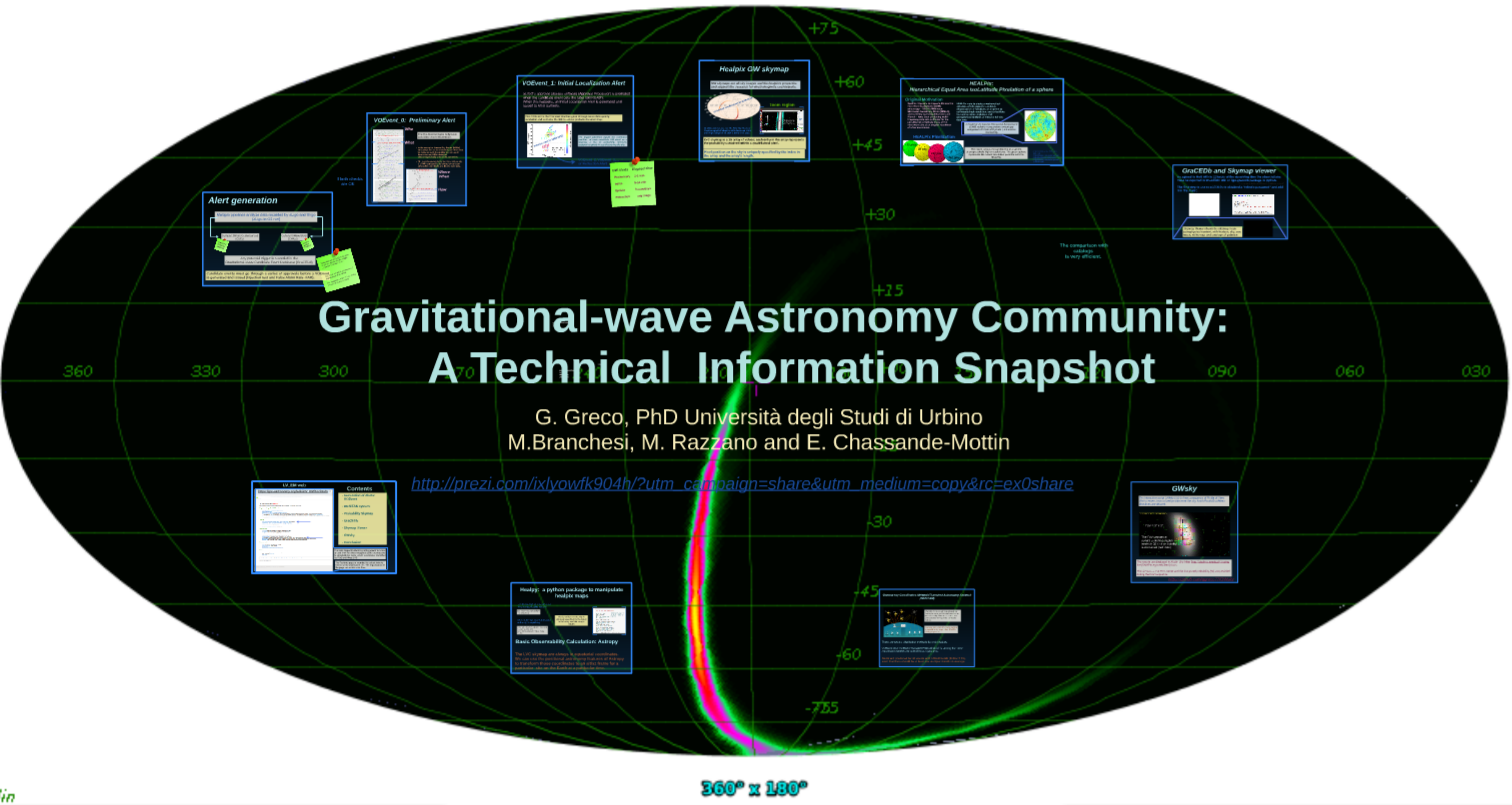

Gravitational-wave Astronomy Community: A Technical Information Snapshot

G. Greco, PhD Università degli Studi di Urbino
M.Branchesi, M. Razzano and E. Chassande-Mottin

http://prezi.com/ixlyowfk904h/?utm_campaign=share&utm_medium=copy&rc=ex0share

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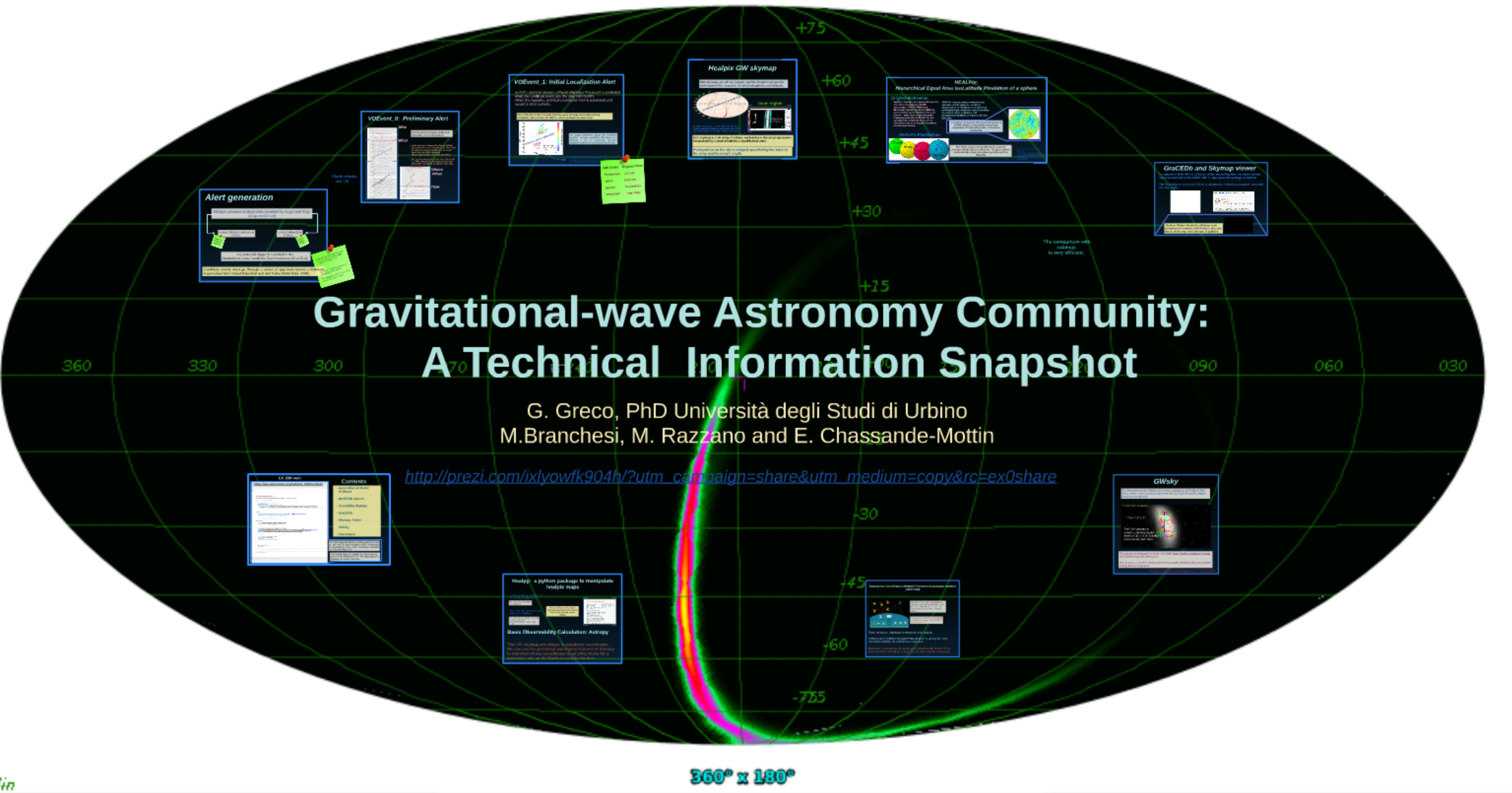


LV_EM web

https://gw-astronomy.org/wiki/LV_EM/TechInfo


You are here: Foswiki > LV_EM Web > TechInfo (22 Oct 2015, Giuseppe)

Technical Information [public]

This page is intended to collect links to technical documentation, etc. The organization of the page can evolve over time.

Register and Login for LV-EM services

- Registering for access to LV-EM services on gw-astronomy.org
- Frequently asked questions
- What should if I do if I want to be registered into more than one MOU?
- Sign up to receive GCN notices, machine-readable alerts communicating times and positions of gravitational wave transient candidates and candidate counterpart information
  - **Important** : If you are a new GCN recipient (as opposed to adding LIGO/Virgo notices to an existing GCN configuration), fill out a 2nd form page New Site or New User
- Sign up to send and receive GCN Circulars, human-written bulletins delivered by e-mail to send and receive messages about follow-up observations on the gravitational wave transient candidates
  - **Important**: special instructions for submitting LSC/Virgo circulars

Tutorials

- Tutorial: receiving, filtering, and processing alerts in Python (VOEvent version) (LIGO-G1500442)
- Example: receiving, filtering, and processing alerts in Python (full-format e-mail version)
- Coming soon: Example: receiving, filtering, and processing alerts in Python (160-byte binary packet version)
