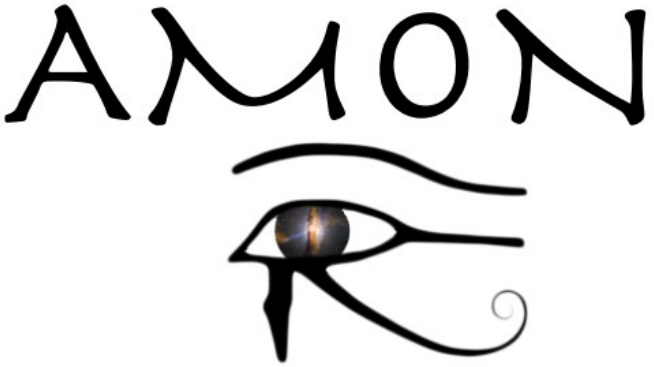
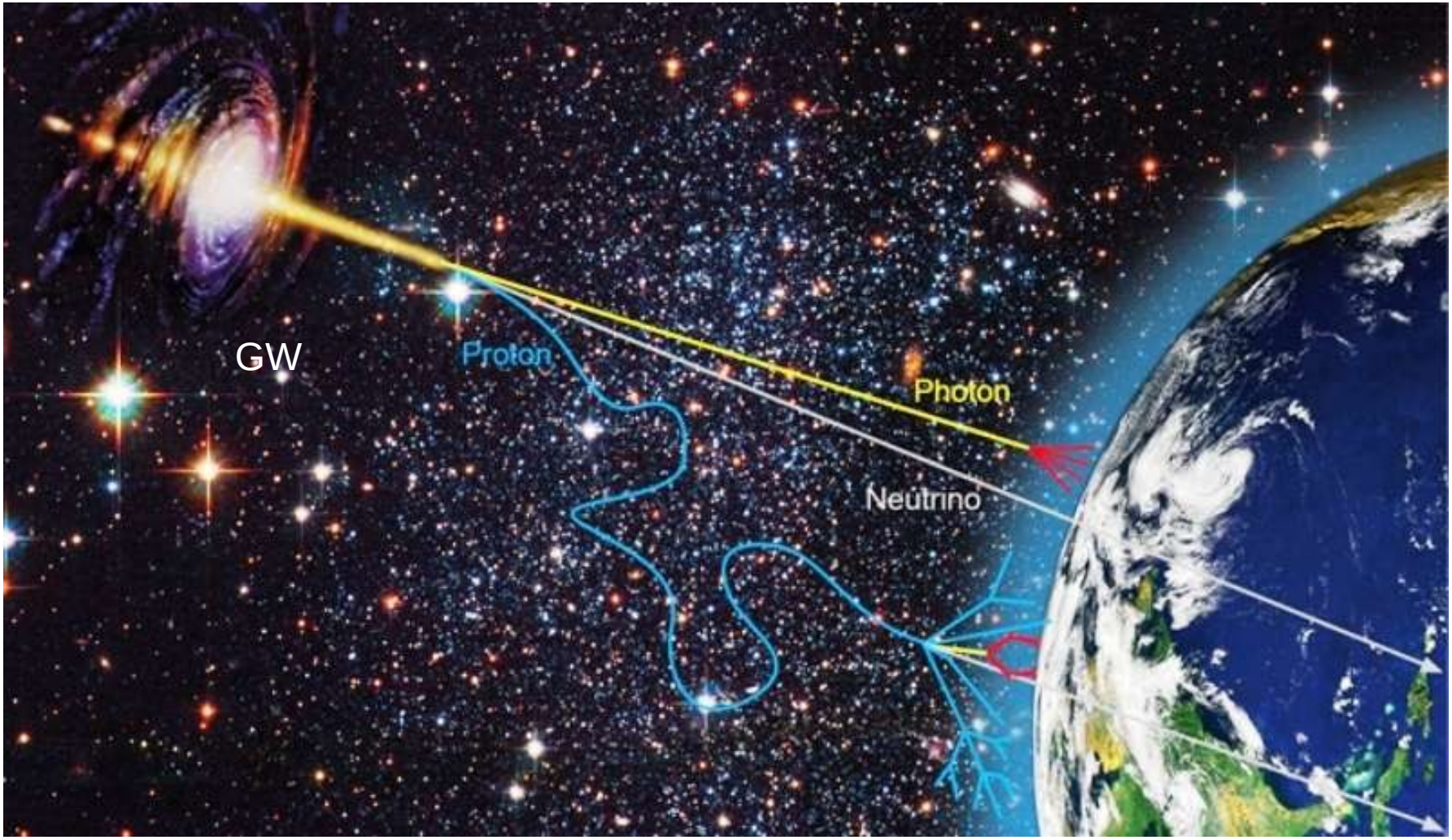
The Astrophysical Multimessenger Observatory Network



