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A Simple Case Study Using Catalyst/Sierra At Sandia Labs: Taylor Anvil Experiment

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Background

- We implemented a production in-situ capability in the Sierra Framework
- Accessible on various SNL HPC platforms
- Based on Catalyst product (which shares source with ParaView)
- Integrated visualization control commands into Sierra parser and input decks
- Gave tutorials, held classes on usage

Taylor Anvil

- Copper cylinder thrown against steel plate
  - high speed
  - Impact on flat end of cylinder
- Cylinder deforms, especially at impact end
- Physical test was conducted
- Physical test conducted decades ago
- Measurements taken from results (mostly from photos)

Taylor Anvil

- Impact is simulated
- Simulated result to be compared to physical result
- Classical problem used often to compare against simulations
- We are simulating with Adagio, a mechanics code in the Sierra simulation framework

Example Results Output In Input Deck

```
begin results output my_output_catalyst
  database type = catalyst
  At time 0.0 Interval = 2e-06
  global variables = momentum_block1_z as mom1_z
  global variables = ND_R_F
  global variables = ND_H_F
  nodal variables = displacement as displ
  element variables = element_shape as shape
  element variables = damage
  element variables = eqps
  element variables = stress
  begin catalyst
     …
  end catalyst
```

Example Camera In Input Deck

```
begin camera my_camera_stress_zz
  look direction = -0.7071067812 0.7071067812 0
  up vector = 0 0 1
end camera my_camera_stress_zz
```

Example Representation In Input Deck

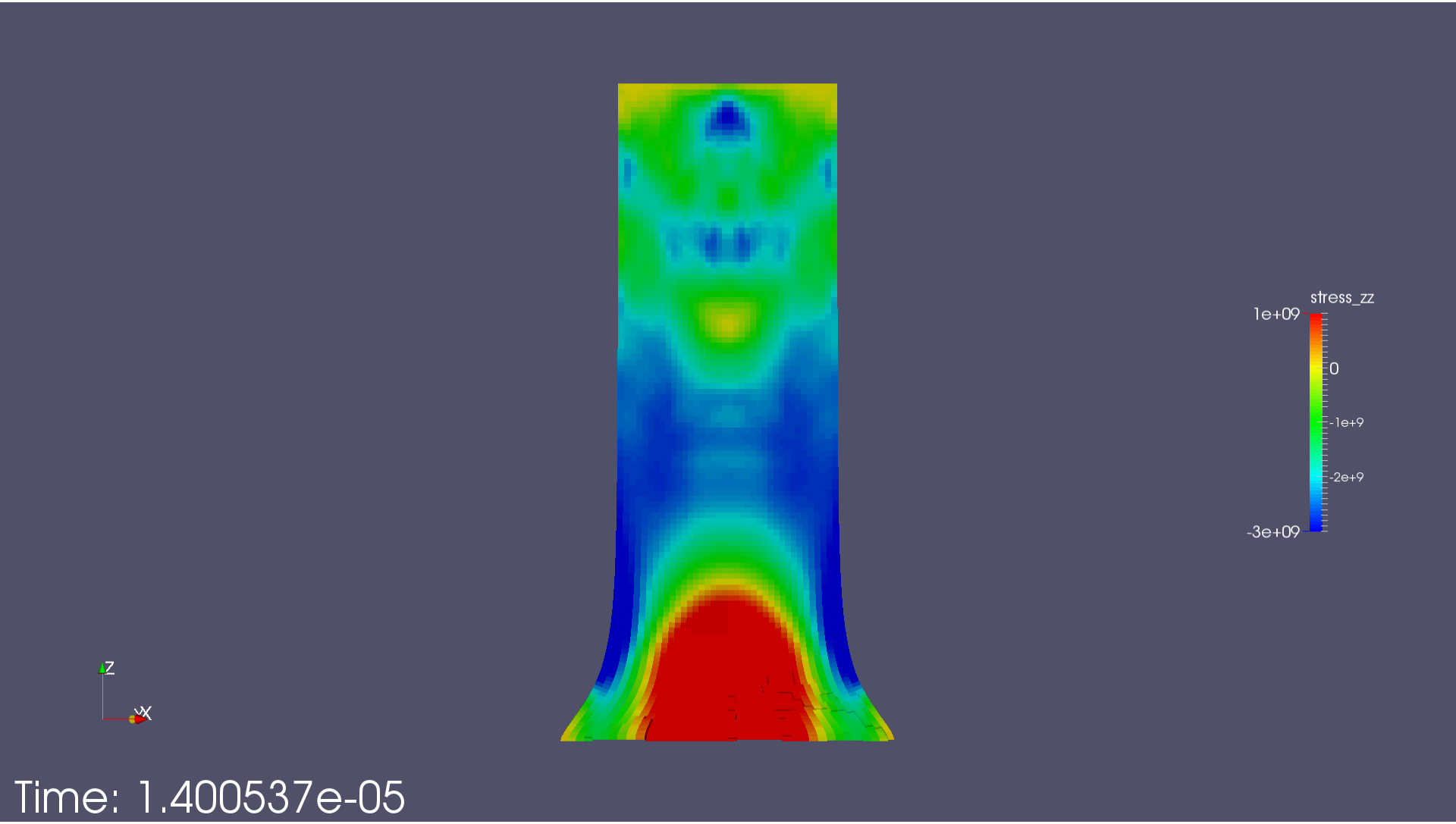
```
begin representation my_representation_stress_zz
  color by tensor component = stress_zz
  show color legend = true
  color legend position = right 1
  color legend range = -3.0e+09 1.0e+09
  preset color scale = Blue_to_Red_Rainbow
  show time annotation = true
  time annotation position = bottom left 0.75
end representation my_representation_stress_zz
```

