Calibration method for NEWSdm detector and Next experiment prospect

Umemoto

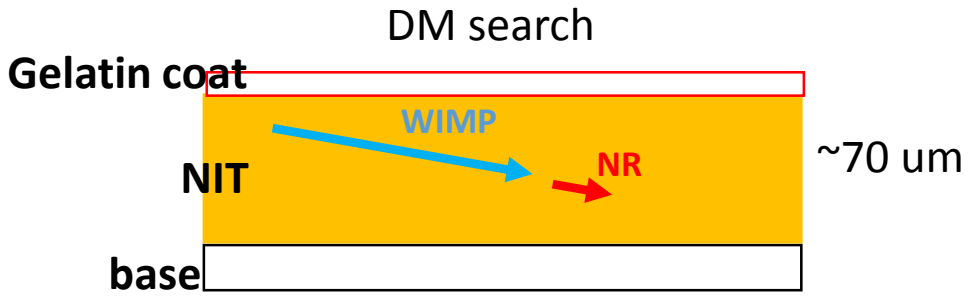
Calibration for understanding NIT

- Calibration should be done in actual experimental setup.

Ion implantation

- NIT thickness is limited because of high vacuum pressure (~ 10 -7 Torr)
- only surface event

DM search



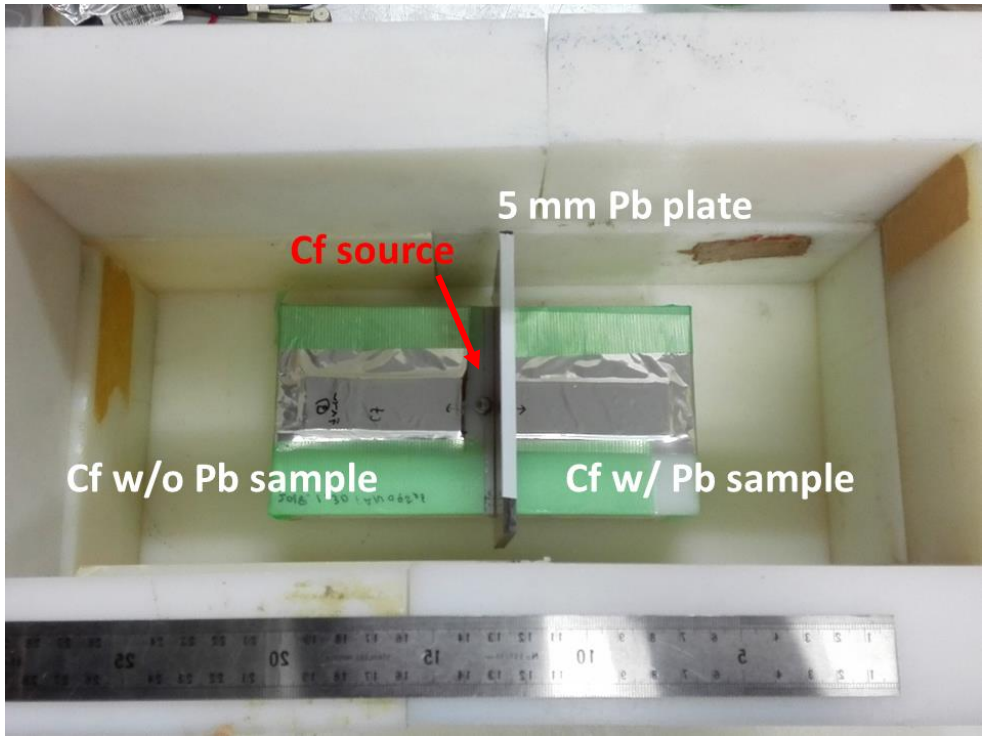
- gelatin coat for surface protection
- set in low temperature (<-15℃)

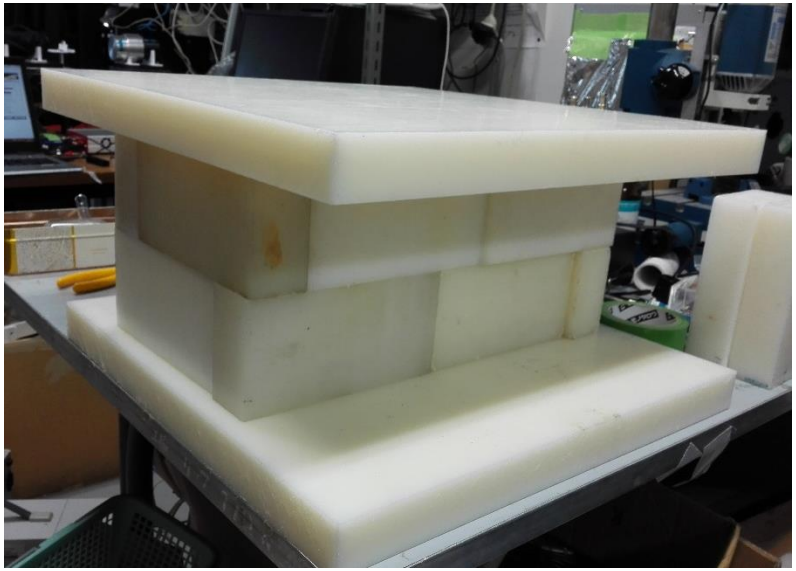
We need to check if Carbon ion sample is OK as a calibration sample.

Neutron measurement

We exposed neutron by Cf252 source at Iguchi lab in Nagoya university.

→possible to compare the result between surface ion track and nuclear recoil.





Neutron intensity = 2×10^4 neutron /sec

in this time, Cf252 was used at room temperature.

