A-10 Portable Absolute Gravimeter Overview

Micro-g LaCoste, Inc.

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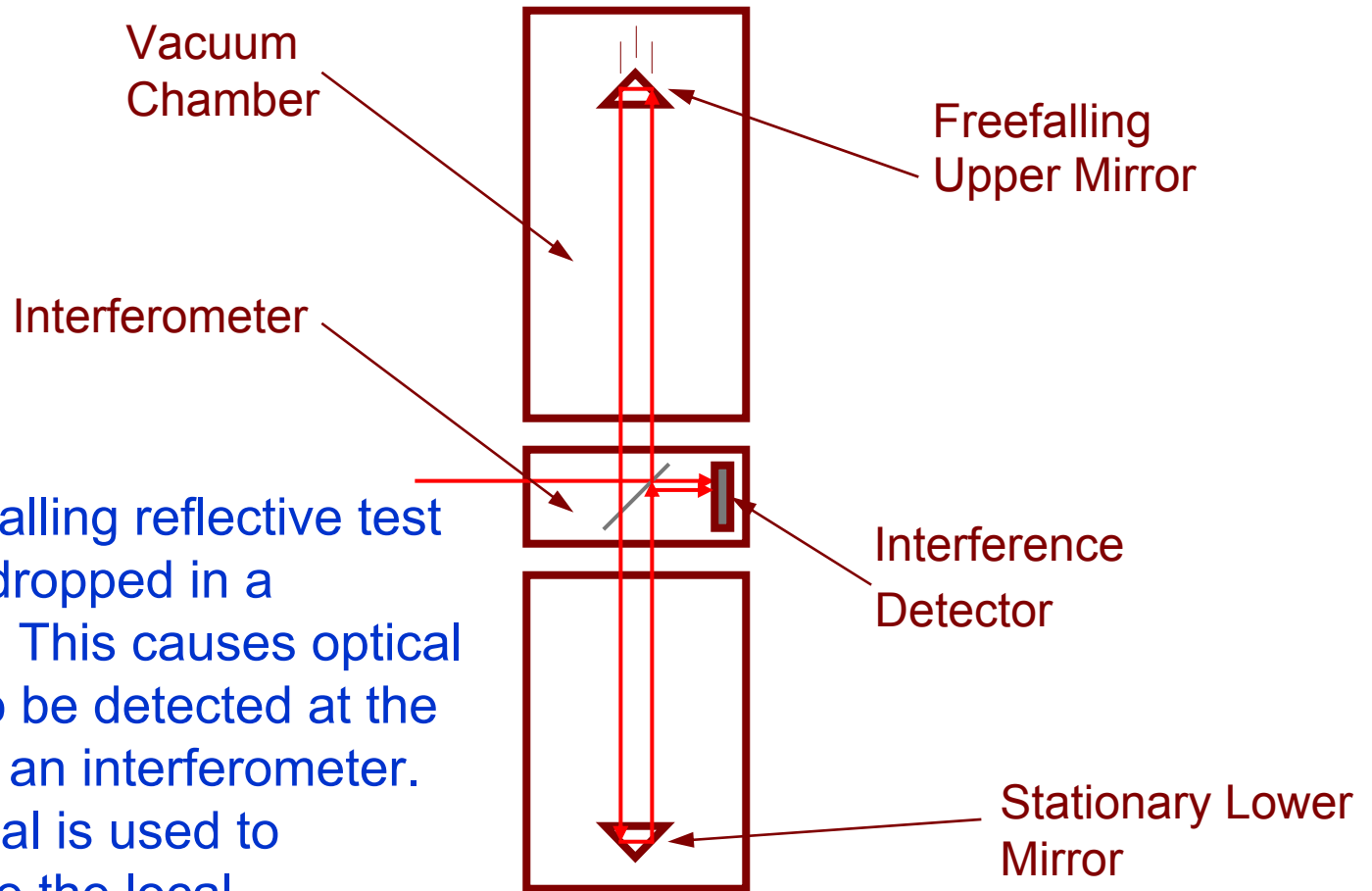
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A10 Specifications

