Understanding and Improving the Accuracy of Advanced LIGO Calibration

LIGO-T1600260

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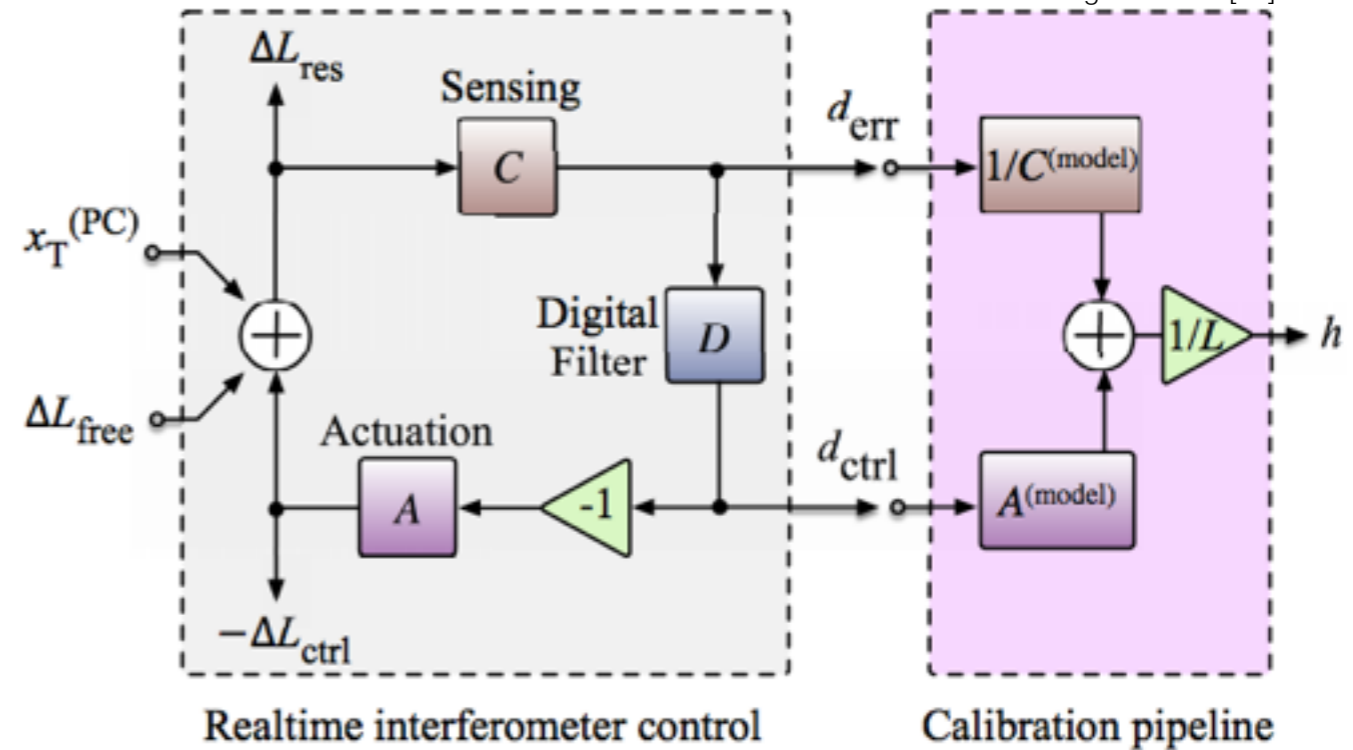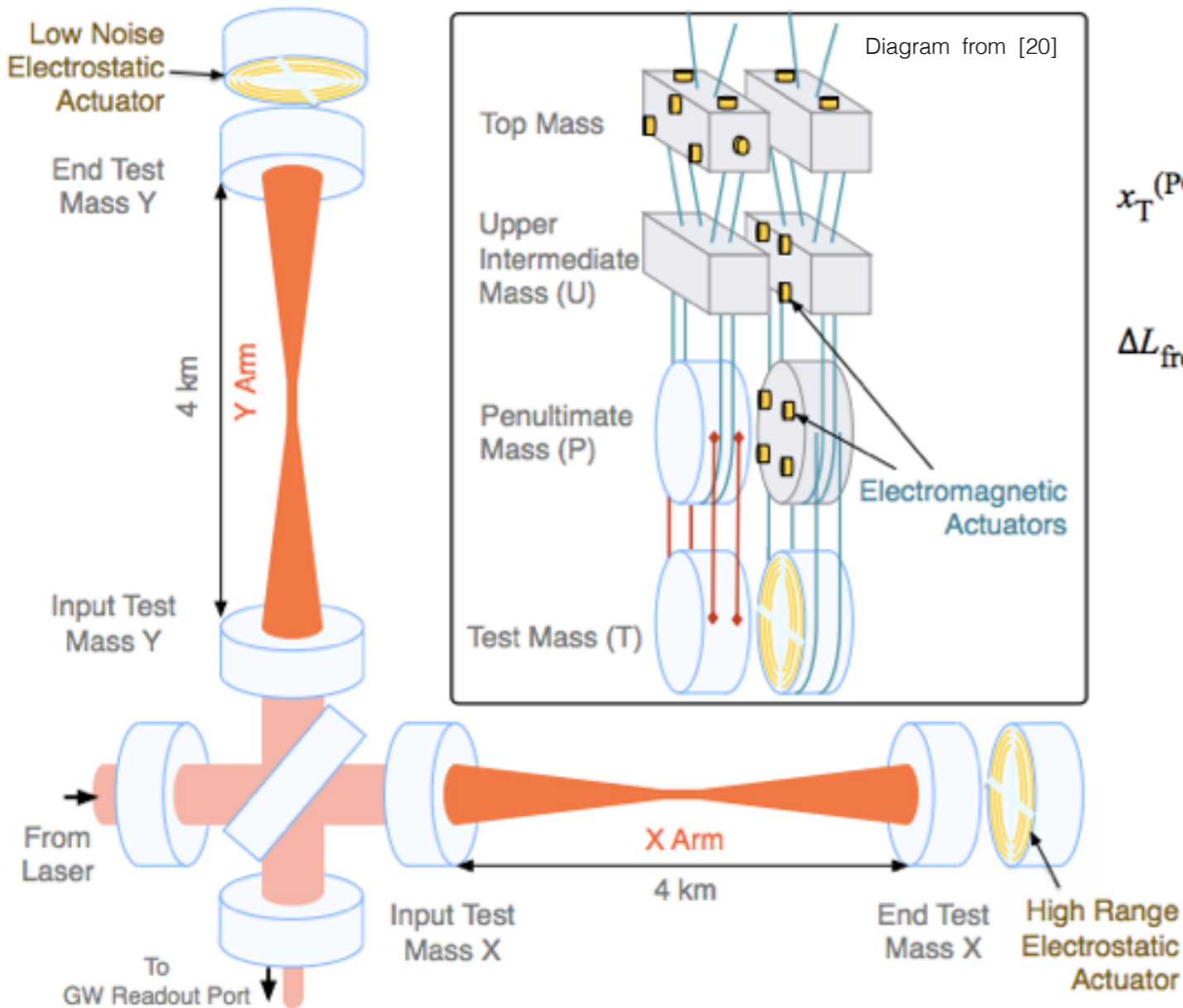
Objective

