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Aim of the project:

- > Study dust formation in SiH₄ plasmas with CRDS
- > Define the collective behaviour of a dust cloud
- > Prepare micro-gravity experiments for ISS*

*International Space Station

Cavity Ring-Down theory:

- > A certain number of photons is trapped in an optical cavity and radiation begins to leak out of it
- > Record the exponential decrease of radiation
- > For a given wavelength λ , the decrease (ring-down) time τ depends on the gas absorption coefficient α and the cavity properties (mirror reflectivity R , cavity length L , broadband scatter processes)

$$\tau = \frac{L}{c} \times \frac{1}{(1-R) + \alpha L}$$

$R = 0.997$; $d = 1 \text{ m} \rightarrow \tau_0 = 1 \text{ ms}$

$\Delta\tau_{\text{min}} < 1 \text{ ns} \rightarrow \alpha < 10^{-6}$

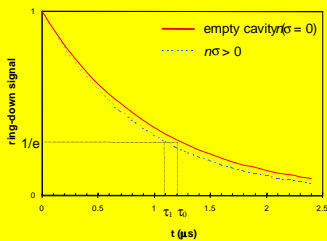
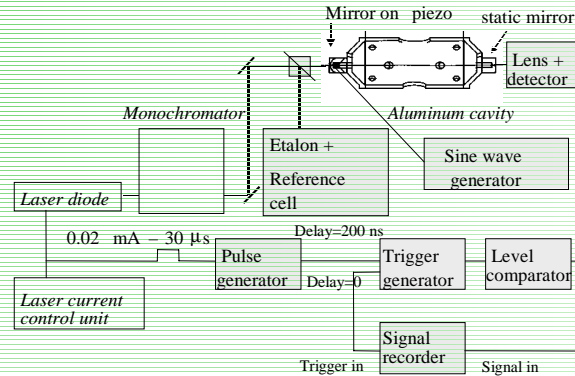


Fig. 1: Theoretical ring-down signal

Set-up:

- > Helium cooled infrared laser diode (wide tuning range, narrow line width)
- > Plano-concave ZnSe cavity mirrors ($R > 99.7\%$, radius of curvature 1 m)
- > LN₂ cooled InSb photodiode detector

CRDS and infrared detection principle:



First results :

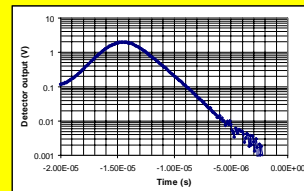


Fig. 2 : Ring-down with a CO laser at 5.518 μm
 $\tau = 1.54 \mu\text{s}$

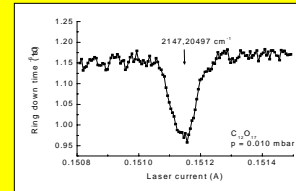


Fig. 3 : Spectroscopic ring-down measurements of CO

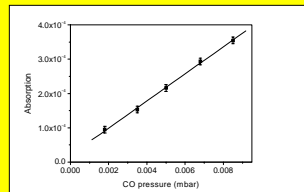


Fig. 4 : Absorption as a function of CO pressure

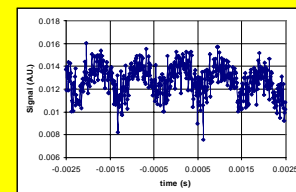


Fig. 5 : Laser diode beam through the cavity

Ring Down Cavity figures:

- > Effective absorption path length: 350 m
 - > Cavity beam waist: 1.72 mm
 - > Spot size on the cavity mirrors: 2.4 mm
 - > Free Spectral range :150 MHz
 - > Fundamental mode FWHM: 100 kHz
- } Finesse = 1000

Current fields of investigation:

- > Laser diode Off-Axis Parabola focus adjustment

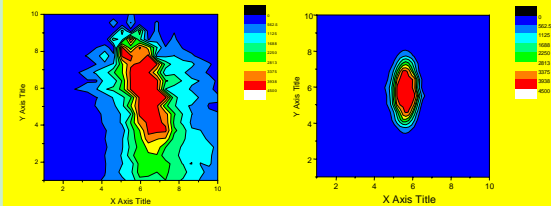


Fig. 6 : IR laser beam focused at 3.30 m from OAP (No HeNe beam splitter, no monochromator)

Fig. 7 : IR laser beam focused at 3.30 m from OAP (with HeNe beam splitter, no monochromator)

> Monochromator optimization

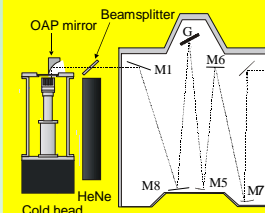


Fig. 8 : Monochromator improved set-up

- M1 3" gold coated plane mirror
- M8 2" gold coated plane mirror

WHY?

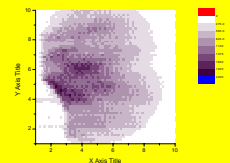


Fig. 9 : Size of the beam at the OAP output