Propellant-less propulsion based on electromagnetic resonant cavities: EM-Drive

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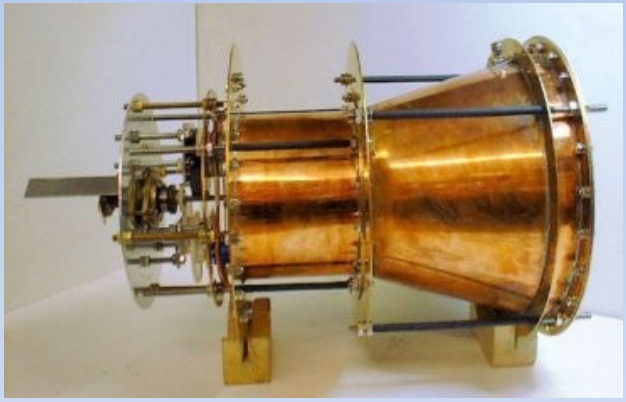
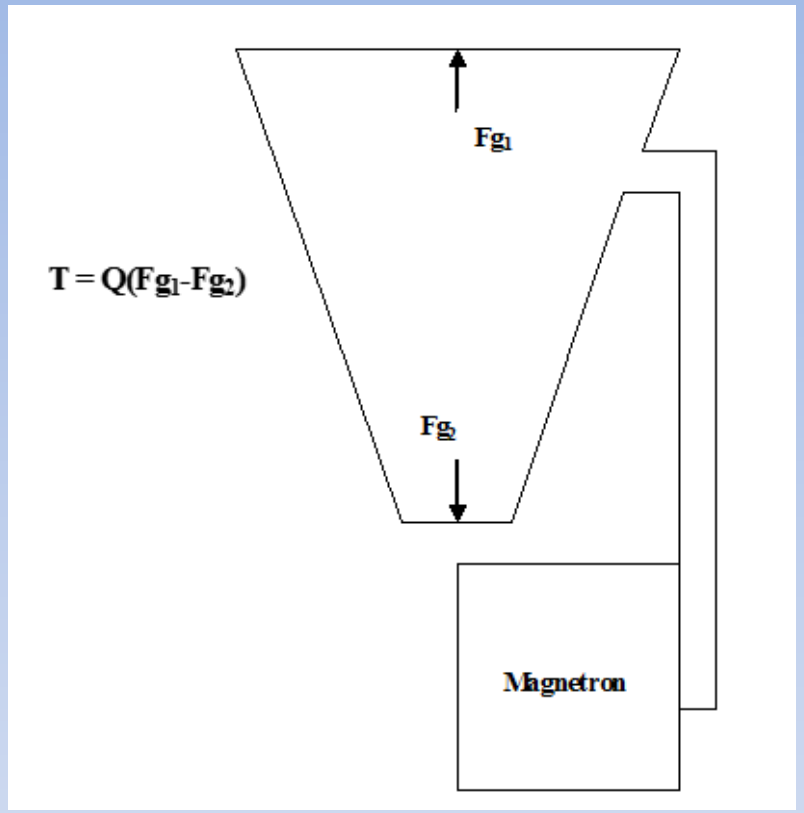
dnr: 239/15

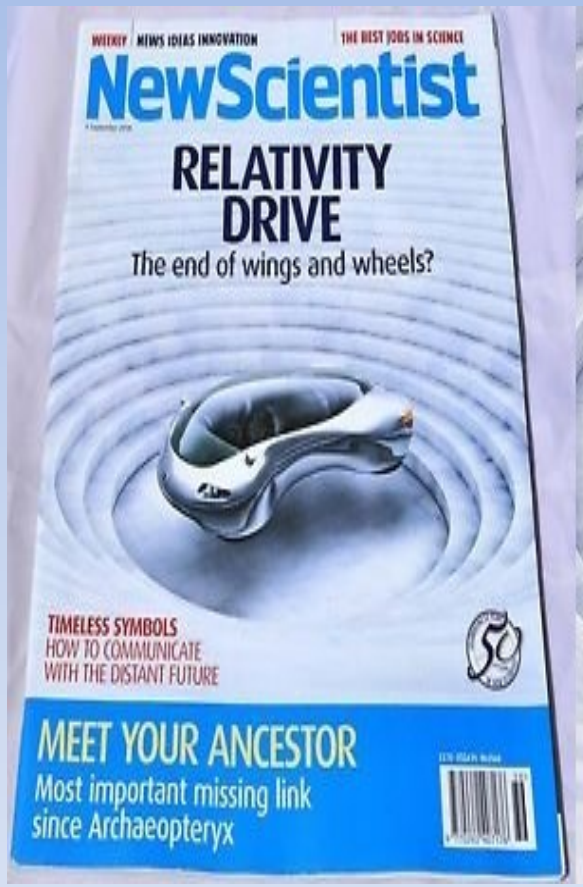
EM-Drive





Roger Shawyer's first prototype 2001

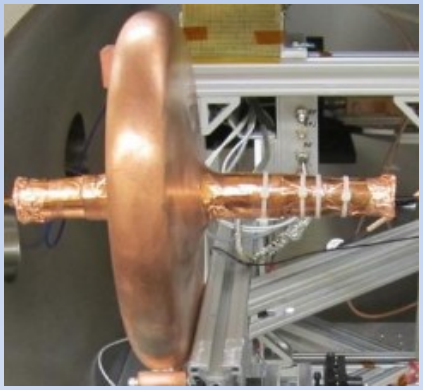
Alleged Thrust 16mN for an input power of 850W


WEEKLY NEWS IDEAS INNOVATION
THE BEST JOBS IN SCIENCE
NewScientist
RELATIVITY DRIVE
The end of wings and wheels?
TIMELESS SYMBOLS
HOW TO COMMUNICATE WITH THE DISTANT FUTURE
MEET YOUR ANCESTOR
Most important missing link since Archaeopteryx

2006

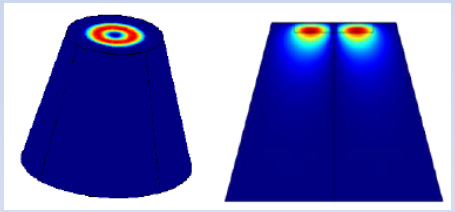
2008 *Yang Juan* Northwestern Polytechnical University (Xi'an) China 750 mN/2500 W

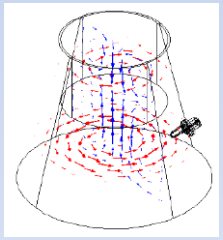
2011 *Guido P. Fetta* The Cannae Drive (Q-drive) Alleged Thrust: 8-10 mN / 10.5 W



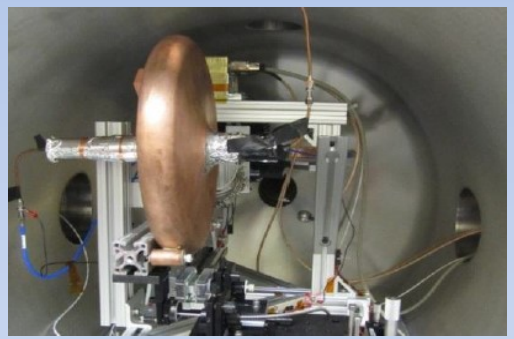
2013-2014 *Harold G. White* Eagleworks - NASA

