



The Rocstar Simulation Suite

Background, Theory,
Compilation and Use

IllinoisRocstar LLC



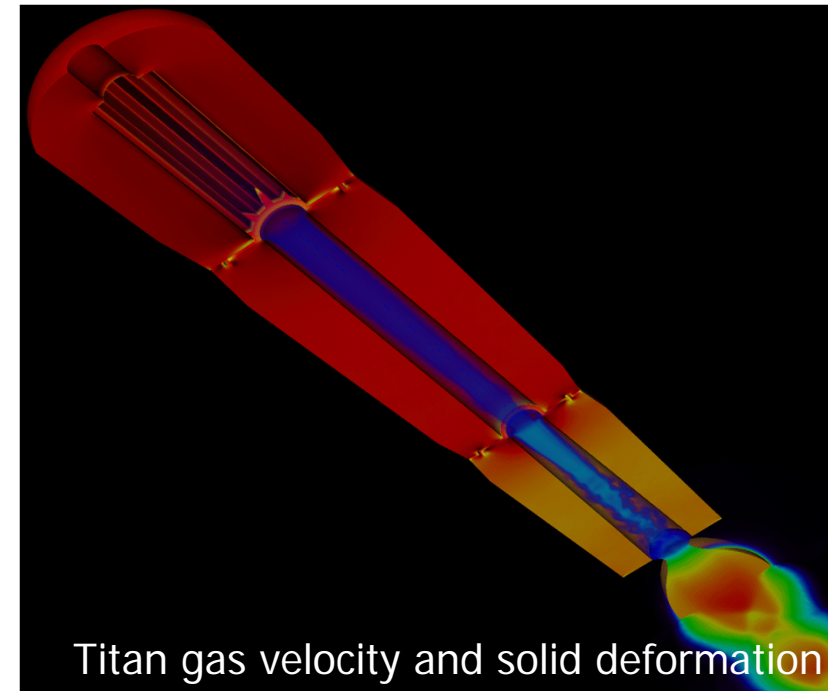
Overview

■ Part 1 - Familiarization

- Lesson 1: Background
- Lesson 2: Selected simulations
- Lessons 3-7: *Rocstar* Architecture Overview
- Lesson 8: Building *Rocstar*
- Lessons 9-10: Running *Rocstar*
- Lessons 11-12, 14: Postprocessing

■ Part 2 – Use Case Examples

- Lesson 13: Attitude Control Motor – *Rocflo*
- Lesson 15: Attitude Control Motor – *Rocflu*
- Lesson 16: Elastic Piston (FSI)
- Lesson 17: Super Seismic Shock (FSI)
- Lesson 18: Shockpanel (FSI)



Rocstar Tutorial Preparation

- Set environment variables:
 - `ROCSTARTUTORIAL=`pwd`/RocstarTutorial`
 - `ROCSTARDATAROOT=`
 - `ROCSTARBIN=`
 - `PATH=${PATH}:${ROCSTARBIN}`
- `mkdir ${ROCSTARTUTORIAL}`
- `cd ${ROCSTARTUTORIAL}`
- `which rocstar`
- `which rocprep`



Section 1

Introduction to *Rocstar*

Background and History



Beginnings

Center for Simulation of Advanced Rockets - Overarching Goal: Simulation of solid propellant rockets from first principles



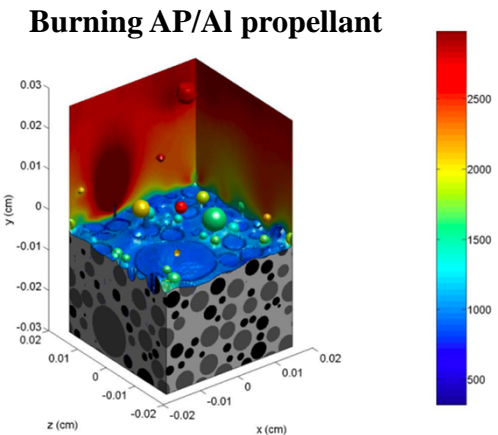
- Detailed, whole-system simulation of solid propellant rockets under normal and abnormal operating conditions
- Accurate models of physical components
- Subscale simulations of materials and accident scenarios
- Software framework to facilitate component integration
- Computational infrastructure to support large-scale simulations
- Research collaborations with government laboratories and rocket industry

