The first results of MSU groups in ANTARES project

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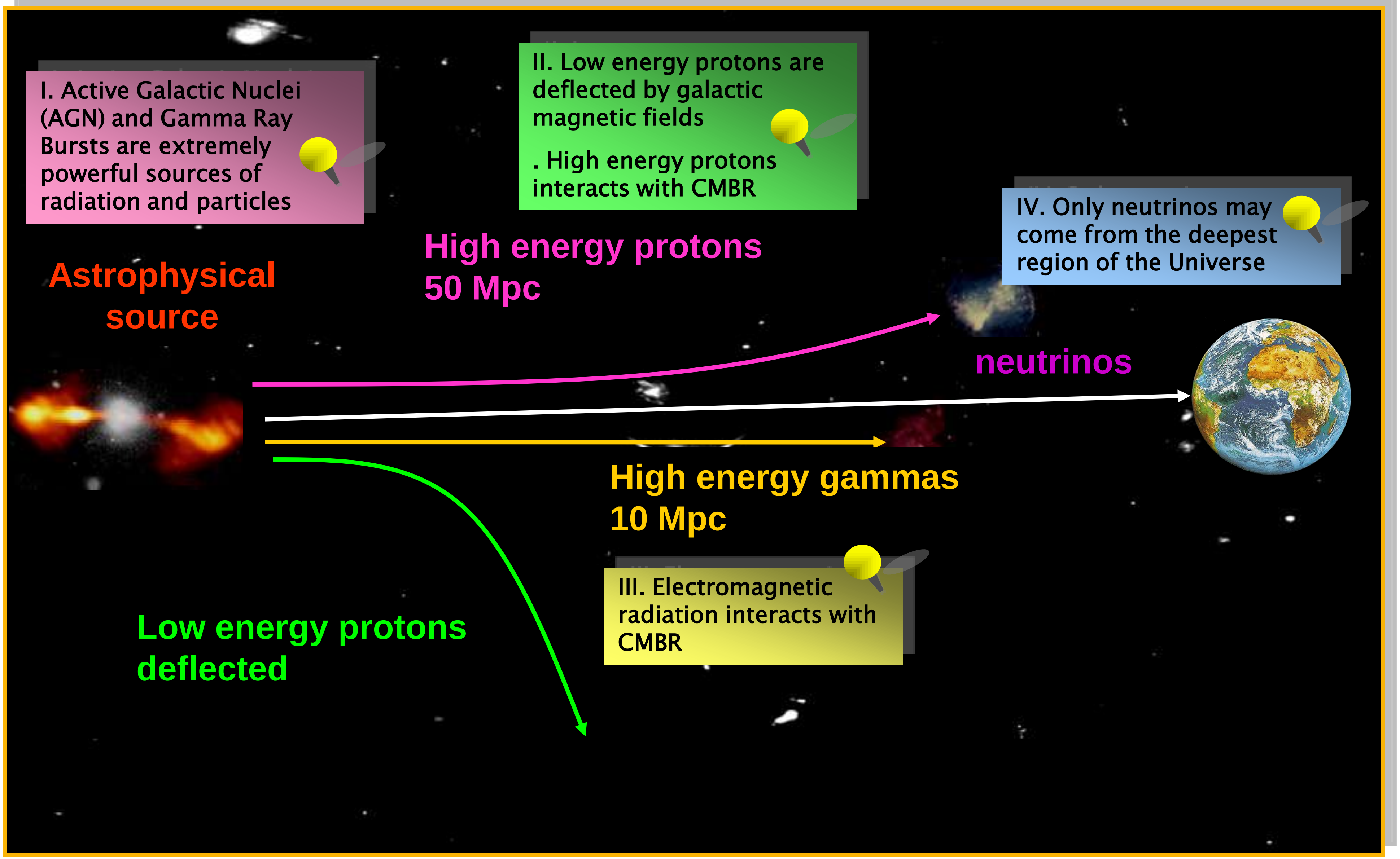
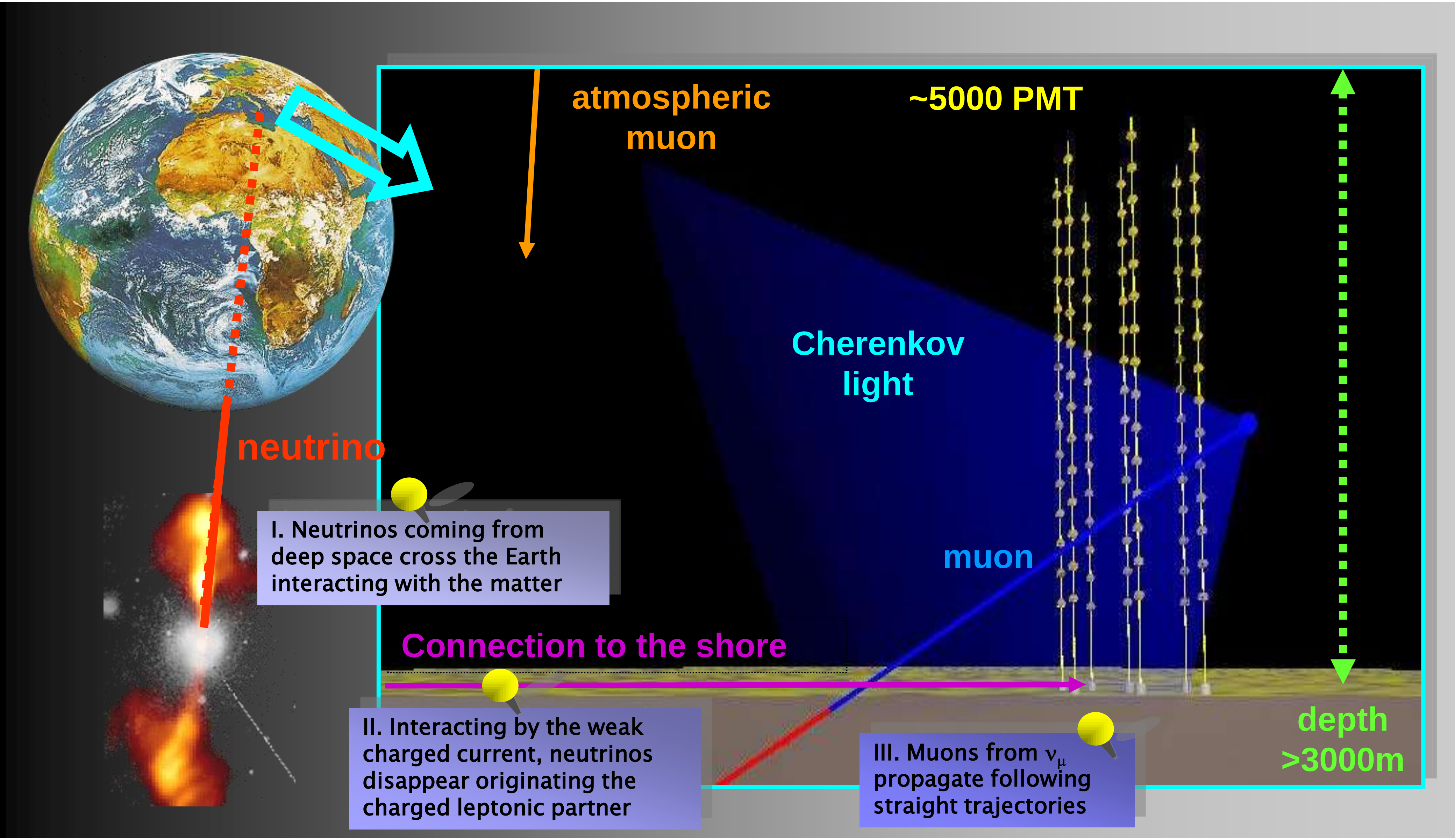
Limits of High Energy Astronomy

