

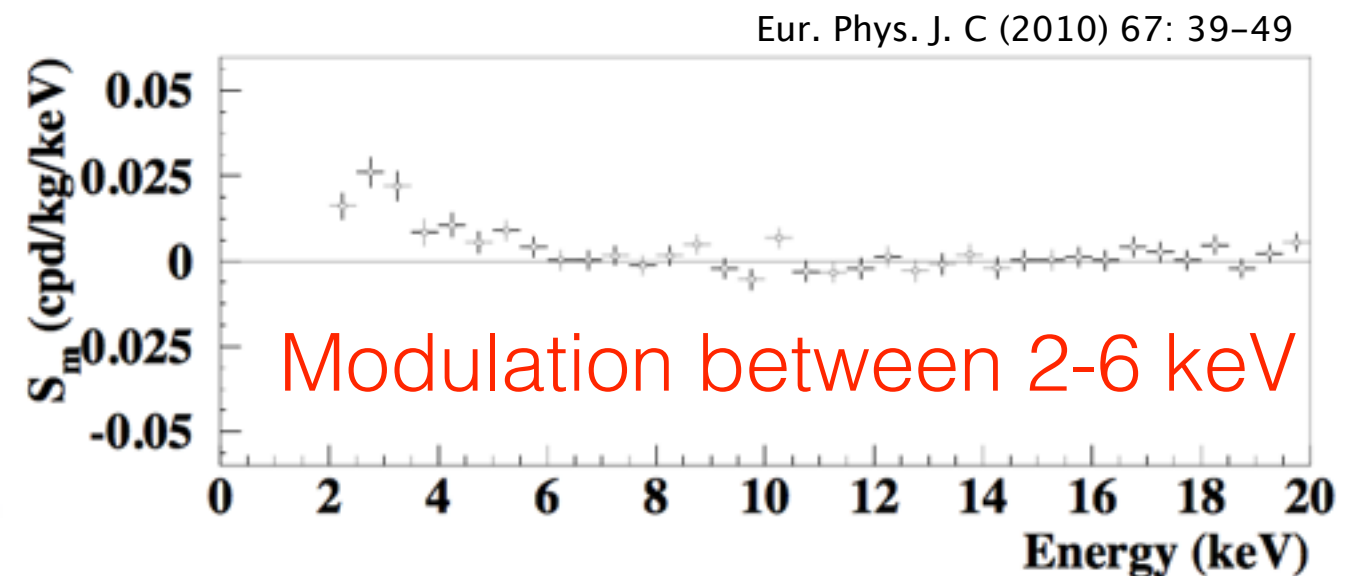
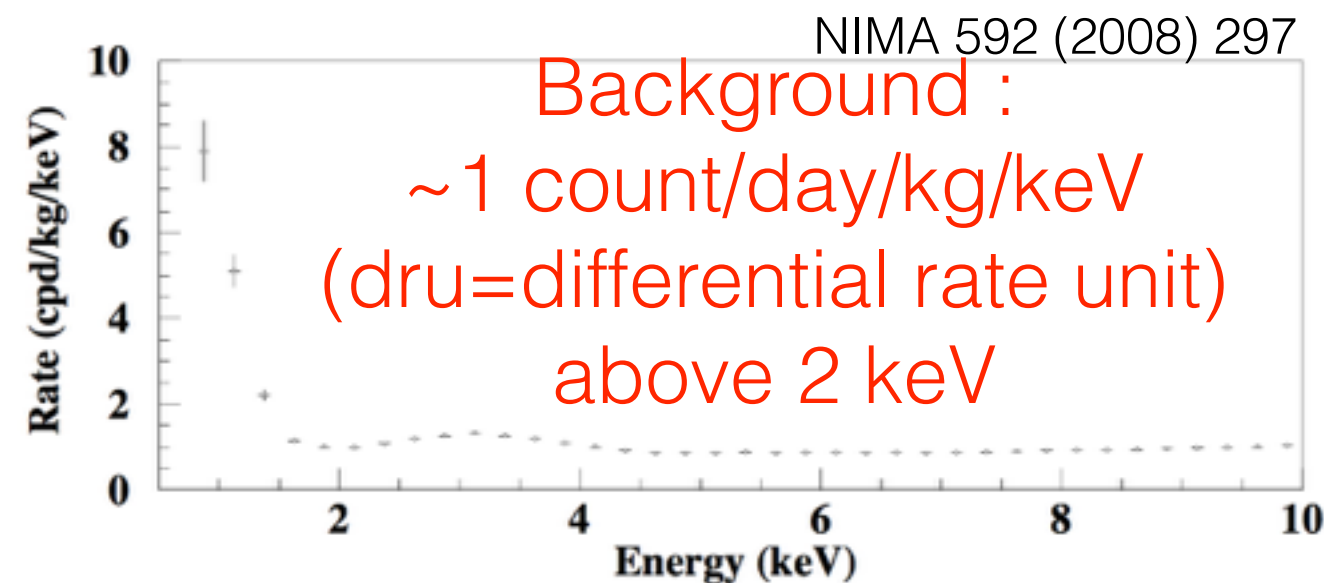
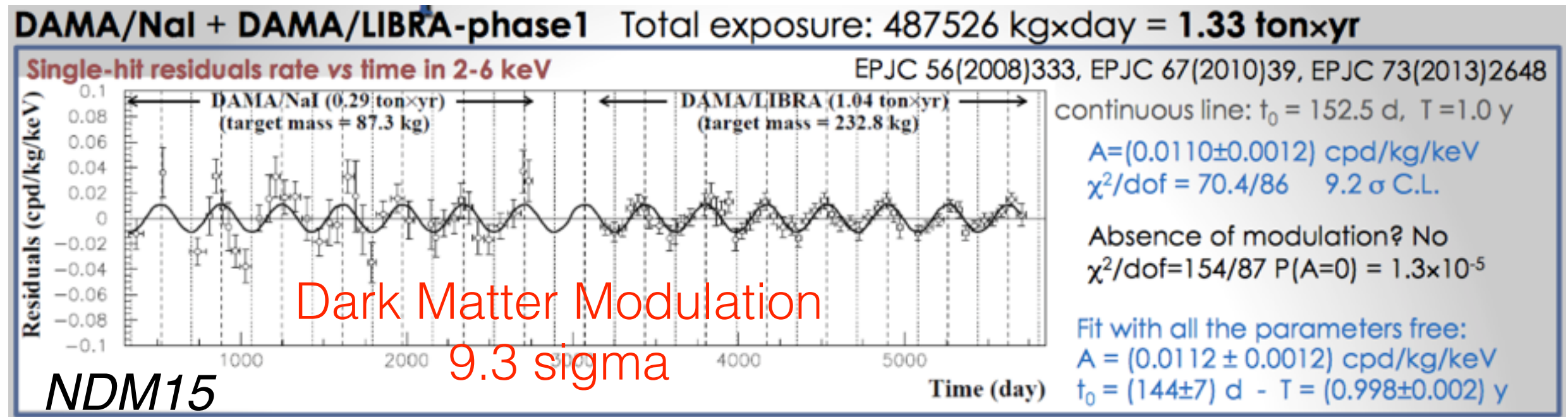
Status of the COSINE-100 experiment



Chang Hyon Ha

On behalf of the COSINE-100 collaboration
Center for Underground Physics (CUP), IBS, Korea

Motivation : The DAMA annual modulation signal,
to be confirmed with independent measurements by the
same NaI(Tl) target material



DAMA/LIBRA-phase2

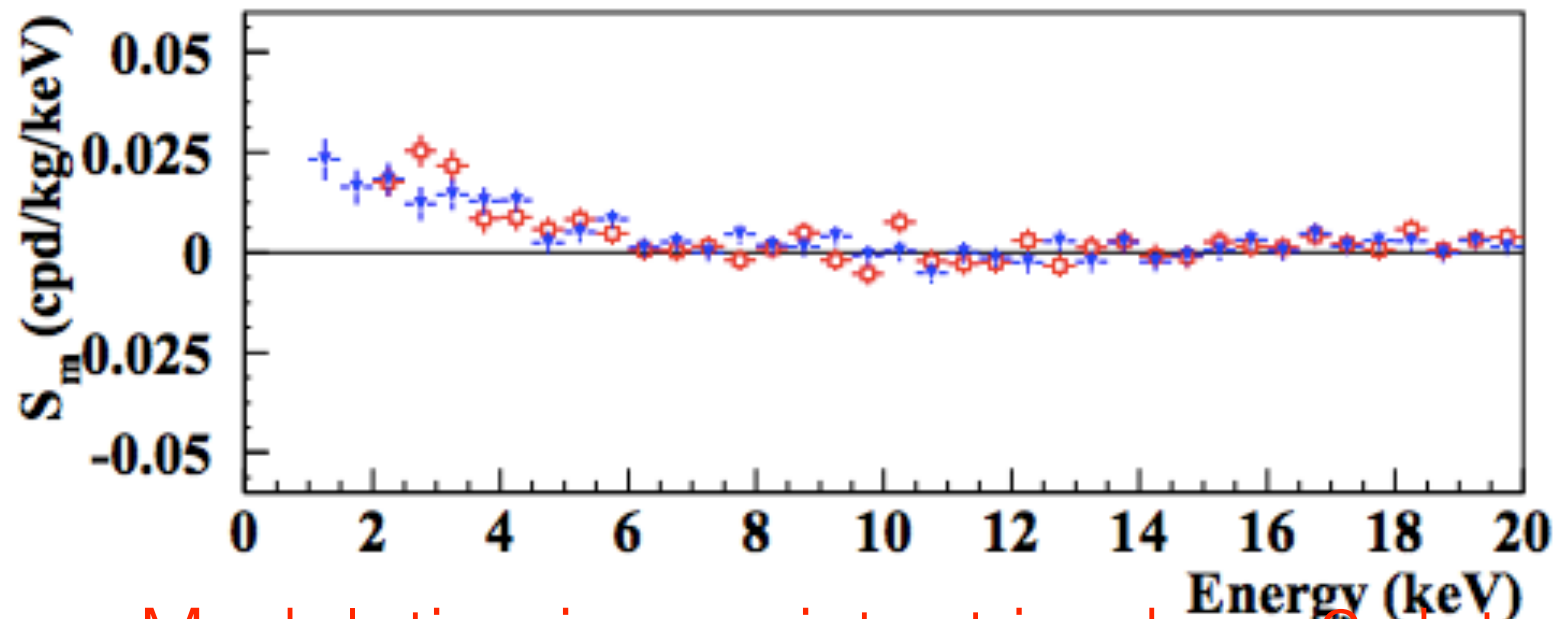
First model independent results from DAMA/LIBRA-phase2

R. Bernabei^{a,b}, P. Belli^{a,b}, A. Bussolotti^b, F. Cappella^{c,d},
V. Caracciolo^e, R. Cerulli^{a,b}, C.J. Dai^f, A. d'Angelo^{c,d},
A. Di Marco^b, H.L. He^f, A. Incicchitti^{c,d},
X.H. Ma^f, A. Mattei^d, V. Merlo^{a,b}, F. Montecchia^{b,g},
X.D. Sheng^f, Z.P. Ye^{f,h}

	A (cpd/kg/keV)	$T = \frac{2\pi}{\omega}$ (yr)	t_0 (days)	C.L.
DAMA/LIBRA-phase2:				
1-3 keV	(0.0184 ± 0.0023)	1.0	152.5	8.0σ
1-6 keV	(0.0105 ± 0.0011)	1.0	152.5	9.5σ
2-6 keV	(0.0095 ± 0.0011)	1.0	152.5	8.6σ
1-3 keV	(0.0184 ± 0.0023)	(1.0000 ± 0.0010)	153 ± 7	8.0σ
1-6 keV	(0.0106 ± 0.0011)	(0.9993 ± 0.0008)	148 ± 6	9.6σ
2-6 keV	(0.0096 ± 0.0011)	(0.9989 ± 0.0010)	145 ± 7	8.7σ
DAMA/LIBRA-phase1 + phase2:				
2-6 keV	(0.0095 ± 0.0008)	1.0	152.5	11.9σ
2-6 keV	(0.0096 ± 0.0008)	(0.9987 ± 0.0008)	145 ± 5	12.0σ
DAMA/NaI + DAMA/LIBRA-phase1 + phase2:				
2-6 keV	(0.0102 ± 0.0008)	1.0	152.5	12.8σ
2-6 keV	(0.0103 ± 0.0008)	(0.9987 ± 0.0008)	145 ± 5	12.9σ

arXiv:1805.10486 (26 May 2018)

