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Interactive comment on "Obtaining reliable localizations with Time Reverse Imaging: limits to array design, velocity models and signal-to-noise ratios" *by* Claudia Werner and Erik H. Saenger

Anonymous Referee #1

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The authors present a good exploration on how to use time inverse imaging to reliably localize seismic events. Enormous synthetic tests on limits to array design, velocity model and signal-to-noise ratios (SNR) have been performed and finally a real dataset in California has been utilized to demonstrate the power of array design based on the synthetic tests. These synthetic tests have shown station distributions and SNR of the data play more important roles than velocity model, even though the true velocity model is really complex like having low velocity zone or fault, which are really impressive to me. But there are some issues I listed below when the array design from the synthetic tests is used to the real data. I think this work is suitable for publication in Solid Earth after the major comments below are addressed.

Major comments are as follows.

1. The study has done a lot of synthetic tests mostly using regular arrays expect for the azimuthal gap and the real dataset. For the azimuthal gap tests, the optimal maximum azimuthal gap is 45o for source at 5 km depth, 47o-52o for source at 11.9 km depth, and 45o-48o for source at 22 km depth (Figure 10). This means more regular arrays should be better than relatively asymmetric arrays. Although the authors proposed an optimal 20-receiver regular array for the real dataset, an irregular 31-receiver array is chosen for the final analysis (Figure 14). Moreover, the optimal 20-receiver regular works better for the actual velocity model than an irregular 20-receiver array, but works a little bit worse for the homogenous velocity model such as source 1 at 11.9 km depth (Figure 15). Since the authors claims that using the previous synthetic tests, one can obtain an optimal array design. The real-data case seems like contrary to the authors' claim. Can the authors present an array design works equally or even better than the 31-receiver irregular array? For example, the authors can add three rows more to the bottom of the 20-receiver regular array, forming a 32-receiver regular array. If this works, the 20-receiver irregular array can be discarded. But if not, the authors need to discuss more about it.

2. The authors improve the RTI procedure by Witten and Artman (2011) using illumination map to remove artifacts from velocity models. To make readers directly know how this works, figures for one velocity model in Figure 11 before dividing illumination map, illumination map, and after dividing could be presented.

3. The authors demonstrate the imaging conditions Ie and Ip in Figure 1. But there other two imaging conditions Is and Id used in this study. To display the imaging conditions well to the readers, the other two should be plotted in Figure 1 as well. At least, I am really interested in the images of the other two imaging conditions.

4. To assess the effect of signal-to-noise ratio to localization quality, a set of SNRs have been used in this study. It will be better to add a noise-free results into Figure 13

as a reference for the other results derived from traces with noise.

In addition, here are some minor comments:

Page 2 Line 8, “Conditions” should be “conditions”.

Page 6 Line 25, “position” should be “positions”.

Page 14 Line 4, “Fig.(a)” should be “Fig.14(a)”.

Page 24 caption of Figure 1. “Conditions” should be “conditions”.

Page 25 Figure 2. The width of the source area may need to be labeled such as , where is the wavelength of P wave.

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