SIMPLE DPA INTEGRATION INTO ANSYS

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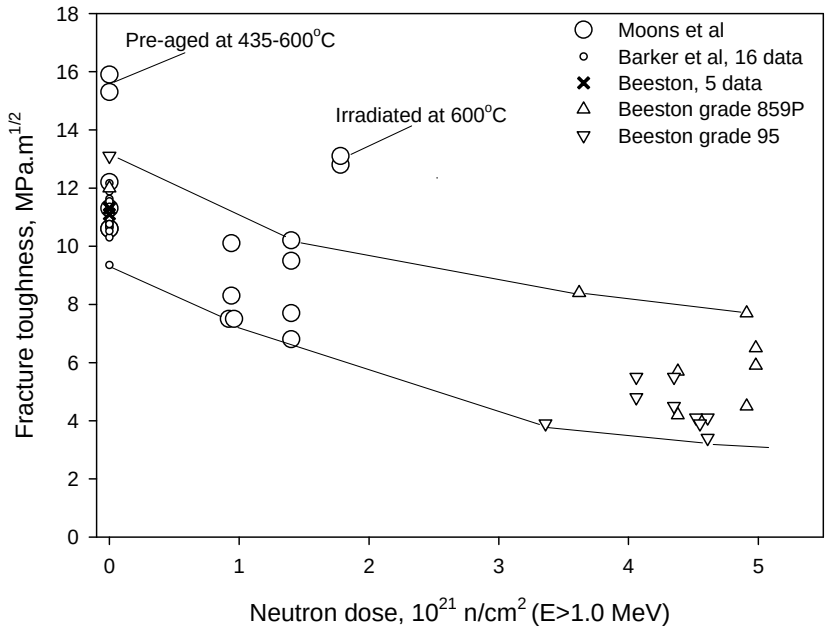
Material properties as f(dpa)

- Based on decrease in fracture toughness.
- Estimate 40% changes in following properties, linear from 0-1.875DPA:
  - E, increase



- Optionally, curve fitting:
  - Set of pairs: (dpa,%decrease)
  - Different curves for each property possible
  - Simple to implement

