NEWAGE

(New generation WIMP search
with an advanced gaseous tracker experiment)

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with

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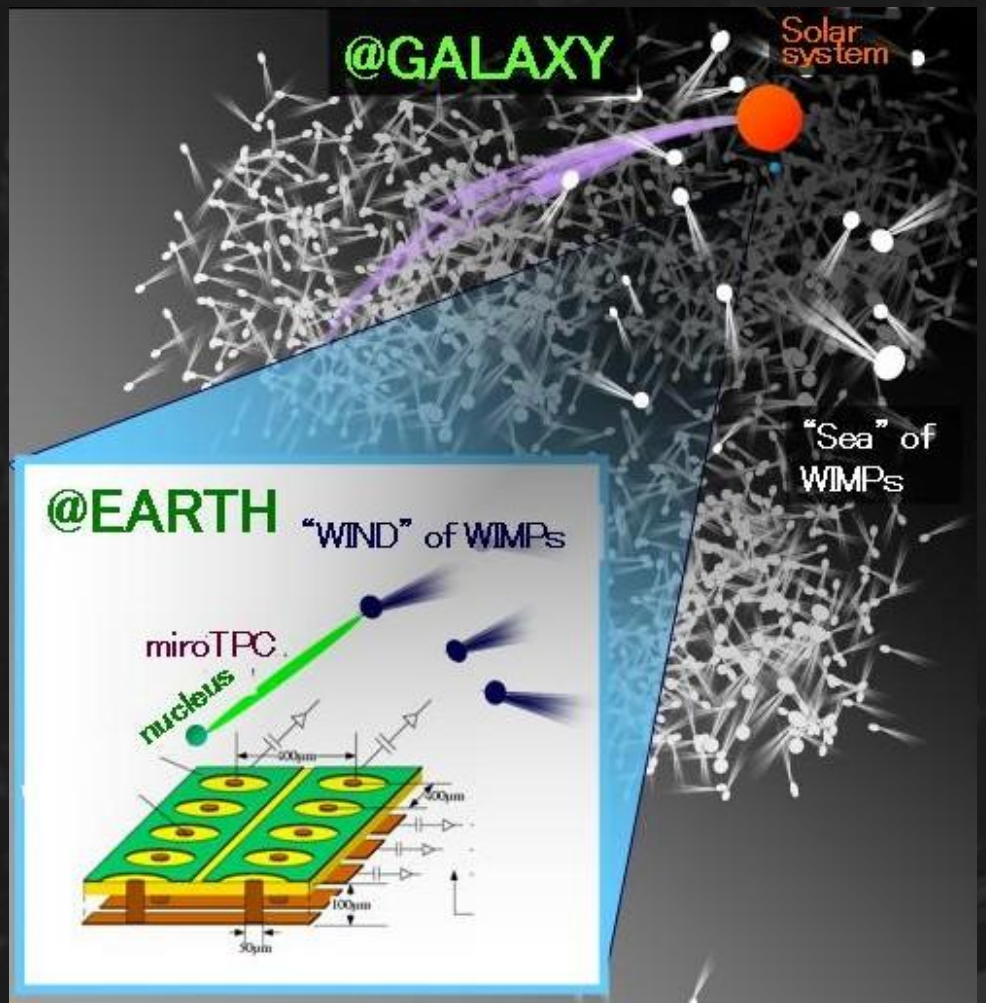
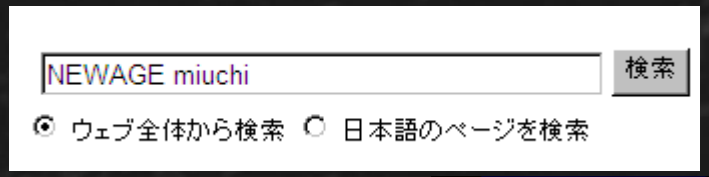


OUTLINE

- NEWAGE
  - detector, its performance
- Highlights since CYGNUS 2007
  - underground activities
  - angular resolution measurement
  - background
  - R&D for future
- Summary

for further info…
visit our page

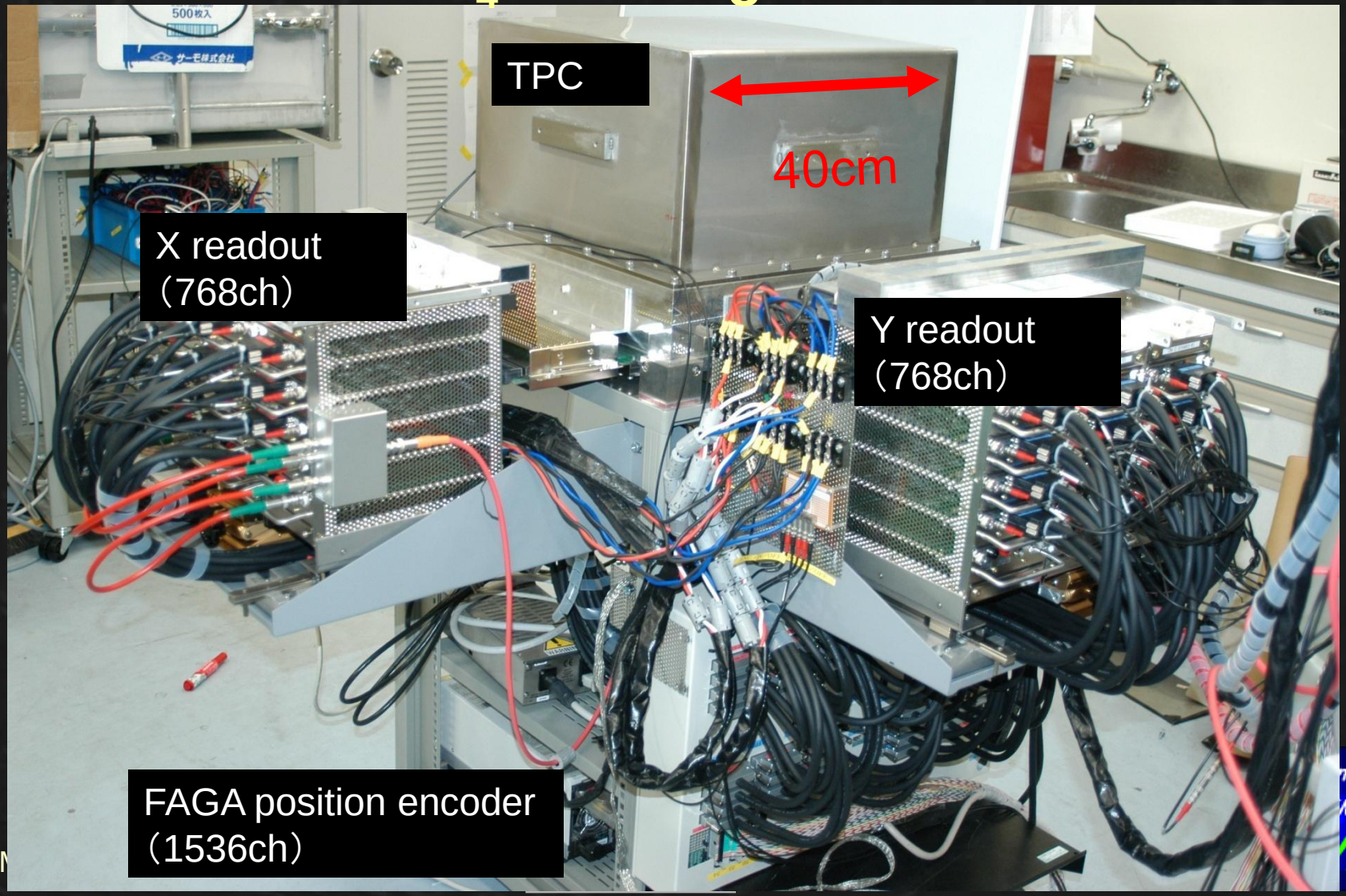


and get Nishimura's doctor thesis

NEWAGE：system

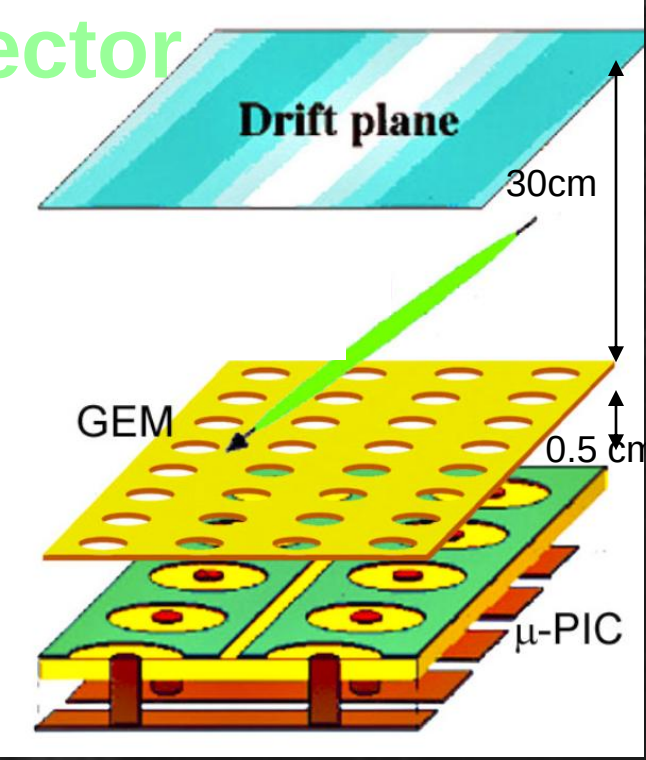
Detector

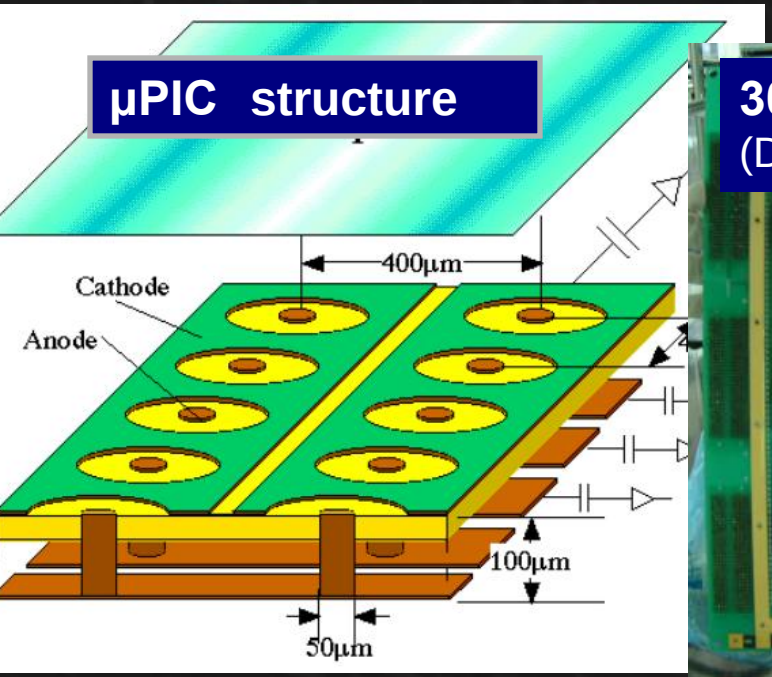
- NEWAGE-0.3a　23×28×31cm^3
- 152torr CF_4 = 11.48g

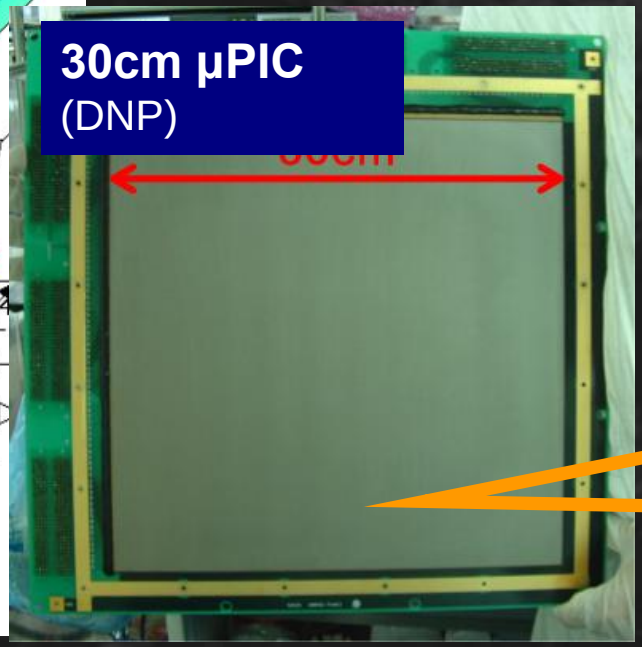


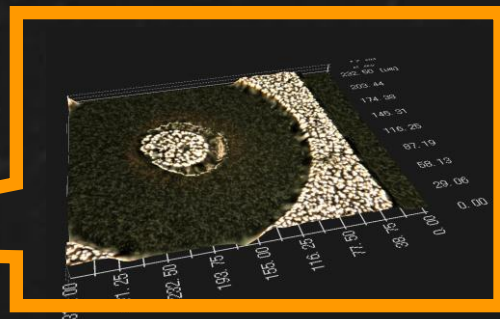
Micro-patterned gaseous detector

- μ-PIC (30*30cm^2)
  - Gas amplification + readout
  - 400μm pitch
  - 768+768 readouts
  - Gas gain ~1000 with 152torr CF_4





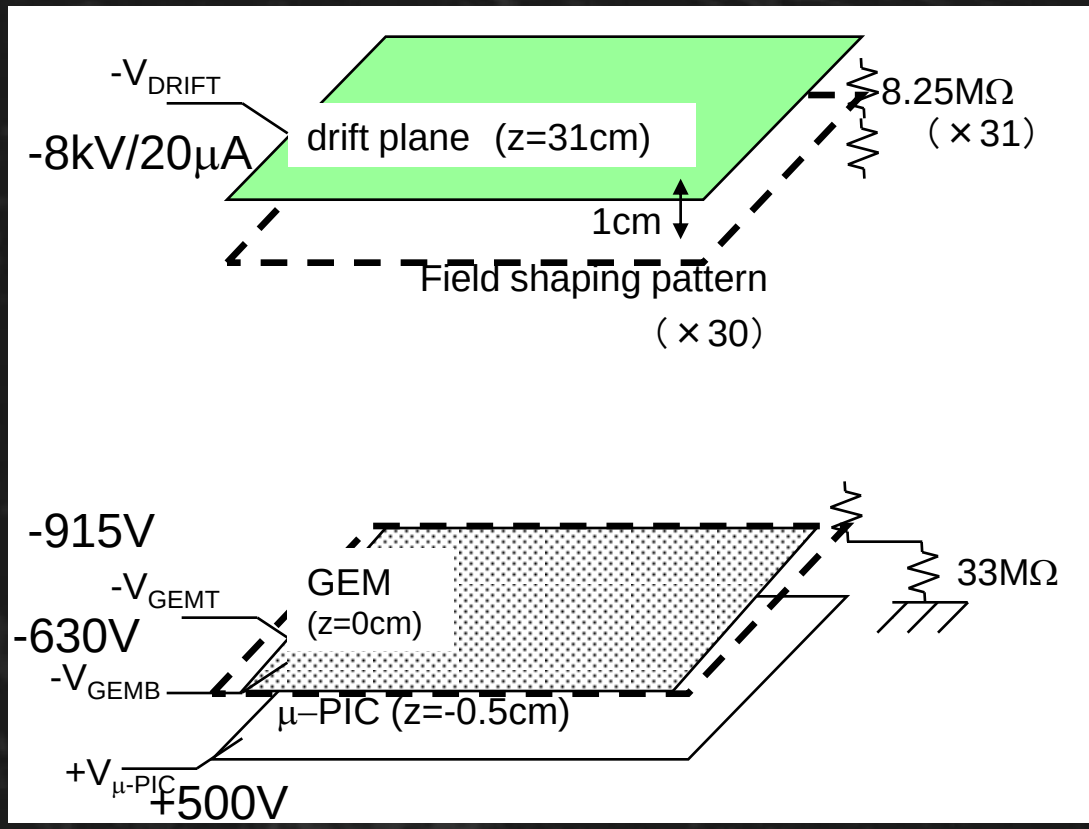


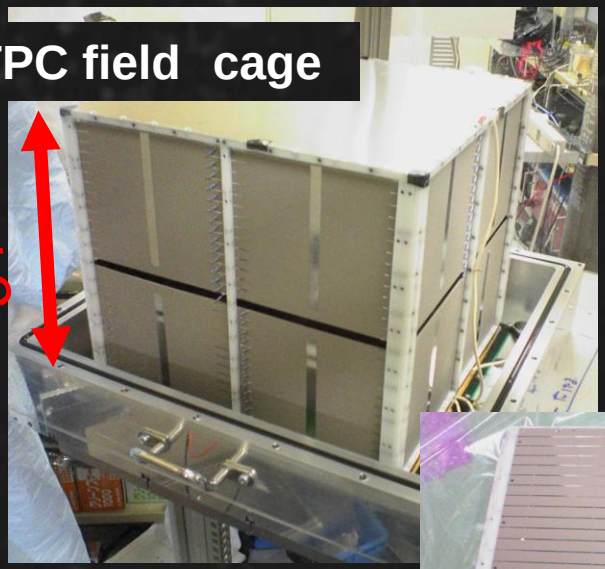


NEWAGE

TPC system

- **Gas volume**
  - DRIFT length 31cm
  - CF_4 152 torr gas
  - sealed operation with a getter pump





