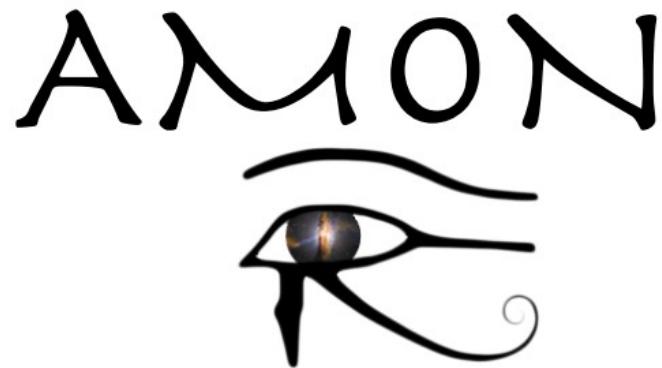


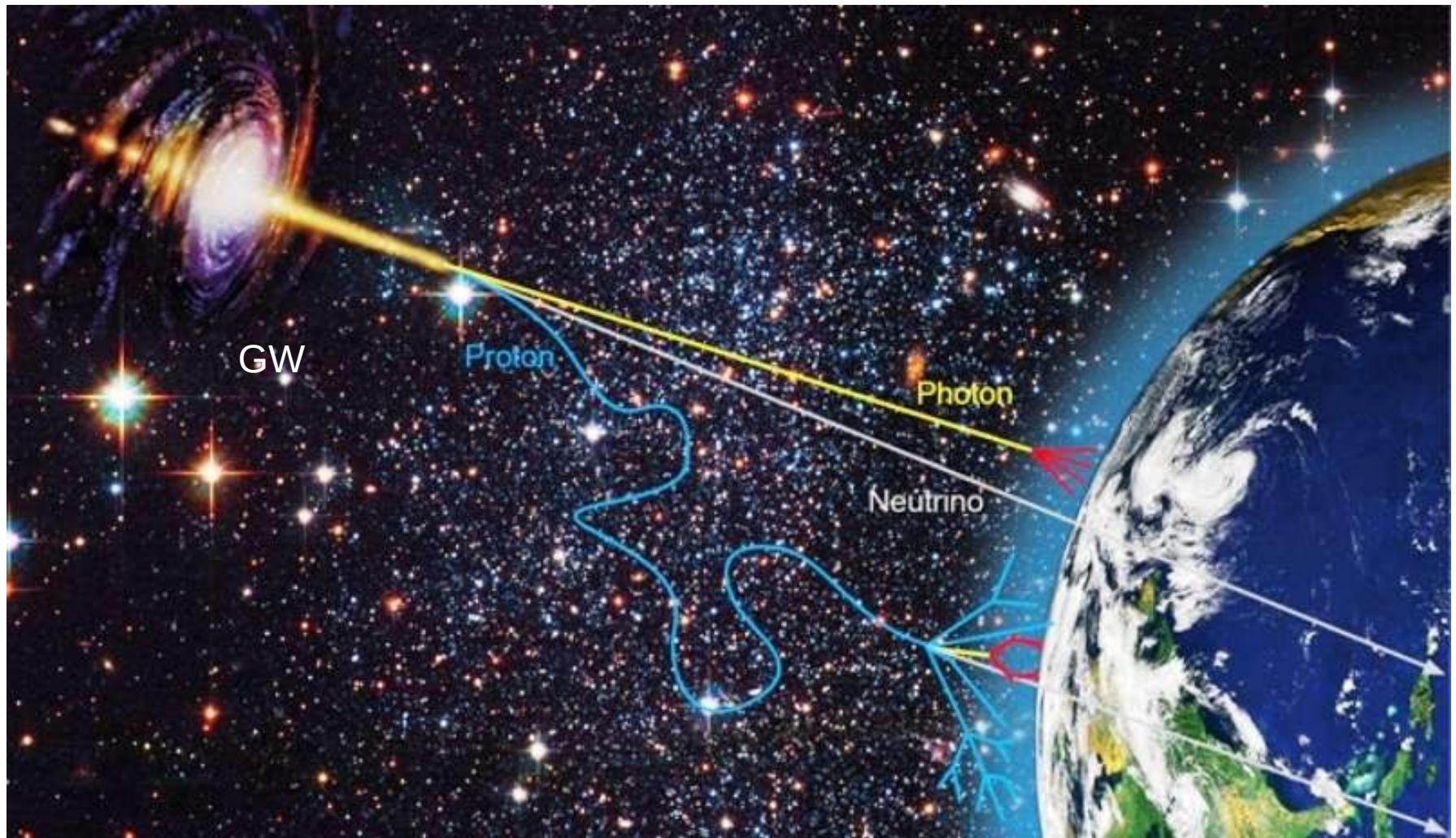
The Astrophysical Multimessenger Observatory Network