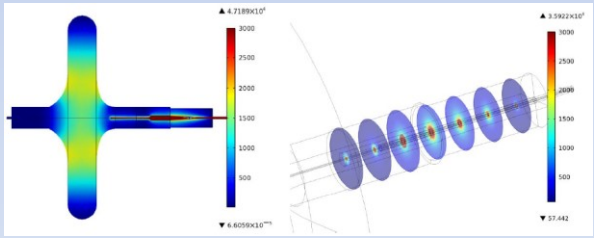
Tapered Cavity Test (EMDrive)





Cannae Test (Cannae drive)





M. Tajmar's prototype with
Waveguide, Magnetron 2015

Tajmar said that: "*Our test campaign cannot confirm or refute the claims of the EmDrive but intends to independently assess possible side-effects in the measurements methods used so far. The nature of the thrusts observed is still unclear. Additional tests need to be carried out to study the magnetic interaction of the power feeding lines used for the liquid metal contacts.*"

M. McCulloch

$$m_i = m\left(1 - \frac{2c^2}{|a|\Theta}\right) = m\left(1 - \frac{\lambda}{4\Theta}\right)$$

c is the speed of light, θ is twice the Hubble distance, a is the magnitude of the relative acceleration of the object relative to surrounding matter and λ is the wavelength of the Unruh radiation it sees

$$F = \frac{-PQl}{c}\left(\frac{1}{W_{big}} - \frac{1}{W_{small}}\right)$$

F is the force generated,
P is the input power
Q the quality factor
l the axial length of the cavity
c the speed of light
W denotes the cavity width

M. McCulloch

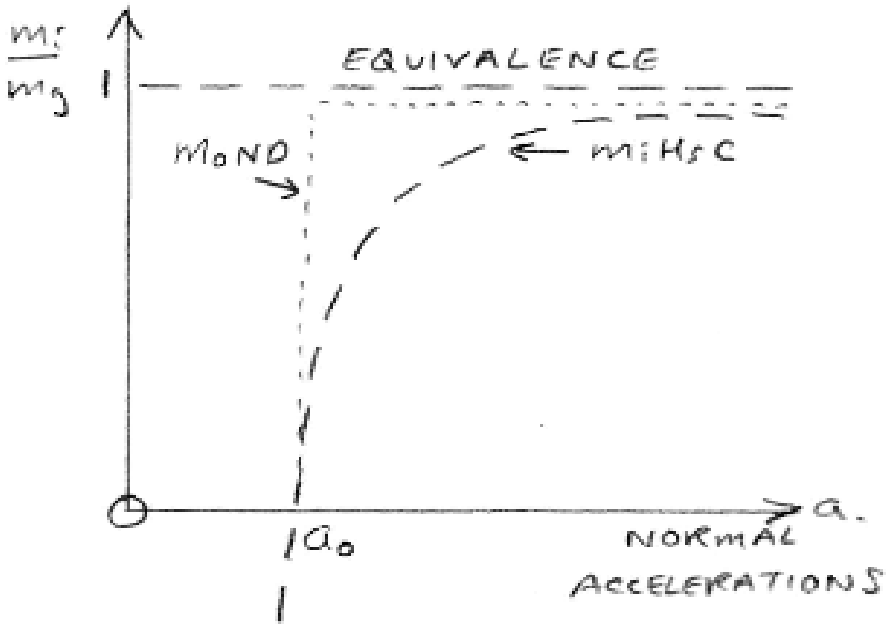
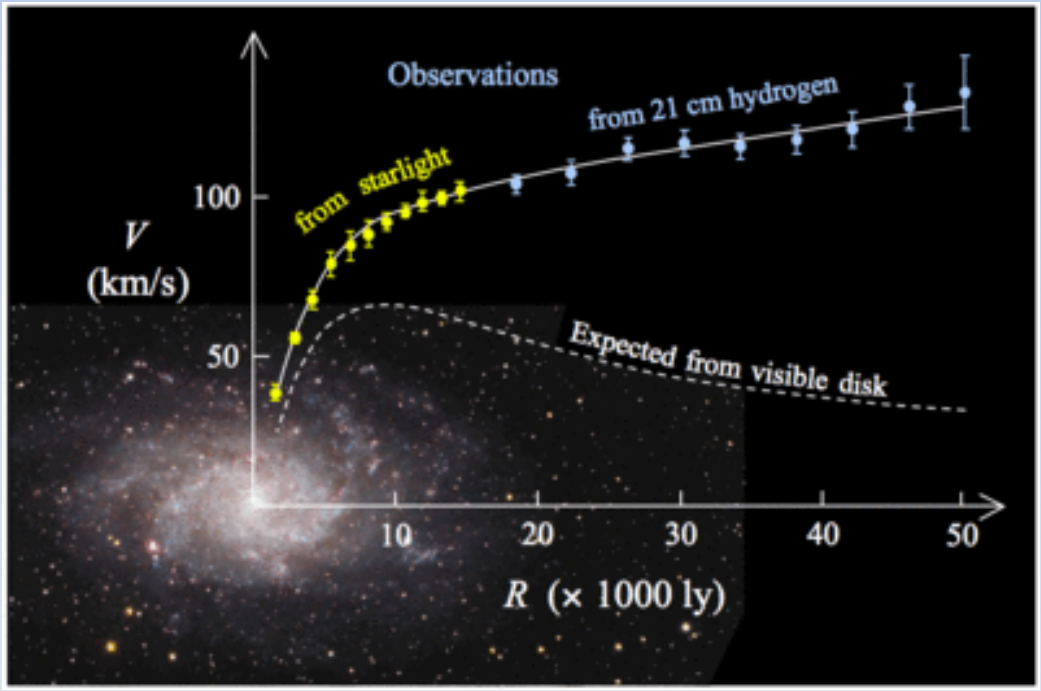


Figure 7. A graph showing the acceleration along the x-axis and the ratio between the inertial and gravitational mass along the y-axis. For the assumption of an equivalence principle there is the straight dashed line $m_i = m_g$. MoND agrees with this until the acceleration is as low as a_0 and inertial mass suddenly reduces. MiHsC approximates the equivalence principle for high (normal) accelerations, but reduces the inertial mass in a new gradual way for tiny accelerations.

