Results from the Borexino experiment

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On behalf of the Borexino Collaboration

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Borexino Collaboration

Milano

Genova

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Max-Planck-Institut für Kernphysik

Heidelberg (Germany)

Dubna JINR (Russia)

APC Paris

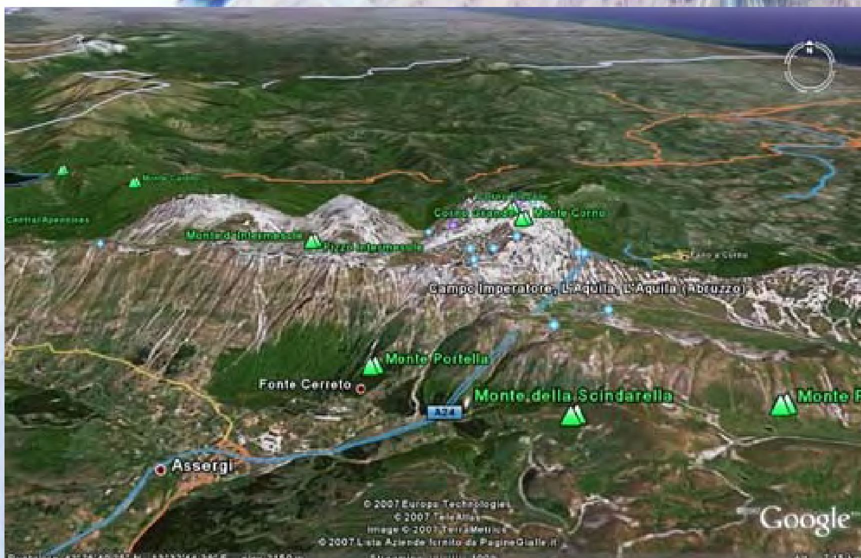
Technische Universität München

Munich (Germany)

