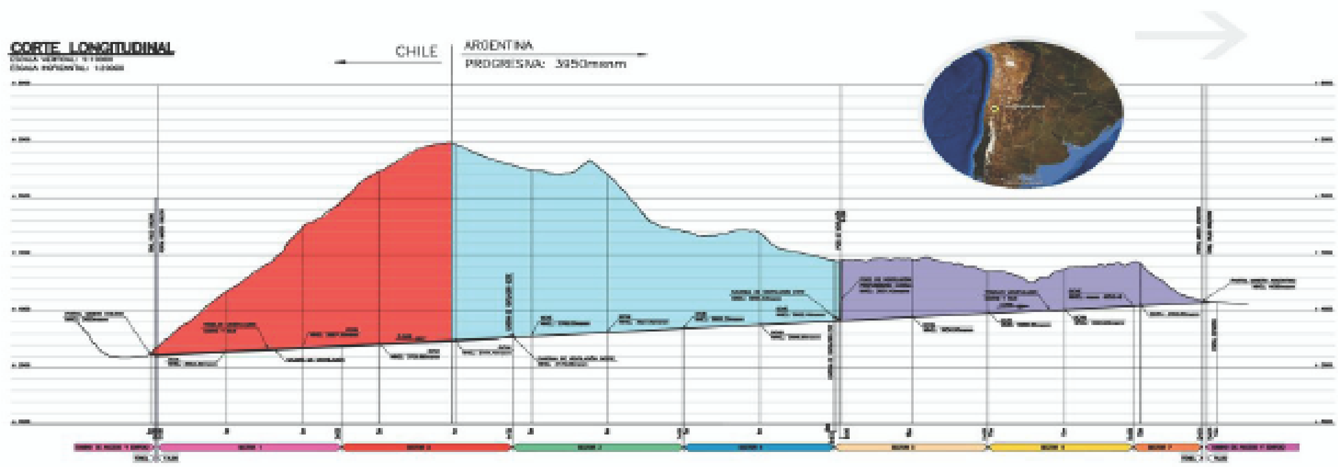
ANDES

The first deep underground laboratory of the Southern hemisphere.

A Latin American project in the Agua Negra tunnel



Agua Negra Deep Experiment Site

On behalf of Osvaldo Civitarese, La Plata Univ.

+ extra slides added by H. Nunokawa
+ some updates provided by X. Bertou and C. Dib

WIN2013, Sep. 16-21, Natal, Brazil

Deep Underground Laboratories and Cosmic Radiation

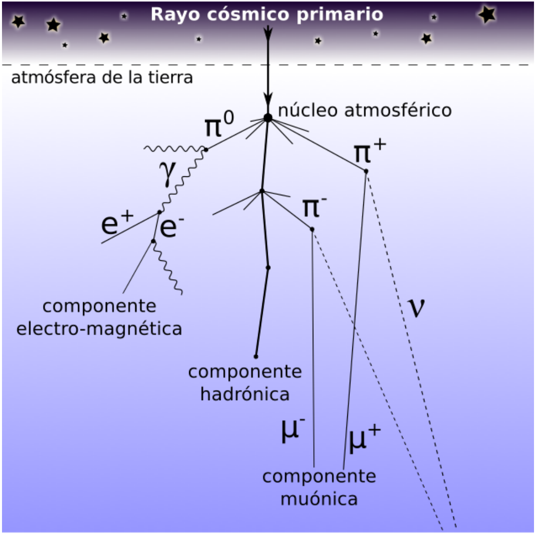
Cosmic Radiation

Primaries

- Protons
- Nuclei
  - Helium...
  - Oxigen...
  - Iron
- Neutrons
- Gamma, X Rays

Secundaries

- muons
- electrons/positrons
- gammas
- neutrons
- neutrinos
- ...



Cosmic Ray Observatories

Sierra Negra, México

Mérida, Venezuela

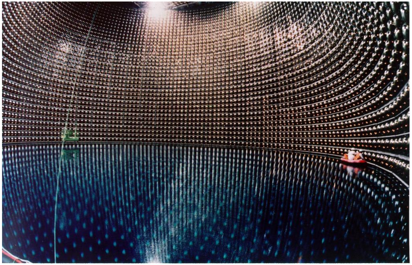
Observatorio Pierre Auger, Malargüe

Why go deep underground?

Cosmic Rays as noise

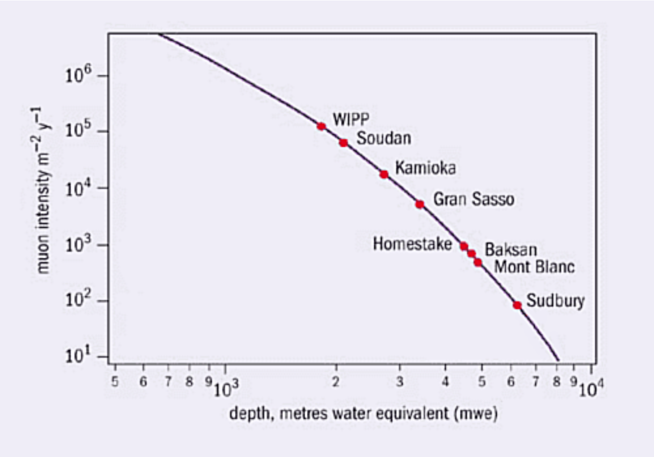
In a cubic meter detection volume, one detects daily:

- 10^8 muons
- 10^8 gammas/electrons/positrons
- 10^6 neutrons
- 10^{-3} neutrinos
- 10^{-7} supernova neutrinos
- maybe 100 dark matter particles
  (there is no dark matter detector of this size yet)



Muon flux and overburden

Muon flux at sea level: a few 100 $m^{-2}\,s^{-1}$



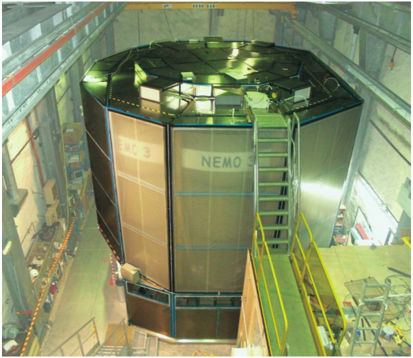
Muon flux 1750 m underground: 1 $m^{-2}\,day^{-1}$

Experiments in Underground laboratories - ν

Neutrinos

- Particle able to cross millions of km of rock without interaction
- Solar neutrino flux: $\approx 10^{11}$ neutrino per cm^2 per second (day and night)

- nuclear reactor neutrinos
- particle accelerator neutrinos
- atmospheric neutrinos
- solar neutrinos
- extrasolar neutrino
- neutrino oscillation
- neutrino mass
- neutrino nature
- geoneutrinos



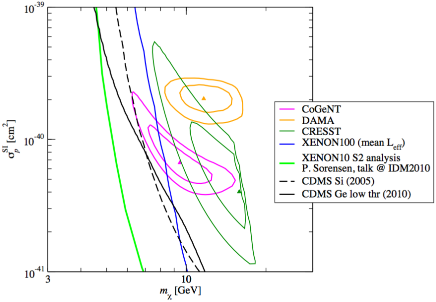
Experiments in Underground laboratories - DM

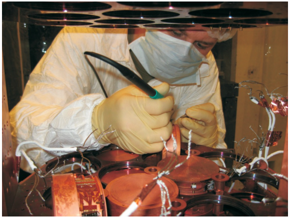
Dark Matter search

- Visible matter $\approx$ 0.4% Universe
- Adding intergalactic gas, reach 4%
- 24% of Universe formed by Dark Matter
- remaining 72%: Dark Energy

- different detector techniques (cryogenics, noble liquids, ...)

- direct detection
- indirect search (modulation)





Light WIMPs or Backgrounds? At this point the situation is confusing and exciting.... Light WIMP s are interesting- however its signal is close to threshold where background is difficult to understand.

There have been many objections to the DAMA result over the years, none conclusive... now extended to CoGeNT too... could they be observing annually modulated backgrounds?

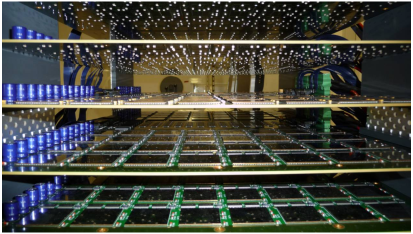
- O(10 MeV) ambient neutrons J. P. Ralston arXiv1006.5255
- $>$TeV cosmic ray μ's J. P Ralston arXiv1006.5255, K. Blum arXiv1110.0857 D, Nygren arXiv1102.0815 (2011)

We need ANDES!

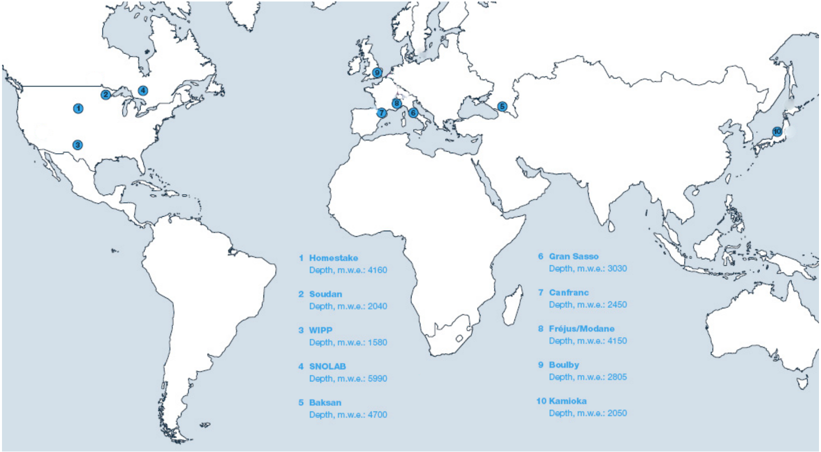
Talk by Graciela Gelmini on Monday

Experiments in Underground laboratories - continued

- Geoscience
  - seismograph (low frequency)
  - geoneutrinos?
- Low radiation measurements
  - material selection
  - climatology, environment
  - microelectronics
- Biology



Underground Laboratories



- + China, Korea, India
- mines (harder to work in), tunnels (harder to plan)
- None in the southern hemisphere

Southern hemisphere and Latin America?

South Africa

- First atmospheric neutrinos in 1965 (together with India)

South America

- Argentina: experiment at Sierra Grande mine (1000 wme)
  - Search for an annual modulation of dark-matter signals with a germanium spectrometer at the Sierra Grande laboratory Astropart.Phys. 10 (1999) 133-139
- Brazil: search for a mine by Lattes
- Chile: El Teniente mine prospected

Latin America

- Mexico: proposal of the multidisciplinary mexican underground laboratory (LSMM) for Mega Proyectos 2006

The ANDES laboratory at the Agua Negra tunnel

Andes crossing

- It is of strategic importance for the region to increase exportation to the Asian market
- The natural way for Argentina and Brazil is to export by boat through Chile
- There are various passes. The main one, the Cristo Redentor tunnel from Mendoza to Santiago, cannot fulfil the increasing international demand, especially in winter when it has to close due to strong snows.

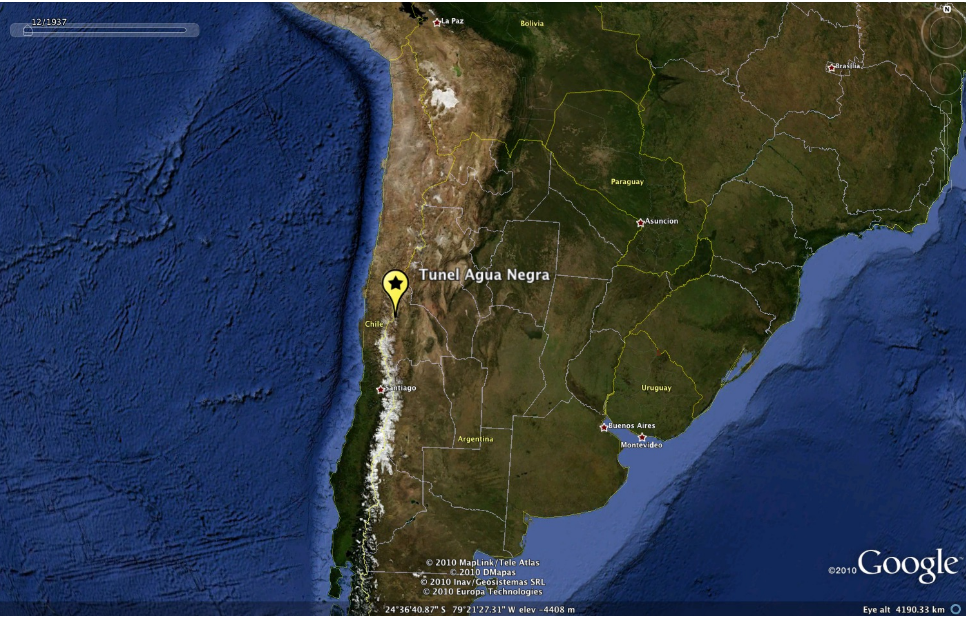
- Argentina, Brazil and Chile have been looking for years at complementary options
- There have been various proposals for Mendoza - Santiago (train tunnel, Las Leñas pass) and San Juan - Coquimbo (Agua Negra)
- Recently the San Juan - Coquimbo option has been favoured

The Agua Negra tunnel context

- Pre-feasibility study done in 2005, feasibility in 2008
- Cristina Fernández de Kirchner and Michelle Bachelet signed a Bi-National Integration treaty, including the San Juan - Coquimbo option, in October 2009, voted later on by both countries
- August 2010 MERCOSUR meeting was in San Juan and a strong support for the Agua Negra tunnel was given, with Luis Inácio Lula da Silva pushing for the tunnel tender
- In December 2011 the Argentine congress voted a 800 MU$D guarantee fund for the Agua Negra tunnel
- In March 2012, Cristina Fernández de Kirchner and Sebastián Piñera signed an international agreement asking for the tender of the tunnel

- Tender expected to start in 2013
- Total cost is estimated to about 850 MU$D

Location of the Agua Negra pass

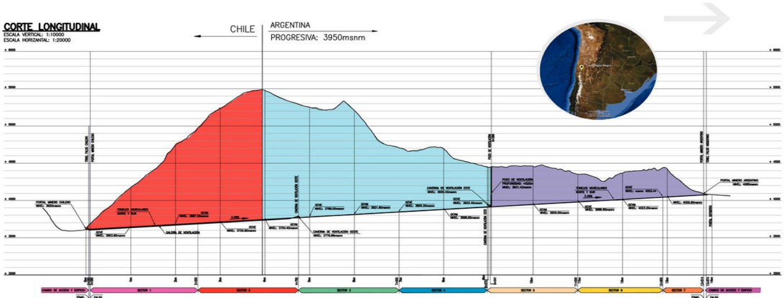


There is no Tunnel yet!

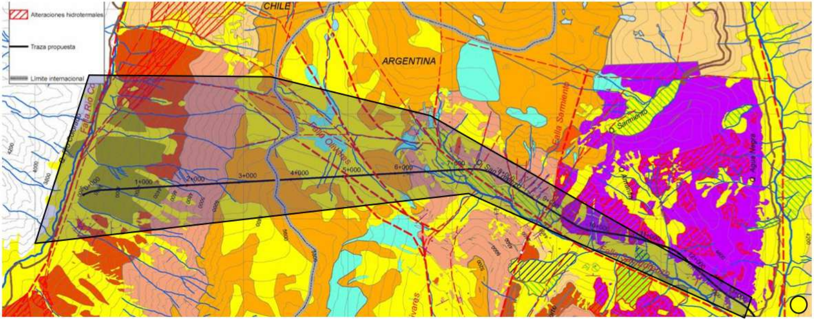
Views of the Agua Negra pass

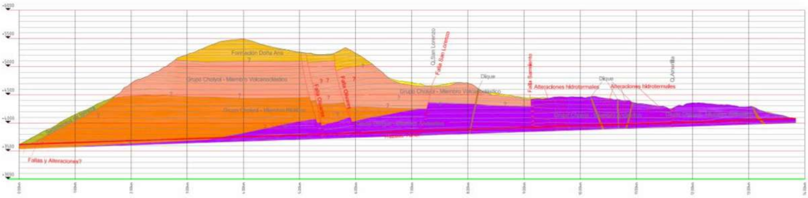
Tunnel proposed

- 2 tunnels, 12 m $\varnothing$ each, separated by 60 m, $\approx$ 14 km long
- Argentine entry point at the Quebrada San Lorenzo, 4085 m a.s.l.
- Chilean entry point on a ridge, at $\approx$ 3600 m a.s.l.
- Internal connexion galleries every 500 m
- Deepest point at $\approx$ 1750 m depth
- Tender in 2013, Construction 2014-2020



Agua Negra geology





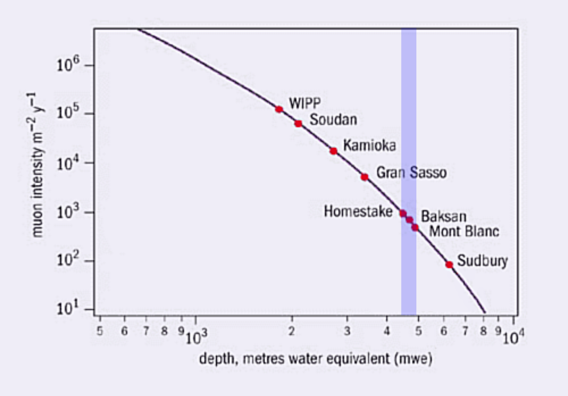
Results of Geology studies

Main rocks

- Andesite
- Rhyolite
- Basalt
- Dacite
- Trachyte

4500-4800 mwe

- World class location



- data from 8 main perforations of up to $\approx 600\,\mathrm{m}$ deep

Rock radioactivity measurements

- 9 samples, mostly from $\approx 600\,\mathrm{m}$ deep

Radioactivity data (Bq/kg)

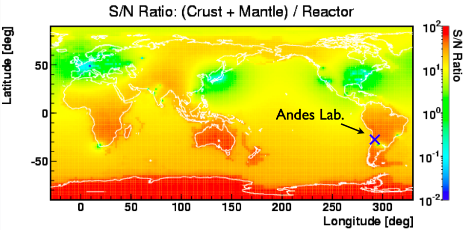
	Basalt	Andesite	Rhyolite 1	Rhyolite 2
^{238}U	2.6 ± 0.5	9.2 ± 0.9	14.7 ± 2.0	11.5 ± 1.3
^{232}Th	0.94 ± 0.09	5.2 ± 0.5	4.5 ± 0.4	4.8 ± 0.5
^{40}K	50 ± 3	47 ± 3	57 ± 3	52 ± 3

What makes ANDES special?

