Liquid Scintillator based experiments in 0ν Double Beta Decay

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@Neutrino 2010, Athens

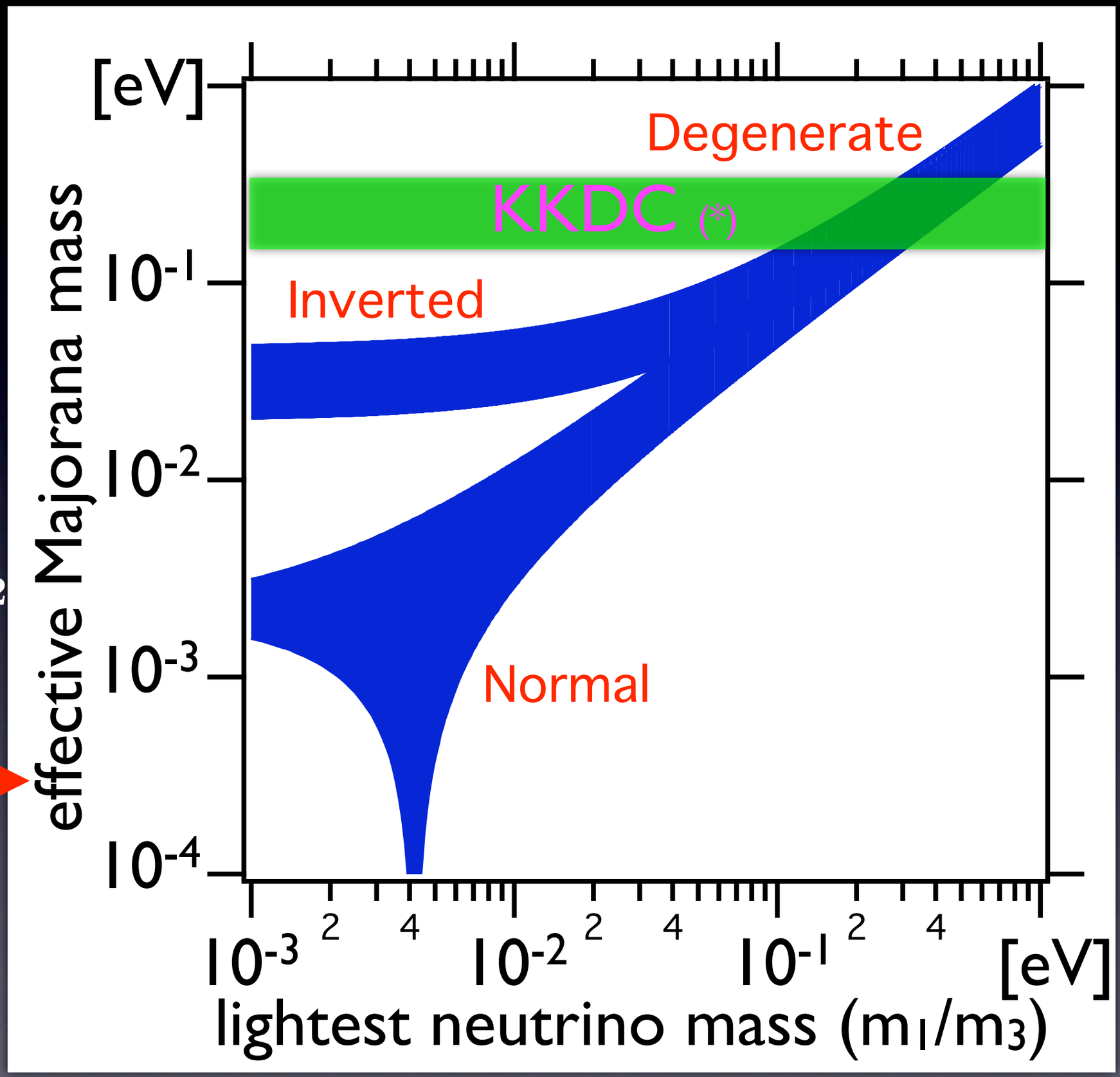
Observable

=

$$\left[T^{0\nu}_{1/2}\right]^{-1}$$

=

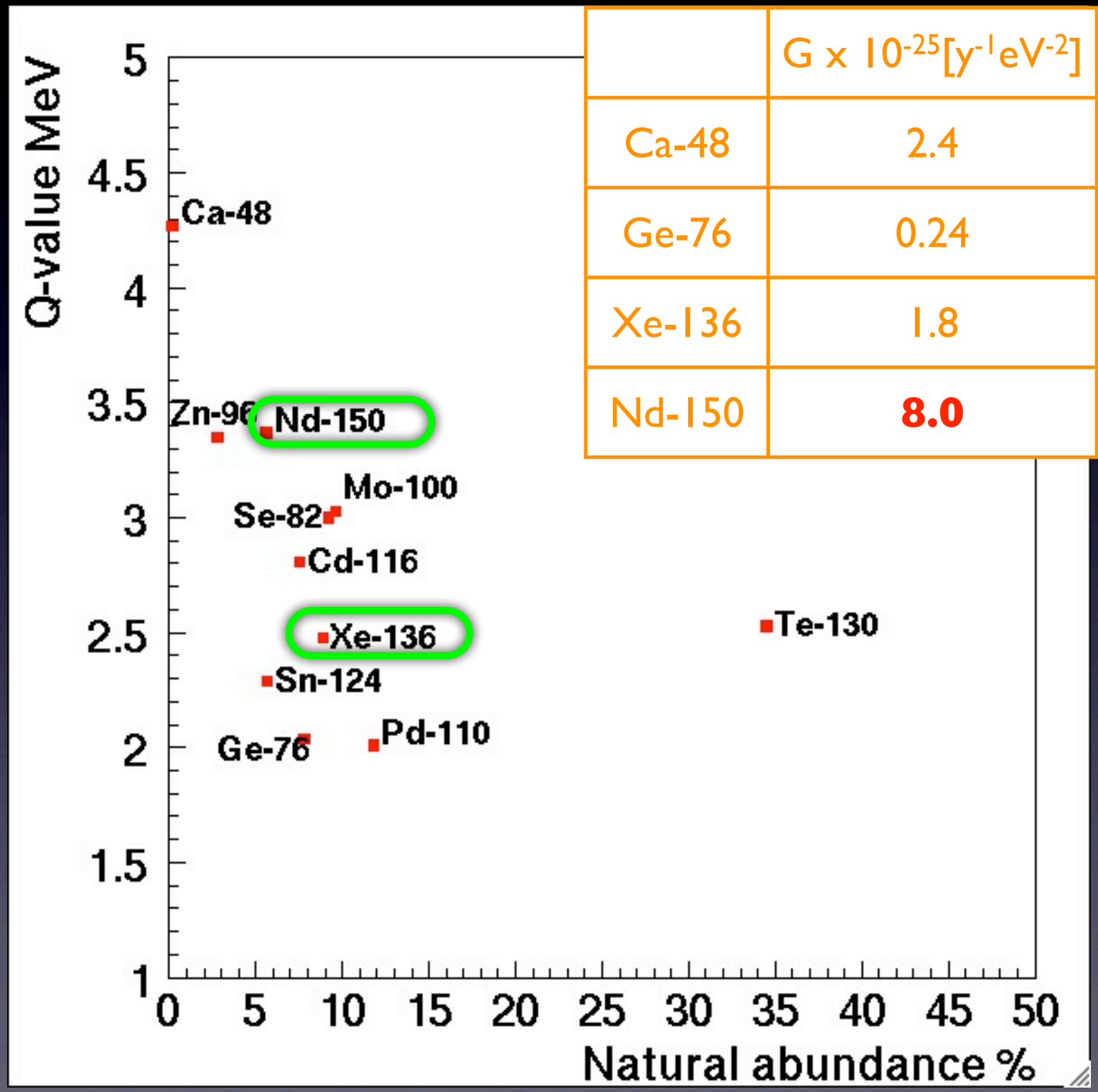
$$G^{0\nu} \left|M^{0\nu}\right|^2 |m_{\beta\beta}|^2$$



(*) PLB586,198(2004)

arXiv:0708.1033

0νββ isotopes



	G x $10^{-25}[y^{-1}eV^{-2}]$	Exp.
Ca-48	2.4	CANDLES
Ge-76	0.24	Majorana, etc
Xe-136	1.8	KamLAND-Zen
Nd-150	**8.0**	NEMOIII, SNO+

Happier

Happier

ACTA PHYSICA POLONICA B, 37 (2006)