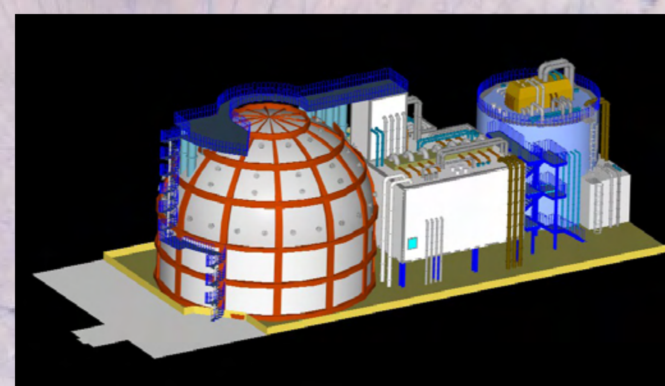
Perugia

Princeton University

The Experimental Site

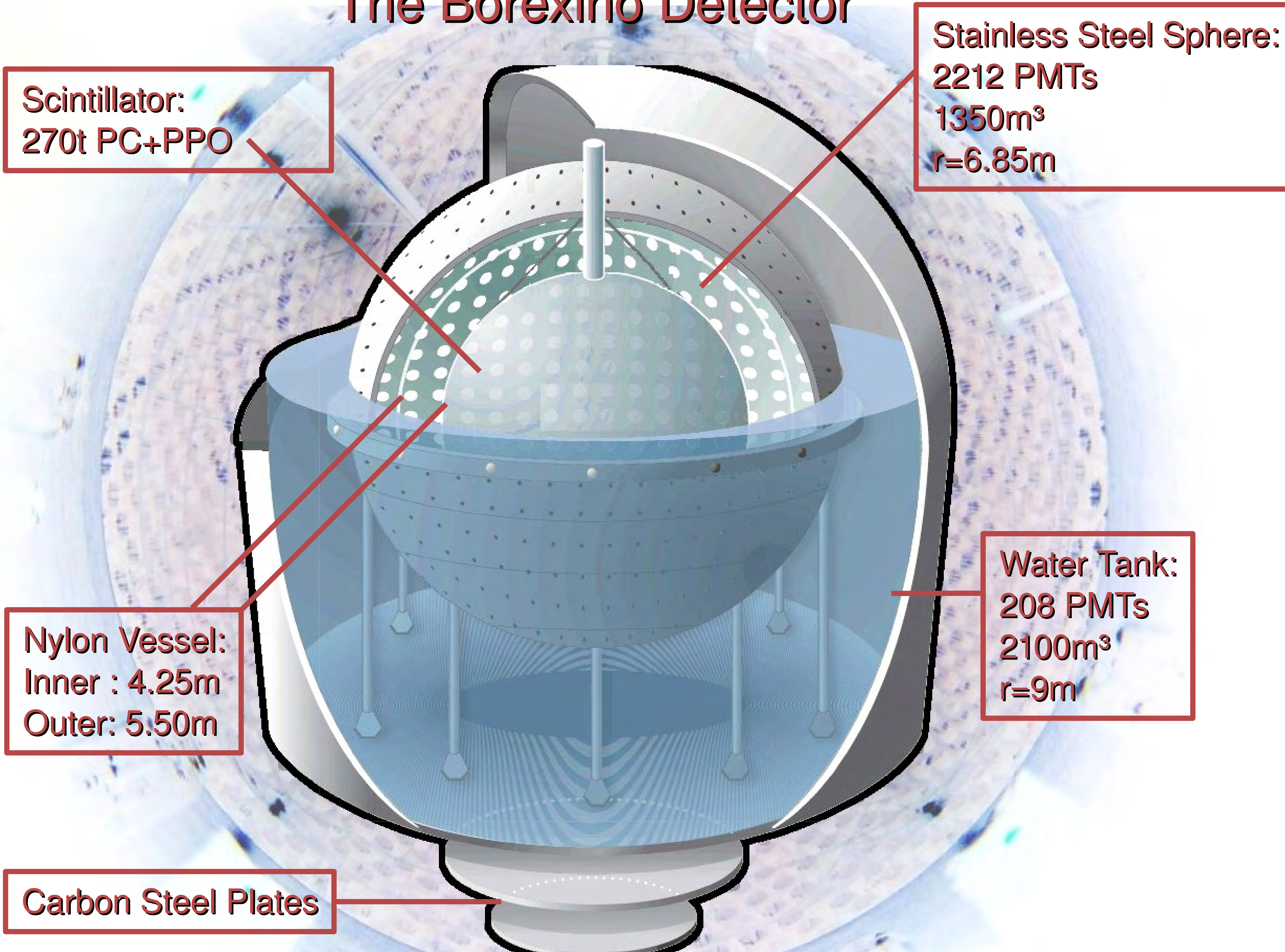


Borexino is located in the LNGS Underground Laboratory in the mountains of Abruzzo, Italy.

