Preliminary results of the structural analysis of the Bucharest TRD Module Type 1 (bTRD)

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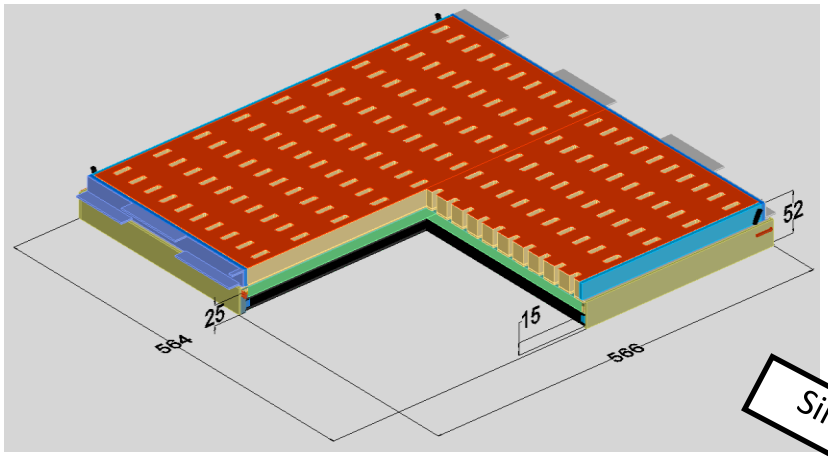
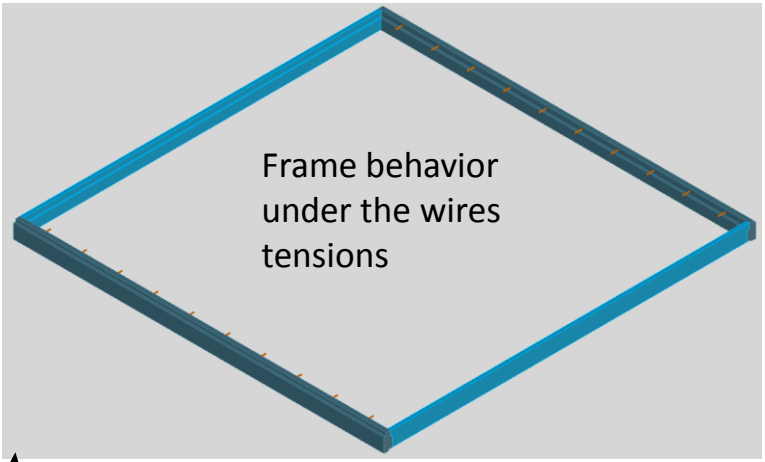
Motivation and Outlook

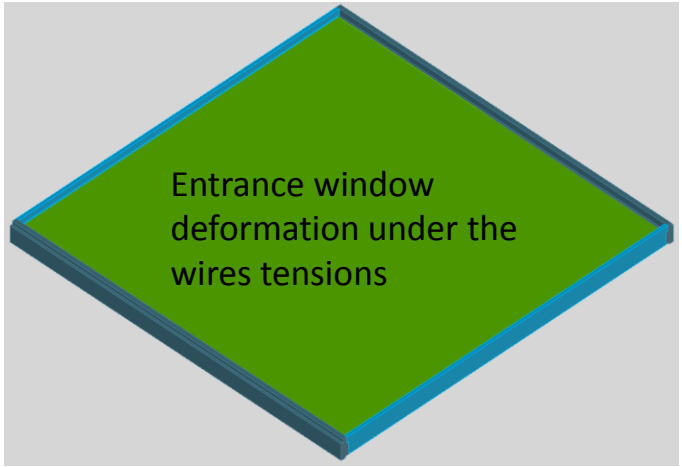
Based on ALICE-TRD experience (see Mariana's presentation)
- chamber frames deforms during construction due to wire tension
- pad plane (and entrance window) deforms during operation/construction

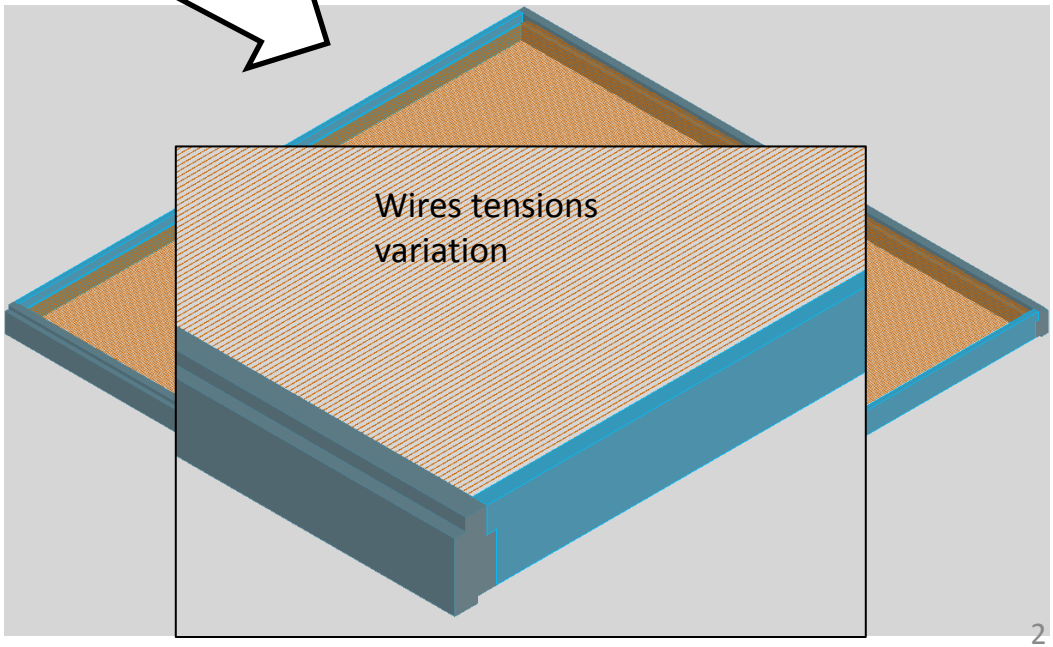




Simplified

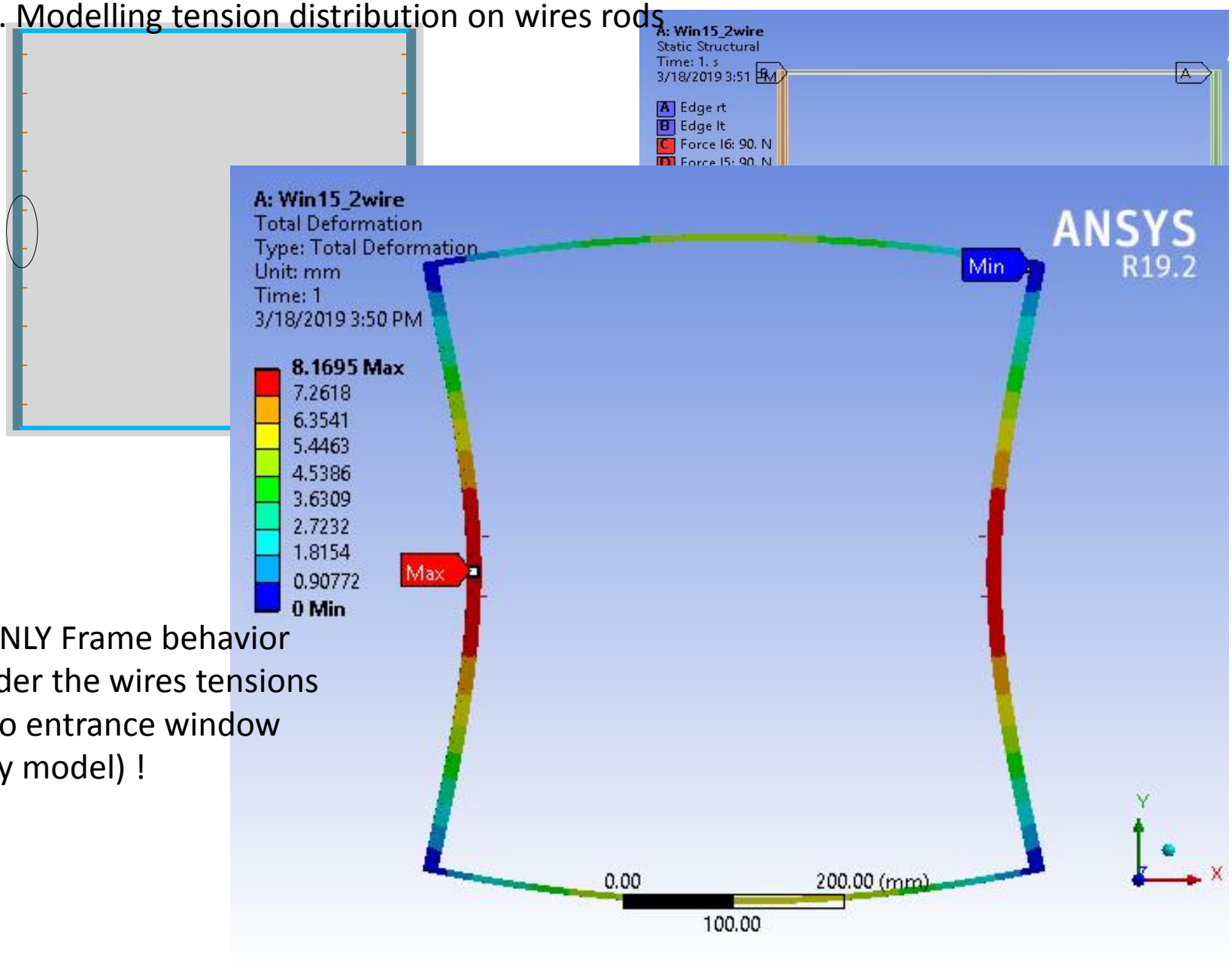
Studying static chamber deformation in ANSYS



