

## A “Multiple-interferometer pipelines” document

### Team members

Sukanta Bose, Patrick Brady, Nelson Christensen, Jolien Creighton, Teviet Creighton, Harald Lück, Benoit Mours, David Reitze

## Description of a code for evaluating the coherence statistic

Below we list the functions involved in a code (being written in LAL) that computes the coherence statistic <sup>1</sup> appropriate for searching inspiral events. To keep it simple here, the specific case of a two-detector network is discussed. However, the code being developed can be used to compute the coherence statistic on the data from an arbitrary number of interferometers.

It is assumed that data from multiple IFOs will be merged into single frames for analysis at a single site. This may require a few additions to existing LDAS metadata DB table definitions in order to store event/filter information from more than one detector simultaneously.<sup>2</sup>

Comments, criticisms, and concerns are welcome.

1. Run the **inspiral-search** codes (Templated and/or FCT) on data  $x^1(t)$  and  $x^2(t)$  to draw separate candidate-event lists for detectors 1 and 2, respectively. For this run choose the rho-squared threshold to be as low as permitted by database capacities. However, keep the chi-squared threshold to correspond to a false-dismissal probability of, say, 10%. Save these events (that is, their times of arrival (more appropriately, times of coalescence), rho-square values and matched-filter information) in two separate **sngl\_inspiral** tables in the LDAS event database.

Label the candidate events in detectors 1 and 2 as  $E_i^1 = E(t_i^{a1}; \theta_i^1)$  and  $E_j^2 = E(t_j^{a2}; \theta_j^2)$ , respectively, where  $t_i^{a1}$  denotes the time of arrival of event  $i$  at detector 1, and  $i = 1, 2, \dots, m$ ,  $j = 1, 2, \dots, n$ . Note that  $m \neq n$ , in general. Also,  $\theta_i^1$  denotes the template-parameter vector characterizing event  $i$  at detector 1. The above nomenclature includes the possibility of two or more templates triggering off simultaneously, say, on the data from detector 1. In such a case, one will have more than one event with  $t_{i-1}^{a1} = t_i^{a1} = t_{i+1}^{a1}$ , but with  $\theta_{i-1}^1 \neq \theta_i^1 \neq \theta_{i+1}^1$ . We may order these events in a table according to, say, the increasing value of  $m_1$ ; if two events happen to have the same value of  $m_1$ , then their sequence in the table could be determined by the value of  $m_2$ . Here  $m_1$  and  $m_2$  are the two masses

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<sup>1</sup>See, e.g., the document on coherence statistic posted at <http://www.aei.mpg.de/~bose/> for a definition.

<sup>2</sup>Alternatively, a slightly modified analysis can be performed if the metadataAPI is eventually endowed with the ability to handle data queries from multiple databases as well as to make insertions into them.

that define a 2PN waveform. Thus, each event in a `sngl_inspiral` will carry a unique identification tag.

2. **Execute coincidence-window vetoing:** With every candidate event,  $E_i^1$ , in detector 1, associate a set  $S^2(t_i^{a1}; \tau_c^{12})$  of candidate events in detector 2, such that  $t_i^a - \tau_c^{12} \leq t_j^a \leq t_i^a + \tau_c^{12}$ . Here,  $\tau_c^{12}$  is the light-travel time between the two detectors.

Note that an event  $E_j^2$  may appear in more than one set. That is, it may happen that  $E_j^2 \in S^2(t_i^{a1}; \tau_c^{12}) \cap S^2(t_k^{a1}; \tau_c^{12})$ , where  $i \neq k$ .

3. **“Vetoing” based on coherence-statistic thresholding:** For every  $i$  and  $j$  compute the coherence-statistic for every event pair  $E_i^1$  and  $E_j^2$ , such that  $E_j^2 \in S^2(t_i^{a1}; \tau_c^{12})$ . Reject the pairs with sub-threshold values of this statistic. Insert the event/filter information into LDAS event DB.

The following functions will be used to effect this vetoing:

- from  $\{t_i^{a1}, t_j^{a2}\}$  compute the source-direction angles  $\theta_{ij}^{12}$ . For three or more detectors, this function will compute the remaining source-direction angle,  $\phi$ , as well
- access the components of the helicity-basis vectors,  $(v^+, v^-)$ ,<sup>1</sup> for the above source-direction angle(s), from the “look-up” table corresponding to the chosen network of interferometers
- compute the coherence statistic using the rho-squares (more precisely,  $C_i^1$  and  $C_j^2$  in the reference mentioned in footnote 1) of  $E_i^1$  and  $E_j^2$ , respectively, and the above  $(v^+, v^-)$
- insert event/filter information into LDAS event DB for candidates having a super-threshold value for the (network) coherence statistic.