

NEWAGE



Kentaro Miuchi KOBE University

K. Nakamura⁽²⁾, Y. Yamaguchi⁽¹⁾,
T.Hashimoto⁽¹⁾, R. Yakabe⁽¹⁾, T. Ikeda⁽¹⁾,
R.Taishaku⁽¹⁾, M. Nakazawa⁽¹⁾,
T.Tanimori⁽²⁾, K.Kubo⁽²⁾, A.Takada⁽²⁾,
H.Nishimura⁽²⁾, J.D.Parker⁽²⁾, T.Mizumoto⁽²⁾,
Y.Mizumura⁽²⁾, Y.Matsuoka⁽²⁾, S.Komura⁽²⁾,
A.Takeda⁽³⁾, H.Sekiya⁽³⁾,

(1) Kobe university

(2) Kyoto university

(3) ICRR

Contents

Direction-sensitive DM search

NEWAGE

Underground results

Recent R&Ds

科研費
KAKENHI

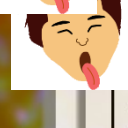
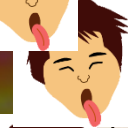
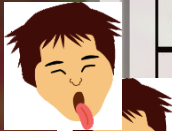
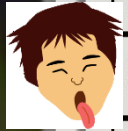


IDM, CYGNUS...

20 Years

Previous IDM Conferenc

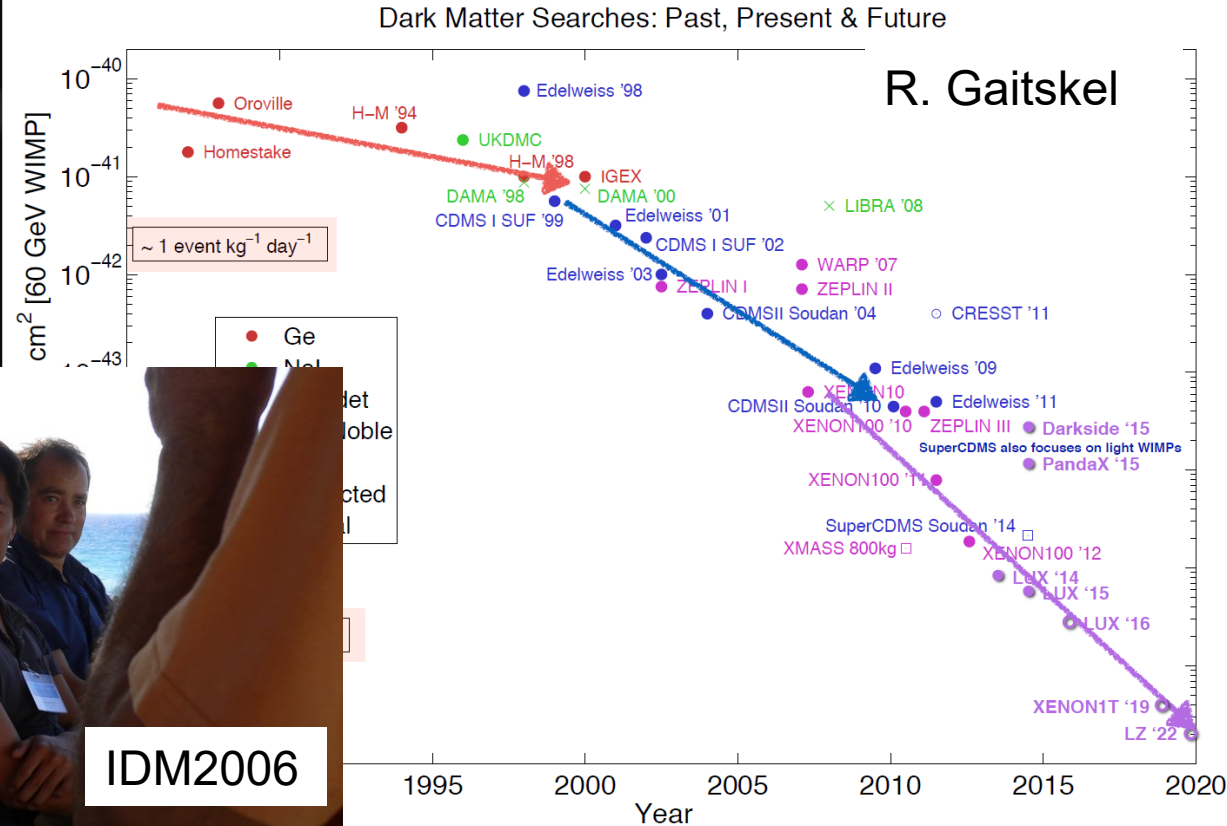
2014	Amsterdam
2012	Chicago, USA
2010	Montpellier, France
2008	Stockholm, Sweden
2006	Rhodes, Greece
2004	Edinburgh, UK
2002	York, UK
2000	York, UK
1998	Buxton, UK
1996	Sheffield, UK



CYGNUS series

10 Years

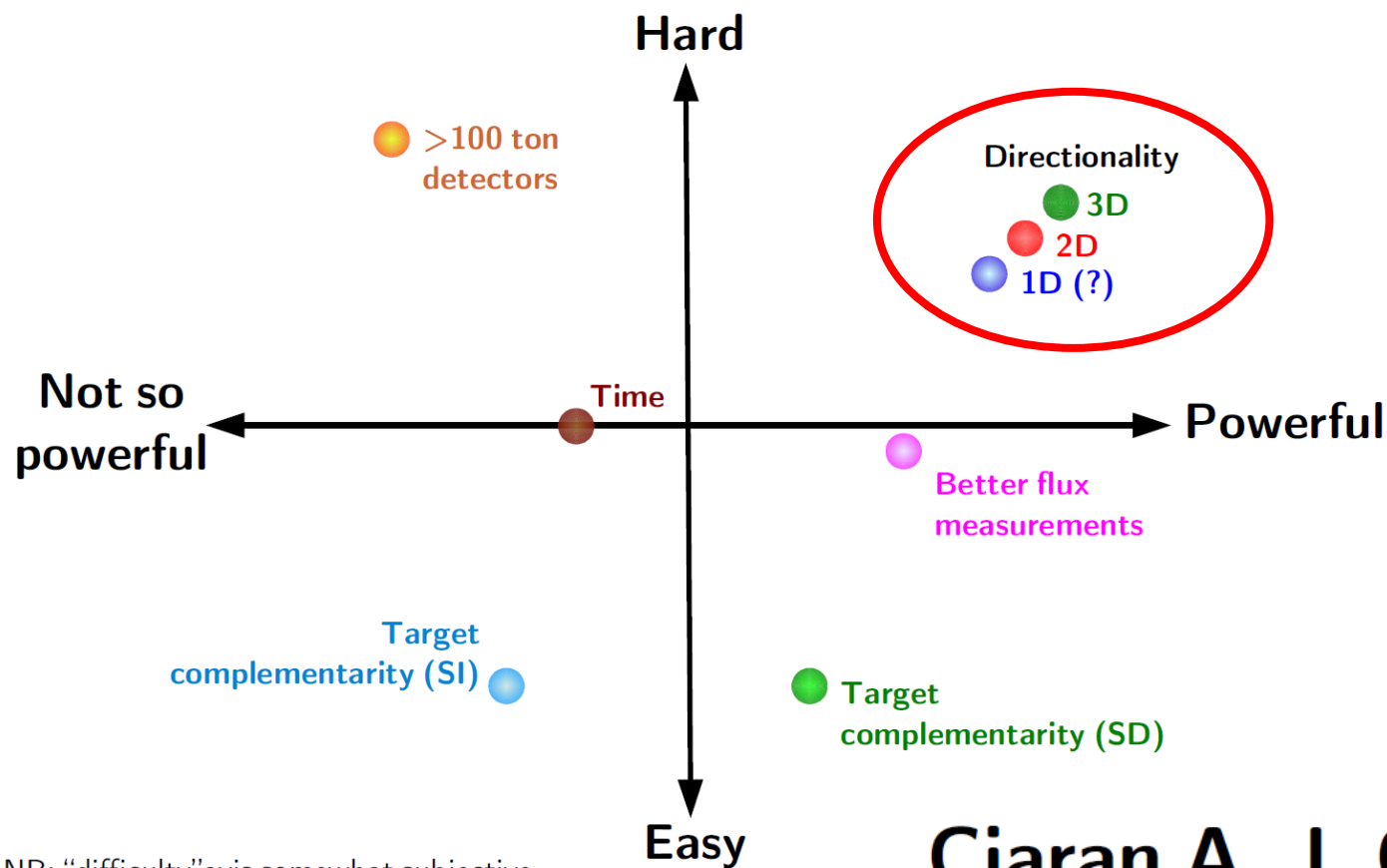
- 2015 LA
- 2013 Toyama
- 2011 Aussois
- 2009 Boston
- 2007 Boulby



