



WWW.TITANE-SERVICES.EU

## Caractéristiques physiques et mécaniques du Titane et de ses alliages

	Titane commercial pur		Alliage Alpha & Béta de titane	
GRADE	Grade 2	Grade 5	Grade 5 Eli	Grade 9
Rupture mécanique (MPa)	345	900	900	620
Limite d'élasticité 0,2 (MPa)	275	830	830	520
Allongement %	20	10	10	15
Résilience (J)	40-80	15-20	24	54
Dureté	160 HB/30	36 HRC	35 HRC	20 HRC
Densité Kg/dm <sup>3</sup>	4,51	4,4	4,4	4,48
Module d'élasticité normal (Gpa)	103	110	110	103
Module d'élasticité tangentiel (Gpa)	40	40	40	40

Shear load: 602 N (p=0.26 MPa) -> Min preload: 2006 with Static friction coefficient: 0.3

Shear load: 602 N (p=0.26 MPa) -> Min preload: 6020 with Static friction coefficient: 0.1

M5	Ti grade 2	Ti grade 5
	Rp0.2=275 MPa	Rp0.2=830 MPa
v [-]	F [N]	F [N]
0.3	906	2735
0.5	1510	4559
0.8	2417	7294

M6	Ti grade 2	Ti grade 5
	Rp0.2=275 MPa	Rp0.2=830 MPa
v [-]	F [N]	F [N]
0.3	1460	4400
0.5	2430	7344
0.8	3893	11750

M8	Ti grade 2	Ti grade 5
	Rp0.2=275 MPa	Rp0.2=830 MPa
v [-]	F [N]	F [N]
0.3	2693	8130
0.5	4490	13550
0.8	7180	21680

## AXIAL + BENDING + SHEAR

Pressure: 2.6 bara (0.26 MPa) / Vessel weight / Static friction coefficient: 0.3

Shear load: 602 N

Bending moment (16.5 mm) = 4964 Nmm / Bending moment (11.2 mm) = 3369 Nmm

			Ti grade 2		Ti grade 5	
			Eq. str. [MPa]	SF [-]	Eq. str. [MPa]	SF [-]
M5	L=16.5 mm	v= 0.8	865	0.32	1307	0.63
		v=0.5	782	0.35	1059	0.78
		v=0.3	599	0.38	893	0.93
	L=11.2 mm	v= 0.8	673	0.41	115	0.74
		v=0.5	591	0.47	867	0.96
		v=0.3	537	0.51	702	1.18
M6	L=16.5 mm	v= 0.8	723	0.38	1166	0.71
		v=0.5	641	0.43	918	0.90
		v=0.3	587	0.47	752	1.10
	L=11.2 mm	v= 0.8	575	0.48	1017	0.82
		v=0.5	493	0.56	769	1.08
		v=0.3	439	0.63	604	1.38
M8	L=16.5 mm	v= 0.8	428	0.64	871	0.95
		v=0.5	346	0.80	622	1.33
		v=0.3	291	0.95	457	1.82
	L=11.2 mm	v= 0.8	368	0.75	811	1.02
		v=0.5	286	0.96	562	1.48
		v=0.3	231	1.19	397	2.09

## ONLY SHEAR

Pressure: 2.6 bara (0.26 MPa) / Vessel weight / Static friction coefficient: 0.3

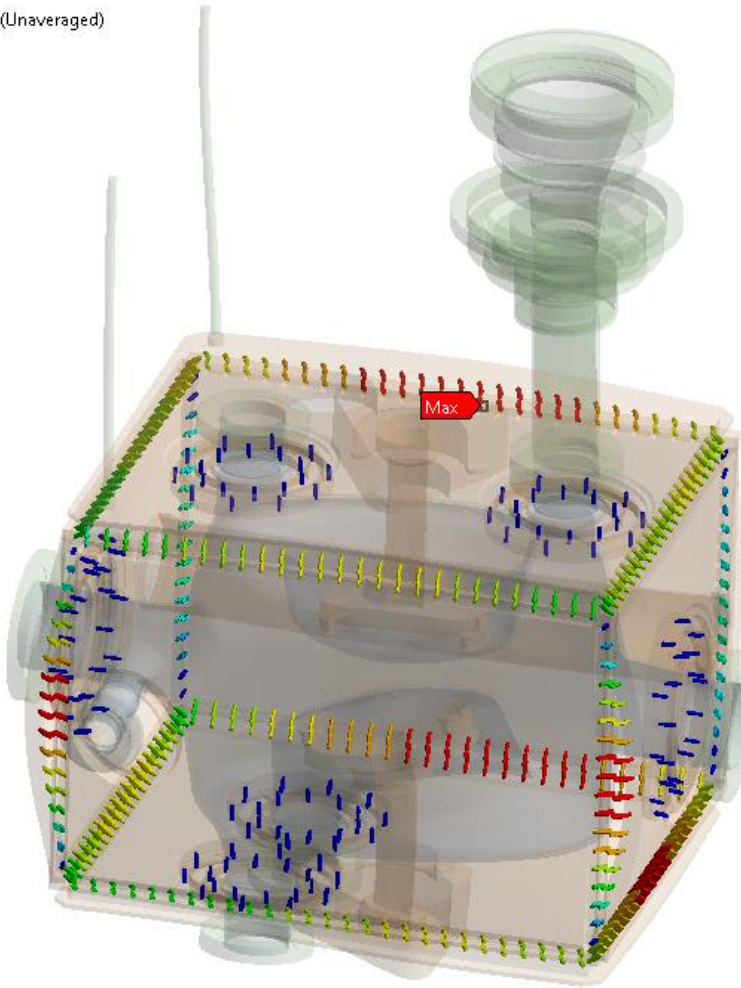
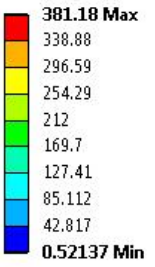
Shear load: 602 N

