KamLAND Experience

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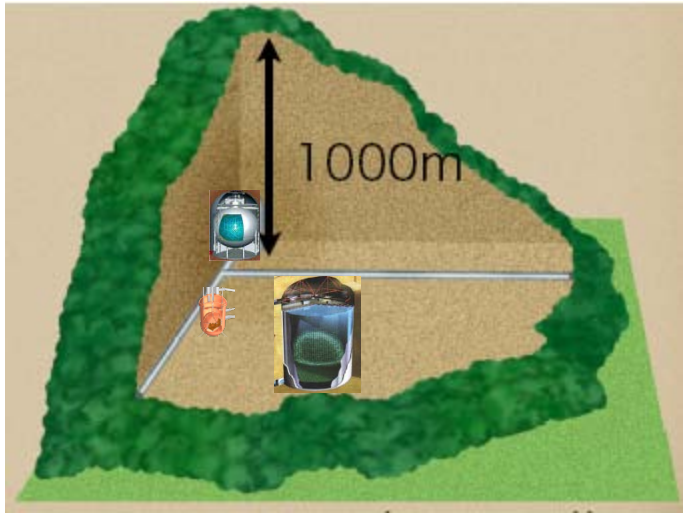
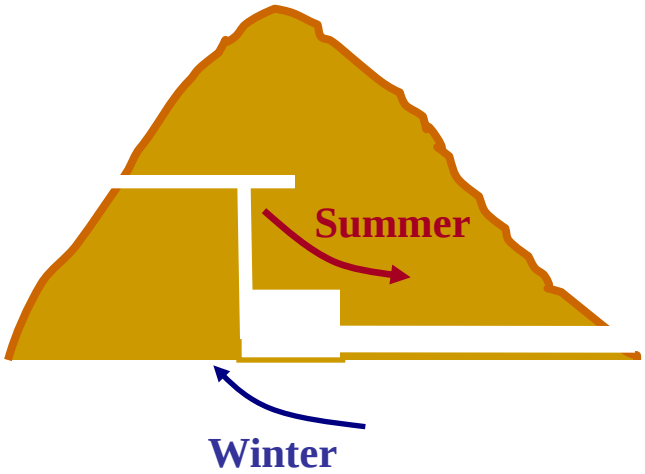
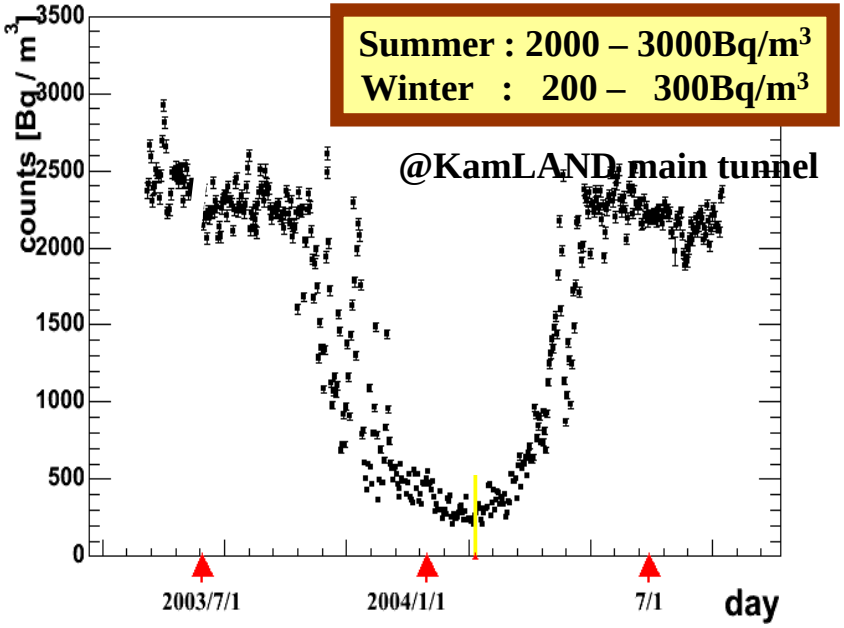
Environment Rn concentration in the kamioka mine



- natural ventilation
- stable temperature ~15 degC
- enough water supply ~10 degC
- water appear at experimental room in spring and summer. (by melted snow and rain)



