
KM3NeT Alert System

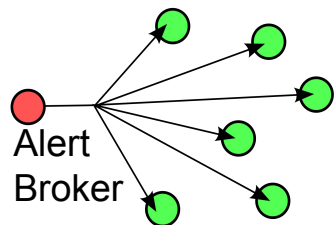
— Jan. 24, 2025 Status - Vincent C. —

Disclaimer

Preliminary material is shown: following information may be subject to final changes.



KM3NeT and Multi-Messenger astronomy



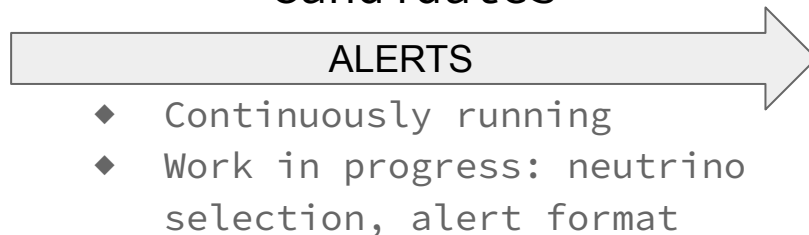
Follow-up: search for neutrino counterpart



Existing pipeline



Identify and Share neutrino candidates



GCN
SNEWS

Today's subject

→ Make other instruments aware of an interesting event seen by KM3NeT

Finality: send alert

```
{  
  "$schema": "https://gcn.nasa.gov/schema/main/gcn/notices/km3net/test/medal_ranking_alert.schema.json",  
  // Reporter  
  "mission": "KM3NeT",  
  "instrument": "ARCA021",  
  "messenger": "Neutrino",  
  "packet_type": 999,  
  // Alert  
  "alert_tense": "test", // current  
  "alert_type": "initial",  
  "alert_datetime": "2024-09-01T12:01:00.00Z",  
  "analysis_pipeline": "exceptionnal_evt_arca",  
  "additional_info": "Observation from single/>1 KM3NeT pipelines. Track only/+Shower analysis. Up-going",  
  // Event  
  "event_name": ["KM240901A"],  
  "id": [2],  
  "trigger_time": "2024-09-01T01:16:47.0Z",  
  "ra": 13.82,  
  "dec": 19.01,  
  "ra_dec_error": 0.9,  
  "healpix_url": "https://www.km3net.org/about-km3net/open-access/",  
  "far": 8.029e-8,  
  "significance": 0.99,  
  // Details  
  "alert_topology": "Multiplet", // Multiplet, Shower, Track.  
  "number_of_events": 2,  
  "src_error_50": 0.4,  
  "potential_counterpart": true,  
}
```

Detector related info

Alert details

Time
Position
Statistics

```
"potential_counterpart": true,  
  "events_details": [  
    {  
      "id": ["196_21343_72853_13018_6"],  
      "trigger_time": "2024-09-01T01:16:47.0Z",  
      "ra": 13.82,  
      "dec": 19.01,  
      "ra_dec_error": 0.9,  
      "cos_zenith": 0.01,  
      "prob_evt_topology": "Track",  
      "reco_energy": 1.2e5 // GeV  
    },  
    {  
      "id": ["196_21343_72853_13018_9"],  
      "trigger_time": "2024-09-01T01:16:47.0Z",  
      "ra": 13.82,  
      "dec": 19.01,  
      "ra_dec_error": 0.9,  
      "cos_zenith": 0.01,  
      "prob_evt_topology": "Track",  
      "reco_energy": 1.2e5 // GeV  
    }  
  ],  
  // Astro related data, additional sources  
  "counterpart_info": [  
    {  
      "name": "SourceName",  
      "reference": "url to catalog or notice",  
      "ra": 13.0,  
      "dec": 19.5  
    }  
  ]  
}
```

