SAND2011-8565C

TCG-I: Shock & Coupled Physics Theory Sierra/Solid Mechanics Progress

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DoD/DOE Joint Munitions Program Rodeo

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Presentation Overview

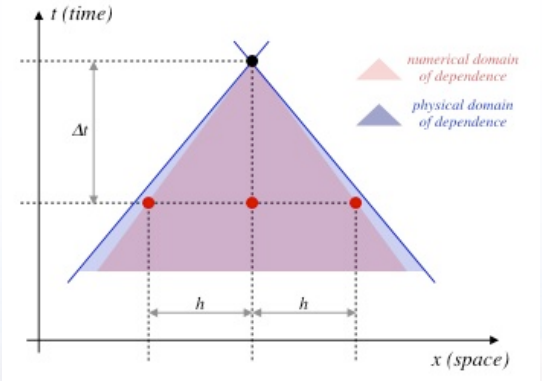
- Overview of recent progress for Sierra/SM
  - Pervasive structural and material failure modeling
  - Modeling of composite structures, e.g., RC
  - Coupling to shock codes, e.g., CTH
  - Coupling to ALEGRA for DoD for ME/EM analyses
- An introduction to Sierra usability initiative
  - Sierra UI's past and present
  - Where we are going with Sierra UI next
  - Distribution and packaging tasks for DoD sites
- Questions and Answers
  - More technical details at TCG-I breakout session

FY11 Milestone Summaries

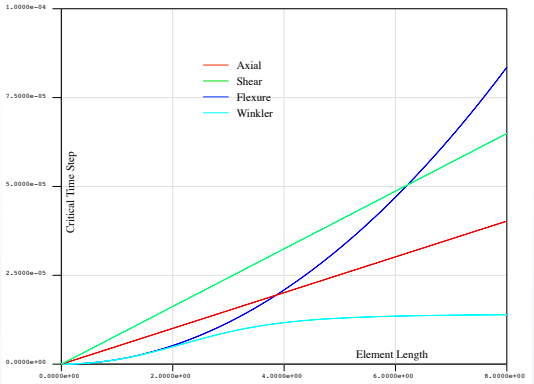
- **Q3FY11**
  - Theory and practice for embedded 1D structural elements capabilities for modeling of composite structures and materials e.g., reinforced concrete
- **Q4FY11**
  - Demonstration of generalized Sierra/SM X-FEM and related capabilities to include pervasive failure mechanisms and 3D failure response
- **Q4FY11**
  - Development and documentation of improved methods for coupling of Sierra/SM and CTH to provide more accurate results for coupled shock-target simulations

Theory and Practice for Reinforcement

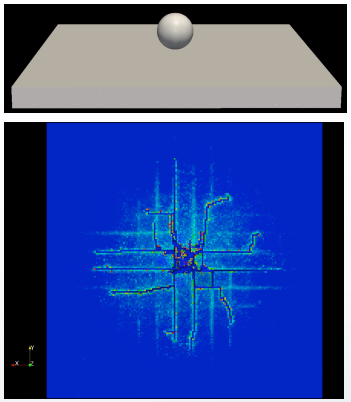
- **Discrete modeling of structural reinforcement**
  - **Goal: provide variety of analysis tools for composites**
  - **Result: development of relevant analyst guidelines for modeling composite reinforcement in structures**



