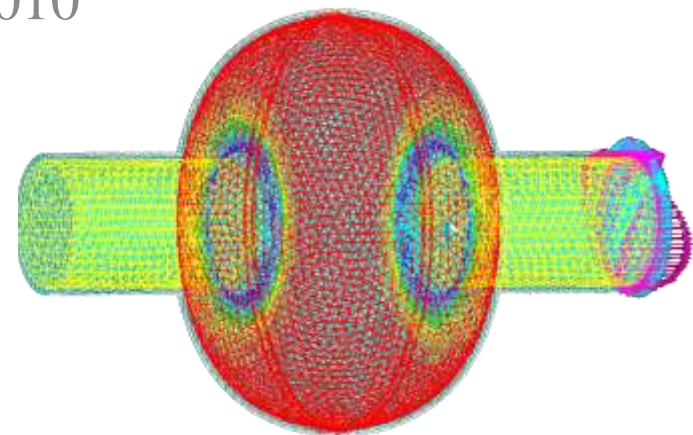
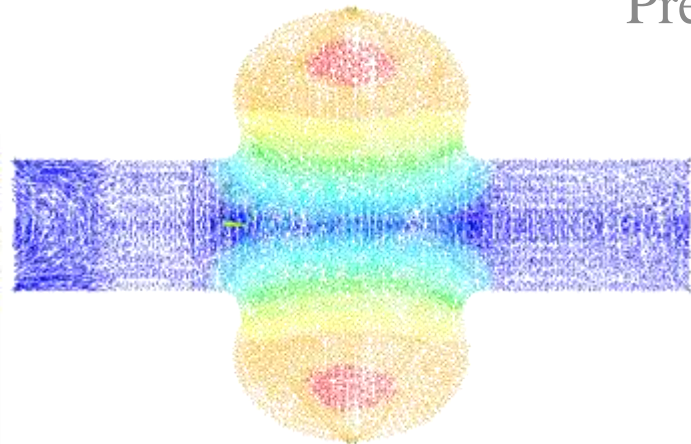


Simulations with ANSYS

Sam Posen
Cornell University
Presented October 13th 2010
at HOM10
In Ithaca, NY





ANSYS

- ANSYS is a finite element analysis package developed for engineering applications
- ANSYS recently acquired several companies and now owns some industry-leading codes (HFSS, ICEM CFD, CVFX, FLUENT)
- Has several types of analysis for different kinds of physics
- Can send results from one analysis to another
- Can couple some analyses together directly

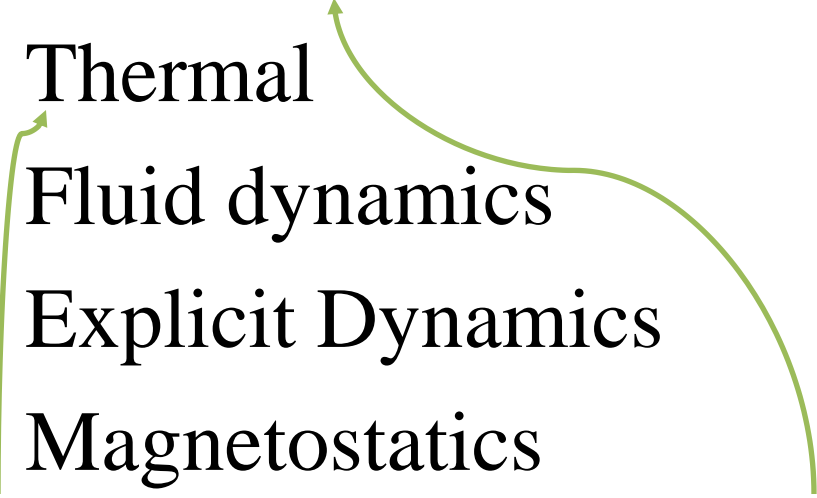


Analysis Types

- Structural
- Thermal
- Fluid dynamics
- Explicit Dynamics
- Magnetostatics
- High Frequency EMAG
- Low Frequency EMAG
- Directly coupled analyses



Analysis Types

- Structural
 - Thermal
 - Fluid dynamics
 - Explicit Dynamics
 - Magnetostatics
 - **High Frequency EMAG**
 - Low Frequency EMAG
 - Directly coupled analyses
- 
- A green arrow originates from the "High Frequency EMAG" item and points to the "Thermal" item, indicating a relationship or flow between these two analysis types.