0.06dpa per
1.6e20 n/cm^2

Creation/verification of materials

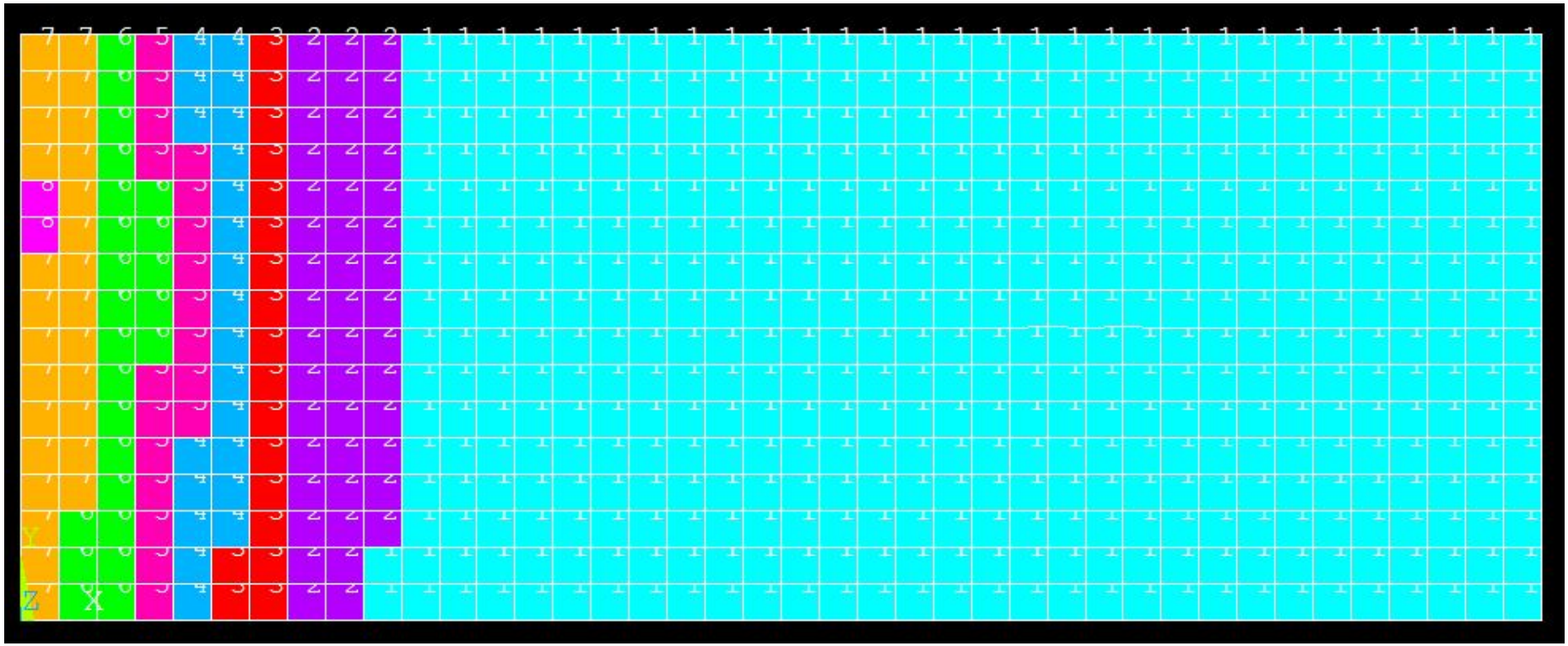
- New materials are created as a function of DPA.
- DPA resolution is adjustable
  - 0.125 DPA increments were used for the initial analysis
- File written out for verification.

```
LIST MATERIALS 1 TO 16 BY 1
  PROPERTY= EX

 MATERIAL NUMBER        1
      TEMP          EX
     20.000      0.29660E+12
     99.850      0.29248E+12
 MATERIAL NUMBER        2
      TEMP          EX
     20.000      0.30451E+12
     99.850      0.30028E+12
…
 MATERIAL NUMBER       16
      TEMP          EX
     20.000      0.41525E+12
     99.850      0.40947E+12
```

Dynamic assignment of materials

- Loop over all elements:
  - Look up X,Y,Z value of element, perform lookup in DPA table as f(x,y,z).
  - Look up material number to be assigned as f(dpa).
  - Assign material to element.
  - Move to next element.



