

XMASS

Masaki Yamashita

Kamioka observatory, ICRR, Univ. Of Tokyo

On behalf of XMASS collaboration

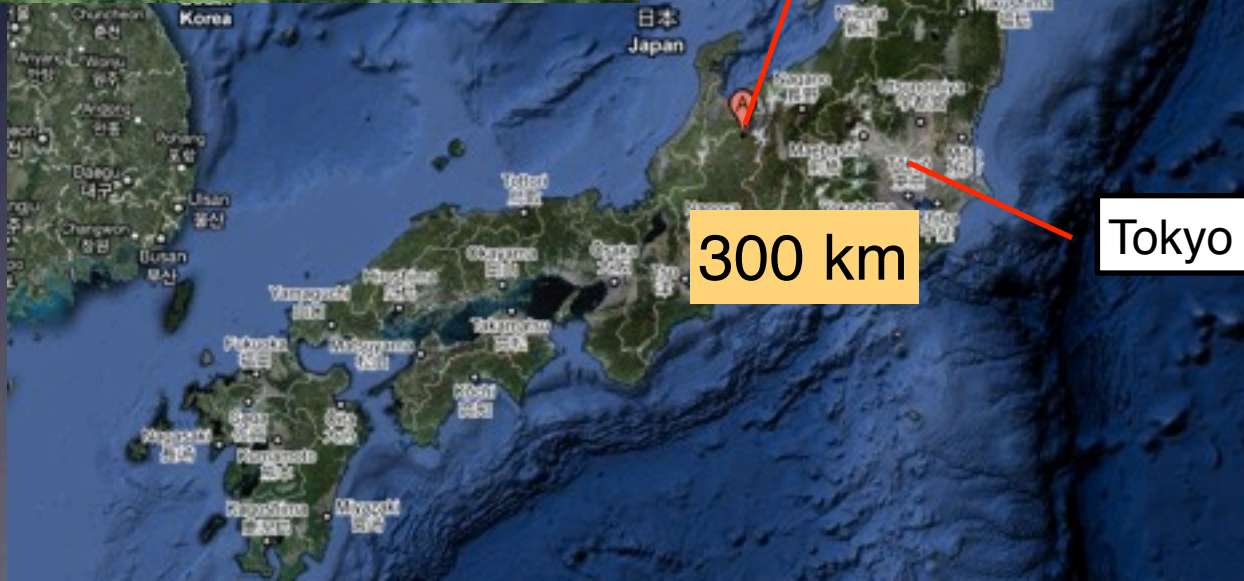
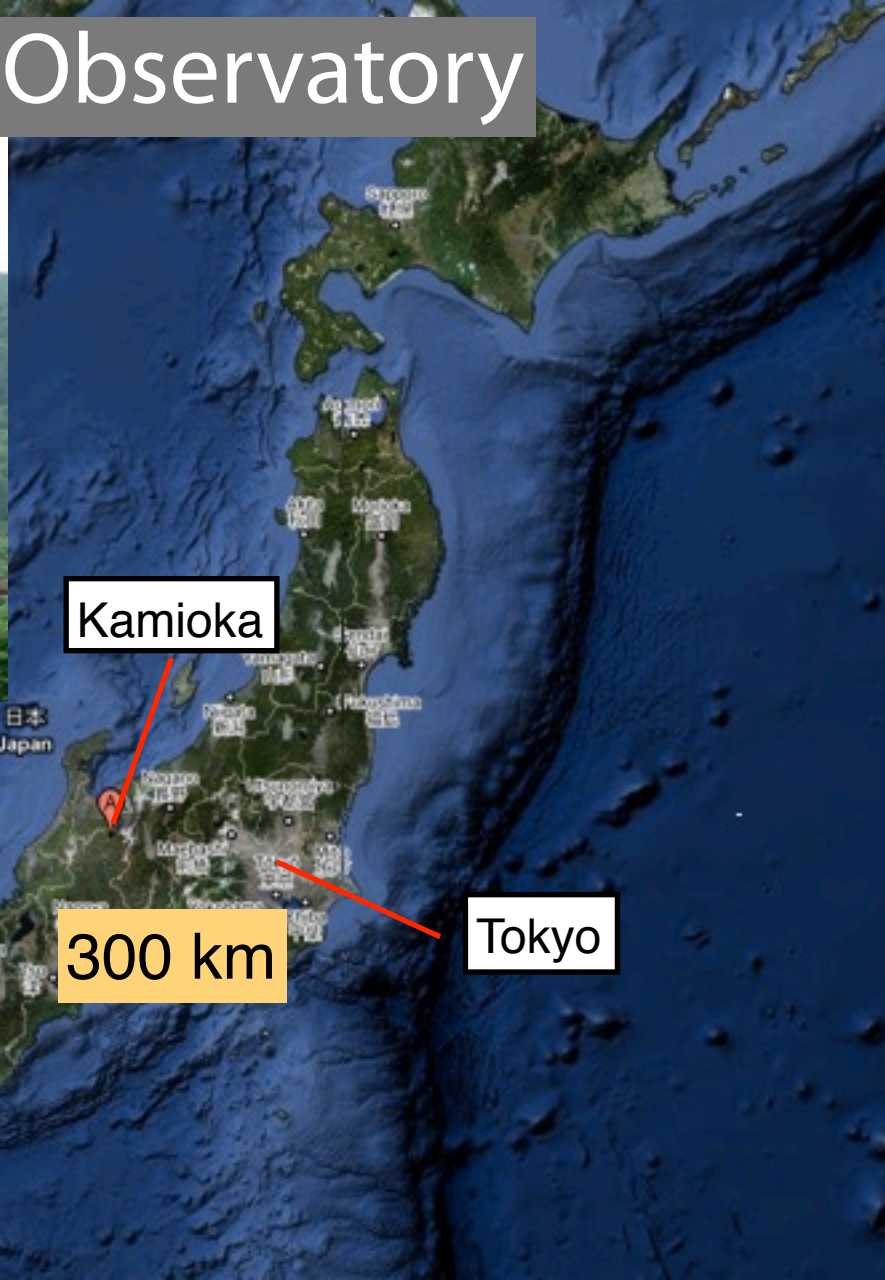
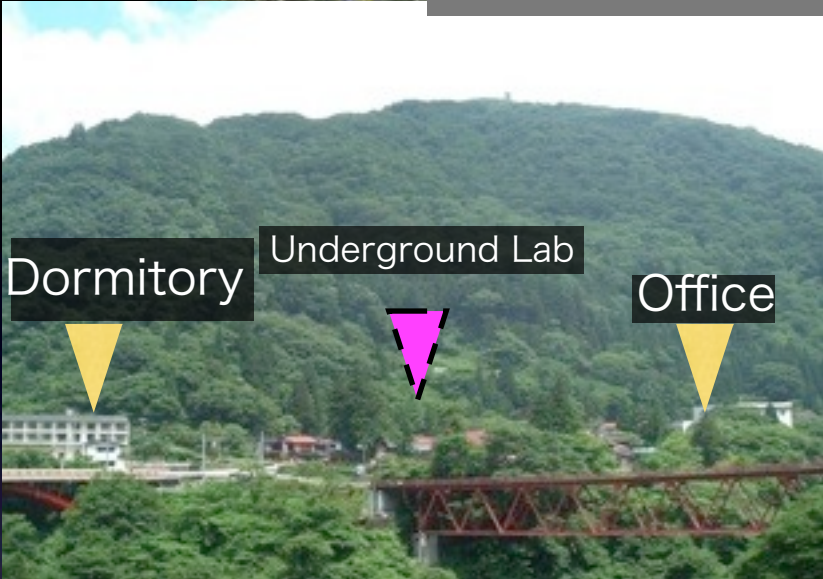
6th Patras Workshop on Axions, WIMPs, WISPs

