

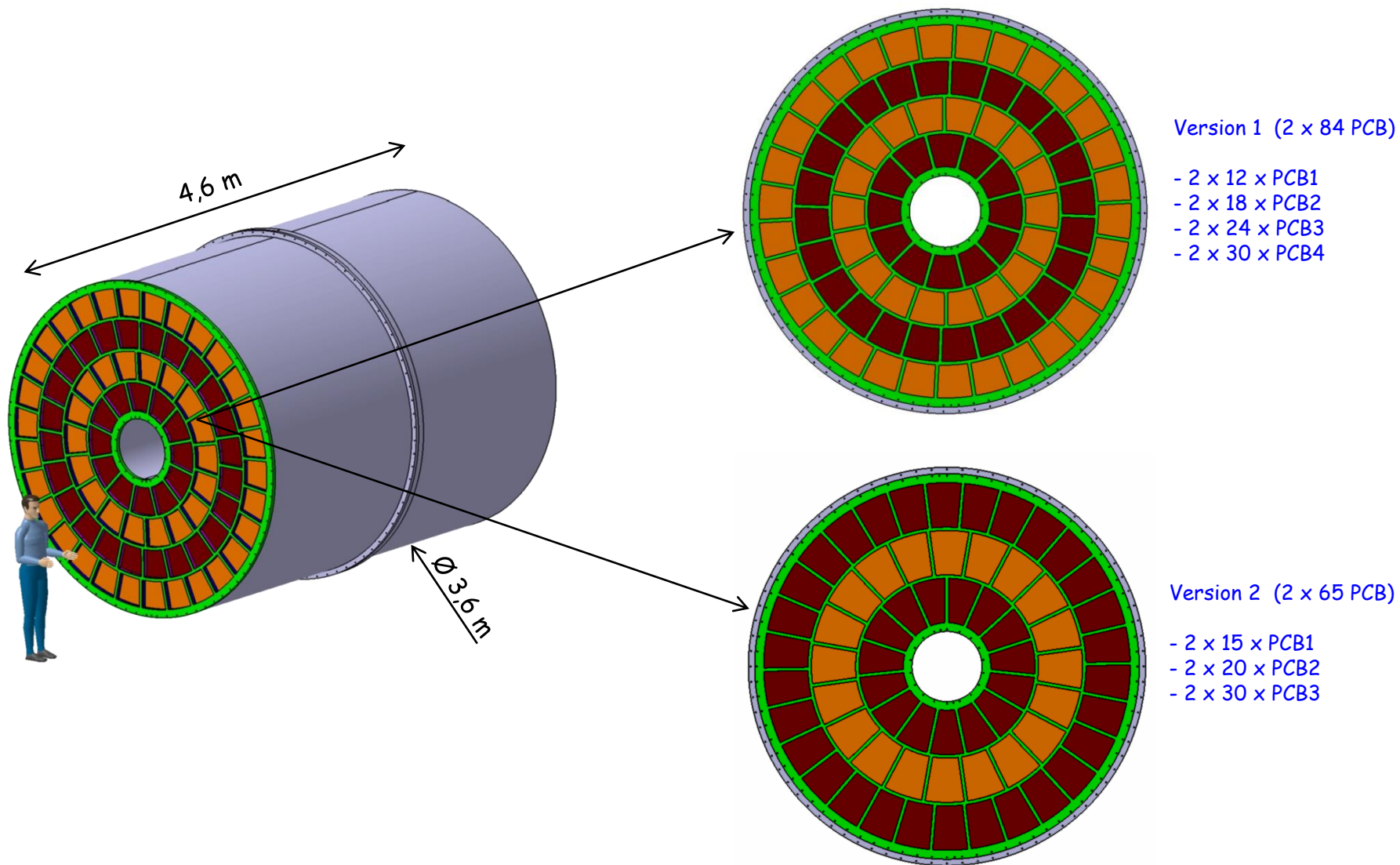
# Preliminary Mechanical Analysis of the ILC TPC