Acceleration anolmaly on edges of Galaxies

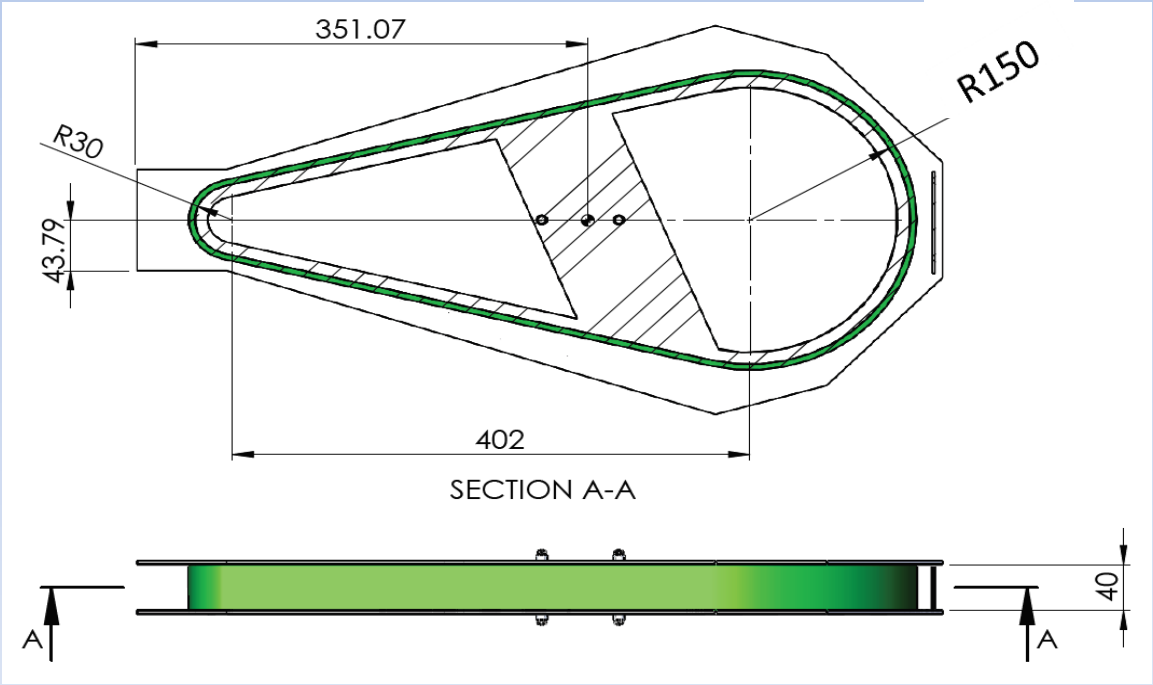
Dark Matter?

