The Astrophysical Multimessenger Observatory Network

AMON – TRANSITION TO REALTIME OPERATIONS

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(for the AMON team)

IPA 2015
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- Founded and hosted at Penn State
- Internal initial funding
- Official NSF funded project as of 2014

AMON project

AMON development and advisory team

Penn State

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Others

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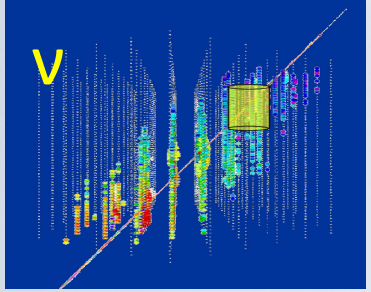
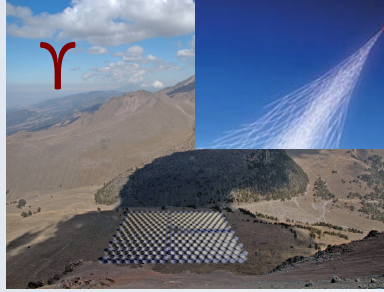
[4]NASA JPL
[5]Georgia Institute of Technology

The AMON Idea

The AMON Idea

Use messenger particles of all four fundamental forces





Triggering observatories

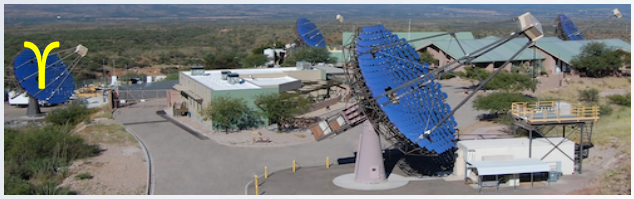
- Provide **sub-threshold** candidate events to AMON in real time

AMON

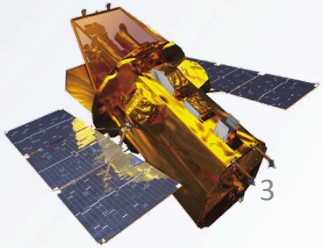
- Seeks **coincidences** in time and space
- Generates **alerts** - broadcast and archived
- Enables archival analyses

Follow-up observatories

- respond to AMON alerts



x, UV, optical



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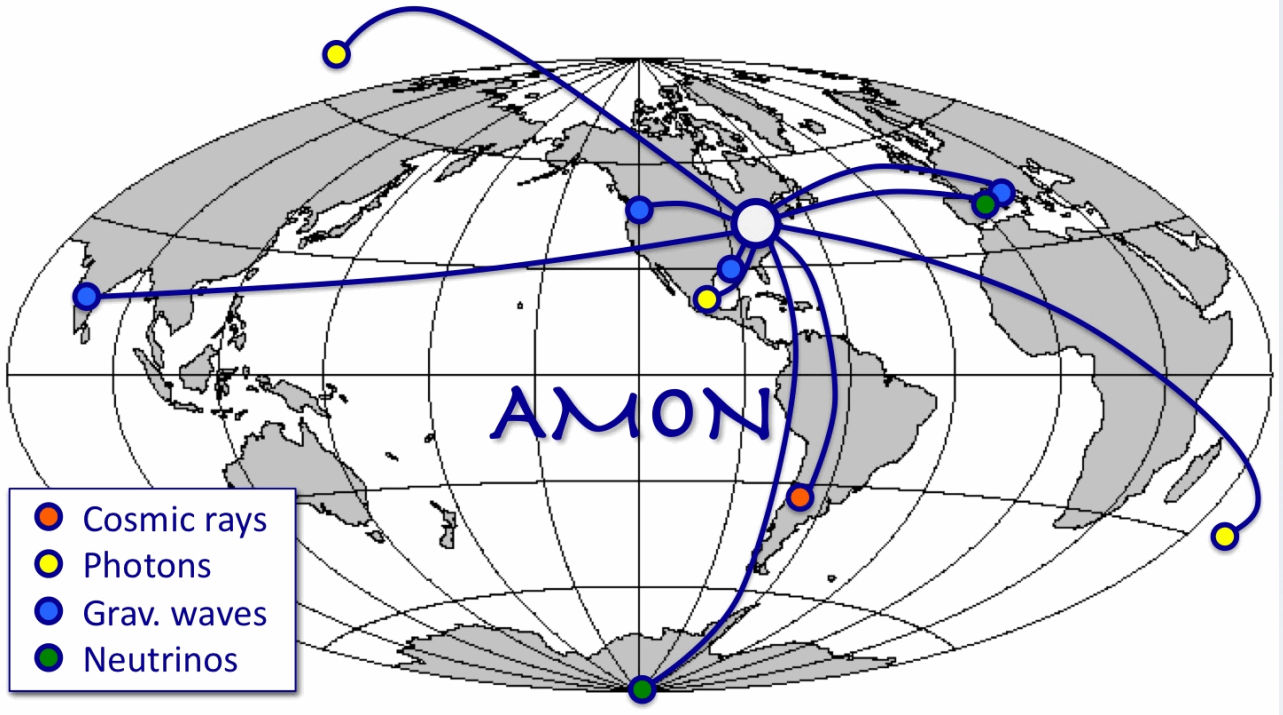
AMON Network