Direction-Sensitive Dark Matter Search

“CYGNUS”

Strategies for the neutrino floor



Ciaran A. J. O'Hare

“CYGNUS” concept

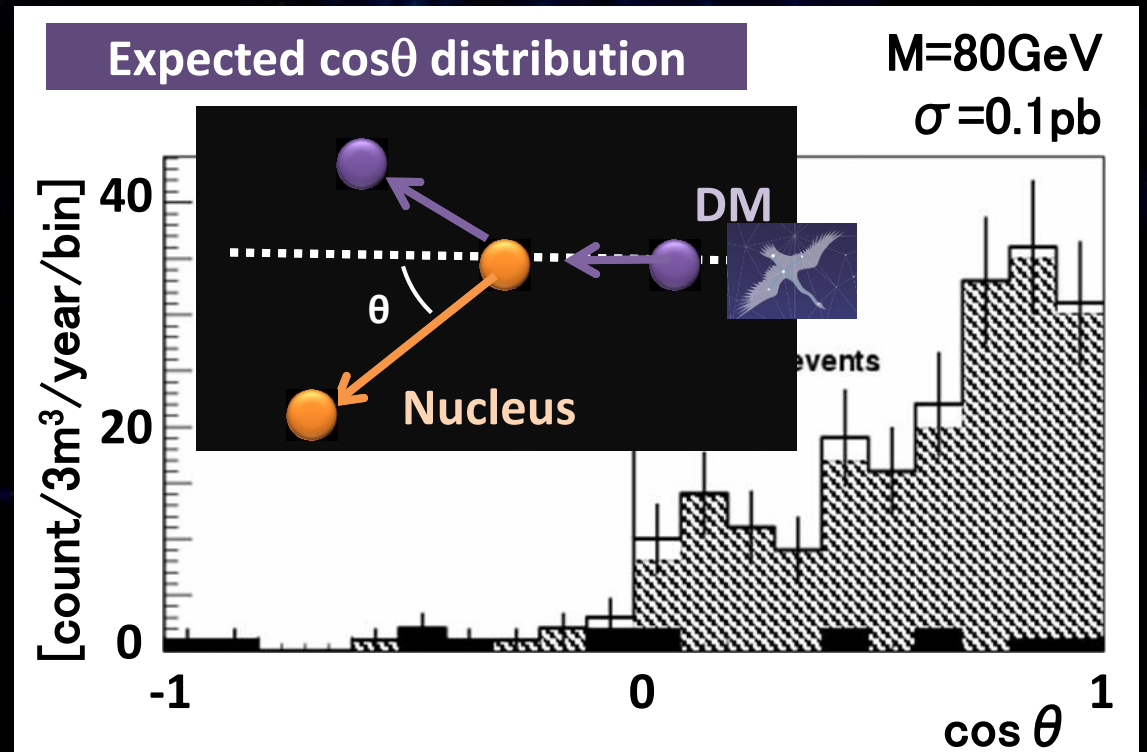
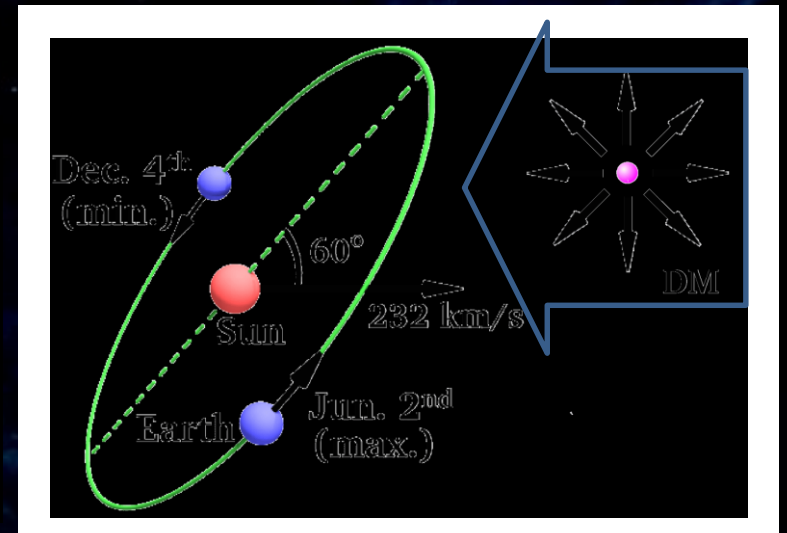
- Direction-sensitive dark matter search
- Clear detection of dark matter
- DM precise study after detection
- Difficulty: short track (a few mm >)

Gas TPC

DRIFT
DM-TPC
NEWAGE MIMAC D3
NITEC

Solid/Liquid

NEWS DCaNT
ZnWO4 RED





NEWAGE

Strategies for the neutrino floor

 >100 ton detectors

Hard

▲
See directional talks(slides)
Tuesday, Thursday
and theory talks

D3, NITEC,
NEWAGE-QPIX

Directionality

NEWAGE, MIMAC

DM-TPC

DRIFT




1D (?)

D

Time

Powerful

 Better flux
measurements

Ciaran A. J. O'Hare

Target

NEWAGE

New general WIMP search with an Advanced Gaseous tracker Experiment

μ-PIC(MPGD) based TPC

3-D tracks SKYMAP

CF4 gas for SD search

Proposal PLB 578 (2004) 241

First direction-sensitive limits

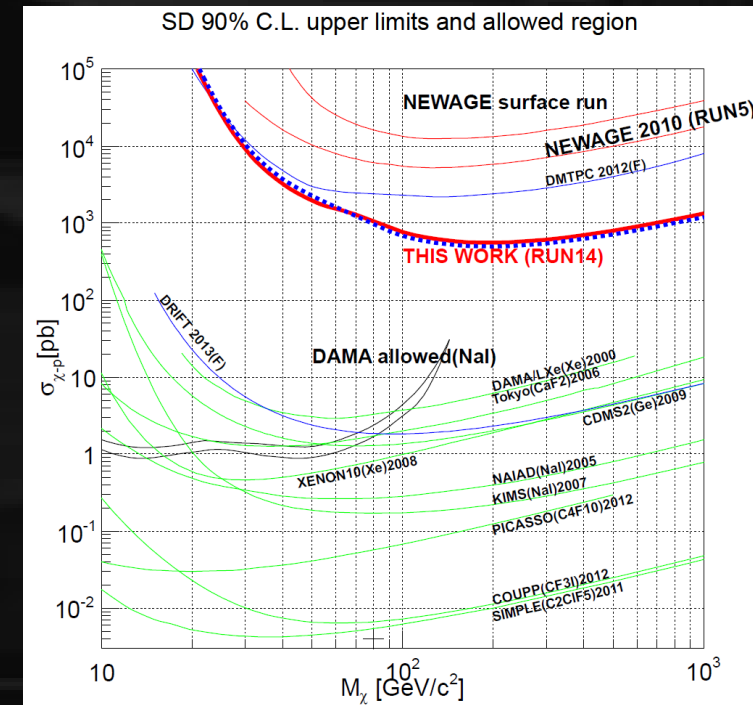
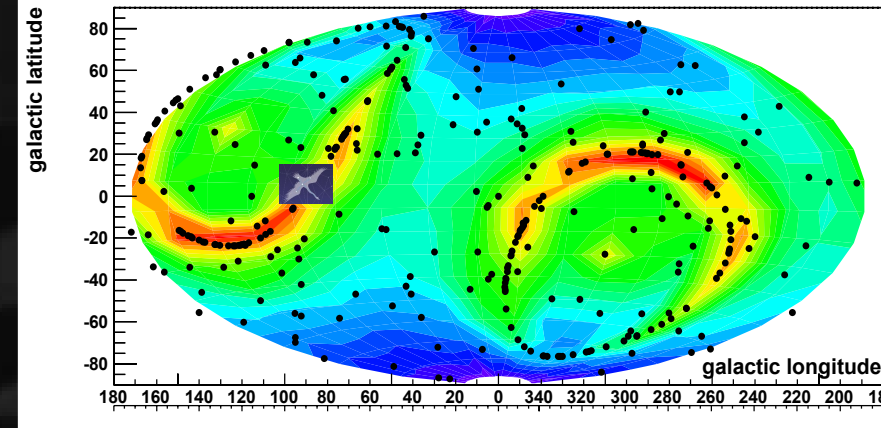
PLB654 (2007) 58

