

Geo-Neutrino Opportunity in Jinping

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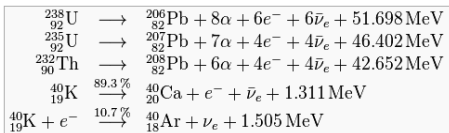
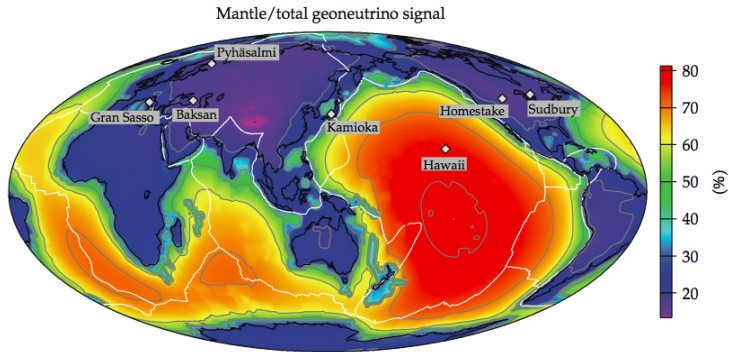
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May 23, 2016

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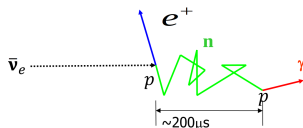
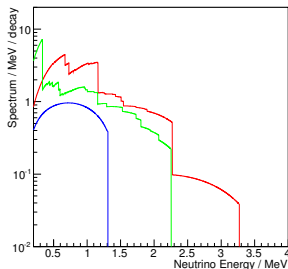
Geo-Neutrinos

Geo-Neutrino Introduction

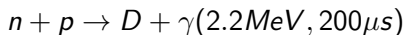
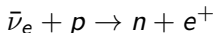


- Compose of $\bar{\nu}_e$
- Low energy ($E_\nu < 3\text{ MeV}$)
- Carry information of abundance and spatial separation

Geo-Neutrino Components



Inverse Beta Decay:



Only $\bar{\nu}_e$'s from **Th** and **U** excess the 1.8 MeV IBD threshold.

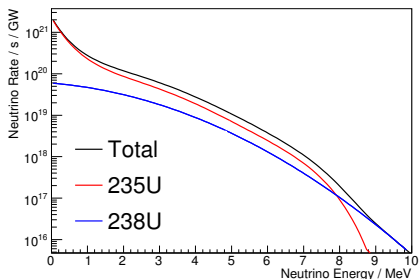
Geo flux calculation
from Bill and Ondrej (Vacuum oscillation,
not official yet...)

	^{238}U	^{232}Th	Total
Rate / TNU	32.9	9.3	42.2

Table : Geo-neutrino IBD event rates at JinPing.

Oscillation analysis shows that for geo neutrinos, **MSW effect is about 3%**.

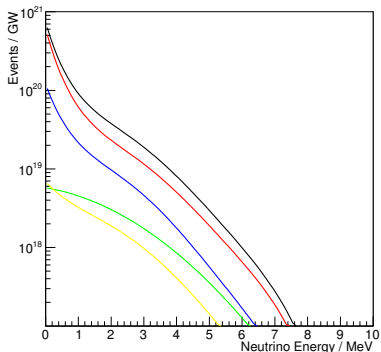
Another possible contribution to geo neutrino flux is $\bar{\nu}_e$'s from the **assumed earth core fission** processes.[Raghavan:2002]



- Thermal power assumed:
3-30 TW
- Fission fuel: 74.6% ^{235}U and 24.9% ^{238}U . [Herndon:2005]
- Corresponding to **7.7 TNU / GW** (MSW oscillation).

Background

Reactor Neutrino Spectrum

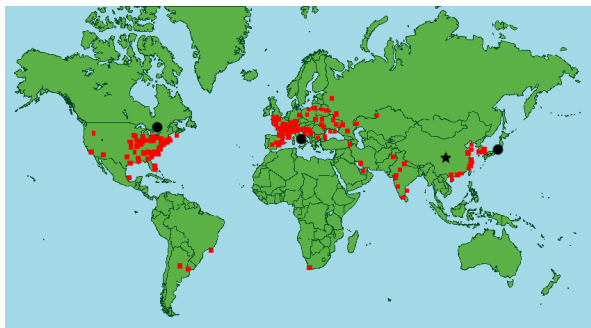


$$\phi(E_\nu) = \frac{W_{th}}{\sum_i f_i e_i} \sum_i f_i S_i(E_\nu)$$

- ① i sums over the four isotopes
- ② W_{th} thermal power of a reactor
- ③ f_i fission fraction of each isotope
- ④ e_i average energy released per fission
- ⑤ $S_i(E_\nu)$ antineutrino spectrum per fission

Typical reactor neutrino spectrum in PWR.

