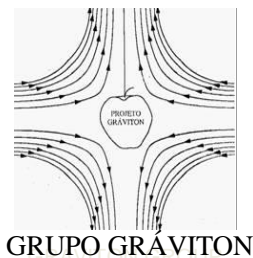


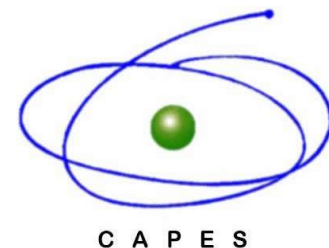
TRANSDUTORES PARA O DETECTOR SCHENBERG

ISOLAMENTO VERTICAL DO *MNP* PARA O DETECTOR *LIGO*

Elvis Camilo Ferreira (Doutorado)
Orientador: Dr. Odylio Denys de Aguiar
Workshop DAS, 08 de abril de 2015.



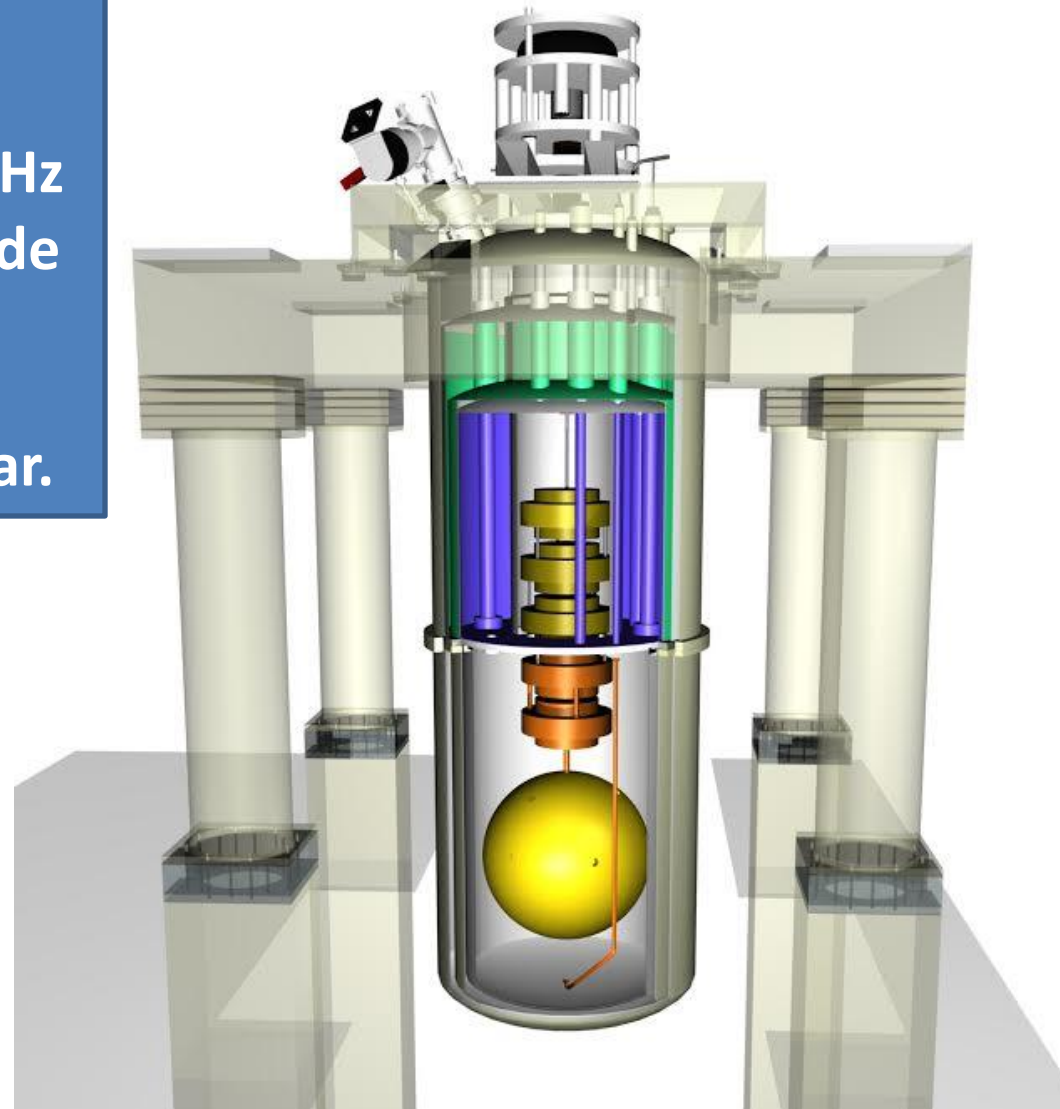
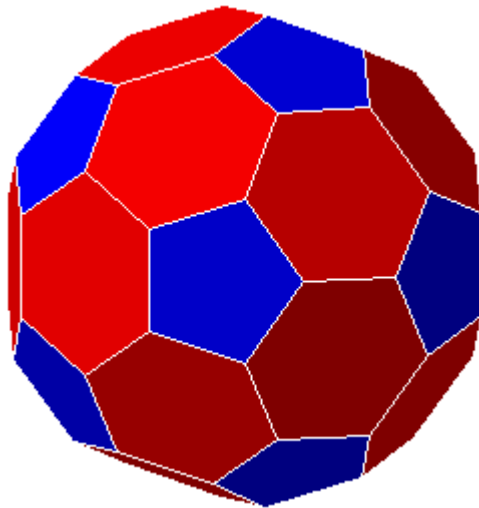
LIGO
Scientific
Collaboration



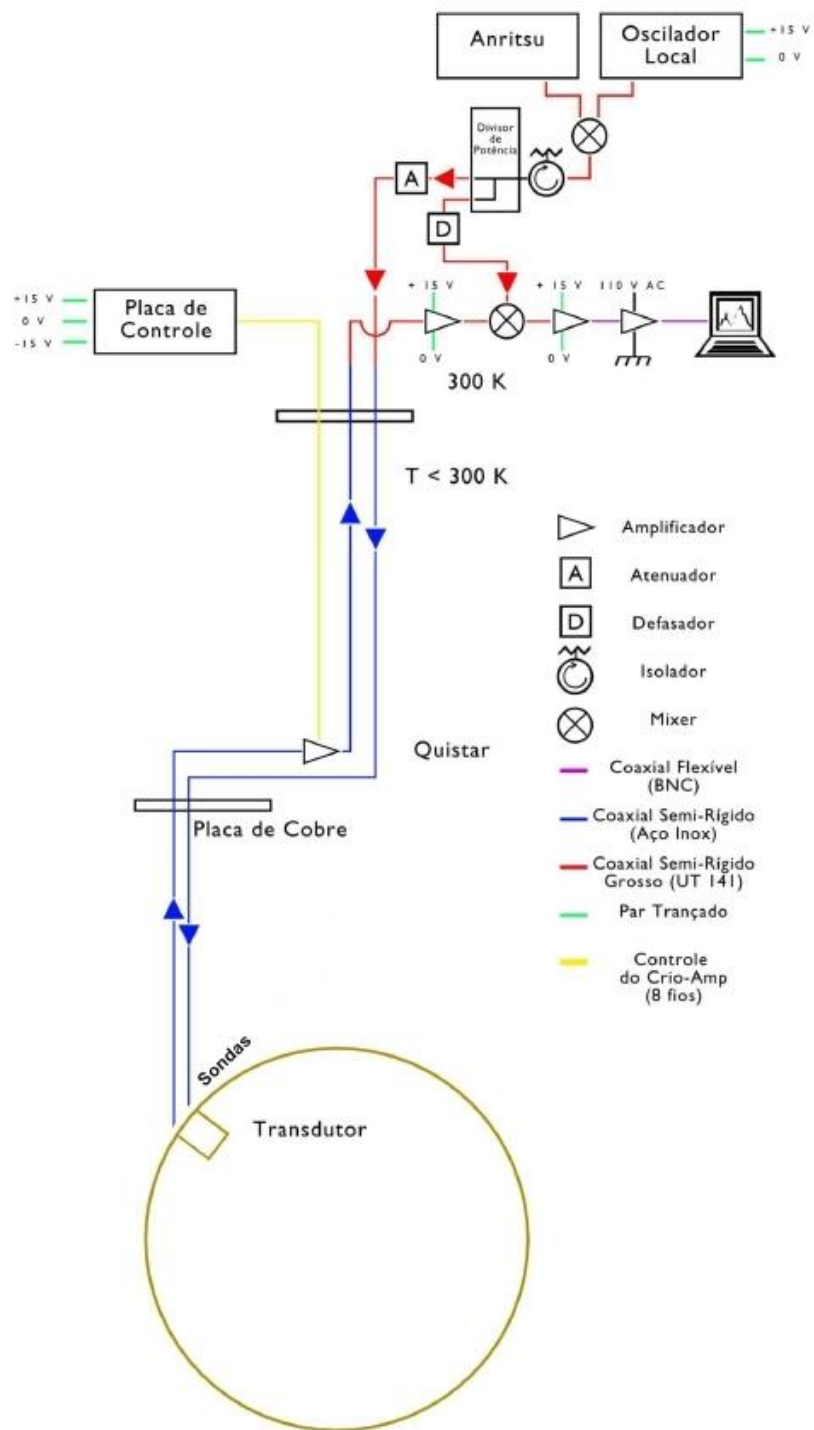
Cu-Al(6%) , 1150 kg e 65 cm de diâmetro;