Timothée Grégoire
Penn State University

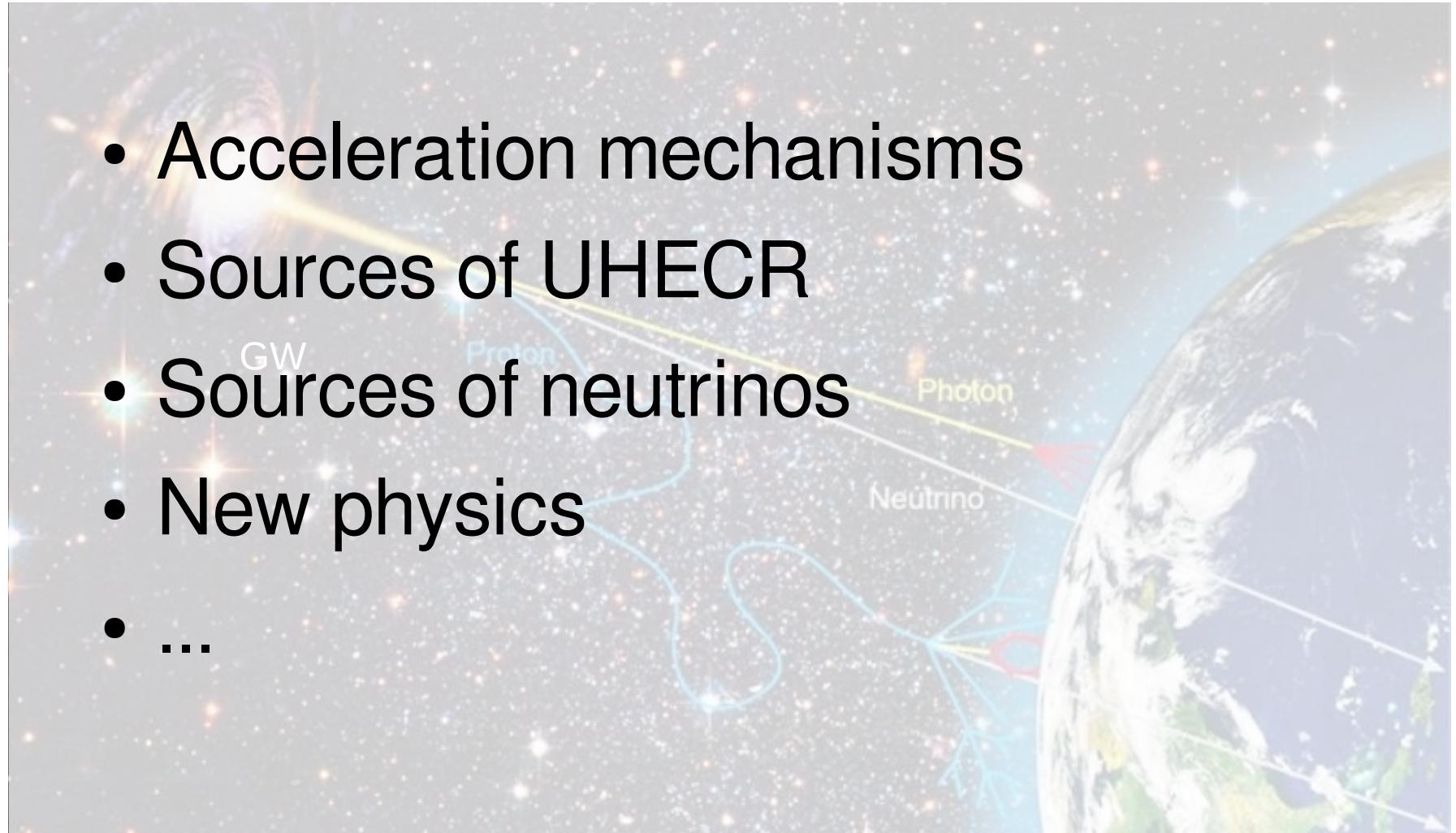
Town Hall KM3NeT Meeting
19 December 2019