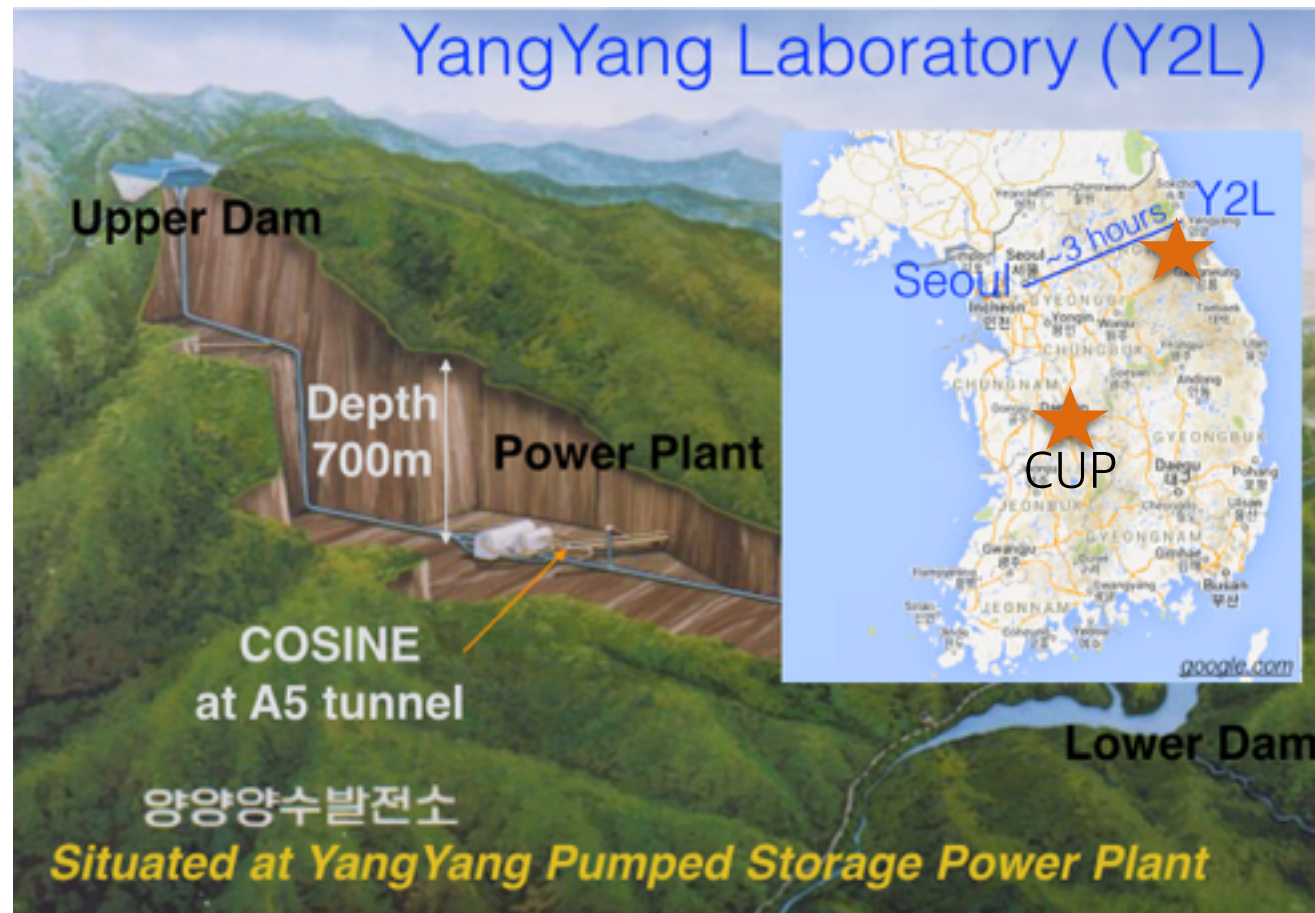
Down to 1 keV region



Modulation is persistent in phase2 data

The COSINE-100 experiment

Joint collaboration between KIMS and DM-Ice to search for dark matter interactions in NaI(Tl) scintillating crystals.



