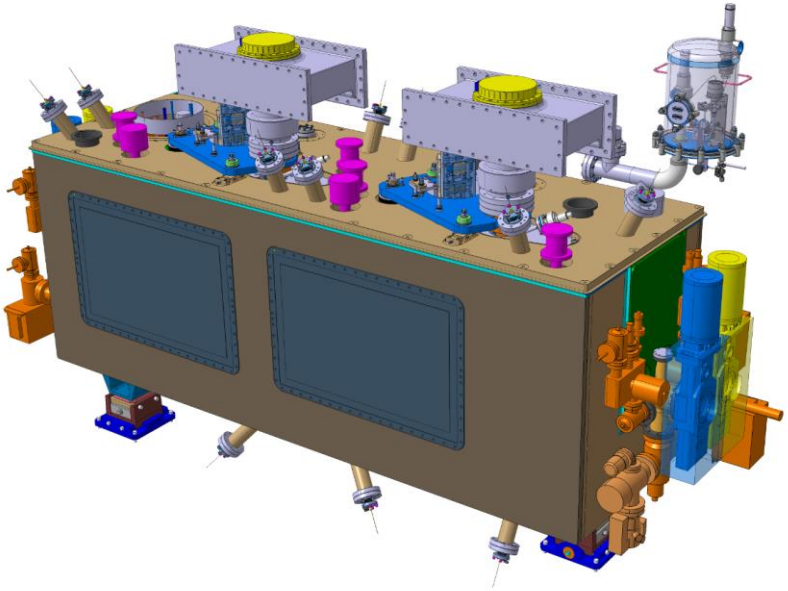
CERN-STFC/UKRI – Cryomodule design update

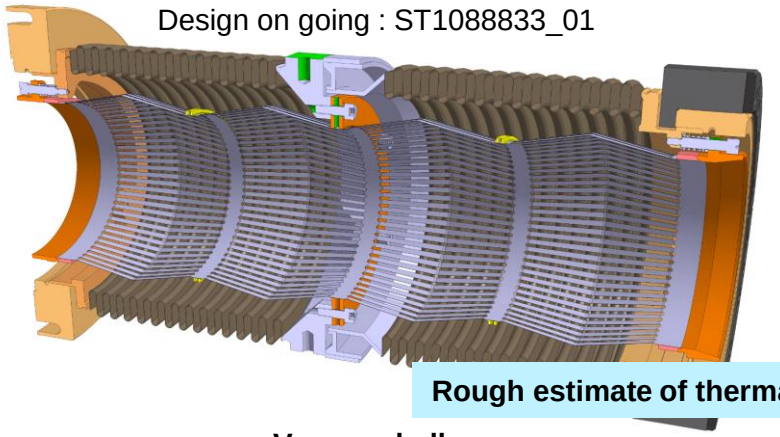
8th of March 2019



Teddy Capelli - CRAB Cavity design team – CERN/STFC

Cold warm transition optimization

Design on going : ST1088833_01



To be optimized :

- -Position of thermal intercept
- -Lateral displacement capacities
- -RF continuity through extremities

Rough estimate of thermal loads on 2K and thermal screen

Vacuum bellows

Calcul conduction

Results static conduction

Material data

$$Q_{max}(G) := \left[\frac{L_1}{\int_{T_{int}}^{T_{room}-G} k_{ss}(T)\,dT \cdot S_t} + \frac{1}{R_c \cdot S_c \cdot G} \right]^{-1}$$

$x := 0$ $\quad x_{star} := \text{Maximize}(Q_{max}, x)$

$x_{star} = 12.675\,K$ Δt optimal sur les contacts

$Q_{max}(x_{star}) = 0.713\,W$ Q(300-80K) external

Valeur sans resistance de contact

$$Q_{screen} := \left(\frac{L_1}{\int_{T_{int}}^{T_{room}} k_{ss}(T)\,dT \cdot S_t} \right)^{-1} = 0.836\,W$$

$$Q_{max2k}(Qa) := \left[\frac{L_2}{\int_{T_c}^{T_{int}-Qa} k_{ss}(T)\,dT \cdot S_t} + \frac{2}{R_c \cdot S_c \cdot Qa} \right]^{-1}$$

