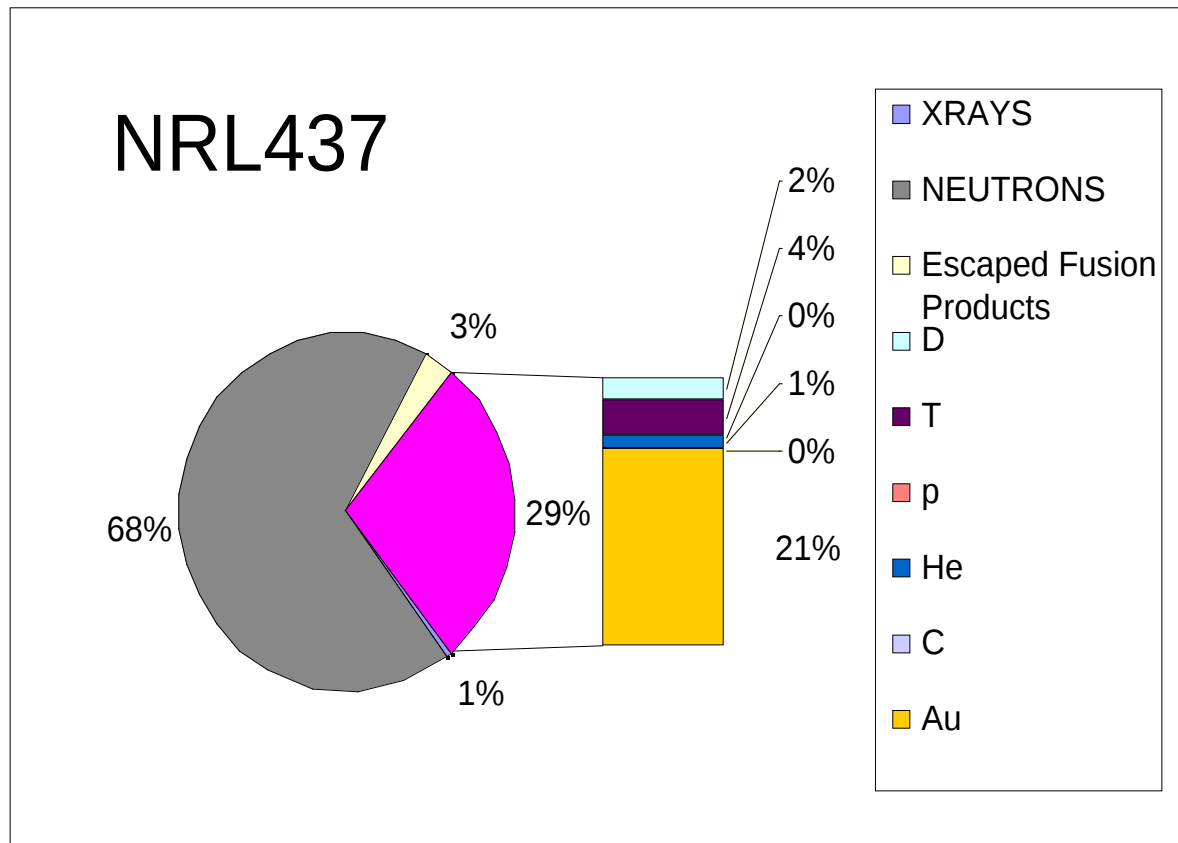


First Wall Response to the 400MJ NRL Target



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Fusion Technology Institute
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Summary/Outline

