The ANTARES detector: background sources and effects on detector performance

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on behalf of the ANTARES Collaboration
Detection Principle

Reconstruction of $\mu$ trajectory ($\sim \nu$) from timing and position of PMT hits
Background sources
Atmospheric muons and neutrinos

Muons induced by atm $\nu$

$1\text{TeV}$

$10\text{TeV}$

$\nu_{\mu}$
Rejection of the atmospheric background

Atmospheric muons

- Optical Modules oriented downward
- Detector at great depth (~2475 m)

**Advantage:**
- $\mu_{\text{atm}}$ can be used for flux measurement
- $\mu_{\text{atm}}$ can be used for pointing accuracy

**Problem:** Some $\mu_{\text{atm}}$ can be reconstructed as upgoing

Atmospheric neutrinos

**Point-like sources:**
Reduced background (see J. Aguilar’s talk)

**Diffuse flux:**

- Energy spectral index $E^\gamma$:
  - $\gamma=-3.7$ for $\nu_{\text{atm}}$
  - $\gamma=-2.2 / -2.0$ for $\nu$ from cosmic accelerators
Optical background

Bioluminescence bursts:
Animal species which emit light by flashes, spontaneous or stimulated around the detector.

Baseline: \( ^{40}\text{K} \) decays
Bacteria luminescence
40K decays

Conclusions:
Absolute PMT efficiencies, stable in time
Agreement within 5%
40K constant contribution at 40 kHz
Baseline variations

Buoy

MILOM

top storey: 1 optical module current profiler

middle storey: 3 optical modules

bottom storey: LED beacon

base: acoustic transducer

Sometimes high bioluminescence activity

ICRC '07, Merida
Effects of the background
Such a study requires detailed simulations for various values of baseline/burst fraction for each physics channel.

Impact of bioluminescence will be very different for:

- **Diffuse sources**: no pointing accuracy, high energy cut \( \sim 50 \text{ TeV} \)
- **Point sources**: high pointing accuracy, no or moderate energy cut
- **Transient sources**: reduced background due to time constraint
- **Dark matter = low energy**
Neutrino effective area

![Graph showing neutrino effective area vs. energy in GeV. The x-axis represents energy in GeV ranging from 50 to 400, and the y-axis represents neutrino effective area in square meters ranging from $10^{-9}$ to $10^{3}$. There are two curves, one for trigger level and one for detection level, indicating the effectiveness of different levels of detection over a range of energies.]
Neutrino effective area
Impact on the data acquisition

Baseline < 300 kHz

All data to shore

Baseline > 300 kHz

Sampling: \( \frac{N}{M} \) frames are transmitted to shore

Off-shore trigger L1: only local coincidences transmitted to shore

Bioluminescence burst > 500 kHz

High rate veto: OM data is not transmitted to shore during burst.
Some ideas are being studied...
Standard trigger

Online Data filter

Level 1 Trigger (L1):

- Look for local coincidences (2/3 OMs in the same storey)
- Charge > 3 p.e. on a single OM

Old trigger:

N local coincidences anywhere inside the detector

**Problem:** For N=5, accidental trigger rate increases as $\propto f^{10}$
Standard trigger

Online Data filter

Level 1 Trigger (L1):

• Look for local coincidences (2/3 OMs in the same storey)
or
• Charge > 3 p.e. on a single OM

Old trigger:

N local coincidences anywhere inside the detector

Problem: For N=5, accidental trigger rate increases as $\propto f^{10}$

New trigger:

N local coincidences with a 3D causality trigger
Generated event

- ANTARES lines
- Trajectory of light from track to OM
- 1 hit in storey
- 2 hits in storey in 2 different OM
- ≥3 hits in storey in ≥2 different OM
- 2 hits in storey in 1 same OM

→ One event produce hits in cluster of storeys

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Alternatives trigger

To remove noise hits…

**Cluster trigger:**

**Cluster T2** = Two L1 in adjacent storeys

**Cluster T3** = Two L1 in next to adjacent storeys
Alternatives trigger

To remove noise hits...

Cluster trigger:

Cluster T2 = Two L1 in adjacent storeys

Cluster T3 = Two L1 in next to adjacent storeys

Causality algorithms:

\[ N \times T2/T3 \] with a causality requirement

→ Work in progress
Conclusion
Review of the bioluminescence activity

2006

Connection Line 1

Connection Line 2

2007 (6 months)

Connections Line 3, 4 & 5

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ICRC ’07, Merida
Latest bioluminescence activity

Bioluminescence activity is very low since one year.
Conclusions

Background sources are being understood

Some seasonal effects can appear, due to biological activity

Studies are still in progress:

• To evaluate precise effects of high bioluminescence activities on the detector performances (effective area, pointing accuracy, dead time, …)

• To optimize trigger and reconstruction efficiency at high bioluminescence levels

Bioluminescence activity is low since 1 year

⇒ A lot of data to analyse