

# BNS Parameter Estimation

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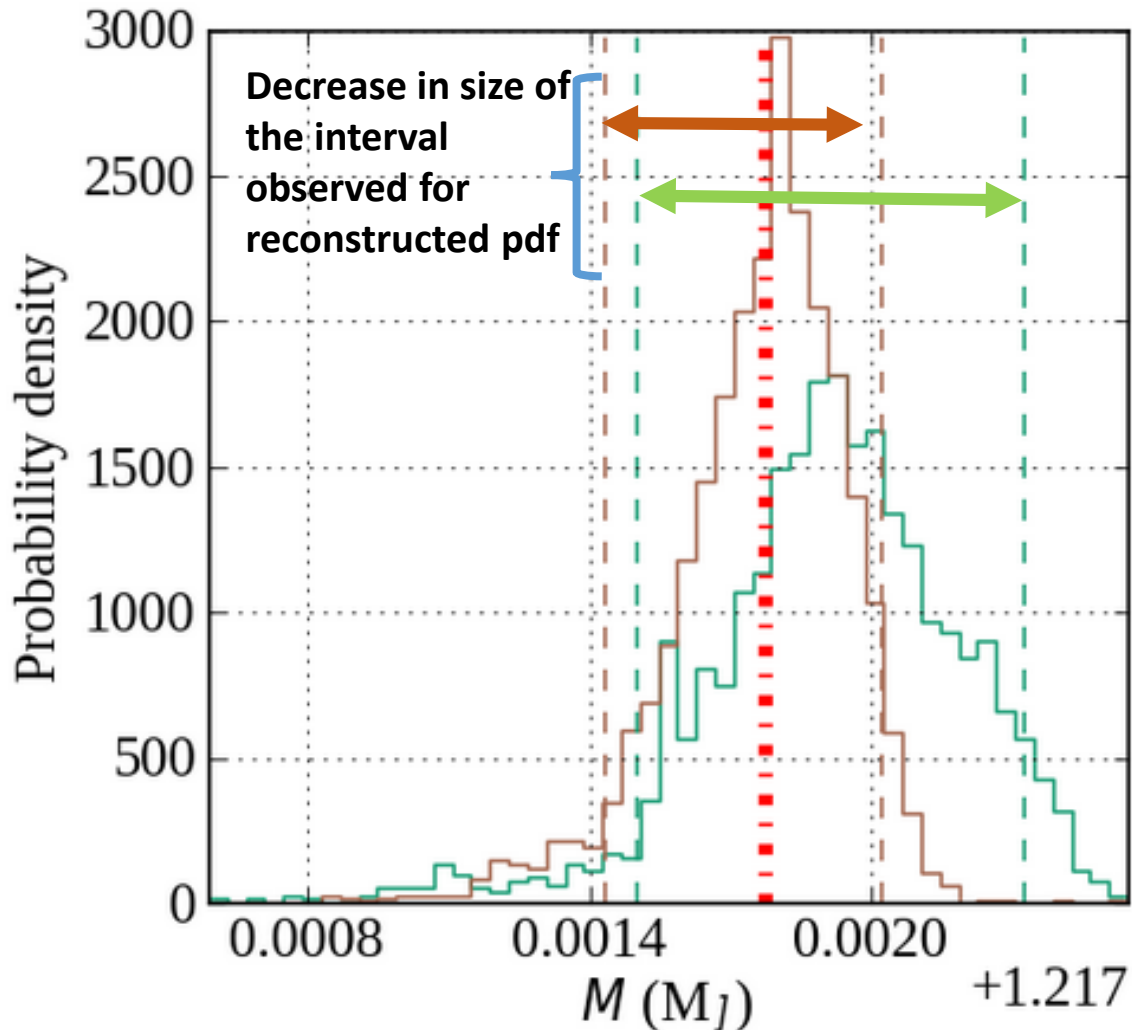
# Simulated 200 BNS events + Parameter Estimation

- Constructed 200 BNS events
  - TaylorF2threePointFivePN
  - Uniformly distributed over volume
  - $f\text{-lower} = 40$
  - SNR between 5 and 20 (includes weak signals)
  - 1.4,1.4 solar masses
- Parameter estimation
  - Also ran parameter estimation after fixing sky position to injection values (“EM observation”)
  - **How does the estimation of parameters (Dist,eta, m1,m2,mchirp,mtotal,psi,q) improve with fixed position?**

# What is improvement?

Simple Parametric for uncertainty Improvement (SPI)

$$= \frac{\text{Full analysis uncertainty width} - \text{Fixed analysis uncertainty width}}{\text{Full analysis uncertainty width}}$$