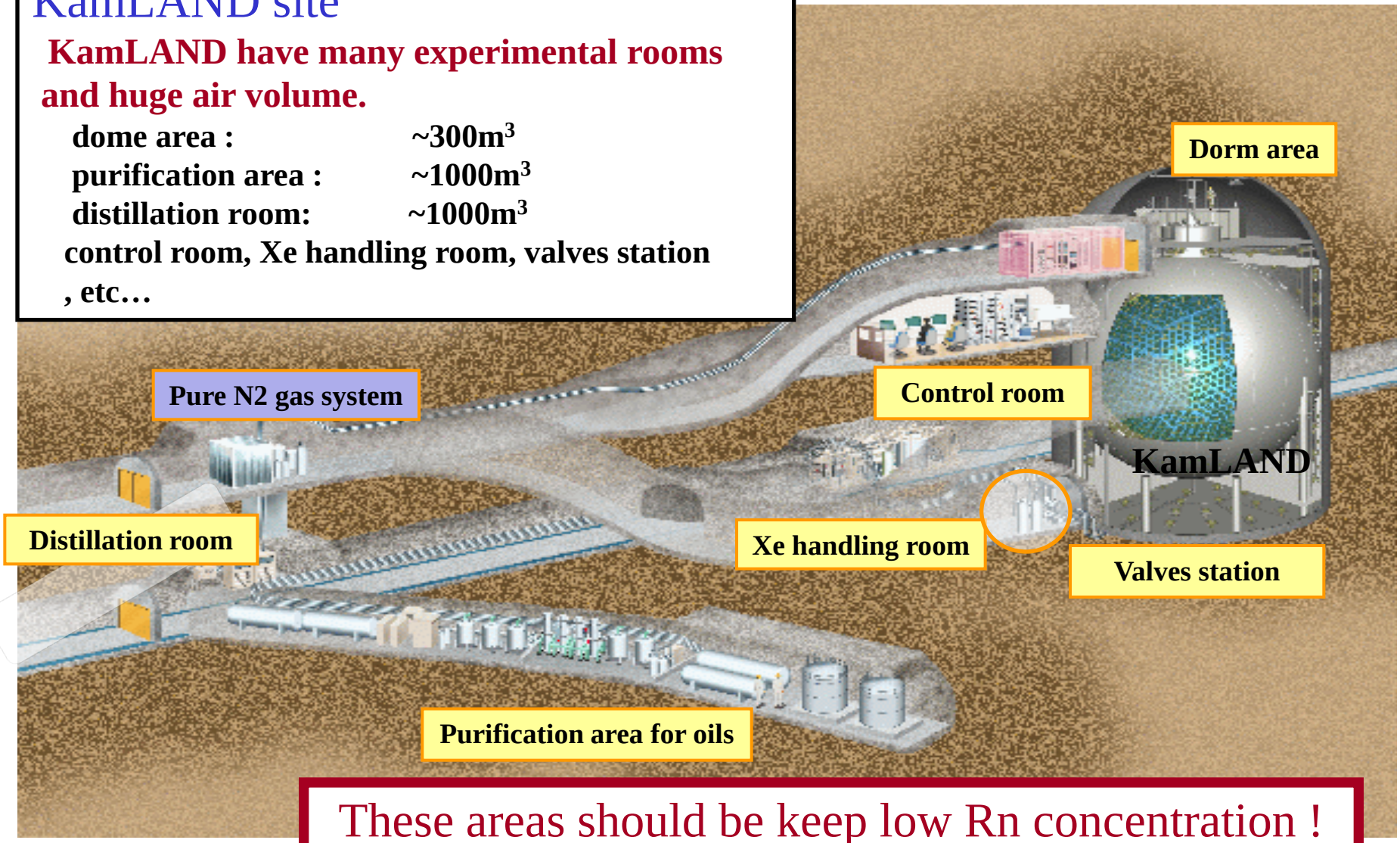
Seasonal variation of Rn concentration in the mine



KamLAND site

KamLAND have many experimental rooms and huge air volume.

dome area : **~300m^3**
purification area : **~1000m^3**
distillation room: **~1000m^3**
control room, Xe handling room, valves station , etc…



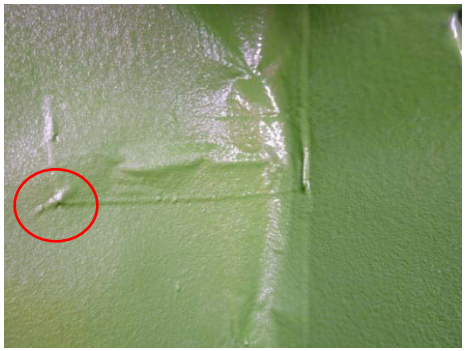
These areas should be keep low Rn concentration !

