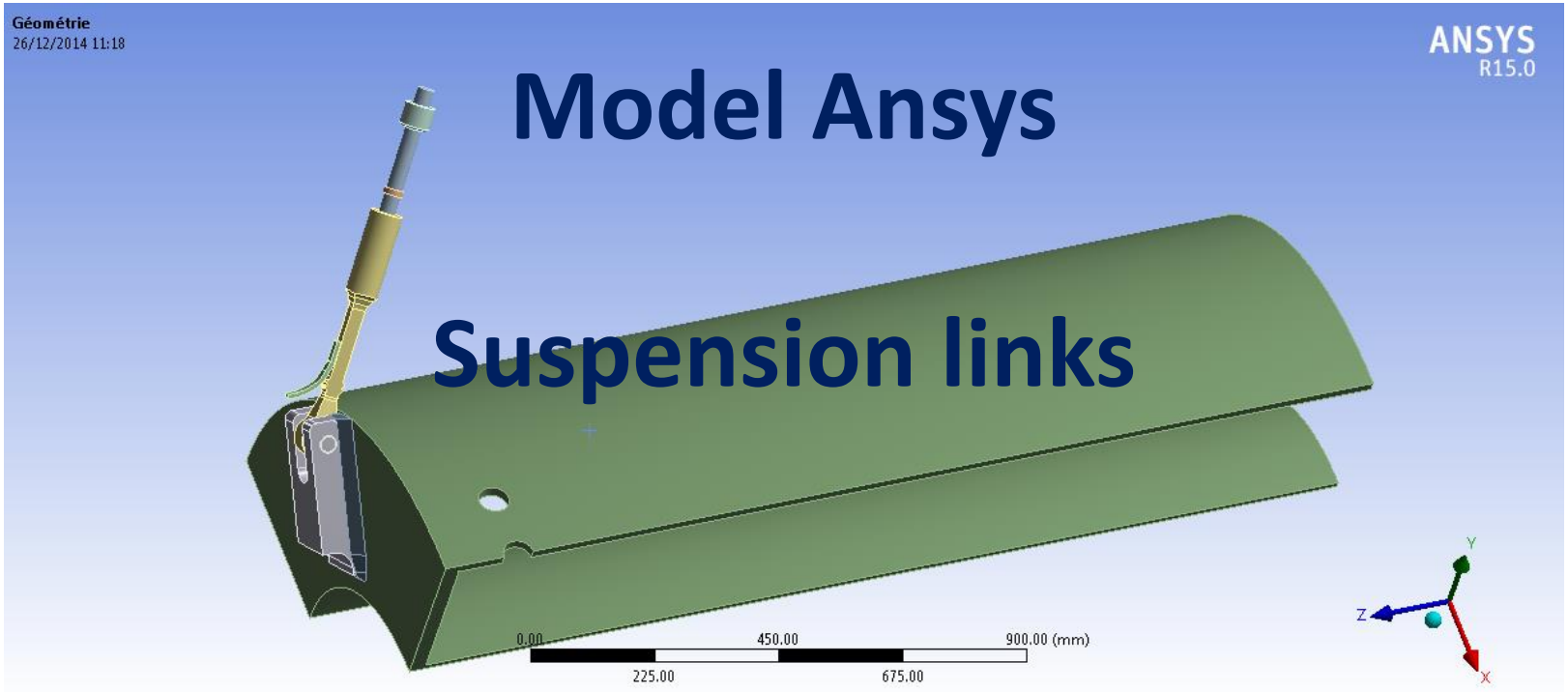
Model Ansys

Suspension links



29/12/2014-SA-AP

Ansys model

Revision and Abstract

Description	Revision	Date
Creation	A	19/12/2014-SA-AP

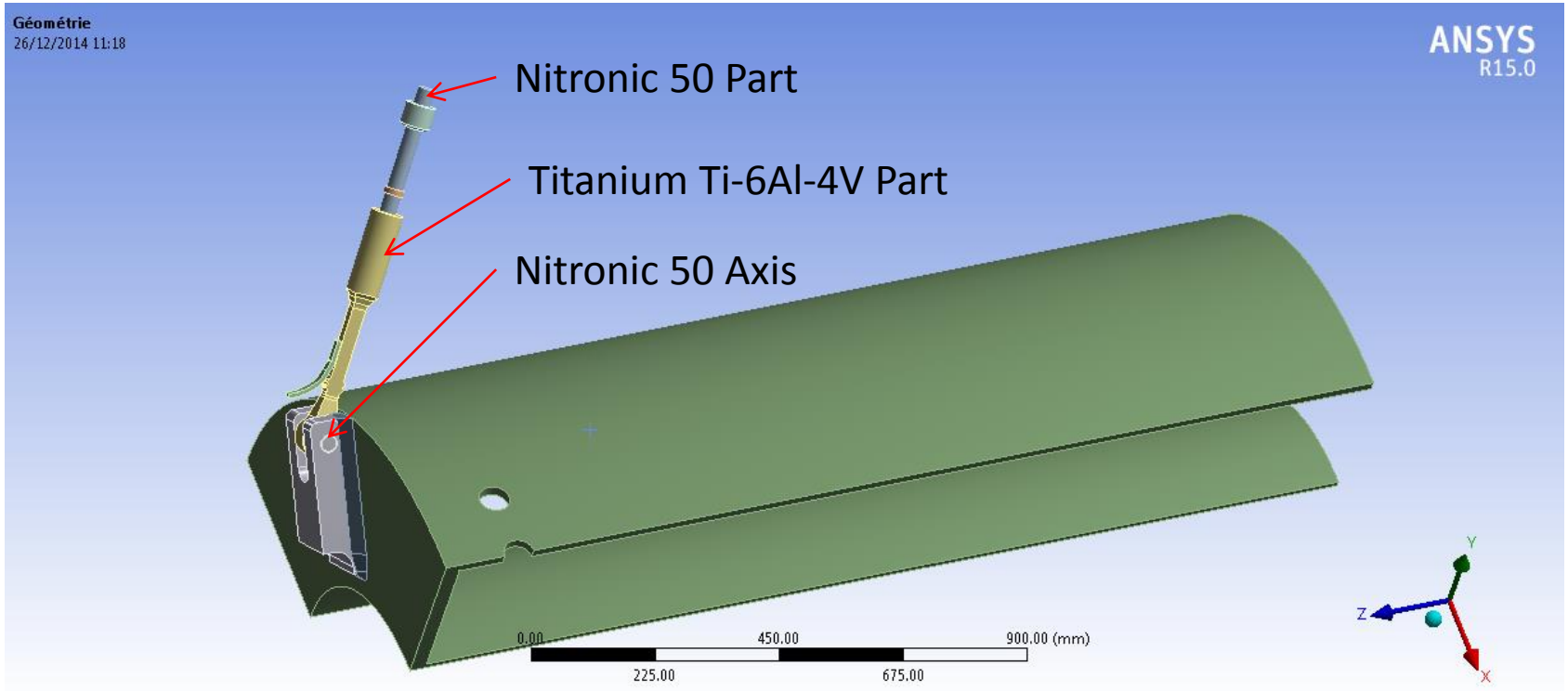
ABSTRACT

This report presents calculation made by Sigmaphi on dipole SHMS suspension links.

Conclusion: the Von Mises stress in suspension links is acceptable.

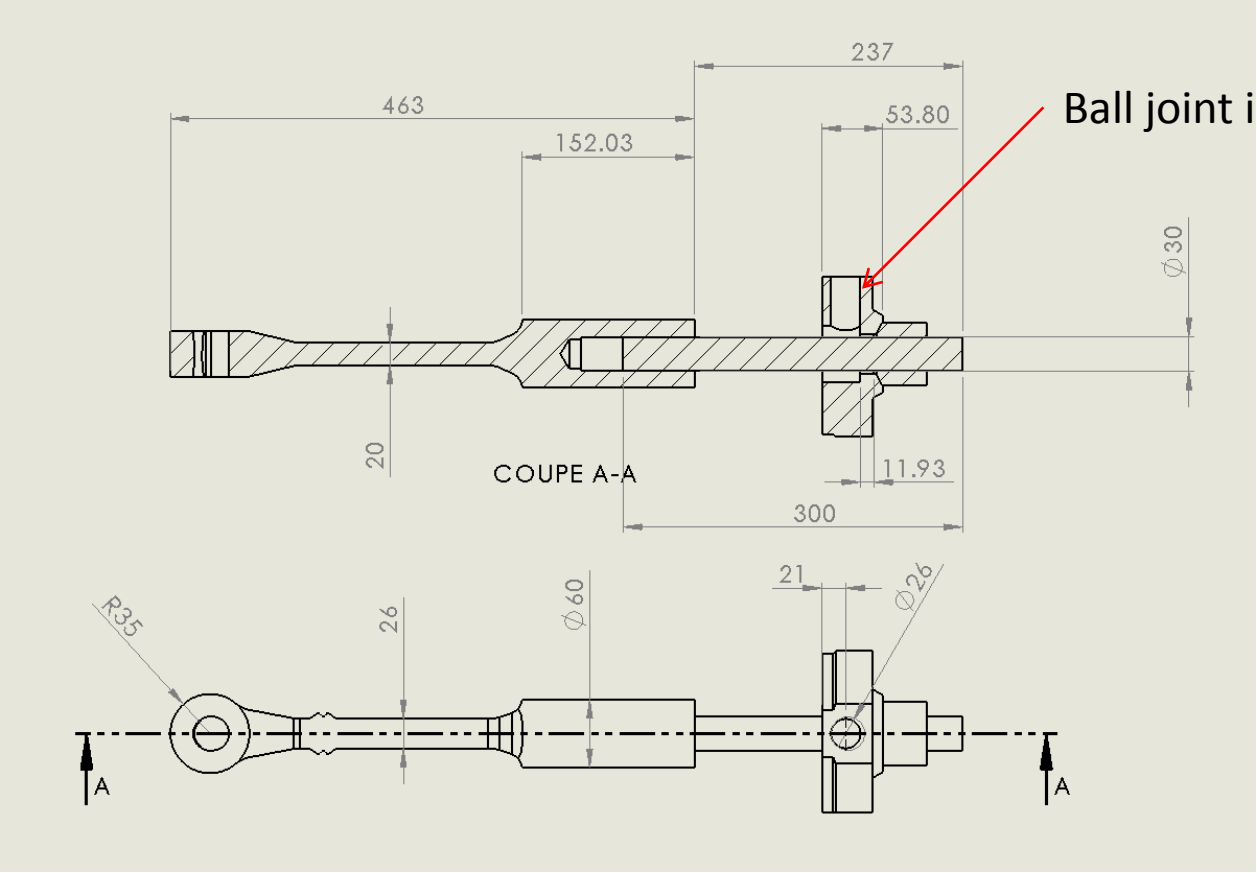
Ansys model

Geometry



Ansys model

Suspension links geometry



Cad files: 317111-JLAB-706-001 Rev G

Ansys model

Material – for all simulations-

Stainless steel 304 L

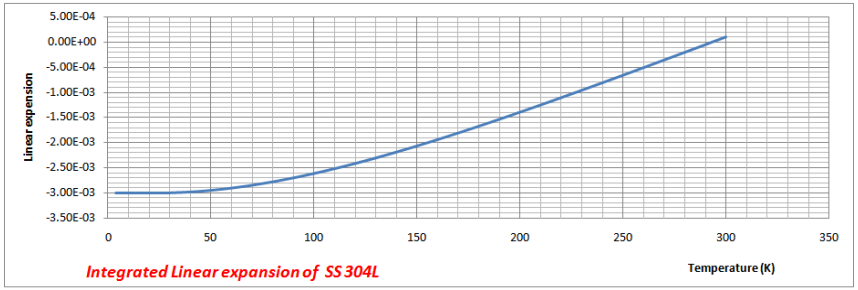
	DL/L*10^5	SS 304 units: GPa	SS 304 units: GPa
a	-2.96E+02	2.10E+02	2.10E+02
b	-3.98E-01	1.22E-01	1.53E-01
c	9.27E-03	-1.15E-02	-1.62E-03
d	-2.03E-05	3.61E-04	5.12E-06
e	1.71E-08	-3.02E-06	-6.15E-09
T	23	5-57	57-300