Cf252 neutron exposure

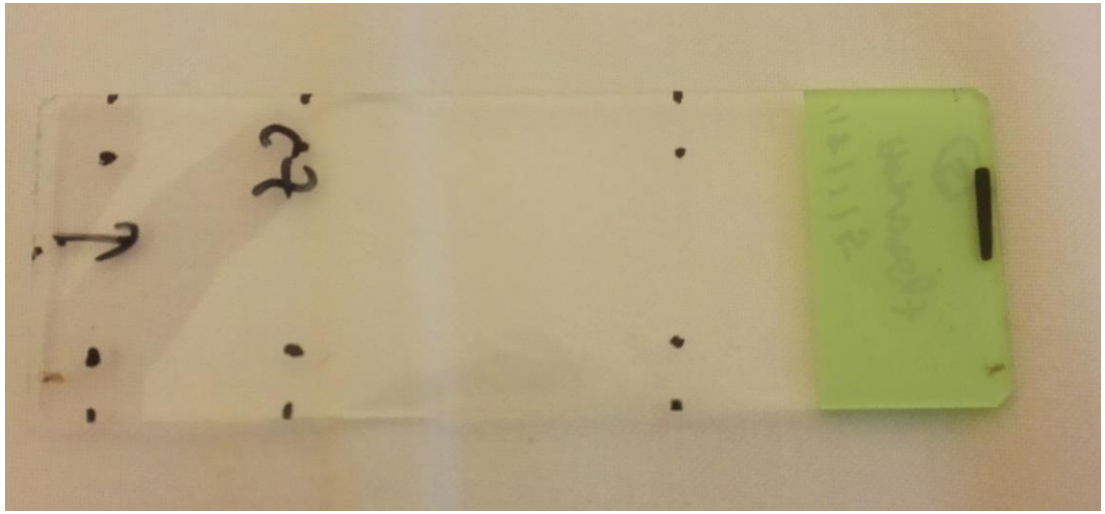
- Log
- NIT batch : FAN095gf (2017/12/22 production)
- Noodle wash 2017/12/23 pH 6.47, Conductivity 0.43 mS/cm
- Coat data 2018/01/05, Surface gel coat (by Naka san)
- HA 2018/01/29

- 2018/01/30 11:54 … packing sample in Flab
- 2018/01/30 12:12:28 … move Iguchi lab and start exposure

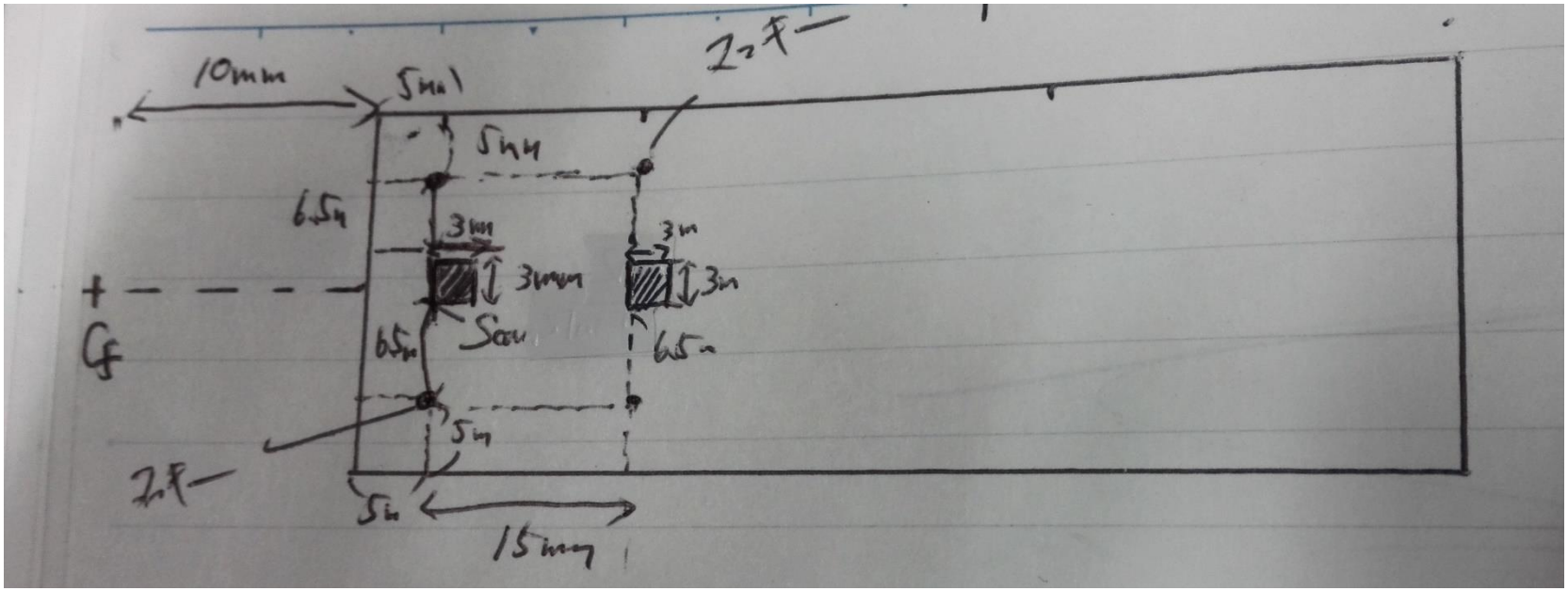
* reference sample was also moved to Iguchi lab and came back to F lab after setting

- 2018/01/31 12:21:42 … remove Cf252 source
- 2018/01/31 12:37:15 … back Flab and start MAA development

