WIPAC and the OSG

OSG Council meeting
March 2018

G. Merino

Short bio (before WIPAC)

2000 - PhD in physics from UAB, Spain - Aleph experiment at CERN

2001 - 2003 - First EU Grid project: eu-datagrid

2003 - 2013

- Manager for the WLCG Tier1 center at PIC (Barcelona, Spain)
    - ATLAS, CMS and LHCb
- EGEE-I, II, III

2013 - Computing Manager for IceCube at WIPAC, UW-Madison

Wisconsin IceCube Particle Astrophysics Center

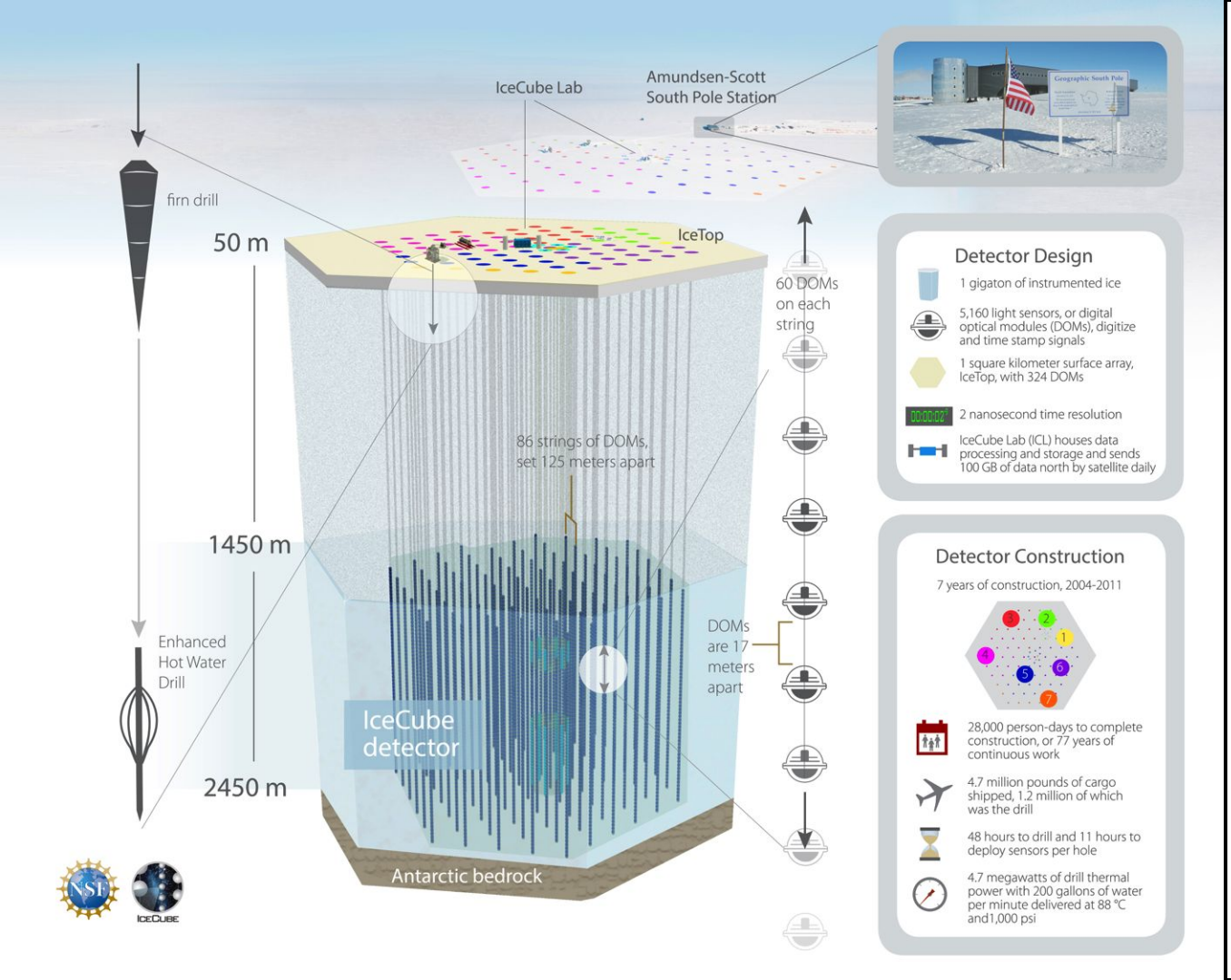
WIPAC is a scientific center at UW-Madison.

