Status of HAPL Tasks 1 & 3 for University of Wisconsin

Gregory Moses

Milad Fatenejad

Fusion Technology Institute

High Average Power Laser Meeting

September 24-25, 2003

Madison, WI

THE UNIVERSITY of WISCONSIN MADISON

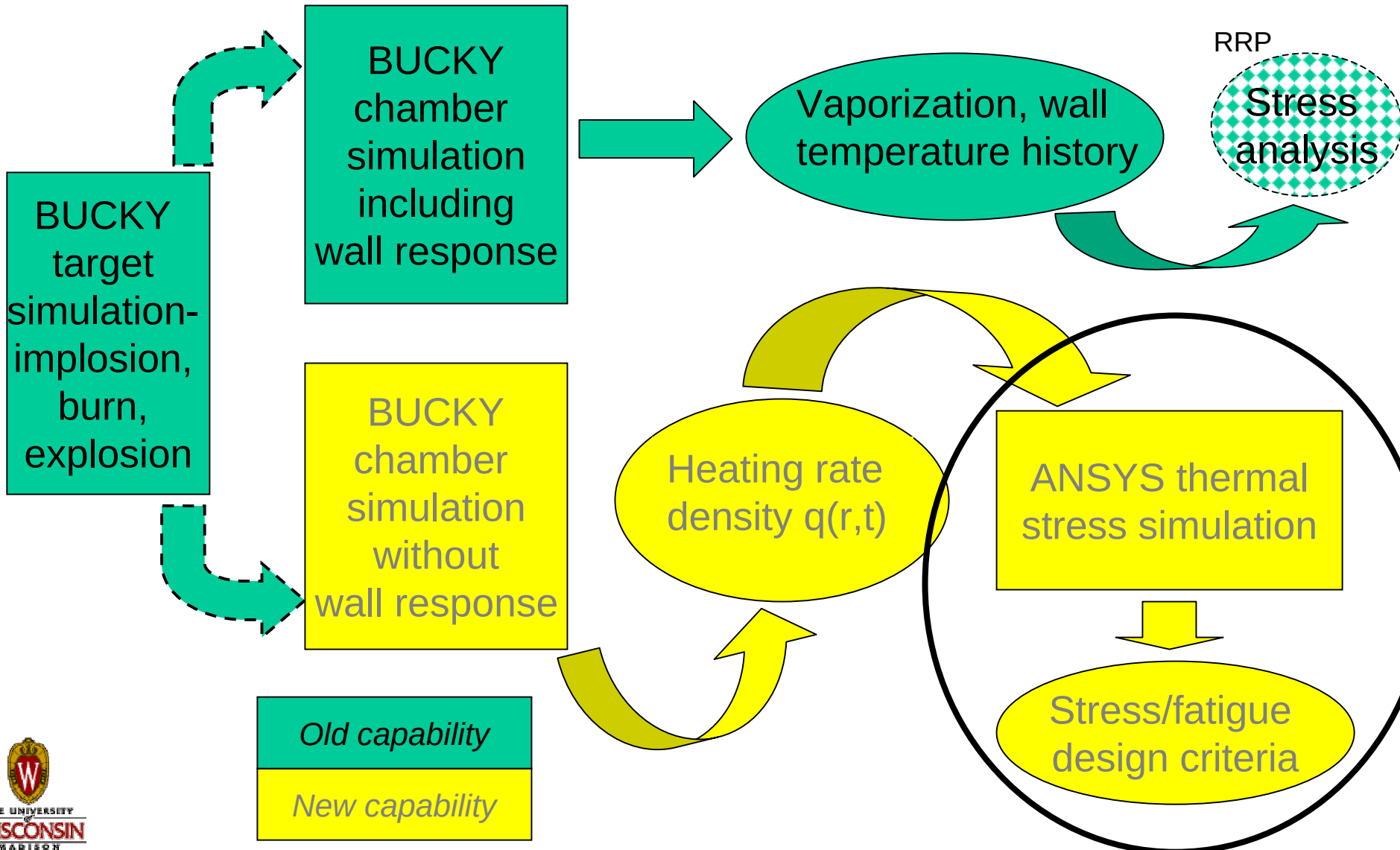
Numbers

01001010110101111000101010101010100101011010010
10001010100101001010101010101010010100100000100
11001100010010010000011111010001001001010010101
01000100101010101000100001011101010010100100010
11011001010001010101001010001010100100111010010
11001001010010001010100101011101001001010010101
10010101010101000101010101101010010101010010100
11001001010101010101010110010100101001011100101
00011001100110101011001100101010101010010101010
10010010010101011010001010011110101010100101001
00010010101101011011001010010100101010101001010
10010000100010101010100010101111010101010010101

