



ESCAPE

European Science Cluster of Astronomy &
Particle physics ESFRI research Infrastructures

WP3.4 status and next steps for innovation group

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Observatory



WP3.4/FG3 tasks

Objectives

Goal is the establishment of an **innovation competence group**. To this end, calls for the exchange of current practices are established and a workshop will be organized in 2020.



What we already did

- *Hangar@Virgo (Orobix-EGO)*
- *Wavefier @Virgo (Trust-IT-EGO-INFN)*
- *IWAPP workshop*



HANGAR AT VIRGO

A. Iess & F. Quarenghi



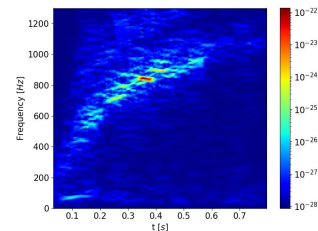
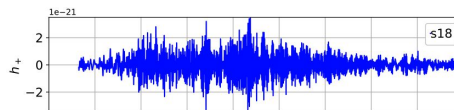
DATA VERSIONING WITH HANGAR

- Open Source with Git-like semantics
- Keep track of changes to data
- Zero-cost branching
- Merging between branches
- Abstracted storage of data files on disk
- Pushing and pulling changes to remotes

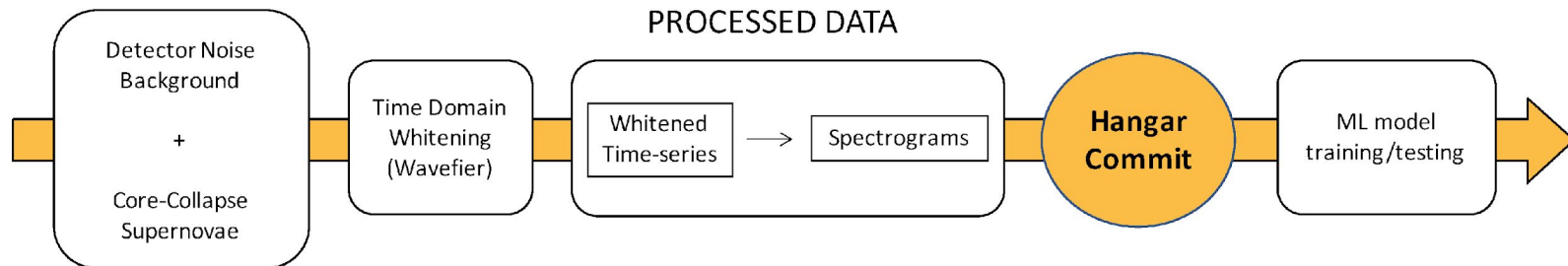
HANGAR IN A VIRGO ML PIPELINE

- Core-Collapse Supernova Classification
- Store full science segments based on GPS starting times
- Store individual time series or spectrogram samples around triggers

- Possibility to store and access time-frequency datasets with different spectrogram parameters
- Access datasets based on distance and source properties
- **Decreased training time** by removing «on the run» spectrogram generation
- **Reduced disk usage** at VIRGO



RAW DATA



A prototype for Real time analysis Wavefier

Real time Gravitational Wave transient signal classifier

Key Objectives

- © *Setup a prototype for a **real time** pipeline for the detection of transient signals and their **automatic** classification*
- © *Best practice for **software management***
- © *Test different software architecture solutions to prototype a **scalable** pipeline for **big data** analysis in GW context.*
- © ***Interoperability** and access to data and services*
- © ***ICT services** supporting research infrastructures*
- © *Use of **data in network** infrastructures and services*