Reactor Background at Jinping



Event Rate (TNU)	Constructed		Under Construction		Total
	China	Others	China	Others	
FER	6.6	4.9	10.6	0.4	22.5
SER	1.5	1.1	2.4	0.1	5.0

Table : Reactor neutrino event rate at Jinping.

(α, n) & Accidental

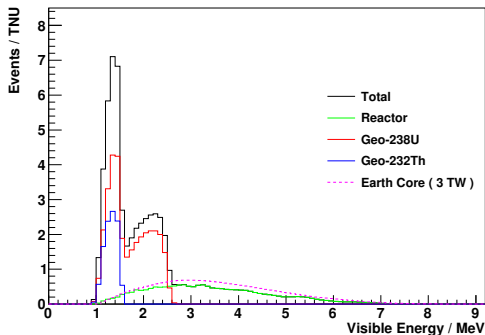
- $^{13}\text{C}(\alpha, n)^{16}\text{O}$ α from spallation.
Muon rate is extremely low in Jinping with the 6,720 w.m.e. overburden (several per day), therefore spallation induced backgrounds can be ignored.
- **Accidental** < 0.1 TNU
Mainly from natural radioactivity in PMT and steel structure. Can be further reduced by position reconstruction.

Geo- ν Opportunity at Jinping

Detector Setup

- 1 **3 kilo-ton** target mass
- 2 **Slow LS** or LS
- 3 **500 p.e.** $\sim 4.4\%/\sqrt{E}$

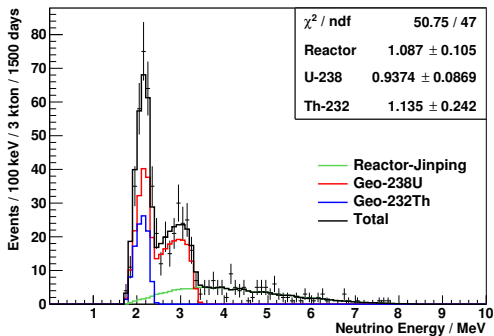
IBD Energy Spectrum at Jinping



	Geo-neutrino			Reactor	
	^{238}U	^{232}Th	Total	FER	SER
Rate / TNU	32.9	9.3	42.2	22.5	5.0

Table : Geo-neutrino and reactor neutrino event rates at JinPing.

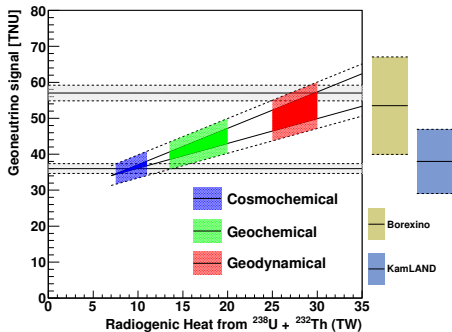
Th/U Ratio



	U	Th	Th/U
Uncertainty	9.5%	21.5%	26.4%

- Fitting with free reactor flux.

BSE Model Test



- Predicted geo $\bar{\nu}_e$ fluxes and uncertainty for 2 extreme situations.
- Expectations for mantle models from **cosmochemical**, **geochemical**, and **geodynamical** estimates.
- Sloped bands response to the mantle $\bar{\nu}_e$ flux (homogeneous / sunk layer distribution).

Jinping will be able to distinguish between BSE models.

Within 300 days of live-time and 3 kiloton fiducial mass, the geo-fission power sensitivity can reach 1.7 TW, conclusively confirm or exclude the assumption of earth core fission process.

Conclusion

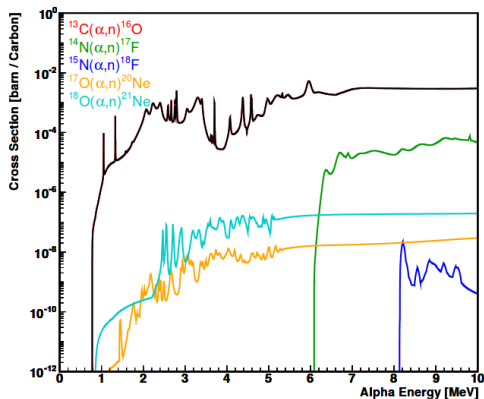
- ① Th/U Ratio (21.5% Sensitivity)
- ② BSE Model Test
- ③ Geo-Fission Test
- ④ Other Geo-Physics Potential

The End

Backup Page

Nuclear Reaction Bkg

(α, n) in LS



Target	Abundance
^1H	99.985%
^2H	0.015%
^3H	-
^{12}C	98.90%
^{13}C	1.10%
^{14}C	-
^{14}N	99.634%
^{15}N	0.366%
^{16}N	-
^{16}O	99.762%
^{17}O	0.038%
^{18}O	0.200%
^{19}O	-

[?]