KM3NeT alerts system

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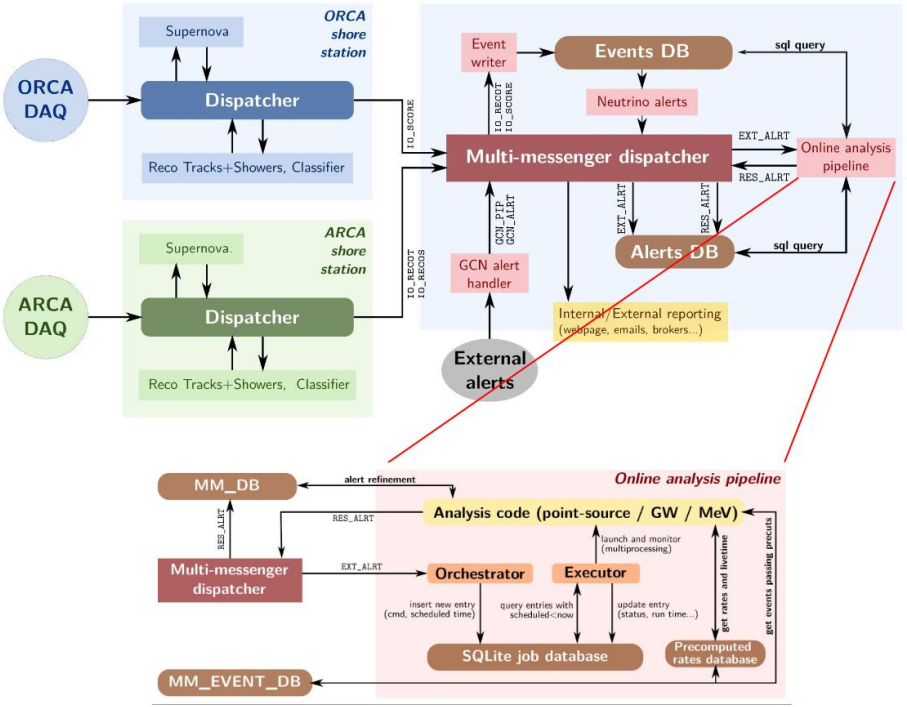
Damien Dornic

3rd AstroColibri Workshop
September 17, 2024

The alert-sending infrastructure



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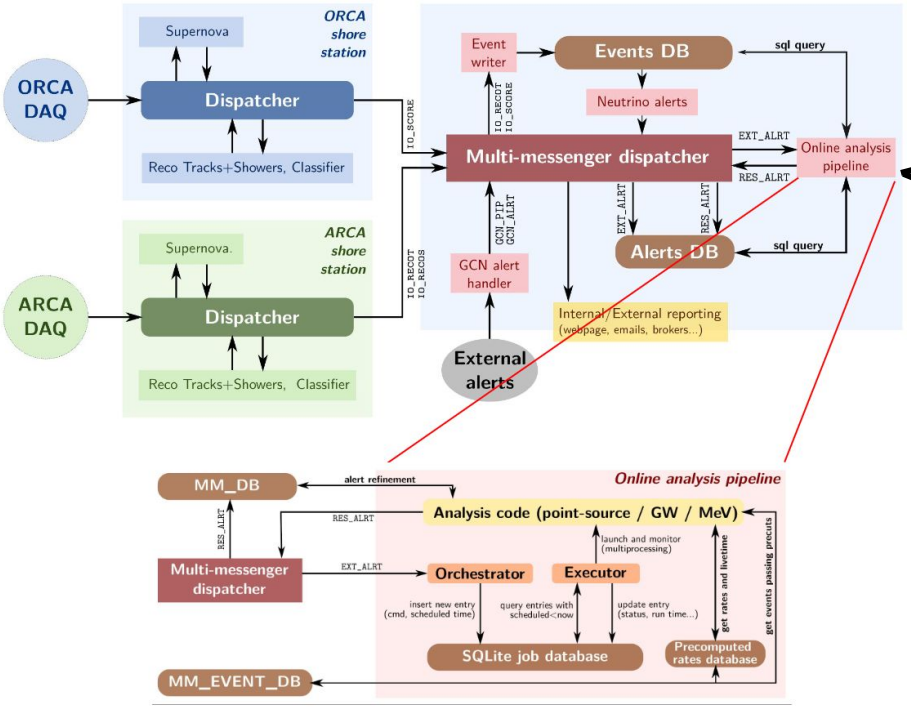
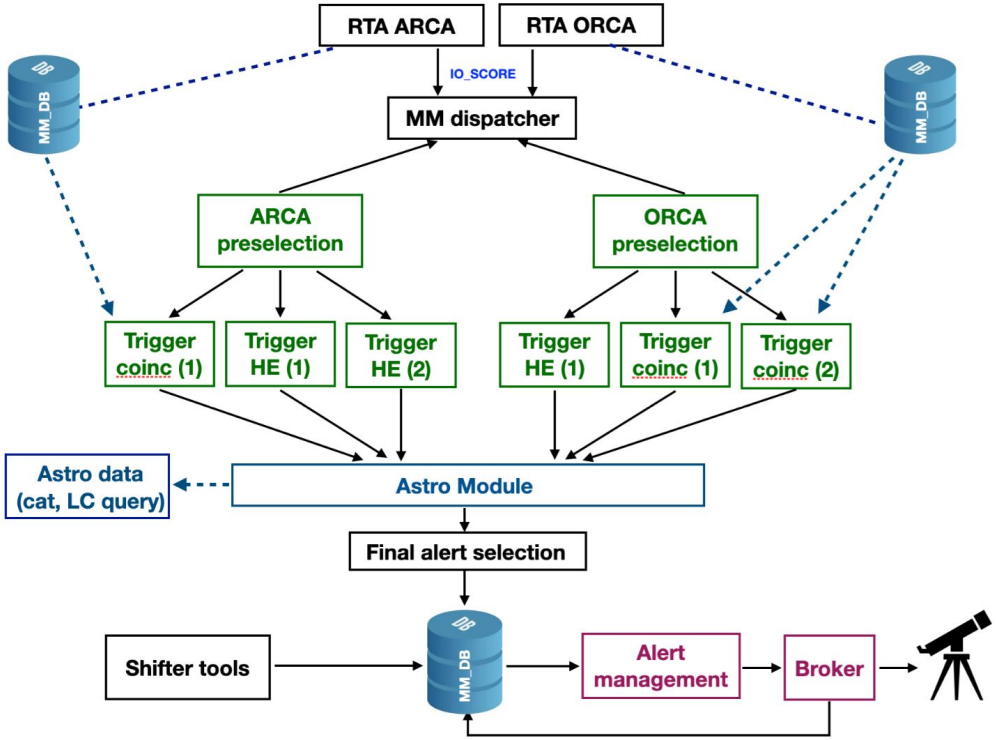