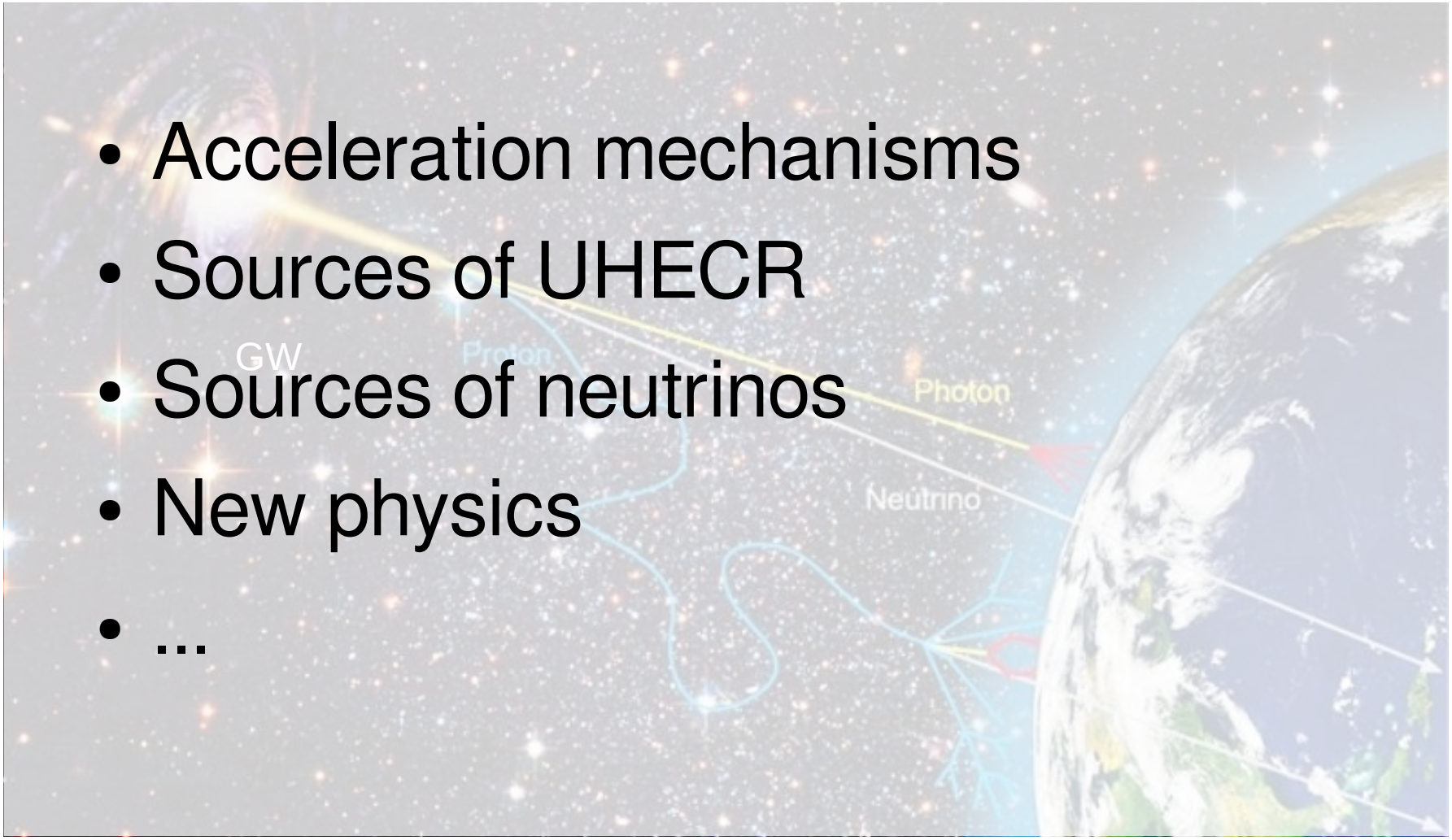
Timothée Grégoire
Penn State University

Town Hall KM3NeT Meeting
19 December 2019

New era of Multimessenger Astrophysics

