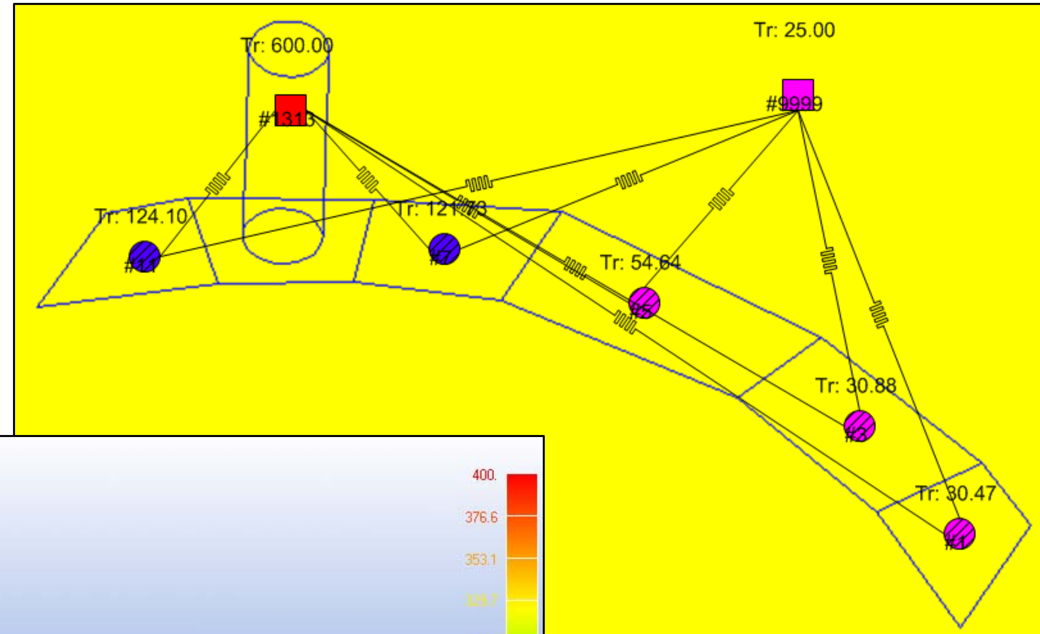
Radiative Heating of Aircraft Strut by Hot Exhaust Pipe