Verification – Material Assignment

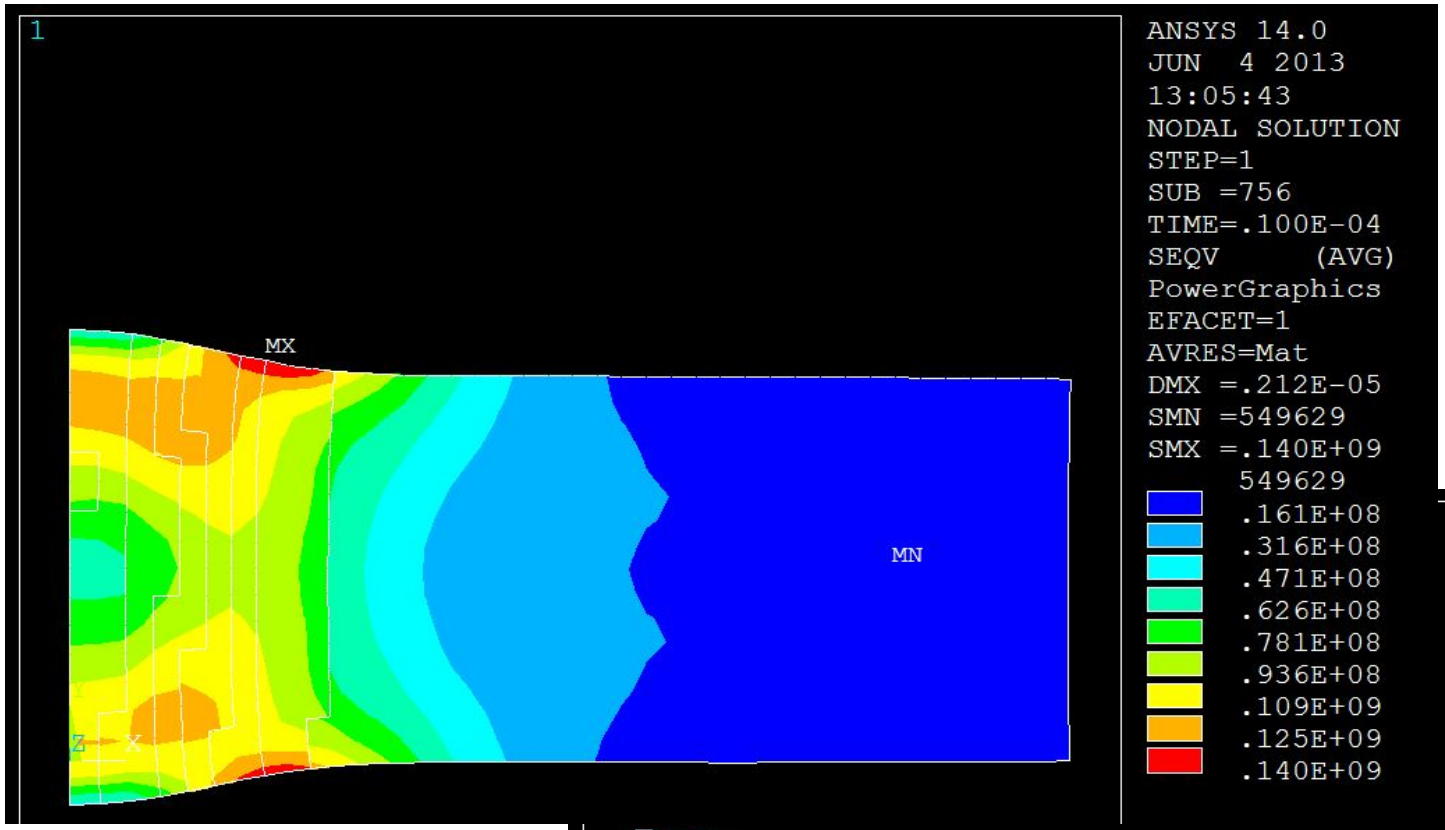
TOTAL,640
ELEMENT:,1,'@(',1.625E-04,1.5625E-04,')DPA:',0.69420181663,'MATLASSIGNMENT:',7
ELEMENT:,2,'@(',4.875E-04,1.5625E-04,')DPA:',0.6567260741,'MATLASSIGNMENT:',6
ELEMENT:,3,'@(',8.125E-04,1.5625E-04,')DPA:',0.58804959709,'MATLASSIGNMENT:',6
ELEMENT:,4,'@(',0.0011375,1.5625E-04,')DPA:',0.49502841293,'MATLASSIGNMENT:',5
ELEMENT:,5,'@(',0.0014625,1.5625E-04,')DPA:',0.39881162281,'MATLASSIGNMENT:',4
ELEMENT:,6,'@(',0.0017875,1.5625E-04,')DPA:',0.30390212604,'MATLASSIGNMENT:',3
ELEMENT:,7,'@(',0.0021125,1.5625E-04,')DPA:',0.22082799167,'MATLASSIGNMENT:',3
ELEMENT:,8,'@(',0.0024375,1.5625E-04,')DPA:',0.15227643381,'MATLASSIGNMENT:',2
ELEMENT:,9,'@(',0.0027625,1.5625E-04,')DPA:',0.09846823977,'MATLASSIGNMENT:',2
ELEMENT:,10,'@(',0.0030875,1.5625E-04,')DPA:',0.06226492943,'MATLASSIGNMENT:',1
ELEMENT:,11,'@(',0.0034125,1.5625E-04,')DPA:',0.03842861412,'MATLASSIGNMENT:',1
ELEMENT:,12,'@(',0.0037375,1.5625E-04,')DPA:',0.02444522349,'MATLASSIGNMENT:',1

