SPIRIT Demystifies the Physics of a Powerful Explosion

Project Purpose: *Use High Performance computing resources to simulate the physics of a simple realistic numerical simulation of the transitions during a violent explosion.*

Anatomy of an Explosion:

Dr. Alexei Y. Poludnenko, a researcher at the Naval Research Laboratory in Washington, D.C., is investigating how slow-burning flames under the right conditions can be transformed to produce dramatically high pressures and strong shock waves, better known as detonations. Detonations in confined places, such as channels and pipes, have been studied for years. But what about a fuel-vapor cloud where there are no walls to confine it? Can a subsonic flame lead to a detonation in such a cloud?

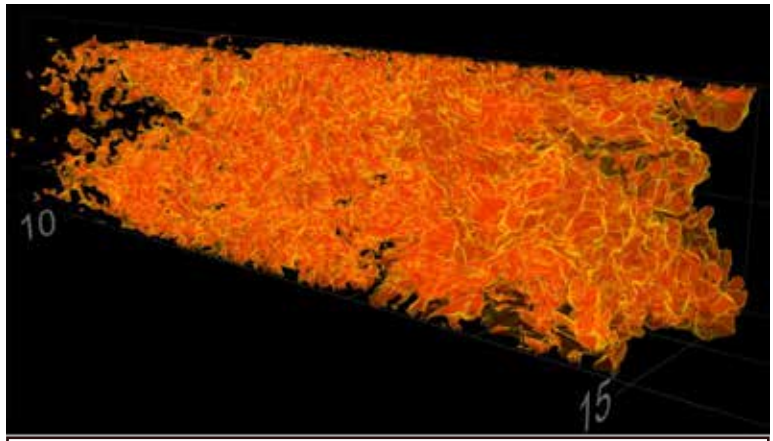
Dr. Poludnenko and his team are studying whether or not a controlled burn (known as deflagration) can lead to a detonation, what is known as the deflagration-to-detonation transition or DDT. Understanding this transition has crucial applications to the safety of fuel storage facilities and chemical plants. Knowing how to harness DDT also promises to revolutionize propulsion systems by introducing detonation engines.

Dr. Poludnenko models unconfined DDT on ARFL's Supercomputer SPIRIT located at Wright-Patterson AFB. Using thirty-two thousand cores on SPIRIT, he is developing numerical simulations which reveal that turbulent flames in unconfined media can become fast enough to produce detonations.

IMPACTS:

- *Insights into next generation efficient detonaton-based engines*
- *Safety of fuel storage and chemical processing facilities*
- *Understanding of dwarf stars and dark energy*

Graphic scene of a facility undergoing destruction and possible loss of life due to a violent explosion.



Complex structure of the turbulent chemical flame in a stoichiometric methane-air mixture. Shown is the isosurface of the fuel mass fraction corresponding to peak reaction rate. In this simulation, burning is fully resolved on all scales. Image rendering by the Department of Defense HPCMP Data Analysis and Assessment Center.

Alexei Y. Poludnenko, Naval Research Laboratory, Washington, D.C., utilized 7,000,000, hours on the AFRL DSRC HPC System, SPIRIT, In addition, this project has performed many successful runs using Sandia National Lab's code Athena-RFX.