

Multi-messenger astronomy with Swift: the IceCube case

Phil Evans

on behalf of the Swift-IceCube collaboration

(Based on Evans et al. 2014/5, submitted to MNRAS)

P.A. Evans^{1*}, J.P. Osborne¹, J.A. Kennea², M. Smith³, D.M. Palmer⁴,
N. Gehrels⁵, J.M. Gelbord^{6,7}, A. Homeier⁸, M. Voge⁸, N.L. Strotjohann^{8,9},
D.F. Cowen¹⁰, S. Böser¹¹, M. Kowalski^{8,9}, A. Stasik⁹

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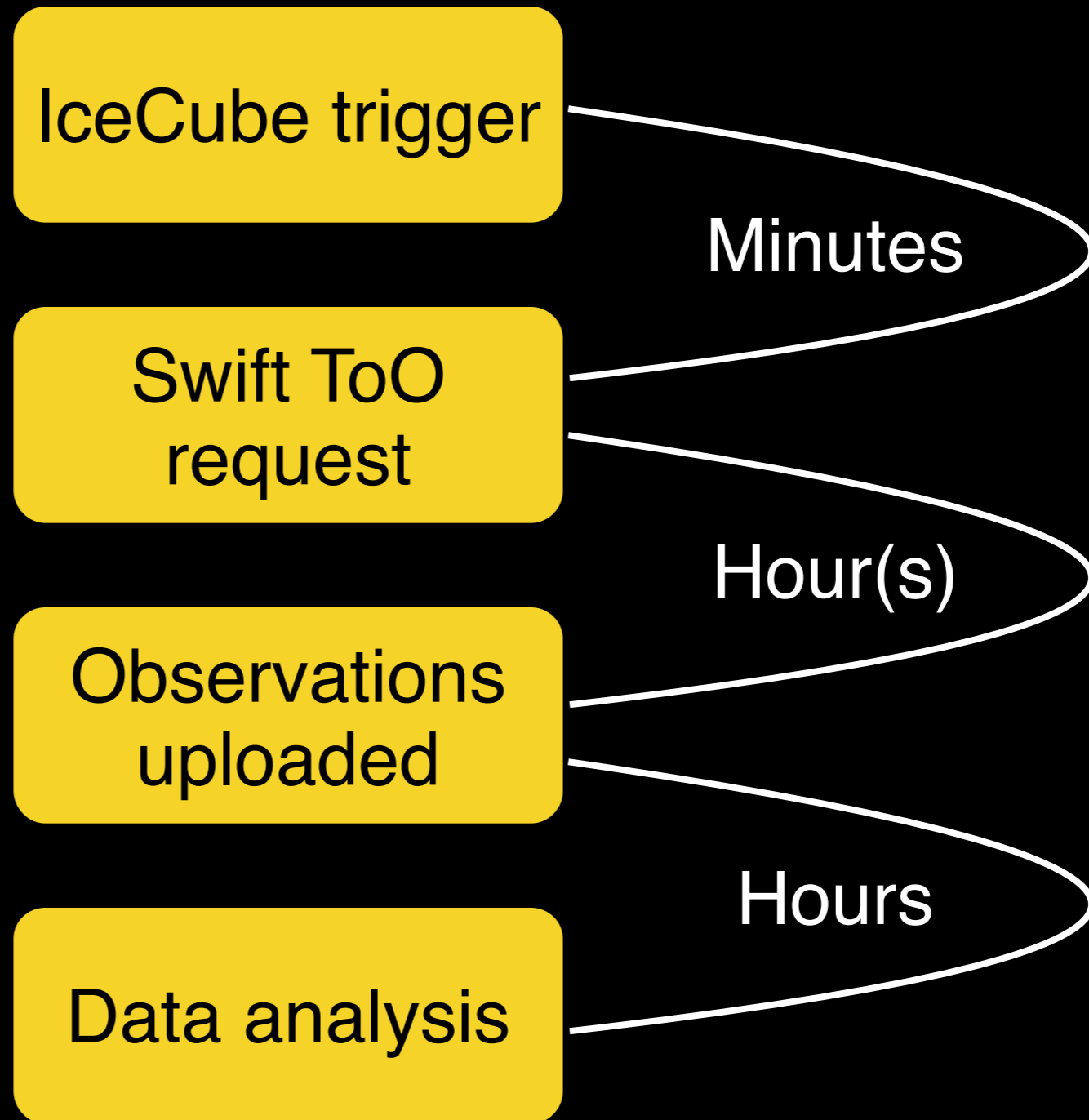
(refereed, revision sent to co-authors Weds night)

