Report on underground LNGS activity

2016/10/27

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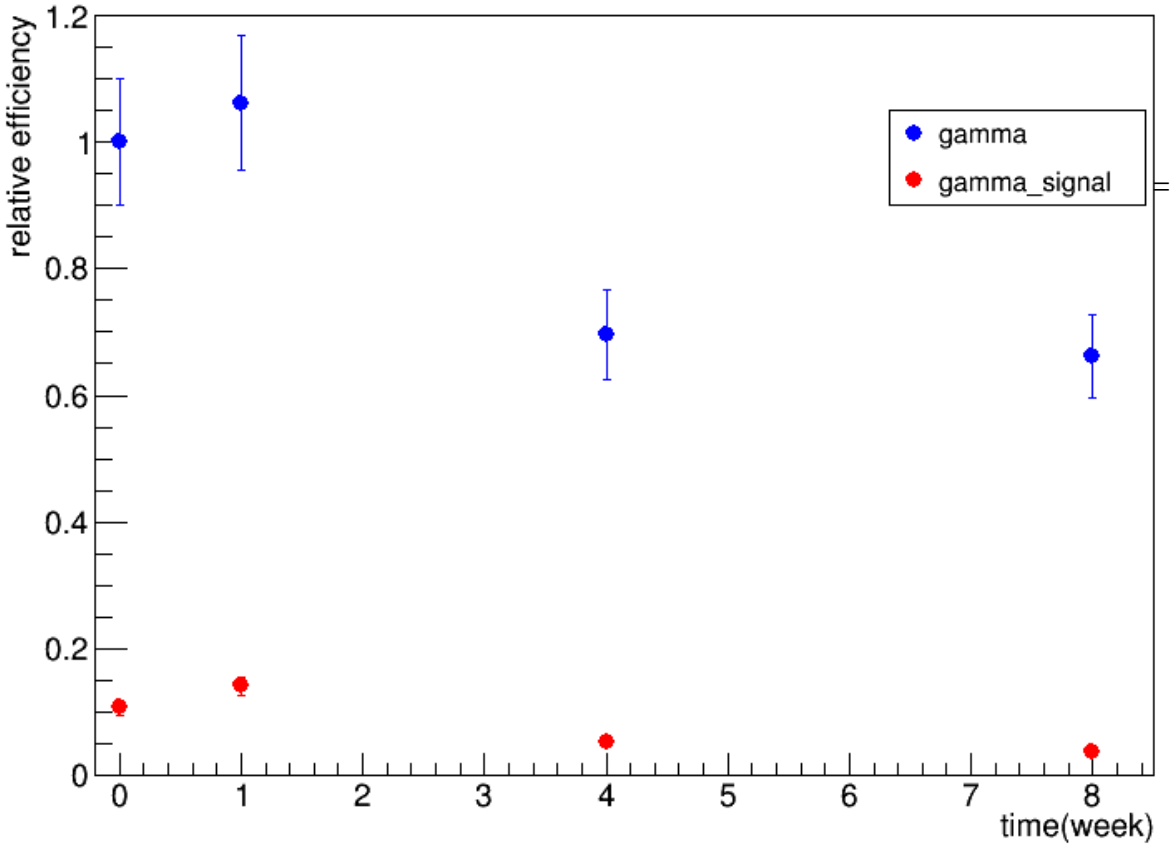
purpose and estimation

Purpose

- test of new PMMA base
- test of cooling system with emulsion
- fading effect under cooling system
- measurement of environmental gamma integration amount (or upper limit)
- estimation of effective BG rate

fading of electron signal

detected gamma event rate measured by Nagoya

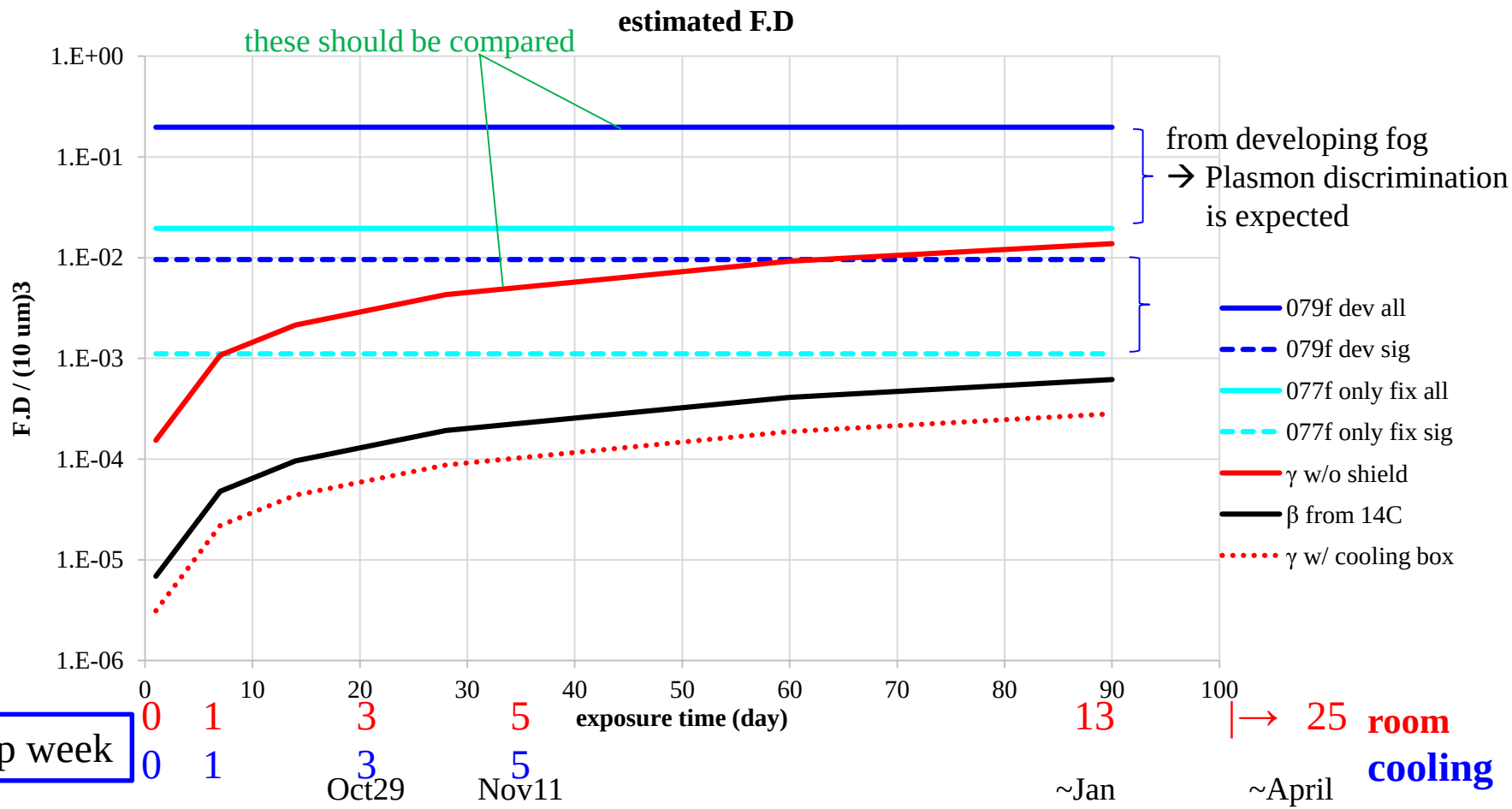


= after ellipticity cut

storage times kept at -10 deg
after gamma exposure

This result affects background integration during exposure
→ same measurement with GS cooling system