COSINE-100 Construction Timeline

Dec. 2015



Jan. 2016

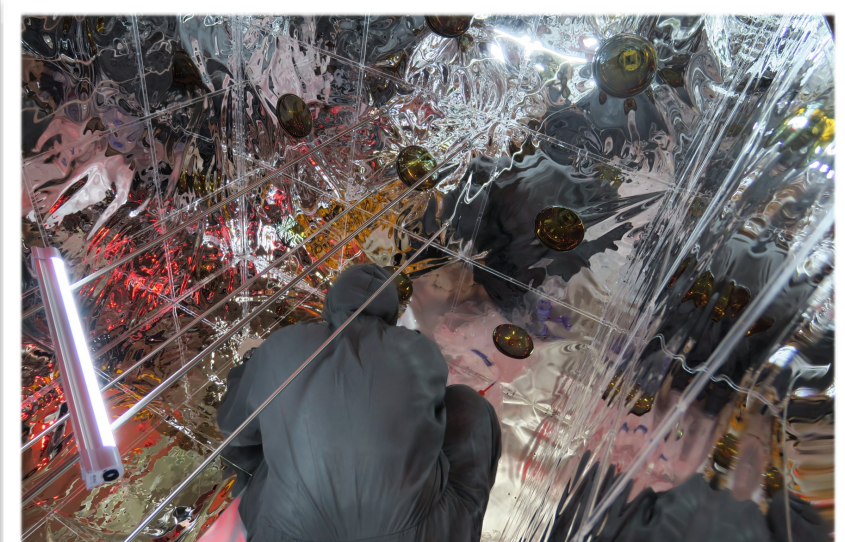


Feb. 2016



Mar. 2016

Apr. 2016



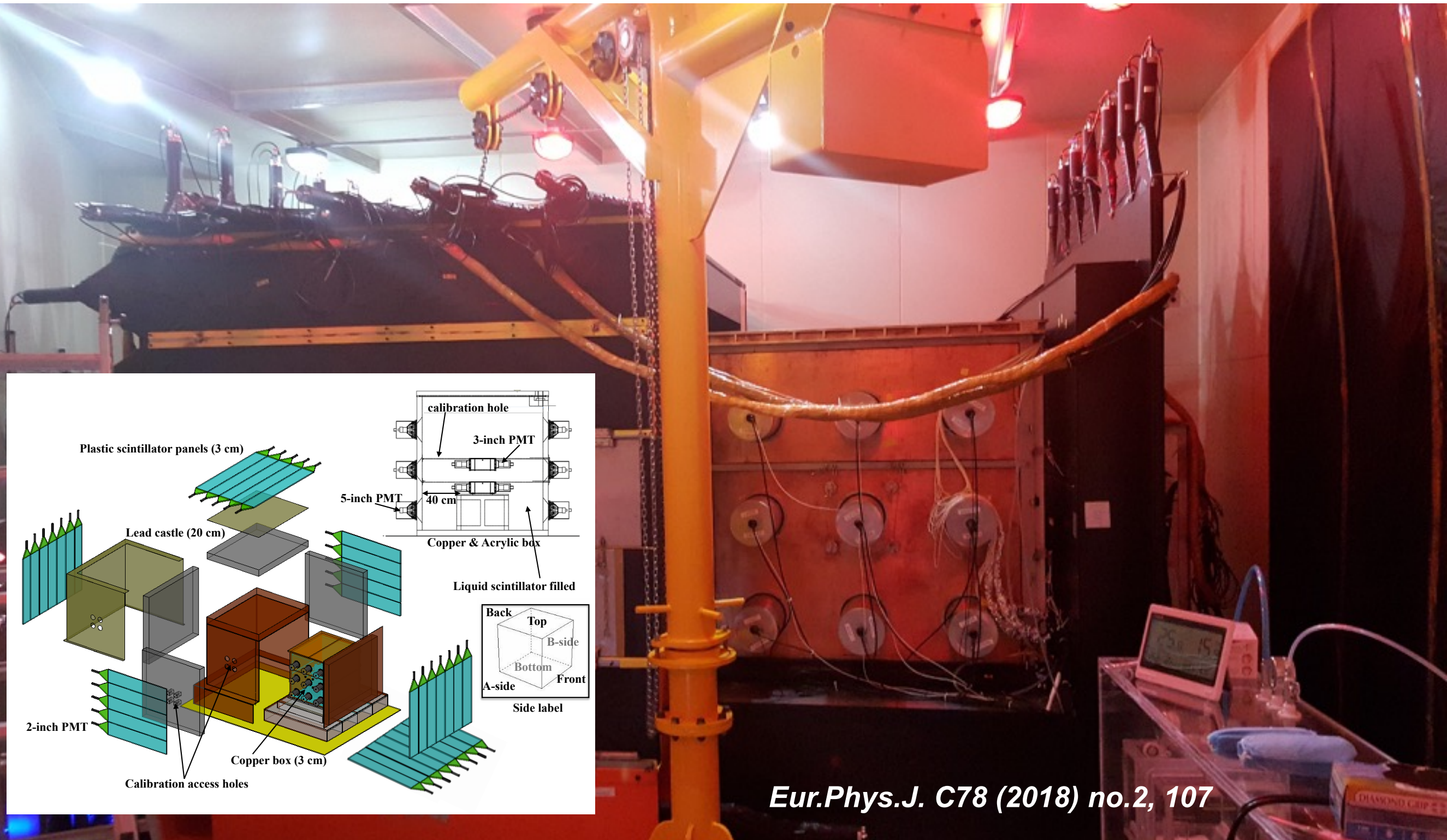
May. 2016

Jun. 2016

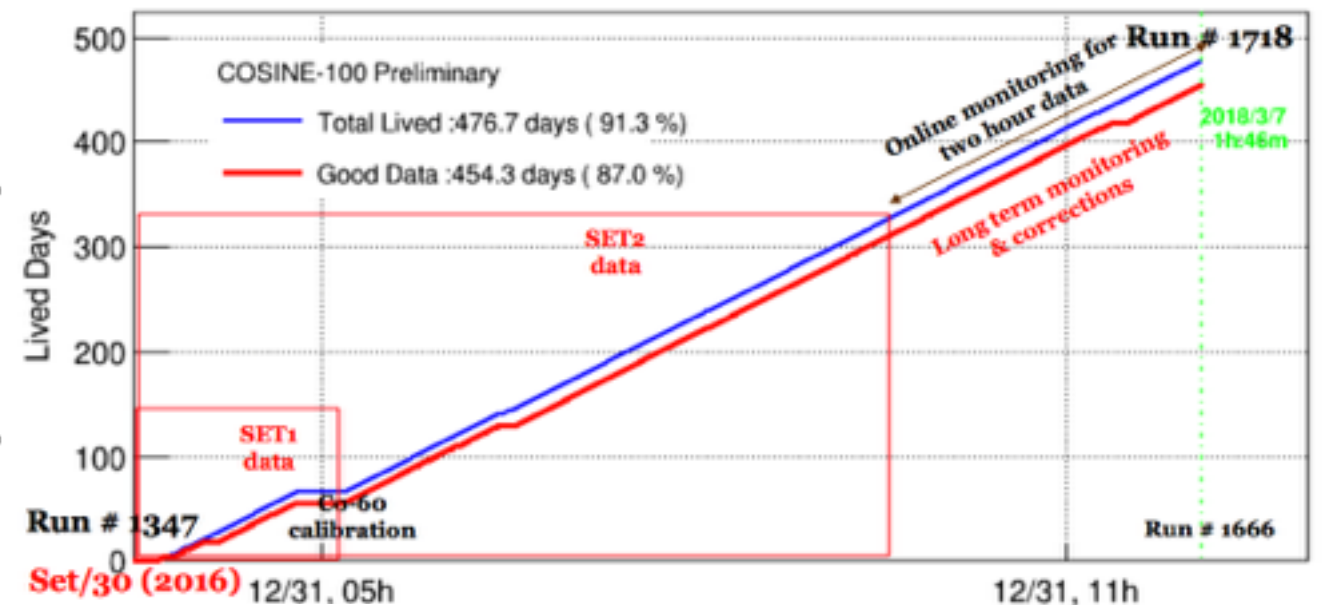
Sep. 2016



The COSINE-100 detector components

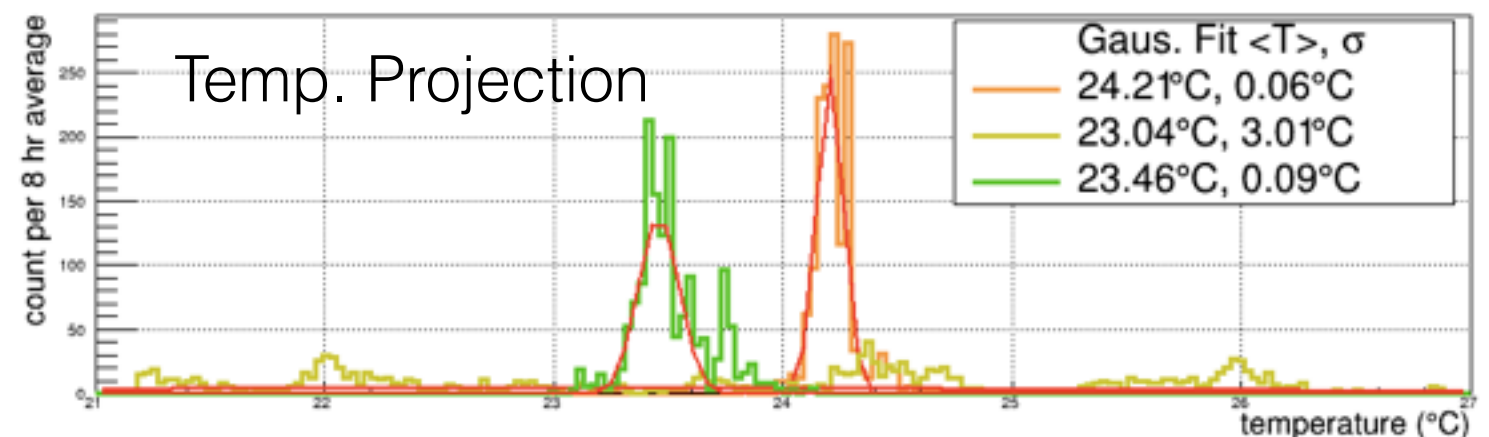
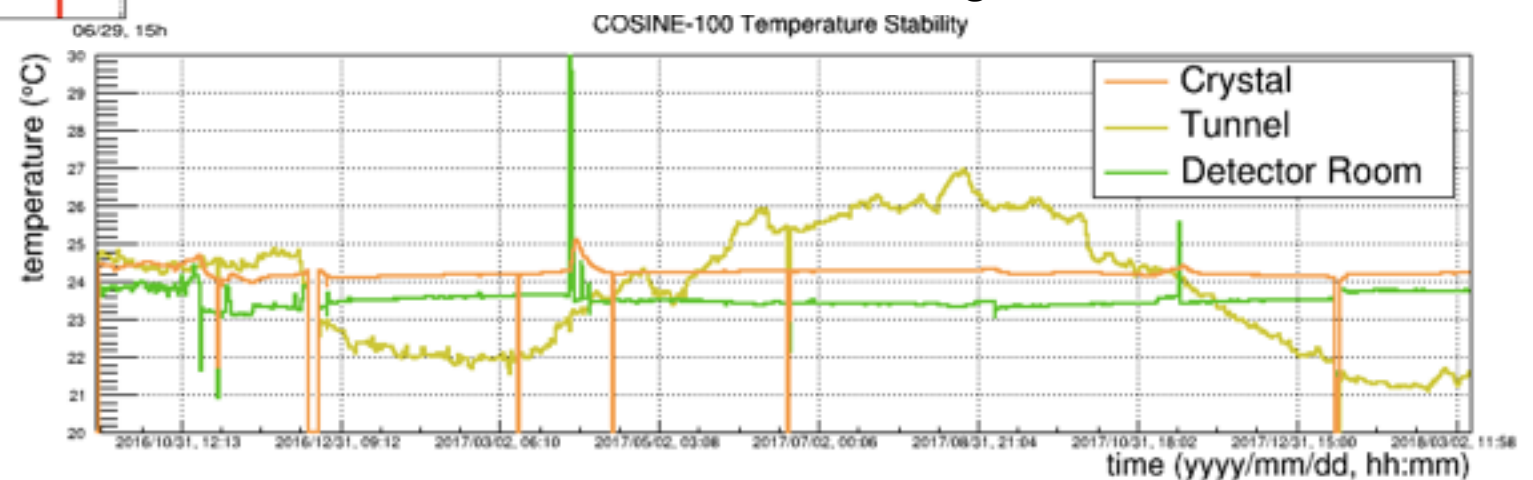


Environmental control/monitoring



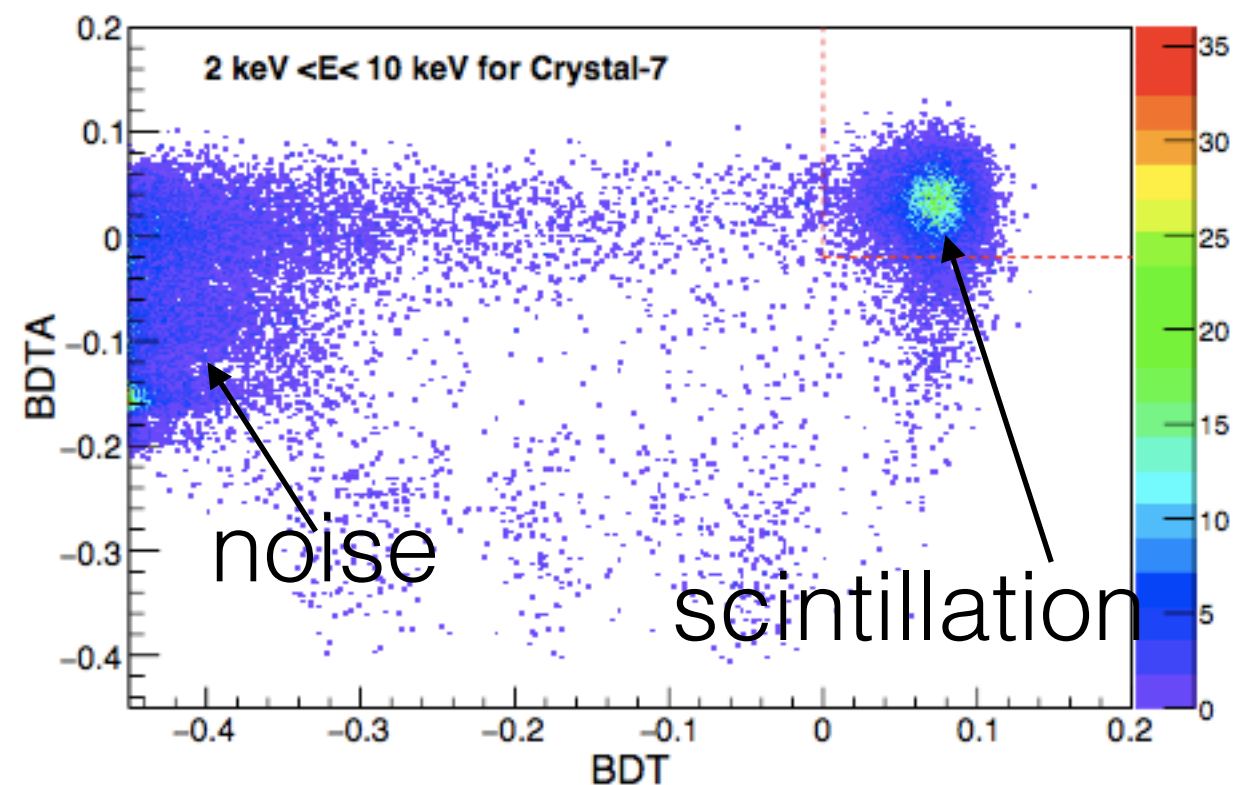
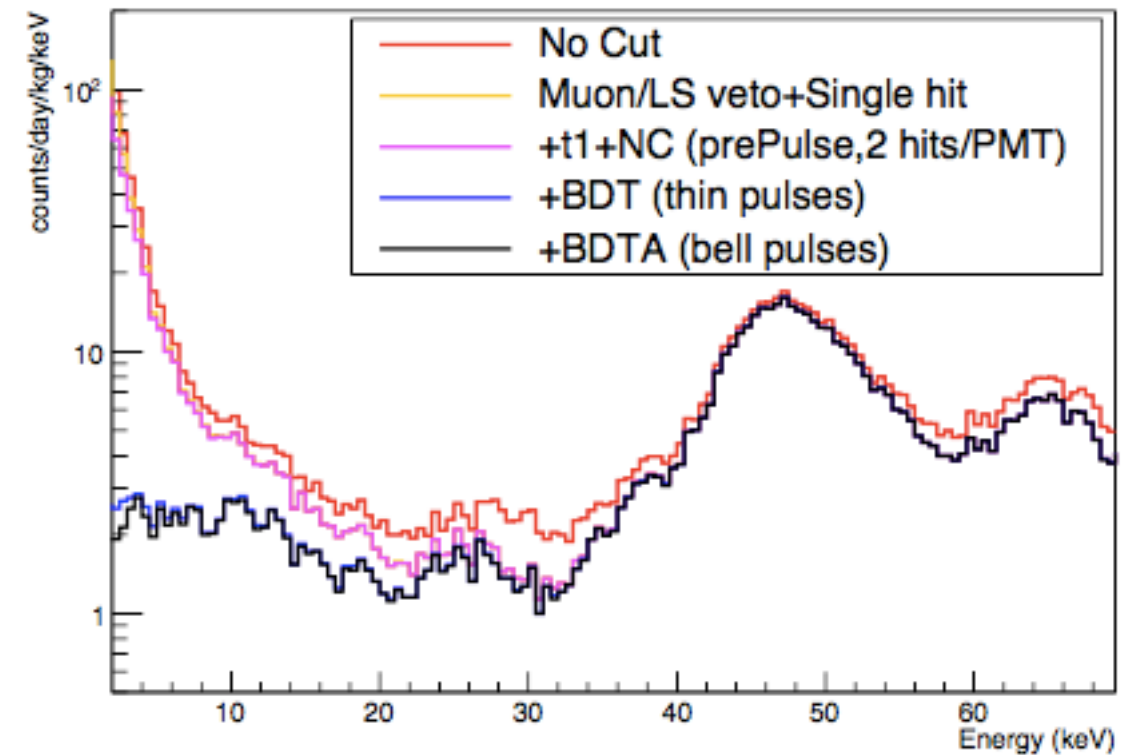
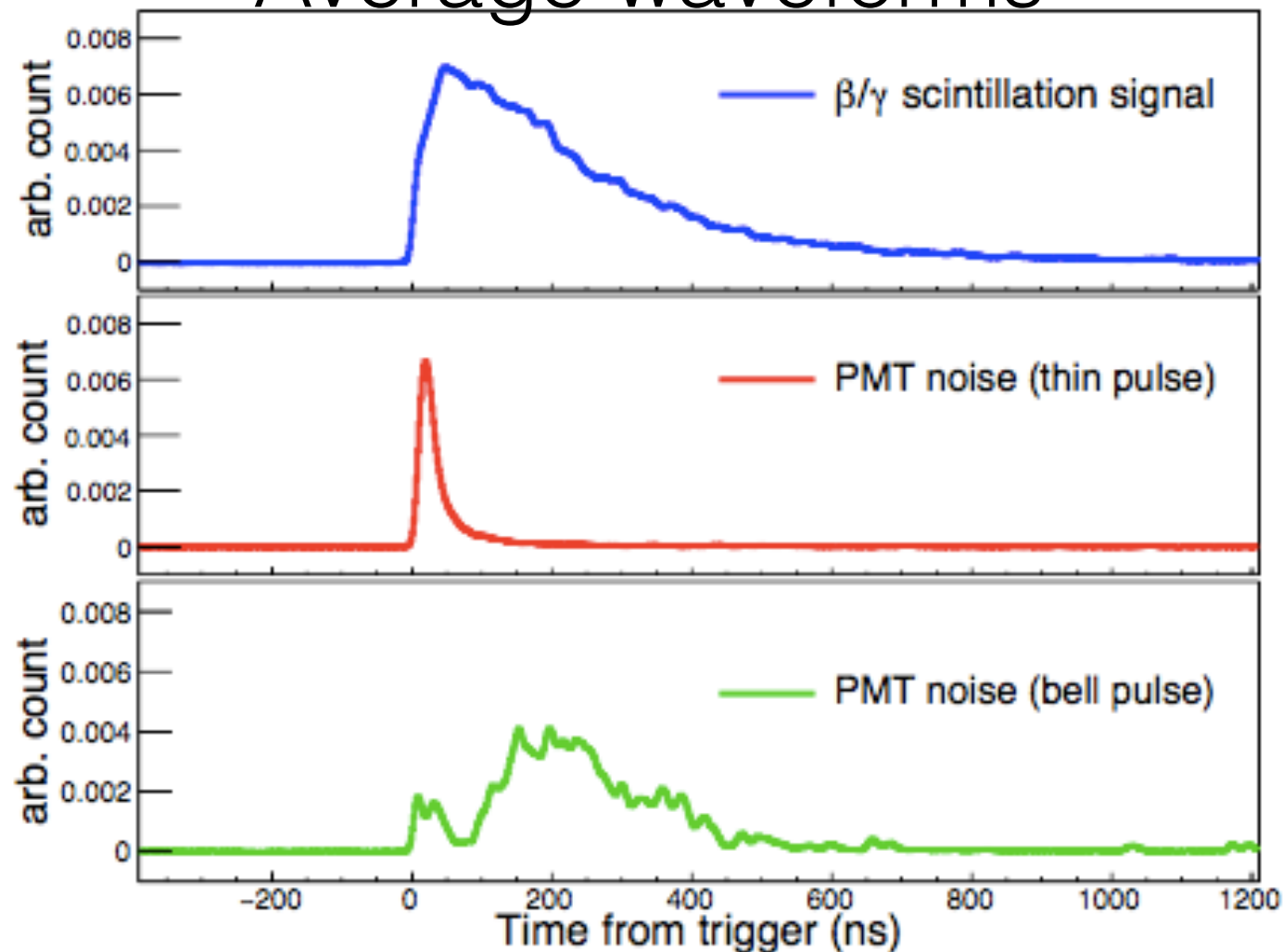
More than 20 months of running

Very stable operation
More than 85%
of physics data.
95% are good runs.
Roughly 20 months
data are collected