Formerly the “IceCube Research Center”, its name and mission were revised in 2011, after IceCube construction completion.

- Research in a broader range of particle astrophysics:
  IceCube, ARA, HAWC, CTA and DM-Ice

- Focus on neutrino astronomy.

Main goal is still maintaining and operating the IceCube detector and support the international Collaboration that does the scientific exploitation.



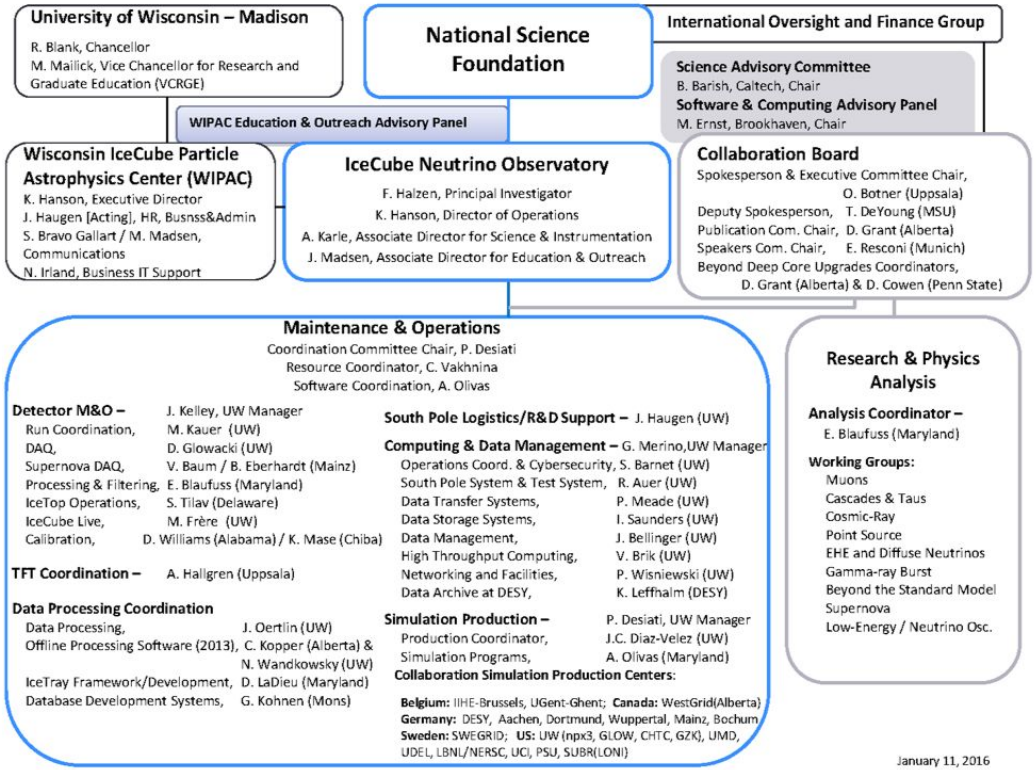
Neutrino observatory at the geographic South Pole

5483 Digital Optical Modules (DOMs) in 1km^3 of ice

7 years after completion the detector continues to operate nominally.