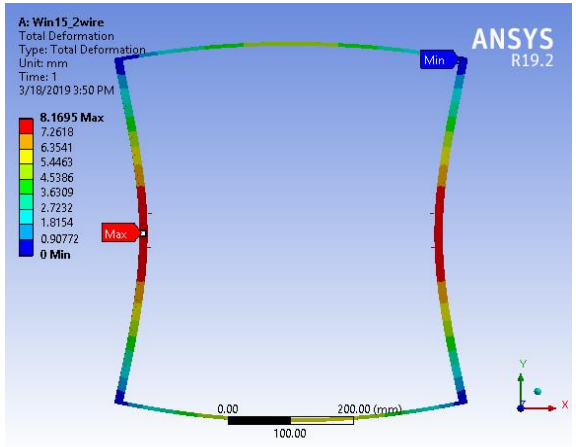


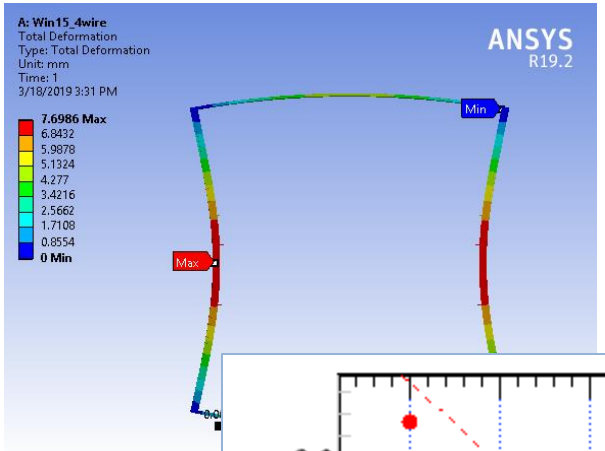
The ANSYS Simulation Model - hypothesis

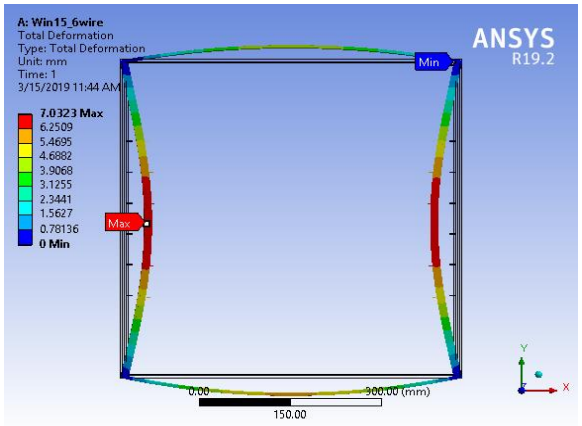
1. Modelling tension distribution on wires rods

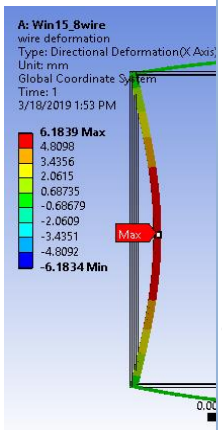


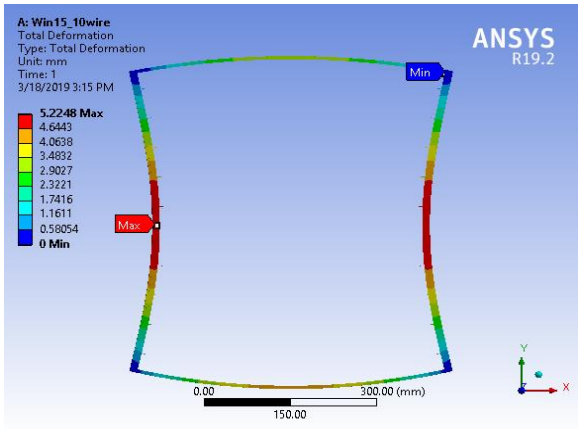
- ONLY Frame behavior under the wires tensions
- No entrance window (toy model) !

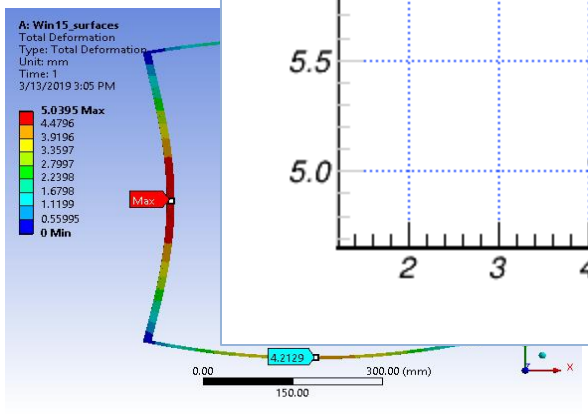

A: Win15_2wire
Total Deformation
Type: Total Deformation
Unit: mm
Time: 1
3/18/2019 3:50 PM
8.1695 Max
7.2618
6.3541
5.4463
4.5386
3.6309
2.7232
1.8154
0.90772
0 Min
ANSYS
R19.2
Min
Max
0.00
200.00 (mm)
100.00

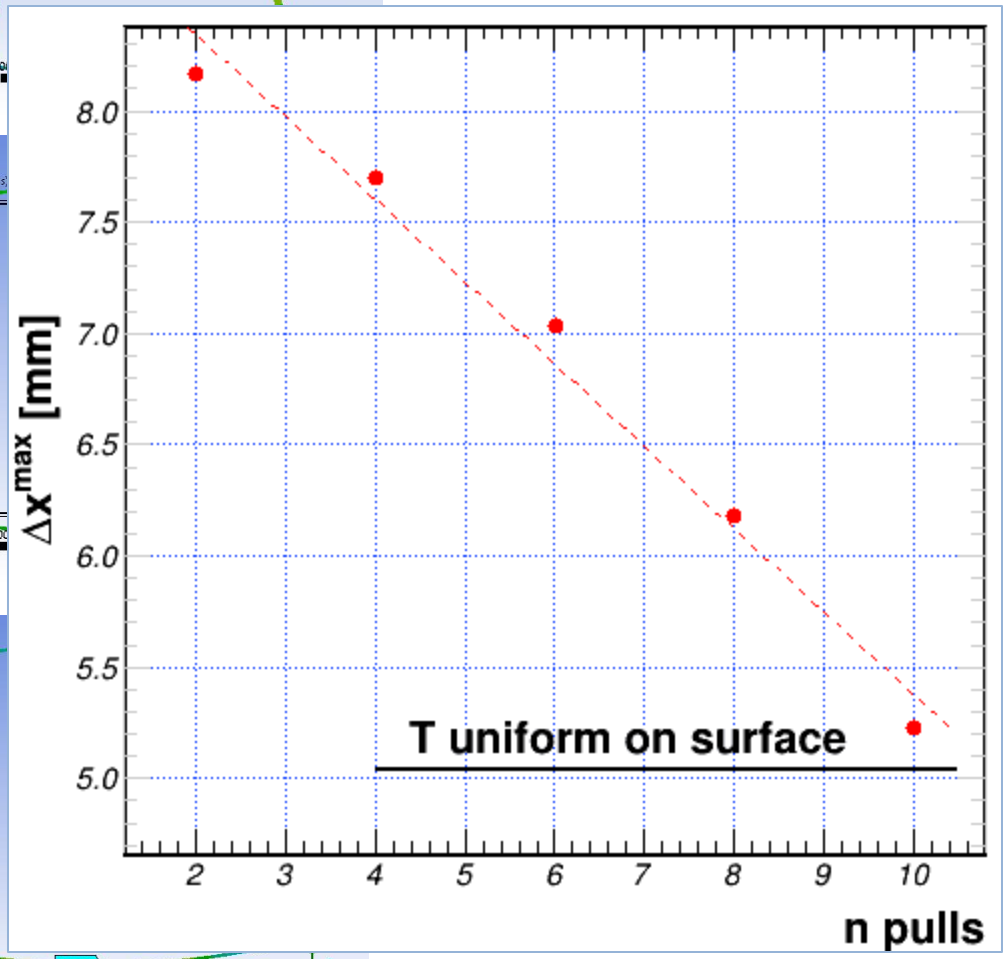

A: Win15_4wire
Total Deformation
Type: Total Deformation
Unit: mm
Time: 1
3/18/2019 3:31 PM
7.6986 Max
6.8432
5.9878
5.1324
4.277
3.4216
2.5662
1.7108
0.8554
0 Min
ANSYS
R19.2
Min
Max


