STUDY OF COSMIC NEUTRINOS WITH ANTARES TELESCOPE: THE TRACK CHANNEL

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OUTLINE

– Cosmic neutrinos and other signals

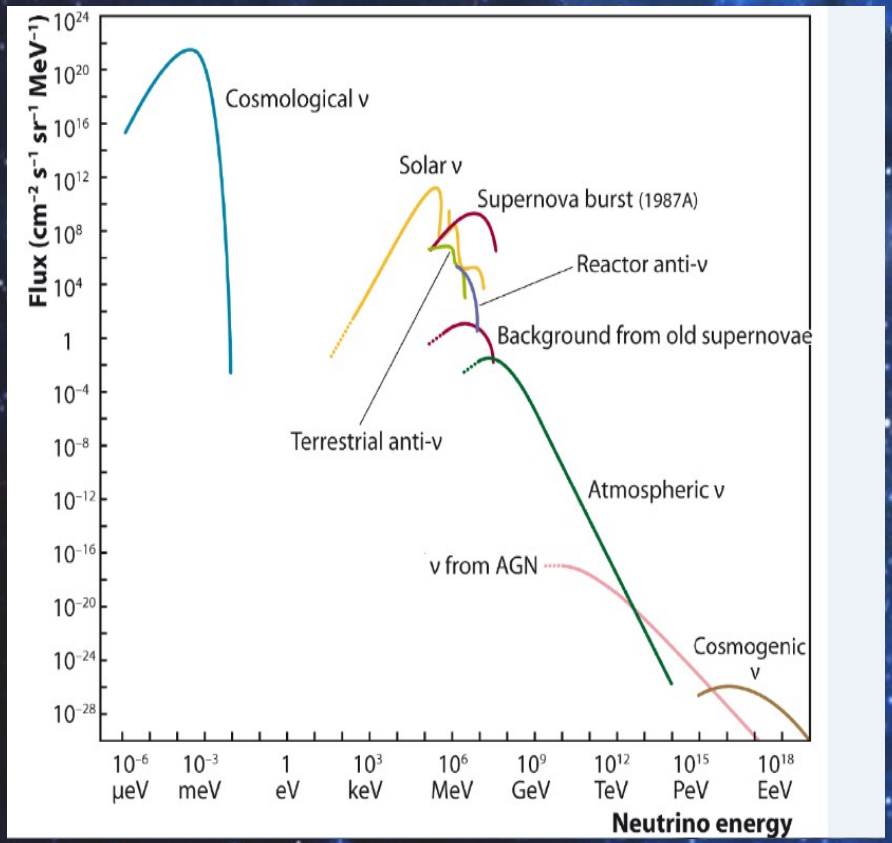
– ANTARES neutrino telescope and neutrino detection

– Searching for the cosmic neutrino signals

– Conclusions

– Bibliography

LOW AND HIGH-ENERGY NEUTRINOS



Important background signal:

Atmospheric neutrinos

$$\pi^{\pm} \longrightarrow \mu^{\pm} + \nu_{\mu}$$

$$\mathrm{K}^{\pm} \longrightarrow \mu^{\pm} + \nu_{\mu}$$

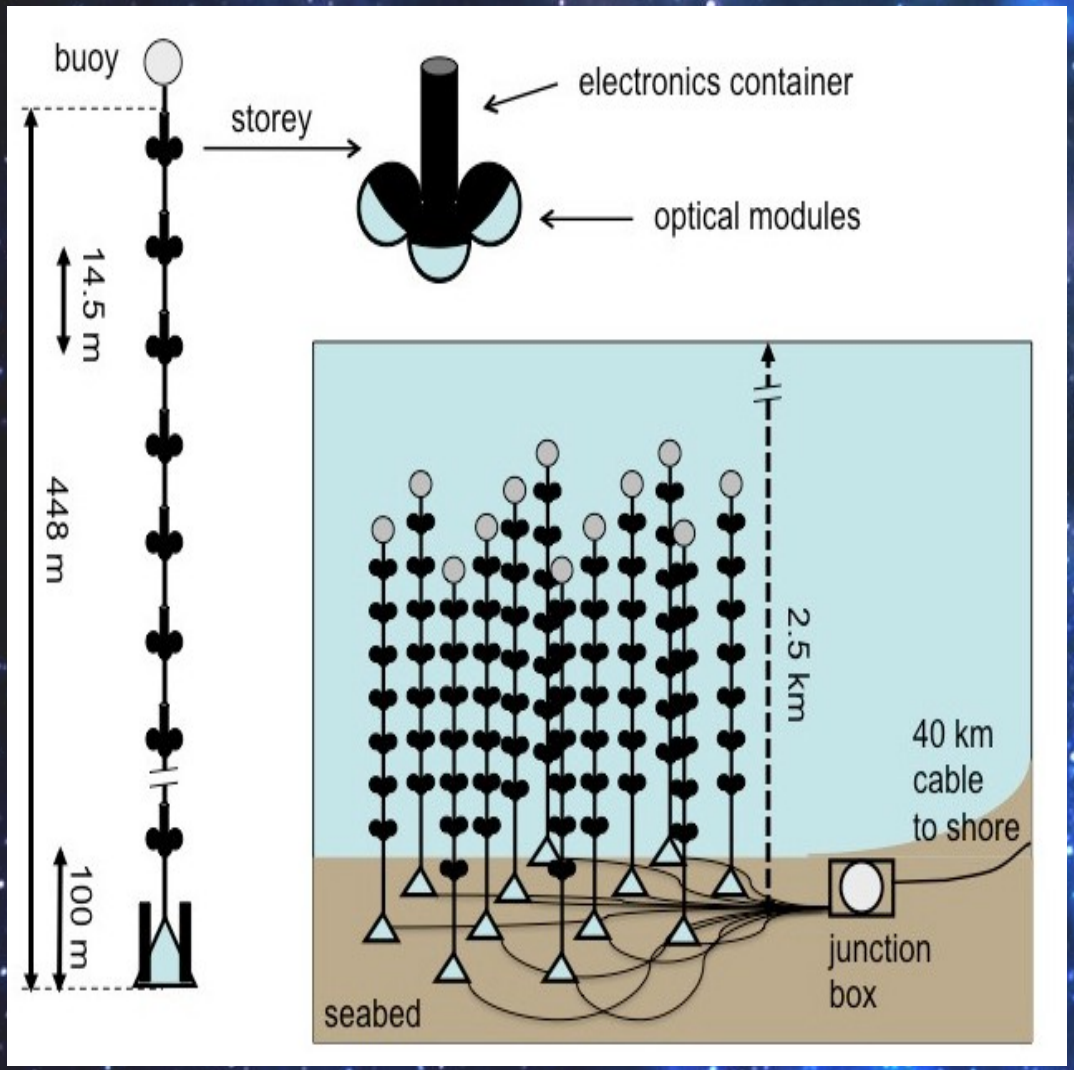
$$\mathrm{K}^{\pm} \longrightarrow e^{\pm} + \nu_{e} + \pi^{0}$$

