The advantages of a well-modeled signal

(NS-NS inspiral)

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- template search (matched filtering)
- signal-based vetoes

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Matched filtering - I

Filter, data are vectors,

$$SNR^2 = \frac{\langle \text{Filter} \mid \text{Data} \rangle}{\sqrt{\langle \text{Filter} \mid \text{Filter} \rangle}}$$

max. inner product when parallel

$\Rightarrow$ max. SNR when Filter = Signal

Best you can do

if signal is well-modeled,

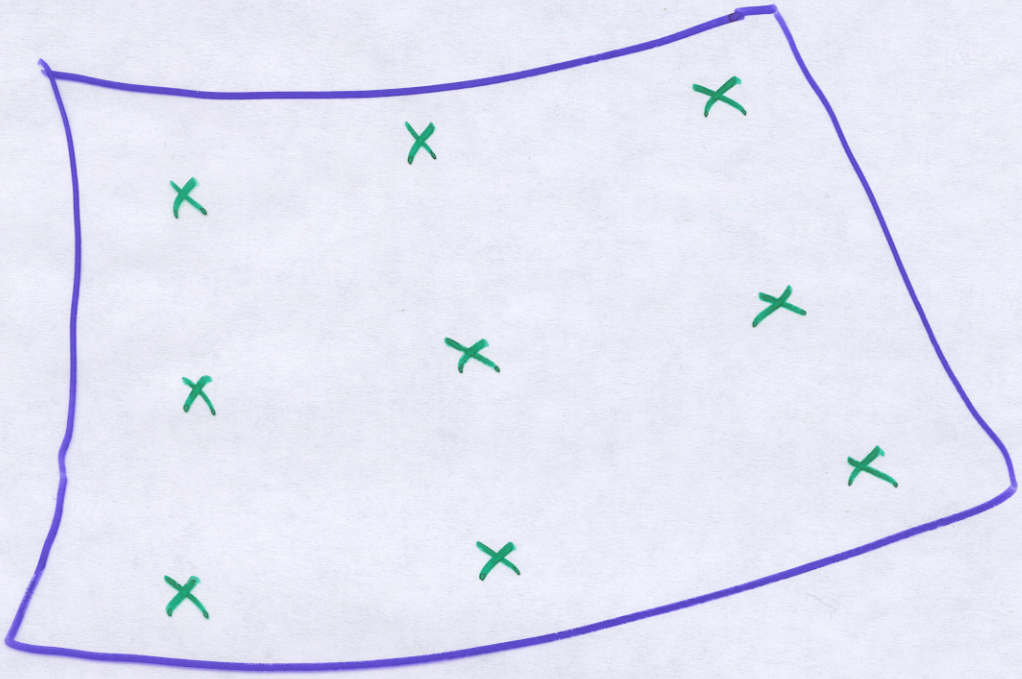
Bad if it's not:

$$\langle a(t) | b(t) \rangle = \int df (\text{stuff}) \cdot \tilde{a}(f) \tilde{b}^*(f)$$

Sensitive to phase information

Matched filtering - II

Search signal parameter space



e.g. with filter grid ...

Looking for SNR above some threshold to avoid spurious "detections"

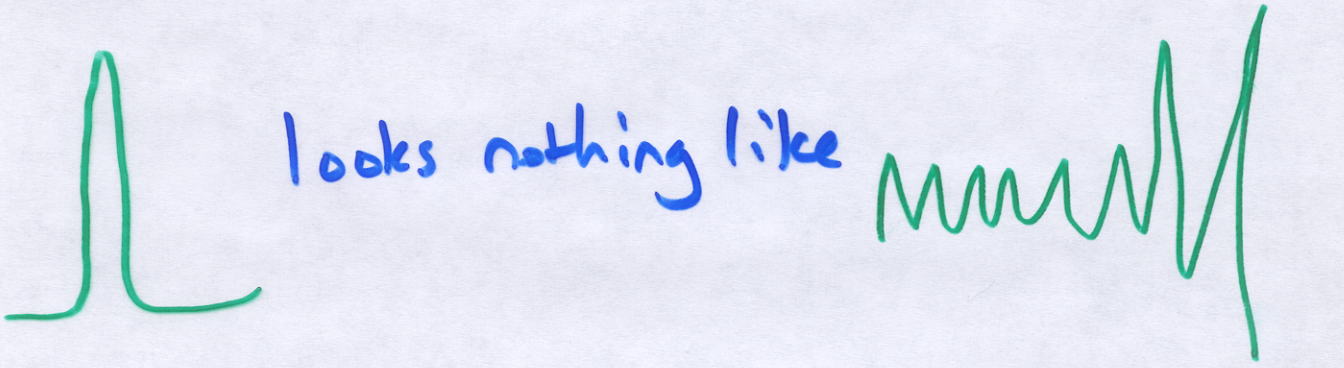
... But SNR is not enough!

