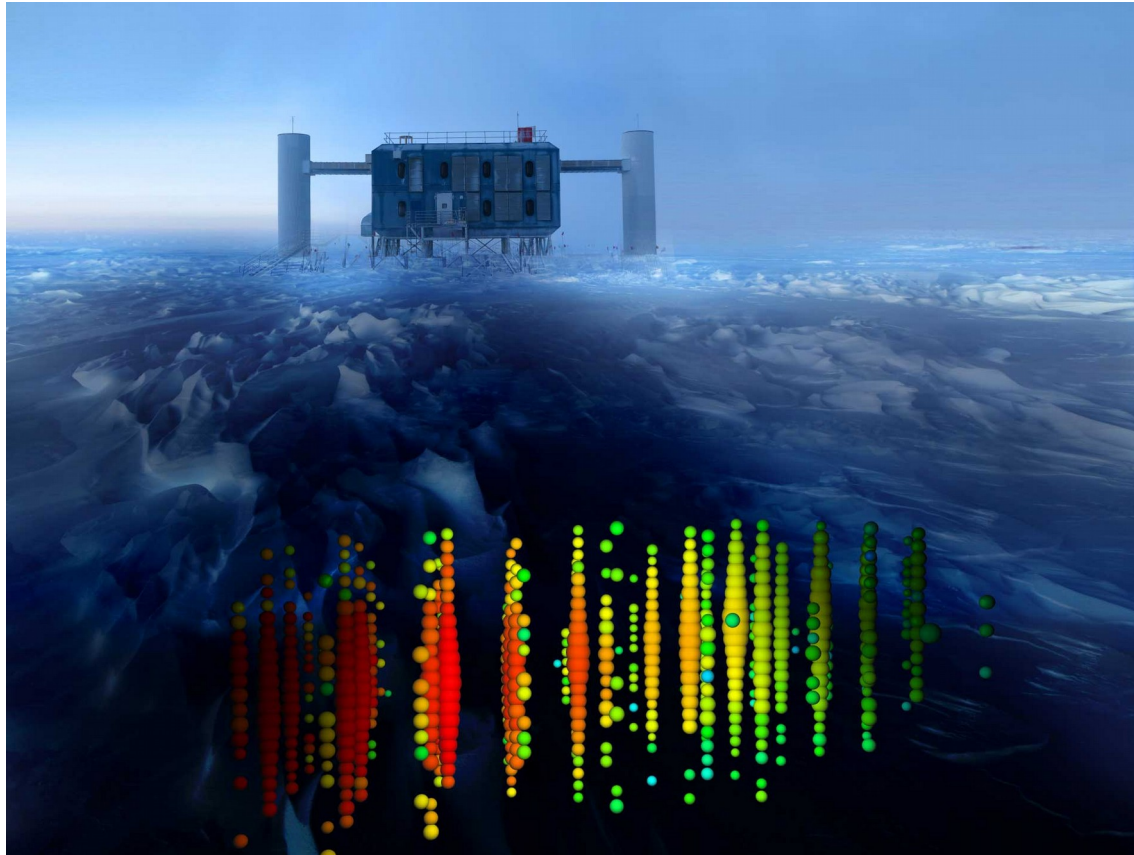


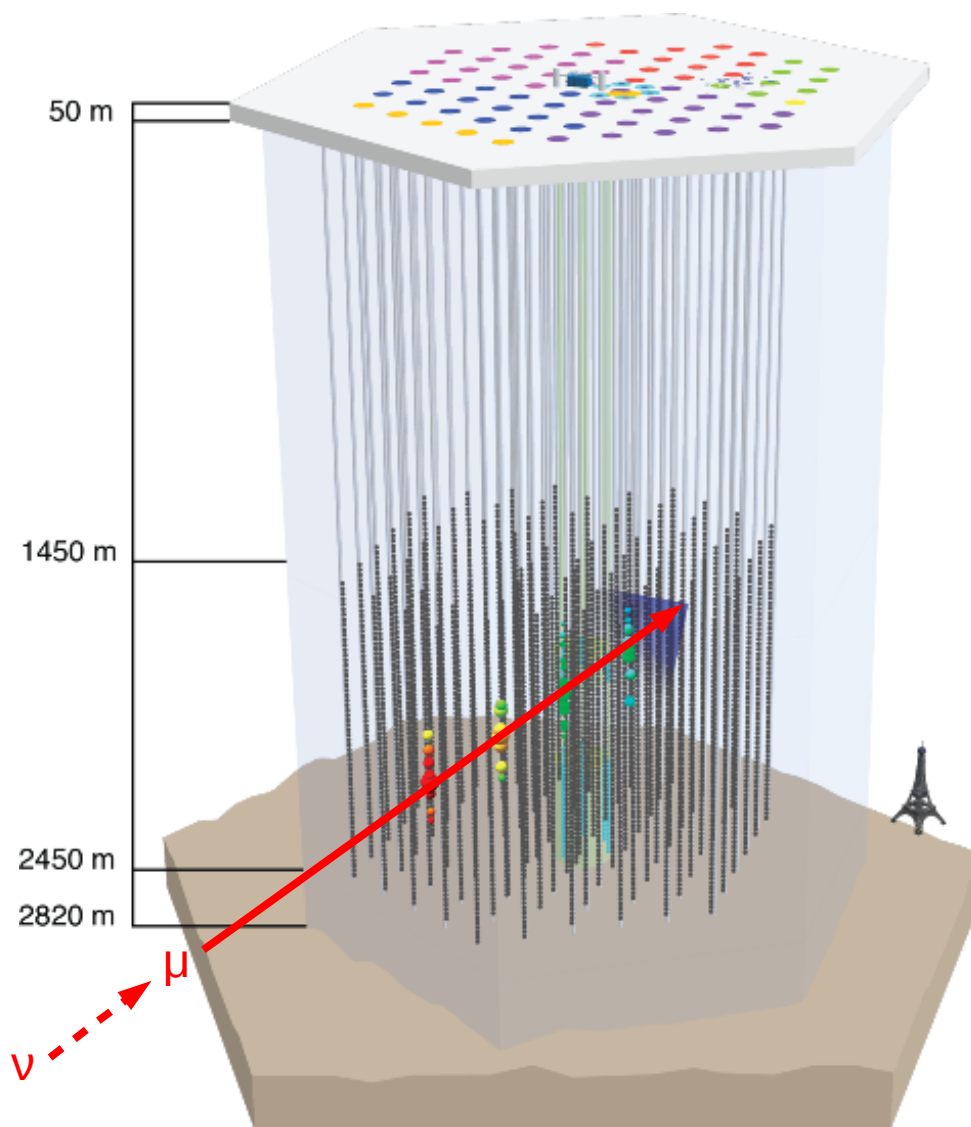
# Search for neutrinos from short transients with IceCube's optical and X-ray follow-up program



