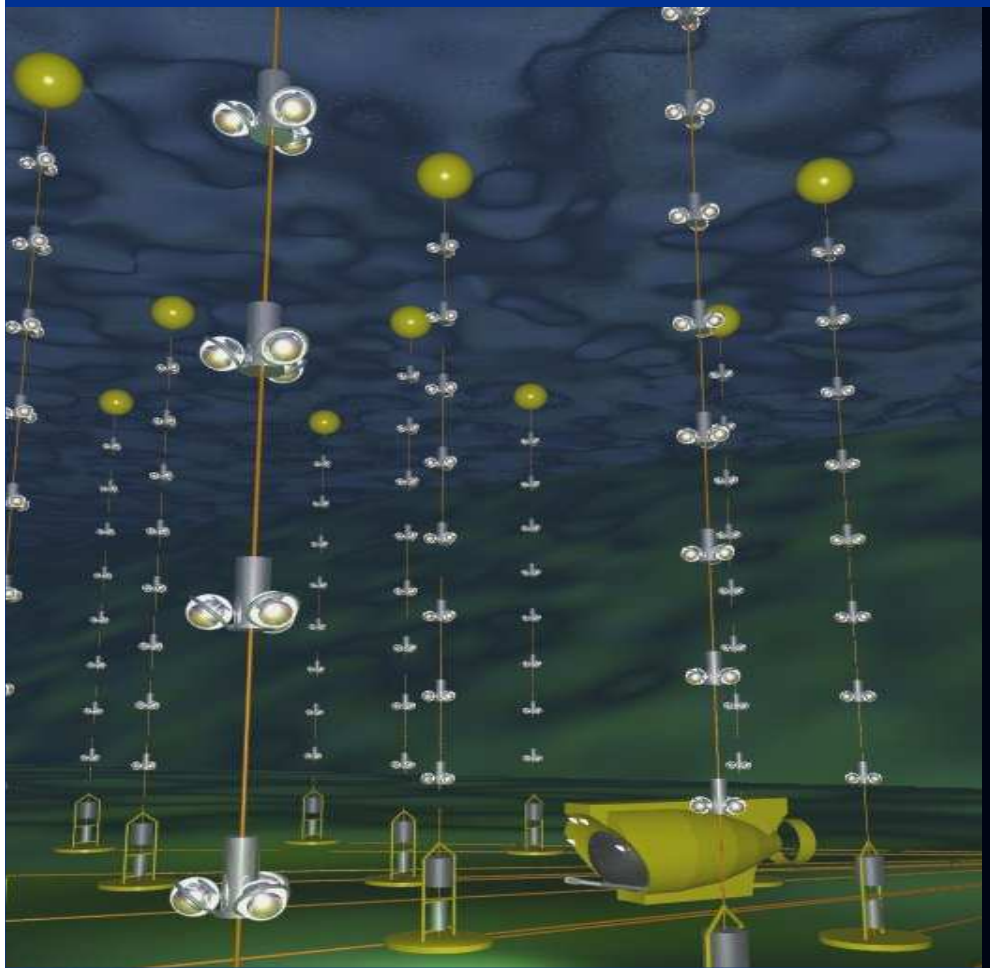
The ANTARES detector: background sources and effects on detector performance