(in addition, for us, of being in Latin America)

- Only deep underground laboratory in southern hemisphere
  - Opposite weather induced modulations

- Low reactor neutrino bkg
  - Embalse: 2.1 GWt, 560km
  - Atucha: 1.2 GWt, 1080km (Atucha II: 2.1 GWt)
- Geoactive region
  - geophysics underground laboratory



- Very long baselines?
  - CERN: 9920 km
  - Fermilab: 7640 km (“magic” baseline)
  - KEK: 12425 km (1500 km from Earth center)

ANDES Initial Scientific Programme

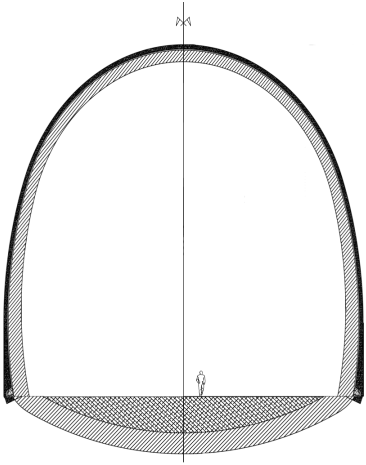
- Neutrino
  - host double beta decay experiments
  - large Latinamerican neutrino detector
    - KamLAND/Borexino style
    - focus on low energy
    - solar/SN/geo neutrinos
- Dark Matter
  - modulation measurement
  - new technologies
- Geophysics
  - link Argentine and Chilean seismograph networks
- Biology
- Low Background measurements
- Accelerator
  - Nuclear Astrophysics
  - DAR neutrino beam?

ANDES Laboratory proposal

Located at km 3.5-5

- main hall: $(21\times23\times50)\,\mathrm{m}^3$
- secondary hall: $(16\times14\times40)\,\mathrm{m}^3$
- multi-level hall: $(17\times15\times25)\,\mathrm{m}^3$, on 3 floors (up to $1200\,\mathrm{m}^3$)
- ultra-low radiation pit: $\varnothing 8$ m, 9 m depth
- single experiment pit: $\varnothing 30$ m, 30 m depth

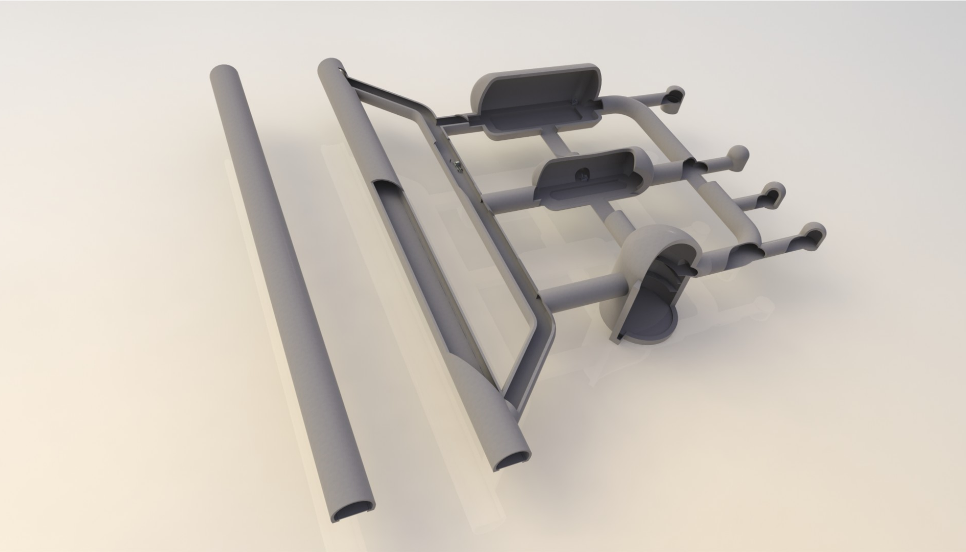
Linear tunnel for interferometer



Total civil work cost $\approx$ 15 MU$D

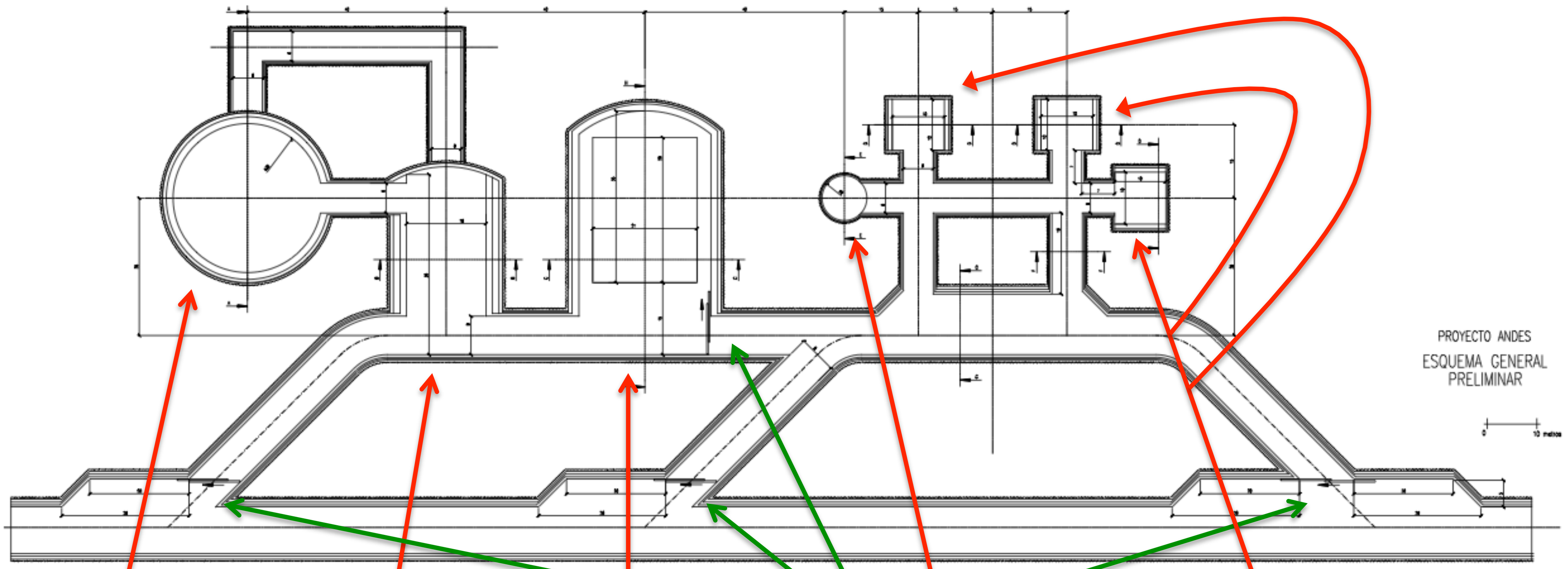
- + 2 external labs
- + experiments cost

ANDES Laboratory concept



ANDES Conceptual Design

Talk by Claudio Dib at TAUP2013, Sep. 8-13, 2013



Gates

Large pit
30 m diam
42 m deep

Access:
at 30 m high
and
at bottom

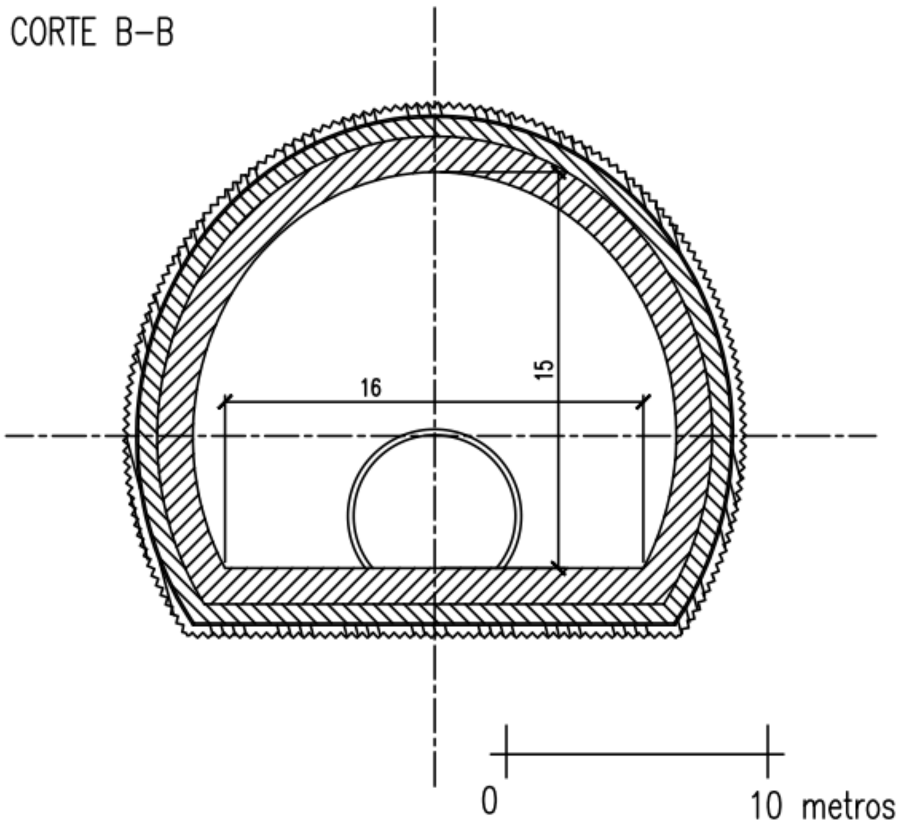
Service hall
40 m long
16 m wide
15 m high
Oval section

Main hall
50 m long
21 m wide
23 m high
Oval section

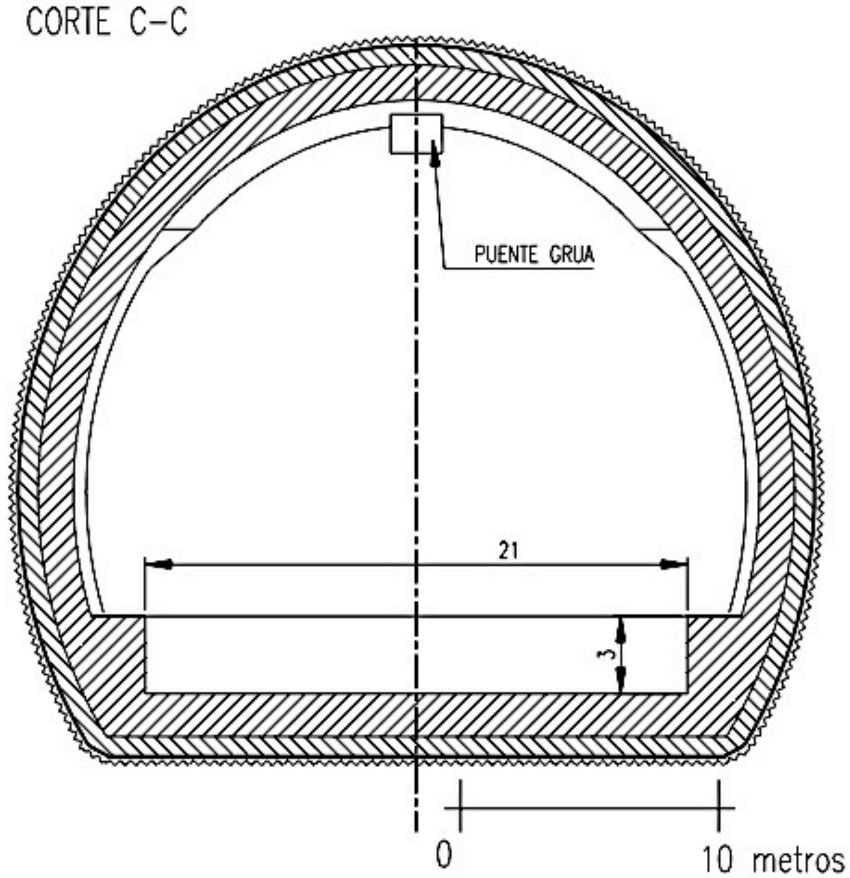
Ultra low radiation pit
9 m diam
15 m deep