Results of our follow-up of external alerts
(see Silvia Celli's presentation)

Releasing internal alerts

The alert-sending infrastructure : internal alerts



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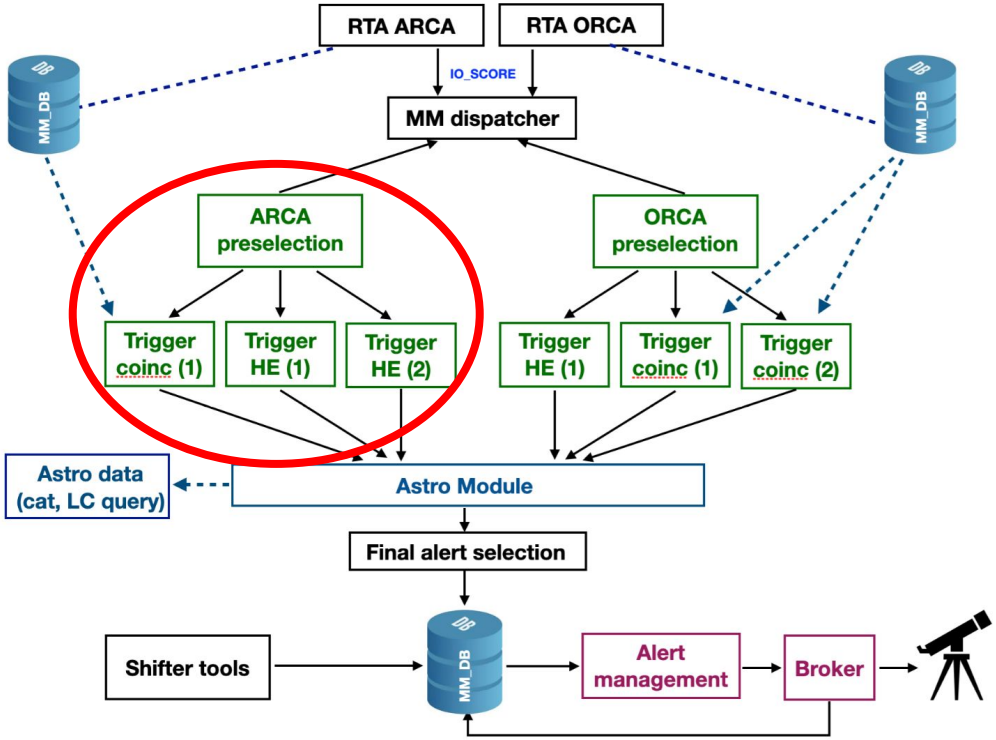
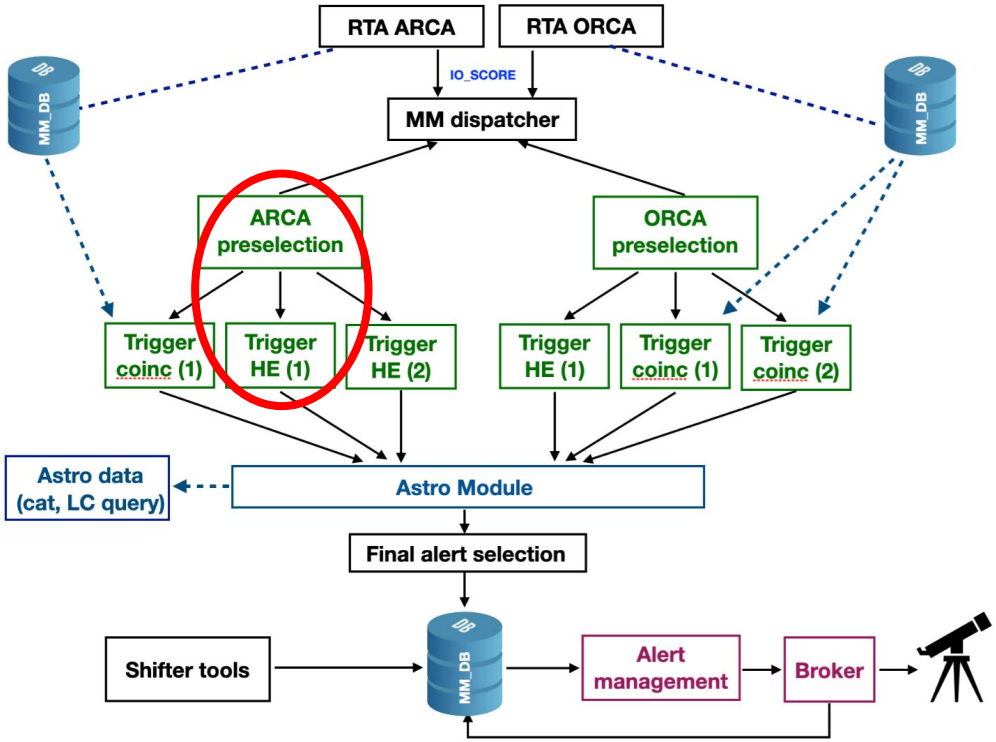


Example of internal alert analysis : ARCA HE

PRE-SELECTION CUTS	
Minimal quality cuts	Energy [GeV] > 0
	RecoQuality > 0
	RecoBeta0 [rad] > 0
	TrackLength [m] ≥ 150
Relaxed upgoing cut	BestMuonDz > -0.1
Additional cuts	RecoQuality > 110
	TrackLength [m] > 150
	Energy [GeV] > 100

- Cosmic neutrino rejection: 0.75
- Atmospheric background rejection: 0.99997

reach ~500 events / month

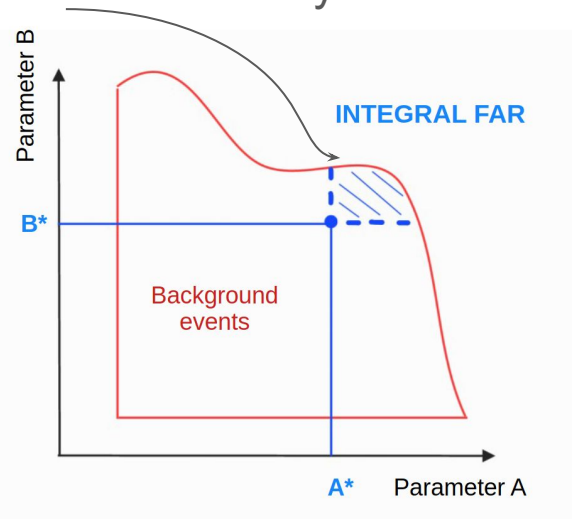


Example of internal alert analysis : ARCA HE

Store a dataframe containing ARCA MC simulated events after pre-selection.