How to scan



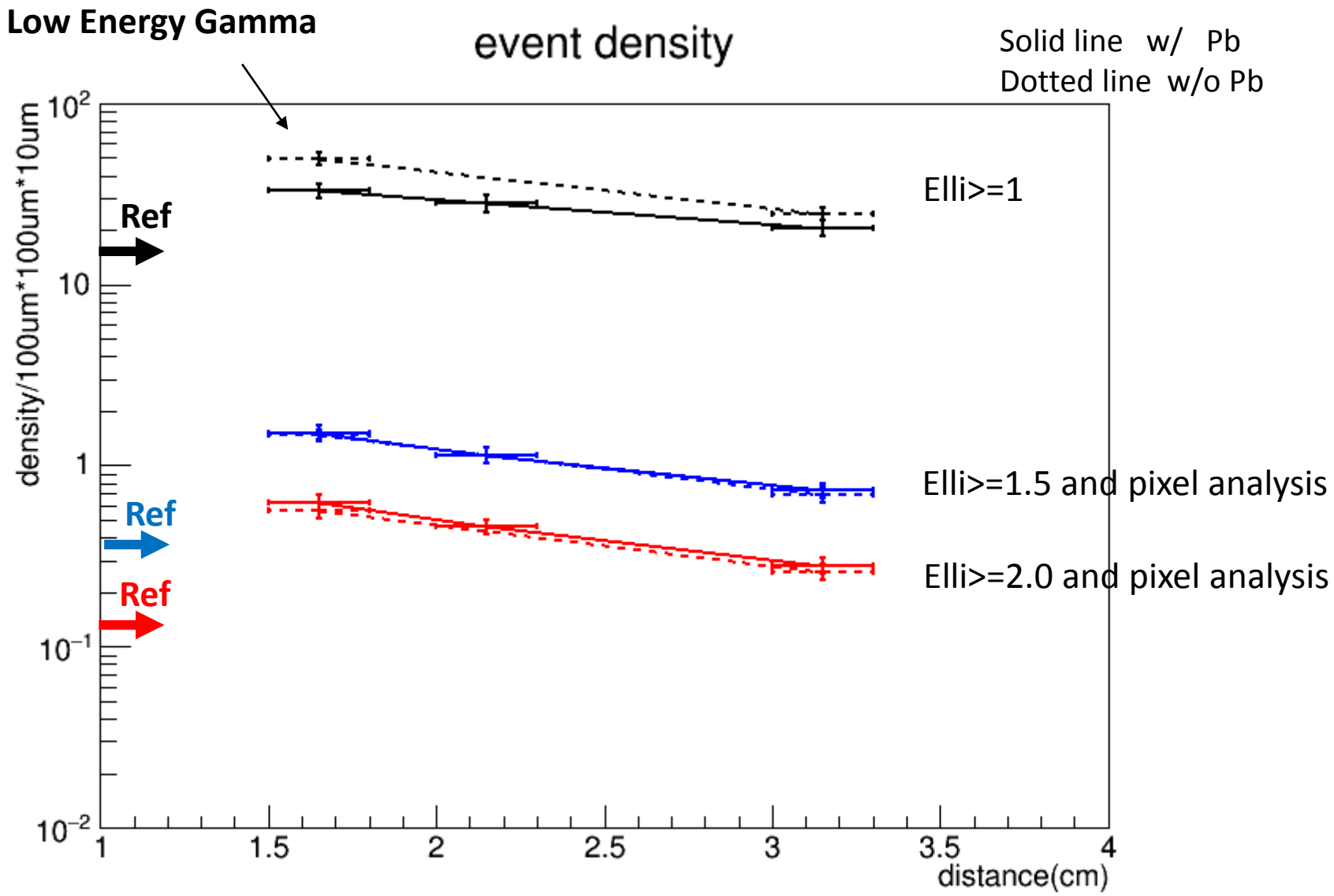
How to scan



Scan area = 3mm × 3mm

Several spots were scanned by PTS2 and the distance from Cf252 was changed.

event density of Cf252 sample



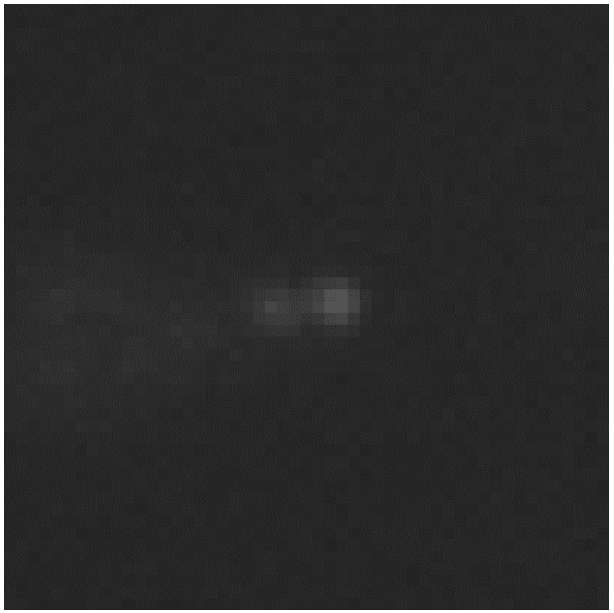
Manual check

- Ellipticity threshold = 2

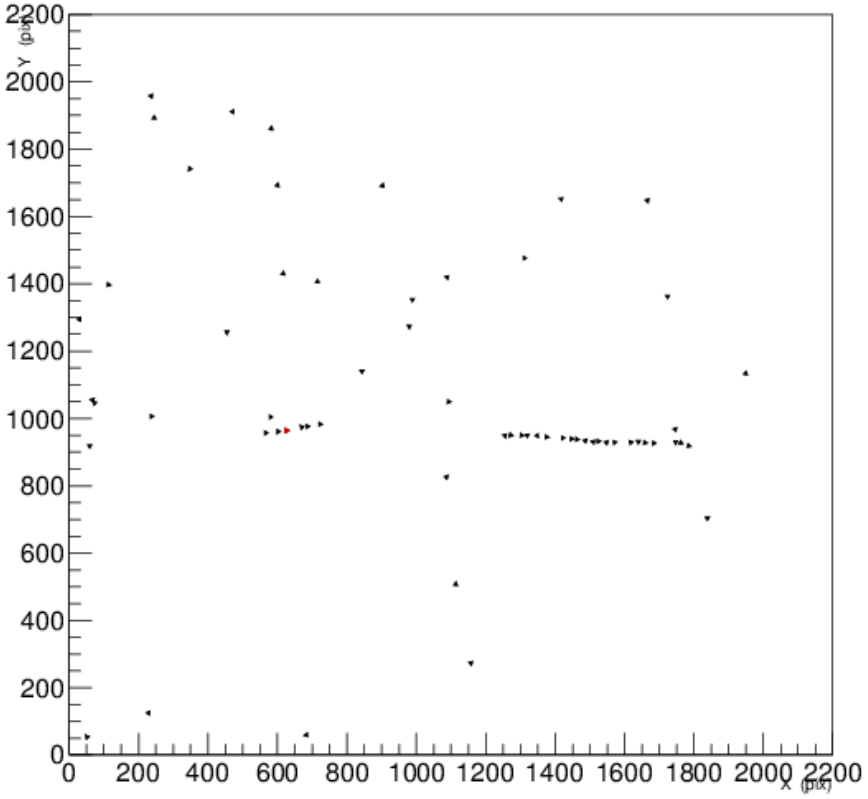
- By manual check, we rejected proton track and obvious dust

  if there are over three grain , I think that it is a part of proton track.