Access:
At 10 m high
and bottom

3 secondary caverns
10 x 10 x 10 m

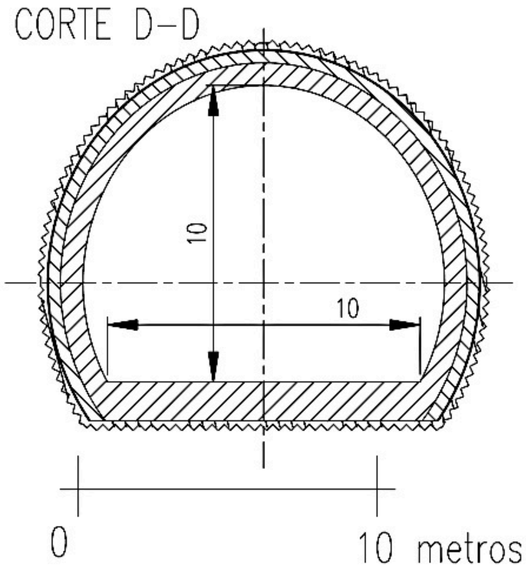


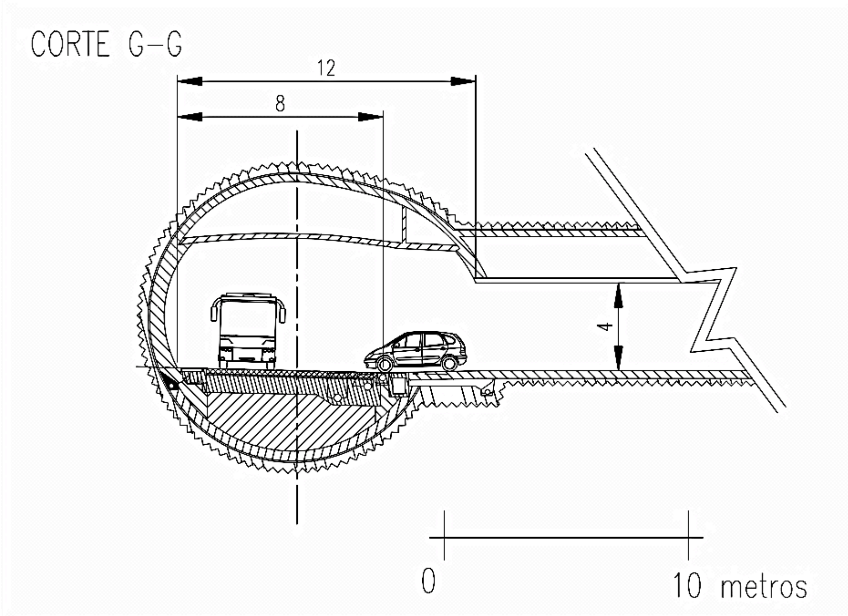
Service Hall
Transverse section



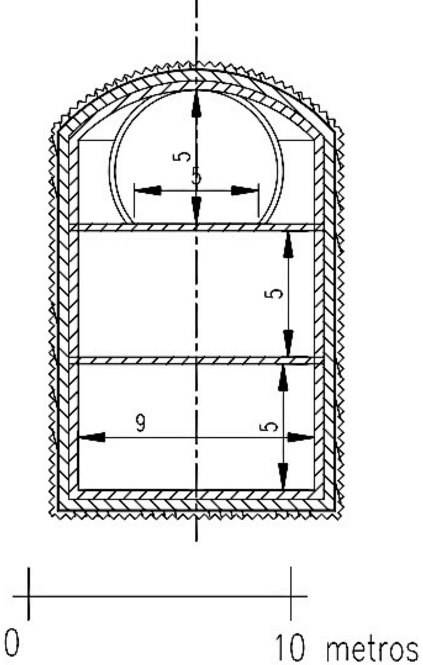
Main Hall
Transverse section

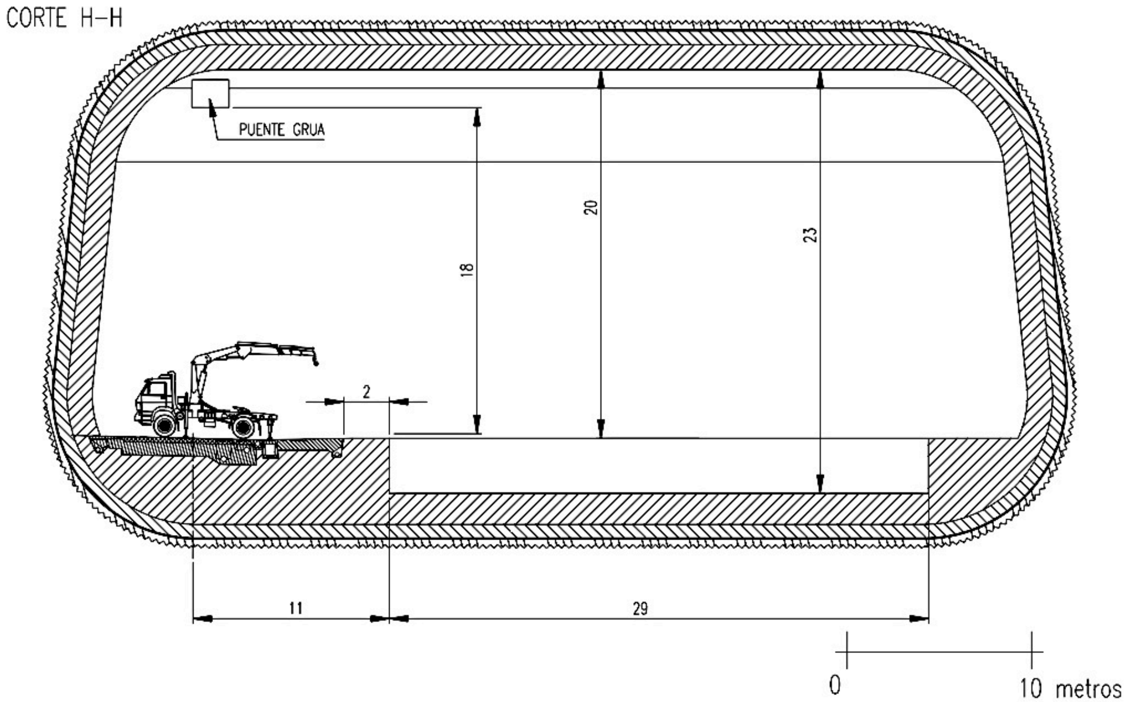
Secondary Halls



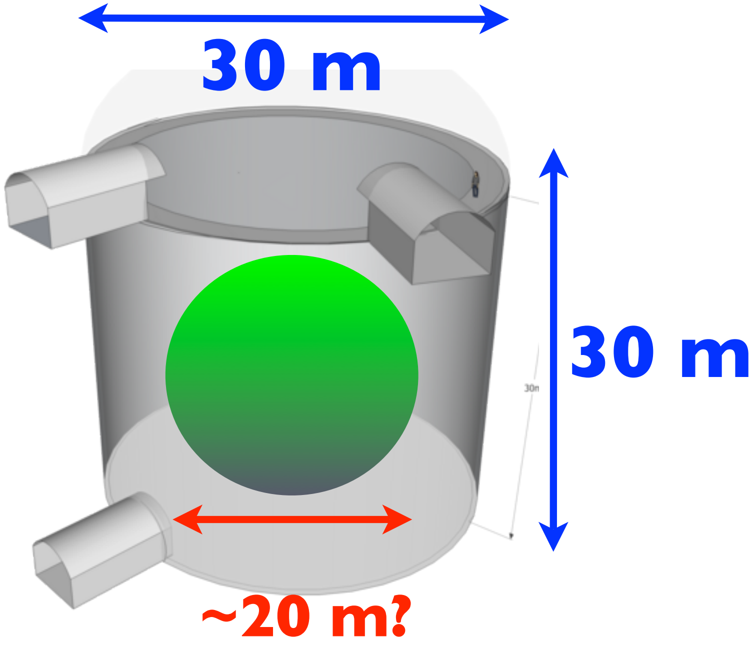


Ultra low rad. Pit

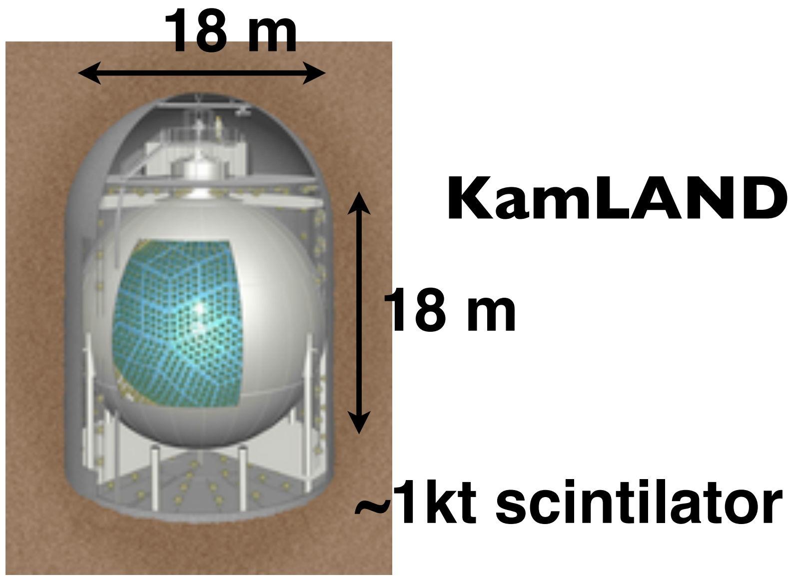


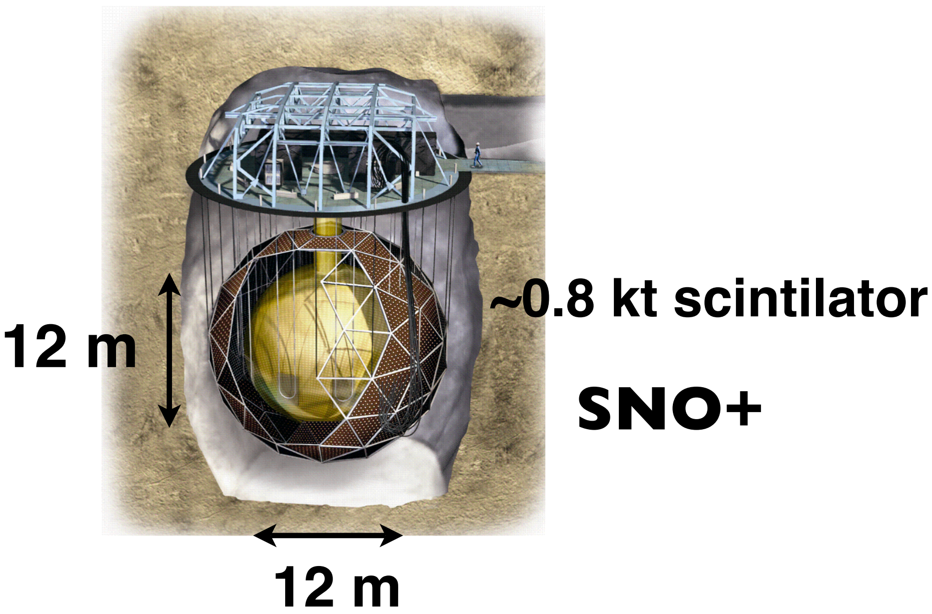


Possible Neutrino Detector at ANDES



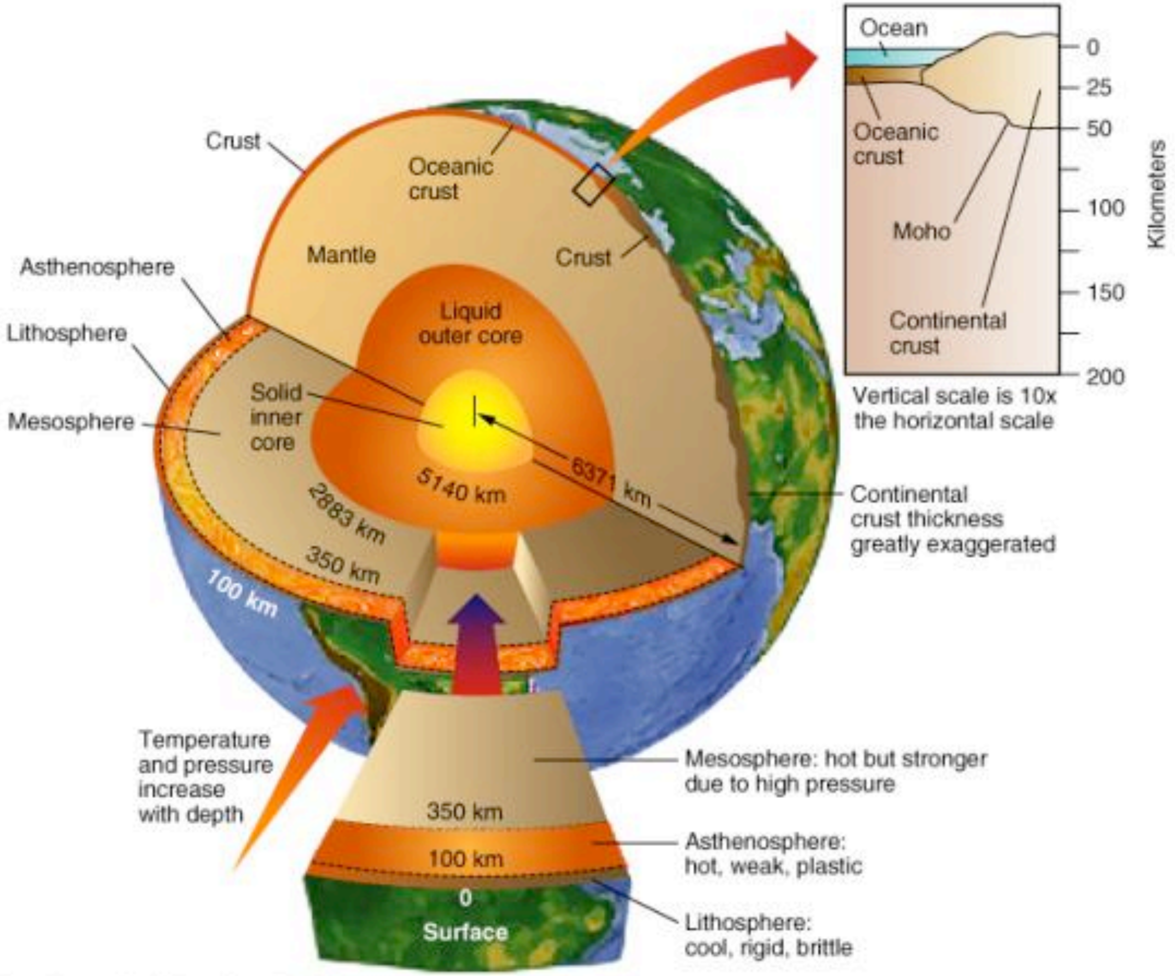
We assume that KamLAND/SNO+ like detector with a few kt can be constructed





Observation of Geoneutrinos at ANDES

We know that Earth Interior should be something like below ...



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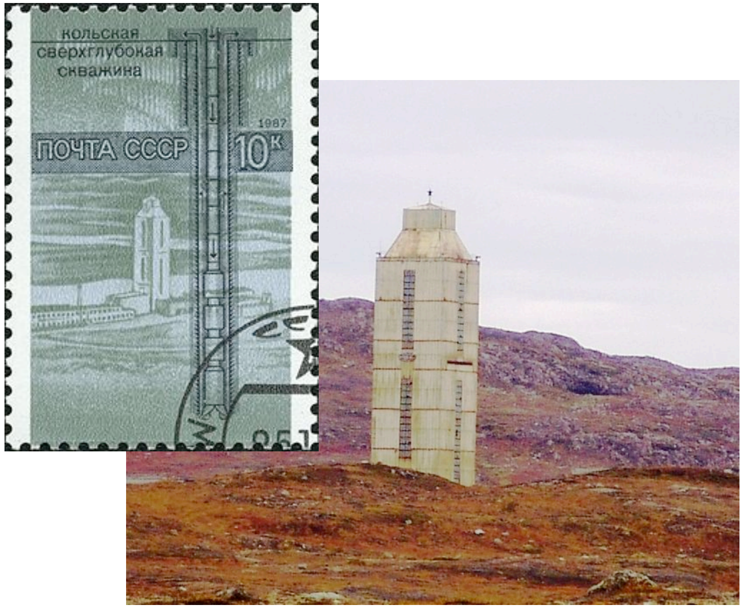
but not so easy to probe directly ...

deepest hole in the Earth ~ 12 km depth

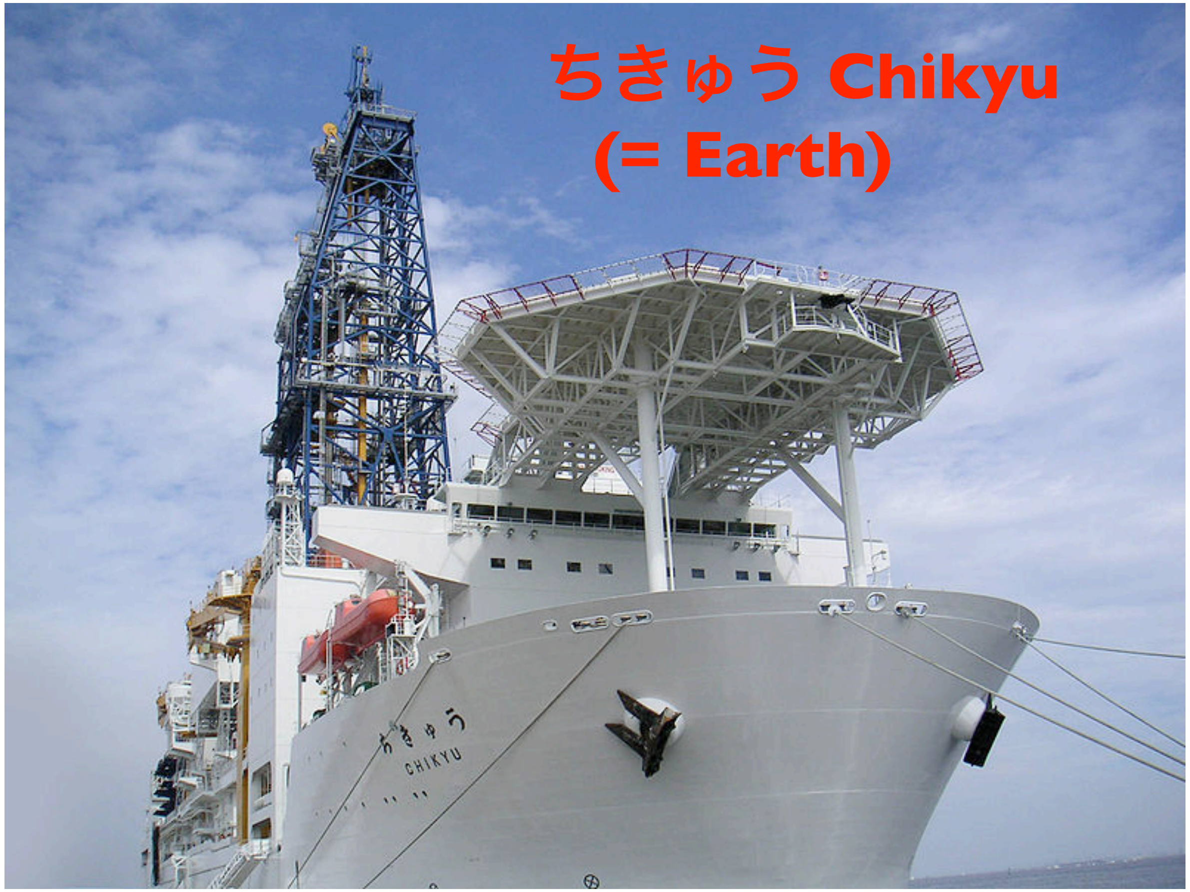
only ~ 0.2 % of the Earth Radius, only upper part of the Earth crust !