Underground results

PLB686 (2010) 11, PTEP (2015) 043F01s

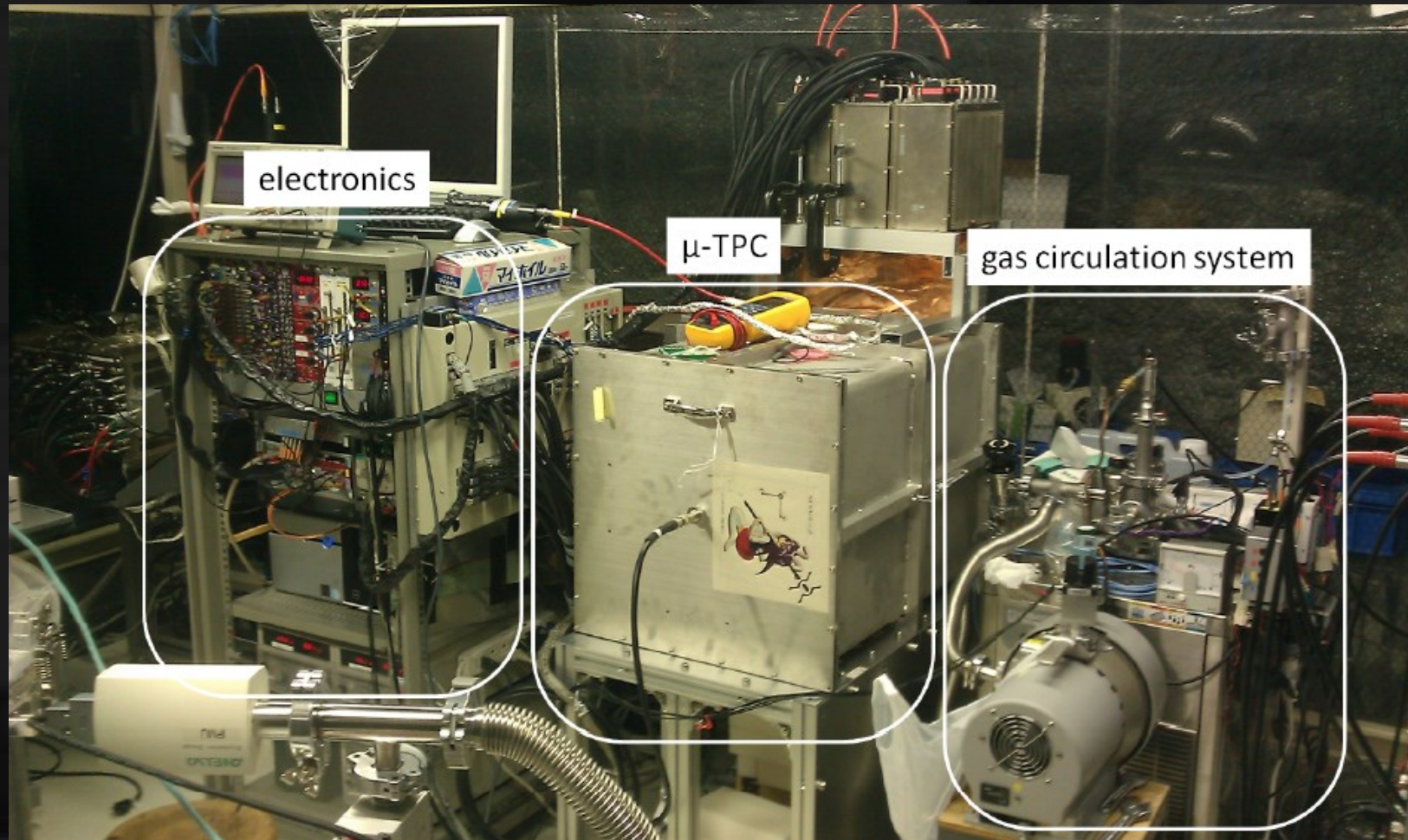
Phase for “low BG detector”

SKYMAP (measured DATA)



