



Heterogeneous Detector Networks

Sky Localization with 3G Detectors

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Issue

- ❑ Sky localization is vital
 - EM counter parts (maybe)
 - Full waveform reconstruction
 - Distance determination (z goes into source frame mass)
- ❑ Full Sky Coverage
- ❑ Advanced detectors:
 - Network with 4-5 detectors of similar sensitivity
 - Sky localization by triangulation
- ❑ 3G detectors:
 - Network probably much smaller
 - Sky localization by polarization?
 - Heterogeneous network with Advanced detectors?

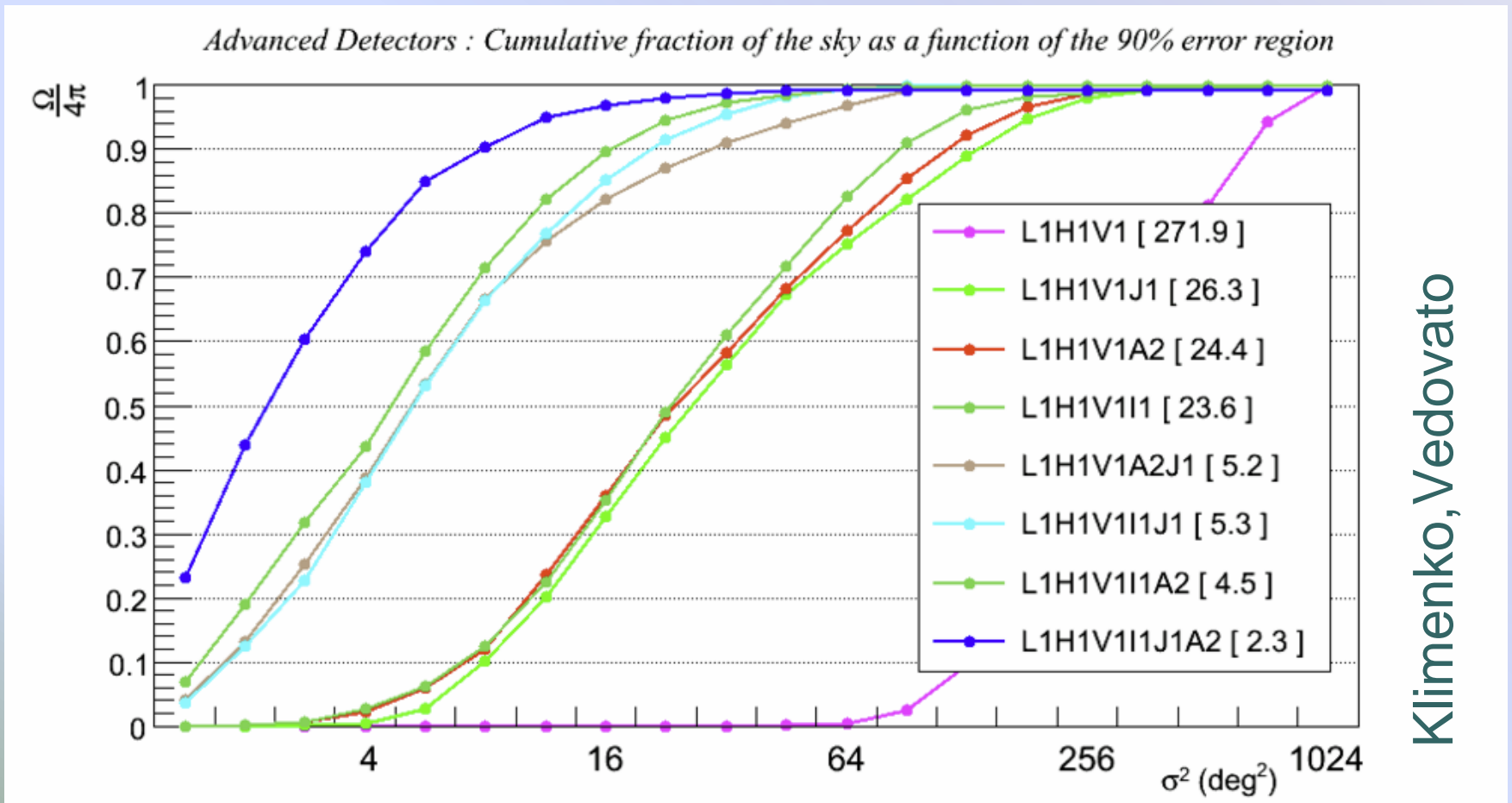
Basics

- Inverse problem solved: Gürsel, Tinto 1989
 - Requires 3 detectors: not collinear, not coplanar (can be collocated)
 - For example: 3 L's randomly on Earth, or 1 Δ & 1 L, or 2 Δ 's
 - With similar detectors combined SNR matters (detector null fine)
 - Sky location by polarization and antenna pattern
- Triangulation:
 - Need 3 facilities minimum
 - Base length matters & high frequency signals give better timing
 - Tends to be superior (on Earth approx. factor of 10 in angle)
 - SNR of worst detector determines resolution (detector null bad)
- Monte Carlo code combines both methods