For any real-time neutrino candidate that pass the same pre-selection :

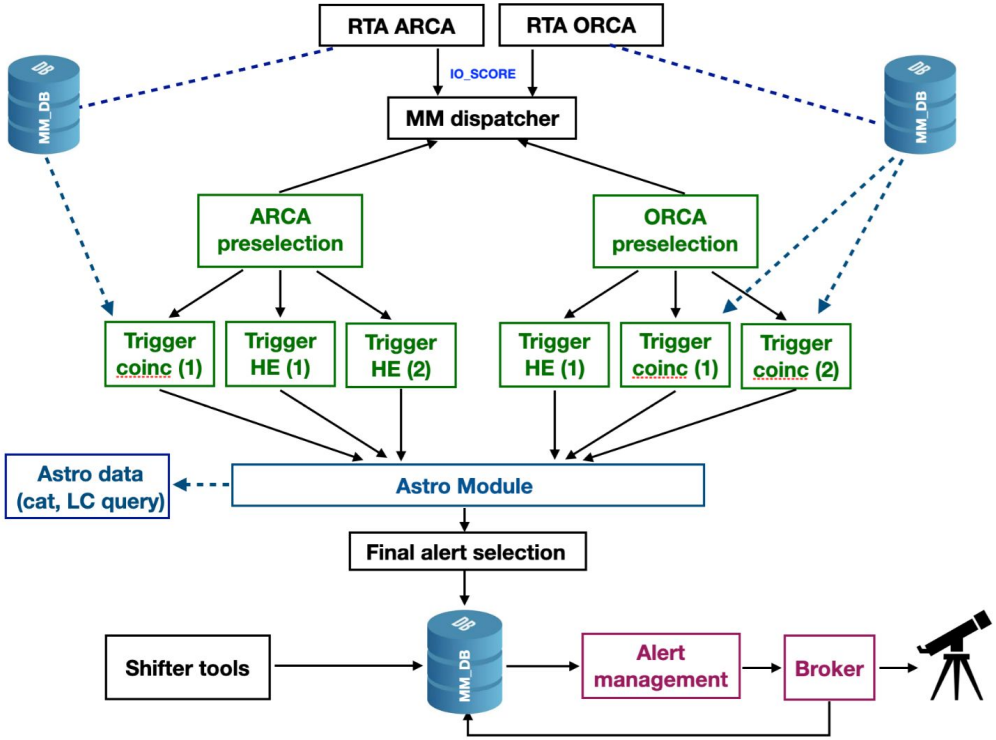
Compute the number of background events that we expect in 1 month that pass the cuts defined by the candidate itself : FAR



Used parameters : RecoQuality, TrackLength, Energy

