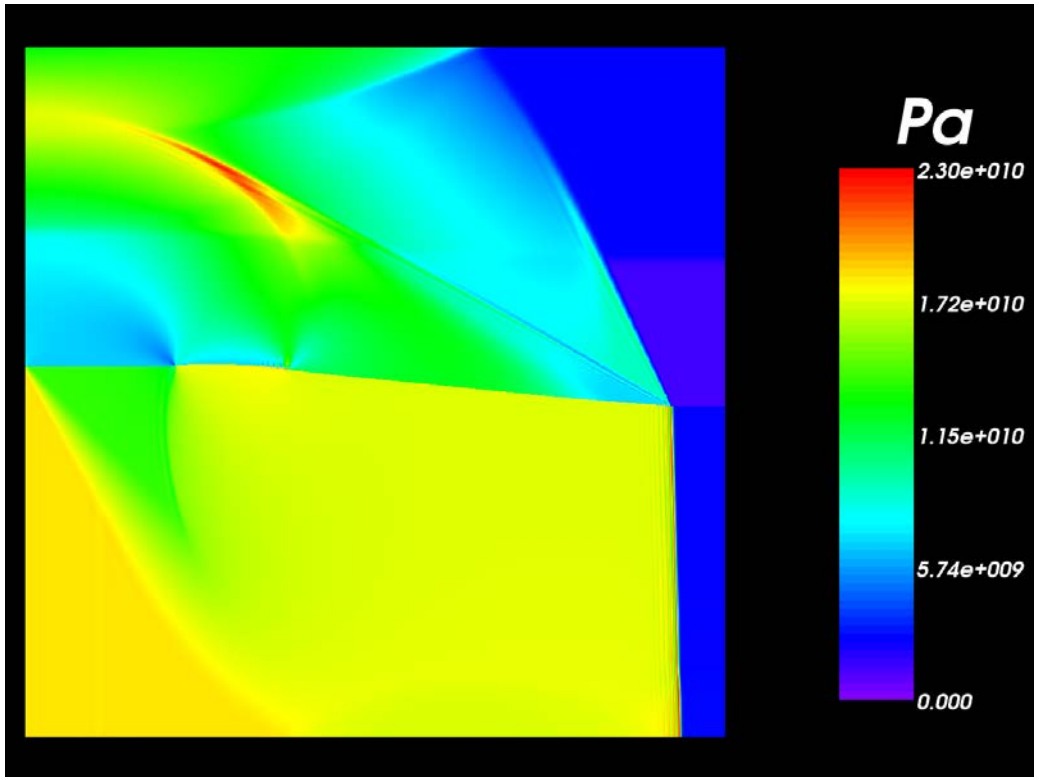
Section 17
Use Case 3:

Super Seismic Shock

Problem Description

- Shock wave propagation causes solid deformation, shock wave in solid
- Rocflo
  - block-structured hexahedral grid
- Rocfrac
  - block-structured hexahedral grid
- Goal: assemble and run fully coupled fluid solid interaction problem with significant solid deformation

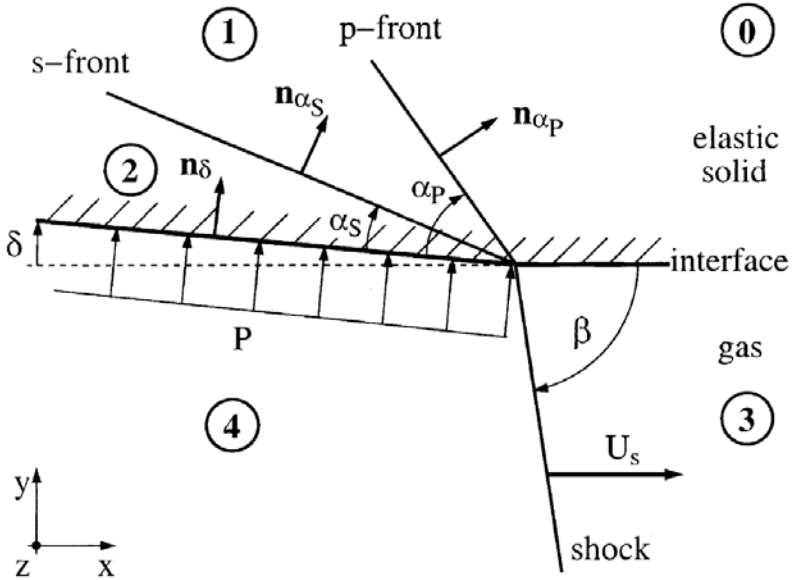


Super Seismic Shock

- Shock in a compressible fluid travels at a speed that exceeds the dilational wave speed in a solid
  - Dilatational wave speed: $c_p = \sqrt{(\lambda + 2\mu)/\rho}$
  - Distortional wave speed: $c_s = \sqrt{\mu/\rho}$
  - Fluid sound speed: $c = \sqrt{\gamma P/\rho}$
- Solid material properties similar to copper
  - E=110x10^9 Pa, ρ=8970 kg/m^3, ν=0.33
- Fluid material properties modified to get a sound speed similar to c_p
  - ρ=1000 kg/m^3
  - Static pressure 2.584x10^9 Pa

Super Seismic Shock (cont.)