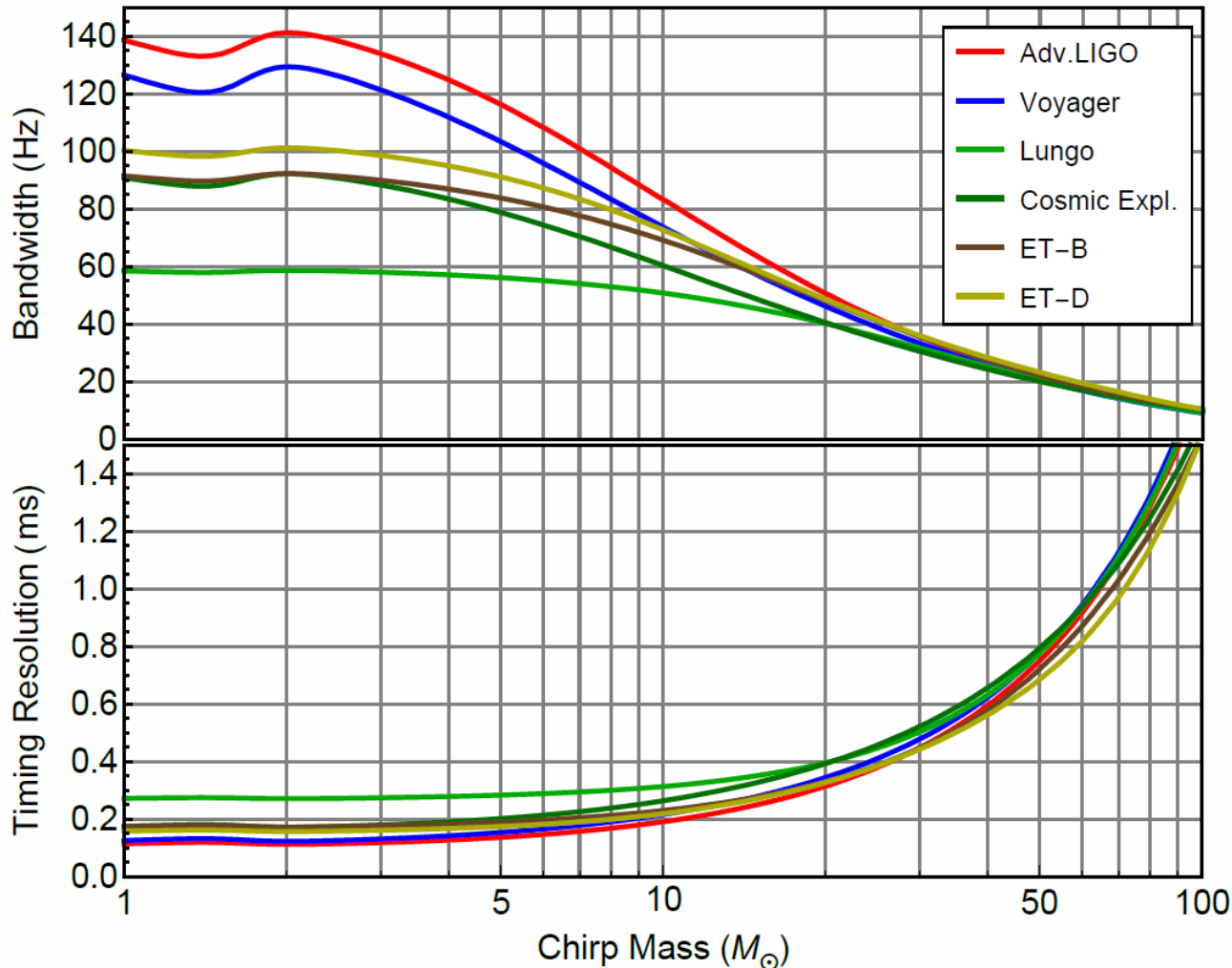
Advanced Detector Network

$$\Omega \propto \frac{1}{\text{SNR}^2}$$

Low SNR events dominate in plot!



Triangulation Error



Time Resolution

$$\sigma_t = \frac{g(\rho_1, \rho_2)}{\pi \sigma_f \rho}$$

with $g(\rho_1, \rho_2) = \frac{\rho_1^2 + \rho_2^2}{2\rho_1\rho_2}$

Effective Bandwidth

$$\sigma_f$$

Heterogeneous Networks

- ❑ 1-2 3G detector facilities + advanced detectors
