ET Trade Studies

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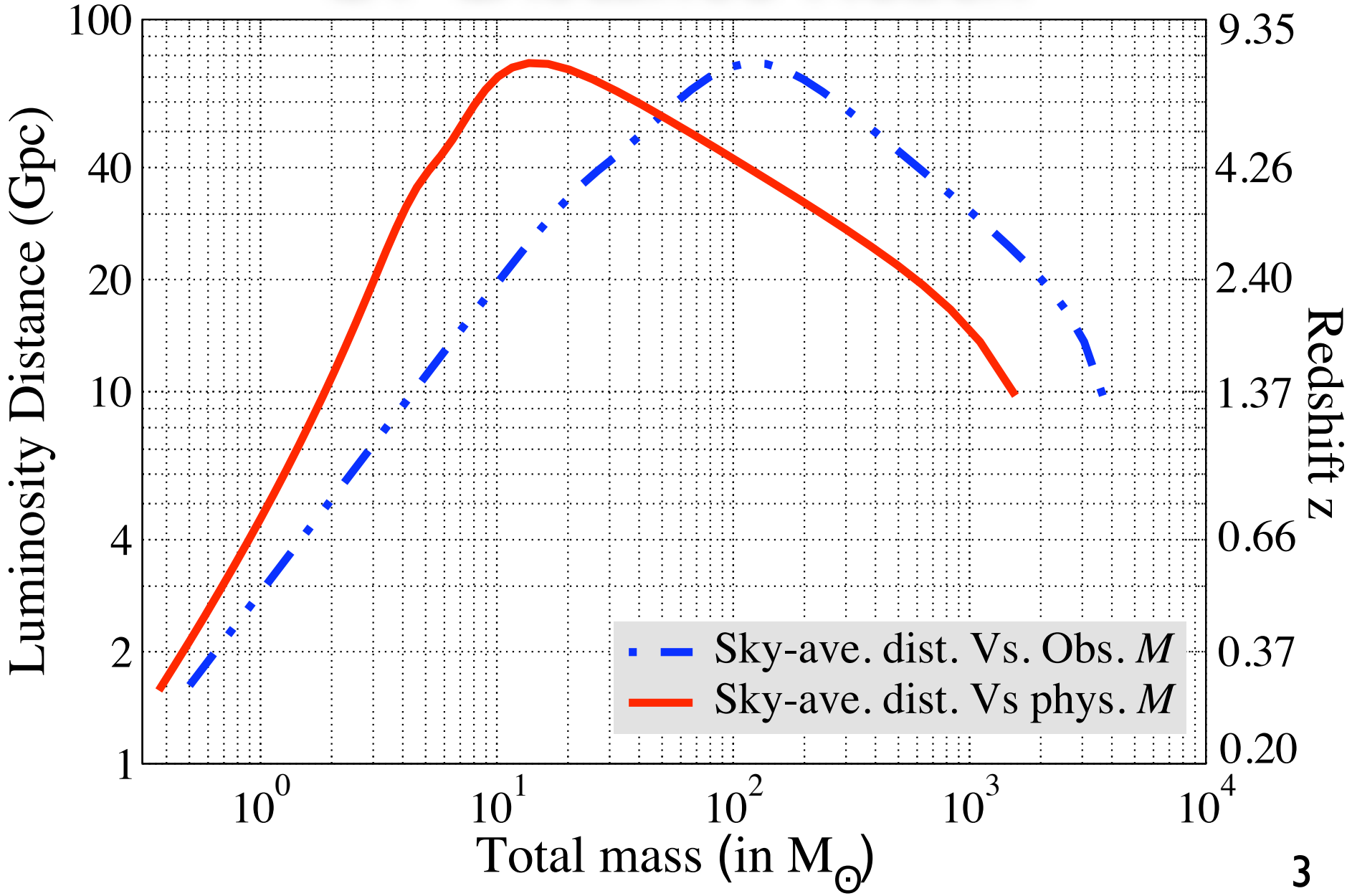
Credits: Einstein Telescope Science Team

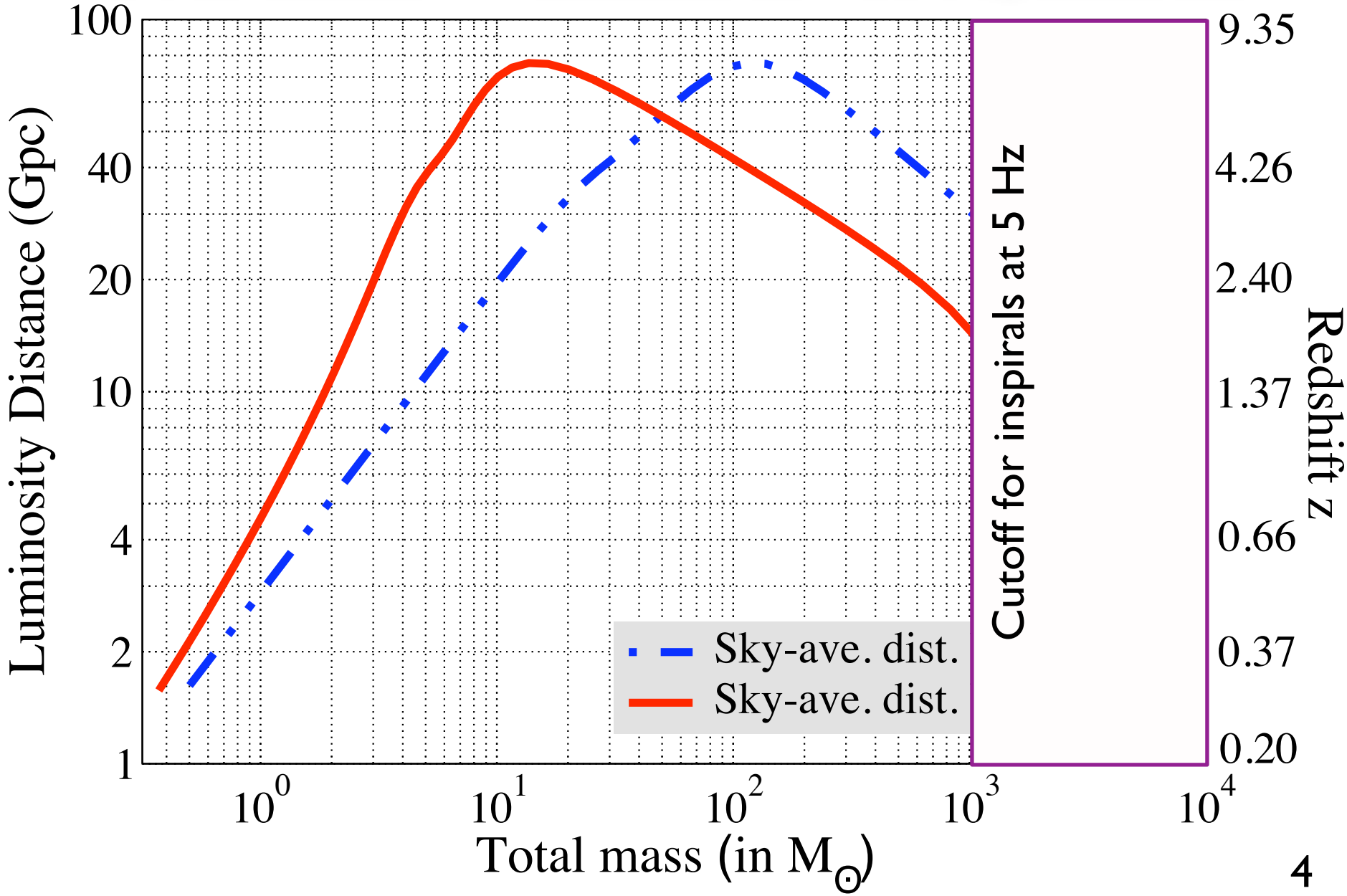
Goal of Trade Studies

- Science potential of a detector with regard to:
  - Detector sensitivity
    - Where is the low-frequency "wall" in sensitivity?
  - Detector topology
    - Geometrical configuration, optical layout, $\triangle$Vs. L
  - Site selection
    - All detectors at the same site, widely separated detectors, how many 3Gs?
- ET mock data challenge
  - ET will contain many overlapping sources
    - What is the value of current algorithms in disentangling sources?
    - What new algorithms do we need?
    - There could be an event every ten seconds!
  - Signals will be long-lived
    - Need to correct for Doppler modulation due to detector motion