Real time Gravitational Wave transient signal classifier

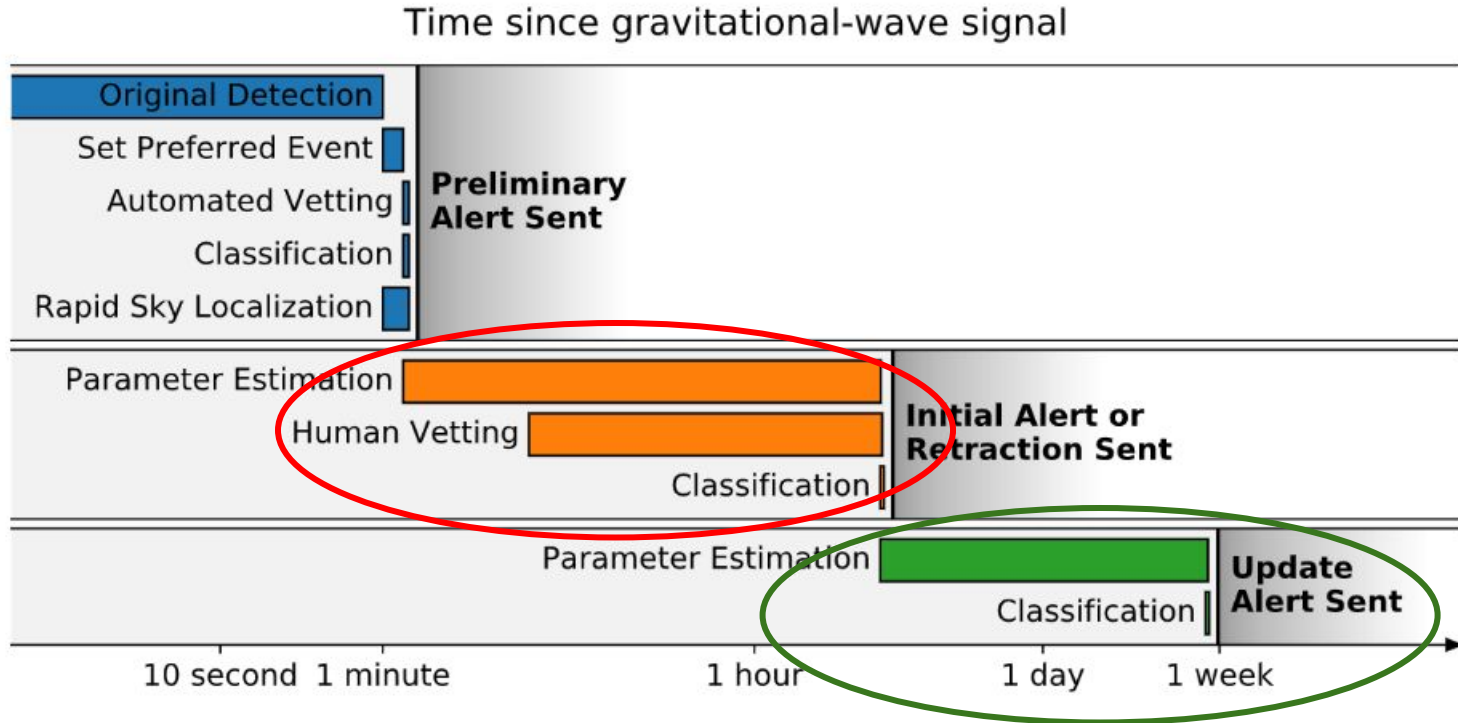
Wavefier: a prototype for a real time transient signal classifier



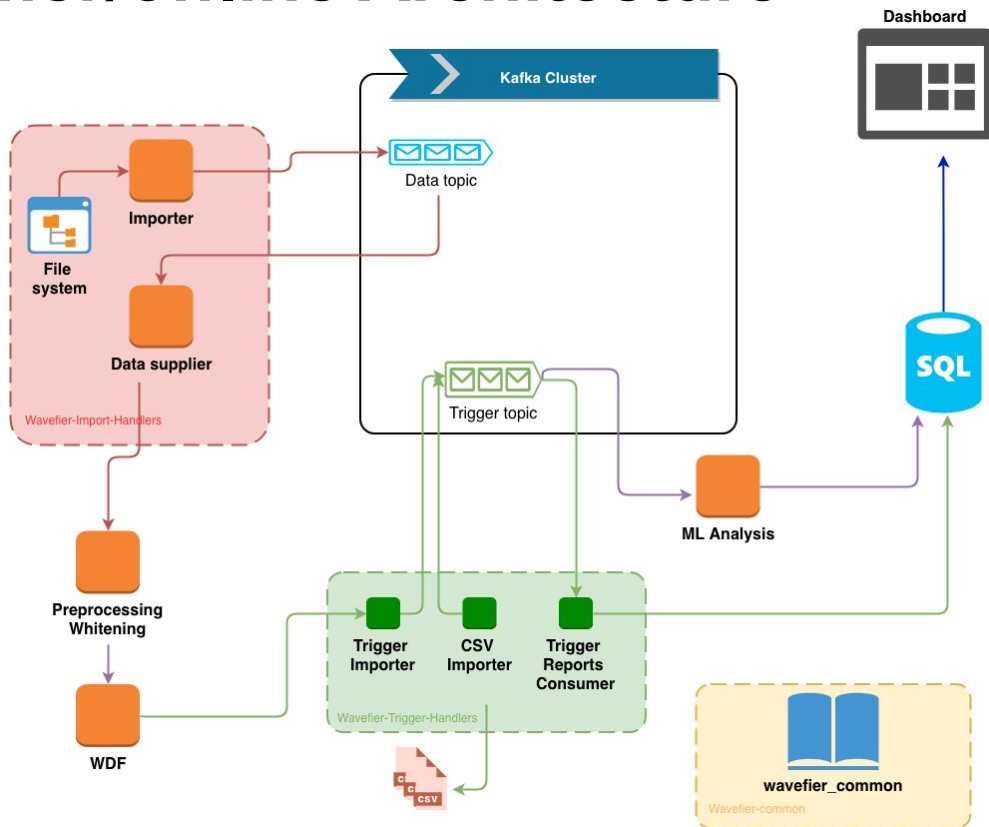
H2020-ASTERICS project brings together for the first time scientists and communities from astronomy, astrophysics, particle astrophysics & big data.
<http://www.asterics2020.eu>

