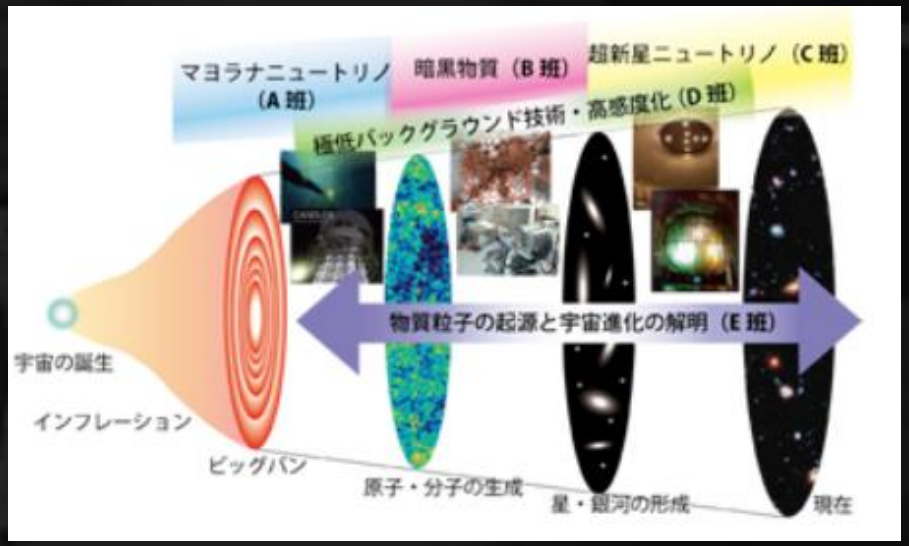
NEWAGE

2014-2019 and beyond

Kentaro Miuchi

KOBE University



Contents

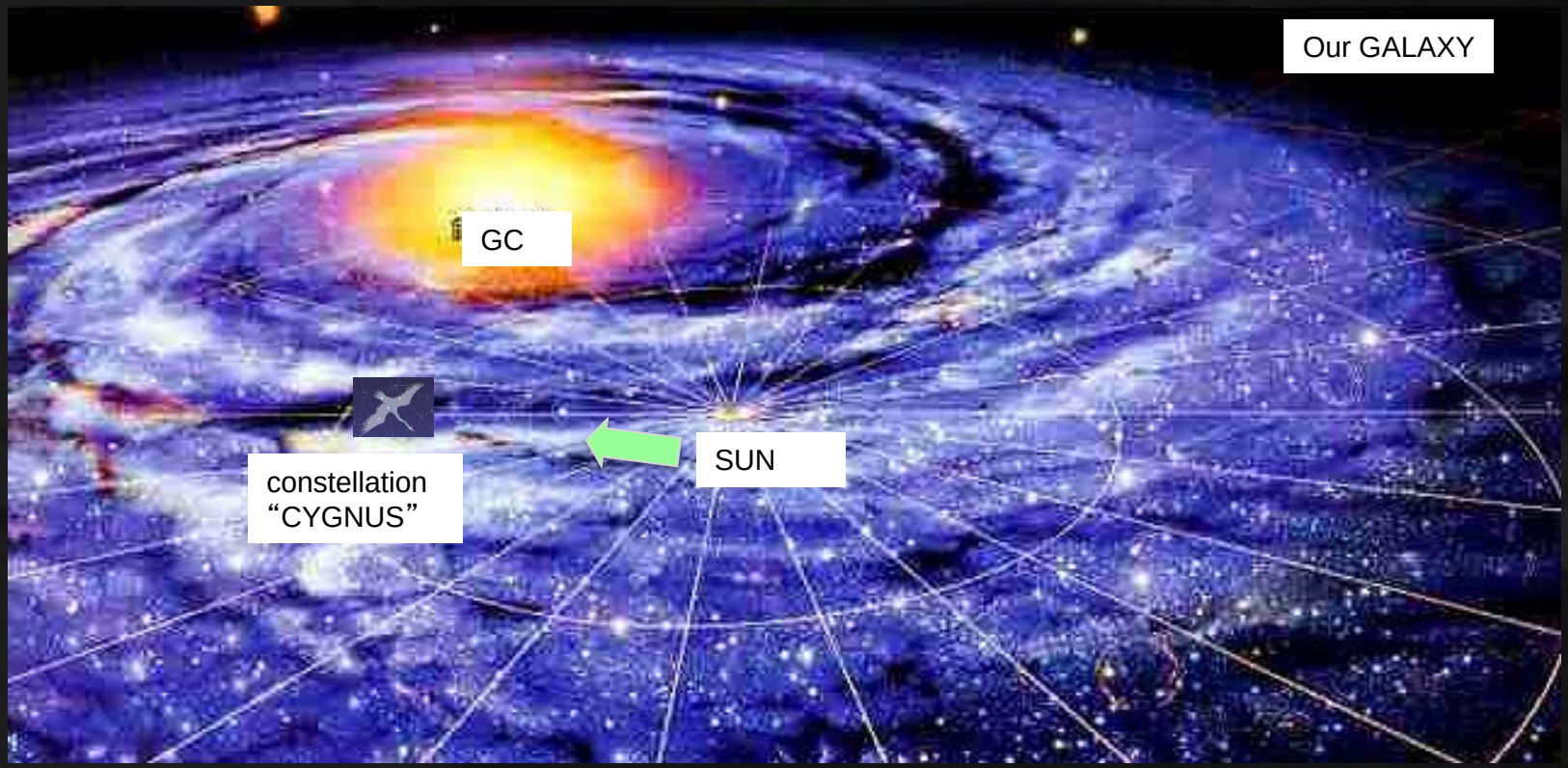
科研費 KAKENHI

Direction-Sensitive WIMP-search NEWAGE

NEWAGE

New general WIMP search with an Advanced Gaseous tracker Experiment

Direction-Sensitive Dark Matter Search

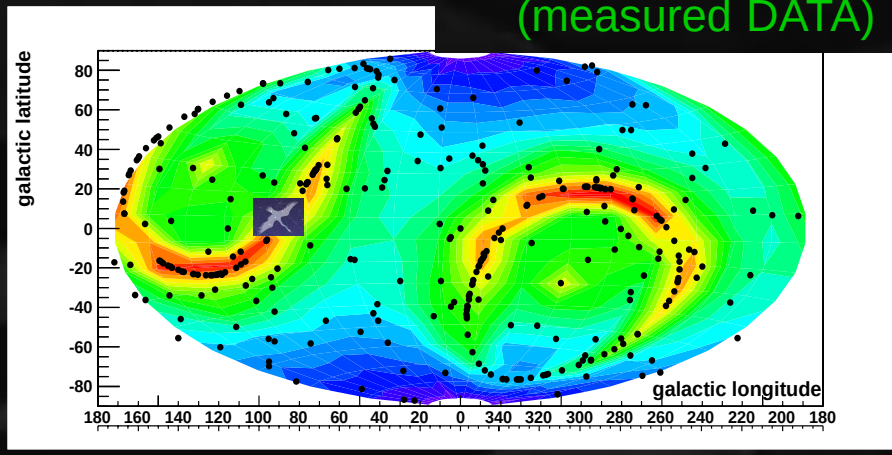


WIMP-WIND from “CYGNUS”

NEWAGE before 2014

- μ-PIC(MPGD) based TPC
  - 3-D tracks SKYMAP
- CF4 gas for SD search

SKYMAP
(measured DATA)