Nora Linn Strotjohann  
for the IceCube  
Collaboration

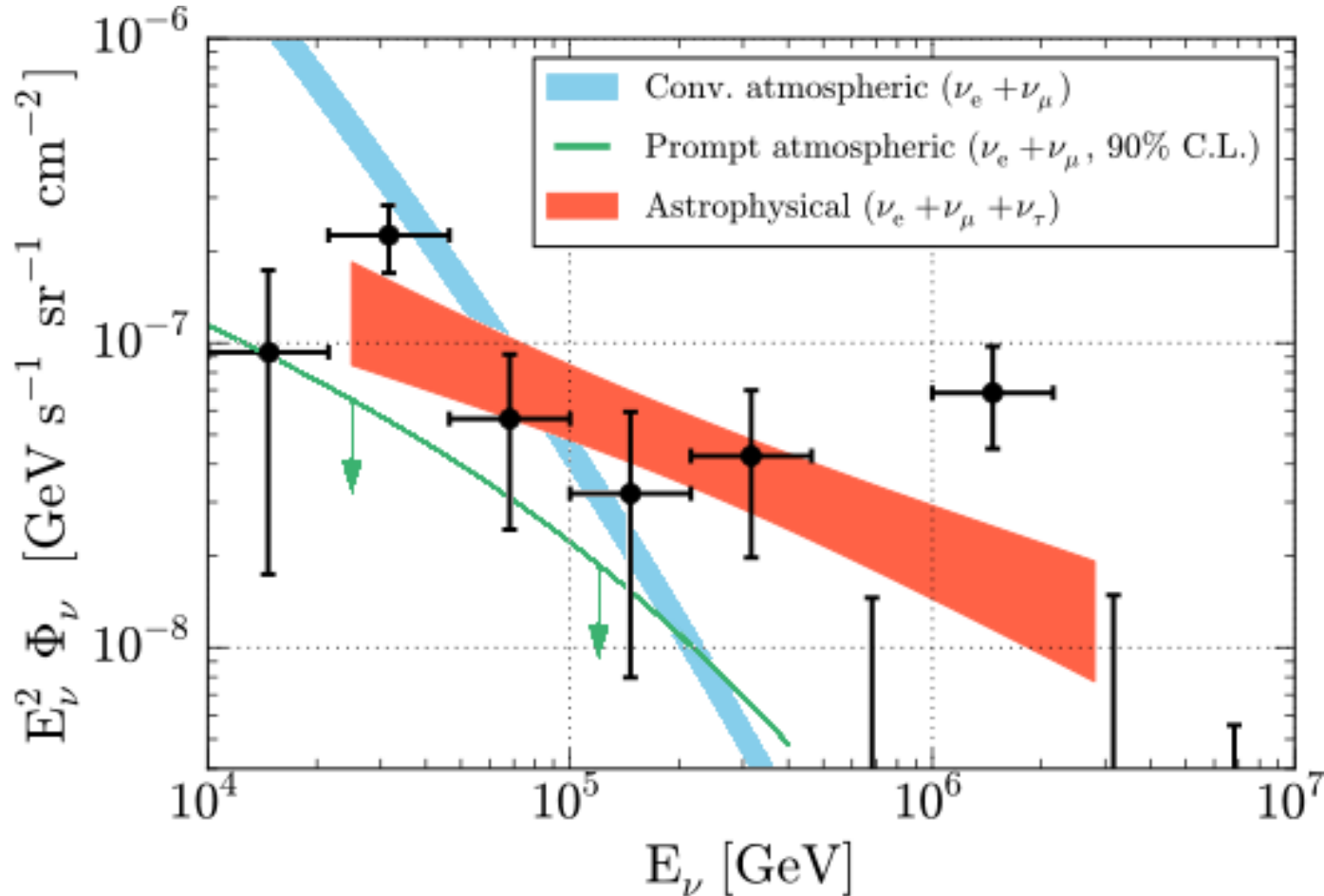
EWASS in Prague  
June 26<sup>th</sup> 2017

# The IceCube Neutrino Observatory



- > largest observatory for high-energy neutrinos (100 GeV – 100 PeV) [arXiv:1612.05093]
- > 5160 optical modules on 86 strings form 1 km<sup>3</sup> detector
- > Cherenkov photons from secondary particles detected
- > good angular resolution of  $\sim 1$  deg for track events
- > tracks used for point source searches

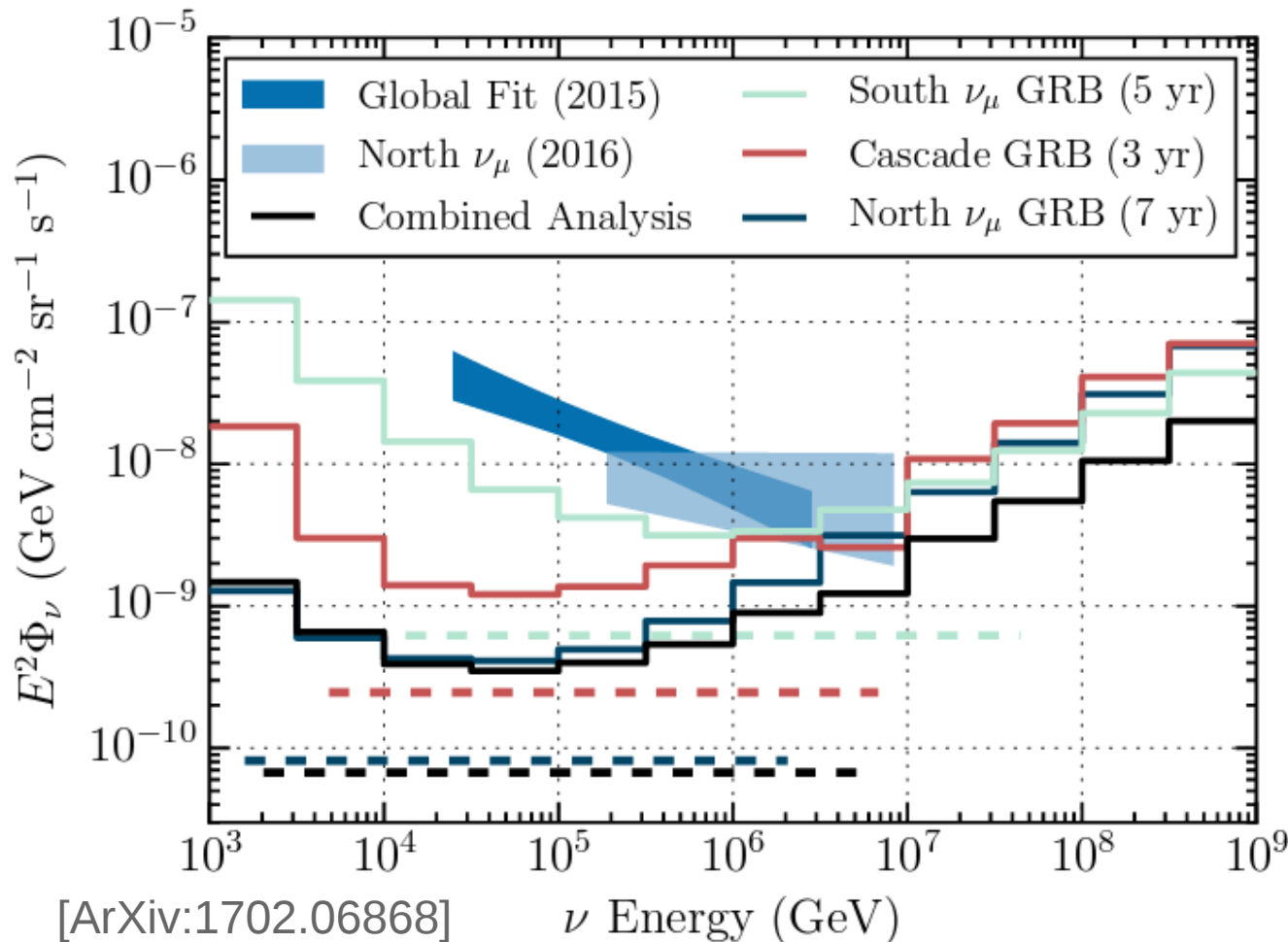
# Astrophysical $\nu$ flux discovered at highest energies



> best fit  $E^{-2.5}$  [arXiv:1507.03991]

> no sources identified so far [arXiv:1609.04981]