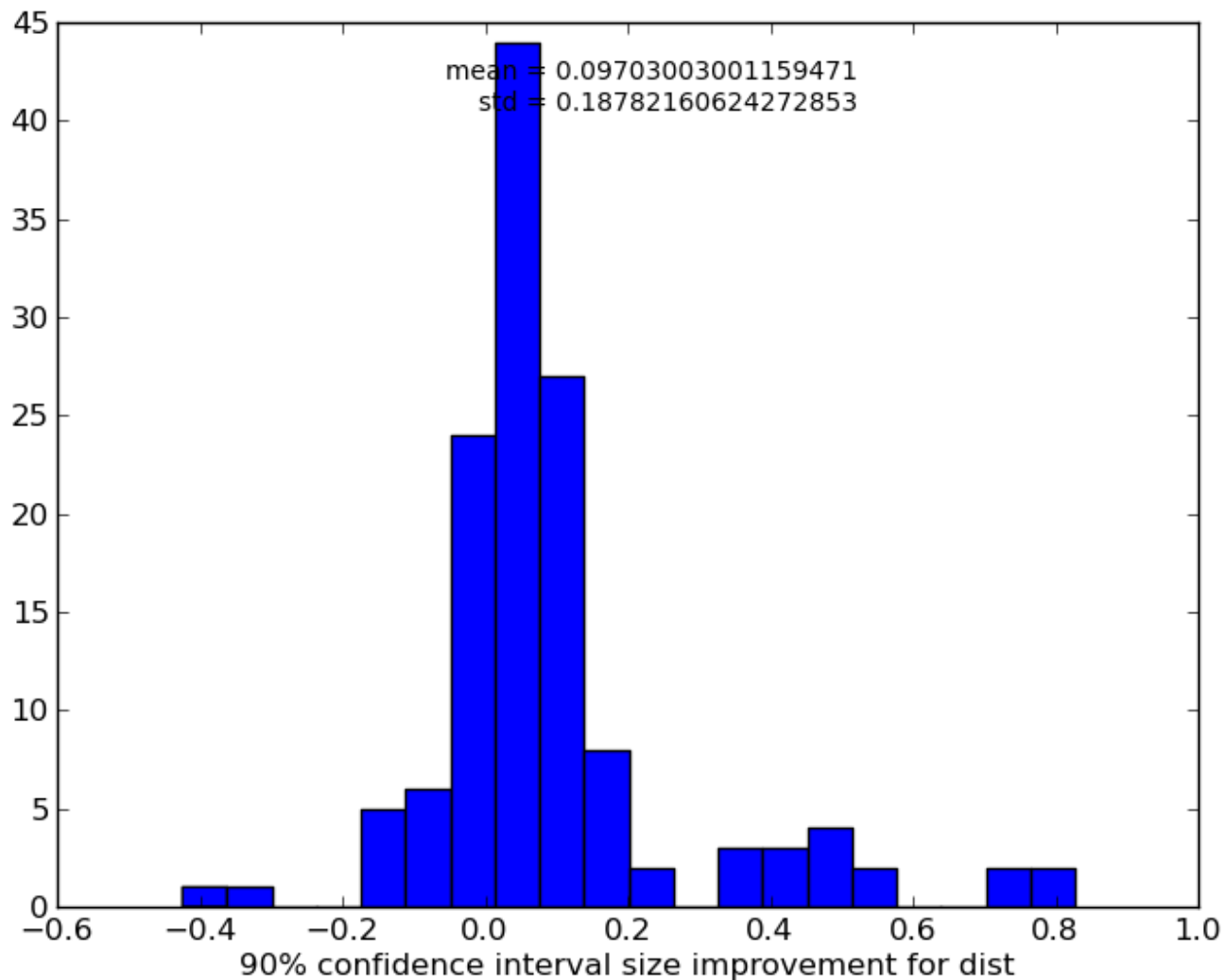


- Compared width of fixed analysis (**fixed sky position**) and full analysis (**no fixed sky position**) pdfs for each parameter
- Larger SPI values = bigger improvement in parameter estimation (or larger decrease in confidence interval size)

SPI for Event 189 (shown left at 90%)