5-9/July/2010 Zurich University

Outline

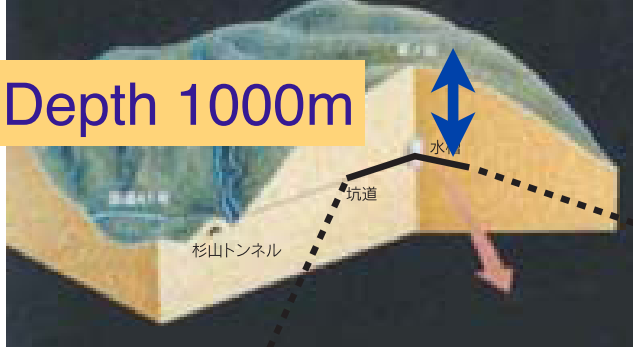
- Kamioka Observatory
- XMASS 800 kg liquid xenon detector
 - Experimental Hall
 - Water Tank
 - Cryogenics, gas/liquid line and Emergency
 - Background
 - Detector and its Assembly
- Summary

Kamioka Observatory

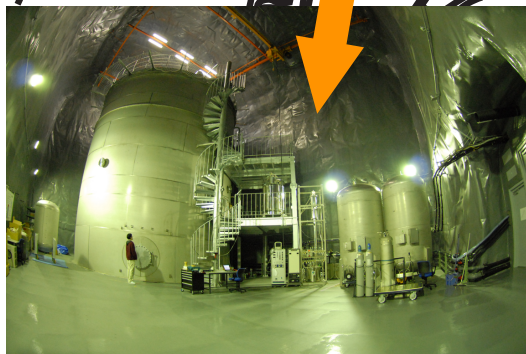
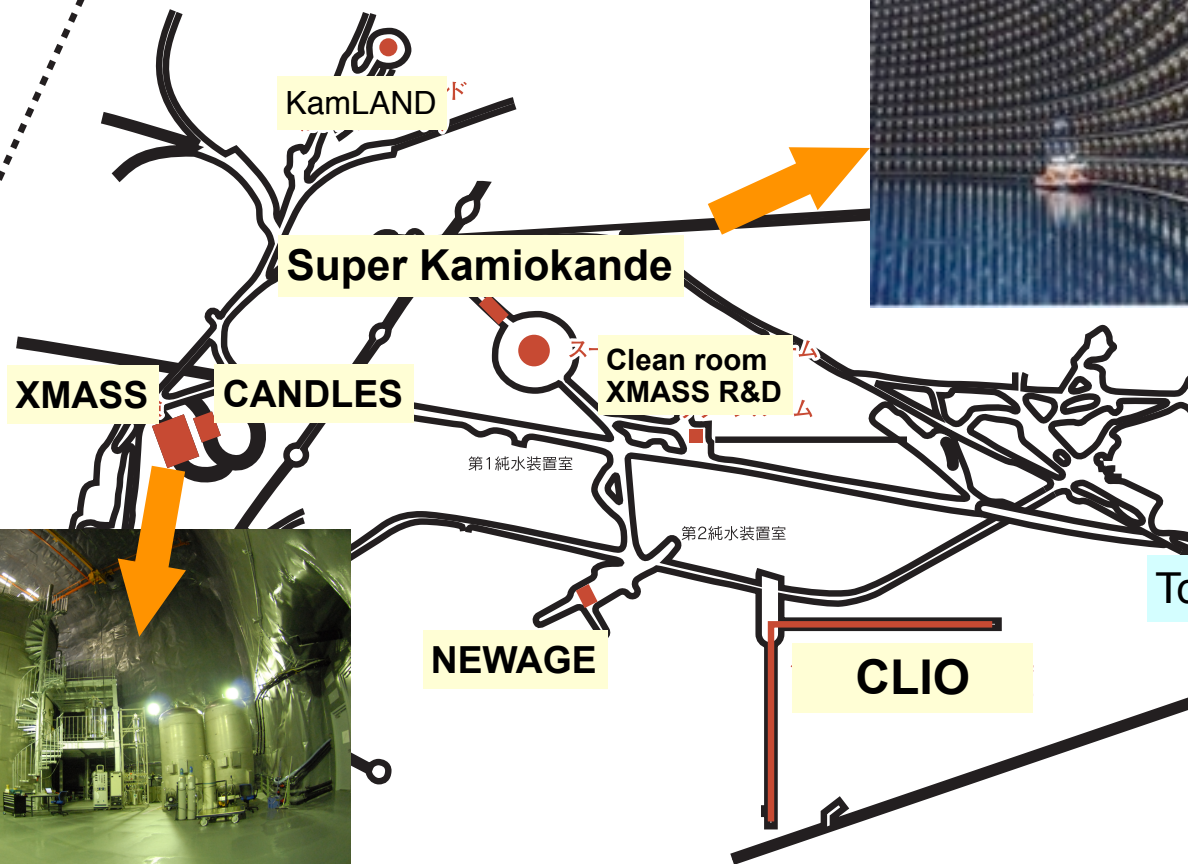


Kamioka Mine

Depth 1000m



2700 m.w.e



XMASS Experiment

Multi purpose low-background experiment with LXe.

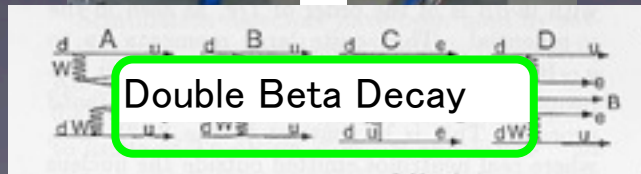
- Xenon **MASS**ive detector for Solar neutrino ($pp/{}^7\text{Be}$)
- Xenon neutrino **MASS** detector (double beta decay)
- Xenon detector for Weakly Interacting **MASS**ive Particles (DM)



Solar Neutrino



Dark Matter





XMASS Collaboration

Dark Matter Search Experiment

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IPMU, University of Tokyo : Kai Martens, J. Liu

Saga University : H. Ohsumi

Tokai University : K. Nishijima, D. Motoki

Gifu University : S. Tasaka

Waseda University : S. Suzuki

Yokohama National University : S. Nakamura, I. Murayama, K. Fujii

Miyagi University of Education : Y. Fukuda

STEL, Nagoya University : Y. Itow, K. Masuda, H. Uchida, Y. Nishitani

Kobe University : Y. Takeuchi, K. Ohtsuka

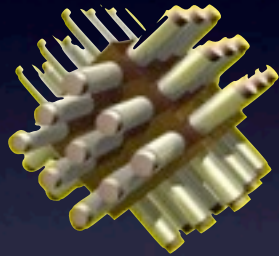
Seoul National University : Soo-Bong Kim