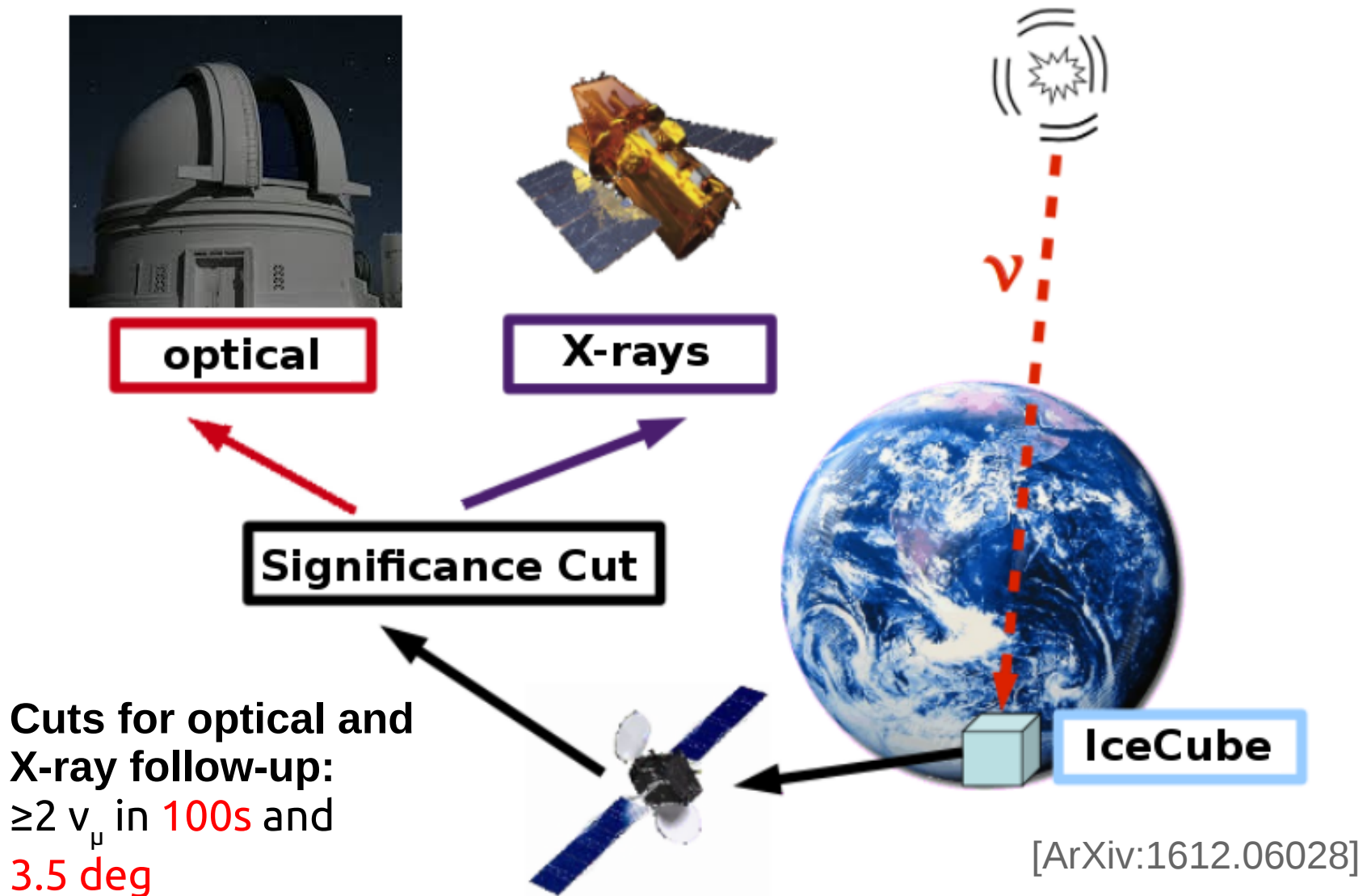
# Sensitivity of stacked GRB analysis



- > 7 years of IceCube data
- > 1172 GRBs
- > look for prompt neutrino emission (during  $T_{100}$ )
- > no coincidence found

> gamma-ray bright GRBs are not the dominant sources of astrophysical flux

# The Optical and X-ray follow-up program

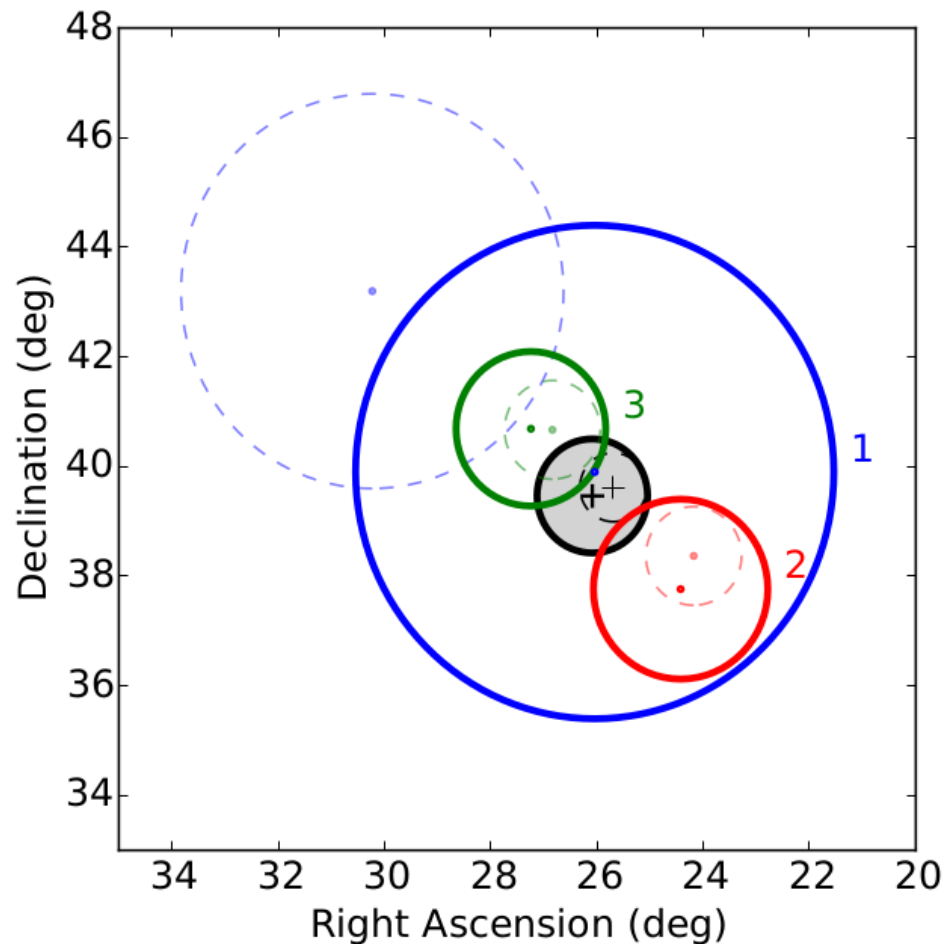


# Results from the X-ray and optical follow-up program

- > 2008 to 2016: 353 doublets detected, 323 chance coincidences expected ( $1.7 \sigma$  overfluctuation)
- > several supernovae detected in optical observations  
→ could be unrelated [arXiv:1506.03115]
- > no likely X-ray counterparts detected [arXiv:1501.04435]
- > one neutrino triplet detected