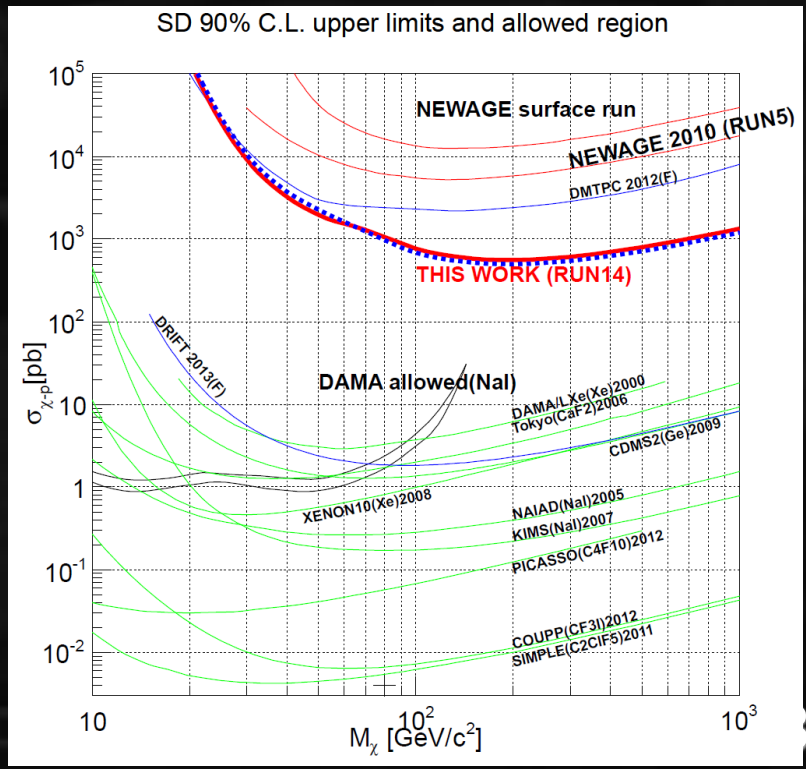


- Proposal PLB 578 (2004) 241
- First direction-sensitive limits

  PLB654 (2007) 58
- Underground results

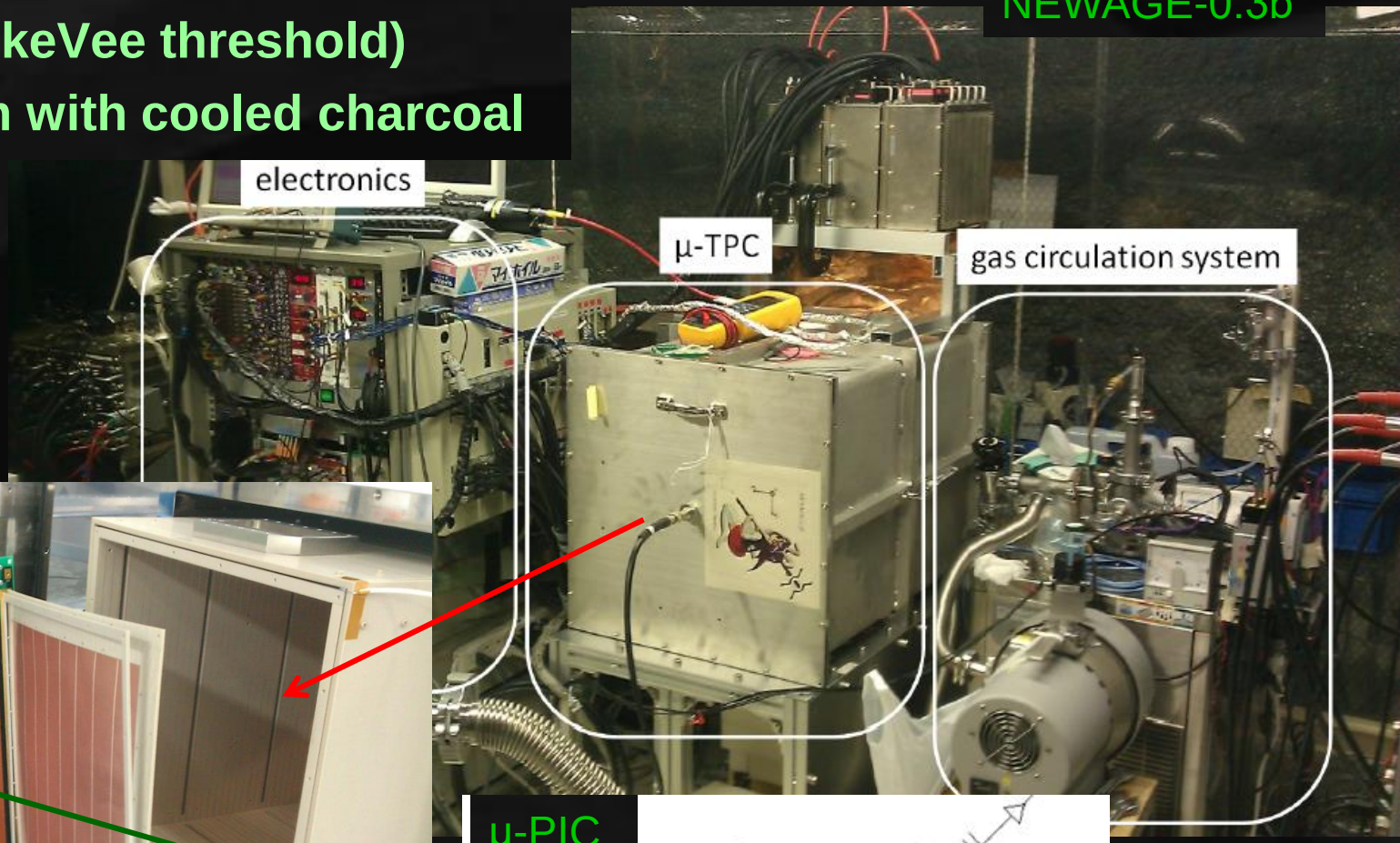
  PLB686 (2010) 11, PTEP (2015) 043F01s
- Phase for “low BG detector”

limits PTEP (2015) 043F01s

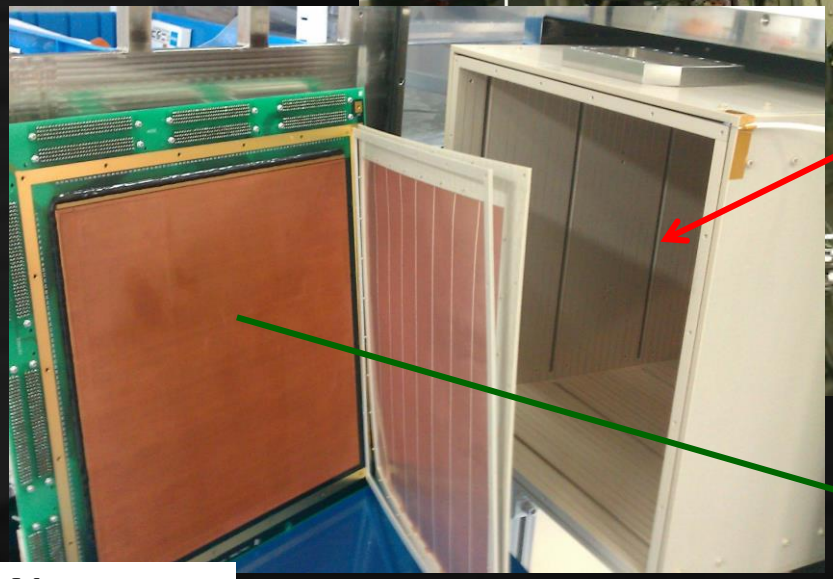


NEWAGE detector

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

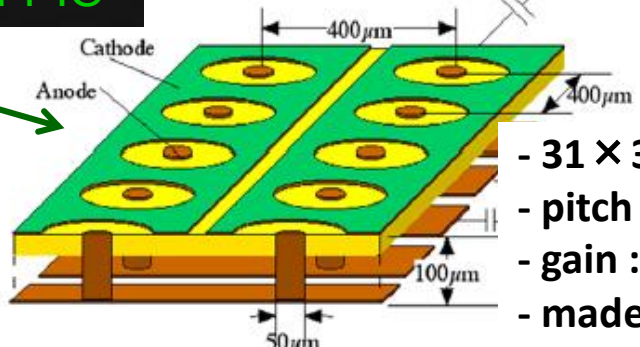


μ-TPC



Drift length: 41cm
PEEK + copper wires

μ-PIC



- 31×31cm^2
- pitch : 400μm
- gain : ~1000
- made by DNP, Japan

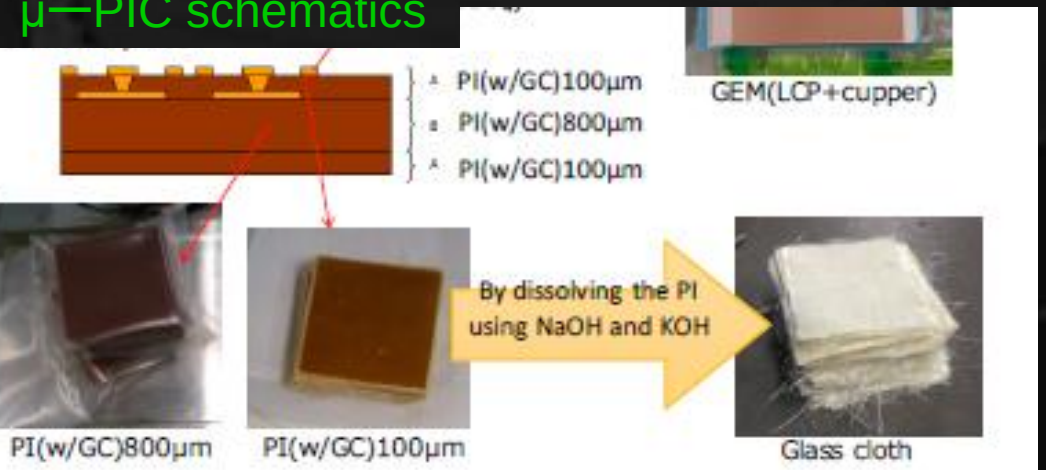
NEWAGE
2014-2019

BG study (2014)

K. Nakamura
T. Hashimoto

BG source: alpha particle from μ-PIC

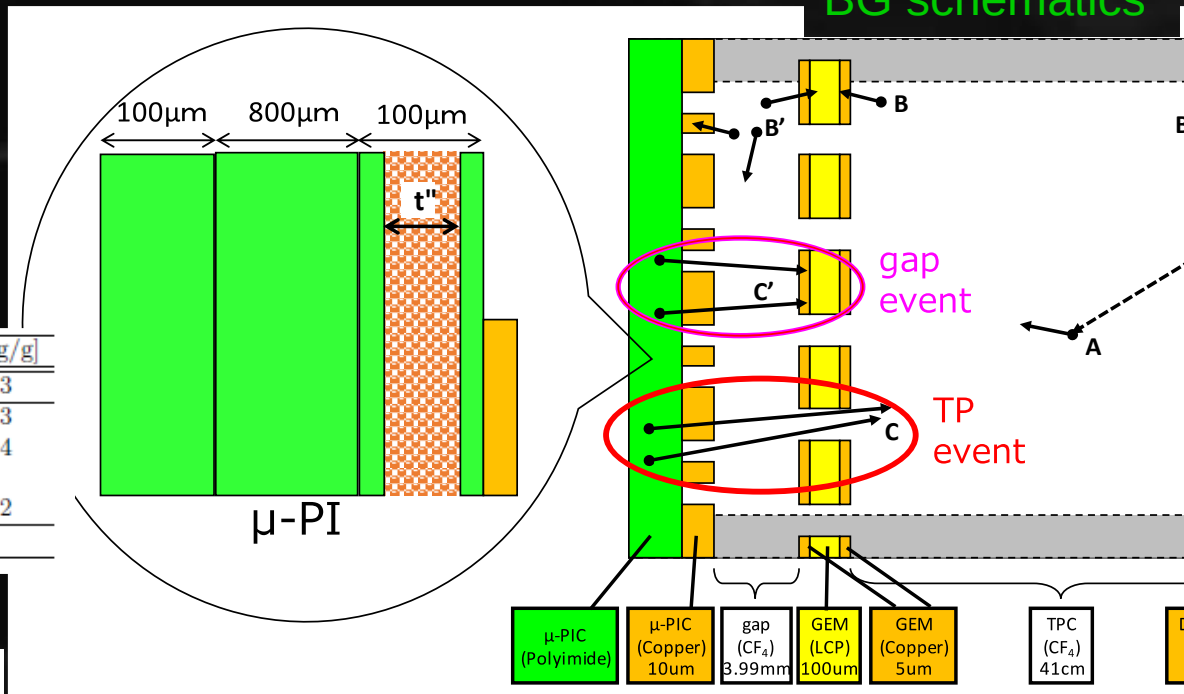
μ—PIC schematics



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

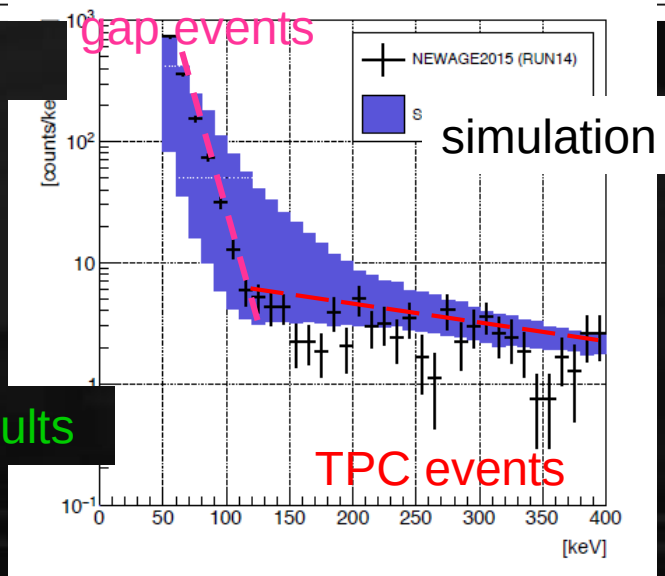
Sample	^{238}U middle stream [10^{-6} g/g]	^{238}U upper stream [10^{-6} g/g]	^{232}Th [10^{-6} g/g]
μ-PIC	1.17 ± 0.01	1.14 ± 0.01	5.84 ± 0.03
PI(w/GC)800 μmpart	0.78 ± 0.01	0.76 ± 0.01	3.42 ± 0.03
PI(w/GC)100 μmpart	0.39 ± 0.01	0.38 ± 0.01	1.81 ± 0.04
Plating solution[1]	< 0.01	< 0.13	< 0.06
Glass cloth	0.84 ± 0.03	0.91 ± 0.02	3.48 ± 0.12
GEM	< 0.02	< 0.17	< 0.12

