Finite Element Analysis Tutorial: Demonstrating processing flow

Three steps:

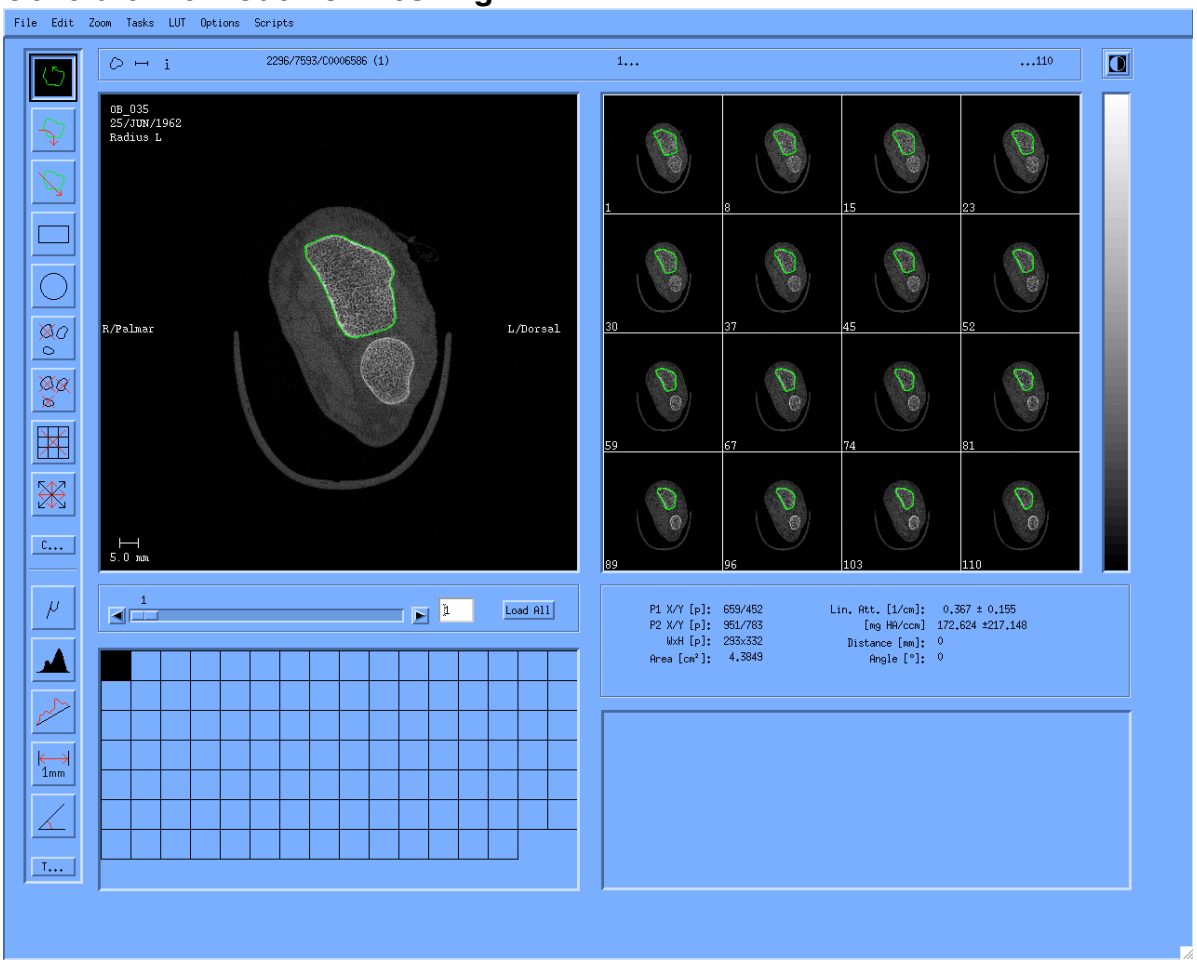
1. Pre-processing (generation of segmented file, meshing and boundary conditions).
2. Solver (running FAIM).
3. Post-processing (DAT and RES file, visualization with Paraview or UCT_3D).

File definitions:

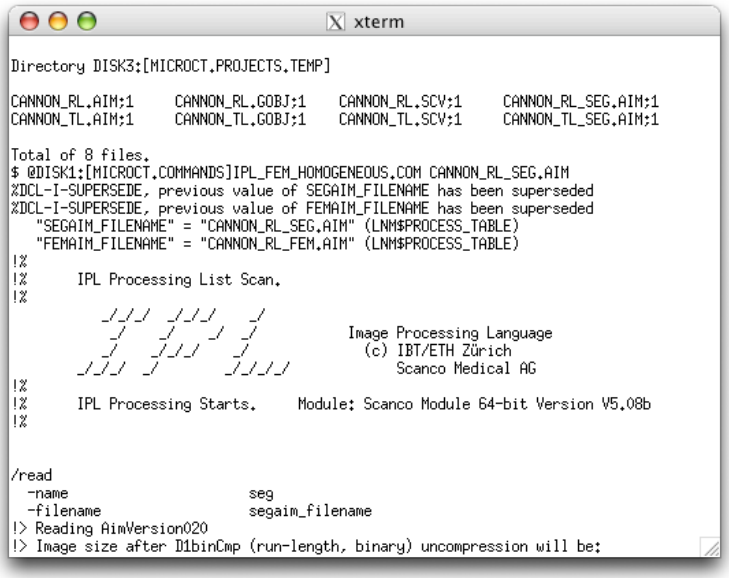
1. AIM - 3D image data (must be in range of 0-127 'char' for meshing).
2. INP - Input file for FE solver FAIM. Generated by AppDirectMechanicsGenerator (large file!).
3. LOG - Log file for FAIM.
4. DAT - Data output from FAIM (large file! Only necessary if results are to be visualized).
5. RES - Results summary.

