Towards an Astrophysics-Based Burst ETG Tuning

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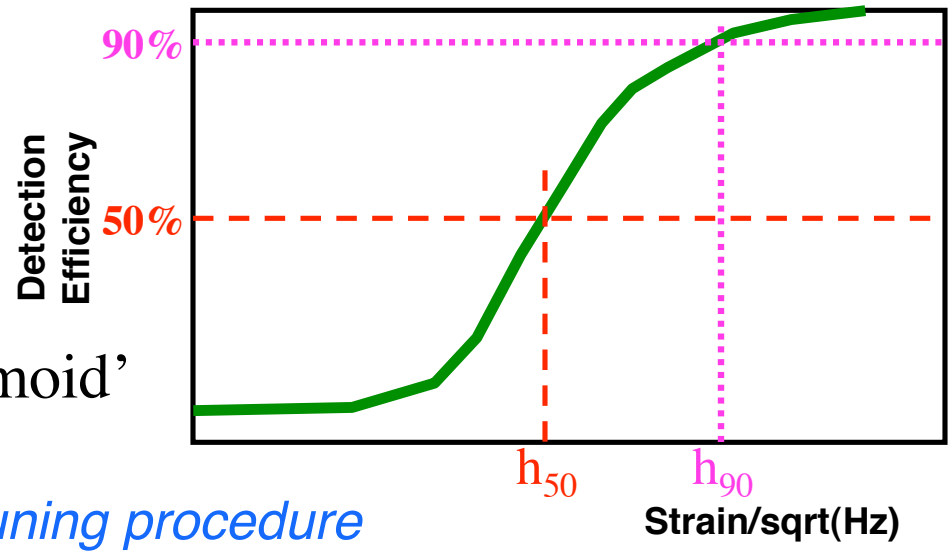
Difficulties in Burst ETG Tuning

- Lack of good source models, waveforms for “bursts”
  - Have used non-physical Sine-Gaussian, Gaussians instead
- Focus has been “best upper limit”
  - Makes no use of distributions in amplitude from source models
- Figure-of-merit (h_{50}) drawn from detector performance
  - No astrophysical content
  - detection efficiency
  - h_{90} was also used



Typical Efficiency ‘Sigmoid’

-->This is an “ad-hoc” ETG tuning procedure

"Upper-Limit" Burst ETG Tuning

- Goal was expectation of much less than 1 false event over the science run to yield strongest upper limit
- ETGs tuned to meet false event rate expectation and simultaneously minimize signal strength where detection efficiency was 50% (h_{50}).
- Used minimum-uncertainty wave packets (low-Q Sine Gaussians) at selected frequencies
- BUT this is only a fraction of the "burst' phase space (P. Sutton)
  - » Phase-space extends along frequency, duration, bandwidth axes
- HOW should ETGs balance optimization amongst different waveforms in that phase space?

