NEWAGE
2014-2019 and beyond

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NEWAGE

New general WIMP search with an Advanced Gaseous tracker Experiment
Direction-Sensitive Dark Matter Search

WIMP-WIND from "CYGNUS"
NEWAGE  before 2014

- \(\mu\text{-PIC(MPGD)}\) based TPC
  - 3-D tracks SKYMAP
- CF4 gas for SD search

- Proposal  PLB 578 (2004) 241
- First direction-sensitive limits
  - PLB654 (2007) 58
- Underground results
- Phase for “low BG detector”
NEWAGE detector

- NEWAGE-0.3b'
- Detection Volume: $31 \times 31 \times 41 \text{cm}^3$
- Gas: CF4 at 0.1atm (50keVee threshold)
- Gas circulation system with cooled charcoal

Drift length: 41cm
PEEK + copper wires
NEWAGE
2014-2019
BG study (2014)

BG source: alpha particle from μ-PIC

Glass cloth in PI had O(ppm) U/Th

TARGET: low-α emitting μ-PIC development
Low-\(\alpha\) \(\mu\)-PIC

2014 material selection
- new material: PI + epoxy
- BG level: < 1/100

Material selection results:

<table>
<thead>
<tr>
<th></th>
<th>238U [ppm]</th>
<th>232Th [ppm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI including glass cloth</td>
<td>0.39±0.01</td>
<td>1.81±0.04</td>
</tr>
<tr>
<td>PI+epoxy</td>
<td>&lt; 2.98\times 10^{-3}</td>
<td>&lt; 6.77\times 10^{-3}</td>
</tr>
</tbody>
</table>

\(\mu\)-PIC structure (original)

\(\mu\)-PIC structure (new)
Low-α μ-PIC : development

Development of low-α emitting μ-PIC

- 2015: 10 × 10 cm² μ-PIC
- 2016: 30 × 30 cm² μ-PIC

perfectly produced! in spite of the material change
Low-α μ-PIC: performance

2017: performance of low-α emitting μ-PIC
- gas gain >1000 (requirements)
- gain non-uniformity RMS < 20% (requirements)

Requirements satisfied!
Low-\(\alpha\) \(\mu\)-PIC : DM run

Installation: Dec. 2017

DM run: 2018-

- RUN22-1 2018/6/6~2018/8/24 (47 days)
- RUN22-2 2018/9/20~2018/12/3 (61 days)

measurement: T. Hashimoto
analysis: T. Ikeda (poster #3)

directional limits

\begin{itemize}
\item energy spectrum
\item SD 90\% C.L. directional upper limits
\end{itemize}

\(~\times 10\) improvements
NEWAGE and beyond
NEWAGE : next

new main BG:

- μ-PIC: surface BG
- radons

μPIC structure (now) surface BG was observed

β-rays from the 800 μm “core substrate” (near future BG)

α counter results (K. Kobayashi)

BG study: see poster #3 (T. Ikeda)

more than ×10 improvements in next 5 years

study: T. Ikeda (poster #3)
helped by K. Kobayashi (XMASS, B01 D01)
Negative ion TPC

- minority peaks “discovery” (DRIFT group)
- O₂ addition to CS₂+CF₄ gas
- SF₆ gas
  
  several species of ions with different velocities

**SF₆ results**

Detection of absolute z-position

⇒ BG reduction
3D tracking + z-fiducialization (first!)

preliminary

paper in preparation
large chamber (CYGNUS/NEWAGE)

- 18 windows for $30 \times 30 \text{ cm}^2$ detectors
- new concept detectors are welcome!

ready for low rate measurement
NEWAGE and low BG activities
Neutron flux @ Kamioka

- $^3$He counter + sim (Geant4+PHITS)
- w/ spectrum prediction
- Other detectors are being prepared

Detection schematics

Neutron spectrum results

Detection schematics:

- Thermal
- Fast

Setup A:
- "Setup A"
- $^3$He
- Polyethylene
- Boron sheet
- "510mm"

Setup B:
- "Setup B"
- "510mm"

Boltzmann

Neutron spectrum results:

- 1/E
- "bump"

Energy range       | Flux ($\times 10^{-6}$ cm$^{-2}$s$^{-1}$)
-------------------|----------------------------------
< 0.5 eV           | 7.88
0.5 eV to 1 keV    | 3.11
1 keV to 1 MeV     | 8.65
$\geq$ 1 MeV       | 3.88
α-ray imaging chamber (Al-cham)

- application of low-α μ-PIC
- α-ray imaging (pos. res. = 0.68 cm)
- BG level = 1.58×10^{-2} α/h/cm^2 (subtraction possible)

H. Ito. (NIMA submitted, 1903.01090) with K. Kobayashi (XMASS, B01 D01)
New concept TPC with sheet resistor

- to overcome potential problem of existing TPCs:
  - distortion of field cage or complicated design
  - radioactive background

K. Miuchi (PTEP submitted, 1903.01663)
With K. ichimura, K. Abe (XMASS, B01, D01)
Prototype of SR $\mu$-TPC

RI measurement (mBq/kg)

<table>
<thead>
<tr>
<th>Upper U-chain</th>
<th>Middle U-Chain</th>
<th>$^{210}$Pb</th>
<th>$^{232}$Th</th>
<th>$^{40}$K</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 59.6</td>
<td>&lt; 18.4</td>
<td>&lt; 134</td>
<td>&lt; 7.77</td>
<td>&lt; 112</td>
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Measured $\mu$ tracks

Prototype

Sheet resistors inside the wall

K. Miuchi (PTEP submitted, 1903.01663)
With K.ichimura, K. Abe (XMASS, B01, D01)
Columnar recombination

- SI (Xe), high pressure

With AXEL (B02-KOUBO)

- proof of concept (for high energy α’s)
Summary

- NEWAGE 2014-2019: low-α μ-PIC development ⇒ great success
- DM sensitivity ×10 improvement

- Neutron flux measurement
- α-imaging chamber (Al-cham)
- low BG TPC with sheet resistor (SRμ-TPC)