Pre-processing

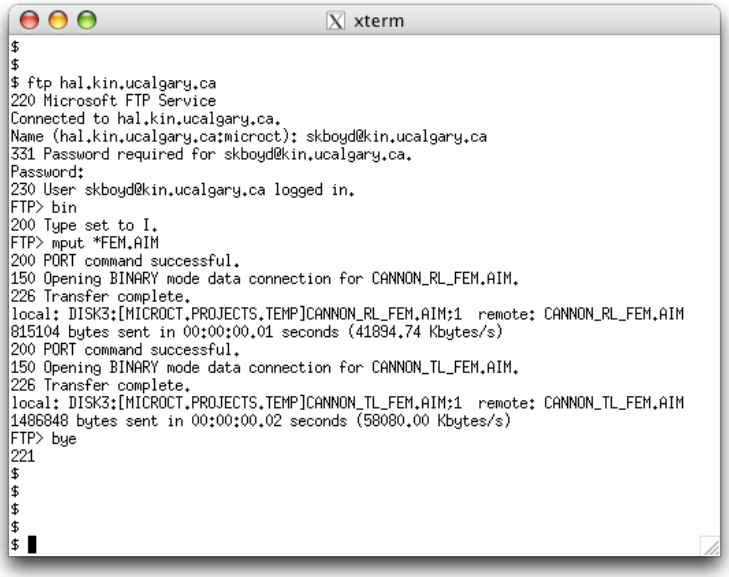
Generate the model for meshing

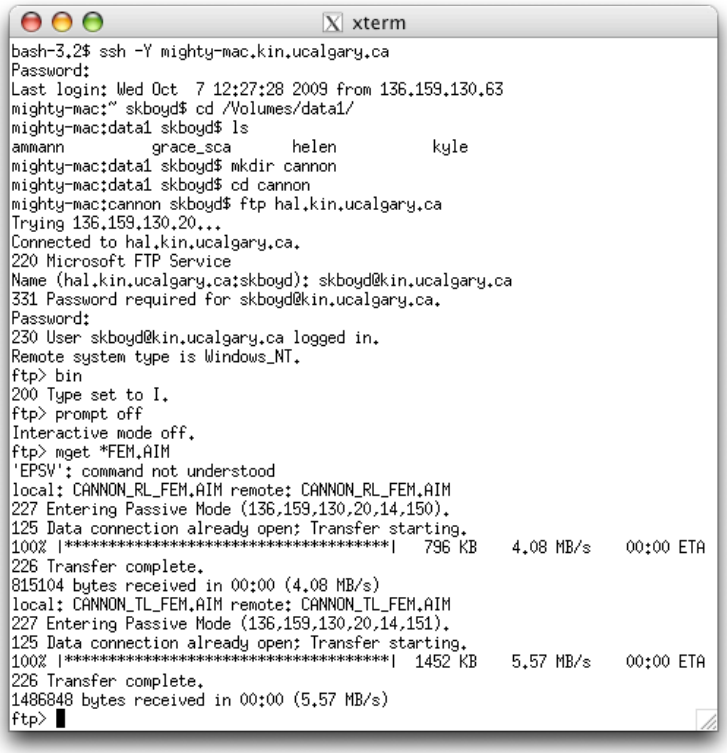


Convert the SEG file to the FEM file



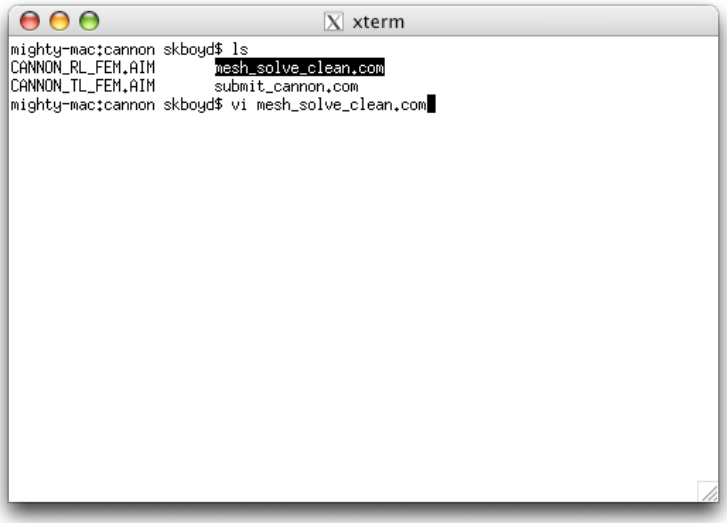
Transfer to mighty-mac



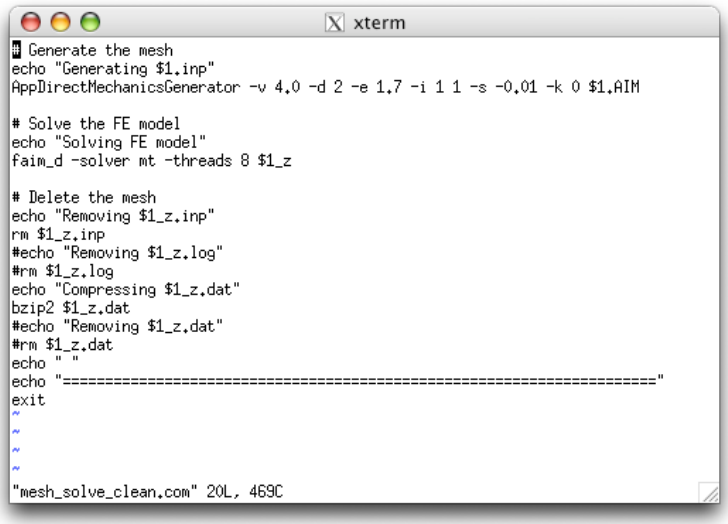


Mesh and Solve

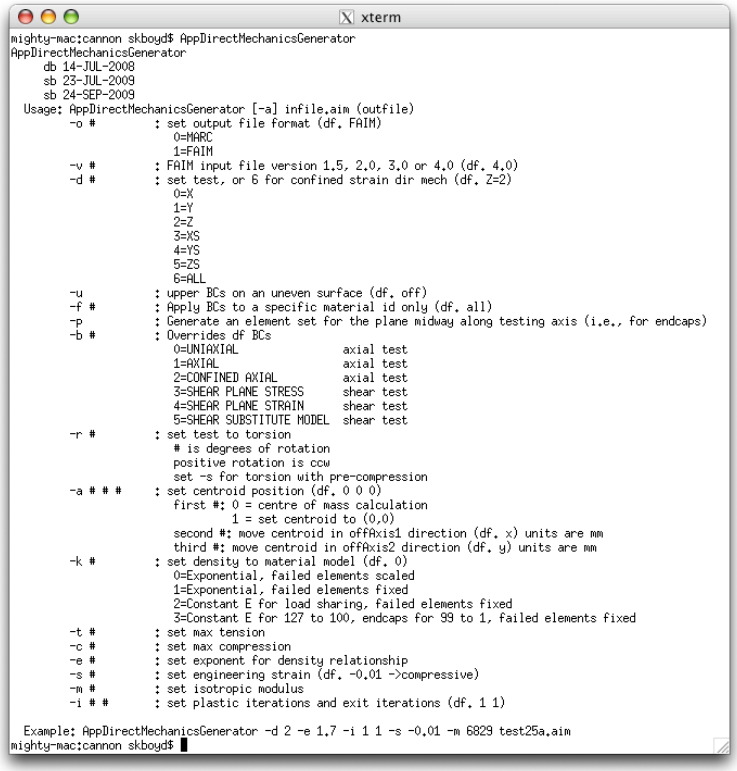
Prepare scripts



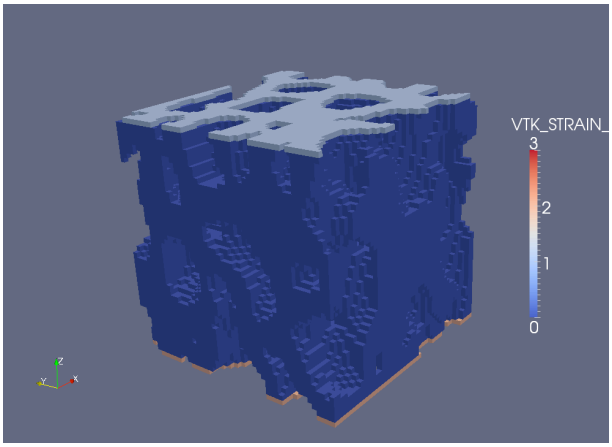
mesh_solve_clean.com



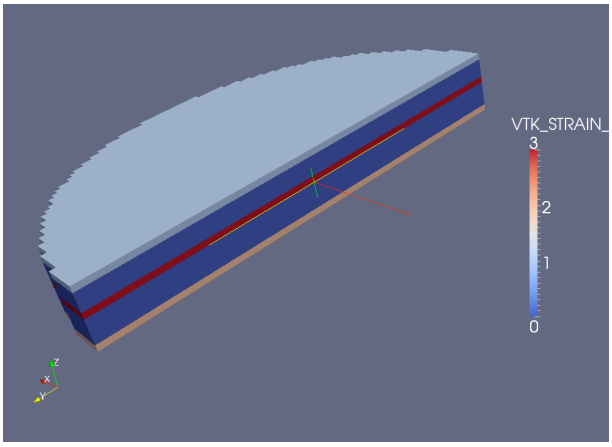
AppDirectMechanicsGenerator



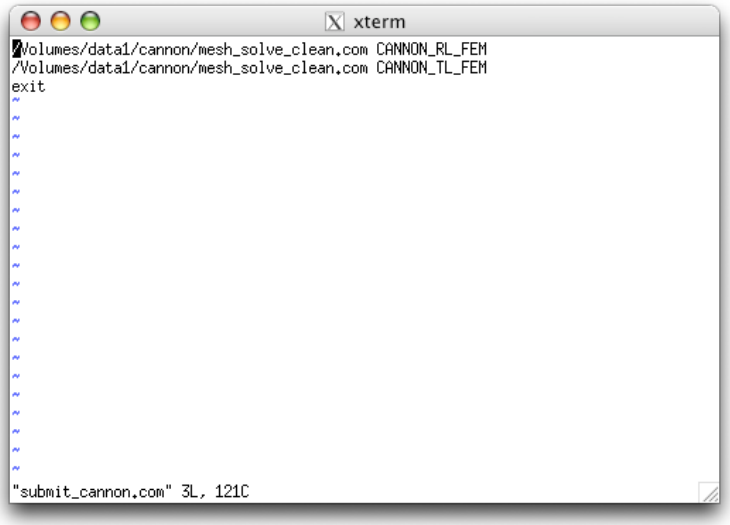
- Boundary conditions at min/max Z. These are also the sites used for determining load sharing.



- There is an option to include a middle layer of elements using AppDirectMechanicsGenerator ('-p' option)

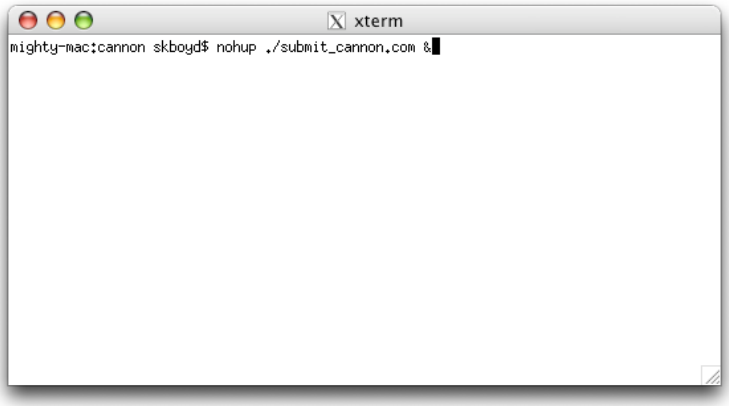


A look at the script for submitting multiple jobs (submit_cannon.com)



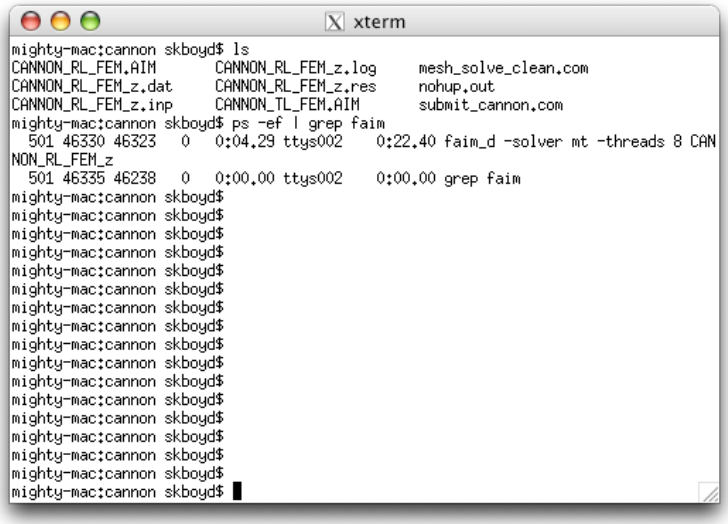
Submit the jobs

- Sets a process that will continue after logging out.

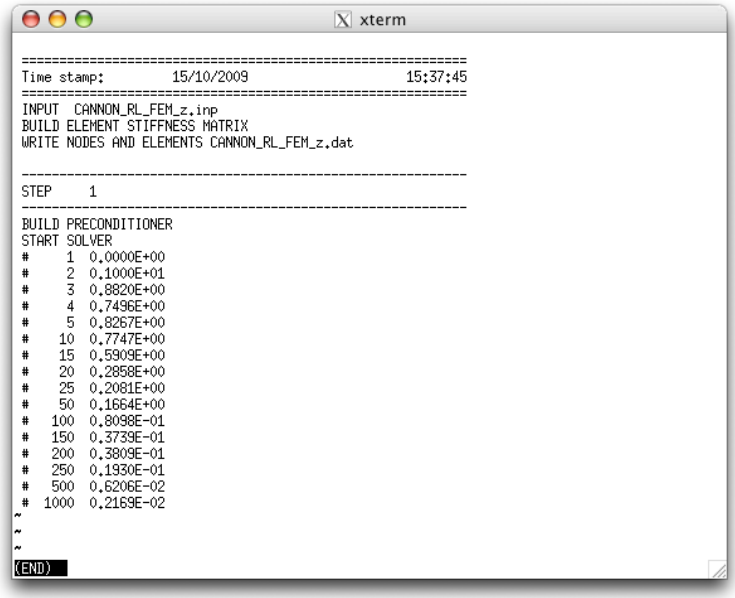


Check the models are running

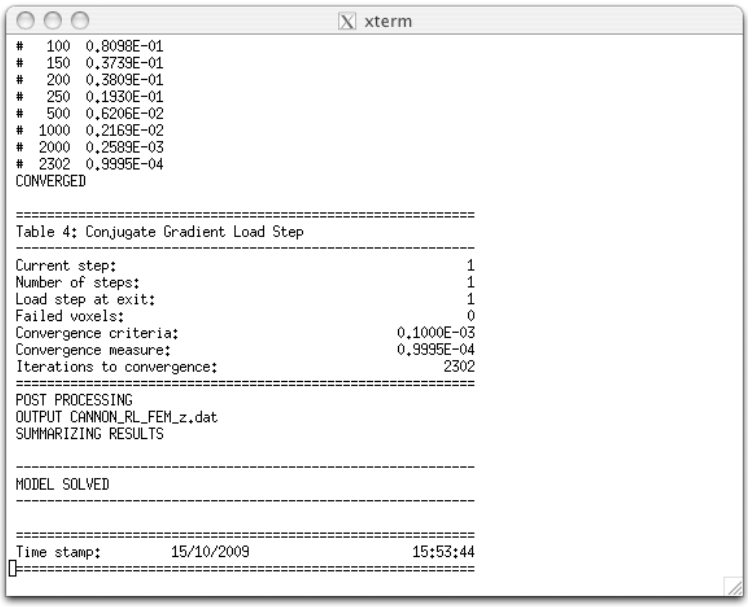
- Take a look at the nohup.out file, and any *.log files.



Monitor LOG file to watch job progression



Converged!



Generated Files

- CANNON_RL_FEM_z.dat.bz2
- CANNON_RL_FEM_z.res
- CANNON_RL_FEM_z.log
- Note that the INP file was deleted as per mesh_solve_clean.com

Results File

```
============================================================
Time stamp:         15/10/2009                      15:37:45
============================================================

============================================================
Table 1: Model Input
------------------------------------------------------------
FAIM version:                                          4.03
Filename:          CANNON_RL_FEM_z
Element:                                          hexahedron
Element dim X:                                        0.0820
Element dim Y:                                        0.0820
Element dim Z:                                        0.0820
Number of nodes:                                     3065396
Number of elements:                                  1944705
Number of integration points:                              8
Number of freedoms per node:                               3
Number of nodes per element:                               8
Dimension of problem:                                      3
Tolerance:                                       0.1000E-03
Maximum number of iterations:                         30000
Number of equations:                                 9165851
Number of steps:                                           1
Number of steps at exit:                                   1
Maximum compression:                            -0.4930E-01
Maximum tension:                                 0.2950E-01
Total load:                                      0.0000E+00
============================================================

============================================================
Table 2: Model Material Table
------------------------------------------------------------
Number of materials available:                           254
Number of materials used:                                  1
Isotropic material:                                     true
------------------------------------------------------------
  id           E           v           G
 127  0.6829E+04  0.3000E+00  0.2627E+04
============================================================

============================================================
Table 3: Model Material Distribution
------------------------------------------------------------
           material    # voxels           %
                127     1944705    100.0000
          ----------  ----------  ----------
               total     1944705    100.0000
============================================================

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Table 4: Conjugate Gradient Load Step
------------------------------------------------------------
Current step:                                              1
Number of steps:                                           1
Load step at exit:                                         1
Failed voxels:                                             0
Convergence criteria:                            0.1000E-03
Convergence measure:                             0.9995E-04
Iterations to convergence:                             2302
============================================================

============================================================
Table 5: Tissue Stresses
------------------------------------------------------------
Material:                                                ALL
Number of elements:                                  1944705
..........................................................
                           s11         s22         s33         s12         s23         s31         sVM
            average  0.7097E-02 -0.1439E-01 -0.3244E+02 -0.1086E-01 -0.3590E-03  0.2832E-02  0.3973E+02
            std_dev  0.8824E+01  0.7983E+01  0.2521E+02  0.4832E+01  0.7166E+01  0.7750E+01  0.2238E+02
            minimum -0.1452E+03 -0.1083E+03 -0.3640E+03 -0.1193E+03 -0.1753E+03 -0.9009E+02  0.0000E+00
            maximum  0.1928E+03  0.2202E+03  0.8349E+02  0.8076E+02  0.1184E+03  0.1213E+03  0.3619E+03
           skewness  0.8618E+00  0.5127E+00 -0.7350E+00 -0.4299E+00 -0.2936E+00  0.2424E+00  0.6962E+00
           kurtosis  0.1068E+02  0.9843E+01  0.1305E+01  0.6398E+01  0.5307E+01  0.3361E+01  0.1525E+01
             median -0.2648E+00 -0.7436E-01 -0.3021E+02  0.9105E-01 -0.6480E-02  0.3118E-01  0.3838E+02
       percentile05 -0.1239E+02 -0.1195E+02 -0.7433E+02 -0.7919E+01 -0.1157E+02 -0.1213E+02  0.6639E+01
       percentile25 -0.3645E+01 -0.3517E+01 -0.5035E+02 -0.2158E+01 -0.3303E+01 -0.4393E+01  0.2290E+02
```