			Ti grade 2		Ti grade 5	
			Eq. str. [MPa]	SF [-]	Eq. str. [MPa]	SF [-]
M5	L=16.5 mm	v= 0.8	274	1.0	710	1.17
		v=0.5	196	1.4	464	1.79
		v=0.3	148	1.86	302	2.75
	L=11.2 mm	v= 0.8				
		v=0.5				
		v=0.3				
M6	L=16.5 mm	v= 0.8	264	1.04	702	1.18
		v=0.5	186	1.48	455	1.82
		v=0.3	136	2.02	292	2.84
	L=11.2 mm	v= 0.8				
		v=0.5				
		v=0.3				
M8	L=16.5 mm	v= 0.8	242	1.14	684	1.21
		v=0.5	161	1.71	436	1.91
		v=0.3	108	2.55	271	3.07
	L=11.2 mm	v= 0.8				
		v=0.5				
		v=0.3				

# FEA: Frictionless (coarse mesh)

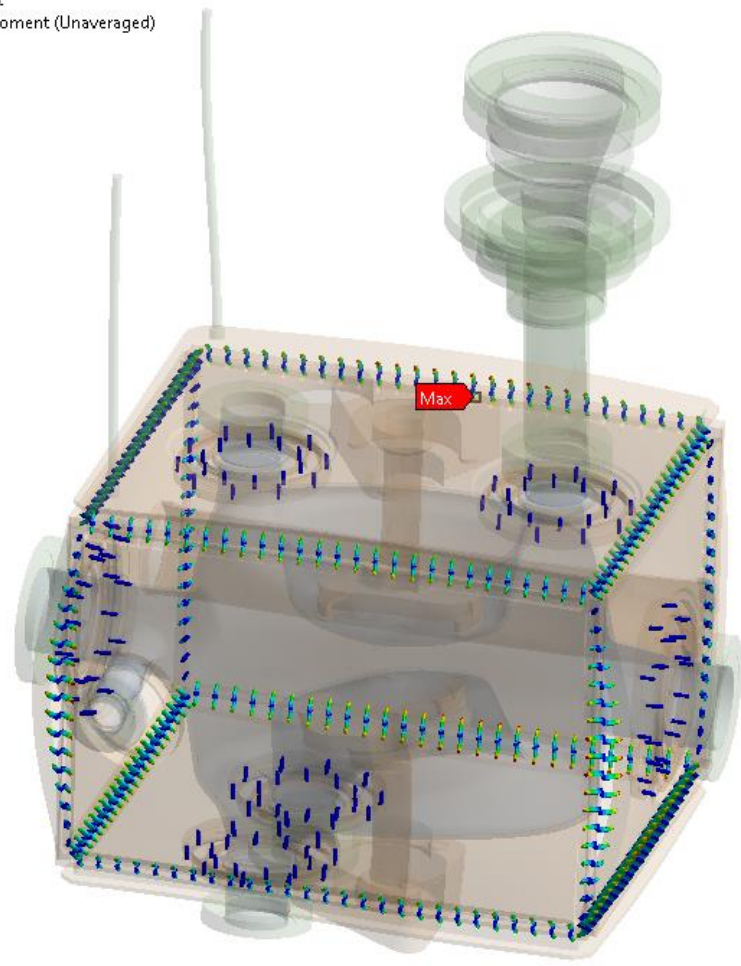
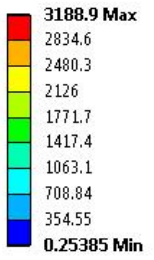
## Shear on bolts

A: Bolts M5  
Total Shear Force  
Type: Total Shear Force (Unaveraged)  
Unit: N  
Time: 2  
16/02/2015 09:17