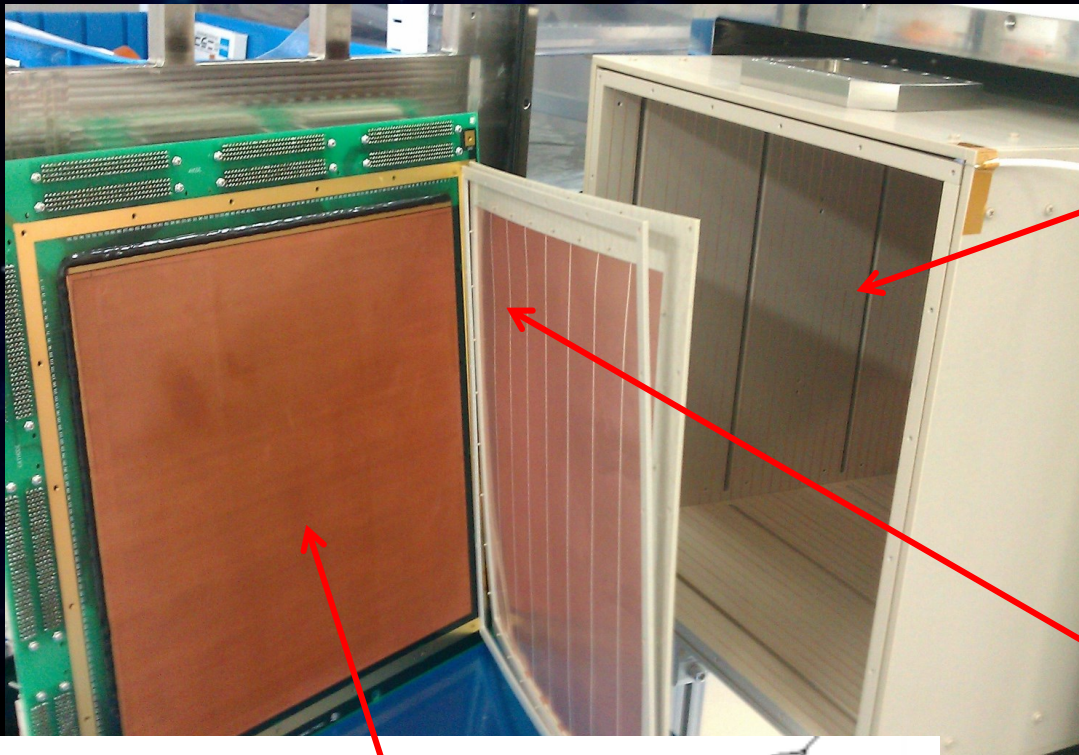
NEWAGE detector

- **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**

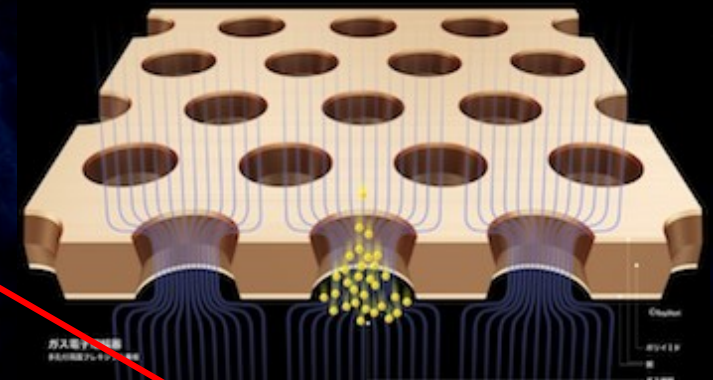


NEWAGE-0.3b' inside view

Detection Volume: $30 \times 30 \times 41 \text{cm}^3$

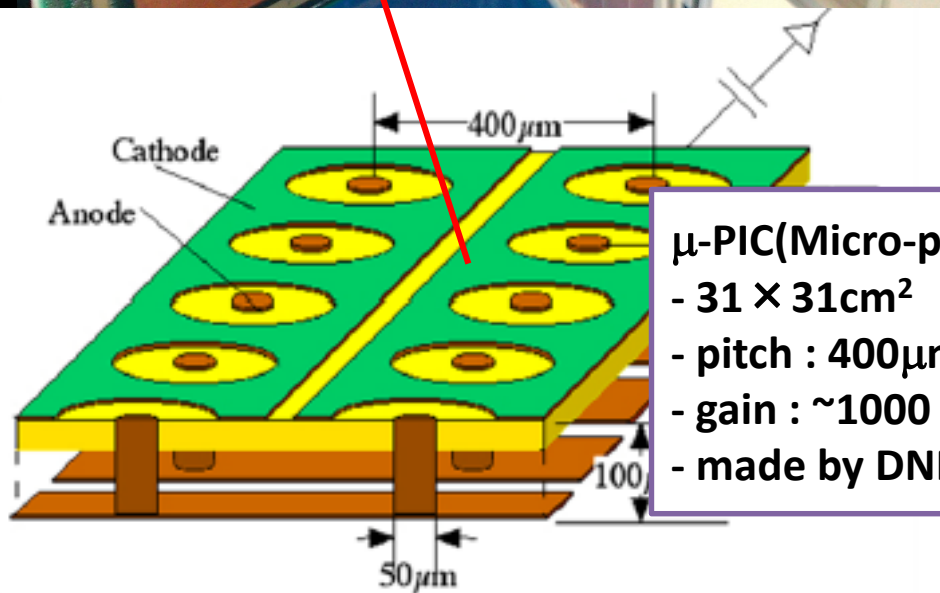


Field cage
Drift length: 41cm
PEEK + copper wires



GEM

- $31 \times 32 \text{cm}^2$
- 8-segmented
- hole pitch : $140 \mu\text{m}$
- hole diameter: $70 \mu\text{m}$
- insulator : LCP $100 \mu\text{m}$
- gain : ~ 5
- made by Scienergy, Japan



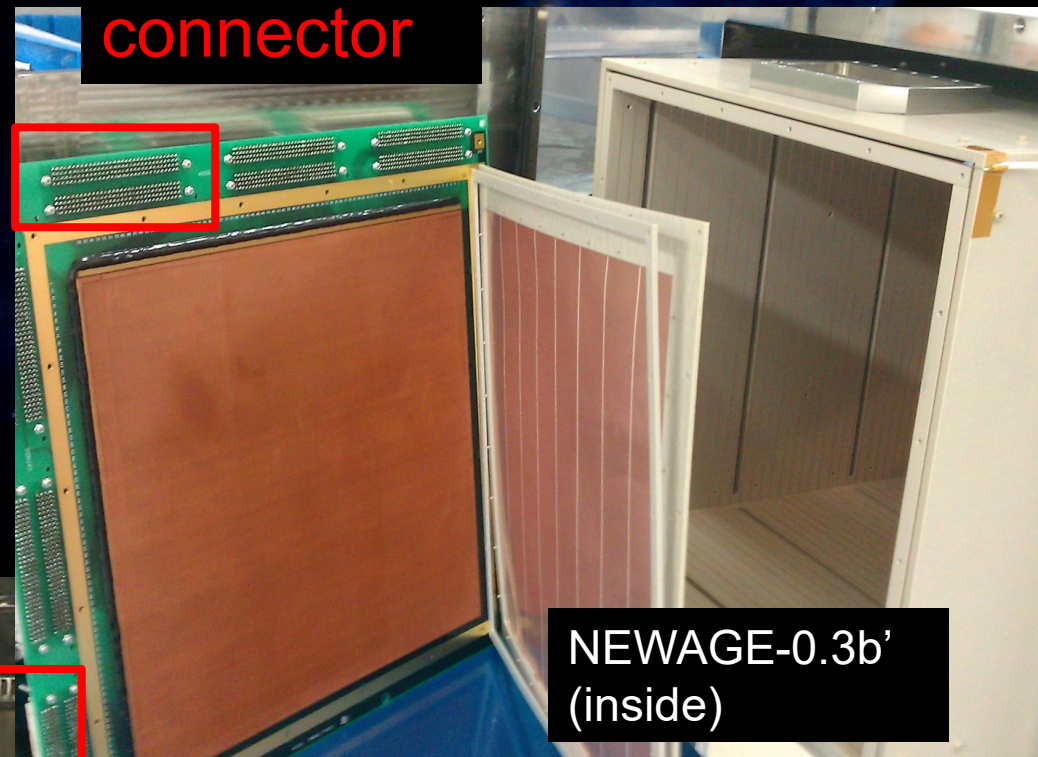
μ-PIC(Micro-pixel chamber)

- $31 \times 31 \text{cm}^2$
- pitch : $400 \mu\text{m}$
- gain : ~ 1000
- made by DNP, Japan

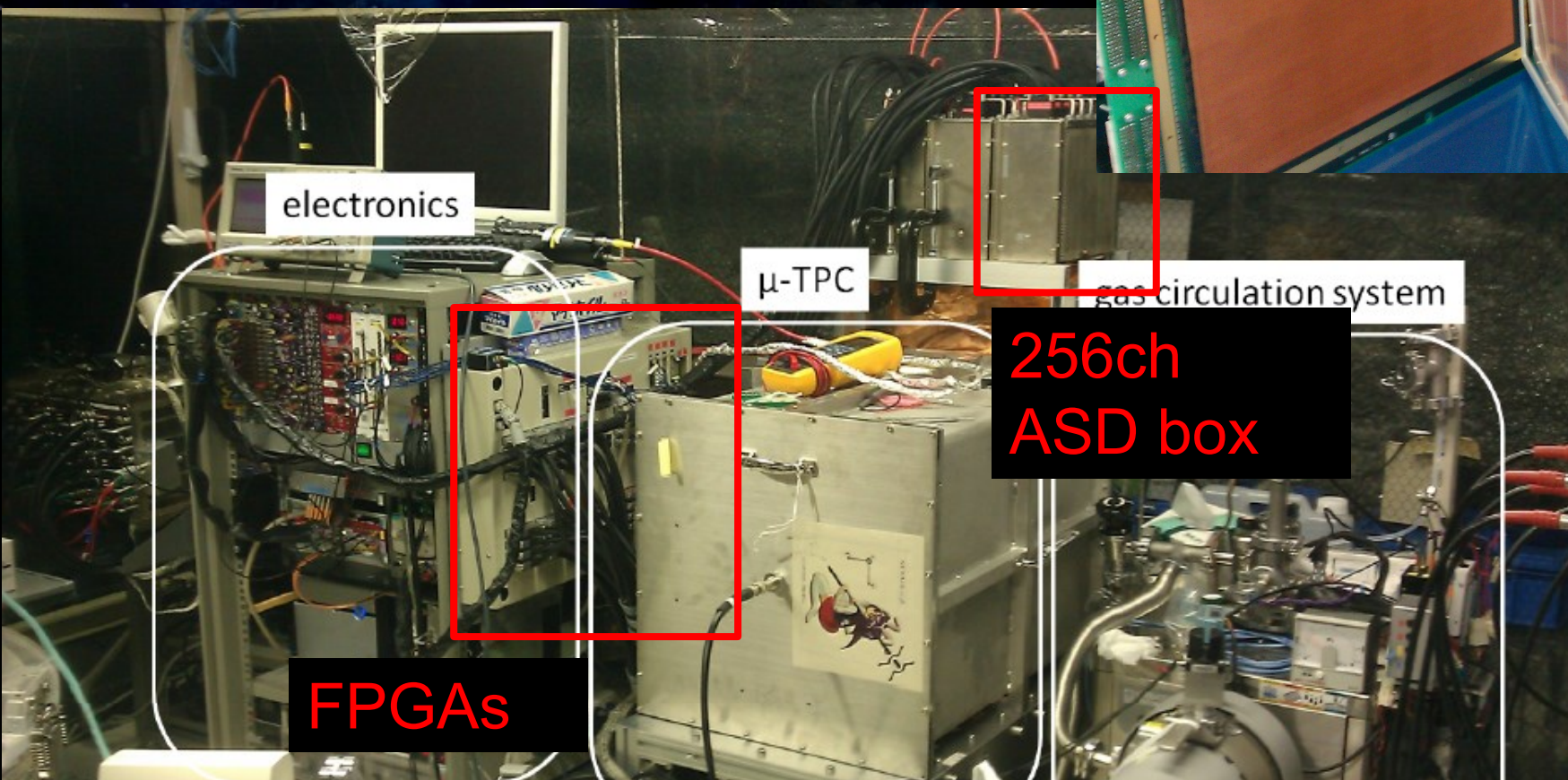
NEWAGE-0.3b' readouts

- μ -PIC is X-Y readout
- General purpose FPGA-based electronics since early 2000's

256ch
connector



NEWAGE-0.3b'
(inside)



electronics

μ -TPC

gas circulation system

256ch
ASD box

FPGAs

NEWAGE-0.3b' data

TOT of every strip by FPGA (clock 100MHz)

