KamLAND status

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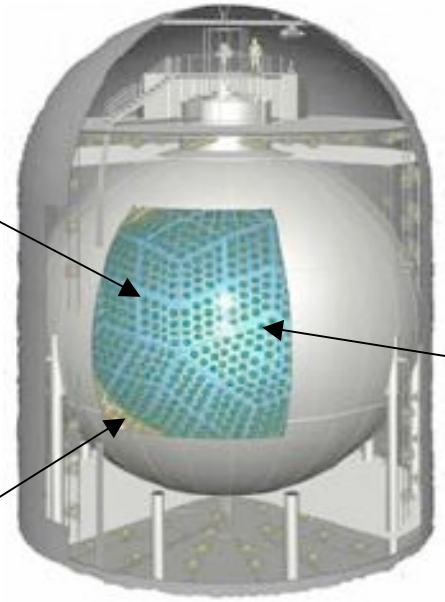
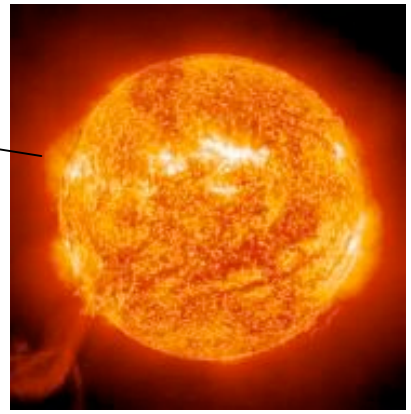
NDM06

KamLAND results and future

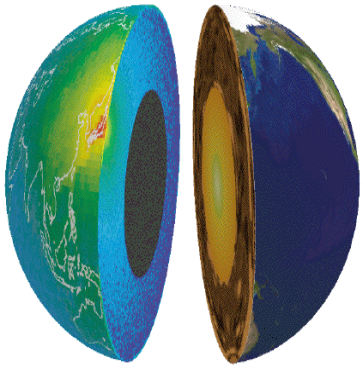
- Reactor antineutrinos



- Solar neutrinos

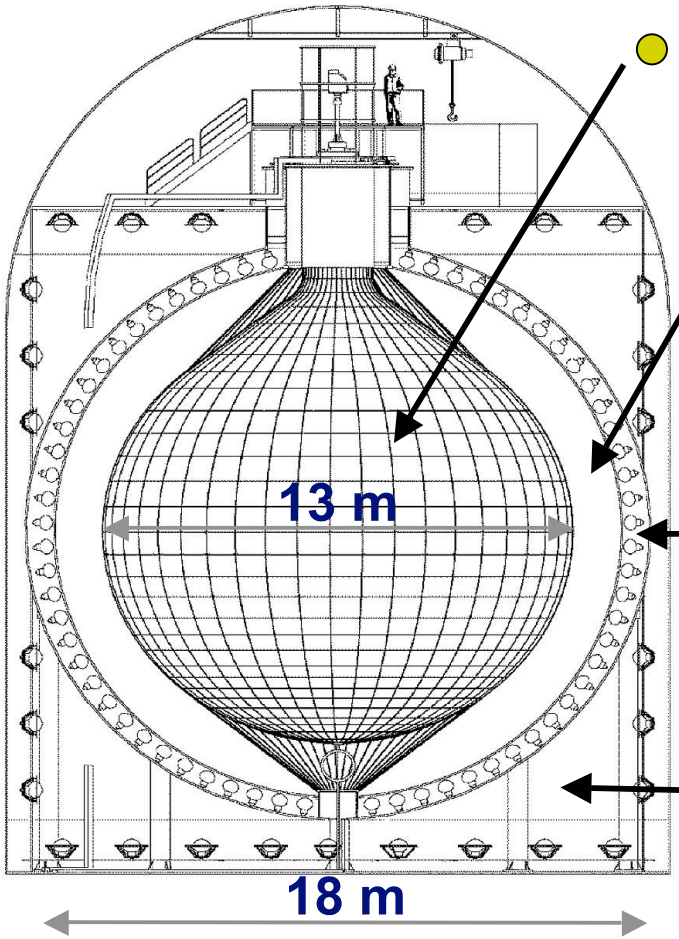


- Geoneutrinos



KamLAND detector

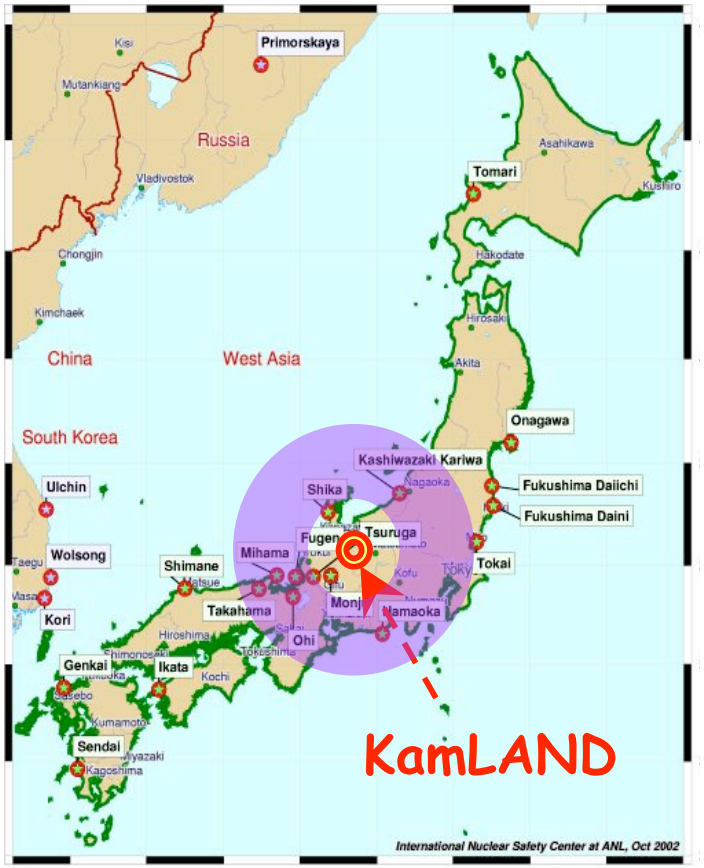
Kamioka mine overburden : 2700 m.e.w



- 1000 tons of liquid scintillator
  80% dodecane + 20% pseudocumene + PPO
- Mineral oil
  $\Delta\rho$ = 0.3 % to guarantee balloon stabilisation
  Buffer against external radiation
- 1879 PMTs (1325 17″ + 554 20″)
  Photocathode coverage 34%
- Outer water Cerenkov detector
  → μ veto

