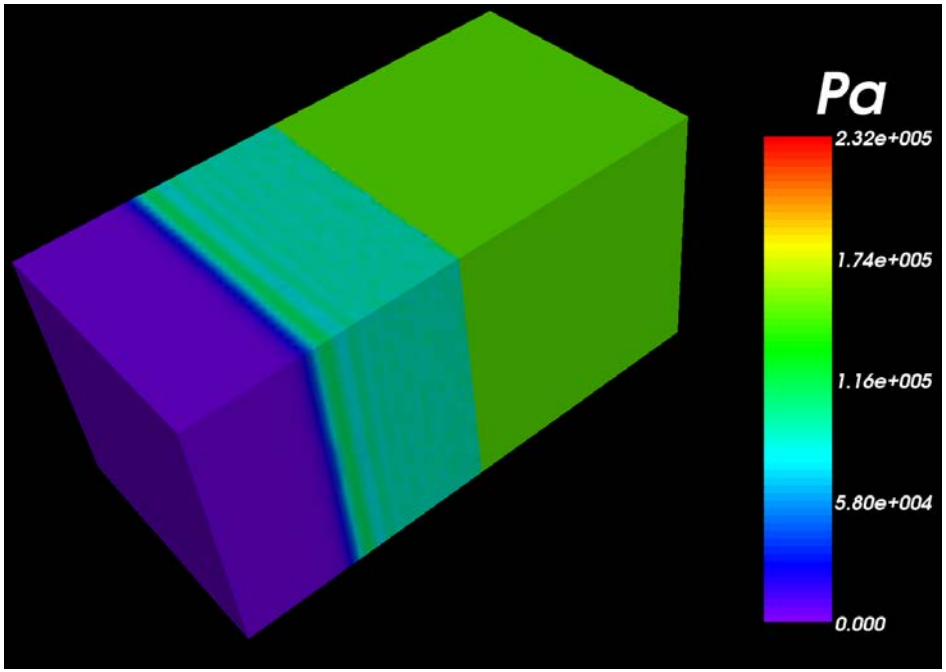
Section 16
Use Case 3:

Elastic Piston

Problem Description

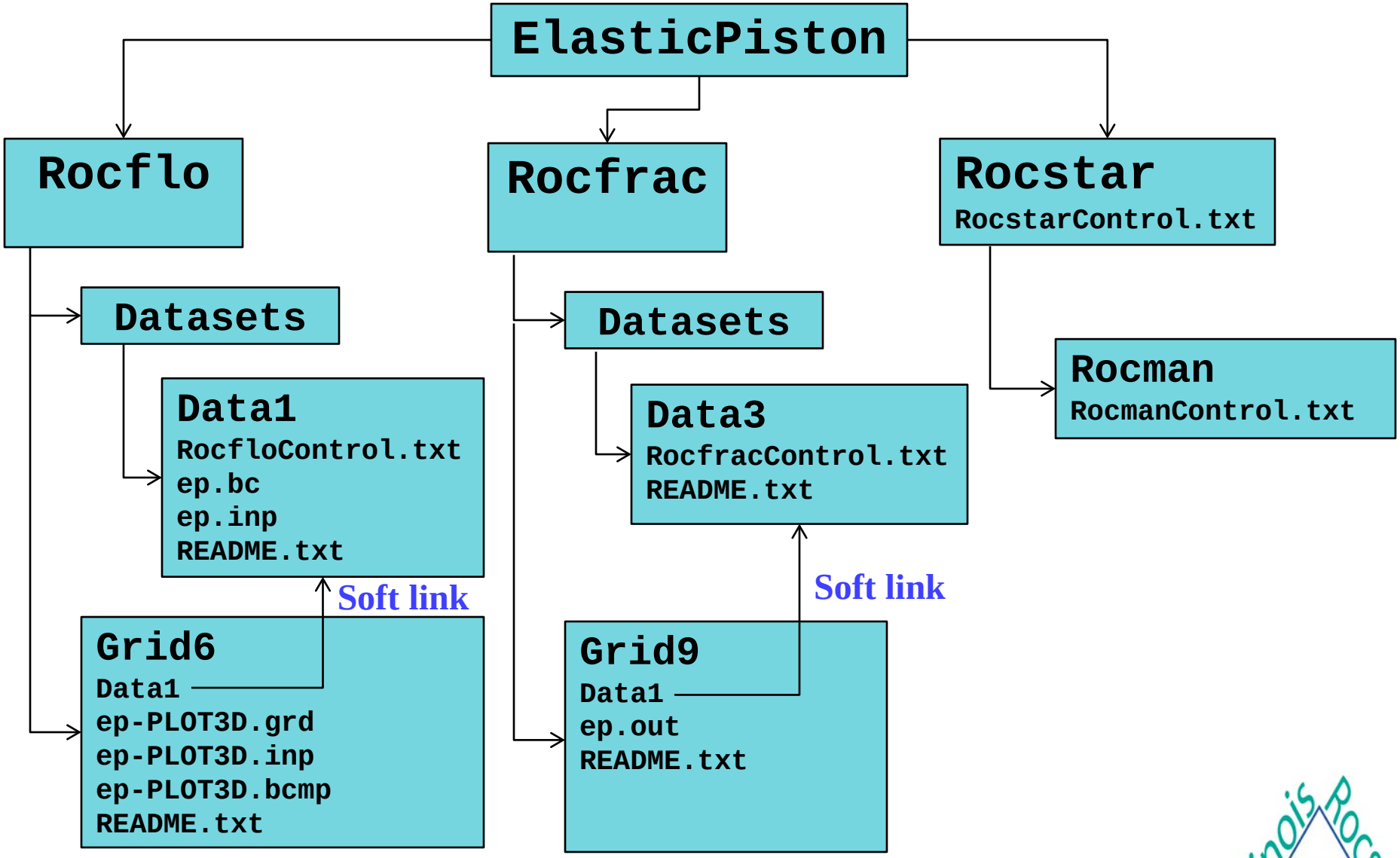
- Impulsive acceleration of fluid-solid interface
- Rocflo
  - block-structured hexahedral grid
  - 1 m cube, pressurized to 1.5×10^5 Pa
- Rocfrac
  - unstructured 10-node tetrahedral grid
  - 1 m cube, initially stress free
- Goal: assemble and run fully coupled fluid solid interaction problem



