GAINING INSIGHT INTO YOUR RESULTS USING ENSIGHT FOR BARRACUDA

COMPUTATIONAL PARTICLE FLUID DYNAMICS

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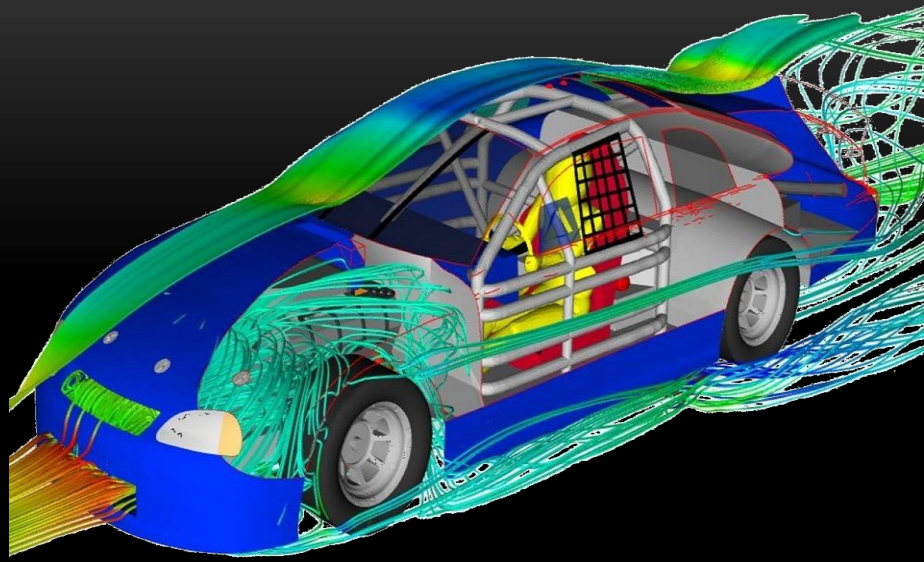
CEI – WHO ARE WE?



- Computational Engineering International, Inc.
- 1994 spun off from Cray Research
- Sole Developers of EnSight
- 500+ Customers, 1500+ copies worldwide
- Largest Markets:
  - Automotive, Aerospace, Energy,
  - Defense, Turbomachinery, Petrochemical
- Focused on visualization and analytical data extraction
- Technology & Customer Driven, Employee-owned Company
- Based on Apex NC, with offices in Detroit, Houston, Munich, Pune, Tokyo

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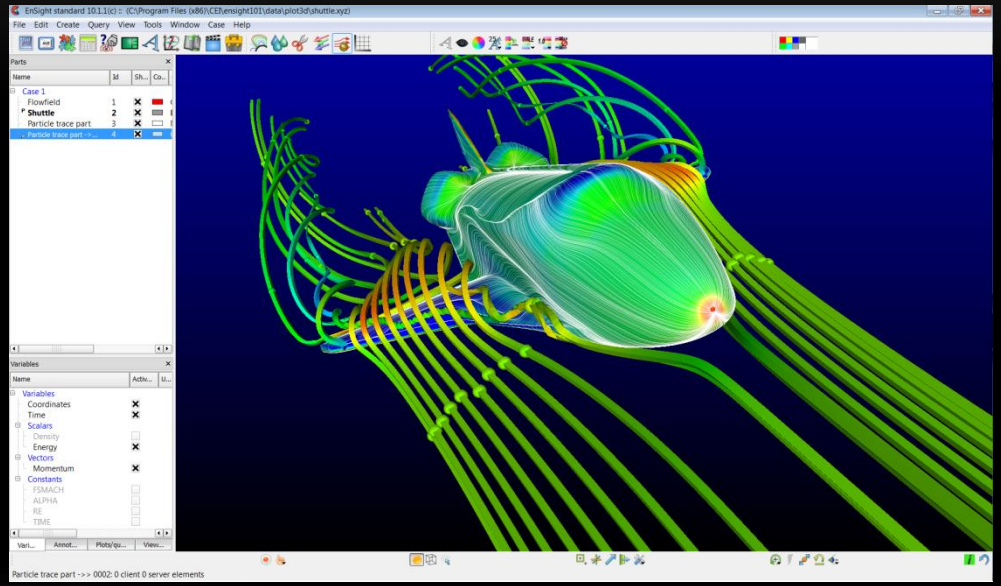
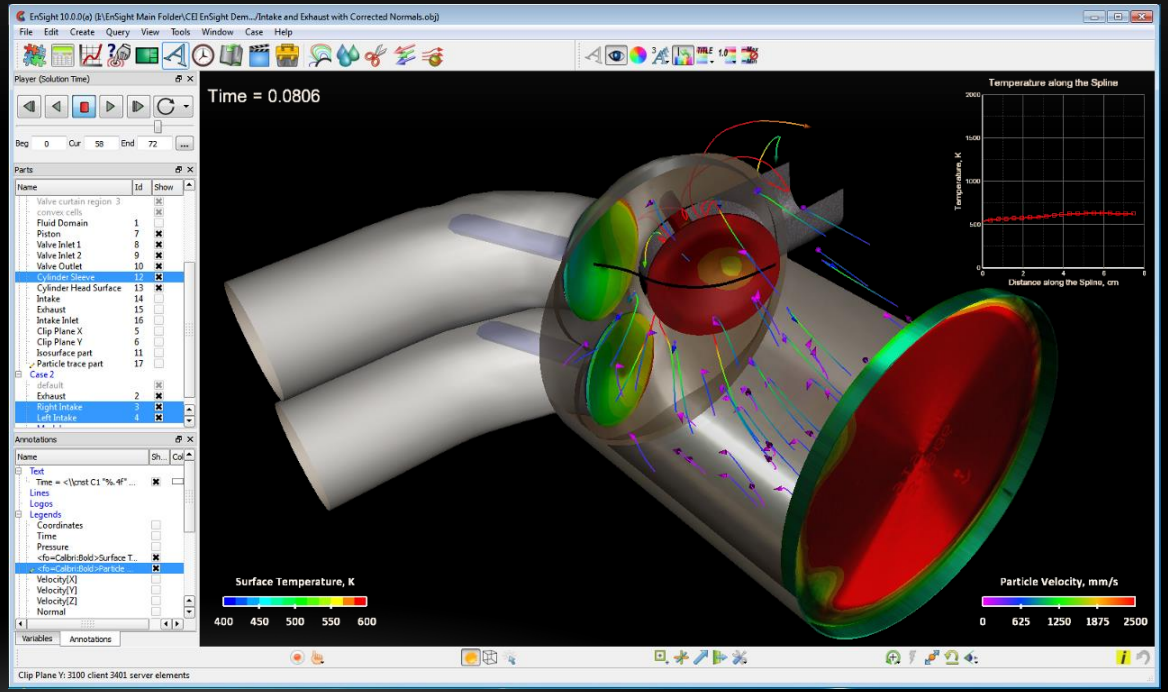
ENSIGHT – WHAT IS IT?