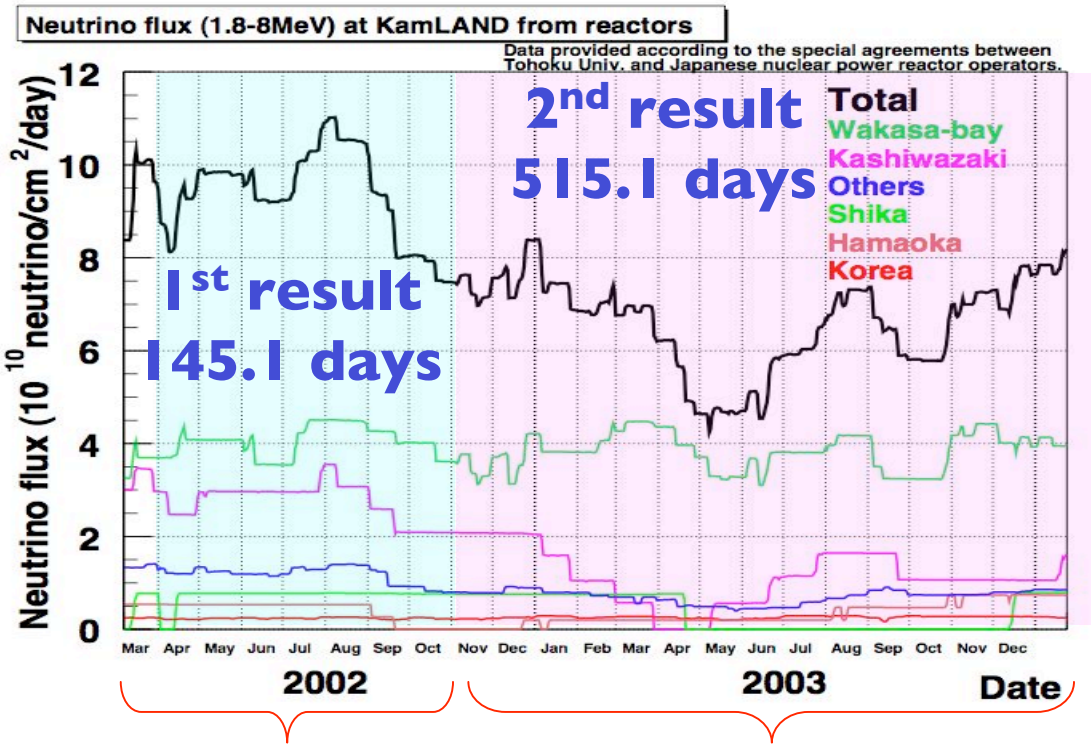
$$\bar{\nu}_e + p \rightarrow e^+ + n$$

Reactor anti-neutrinos flux



80 % of expected $\bar{\nu}_e$

from baselines 140-210 km

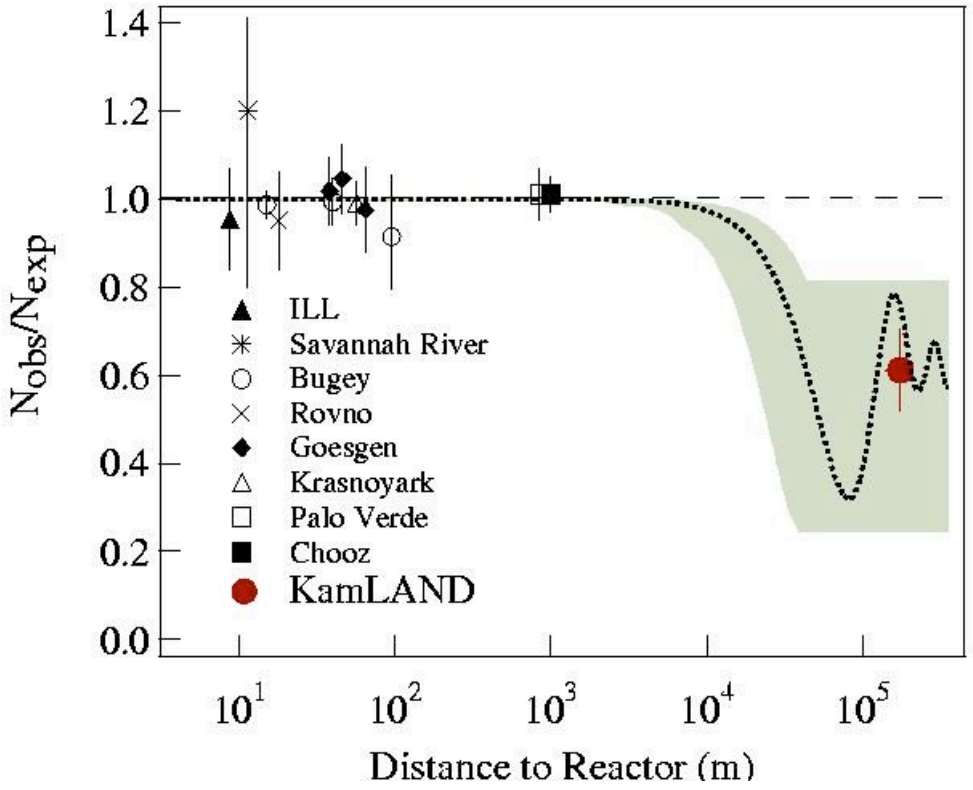


Reactor ν disappearance

Spectral distortion

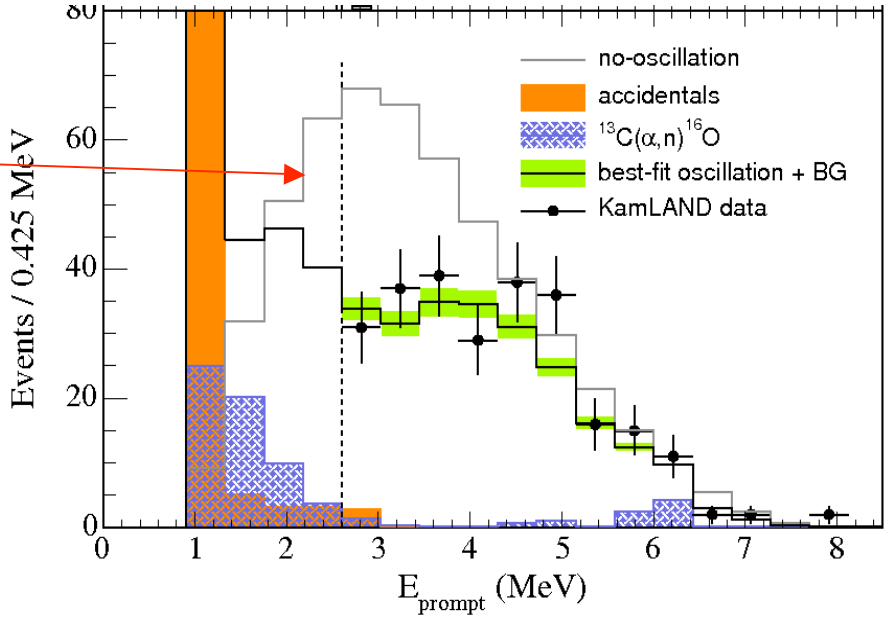
Reactor anti-neutrinos Results

1st result : neutrino disappearance at 99.95% CL