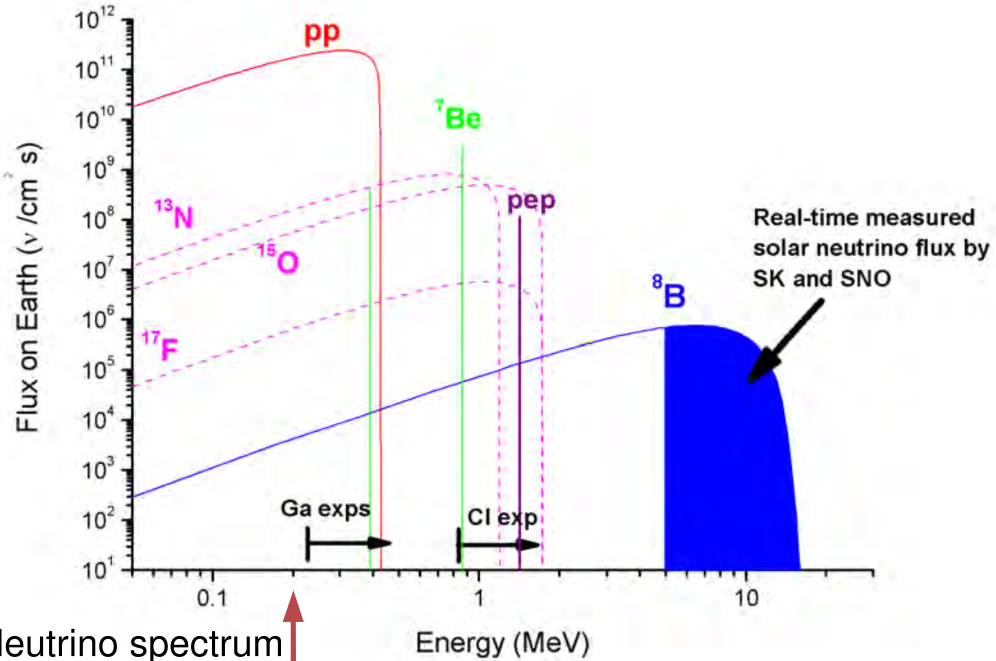


Shielding provided by 1400m of rock: ~3800 m.w.e

The Borexino Detector



Expected Spectrum in Borexino



Neutrino spectrum

Borexino threshold

Neutrino detection principle: Electron scattering

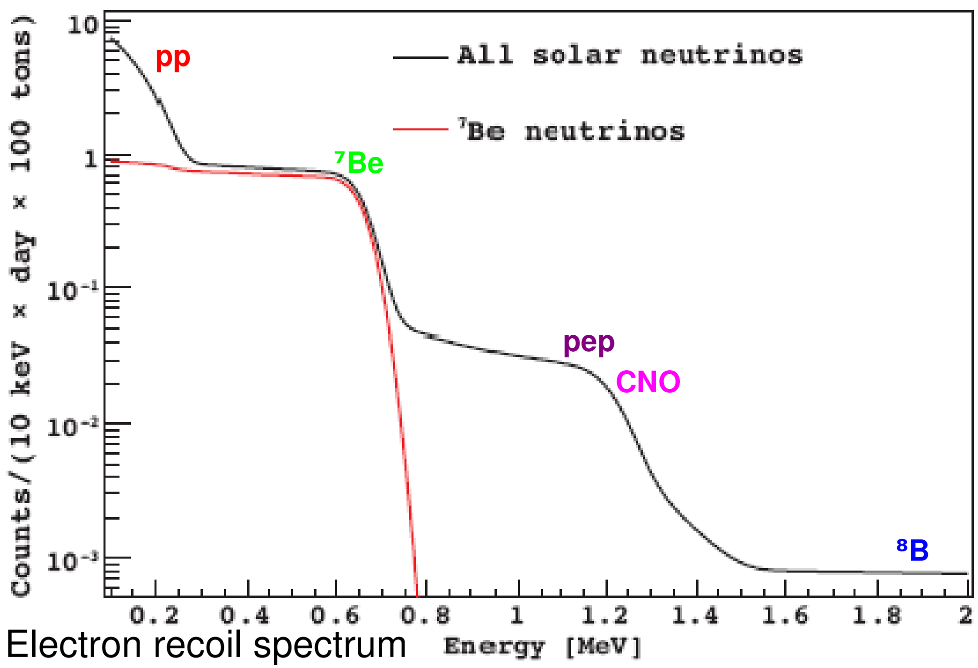
$$\nu + e^- \rightarrow \nu + e^-$$

First real-time measurement down to 200keV.

First simultaneous measurement of solar neutrinos from vacuum dominated and matter-enhanced oscillation regions.

