tilepy: optimized follow-up observations of multi-messenger events

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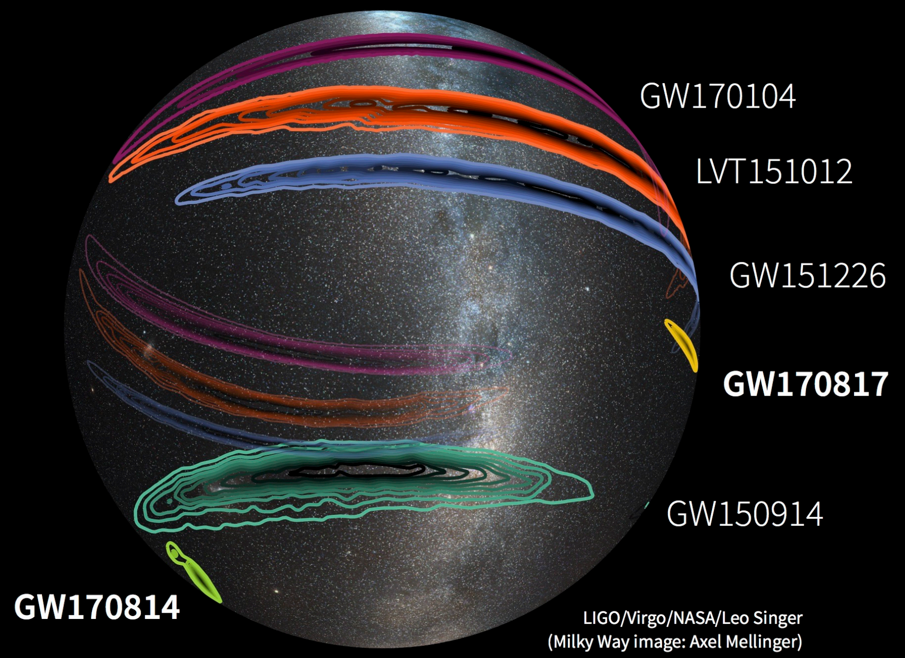
Formulating the problem

Finding a counterpart to poorly localized transient astrophysical events is difficult

1. Transient events are often variable and can fade quickly
2. They can spam tens to thousands of degrees in the sky
3. Technical and visibility challenges are often encountered in ground-based Astronomy