Estimate the impact of aLIGO calibration uncertainty on precision tests of GR using observations of GWs from BBH mergers

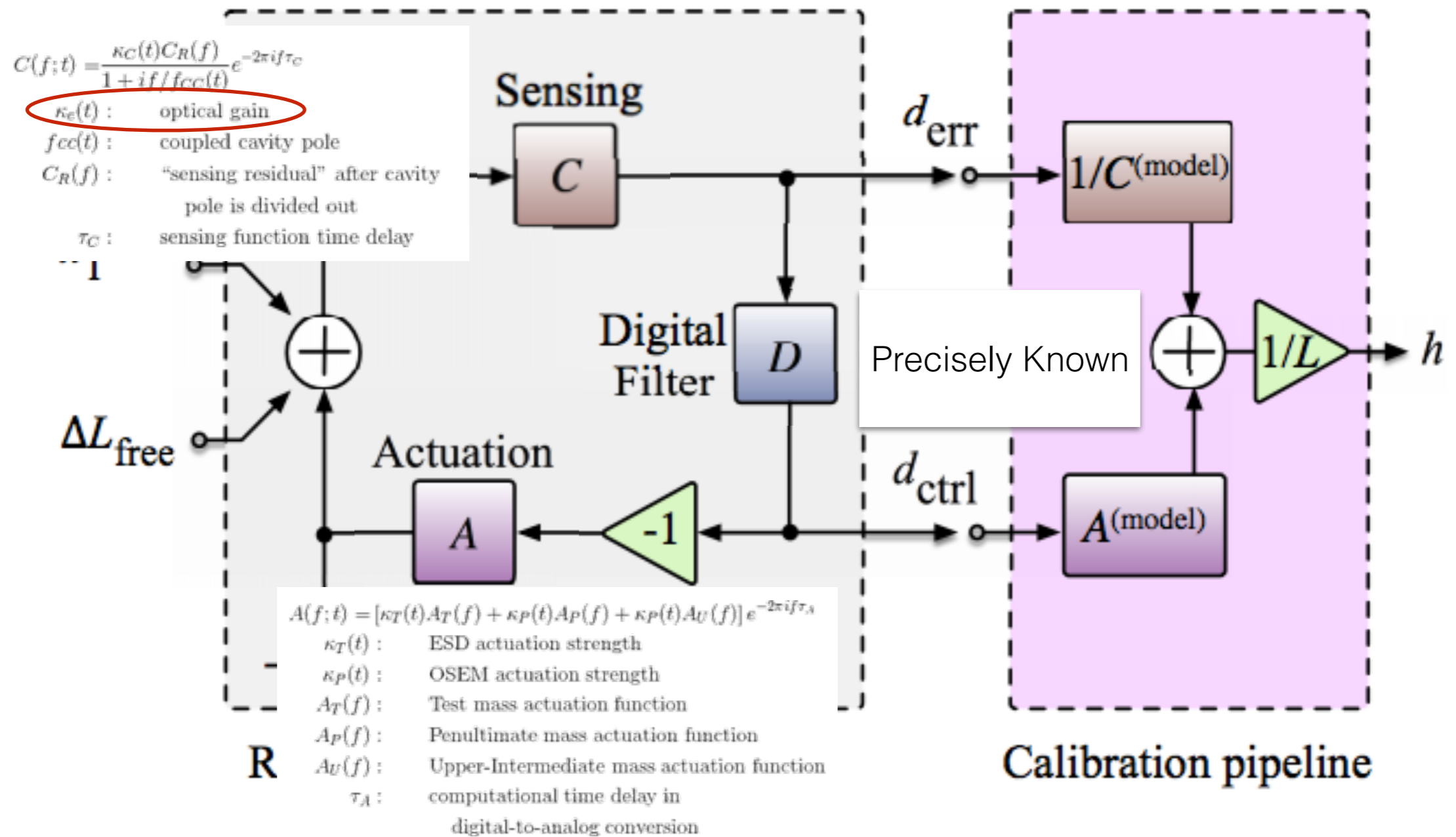Optical Gain Calibration
&
Ringdown deviation

