

Neutrino Astronomy at DESY

A new window to the high-energy Universe

Helmholtz Program: Matter and the Universe (MU)

PoF III Topic: Matter and Radiation from the Universe

DESY Research Unit: Astroparticle Physics

Anna Franckowiak

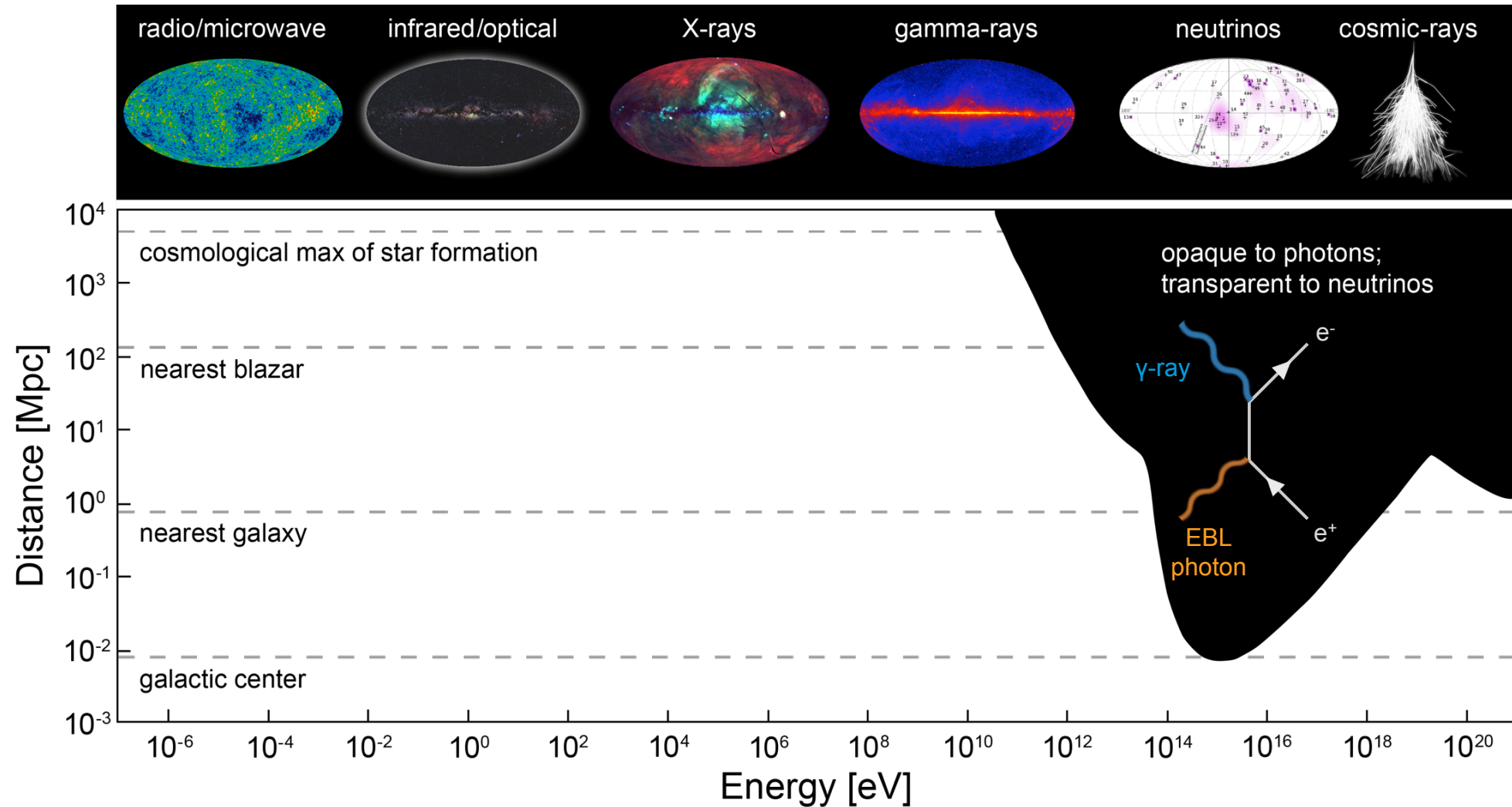
Center Evaluation DESY, 5 – 9 February 2018