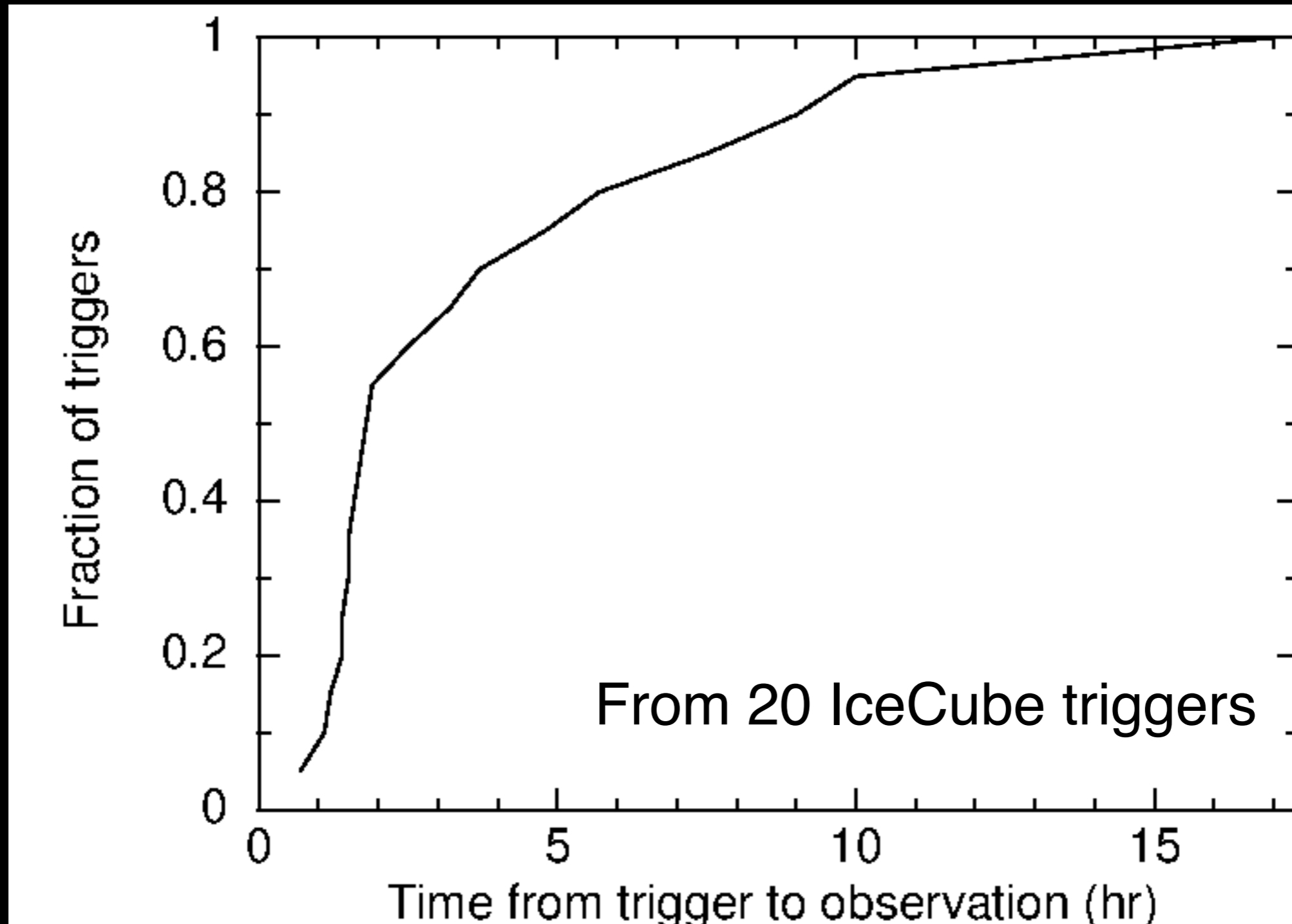
IceCube trigger

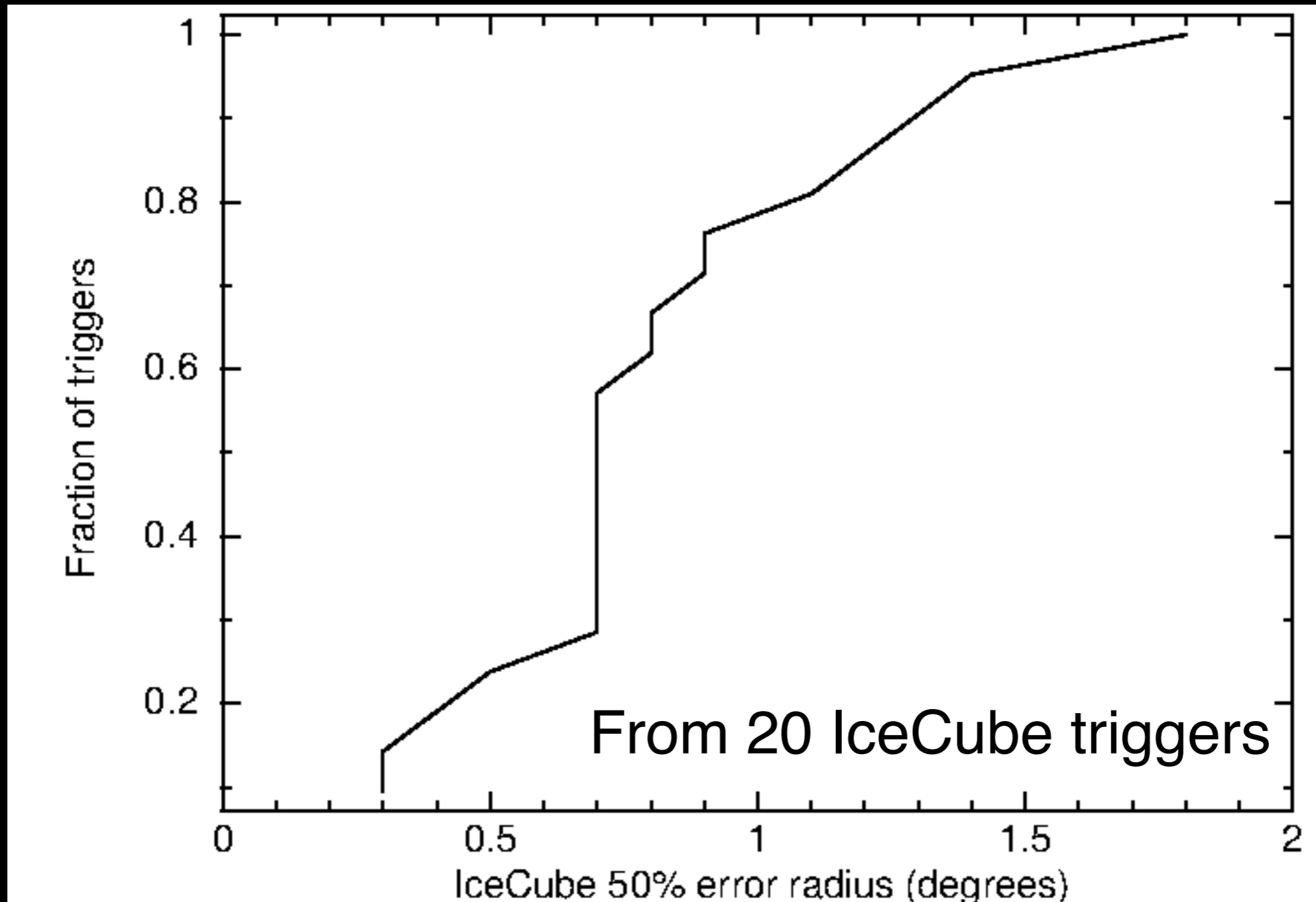
Swift ToO
request

