Current Status of the Borexino experiment

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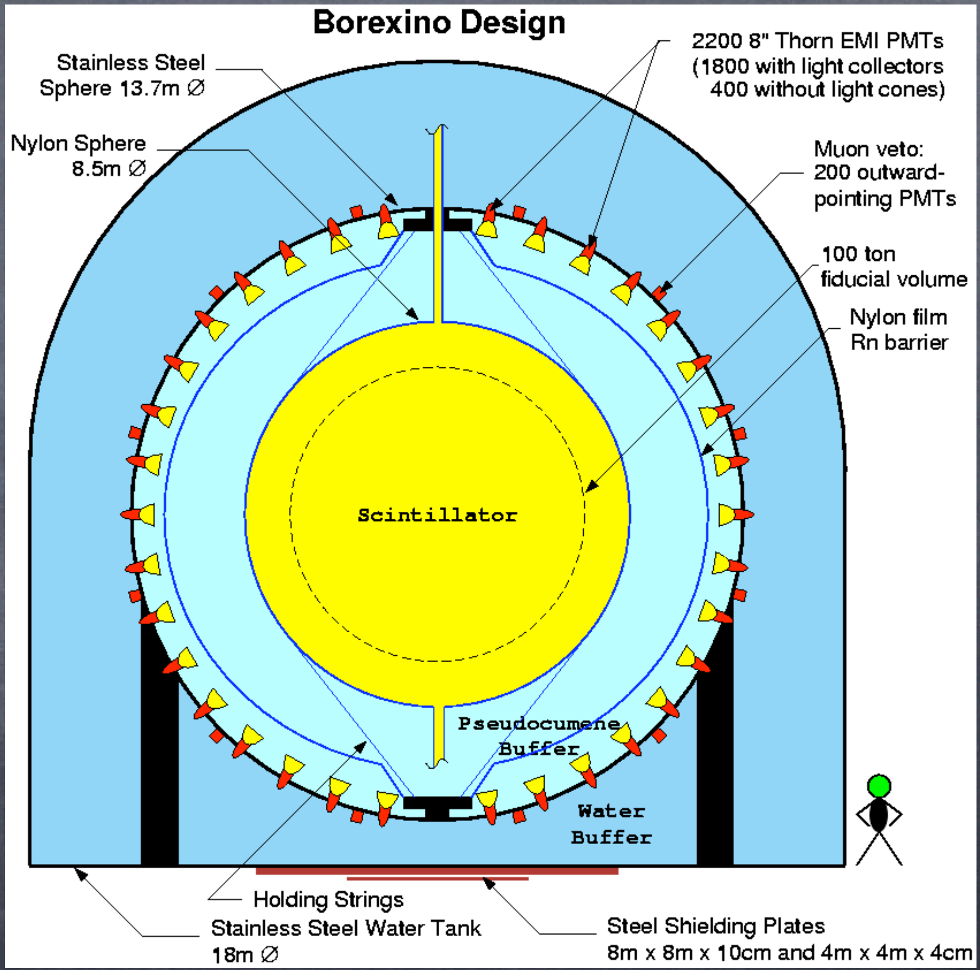
Talk Outline

- Borexino at a glance
- Detector Status and Commissioning
- Borexino physics: an update
- Background issues & goals, projected sensitivity
- Borexino @ Gran Sasso: what is the future?