SNO+

Thanks to Mark Chen

SNO+

1000 t D_2O will be replaced by Nd loaded LS

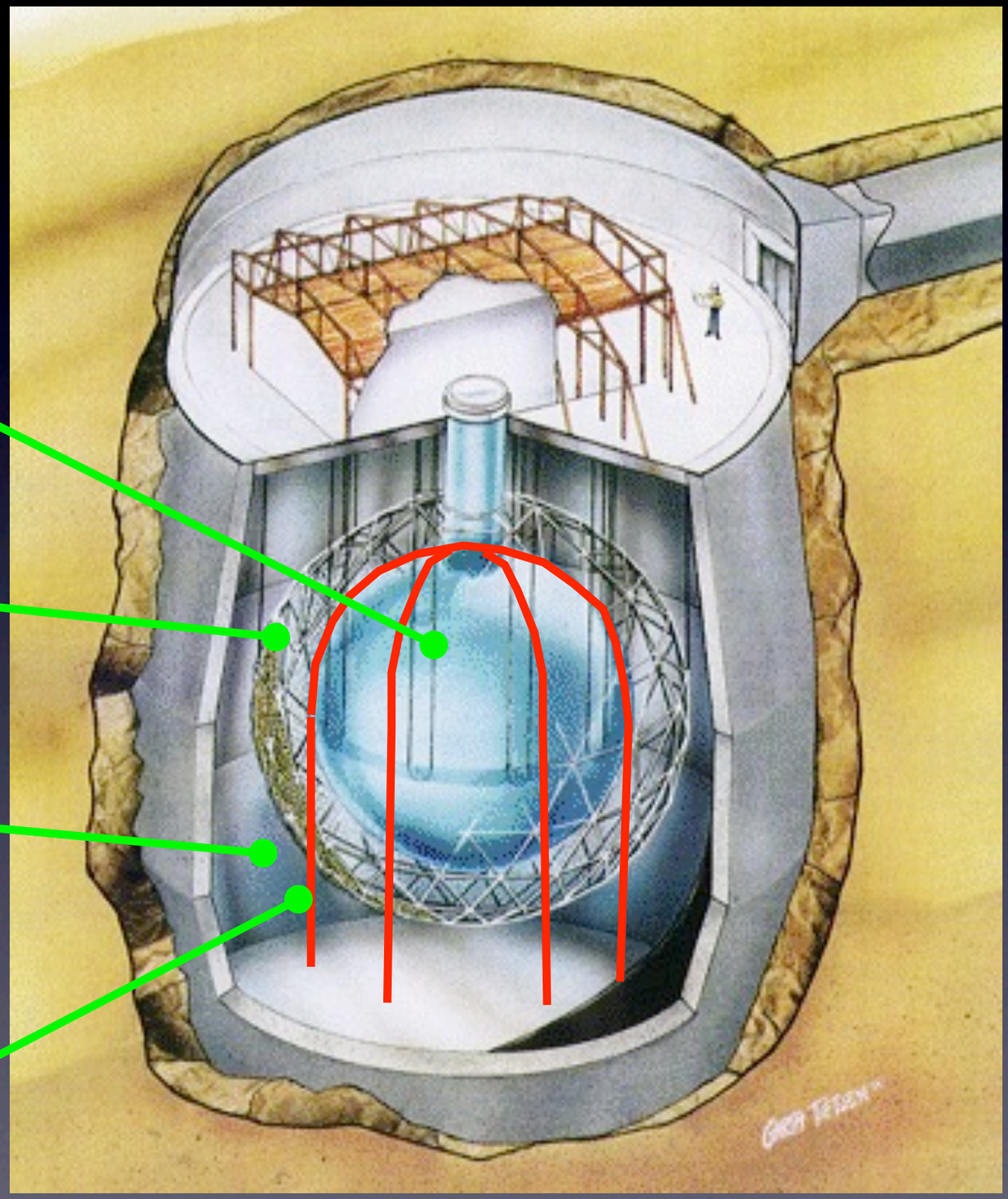
0.1 wt% = 780 kg Nd(natural)
= 44 kg Nd-150

