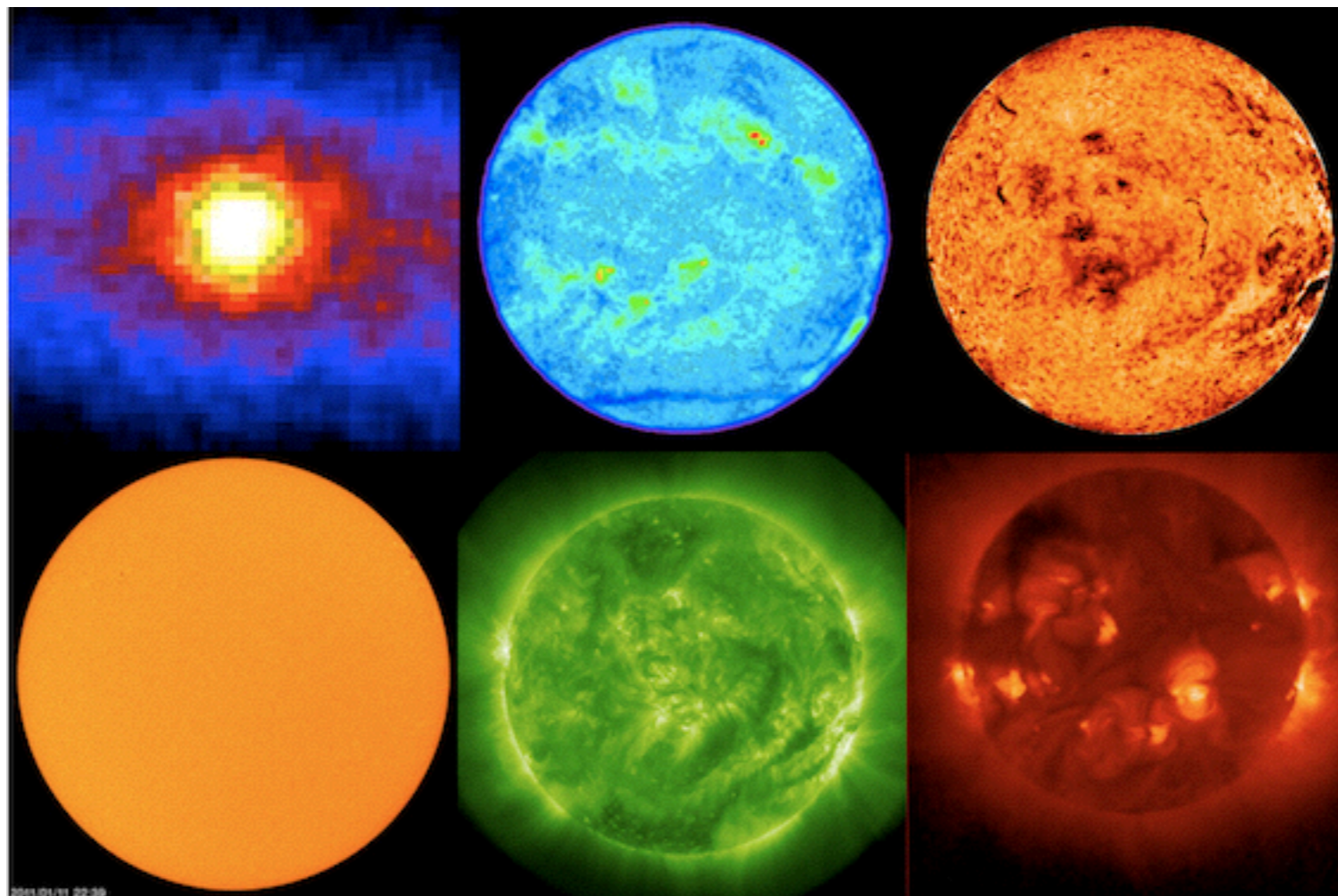


WP 7

Multi-messenger analysis



D. Dornic (CPPM)

H2020 kick off meeting - Athens - Feb 2017

Context: fast development of the time-domain and multi-messenger astronomy (new large astronomical facilities existing in ~2020)