Sejong University : Y. D. Kim

KRISS : Y. H. Kim, M. K. Lee, K. B. Lee, J. S. Lee

XMASS Project

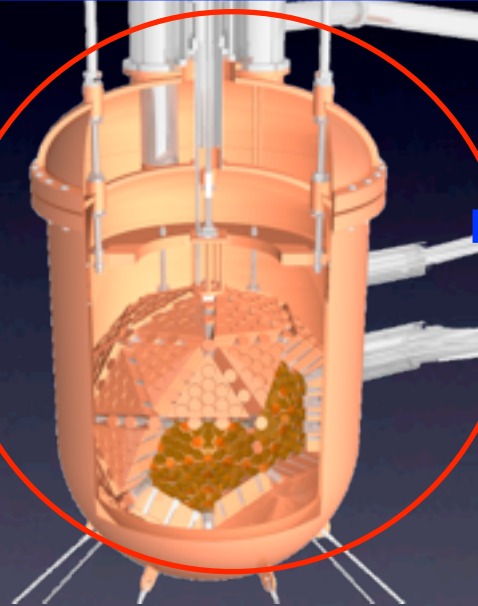
100kg Prototype
(FV:30kg、~30cm)



R&D

completed

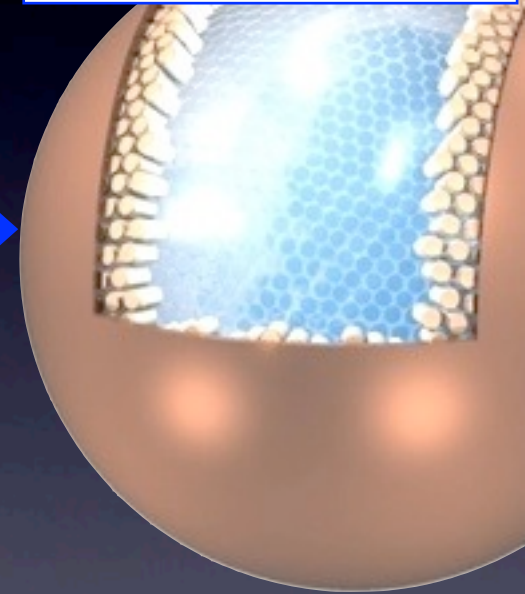
800kg Detector
(FV:100kg、80cm)



Dark Matter

2010 start

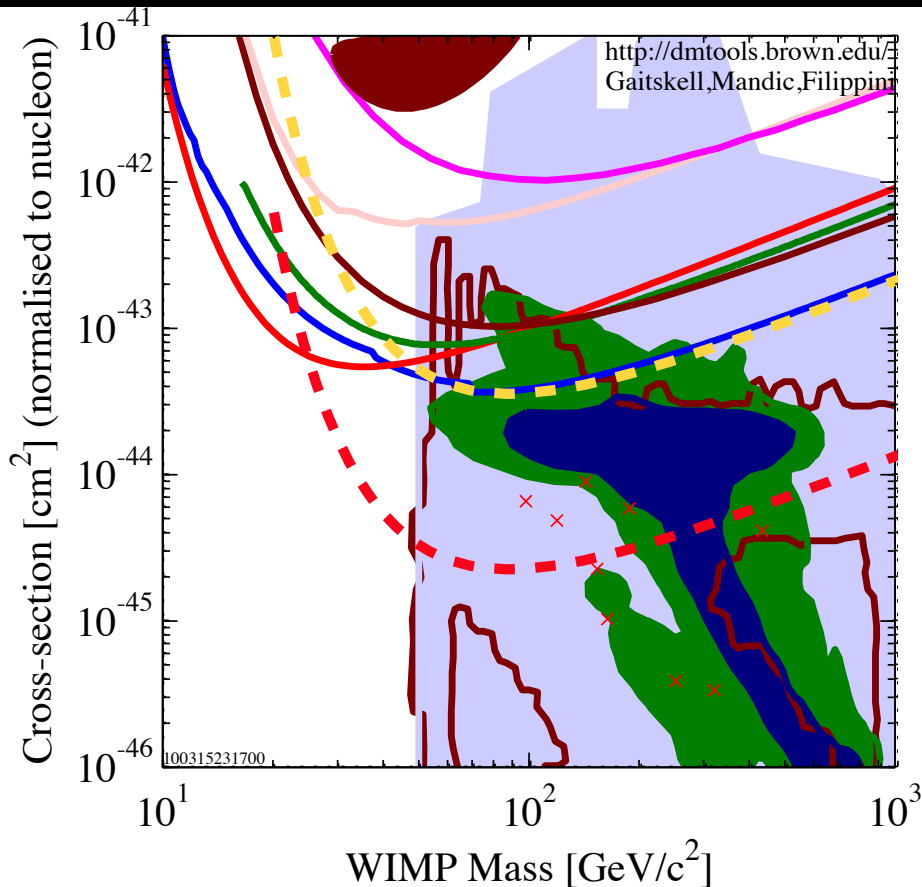
20ton Detector
(FV:10ton、~2.5m)



Solar neutrino
Dark Matter

Future

Sensitivity for SI case



10^{-4} dru, 100 kg fiducial

XMASS 800 kg 10 days

XMASS 800 kg 1 year
(flat bg assumed)

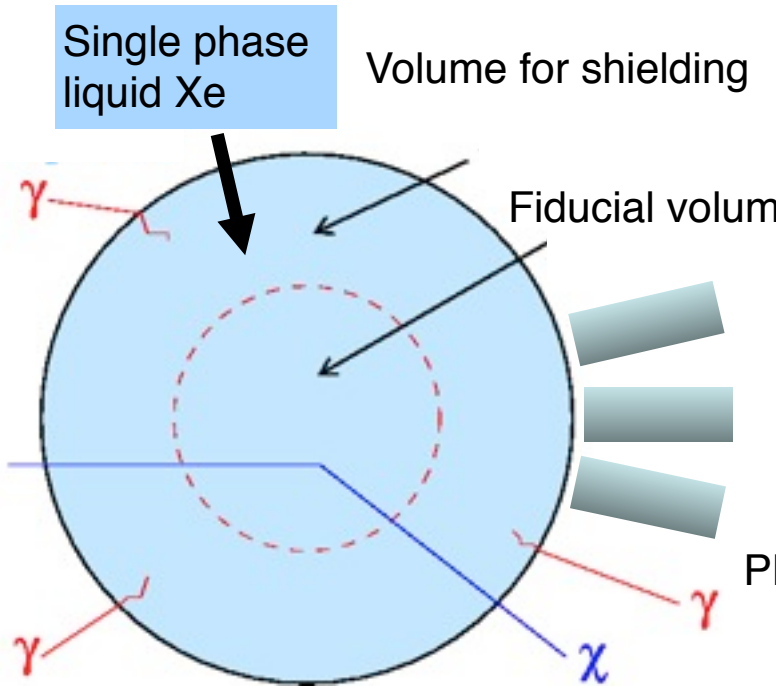
- DATA listed top to bottom on plot
- DAMA/LIBRA 2008 3sigma, no ion channeling
 - WARP 2.3L, 96.5 kg-days 55 keV threshold
 - CRESST 2007 60 kg-day CaWO₄
 - Edelweiss II first result, 144 kg-days interleaved Ge
 - ZEPLIN III (Dec 2008) result
 - XENON10 2007, measured Leff from Xe cube
 - CDMS: Soudan 2004-2009 Ge
 - Trotta et al 2008, CMSSM Bayesian: 68% contour
 - Trotta et al 2008, CMSSM Bayesian: 95% contour
 - x x x Ellis et. al Theory region post-LEP benchmark points
 - Baltz and Gondolo 2003
 - Baltz and Gondolo, 2004, Markov Chain Monte Carlos
- 100315231700

Why Liquid Xenon ?