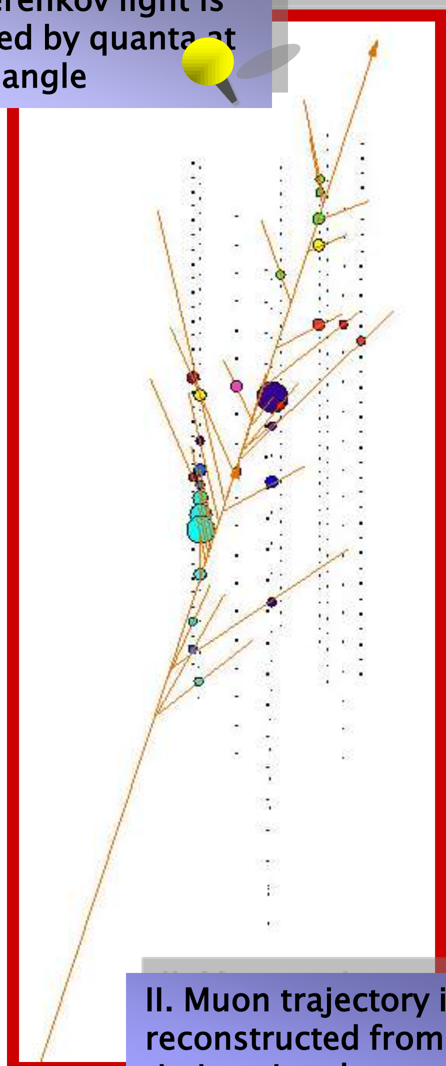


Neutrino Detection Principle



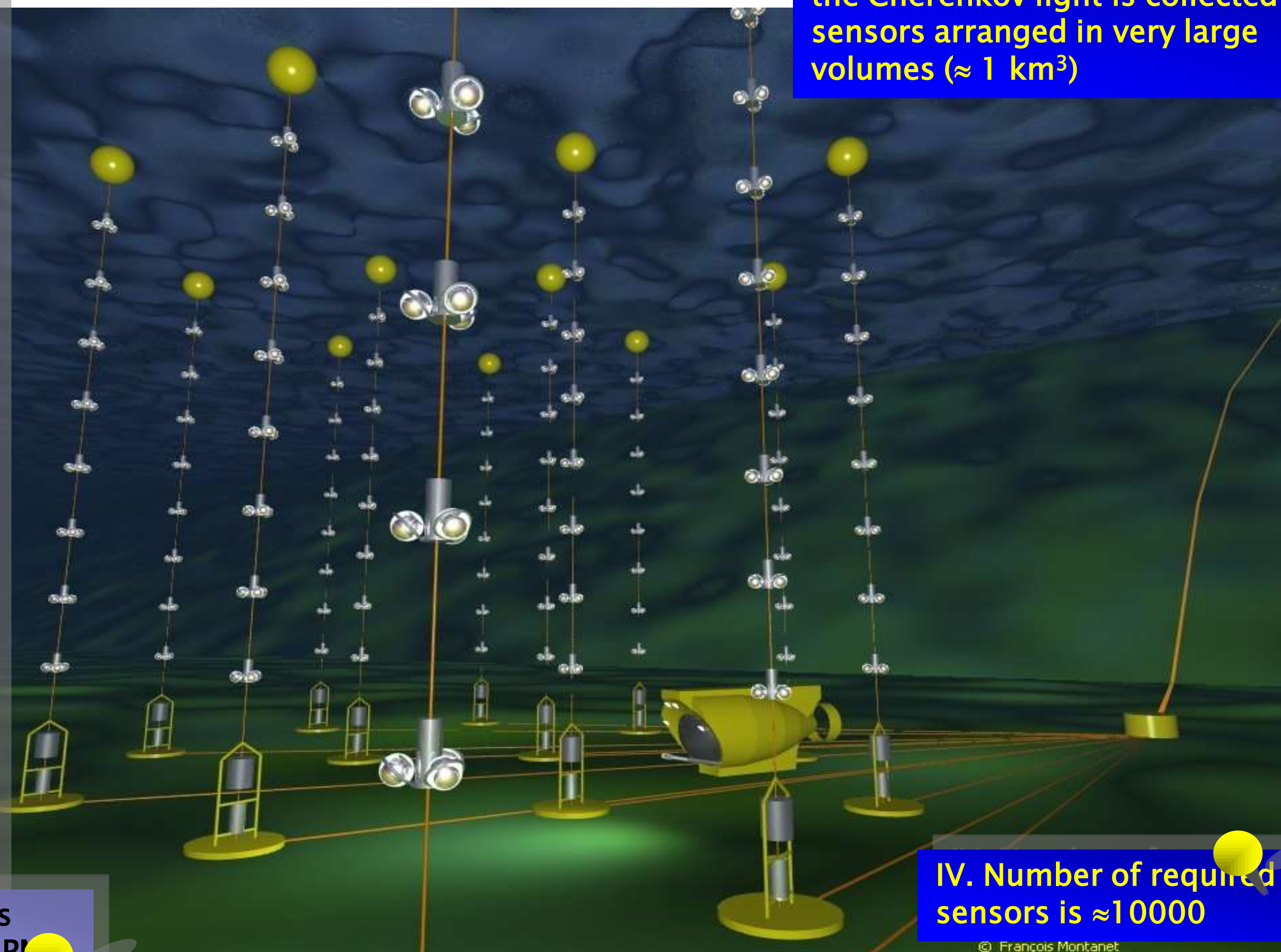
Neutrino Detection Principle

I. Cherenkov light is emitted by quanta at fixed angle



II. Muon trajectory is reconstructed from PM timing signals

III. To improve the detection efficiency the Cherenkov light is collected by sensors arranged in very large volumes (≈ 1 km^3)



IV. Number of required sensors is ≈10000

The part of ANTARES collaboration (http://antares.in2p3.fr/Collaboration/index.html)

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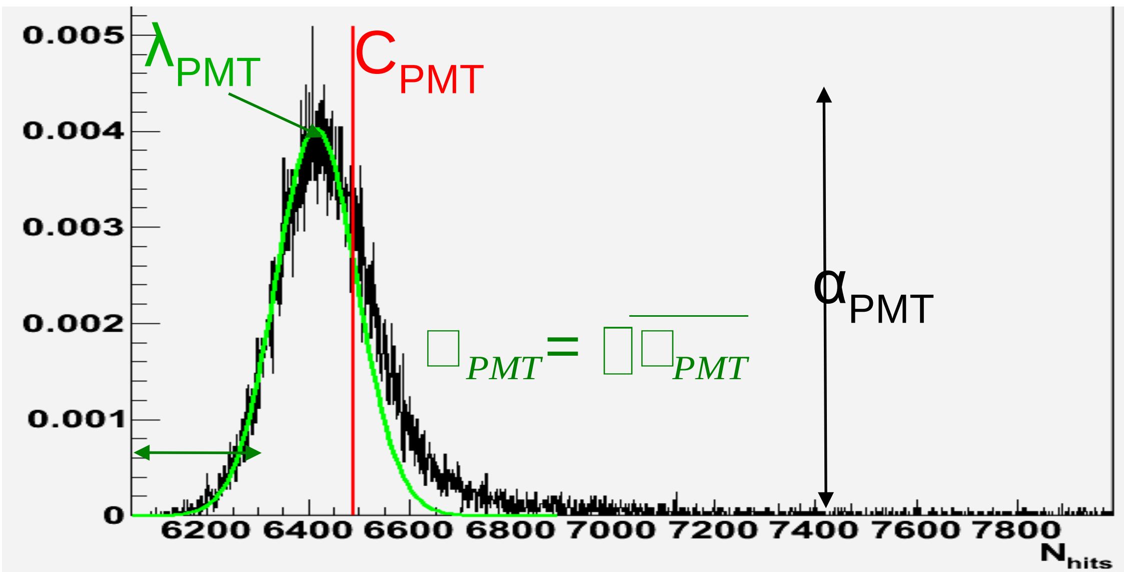
The some direction of MSU group activity in the project

- Bioluminescence cut
- Quality cuts
- SN search

Bioluminescence cut

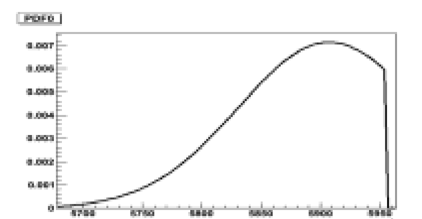
- We have collected distributions of hit counts for each PMT during one K40 run (~45min)
- Usually these distributions consist of 2 parts – Poissonian (due to K40 and plankton bioluminescence) and long tail (due to bioluminescence bursts)



Fit with Poisson distribution.
Free parameters:

- λ_{PMT} (mean value)
- C_{PMT} (fit only until this hit count)
- α_{PMT} (scaling factor)

- This cut Poisson distribution we'll call PDF (probability density function) of hit counts in PMT.

