

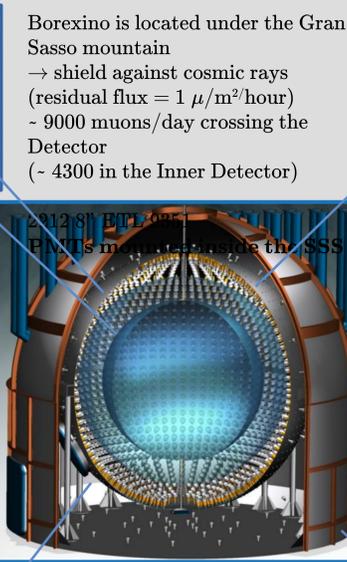
The Borexino detector



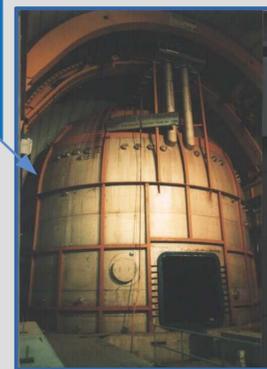
Two Nylon balloons
150 μm thick

Inner Vessel
($d=8.5\text{ m}$, $V=340\text{ m}^3$)
Filled with 278 tons of scintillator
(PC @ 1.5 g/l of PPO)

Inner Buffer
($d=11.5\text{ m}$)
filled with PC + DMP



Water Tank
($d=18\text{ m}$, $V=2400\text{ m}^3$)
Shielding from γ and n.
Water Cerenkov detector
(Muon Veto)
208 PMTs mounted on the SSS



Stainless Steel Sphere (SSS)
($d=13.7\text{ m}$, Volume = 1340 m^3)

Borexino is located under the Gran Sasso mountain
→ shield against cosmic rays
(residual flux = $1\ \mu\text{m}^2/\text{hour}$)
~ 9000 muons/day crossing the Detector
(~ 4300 in the Inner Detector)

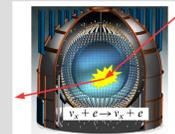
Abstract

The Borexino experiment, located at Laboratori Nazionali del Gran Sasso, and widely known for its rich Solar Neutrino physics program, has entered its 13th year of data taking. The detector, at present in its high-purity Phase III data taking, was thermally insulated in order to improve the fluid stability. As an outcome, quality of the data has significantly increased leading to new levels of sensitivity to all solar neutrino fluxes and allowing a more sensitive probe for CNO neutrinos.

The quality of the collected data, the stability of the detector as well as the capability to maintain the highest possible duty cycle have been essential for the success of all the Borexino analysis, and have to be constantly monitored. This poster presents the strategies adopted to improve data quality and to maintain the stability of data taking at the same level of reliable operation achieved in the past years.

The Borexino PMTs detect the scintillation light produced by electrons scattered by νs

- **Number of collected photons** (Photoelectron yield 500 p.e./MeV)
→ Energy (energy resolution ~ 5% @ 1MeV)
- **Time of arrival of photons**
→ Position reconstruction (by T.O.F. ~10cm @ 1 MeV)



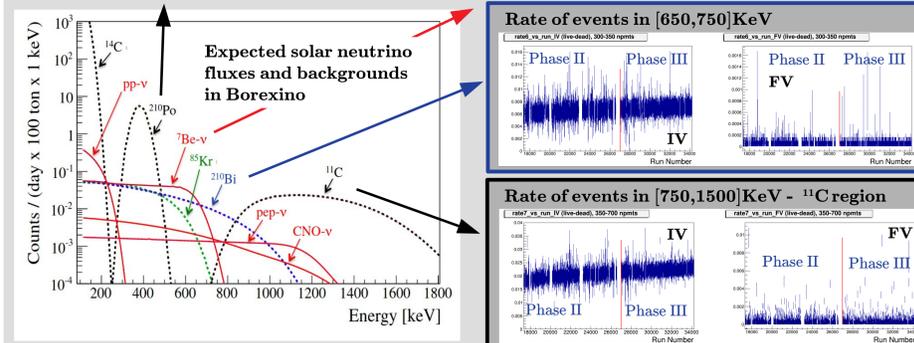
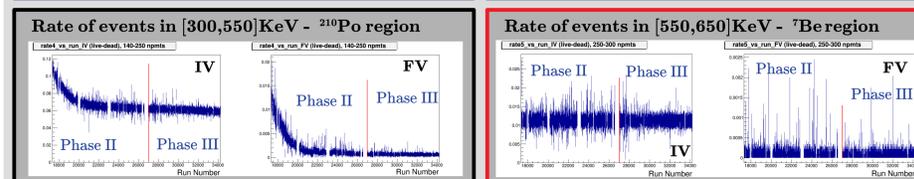
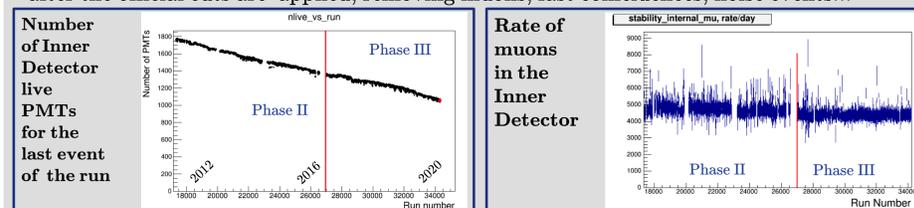
Drawbacks → No directionality → **Key points:**

