Mirror Reflectivity Test Station Upgrade

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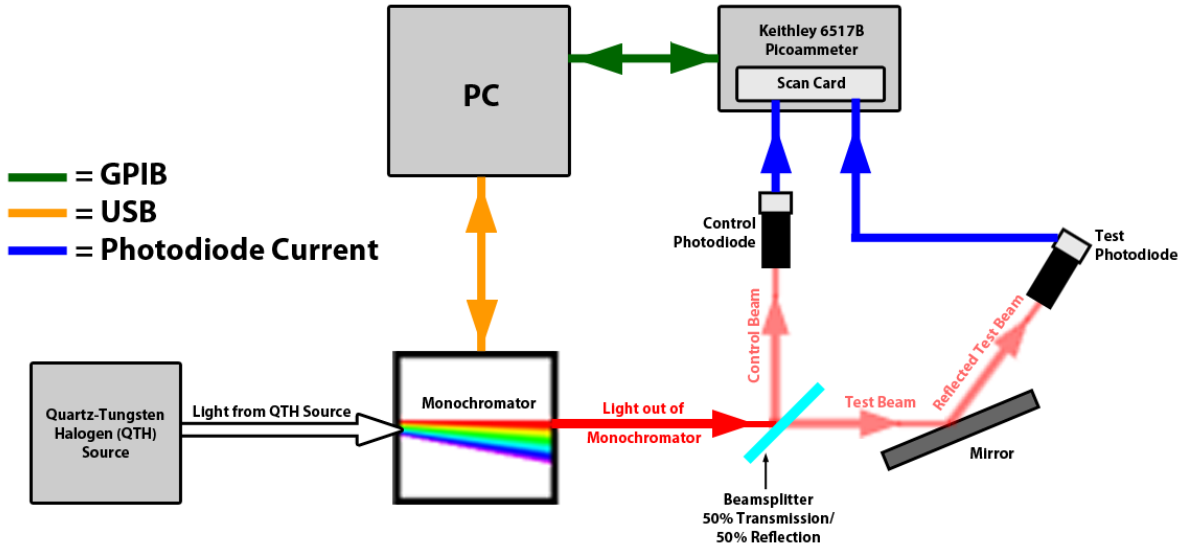
Present Mirror Reflectivity Test Station



- Monochromator provides light of a specified wavelength
- Using beam-splitter, light splits into control beam and test beam
- Test beam reflects off mirror
  - For calibrations, test photodiode is positioned so that test beam directly hits test photodiode
- Control beam's and test beam's power are measured by separate photodiodes
- Photodiodes' current response measured by Keithley picoammeter

Present Test Station Procedure – Calibration

- Calibration must be repeated several times throughout day to compensate for changes in light source's power over time

1. Move test photodiode and its mount to calibration rail in test station
2. Remove test photodiode from its mount
3. Attach collimators to both ends of tube on mount
4. Place alignment laser on monochromator and turn on
5. Align test photodiode so light from laser passes through both collimators
6. Turn off alignment laser, remove it from monochromator, and replace monochromator lid
7. Remove collimators and re-install test photodiode on its mount
8. Run LabVIEW program in calibration mode

