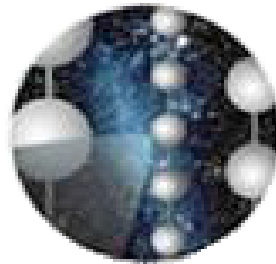


Cascade Reconstruction in IceCube



www.pinguin.de

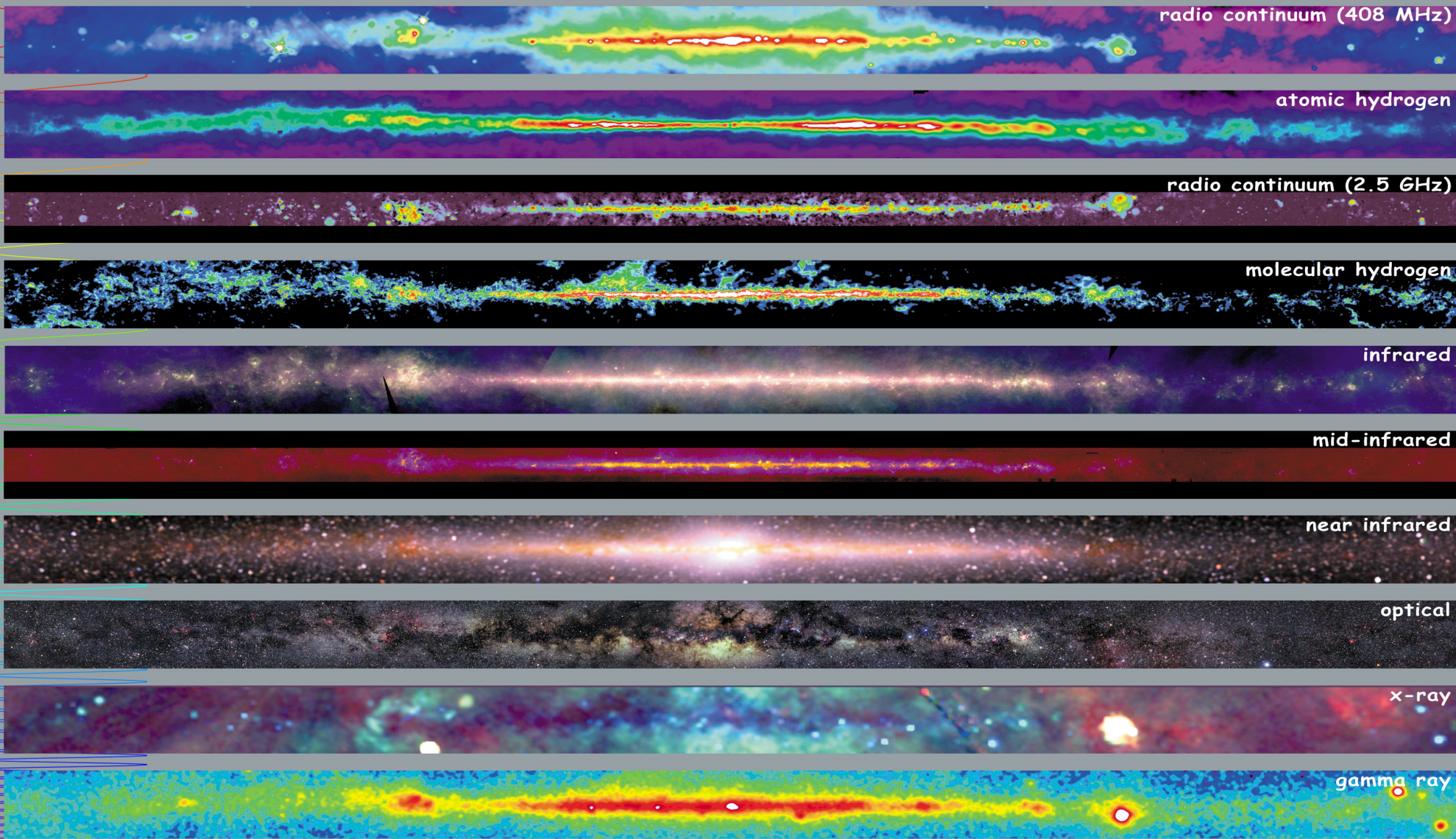


Arne Schönwald, DESY Zeuthen

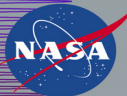


Outline

- Introduction
- IceCube Detector
- Cascade Channel

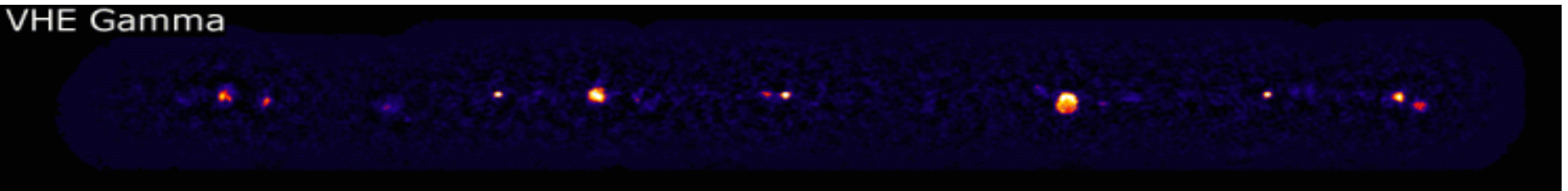


