

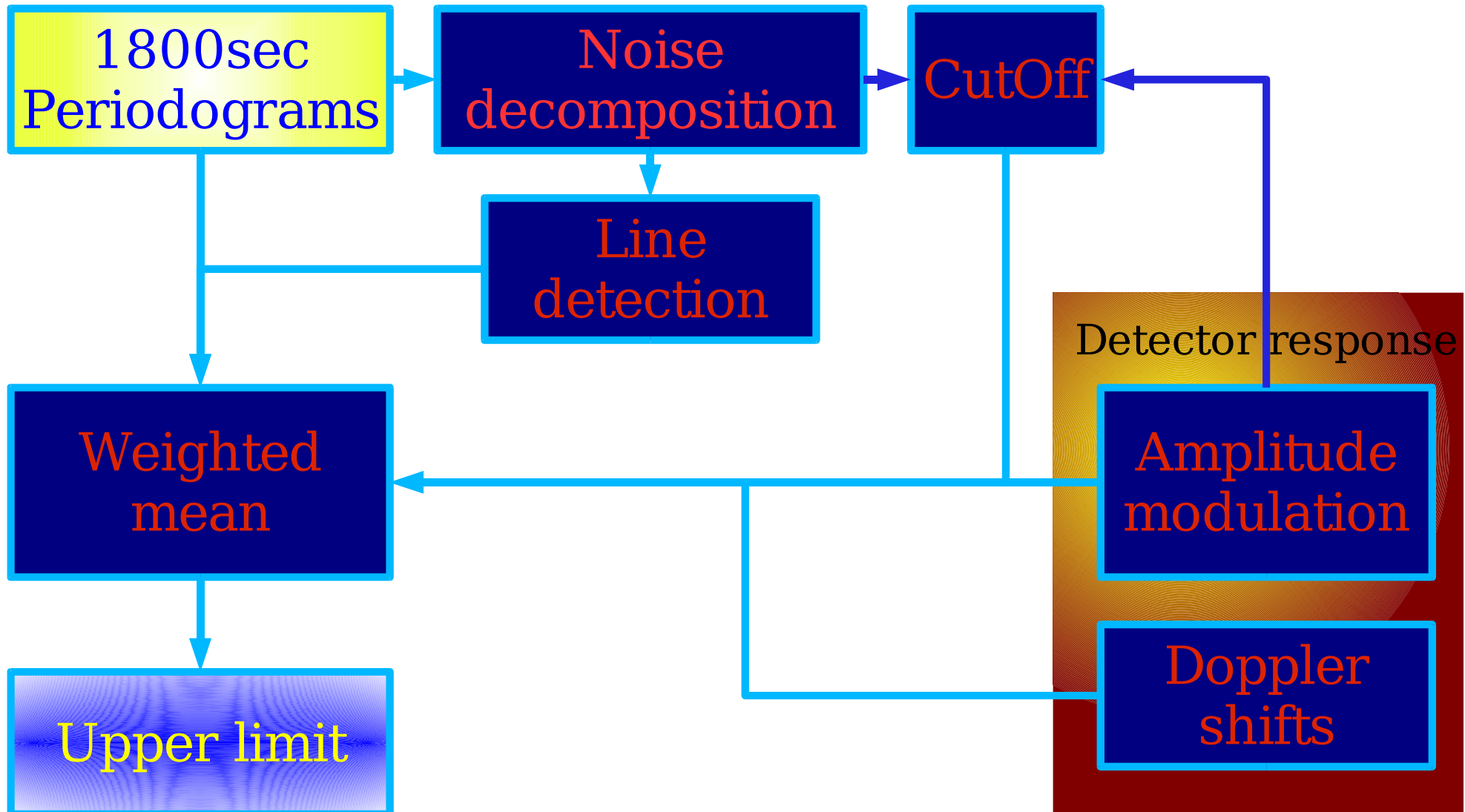
# Broadband Search for Continuous-Wave Gravitational Radiation with LIGO

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# Challenges of search for CW gravitational waves

- Gravitational waves are weak – need to average over long time periods
- Several parameters to search for: frequency, sky position, spindown, polarization
- Coherent methods are very sensitive, but result in enormous search space size – broadband search is impractical when using large time base
- **PowerFlux** – place upper limits and detect signals by averaging power. Practical for all-sky broadband searches.