Expected rates:

^{7}Be :	~ 50 c/d/100t
^{8}B :	~0.3 c/d/100t

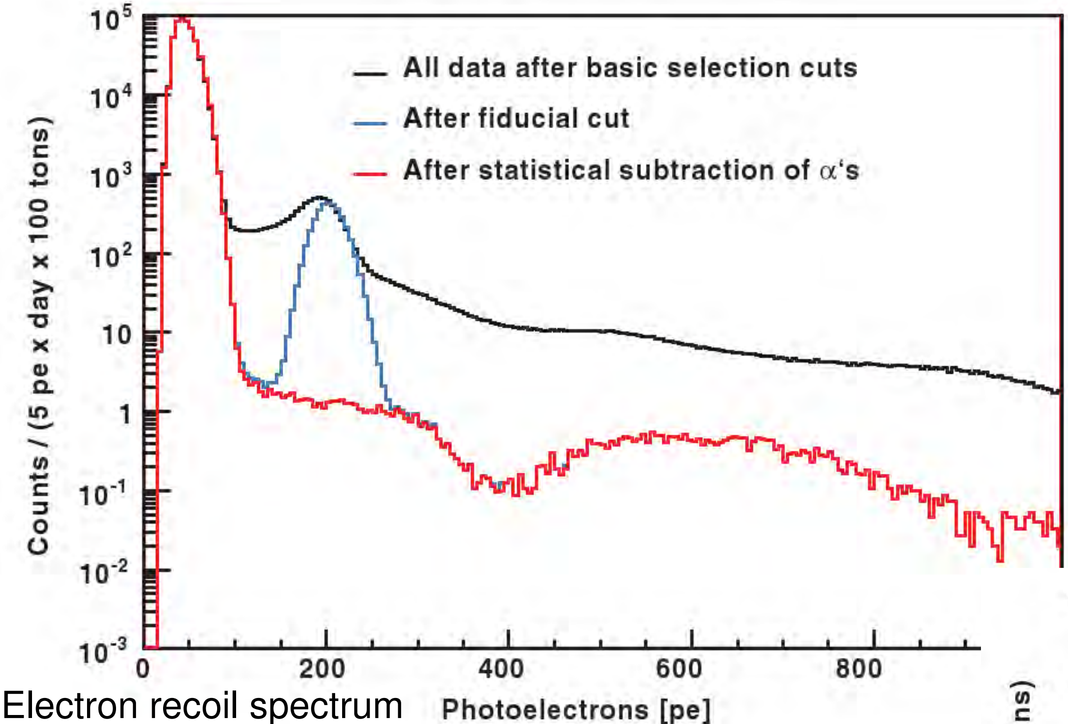


Electron recoil spectrum

Low threshold of 200keV because of high radioactive purity:

^{238}U	$1.6\cdot10^{-17}$ g/g
^{232}Th	$6.8\cdot10^{-18}$ g/g

^{7}Be Solar Neutrino Flux



Electron recoil spectrum

Spectrum of 192 live days

Applied cuts:

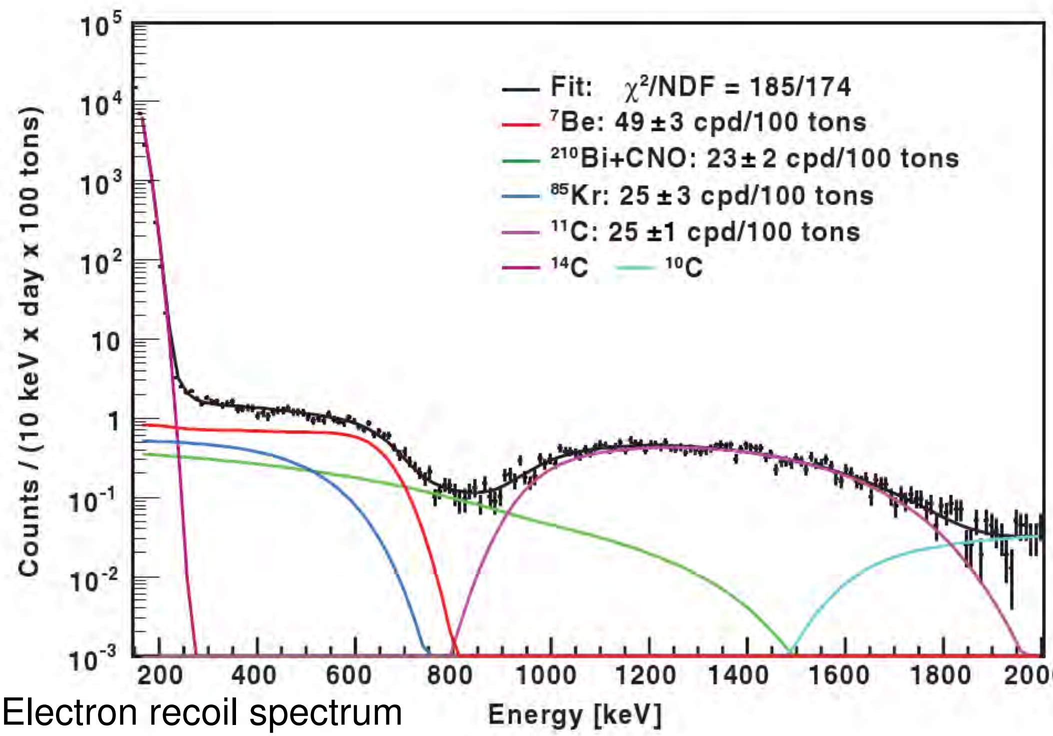
- Muons rejected
- 2ms cut after each muon
- Rn daughters vetoed
- FV cut