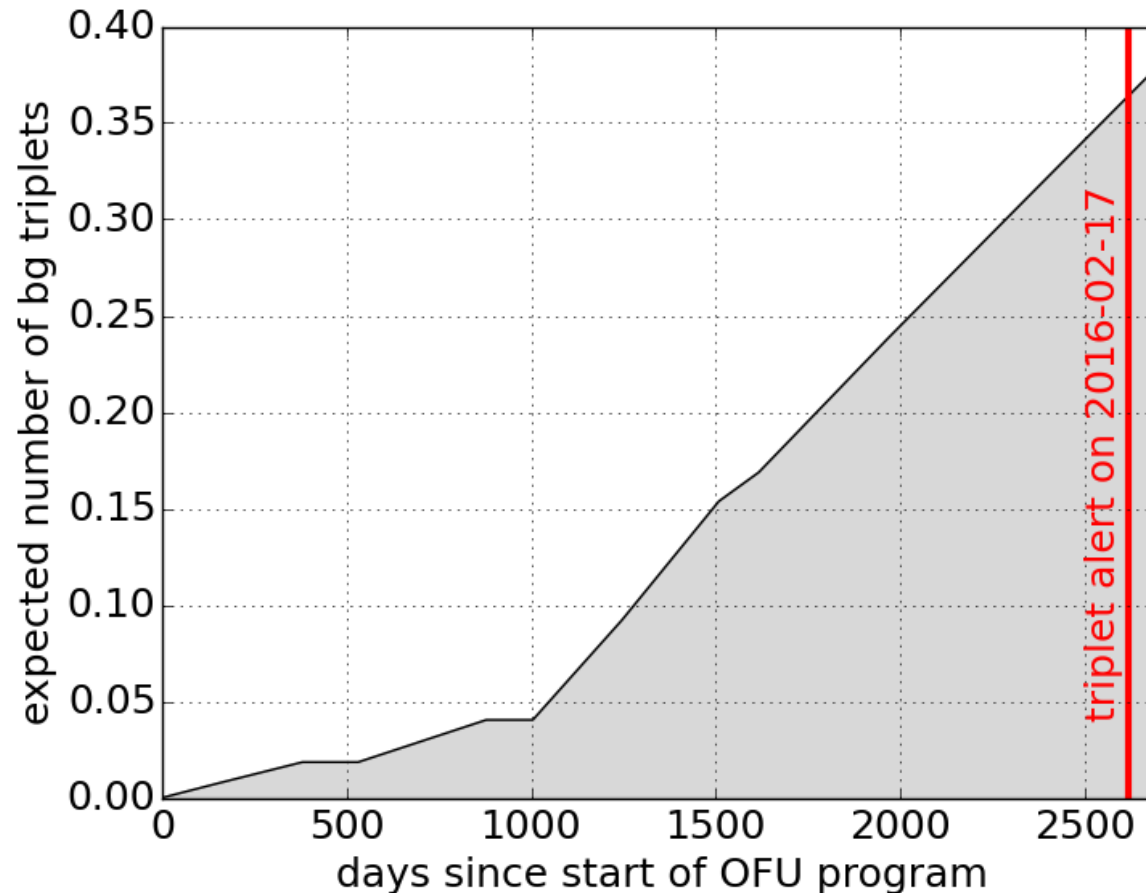


# Triplet Properties



- > detection of 3 events in <100 s  
[arXiv:1702.06131]
- > events deposited 0.3, 0.5 and 1.1 TeV in detector

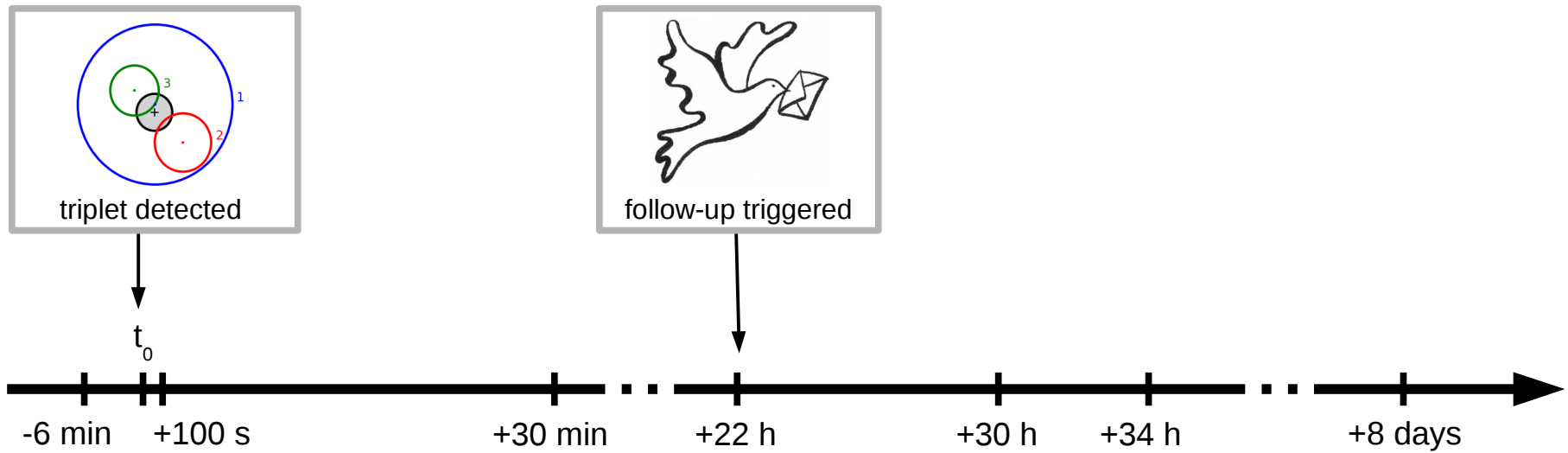
# Expected Number of Triplets from Background



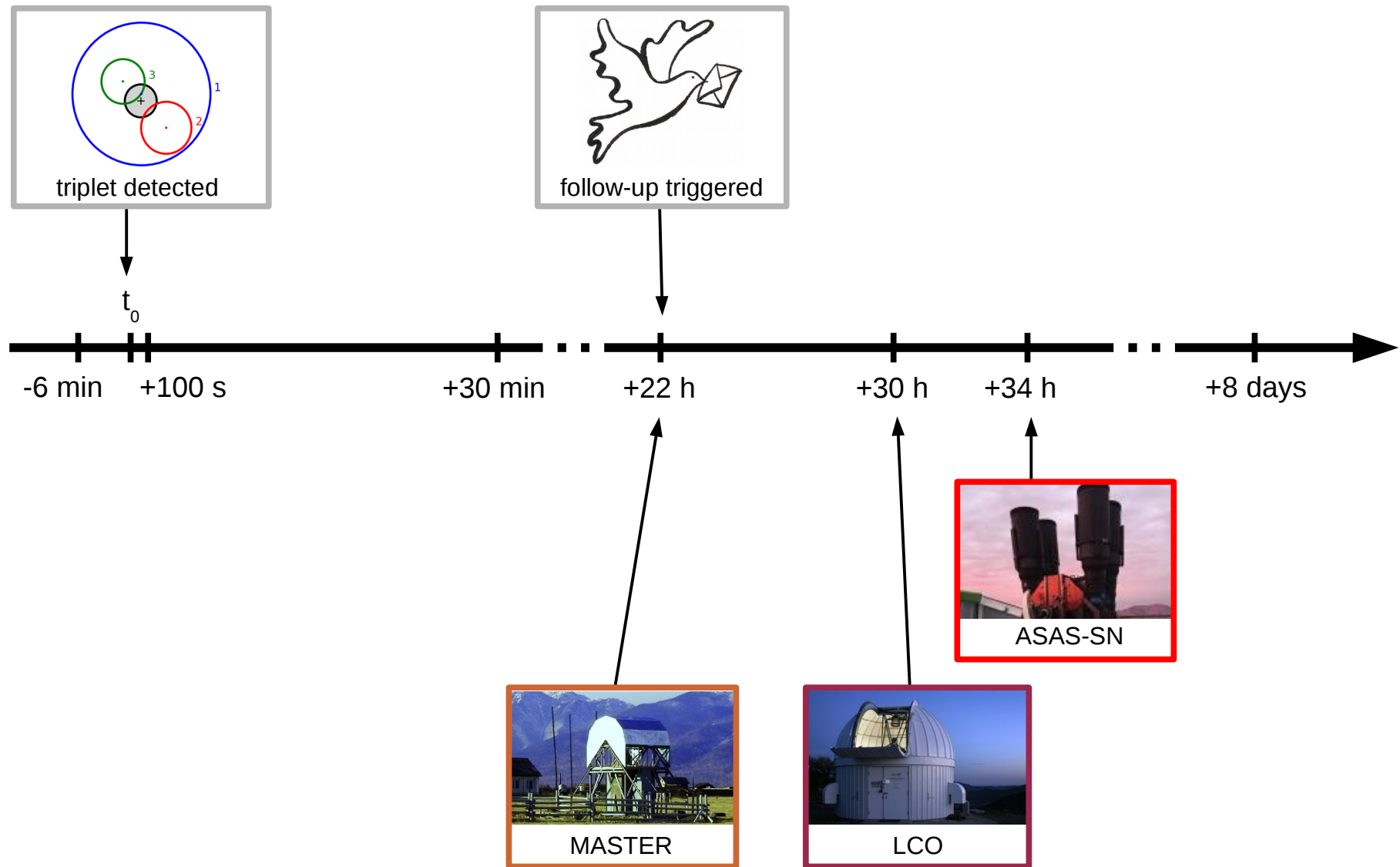
> 0.36 triplets expected due to chance alignment of background events (once every 13.7 years)