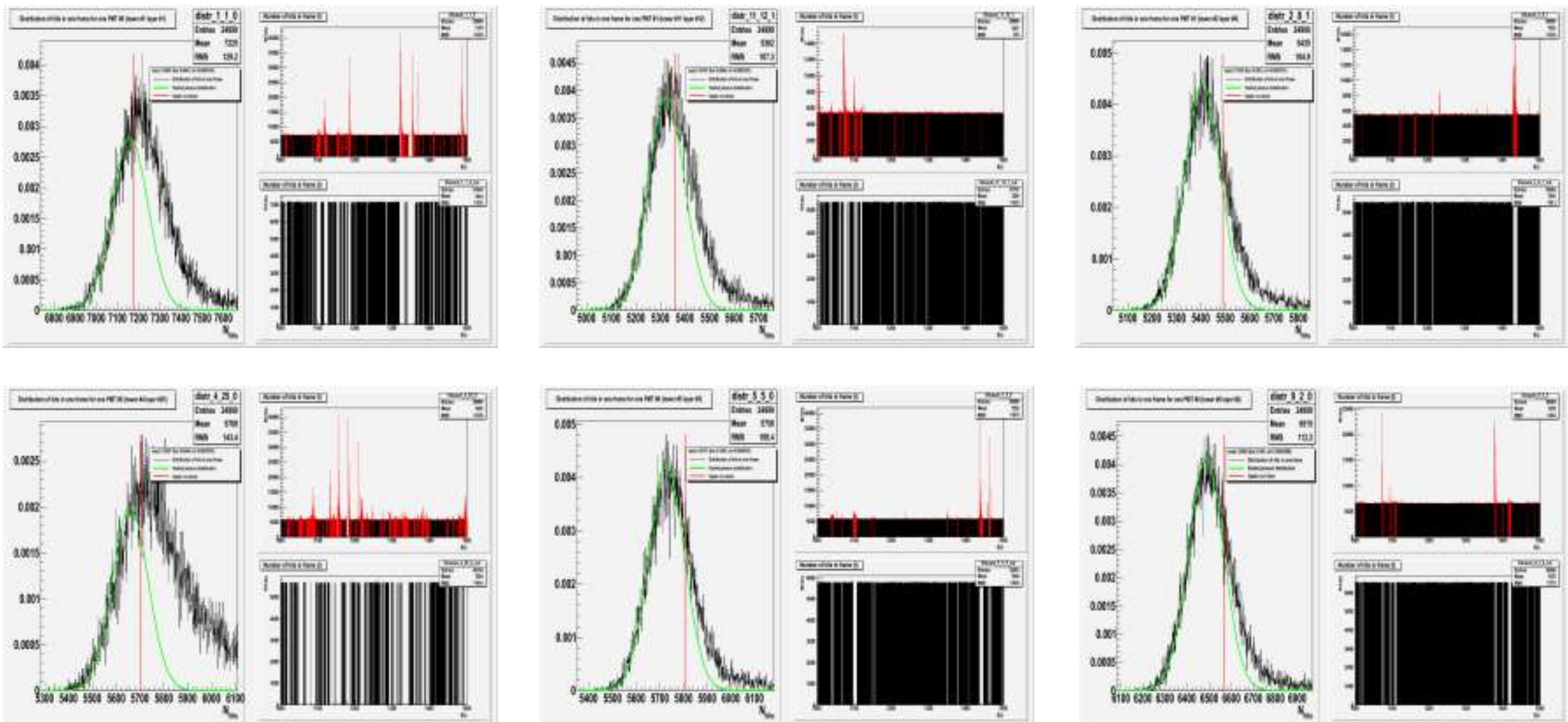


Quality cuts

- Some of the PMTs have the following problems
  - extremely low number of hits (problems with HV)
  - extremely high bioluminescence bursts
  - Floating mean number of hitcounts (not stable HV, or change in activity of plankton)

- Quality cuts are needed to exclude them. To exclude
- for I one could use cut based on λ
- for II and III one could use cut based on χ (chi of the Poissonian fit)

