

Suspension systems for TAMA300

Suspension systems of TAMA300

The Suspension group was not much concerned with the 3 MC suspensions.

5 Mirror suspensions + 1 BS suspension + 4 Pick-off suspensions

Double pendulum with eddy current damping

by flexibly supported permanent magnets

Design strategy (Mirror suspension)

Prototype -> TAMA version -> Modifications

Main concerns in the TAMA suspensions

- o Vibration isolation
- o Thermal noise
- o Controllability
- o Coarse adjustment
- o Vacuum compatibility
- o Installation process
- o Mirror protection

Vibration isolation

Requirements

Vibration isolation ratio 105dB@150Hz~450Hz

RMS value Translation: several μm , Rotation: 0.5 μrad

Experiments

Measurements with vibration table

Vibration isolation ratios (H-H, V-V, V-H coupling)

Mirror rotations (Pitch-Pitch, Yaw-Yaw, H-Pitch, H-Yaw, V-Pitch, etc.)

Measurements at the site

Angular Fluctuation (Pitch, Yaw)

Operation of TAMA300

Calculations

Rigidbody model

Point-mass model (including violin modes)

~ Good agreement with the experiments

Thermal noise

Dissipation introduced by magnet damping

-> well filtered by the final stage

Wire clamps, Stand off

-> to increase violin Q

Pendulum thermal noise, mirror thermal noise

Comprehensive calculations by K. Yamamoto

Significant factors: Mirror Q, Violin Q, Mirror Pitch Q (or spot centering)

Intrinsic Q measurement by K. Numata

Violin mode ~ Q estimations from the TAMA observation data

Individual R&D experiments

~ No measurement of actual mirror Q's with the TAMA suspension

Controllability

Longitudinal and Alignment control

Coil-magnet pairs -- 4 coils per mirror

- > optimized coils (coupling, gradient of coupling)
- > Q/C of coils (resistance, inductance, coupling)

PZTs for alignment ($0.3\text{mrad}_{\text{pp}}$)

- > prepared but not used

PZT for longitudinal drift compensation ($60\mu\text{m}_{\text{pp}}$)

- > in preparation

Coarse adjustment

Pico motors

- > 5 degrees of freedom (X, Y, Z, Pitch, Yaw)

PZTs

Vacuum compatibility

Outgas consideration

Vacuum compatible components

Stages

Picomotors

Cables

Connectors

Minimum amount of organic materials

Small amount of teflon blocks for mirror protections

Glue: vac-seal

Installation process

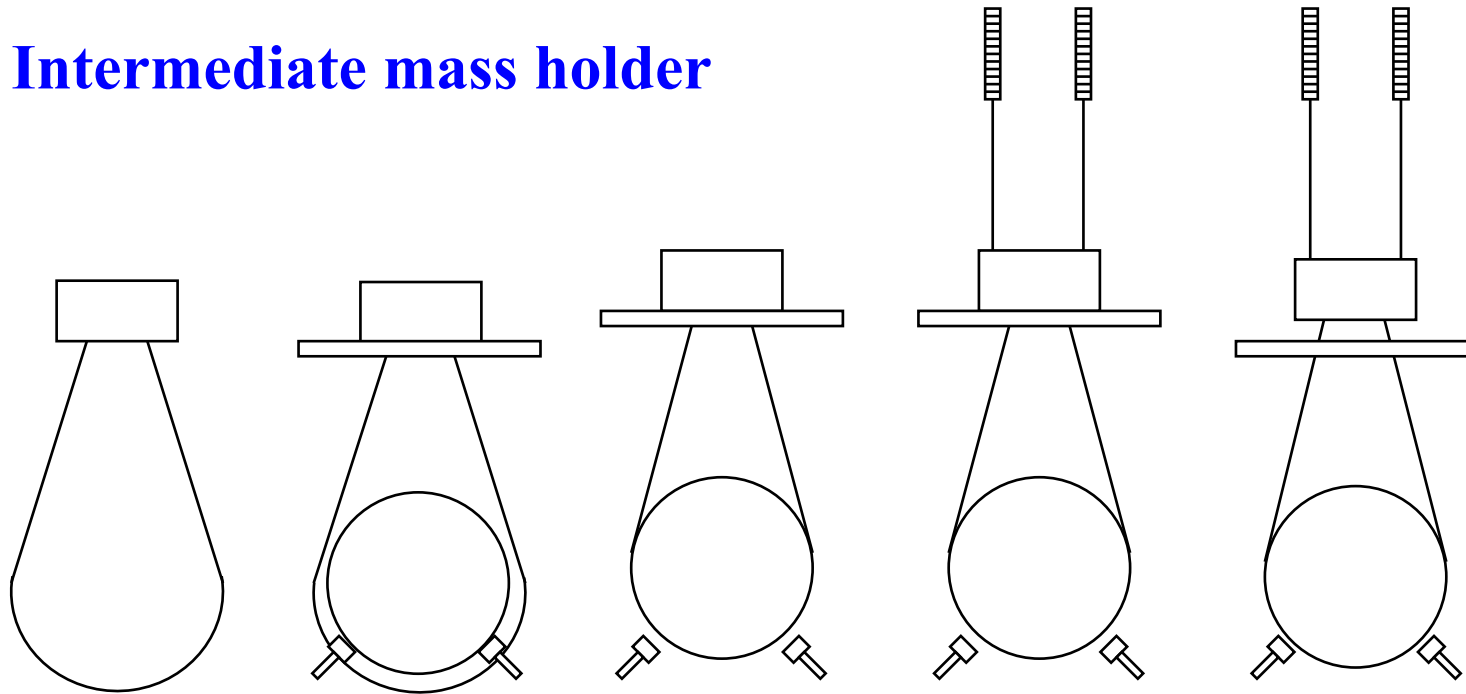
To make the installation easy and precise

Fixtures for installation

Magnet attaching machines (for Mirror, BS, PO)

“Dock” (wire preparation machine)

Intermediate mass holder



Mirror protection

To prevent from ...

**knocking out the magnets
and falling down of the masses**

**during the installation process
and by earthquakes**