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES



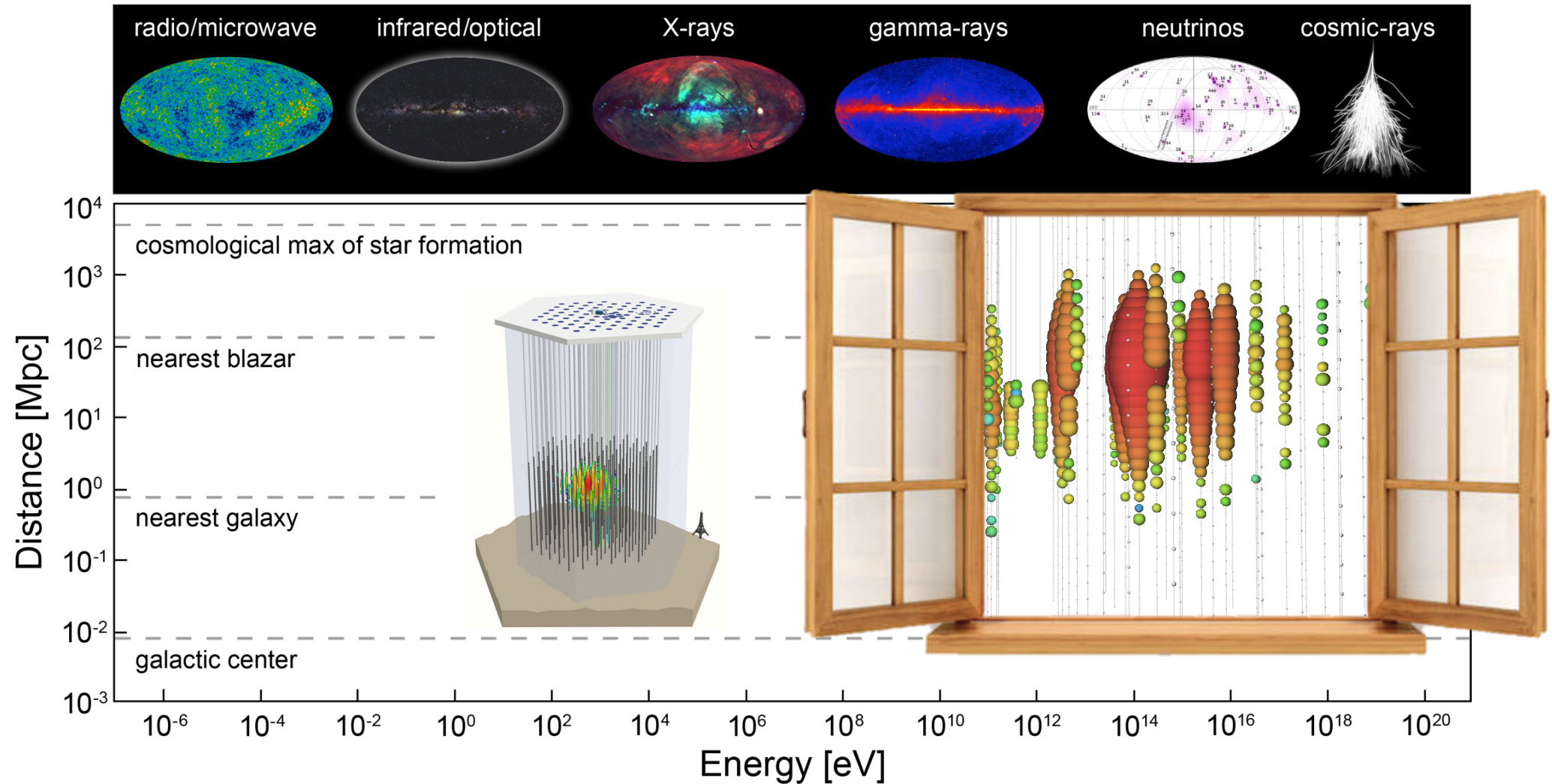
The Energy Frontier in Astronomy

Observing the most extreme places in the Universe



The Energy Frontier in Astronomy

Observing the most extreme places in the Universe



The Group

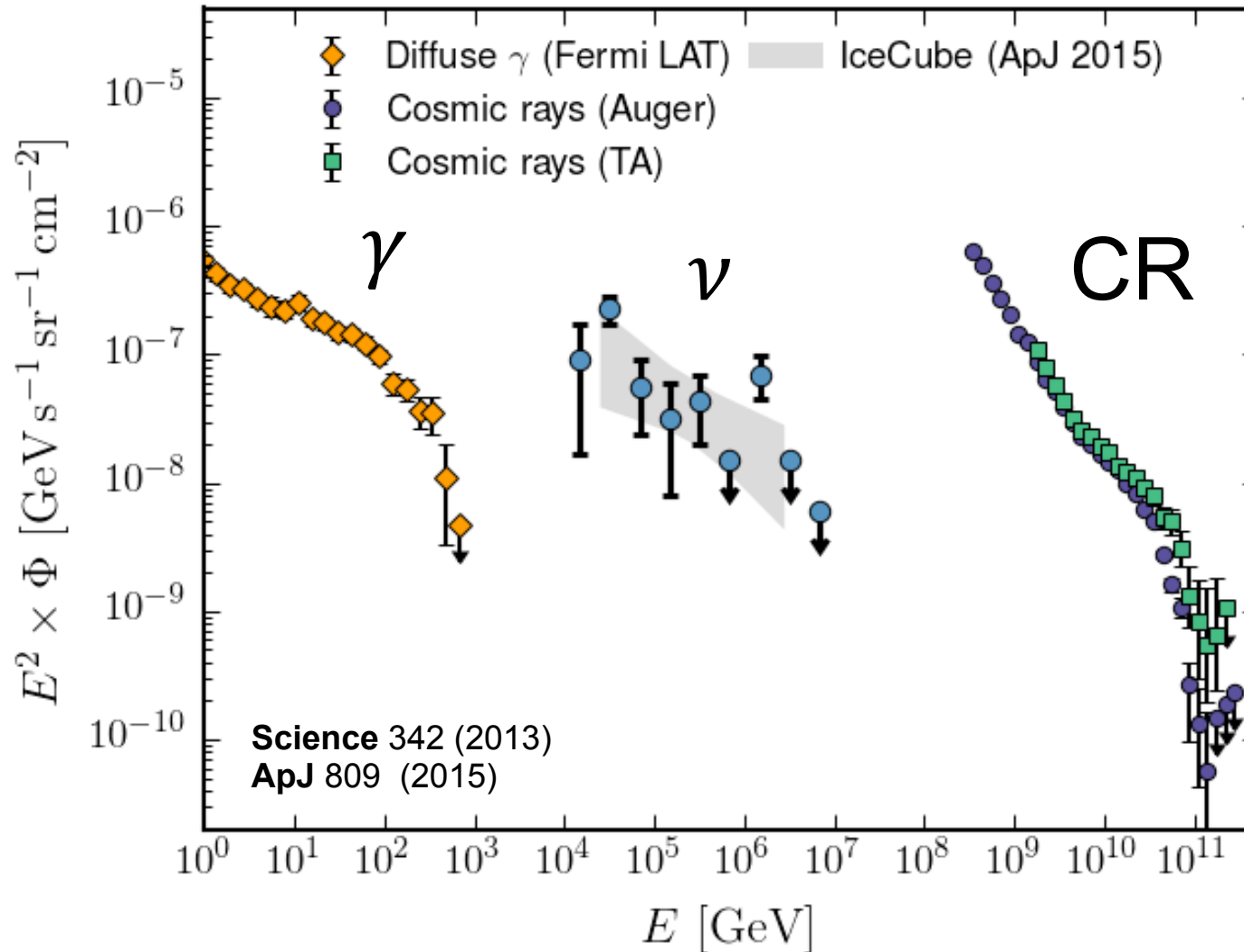
Second largest group in IceCube



- 5 staff members, 4 postdocs, 8 PhD students
- Over the last 5 years: analysis coordinator, publication chair, coordination of several working groups (Gen2, CR calibration, cascades)