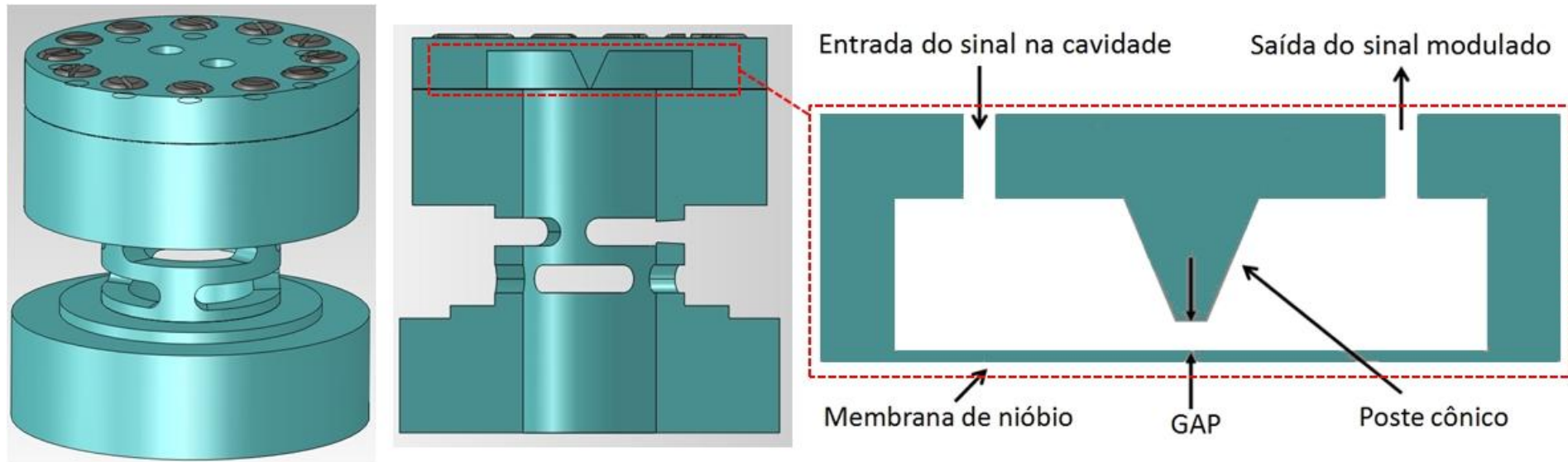
Maior sensibilidade em 3,2 kHz nos 5 modos quadrupolares de massa efetiva 287 kg;

E também o modo monopolar.



Sistema de detecção





Ganho em amplitude $\sim 10^4$.

Ressonância membrana: 3,2 kHz.

Meta: ressonância elétrica da cavidade em 9,44 GHz.

Gap de 3 microns.

- Os transdutores ressonantes paramétricos serão acoplado à antena.





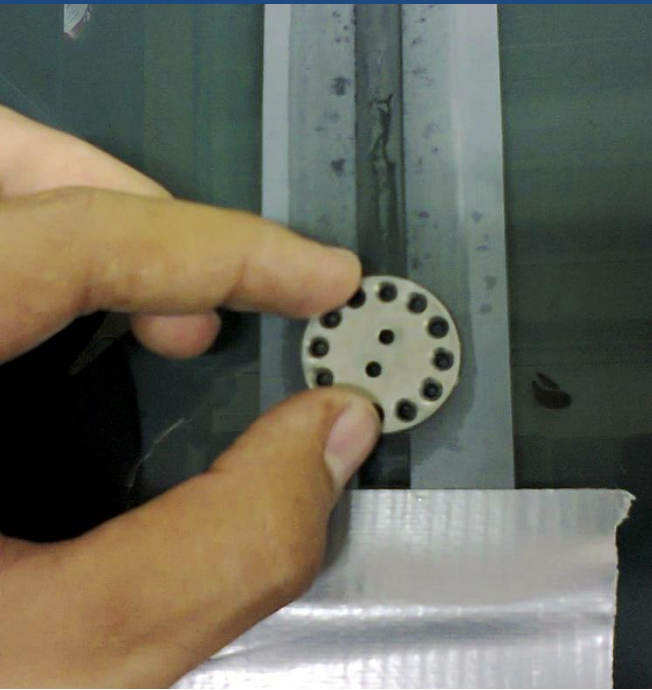
desgaste com retífica



lixamento no torno mecânico



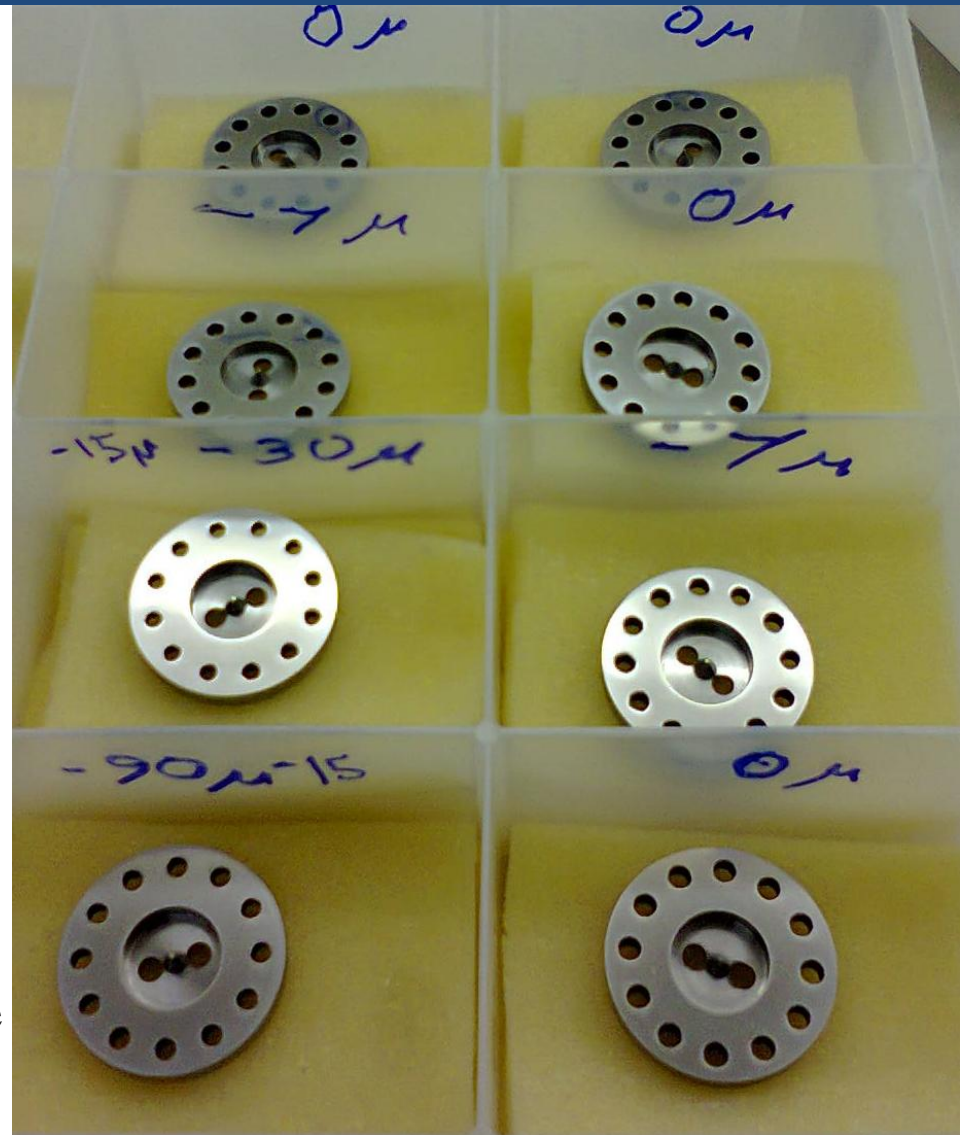
Resultado preliminar: *gaps* eram ~100 microns
e se tornaram 10-20 microns



Irregularidades no procedimento anterior
→ Lixamento manual.

