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Technical Note **LIGO-T00000-0** 2016/08/31

Calibration requirements for CBC parameter estimation in O2

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1 Introduction

In this document we report on the level of calibration the CBC parameter estimation (PE) group requires in O2a, for low-latency and offline calibration.

In O2a the PE group plans to use the same methods used in O1 to marginalize over calibration uncertainties. In particular, for each interferometer in the network a spline with 5 points is used for both amplitude and phase uncertainties. The prior for each of the spline points is *the same*: a gaussian centered at zero with a 1-sigma given by the user from command line or init file. All points use the same prior, hence we don't use a frequency dependent prior.

During O1 the calibration group provided input to the PE group in the form of all-band 1-sigma uncertainties. A phase and an amplitude error were calculated for each IFO by the calibration group, and used to inform our gaussian prior on the spline points.

Update of these numbers were provided at different stages, as increasingly better calibration became available. The C00 calibration is the most rough and the first to be available, essentially in low latency. This is the calibration that most deeply affects our chances of finding an EM counterpart. Later updates, C01 and C02 are used for eventual updates to (3-D) skymaps and to produce the numbers used in the published results.

2 O2 requirements

2.1 Low latency

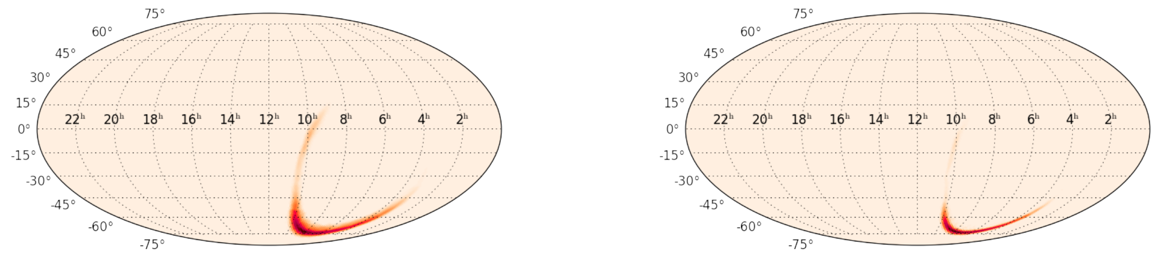
For the low-latency calibration the PE group will be able to deliver meaningful skymaps and parameters' estimates with a *10%* amplitude uncertainty and 5° phase uncertainty. Values larger than those, in particular for the amplitude uncertainties, could hinder our chances of a successful EM counterpart detection.

Obviously, if better calibration can be provided it would decrease the uncertainty in sky localization (see below), however we do not require that for the C00 calibration.

2.2 High latency

Based on our O1 experience, we find that uncertainties of 5% for amplitude and 3 degrees for phase (roughly what we had for C02 frames in O1) are a perfect goal for medium-high latency frames and that any further improvement would only have a negligible impact.

In Fig. 1 we show the skymap for GW150914 obtained with C01 and C02 frames. The 90% sky area goes down by roughly a factor of 3 using the better calibrated C02 frames (from 613 deg2 to 231 deg2). On the other hand, we saw that the C02 results were basically identical to what would have been obtained if one knew exactly the transfer function, this is why we don't request anything better than what reached in O1 (at least for O2a...).



(a) (b)

Figure 1: The skymaps for GW150914 with C01 calibration (left) and C02 calibration (right).

3 Conclusions

The parameter estimation group requires that the same approach used in O1 is followed in O2 to communicate calibration uncertainties. In particular, we require one number for the whole band of interest for CBCs (20-1500Hz), for phase and amplitude errors. For the low-latency frames we require amplitude not worse than 10% and phase not worse than 5 degrees. For sub-sequential updates, we will be happy with amplitude uncertainty of 5% and phase uncertainty of 3 degrees. O1 experience suggests that going below those values might not have any significant impact in the astrophysical conclusions we draw, at least with the methods we will use in O2a.

This is summarized in the table below.

Table 1: Calibration requirements for CBC parameter estimation in O2.

	Low-latency calibration	Final calibration
Amplitude	10%	5%
Phase	5 degs	3 degs

We will produce an update of this document as new methods to marginalize over calibration become mainstream in the next science runs.