# PowerFlux analysis pipeline



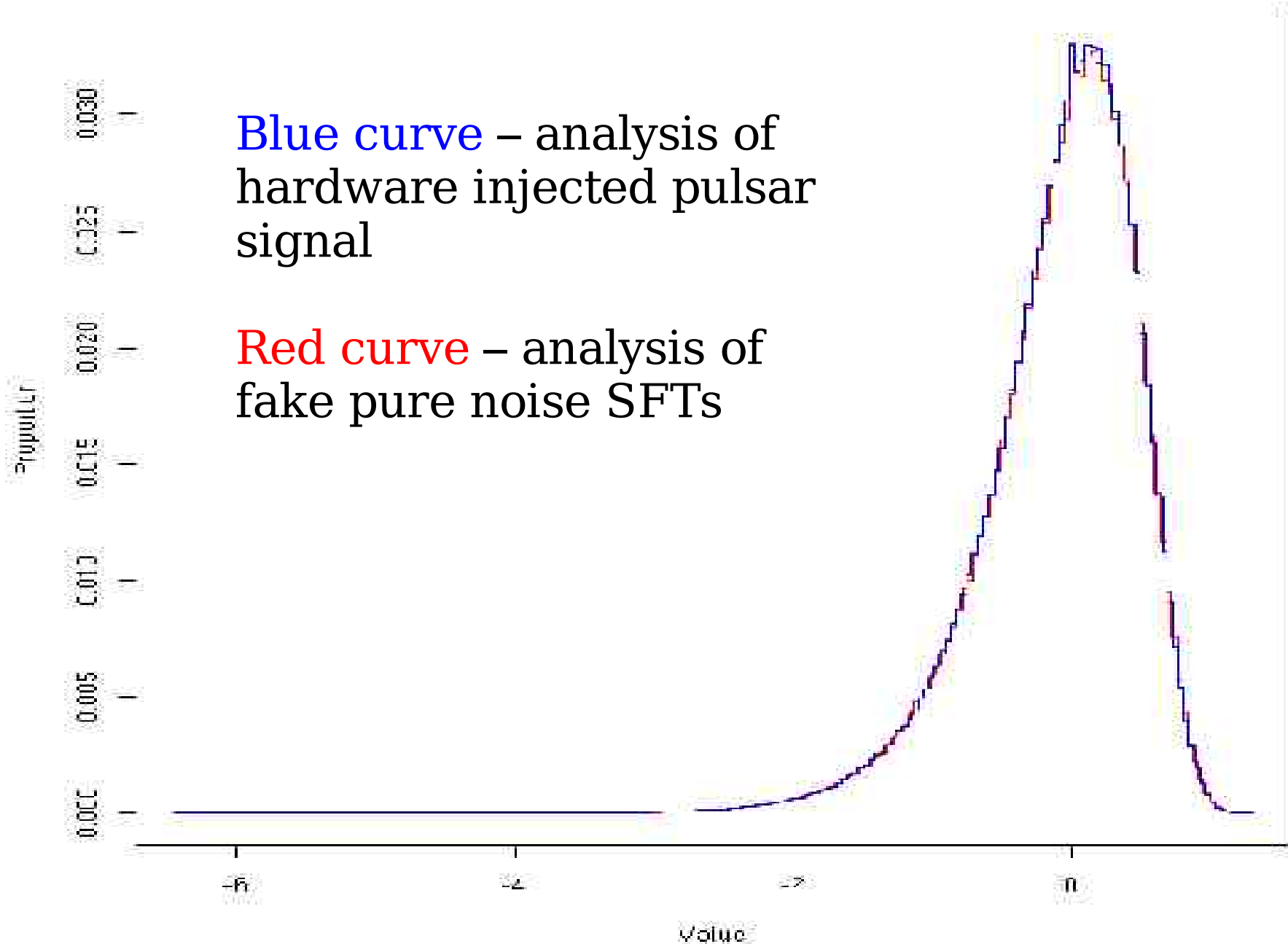
# Noise decomposition algorithm

$$\text{Power} = 10^{\text{TMedian}} \cdot 10^{\text{FMedian}} \cdot 10^{\text{Residual}}$$