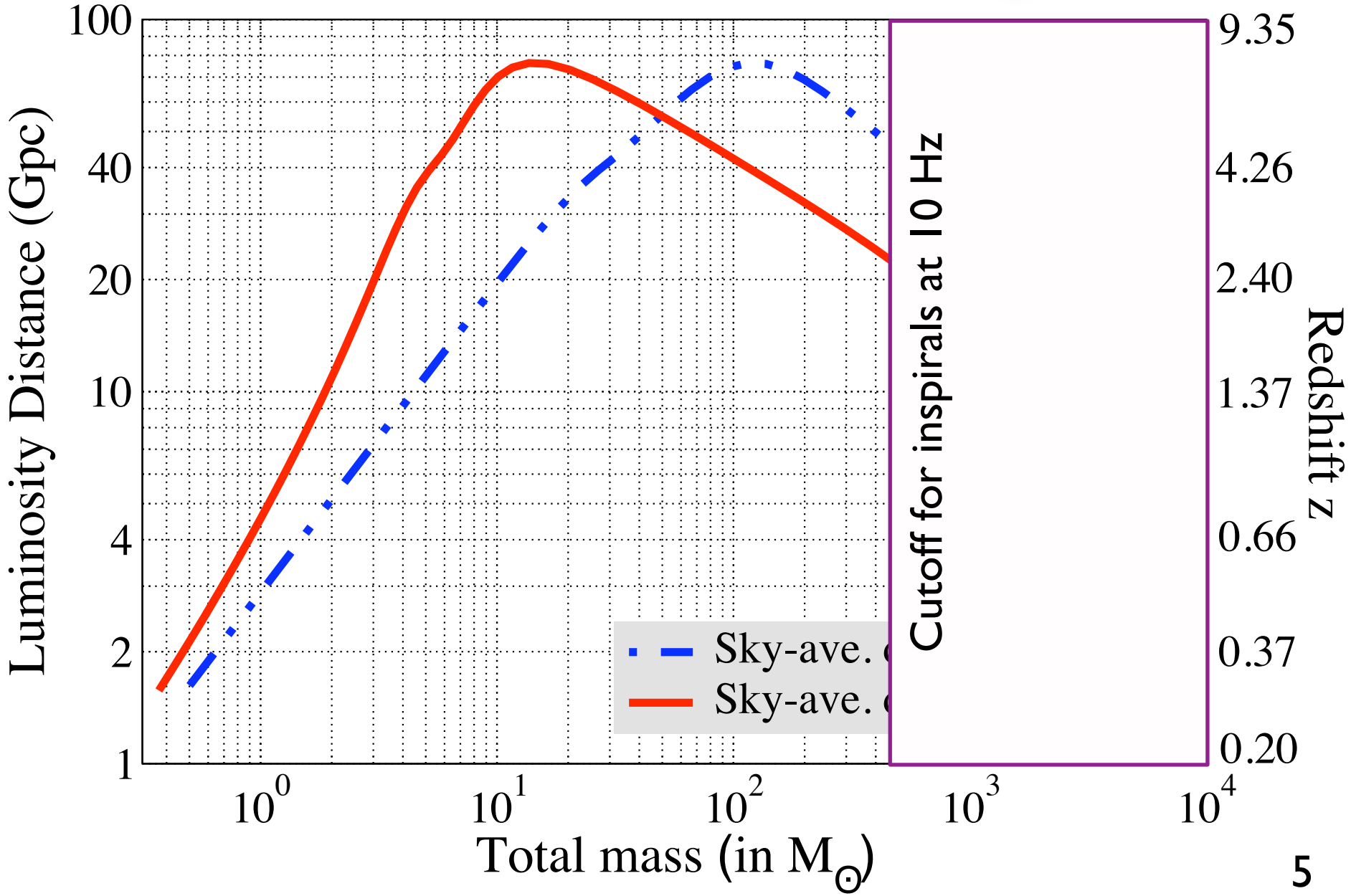
ET Distance Reach



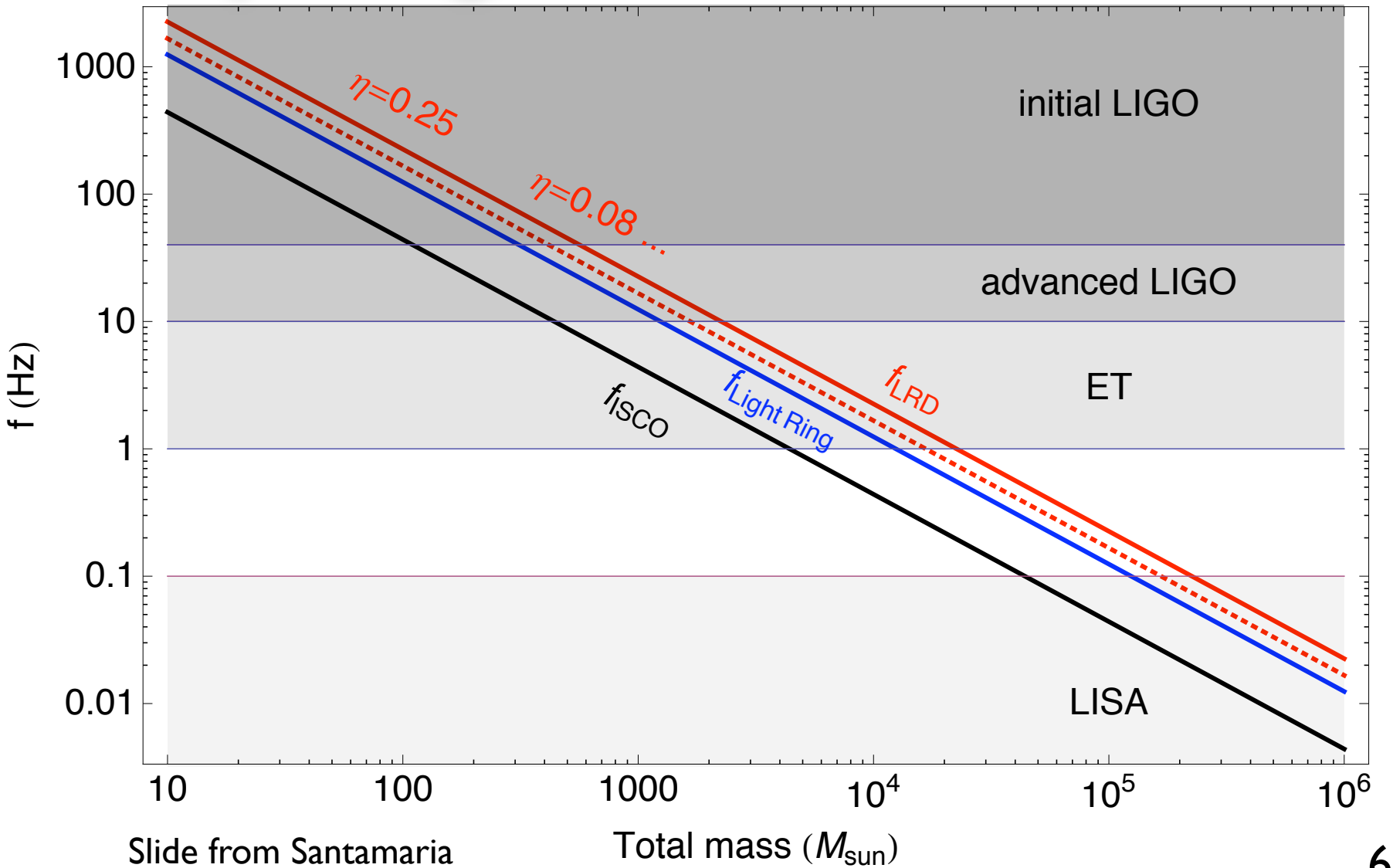
5 Hz Cutoff => Limited to 900 $M_\odot$ Binaries