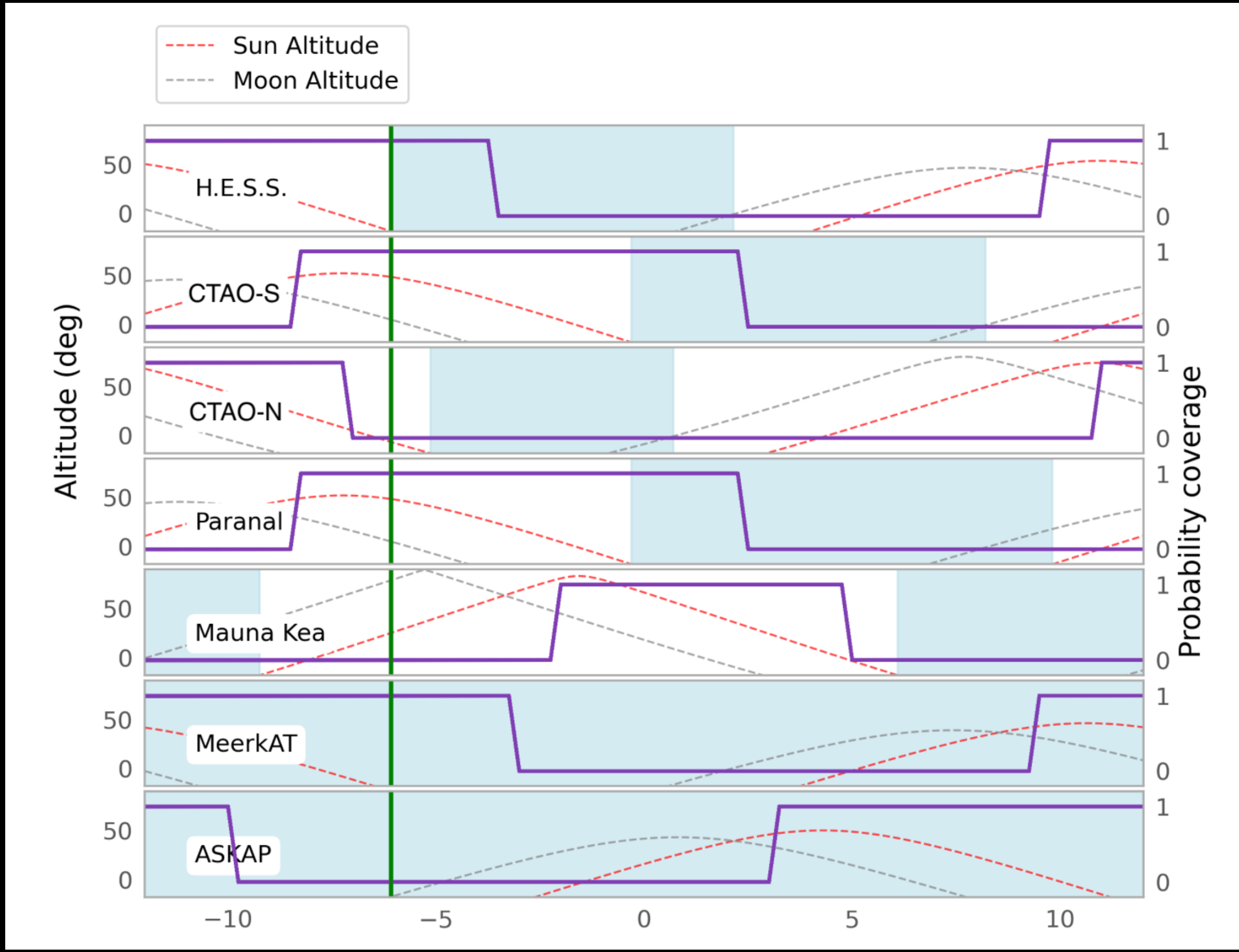
Builiding the solution

- Optimizing follow-up observations of poorly localized events
    1. Slew to the most probable target as soon as possible
    2. Maximize spatial coverage by targeting the most probable regions
    3. Create a flexible tool that can be adapted to a wide range of observatory configurations