Capability Comparison

Capability	ANSYS	MWS	ACE3P
Eigenmode Solver	★	★	★
Time Domain (wakefields)		★	★
S-Parameters	★	★	★
Multipacting			★
Coupled EM-Thermal-Structural	★		Not Yet
Complex μ and ϵ	★	★	★
Parallel Computing	★	★	★



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Excellent for thermal, structural analyses!

Not capable of introducing particles.

Not meant for accelerator applications!



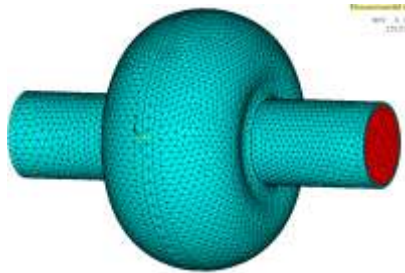
Benefits of ANSYS

- Excellent support, documentation
- Low cost academic license for universities
- Well benchmarked
- Versatile – can easily access data at any selection of nodes, load any elements



Benefits of ANSYS

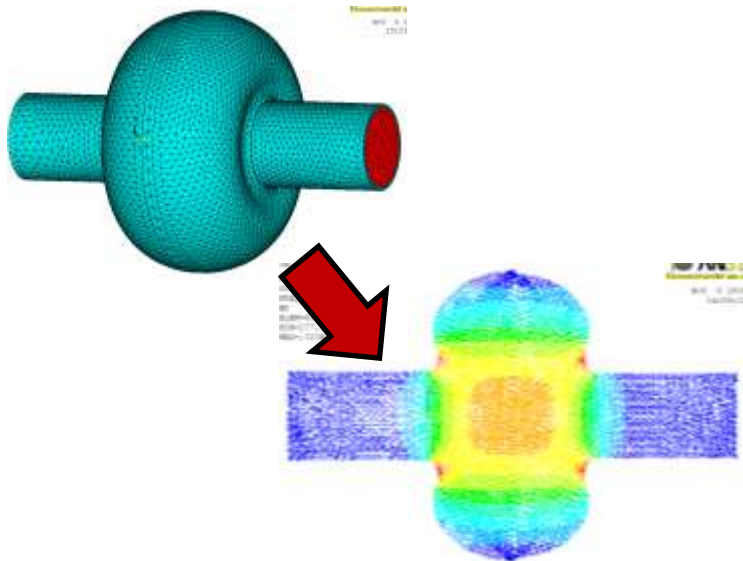
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Benefits of ANSYS