Density	7900 Kg/m3

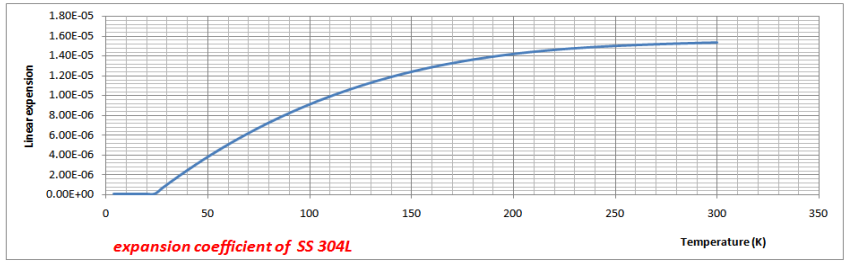
Equation of the form	
$y = a + bT + cT^2 + dT^3 + eT^4$	T≥Tlow(23°K)
y=f	T<Tlow(23°K)

*References for this material : http://Cryogenics.nist.gov

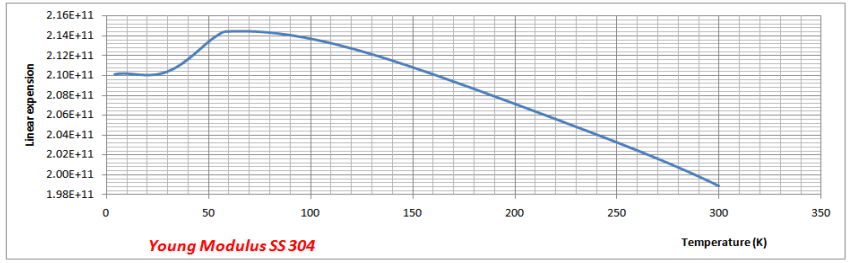
Equation of the form - Integrated coefficient	
$dy/dT = b + 2.cT + 3.dT^2 + 4.eT^3$	T≥Tlow(23°K)
dy/dT=0	T<Tlow(23°K)



Integrated Linear expansion of SS 304L



expansion coefficient of SS 304L



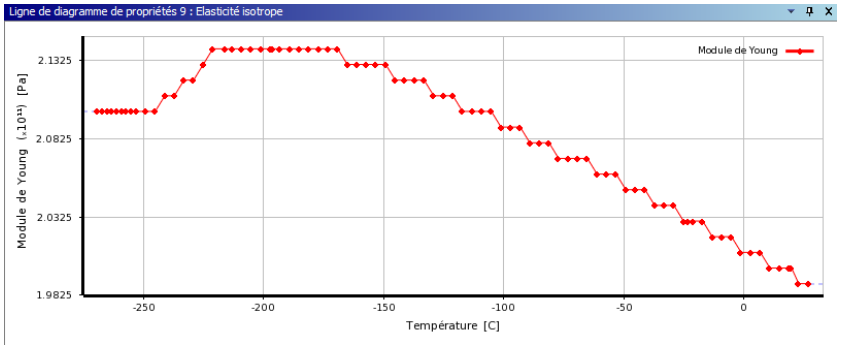
Young Modulus SS 304

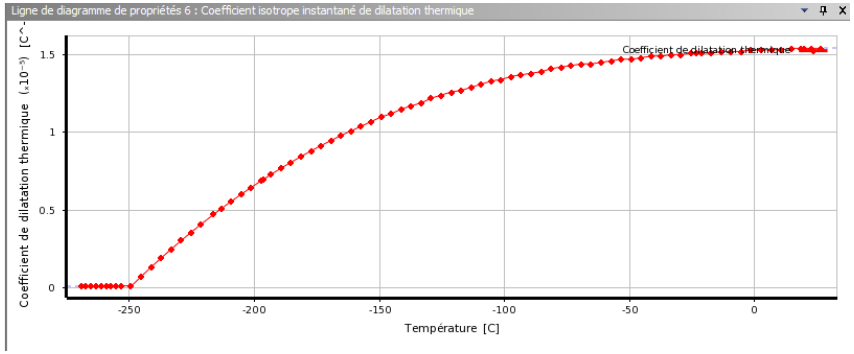
*Nist cryogenics

Ansys model

Material – for all simulations-

- *Nitronic 50*





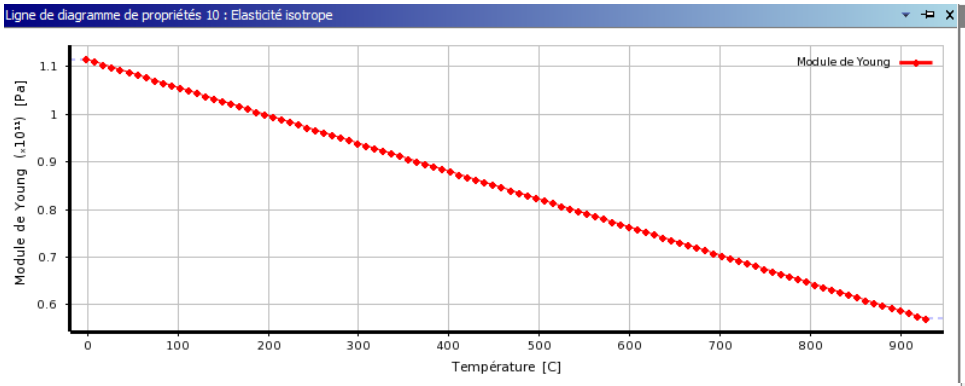
	Température (C)	Module de Young (Pa)	Coefficient de Poisson	Module de compressibilité (Pa)	Module de cisaillement (Pa)
2	-269.15	2.1E+11	0.31	1.8421E+11	8.0153E+10
3	-267.15	2.1E+11	0.31	1.8421E+11	8.0153E+10
4	-265.15	2.1E+11	0.31	1.8421E+11	8.0153E+10
5	-263.15	2.1E+11	0.31	1.8421E+11	8.0153E+10
6	-261.15	2.1E+11	0.31	1.8421E+11	8.0153E+10
7	-259.15	2.1E+11	0.31	1.8421E+11	8.0153E+10
8	-257.15	2.1E+11	0.31	1.8421E+11	8.0153E+10
9	-255.15	2.1E+11	0.31	1.8421E+11	8.0153E+10
10	-253.15	2.1E+11	0.31	1.8421E+11	8.0153E+10
11	-249.15	2.1E+11	0.31	1.8421E+11	8.0153E+10
12	-245.15	2.1E+11	0.31	1.8421E+11	8.0153E+10
13	-241.15	2.11E+11	0.31	1.8509E+11	8.0534E+10
14	-237.15	2.11E+11	0.31	1.8509E+11	8.0534E+10
15	-233.15	2.12E+11	0.31	1.8596E+11	8.0916E+10
16	-229.15	2.12E+11	0.31	1.8596E+11	8.0916E+10
17	-225.15	2.13E+11	0.31	1.8684E+11	8.1298E+10
18	-221.15	2.14E+11	0.31	1.8772E+11	8.1679E+10
19	-216.15	2.14E+11	0.31	1.8772E+11	8.1679E+10
20	-213.15	2.14E+11	0.31	1.8772E+11	8.1679E+10
21	-209.15	2.14E+11	0.31	1.8772E+11	8.1679E+10