candidate



tracking6



Expectation and scan data

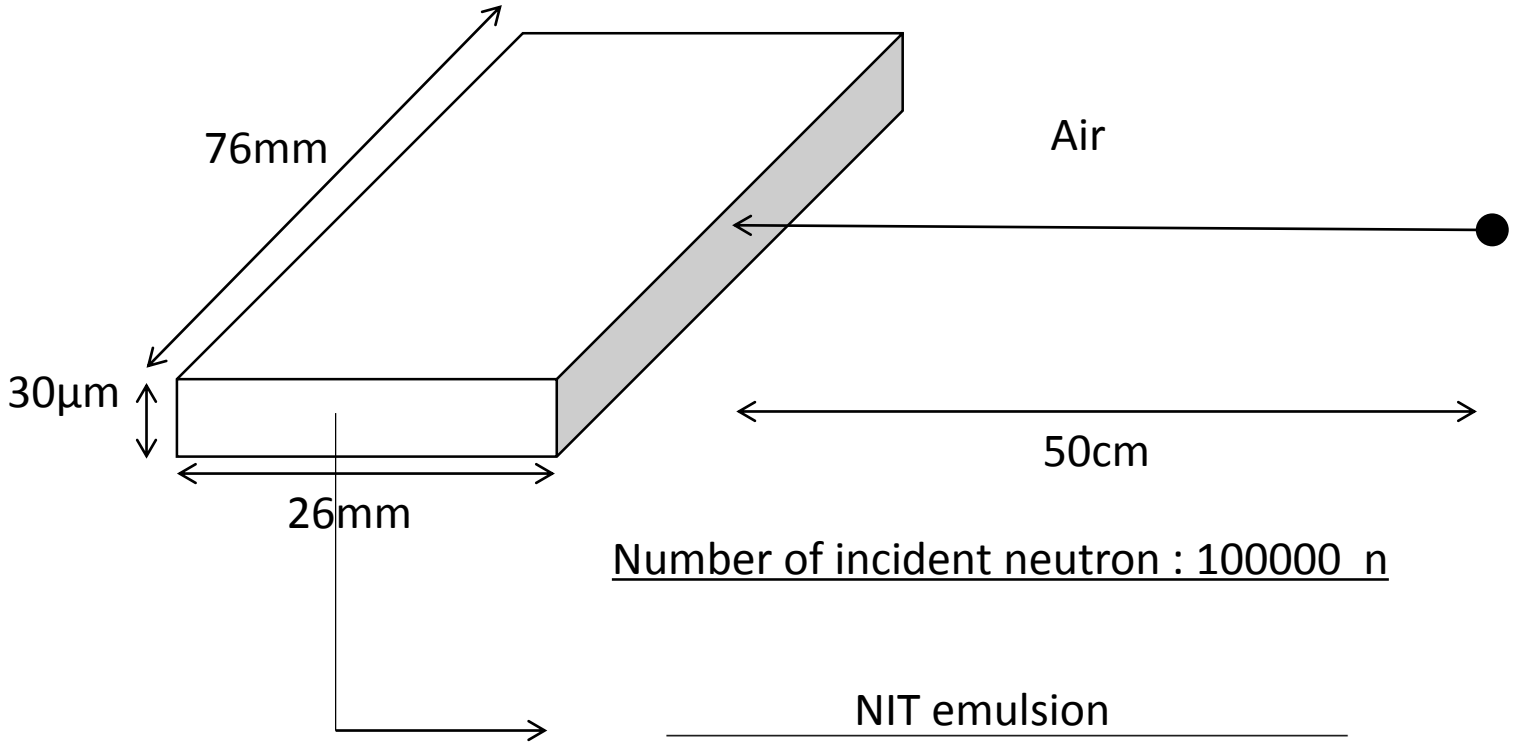
- From Geant4 simulation by Naka-san(its very
- Neutron intensity = 2×10^4 neutron /sec
- C, N, O recoil
- track length 275 nm – 1000 nm
- 1 view = 100 × 100 × 7.5 (um3)

*Dust density from reference sample = 0.017/view

Distance	1.65 cm	2.15 cm
Expectation	0.178 /view	0.106 /view
Scan data	0.040 /view	0.024 /view
Data - dust	0.023 /view	0.007 /view
Detection efficiency	13 %	6%