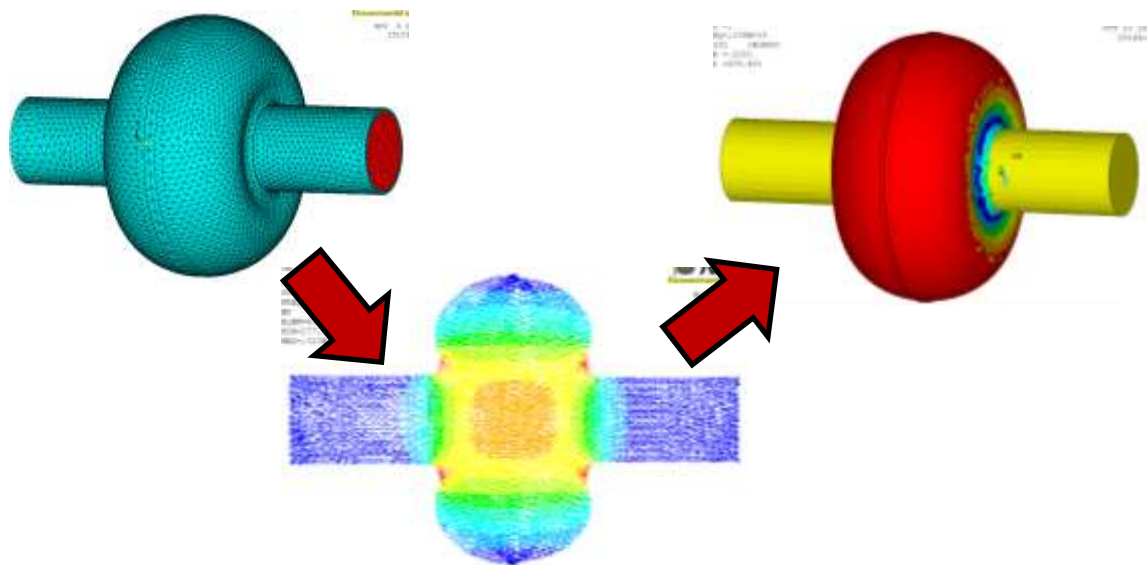
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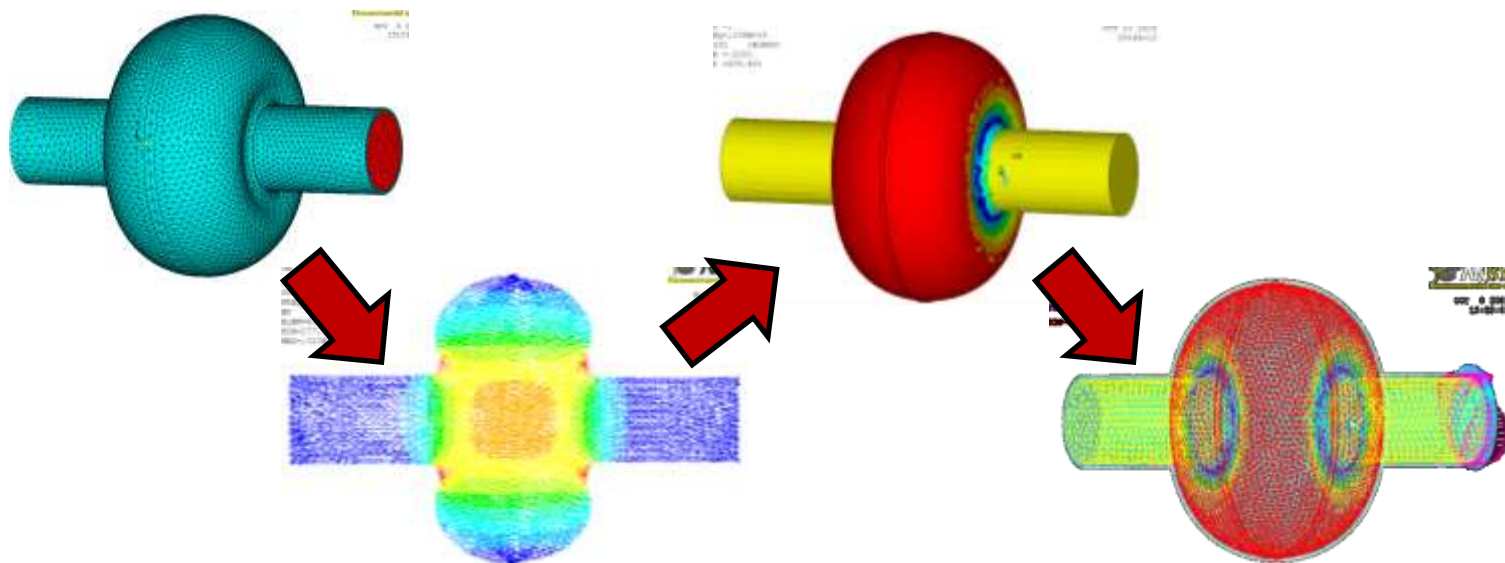
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Benefits of ANSYS