For any event passing a given FAR threshold compute the directional error evaluation

The alert-sending infrastructure : internal alerts



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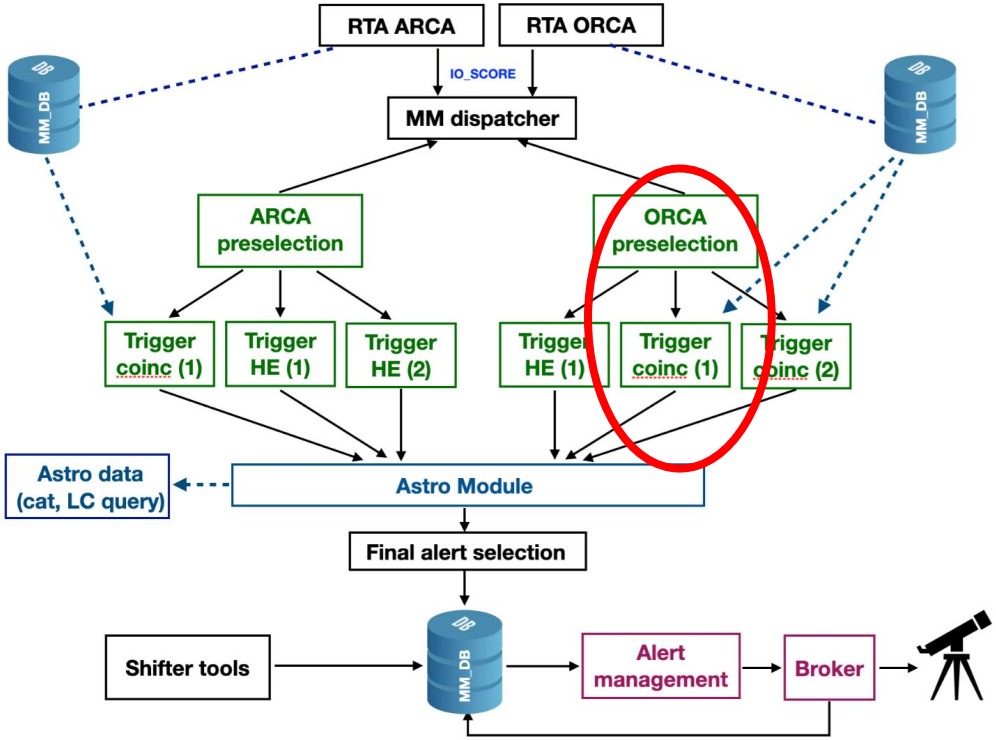
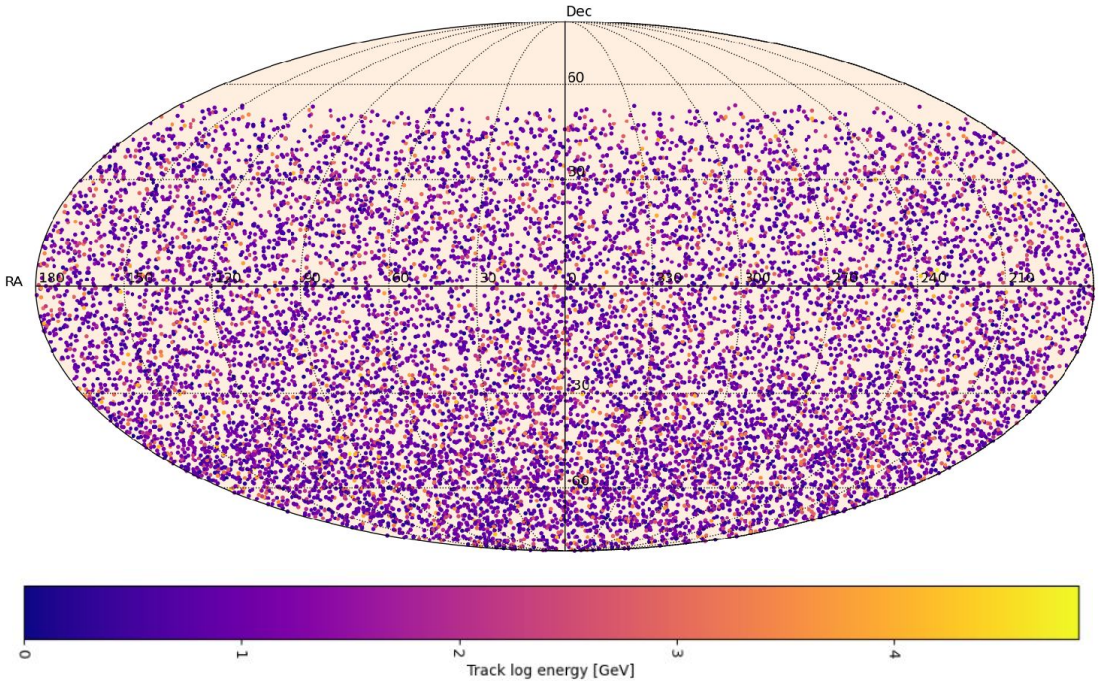