KamLAND liner for Rn shielding

- KamLAND liner: Polyurethane “mine guard” splaying on a nonwoven fabric with a primer.

1. putted Al support frame
2. nonwoven fabric
3. splay primer
4. splay “mine guard” resin 3times (>1mm thickness)

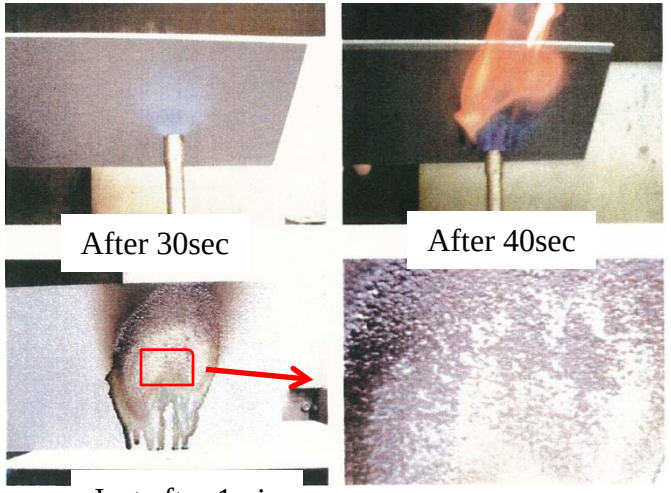
- Liner working well (almost 100%), but ……
  - There are pin holes. Leaked water bring Rn.
  - Rn enter from outside, while worker open the door.
  - emanation from materials.



- We cannot keep low Rn level without the Rn reduced air supply.

Characteristics of Polyuretan resin

- "mine guard" were produced by mine guard company, Canada (closed)
- Japanese company "Santem Co." bought all of their stocks.
- It is one of polyurethane resin
- Cost: ~100US$/$m^2$
  (on KamLAND standard method)
- Low gas permeability
- Autolysis nature
- Ignition temp. ~310 ℃
  Self-ignition temp. ~416 ℃
  *ASTM D1929-68



C.J.Hilado: Flammability Handbook for Plastic,1969(Technomic Pub)

- Combustion product gas under 1L/hr air supply (mg/1g sample)
  CO2 665, CO 173, HCN 3.3, CH4 16, C2H4 2.2, C2H2 7.4
  * Ashida plasticmaterial, 15(1), 52(1974)
- We had to get special permission from fireman's office.