10 Hz Cutoff => Limited to 450 $M_\odot$ Binaries



ET Could Observe Seed Black Holes Depending on Where the Cutoff Is



Slide from Santamaria

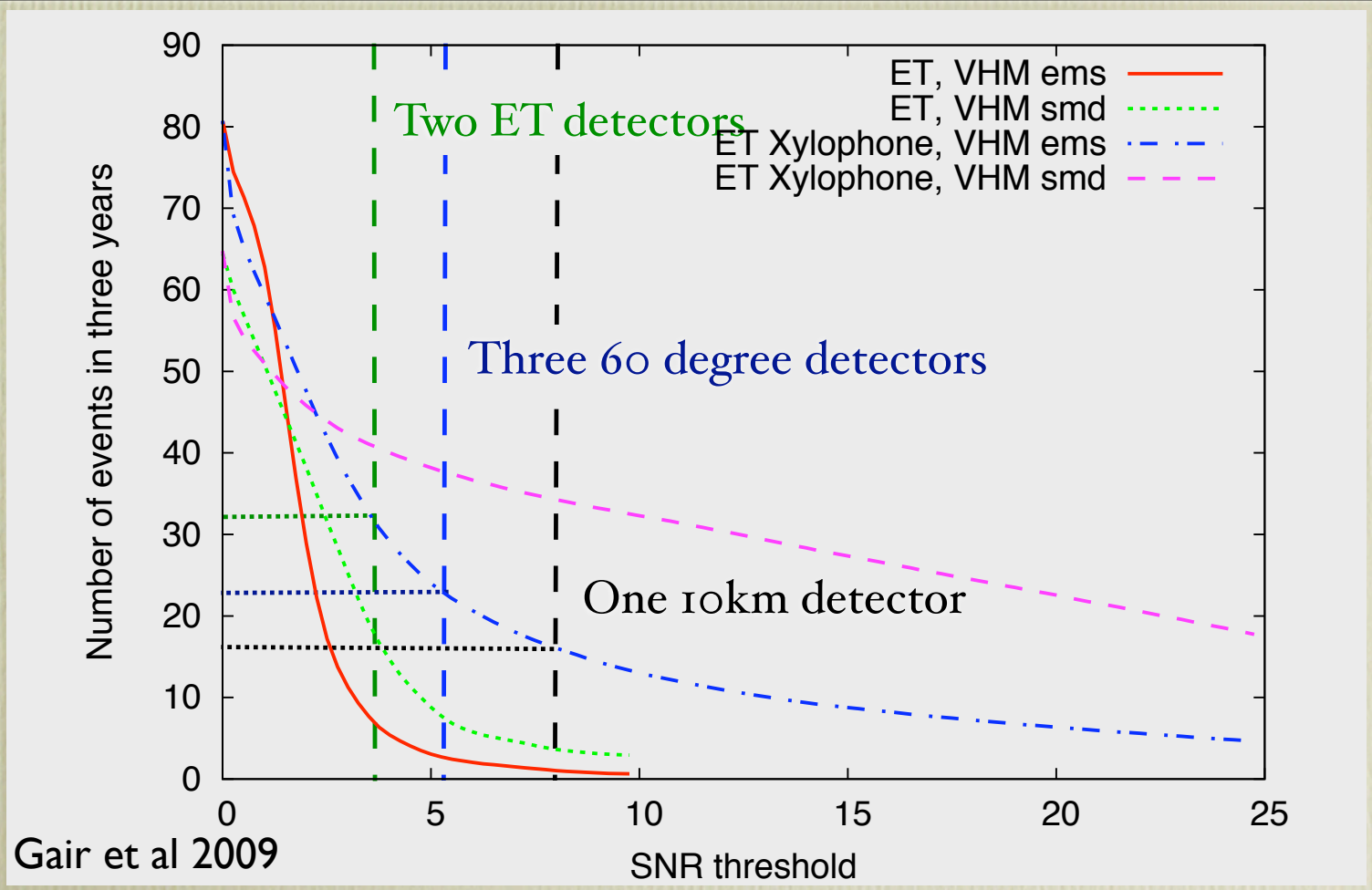
Can ET distinguish b/w seed black hole models?

- Models for mass distribution and accretion history could differ greatly
  - HM, equal mass seeds (EMS): all BHs have mass of M=150 $M_\odot$ and accrete at Eddington rate a mass that scales as the fifth power of the halo circular velocity
  - VHM, seed mass distribution (SMD): as above, but now BH seeds have a flat distribution of masses from 30-600 $M_\odot$
  - calk: Eddington rate varies with redshift
  - hopk: Eddington rate varies with AGN luminosity