Detection efficiency ~ 10 %

Condition of simulation



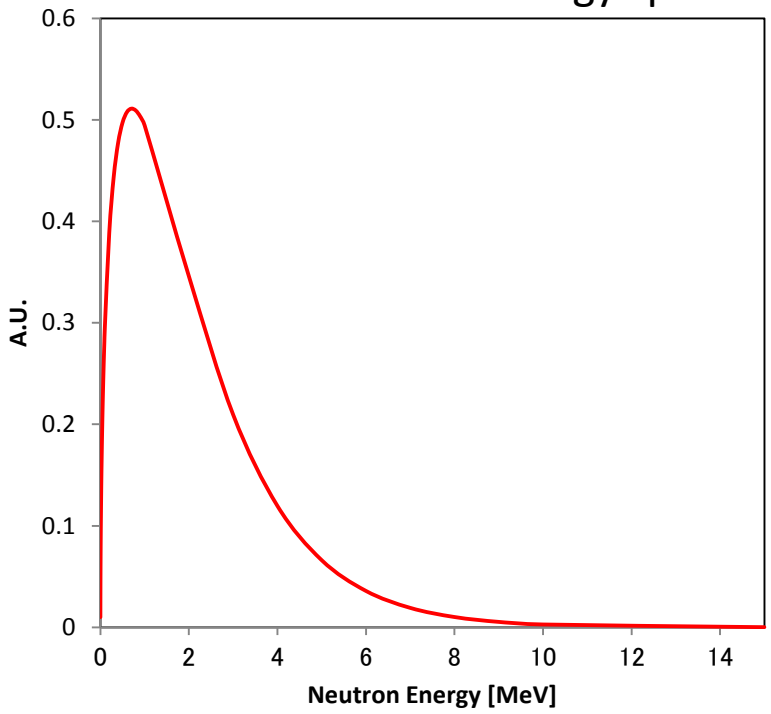
Number of incident neutron : 100000 n

NIT emulsion

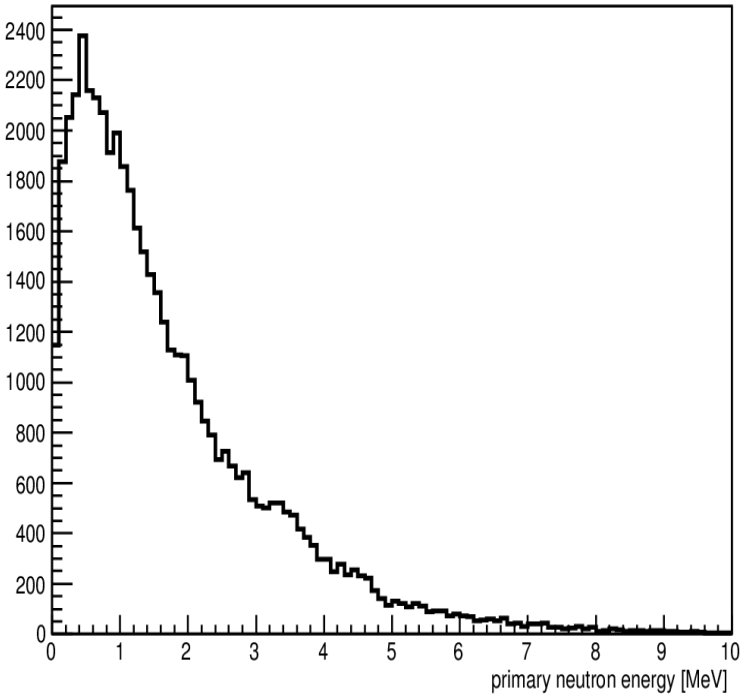
element	Number of atom [%]	weight [%]
Ag	7.31	39.65
Br	7.22	29.01
I	0.15	0.96
C	19.41	11.72
O	14.62	11.76
N	6.49	4.57
H	44.78	2.27
S	7.31	2.27

^{252}Cf neutron energy

Calculated neutron energy spectrum



Used energy spectrum by Geant4



En = sqrt(E)xExp(-E/T)

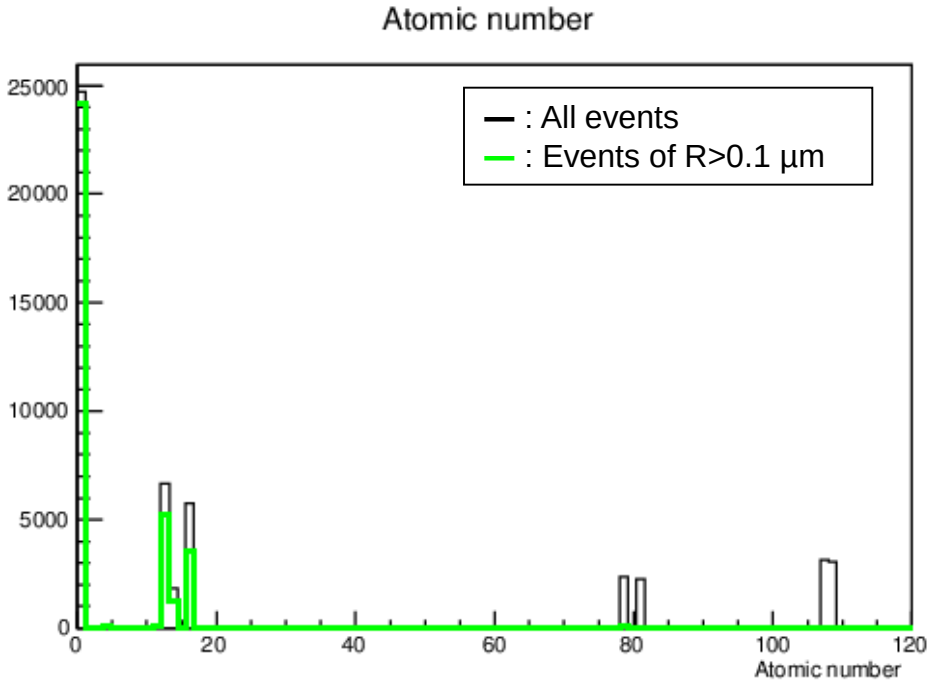
where T is 1.42 MeV

Paulo R.P. COELHO, Aucyone A. DA SILVA and Jose R. MAIORINO
Nucl. Inst. Meth. A 280 (1989) 270-272

Number of Interacted events

# of induced signals

H	24720
d,He	149
C	6771
N	1836
O	5743
Br	4712
Ag	6263
S	7
I	128
total	**50329**



	mean cross section [barn]
H	6.48
d,He	
C	4.13
N	3.35
O	4.65
Br	7.73
Ag	10.15
S	2.92

※Consistent with JNDL nuclear data base

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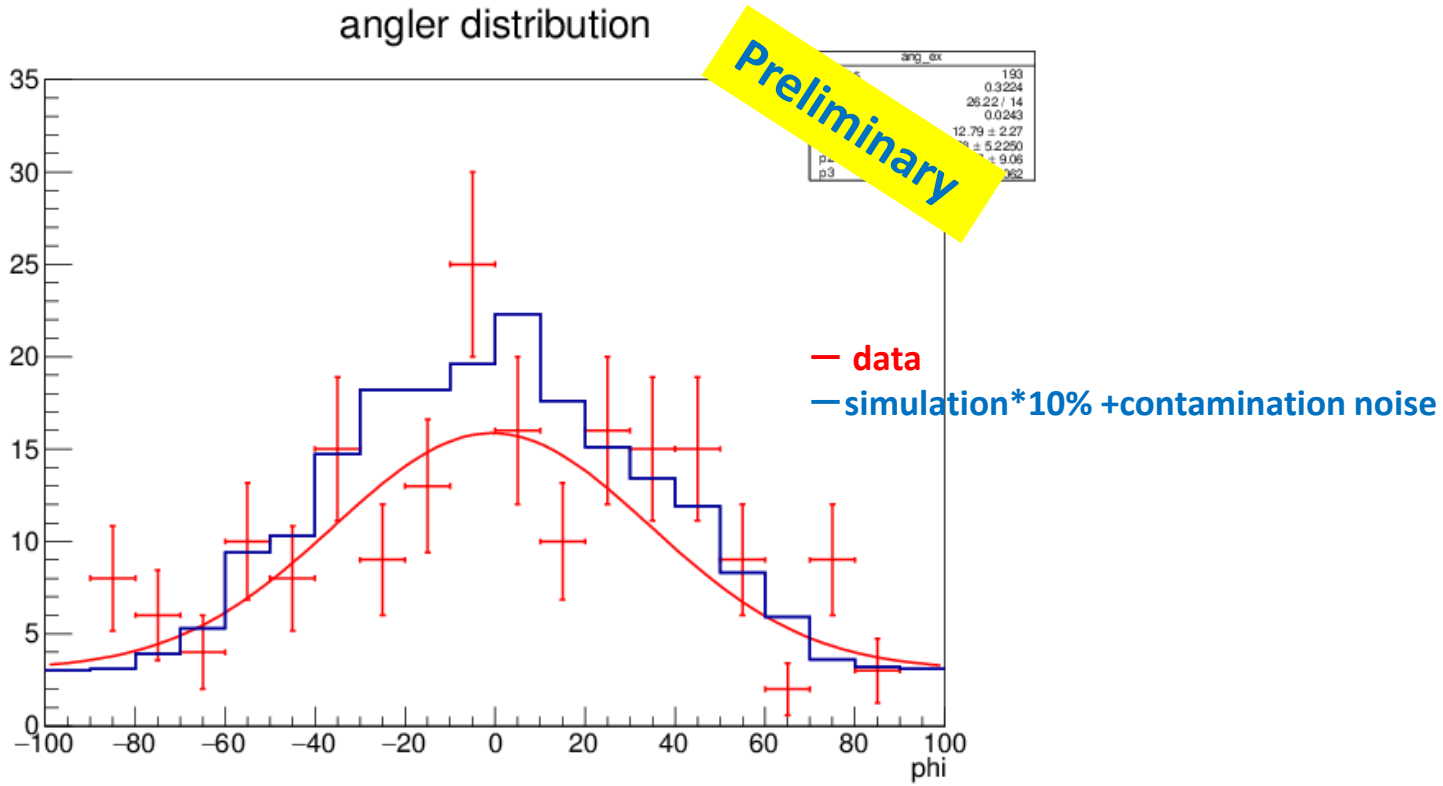
Angler distribution