File Checklist

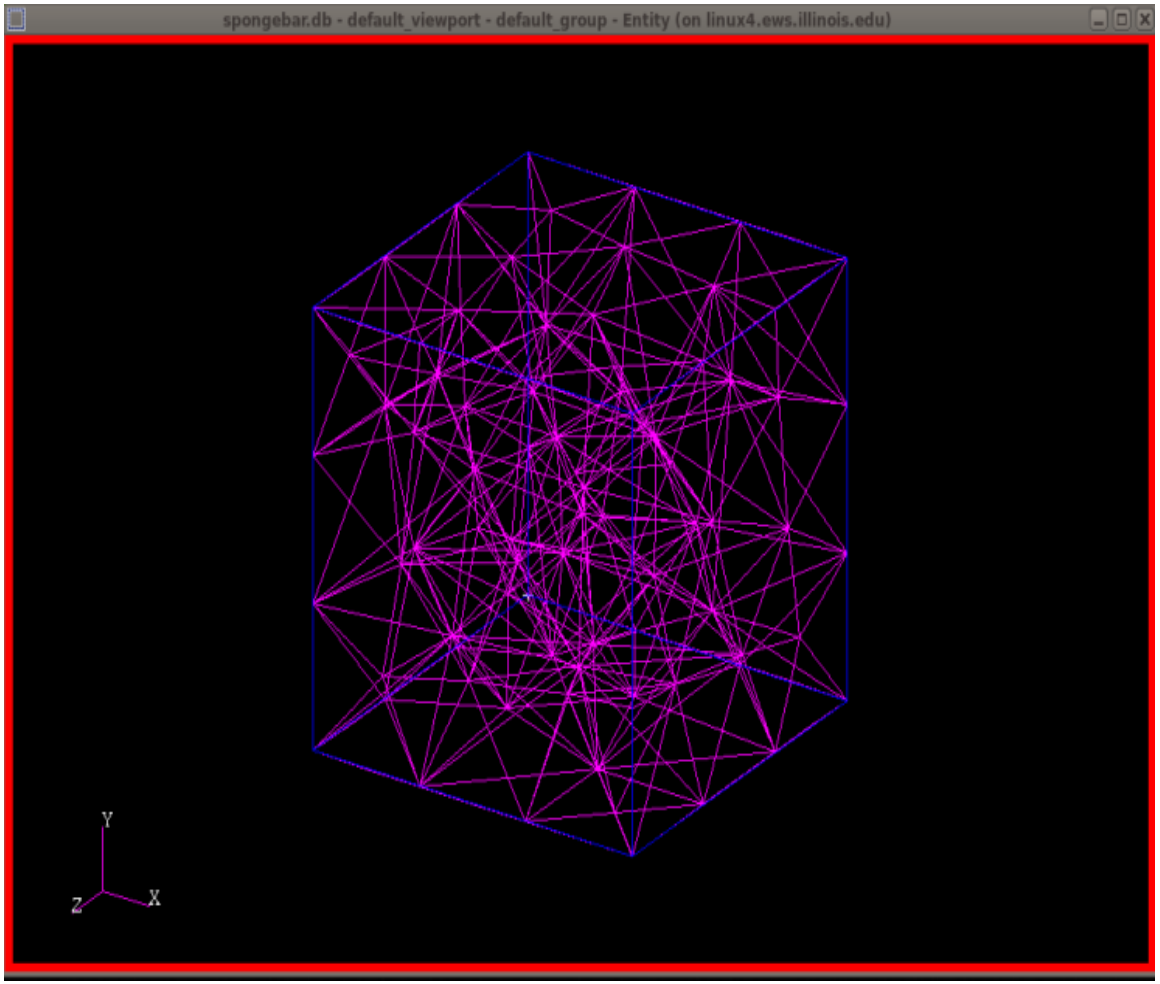
- Rocstar
  - RocstarControl.txt
- Rocman
  - RocmanControl.txt
- Rocfrac
  - RocfracControl.txt
  - ep.out
- Rocflo
  - RocfloControl.txt
  - ep-PLOT3D.inp
  - ep-PLOT3D.bcmp
  - ep-PLOT3D.grd
  - ep.bc
  - ep.inp

