Improved Primary Accelerometer Calibration via Laser Interferometry

Mark I Schiefer

The Modal Shop

ISO 16063 Methods for the Calibration of Vibration and Shock Transducers

- 16063 Part 11. Primary vibration calibration by laser interferometry
- 16063 Part 13. Primary shock calibration by laser interferometry
- 16063 Part 21. Vibration calibration by comparison method
- 16063 Part 22. Shock calibration by comparison method
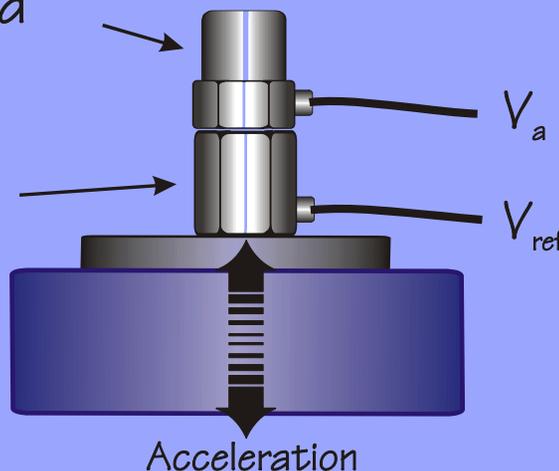
ISO 16063 Part 21

Comparison - Back to Back Method

Reference uncertainty is dominant factor in cal

Accelerometer
to be calibrated

Calibration
Standard
Accelerometer
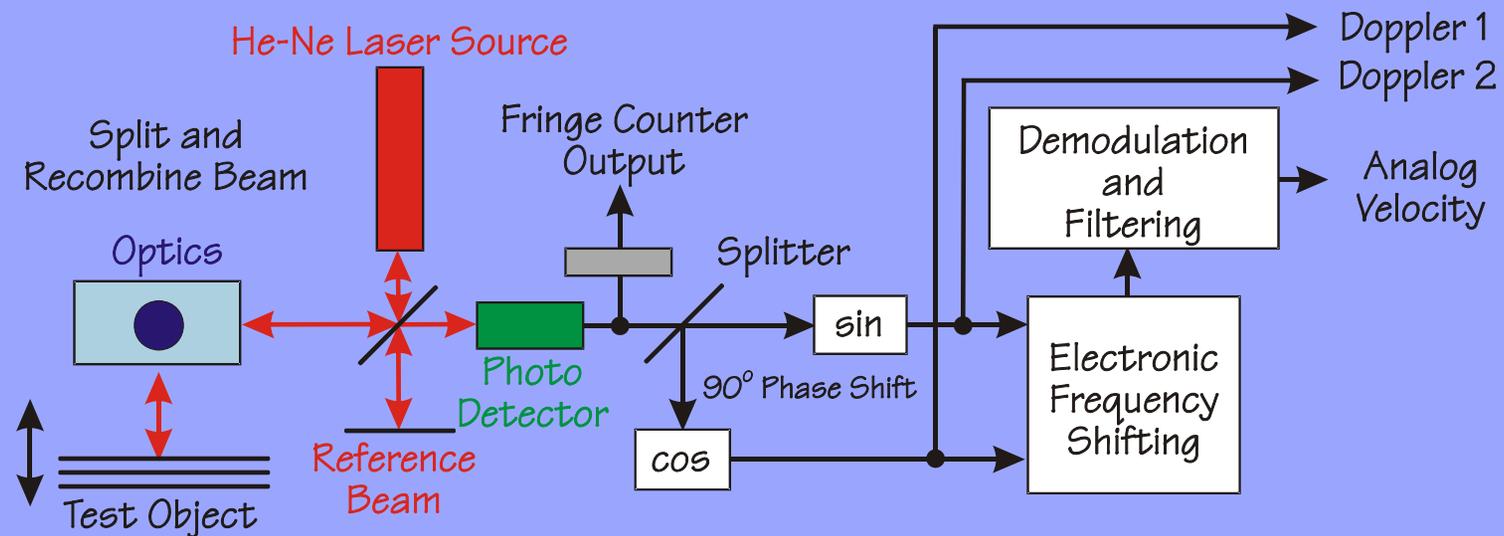(Known sensor S_{ref})

