

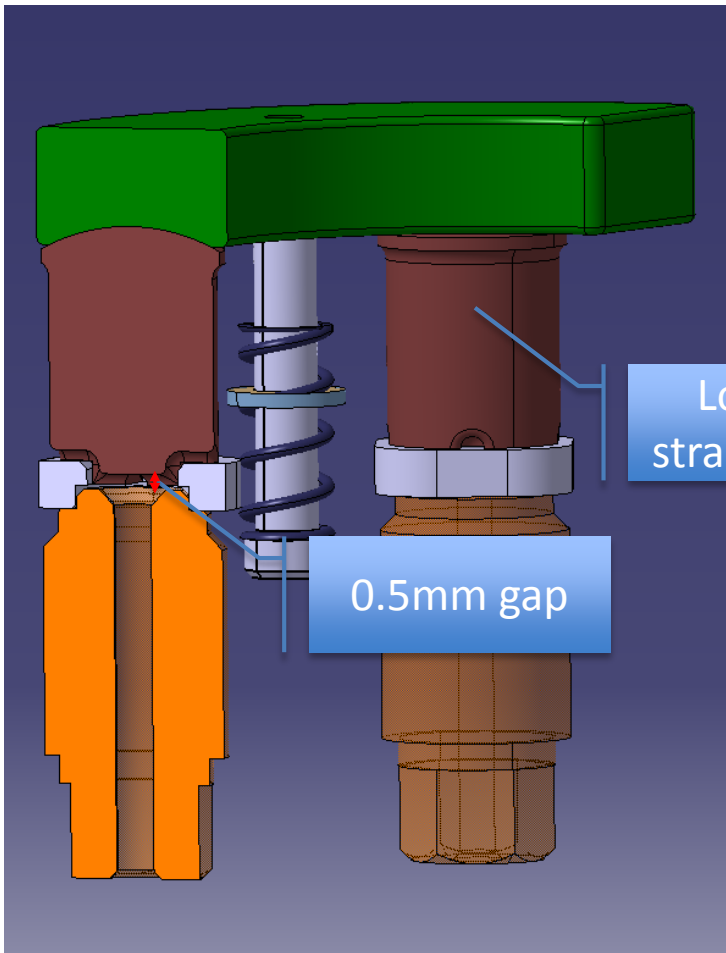
[www.cern.ch](http://www.cern.ch)



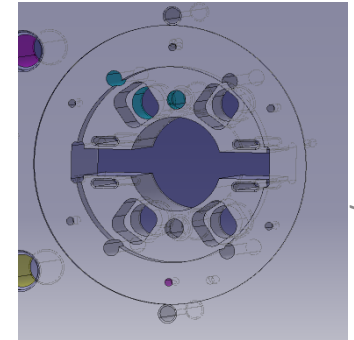
# content

- Current design (25.11.14)
- Goals for analysis
- Pushing unit
  - structural strength - pushing unit
  - uniformity of stress in the bullets -> affects instrumentation quality
- -distribution of stress in the bullets caused by the deflection of the end plate
- End plate 2in1
  - structural strength - end plate
  - deflection - end plate

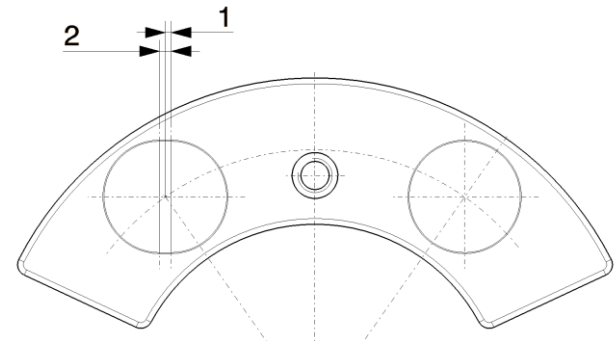
# Current design



- Two bullets per coil on one pushing plate
- Torsion free bullet
- Ball notch for compensation for angular mismatch



150420\_2in1-Bullet gauges - Current design and structural analysis





# Goals for analysis

## Aspects:

- Structural strength
  - Pushing unit
  - End plate
- Deflection of end plate
- Influence of deflection on instrumentation

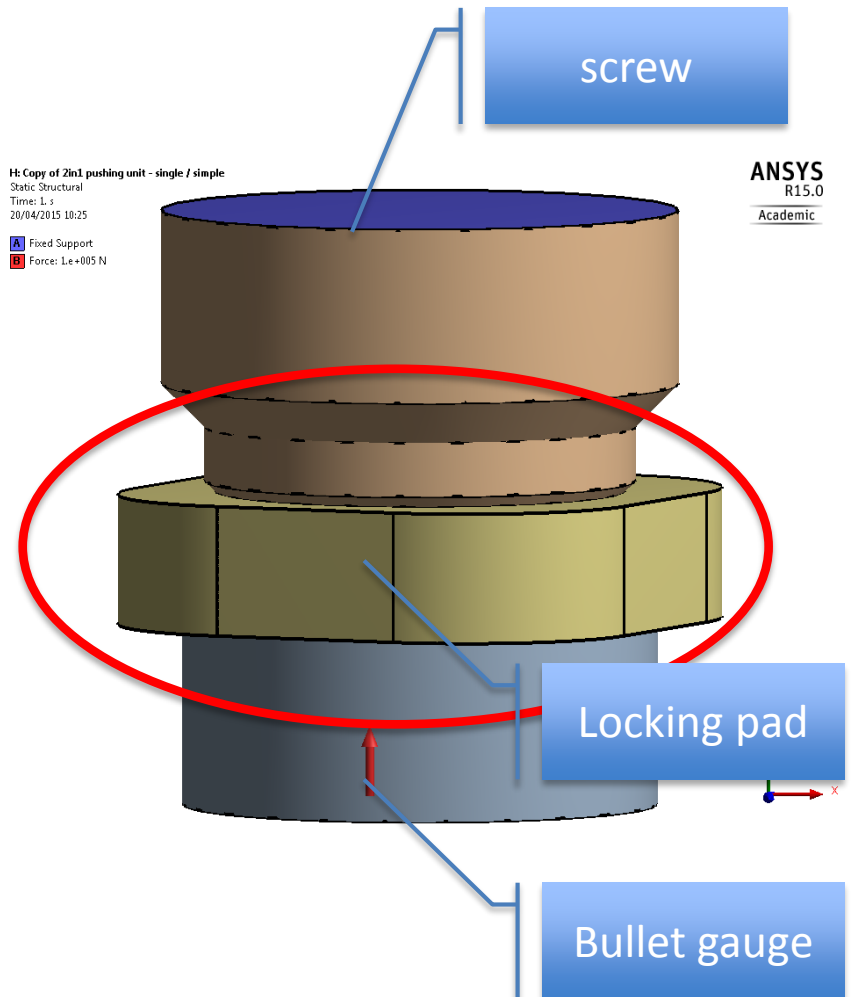
## Boundaries:

- Force:
  - Theory 400kN per coil per side
  - Measured 153kN at 11.8kA
  - For analysis **200kN**
- Pre stress in the bullets 20MPa
- Max. angle 1 degree
- Uniform temperature condition



# Structural strength – pushing unit

- model
  - Simplified
  - No groove for wire
- boundary
  - Frictionless contacts
  - Fixed screw
- load
  - 50kN on bullet gauge
  - 130% of measured
  - uniaxial

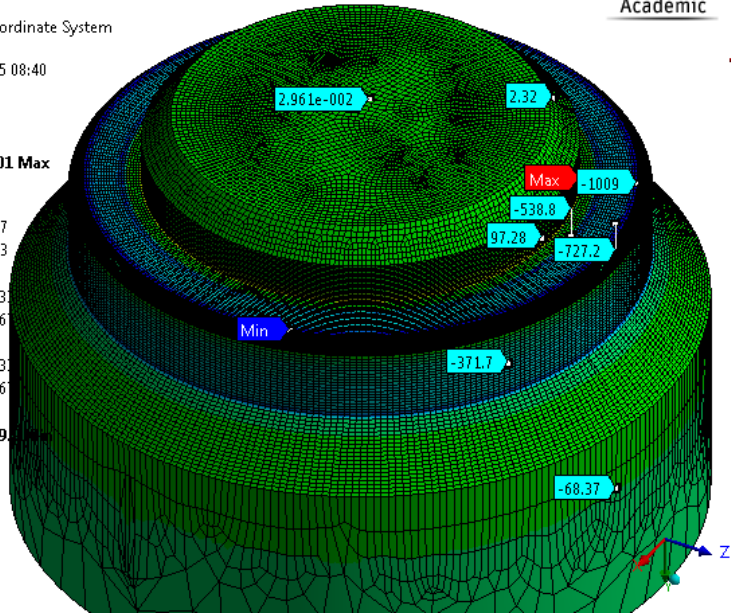
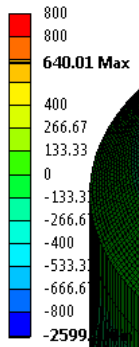