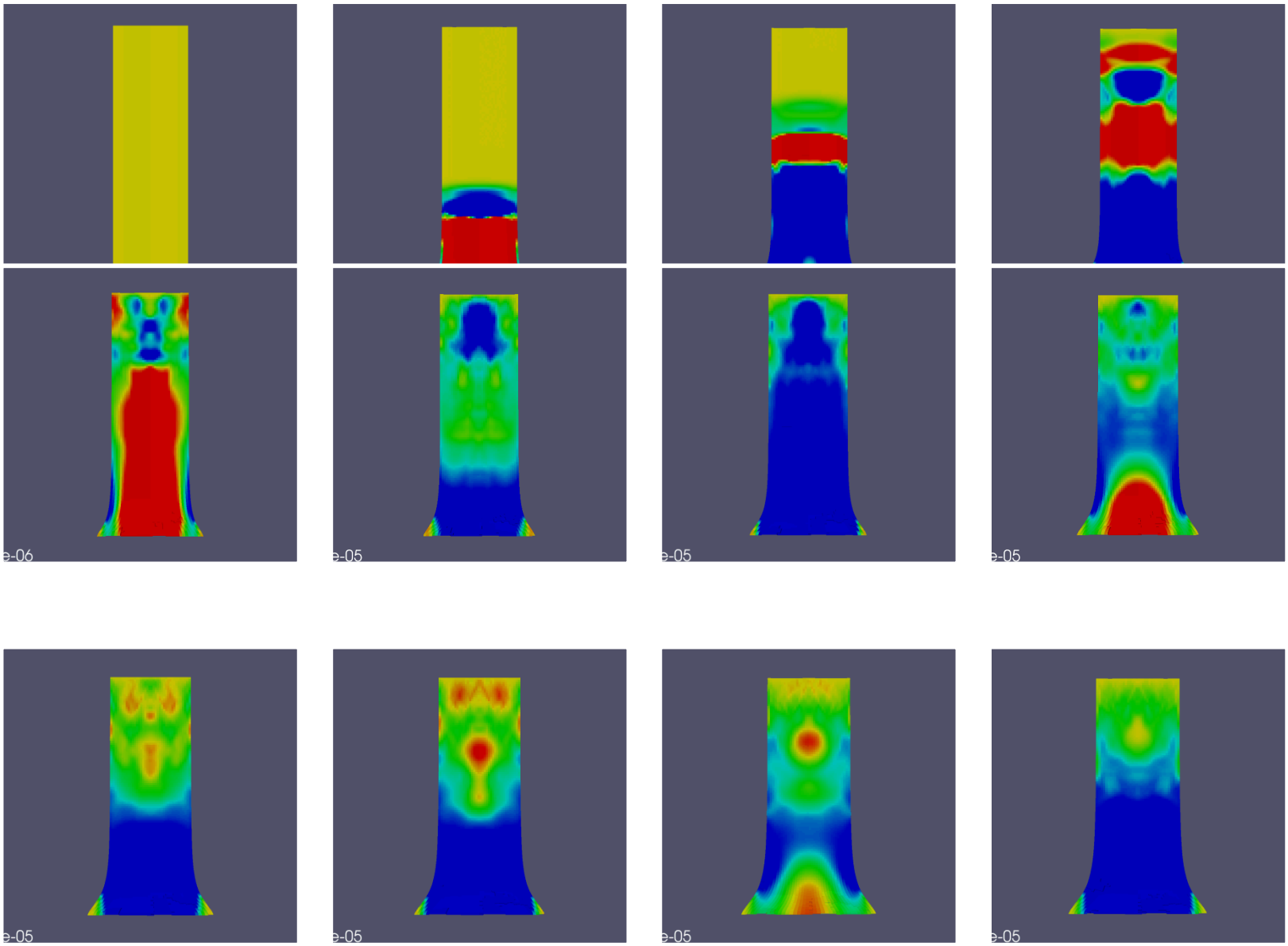
Example Slice Operation In Input Deck

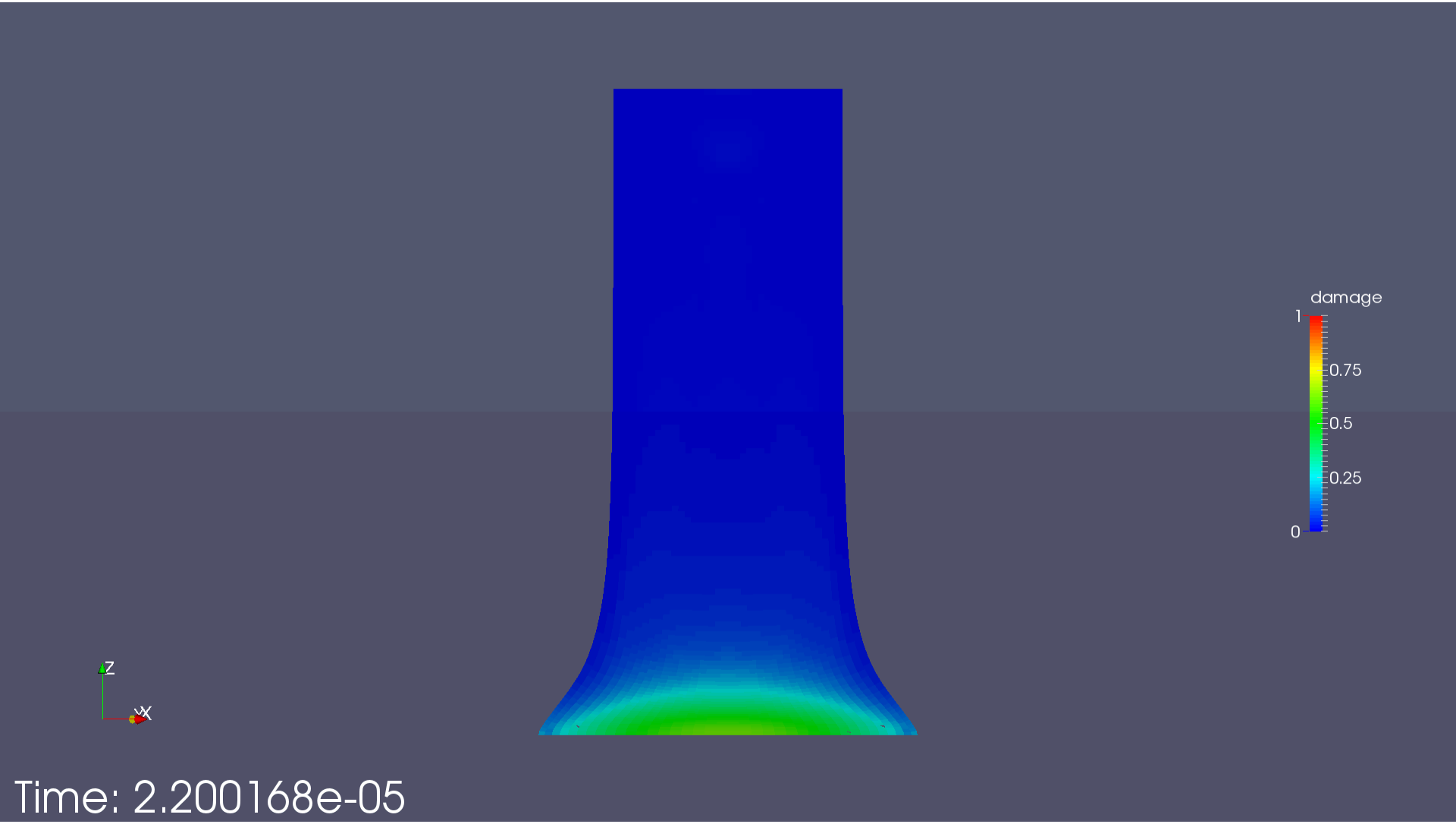
```
begin slice my_slice_stress_zz
  absolute point on plane = 0 0 0
  plane normal = 0.7071067812 -0.7071067812 0
  cut type = crinkle
end slice my_slice_stress_zz
```

