

Montana Gravitational Wave Astronomy Group

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MtGWAG Activities

LISA International Science Team

-  Co-Chair Data Analysis Development Group

-  Mock LISA Data Challenge

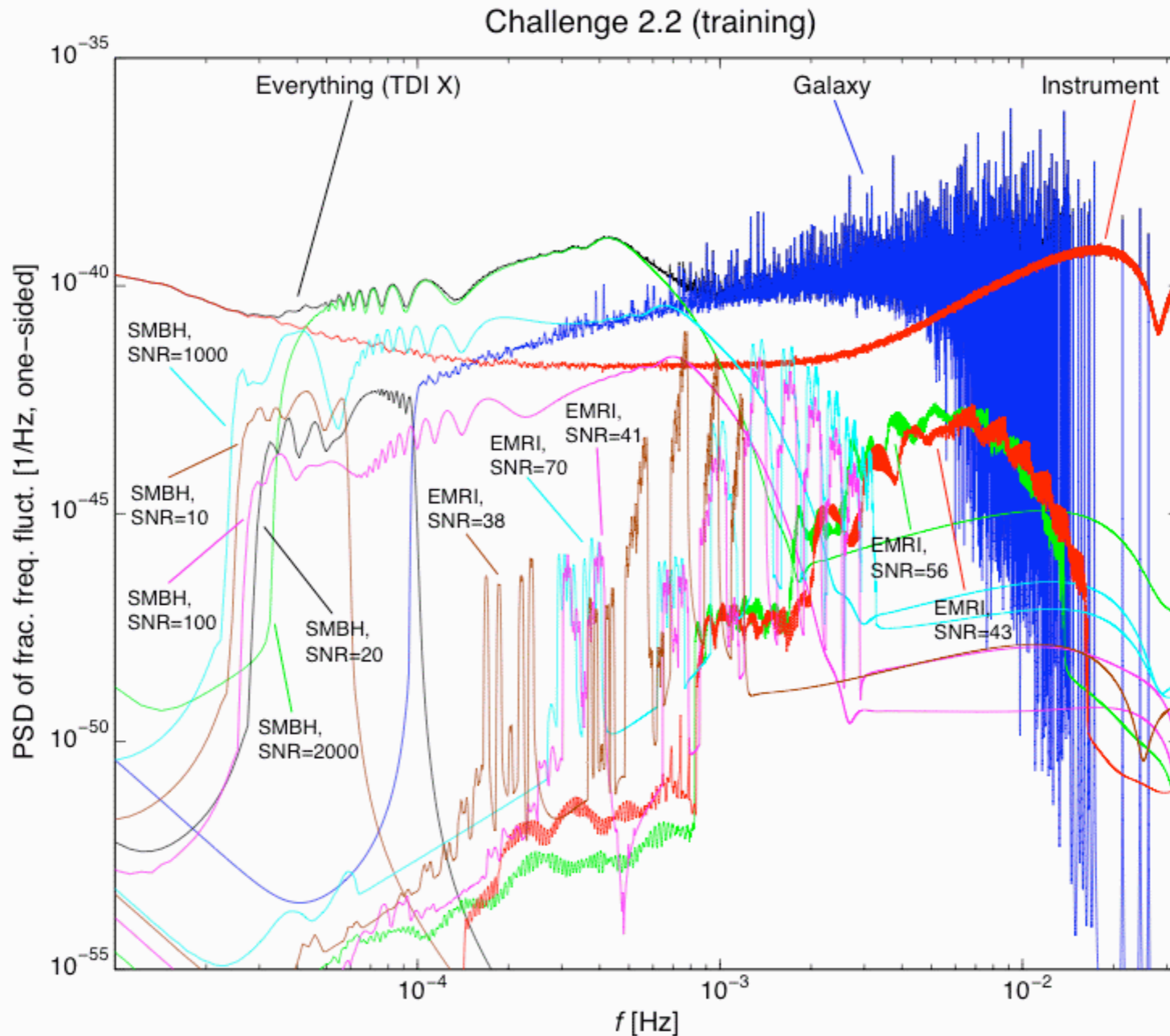