Assignments are rounded to nearest integer material – Example:

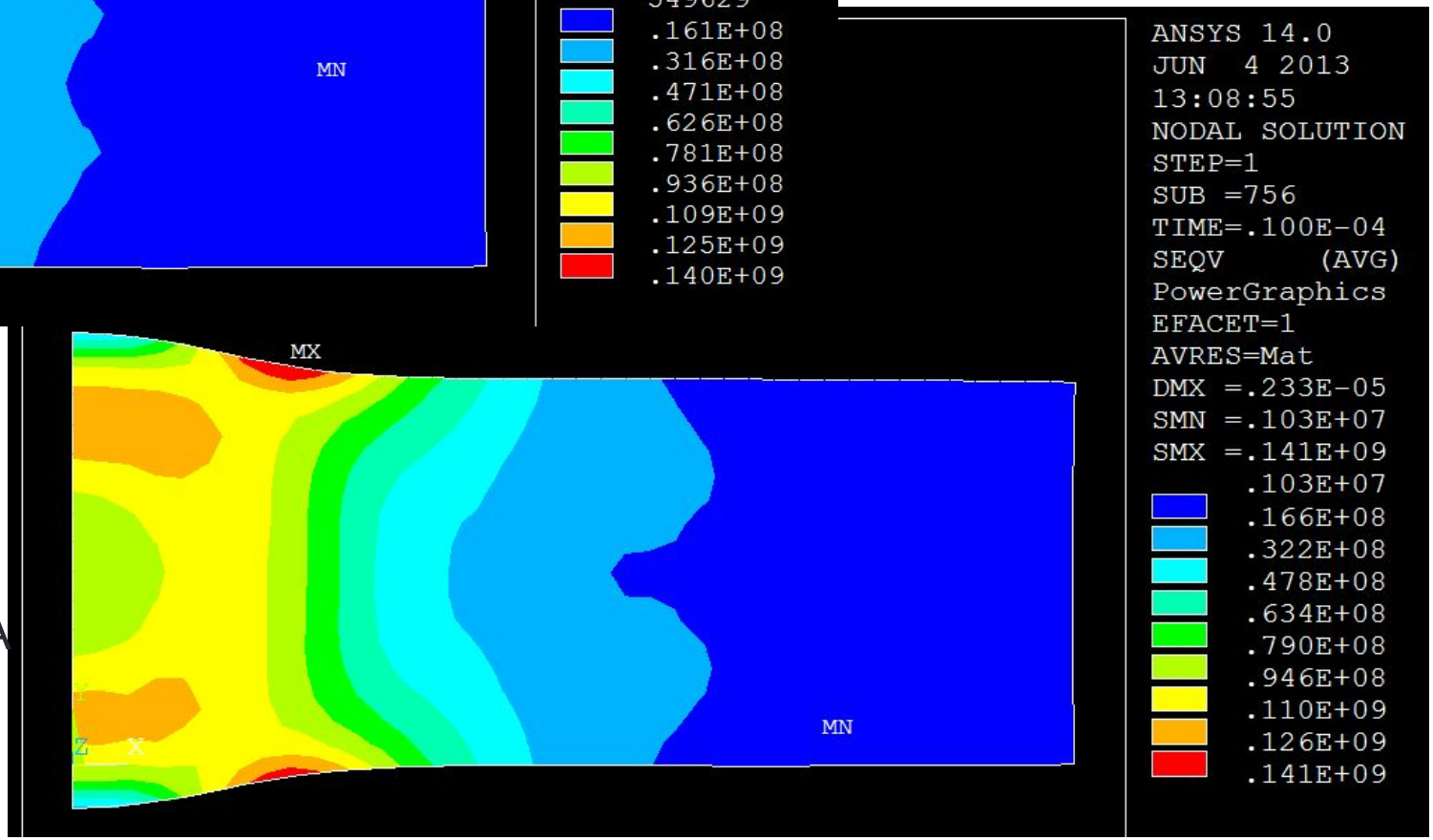
Material properties have DPA values of 0, 0.125, 0.25, …