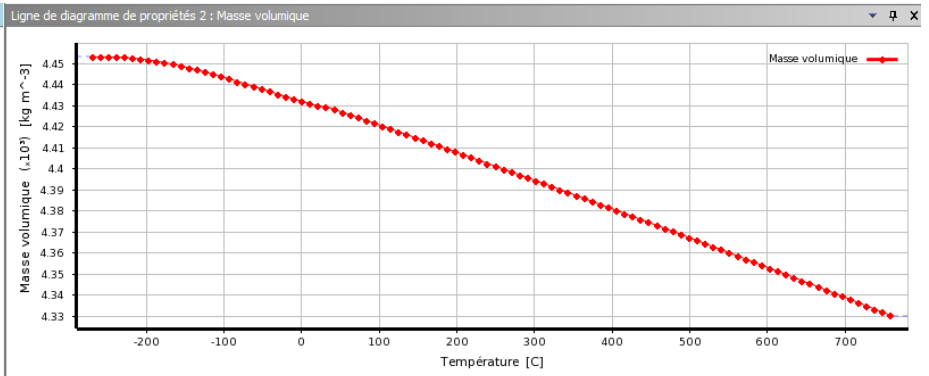
**DBPM software and nist cryogenics*

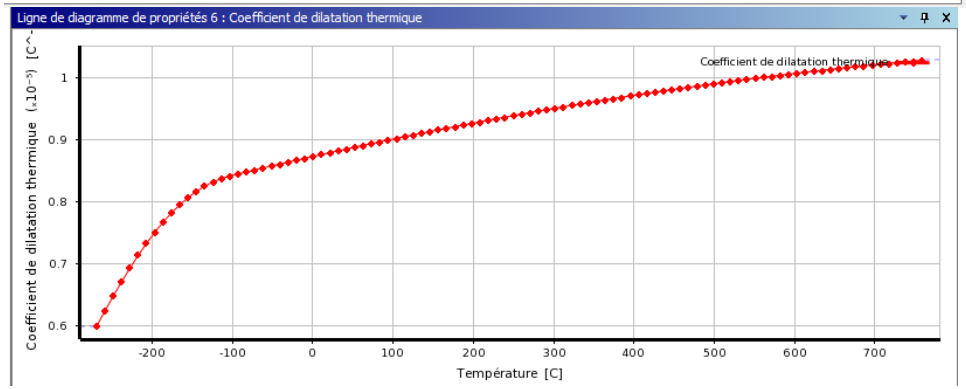
Ansys model

Material – for all simulations-

- *TI-6Al-4V (UNS R56400)*





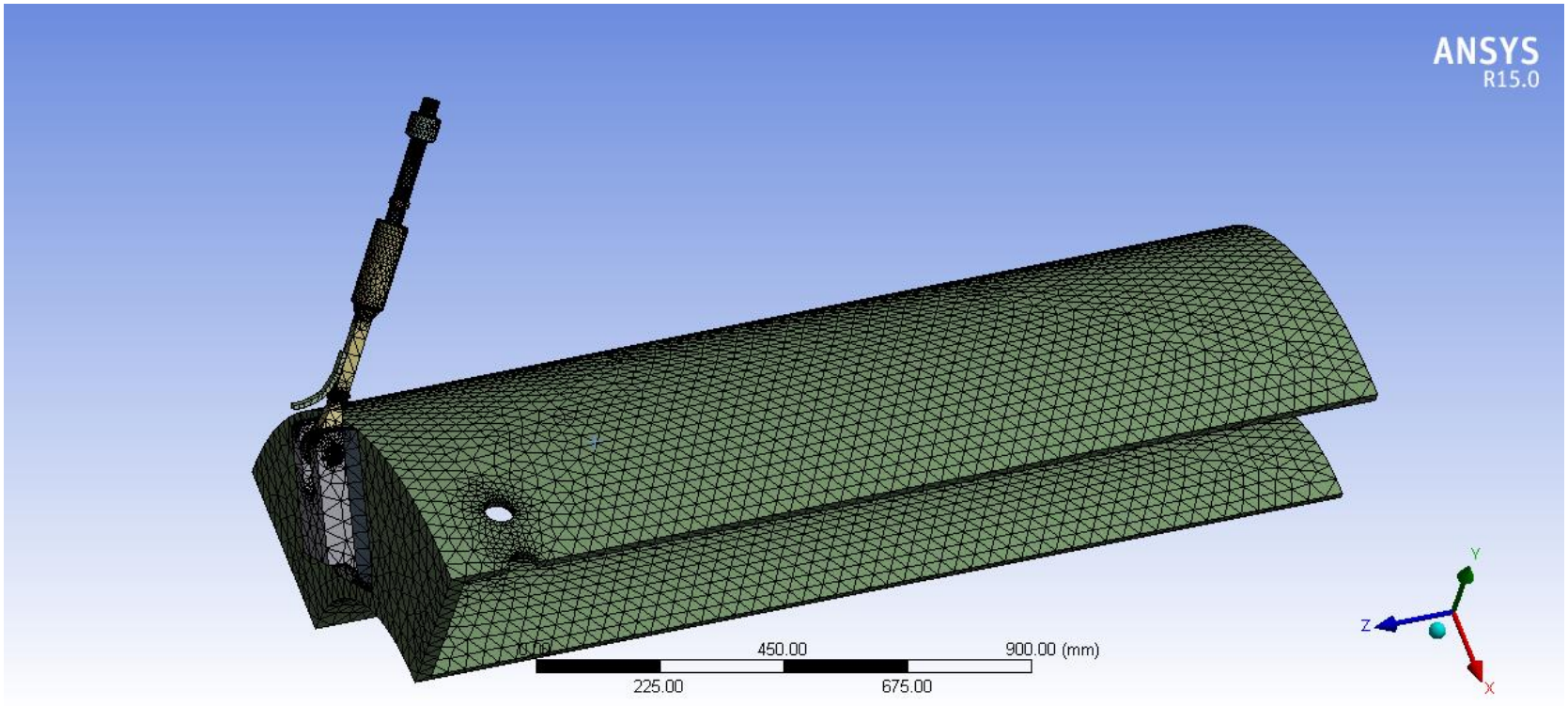


	A	B	C	D	E
1	Température (K)	Module de Young (Pa)	Coefficient de Poisson	Module de compressibilité (Pa)	Module de cisaillement (Pa)
2	273	1.1152E+11	0.40365	1.9291E+11	3.9725E+10
3	282.36	1.1097E+11	0.40364	1.9194E+11	3.9529E+10
4	291.73	1.1042E+11	0.40363	1.9096E+11	3.9334E+10
5	301.09	1.0987E+11	0.40362	1.8999E+11	3.9138E+10
6	310.45	1.0932E+11	0.40361	1.8902E+11	3.8943E+10
7	319.82	1.0877E+11	0.40359	1.8804E+11	3.8748E+10
8	329.18	1.0822E+11	0.40358	1.8707E+11	3.8552E+10
9	338.55	1.0767E+11	0.40357	1.861E+11	3.8357E+10
10	347.91	1.0712E+11	0.40356	1.8513E+11	3.8161E+10
11	357.27	1.0657E+11	0.40355	1.8416E+11	3.7966E+10
12	366.64	1.0602E+11	0.40354	1.8318E+11	3.777E+10
13	376	1.0547E+11	0.40352	1.8221E+11	3.7575E+10
14	385.36	1.0492E+11	0.40351	1.8124E+11	3.7379E+10
15	394.73	1.0438E+11	0.4035	1.8027E+11	3.7184E+10
16	404.09	1.0383E+11	0.40349	1.793E+11	3.6988E+10
17	413.45	1.0328E+11	0.40348	1.7833E+11	3.6793E+10