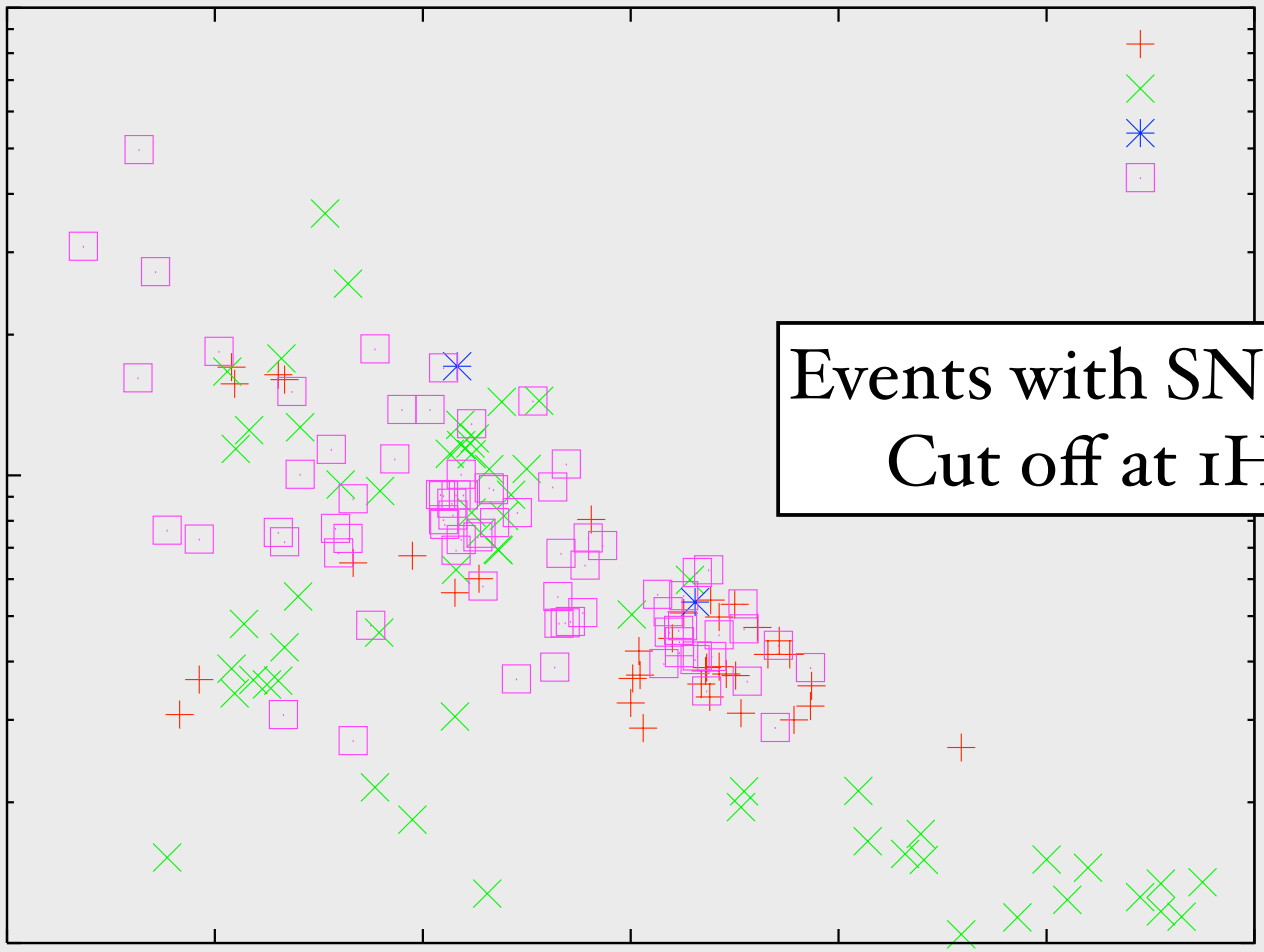
Volonteri, Salvaterra & Haardt 2006

Number of Events is Sensitive to ET Configuration and Astrophysical Model

ET seed merger event rate



ET seed merger events with SNR>5

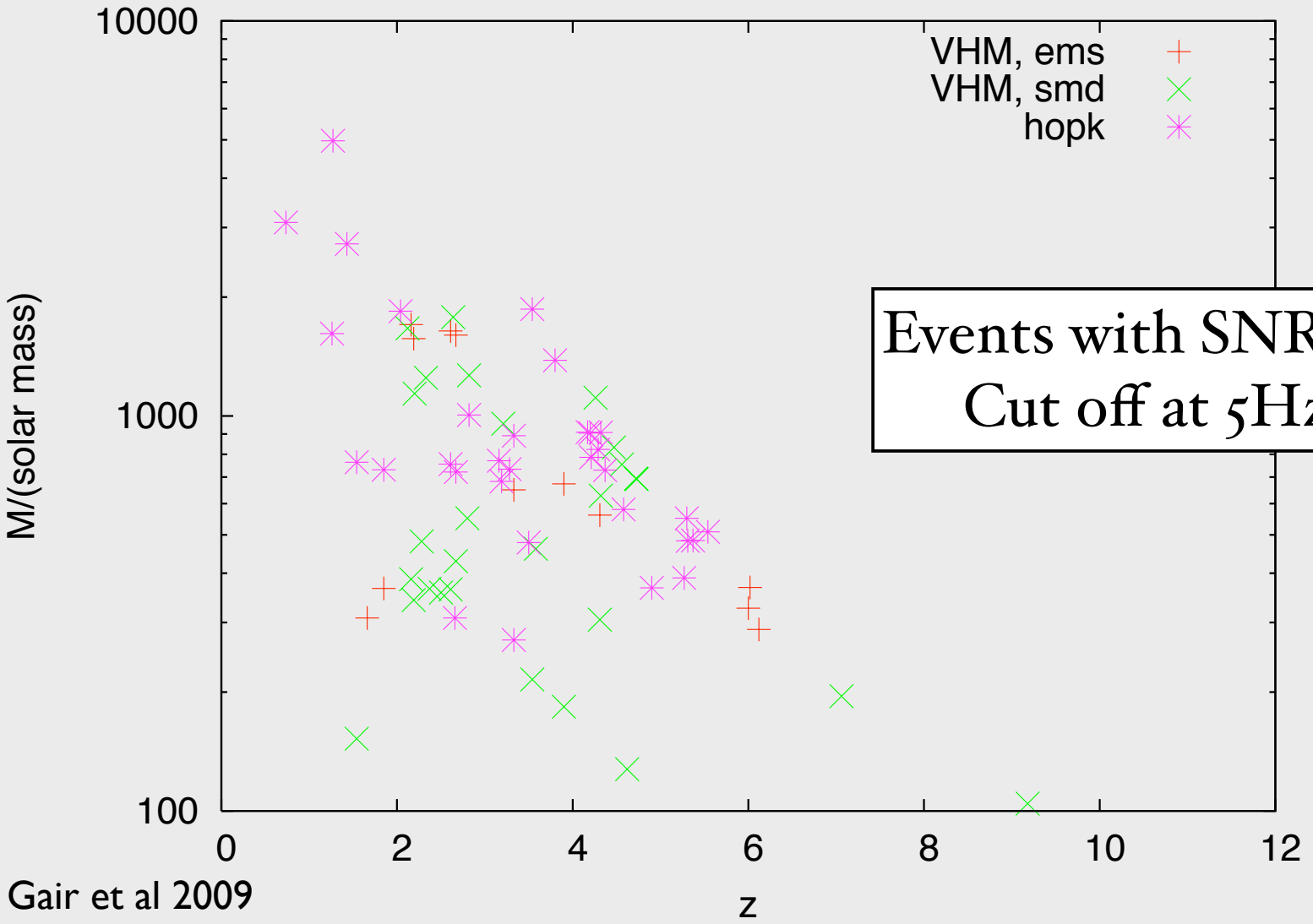


Events with SNR > 5
Cut off at 1Hz

Gair et al 2009