New era of Multimessenger Astrophysics

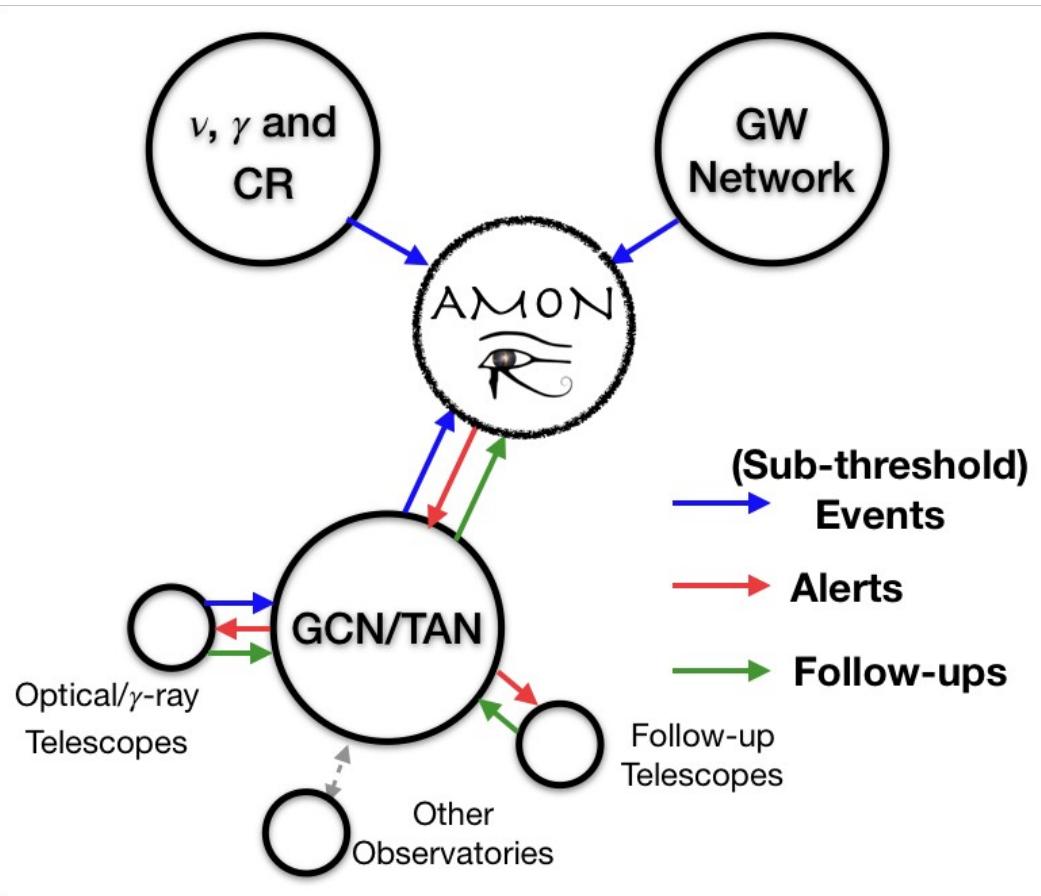


New era of Multimessenger Astrophysics

- 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

AMON Members

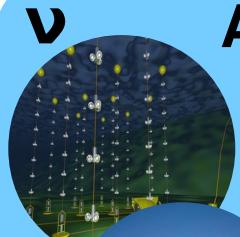


Pierre
Auger

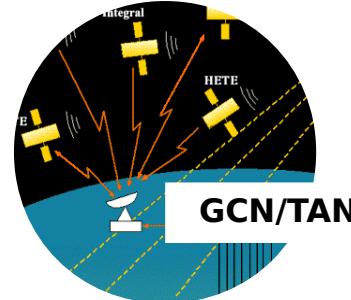


SWIFT
VERITAS
HESS
MAGIC

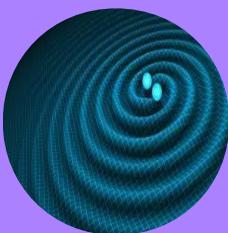
FACT
Fermi
HAWC



ν
ANTARES
IceCube



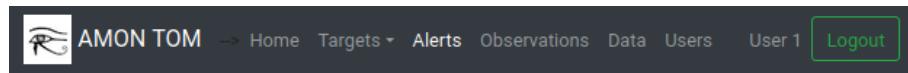
LMT
GROWTH/ZTF
MASTER



GW
LIGO-
Virgo

AMON TOM

Target of Opportunity Management



TestBroker Query Form

Test

Query name*

Evt num



Streams

IceCube Gold

Time based filters

Time Since



Alerts younger than this number of seconds

Time Lower

 mm / dd / yyyy

Time Upper

 mm / dd / yyyy

JD Lower

JD Upper



Energy based filters

Energy [TeV] Lower

Energy [TeV] Upper



Signalness based filters

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

ON TRACK

AMON TOM

Target of Opportunity Management

The screenshot shows the AMON TOM web application interface. At the top, there is a navigation bar with links for Home, Targets, Alerts, Observations, Data, Users, User 1, and Logout. Below the navigation bar, there