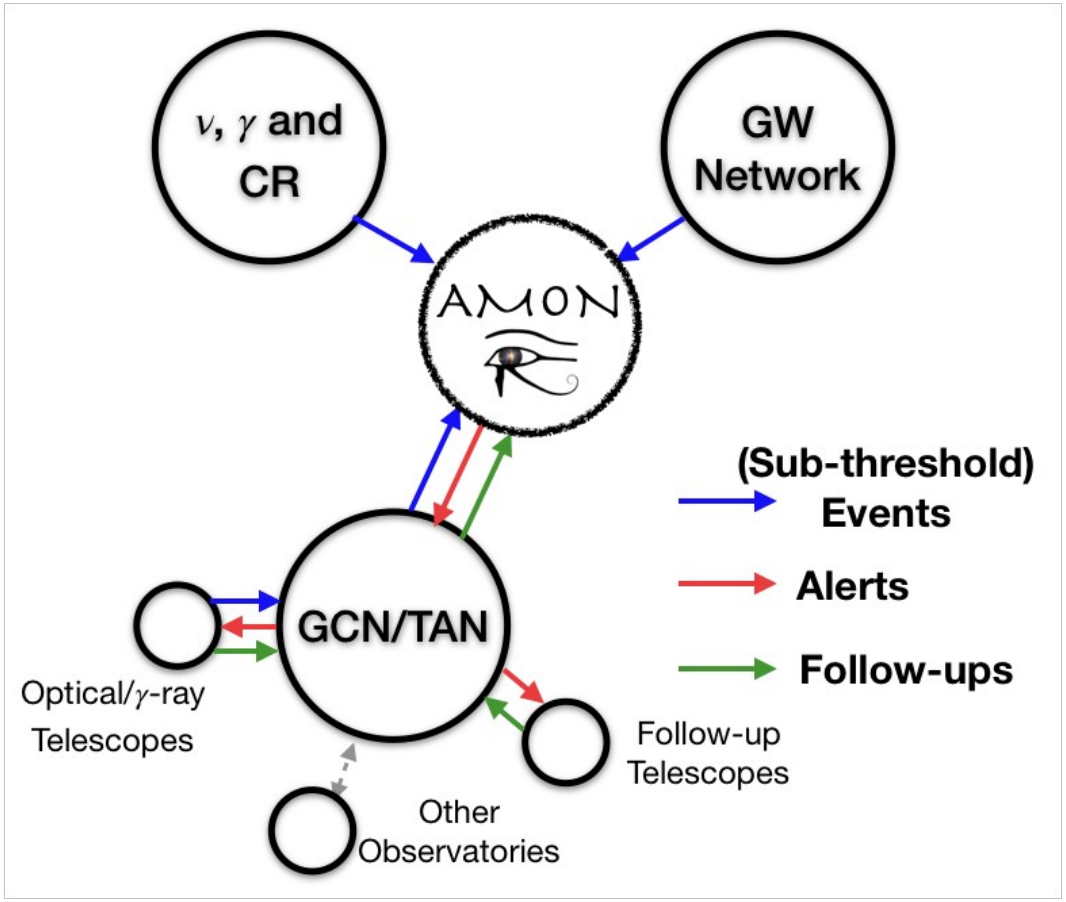


New era of Multimessenger Astrophysics



- Acceleration mechanisms
- Sources of UHECR
- Sources of neutrinos
- New physics
- ...