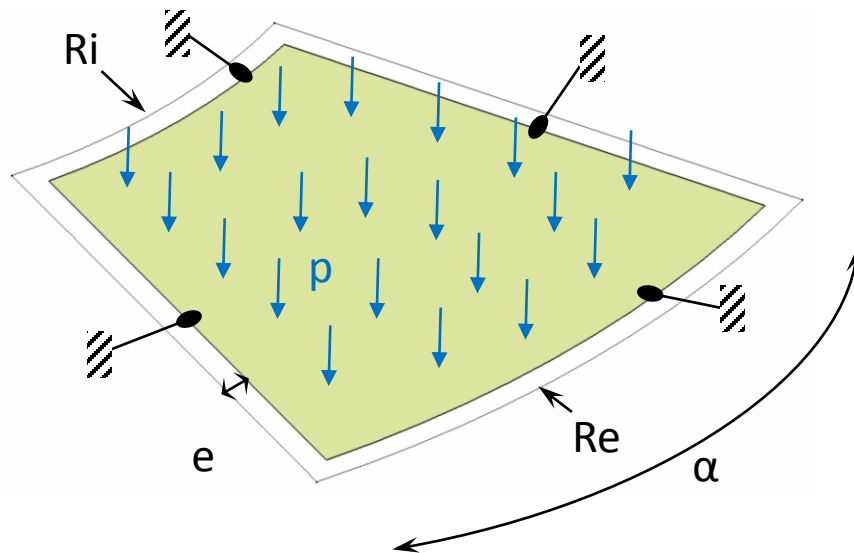


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DESY - September 22, 2009

- Structure Configuration
- PCB Analysis
- TPC Analysis
- Perspectives



Loads :

$$\Delta P = 10 \text{ mbar}$$

Material :

G11 (TBC)

$$E = 24\,000 \text{ MPa}$$

$$\rho = 1\,850 \text{ kg/m}^3$$

$$\nu = 0.15$$

## Version 1 - 4 wheel

|      | Qt | Ri (mm) | Re (mm) | $\alpha$ (deg) | e (mm) | t (mm)<br>(Epaisseur) | p (mbar) |
|------|----|---------|---------|----------------|--------|-----------------------|----------|
| PCB1 | 12 | 395     | 730,5   | 30             | 15     | 3,20                  | 10       |
| PCB2 | 18 | 731,5   | 1066,5  | 20             | 15     | 3,20                  | 10       |
| PCB3 | 24 | 1067,5  | 1402,5  | 15             | 15     | 3,20                  | 10       |
| PCB4 | 30 | 1403,5  | 1739    | 12             | 15     | 3,20                  | 10       |

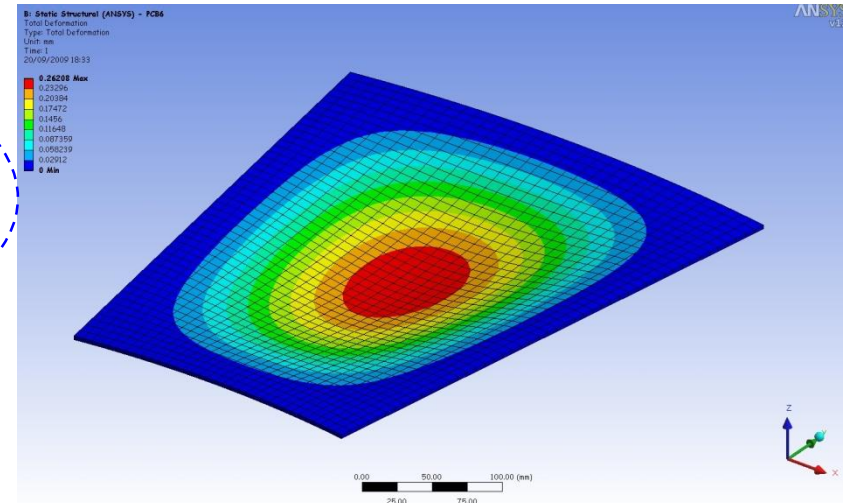
## Version 2 - 3 wheel

|      | Qt | Ri (mm) | Re (mm) | $\alpha$ (deg) | e (mm) | t (mm)<br>(Epaisseur) | p (mbar) |
|------|----|---------|---------|----------------|--------|-----------------------|----------|
| PCB5 | 15 | 395     | 842,5   | 24             | 15     | 3,20                  | 10       |
| PCB6 | 20 | 843,5   | 1290,5  | 18             | 15     | 3,20                  | 10       |
| PCB7 | 30 | 1291,5  | 1739    | 12             | 15     | 3,20                  | 10       |