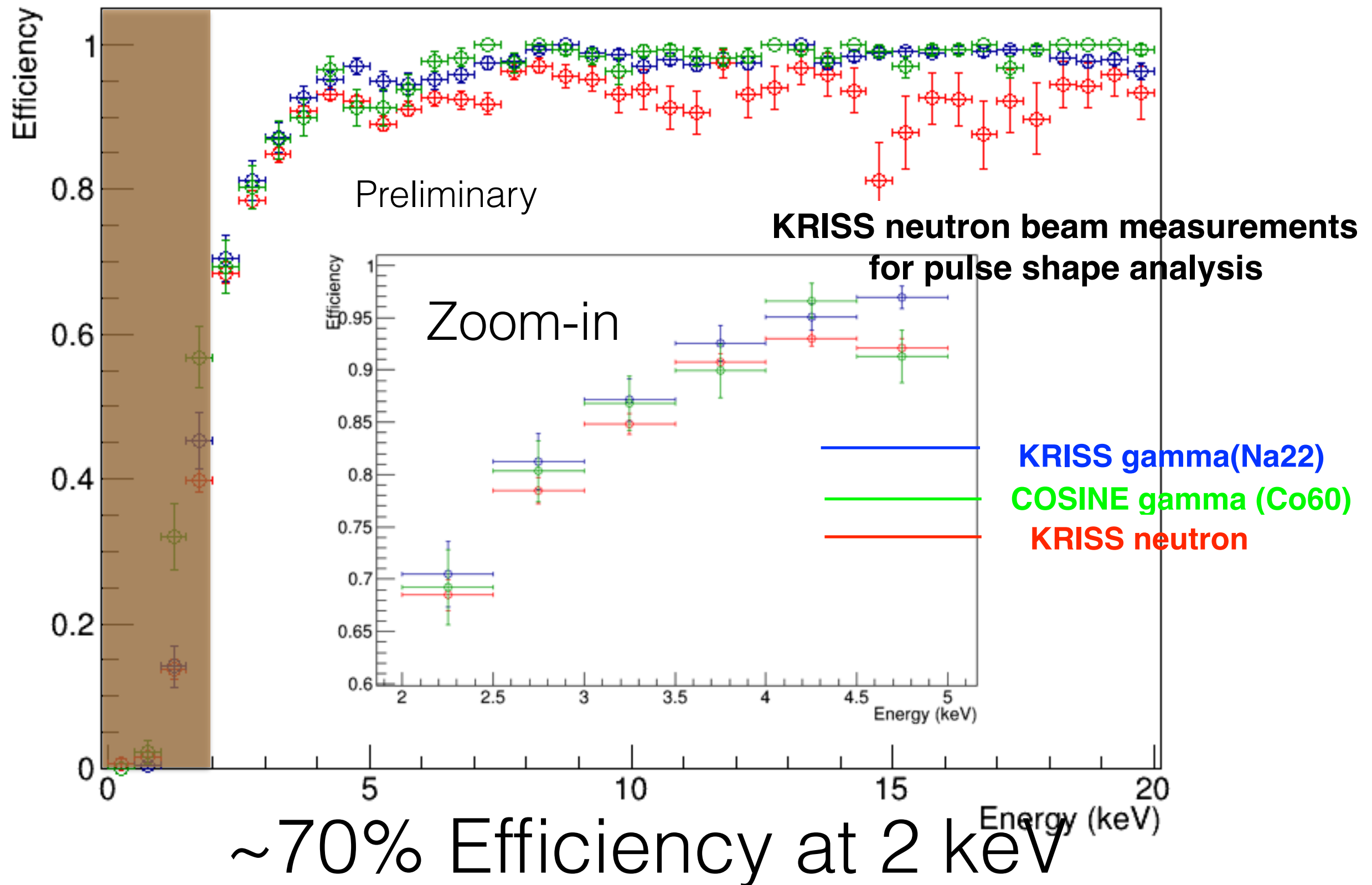
PMT noise rejection

Average waveforms



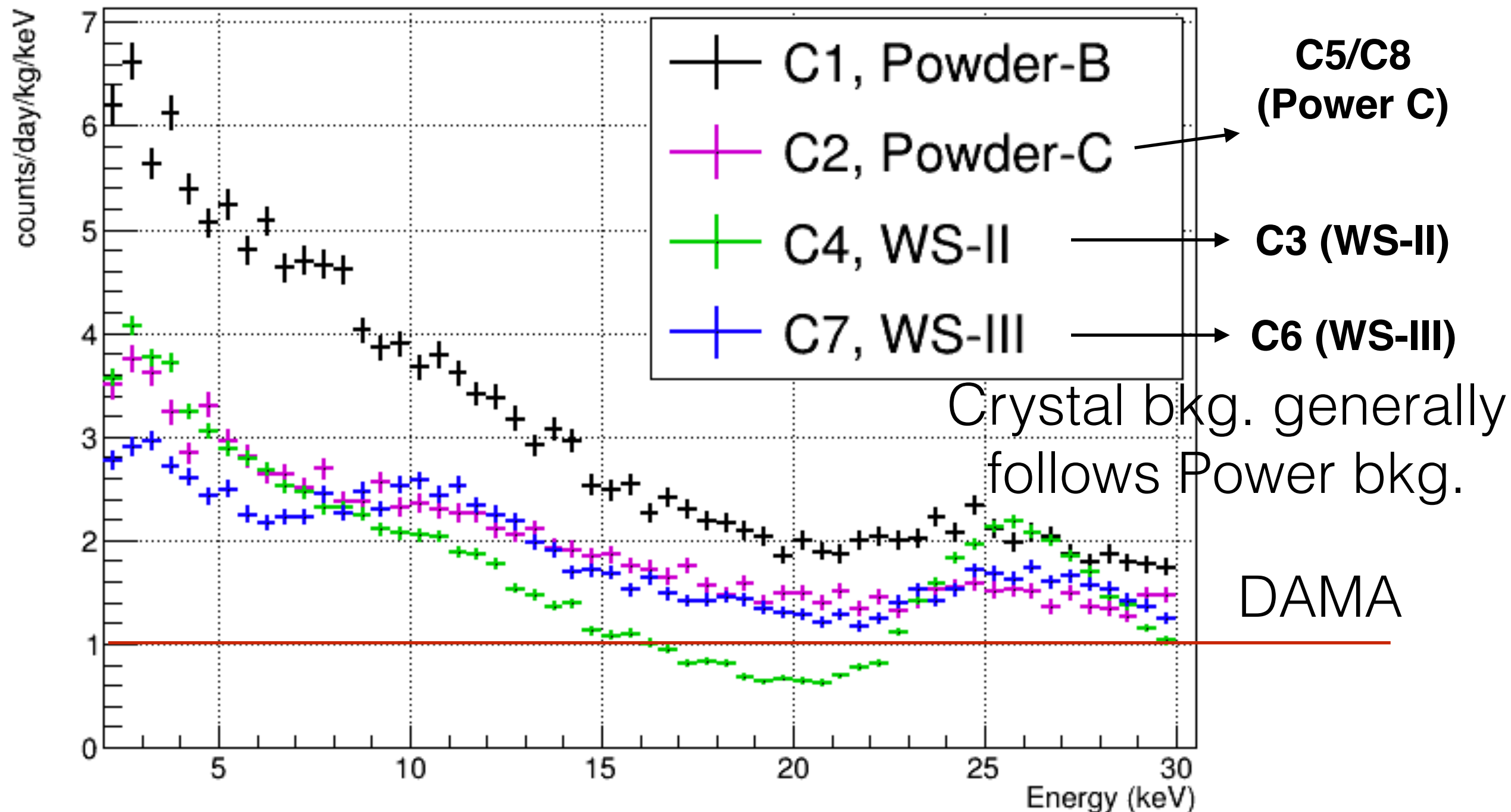
With Machine learning technique, we have successfully rejected PMT noise backgrounds.

Analysis Selection Efficiency



Energy Spectrum (Single-hit spectrum)

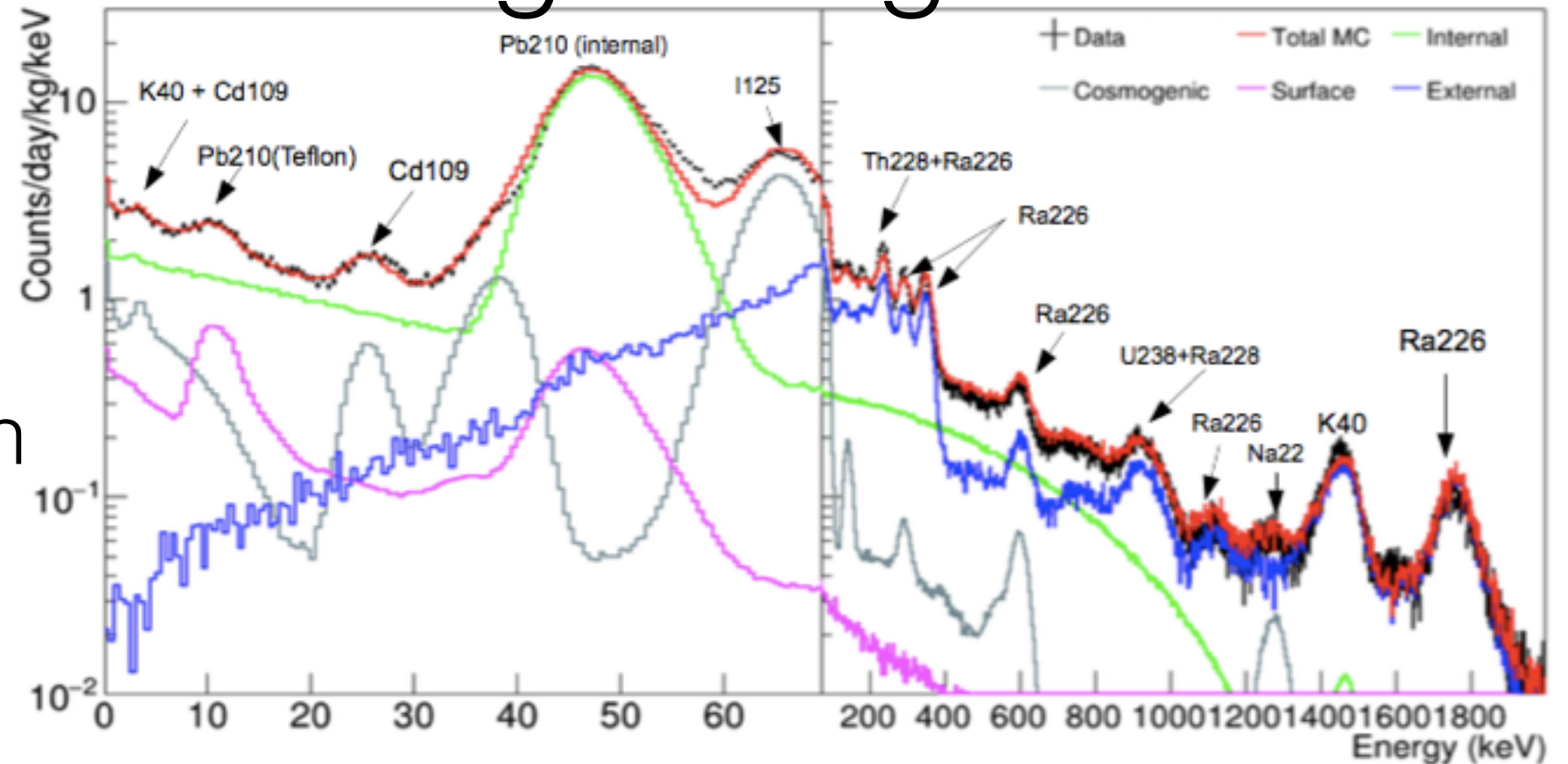
Efficiency Corrected



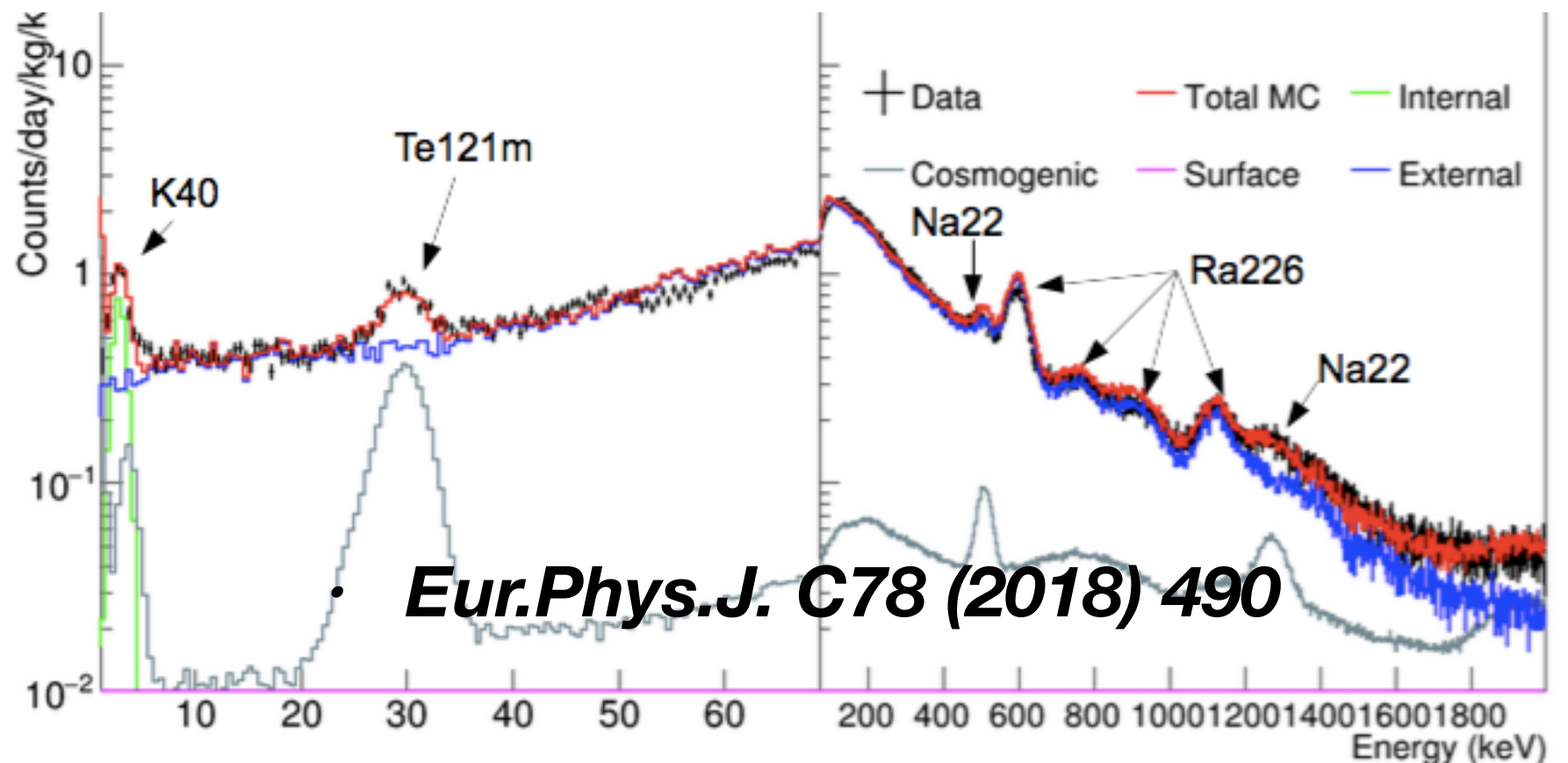
Average count rate at 2-6 keV is
3.5 counts/day/kg/keV