- Portable, temperature-controlled, self-leveling absolute gravimeter

- No drifts or tares

- Accuracy: 10 μGal (observed agreement between A10 instruments)

- Precision: at a quiet site, 1s drop interval, 50μGal/sqrt(Hz) [eg. About 1 μGal in 30 minutes]

- Operating dynamic range: World-Wide

- Operating temperature range: -30$°$C to 45$°$C

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A-10 Principle of Operation

Vacuum Chamber

Freefalling Upper Mirror

Interferometer

Interference Detector

A freely falling reflective test mass is dropped in a vacuum. This causes optical fringes to be detected at the output of an interferometer. This signal is used to determine the local gravitational acceleration.

Stationary Lower Mirror

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A-10 Schematic
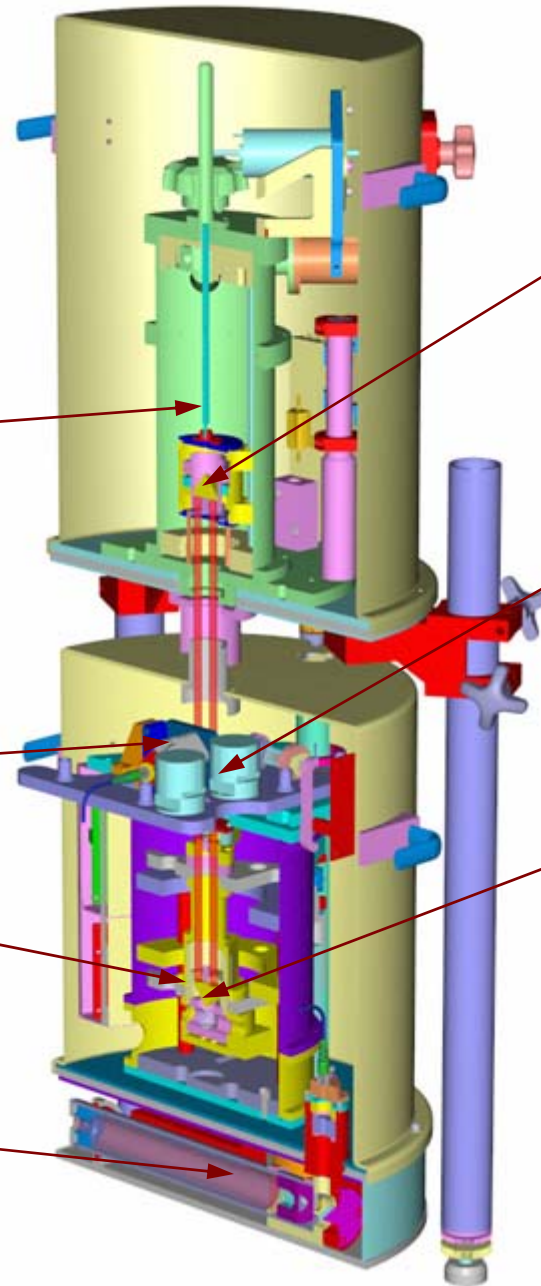