Shaker

V_a

V_{ref}

Acceleration

$A_a = A_{ref}$

$$\frac{V_a}{S_a} = \frac{V_{ref}}{S_{ref}}$$

$$S_a = S_{ref}\,\frac{V_a}{V_{ref}}$$

ISO 16063 Part 11

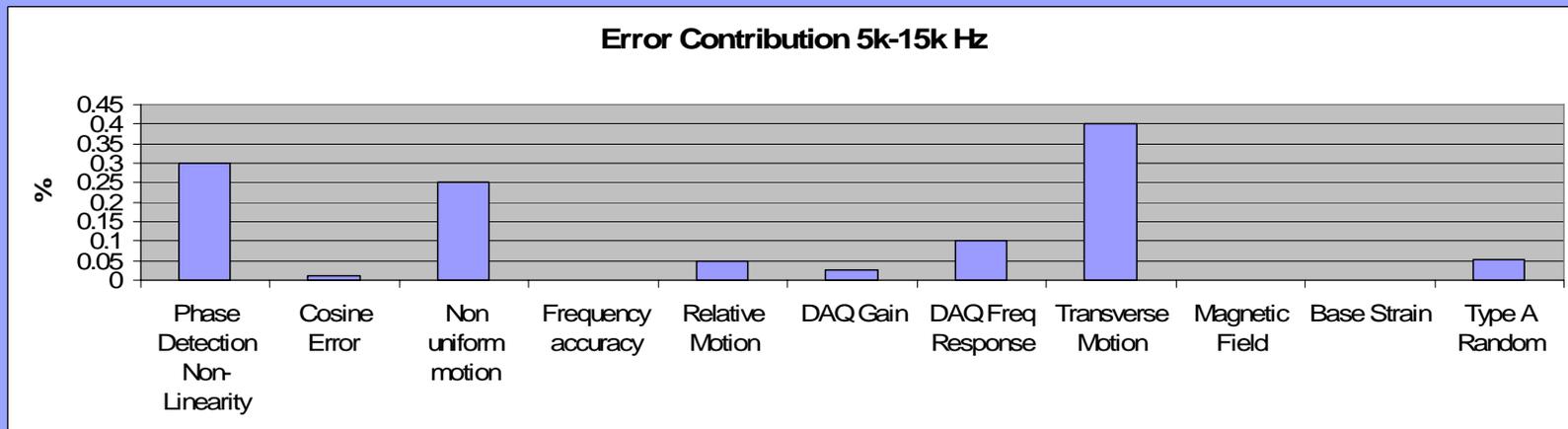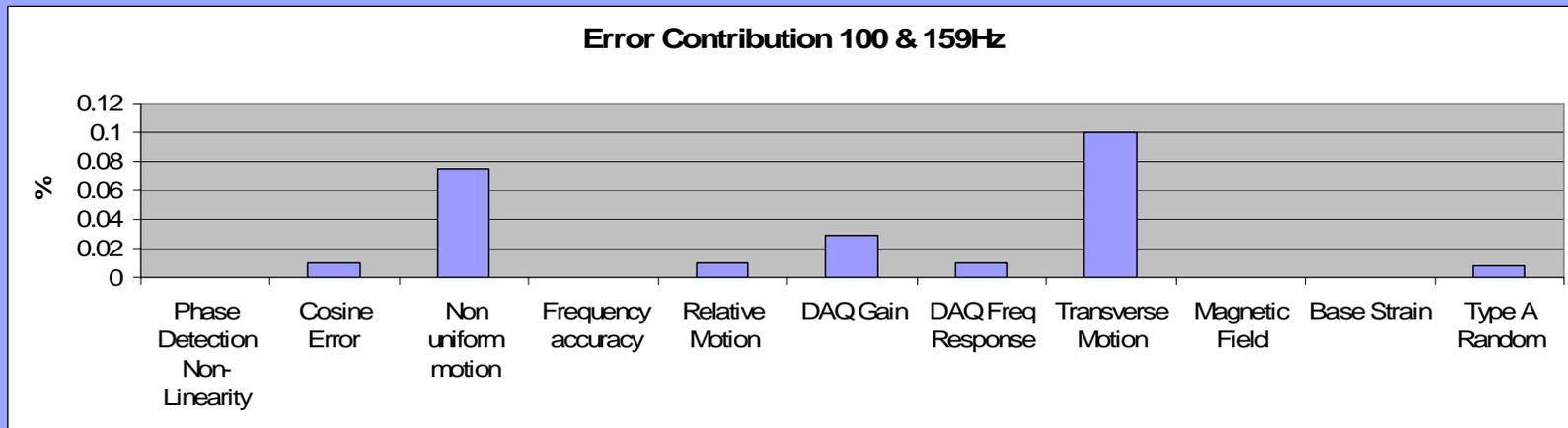- Michelson Interferometer operational schematic