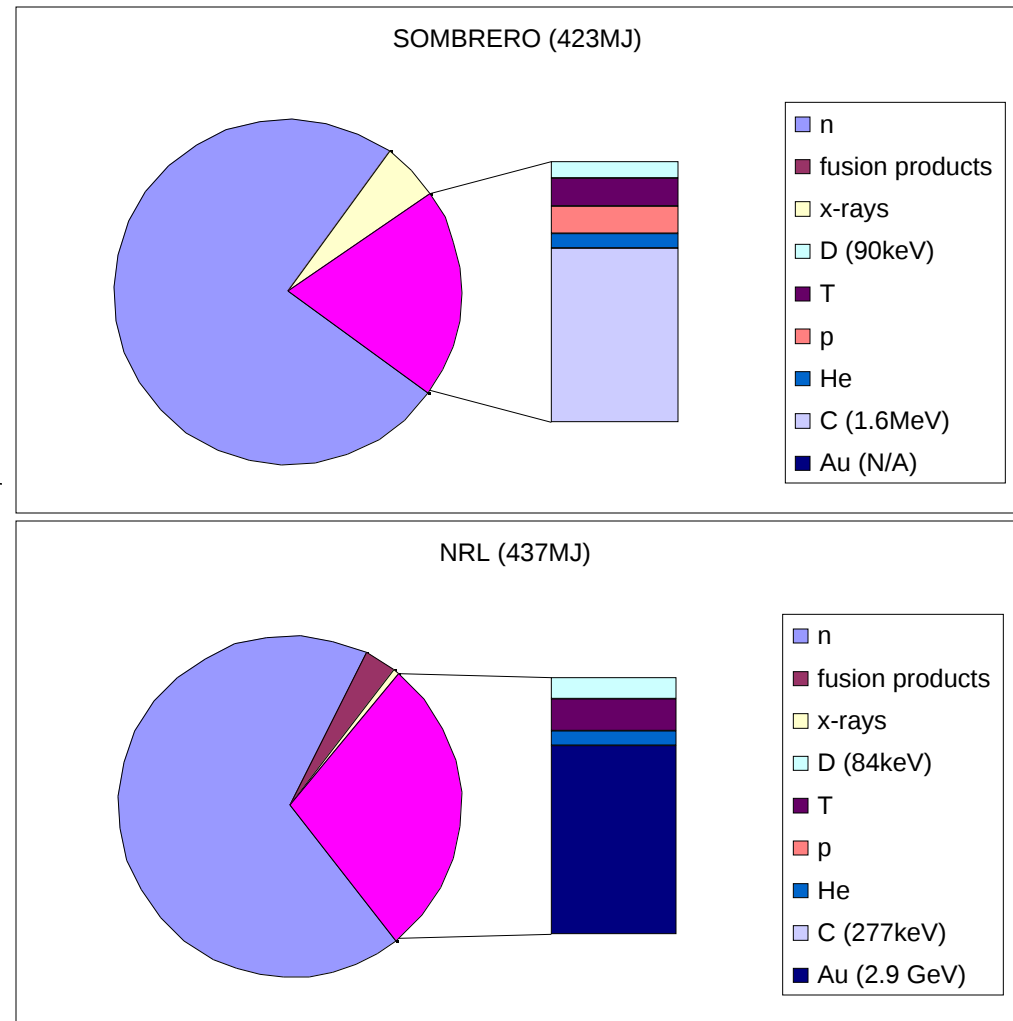


The remarkable differences between the ~400MJ NRL and SOMBRERO targets lead to marked difference in first wall survival. The BUCKY 1D target output calculation for the 437MJ NRL target indicates a large fraction of non-neutronic yield in high energy, highly penetrating ions and x-rays, resulting in less threat to the first wall, requiring less buffer gas than SOMBRERO.

- Comparison of threat spectra from SOMBRERO and NRL400
- First wall survival
- Future work

Though the total yields of the SOMBRERO and high yield NRL targets are similar, the partitioning and spectra of the non-neutronic output differ significantly.

•73% of the 127MJ of NRL target ion output is Au, averaging 2.9GeV, and does not pose a threat to the wall surface (though what its accumulation in the wall will do to the wall over time may need to be considered).