BG schematics



HPGe results

MC results



TARGET:
low-α emitting μ-PIC development

Low-α μ-PIC

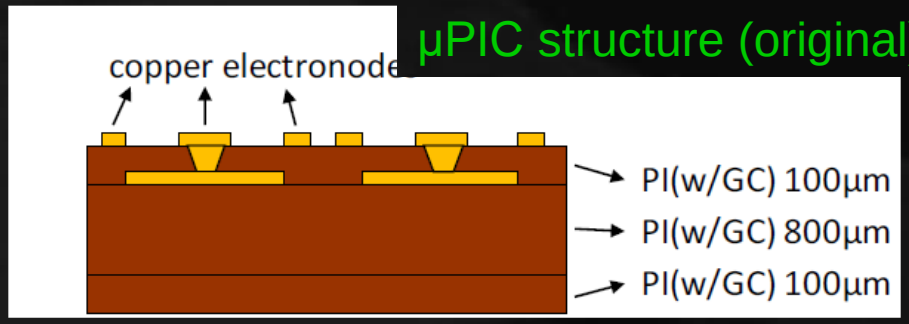
T. Hashimoto
helped by K. Ichimura, K.Abe (XMASS, B01,D01)

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

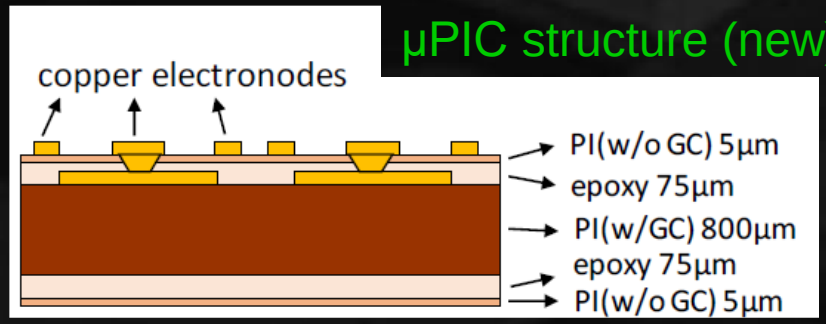
material selection results

	^{238}U[ppm]	^{232}Th[ppm]
PI including glass cloth	0.39±0.01	1.81±0.04
PI+epoxy	$< 2.98\times10^{-3}$	$< 6.77\times10^{-3}$ ← New material

μPIC structure (original)



μPIC structure (new)



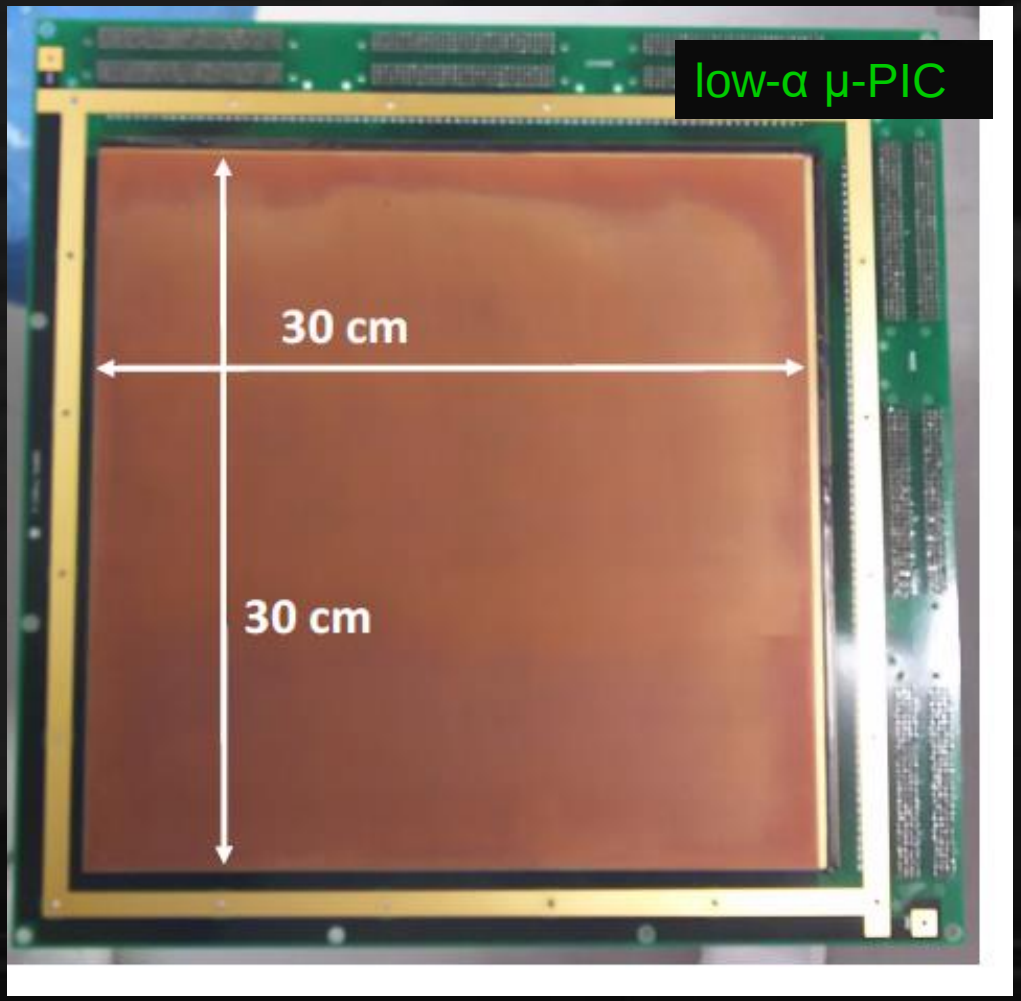
Direction Sensitive WIMP-search NEWAGE

Low-α μ-PIC：development

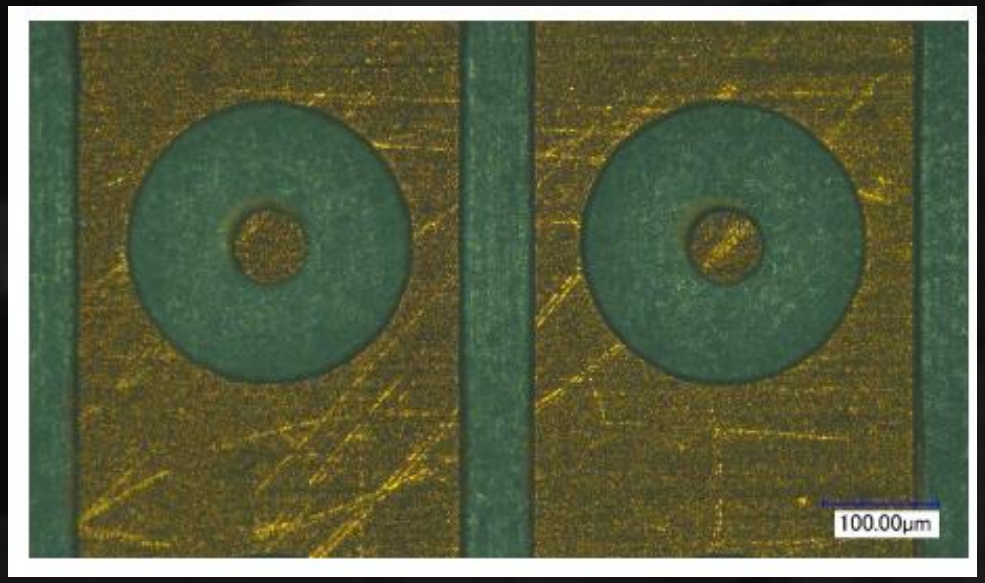
T. Hashimoto

& DNP Co.