are buttons for 'Create Targets', 'Update Targets', and 'Export Filtered Targets'. A 'Target Distribution (sidereal)' section contains a circular plot with a grid, showing several blue dots representing targets. To the right of the plot are input fields for 'Target Type' (dropdown), 'Name' (text input), 'Key' (text input), 'Value' (text input), and 'Cone Search (RA, Dec, Search Radius in degrees)'. Below the plot is a table with a single row, page navigation (« 1 »), and buttons for 'Add/Remove from grouping' (with dropdown and Add/Remove buttons), 'Target Grouping' (dropdown), 'Cone Search (Target)' (dropdown), and 'Filter' (button). The table has columns for Name, Type, Observations, and Saved Data. The data in the table is:

	Name	Type	Observations	Saved Data
<input type="checkbox"/>	0	Sidereal	0	0
<input type="checkbox"/>	1	Sidereal	0	0
<input type="checkbox"/>	4	Sidereal	0	0

- 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?

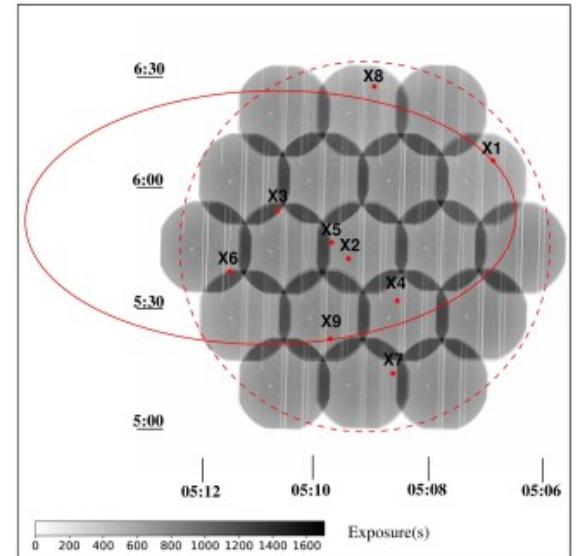
UPCOMING

Analyses

- ANTARES + Fermi-LAT
 - LAT FoV : 20 % of sky
 - $\nu+\gamma$ within 1000s
 - Trigger **AMON partners**
- 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

