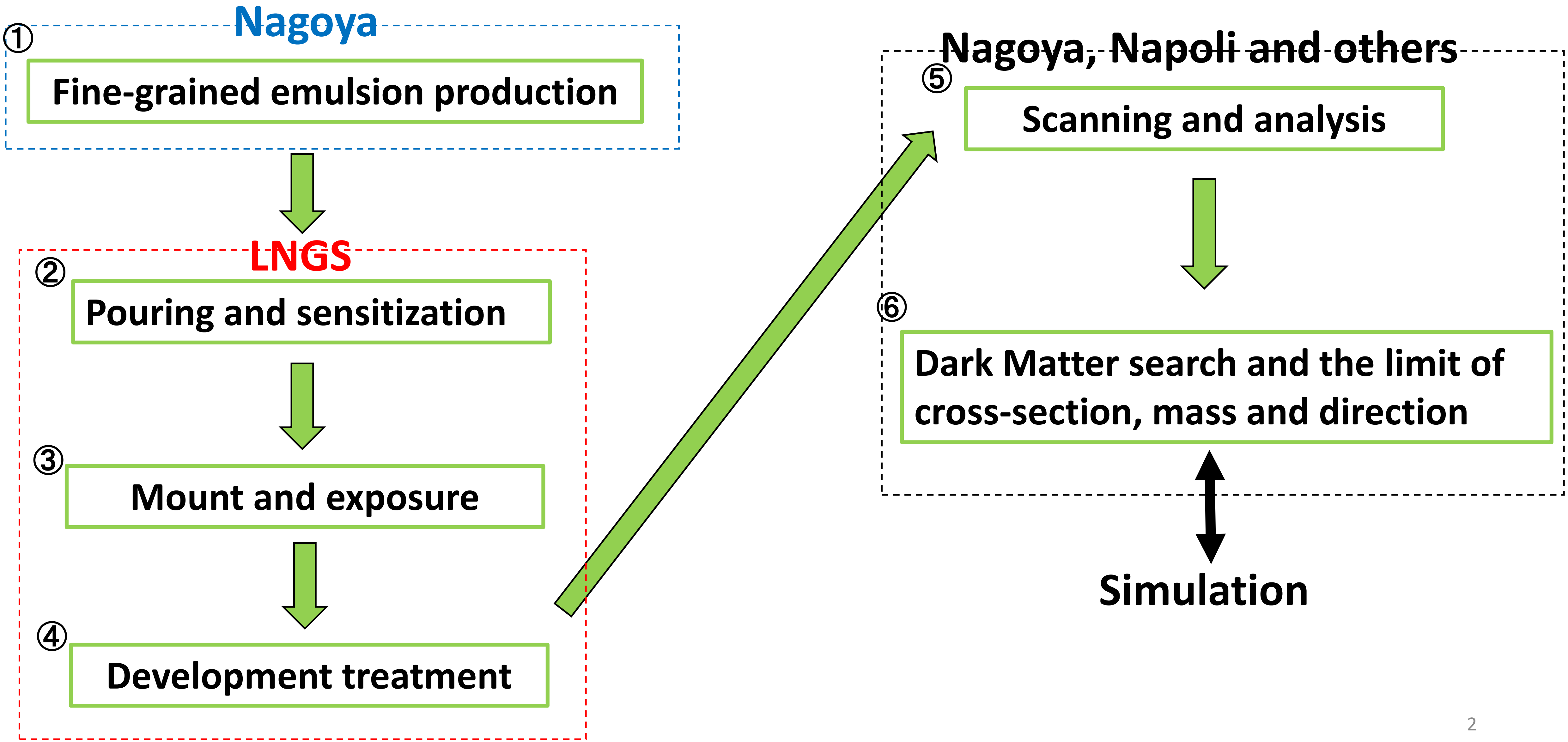
Introduction:
Detector Status and Planning

Nagoya University

Tatsuhiro Naka

2016. Oct. 27 International Workshop on Nuclear Emulsion for Neutrino Studies and WIMP search @ Naple, Italy

NEWS experiment chain



① Fine-grained emulsion production

Achievement:

1. Stable gel production and confirmation of standard process

2. Understanding of density and composition

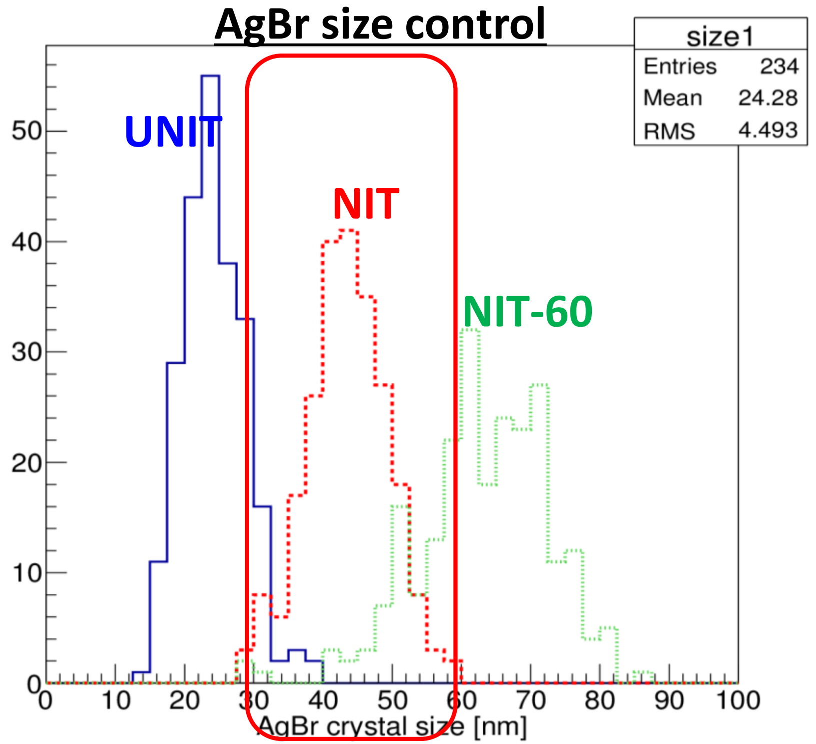
3. Understanding of intrinsic radioactivity

Task :

1. Background contamination (especially, dust)
2. Crystal sensitivity control toward further background rejection
3. Further low-radioactive device (gelatin⇒synthetic polymer)
4. Gel production in underground

(Items 3–4: Future plan)

Understanding of device itself



Composition table for NIT

	Mass fraction	Atomic Fraction
Ag	0.44	0.10
Br	0.32	0.10
I	0.019	0.004
C	0.101	0.214
O	0.074	0.118
N	0.027	0.049
H	0.016	0.410
S	0.003	0.003

Device density : 3.3 +- 0.1 g/cm^3

- ✓ Elemental analyze
- ✓ SEM-EDX
- ✓ content for added chemical

Current intrinsic radioactivity

	U-238	Th-232	K-40	Ag-110m	C-14
Activity [mBq/kg]	27	6	35	(400)	24000

Ge and ICP-MS (U-238, Th-232, K-40, Ag-110m)

AMS (C-14)

② Pouring and sensitization

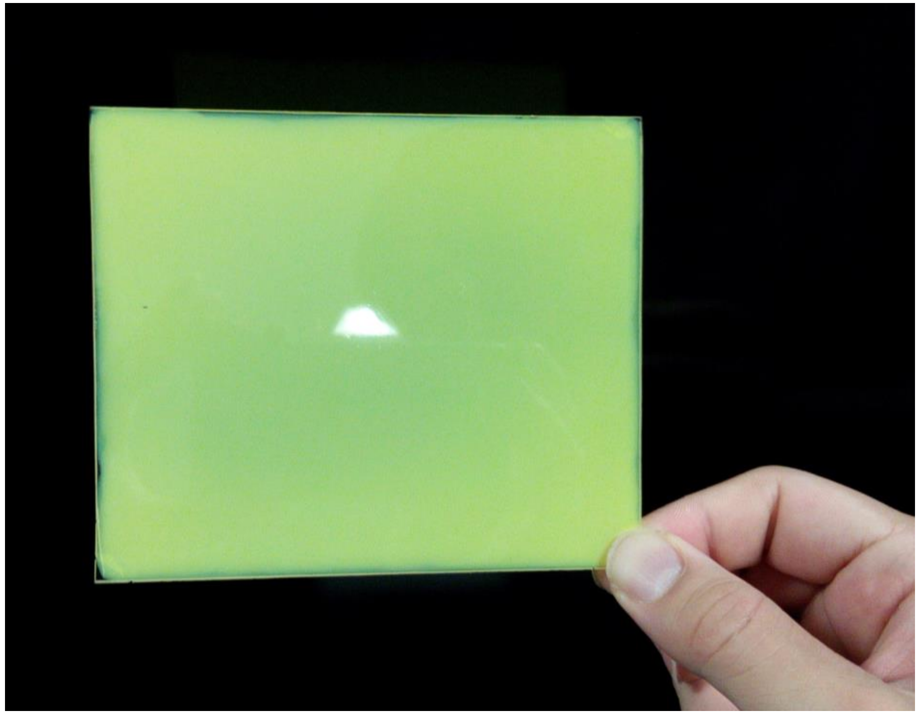
Achievement:

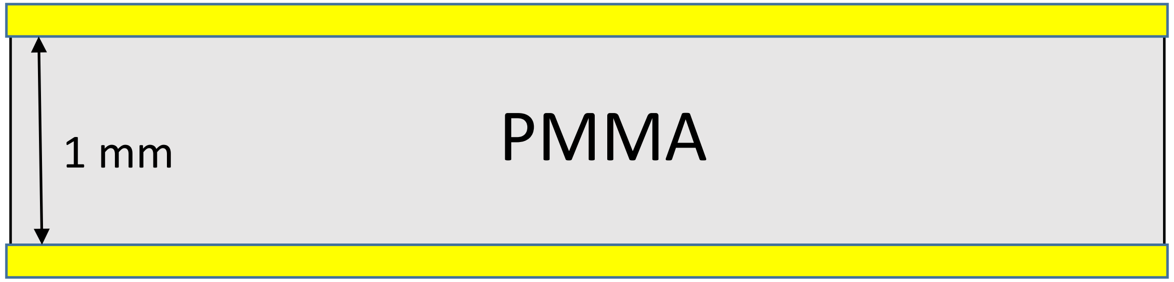
1. Low-background base and the pre-treatment ⇒ PMMA base
2. Halogen-Accepter(HA) sensitization as standard treatment
3. Humidity control and demonstration at underground

Task :

1. Radioactivity measurement of base by ICP-MS or Ge
2. Accumulation of environment γ-ray background and the prevention
3. Clean environment to prevent the contamination

NIT film for dark matter experiment





Size : 10 x 12 cm^2 (7.6 x 2.6 cm^2 for R&D)
NIT layer thickness : ~ 50 μm

<u>Target mass</u>
Both-side pouring: 3 g/film   (AgBr(I) 70 %, other 30 %)

- One-side pouring is also possible because of thicker and hard base.
- We don't need the vacuum pump because same reason.

Counterplan

1. Making the shielded space for drying

2. Refresh process before exposure

③ Mount and exposure

Achievement:

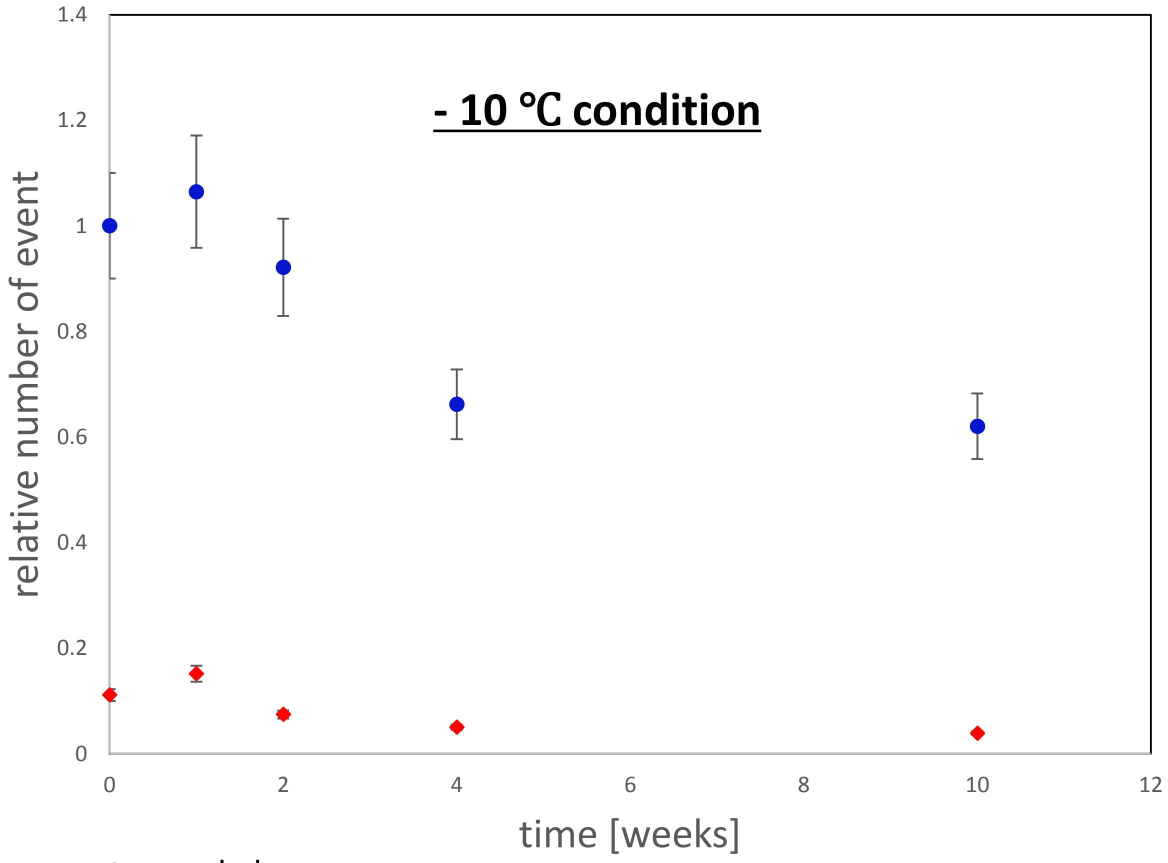
1. Prototype cooling system
2. Fading effect (done preliminary test at Nagoya)
3. Demonstration of that in underground

Task :

1. Sensitivity of device at cooling condition
2. Environment background effect and further shield design
3. Further understanding of fading effect
4. System for lower temperature

Fading effect for NIT

Analysis of electron events induced by Am-241 γ-rays



● : total electron events

♦ : leakage events into signal region

Error is 10 % systematics due to uncertainty from exposure time of γ-rays

- **Fading affect can be seen between 1 – 4 weeks, but become stable after 4 weeks.**
- **Probably, this effect is not standard process for oxidation decomposition due to environment H_2O or O_2**
- **This result should be checked using the sample that tested at LNGS in this month (but, temperature is lower) .**

✓ **to check about dE/dx dependence**

✓ **repeatability**

✓ **other dependence (crystal size, structure of crystal etc.) to understand this effect.**

④ Development treatment

Achievement:

1. MAA and 5 ℃ treatment as current standard

2. Demonstration in underground

Task :

1. Further improvement
2. Understanding of activation energy for latent image specks and the optimization of developer

⑤ Scanning and analysis

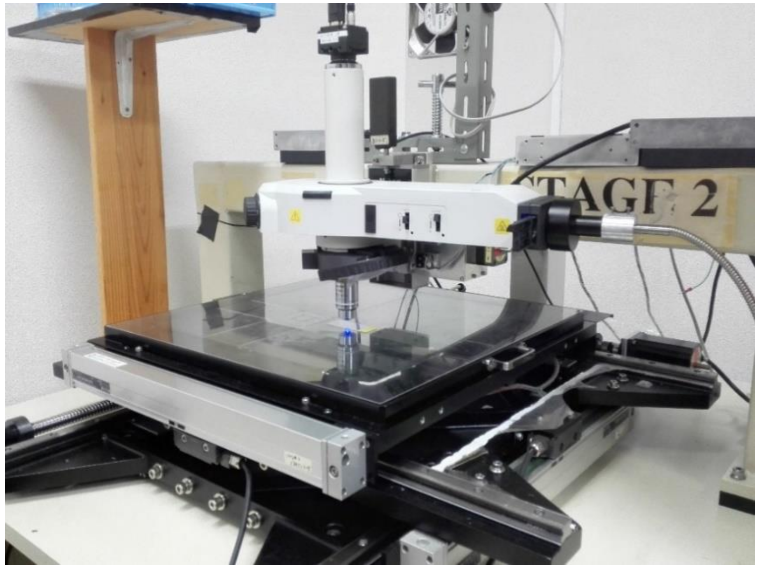
Achievement:

1. Elliptical shape selection for first event trigger
2. Prototype scanning machine for small scale and the understanding of that
3. super-high resolution analysis using Plasmon effect (proof-of-principle)

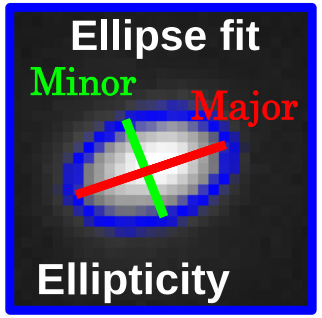
Task :

1. Detection efficiency and the improvement
2. Effective plasmon analysis system
3. Higher level image processing not only elliptical shape (include machine larning)
4. Higher scanning speed system
5. New optical information (e.g., Raman spectrum)
6. Data-base and the sharing

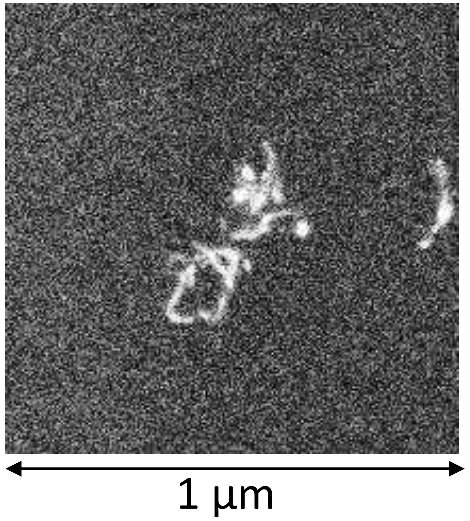
New technologies for nano-scale tracking



- ☐ Volume scanning (current speed ~ 10 g/month)
- ☐ Ellipitical shape analysis ⇒ first event trigger
- ☐ Spatial resolution ~ 230 nm for blue light + high N.A. lens



Accurate shape analysis is not done yet, but it's very important task.



- ➢ **Nano-scale structure has more detail information reflecting the character of particle or background like low-dE/dx particle, fog and dust.**
- ➢ **Super-high resolution technologies and the output due to that should be enable to distinguish those events**
- ➢ **For example, localized plasmon resonance from developed silver grain is ont of the promising effect. ⇒ new optical microscope system**

⑥ Dark matter search and the limit

Achievement:

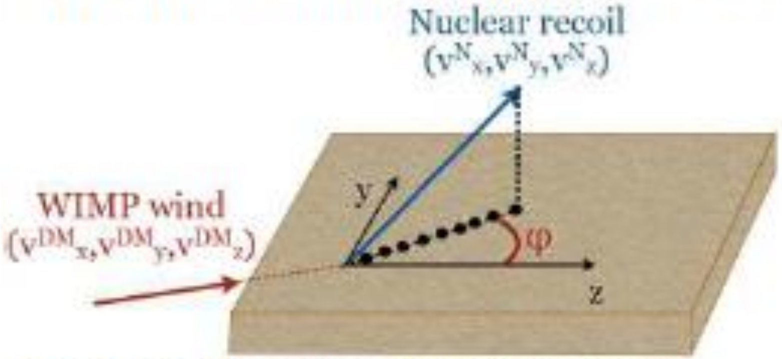
1. Simulation using direction information