**DBPM software and nist cryogenics*

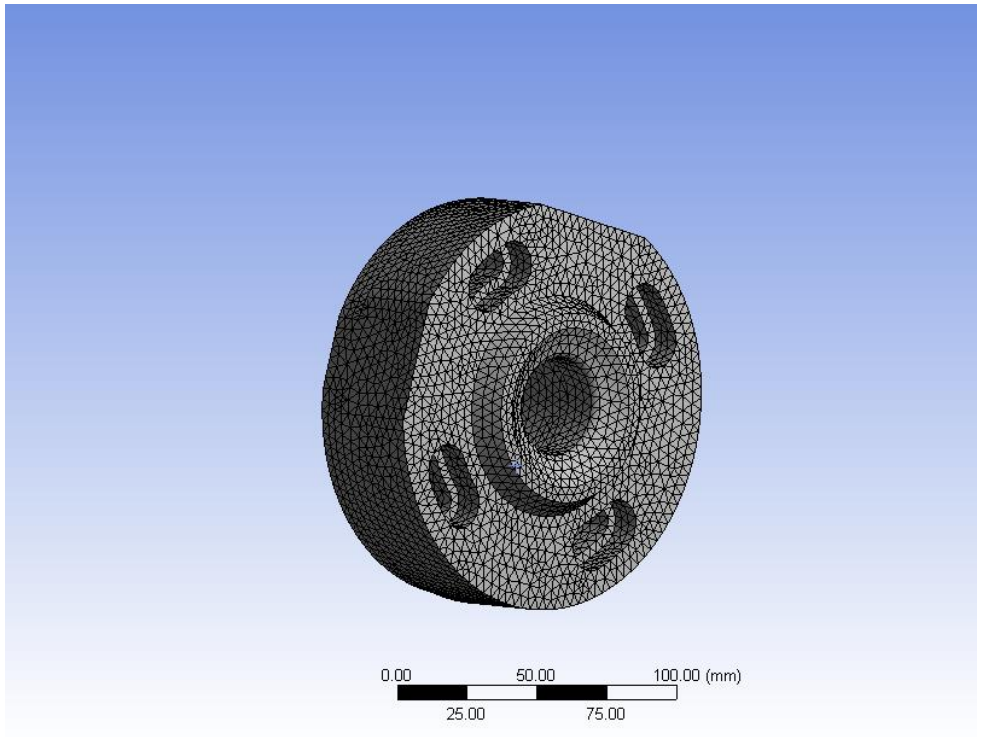
Ansys model

mesh –Thermal study and static study-



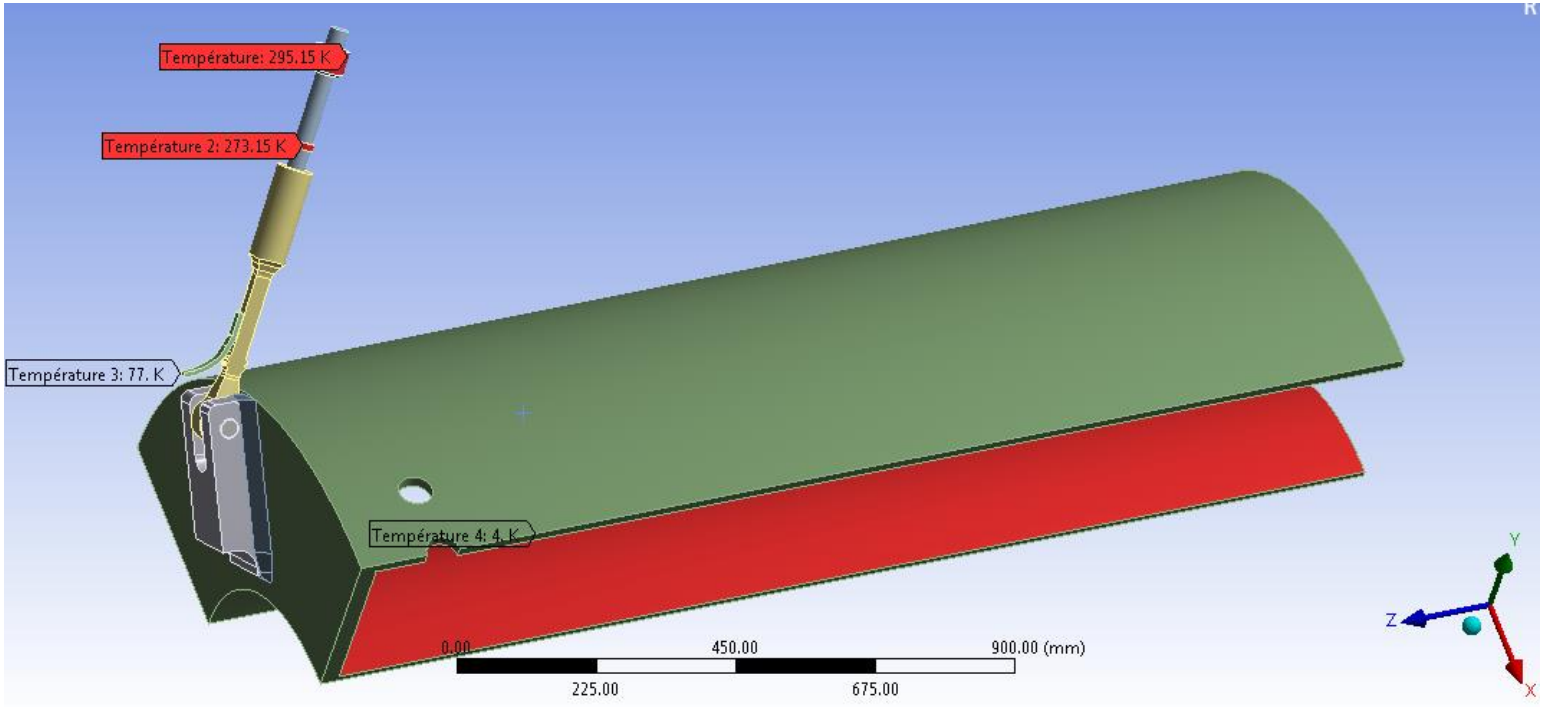
Ansys model

mesh –static study- 304L support



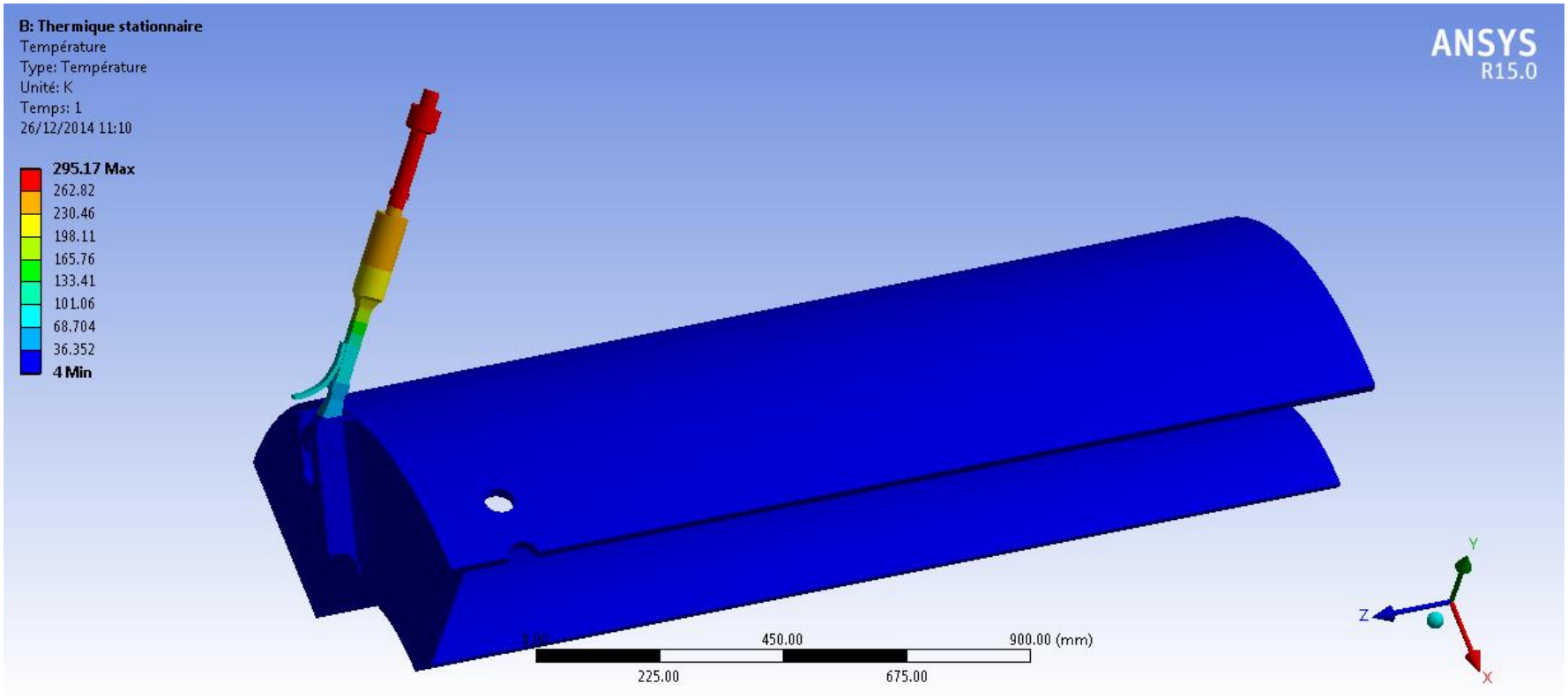
Ansys model

Loading –Thermal study-



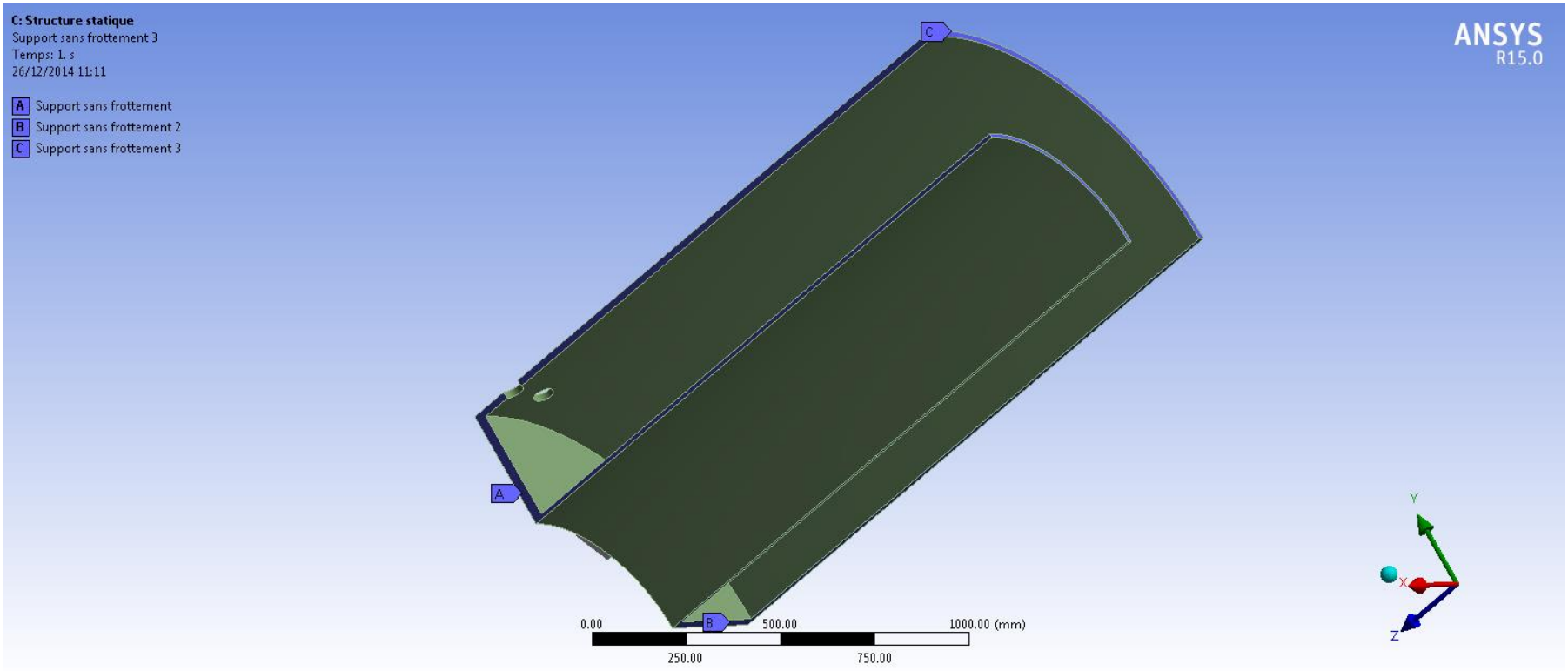
Ansys model