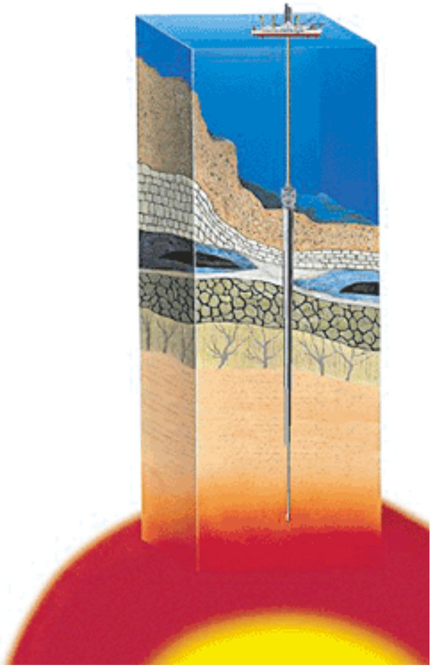


deepest hole of 12.262 m depth 1989

Kola Superdeep Barehole (Soviet Union)

Integrated Ocean Driling Program (IODP)





capable to dig more than 7 km from the seabed

one of the purposes: direct access to the Earth Mantle

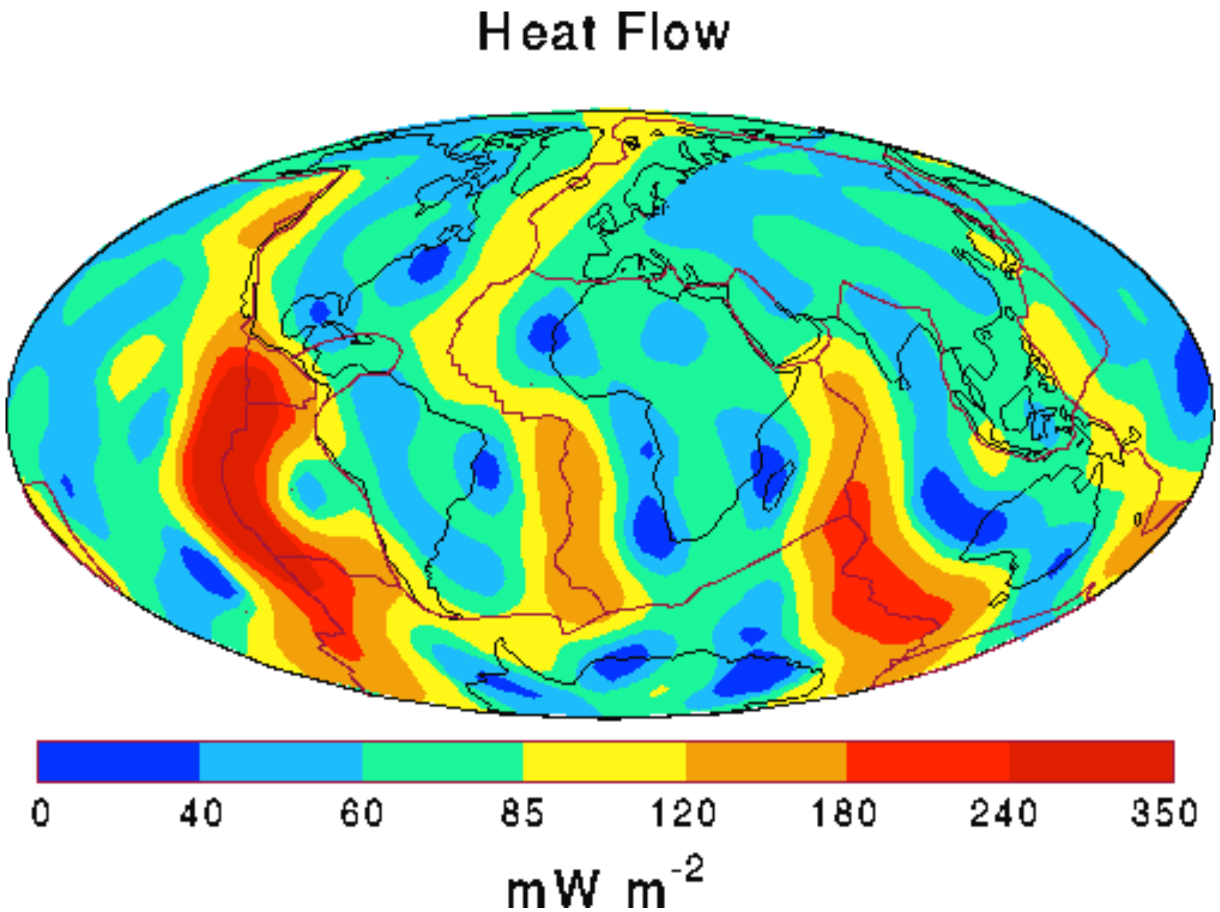
Methods to study Earth Interior

geochemistry: analysis of samples from the crust and upper mantle (deepest hole ~ 12 km, deepest rock samples from ~ 200 km)

seismology: it is possible to reconstruct the density profile of the Earth (and ditinguish solid from liquid) but not the compositions

geoneutrinos: new probe to study Earth Interior

Origin of the Earth Heat?

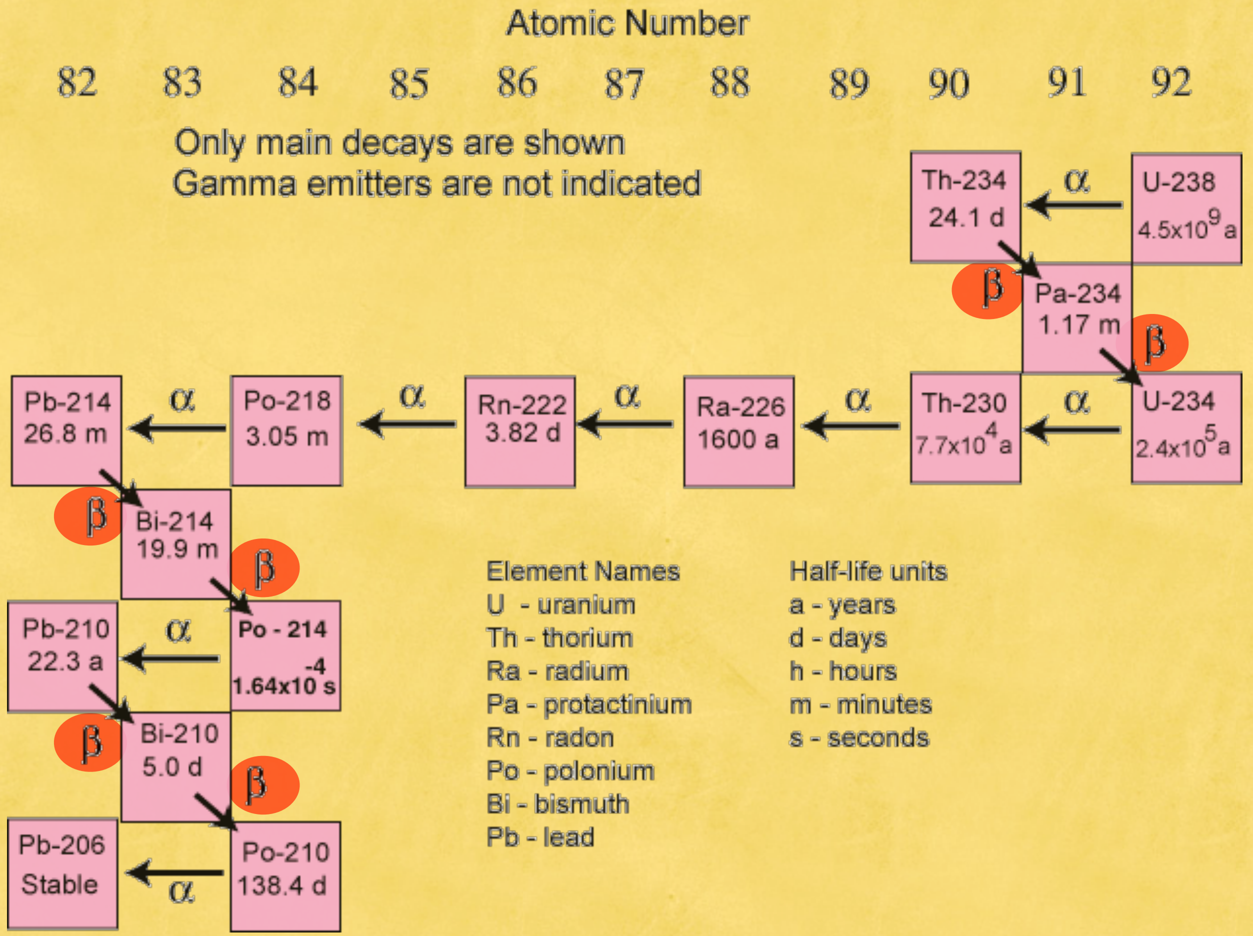


Observed (estimated): ~ 44 ± 1 TW

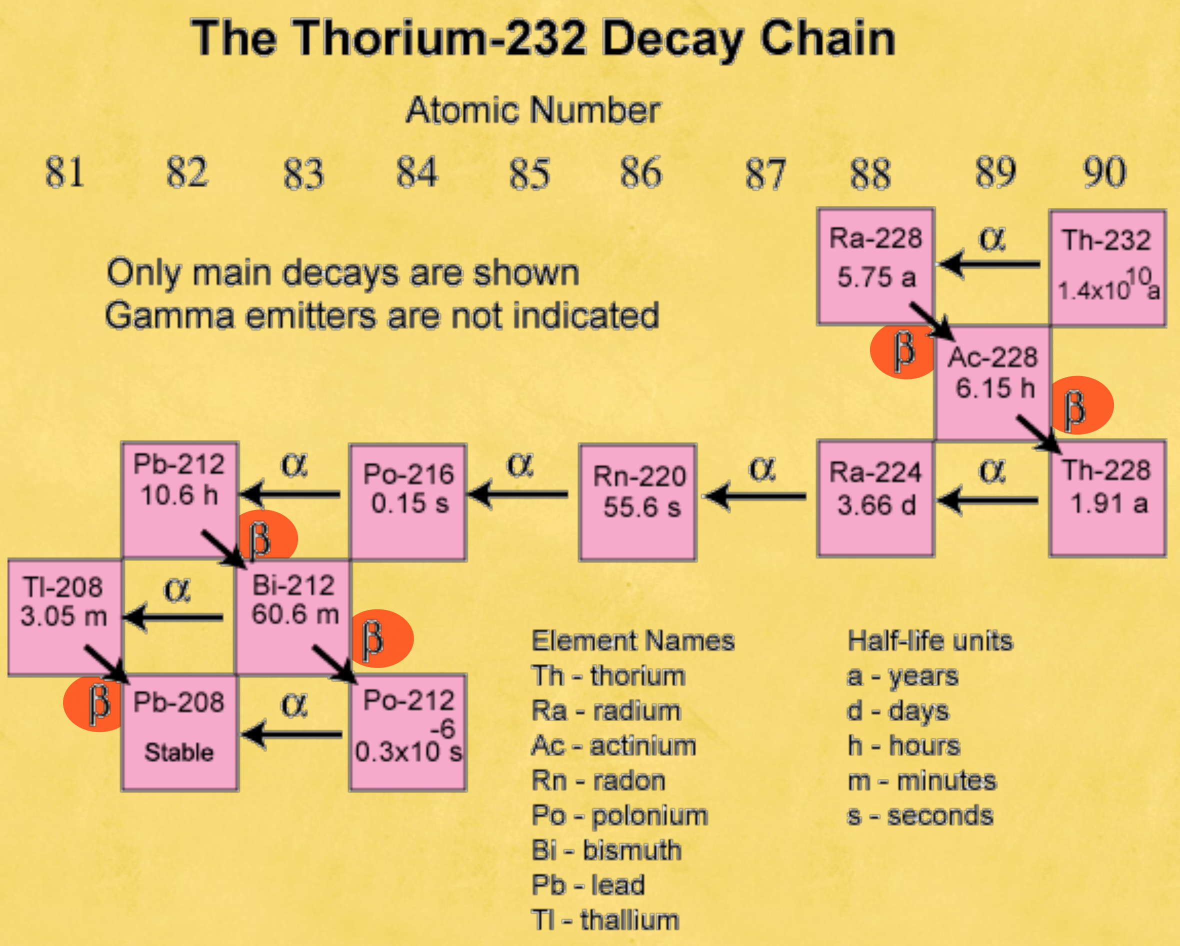
Theoretical Predictions: ~ 20 - 45 TW

large uncertainty

The Uranium-238 Decay Chain

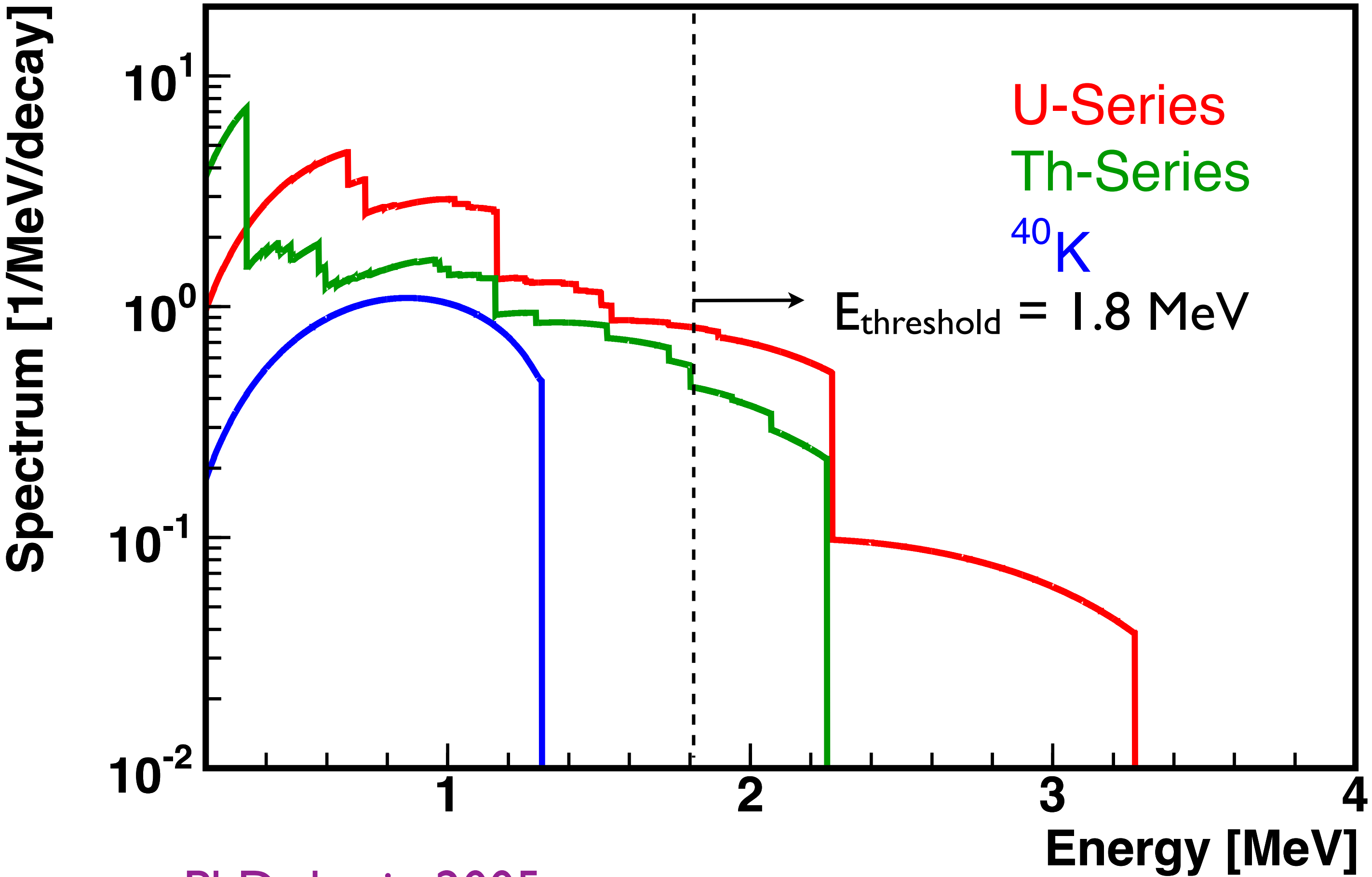


$$^{238}\mathrm{U} \rightarrow {}^{206}\mathrm{Pb} + 8\,{}^{4}\mathrm{He} + 6\,\mathrm{e}^{-} + 6\,\bar{\nu}_{\mathrm{e}} + 51.7\ [\mathrm{MeV}]$$



$$^{232}\mathrm{Th} \rightarrow \ ^{206}\mathrm{Pb} + 6\ ^{4}\mathrm{He} + 4\,\mathrm{e}^{-} + 4\,\bar{\nu}_{\mathrm{e}} + 42.7\ [\mathrm{MeV}]$$