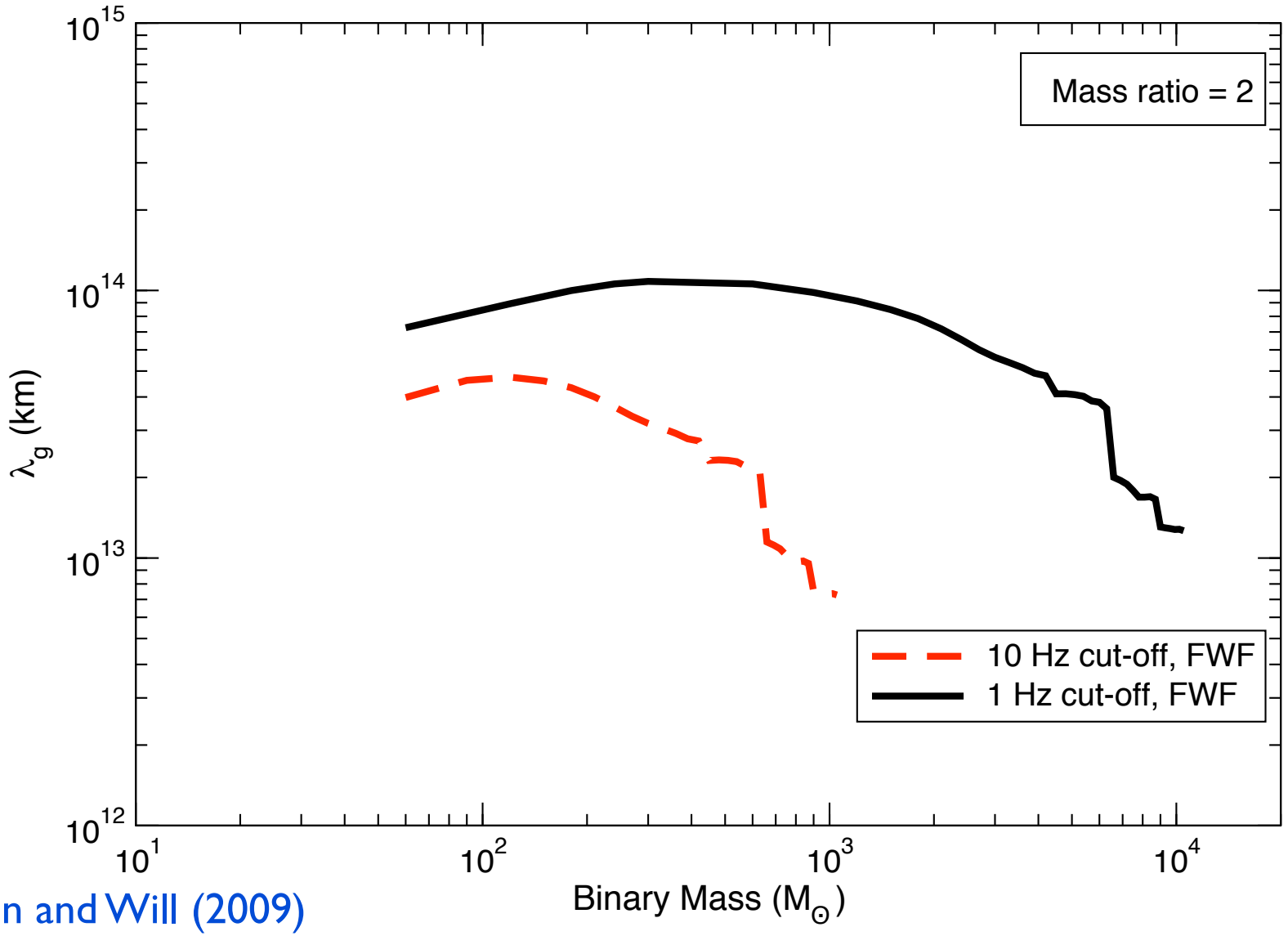
z

ET seed mergers - effect of cut off



Events with SNR > 5
Cut off at 5Hz

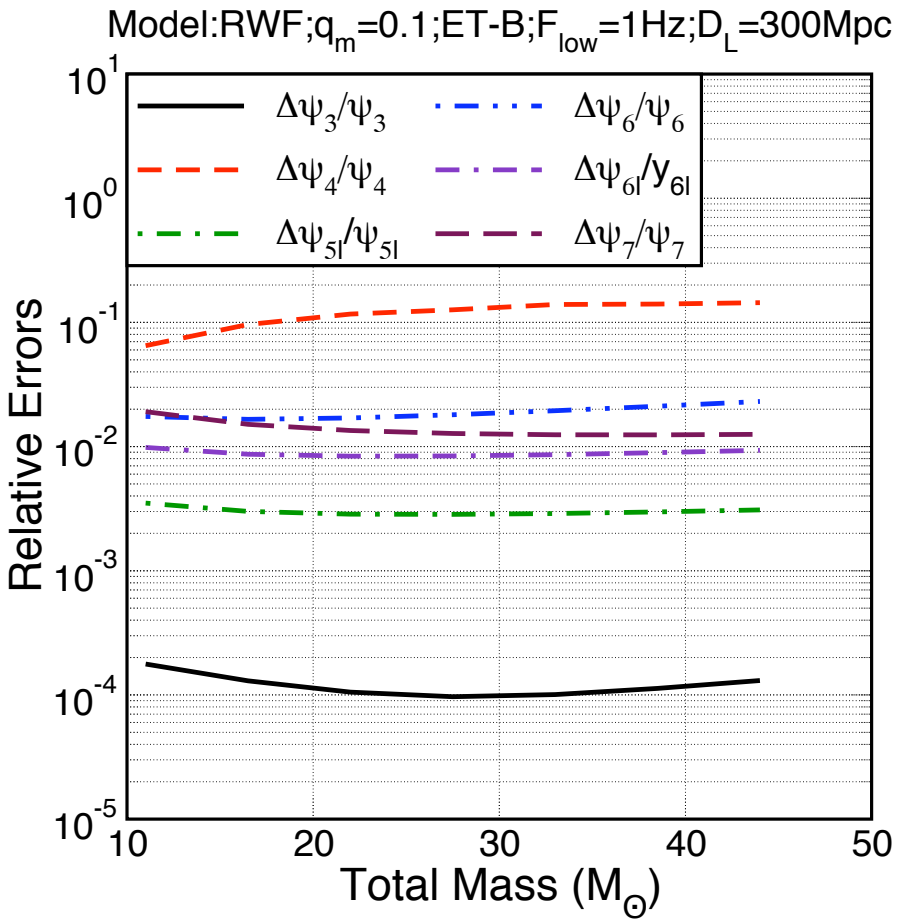
Effect of lower frequency cutoff on λ_g bounds

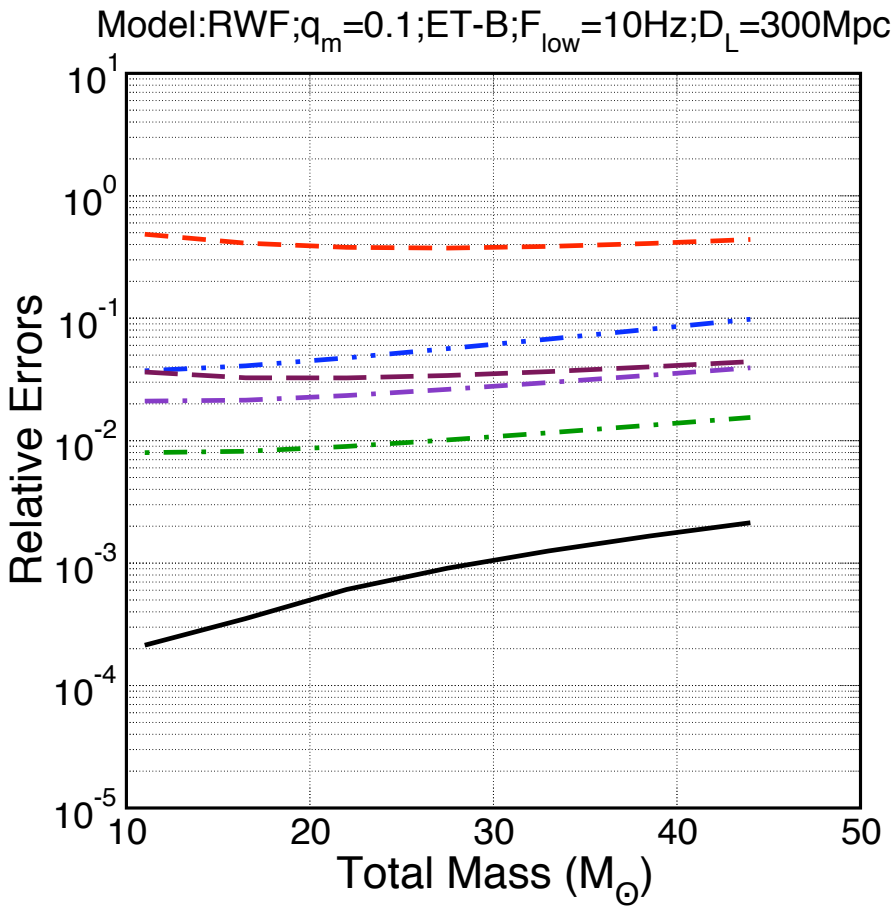


Arun and Will (2009)

Effect of lower frequency cutoff on measurement of non-linear effects?

