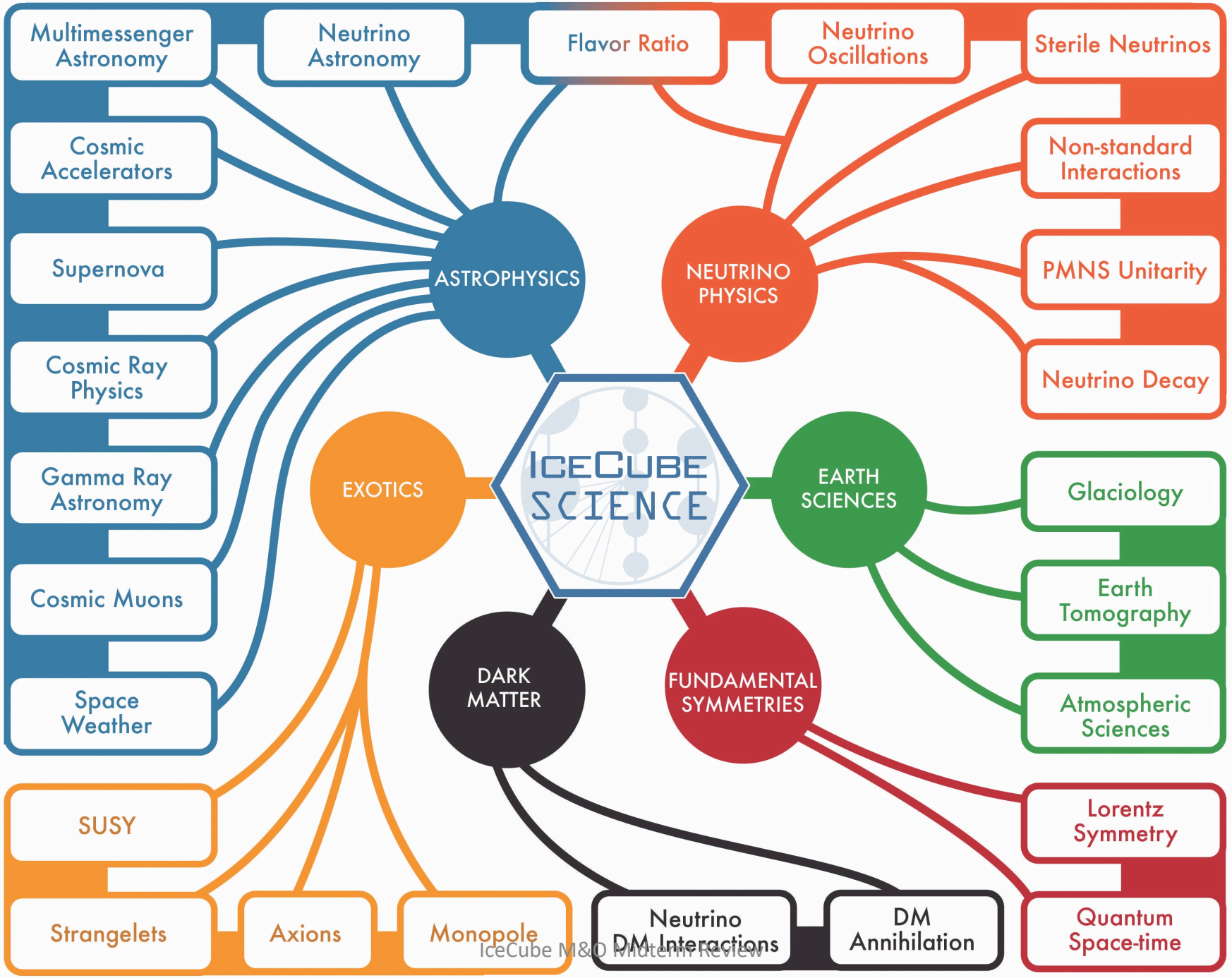
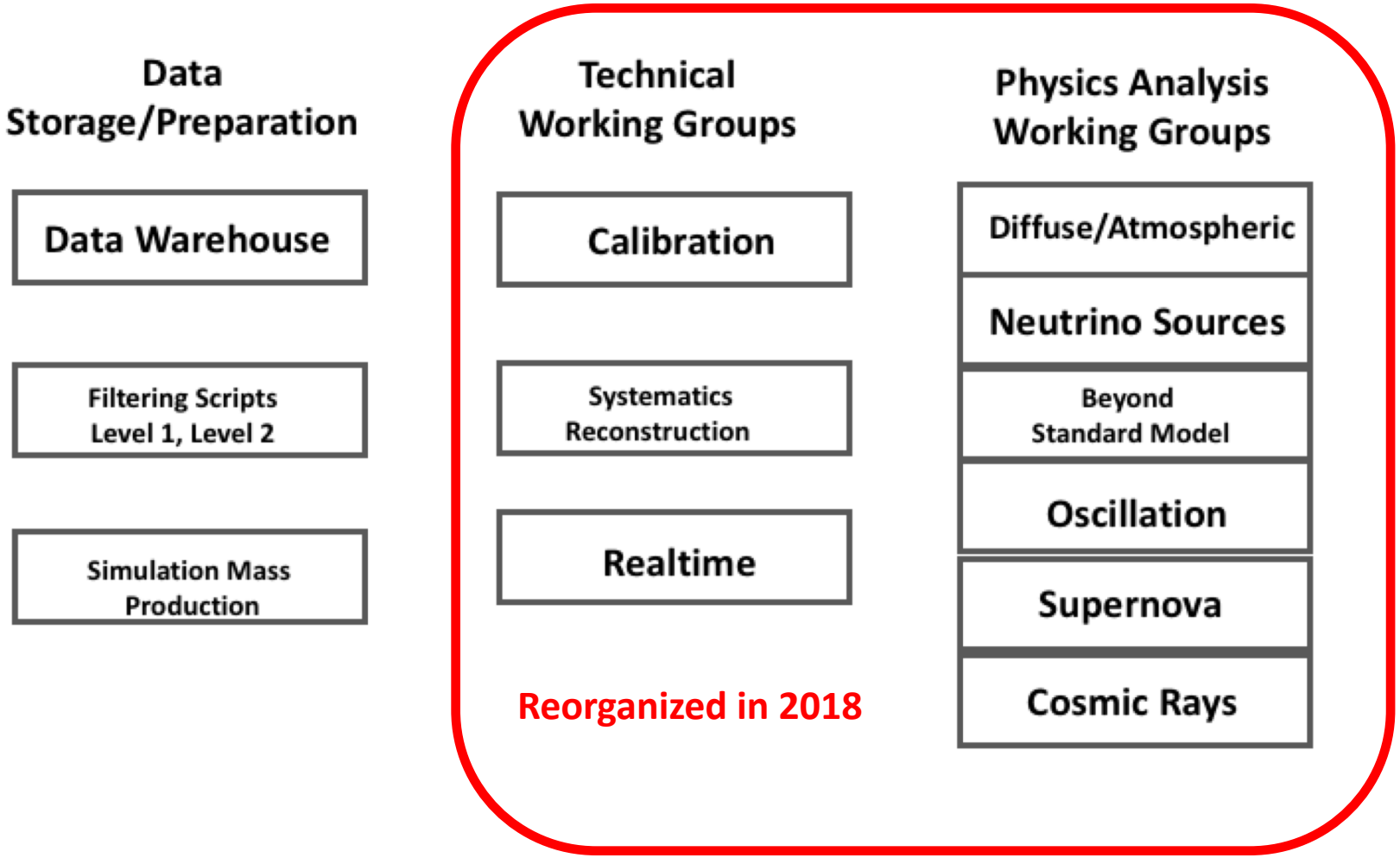
Analysis Coordination and Publications