F.D expectation (without fading effect)

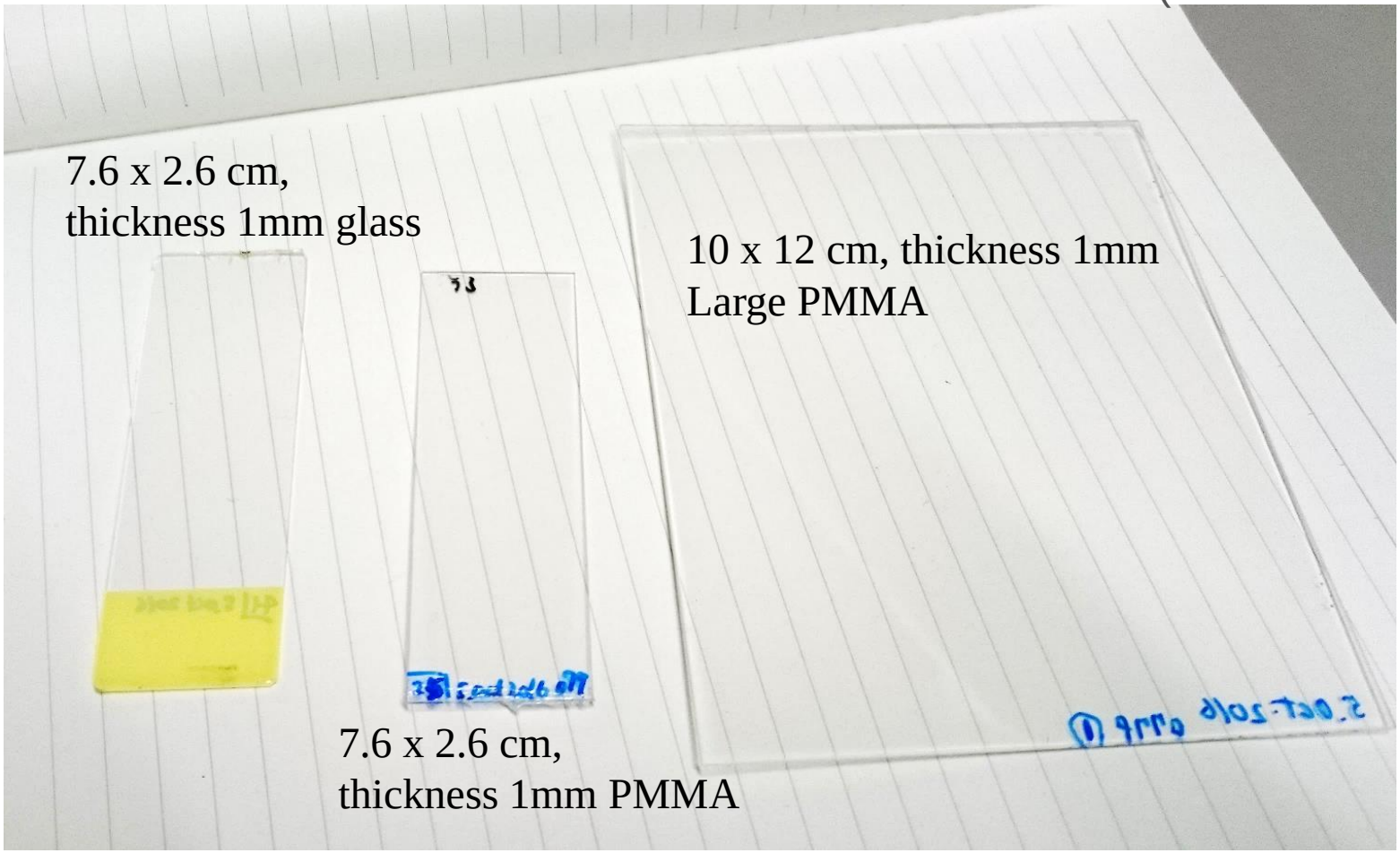


077f only fix : without developing fog (intrinsic limit)
079f dev : 0 day developing fog measured by Nagoya (effective amount)
sig(dotted line) : signal amount selected by ellipticity
γ : environmental gamma integration estimated by Gentile, 100% eff
β : estimation from intrinsic ^{14}C