1. Time constraints

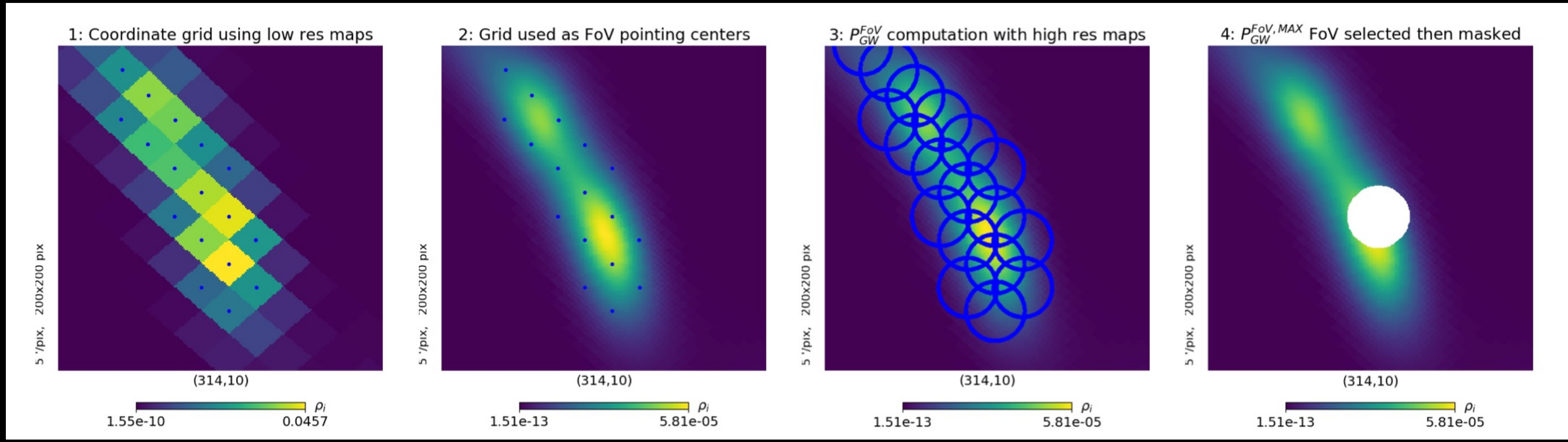
Tackling

1. Observability constraints
2. Visibility constraints

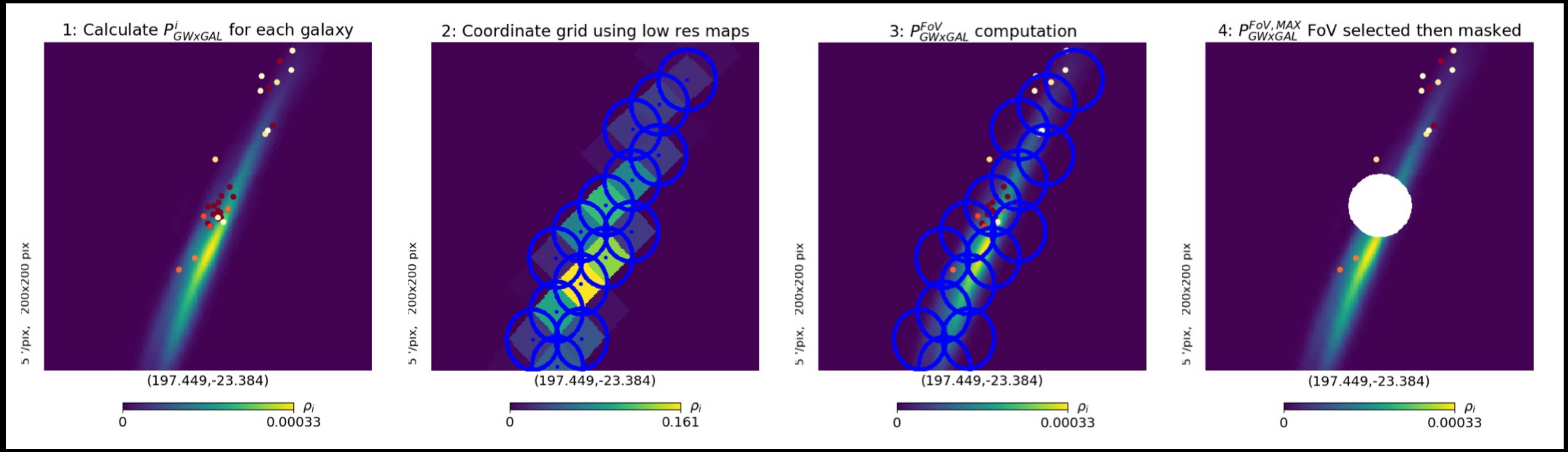


2. Spatial coverage

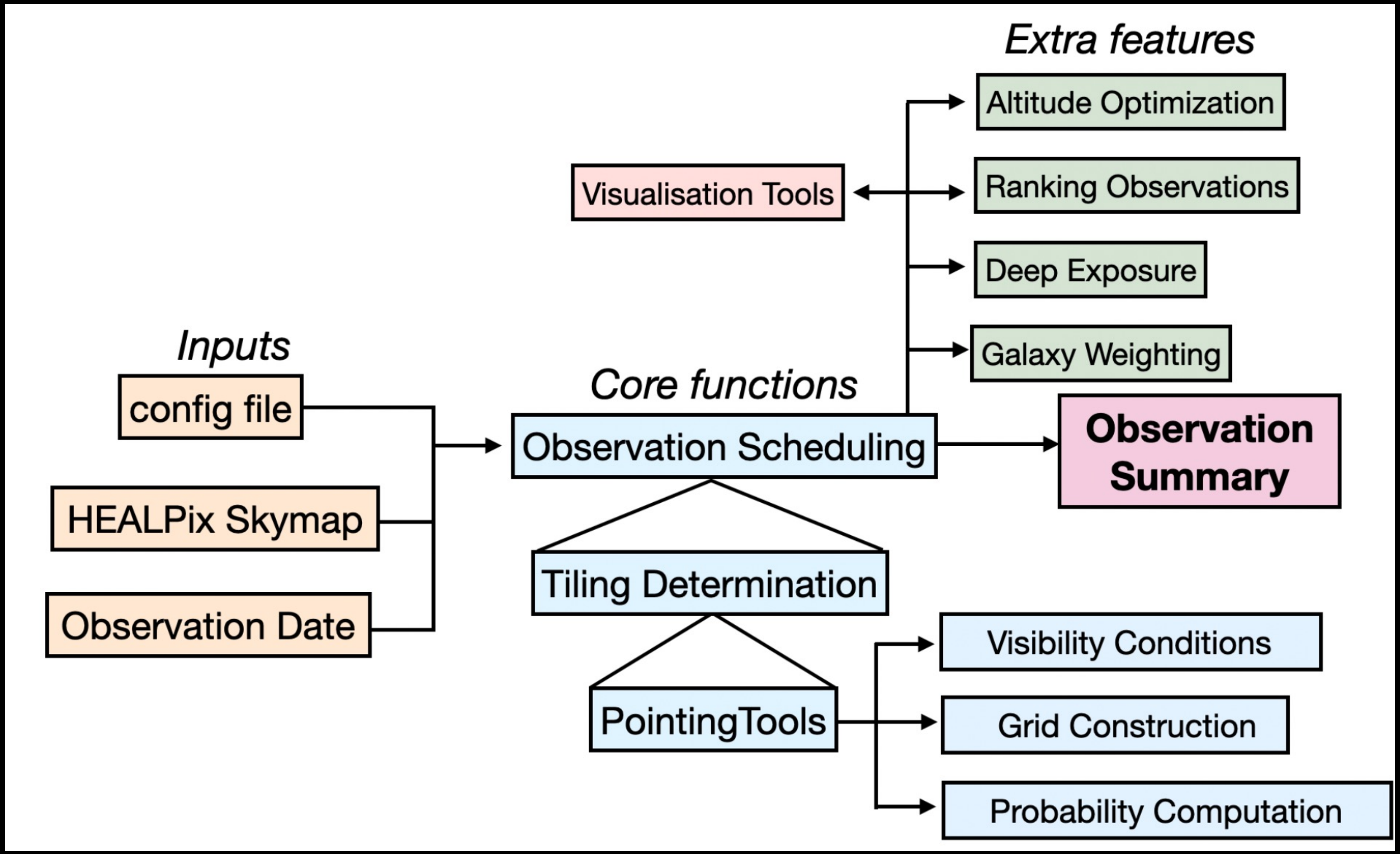
2D strategy if distance information is not usable