Dawn Williams

Maintenance and Operations Mid-term Panel Review


ICECUBE SCIENCE
ASTROPHYSICS
NEUTRINO PHYSICS
EXOTICS
EARTH SCIENCES
DARK MATTER
FUNDAMENTAL SYMMETRIES
Multimessenger Astronomy
Neutrino Astronomy
Cosmic Accelerators
Supernova
Cosmic Ray Physics
Gamma Ray Astronomy
Cosmic Muons
Space Weather
Flavor Ratio
Neutrino Oscillations
Sterile Neutrinos
Non-standard Interactions
PMNS Unitarity
Neutrino Decay
Glaciology
Earth Tomography
Atmospheric Sciences
SUSY
Strangelets
Axions
Monopole
Neutrino DM Interactions
DM Annihilation
Lorentz Symmetry
Quantum Space-time

Interface between M&O and Analysis



M&O delivers level 2 filtered data in the northern hemisphere, large scale simulated data in the same format as real data, calibration constants

Analysis working groups deliver high-level physics results for presentation and conferences and for publication

New WG structure in 2018

Main motivations:

1. Consolidating topics
2. Improving communication between working groups on systematics
3. Moving some technical tasks out of overburdened working groups

Analysis WG	Convenor(s)
Diffuse	Claudio Kopper, Klas Hultqvist
Neutrino Sources	Naoko Kurahashi Neilson, Ignacio Taboada
Beyond Standard Model	Carsten Rott, Anna Pollman
Cosmic Rays	Kath Rawlins, Dennis Soldin
Oscillation	Juan Pablo Yanez, Tom Stuttard
Supernova	Lutz Koepke, Segev BenZvi

Technical WG	Convenor(s)
Realtime	Erik Blaufuss
Calibration	Summer Blot, Keiichi Mase
Systematics and Reconstruction	Joshua Hignight, Jakob Van Santen, Juanan Aguilar
Systematics Coordinator	Nathan Whitehorn

Working group technical personnel

Role/Area	Tech Lead	Affiliation	Data Curator	Affiliation	Current Datasets
Neutrino Sources WG	Joshua Wood	UW-Madison	Liz Friedman	UMD	Nu Sources Datasets
Oscillations WG	Philipp Eller	PSU			
Diffuse WG	Lu Lu	Chiba U.			
Cosmic Rays WG	Katherine Rawlins	U. Alaska			
Beyond Standard Model WG	Carlos Argüelles	MIT			