H2020-Astronomy ESFRI and Research Infrastructure Cluster (Grant Agreement number: 653477)

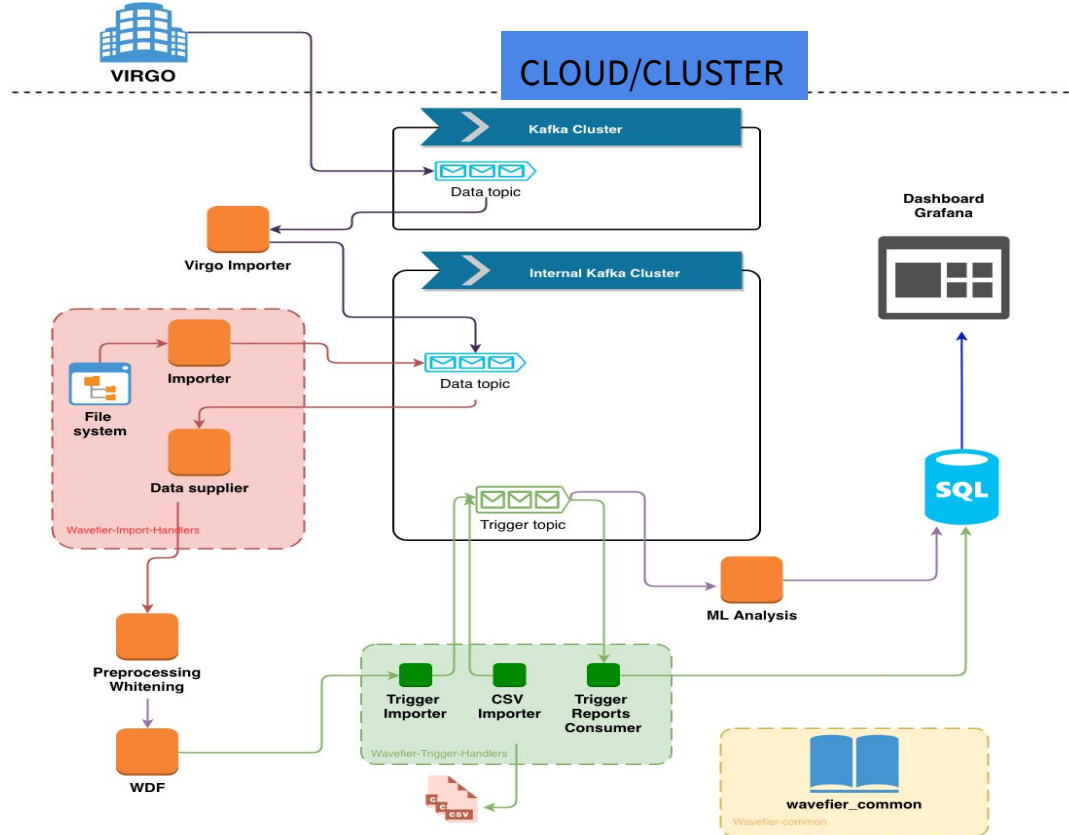