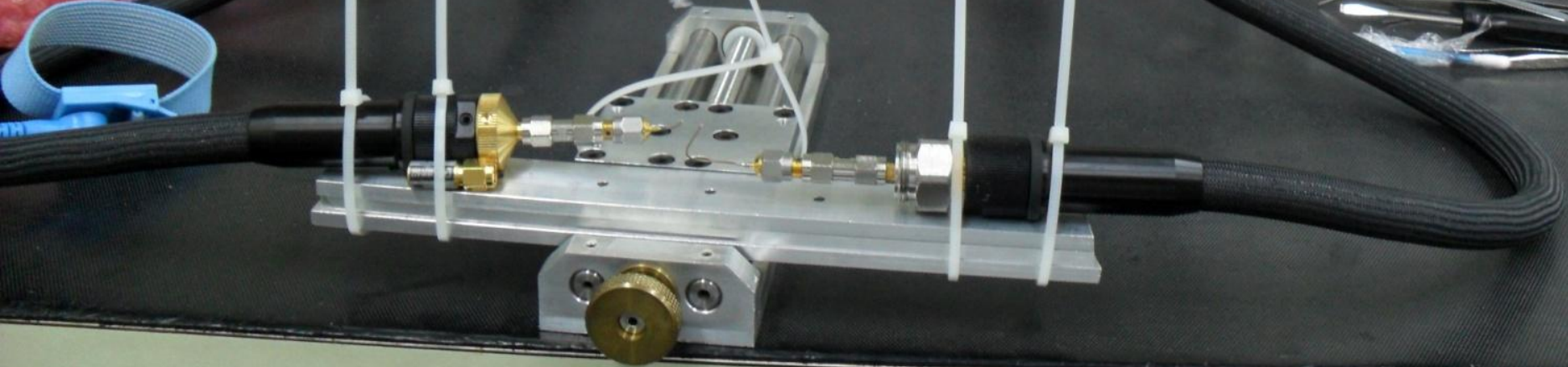
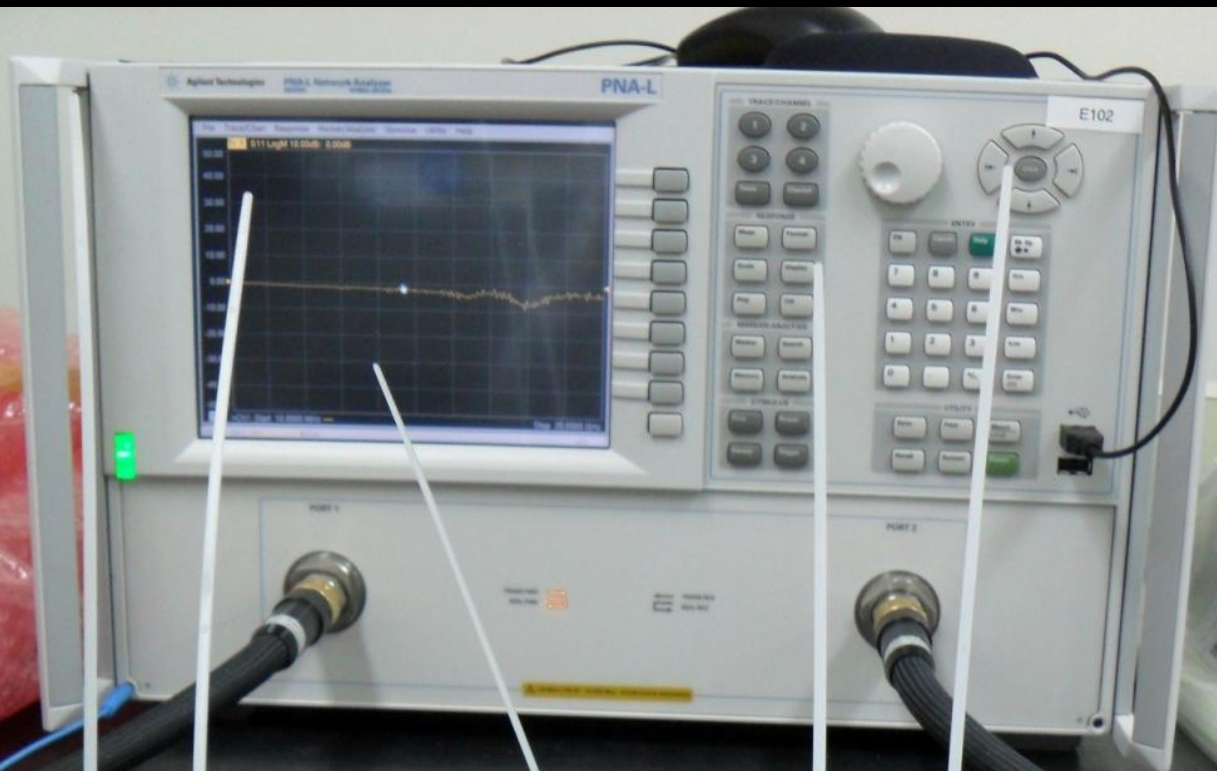
Lixas 600, 1200 e 2000.

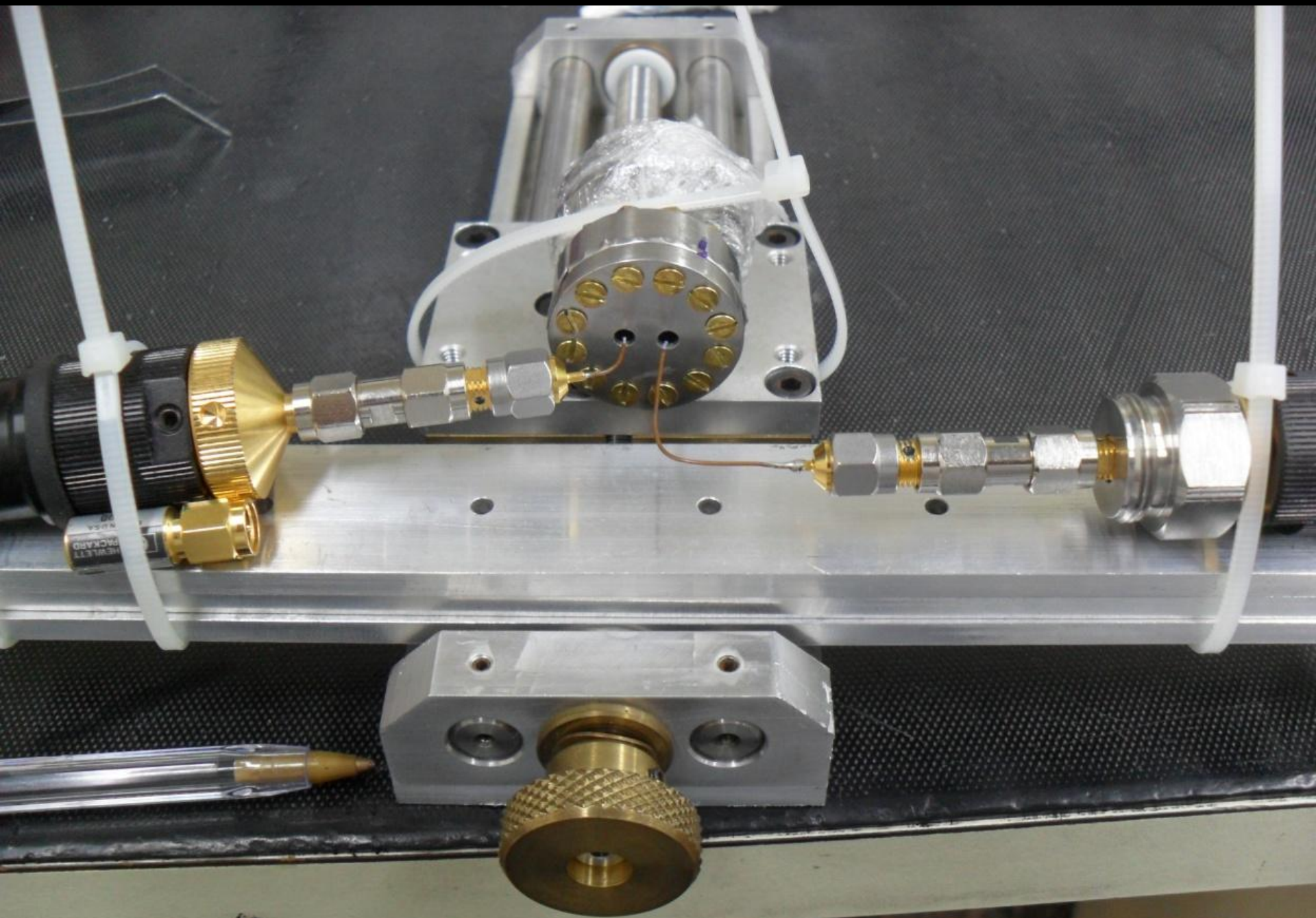
As amostras obtiveram um ótimo acabamento e os *gaps* se reduziram para a ordem de grandeza esperada.



DESENVOLVIMENTO DOS TRANSDUTORES Montagem das cavidades







Amostra	f_0^{cav} [GHz]				
	Etapa 1	Etapa 2	Etapa 3	Etapa 4	Etapa 5
1	12,76	12,88	9,52	9,52	9,52
2	12,44	12,32	9,52	9,52	9,52
3	13,40	13,88	13,36	13,16	12,76
4	10,96	10,92	9,88	9,88	9,88
5	13,12	13,28	13,00	12,76	12,64
6	12,64	13,20	12,36	12,00	11,74
7	9,76	9,76	9,76	9,76	9,76
8	11,28	11,28	10,60	10,08	9,48

Amostra	f_0^{cav} [GHz]			
	Etapa 6	Etapa 7	Etapa 8	Etapa 9
1	9,52	9,52	9,52	9,52
2	9,52	9,52	9,52	9,52
3	12,72	12,32	12,06	11,08
4	9,88	9,88	9,88	9,88
5	12,08	11,92	11,56	10,54
6	(nenhum pico)	12,52	12,20	12,13
7	9,76	9,76	9,76	9,76
8	9,48	9,48	9,48	9,48

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High sensitivity niobium parametric transducer for the Mario Schenberg gravitational wave detector