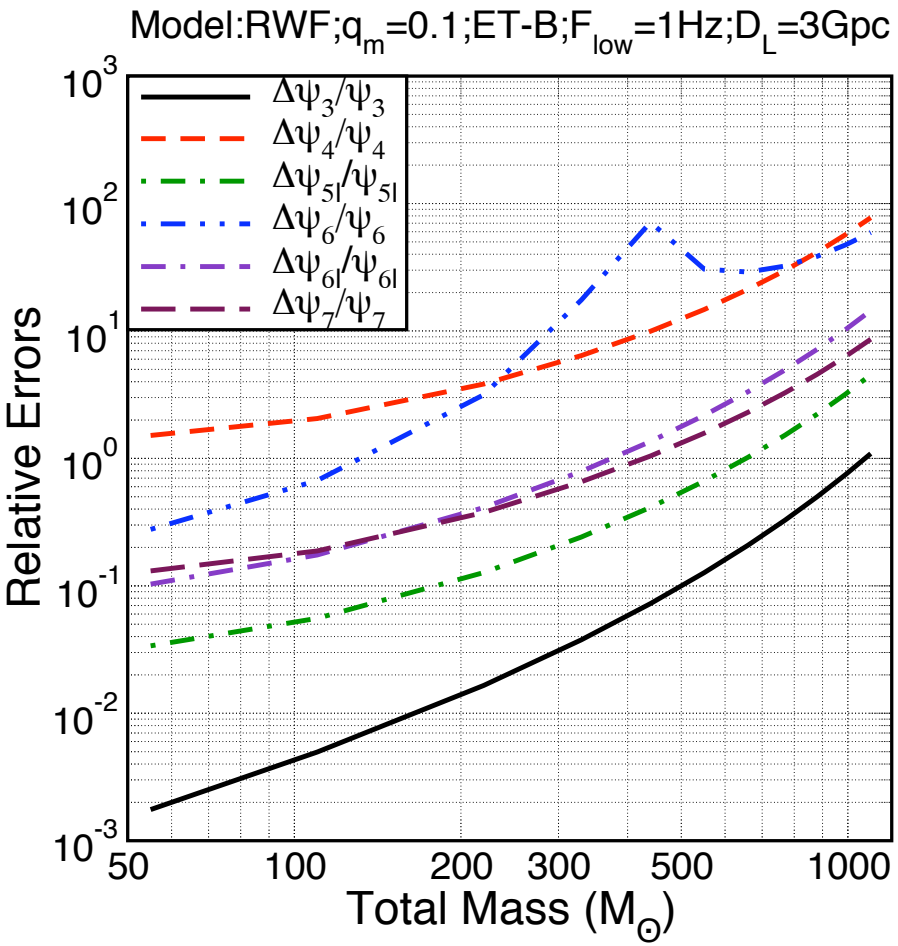
Mishra, et al arXiv:1005.0304

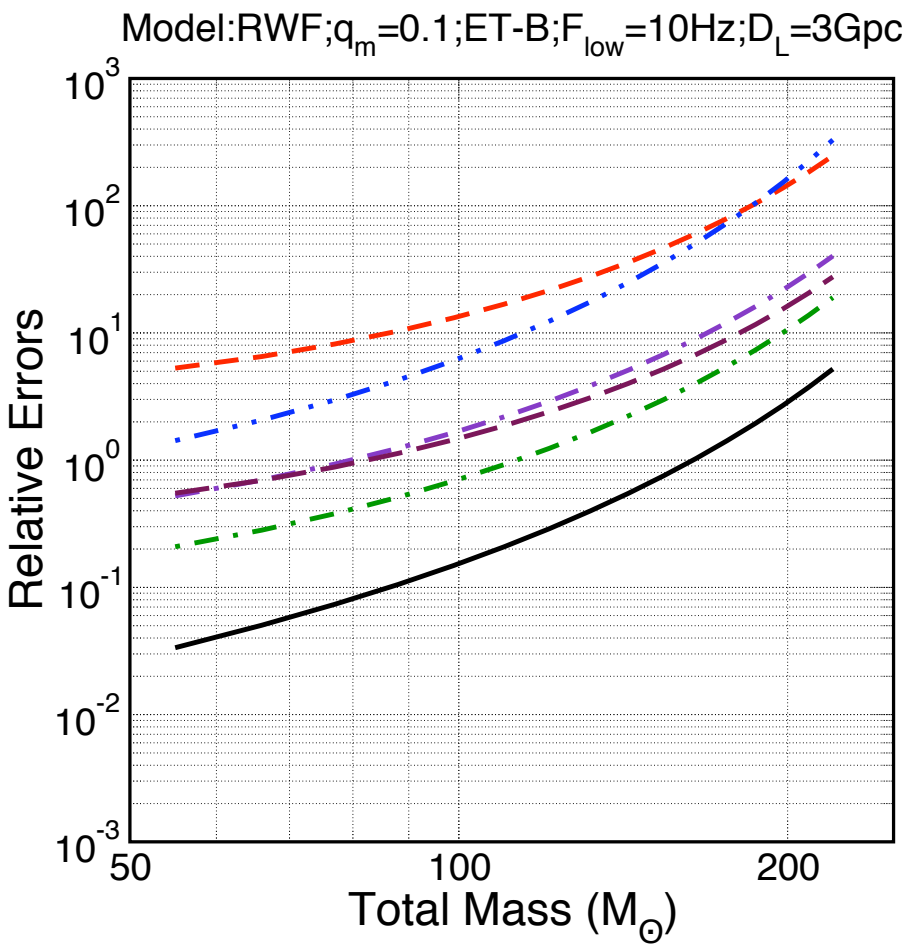




A factor of 10-60 better estimation of parameters with 1 Hz lower frequency cutoff as compared to 10 Hz

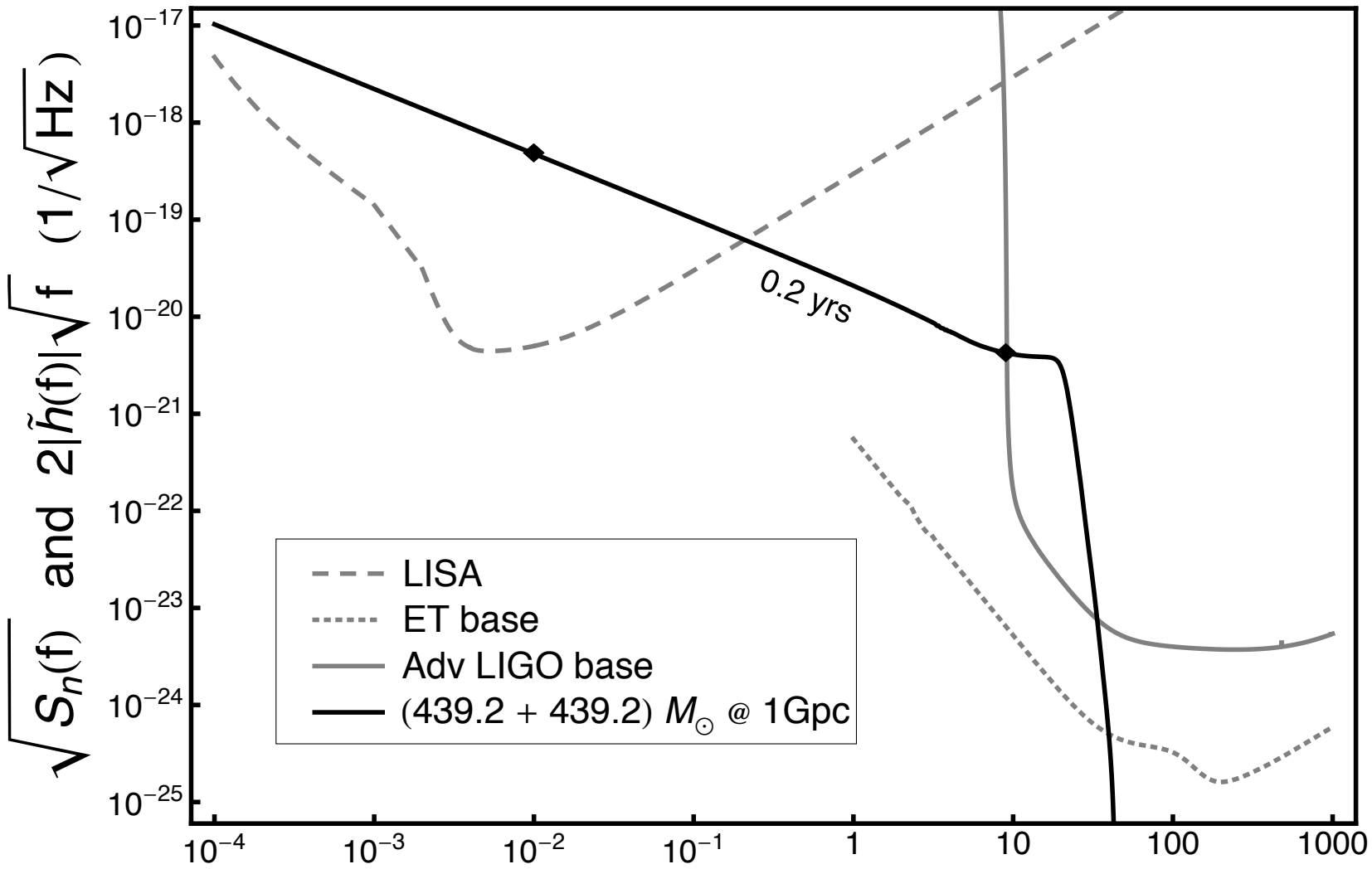
Effect of lower frequency cutoff is greater in the case of IMBH binaries





