# Review of "In-Line Holographic Droplet Imaging: Accelerated Classification with Convolutional Neural Networks and Quantitative Experimental Validation" by Thiede et. al

This manuscript presents CloudTarget, a calibration tool for holographic droplet images, and a CCN-based classification system for distinguishing between particles and artifacts when reconstructing holograms for cloud droplet studies. The authors demonstrate a method they call CloudTarget to quantify droplet detection efficiency, diameter measurement, and position accuracy using a series of chrome photomasks. The methodology is evaluated on several datasets and the performance of the method is evaluated quantitatively. The use of CCN is shown to achieve high accuracy in object classification while enabling faster data processing.

## General Comments

This manuscript is very thorough in the reporting of results and it demonstrates high level of technical rigor. Using quantitative metrics and various datasets, the authors systematically compare the performance of their calibration method, CloudTarget, and the CCN used to classify particles and holograms. The paper is well written and organized, however, it can feel dense at some points. As it stands, the manuscript is detailed enough to serve as a good introduction to a beginner calibration methods for holograms of droplet. However, it may be worth considering trimming some content. Overall, I believe this is a useful manuscript to the scientific community and researchers using in-situ holographic data. Therefore, I recommend publication after minor revisions.

## Specific Comments

1. Another source of optical artifacts comes from beam quality, which is a result of the quality of the light source, optics used to generate the beam, and any optics that may be used to project an image of the holographic field on a camera. The authors state that artifacts may come from dust and water droplets, however, it seems that the data is processed so that there is background subtraction, so I am unsure how these features might produce artifacts. Can the authors please clarify?

2. Related to the previous point, can the authors comment on why case 1 in Table 2 shows only 22 percent features are droplets? Presumably the other detected features are artifacts?

3. Can the authors discuss how hologram quality impacts the fine-tuning of CNN classifier? To the best of my understanding, the CNN needs to be trained for a specific hologram exposure and image quality. For example, if the beam quality or mean hologram exposure changes from one dateset to another, then the CNN

will need to be retrained on a dataset that has similar hologram image quality. Is this true? If this is the case, it would be useful if the authors acknowledge in a direct way that the CNN is highly sensitive to image quality. There is some discussion on this in the manuscript (Section 2.3), but it does not discuss changes in hologram quality.

4. The calibration targets used in the CloudTarget has particles which are deposited on a glass slide. Do the authors think the thickness of the glass slide (and subsequent change in index of refraction and optical path length) change their accuracy to measure droplet location in the $z$ direction?

5. In Section 5.2.2 a discussion on the diameter dependence of the droplet spatial position is discussed. This effect has been previously reported. For example, see https://doi.org/10.1088/1361-6501/ab79c6

6. The authors acknowledge that the small glass beads tend to clump together. How are these regions identified and measured? Are they presumed to be artifacts?

7. As mentioned in the general comments, parts of the paper seem dense. It may be worth considering trimming some content. For example, the Fraunhofer diffraction equations are standard in holography and well-covered in cited references. Another example is the discussion of alternative calibration methods can read more like a part of a review article.

## Technical Comments

1. Line 4: consider rephrasing "... with a customized pattern of opaque circles as a verification tool" to something like "... with a customized pattern of opaque circles, serving as a verification tool"

2. Line 20: fix "on board of an aircrafts"

3. Line 122: remove comma "We discovered, that ..."

4. Line 465: there seems to be a grammar error in "from CloudTarget as a reference"

5. Line 604: grammar error in "... and don not see ..."