Calibration methods

Diagram from [20]

Diagram from [20]

$$R_e(f;t) = \frac{1 + A(f;t)D(f)C(f;t)}{C(f;t)}$$

$$= \frac{1 + G(f;t)}{C(f;t)}$$
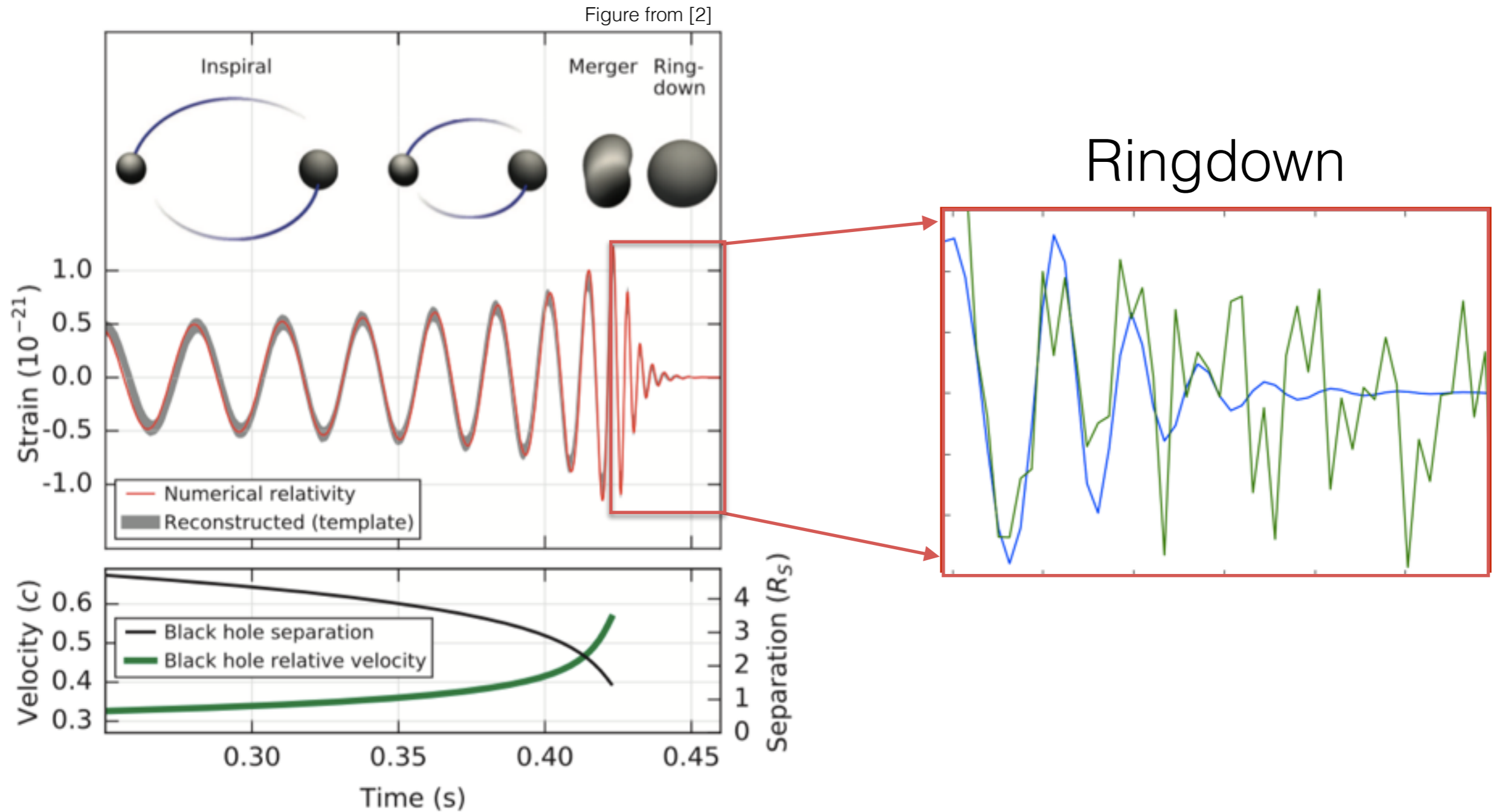
Calibration methods