KamLAND Rn reduction techniques

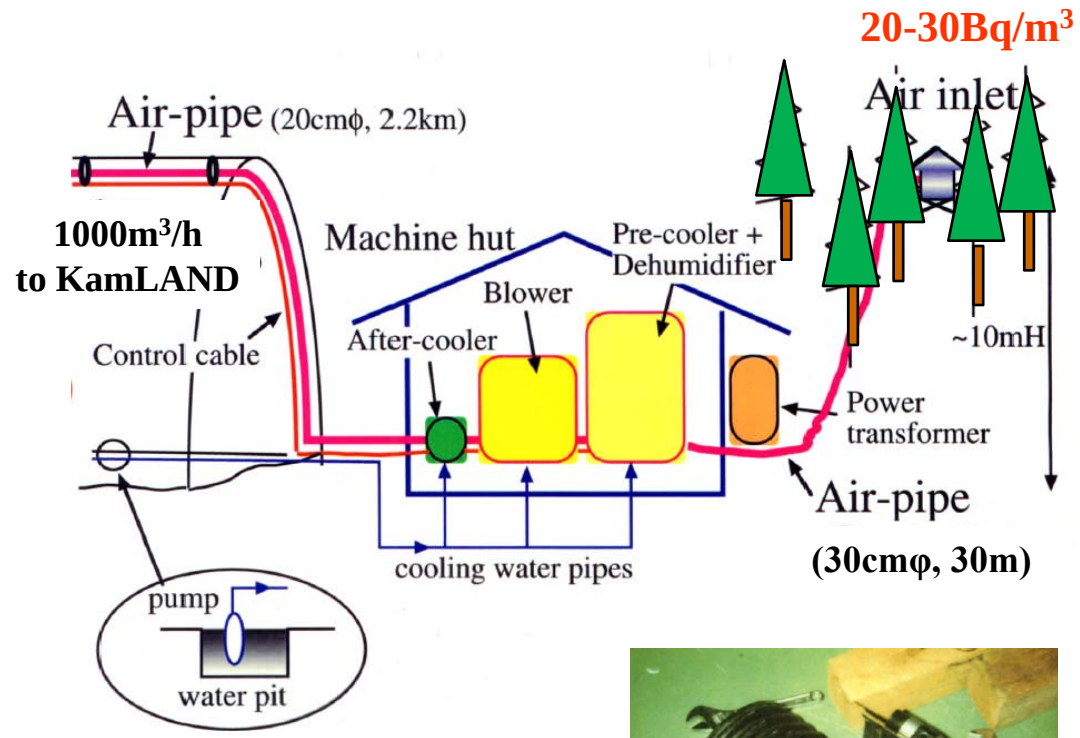
- All of rooms should be coated by polyurethane resin .
- Spaces are limited in the mine
- Low cost
- We need large volume Rn-reduced air or gas supply for each experimental rooms .

Three systems exist on KamLAND

1. large volume outside fresh air supply
2. very low Rn concentration air supply to the access point of a detector (ex. chimney area on KamLAND)
3. noble gas supply system to the inside of detector

   (we use pure N_2 gas)