$yx := 0$ $\quad yx_{star} := \text{Maximize}(Q_{max2k}, yx)$

$yx_{star} = 2.861\,K$ Δt optimal sur les contacts

$Q_{max2k}(yx_{star}) = 0.053\,W$ Q(80-2K) External

Valeur sans resistance de contact

$$Q_{bath} := \left(\frac{S_t}{L_2} \cdot \int_{T_c}^{T_{int}} k_{ss}(T)\,dT \right) = 0.058\,W$$

Internal RF bellows

Calcul conduction

Results static conduction

$$Q_{maxi}(H) := \left[\frac{L_{1i}}{\int_{T_{inti}}^{T_{room}-H} k_{CuBe}(T)\,dT \cdot S_{ti}} + \frac{1}{R_c \cdot S_{ci} \cdot H} \right]^{-1}$$

$y := 0$ $\quad y_{star} := \text{Maximize}(Q_{maxi}, y)$

$y_{star} = 17.053\,K$ Δt optimal sur les contacts

$Q_{maxi}(y_{star}) = 1.457\,W$ Q(300-80K) Internal

Valeur sans resistance de contact

$$Q_{screeni} := \left(\frac{L_{1i}}{\int_{T_{inti}}^{T_{room}} k_{CuBe}(T)\,dT \cdot S_{ti}} \right)^{-1} = 2.101\,W$$

$$Q_{maxi2k}(P) := \left[\frac{L_{2i}}{\int_{T_c}^{T_{inti}-P} k_{CuBe}(T)\,dT \cdot S_{ti}} + \frac{2}{R_c \cdot S_{ci} \cdot P} \right]^{-1}$$

$yz := 0$ $\quad yz_{star} := \text{Maximize}(Q_{maxi2k}, yz)$

$yz_{star} = 10.135\,K$ Δt optimal sur les contacts

$Q_{maxi2k}(yz_{star}) = 0.481\,W$ Q(80-2K) Internal

Valeur sans resistance de contact

$$Q_{bathi} := \left(\frac{S_{ti}}{L_{2i}} \cdot \int_{T_c}^{T_{inti}} k_{CuBe}(T)\,dT \right) = 0.636\,W$$