Examine NDA



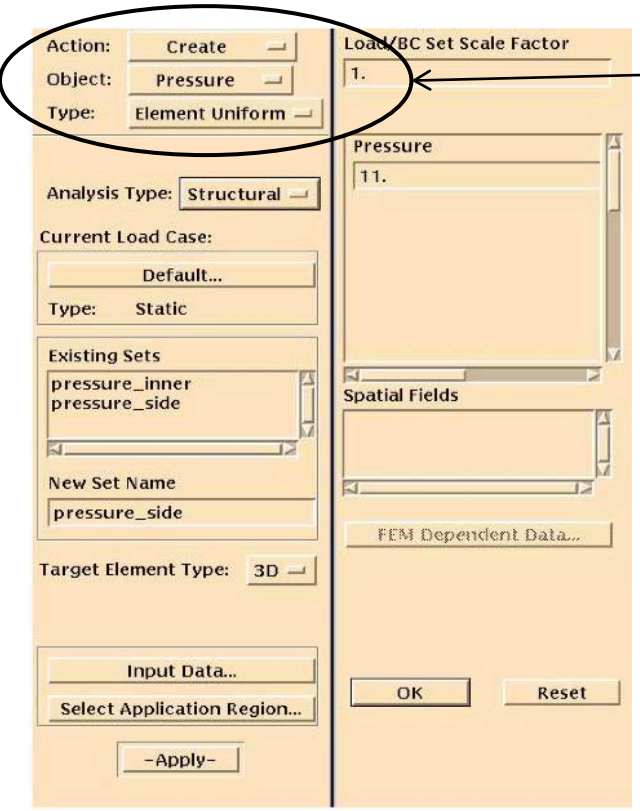
Create *Rocfrac* Mesh in Patran

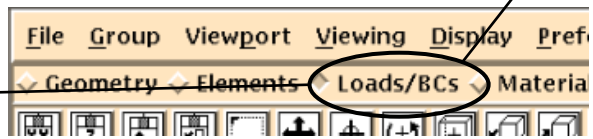
- Import DB into Patran and create volume mesh
- Linear and quadratic tetrahedrons
- Linear and quadratic hexahedrons
- No mixing