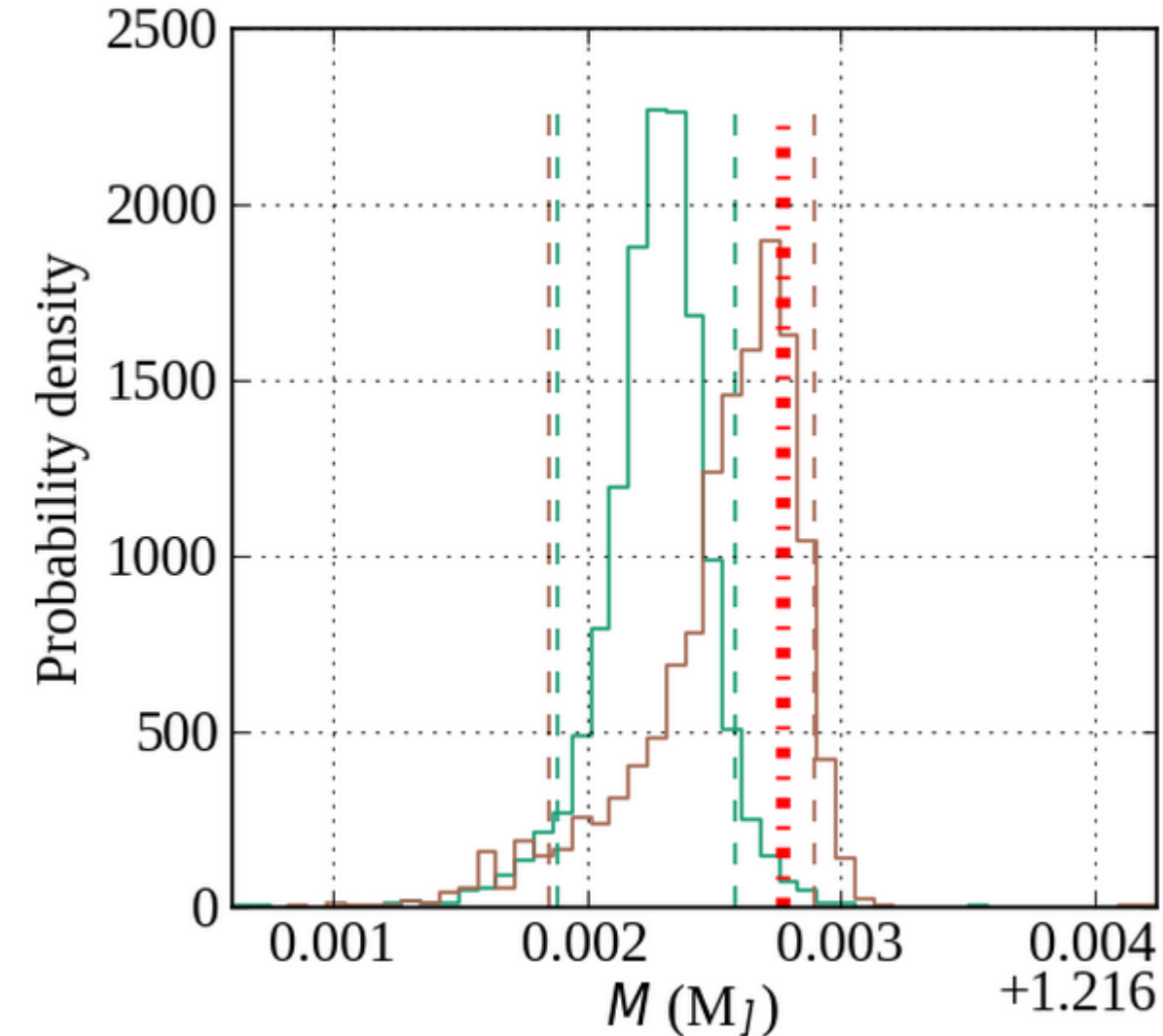
68%	90%	95%	99.7%
.340	.289	.316	.213

# How does fixing sky position improve parameter estimate?



- Histogram for improvement in parameter estimation for distance parameter shown left
- All parameters roughly Gaussian improvements
  - mean  $\sim .05 - .20$
  - std  $\sim .15 - .25$
- But...why are some events *negatively* improving after fixing sky position?