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       percentile75  0.2818E+01  0.3189E+01 -0.1181E+02  0.2409E+01  0.3593E+01  0.4075E+01  0.5420E+02
       percentile95  0.1435E+02  0.1229E+02  0.8266E+00  0.7132E+01  0.1126E+02  0.1250E+02  0.7737E+02
fraction_below_zero  0.5332E+00  0.5120E+00  0.9270E+00  0.4828E+00  0.5022E+00  0.4937E+00  0.0000E+00
            ave_neg -0.5174E+01 -0.5115E+01 -0.3525E+02 -0.3457E+01 -0.4966E+01 -0.5696E+01  0.0000E+00
            med_neg -0.3336E+01 -0.3400E+01 -0.3289E+02 -0.2274E+01 -0.3282E+01 -0.4474E+01  0.0000E+00
            ave_pos  0.5926E+01  0.5337E+01  0.3157E+01  0.3206E+01  0.5009E+01  0.5561E+01  0.3973E+02
            med_pos  0.3177E+01  0.3314E+01  0.1780E+01  0.2300E+01  0.3616E+01  0.4004E+01  0.3838E+02
============================================================

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Table 6: Tissue Strains
------------------------------------------------------------
Material:                                              ALL
Number of elements:                                1944705
............................................................
                           e11         e22         e33         e12         e23         e31         SED
            average  0.1427E-02  0.1423E-02 -0.4751E-02 -0.4133E-05 -0.1367E-06  0.1078E-05  0.1528E+00
            std_dev  0.1465E-02  0.1331E-02  0.3517E-02  0.1840E-02  0.2728E-02  0.2951E-02  0.1750E+00
            minimum -0.1825E-01 -0.1166E-01 -0.4850E-01 -0.4544E-01 -0.6676E-01 -0.3430E-01  0.0000E+00
            maximum  0.2592E-01  0.2987E-01  0.9547E-02  0.3075E-01  0.4507E-01  0.4619E-01  0.1050E+02
           skewness  0.4658E+00  0.3198E+00 -0.6857E+00 -0.4299E+00 -0.2936E+00  0.2424E+00  0.4705E+01
           kurtosis  0.3001E+01  0.2328E+01  0.9709E+00  0.6398E+01  0.5307E+01  0.3361E+01  0.6987E+02
             median  0.1327E-02  0.1413E-02 -0.4430E-02  0.3467E-04 -0.2467E-05  0.1187E-04  0.1067E+00
       percentile05 -0.5783E-03 -0.5181E-03 -0.1067E-01 -0.3015E-02 -0.4407E-02 -0.4617E-02  0.3096E-02
       percentile25  0.4003E-03  0.4804E-03 -0.7238E-02 -0.8217E-03 -0.1257E-02 -0.1673E-02  0.3718E-01
       percentile75  0.2331E-02  0.2252E-02 -0.1898E-02  0.9170E-03  0.1368E-02  0.1551E-02  0.2156E+00
       percentile95  0.3849E-02  0.3598E-02  0.1466E-04  0.2715E-02  0.4288E-02  0.4758E-02  0.4421E+00
fraction_below_zero  0.1420E+00  0.1315E+00  0.9444E+00  0.4828E+00  0.5022E+00  0.4937E+00  0.0000E+00
            ave_neg -0.6265E-03 -0.5798E-03 -0.5055E-02 -0.1316E-02 -0.1891E-02 -0.2169E-02  0.0000E+00
            med_neg -0.3617E-03 -0.3547E-03 -0.4708E-02 -0.8659E-03 -0.1250E-02 -0.1704E-02  0.0000E+00
            ave_pos  0.1767E-02  0.1726E-02  0.4222E-03  0.1221E-02  0.1907E-02  0.2117E-02  0.1528E+00
            med_pos  0.1599E-02  0.1618E-02  0.2457E-03  0.8758E-03  0.1377E-02  0.1525E-02  0.1067E+00
============================================================

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Table 7: Nodal Displacements
------------------------------------------------------------
Number of node sets:                                     2
------------------------------------------------------------
Node set:                                                1
Number of nodes:                                     22892
+-----------------------------------------------------------
                           Ux          Uy          Uz
            average  0.1419E-01 -0.1106E-01 -0.8528E-01
            std_dev  0.8994E-02  0.8577E-02  0.1303E-06
            minimum -0.1170E-01 -0.4110E-01 -0.8528E-01
            maximum  0.5608E-01  0.2675E-01 -0.8528E-01
             median  0.1458E-01 -0.1070E-01 -0.8528E-01
------------------------------------------------------------
Node set:                                                2
Number of nodes:                                     30337
+-----------------------------------------------------------
                           Ux          Uy          Uz
            average -0.1493E-01  0.1054E-01  0.0000E+00
            std_dev  0.3115E-01  0.3033E-01  0.0000E+00
            minimum -0.7915E-01 -0.7555E-01  0.0000E+00
            maximum  0.5922E-01  0.7340E-01  0.0000E+00
             median -0.1625E-01  0.1049E-01  0.0000E+00
============================================================

============================================================
Table 8: Nodal Forces
------------------------------------------------------------
Number of node sets:                                     2
------------------------------------------------------------
Node set:                                                1
Number of nodes:                                     22892
+-----------------------------------------------------------
                           Fx          Fy          Fz
              total  0.1046E-02 -0.1985E-02 -0.4079E+04
            average  0.4571E-07 -0.8672E-07 -0.1782E+00
            std_dev  0.4075E-04  0.4157E-04  0.1922E+00
            minimum -0.3426E-03 -0.4049E-03 -0.1210E+01
            maximum  0.3695E-03  0.4074E-03  0.1143E+00
             median  0.4139E-07  0.7536E-07 -0.1125E+00
------------------------------------------------------------
Node set:                                                2
Number of nodes:                                     30337
+-----------------------------------------------------------
                           Fx          Fy          Fz
              total -0.7377E-02  0.1019E-01  0.4079E+04
```

```
            average -0.2432E-06  0.3360E-06  0.1345E+00
            std_dev  0.9434E-05  0.9251E-05  0.1595E+00
            minimum -0.1019E-03 -0.6381E-04 -0.2891E+00
            maximum  0.5274E-04  0.6749E-04  0.1264E+01
             median -0.1211E-06  0.1265E-06  0.8649E-01
============================================================

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Table 9: Load Sharing (by elements)
------------------------------------------------------------
Number of element sets:                                   2
Element area x-y face:                           0.6724E-02
Element area y-z face:                           0.6724E-02
Element area z-x face:                           0.6724E-02
------------------------------------------------------------
Element set:                                              1
Number of elements:                                   17182
+-----------------------------------------------------------
           material          Fx          Fy          Fz        % Fz
                127 -0.8340E+03 -0.7196E+03 -0.4079E+04      100.00
          ---------- ----------- ----------- -----------  ----------
               total -0.8340E+03 -0.7196E+03 -0.4079E+04      100.00
------------------------------------------------------------
Element set:                                              2
Number of elements:                                   20342
+-----------------------------------------------------------
           material          Fx          Fy          Fz        % Fz
                127  0.3093E+03  0.2605E+03 -0.4079E+04      100.00
          ---------- ----------- ----------- -----------  ----------
               total  0.3093E+03  0.2605E+03 -0.4079E+04      100.00
------------------------------------------------------------
NOTE: Total Fx & Fy are determined by summing over the
      element faces.  Therefore, total Fx & Fy are different
      than reported in Nodal Forces (Table 8).  Total Fz
      should be identical.
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Table 10: Failure Load Estimate
------------------------------------------------------------
Pistoia Criterion for Energy-Equivalent-Strain (EES)
  (*) Results valid for linear, isotropic model only.
------------------------------------------------------------
Number of elements in analysis:                     1944705
Excluded material id:                                  none
............................................................
Critical volume (%):                                 2.0000
Critical EES:                                        0.0070
EES at vol_crit:                                     0.0134
Factor (from table):                             0.5226E+00
Reaction force z:                               -0.4079E+04
Failure load (rfz / factor) [N]:                -0.2132E+04
Stiffness [N/mm]:                                0.4783E+05
------------------------------------------------------------
Distribution of energy-equivalent-strain: EES = sqrt(2U/E).
............................................................
                          EES
            average  0.5806E-02
            std_dev  0.3325E-02
            minimum  0.0000E+00
            maximum  0.5546E-01
           skewness  0.7718E+00
           kurtosis  0.1902E+01
             median  0.5589E-02
------------------------------------------------------------
Distribution of failed materials.
............................................................
           material       # els           %
                127       38895    100.0000
          ---------- ----------- -----------
               total       38895    100.0000
------------------------------------------------------------
Factor table:
         crit_vol |    crit_ees
      %     # vox |      0.0050      0.0060      0.0070      0.0080      0.0090
 ------ -------- | ----------- ----------- ----------- ----------- -----------
   1.00   1944705 |  0.3325E+00  0.3990E+00  0.4655E+00  0.5320E+00  0.5986E+00
   2.00   3889410 |  0.3733E+00  0.4480E+00  0.5226E+00  0.5973E+00  0.6720E+00
   3.00   5834115 |  0.4002E+00  0.4802E+00  0.5602E+00  0.6402E+00  0.7203E+00
   4.00   7778820 |  0.4218E+00  0.5062E+00  0.5906E+00  0.6749E+00  0.7593E+00
   5.00   9723525 |  0.4394E+00  0.5273E+00  0.6152E+00  0.7030E+00  0.7909E+00
```

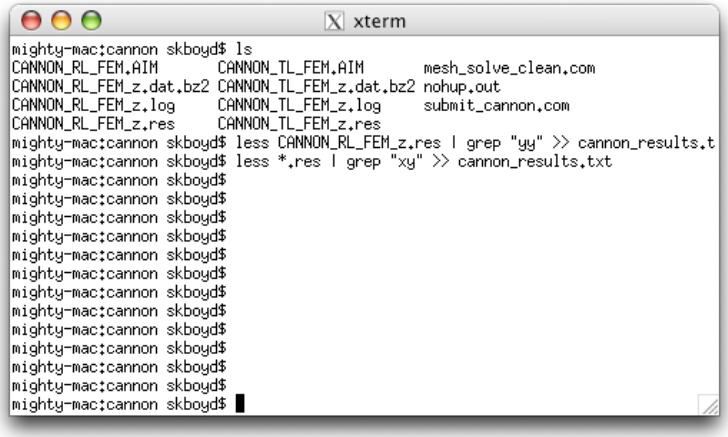
```
   6.00  11668230 |  0.4547E+00  0.5456E+00  0.6365E+00  0.7274E+00  0.8184E+00
   7.00  13612935 |  0.4682E+00  0.5618E+00  0.6554E+00  0.7491E+00  0.8427E+00
 ============================================================

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 Table 20: Computational Cost
 ------------------------------------------------------------
 Number of threads:                                        8
 Device number:                                            0
 Solver:                                      multi-threaded
 Precision:                                           double
 ------------------------------------------------------------------------|
 Computation time  |          wall (s)        |          cpu (s)         |
 ------------------|--------------------------|--------------------------|
                   |       time        delta  |       time        delta  |
 ------------------|--------------------------|--------------------------|
       Read input  |     21.2140     21.2140  |     21.2098     21.2098  |
   Pre-processing  |     48.8500     27.6360  |     48.0787     26.8689  |
           Solver  |    870.1450    821.2950  |   5666.1918   5618.1131  |
   Write DAT file  |    943.9990     73.8540  |   5738.4095     72.2176  |
  Element summary  |    957.1570     13.1580  |   5751.5666     13.1571  |
    Nodal summary  |    958.0020      0.8450  |   5752.4120      0.8454  |
     Load sharing  |    958.0090      0.0070  |   5752.4184      0.0064  |
 Failure estimate  |    959.4580      1.4490  |   5753.8678      1.4495  |
 ------------------|--------------------------|--------------------------|
        % solver   |         90.7           %  |         98.5           %  |
      % pre/post   |          9.3           %  |          1.5           %  |
 ------------------|--------------------------|--------------------------|
     Charged time  |    959.4580           s  |   5753.8678           s  |
 ------------------------------------------------------------------------|
 ============================================================