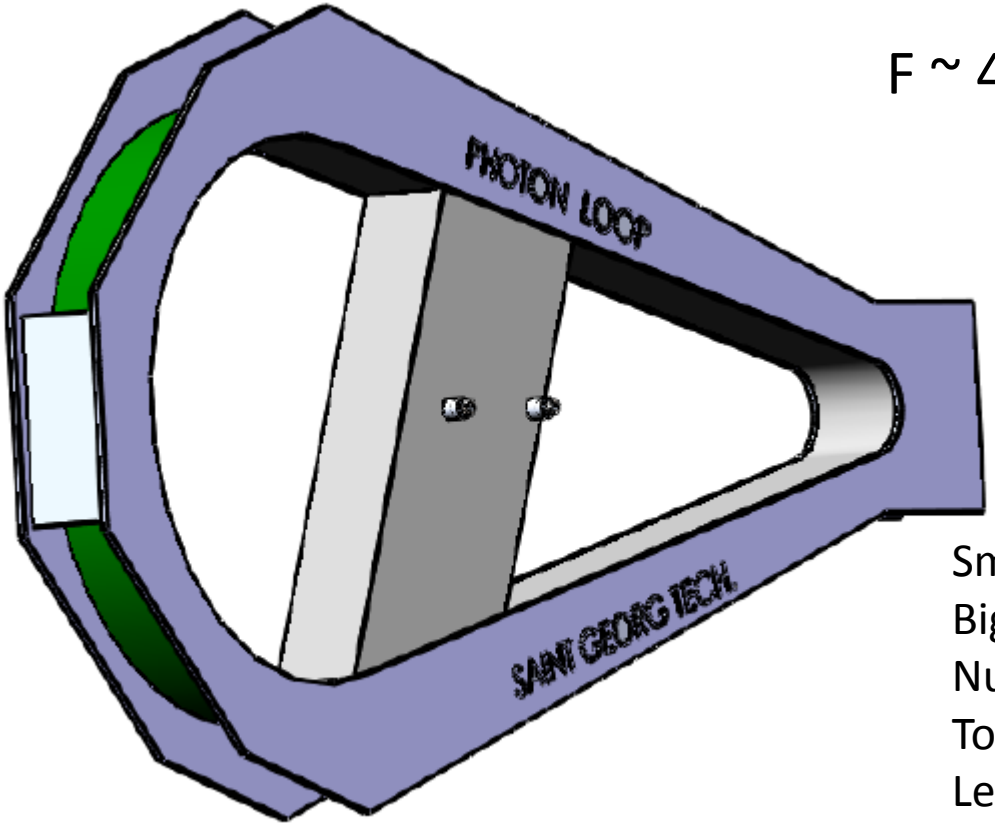
Fritz Zwicky in 1933: galaxy clusters



Rubin and Ford in the 1970s:
Saint James Way or Milky Way

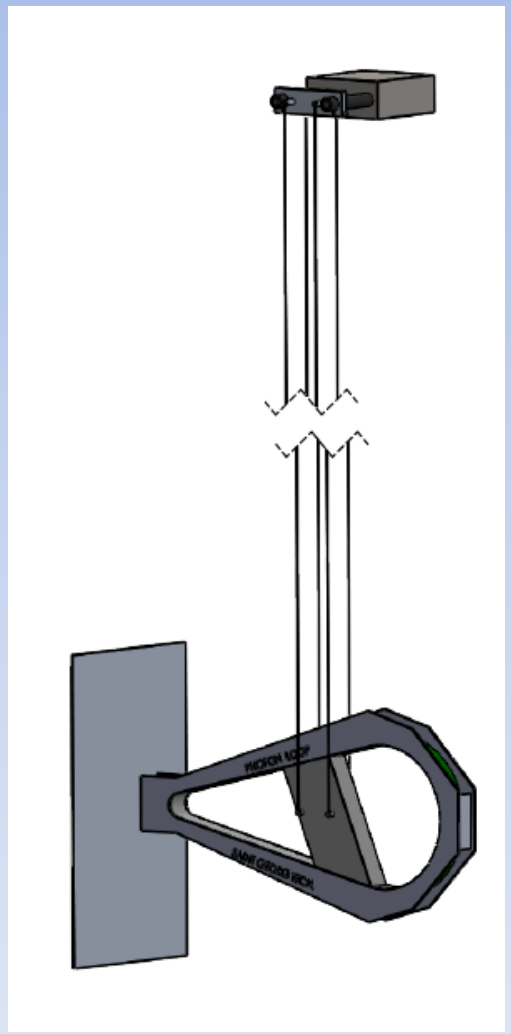
Photon-loop: a “clean” experiment

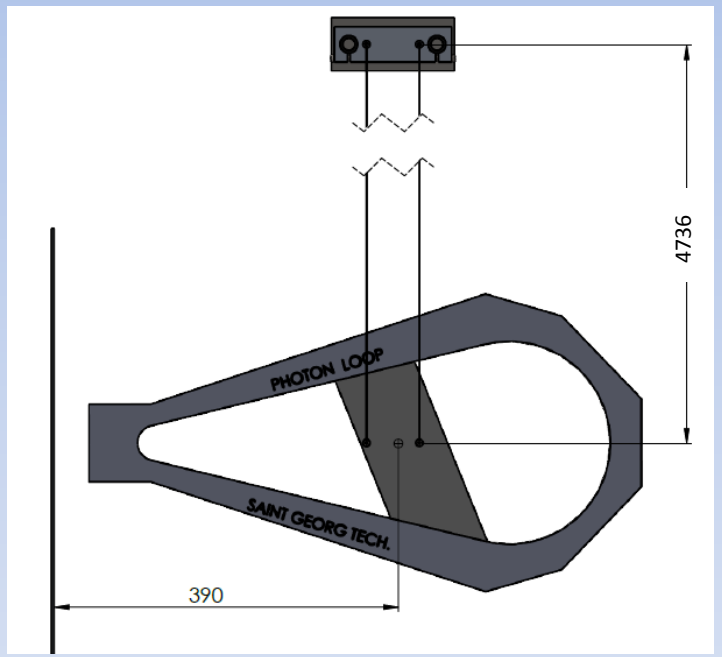




$$F \sim 4*pi*rb*PQ/c * (1/rb-1/rs)$$

Small Radius (rs): 30 mm
Big radius (rb): 150 mm
Number of turns: 2018