Version 1 - 4 wheel

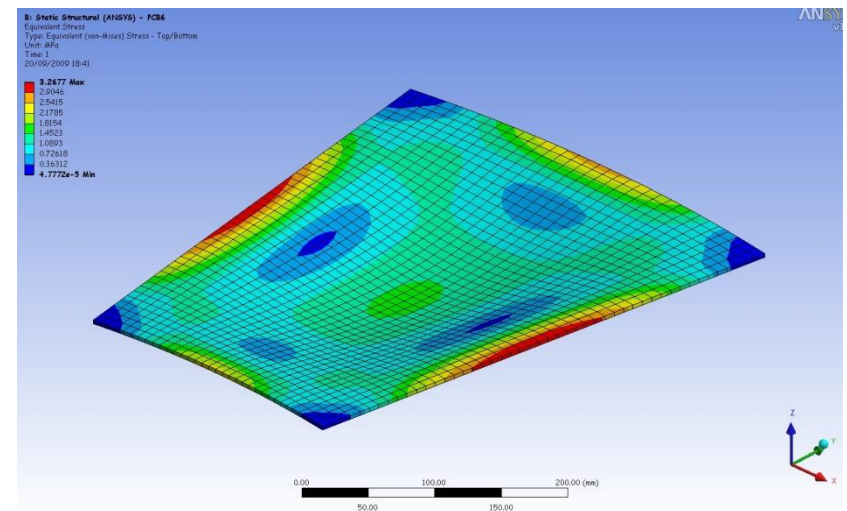
|                 | PCB1 | PCB2 | PCB3 | PCB4 |
|-----------------|------|------|------|------|
| Deflection (mm) | 0,12 | 0,14 | 0,15 | 0,16 |
| Sigma VM (Mpa)  | 2,09 | 2,24 | 2,29 | 2,34 |

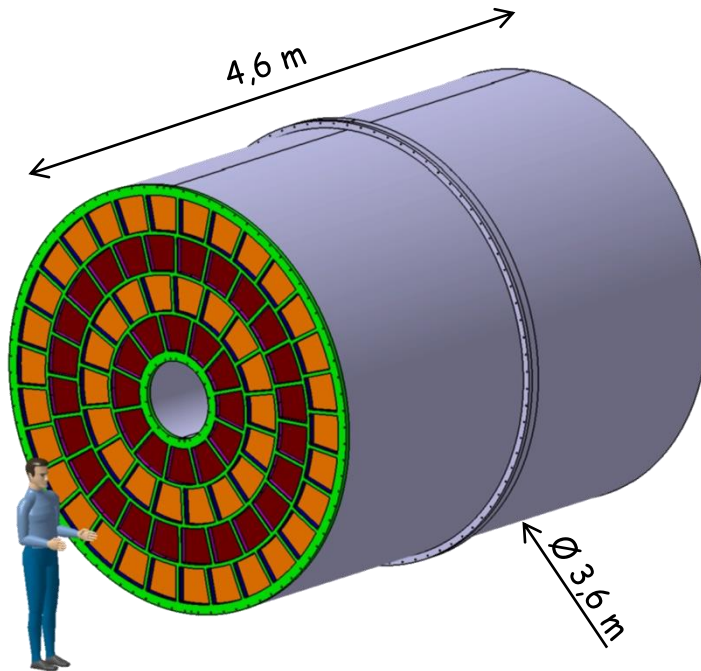
Better from mechanical (deformation) point of view



Version 2 - 3 wheel

|                 | PCB5 | PCB6 | PCB7 |
|-----------------|------|------|------|
| Deflection (mm) | 0,11 | 0,26 | 0,22 |
| Sigma VM (Mpa)  | 2,1  | 3,27 | 3,03 |



**Size :**

$\text{Ø}3,6\text{m} \times 4,6\text{m}$

**Weight :**

WEB V1  $\Rightarrow 2 \times 370$  kg (for Aluminium)

WEB V2  $\Rightarrow 2 \times 345$  kg (for Aluminium)

PCB  $\Rightarrow 2 \times 44$  kg (TBC)

Cage  $\Rightarrow 265$  kg (TBD)

**Loads :**

Standard Earth Gravity

Case 1  $\Rightarrow \Delta P = 0$  mbar

Case 2  $\Rightarrow \Delta P = 10$  mbar (TBC)

**Material :**

WEB  $\Rightarrow$  Aluminium Alloy (TBC)

$E = 71\,000$  MPa

$\rho = 2\,770$  kg/m<sup>3</sup>

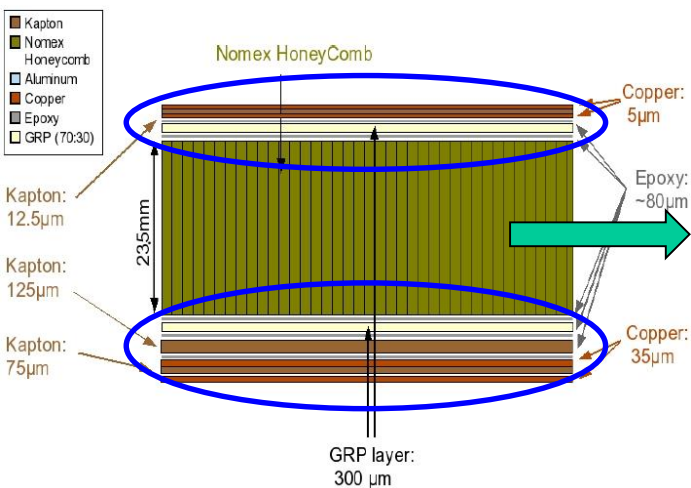
$\nu = 0.33$

TPC  $\Rightarrow$  Composite (TBD)