Solares et al. 2019, ApJ, 886, 98



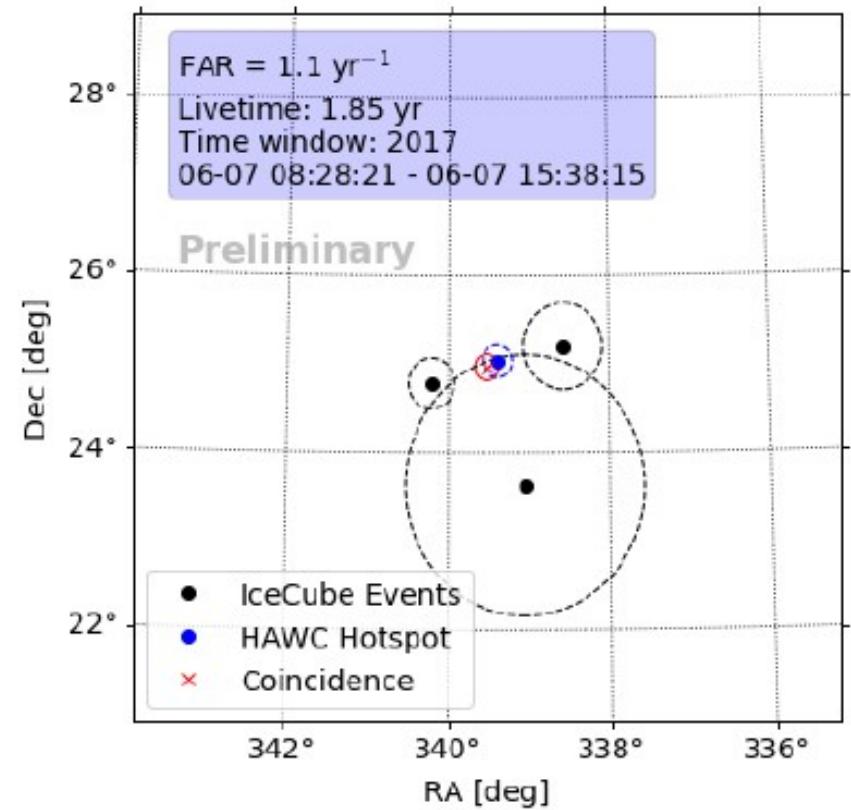
Analyses

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

PoS(ICRC2019)841

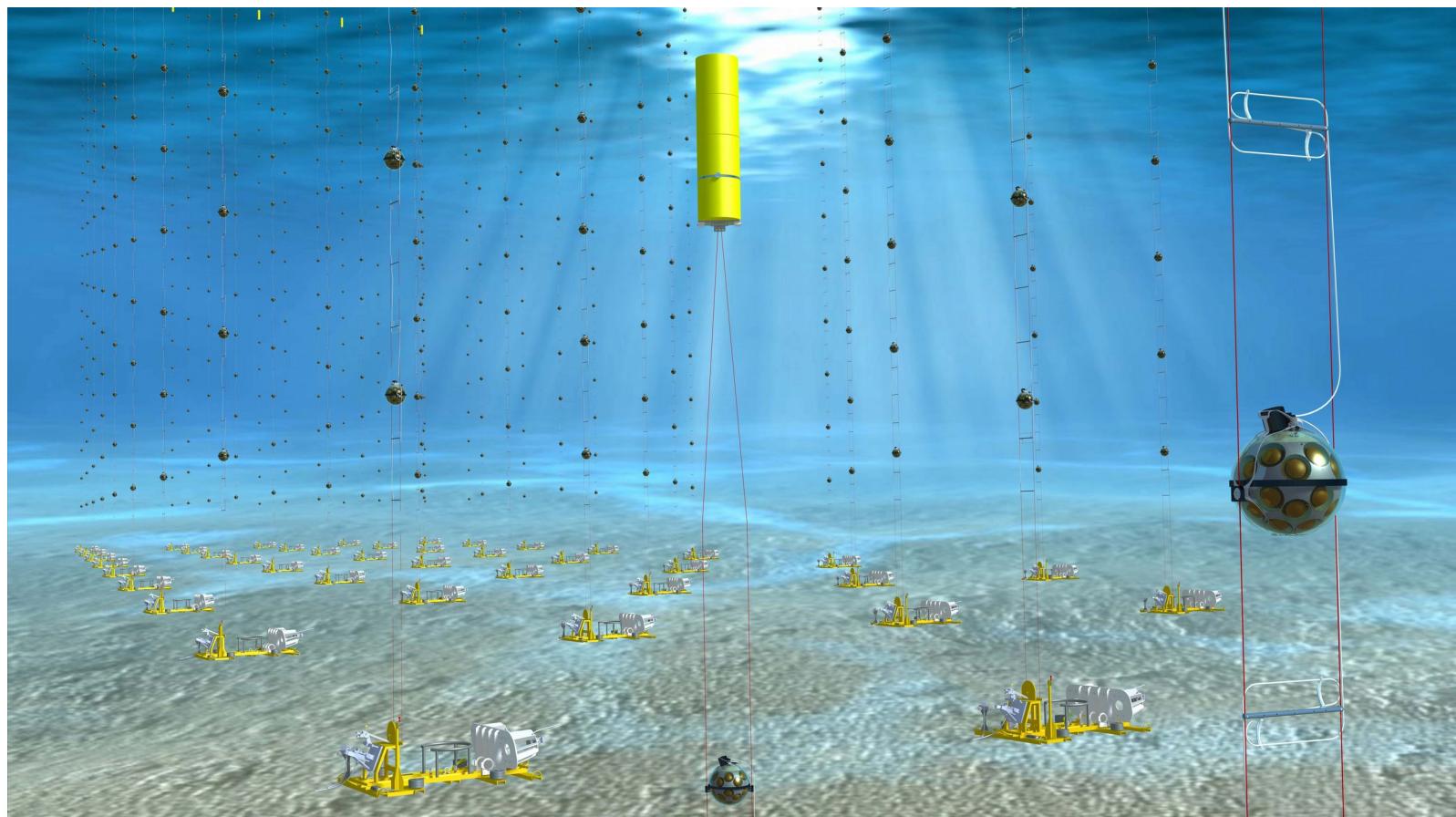
- GW + Swift-BAT ON TRACK
 - BAT FoV : 15 % of sky