Temperature – Thermal study-



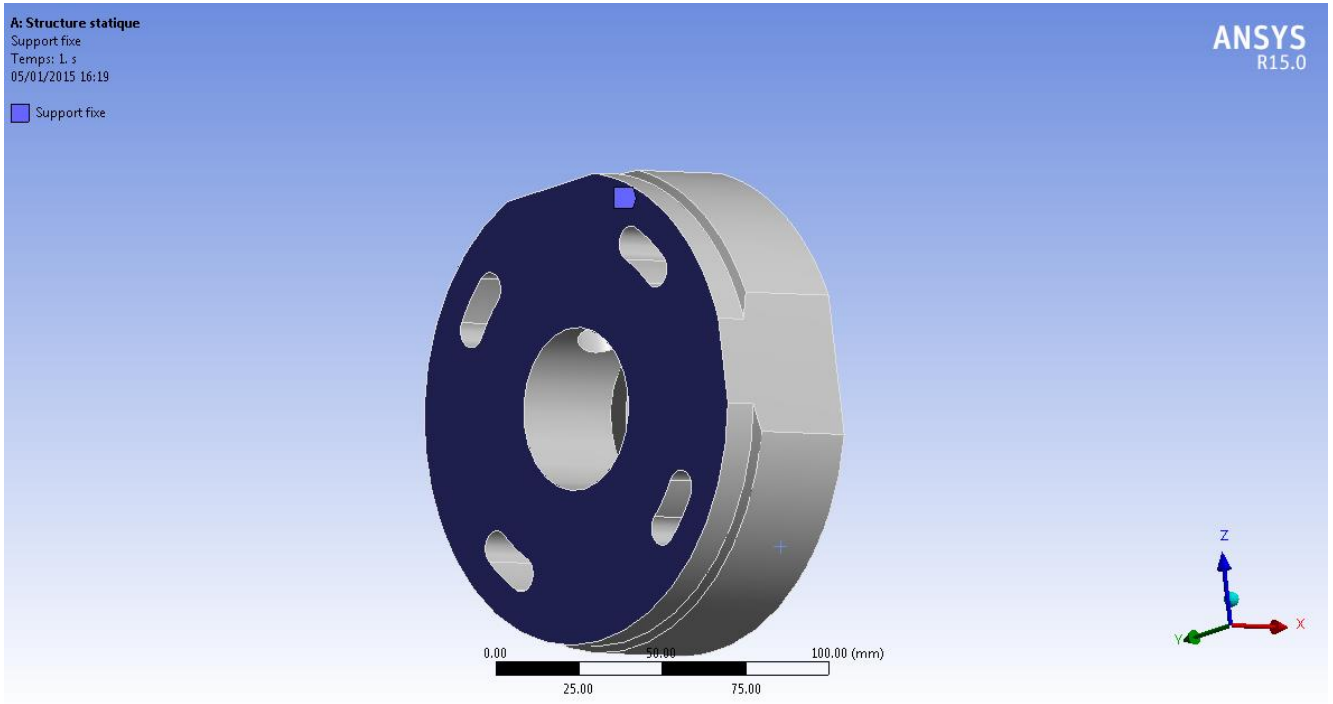
Ansys model

Boundary condition – Static study-



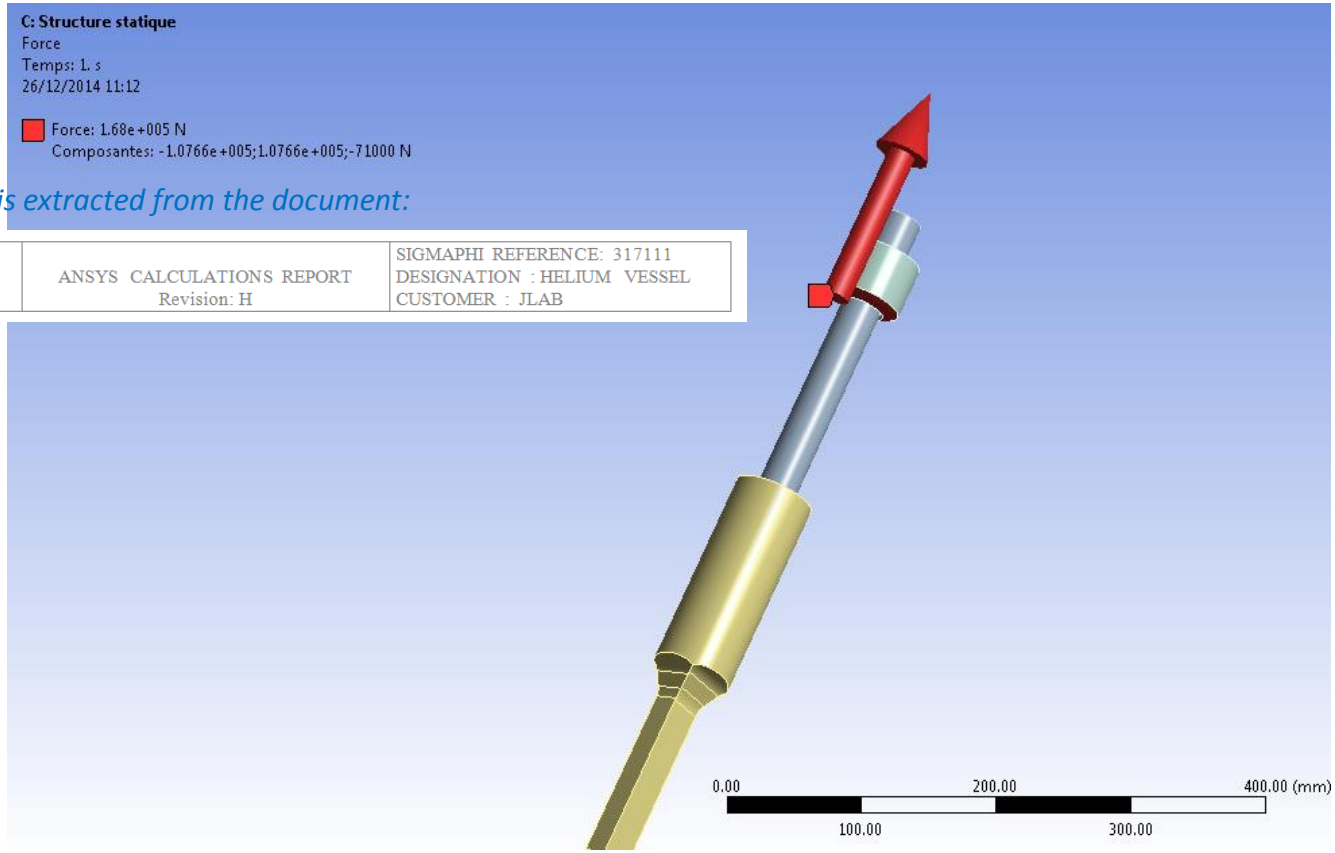
Ansys model

Boundary condition – Static study-304L support



Ansys model

Loading – Static study-

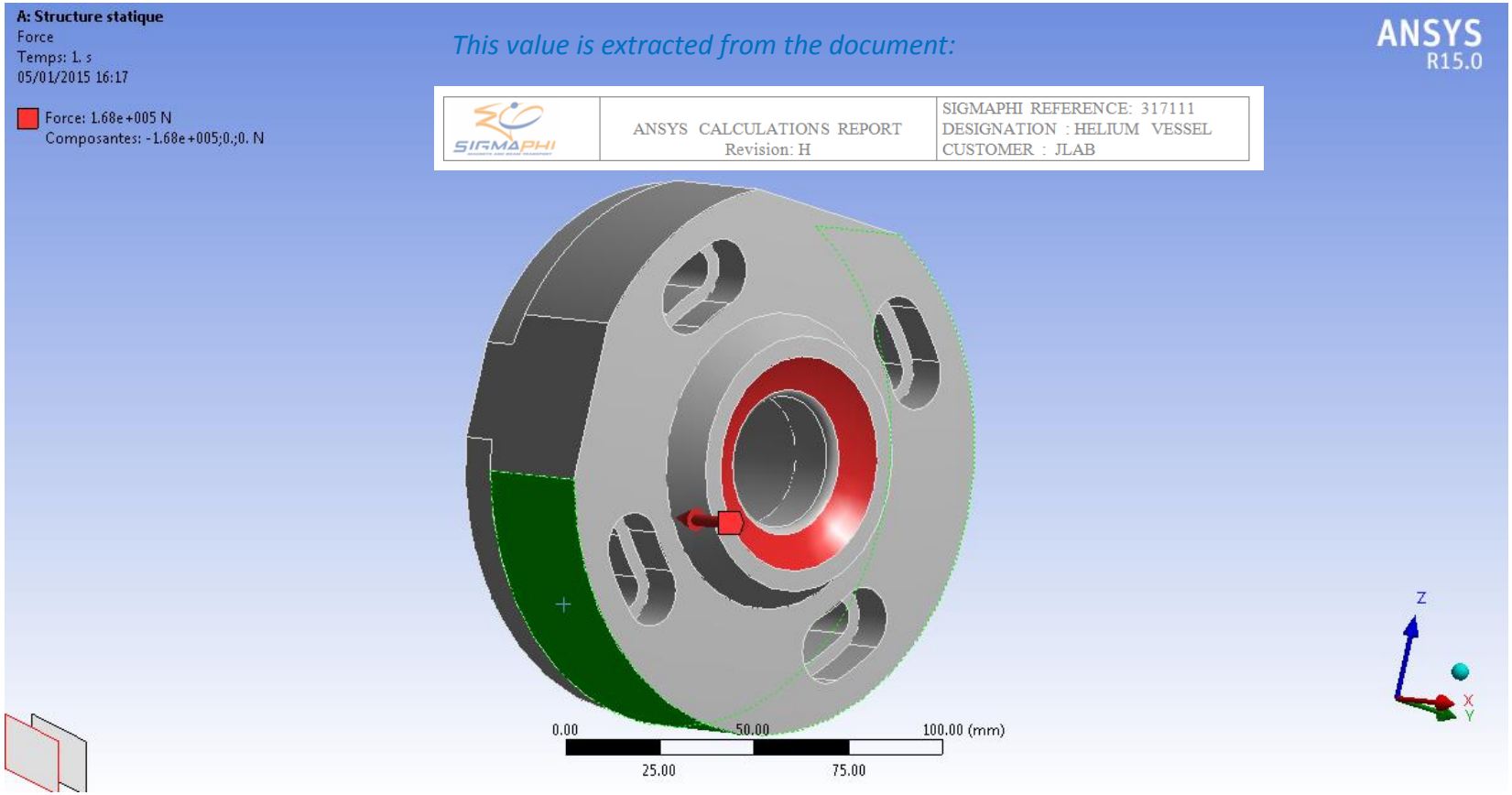


This value is extracted from the document:

SIGMAPHI	ANSYS CALCULATIONS REPORT Revision: H	SIGMAPHI REFERENCE: 317111 DESIGNATION : HELIUM VESSEL CUSTOMER : JLAB

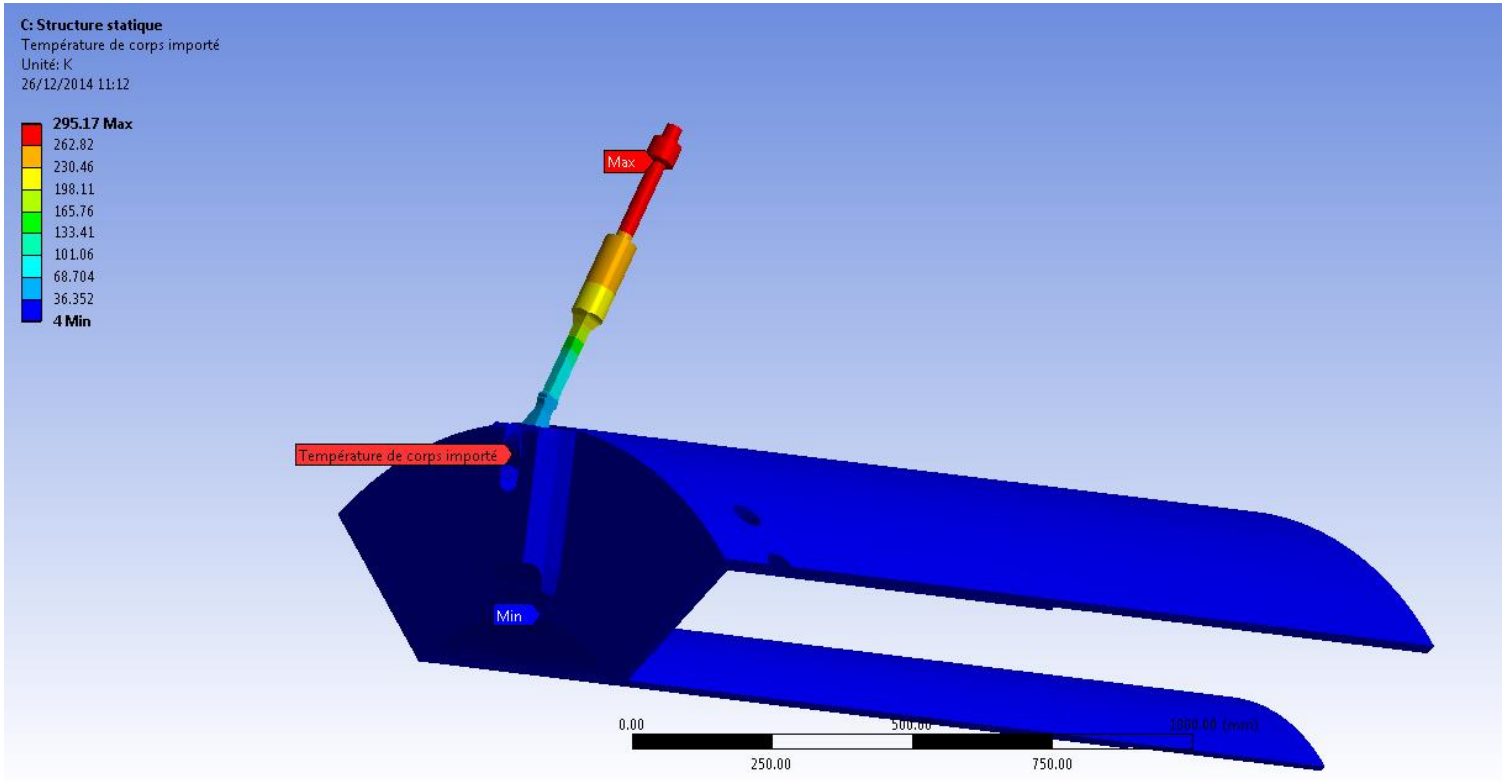
Ansys model

Loading –Static study- 304L Support



Ansys model

Loading –Static study-



Import from the thermal study

Ansys model

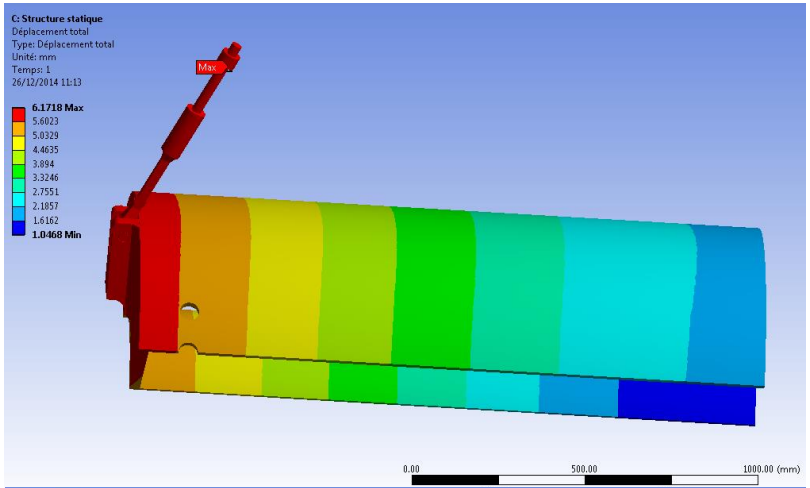
summary

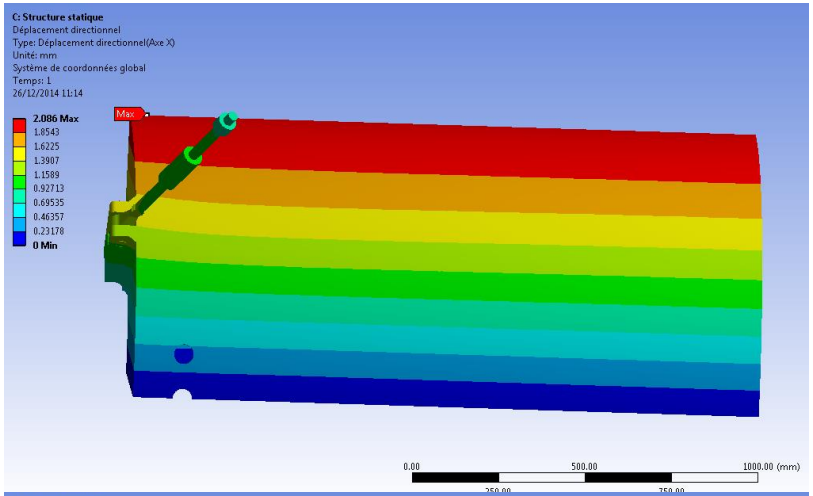
Part	Von Mises	Criteria 2/3 Rp0.2%
Nitronic 50 part	**316.5** MPa	345 MPa
Titanium Ti-6AL-4V Part	**439** MPa	448 MPa
Nitronic 50 axis	**356** MPa < Rp0.2% = 517 MPa **308.1** MPa after linearization	345 MPa
304 L Ball joint	**168** MPa < Rp0.2% = 172 MPa **84** MPa after linearization	115 MPa

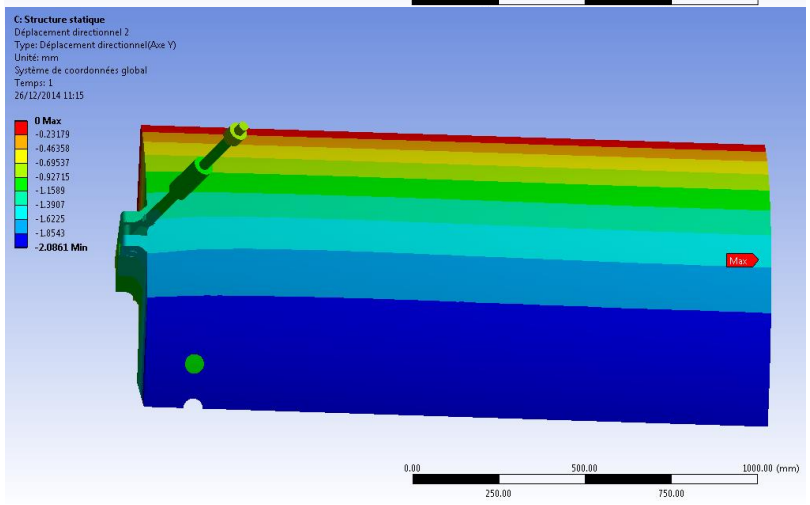
The Yield Strength of these three materials comes from ASME II Part D version 2010.