# Structural strength – pushing unit

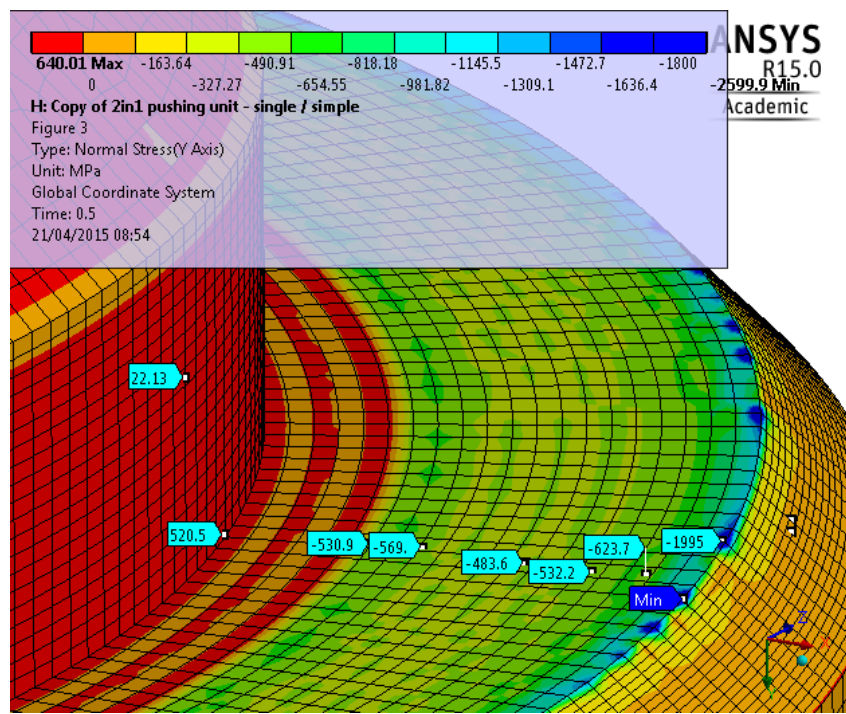
## Screw - Y - normal stress

H: Copy of Zin1 pushing unit - single / simple  
 Figure 3  
 Type: Normal Stress(Y Axis)  
 Unit: MPa  
 Global Coordinate System  
 Time: 0.5  
 21/04/2015 08:40



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## Screw – stress concentration

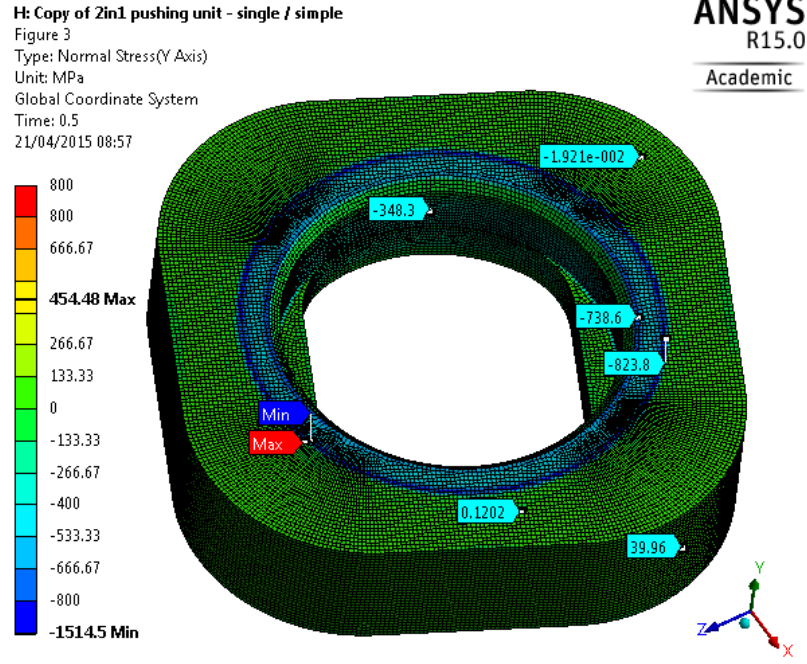


150420\_zin1-Bullet gauges - Current design and structural analysis

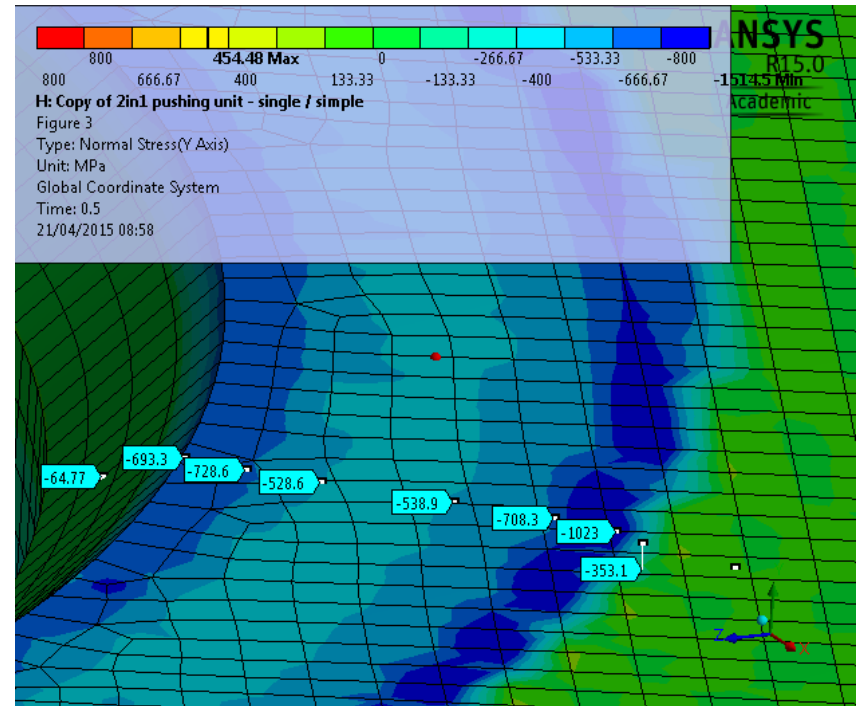


# Structural strength – pushing unit

## Locking pad / bullet side - Y - normal stress



## Locking pad / bullet side - Y - normal stress



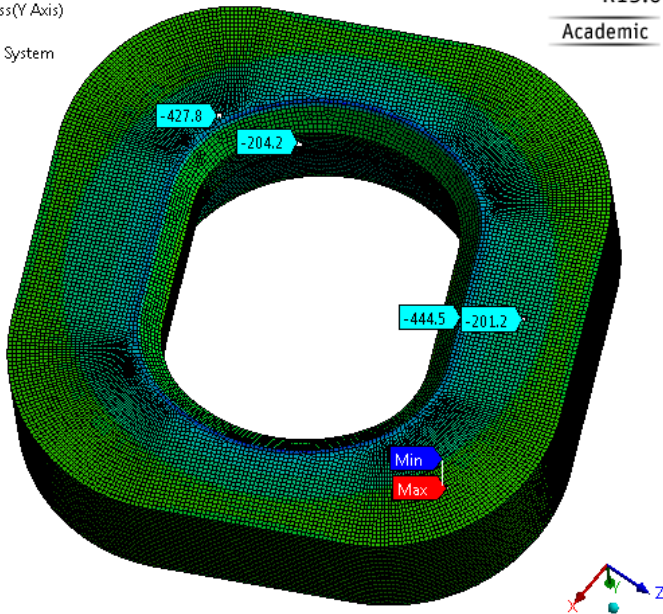
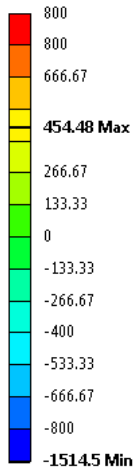


# Structural strength – pushing unit

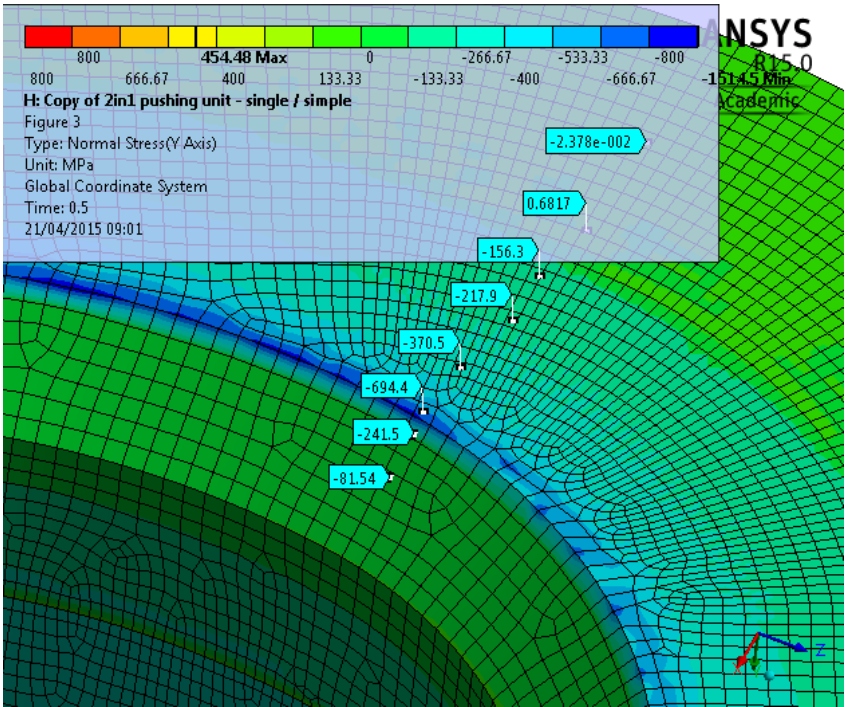
## Locking pad / screw side - Y - normal stress

H: Copy of 2in1 pushing unit - single / simple  
 Figure 3  
 Type: Normal Stress(Y Axis)  
 Unit: MPa  
 Global Coordinate System  
 Time: 0.5  
 21/04/2015 08:59

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## Locking pad / screw side - Y - normal stress