AMON



- **Sub-threshold data**
- **Realtime coincidences**
- Pass-through
- Send alerts
- Trigger follow-ups

- Archival searches

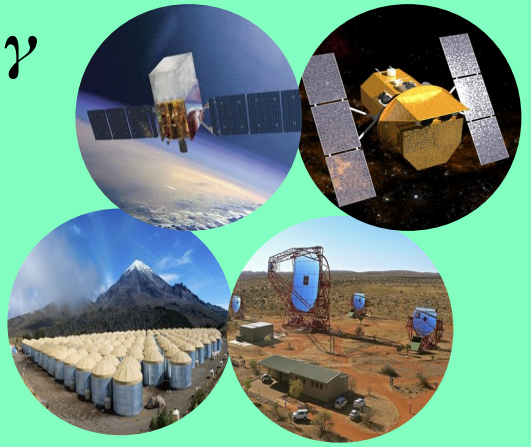
Ayala Solares et al. 2019, Astropart. Phys. 114, 68

AMON Members

CR

Pierre Auger

γ



SWIFT
VERITAS
HESS
MAGIC

FACT
Fermi
HAWC

ν

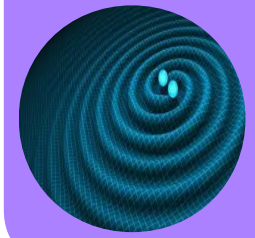