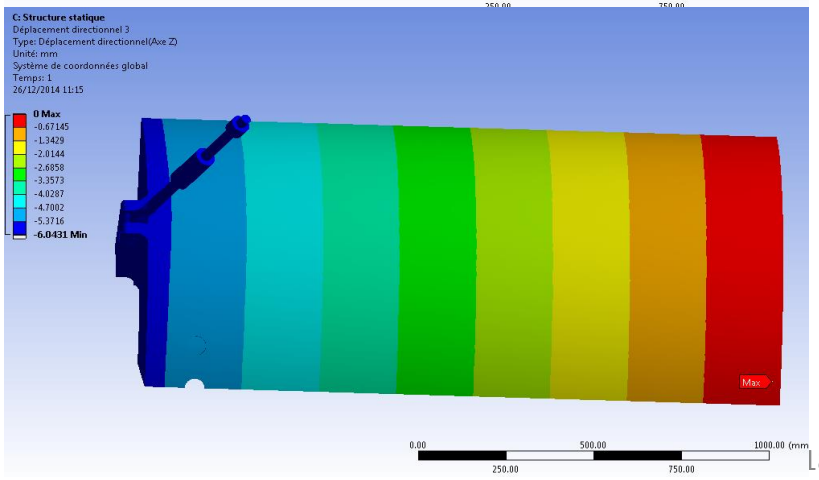
Ansys model

Displacement –static study-



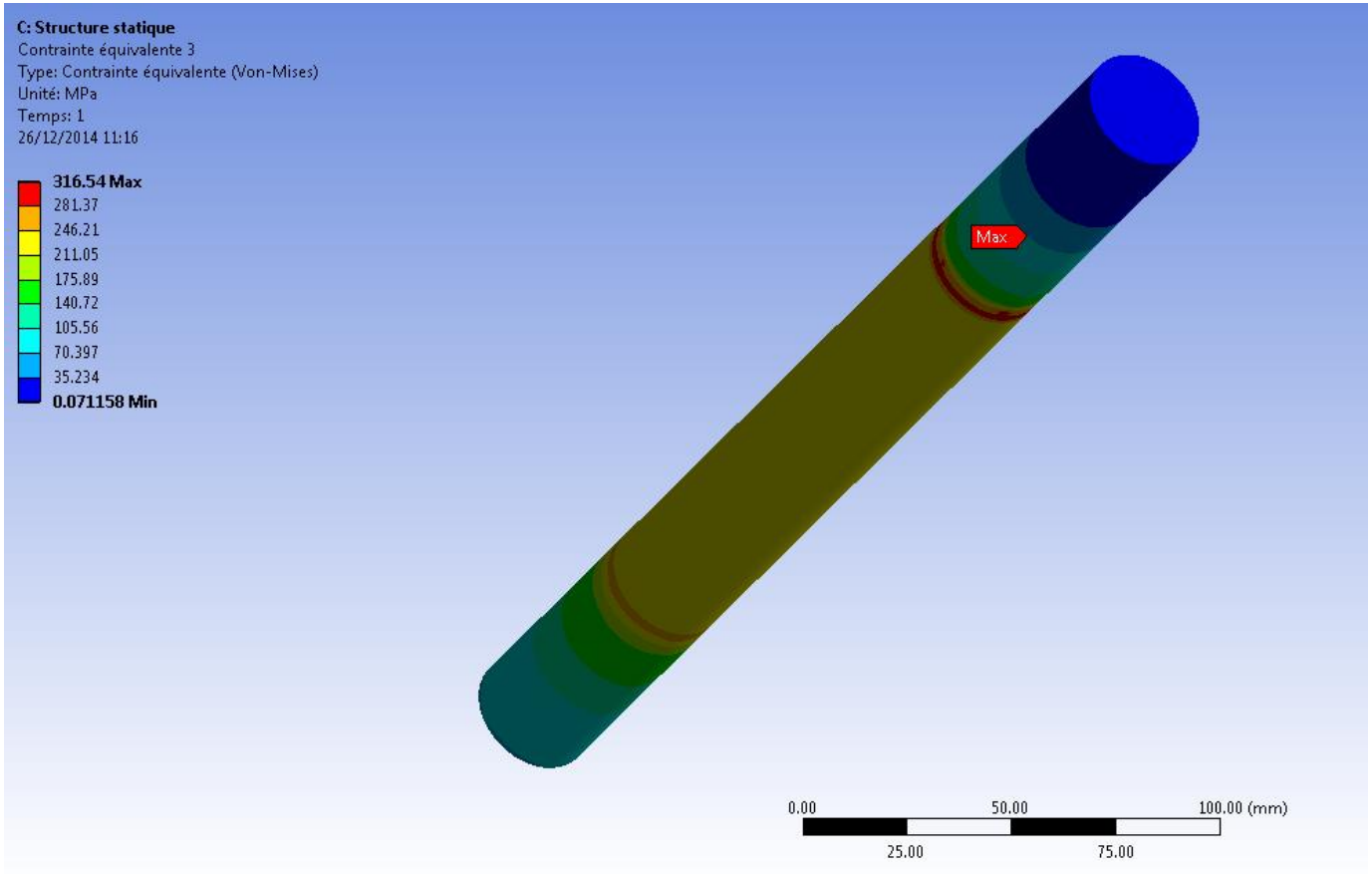






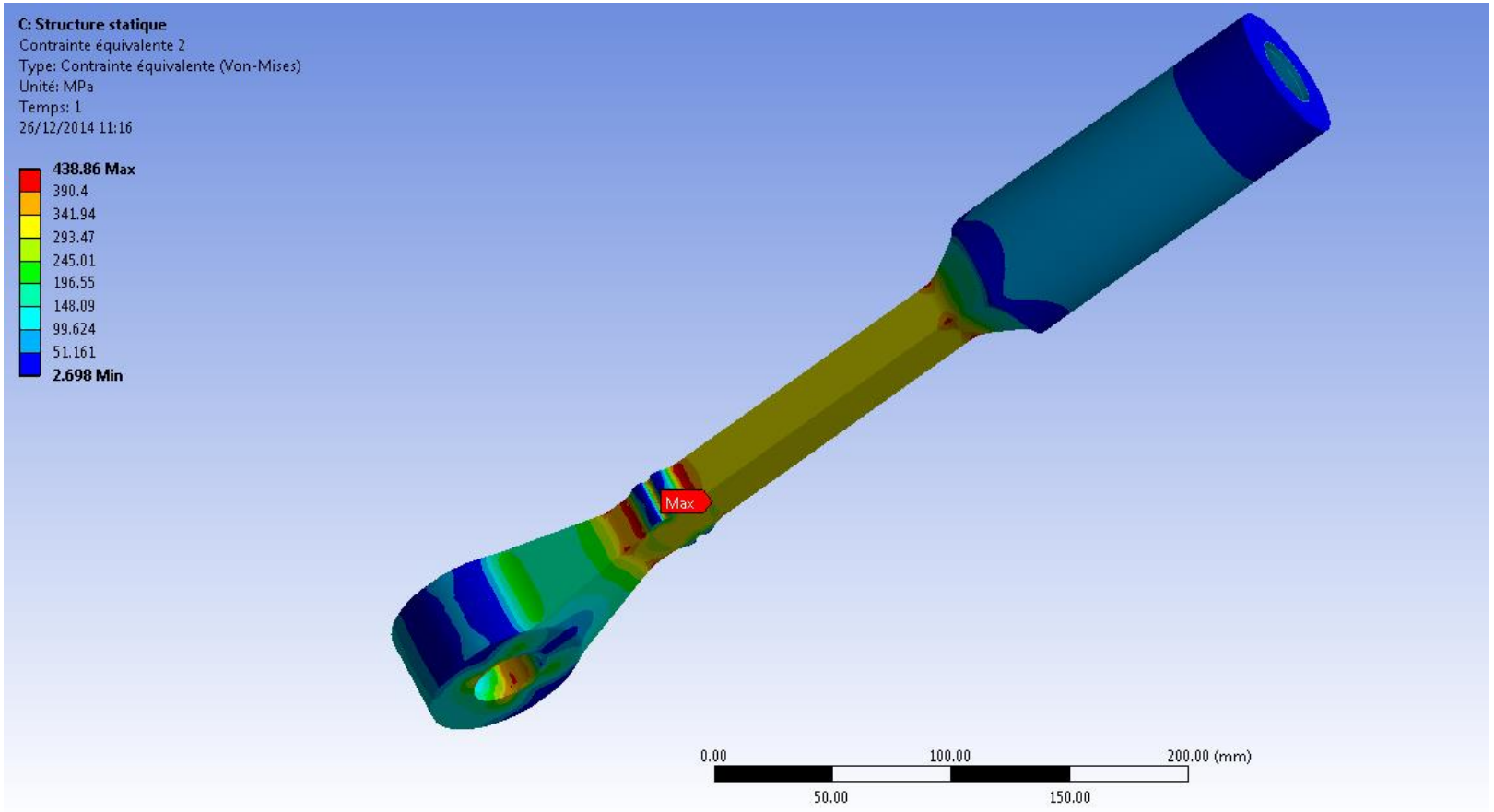
Ansys model

Nitronic 50 Part -Von mises stress –Static study-



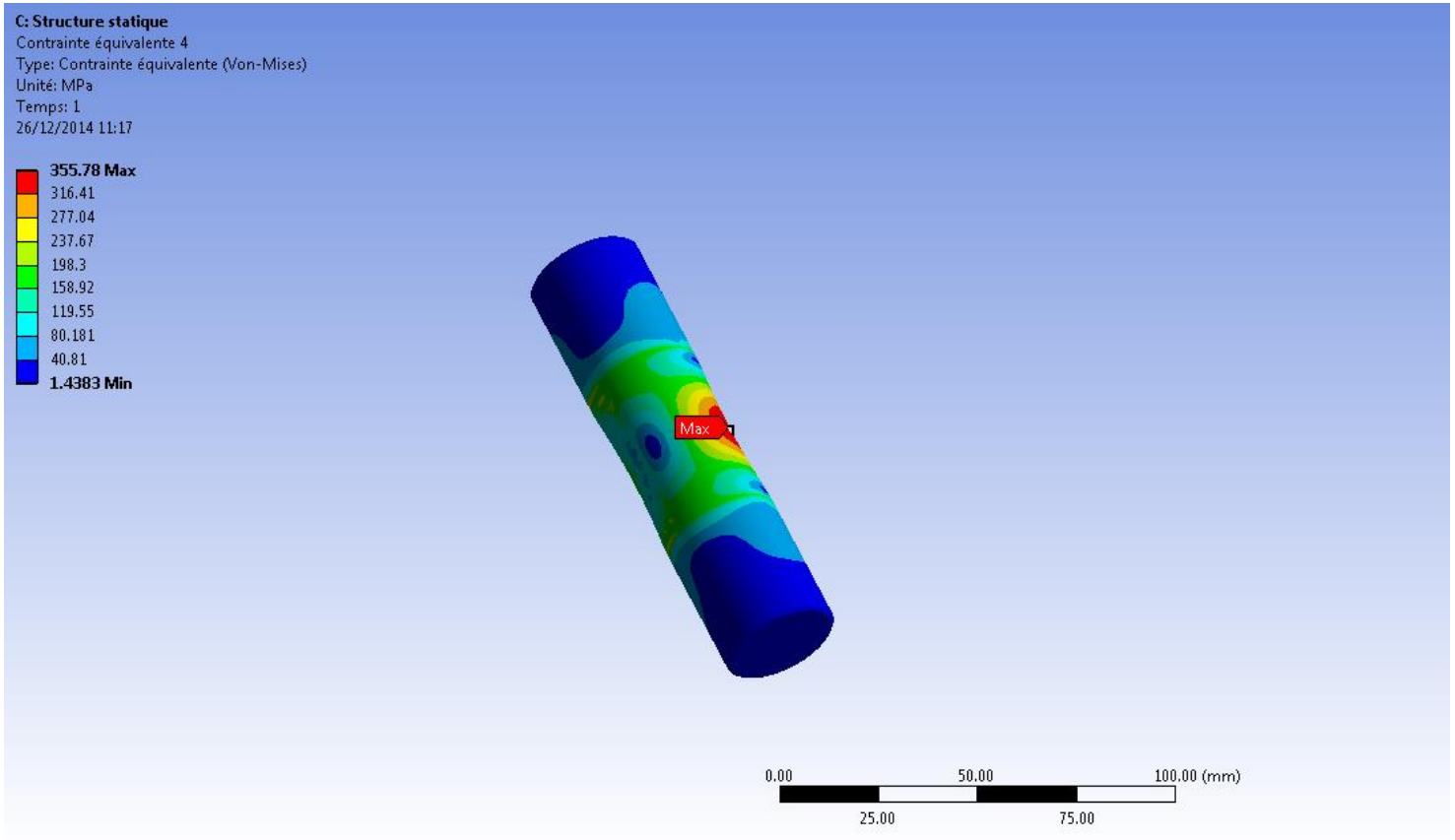
Ansys model

Titanium Part Ti- 6Al- 4v -Von mises stress –Static study-



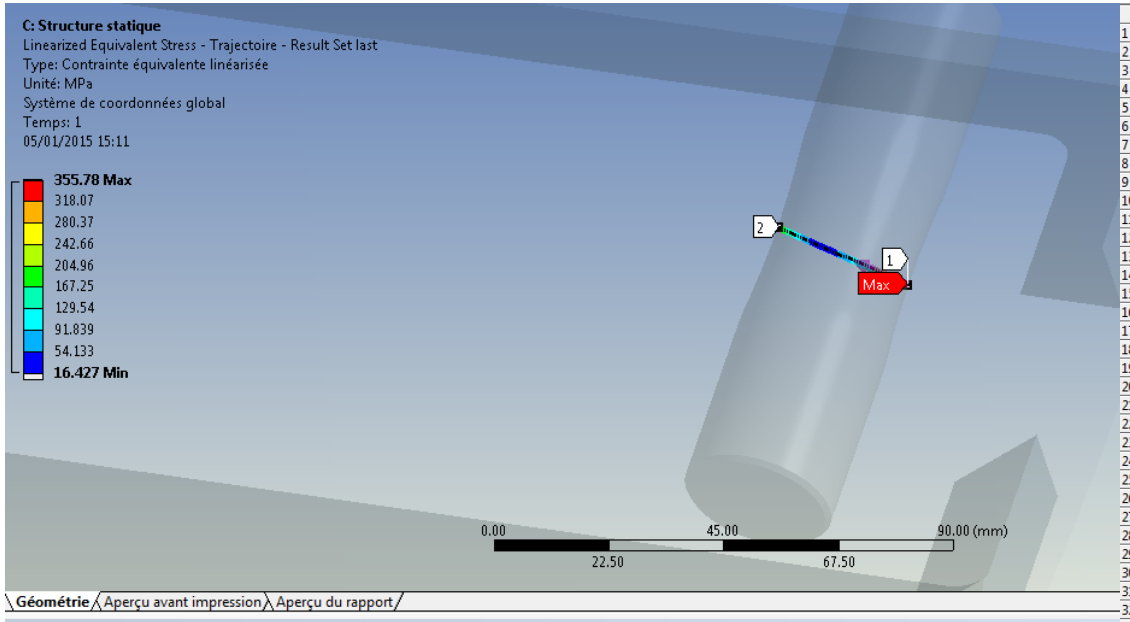
Ansys model

Nitronic 50 Axis -Von mises stress –Static study-

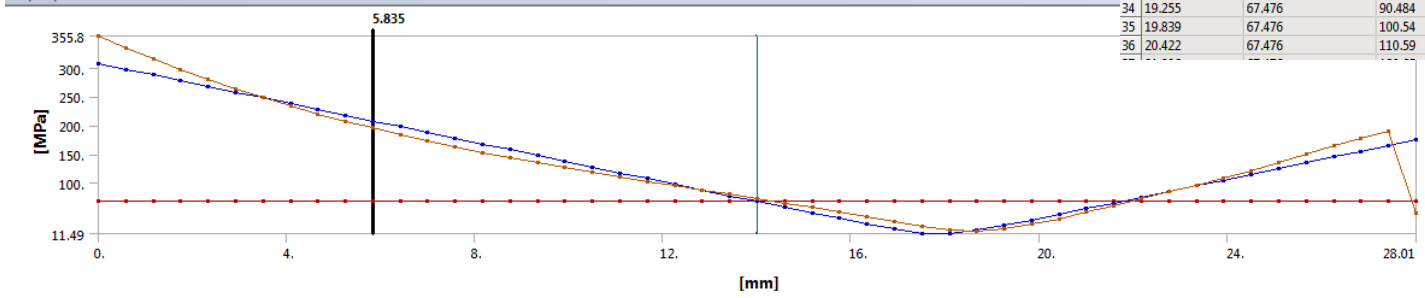


Ansys model

Nitronic 50 Axis –Linearized equivalent stress –Static study-

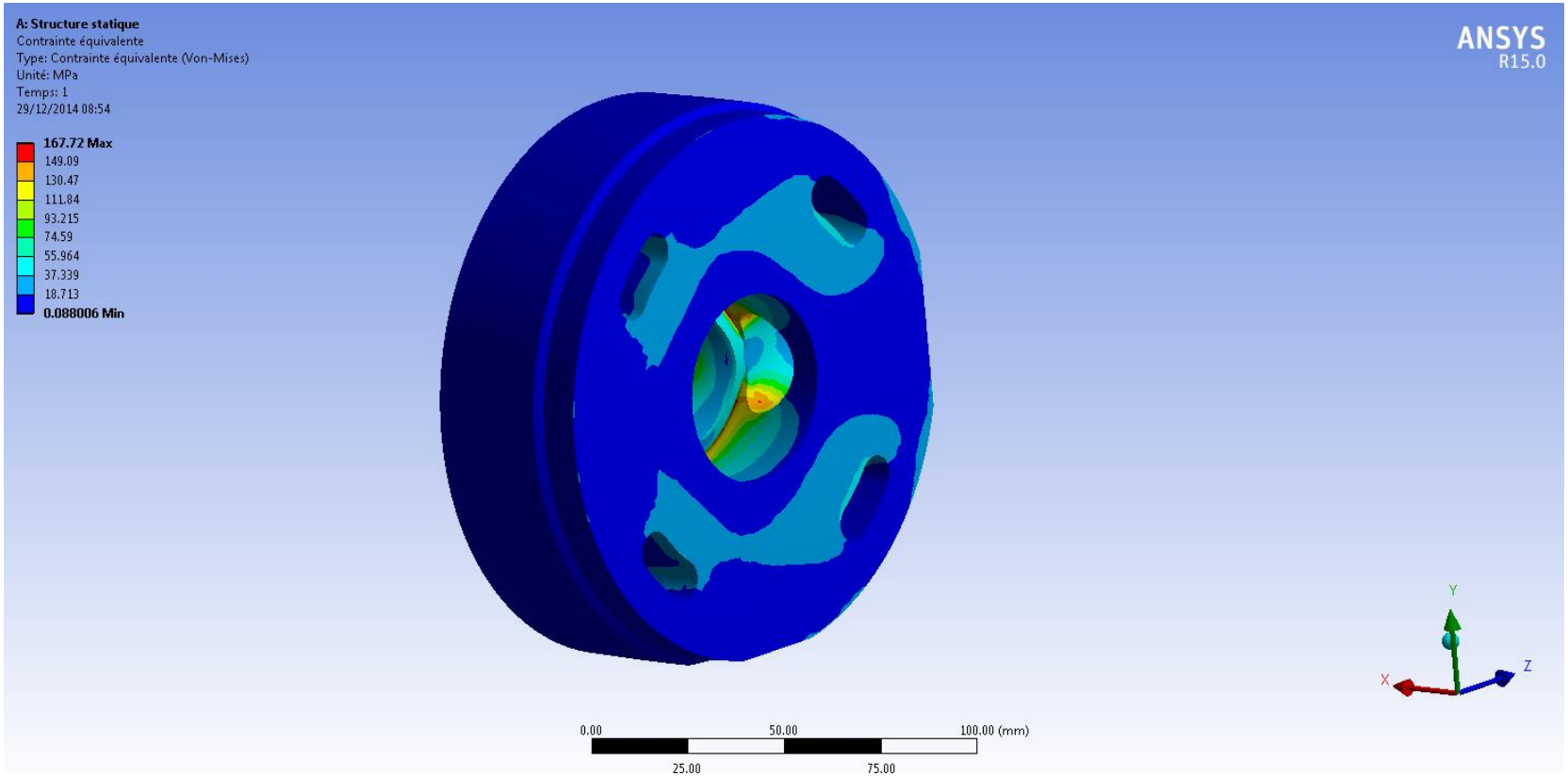


	Longueur [mm]	Membrane [MPa]	Flexion [MPa]	Membrane+Flexion [MPa]	Pointe [MPa]	Total [MPa]
1	0.	67.476	241.29	308.08	58.027	355.78
2	0.58349	67.476	231.24	298.03	48.374	335.78
3	1.167	67.476	221.18	287.99	39.04	315.79
4	1.7505	67.476	211.13	277.94	31.164	297.2
5	2.334	67.476	201.08	267.89	24.786	280.46
6	2.9175	67.476	191.02	257.85	19.093	263.9
7	3.501	67.476	180.97	247.8	14.695	248.45
8	4.0844	67.476	170.91	237.76	11.844	233.6
9	4.6679	67.476	160.86	227.72	11.066	219.54
10	5.2514	67.476	150.81	217.67	11.075	207.42
11	5.8349	67.476	140.75	207.63	12.35	195.32
12	6.4184	67.476	130.7	197.6	14.332	183.55
13	7.0019	67.476	120.65	187.56	16.307	172.57
14	7.5854	67.476	110.59	177.52	17.784	162.54
15	8.1689	67.476	100.54	167.49	19.228	152.9
16	8.7524	67.476	90.484	157.46	20.581	143.77
17	9.3359	67.476	80.43	147.43	22.187	134.75
18	9.9194	67.476	70.376	137.4	23.452	126.16
19	10.503	67.476	60.323	127.38	24.296	118.08
20	11.086	67.476	50.269	117.37	25.097	110.31
21	11.67	67.476	40.215	107.36	25.418	102.67
22	12.253	67.476	30.161	97.366	25.808	95.172
23	12.837	67.476	20.108	87.382	25.784	87.747
24	13.42	67.476	10.054	77.416	25.021	80.067
25	14.004	67.476	2.3912e-013	67.476	23.96	72.326
26	14.587	67.476	10.054	57.576	23.105	64.799
27	15.171	67.476	20.108	47.74	22.29	57.373
28	15.754	67.476	30.161	38.019	20.116	49.09
29	16.338	67.476	40.215	28.528	17.782	40.92
30	16.921	67.476	50.269	19.607	15.631	33.127
31	17.505	67.476	60.323	12.537	12.5	24.815
32	18.088	67.476	70.376	11.493	9.5809	18.22
33	18.672	67.476	80.43	17.583	7.777	16.427