- Using Skymap Viewer (youtube introduction 6:14)
- Submitting and visualizing EMObservations (youtube 5:29)

Sample code

- CurlGetSkymap forms the curl command that downloads a skymap from LIGO-Virgo
- PythonGetSkymap the same, but with the GraceDB Python client instead of curl
- SampleSkymap reads and interpolates a LIGO-Virgo skymap
- SortMyFields reads a list of telescope fields and sorts them in order of probability
- CurlUploadFootprints uploads the locations of images (footprints) to LIGO-Virgo
- PythonUploadFootprints the same, but with the GraceDB Python client instead of curl
- GWsky reprojects a probability Healpix sky map, gets a reprojected pixel table and sends them via SAMPIntegratedClient? class
- Make2MASSMaps builds a FITS file of the galaxy surface density within a catalogue (the example is the 2MASS XSC) compatible with the LIGO-Virgo skymap
- reproject.grid_size is a command-line function for healpix reprojection just specifying the required resolution of the pixels in degrees.

Documentation

- GraceDB: an astronomer's short guide to the web page
- VOEvent Documentation (LIGO-T1400414)
- Example VOEvents
- Detailed description of GCN notice types for LIGO-Virgo alerts

Tools

- Receiving and handling VOEvents from GCN with Comet, a complete VOEvent transport system.
- Parsing VOEvents with VOEventLib
- SkymapViewer

Edit | Attach | Print version | History: r33 < r32 < r31 < r30 | Backlinks | View wiki text | Edit wiki text | More topic actions

Topic revision: 22 Oct 2015, Giuseppe

Contents

- Generation of Alerts: VOEvent
- GCN/TAN system
- Probability Skymap
- GraCEDb
- Skymap Viewer
- GWsky
- Conclusion

This wiki supports efforts by astronomers to follow up and look for electromagnetic (EM) counterparts to gravitational wave event candidates identified by LIGO and Virgo (LV).

