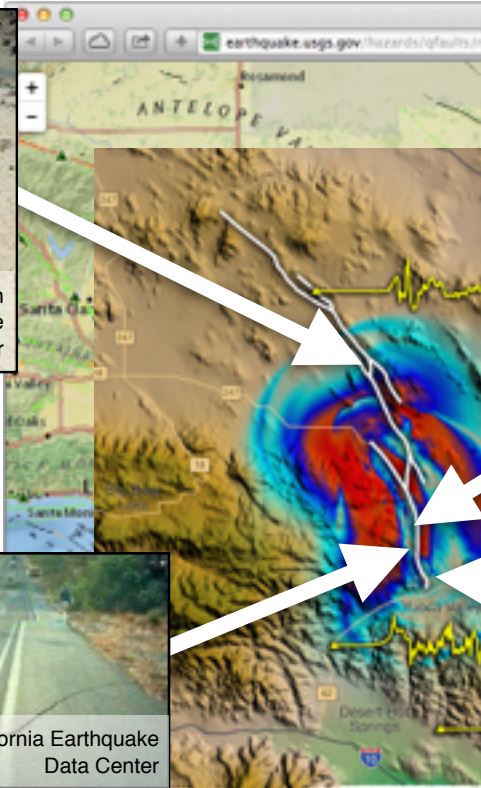


High Performance Earthquake Simulations

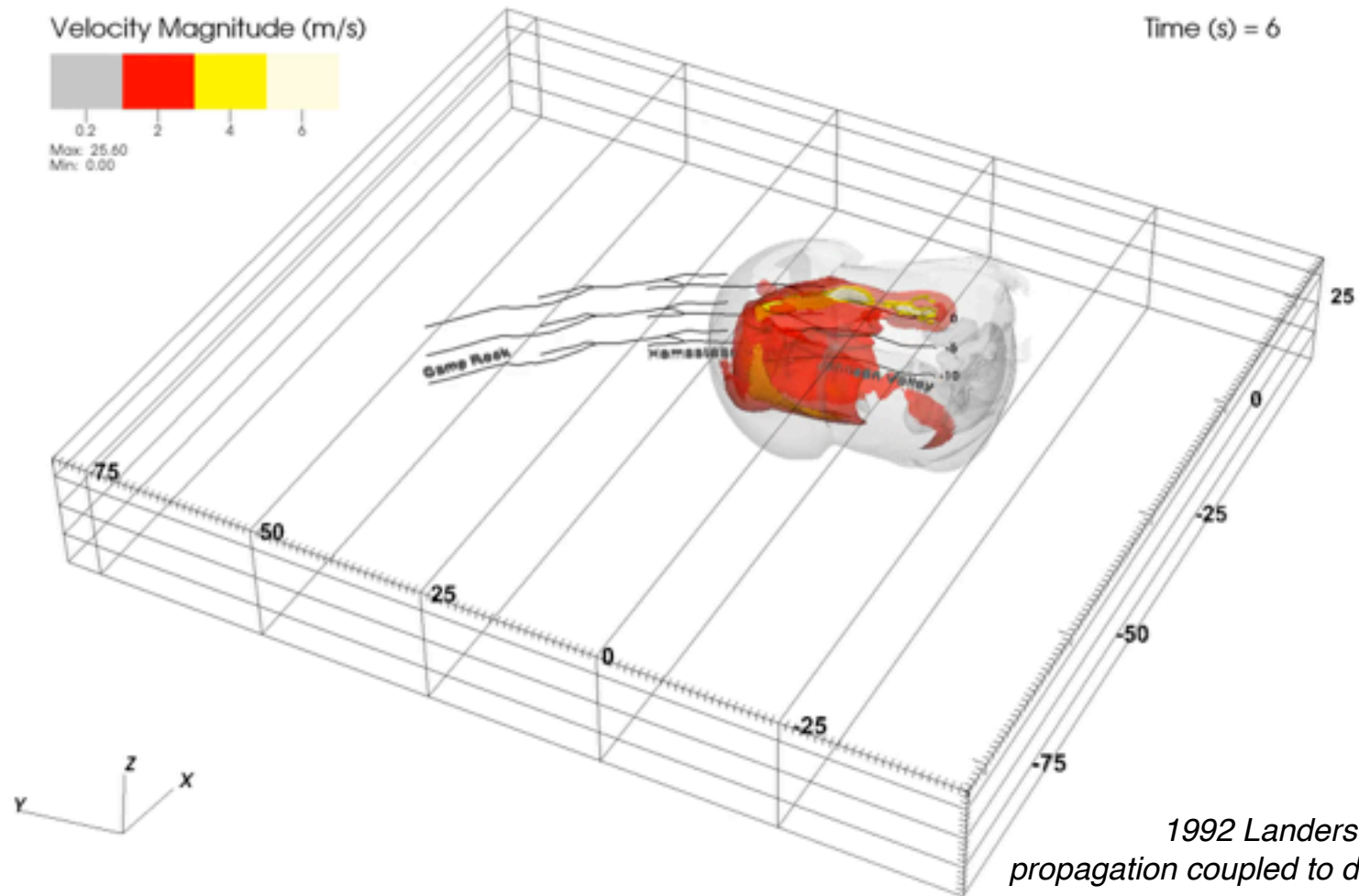
Alexander Breuer



1992 Landers

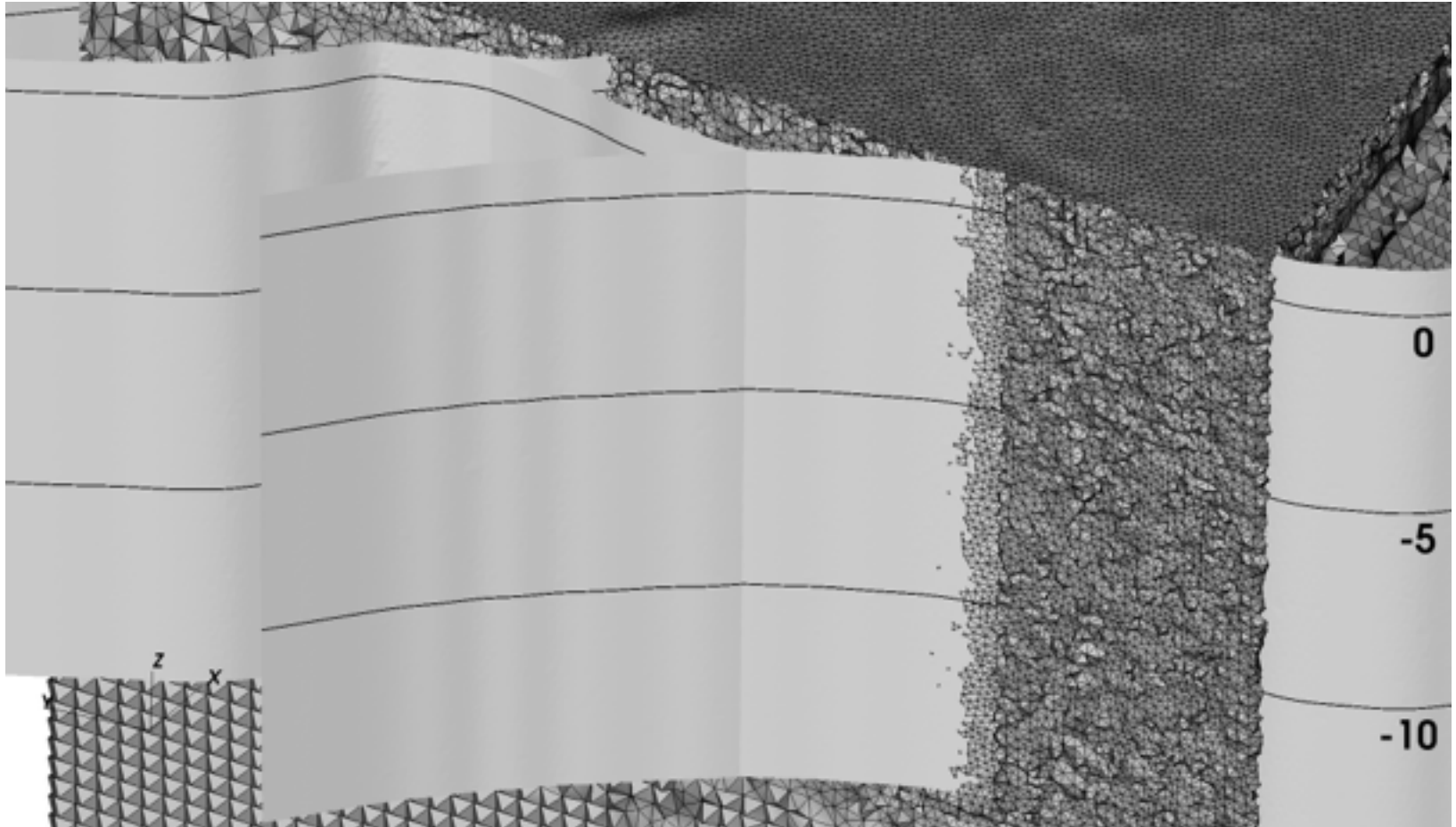


Wave Propagation