→ **alert is not significant**

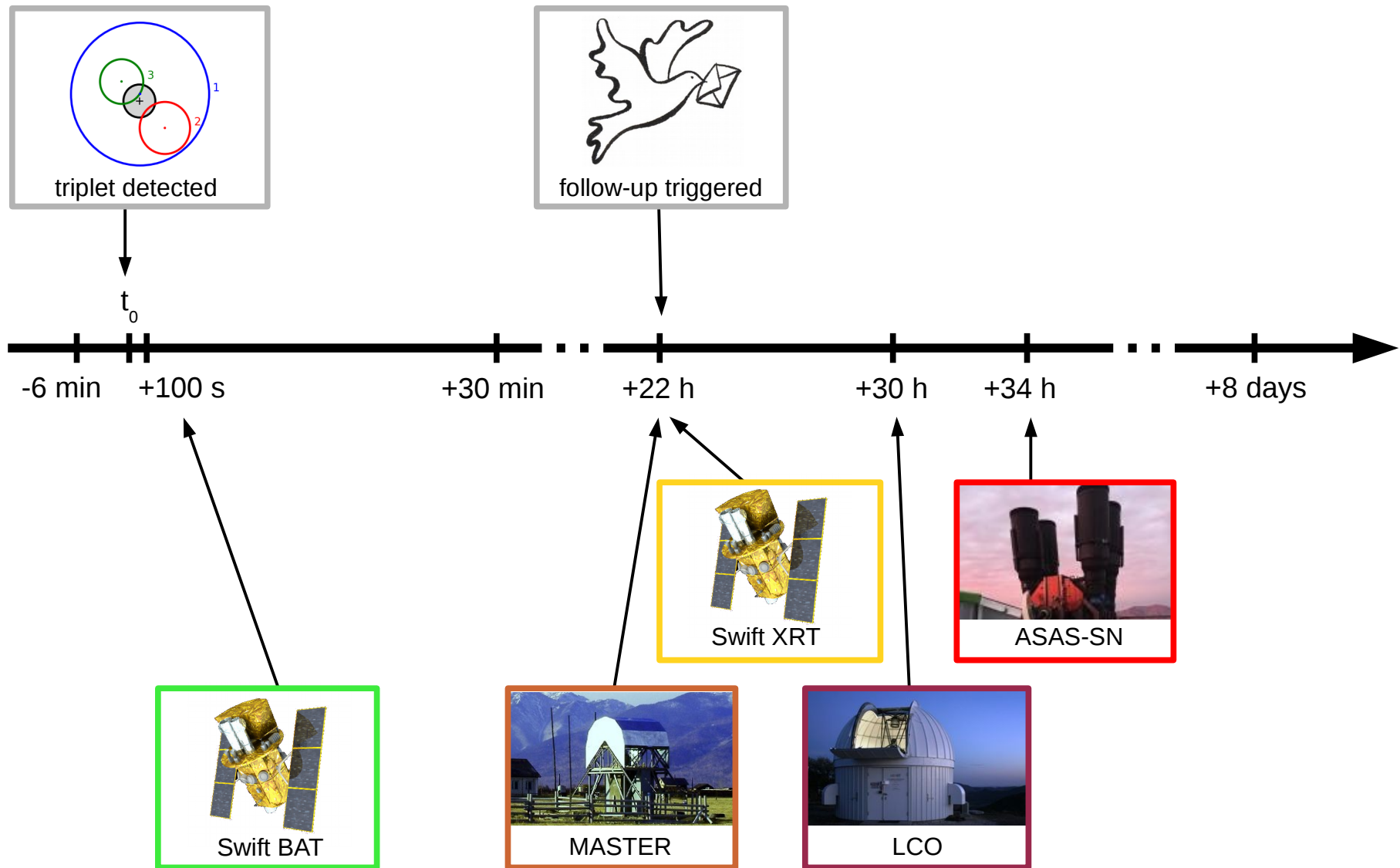
# Follow-up observations



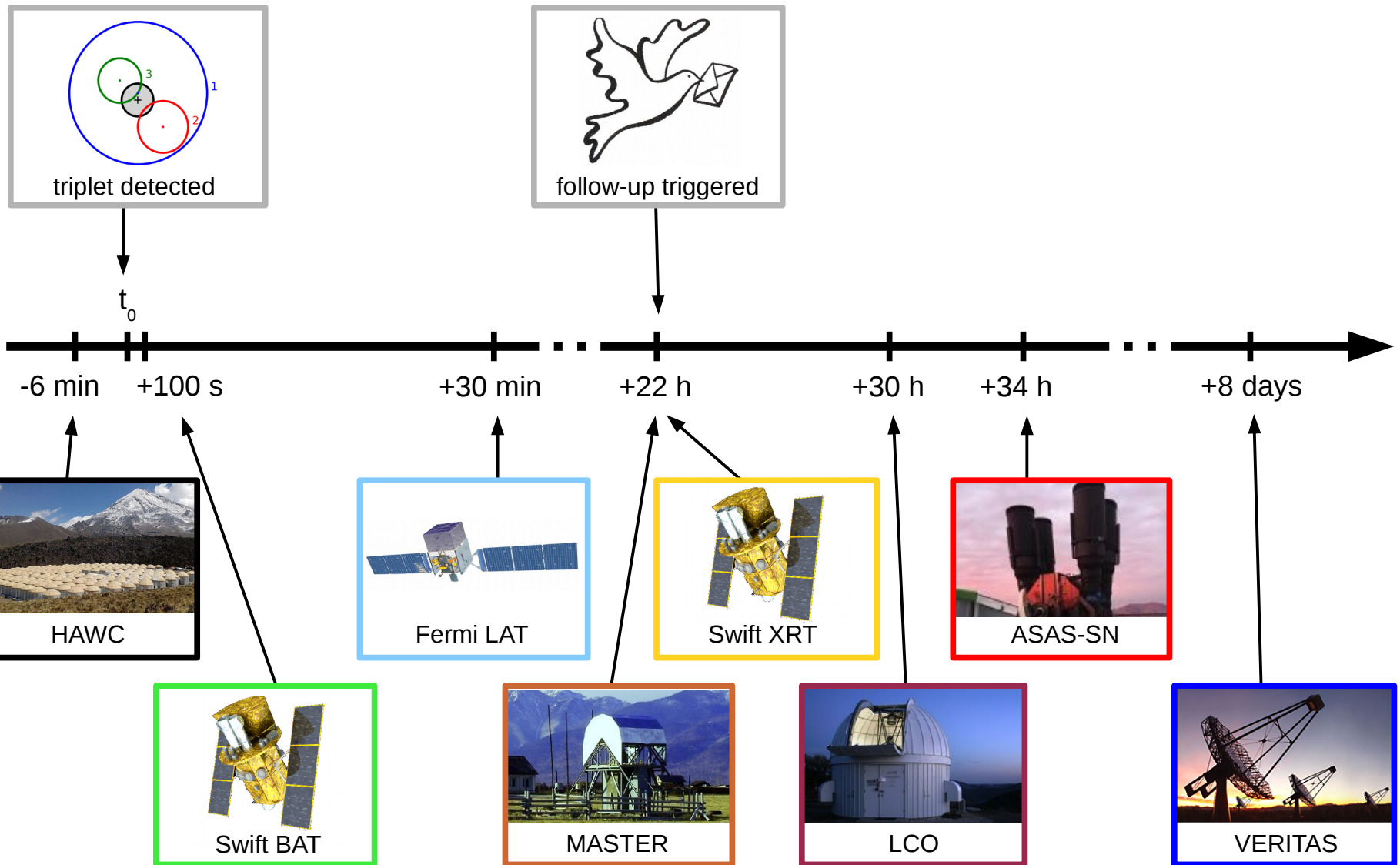
# Follow-up observations



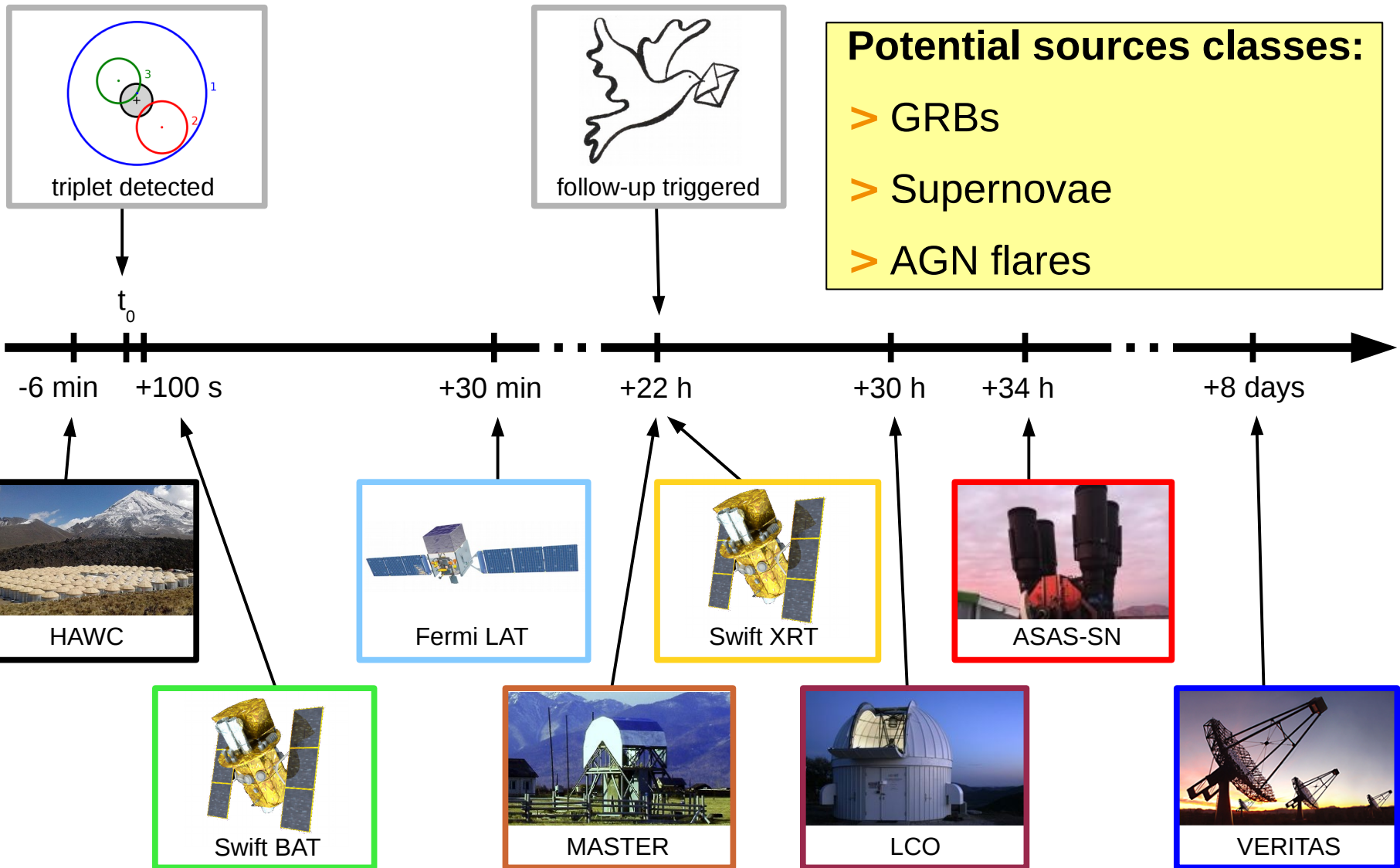
# Follow-up observations



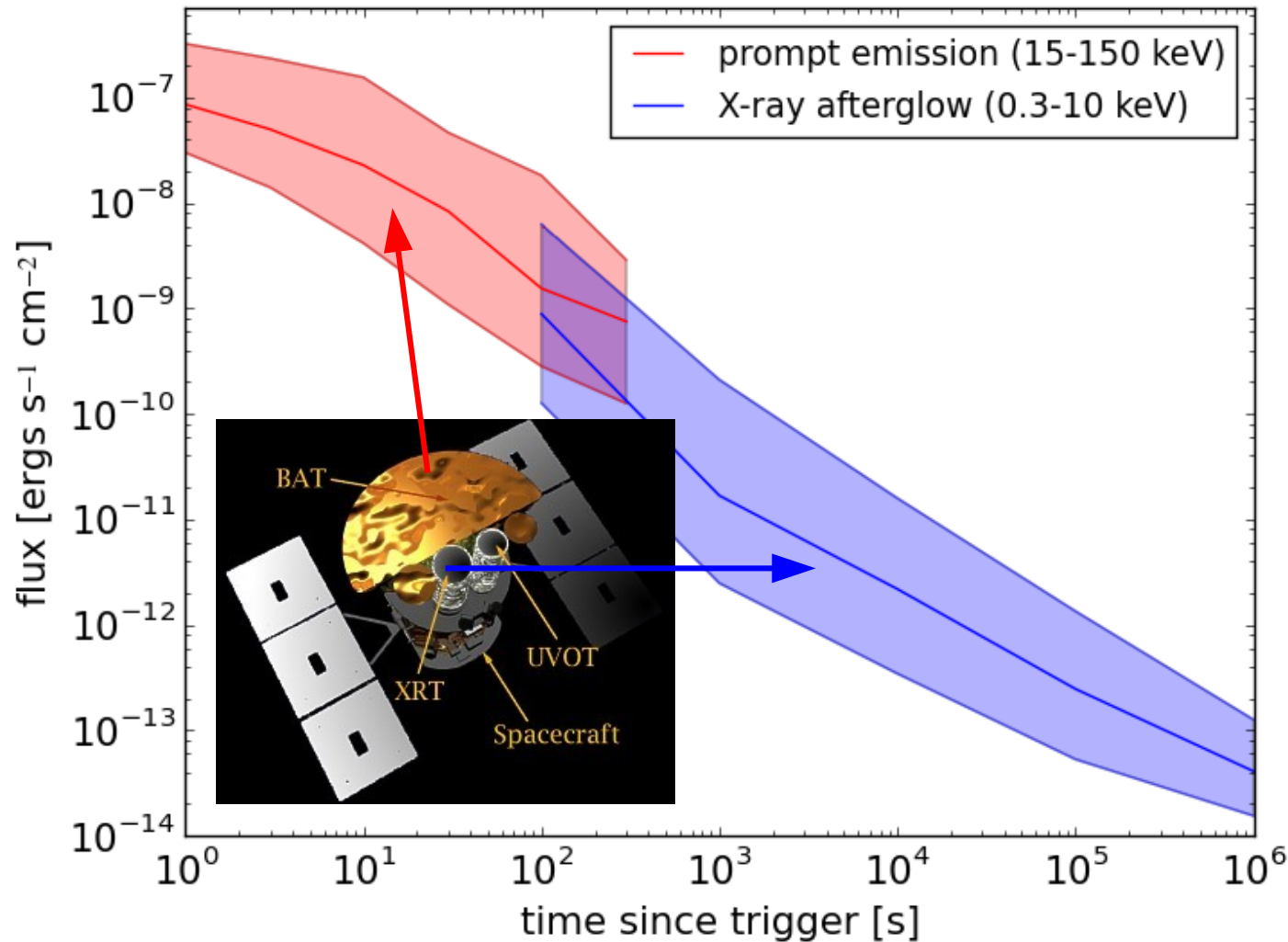
# Follow-up observations



# Follow-up observations

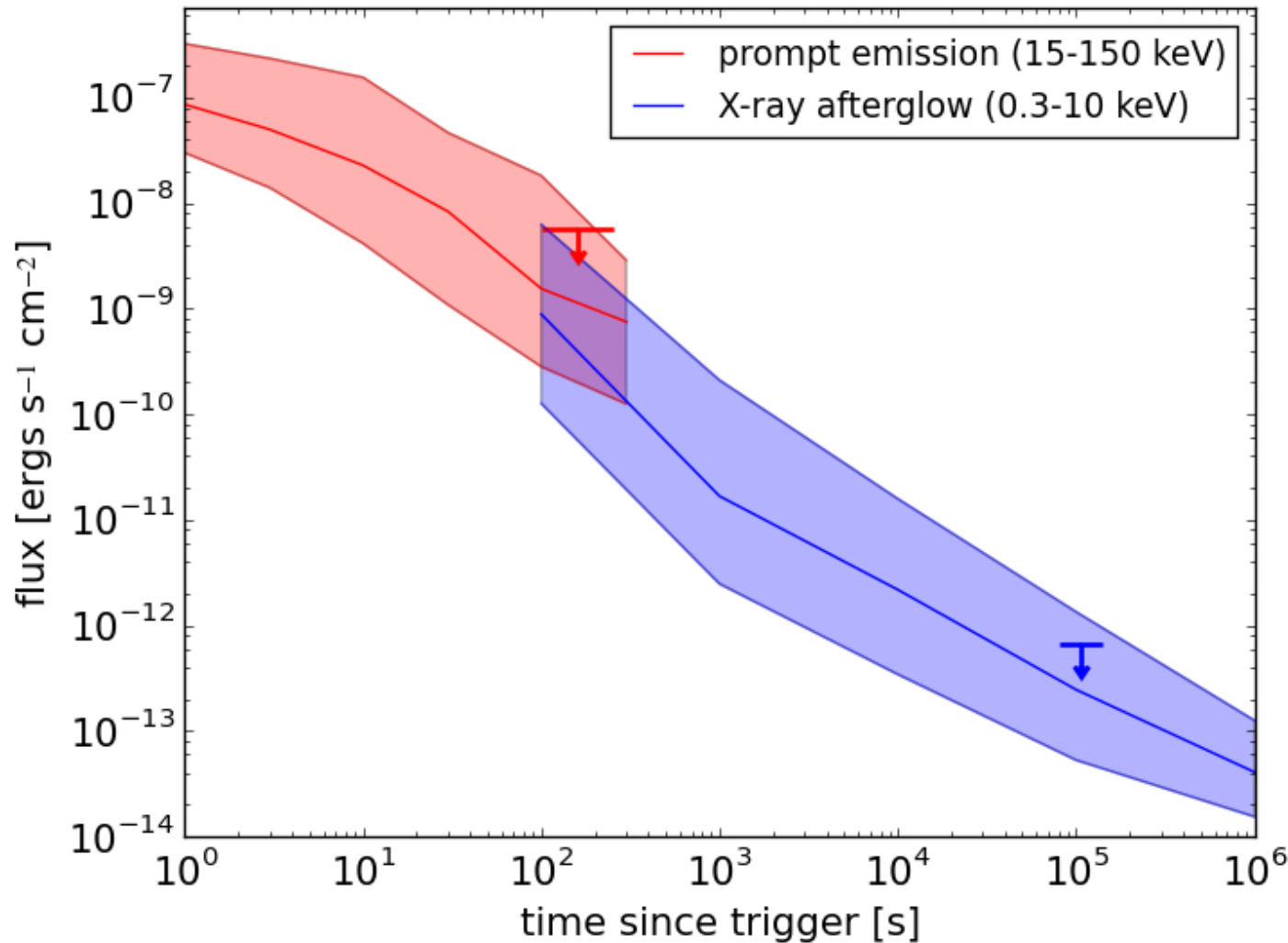