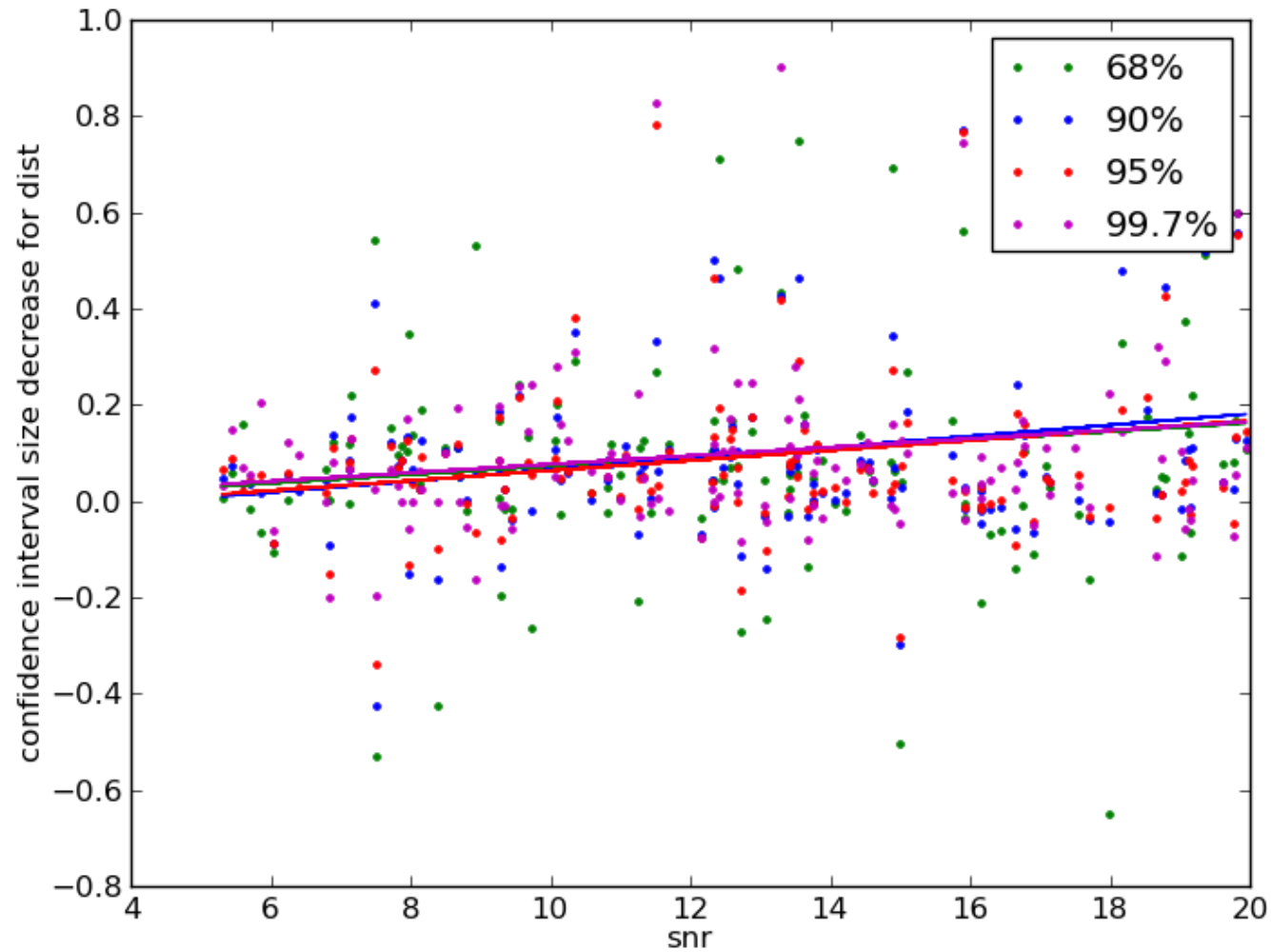
# Bias in the pdf



## When the bias in the full analysis is significant:

- The full analysis may give a higher probability for an incorrect value (bias from the injection value), or exclude the injection value entirely
- The fixed position analysis will now contain the injection value, but have a wider spread
- Fixing sky position may increase accuracy but decrease precision of parameter pdf