$$p + \gamma \longrightarrow \Delta^{+}(1232MeV) \begin{cases} \longrightarrow n + \pi^{+} \\ \longrightarrow p + \pi^{0} \end{cases}$$

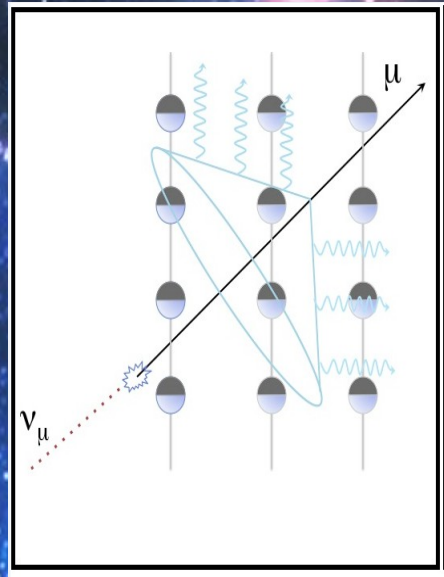
$$\pi^{+} \longrightarrow \mu^{+} + \nu_{\mu} \longrightarrow e^{+} + \nu_{e} + \nu_{\mu}$$

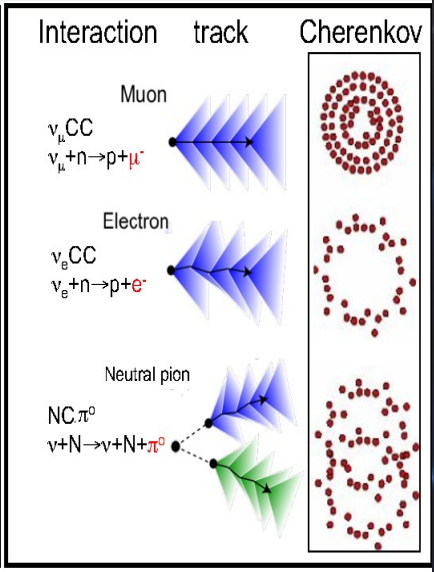
Cosmic neutrinos origin

DETECTION OF NEUTRINO WITH ANTARES NEUTRINO TELESCOPE

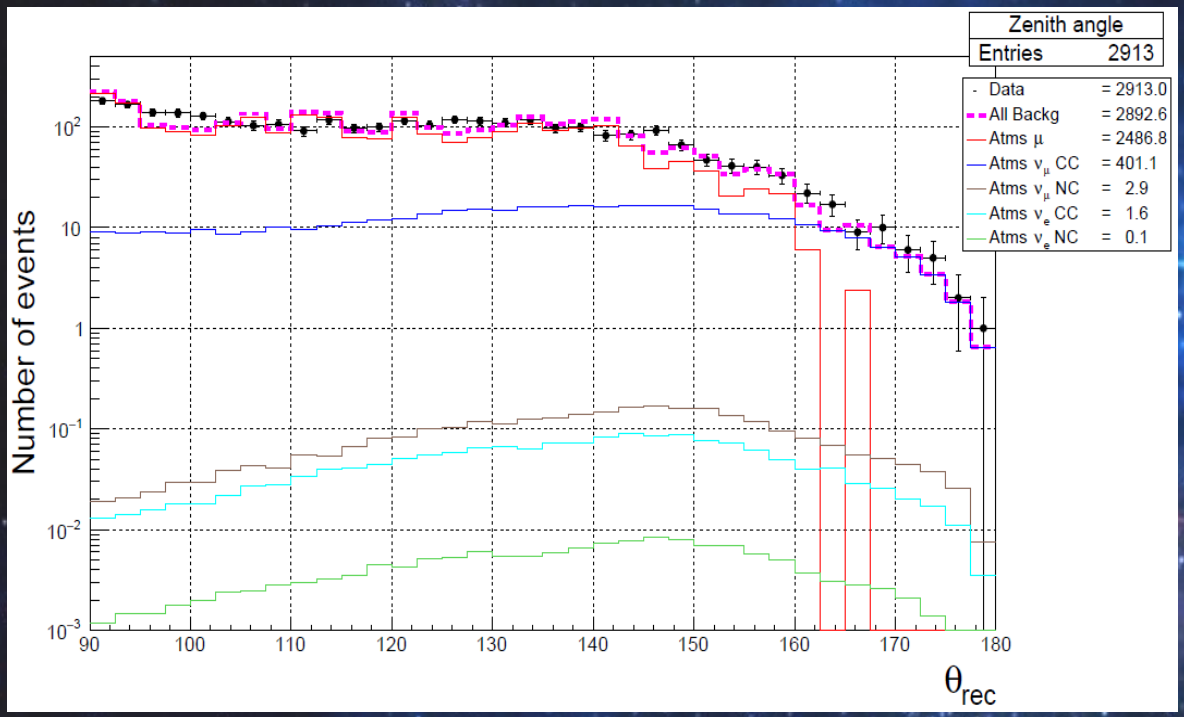


CC Charged Current Reaction	$\upsilon_e + d \rightarrow p + p + e^-$	$E_{threshold} = 1.4MeV$
NC Neutral Current Reaction	$\upsilon_x + d \rightarrow \upsilon_x + p + n$	$E_{threshold} = 2.2MeV$
ES Elastic Scattering Reaction	$\upsilon_x + e^- \rightarrow \upsilon_x + e^-$	$E_{threshold} \approx 0$





Atmospheric muons are the greatest background signal!