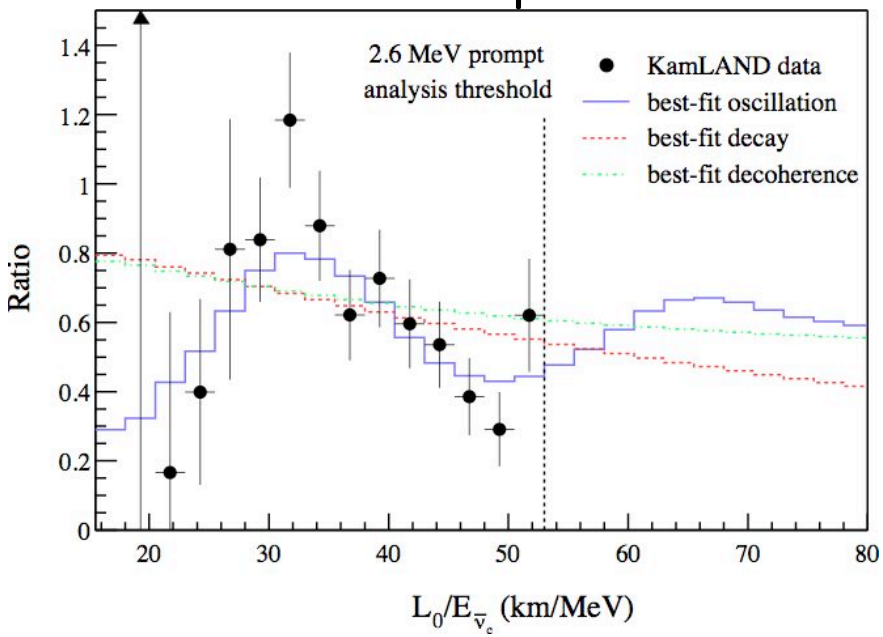
Reactor anti-neutrinos Results

2nd result : disappearance confirmed at 99.998% CL



Scaled reduced spectrum rejected @ 99.6 % CL

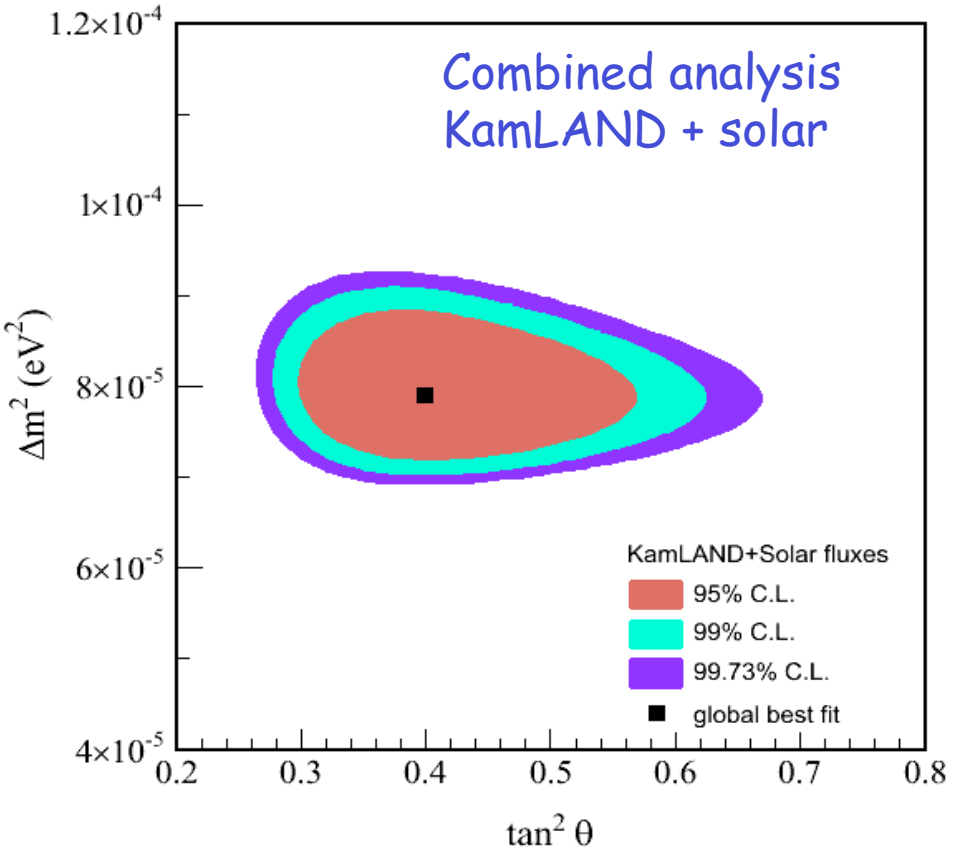
L/E plot



Eliminate other disappearance hypothesis at 98% CL

Spectral distortion → strong further support for neutrino oscillation

Reactor anti-neutrinos Results



Best fit :