Readout electronics tomorrow

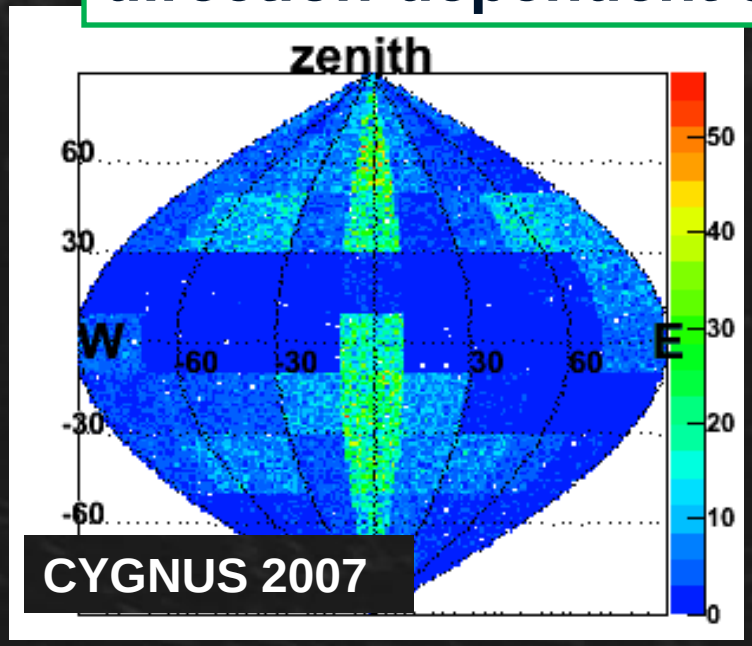
Direction Sensitive WIMP-search NEWAGE

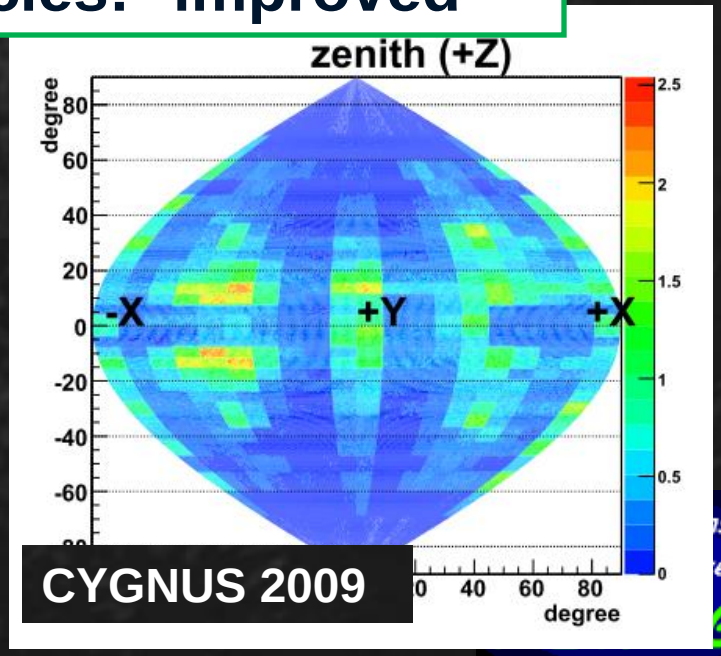
NEWAGE：performance

- **Performance summary (skipping measurement details…)**

parameter	value	
energy resolution	45%(FWHM)	@6MeV
	70%(FWHM)	@100keV
γ-ray efficiency	8.1×10^{-6}	@100keV
Energy threshold	100keV	
Detection efficiency	80%	@100keV

direction-dependent efficiencies: improved

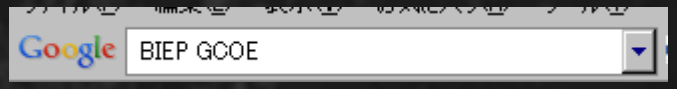




Before the HIGHLIGHTS : announcement

Kyoto university's GCOE started
BIEP (Bilateral International Exchange Program)

for graduate students, up to 3 month



Direction Sensitive WIMP-search NEWAGE

HIGHLIGHTS: underground activities

Direction Sensitive WIMP-search NEWAGE

Underground log (NEWAGE-0.3a at Kamioka)

run ID
exposure(kg・days)

2007

Installation | run1 0.08 | run2 0.15 | Commissioning

2007/3/6 2007/5/15 2007/8/6 2007/12/7

1/4 volume run

GEM replacement

2008

run3 1.744 kg・days | run4 0.602 | run5 0.524

2008/6/9 2008/9/9 2008/12/2

full operation performance study

BG study

DM run

2009

Commissioning | run6 0.817+

2009/3/2

gas circulation system installation

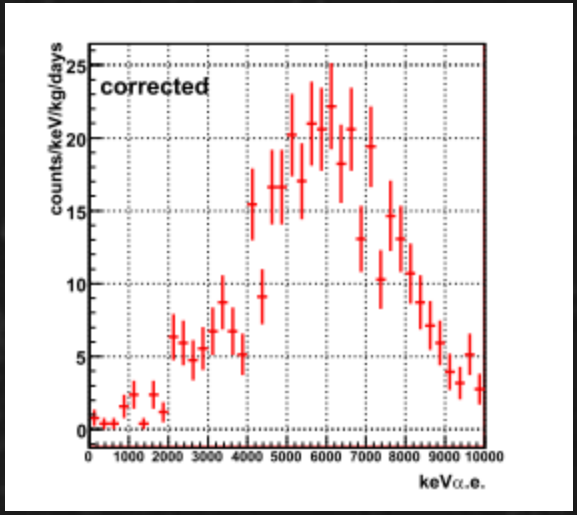
total exposure 3.917 kg・days

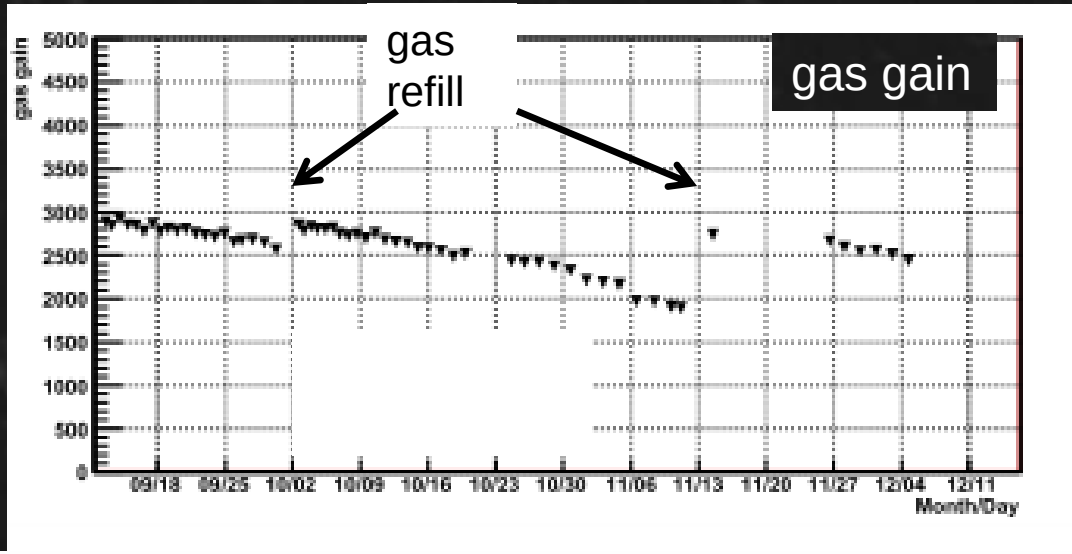
K.

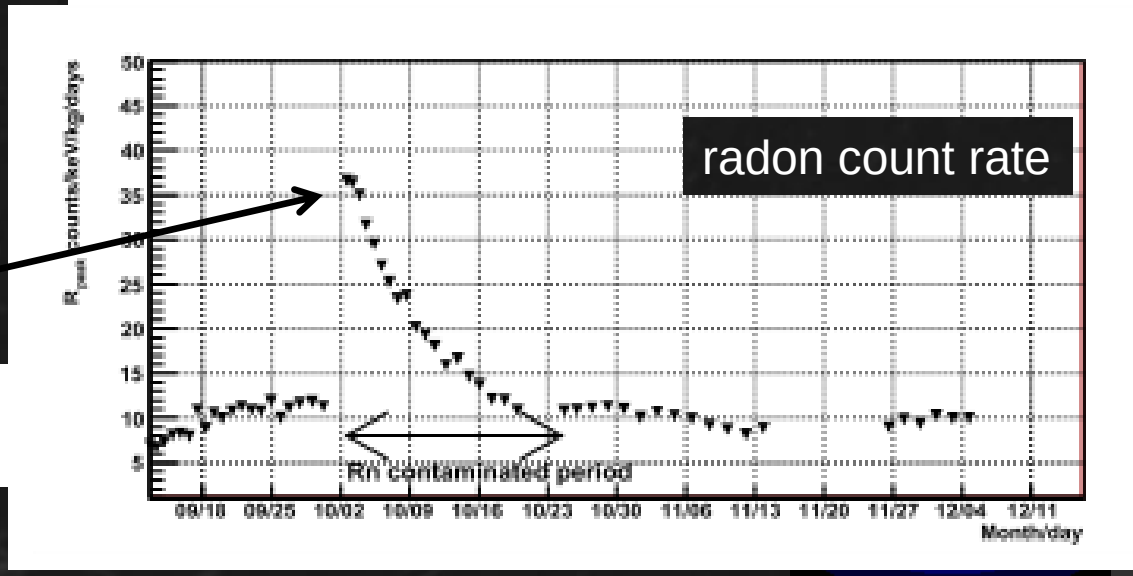
HIGHLIGHTS：
Latest Dark Matter Run

RUN5 results①：stability

- gas gain 3000 ⇒ 2000 in one month
  ⇒ refilled with fresh gas
- radon rate (~6MeV)

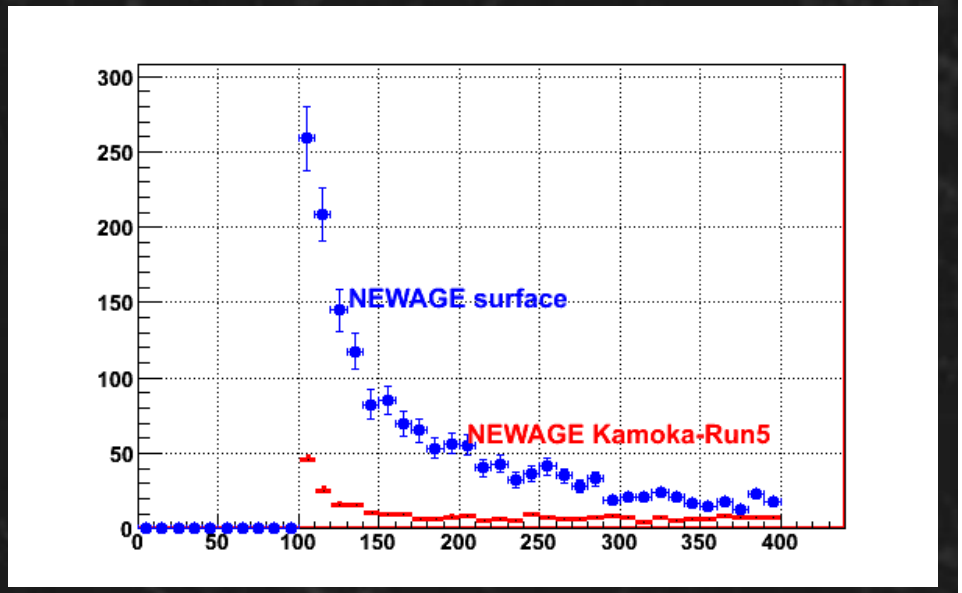


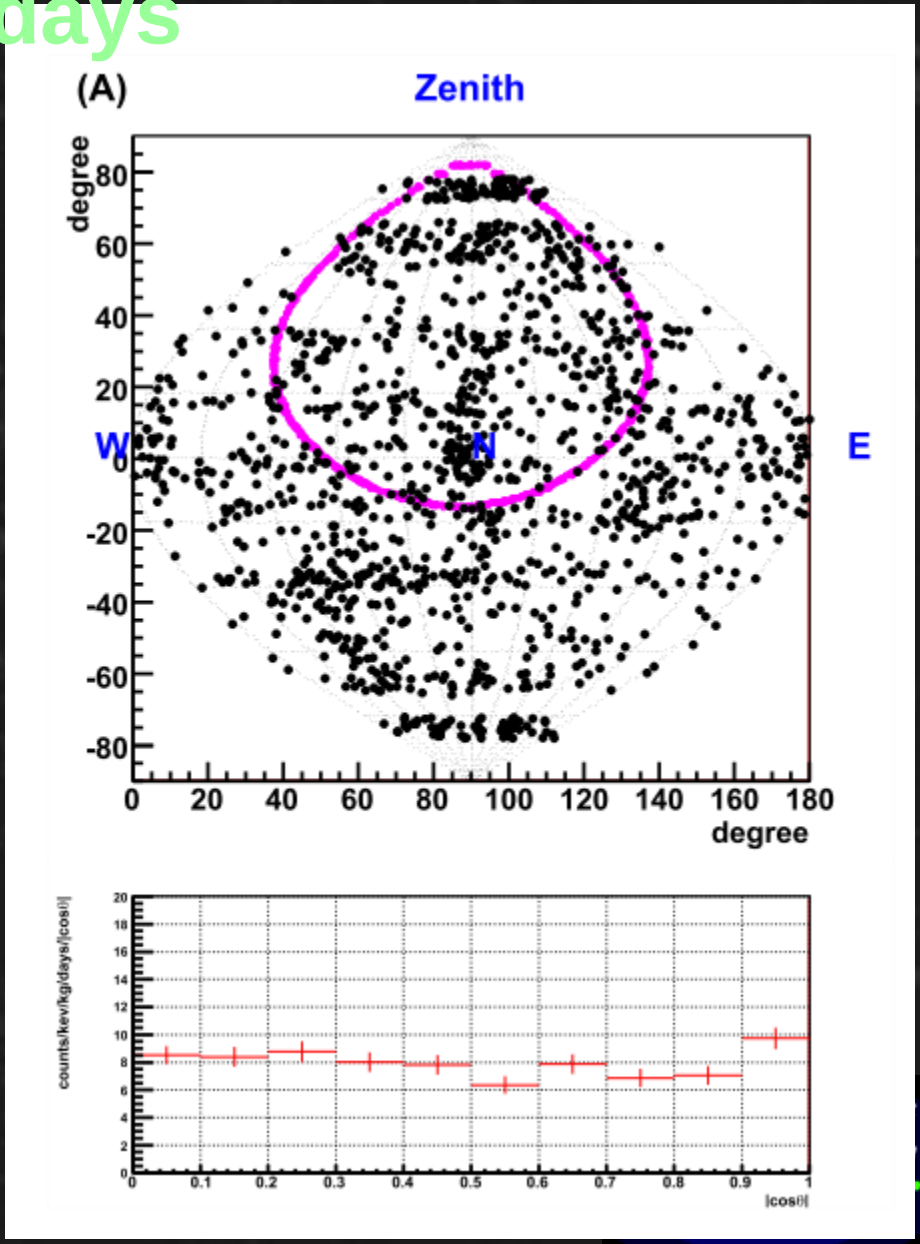




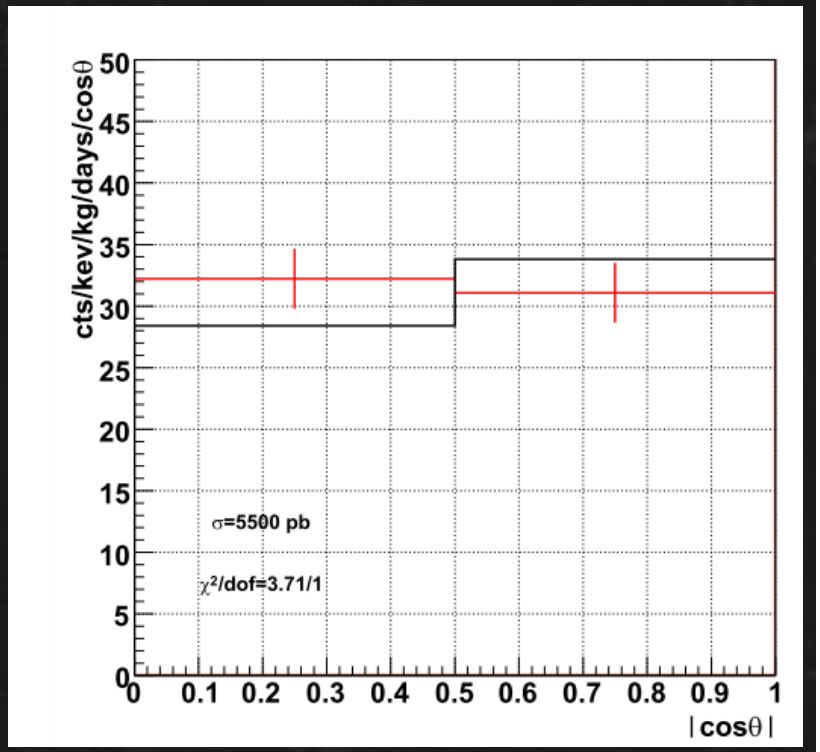
We used a gas tube exposed to the mine air…