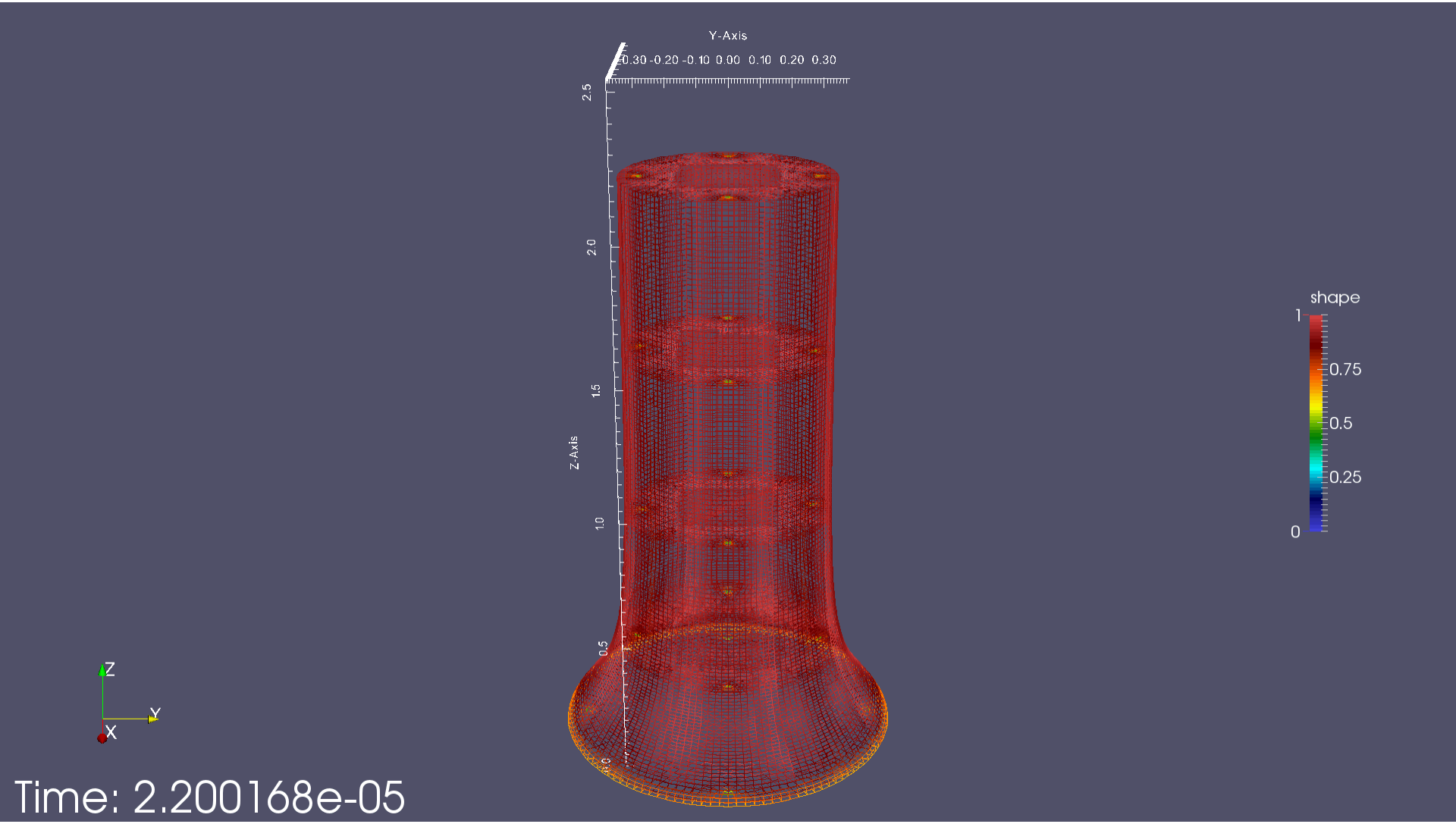
Example Imageset In Input Deck

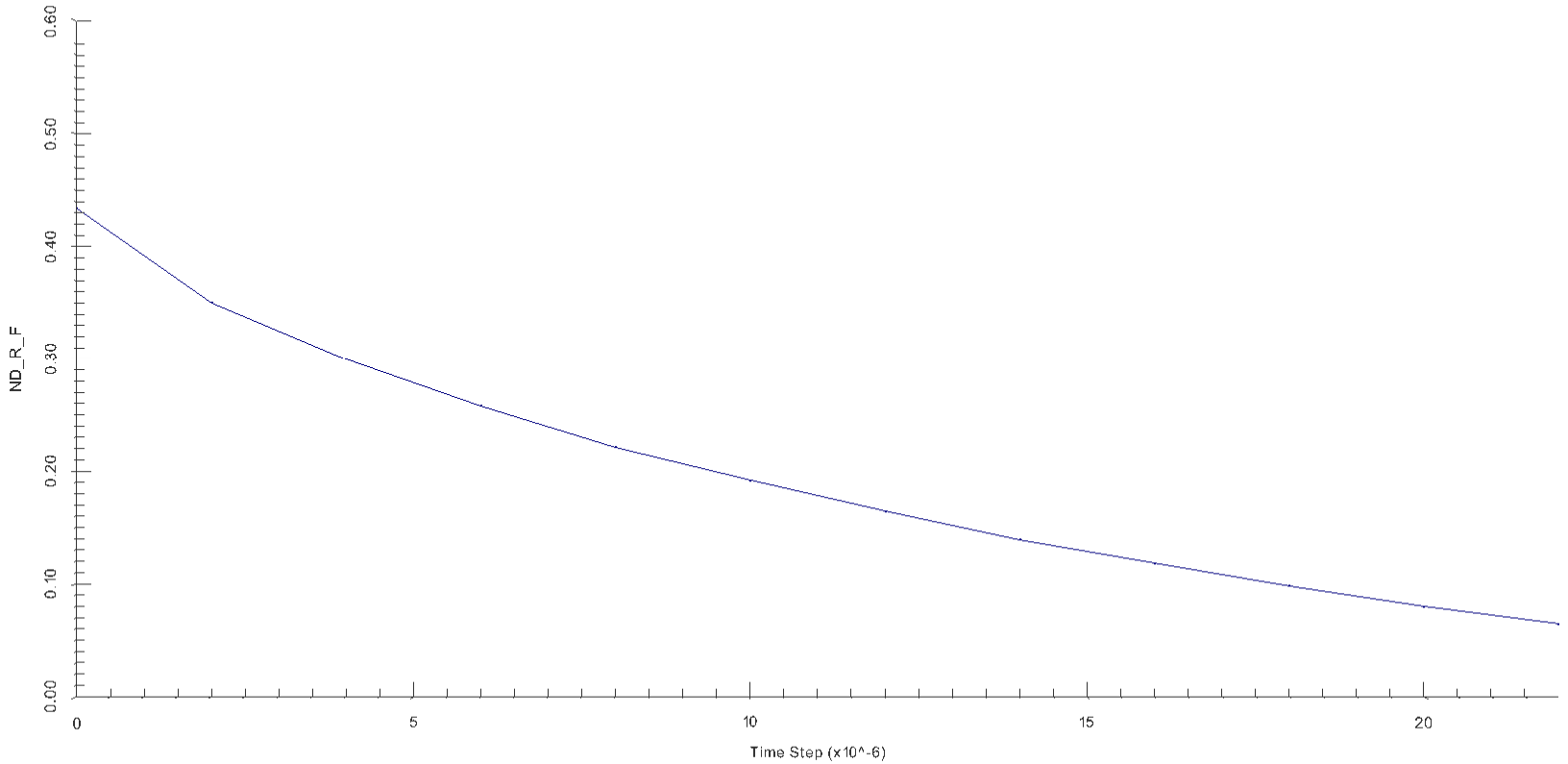
```
begin imageset my_imageset_stress_zz
  camera = my_camera_stress_zz
  operation = my_slice_stress_zz
  representation = my_representation_stress_zz
  image format = png
  image size = 1920 1080
  image digit count = 6
  image basename = stress_zz_
  image basedirectory = images
end imageset my_imageset_stress_zz
```

