Borexino is a real-time detector for low energy Solar neutrino spectroscopy installed in the underground laboratories (3800 mwe depth) at Gran Sasso, Italy (LNGS). Borexino is specifically designed to measure the mono-energetic (662 keV) 7Be flux via neutrino-electron elastic scattering in ultra-pure organic scintillation liquid. The separation of signal and background relies on the identification of the Compton-like edge in the recoil electron energy spectrum at 667 keV. The physics potential of Borexino strongly depends on the unprecedented requirements of low level background. The exceptional radio-purity reached by the Borexino, in order to guarantee the success of the experiment, must be complemented with the identification and discrimination of the residual intrinsic contaminants, as well as of the external and cosmogenic backgrounds. Crucial in this respect are the energy and spatial reconstruction capabilities of the detector, which thus require a careful and precise calibration. Identified background sources can represent optimal sample for auto-calibrating the detector. We report on the Borexino performances after 1 year of data taking in reconstructing event energy and position, in discriminating on the nature of the contaminant with the pulse shape analysis and in the identification of fast coincidences looking at time and space correlations.

**Energy Scale**

The calibration of energy scale requires well defined sample of a known source. The best candidates are: $^{14}C$ decays, whose activity is dominant below 0.2 MeV, 2.2 MeV gammas from capture of cosmogenic neutrinos, tagged in coincidence with the muon parent, and cosmogenic $^{14}C\beta\beta$ events, identified with the three fold coincidence with the muon parent and the associated emission.

The energy distortion due to the **quenching effect** is formalized with the Birks model. The expected quenching factors for $\beta$ and $\alpha$ are energy dependent and belong to the [1.02-1.05] and [1.0-1.3] ranges, respectively. Even if the effect in the $\beta$ case is smaller, it is amplificiated in the Compton electron gamma induced showers: $\gamma$ energy can be reduced by a factor up to 1.3, introducing a bias in the analysis. 2.2 MeV $\gamma$ induced by neutrons and the 0.511 MeV $\gamma$ from the positron annihilation in the $^{11}C$ decay, are optimal calibration candidates for determining the KB parameter.

**Monte Carlo Simulations**

![Monte Carlo simulations](image)

The Borexino Geant-4 based code (G4Bx) provides a detailed description of the detector geometry and materials, electromagnetic and hadronic processes and the scintillator optical properties. Moreover, G4Bx interacts with simpler code based on FLUKA, to study the neutron physics. A complete simulation of the electronic chain, produce an output file that can be processed by the Borexino reconstruction code. A strict validation of the simulation package is in progress.

**Pulse Shape**

\[ \alpha/\beta \] analysis with the optimum Gatti method based on the different time response of the scintillator to $\alpha$ and $\beta$ particles

\[ \tau = \frac{\text{energy}}{\text{rate}} \]

**Energy range**

- 534 MeV
- 2 - 3 MeV
- 2.5 MeV

**Position Reconstruction and Vessel Shape**

The event spatial reconstruction is based on the time information of each photon. The arrival time $t_1$ of the first photon of the electron-positron channel is equal to $t_1 = t_1 + t_2 + t_3$, where $t_1$ is the absolute time of the event, $t_2$ the scintillator decay time, $t_3$ the time of flight, and $t_4$ is the jitter time proper of the PMT. Spatial position results from the maximum likelihood fit of the time distribution.

Fast coincidence (\(t < 216\) ms) between $^{210}Po$ and $^{214}Bi$ ($^{214}Po$ chain): both alphas are produced at the same position and their distance is affected only by the spatial resolution. The fit results $\sigma \sim 15$ cm at $-250$ photoelectrons (500 keV).

Fast coincidence identification have a determinant role in the Borexino analyzes: beyond the event by event identification of single neutrinos, they allow statistical subtractions of segments of radioactive chain in equilibrium ($^{214}Po-Pb$) or secondary decaying channels with known branching ratio ($^{210}Po-Rb$). Moreover, they represent optimal calibration candidates for studying the detector response in energy and time.

**Position Reconstruction**

- The two plots confirms the CCD camera calibration results: vessel origin is shifted along positive z-axis by about 5 cm.

**Bibliography**