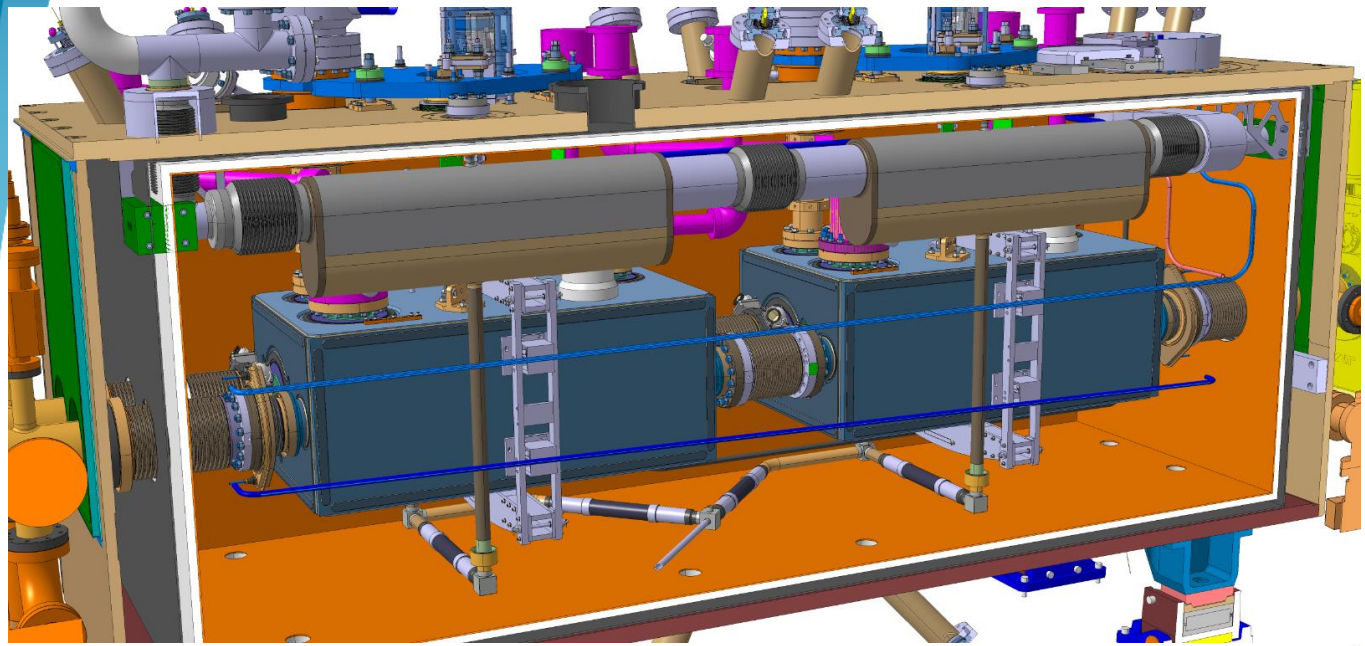
Results worst case

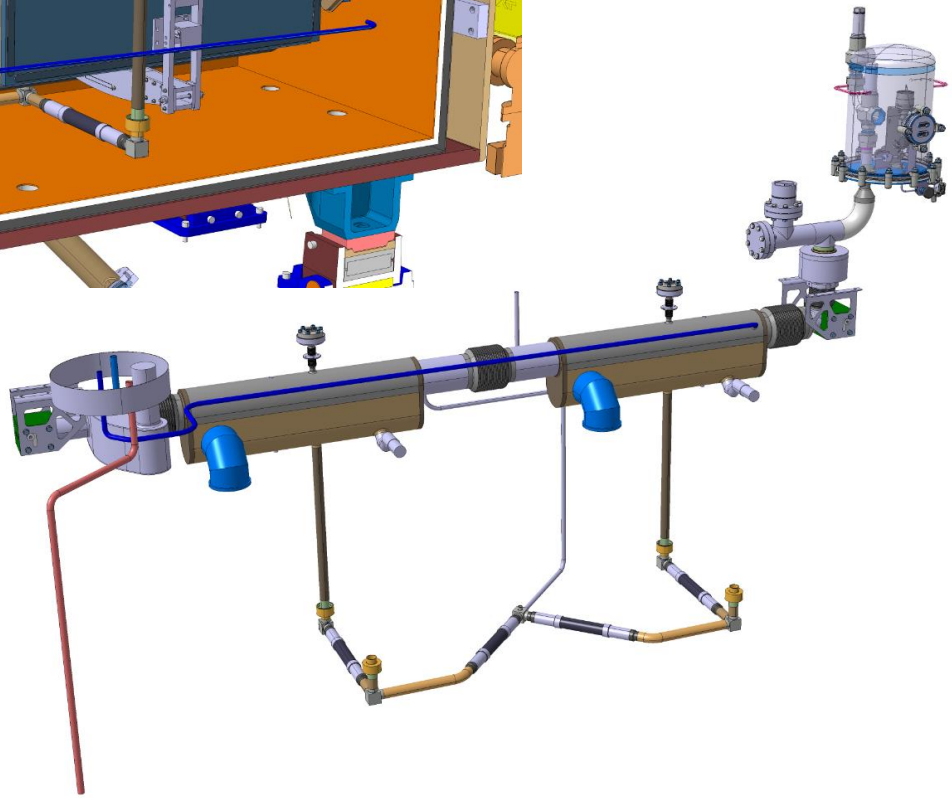
Without contact resistance

$Q_{80K} := Q_{screen} + Q_{screeni} = 2.937\,W$

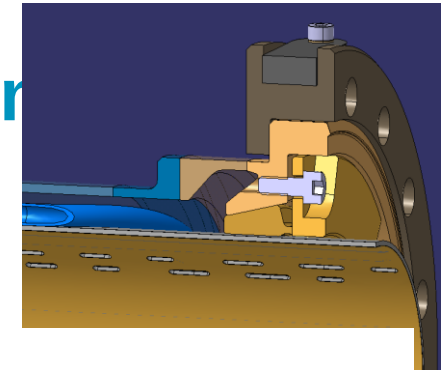
$Q_{2K} := Q_{bath} + Q_{bathi} = 0.694\,W$