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



AT SOME POINT
IN THE FUTURE

What if KM3NeT joins AMON?



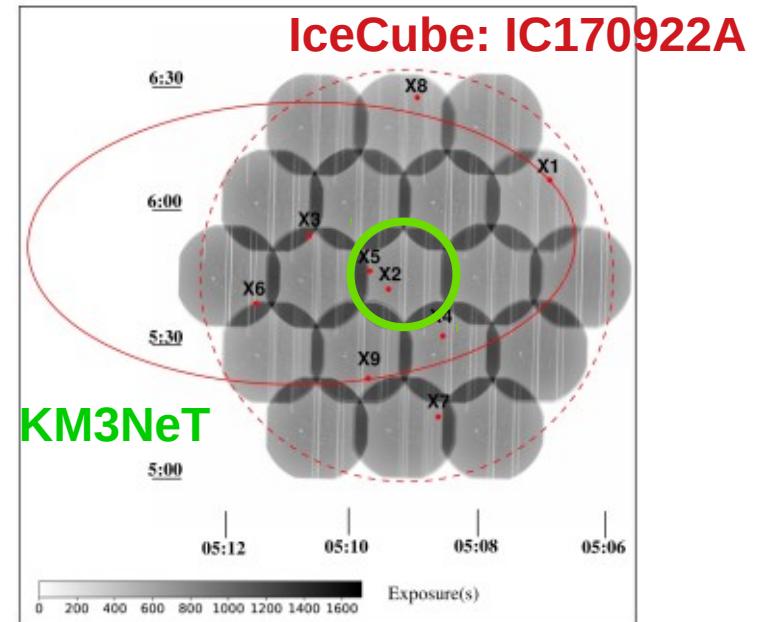
What if KM3NeT joins AMON?

- 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

Lol track resolution