9500 PMTs

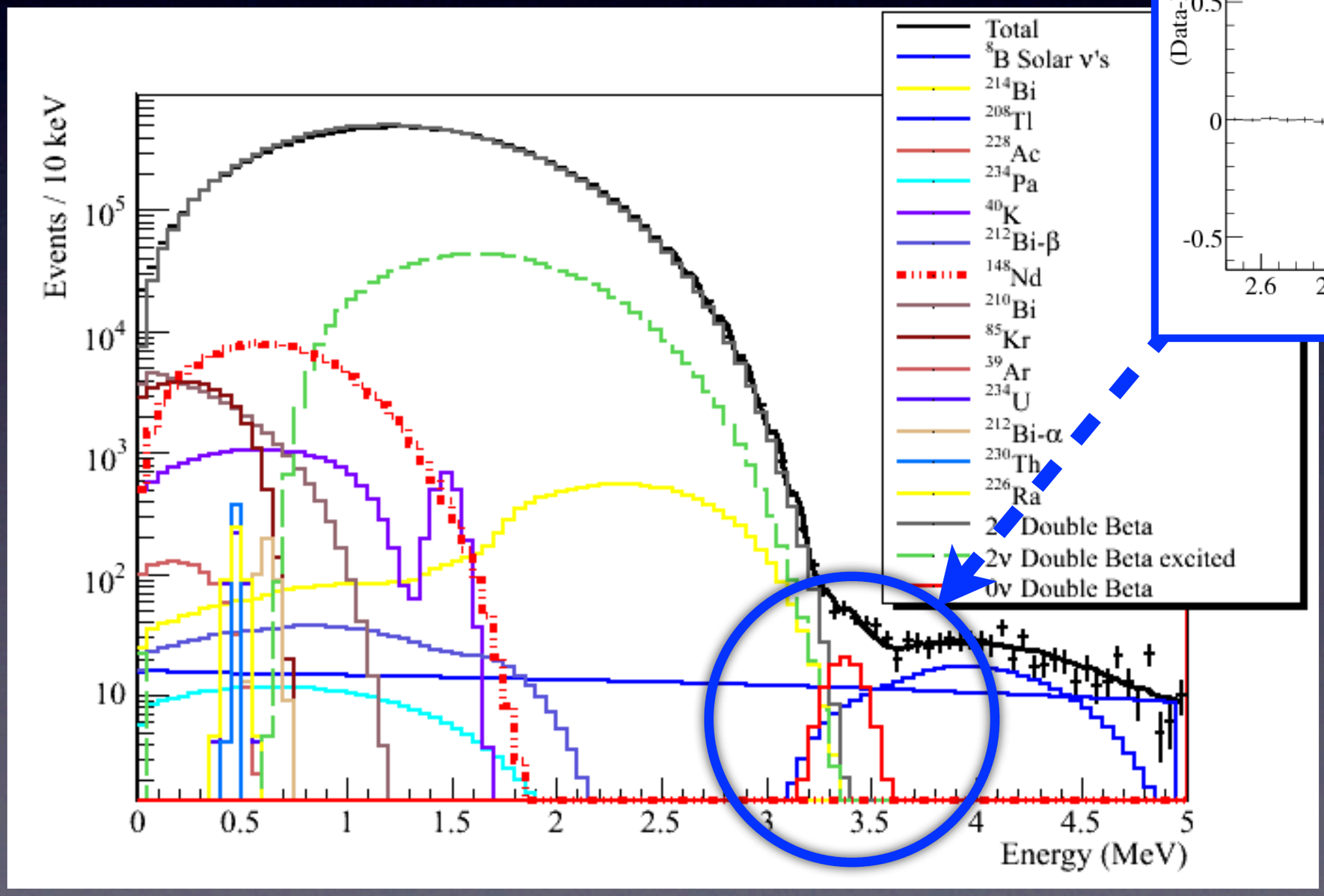
Energy res = 5 %@1 MeV

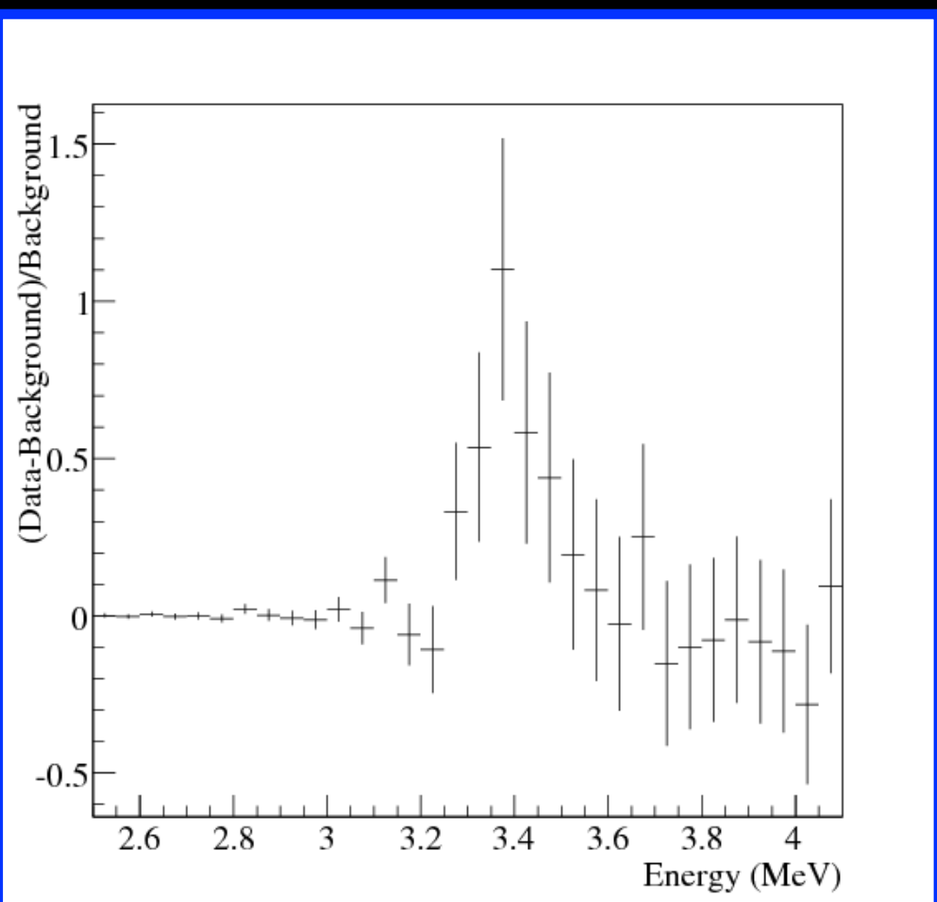
7000 t pure water shield

Hold down ropes will be installed



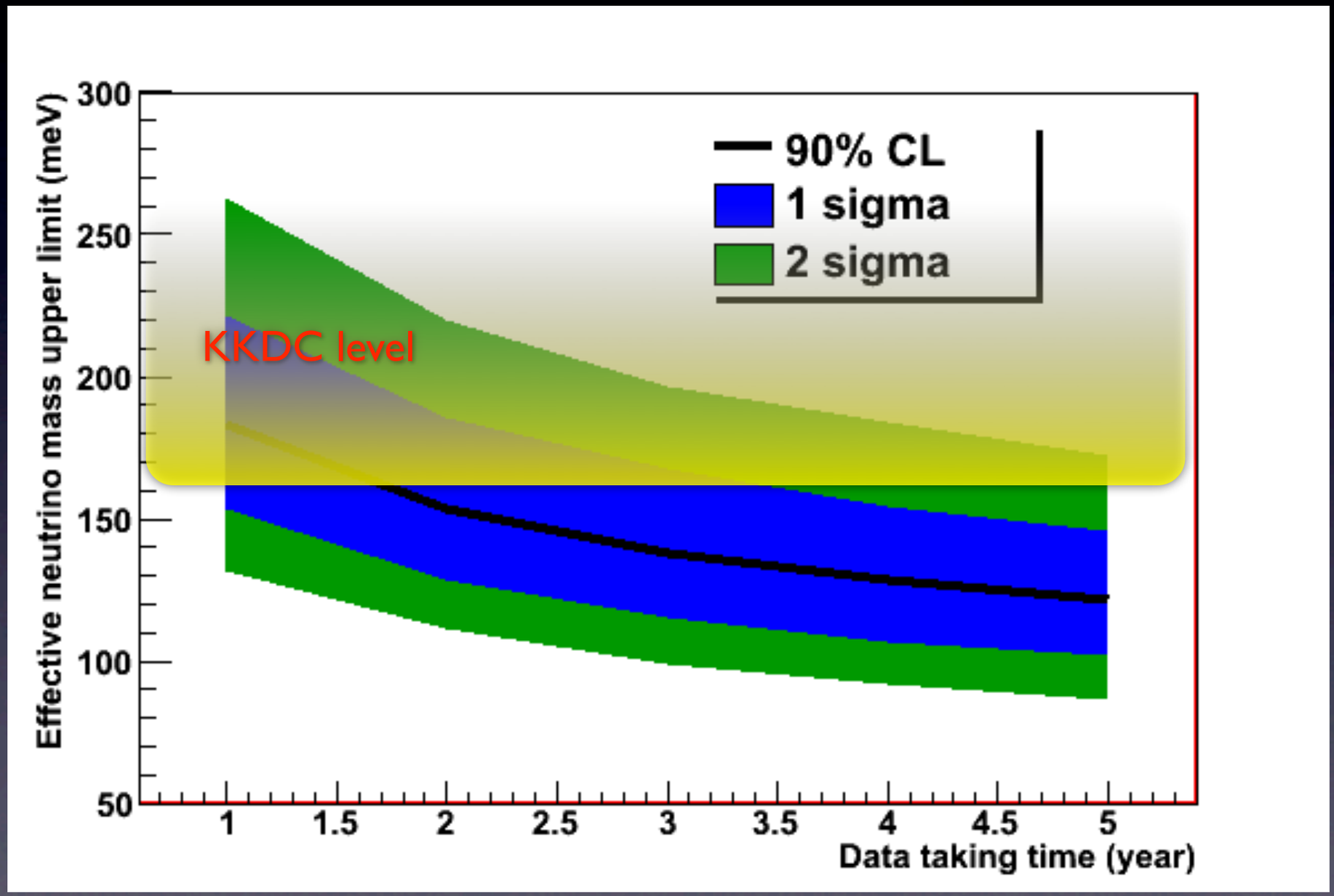
Double beta decay signal at the "KKDC level"





@1 year

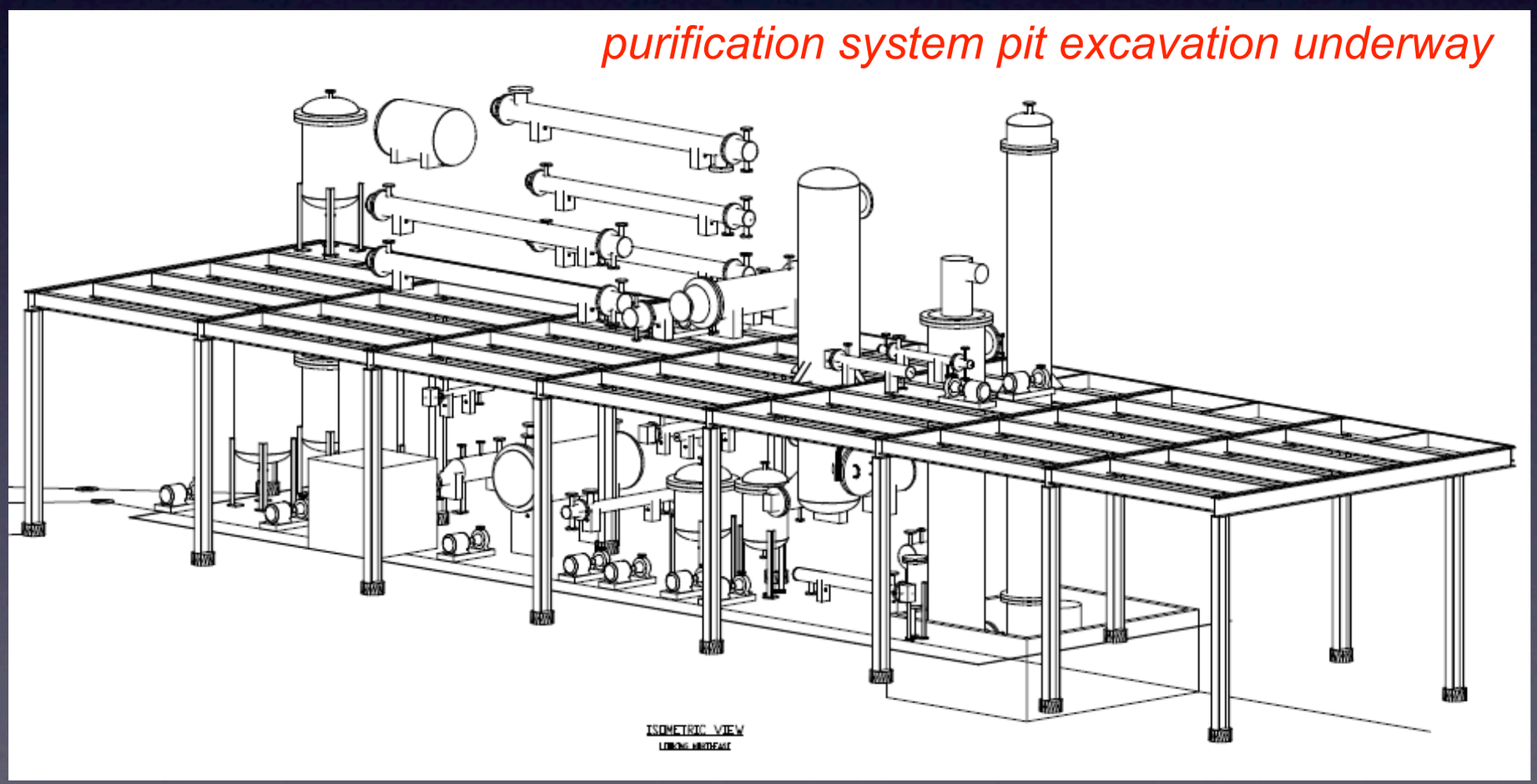
Sensitivity

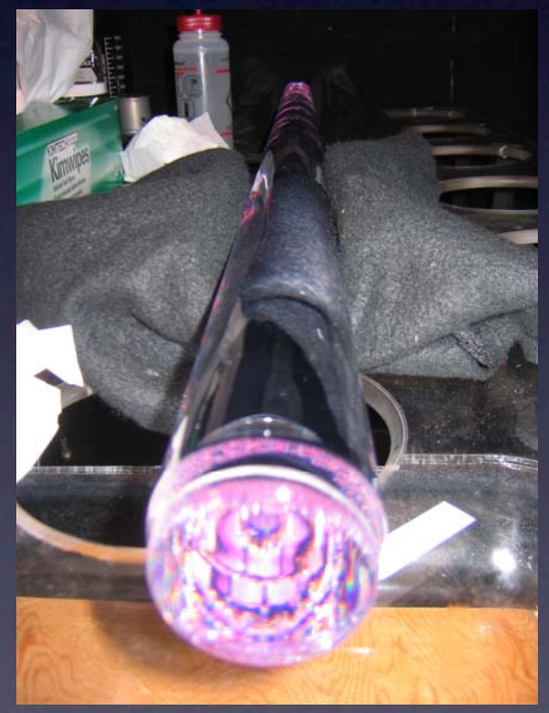


R&D

Nd loaded liquid scintillator (0.1 wt%): Stable>3 years
Liquid scintillator purification: developed.