Measured rate: $49 \pm 3_{stat} \pm 4_{sys}$ c/d/100t

Theoretical rate

- MSW-LMA: 48±4 c/d/100t
- no oscillation: 75±4 c/d/100t

Hypothesis of no oscillation for ^{7}Be solar neutrinos is rejected by the measurement at 4σ.



Electron recoil spectrum

Calculation of the pp & CNO Fluxes

(Combining the Borexino results with other Experiments)

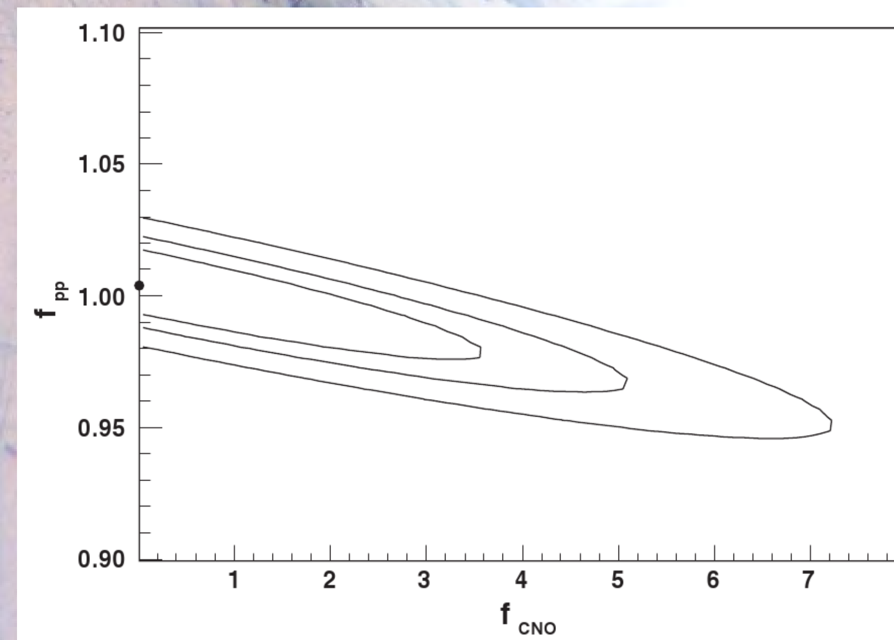
$$R_k = \sum_i R_{i,k} f_i P_{ee}^{i,k} \qquad f_i = \frac{\Phi_{i_{measured}}}{\Phi_{i_{predicted}}}$$