- After manual check event



- We can detect recoil track angle which is similar to the simulation .

Future prospect

- To understand more detail, simulation with geometry will be done.

- Current PTS2 contrast is low. So we rescan it with higher contrast by taking camera exposure time longer.

  → signal brightness, relation track length and ellipticity between ion track and recoil track will be compared.

- I would like to do neutron experiment at lower temperature.

- Plasmon analysis is also needed to check by using Cf252 sample.

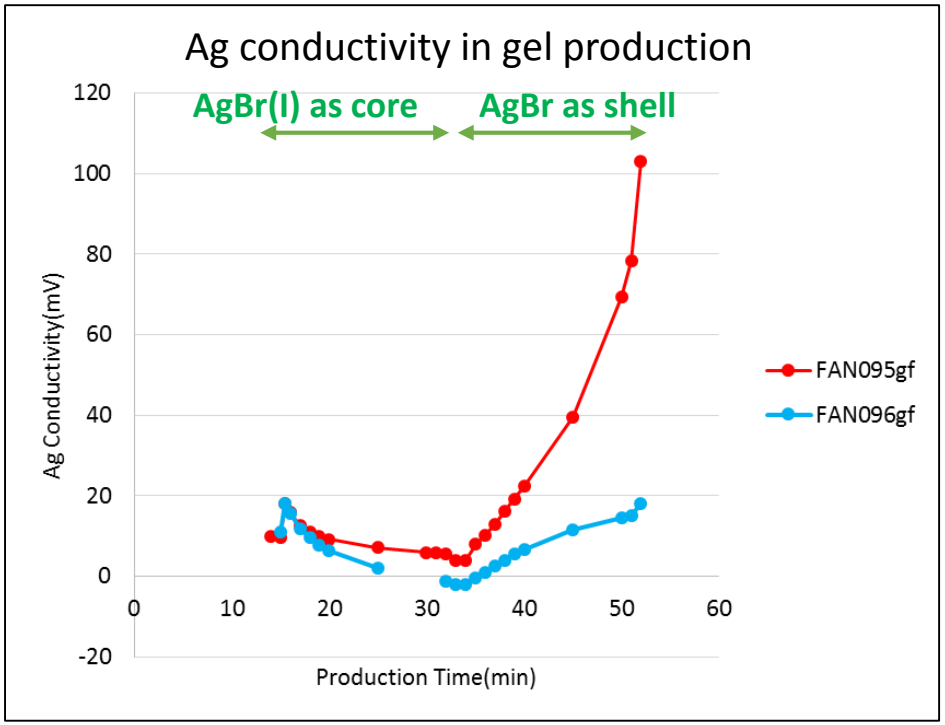
→ data was already taken by Napoli microscope in Feb2018.