Objective

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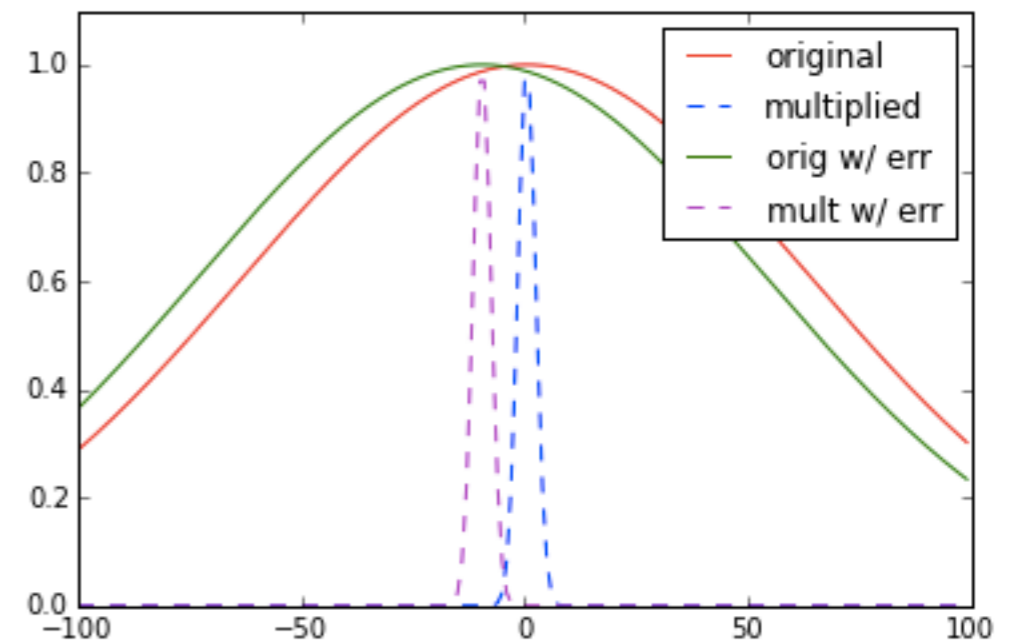~~Optical Gain Calibration~~
&
Ringdown deviation