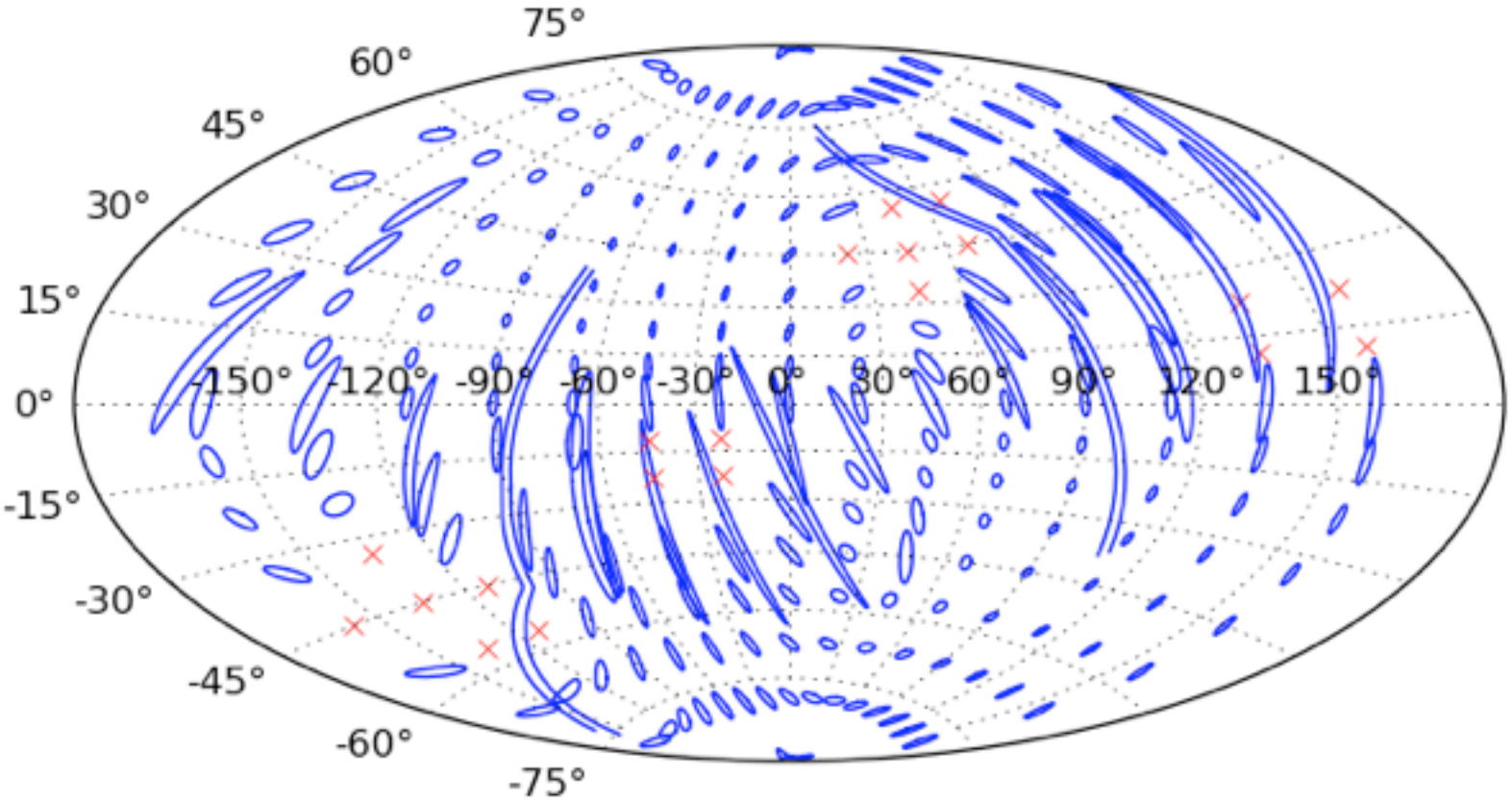
Mishra, et al arXiv:1005.0304

Simultaneous Observation with LISA: Depends on lower-frequency cutoff



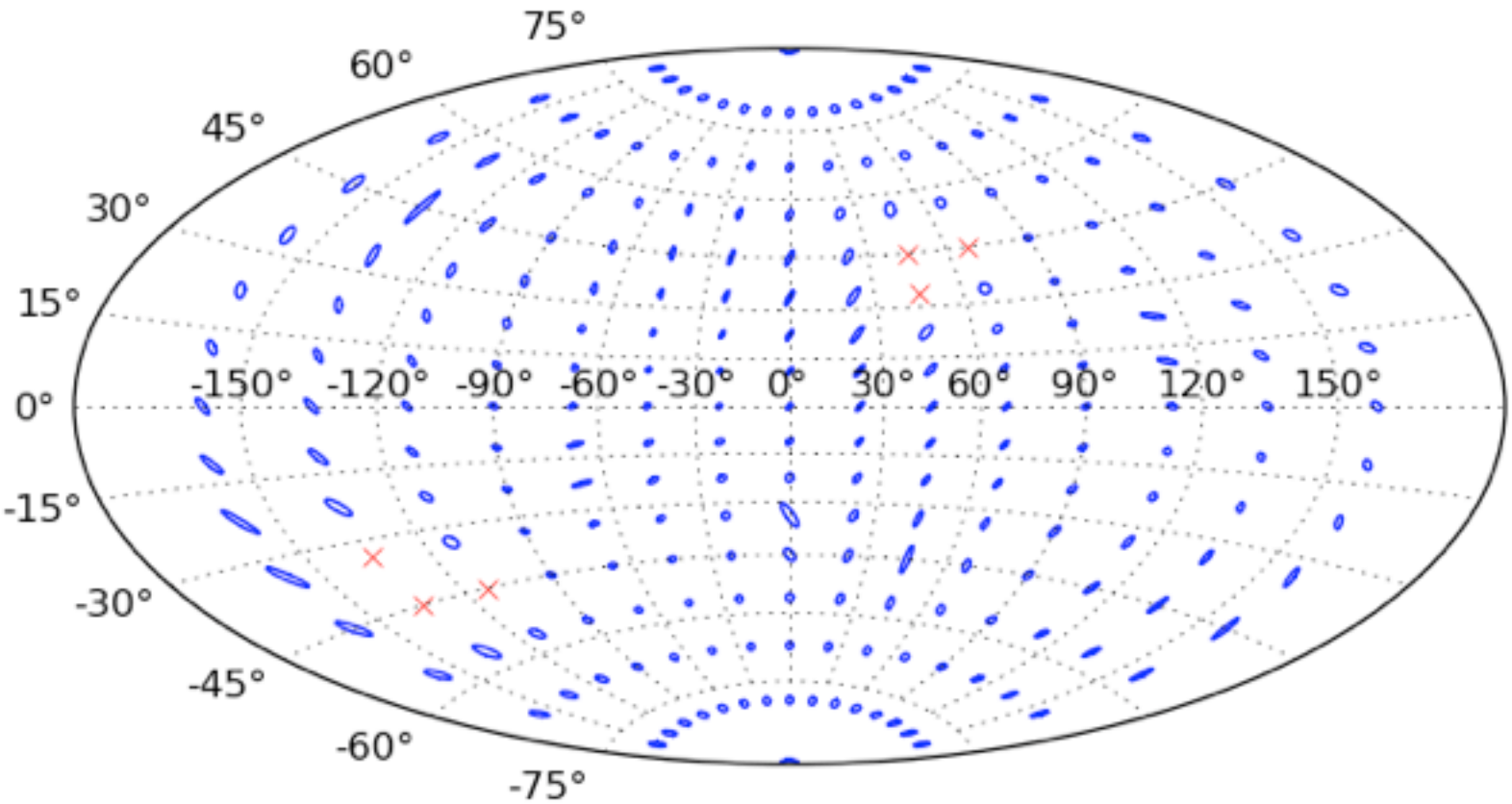
Slide from Santamaria

Angular Resolution Greatly Improves with Detector Baseline: HHLV



Slide from S. Fairhurst

Angular Resolution Greatly Improves with Detector Baseline: AHLV

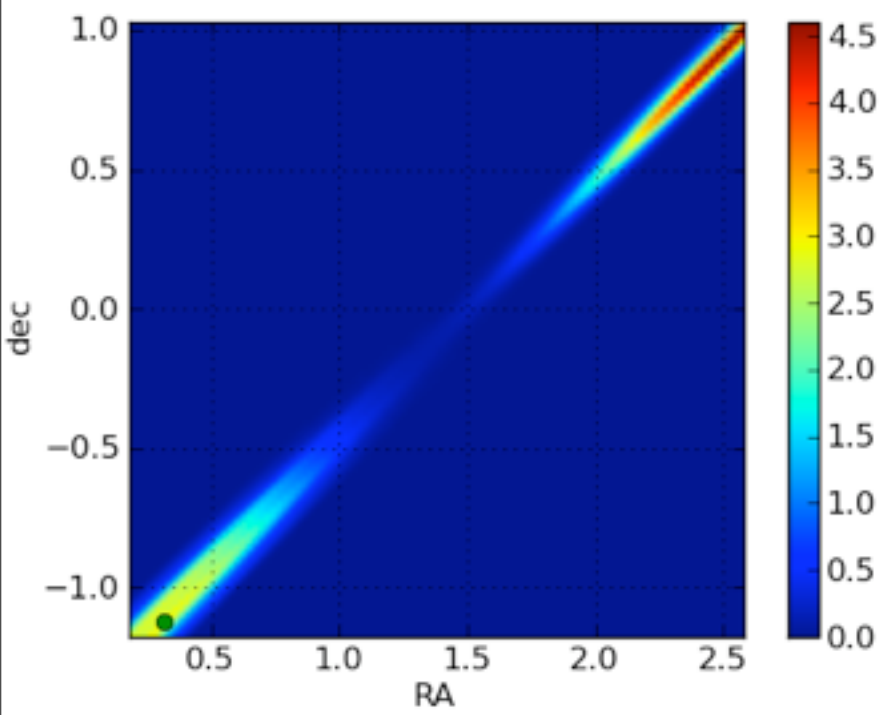


Slide from S. Fairhurst

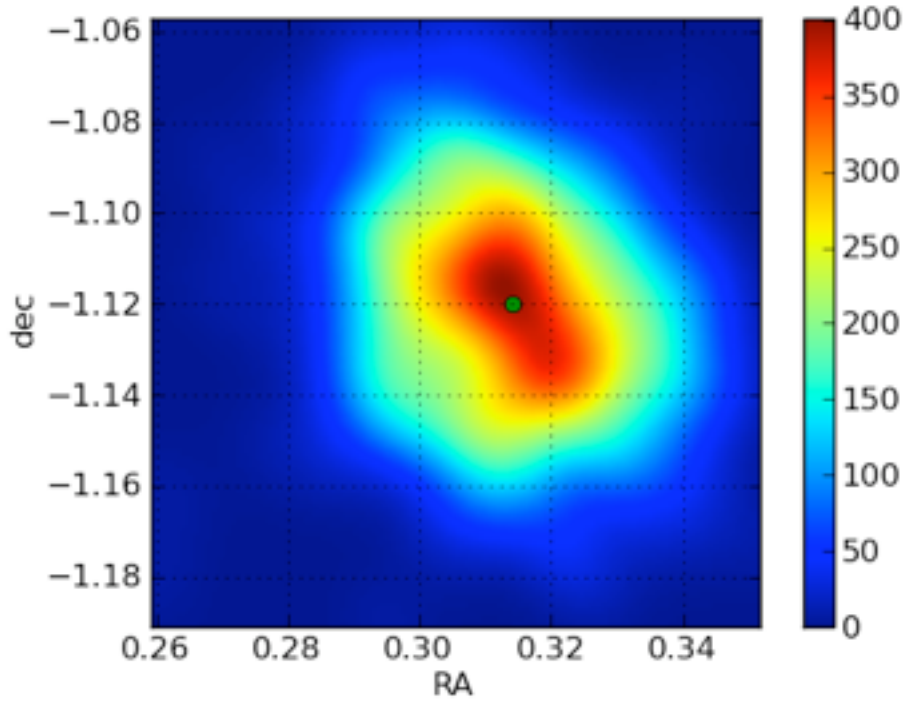
Breaking Localization Degeneracy: An Example from LIGO-South Study