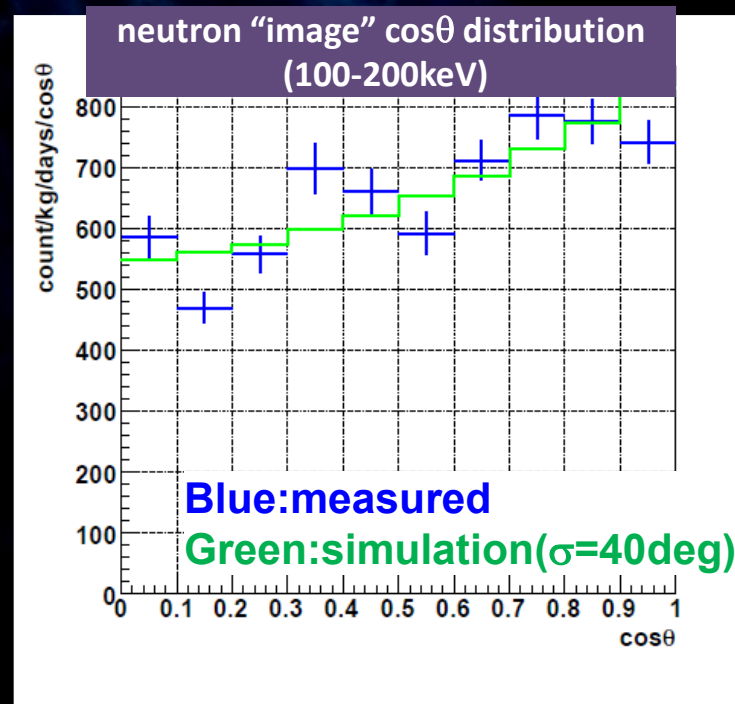
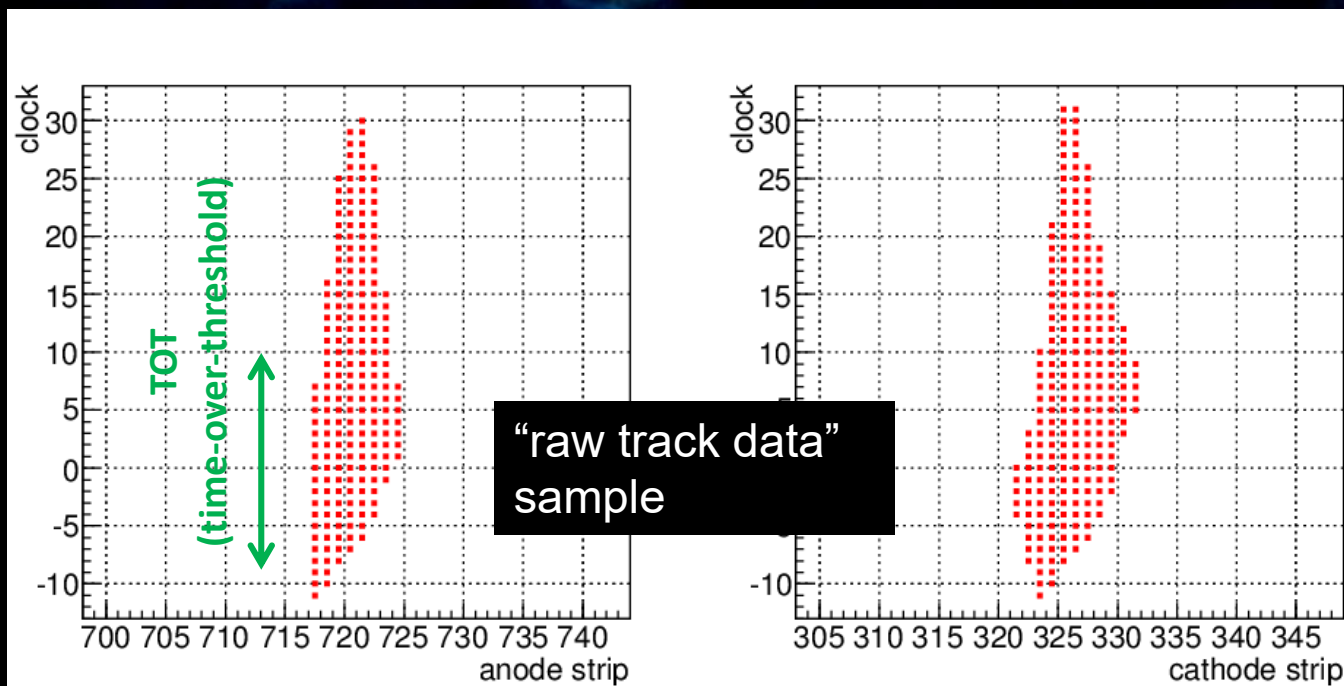
⇒ 3D tracks, headtails in X,Y

+

Summed waveforms by FADC (100MHz)

⇒ energy, headtails in Z

combined ⇒ PID, absolute z



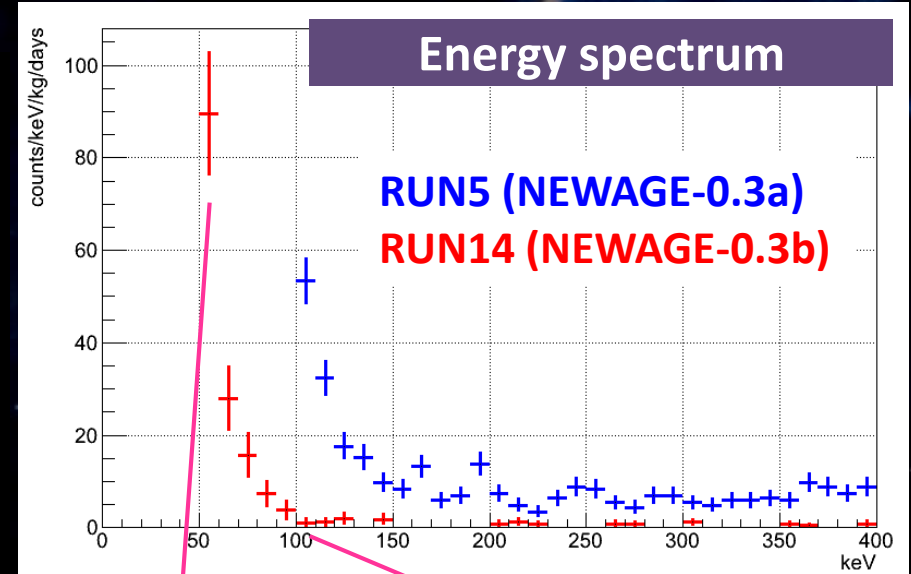


NEWAGE
Kamioka RUN14 results

NEWAGE underground run

RUN14

- period : 2013/7/20-8/11, 10/19-11/12
- live time : 31.6 days
- fiducial volume : $28 \times 24 \times 41 \text{cm}^3$
- mass : 10.36g
- exposure : 0.327 kg·days