- **Development of low-α emitting μ-PIC**
  - **2015: 10×10 cm² μ-PIC**
  - **2016: 30×30 cm² μ-PIC**



low-α μ-PIC electrodes



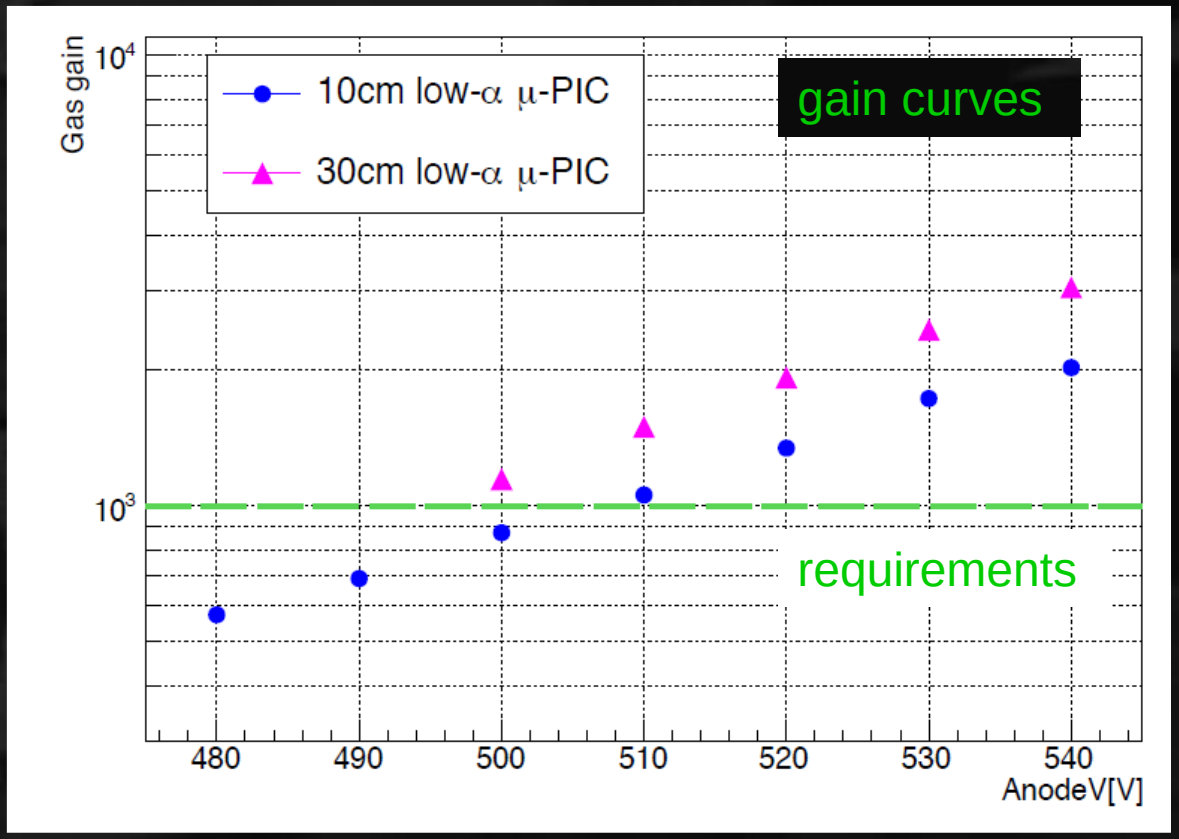
perfectly produced !

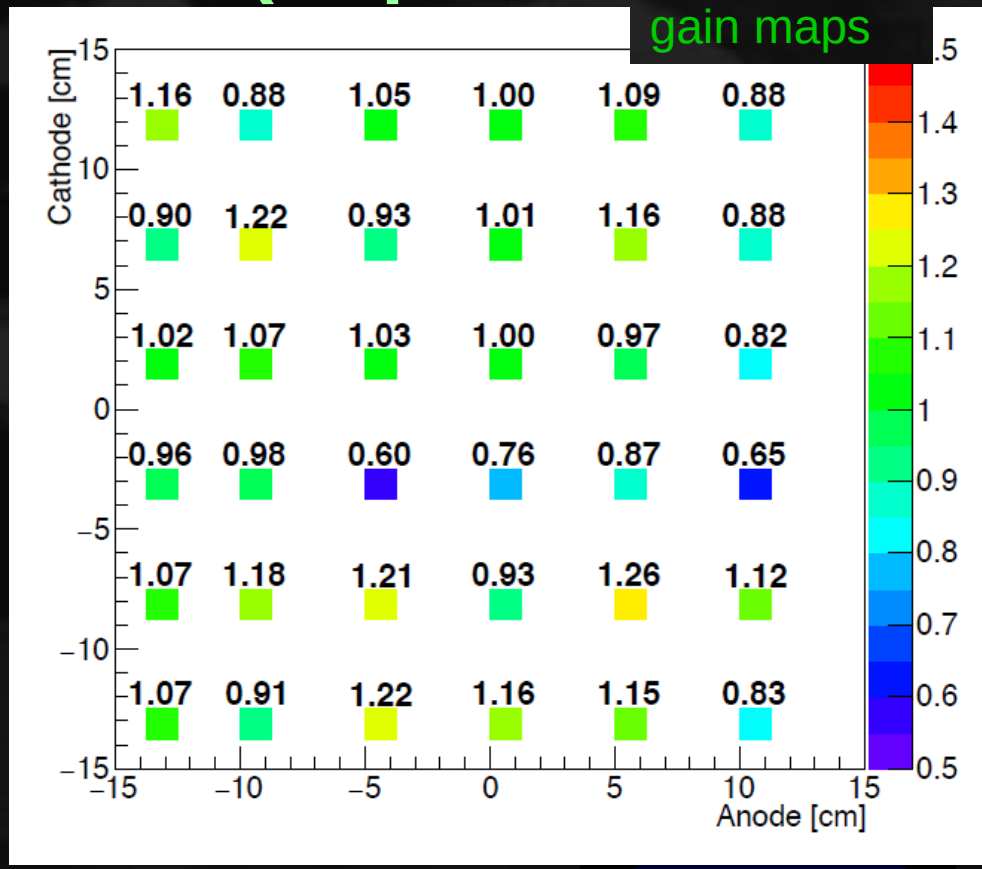
in spite of the material change

Low-α μ-PIC：performance

T. Hashimoto

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





Direction Sensitive

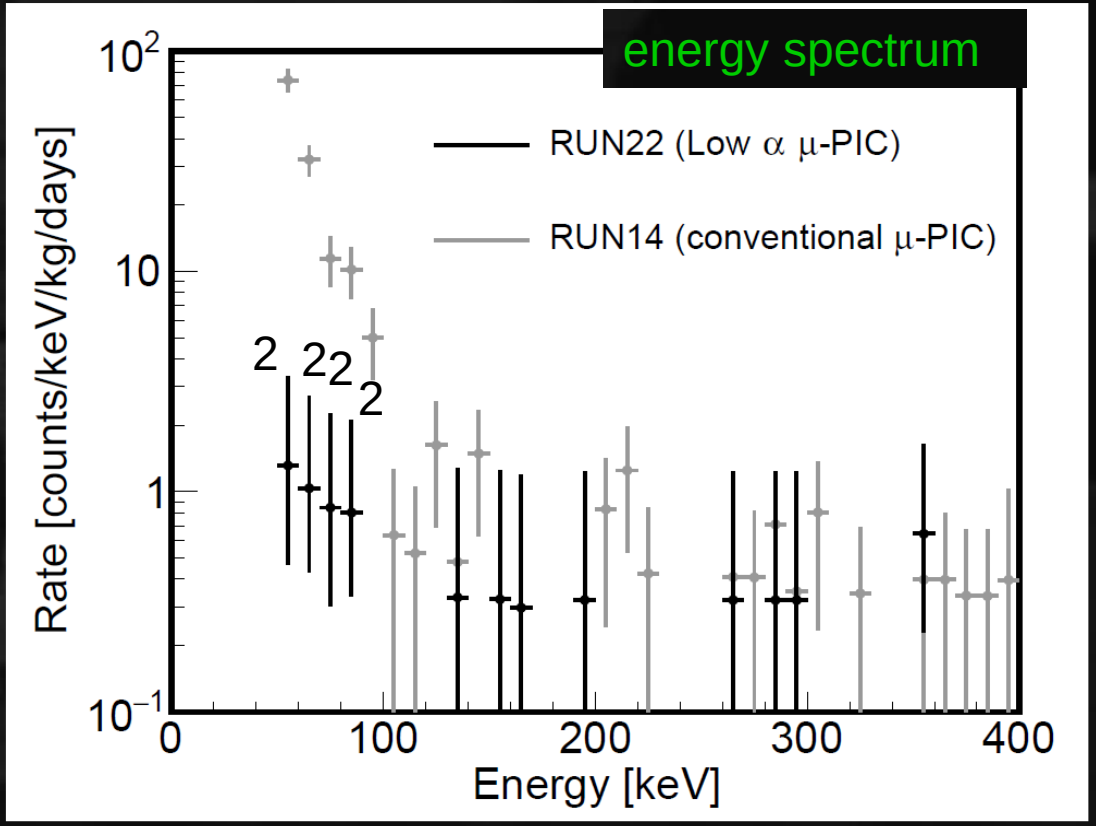
requirements satisfied !

Low-α μ-PIC：DM run

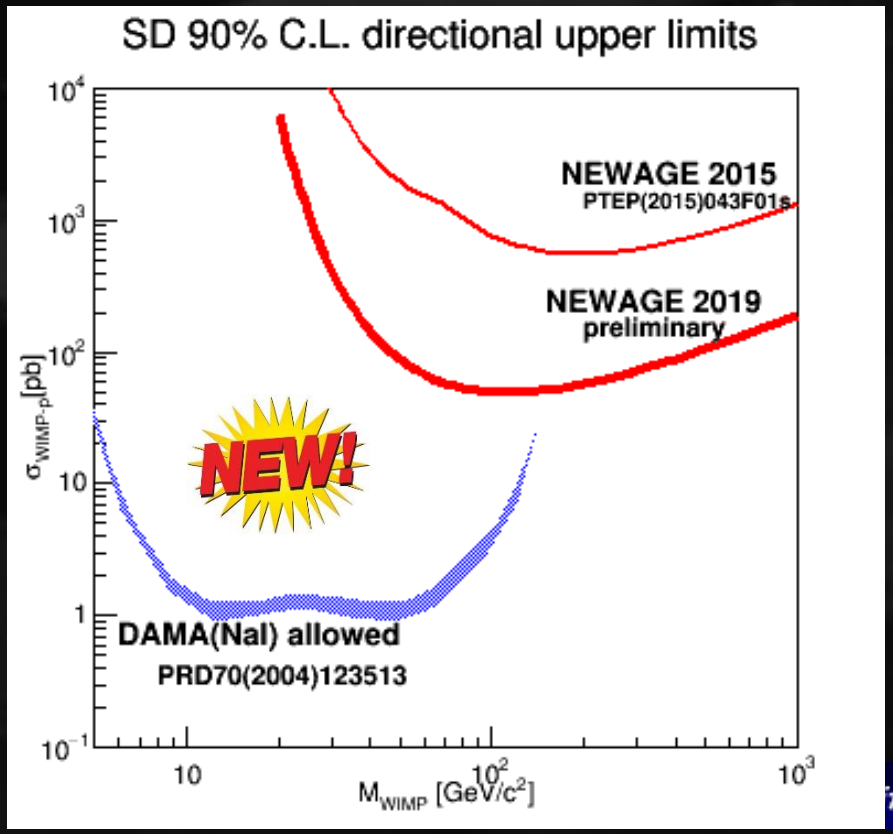
measurement: T. Hashimoto
analysis: T. Ikeda (poster #3)