34	19.255	67.476	90.484	26.237	7.2186	20.498
35	19.839	67.476	100.54	35.633	8.3277	28.345
36	20.422	67.476	110.59	45.313	10.769	37.706



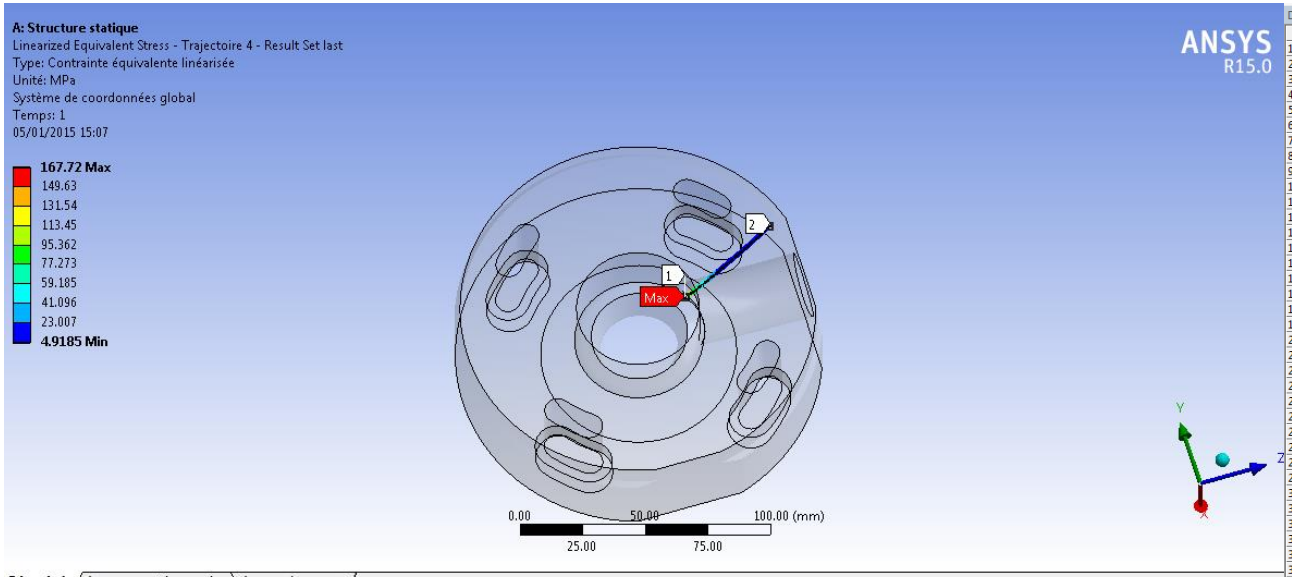
Ansys model

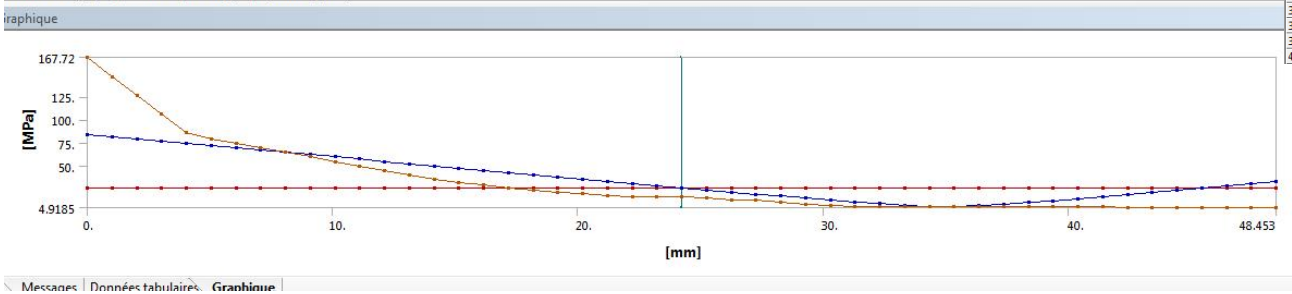
Support 304L-Von mises stress –Static study-



Ansys model

Support 304L-Von mises stress –Static study-





Données tabulaires

	Longueur [mm]	Membrane [MPa]	Flexion [MPa]	Membrane+Flexion [MPa]	Pointe [MPa]	Total [MPa]
1	0.	26.531	57.841	83.822	86.554	167.72
2	1.0094	26.531	55.431	[illegible]	68.143	147.05
3	2.0189	26.531	53.021	79.017	49.977	126.5
4	3.0283	26.531	50.611	76.616	32.474	106.15
5	4.0378	26.531	48.2	74.215	17.717	86.145
6	5.0472	26.531	45.79	71.814	11.863	79.761
7	6.0566	26.531	43.38	69.414	8.3315	74.639
8	7.0661	26.531	40.97	67.015	6.0382	69.931
9	8.0755	26.531	38.56	64.617	6.1008	65.327
10	9.085	26.531	36.15	62.219	7.0467	60.23
11	10.094	26.531	33.74	59.823	9.1896	54.682
12	11.104	26.531	31.33	57.427	11.845	49.459
13	12.113	26.531	28.92	55.033	14.372	44.765
14	13.123	26.531	26.51	52.641	16.77	40.298
15	14.132	26.531	24.1	50.25	18.918	36.043
16	15.142	26.531	21.69	47.861	20.352	32.529
17	16.151	26.531	19.28	45.474	21.567	29.24
18	17.16	26.531	16.87	43.09	22.836	25.992
19	18.17	26.531	14.46	40.709	23.541	23.452
20	19.179	26.531	12.05	38.331	23.755	21.673
21	20.189	26.531	9.6401	35.958	23.928	20.042
22	21.198	26.531	7.2301	33.59	23.869	18.319
23	22.208	26.531	4.82	31.228	22.991	17.096
24	23.217	26.531	2.41	28.875	22.278	16.557
25	24.227	26.531	1.6131e-015	26.531	21.862	16.793
26	25.236	26.531	2.41	24.201	20.432	15.613
27	26.245	26.531	4.82	21.888	18.617	13.747
28	27.255	26.531	7.2301	19.598	17.154	12.629
29	28.264	26.531	9.6401	17.342	15.652	10.864
30	29.274	26.531	12.05	15.132	13.843	8.7133
31	30.283	26.531	14.46	12.994	12.388	6.9304
32	31.293	26.531	16.87	10.969	10.827	6.078
33	32.302	26.531	19.28	9.1325	9.2234	5.6033
34	33.311	26.531	21.69	7.6231	7.7661	5.598
35	34.321	26.531	24.1	6.6662	6.7055	5.883
36	35.33	26.531	26.51	6.5101	5.3715	5.716
37	36.34	26.531	28.92	7.2069	4.9081	5.5828
38	37.349	26.531	31.33	8.5508	5.5725	5.5967
39	38.359	26.531	33.74	10.291	7.0326	5.8811
40	39.368	26.531	36.15	12.26	8.7353	5.8561