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A search for ^{7}Li solar axions with Li_2MoO_4 detectors in the AMoRE experiment

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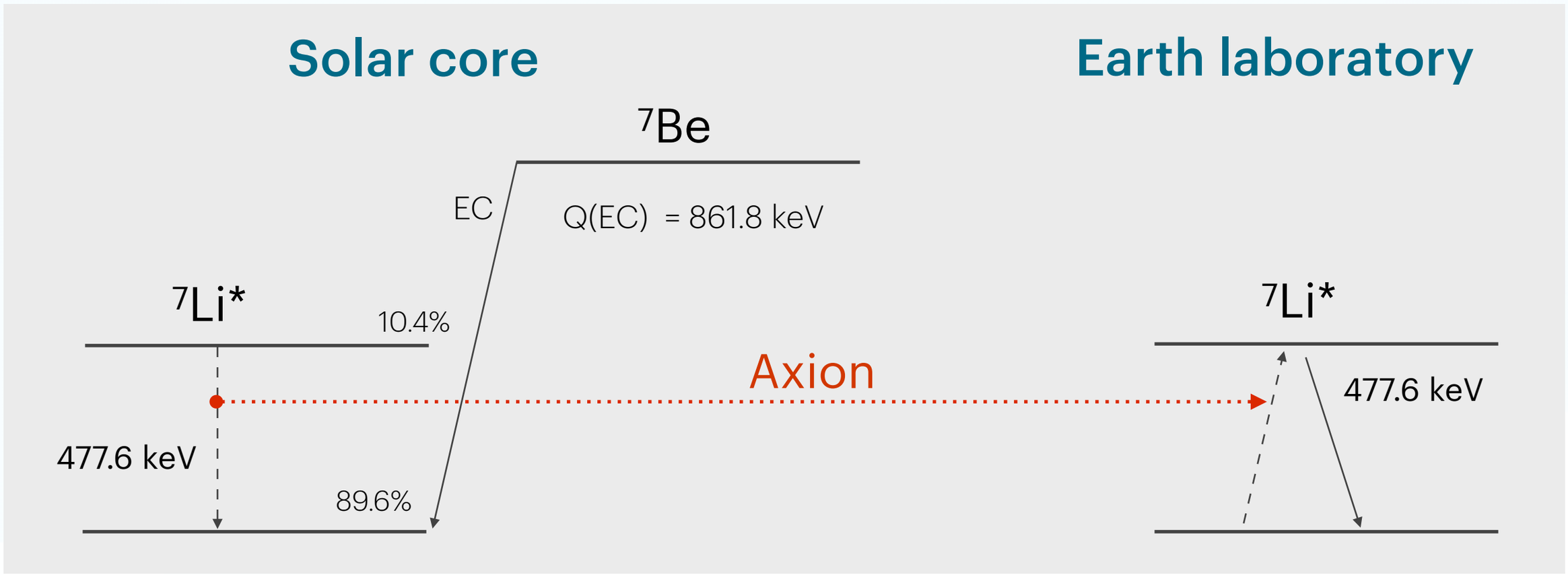
INTRODUCTION

- Axion is a hypothetical particle considered as one of the candidates for the dark matter particles.
- Monoenergetic solar axions emitted in magnetic transitions by an excited state of ^{7}Li in the Sun could excite the same nuclei on the Earth to the corresponding level resonantly [1].
- Detection of subsequent gamma rays would be a sign of solar axion existence.
- This method is free from the uncertainty of the axion-photon coupling because both the emission and absorption occur not via the axion-photon coupling but via the axion-nucleon coupling [2].
- Latest result of axion mass limit of 8.6 keV at 90% C.L. [3].

[1] Shigetaka Moriyama, Phys. Rev. Lett. ***75****, 3222 (1995).*
[2] M.Krcmar et al., Phys. Rev. ***D64****, 115016 (2001).*
[3] P.Belli et al., Phys. Lett. ***B711****, 41 (2012).*