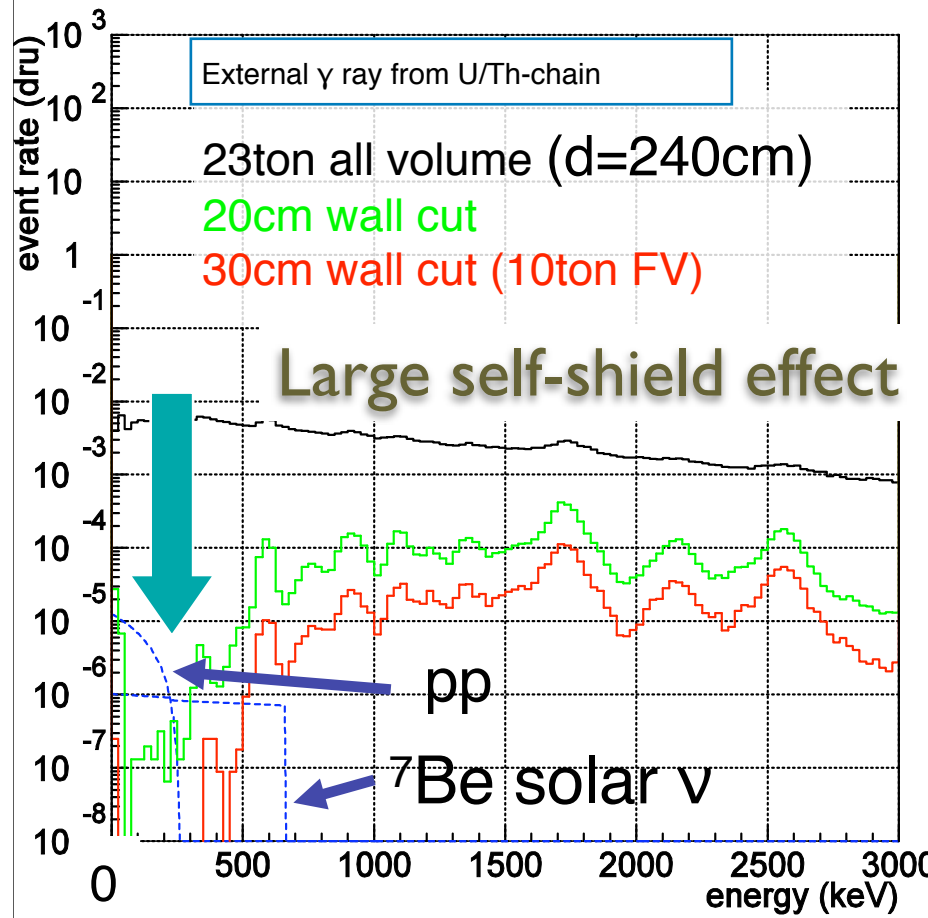
- High Atomic mass Xe ($A \sim 131$) good for **SI** case (cross section $\propto A^2$)
- Odd Isotope (Nat. abun: **48%**, 129,131) with large **SD** enhancement factors
- High atomic number ($Z=54$) and density ($\rho=3\text{g/cc}$):
 - compact, flexible and large mass detector.**
- High photon yield (~ 46000 UV photons/MeV at zero field)
- Easy to purify for both electro-negative and radioactive purity
 - by recirculating Xe with getter for electro-negative
 - Distillation for Kr removal

Concept of background reduction

Self-shielding

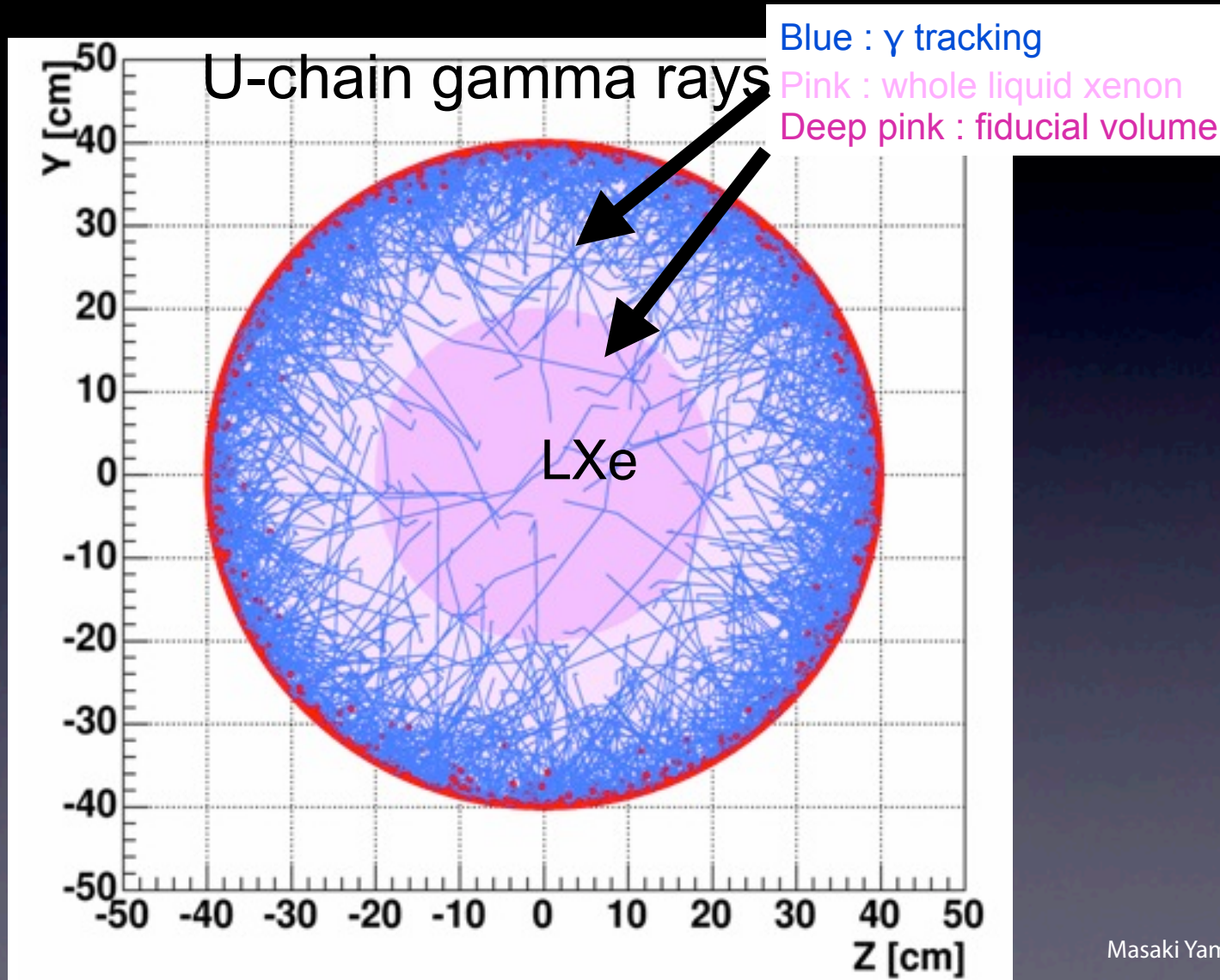


$g_{\gamma\gamma}$ at 10^{-10} GeV $^{-1}$
 0.267 event/(Xe)ton/year
 F. Avignone talk