Outline

- BUCKY-ANSYS coupling (Task 3)
  - Task 3—couple BUCKY output to ANSYS input so that a large number of cases can be examined in a short time using CONDOR
- Modeling target ion threat spectrum for chamber response studies (Task 1)
  - Task 1—simulate target output spectra with BUCKY and improve underlying models to more reliably compute threat spectra
    - Energy spectrum
    - Time of arrival

Task 3 -- Stress Analysis

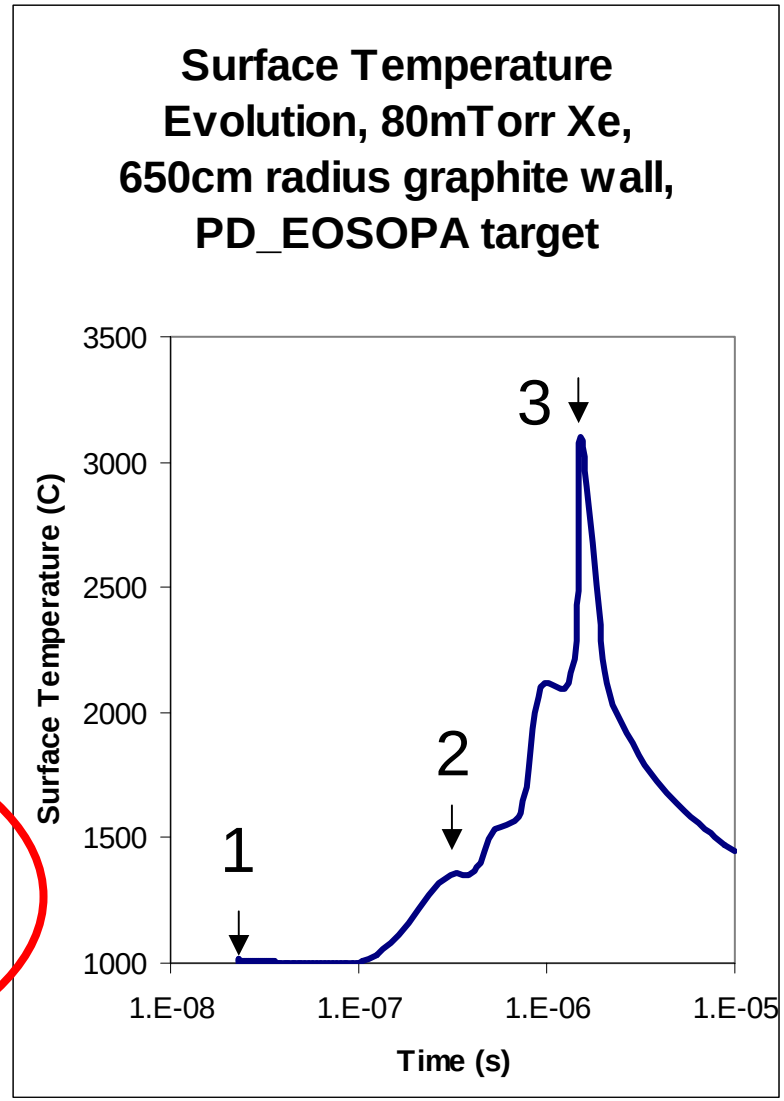


Task 1 -- Modeling target ion threat spectrum

- Historical reminder of Carbon wall analysis
  - HAPL Meeting December 2002
  - HAPL Meeting April 2003

BUCKY simulations of chamber response allow the prediction of first wall surface temperature evolution.

- Roughly speaking, there are three peaks in the first wall temperature:
  1) A response to the prompt, unattenuated x-rays hitting the wall (heating it practically volumetrically, in the case of a graphite first wall).
  2) Response to soft xrays re-radiated after the Xe slows and captures the least penetrating ions.
  3) Bursts of temperature rise as the unstopped ions strike the wall. This effect is somewhat exaggerated in these simulations due to the coarse binning of the ion spectum.