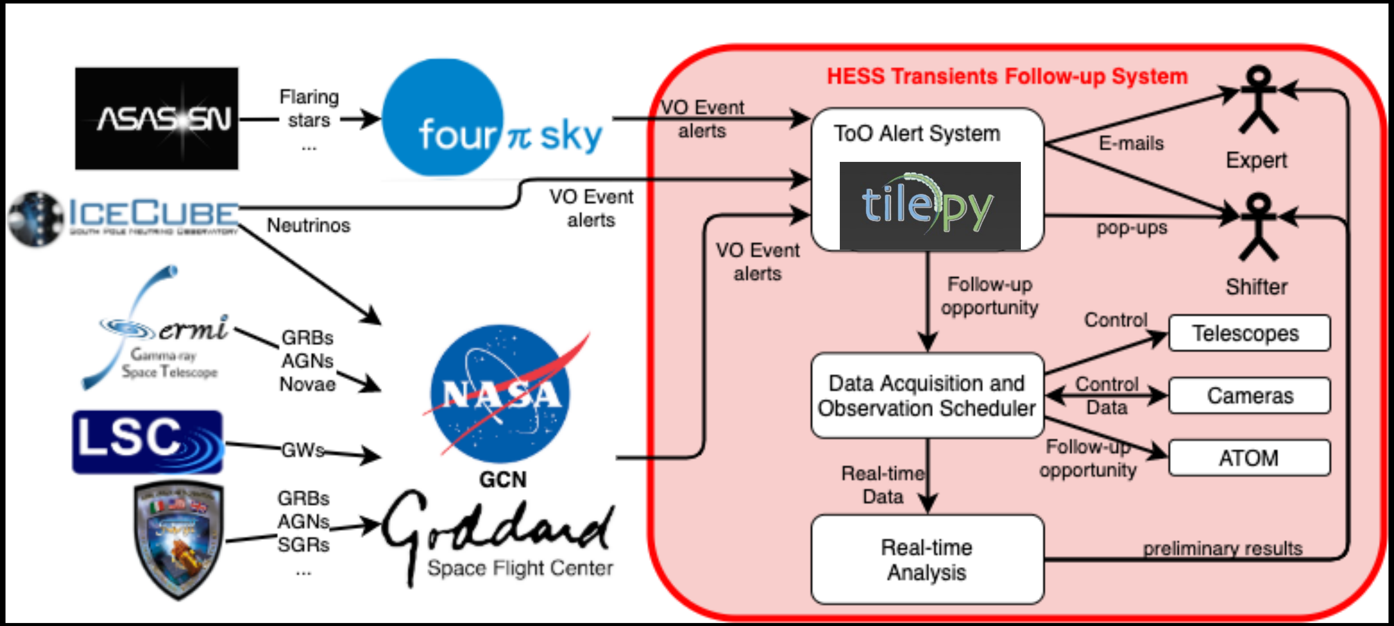
3D strategy if distance information is usable