Expected Geoneutrino Spectra



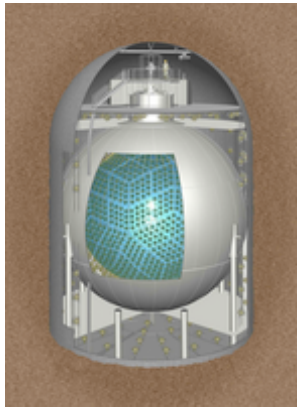
Enomoto, PhD thesis, 2005

Can be detected by the inverse beta decay reaction

$$\bar{\nu}_e + p \rightarrow n + e^+$$ $E_{threshold}$ = 1.8 MeV

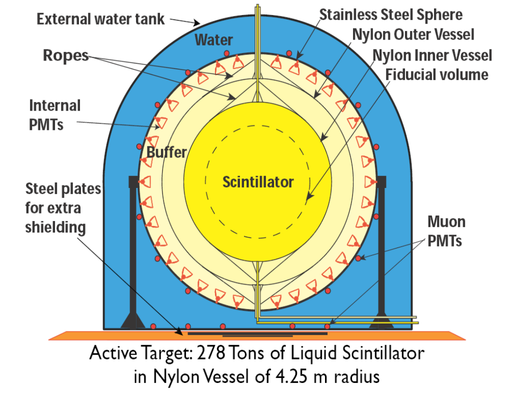
KamLAND

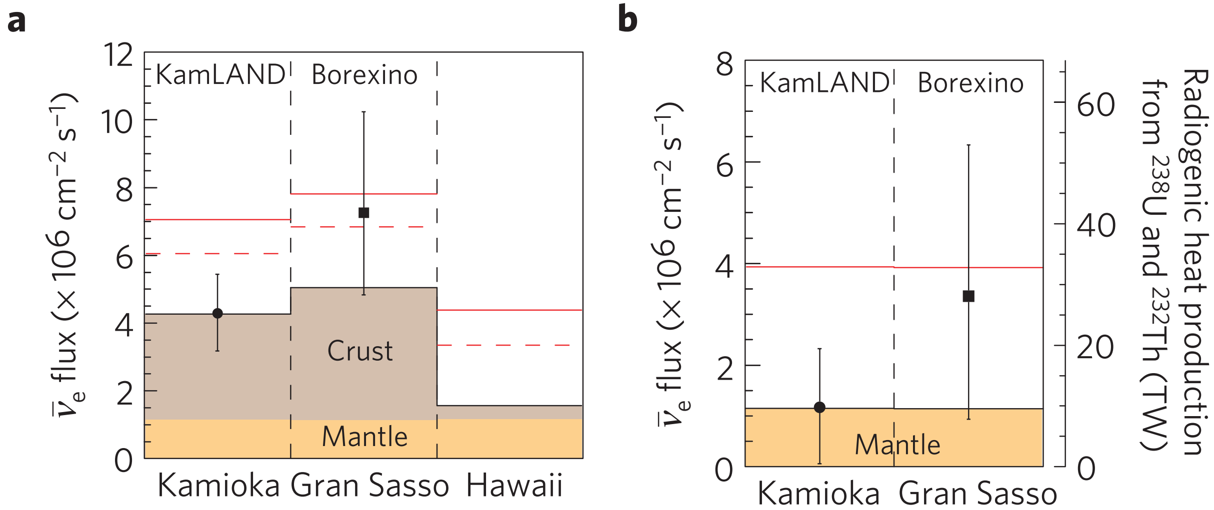
Nature Geocience 4, 647 (2011)



Borexino

Phys. Lett. B687, 299 (2010)





KamLAND + Borexino → 20.0+8.8-8.6 TW

Fully radiogenic model is disfavored at 97.2 % CL.

Only ~ half of the observaed heat flow ~ 44 TW.

Observation of Geoneutrinos at ANDES

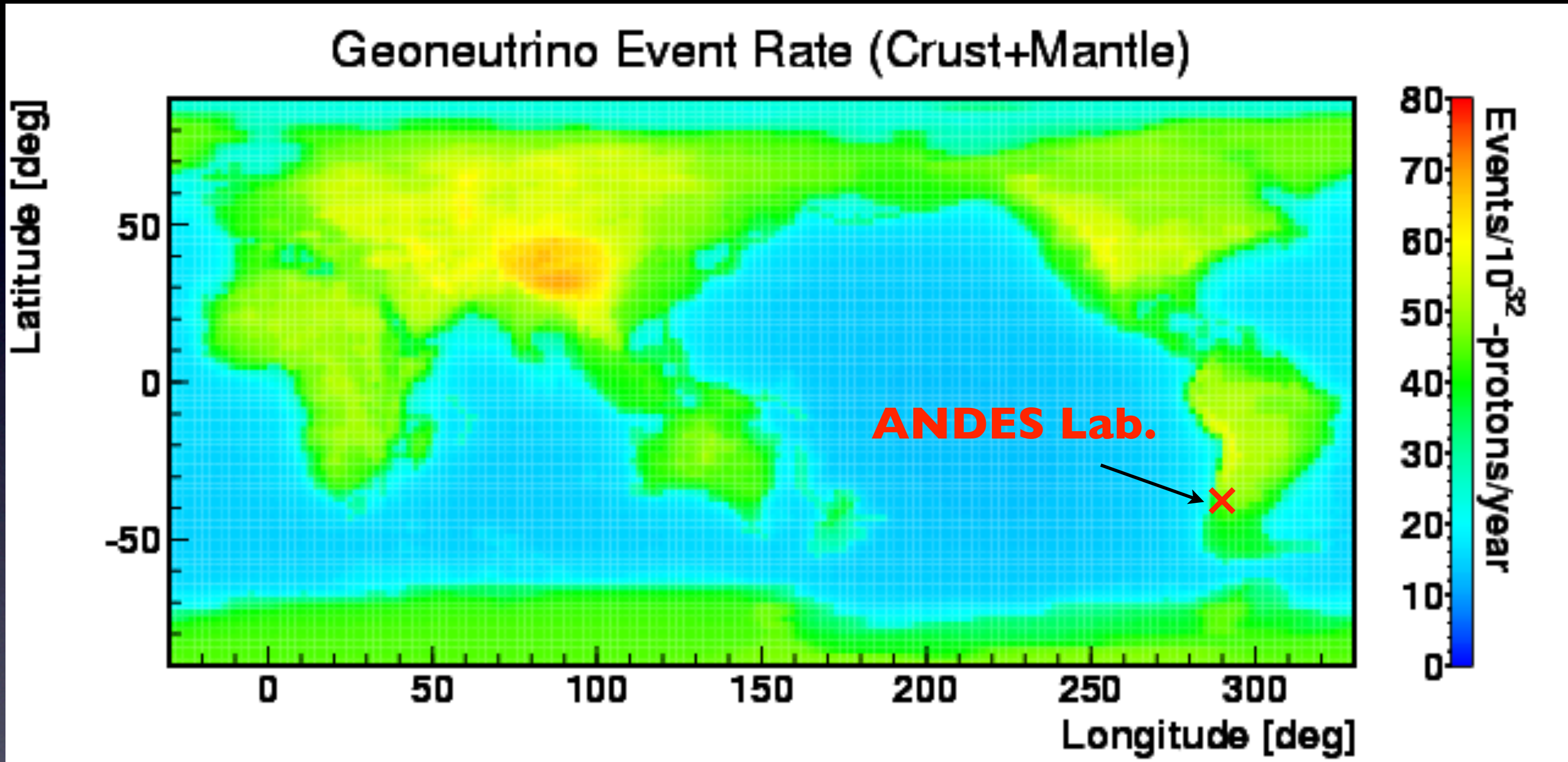
Why at ANDES?

Interesting Location (Higher Geo-nu flux)

Interesting to confirm site dependence

Very low reactor neutrino background

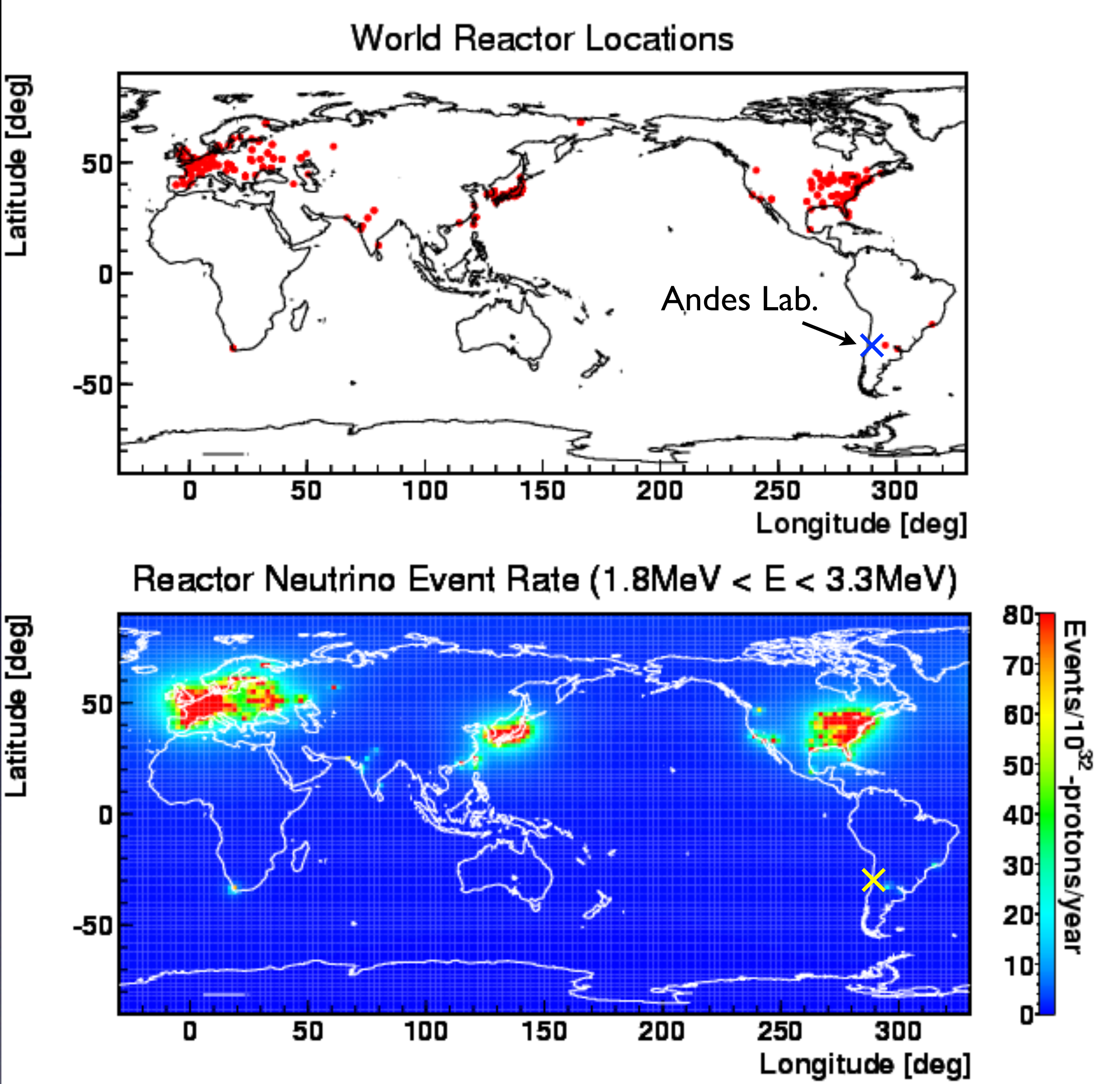
Interesting place because of larger flux of Geo-neutrinos (to confirm site dependence)