Observations
uploaded

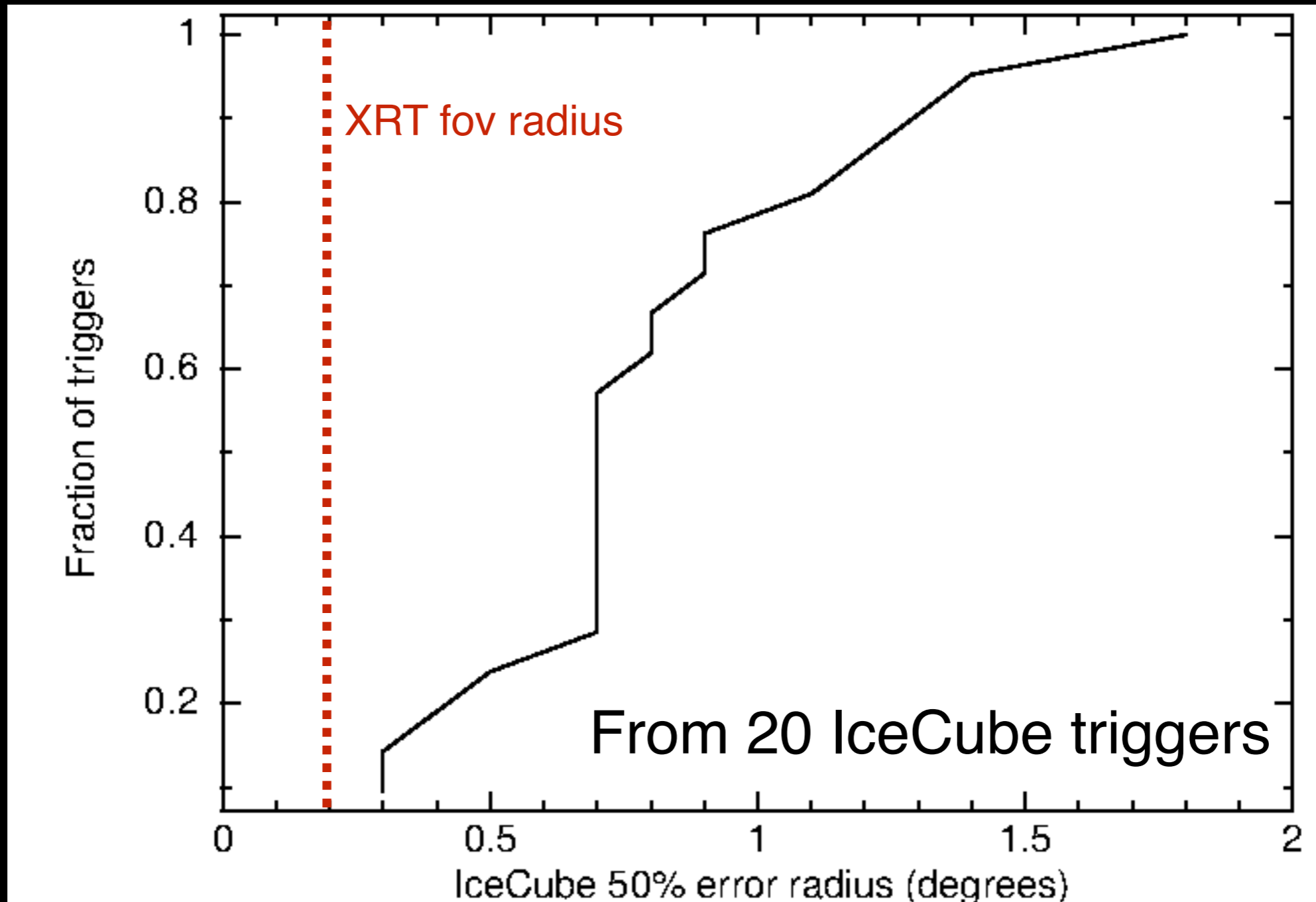
Data analysis



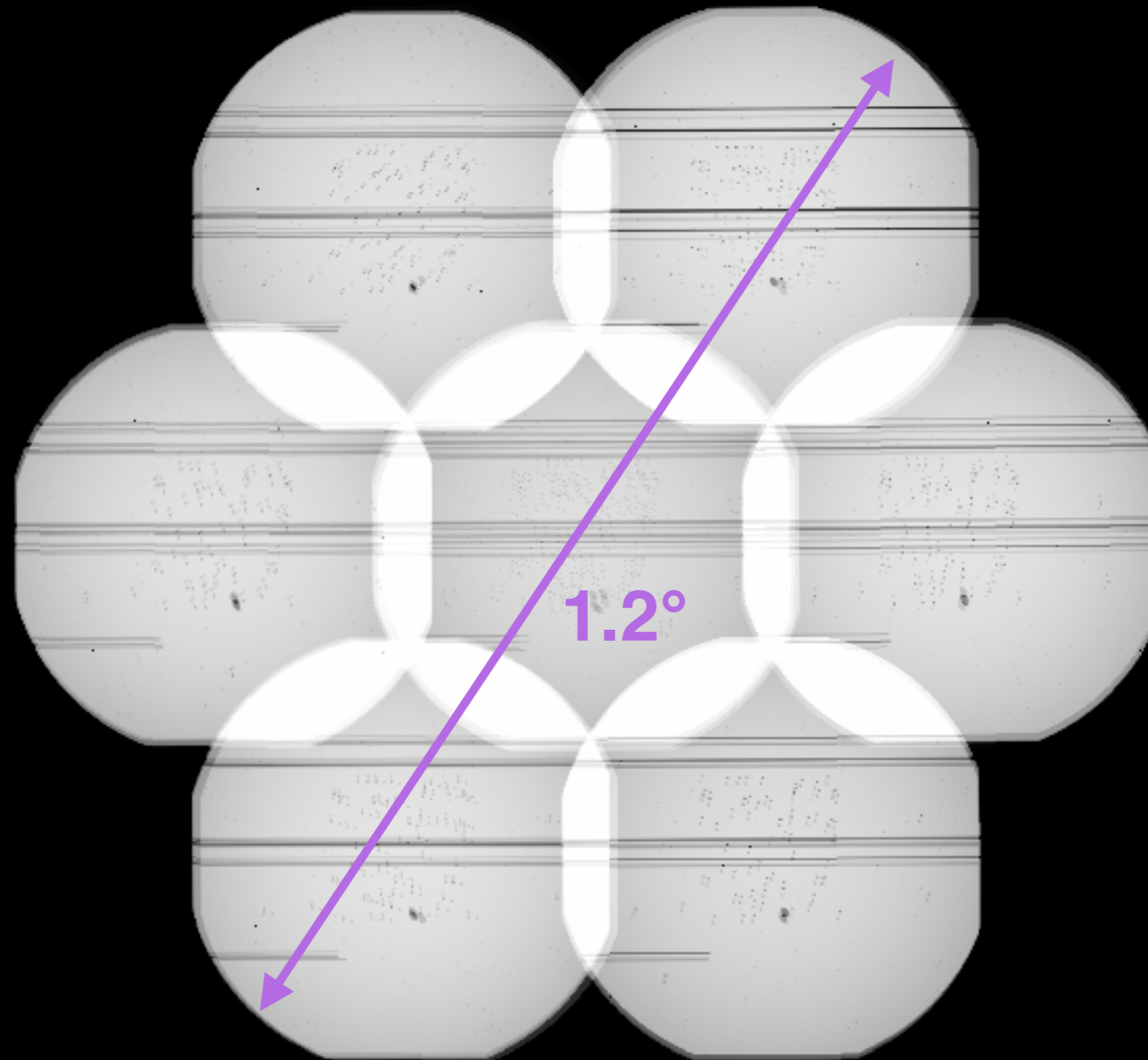