<http://adc.gsfc.nasa.gov/mw>

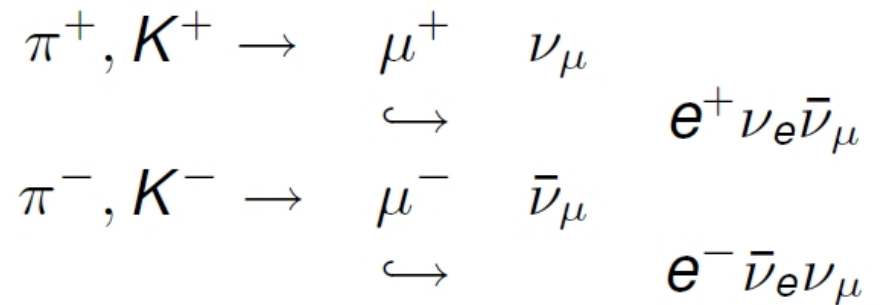
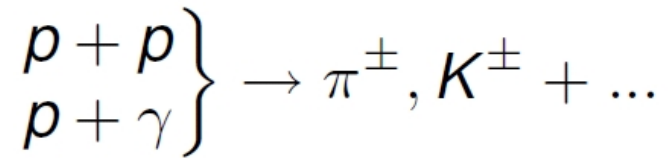
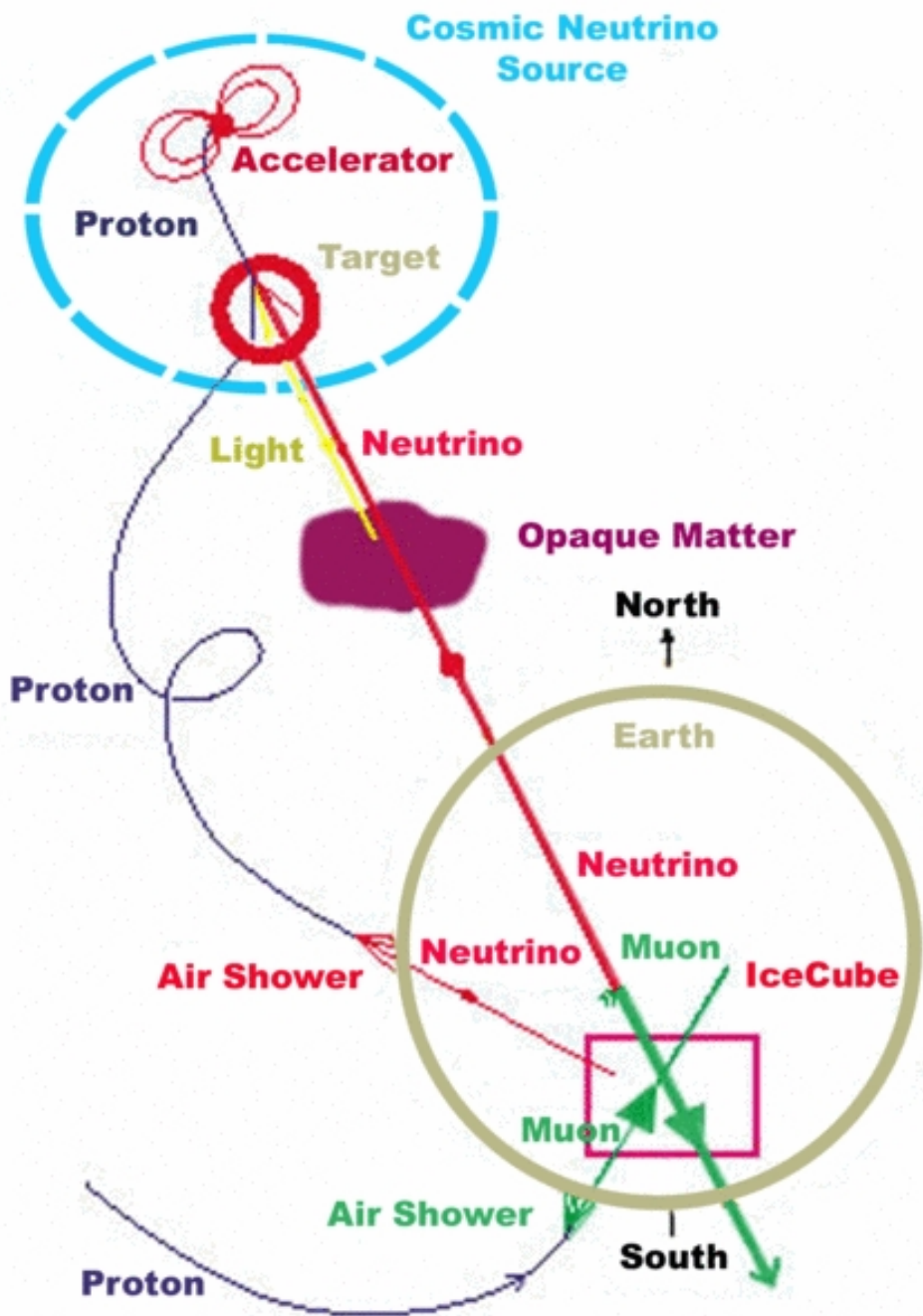


Multiwavelength Milky Way

VHE Gamma

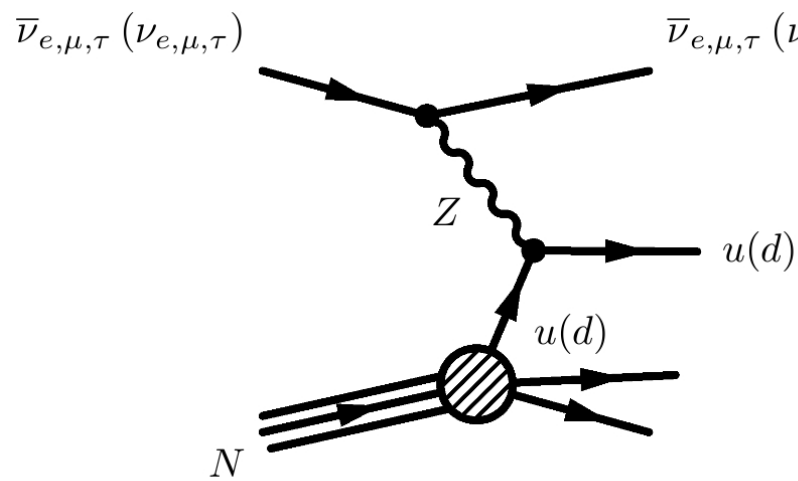
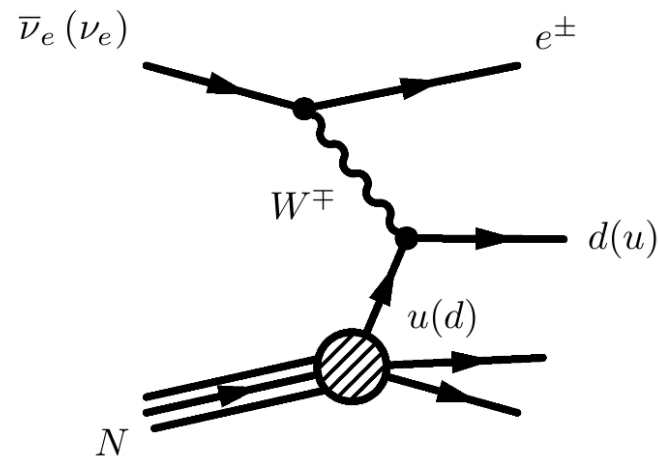
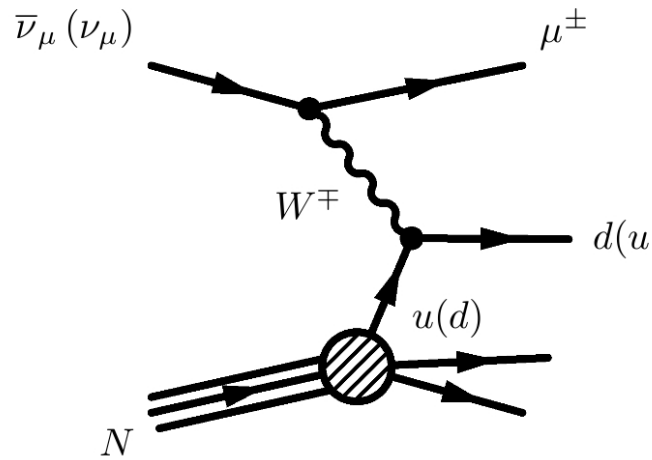