underground activity

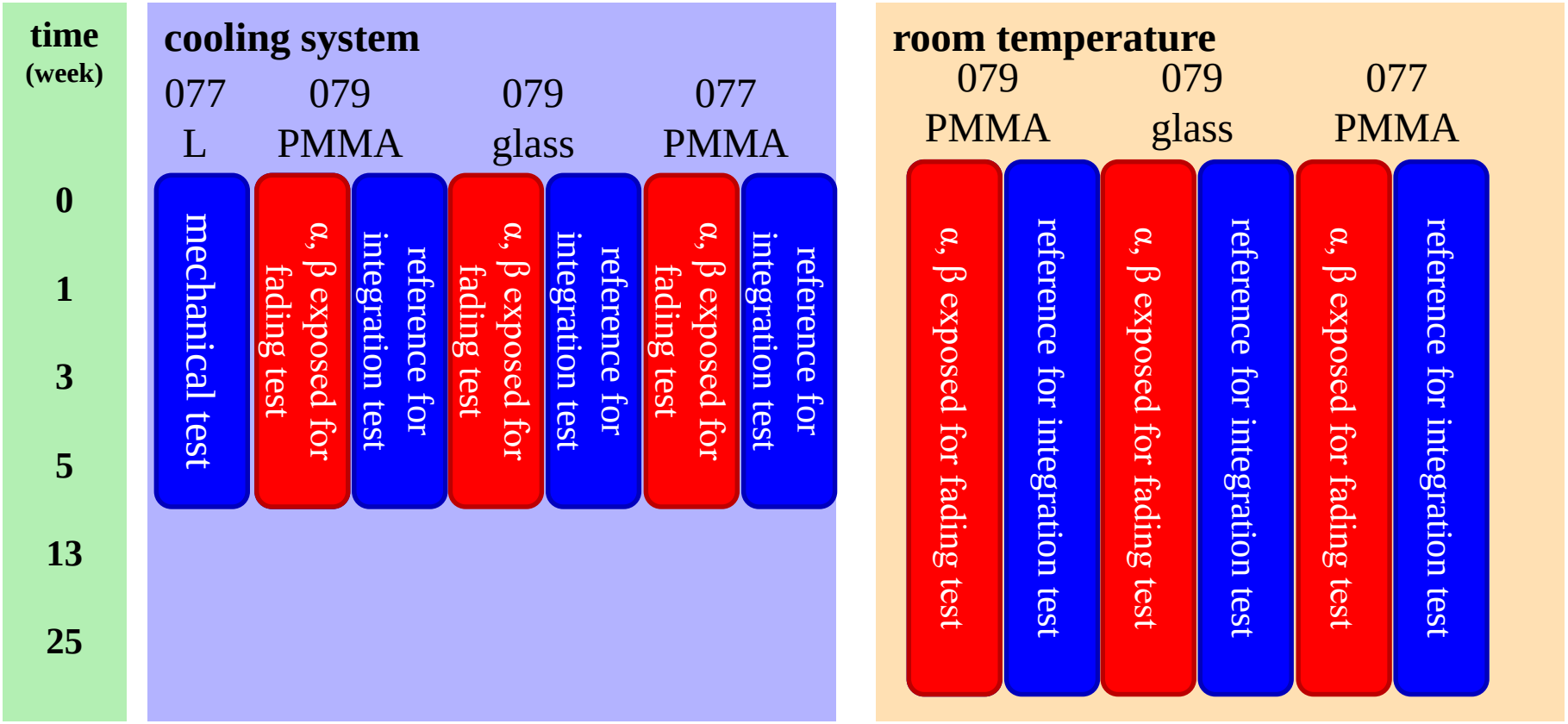
base type

(PMMA = acrylic resin)



slide grass base : efficiency check for optical backward compatibility ← basic sample
PMMA base : efficiency check as new standard optics
Large PMMA base : mechanical test

sample list (plan)



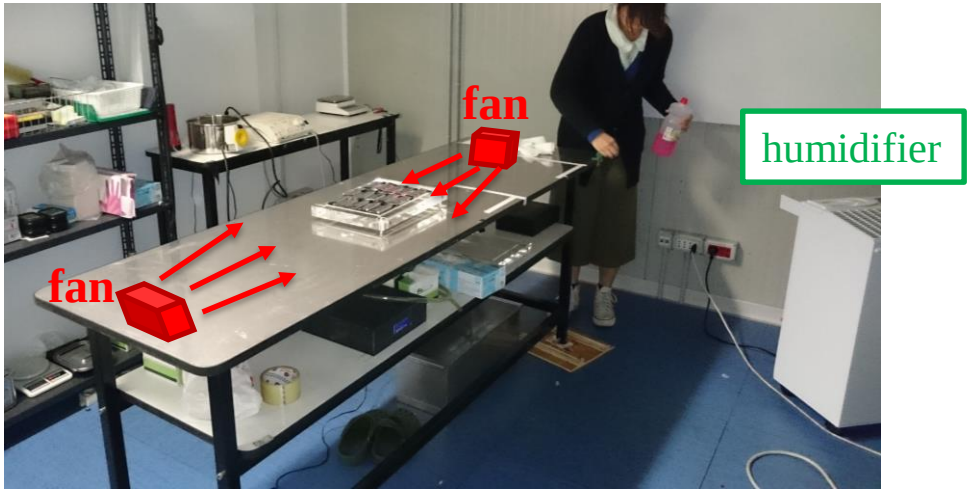
emulsion : NIT, filtered solution & non-stress deionization method

077f dev all events : F.D = 0.335 /(10 um)^3 bad quality ← reference, mechanical test

079f dev all events : F.D = 0.197 /(10 um)^3 good quality ← basic sample

sample treatment

- sample list
  - No.1-4 Large PMMA / 077f
  - No.5-24 PMMA / 077f
  - No.25-40 PMMA / 079f
  - No.81-85 PMMA / 079f (add)
  - No.41-68 glass / 079f
- drying condition
  - humidity 55%
  - uniform air flow



process

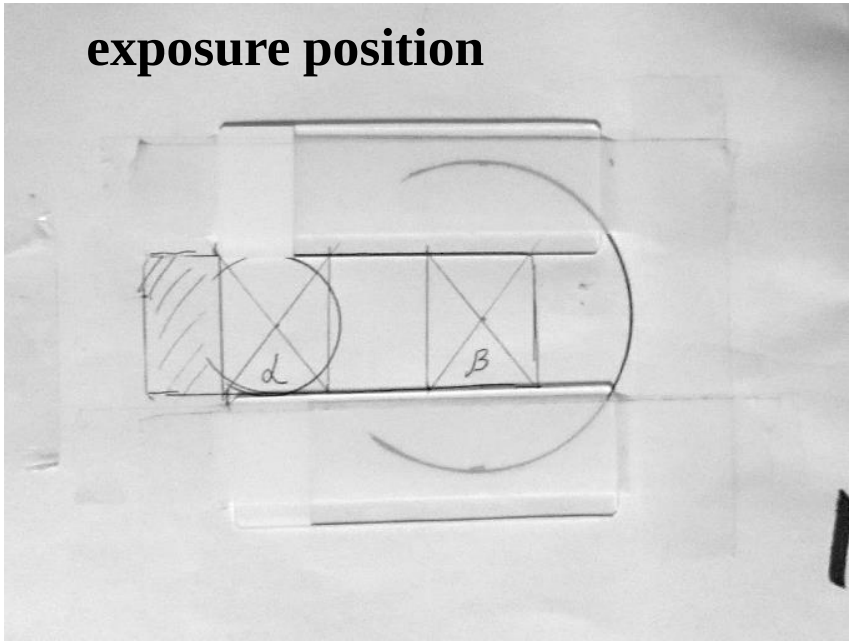
- 5 Oct 3 p.m. : pouring (1 side)
- 6 Oct 0 p.m. : protection coat
- 6 Oct 5 p.m. : HA sensitization
- 7 Oct 10 - 4 p.m. : exposure & cooling start
- 7 Oct 5 p.m. : 0 week dev
- 14 Oct 4.m. : 1 week dev

alpha & beta exposure

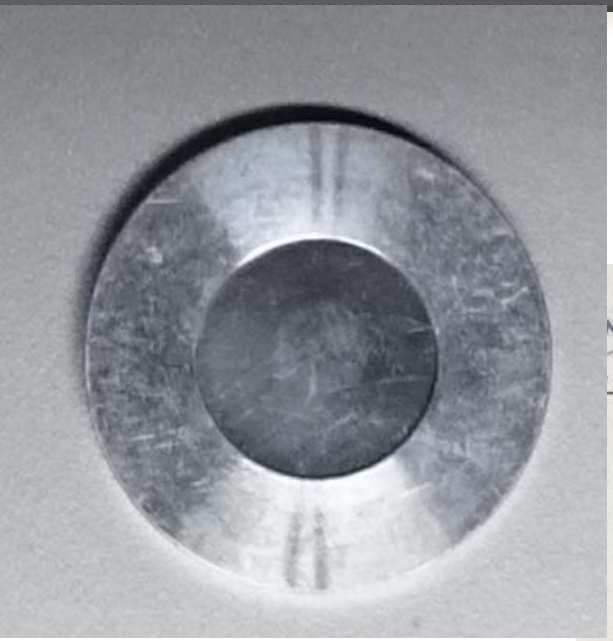
previous test beta is exposed for 15 min
→changed to 10 min to finish in 1 day