An element with DPA of 0.07 would be assigned properties for 0.125 DPA

Results

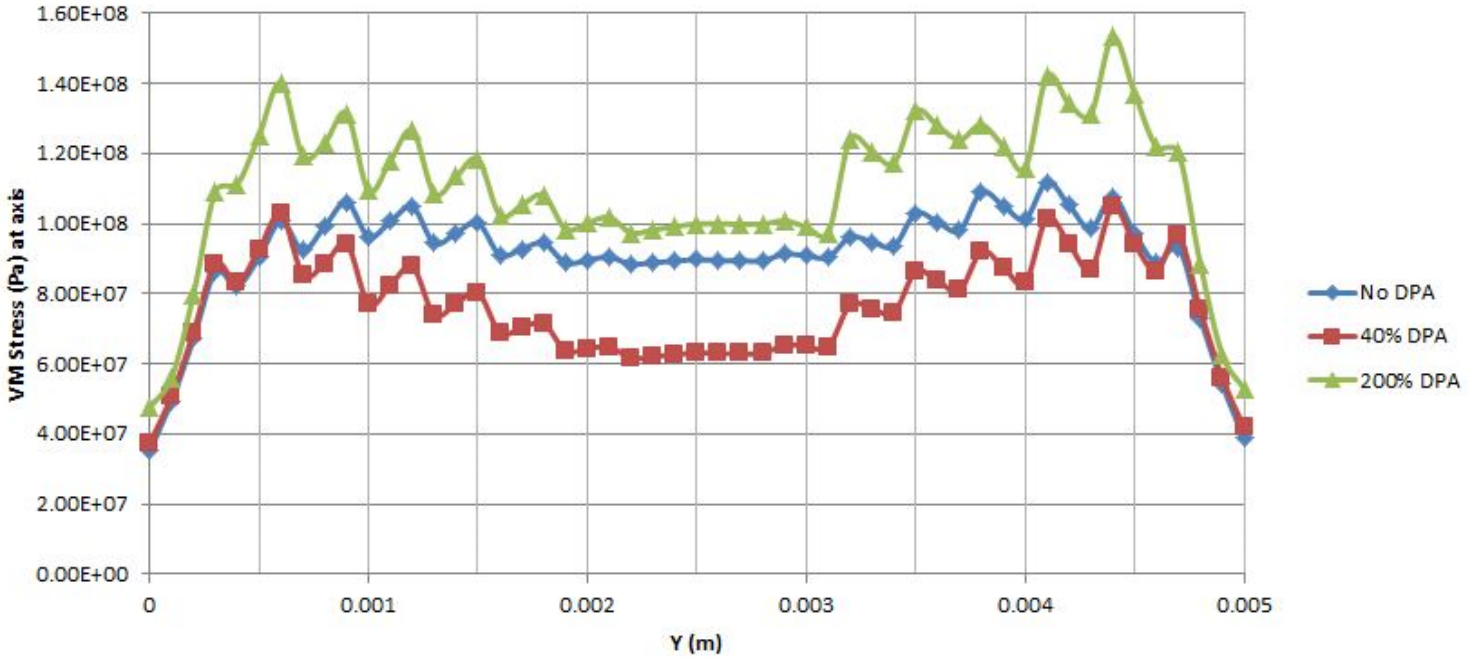


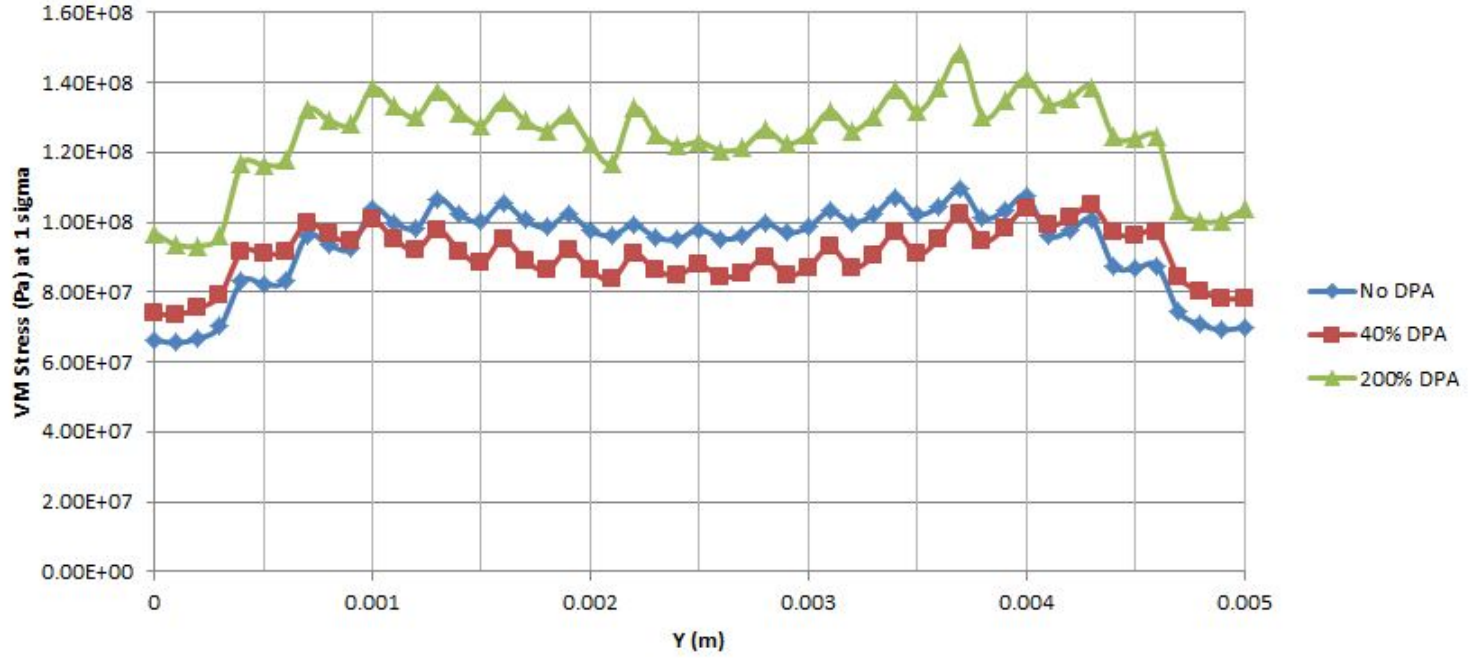
DPA Enabled



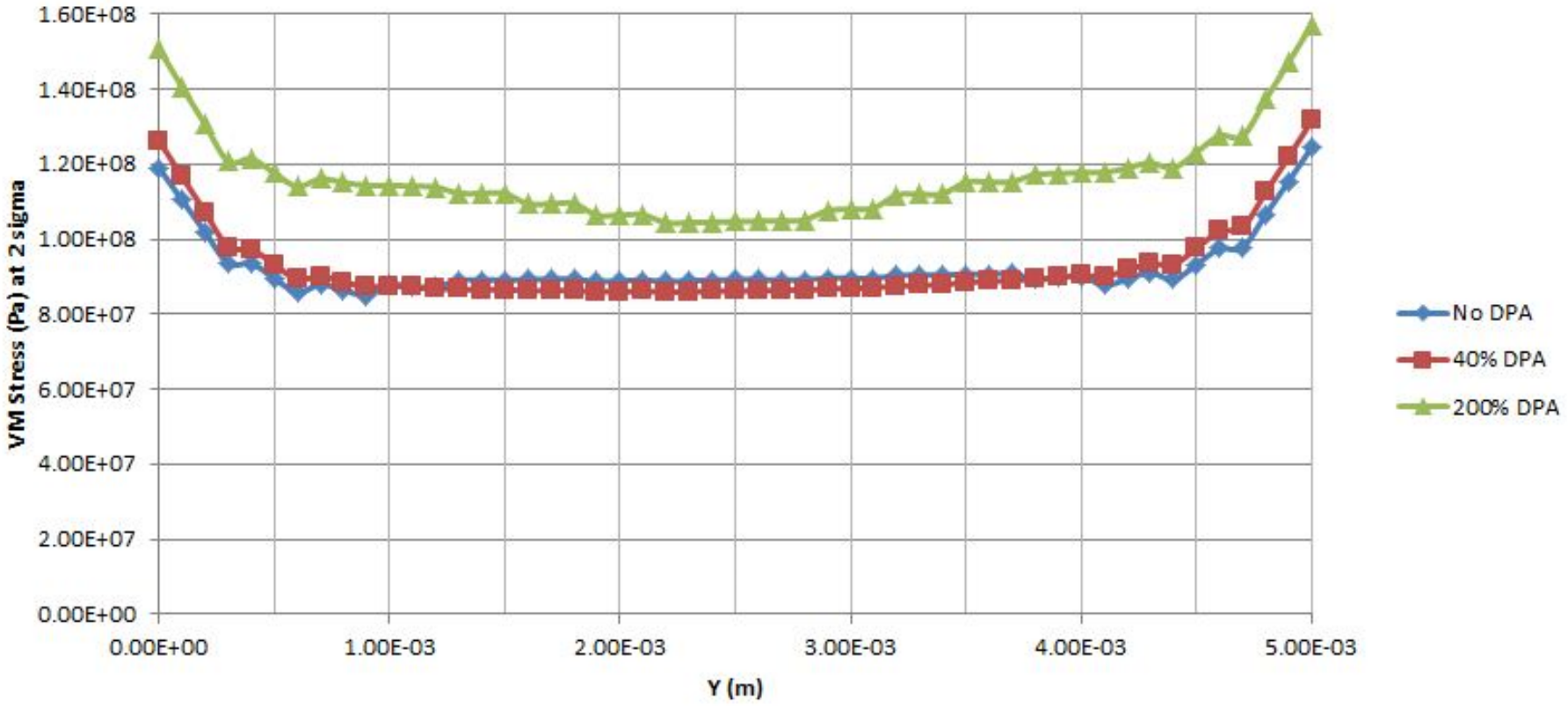