Gravitational Wave alert system



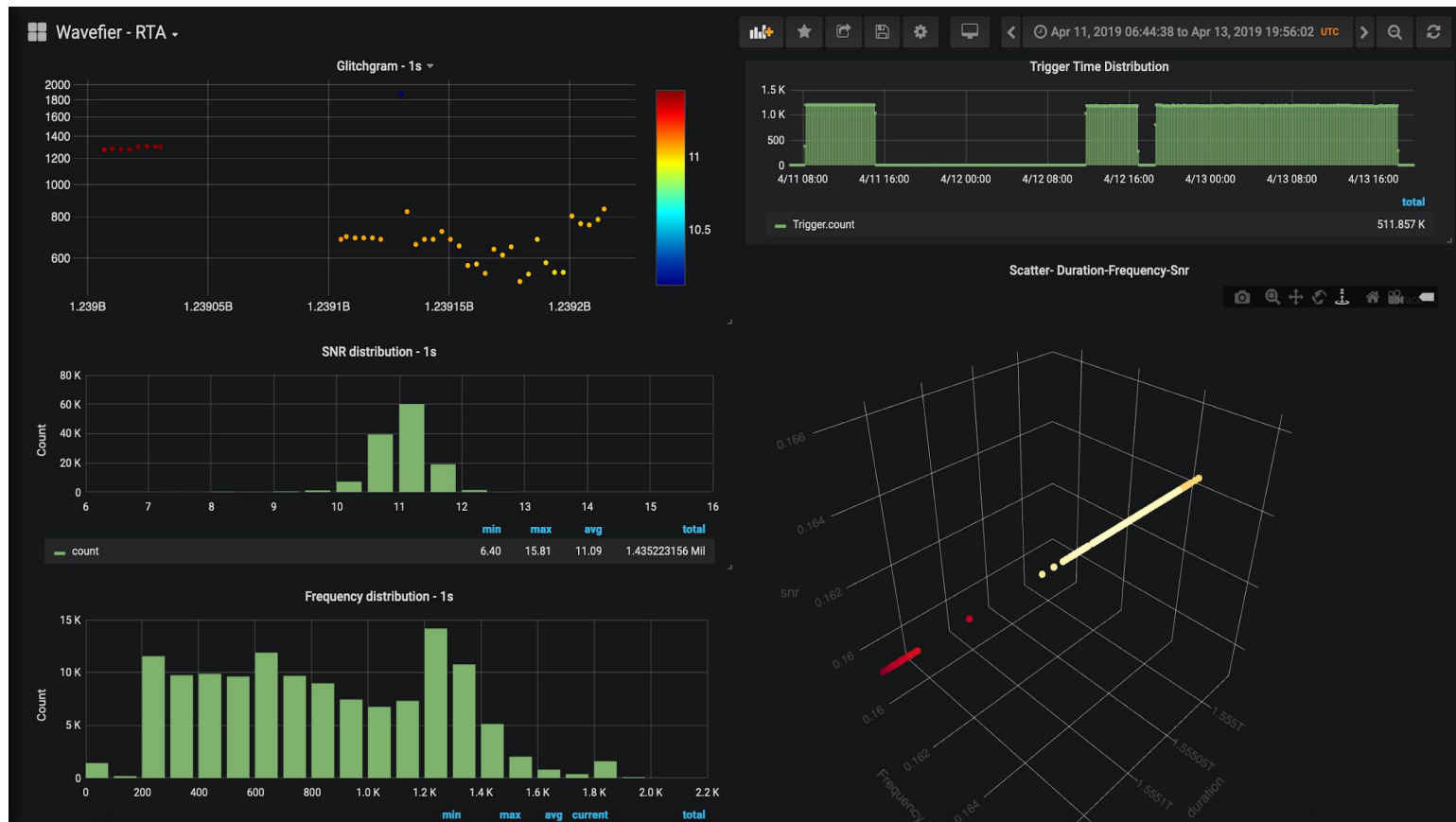
Wavefier/offline Architecture