Test Mass Corner Cube

Dropping chamber

Inclinometers

Interferometer
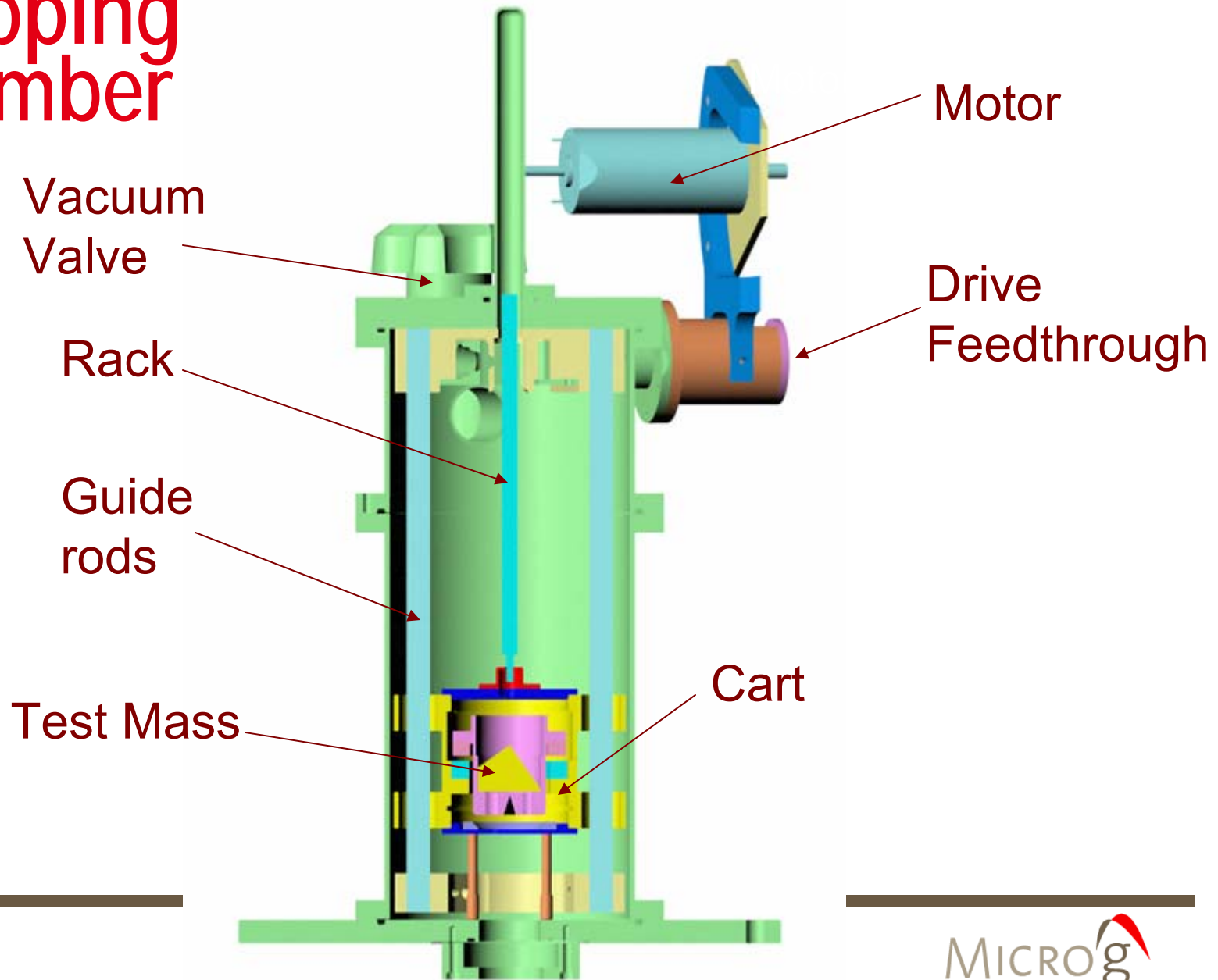
Lower Corner Cube

Superspring

Laser

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A10 Subsystems
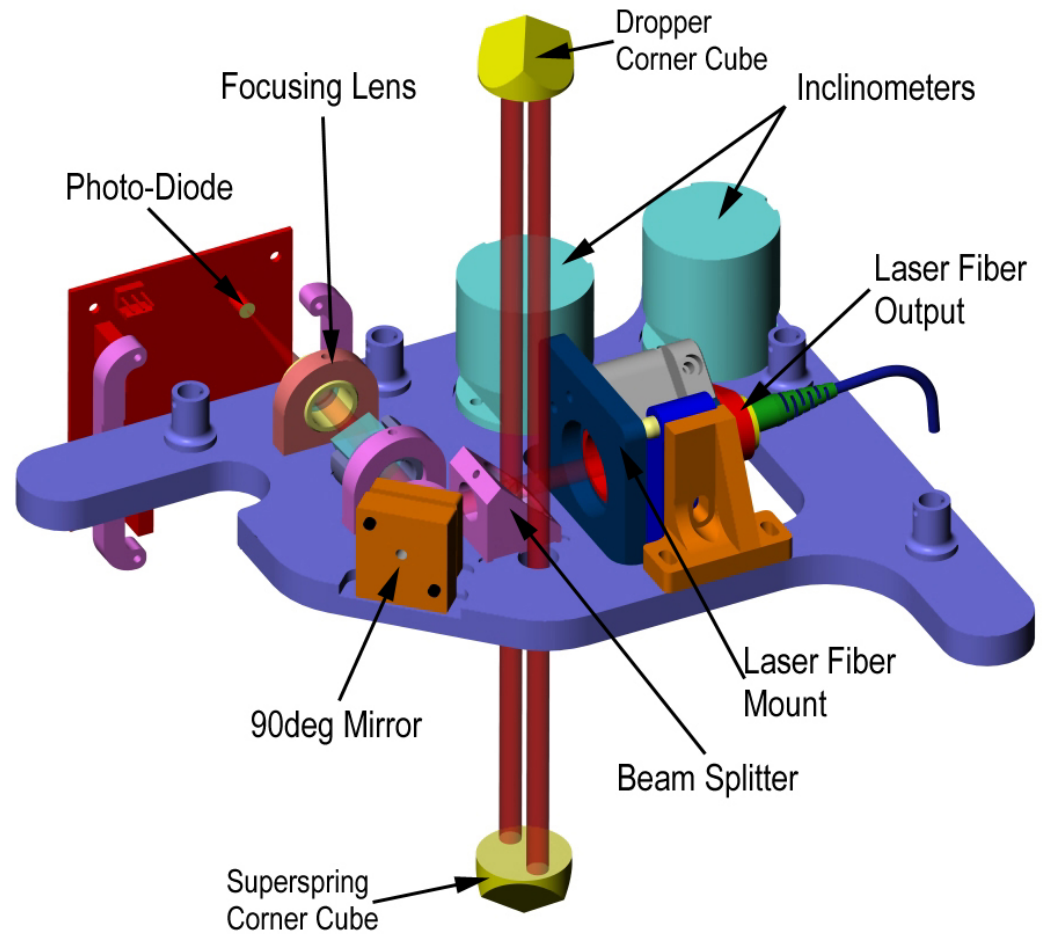
- Dropping Unit
  - Heat-controlled (>20°C)
  - Dropping chamber
- Interferometer Base (I.B.) Unit
  - Heat-stabilized
  - Superspring and interferometer housing (5°C above ambient)
  - Laser housing (10°C above ambient)
  - Auto-leveling system

- Electronics
  - Power supply: Ion pump, laser, superspring, leveling control, etc.
  - Dropper controller
  - Patch panel
  - Computer
- Software
  - Real-Time Data Acquisition
  - Post-Processing Data Analysis