- Installation: Dec. 2017
- DM run: 2018-
  - RUN22-1 2018/6/6~2018/8/24 (47days)
  - RUN22-2 2018/9/20~2018/12/3 (61days)

energy spectrum



directional limits



～×10 improvements

NEWAGE
and beyond

NEWAGE：next

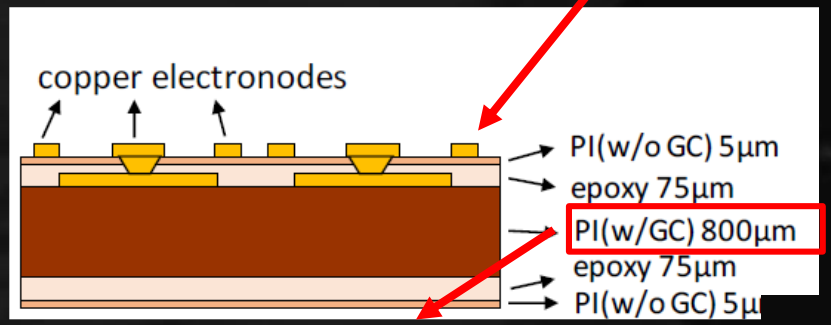
study: T. Ikeda (poster #3)

helped by K. Kobayashi (XMASS, B01 D01)

- **new main BG:**
  - **μ-PIC: surface BG**
  - **radons**

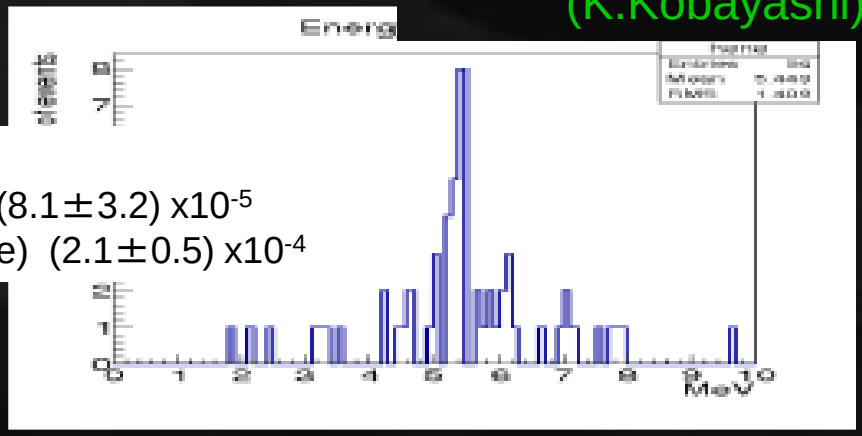
μPIC structure (now)

surface BG was observed



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

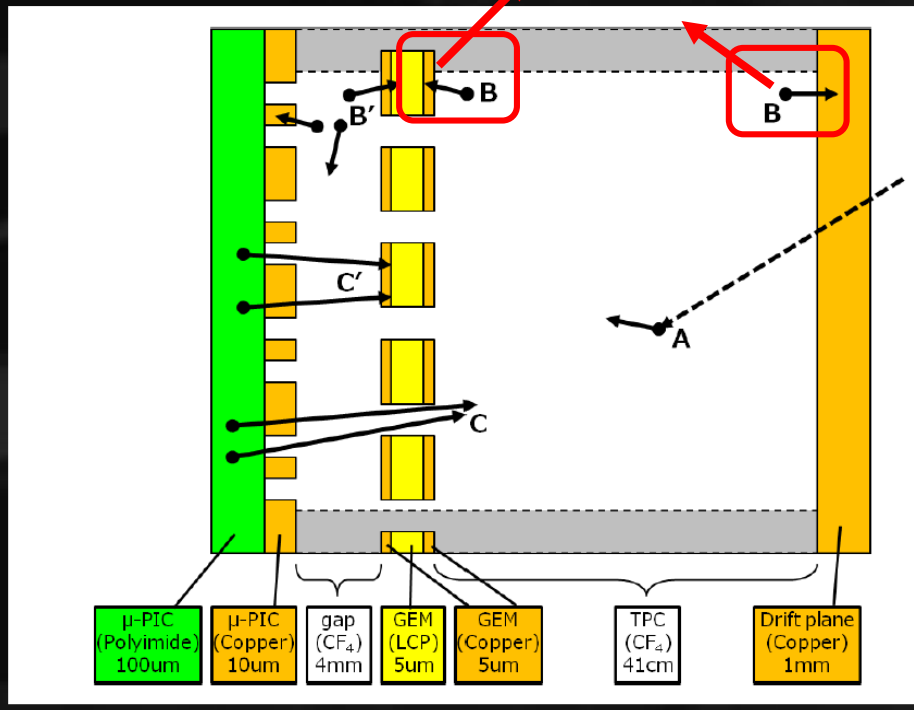
α counter results (K.Kobayashi)



[α/cm^2/hr]
2.5<E<4.8MeV(bulk) (8.1±3.2) x10^{-5}
4.8<E<5.8MeV(surface) (2.1±0.5) x10^{-4}

BG schematics

Radon BG



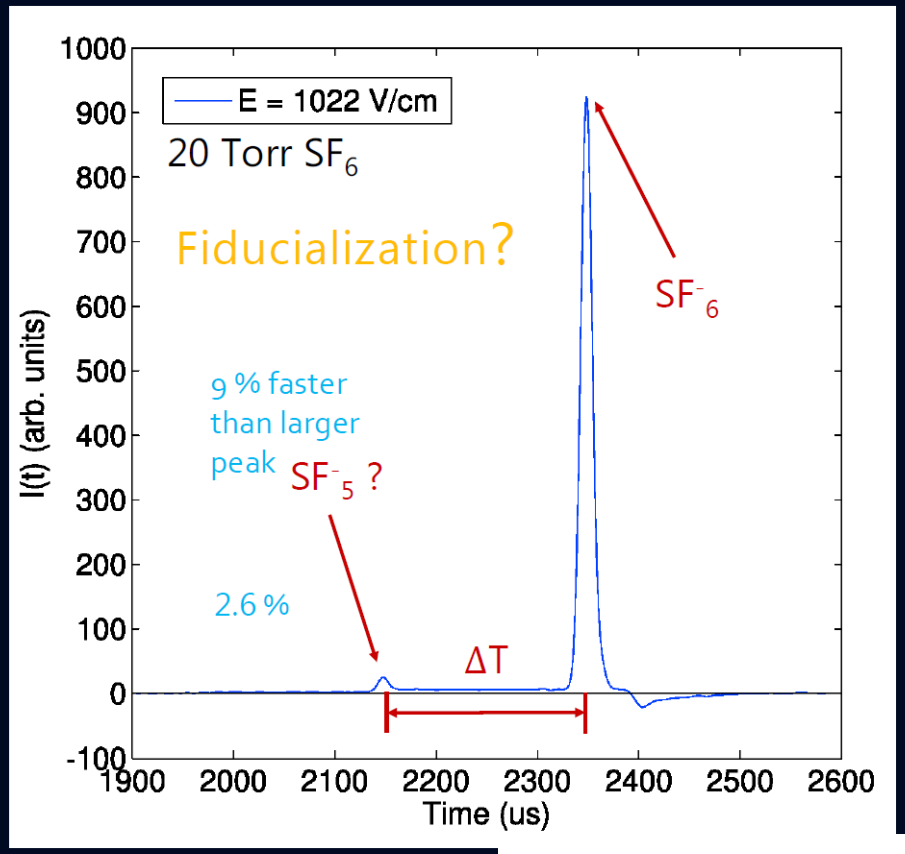
BG study: see poster #3(T. Ikeda)

more than ×10 improvements in next 5 years

- **Negative ion TPC**
  - **minority peaks “discovery”** （DRIFT group）
  - **O_2 addition to CS_2+CF_4 gas**
  - **SF_6 gas** several species of ions with different velocities

$$z = (t_a - t_b)\frac{v_a v_b}{(v_b - v_a)}$$

SF_6 results



averaged waveform

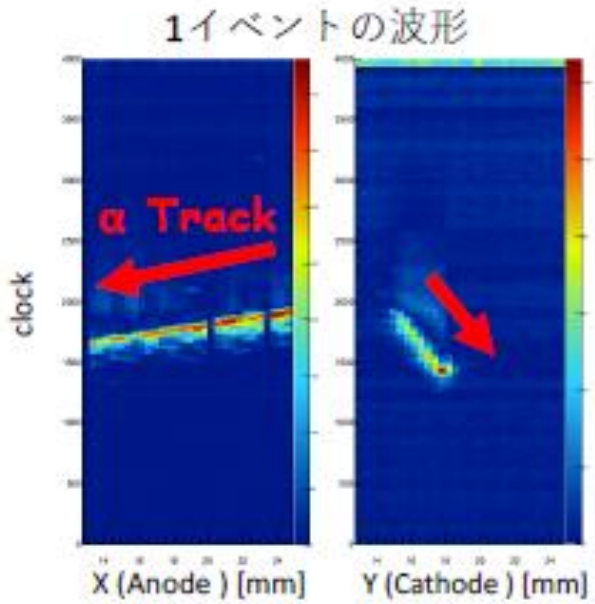
Detection of absolute z-position

⇒ BG reduction

NEWAGE

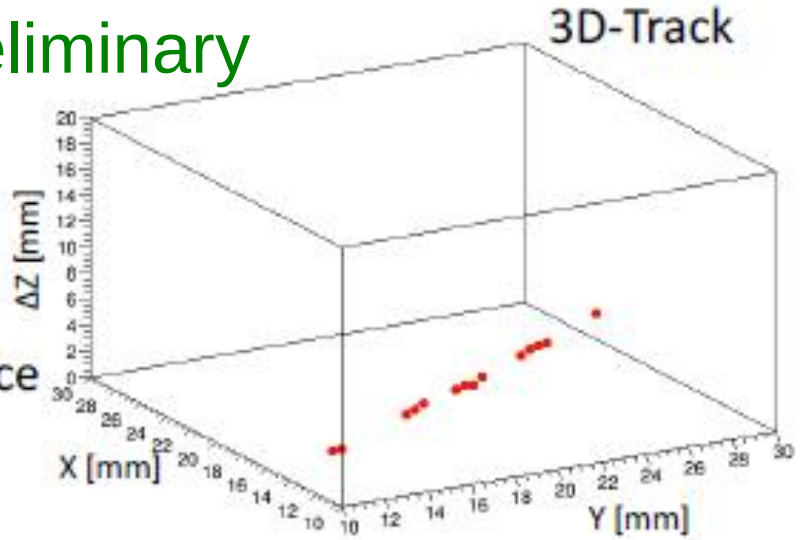
3D tracking + z-fiducialization (first!)