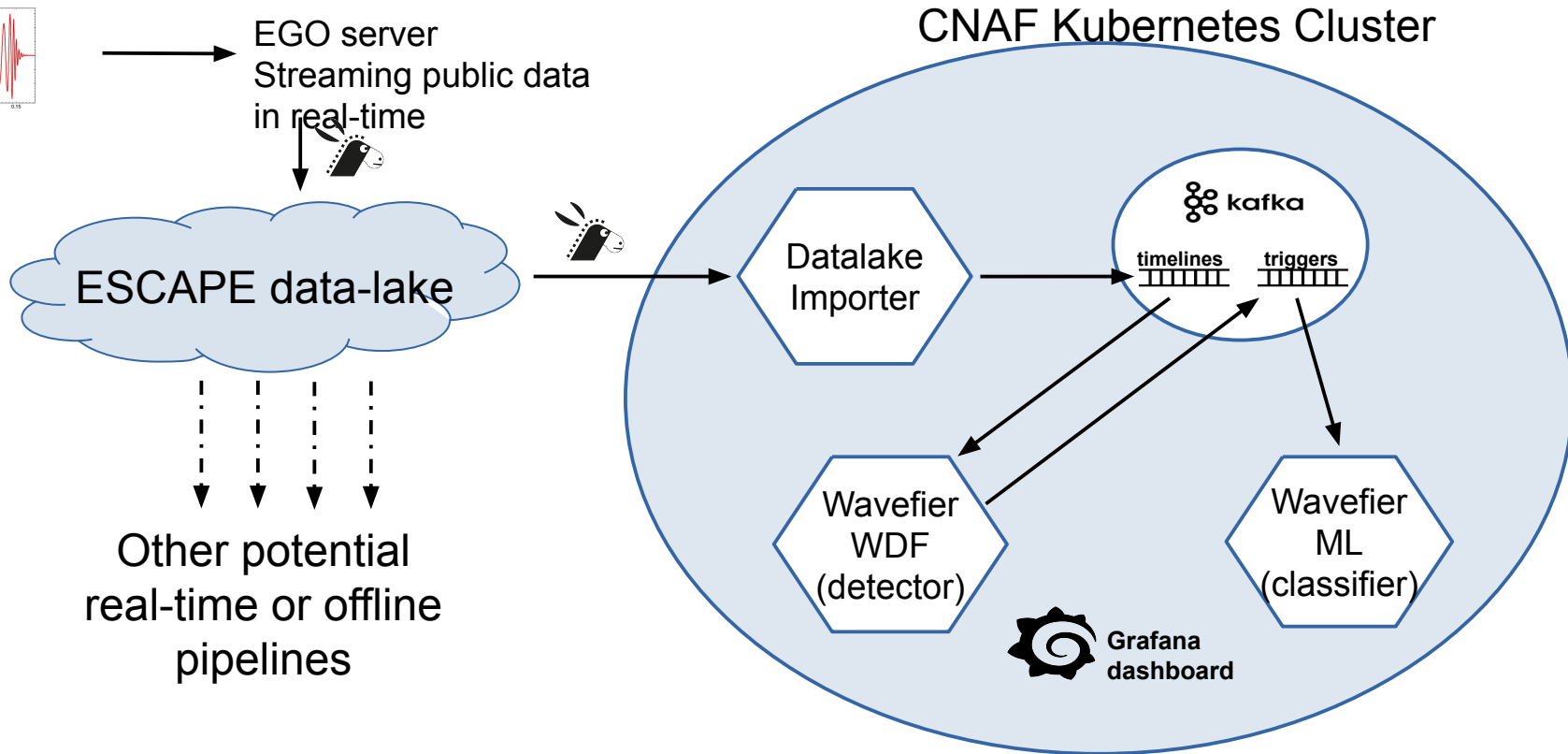
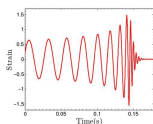
Wavefier/online Architecture