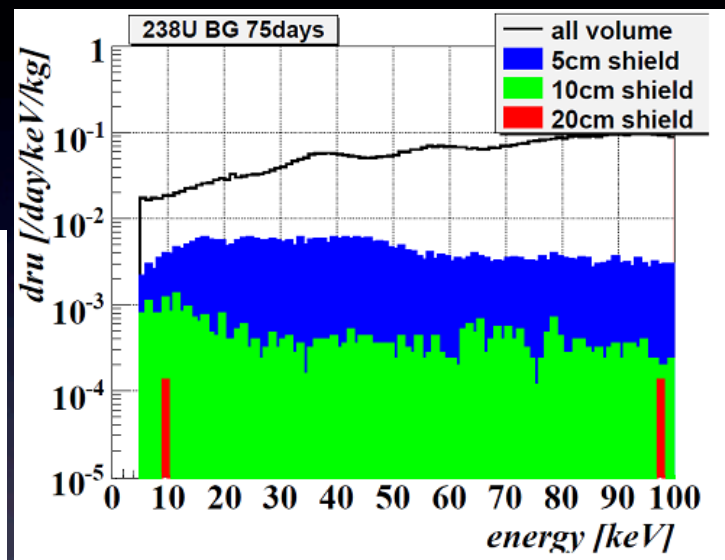
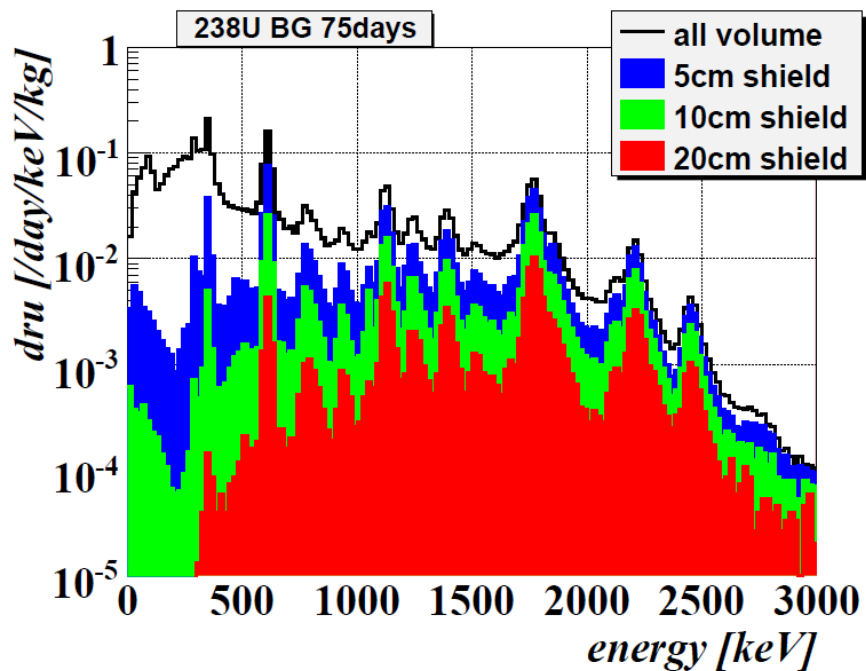
Low Background region near the center of the fiducial volume

γ tracking MC from external to Xenon



Concept of background reduction Self-shielding

For ^{238}U
Assumed 1.8mBq/PMT
Absorption 100cm , scattering 30cm



distance from wall

0cm ~ 800 kg

5cm ~ 540 kg

10cm ~ 340 kg

20cm ~ 100 kg

Background

Background in the 100 kg fiducial volume out of 1 ton.

- External

- gamma
- neutron



Water Shield

- Detector material

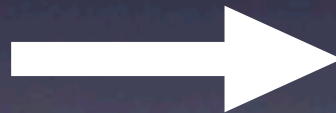
- PMT+Base (2 inch)
- U/Th/⁴⁰K/⁶⁰Co
(0.7/1.5/<5.1/2.9 mBq/PMT)



<10⁻⁴ dru

- Internal

- ⁸⁵Kr
 - <1 ppt Kr required
 - 3 ppt is achieved



Distillation Tower

- U/Th(Rn)

- <10⁻¹⁴ g/g required
- U/Th 9±6/<23 x 10⁻¹⁴ g/g



MS, Charcoal
goal <10⁻¹⁴ g/g

PMT

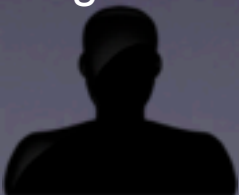
XMASS PMT HISTORY



YEAR	2000	2002	2009
Model	Prototype	R8778	R10789
Material:Body	glass	Kovar	Kovar
QE	25%	25%	27-39%
RI:			
U [mBq/PMT]	50	18±2	0.7 +/- 0.28
Th [mBq/PMT]	13	6.9±1.3	1.5 +/- 0.31
⁴⁰ K [mBq/PMT]	610	140±20	<5.1
⁶⁰ Co [mBq/PMT]	<1.8	5.5±0.9	2.9 +/- 0.16