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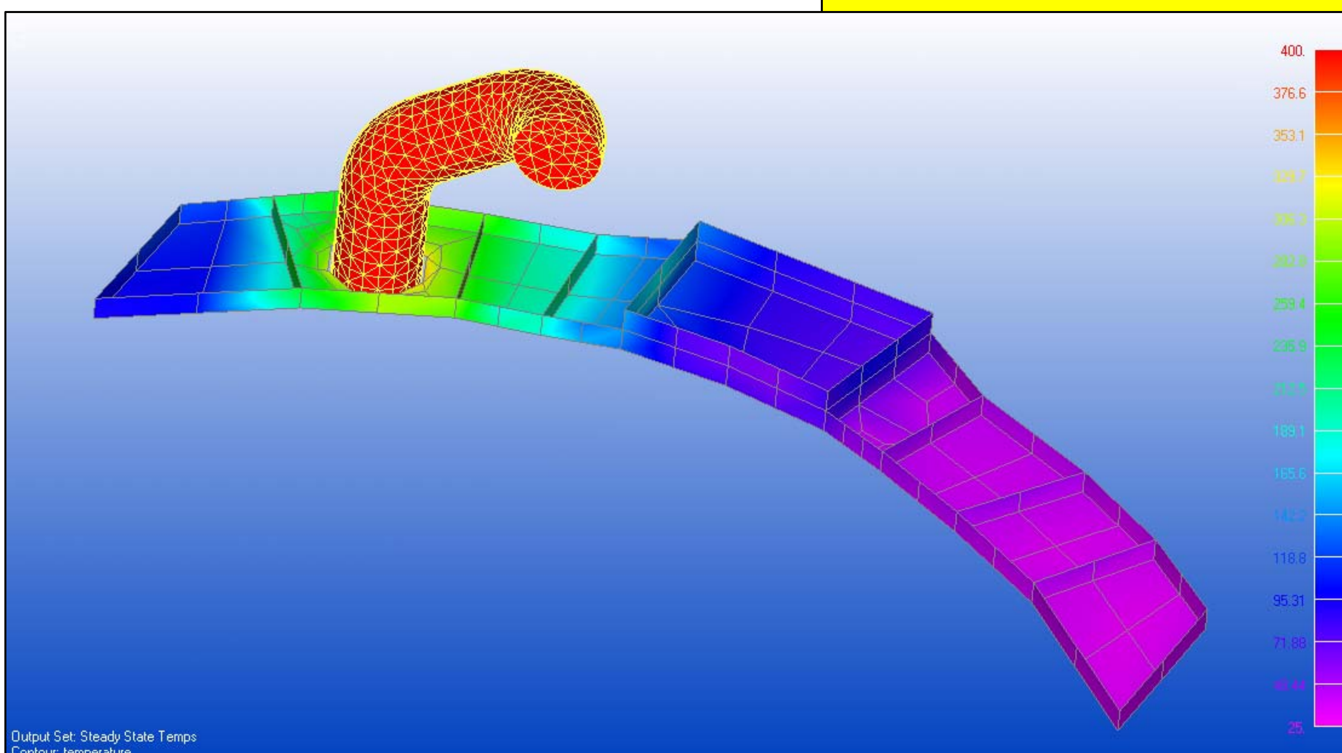
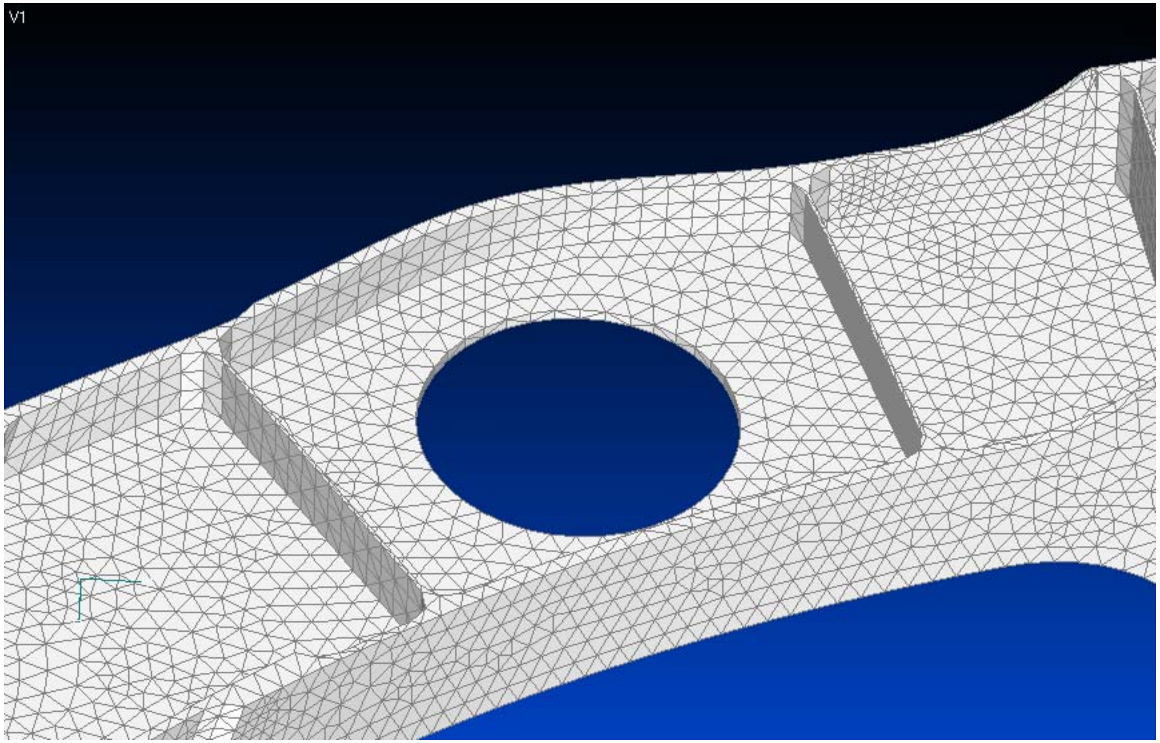