 ============================================================
 Table 19: One Liner
 ------------------------------------------------------------
  yy                                filename    faim_version         num_els       num_nodes       tolerance
num_eqns        max_comp        max_tens    num_materials         mat_id1     num_mat_id1         mat_id2
num_mat_id2         mat_id3     num_mat_id3    es1_fz_total     es1_fz_mat1     es1_fz_mat2     es1_fz_mat3
es2_fz_total     es2_fz_mat1     es2_fz_mat2     es2_fz_mat3     es3_fz_total     es3_fz_mat1     es3_fz_mat2
es3_fz_mat3        fz_total    failure_load       stiffness    wtime_solver   wtime_prepost     wtime_total
  xy CANNON_RL_FEM_z                                    4.03         1944705         3065396      0.1000E-03
9165851     -0.4930E-01      0.2950E-01               1             127         1944705               0
0               0               0     -0.4079E+04     -0.4079E+04      0.0000E+00      0.0000E+00     -0.4079E
+04     -0.4079E+04      0.0000E+00      0.0000E+00      0.0000E+00      0.0000E+00      0.0000E+00
0.0000E+00     -0.4079E+04     -0.2132E+04      0.4783E+05          821.29          138.16          959.46
 ============================================================

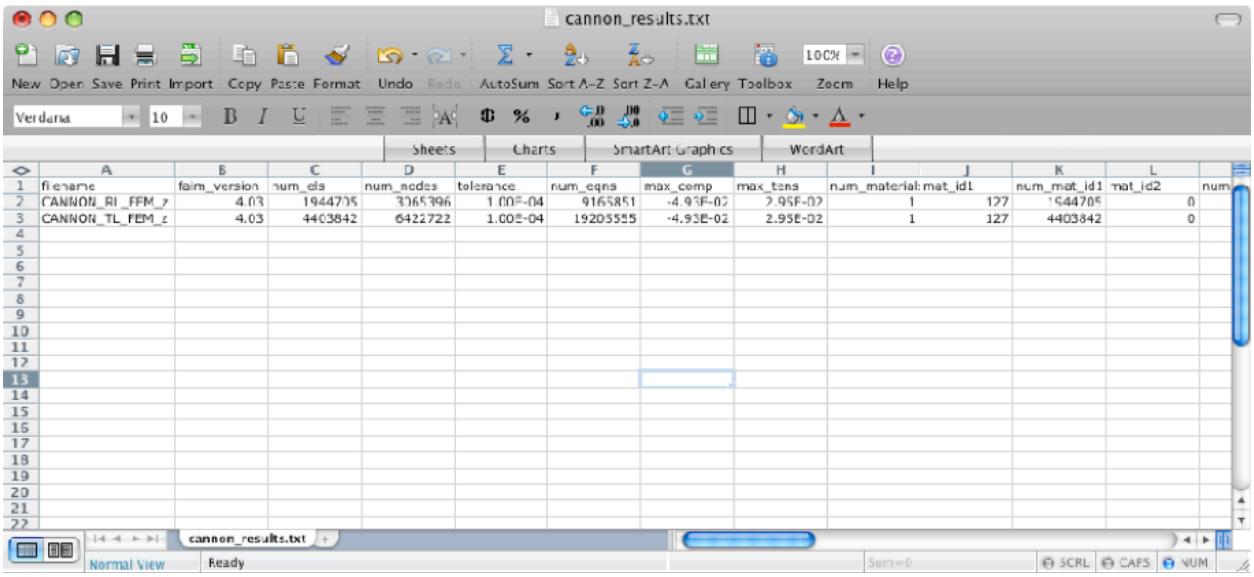
 ============================================================
 Time stamp:          15/10/2009                      15:53:44
 ============================================================
```

Extract summary results



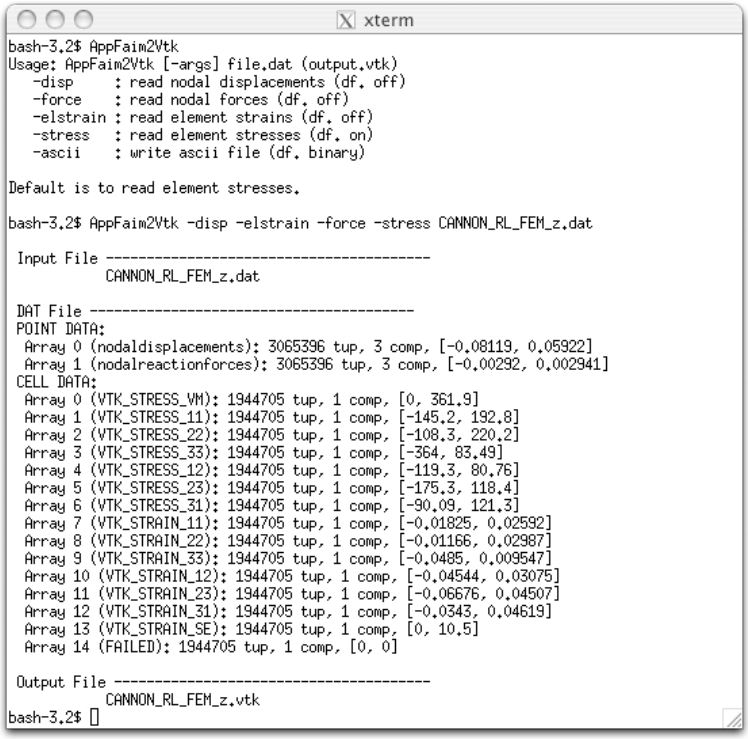
Import into Excel

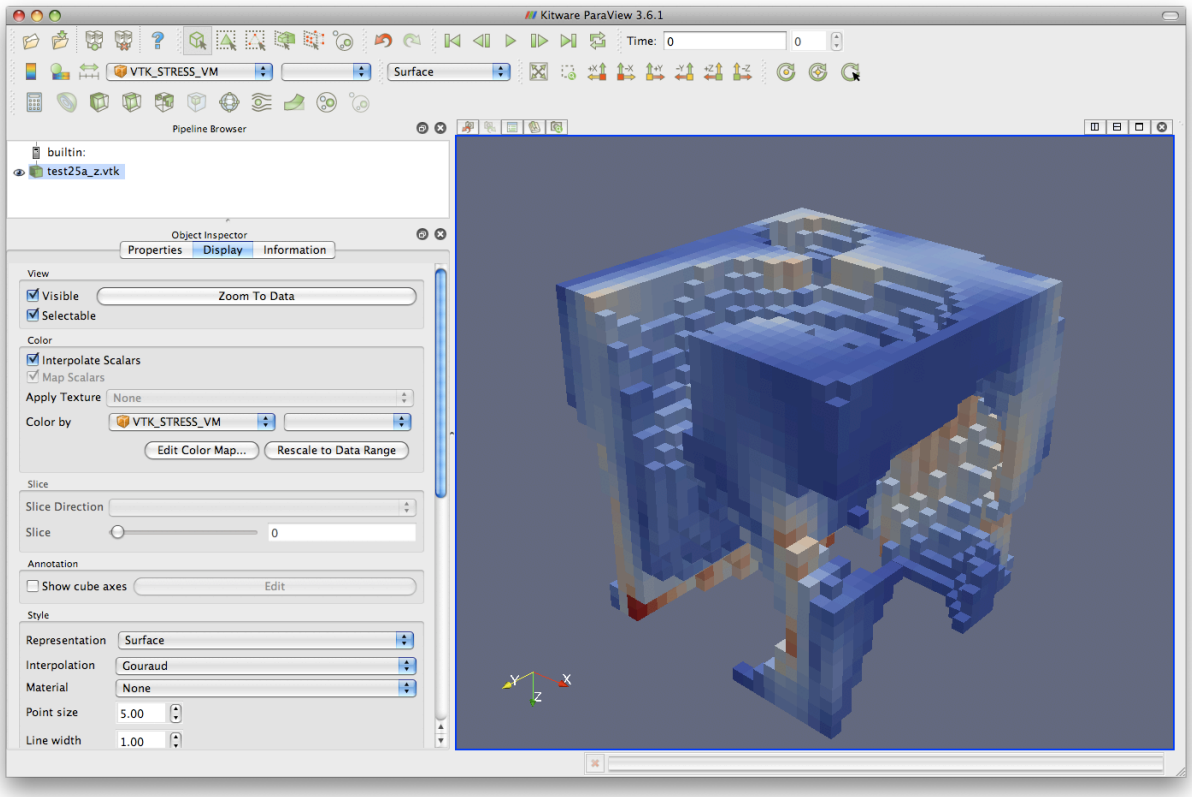
- Note that not all the information in the RES file is included.



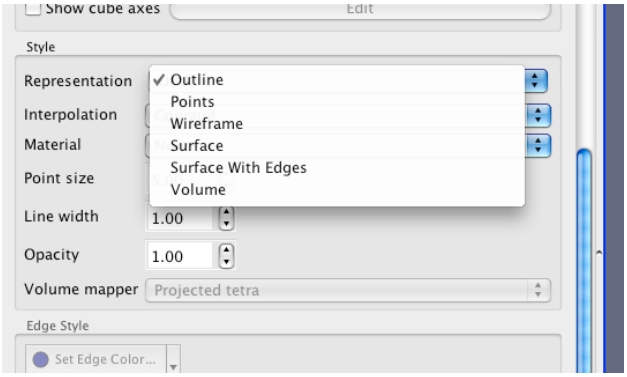
Post-Processing

Convert to DAT to VTK format for use with Paraview

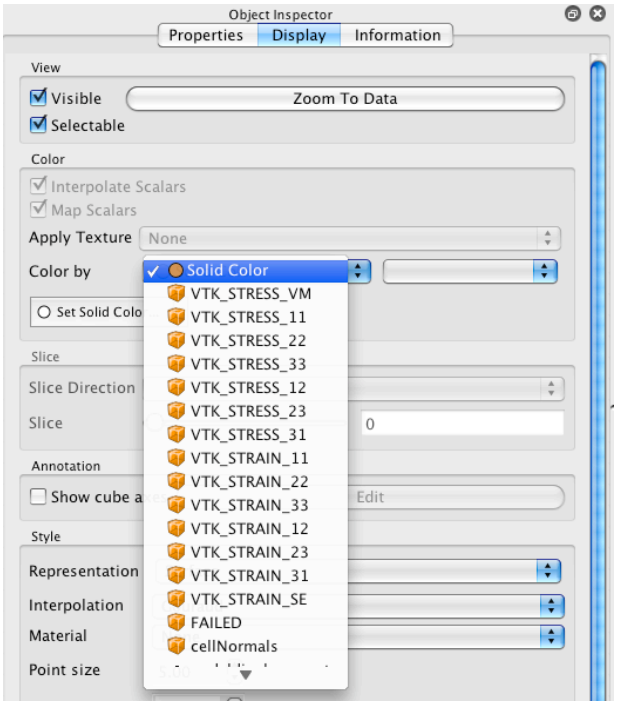


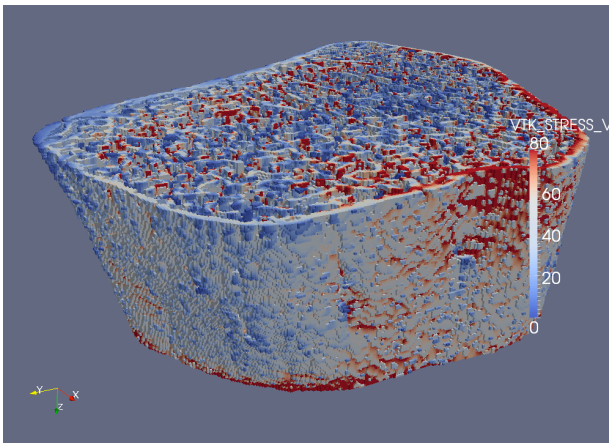


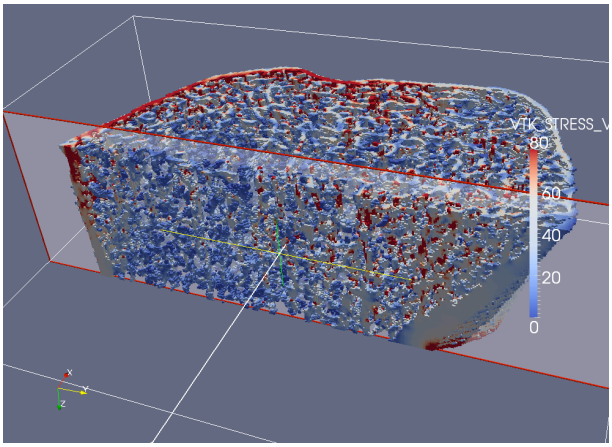
Set to “Surface mode”

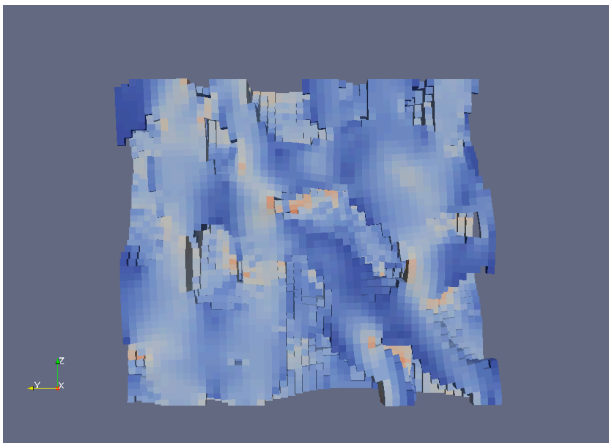


Select variable to show and be sure to re-scale the data range if necessary.

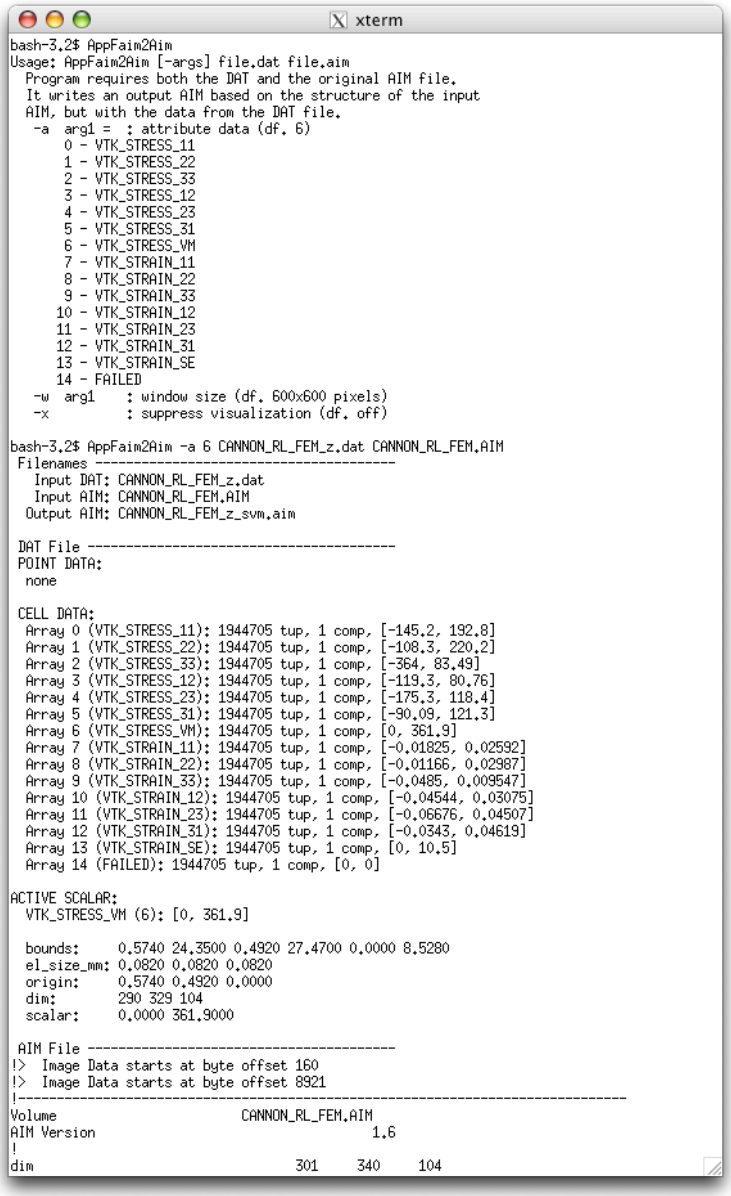


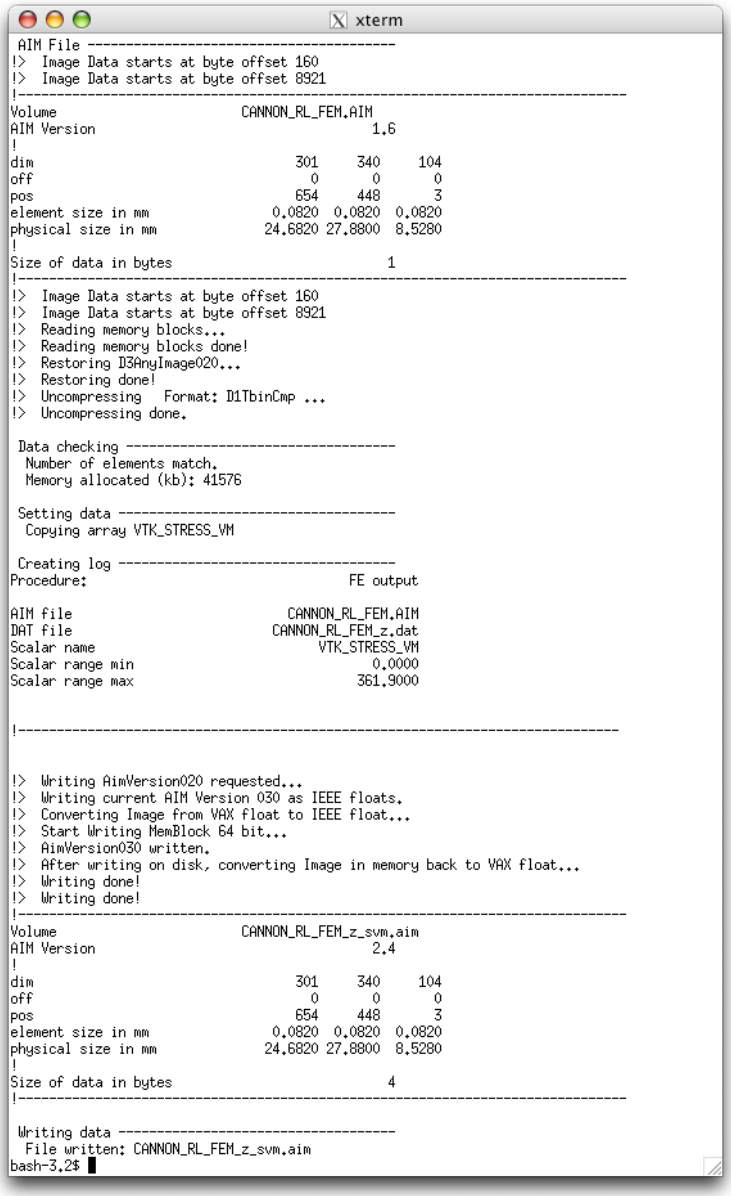




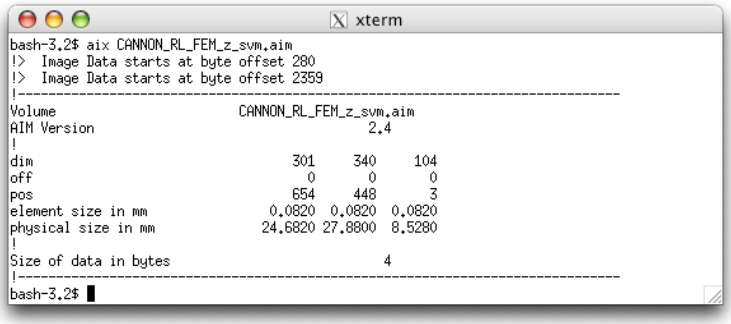


Use AppFaim2Aim


xterm
bash-3.2$ AppFaim2Aim
Usage: AppFaim2Aim [-args] file.dat file.aim
Program requires both the DAT and the original AIM file.
It writes an output AIM based on the structure of the input
AIM, but with the data from the DAT file.
-a arg1 = : attribute data (df. 6)
0 - VTK_STRESS_11
1 - VTK_STRESS_22
2 - VTK_STRESS_33
3 - VTK_STRESS_12
4 - VTK_STRESS_23
5 - VTK_STRESS_31
6 - VTK_STRESS_VM
7 - VTK_STRAIN_11
8 - VTK_STRAIN_22
9 - VTK_STRAIN_33
10 - VTK_STRAIN_12
11 - VTK_STRAIN_23
12 - VTK_STRAIN_31