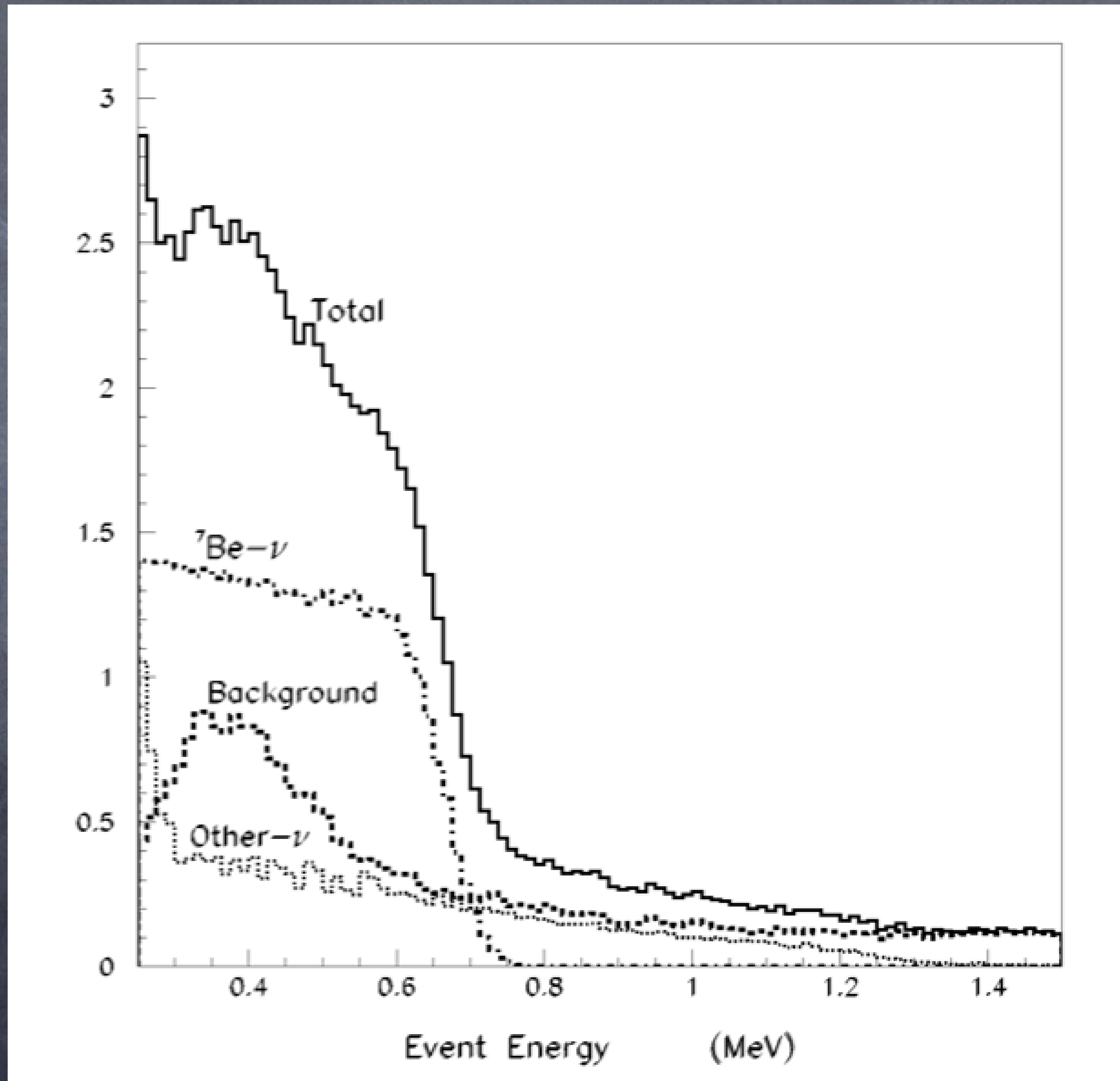
Borexino at a glance

- Electron scattering in organic scintillator
- Scintillator 300 tons, fiducial 100 tons
- Two buffers 900 tons; water 2200 tons
- 2200 PMTs, optical coverage 30%
- Muon flux 1/m^2/hr;
- 250 KeV threshold (^{14}C)