- General Purpose Post processing software for CFD/FEA/CAE Simulations.
- ~50 direct reader formats, many more export to our format.
- Interactive, extensive feature set
- Market leading animation
- Right Mouse Menus, Click-n-Go Control
- Extensive scripting and batch operation
- Multi-Case comparisons
- Parallel processing; Client-Server based
- Apple/Linux/Windows native program
- Stereo/Head tracking/Immersive environments



ENSIGHT 10.1

- Latest version of EnSight focused on drag/drop interface with more direct access to features and capabilities.
- Focused on providing the best interactive, dynamic, responsive, capable environment for extracting the “story” from your simulation.



CHALLENGES

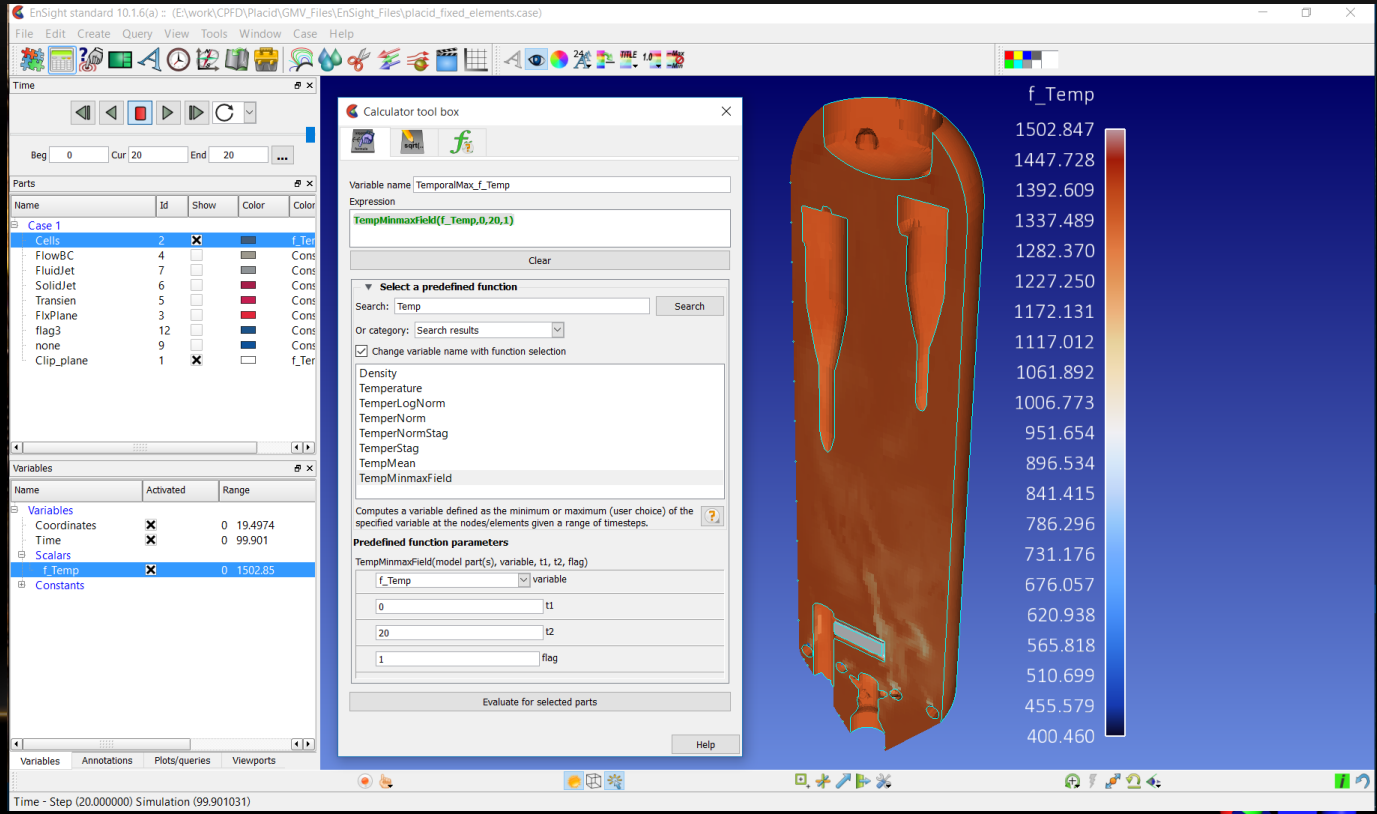
- Extracting out the visual clarity to the flow field.
- Reducing data order
  - Separating out the temporal fluctuations from time averaged values.
  - Spatial reducing information (radial average, 2D distribution).
  - Venn Diagram Variable operations (Multi-variable Filtering).
- Seeing inside complex flow fields with Volume Rendering.
- Sharing an interactive “scenario” with colleagues/designers.