Total weight: 620 ±10 g
Length of threads: 4825 ±3 mm
Power of laser: 100 mW





Nominal oscillation resonance 0.2290 Hz

1 µm displacement equivalent to 1.3 µN

Q= 204.6

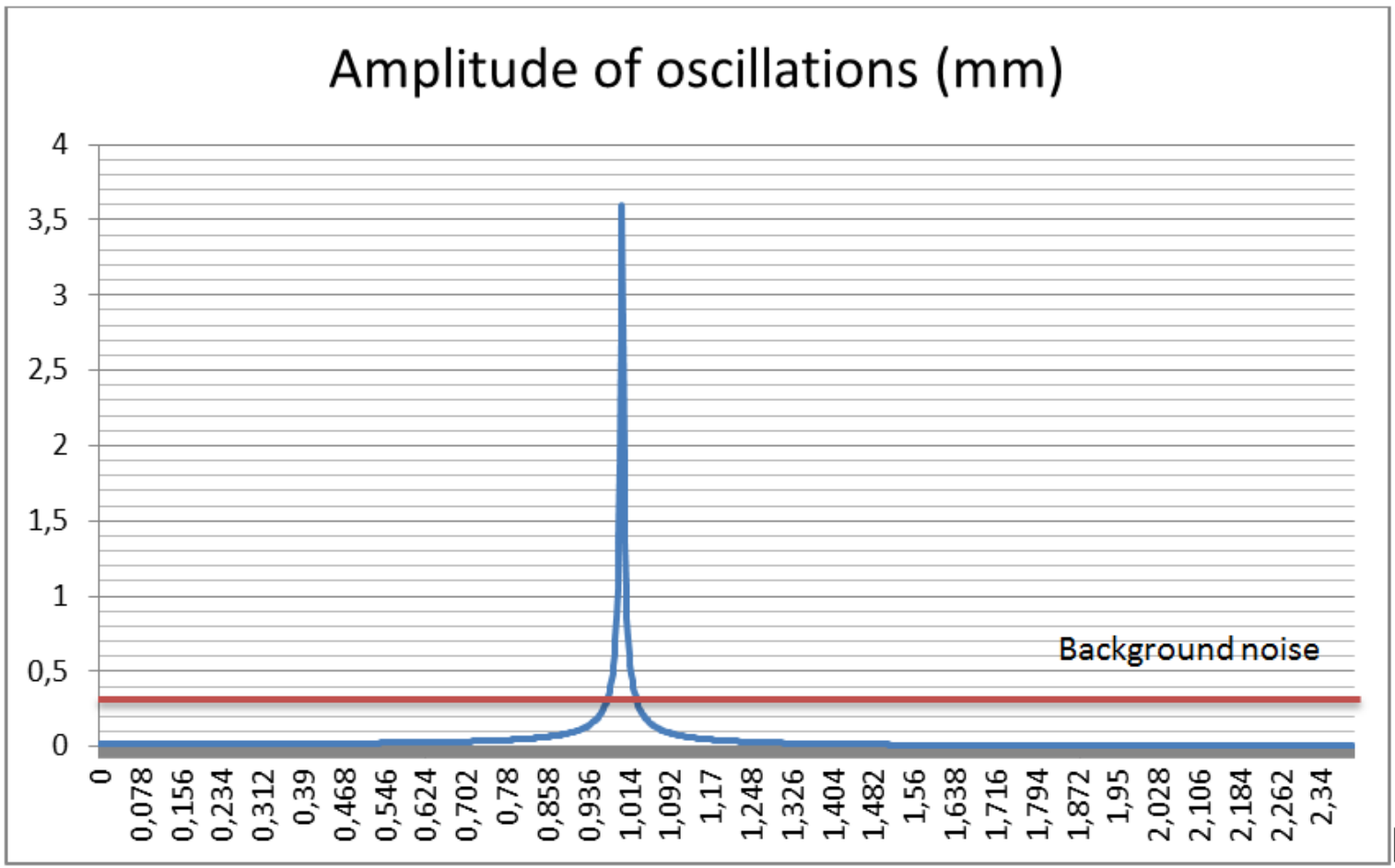
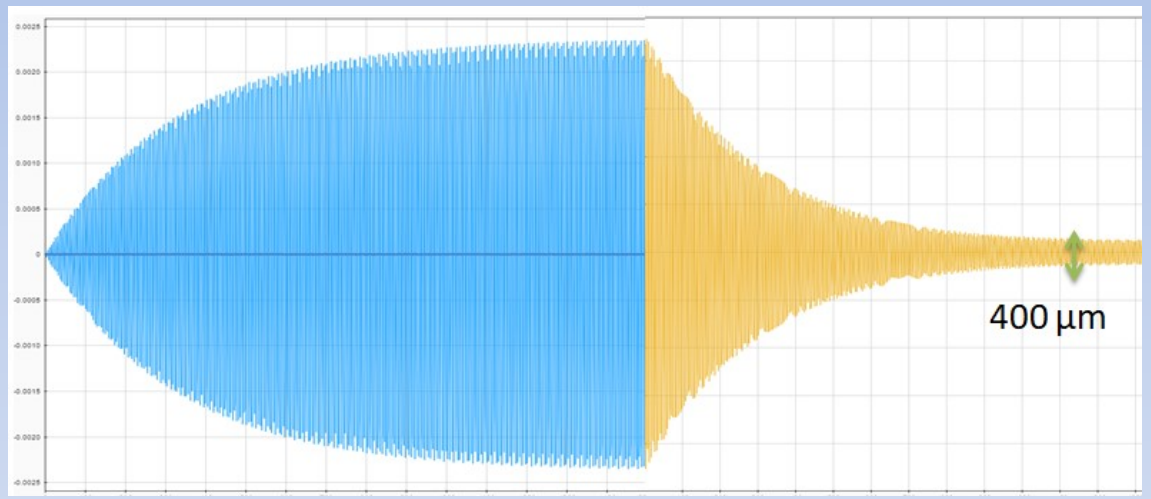
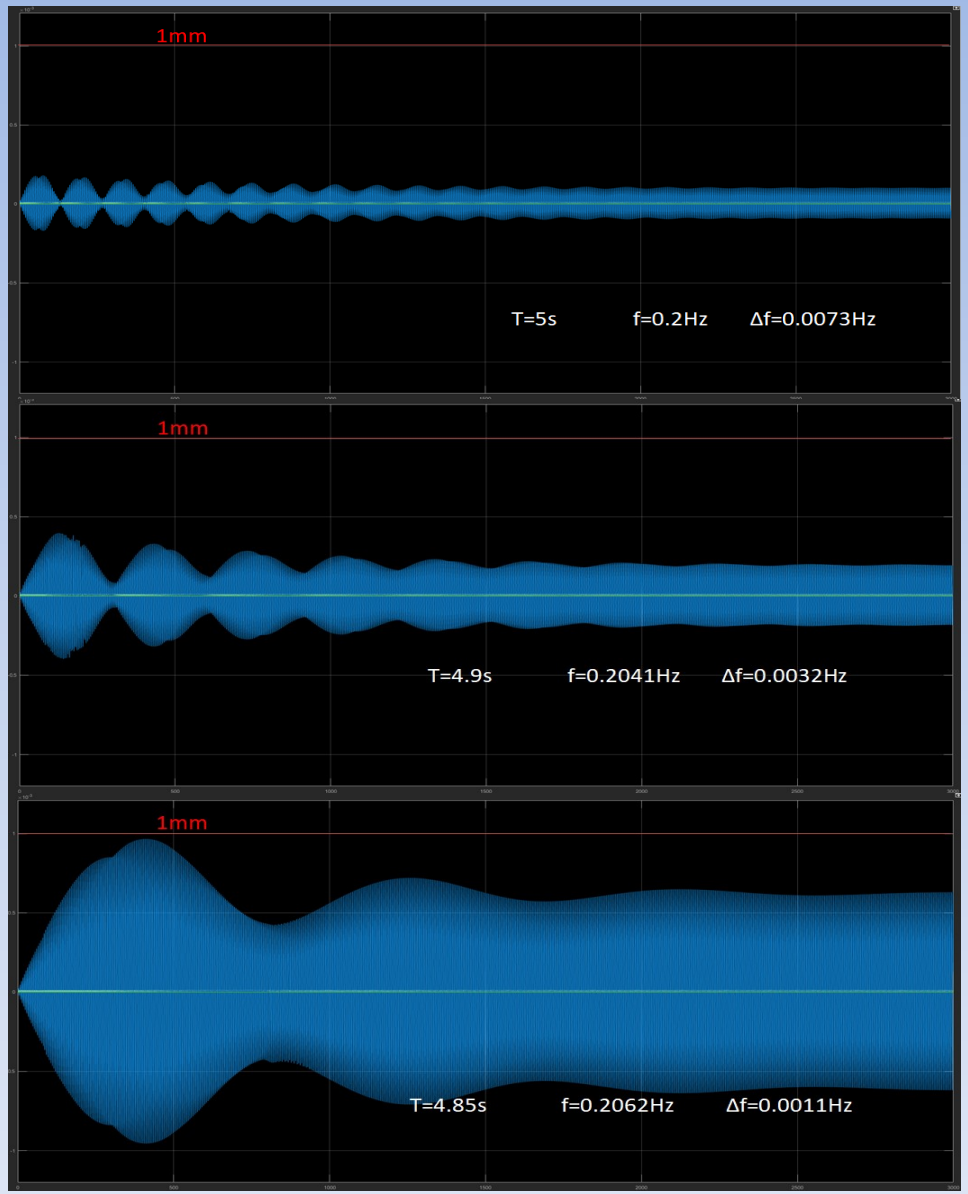
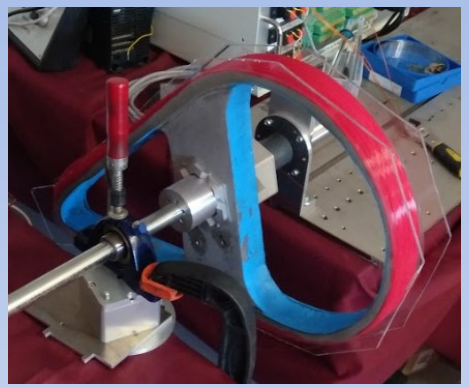
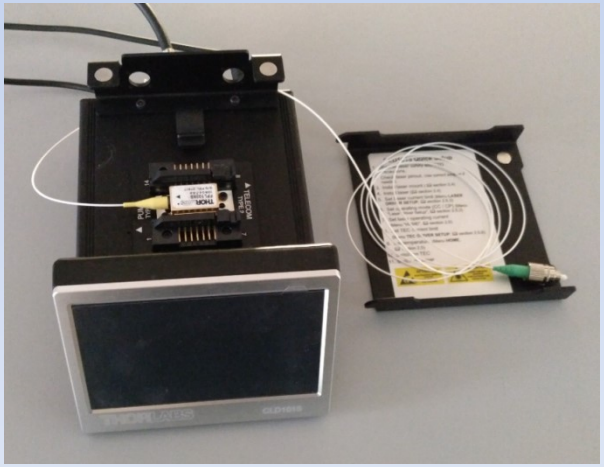