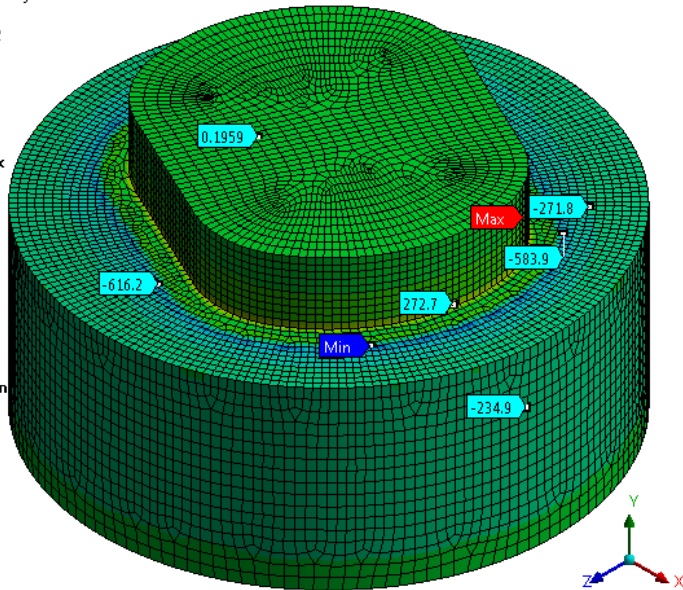
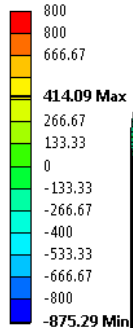


# Structural strength – pushing unit

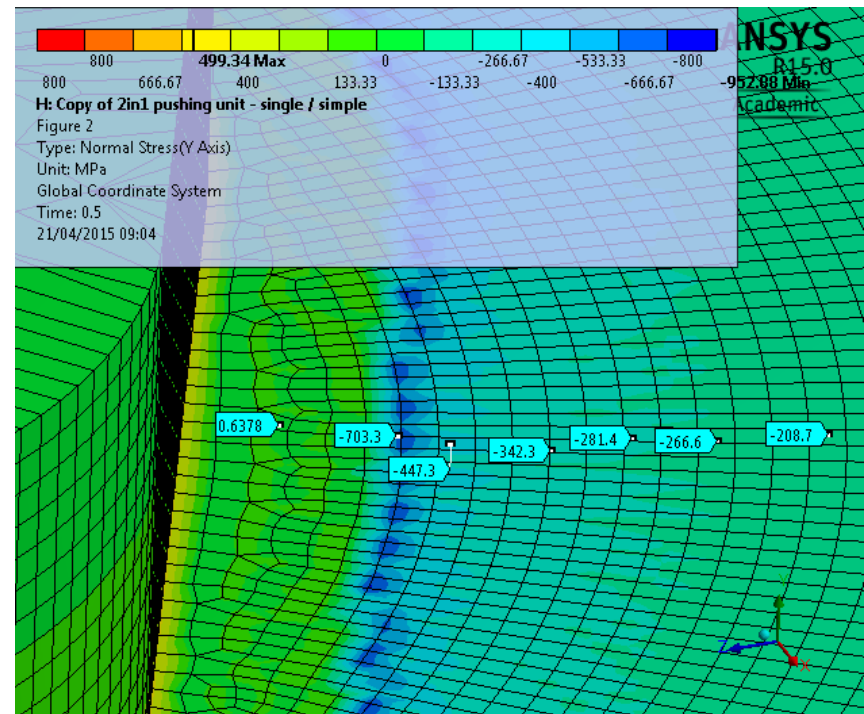
## Bullet - Y normal stress

H: Copy of 2in1 pushing unit - single / simple  
 Figure 2  
 Type: Normal Stress(Y Axis)  
 Unit: MPa  
 Global Coordinate System  
 Time: 0.5  
 20/04/2015 12:22

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## Bullet - Y normal stress



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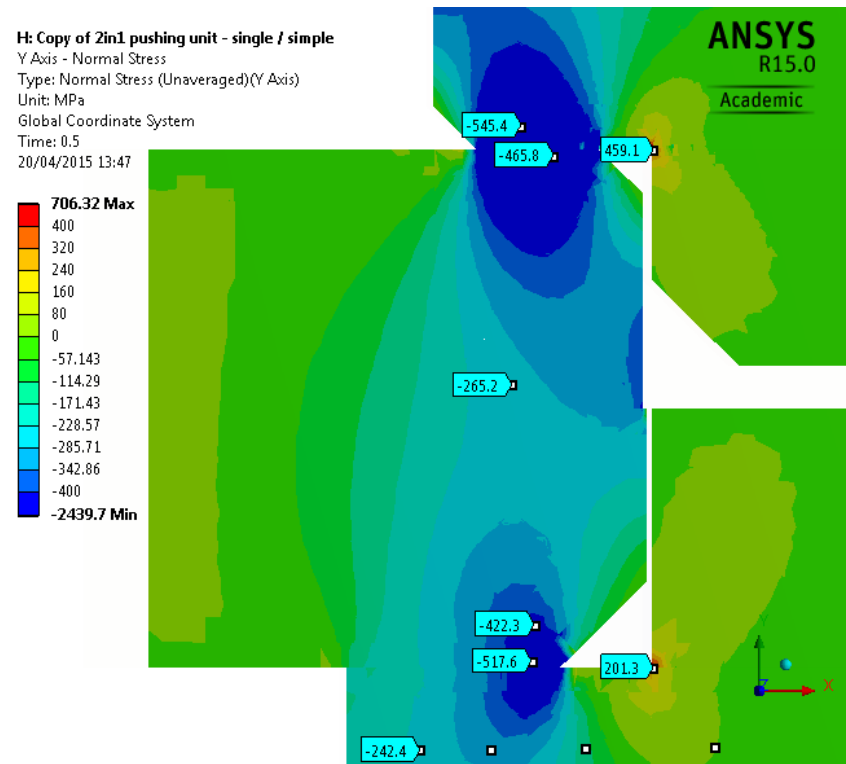


# Structural strength – pushing unit

## conclusion

- The contact area should be increased to exclude plastic deformation
- These results are without safety margin and simplified geometry / boundaries

## Cross-section - Y - normal Stress





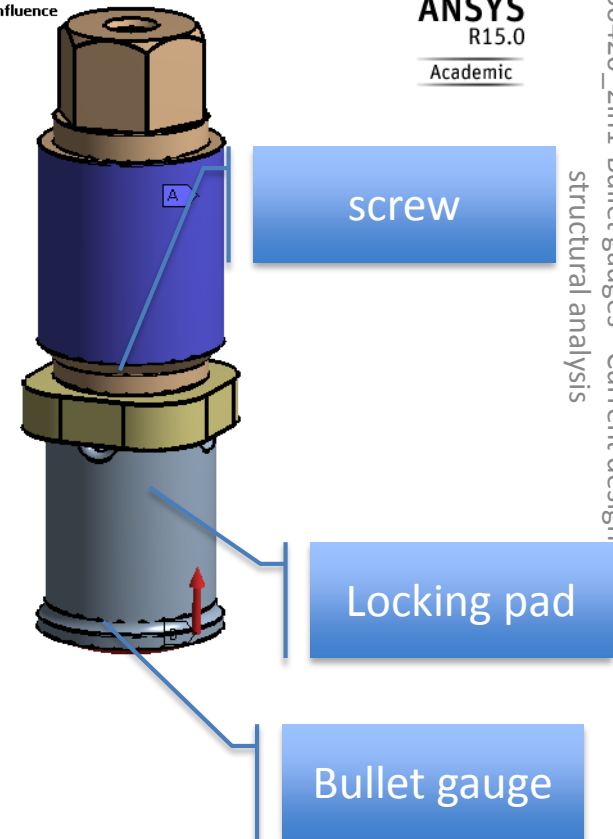
# Structural deflection – pushing unit

- model
  - Full model with cable groove
- boundary
  - Frictionless contacts
  - Fixed screw
- load
  - 50kN on bullet gauge
  - 130% of measured
  - **Uniaxial** // angle 1 degree

G: 2in1 pushing unit - single - F angle influence  
Force angle influence  
Time: 2. s  
20/04/2015 14:01

**A** Fixed Support  
**B** Force: 1e+005 N

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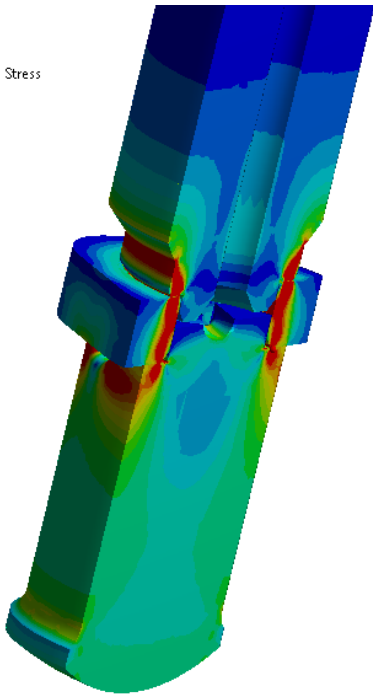
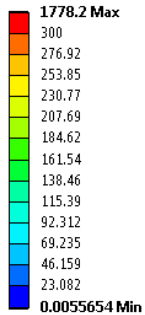