3. Flexible architecture



The H.E.S.S. ToO Alert System case



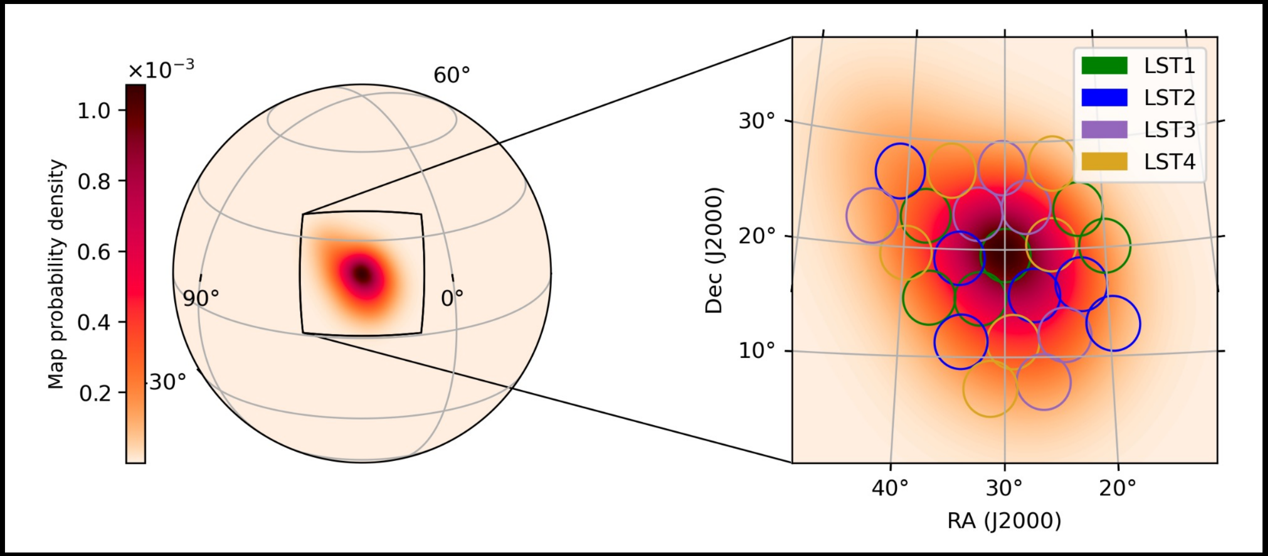
H.E.S.S. became the first ground-based instrument to collect data on the historic GW170817 event

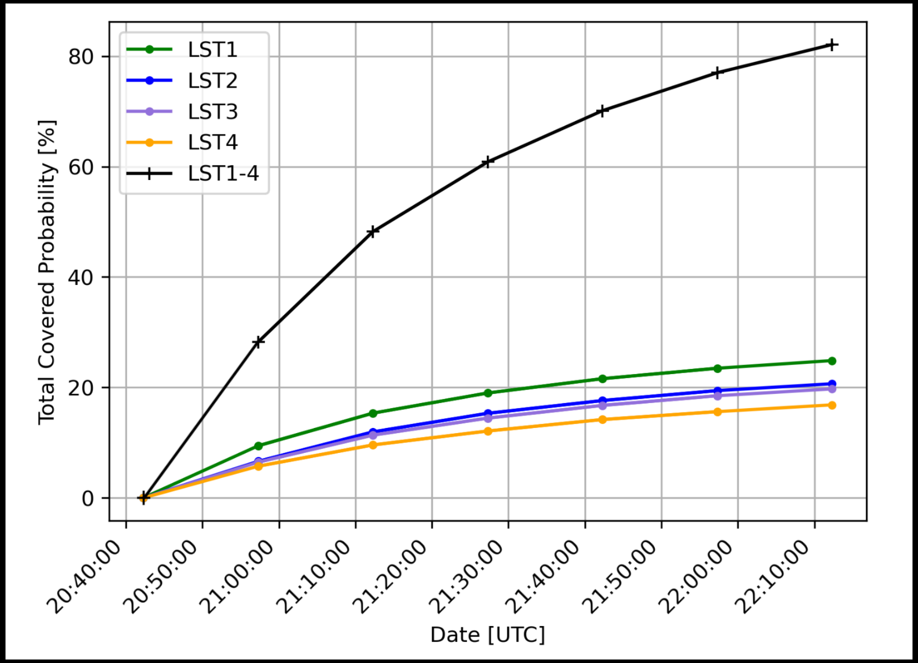
During observing runs O2 and O3, H.E.S.S. autonomously tracked and observed 4 BBH merger events.

H.E.S.S. continues to operate automatically in the ongoing O4 observing run, ensuring timely observations of gravitational wave events.