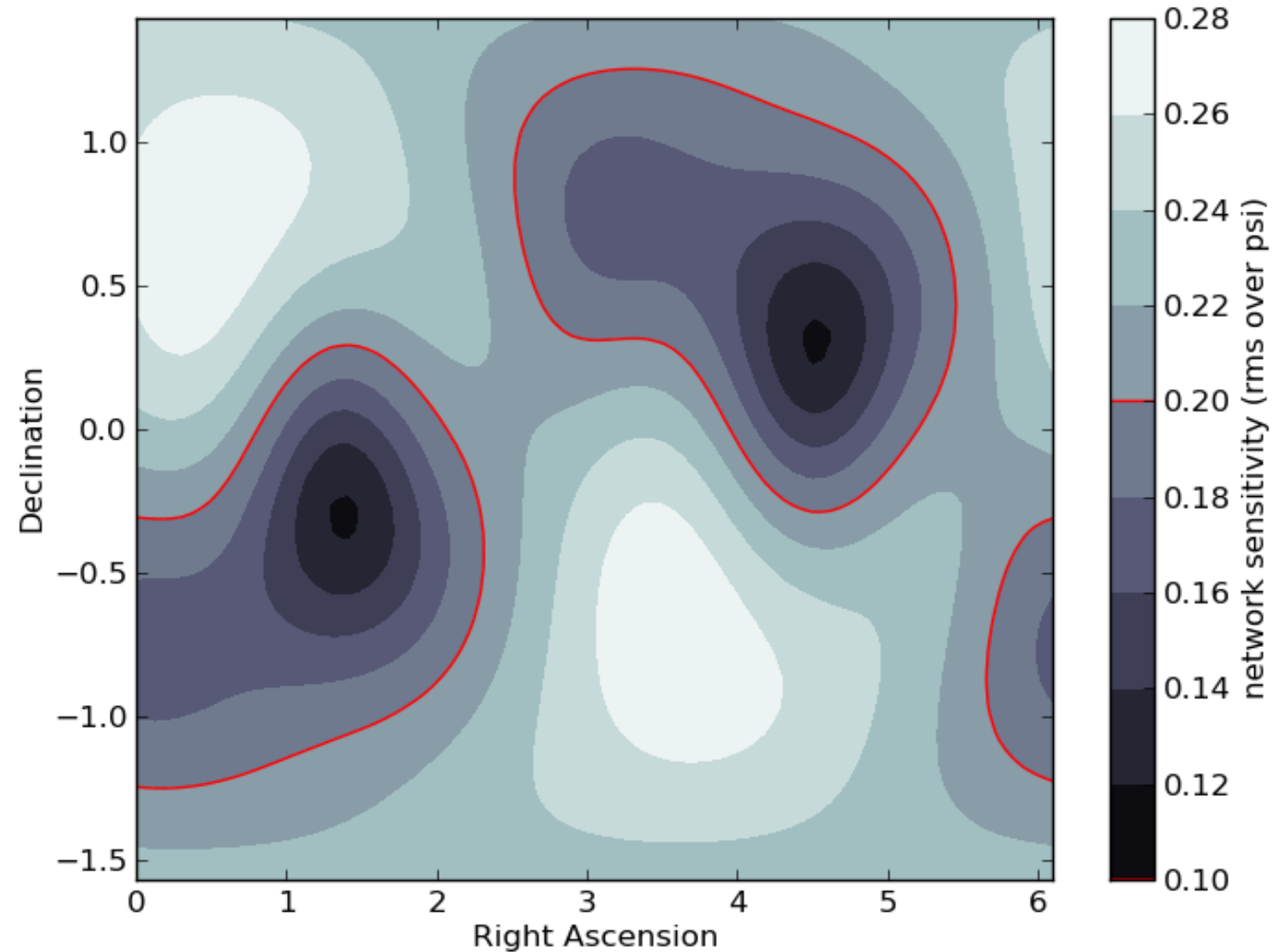
# Checking SNR correlation



- Weak correlation between parameter estimation improvement and snr
  - All parameters had weak correlation