Rn-reduced air supply system ①
Flesh air supply from outside of the mine

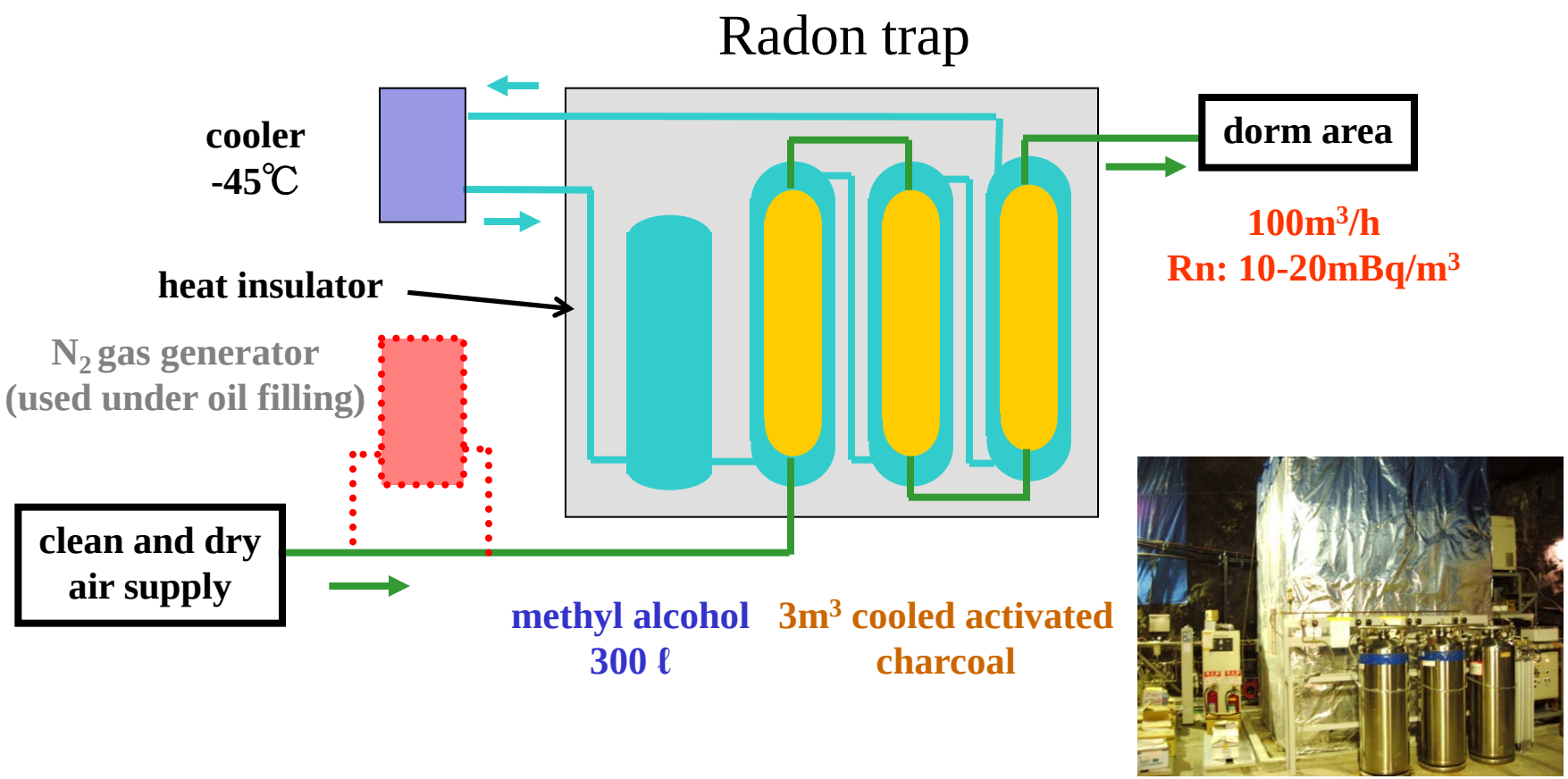


expected Rn concentration
20Bq/m3

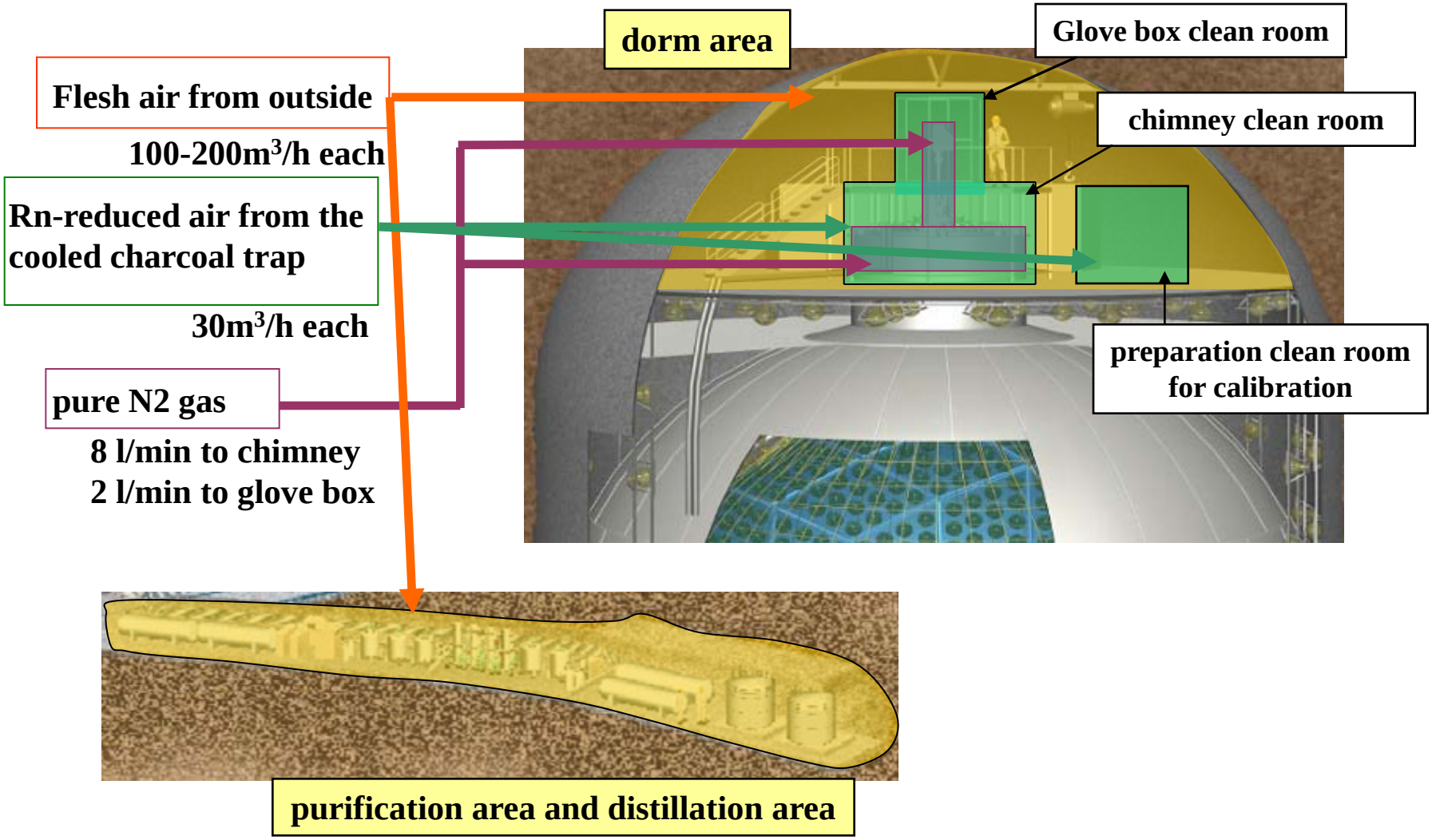
20cmφ polyethylene pipe

Rn-reduced air supply system ②

Rn-reduced air using a cooled activated charcoal Rn trap



KamLAND Rn-reduced air and N_2 gas systems



Achieved Rn concentration level

	Rn level	Supply to	achieved value	Comment
Fresh air from outside **1000 m^3/h total** **350K US$** **(2.2km piping cost was 1/2)**	**Same as outside** **~20 Bq/m^3**	**•dorm area** **•purification room** **•Distillation room**	**20-30 Bq/m^3** **30-40 Bq/m^3** **30-40 Bq/m^3**	**Each room has double door**
Rn-reduced air from cold Charcoal trap **100 m^3/h total** **300K US$**	**~ 10 mBq/m^3**	**•Chimney clean room** **•glove box clean room** **•preparation room**	**1-2 Bq/m^3**	**cover by acrylic plate or plastic film**
Rn-less N2 gas **8l/min (+2l/min for grove box and cal. material purge)** **1M US$**	**negligible**	**•Inside of chimney**	**KamLAND LS** **<0.1m Bq/m^3**	**Pure N2 gas System was installed 2006**