1. Compute  $\log_{10}$  of each matrix entry.
2. Compute medians of each row, subtract from the matrix and add to Tmedians accumulation array.
3. Compute medians of each column, subtract from the matrix and add to Fmedians accumulation array.
4. Continue steps 2 and 3 until all medians are 0 or very small.
5. If matrix dimensions are odd always finishes in finite time with exact precision.

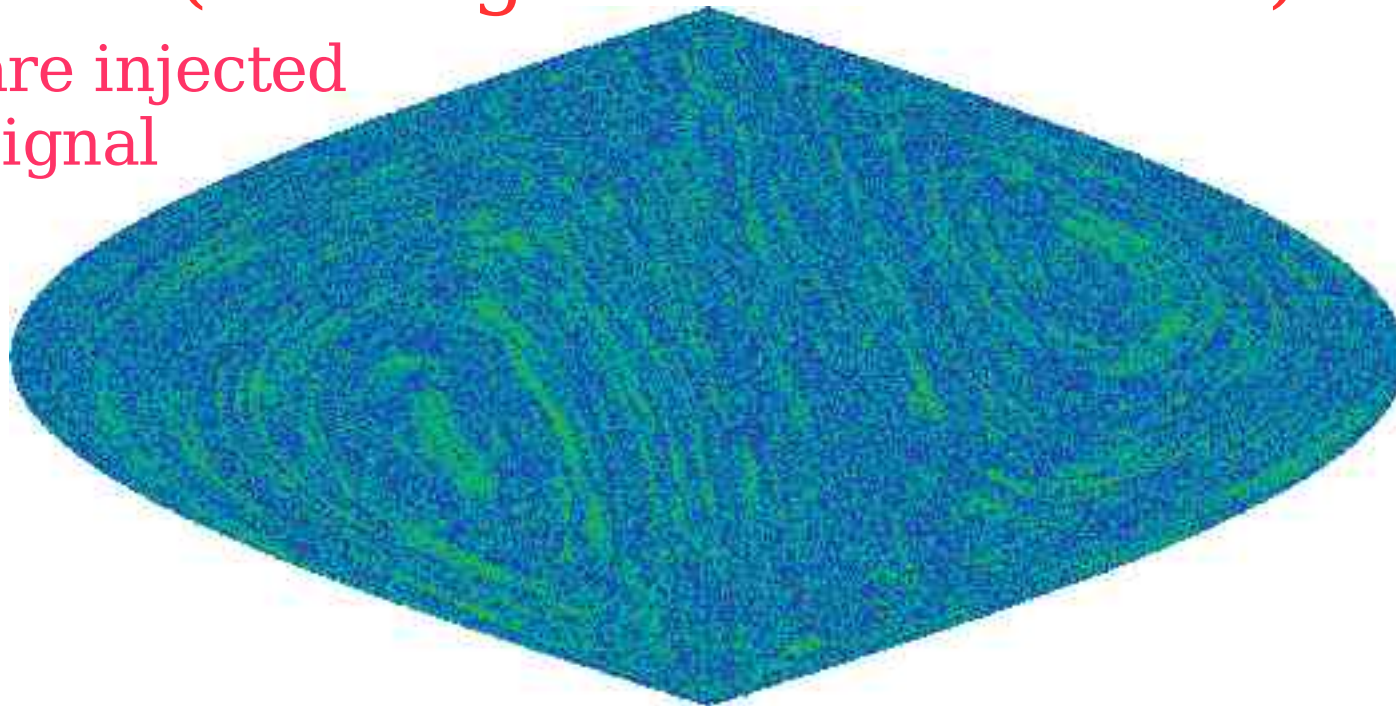
# Residuals histograms

Noise decomposition residuals

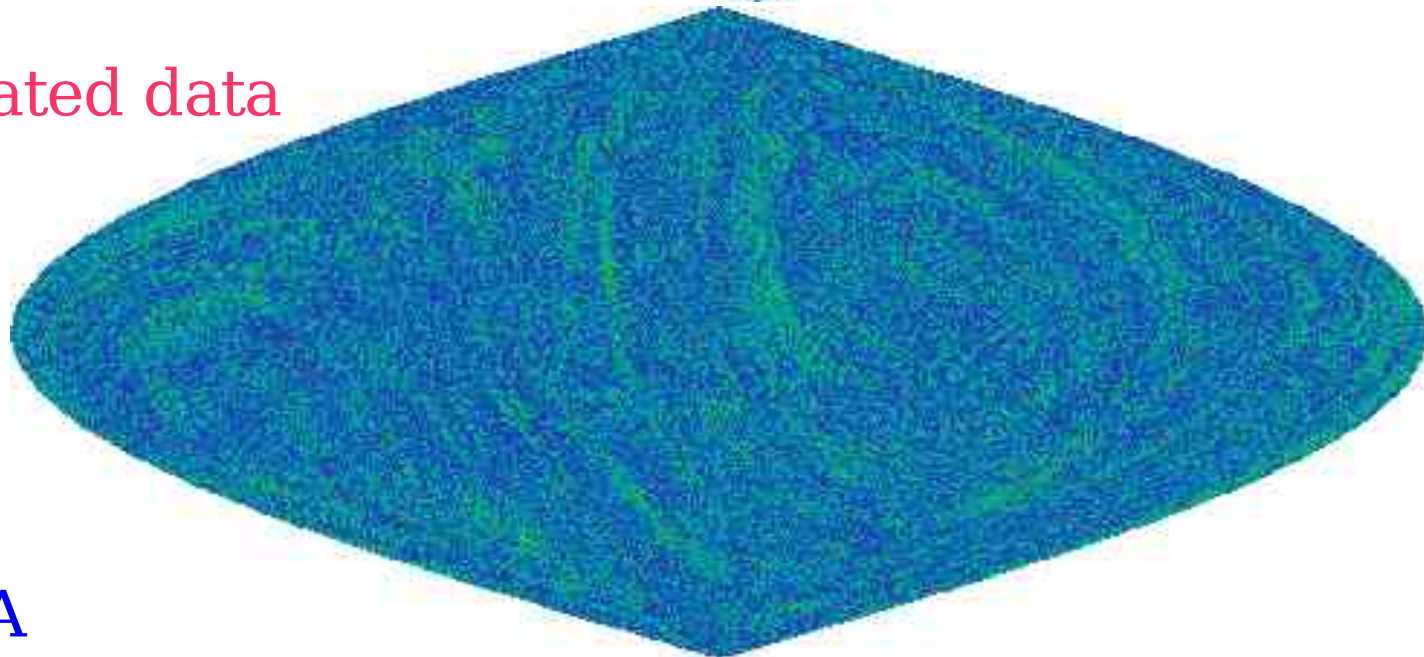


# Are averaged powers gaussian ? (Kolmogorov-Smirnov test)

Hardware injected  
pulsar signal



Simulated data



RA

DEC

0.067

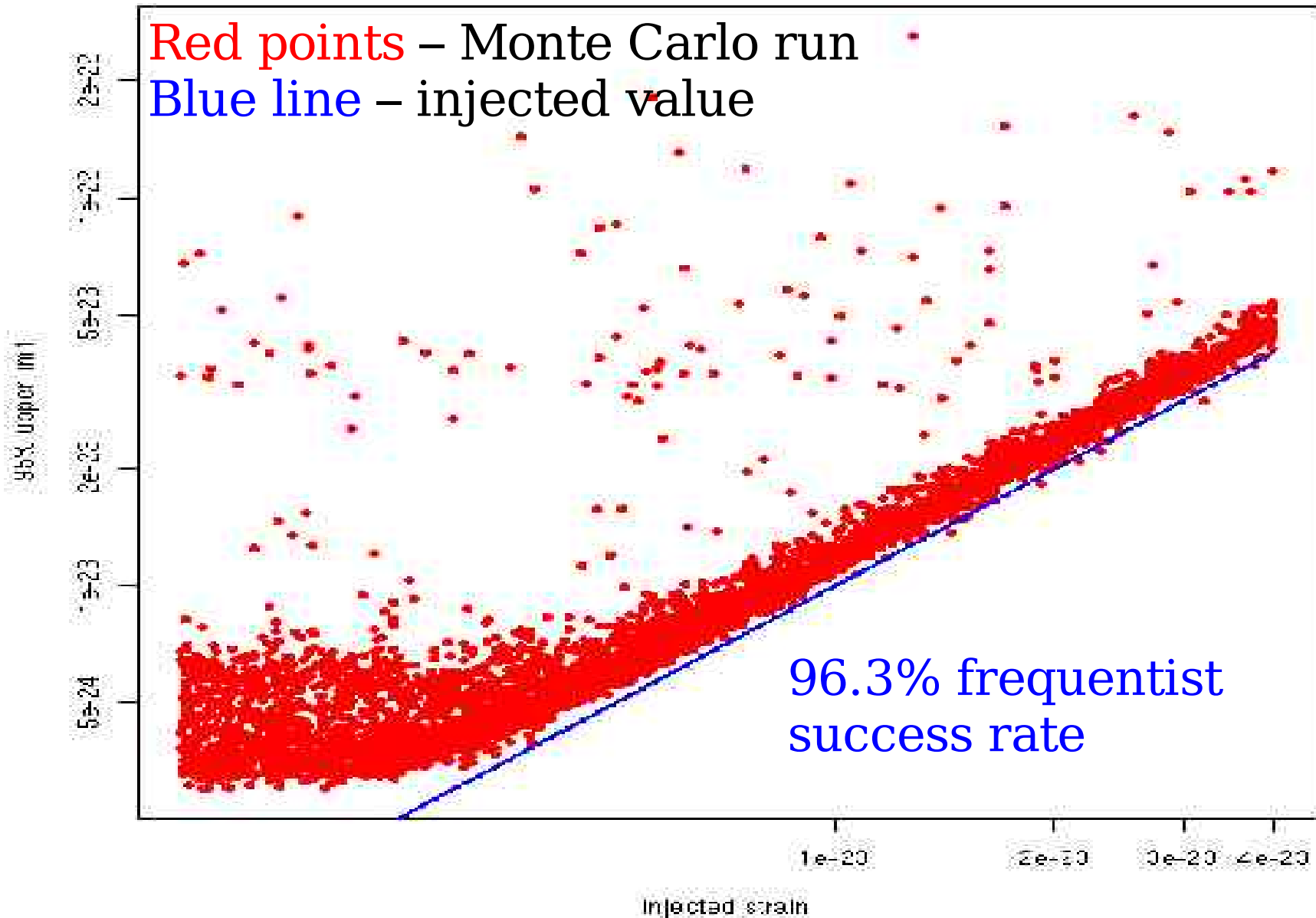
0.017

# Monte-Carlo run

- 8000 injections between 200Hz and 300Hz using background data collected by H1 interferometer during S3 run
- 20 injections into each 0.25 Hz band
- Uniformly distributed locations on the sky and orientation of the linearly polarized injected signal
- Power-only injection – phase was assumed to be independent and uniformly distributed for each SFT
- $\log_{10}$  of injected strain values was uniformly distributed between -24 and -22.4