$E = ???$  MPa

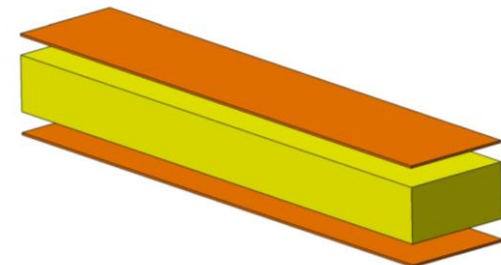
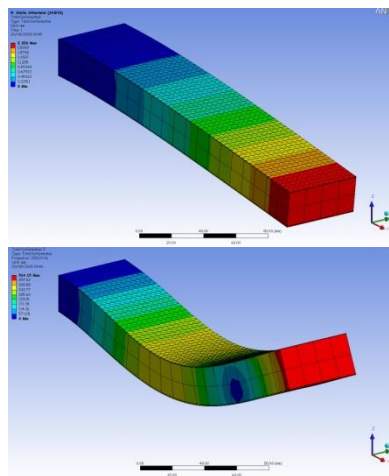
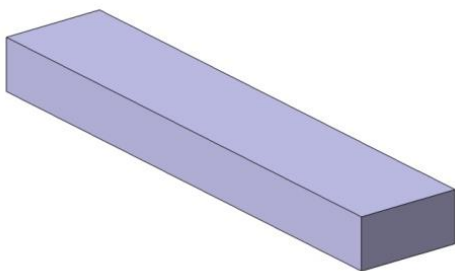
$\rho = ???$  kg/m<sup>3</sup>

$\nu = ???$



|              | Ep/u   | Ep/c   | %       | E (Mpa) | % E   | E equ (Mpa) | Rho (kg/m3) | % Rho | Rho equ (kg/m3) |
|--------------|--------|--------|---------|---------|-------|-------------|-------------|-------|-----------------|
| Cu           | 0.005  |        | 1.04%   | 124 000 | 1 285 |             | 8 920       | 92    |                 |
| Kapton       | 0.013  |        | 2.59%   | 2 500   | 65    |             | 1 420       | 37    |                 |
| Cu           | 0.005  | 0.4825 | 1.04%   | 124 000 | 1 285 | 4 946       | 8 920       | 92    | 2 336           |
| Epoxy        | 0.080  |        | 16.58%  | 3 500   | 580   |             | 1 500       | 249   |                 |
| GRP          | 0.300  |        | 62.18%  | 1 850   | 1 150 |             | 2 600       | 1 617 |                 |
| Epoxy        | 0.080  |        | 16.58%  | 3 500   | 580   |             | 1 500       | 249   |                 |
| <b>Nomex</b> |        |        |         |         |       |             |             |       |                 |
|              | 23.500 | 23.500 | 100.00% | TBD     |       |             | 46          |       | 46              |
| <b>Epoxy</b> |        |        |         |         |       |             |             |       |                 |
| Epoxy        | 0.080  |        | 9.88%   | 3 500   | 346   |             | 1 500       | 148   |                 |
| GRP          | 0.300  |        | 37.04%  | 1 850   | 685   |             | 2 600       | 963   |                 |
| Epoxy        | 0.080  |        | 9.88%   | 3 500   | 346   | 13 056      | 1 500       | 148   | 2 529           |
| Kapton       | 0.125  | 0.810  | 15.43%  | 2 500   | 386   |             | 1 420       | 219   |                 |
| Epoxy        | 0.080  |        | 9.88%   | 3 500   | 346   |             | 1 500       | 148   |                 |
| Cu           | 0.035  |        | 4.32%   | 124 000 | 5 358 |             | 8 920       | 385   |                 |
| Kapton       | 0.075  |        | 9.26%   | 2 500   | 231   |             | 1 420       | 131   |                 |
| Cu           | 0.035  |        | 4.32%   | 124 000 | 5 358 |             | 8 920       | 385   |                 |