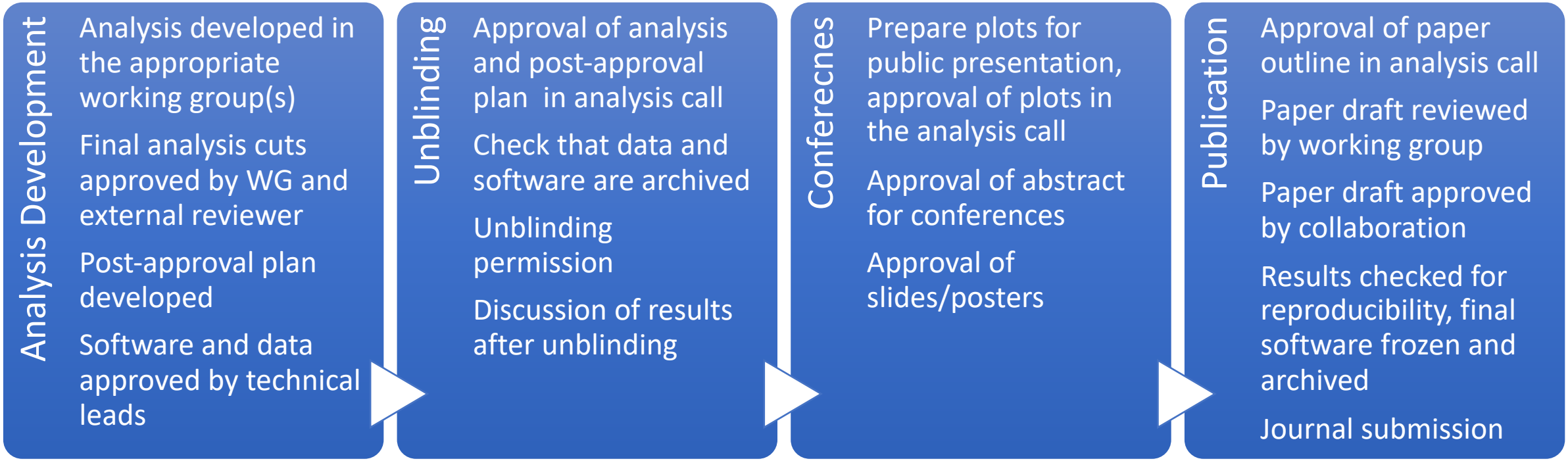
Physics analysis organization

- Physics working groups have weekly or bi-weekly teleconferences
- Most working groups also use dedicated Slack channels in between calls
- Weekly plenary “Analysis call” teleconference

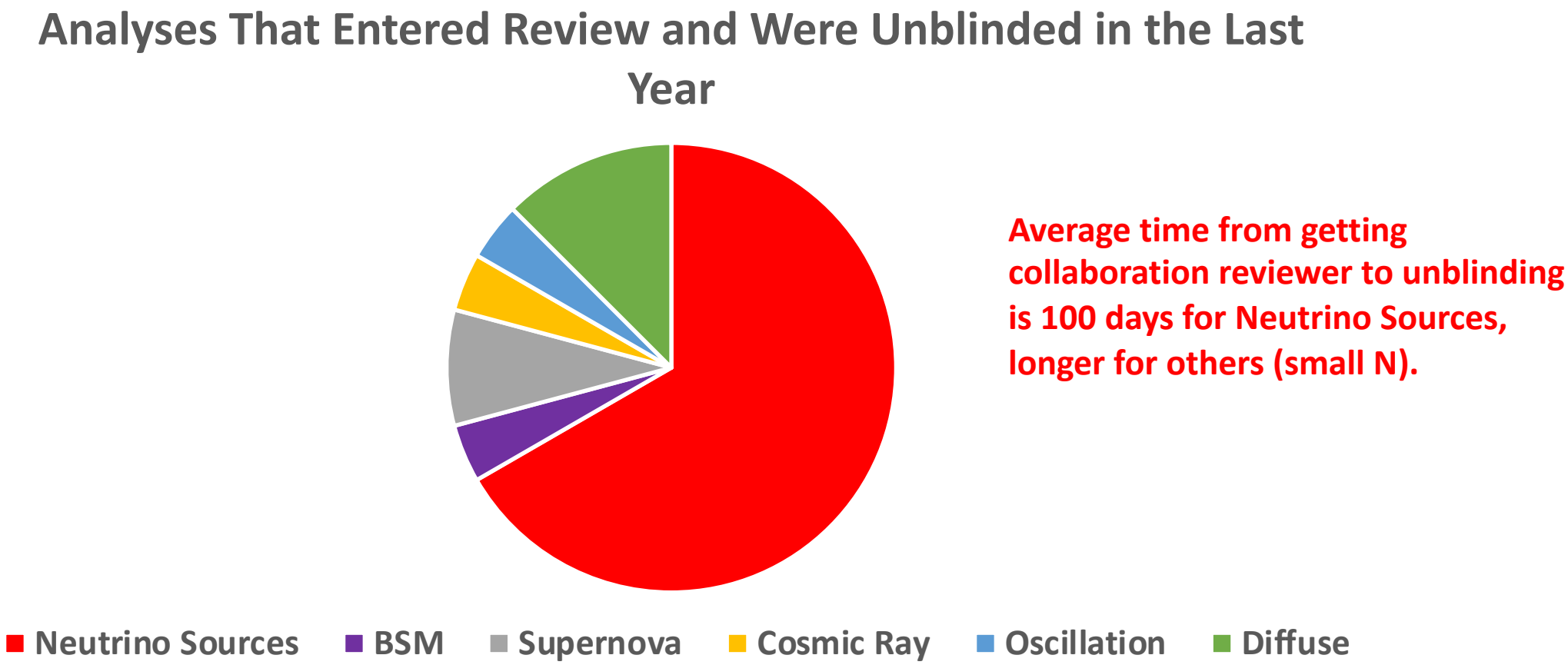
IceCube Physics WG Analysis Products

- High level data sets
  - L2 data (see B. Riedel's talk) is dominated by cosmic ray muons, background for most analyses outside of cosmic rays
  - Physics working groups produce signal-rich sets suitable for high level physics analysis and public release
  - Most high level data sets are used in multiple analyses
- Software
  - Core M&O software handles common filtering and reconstruction and simulation tasks
  - Physics working groups develop high level specialized analysis software, common software packages
  - Example: Skylab likelihood software for Neutrino Sources analyses
- Documentation
  - All analyses are required to produce documentation which is reviewed by the physics working group and by the collaboration, including archiving data samples and software
- Ultimately, conference presentations and refereed publications