Example of internal alert analysis : ORCA multiplet

Look for multiplets of events, i.e. more than one event coming from compatible sky localisation in a given time window



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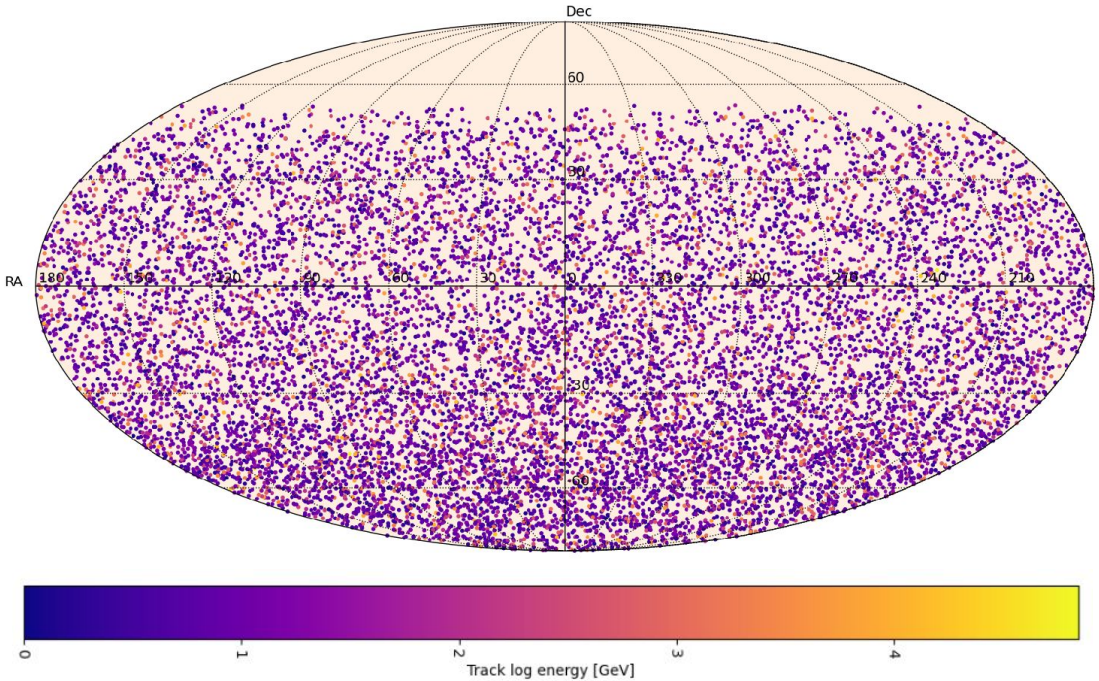
Look for multiplets of events, i.e. more than one event coming from compatible sky localisation in a given time window