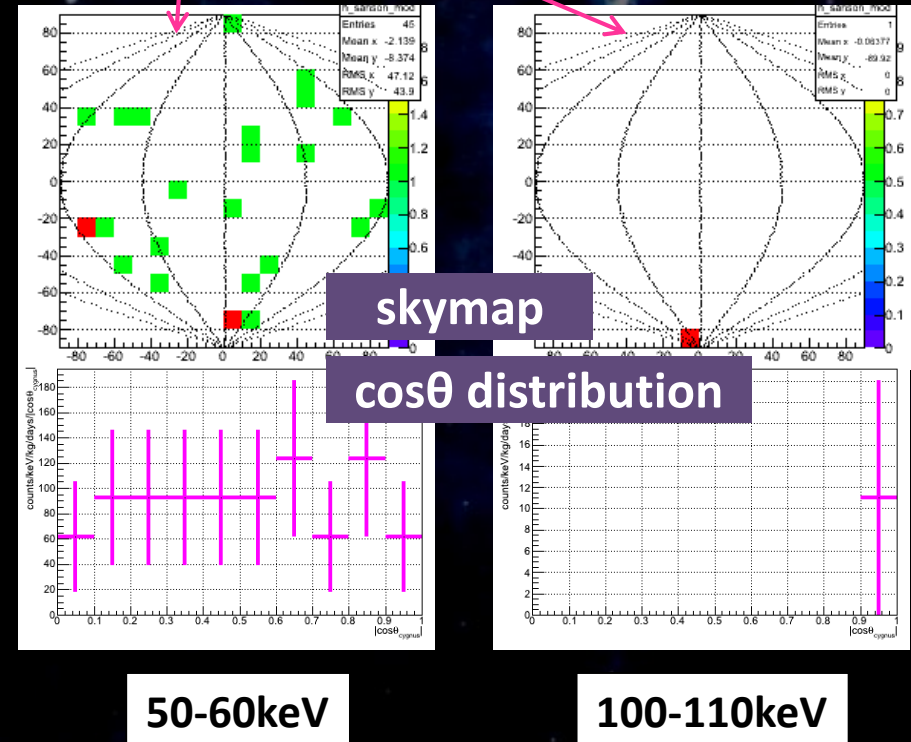


Energy spectrum

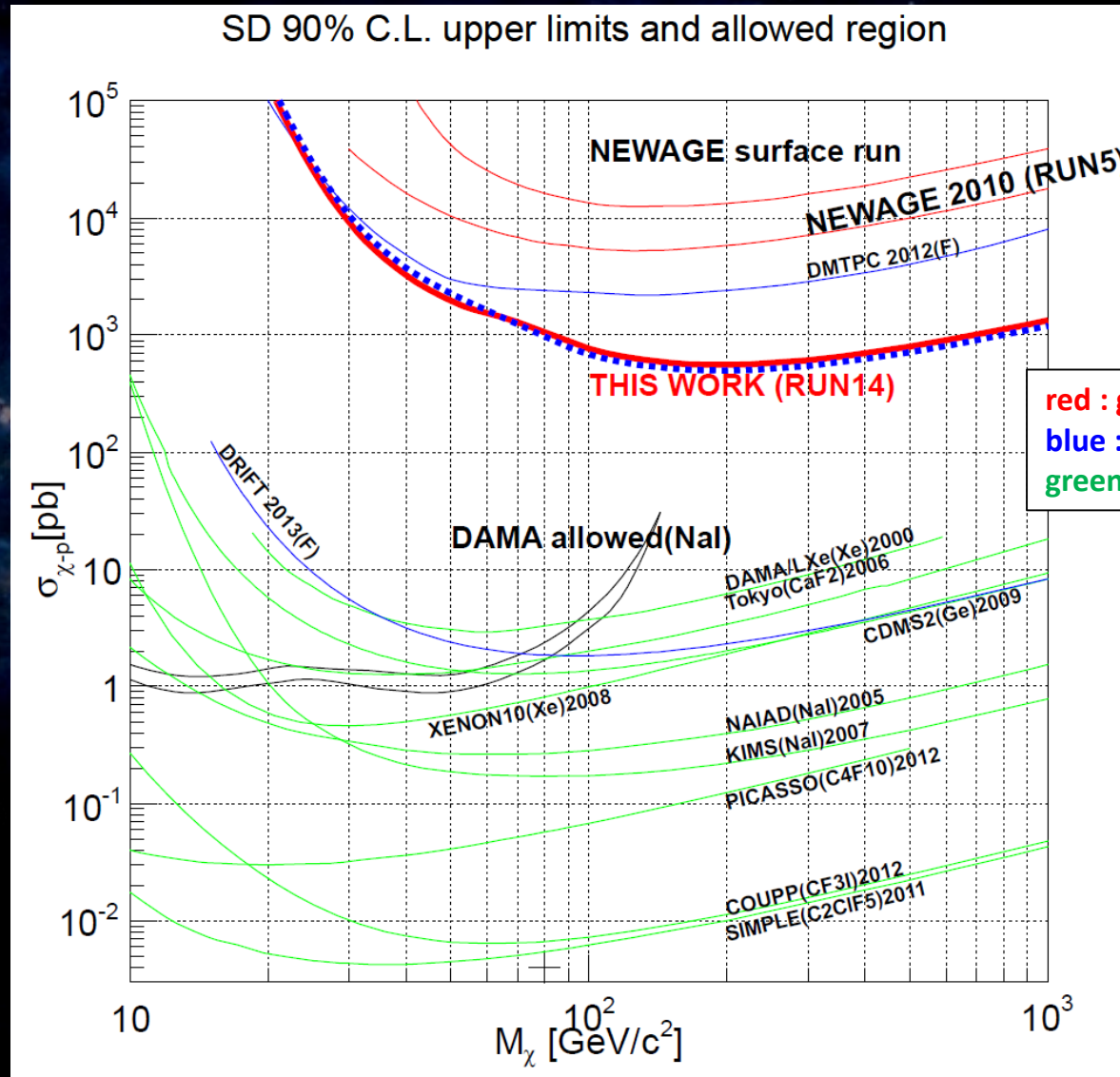
- Threshold : 100 => **50keV**
- BG rate : **1/10**@100keV

Skymap, $\cos\theta$ distribution

- Set limit by significant difference in 2-binned measured $\cos\theta$ and DM-wind simulated $\cos\theta$



Direction-sensitive limit



- Obtained limit : **557pb @200GeV**
(Best direction-sensitive limit)
- Improved one order of magnitude from previous RUN5



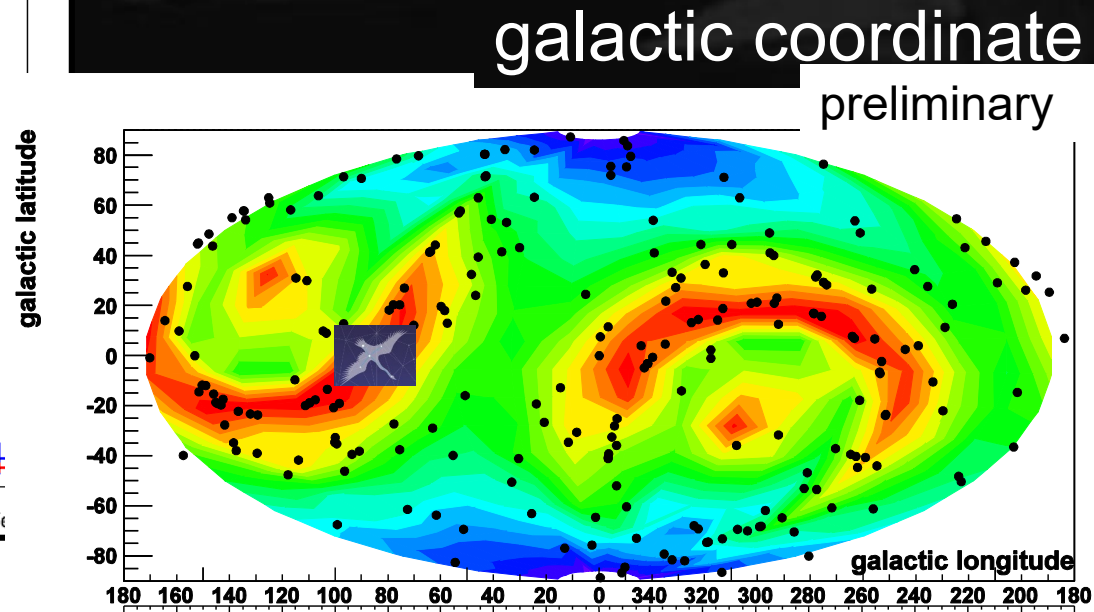
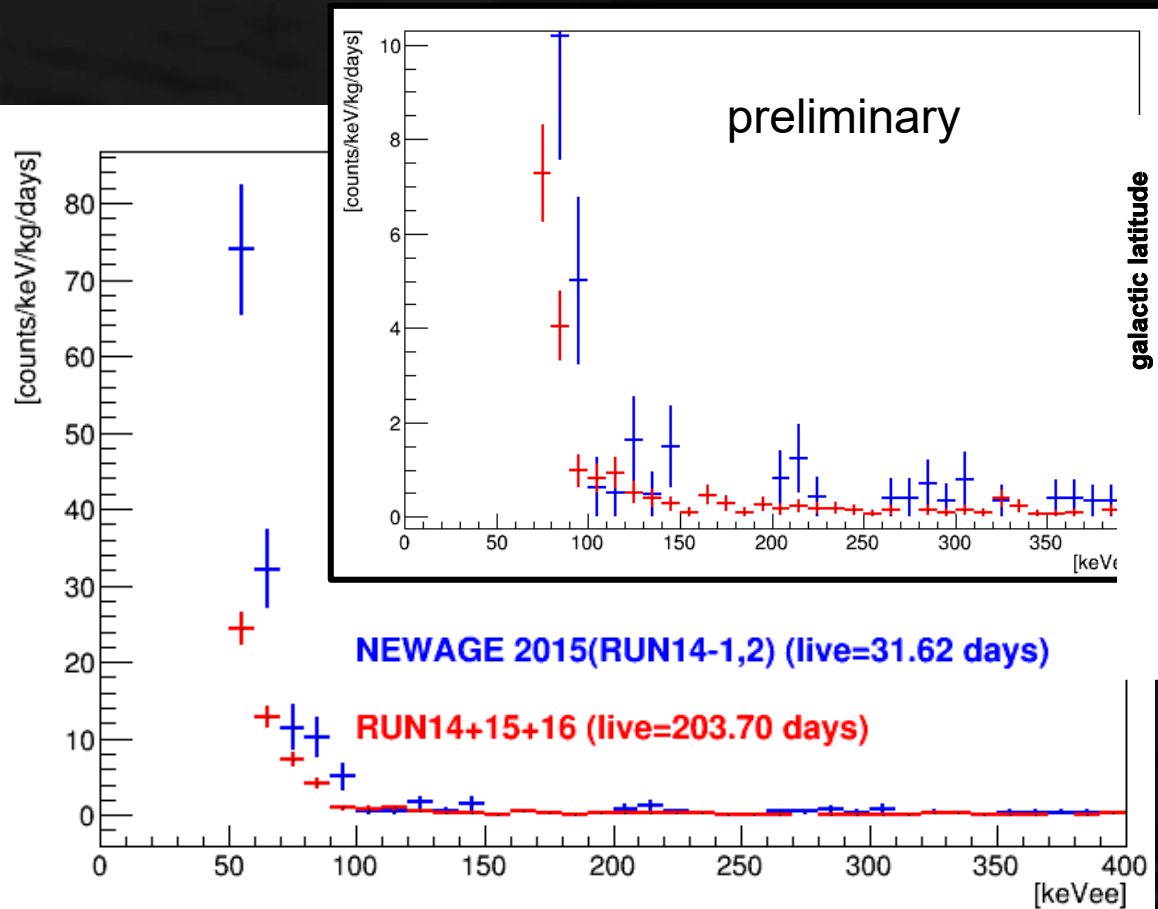
Recent R&Ds