Fitting examples – Q_{cut} passed



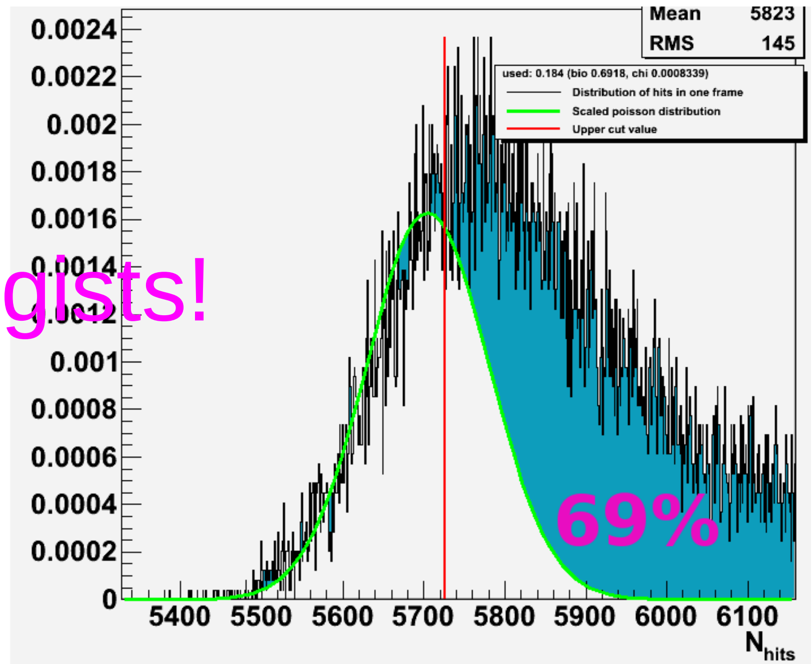
- Total amount of this PMTs – 553 (only on K40 run in 17th May 2009 analyzed – number of working PMTs is about 570 according to e-log)

Application of the cut

- SN search
- Slow control of PMTs

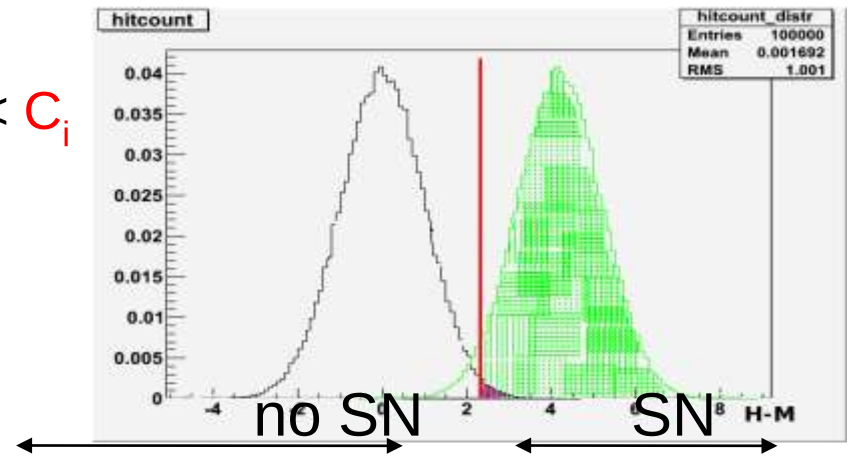
Special offer for marine biologists!

- Bioluminescence analysis (bio ratio parameter – ratio of area between experimental hitcount distribution and Poissonian fit to experimental hitcount distribution)