Probability of time correlation between two events :

$$P(\Delta t \leq \tau|\lambda) = 1 - e^{-2\lambda\tau}$$



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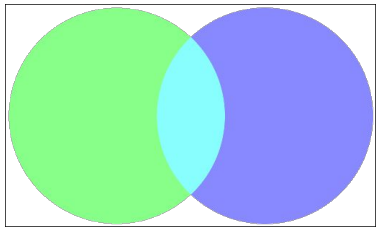
Probability of localisation correlation between two events (example of computation):

$$\text{ploc} = 1 - \left(\frac{N_{\text{comp}}}{N_{\text{use}}} \times \left(1 - \frac{N_{\text{use}}}{N_{\text{tot}}}\right)\right)$$



Ncomp = overlapping pixels (cyan)

Nuse = union pixels (green+blue+cyan)

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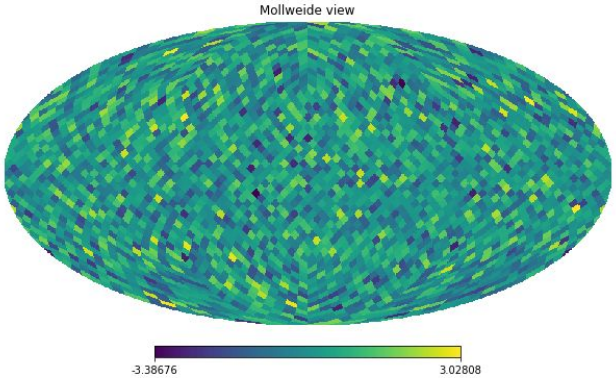

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Overall score (example of computation):

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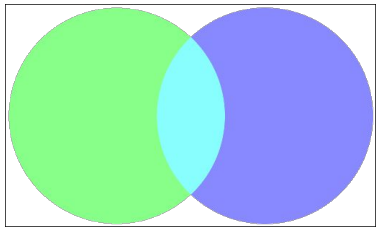

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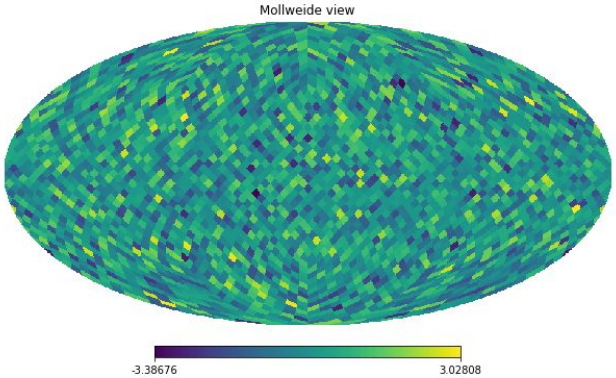

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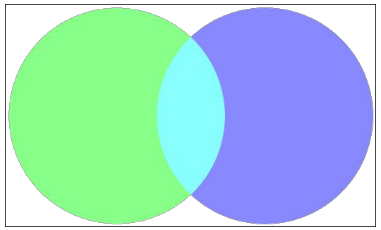