Enomoto, Neutrino Sciences 2007

U and Th are more concentrated in the continental crust

Another Advantage: Very few reactors



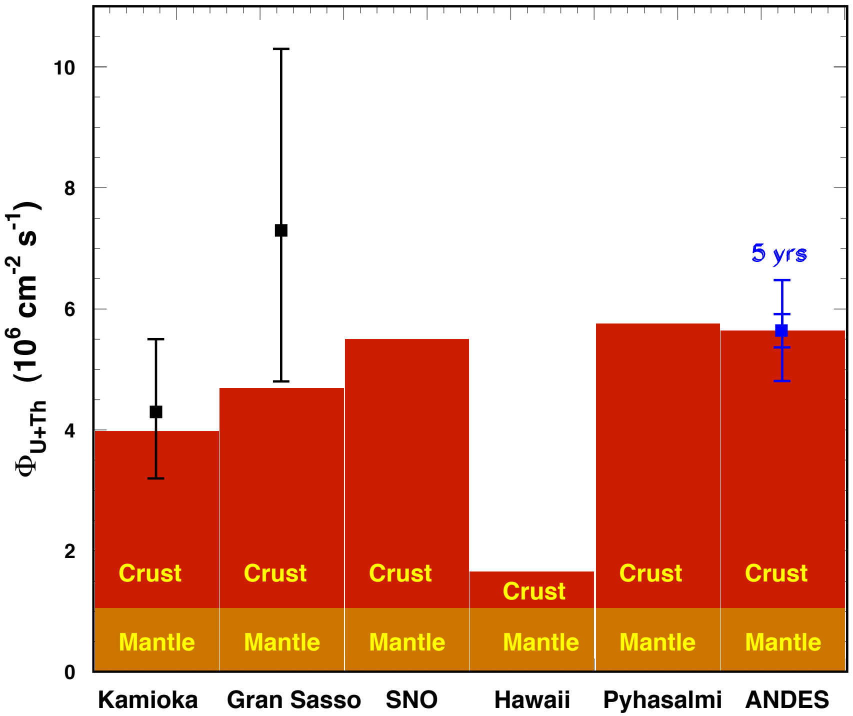
Enomoto, Neutrino Sciences 2007

distance to nearest reactor ~ 600 km

$N_{reac\ BG}$ ~ 2 event for 3 kt/yr at Andes Laboratory

Expected Geoneutrino flux and events at ANDES

comparison with other sites

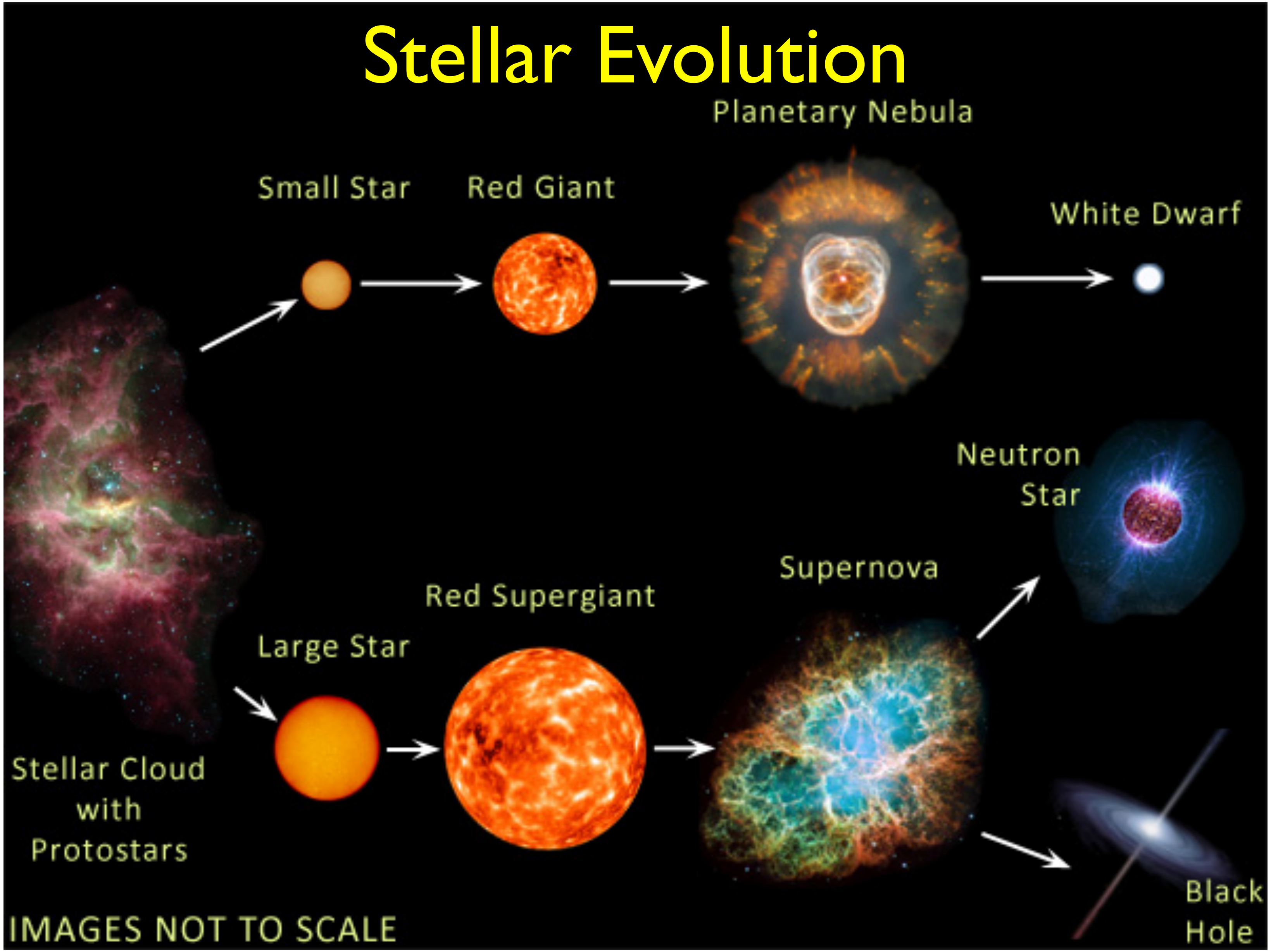


of event /3 kt/yr

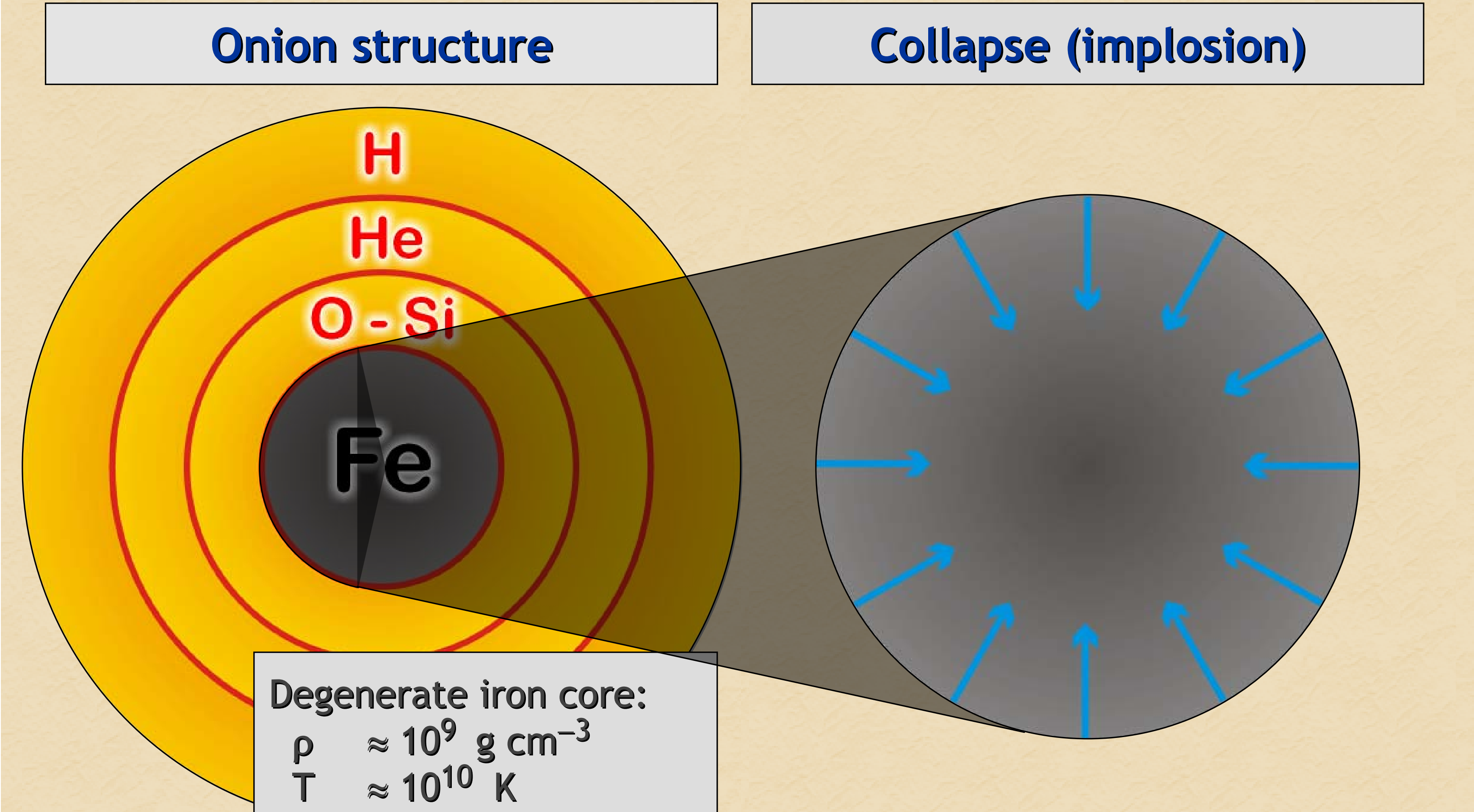
Location	Number from U	Number from Th	Total
Gran Sasso	53.8	14.7	68.5
Kamioka	45.7	12.4	58.1
Hawaii	27.3	7.4	34.7
Sudbury	63.2	17.2	80.4
Pyhäsalmi	66.1	18.0	84.1
ANDES	64.8	17.6	82.4

Machado et al, PRD86, 125001 (2012) [arXiv:1207.5454[hep-ph]]

Observation of Supernova (SN) Neutrinos at ANDES


Stellar Evolution
Planetary Nebula
Small Star
Red Giant
White Dwarf
Neutron Star
Supernova
Red Supergiant
Large Star
Stellar Cloud with Protostars
Black Hole
IMAGES NOT TO SCALE

Stellar Collapse and Supernova Explosion



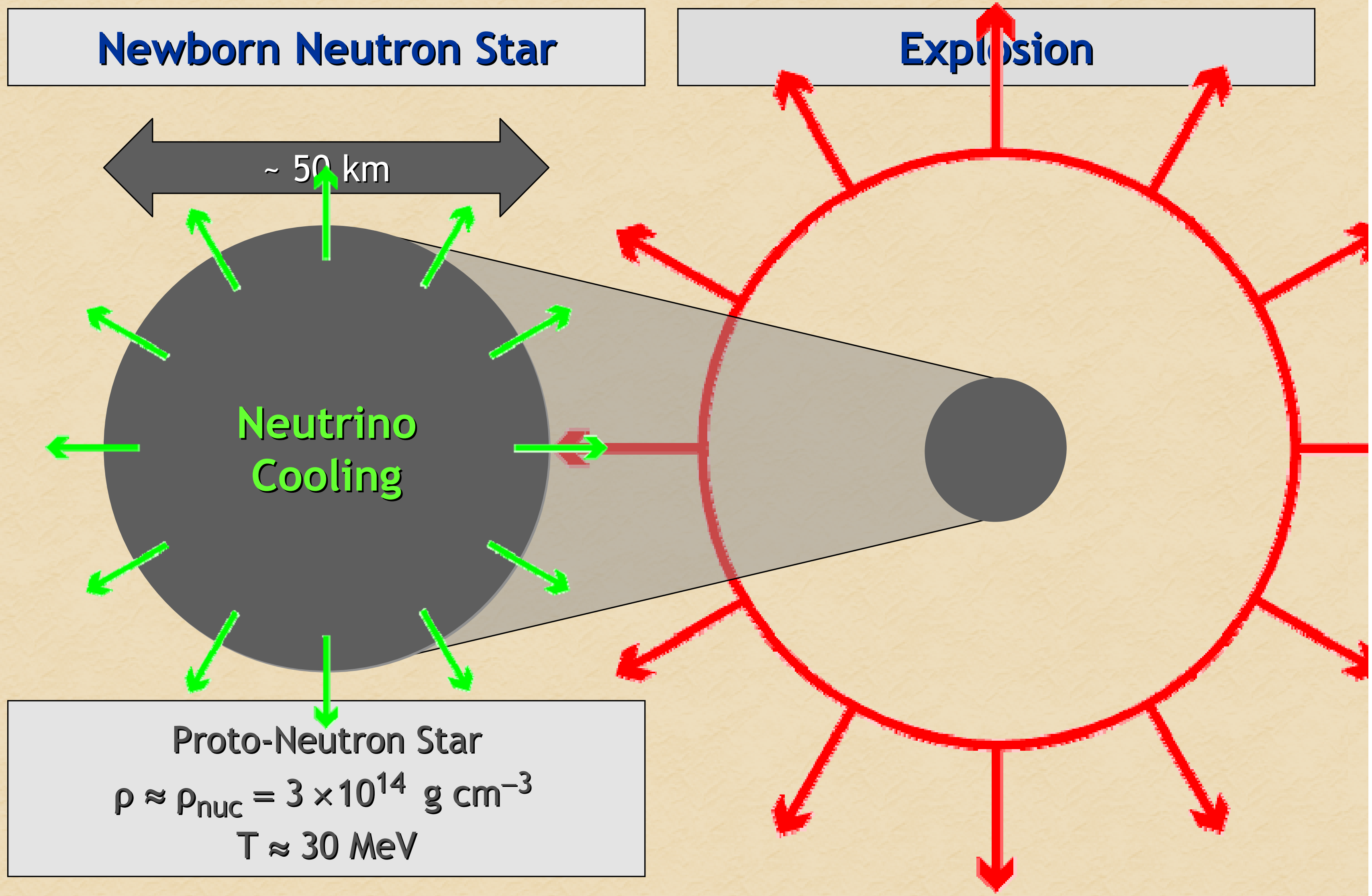
Degenerate iron core:

$\rho \approx 10^9\ \mathrm{g\ cm^{-3}}$
$T \approx 10^{10}\ \mathrm{K}$
$M_{Fe} \approx 1.5\ M_{sun}$
$R_{Fe} \approx 8000\ \mathrm{km}$