Understanding Background

Single-Hit
(2-6 keV region
not used)

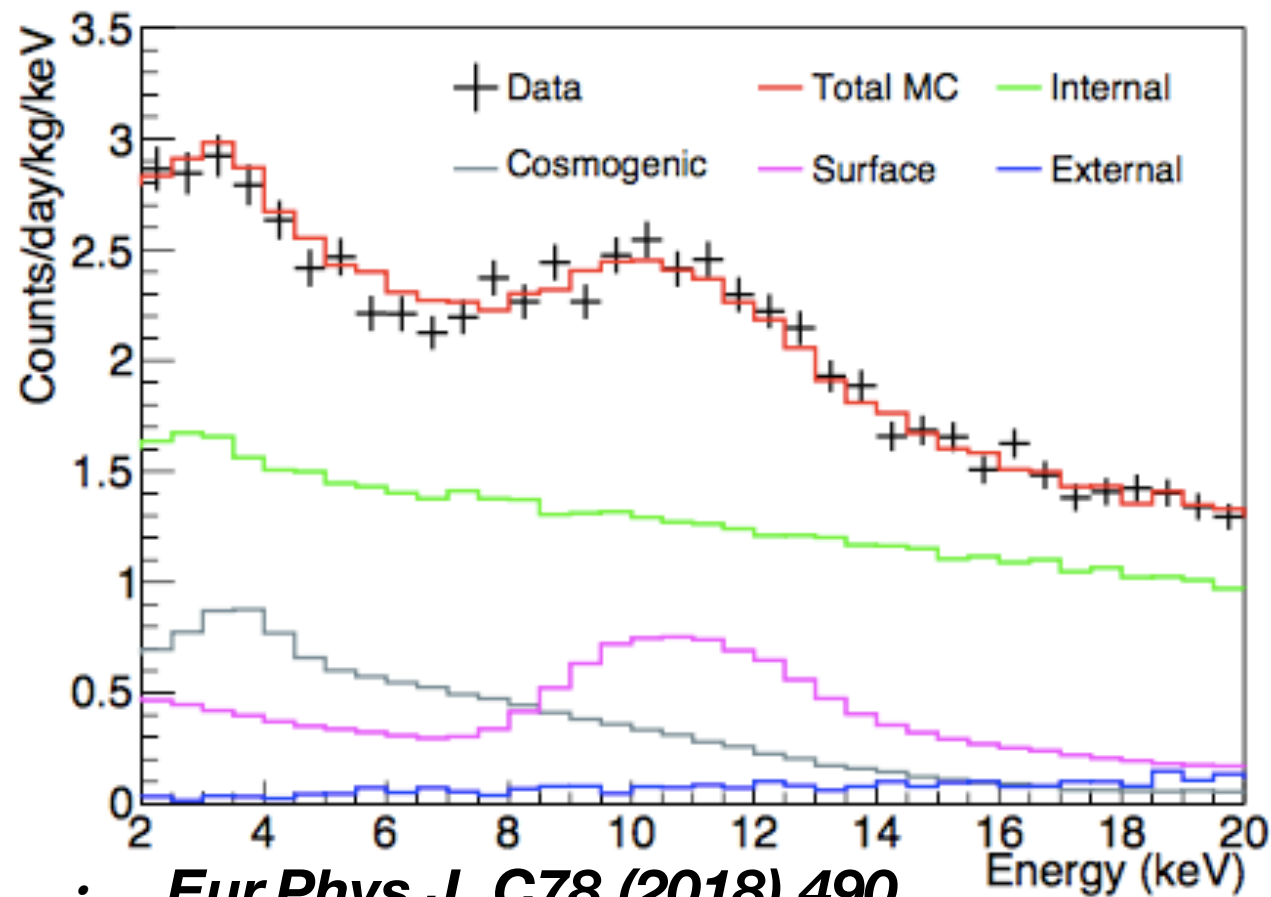


Multiple-Hit

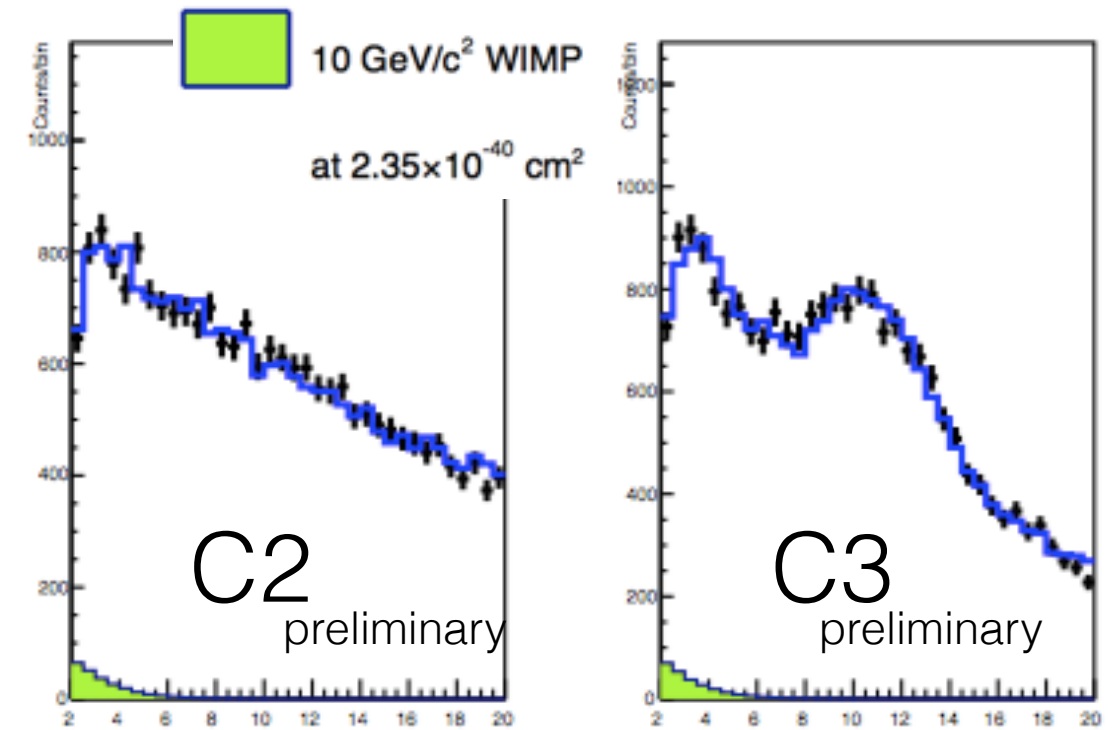


• *Eur.Phys.J. C78 (2018) 490*

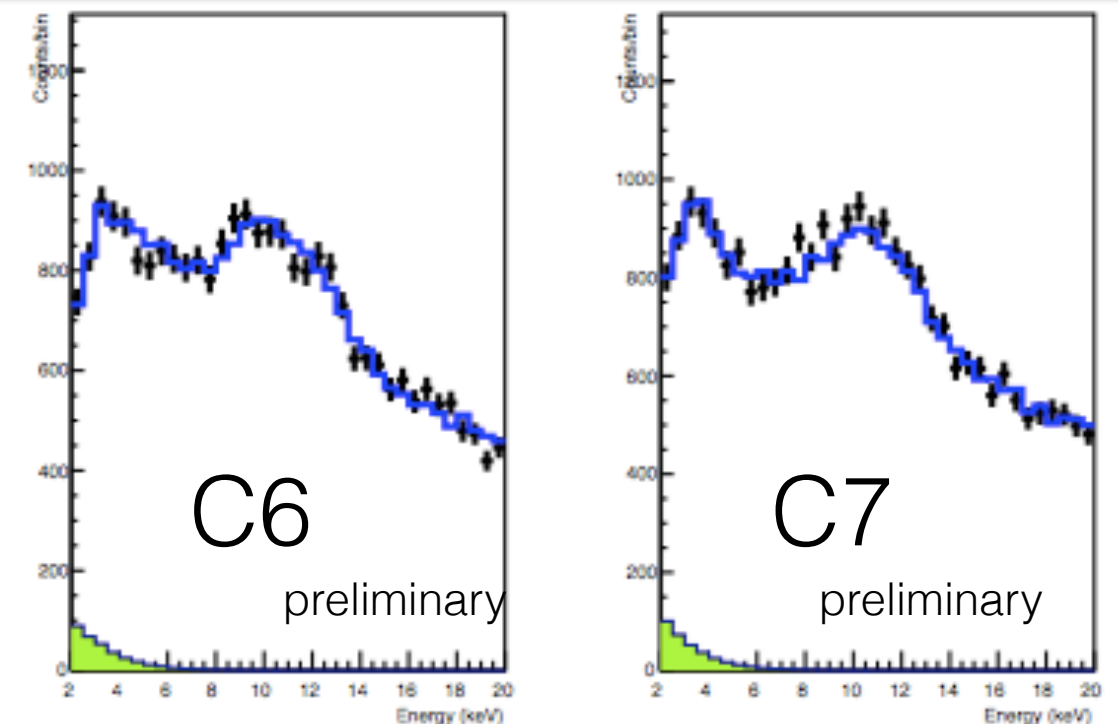
WIMP Search, 59.5 days of Data



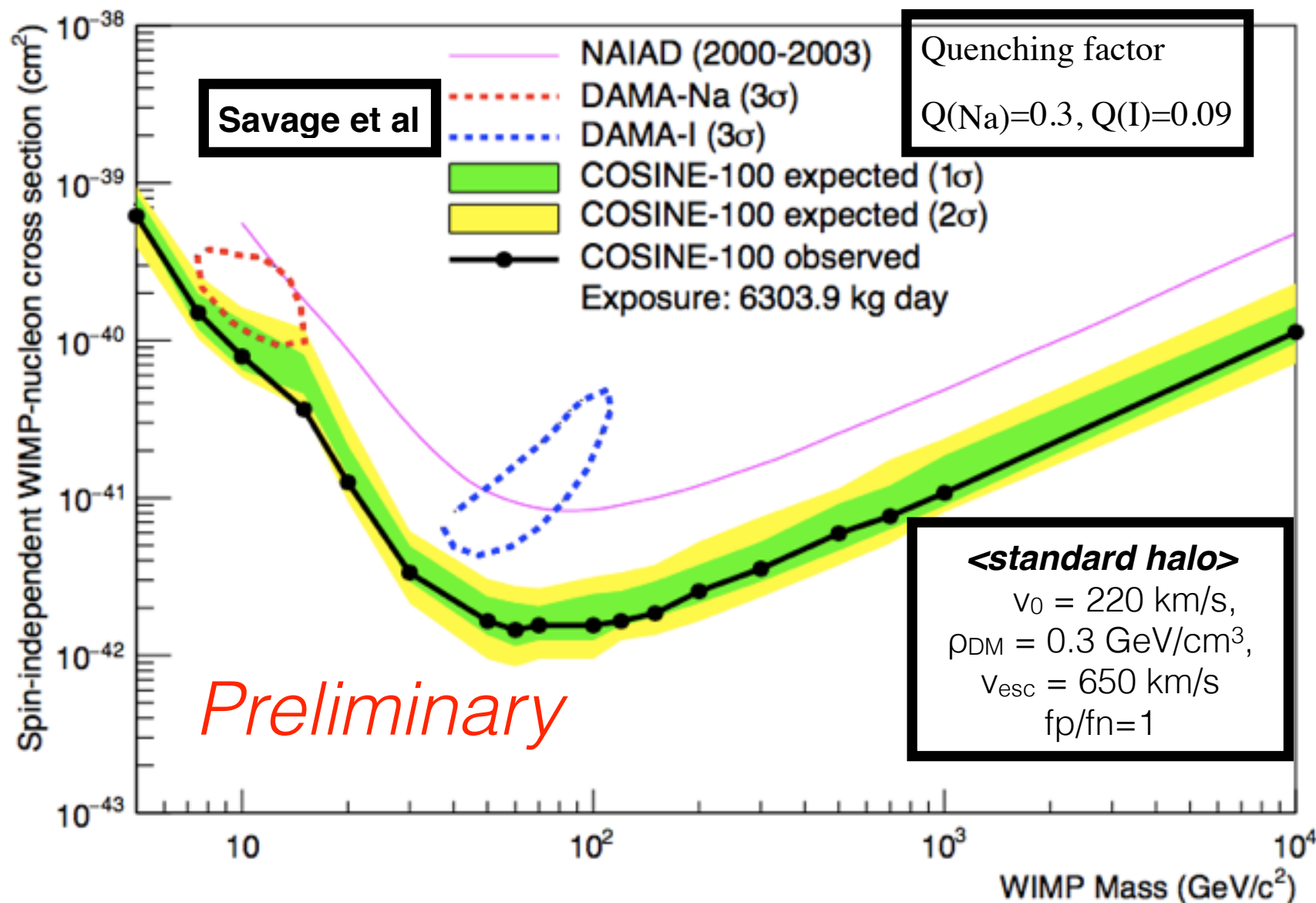
With bkg. understanding, 8 single-hit spectra are fit simultaneously with an assumed WIMP signal (SHM as described in Savage et al., Journal of cosmology and astrophysics), Note that bkg. understanding consideration from Kudryavtsev et al. Astropart.Phys. 33 (2010) 91