Neutrino Achievements during POF III – Cosmic Neutrinos

Detection of cosmic neutrinos



Pioneered cascade channel

A. Stössel PhD'14, A. Schönwald PhD'15,
postdoc JvS



Tau neutrino identification

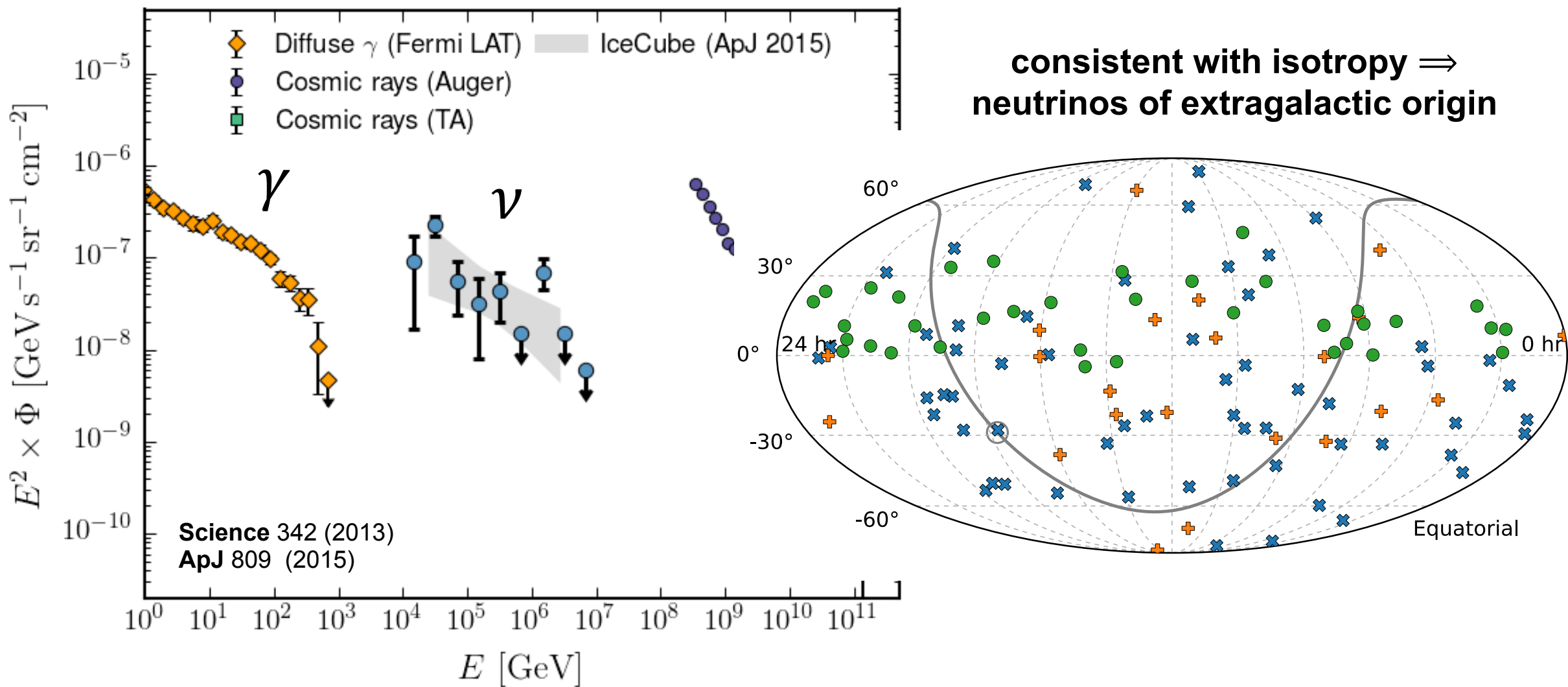
M. Usner PhD '18

First multichannel analysis

L. Mohrmann PhD '15

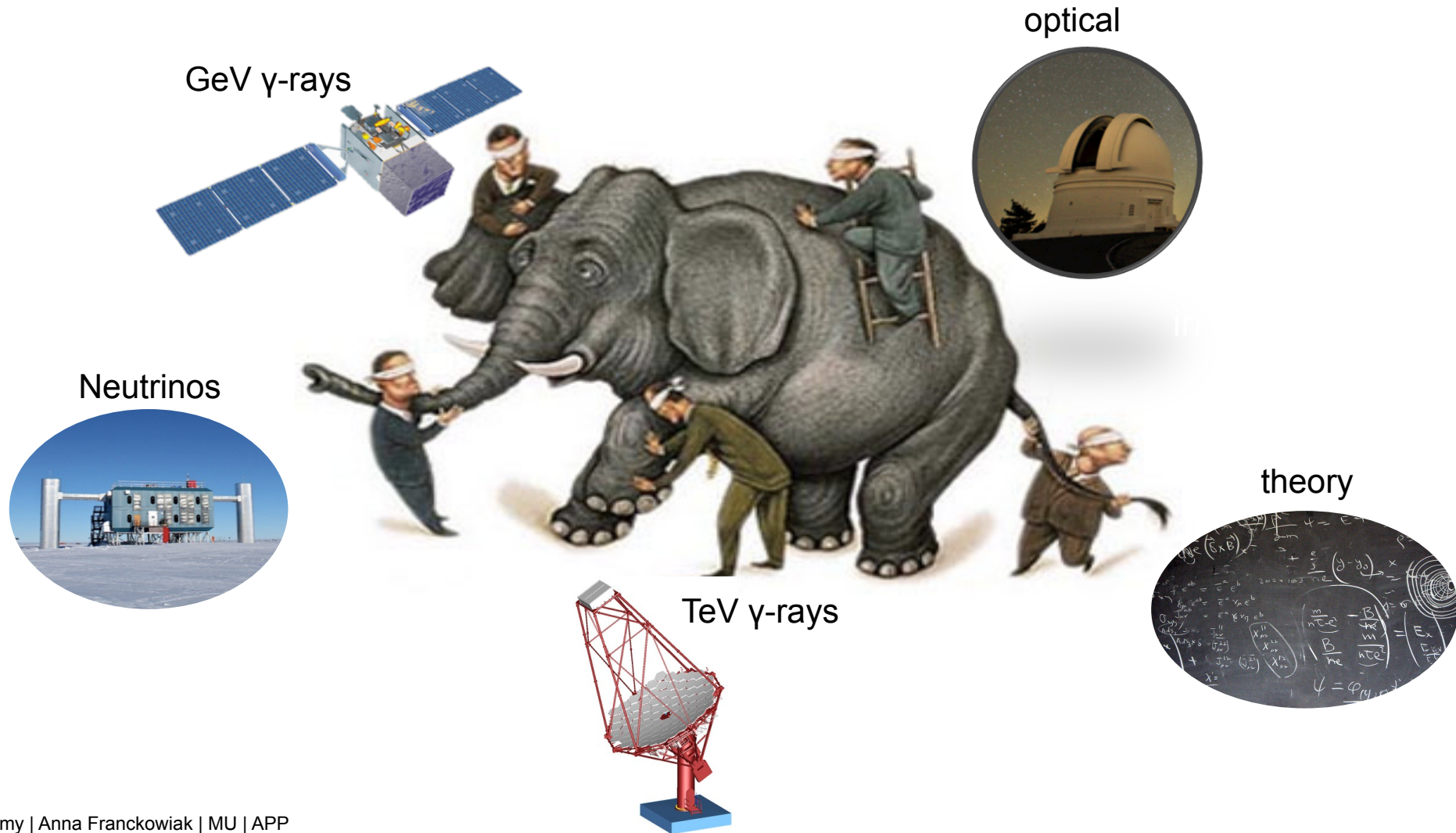
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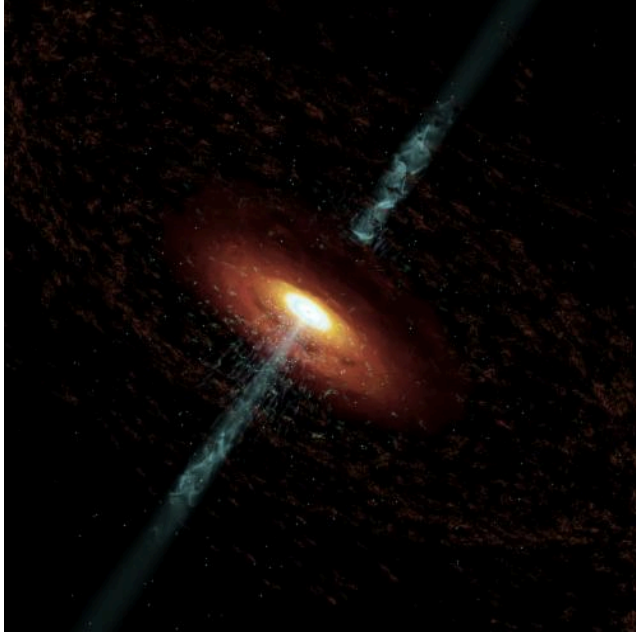
Neutrino Achievements during POF III – Multi-Messenger

Unveiling the elephant



Neutrino Achievements during POF III – Sources

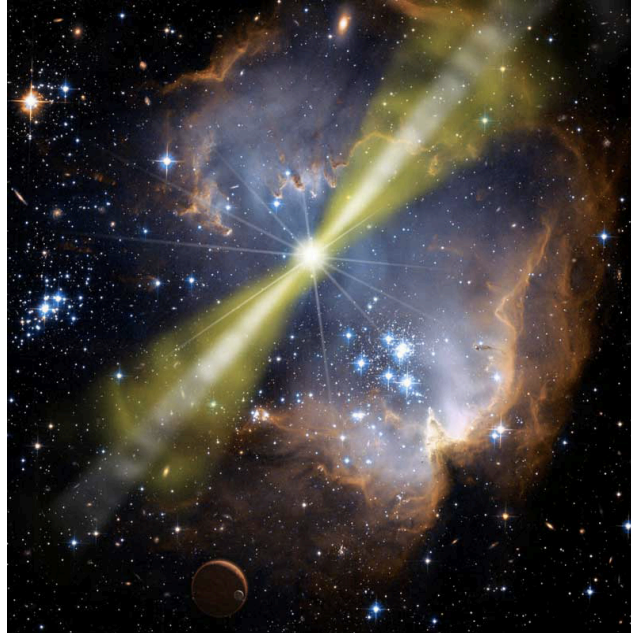
Probing potential source candidates motivated by electromagnetic observations