The TechInfo page is intended to collect links to technical documentation, etc. The organization of the page can evolve over time.

Alert generation

Multiple pipelines analyze data recorded by aLigo and Virgo
(aLigo in O1 run)

Compact Binary Coalescences
(CBCs)

Matched filtering method

Coherent Wave Burst
(CWBs)

Excess power method

Any potential trigger is recorded in the
Gravitational-wave Candidate Event Database (GraCEDb)

Candidate events must go through a series of approvals before a VOEvent is generated and issued (Injection test and False Alarm Rate -FAR).

False Alarm Rate
at which signals
come from ran

The inverse
significanc

For exam
means

Db)

re a VOEvent
AR).

False Alarm Rate [Hz] is the rate at which signals like this might come from random noise.

The inverse FAR is a measure of significance of an event.

For example a FAR of 3.2e-10 Hz means once per century.

VOEvent_0: Preliminary Alert

The Pre-Alert contains only basic candidate event information.

Who

<Who> states for when and from where the VOEvent is sent.

```xml
<?xml version="1.0" ?>
<voe:VOEvent xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:voe="http://www.ivoa.net/xml/VOEvent/v2.0"
xsi:schemaLocation="http://www.ivoa.net/xml/VOEvent/v2.0 http://www.ivoa.
    net/xml/VOEvent/VOEvent-v2.0.xsd"
 version="2.0" role="test" ivorn="ivo://gwnet/G96195-1">
    <Who>
        <Date>2014-12-03T16:03:34</Date>
        <Author>
            <contactName>LIGO Scientific Collaboration and Virgo
                Collaboration</contactName>
        </Author>
    </Who>
```

What

<What> states for the parameters that describe the particular candidate

These parameters are the same for both CBC and CWB

```xml
    <What>
        <Param name="GraceID" dataType="string" value="G96195" ucd="meta.
            id" unit="">
            <Description>Identifier in the GraceDb database</Description>
        </Param>
        <Param name="AlertType" dataType="string" value="Initial" ucd="
            meta.version" unit="">
            <Description>VOEvent alert type</Description>
        </Param>
        <Param name="FAR" dataType="float" value="7.803211[illegible]e-12" ucd="
            arith.rate;stat.falsealarm" unit="Hz">
            <Description>False alarm rate for GW candidates with this
                strength or greater</Description>
        </Param>
        <Param name="EventPage" dataType="string" value="https://gracedb.
            ligo.org/events/G96195" ucd="meta.ref.url" unit="">
            <Description>Web page for evolving status of this candidate
                event</Description>
        </Param>
        <Param name="Pipeline" dataType="string" value="gstlal-spiir" ucd=
            "meta.code" unit="">
            <Description>Low latency data analysis pipeline</Description>
        </Param>
        <Param name="Search" dataType="string" value="LowMass" ucd="meta.
            code" unit="">
            <Description>Low latency search type</Description>
        </Param>
```

The other parameters change with the pipeline

```xml
        <Param name="ChirpMass" dataType="float" value="0.912880957127"
            ucd="phys.mass" unit="solar mass">
            <Description>Estimated CBC chirp mass</Description>
        </Param>
        <Param name="MaxDistance" dataType="float" value="57.5933" ucd="
            pos.distance" unit="Mpc">
            <Description>Estimated maximum distance for CBC event<
                /Description>
        </Param>
        <Param name="Eta" dataType="float" value="0.2484173" ucd="phys.
            mass;arith.factor" unit="">
            <Description>Estimated ratio of reduced mass to total mass<
                /Description>
        </Param>
        <Group type="GW_SKYMAP" name="BAYESTAR">
            <Param name="skymap_png_x509" dataType="string" value="
                https://gracedb.ligo.org/api/events/G96195/files/skymap.
                png,0" ucd="meta.ref.url" unit="">
                <Description>Sky Map image X509 protected</Description>
            </Param>
            <Param name="skymap_fits_x509" dataType="string" value="
                https://gracedb.ligo.org/api/events/G96195/files/skymap.
                fits.gz,0" ucd="meta.ref.url" unit="">
                <Description>Sky Map FITS X509 protected</Description>
            </Param>
            <Param name="skymap_png_shib" dataType="string" value="
                https://gracedb.ligo.org/events/G96195/files/skymap.png,0"
                ucd="meta.ref.url" unit="">
                <Description>Sky Map image Shibboleth protected<
                    /Description>
            </Param>
            <Param name="skymap_fits_shib" dataType="string" value="
                https://gracedb.ligo.org/events/G96195/files/skymap.fits.
                gz,0" ucd="meta.ref.url" unit="">
                <Description>Sky Map FITS Shibboleth protected<
                    /Description>
            </Param>
        </Group>
    </What>
```

- In the survey for Gamma Ray Bursts (GRBs), time coincidences are interesting and the faster we issue an alert, the quicker we can see if there were any GRBs detected electromagnetically around the same time.
- The Low-Frequency Array for radio astronomy (LOFAR) requested to be alerted since it can only buffer one minute at a time to save data.

