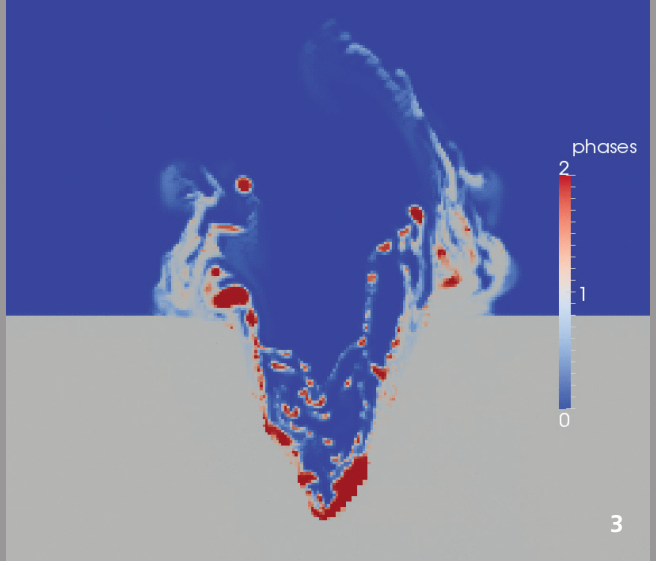


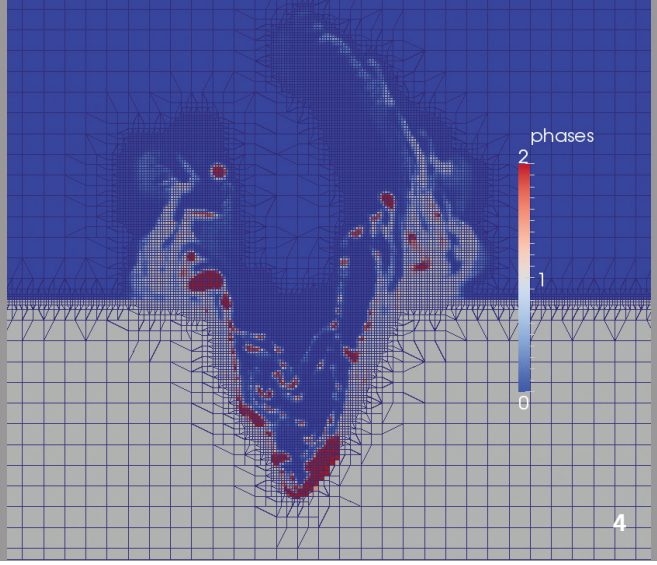


# MODELING AND SIMULATION OF MELT ABLATION

### Task

Drilling/ablation by melt ejection is the most efficient process for manufacturing holes with a large aspect ratio in materials with a molten phase. The complex behavior of the melt and the influences of vaporization, surface tension and process gases still remain an object of research.

### Method

An operational model is required to optimize productivity and quality. This model should describe the key physical phenomena responsible for the ablation and the melt flow.

### Result

A finite-volume CFD code with volume-of-fluid (VoF) processes for calculating the free surfaces was implemented. An enthalpy model was created for the phase transitions (melt, vaporization). The beam propagation within the hole is at the moment based on an advection scheme (geometrical optics) but is about to be extended to a beam propagation scheme (wave optics). A Continuous-Surface-Force (CSF) model is used to model the recoil pressure of the vaporization and other surface forces such as the surface tension.

Particular attention was paid to adaptive meshing, which is required in particular at the phase boundaries in order to resolve the resulting fine structures, which are based on the mechanisms of thin film flow with surface tension and vaporization.

### Applications

The presented simulation describes the absorption of laser radiation on workpiece surfaces, the thermal diffusion and convection, and the melt flow driven by vaporization. The simulation has no restrictions in terms of the geometrical form of the ablation area produced and can, for instance, describe disconnected molten areas. It can therefore be used wherever materials are melted using laser radiation and whose melts are driven to a certain extent through vaporization. It has initially been developed for use in drilling using laser radiation.

### Contacts

Dipl.-Phys. Urs Eppelt
Phone +49 241 8906-163
urs.eppelt@ilt.fraunhofer.de

Prof. Wolfgang Schulz
Phone +49 241 8906-204
wolfgang.schulz@ilt.fraunhofer.de

*3 Simulation of the phases: solid (gray), liquid (red) and gaseous (blue).*

*4 Simulation result with illustration of the adaptive meshing.*