- **Suppression of background sources** → $^{238}\text{U} < 9.4 \cdot 10^{-20}\text{ g/g}$, $^{232}\text{Th} < 5.7 \cdot 10^{-19}\text{ g/g}$
- **Stability of residual backgrounds**
- **Stable and good quality Data**
→ **Online and Offline Data Quality and Stability Monitor**

Monitor Stability

Software tool to monitor the integrity and quality of the data

- stability in time of different categories of events in the detector (muons, backgrounds and noise)
- stability of some hardware parameters such as the number of live pmts
- stability of events in Fiducial Volume (FV) and Inner Vessel (IV) in the ROI of neutrino signals after the official cuts are applied, removing muons, fast coincidences, noise events...

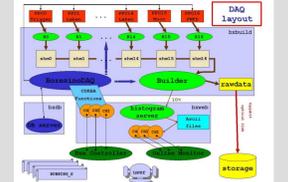


Online Data Quality monitoring

Online feedback on the quality of the data recorded to catch and diagnose problems in real time and quickly, in order to minimize data losses

Borexino Online Software is a complex system that runs on 27 cpus → it monitors detector, trigger and DAQ hardware statuses.

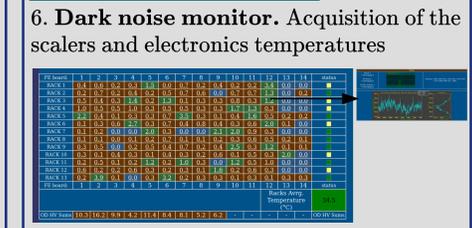
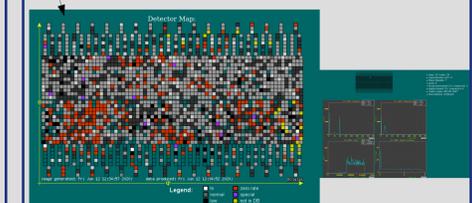
Borexino Online Software



- Data read-out.** Read-out of the event information from digital electronics
- Event Building.** Assembling the event from the sub-systems data
- Run Control.** Control over the data taking run → The detector state is displayed on a web page (rate, trigger..)
- Slow Control.** Control over the hardware → Monitor and Control: Read and display the status and the alarms of any device, Turn devices on/off and issue reset, Set/Read HV values ...



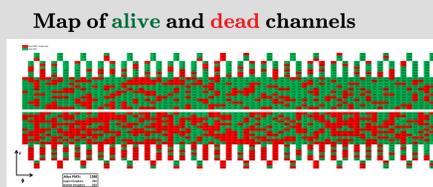
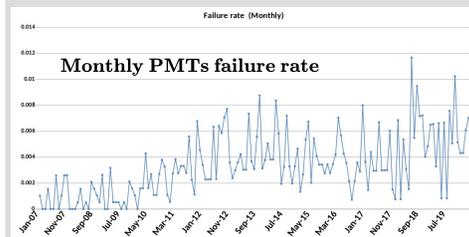
- Online Monitor.** Run-time detector performance check-up → to be immediately aware of any possible problem. PMTs dark rates, time and charge for each channel.
- Dark noise monitor.** Acquisition of the scalers and electronics temperatures



Offline Data Quality monitoring

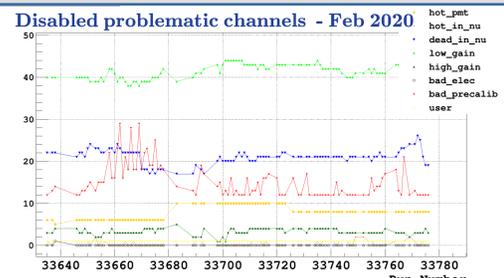
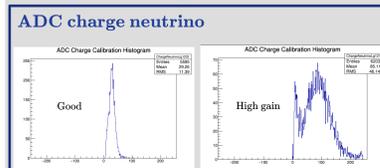
Monitoring that follows data storage

- **Validation of data on a run by run basis** → control the quality of the data recorded. A set of histograms is provided to categorize the data as usable or not according to the stringent needs of various physics analysis
- **Monitor carefully the number of failed PMTs for each month**



- **"Broken Channel Monitor"** → Check on problematic channels

Info about ADC pulser, ADC neutrino, charge and timing calibration info, PMTs HV set and monitored, DarkNoise...



- Check on number and reason of problematic channels selected by the reconstruction code

Stable Detector for 13 years!

Borexino is the only experiment to simultaneously test neutrino flavour conversion both in the vacuum and in the matter-dominated regimes, and alone it has performed the full spectroscopy of pp-chain neutrinos.

➔ We have reached 13 years of Borexino running with a stable detector

- Improved radiopurity and unprecedented backgrounds
- High duty cycle, Data Quality, Online and Offline monitoring
- Increased stability of the detector (Temperature stabilization for preventing ^{210}Po mixing)
- Better comprehension of the details of the energy scale and detector response