Typical Analysis review cycle

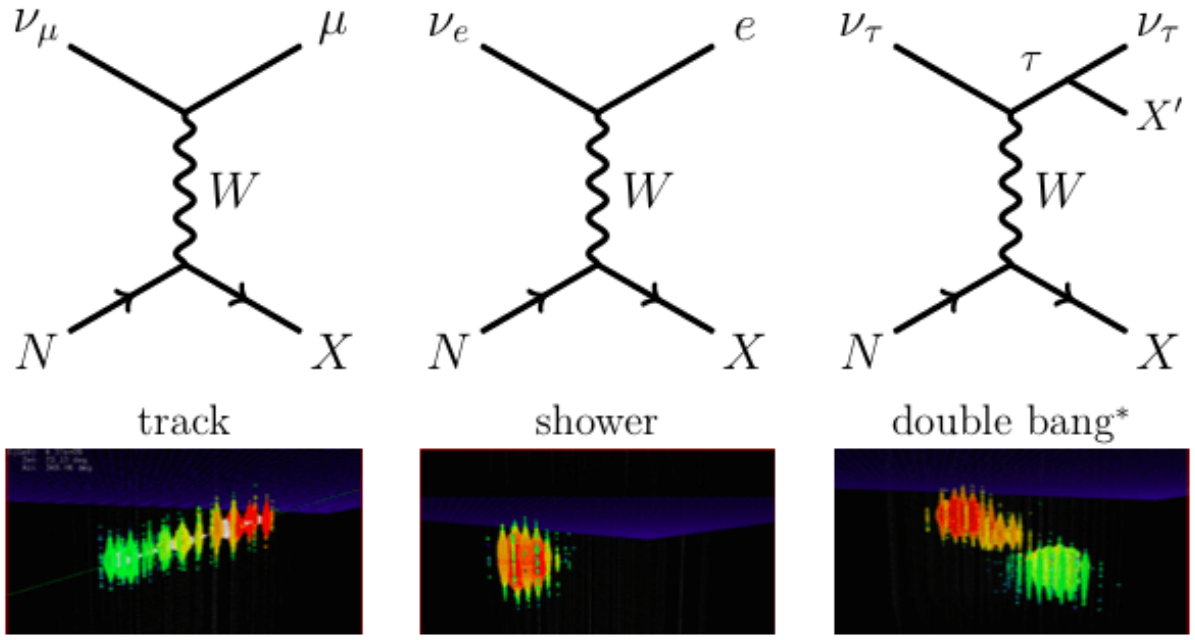


Analysis coordination metric: time to unblinding



Average time from getting collaboration reviewer to unblinding is 100 days for Neutrino Sources, longer for others (small N).

Neutrino signatures in IceCube



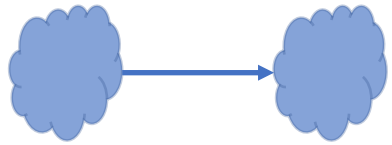
A shower is also seen for all flavor neutral current events

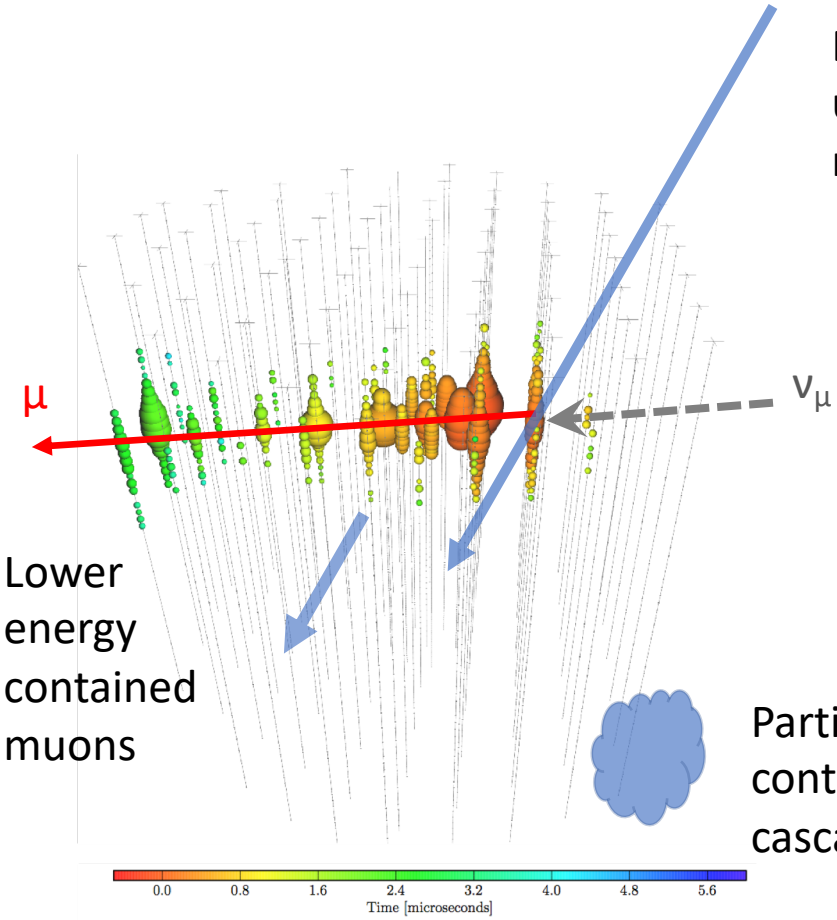
Red = early
Blue = late
Larger = more charge