2. Simulation taking into account the track length spectrum and calibration

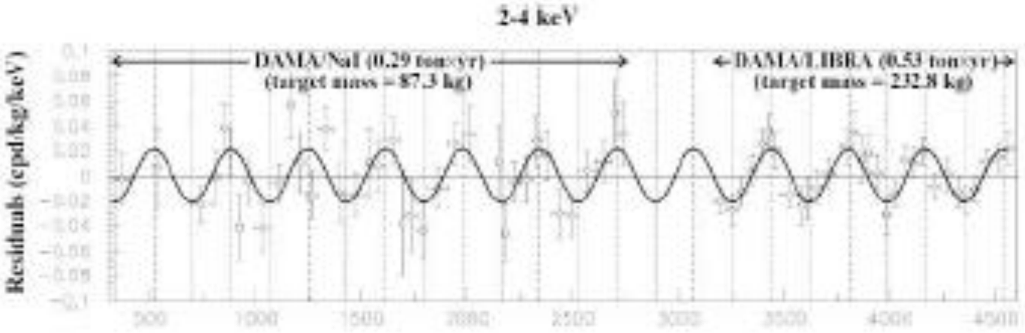
Task :

1. The simulation taking into account more realistic detector performance
2. Various scenario in terms of astrophysics and model of dark matter ⇒ discuss in Antonia's talk
3. Background contamination ⇒ discuss in Valerio's talk

studied by
A. Di Crescenzo, N. Di Marco, T. Asada

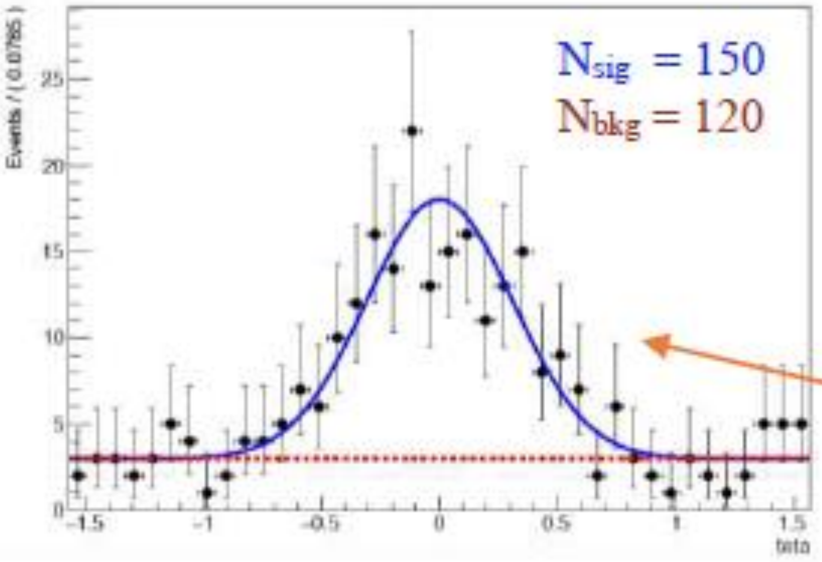


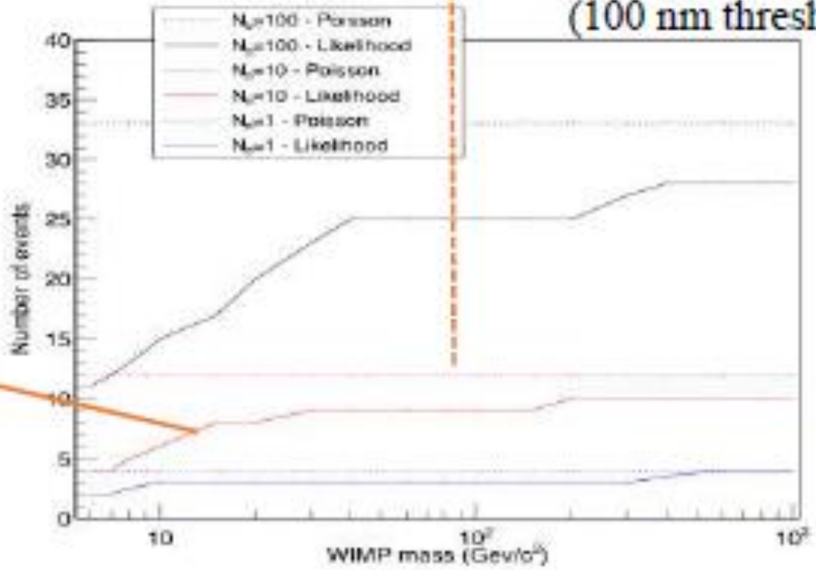
(fixed to emulsion by equatorial telescope)