with base

e.g. ⁴⁰K case

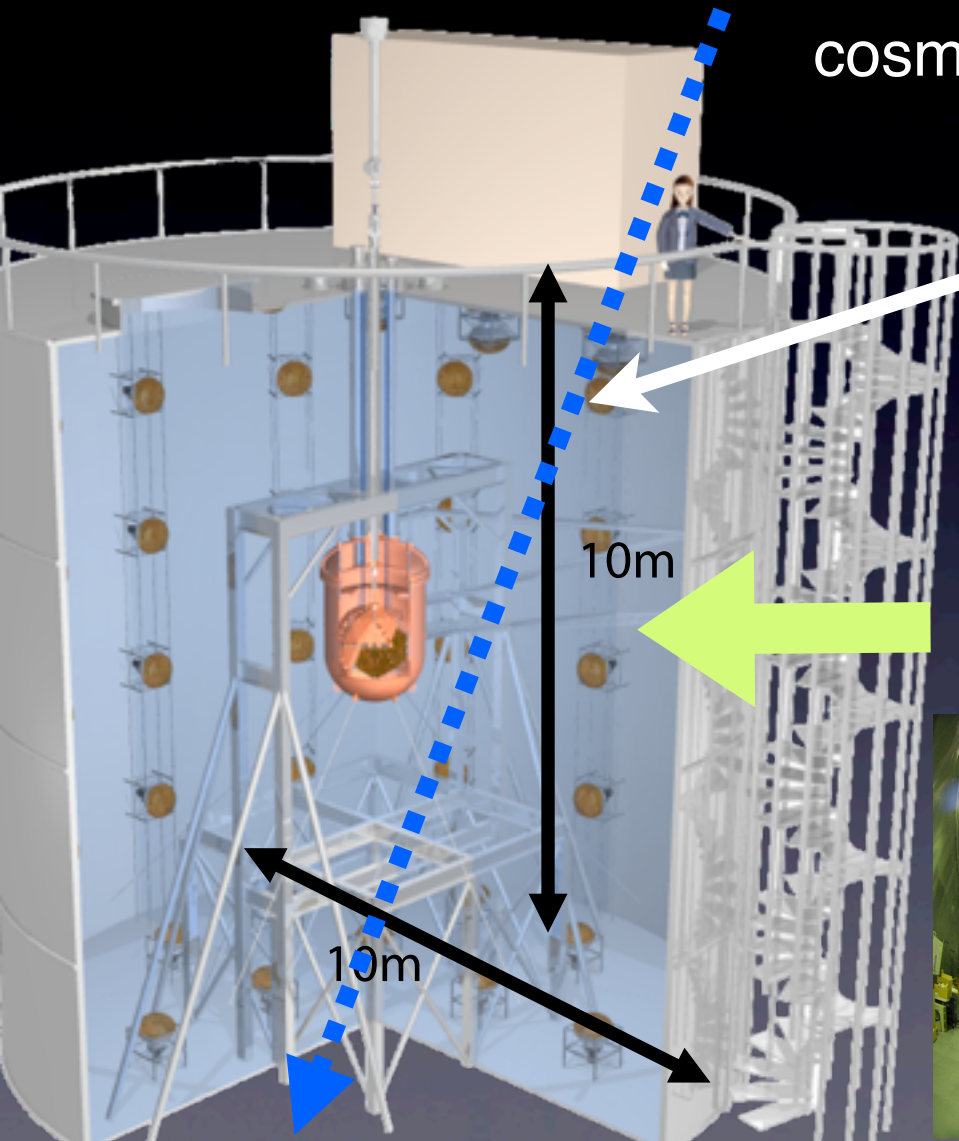


4000 Bq/Human



15 Bq/Banana

Water Tank

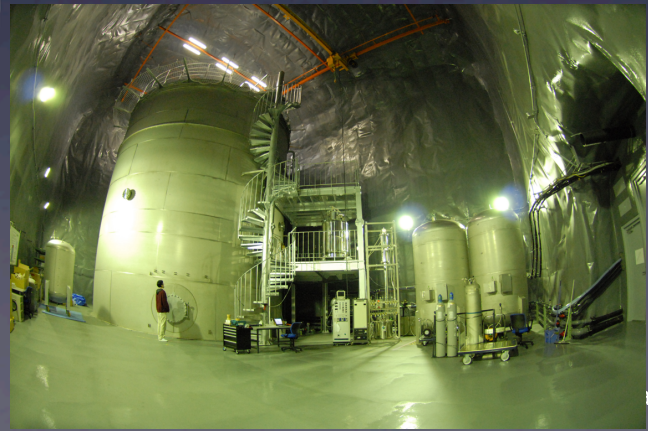


cosmic ray

70 PMTs (20 inch) to detect Cerenkov Light (same as SK)

Active shield for muon induced events

Passive shield for γ and neutron from Rock



water purification system



Experimental Hall

Rn: $\sim 1 \text{ mBq/m}^3$
5ton/hour

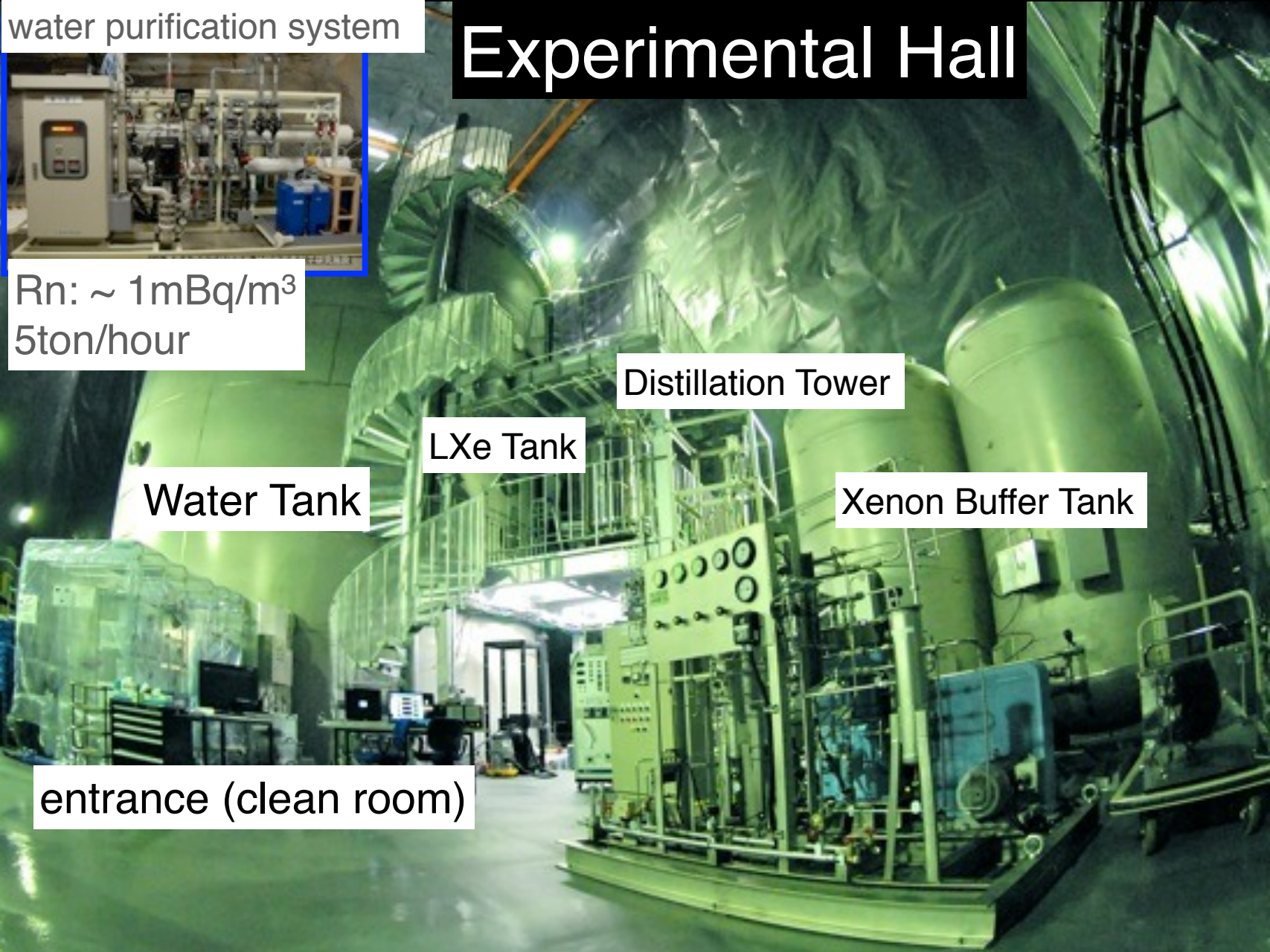
Water Tank

LXe Tank

Distillation Tower

Xenon Buffer Tank

entrance (clean room)



Distillation to reduce krypton in Xe (2003)

A distillation system was made and tested.