Overlay of DAMA-Na Signal at 10 GeV/c²



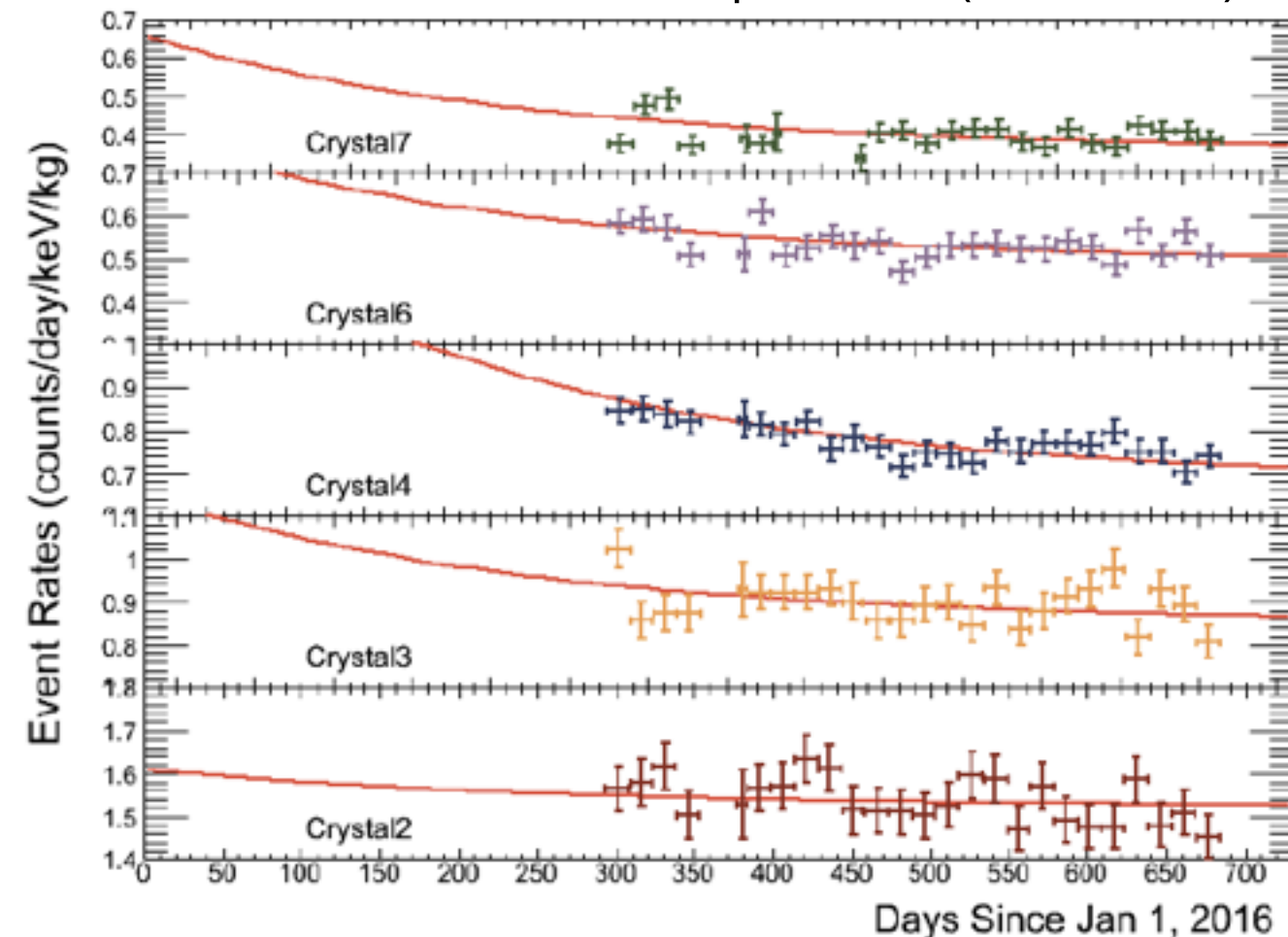
Spin independent WIMP-nucleon cross section limit (59.5 days of the COSINE-100 data)



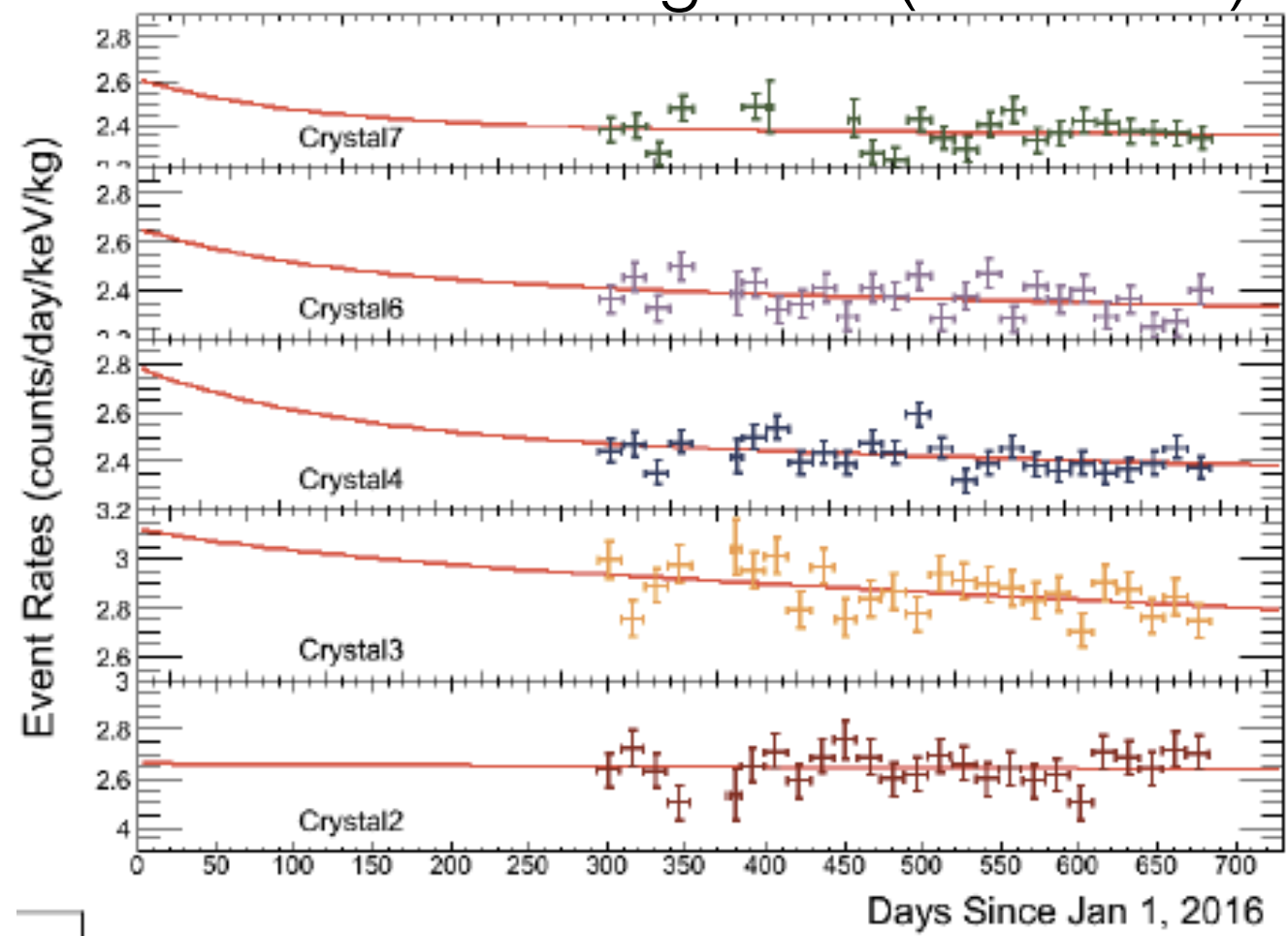
- Spectrum with known sources of backgrounds
- COSINE-100 excludes DAMA/LIBRA-phase1's signal as spin-independent WIMP with Standard Halo Model in NaI(Tl)
- Consistent with null results from other direct detect experiments with different target medium

Annual Modulation Analysis

Side band : Multiple-hit (2-6 keV)



Side band : Single-hit (6-10 keV)

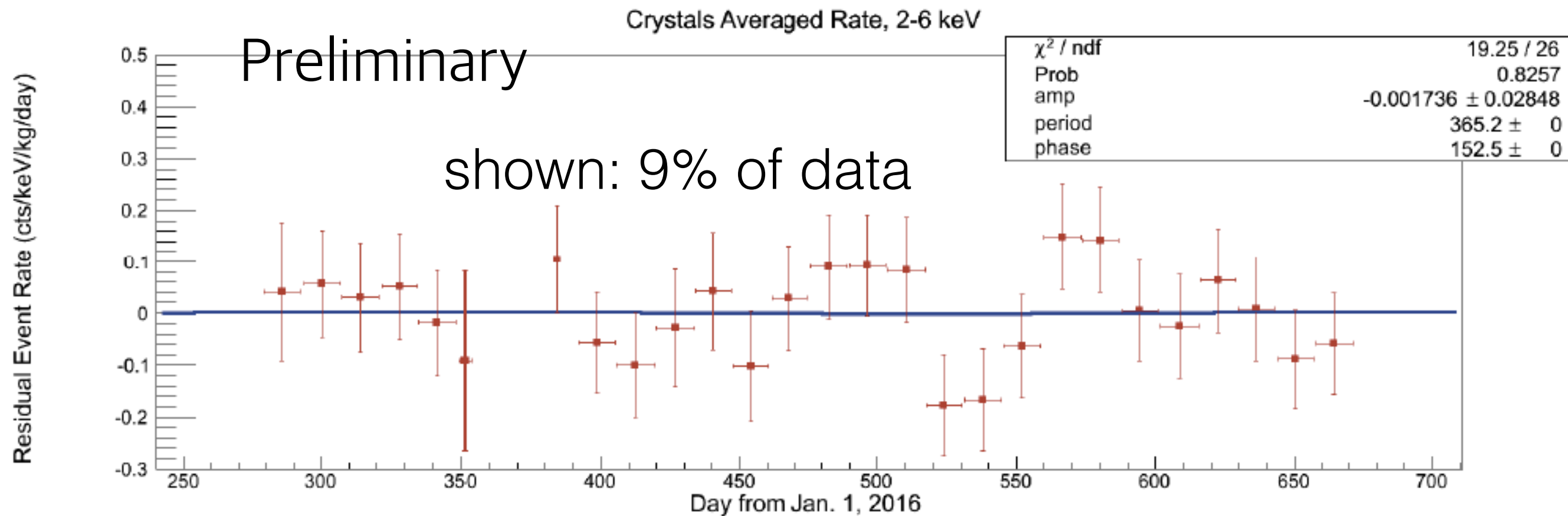


(Full 400 days of data)