SEARCH FOR SOLAR AXIONS USING ^{7}Li



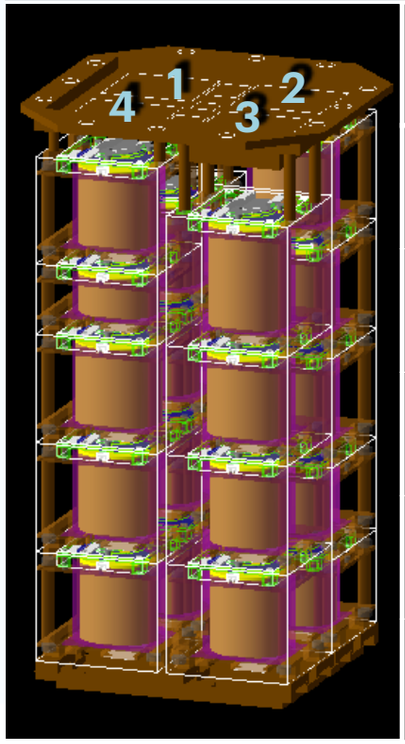
- Why ^{7}Li?: populated in the pp chain by the electron capture decay of ^{7}Be.
- The total number of resonant axion absorption process in ^{7}Li:

$$R = N_7 \times t \times 1.74 \times 10^{-45} \times (\frac{m_a}{1eV})^4$$

Derbin, JETP Letters, ***81****, 365 (2005).*

(N_7: the number of ^{7}Li in the target, t: measurement time in second)

AMORE-I DETECTOR



Detector tower			
1	2	3	4
	LMO2		LMO1
CMO	LMO4	LMO5	CMO
CMO	LMO3	CMO	CMO
CMO	CMO	CMO	CMO
CMO	CMO	CMO	CMO

Area of γ peak at 477.6 keV

$$m_a = 1.55 \times 10^{11} \times \left(\frac{S}{\epsilon N_7 t}\right)^{\frac{1}{4}} eV$$

Detection efficiency

Measurement time

of ^{7}Li in the target

- Target: 1.6 kg of Li_2MoO_4(LMO) crystals
- # of ^{7}Li in target: 1.03×10^{25} ^{7}Li

Full peak detection efficiency (for 5 LMOs: 13.5%)

LMO1 (13.92%)

	0.13		12.26
0.35	0.06	0.33	0.50
0.07	0.02	0.09	0.09
0.01	0.00	0.01	0.00
0.00	0.00	0.00	0.00

LMO2 (13.95%)

	12.38		0.13
0.30	0.52	0.35	0.03
0.07	0.04	0.08	0.03
0.02	0.00	0.01	0.01
0.00	0.00	0.00	0.00

LMO3 (15.65%)

	0.03		0.02
0.12	0.51	0.11	0.02
0.39	12.43	0.53	0.17
0.25	0.52	0.28	0.09
0.07	0.04	0.07	0.02

LMO4 (15.33%)