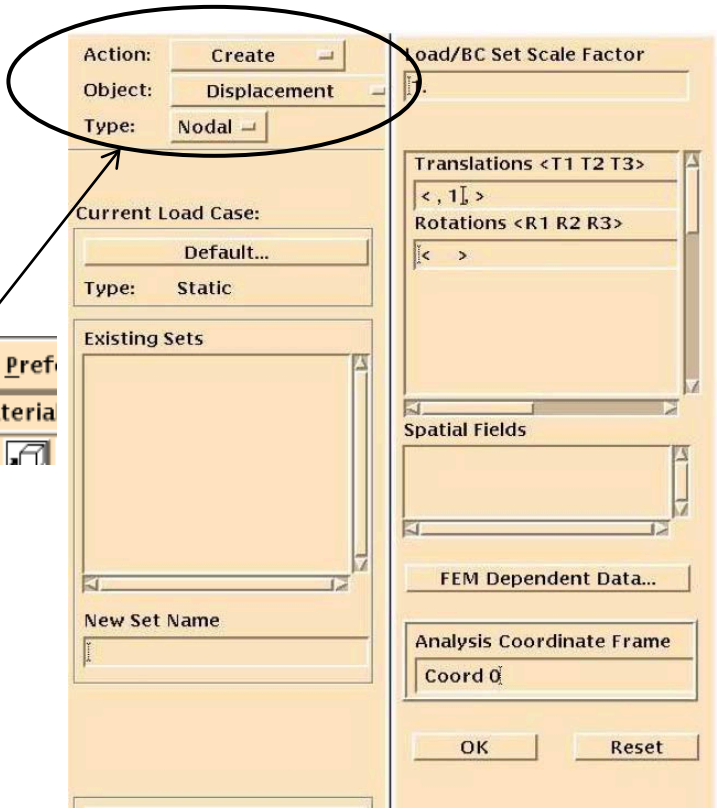


Rocfrac Boundary Conditions

- Loads/BCs - values are identifiers only
  - Translations
    - T1 – displacement
    - T2 – temperature
    - T3 – velocity



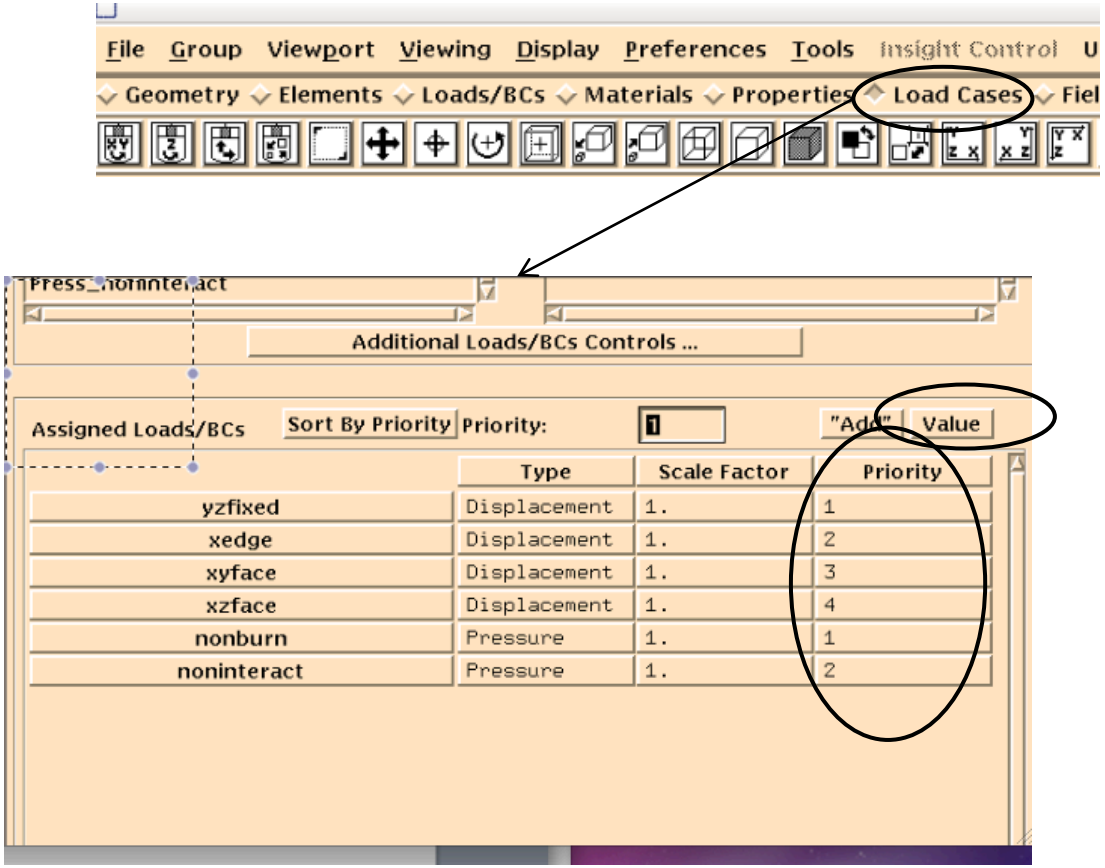




- Pressure Settings – coupling mode
  - 0 – non-burning
  - 1 – burning
  - 2 – non-interacting
- Assign identifiers to all physical boundaries
- Identifiers map to “BC cards” in *Rocfrac*’s RocfracControl.txt