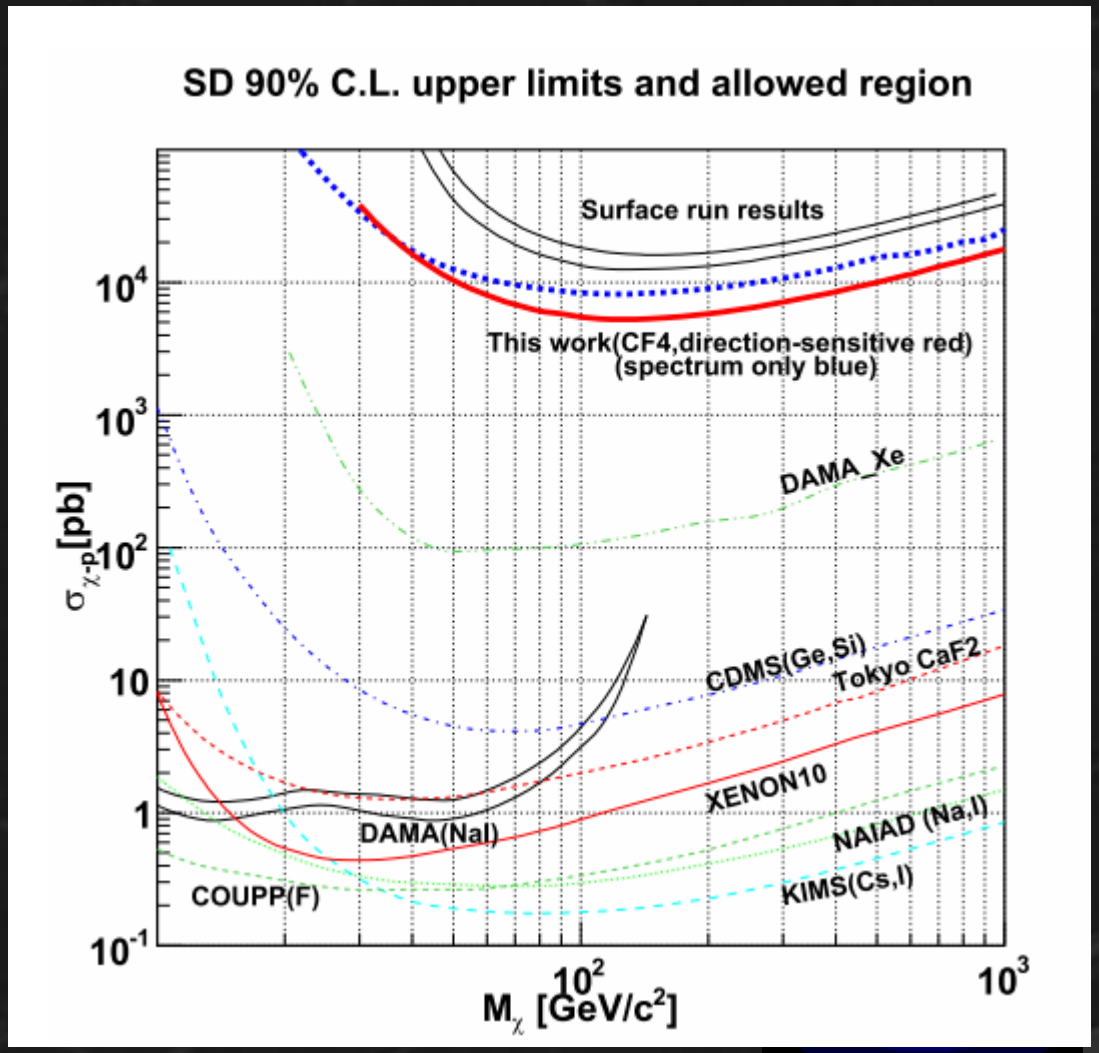
- RUN5 results②
  - exposure 0.524 kg･days
  - spectrum
    1/5 rate of the surface run
  - sky map
    flat cosθ distribution





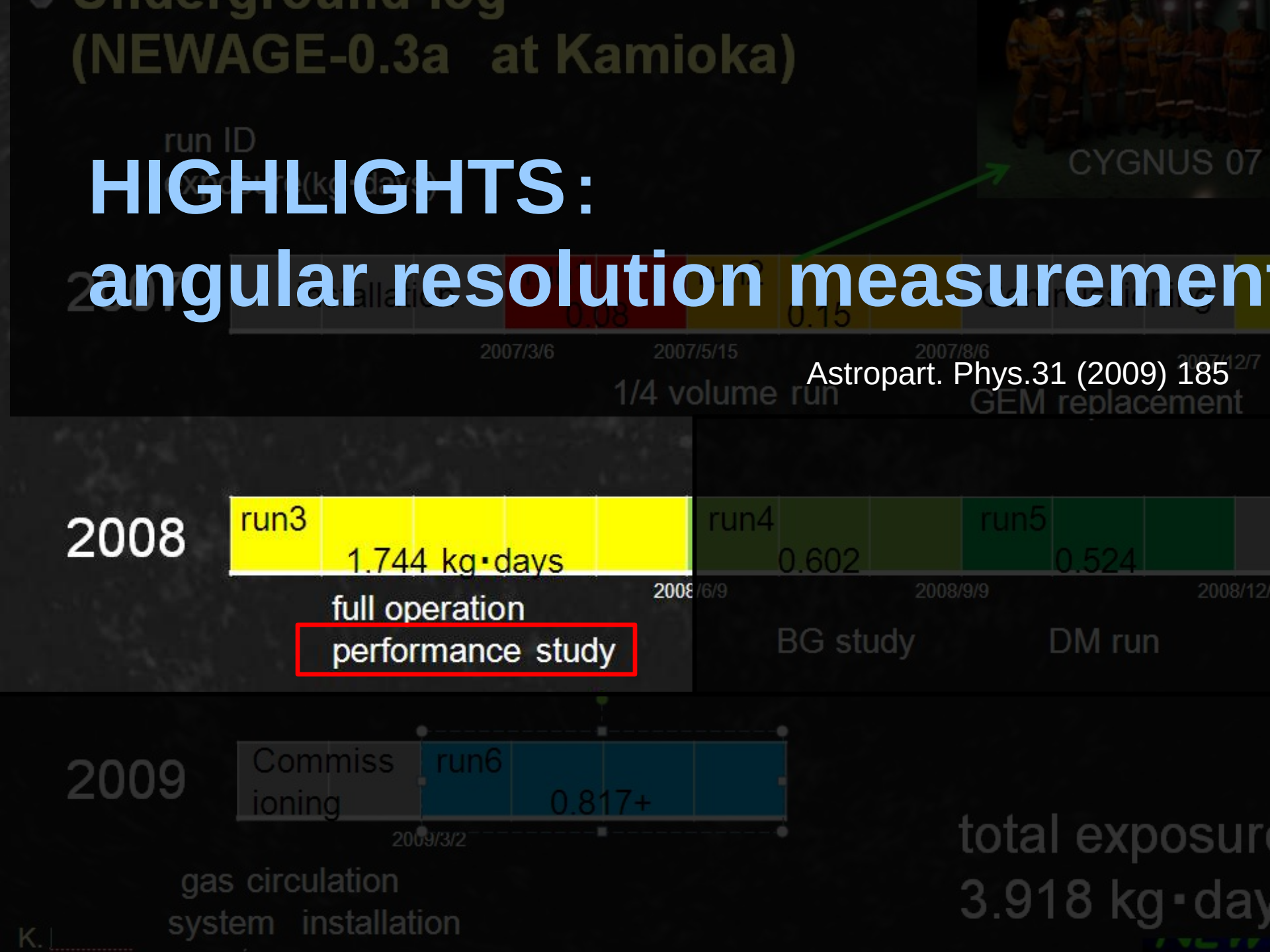
- RUN5 results③
  - poor statistics： 2bin analysis
  - new limits 5400pb for 150GeV





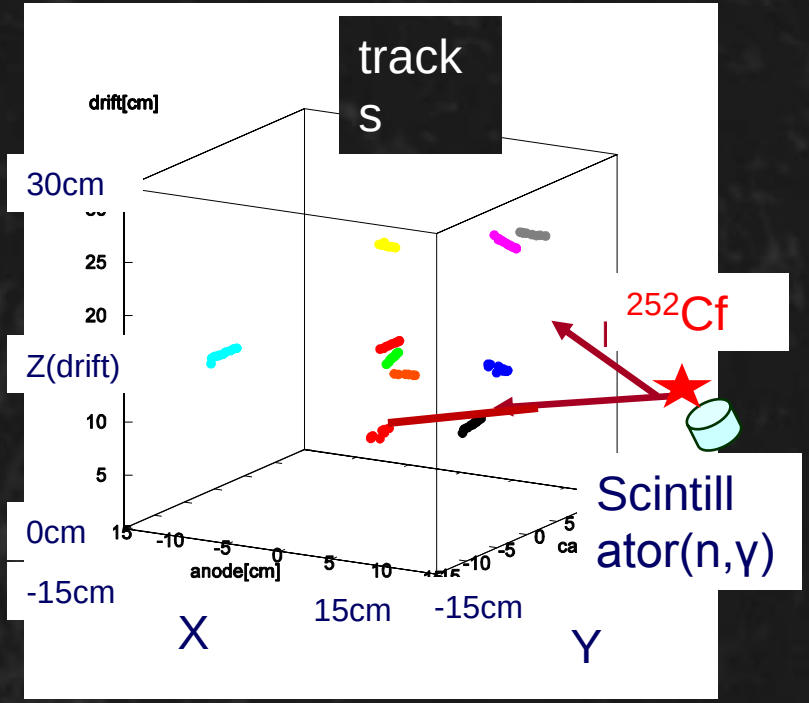
HIGHLIGHTS：
angular resolution measurement

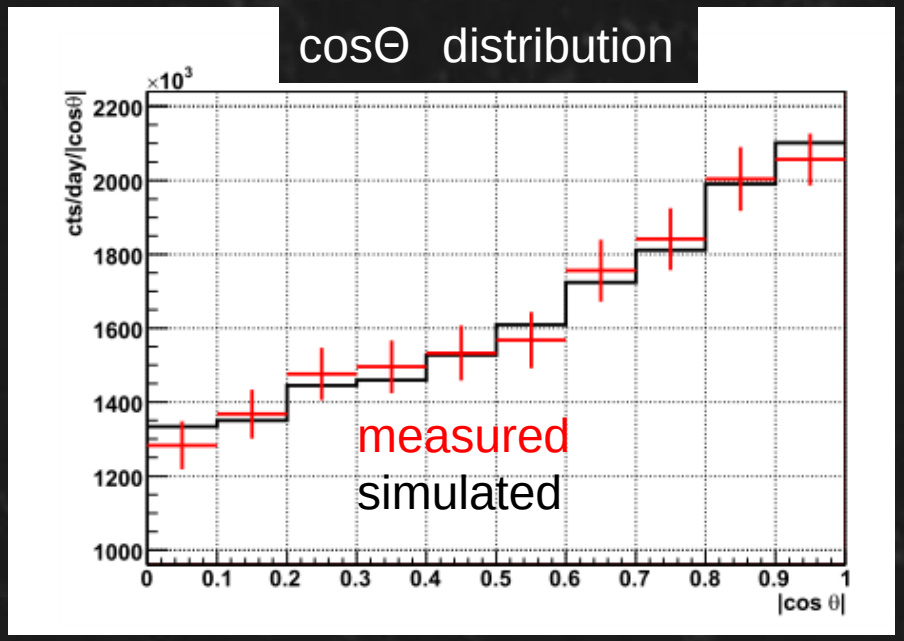
Astropart. Phys.31 (2009) 185



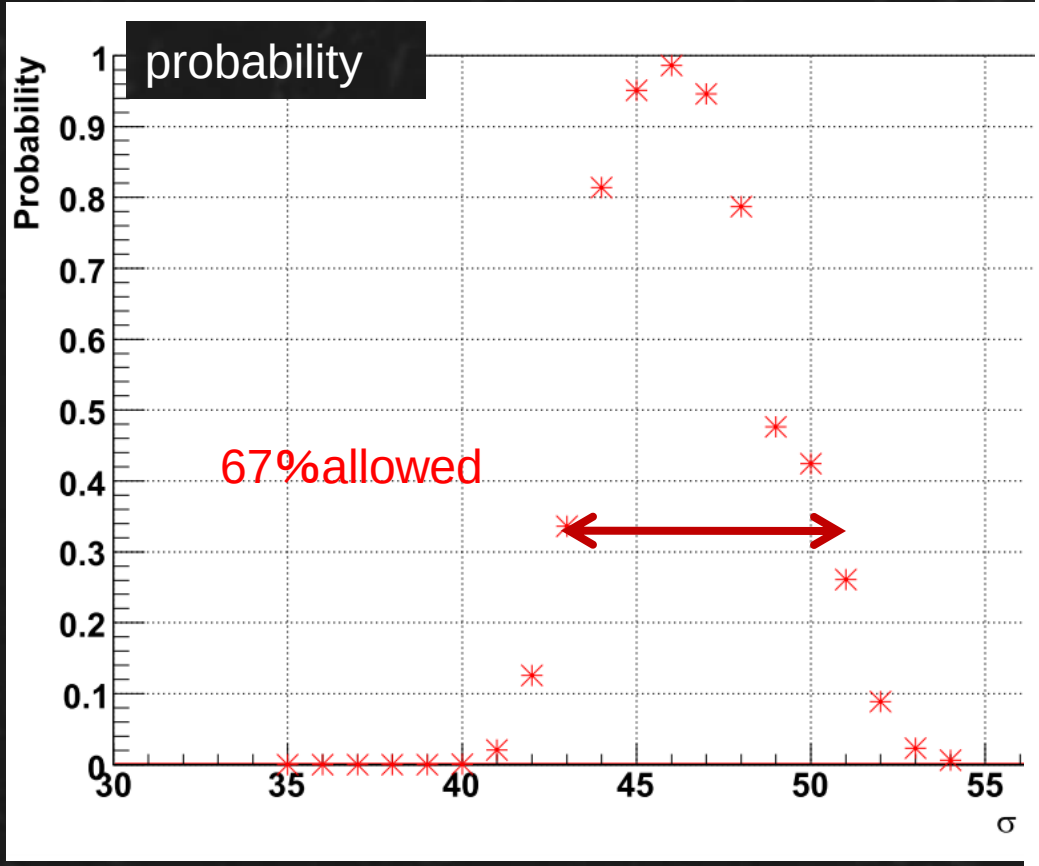
Methods

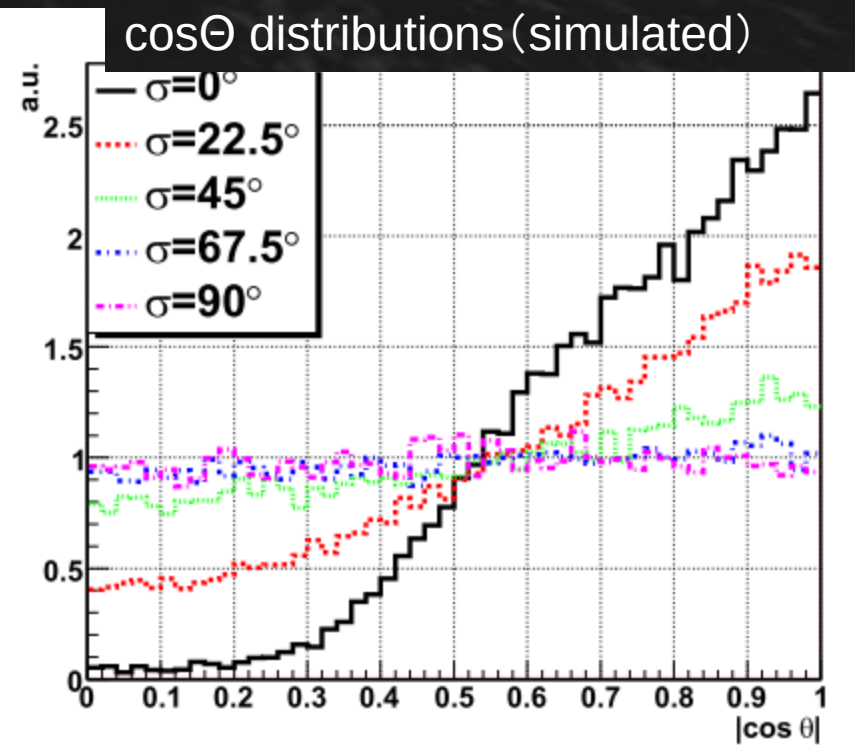
- 252Cf + trigger scintillator
- tracks with an absolute z
- measure recoil angle θ
- compare θ distribution