Spectrum

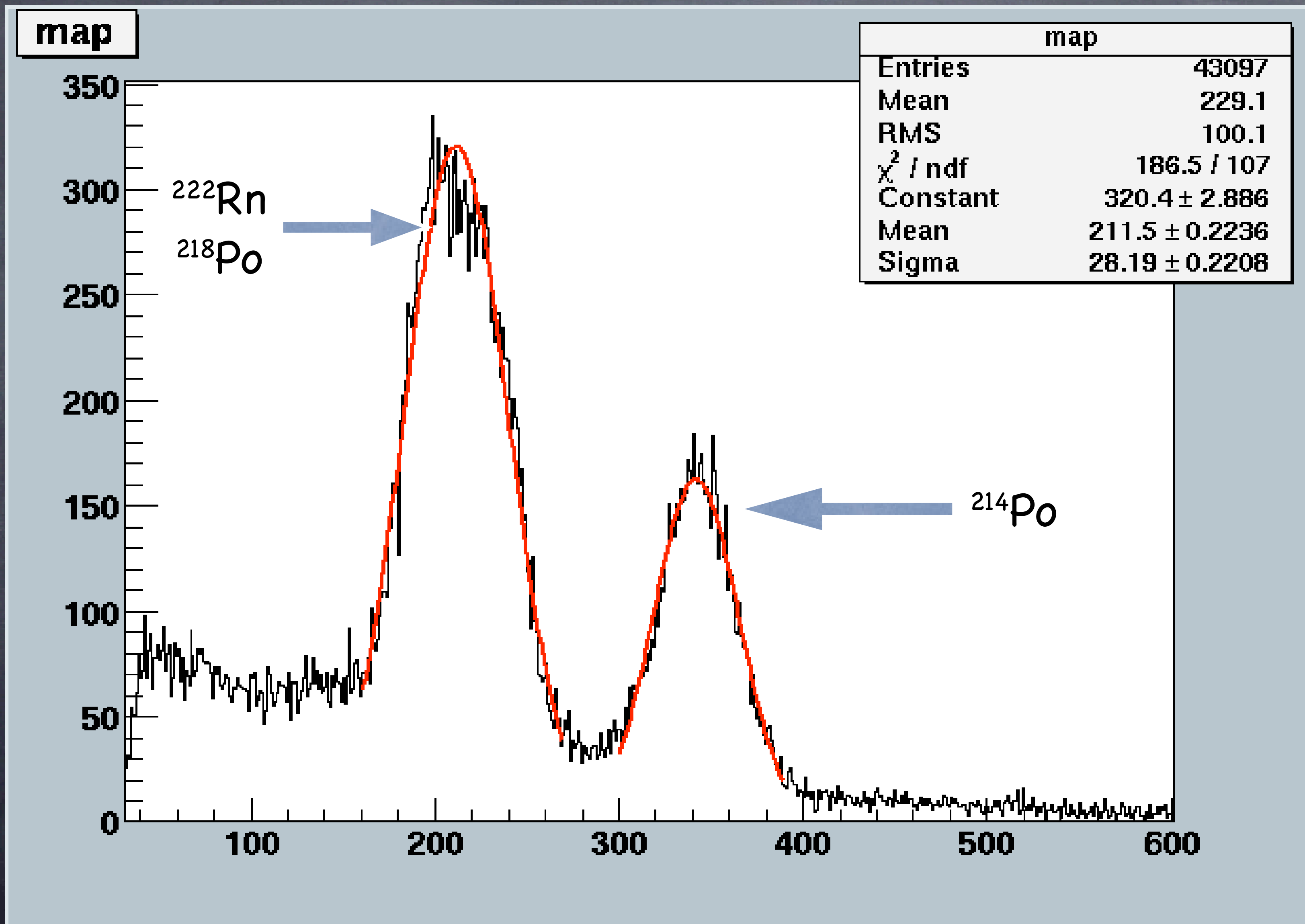
Note:
Arbitrary Units
U, Th 10^{-16} g/g



Detector Status

- Borexino operating in a restricted mode since incident on August 16 2002
- Structures finished
- Purification plants completed
- Inner PMTs installed and tested
- Electronics commissioned and calibrated