Figure 15. Plot of the amplitude of vibrations for a ratio of frequencies.

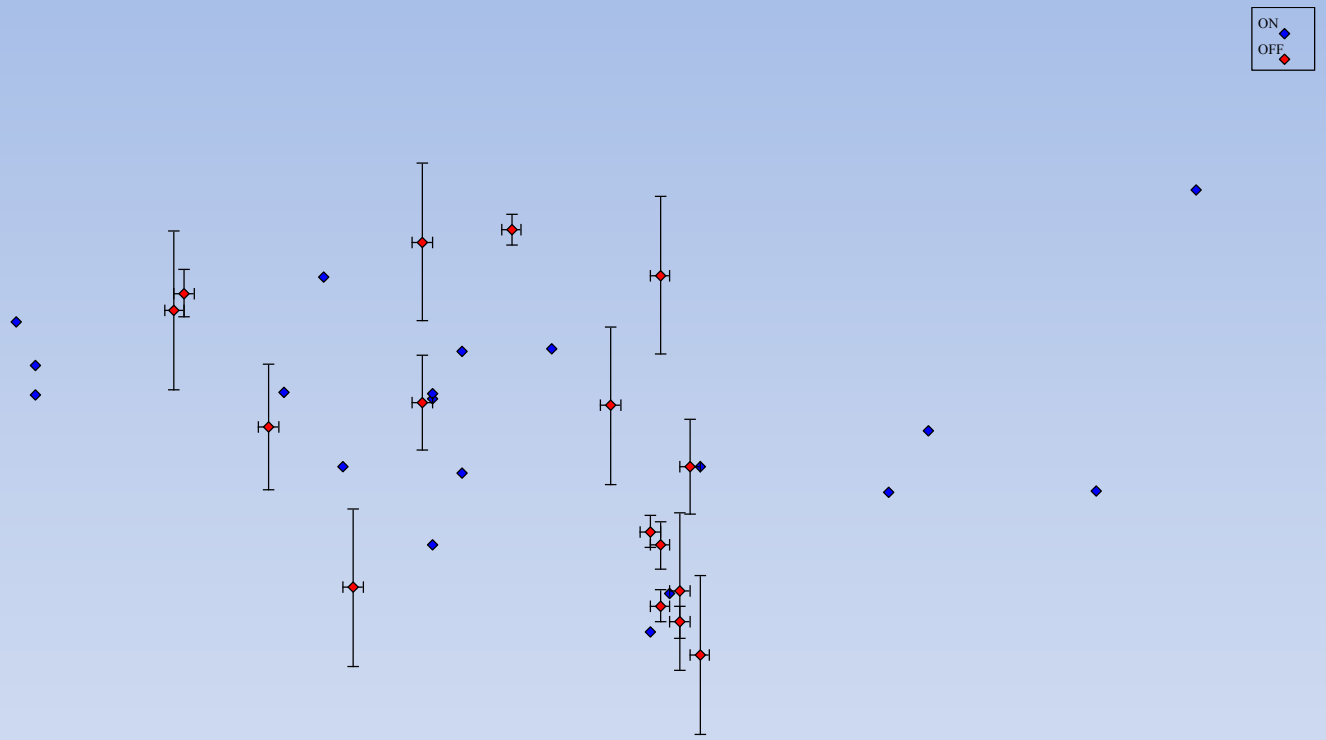

400 µm





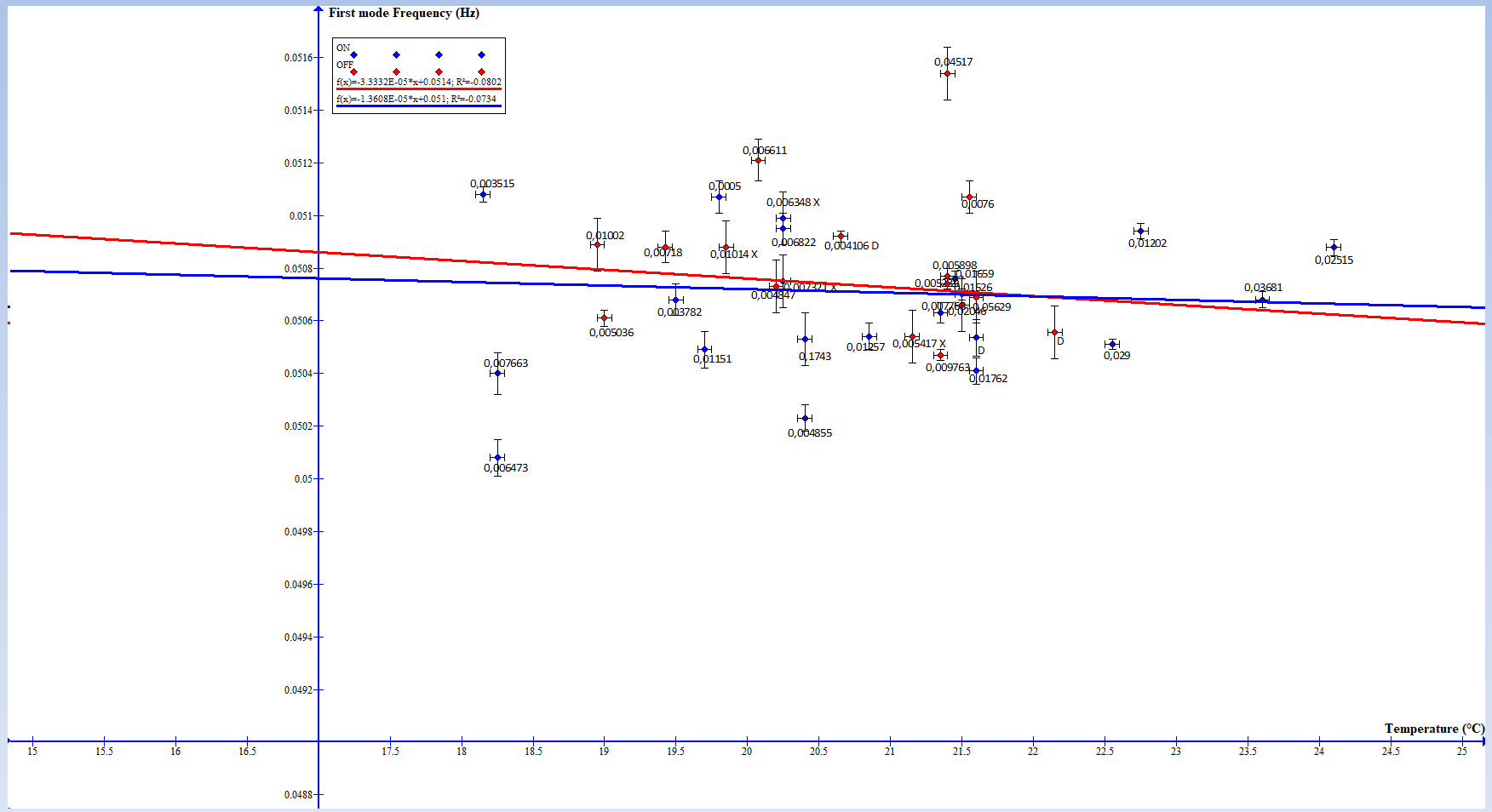


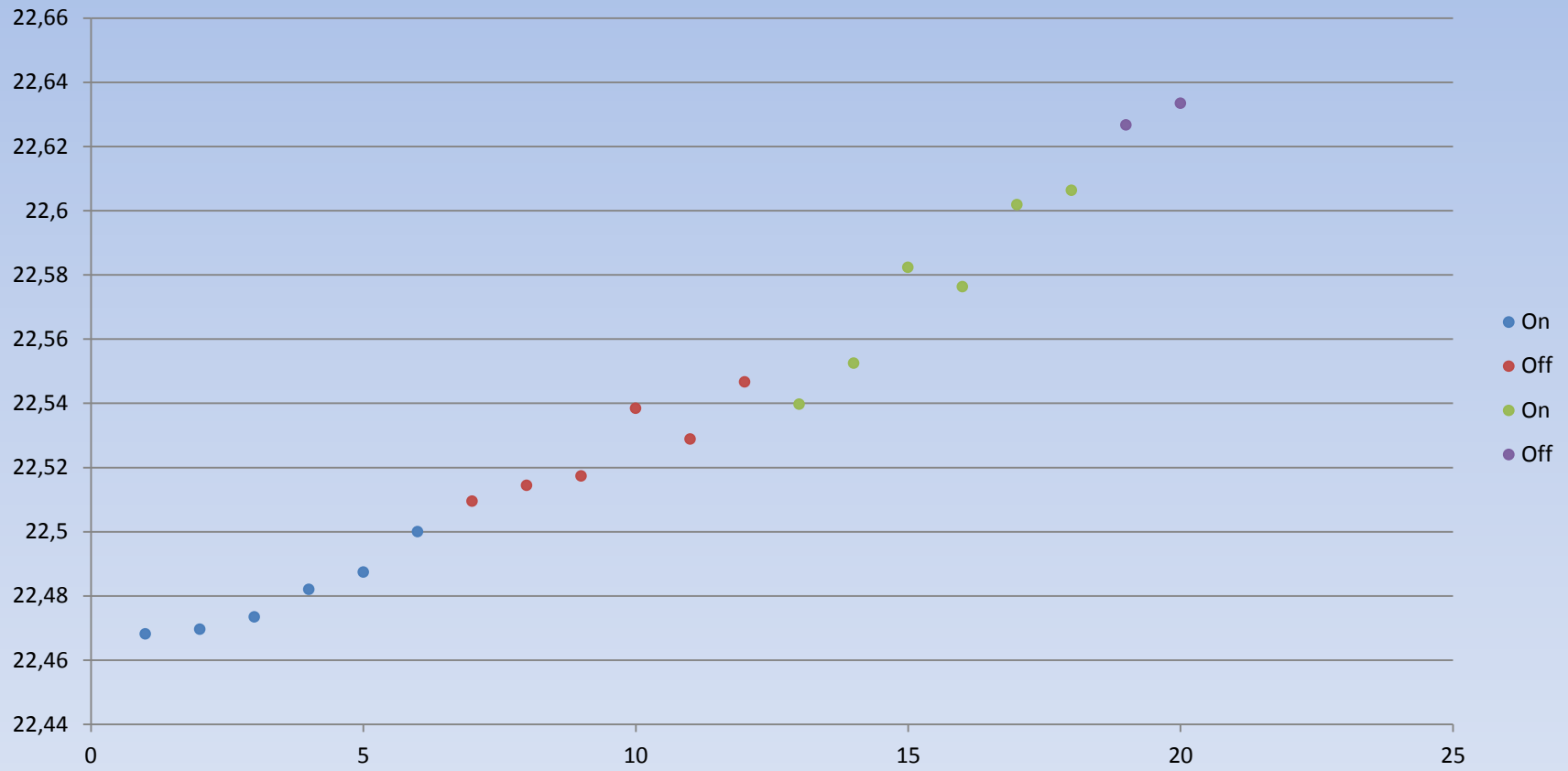

LD Current Reading
Setpoint 450.0 mA
LD Limit 470.0 mA
NR Filter ENABLED
450.2 mA
Temperature Reading
Setpoint 25.00 °C
NTC 8.198 kΩ
TEC Current 100 mA
29.51 °C
PD Current Reading
BIAS Voltage OFF
0.000 mA
LD Voltage Reading
Modulation DISABLED
1.596 V
LASER is ON
TEC is ON
MENU

