SPATS
an acoustic array at south pole

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SPATS

South Pole Acoustic Test Setup

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with much help and support from IceCube
Physics Motivation

Detection of GZK neutrinos ($p+\gamma_{\text{CMB}}$)

- the highest energy cosmic rays are extragalactic
- are composed of protons, helium,...
- allow to study Grand Unified Models
- non-detection would be a great surprise

Exotic sources – Physics of the early Universe

- Topological Defects, Heavy Boson decay, Z-bursts, Mini-blackholes

AGN models

- complementary in energy to neutrino telescopes
Why at South Pole?

- Long absorption length (up to 10km vs. 100m for photons)
- Negligible scattering
- Ice is dead = quiet – no background noise (?)
- IceCube + IceTop + RICE
- IceCube runs out of “steam” for GZK (~1/year)

Hybrid Detector Neutrino Observatory at South Pole

P. Brice et al
AMANDA UHE Analyses

Neutrino telescopes have some sensitivity at UHE, but very little at EHE

The increase of detection volume with energy is not enough to compensate for falling flux
SPATS Goals

Investigate the possibility of acoustic $\nu$-detection at South Pole
- measure the absorption length
- determine the background noise level (variations with time)
- determine variations of acoustic properties with depth

Prepare for a large hybrid detector (IceCube + acoustic + radio)
- verify detector concept
SPATS Detector Layout

- Uses top 400m of 3 IceCube holes
- 3x7 acoustic stages
- Sensor transmitter
- 3x1 Acoustic box
- DAQ
- 1 Master PC
  - Experiment control
  - Data aggregator
  - GPS distribution
SPATS Layout on the Ice
Acoustic Stages

Transmitter module
HV pulse generation (1kV - 10μs)
Amplitude control
Triggered by TTL pulse from surface
Temperature or pressure sensors

Transmitter
ring-shaped piezo-ceramic
uniform emission

Sensor module
low noise
three channels
directional sensitivity
mechanically pressed against housing

Modules connected via electrical cables
to surface DAQ
3 strings x 7 stages = 21 stages
The complete detector being installed and tested in Zeuthen.

Sensor opened - 3 preloaded piezo elements with amplifier.
SPATS – Data Aquisition

Remote data collection and digitization

Central control and storage

Relies on IceCube components

Integrates in the IceCube network and data handling

- GPS antenna
- Master-PC
- Patch panel
- IceCube surface cable
- Power – Ethernet Timing
- Acoustic junction box
- Patch cable
- Acoustic inice cable
- DAQ
- Patch cable
- Remote data collection and digitization
- Central control and storage
- Relies on IceCube components
- Integrates in the IceCube network and data handling
System Test in Northern Sweden

Up to 800m between Transmitter and Receiver

String PC DAQ

Acoustic Stages

Towel
System Test in Northern Sweden
System Test in Northern Sweden

Depth of lake ~50m

Signal clearly visible over a distance of 800m

On a really stormy day

(not expected in ice...)

Stephan Hundertmark
The South Pole Acoustic Test Setup will be deployed this season
The whole system was/is being tested in Zeuthen and during a deployment in Northern Sweden
Tests include deep freezing, pressure and power cycling as well as data taking
SPATS benefited from the help and support of IceCube, simplifying many things during development and clearly for deployment
We are looking forward for data from South Pole