Blazars < 20%



T. Glusenkamp PhD'16



Gamma-Ray Bursts < 1%



N.Strotjohann PhD'18



Supernovae < 50%

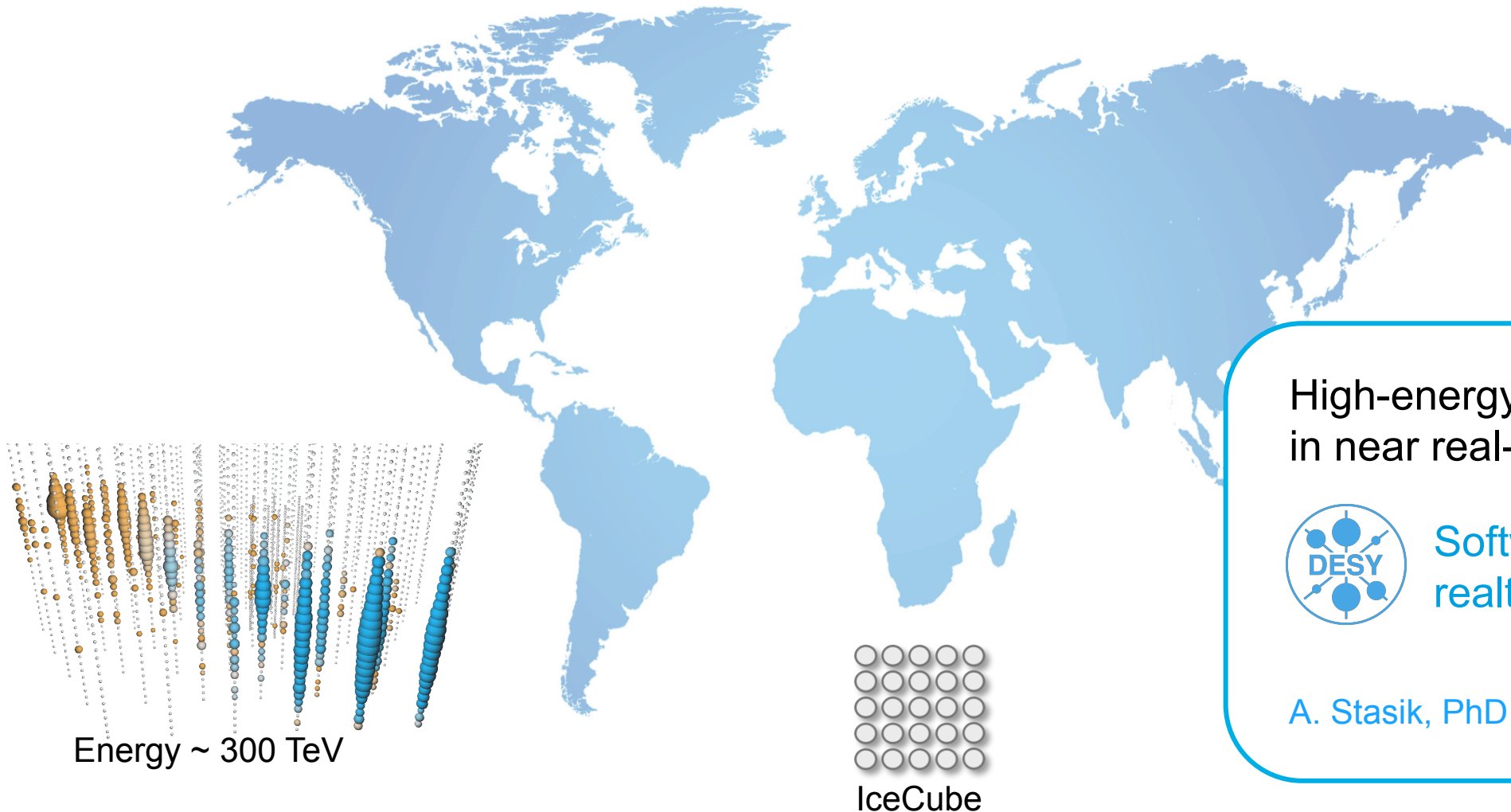


A. Stasik PhD'17

ApJ 835 (2017)
A&A 607 (2017)

Neutrino Achievements during POF III – Real-time

Real-time IceCube Alert #10: IceCube-170922A



High-energy neutrinos identified
in near real-time



Software framework for
realtime event stream

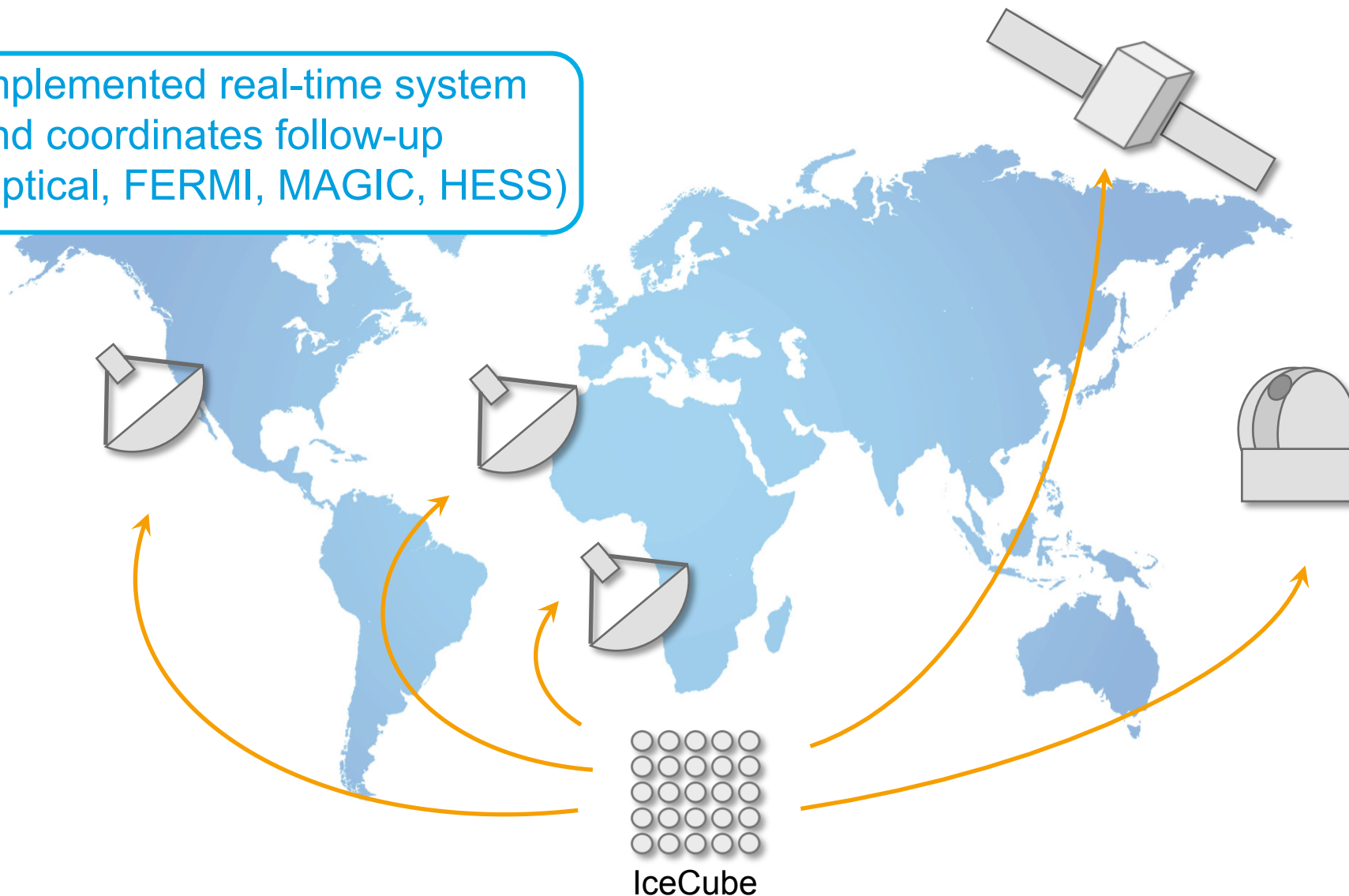
A. Stasik, PhD '17, T. Kintscher, PhD '18