Introduction



- source e:μ:τ=1:2:0
- neutrino oscillation -> e:μ:τ=1:1:1 at earth
- neutrinos can pass opaque matter -> astronomy
- generation mechanism of high energy gamma rays

Neutrino Interactions in Matter



- cross section proportional to mass
-> coupling to nucleons dominates
- but: Glashow resonance ($\bar{\nu} + e^- \rightarrow W^-$) at 6×10^{15} eV

IceCube Collaboration

USA:

Bartol Research Institute, Delaware
Pennsylvania State University
UC Berkeley
UC Irvine
Clark-Atlanta University
University of Maryland
University of Wisconsin-Madison
University of Wisconsin-River Falls
Lawrence Berkeley National Lab.
University of Kansas
Southern University and A&M
College, Baton Rouge
University of Alaska, Anchorage

Sweden:

Uppsala Universitet
Stockholm Universitet

UK:

Oxford University

Netherlands:

Utrecht University

Germany:

Universität Mainz
DESY-Zeuthen
Universität Dortmund
Universität Wuppertal
Humboldt Universität
MPI Heidelberg
RWTH Aachen

Belgium:

Université Libre de Bruxelles
Vrije Universiteit Brussel
Universiteit Gent
Université de Mons-Hainaut

Japan:

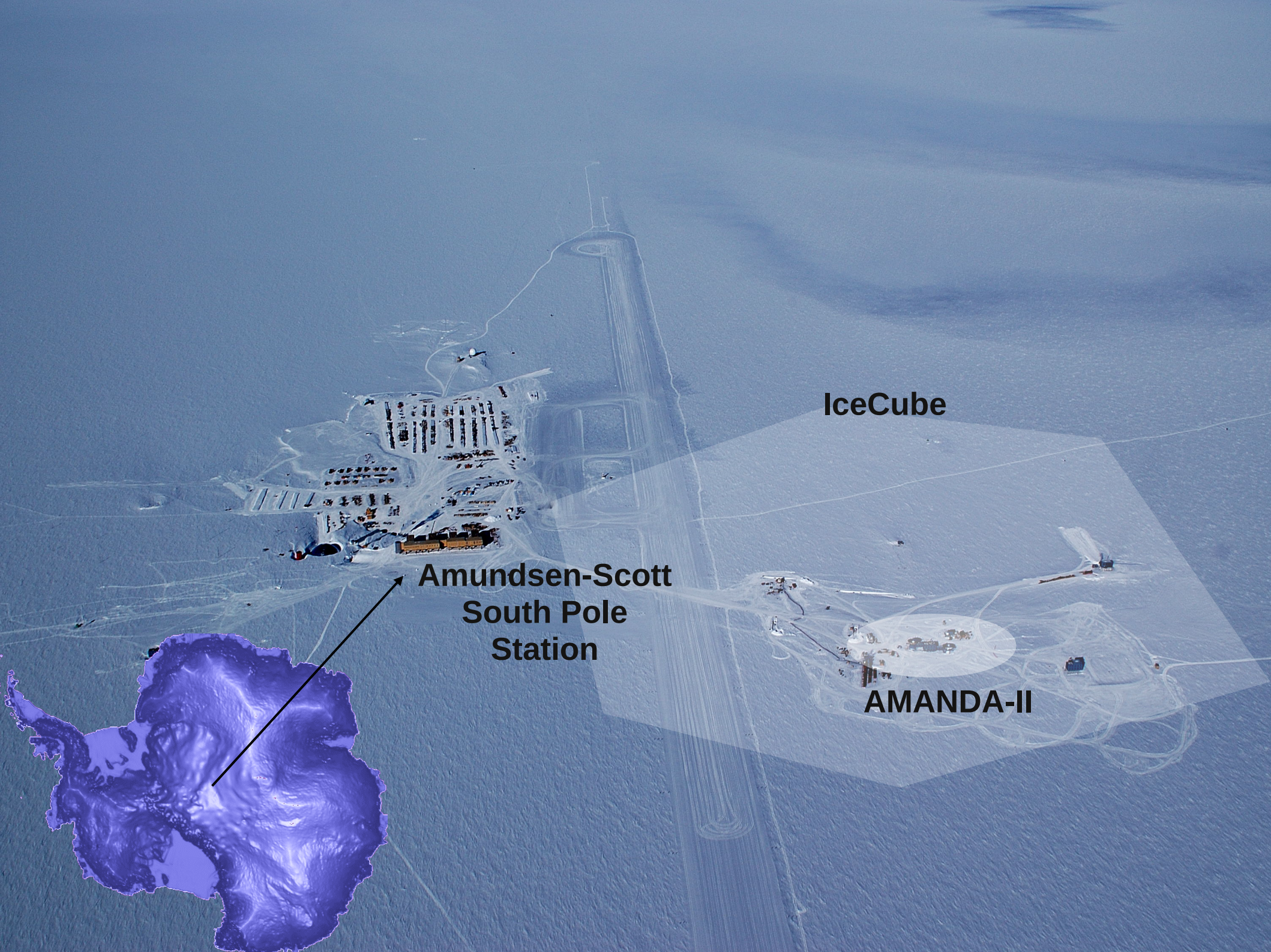
Chiba university

New Zealand:

University of Canterbury



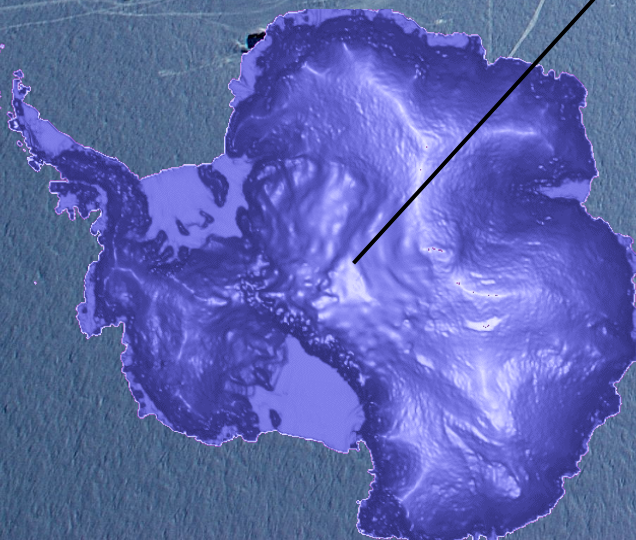
30 institutions, ~250 members <http://icecube.wisc.edu>



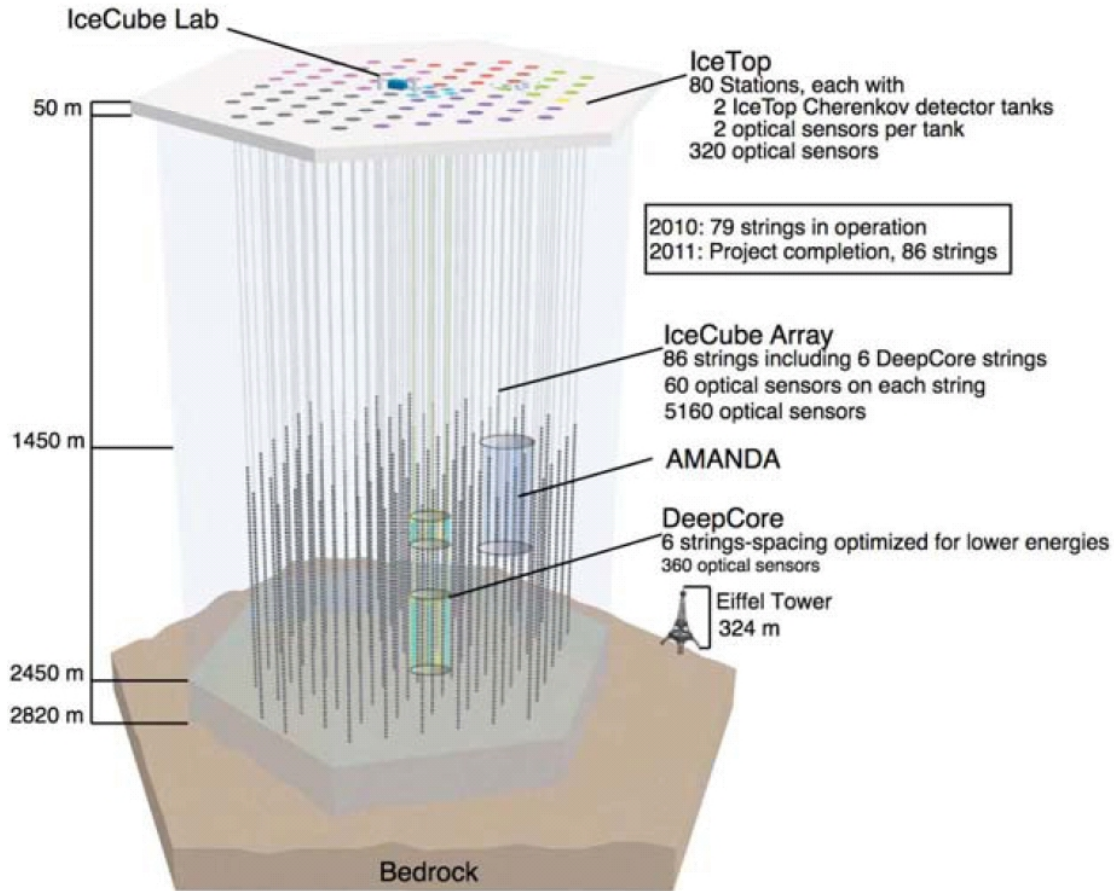
IceCube

**Amundsen-Scott
South Pole
Station**

AMANDA-II



IceCube Detector I

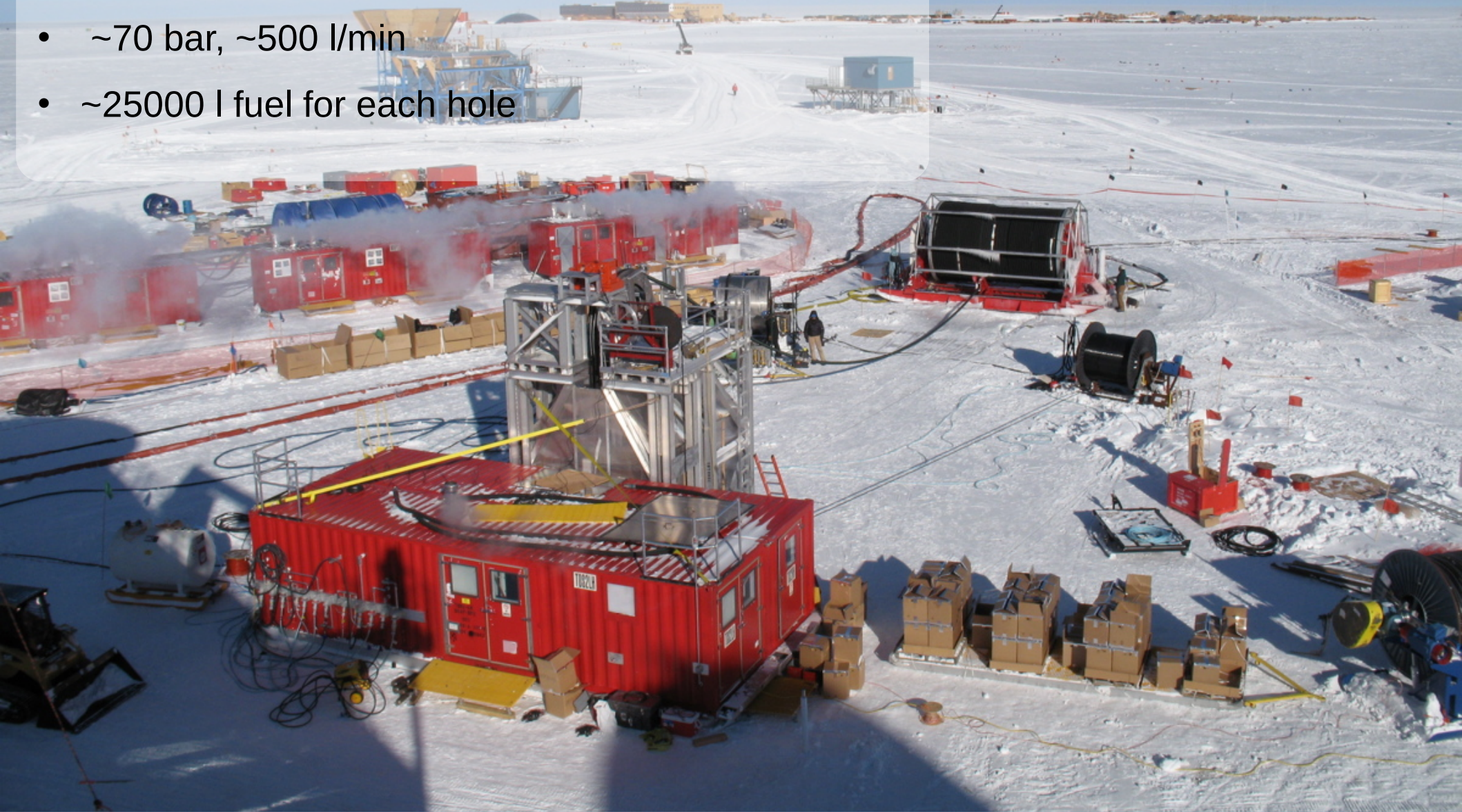


- z spacing 17 m
- x,y spacing 125 m

- since April: IC 79
- will be finished 2011: IC 86 (about 5000 DOMs)