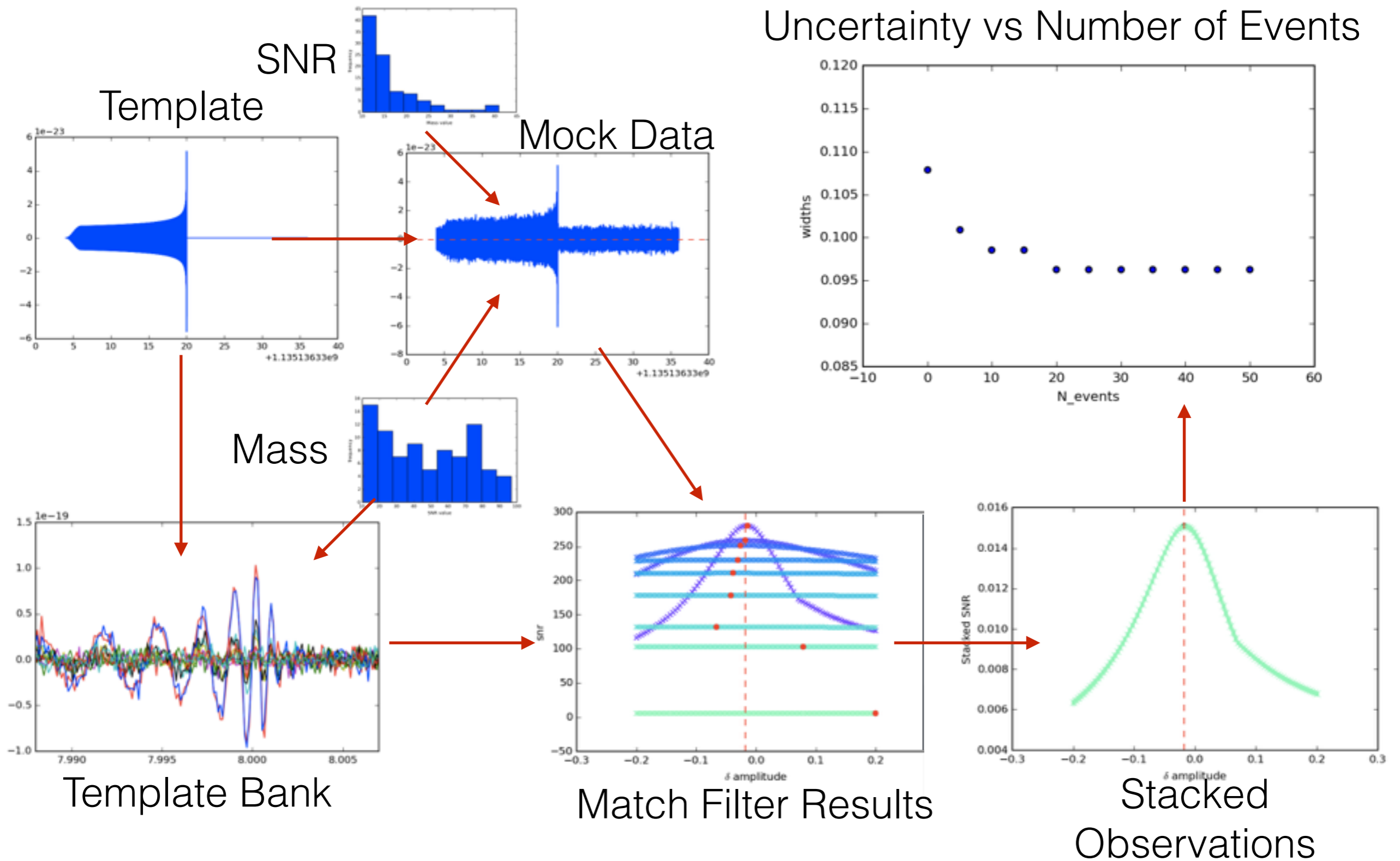# Calibration uncertainty & precision tests of GR

Figure from [2]

Ringdown

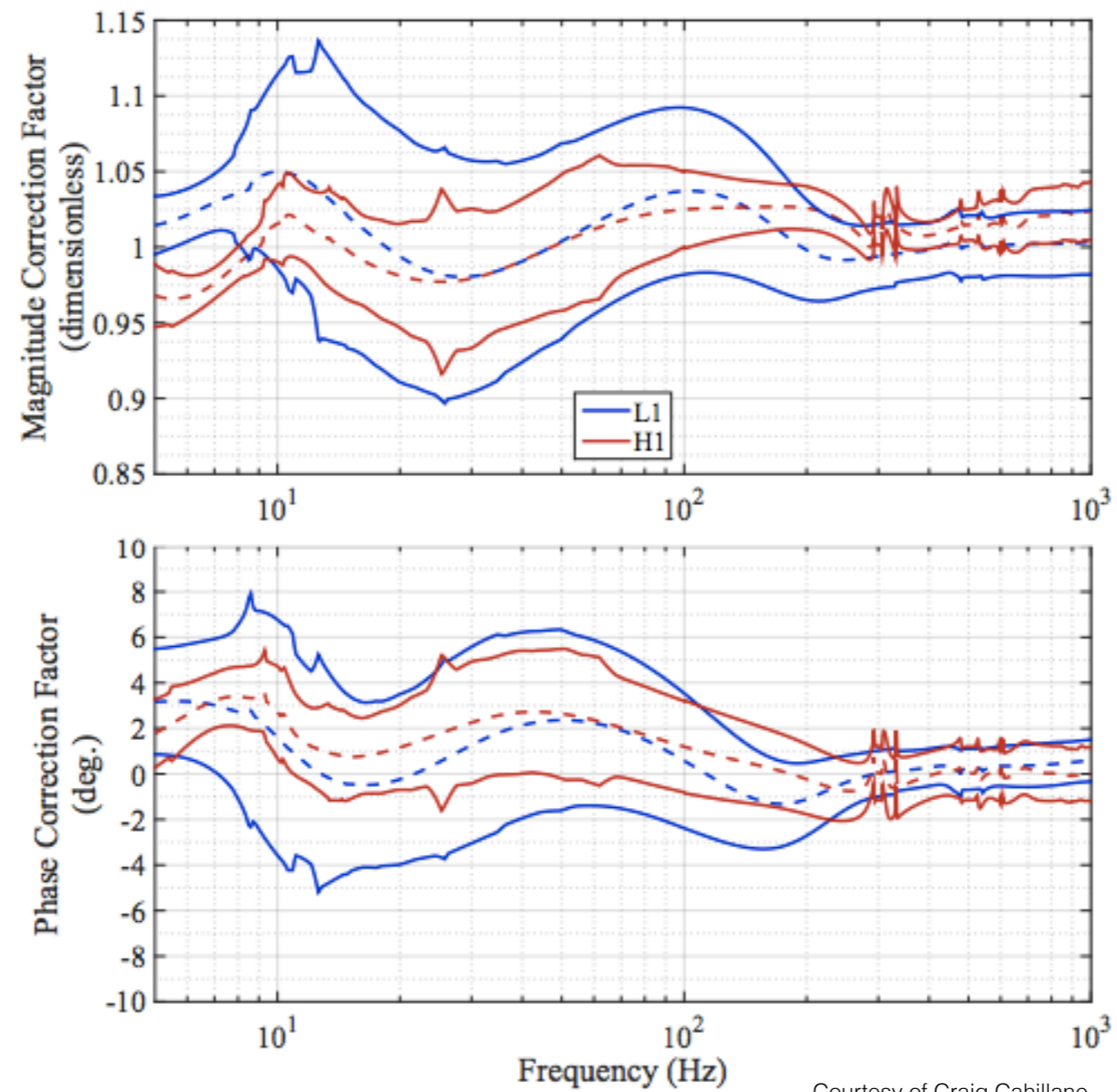# Calibration uncertainty & precision tests of GR