Rocfrac Boundary Condition Priorities

- Load Cases: Set BC Priorities
- Determines which BC's take precedence in presence of two or more BC's on a geometrical entity
- Ensure priorities are set to Value, not "Add"
- Default IO:
  - <casename>.db: Patran reference file
  - <casename>.out: Patran Neutral File required for Rocfrac preprocessing



Run *Rocprep* on NDA

```
rocprep –A –o 1 6 –f 3 9 –d /IR/NDAs/ElasticPiston –t ./ –n 16 [–p ~/build/bin/]
```

Extract from NDA and preprocess to make full Rocstar dataset

Process Data 1 and Grid 6 for Rocflo

Process Data 3 and Grid 9 for Rocfrac

Root directory for NDA problem to be processed

Target dir for dataset

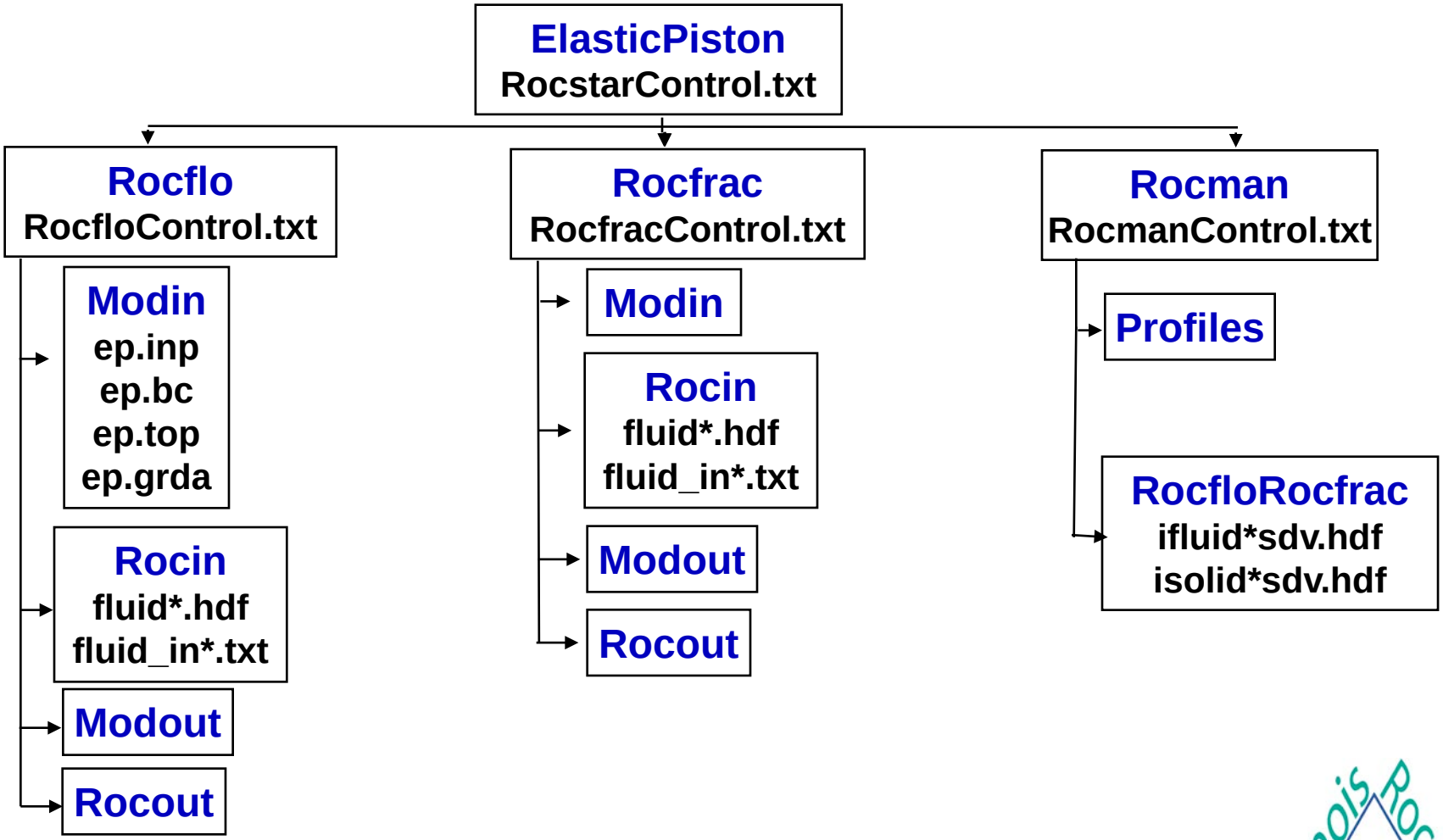
Number of partitions to make

Optional path to pre-processing tools

Execute *Rocprep* with no arguments for help screen:

```
[mdbrandy@taubh1 Modin]$ ~/Rocprep/Rocprep.pm
First switch must be mode switch -A|C|E|P|U, not:

********************************************************************************
Usage: /home/mdbrandy/Rocprep/Rocprep.pm -A|C|E|P [OPTION]...

Major modes of operation:
  -A, --all         extract and preprocess
  -C, --check       check an existing dataset at -d <path>
  -E, --extract     copy NDA files to target at -t <path>
  -P, --preprocess  run module preptools on data at -d <path>

Physics module selection:
  -o [m] [n]     Rocflo preprocessing, optional NDA Data<m> & Grid<n> dirs
  -u [m] [n]     Rocflu preprocessing, optional NDA Data<m> & Grid<n> dirs
  -f [m] [n]     Rocfrac preprocessing, optional NDA Data<m> & Grid<n> dirs
  -s [m] [n]     Rocsolid preprocessing, optional NDA Data<m> & Grid<n> dirs
  -b             Rocburn preprocessing

Module-specific flags:
  -r <m>         specify <m> regions (rocflu only), default is -n value