$R_{i,k}$ = expected rate of source i for experiment k at the nominal SSM *flux*

$P_{ee}^{i,k}$ = survival probability for source i above the threshold for experiment k

k = Homestake, Gallex

i = pp, pep, CNO, ^{7}Be, ^{8}B



$f_{^8B}$ = 0.83±0.07, measured by SNO and SuperK

$f_{^7Be}$ = 1.02±0.10 given by the Borexino results

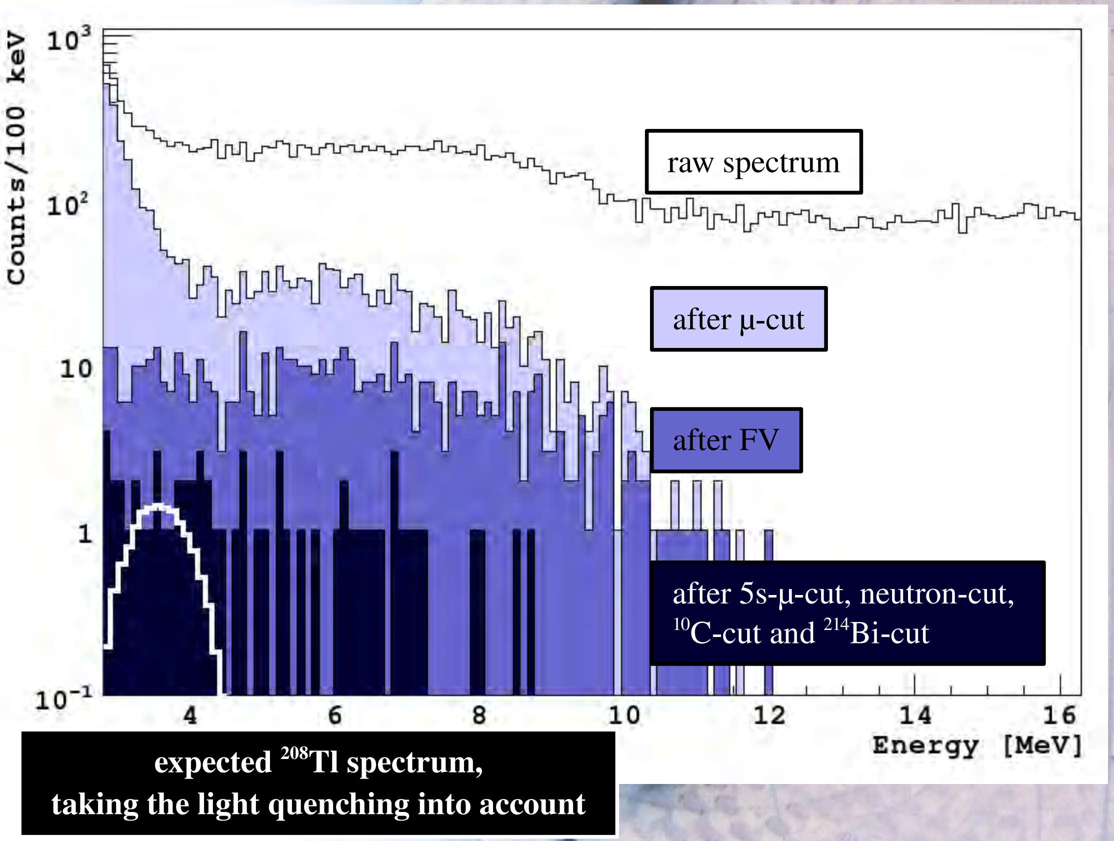
Performing a χ^2 based analysis of all neutrino experiments adding the luminosity constraint:

$f_{pp} = 1.005^{+0.008}_{-0.020}$ (1σ)

f_{CNO} < 3.80 (90% C.L.)

This represents the best determination of the pp solar neutrino flux.