- Causes deformation of the solid due to high pressures behind the shock
  - Angle between the fluid shock and solid interface
  - Directly relevant to high explosive cylinder tests

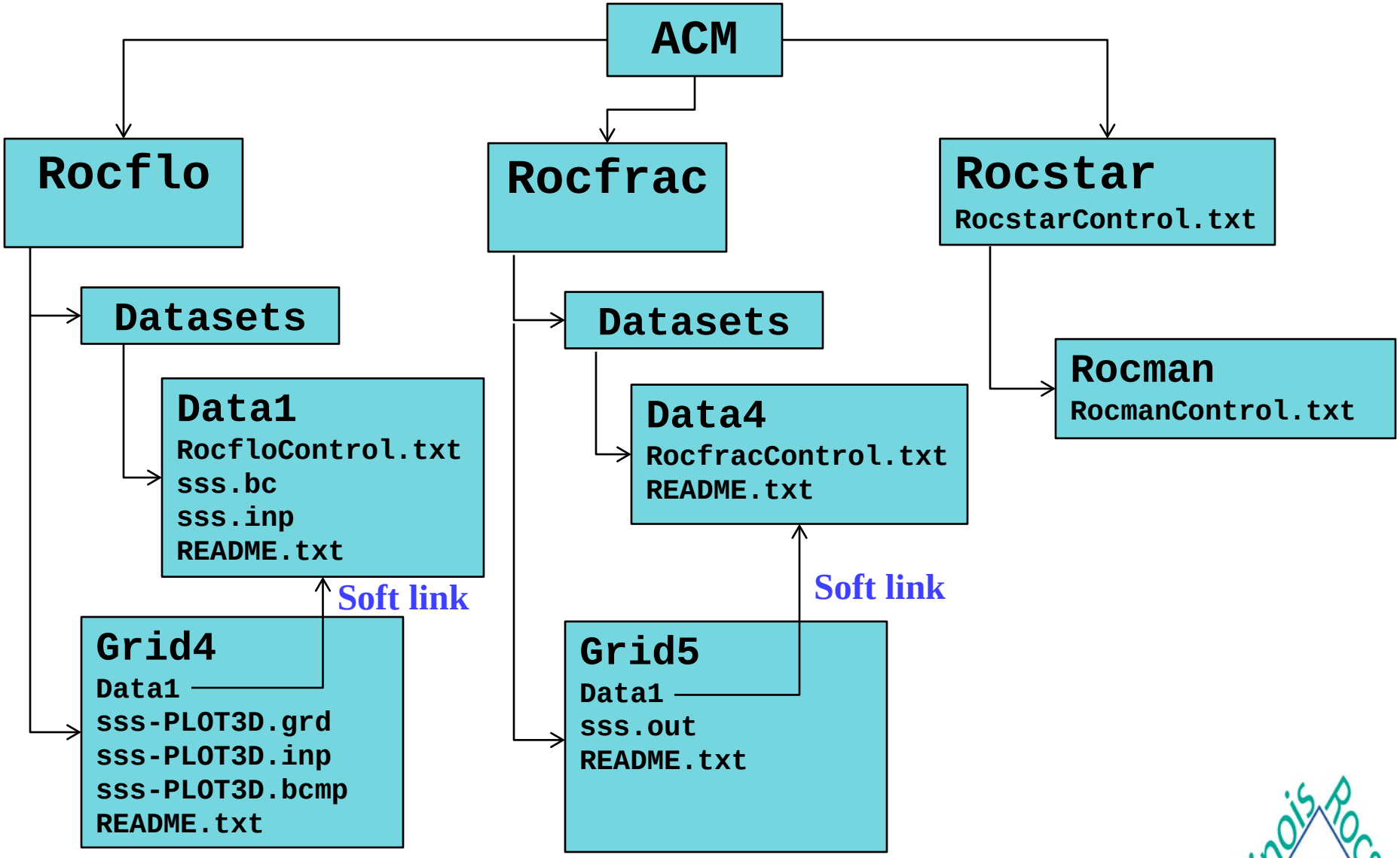


- Analytical similarity solution exists
  - Arienti, M., Hung, P., Morano, E., and J.E. Shepherd, "A Level Set Approach to Eulerian–Lagrangian Coupling," *Journal of Computational Physics*, Vol. 185, 2003, pp. 213-251.
  - Jaiman, R.K., Jiao, X., Geubelle, P.H., and E. Loth, "Assessment of Conservative Load Transfer for Fluid-Solid Interface with Nonmatching Meshes," *International Journal for Numerical Methods in Engineering*, 2004:0; 1-40.