Problem Description

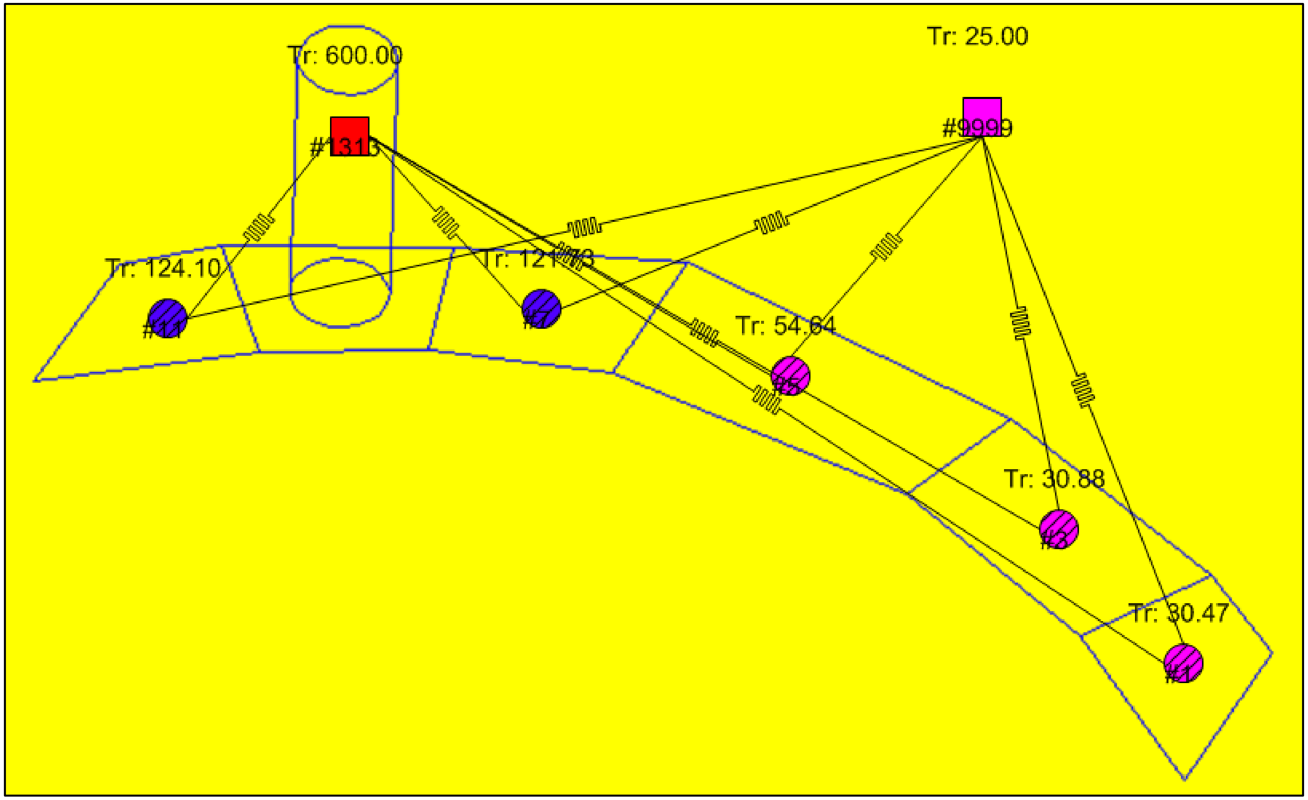
- Find temperatures in aircraft strut through which a hot pipe is inserted.
- The temperature of the outer surface of the pipe is 600 ^{O}C .
- The heat transfer is by radiation. Convection is ignored.
- The system is surrounded by enclosure held at 25 ^{O}C.

Native CAD Geometry is Overly Complex

The CAD geometry is too complex to model for current Monte Carlo radiation solvers. A fully meshed strut contains almost 48,000 elements. Ray tracing from all the element faces would take days. The geometry must be simplified before exporting to a radiation solver.