$\Delta m^2 = 7.9\,^{+0.6}_{-0.5} \times 10^{-5}$ eV^2

$\tan^2\theta = 0.40\,^{+0.10}_{-0.07}$

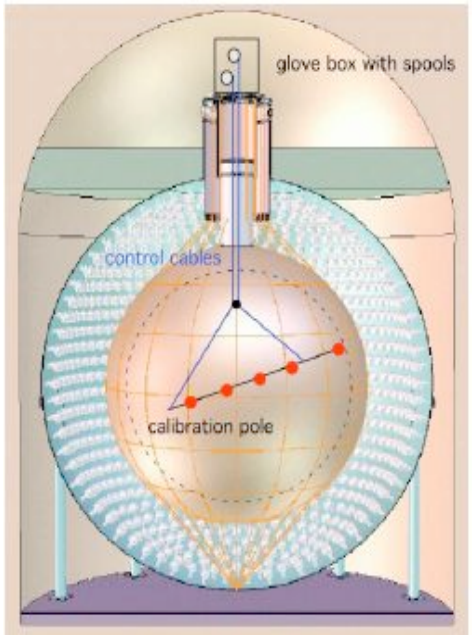
We have entered an era of precision measurement

Reactor anti-neutrinos
Future

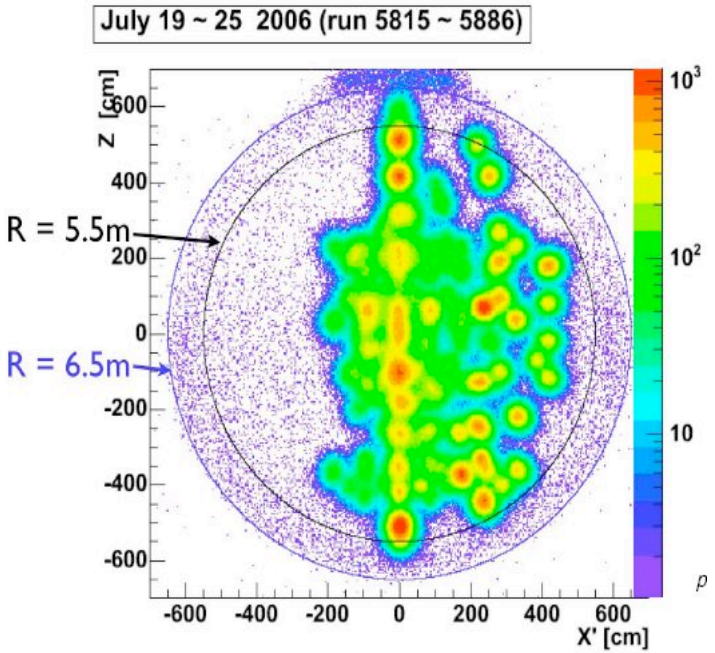
Current systematics

Systematic	%
Fiducial volume	4.7
Energy threshold	2.3
Efficiency of cuts	1.6
Livetime	0.06
Reactor power	2.1
Fuel composition	1.0
$\bar{\nu}_e$ spectra	2.5
Cross section	0.2
Total	6.5