LISA Instrument Response Simulation

LISA Data Analysis

-  Galactic Binaries, MBH, EMRIs, Cosmic String Cusps, Stochastic Backgrounds

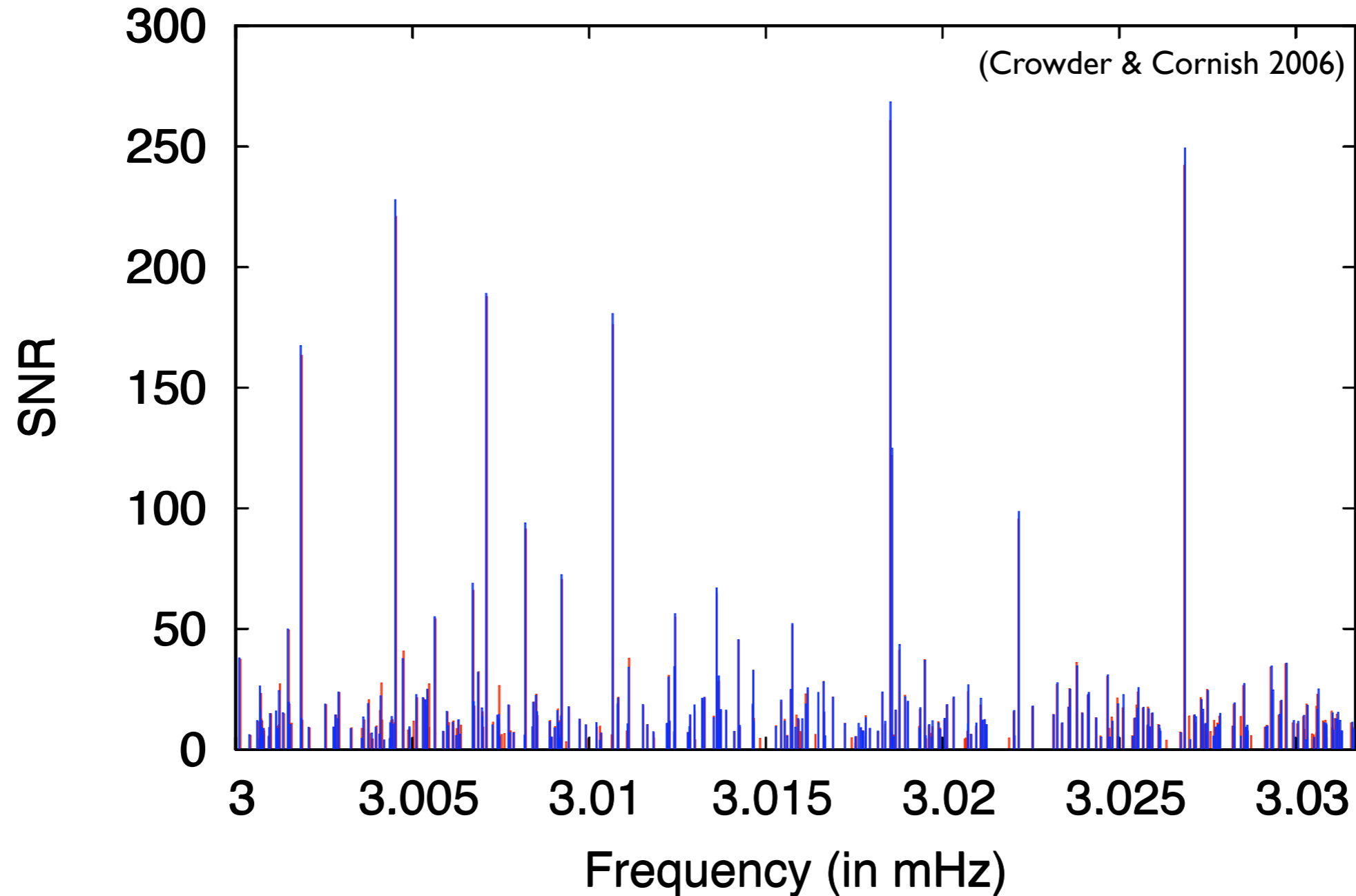
-  Template Metric Grid, MCMC, Genetic Algorithms