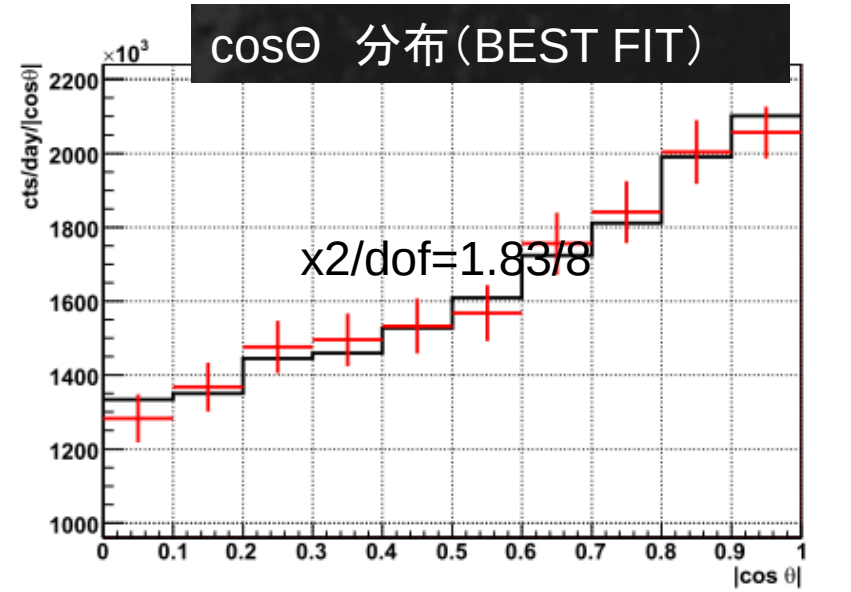




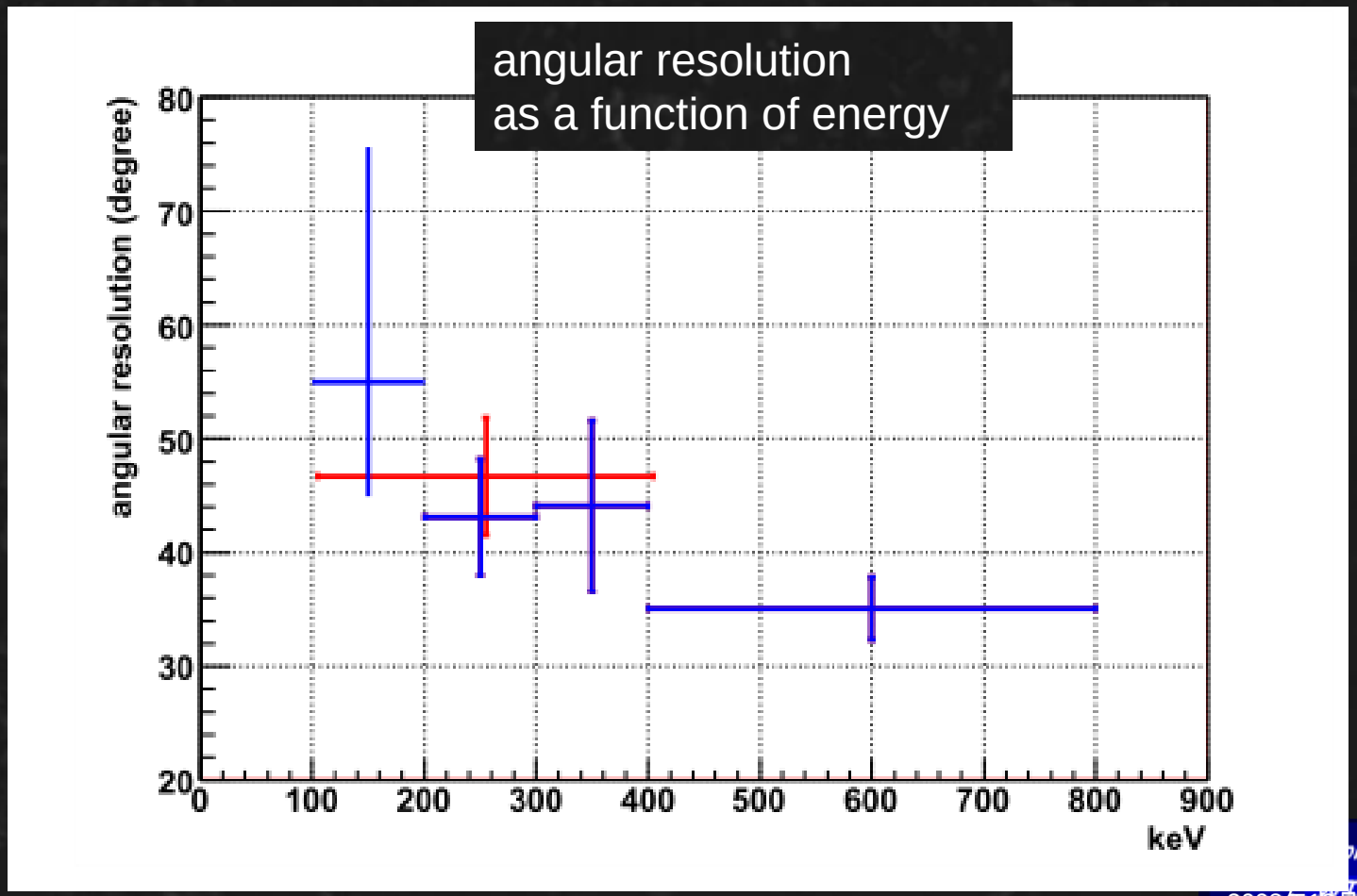
- analysis
  - 分解能σをふって、cosθ分
  - χ2 tests







- **results**
  - **46±3° (100-400keV)**
  - **would be improved with lower pressure gas**

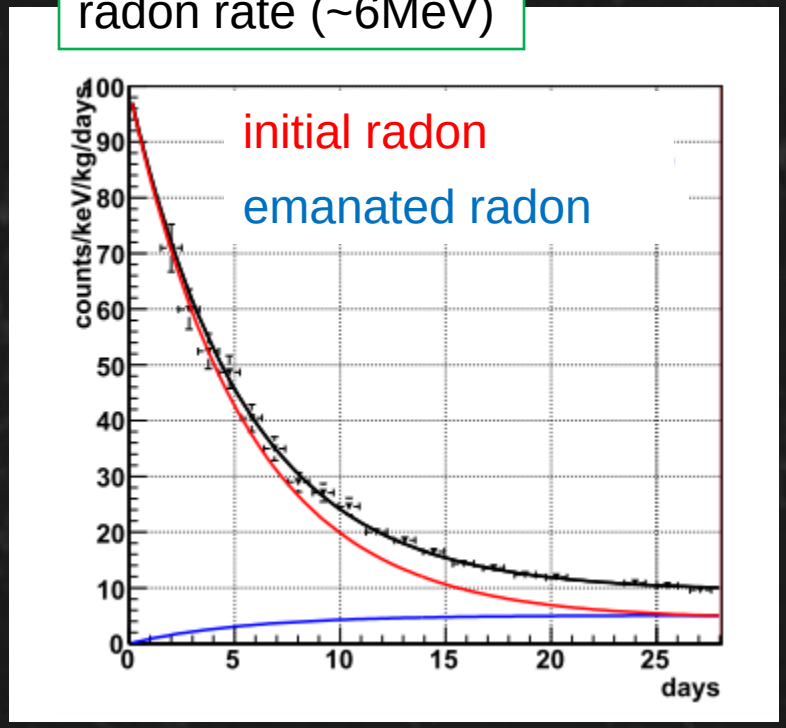


HIGHLIGHTS：
Background Studies

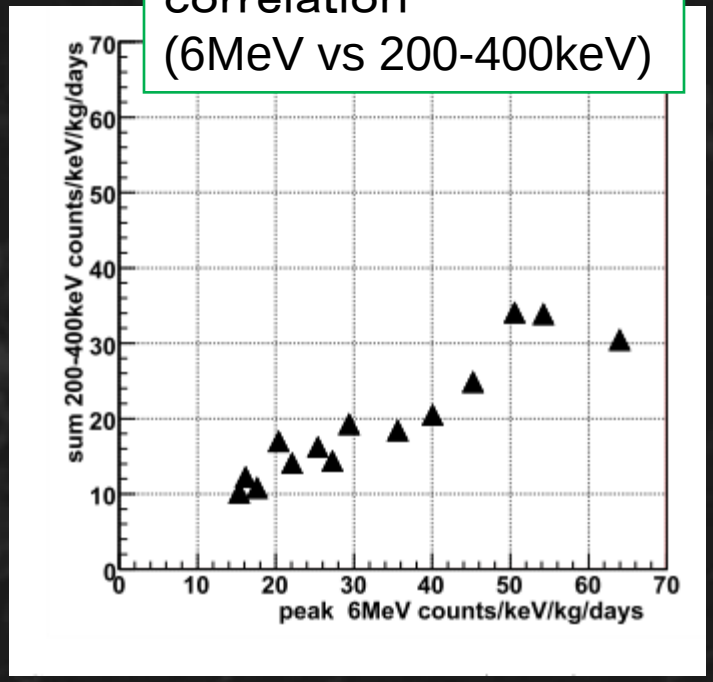
Radon contribution study (run4)

- exposed the TMP mine air
- radon-rich run

radon rate (~6MeV)



correlation
(6MeV vs 200-400keV)



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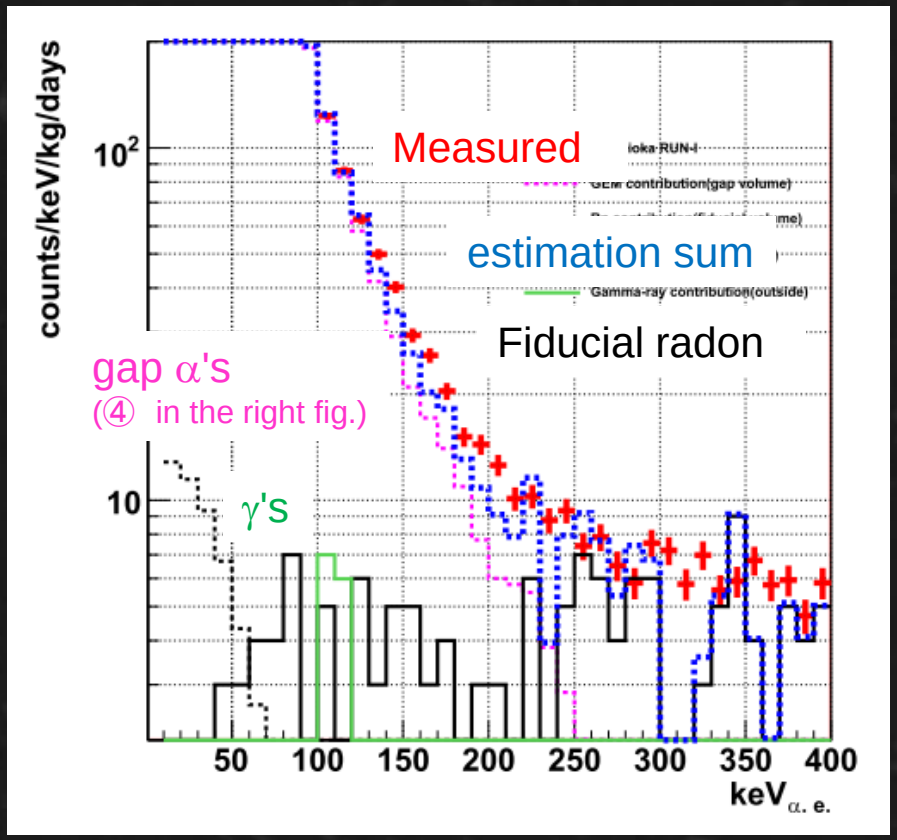
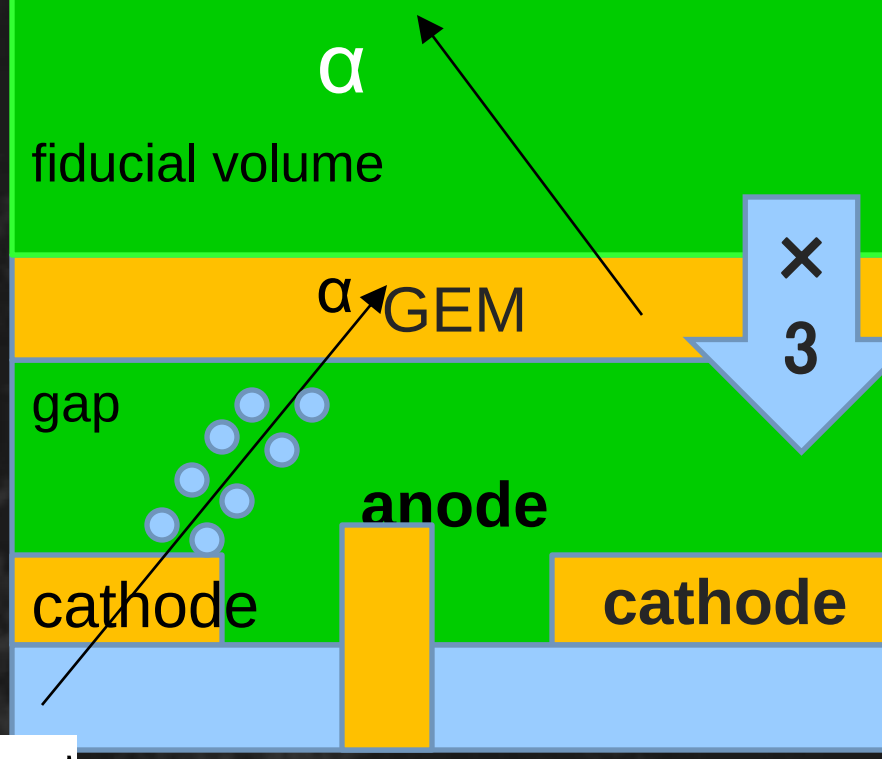
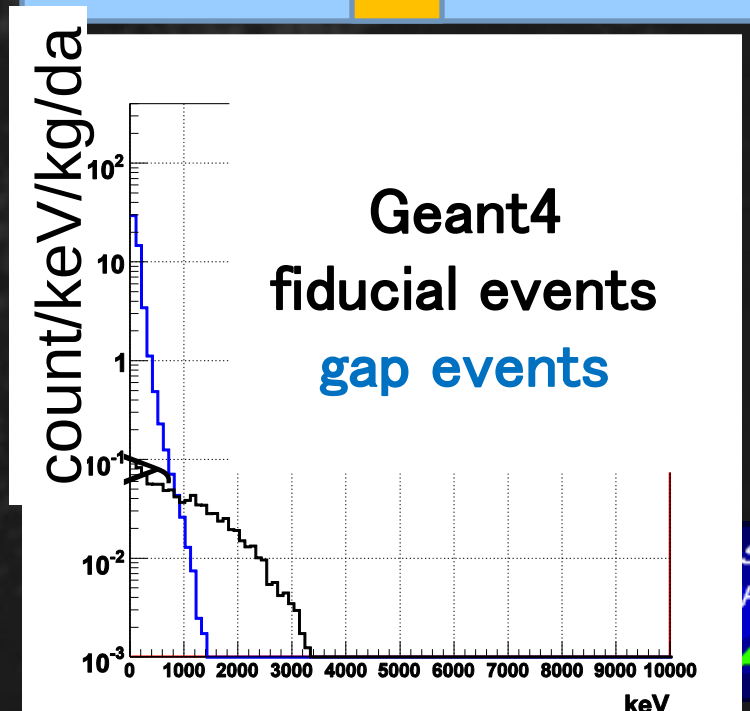
- **Background budgets**
  gap α's contribute most





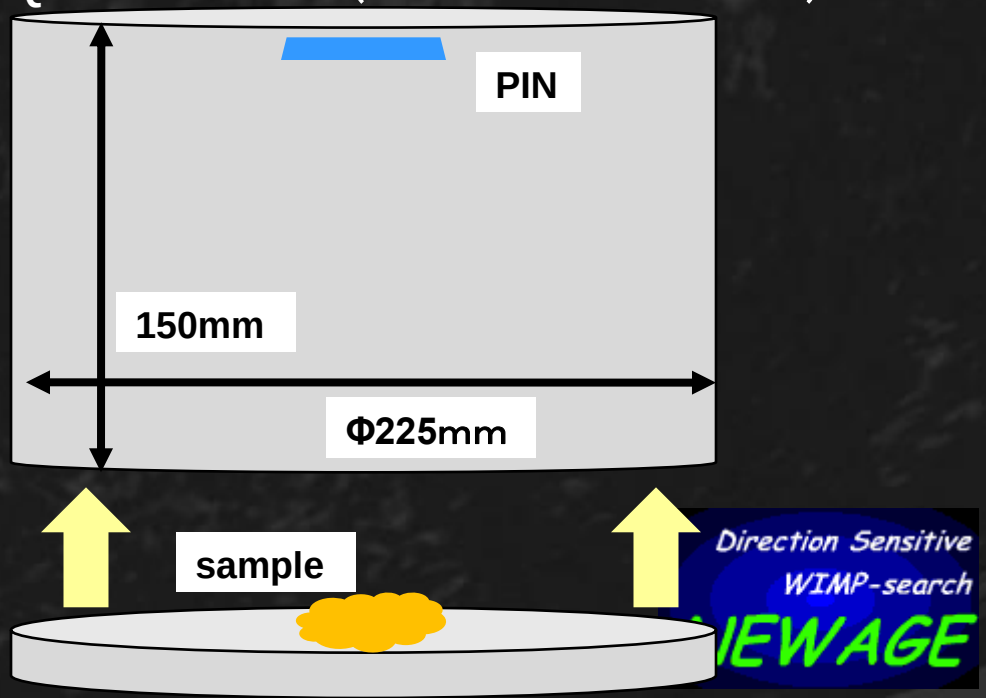


Material screening (Kyoto)

Radon detector (NEWAGE RD-1)

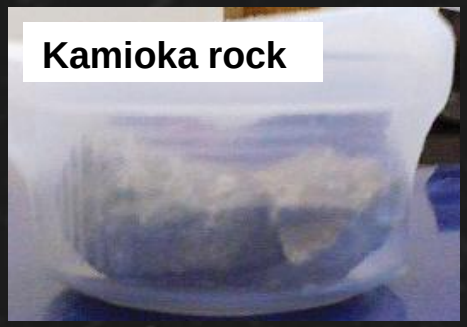
SPEC

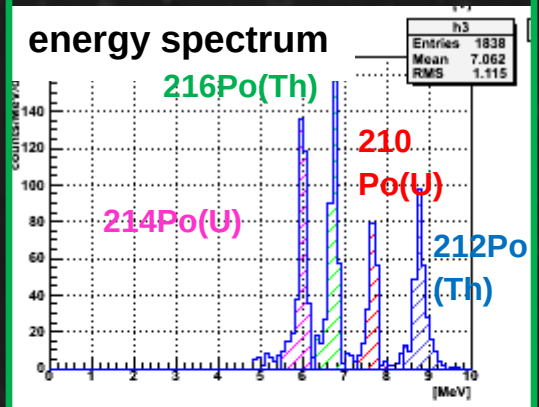
SUS 304 vessel 3mm-thick
electric polished
Windowless PIN photo-diode
（10×10mm^2 S3590-02）
Typical operation
-375V Po^+ capture / 9V reverse-bias
DAQ LPC-320901 （PCI-bus 40MHz FADC）

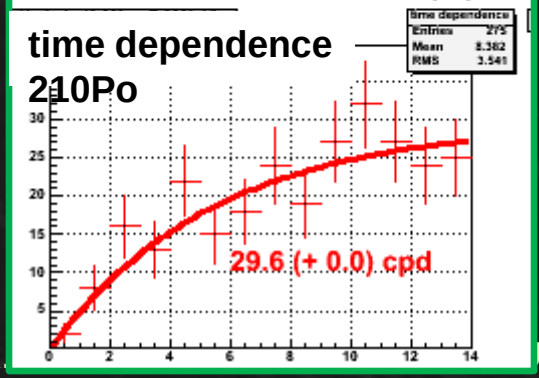


NEWAGE RD-1 results (preliminary)