Double bang signature only resolved in IceCube above 100 TeV energy

New samples in progress

Tau Double cascades

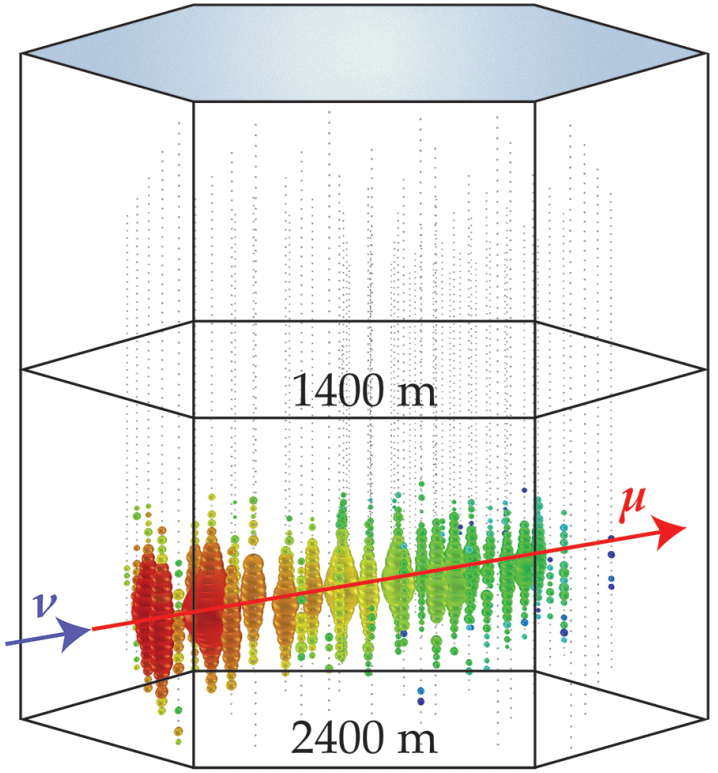




Downgoing uncontained muons

Lower energy contained muons

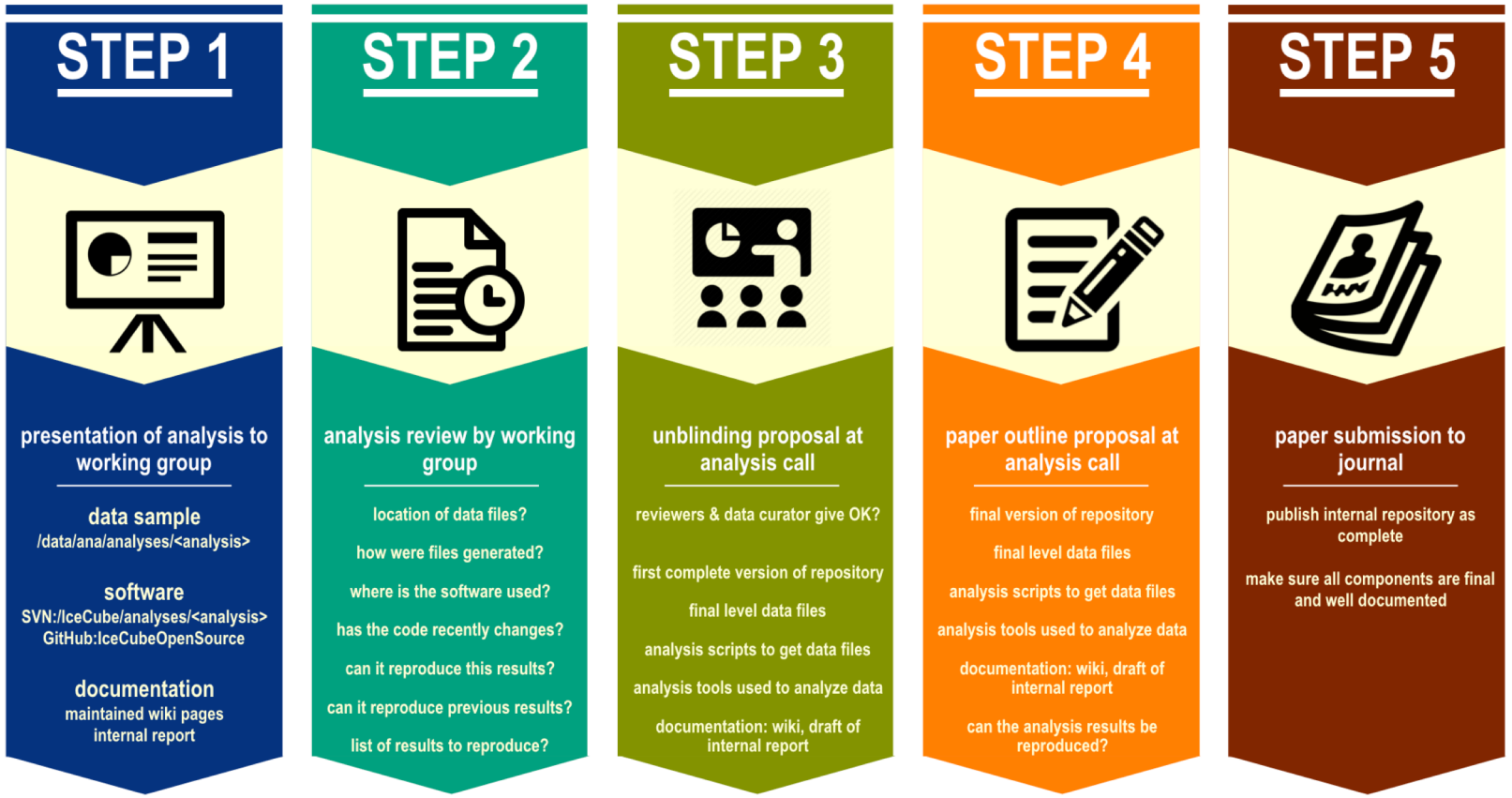
Partially contained cascades



Internal data release protocol

- For unblinding, data sample must be in the data warehouse and software (analysis scripts beyond core software) must be in SVN or GitHub, documentation must be complete
- Technical coordinator/data curator of analysis WG must sign off on this
- For publication, higher threshold: analysis must be able to be reproduced. This is only reproduction of high level results, not reproduction of all data processing