CALCULATOR OPERATIONS

- EnSight has a fully functional variable expression calculator.
  - PreDefined functions like Min, Max, Spatial Mean, Integral, Volume, etc.
  - Resulting Calculated Variables can be
    - Spatial variables (i.e. Pressure * Density)
    - Temporal Variables (i.e. Temporal Min, Max, Average)
    - “Constant” variables (i.e. Max of Temperature on a ‘part’)

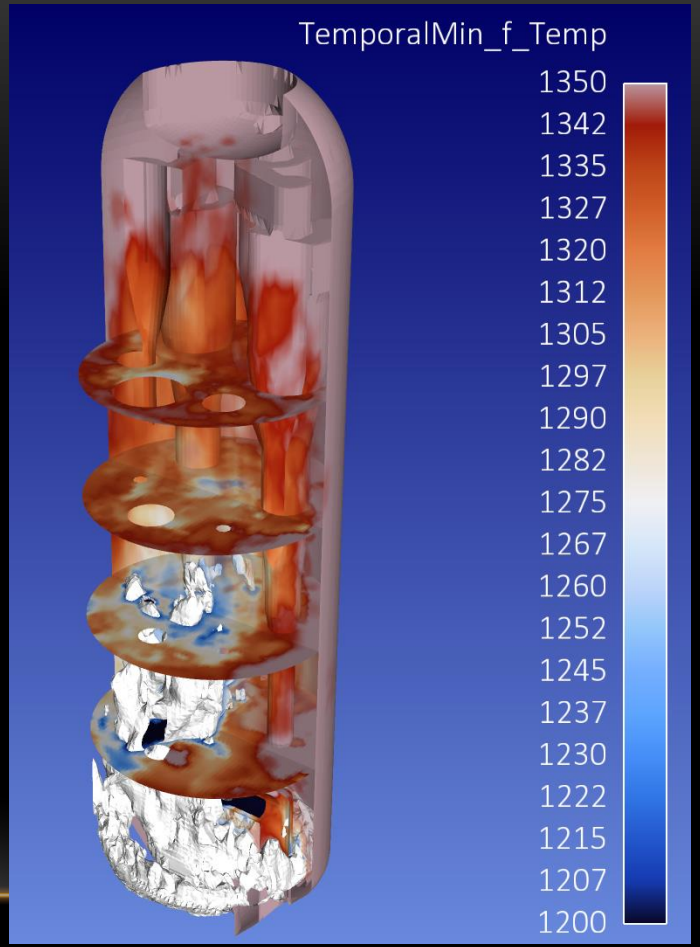
TEMPORAL INFORMATION

- Temporal Max of “Temperature” on Fluid Domain
- Each Element now has stored its maximum over a defined time range.
- Gives a better indication of the upper bound of temperature



TEMPORAL MIN

- Temporal Min of “Temperature” on Fluid Domain
- Each Element now has stored its minimum over a defined time range.
- Gives a better indication of the lower bound of temperature…
- Indication of historically cold spots in the model.
- IsoSurface of Temporal_Min_f_Temp = 1250. Indication of colder spots.



