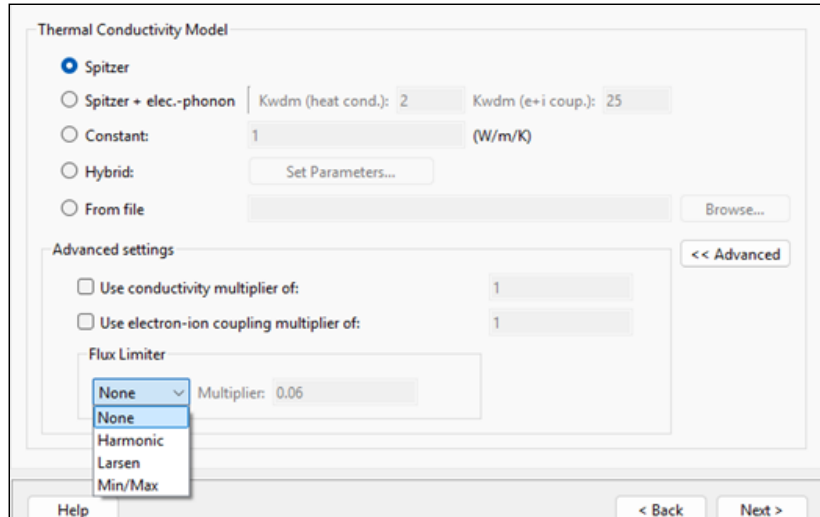




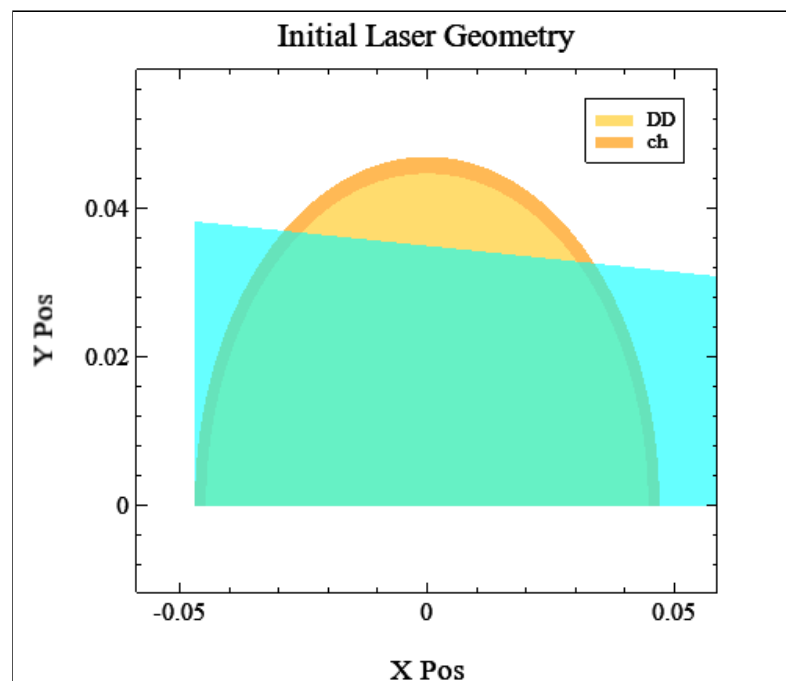
HELIOS USER'S GUIDE

Revisions for HELIOS: version 12.0.0

- The option to write *HELIOS* workspaces with the older non-JSON format has been removed. Previously created non-JSON workspaces can still be read in.
- Electron-Ion Coulomb logarithm update using Skupsky's formula for degenerate plasmas.
- Added new option for thermal conductivity (Spitzer + electron-phonon component)
- In addition to *Harmonic* flux limiter, options for *Larsen* and *Min/Max* have been implemented.