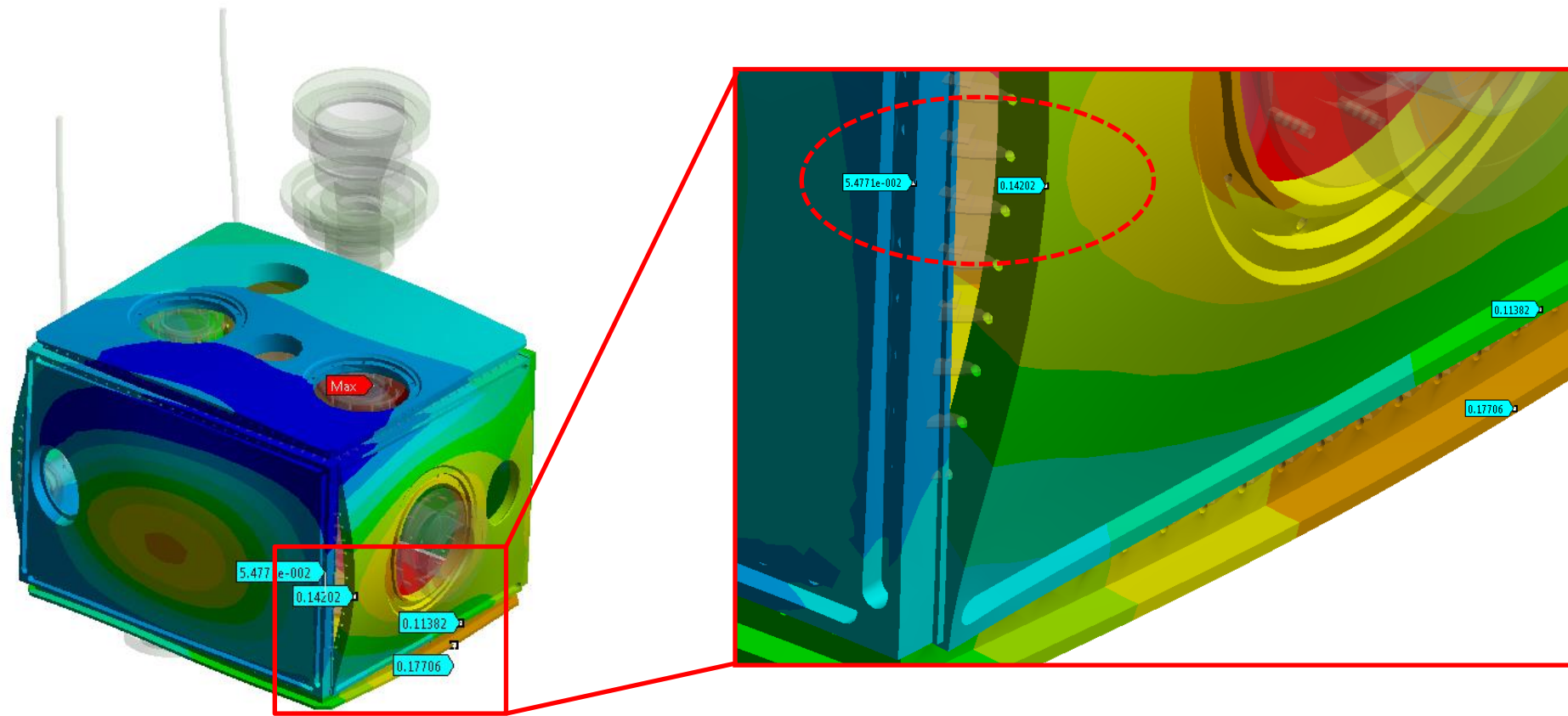
## Bending moment on bolts

A: Bolts M5  
Total Bending Moment  
Type: Total Bending Moment (Unaveraged)  
Unit: N-mm  
Time: 2  
16/02/2015 09:18



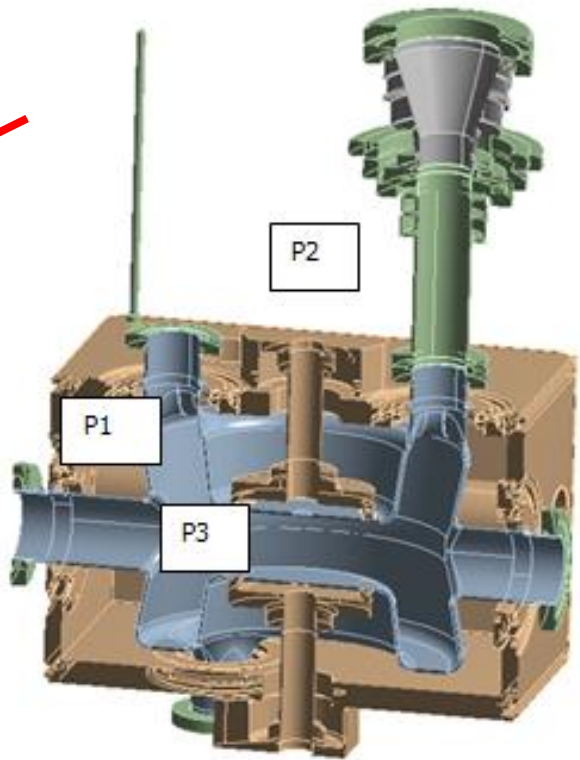
Warning: overloaded bolts beyond elastic limit!