G. Raffelt @ISAPP2008

Stellar Collapse and Supernova Explosion

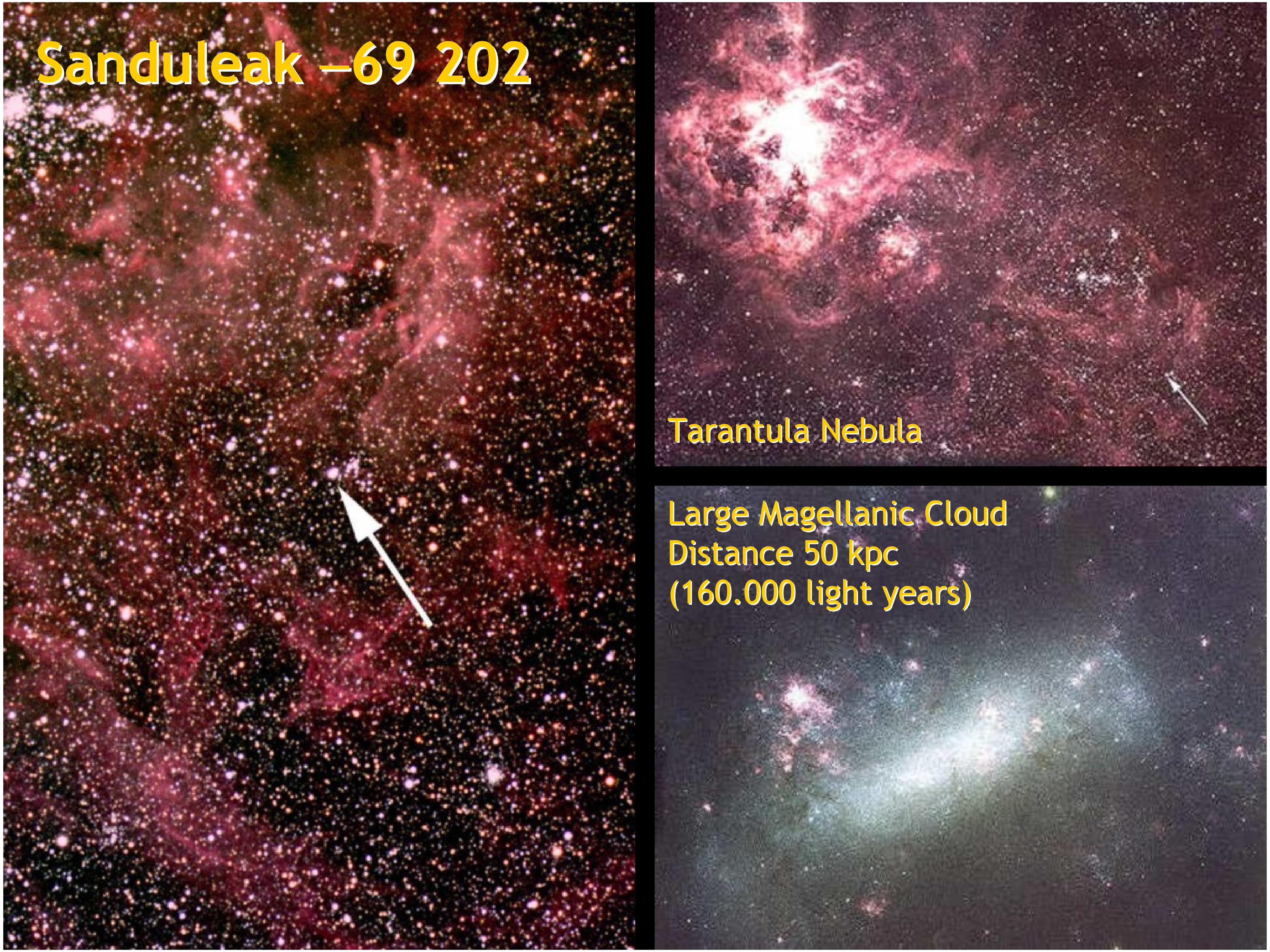
G. Raffelt @ISAPP2008

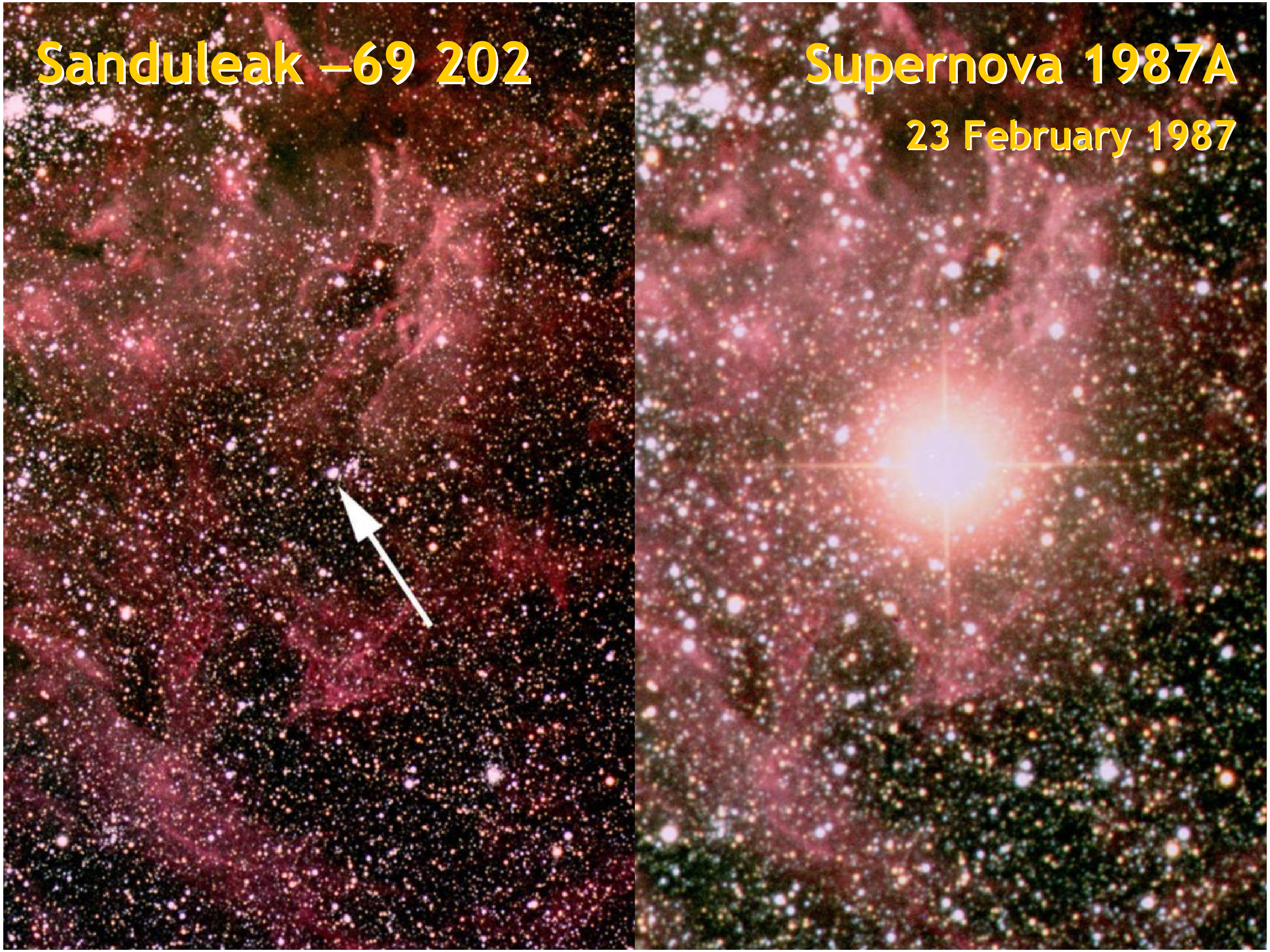


Proto-Neutron Star

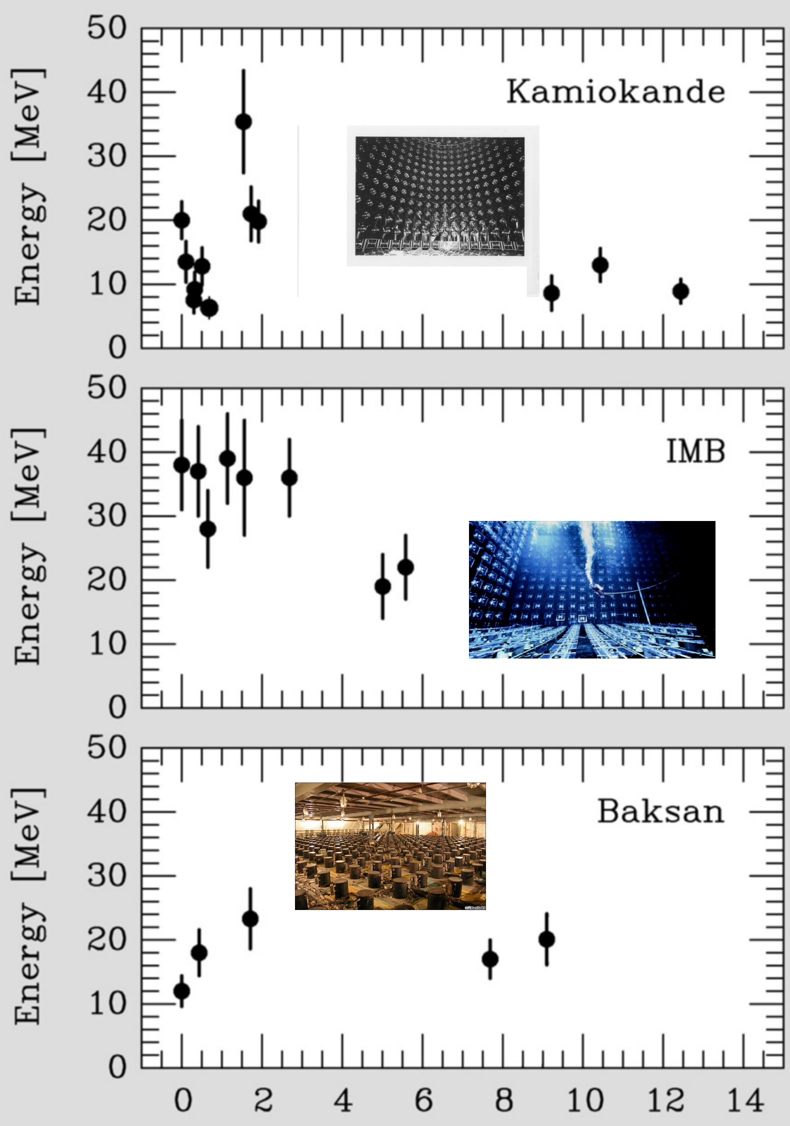
$\rho \approx \rho_{nuc} = 3 \times 10^{14}\ \mathrm{g\ cm^{-3}}$

$T \approx 30\ \mathrm{MeV}$


Sanduleak –69 202
Tarantula Nebula
Large Magellanic Cloud
Distance 50 kpc
(160.000 light years)


Sanduleak –69 202
Supernova 1987A
23 February 1987

Neutrino Signal of Supernova 1987A



G. Raffelt

Kamiokande-II (Japan)
Water Cherenkov detector
2140 tons
Clock uncertainty ±1 min

Irvine-Michigan-Brookhaven (US)
Water Cherenkov detector
6800 tons
Clock uncertainty ±50 ms

Baksan Scintillator Telescope
(Soviet Union), 200 tons
Random event cluster ~ 0.7/day
Clock uncertainty +2/-54 s

Within clock uncertainties,
signals are contemporaneous

Observation of Supernova (SN) Neutrinos at ANDES

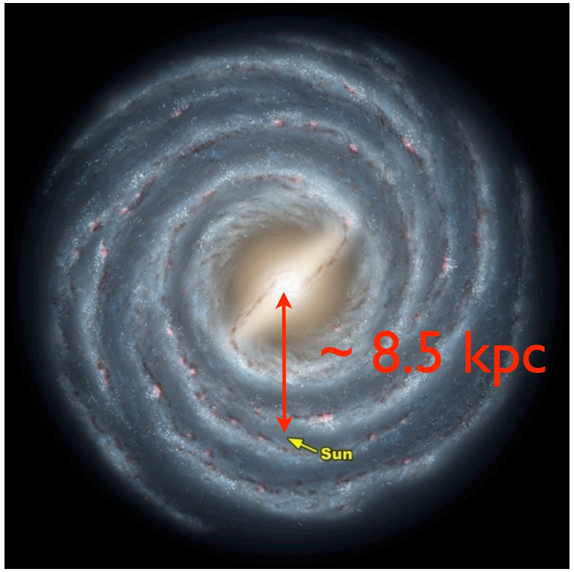
Relevance of the ANDES detector

Galactic SN is so rare that it is highly welcome to have as many detector runnig as possible

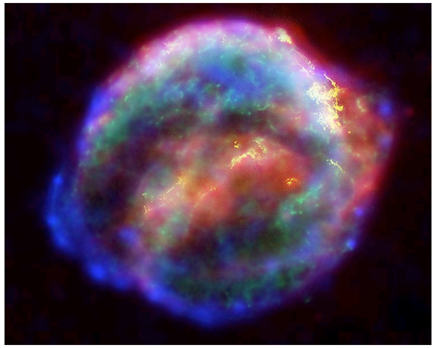
~ 10 Galactic SN in last ~ 2000 yrs

Complementary to the detectors in the Northern Hemisphere, increase the chance to see Earth matter effect

Observation of ν coming from next galactic supernova

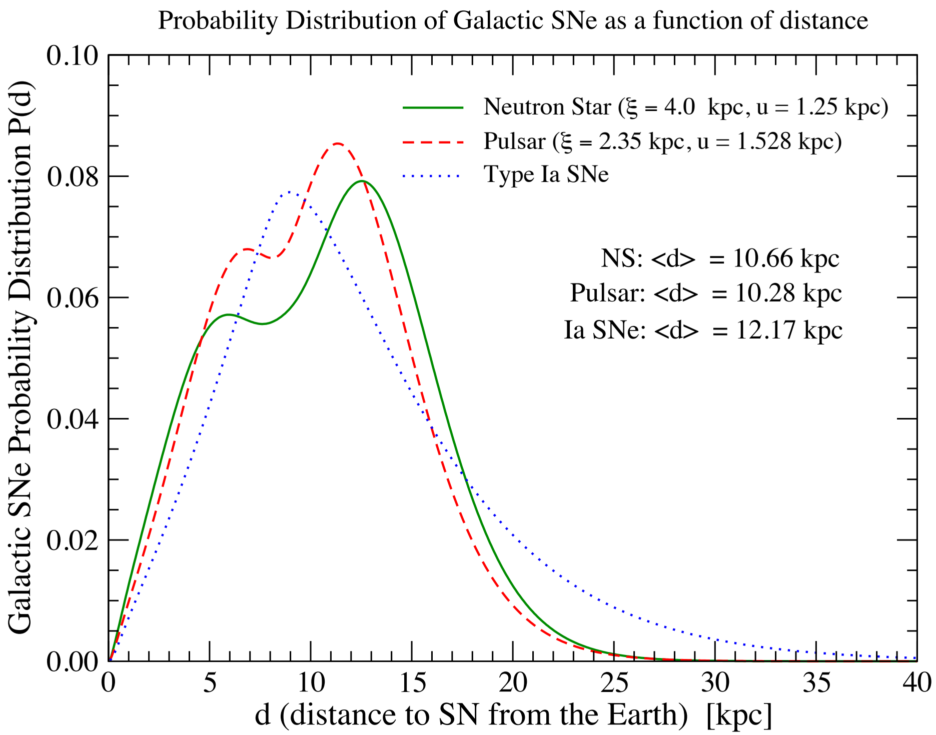


last Galactic SN was observed in1604



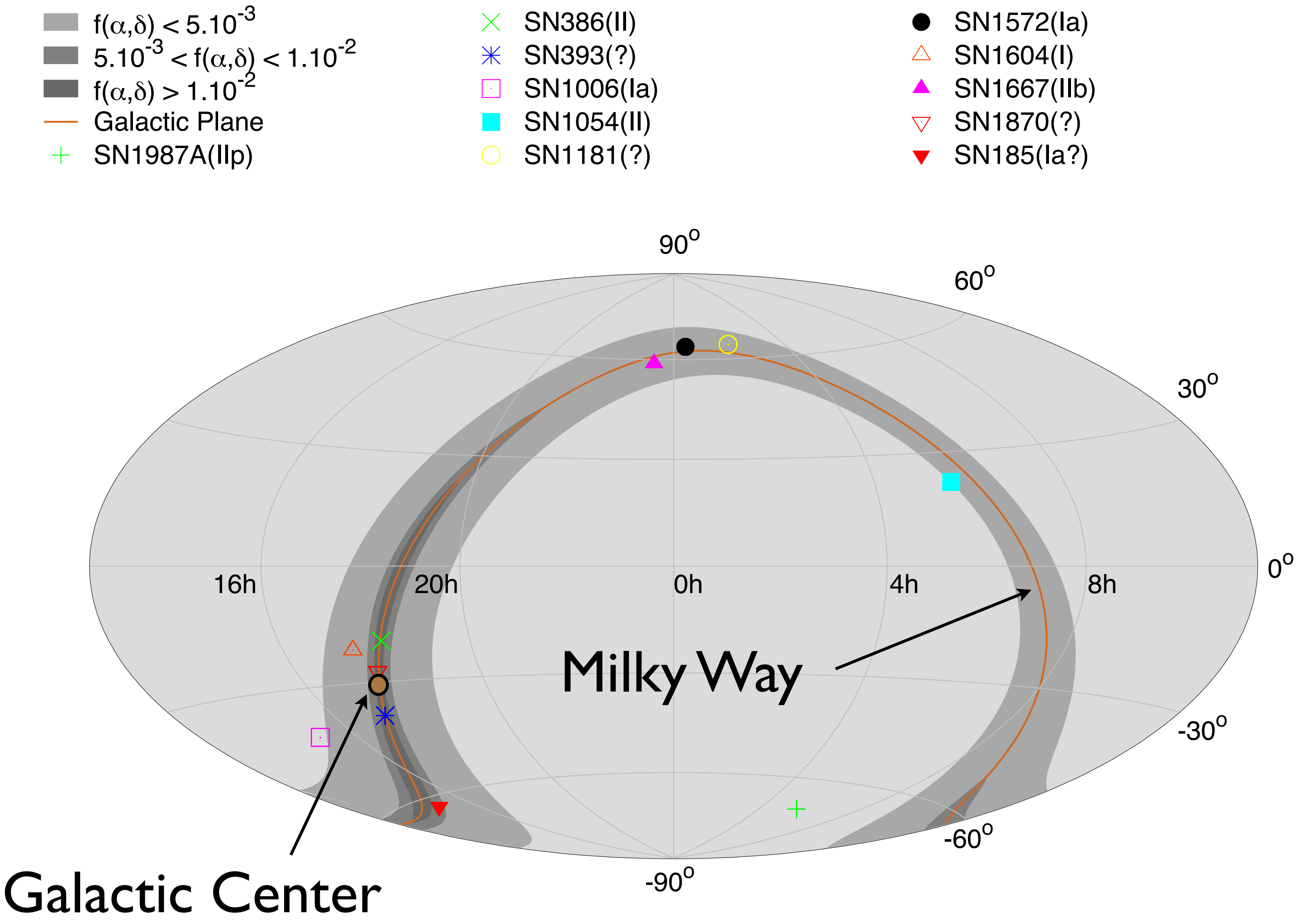
Distance ~ 6 kpc

theoretical prediction
rate of galactic SN
~ a few SN per century



Distributions taken from Mirizzi et al, JCAP05, 012 (2006)

Historical Galactic SN distribution



prepared by T. Mühlbeier

For simplicity, we consider only the following 2 channels of CC and NC reactions

(1) CC: Inverse Beta Decay

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

depends on neutrino oscillation

(2) NC: Neutrino-Proton elastic scattering

$$\nu + \mathrm{p} \rightarrow \nu + \mathrm{p}$$

does not depend on oscillation

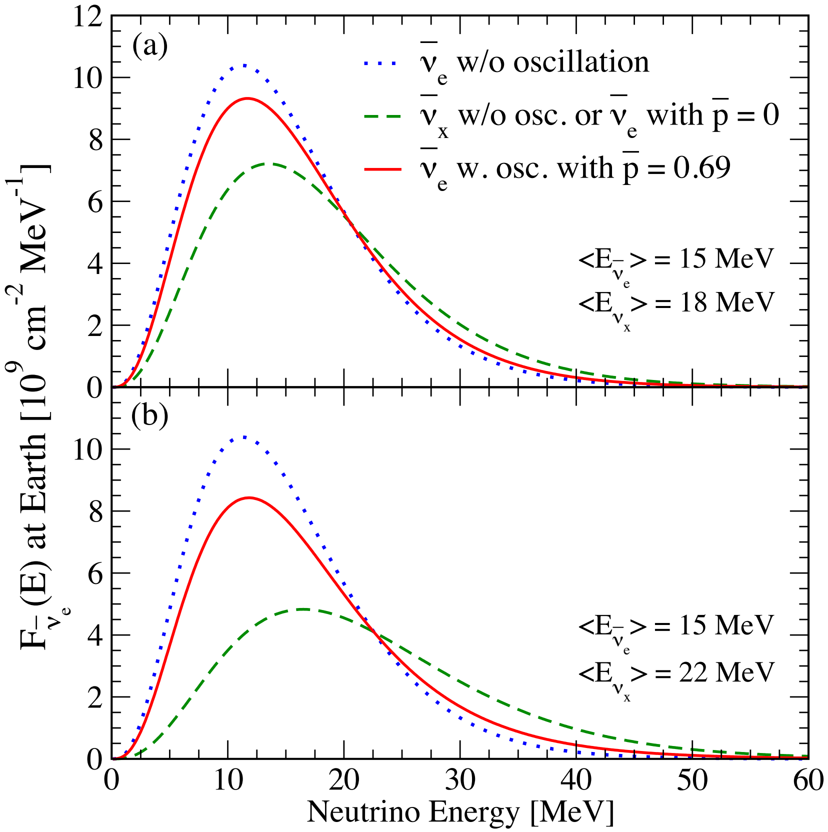
Beacom, Farr & Vogel, PRD66, 033001 (2002)

Dasgupta & Beacom, PRD83, 113006 (2011)

Expected SN neutrino spectra at Earth

$$F_{\bar{\nu}_e}(E) = \bar{p}(E)\, F^0_{\bar{\nu}_e}(E) + [1 - \bar{p}(E)] F^0_{\bar{\nu}_x}(E)\,,$$

$$F^0_{\nu_\alpha}(E) = \frac{1}{4\pi D^2}\,\frac{\Phi_{\nu_\alpha}}{\langle E_{\nu_\alpha}\rangle}\,\frac{\beta_\alpha^{\beta_\alpha}}{\Gamma(\beta_\alpha)}\left[\frac{E}{\langle E_{\nu_\alpha}\rangle}\right]^{\beta_\alpha - 1} \exp\left[-\beta_\alpha \frac{E}{\langle E_{\nu_\alpha}\rangle}\right]$$



reference SN parameters

$\langle E_{\nu_e} \rangle = 12$ MeV

$\langle E_{\bar{\nu}_e} \rangle = 15$ MeV $\quad D = 10$ kpc

$\langle E_{\nu_x} \rangle = 18$ MeV

$\nu_x = \nu_\mu, \nu_\tau, \bar{\nu}_\mu, \bar{\nu}_\tau$

$\langle E_{\nu_\alpha} \rangle \Phi_{\nu_\alpha} = 5 \times 10^{52}$ erg for any flavor

$\beta = 4$

reference Osc. parameters

$\bar{p}(E) \sim \cos^2\theta_{12} = 0.69$

for normal mass hierarchy

$\bar{p}(E) \sim 0$

for inverted mass hierarchy

However, collective effects, shock wave, etc, can change the value of $\overline{p}$(E)