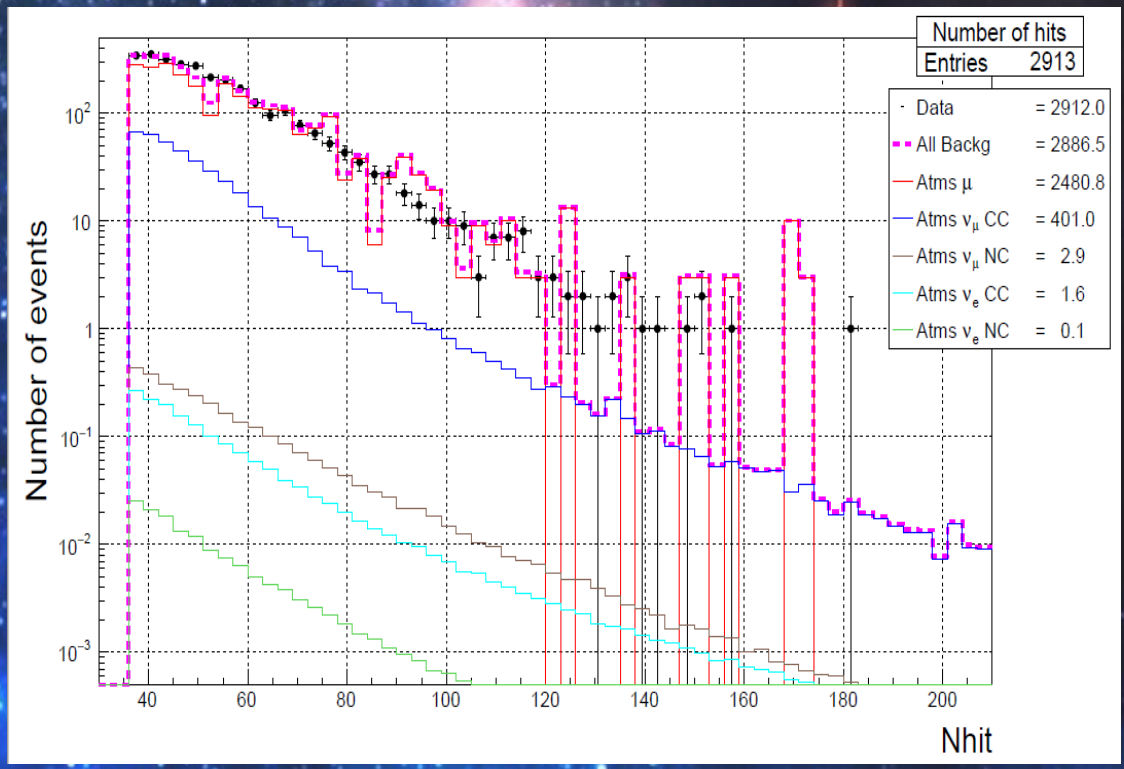


DIRECTION

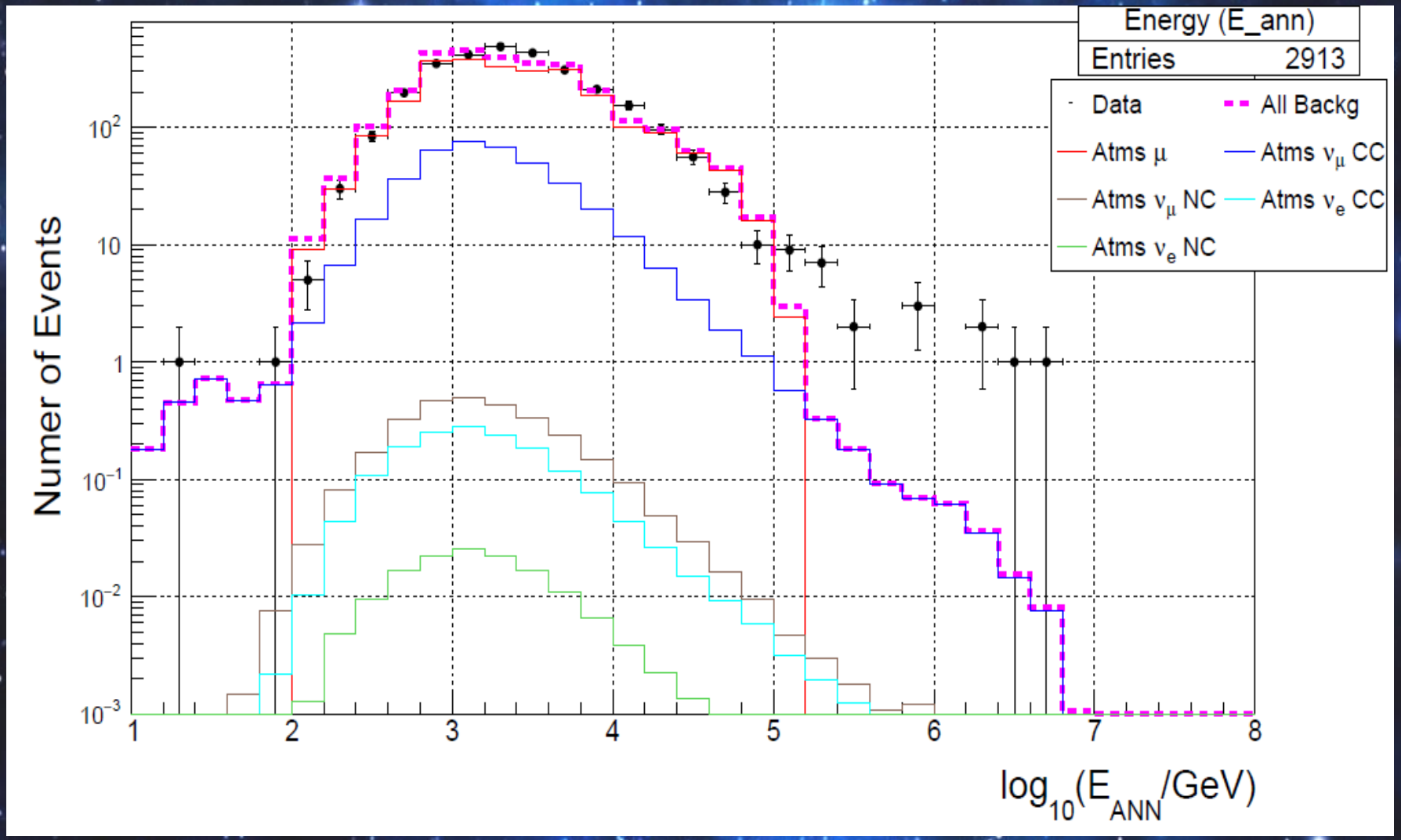
θ > 90°

