Radiation

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Radiation

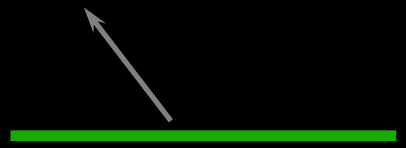
- In Many Situations (Especially Forced Convection), Conduction and Convection Dominate and Radiation Can (and Should) Be Neglected.
- Radiation Becomes Important in Situations Such As:
  - (Typically Outdoor) Sealed Systems
  - Natural Convection Cooled Rack Systems
  - Hot Isolated Components Radiating to Ambient
  - Solar Loading on Outdoor Equipment
  - In a Rack Between Boards With Different Power Consumption etc.
- Radiation is Often Critical When Solid Temperatures are Sought

Radiation

- Review of Concepts
  - Thermal Radiation
    - Electromagnetic Emission From a Surface Due Solely to the Fact That the Surface Is Above Absolute Zero
    - Wavelengths: 0.1–100 μm (Visible Spectrum: 0.3-0.7 μm)
  - Black Body
    - Absorbs All Incident Radiation
    - Emits Radiant Energy at Highest Possible Level: $W=\sigma T^4$
  - View Factors
  - Geometric Relationship of Surfaces

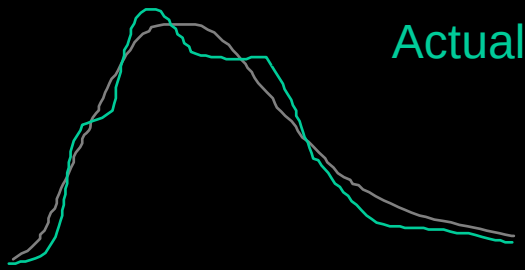
Radiation

- FLOTHERM's Radiation Model Assumes Surfaces Are:
  - Gray
  - Diffusely Absorbing, Reflecting, Emitting



Gray Body Approx.

Actual Body

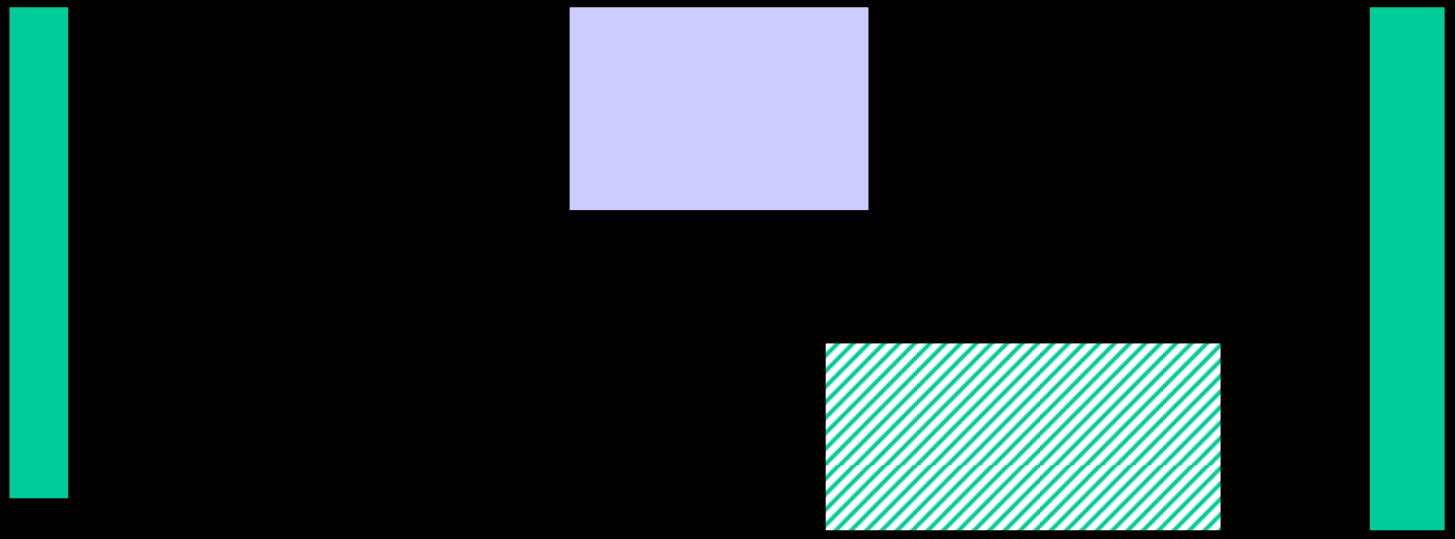


Radiation

- FLOTHERM's Radiation Model
  - Surface-to-Surface Radiation
  - Cuboids Can Actively Participate in Radiation
    - Non-Collapsed Conducting (or Fixed Temperature)
    - Collapsed Fixed Temperature (With Restrictions)
  - Reflections Are Considered Only From Surfaces Defined As Radiating
    - Effect Is to Under-Predict Net Heat Current Between Surfaces (Which Is Conservative From a Design Standpoint)
    - The More Surfaces That Are Defined As Radiating the More Accurate the Predictions…Balance This With Goals and Computational Time