Wavefier dashboard



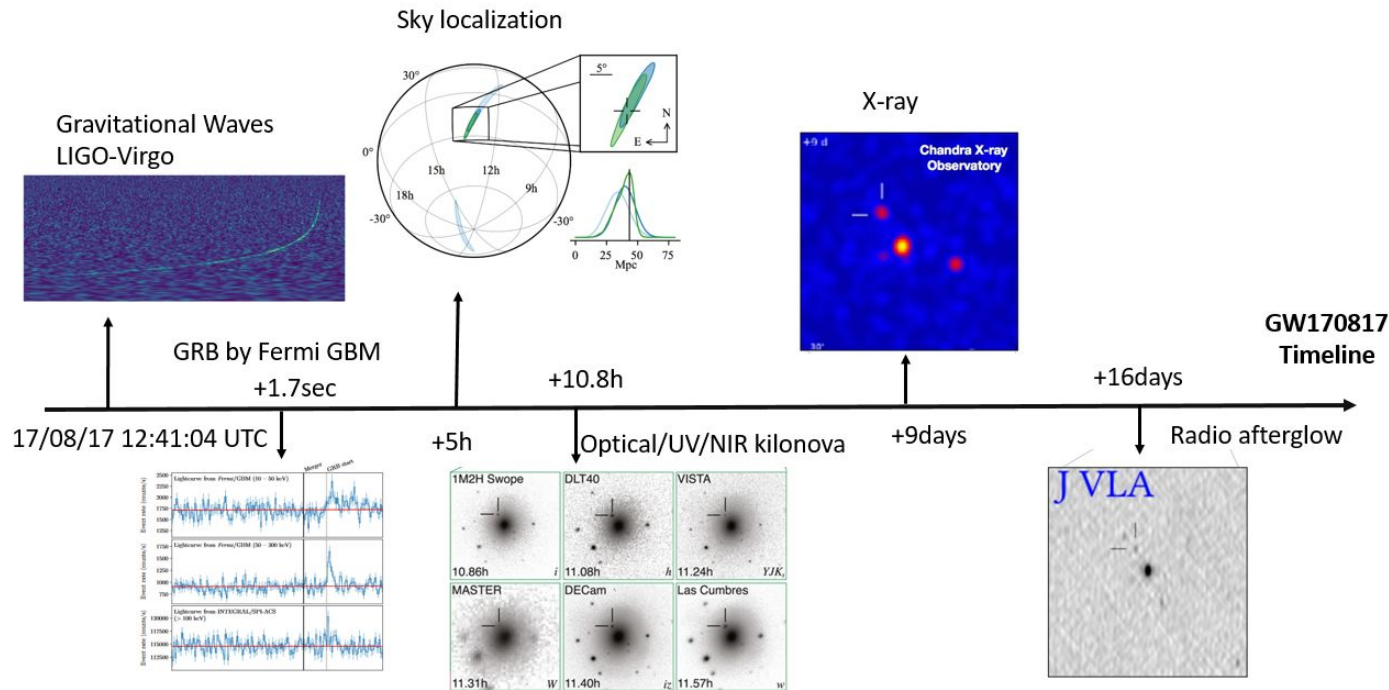
Wavefier Online / Offline Architecture



Wavefier 2.0 status

- ✓ Restarted Version 1 on local machines
- ✓ Software updated <https://gitlab.com/wavefier2021>
- ✓ Installation at CNAF Cloud kubernetes cluster
- ✓ Interaction with WP2 group for participation to ESCAPE DAC2021
- ✓ Work on going for on line challeng for Virgo O3 replay challenge
- ✓ Need to integrate Wavefier with updated ML workflow on cluster with GPU.

Multimessenger Astronomy: GW170817 detection and EM follow up



Gravitational Waves & Multimessenger astronomy

- **Short GRB**

Fermi GBM, INTEGRAL, Astrosat, IPN, Insight-HXMT, Swift, AGILE, CALET, H.E.S.S., HAWC, Konus-Wind

- **Gravitational waves (well-modeled)**

Ligo/Virgo

- **X-Ray**

Swift, MAXI/GSC, NuSTAR, Chandra, Integral

- **UV**

Swift, HST

- **RADIO**

ATCA, VLA, ASKAP, VLBA, GMRT, MWA, LOFAR, LWA, ALMA, OVRO, EVN, e-MERLIN, MeerKAT, Parkes, SRT, Effelsberg

- **IR**

REM-ROS2, VISTA, Gemini-South, 2MASS, SPITZER, NTT, GROND, SOAR, NOT, ESO-VLT, Kanata Telescope, HST

- **Optical**

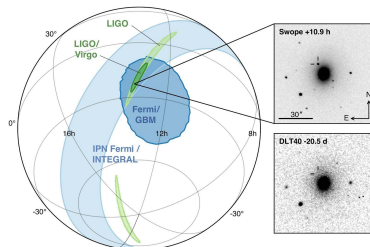
Swope, DECam, DLT40, MASTER, VISTA, ESO-VLT + *others*

EARLY
TRIGGERS
(sec to mins)

BROADBAND
FOLLOW-UP
(hrs to days)

**Binary Neutron Star
Merger**

- *Fast alert and sky Localization for follow-up study*
- *Better understanding of physical processes (e.g. heavy-element nucleosynthesis)*



Abbott et al. (2017)

- **Neutrinos**

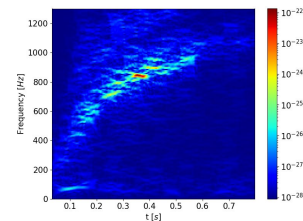
(prompt emission of ~ 90% of total CCSNe energy)

IceCube, ANTARES, Pierre Auger Observatory

- **Gravitational waves**

(prompt emission, unknown waveform, carry little energy)