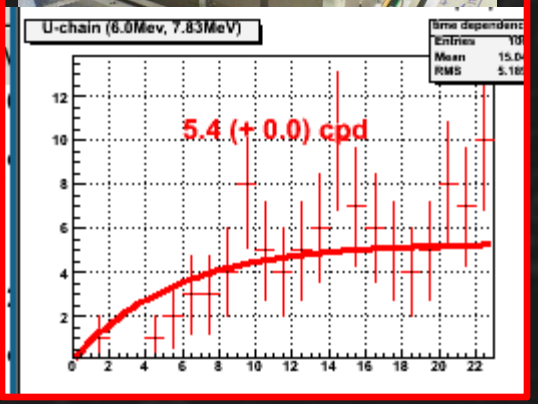
TEST SOURCE
(calibration to be done somehow…)



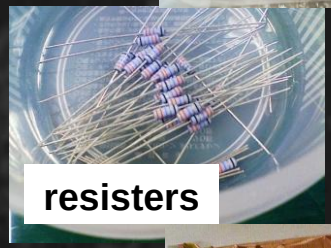




GUILTY

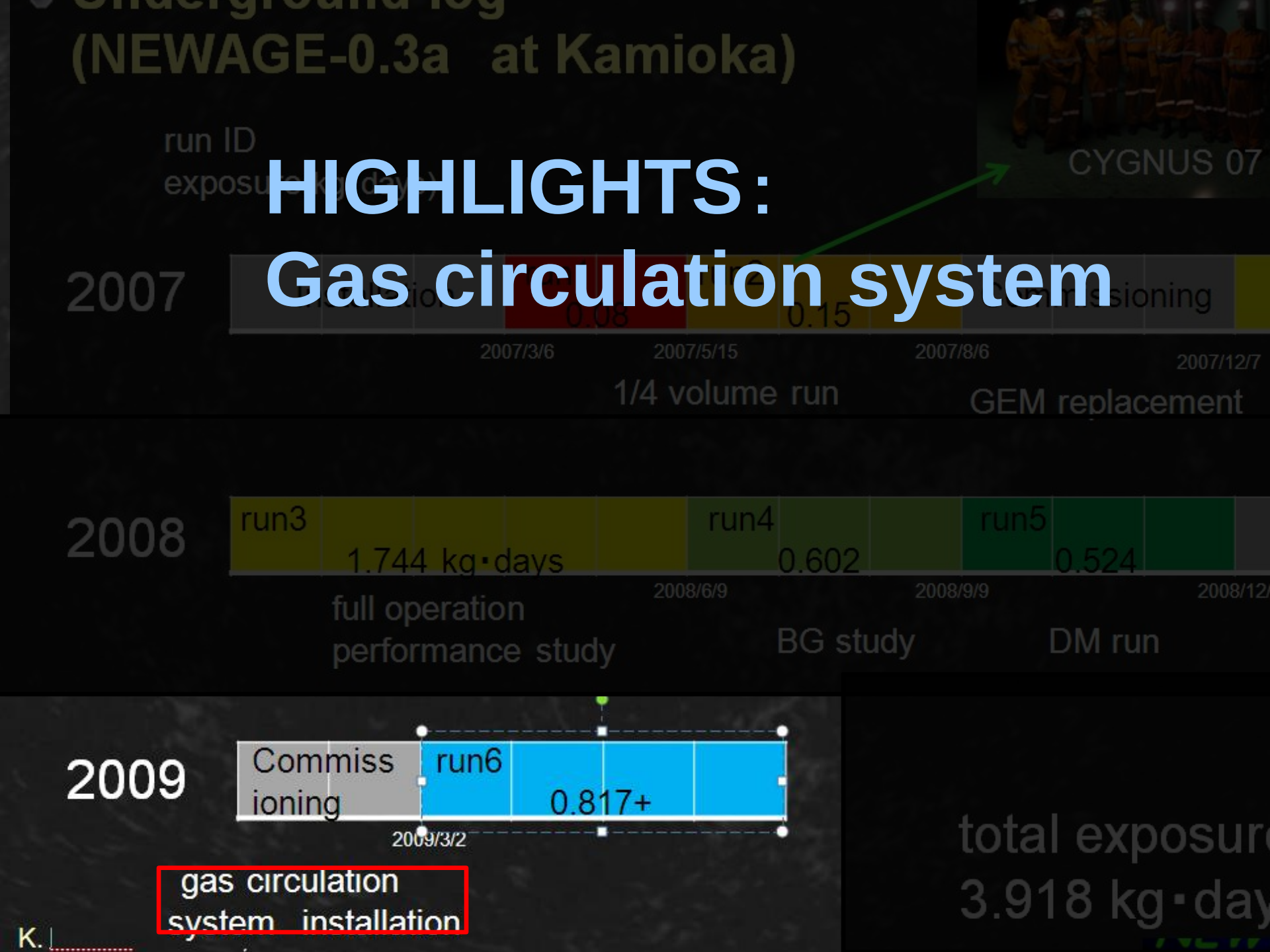


NOT GUILTY



Direction Sensitive WIMP-search NEWAGE

HIGHLIGHTS：
Gas circulation system



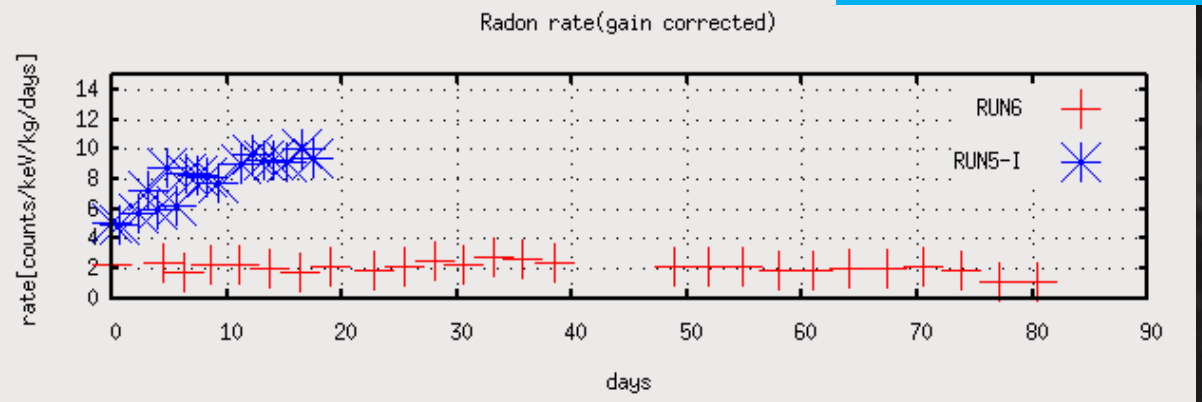
Gas system upgrade

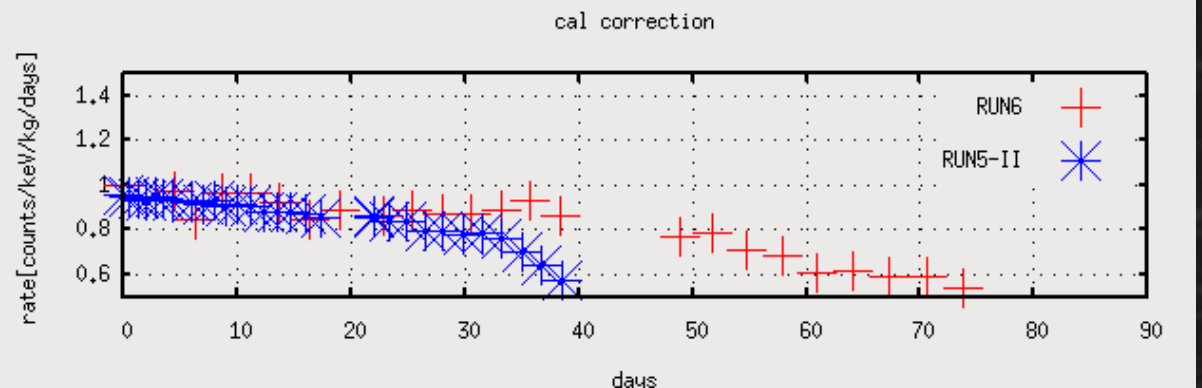
~ RUN5

sealed vessel
getter pump
(SAES GETTER C400-2DSK)
no circulation

RUN6 ~

sealed vessel
getter pump
(SAES GETTER C400-2DSK)
circulation
(Teflon bellows pump)
charcoal filter ~100g
(TSURUMICOAL 2GS)





- **radon rate**
  ×1/5 @day10
- **gain stability**
  ×2

Direction Sensitive WIMP-search NEWAGE

TO THE FUTRUE

Direction Sensitive
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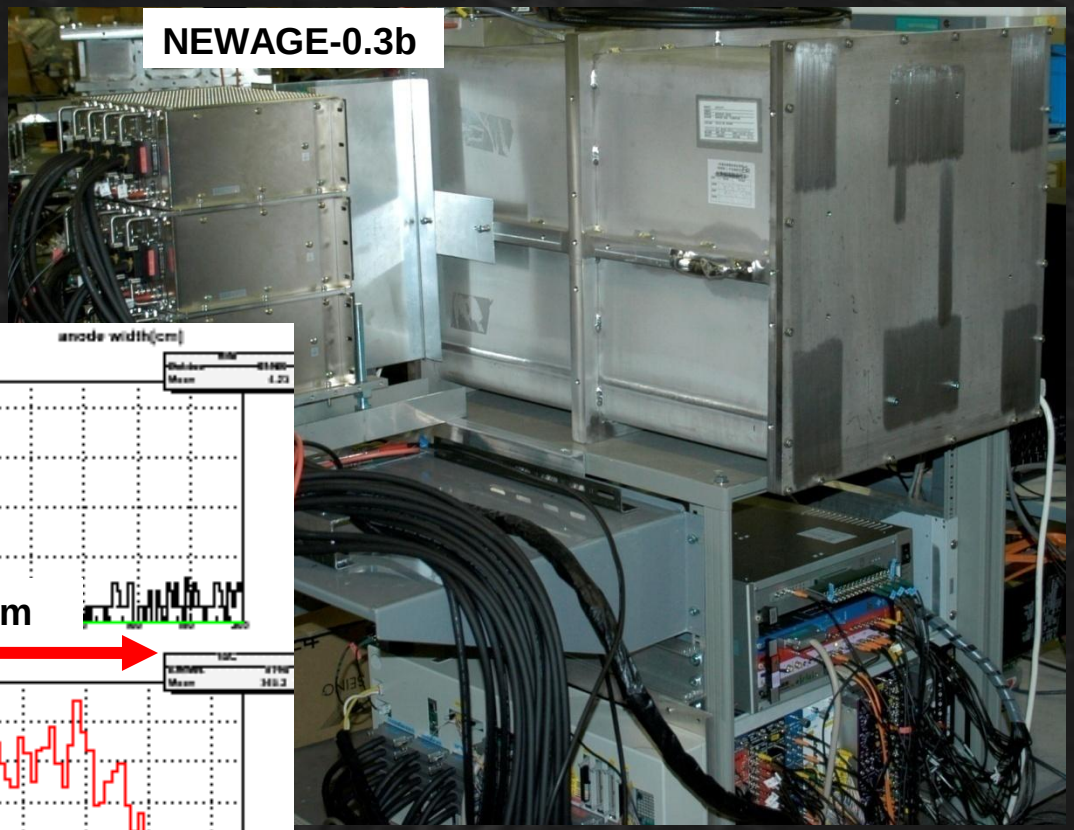
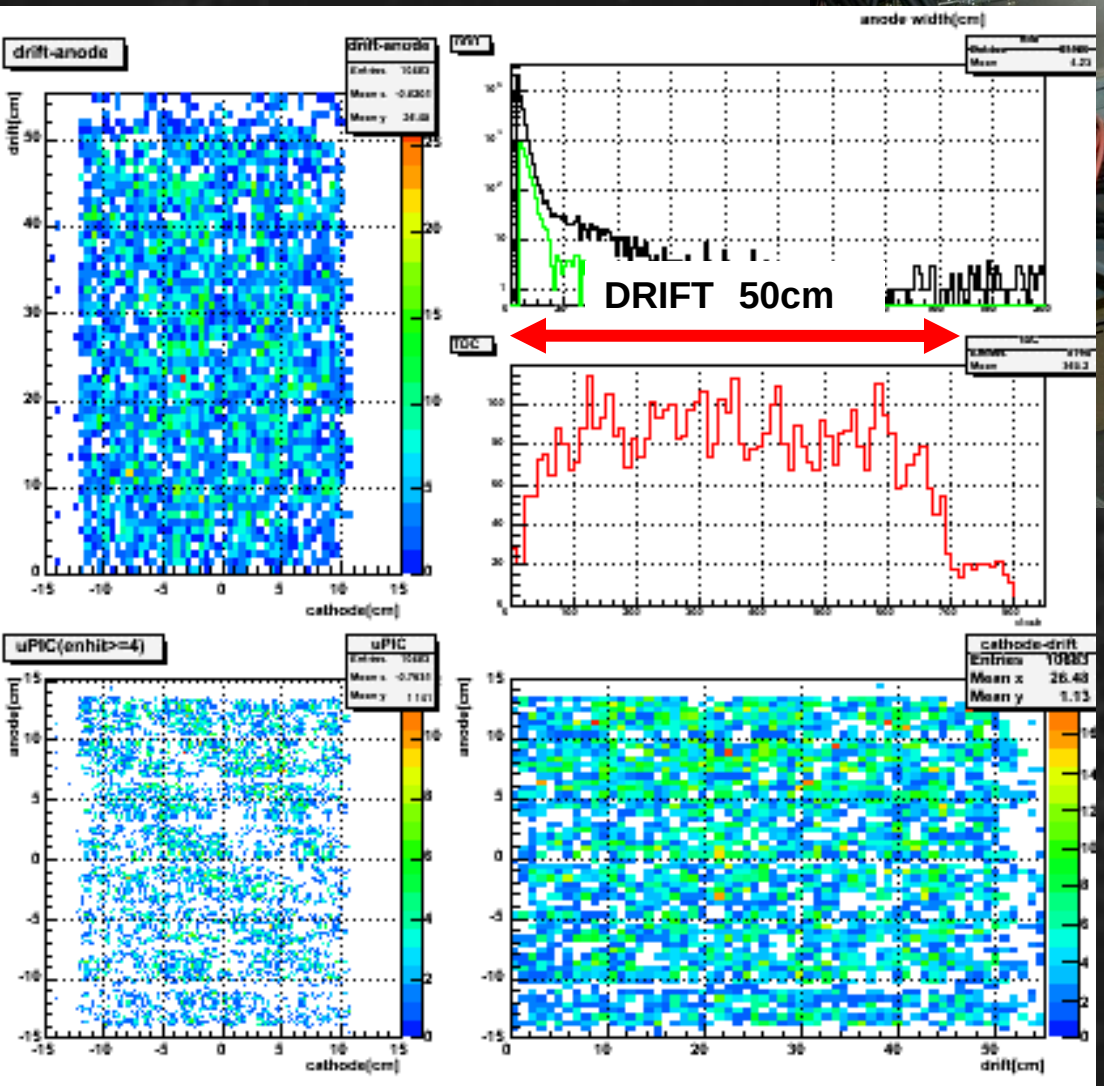
NEWAGE

- **DRIFT 50cm**
  - **(CF4 152 torr)**





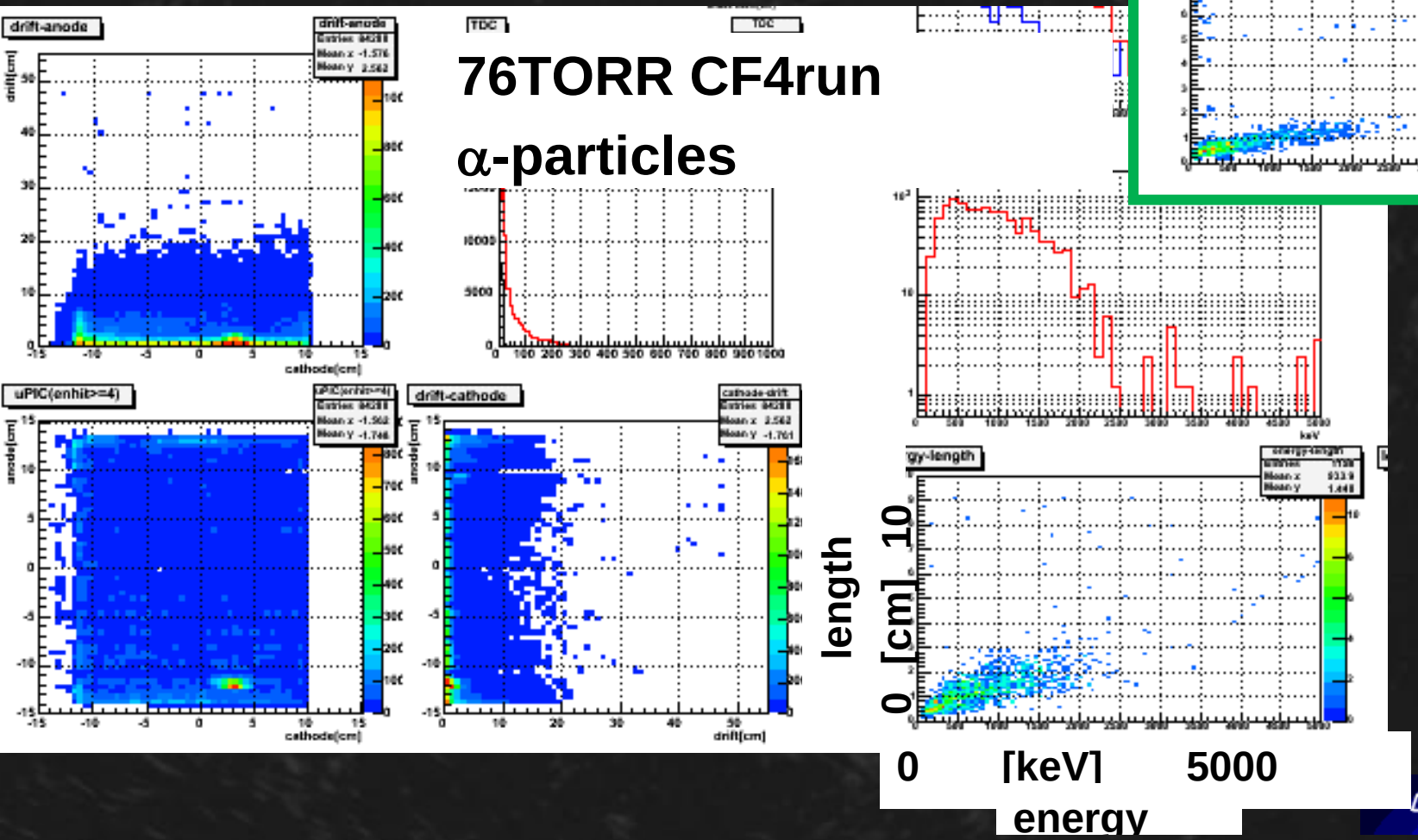
irradiated with neutrons
@1m distance (252C

uniform in 50cm drift

angular resolution:
to be measured

NEWAGE

- CF4 76torr operation (designed value 30torr)