25	41	7	for 0day developing
27	43	9	
29	45	11	for cooling system
31	47	13	
33	49	15	
35	51	17	
37	53	19	for room exposure
39	59	21	
81	57	23	

alpha : 30 sec
beta : 10 min



alpha source



INFN
LNGS

Attention ! PRESENCE OF RADIOACTIVE SOURCE

RADIONUCLIDE	Cod. LNGS:		
Am-241	N. 071	Source certif.	AF-241-A1 n. 1168-1-1
kBq	4.37	at: 02/09/2006	SEALED SOURCE Radioactive contamination : absent

T1/2 (y) = 432.70 **Half value layer (mmPb) =**

Rad. emission : gamma (keV 60) , alfa (MeV 5.48;5.44) , + neutrons on Be

Dose rate (µGy/h) (foton)	d= 10 cm	d= 20 cm	d= 50 cm	d= 100 cm
	0.00	0.00	0.00	0.000

Notes *Am-241 electroplated Alfa source*

This CARD must be exposed where the source is in use

Delivery date : 29/7/16

User : Nicola D'Ambrosio

Experim. and Location : Opera Lab. Microscopi Laboratori Esterni

Signature of the user : Nicola D'Ambrosio

beta source

Attention ! PRESENCE OF RADIOACTIVE SOURCE

RADIONUCLIDE	Cod. LNGS:		
Sr-90	N. 036	Source certif.	SIR1221 n. 109988-1
kBq	360.52	at: 02/09/2006	SEALED SOURCE Radioactive contamination : absent

T1/2 (y) = 28.20 Half value layer (mmPb) =

Rad. emission : beta (Mev 0,546; 2,24)

Dose rate (µGy/h) (foton)	d= 10 cm	d= 20 cm	d= 50 cm	d= 100 cm

Notes

This CARD must be exposed where the source is in use

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detail sample number list (for staffs)

[077f:old&filtered] 4 large PMMA, 18+1 PMMA
[079f:new&filtered] 21 PMMA, 28 slide glass

α, β exposure for fading test
no exposure for BG integration

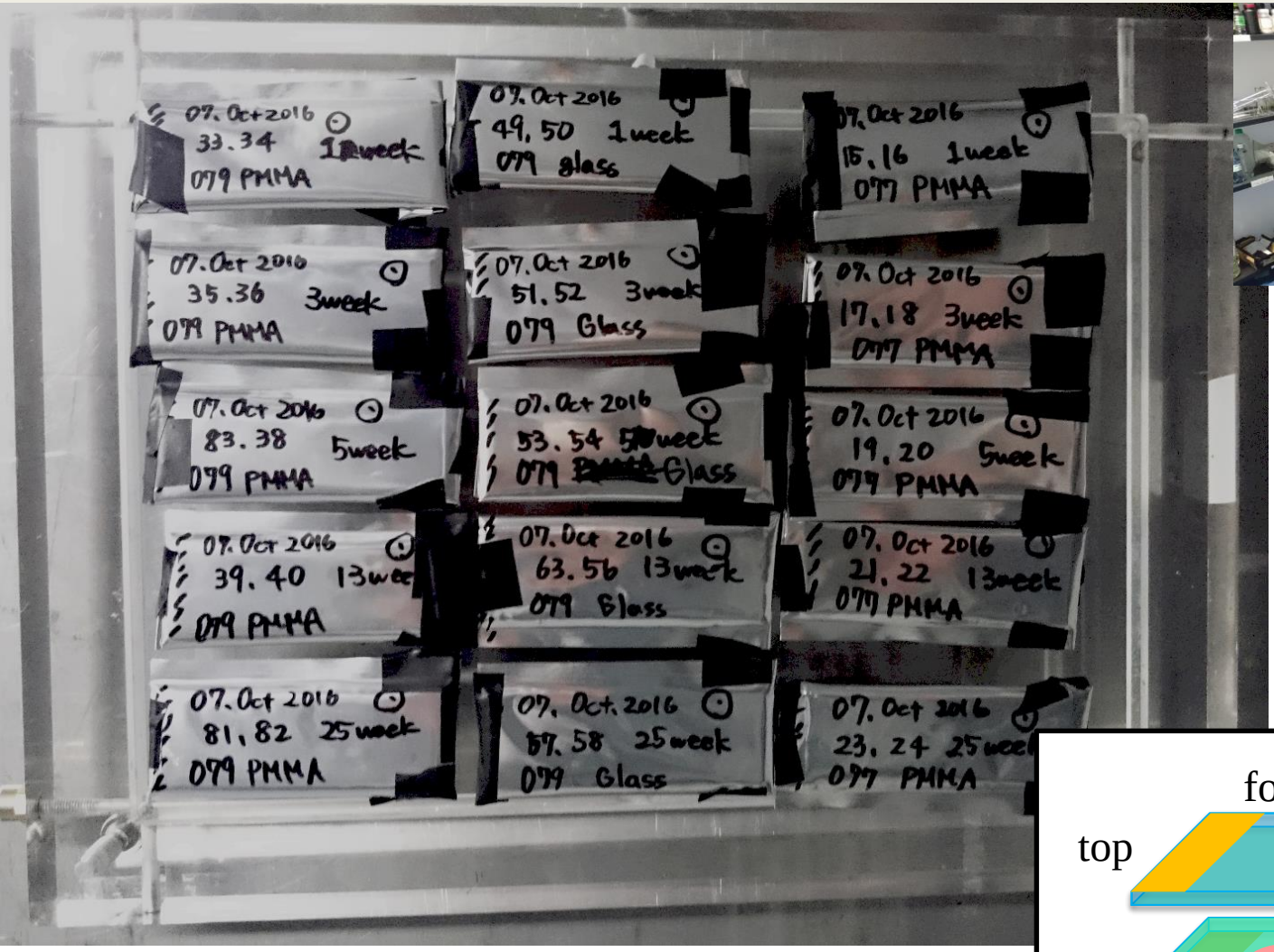
week	cooling system 077 L	079 PMMA		079 glass		077 PMMA		room temperature 079 PMMA		079 glass		077 PMMA	
0	1	25	26	41	42	7	6	-	-	-	-	-	-
													dev finished
1	2	27	~~38~~ **28**	43	~~44~~ **65**	9	10	33	34	49	50	15	16
3	3	29	30	45	46	11	12	35	36	51	52	17 β +30sec	18
5	4	31	32	47	48	13	14	~~37~~ **83**	38	53 α +8sec	54	19	20
13								39	40	~~59~~ **63**	56	21	22
25								81	82	57	58	23	24