Neutrino Achievements during POF III – Real-time

Real-time IceCube Alert #10: IceCube-170922A

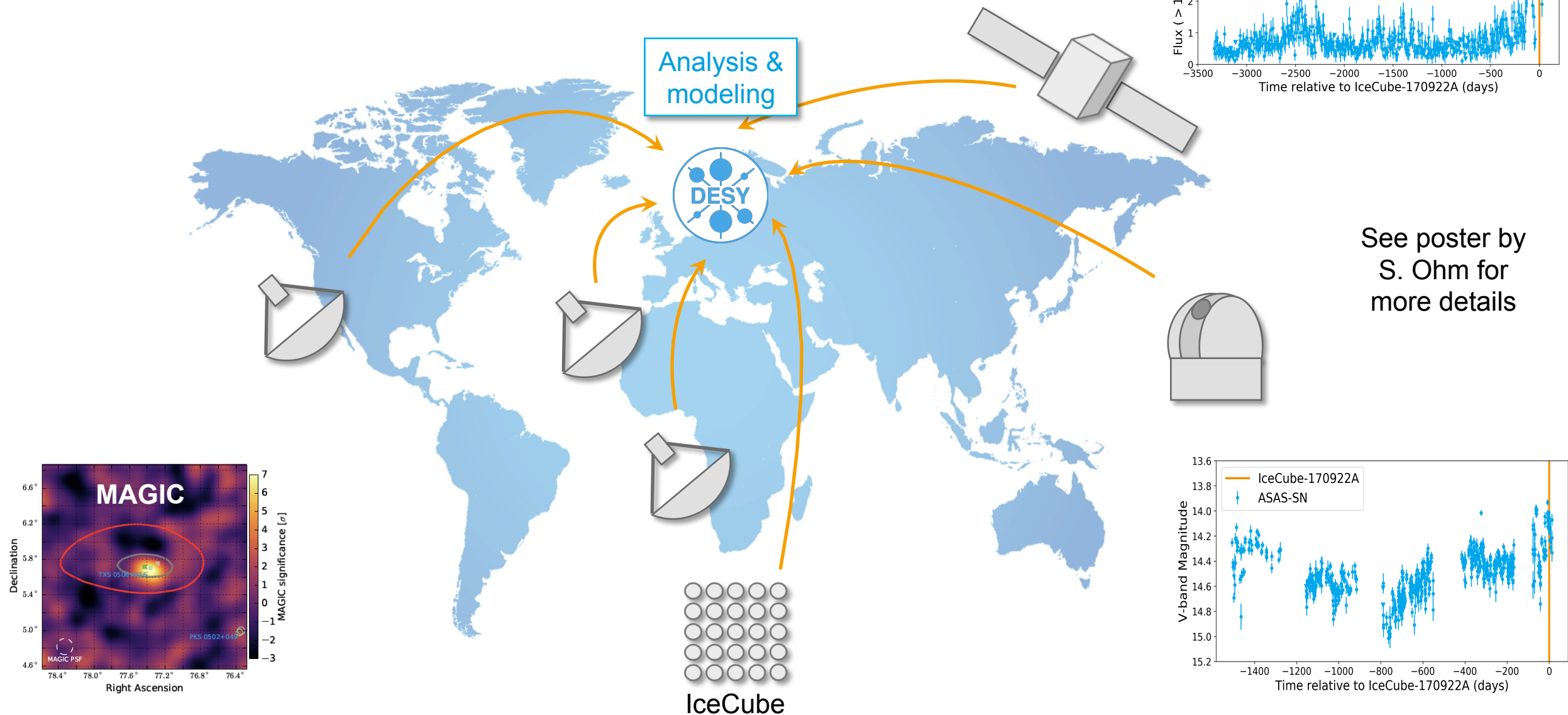


Implemented real-time system
and coordinates follow-up
(optical, FERMI, MAGIC, HESS)



Neutrino Achievements during POF III – Real-time

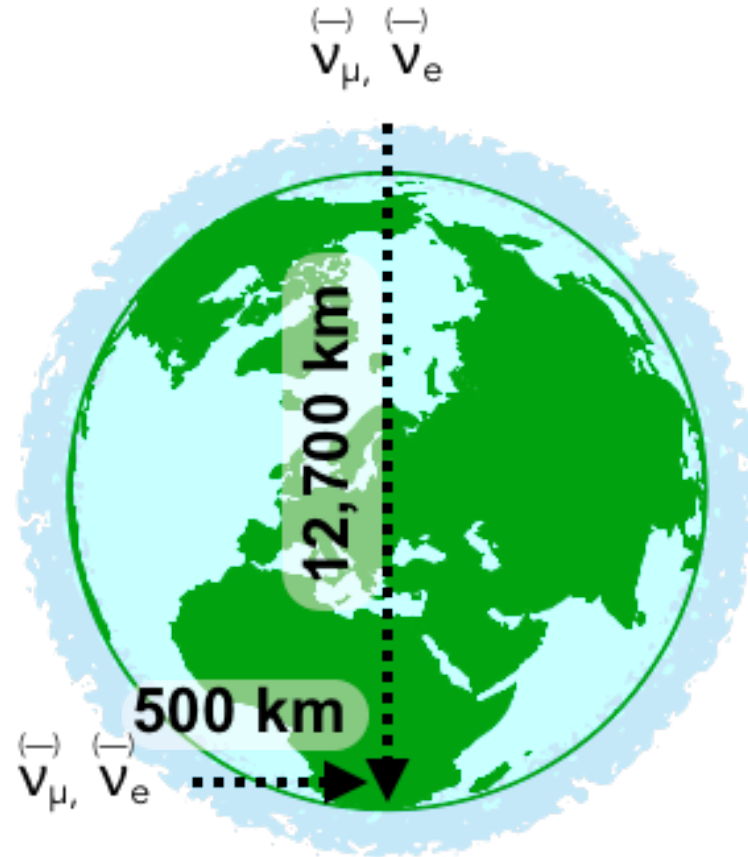
Real-time IceCube Alert #10: IceCube-170922A



See poster by
S. Ohm for
more details

Neutrino Achievements during POF III – Neutrino Physics

Neutrino oscillations using atmospheric neutrinos

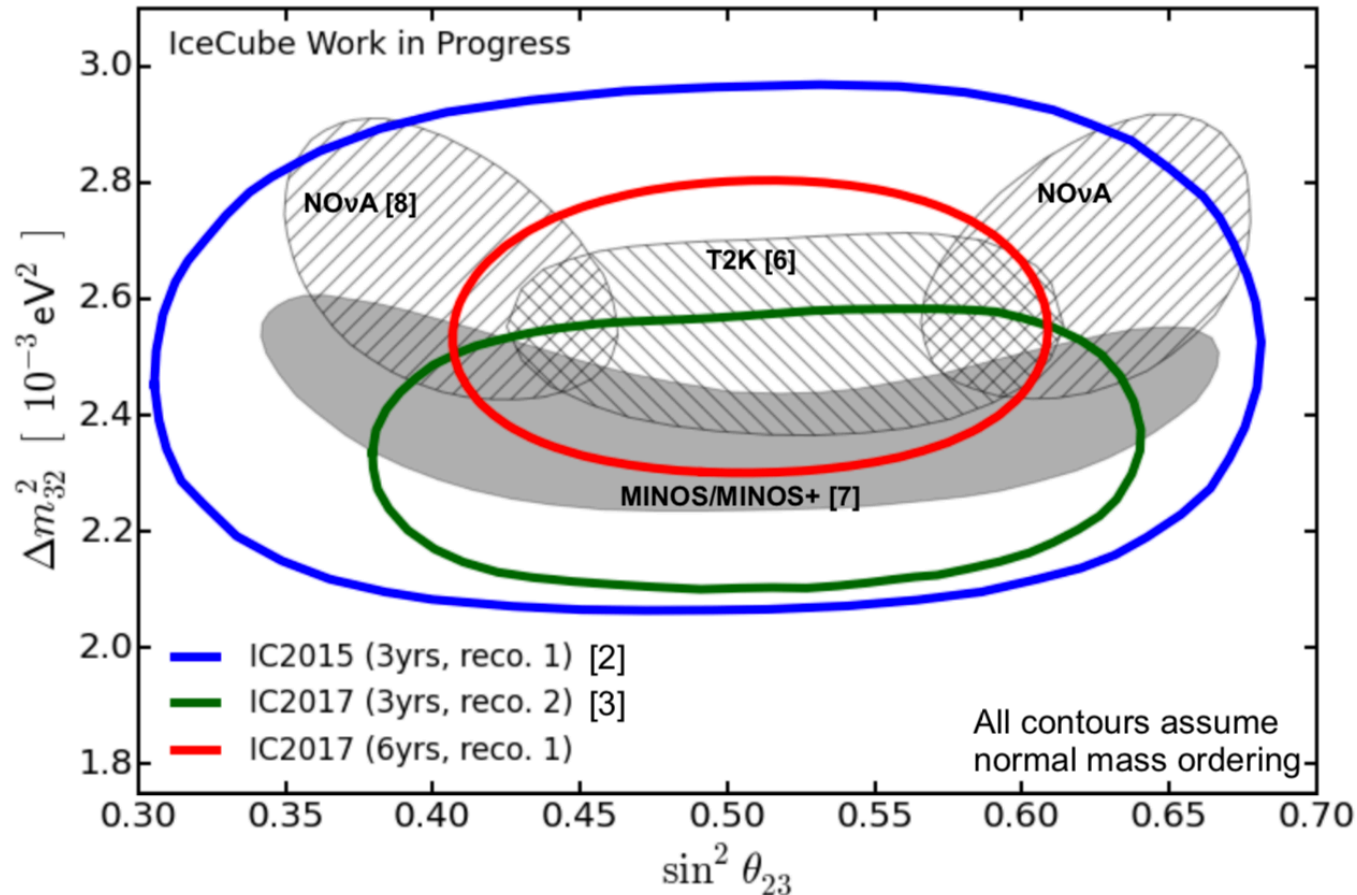


10^5 atmospheric neutrino events per year, probing multiple baselines and energies

