

Low Frequency Facility

Approved by the Virgo Collaboration:

Lyon, Nice, Paris–ESPCI, Orsay–LAL
Firenze, Frascati, Napoli, Perugia, Pisa, Roma1

Firenze–Urbino, Napoli, Pisa, Roma1

International Collaboration with:

University of Taiwan

ACIGA: Adelaide, Camberra, Perth

LFF People

- ② Firenze–Urbino: E. Cuoco, P. De Natale, C. Ricci, R. Stanga and F. Vetrano
- ② Napoli: M. Fiorentino, S. Gasparoni, A. Porzio and S. Solimeno
- ② Pisa: V. Chickarmane, A. Di Virgilio, A. Giazotto, G. Losurdo and D. Passuello
- ② Roma1: E. Majorana, P. Puppo, P. Rapagnani and F. Ricci
- ② J–S Wu and JS Chang (Taiwan) and F. Benabid (UWA Perth)

LFF and Virgo

- ② Below 600 Hz, the Virgo sensitivity is dominated by the Thermal Noise of the suspensions SA
- ② *The low frequency region is of great interest for coalescing and periodic signal*

Low Frequency Facility

Goal: to select future Virgo Suspension, in order to improve the antenna for $\nu < 600$ Hz.

The goal implies the direct measurement of pendulum thermal noise outside resonance

The R&D SA, equal to the Virgo suspension, is located inside the Pisa INFN section.

Two mirrors, arranged as a Fabry–Perot cavity, will be attached to the R&D SA

The displacement sensitivity will be 10^{-18} m/sqrt[Hz] at 10 Hz, using an ultra–stable Nd–YAG source

R&D SA

A suspension, called R&D SA, has been assembled inside the INFN Pisa section. Work is in progress to well understand the R&D SA control features:

the inertial damping has been working before summer 1999

(see G. Losurdo in Amaldi 1999 proceedings, and Urbino School proceedings)

Recently we have measured the transfer function for the internal forces produced between the steering filter and the marionetta to the test-mass, up to 10 Hz, in all degrees of freedom, and cross couplings among degrees of freedoms

(Marina Pasotti Thesis, to be completed March 7, 2000)

The near future plan is start applying feed-backs to the test mass

Optics

A short Fabry–Perot Cavity has been assembled and studied: all signals have been extracted and feed–backs applied using the Virgo digital electronic (*A. Di Virgilio et al., "Reflected wave–front sensing computation and experimental digital control of a cavity", Il Nuovo Cimento, Vol 114 B, 10, pg 1197–1210*)

The frequency stabilization circuit, equal to the Virgo prestabilization one, is working (*VI ICSSUR (1999) proceedings, and F. Benabid et al. "The Low Frequency Facility, R&D project of the Virgo", to appear in special issue of Journal of Optics B, 2000*)
the whole circuit has been assembled on the optical table, in order to make working together the two circuits

Future Transducer

At the beginning the suspended cavity will be a 1cm stable cavity. Later on, in order to increase the sensitivity by a factor 100, the transducer has to be changed.

In order to reduce the frequency fluctuation induced noise, a possibility is to make a very short (less than 1 mm) cavity, with flat mirrors. Studies are in progress in order to well address this problem (*P. LaPenna et al. "Transmittivity profile of high finesse plane parallel Fabry–Perot cavity illuminated by Gaussian beams", Optics Communications 162 (1999) 267–279*)

The AX suspensions

In order to suspend two mirrors to the R&D SA, we have to attach one more mirror, called AX.

We have studied the thermal noise of the AX done by a suspended small mirror (few kg), loaded with an extra mass, in order to override radiation pressure noise (*G. Cella et al. , "Suspension for the Low Frequency Facility", accepted by Phys. Lett. A*)

The noise of the AX is close to the Virgo one around 10 Hz if the AX suspension is monolithic

Changing the loaded mass dissipation dilution effect can be studied

Changing the last mass, creep can be studied as well looking the violin modes

Summary

- ② Study on the optical table the whole optical lay-out, and be ready for installation on front of the R&D SA
- ② continue the work on the test mass control, using the LVDT array signals, in air and in vacuum
- ② objects to be completed: AX and test mass with holder (Rome), array of LVDT vacuum compatible (Florence), upgrade the electronics
- ② Naples (S. Solimeno) is working on the theoretical study of the plane mirrors cavity
- ② Schedule strongly depends on Virgo