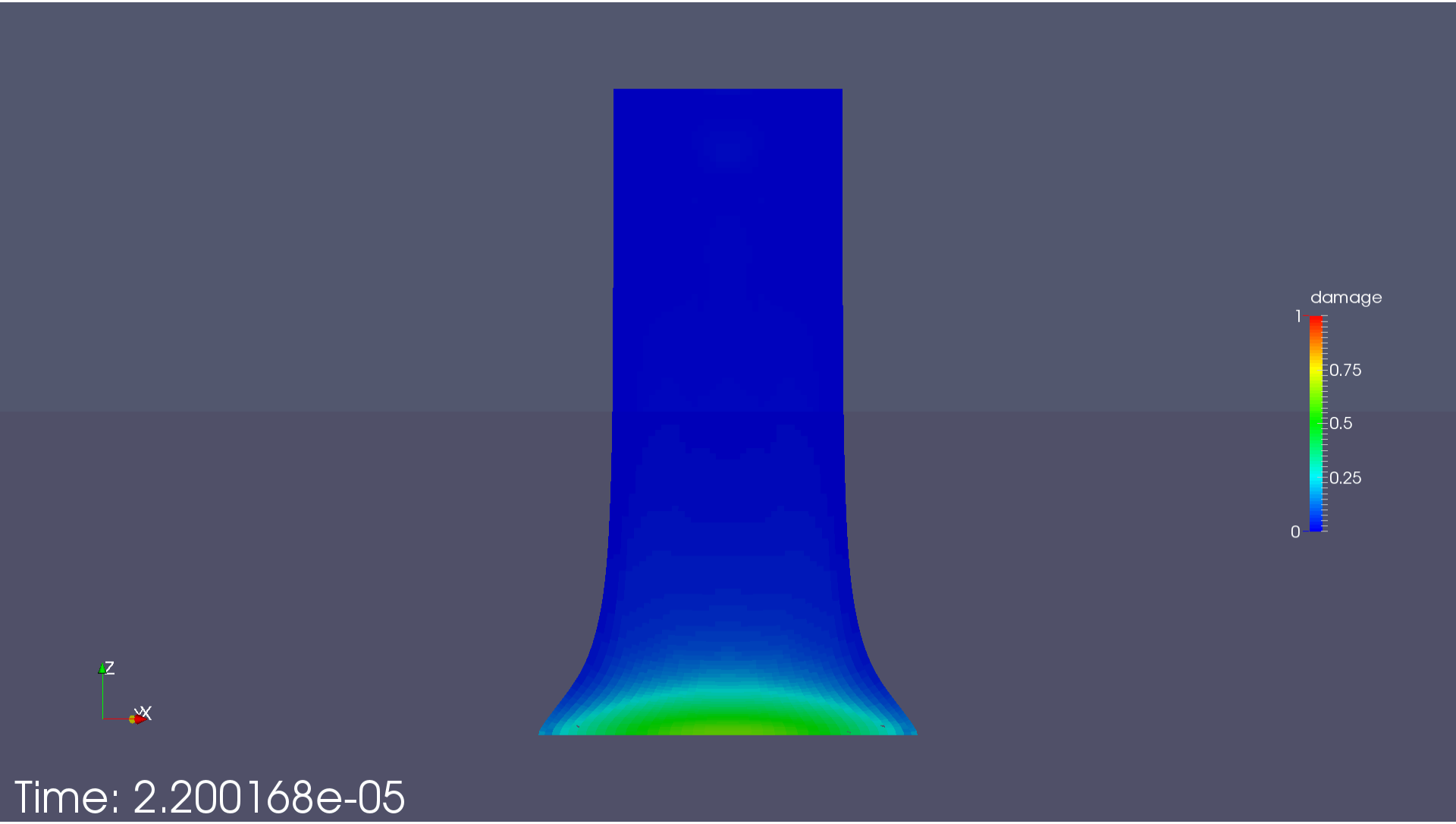

stress_zz
1e+09
0
-1e+9
-2e+9
-3e+09
Z
X
Time: 1.400537e-05


e-06
e-05
e-05
e-05
e-05
e-05
e-05
e-05


damage
1
0.75
0.5
0.25
0
Z
X