Internal data release protocol

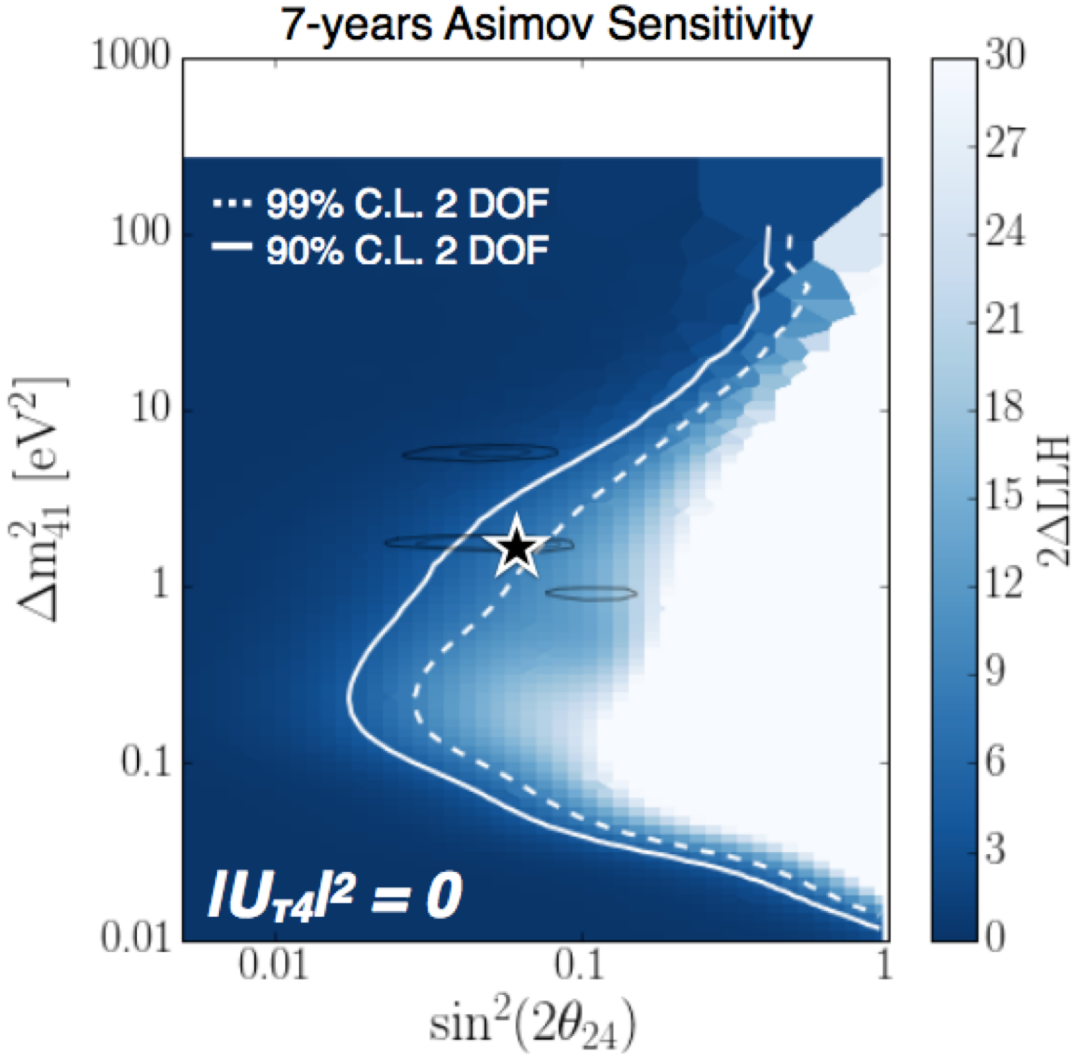


External data releases

- Text format data release of 3 years of tracks in October
- Looking into next generation of data releases: supporting versions, different types of data sets, database functionality
- A data release task force has been convened to look into this
- Possible solutions being investigated include High Energy Astrophysics Archive for NASA (HEASARC) and Italian Space Energy Space Science Data Center
  - We are in initial discussed with HEASARC, led by Marcos Santander at U. Alabama

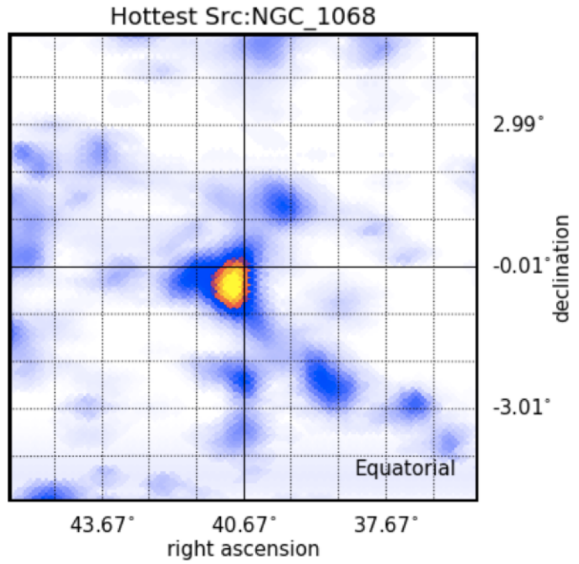
Selected Analyses on the horizon

- Multi-flare blazar search and many more multimessenger and realtime campaigns
- Lower energy starting tracks from Southern Hemisphere
- Updated sterile neutrino analysis
- OscNext oscillation analysis
- Global fit of multiple diffuse neutrino data samples