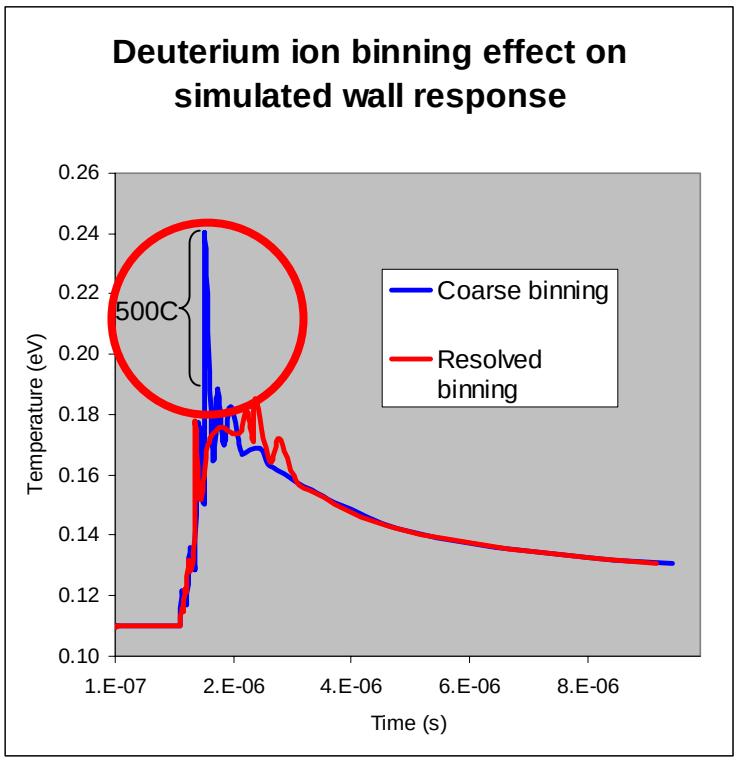


D. Haynes, HAPL Dec 2002

THE UNIVERSITY of WISCONSIN MADISON

Ion binning: For compatibility with earlier studies, ion spectra were divided into 15 energy bins. This led to an overestimate in the temperature rise due to ions.

- Increasing the detail in the reproduction until the wall response converges indicates that this led to an conservative definition of the operating window.



Though brief, the spurious temperature excursions can lead to unphysical mass loss or melting.

However:

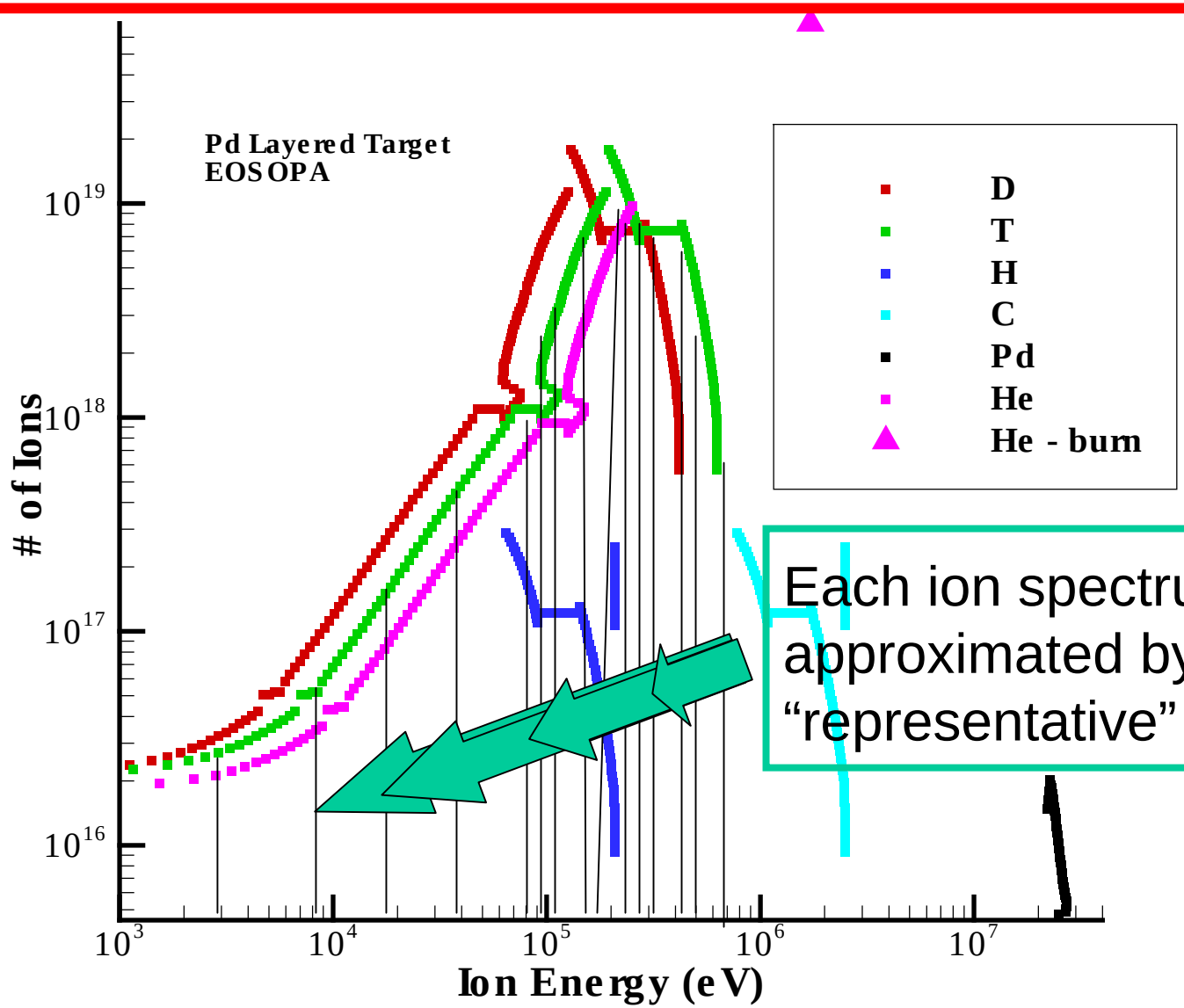
D. Haynes, HAPL Apr 2003

THE UNIVERSITY of WISCONSIN MADISON

Conclusions

- Two approximations in previously reported BUCKY/CONDOR studies were examined:
  - Looking only at shot 1 underestimated the starting temperature of the armor surface; and,
  - Coarse binning of ion spectrum overestimated mass loss.
  - These two approximations compensated for each other, at least for the carbon wall case considered.
  - Thus, operating windows previously reported for C walls are still in force through serendipity.
- Yield was added as a dimension in the space of chamber design parameters.
- A single figure of merit for ion deposition effects needs to be carefully applied, as differences in spectrum change temperatures and gradients within the wall.