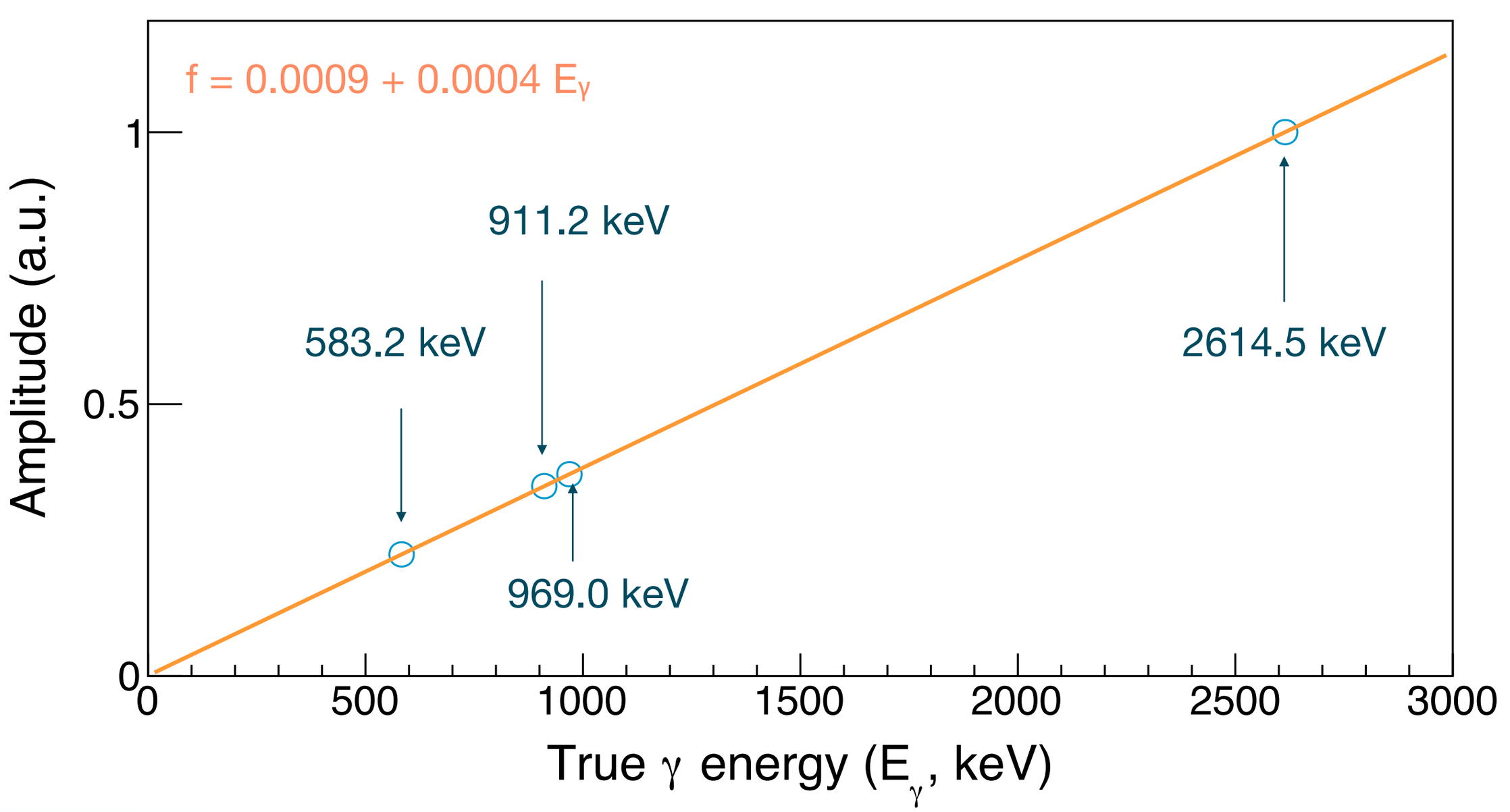
	0.52		0.05
0.41	12.39	0.44	0.06
0.27	0.52	0.33	0.12
0.07	0.02	0.06	0.03
0.02	0.00	0.01	0.01

LMO5 (15.66%)

	0.27		0.27
0.15	0.35	13.36	0.19
0.06	0.09	0.63	0.21
0.02	0.02	0.01	0.04
0.01	0.01	0.00	0.01