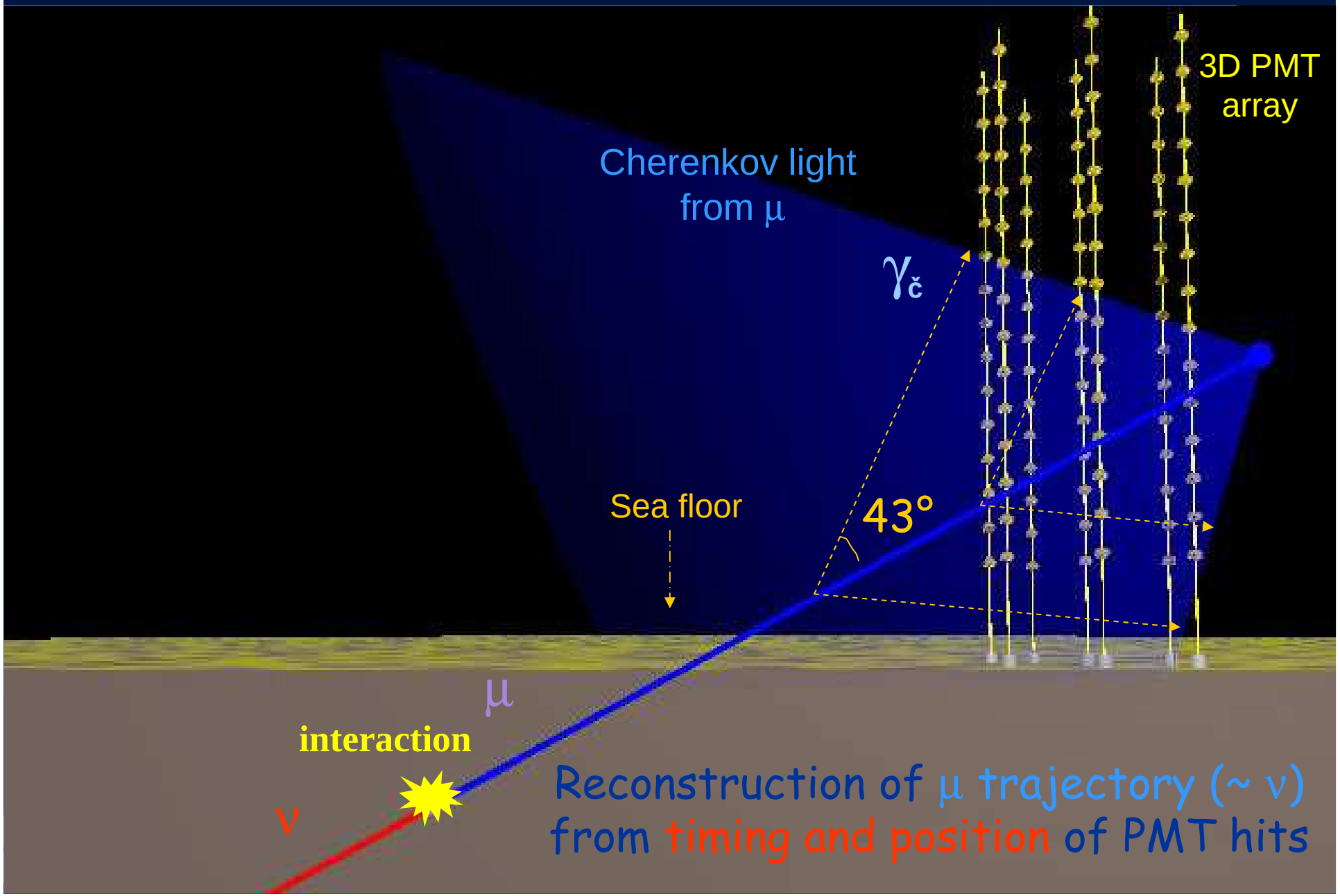
S. Escoffier

CNRS
Centre de Physique des Particules de Marseille

on behalf of the ANTARES Collaboration

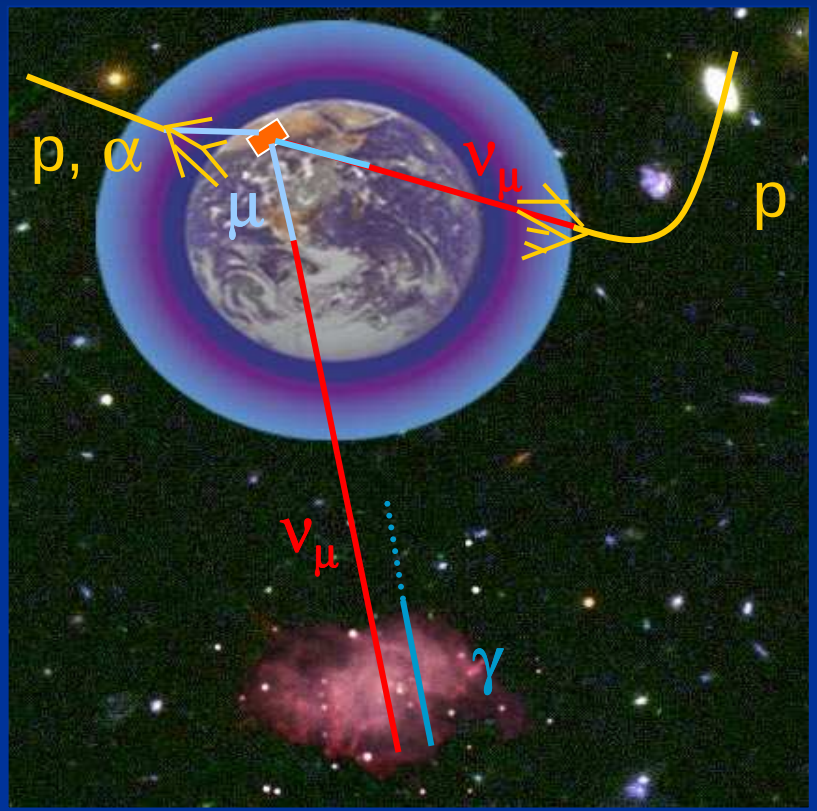
ICRC'07 Mérida, Yucatán, Méx.