さらに数%の季節変動をみる

Minimum number of signal events
to reach 3σ observation
(100 nm threshold)





Summary

Device

- Purification of background
- Stability
- Sensitivity

Scanning and analysis

- Image processing
- Plasmon analysis system
- High speed scanning
- New technologies

Simulation and DM search

- More realistic simulation
- Background simulation

- ✓ Strategy
- ✓ Near future plan
- ✓ Future plan
- ✓ Priority and schedule
- ✓ Work-sharing

Back up

Corona discharge treatment for PMMA base

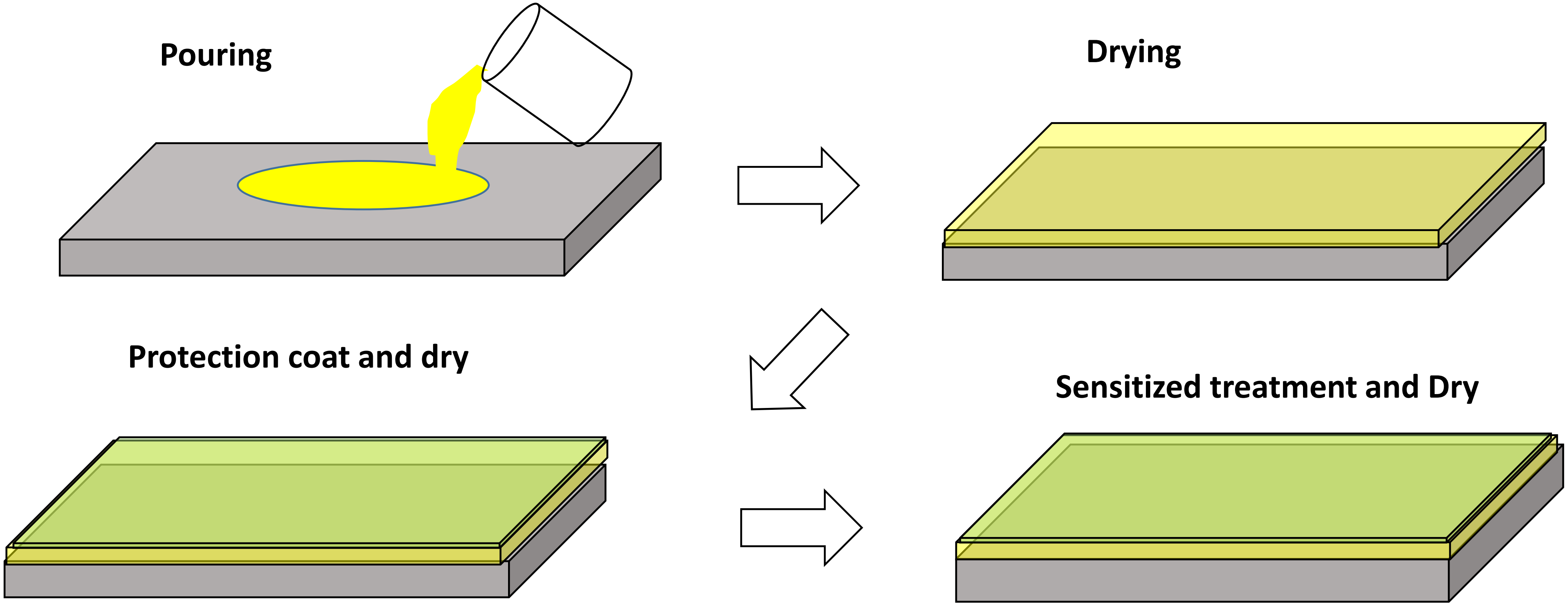
1. Corona discharge; hydrophilic treatment

2. Gelatin coating and dry

New recipe (K free)	Quantity
H_2O (de-ionized)	1980 g
Gelatin (P6406)	20 g
Drywel	10 cc
$N333$ (4 %)	20 cc

3. Pouring the emulsion

Production of film



Total process : 2 days

We have to understand accumulation of environment γ-ray background during film production