6 Memoranda of Understandings (MoUs) signed
+ 1 MoU in review, + 2 more letter of collaboration + many more in the future



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Triggering:

IceCube
ANTARES
Auger
HAWC
VERITAS
Swift BAT

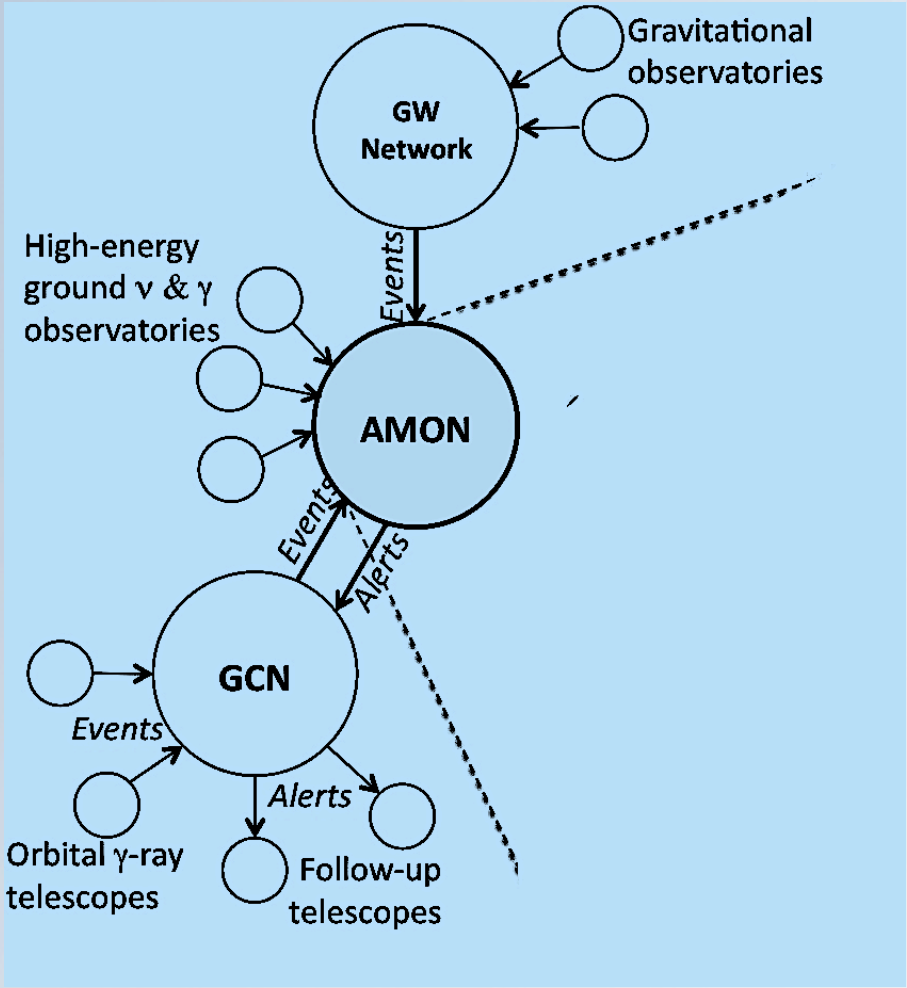
Follow-up:

Swift XRT &UVOT
VERITAS

Pending:

LIGO
MAGIC
FACT
H.E.S.S.
PTF
TA…

AMON system-data flow



AMON will utilize existing:

Gamma-ray Coordinates Network (GCN)
Gravitational Wave (GW) Network
Open to other networks (e.g. SNEWS)

NETWORK STATUS

Database

First full version of AMON database designed and implemented, now being used and tested:

- Data from triggering observatories inserted
  - -done: IC-40, IC-59, Swift, Fermi [public]
  - -done: ANTARES 2008 [private]
  - -in progress: IceCube, HAWC, VERITAS , ANTARES [private – pending permissions], Auger [private - approved] LIGO S5 [public]
- Real-time test with fake and real (IC scrambled) data performed

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Current status

Archival analysis using public data:

- IC40 and Fermi LAT (done, see talk by A. Keivani)
- IC40/59 and Swift BAT sub threshold (in progress)
- IC40/59 and Fermi LAT (in progress)
- Swift and LIGO S5 (in progress)

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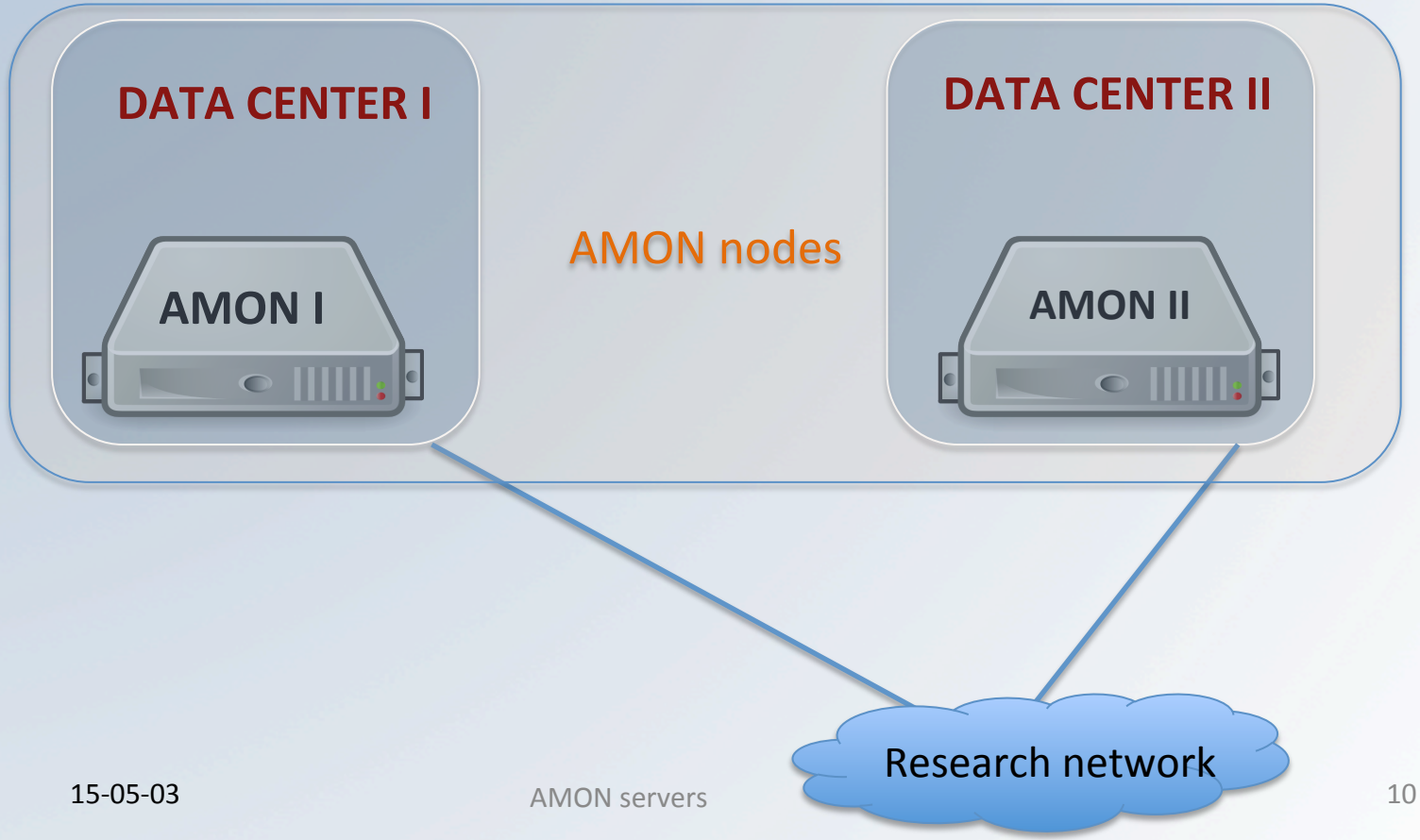
AMON application server

AMON application server is up and running since August 2014!