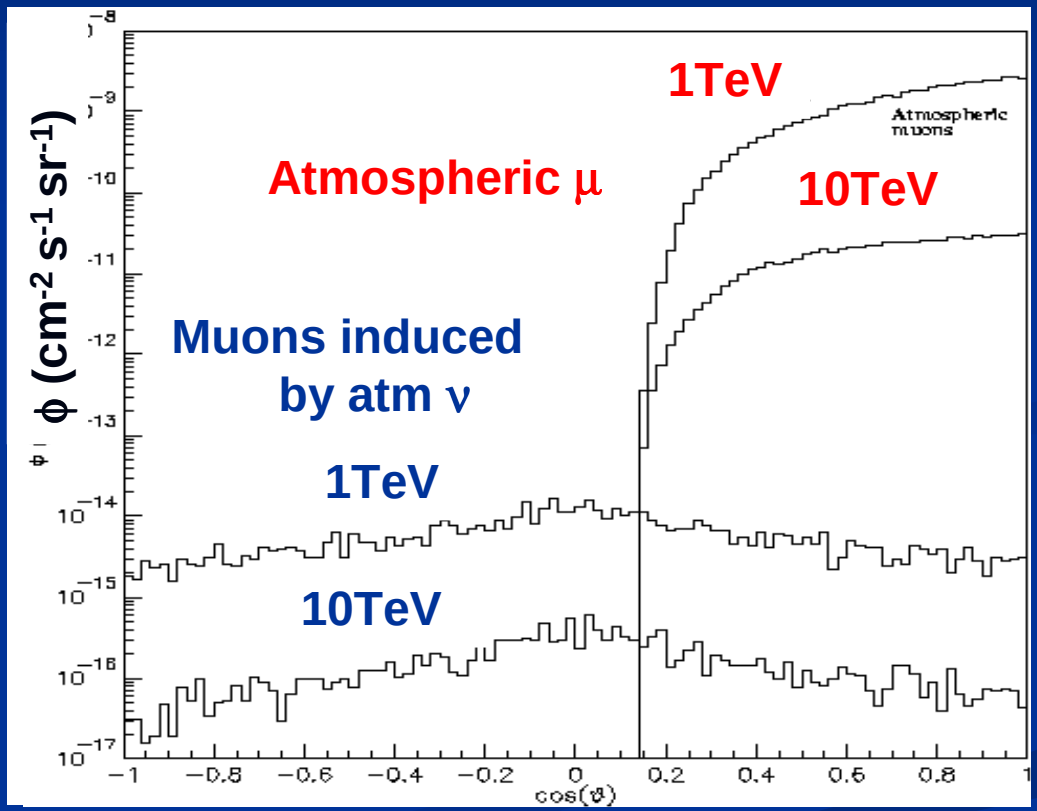
Detection Principle



Background sources

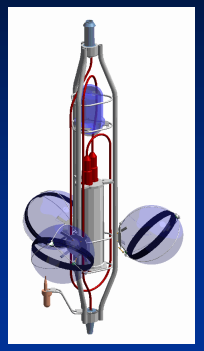
Atmospheric muons and neutrinos

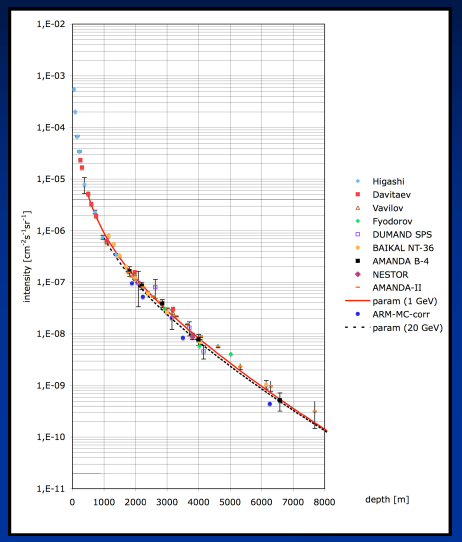




Rejection of the atmospheric background

Atmospheric muons





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

Advantage:
- μ_{atm} can be used for flux measurement
- μ_{atm} can be used for pointing accuracy (moon shadow)

Problem: Some μ_{atm} can be reconstructed as upgoing

Atmospheric neutrinos

Point-like sources:

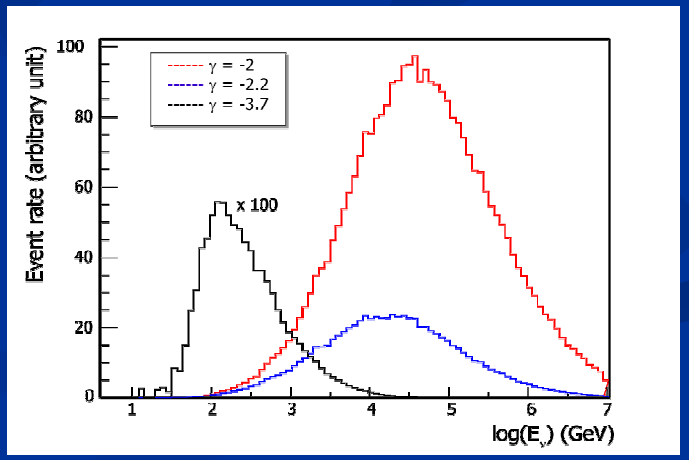
Reduced background (see J. Aguilar's talk)

Diffuse flux:

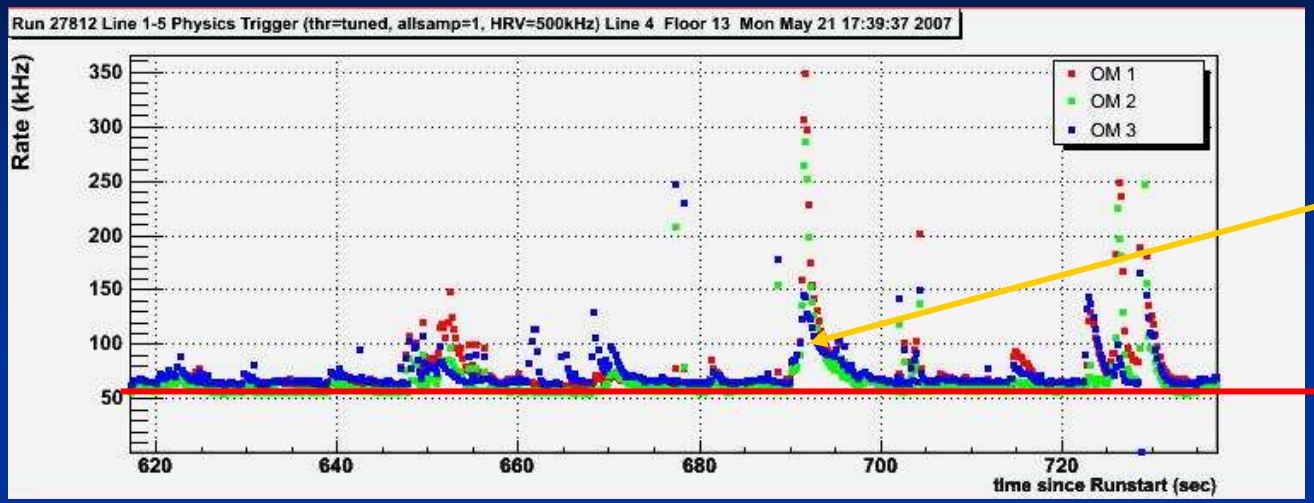
Energy spectral index E^{γ}:

γ=-3.7 for ν_{atm}

γ=-2.2 / -2.0 for ν from cosmic accelerators

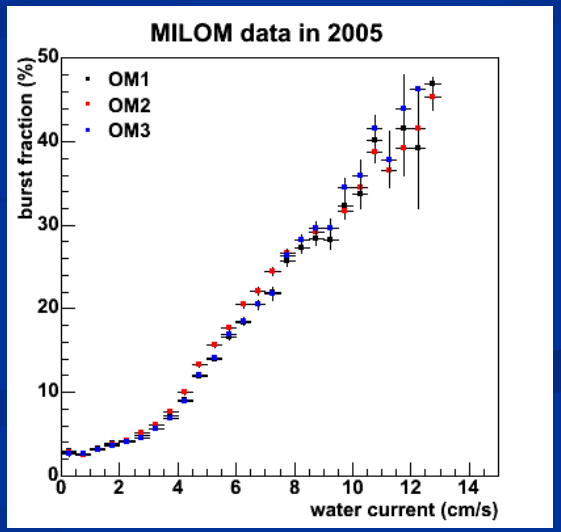


Optical background



Bioluminescence bursts:

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

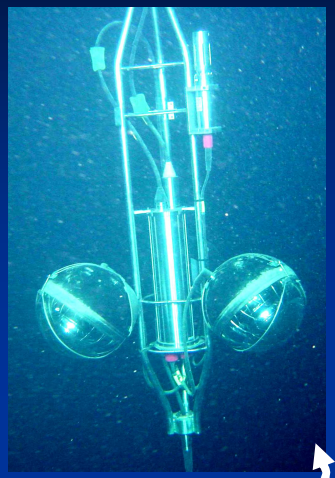


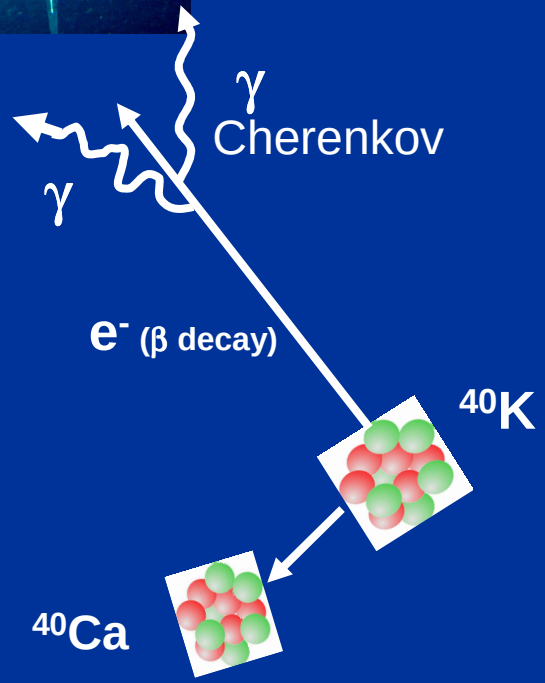
Baseline:

^{40}K decays

Bacteria luminescence

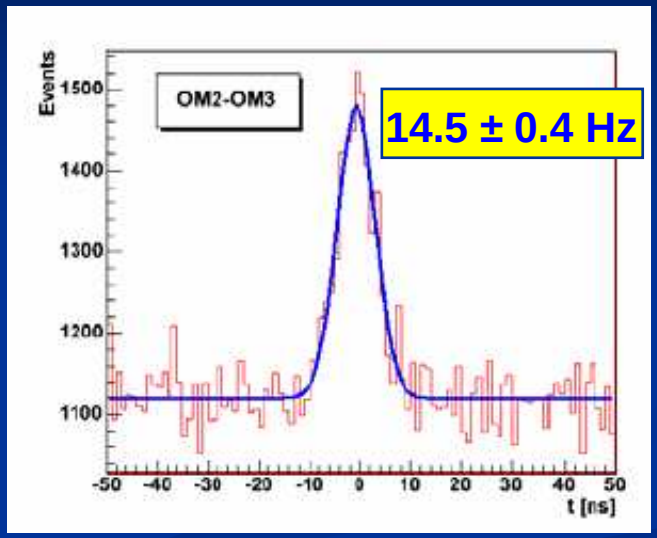
^{40}K decays





^{40}K coincidence rate

from Gaussian fit on data:



from simulation:

13 Hz ± 4 Hz (syst.)

Conclusions:

Absolute PMT efficiencies, stable in time

Agreement within 5%

^{40}K constant contribution at 40 kHz

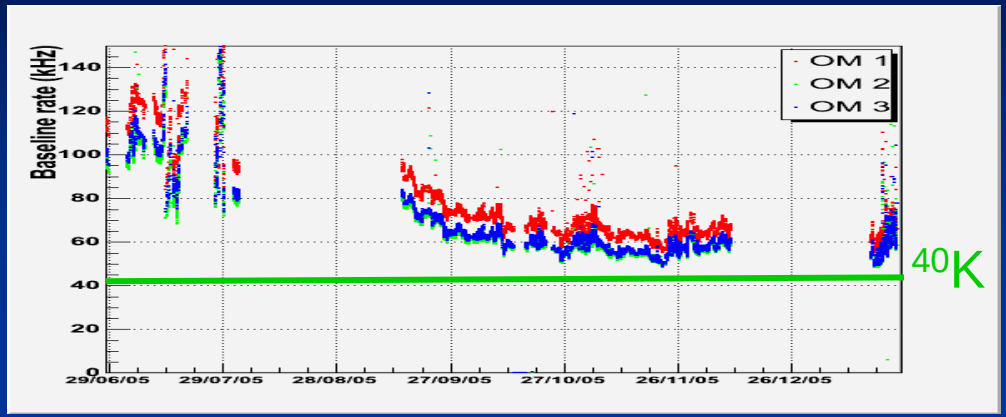
Baseline variations

top storey:
1 optical module
current profiler

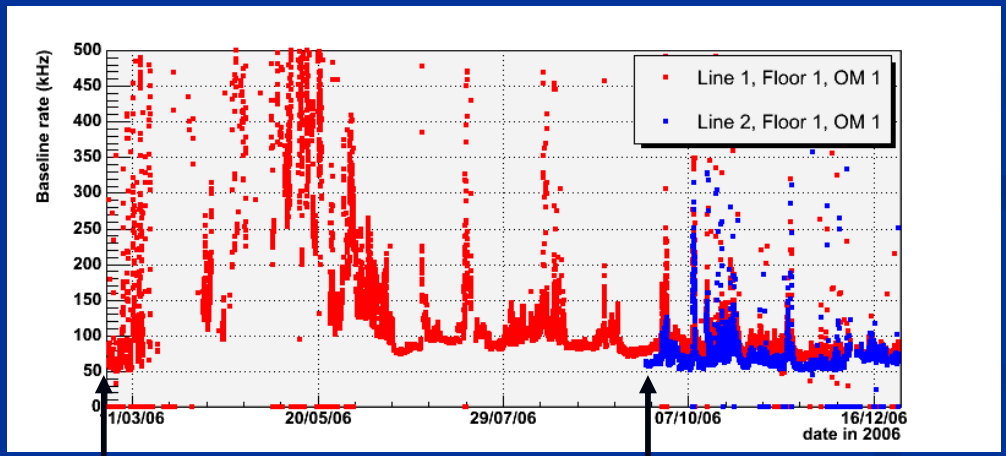
middle storey:
3 optical modules

bottom storey:
LED beacon

base:
acoustic transducer



2005



2006

Connection Line 1

Connection Line 2

➔ **Sometimes high bioluminescence activity**

Effects of the background

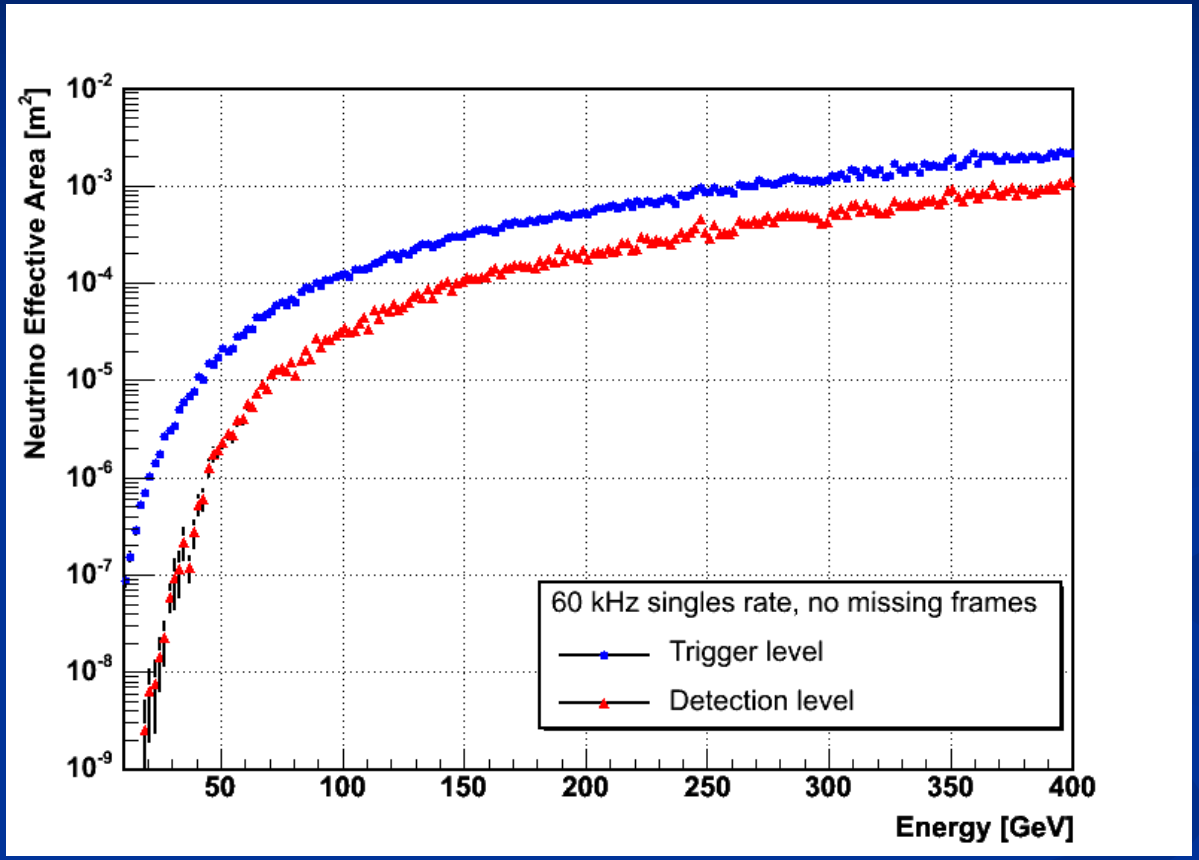
Status

Such a study requires detailed simulations for various values of baseline/burst fraction for each physics channel

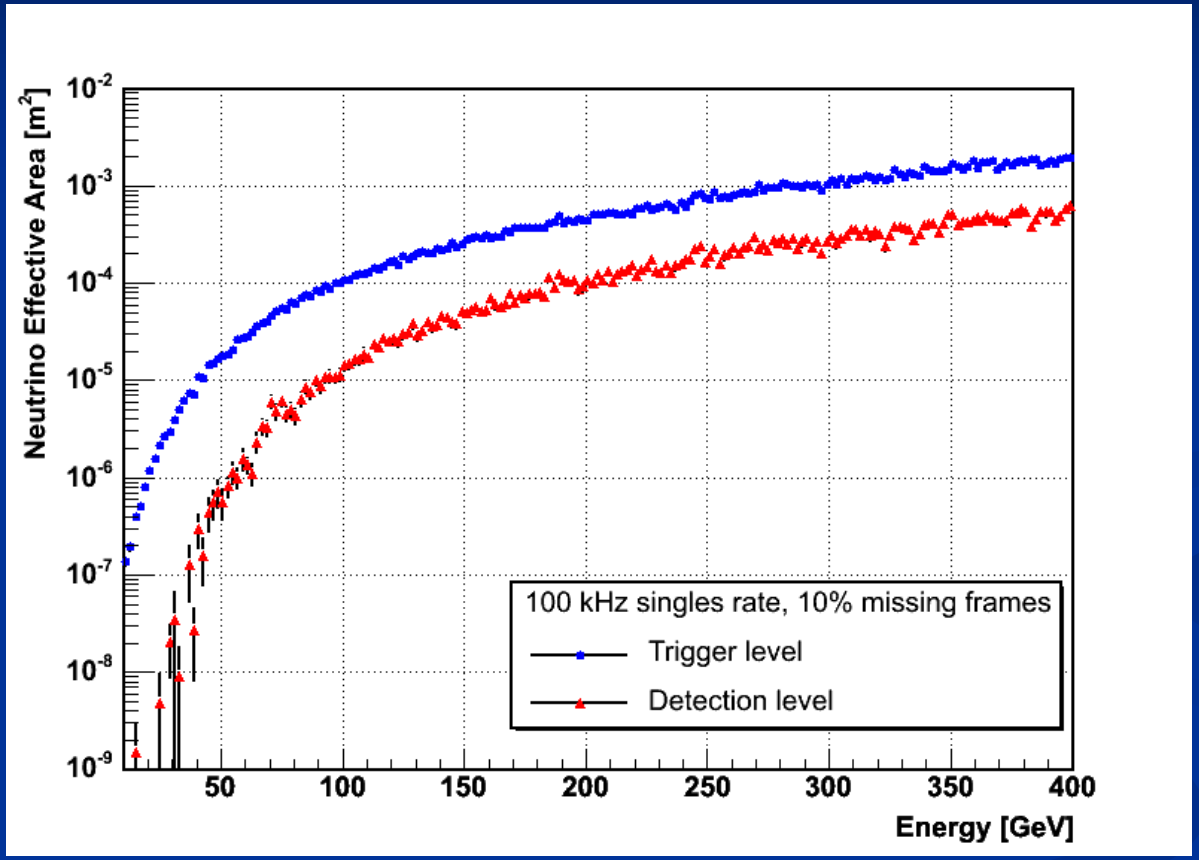
Impact of bioluminescence will be very different for:

- Diffuse sources: no pointing accuracy, high energy cut ~50 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



Neutrino effective area



Impact on the data acquisition

Baseline < 300 kHz

All data to shore

Baseline > 300 kHz

- Sampling: 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

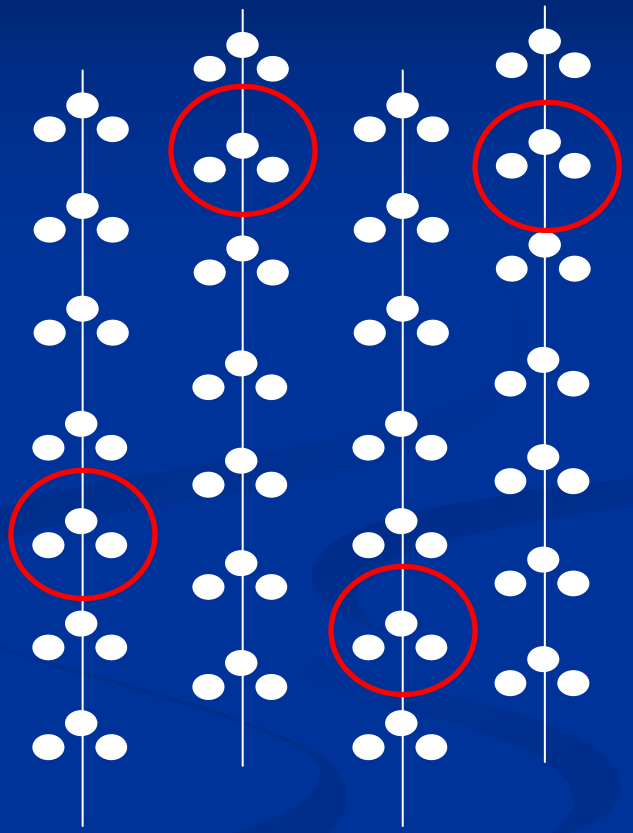
Online Data filter

Level 1 Trigger (L1):

- Look for local coincidences (2/3 OMs in the same storey)

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 $\propto f^{10}$

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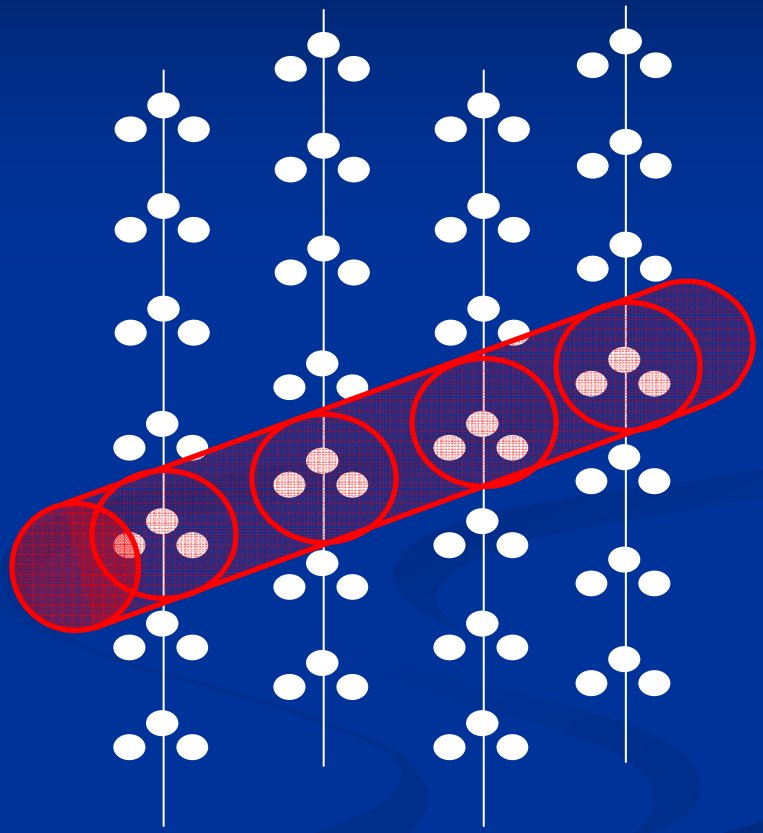


Old trigger :