NUMBER OF HITS

N_{hits} > 35

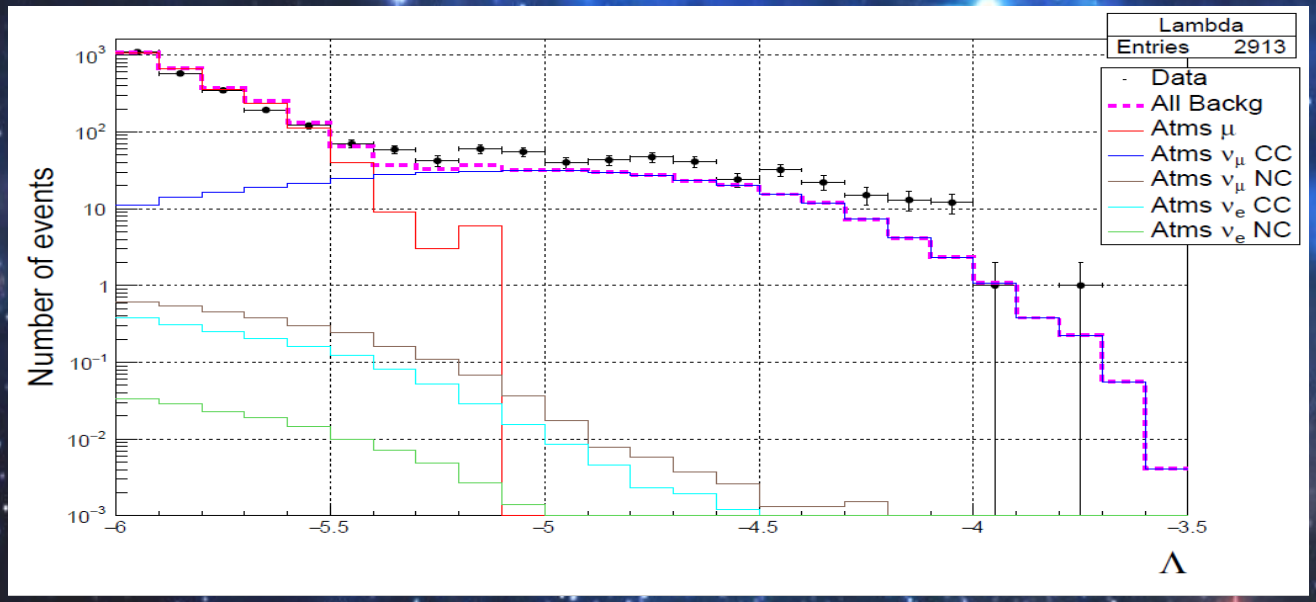


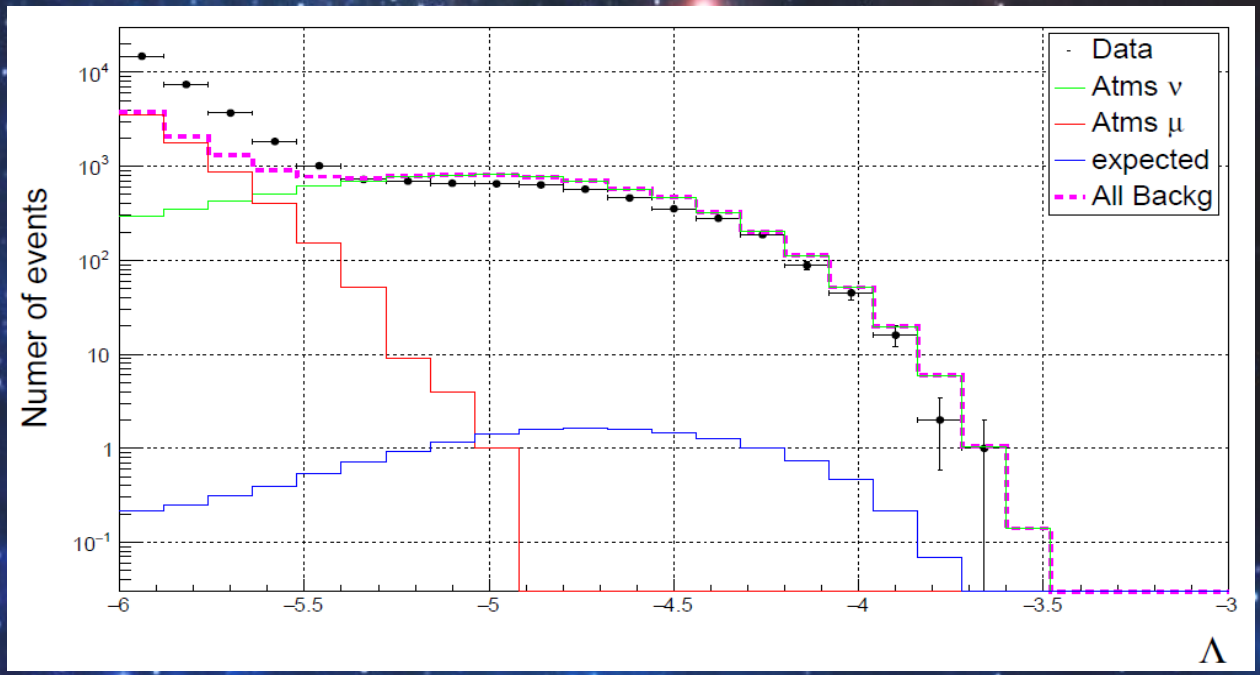