Near detector

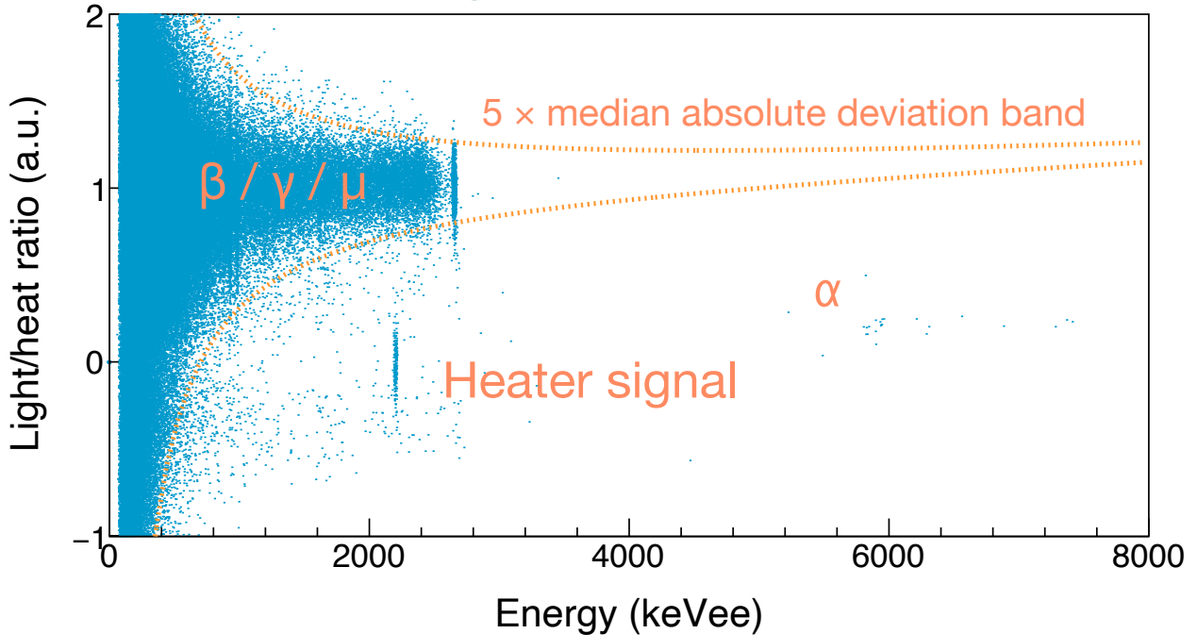
ENERGY CALIBRATION



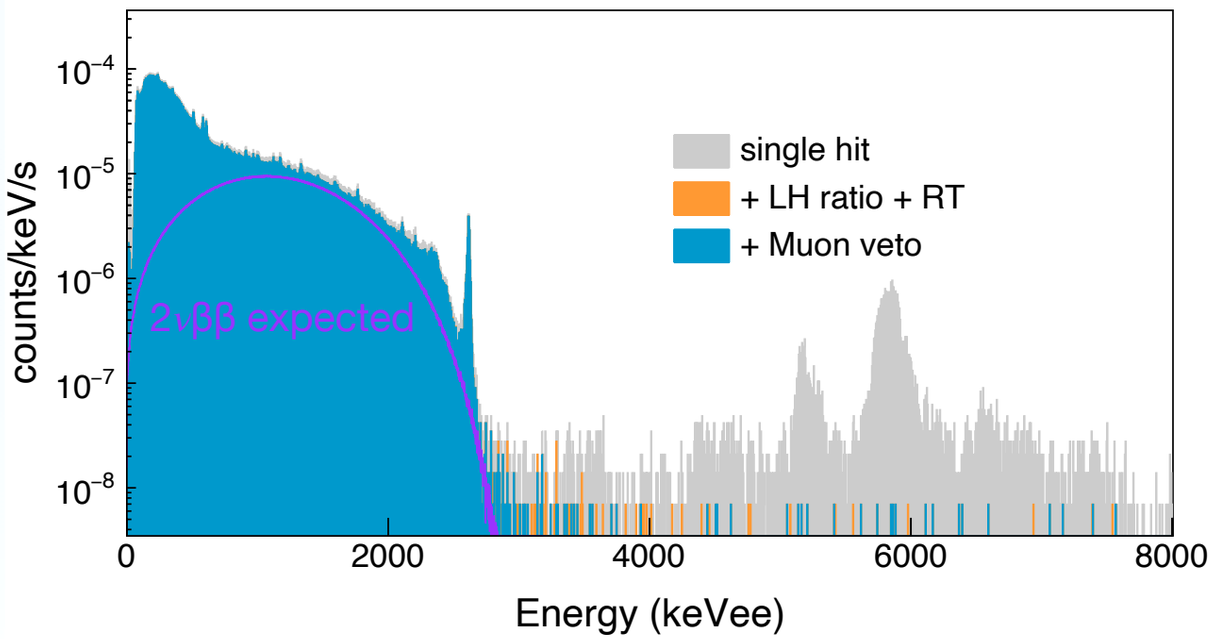
- Calibration source: ^{232}Th-rich welding rods