M77 (NGC 1068)

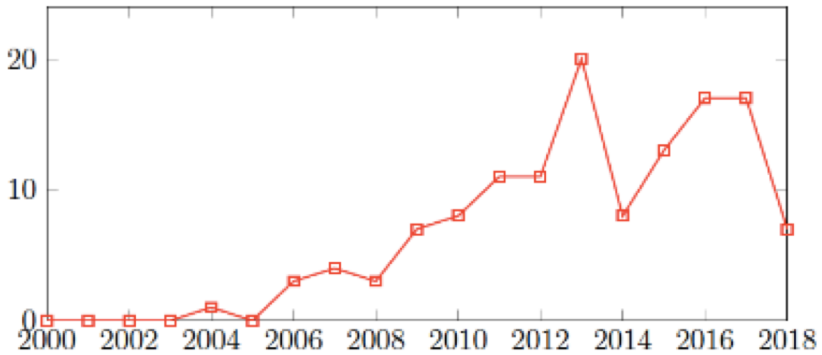
- Recent result: combined muon sample with updated catalog, showed a warm spot near M77, 2.9σ
- Result communicated as preliminary to MOU partners, promptly due to the source leaving FOV of air Cherenkov observatories soon
- Private communication based on time integrated result, not public release or realtime
- Publication in progress



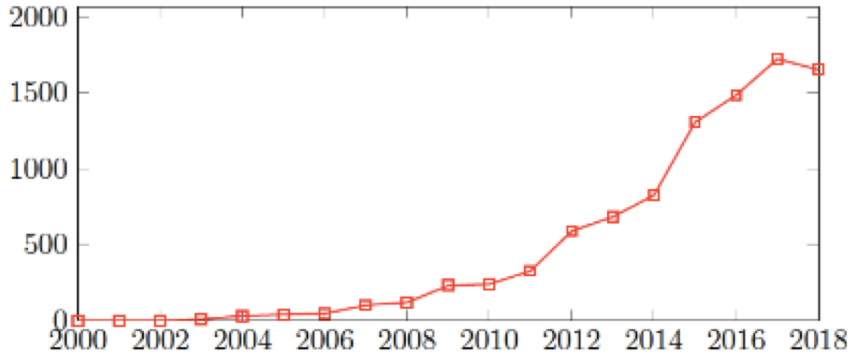
Publications Committee:

Markus Ackerman, Jenni Adams, Juanan Aguilar, Segev BenZvi, Doug Cowen, Chad Finley, Jason Koskinen, Carsten Rott, Subir Sarkar, David Seckel, Justin Vandenbroucke, Christopher Wiebusch

published papers



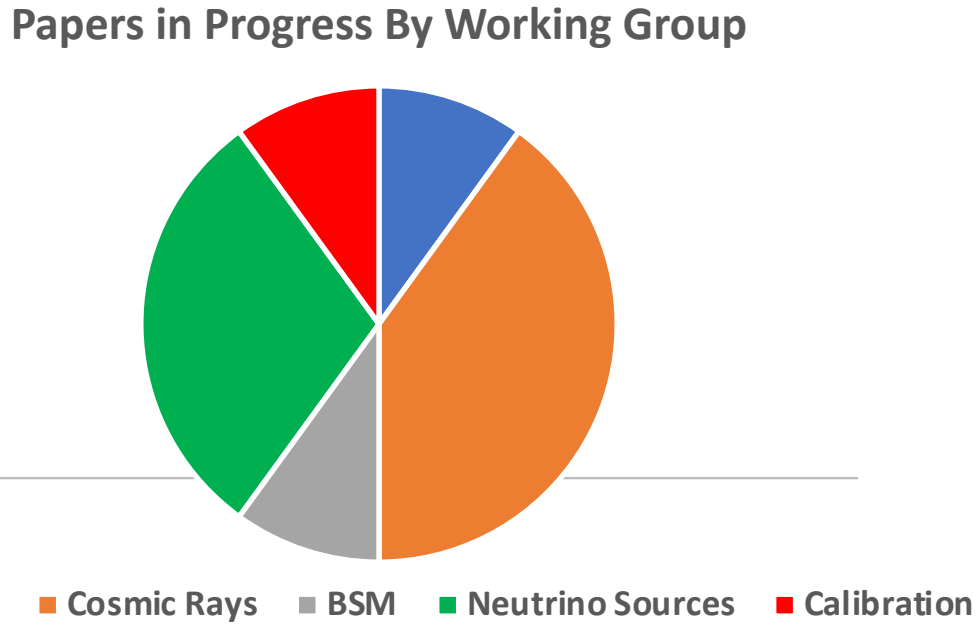
citations (no self-cit.)