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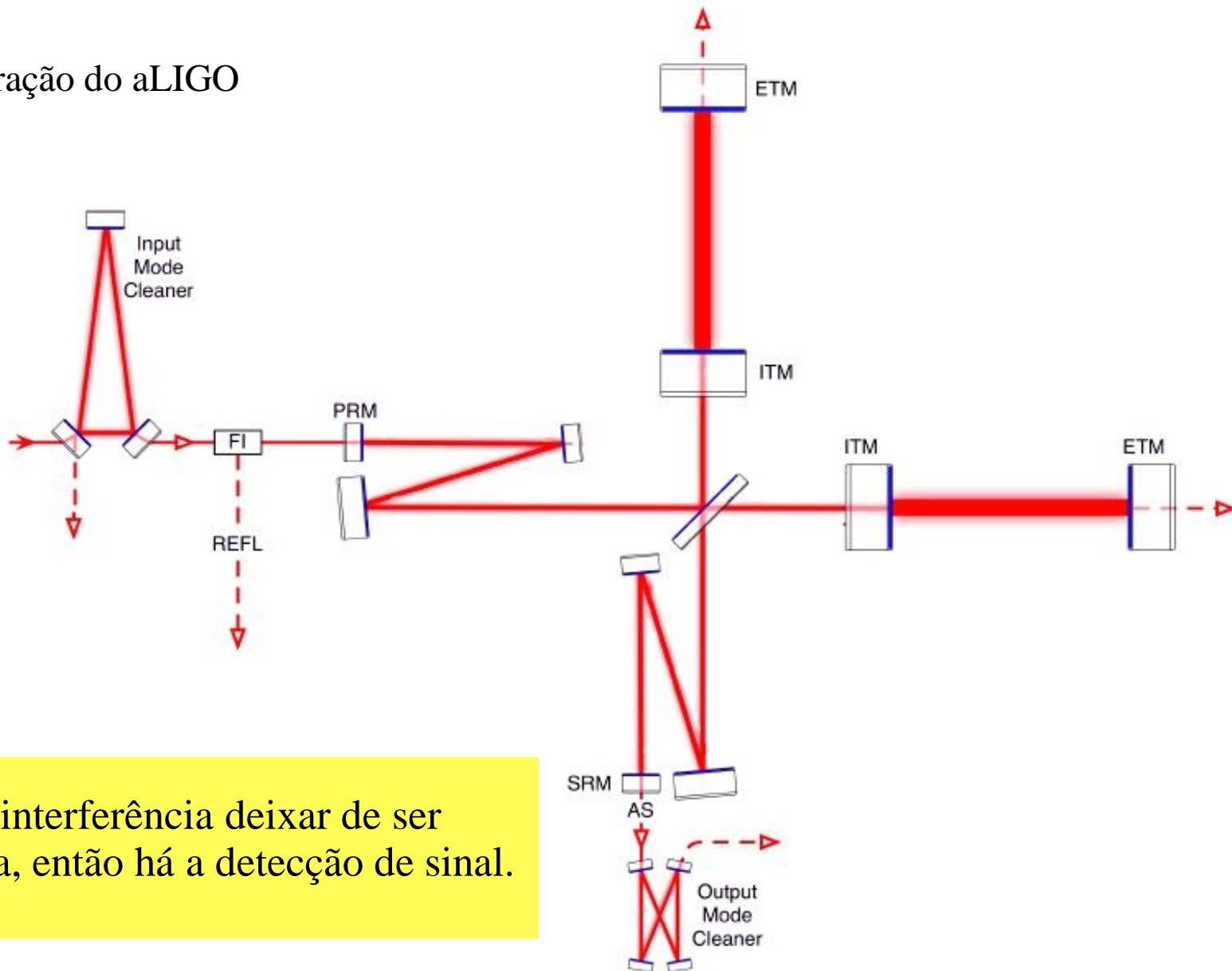


CORRIDA CRIOGÊNICA- COLETA DE DADOS- TESTES



DETECTOR INTERFEROMÉTRICO *Advanced LIGO*

Configuração do aLIGO



Se a interferência deixar de ser destrutiva, então há a detecção de sinal.

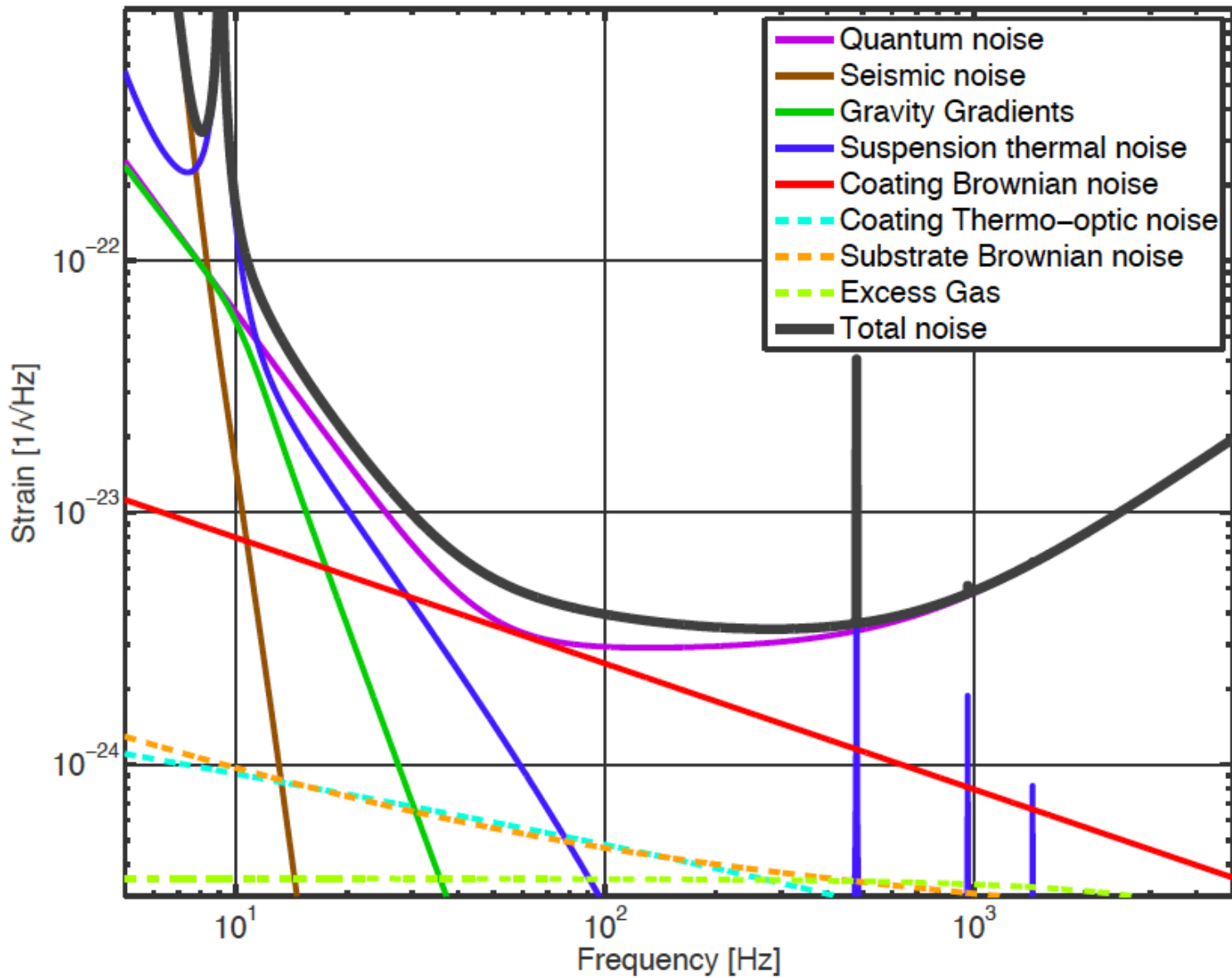
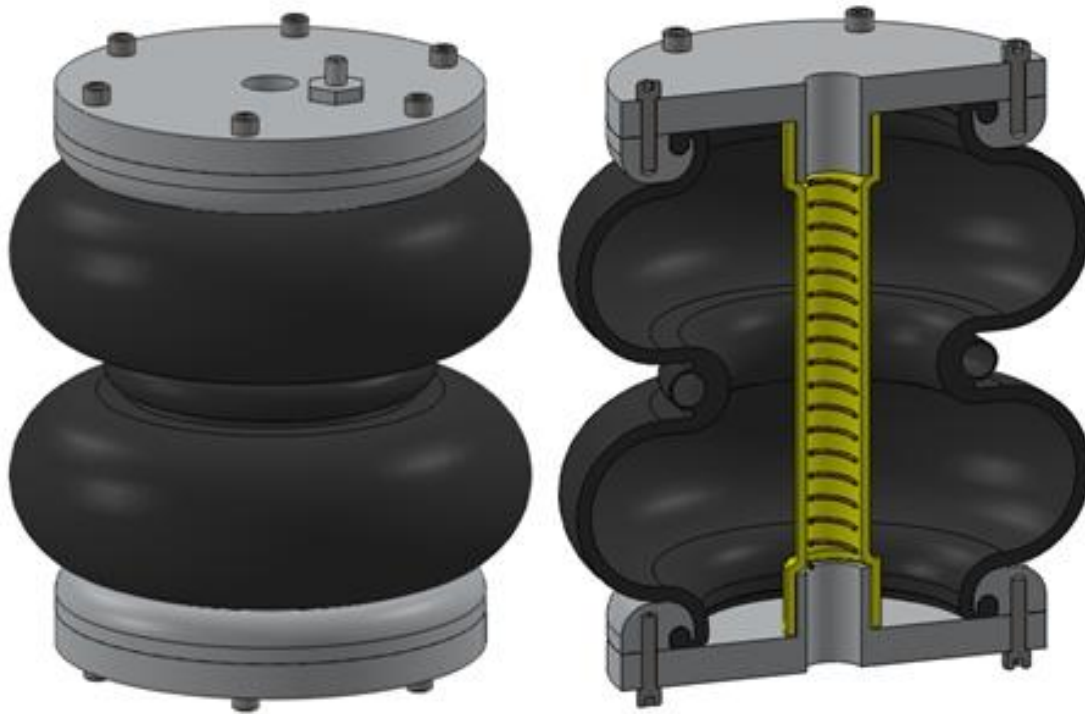


Figure 2: Baseline aLIGO Noise Budget (GWINC v2.0). Power into the interferometer is 125 W. Arm cavity power is 730 kW. SRM position is tuned to 0 deg for broadband operation.