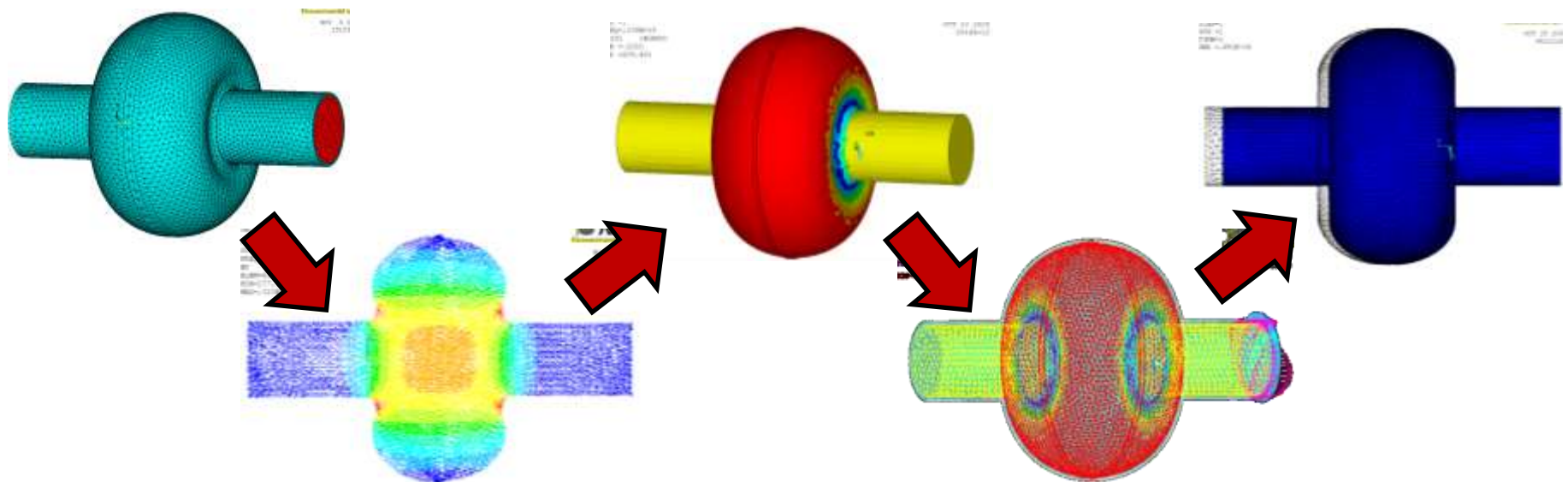
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Drawbacks of ANSYS

- Program issues (issues as of right now—I'll talk about the future)
 - Interface not very user friendly
 - Mesher takes a long time
- Requirements of accelerator community not likely to influence development of code



Plans for ANSYS

- ANSYS is switching from its arcane FORTRAN-based system to new “Workbench” environment
- Much more user friendly, fast mesher
- Strong CAD model compatibility
- Built-in optimization algorithms
- Current WB 12.0 no HF simulations, but planned for 13.0 (January) or 14.0 (~1 year later)



Workbench Environment

B : Steady-State Thermal (ANSYS) - Mechanical [ANSYS Academic Research]

File Edit View Units Tools Help Solve Mesh Update Mesh Mesh Control Options

Outline

- Project
 - Model (B4)
 - Geometry
 - Coordinate Systems
 - Connections
 - Mesh
 - Steady-State Thermal (B5)
 - Initial Temperature
 - Analysis Settings
 - Internal Heat Generation
 - Temperature
 - Heat Flow
 - Heat Flux
 - Solution (B6)
 - Solution Information
 - Temperature
 - Temperature Probe

ANSYS Noncommercial use only

0.000 0.025 0.050 (m)
0.013 0.038

Details of "Mesh"

- Defaults
 - Physics Preference: Mechanical
 - Relevance: 0
- Sizing
- Inflation
- Advanced
- Pinch
- Statistics

Geometry | Worksheet | Print Preview | Report P

Messages

Text

Timestamp

Parameter Set

Steady-State Thermal (ANSYS)