ANTARES
IceCube

AMON

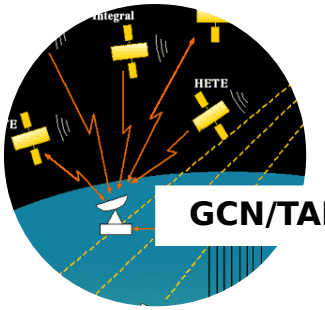
γ

LMT
GROWTH/ZTF
MASTER

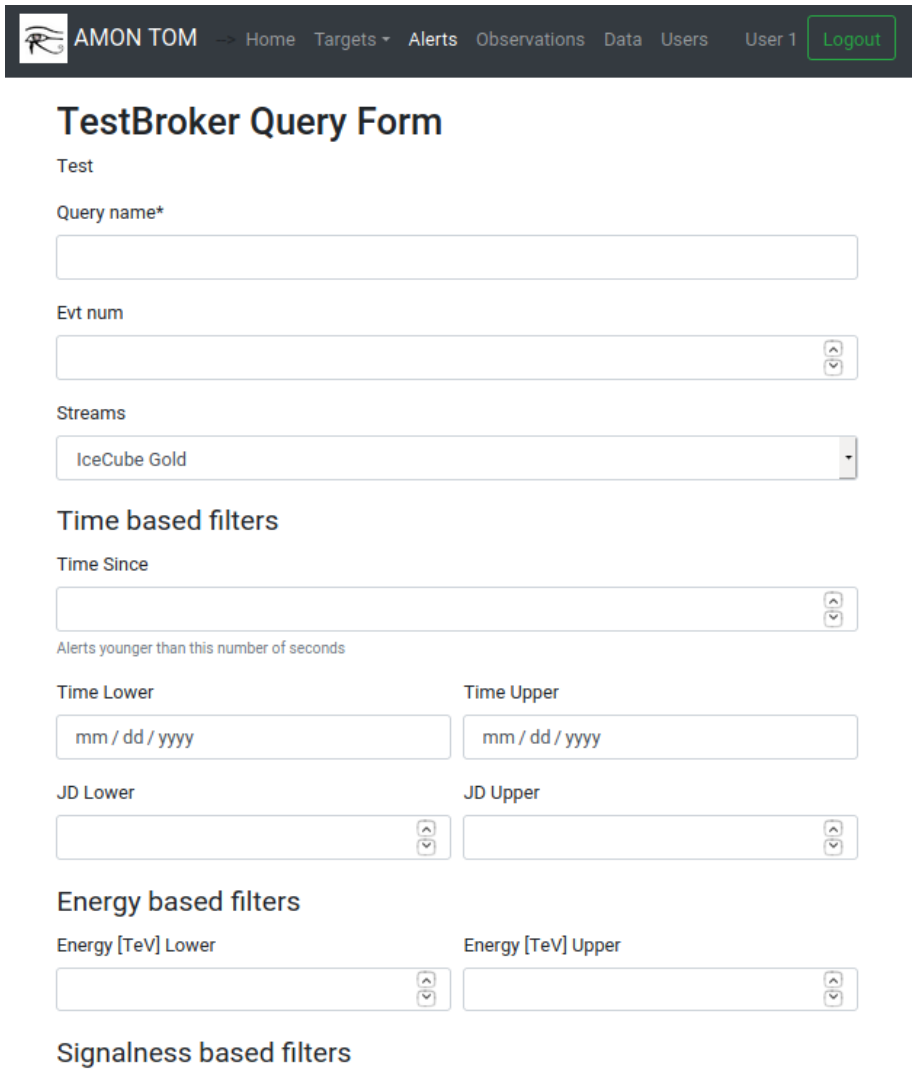
GW



LIGO-
Virgo



AMON TOM
Target of Opportunity Management

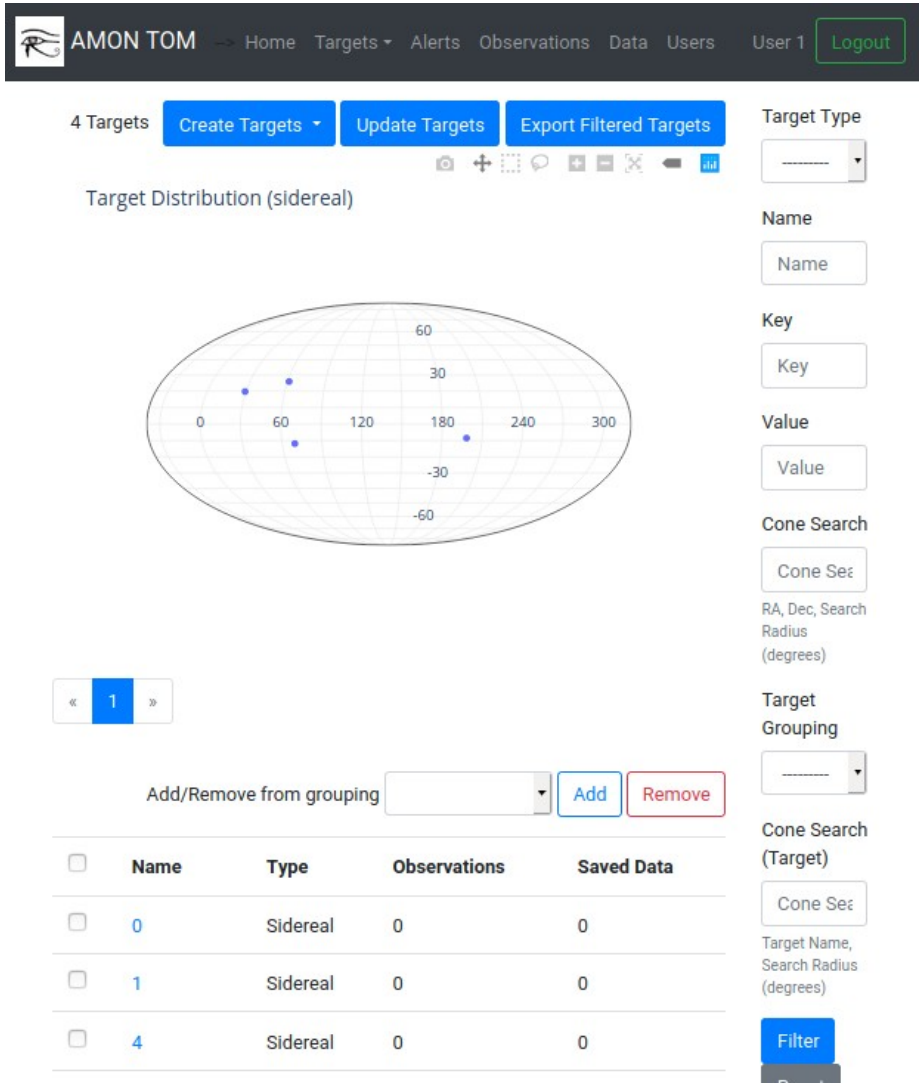


- TOM toolkit

- Query AMON alerts database
- Query catalogs
- Display events
- Query observations? ZTF...?