- detection of Cherenkov light of charged particles (41 degree)
- 1 km³ detector volume
- IceTop: air shower detector (tanks with optical sensors)
- DeepCore
- Energy 100 GeV ... 1 EeV

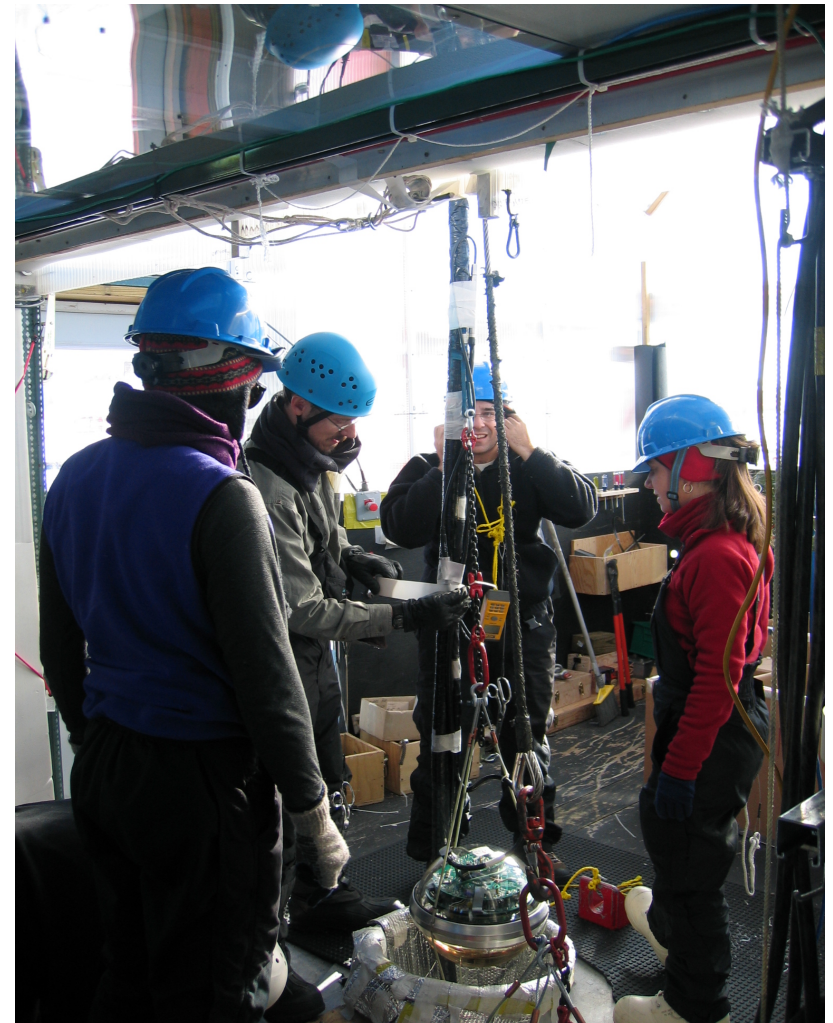
Hot water drilling

- melting with 80 degree hot water
- 2450 m deep holes, 60 cm Ø
- ~70 bar, ~500 l/min
- ~25000 l fuel for each hole