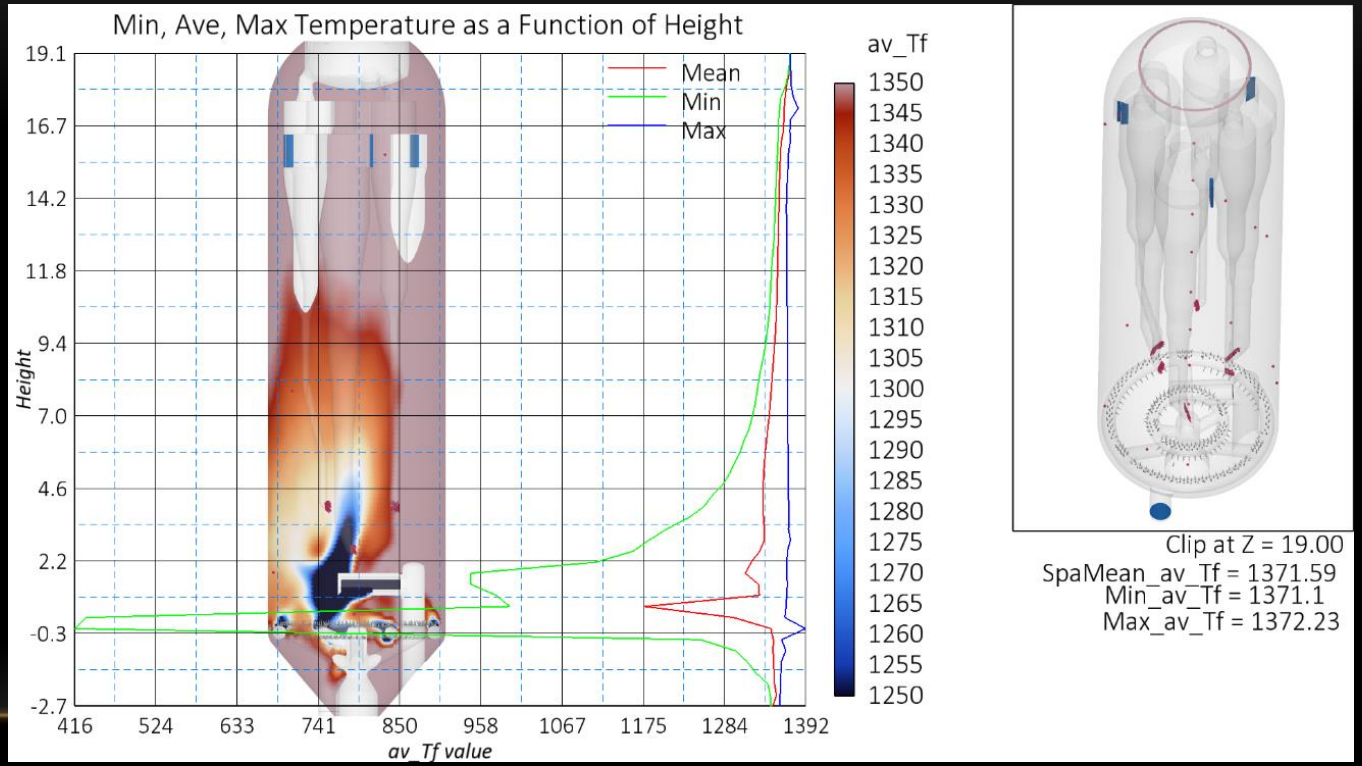
SPATIAL AVERAGING OF DATA

- Initially I have a 3D volume, and 3D distribution of a variable.
- Goal: To boil this data down into an average value versus distance.
- Method:
  - A. Create a Clip in a Z direction through Fluid.
  - B. Calculate Average Variable (Temperature) on the Clip (using Spatial Weighted Mean).
  - C. Use a “Part Constant Query Tool” to record values of Average Temperature vs. Z location of the clip

SPATIAL AVERAGING OF DATA

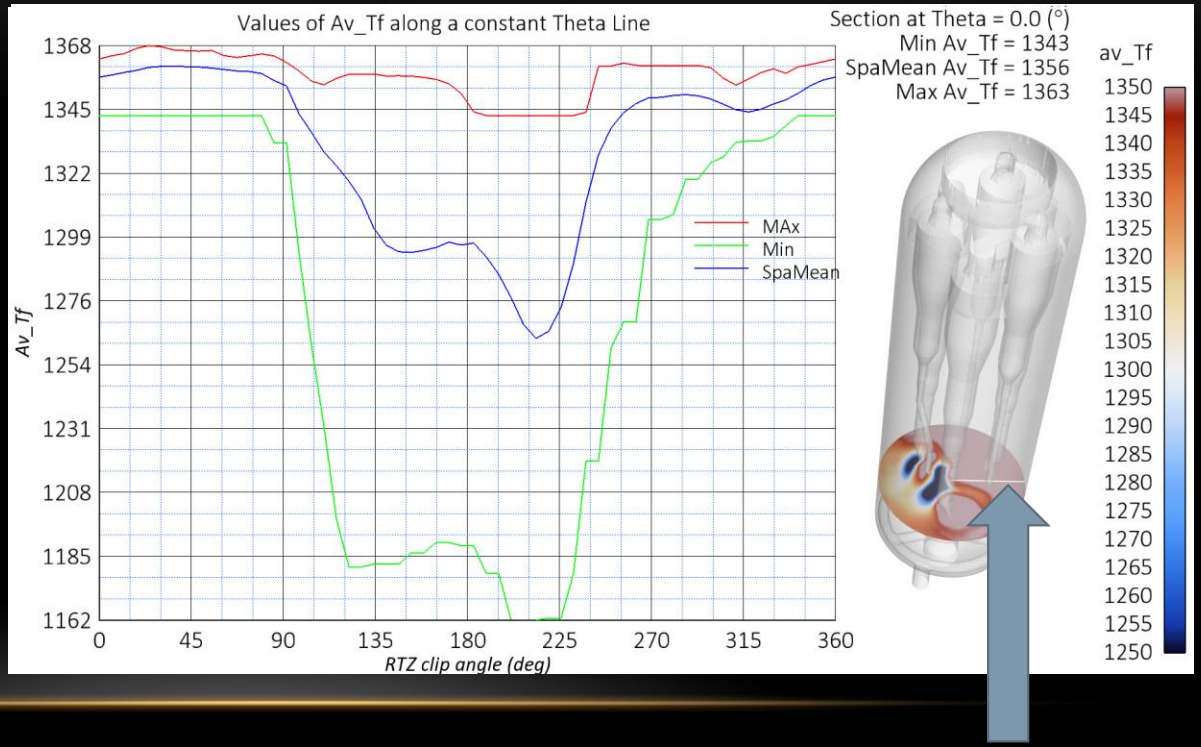
Graph is a reduced spatial representation of the temperature variation vs. Height

At each Z location, EnSight calculates Min, Average, Max values, and collects as Z is swept.