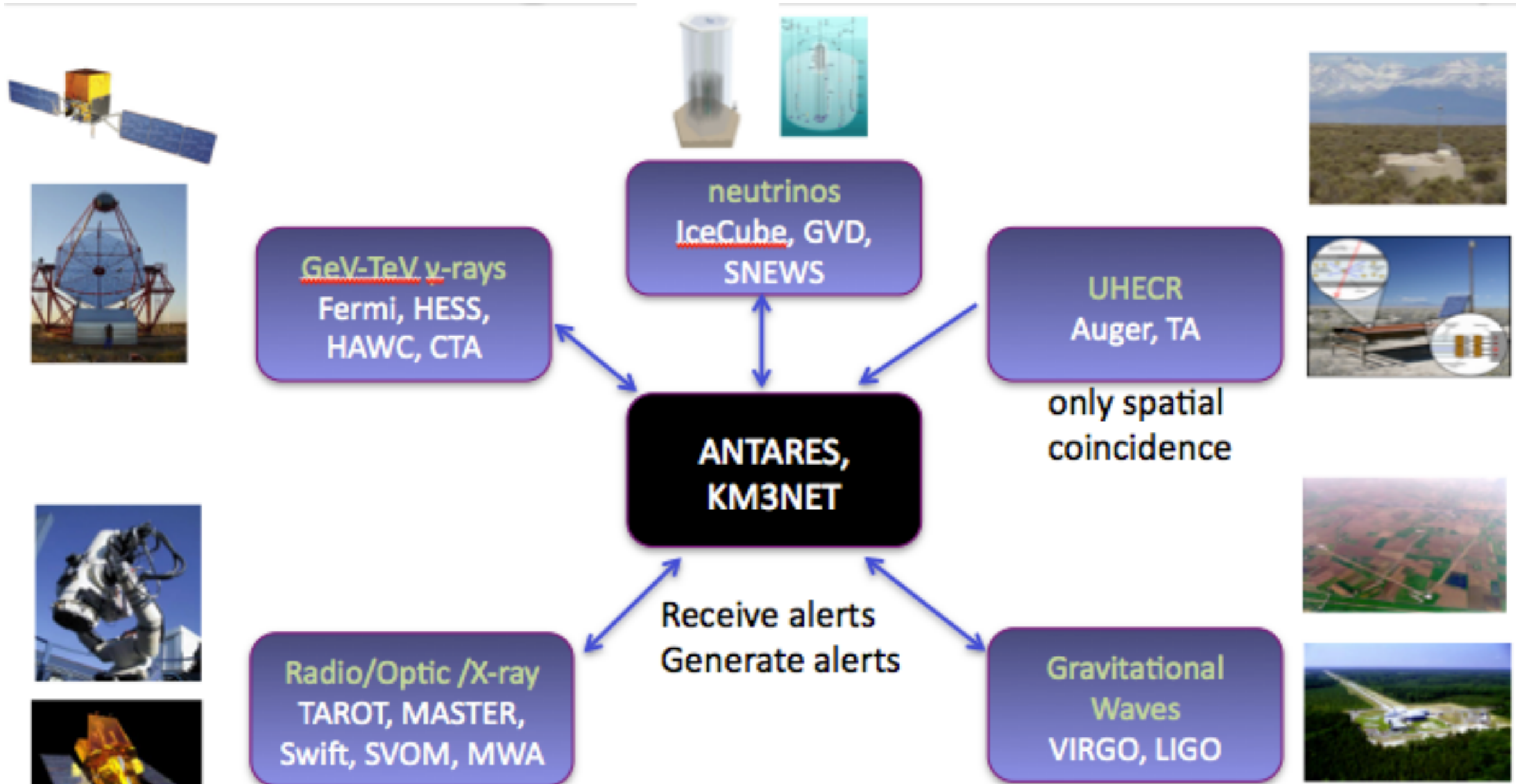
Memories of Neil Gehrels

A thought to this visionary in the time-domain astronomy



<http://www-glast.stanford.edu/neil/gbook.php>

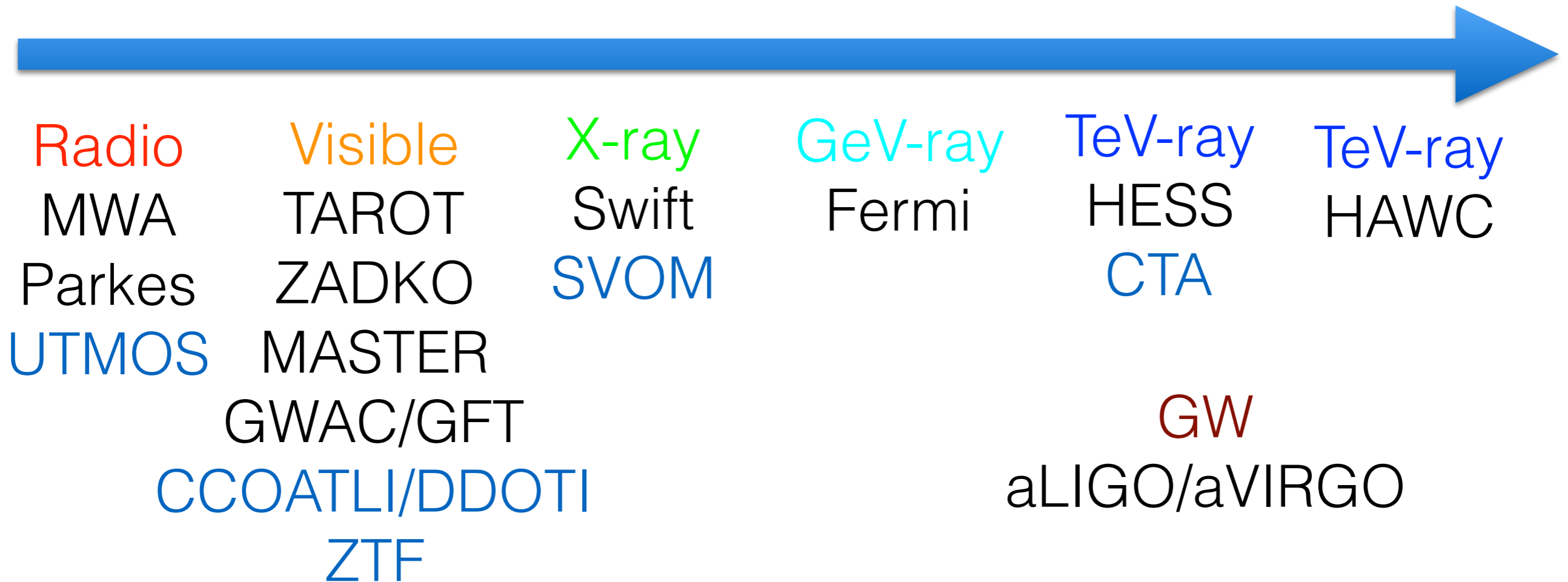
Multi-messenger / Multi-flavour astronomy



- Space/time correlation reduced background (improved sensitivity)
- Track and shower topologies
- Rapid (few secs) real-time alerts for interesting neutrino events
- Event-by-event identification of neutrino origin