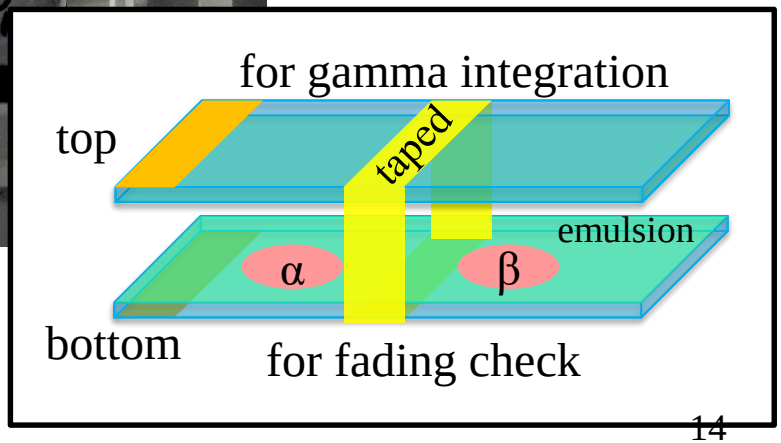
abnormal
thin film 8, 55, 60, 62,
lost 5, 61, ~~44~~, ~~37~~, ~~59~~, ~~66~~

remains 079f only
glass ~~61~~, ~~63~~, 64, ~~65~~, ~~66~~, 67, 68
PMMA ~~83~~, 84, 85