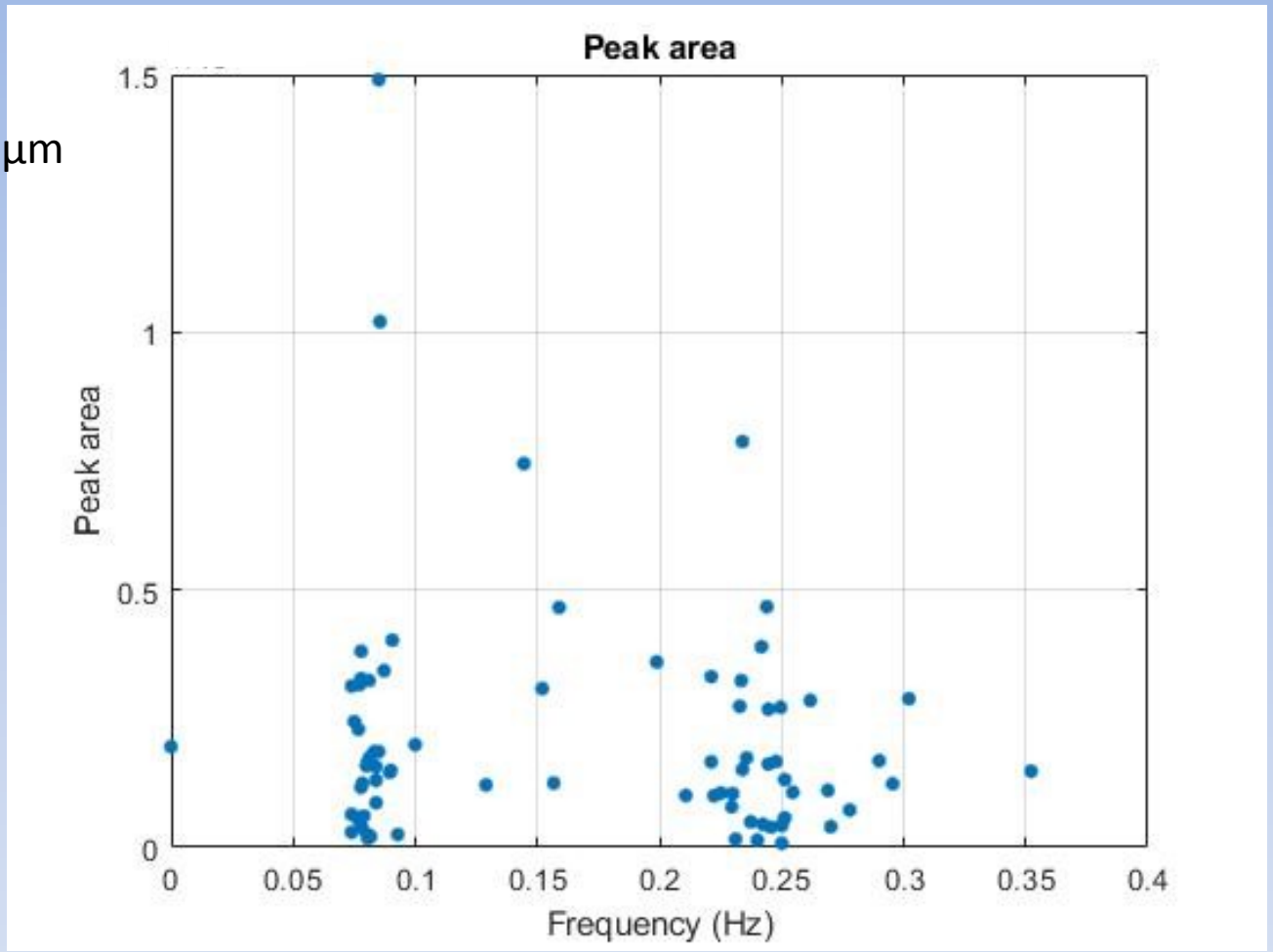


Damping ratio $\zeta = \gamma / \omega_0 = 0.00244 \pm 0.00007$

Quality factor $Q = \sqrt{k * m} / b = 205 \pm 2$

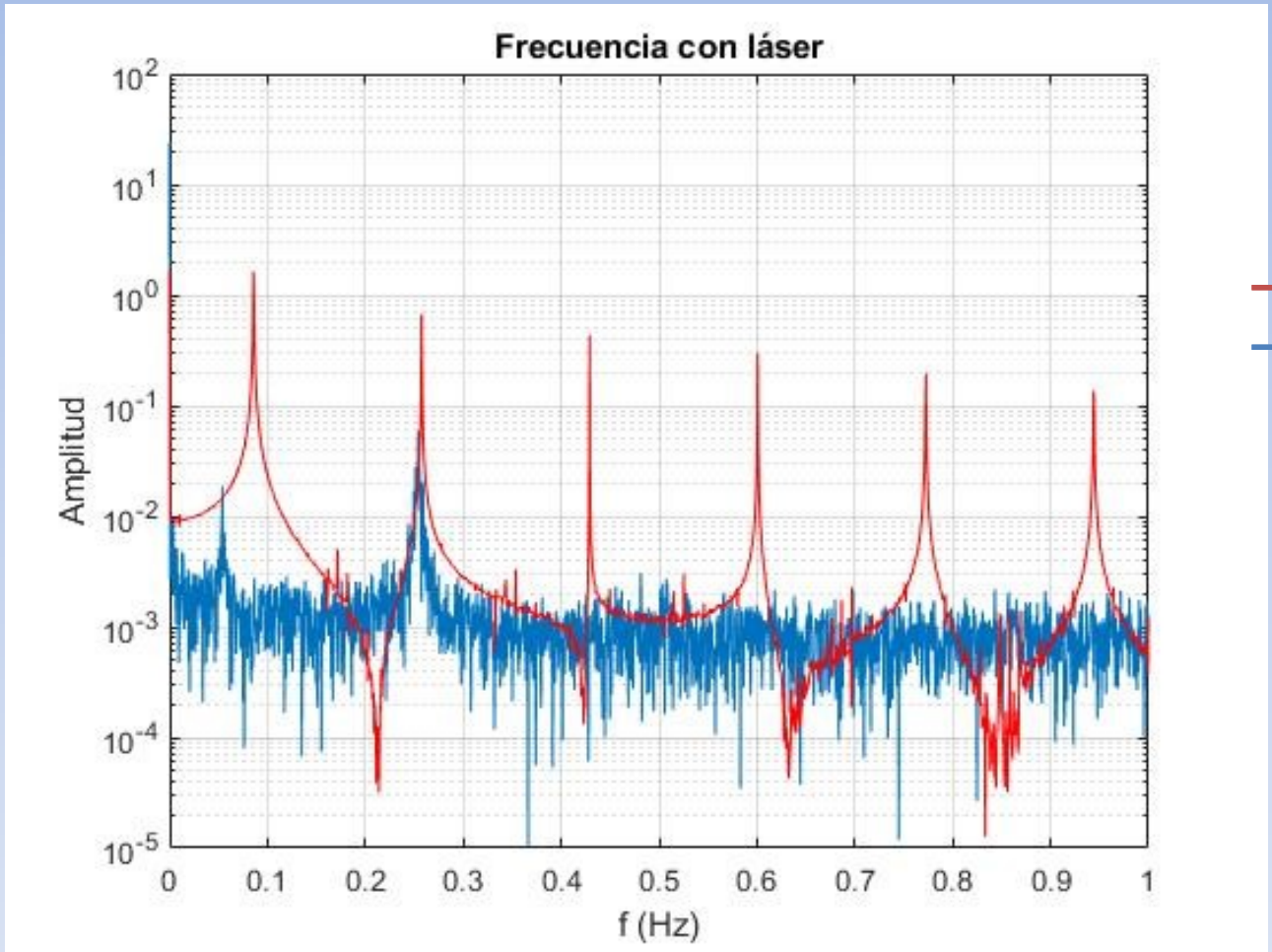

First mode Frequency (Hz)
ON
OFF
f(x)=-3.3332E-05*x+0.0514; R²=-0.0802
f(x)=-1.3608E-05*x+0.051; R²=-0.0734
Temperature (°C)
0,04517
0,006611
0,003515
0,0005
0,006348 X
0,0076
0,01002
0,00718
0,01014 X
0,006822
0,004106 D
0,01202
0,02515
0,005898
0,01659
0,01526
0,03681
0,005629
0,02046
0,005036
0,013782
0,007321 X
0,004347
0,01151
0,1743
0,01257
0,005417 X
D
0,009763
0,01762
0,029
0,007663
0,004855
0,006473


Average
22,66
22,64
22,62
22,6
22,58
22,56
22,54
22,52
22,5
22,48
22,46
22,44
0
5
10
15
20
25
On
Off
On
Off



1 µm displacement equivalent to 1.3 µN