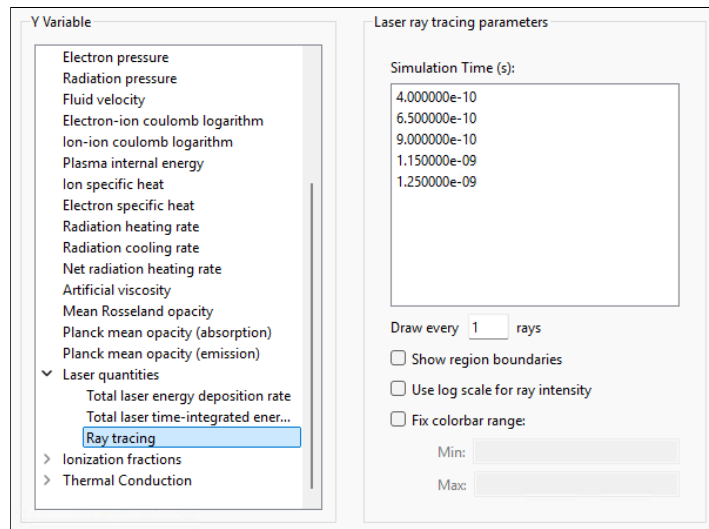


- The electron-ion and ion-ion Coulomb logarithm is now saved to the plot file for each cell and time.
- *Laser Beam Source*: A list of laser beams is now used:
 - The number of laser beams supported has been increased from 3 to 100. This has been done to support time-dependent focusing and beam profiles.
 - Beams can be added, deleted, and duplicated in the list. Beam names can now be specified, and are utilized in *HydroPLOT*.
- The initial laser geometry, for spherical and cylindrical geometry, can now be viewed with the *Show geometry* button on the *Lasers* setup page.



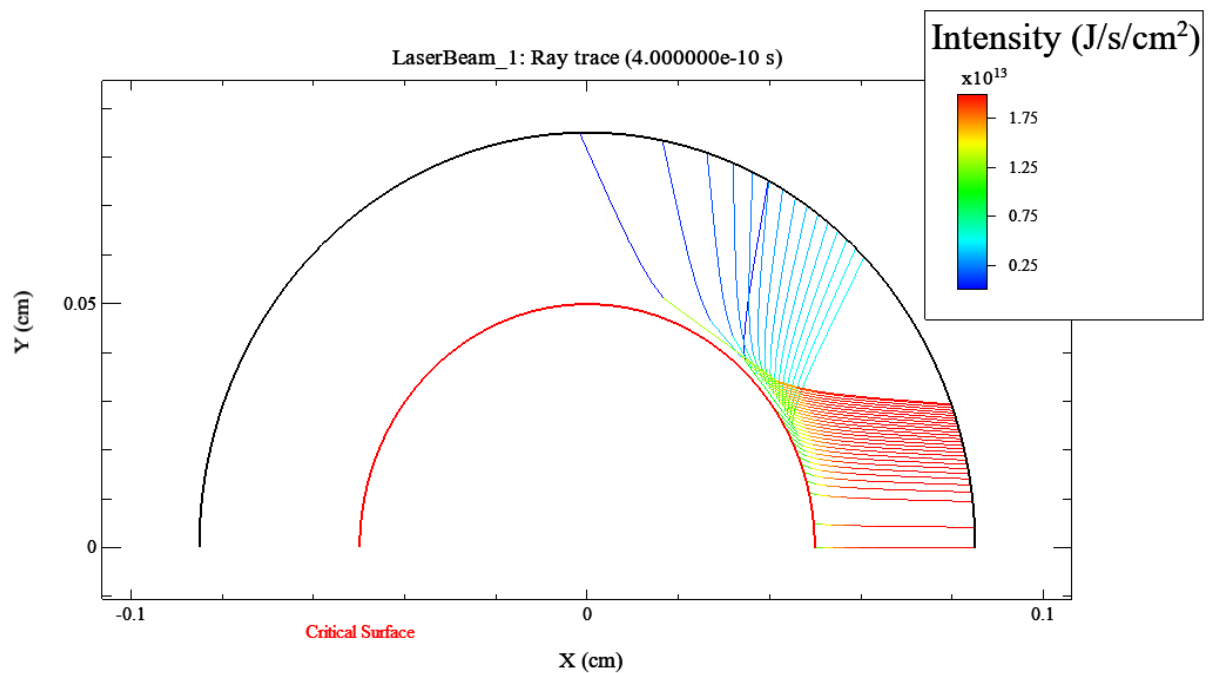
- Laser ray trace plots are now supported, for spherical geometry only. In order to view them in *HydroPLOT*, the *Laser ray-trace data* checkbox must be checked in the *Output* setup page. Output is written to the plot file for all laser beams which have a non-zero power at that simulation time.