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Dropping Chamber

Motor

Vacuum Valve

Drive Feedthrough

Rack
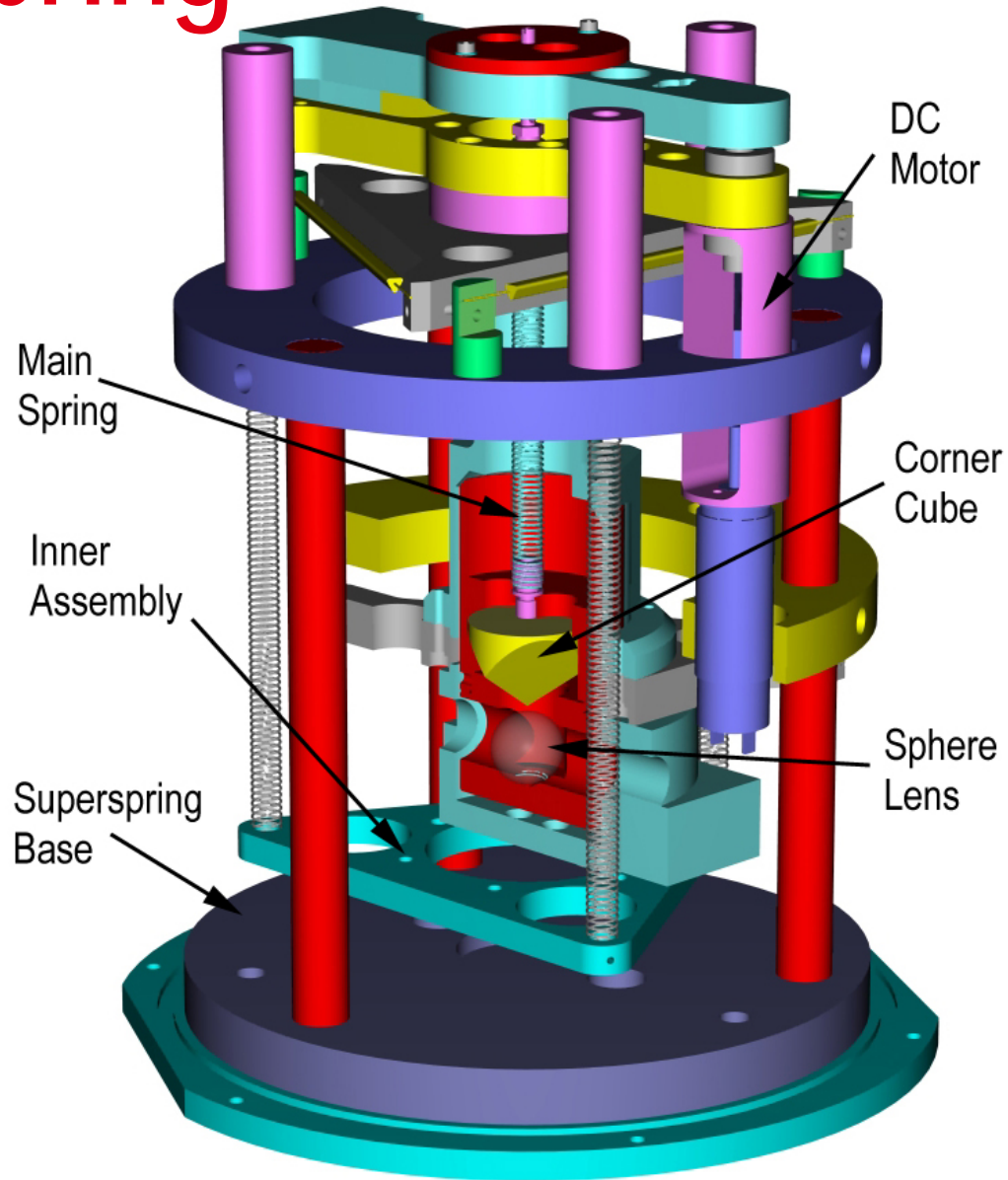
Guide rods

Cart

Test Mass

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A10 Interferometer

- Self-overlapping
- One optical output
  - Main signal interferometer (APD)
- Mirror to steer to Photodetector
- Two Electronic Output Signals
 - Analog (Alignment)
  - TTL (Timing)

Superspring

A10 Electronics

- Computer
  - Data acquisition & Reprocessing
- Control Panel
  - Main Power Supply
  - Unit I & II Cable Connections
  - Superspring Controller
  - Ion pump power supply
  - Laser Controller
  - Auto-leveling
- Dropping Chamber Controller
- Patch Panel
  - Analog & Digital IO