CFL Stability Theory



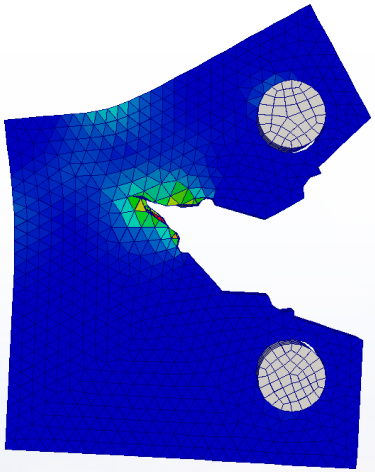
Element Choice Guidelines



Practical Examples

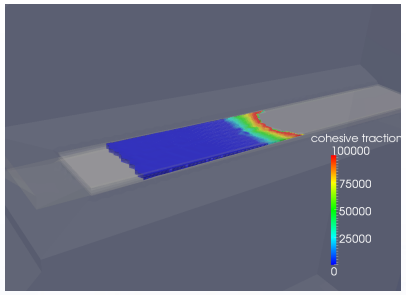
Structural and Material Failure

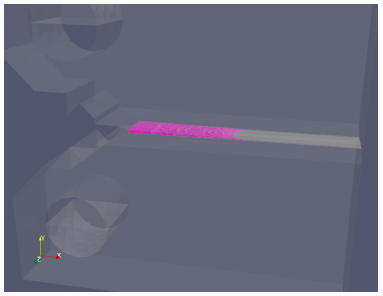
- **Develop and deploy within Sierra/SM advanced techniques to model pervasive failure**
  - **Examples: XFEM, Peridynamics, NBT, SPH**

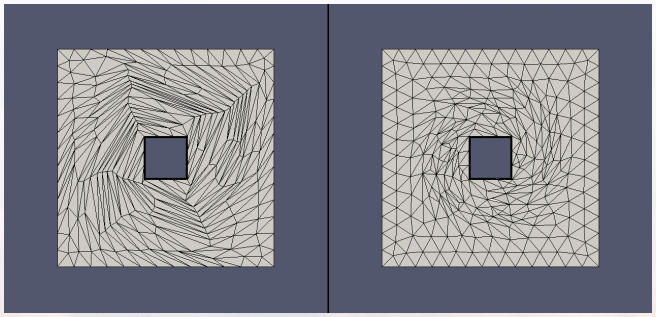


XFEM Material Failure Predictions

Ductile failure models



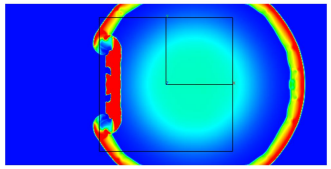




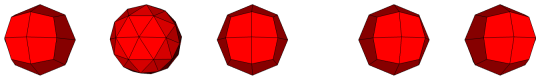
Effective Remeshing Strategies

Shock-Target Coupling Techniques

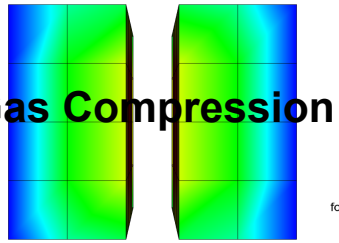
- **Gain improvements in Fortissimo capabilities**
  - **Result: better performance from CTH/Sierra coupling**

