**CNO and pep neutrino spectroscopy in BOREXino: measurement of the cosmogenic $^{11}$C background with the Counting Test Facility**

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**Introduction**

Borexino is an experimental low-energy neutrino spectrometry at the Gran Sasso underground laboratories. It is designed to measure the main energetic solar neutrino fluxes by means of neutrino-electron elastic scattering in ultra-pure organic liquid scintillator.

Borexino has the potential to also detect rare events from the pep and CNO processes and the CNO cycle. For this measurement, to be possible, a low level of background must be achieved in the detector mass. The main backgrounds are: radiation from the residual reactor core, neutrons from muon-proton interactions in the experimental setup, and finally background neutrons and gammas from cosmic rays.

$^{11}$C and $^{14}$N neutrinos are produced in the sun by the proton-proton chain and the CNO cycle processes. Their neutrino cross sections and decay rates are well known. The main background reactions that can mimic these neutrino events are the neutron capture reactions on carbon, nitrogen, and oxygen.

**Why pep and CNO neutrinos?**

- Ideal source for probing the energy region, between 1 and 3 MeV, at which the transition between matter and reaction-dominated reactions occurs.
- Useful to study the fundamental open questions regarding the neutrino energy dependence.
- CNO neutrinos play a key role in understanding the age and core properties of the sun.

**Expected rate in Borexino**

- pep: $1.5 \times 10^{-2}$ d$^{-1}$ ton$^{-1}$
- CNO: $6 \times 10^{-3}$ d$^{-1}$ ton$^{-1}$
- Internal background: $6 \times 10^{-3}$ d$^{-1}$ ton$^{-1}$

**Goal**

- To reach a signal-to-background ratio $f > 1$.
- To achieve $f > 1$, the required reduction factor is $f = R_{\text{total}}/R_{\text{total}} = 5$.

**Text of the TCTC (TFCT)**

- The Counting Test Facility Detector (CTF)
- CTF geometry
- Event selection criteria
- Detection efficiency and results
- Simulation results
- Measured rates
- Conclusion
- Bibliography

**BOREXino potential**

- Goal in BOREXino: $^{11}$C background reduction with efficiency larger than 2.2 MeV.
- Neutrino detection and identification of a spherical volume of radius $r$, centered on the neutrino capture gamma; for a time $t$.

**Conclusions**

- The agreement between the $^{11}$C production rate measured at LNGS by CTF and the one extrapolated from the NA54 CERN experiment results demonstrates that the three-fold coincidence technique is a powerful tool for isolating and discriminating the $^{11}$C background.
- BOREXino has the potential to lower the $^{11}$C background to a level compatible with the observation of pep and CNO neutrinos, knowing only 10% of the rate.

**Bibliography**

- BAL06: M. Balata et al., Borexino Collaboration, Jan 2006, hep-ex/0601035
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