Mock LISA Data Challenges



LISA Experience: Galactic Binaries

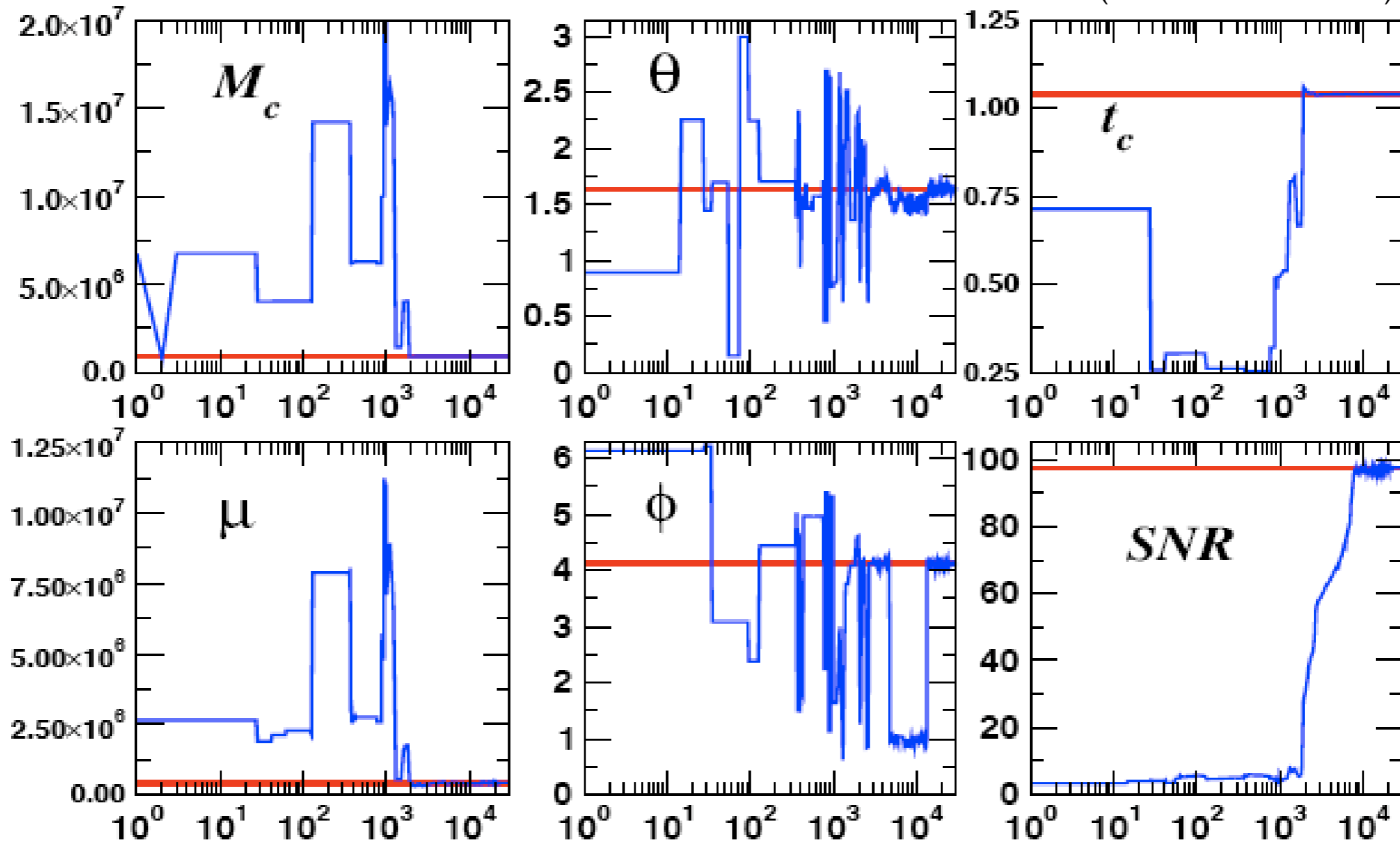
Recovered Source Data



Simultaneous 1890 Parameter Fit using MCMC approach

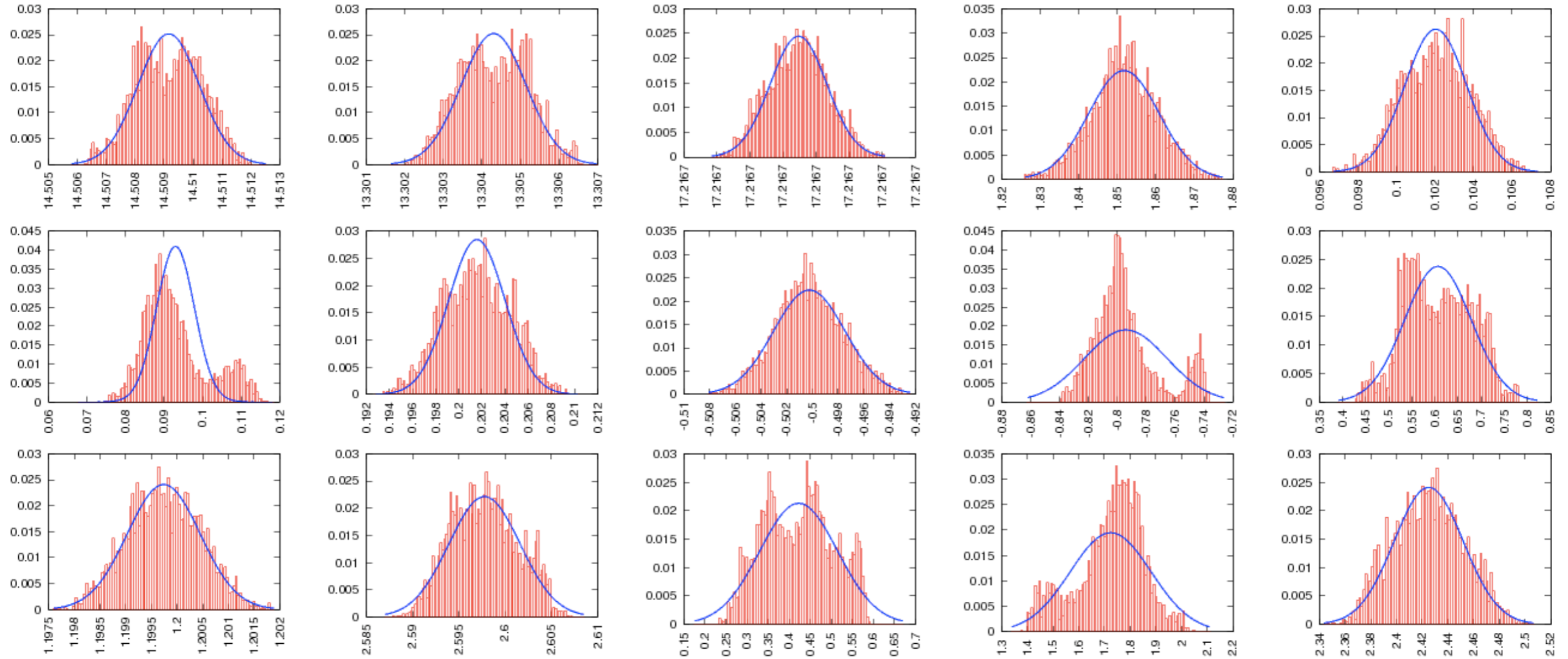
LISA Experience: MBH

(Cornish & Porter 2006)



MCMC type gridless searches

Spinning MBH Parameter Posteriors



(Cornish, Hughes, Lang & Nissanke, 2007)

Proposed LIGO Activities

- Help with existing search pipelines
- Optimized search for acoustic supernovae
- Coherent Inspiral-Merger-Ringdown search
- MCMC exploration of burst reconstruction
- MCMC search for spinning BH

Constrained Signal Reconstruction

$$\begin{array}{ccc} \text{multi-detector data} & & \text{incident waveform} \\ \downarrow & & \downarrow \\ \mathbf{s} = \mathbf{F} \mathbf{h} + \mathbf{n} & & \\ \uparrow & & \uparrow \\ \text{network response operator} & & \text{noise} \end{array}$$