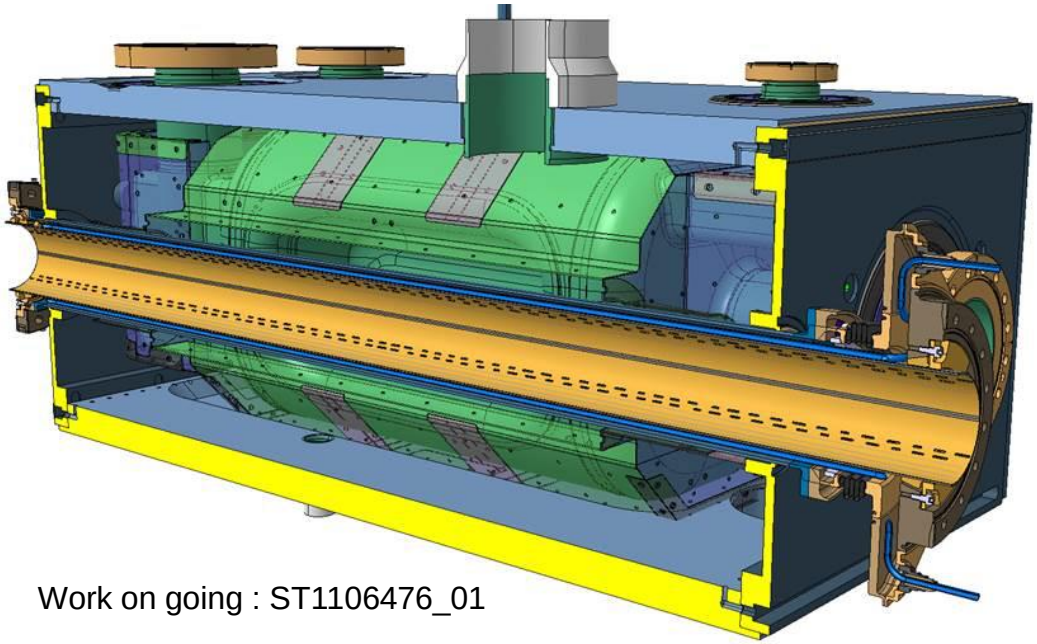
Cryogenic line details



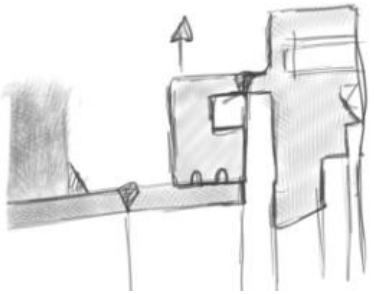


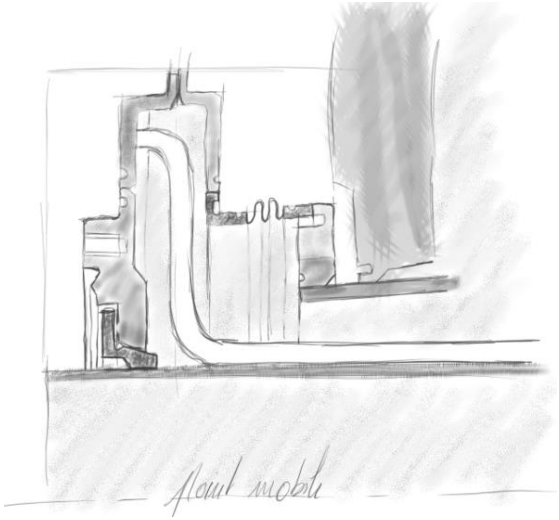