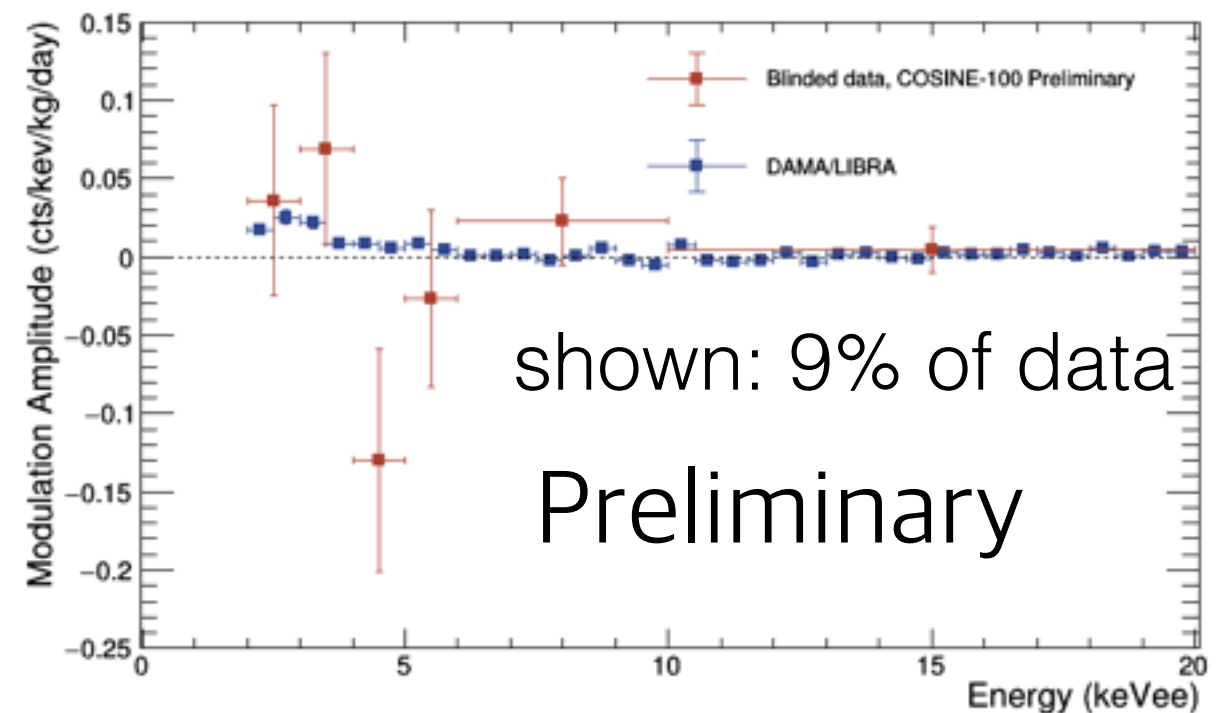
Crystal 1, 5, and 8 are excluded in this analysis due to low light yield and excessive PMT noise

Side band data fits well with simple exponential models built from the known cosmogenic components

Annual modulation analysis : Preliminary, Blinded



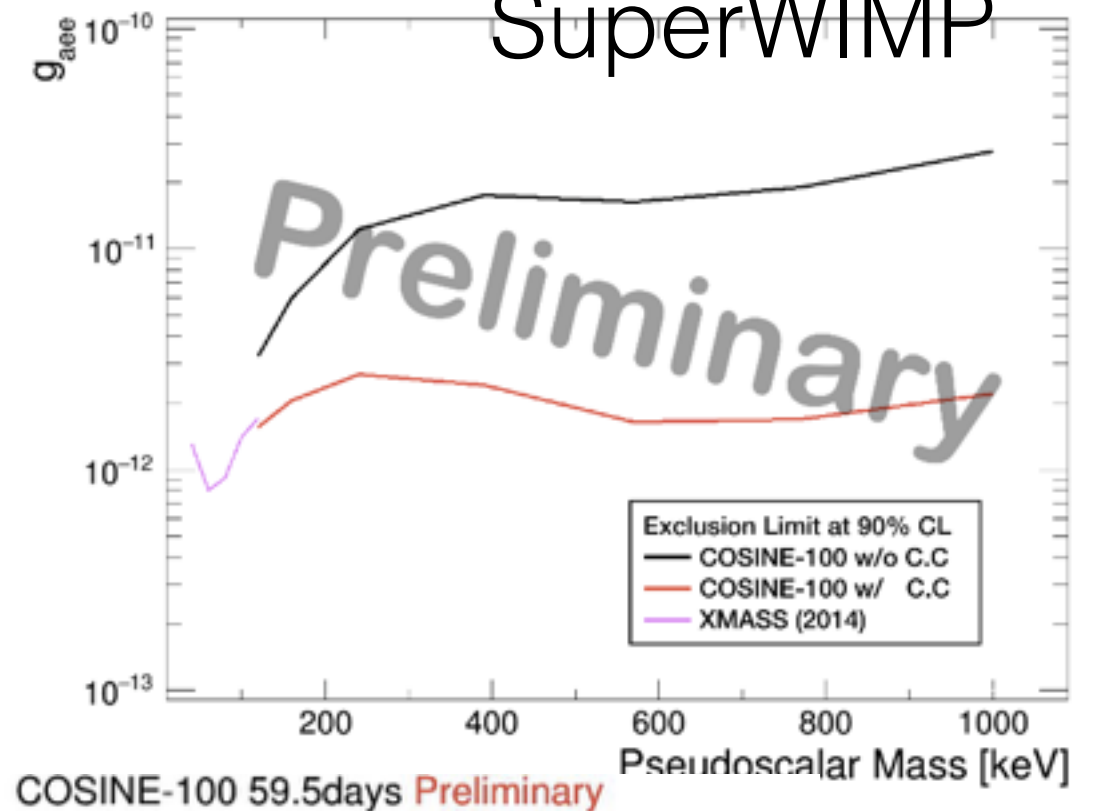
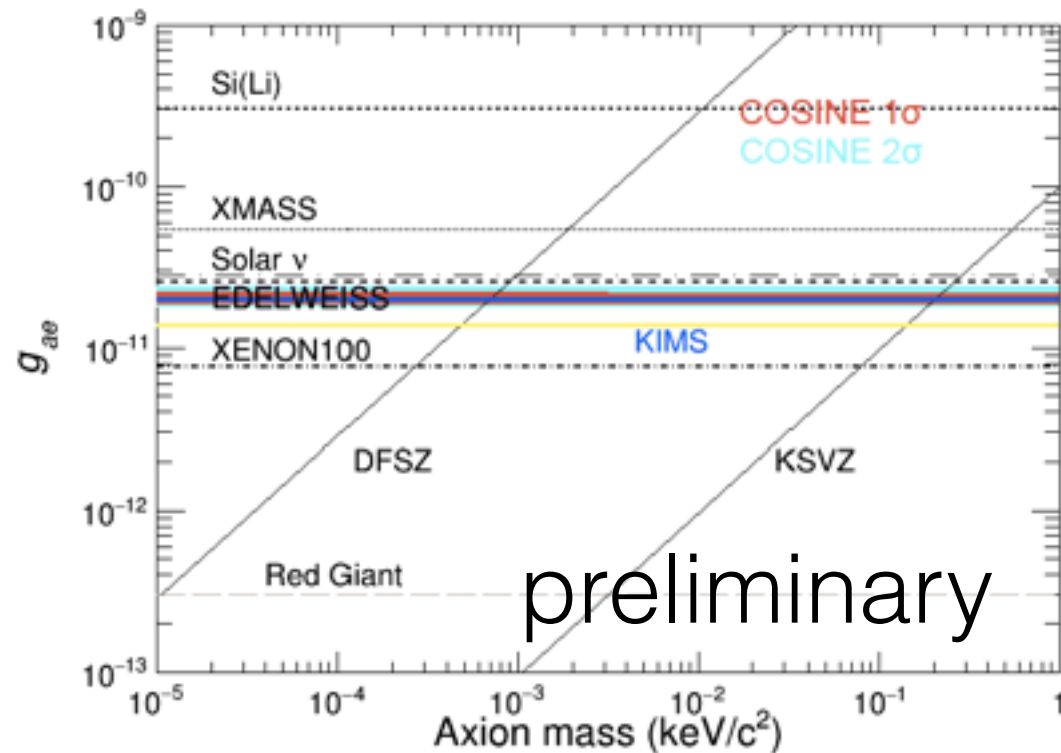
unblinding soon. Stay tuned!