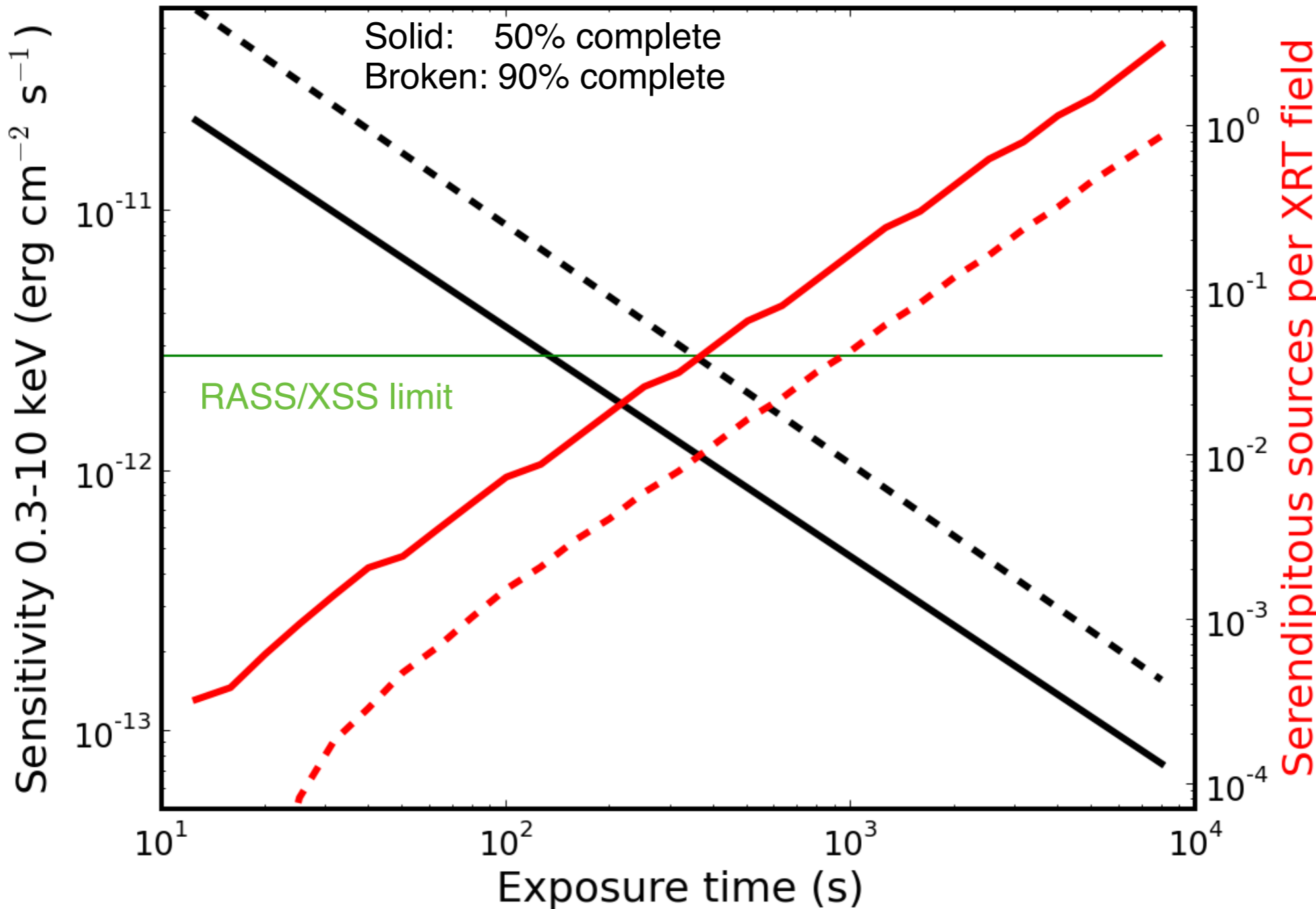


XRT field of view: radius 0.2°

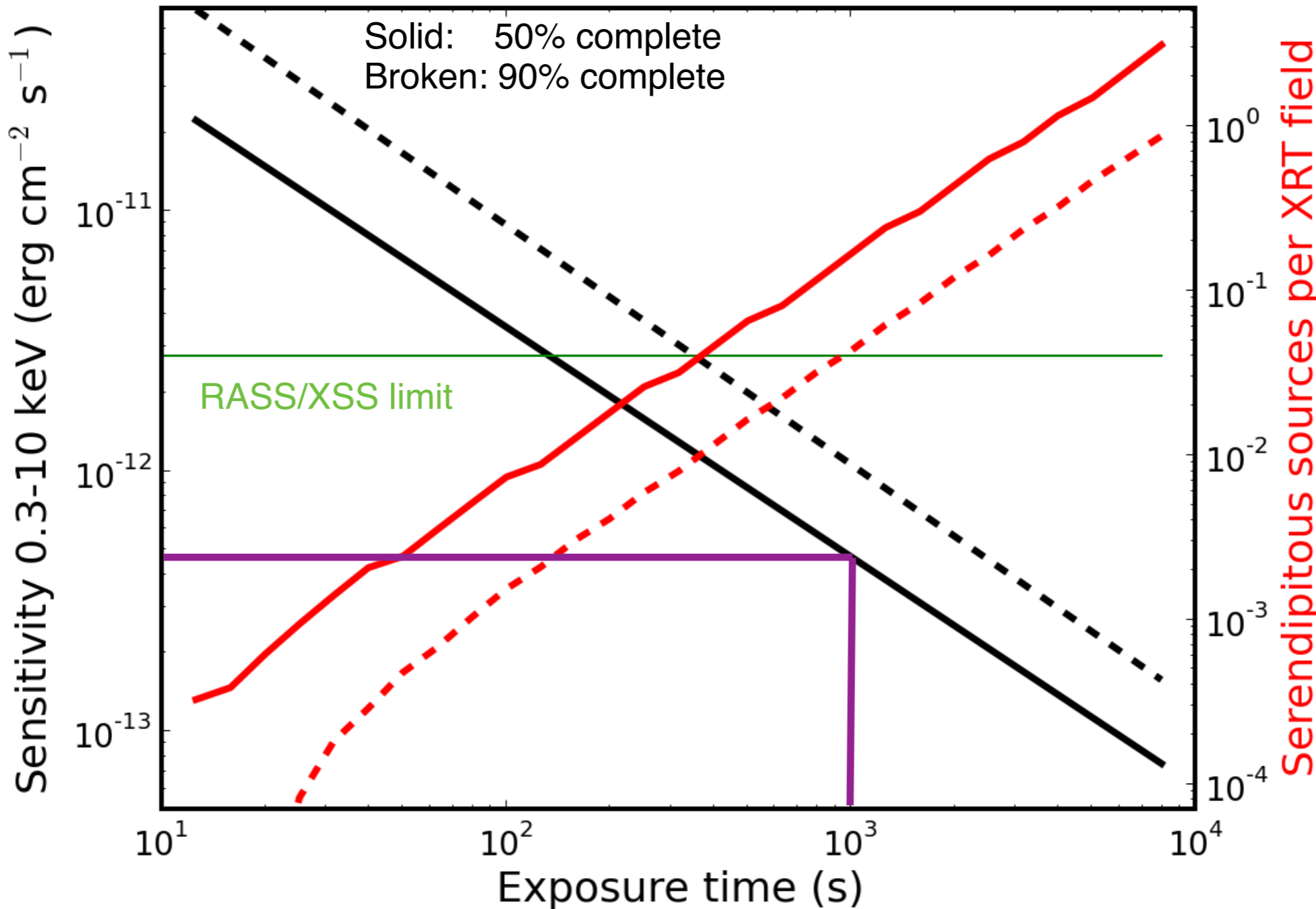