File Checklist

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

Examine NDA



Run *Rocprep* on NDA

```
rocprep –A –o 1 4 –f 4 5 –d /IR/NDAs/SuperSeismicShock –t ./ –n 32 [–p ~/build/bin/]
```

Extract from NDA and preprocess to make full Rocstar dataset

Process Data 1 and Grid 4 for Rocflo

Process Data 4 and Grid 5 for Rocfrac

Root directory for NDA problem to be processed

Target dir for dataset

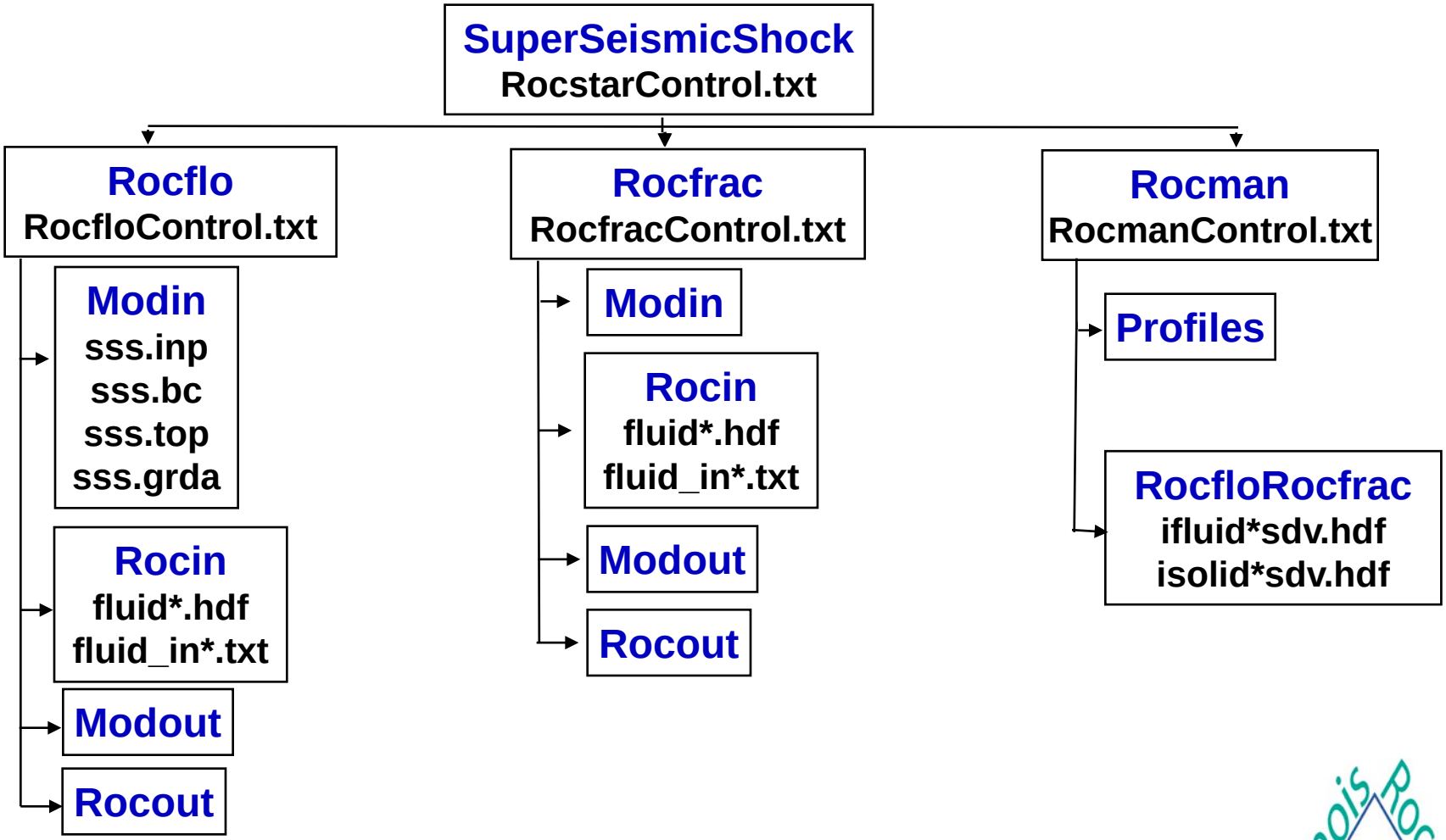
Number of partitions to make

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



sss.bc

- Inflow boundary condition

```
# BC_INFLOW
BLOCK     0  0   ! applies to block ... (0 0 = to all)
PATCH     0  0   ! applies to patch ... (0 0 = to all patches of
BLOCK)
TYPE      0      ! supersonic inflow
DISTRIB   0      ! single value (=0) or distribution (=1)
PTOT      4.447033332E+10  ! for shock Mach number M1 = 2.5
TTOT      8.249991182E+03
MACH      1.196974774E+00

BETAH     0.0
BETAV     0.0
```

Run Super Seismic Shock problem

- Need to set up a batch-system specific job script for your system.
- Example batch script for SSS:

```
# SSS Batch Script
#
# Request 4 nodes, 8 procs each
#PBS -l nodes=4:ppn=8
#PBS -l walltime=24:00:00
#PBS -j oe
# Inherit submit shell variables
#PBS –V

cd $PBS_O_WORKDIR
mpirun -np 32 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

Coupled Fluid-Solid Interaction