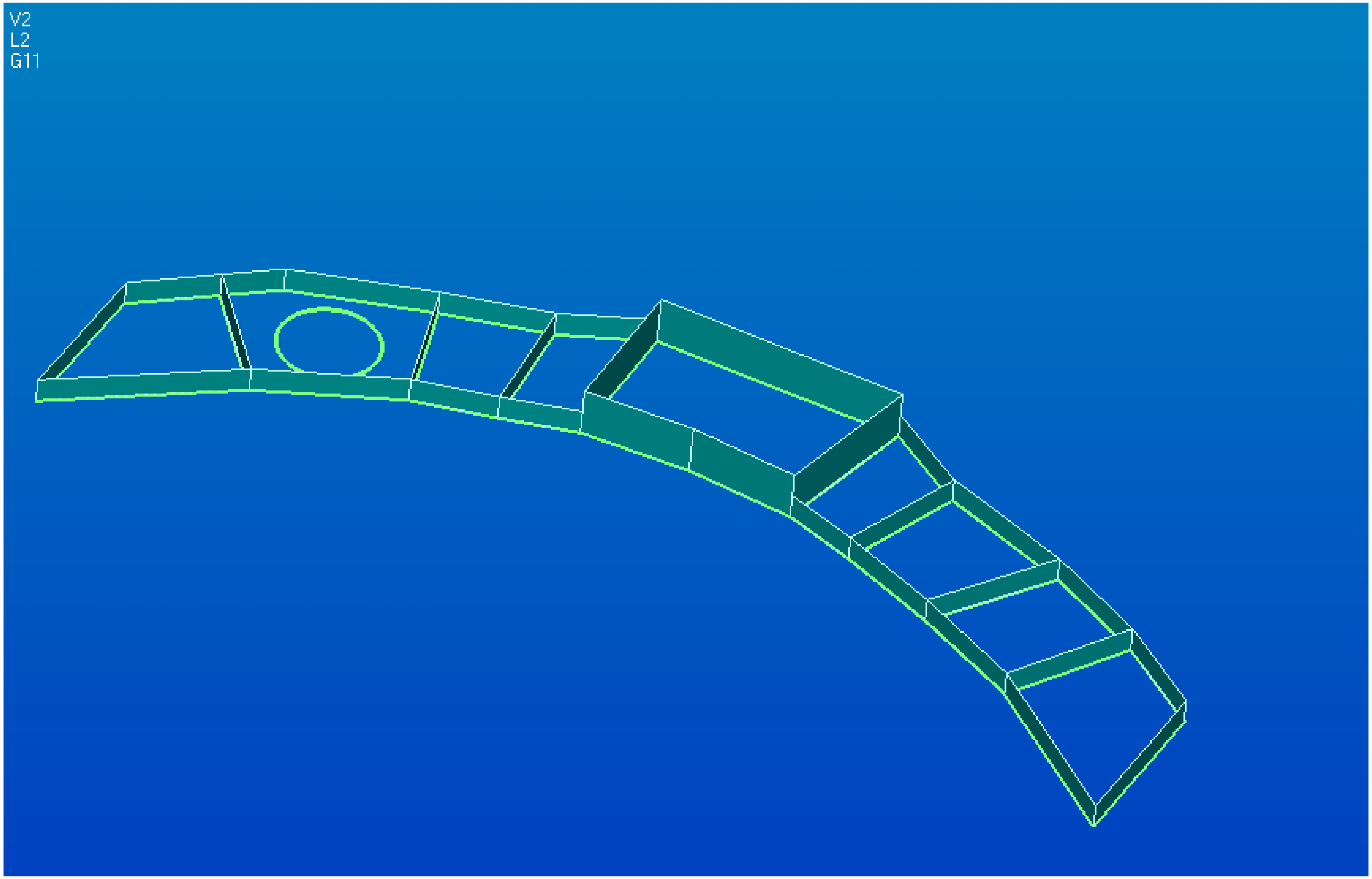


A preliminary model can be constructed in Nevada. The model contains all the essential features. Here the pipe is modeled as a straight cylinder.