ENERGY OF EVENTS



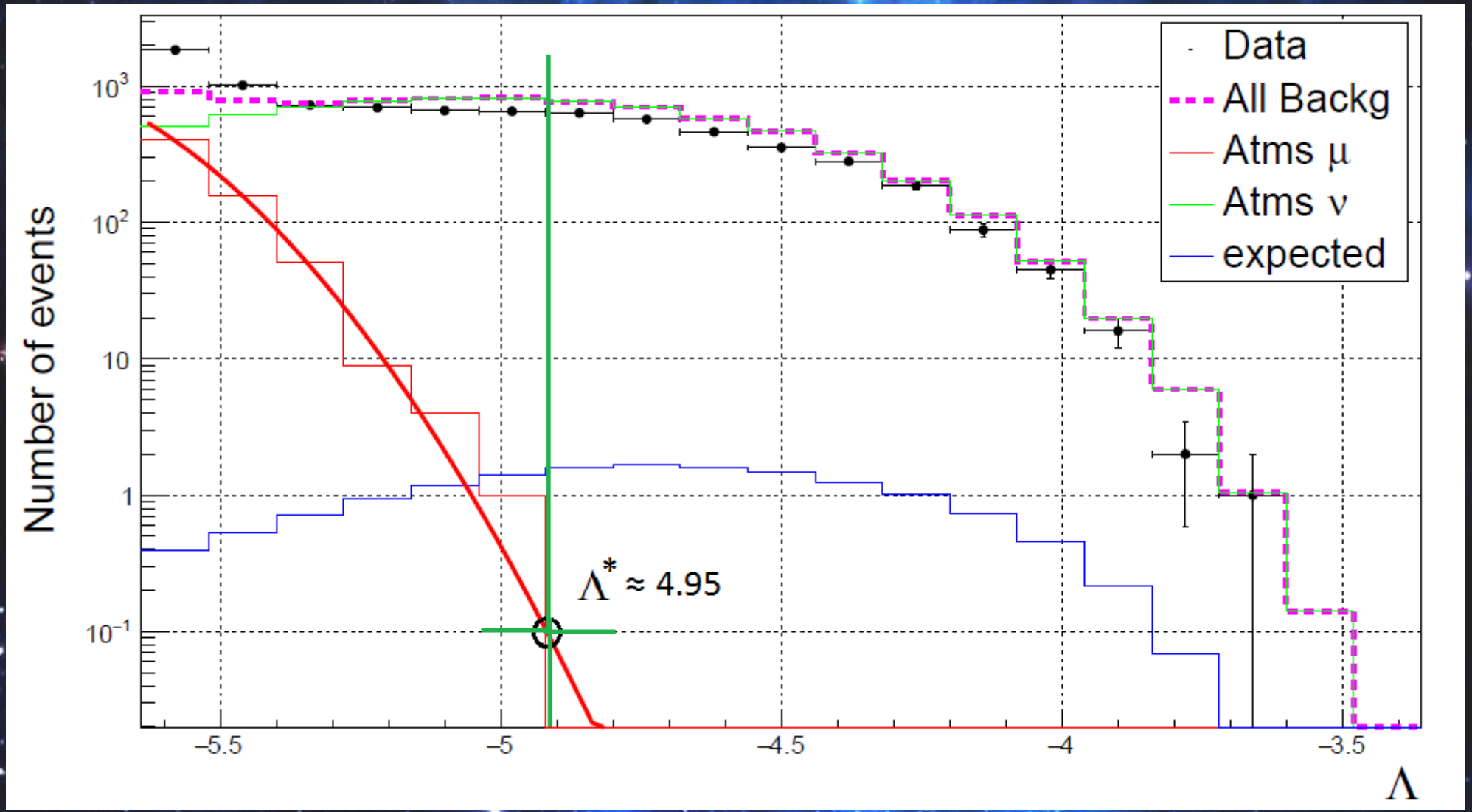
Most of the differences in the high-energy side