- More reliable than expected
- Only 32 of 5483 DOMs have failed

IceCube M&O Organization



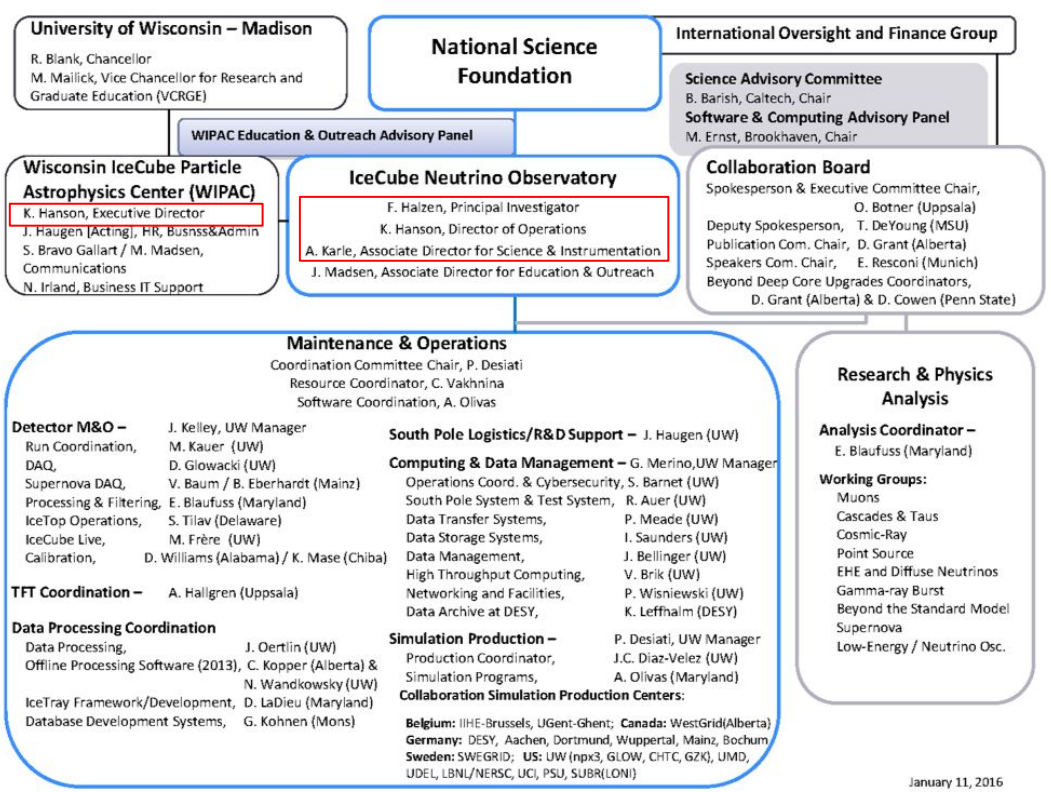
NSF funded

- 2004-2010: construction
- 2011-2015: 1st M&O grant
- 2016-2021: 2nd M&O grant

The Host Institution is the University of Wisconsin - Madison

- P.I. Franzis Halzen

IceCube M&O Organization



This request for membership has full support of IceCube management at UW-Madison

- Francis Halzen: PI
- Kael Hanson: Director of Operations, WIPAC Director
- Albrecht Karle: Associate Director for Science & Instrumentation

THE ICECUBE COLLABORATION

49 institutions
12 countries
>300 researchers

AUSTRALIA
University of Adelaide

BELGIUM
Université libre de Bruxelles
Universiteit Gent
Vrije Universiteit Brussel

CANADA
SNOLAB
University of Alberta–Edmonton

DENMARK
University of Copenhagen

GERMANY
Deutsches Elektronen-Synchrotron
ECAP, Universität Erlangen-Nürnberg
Humboldt–Universität zu Berlin
Ruhr-Universität Bochum
RWTH Aachen University
Technische Universität Dortmund
Technische Universität München
Universität Mainz
Universität Wuppertal
Westfälische Wilhelms-Universität Münster

JAPAN
Chiba University

NEW ZEALAND
University of Canterbury

REPUBLIC OF KOREA
Sungkyunkwan University

SWEDEN
Stockholms Universitet
Uppsala Universitet

SWITZERLAND
Université de Genève

UNITED KINGDOM
University of Oxford

UNITED STATES
Clark Atlanta University
Drexel University
Georgia Institute of Technology
Lawrence Berkeley National Lab
Marquette University
Massachusetts Institute of Technology
Michigan State University
Ohio State University
Pennsylvania State University
South Dakota School of Mines and Technology
Southern University and A&M College
Stony Brook University
University of Alabama
University of Alaska Anchorage
University of California, Berkeley
University of California, Irvine
University of California, Los Angeles
University of Delaware
University of Kansas
University of Maryland
University of Rochester
University of Texas at Arlington
University of Wisconsin–Madison
University of Wisconsin–River Falls
Yale University