13 - VTK_STRAIN_SE
14 - FAILED
-w arg1 : window size (df. 600x600 pixels)
-x : suppress visualization (df. off)
bash-3.2$ AppFaim2Aim -a 6 CANNON_RL_FEM_z.dat CANNON_RL_FEM.AIM
Filenames ----------
Input DAT: CANNON_RL_FEM_z.dat
Input AIM: CANNON_RL_FEM.AIM
Output AIM: CANNON_RL_FEM_z_svm.aim
DAT File ----------
POINT DATA:
none
CELL DATA:
Array 0 (VTK_STRESS_11): 1944705 tup, 1 comp, [-145.2, 192.8]
Array 1 (VTK_STRESS_22): 1944705 tup, 1 comp, [-108.3, 220.2]
Array 2 (VTK_STRESS_33): 1944705 tup, 1 comp, [-364, 83.49]
Array 3 (VTK_STRESS_12): 1944705 tup, 1 comp, [-119.3, 80.76]
Array 4 (VTK_STRESS_23): 1944705 tup, 1 comp, [-175.3, 118.4]
Array 5 (VTK_STRESS_31): 1944705 tup, 1 comp, [-90.09, 121.3]
Array 6 (VTK_STRESS_VM): 1944705 tup, 1 comp, [0, 361.9]
Array 7 (VTK_STRAIN_11): 1944705 tup, 1 comp, [-0.01825, 0.02592]
Array 8 (VTK_STRAIN_22): 1944705 tup, 1 comp, [-0.01166, 0.02987]
Array 9 (VTK_STRAIN_33): 1944705 tup, 1 comp, [-0.0485, 0.009547]
Array 10 (VTK_STRAIN_12): 1944705 tup, 1 comp, [-0.04544, 0.03075]
Array 11 (VTK_STRAIN_23): 1944705 tup, 1 comp, [-0.06676, 0.04507]
Array 12 (VTK_STRAIN_31): 1944705 tup, 1 comp, [-0.0343, 0.04619]
Array 13 (VTK_STRAIN_SE): 1944705 tup, 1 comp, [0, 10.5]
Array 14 (FAILED): 1944705 tup, 1 comp, [0, 0]
ACTIVE SCALAR:
VTK_STRESS_VM (6): [0, 361.9]
bounds: 0.5740 24.3500 0.4920 27.4700 0.0000 8.5280
el_size_mm: 0.0820 0.0820 0.0820
origin: 0.5740 0.4920 0.0000
dim: 290 329 104
scalar: 0.0000 361.9000
AIM File ----------
!> Image Data starts at byte offset 160
!> Image Data starts at byte offset 8921
!----------
Volume CANNON_RL_FEM.AIM
AIM Version 1.6
!
dim 301 340 104



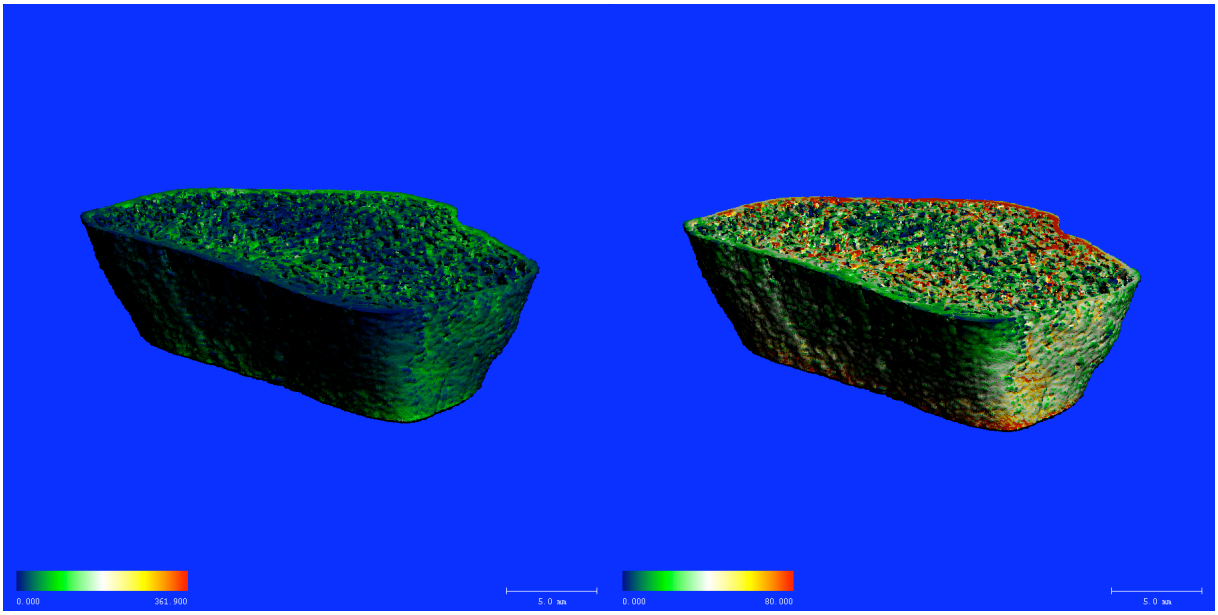
- Float data!



Visualize with uct_3d

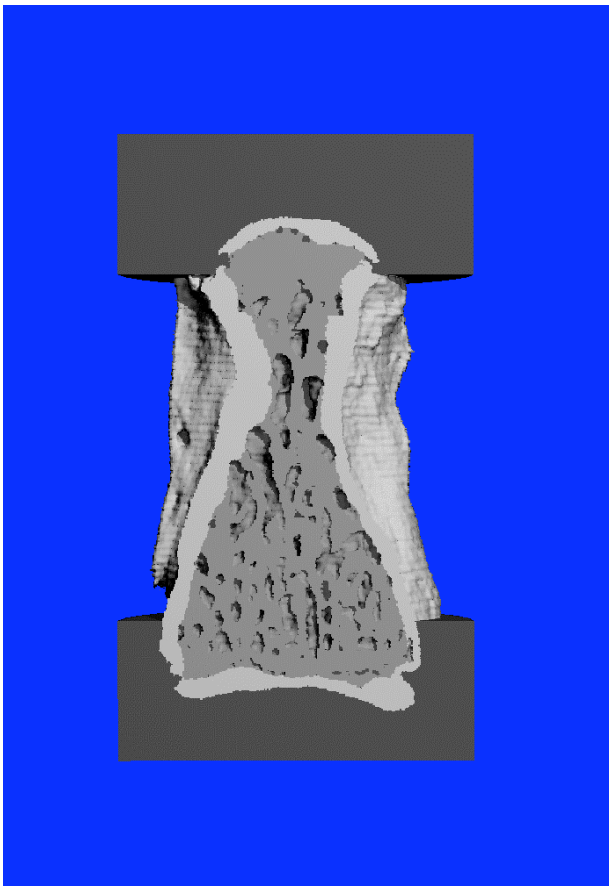
- Transfer back to VMS station
- Adjust the scale with Options:Values

- Now one can access all the standard IPL commands to do further evaluation with this data set.



End Caps

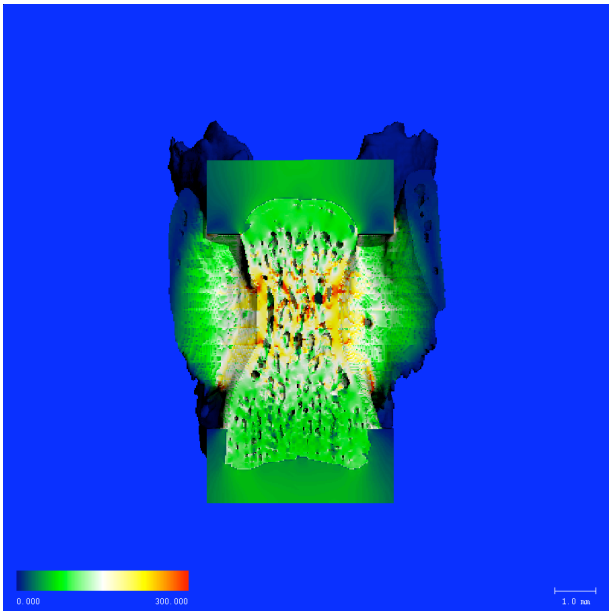
Modeling with Endcaps



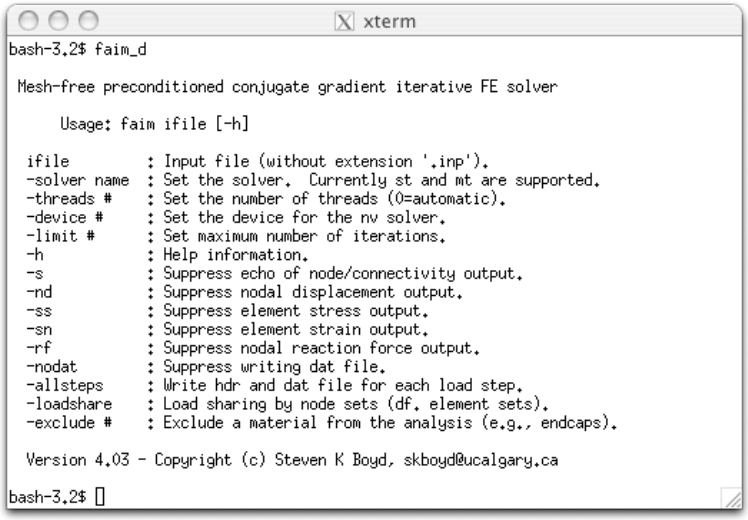
AppDirectMechanicsGenerator requires the following options if we are interested in a mid-plane analysis of the load sharing, and if we want to ensure the BCs are applied to the platens (and not the min/max Z values):

- -f # : Apply BCs to a specific material id only (df. all)
- -p : Generate an element set for the plane midway along testing axis

- Specifying -f 56 forces the BCs to be applied on material 56 only (i.e., the end caps). This is useful when the bone extends beyond the endcaps.



- Running the FE model, include the parameter “-exclude 56” if the end caps are identified as 56. This removes them from the post-processing analysis of stress distribution, etc.



Results file