purification system pit excavation underway





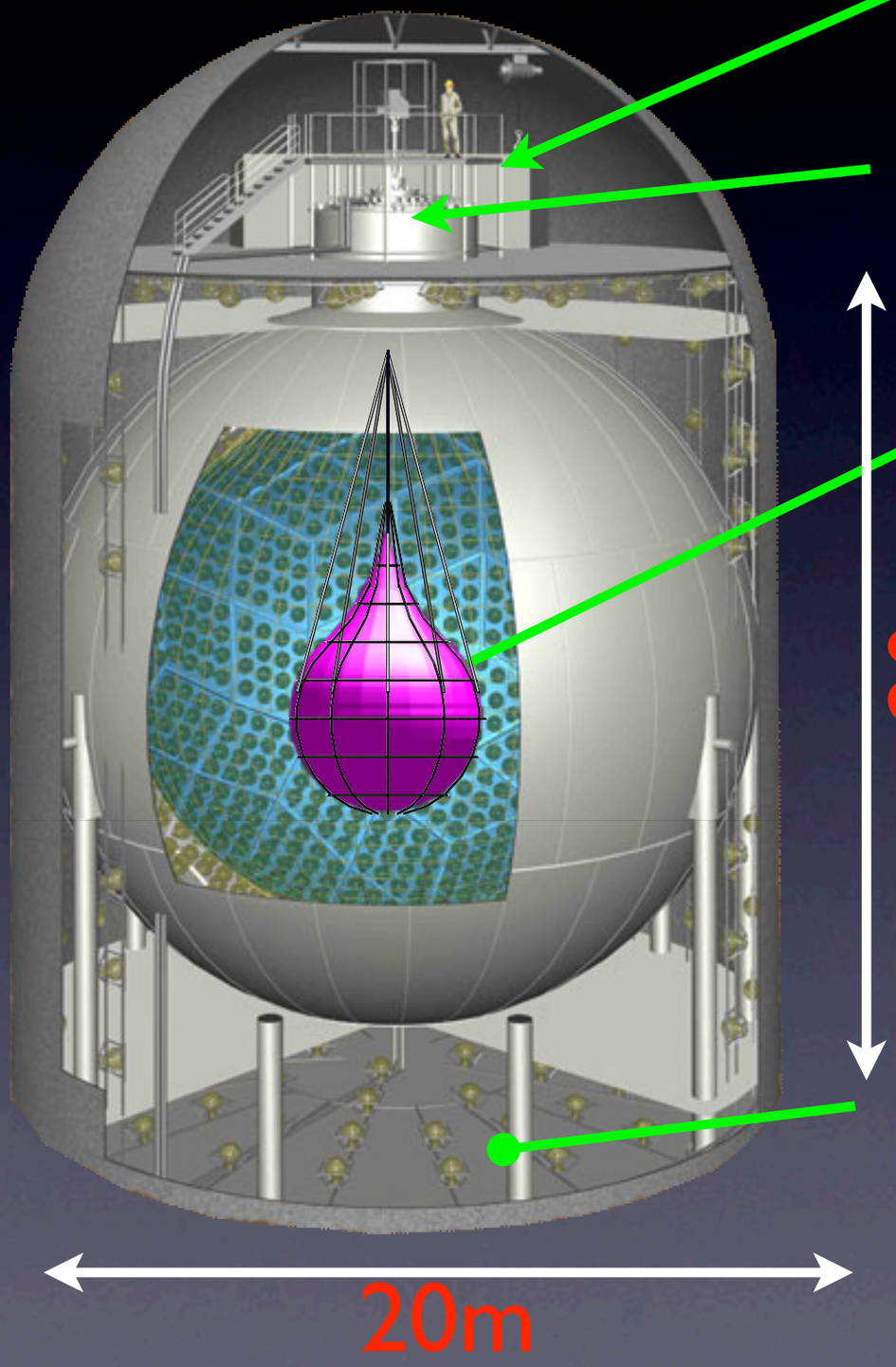
Schedule

- install hold down ropes for the acrylic vessel Feb 2011
- build/install liquid scintillator purification system completed August 2011
- receive Universal Interface October 2010, install UI March 2011
- upgrades to the DAQ completed January/February 2011
- begin detector final fill (initially with water) October 2011
- receive liquid scintillator / detector filled with liquid scintillator April 2012

KamLAND-Zen

KamLAND Zero Neutrino Double beta decay

KamLAND-Zen



Electronics Hut

Calibration system at access chimney

1200 m^3 LS+1800m^3 BO

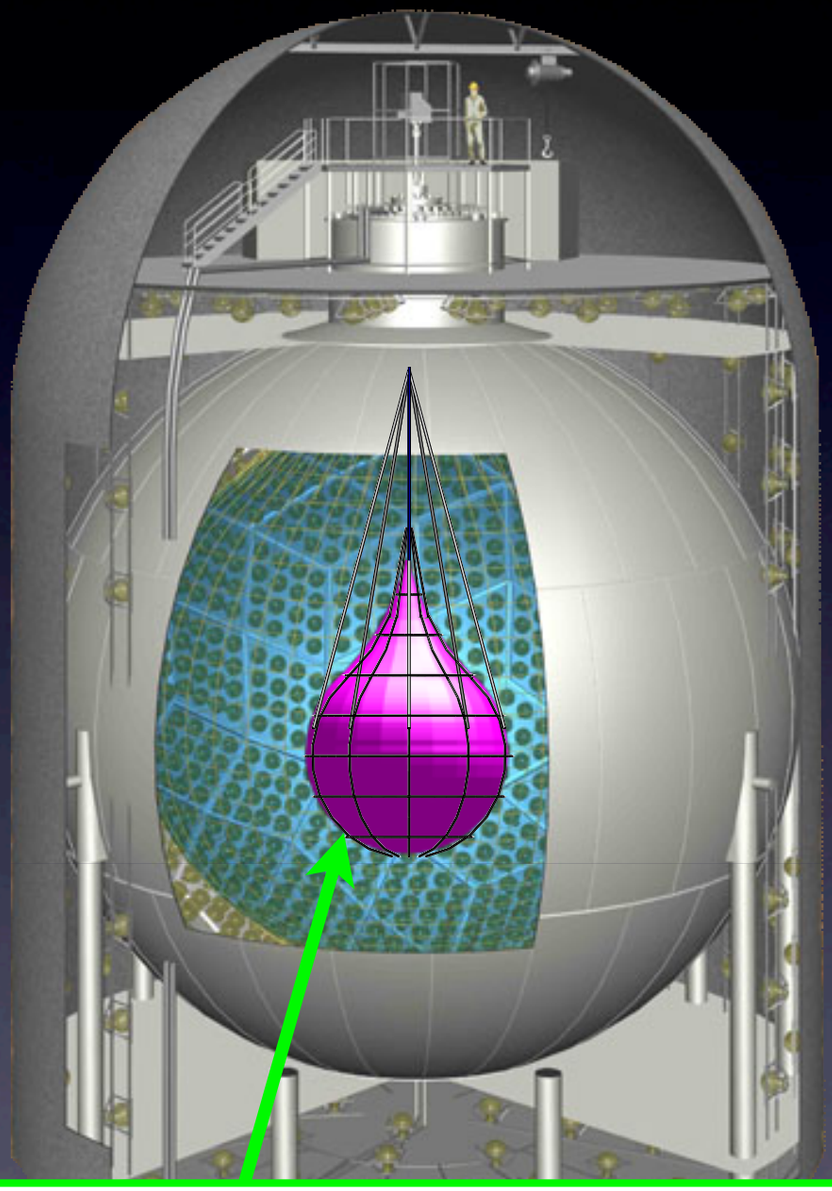
1325 17”PMTs + 554 20”PMTs

Energy Res. = 7 % / $\sqrt{E}$

Water Cherenkov Outer Detector

225 20” PMTs

KamLAND-Zen



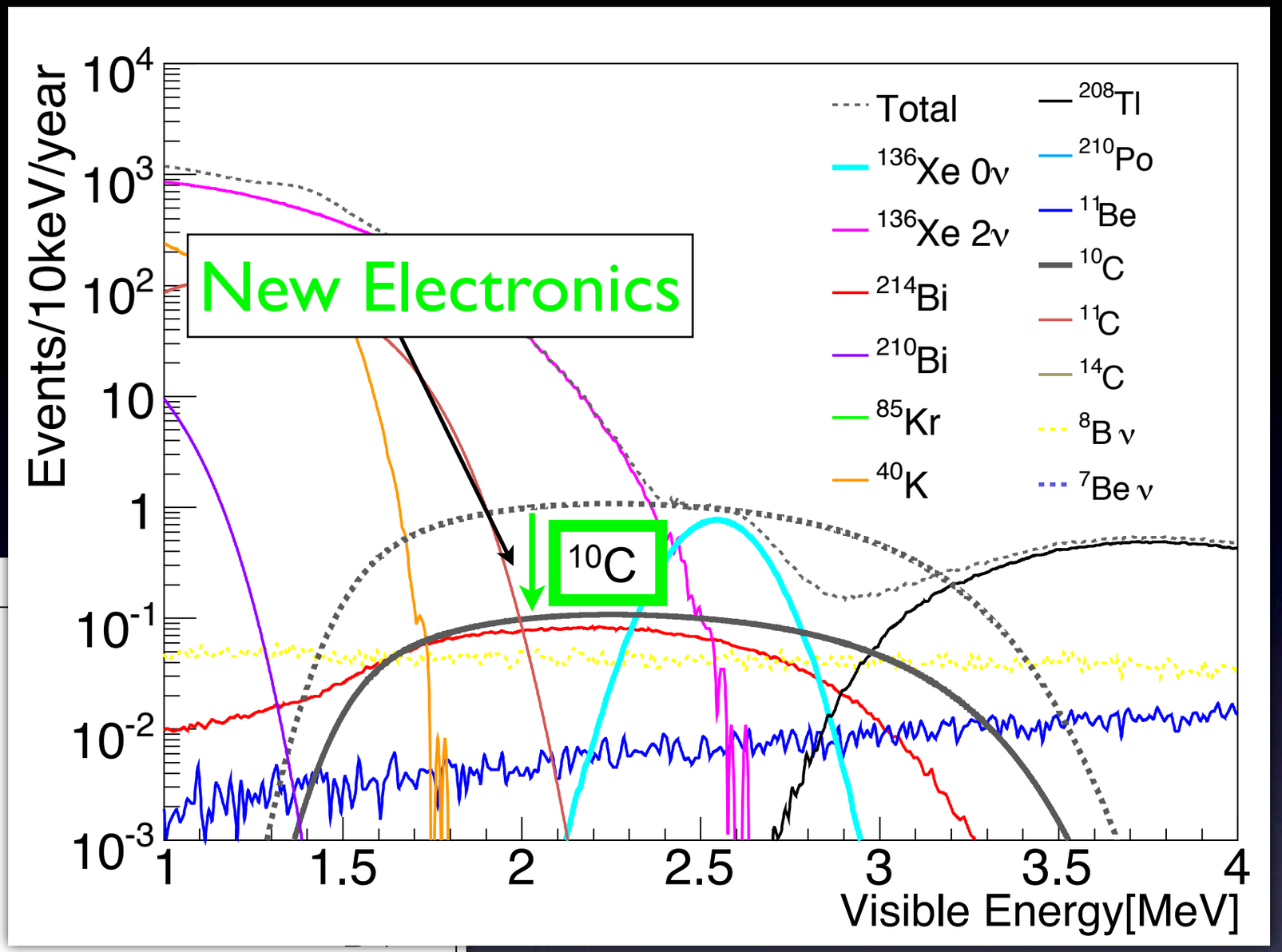
^{136}Xe 400 kg loaded LS
in mini-balloon, R=1.7m