Probability density for

HHLV



AHLV

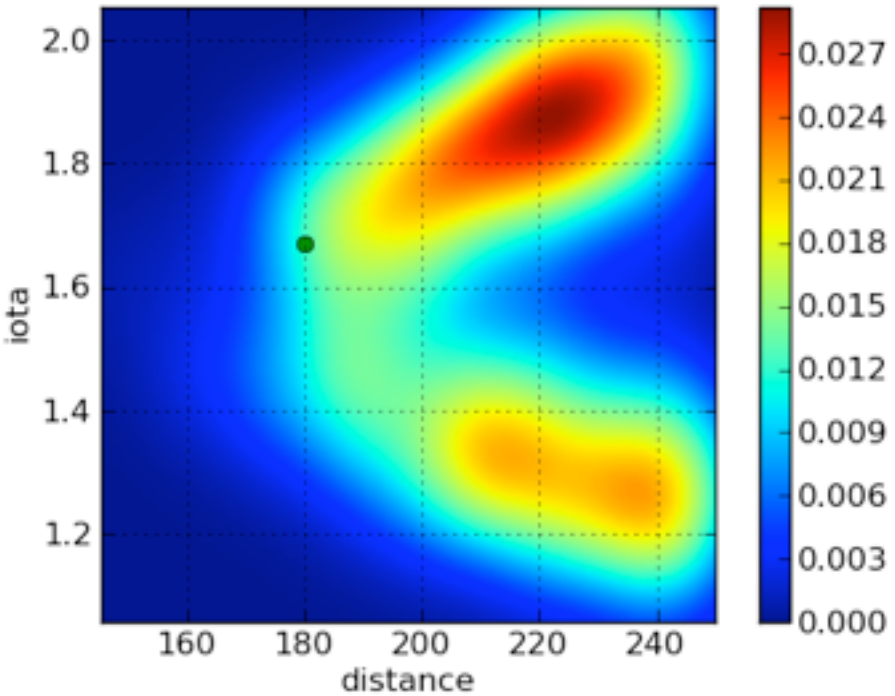


Slide from J.Veitch

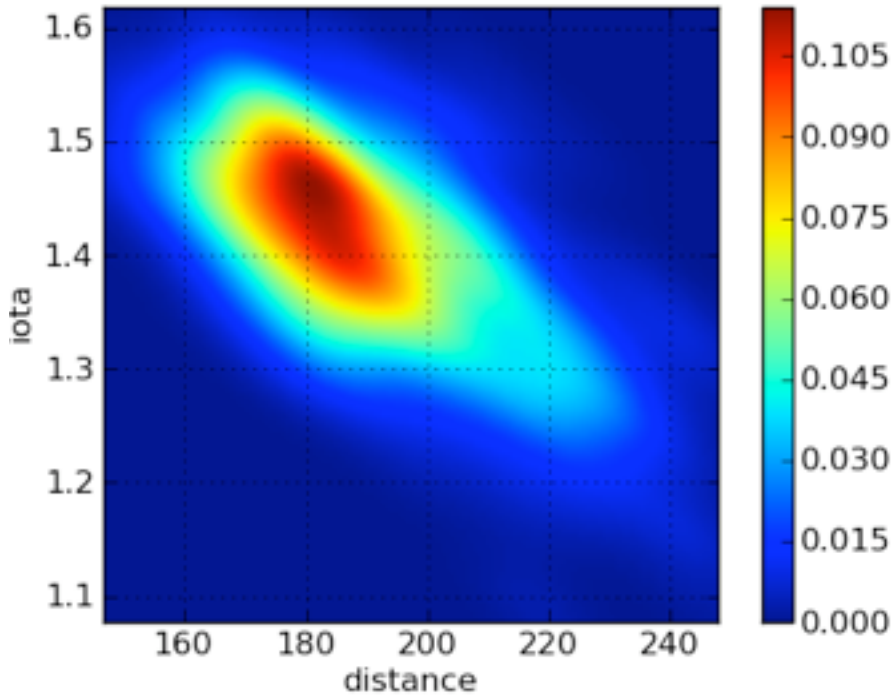
Breaking Distance-Orientation Degeneracy: An Example from LIGO-South Study

Probability density for

HHLV



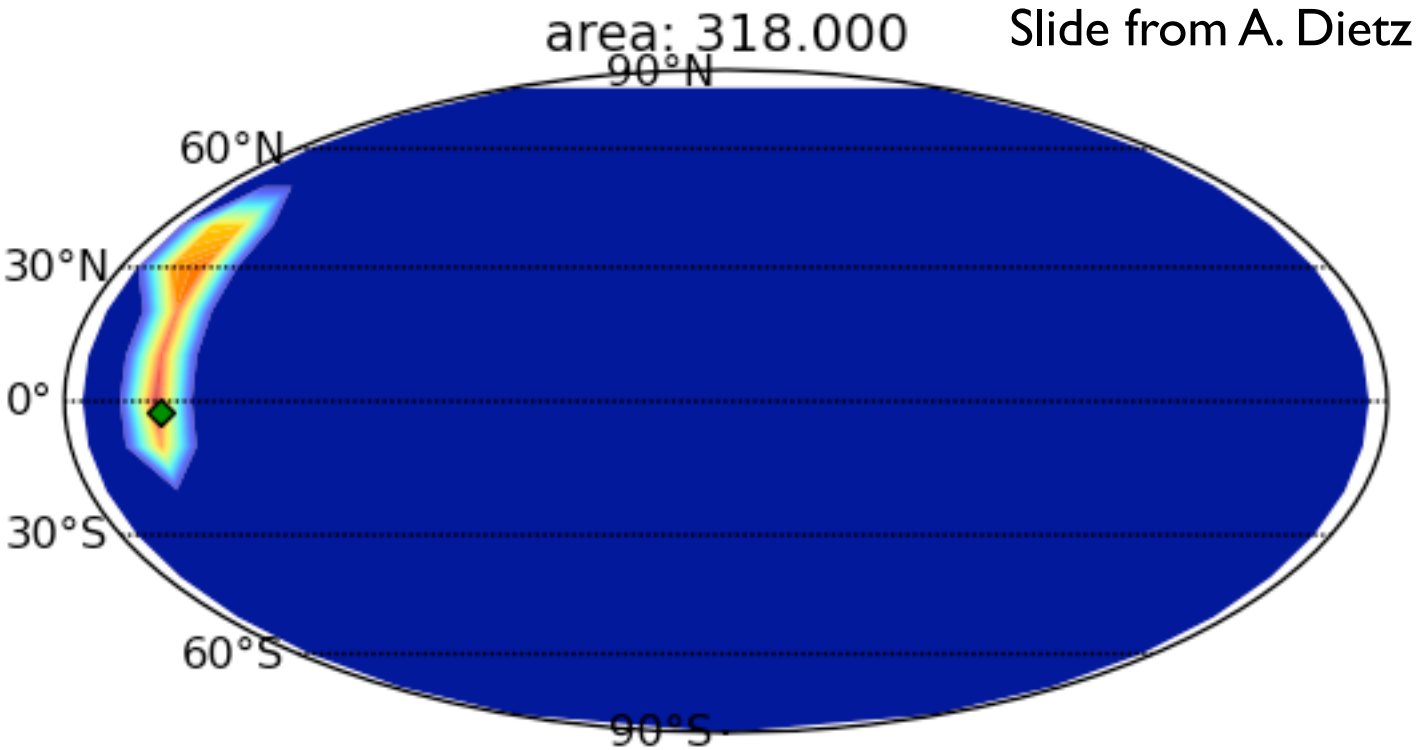
AHLV



Slide from J.Veitch

Pointing accuracy for different geometrical configurations

- Ongoing effort to make a systematic comparison
- Example of sky map



Slide from A. Dietz