^{8}B Solar Neutrino Flux

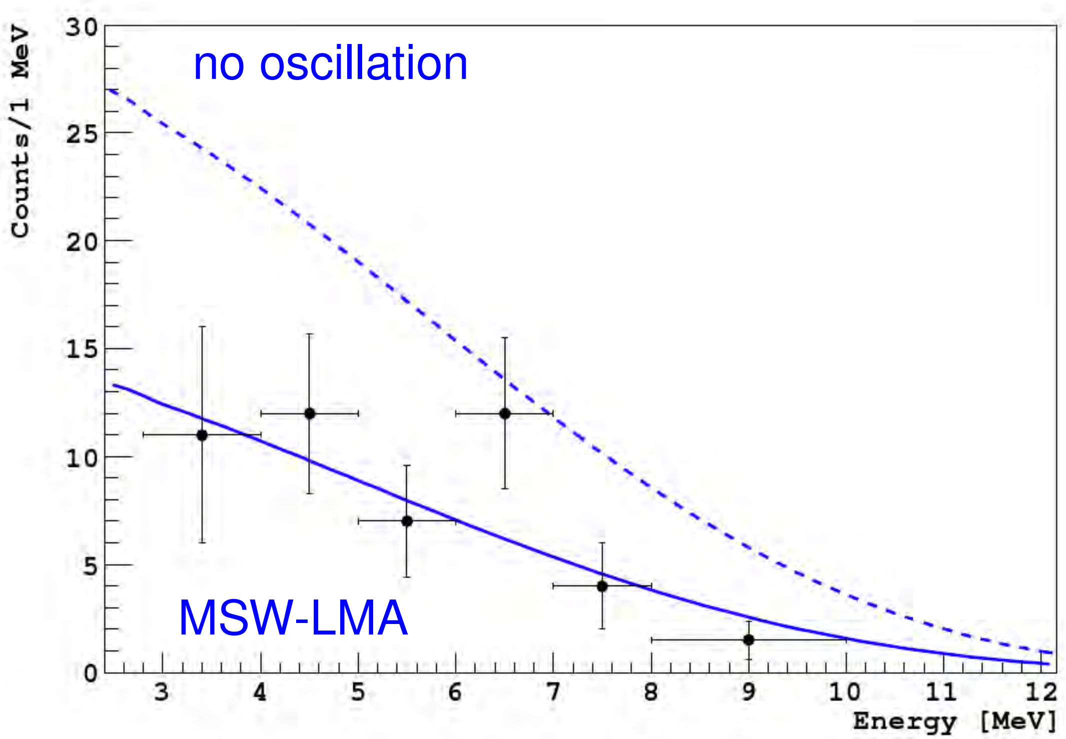


Spectrum of 246 live days measurement.

Cosmogenic background sources:
- Muons
- Muon induced secondaries
- Muon induced radionuclides

Internal background:
- Radon emanation from the nylon vessel
- ^{208}Tl contamination of the scintillator