Computer

Control Center

Patch Panel

Dropper Controller

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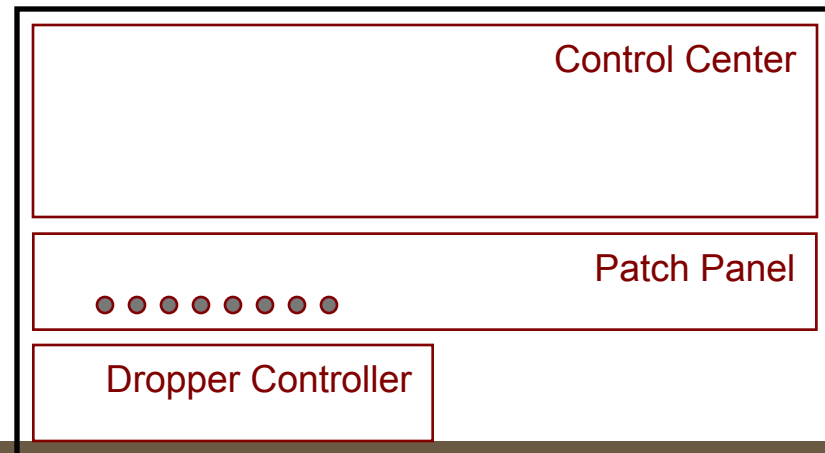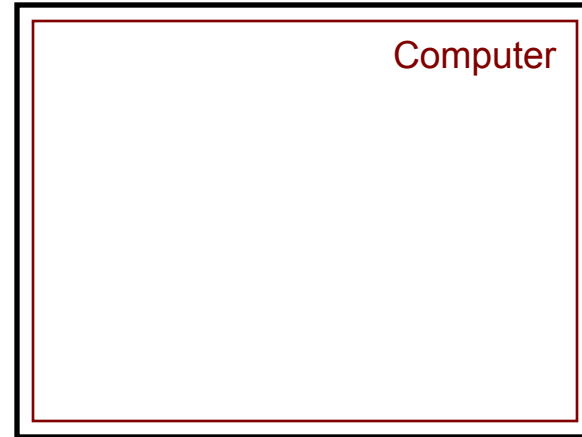
A10 System Adjustments

- Spring Position
- Can temperatures
    - Dropping Chamber
    - Interferometer
    - Laser Chamber
- Verticality reference

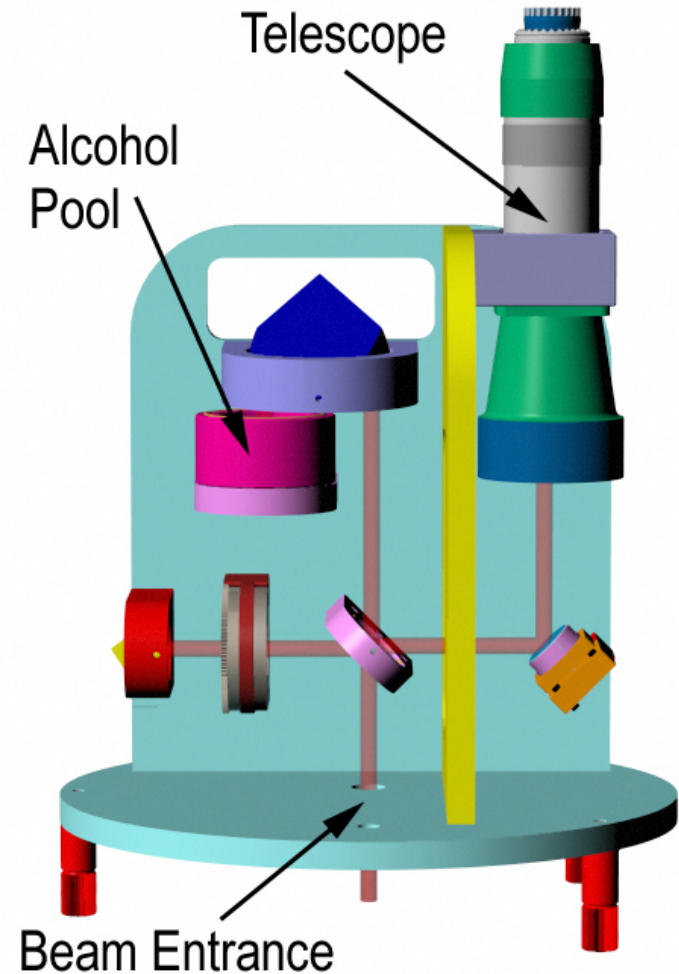- Laser Power (fringe amplitude)
- Detector Alignment