A: Win15_6wire
Total Deformation
Type: Total Deformation
Unit: mm
Time: 1
3/15/2019 11:44 AM
7.0323 Max
6.2509
5.4695
4.6882
3.9068
3.1255
2.3441
1.5627
0.78136
0 Min
ANSYS
R19.2
Min
Max
0.00
300.00 (mm)
150.00


A: Win15_8wire
wire deformation
Type: Directional Deformation(X Axis
Unit: mm
Global Coordinate System
Time: 1
3/18/2019 1:53 PM
6.1839 Max
4.8098
3.4356
2.0615
0.68735
-0.68679
-2.0609
-3.4351
-4.8092
-6.1834 Min
Max

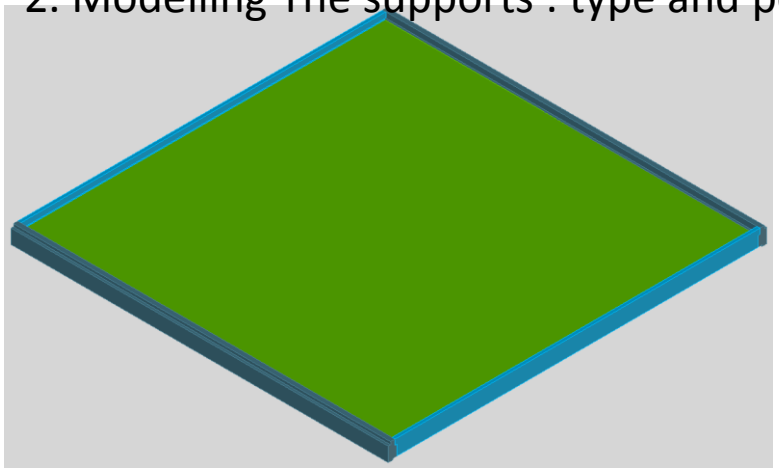

A: Win15_10wire
Total Deformation
Type: Total Deformation
Unit: mm
Time: 1
3/18/2019 3:15 PM
5.2248 Max
4.6443
4.0638
3.4832
2.9027
2.3221
1.7416
1.1611
0.58054
0 Min
ANSYS
R19.2
Min
Max
0.00
300.00 (mm)
150.00

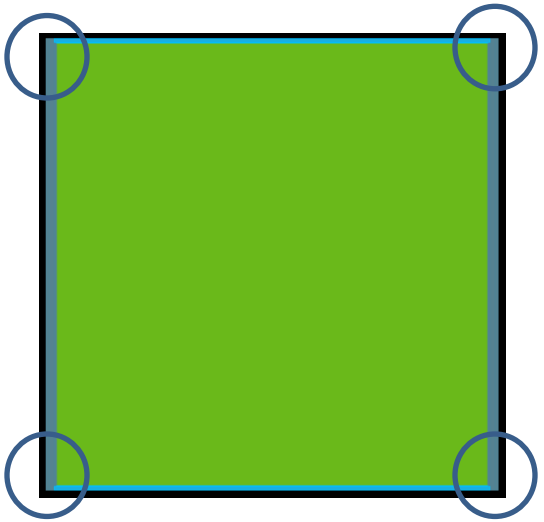

A: Win15_surfaces
Total Deformation
Type: Total Deformation
Unit: mm
Time: 1
3/13/2019 3:05 PM
5.0395 Max
4.4796
3.9196
3.3597
2.7997
2.2398
1.6798
1.1199
0.55995
0 Min
Max
4.2129
0.00
300.00 (mm)
150.00

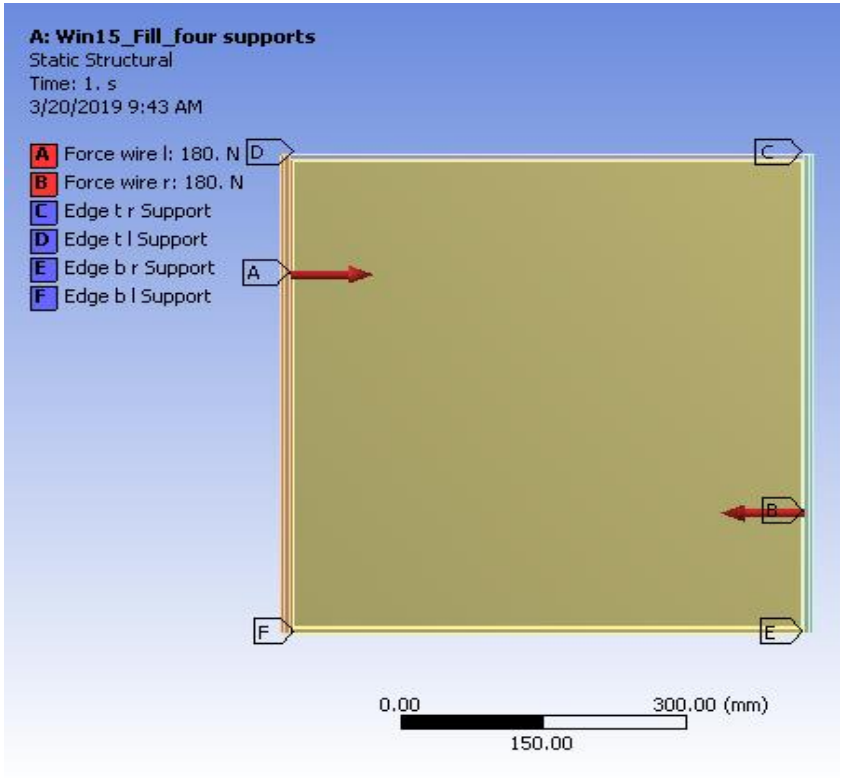

8.0
7.5
7.0
6.5
6.0
5.5
5.0
Δx^max [mm]
T uniform on surface
2
3
4
5
6
7
8
9
10
n pulls

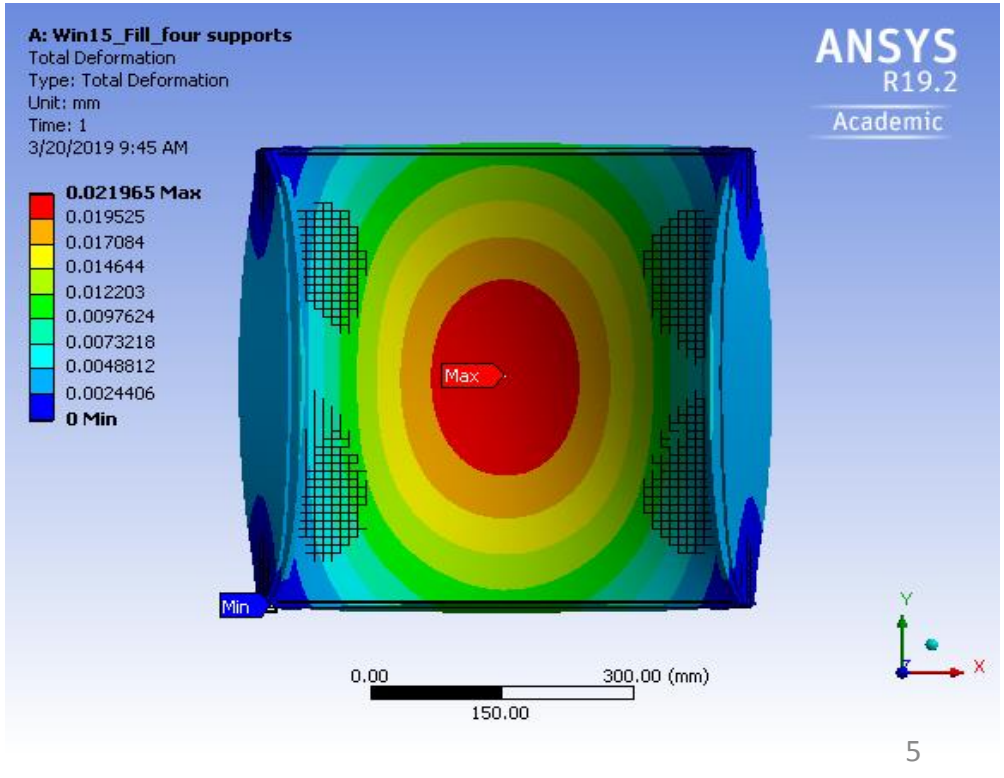
The ANSYS Simulation Model - hypothesis

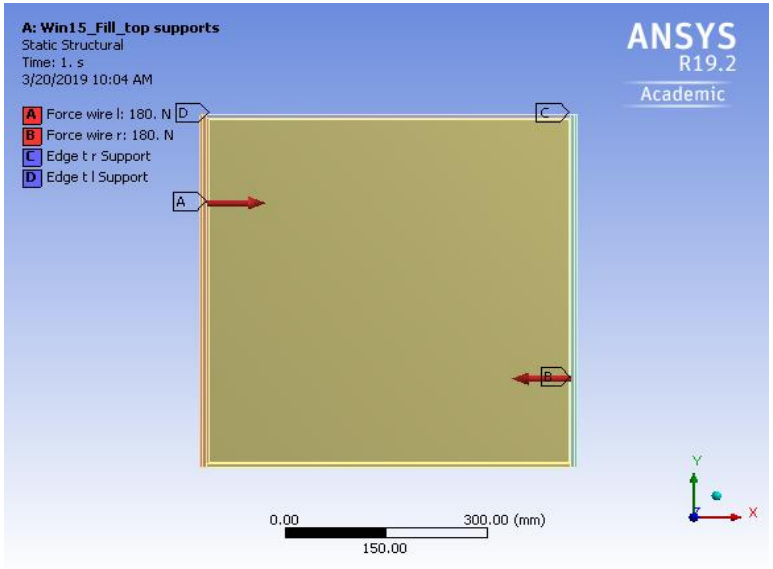
2. Modelling The supports : type and position