4pi calibration system



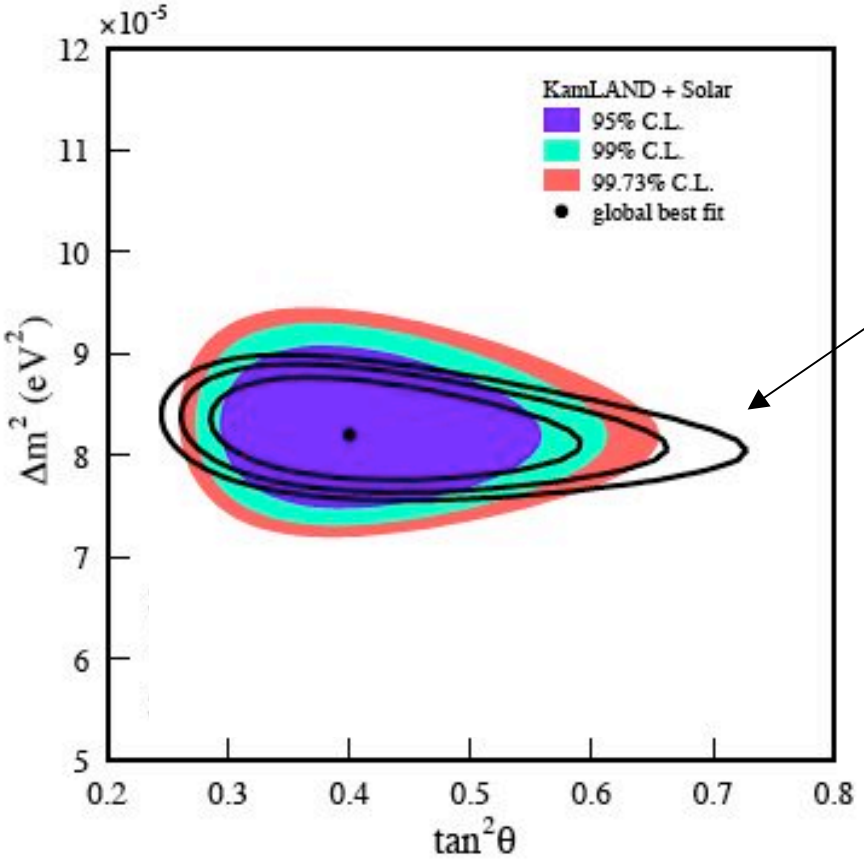
^{60}Co calibration data



Full volume calibration
systematics : 4.7% -> 1-1.5 %

Reactor anti-neutrinos
Future

With 1%
Syst. on FV



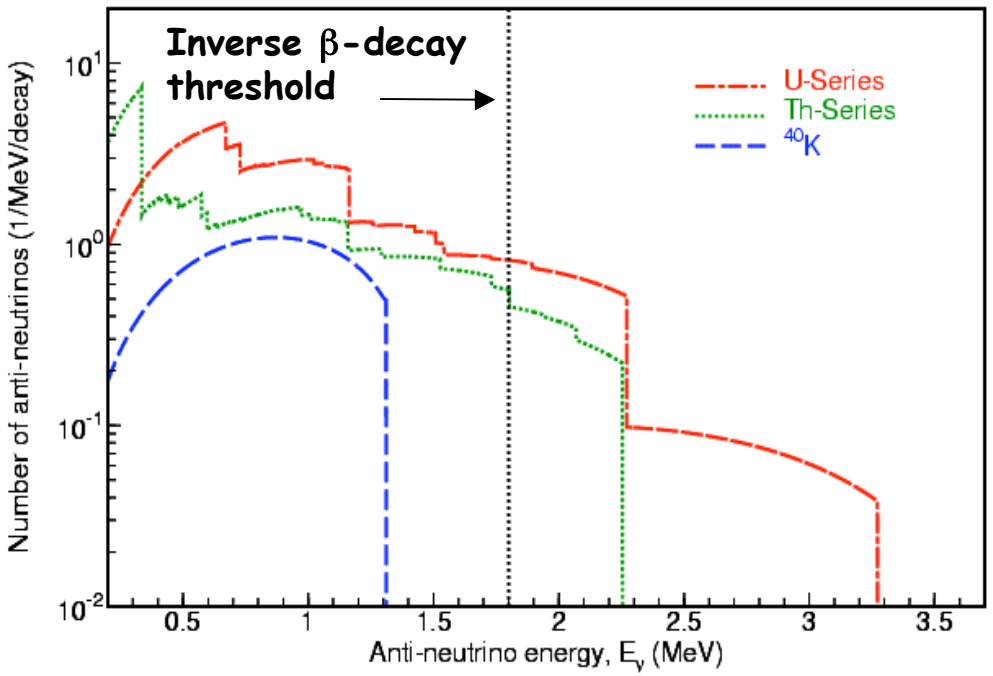
Expected 3 kt-yr
KamLAND only

Mixing angle determination comparable with current solar data

Updated results expected in 2007

Geo-neutrinos

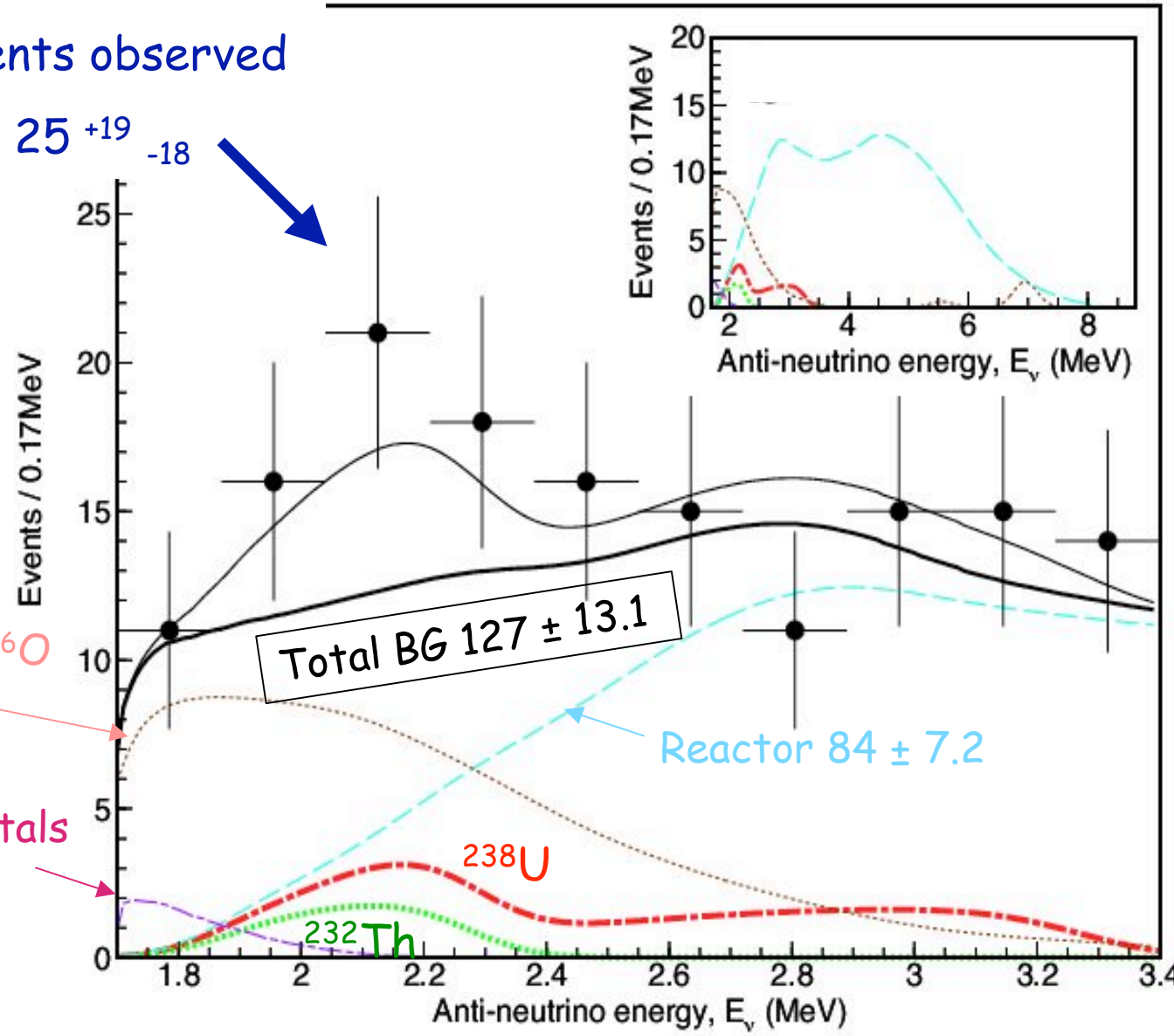
- Earth heat → earthquake, volcanoes, plaque tectonics …
- 40% of total heat come from radiogenic power ! Antineutrinos from ^{238}U, ^{232}Th and ^{40}K are an unique opportunity to bring insights in the Earth internal composition and energy generation mechanism : obvious interests for Earth sciences
- KamLAND is the first detector sensitive enough to measure geo-neutrinos from ^{238}U and ^{232}Th



