Dark matter search by means of segmented scintillator
PICO-LON Project

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for
PICO-LON Collaboration
PICO-LON concept

- DAMA/LIBRA reports annual modulation
  - No other group reports any modulation
  - Almost all the allowed region was ruled out
  - NaI(Tl) with different method is needed

- PICO-LON

- Planar Inorganic Crystal Observatory for Low-background Neutr(al)inos
  - Highly segmented detector system
  - Propose coincidence measurement of WIMPs
  - Identify the type of interaction SD/SI
Signal Identification by Segmentation

K. Fushimi et al., JPSJ 74(2005)3117
astro-ph/0506329

H. Ejiri, Ch. C. Moustakidis, J. D. Vergados,

γ(INELASTIC) X-ray

χ

RECOIL

χ

γ(INELASTIC) X-ray

S1

S2
Prototype of thin NaI(Tl) scintillator

$(18\text{cm})^2 \times 0.5\text{cm} \text{ NaI(Tl)}$
Performance test

- Energy resolution

$^{241}$Am

- 60keV
- 32keV
- 17keV
- 14\%(FWHM) @ 60keV

$^{133}$Ba

- 31keV
- 81keV
- 17\%(FWHM) @ 30keV
OTO Cosmo Observatory

OTO (Underground)
Cosmic ray: $4 \times 10^{-7}$/cm$^2$/sec
Neutron: $4 \times 10^{-5}$/cm$^2$/sec

Surface Labs.
Cosmic ray: $1.6 \times 10^{-2}$/cm$^2$/sec
Neutron: $8 \times 10^{-3}$/cm$^2$/sec
- Energy resolution ($^{241}\text{Am}$, $^{133}\text{Ba}$)
- BG run
Results at OTO

- Energy resolution
  - $^{241}$Am, $^{133}$Ba

$^{241}$Am

$^{133}$Ba

17keV, 32keV, 60keV, 81keV

15\% (FWHM) @ 60keV

19\% (FWHM) @ 30keV
Low Energy Threshold

500ch = 2.5 keV
Background reduction

Surface (Tokushima)
Underground (OTO)

2.5-orders
High BG
Simulation
Al contamination
U 54ppb  Th 50ppb

PMT Glass contamination
U 90ppb  Th 140ppb  natK 150ppm
PSD analysis for alpha ray emitter

K. Ichihara, K. Fushimi et al., NIMA 515 (2003) 651-656
$^{210}\text{Pb} = 5\text{mBq/kg}$
Conclusion and Prospect

- Prototype detector of PICO-LON
  - 14% at 60keV
  - Enough for inelastic scattering
- Low energy threshold
  - ~2keV for short term run
  - 20keV for long term run → Pulse shape and baseline analysis
- Background
  - Almost all the BGs are from surrounding materials = Al frame, Al-Base, PMTs
  - $^{210}$Pb is big problem
Plan

- **2009-2010**
  - Reduction of $^{210}\text{Pb}$ in NaI(Tl) → Carrying out now
  - Make thin and multilayer NaI(Tl) → Technique established

- **2010-2012**
  - Test experiment
  - Low BG run