XRT field of view: radius 0.2°

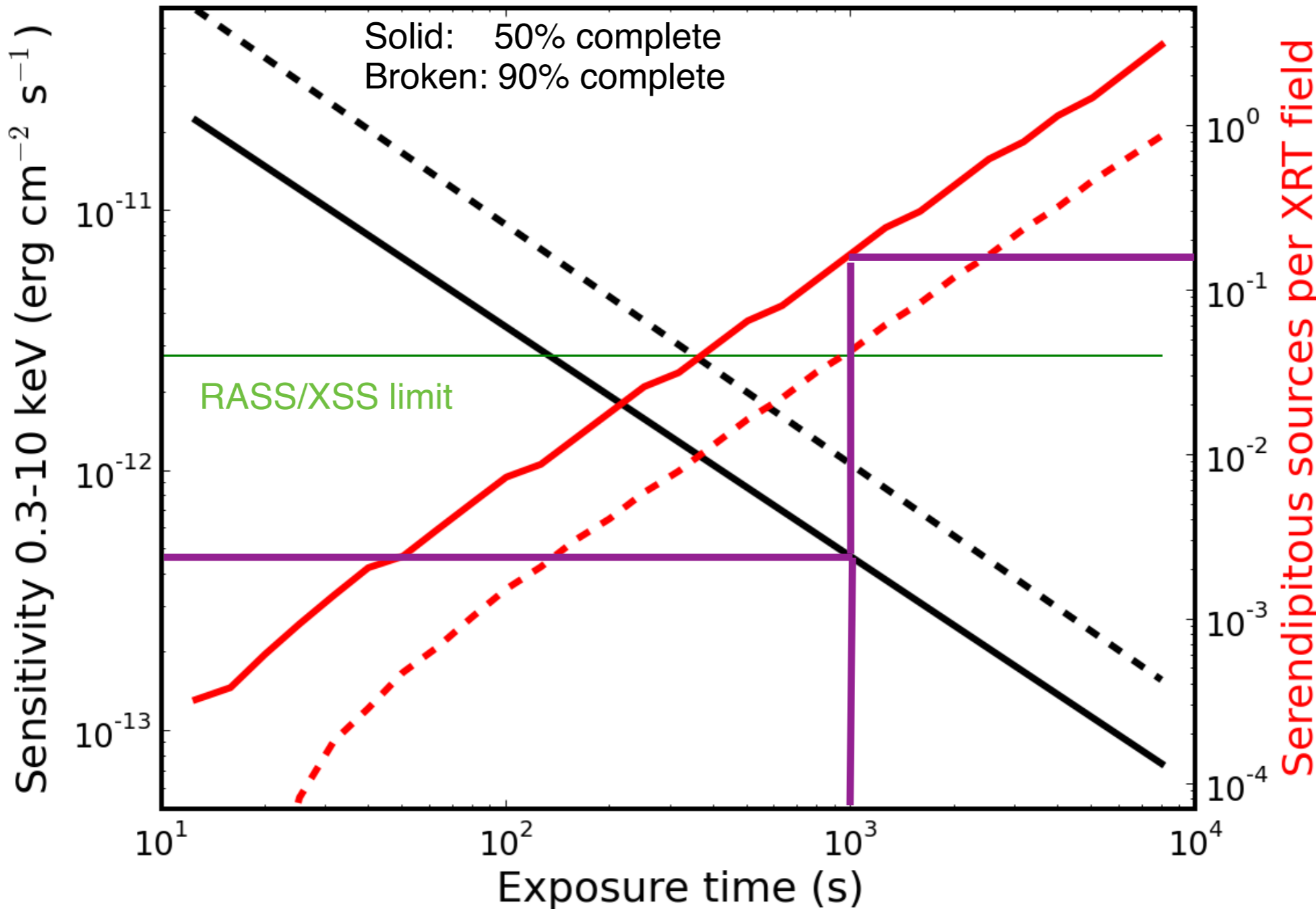




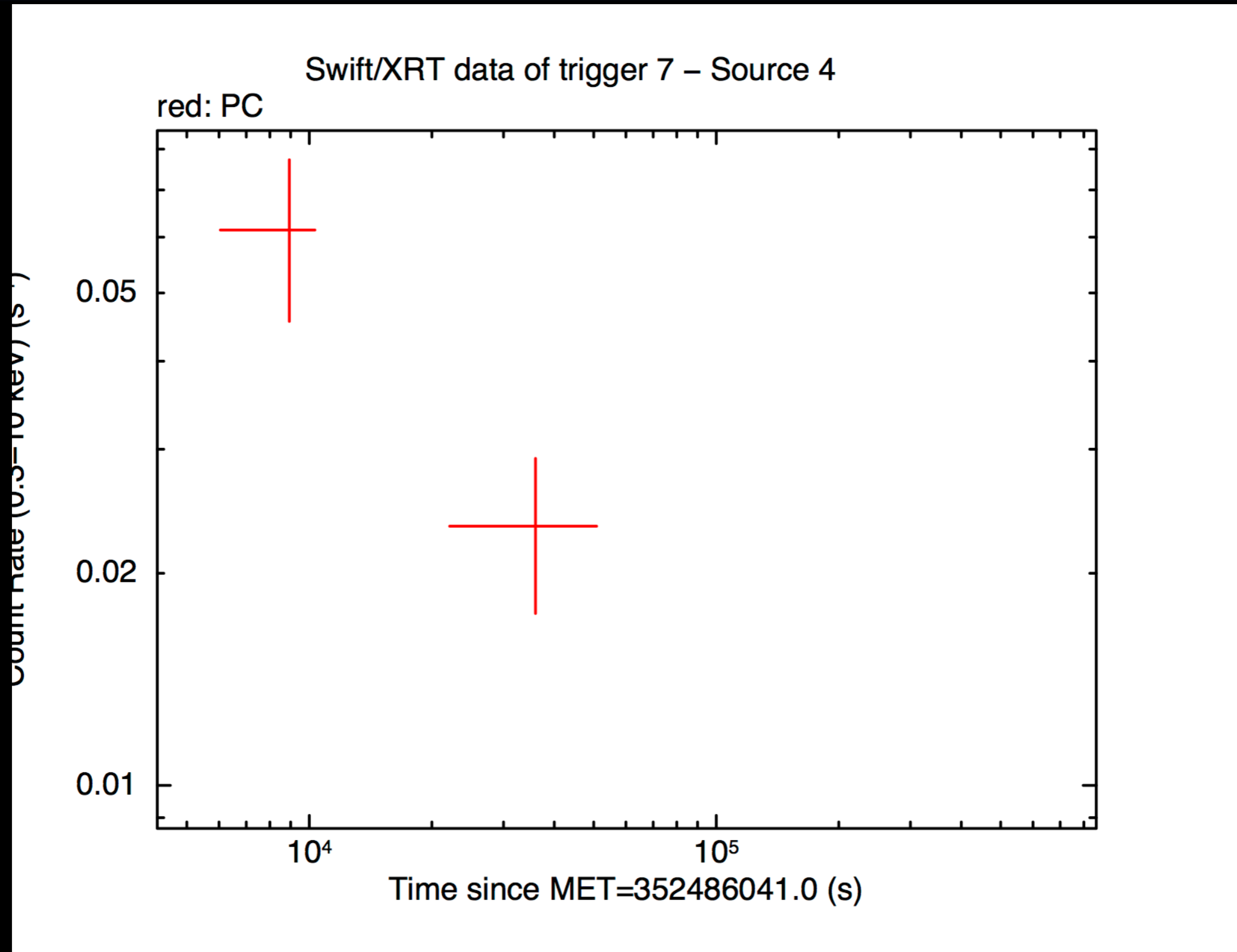
Evans et al (2014)