Where When

<WhereWhen> *reports the location of the observatory and where and when the observation was made.*

```xml
    <WhereWhen>
        <ObsDataLocation>
            <ObservatoryLocation id="LIGO Virgo"/>
            <ObservationLocation>
                <AstroCoordSystem id="UTC-FK5-GEO"/>
                <AstroCoords coord_system_id="UTC-FK5-GEO">
                    <Time>
                        <TimeInstant>
                            <ISOTime>2014-03-01T03:57:59</ISOTime>
                        </TimeInstant>
                    </Time>
                    <Position2D>
                        <Value2>
                            <C1>0.000000</C1>
                            <C2>0.000000</C2>
                        </Value2>
                        <Error2Radius>180.000000</Error2Radius>
                    </Position2D>
                </AstroCoords>
            </ObservationLocation>
        </ObsDataLocation>
    </WhereWhen>
```

How

<How> refers to the detectors involved with the candidate event

```xml
    <How>
        <Description>L1: LIGO Livingston 4 km gravitational wave detector<
            /Description>
        <Description>V1: Virgo 3 km gravitational wave detector<
            /Description>
    </How>
    <Why>
        <Description>Candidate gravitational wave event identified by low-
            latency analysis</Description>
    </Why>
    <Description>Report of a candidate gravitational wave event<
        /Description>
</voe:VOEvent>
```

necks

K

```
<?xml version="1.0" ?>
<voe:VOEvent xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:voe="http://www.ivoa.net/xml/VOEvent/v2.0"
xsi:schemaLocation="http://www.ivoa.net/xml/VOEvent/v2.0 http://www.ivoa.
    net/xml/VOEvent/VOEvent-v2.0.xsd"
 version="2.0" role="test" ivorn="ivo://gwnet/G96195-1">
    <Who>
```

states for when and from where the VOEvent is sent.

```
        <Date>2014-12-03T16:03:34</Date>
        <Author>
            <contactName>LIGO Scientific Collaboration and Virgo
                Collaboration</contactName>
        </Author>
    </Who>
    <What>
```

states for the parameters that describe the particular candidate

```
        <Param name="GraceID" dataType="string" value="G96195" ucd="meta.
            id" unit="">
            <Description>Identifier in the GraceDb database</Description>
        </Param>
        <Param name="AlertType" dataType="string" value="Initial" ucd="
```

```
        </Author>
    </Who>
    <What>
```

states for the parameters that describe the particular candidate

```
        <Param name="GraceID" dataType="string" value="G96195" ucd="meta.
            id" unit="">
            <Description>Identifier in the GraceDb database</Description>
        </Param>
        <Param name="AlertType" dataType="string" value="Initial" ucd="
            meta.version" unit="">
            <Description>VOEvent alert type</Description>
        </Param>
        <Param name="FAR" dataType="float" value="7.8032113878e-12" ucd="
            arith.rate;stat.falsealarm" unit="Hz">
            <Description>False alarm rate for GW candidates with this
                strength or greater</Description>
        </Param>
        <Param name="EventPage" dataType="string" value="https://gracedb.
            ligo.org/events/G96195" ucd="meta.ref.url" unit="">
            <Description>Web page for evolving status of this candidate
                event</Description>
        </Param>
        <Param name="Pipeline" dataType="string" value="gstlal-spiir" ucd=
            "meta.code" unit="">
            <Description>Low latency data analysis pipeline</Description>
        </Param>
        <Param name="Search" dataType="string" value="LowMass" ucd="meta.
            code" unit="">
            <Description>Low latency search type</Description>
        </Param>
```

These parameters are the same for both CBC and CWB

```
code" unit="">
        <Description>Low latency search type</Description>
    </Param>
    <Param name="ChirpMass" dataType="float" value="0.912880957127"
        ucd="phys.mass" unit="solar mass">
        <Description>Estimated CBC chirp mass</Description>
    </Param>
    <Param name="MaxDistance" dataType="float" value="57.5933" ucd="
        pos.distance" unit="Mpc">
        <Description>Estimated maximum distance for CBC event<
            /Description>
    </Param>
    <Param name="Eta" dataType="float" value="0.2484173" ucd="phys.
        mass;arith.factor" unit="">
        <Description>Estimated ratio of reduced mass to total mass<
            /Description>
    </Param>
    <Group type="GW_SKYMAP" name="BAYESTAR">
        <Param name="skymap_png_x509" dataType="string" value="
            https://gracedb.ligo.org/api/events/G96195/files/skymap.
            png,0" ucd="meta.ref.url" unit="">
            <Description>Sky Map image X509 protected</Description>
        </Param>
        <Param name="skymap_fits_x509" dataType="string" value="
            https://gracedb.ligo.org/api/events/G96195/files/skymap.
            fits.gz,0" ucd="meta.ref.url" unit="">
            <Description>Sky Map FITS X509 protected</Description>
        </Param>
        <Param name="skymap_png_shib" dataType="string" value="
            https://gracedb.ligo.org/events/G96195/files/skymap.png,0"
            ucd="meta.ref.url" unit="">
            <Description>Sky Map image Shibboleth protected<
                /Description>
        </Param>
        <Param name="skymap_fits_shib" dataType="string" value="
            https://gracedb.ligo.org/events/G96195/files/skymap.fits.
            gz,0" ucd="meta.ref.url" unit="">
            <Description>Sky Map FITS Shibboleth protected<
                /Description>
        </Param>
    </Group>
</What>
```