- Parallel particle transport improvement with better CPU utilization.
- For 1-T simulations, the conductivity is defined as a sum of electron and ion conductivities, not just electron conductivity. The electron component now includes flux limiter, if specified.
- Specifying *Data Directories* in *Preferences* has been updated. Using environment variables on Windows to obtain default locations for atomic data, and equation of state, and opacity libraries has been removed. Users set the location of the data libraries by browsing for the relevant directory. A history of the data directories utilized is now stored, so that users can more easily change data directories (e.g., changing between FAC and ATBASE atomic data).
- The *Data Directories* in *Preferences* are now written to the workspace file. When reading in a workspace file, if the data directory names in the workspace file are different from those in *Preferences*, a message is displayed, notifying the user that if a calculation was previously run using this workspace, running a new may lead to different results due to using the different databases.
- Bug fixes:
 - When using a thermal flux limiter in advanced thermal conduction options, a factor of 1/4 was missing from the physical limit q_{max} , causing the user input scale factor to be less sensitive than is typically expected. Furthermore, a factor of $3\sqrt{3}/8$ was removed from the definition of q_{max} , making the flux limiter definition consistent with other codes. It has been benchmarked against FLASH, MULTI, and HYADES.
 - A bug affecting tables which require integer input (cycle-based tables in the *Output* widget, and the *Zoning* table widget) has been fixed.
 - Check is now made on use of laser beam spot radius to avoid unnecessary warnings.
 - Fusion fuel depletion bug fix when there is hydrodynamic expansion/compression of cells with fuel.
 - Ion conductivity modified to have the correct $1/Z^4$ dependence.
- *HydroPLOT*:
 - Support for writing JSON-formatted workspace files has been added. This approach provides better support for reading/writing workspaces that use different versions of *HydroPLOT*.
 - The electron-ion and ion-ion Coulomb logarithm can now be plotted in the *Spatial* tab, and in the *Time* tab under "Volume Element Properties".
 - Fusion burn fractions can now be plotted in the *Spatial* tab and the *Time* tab. The data plotted is the total fraction integrated over zones. In both cases, the plotted quantity is the mass fraction remaining for each reactant, which is $1.0 - (mass / initial_mass)$. Reactant masses can also be plotted vs. radius and vs. time.
 - On the *Spatial* tab, multiple selection is supported in the *DCA Populations* box.
 - On the *Time* tab, multiple 'like' *Y-Variable* items can now be selected for a plot window. For example, *Electron Temperature*, *Ion Temperature*, and *Radiation Temperature* can be selected for the same plot window.
 - Additional options for units are provided in the *Spatial* tab and the *Time* tab. In addition, units can be specified for several dependent variables ("y" values in line plots, and "z" values in contour plots) in *Preferences*.
 - Plot window arrangement can now be managed using the *Windows* menu (or associated tool buttons):
 - *Minimize All* minimizes all plot windows ()
 - *Tile All* tiles all plot windows ()
 - *Cascade All* cascades all plot windows ()
 - 2D plot windows now support mouse wheel zooming centered on the cursor position.
 - Support for a large number of laser beams (max. currently set at 100) has been added. Results for cases with multiple beams are listed under each beam's name.
 - Thermal conduction quantities can now be plotted. They are available in the *Spatial* tab. The units for conductivities can be set in *Preferences*.
 - Plot right press context menu has been updated for line plots. Now has direct "Save Node Data" and "View Node Data" options.
 - Plot right press context menu has been updated for contour/isosurface plots. Now has direct "Save Node Data", "Save Zone Data", "View Node Data" and "View Zone Data" options.
 - In Hydroplot line plot data can now be edited under the "View plot data" context menu option. Once a change has been applied [edited] is applied to the line plot legend name. Edited plots can be reverted to their original state using the "Undo edits" button in the data table, after which [edited] will be removed from legend name.
 - Laser ray trace plots are now available for spherical geometry. In order for this output to be written, *Laser ray-trace data* must be checked in the *Output* page in *Helios*, in which case the *Ray tracing* plot option will appear under *Laser Quantities*:



In the case of multiple lasers, these will appear under the plot options for individual lasers.

Ray tracing plots show the paths of the rays as they are refracted and attenuated, with the line color showing the residual power as the ray travels. The ray plot will truncate if the laser ray is fully attenuated. If there is a critical surface, its position is also shown:



o Bug fixes:

- When more than one laser beam is used, the time-dependent plot variable "Total laser power" was plotting incorrect values. This has been fixed.
- The time-dependent plot variable for laser power incident on the boundary facing the laser was incorrect for the case where some laser light misses the plasma. This plot option has been removed.

• *EOS and Opacity Viewer*

- o Plot right press context menu has been updated for line plots. Now has direct "Save Node Data" and "View Node Data" options.
- o Plot right press context menu has been updated for contour/isosurface plots. Now has direct "Save Node Data" , "Save Zone Data", "View Node Data" and "View Zone Data" options.