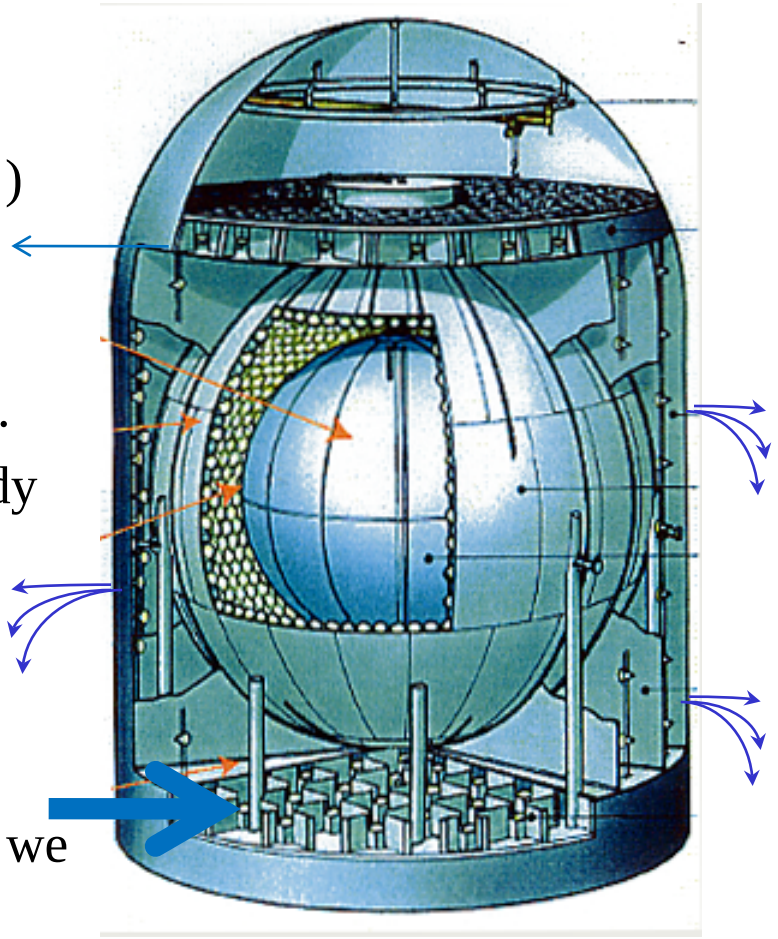
Liner for pure water tank

- KamLAND OD:

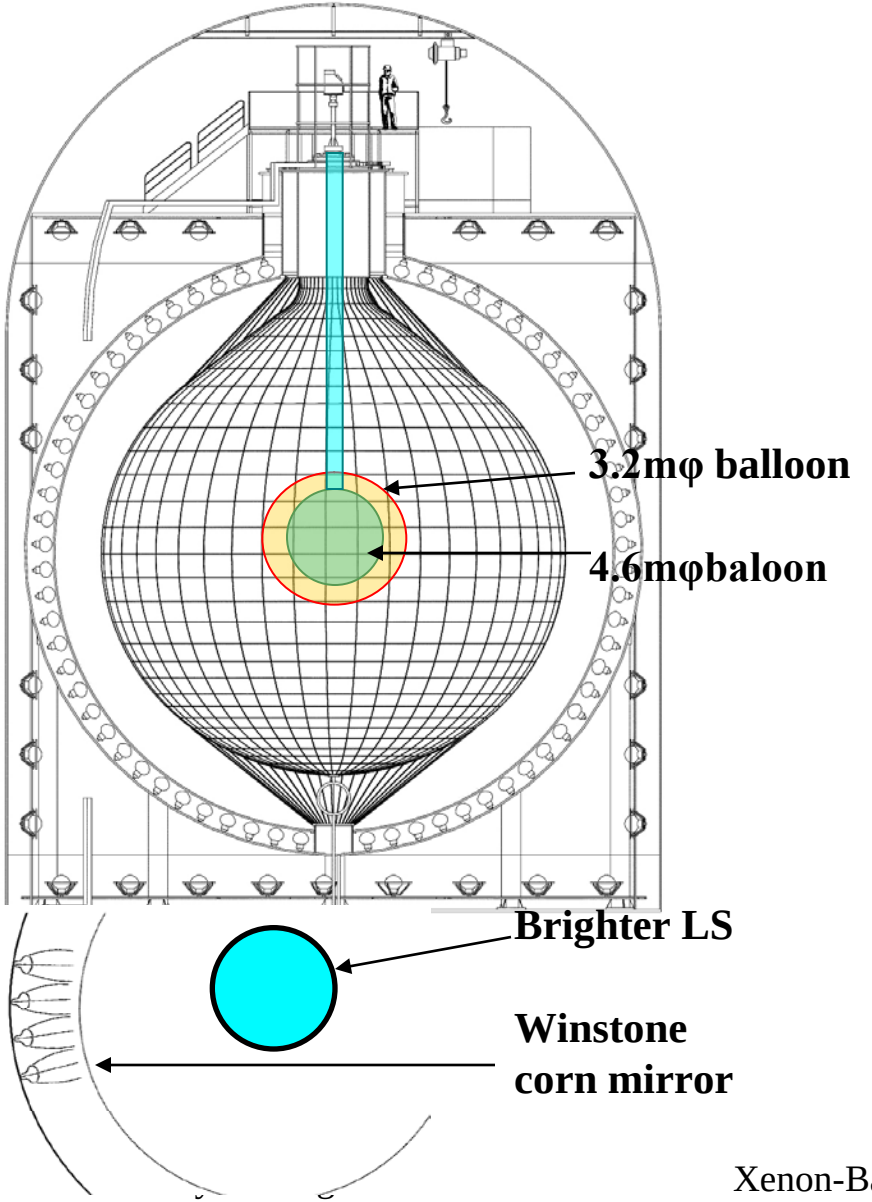
  nonwoven fabric + “mine guard” on the rock surface.
- There are large amount water leakage.