The other parameters change with the pipeline


```
<WhereWhen>
    <ObsDataL
        <Obse
        <Obse
            <A
            <A
            </
        </Obs
    </ObsData
</WhereWhen>
<How>
    <Descripti
        /Descr
    <Descriptio
        /Descri
</How>
<Why>
    <Descriptio
        latency
</Why>
<Description>Re
    /Descriptio
</voe:VOEvent>
```


refers t

reports the location of the observatory and where and when the observation was made.

```
<WhereWhen>
    <ObsDataLocation>
        <ObservatoryLocation id="LIGO Virgo"/>
        <ObservationLocation>
            <AstroCoordSystem id="UTC-FK5-GEO"/>
            <AstroCoords coord_system_id="UTC-FK5-GEO">
                <Time>
                    <TimeInstant>
                        <ISOTime>2014-03-01T03:57:59</ISOTime>
                    </TimeInstant>
                </Time>
                <Position2D>
                    <Value2>
                        <C1>0.000000</C1>
                        <C2>0.000000</C2>
                    </Value2>
                    <Error2Radius>180.000000</Error2Radius>
                </Position2D>
            </AstroCoords>
        </ObservationLocation>
    </ObsDataLocation>
</WhereWhen>
```

refers to the detectors involved with the candidate event

```
<How>
    <Description>L1: LIGO Livingston 4 km gravitational wave detector</Description>
```

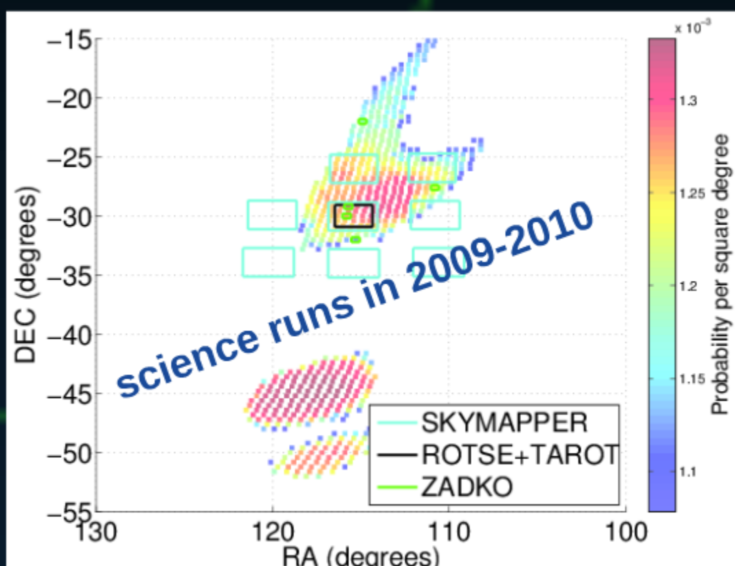
```xml
                <Error2Radius>180.000000</Error2Radius>
            </Position2D>
        </AstroCoords>
    </ObservationLocation>
  </ObsDataLocation>
</WhereWhen>
<How>
  <Description>L1: LIGO Livingston 4 km gravitational wave detector</Description>
  <Description>V1: Virgo 3 km gravitational wave detector</Description>
</How>
<Why>
  <Description>Candidate gravitational wave event identified by low-latency analysis</Description>
</Why>
<Description>Report of a candidate gravitational wave event</Description>
</voe:VOEvent>
```

refers to the detectors involved with the candidate event

VOEvent_1: Initial Localization Alert

aLIGO's approval process software (Approval Processor) is prompted when the candidate event gets the label EM READY.
When this happens, an Initial Localization Alert is generated and issued to MoU partners.

This VOEvent is the first alert that has gone through some data quality validation and contains the link to a most probable location map.



The trigger pipelines report the estimated position of each candidate GW event as a skymap, a list of probability densities assigned to pixels in a grid covering the sky.

VOEvent_2, VOEvent_3,...,
or Retraction Alert

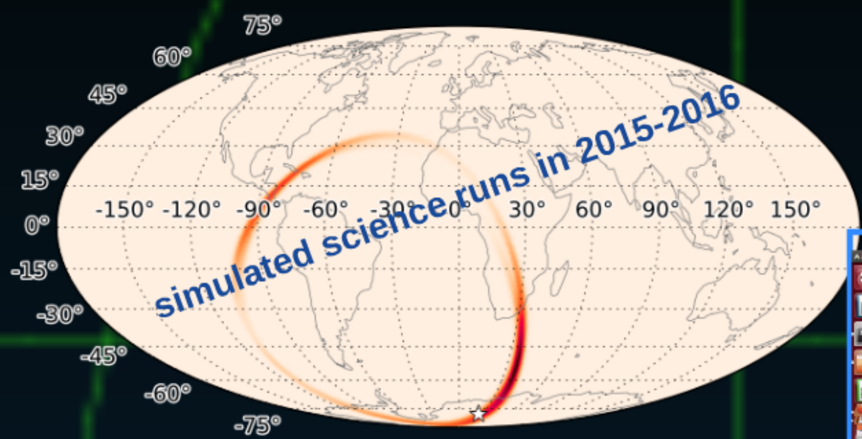
GW Alerts Elaps

VOEvent_3,...,
n Alert

GW Alerts	Elapsed time
Preliminary	3-5 min
Initial	5-10 min
Update	hours/days
Retraction	any stage

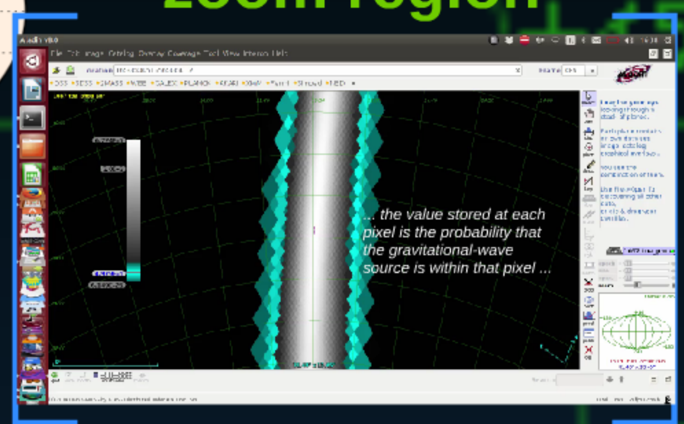
Healpix GW skymap

GW skymaps are all-sky images and the healpix's properties well support the research for electromagnetic counterparts.