N local coincidences anywhere inside the detector

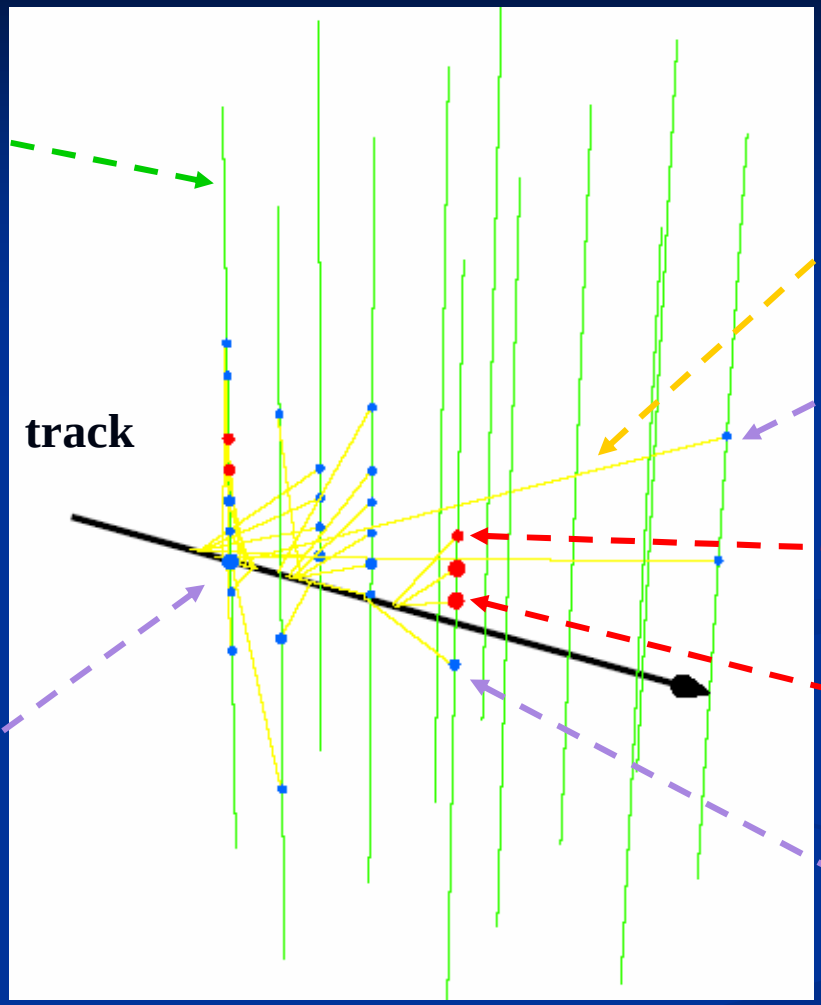
Problem: For N=5,

accidental trigger rate increases as $\propto f^{10}$

New trigger :

N local coincidences with a 3D causality trigger

Generated event



➔ One event produce hits in cluster of storeys

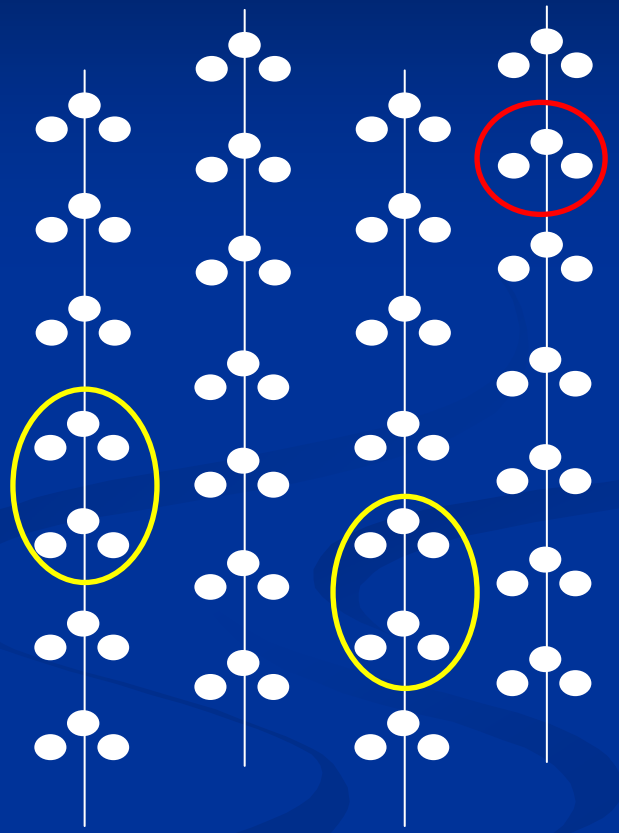
Alternatives trigger

To remove noise hits…

Cluster trigger :

Cluster T2 = Two L1 in adjacent storeys

Cluster T3 = Two L1 in next to adjacent storeys



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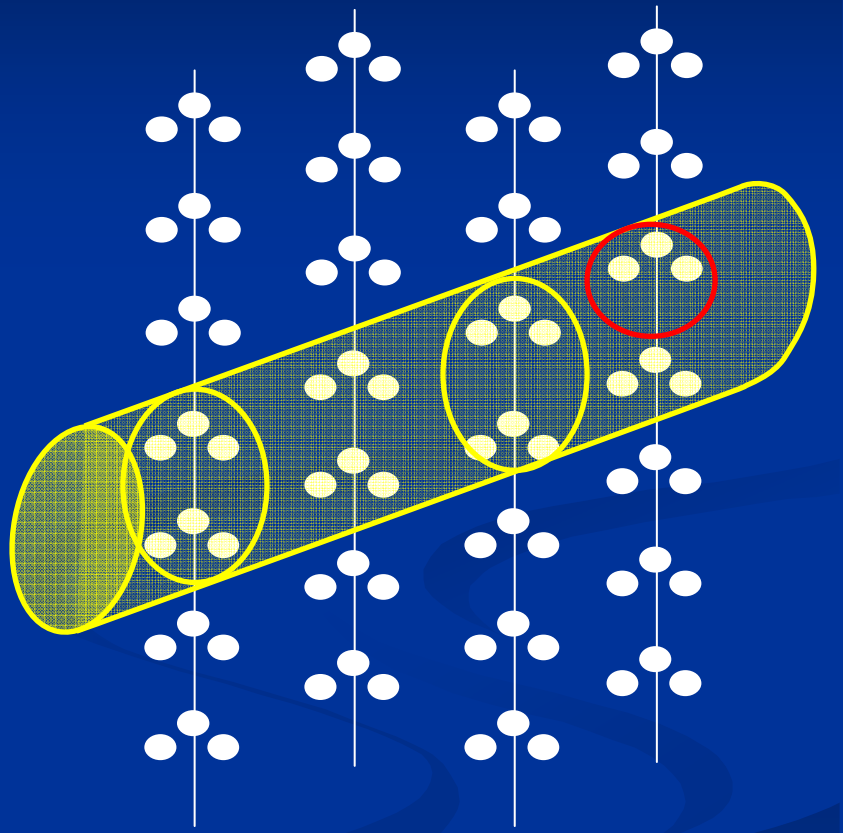


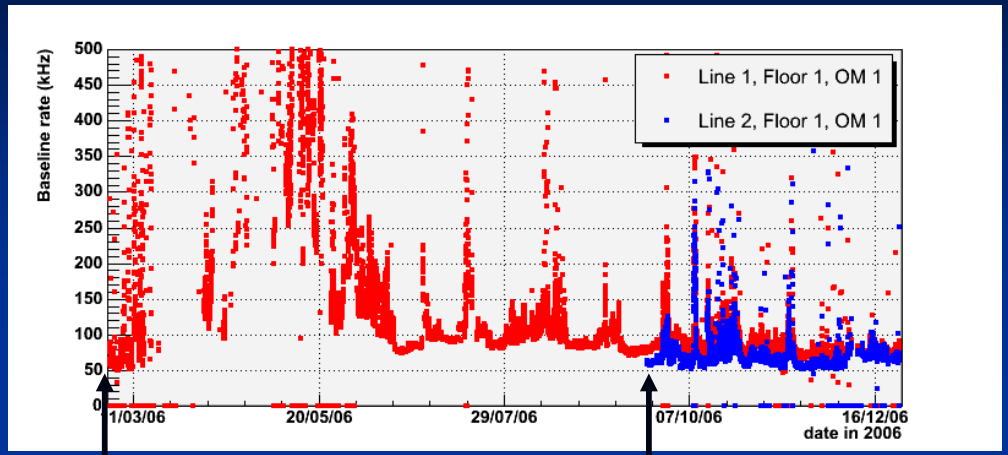
Causality algorithms :