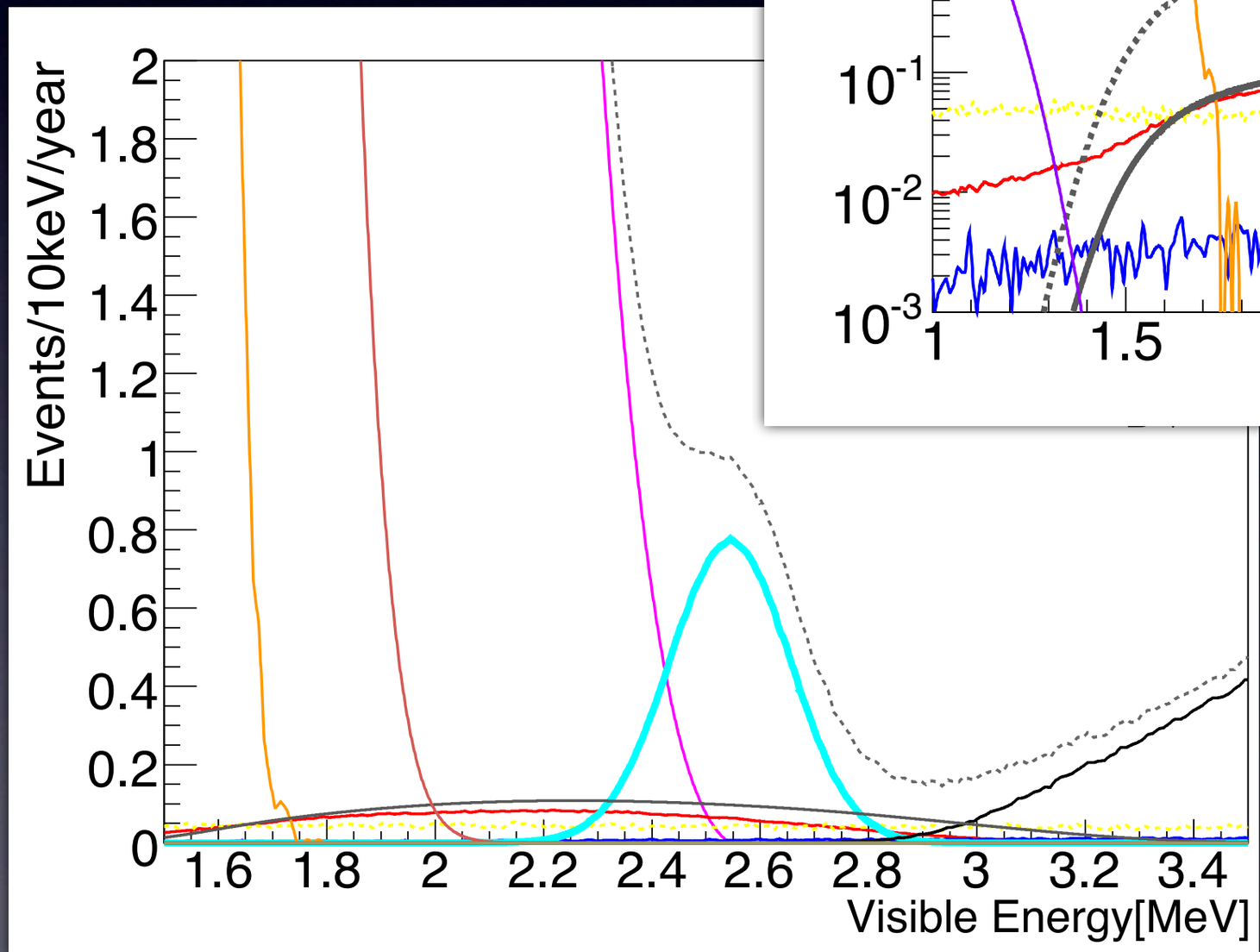
^{136}Xe 400 kg:

- 2.7 wt% dissolved into LS
- easy handling/ enrichment (90%)
- longer 2ν beta decay life time
- $T^{2\nu} > 10^{22}$ years (cf: ~$10^{19\text{-}20}$)

KamLAND exists:

- ultra pure environment (U/Th~10^{-17} g/g)
- LS techniques
- Balloon experience
- LS Density control techniques
- Reactor/Geo neutrino



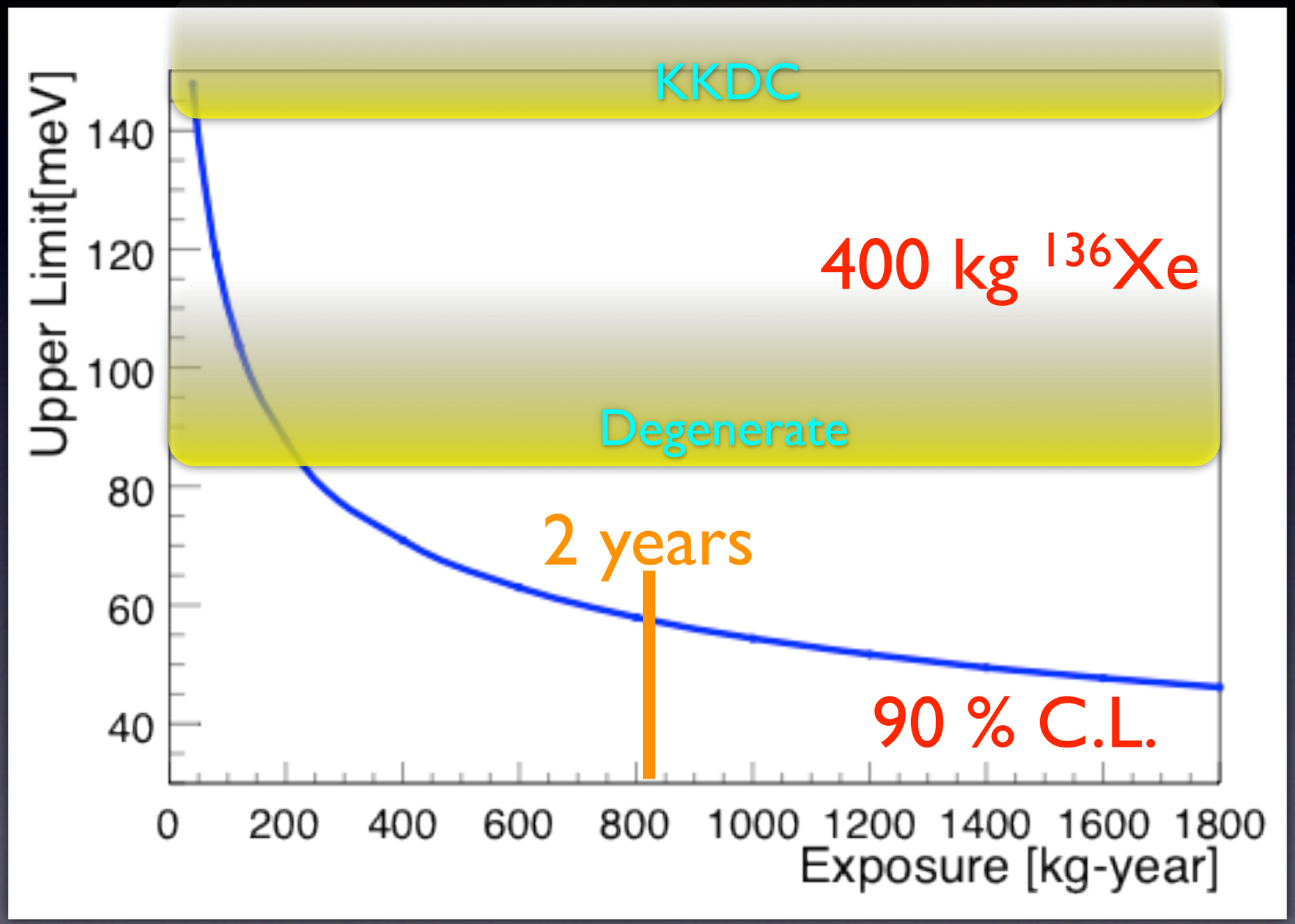


$\langle m_\nu \rangle$ = 0.15 eV (minimum KKDC)