EVENT SELECTION

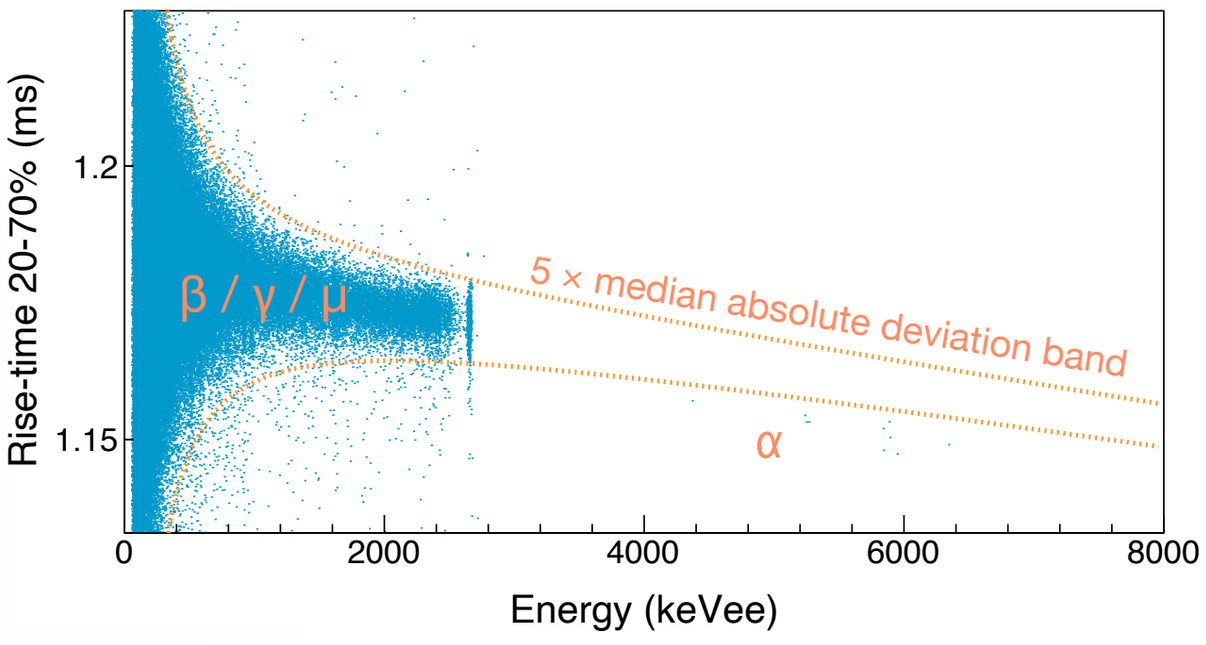
Light-heat ratio



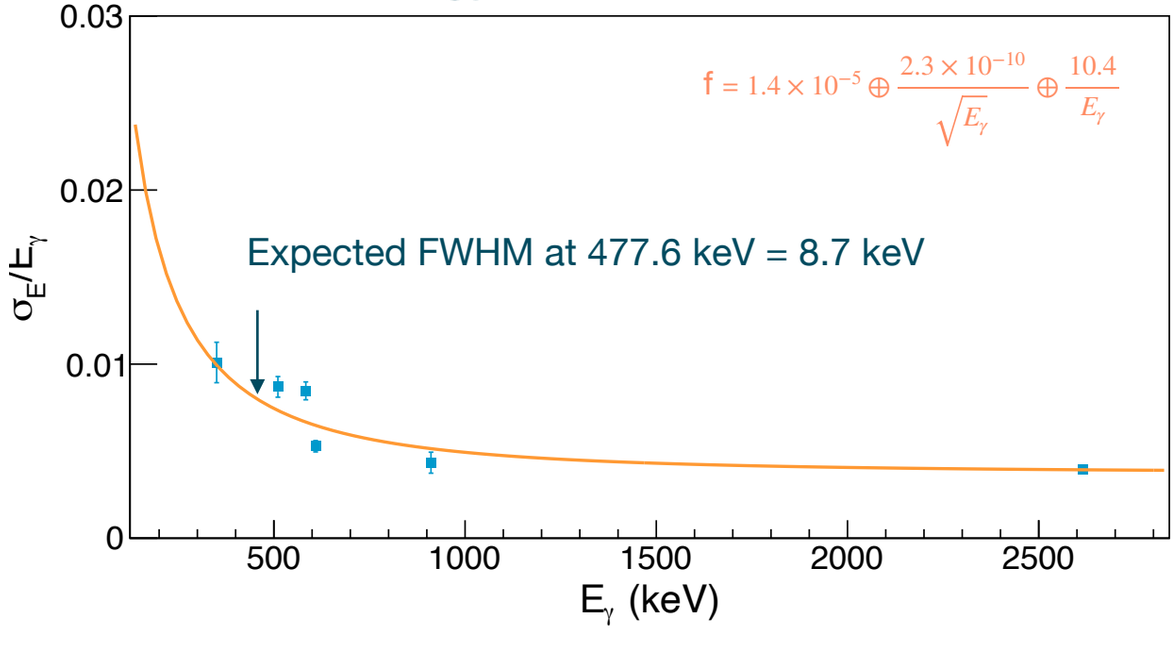
Background distribution



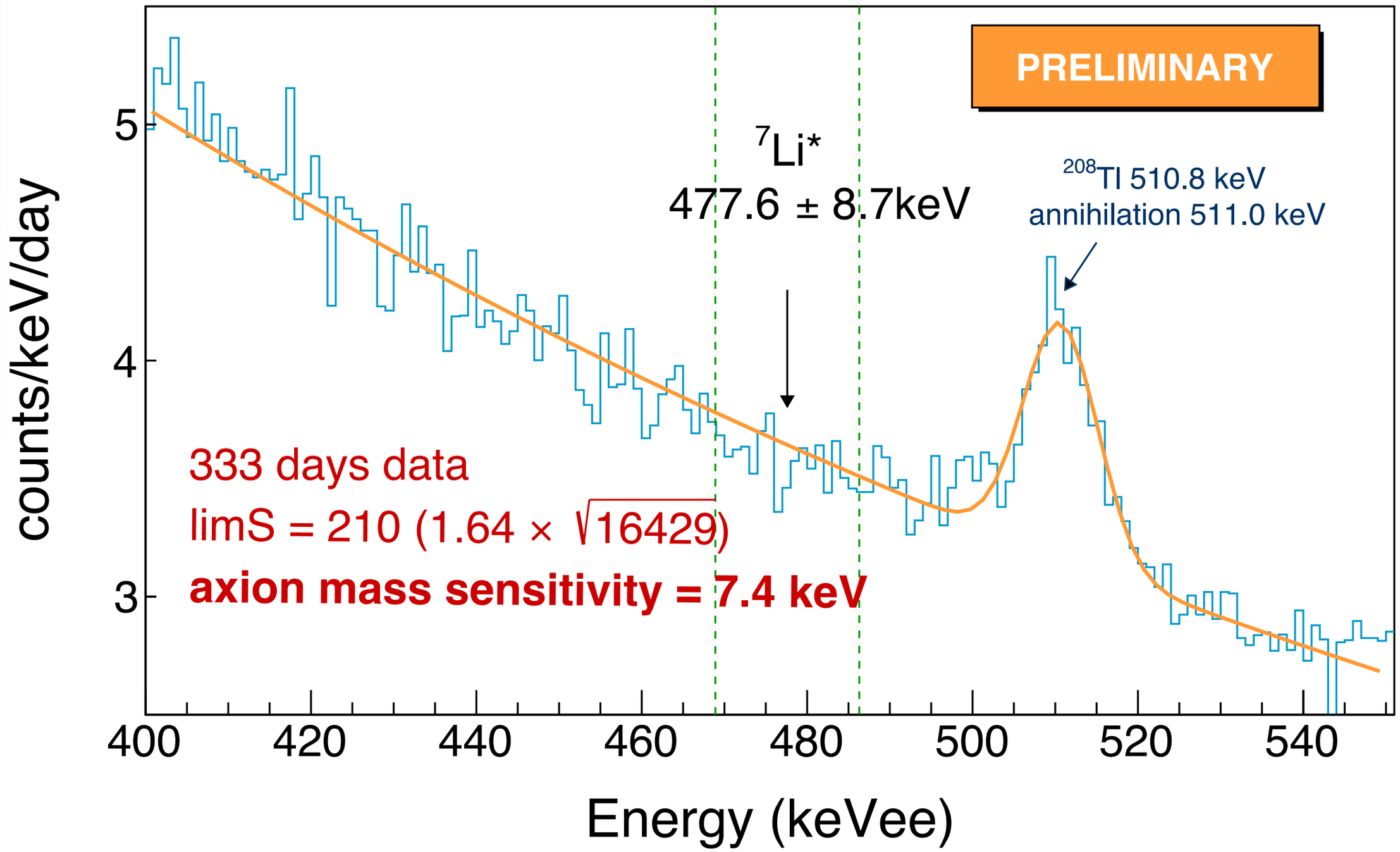
Rise-time 20-70%



Energy resolution function



PRELIMINARY AXION MASS SENSITIVITY FROM AMORE-I



SUMMARY AND FUTURE PLAN

- Studied ^{7}Li solar axions using the AMoRE-I data with five Li_2MoO_4 detectors and 1.46 kg·year.
- The axion mass sensitivity is 7.4 keV with $\lim S$ = 210 using the square root estimation.

P.Belli et al., Phys. Lett. ***B711****, 41 (2012).*

- Include the multi hit events in the analysis.
- Build a background model in region of interest.
- Analyze the detectors separately to take into the effects of different energy resolution.
- ~ 420 detectors (~178 kg Li_2MoO_4) will be used in AMoRE-II (Expected sensitivity ~2 keV with 1.28×10^{27} ^{7}Li).