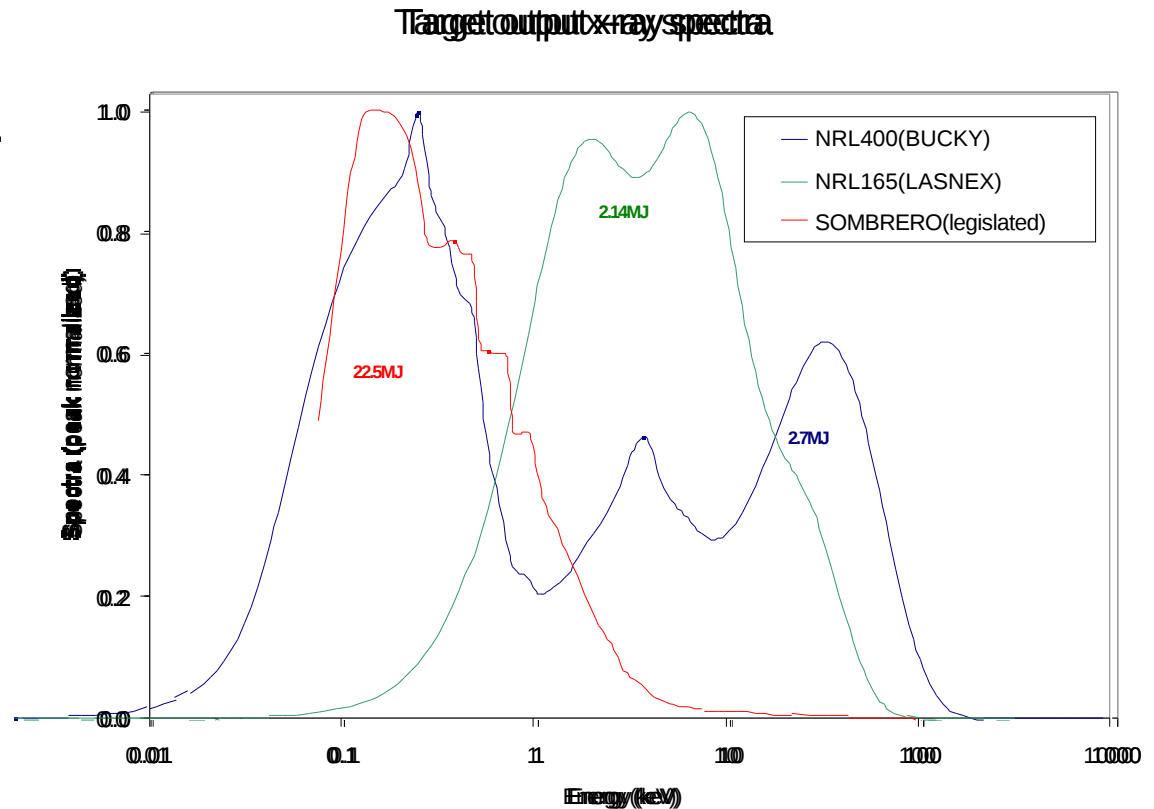
X-ray Spectra

- The x-ray spectrum of the NRL400 MJ target is markedly harder than that of the SOMBRERO spectra.

- Not only is there only 1/10th the total x-ray energy, but those x-rays deeply penetrate and volumetrically heat (or simply ignore) the armor.

- In fact, the x-ray spectrum from the 400MJ NRL target more closely resembles that of the 165MJ NRL target.