ON TRACK

AMON TOM
Target of Opportunity Management



- TOM toolkit

- Query AMON alerts database
- Query catalogs
- Display events
- Query observations? ZTF...?

ON TRACK

Pass-through Streams

- IceCube Gold and Bronze
  - Track-like events :
    - **Median ~0.2°**
  - Gold : ~10 evts/yr, 50 % cosmic
  - Bronze : ~18 evts/yr, 30 % cosmic
- HAWC Burst
  - ≤ 4 events per year

- IceCube Cascades
  - ~8 evts/yr
  - **85 % astrophysical!**
  - Full sky
  - ~7° median (neural net)
  - **Next February-March**
  - ANTARES/KM3NeT follow-up?

UPCOMING

Analyses

- ANTARES + Fermi-LAT
  - LAT FoV : 20 % of sky
  - ν+γ within 1000s
  - **Trigger AMON partners**

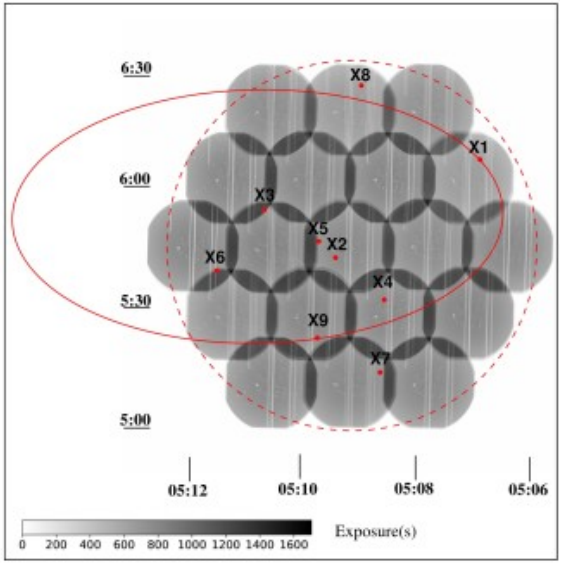
Solares et al. 2019, ApJ, 886, 98

- IceCube + Swift-XRT
  - IceCube Gold/Bronze to trigger *Swift*-XRT
  - Tile ν error region
  - Coincident transient source
  - First ν counterpart : **TXS 0506+056 !**