Mechanical APDL

Mechanical APDL

Timestamp

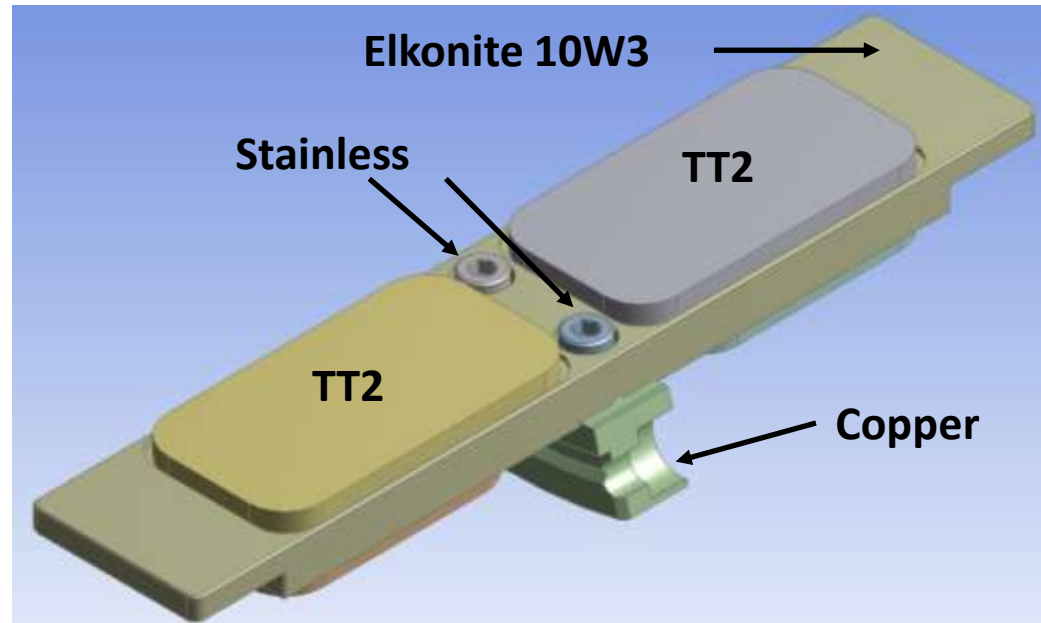
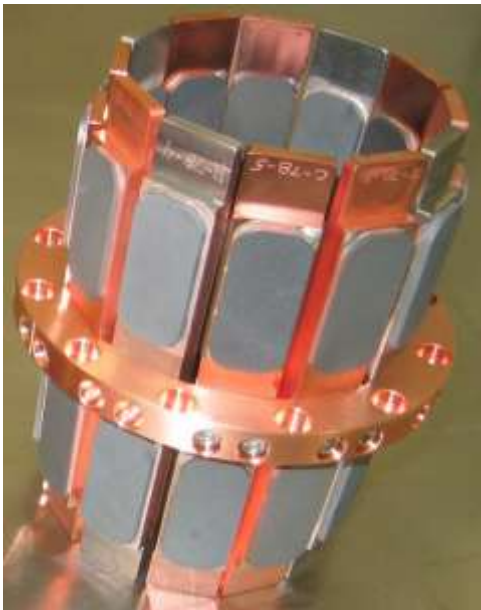
N, s, v, A) Degrees rad/s Celsius

Press F1 for Help No Mess



ANSYS Example: ERL HOM Tile

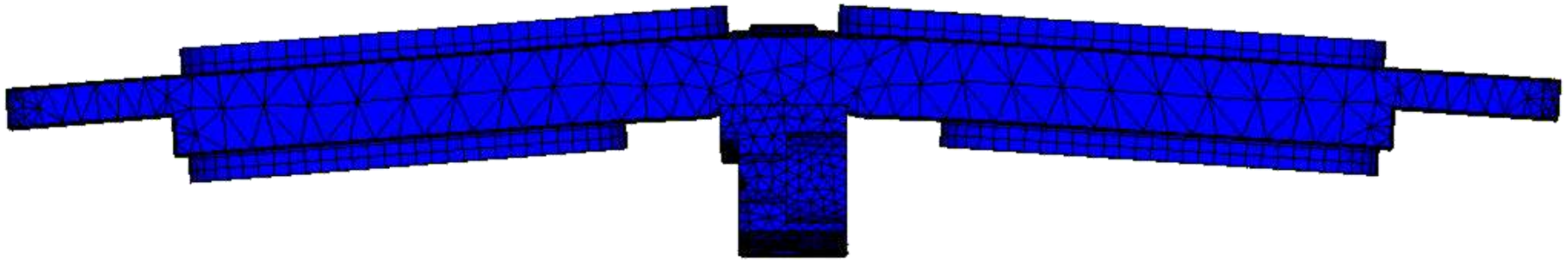
- ERL HOM absorbing tiles had been found cracked and fallen off assembly
- Thought to be thermal expansion mismatch causing stresses when assembly was cooled