1992 Landers: Seismic wave propagation coupled to dynamic rupture propagation, 199 Mio. elements

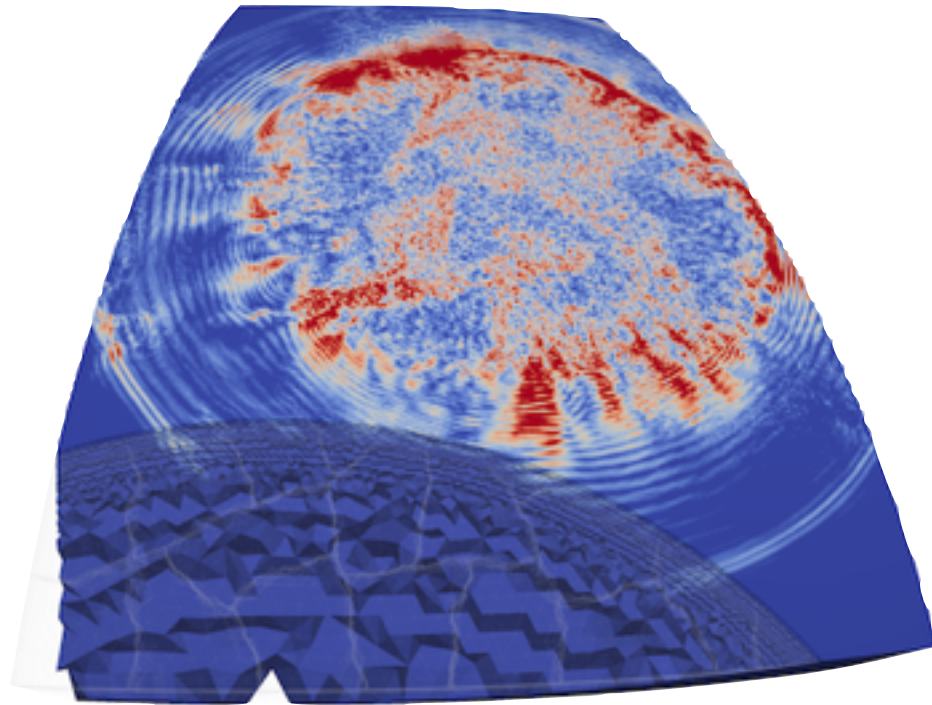
Mesh



1992 Landers: Mesh, 199 Mio. elements

SeisSol

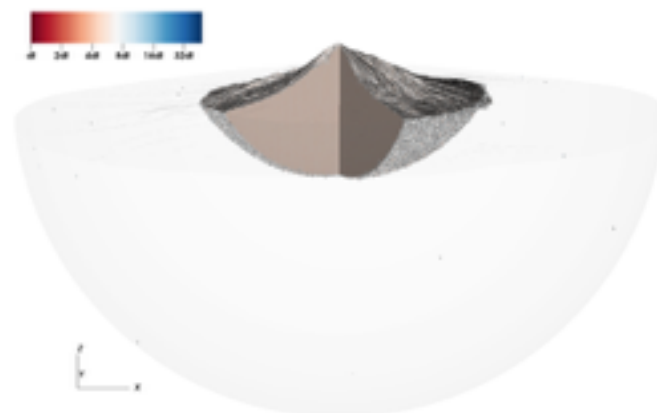
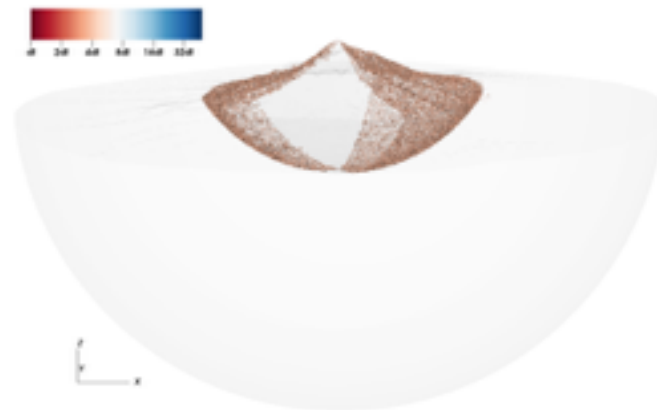
- Dynamic rupture earthquake simulations with ADER-DG FEM
- Full elastic wave equations in 3D and complex heterogeneous media
- Unstructured tetrahedral meshes
- <https://github.com/SeisSol/>



