1p^\Lambda$	$(0g^\Lambda)$	$0s^\Lambda$	$0p^\Lambda$	$0d1s^\Lambda$	$0f1p^\Lambda$	$0g1d2s^\Lambda$
$(2s_{1/2})_{\rm p}^{-1}$	15.2	18.2	21.6	2.1	38.8	1.09	31.2	3.6	10.2	11.4	14.5	20.0
$(1d_{3/2})_{\rm p}^{-1}$	19.5	43.9	54.0	4.7	46.8	16.7	37.6	5.4	19.6	30.9	34.8	37.9
$(0h_{11/2})_{\rm p}^{-1}$	2.2	14.8	28.9	8.8	44.2	20.7	49.9	2.3	10.1	29.3	41.7	60.5
$(1d_{5/2})_{\rm p}^{-1}$	29.0	64.0	80.7	6.9	69.0	24.9	46.5	7.9	28.0	45.2	53.8	55.9
$(0g_{7/2})_{\rm p}^{-1}$	5.2	22.2	36.2	9.6	46.2	27.1	49.0	3.1	12.9	27.2	41.9	58.2
$(0g_{9/2})_{\rm p}^{-1}$	6.5	26.6	44.9	11.9	55.0	32.8	60.9	3.8	15.1	31.5	49.1	70.6

Assumptions of the yield and rate

Title	Setting	Current (μA)	Name	t (mg /cm2)	Spectrometer	Spectrometer	Efficiency	day	Hyper Yield	Significance (1sigma)	Peak Precision (keV/c)	e' rate (Hz)	pi rate (Hz)	K rate (Hz)	p rate (Hz)	K trig rate (Hz)	Coin rate (Hz)	Mass Resolution (MeV)	BG Height (Counts/ 0.3MeV)	S/N (1sigma)	Expected yield (/hour)	BG rate (/MeV/h)
He6Lambda	1-pass	50	Li6	150	PCS+HES(H) 8.5deg	PCS+HKS(H)	Setting 1	10.00	**330**	**8.7**	**14.3**	150,000	34,000	410	43,000	5,700	60	0.61	50.1	2.6	1.37	0.70
Li9Lambda	1-pass	50	Be9	150	PCS+HES(H) 8.5deg	PCS+HKS(H)	Setting 1	14.00	**310**	**7.4**	**14.7**	160,000	32,000	390	40,000	5,300	63	0.61	68.2	1.8	0.91	0.68
Be11Lambda	1-pass	50	B11	150	PCS+HES(H) 8.5deg	PCS+HKS(H)	Setting 1	6.00	**320**	**9.7**	**14.5**	200,000	31,000	380	39,000	5,200	75	0.61	33.6	3.8	2.24	0.78
B12Lambda	1-pass	50	Graphite	150	PCS+HES(H) 8.5deg	PCS+HKS(H)	Setting 1	10.00	**1,500**	**25.1**	**6.7**	260,000	31,000	370	39,000	5,100	96	0.61	69.7	8.4	6.15	0.97
Mg27Lambda(g.s)	1-pass	50	Al27(gs)	150	PCS+HES(H) 8.5deg	PCS+HKS(H)	Setting 1	28.00	**200**	**2.7**	**18.3**	500,000	27,000	330	34,000	4,600	160	0.61	287.5	0.3	0.30	1.43
Mg27Lambda(e.x)	1-pass	50	Al27(ex)	150	PCS+HES(H) 8.5deg	PCS+HKS(H)	Setting 1	28.00	**980**	**8.3**	**8.3**	960,000	30,000	360	38,000	5,000	350	0.61	688.6	0.6	1.47	3.42
K40Lambda	1-pass	50	Ca40	150	PCS+HES(H) 8.5deg	PCS+HKS(H)	Setting 1	26.00	**640**	**7.3**	**10.3**	770,000	26,000	310	33,000	4,300	240	0.61	364.6	0.7	1.03	1.95
K48Lambda	1-pass	50	Ca48	150	PCS+HES(H) 8.5deg	PCS+HKS(H)	Setting 1	30.00	**620**	**7.3**	**10.4**	650,000	25,000	310	32,000	4,200	200	0.61	330.1	0.7	0.85	1.53
Tl208Lambda(g.s)	1-pass	25	Pb208(gs)	150	PCS+HES(H) 8.5deg	PCS+HKS(H)	Setting 1	30.00	**71**	**1.2**	**30.8**	1,200,000	10,000	120	13,000	1,700	140	0.61	182.6	0.2	0.10	0.85
Tl208Lambda(e.x)	1-pass	25	Pb208(ex)	150	PCS+HES(H) 8.5deg	PCS+HKS(H)	Setting 1	30.00	**210**	**3.5**	**17.9**	1,200,000	10,000	120	13,000	1,700	140	0.61	182.6	0.5	0.30	0.85
Lambda	1-pass	2	CH2	450	PCS+HES(H) 8.5deg	PCS+HKS(H)	Setting 1	6.00	**1,000**	**26.2**	**8.2**	46,000	3,600	44	4,500	600	2	0.61	0.8	475.4	7.03	0.02

https://docs.google.com/spreadsheets/d/18GEnIWgMTDtWNbbDInGvp9WjeGrG-XeFp1jVcL0nBys/edit#gid=2056335386

Graphite	6	12	1.75	90	42.7
Ca40	20	40	1.55	50	16.43
Ca48	20	48	1.55	50	16.43
Pb208(gs)	82	208	11.3	50	6.31
Pb208(ex)	82	208	11.3	150	6.31
CH2	8	14	0.9	1000	44.77
Li6	3	6	0.534	10	82.78
Li7	3	7	0.534	10	82.78
Be9	4	9	1.85	10	65.19
B10	5	10	2.08	17	49.19
Cr52	24	52	7.19	20	15.3
Al27(gs)	13	14	2.7	10	24.26
Al27(ex)	13	14	2.7	25	24.26
He4(40K)	2	4	0.00214	20	89.95
H2(40K)	2	2	0.00283	2000	63.79
He4	2	4	0.0131	20	94
He3	2	3	0.0095	5	94
Li6	3	6	0.534	10	82.78
B11	5	11	2.08	30	49.19