N x T2/T3 with a causality requirement

➔ **Work in progress**

Conclusion

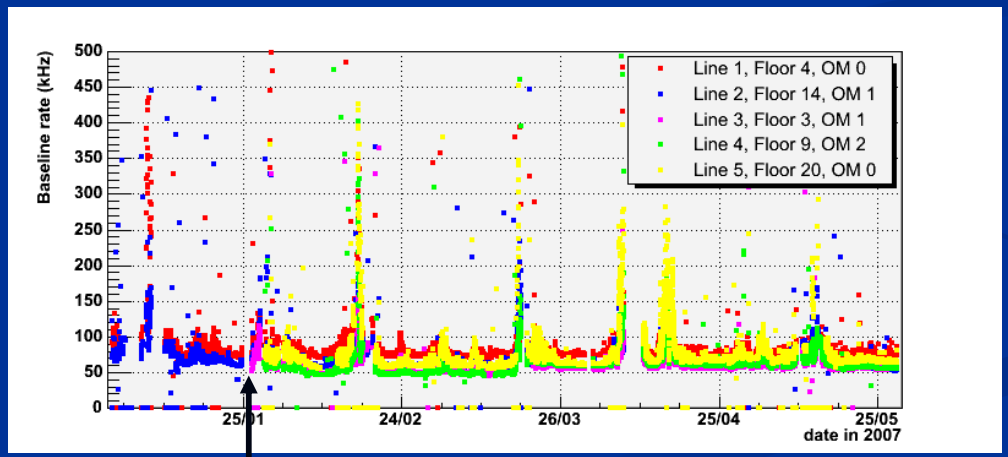
Review of the bioluminescence activity



2006

Connection Line 1

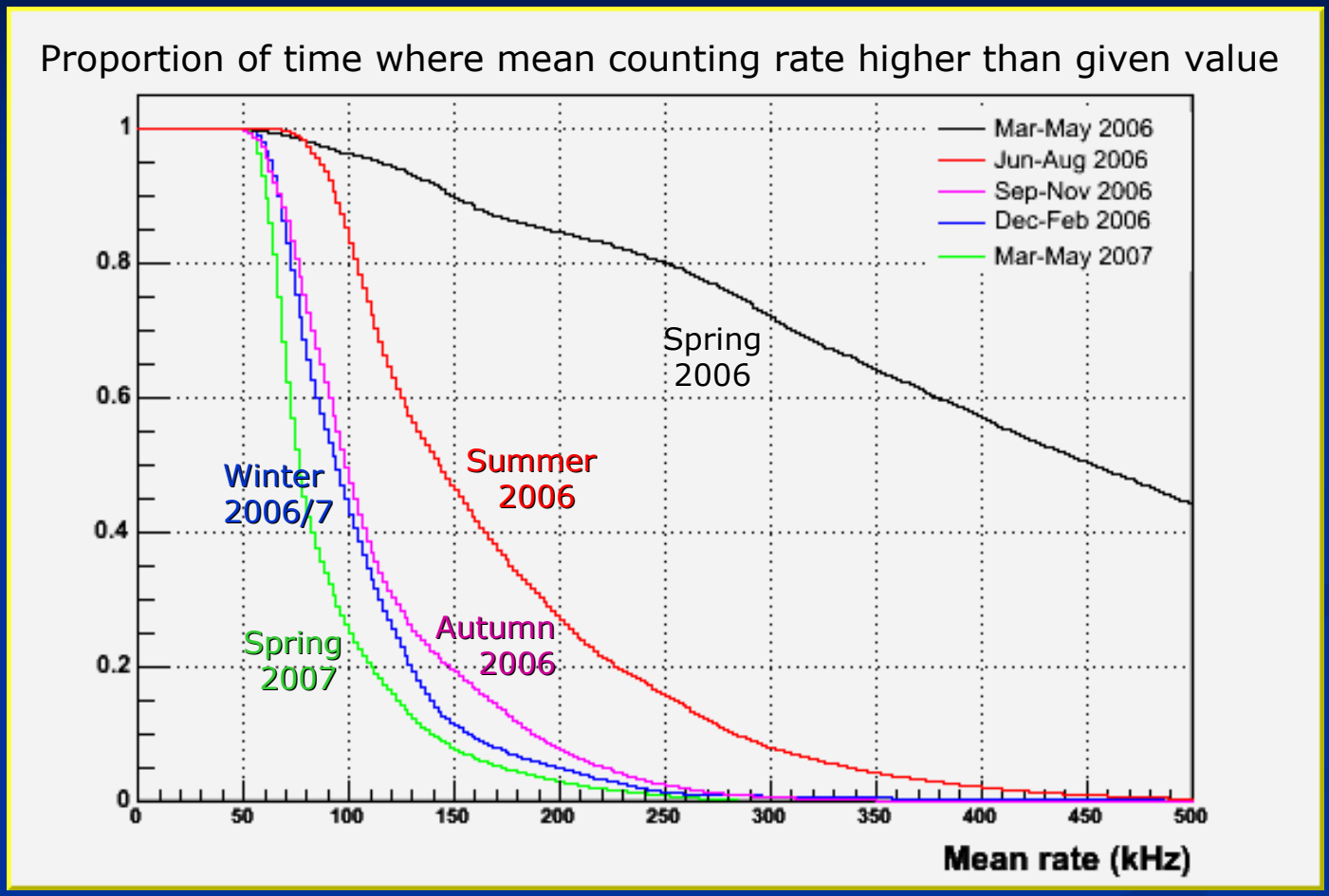
Connection Line 2



2007
(6 months)

Connections Line 3, 4 & 5

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