ID 4532; data release for The First Two Years of Electromagnetic Follow-Up with Advanced LIGO and Virgo. Singer et al. 2014 & Berry et al. 2015

zoom region



LVC skymap is a 1D array of values; each entry in the array represents the probability contained within a quadrilateral pixel.

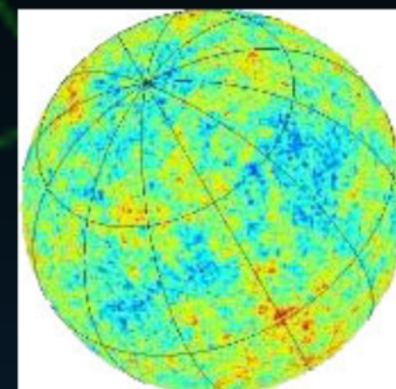
Pixel position on the sky is uniquely specified by the index in the array and the array's length.

HEALPix:
Hierarchical Equal Area isoLatitude Pixelation of a sphere

Original Motivation

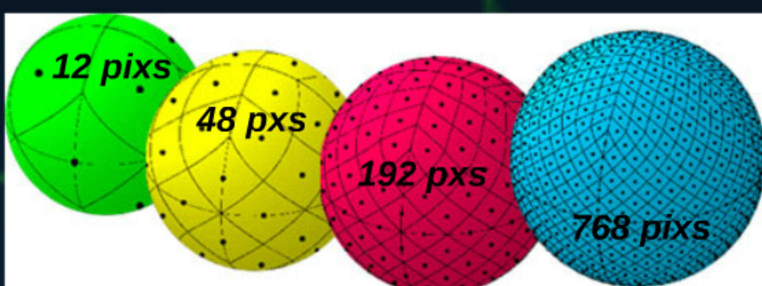
Satellite missions to measure the cosmic microwave background (CMB) anisotropy -- NASA's Wilkinson Microwave Anisotropy Probe (WMAP), and currently operating ESA's mission Planck -- have been producing multi-frequency data sets sufficient for the construction of full-sky maps of the microwave sky at an angular resolution of a few arcminutes.

HEALPix were to create a mathematical structure which supports a suitable discretization of functions on a sphere at sufficiently high resolution, and to facilitate fast and accurate statistical and astrophysical analysis of massive full-sky data sets.



A model of the Cosmic Microwave Background (CMB) radiation temperature anisotropy composed of 12,582,912 pixels (~3.4 arcmin resolution).

HEALPix Pixelization



The figure shows the partitioning of a sphere at progressively higher resolutions. The green sphere represents the lowest resolution possible with the HEALPix.

- K.M. Gorski et al., 2005, ApJ., 622, 759
- http://healpix.sourceforge.net/
- http://healpix.jpl.nasa.gov/
- http://healpix.sourceforge.net/pdf/intro.pdf

Healpy: a python package to manipulate healpix maps

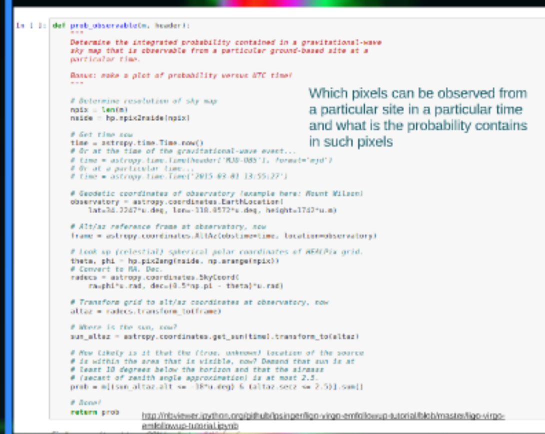
Let's find the highest probability pixel.
 What is the probability inside it?

```
ipix_max = np.argmax(hpx)
hpx[ipix_max]
```

Pixel position on the sky is uniquely specified by the index in the array and the array's length

Where is the highest probability pixel on the sky? Use pix2ang.

```
theta, phi = hp.pix2ang(nside, ipix_max)
ra = np.rad2deg(phi)
dec = np.rad2deg(0.5 * np.pi - theta)
ra, dec
```



```
In [ ]: def prob_observable(m, header):
    """
    Determine the integrated probability contained in a gravitational-wave
    sky map that is observable from a particular ground-based site at a
    particular time.

    Bonus: make a plot of probability versus UTC time!
    """

    # Determine resolution of sky map
    npix = len(m)
    nside = hp.npix2nside(npix)

    # Get time now
    time = astropy.time.Time.now()
    # Or at the time of the gravitational-wave event...
    # time = astropy.time.Time(header['MJD-OBS'], format='mjd')
    # Or at a particular time...
    # time = astropy.time.Time('2015-03-01 13:55:27')

    # Geodetic coordinates of observatory (example here: Mount Wilson)
    observatory = astropy.coordinates.EarthLocation(
        lat=34.2247*u.deg, lon=-118.0572*u.deg, height=1742*u.m)

    # Alt/az reference frame at observatory, now
    frame = astropy.coordinates.AltAz(obstime=time, location=observatory)

    # Look up (celestial) spherical polar coordinates of HEALPix grid.
    theta, phi = hp.pix2ang(nside, np.arange(npix))
    # Convert to RA, Dec.
    radecs = astropy.coordinates.SkyCoord(
        ra=phi*u.rad, dec=(0.5*np.pi - theta)*u.rad)

    # Transform grid to alt/az coordinates at observatory, now
    altaz = radecs.transform_to(frame)

    # Where is the sun, now?
    sun_altaz = astropy.coordinates.get_sun(time).transform_to(altaz)

    # How likely is it that the (true, unknown) location of the source
    # is within the area that is visible, now? Demand that sun is at
    # least 18 degrees below the horizon and that the airmass
    # (secant of zenith angle approximation) is at most 2.5.
    prob = m[(sun_altaz.alt <= -18*u.deg) & (altaz.secz <= 2.5)].sum()

    # Done!
    return prob
```