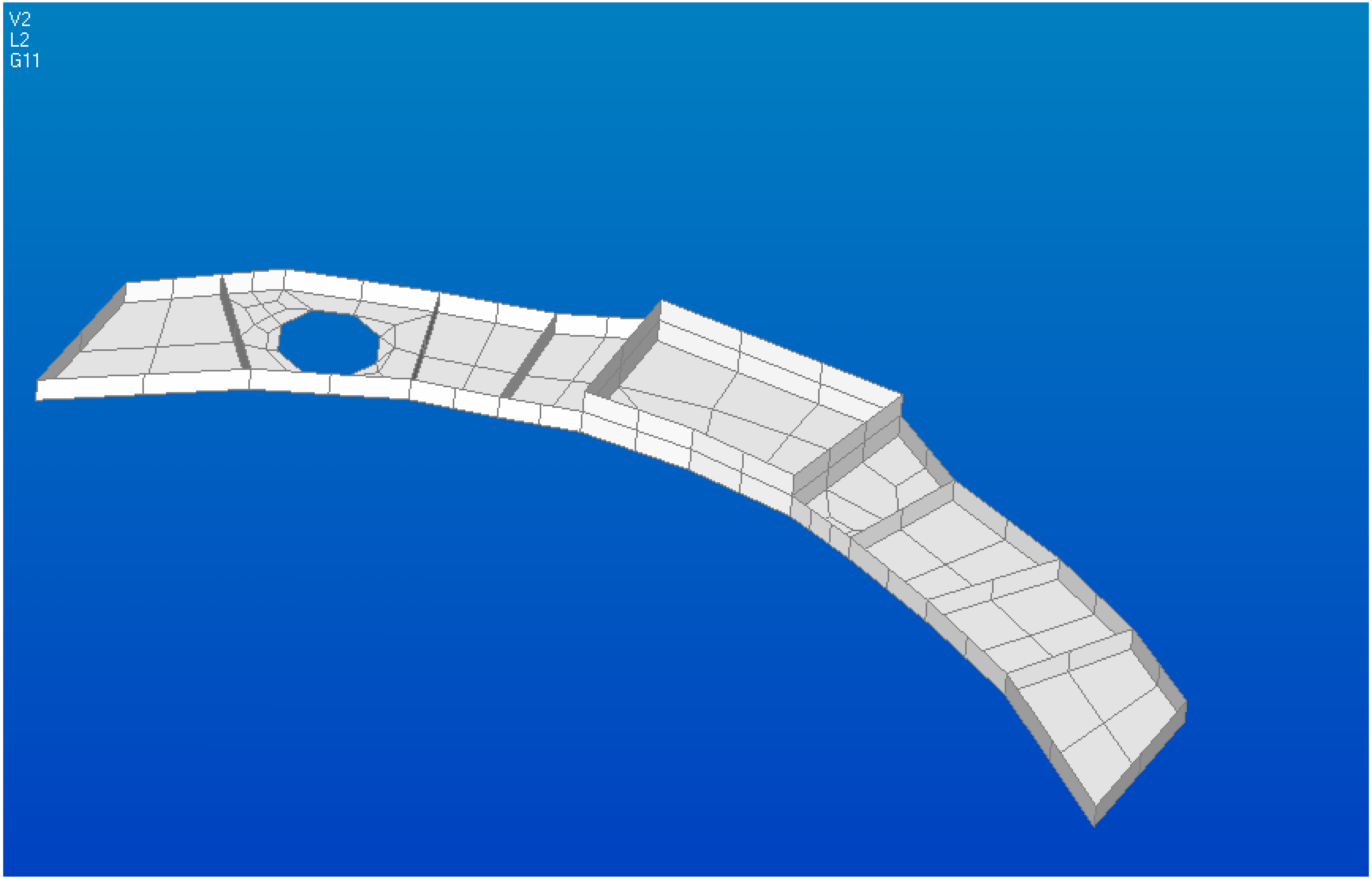


The radiation conductors between surfaces are computed by Nevada and the thermal results obtained by *SINDA/G.*

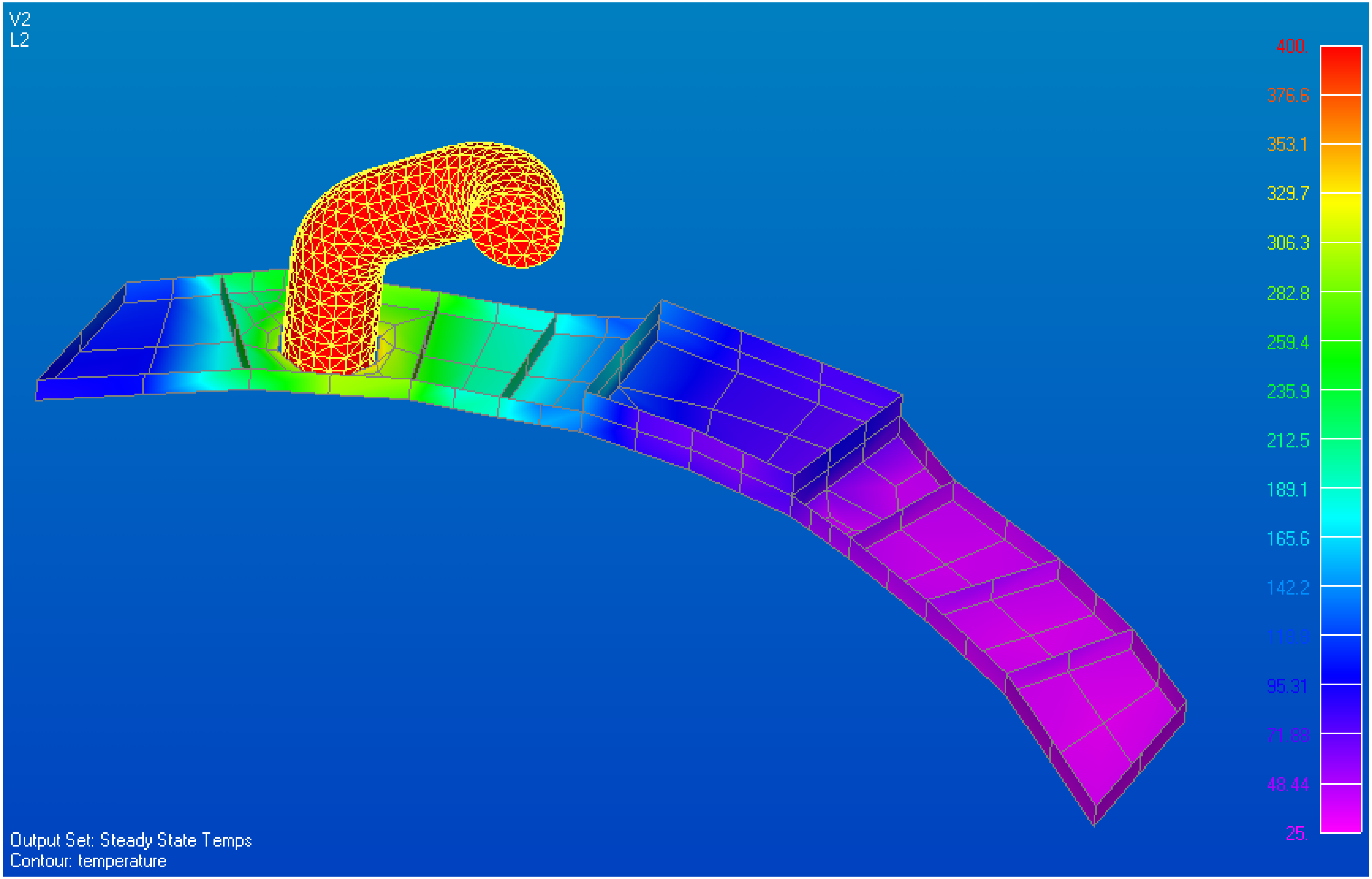
New geometry in constructed in Femap using the basic dimensions of the strut.