Primary System Methods

- Method 1: Fringe-Counting

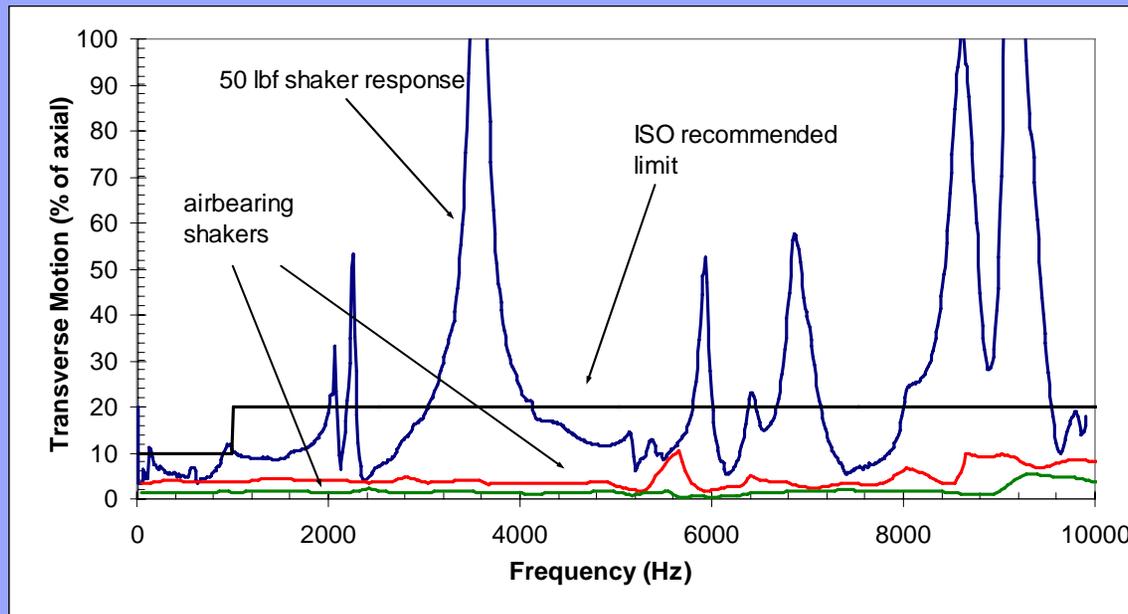- Method 2: Minimum-Point

- Method 3: Sine Approximation

Method III Primary System

- Data intensive

- Most accurate

- Provides Phase information

- Implemented as reference option to 9155

Error Contributions

Error Contribution 100 & 159Hz

%

Categories: Phase Detection Non-Linearity, Cosine Error, Non uniform motion, Frequency accuracy, Relative Motion, DAQ Gain, DAQ Freq Response, Transverse Motion, Magnetic Field, Base Strain, Type A Random