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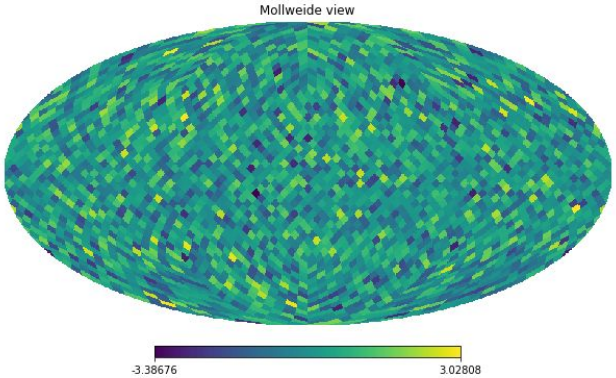
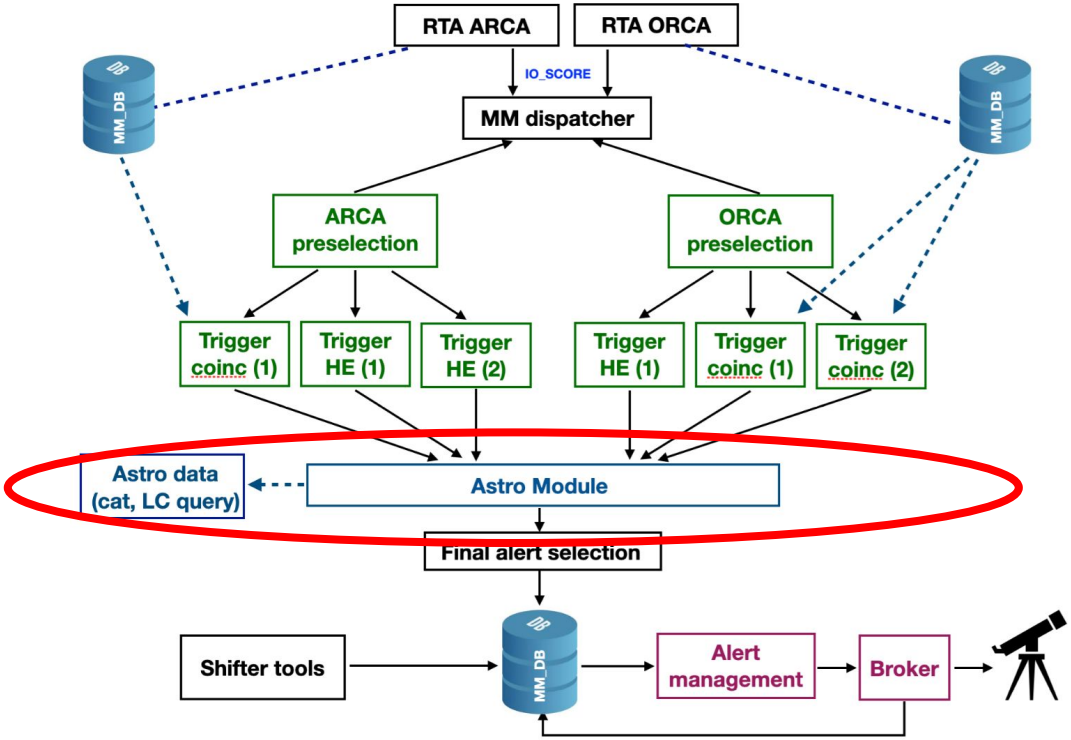


Compute the FAR and if it pass a given threshold, compute the convolved sky localisation for the alert

The alert-sending infrastructure : internal alerts



The alert-sending infrastructure : astro alert module

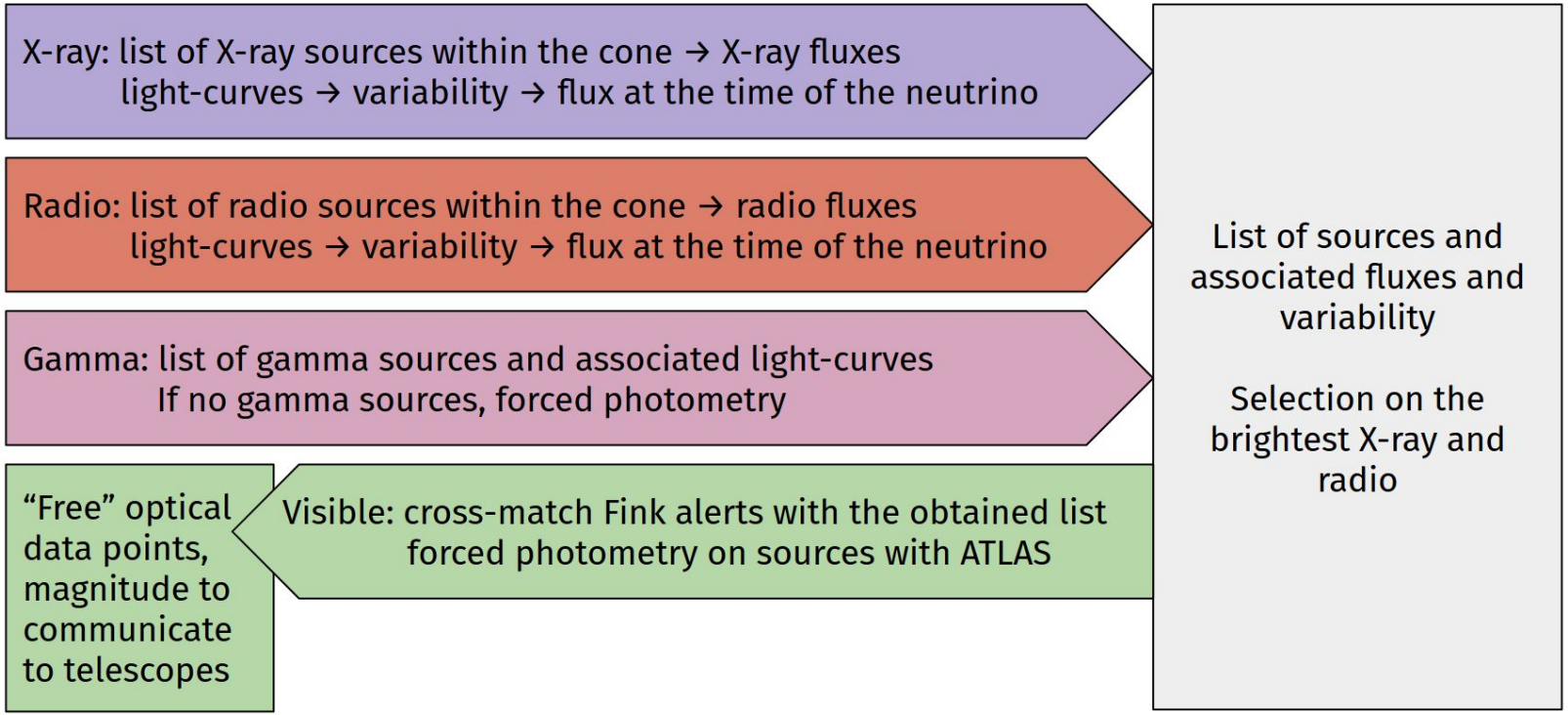
To enhance the scientific output and the community effort in follow-up we propose to incorporate astrophysical ingredients