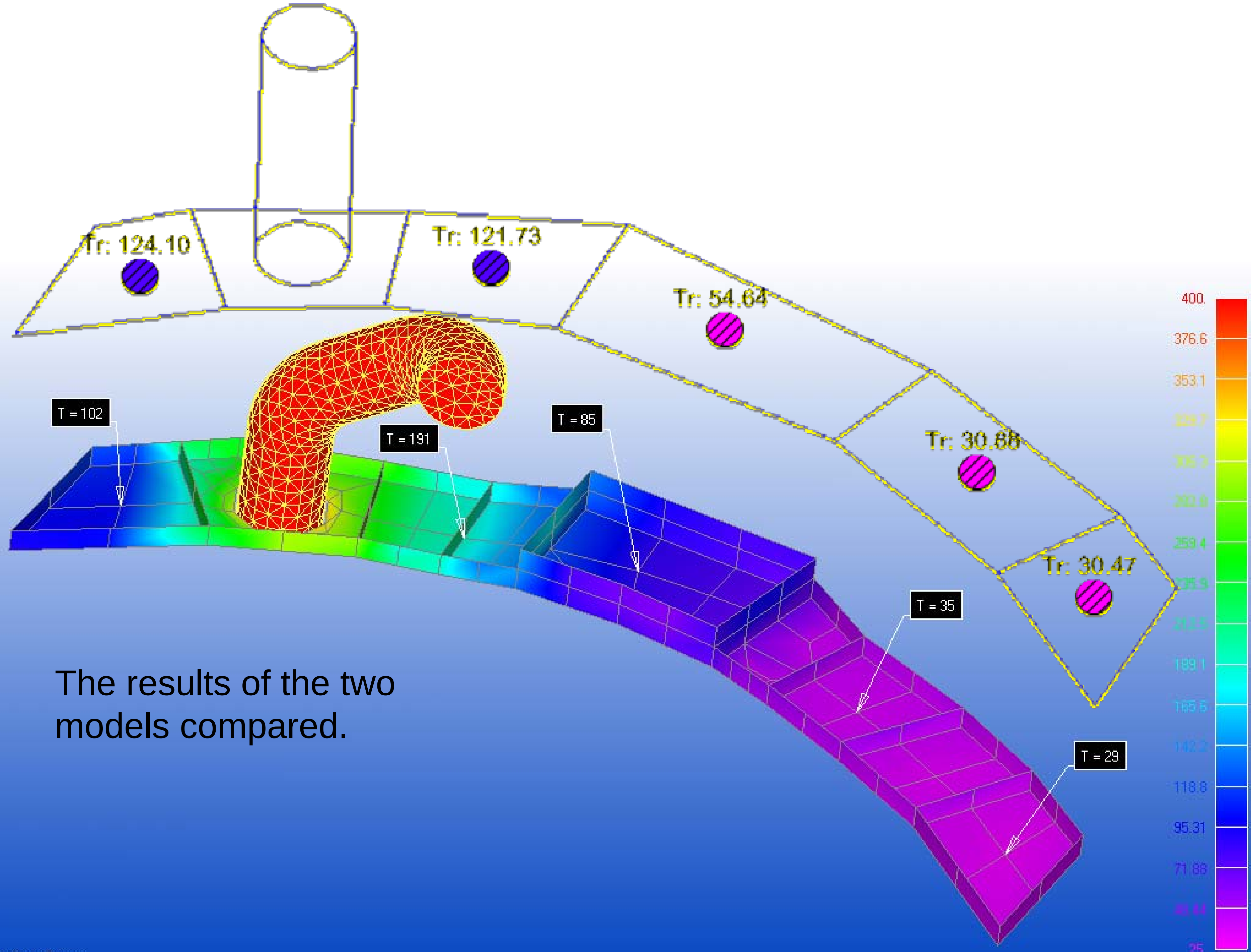


The surfaces are then individually meshed and elements interconnected by using node merge command.



The pipe was meshed boundary conditions applied and the model analyzed.