System specification:

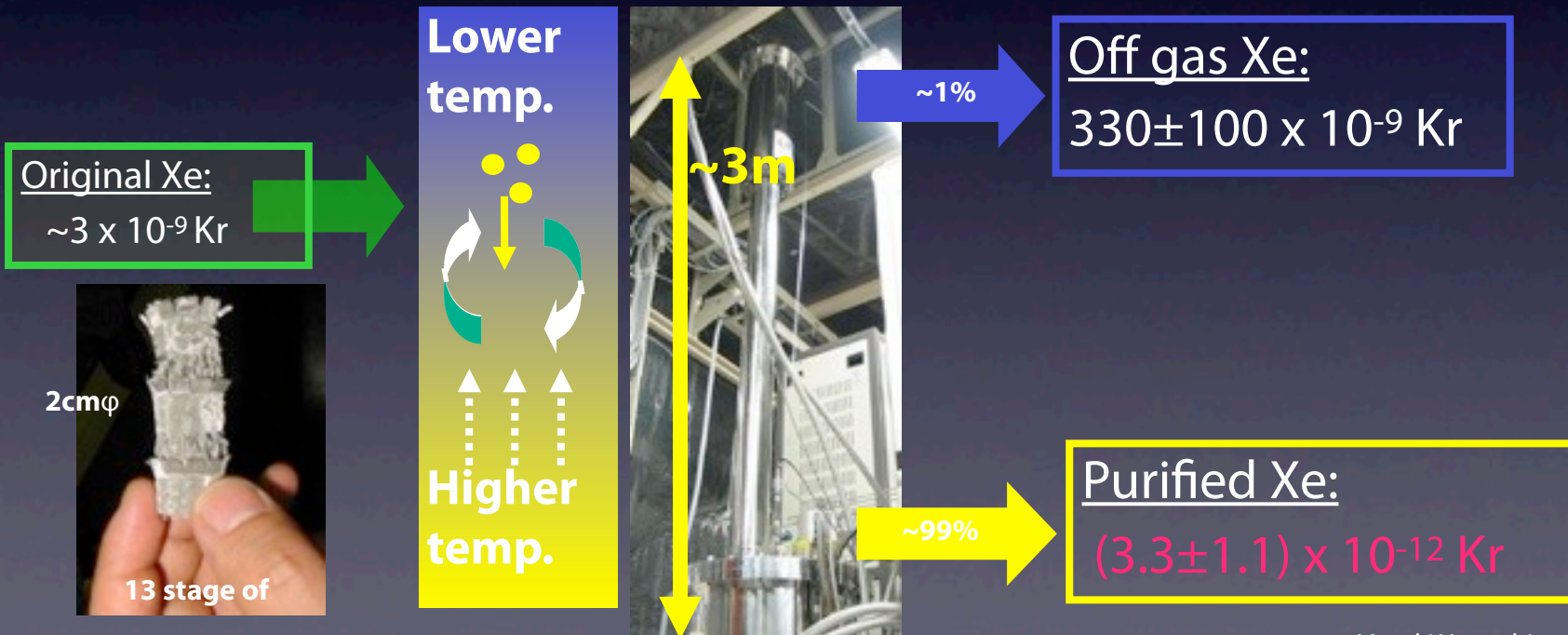
Process speed: 0.6kg Xe/hour

Collection efficiency: > 99%

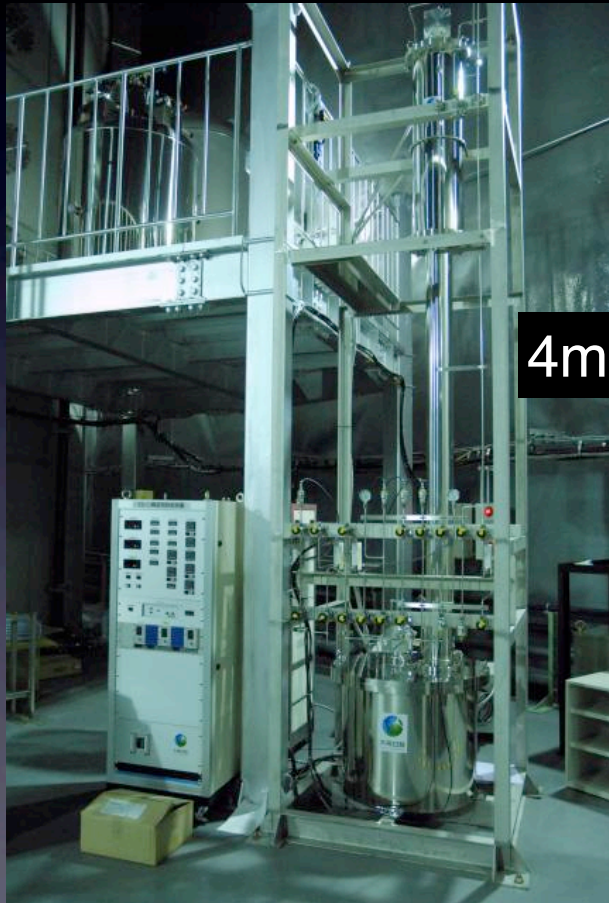
Kr concentration after process: < 1/1000

	Boiling point (@1 atm)
Xe	165K
Kr	120K

178±2K in tower



Distillation Tower (Upgrade)

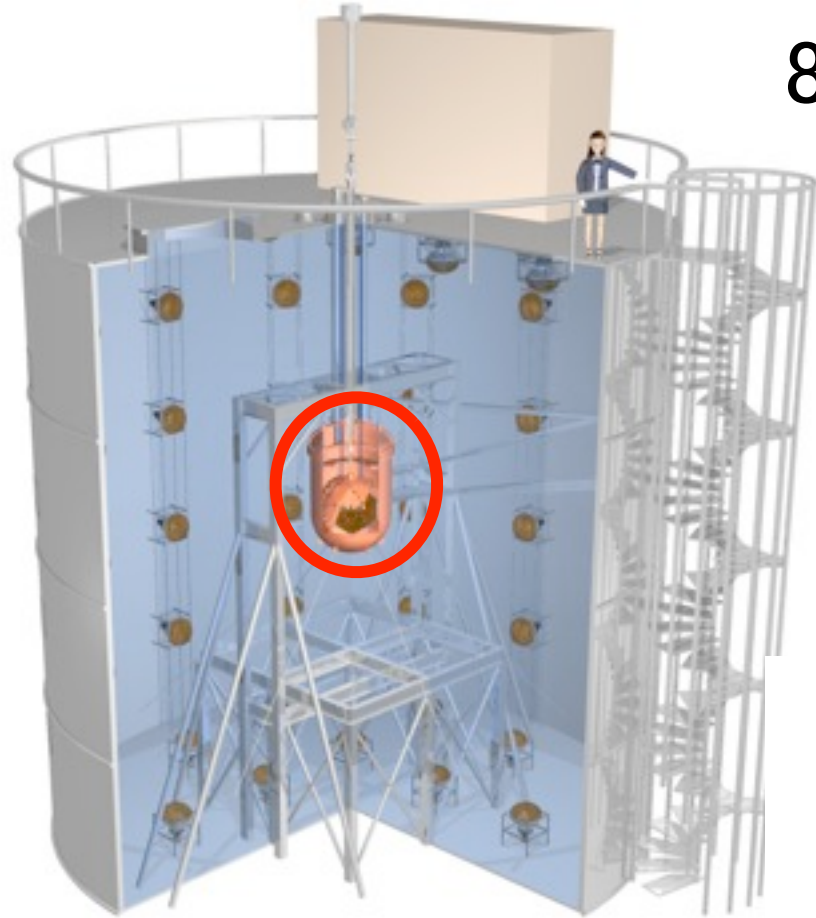


- 5kg/hour production
 - ~ 8 days for 1 ton
- $>10^5$ Kr reduction (goal < 1 ppt)