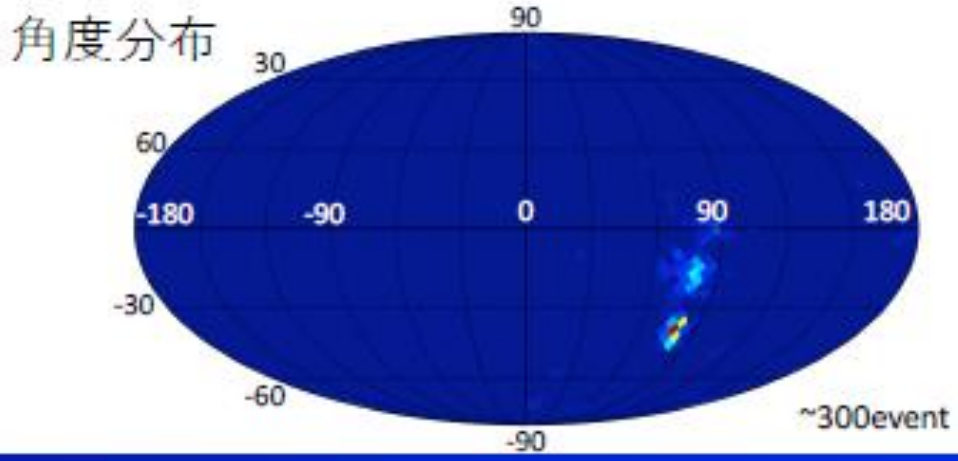
Tomonori Ikeda JPS
Mar2018



coincidence

preliminary

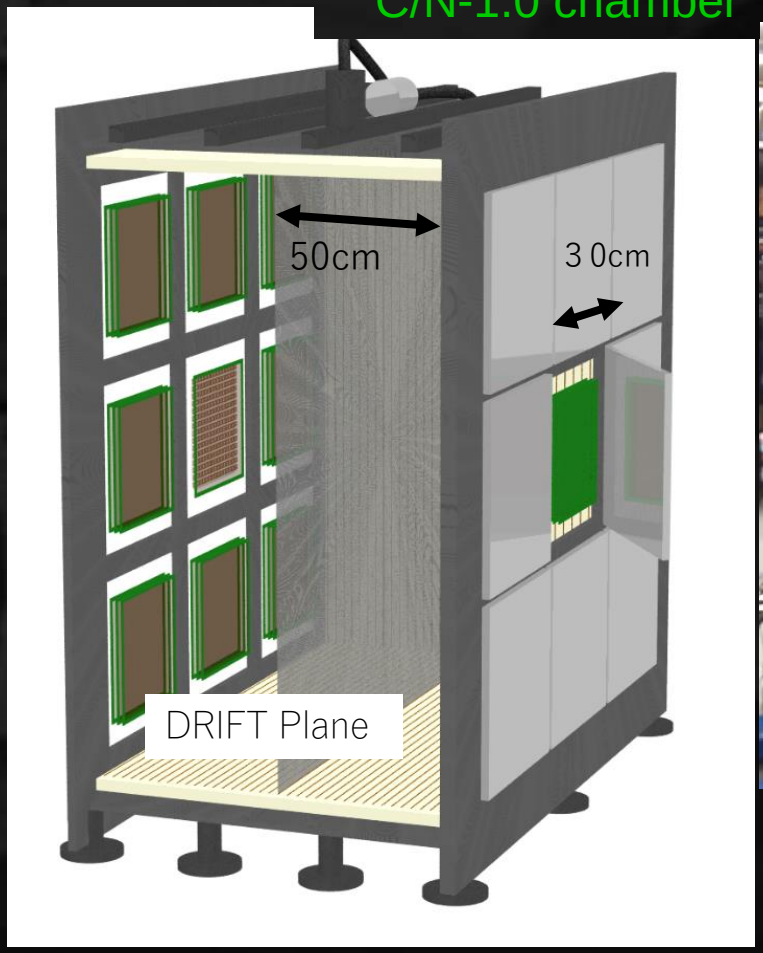




paper in preparation

- **large chamber (CYGNUS/NEWAGE)**
  - **18 windows for 30×30 cm² detectors**
  - **new concept detectors are welcome!**

C/N-1.0 chamber



C/N-1.0 chamber

"BENTO " chamber

ready for low rate measurement

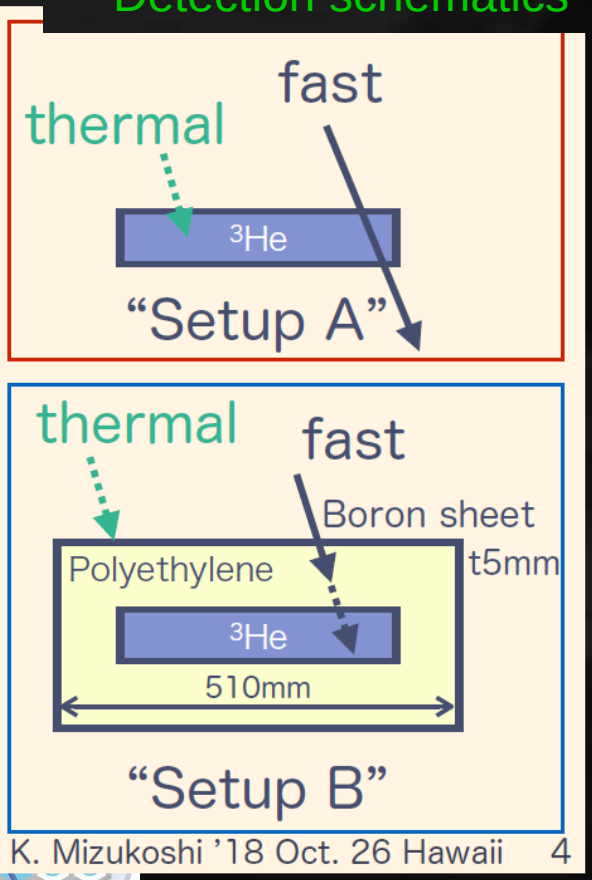
NEWAGE
and low BG activities

Neutron flux @ Kamioka

Mizukoshi (poster #9)
with A01,A02,B01,D01
PTEP 2018 123C01

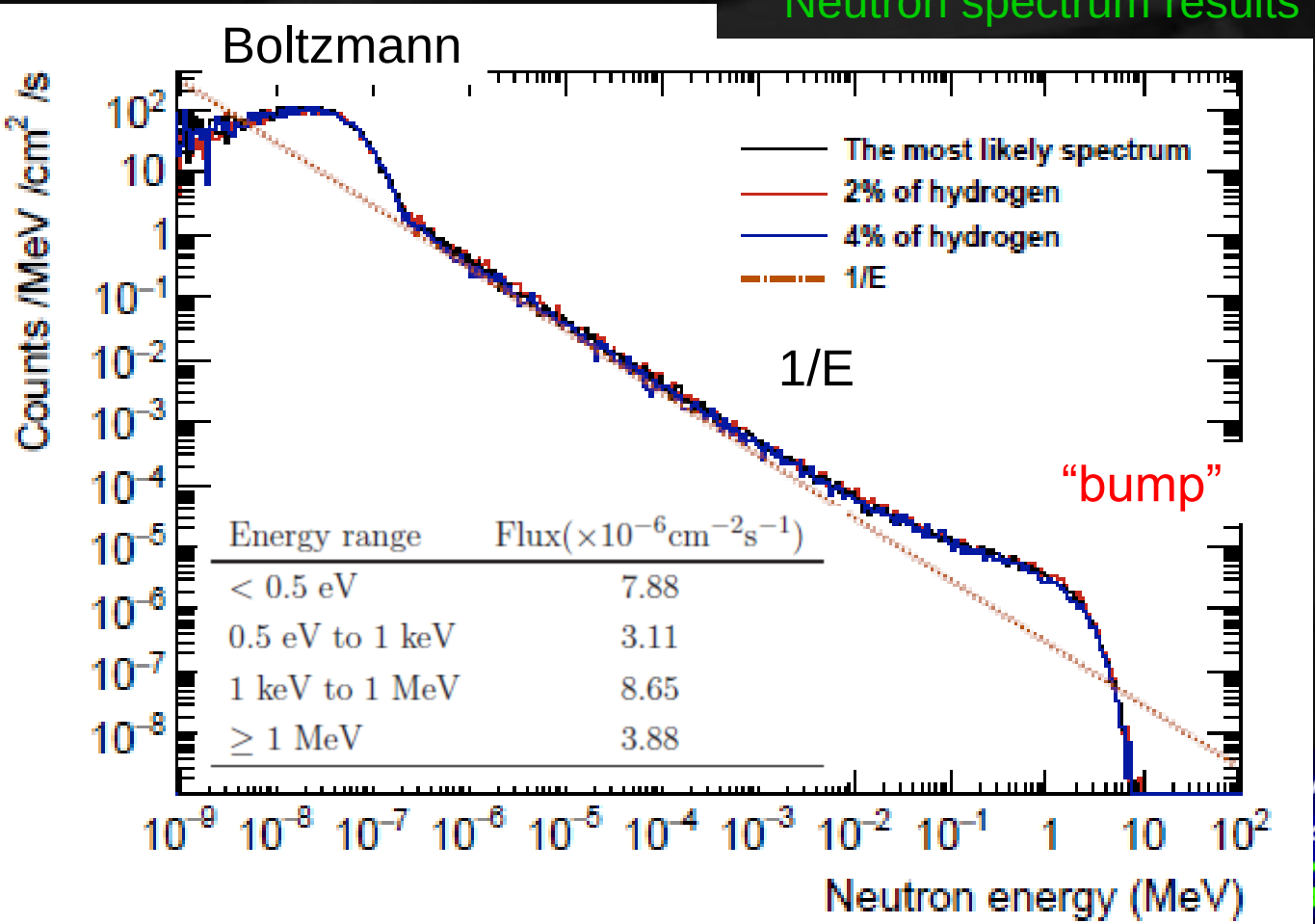
- ^{3}He counter + sim (Geant4+PHITS)
- w/ spectrum prediction
- Other detectors are being prepared