Example 1

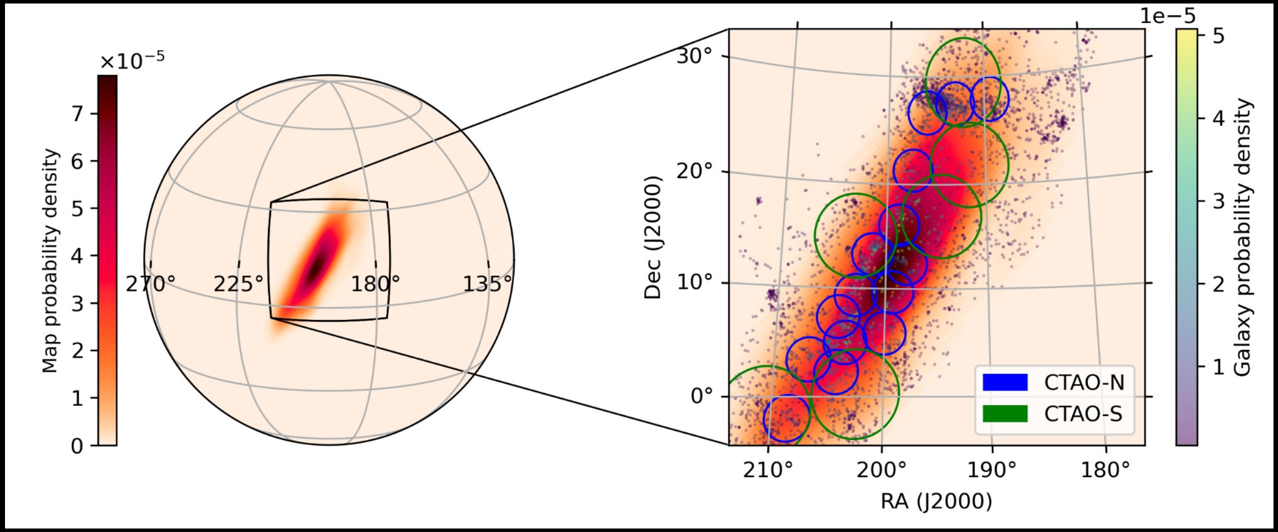
Very poorly localized Fermi-GBM GRB: Multi-telescope campaign at one site