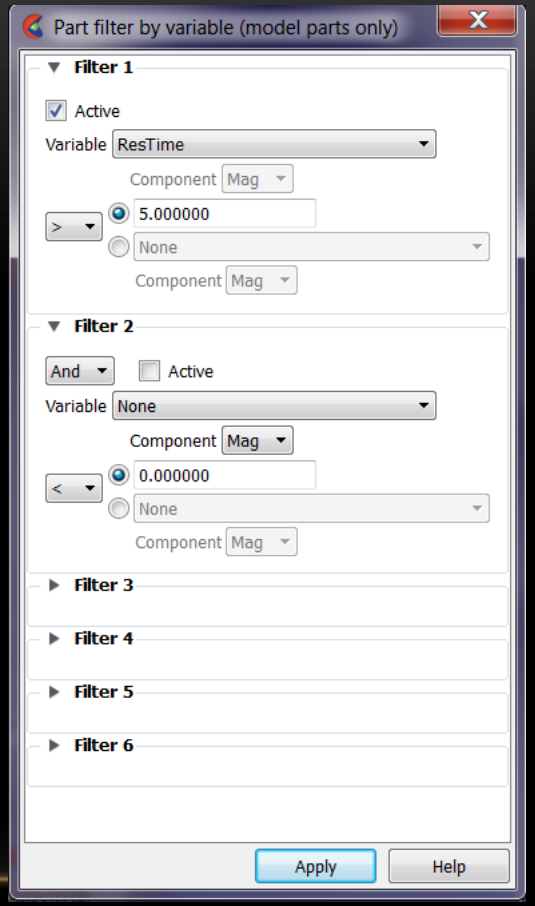
SPATIAL RANGE OF DATA

- Using the Part Constant Query, Creating a graph of the min, average, and max value of Av_Tf as a function of theta about the device center.



FILTERING

- Utilize Filtering capability in EnSight to filter out elements (discrete or continuous domain) according to variable values.
- Example: Filter out all particle with ResTime > 5.0 seconds

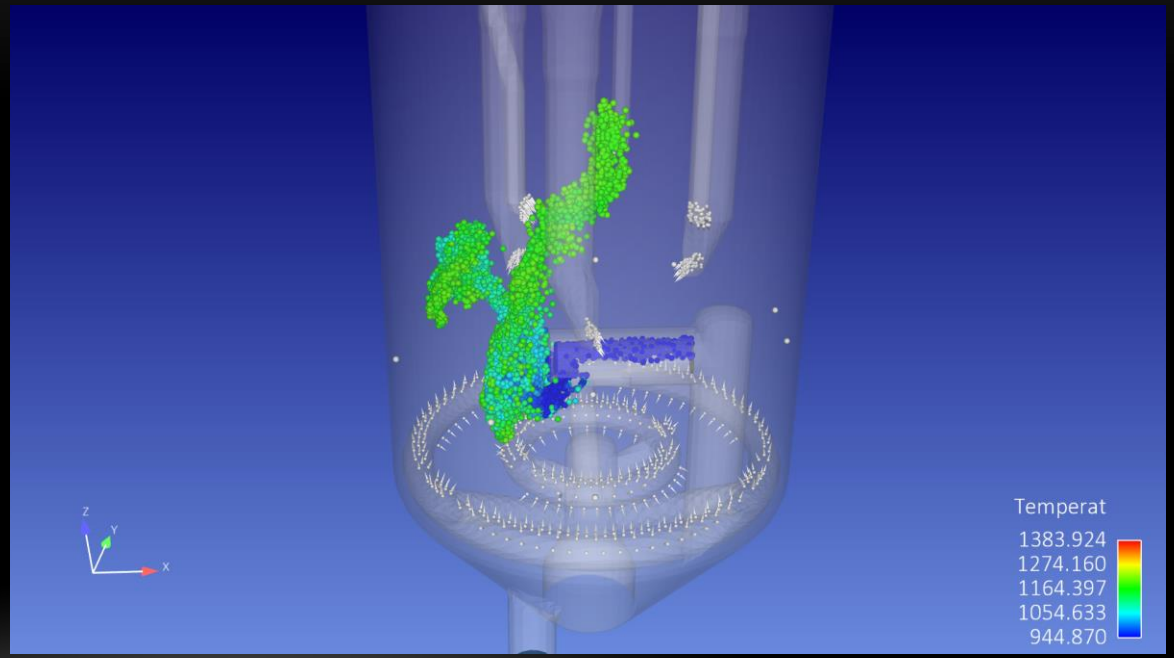


FILTERING EXAMPLE

No Filtering (all Particles)

Filter <u>out</u> particles with ResTime > 5
(ie newbies)