Find \mathbf{h} that maximizes
posterior

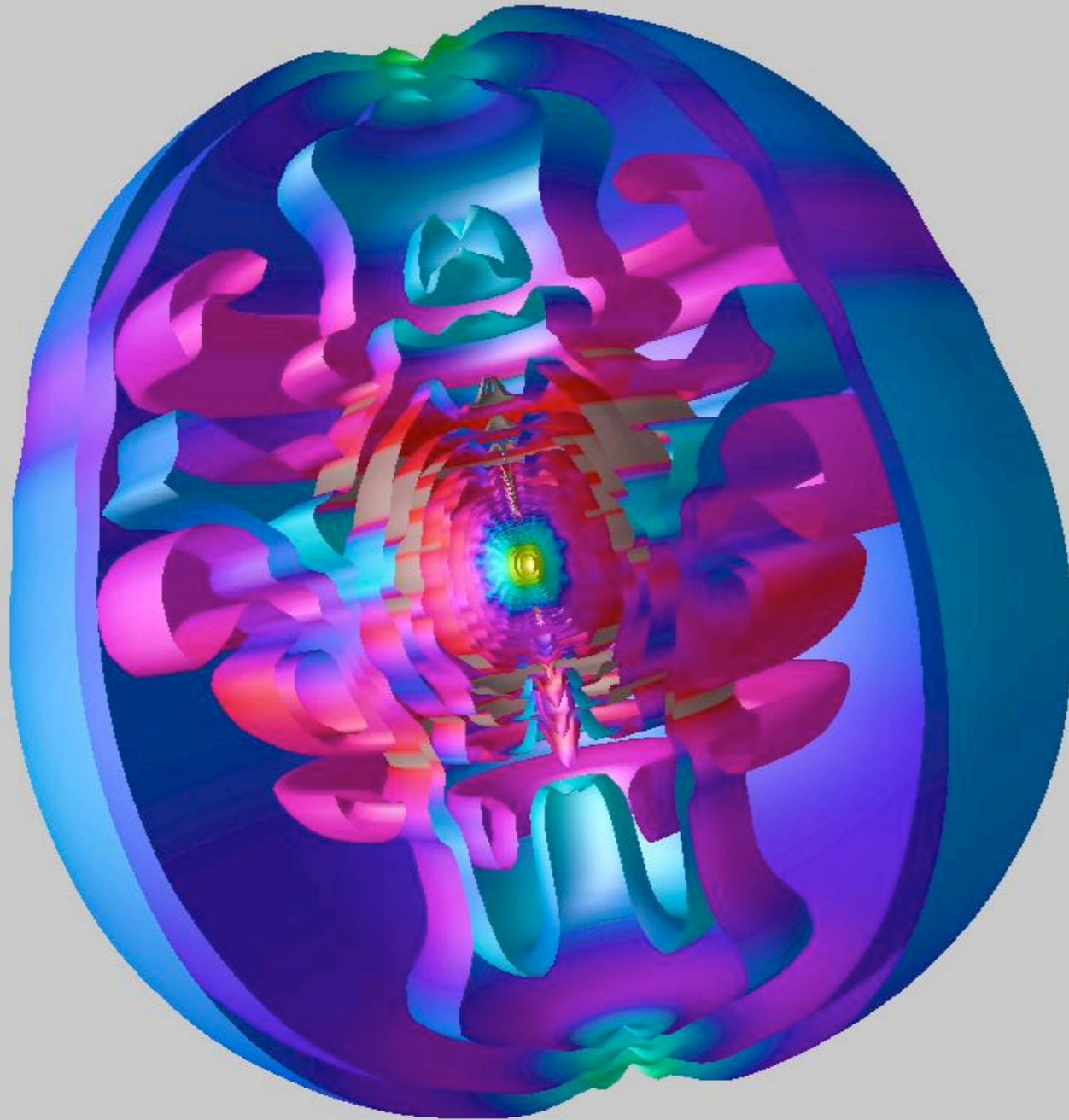
$$p(\mathbf{h}|\mathbf{s}) \propto p(\mathbf{h})p(\mathbf{s}|\mathbf{h})$$

Priors enhance posterior contrast, break inversion degeneracies

E.g. Time – frequency volume prior for bursts $p(\mathbf{h}) : \mathbf{h} \rightarrow \mathbf{h}'$