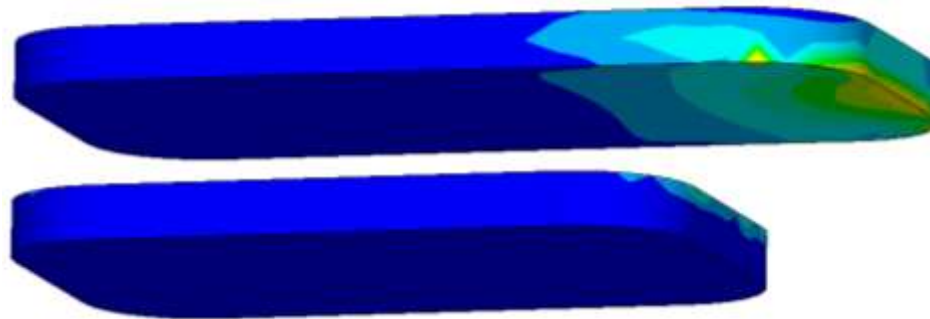


ANSYS Example: ERL HOM Tile

- Found small deflection in assembly when cooled



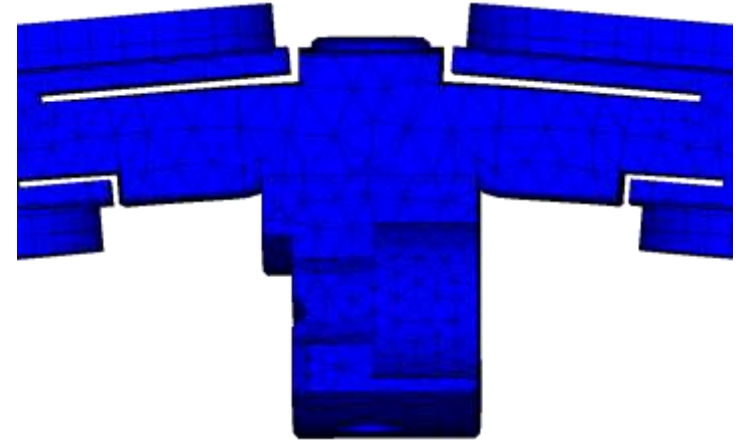
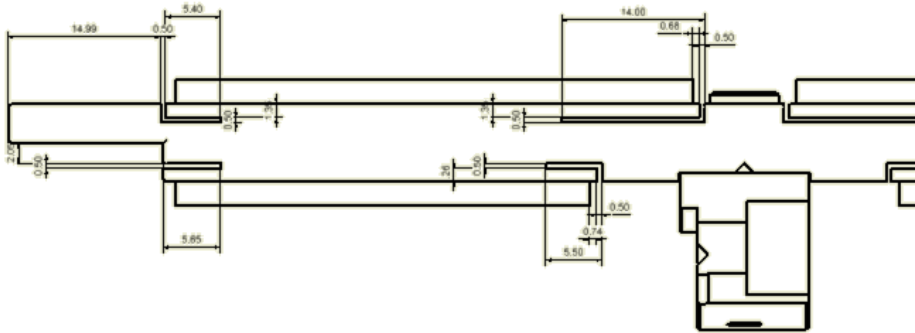
- large concentration of stress at edge of tile, near pivot point