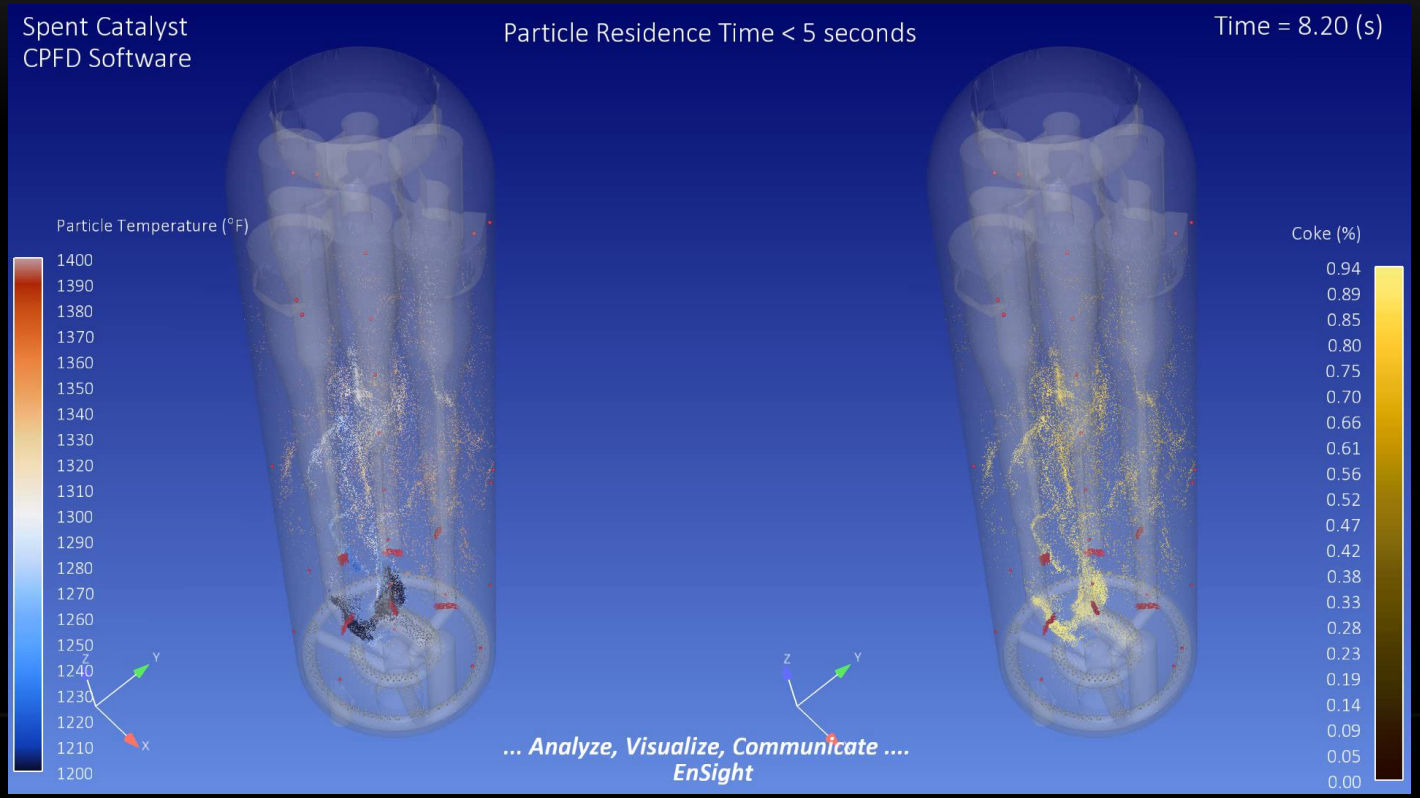
Filter <u>out</u> particles with ResTime > 5 and Temperat > 1200
(new and cold)



FILTERING

- All Calculations are effected by Filtering.
  - You can therefore calculate values on your filtered particles.
    - Ie. How much mass do I have with Res Time < 5 and Temperature < 1200?
    - How does that vary over time? (Right Click on this Constant variable and plot vs. time).