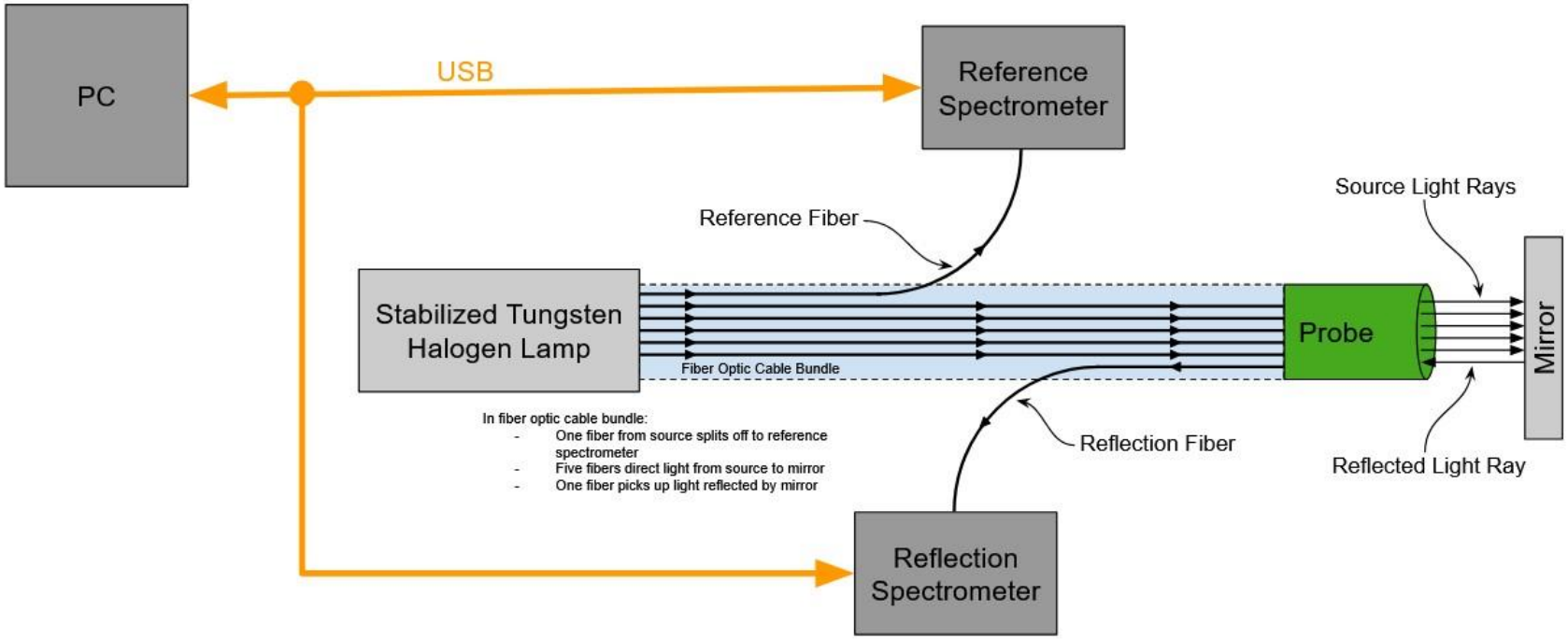
Highlighted items are steps with largest potential to cause error in measurements

Present Test Station Procedure – Measurement

1. Move test photodiode and its mount to measurement rail in test station
2. Remove test photodiode from its mount
3. Attach collimators to both ends of tube on mount
4. Place alignment laser on monochromator and turn on
5. Align mirror to be tested so alignment laser reflects off of mirror and to test photodiode mount
6. Align test photodiode and mirror so reflected beam from laser passes through both collimators
7. Turn off alignment laser, remove it from monochromator, and replace monochromator lid
8. Re-install test photodiode on its mount
9. Run program in measurement mode

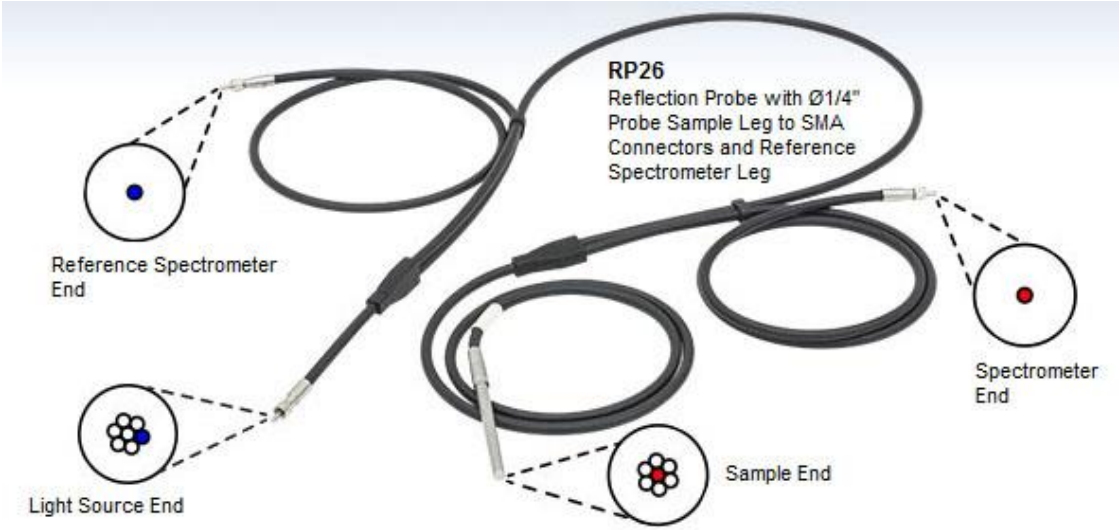
Highlighted items are steps with largest potential to cause error in measurements