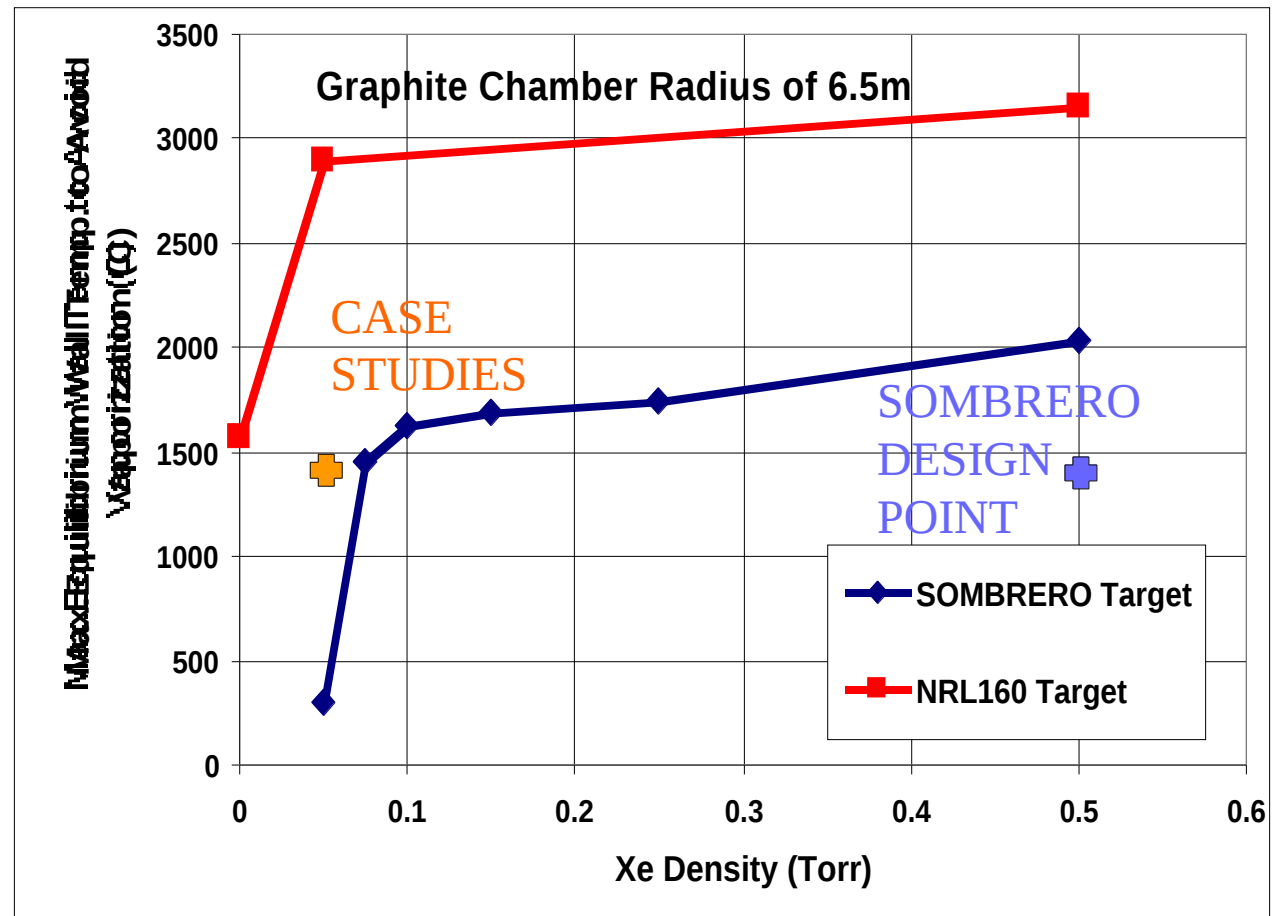
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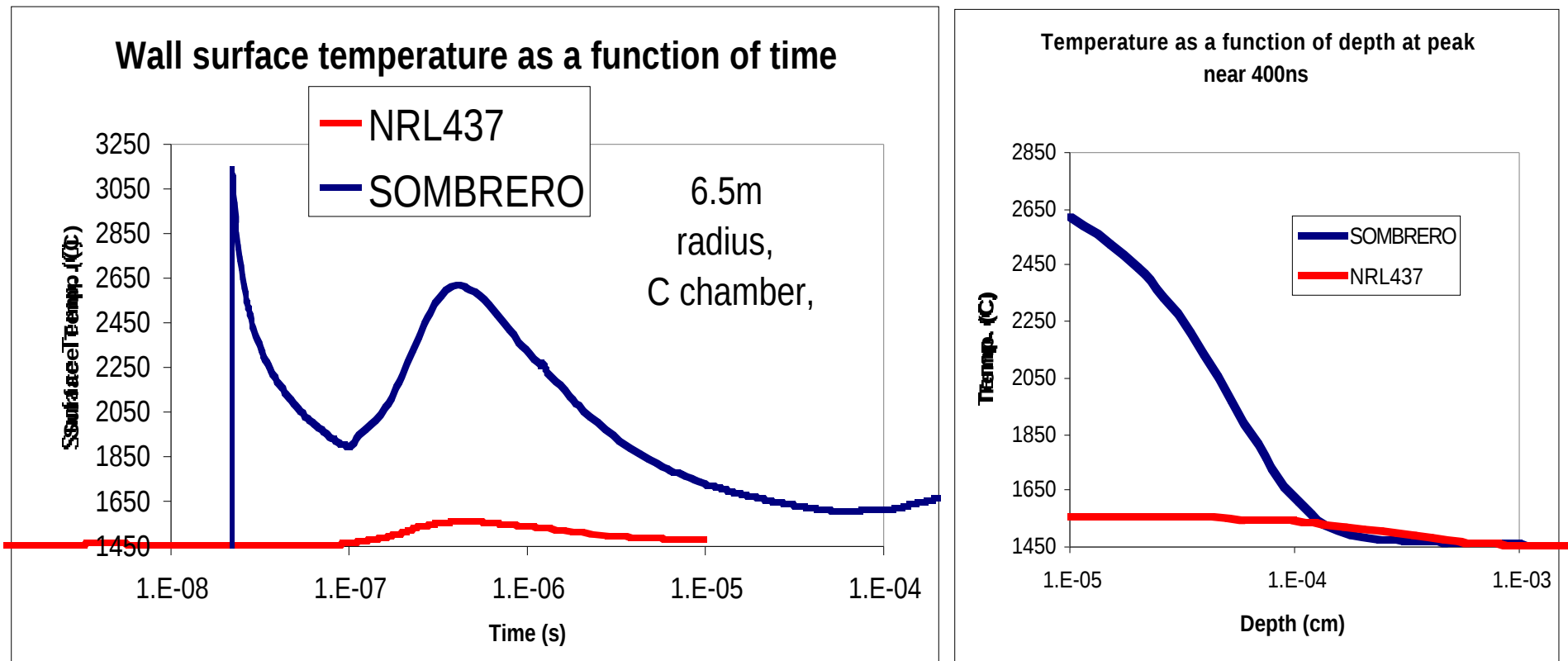
Indeed, if we discount the deeply penetrating Au and He, both the ionic and x-ray output much more closely resemble the NRL165 output than SOMBRERO for the purposes of first wall survival.