TRACK RECONSTRUCTION QUALITY PARAMETER

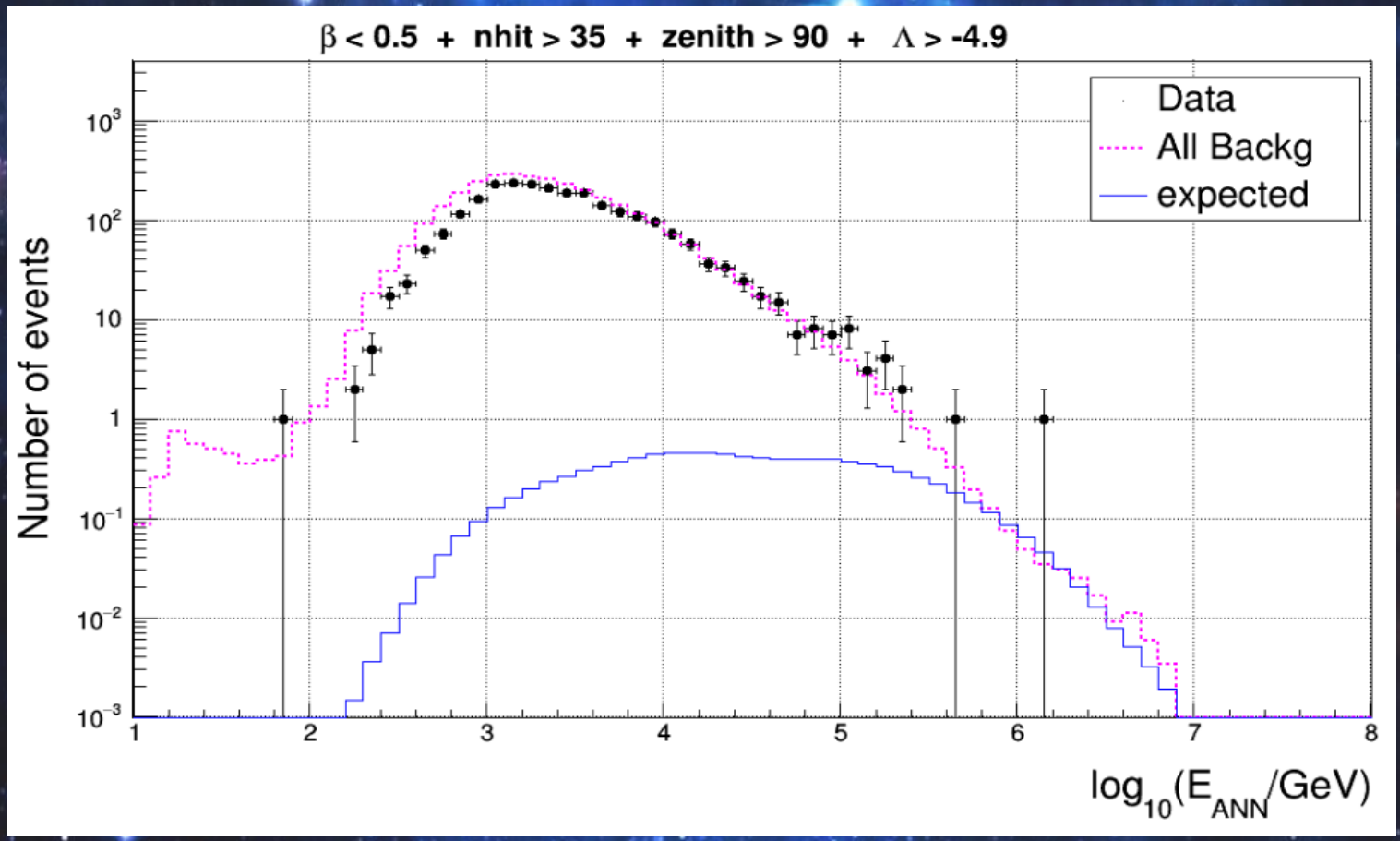




Λ CUT-OFF


Data
All Backg
Atms μ
Atms ν
expected
Number of events
10^3
10^2
10
1
10^{-1}
$\Lambda^* \approx 4.95$
–5.5
–5
–4.5
–4
–3.5
Λ