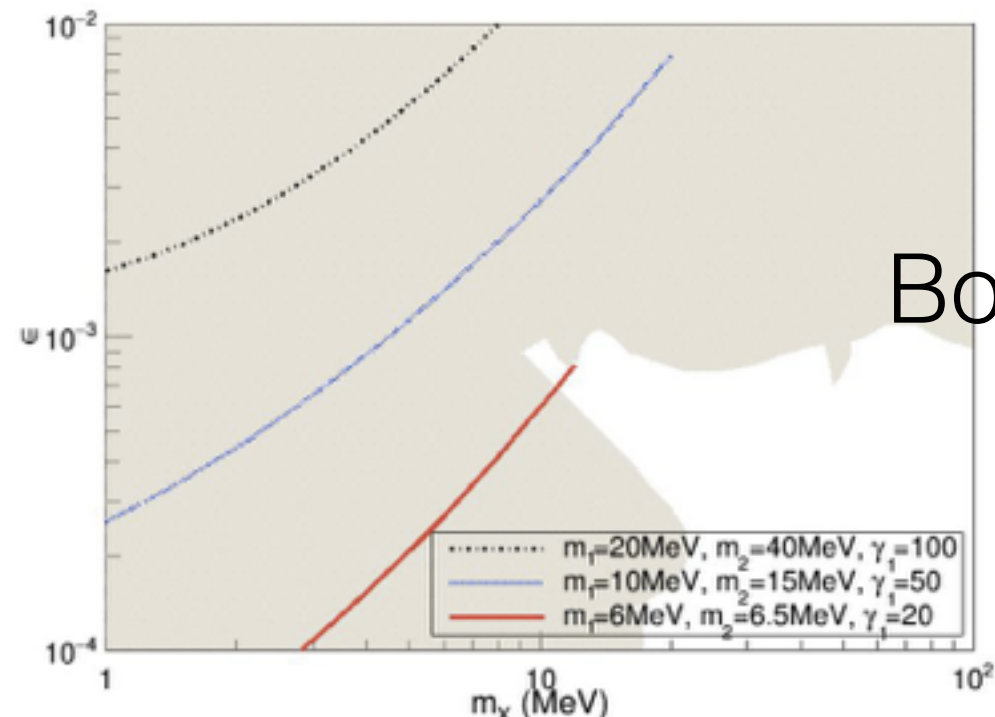
Other searches

Axion

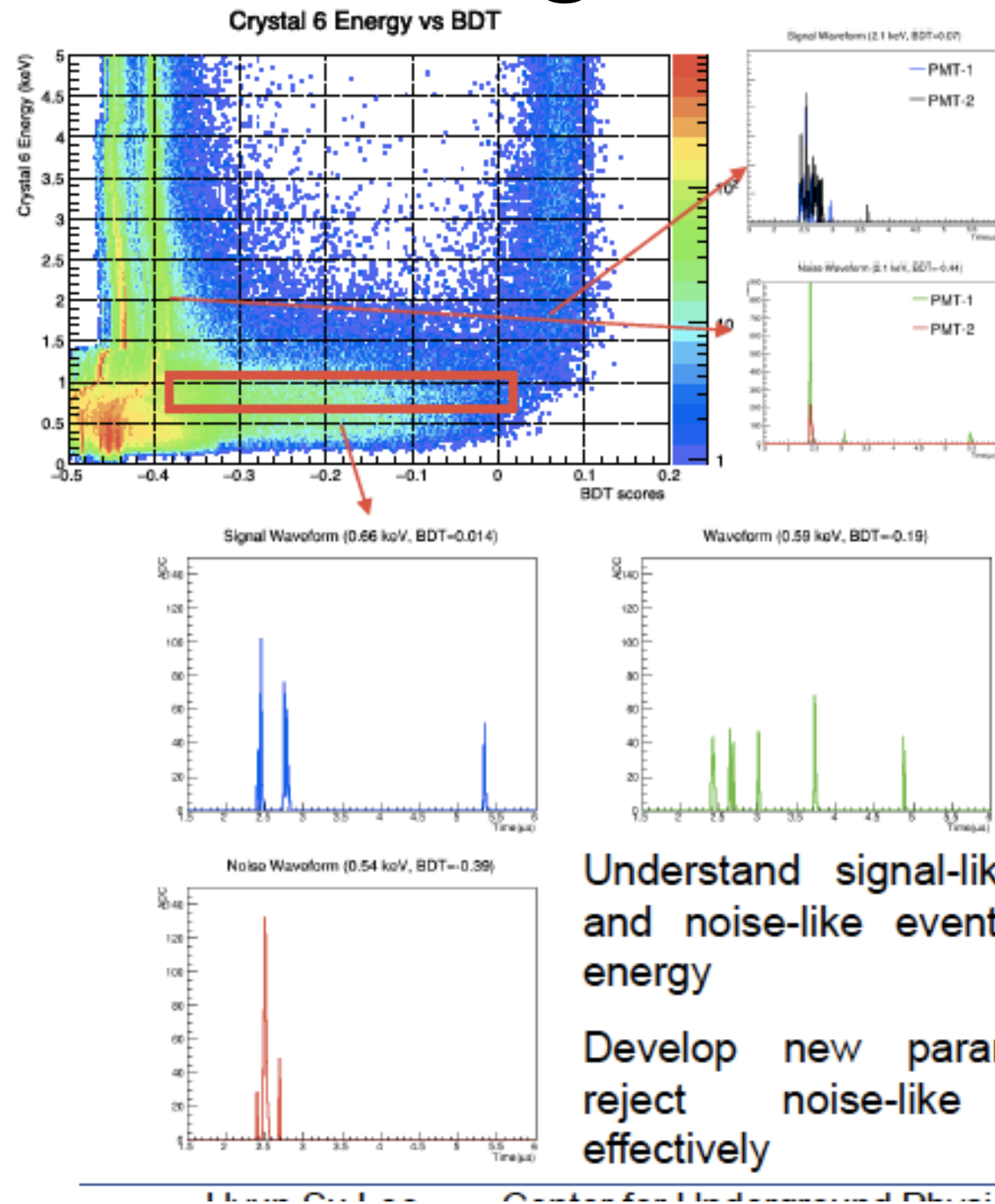
SuperWIMP



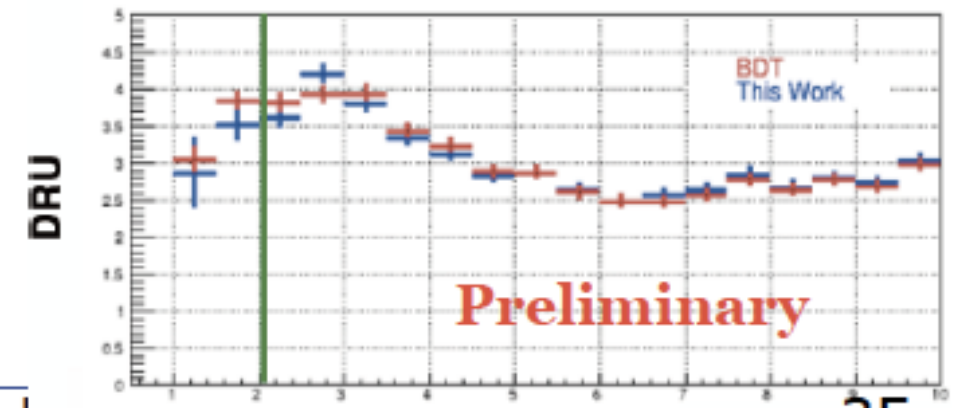
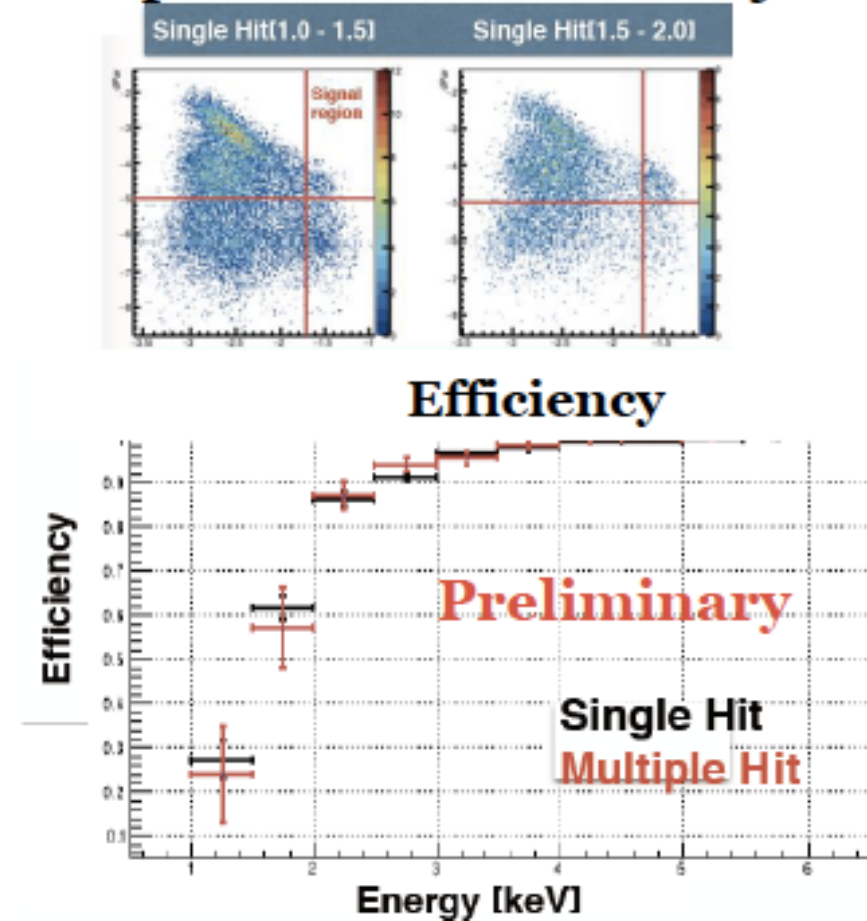
From the background understanding,
Other interesting searches are actively on-going



Going to 1 keV threshold

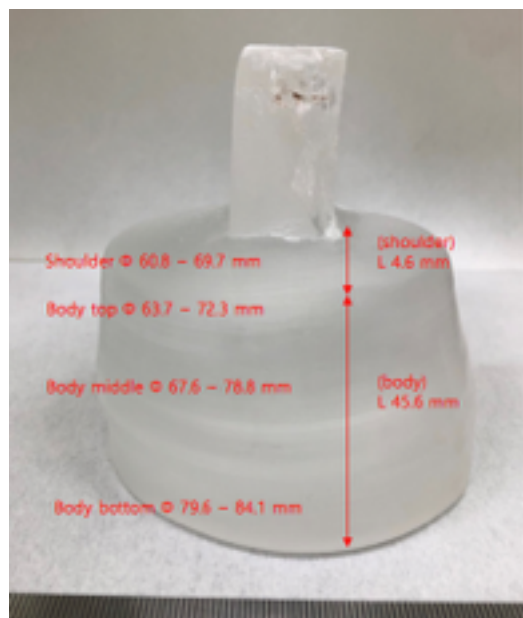


New parameters for noise rejection

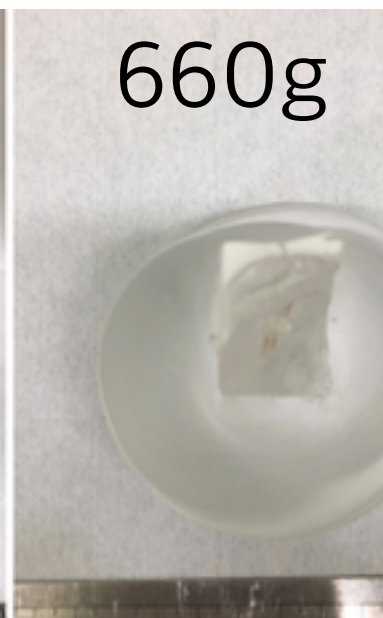


In near future, we expect to minimize this noise as much as possible

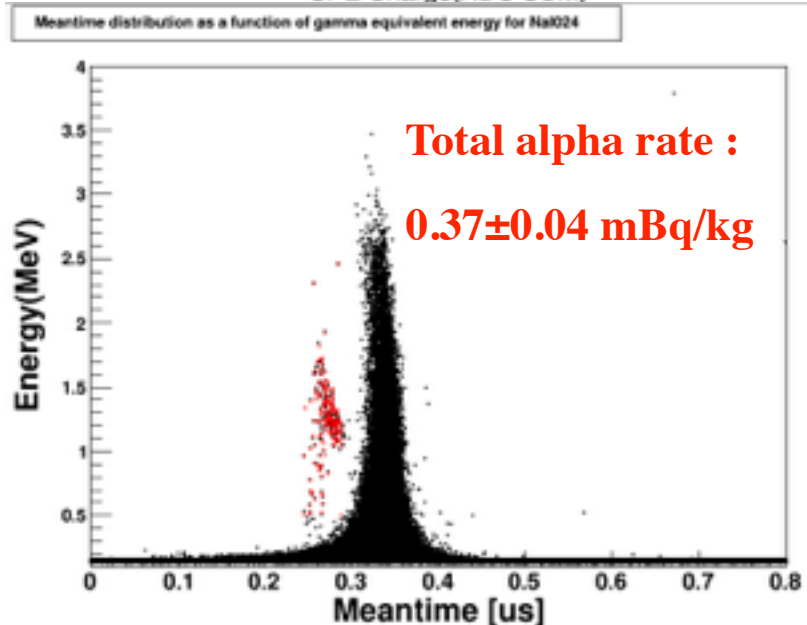
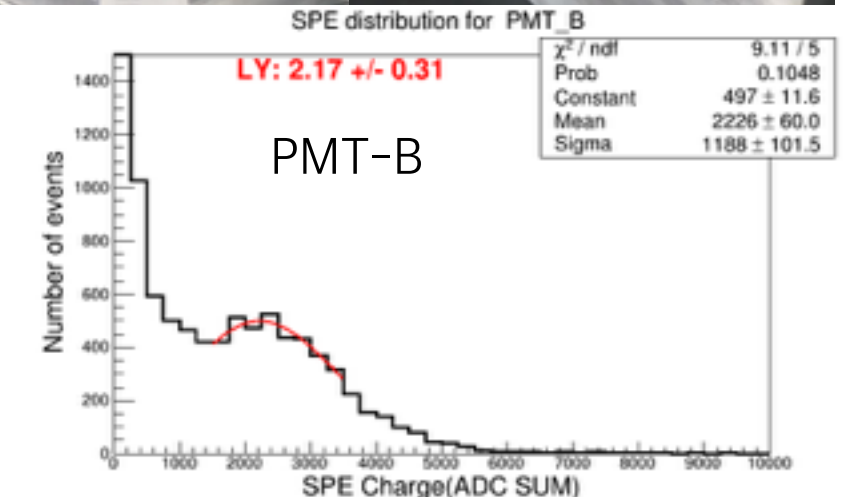
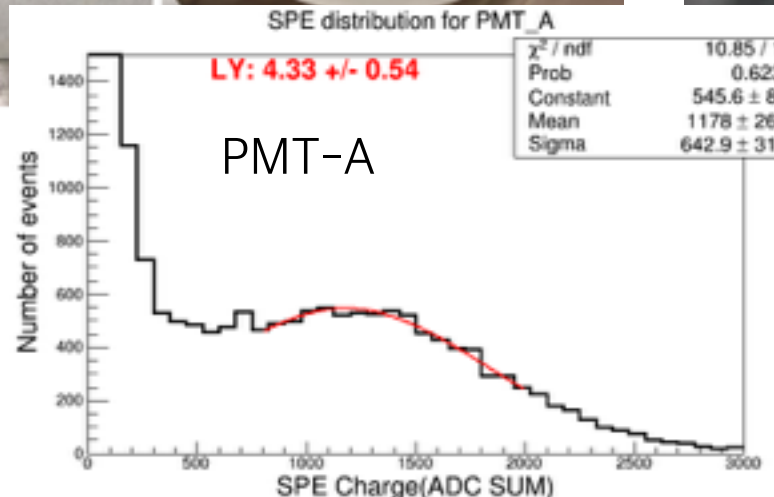
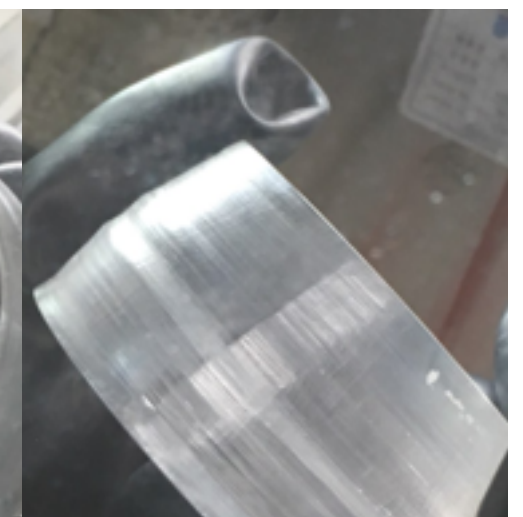
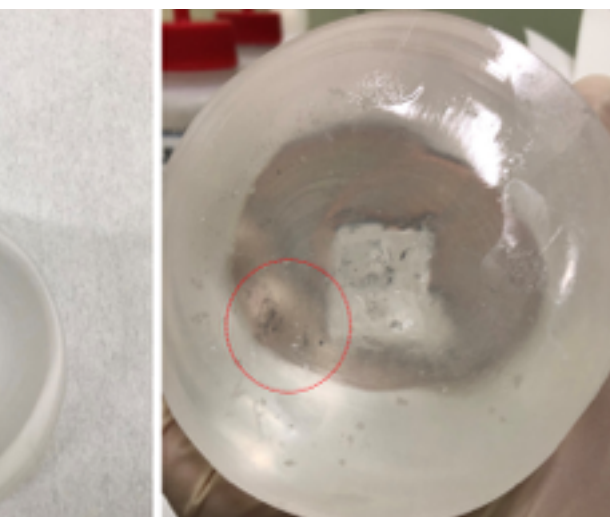
Growing low radioactive NaI(Tl) Crystals at CUP



<결정 사이즈>



<결정 모양>



- A few NaI(Tl) Crystals are grown, encased, and measured at CUP.
- L.Y. ~ 6.5 p.e./keV, Stable
- Low Pb-210/Po-210 : Surface Bkg.
- K-40 : less than 100 ppb

Summary & Outlook

- The COSINE-100 experiment was installed at Y2L and runs smoothly for 20+ months.
- In COSINE-100, we have reached on average 3.5 counts/day/kg/keV with 2 keV thresholds.
- COSINE-100 confirms that DAMA's modulation signal cannot be from standard WIMP & SHM with NaI(Tl).
- Modulation analysis is on-going.
- Analysis with lower threshold is underway
- Much progress made in developing the capabilities to grow and encapsulate radio-pure NaI(Tl) crystals at IBS-CUP