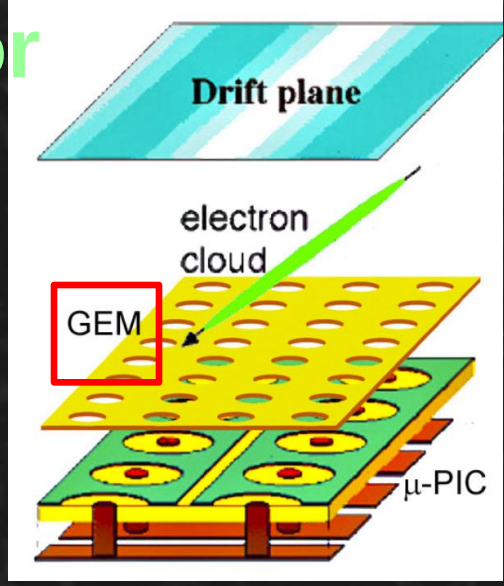
- parameter optimization ⇒ underground run

SUMMARY

- NEWAGE-0.3a: 2years' underground measurement total exposure 3.917 kg･days
  - New limits / BG studies / stability improvement
- R&D s in Kyoto
  - material screening (NEWAGE-RD1)
  - NEWAGE-0.3b
- Scaling up issues, electronics: tomorrow

Direction Sensitive WIMP-search NEWAGE

Micro-patterned gaseous detector

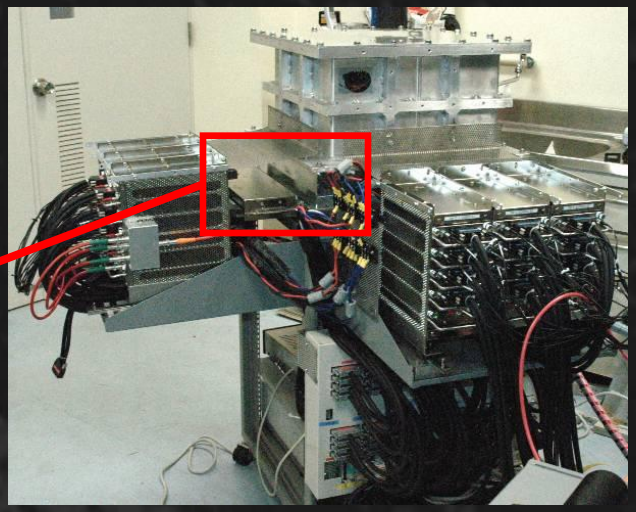


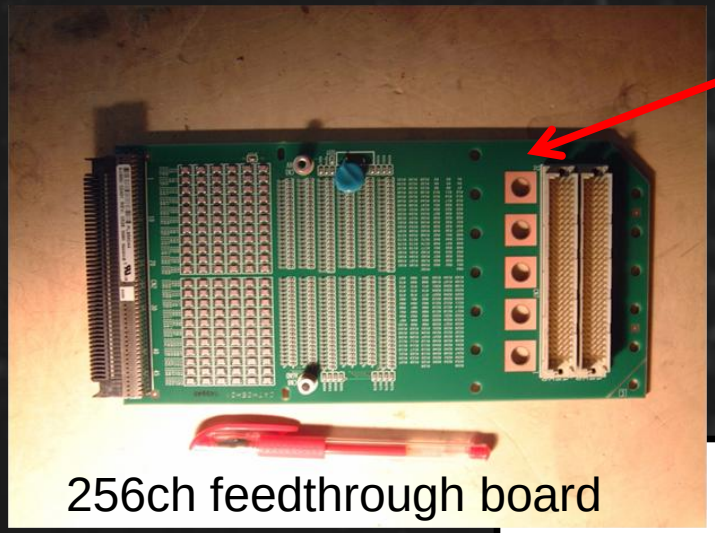
- GEM (23*28cm^2)
  - Pre-amplifier (temporally use)
  - Segmented to 8 areas
  - Liquid Crystal Polymer 50μm-thick
  - 140μm pitch 70μm diameter
  - Gas gain ~10 with 0.2bar CF_4

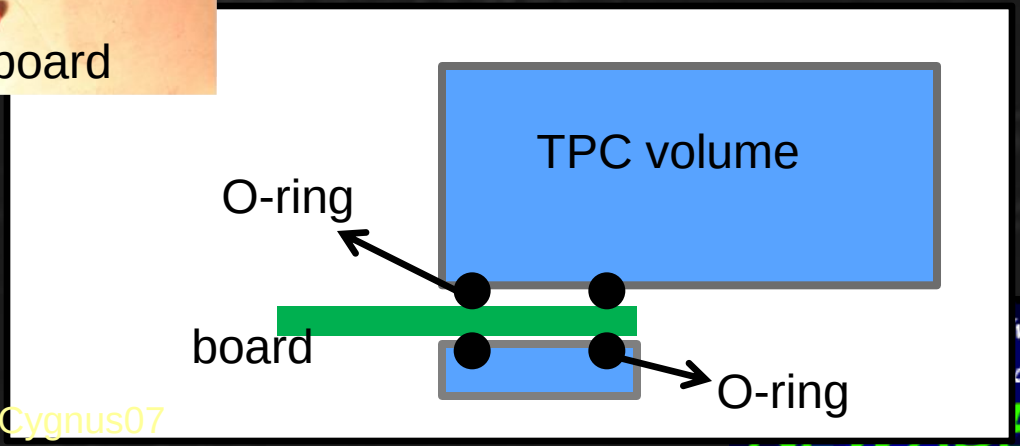
Large area GEM
(scienergy)

Direction Sensitive
WIMP-search
NEWAGE

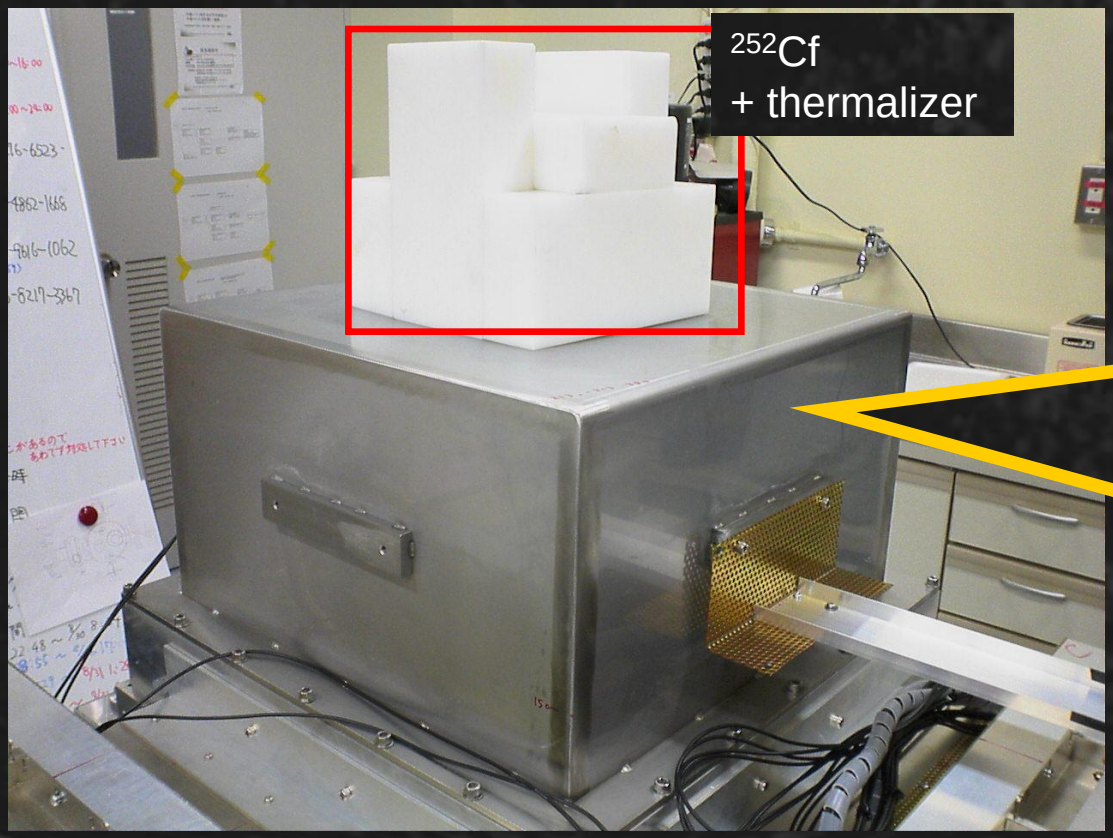
- **1500ch feedthrough**
  - feedthrough board
  - everything is out of the vessel
  - easy to maintain
  - keep the gas purity



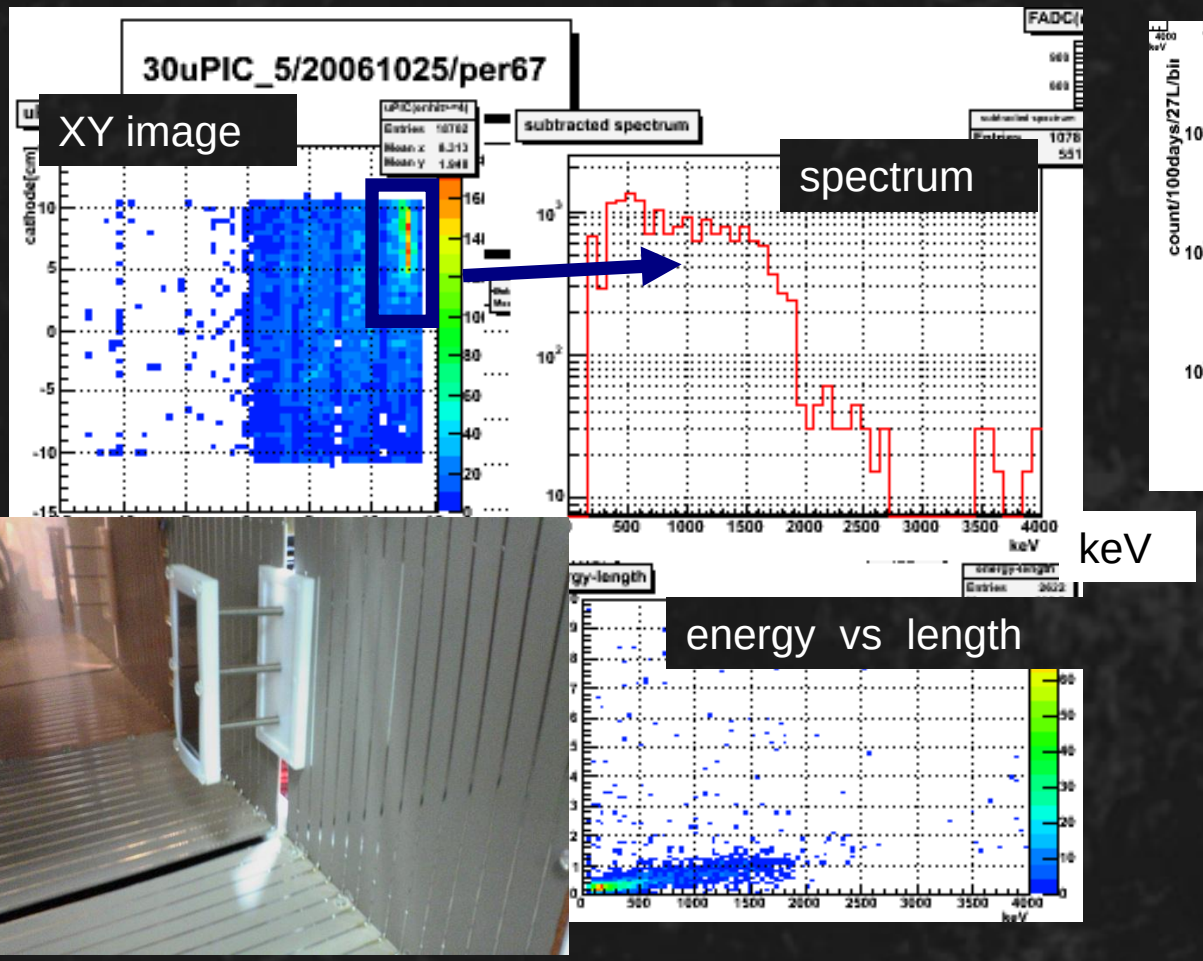


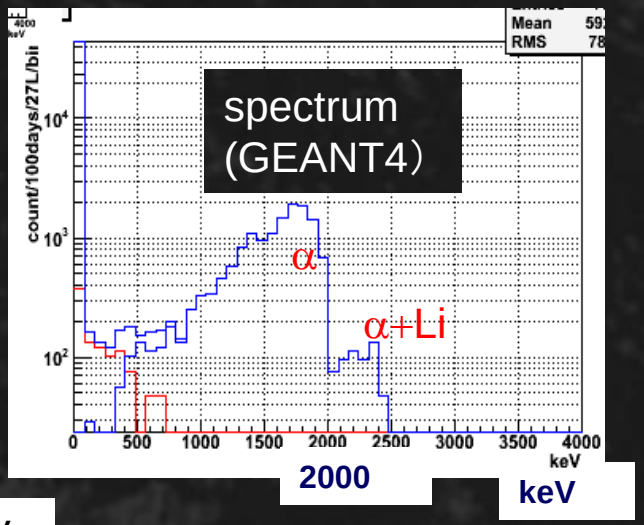


- **Calibration / gain monitor**
  - Heavy ion (not a γ source)
  - On / off from outside
  - $^{10}B(n,\alpha)^{7}Li$ reaction
    (Q=2.70MeV 1.8MeV for α)



- **Calibration / gain monitor**
  - **typical results**

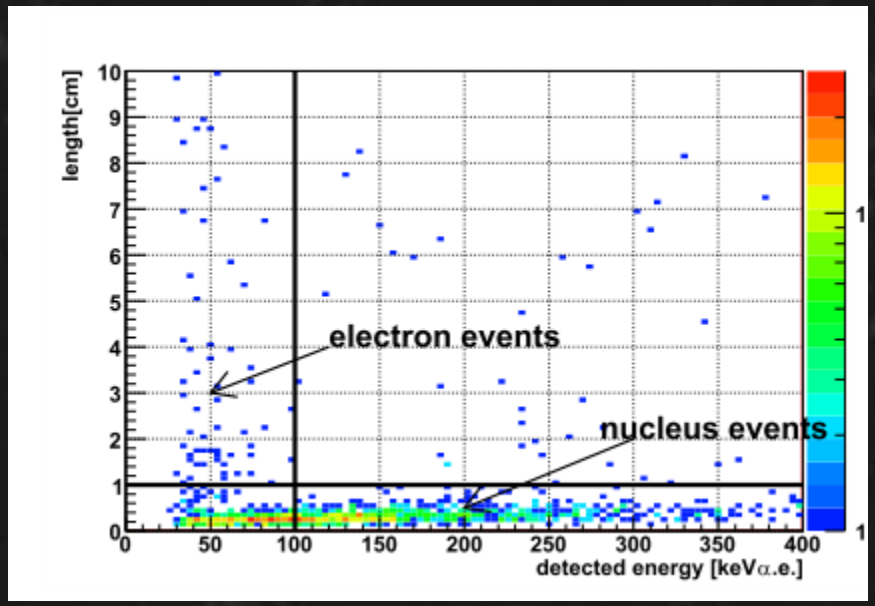




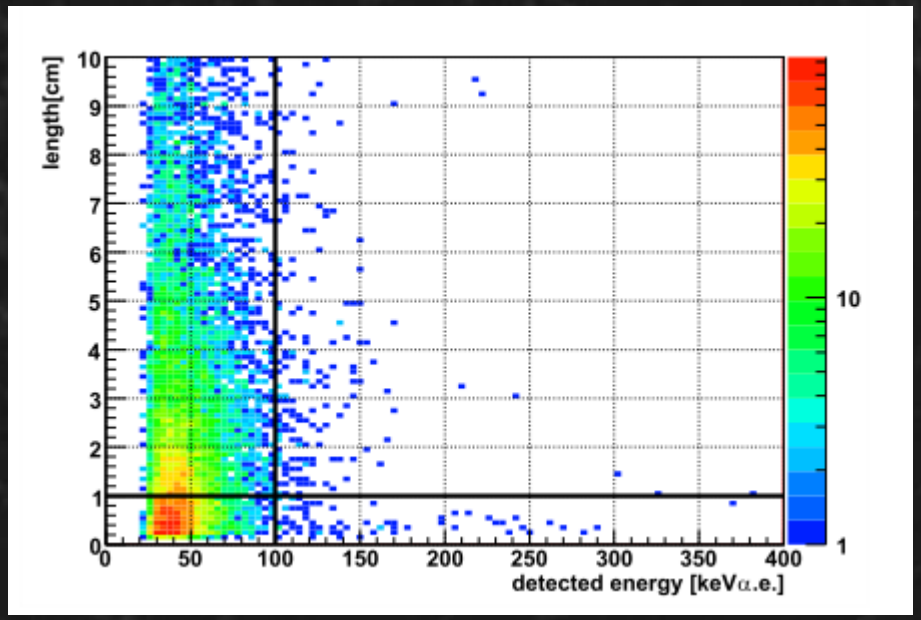
- **@DM energy region (~100keV):**
  - **extrapolation by energy-length correlations**
  - **direct measurement method is being investigated**