$T_{1/2}$ (0ν) = 9.8 × 10^{25} y

$T_{1/2}$ (2ν) = 1.0 × 10^{22} y

Sensitivity

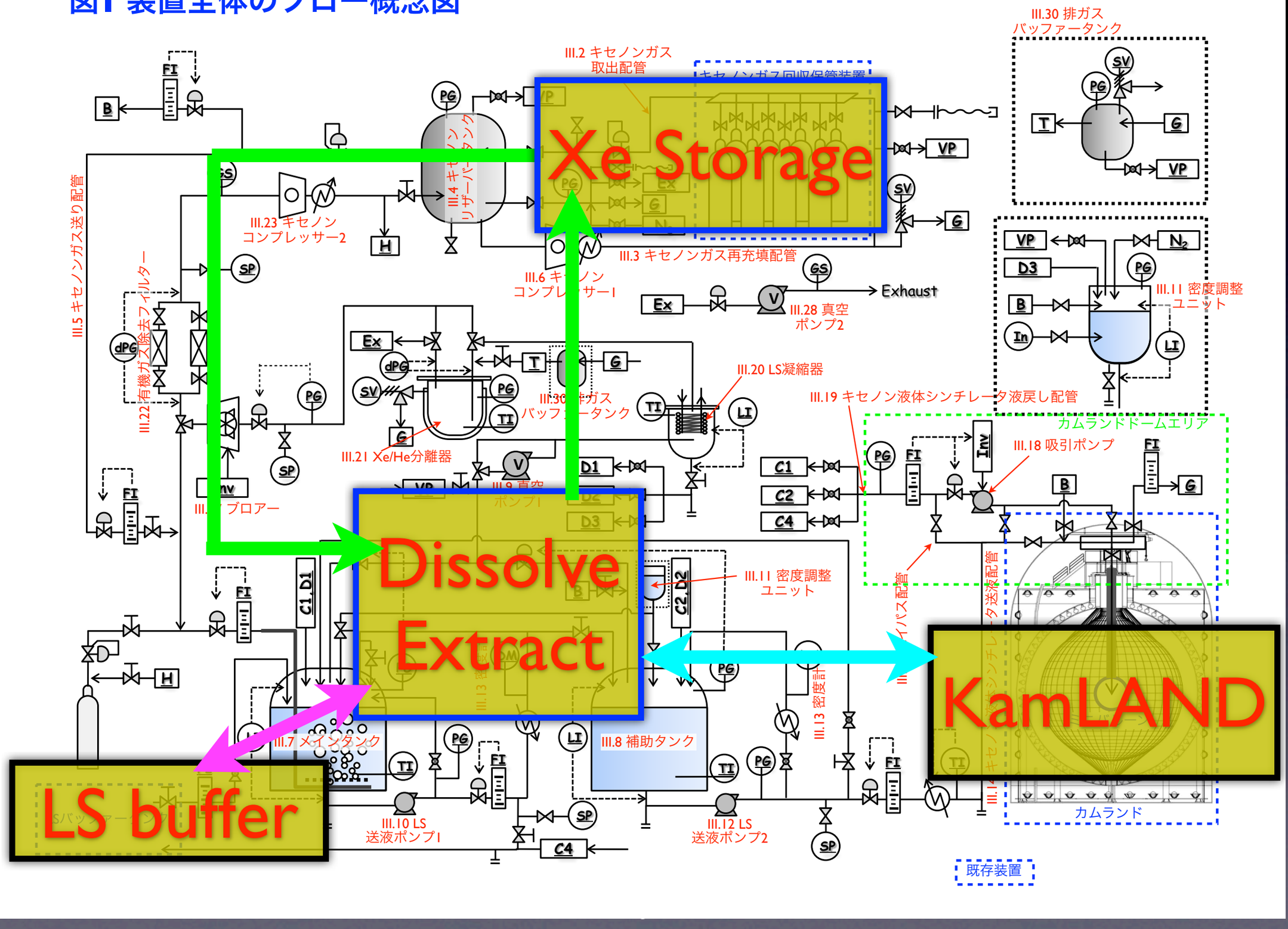


KamLAND-Zen R&D issues

- Xe loaded liquid scintillator
- Xe gas handling system
- mini-balloon
- New electronics

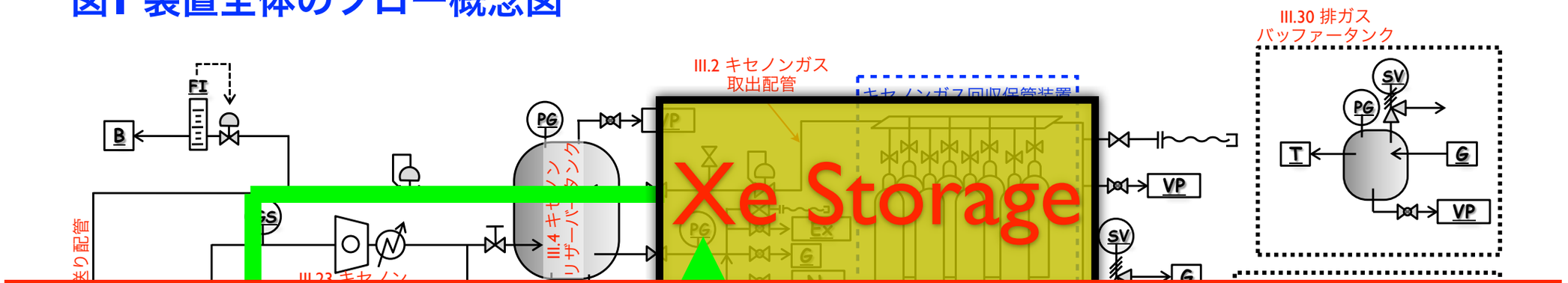
Gas handling system

図1 装置全体のフロー概念図



Gas handling system

図I 装置全体のフロー概念図

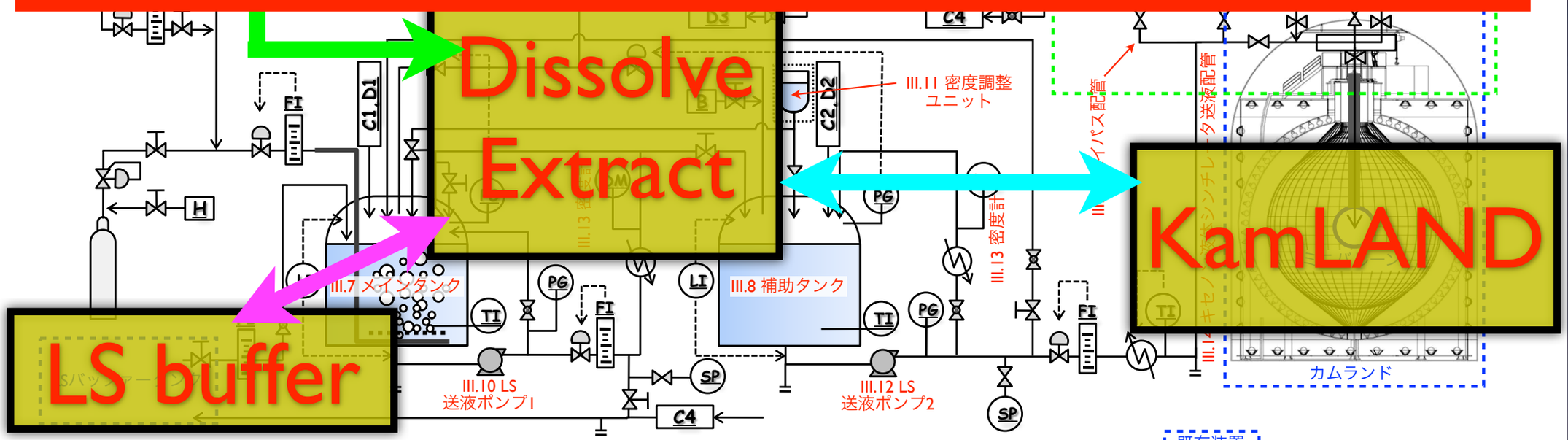


Based on a lab. set up, full scale design finished.

Pressure control: 2.7% solubility

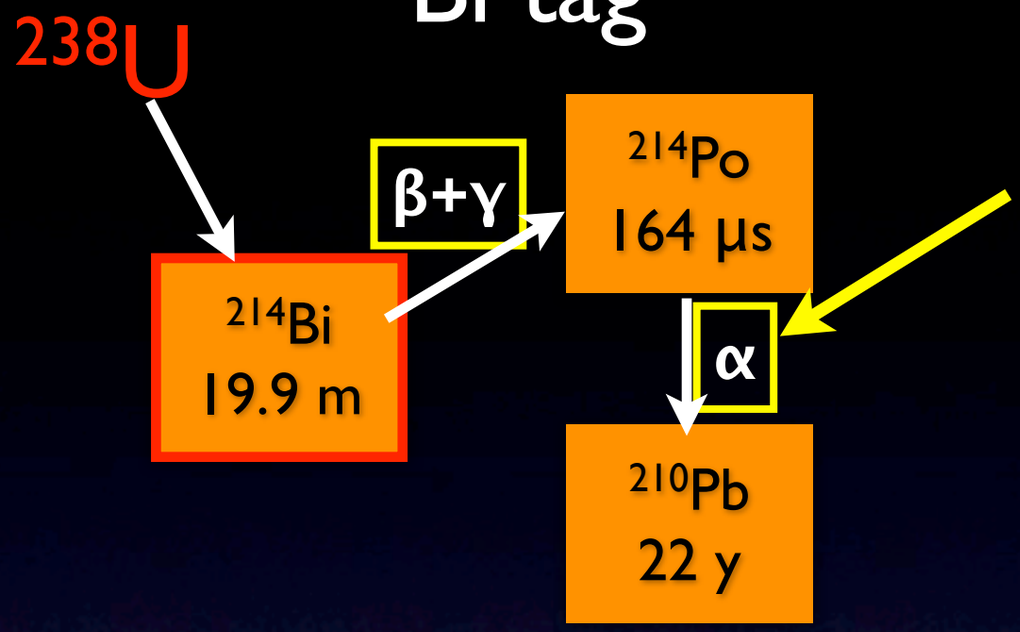
Degas+HePurge: 99.7 % or more Xe collection back from LS

Going to be installed this year (2010).