Expected # of events for galactic SN

Prediction for ANDES D = 10kpc

3kt liquid scintilator

type KamLAND BOREXINO SNO

	Chemical Composition of the Scintillator			
Reaction	(a) $C_{12}H_{26}$ + C_9H_{12} (80% + 20%)	(b) C_9H_{12} pseudocumene	(c) $C_6H_5C_{12}H_{25}$ alkyl benzene	Assumptions
$\bar{\nu}_e + p \to n + e^+$	873	630	762	No Oscillation
$\bar{\nu}_e + p \to n + e^+$	924	669	804	$\bar{p} = c_{12}^2 = 0.69$ (NH), $\langle E_{\nu_x} \rangle$= 18 MeV
$\bar{\nu}_e + p \to n + e^+$	1038	750	903	$\bar{p} = 0.0$ (IH), $\langle E_{\nu_x} \rangle$= 18 MeV
$\bar{\nu}_e + p \to n + e^+$	957	690	834	$\bar{p} = c_{12}^2 = 0.69$ (NH), $\langle E_{\nu_x} \rangle$= 20 MeV
$\bar{\nu}_e + p \to n + e^+$	1140	825	993	$\bar{p} = 0.0$ (IH), $\langle E_{\nu_x} \rangle$= 20 MeV
$\bar{\nu}_e + p \to n + e^+$	987	714	858	$\bar{p} = c_{12}^2 = 0.69$ (NH), $\langle E_{\nu_x} \rangle$= 22 MeV
$\bar{\nu}_e + p \to n + e^+$	1239	894	1080	$\bar{p} = 0.0$ (IH), $\langle E_{\nu_x} \rangle$= 22 MeV
$\nu + p \to \nu + p$	294	318	453	all flavors $T' > 0.2$ MeV, $\langle E_{\nu_x} \rangle$= 18 MeV
$\nu + p \to \nu + p$	399	405	561	all flavors $T' > 0.2$ MeV, $\langle E_{\nu_x} \rangle$= 20 MeV
$\nu + p \to \nu + p$	510	492	663	all flavors $T' > 0.2$ MeV, $\langle E_{\nu_x} \rangle$= 22 MeV

# of event for $\bar{\nu}_e + \mathrm{p} \to \mathrm{n} + \mathrm{e}^+$ ~ 800-1000 for 3 kt

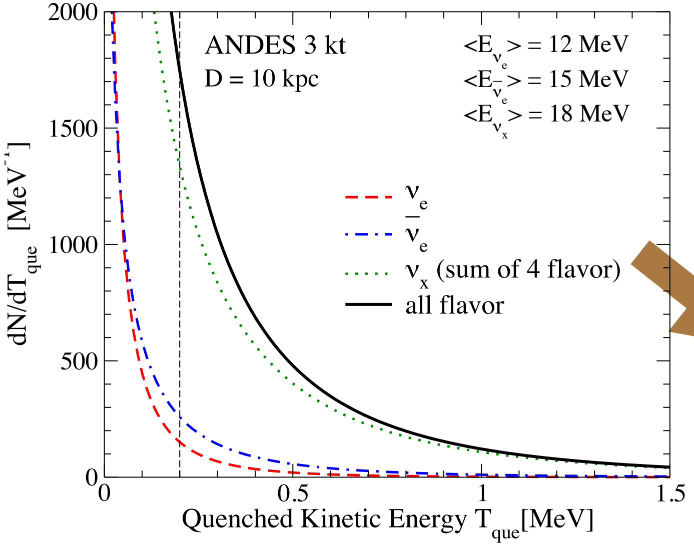
 # event for $\nu + \mathrm{p} \to \nu + \mathrm{p}$ ~ 350-650 for 3 kt

Reconstruction of the Original SN ν flux

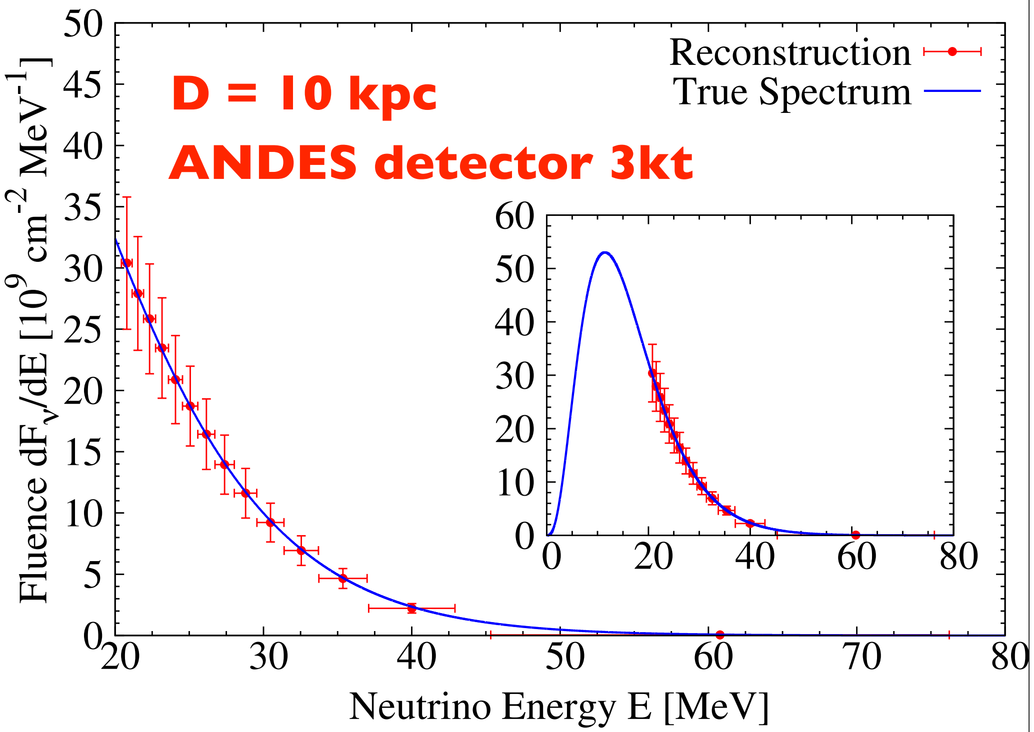
Beacom, Farr & Vogel, PRD66, 033001 (2002)
Dasgupta & Beacom, PRD83, 113006 (2011)

$\nu + \mathrm{p} \rightarrow \nu + \mathrm{p}$: **Neutral Current (common for all types of neutrinos)**

recoil proton energy dist.



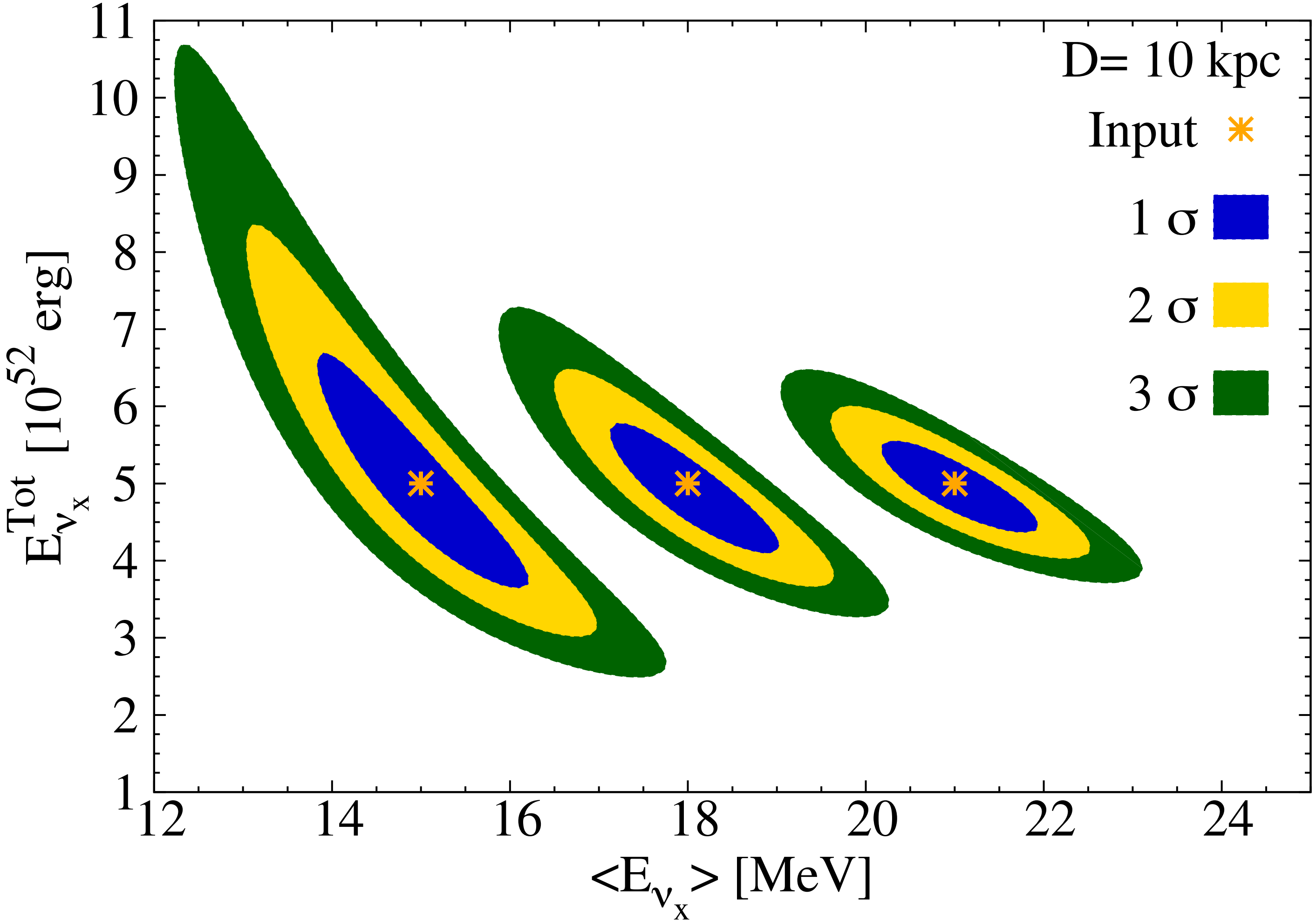
results do not depend on oscillation!



if $\langle E_{\nu_x} \rangle > \langle E_{\bar{\nu}_e} \rangle$, we can reconstruct spectra of ν_x

Determination of SN paramters for ν_μ, ν_τ

Machado et al, PRD86, 125001 (2012) [arXiv:1207.5454[hep-ph]]

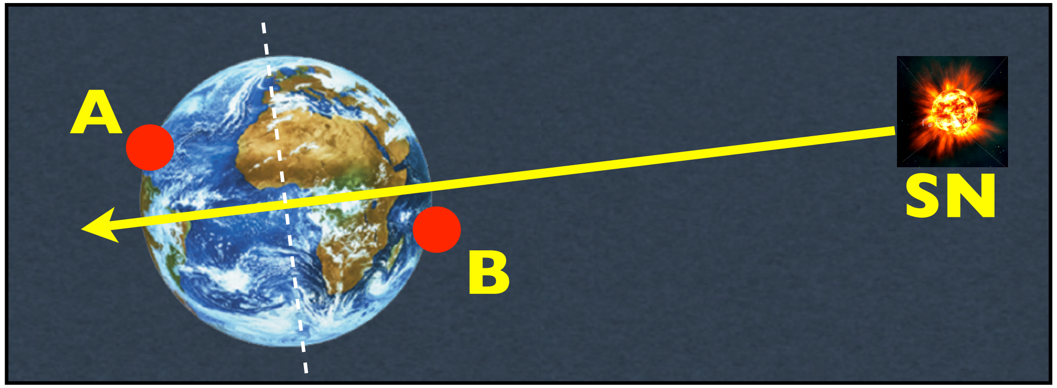


$\nu + \mathbf{p} \rightarrow \nu + \mathbf{p}$

No Uncertainty by Neutrino Oscillations!

Earth Matter Effect: Shadowing probabilities

Mirizzi, Raffelt and Serpico, JCAP05, 012 (2006)



SN is shadowed for A non-shadowed for B

Site	Latitude	Longitude	Shadowing Probability Mantle (Core)
Kamioka, Japan	36.42^{o}N	137.3^o E	0.559 (0.103)
South Pole	90^{o}N	-	0.413 (0.065)
ANDES	30.25^{o}S	68.88^{o}W	0.449 (0.067)
SNO, Canada	46.476^{o}N	81.20^{o}E	0.571 (0.110)

shadowing prob. for one detector only

Case	Earth Matter Effect Kamioka	South Pole	Shadowing Probability Mantle (Core)
(1)	No	No	0.152 (0.832)
(2)	Yes	No	0.435 (0.104)
(3)	No	Yes	0.288 (0.065)
(4)	Yes	Yes	0.125 (0.000)

shadowing prob. for two detectors

prob. that at least one detector is showed is **0.848**

Earth Matter Effect: Shadowing probabilities

	Earth Matter Effect			
Case	Kamioka	South Pole	ANDES	Shadowing Probability Mantle (Core)
(1)	No	No	No	0.024 (0.767)
(2)	Yes	No	No	0.388 (0.105)
(3)	No	Yes	No	0.034 (0.061)
(4)	No	No	Yes	0.128 (0.063)
(5)	Yes	Yes	No	0.106 (0.000)
(6)	No	Yes	Yes	0.254 (0.003)
(7)	Yes	No	Yes	0.047 (0.000)
(8)	Yes	Yes	Yes	0.020 (0.000)

shadowing prob. for three detectors

prob. that at least one detector is showed is **0.976**

	Earth Matter Effect				
Case	Kamioka	South Pole	ANDES	SNO	Shadowing Probability Mantle (Core)
(1)	No	No	No	No	0.008 (0.657)
(2)	Yes	No	No	No	0.206 (0.105)
(3)	No	Yes	No	No	0.034 (0.061)
(4)	No	No	Yes	No	0.001 (0.063)
(5)	No	No	No	Yes	0.016 (0.111)
(6)	Yes	Yes	No	No	0.205 (0.000)
(7)	Yes	No	Yes	No	0.000 (0.000)
(8)	Yes	No	No	Yes	0.282 (0.000)
(9)	No	Yes	Yes	No	0.163 (0.003)
(10)	No	Yes	No	Yes	0.000 (0.000)
(11)	No	No	Yes	Yes	0.127 (0.000)
(12)	No	Yes	Yes	Yes	0.091 (0.000)
(13)	Yes	No	Yes	Yes	0.047 (0.000)
(14)	Yes	Yes	No	Yes	0.011 (0.000)
(15)	Yes	Yes	Yes	No	0.012 (0.000)
(16)	Yes	Yes	Yes	Yes	0.008 (0.000)

shadowing prob. for four detectors

prob. that at least one detector is showed is **0.992**

Supernova Neutrino Early Warning System

Super-Kamiokande @Kamioka

LVD (Large Volume Detector)@Gran Sasso

Borexino@Gran Sasso

IceCube@South Pole

http://snews.bnl.gov/

Agua Negra surroundings

- Two support labs, one in La Serena or Vicuña (Chile), the other one in Rodeo (Argentina)
- Integration with local universities
- Visitor centers
- Offices at the portals

El Consorcio Latinoamericano de Estudios Subterráneos

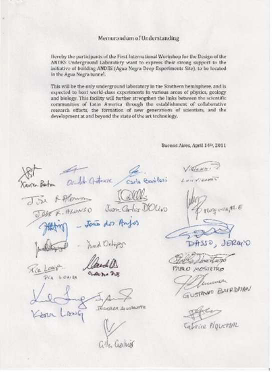
- The MERCOSUR (UNASUR) aspect of the Agua Negra tunnel can be naturally extended to the ANDES laboratory
- Excellent opportunity to have an international laboratory, not only international experiments
- The CLES would be our “seed” for a small CERN with respect of underground science (not only high energy: geology, biology, technology...)

- Common participation for the ANDES laboratory operation and operating funds
- CLES manages the ANDES laboratory (with support from external international scientific advisory board)
- Initial participants: Argentina, Brazil, Chile, Mexico

Current Status

- International community support:
  - 19 support letters
    (underground lab directors, international projects spokespersons, national physics associations and academies...)
- Regional interest:
  - 26 letters from latinamerican groups
- First workshop in Buenos Aires, April 2011
- Second in Rio, June 2011
- Third in Valparaíso, January 2012
- Next in Mexico, beginning 2013
- Official support from Argentine MinCyT
  (Comisión Asesora Grandes Instrumentos)
- Official support from EBITAN
  (Entidad bi-nacional túnel Agua Negra)

Memorandum of Understanding (First workshop, Buenos Aires, April 2011)



Memorandum of Understanding

Hereby the participants of the First International Workshop for the Design of the ANDES Underground Laboratory want to express their strong support to the initiative of building ANDES (Agua Negra Deep Experiments Site), to be located in the Agua Negra tunnel.

This will be the only underground laboratory in the Southern hemisphere, and is expected to host world-class experiments in various areas of physics, geology and biology. This facility will further strengthen the links between the scientific communities of Latin America through the establishment of collaborative research efforts, the formation of new generations of scientists, and the development at and beyond the state of the art technology.

Buenos Aires, April 14th, 2011

Conclusions and prospects

Unique opportunity for a Latinamerican Consortium

- Argentina, Brazil, Chile, Mexico
- Participation to the Scientific Committee
- Contribution to Operating Costs
- Latinamerican neutrino flag experiment

Project status

- Scientific support
- Political support
- Need to finish Feasibility study
- Work on including the lab in the tunnel tender
- Work on science and lab white papers

Open laboratory

- Natural integration with other labs/experiments
- Host large 3-gen double beta decay/dark matter exp.
- Students/posdocs formation phase for 8 years

Web page: http://andeslab.org/

Conclusion

This is a unique opportunity to build a
world class deep underground laboratory,
the only one in the sourthern hemisphere,
with a strong impact on the regional integration

http://andeslab.org/