Air Run with Rn source
Dec 2003



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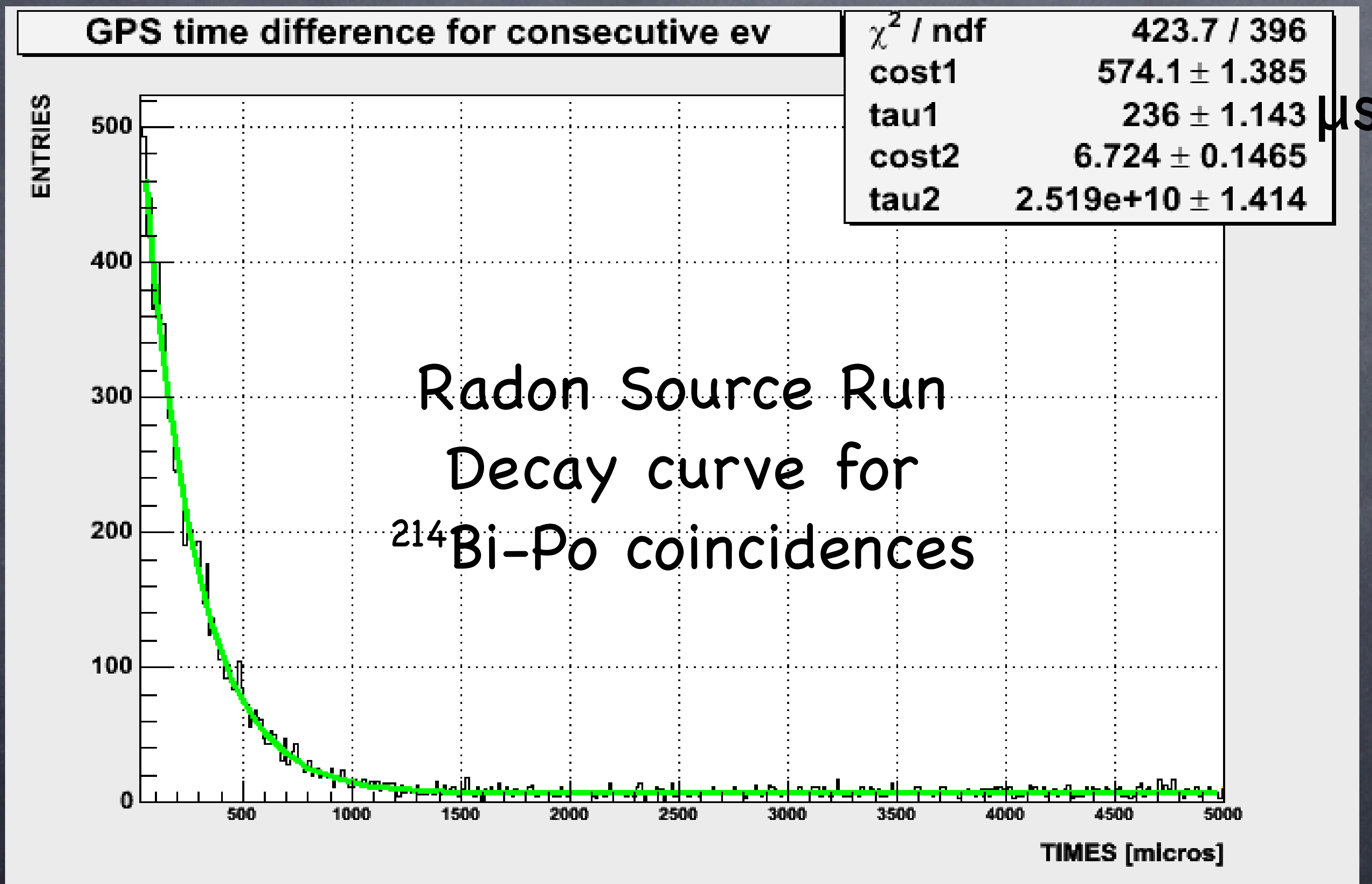
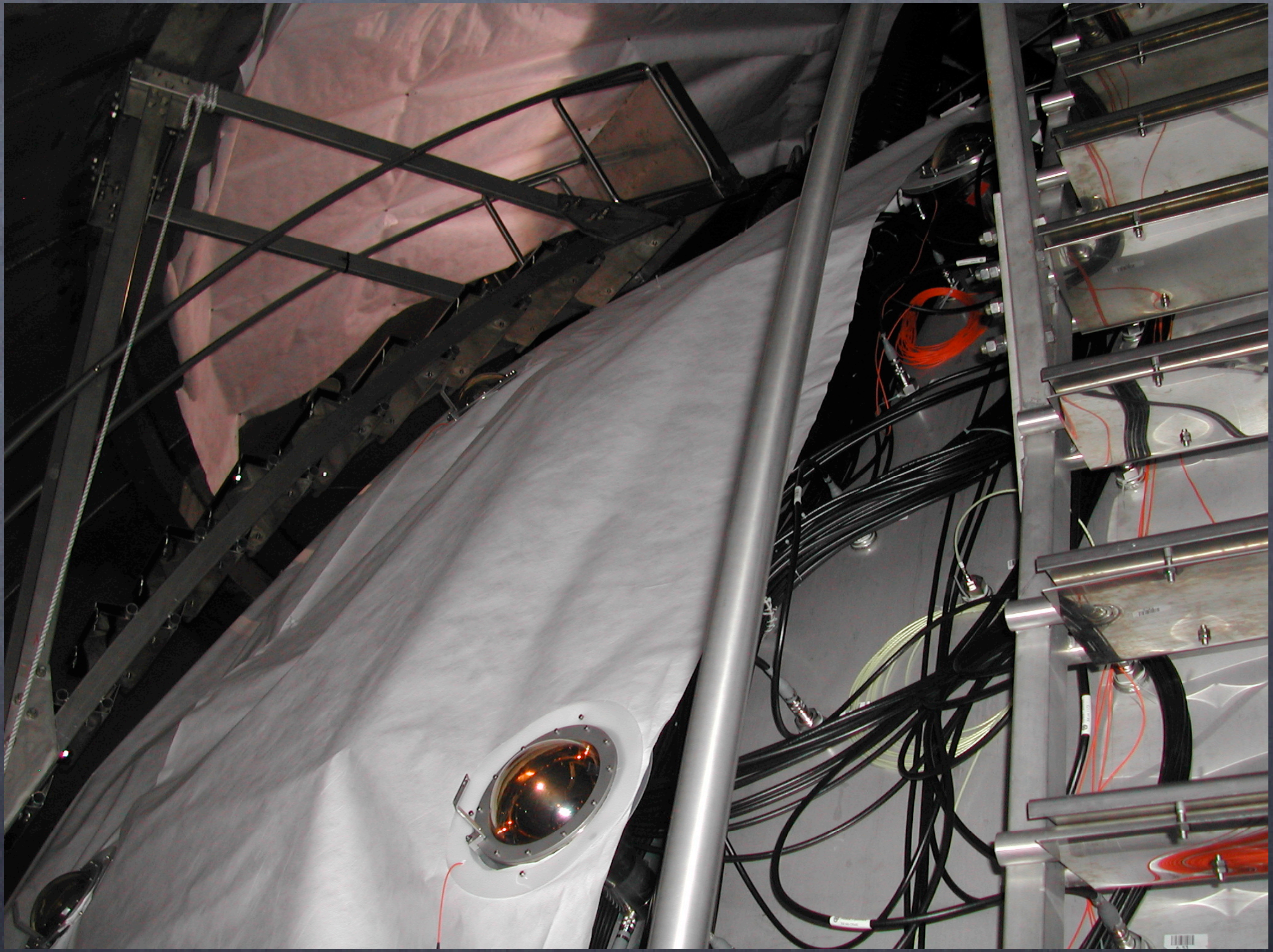