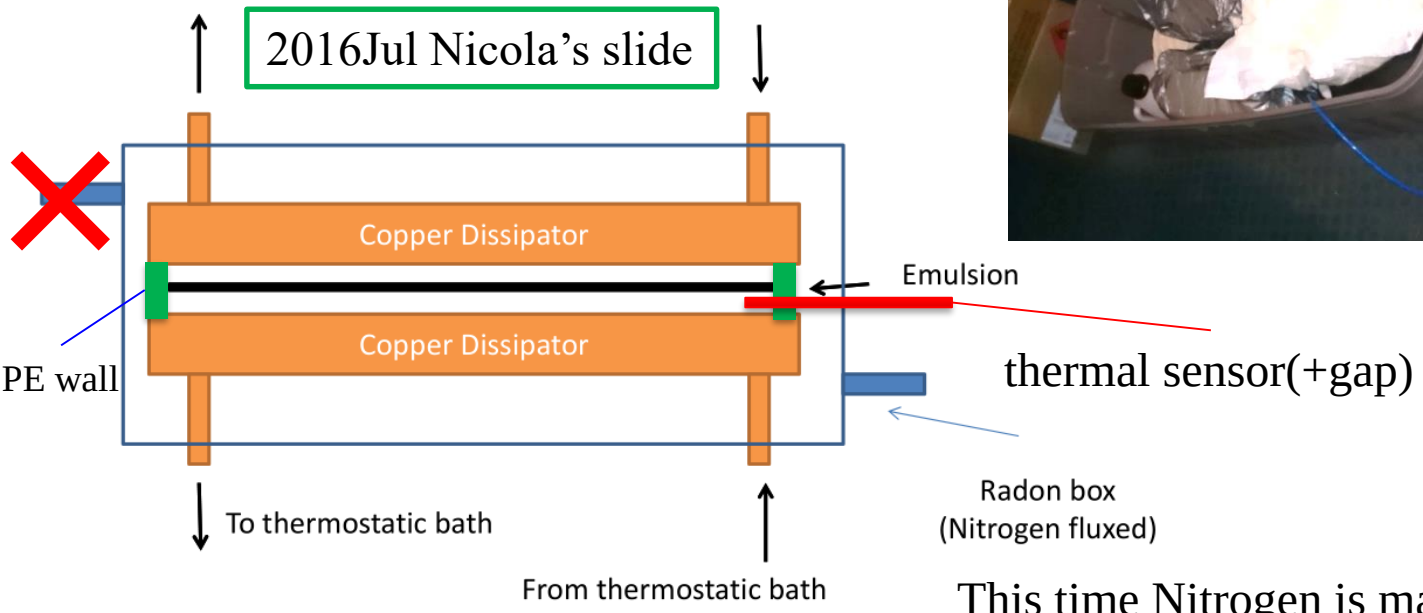
_:used

room temperature exposure set up





cooling system

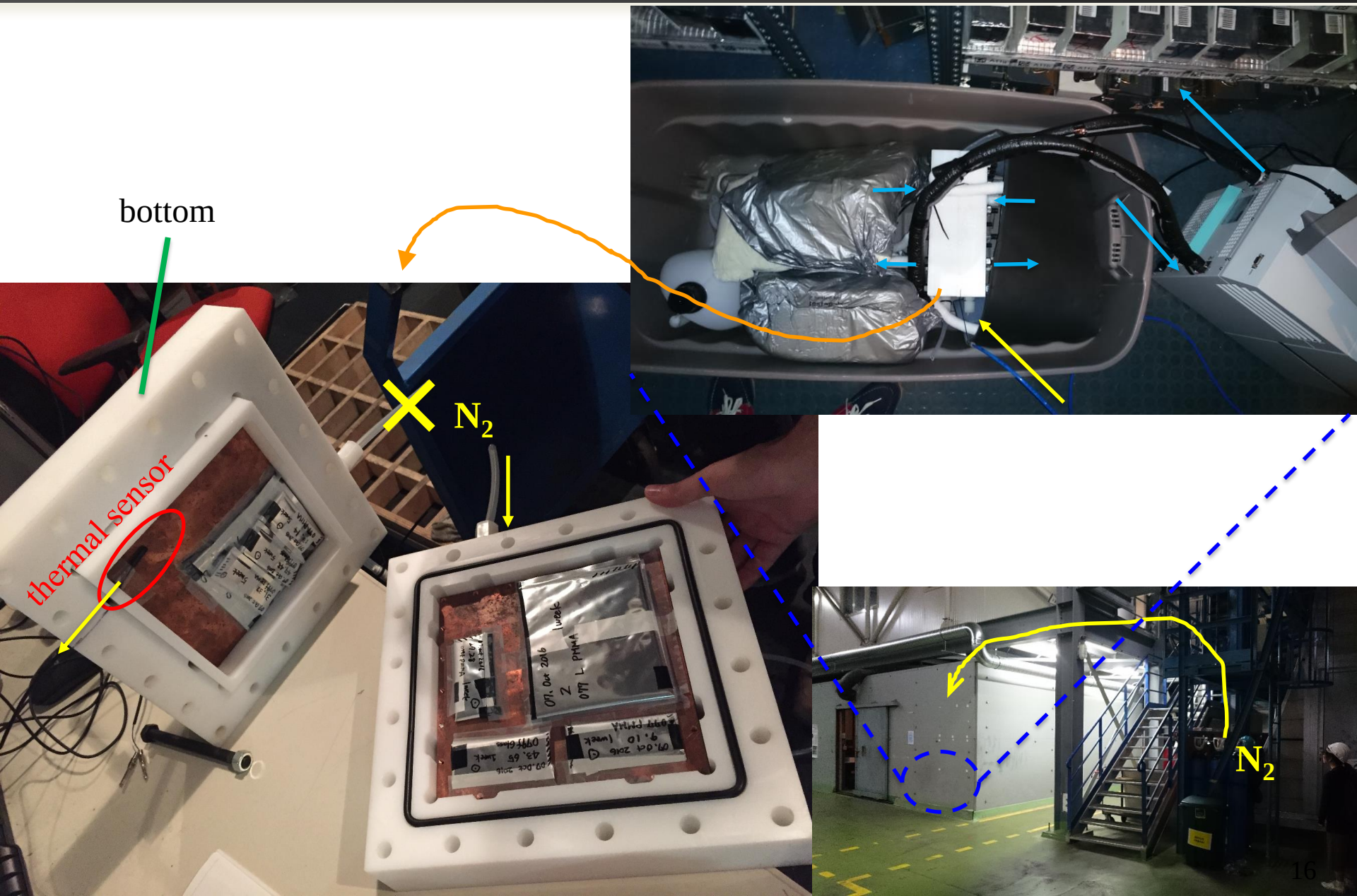


inner space ~16 cm x 16cm x 3.5 cm

sensor temperature was at -15.6 degree

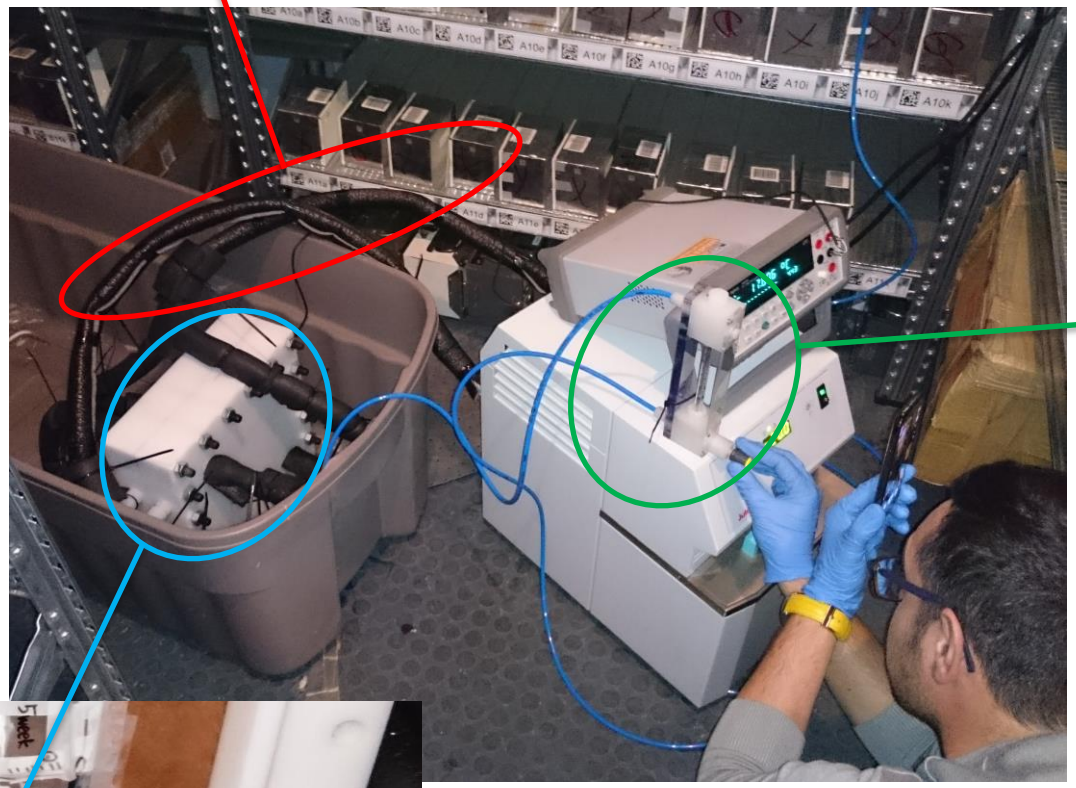
This time Nitrogen is mainly used to disturb freezing, so nitrogen flux is a little. (The minimum amount for radon purging have not been checked yet)
The tube of nitrogen is closed, and nitrogen escapes from gap of thermal sensor hole.

cooling system set up (0 – 1 week)



update of cooling system (1 week ~)

coolant tubes were completely wrapped by insulation seats
temperature became at -17.8 degree



N2 flux became visible

gas flow meter

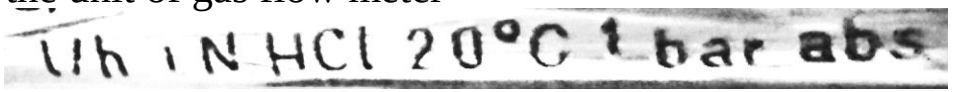
Thermal sensor was packed as same as films

status of N_2 gas

1 of 3 cylinder

from 14 Oct

the unit of gas flow meter



set value is ~4

- 108 bar @14 Oct
- gas cylinder = 50L?
- 4 l/h ?

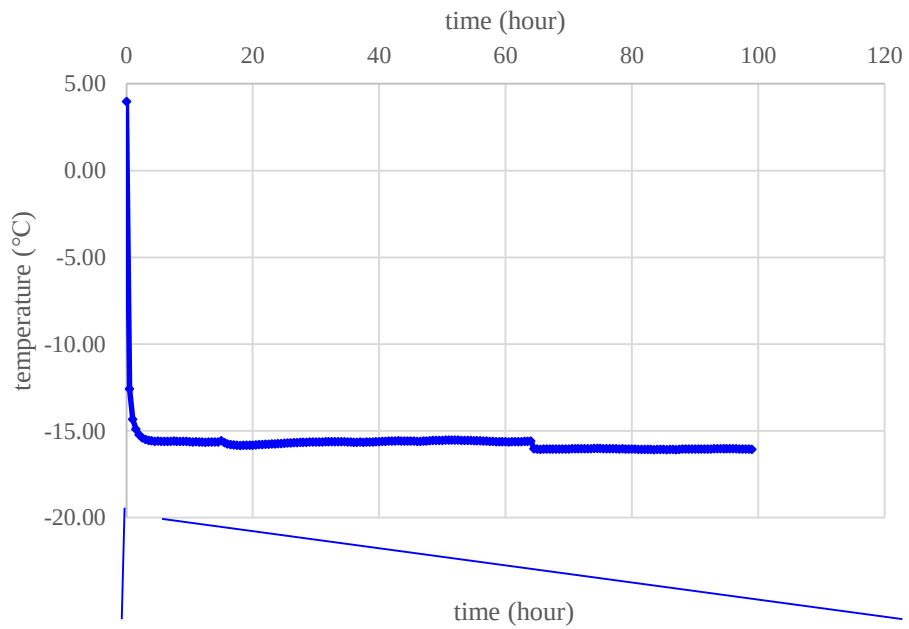
→ 56 day?