# Detector Sensitivity

- Gps time: 1064311042

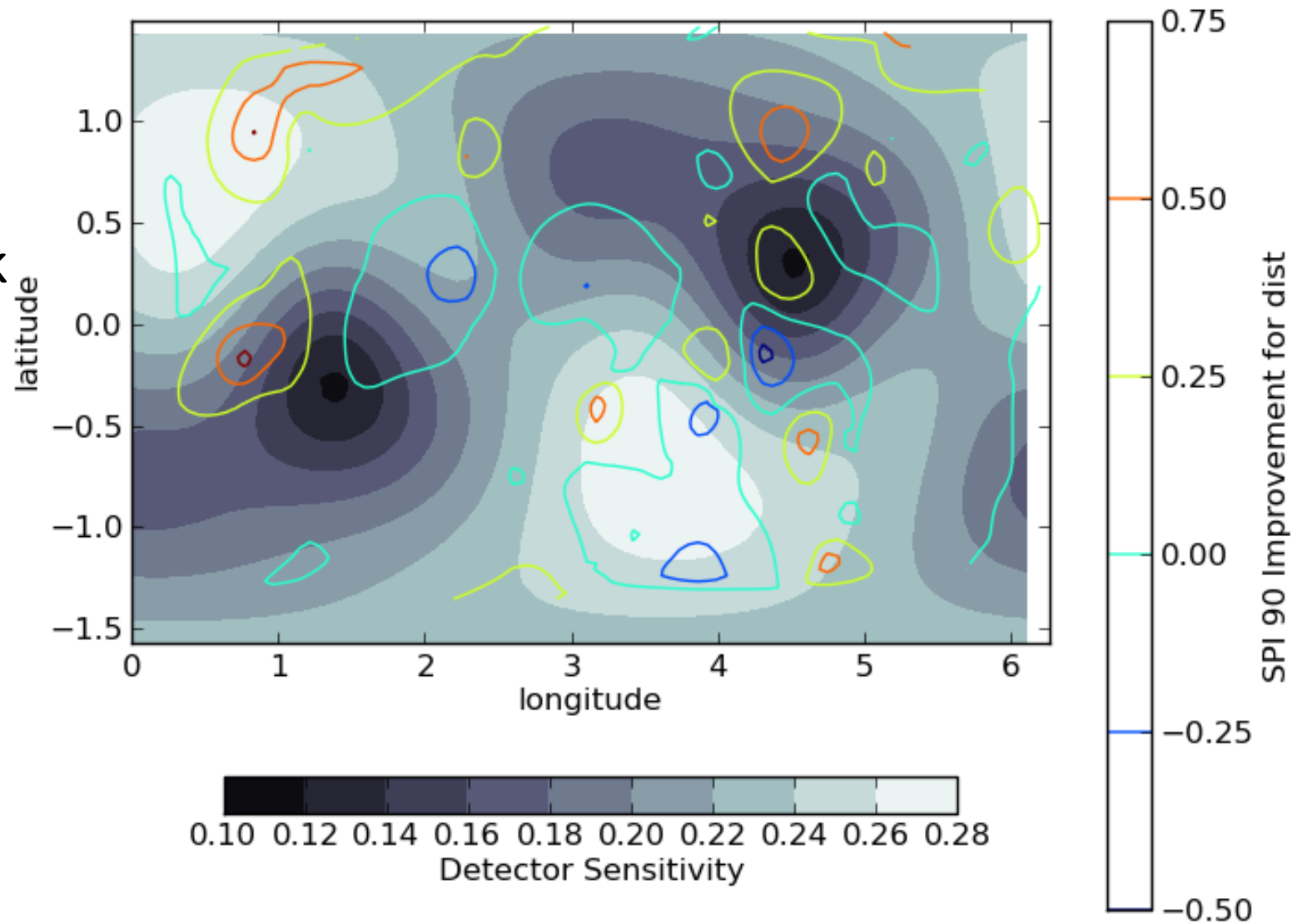


$$\text{Network Sensitivity} = \sqrt{\sum_{i=1}^N \left( \frac{1}{\pi} \int_0^{\pi} \sqrt{F_{+,i}^2 + F_{\times,i}^2} d\psi \right)^2} \quad (1)$$

The network sensitivity is the combined sensitivity of the  $N$  individual networks added in quadrature. Here we take the long wavelength approximation (so that the antenna beam pattern functions  $F_+$  and  $F_{\times}$  are independent of wavelength) and the rms average over all values of  $\psi \in [0, \pi)$ .