L'Aquila: Seismic wave propagation

Doctoral Research

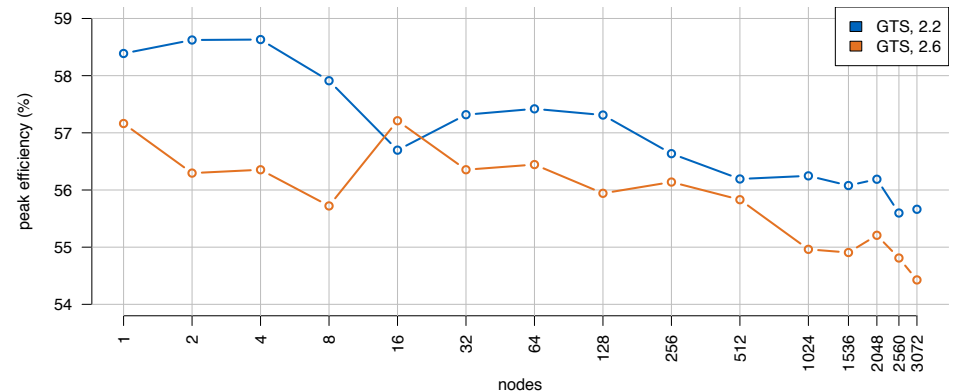
- **Single Node:**
 - Kernels
 - OMP
 - Custom memory layout incl. alignment and NUMA-awareness
- **Multi Node:**
 - Asynchronous MPI incl. LTS
 - Prioritization of crucial work
 - Communication “as is”, no additional MPI-buffers
- **Algorithmic: Clustered Local Time Stepping**



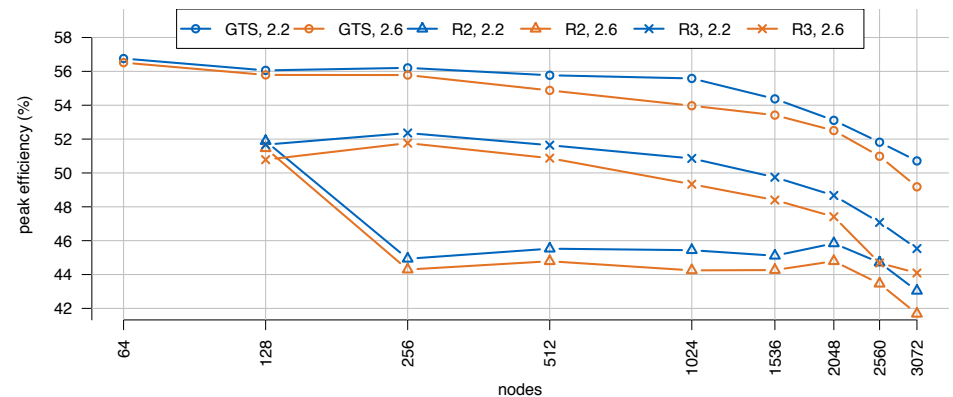
Two local time stepping clusters of a 99 Mio. element setup

Results

- **Weak Scaling**
 - **8.6 PFLOPS @ 8,192 Tianhe-2 nodes (~half machine)**
 - **1.95 PFLOPS @ SuperMUC-2 (69% of HPL)**
- **Production**
 - **Dynamic Rupture: 1.4 PFLOPS @ SuperMUC-2 (51% of HPL)**
 - **LTS Wave Propagation: 1.3 PFLOPS @ SuperMUC-2 (46% of HPL)**
- **High order speedup: 5x-10x over “classic” implementation, full machine LTS over GTS +5.6x**



GTS weak scaling: SuperMUC-2



GTS and LTS strong scaling: SuperMUC-2