FUNDING AGENCIES

Fonds de la Recherche Scientifique (FRS-FNRS)
Fonds Wetenschappelijk Onderzoek-Vlaanderen (FWO-Vlaanderen)
Federal Ministry of Education and Research (BMBF)
German Research Foundation (DFG)
Deutsches Elektronen-Synchrotron (DESY)
Japan Society for the Promotion of Science (JSPS)
Knut and Alice Wallenberg Foundation
Swedish Polar Research Secretariat
The Swedish Research Council (VR)
University of Wisconsin Alumni Research Foundation (WARF)
US National Science Foundation (NSF)

ICECUBE
SOUTH POLE NEUTRINO OBSERVATORY
icecube.wisc.edu

Multi-messenger astronomy

Highlighted as one of the priority topics in NSF 2016 report

“10 Big Ideas for Future NSF Investments”

https://www.nsf.gov/news/special_reports/big_ideas/

Windows on the Universe: The Era of Multi-Messenger Astrophysics

Using powerful new syntheses of observational approaches to provide unique insights into the nature and behavior of matter and energy and help to answer some of the most profound questions before humankind.

For years, we have been making observations across the known electromagnetic spectrum -- from radio waves to gamma rays -- and many great discoveries have been made as a result. Now, for the first time, we are able to observe the world around us in fundamentally different ways than we previously thought possible. Using a powerful and synthetic collection of approaches, we have expanded the known spectrum of understanding and observing reality.

Multi-messenger astronomy

IC-170922: IceCube alert for very energetic neutrino

```
Date: 22 Sep, 2017
Time: 20:54:30.43 UTC
RA: 77.43 deg (-0.80 deg/+1.30 deg  90% PSF containment) J2000
Dec: 5.72 deg (-0.40 deg/+0.70 deg 90% PSF containment) J2000

We encourage follow-up by ground and space-based instruments to help
identify a possible astrophysical source for the candidate neutrino.
```

Later identified by several telescopes as enhanced gamma emission from blazar TXS 0506+056

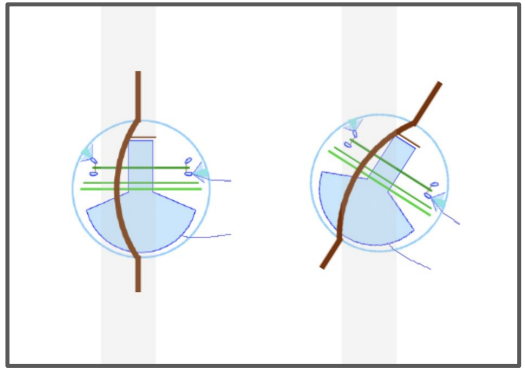
Multi-messenger astronomy with neutrinos becomes a reality

Precision measurements - control of systematics

Understanding the ice properties is now key to increase resolution.

Use LED calibration data to “fit” the ice properties parameters - GPU simulations.

- scattering/absorption params vs. depth
- dust layer, tilt vs depth
- azimuthal dependency (ice flow)
- next: hole ice, cable shadow, DOM tilt …



LOTS of simulation required to estimate systematics.