Signal-based vetos

Not detector-based (seismometer, etc.)

Real noise has non-Gaussian events

e.g. a hammer blow:



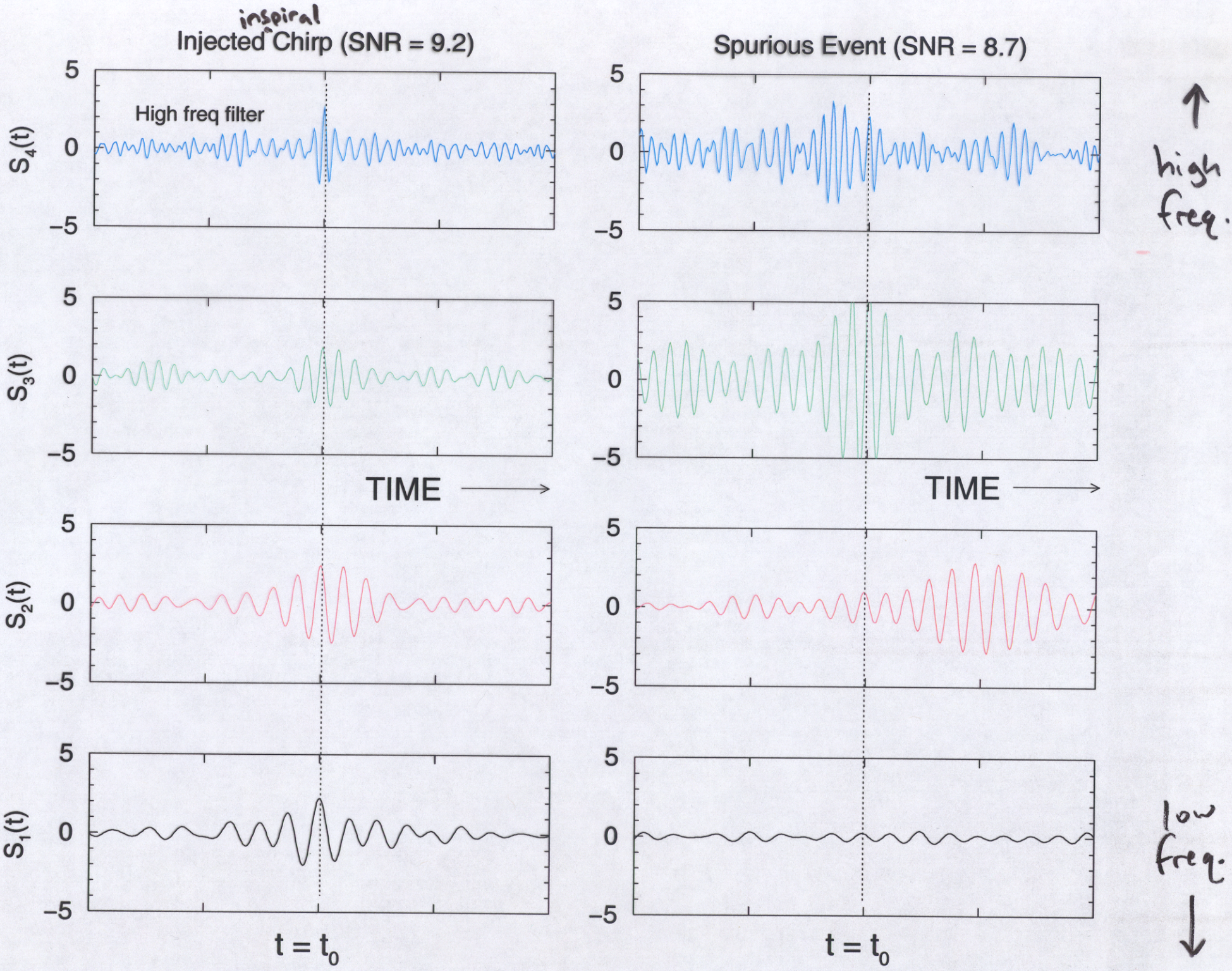
looks nothing like

different phase, nearly orthogonal vectors

but $\langle a|b \rangle$ still large if $\langle a|a \rangle$ is large

Veto using info from signal model

e.g. time & frequency behavior


inspiral
Injected Chirp (SNR = 9.2)
Spurious Event (SNR = 8.7)
High freq filter
$S_4(t)$
$S_3(t)$
$S_2(t)$
$S_1(t)$
5
0
−5
TIME
$t = t_0$
high freq.
low freq.