- IceCube + Fermi-LAT

Turley et al. 2018, ApJ, 863, 64

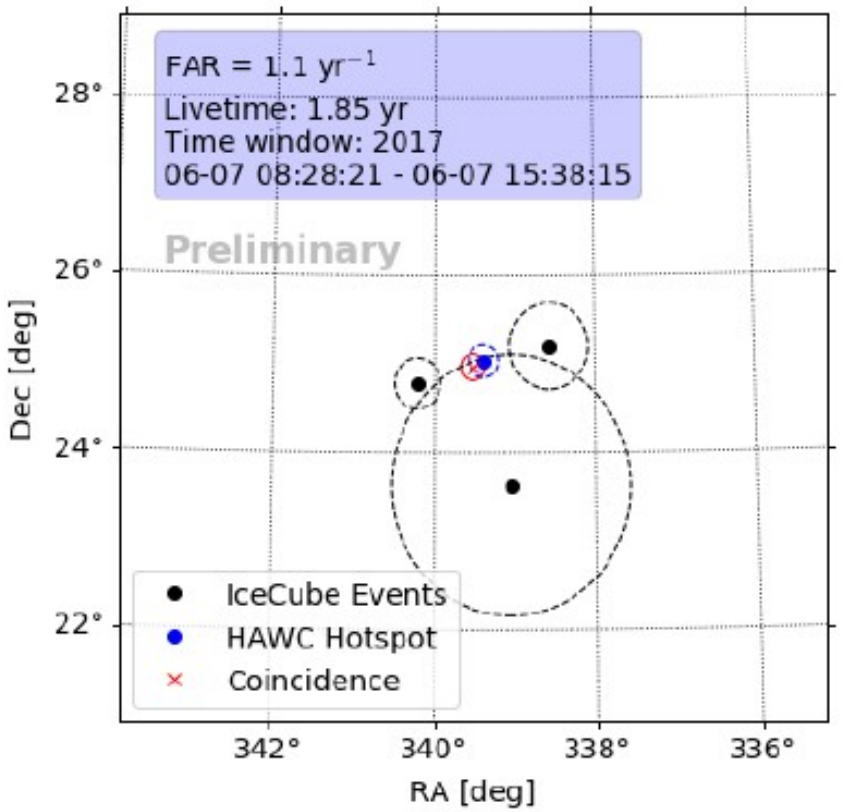
ON TRACK



Analyses

- IceCube + HAWC
  - Within transit time of HAWC “hotspot”
  - Public (Circulars, Notices soon)

PoS(ICRC2019)841



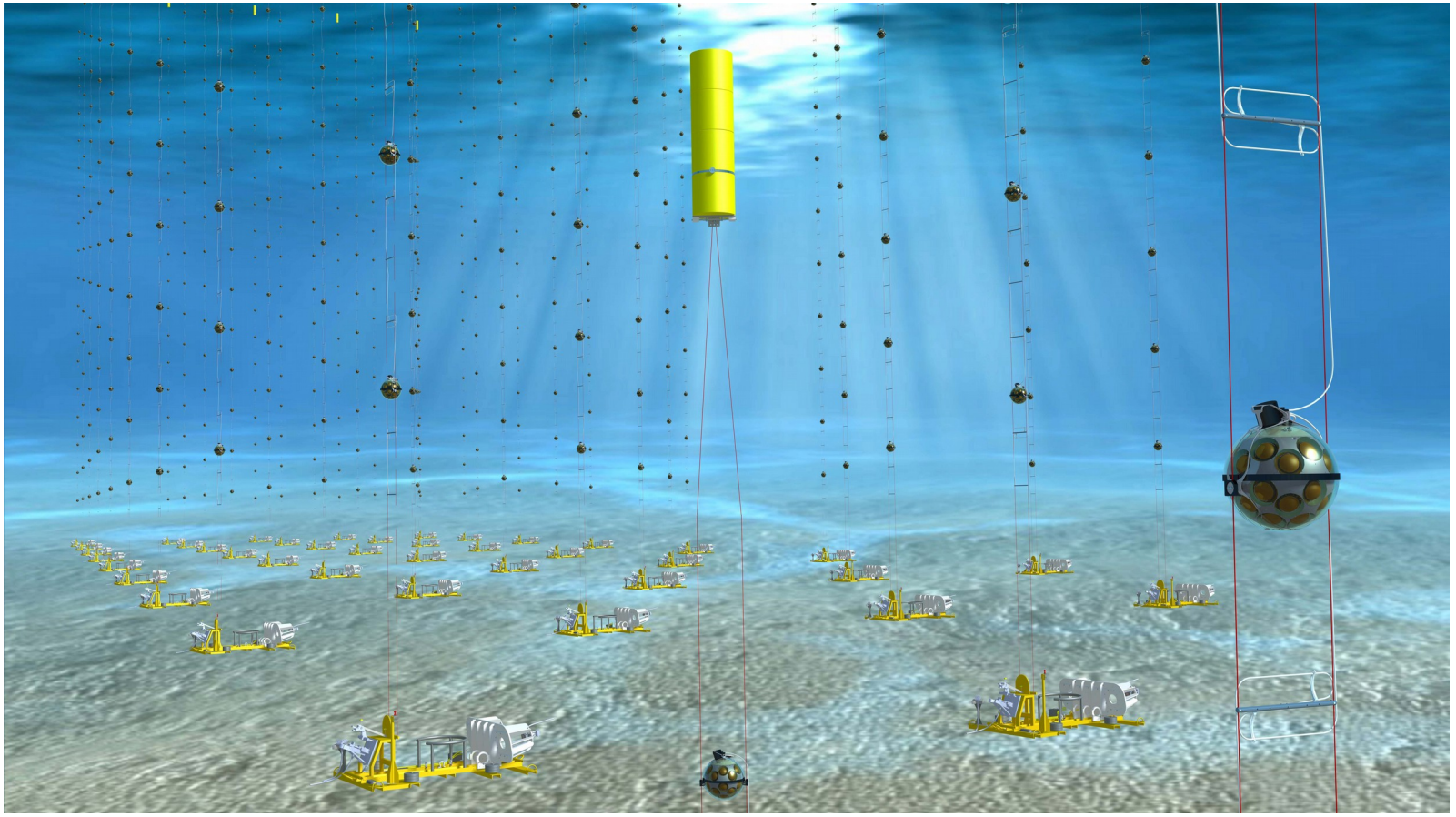
- GW + Swift-BAT
  - BAT FoV : 15 % of sky