Latest underground data

■ RUN14 (31.6days) + 172.08days

■ gamma-ray cut improvements

■ increased statistics



color: efficiency
dots: recoil events

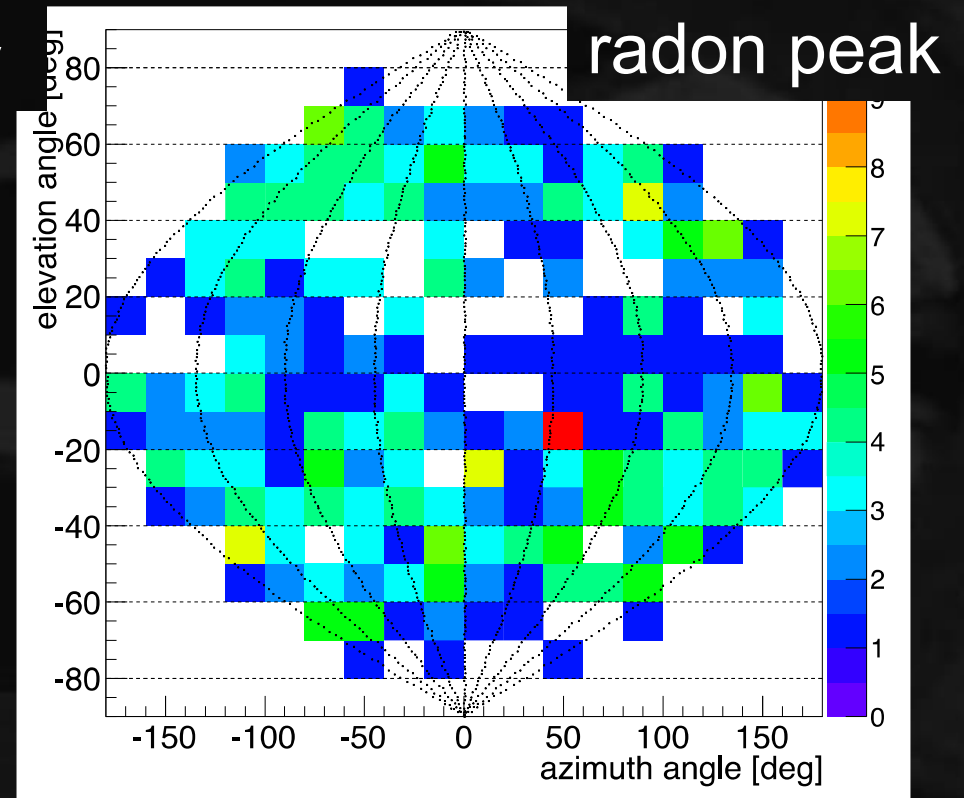
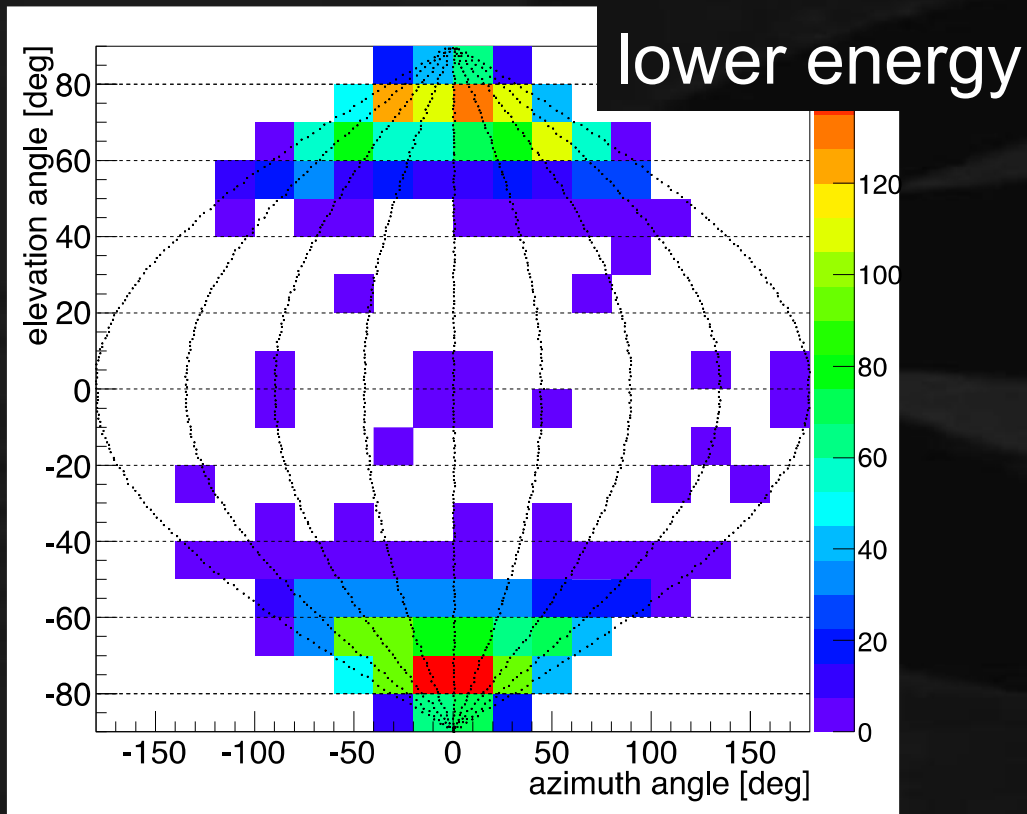
NEWAGE

IBG(Identification of BackGround) study

Directionality helps!