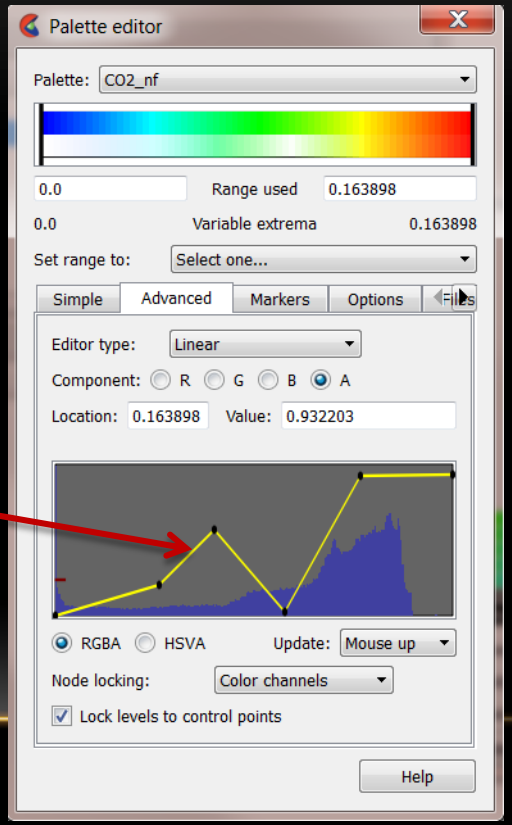
FILTERING EXAMPLE

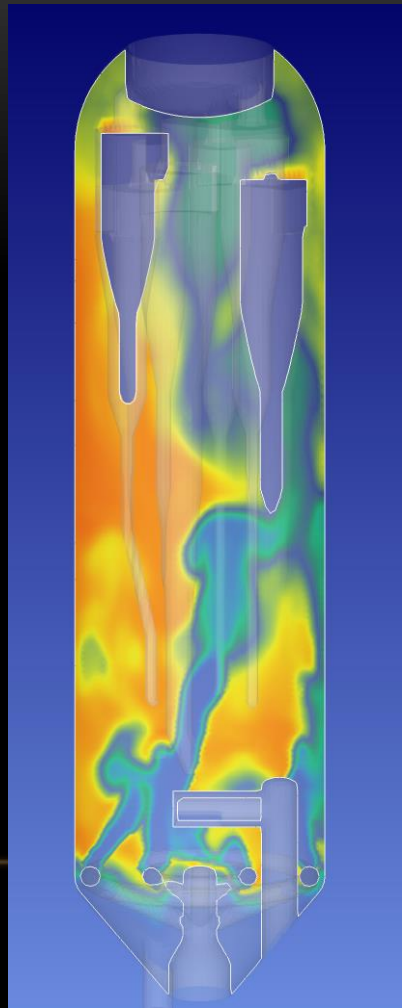


2D PART RENDERING, VARIABLE OPACITY

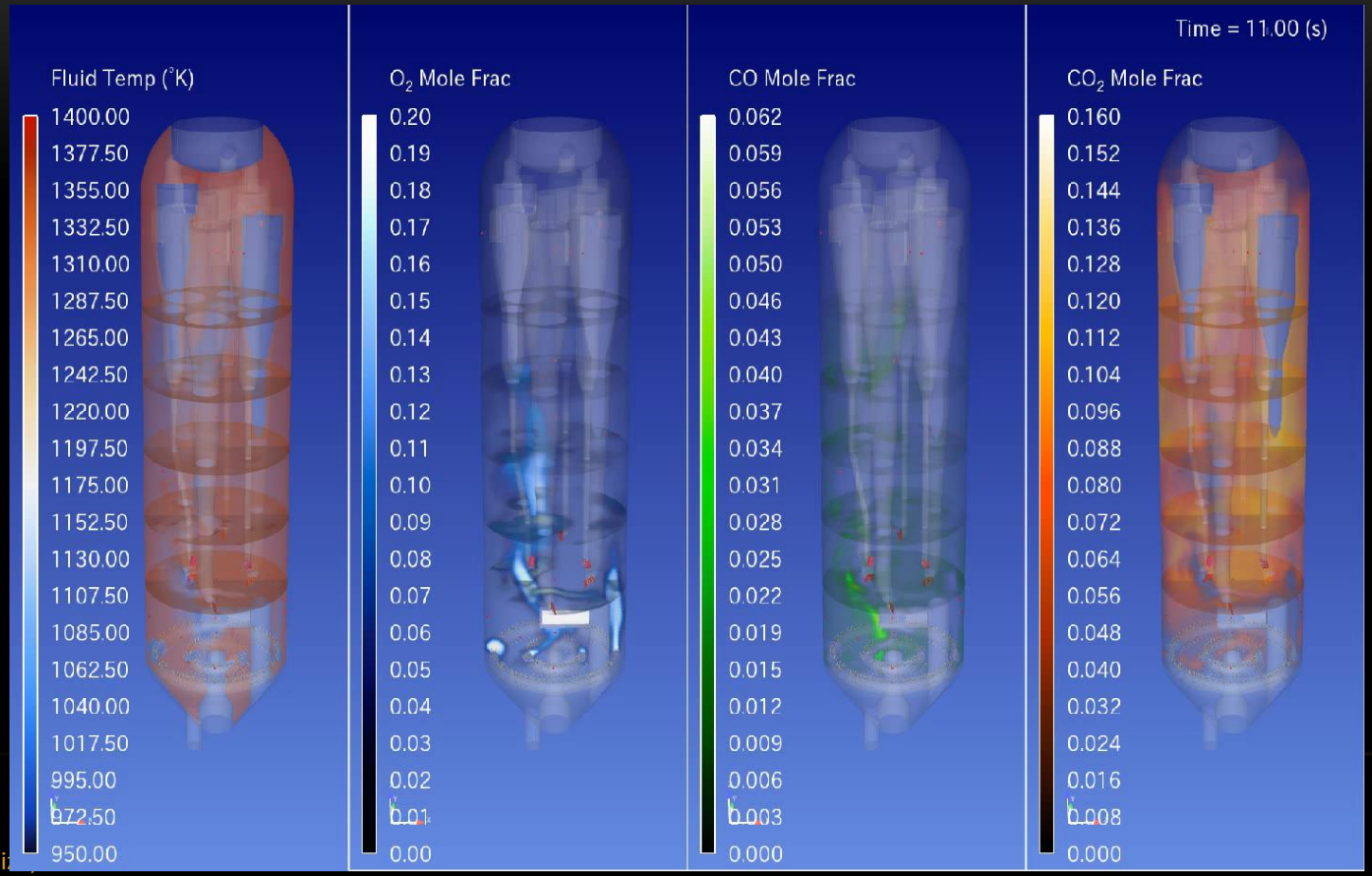
- Rather than color clips via variable RGB, color by transfer function of opacity * RGB.

