Towards a Planetary Neutrino Monitoring System

XVIII International Workshop on Neutrino Telescopes - Venezia -
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Elisa Resconi

&

ECP team, UofA, ONC-UofVic

Image: K. Krings (TUM)
For the first high energy neutrino source: 8 years of exposure from 1km³ Neutrino Telescope -IceCube- under ideal detector conditions.
What do we need in order to open the cosmic neutrino sky to more *routine* observations?
What do we need in order to open the cosmic neutrino sky to more routine observations?

More OBSERVERS
*Planetary neutrino monitoring
THE AFTERMATH OF TXS 0506+056

1) ICECUBE-170922A: HORIZONTAL ALERT [~290 TEV, DEC ~5.72 DEG]

“Multimessenger observations of a flaring blazar coincident with high-energy neutrino IceCube-170922A”, The IceCube, Fermi-LAT, MAGIC, AGILE, ASAS-SN, HAWC, H.E.S.S, INTEGRAL, Kanata, Kiso, Kapteyn, Liverpool telescope, Subaru, Swift/NuSTAR, VERITAS, and VLA/17B-403 teams. Science 361, 2018
THE AFTERMATH OF TXS 0506+056: WHY AT THE HORIZON?

AT HIGH ENERGY THE EARTH IS OPAQUE TO NEUTRINOS

THE FIELD OF VIEW OF NTs (>50 TeV): THE HORIZON

ICECUBE FIELD OF VIEW AT HIGH ENERGIES (>50 TeV)
ABOUT 1/3 OF THE SKY COVERED

M. Huber (TUM)
THE AFTERMATH OF TXS 0506+056: IS A BLAZAR
TXS0506+056 IS AN INTERMEDIATE BLAZAR
→ EXPECTED NEUTRINOS FROM BLAZARS AT HIGH ENERGY

ICECUBE-170922A


THE AFTERMATH OF TXS 0506+056: IS A BLAZAR

TXS0506+056 NEUTRINO CONTRIBUTION TO THE DIFFUSE: SMALL

→ MUCH MORE TO DISCOVER OUT THERE!!

see talk from Hans Niederhausen

M. Huber (TUM)
THE FRONTIER: A PLANETARY NEUTRINO MONITORING SYSTEM

- IceCube
- GVD, Russia
- KM3NeT, Sicily
- ONC, Canada
- Galactic center/plane
- TXS 0506+056

M. Huber (TUM)
ASSUME ONE ICECUBE @ BAIKAL, @ CAPO PASSERO, @ OCEAN NETWORK CANADA

IceCube acceptance 
≡ \int_0^\infty A_{\text{eff}}(\delta, E) \cdot E^{-\gamma} dE

on going study by M. Huber (TUM)
ICECUBE & BAIKAL & CAPO PASSERO & OCEAN NETWORK CANADA

RELATIVE IMPROVEMENT VS ICECUBE HORIZON BEST SENSITIVITY

on going study by M. Huber (TUM)
**RELATIVE IMPROVEMENT VS ICECUBE ALL SKY**

ICECUBE & BAIKAL & CAPO PASSERO & OCEAN NETWORK CANADA

$\propto E^{-2.0}$

on going study by M. Huber (TUM)
On-going study by M. Huber (TUM)
* … in a plenum, there are no empty places.
(Bertrand Russell)
NEW ENTRY ON THE NEUTRINO MAP - @ONC
STRAW PATHFINDER DEPLOYED IN 2018, DATA TAKEN ON-GOING
ONC (U. VICTORIA), U. OF ALBERTA, QUEEN’S U., TU MUNICH

Huge volume available and (partly) cabled

Water properties ~ Antares

see Imma Rea’s poster, this conference
NEW ENTRY ON THE NEUTRINO MAP - @ONC
STRAW-B PATHFINDER II: DEPLOYMENT IN 2020
ONC (U. VICTORIA), U. OF ALBERTA, QUEEN’S U., TU MUNICH

Test longer mooring (500m) and specialised devices.
NEW ENTRY ON THE NEUTRINO MAP – @ONC

CONCEPTUAL DESIGN FOR 10 STRINGS BUNDLE AND FUTURE
ONC (U. VICTORIA), U. OF ALBERTA, QUEEN’S U., TU MUNICH

GVD style approach of cluster of strings.