An old slide waved for context. As part of ARIES-IFE we exercised BUCKY to study the Xe density required to prevent first wall vaporization for a 6.5m C chamber.

- The gas density and equilibrium wall temperature have been varied to find the highest wall temperature that avoids vaporization at a given gas density.
- Vaporization is defined as more than one mono-layer of mass loss from the surface per shot.
- The use of Xe gas to absorb and re-emit target energy increases the allowable wall temperature substantially.

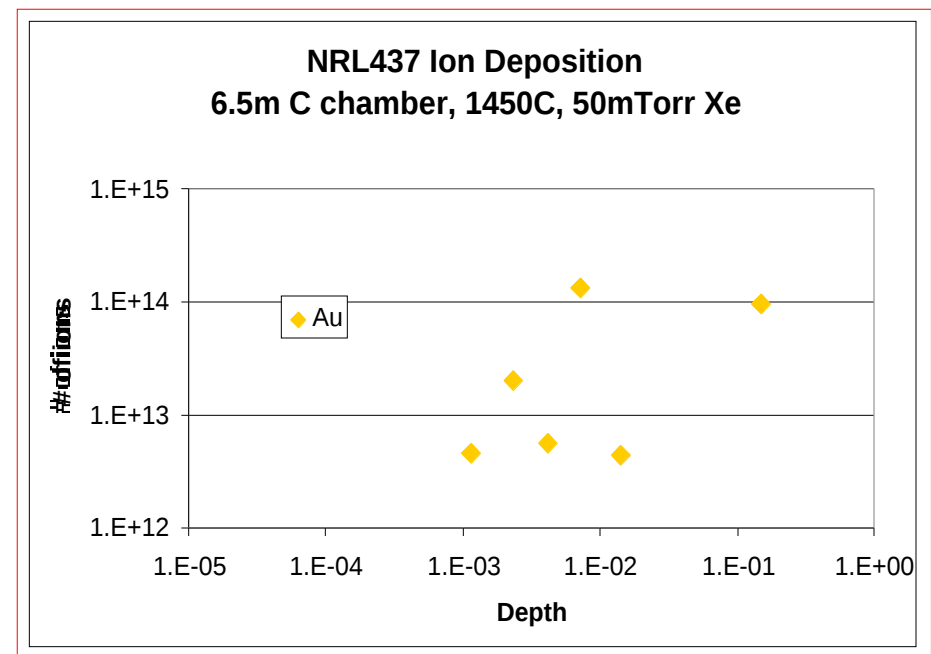
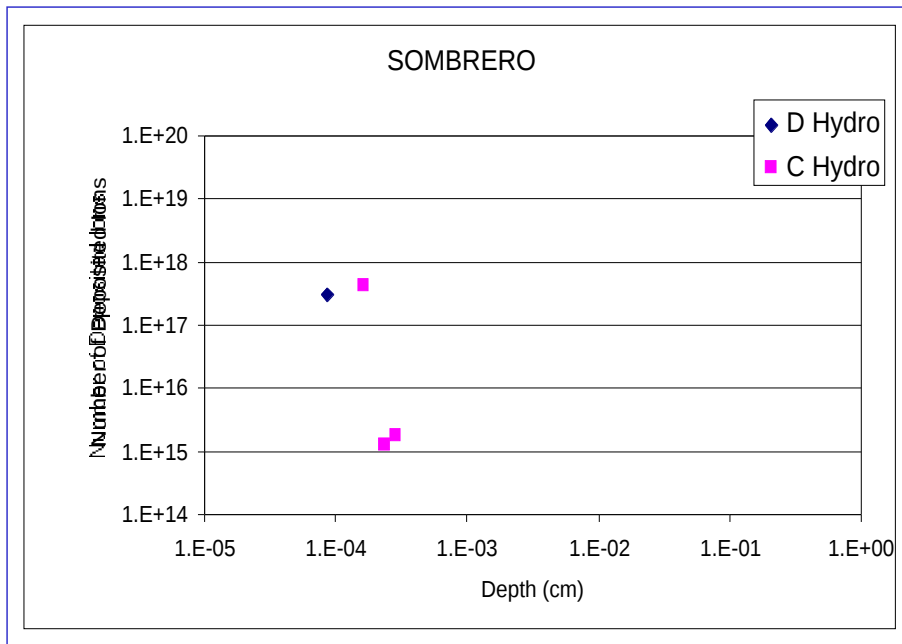


The SOMBRERO target caused over 6 grams of C to vaporize each shot at the case study point, whereas the NRL437 target does not vaporize the wall.