Framework overview

Acquire & process data

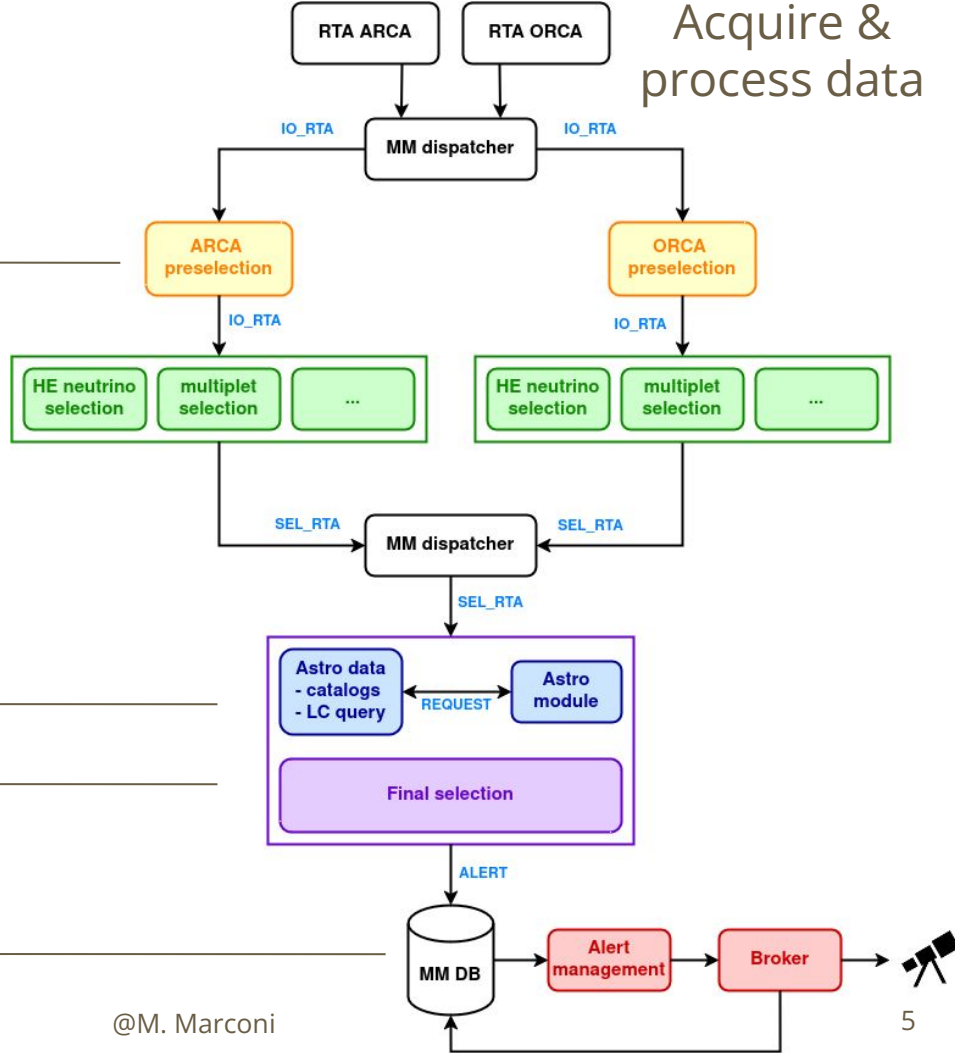
Reduce data flow

Select candidates of interest

Gather pipeline's info

Search for counterpart

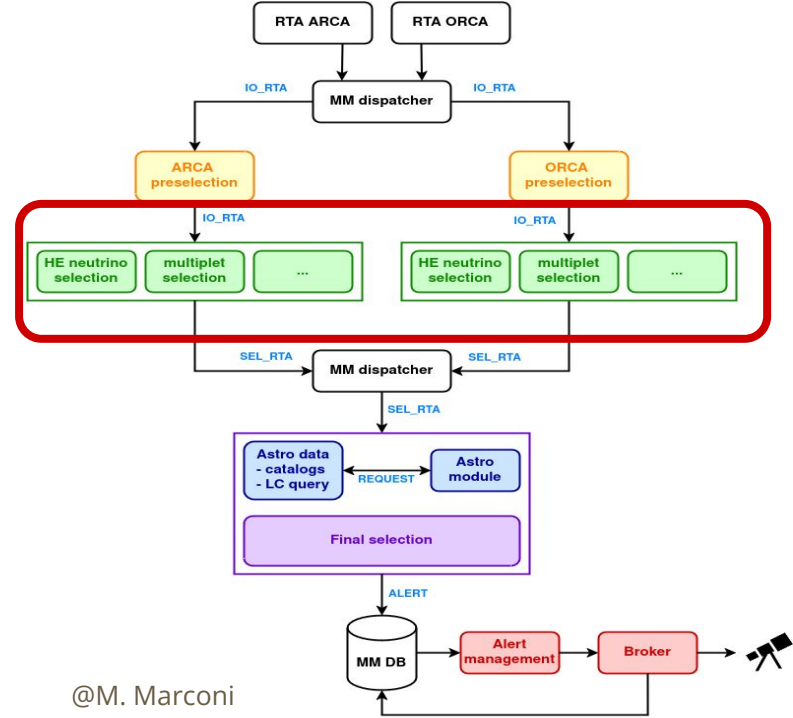
Fill JSON/VOE template + send



Event selection

- 2 selections, 2 detectors
- Compute False Alarm Rate (FAR)
- Identify how many events with more extreme parameters are likely to occur
- Select if FAR is low enough

HE: Exceptional event by itself
⇒ FAR on event parameters is sufficiently low to report the event.



@M. Marconi

- Multiplet**: Coincidence search
- Look for space-time correlated events in our data.
 - Compute FAR on correlation probability.