# Structural deflection – pushing unit - **Uniaxial**

## Pushing unit – Eq - Stress

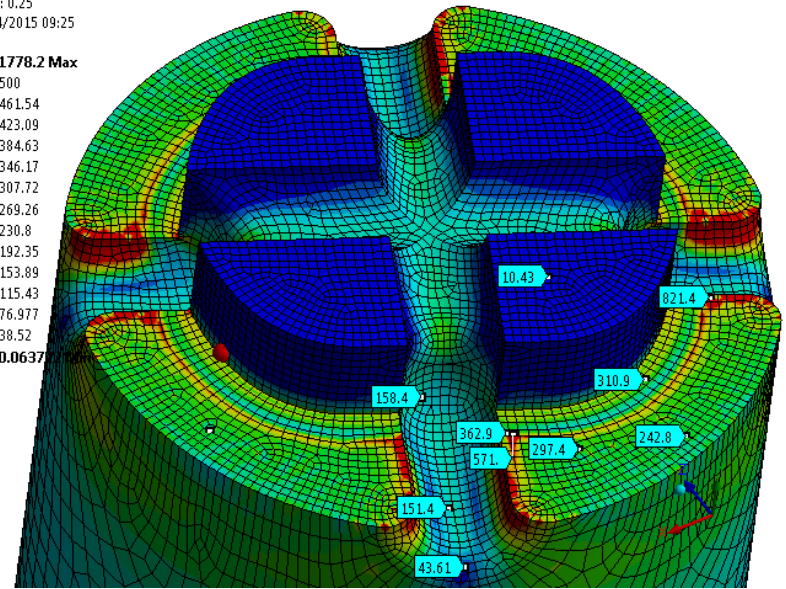
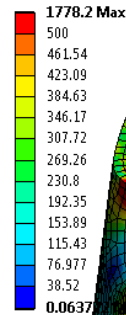
D: 2in1 pushing unit - single  
Equivalent Stress  
Type: Equivalent (von-Mises) Stress  
Unit: MPa  
Time: 0.25  
21/04/2015 09:21



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## Bullet– Eq - Stress

D: 2in1 pushing unit - single  
Equivalent (von-Mises) Stress - bullet\_gauge  
Type: Equivalent (von-Mises) Stress  
Unit: MPa  
Time: 0.25  
21/04/2015 09:25



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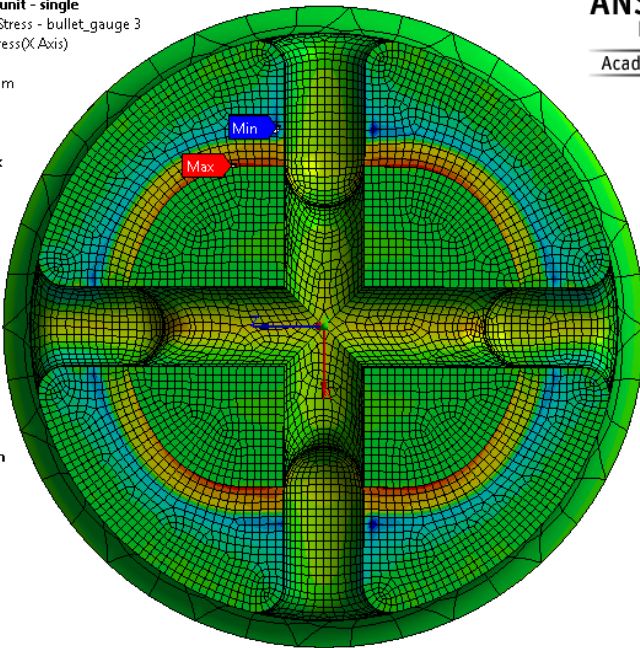
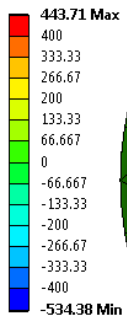




# Structural deflection – pushing unit - **Uniaxial**

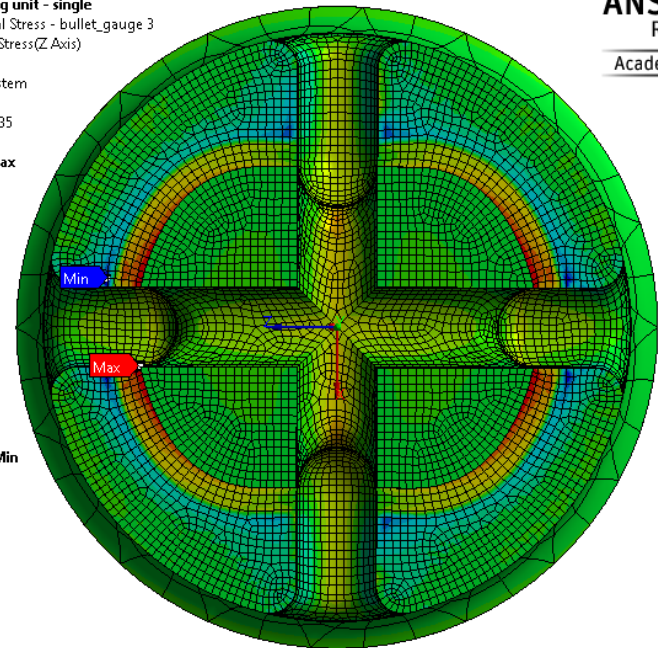
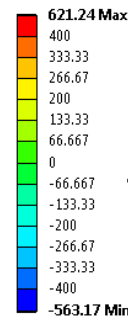
## Pushing unit - X - normal stress

D: 2in1 pushing unit - single  
Y Axis - Normal Stress - bullet\_gauge 3  
Type: Normal Stress(X Axis)  
Unit: MPa  
Coordinate System  
Time: 0.25  
21/04/2015 09:36



## Pushing unit - Z - normal stress

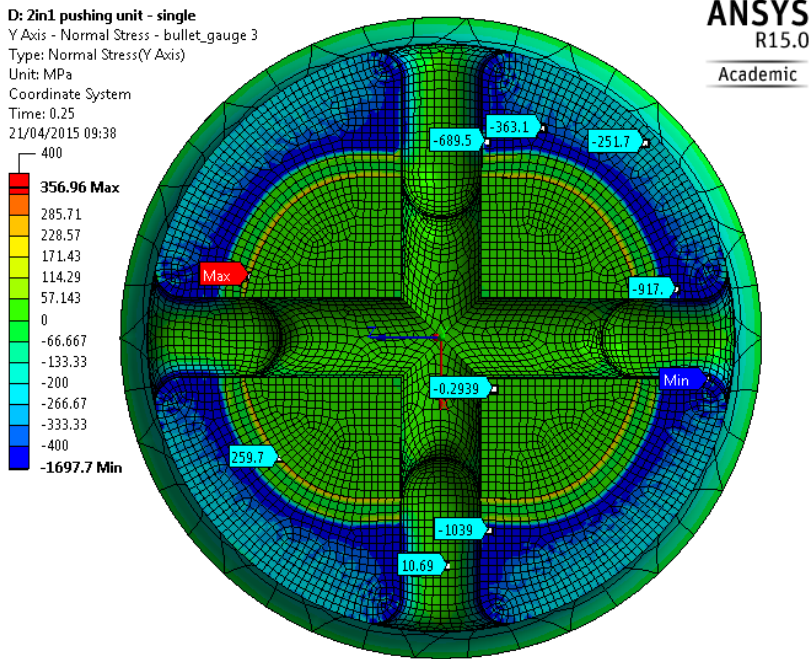
D: 2in1 pushing unit - single  
Y Axis - Normal Stress - bullet\_gauge 3  
Type: Normal Stress(Z Axis)  
Unit: MPa  
Coordinate System  
Time: 0.25  
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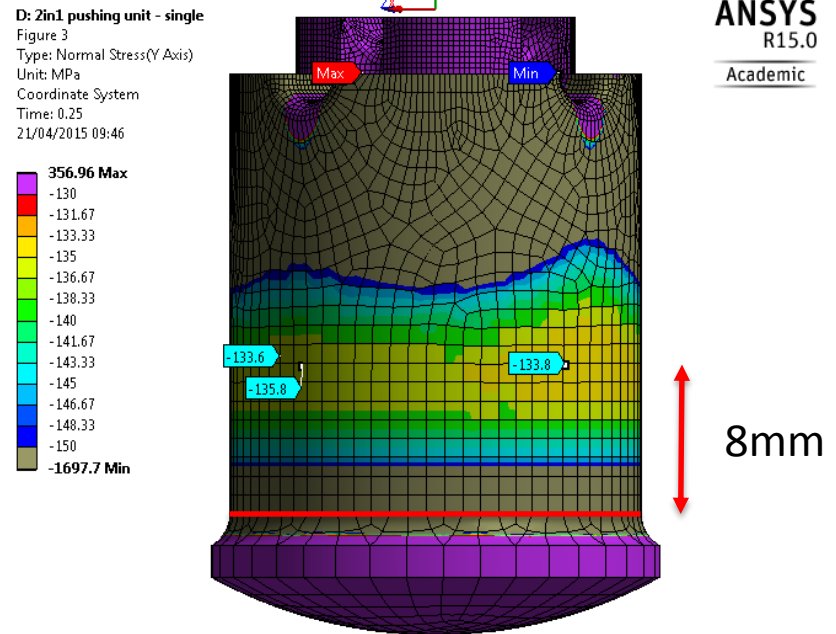


# Structural deflection – pushing unit - **Uniaxial**

## Pushing unit - Y - normal stress



## Pushing unit - Y - normal stress



Measured in MBHSP101  
 100MPa  
 x30%=130MPa

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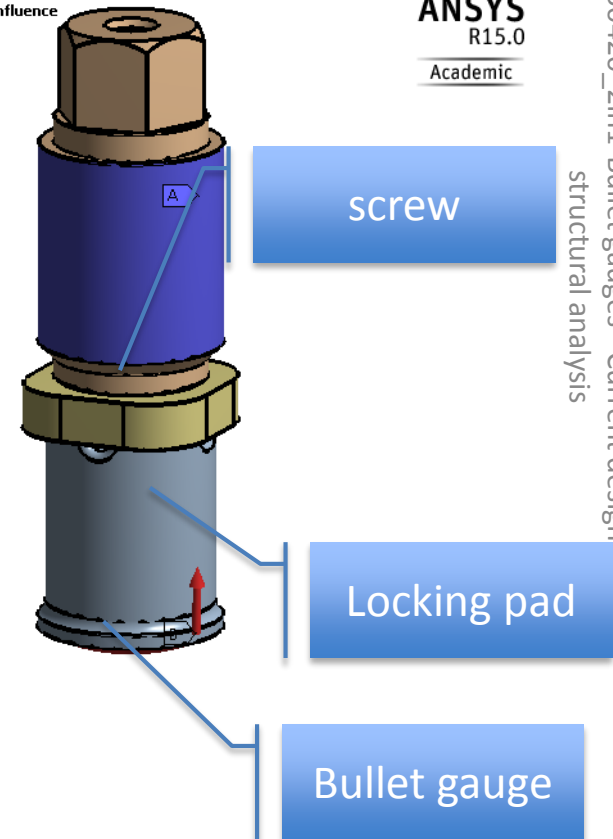
# Structural deflection – pushing unit - angle