Stacking Observations

$$P(\theta|x_i) \propto \left[\prod_i P(x_i|\theta)\right] \times P(\theta)$$
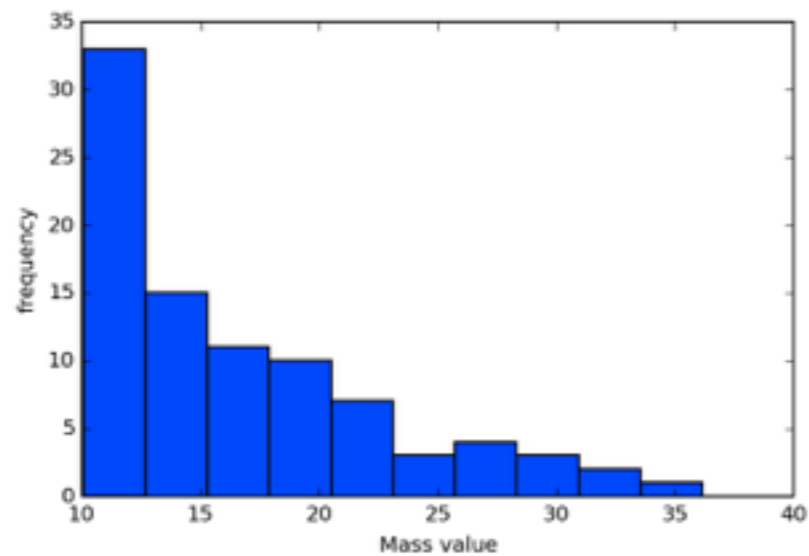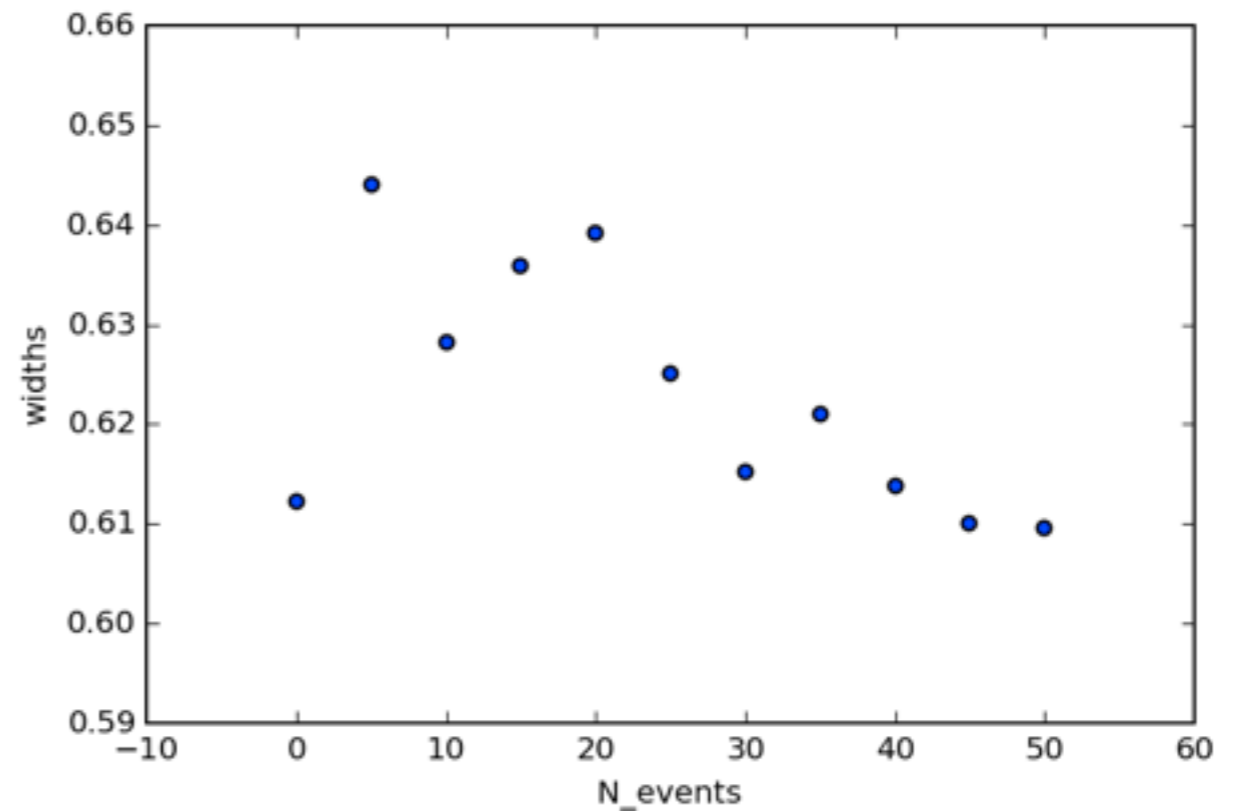
A Simple Model