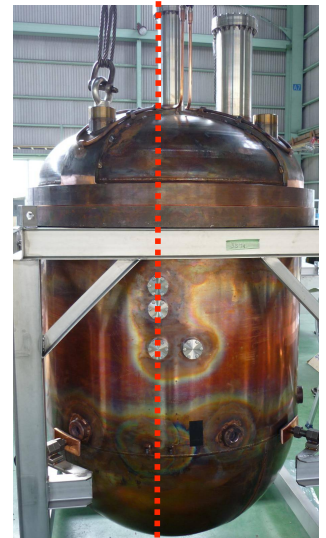
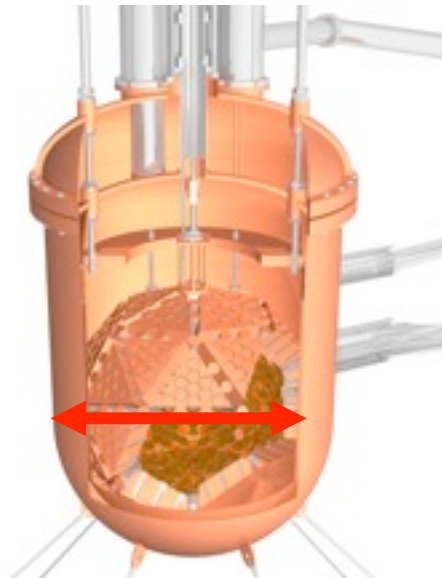
	2003	2009
Height	3 m	4m
production [kg/hr]	0.6	5
Kr Reduction	$1/10^3$	$1/10^5$

800 kg Detector

- The detector will be attached to SUS frame.
- diameter of the PMT holder is **$\Phi 1113$** .
- 2009/11 – 2010/02: PMT assembly and cabling.

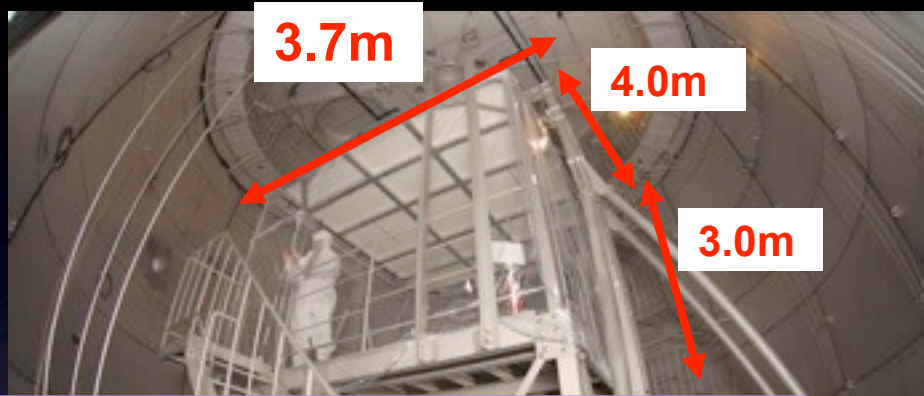


$\Phi 1113$



Clean Room in Water Tank

Stage for the assembly of detector



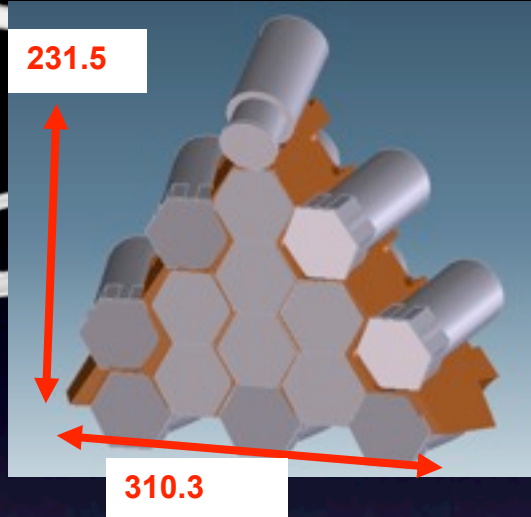
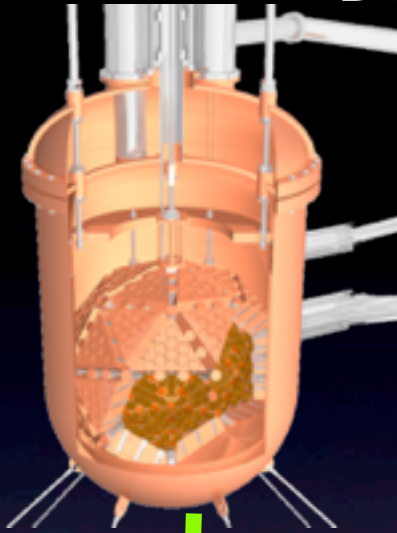
Rn level in the air $\sim 10\text{mBq/m}^3$

写真update



(c) 東京大学宇宙線研究所 神岡宇宙

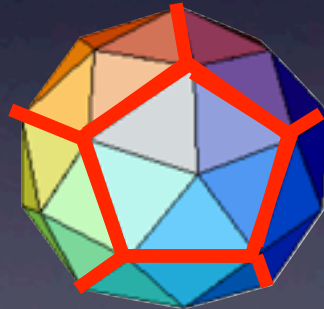
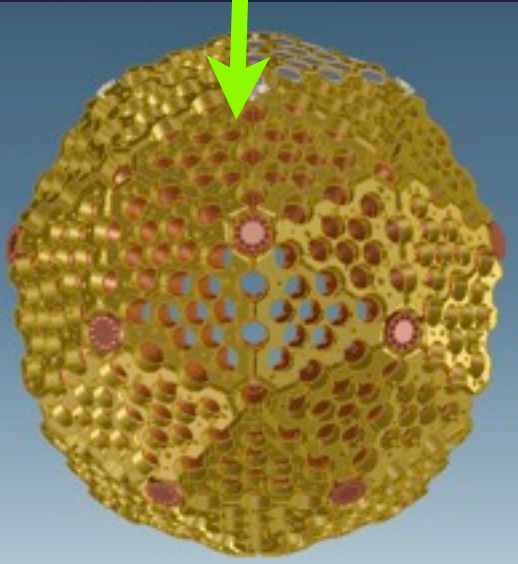
Design of 800 kg Detector



pentakis dodecahedron



Hexagonal PMT
Hamamatsu
R10789
QE 28-39%



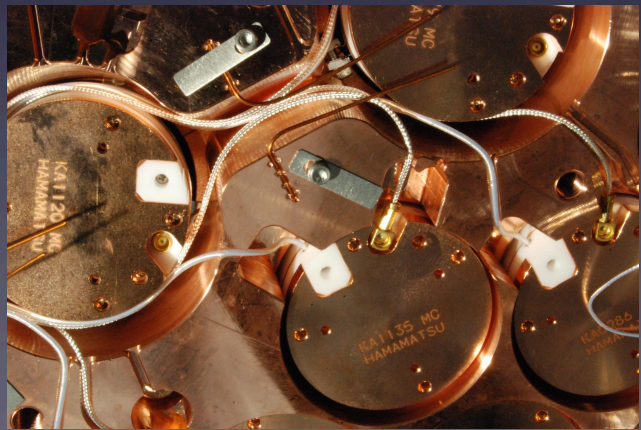
- 60 triangle in total
- about 10PMT/triangle \times 60
- Total: 642 PMTs
- Photo coverage: 62%



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642 PMTs



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PMT Holder



OFHC Filler

Summary

- XMASS 800 kg detector is under constructing at Kamioka. The goal is to reach a few $\times 10^{-45}\text{cm}^2$ for spin independent case.
- PMT assembly was completed and the detector vessel will be delivered in the end of July and the installation will be finished in August.
- The WIMP search run will be started in this year 2010 after the commissioning run.