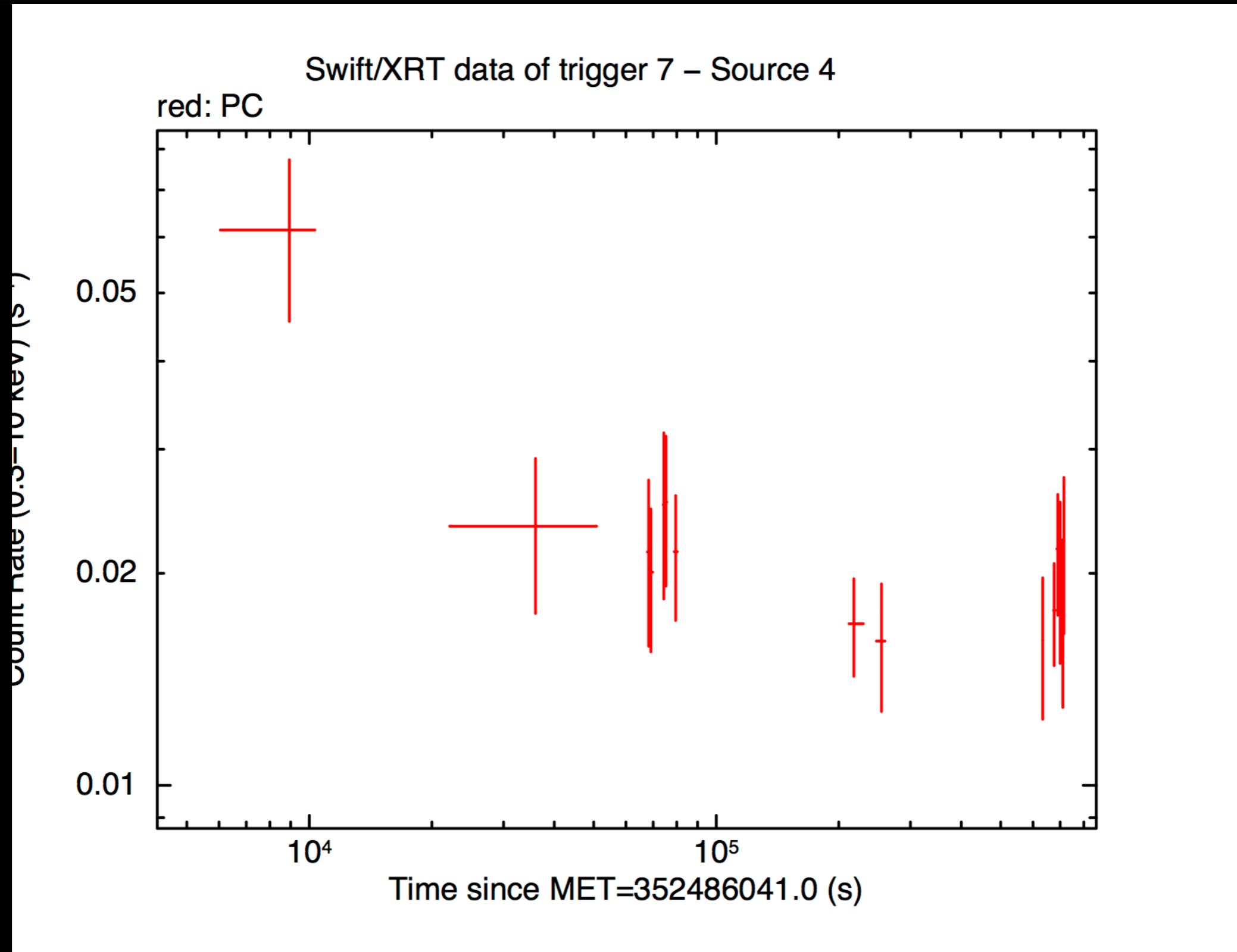


Evans et al (2014)



Evans et al (2014)





- Responded to 20 triggers.
- Detected 109 X-ray sources
 - 16 already catalogued.
 - 22 found when following up the possible fading object
 - **71 uncatalogued sources in initial observations**
- None can be identified as the counterpart to the trigger.
Any of them could be!

So why didn't we detect any counterparts?

What can we do to improve our chances of detecting the counterpart?

So why didn't we ~~detect~~ identify any counterparts?

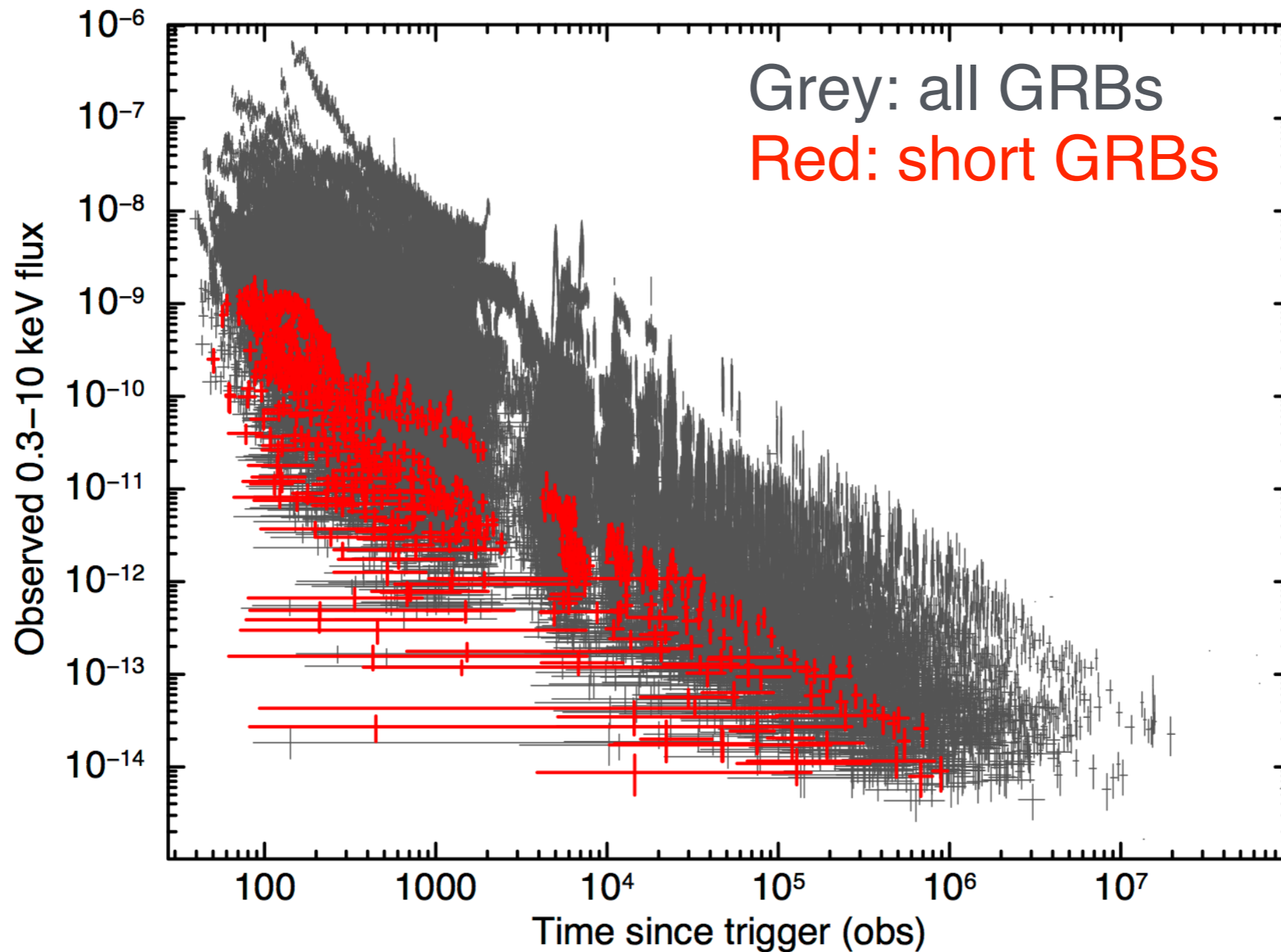
What can we do to improve our chances of ~~detecting~~ identifying the counterpart?

So why didn't we ~~detect~~ identify any counterparts?

What can we do to improve our chances of ~~detecting~~ identifying the counterpart?