Which pixels can be observed from a particular site in a particular time and what is the probability contains in such pixels

http://nbviewer.ipython.org/github/lpsinger/ligo-virgo-emfollowup-tutorial/blob/master/ligo-virgo-emfollowup-tutorial.ipynb

Basic Observability Calculation: Astropy

The LVC skymap are always in equatorial coordinates. We can use the positional astronomy features of Astropy to transform those coordinates to an alt/az frame for a particular site on the Earth at a particular time.

```python
In [ ]: def prob_observable(m, header):
            """
            Determine the integrated probability contained in a gravitational-wave
            sky map that is observable from a particular ground-based site at a
            particular time.

            Bonus: make a plot of probability versus UTC time!
            """

            # Determine resolution of sky map
            npix = len(m)
            nside = hp.npix2nside(npix)

            # Get time now
            time = astropy.time.Time.now()
            # Or at the time of the gravitational-wave event...
            # time = astropy.time.Time(header['MJD-OBS'], format='mjd')
            # Or at a particular time...
            # time = astropy.time.Time('2015-03-01 13:55:27')

            # Geodetic coordinates of observatory (example here: Mount Wilson)
            observatory = astropy.coordinates.EarthLocation(
                lat=34.2247*u.deg, lon=-118.0572*u.deg, height=1742*u.m)

            # Alt/az reference frame at observatory, now
            frame = astropy.coordinates.AltAz(obstime=time, location=observatory)

            # Look up (celestial) spherical polar coordinates of HEALPix grid.
            theta, phi = hp.pix2ang(nside, np.arange(npix))
            # Convert to RA, Dec.
            radecs = astropy.coordinates.SkyCoord(
                ra=phi*u.rad, dec=(0.5*np.pi - theta)*u.rad)

            # Transform grid to alt/az coordinates at observatory, now
            altaz = radecs.transform_to(frame)

            # Where is the sun, now?
            sun_altaz = astropy.coordinates.get_sun(time).transform_to(altaz)

            # How likely is it that the (true, unknown) location of the source
            # is within the area that is visible, now? Demand that sun is at
            # least 18 degrees below the horizon and that the airmass
            # (secant of zenith angle approximation) is at most 2.5.
            prob = m[(sun_altaz.alt <= -18*u.deg) & (altaz.secz <= 2.5)].sum()

            # Done!
            return prob
```

Which pixels can be observed from a particular site in a particular time and what is the probability contains in such pixels

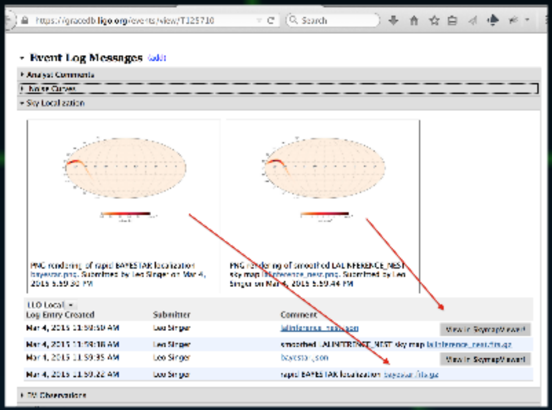
http://nbviewer.ipython.org/github/lpsinger/ligo-virgo-emfollowup-tutorial/blob/master/ligo-virgo-emfollowup-tutorial.ipynb

GraCEDb and Skymap viewer

As agreed in MoU within 12 hours of the observing time the observations must be reported in GraCEDb: GUI or ligo-gracedb package in python.

https://dcc.ligo.org/public/0110/F1300021/003/MOUtemplate.pdf

The first step to use GraCEDb is to obtained a "robotic password" and add it in file ./netrc