Detection schematics



K. Mizukoshi '18 Oct. 26 Hawaii 4

Neutron spectrum results



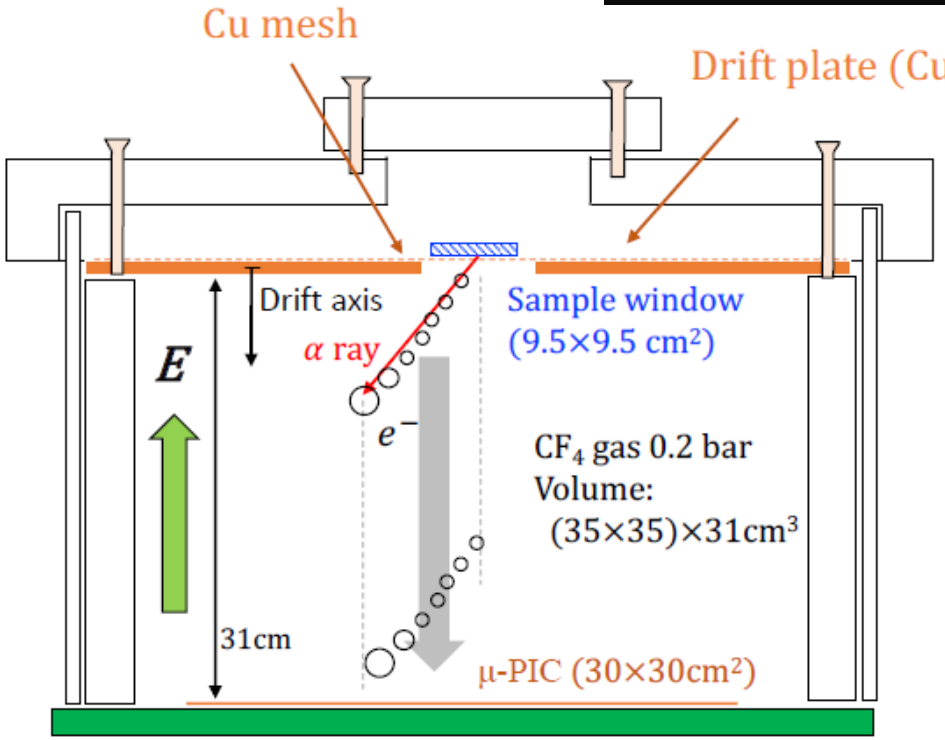
Energy range	Flux($\times 10^{-6}$cm^{-2}s^{-1})
< 0.5 eV	7.88
0.5 eV to 1 keV	3.11
1 keV to 1 MeV	8.65
≥ 1 MeV	3.88

α-ray imaging chamber (AI-cham)

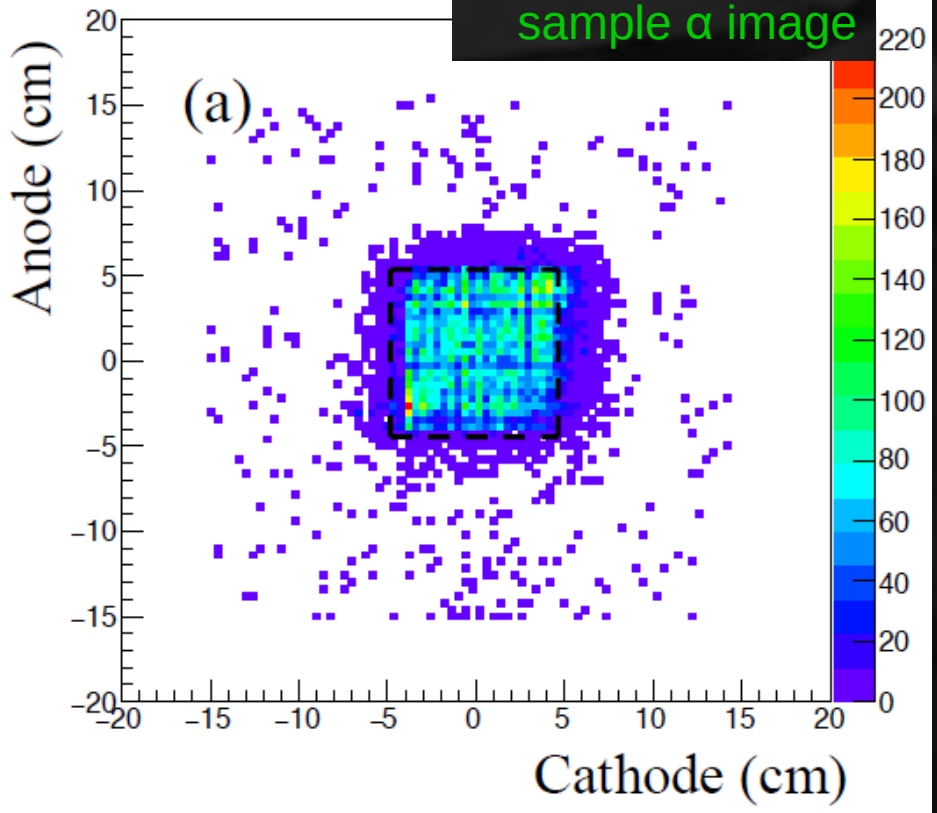
- application of low-α μ-PIC
- α-ray imaging (pos. res. = 0.68 cm)
- BG level = 1.58×10^{-2} α/h/cm^2 (subtraction possible)

