DANTE Modeling in *VisRad*

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We are modeling OMEGA experiments in *VisRad*, using known beam powers, pointings, halfraum properties, etc. The XCE is a free parameter, which will ideally be constrained using DANTE data. DANTE (once unfolded) provides a radiation temperature, which our simulations attempt to match (and once this is accomplished, we can use the drive spectrum incident on the witness plate as input to *Bucky*). We are currently also exploring the issue of witness plate T_{R} vs. DANTE T_{R}, which Livermore assumes to be more or less the same for halfraums on the P6-P7 axis. We are exploring this systematically, and will report the results in a separate document.

At this point, we simply want to standardize and document our procedure for comparing calculated DANTE radiation temperatures within *VisRad* to those recorded by DANTE itself. In the DANTE unfold process, various corrections are made to convert ten-band fluxes to a single (blackbody equivalent) radiation temperature. My understanding is that this T_{R} is that which is emergent from the LEH (but with the perspective of a detector at infinity).

In our *VisRad* simulations we have a surface at the position of DANTE but closer to the center of the target chamber (100 cm from the center). *VisRad* will calculate the T_{R} on that surface, and then we need to make a (multiplicative) correction to arrive at a "DANTE temperature" that can be compared directly to the DANTE data.

The basic numbers are the following (we do not need to use all of these numbers to calculate our conversion factor, but they are included here for completeness):

- LEH diameter = 1200 μm (for our OMEGA shots; we're using 1600 for the numerical experiments described above)
- θ_{DANTE}, the DANTE angle = 37.4 deg (with the halfraum on the P6-P7 axis)
- effective distance of the actual DANTE = 441.5 cm
- effective area of DANTE = 1.379 cm^2

Joe had originally calculated the conversion factor to go from the *VisRad* radiation temperature on the surface 100 cm from the halfraum to a DANTE radiation temperature. I include my own derivation below (which gave the same answer that Joe got for our standard 1200 micron LEH).

So, my assumption is that what *VisRad* calls the radiation temperature on our DANTE surface is defined as:

$$\sigma T_R^4 = F \equiv \int_{\Delta\Omega} I \cos\theta \, d\Omega \approx I \Delta\Omega$$

Now, the specific intensity, I, can be related to the emergent, or surface, flux coming out the LEH, and thus to the temperature at the LEH. In an analogy to astrophysics, I will call this LEH temperature the effective temperature, $T_{\rm eff}$. This implies that it is a blackbody equivalent temperature that satisfies:

$$\sigma T_{eff}^4 \equiv F_{surf} = \pi I \ .$$

Note that this assumes a spatially uniform I over the LEH. And the last equality comes from integrating the specific intensity over a hemisphere (at the LEH plane):

$$\begin{aligned} F_{surf} &= \int_0^{2\pi} d\phi \int_0^{\pi/2} I \cos\theta \sin\theta \, d\theta \\ F_{surf} &= 2\pi \int_0^1 I \mu \, d\mu \\ F_{surf} &= \pi I \end{aligned}$$

What I'm calling $T_{\rm eff}$ is the "DANTE temperature" quoted by Livermore (Bob Turner), while the quantity $T_{\rm R}$ in the first equation is what's given by *VisRad*. Since specific intensity is constant along a ray, we can equate I in the two equations to get:

$$\frac{T_{eff}}{T_R} = \left(\frac{\pi}{\Delta\Omega} \right)^{.25},$$

where the denominator is the solid angle of the source (the LEH) as seen from the detector.

For our standard 1200 μm LEH diameter viewed at an angle of 37.4 degrees, this gives:

$$\Delta\Omega = 8.98X10^{-7}\, ster$$

$$\frac{T_{eff}}{T_R} = 43.25$$

and for the 1600 mm LEH diameter (no LEH lip; used for exploration of beam pointing effects on witness plate temperature vs. DANTE temperature), we have:

$$\Delta\Omega = 1.596X10^{-6}\, ster$$

$$\frac{T_{eff}}{T_R} = 37.46$$

VisRad also gives us a spectrum (flux vs. wavelength) on the DANTE surface. In order to compare that flux to the spectrum incident on the witness plate (also calculated by *VisRad*), we make a similar correction:

$$F_{surf} = \pi I$$

$$F_{DANTE} \approx I \Delta\Omega$$

$$F_{surf} \approx F_{DANTE} \left(\frac{\pi}{\Delta\Omega} \right)$$

where the quantity F_{surf} is what we want to compare to the witness plate flux.