# Limits on GRBs



shaded bands  
contain 80% of  
Swift detected  
long GRBs

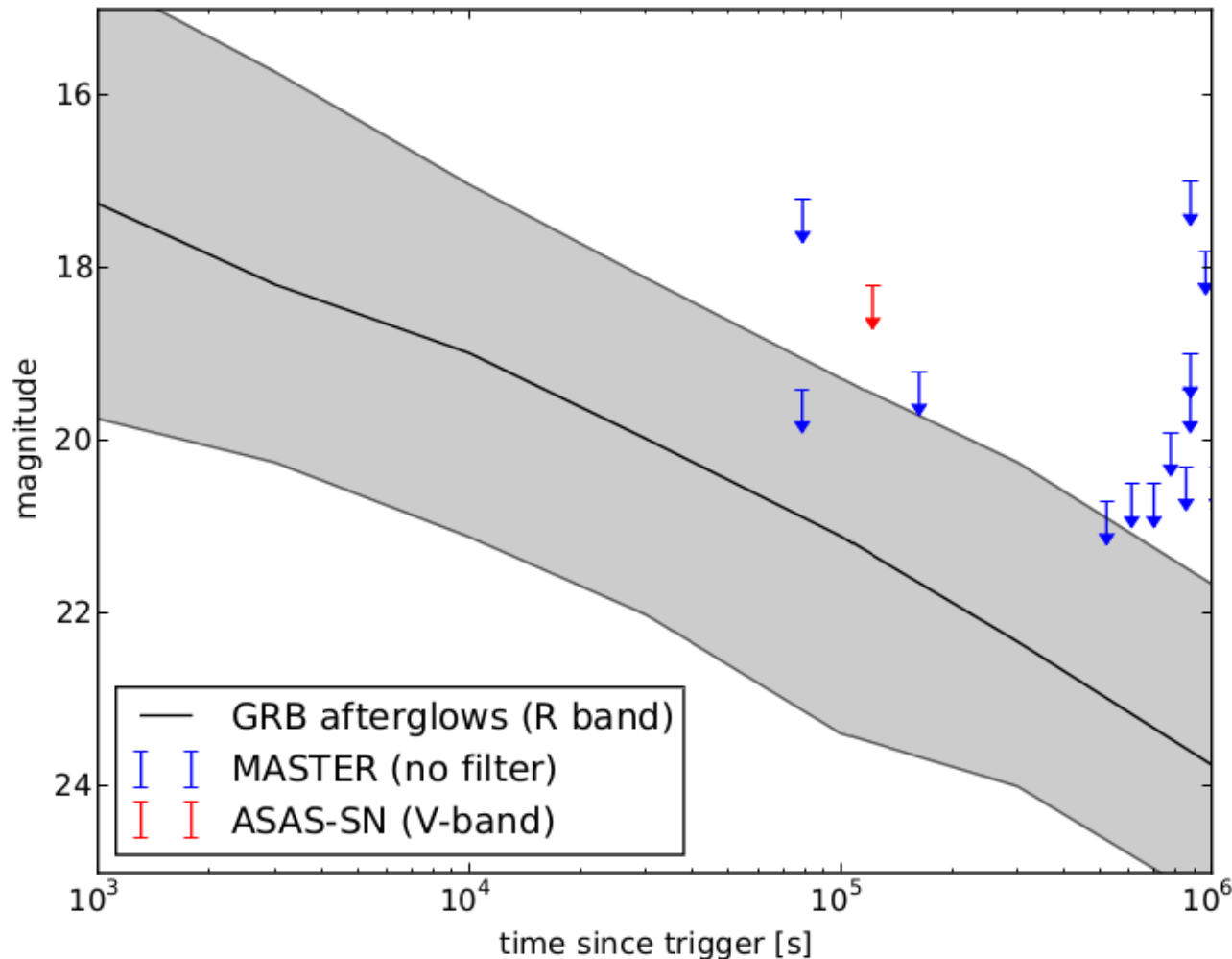
# Limits on GRBs



shaded bands  
contain 80% of  
Swift detected  
long GRBs

> only a bright GRB is ruled out by Swift observations

# Limits on GRBs

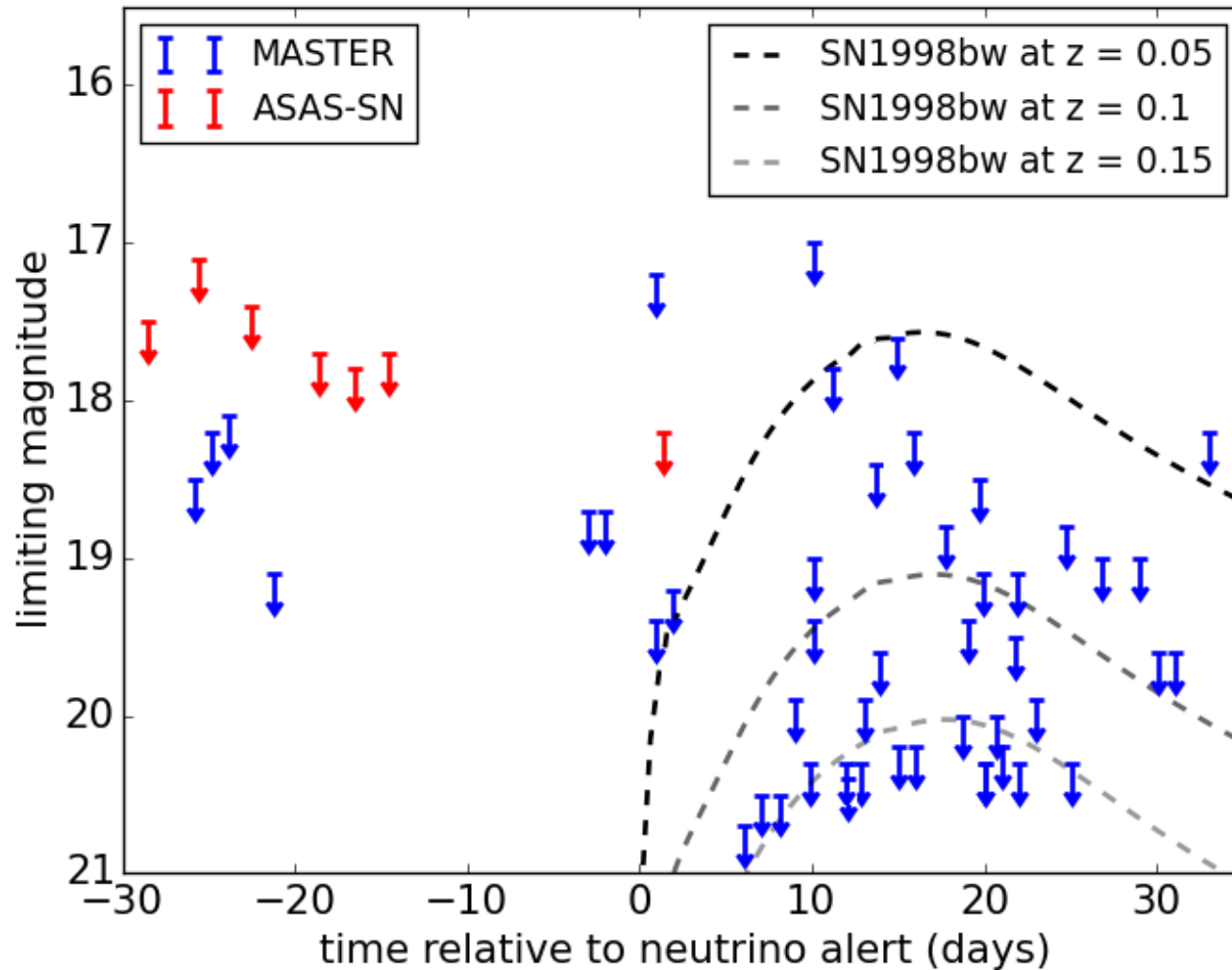


shaded band  
contains 80% of  