# Upper limit versus injected strain

Upper limit versus injected strain



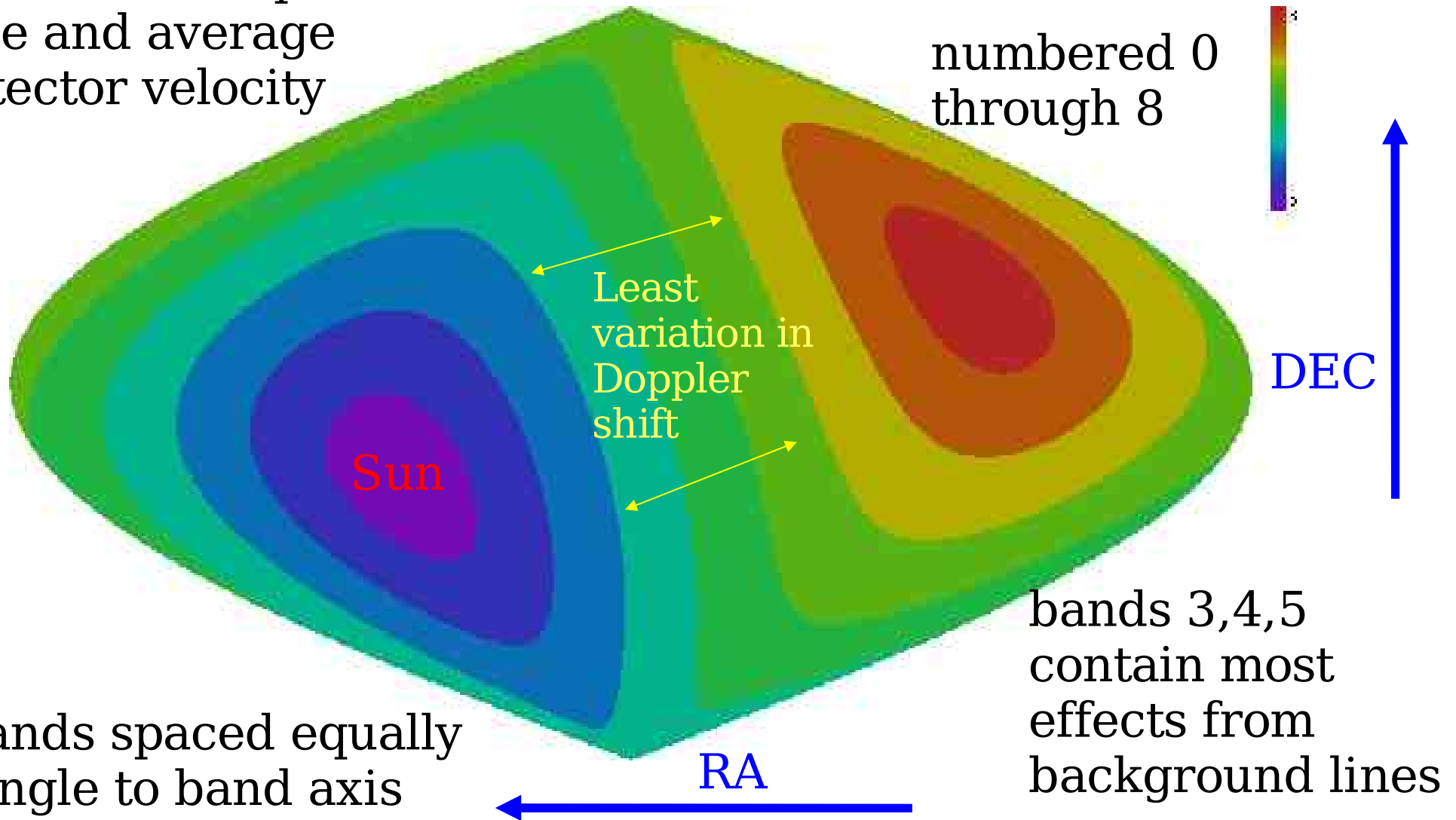
# Interpretation of results

- Sky bands: sky partitioned into 9 bands, according to the angle to average direction towards Sun (useful for short runs when some sky areas can have stationary Doppler shift)
- 5 polarizations sampled: plus, cross,  $\text{Pi}/8$ ,  $3*\text{Pi}/8$ , circular
- Maxima over sky bands, frequencies or entire sky
- Derivative limits: universal limit on linearly polarized signals