Ligo/Virgo



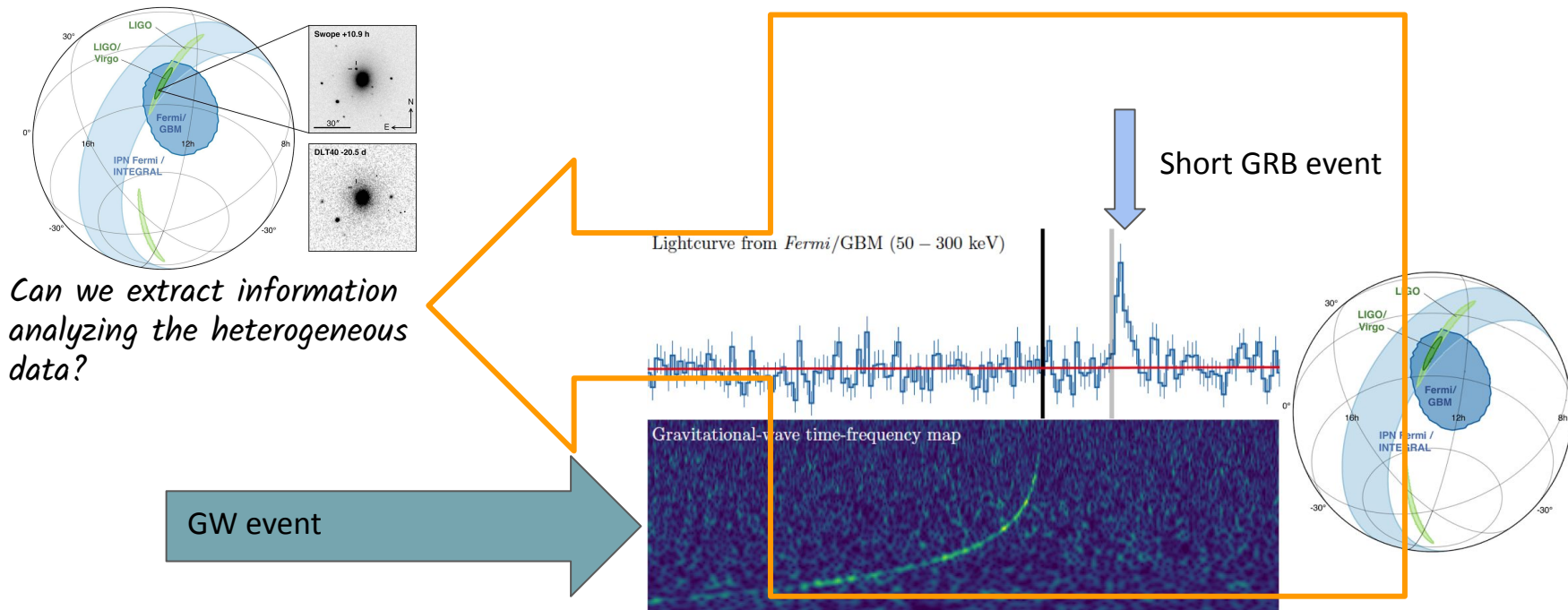
less et al. (2020)