SN search scheme

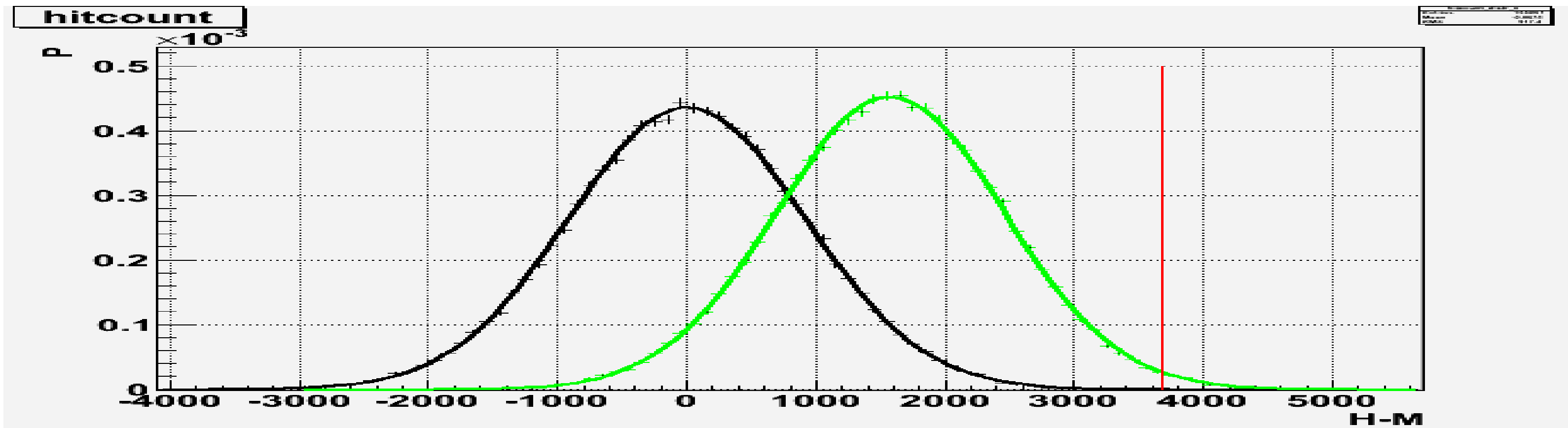
- Make Poissonian fits analyzing one run. After for each PMT we'll have: λ_i, C_i, mean value PDF (m_i), standard deviation (σ_i)
- Time slice by time slice:
  - use hit counts of PMT (h_i) if only $h_i < C_i$
  - Calculate:
    - total hits in detector ($H_{det} = \Sigma h_i$)
    - $M_{det} = \Sigma m_i$ $\quad S_{det} = \sqrt{\sum \sigma_i^2}$

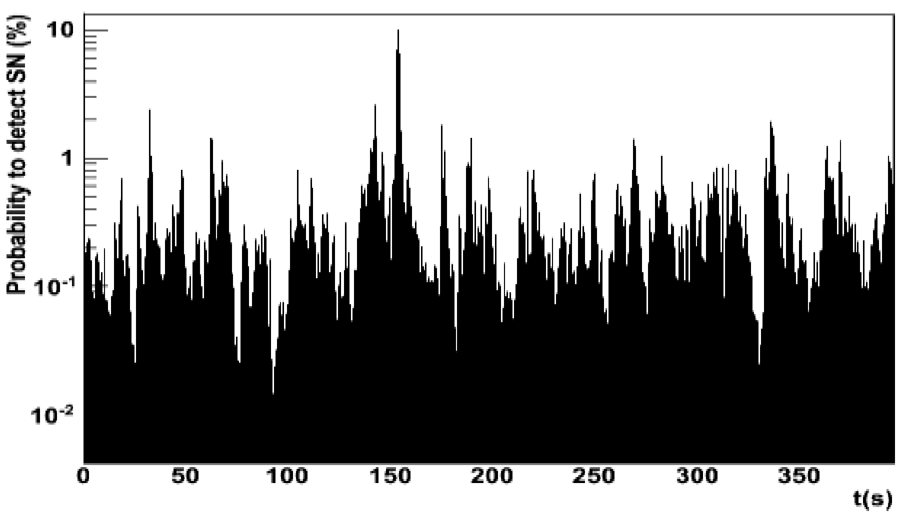


  - Approximate H_{det} PDF by Gaus function with M_{det}, S_{det} choose H_{cut} to have 1 fake event in 1 hour (or another)
  - If $H_{det} - H_{cut} > 0$ we have SN in time slice

SN search results

Simulations for 267 PMTs. Hcut for 1ev/hour shown





- One K40 run treated
- Required number of fake SN events was 1/hour.
- Probability to detect SN was calculated using approximation, that signal from SN has Poisson distribution with $\lambda = 11.6$.

Conclusion

- Bioluminescence cut was done. It could be applied for different studies.
- With current detector configuration probability to detect SN is incredibly low (~0.1%). With 900 PMTs situation is better, but still not enough to produce trigger.
- To make lower number of fake PMTs and increase probability to detect SN, we can try to use 2 subsequent time slices.

Our website is here
http://antares.sinp.msu.ru