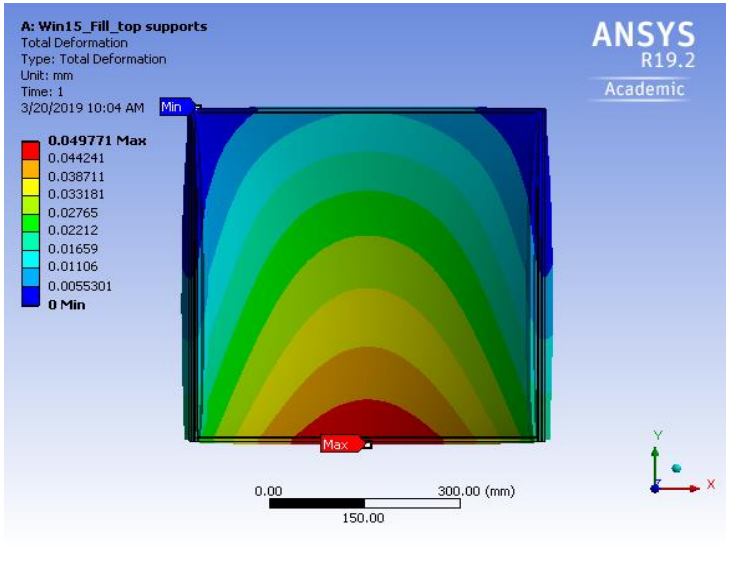


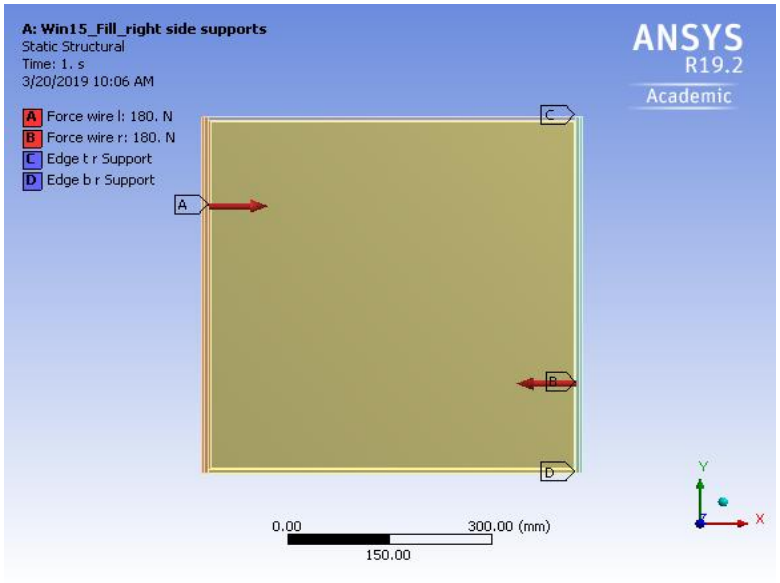


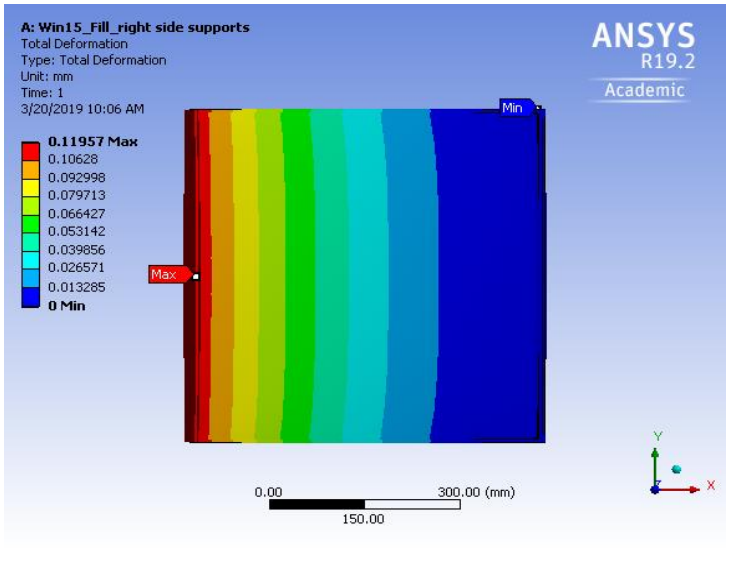





A: Win15_Fill_top supports
Static Structural
Time: 1. s
3/20/2019 10:04 AM
A Force wire l: 180. N
B Force wire r: 180. N
C Edge t r Support
D Edge t l Support
ANSYS
R19.2
Academic
0.00
300.00 (mm)
150.00
Y
X

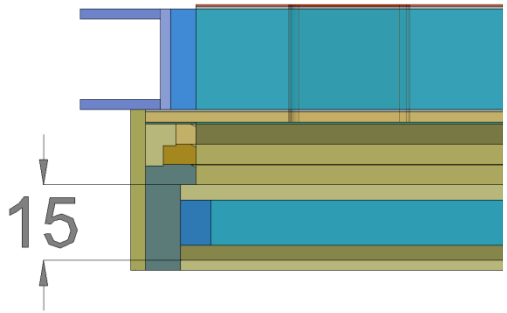

A: Win15_Fill_top supports
Total Deformation
Type: Total Deformation
Unit: mm
Time: 1
3/20/2019 10:04 AM
0.049771 Max
0.044241
0.038711
0.033181
0.02765
0.02212
0.01659
0.01106
0.0055301
0 Min
Min
Max
ANSYS
R19.2
Academic
0.00
300.00 (mm)
150.00
Y
X

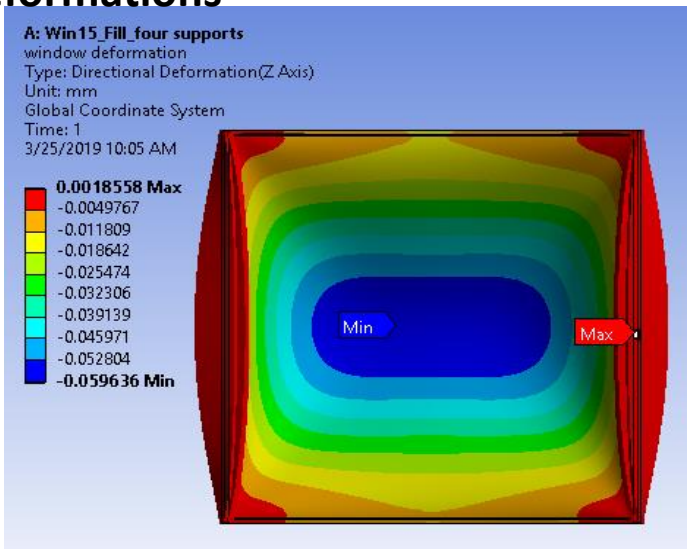

A: Win15_Fill_right side supports
Static Structural
Time: 1. s
3/20/2019 10:06 AM
A Force wire l: 180. N
B Force wire r: 180. N
C Edge t r Support
D Edge b r Support
ANSYS
R19.2
Academic
0.00
300.00 (mm)
150.00
Y
X

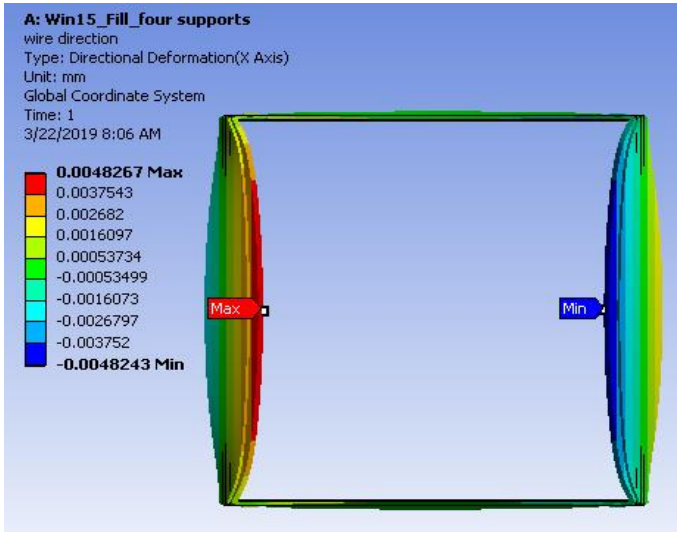

A: Win15_Fill_right side supports
Total Deformation
Type: Total Deformation
Unit: mm
Time: 1
3/20/2019 10:06 AM
0.11957 Max
0.10628
0.092998
0.079713
0.066427
0.053142
0.039856
0.026571
0.013285
0 Min
Min
Max
ANSYS
R19.2
Academic
0.00
300.00 (mm)
150.00
Y
X