Template

SNR

Mock Data

Mass

Template Bank

Match Filter Results

Uncertainty vs Number of Events
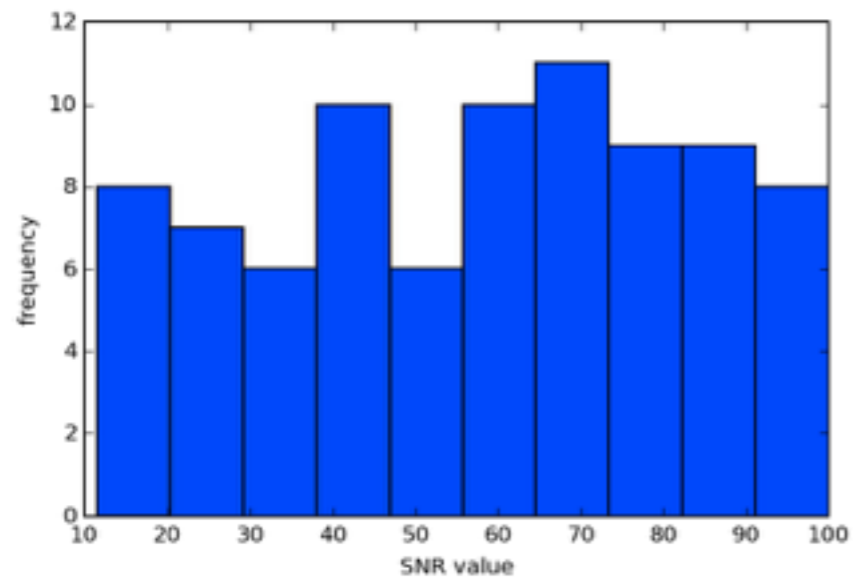
Stacked Observations

