Response to the referee's report on PoP: MS #POP28745 – “Numerical modeling of hohlraum radiation conditions…” Cohen, Landen, & MacFarlane

In this document we respond, point-by-point, to the referee’s comments (omitting a few very minor points for which we have implemented the suggested changes).

We appreciate the referee’s thoughtful and thorough suggestions and comments. In general, we have made each of the changes the referee has requested (see the revised manuscript submitted via the AIP/PoP website on 17 June 2005). For some of these suggestions, we respond in this document to the referee and either have not made changes to the manuscript or have partially implemented the referee’s suggestions. We are open to making further changes (including to some of the figures), but would like the referee to first consider our responses here and the changes we have made to the manuscript, and then he or she can let us know whether further changes should, in fact, be made.

Thank you,

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PS Please note that the referee’s comments are reproduced here in Courier font, while our responses are in this (Trebuchet) font.

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     The VISRAD capability for producing color images is very nice.
However, the paper presents far more than are really needed.  Some of
the images are reproduced more than once, which I don't believe is
necessary.  For example, in Fig. 6 the top left appears to be Fig. 1
(bottom) and the bottom left is Fig. 5 (top).  The top left of Fig. 6
appears a third time as the top of Fig. 10, and the top left of Fig. 5
appears a third time in Fig. 21.  It's not difficult for the reader to
flip back to a previous figure to make a comparison.  Many of the
images aren't needed.  The authors don't need to provide these images
for all the cases they model.
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We agree that we can eliminate some of the color images (and a portion of the individual panels from others). However, we feel that the color images, in addition to conveying quantitative information about a given calculation, also allow the reader to much better visualize each configuration/calculation. For this reason, we have a left a few figures that are, arguably, not strictly necessary (e.g. Fig. 22). We will call out some of these changes in our comments below.

I found it very difficult to convince myself visually that the front, Dante-facing LEH is in the top right (see caption to Fig. 1), rather than the open area in the bottom left. The grid forming the lip of the LEH (on the Dante-facing flat end of the cylinder) can partially be discerned on my copy as green lines on a green background. The images could be greatly improved by using thicker lines or a stronger color for the outer circumference of the visible LEH and cylinder end. Throughout the paper, the lip is almost impossible to see.

Agreed. We have added a thick, white ellipse over the inner rim of the LEH lip and also along the outer edge of the lip (where it joins the barrel); at least in most of the relevant images. We think that this makes the lip much more visible, allows the reader to much better determine what parts of the interior of each hohlraum/halfraum are visible to DANTE, and also helps the reader see that the LEH on the right in all of these images is the front LEH.

1. p. 5, bottom. I would like to see some discussion of where the time-dependent albedo comes from. This is a spatially varying quantity, higher on the directly irradiated surface elements. In related view-factor calculations (Phys Plas 7, 2964, 2000) Schnittman performed a 1D diffusion calculation at each point of the hohlraum wall to get the spatially dependent albedo. How does the present treatment compare with this? What exactly is the 1D gold-foil simulation the authors use? If a spatially independent albedo is used, what inaccuracies result from this?

The albedo is mentioned briefly here and discussed a bit more in depth a few paragraphs later, on p.8 of the original submitted version – basically in the same place that the XCE, called out in the next comment, is discussed. We have added some elaboration about the albedo calculation at that, slightly later, location in the manuscript. However, we also would like to address the referee's detailed comments here (we are open to including some of this in the revised manuscript as well; please let us know).

The 1-D simulation was performed with the 1-D Lagrangian code, Helios (Golovkin et al., "Proc. of the Third Intl. Conf. on Inertial Fusion Sciences and Applications," Elsevier (2004)), and modeled two gold slabs facing each other. Laser energy was deposited on one slab (in a 1 ns square pulse), and the x-ray energy produced irradiated the other slab. We monitored the incident energy and the re-emitted energy on this second slab. Their ratio defines the albedo. We adjusted the laser intensity to generate an x-ray profile with a peak temperature of 190 eV. These simulations used a detailed gold opacity model.

Our assumption of a spatially uniform albedo is certainly not as detailed as the diffusion model of Schnittman and Craxton. However, as Schnittman and Craxton show in Fig. 7, the agreement between view factor simulations with and without diffusion is very good in the case of a square pulse, such as we use in our simulations. Furthermore, the agreement between this spatially varying albedo model and uniform albedo model is best at late times, which is the part of the pulse we focus on in our paper.

The albedo values are about 10 % higher in Schnittman, though the overall shape is the same. This is likely because the temperature is higher in Schnittman and Craxton, which is due to a higher XCE in that paper than in our calculations.

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2. p. 8.  The authors could say more about the simple model of x-ray
conversion efficiency.  It probably isn't based on the 1D gold-foil
simulation referred to earlier, as that was driven by x rays, but did
it come from a similar 1D calculation driven by laser radiation?
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We have added two sentences, elaborating on the XCE assumption (it is, indeed, not based on the same hydro calculation we used to determine the albedo). We also have added some text near this location about the albedo calculation itself. Once again, the referee or editor should please let us know if they would like us to put more of the information we list in this document, in response to the previous point, in the manuscript.