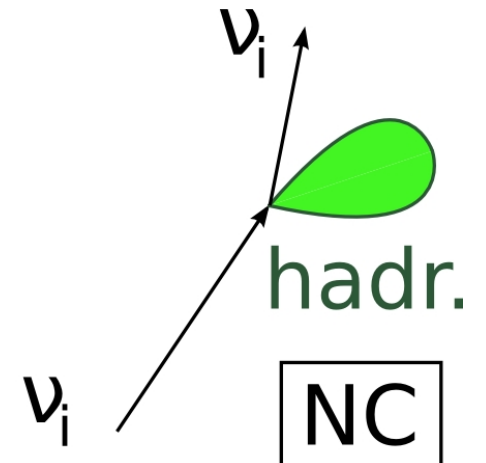
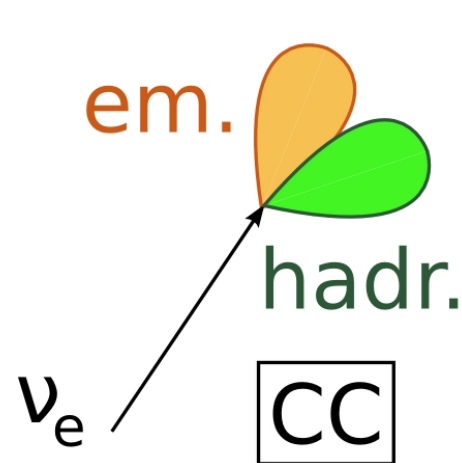
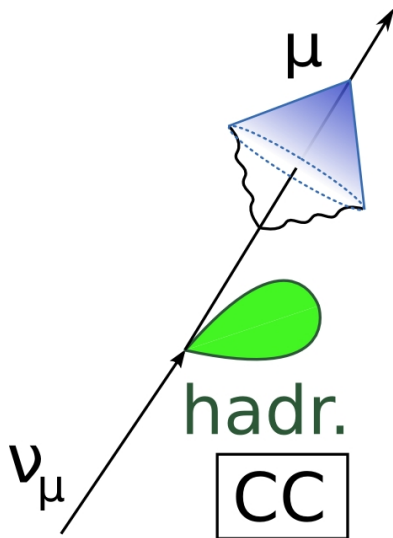
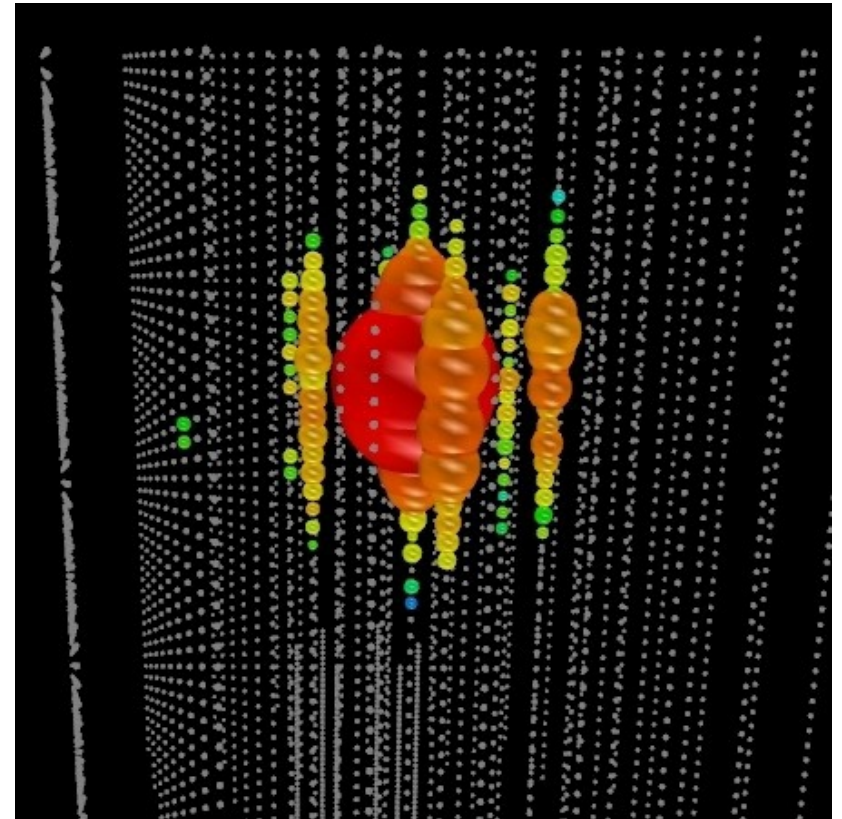
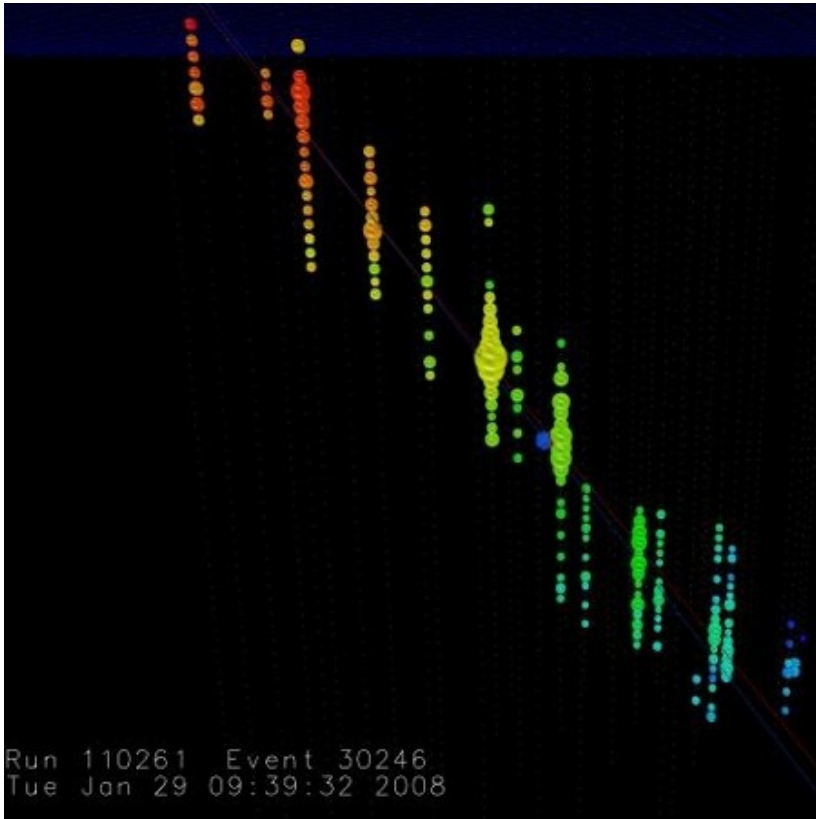




- 2500 m cable
- each string 6 t
- 60 modules / string

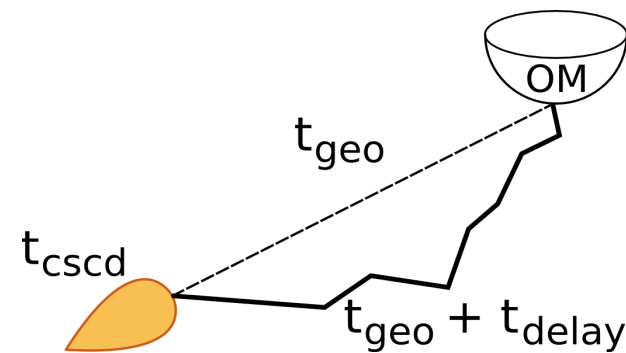
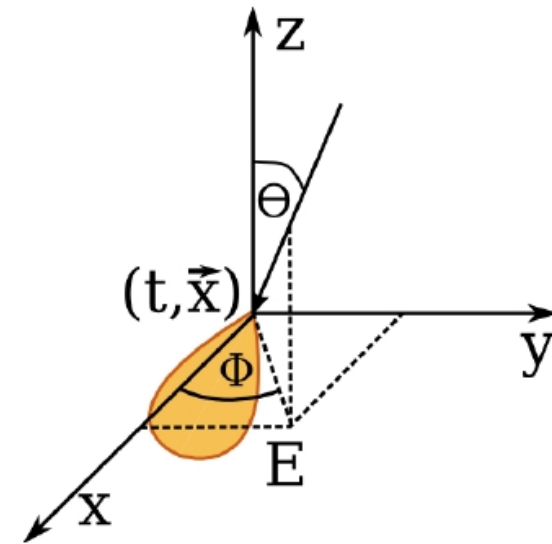