Calibration methods

Courtesy of Craig Cahillane

Results
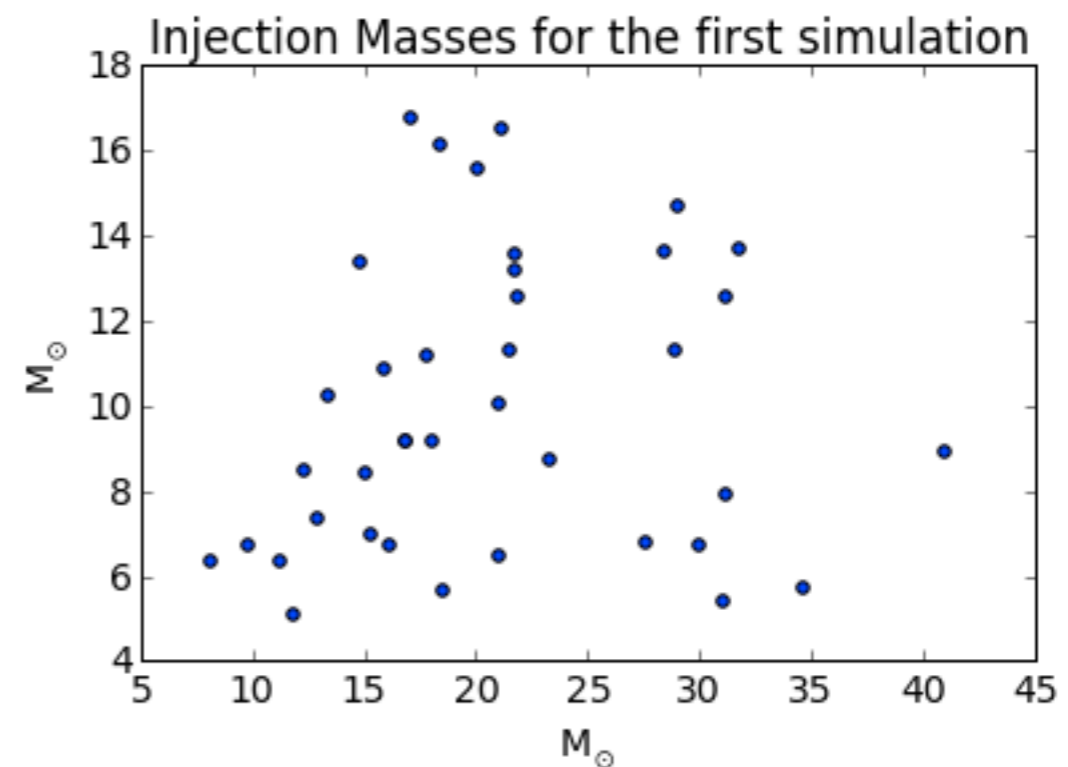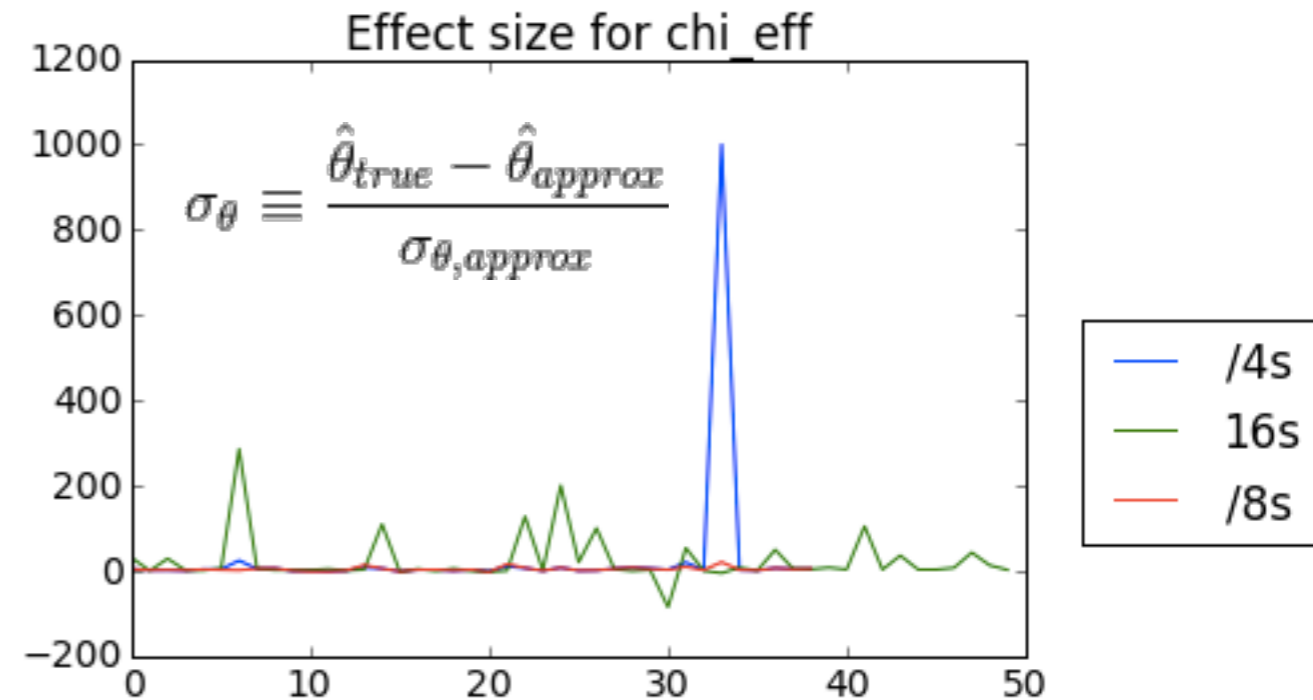
50 events
550 templates

Next Steps

- Repeat with calibration errors & error models

- Repeat for low SNR

- Increase sophistication of model: LALSuite

LALInference & TIGER

Test Infrastructure for GEneral Relativity

Odd's Ratio

$$O_{GR}^{modGR} \equiv \frac{P(H_{modGR}|d, I)}{P(H_{GR}|d, I)}$$

Effect size for chi_eff

$$\sigma_\theta \equiv \frac{\hat{\theta}_{true} - \hat{\theta}_{approx}}{\sigma_{\theta, approx}}$$

/4s
16s
/8s

Injection Masses for the first simulation

Acknowledgements

For funding:
- NSF, Caltech/LIGO-SURF

For mentorship:
- Alan Weinstein
- Craig Cahillane
- Kent Blackburn

For coding help:
- Nicolas Rothbacher
- Avi Vajpeyi

For moral support:
- the rest of LIGO-SURF :)