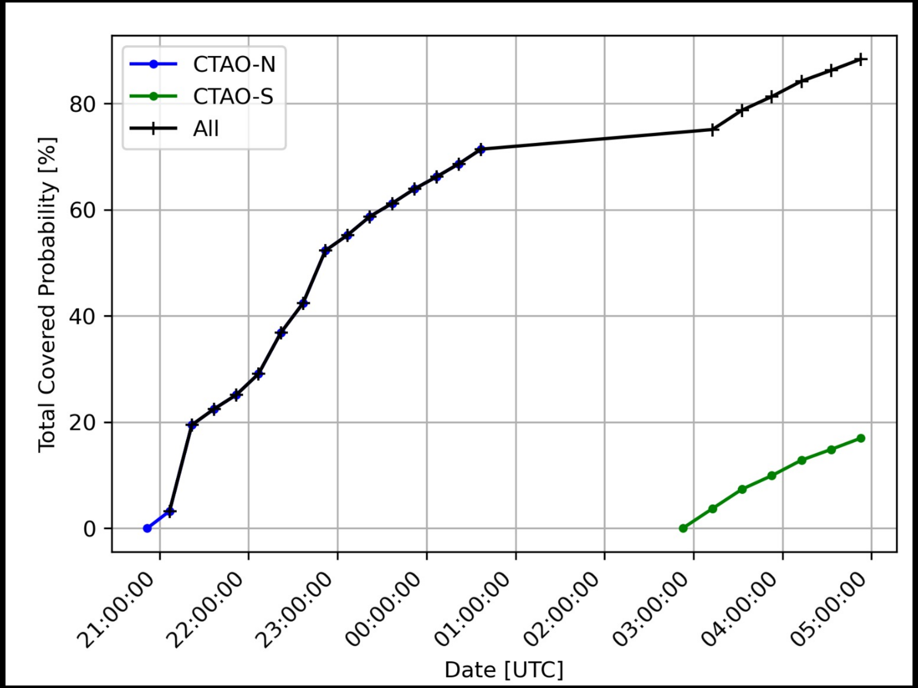




Example 2

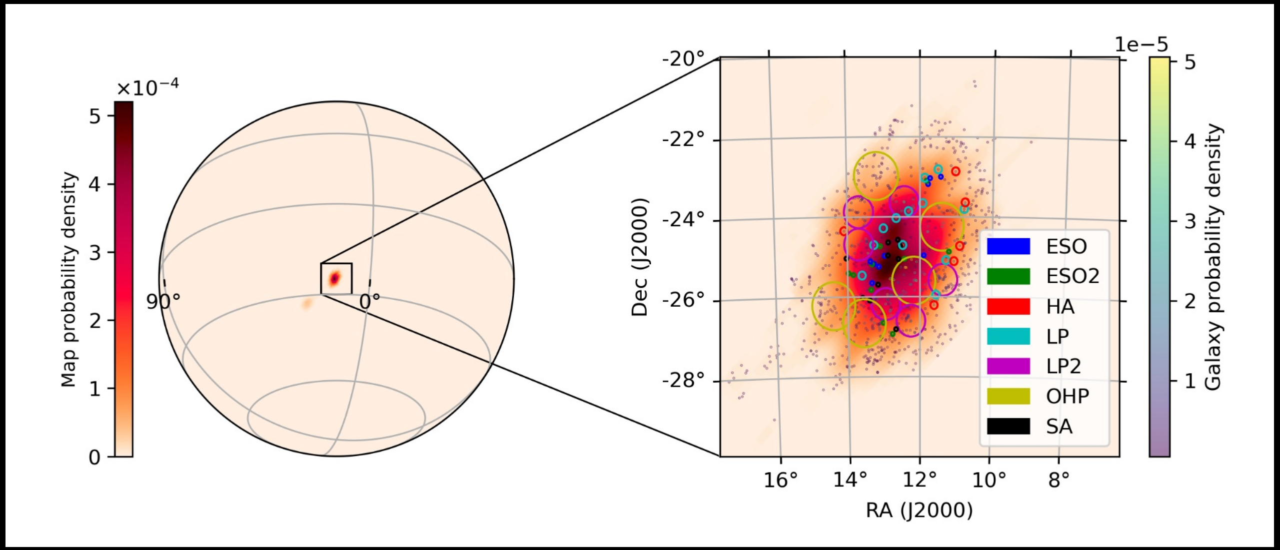
GW follow-up: Multi-observatory campaign from the Northern and Southern hemisphere using the FoV-integrated 3-dimensional strategy