Follow-up: experience of ANTARES

Private MoU with all the observatories + AMON

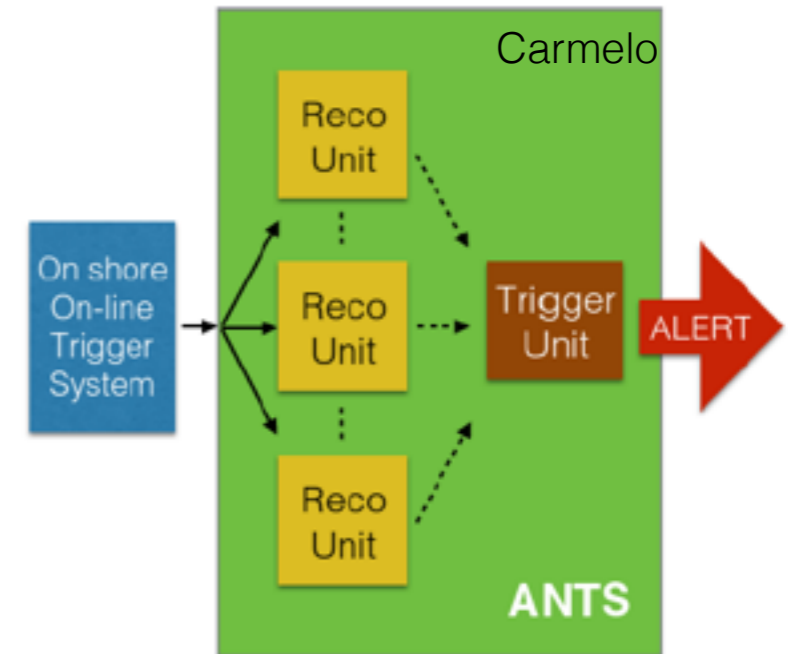


For some observatories, it is a long task:
=> need to start soon, especially for LVC

Task 7.1 & 7.2

Task 7.1: Develop algorithms for fast real-time event reconstruction (Tracks + Showers - ORCA +ARCA) (36 months)

- Able to reconstruct all events in real-time despite the large data-taking rate
- Keep the offline performances on-line



Task 7.2: Develop real-time system to distribute neutrino alerts to the worldwide astrophysical community (24 months)

- Create the event filters to select the neutrino candidates
- Send the alerts to the astro community

The screenshot shows a software interface for real-time reconstruction and alert distribution. It is divided into several sections:

- Reconstruction:** Includes controls for 'Run' and 'Stop', and a table of program status for '2016:V1.2'. The status is 'Ok, Program is running' on machine 'shift@anttato0'. It shows trigger rates of 3.55 Hz and is connected to 'ligier' on host 'node-9'.
- Offline:** Shows a program running on 'shift@anttato0' with a 'Ligier alive' status.
- BBwebliq:** Shows a program running on 'shift@anttato0'.
- Rate Filter:** Shows a 'PASS' status with a threshold of 80 and a current rate of 3.55.
- Connections:** A table listing various sites and their connection status. Most are 'Connected' with a 'Pass' filter, but 'Master Kislovodsk' is 'Conn refused'.
- Notices:** A list of recent alerts with details like date, time, and event ID.
- Alert Distribution:** A 'Send Alert Manual' button and a 'Show log' button.

The interface also displays the current date and time: 'Fri Feb 10 13:38:12 UTC'.