Rocstar development and support now continues in IllinoisRocstar LLC

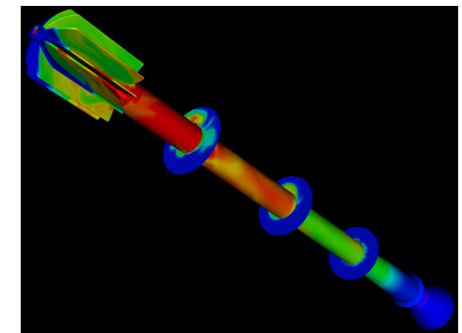


IllinoisRocstar Background

- IllinoisRocstar LLC in sixth year as an independent business
 - Generating increasingly large set of simulation technologies through investment and contracts
 - Focus on high-performance-computing and simulation; partnering for validation data
 - Macroscale fluid-structure-thermal analyses (*Rocstar*)
 - Mesoscale energetic material modeling (*IMSim*)
- Have been successful in the government contracting world
 - 41 R&D and technical support awards, including 7 Phase II SBIR/STTR contracts (5 currently ongoing)
 - Army, Navy, Air Force, MDA, DOE, NASA
 - OEM engineering analysis, *Rocstar* licensing
- University Partners: Illinois, Purdue, Notre Dame, Florida

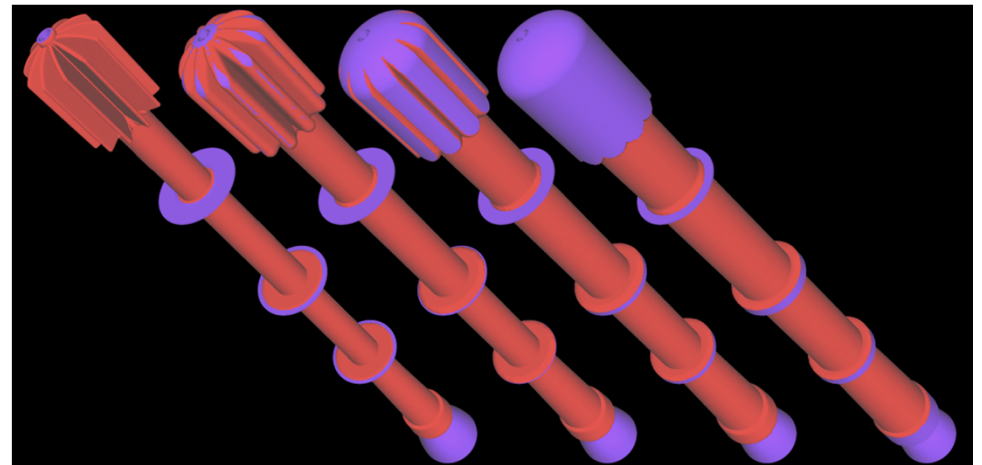
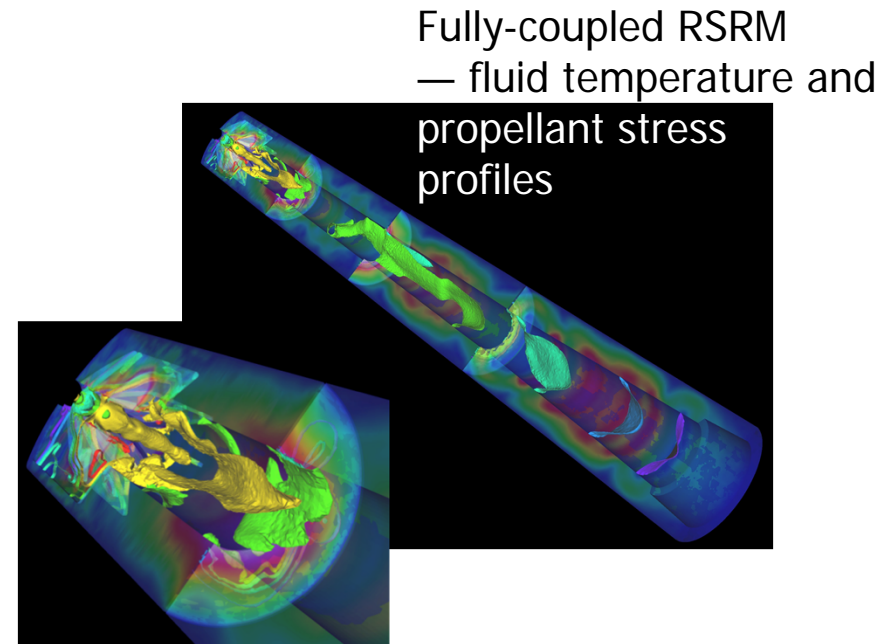