Neutrino Achievements during POF III – Neutrino Physics

See poster by
S. Blot for
more details

Measurement of neutrino mixing parameters



Measurements competitive with dedicated
neutrino beam experiments

Pioneered technique, first
analysis J.P. Yáñez PhD'14

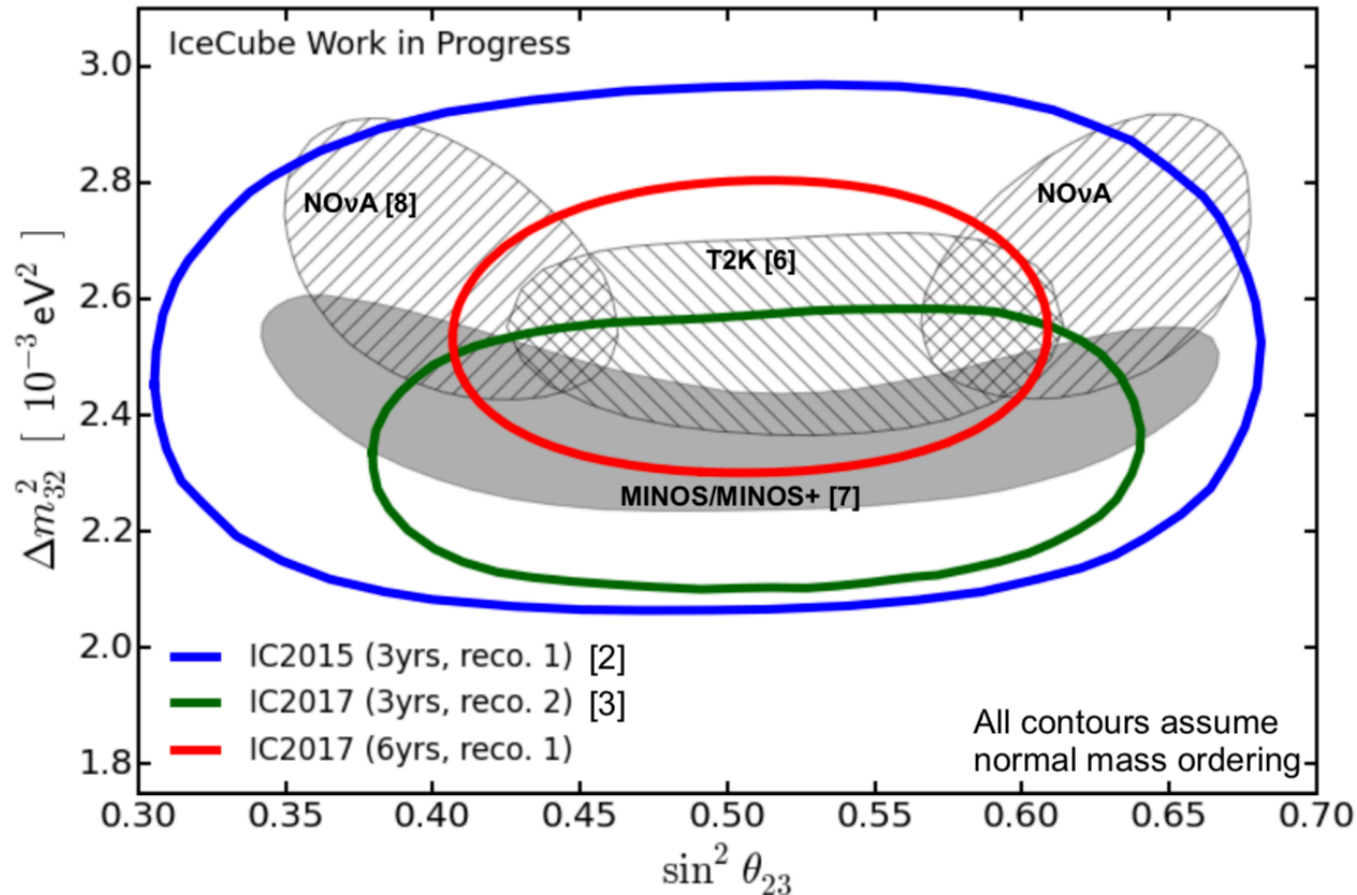


Continuously improving
analyses and systematics
postdoc S. Blot

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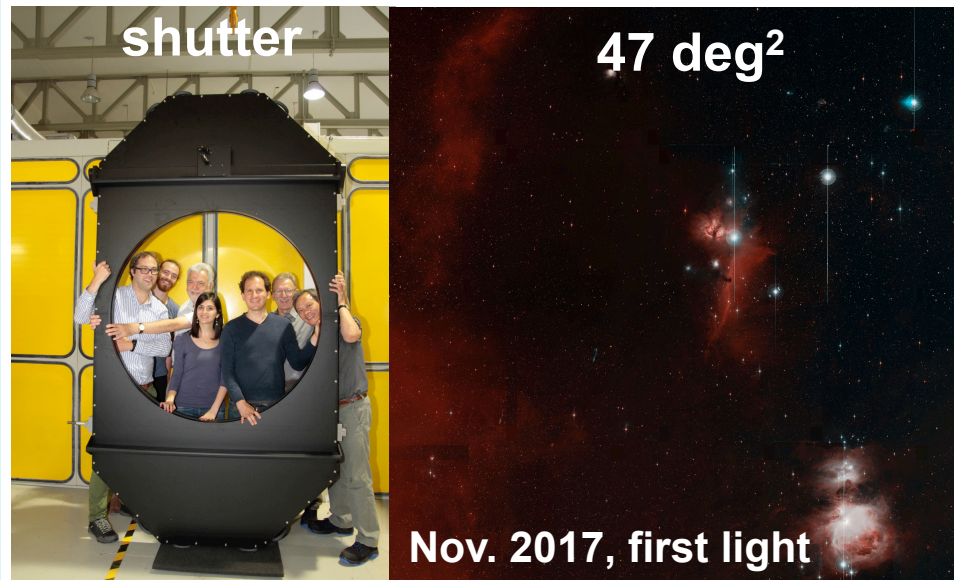


Continuously improving
analyses and systematics
postdoc S. Blot

Search for sterile neutrinos at
low energies A. Terliuk PhD'18

Outlook

Zwicky Transient Facility



- New optical survey instrument
- Search for neutrino counterparts
- Synergies with gamma-rays
- Precursor to LSST