Geo-neutrinos results

152 events observed

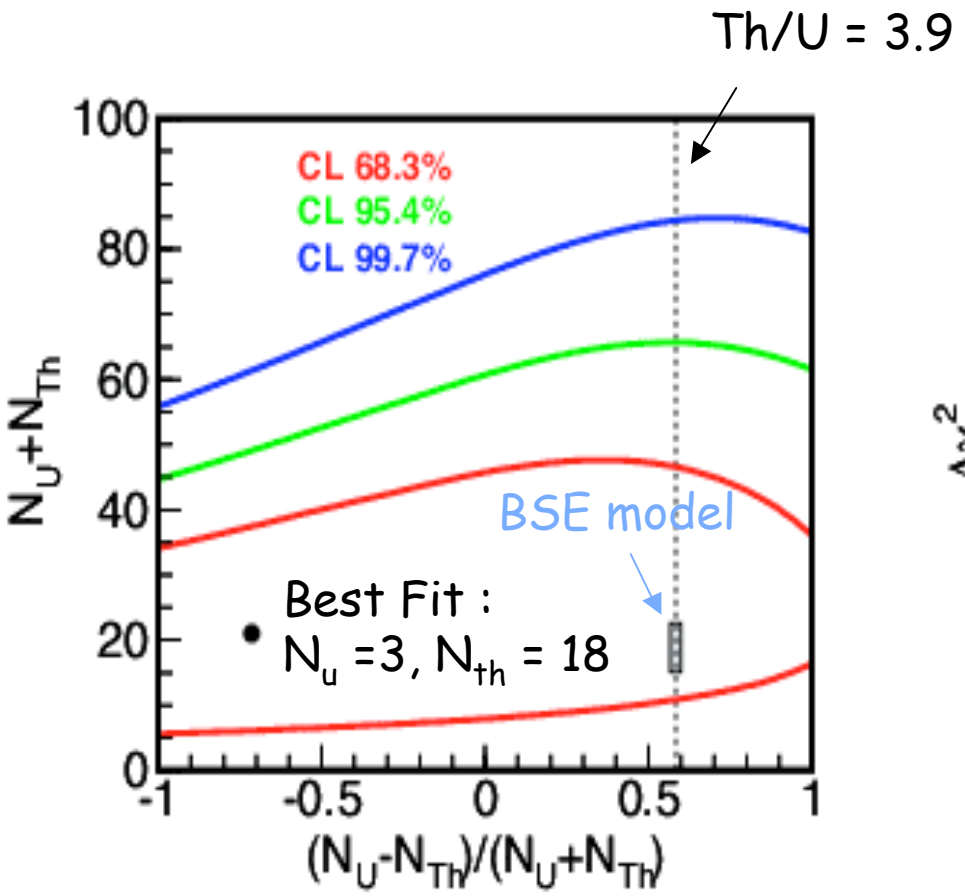
signal = 25^{+19}_{-18}



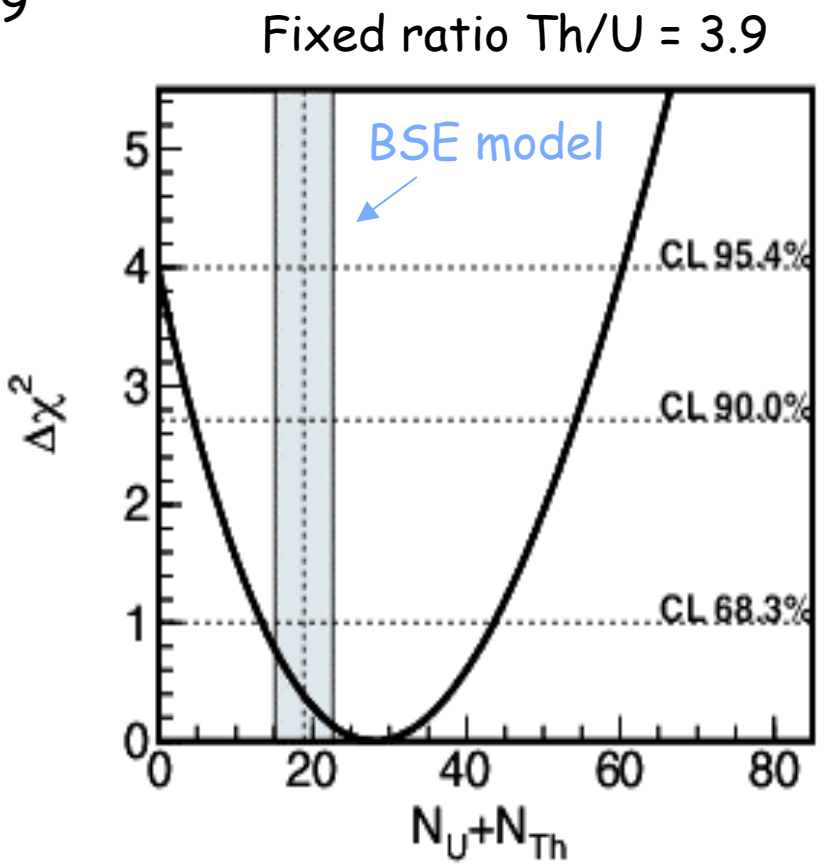
Data :
749.1 days
Mar 9 2002,
Oct 30 2004