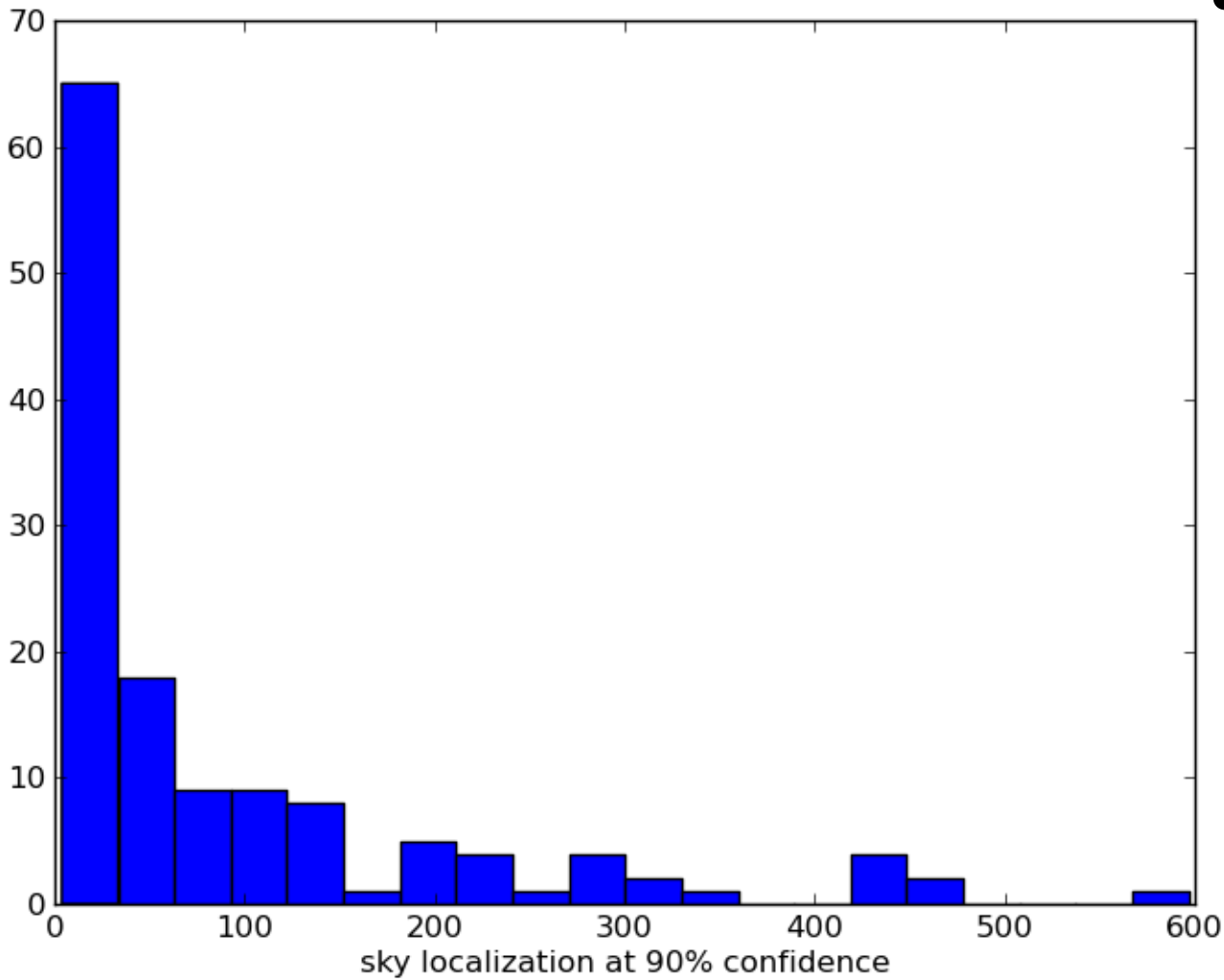
# Parameter estimation as a function of sky position

- Correlation between network sensitivity and parameter estimation cannot be seen