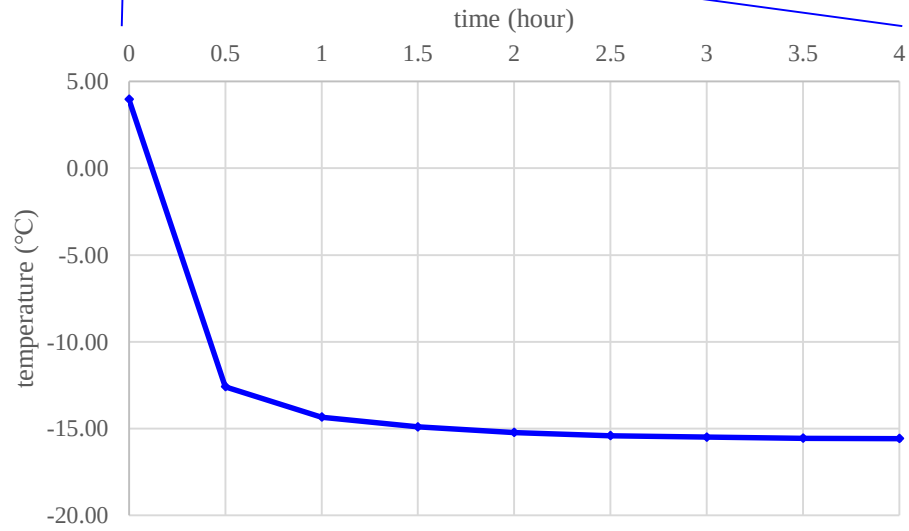
time	8 Oct 12:47	9 Oct 11:25	14 Oct 10:27	14 Oct 17:46
Pressure [bar]	182	175	113	108

cooling start

extraction (<4 h) 1week dev

Temperature of cooling system / extraction





Temperature becomes stable within 1~2 hours
The temperature is -15.6 degree (0 – 1 week)
-17.8 degree (1 week -)

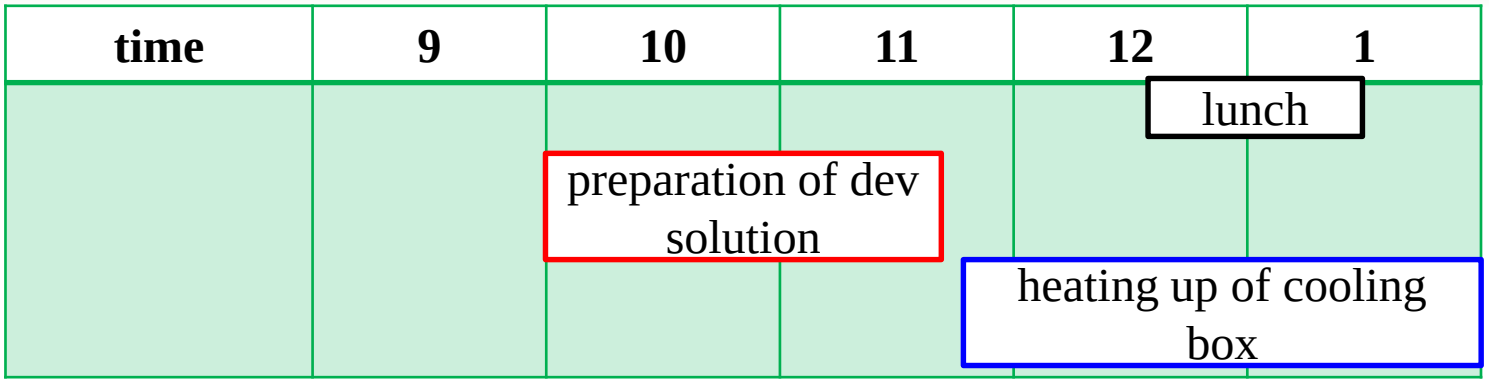
To pick up the samples, we need to heat them up to room temperature to avoid condensation

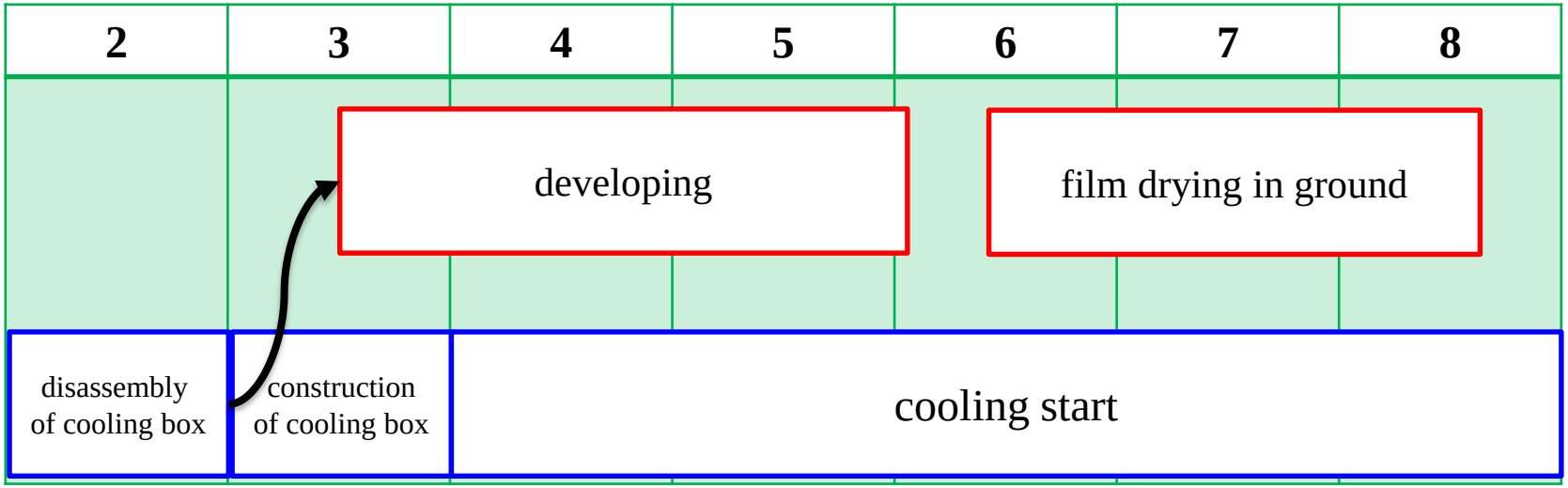
time of sample extraction

1. box heating 1-2 h
2. disassembling/assembling 1-2 h
3. box cooling 1-2 h

The samples may be kept at room temperature for ~4 hours on extraction

extraction /developing (14 Oct 2016)





developing of 0 week and 1 week are finished successfully

several samples are scanned by Nagoya and Napoli → to be compared

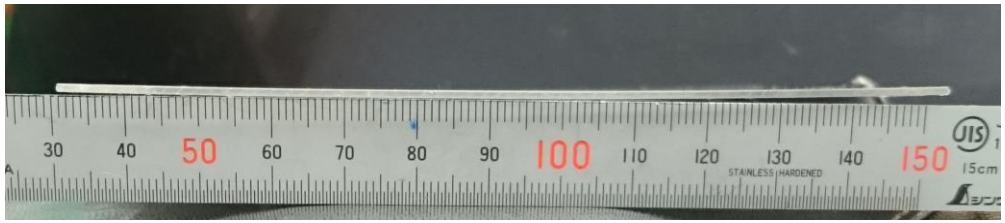
result

result of PMMA mechanical test

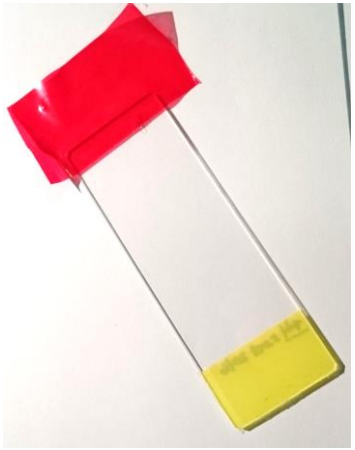
basically OK, but be careful

- The developing was no problem including Large size PMMA film, after 1 week cooling.
- 1 side pouring cause the bend of the film even with 1 mm thickness