Time: 2.200168e-05

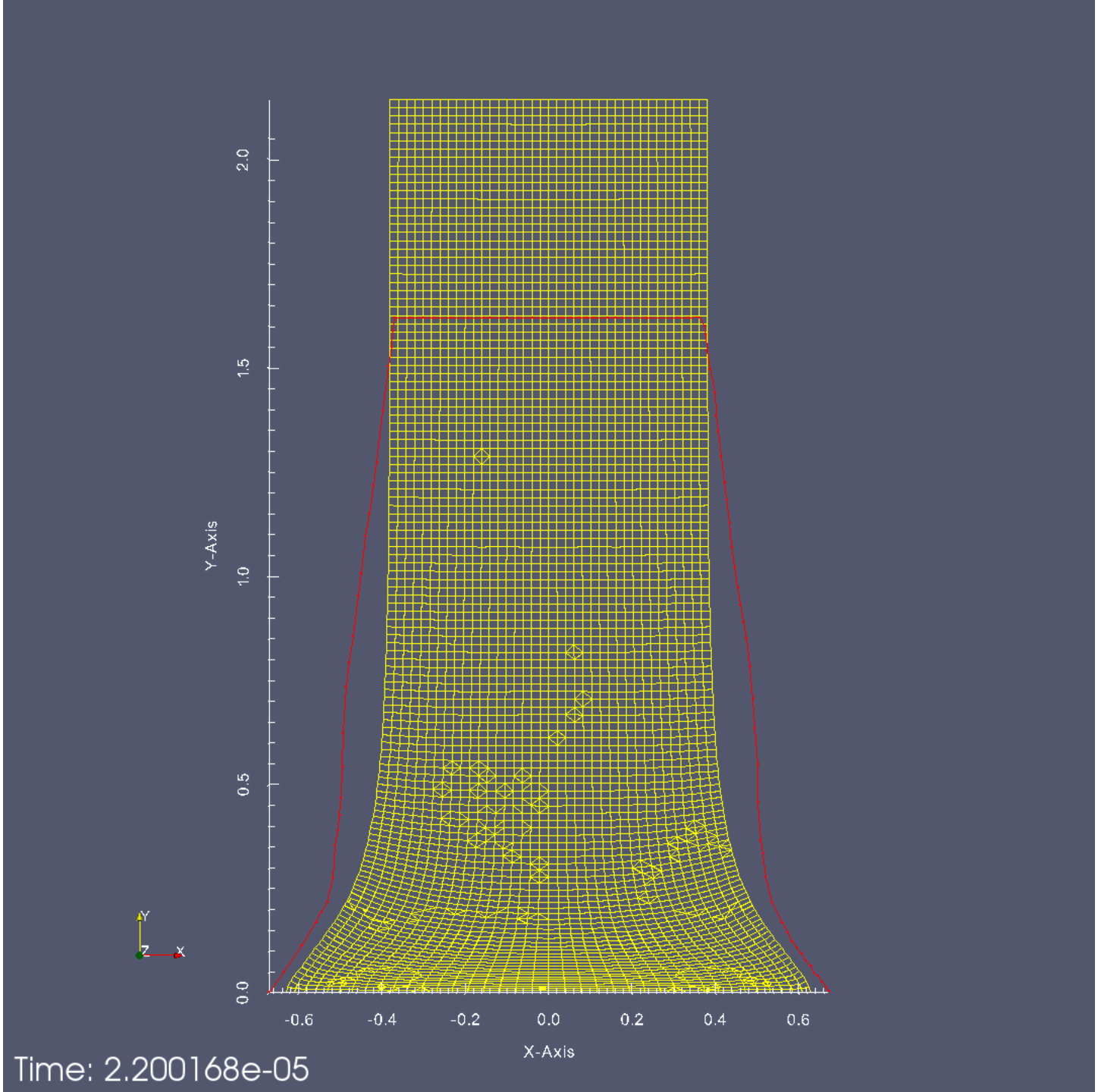

Y-Axis
-0.30 -0.20 -0.10 0.00 0.10 0.20 0.30
Z-Axis
2.5
2.0
1.5
1.0
0.5
0.0
shape
1
0.75
0.5
0.25
0
Z
Y
X
Time: 2.200168e-05