WARNING:  $p=0.18$  MPa



Max def = around 0.1 mm

LC	Load cases	Pressure [MPa - absolute]	Temperature [K]	Failure mode	Classification (for selection of safety factors)
					ASME BPVC
LC1	Leak testing 1. ??????	P1	Vacuum 0	293	Occasional (SF=1.05)
		P2	Patm	293	
		P3	Patm	293	
LC2	Leak testing 2 (He into the He v)	P1	Patm (0.1)	293	Occasional (SF=1.05)
		P2	Vacuum (0)	293	
		P3	Vacuum (0)	293	
LC3	Design Conditions	P1	PS (=0.18)	293	Sustained (SF=1.5)
		P2	Vacuum (0)	293	
		P3	Vacuum (0)	293	
LC4	Warm pressure test (Test conditions)	P1	PI=0.26 (1.43 x PS)	293	Occasional (SF=1.05)
		P2	Vacuum (0)	293	
		P3	Vacuum (0)	293	
LC5	Purge	P1	Vacuum (0)	2	Occasional (SF=1.05)
		P2	Vacuum (0)	293	
		P3	Vacuum (0)	2	
LC6	Cold operation (max PS, max thermal) Nominal conditions 1	P1	Pop (20 x 10 <sup>-4</sup> )	2	Sustained (SF= 1.5)
		P2	Vacuum (0)	293	
		P3	Vacuum (0)	2	
LC7	Cold operation + tuner (max PS, max thermal, tuner at max ext) Nominal conditions 2	P1	Pop (20 x 10 <sup>-4</sup> )	2	Sustained (SF= 1.5)
		P2	Vacuum (0)	293	
		P3	Vacuum (0)	2	
LC8	Overpressure (Cavity quench...)	P1	1.1*PS	2	Occasional (SF=1.05)
		P2	Vacuum (0)	293	
		P3	Vacuum (0)	2	
LC9	Loss of insulation vacuum	P1	1.1*PS	2	Occasional (SF=1.05)
		P2	1	2	
		P3	Vacuum or Patm ?????	2	
LC10	Cold leak (ext)	P1	Pop (20 x 10 <sup>-4</sup> )	2	Occasional (SF=1.05)
		P2	Patm+ΔP	2	
		P3	0	2	



Fluid process volumes: P1  
 Vacuum insulating volume: P2  
 UHV volume (bare-cavities): P3

## Weld seam sizing (long edge)

Material	
E	110 [GPa] 1.1E+11 [N/m <sup>2</sup> ]
R <sub>p0.2</sub>	275 [MPa] 275000000 [N/m <sup>2</sup> ]
η	1.5 [-]
sigma_adm	183 [MPa] 183333333 [N/m <sup>2</sup> ]
Geometry	
t	1 [mm] 0.001 [m]
w	11 [mm] 0.011 [m]
l	531 [mm] 0.531 [m]
A	5841 [mm <sup>2</sup> ] 0.005841 [m <sup>2</sup> ]
Load	
p	2.6 [bar] 0.26 [MPa] 260000 [N/m <sup>2</sup> ]
F	1519 [N]

Evaluation 1	
F <sub>w</sub>	759.33 [N]
F <sub>w_a</sub>	537 [N]
F <sub>w_s</sub>	537 [N]
A <sub>w_v</sub>	531 [mm <sup>2</sup> ] 0.000531 [m <sup>2</sup> ]
A <sub>w_s</sub>	375 [mm <sup>2</sup> ] 6.425E-05 [m <sup>2</sup> ]
σ <sub>ax</sub>	1.4 [MPa]
τ <sub>shear</sub>	1.4 [MPa]
σ <sub>eq</sub>	3.2 [MPa]
Evaluation 2 (partial)	
τ <sub>pure_shear</sub>	2.9 [MPa] 2860000 [N/m <sup>2</sup> ]
Evaluation 3 (partial)	
M <sub>w</sub>	1.0 [Nm]
l	4.425E-11 [m <sup>4</sup> ]
σ <sub>Mw</sub>	11797500 [N/m <sup>2</sup> ] 11.8 [MPa]