No DPA

Results – VM Plots

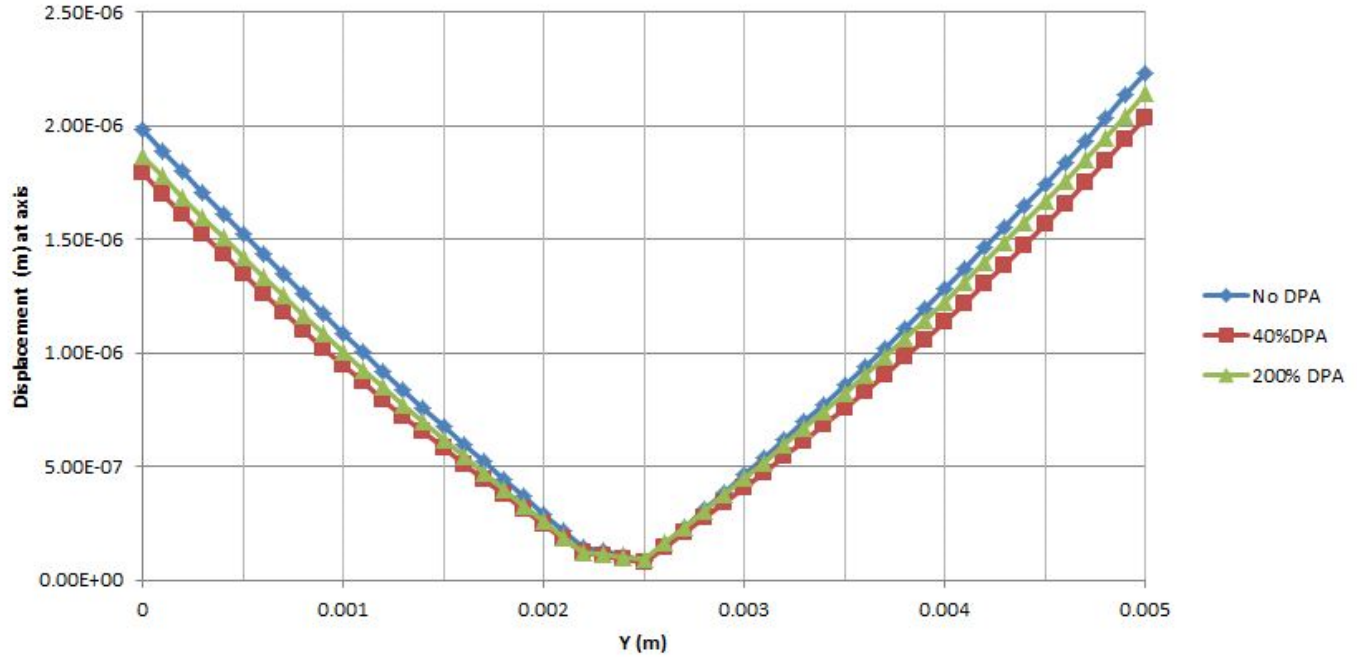