Idea behind Excess Power & Wave Burst Algorithms

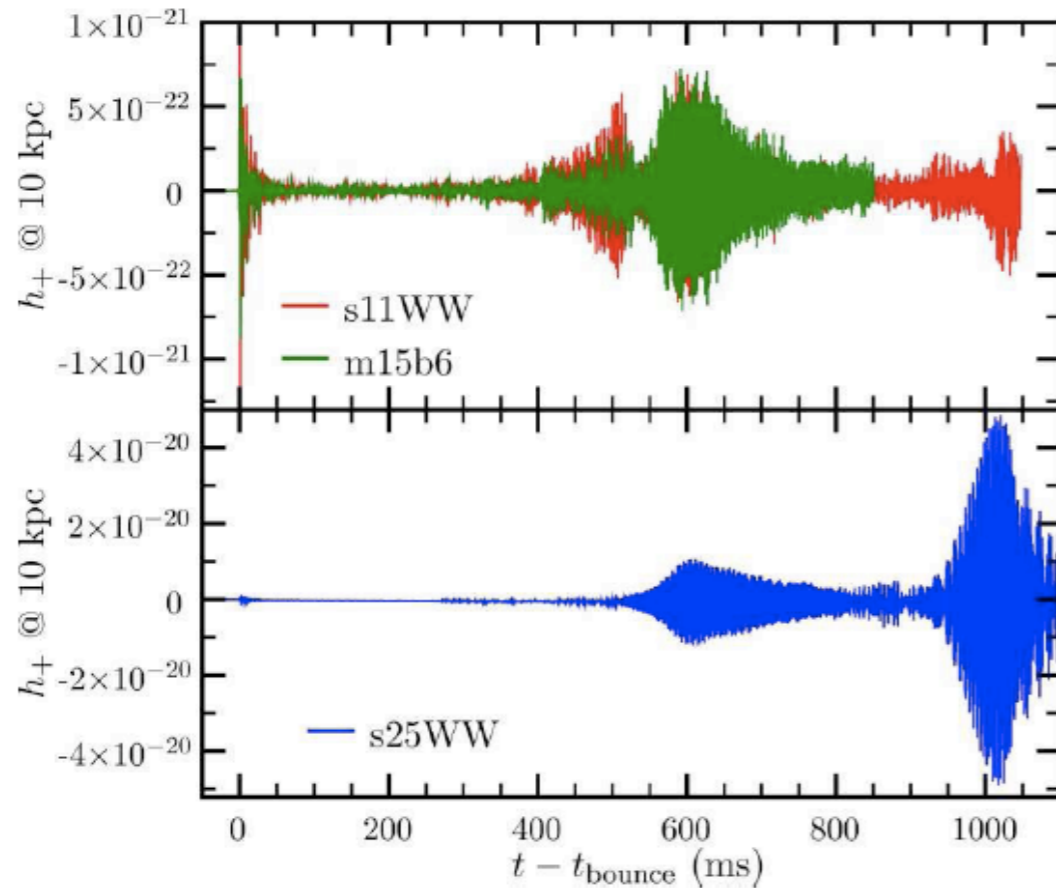
Acoustic Supernovae



Core g-modes act as transducers. Convert gravitational energy of stalled shock into acoustic power. Sound waves drive explosion.

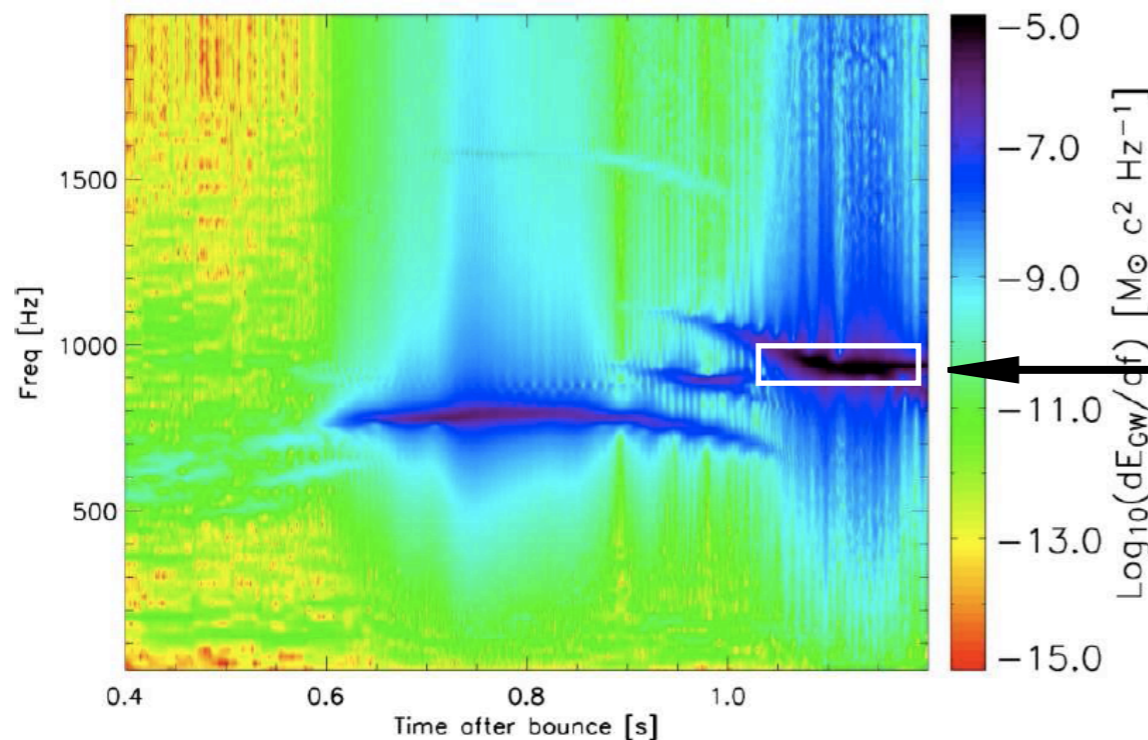
(Burrows, Livne, Dessart, Ott & Murphy 2006)