Title	Journal	# cit.
Multi-messenger Observations of a Binary Neutron Star Merger	Astrophys.J. (2017)	430
Observation of High-Energy Astrophysical Neutrinos in Three Years of IceCube Data	Phys.Rev.Lett. (2014)	244
Evidence for High-Energy Extraterrestrial Neutrinos at the IceCube Detector	Science (2013)	238
First observation of PeV-energy neutrinos with IceCube	Phys.Rev.Lett. (2013)	142

IceCube led back-to-back papers publish in Science — July 2018 (~50 citations each to date)

Papers in Progress

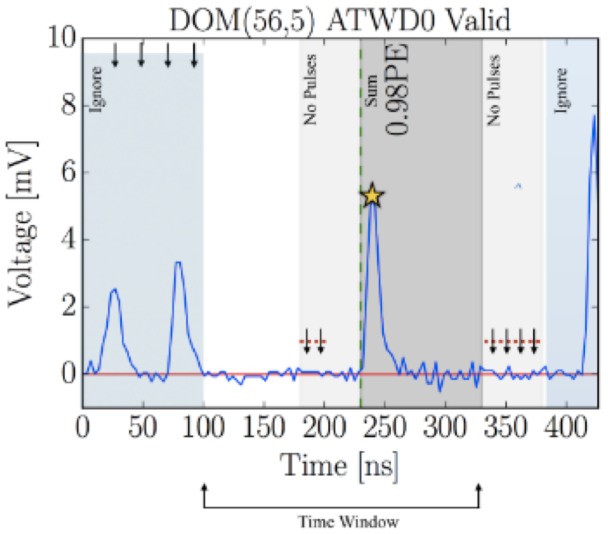


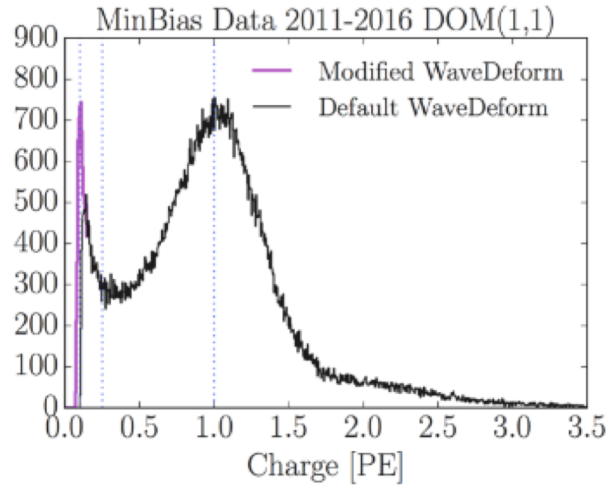
Papers in Progress

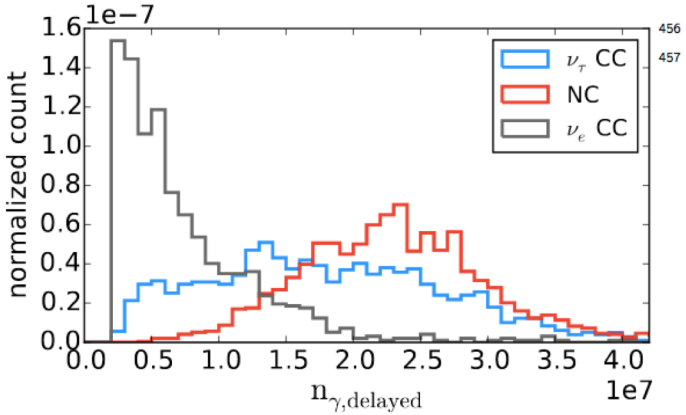
- JUNO and PINGU NMO analysis paper Added 2019-01-07
- FRB search with Level2 tracks and SNDAQ Added 2018-12-05
- Cascade Type Distinction Added 2018-10-30
- Non-Poissonian Template Fitting Added 2018-10-11
- SPE Templates Paper Added 2018-09-22
- Density of GeV muons in air showers measured with IceTop Added 2018-09-22
- Search for PeV Gamma Rays with 5 Years of Data from the IceCube Observatory Added 2018-09-22
- 3 Year Energy Spectrum and Composition Added 2018-09-22
- Search for Large Scale Northern Sky Cosmic Ray Anisotropy with 6 Years of IceCube Atmopsheric Neutrinos Added 2018-09-22
- Neutrino Mass Ordering Paper with 3 Years of DeepCore (DRAGON and GRECO analyses) Added 2018-08-03
- Upper Limits on High Energetic Neutrinos from Core Collapse Supernovae using the IceCube Neutrino Telescope added 2017-11-01

Technical and new methods papers

- New SPE Templates
- Application of Non-poissonian template fitting to point source searches
- Cascade type distinction
- Forthcoming: deep neural network reconstruction of IceCube cascades







Recent paper outlines

- Neutrino sources
  - Pulsar Wind Nebula Stacking
  - 10 year time integrated point source search (includes M77 result)
- Diffuse
  - Contained cascade paper
  - HESE 7 year paper
- Future technologies
  - IceACT demonstrator paper
  - JUNO/PINGU combined NMO sensitivity

Selected Paper outlines expected soon

- First hint of the Glashow resonance in IceCube data, including technical details of the reconstruction in a supporting paper
- Multiple papers derived from HESE sample including first tau neutrino candidate
- Neutrino cross section with cascades and HESE

Paper review process

- Initial drafts are reviewed in the working group, this can take 1 month to > 2 years
- Publications committee is working on defining draft/response cycles and setting deadlines for comments in the working group to keep reviews on track, although some delays are unavoidable, i.e. when bugs are found
- Papers are usually submitted to journals 3-6 weeks after entering collaboration review phase

Summary

- IceCube continues to deliver high quality science results
- Majority of analyses coming from Neutrino Sources group, reflecting IceCube's core mission as an astrophysical neutrino detector and prominent member of multimessenger astrophysics community
- High profile analyses and publications continue in all areas of IceCube science
- New data release is out, next generation data release planning in progress
- Time to unblinding is averaging 3 months for most analyses once they enter review
- Papers are submitted 3-6 weeks after entering collaboration review, procedures are being developed to keep the working group review process on track

Backup