```
============================================================
Time stamp:          29/09/2009                    14:41:55
============================================================

============================================================
Table 1: Model Input
------------------------------------------------------------
FAIM version:                                          4.01
Filename:          AMMANN_VERT_01_ENDCAPS_R02_z
Element:                                         hexahedron
Element dim X:                                       0.0320
Element dim Y:                                       0.0320
Element dim Z:                                       0.0330
Number of nodes:                                    3138944
Number of elements:                                 2891074
Number of integration points:                             8
```

```
Number of freedoms per node:                              3
Number of nodes per element:                              8
Dimension of problem:                                     3
Tolerance:                                      0.1000E-03
Maximum number of iterations:                        30000
Number of equations:                                9397101
Number of steps:                                          1
Number of steps at exit:                                  1
Maximum compression:                           -0.4930E-01
Maximum tension:                                0.2950E-01
Total load:                                     0.0000E+00
============================================================

============================================================
Table 2: Model Material Table
------------------------------------------------------------
Number of materials available:                          254
Number of materials used:                                 3
Isotropic material:                                    true
------------------------------------------------------------
  id          E           v           G
 127  0.1934E+05  0.3000E+00  0.7438E+04
 125  0.1934E+05  0.3000E+00  0.7438E+04
  56  0.3000E+04  0.3000E+00  0.1154E+04
============================================================

============================================================
Table 3: Model Material Distribution
------------------------------------------------------------
           material    # voxels           %
                127      357630     12.3701
                125      599806     20.7468
                 56     1933638     66.8830
          ----------  ----------  ----------
              total     2891074    100.0000
============================================================

============================================================
Table 4: Conjugate Gradient Load Step
------------------------------------------------------------
Current step:                                             1
Number of steps:                                          1
Load step at exit:                                        1
Failed voxels:                                            0
Convergence criteria:                           0.1000E-03
Convergence measure:                            0.9451E-04
Iterations to convergence:                              1532
============================================================

============================================================
Table 5: Tissue Stresses
------------------------------------------------------------
Material:                                               ALL
Number of elements:                                 2891074
..........................................................
                          s11         s22         s33         s12         s23         s31         sVM
            average -0.1610E-01  0.5799E-02 -0.5123E+02 -0.1237E-02  0.2687E-01  0.4980E-01  0.5669E+02
            std_dev  0.1035E+02  0.1079E+02  0.5787E+02  0.4608E+01  0.1173E+02  0.1094E+02  0.5724E+02
            minimum -0.2911E+03 -0.2237E+03 -0.9088E+03 -0.8763E+02 -0.1769E+03 -0.2027E+03  0.4357E-01
            maximum  0.2038E+03  0.2041E+03  0.4216E+02  0.1119E+03  0.1929E+03  0.2382E+03  0.7154E+03
           skewness -0.9526E+00 -0.6800E+00 -0.1983E+01 -0.2234E+00  0.2026E+00 -0.1837E+00  0.1812E+01
           kurtosis  0.1281E+02  0.1043E+02  0.4448E+01  0.1478E+02  0.1125E+02  0.1214E+02  0.3509E+01
             median  0.9328E+00  0.7357E+00 -0.3285E+02  0.6570E-01  0.9737E-03 -0.5067E-01  0.3779E+02
      percentile05 -0.1833E+02 -0.1808E+02 -0.1831E+03 -0.6366E+01 -0.1774E+02 -0.1558E+02  0.4330E+01
      percentile25 -0.1760E+01 -0.2091E+01 -0.6612E+02 -0.1606E+01 -0.1654E+01 -0.2417E+01  0.1735E+02
      percentile75  0.3848E+01  0.3356E+01 -0.1177E+02  0.1686E+01  0.1621E+01  0.2445E+01  0.7650E+02
      percentile95  0.1230E+02  0.1569E+02 -0.6126E+00  0.6225E+01  0.1809E+02  0.1641E+02  0.1863E+03
fraction_below_zero  0.3949E+00  0.4056E+00  0.9771E+00  0.4860E+00  0.4995E+00  0.5175E+00  0.0000E+00
            ave_neg -0.7707E+01 -0.7543E+01 -0.5245E+02 -0.2845E+01 -0.5913E+01 -0.5682E+01  0.0000E+00
            med_neg -0.3463E+01 -0.3563E+01 -0.3421E+02 -0.1677E+01 -0.1659E+01 -0.2248E+01  0.0000E+00
            ave_pos  0.5003E+01  0.5157E+01  0.7738E+00  0.2688E+01  0.5954E+01  0.6199E+01  0.5669E+02
            med_pos  0.3103E+01  0.2778E+01  0.4277E+00  0.1618E+01  0.1617E+01  0.2633E+01  0.3779E+02
------------------------------------------------------------
Material:                                   ALL EXCEPT  56
Number of elements:                                957436
..........................................................
                          s11         s22         s33         s12         s23         s31         sVM
            average -0.2838E+01 -0.1568E+01 -0.1116E+03 -0.1056E-01 -0.7634E-01  0.6466E+00  0.1199E+03
            std_dev  0.1666E+02  0.1793E+02  0.6394E+02  0.7469E+01  0.1985E+02  0.1813E+02  0.5832E+02
            minimum -0.2911E+03 -0.2237E+03 -0.9088E+03 -0.8763E+02 -0.1769E+03 -0.2027E+03  0.1761E+01
            maximum  0.2038E+03  0.2041E+03  0.4216E+02  0.1119E+03  0.1929E+03  0.2382E+03  0.7154E+03
```