- **gamma-ray rejection**
  - energy-length correlation
  - gamma-rays from ^{137}Cs

252Cfrun

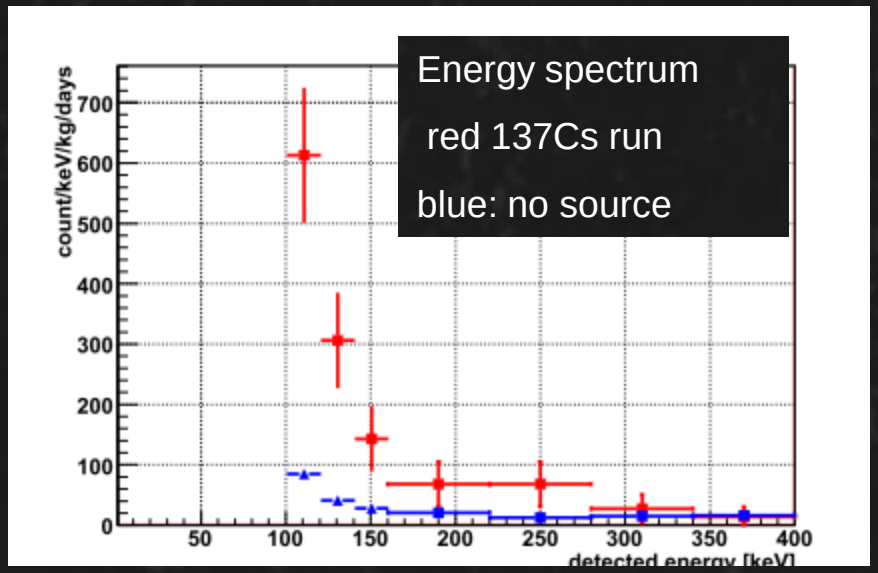


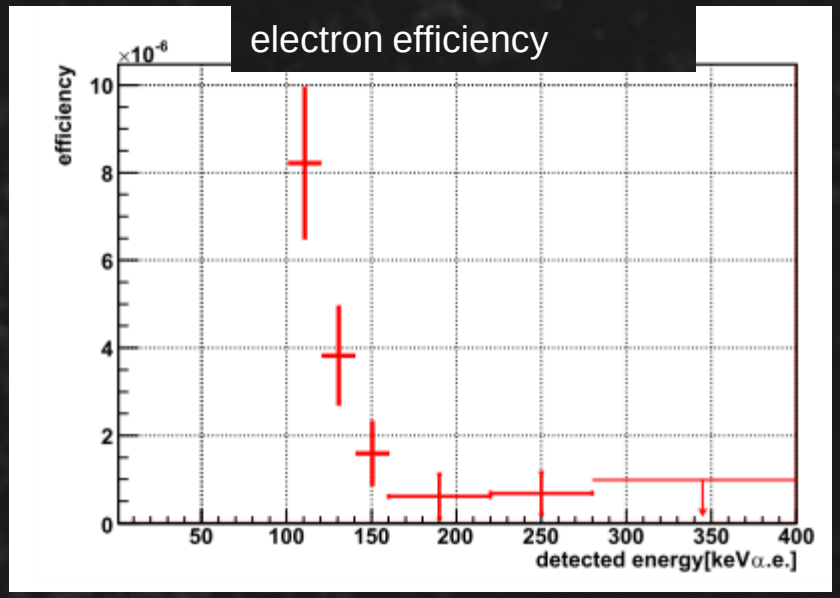
137Cs run



Direction Sensitive WIMP-search NEWAGE

- **gamma-ray rejection**
  - **spectrum, BG subtraction**

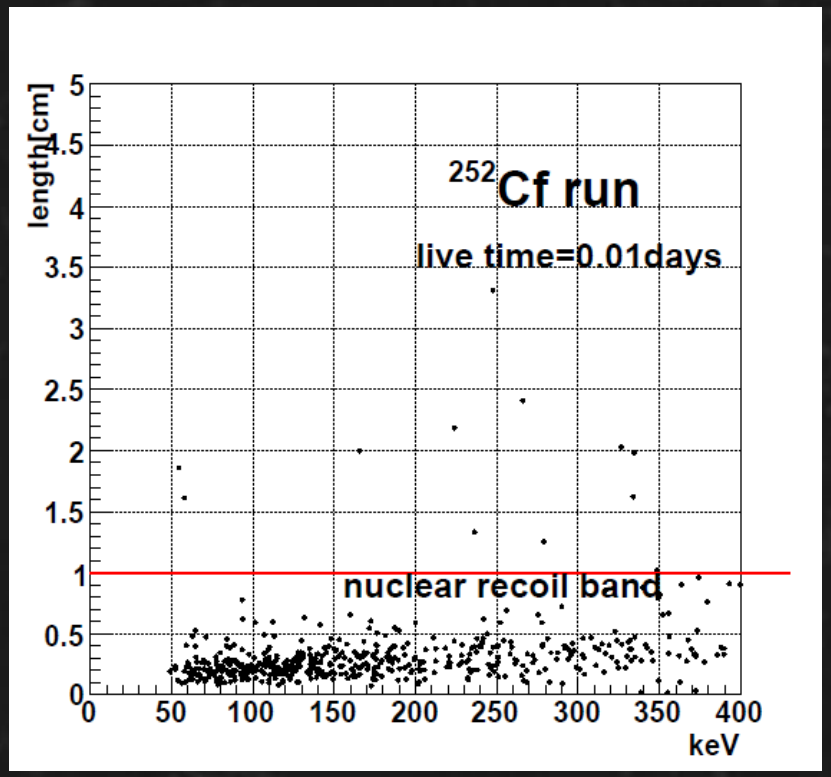


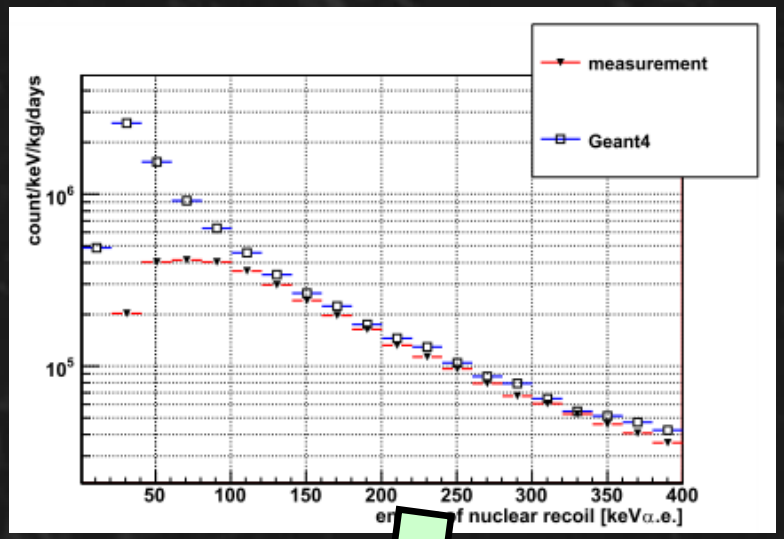


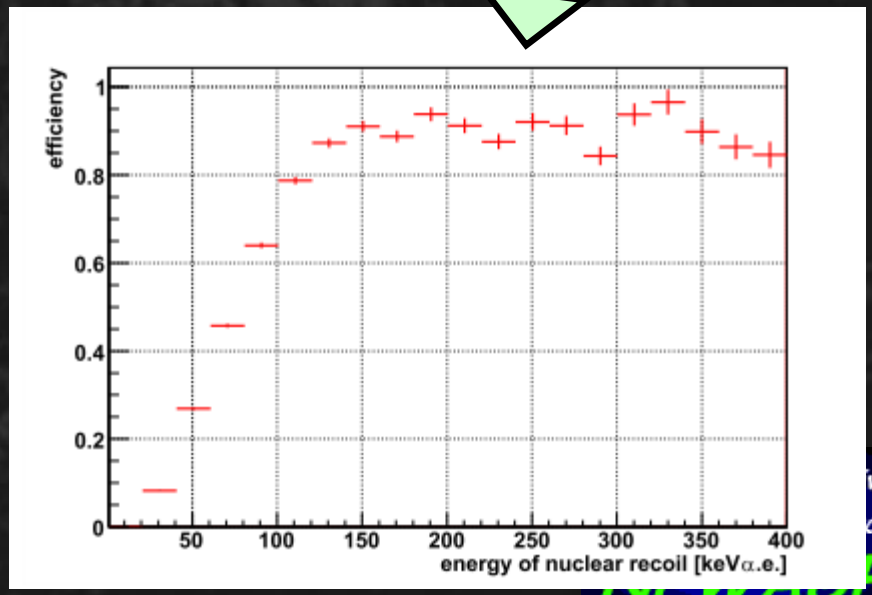
- **gamma rejection (=efficiency to electron tracks)**
  8.1e-6

nuclear detection efficiency

- neutrons from ^{252}Cf







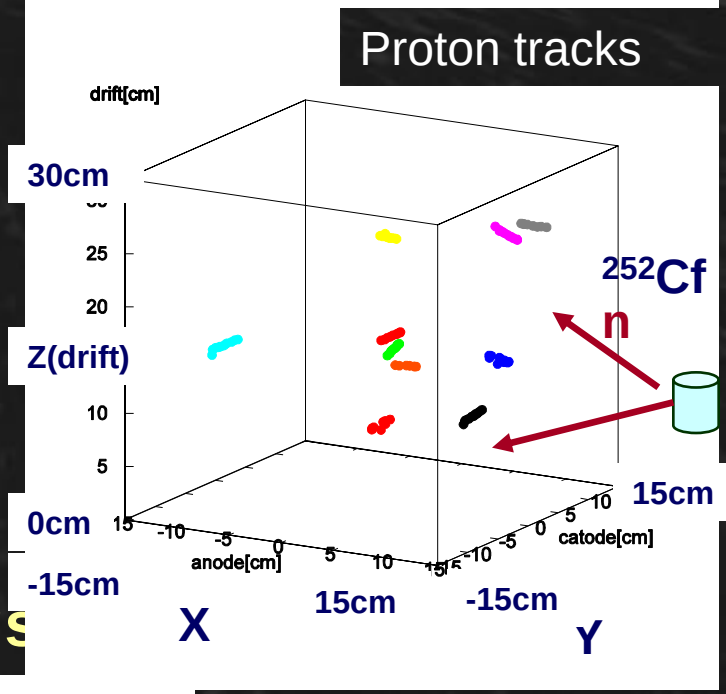
- 0.8 @ 100keV

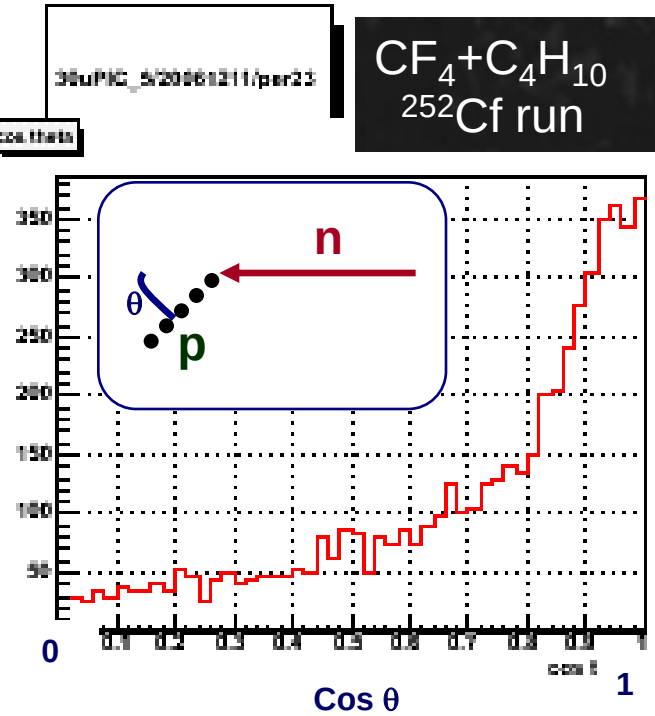
TPC Performance

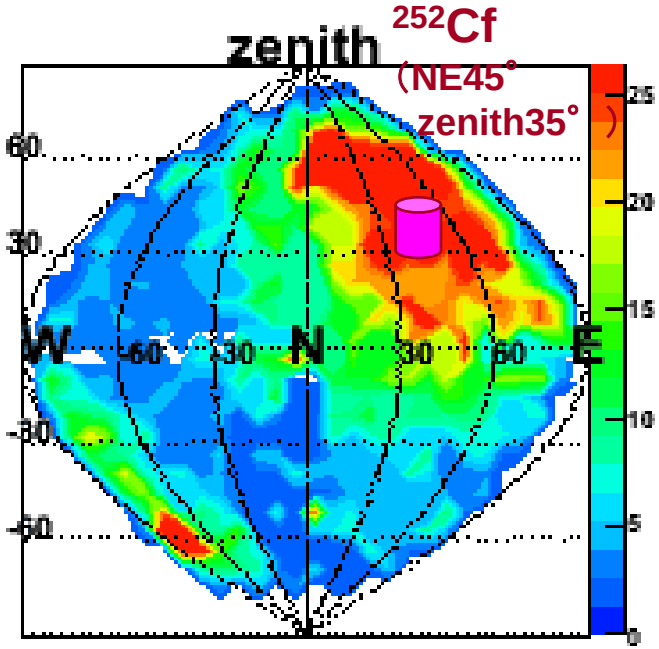
please note:
these performance are still in progress

- **nuclear tracking**

- CF_4+C_4H_{10} (9:1) 0.2 atm
- n -> p forward scattering
  (emulation of WIMP -> F scatterings