BSE
Geophysical
model : 16 TW

Geo-neutrinos results
Rate and shape analysis



From chondritic meteorites
Th/U ~ 3.9



$N_U + N_{Th}$ = 4.5 - 54.2 @ 90% CL

Geo-neutrinos results
Future

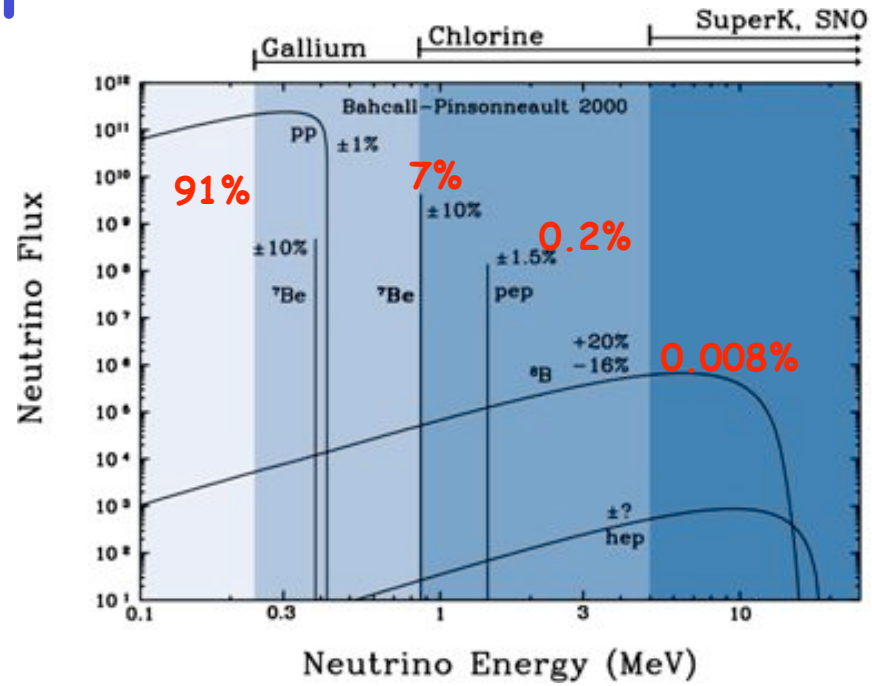
- New cross-section of $^{13}C(\alpha,n)^{16}O$ (Harissopulos et al - 2005) systematics: 20%→ 4%
- 4Pi system : will decrease systematics (6.5% → 4%) on reactor neutrinos events
- Purification of KamLAND for solar phase : $^{13}C(\alpha,n)^{16}O$ BG will be negligible

Increase sensitivity for geoneutrinos detection

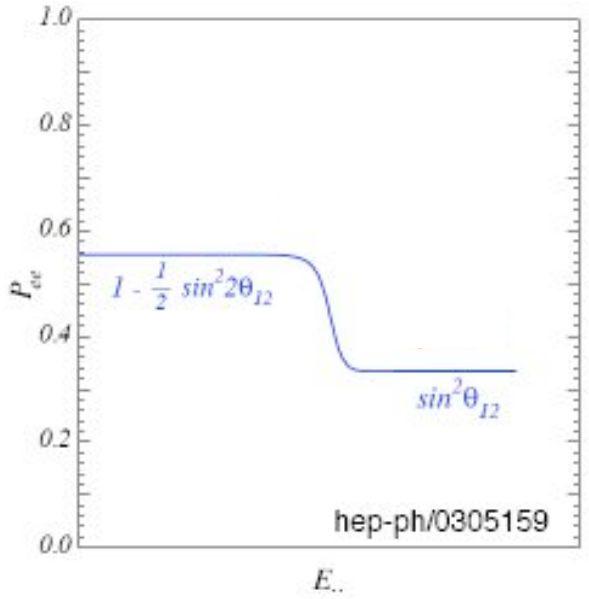
Solar phase

^{7}Be solar neutrino :