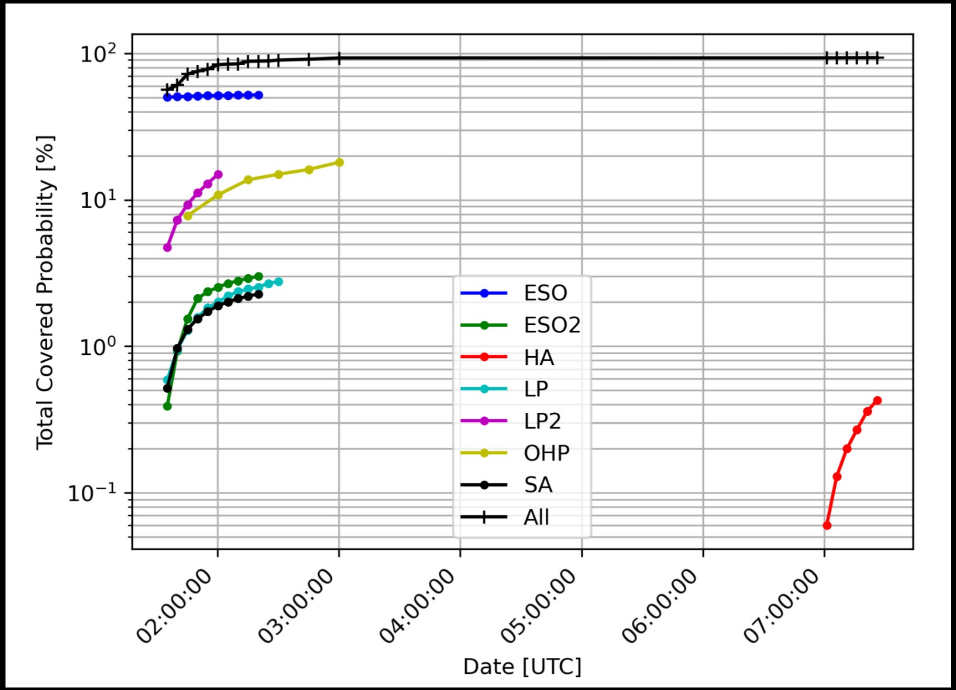




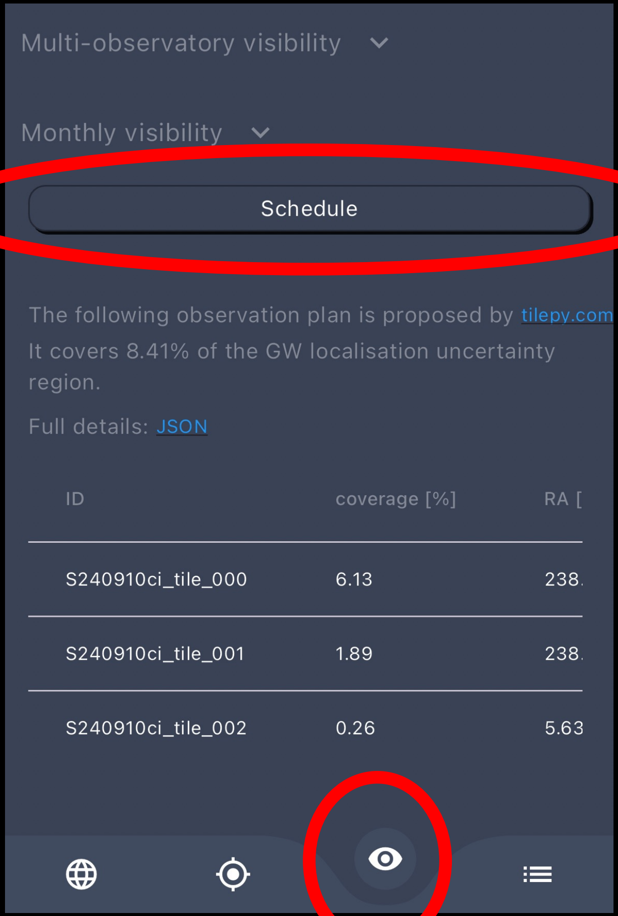
Example 3

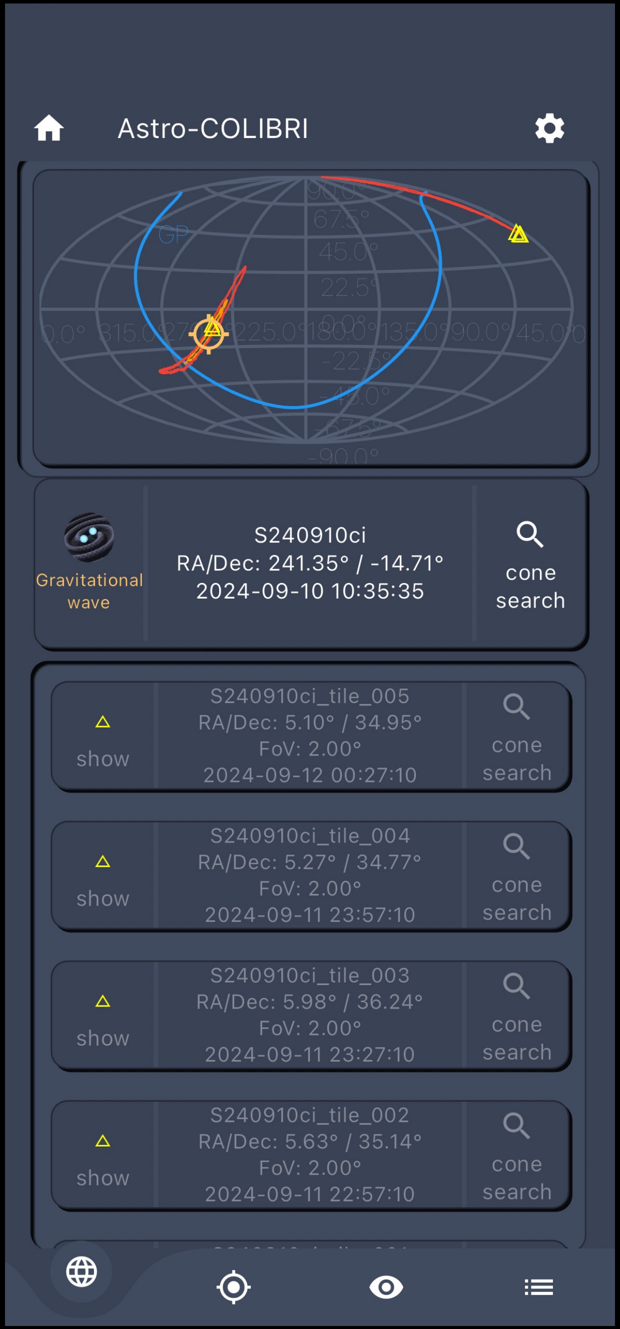
GW follow-up: Multi-observatory campaign from the Northern and Southern hemisphere using the FoV-integrated 3-dimensional strategy





Integration with Astro-COLIBRI





Conclusion

- *tilepy* is a tool for the optimization of spatial and temporal aspects of the observations of poorly localized astrophysical events
- The functionalities of *tilepy* make it an ideal scheduling tool that can be integrated into various automatic transient handlers with the least possible effort
- *tilepy* is integrated in the H.E.S.S. and CTA/LST observatories and in the Astro-COLIBRI platform

https://www.tilepy.com