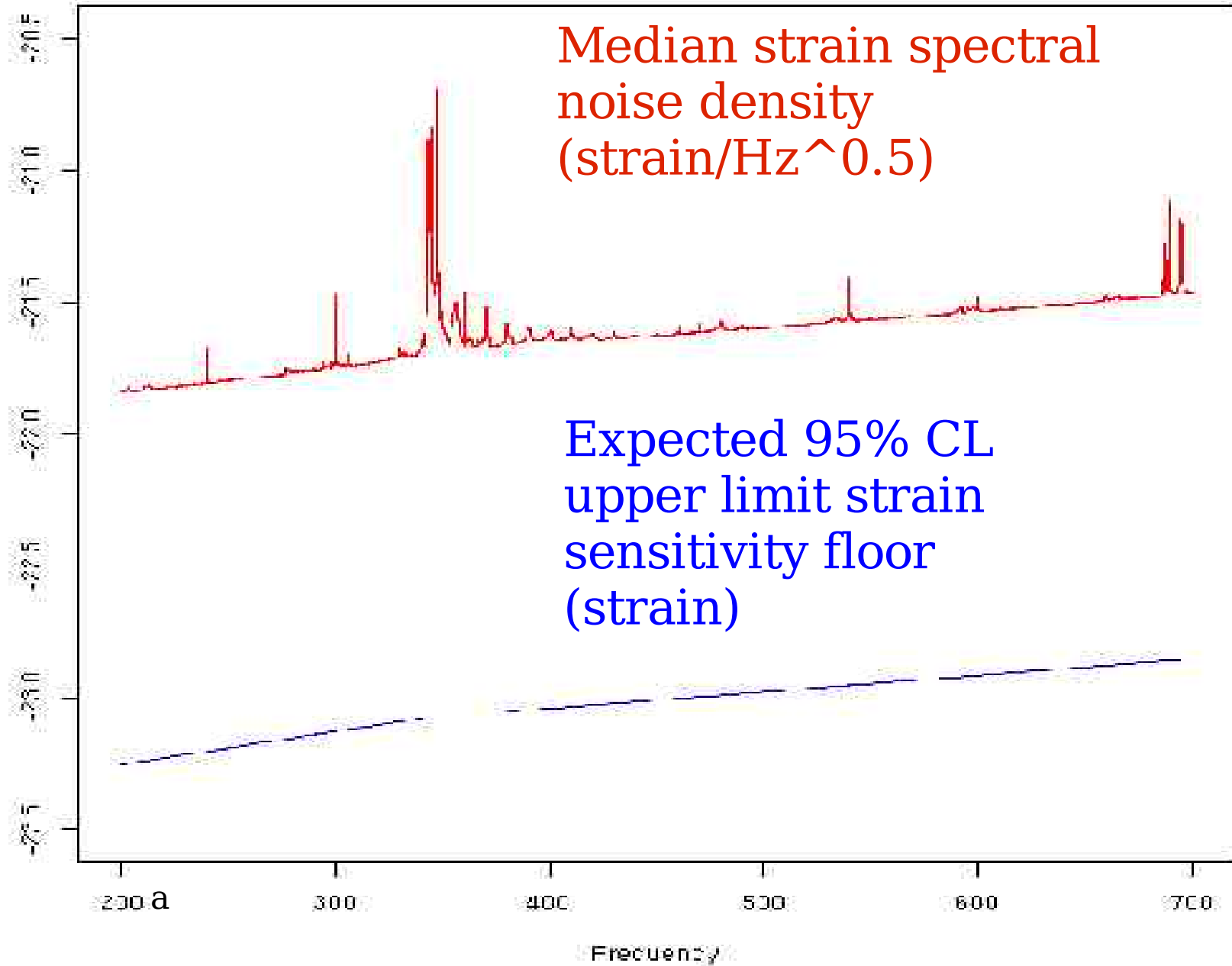
# Sky bands

band axis – cross product of ecliptic pole and average detector velocity

numbered 0 through 8



# PowerFlux sensitivity



# Hardware injected pulsar signal (maximum upper limits over narrow band)