  (1 ton return as over flow/ 8 ton supply)
- Divers could not find any holes.
- Leakage rate was changed sometime.
- There are possibility of many pin holes.
- It’s surface seem no damage, but nobody proof the pure water compatibility of “mine guard”
- There are static temperature gradient

  (bottom:10 ℃, top: 12℃)
- Convection occurs in KamLAND after we change the OD water flow amount.



KamLAND-Zen: double beta decay experiment



1st phase ^{136}Xe 400kg (original design)

R=1.6m balloon

V=17m^3

LS : C10H22(81.8%)+PC(18%)

+PPO(2.5g/ ℓ)+Xe(3wt%)

ρLS： 0.78kg／ℓ

high sensitivity with low cost

~60meV with 1.5 year

tank opening (2013)

2nd phase ^{136}Xe 1000kg

R=2.3m balloon

V=51.3m^3,S=66.7m^2

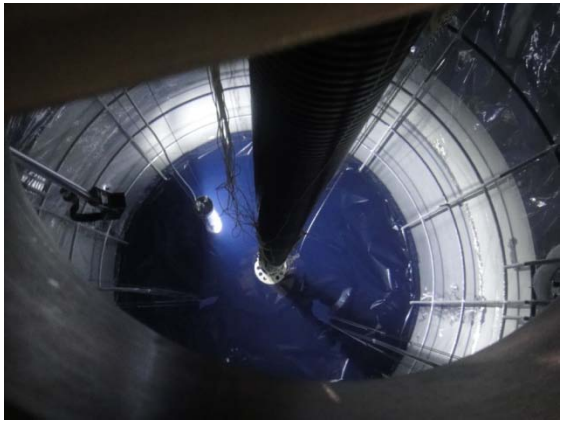
improvement of energy resolution

(brighter LS, higher light concentrator)

~25meV with 5 years

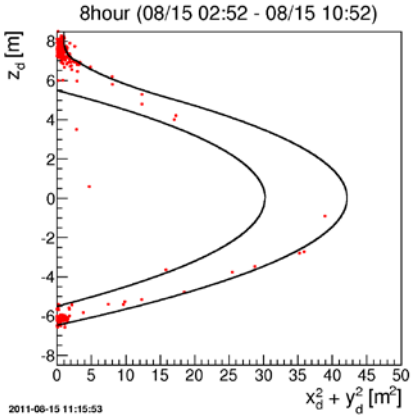
Mini Inner Balloon deployment, August 2011



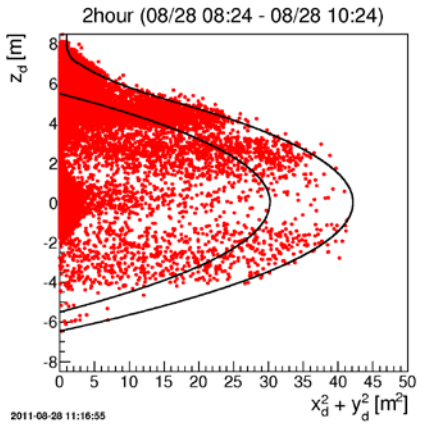
Recent status of KamLAND and Zen

- Finished Xe136 loaded LS filling in September.
- There are Rn contamination in inside. But this is a same amount as expected one.
- This Rn came out by emanation of tanks and pipes.
- We will start observation of 0νββ after Rn decay out enough.



Back to original topics

- Chimney part were exposure few days by accident while we deploy MIB.
- We supplied Many Rn to KamLAND.
  1000 times as usual.
- We will get usual condition after a month.



=> Liner and Rn reduced air helped us

summary

- polyurethane resin liner work well
- 3 kind of systems exist for Rn reduction.

  outside fresh air, cooled activated charcoal and pure N2 gas

  dorm area, purification area : **20-40 Bq/m^3**

  clean room for chimney, glove box: **1-2 Bq/m^3**

  KamLAND LS: **<0.1 mBq/m^3**
- I don't recommend only "mine guard" use as a pure water tank. The quality control will be difficult.
- Low Rn environment will help us while we cause problems.