10 strings bundle
V = ~0.1km³

70-100 strings
V = ~2km³

PRELIMINARY geometry
NEW ENTRY ON THE NEUTRINO MAP - @ONC
BRAINSTORMING AROUND A SEGMENTED DETECTOR FOR HE HORIZONTAL TRACKS
→ STARTING UP CONCEPTUAL DESIGN

rectangular bundle

Water model from Antares

\[ E_{\nu} = 50 \text{ TeV}, E_{l, \text{vertex}} = 28 \text{ TeV} \]

pentagonal bundle

\[ E_{\nu} = 50 \text{ TeV}, E_{l, \text{vertex}} = 28 \text{ TeV} \]

Study on going from K. Krings (TUM)
NEW ENTRY ON THE NEUTRINO MAP – @ONC

STARTING UP CONCEPTUAL DESIGN

~500 strings
V = ~50km³
IN SUMMARY

Thanks to IceCube stable operation over many years *neutrino astronomy is becoming a reality.*

The aftermath of the first association between neutrinos and TXS0506+056:

- **Blazars** are viable HE neutrino sources and so far the only;
- Neutrino signal from blazars most probably **100 TeV - 100 PeV**;
- Neutrino absorption in the Earth significant effect, **field of view at the horizon**.

Need of **more neutrino telescopes** around the planet Earth to cover the sky.

With 3 IceCubes in the North overall improvement by a factor of 5: strong **synergy**.

New collaboration established with **Ocean Network Canada** for a possible neutrino telescope in the Pacific ocean - might give new insights into deep sea operations.
IN SUMMARY

“Contrappunto bestiale alla mente” - Adriano Banchieri

Thanks to IceCube stable operation over many years neutrino astronomy is becoming a reality.

- Blazars are viable HE neutrino sources … and so far the only;
- Neutrino signal from blazars most probably 100 TeV - 100 PeV;
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We need neutrino telescopes in WATER as „counterpoint“ to the IceCube present and future theme.
some conclusions ....
NEW ENTRY ON THE NEUTRINO MAP - PLENUM@ONC

BRAINSTORMING AROUND A SEGMENTED DETECTOR FOR HE HORIZONTAL TRACKS

medium: IceCube ice

1 PeV muon

medium: Antares water

K. Krings (TUM)
NEUTRINO INTERACTION CHANNEL - MUON TRACKS

~1KM: SHORT FOR HIGH ENERGY MUONs

Muon path length (1PeV) = ~20 km
Muon path length (10PeV) = ~25 km
NEW ENTRY ON THE NEUTRINO MAP - PLENUM@ONC

BRAINSTORMING AROUND A SEGMENTED DETECTOR FOR HE HORIZONTAL TRACKS

medium: IceCube ice

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1 PeV muon

K. Krings (TUM)
A History of Neutrino Astronomy in Antarctica

IceCube and MM partners first association to a source

IceCube discovery of diffuse astrophysics neutrinos
PLE\textsubscript{\textnu M}

**ICECUBE & BAIKAL (OR ANOTHER SINGLE SITE IN THE NORTH)**

→ RELATIVE IMPROVEMENT VS ICECUBE HORIZON BEST SENSITIVITY

GVD only

GVD+IceCube / IceCube horizon

on going study by M. Huber (TUM)
RELATIVE IMPROVEMENT VS ICECUBE HORIZON BEST SENSITIVITY

IceCube vs Gen2

IceCube vs Gen2+GVD+KM3NeT+ONC

on going study by M. Huber (TUM)