SKYMAP @ detector coordinate

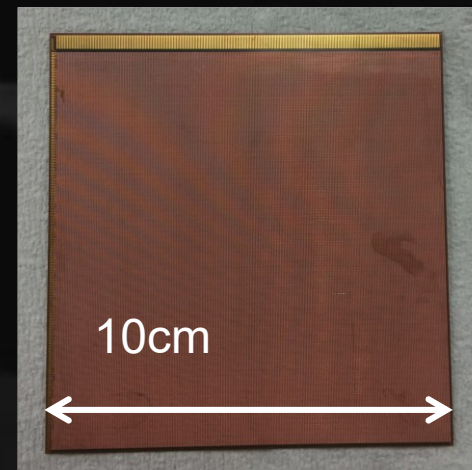
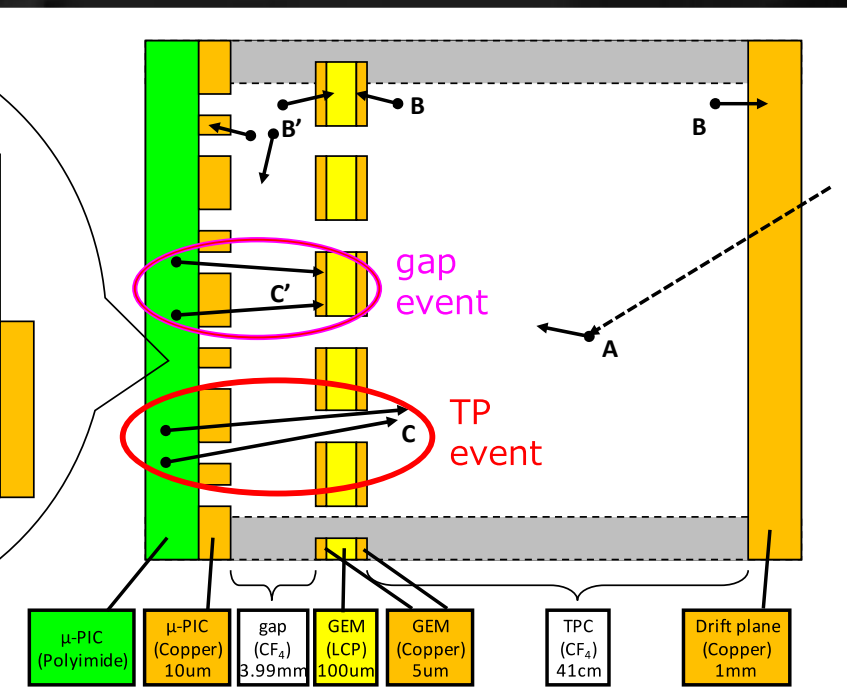
color: number of events



BG identified: upgoing events

IBG (cntd.)

- Largest BG source: alpha particle from μ -PIC
- Development of radio-pure(BG $\times 1/100$) μ -PIC:
10 \times 10 cm² μ -PIC was made and tested

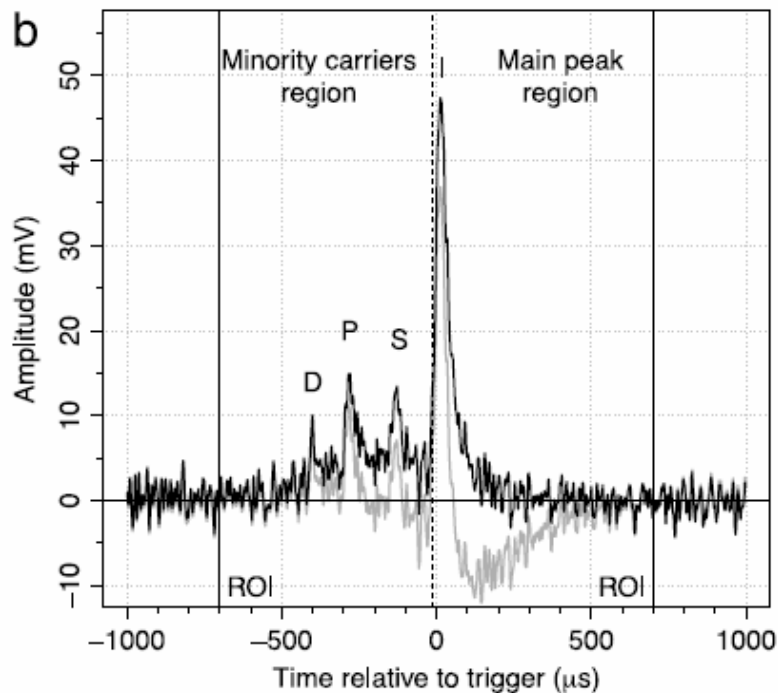


- FY2016: development of 30 \times 30 cm² μ -PIC
- FY2017~: underground run

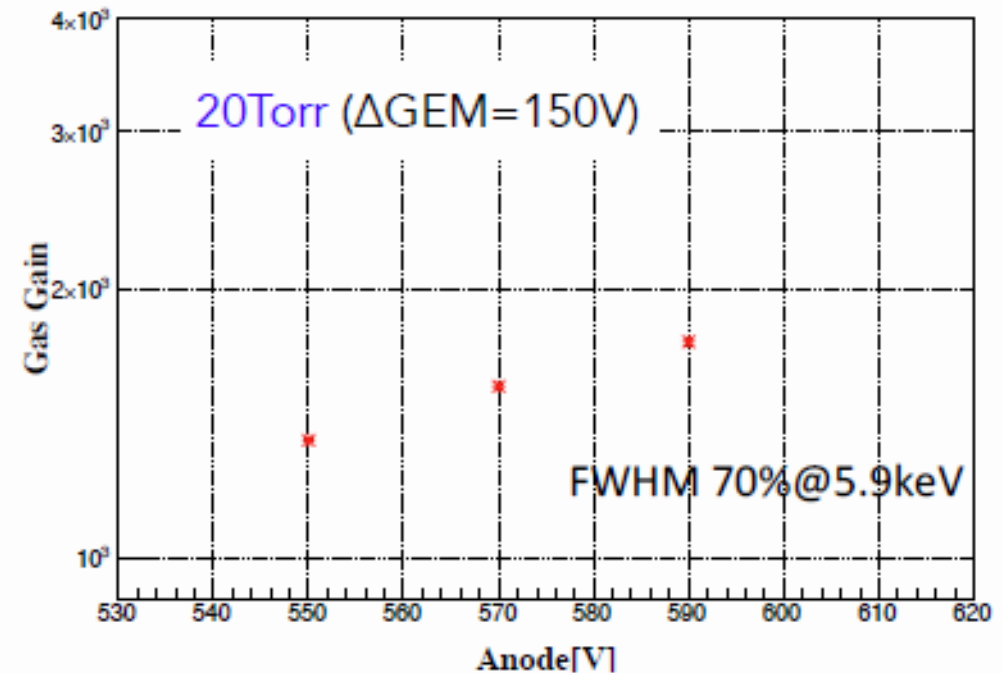
Z-fiducialization

- minority peaks “discovery” by DRIFT group
- SF₆ study for GEM+μPIC system
- wide dynamic-range ASIC development for

minority peaks (DRIFT group)



SF6 study



“CYGNUS”

concept to collaboration

2007 ~ biannual workshop

2007 Boulby

2009 Boston

2011 Aussois

2013 Toyama

2015 LA

2017

for 10th anniversary

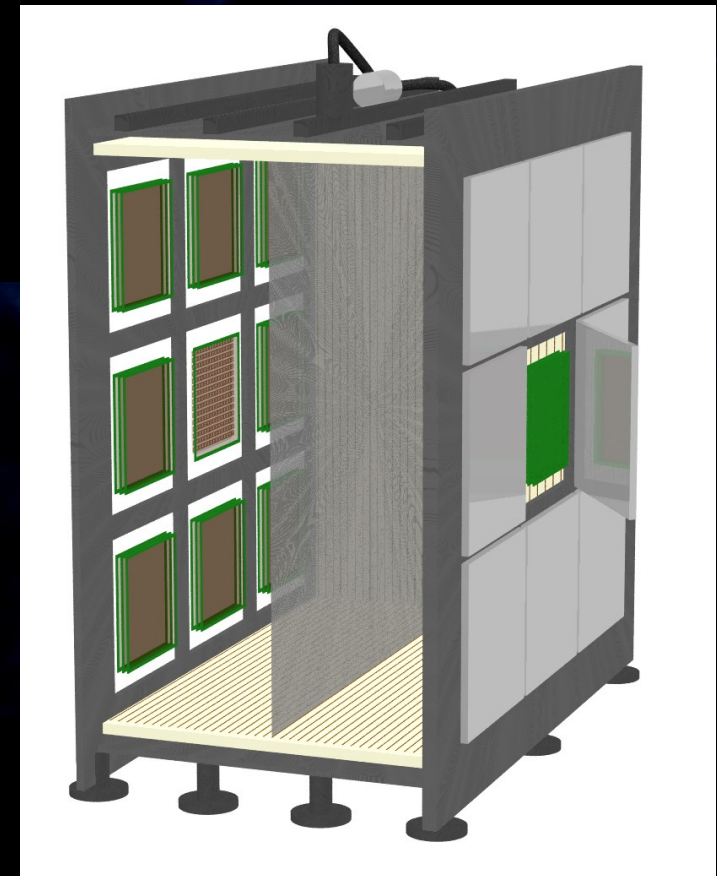
2016 co-working meetings

Jan Boulby

Apr Roma

July Sheffield

CYGNUS-Kamioka
test chamber



Summary

- **NEWAGE :**
direction sensitive with 3D track detection.
- **Sensitivity improvements are on-going.**
- **CYGNUS concept to collaboration**