ON TRACK

- IceCube Cascades + Swift-BAT
  - IceCube casc : 85 % cosmic
  - BAT FoV : 15 % of sky

AT SOME POINT IN THE FUTURE

What if KM3NeT joins AMON?



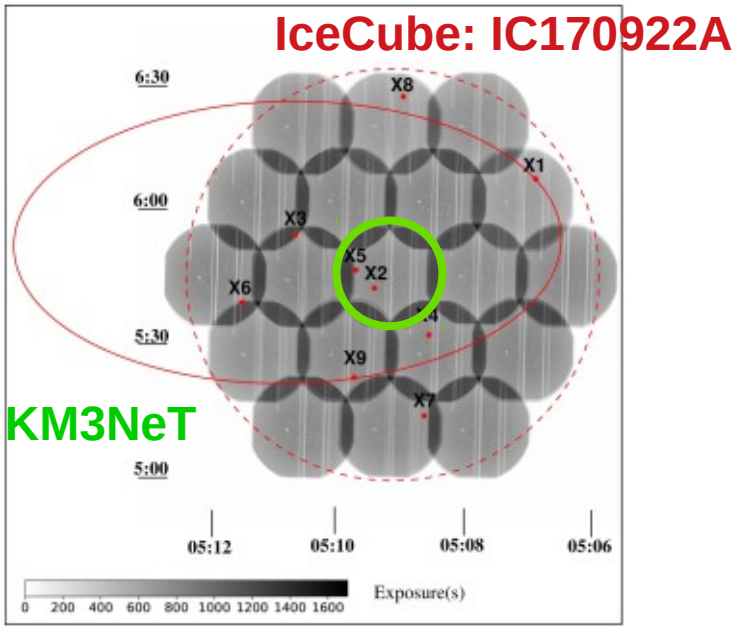
What if KM3NeT joins AMON?

- Easy to adapt running analyses to KM3NeT
  - KM3NeT + Fermi-LAT
  - KM3NeT + HAWC
  - KM3NeT Cascades + Swift-BAT
  - KM3NeT + Swift-XRT
- Private or public
- Pass-through streams
  - KM3NeT Tracks (no resolution selection)
  - KM3NeT Cascades
- New analyses? KM3NeT + IceCube (cascades)?

What if KM3NeT joins AMON?

Walter Winter: X-ray monitoring of neutrinos is high in the priority list

- KM3NeT + Swift-XRT
  - **1 tile → ~85% coverage**
  - Faster observation
    - Better Afterglow detection
  - More follow-ups
    - Up to ~40/yr
  - Less random coincidences
    - More significant
  - **Potential for detection**
    - Trigger AMON partners
    - Public?



Join AMON

Memorandum of Understanding between observatories participating in the Astrophysical Multimessenger Observatory Network

AMON Executive Board

May 24, 2019

The Astrophysical Multimessenger Observatory Network (AMON) provides a framework for correlating high energy astrophysical signals across all possible astronomical messengers: photons, neutrinos, cosmic rays, and gravitational waves. The primary goals of the program are: (1) To allow participating observatories to share their data with one another with strict anonymity, confidentiality and in accordance with their blind analysis procedures, (2) To enhance the combined sensitivity of participating observatories to astrophysical transients by enabling them to search for coincidences in their sub-threshold archival data and then in their sub-threshold real-time data and (3) To enable follow-up imaging of possible astrophysical sources with minimal latency.

www.amon.psu.edu/join-amon

- Don’t publish on someone else’s private alert without their participation or permission
- Ultimately: Joint or separate (but coordinated) publication
- Damien: End of next year after commissioning

Backup slides

LoI track resolution