

# TERRA-NEO

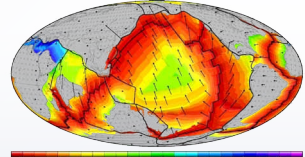
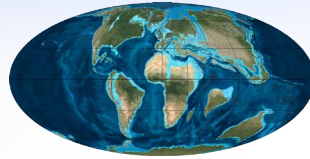
## Integrated Co-Design of an Exascale Earth Mantle Modeling Framework

### Challenges in Geophysics

- Frontier in coming decades: Rheology
- Global nonlinear heat convection and flow problem
- High-resolution for long-term simulation
- Inherent uncertainties of parameters
- Lack of initial condition renders it an inverse problem

### Challenges in Exascale

- Model adapted accurate, stable hybrid DG-FEM
- Communication-avoiding asynchronous multigrid
- Heterogeneous architecture
- Power efficiency
- Algorithmically supported resilience



Age of Oceanic Lithosphere (mio. years)

### Visions for Geophysics

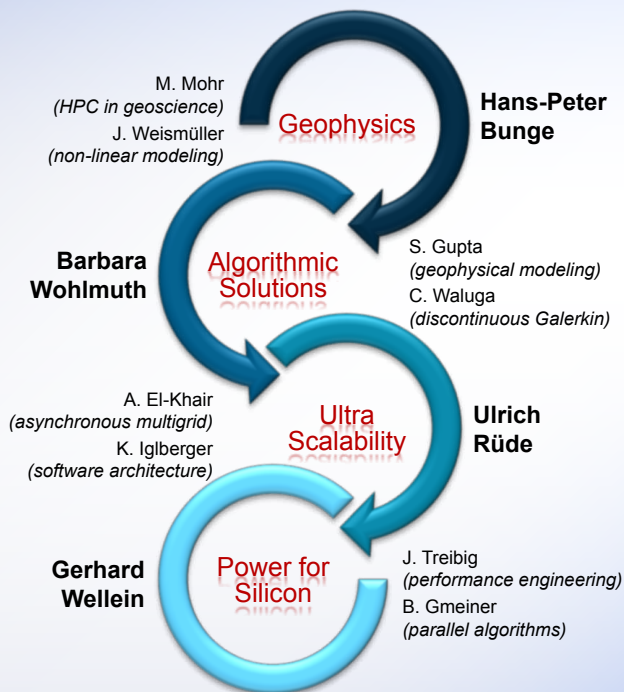
- Fundamental new insights into earth dynamics
- Crucial rheologic constraints from inversion of geologic data

### Visions for Exascale

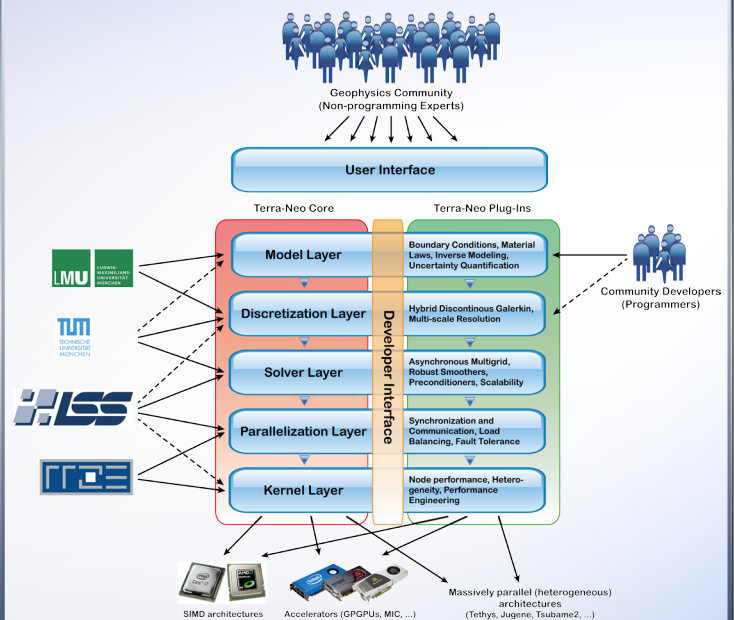
- Ultra-scalability beyond  $10^8$  cores
- Novel asynchronous algorithmic paradigms

**TERRA-NEO: A new kind of community code enabling cutting-edge research in the coming decades**

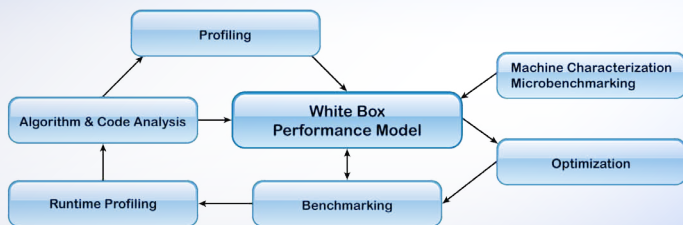
### 21st Century Exascale Computational Science



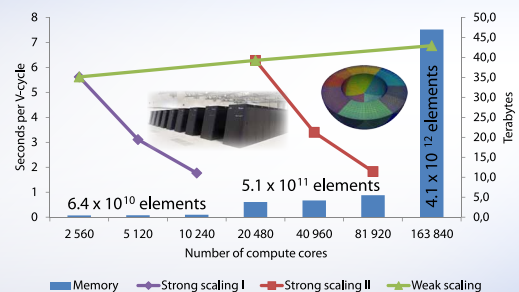
### Software Structure



### Systematic Performance Engineering



### Ultra-scalability on Jugene



### TERRA-NEO will contribute to the following subtopics

- Computational algorithms** by developing efficient exascale enabled hybrid discontinuous Galerkin finite element discretizations in combination with ultra-scalable, communication avoiding multilevel solvers
- Application software** by developing innovative models for stochastic geophysical forward and inverse problem
- Programming** by using conservative tier base software for a radical tier asynchronous execution paradigm

### Project Consortium

- Cross-disciplinary links: Mathematics, informatics, geophysics, HPC systems
- Spatially close: Erlangen - Munich
- Scientifically close: Joint CSE activities, joint publications, cross PhD advisors
- Gender & diversity balance
- Fast track early careers
- Track record of highly effective outreach activities