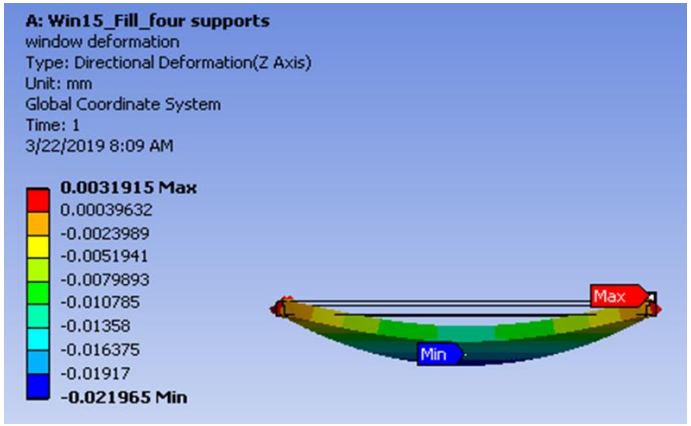
The ANSYS Simulation Model – results Chamber Deformations

1. Entrance Window Thickness = 15 mm





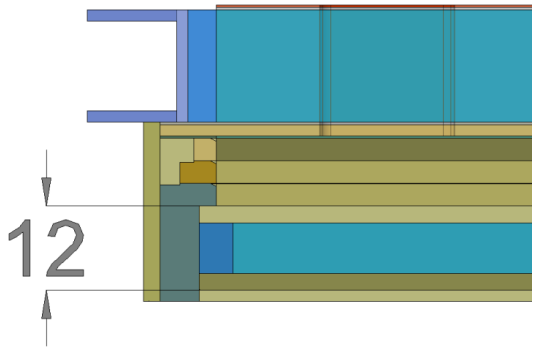


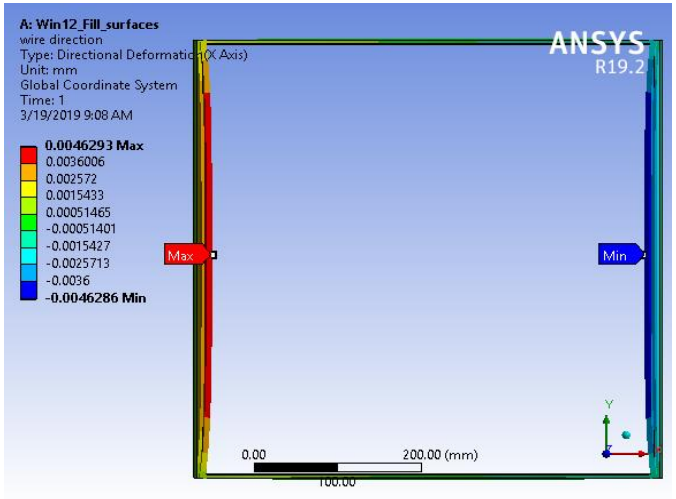


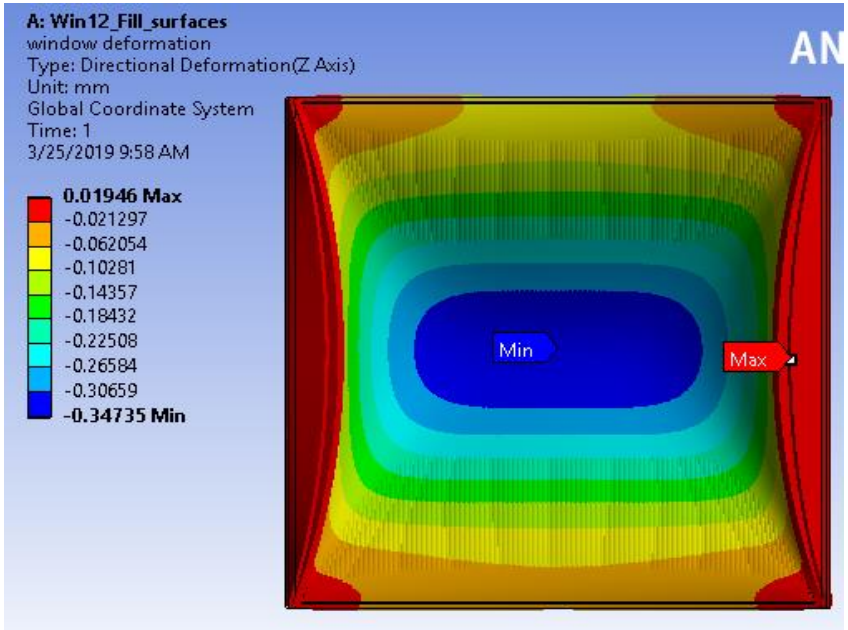
△x [μm]	Window type_15mm
4.8 x 2	15_full fill
93.4 x 2	15_without Cfibber in
11.1 x 2	15_without Cfibber out

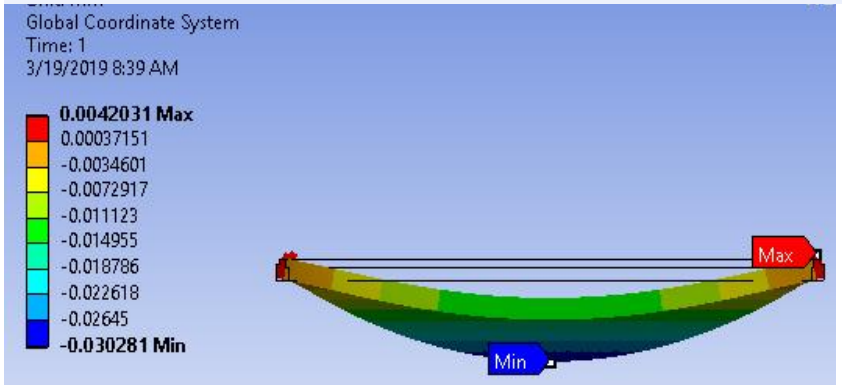
△z [μm]	Window type_15mm
22	15_full fill
346	15_without Cfibber in
59	15_without Cfibber out

Deformations for entrance window_12mm





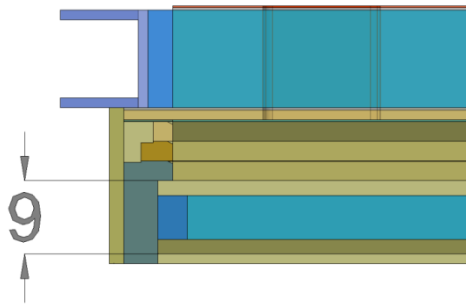


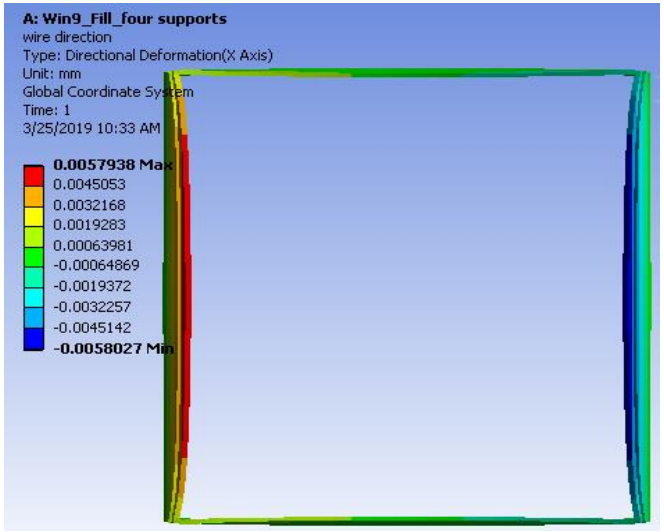


Δx [μm]	Window type_12mm
4.6 x 2	12_full fill
88.6 x 2	12_without Cfibber in
12.6 x 2	12_without Cfibber out

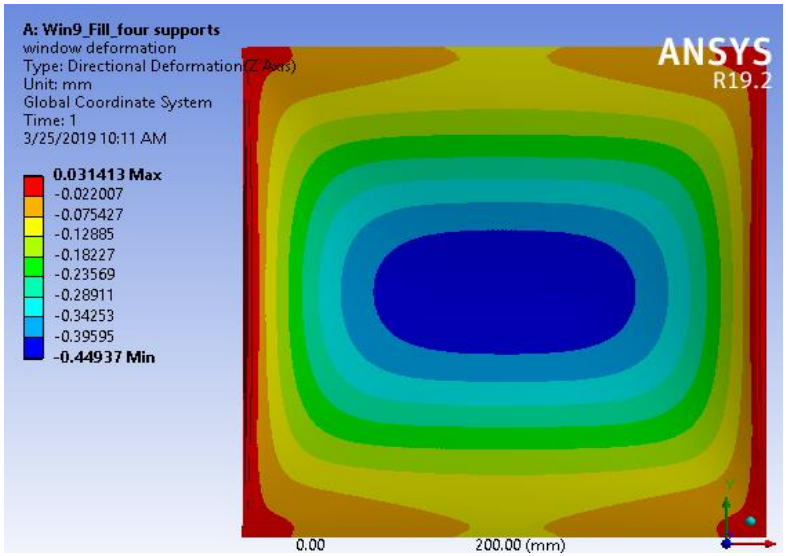
Δz [μm]	Window type_12mm
30.3	12_full fill
347	12_without Cfibber in
102	12_without Cfibber out