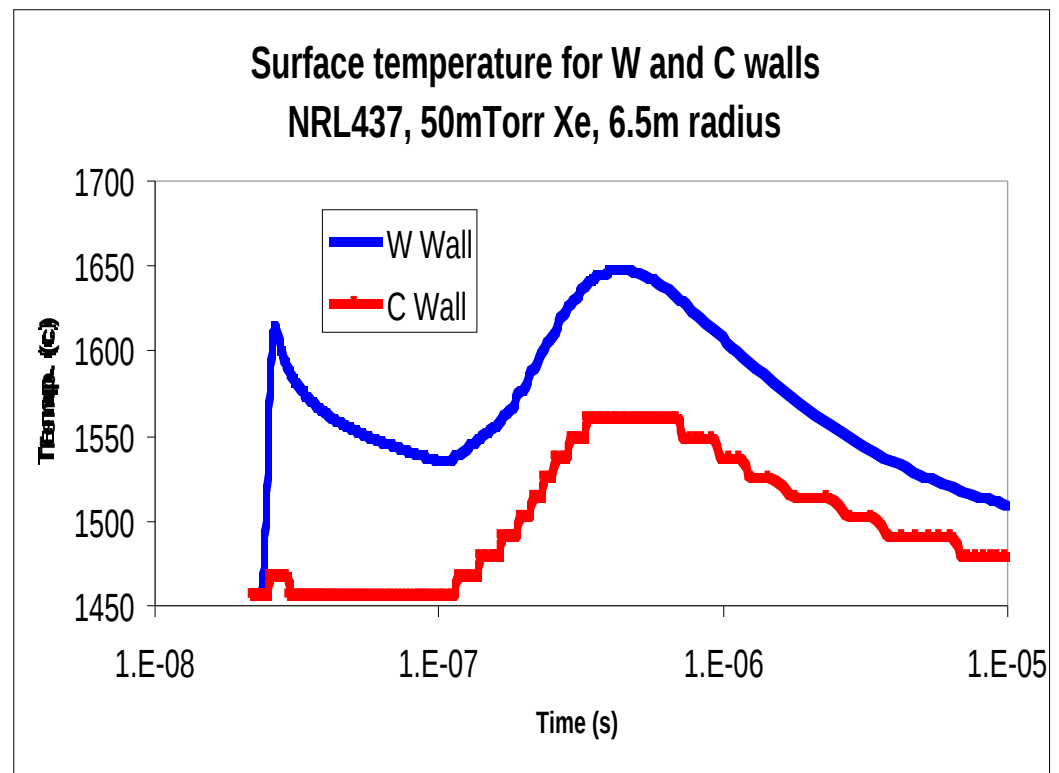
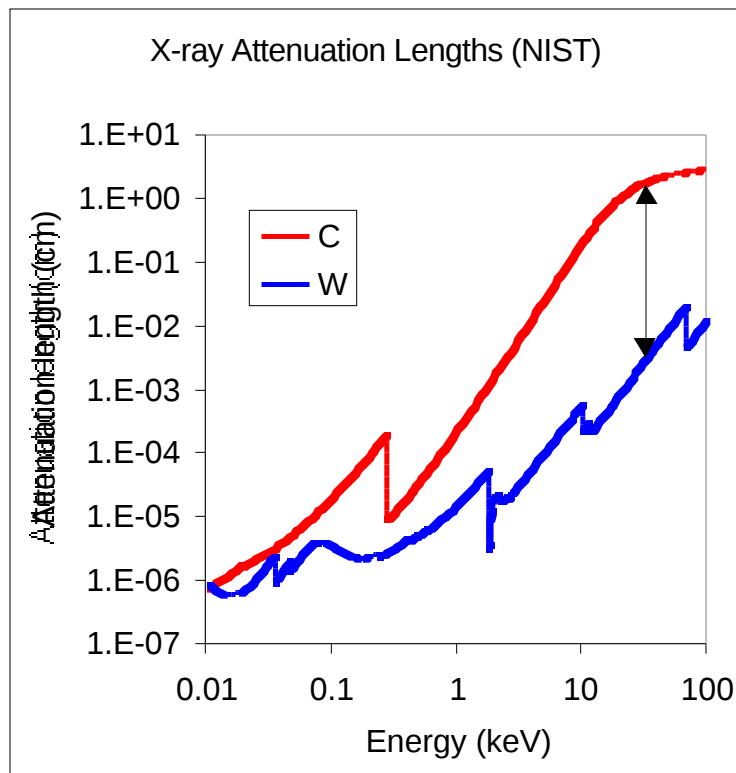


Not only is there less heating, but that heating which does occur is more volumetric.

The Au ions in the NRL target deposit deep in the wall, while the C does not reach it. For SOMBRERO, the C penetrated to a depth of 1 micron.



Though the x-ray deposition length in W is considerably shorter than that of C, it is still long enough that a W wall survives at a low Xe pressure, as it did for the 160MJ NRL target case.



Conclusion and future work

- Based on the target output calculations presented earlier, the remarkable differences between the ~400MJ NRL and SOMBRERO targets lead to marked difference in first wall survival.
- The output calculation 437MJ NRL shows a large fraction of non-neutronic yield in high energy, highly penetrating ions and x-rays, resulting in less threat to the first wall, requiring substantially less buffer gas than SOMBRERO
- E.g., for this target output and a 6.5m C/C chamber, practically no (= at most 5 microtorr of) Xe is required to protect the first wall for a starting temperature of 1450C.

- Future work:

- minimum pressure for a W armored chamber
- Study a non-legislated thick shell target, similar to SOMBRERO (possibly attractive due to target heating or fabrication issues).
- Smallest chamber for “low pressure” operation.
- $[v/c] > 0.1$ for Au ions, on average. Need to work on BUCKY’s modeling of fast ions, and extremely low pressure simulations.