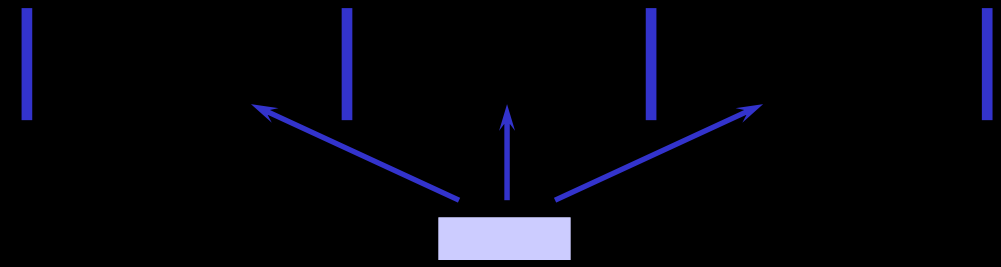
Treatment of Obstructions

- FLOTHERM Checks for Blockages Between Pairs of Radiating Surfaces
- View Factors Are Re-Calculated Automatically to Account for Partial Blockages



Surface Subdivision

- Affects Accuracy of Surface Temperature Distribution
- Single Radiating
  - Treats Entire Surface As Having One Single Average Temperature (in Radiation Calculations)
  - Accurate Enough for Most Practical Situations
- Subdivided Radiating
  - Splits Surface up Into a Number of Isothermal Segments
  - Radiation Is Calculated Separately for Each Segment



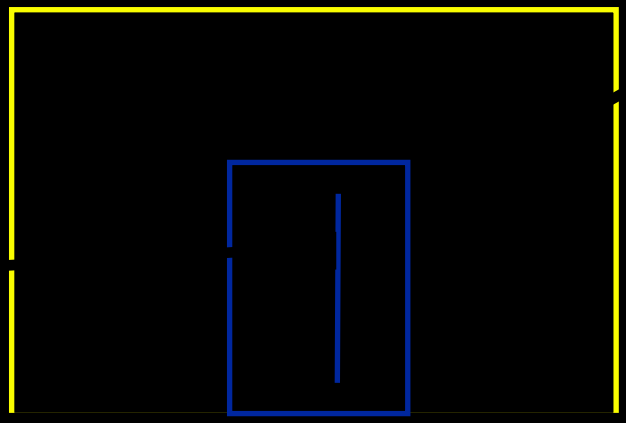
Effect on Calculation Time

- Radiation Solver Calculation Time Increases With the Number of Radiating Surfaces in the Model. Minimize Solution Time By:
  - Using Single Rather Than Sub-Divided Radiation Surfaces Where Possible
  - Using Larger Values for the Minimum Area Considered
  - Using Larger Subdivided Surface Tolerances

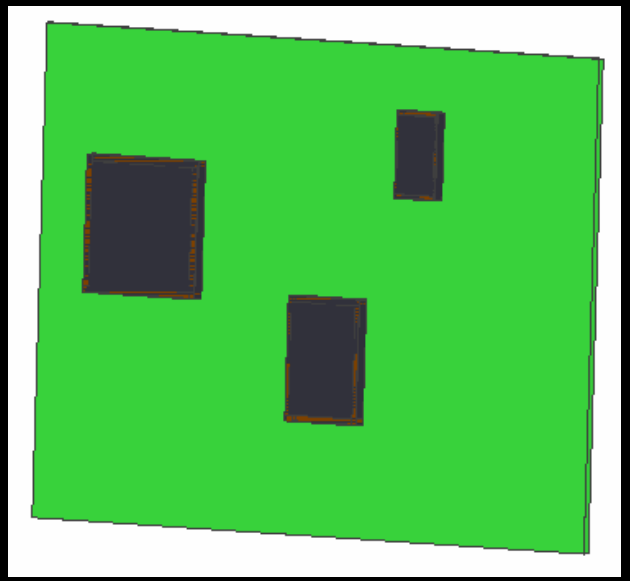
- The CFD Solution Time Will Also Be Affected
  - Each Iteration Can Take Longer
  - More Iterations May Be Needed to Reach Convergence

Radiation

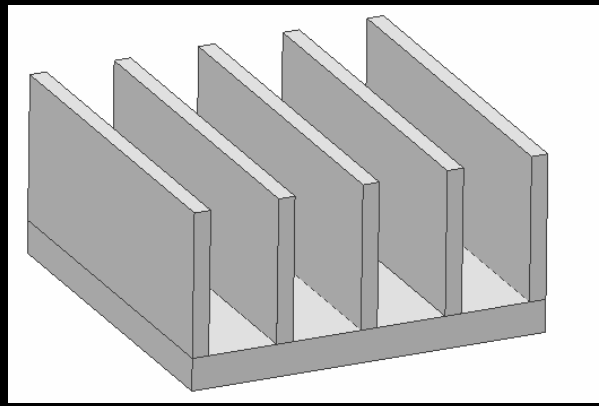
- Things to Note
  - Radiation To External Is Allowed Through Open Domain Faces and Collapsed Resistances
  - Remember to Set External Radiant Temperature (PM, System/Global)



Radiation



- Radiation To/From SmartParts
  - Applicable To
    - Heat Sink
    - PCB
    - Enclosure
    - Cylinder
  - Must Apply Radiation Attribute to All Surfaces
    - Normal Rules Apply, e.g., “Sub-Dived Surface Tolerance”, “Minimum Area Considered” - Determines If PCB Component or Heat Sink Fin Surface Actually Participates in Radiation
    - Or Decompose First



Radiation

- In Summary - There Are 3 Things to Remember for Modeling Radiation:

1. Turn it on.
2. Attach Radiation Attributes to Important Surfaces (Only these are Calculated)
3. For These Surfaces, Make Sure The Emissivity is Set (Surface Attribute) (Hint, if You Don’t Know Exactly What Value – Low is Conservative)