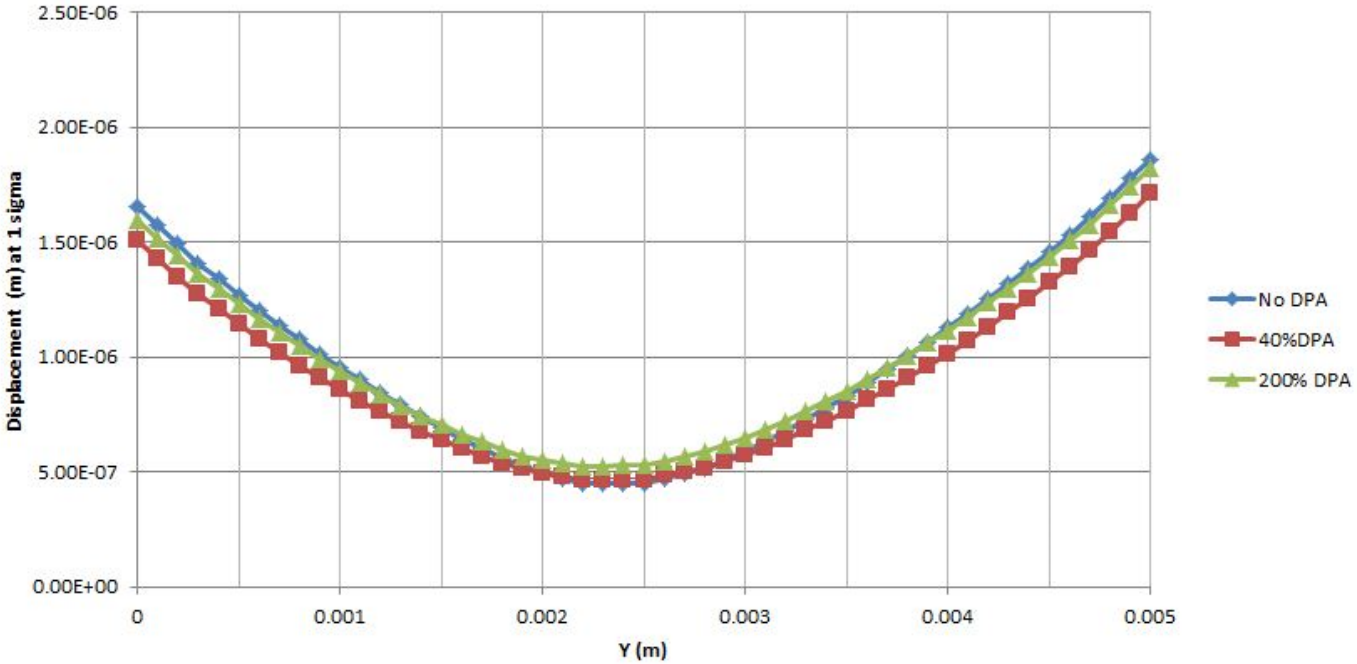


Results – VM Plots



Results – Disp Plots





Results – Disp Plots