Detector Status

- Stainless Steel Sphere closed on June 9
- Last section of muon veto will soon be installed



Detector Commissioning

July 30 2004

Borexino Physics Goals

- Real time observation of low energy neutrinos: only 1/2000 of solar flux measured in real time so far... New stuff at low energy?

- ^{7}Be measurement fundamental for comparison of photon luminosity to neutrino luminosity of sun. Check for non-standard energy mechanism in the sun

- Probe the transition matter-vacuum oscillation transition expected (2-3 MeV) in favoured MSW-LMA

- New results on background 1-2 MeV: opportunity for pep+CNO observation

- Super Novae neutrinos

- Geo anti-neutrinos (20 events/yr expected)

Expected ^{7}Be Signal

- Theoretical uncertainty of SSM on ^{7}Be is 12% (BP04)
- Large experimental uncertainty of ^{7}Be flux:
  - 0.91+0.24-0.61 of BP04 (Bahcall-Peña "Roadmap")
- Scattering cross section (ν-e) 5 times larger for electron ν @ ^{7}Be energy
- Reduced interaction rate (ν-e) expected at 66% of SSM prediction

MSW-LMA Scenario Signal & projected sensitivity

- 30 ev/day above threshold
- Well positioned from statistical point of view:
  - 11000 ev in 1 yr (1%)
  - 22000 ev in 2 yrs (0.7%)
  - 44000 ev in 4 yrs (0.5%)
- Accuracy of Borexino measurement most likely determined by background and systematics

Background Classes

In increasing order of difficulty...

Background from long-lived isotopes (U, Th, K)

Noble Gases (^{85}Kr, ^{39}Ar)

Radon Daughters (^{210}Bi-Po-Pb)

Cosmogenic Background

Goal: keep each source below 1 ev/day in fiducial mass

U-Th Background

- Feasibility of 10^{-16} g/g U, Th contamination first demonstrated in CTF (@limits of apparatus sensitivity)
- Highly desirable reduction of background at level of 10^{-17} g/g U, Th
  - precision ^{7}Be measurement
  - open pep observation
- Collaboration focus on cleanliness & development of purification methods

^{85}Kr & ^{39}Ar

- Present in air, traces in LN_2 (ubiquitous in purification processes)
- Possible systematic problem: diffusive, penetrates thin plastics over time; need to address overall contamination in detector & leaks over time
- Goal: < 1ev/day ~ 100 nBq/m^3 ~ 0.3 ppm Ar, 0.1 ppt Kr -> 10^4 higher than standard LN_2
- Strategy:
  - Search commercial LN_2 compliant with specs: Achieved!
  - Implement global purge of all detector

Radon Daughters
^{210}Bi-Po-Pb

- Air-borne contamination
- Deposits on exposed surfaces; Possible washoff over time; Cross-contamination?
- Goal of < 1 ev/day... very ambitious!
- Helps vessel built in clean conditions
- Further testing needed in CTF for purification and cross-contamination
- CTF sensitivity far from Borexino ultimate needs

Cosmogenic Background

- Cosmogenic nuclides production related in fundamental way to of neutron production rate
- Fast decaying cosmogenic background almost completely removed by tagging with muon
- Cosmogenic nuclides removed include problematic ^{11}C
  - 30 min, positron, 1-2 MeV spectrum):
  - 14 ev/day fiducial mass
  - tagged in three-fold coincidence with parent muon and neutron capture

pep+CNO neutrinos

- Recent results: ^{11}C reduced to < 0.5 ev/day by coincidence tagging
- pep+CNO neutrinos: 2 ev/day [0.8-1.3 MeV]
- Internal Bgd 0.6 ev/day @ 10^{-17} g/g U, Th
- External Background:
  - 1 ev/day in 100 tons
  - 0.1 ev/day in 70 tons
- Opportunity for real-time observation of one of two basic reactions of (4p->He) cycle

Filling Strategy

- How to check ultimate background before committing to fill detector?
- Collaboration decided to fill with water first
- Water displaced top down and replaced with PC
- Allows “early screening” of PC with 4π shielding
- Cost in time, benefit in background checks & vessel wash

Gran Sasso Situation

- Preventive sequestration of entire Hall C on May 29 2003, upon discovery of mixing between waste and aqueduct water on Lab site and lacking authorizations
- Government declated state of emergency; strong committment to repair lab facilities
- Contracts for Lab repairs assigned early May
- Fixing of Hall C to start middle of June, 3mos expected
- Back at work with PC by year's end
- Collaboration strongly engaged & optimistic
- Agencies strongly committed

Spare Stuff