→provide clear scientific objectives and constraints for the observation

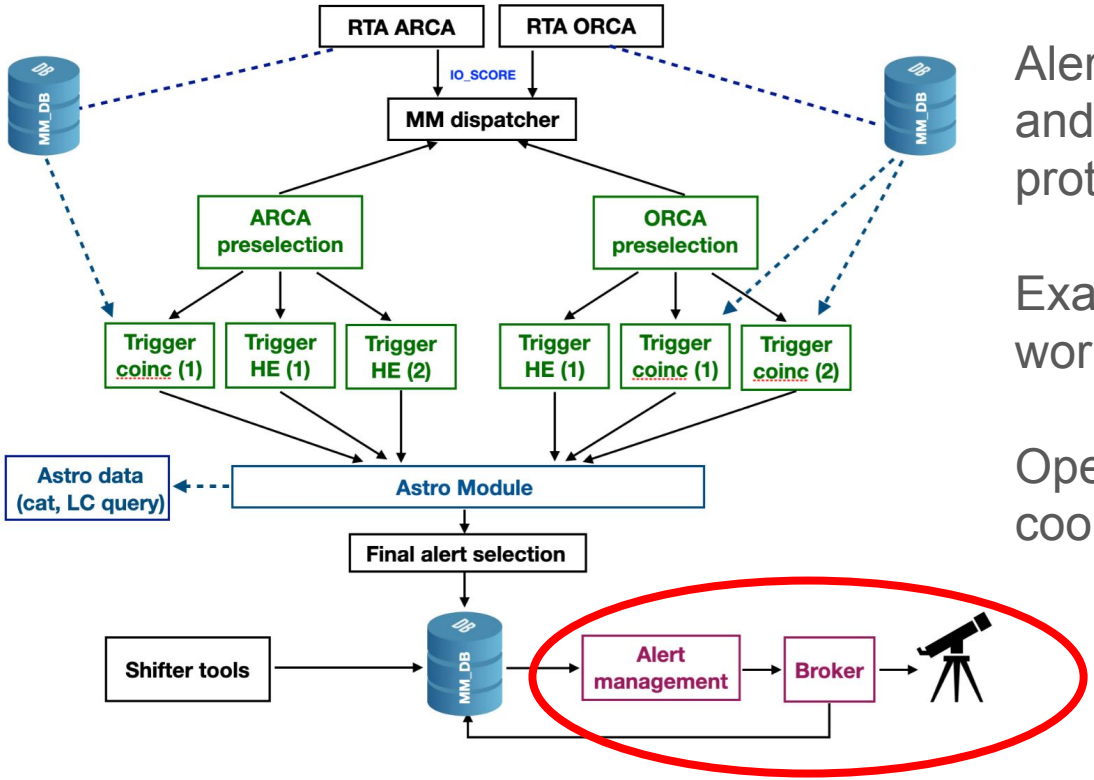
For every neutrino candidate passing a given FAR threshold

→ retrieval of available public astronomy data (from catalogues + light curve repositories)

The alert-sending infrastructure : astro alert module



The alert-sending infrastructure : alert management



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

Exact KM3NeT alert format is still a work in progress

Open discussion with IceCube to coordinate a common core schema

Conclusion

The KM3NeT online alert sending system development is making great progress

First end-to-end test made last week

Alert structure and topologie is being fixed

First public alerts soon
(few months scale)