MOLAS DE GAS





O MNP tem 30 graus de liberdade:

5 graus acoplados na direção Z (vertical);

5 acoplados na direção de rotação em torno do eixo Z;

5 na direção X (horizontal) acoplados com 5 na direção de rotação em torno de Y (também horizontal);

5 na direção Y acoplados com 5 na direção de rotação em torno de X.

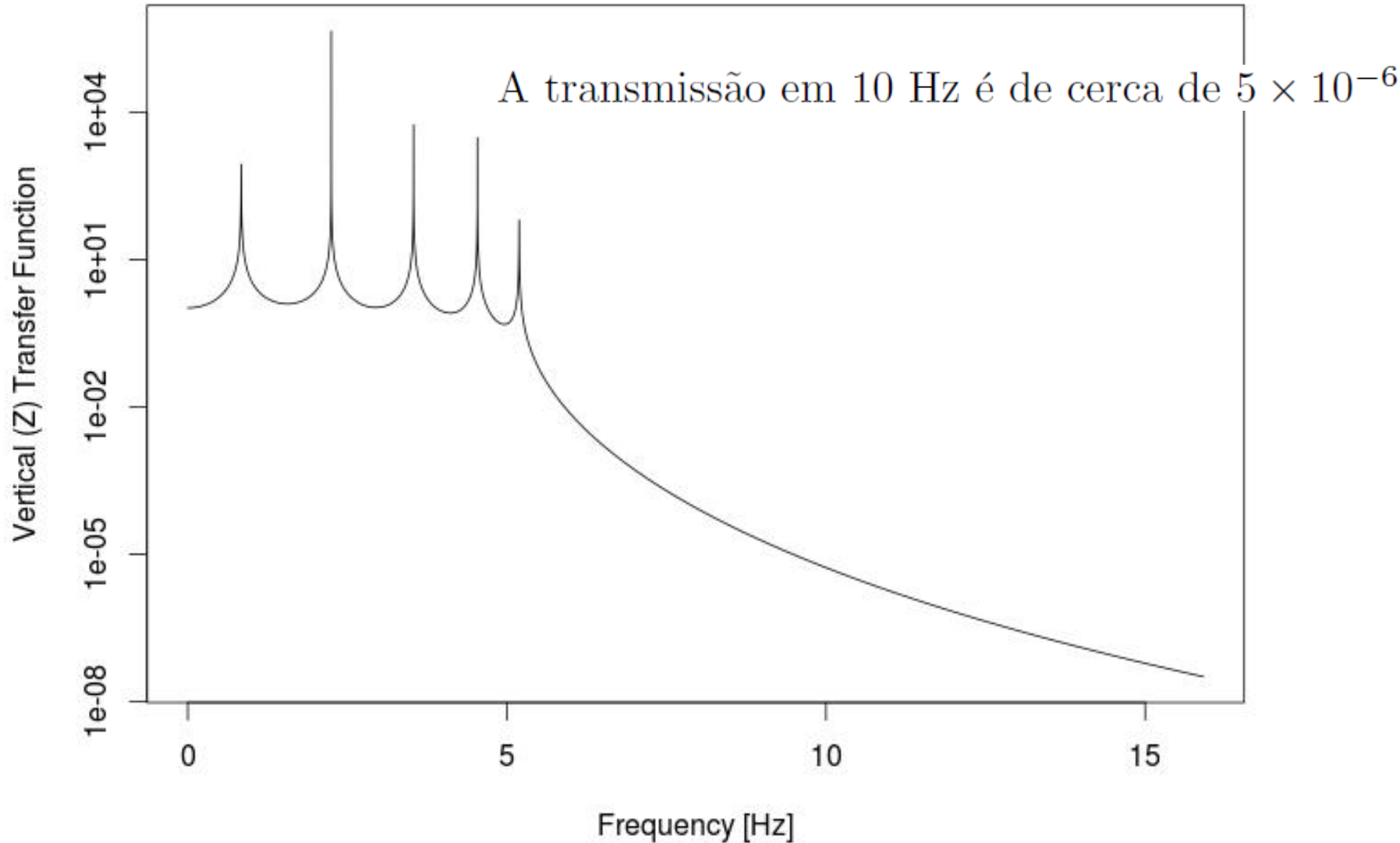
Em Z:

$$\ddot{z}_i + \left(\frac{k_i + k_{i+1}}{m_i} \right) z_i - \frac{k_i}{m_i} z_{i-1} - \frac{k_{i+1}}{m_i} z_{i+1} = 0$$

tomando

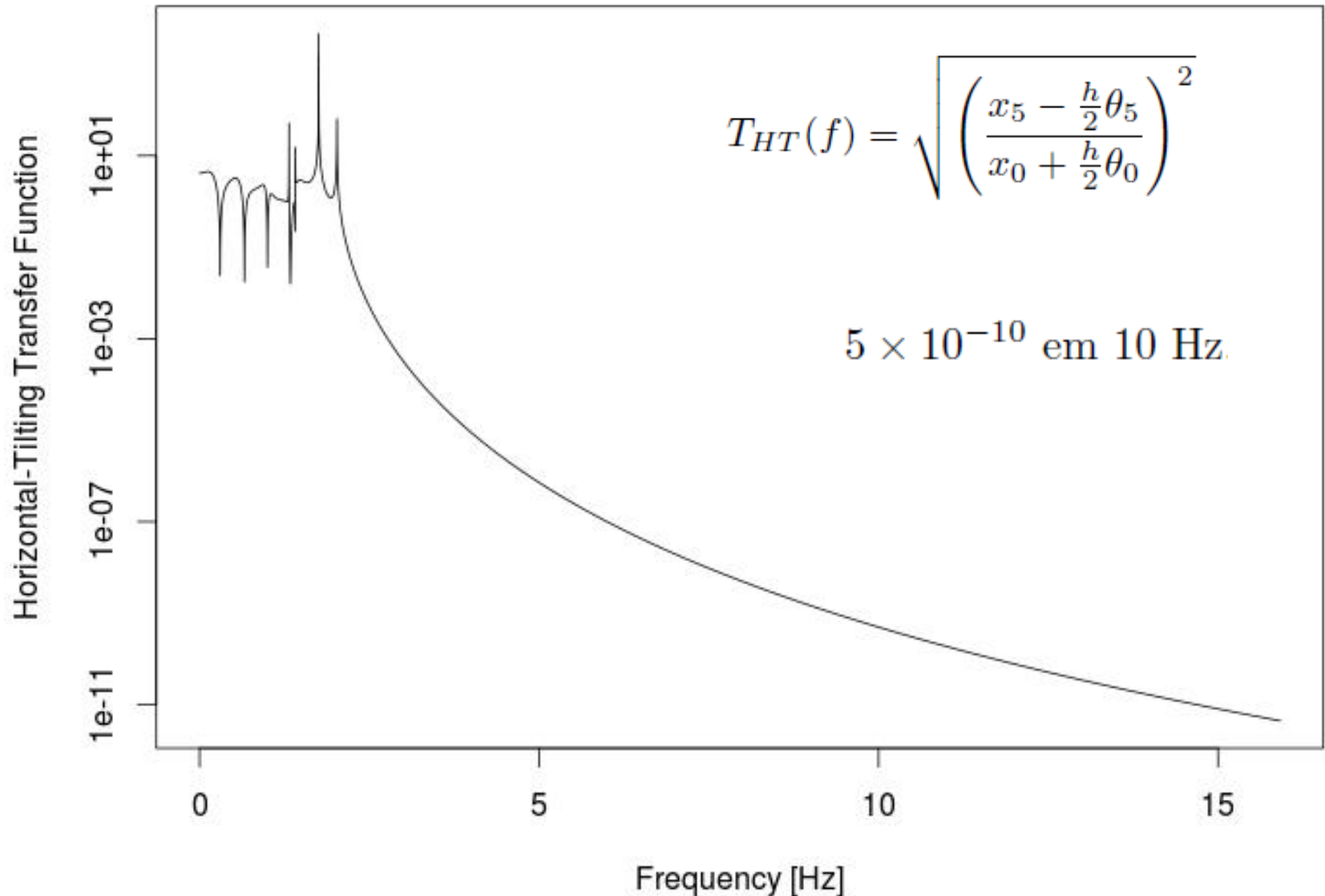
$$T_Z(f) = z_5/z_0$$

geramos:



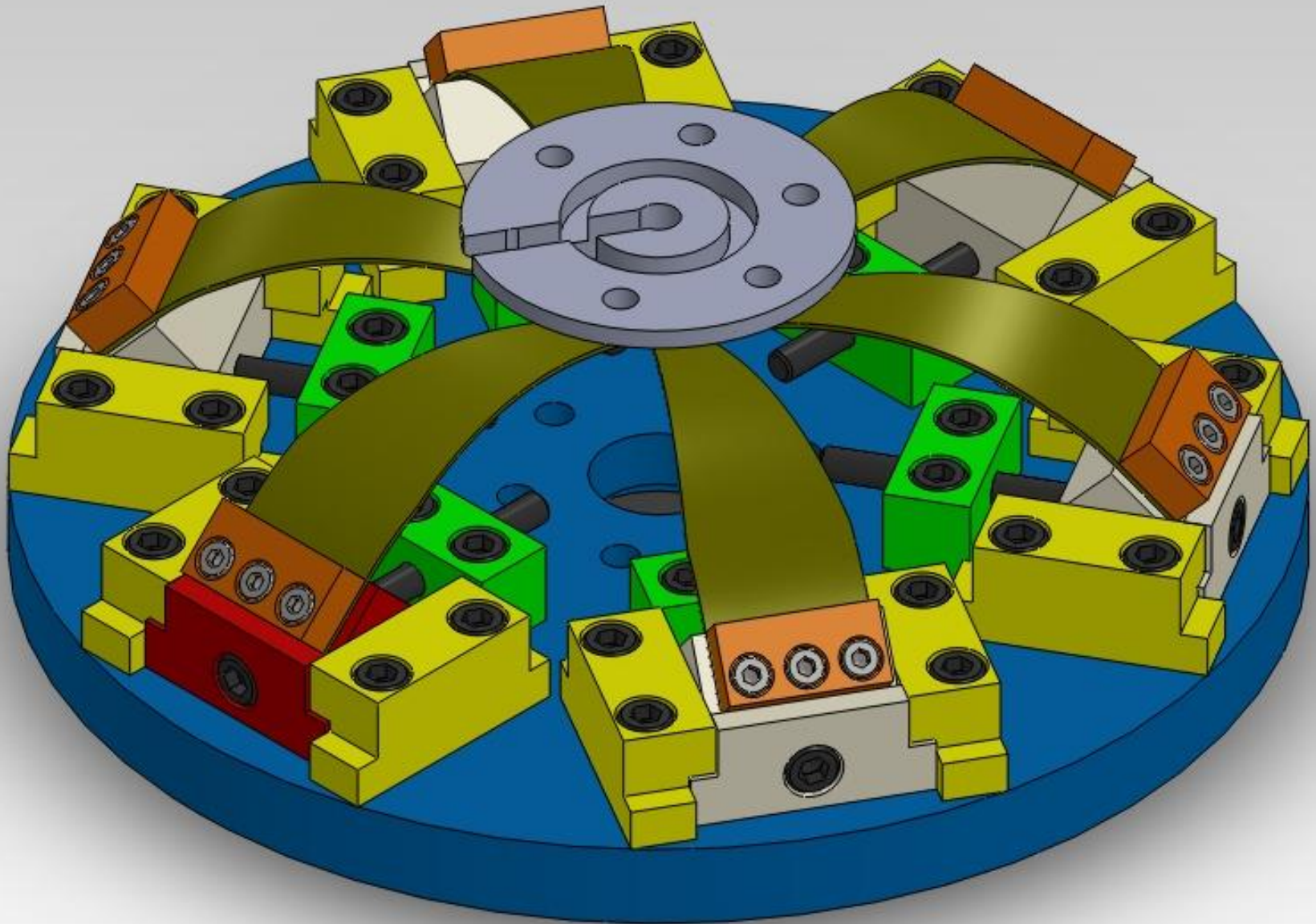
Para Horizontal-Tilting,

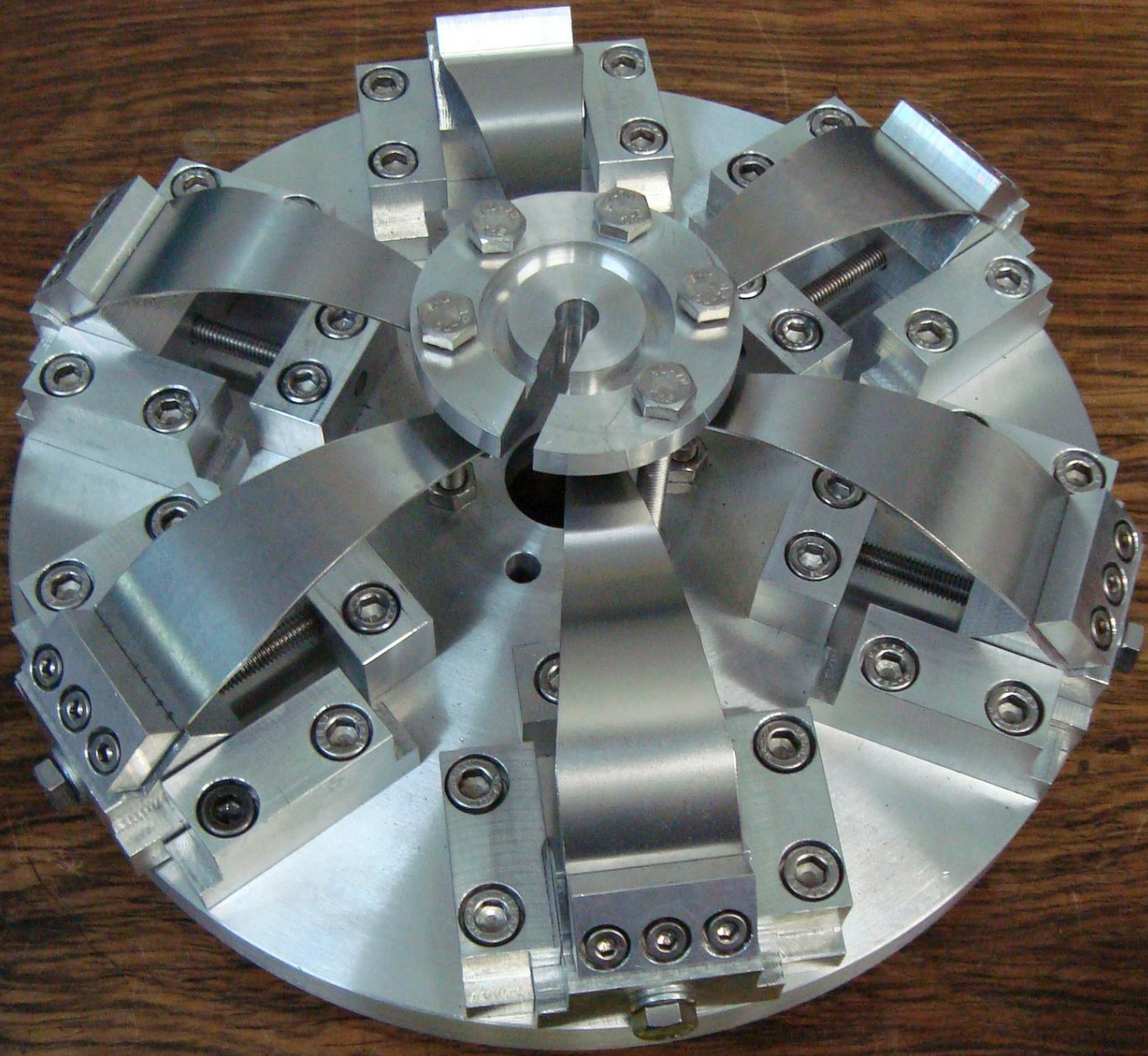
$$\left\{ \begin{aligned} m_i \ddot{x}_i &= -k_{xi} \left[\left(x_i - \frac{h}{2} \theta_i \right) - \left(x_{i-1} + \frac{h}{2} \theta_{i-1} \right) \right] + k_{x_{i+1}} \left[\left(x_{i+1} - \frac{h}{2} \theta_{i+1} \right) - \left(x_i + \frac{h}{2} \theta_i \right) \right] \\ 2J_i \ddot{\theta}_i &= h m_i \ddot{x}_i - 3k_{zi} r_i^2 (\theta_i - \theta_{i-1}) + 3k_{zi} r_i^2 (\theta_{i+1} - \theta_i) \end{aligned} \right.$$