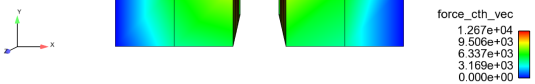


Flyer Plate V&V

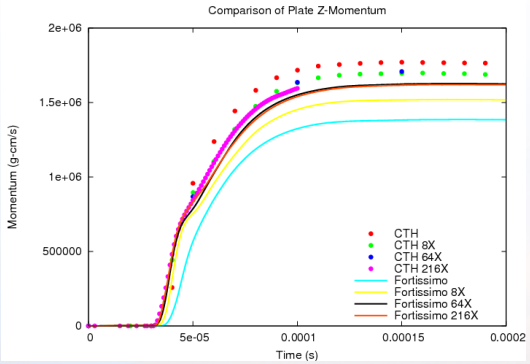


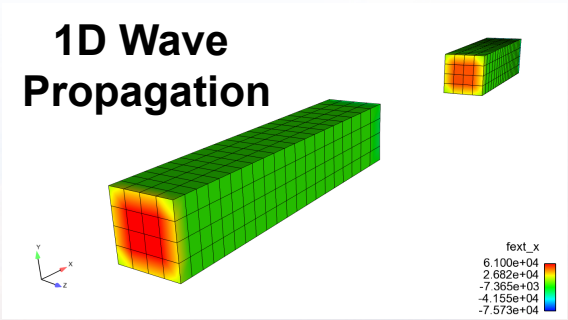
Spheres in Constant Pressure Gas



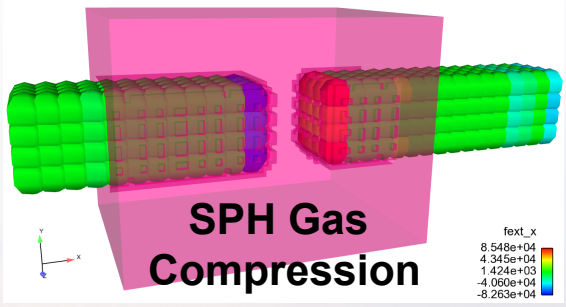


Gas Compression





1D Wave Propagation



SPH Gas Compression

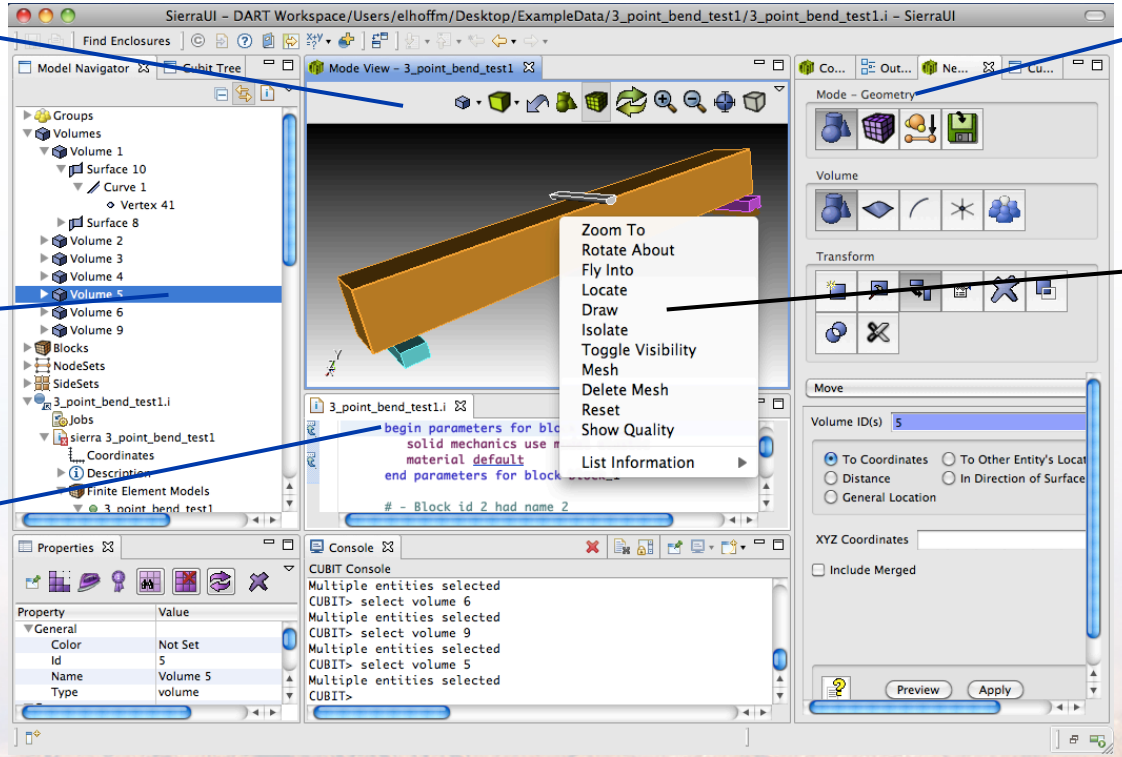
Continued Progress on Sierra/UI

- **Usability initiative for Sierra-friendly GUI**
  - **DoD needs are key program drivers for this enterprise**

Integrated VTK Geometry and Mesh

Unified Model Tree

Sierra Input Deck (Text and Tree)



Command Panel

Contextual Menus

Questions and Answers

Note: more technical details on Sierra/SM progress and capabilities will be provided in the TCG-I Breakout Session on Thursday

Back Up Slides

Sierra Coupled Physics Four-Question Chart

What are you trying to do in this task?

- *Extend Sierra/SM capabilities to model coupled physics problems of joint DoD/ DOE interest*
- *Document these capabilities (theory and practice) sufficiently to aid new users in performing accurate analyses*
- *Provide individual support for more advanced DoD users of Sierra/SM*

What makes you think you can do it?