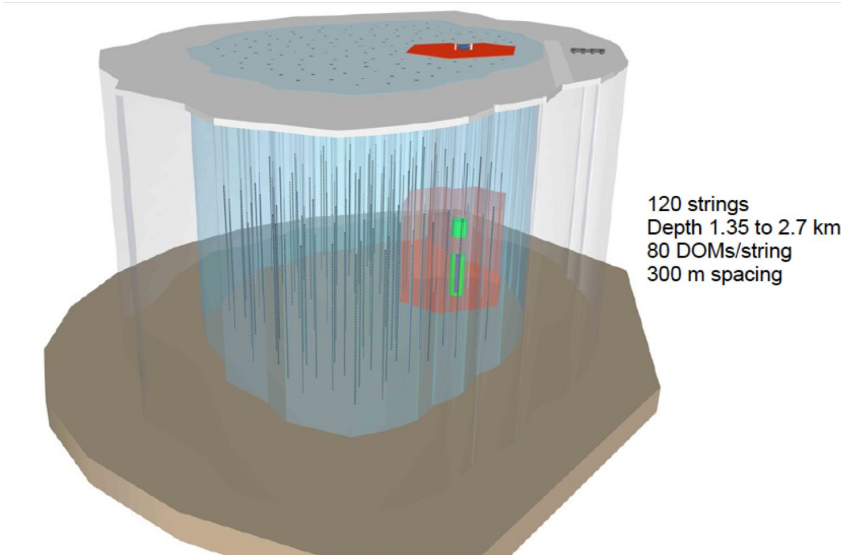
IceCube Gen2

Plans for an IceCube expansion.

- Instrumented volume x10

First phase will increase sensor density inside current volume.

- improved calibration ⟶ 4x sensitivity
- can be applied to 10 years of archived data



Improved precision is computationally expensive ...

Center for High Throughput Computing CHTC

The IceCube M&O team at WIPAC is lucky to share campus with the CHTC.

HTCondor has been at the core of the IceCube offline computing environment for many years.

The relationship with OSG also dates back a long time.

- In the early times, through the UW Campus Grid (GLOW).

IceCube soon discovered the benefits of sharing

- became a happy consumer of opportunistic resources (thanks!)

IceCube and OSG

Engagement within OSG has evolved in the last 5 years. Aiming to play a more active role. More than being just a net consumer of cycles.

Work inside IceCube to make the Grid more **user friendly**:

- back in 2013, the Grid was just for simulation production. Lots of barriers for users.
- lowering barriers: CVMFS, glideins, IceCube s/w modules for transparent remote i/o ...
- Today: New users are encouraged to build their jobs for the Grid, and run them everywhere (local + Grid)

IceCube and OSG

Also, worked to make the Grid more **friendly for IceCube sites**:

- back in 2013, an IceCube site willing to share their local cluster would have to dedicate >0.5 FTE to maintain a full local install of the software, and operate it.
- lowering barriers

```
pip install pyglidein_client
crontab -e ...
```

- Today: most IceCube sites with local resources are part of the central HTCondor pool, actively used and with minimal effort from local people.

WMS - Pyglidein/IceProd

Borrowing from the glidein pilot model, we started exploring this paradigm variation - trying to solve a real problem in the simplest way we could think of

- This has worked for us to present federated resources to users.
  - Got us going quickly with XSEDE GPU clusters: Comet, Bridges, XStream
- Open dialog with HTCondor, GlideinWMS teams to understand pros/cons and define the best common approach moving forward.

Currently exploring ways to integrate a big GPU HPC system: TITAN

- Collaborating/discussing with various groups (HTCondor/Panda) to try and test different approaches and learn pros/cons.

Data Management

In-house developed software JADE - **Custom functionality**:

- Fetch from DAQ and archive on site
- Satellite transfer
- Bundling for efficient tape archive
- Metadata/bookkeeping

Common functionality: exploring ways to “outsource” this to a common tool

- File replication between sites
- Replica location catalog

Outlook

IceCube is the largest neutrino detector in the world. One of the pillars of the NSF priority area of multi-messenger astronomy.

The ice of the antarctic glacier 1 mile deep is extraordinarily transparent.

- sensitivity limited by computing.

The IceCube science totally relies on DHTC. Engagement with the OSG community dates back many years and it is growing.

WIPAC wants to request membership in the OSG Council, to represent the neutrino astrophysics community.

thanks

Real-time alerts and followups

Motivation

- Identify sources of our astrophysical neutrino signals
- Robust reconstructions and event selections
- Interest in the community (what did IceCube see?)

Online selection of candidate events

- sent North via Iridium satellite channel
- alert generated at UW and sent out - expected total latency ~2-3 min
- higher resolution reconstructions - update alert info after few hours