An Experimentalists view of requirements II

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1. Resolution

As (probably) discussed by Peter:

- 3 detectors give 3 amplitudes and 2 independent delay times => 5 source parameters (2 angles of direction, h_+, h_x, and orientation of polarisation angle on the sky)

- 4 detectors -> 2 relative time delays to give complete (unambiguous) solution of source parameters

- ~ arcmin resolution will allow identification of the galaxy in which the source is located

- for best resolution an Australian detector MUST (?) be in the network as it provides the maximum baselines to all other detectors (> 35 msec cf next closest 27 msec for Hanford – VIRGO)

- The Australian detector should be the reference detector.

2. False Alarms

- Rate: $P_N = R^N \times \tau_i^{N-1}$ (see for eg, Saulson or Blair)

  where R background rate in one detector;
  τ_i measurement time;
  N number of detectors.
  (assumes rare events are Gaussian distributed without clustering)

- Assume: $R = .1$ (1 every 10 seconds) $\tau_i = 0.01s$

  Require: $P_N < 10^{-8}$
  (one accidental coincidence in 3 years)

  => $N = 4!$
  (bar example from Blair)

- If detectors have different τ must use longest value.

- More stringent if assumptions are invalid.

3. Sky Coverage

- 4 detectors provide 100% sky coverage for 2 way coincidences
  50% sky coverage for 4 way coincidences

- 8 detectors provide 100% sky coverage for 4 way coincidences

(ref: Blair, Det. of GWs)

4. Near or Far: time delay window size?

- Near: - provides best coincidence discrimination using zero time delay
  - as detectors get farther apart, delay window widens => more false alarms
  - space-time overlap required for stochastic searches

- Far: - provides better resolution and smaller error in determination of source parameters for plane wave sources .

- => **optimisation to be done**

- Unpublished work (Bhawal and Dhurandhar) =>
  - 4 detector array must always have an Australian detector
  - 3 detector sub (reference array) optimisation leads to Hanford, VIRGO and AIGO.

5. Orientation?

- Interferometers cannot be parallel due to earth curvature (Hanford and Livingstone are 28 degrees out of plane giving 0.91 overlap function)
- Maximal alignment allow best coincidence discrimination
- But provides no polarisation information
- How should the detectors of a global array be oriented?

6. Degree of similarity?

- Noise floors:
  - drastically different would give independent signatures may be better for signal extraction
  - similar noise floor design would allow easier trouble shooting

- sensitivities:
  - contributions sum in quadrature
    => all detectors in the array must have similar h over some frequency range (not worth computational overhead of including detectors of worse h)
    (LIGO/VIRGO not sure whether to include the 2 km)

    How similar?

7. When should a new detector be added to the network?

- Opposed to increasing the sensitivity of current detectors. –
  - adding GEO600 and AIGO500 to LIGOI/VIRGO may only increase seeing distance by 20%
  - LIGOII increases distance by ~ 10!

- traded off against array resolution and determination of system parameters.

SUMMARY QUESTIONS:

- What would have to be achieved to make it worthwhile to build another full scale detector(s)?

- On the basis of science, where should it (they) be located?

- What are the crucial 'in common' parameters?