

## Follow-up strategies of GW events for O4

For GRANDMA

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### GW events

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#### Science cases

- Early prompt observations of Kilonovae and GRB afterglows associated to GW events
- Early and late observations of supernovae associated to GW events in the local group
- Accretion/ejection physics" associated to BBH mergers associated to BBH events

#### Roadmap

- Define the criteria based on simulations to perform the filtering of the alerts
- Define the criteria we need for the follow-up, tools, processing, observations needed to achieve a performant follow-up that depends on the source
- WHO DO WHAT ???

#### Follow-up strategies

1. If the event implies BBH coalescences (1 per day)

We trigger wide-field of view telescopes ONLY if

- 90% c.r < 200 degrees square or if DL < 200 Mpc (< 1 per run) - A suggestion from JG ducoin is to observe events for which we can cover 90% of the c.r in a night
- OR/AND if GRB identified in timing and sky coincidence (< 1 per run)

We trigger narrow field of view telescopes ONLY if

- if 70 % of the galaxies (or count by number of galaxies, proposition from JG Ducoin) with stellar mass > XXX, located at the distance max given by the GW alert can be observed in GRANDMA within the first 24h (< 1 per run). One reference could be the figure 6 of <https://arxiv.org/pdf/1911.05432.pdf>.
- If optical or golden neutrino candidates have been found in the next 24h post merger and can be observable by GRANDMA (< 2 per run)

- What about Swift-XRT candidates or we just restrict our follow-up to optical sources ? JG suggestion; probably it is a good idea since XRT only follows BBH event 0% of the skymap is observable by XRT
- If optical candidates found within GRANDMA or by Fink/ZTF that passed our criteria for non-supernova transient
- [if Fink/ZTF or Fermi-LAT reports AGN flares activity within the sky localization area] → to be discussed depending on the source

2. If the event implies NS-BH or BNS coalescences:

We deal with NS-BH, BNS and mass-gap events in a similar way for O4 (expectation 1 per week) for prompt observations.

We trigger wide-field of view telescopes ONLY if

- effective observable 90% c.r. (? real c. r. ?) < 250 degrees square or if DL < 300 Mpc (e.g need to reach 21.5 mag in clear band within 24h) (< 1 per 2 months). SA proposition: From events not observable on Earth, we skip them or we sent an observable plan with only few tiles, but we know it is incomplete.

Proposition by JG Ducoin: Any BNS/NSBH ?

- OR/AND if GRB identified in timing and sky coincidence (probably 1 per run)
- Further restrictions might be applied, for OAJ and CFHT since the ToO time is restricted.

We trigger narrow field of view telescopes ONLY if

- on galaxies if event located at DL < 200 Mpc (e.g 21ish in clear band to observe the peak mag of the KN in the first 24h) (< 2 per run)
- If optical or golden neutrino candidates have been found in the next 72h post merger and can be observable by some telescope of GRANDMA geographically and can be reachable in terms of sensivity according to rapid estimates of KN and GRB afterglow brightness in the coming nights (< 2 per run)
- If optical candidates found within GRANDMA or by Fink/ZTF or (GOTO ? or any public surveys) that passed our criteria for non-supernova AND transients (< 1 per run)

3. If the event implies a burst event (1 - 2 per run)

We trigger wide-field of view telescopes for all the cases for 72h plain observations (Supernovae II), followed by revisits (T0+7 days, T0+14 days, T0+21 days)). In which color ?

We trigger narrow field of view telescopes for galaxies located in the local Group (with DL < 50 Mpc) and follow the same strategies as wide-field of view

[Tools / coordinations needs](#)

- All observational teams need to receive their personal observational plan

- All observational teams need to promptly reduce their data, near-by galaxies or at the location of EM counterpart candidates (a source or not). I Tostoa e Melo
- We keep the weekly coordinator to adjust the strategy to follow-up neutrino/X-ray/any other sources reported by external teams during a follow-up campaign
- A study about how many galaxies with a stellar mass  $> 10^{10}$  solar mass we can observe in a night vs the distance of the GW event ?  
→ suggestion from JG Ducoin What is interesting is not the magnitude of the galaxy but the expected magnitude of the transient (at the distance of the galaxy), so I propose to remove this criteria. - Cutting the galaxies only on stellar mass properties is probably not what we want to do. The number of galaxies (and their stellar mass) compatible with a given alert is already computed and outputted by gwemopt. This should be easy to implement.

### Observing Scenarios

- Within ZTF, we have started to put together a set of tools here: <https://github.com/growth-astro/proposals>. I would suggest that whoever takes on this task at least look at this software when getting started with making quantitative assessments of sky areas, distances, etc.