- *Successful precedents for this work already exist within Sierra's DOE scope*
- *Now have a growing community of Sierra analysts within DoD*
- *Currently working on next-generation capabilities of import in national-security settings, e.g., UQ*

What difference will it make?

- *Permit DoD analysts to solve complex coupled-physics problems using codes from within federal complex*
- *Improve productivity of DoD mechanical analysis processes (important given budget duress)*
- *Support increasingly higher levels of fidelity in computational analysis as HPC resources become more available*

What/When/To Whom Will You Deliver?

- *What: regular releases of Sierra/SM applications, including appropriate documentation and example sets*
- *When: same distribution cycle as DOE customers (approximately every 6 months)*
- *To Whom: disseminated to DoD labs and HPC centers in source or binary form*
- *TRL: 6/7, depending on specific subtask*

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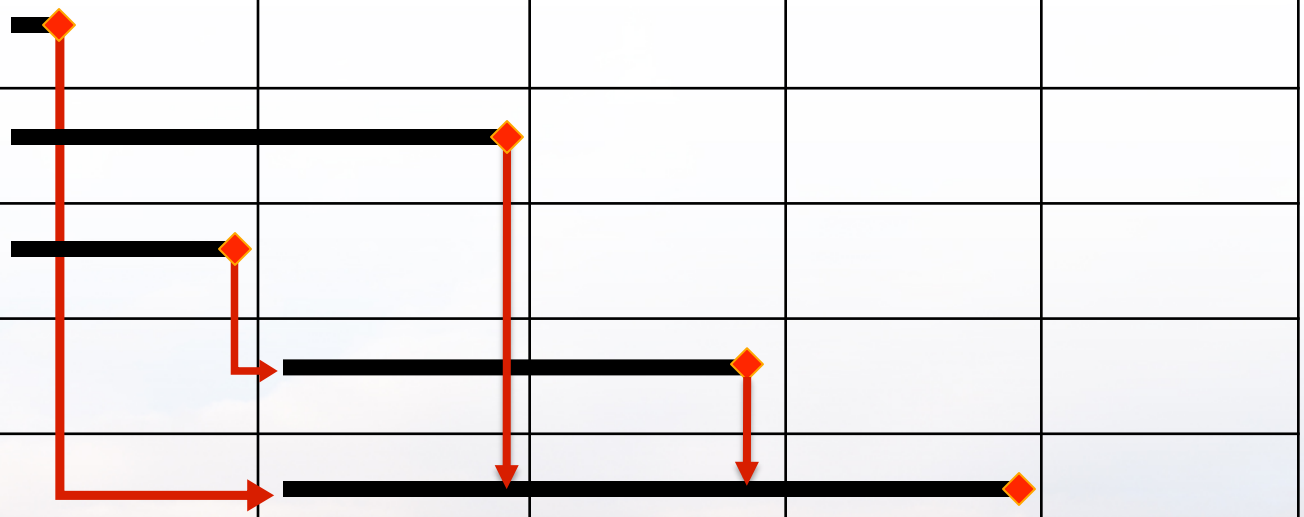
Sierra Coupled Physics Schedule

	FY12 Q1 Q2 Q3 Q4	FY13 Q1 Q2 Q3 Q4	FY14 Q1 Q2 Q3 Q4	FY15 Q1 Q2 Q3 Q4	FY16 Q1 Q2 Q3 Q4
Project Milestones					
Task 4 Milestones	**Composite Demo** ◆ **CTH/Sierra Prototype** ◆	**XFEM Demo** ◆	**CTH/Sierra Production Code** ◆	**Collapse Demo** ◆	**Inverse/UQ Methods** ◆
Subtask 4.1 1D Composite Reinforcement					
Subtask 4.2 Pervasive Failure Development					
Subtask 4.3 Eulerian-Lagrangian Coupling Algorithm R&D					
Subtask 4.4 Robust Eulerian-Lagrangian Coupling Implementation					
Subtask 4.5 Large Deformation and Progressive Collapse					
Subtask 4.6 Inverse and Uncertainty Quantification Capabilities					



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