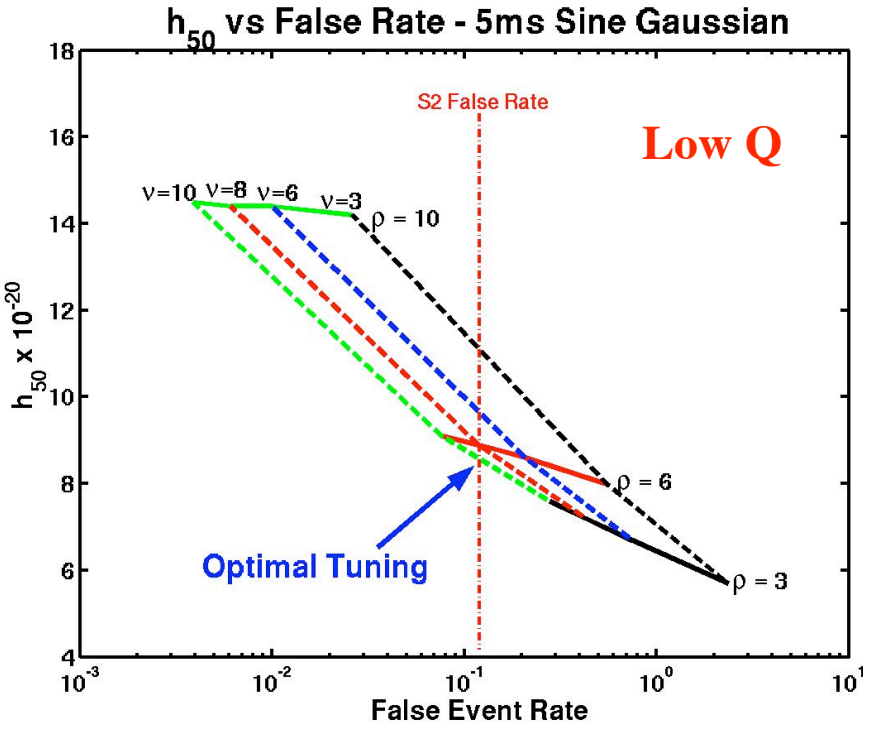
ETG Tuning Investigation

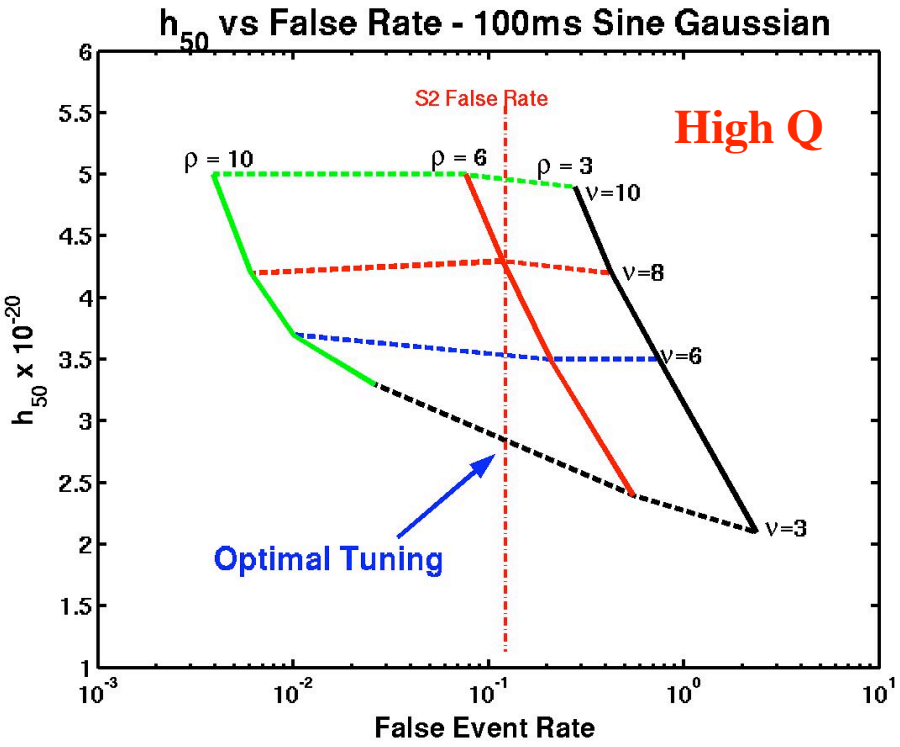
- Each ETG has multiple parameters controlling performance
  - » This gives several ways to tune to achieve the same false rate
- Can these different tunings be optimal for different waveforms in the “burst” phase space?
- Can different ad-hoc figures-of-merit (h_{50}, h_{90}) select different ETG tunings for optimization, even on the same waveform?

- Carried out a study (Jason Rothenberger REU)
  - » Used BlockNormal on S2 playground
  - » Added 576Hz Sine-Gaussians at two durations (5ms, 100ms)
  - » Only varied two of the “knobs” (ρ (change-point) and ν (event variance))
  - » Studied two ad-hoc figures-of-merit (h_{50}, h_{90}) for single IFO (H1)

Tuning depends on signal duration

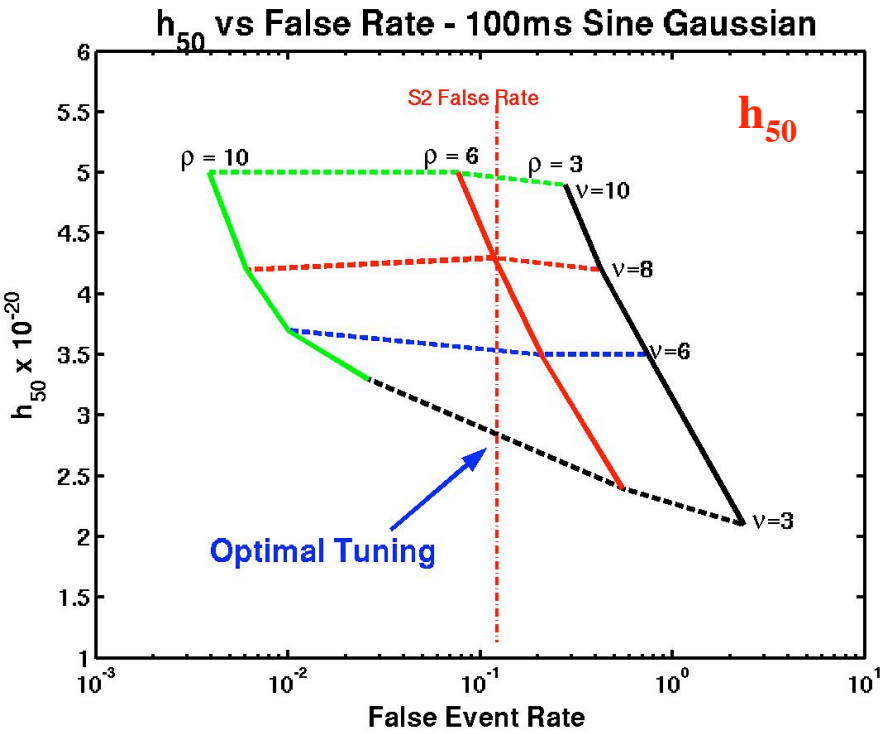
- For same false rate, different tunings optimize for different durations of the same waveform