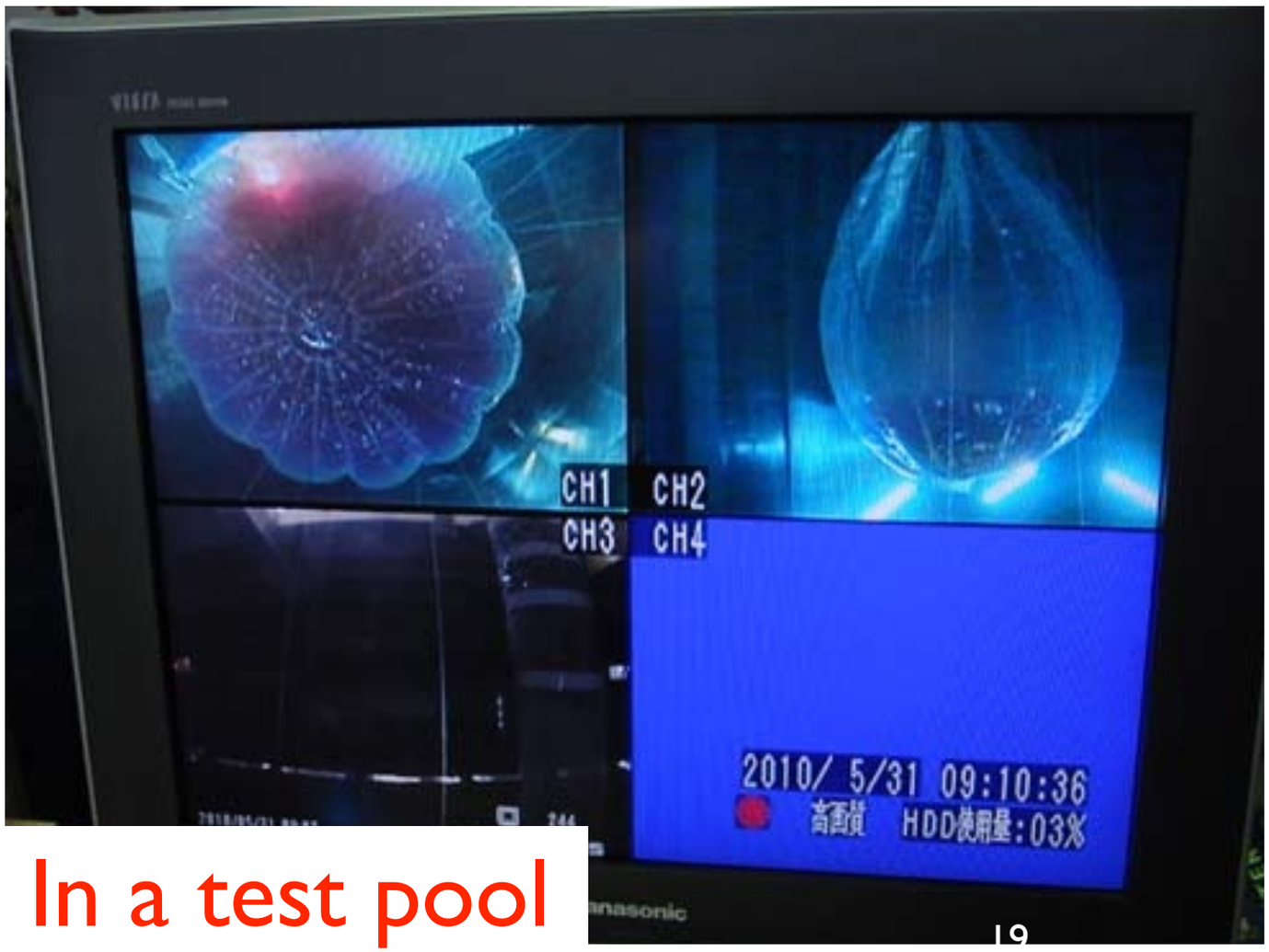
Gas storage facility has already been installed.
It can handle up to 1000 kg Xe.

mini-Balloon



25 μm thick Nylon balloon

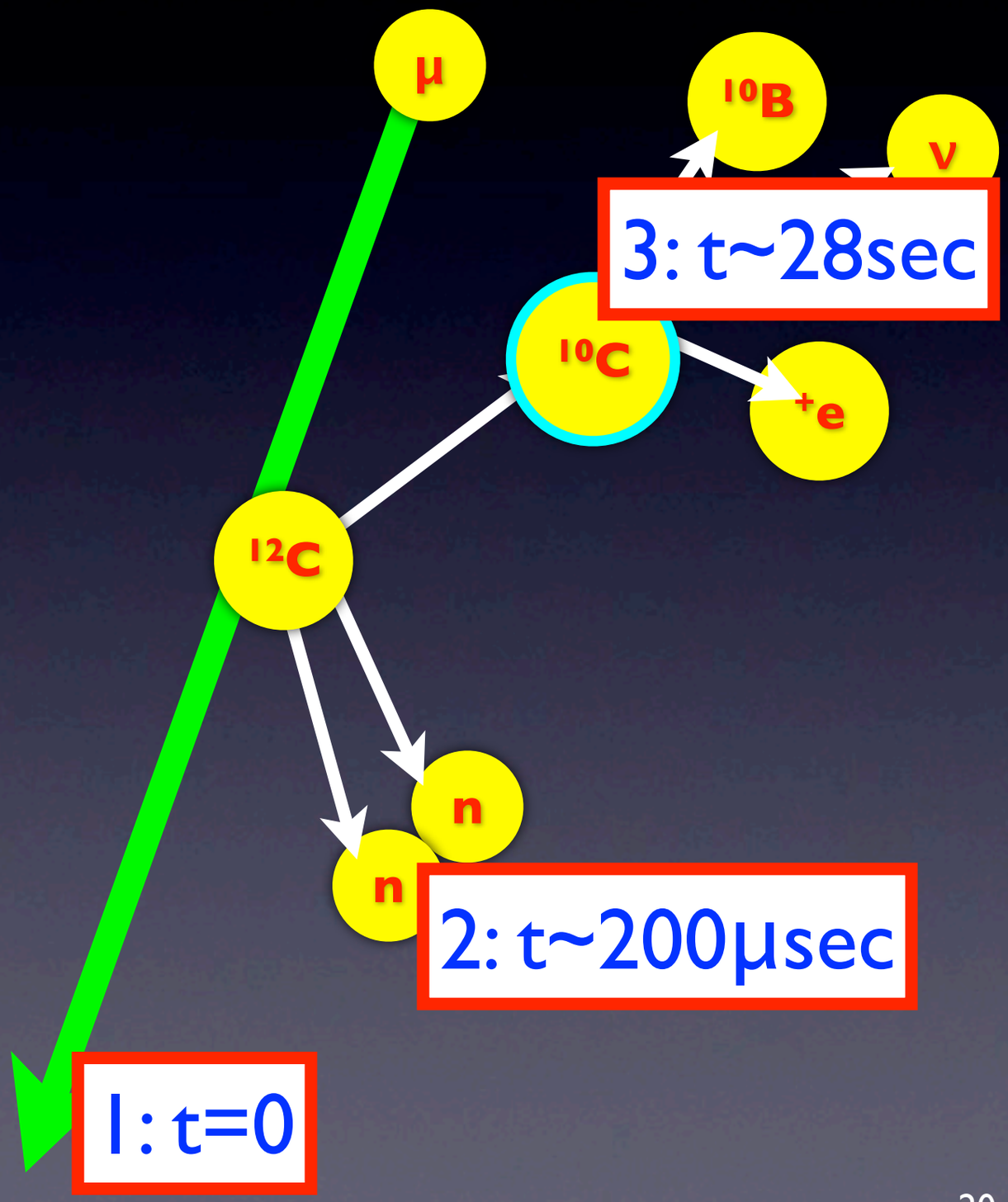
^{238}U~10^{-11}g/g (target~10^{-12}g/g)
^{232}Th~10^{-11}g/g (target~10^{-12}g/g)
^{40}K~10^{-11}g/g (target~10^{-12}g/g)