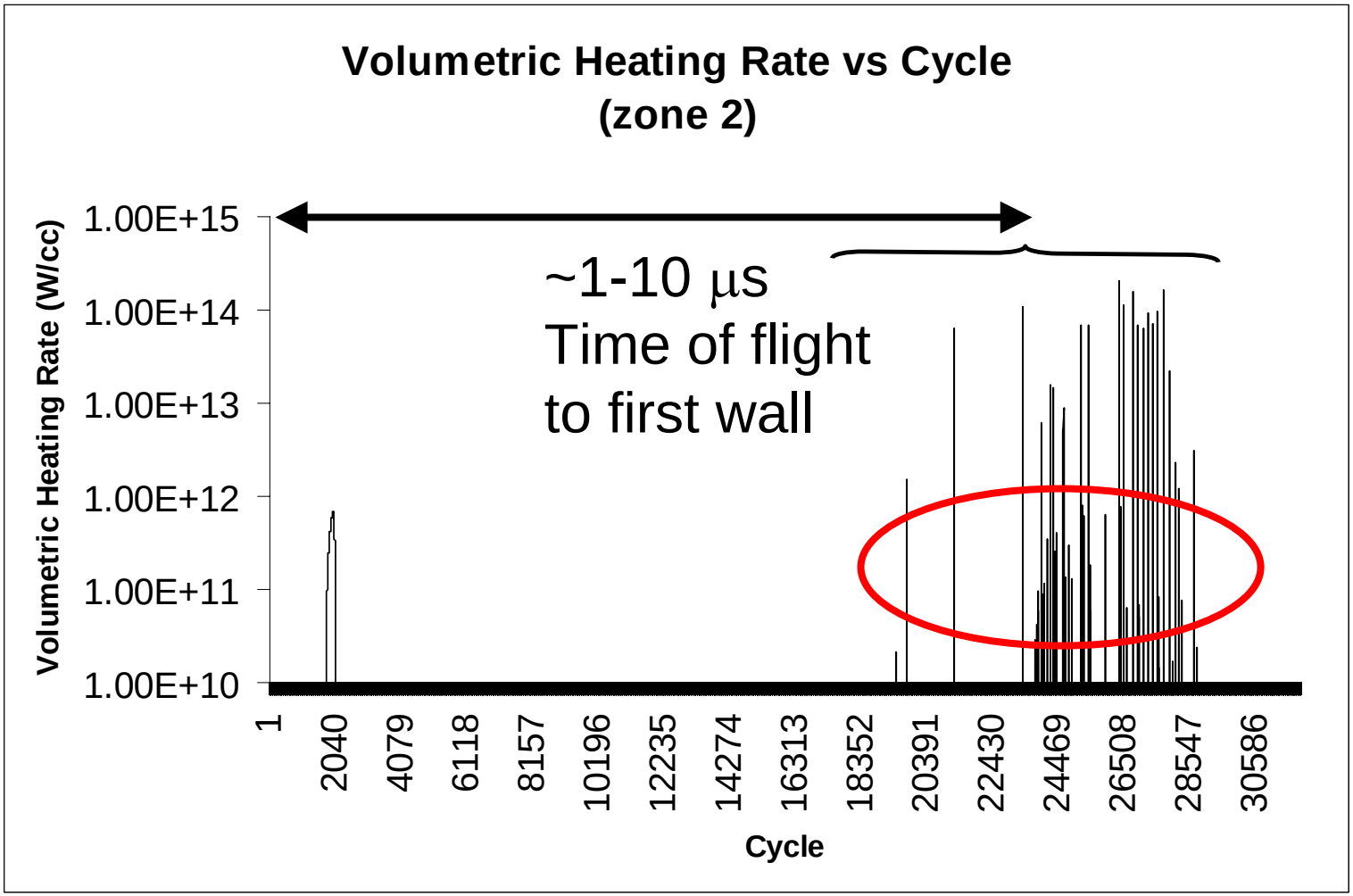
Ion Debris Spectra



Each ion spectrum approximated by 15 “representative” energies

THE UNIVERSITY of WISCONSIN MADISON

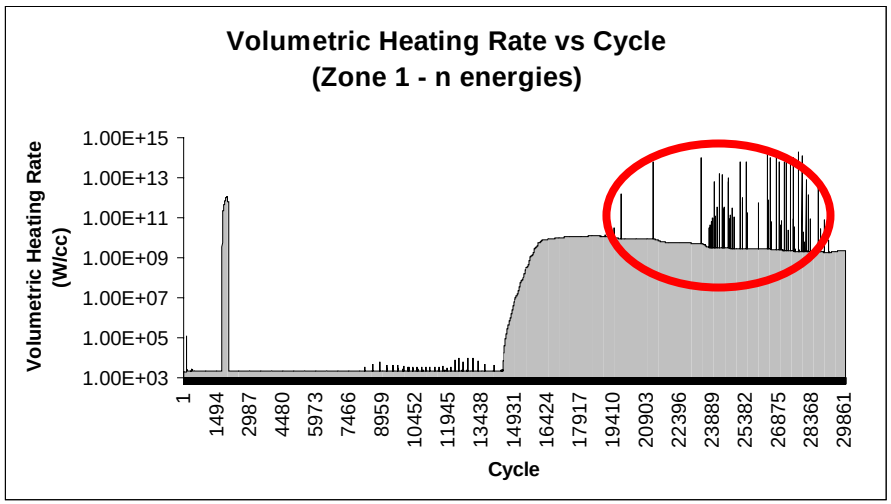
Ion heating source is not temporally resolved



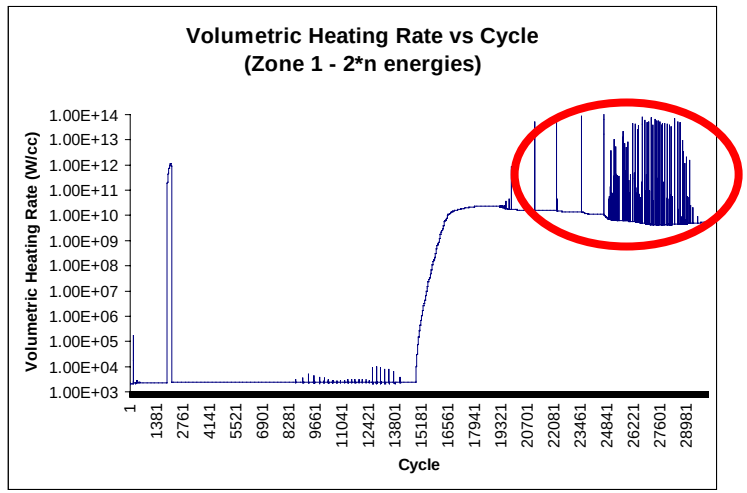
THE UNIVERSITY of WISCONSIN MADISON

Increase “resolution” of spectrum

15 representative ions



30 representative ions



Future plans

- We are now capable of doing large parameter sweeps involving complex lengthy calculations. Hands-off analysis.
- We must focus on correctly doing the right calculations.
- Need better characterization of x-ray and ion spectra for all ions and relevant target designs. (Target threat group?).