  -splitaxis <n> force split along n=0,1, or 2 axis (rocflo only)
  -un <units>    convert model units to meters (rocfrac only)

General options:
  -i <o|u|f|s>   surfdive interface meshes, default infers from physics options
  -d <path>      path to source data, default is current working directory
  -h, --help     print this help message and terminate
  -n <m>         specify <m> processors/partitions
  -t <path>      target path for new rocstar dataset
  -p <path>      path to preptool binaries, default will use shell path
  -x, --ignore   ignore RocprepControl.txt control file

Example: /home/mdbrandy/Rocprep/Rocprep.pm -A -o 1 1 -f 2 4 -d archiveDir/ -t newDataset/ -n 8
********************************************************************************
```

Resulting Rocstar Dataset



Examine RocfracControl.txt (1)

```
** Structure of Control File
** --------------------------
**
** Lines with '**' in the 1st two columns indicate comments
** Lines with '*' in the 1st column indicates keyword
**
** PREFIX:
** Directory name containing Mesh input files
**
*PREFIX
ep
**
** SCALE FACTOR: set this parameter equal to the factor that is used
**   to scale the time increment computed by Rocfrac. Default setting
**   is 1.0.
**
*DYNAMIC, SCALE FACTOR = 0.2
**
** Select the 10-node tetrahedral
**
*ELEMENT,TYPE=V3D10
```

Examine RocfracControl.txt (2)

```
**
** Young's Modulus, Poisson's Ratio, Density, Expansion Coeffs
**
*ELASTIC, NLGEOM = NO
1
70.0e9  0.29  2800.0  0.0
**
** Boundary Conditions
**
*BOUNDARY
4
1 1 1 0 0. 0. 0.
2 1 0 1 0. 0. 0.
3 1 0 0 0. 0. 0.
4 0 0 0 0. 0. 0.
*BOUNDARYMM
4
1 1 1 0 0. 0. 0.
2 1 0 1 0. 0. 0.
3 1 0 0 0. 0. 0.
4 0 0 0 0. 0. 0.
*END
*MESHSOFT (Choices: TetMesh, Patran, Ansys)
Patran
*END
```