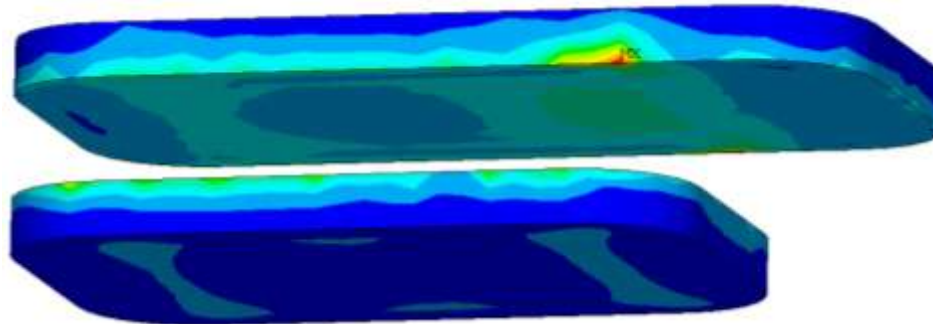


ANSYS Example: ERL HOM Tile

- Came up with series of stress relieving cuts



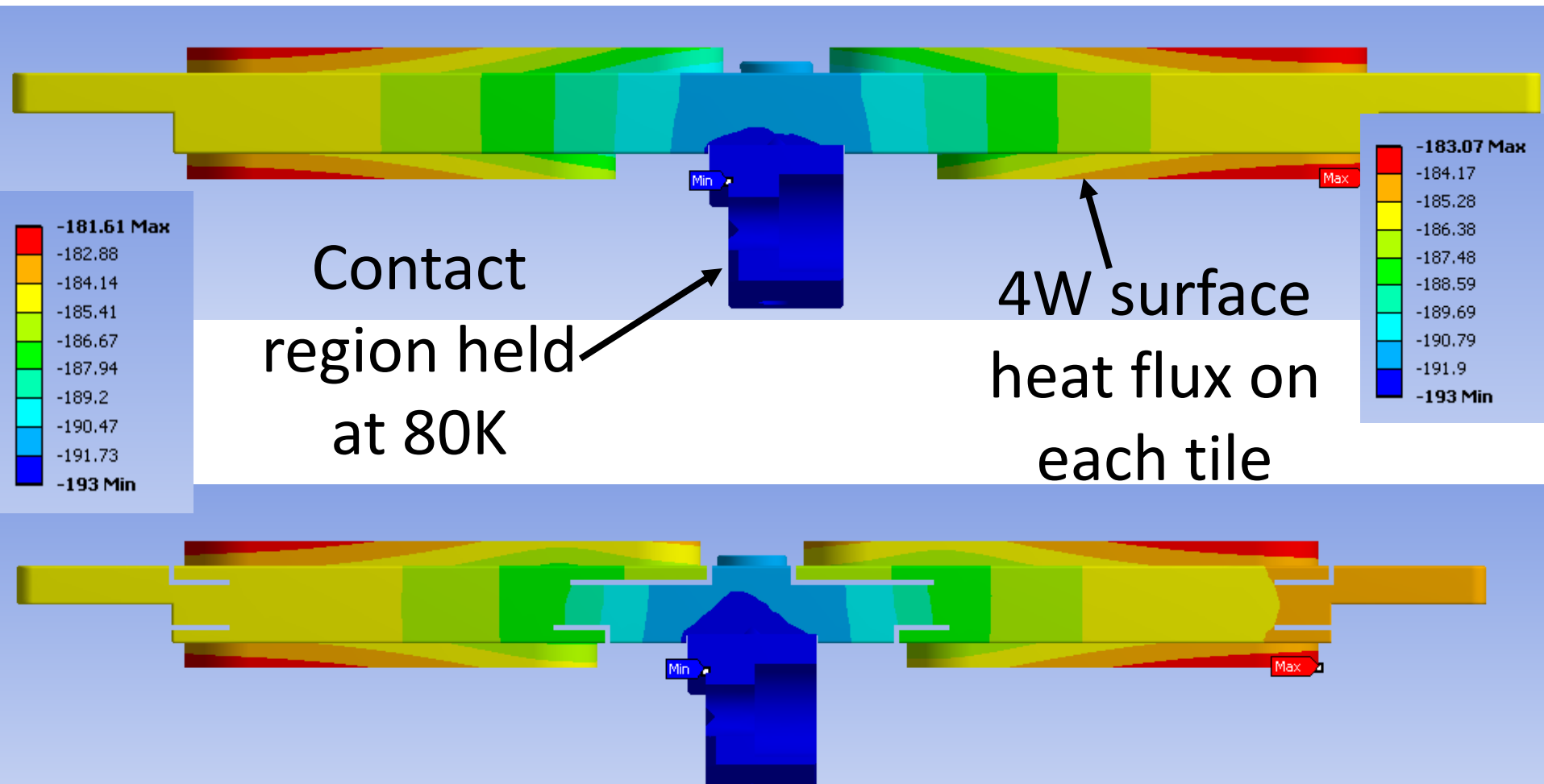
- Cuts reduced maximum calculated stress by more than 80%





ANSYS Example: ERL HOM Tile

- Simulations show negligible effect on heat transport





Summary

- ANSYS is useful for multiphysics studies
- Not good for particles (wakefields, multipacting)
- Good documentation, support, benchmarks; small \$ for universities, versatile
- Upcoming versions of ANSYS supposed to have user-friendly HF simulation capabilities