- Alpha on vertical axis (0 to 1)
- Variable on horizontal axis (min to max)
- Transfer function is relationship of alpha and variable.
- Resultant RGB*alpha, based on transfer function

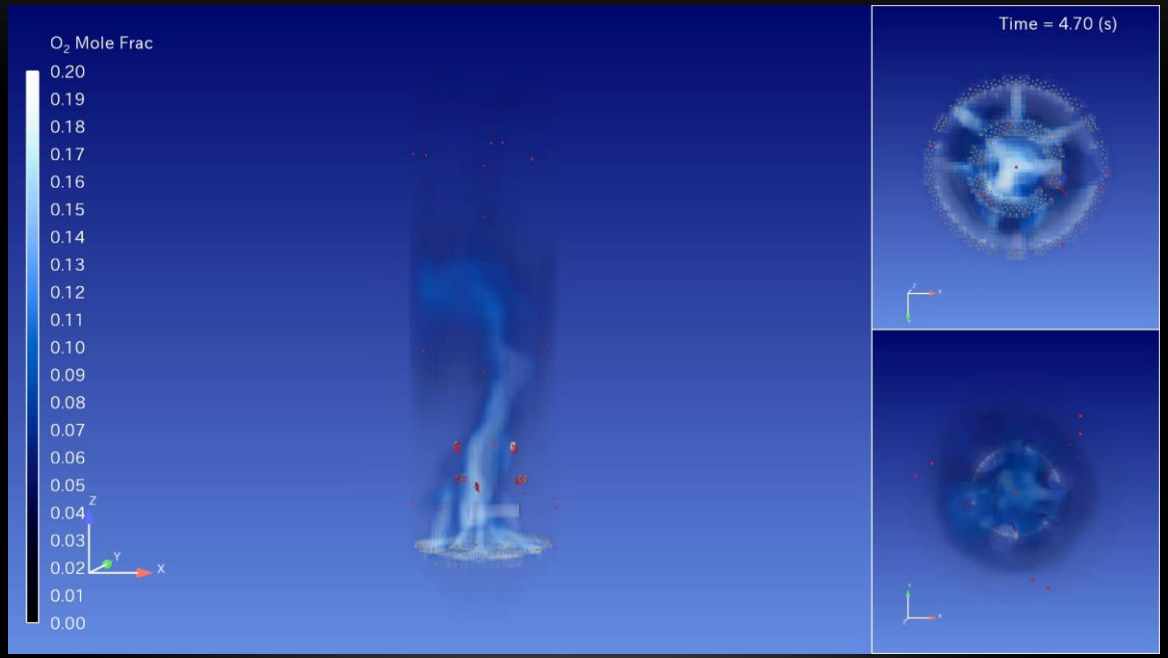




CLIP WITH VARIABLE OPACITY

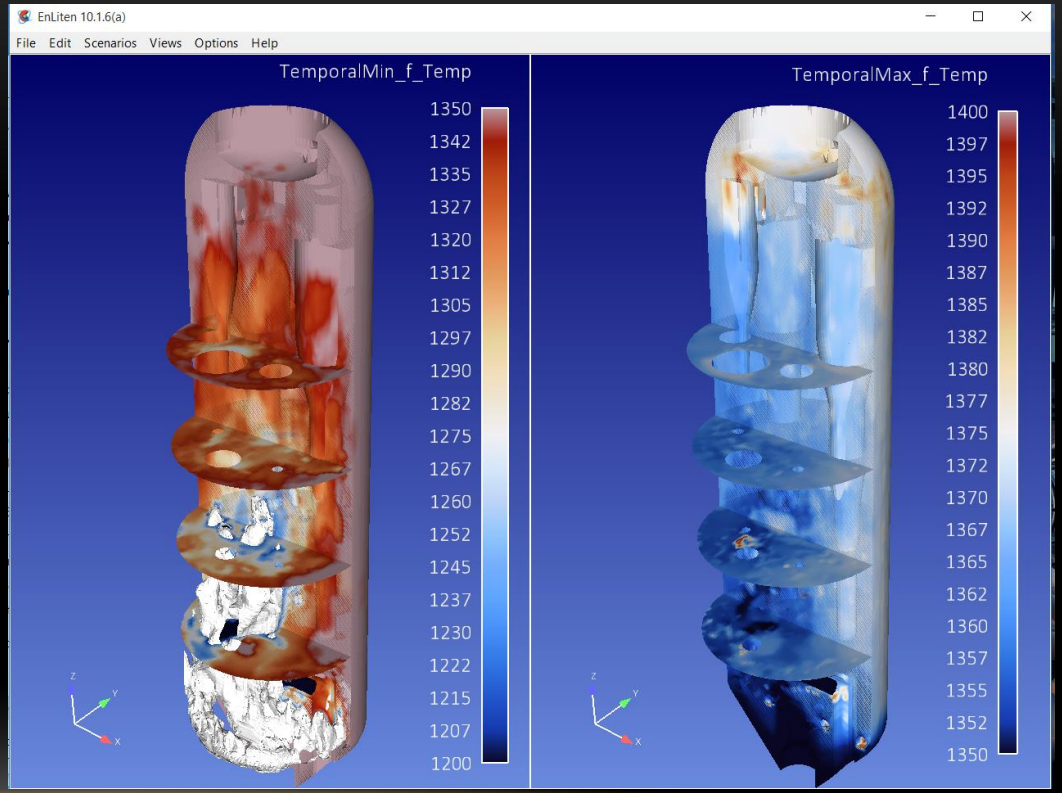


3D PART, VARIABLE OPACITY (VOL RENDERING)



ENLITEN FILES

- Export Result in a Dynamic 3D format.
- No license, Download, or Instructions Needed.
- Full 3D Capability
- Self-extracting (embedded) executable for Windows or Linux



EXAMPLE ENLITEN FILES

- Example of static EnLiten file, two variables, viewports linked.
- Linked here
- Example of static EnLiten file, particles as spheres, viewports linked.
- Linked here
- Example Transient EnLiten file of 50 timesteps, two variables, viewports linked.
- Linked here

Questions?

THANK YOU