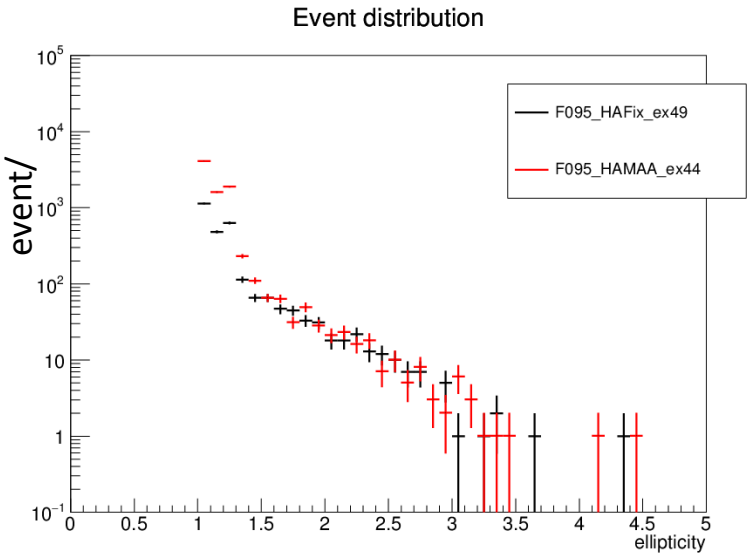
Next experiment prospect

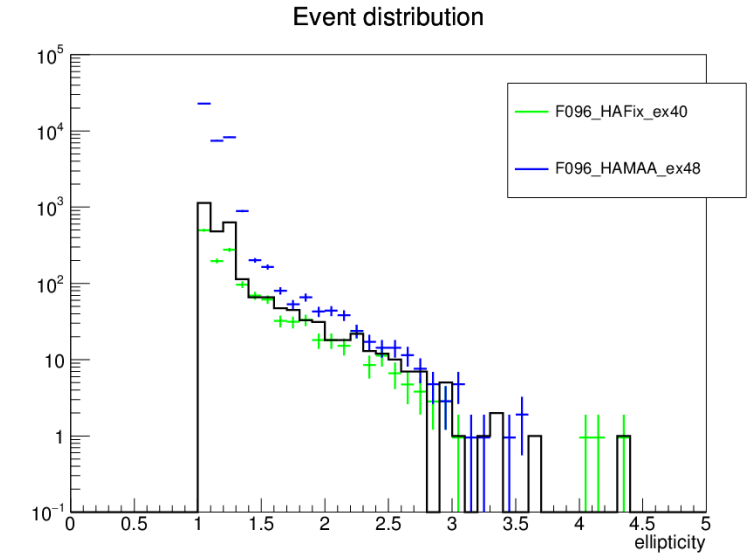
Development of low BG NIT

- We study gel production process for developing Dust free NIT

→ we focus on the Ag conductivity in gel production





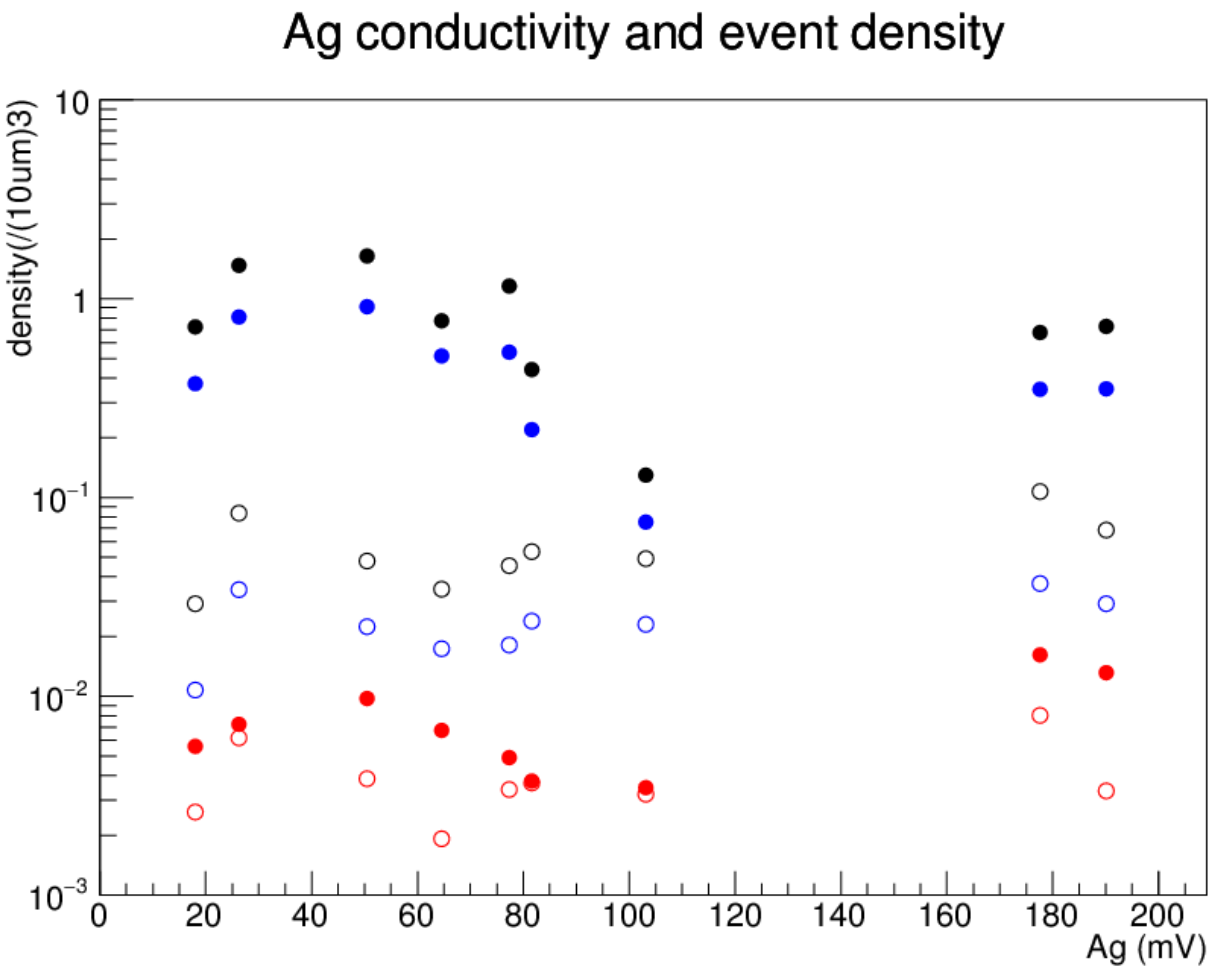


- Ag conductivity in gel production decides AgBr crystal formation.

→Surface state of AgBr crystal is changed by Ag conductivity.

- The relation between fog density and Ag conductivity in shell production process was studied by changing a concentration of NaBr solution

  → final state of Ag conductivity



Black : w/o any cut

Blue : 4<=minor<=6 and bin<=35
Elli>=1

Red : 4<=minor<=6 and bin<=35
Elli>=1.5

● **: Maa develop w/o any cut**
○ **: Fix only**

Fog caused by MAA development is negligible

New experiment method

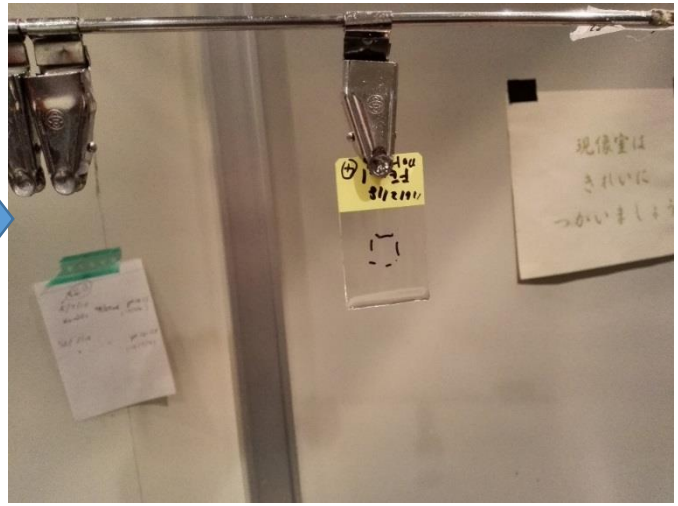
Fog background is suppressed by controlling Ag conductivity.