- model
  - Full model with cable groove
- boundary
  - Frictionless contacts
  - Fixed screw
- load
  - 50kN on bullet gauge
  - 130% of measured
  - Uniaxial // **angle 1 degree**

G: 2in1 pushing unit - single - F angle influence  
Force angle influence  
Time: 2. s  
20/04/2015 14:01

**A** Fixed Support  
**B** Force: 1e+005 N

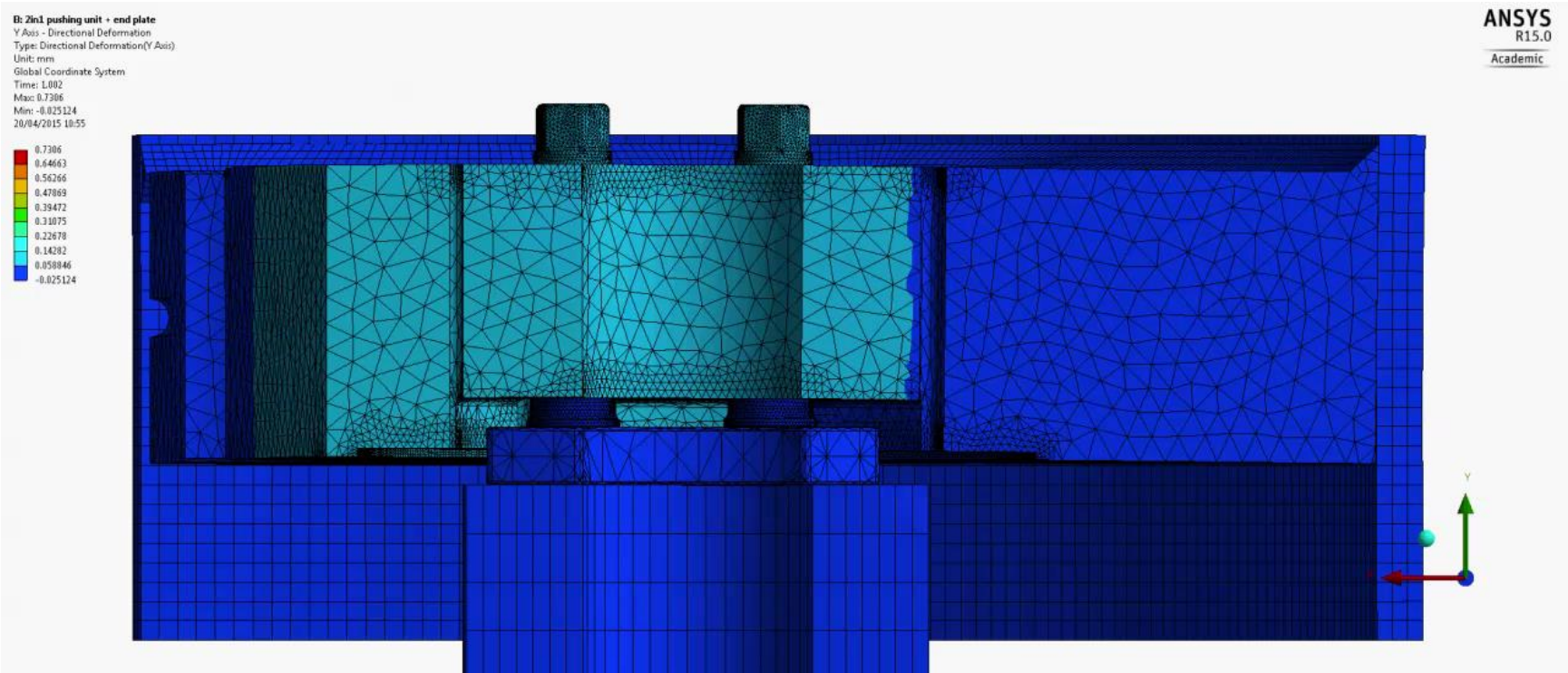
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# Structural deflection – pushing unit - angle



Max. angle in pushing unit 0.1 degree at 200kN from one aperture



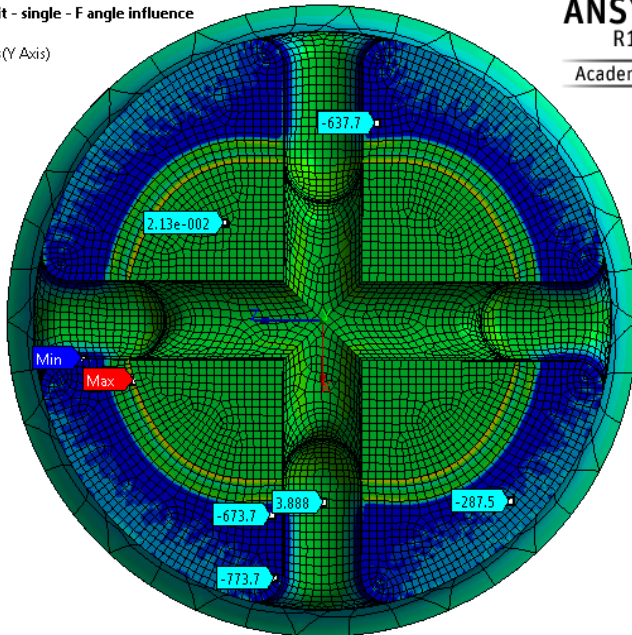
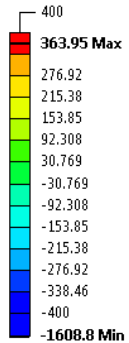


# Structural deflection – pushing unit - angle

## Pushing unit - Y - normal stress

G: 2in1 pushing unit - single - F angle influence

Figure 2  
Type: Normal Stress(Y Axis)  
Unit: MPa  
Coordinate System  
Time: 1.5  
21/04/2015 12:25

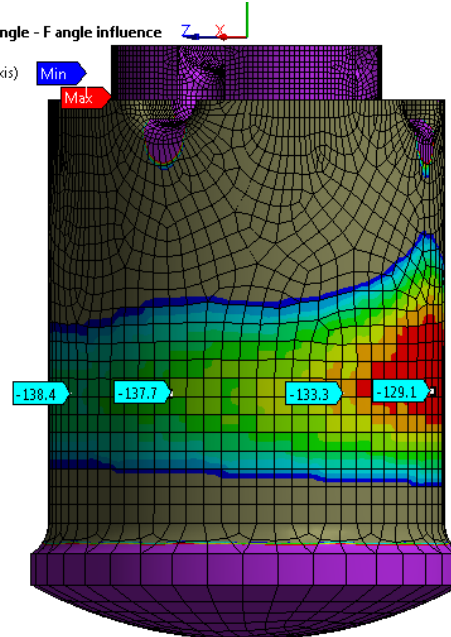
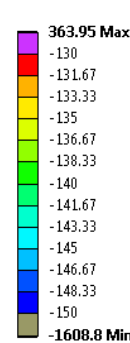


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## Pushing unit - Y - normal stress

G: 2in1 pushing unit - single - F angle influence

Figure 3  
Type: Normal Stress(Y Axis)  
Unit: MPa  
Coordinate System  
Time: 1.5  
21/04/2015 12:28



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Measured in MBHSP101  
100MPa  
x30%=130MPa



# Structural deflection – pushing unit

## Conclusion

- Bullets are suitable for instrumentation
- maximum difference in the location of the instrumentation 10MPa under 1 degree load

G: 2in1 pushing unit - single - F angle influence

Force angle influence

Time: 2. s

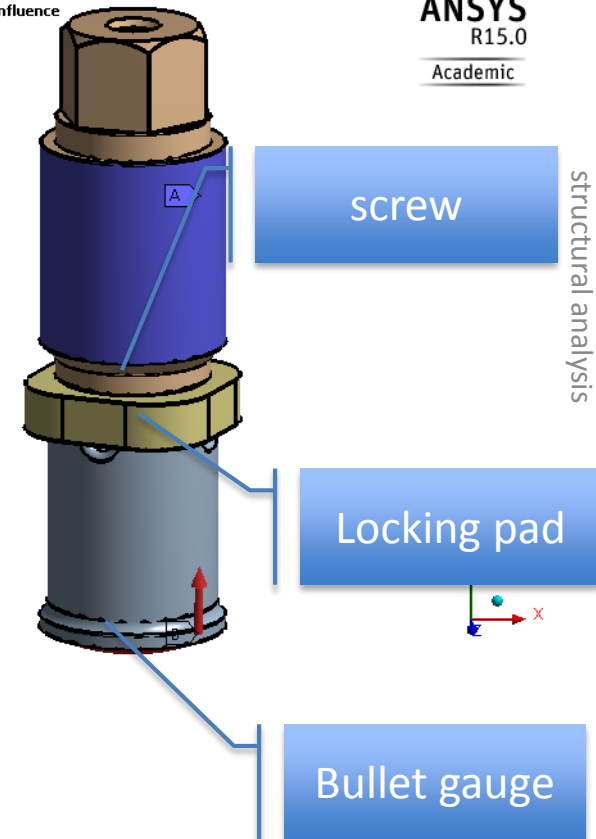
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A Fixed Support