- **E.M. emission (delayed emission)**

Core-Collapse Supernovae

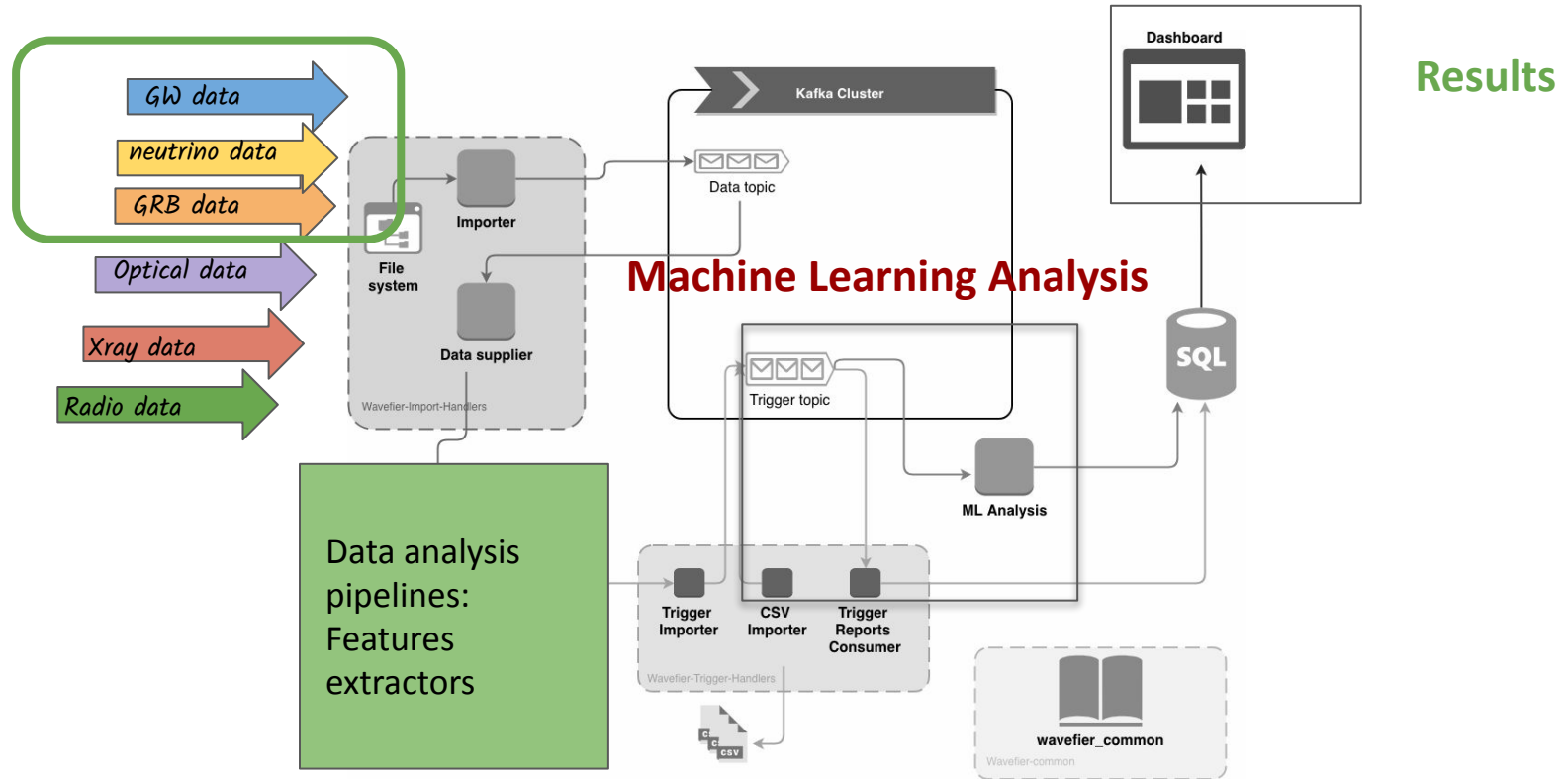
- *Shed Light on explosion mechanism (neutrino-driven, MHD, acoustic)*
- *Information on physical characteristics of progenitor star (mass, rotation)*
- *Information on proto-neutron star*

Multi-probe real time analysis



<https://arxiv.org/abs/2110.09833>

Multi-probe real time analysis



WP3.4 tasks

Objectives

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Why didn't work?

- Not interesting project?
- Not enough man power?
- Not good organization?
- What else?



Real time multi-messenger (MM) analysis: what's next

- For GWs: [Wavefier](#)
- MM analysis: extension of [Wavefier](#) to other messengers (photons, neutrinos)
- A large set of data (both simulated and real) is needed for testing purpose
- The dataset (MM simulator) so far:
 - GW data from LIGO, Virgo, KAGRA, ET (hdf5 files)
 - High level EM data from CTA (fits files)
 - Fermi-LAT light curves (fits files)
- What's missing:
 - High level neutrino (KM3Net) data and expert people
 - Raw (low level) EM (CTA) and neutrino data and expert people

Neutrino data

- We need a set of real or simulated high-level (low-level) neutrino data, to be coupled/injected (and analysed) together with EM and GW data
 - Who can act as reference person for KM3NeT?
 - Who can help with the integration of neutrino data?
 - Should we prepare a document/MoU to request the data? Are there public data we can use?
- Ongoing project @ECAP on multi-messenger (CTA + KM3NeT) analysis for AGN flares (see <https://indico.in2p3.fr/event/24280/>)
 - Is there someone involved in this project? Which is the status?
 - Are there common tools we can use?

EM raw data

- Who can help with the integration of CTA raw data?
- There are other ESCAPE test cases that require access to raw CTA data:
 - *GammaLearn*
 - *Data Lake tests*
- Would a single reference dataset be enough, or different datasets are needed for the different test cases? A document was set-up by Thomas Vuillaume to collect the relevant informations from all the test cases; any update on this?
- An MoU to get access to the raw CTA data should be prepared; any update on this?
- Do we want to put GammaLearn into a common framework with Wavefier?