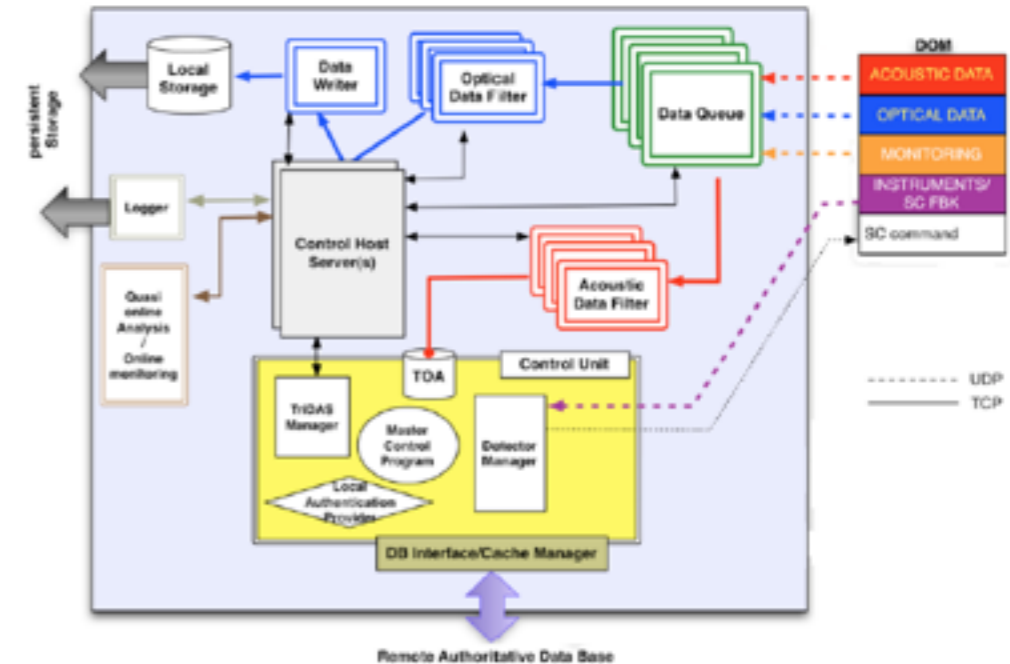
Task 7.3, 7.4 & 7.5

Task 7.3: Develop real-time system to receive alerts from the other observatories and store the complete raw data on disk for a short duration around the alert (like L0 GRB in ANTARES)

Task 7.4: Develop real-time algorithms for the detection of nearby supernova explosions and integrate within the worldwide SNEWS alert system

Task 7.5: Establish MoUs with relevant astronomical telescopes and satellites

- Establish a MoU template (MoU KM3NeT/MWA)
- Contact EM followers
- Special case: LVC + AMON
- Private GCN for intercommunication (eg private LVC GCN) + mailing list



Memorandum of Understanding

ANTARES-MASTER

Optical follow-up of "special" neutrino events
from the ANTARES detector with the MASTER telescopes

The ANTARES telescope has the potential to detect transient sources emitting high-energy neutrinos, such as gamma-ray bursts (GRBs), core-collapse supernovae (SNe), flares of active galactic nuclei (AGNs)... To enhance the sensitivity to these sources, a new detection method based on the coincidence of neutrino signal and an optical detection has been developed. The ANTARES Collaboration has implemented a fast on-line track reconstruction with a good angular resolution. These characteristics allow triggering an optical telescope network in order to help identify the nature of the neutrino sources. This Memorandum of Understanding formalizes the agreement between the ANTARES and MASTER Global Robotic Net Collaborations to assure the optical follow-up of the neutrino alerts. The project is named ANTARES-MASTER in the context of the TAToO program (Telescopes - ANTARES Target of Opportunity).

Introduction:

The search for HE neutrinos from transient sources can be performed using two different approaches: the triggered search method and the rolling search method. The first method is based on the search for neutrino candidates in conjunction with accurate timing and positional information provided by an external trigger: the triggered search. The second method is based on the search for "special neutrino events" originating from the same location within a given time window: the rolling search. The purpose of this Memorandum of Understanding is the use of the MASTER telescopes for the optical follow-up of ANTARES neutrino alerts resulting from the rolling search. MASTER is universal follow-up/alert and survey telescope. Up to this moment MASTER discovered 700 optical transients (more than 200 per year), during its own survey and alert modes.

The MASTER Global Robotic Net is comprised of ten 40-cm optical robotic telescopes located in five working observatories:

MASTER-Azur (LONG 127.483333, LAT 50.3186111),
MASTER-Tunka (103.067392, 51.810000)
MASTER-Ural (59.54166666, 57.03638888)
MASTER-Kislovodsk (42.52361666, 43.74611666)
MASTER-SAAO (20.810682, -32.379369)

and two very wide field cameras, installed at MASTER-ICATE (-31.802250, -69.000000).
(and two observatories are building now).

Summary

Work package number	7	Start Date or Starting Event					Month 3
Work package title	Multi-messenger astronomy						
Participant number	1	2	3	4	5	6	
Short name of participant	FOM	CNRS	FAU	UVEG	INFN	NCSR-D	
Person/months per participant:	3	40	9	-	14	-	
Start month	1			End month		36	

=> Post-doc 2+1 yrs at CPPM

=> A lot of work: all interested persons can contact me to organize a KM3NeT Multi-messenger group (ORCA/ARCA)

=> Regular deliverables all along the project

Deliverables

- D.7.1. Report on the online event reconstruction development (month 24);
- D.7.2. Report on the online alert sending and receiving system (month 24);
- D.7.3. Report on the online physics analysis (month 36);
- D.7.4. Report on the online SN detection system (month 36);
- D.7.5. Report on the status of the MoU negotiations (month 12);

Time-domain + Multi-messenger: What we know now is just a foretaste of what is to come in the future...