CUT-OFF IN ENERGY

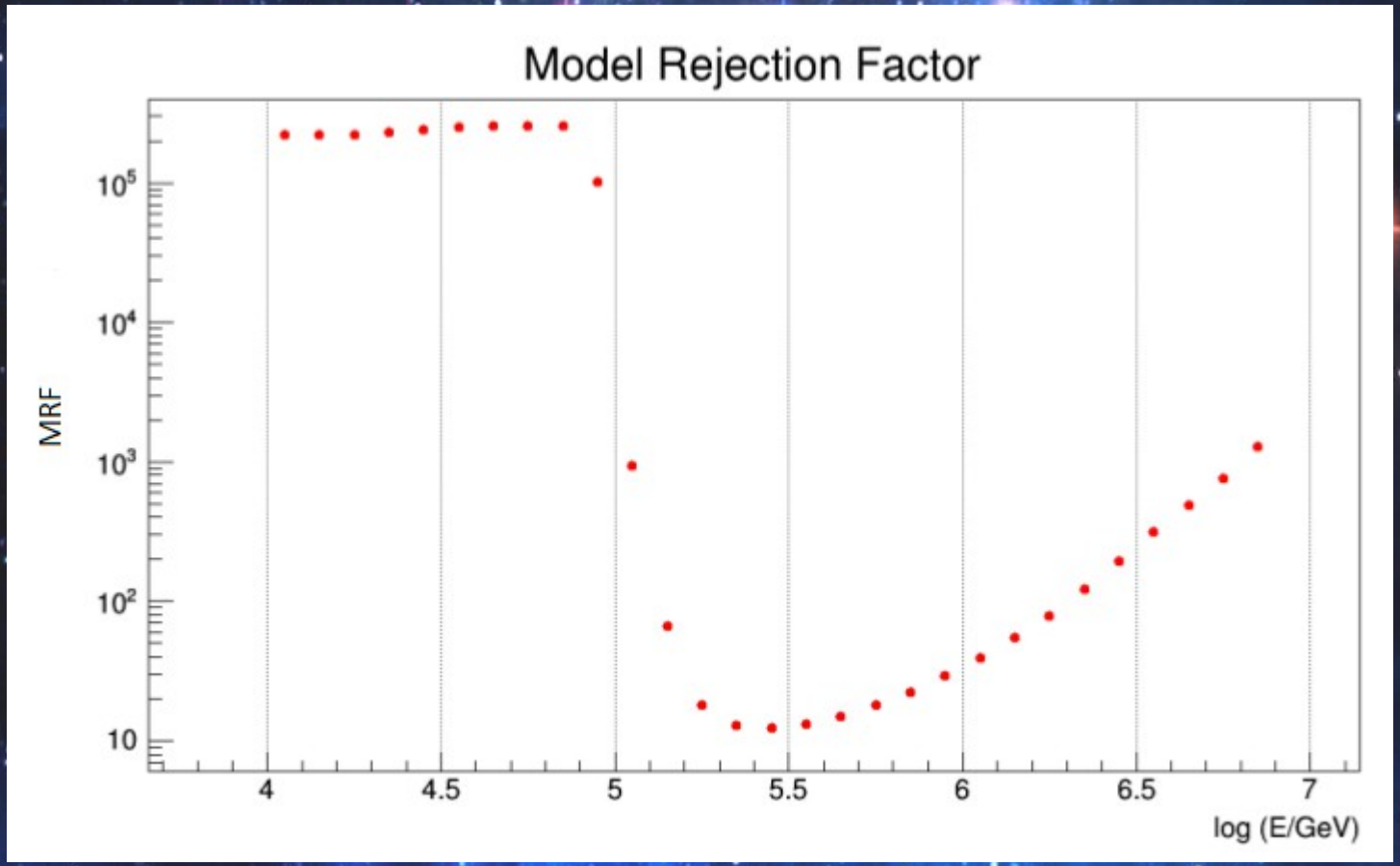


Model Rejection Factor Method

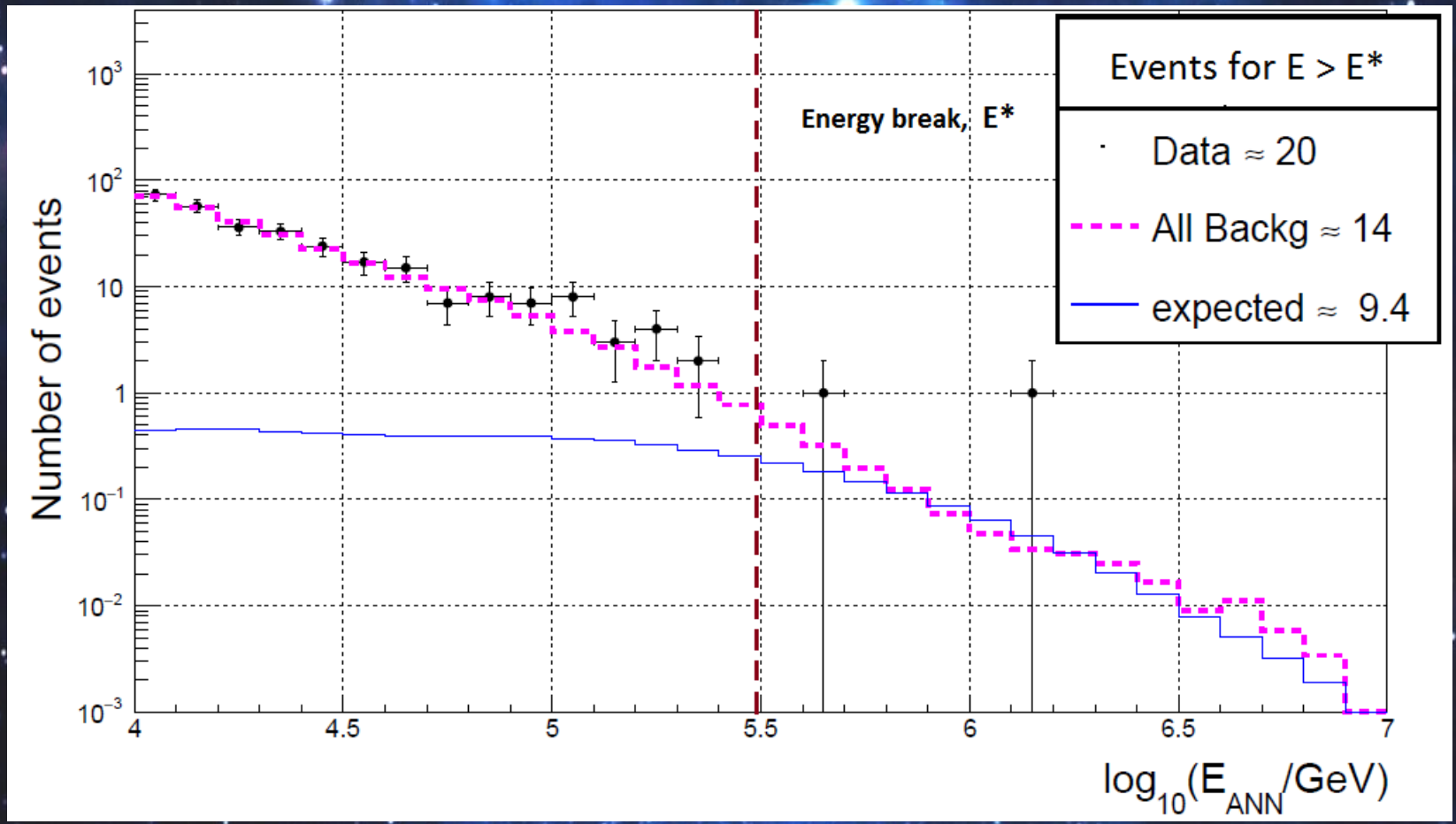
$$\bar{\mu}_{90\,\%}(n_b) = \sum_{n_{obs},n_b}^{\infty} \mu_{90\,\%}(n_b)\frac{(n_b)^{n_{obs}}}{(n_{obs})!}e^{-n_b}$$

MODEL REJECTION FACTOR

$$MRF = \bar{\mu}_{90\,\%}(n_b)/n_s$$



FINDING COSMIC NEUTRINOS



An excess of cosmic neutrinos is found, but there are very few signals to study the behavior of the flux.

CONCLUSIONS

Data from ANTARES telescope reveals an excess of signals which seems to come from cosmic neutrinos.

The next step in this study is to compute the upper limit flux of cosmic neutrinos and to search for puntual sources.

It is necessary a new generation of bigger detectors (like KMN3NeT) or detectors based on other detection principles, like the Askaryan effect to study better the behaviour of cosmic neutrinos.

BIBLIOGRAPHY

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