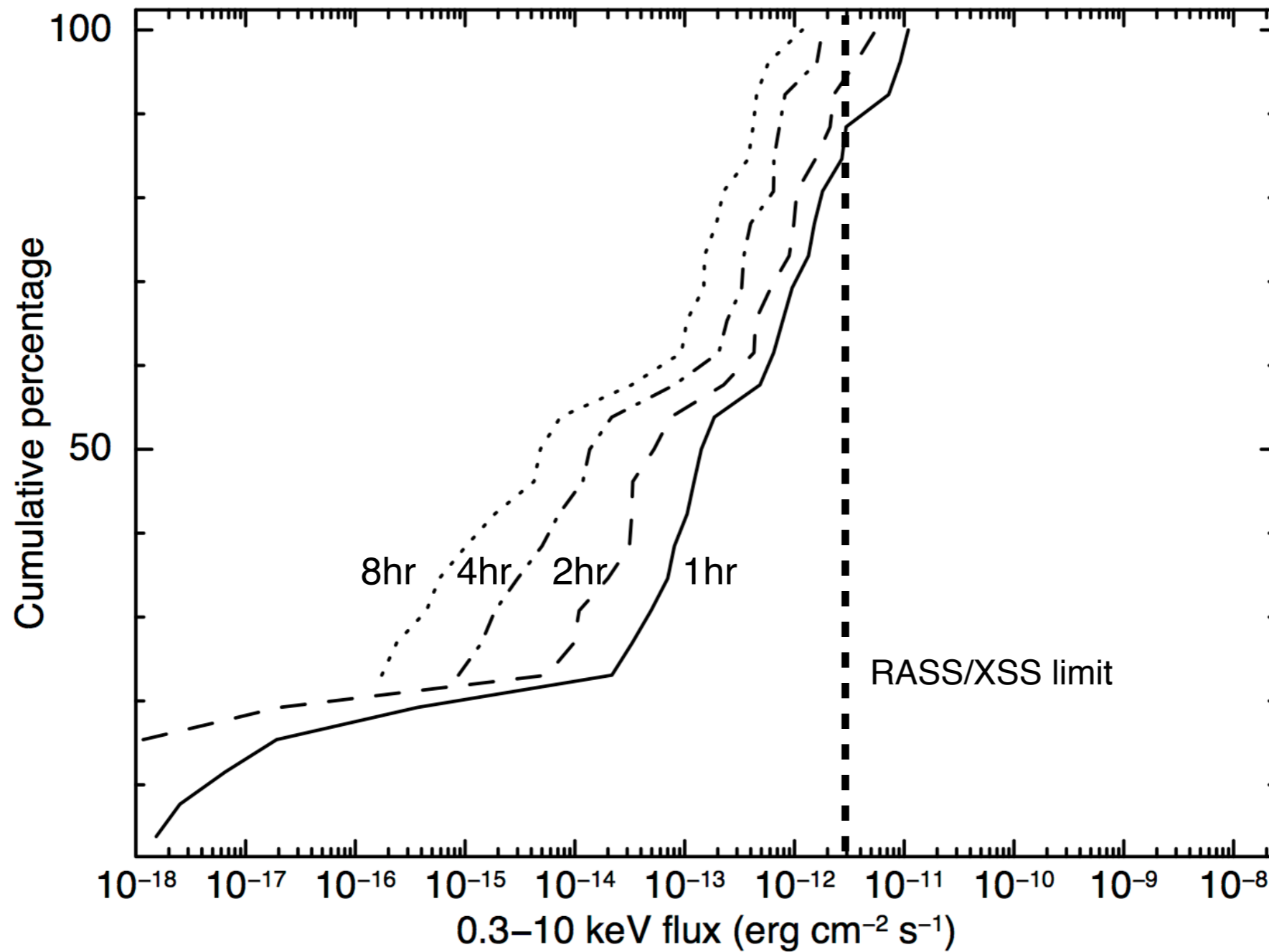
For this dicussion, I am going to consider short GRBs, with particular reference to aLIGO.

http://www.swift.ac.uk/xrt_curves



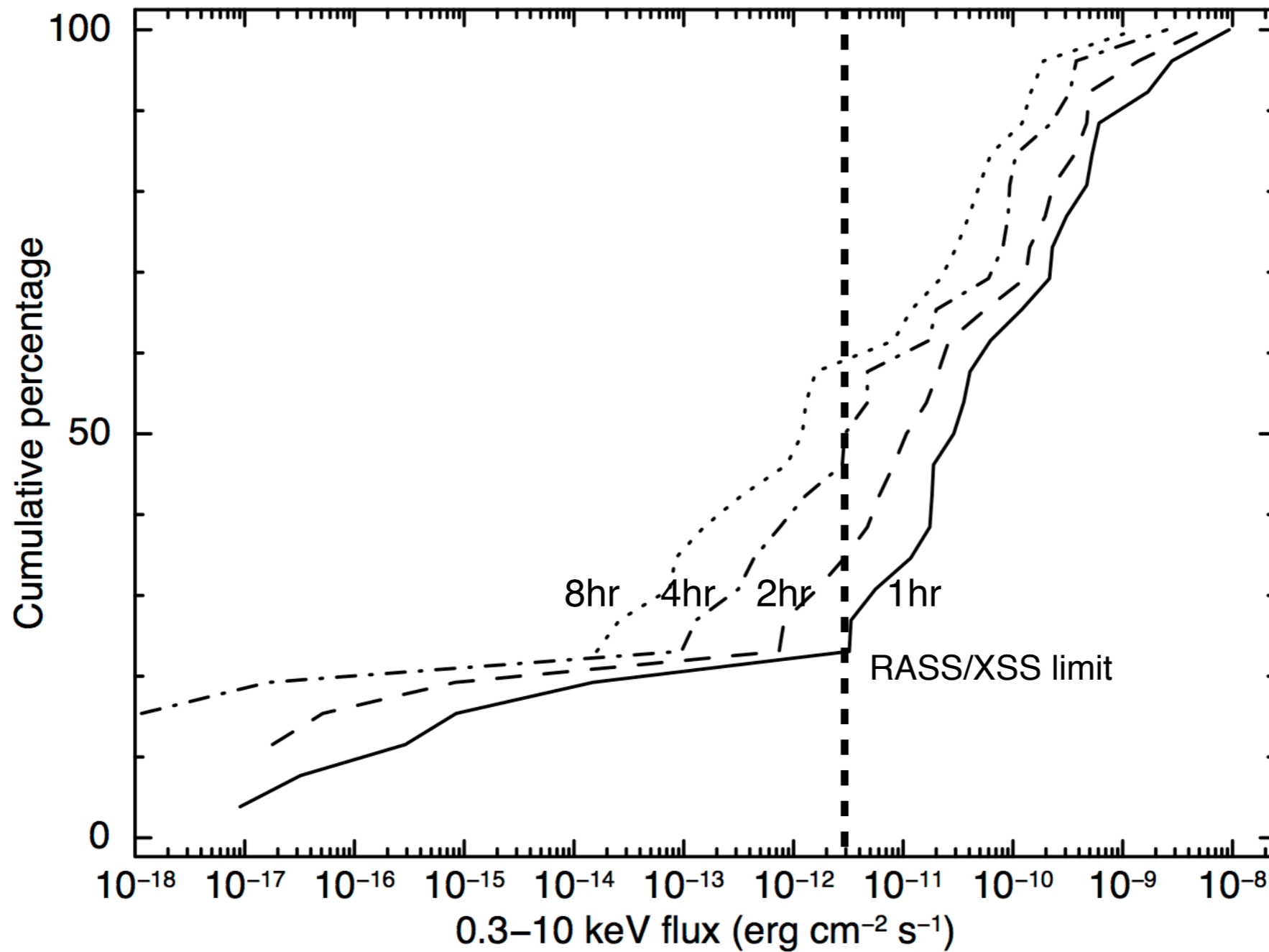
Short GRBs

Evans et al (2009)