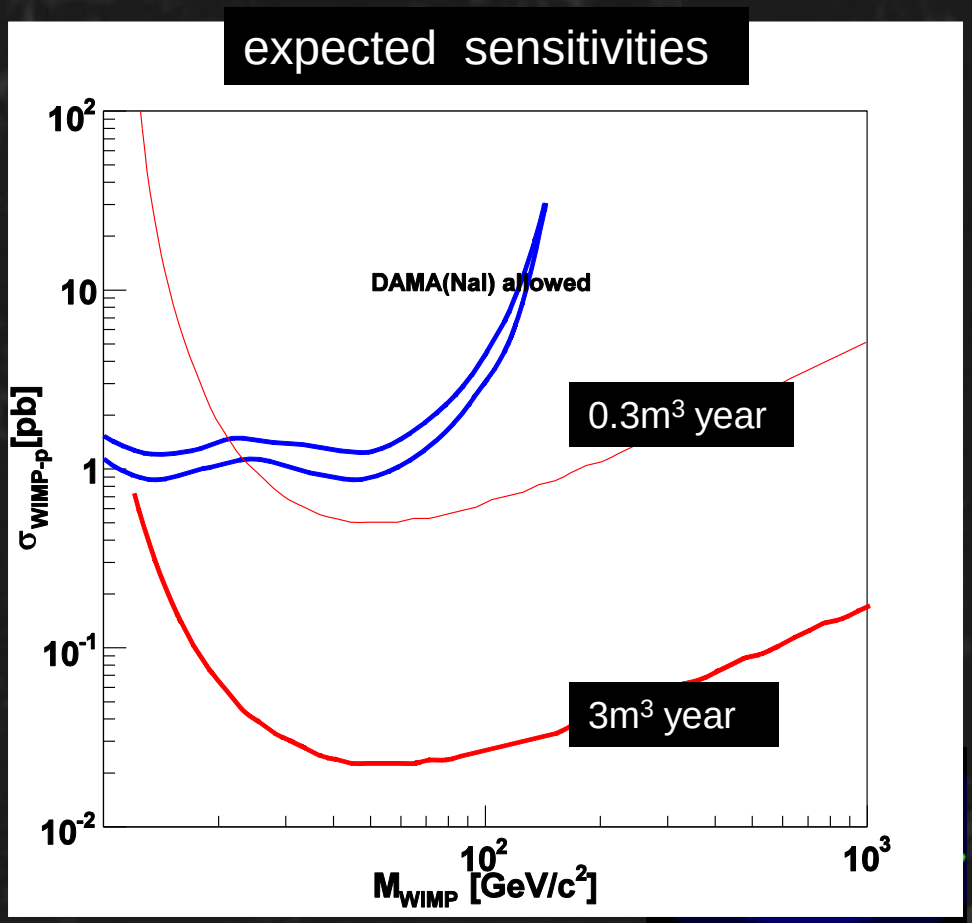


Recoil direction image

Direction Sensitive WIMP-search NEWAGE

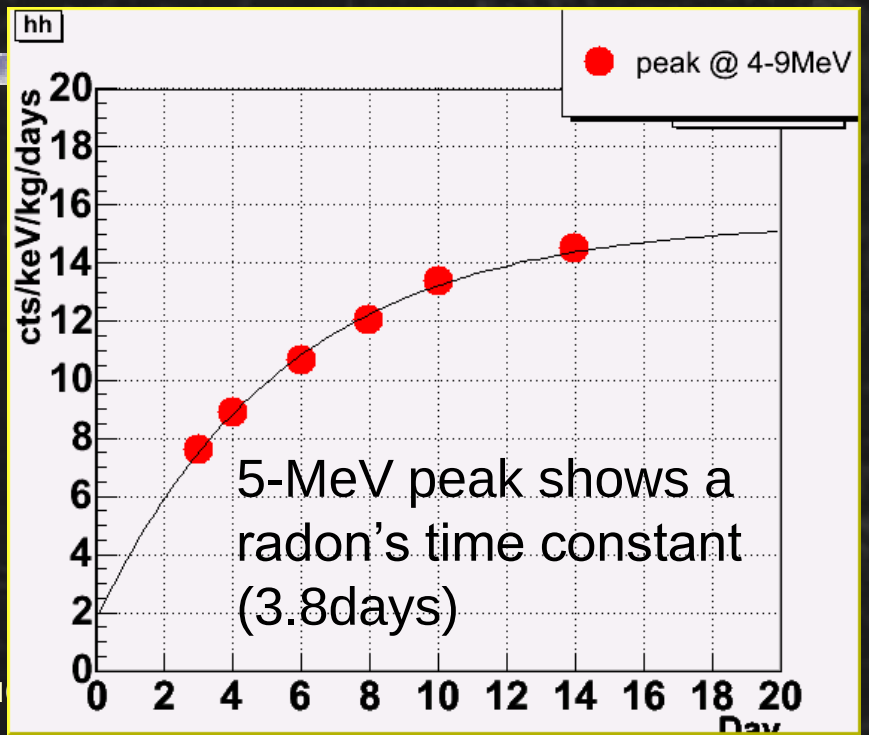
Expected Sensitivities

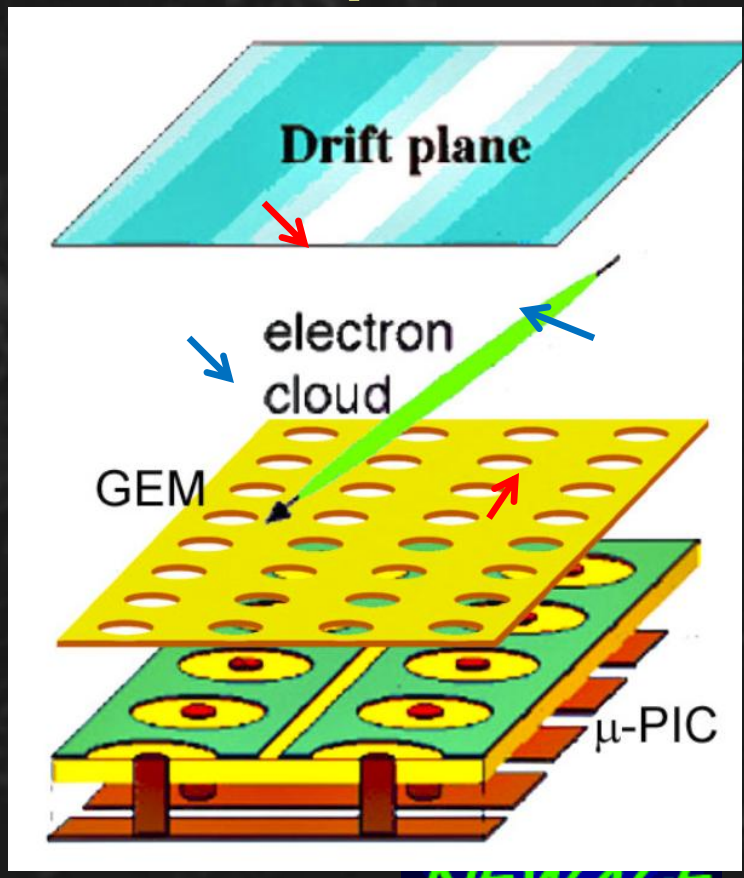
- **Goal: Detect the WIMP-wind**
  - low pressure (CF_4 0.05 bar)・large volume（$1m^3$ × N）・radio-pure materials
- **CURRENT: pilot run**
  - CF_4 0.2 bar ・$(0.3m)^3$
    ・normal materials



Background studies

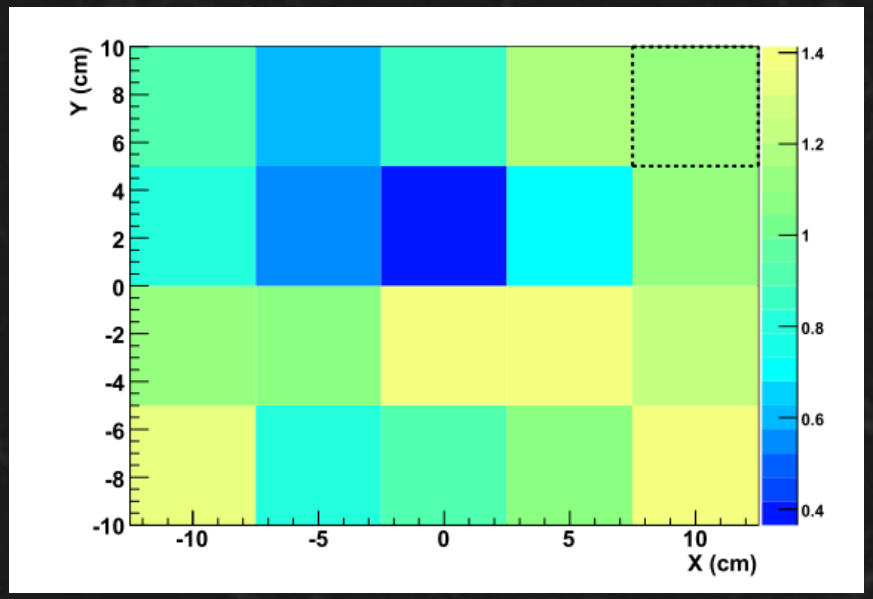
- α particles :highly possible
  - Decayed α's from Uranium Thorium in the GEMs and drift planes (shown by red arrows)
  - Decayed α's from radon in the gas volume (blue)

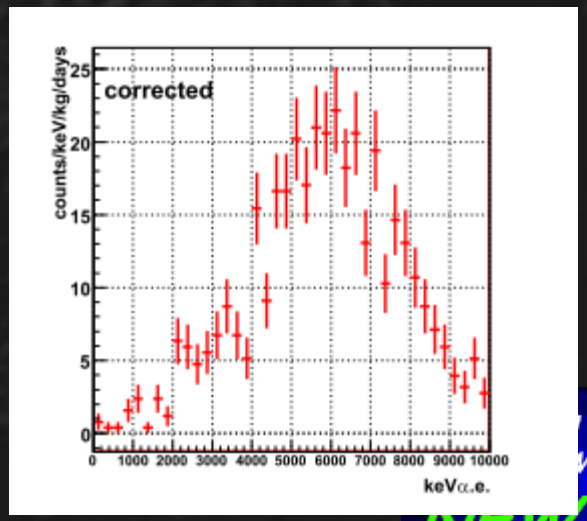




- **energy resolution**
  - Radon peak（5-8MeV） 40%FWHM
  - due to the gain inhomogeneity of the μ-PIC

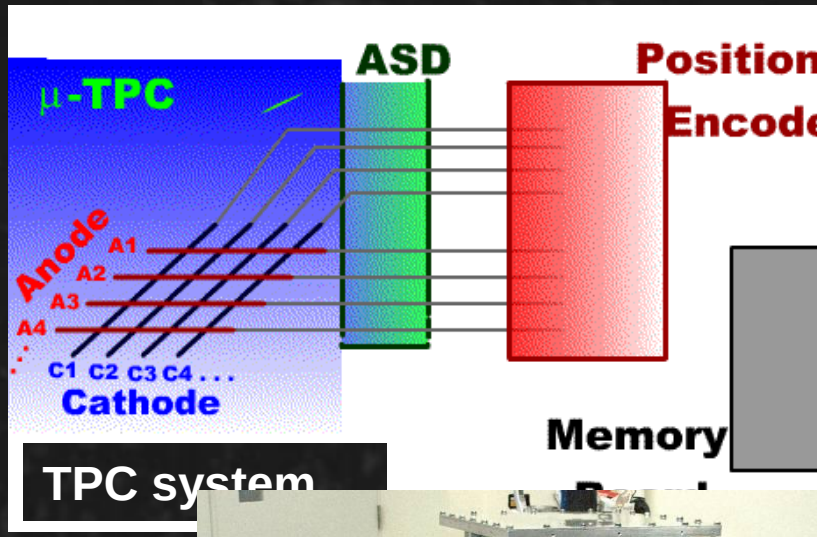
  - low energy: measurement with Ar-based gas : 60%FWHM@60keV
  - statistics restricted
  - extraporation with
    W value, num of electron 60 × sqrt((54/26) × (60/100))
    = 70%FWHM @100keV
    60%@59.5keV
  - direct measurement is needed.



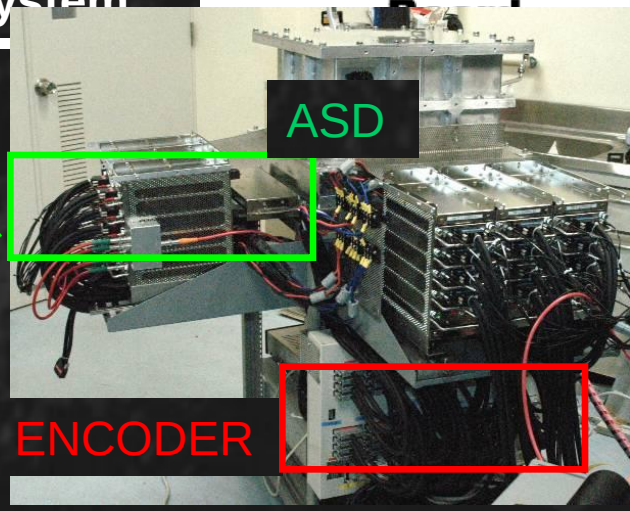


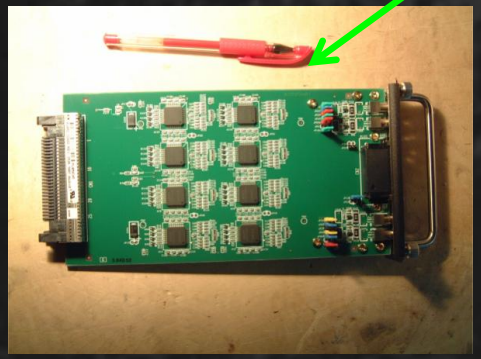
Readout electronics

- **DIGITAL : Tracking**
  - 768 anode + 768 cathode
  - Digital (LVDS) signals at ASD
  - (X,Y,T) at the position encoder
  - 100MHz pipeline



- **ANALOG : energy**
  - 768 cathode –sum--> 4ch

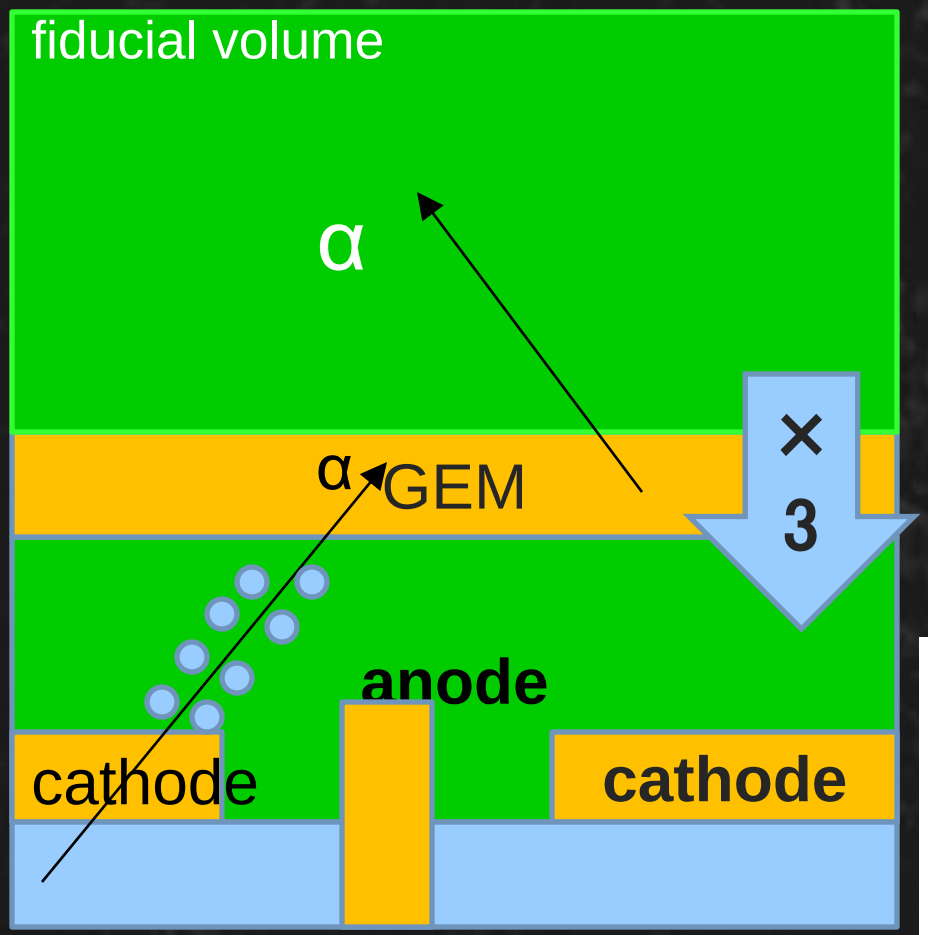


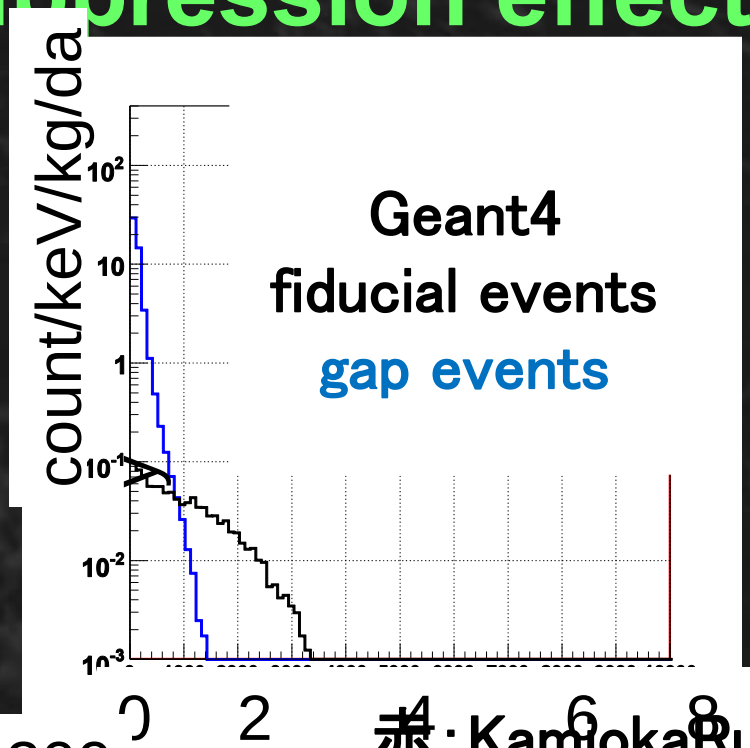


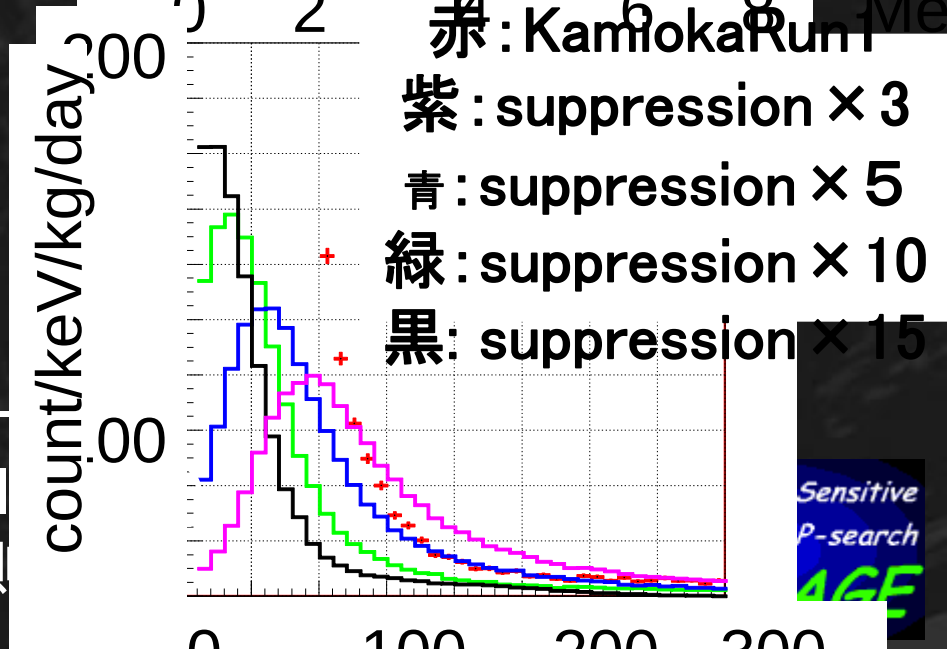
- **DATA size**
  - 16k byte /event
  - ~ 20Gbyte /month @0.5Hz

Direction Sensitive WIMP-search NEWAGE

GEM-μPIC gap "suppression effect"







GEM-μ-PIC間に落ちたエネルギー
GEMのゲイン+電荷収集効率(μPI
によって低いエネルギーとして観測

K. Miuchi