detected optical  
afterglows  
[arXiv:0712.2186]

> no good constraints on optical afterglow

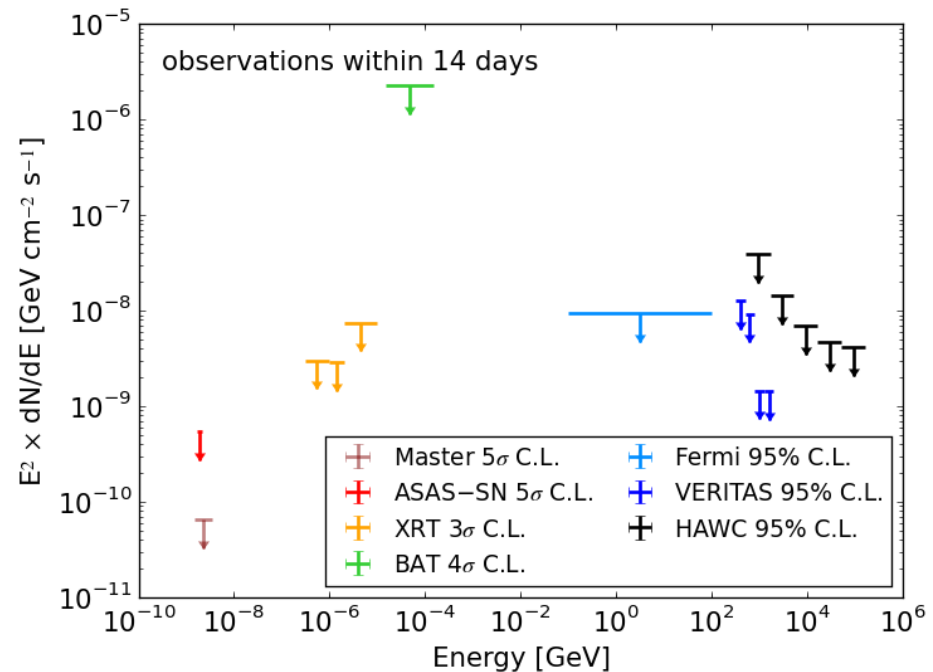
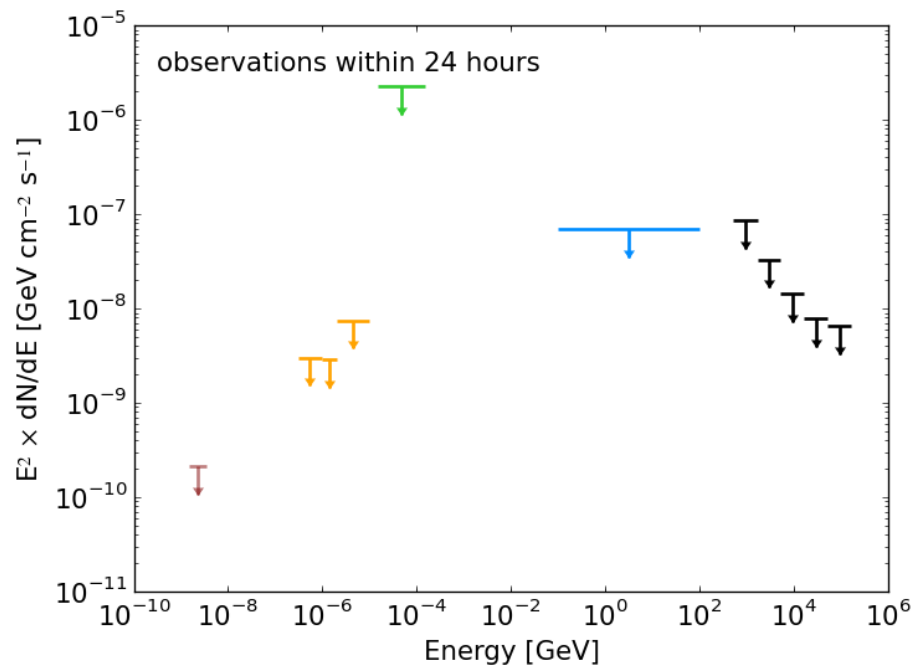


# Limits on core-collapse supernovae (with choked jets)



> a nearby supernova is disfavored by optical observations

# Constraints from Multiwavelength Observations



- > good data coverage
- > no likely counterpart identified [arXiv:1702.06131]

## Thank you to all collaborators!



# Summary

- > IceCube detects neutrinos in 100 GeV to few PeV energy range
- > established real-time multiwavelength follow-up program(s)
- > so far no evidence for neutrinos from GRBs or other short (<100s) transients
- > detected neutrino triplet consistent with background