```
          skewness -0.1066E+00 -0.1411E+00 -0.1148E+01 -0.1556E+00  0.1384E+00 -0.2076E+00  0.1182E+01
          kurtosis  0.3559E+01  0.2072E+01  0.1358E+01  0.4711E+01  0.2217E+01  0.3040E+01  0.1262E+01
            median -0.2565E+01 -0.1634E+01 -0.9259E+02  0.1631E+00 -0.5328E+00  0.1241E+01  0.1009E+03
      percentile05 -0.2980E+02 -0.3116E+02 -0.2395E+03 -0.1201E+02 -0.3196E+02 -0.2956E+02  0.5608E+02
      percentile25 -0.1189E+02 -0.1123E+02 -0.1455E+03 -0.3629E+01 -0.1062E+02 -0.8237E+01  0.7686E+02
      percentile75  0.6283E+01  0.8226E+01 -0.6541E+02  0.3717E+01  0.9999E+01  0.9666E+01  0.1511E+03
      percentile95  0.2342E+02  0.2825E+02 -0.3905E+02  0.1152E+02  0.3331E+02  0.2976E+02  0.2373E+03
fraction_below_zero  0.5826E+00  0.5522E+00  0.9983E+00  0.4874E+00  0.5170E+00  0.4585E+00  0.0000E+00
           ave_neg -0.1308E+02 -0.1349E+02 -0.1118E+03 -0.5397E+01 -0.1394E+02 -0.1340E+02  0.0000E+00
           med_neg -0.1004E+02 -0.9947E+01 -0.9271E+02 -0.3759E+01 -0.1014E+02 -0.9325E+01  0.0000E+00
           ave_pos  0.1146E+02  0.1313E+02  0.5523E+01  0.5111E+01  0.1477E+02  0.1254E+02  0.1199E+03
           med_pos  0.8482E+01  0.9831E+01  0.3596E+01  0.3599E+01  0.1055E+02  0.8713E+01  0.1009E+03
-------------------------------------------------------------
Material:                                            127
Number of elements:                                357630
.............................................................
                           s11         s22         s33         s12         s23         s31         sVM
           average -0.8081E+00 -0.1066E+01 -0.1256E+03 -0.7591E-02 -0.3067E+00  0.7331E+00  0.1348E+03
           std_dev  0.1808E+02  0.2029E+02  0.7196E+02  0.7009E+01  0.2068E+02  0.1895E+02  0.6359E+02
           minimum -0.2911E+03 -0.2237E+03 -0.9088E+03 -0.8763E+02 -0.1769E+03 -0.1747E+03  0.1899E+01
           maximum  0.1241E+03  0.1856E+03  0.2476E+02  0.7400E+02  0.1929E+03  0.2382E+03  0.7154E+03
          skewness -0.4378E+00 -0.4558E-01 -0.8541E+00 -0.2755E+00  0.1515E+00 -0.3819E+00  0.9055E+00
          kurtosis  0.2992E+01  0.1178E+01  0.1723E+00  0.3873E+01  0.1775E+01  0.2607E+01  0.2250E+00
            median -0.7314E+00 -0.2454E+01 -0.1028E+03  0.1097E+00 -0.8415E+00  0.1056E+01  0.1112E+03
-------------------------------------------------------------
Material:                                            125
Number of elements:                                599806
.............................................................
                           s11         s22         s33         s12         s23         s31         sVM
           average -0.4048E+01 -0.1868E+01 -0.1032E+03 -0.1232E-01  0.6101E-01  0.5951E+00  0.1110E+03
           std_dev  0.1563E+02  0.1636E+02  0.5702E+02  0.7730E+01  0.1935E+02  0.1762E+02  0.5298E+02
           minimum -0.1693E+03 -0.1808E+03 -0.7043E+03 -0.7925E+02 -0.1657E+03 -0.2027E+03  0.1761E+01
           maximum  0.2038E+03  0.2041E+03  0.4216E+02  0.1119E+03  0.1662E+03  0.1724E+03  0.6378E+03
          skewness  0.1184E+00 -0.2744E+00 -0.1295E+01 -0.1015E+00  0.1316E+00 -0.7900E-01  0.1352E+01
          kurtosis  0.4252E+01  0.2775E+01  0.2477E+01  0.4957E+01  0.2523E+01  0.3334E+01  0.2273E+01
            median -0.3625E+01 -0.1211E+01 -0.8777E+02  0.1970E+00 -0.3234E+00  0.1344E+01  0.9536E+02
-------------------------------------------------------------
Material:                                             56
Number of elements:                                1933638
.............................................................
                           s11         s22         s33         s12         s23         s31         sVM
           average  0.1381E+01  0.7853E+00 -0.2134E+02  0.3378E-02  0.7797E-01 -0.2457E+00  0.2538E+02
           std_dev  0.4114E+01  0.3591E+01  0.1694E+02  0.2033E+01  0.3235E+01  0.4014E+01  0.1595E+02
           minimum -0.1192E+03 -0.1213E+03 -0.9747E+02 -0.2698E+02 -0.6562E+02 -0.6260E+02  0.4357E-01
           maximum  0.2532E+02  0.2157E+02  0.3841E+01  0.3347E+02  0.5524E+02  0.5889E+02  0.1297E+03
          skewness -0.3387E+01 -0.3235E+01 -0.6135E+00  0.1528E-01  0.3293E+00 -0.3852E+00  0.4471E+00
          kurtosis  0.4273E+02  0.4302E+02 -0.5661E+00  0.3228E+01  0.1525E+02  0.8079E+01 -0.6165E+00
            median  0.1343E+01  0.9706E+00 -0.1757E+02  0.5253E-01  0.1203E-01 -0.9866E-01  0.2310E+02
=============================================================

=============================================================
Table 6: Tissue Strains
-------------------------------------------------------------
Material:                                            ALL
Number of elements:                                2891074
.............................................................
                           e11         e22         e33         e12         e23         e31         SED
           average  0.2215E-02  0.2071E-02 -0.6791E-02  0.1488E-05  0.4180E-04 -0.1136E-03  0.2528E+00
           std_dev  0.2082E-02  0.1448E-02  0.4995E-02  0.1553E-02  0.2760E-02  0.3175E-02  0.3533E+00
           minimum -0.2986E-01 -0.3054E-01 -0.3912E-01 -0.2338E-01 -0.5687E-01 -0.5425E-01  0.2965E-06
           maximum  0.1074E-01  0.1157E-01  0.9334E-02  0.2901E-01  0.4787E-01  0.5103E-01  0.1665E+02
          skewness  0.1541E+00 -0.1874E+00 -0.7892E+00  0.2616E-02  0.2741E+00 -0.4083E+00  0.3870E+01
          kurtosis  0.2427E+01  0.6178E+01 -0.1092E-01  0.4358E+01  0.1152E+02  0.8417E+01  0.3120E+02
            median  0.1764E-02  0.1927E-02 -0.5459E-02  0.3443E-04  0.7594E-06 -0.3739E-04  0.1432E+00
      percentile05 -0.3814E-03 -0.4275E-04 -0.1592E-01 -0.2664E-02 -0.4056E-02 -0.5058E-02  0.2946E-02
      percentile25  0.7512E-03  0.1152E-02 -0.1000E-01 -0.7958E-03 -0.8868E-03 -0.1247E-02  0.4435E-01
      percentile75  0.3623E-02  0.2986E-02 -0.3152E-02  0.7937E-03  0.9212E-03  0.1123E-02  0.3121E+00
      percentile95  0.5891E-02  0.4583E-02 -0.2694E-03  0.2584E-02  0.4269E-02  0.4579E-02  0.9270E+00
fraction_below_zero  0.1053E+00  0.5499E-01  0.9743E+00  0.4860E+00  0.4995E+00  0.5175E+00  0.0000E+00
           ave_neg -0.7322E-03 -0.6953E-03 -0.6984E-02 -0.1153E-02 -0.1625E-02 -0.2047E-02  0.0000E+00
           med_neg -0.3562E-03 -0.3329E-03 -0.5623E-02 -0.8280E-03 -0.8885E-03 -0.1179E-02  0.0000E+00
           ave_pos  0.2563E-02  0.2232E-02  0.5104E-03  0.1094E-02  0.1705E-02  0.1960E-02  0.2528E+00
           med_pos  0.2047E-02  0.2023E-02  0.2074E-03  0.7631E-03  0.9194E-03  0.1192E-02  0.1432E+00
-------------------------------------------------------------
Material:                                    ALL EXCEPT  56
Number of elements:                                957436
.............................................................
                           s11         s22         s33         s12         s23         s31         sVM
           average  0.1608E-02  0.1694E-02 -0.5701E-02 -0.1419E-05 -0.1026E-04  0.8693E-04  0.4693E+00
           std_dev  0.1073E-02  0.9202E-03  0.3081E-02  0.1004E-02  0.2669E-02  0.2437E-02  0.5042E+00
           minimum -0.7179E-02 -0.8654E-02 -0.3912E-01 -0.1178E-01 -0.2378E-01 -0.2724E-01  0.8199E-04
```

```
           maximum  0.9805E-02  0.1157E-01  0.2358E-02  0.1504E-01  0.2593E-01  0.3203E-01  0.1665E+02
          skewness  0.7645E+00  0.7373E+00 -0.1213E+01 -0.1556E+00  0.1384E+00 -0.2076E+00  0.2692E+01
          kurtosis  0.1199E+01  0.2542E+01  0.1421E+01  0.4711E+01  0.2217E+01  0.3040E+01  0.1599E+02
            median  0.1413E-02  0.1568E-02 -0.4705E-02  0.2193E-04 -0.7163E-04  0.1668E-03  0.2627E+00
      percentile05  0.1577E-03  0.4402E-03 -0.1202E-01 -0.1615E-02 -0.4296E-02 -0.3973E-02  0.7789E-01
      percentile25  0.9027E-03  0.1141E-02 -0.7249E-02 -0.4878E-03 -0.1428E-02 -0.1107E-02  0.1482E+00
      percentile75  0.2162E-02  0.2128E-02 -0.3516E-02  0.4996E-03  0.1344E-02  0.1299E-02  0.6068E+00
      percentile95  0.3656E-02  0.3434E-02 -0.2281E-02  0.1548E-02  0.4477E-02  0.4000E-02  0.1502E+01
fraction_below_zero  0.3526E-01  0.1997E-01  0.9994E+00  0.4874E+00  0.5170E+00  0.4585E+00  0.0000E+00
           ave_neg -0.4049E-03 -0.5354E-03 -0.5705E-02 -0.7256E-03 -0.1874E-02 -0.1801E-02  0.0000E+00
           med_neg -0.2739E-03 -0.3575E-03 -0.4707E-02 -0.5053E-03 -0.1363E-02 -0.1254E-02  0.0000E+00
           ave_pos  0.1682E-02  0.1739E-02  0.3656E-03  0.6871E-03  0.1985E-02  0.1685E-02  0.4693E+00
           med_pos  0.1451E-02  0.1586E-02  0.2538E-03  0.4838E-03  0.1419E-02  0.1171E-02  0.2627E+00
-------------------------------------------------------------
Material:                                             127
Number of elements:                                357630
.............................................................
                          s11         s22         s33         s12         s23         s31         sVM
           average  0.1923E-02  0.1906E-02 -0.6466E-02 -0.1021E-05 -0.4123E-04  0.9855E-04  0.5863E+00
           std_dev  0.1078E-02  0.9749E-03  0.3431E-02  0.9423E-03  0.2780E-02  0.2548E-02  0.5815E+00
           minimum -0.7179E-02 -0.8654E-02 -0.3912E-01 -0.1178E-01 -0.2378E-01 -0.2348E-01  0.8368E-04
           maximum  0.9805E-02  0.1044E-01  0.2090E-02  0.9948E-02  0.2593E-01  0.3203E-01  0.1665E+02
          skewness  0.5052E+00  0.6635E+00 -0.9341E+00 -0.2755E+00  0.1515E+00 -0.3819E+00  0.2162E+01
          kurtosis  0.7855E+00  0.1316E+01  0.2258E+00  0.3873E+01  0.1775E+01  0.2607E+01  0.1305E+02
            median  0.1712E-02  0.1776E-02 -0.5183E-02  0.1475E-04 -0.1131E-03  0.1420E-03  0.3212E+00
-------------------------------------------------------------
Material:                                             125
Number of elements:                                599806
.............................................................
                          s11         s22         s33         s12         s23         s31         sVM
           average  0.1421E-02  0.1567E-02 -0.5245E-02 -0.1657E-05  0.8202E-05  0.8000E-04  0.3995E+00
           std_dev  0.1025E-02  0.8615E-03  0.2753E-02  0.1039E-02  0.2601E-02  0.2369E-02  0.4372E+00
           minimum -0.6983E-02 -0.5415E-02 -0.3407E-01 -0.1065E-01 -0.2228E-01 -0.2724E-01  0.8199E-04
           maximum  0.9595E-02  0.1157E-01  0.2358E-02  0.1504E-01  0.2234E-01  0.2318E-01  0.1164E+02
          skewness  0.9802E+00  0.7318E+00 -0.1353E+01 -0.1015E+00  0.1316E+00 -0.7900E-01  0.3184E+01
          kurtosis  0.1994E+01  0.3752E+01  0.2533E+01  0.4957E+01  0.2523E+01  0.3334E+01  0.1884E+02
            median  0.1222E-02  0.1483E-02 -0.4461E-02  0.2649E-04 -0.4348E-04  0.1806E-03  0.2350E+00
-------------------------------------------------------------
Material:                                              56
Number of elements:                               1933638
.............................................................
                          s11         s22         s33         s12         s23         s31         sVM
           average  0.2516E-02  0.2258E-02 -0.7331E-02  0.2927E-05  0.6757E-04 -0.2130E-03  0.1456E+00
           std_dev  0.2374E-02  0.1616E-02  0.5633E-02  0.1762E-02  0.2804E-02  0.3479E-02  0.1613E+00
           minimum -0.2986E-01 -0.3054E-01 -0.2522E-01 -0.2338E-01 -0.5687E-01 -0.5425E-01  0.2965E-06
           maximum  0.1074E-01  0.1142E-01  0.9334E-02  0.2901E-01  0.4787E-01  0.5103E-01  0.3612E+01
          skewness -0.1756E+00 -0.4987E+00 -0.5260E+00  0.1528E-01  0.3293E+00 -0.3852E+00  0.1678E+01
          kurtosis  0.1697E+01  0.5725E+01 -0.6464E+00  0.3228E+01  0.1525E+02  0.8079E+01  0.5152E+01
            median  0.2296E-02  0.2294E-02 -0.6257E-02  0.4552E-04  0.1043E-04 -0.8550E-04  0.8235E-01
=============================================================