- built using Python/Twisted, asynchronous, tested with several simulated clients
- Accepts HTTP POST requests (Twisted client available, but accepts other clients)
- Open for authorized connections (TLS certificates)
- Start issuing alerts (VOEvents) in August 2015

AMON new hardware

- Deployment of the two new high-uptime servers [in progress]
  - systems are physically and cyber secure
  - hardware and power redundant
  - memory mirroring
- Operational by June 30, 2015



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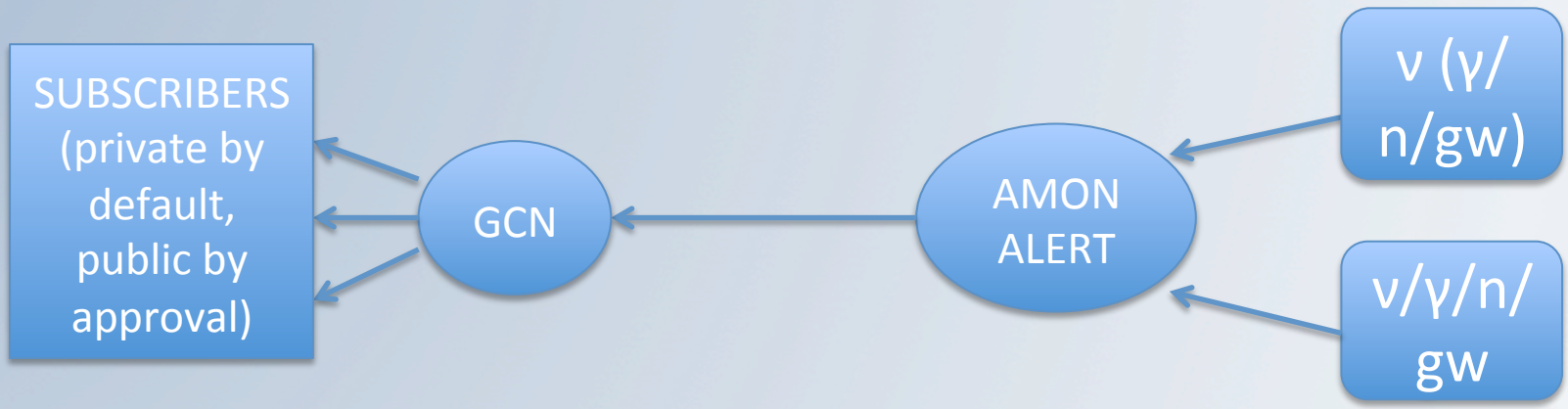
Real-time operations

Several efforts toward real-time analysis:

- IceCube ν_μ singlet stream – done
- IceCube high-energy starting events (HESE) – underway
- IC extremely high-energy (EHE) events – underway
- Auger events – underway
- Ongoing efforts with other member collaborations on getting their real-time subthreshold streams

Subthreshold streams – used in AMON coincidence analysis

Event and alert reporting - GCN



- GCN client directly connects to AMON by using vTCP protocol and gets AMON alerts
- Subscribers can choose to get original AMON VOEvent format or any other standard GCN formats (e.g. email)
- AMON receiver program is already built by GCN (S. Barthelmy)
- To get connection running within next few weeks

Steps needed to set up a real-time stream with AMON

Observatory links to AMON

Observatory	Stream content & format	TLS certificate	Test stream (fake data)	Test steam (real data scrambled)	Real data stream
IC Singlet	✔	✔	✔	✔	In progress
IC HESE	✔	✔	In progress		
IC EHE	✔	✔			
Auger	✔	✔	In progress		
HAWC	In progress				
VERITAS	In progress				
Swift	✔	Not needed	Not needed	Not needed	In progress
Fermi	✔	Not needed	Not needed	Not needed	In progress

Conclusions

- AMON has made a significant progress toward real-time and archival analysis
- AMON application server is online - open for authorized connections!
- New high-uptime dual hardware deployment underway
- Ongoing realtime stream with the scrambled neutrino singlet events from IceCube
- Expecting soon realtime new streams
- AMON will distribute alerts via GCN (private streams by default, public if approved– ready within few weeks)
- AMON will start issuing alerts in August 2015

EXTRA SLIDES

Event content

Event content common to each observatory :

stream number,
id number,
revision number
trigger time
position
positional error
number of events
time window
error on time
false positive rate density
p-value
type of the event
pointing
observatory location
type of the PSF

Event content specific to each observatory :

parameter name: *(energy, SNR, etc)*.
value of the parameter
units (*TeV etc.*)

Alert content

AMON Alert content:

stream number
id number
revision number
time
position of the best fit
positional error
number of events
time window
error on time
false positive rate density
experiments observing
experiments triggered
type of the alert
skymap

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Event/Alert Format

AMON will receive events and send alerts in VOEvent format

- Standardized data packet format simplifies protocols for data handling (e.g. adding new observatory will not require new methods for injection of data into database and analysis stream)
- VOEvent is used by larger astronomical community i.e. became a standard for real-time event distribution (e.g. GCN notices, Swift, Fermi, LIGO, AMON etc.)
- Well structured in XML format with simple schema
- Easily interpreted by software, can be read by robotic telescopes (important for real-time analysis and near real-time follow-up)