Run Elastic Piston problem

- Need to set up a batch-system specific job script for your system.
- Example below for our system

```
#!/bin/tcsh
#
# Job Name
#PBS -N ElasticPiston
# Request 2 nodes, 8 procs each
#PBS -l nodes=2:ppn=8
# Run Time
#PBS -l walltime=24:00:00
# Join the stdout and stderr into the output file
#PBS -j oe
# Name the output file the following name
#PBS -o job.out
# export shell variables
#PBS -V

# cd to the directory from which the job was submitted
cd $PBS_O_WORKDIR
mpirun -np 16 rocstar
```

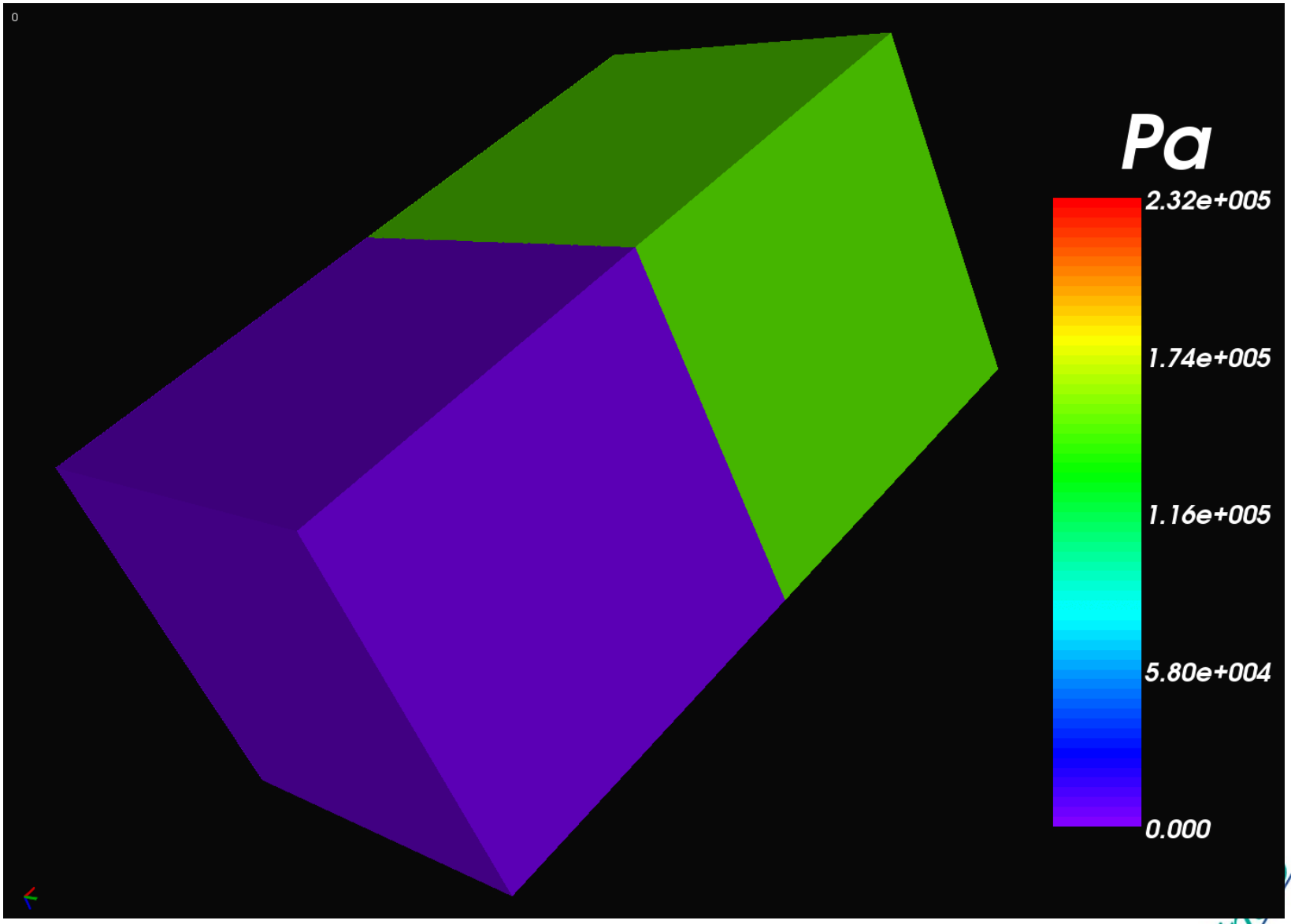
Monitor Standard out/err