Error Contribution 5k-15k Hz

%

Categories: Phase Detection Non-Linearity, Cosine Error, Non uniform motion, Frequency accuracy, Relative Motion, DAQ Gain, DAQ Freq Response, Transverse Motion, Magnetic Field, Base Strain, Type A Random
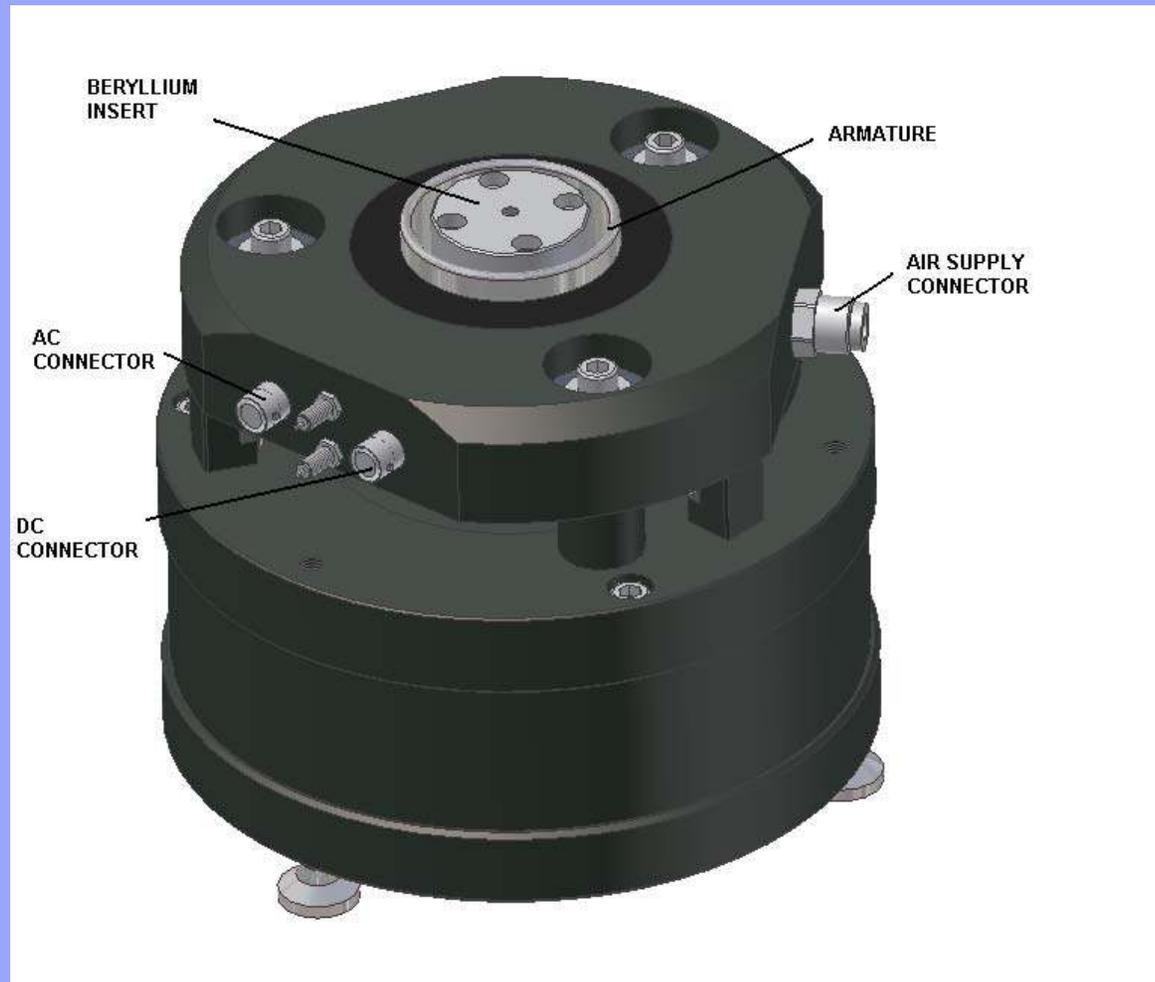
Transverse Comparison

- Flexure based shakers rarely meet transverse motion recommendations
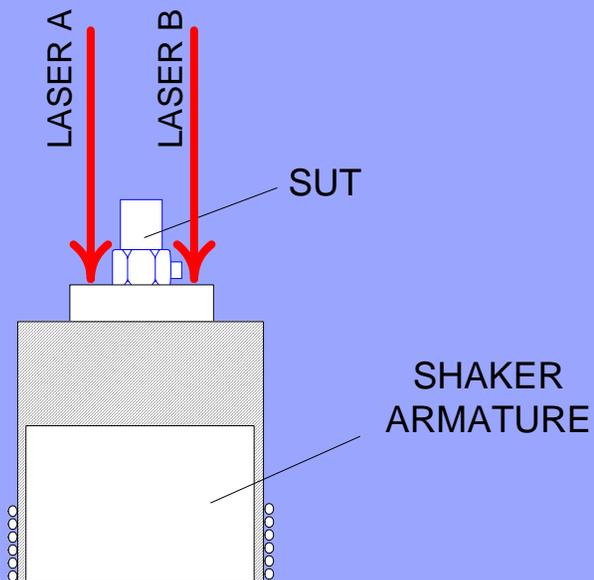
Vibration Exciter