^{8}B Solar Neutrino Flux



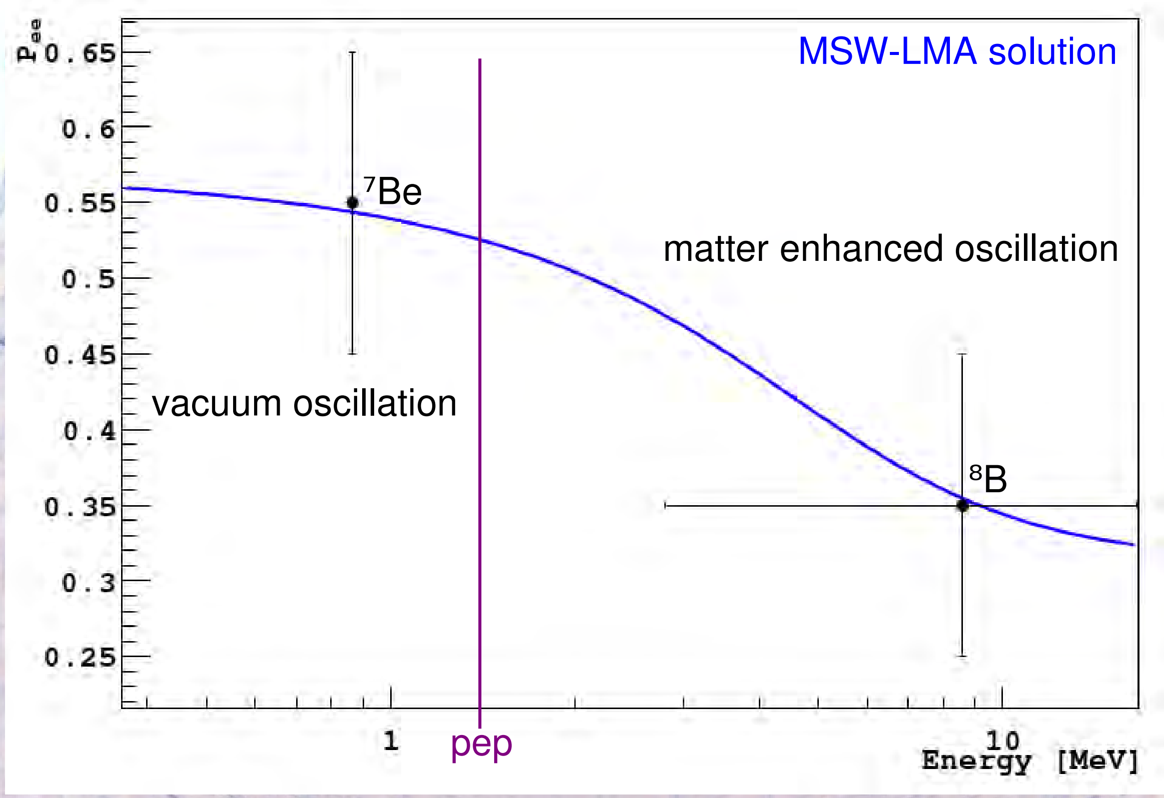
	Threshold [MeV]	Φ^{ES}_{8B} [10^6 cm^{-2} s^{-1}]
SuperKamiokaNDE I (8)	5.0	$2.35 \pm 0.02 \pm 0.08$
SuperKamiokaNDE II (9)	7.0	$2.38 \pm 0.05\ ^{+0.16}_{-0.15}$
SNO D_2O (7)	5.0	$2.39\ ^{+0.24}_{-0.23}\ ^{+0.12}_{-0.12}$
SNO Salt Phase (6)	5.5	$2.35 \pm 0.22 \pm 0.15$
SNO Prop. Counter (10)	6.0	$1.77\ ^{+0.24}_{-0.21}\ ^{+0.09}_{-0.10}$
Borexino	5.0	$2.75 \pm 0.54 \pm 0.17$
Borexino	2.8	$2.65 \pm 0.44 \pm 0.18$

Measured ^{8}B neurino rate: $0.26 \pm 0.04_{stat} \pm 0.02_{sys}$ c/d/100t

Expected rate (SSM and MSW-LMA): 0.27 ± 0.03 c/d/100t

Non-oscillation excluded at 4.2σ

Survival Probability



Assuming the SSM and MSW-LMA solution the measurement of ^{7}Be and ^{8}B neutrino rate corresponds to:

$P_{ee}(^7Be) = 0.56 \pm 0.10$

$P_{ee}(^8B) = 0.35 \pm 0.10$ at the effective energy of 8.6MeV

Measurement is in agreement with the prediction of the MSW-LMA solution for solar neutrinos.

Summary

Achieved so far:

- First real-time measurement of ^{7}Be neutrinos
- First real-time measurement of ^{8}B neutrinos down to an energy of 2.8MeV using a liquid scintillator
- First simultaneous measurement of solar neutrinos from vacuum dominated and matter-enhanced oscillation regions
- Current best limits for pp- and CNO-neutrinos

In progress:

- Direct measurement of pep- and CNO-neutrinos
- Source calibration to decrease systematic errors

In future:

- Measurement of the solar pp-flux
- Antineutrino observations (geoneutrinos, reactor, from the sun)
- Supernova neutrinos and antineutrinos (joining SNEWS during 2009)