Fluid-flow modeling: An array of arrows and color

(MIR broad view pic) INL's Matched Index of Refraction facility, or MIR, reveals how well fluid-flow computer simulations will work in the real world. This is important: Once engineers know their simulations are good, they can draw up better designs for everything from *(building design pic)* office buildings to nuclear reactors *(NGNP core schematic)*.

To run an experiment at MIR, scientists *(model pic)* submerge a quartz model of their design into MIR's huge recirculating mineral-oil bath *(MIR schematic)*. This oil is seeded with tiny silver-coated balls. Laser pulses *(laser pic)* blast into the oil flowing past the model, and cameras snap photos *(camera pic 1)* as light reflects off the tiny spheres *(camera pic 2)*. Computer algorithms then analyze the pictures to reveal details of the spheres' — and thus the oil's — flow. These measurements can then be compared with the computer simulations' predictions.

The algorithms crank out huge numbers of velocity vectors — up to 7,000 per picture. Here is what a few of them look like.

(vector pic 1) These images show how helium coolant would flow through part of a gas-cooled nuclear reactor. The arrows point in the direction of flow, and the different colors indicate different velocities. Red is fast, and green and blue are slow.

The black bars represent the quartz model's solid posts.

(vector pic 2) Sometimes these posts vibrate slightly; the computer algorithms show this movement as a chaotic jumble of green arrows. *(vector pic 3)*

(vector pic 4)

(vector pic 5) The technique can show where flow gets hung up and recirculates — like in the center of this picture — alerting engineers that they may need to tweak their designs.

(vector pic 6) A close-up of part of the flow.

Flow can be represented as streamline diagrams, too *(streamlines pic)* — elegant black-and-white renderings that look like the cross-sections of trees. In either case, scientists get a valuable inside look at how well their computer simulations, and their designs, will work.