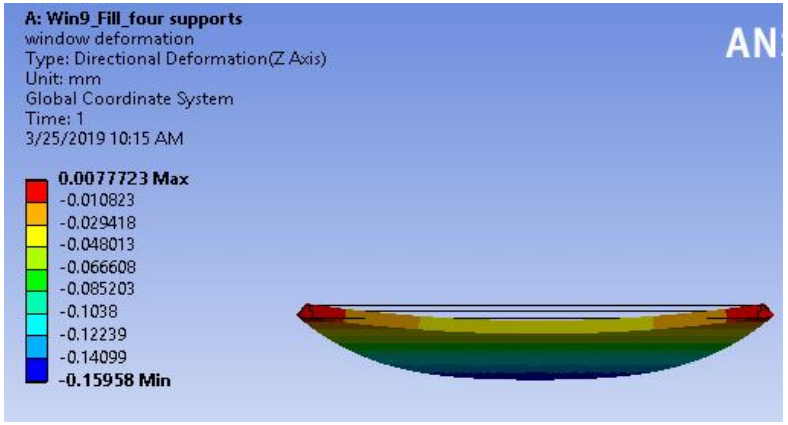
Deformations for entrance window_9mm





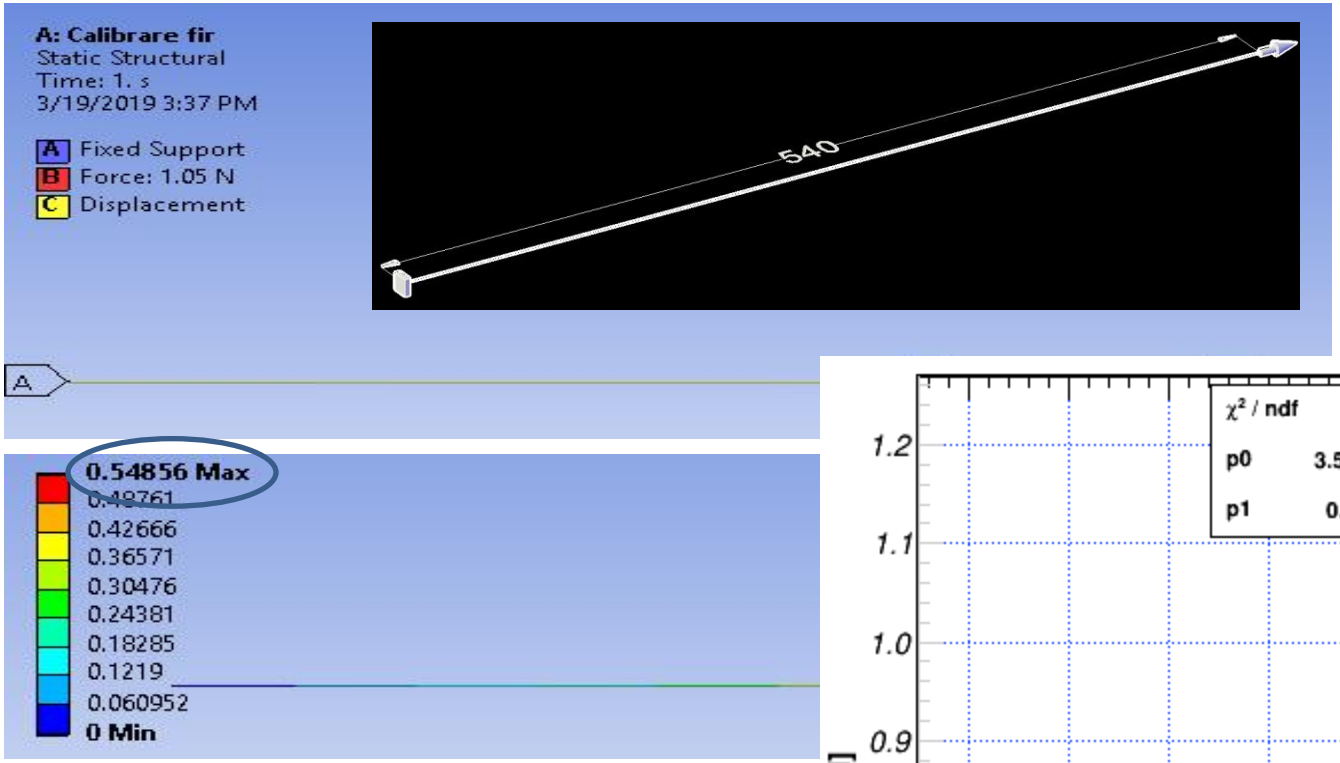
Δx [μm]	Window type_9mm
5.8 x 2	12_full fill
90 x 2	12_without Cfibber in
16.6x 2	12_without Cfibber out

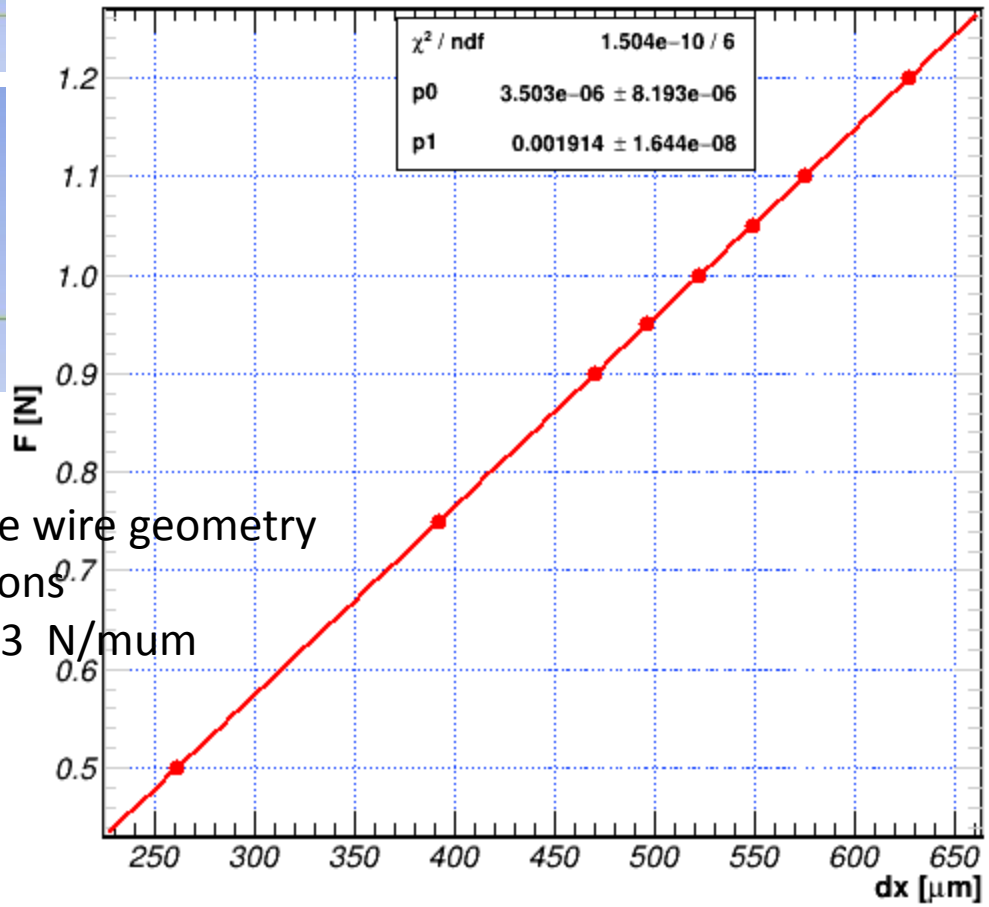




Δz [μm]	Window type_9mm
44	12_full fill
449	12_without Cfibber in
159.5	12_without Cfibber out