Final selection

→ Compute Significance

Translate FAR to p-value

→ Compute multiplet position

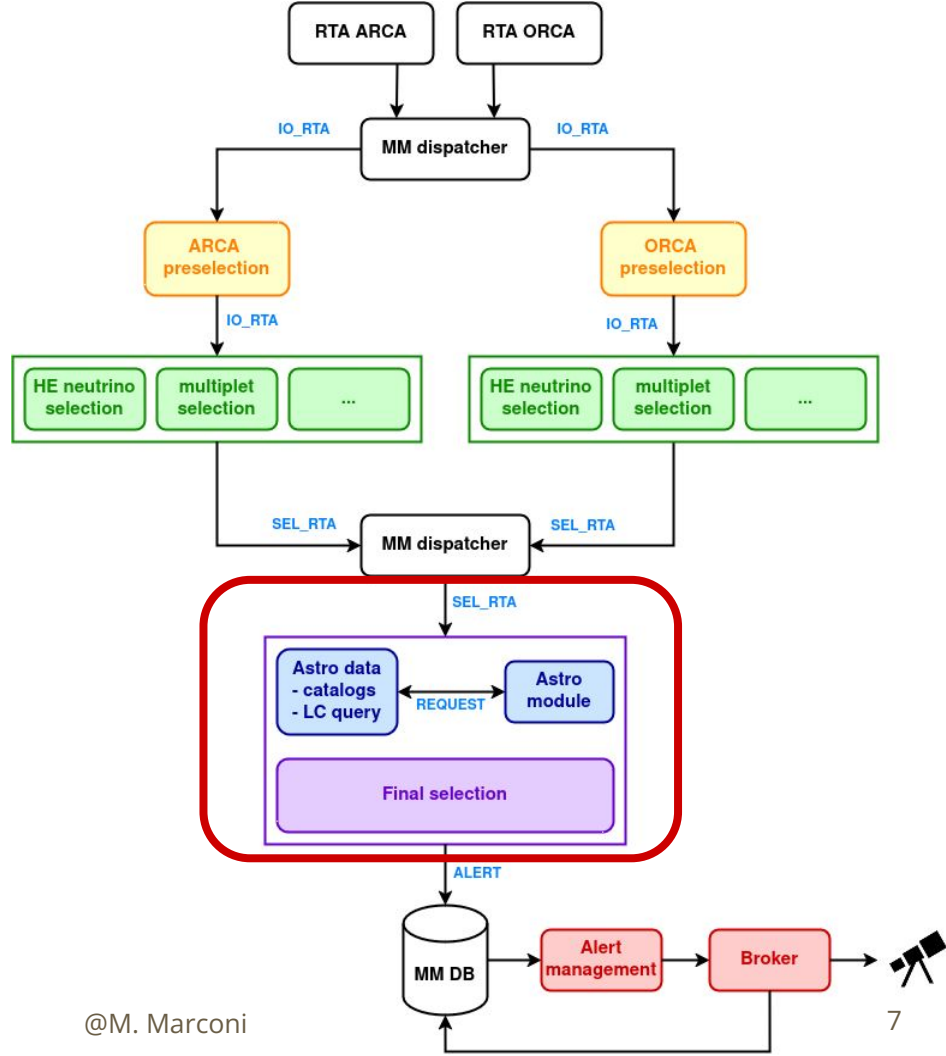
Weighted arithmetic mean

→ Healpix map

→ Astro Module

Search for counterpart

⇒ if FAR < 1/month: send alert



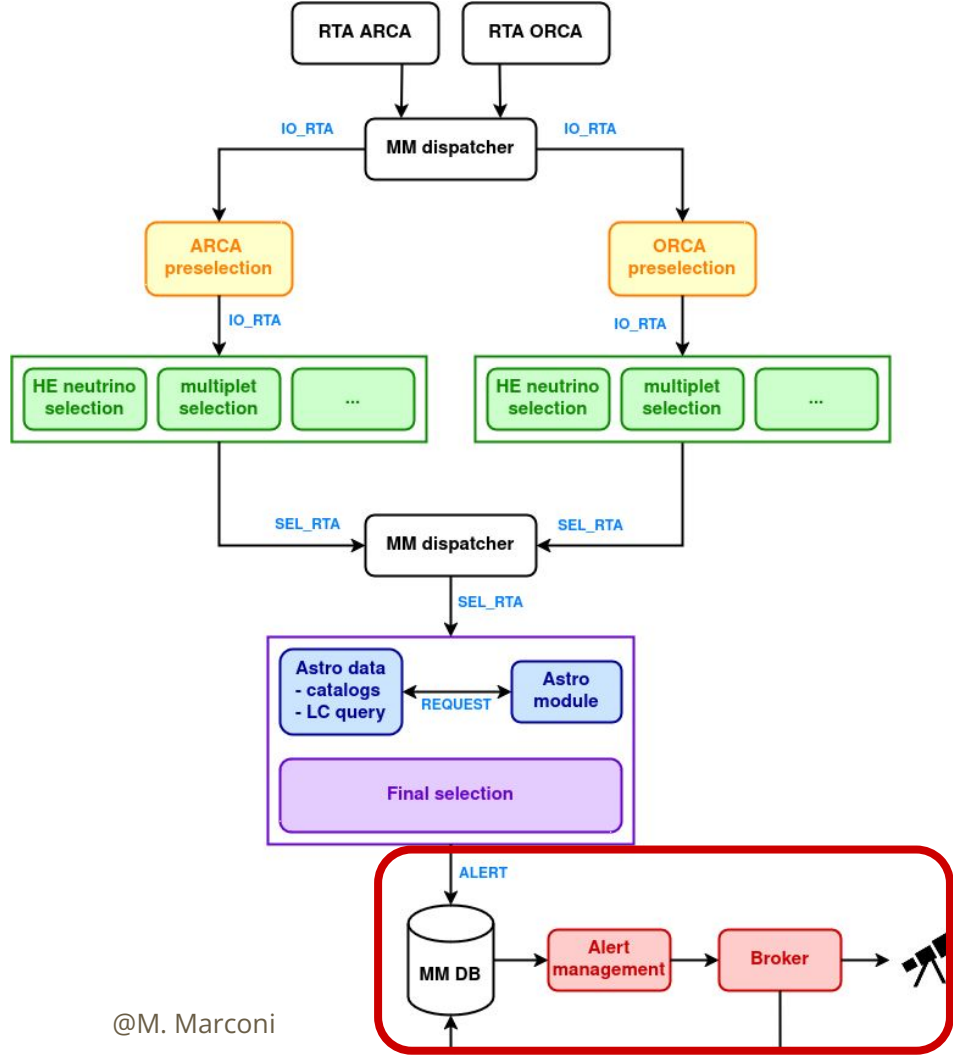
Create & Report Alerts

Listen to internal DB and report the new entries

⇒ No (physics) selection at this stage, 2 modules:

- **Handle** the event: parse the DB entry and fill templates
- **Report** the information:
 - Internal (mail, rocketchat)
 - GCN (if no veto) through Kafka

NB: SN alerts use the same software



Take away

Alert sending architecture and format are defined

- Single alert type (no Gold/Bronze)
- Significance and Counterpart: incentive to follow-up our alerts (in addition to Time/Position).

Alerts will be sent to **GCN** in JSON and VOEvent formats via Kafka protocol

- JSON alerts share a common core with IceCube

Alerts sent for events with FAR < 1/month