- The key to good calibrations
  - Low rocking and transverse motions
  - Simplicity and reliability of use

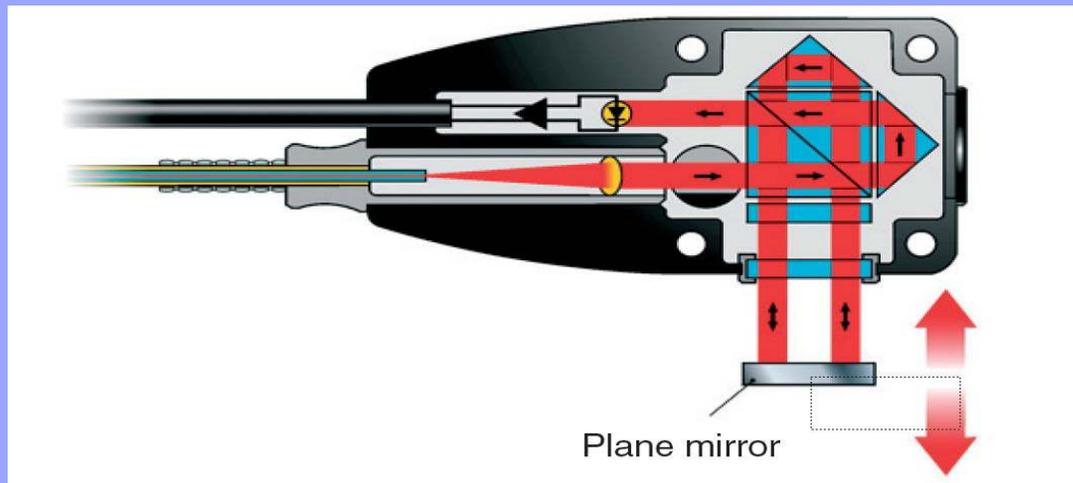# K394A30/31 Vibration Exciter

Improved implementation

- Dual Beam-Dual pass HomodyneLaser

Interferometer Head

Each small, light-weight head contains
- integrated dual-pass optics
- specialized phase sensitive detector
- differential preamplifier