2018

2019

2020

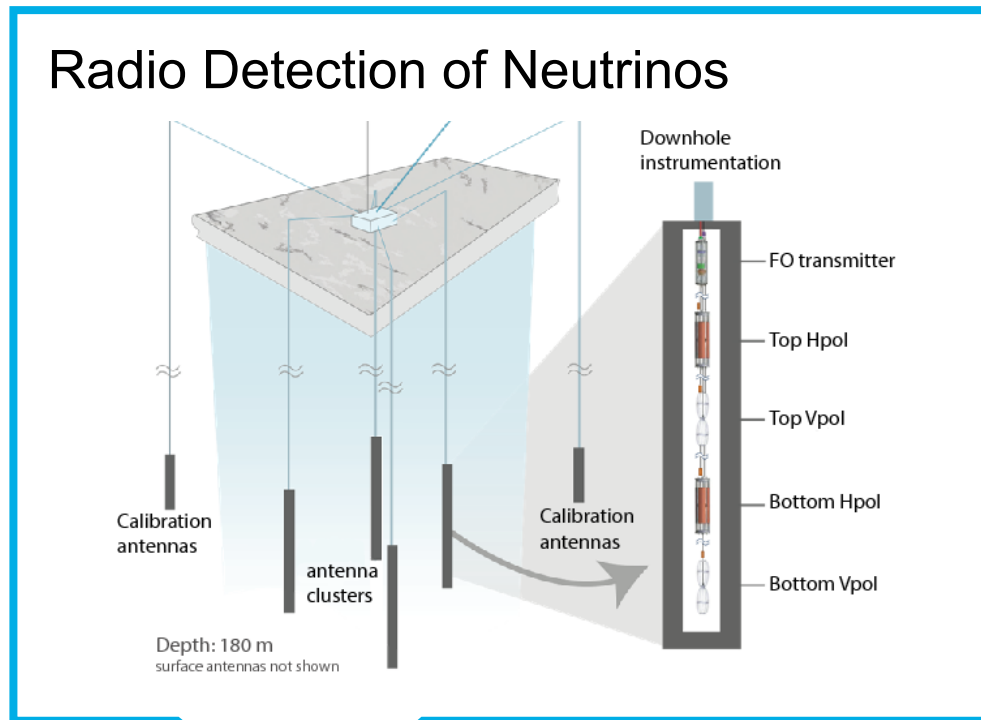
2022

2023

2024

2025

Outlook



- New technology for 10^{18} eV neutrino detection at South Pole or Greenland
- A new group to be lead by Dr. Anna Nelles (W2 HGF recruitment initiative)

2018

2019

2020

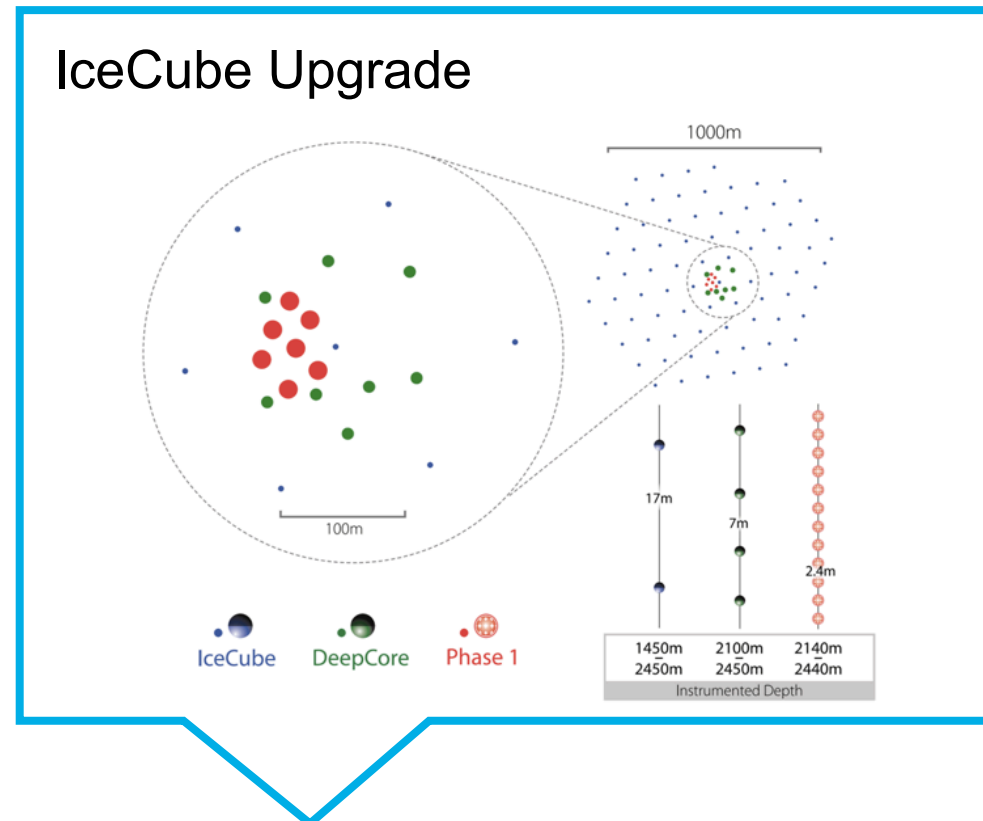
2022

2023

2024

2025

Outlook



- 7 new dense strings
- New sensor technology (developed at DESY)
- New physics at low energies
- Calibration devices