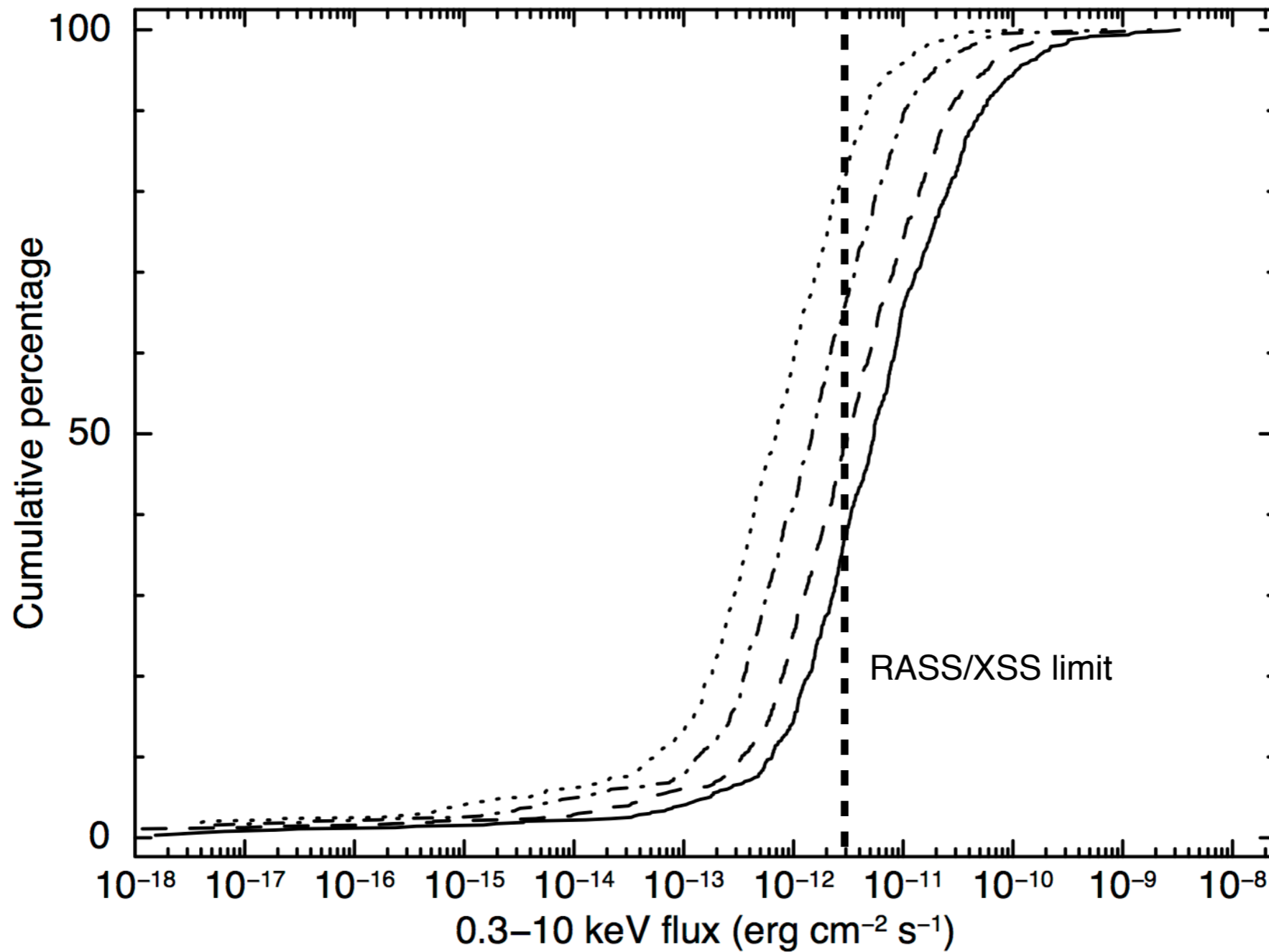
Short GRBs at 200 Mpc

Evans et al (2009)

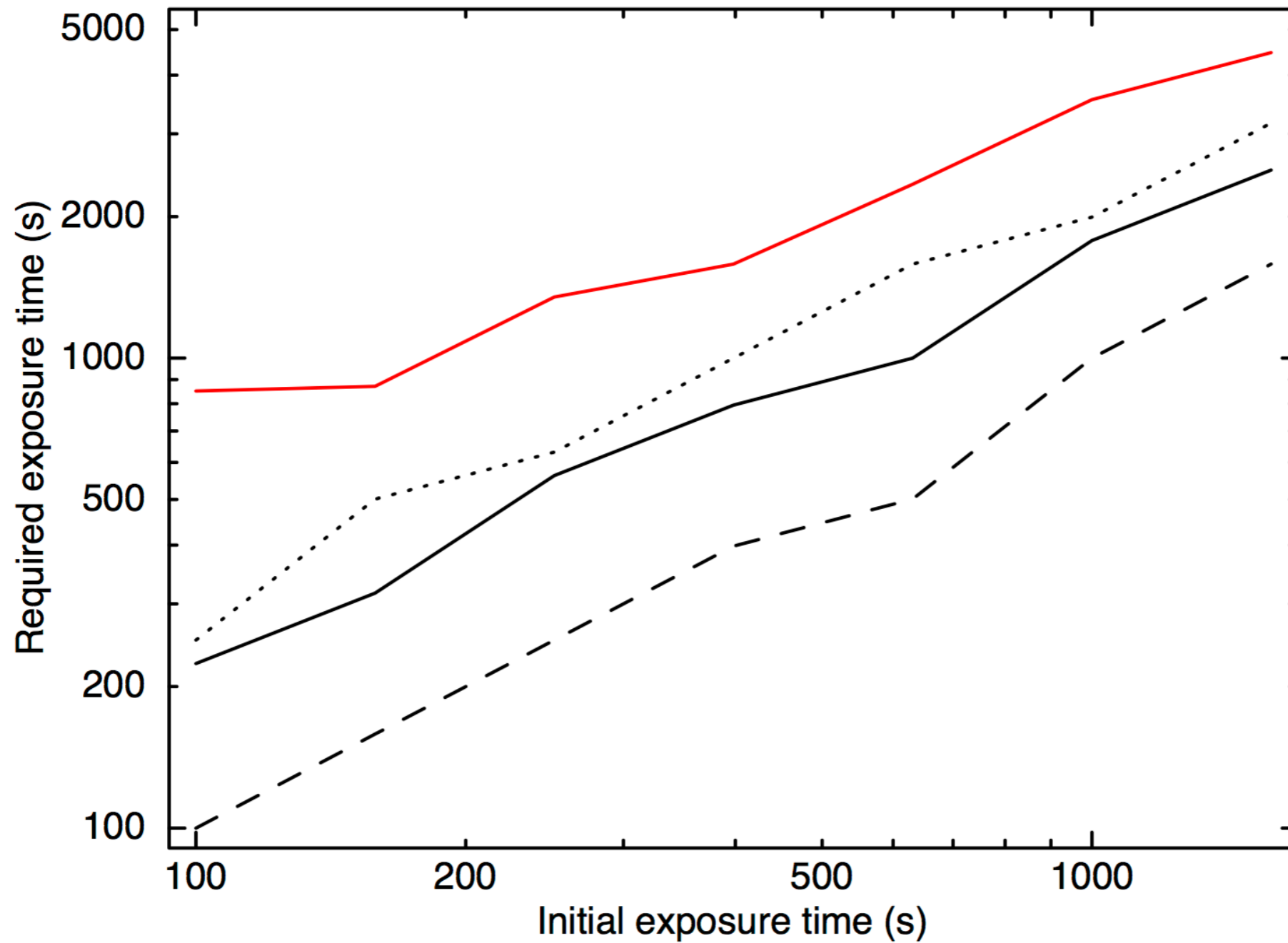


All GRBs

Evans et al (2009)



Can we identify fading?



- We have observed the fields of 20 IceCube neutrino multiplet triggers with Swift - no X-ray counterparts **identified.**
- **For short GRBs in the aLIGO horizon:** Identifying the EM counterpart based on a simple detection may be possible, especially if we have a more sensitive, all-sky catalogue (e.g. *eROSITA*).
- Performing a second observation of any previously uncatalogued sources gives us a fairly robust means of identifying the EM counterpart, if it was detected. For short GRBs, ~ 1 ks is long enough, if we wait ~ 12 hours.