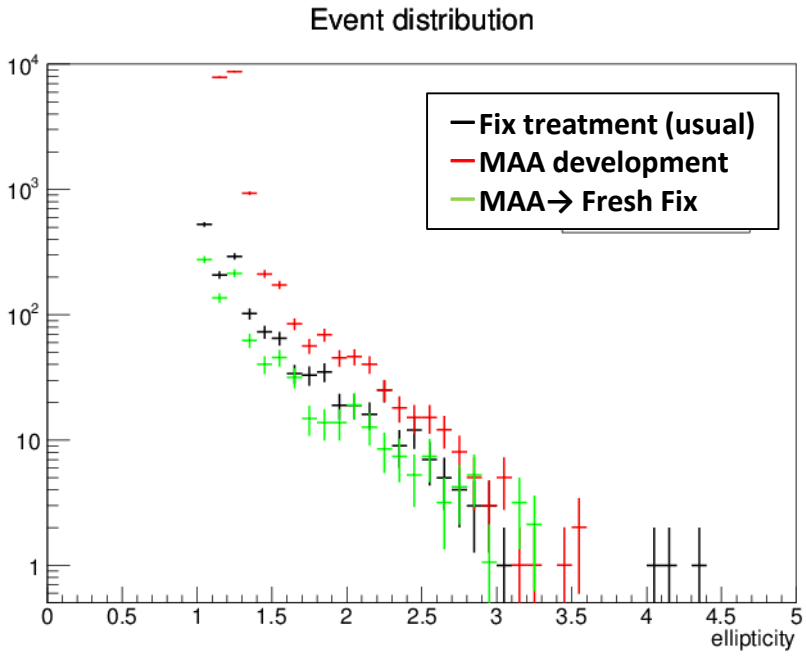
Then we make a new idea

“Signal disappearance method by fresh FIX treatment”

Character of fresh Fix

After fresh Fix treatment





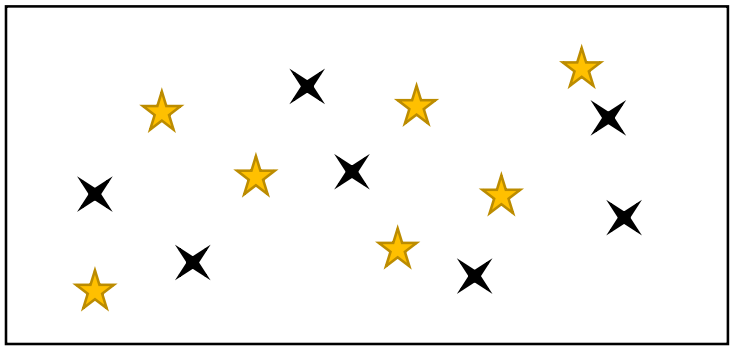
Fresh Fix can delete
Silver (fog, alpha track, nanoparticle and so on)
but can not delete
Dust

Concept of new experiment

Event map of scanning data

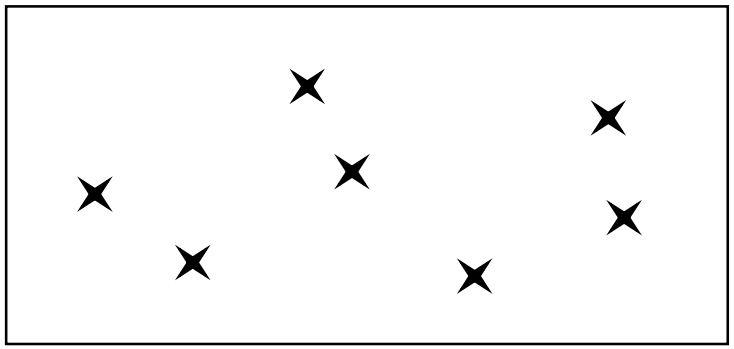
signal

dust



Fresh Fix

Event map of rescanning data



Signal candidate is selected by elliptical fitting.

↓

Fresh Fix

↓

Only candidate events are rescanned and judged if they are deleted or not.

- We have to evaluate following

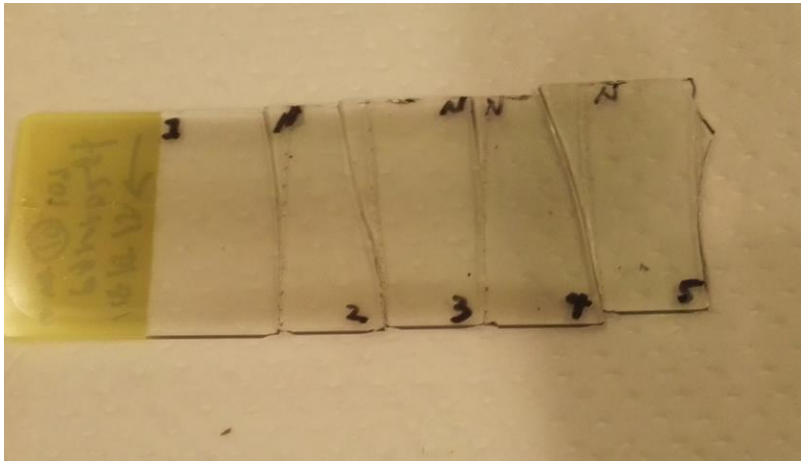
- How many signal and dust are vanished (or survived) after fresh Fix solution?

ε(signal_delete) → by using ion sample

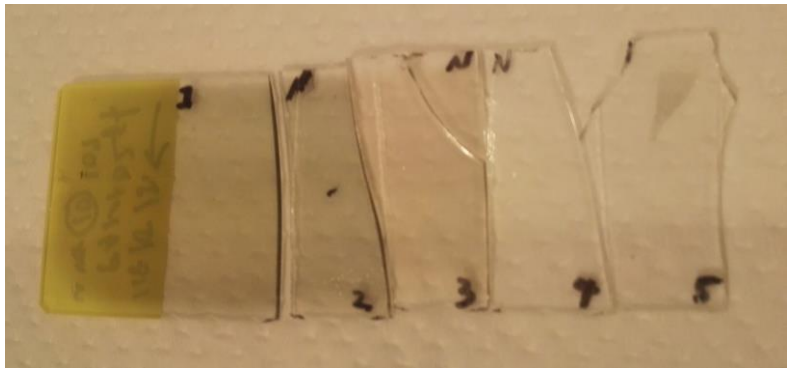
ε(noise_delete) → by using 0day exposure sample

Signal

- HIMAC 290 MeV/n Carbon Ion beam
- FAN102gf



After fresh Fix treatment



Ref 1min 5min 12 min 30min

F.D = 0.05 /(10^3)

discussion

Signal