- Large amounts of information is written to standard out/err

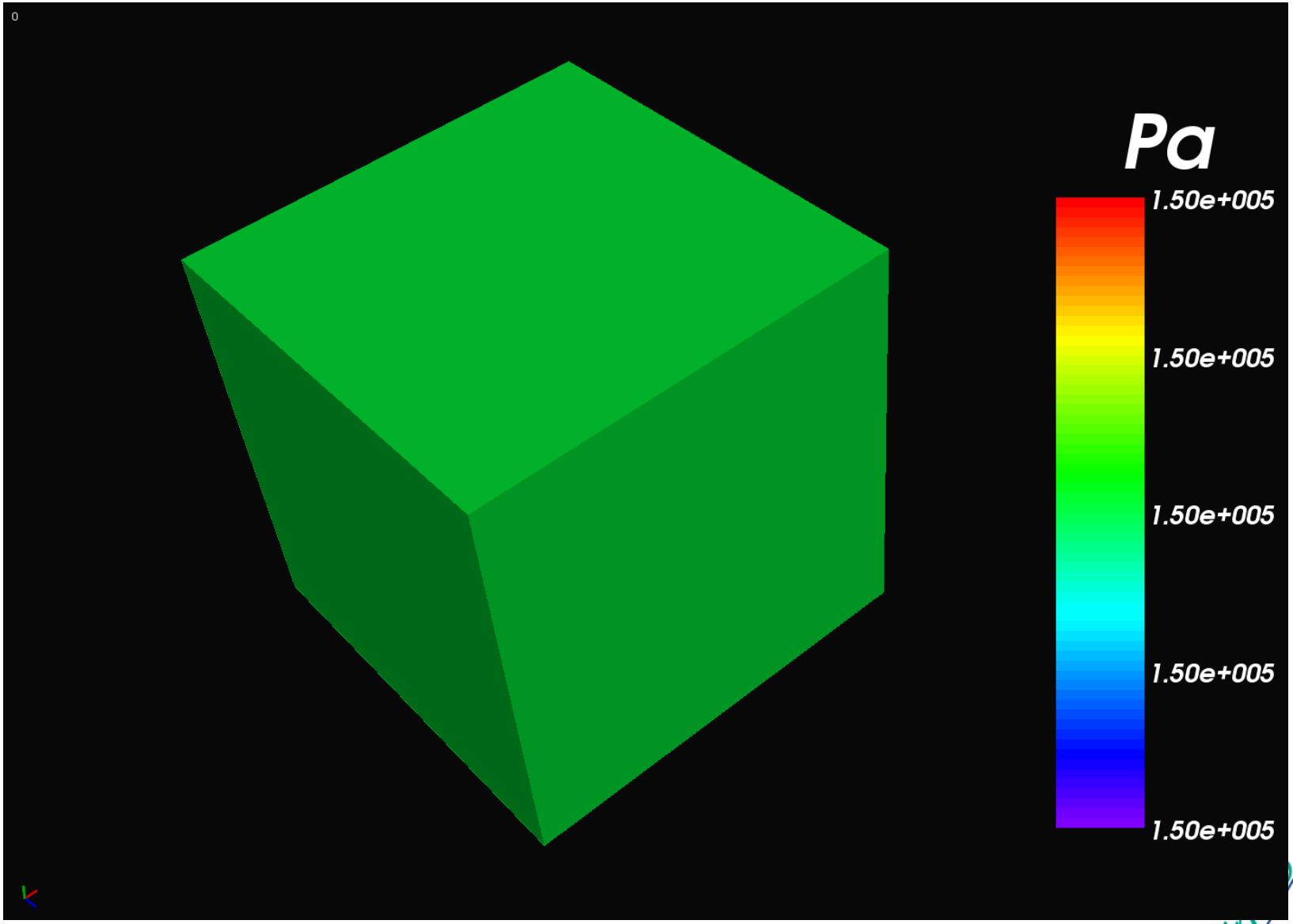
Output

- Visualize with Rocketeer
  - 3-D fluid volume, fluid_*.hdf
  - 3-D solid volume, solid_*.hdf
  - Plot pressure in the fluid and stress in the solid
  - Use solid displacement vector to deform the solid mesh

Solid Wave Propagation



Fluid Wave Propagation



Pre-run Visualization Files

- For elastic piston, pre-run visualization files are available for one time dump for both Rocflo and Rocfrac
- Load these into Rocketeer from the VizData directory