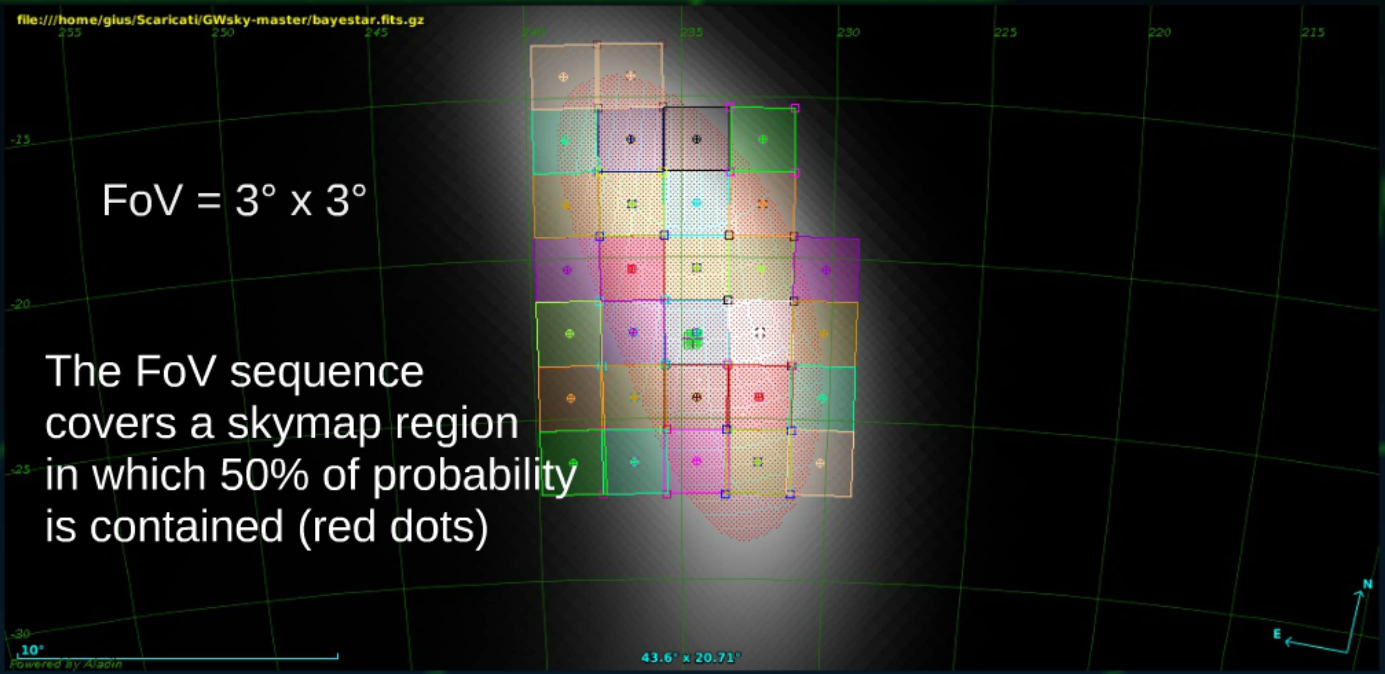



```
from ligo.gracedb.rest import GraceDbBasic, HTTPError

service = 'https://gracedb.ligo.org/apibasic/'
g = GraceDbBasic(service)

graceid = 'T125706'
raList = [45.0, 47.0, 49.0]
raWidthList = 2.0
decList = [45.0, 47.0, 49.0]
decWidthList = 2.0
startTimeList = ['2015-05-01T12:30:10.95', '2015-05-01T12:31:10.95'
durationList = 100.0
comment = 'Some text comment goes here. This is optional.'

g.writeEMObservation(graceid, 'Test', raList, raWidthList,
    decList, decWidthList, startTimeList, durationList, comment)
```

Skymap Viewer shows the skymap in an astrophysical context, with horizon, sky, sun, moon, milky way, and catalogs of galaxies

GWsky

The interactive script GWsky (v2) defines a sequence of Fields of View (FoV) centers from a fixed position over the sky. North/South/East/West directions are allowed.

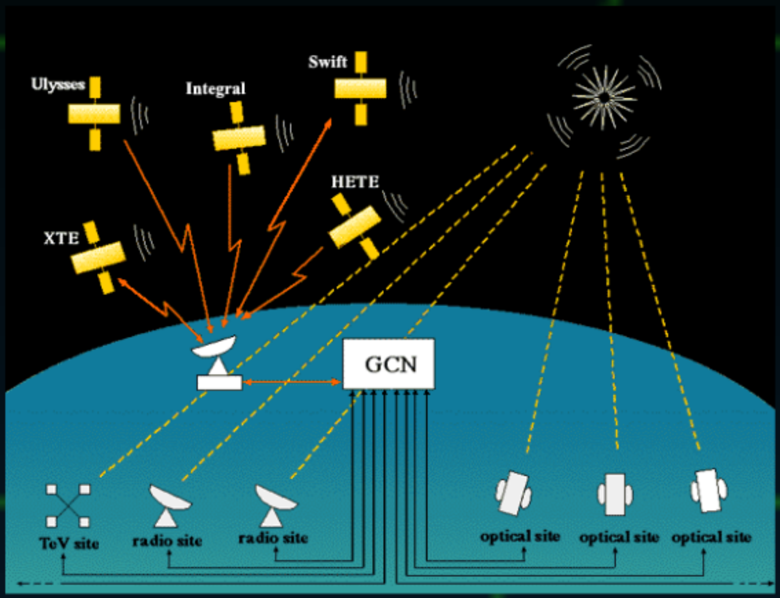


The results are displayed in Aladin Sky Atlas (http://aladin.u-strasbg.fr/) using the |SAMPIntegratedClient| class.

The airmass at the FoV center and the integrated probability (%) are provided during the FoV sequence.

https://github.com/ggreco77/GWsky

Gamma-ray Coordinates Network/Transient Astronomy Network (GCN/TAN)



The GCN/TAN system may already be familiar to some, as it is has been in use since the early 1990s to transmit times and coordinates of gamma-ray bursts (GRBs)

A pointer URL to a FITS file containing a probability sky map in the HEALPix all-sky projection.

There are several distribution methods for GCN notices.

VOEvent over VOEvent Transport Protocol,which is among the more convenient methods for autonomous operations.

Alerts will produced for all events with FAR≥1/month (4×10e−7 Hz), such that there should be at least one alert per month on average.