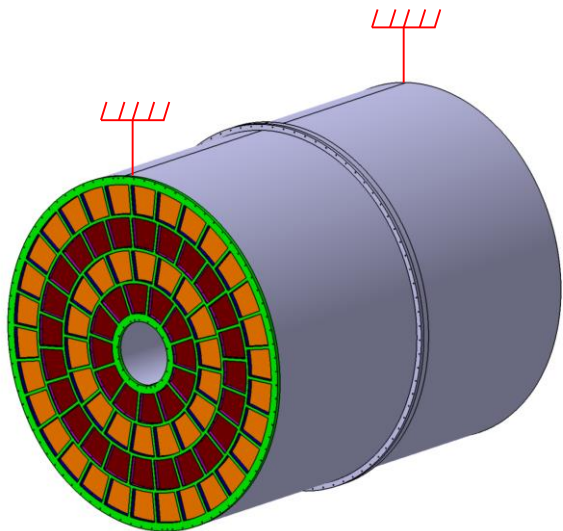
TPC => Composite (TBD)  
 $E_p = 25 \text{ mm}$   
 $E = 1\,500 \text{ MPa}$   
 $\rho = 172 \text{ kg/m}^3$   
 $\nu = 0.3$



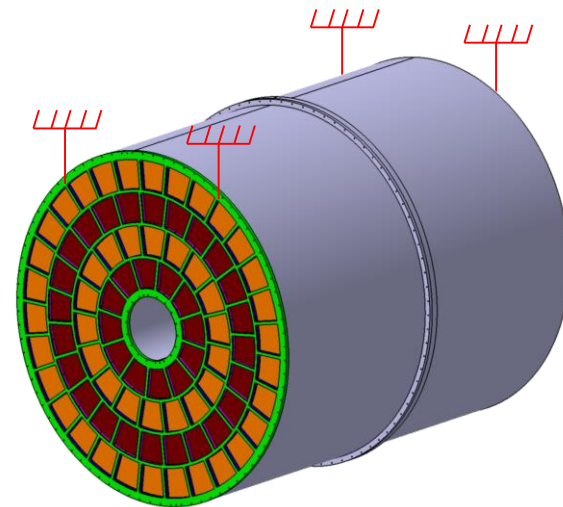


## 4 possible configurations

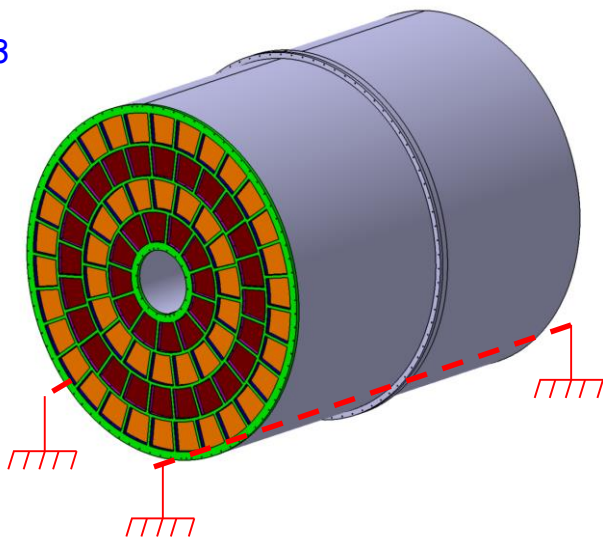
Case 1



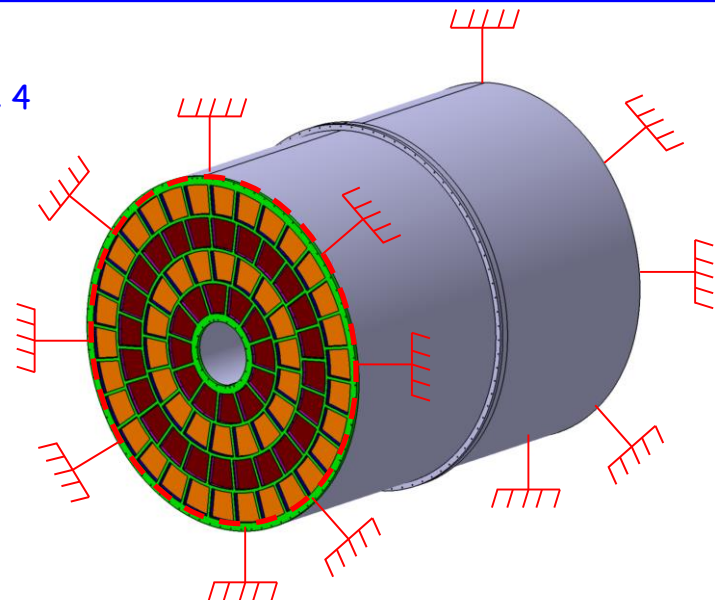
Case 2



Case 3

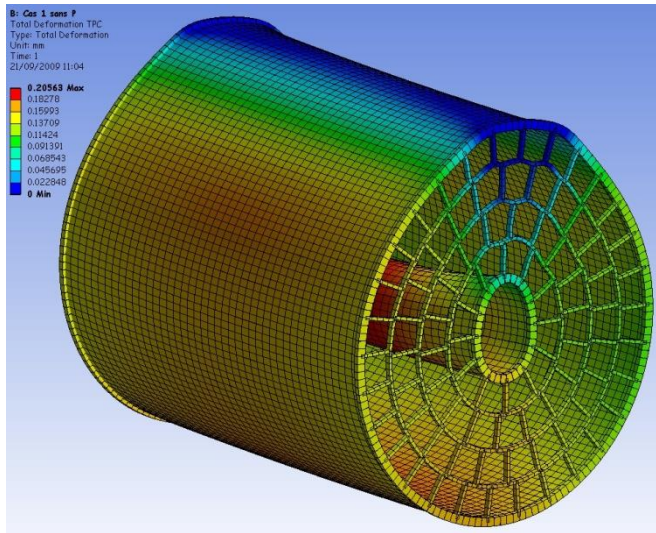


Case 4

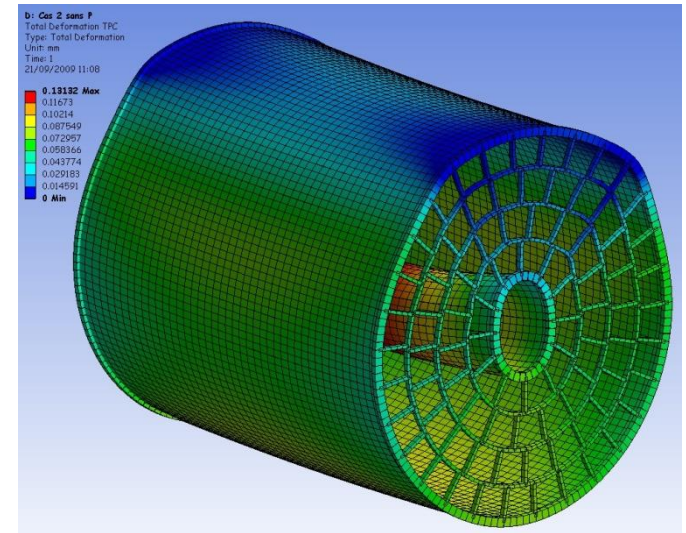




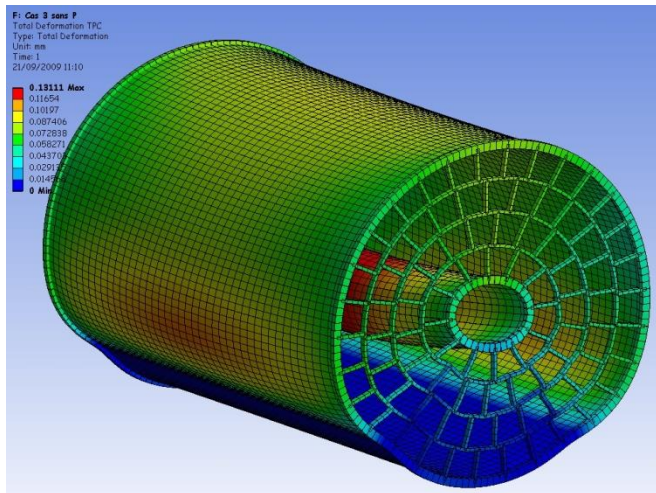
Case 1



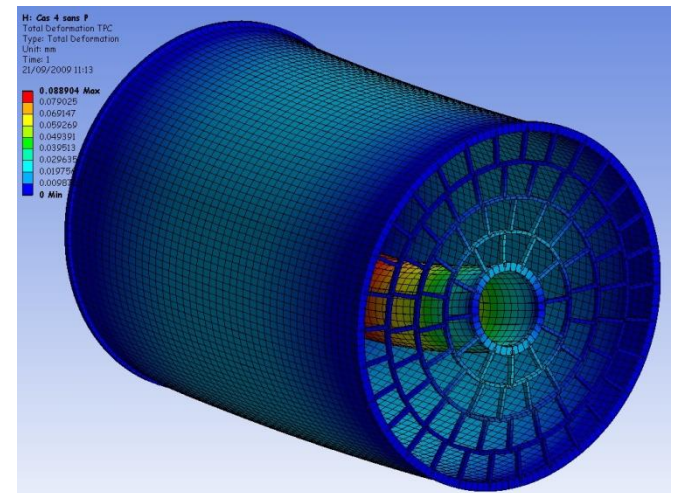