H. Ito. (NIMA submittd, 1903.01090)
with K. Kobayashi (XMASS, B01 D01)

AIcham profile



sample α image

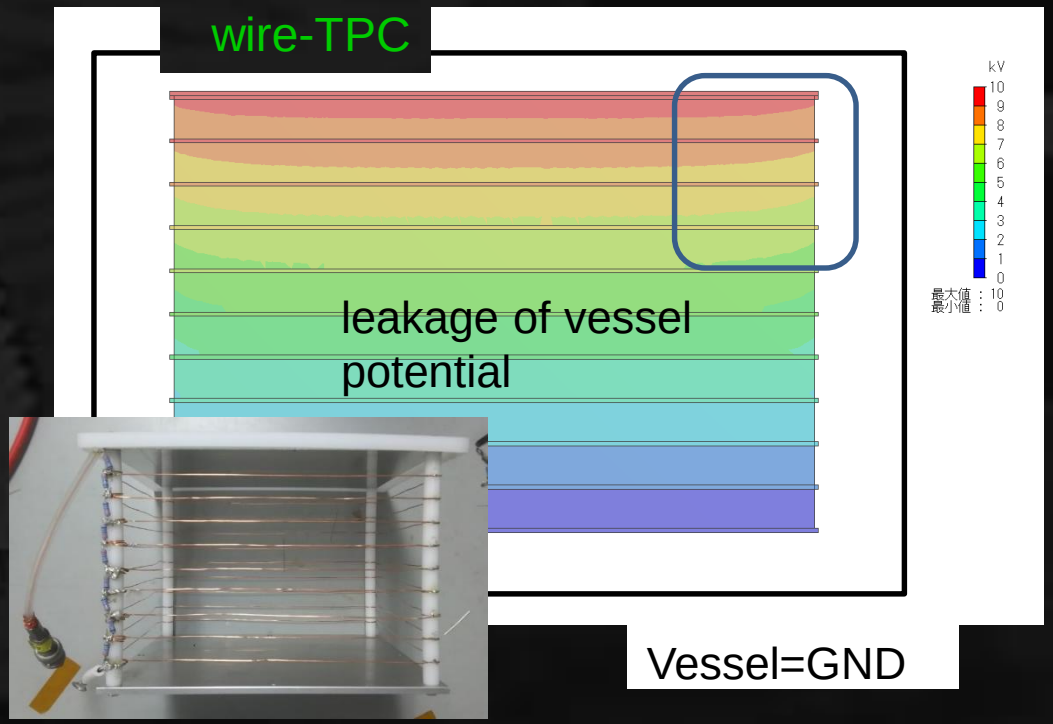


K. Miuchi (PTEP submitted, 1903.01663)
With K.ichimura, K. Abe (XMASS, B01, D01)

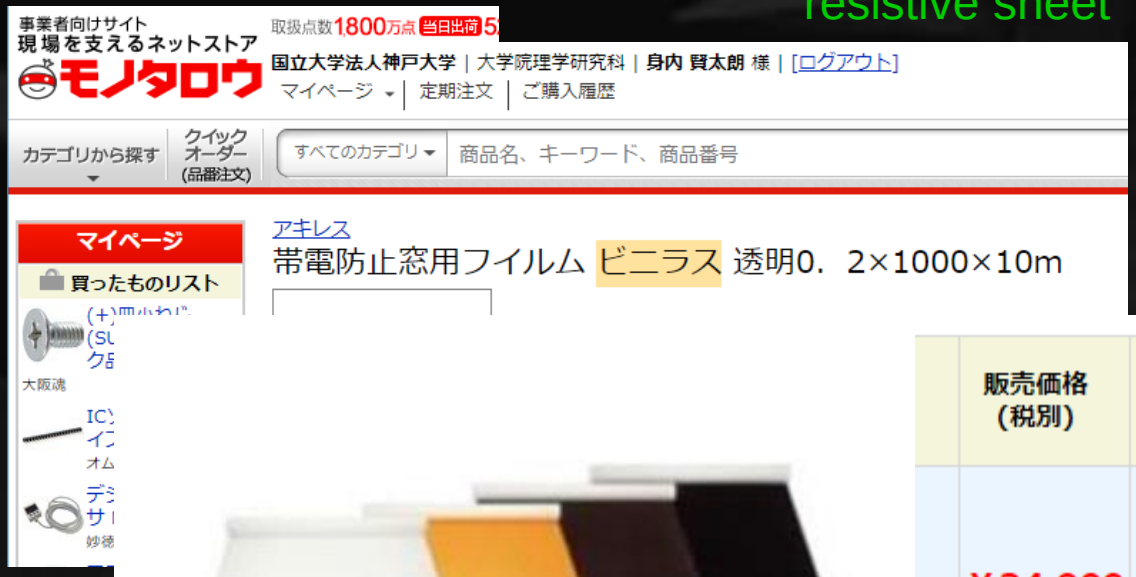
New concept TPC with sheet resistor

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

E filed of wire-TPC



Commercially available resistive sheet



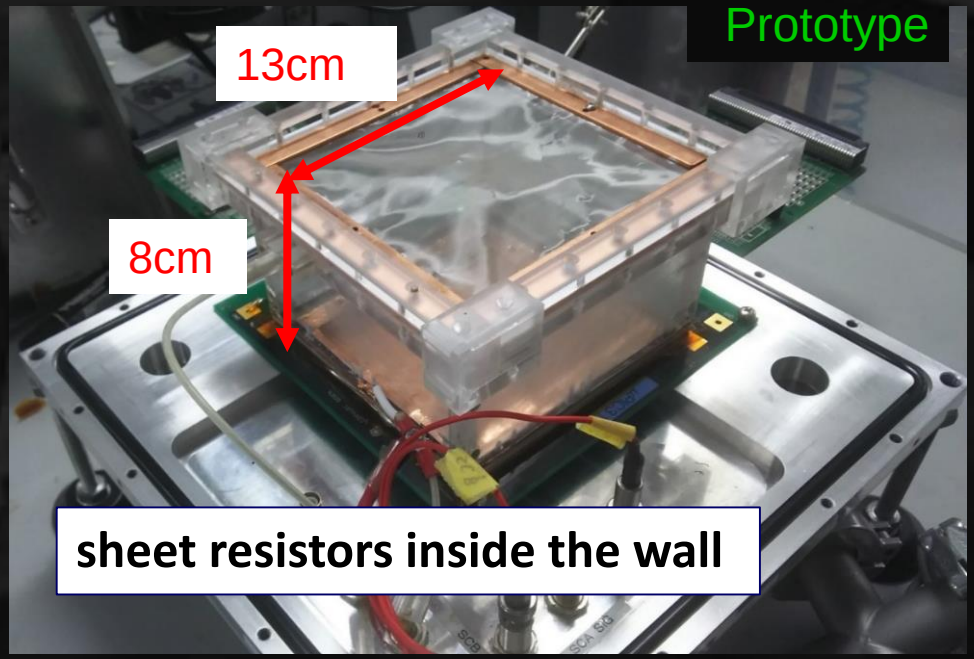
(～10GΩ/□)

prototype of SR μ-TPC

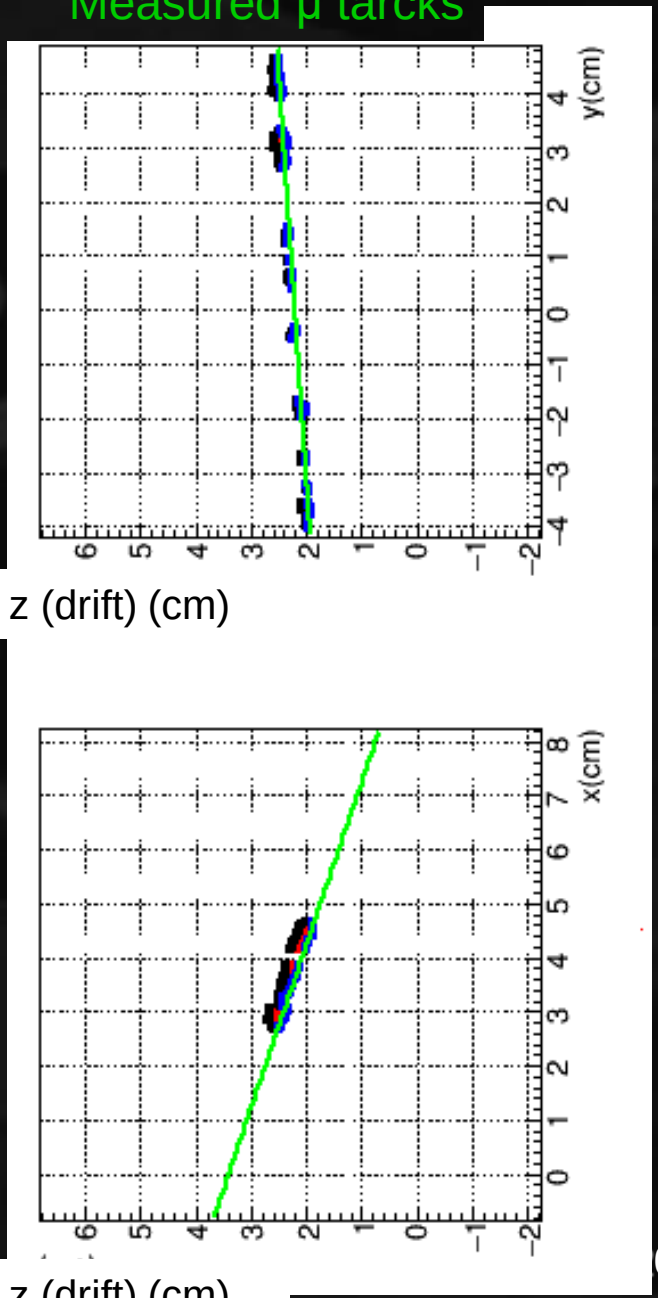
K. Miuchi (PTEP submitted, 1903.01663)
With K.ichimura, K. Abe (XMASS, B01, D01)

RI measurement (mBq/kg)

Upper U-chain	Middle U-Chain	^{210}Pb	^{232}Th	^{40}K
< 59.6	< 18.4	< 134	< 7.77	< 112



Measured μ tarcks



Columnar recombination

- SI (Xe), high pressure

K. D. Nakamura (JINST 13(2018)P7015)
With AXEL (B02-KOUBO)

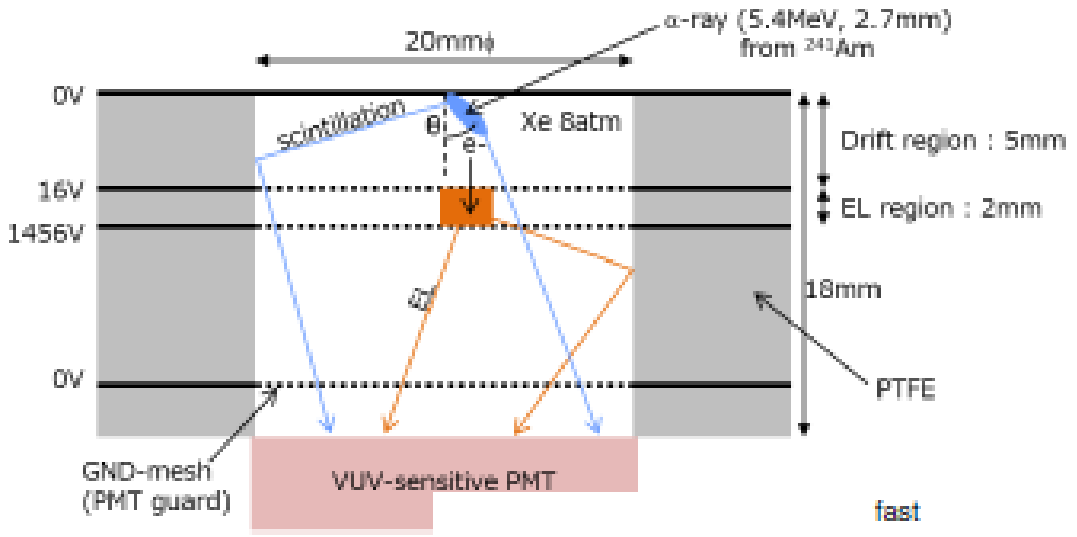
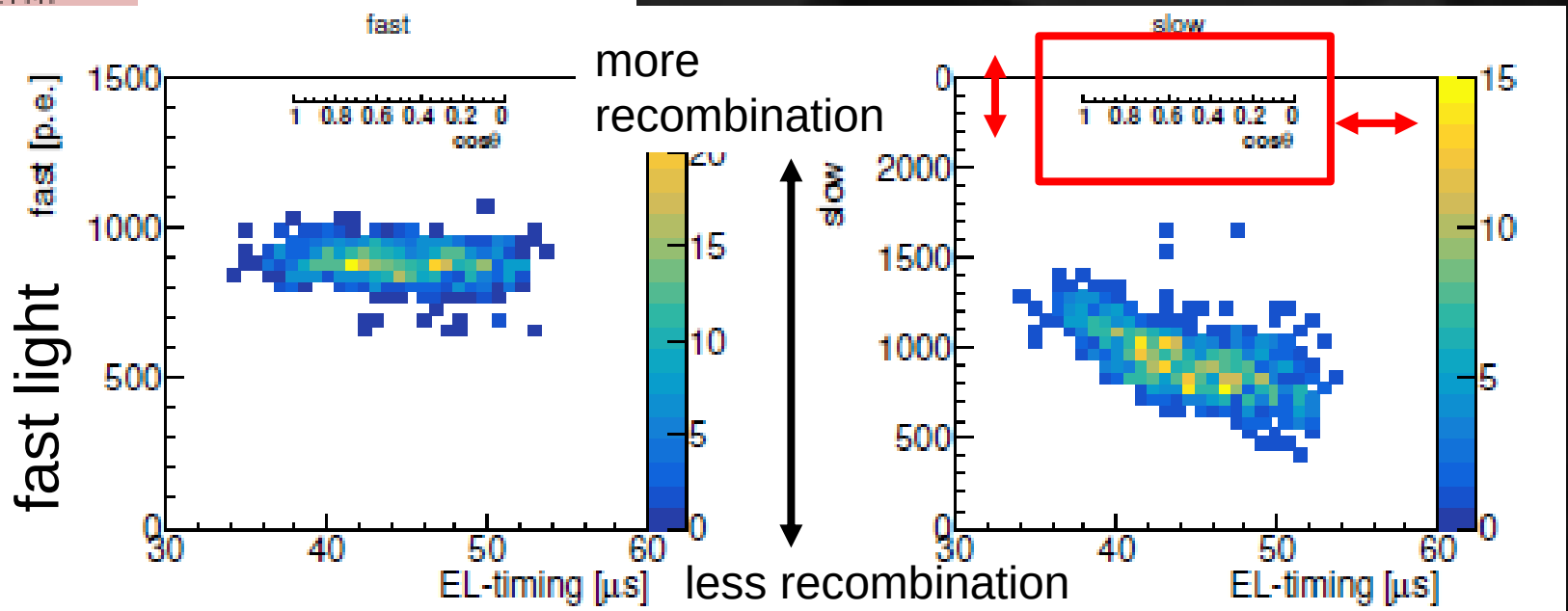


Figure 1.

- 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 (AI-cham)
- low BG TPC with sheet resistor (SRμ-TPC)