============================================================
Table 7: Nodal Displacements
------------------------------------------------------------
Number of node sets:                                    3
------------------------------------------------------------
Node set:                                               1
Number of nodes:                                    19731
+-----------------------------------------------------------
                          Ux          Uy          Uz
           average -0.7189E-02  0.3505E-02 -0.9091E-01
           std_dev  0.5740E-02  0.4352E-02  0.7623E-08
           minimum -0.1564E-01 -0.5545E-02 -0.9091E-01
           maximum  0.2366E-02  0.1161E-01 -0.9091E-01
            median -0.7772E-02  0.3562E-02 -0.9091E-01
------------------------------------------------------------
Node set:                                               2
Number of nodes:                                    19731
+-----------------------------------------------------------
                          Ux          Uy          Uz
           average  0.4079E-02 -0.3221E-02  0.0000E+00
           std_dev  0.6345E-02  0.5470E-02  0.0000E+00
           minimum -0.4713E-02 -0.1266E-01  0.0000E+00
           maximum  0.1468E-01  0.6217E-02  0.0000E+00
            median  0.3228E-02 -0.2986E-02  0.0000E+00
------------------------------------------------------------
Node set:                                               3
Number of nodes:                                     3834
+-----------------------------------------------------------
                          Ux          Uy          Uz
           average  0.4150E-02 -0.6676E-03 -0.5202E-01
```

```
            std_dev  0.1925E-02  0.1346E-02  0.1574E-02
            minimum -0.1063E-02 -0.4800E-02 -0.5626E-01
            maximum  0.7702E-02  0.3096E-02 -0.4688E-01
             median  0.4413E-02 -0.7132E-03 -0.5197E-01
============================================================

============================================================
Table 8: Nodal Forces
------------------------------------------------------------
Number of node sets:                                      3
------------------------------------------------------------
Node set:                                                 1
Number of nodes:                                      19731
+-----------------------------------------------------------
                             Fx          Fy          Fz
              total  0.4984E-02  0.1008E-02 -0.5534E+03
            average  0.2526E-06  0.5109E-07 -0.2805E-01
            std_dev  0.1400E-04  0.1381E-04  0.1374E-01
            minimum -0.7518E-04 -0.1109E-03 -0.4965E-01
            maximum  0.1160E-03  0.1140E-03  0.7305E-04
             median  0.1964E-06 -0.8082E-08 -0.2891E-01
------------------------------------------------------------
Node set:                                                 2
Number of nodes:                                      19731
+-----------------------------------------------------------
                             Fx          Fy          Fz
              total -0.7607E-02 -0.5229E-02  0.5533E+03
            average -0.3855E-06 -0.2650E-06  0.2804E-01
            std_dev  0.1762E-05  0.1900E-05  0.1797E-01
            minimum -0.6550E-05 -0.6655E-05 -0.1498E-02
            maximum  0.5472E-05  0.5216E-05  0.6979E-01
             median -0.2353E-06 -0.2340E-06  0.2405E-01
------------------------------------------------------------
Node set:                                                 3
Number of nodes:                                       3834
+-----------------------------------------------------------
                             Fx          Fy          Fz
              total -0.4558E-02  0.1357E-02  0.6434E-02
            average -0.1189E-05  0.3539E-06  0.1678E-05
            std_dev  0.4783E-04  0.4867E-04  0.3803E-04
            minimum -0.8291E-03 -0.9318E-03 -0.3767E-03
            maximum  0.1324E-02  0.1424E-02  0.9377E-03
             median -0.3577E-06 -0.2739E-06  0.1237E-05
============================================================

============================================================
Table 9: Load Sharing (by elements)
------------------------------------------------------------
Number of element sets:                                   3
Element area xy face:                             0.1024E-02
Element area yz face:                             0.1056E-02
Element area zx face:                             0.1056E-02
------------------------------------------------------------
Element set:                                              1
Number of elements:                                   19415
+-----------------------------------------------------------
           material          Fx          Fy          Fz        % Fz
                 56  0.6471E+02  0.3055E+02 -0.5534E+03      100.00
          ----------  ----------  ----------  ----------  ----------
              total  0.6471E+02  0.3055E+02 -0.5534E+03      100.00
------------------------------------------------------------
Element set:                                              2
Number of elements:                                   19415
+-----------------------------------------------------------
           material          Fx          Fy          Fz        % Fz
                 56  0.8599E+02  0.6456E+02 -0.5533E+03      100.00
          ----------  ----------  ----------  ----------  ----------
              total  0.8599E+02  0.6456E+02 -0.5533E+03      100.00
------------------------------------------------------------
Element set:                                              3
Number of elements:                                    3063
+-----------------------------------------------------------
           material          Fx          Fy          Fz        % Fz
                127 -0.9460E+01 -0.1501E+02 -0.2732E+03       49.38
                125 -0.6836E+01 -0.2011E+02 -0.2801E+03       50.62
          ----------  ----------  ----------  ----------  ----------
              total -0.1630E+02 -0.3512E+02 -0.5533E+03      100.00
------------------------------------------------------------
NOTE: Total Fx & Fy are determined by summing over the
      element faces.  Therefore, total Fx & Fy are different
      than reported in Nodal Forces (Table 8).  Total Fz
```

```
      should be identical.
============================================================

============================================================
Table 10: Failure Load Estimate
------------------------------------------------------------
Pistoia Criterion for Energy-Equivalent-Strain (EES)
  (*) Results valid for linear, isotropic model only.
------------------------------------------------------------
Number of elements in analysis:                      957436
Excluded material id:                                    56
............................................................
Critical volume (%):                                 2.0000
Critical EES:                                        0.0070
EES at vol_crit:                                     0.0141
Factor (from table):                              0.4975E+00
Reaction force Z:                                -0.5534E+03
Failure load (rfz / factor) [N}]:                -0.2753E+03
Stiffness [N/mm]:                                 0.6088E+04
------------------------------------------------------------
Distribution of energy-equivalent-strain: EES = sqrt(2U/E).
............................................................
                        EES
            average  0.6231E-02
            std_dev  0.3115E-02
            minimum  0.9208E-04
            maximum  0.4149E-01
           skewness  0.1191E+01
           kurtosis  0.1348E+01
             median  0.5212E-02
------------------------------------------------------------
Distribution of failed materials.
............................................................
           material       # els           %
                127       10977     57.3241
                125        8172     42.6759
           ----------  ----------  ----------
              total       19149    100.0000
------------------------------------------------------------
Factor table:
         crit_vol |    crit_ees
      %     # vox |      0.0050      0.0060      0.0070      0.0080      0.0090
 ------  -------- |  ----------  ----------  ----------  ----------  ----------
   1.00    957436 |  0.3280E+00  0.3937E+00  0.4593E+00  0.5249E+00  0.5905E+00
   2.00   1914872 |  0.3553E+00  0.4264E+00  0.4975E+00  0.5686E+00  0.6396E+00
   3.00   2872308 |  0.3738E+00  0.4485E+00  0.5233E+00  0.5980E+00  0.6728E+00
   4.00   3829744 |  0.3886E+00  0.4663E+00  0.5440E+00  0.6218E+00  0.6995E+00
   5.00   4787180 |  0.4012E+00  0.4815E+00  0.5617E+00  0.6420E+00  0.7222E+00
   6.00   5744616 |  0.4126E+00  0.4951E+00  0.5776E+00  0.6601E+00  0.7426E+00
   7.00   6702052 |  0.4233E+00  0.5079E+00  0.5926E+00  0.6773E+00  0.7619E+00
============================================================

============================================================
Table 20: Computational Cost
------------------------------------------------------------
Number of threads:                                       8
Device number:                                           0
Solver:                                     multi-threaded
Precision:                                          double
------------------------------------------------------------------------|
Computation time  |          wall (s)        |          cpu (s)         |
------------------|--------------------------|--------------------------|
                  |       time        delta  |       time        delta  |
------------------|--------------------------|--------------------------|
       Read input |     29.2410     29.2410  |     28.2085     28.2085  |
   Pre-processing |     66.8430     37.6020  |     62.1202     33.9117  |
           Solver |    715.9410    649.0980  |   4691.9499   4629.8297  |
   Write DAT file |    809.2990     93.3580  |   4783.3397     91.3898  |
  Element summary |    852.1680     42.8690  |   4826.2061     42.8664  |
    Nodal summary |    853.3110      1.1430  |   4827.3494      1.1433  |
     Load sharing |    853.3190      0.0080  |   4827.3567      0.0072  |
 Failure estimate |    854.0030      0.6840  |   4828.0414      0.6847  |
------------------|--------------------------|--------------------------|
         % solver |        83.8           % |        97.2           % |
       % pre/post |        16.2           % |         2.8           % |
------------------|--------------------------|--------------------------|
     Charged time |    854.0030           s |   4828.0414           s |
------------------------------------------------------------------------|
============================================================

============================================================
```

Table 19: One Liner

yy	faim_version	num_els	num_nodes	tolerance	num_eqns	max_comp
xy	4.01	2891074	3138944	0.1000E-03	9397101	-0.4930E-01
0.2950E-01	3	127	357630	125	599806	56

max_tens	num_materials	mat_id1	num_mat_id1	mat_id2	num_mat_id2	mat_id3
1933638	-0.5534E+03	-0.5534E+03	0.0000E+00	0.0000E+00	-0.5533E+03	-0.5533E+03

num_mat_id3	es1_fz_total	es1_fz_mat1	es1_fz_mat2	es1_fz_mat3	es2_fz_total	es2_fz_mat1
0.0000E+00	0.0000E+00	-0.5533E+03	-0.2732E+03	-0.2801E+03	0.0000E+00	-0.5534E+03

es2_fz_mat2	es2_fz_mat3	es3_fz_total	es3_fz_mat1	es3_fz_mat2	es3_fz_mat3	fz_total
-0.2753E+03	0.6088E+04	649.10	204.90	854.00		

failure_load	stiffness	wtime_solver	wtime_prepost	wtime_total

Time stamp: 29/09/2009 14:56:09