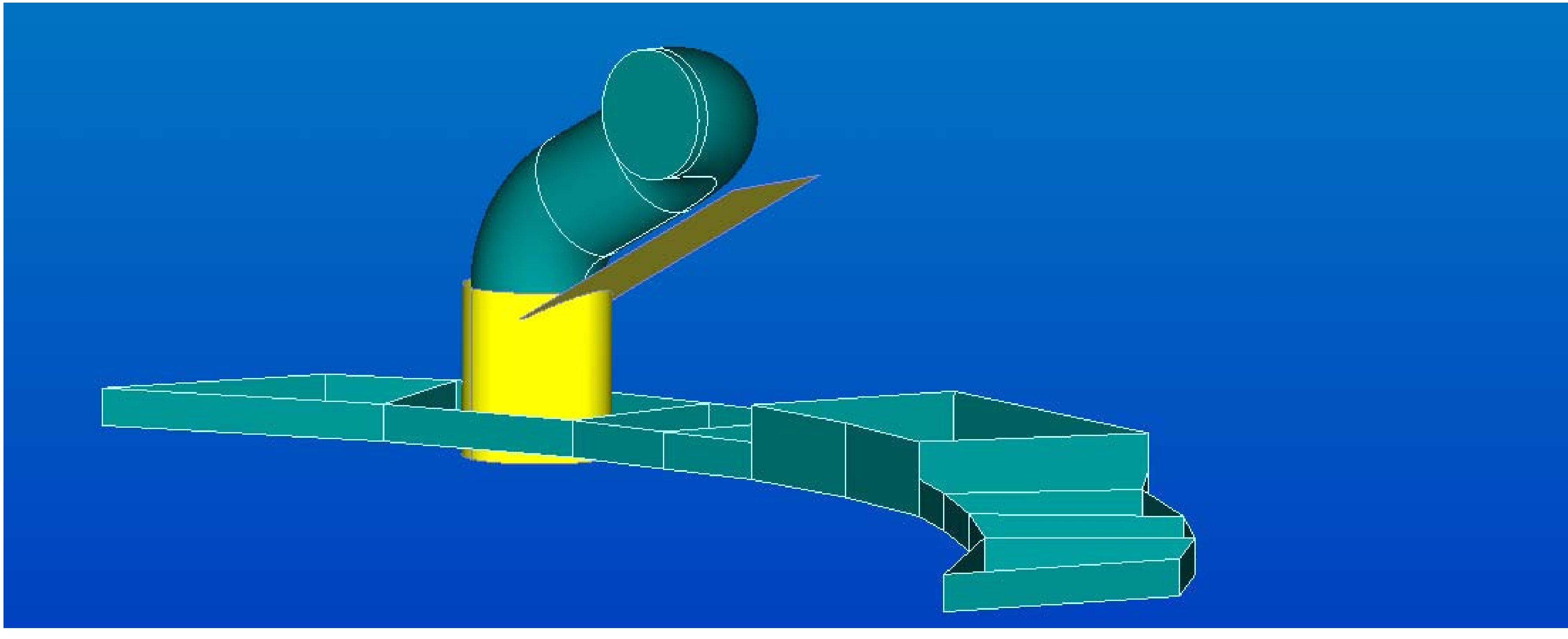


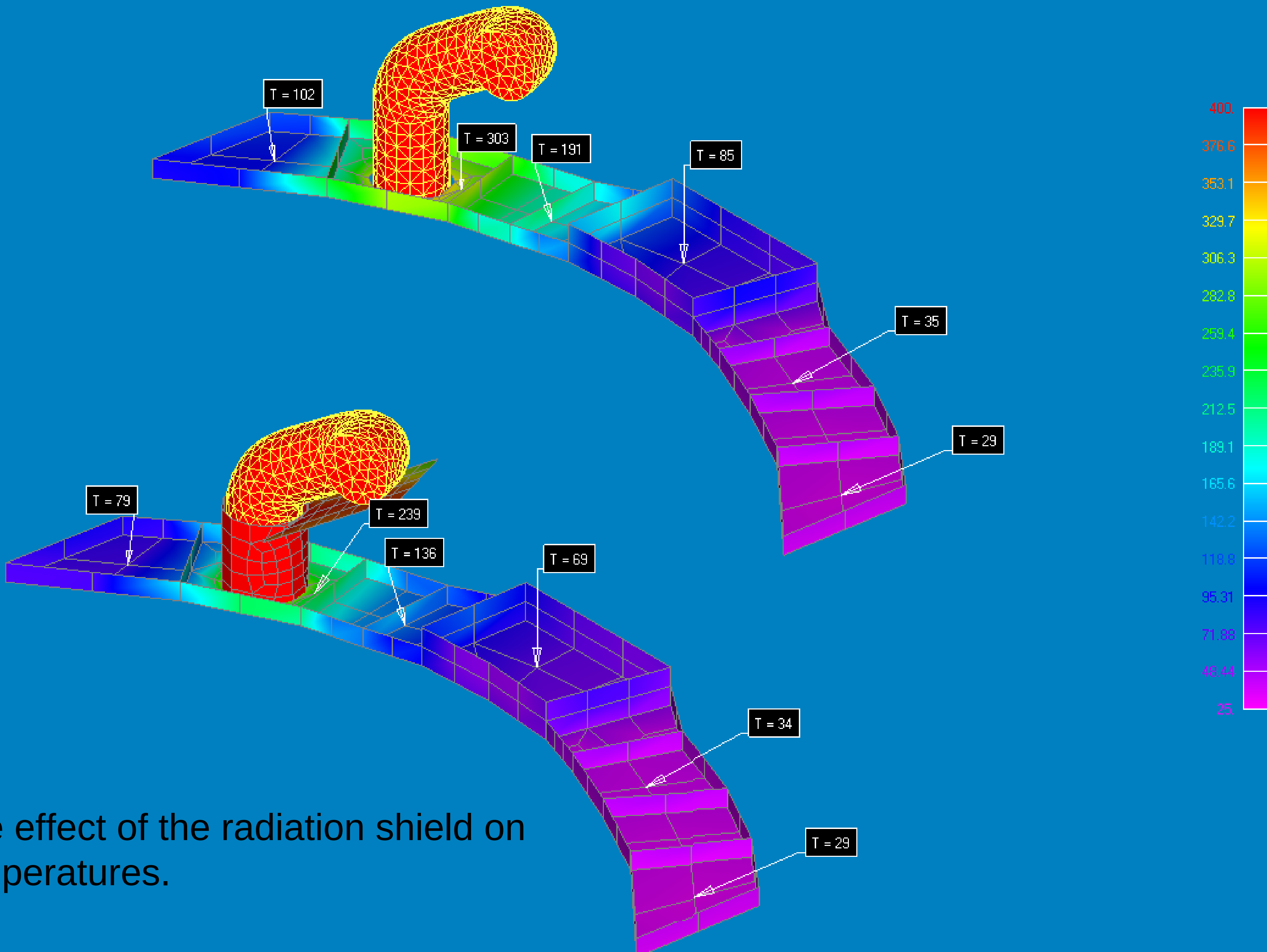
The results of the two models compared.

Comments

The two models have reasonable agreement but some discrepancies. The Nevada model shows lower temperatures for the areas adjacent to the pipe. For the two nodes to the right of the pipe the Nevada model was a straight cylinder while the actual pipe bends over these areas so the view factors between the pipe and strut in the Nevada model will be smaller. However for the node to the left of the pipe the view factor between this area and the pipe is the same yet the temperature is lower in the Femap model. This is due to the Lambertian ray distribution that Nevada uses; for the slanted pipe less rays hit this area than for the vertical pipe.

Add a radiation shield to the pipe.





The effect of the radiation shield on temperatures.

Conclusions

- Useful results can be obtained from building a very simple model (in this case 7 nodes).
- The CAD geometry must be simplified in order to run radiation solvers.
- Adding a radiation shield to the pipe lowers the maximum temperature in the strut by about 60 ^{O}C.