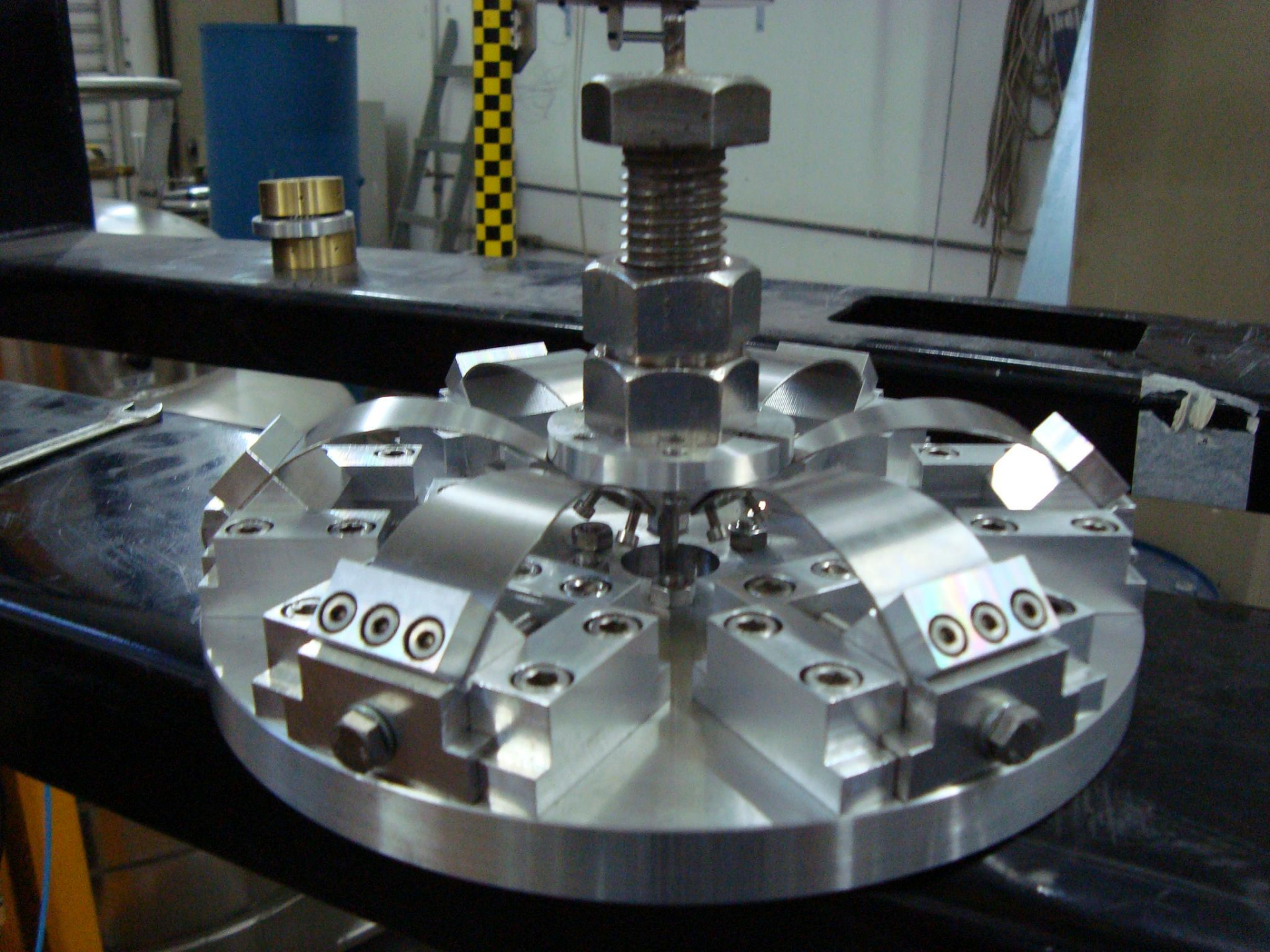




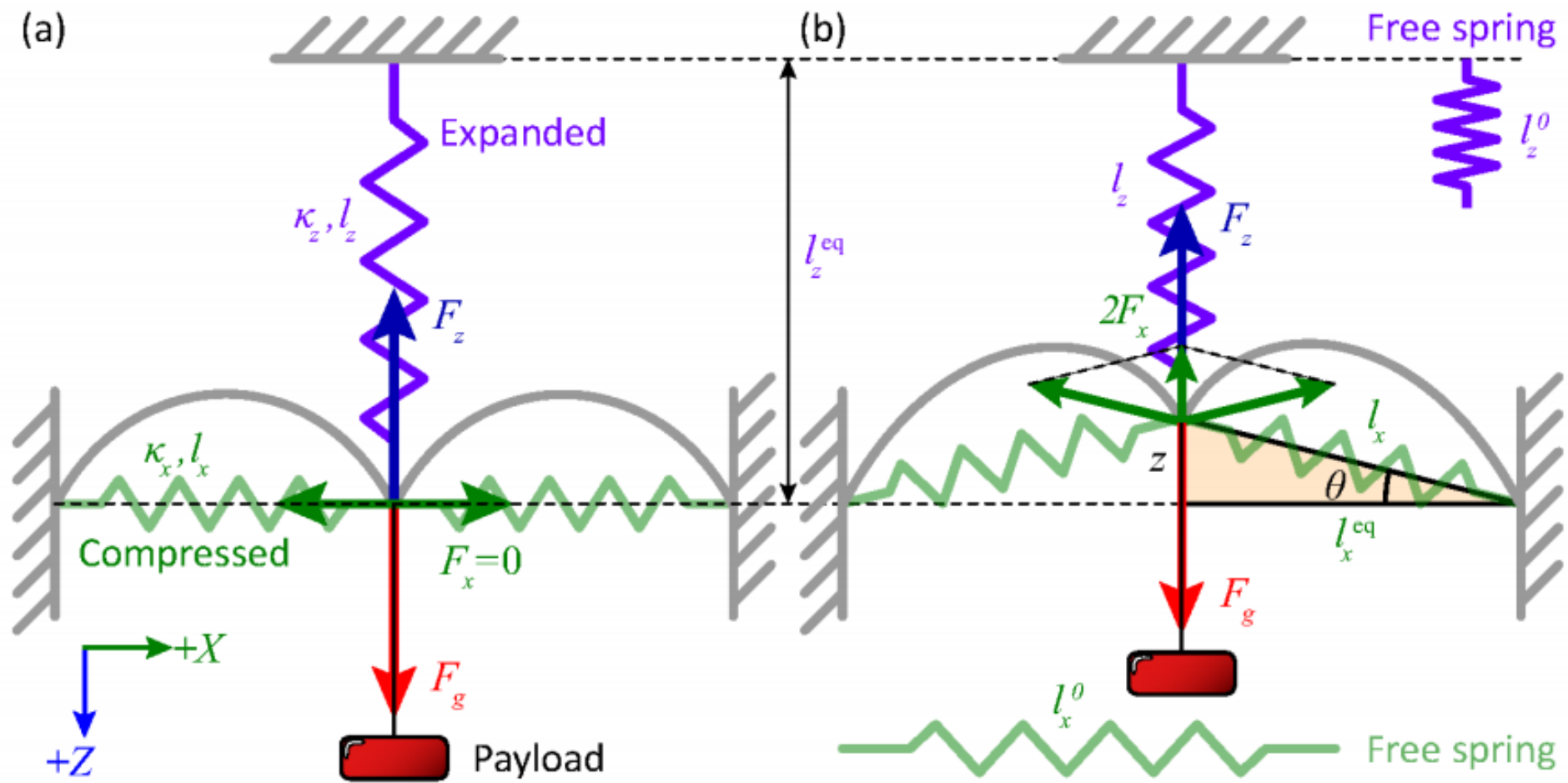
MOLA ANTI-GEOMÉTRICA



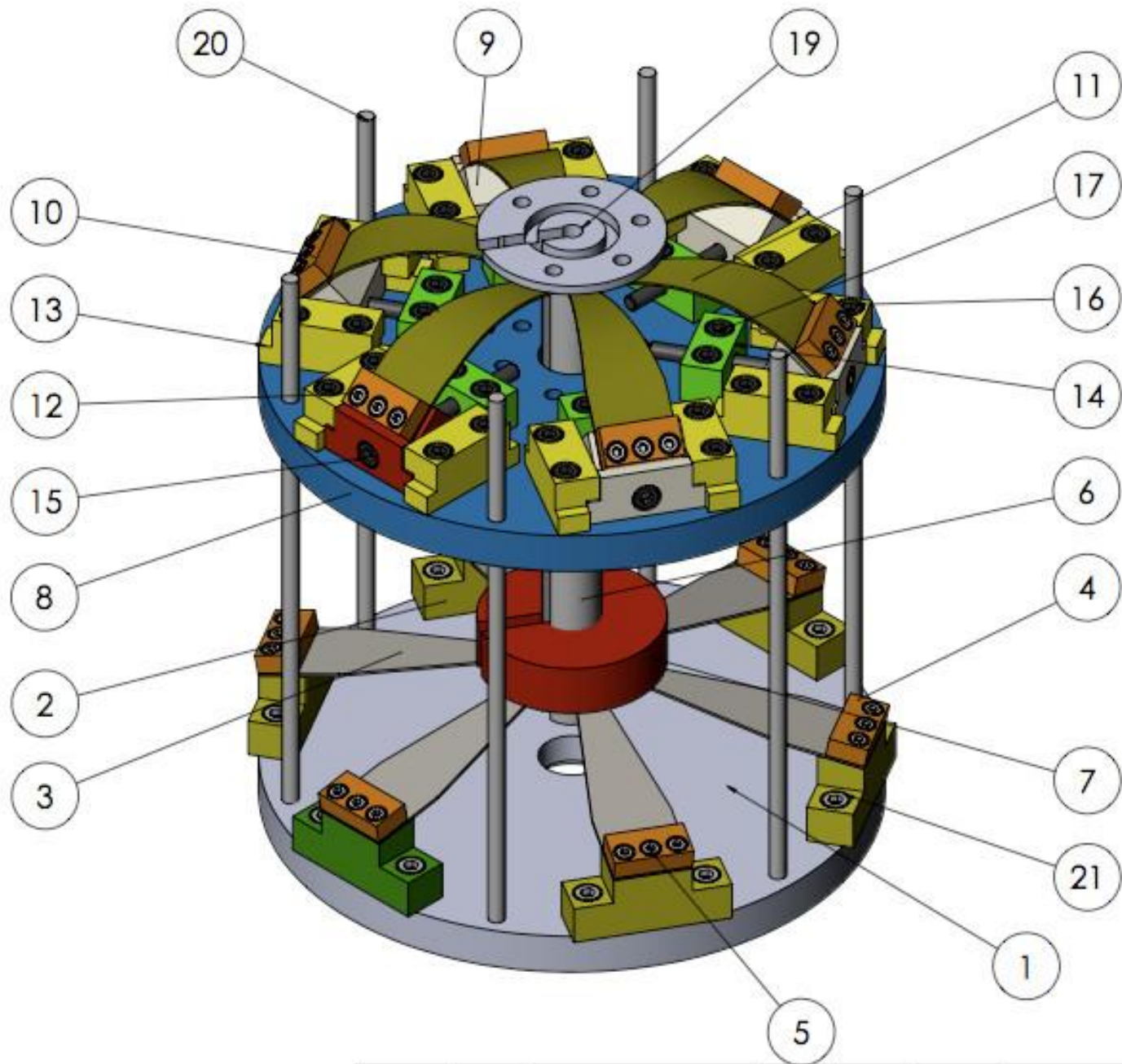








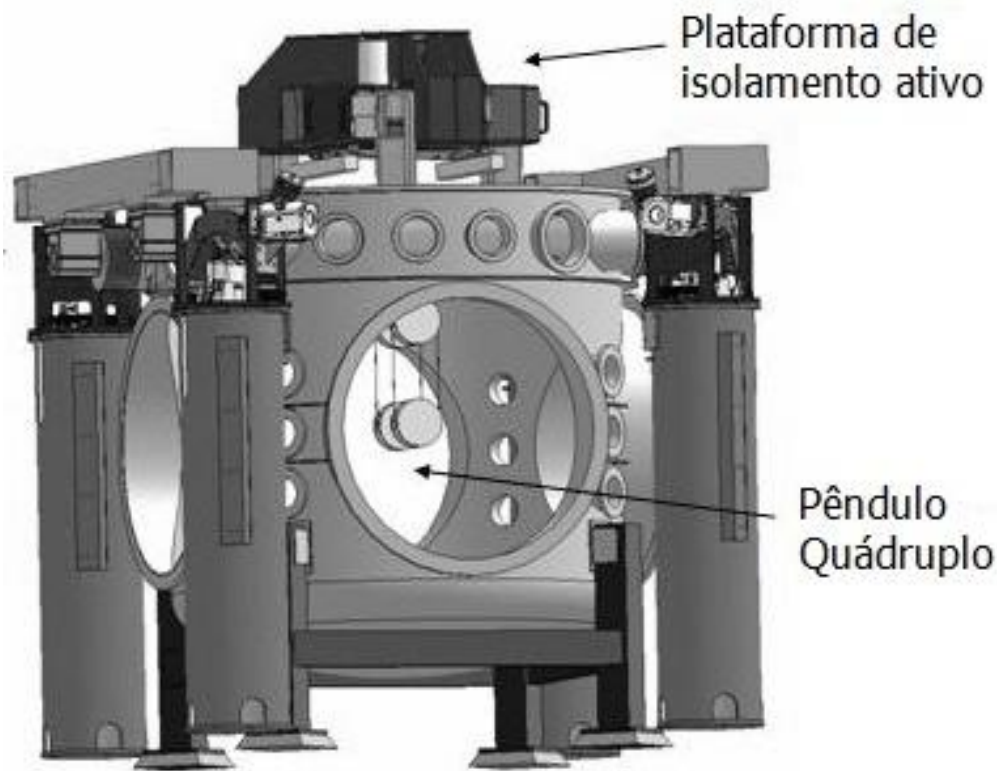
$$k_{\text{eff}} = k_z + k_x \left(\frac{l_x - l_x^0}{l_x} \right)$$

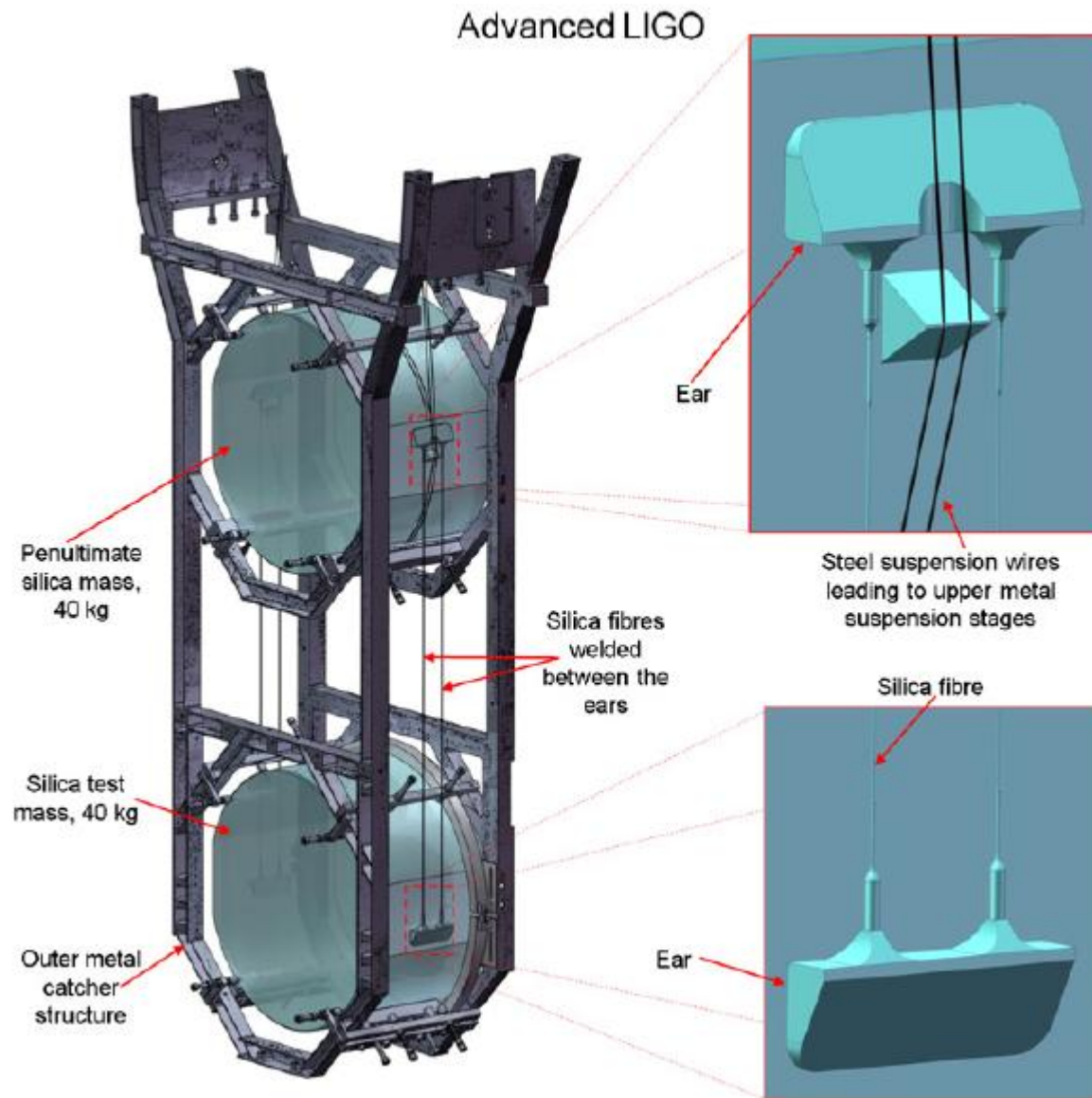




Obrigado!

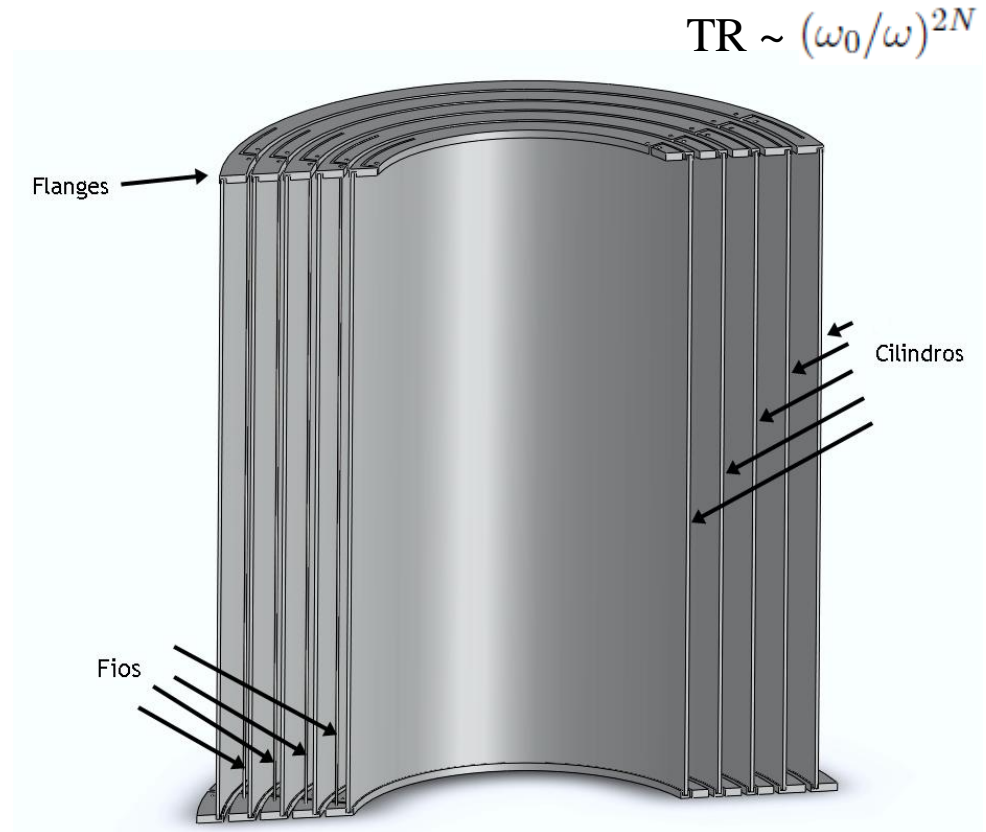
Obrigado!





DETECTOR INTERFEROMÉTRICO Sistema de Pêndulos Multi-Aninhados

Proposta do Multi-Nested Pendula (MNP): Isolamento adicional passivo em baixas frequências para o sistema de suspensão.



O movimento pendular é responsável pela atenuação de vibrações horizontais e os braços atuam como molas, atenuando as vibrações verticais.