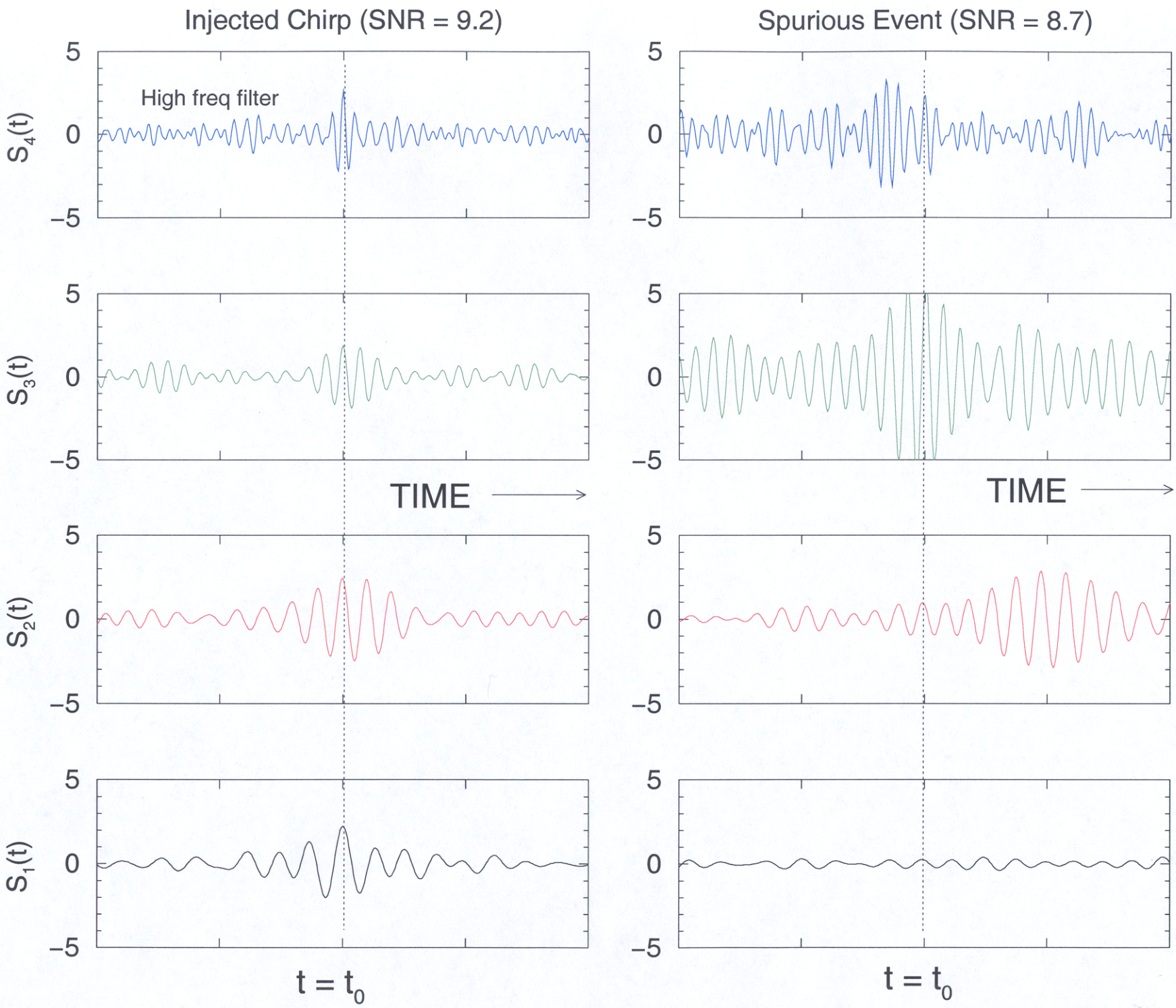
B. Allen's Inspiral Veto:

[B. Allen et al., PRL 1999]

- Cut frequency band into subbands such that signal would equipartition.
- Check that power in bands is consistent with equipartition (modulo some Gaussian noise).

  $\Rightarrow \chi^2$ statistic

- Check that "arrival times" indicated by pieces of filter agree.


Injected Chirp (SNR = 9.2)
Spurious Event (SNR = 8.7)
High freq filter
$S_4(t)$
$S_3(t)$
$S_2(t)$
$S_1(t)$
5
0
−5
TIME
$t = t_0$