Case 2



Case 3

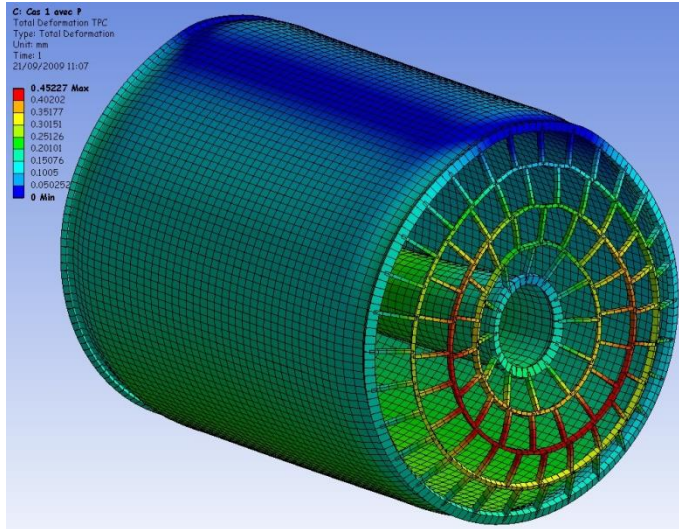


Case 4

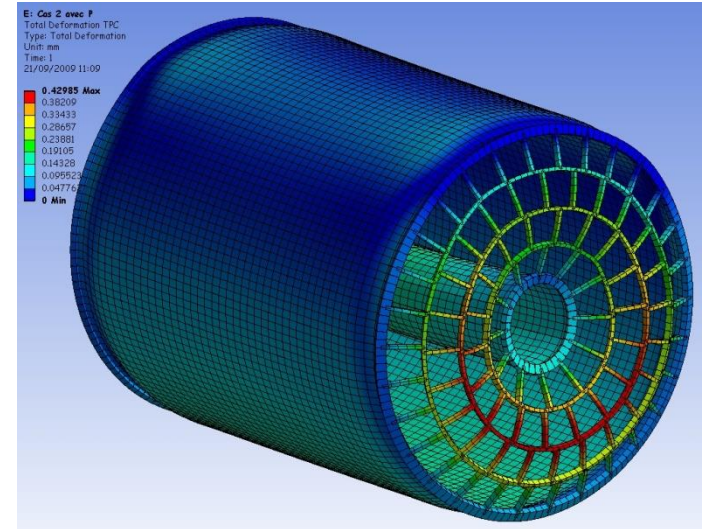




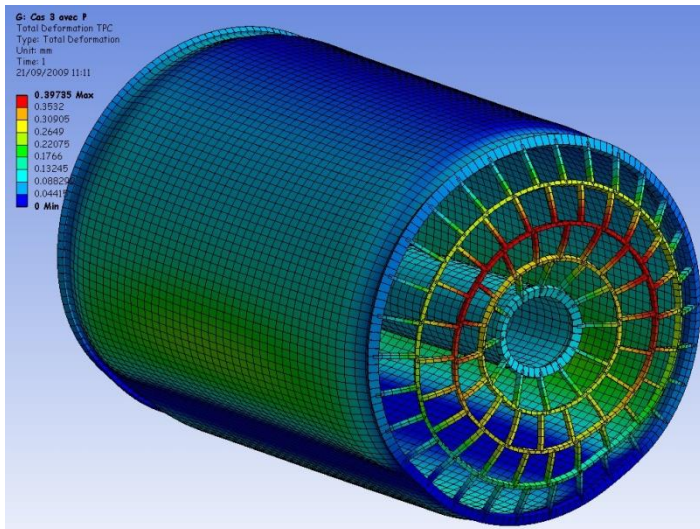
Case 1



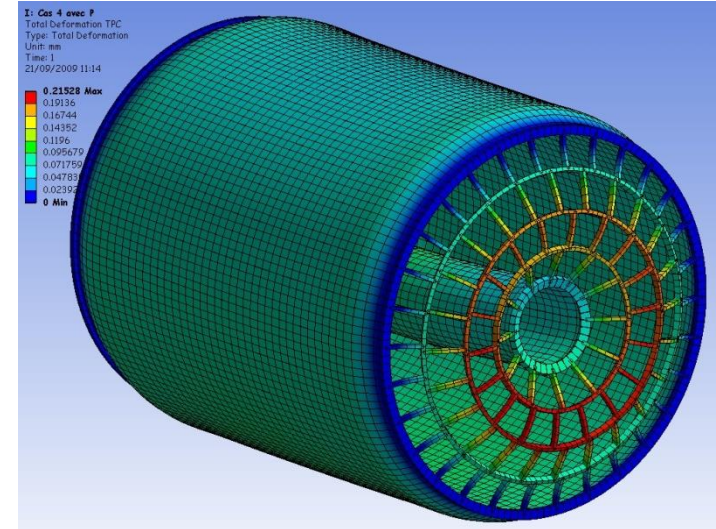
Case 2



Case 3

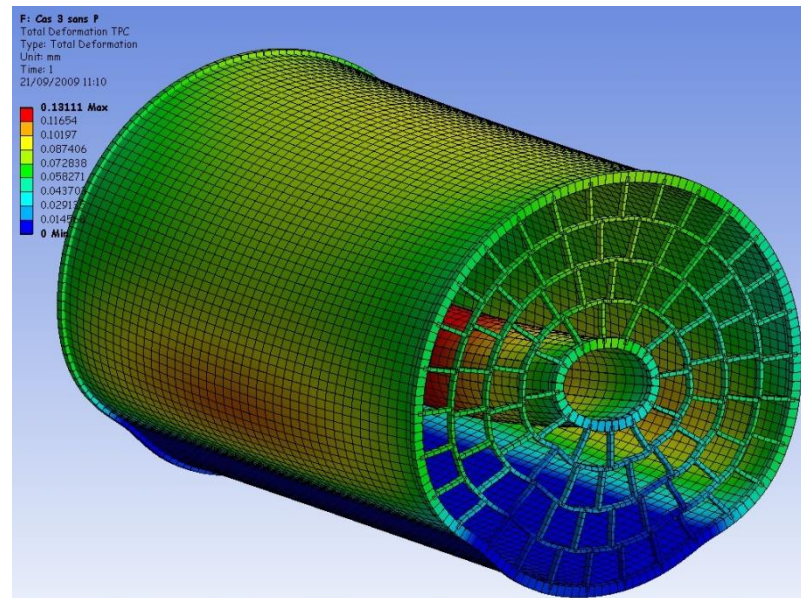


Case 4

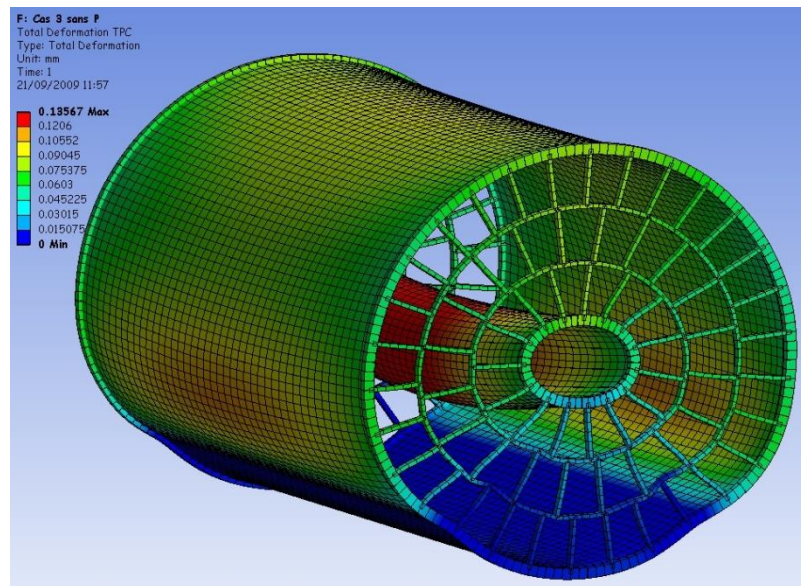


|        |          | Deflection (mm)     |                      |
|--------|----------|---------------------|----------------------|
|        |          | $\Delta P = 0$ mbar | $\Delta P = 10$ mbar |
| Case 1 | V1       | 0.2                 | 0.45                 |
|        | V2       | 0.18                | 0.42                 |
|        | $\Delta$ | -10%                | -7%                  |
| Case 2 | V1       | 0.13                | 0.43                 |
|        | V2       | 0.13                | 0.4                  |
|        | $\Delta$ | 0%                  | -7%                  |
| Case 3 | V1       | 0.13                | 0.4                  |
|        | V2       | 0.13                | 0.36                 |
|        | $\Delta$ | 0%                  | -10%                 |
| Case 4 | V1       | 0.09                | 0.21                 |
|        | V2       | 0.09                | 0.21                 |
|        | $\Delta$ | 0%                  | 0%                   |

Déformation V1 -  $\Delta P = 0$  mbar



Déformation V2 -  $\Delta P = 0$  mbar



Evaluation more precise of the Cage material (sample, measure)

Simulation with composite material (carbon fiber) for the WEB

Thermo-mechanical simulation

Other configuration ?

THANKS