Acoustic Supernovae



GW from $\ell = 2$ overtone
of $\ell = 1$ g – mode

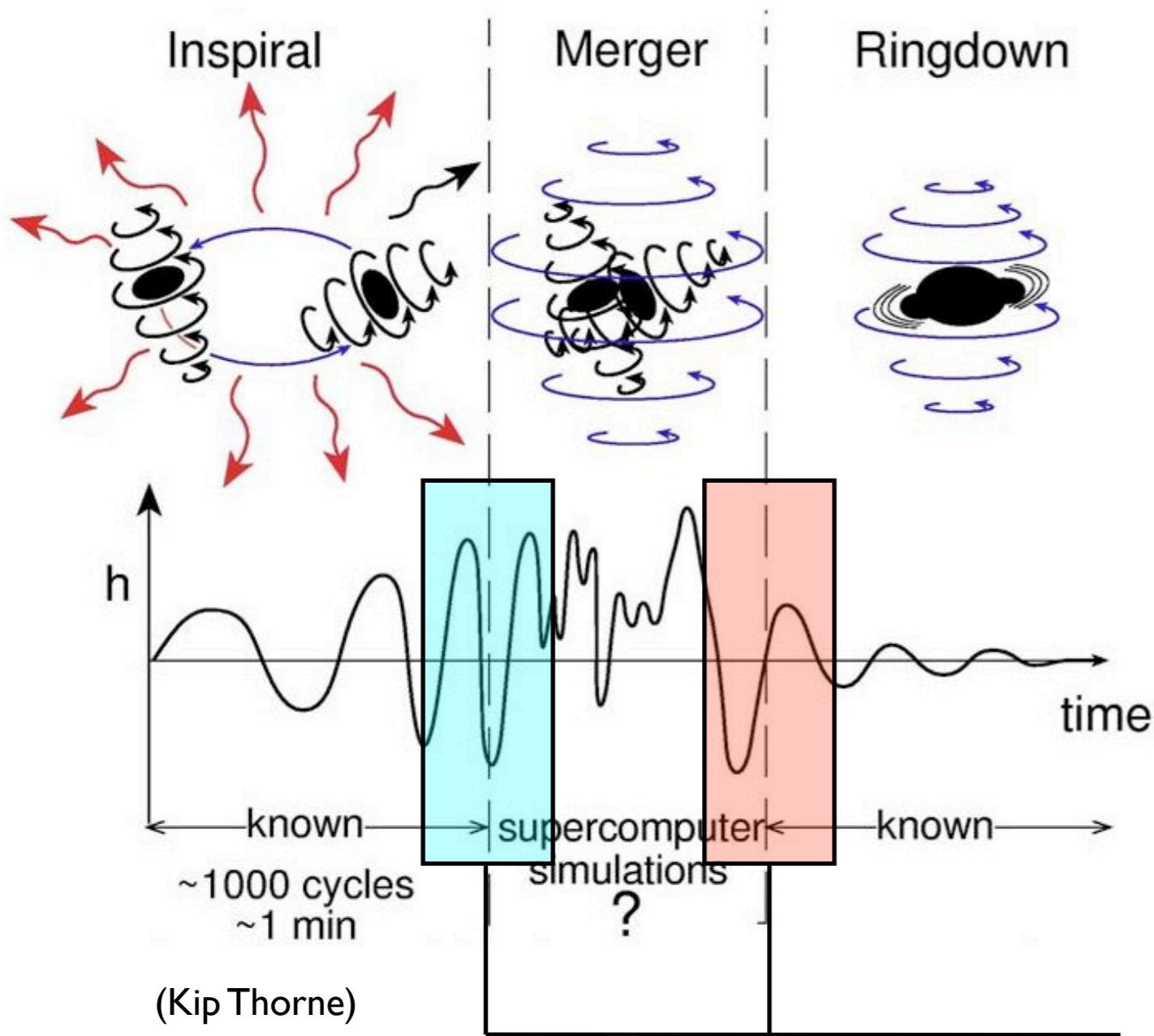
Relatively simple dynamics.
Semi-analytic waveforms?



Better performance with
targeted burst reconstruction.

Small TF volume. Good
candidate for general burst
searches.