B Force: 1.e+005 N

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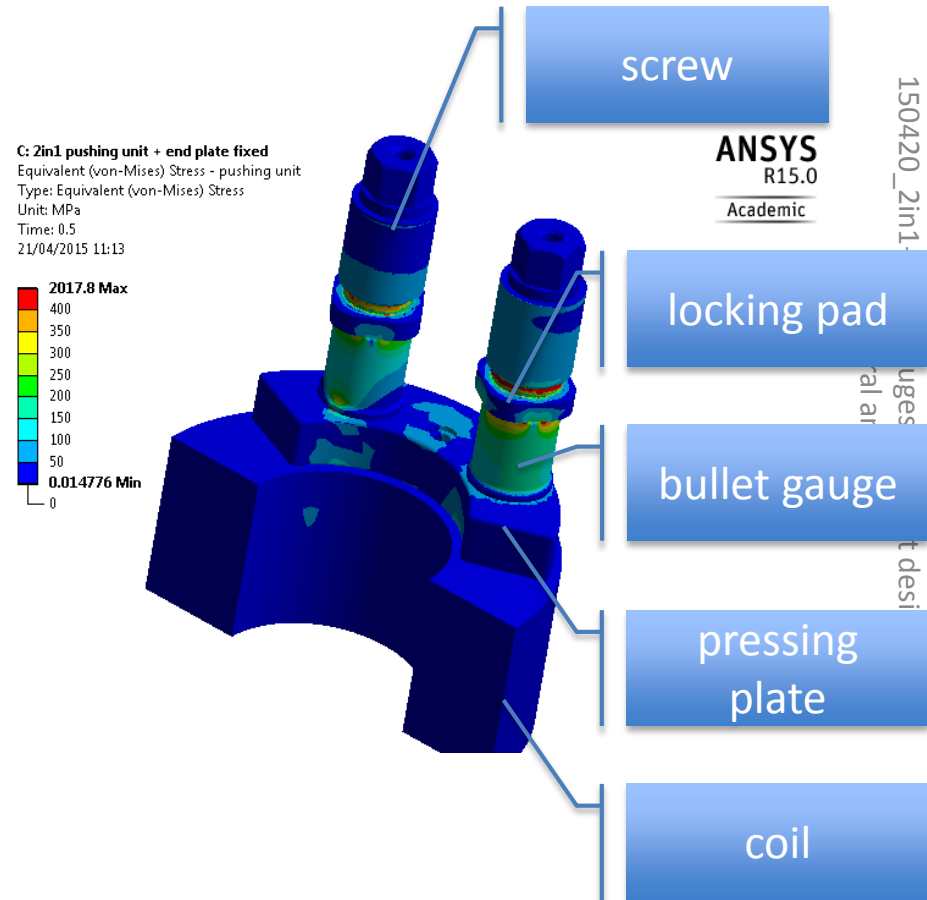
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# Structural deflection – pushing unit

- model
  - Full model with cable groove
- boundary
  - Frictionless contacts
  - Fixed end plate
- load
  - 100kN on coil
  - 130% of measured
  - Coil only one DOF

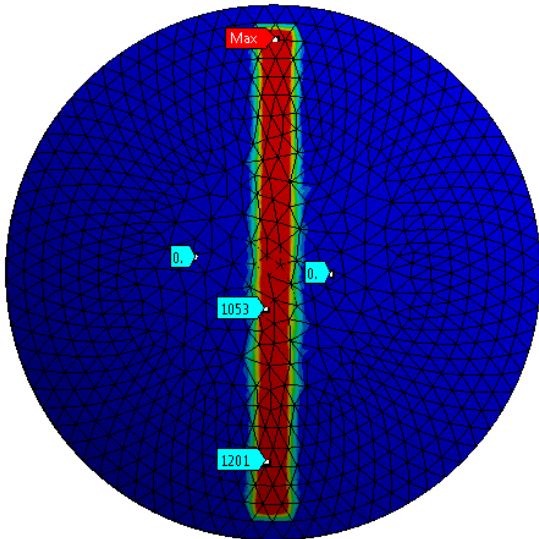
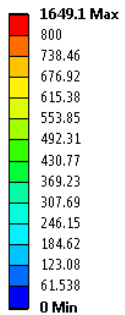




# Structural deflection – pushing unit

## Bullet contact - Ball notch

C: 2in1 pushing unit + end plate fixed  
Figure 3  
Type: Pressure  
Unit: MPa  
Time: 0.5  
21/04/2015 11:25

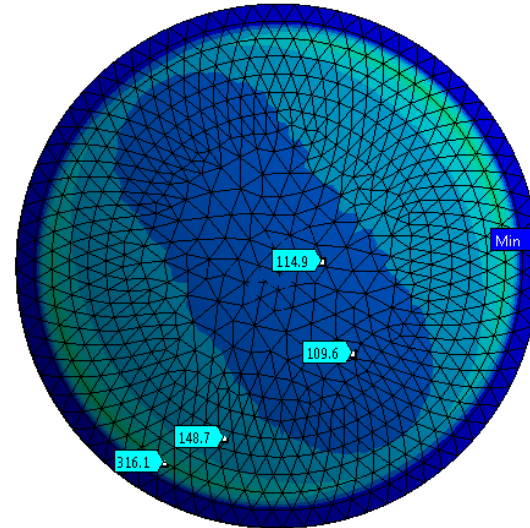
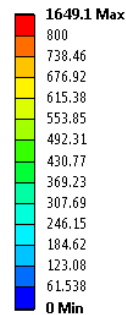


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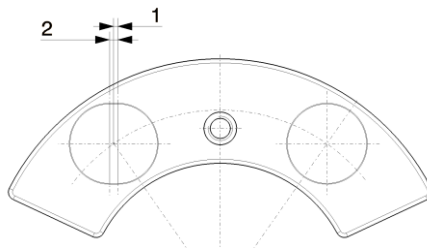
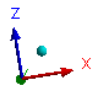


## Bullet contact – norm

C: 2in1 pushing unit + end plate fixed  
Figure 2  
Type: Pressure  
Unit: MPa  
Time: 0.5  
21/04/2015 11:23



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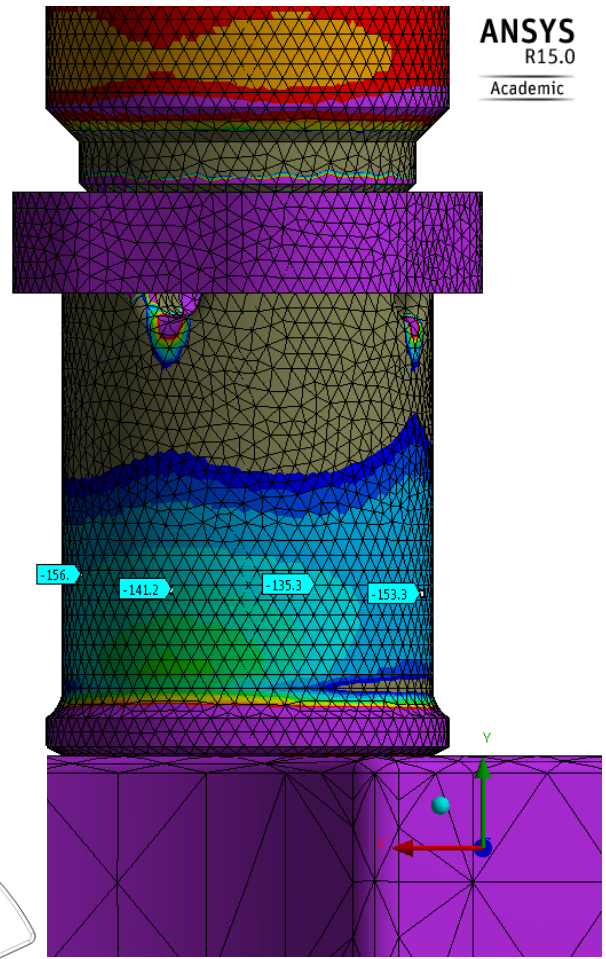
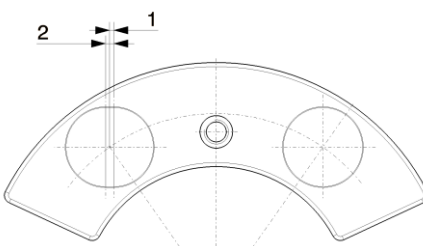
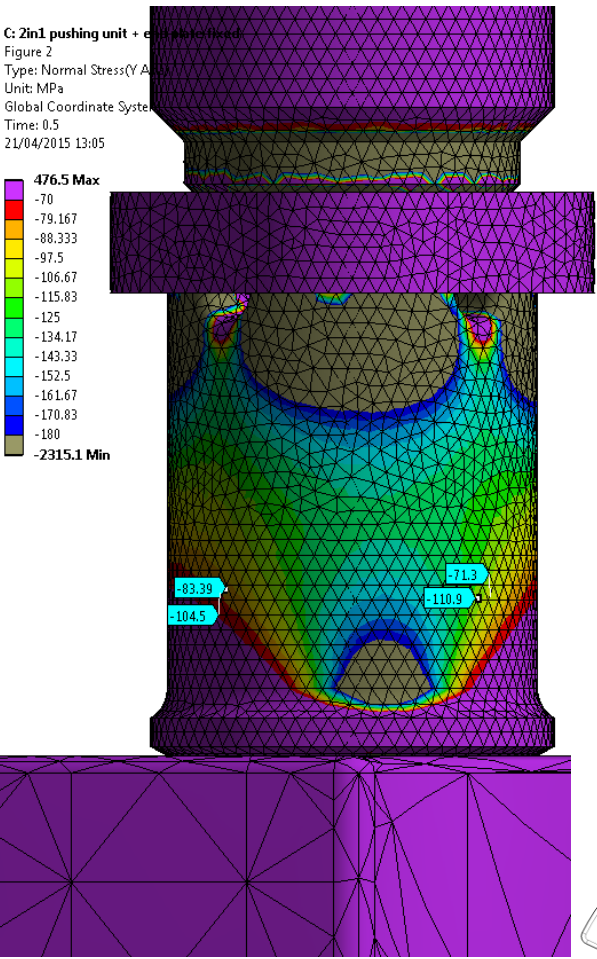
21/04/2015

