

SOXS FOR GW & NEUTRINOS: MULTI-MESSENGER ASTRONOMY WG12

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- Most subscribed WG (28) testifying for the strong interest
- Not too much discussion, since the science case is clear and what we have to do either

THE FIRST MESSENGER: NEUTRINOS

(A)



(B)

ICECUBE-170922A TXS0506+058

Tentative association

MULTI-WAVELENGTH MONITORING



TeV/MAGIC Gamma-ray/Fermi X-ray/Swift X-ray PL/Swift OPTICAL Radio/OVRO

z=0.34 V~14.5



Figure S5: Subaru/FOCAS spectra of TXS 0506+056. Normalized spectra taken with

ETC SIMULATION

1200 s



NEUTRINO EVENTS

In 2019, the IceCube collaboration is introducing a new set of neutrino candidate selections that expand the alert program.

- A "Gold" channel will issue alerts for neutrino candidates at least 50% likely to be of astrophysical origin and is expected to deliver ~10 alerts per year.
- A more frequent "Bronze" channel will provide ~20 alerts per year for neutrino candidates that are between 30% and 50% likely to be of astrophysical origin.

Follow up GOLD events:

- 5 observable from the Southern hemisphere /yr
- 3 targets on average
- 20 min each
- Follow-up the right ones 1obs every 15d for 3 months

TOTAL OBSERVING TIME 10 hr/yr

THE SECOND MESSENGER: GW



NS-NS mergers do exist! Observational features

- short GRBs
- kilonovae
- early blue emission





CANDIDATE SEARCH



SOXS will **not** actively search photometric candidates

SOXS will point at any meaningful candidate to help identifying the true GW counterpart

COUNTERPART FOLLOW UP

Once the counterpart is identified, SOXS will follow it up intensively as much as it can







LINE IDENTIFICATION

Watson et al. 2019 Smartt et al. 2017

X-shooter spectra







Brightness

TIMELINE

SOXS will be ready in 2022, and eventually during commissioning and Science Verification we will be able to search for GW counterparts.

Ready to catch "O4" run (not earlier than June 2022) and then LVK at design sensitivity.



or incomincian le dolenti note (Dante)

TIME ESTIMATE FOR SOXS

Based on the latest O3a observation the NS-NS predicted rate is 320⁺⁴⁹⁰-240 Gpc⁻³ yr⁻¹.

Scaling in distance GW170817 we can reach a peak magnitude of r~20 at ~150 Mpc.

With this rate, we would expect 0.9 NS-NS merger per year, 2.9 in the best case and 0.4 in the worst.

In case, we want to confirm/exclude target we can probably go out to ~200 Mpc, with 1.8 NS-NS/yr, with a range of 0.7-5.8.

BH-NS should be rarer and more distant and will fall within this (rough estimate)

TIME ESTIMATE: THE RIGHT ONE

We might expect ~0-3 NS-NS event/yr within 150 Mpc per year.

For this exercise we can consider one event per year visible from La Silla, keeping in mind that GWs are the utmost topic in SOXS and, independently on this estimate, we will invest all the time that we will need.

For the single event we will dedicate all the time needed, something like 15 hr/yr.

TIME ESTIMATE: ANCILLARY OBSERVATIONS

For the search of candidates, we might expect 1-6 NS-NS events/yr within 200 Mpc. Going for three events visible from La Silla and observing 5 candidates per event, 1hr each, we end up with 15 hr/yr.



LVK will not operate continuously in the 2022-2027 time frame. There will be 1.5 year leap.

So (15+15) hr/yr*3.5 (LVK on) / 5 yr (SOXS GTO) = 21 hr/yr on average

Based on O3 results, we might expect to have really just one NS-NS event within 100 Mpc during the entire SOXS GTO.

CONCLUSIONS

High rewarding observations!

Need for observations to start as soon as possible, especially for GWs. Need for a very quick write up of the paper(s), similar to ENGRAVE.

Not need for a large amount of time:

- 10 hr/yr neutrino science
- 21 hr/yr GW