RSRM Ignition



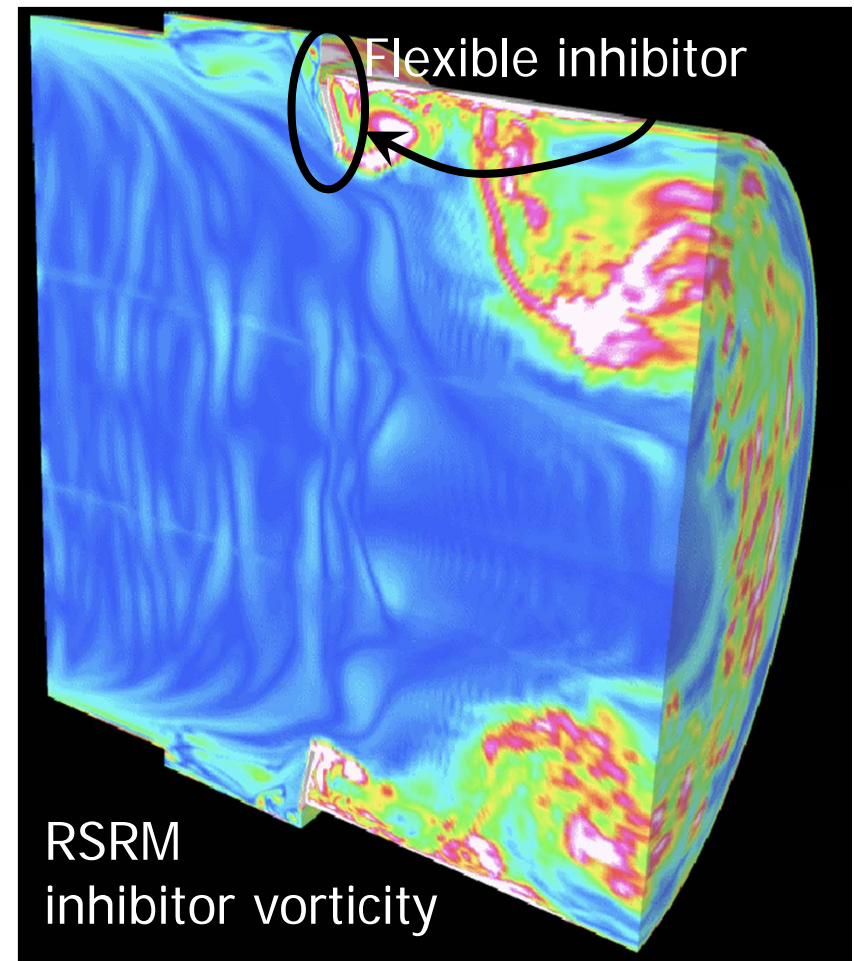
Challenges in Rocket Simulation

- Full 3-D modeling
 - Essential to capture physics
- Strong, nonlinear coupling among components
- Complex, dynamically changing geometry
- Extremely diverse spatial and temporal scales
- Complex material properties and physical processes
- Enormous computational capacity required for high-resolution simulation of full burn
 - Scalability to 1000s of processors essential



Rocstar Simulation Suite

- Scalable to thousands of processors
- Applicable to many other problems
 - Fluid-structure interaction
 - Reactive, multiphase flows
 - Acoustics
 - Examples
 - Naval ship stacks
 - Helicopter blades
 - Volcanoes
 - Tall buildings
 - Airfoils



Rocstar Components

■ Structural Mechanics

- *Rocfrac* – explicit, cracks
- ALE formulation
- Large deformations

■ Combustion: *Rocburn*

- Burn rate at propellant surface
- 1-D heat conduction
- Propellant heating & ignition



■ Fluid Dynamics

- *Rocflo* – structured mesh
- *Rocflu* – unstructured
- Explicit, ALE formulation
- Unsteady, compressible, viscous, turbulence, particles, smoke, radiation

■ Infrastructure

- *Rocman* – time stepping
- *Rocface* – interpolation
- *Rocom* – integration glue
- *Rocprop* – surface motion

Rocstar Simulation Suite