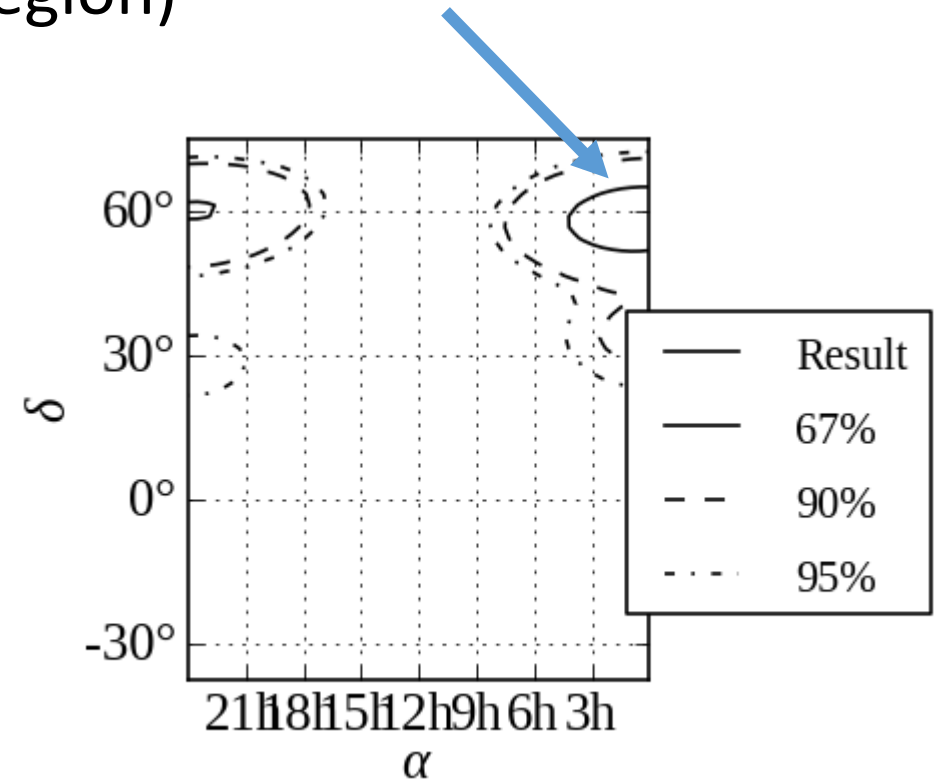




# How well can we determine sky position of source?

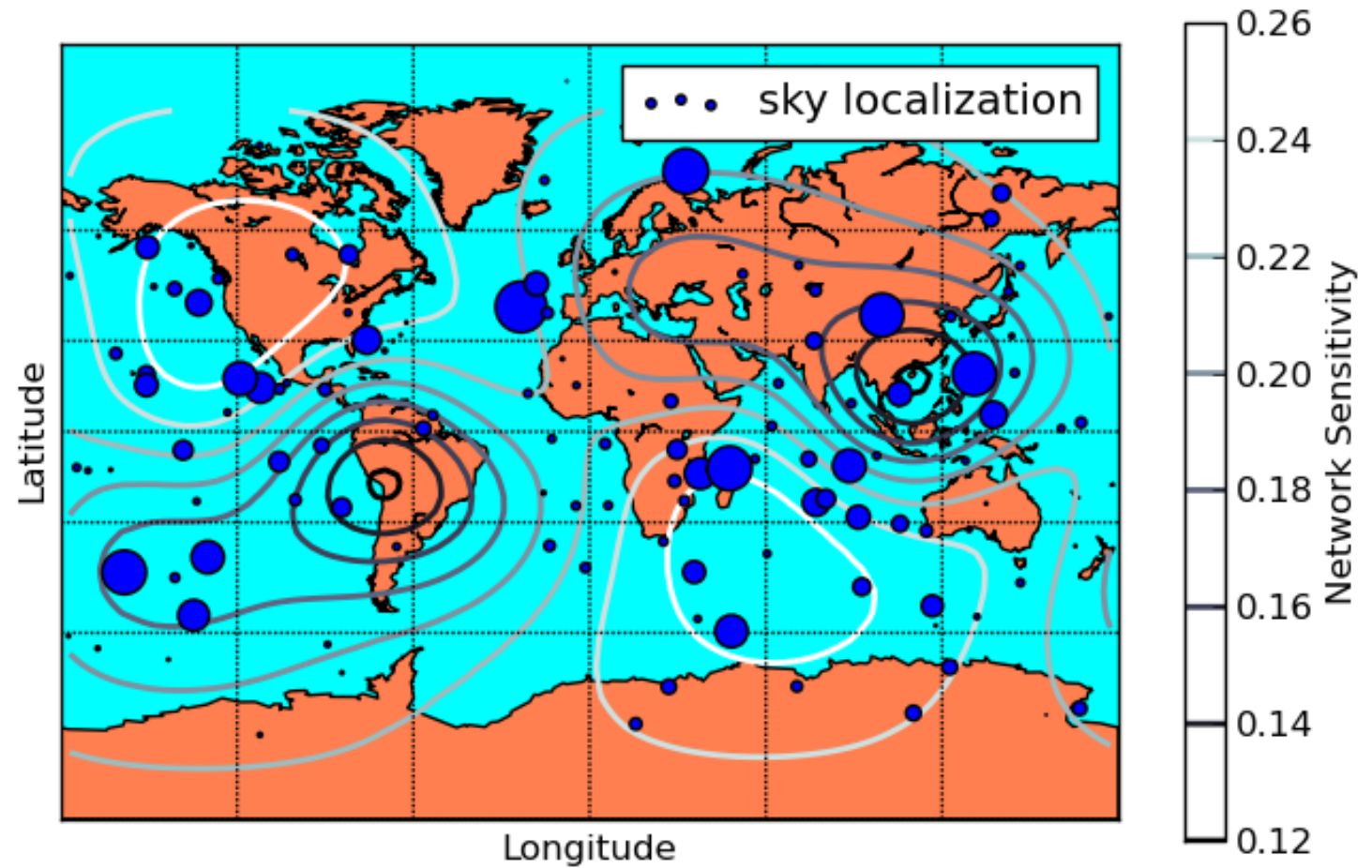


- Sky localization in units of sq. degrees (area of 2D confidence region)



How does sky localization (uncertainty in sky position) change with network sensitivity?

- Area of circle proportional to the uncertainty in sky position (area of 2D confidence region)
- More samples needed to conclude about trends (only 134 events in set currently)



# Next Steps

- Investigate relationship of bias in pdf with snr, improvement
  - Decrease in confidence interval size is not satisfactory for summarizing events with large bias
- Run more stringent MCMC post processing chain to improve data quality
- “Reduced Order Modeling” to get more data points