20



# Structural deflection – pushing unit

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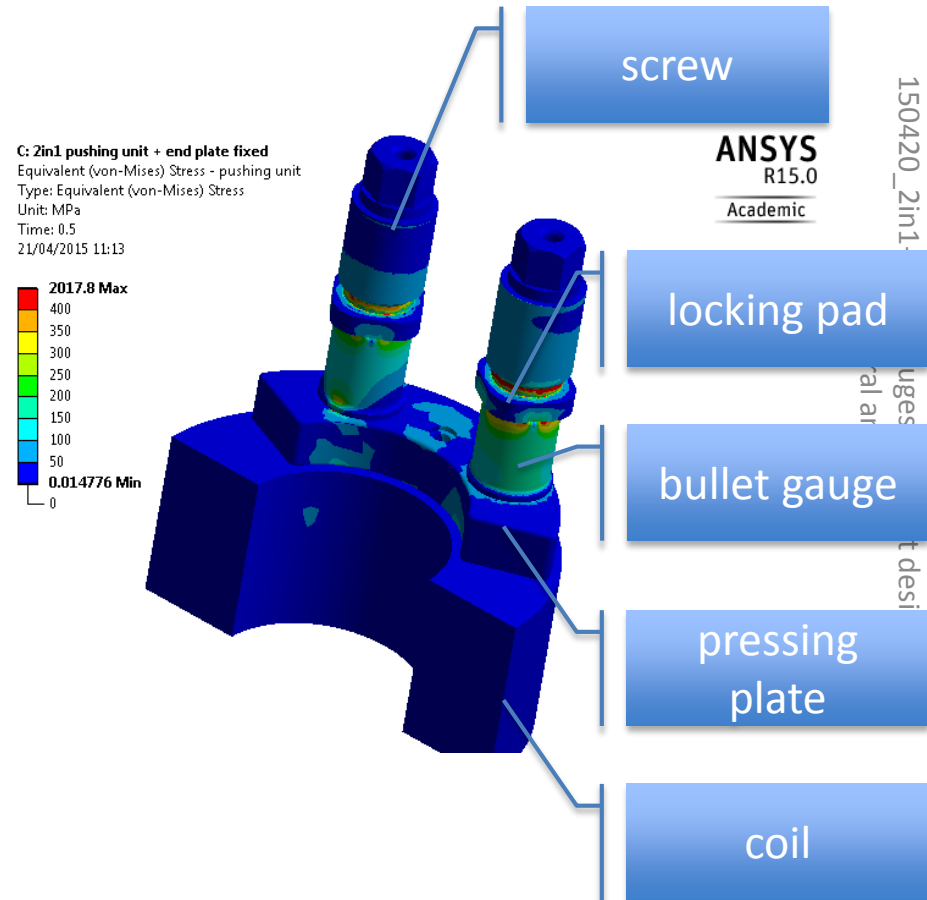


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# Structural deflection – pushing unit

## Conclusion

- Deformation caused by ball notch shifts the stress concentration
- Line contact in ball notch is under high stress



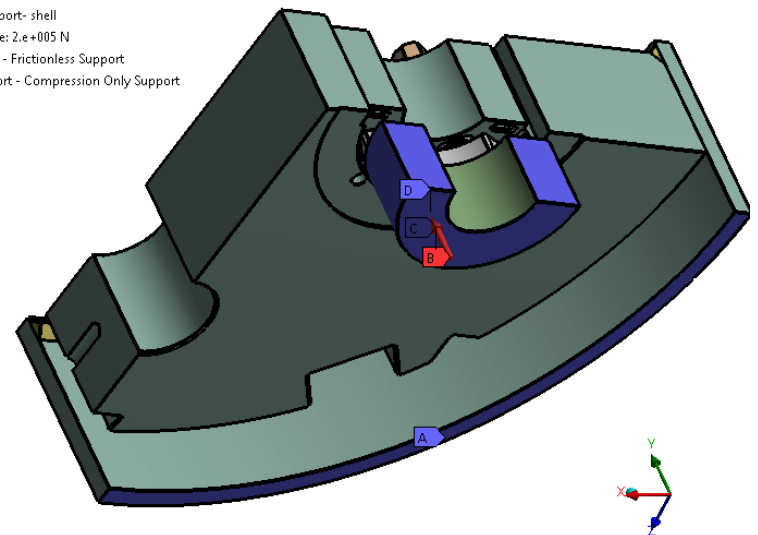
# Structural analysis – end plate 2in1

- model
  - Full model of end plate with pushing unit
- boundary
  - Frictionless contacts
  - Shell fixed
  - Symmetry condition
- load
  - 100kN on coil
  - 130% of measured
  - Coil only one DOF

**B: 2in1 pushing unit + end plate**  
 Static Structural  
 Time: 2. s  
 21/04/2015 13:21

- A** Fixed Support- shell
- B** EM - Force: 2.e+005 N
- C** 1 DOF coi - Frictionless Support
- D** coil support - Compression Only Support

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 R15.0  
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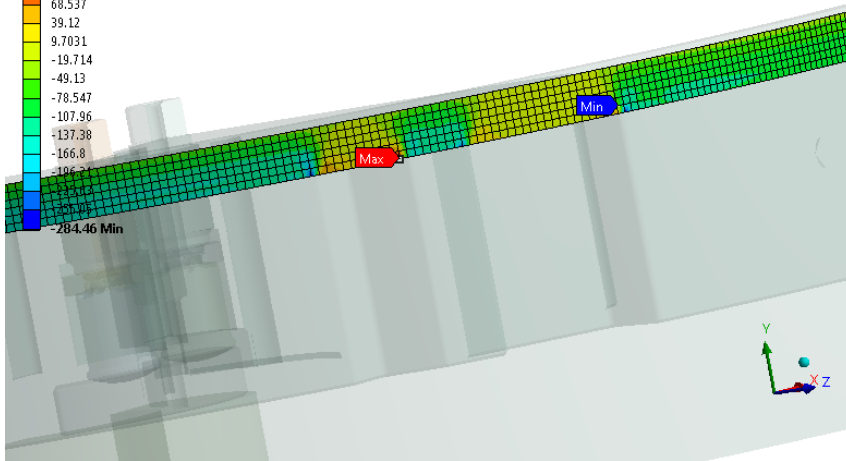
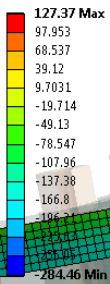


# Structural analysis – end plate 2in1

## Weld – Y – norm Stress

B: 2in1 pushing unit + end plate  
 Y Axis - Normal Stress - weld 5x5  
 Type: Normal Stress(Y Axis)  
 Unit: MPa  
 Global Coordinate System  
 Time: 2  
 21/04/2015 13:32

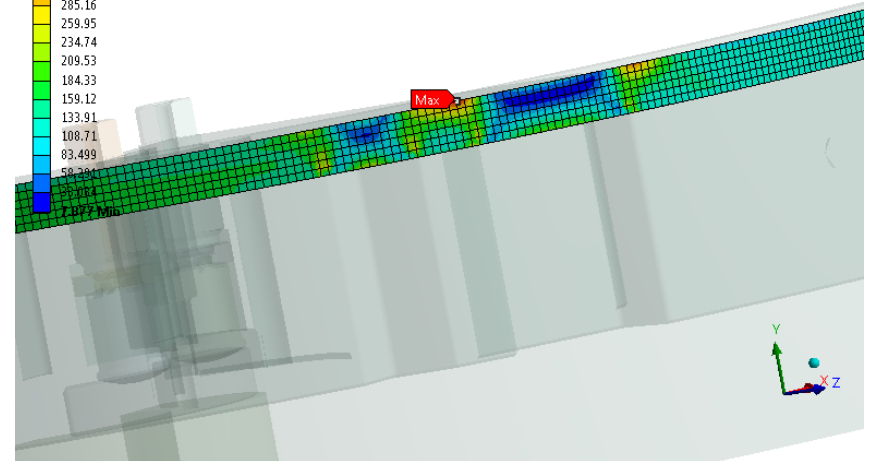
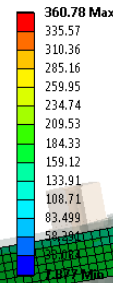
ANSYS  
 R15.0  
 Academic



## Weld – Equ. Stress

B: 2in1 pushing unit + end plate  
 Equivalent (von-Mises) Stress - weld 5x5  
 Type: Equivalent (von-Mises) Stress  
 Unit: MPa  
 Time: 2  
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 Academic