Beam screen optimization





Work on going : ST1106476_01

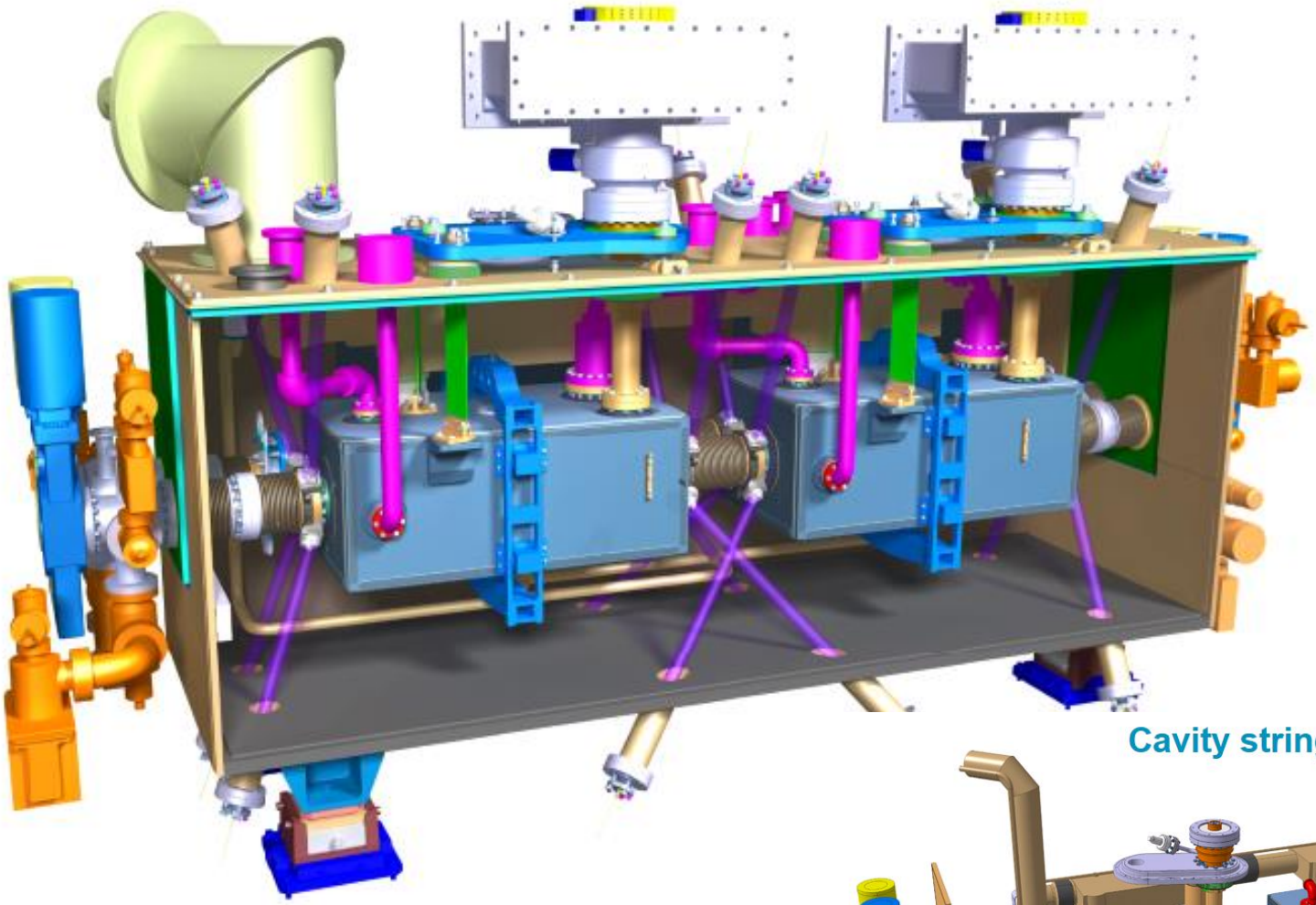




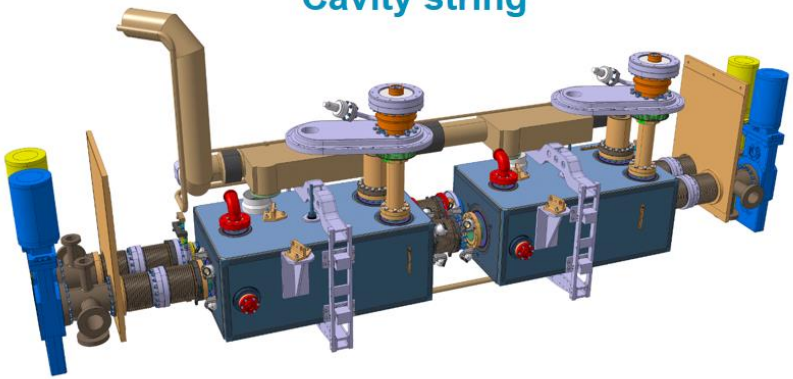
To be optimized :