- ❑ Cut on high SNR events in 3G detector
- ❑ Solid angle reduction (SNR 3G/AD ~ 10)
 - Add one 3G facility: ~2
 - Add two 3G facilities: ~10
 - Three 3G facilities: ~70 (due to reduced bandwidth)
- ❑ Will allow for distance measurements
- ❑ Two 3G facilities on their own?

Double Trigon Configuration

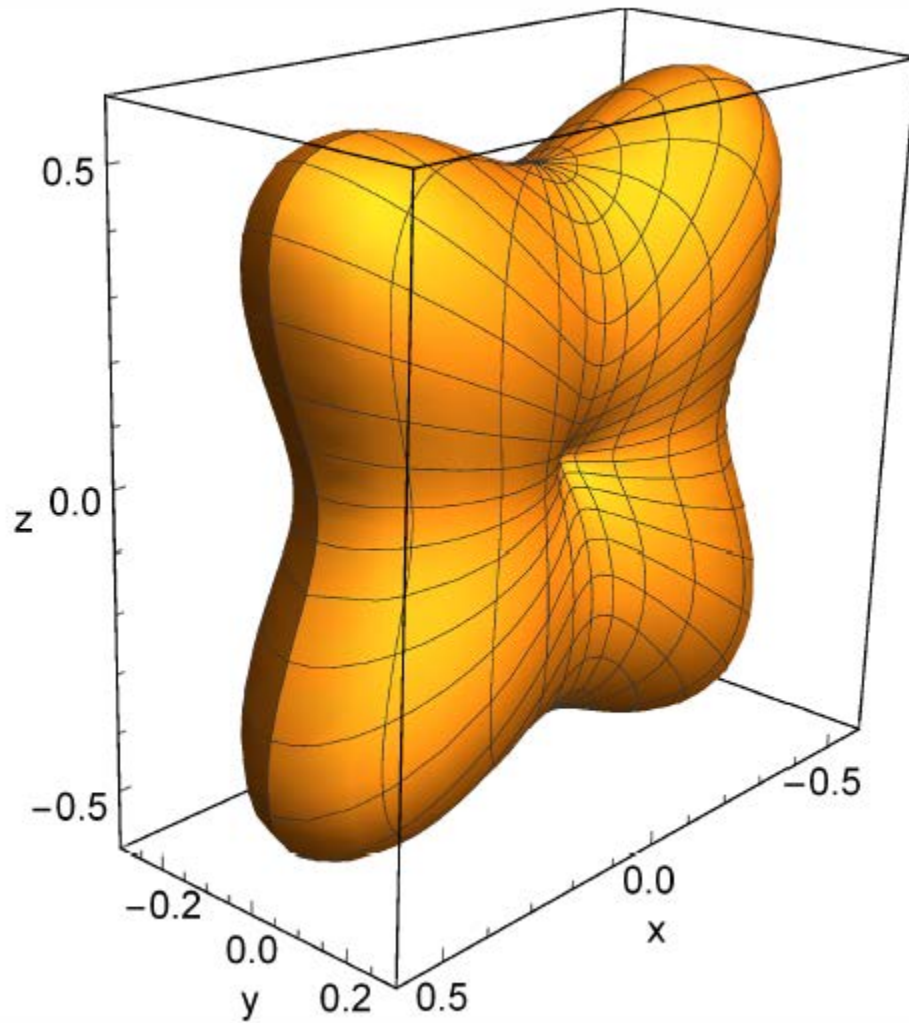
- ❑ Measure both polarization at both observatories
- ❑ Try to locate 90° apart on Earth
- ❑ Detector normals:

$$\begin{pmatrix} +1 \\ 0 \\ +1 \end{pmatrix}$$

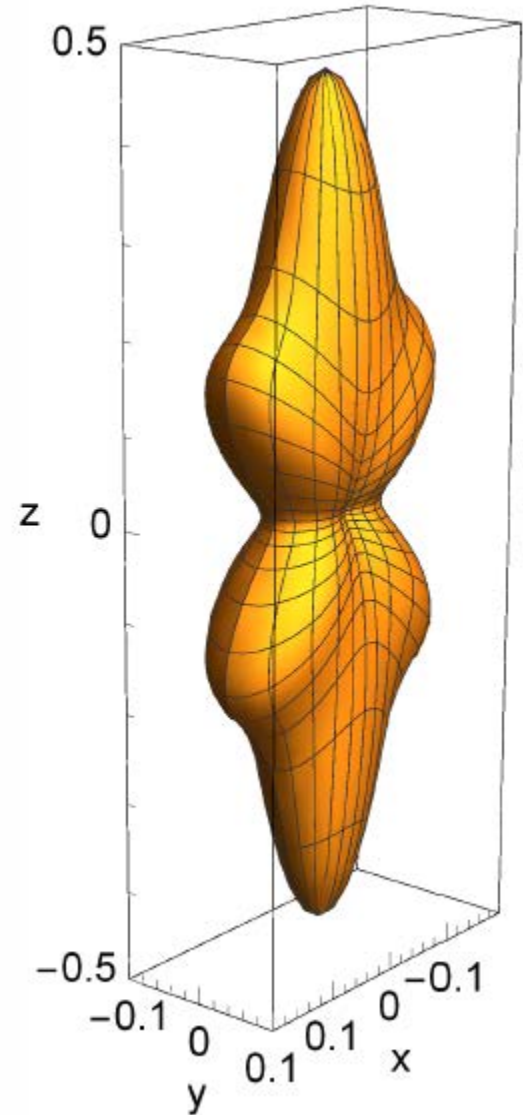
$$\begin{pmatrix} +1 \\ 0 \\ -1 \end{pmatrix}$$



Solid angle for SNR 100 events (BW 50Hz)



Polarization alone



Polarization & Timing

Open Questions

- ❑ How important is accurate sky localization?
- ❑ Is the sky localization of the advanced detector network good enough for 3G physics?
 - If not, need more than one 3G facility
- ❑ How important is full sky coverage?
 - If you can see all binary inspiral events, you can subtract/veto them from the stochastic background!
- ❑ How many facilities can we afford?
 - Trade off: 3 L's vs 2 Δ 's ?
- ❑ Need MC code simulations