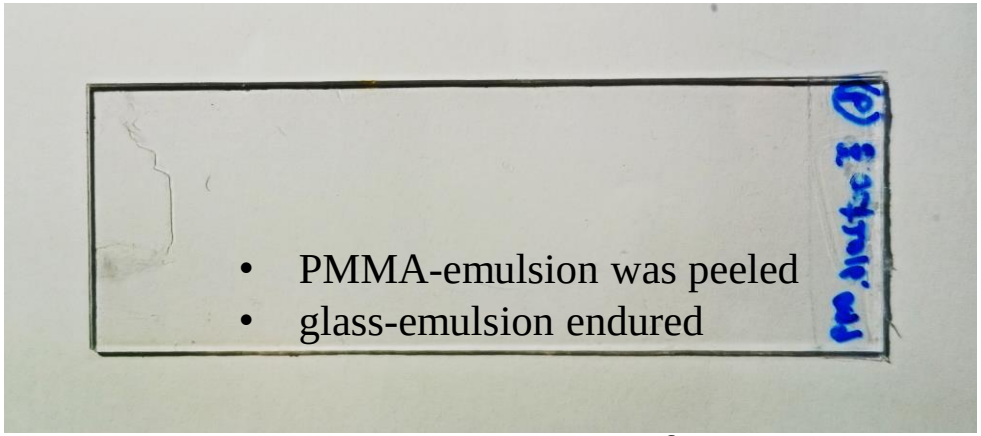
  → both side pouring or mechanical fixation(this time) is required



- the adhesive strength is weaker than that of glass type
  - taping cause peeling of emulsion layer



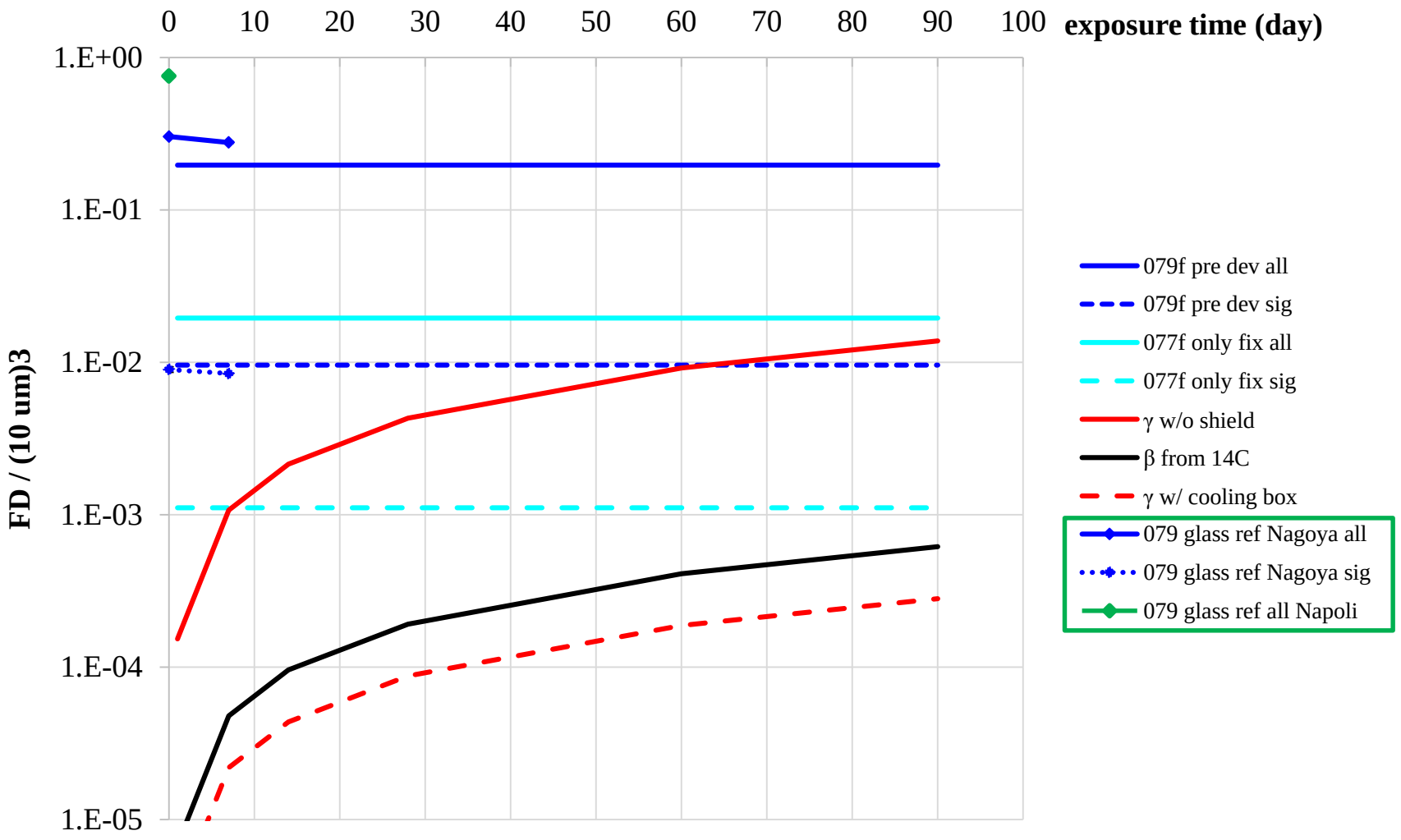
after taping and peeling



use weights or vacuuming for scanning

- Optical difference is under checking

result of Scanning : reference sample



sample 42 (0 week, 079f slide grass, non-exposed)
sample 65 (1 week, 079f slide grass, non-exposed)

Nagoya scan : removing large dust & cluster dust & surface
Napoli scan : including all above
the difference must be checked

prospects

- all sample check up to 1 month
  - fading effect (standard parameter is needed for comparison)
  - integration of environmental gamma and ^{14}C
- combined calculation of fading effect and integration

  → conservative BG estimation (or upper limit)

- fading parameter from exposure timing and temperature (Okada start this study)

  → approximate BG estimation (or upper limit)

summary

- We started underground test for demonstration under cooling system.
- Pouring, developing, and cooling system look no problem.
- Scanning also started in Nagoya and Napoli for cross check.
- The result will show fading effect and environmental gamma integration.