- -Size (length) of extremities
- -Integration of transition Ti/Ss brazed
- -Sliding of mobile extremities

Solution #1 – fully welded

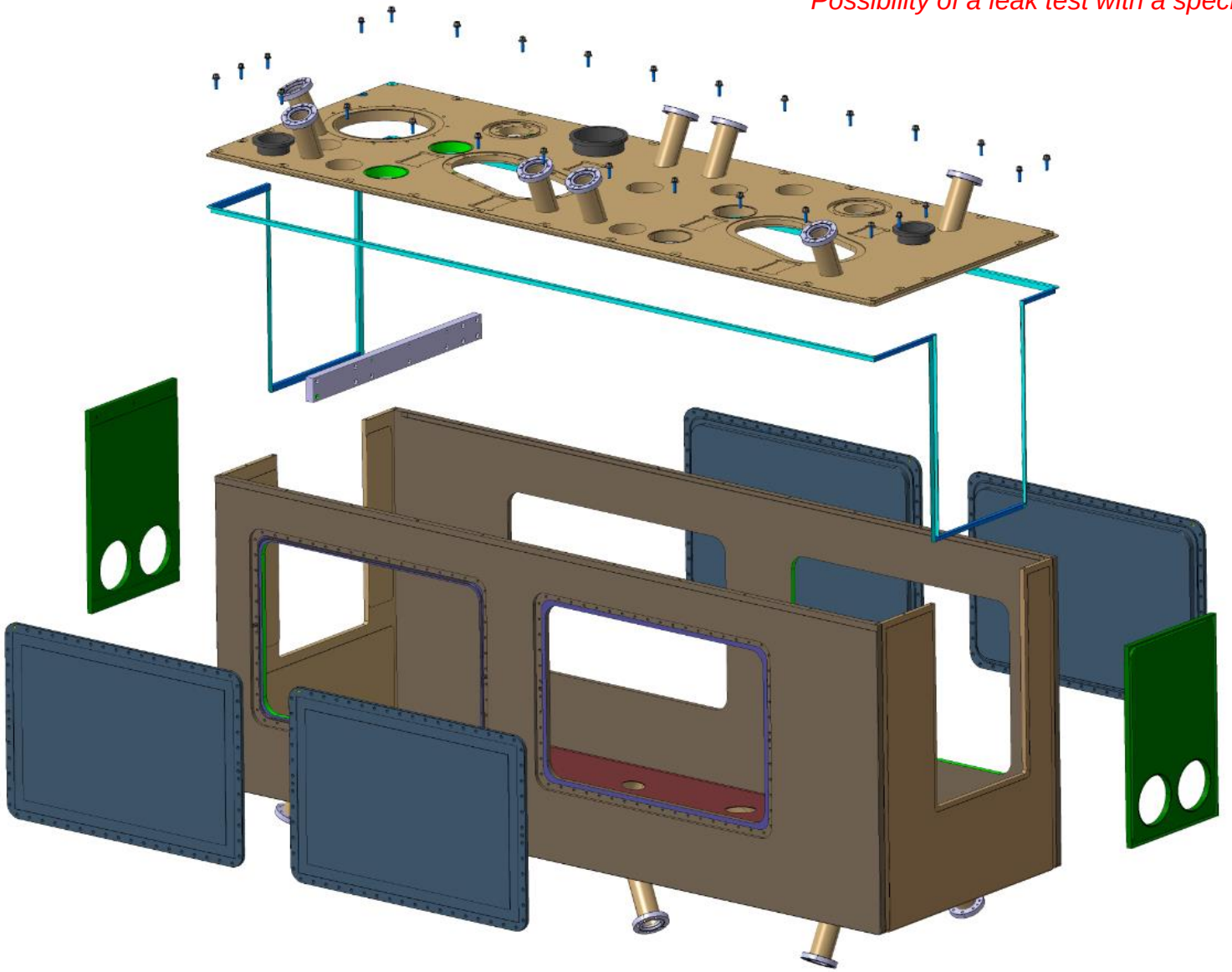


Cavity string



Solution #1 – fully welded

Possibility of a leak test with a specific tooling



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