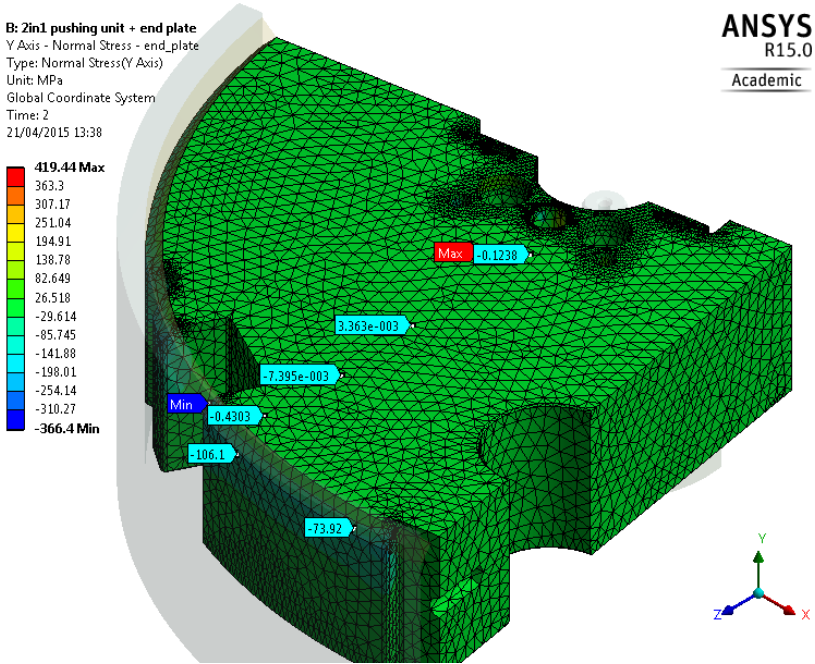
Full theoretical EM force 200kN



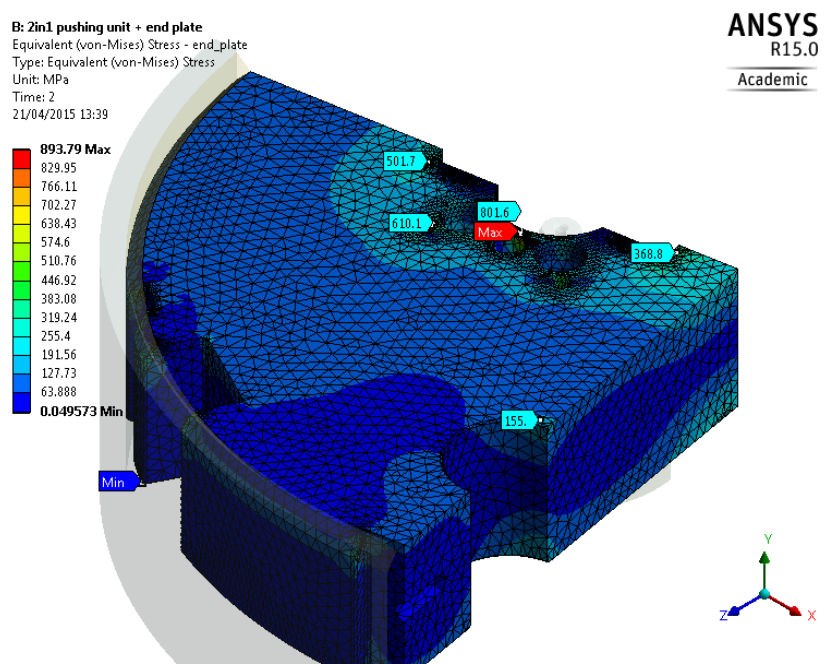


# Structural analysis – end plate 2in1

## End Plate – Y – norm Stress



## End Plate – Equ. Stress



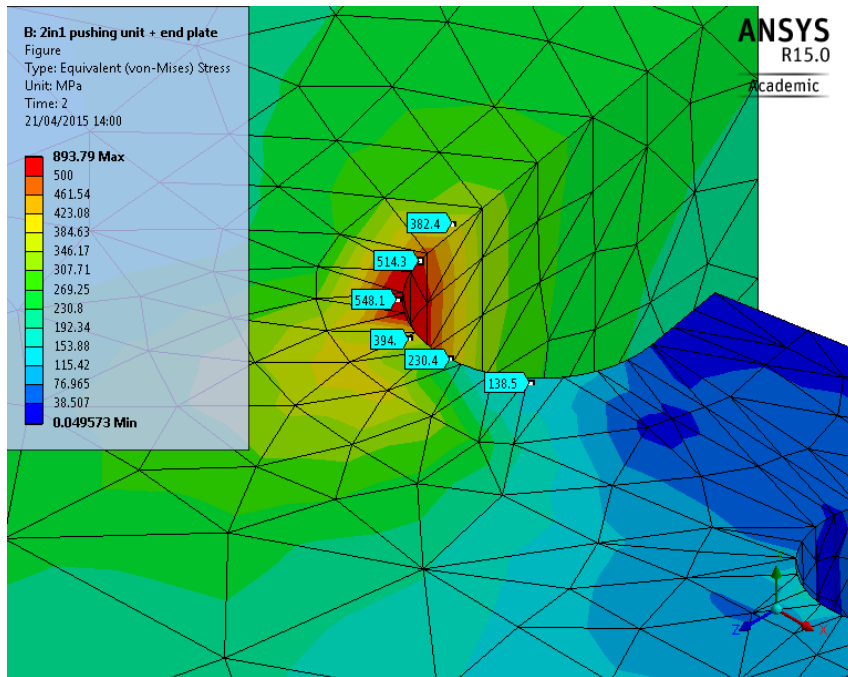
Full theoretical EM force 200kN

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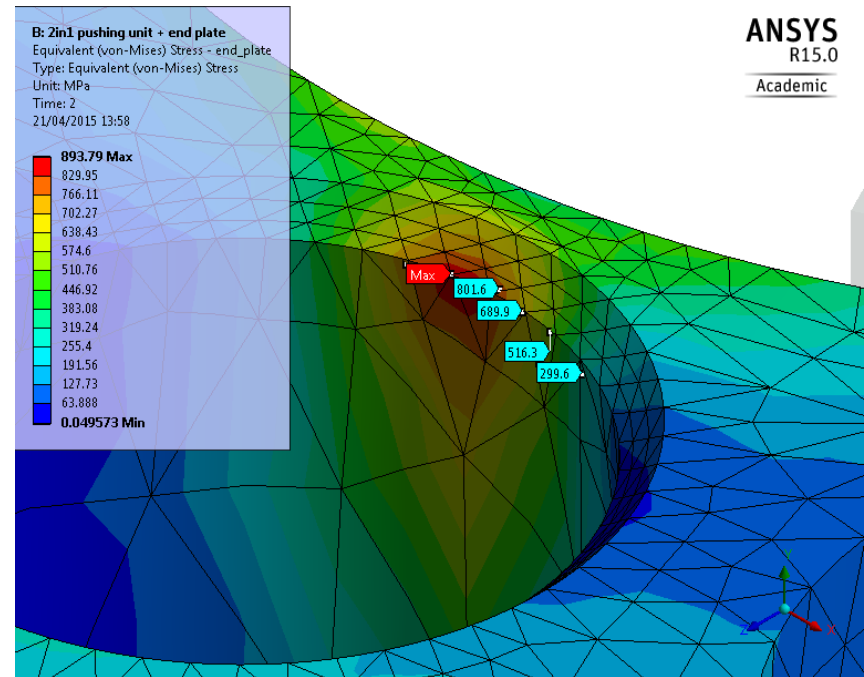


# Structural analysis – end plate 2in1

## End Plate – Equ. Stress



## End Plate – Equ. Stress



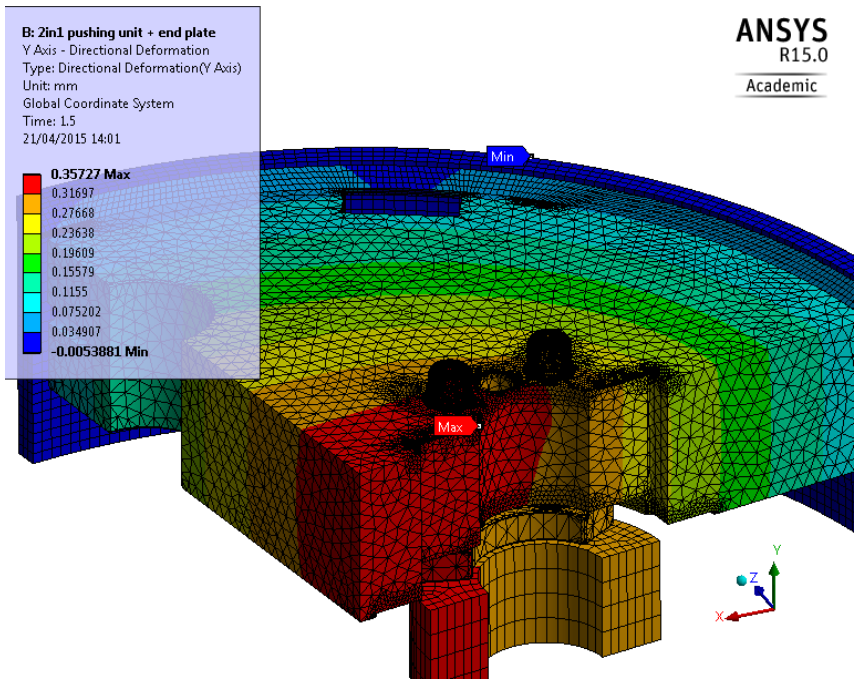
Full theoretical EM force 200kN



# Structural analysis – end plate 2in1

## End Plate – Y- Defo

## End Plate – Y- Deformation



- 50kN = 0.15mm
- 100kN=0.35mm
- 150kN=0.5mm
- 200kN=0.73mm

EM force 100kN



# Structural analysis – end plate 2in1

## Conclusion

- Structural strength on narrow geometries not guaranteed
- Deformation of 0.35mm at expected load