ML-1 Polarization Stabilized Laser

- Calibrated to Primary Standard (WEO Iodine Laser – recommended once per year)
- Accuracy at 2 parts in 10^9
- Two modes, automatically switched between sets. Average should be stable with temperature
- Fiber launching system:
  - Faraday Isolator
  - 5-axis stage
  - Single mode fiber
  - Output collimation: (6mm)
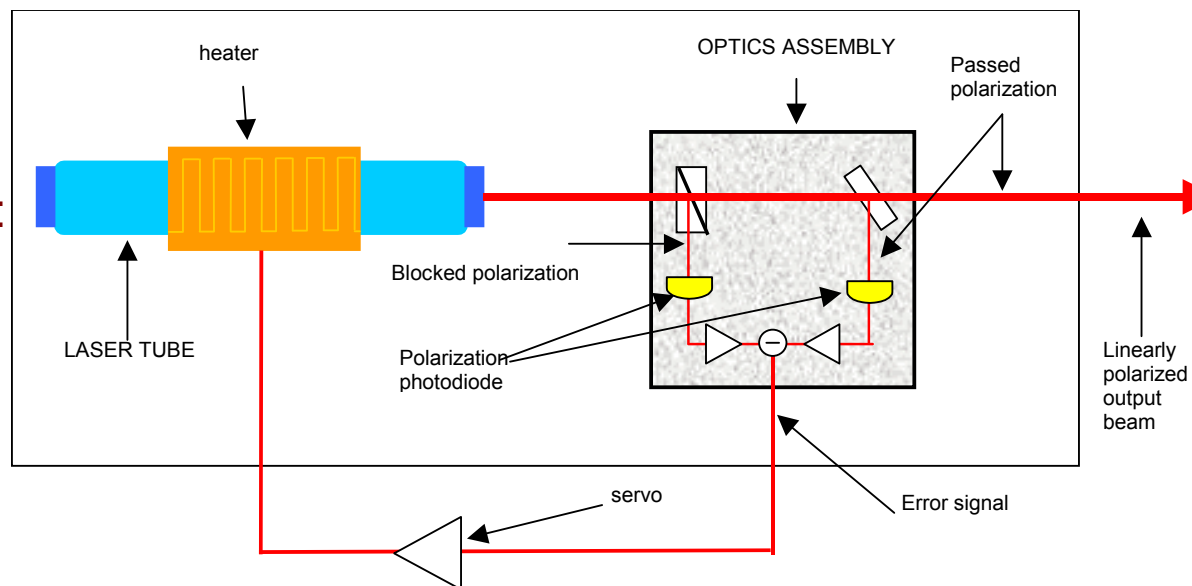
Beam (Verticality) Checker

- Deviations from verticality result in gravity values that are too low. Error ~ θ^2

- Though the meter is self-aligning, verticality can be verified by placing the "beam checker" on top of the IB.

- Alcohol pool provides level standard

- Adjustments, if necessary, are made using the "pots" on the IB cable connection plate

Telescope

Alcohol Pool

Beam Entrance

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g Gravity Acquisition and Processing Software

- Windows Based
- Graphics package
- Gravity corrections
- Earth Tide Models
- Ocean Load Correction
- Statistical analysis
- Real time data acquisition
- Post processing

Regular Maintenance

- Regular maintenance approximately every 1,000,000 drops

- Optics Cleaning

- Ball & Vee wear   (Micro-g)

- Laser tube degradation   (Micro-g)

- Ion pump degradation (plating)   (Micro-g)

- ML-1 laser calibration   (Micro-g)

Field Considerations

- 12VDC-Only operation to deploy from vehicle. Lab operation with AC/DC converter

- Vehicle w/2nd battery advisable

- Place A-10 on stable rock

- Tent necessary to shield from wind, rain, and sun

- 18m cables to get A-10 far from vehicle

- Fast Acquisition (1s drop rate) – 1 hour observations

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Field Examples