Resonant thrust 0.04 µN/W


Frecuencia con láser
Amplitud
f (Hz)
Laser light
Pendulum position

Force due to Photon momentum absorption

Light Power= 100 mW = $dNp/dt \cdot h \cdot \nu$

$= dNp/dt \cdot c \cdot h/\lambda$

$P=h/\lambda$

Force = Power/c = $3x10^{-10}$ N = $3x10^{-4}$ μN

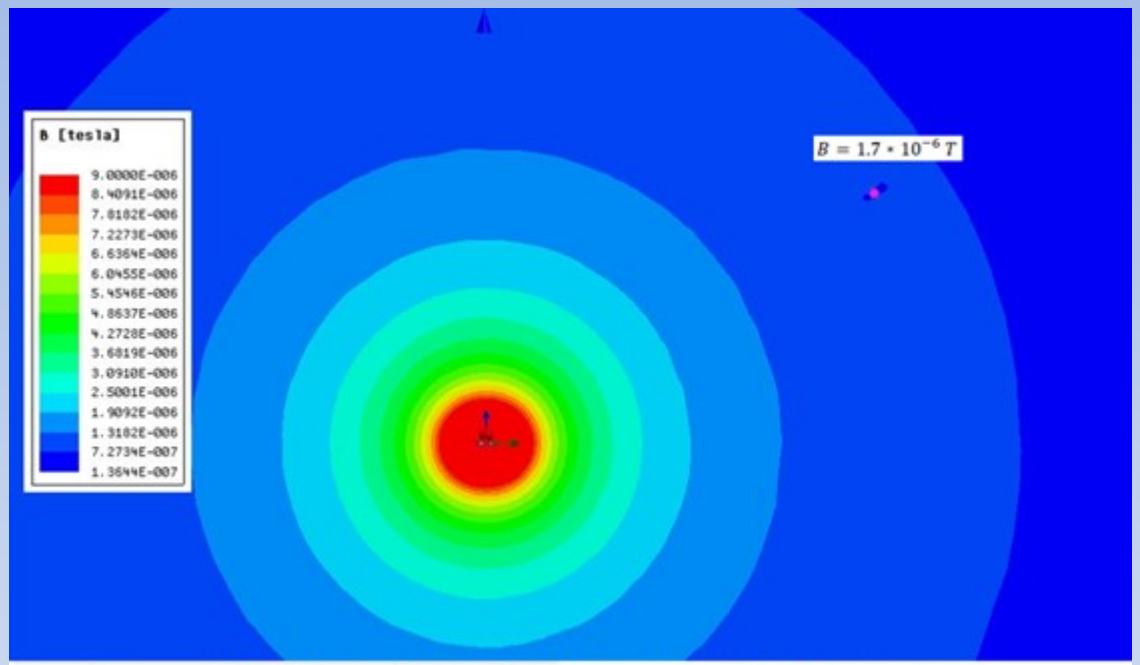


Figure 3. Magnetic field B and force on the nuts in the FEM simulation.

Magnetic Force ~ 2×10^{-10} N

Conclusions

- There is a photon-thrust effect in the amplitude (4 times larger than noise level - third harmonic)

- Magnetism, thermal, photon momentum and any opto-striction effects are estimated to be much smaller.

- Is eventually Dark matter not needed **?** !

Acknowledgements

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