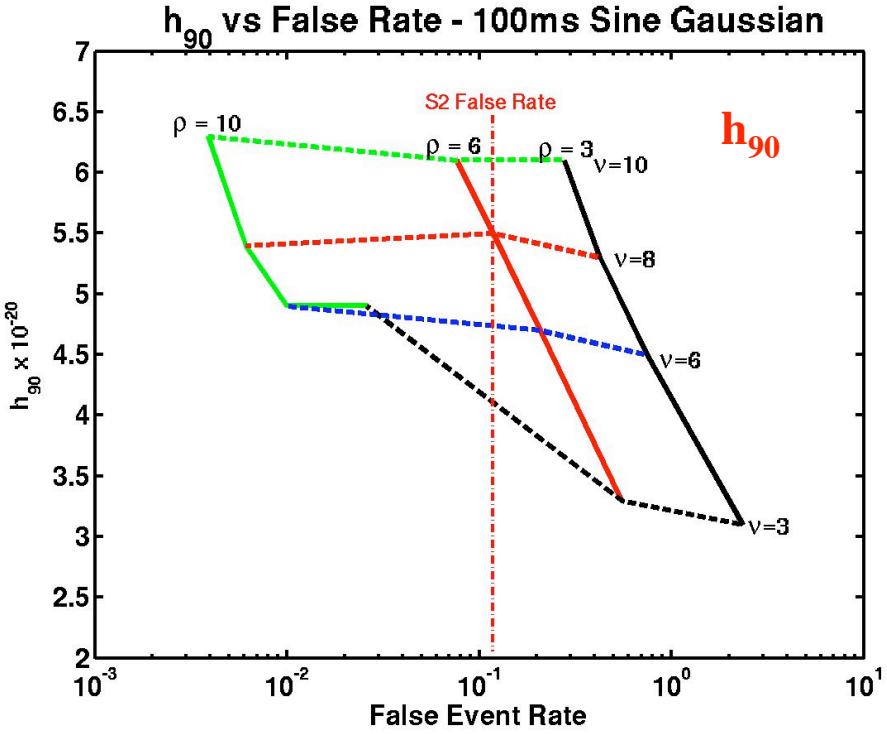




Tuning depends on Figure-Of-Merit

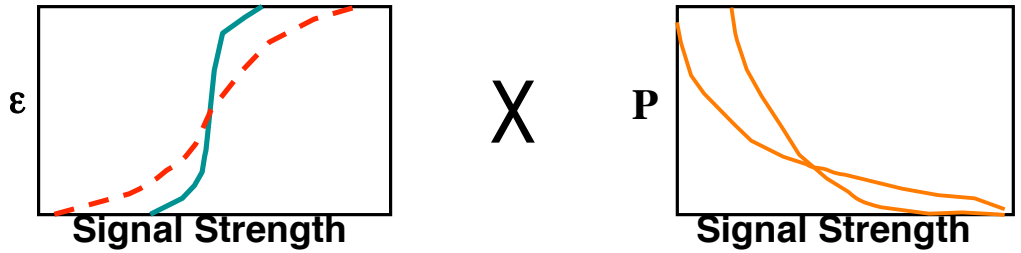
- Different optimization behavior for h_{50}, h_{90}





An improved tuning process

- ***Tuning Figure-Of-Merit tied to the science goals***
- Science Goal: For a given false rate, detect the greatest number of sources from an astrophysical distribution
- This detection rate is a convolution of the detection efficiency (**ε**) and the source distribution probability (**P**) as functions of the signal strength



- Simple examples of source distributions
  - » Cosmologic distribution of "standard candles" P(h) ~ $1/h^4$
  - » Galactic Disk Distribution of "standard candles" P(h) ~ $1/h^3$

Next Steps

- Study ‘detection rate’ figure-of-merit using simple source models, same sine-Gaussians
  - » Determine a different tuning is now optimal
- Move on to more sophisticated studies
  - » Random white noise burst simulation
  - » Distribution of Galactic burst sources (candidates?)
- Pursue statistical tests which utilize distributions in signal strength
  - » Non-parametric (Mann-Whitney)