The ANSYS Simulation Model – Wire tension variations



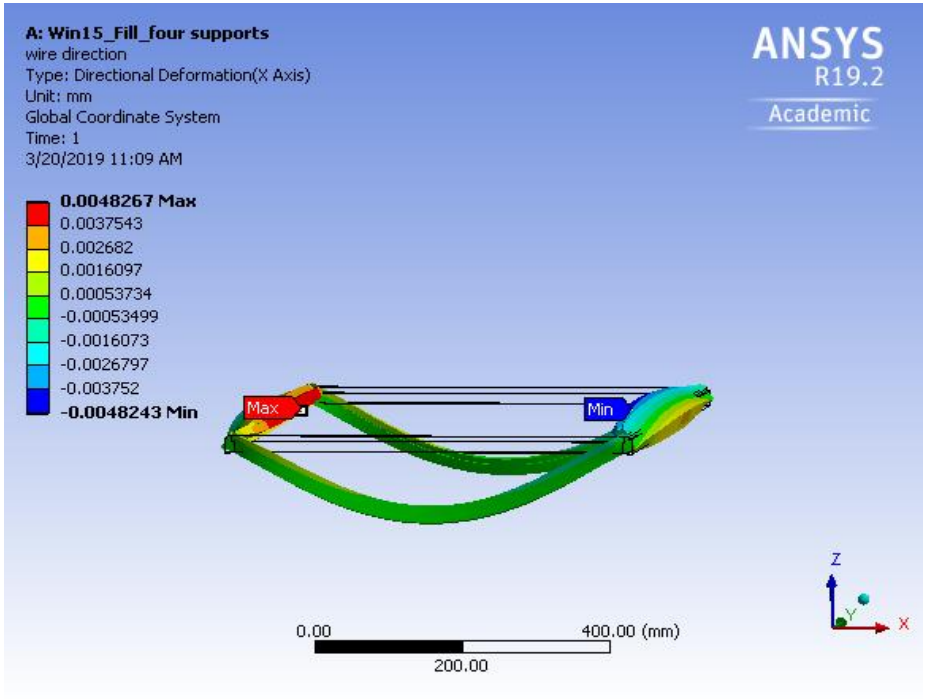


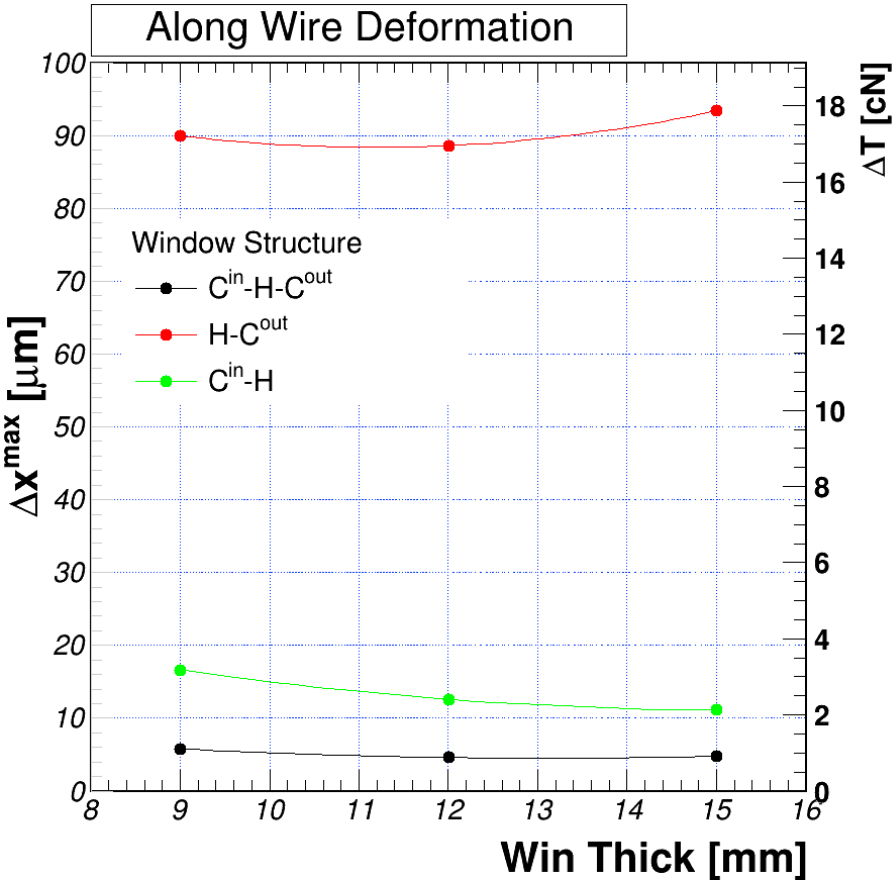
- Realistic simulation of the cathode wire geometry
- F(x) agrees with elastic deformations
- Elastic constant found to be 1.9e-3 N/mum

The ANSYS Simulation Model – results Cathode Wire Tension

4. Systematics with Entrance Window Structure

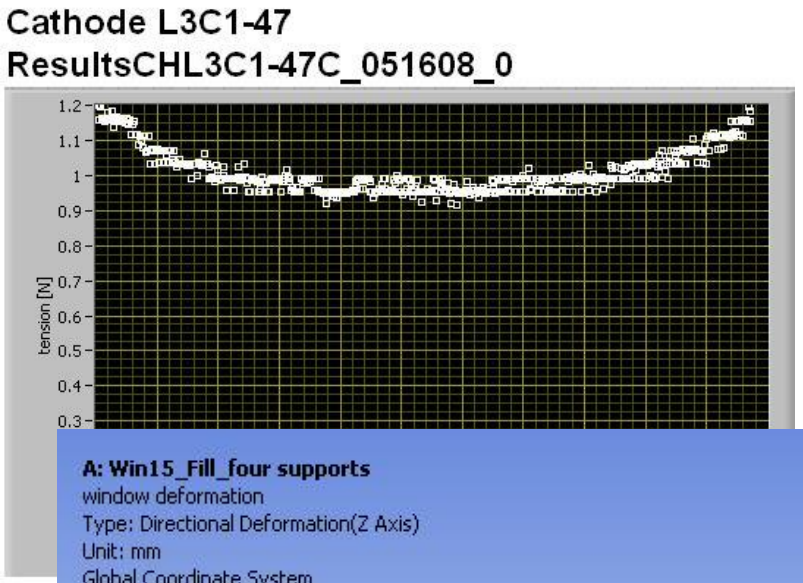
Very preliminary results for the variation of the wires tensions taking into account the rods and entrance window deformations



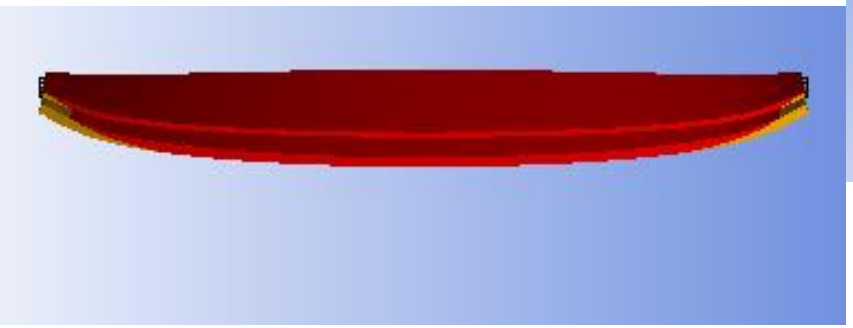


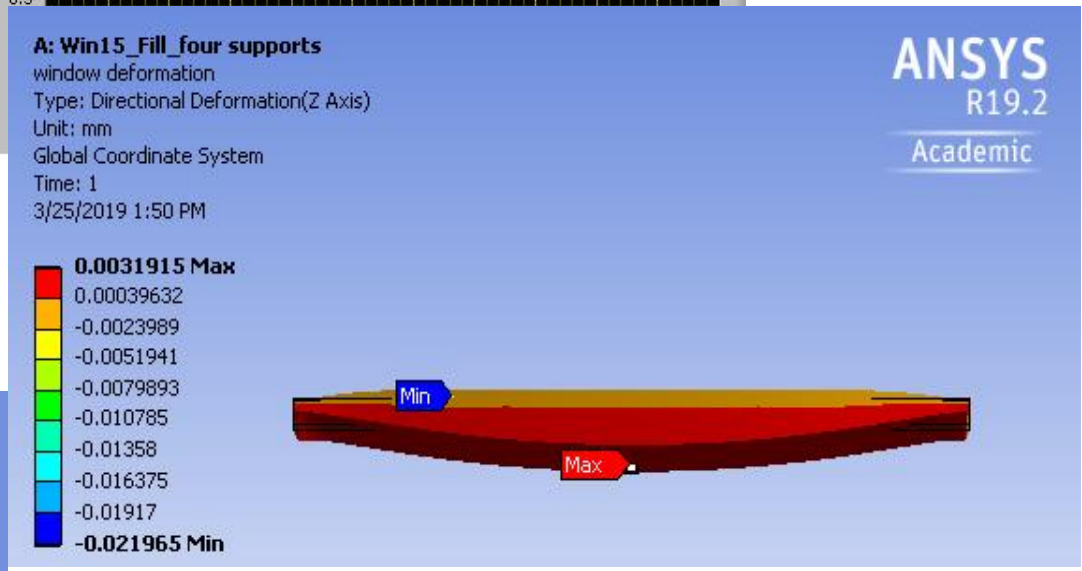
Model sustain by Measured deformations

- Nominal Cathode tension (CT) ~ 100 cN
- Wire elasticity limits 80 cN< CT <120 cN
- Observed DTmax = 20 cN



- Comparison between ALICE-TRD measured deformation (Tension variation) agrees qualitatively with ANSYS simulations