Plane mirror
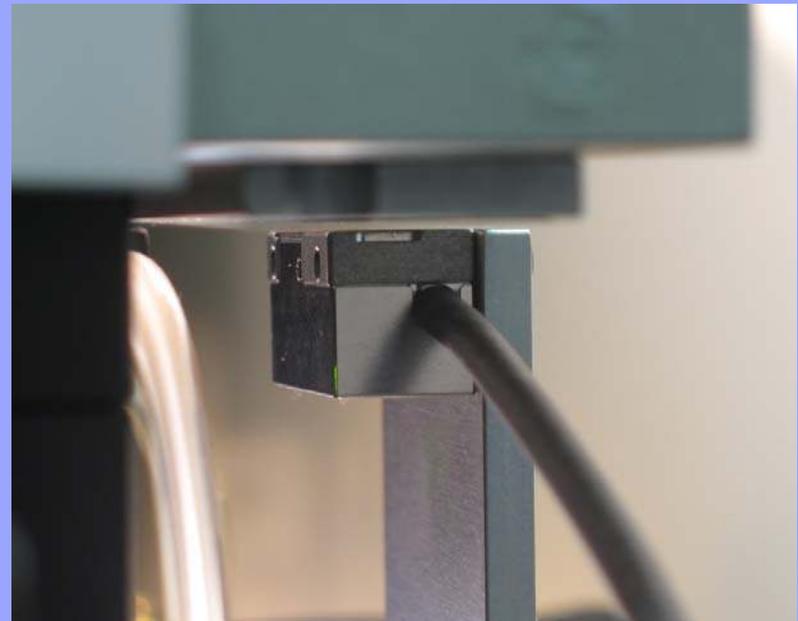
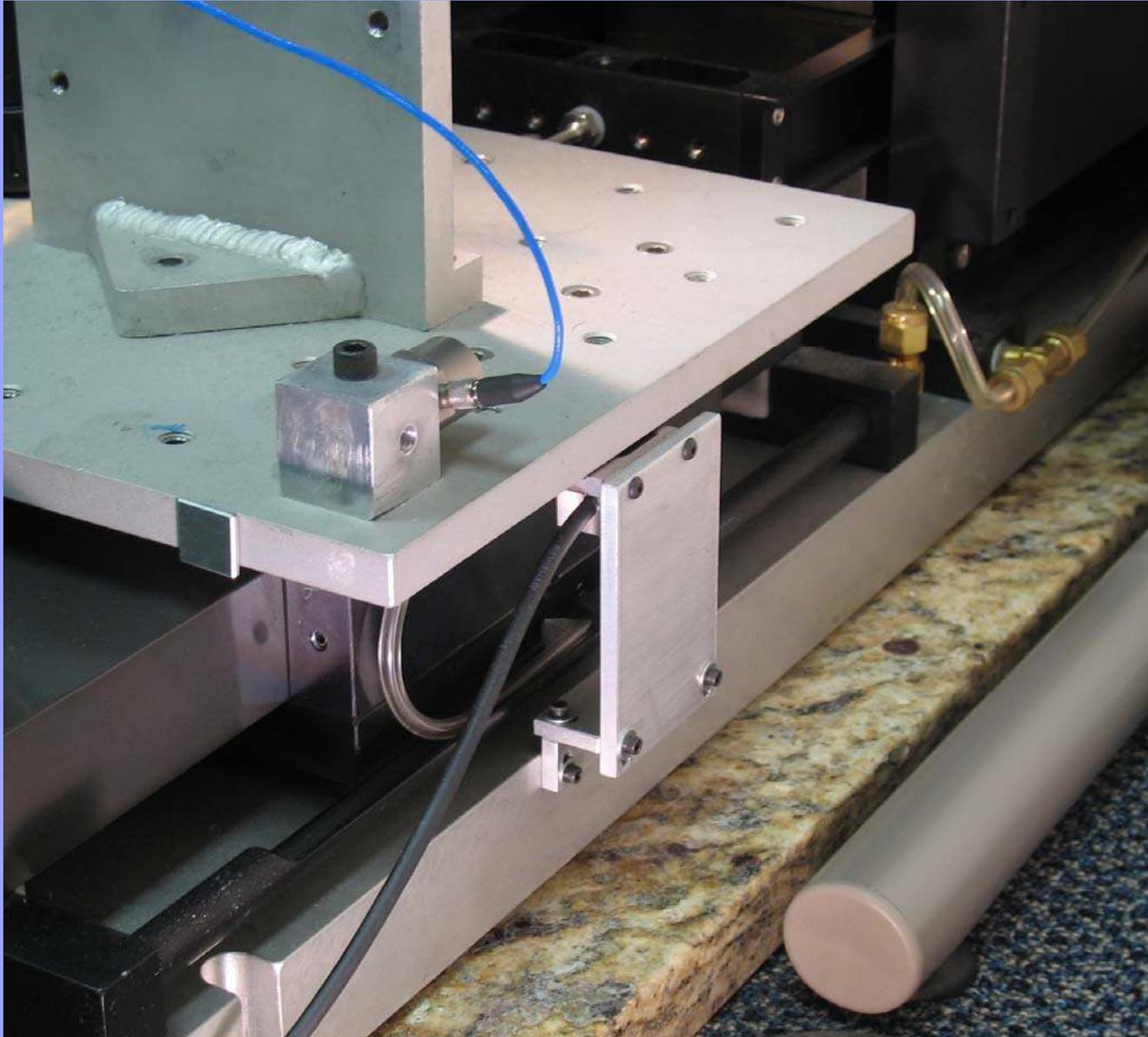Compact optics

Large(3mm) spot

Dual pass

Alignment

Linear Detector

Low Frequency Reference

- Long-stroke ABS reference is traditionally an accelerometer
- What if we replace this with displacement sensor?
- Optical displacement
- No drift, alignment
- No resolution reduction
- Inexpensive
- Great for < 20 Hz

Low Frequency Reference

Conclusion

- Vibration Excitation is key

- Simple reliable setup and positioning

- Dual Beam Dual Pass interferometer

- Low frequency improved reference

For further information, contact:
Mark Schiefer (mschiefer@modalshop.com)
Or visit us at www.modalshop.com

Thank you very much for attending!!