Coherent Black Hole Search



Possibly trigger off individual inspiral, burst, ringdown searches

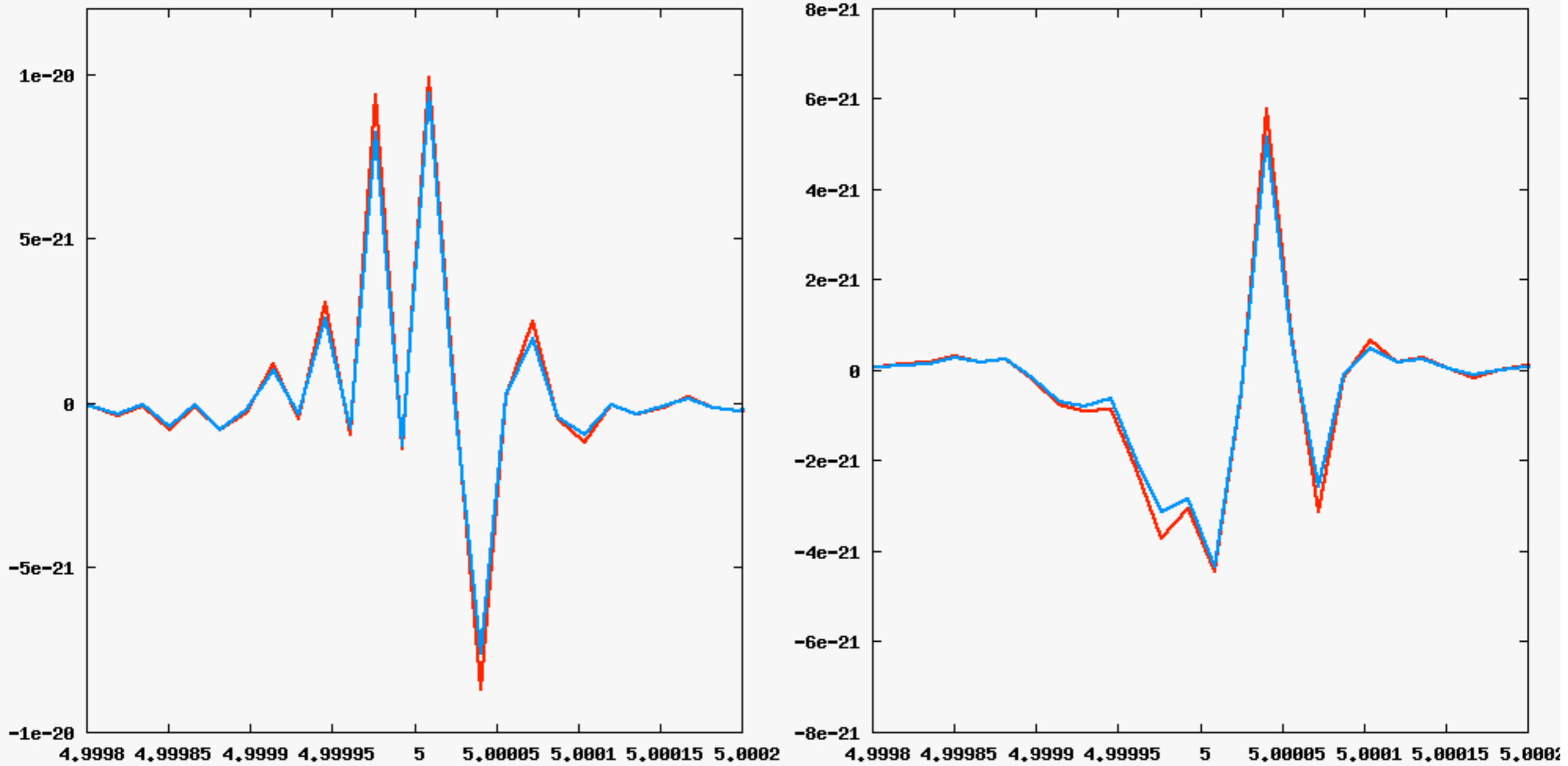
Coherent reconstruction: PN inspiral + Ringdown templates as constraints. Weaker NR constraints for merger.

Continuity (C^{2+}) + spectral matching conditions

MCMC Exploration of Burst Reconstruction

- MAP estimate only gives best fit reconstruction
- Helpful to know range of waveforms consistent with data
- Can be applied to both parameterized and non-parametric reconstructions (where model dimension can be 10,000+)

MCMC Waveform Exploration



Come visit MtGWAG anytime...