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3. p. 8, line 1 of last para.  Clarify whether the radiation
temperature relates to the incident flux on the hohlraum wall or the
emitted flux from the wall.  From the equation at the bottom of p. 9,
it seems that it is incident, but in Fig. 3b it is compared with a
Dante measurement that is based on emitted flux.
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We have elaborated. It is indeed the incident flux (what a package mounted on the midplane wall would see). The point is that DANTE looking through the LEH is thought to give a good estimate of the drive onto a wall-mounted package. The exact correspondence depends on the viewing angle (and other factors. See http://astro.swarthmore.edu/~cohen/projects/hohlraum/resubmitted/LLNL_DantevsTr.ppt for elaboration.

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4. p. 9, last line.  Make sure all algebraic quantities in the equation
are defined.
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Done.

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5. p. 10.  The last two lines of para. 2 ("where the significant" ...
"photons") could be explained clearer.
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Minor changes made. We think it is clearer now.

6. p. 13. The capsule albedo of 0.3 seems large. Is there a reference to an experiment or to a hydrodynamic simulation to justify this?

We have not modified the text, but we refer the referee to Fig. 4 and the associated discussion in Murakami and Meyer-ter-Vehn, Nucl. Fusion, 31, 1315 (1991).

7. p. 13. There is no "upper right-hand" panel in Fig. 5. Also, there is no way one can see from the colored contours of Fig. 6 that the right-hand figures have lower temperatures. Lineouts of emission temperature on the hohlraum surface parallel to the z axis (either at a particular phi or azimuthally averaged) would provide a much more useful comparison.

We have eliminated the two panels originally in the left-hand column of this figure (the “no capsule” images, which are shown in other figures already, as the referee points out).

We have chosen, at this point, not to include any of the line-out plots that the referee suggests. We made a few of them, and have concluded for now that the color images and quantitative spectral plots are sufficient. The somewhat arbitrary choice of which azimuthal value to use in these lineouts is another reason we are not including them in the revised manuscript. If the referee or editor would like to see some of these lineout plots, please let us know. An example of this capability is shown at http://astro.swarthmore.edu/~cohen/projects/hohlraum/resubmitted/example_lineout.jpg, where a color contour plot of temperature on the hohlraum barrel along with two lineouts are shown.

8. p. 17, Fig. 9 caption. The difference between the two spectra is so small that "significantly harder" seems an overstatement. This might possibly be significant in the context that uniform incident radiation temperature on a capsule may not result in uniform drive.

We have changed “significantly” to “modestly” though we point out that the difference is 25% at 2 keV, which could be significant in the context of radiation preheat of a fuel capsule, for example.

9. p. 17, line 2. It is misleading to say that the wall area of a halfraum is about half that of a hohlraum because the halfraum has an extra circular wall at one end. The LEH area is surely exactly half.

Yes. The wording has now been changed.

10. p. 21. The right-hand columns of Fig. 11 and similar figures provide very little information. One such image might be worth including to show the capability of VISRAD, but the others could be replaced with 1D lineouts as suggested in #7 above. (Such lineouts could also include a radial segment from the center of the far wall of the halfraum to its edge.)

We are keeping all eight panels in Fig. 11, not just to show VisRad's capabilities, but to help the reader visualize what this sequence of calculations is, and by extension, what the following few sequences of four calculations look like.

We are eliminating the similar eight panel figures, Figs. 13, 15, 17, and 19, however.

11. p. 22. In Fig. 12 or its caption, make it clear that the laser spot position is relative to the LEH. The same applies to similar figures.

Done.

12. p. 22. The statement, "It is clear ... that the LEH lip" cannot be made until the figures are amended to show the lip clearly. Repetition can be avoided on the last five lines by saying, "To investigate this quantitatively, we have repeated the simulations of Fig. 11 without the LEH lip."

Done.

13. p. 23. There is really no need for Fig. 13 as it looks so similar to Fig. 11. The quantitative results are shown very well in Fig. 14.

We have eliminated it.

14. p. 24, line 3. Clarify that "Here" means the case of no lip. Check the following sentence, "As the beams are pointed further in, the DANTE view factor of hot spots increases." It's not clear why this should be true, and looking at Fig. 13 (or just obliquely into a coffee mug) suggests that it isn't true.

The referee is correct. The real cause appears to be greater LEH losses in the case of no LEH lip when the beam pointing is shallow.

15. p. 32. Fig. 21 could be omitted. A comparison of temperature contours with and without shields shows no observable difference in the color plots, and there is some duplication with respect to Fig. 5. It would be much more informative to produce 1D lineouts as suggested earlier.

16. p. 33. The color maps of Fig. 22 aren't needed to show the rather obvious result that the halfraum is hotter when extra laser beams heat the foil. Fig. 23 does this much better.

In response to these last two comments, we would like to keep these two figures (and have, in the resubmitted version of the manuscript) because they help the reader visualize the geometry of these simulations. Specifically, in the first one, the fact that DANTE sees the (cold) back of the shield is easy to see from the figure, and in the second one, the figure enables the reader to see how the beams can, in fact, be successfully put onto the external foil.