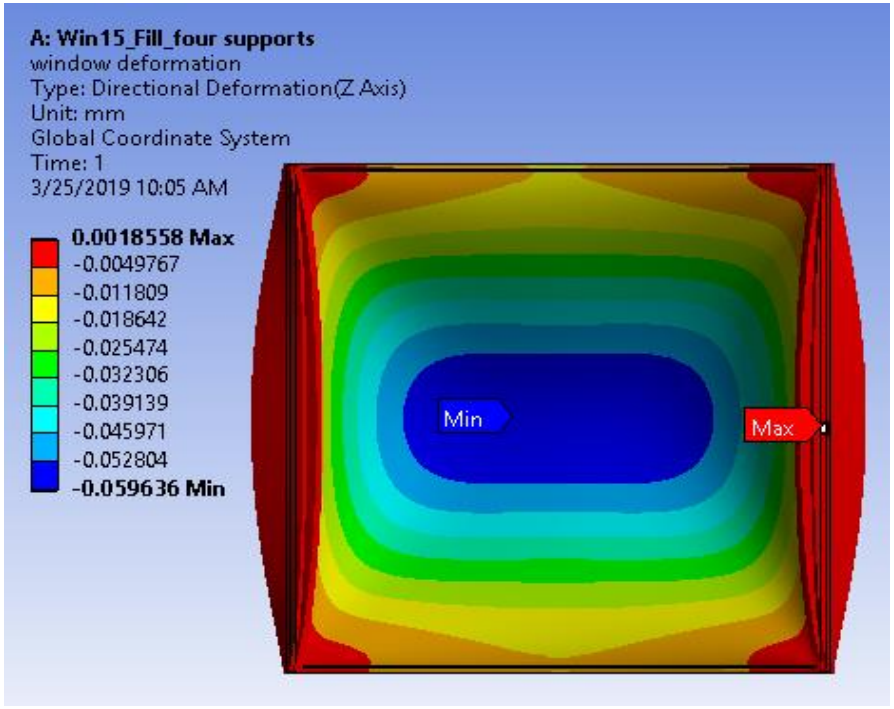


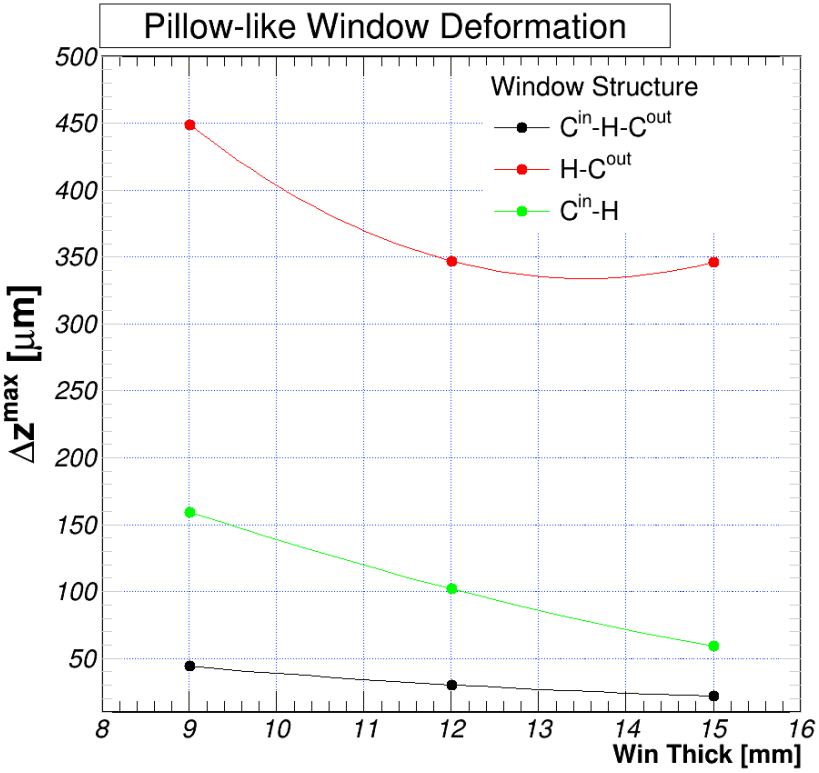


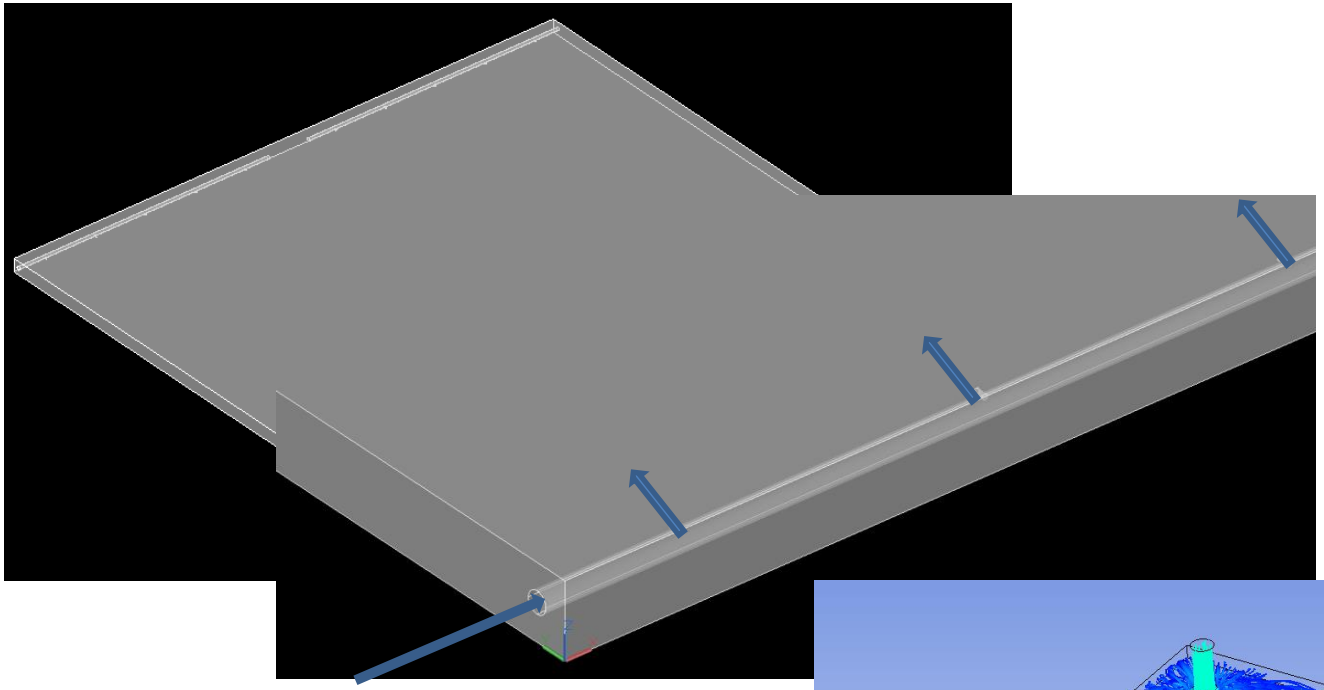
The ANSYS Simulation Model – results Entrance Window Concavity

5. Systematics with Entrance Window Structure

Entrance window deformations may also affect padplane planarity and gain uniformity ! To be followed !



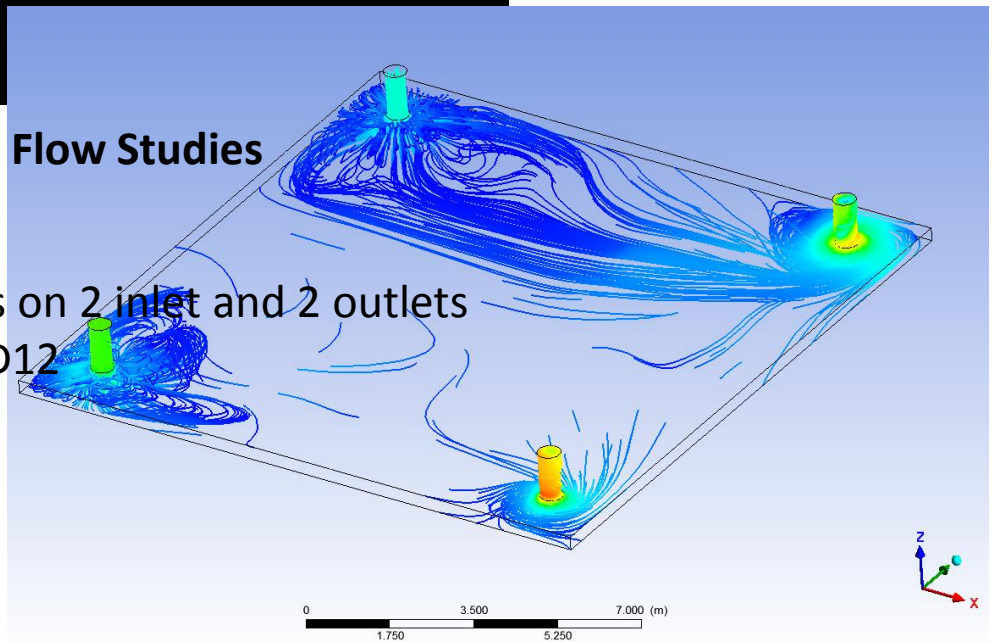




The ANSYS Simulation Model – Gas Flow Studies

Studying Inlet/Outlet geometry

- Current gas flow geometry relies on 2 inlet and 2 outlets
- Possible gas flow patterns in TRD12
- Ways to obtain an uniform flow



CBM-TRD HPD Bucharest team

Alexandru Bercuci, Valerica Aprodu, Daniel Bartos, Gheorghe Caragheorgeopol, Vasile Catanescu, Viorel Duta, Mariana Petris, Mihai Petrovici, Lucia Prodan, Andrei Radu, Claudiu Schiaua, Victor Simion

Thank you!