Event View



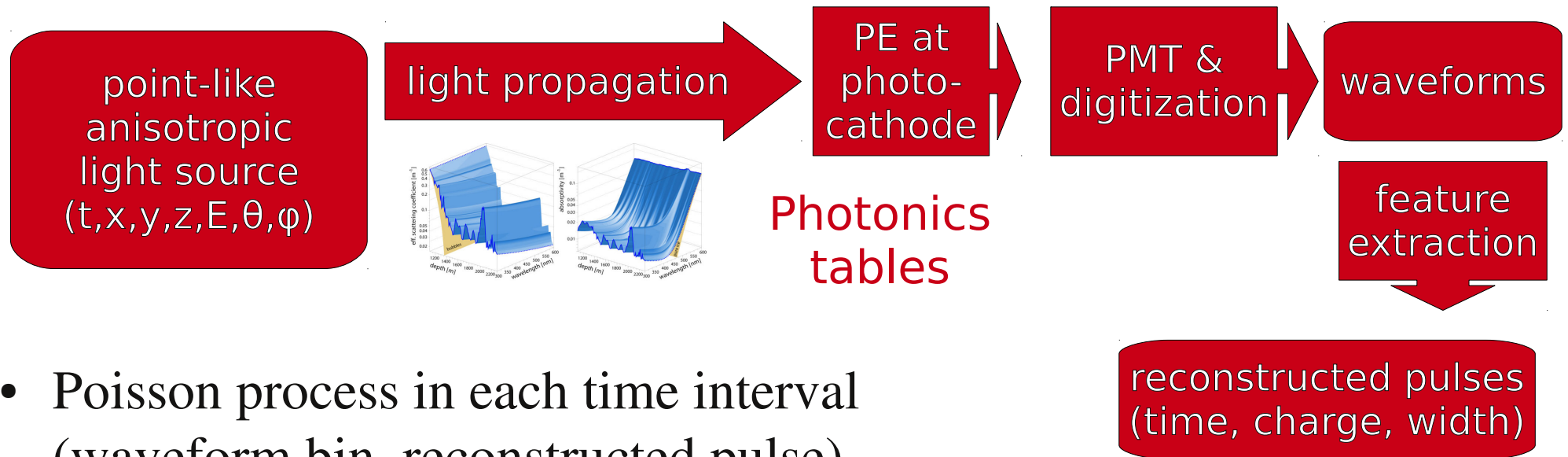
Light Propagation in Ice

- cascades are nearly point-like but anisotropic light sources
- inhomogeneous medium (dust layers)
- light propagation (scattering, absorption) simulated with Photonics
 - mean amplitude
 - delay time probability



Likelihood Reconstruction

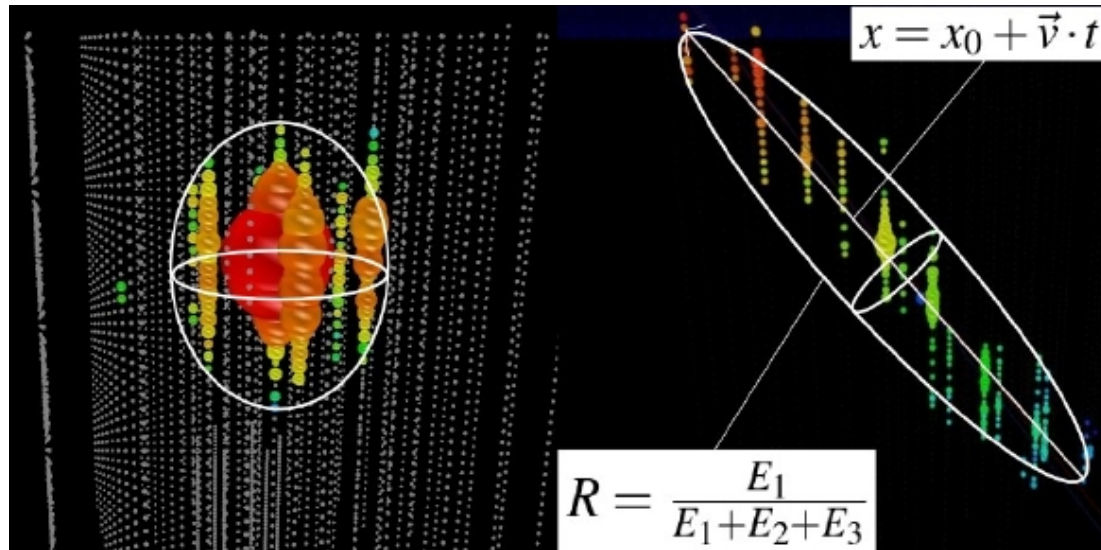
- need a probabilistic description of the measurement



- Poisson process in each time interval (waveform bin, reconstructed pulse)
- tables allow to predict the measured charge
- in DOM o , pulse i : compare charge n_{oi} to prediction μ_{oi}

$$L = \prod_o \prod_i \frac{\mu_{oi}^{n_{oi}}}{n_{oi}!} \exp(-\mu_{oi}) \prod_o \exp(-\mu_o)$$