2018

2019

2020

2022

2023

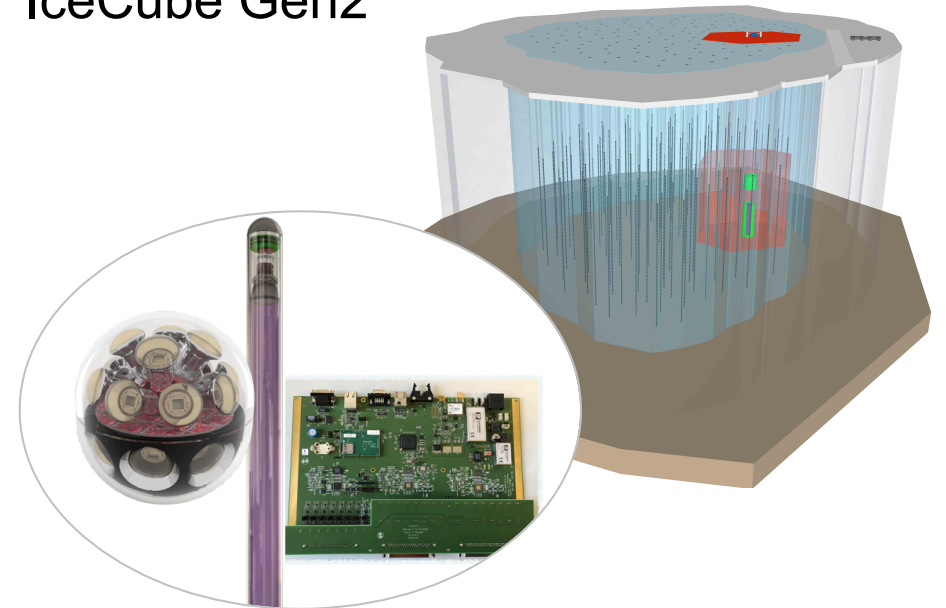
2024

2025

Outlook

- Design study coordinated by DESY
- 8-10 larger volume through larger spacing

IceCube Gen2



2018

2019

2020

2022

2023

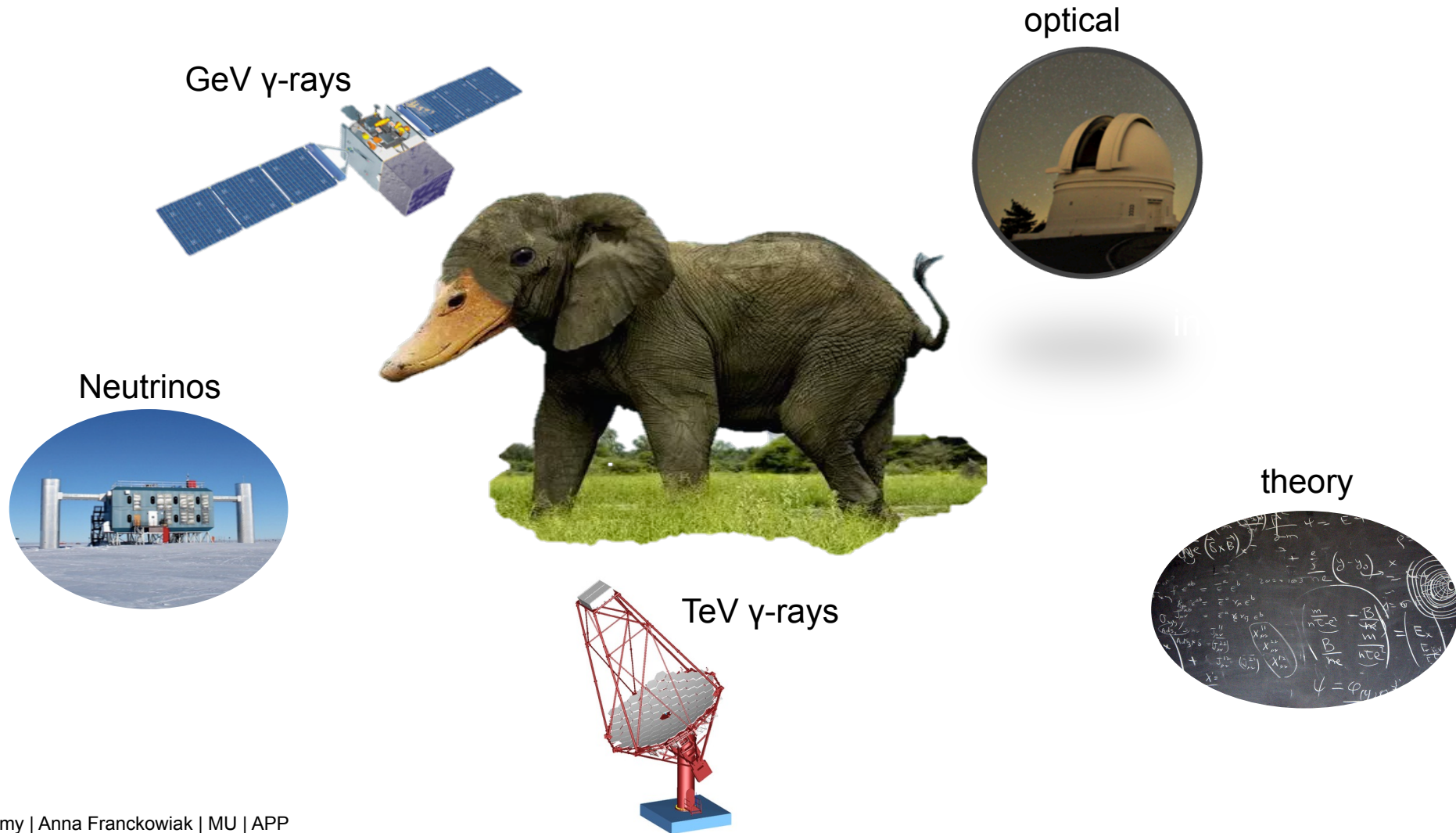
2024

2025

Conclusion

- Neutrinos are important new messengers from the high-energy Universe and are essential to the multi-messenger picture
- DESY played leading role in several IceCube breakthroughs
- DESY provides an excellent environment for multi-messenger studies
- New analysis strategies and new instrumentation driven by DESY aim at continuous progress in the field of neutrino astronomy

At DESY we have the infrastructure and expertise necessary to unveil the elephant!



Back-Up

IceCube-Gen2

Exploiting the science opportunities from IceCube's discovery

Science goals:

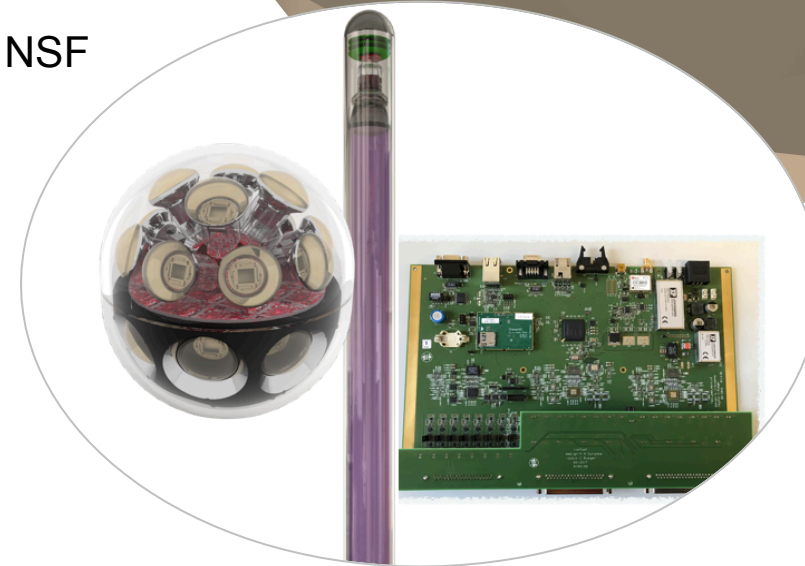
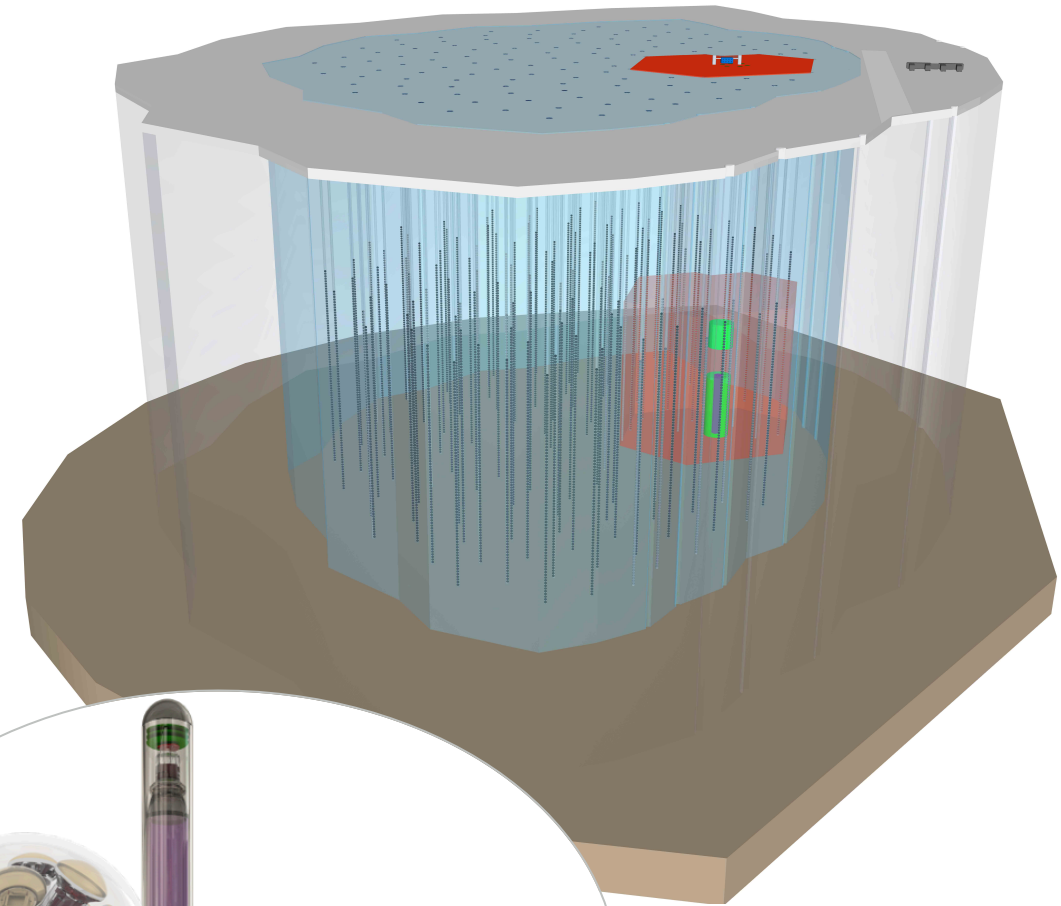
- Explore the PeV-Universe through neutrinos
- Cosmic accelerators

Detector concept & status

- 8-10 larger volume through larger spacing
- Improved sensor design, e.g. multi-pixel sensors
- A radio and surface array (developed with KIT)
- IceCube upgrade / Gen2-Phase 1 proposal in review @ NSF
- Construction ~2022-2030

DESY perspective

- Lead of German groups (DESY+KIT+8 Universities)
- Technology driver
- Design study coordinated by DESY



Pushing the neutrino energy frontier through radio

Strategic expansion of the DESY portfolio

The 2017 strategy process identified the **EHE neutrino energy range** with the radio technique as unique opportunity:

- Exiting science prospects while still underdeveloped
- Complementing existing IceCube and Gen2 focus

A new group to be lead by Dr. Anna Nelles:

- successful in **W2/W3** HGF recruitment initiative; initial funded through Emmy Noether-program of DFG
- First goal: develop a concept for a next generation of radio neutrino detector
- South Pole remains prime deployment candidate site, but Greenland, as well as other options will be evaluated as NSF-independent sites for a new neutrino observatory