- No real time measurement
- Experimental uncertainty is 40%

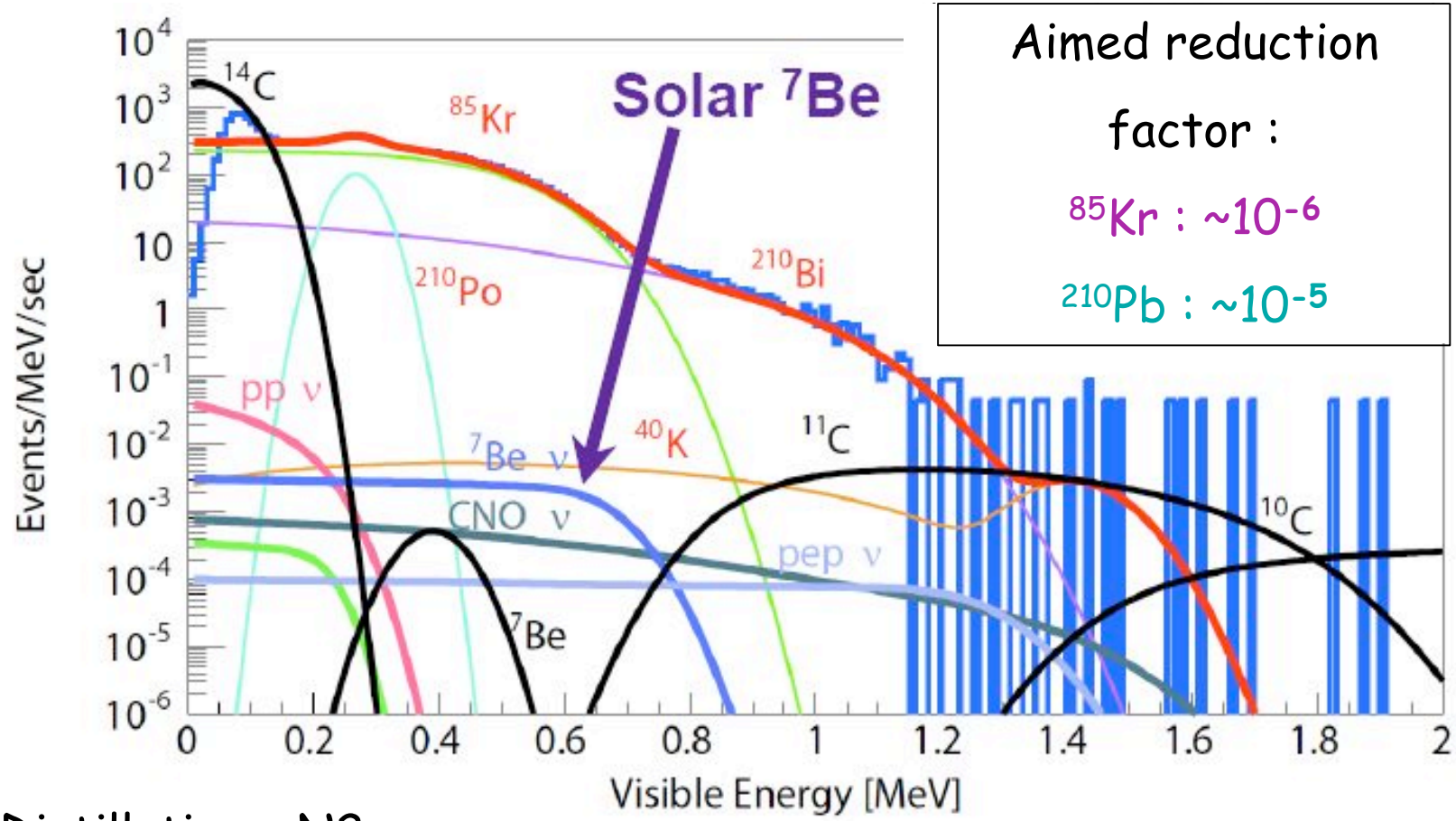


- KamLAND goal : 5-10%
- Improve SSM : pp 2% → 1%
- Be7 ν_e below MSW threshold
  verification of MSW effect



ES : $\nu_e + e^- \rightarrow \nu_e + e^-$
Intense purification of LS to reduce BG

Background reduction



Aimed reduction factor :

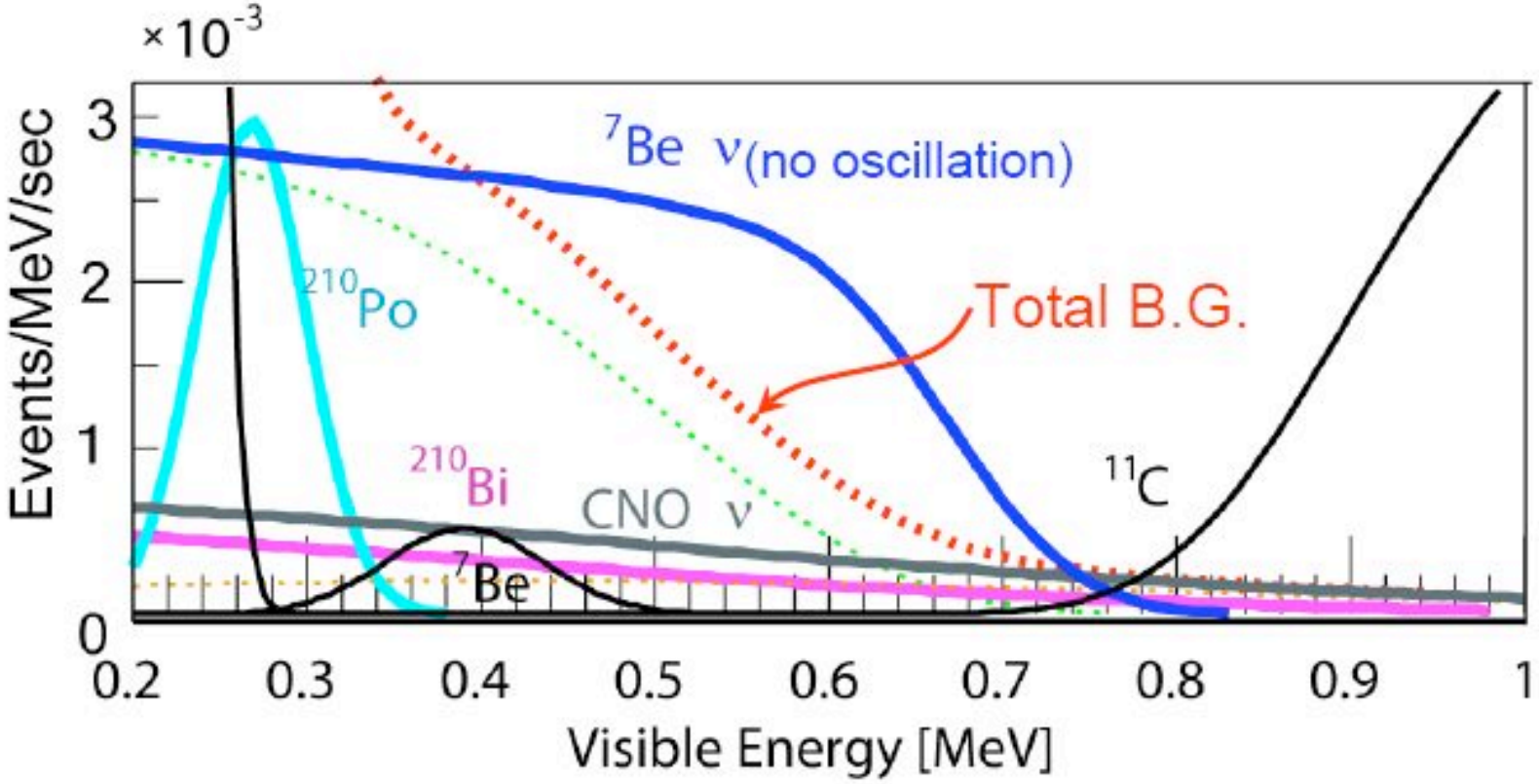
^{85}Kr : ~10^{-6}

^{210}Pb : ~10^{-5}

- Distillation + N2 purge
- Very promising results obtained with distillation test system : reduction factor ^{210}Pb 10^{-4}, 10^{-5}
- Purification system in construction

Solar phase : expected results

After 3 10^{-5} reduction for ^{210}Pb



Clear signal :
10% uncertainty on flux after 3 years data

Summary

- Reactor antineutrinos :
  - Spectral distortion and precise measurement of oscillation parameters
  - Data taking ongoing
  - Full volume calibration started, updated results will come soon

- Geoneutrinos :
  - First observation of geoneutrinos
  - Effort to reduce systematic error on BG

- Solar neutrino :
  - Purification will start very soon
  - Goal : measure 7Be solar neutrinos with 10%