Cascade Selection

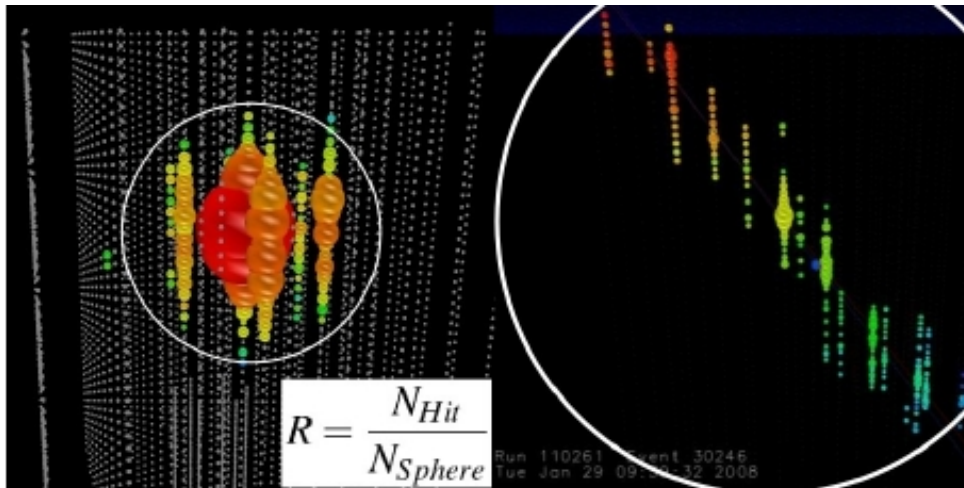


- LineFit velocity
- $$x = x_0 + \vec{V} \cdot t \quad V = \frac{\langle r_i \cdot t_i \rangle - \langle r_i \rangle \cdot \langle t_i \rangle}{\langle t_i^2 \rangle - \langle t_i \rangle^2}$$

- eigen value ratio of Tensor of Inertia

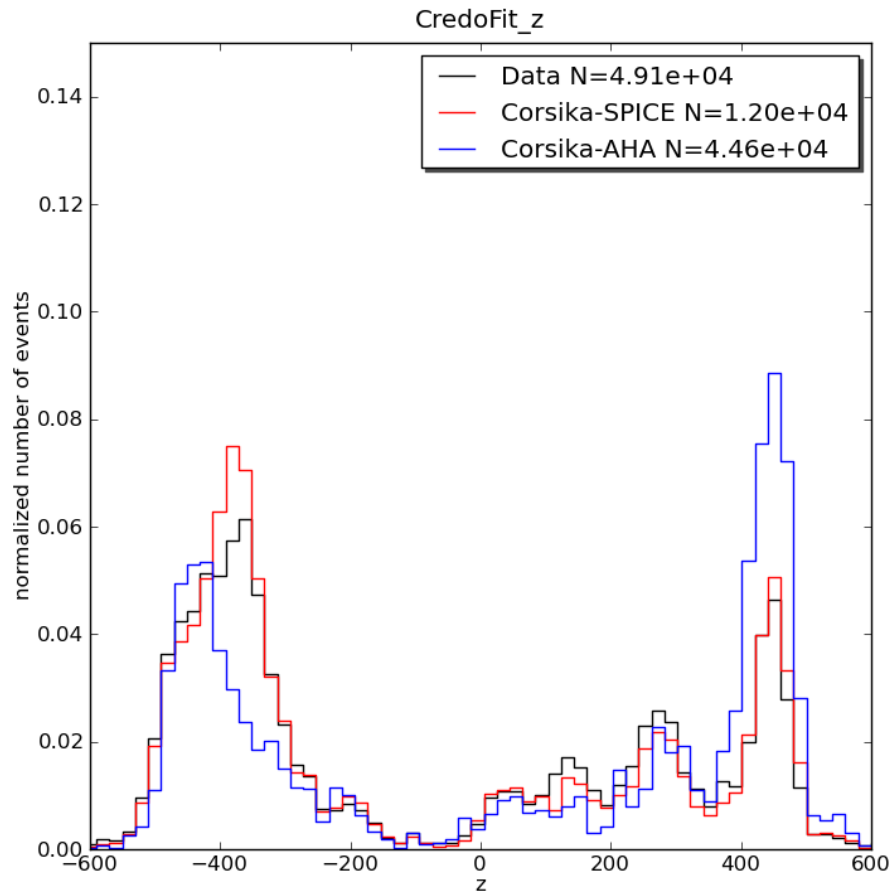
$$R = \frac{E_1}{E_1 + E_2 + E_3}$$

- Fill ratio

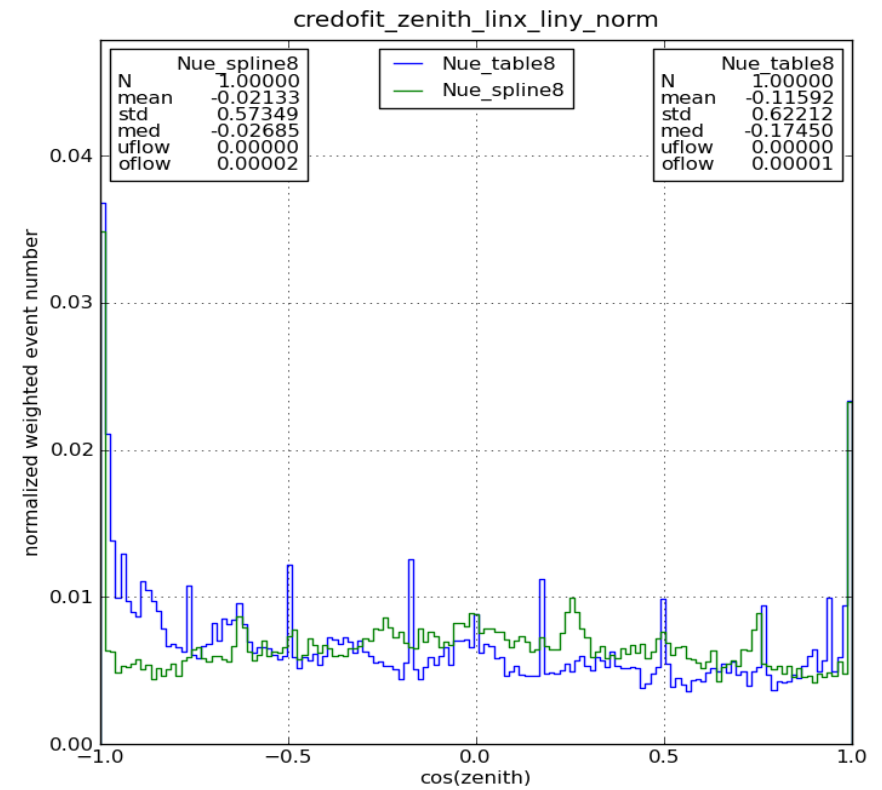


$$R = \frac{N_{hit}}{N_{sphere}}$$

Some Work



- ice model studies



- photospline studies

Current Work

- improvement of cascade reconstruction algorithm „Credo“:
 - test interpolation splines
 - new likelihood approaches
 - new reconstructions
- cascade channel IC59 analysis → search for electron neutrinos

Thank you!