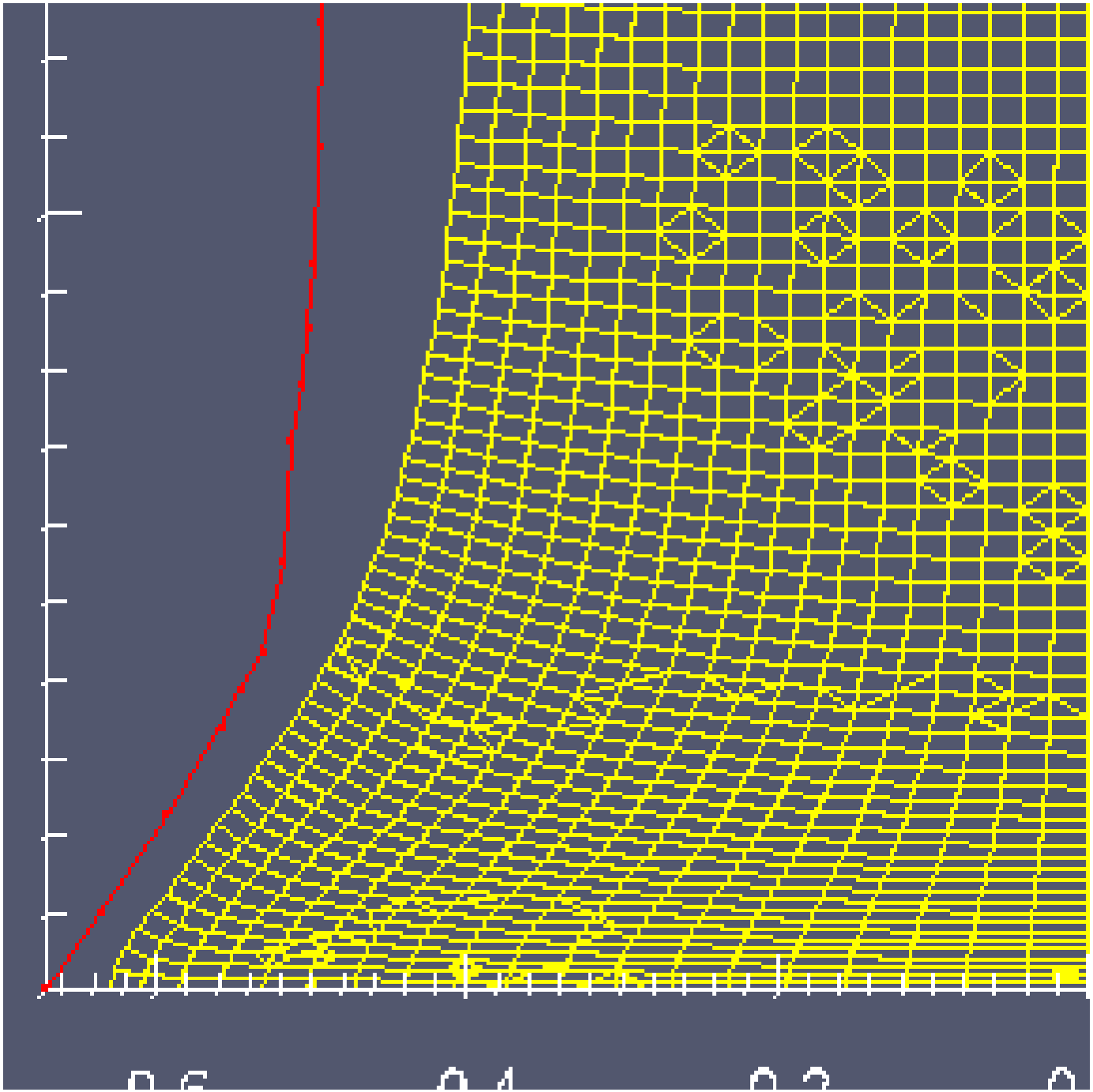

ND_R_F
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0
5
10
15
20
Time Step (x10^-6)


damage
1
0.75
0.5
0.25
0
Z
X
Time: 2.200168e-05

Added Features for Client

- As anticipated, use of Catalyst/Sierra generated requests for additional capability
- Client had data for outline of cross section of post-impact cylinder
- Taken from measurements of photograph
- Wanted to superimpose physical measurements on simulated in-situ output, properly registered


Y-Axis
0.0
0.5
1.0
1.5
2.0
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
X-Axis
Y
Z
X
Time: 2.200168e-05



Work After Sierra/Catalyst

- Sierra Catalyst in-situ was actually step 1
- Parameter study to see what mimicked reality best
- Using Dakota to run multiple simulation runs with different material properties, etc.
- Using Slycat to look at the results of many simulation runs in a comprehensible manner