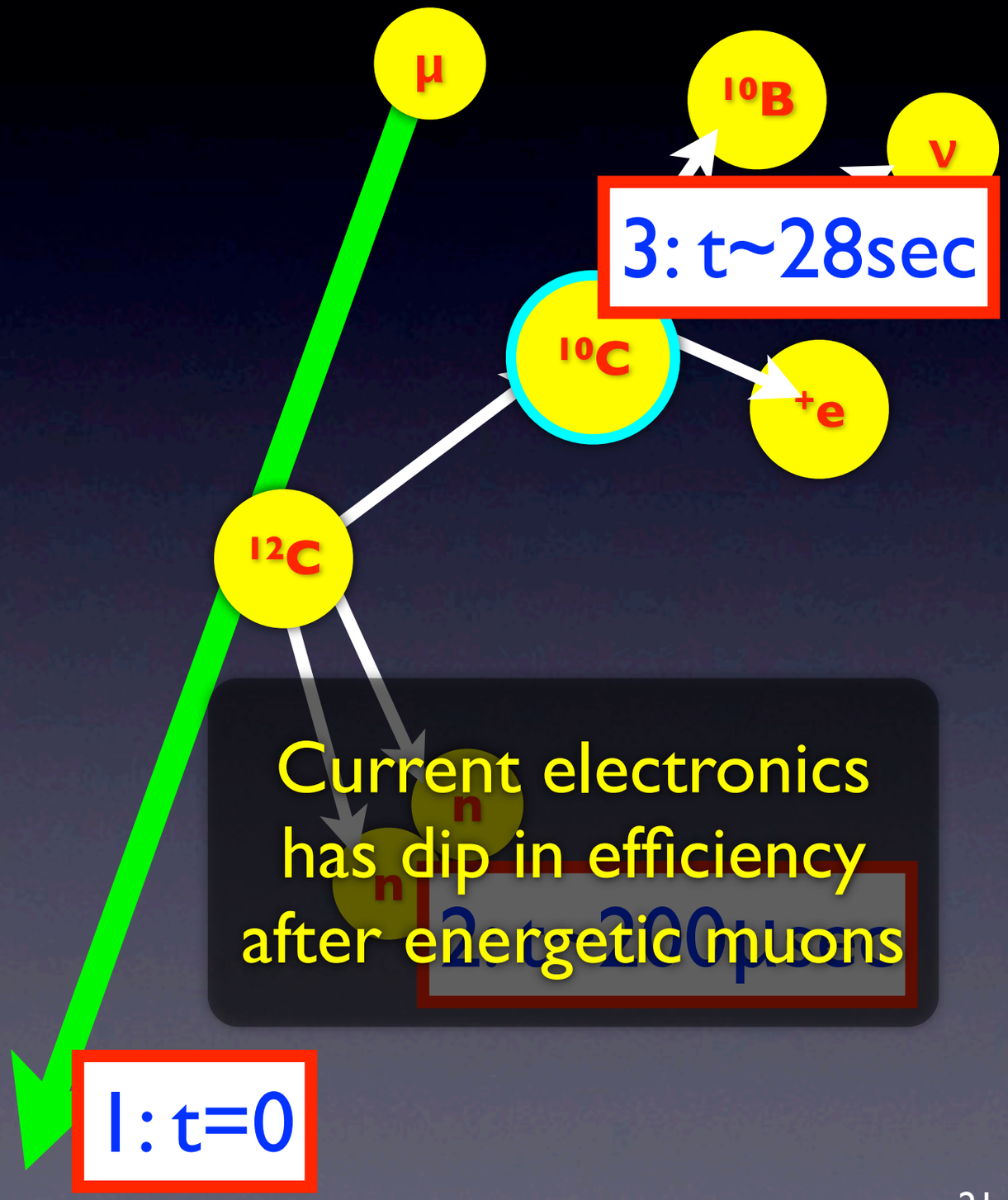
In a test pool

In a gym

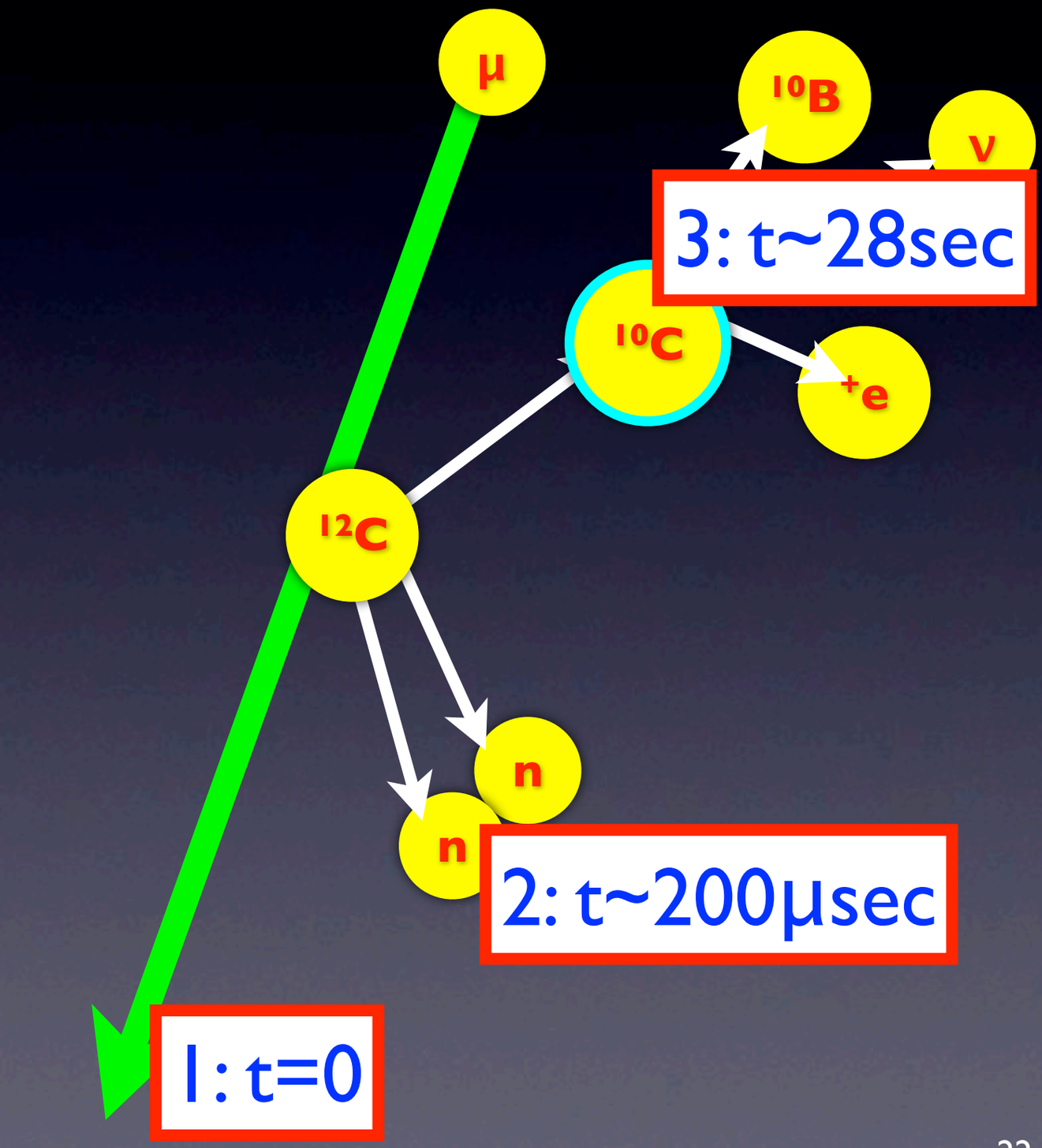
New electronics



New electronics

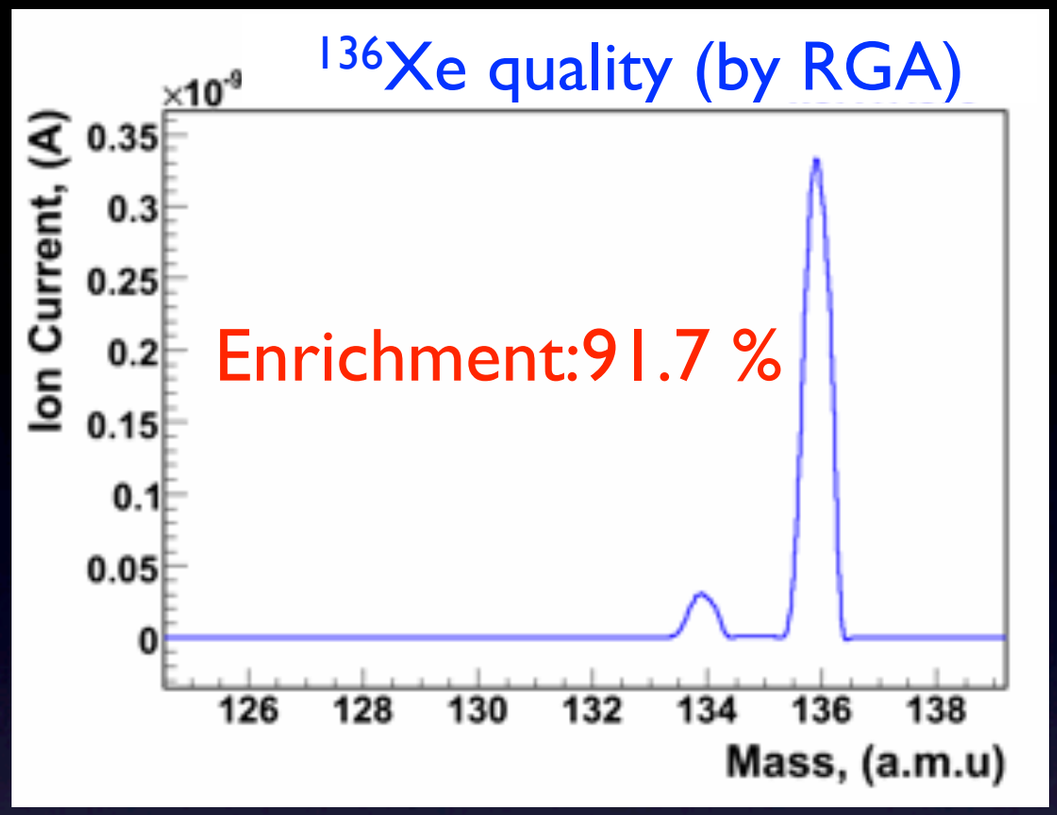


New electronics



90 % tagging efficiency

Status and schedule



- ☑ We have 190 kg Xe-136 (400 kg budgeted).
- ☑ New electronics is about ready.
- ☑ Design of the gas system finished.
- ☑ Infrastructure done.
- ☐ Continue mini-ballon R&D.
- ☐ The gas system will be installed in 2010.
- ☐ Full volume calibration in 2011.02 →Shutdown KamLAND
- ☐ Modification of KamLAND chimney.
- ✱ Launch in 2011.05.

KamLAND-Zen collab.

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Conclusion

	SNO+	KamLAND-Zen
Isotope	Nd-150	Xe-136
Amount	44 kg	400 kg (enriched)
G x10^{-25}	~8 $y^{-1}eV^{-2}$	~2 $y^{-1}eV^{-2}$
Sensitivity	~100 meV@5 years	~60 meV@ 2.5 years
DAQ will Start	2012.05	2011.05
	Both detectors already exist.	

Liquid scintillator based experiments in the next few years will be able to reach below the "KKDC" and be reaching to the "Inverted" region.

Thank you.