Proposed Test Station Ugrade



- Use fiber optic reflection probe, compact spectrometers, and stabilized source for measurements
- Limits alignments required

Upgrade's DAQ Components – Fiber Optic Reflection Probe



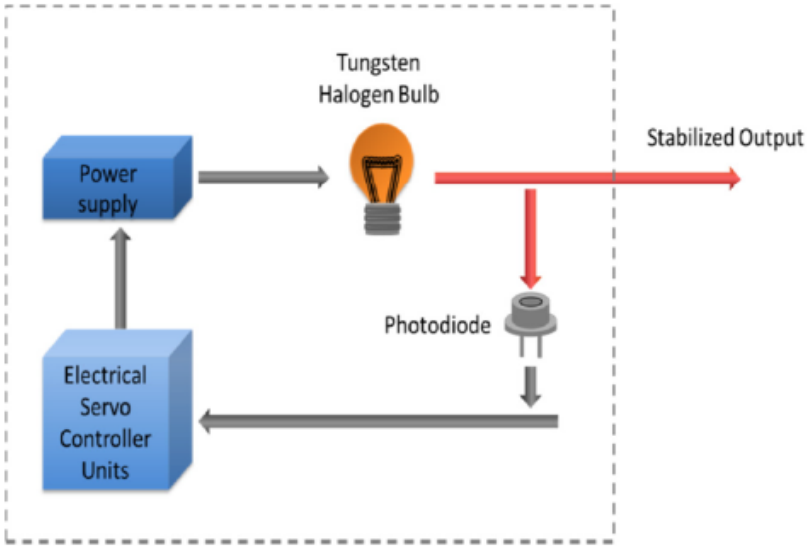
- Thorlabs item # RP26
- Seven-fiber, fiber optic cable bundle
- Sample end has 0.25" diameter probe
- Source, reference, and measurement ends have SMA connectors
- **Flexible fiber optic cable eliminates need to align reference light with detector**
- Only alignment needed is probe with mirror

Upgrade Components
Compact USB Spectrometer

- Thorlabs part # CCS200
  - Two required
- Measures power across full spectrum of input light
  - Analyzes all wavelengths at once
  - 200 nm – 1000 nm analysis range
  - 2 nm spectral accuracy
- Includes DAQ program and full suite of LabVIEW drivers

Upgrade Components
Stabilized Tungsten-Halogen Broadband Source

- Thorlabs part # SLS201L
- Output: 360 nm – 2600 nm “white light”
- Has built-in output stabilization circuit that ensures output power is steady



Output stabilization circuit

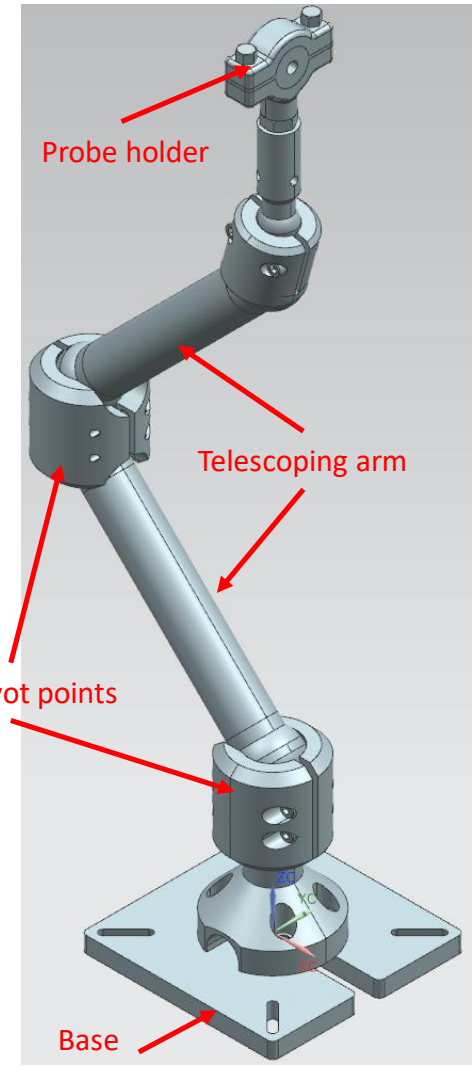
Option
Manual

- Probe must be securely held over mirror for measurements
  - Support arm should be strong enough to hold probe setup in extended position
- McMaster-Carr heavy duty, ball grip, positioning arm proposed for support arm
  - Can support 35 lbs.
  - Probe weight ≤ 5 lbs.

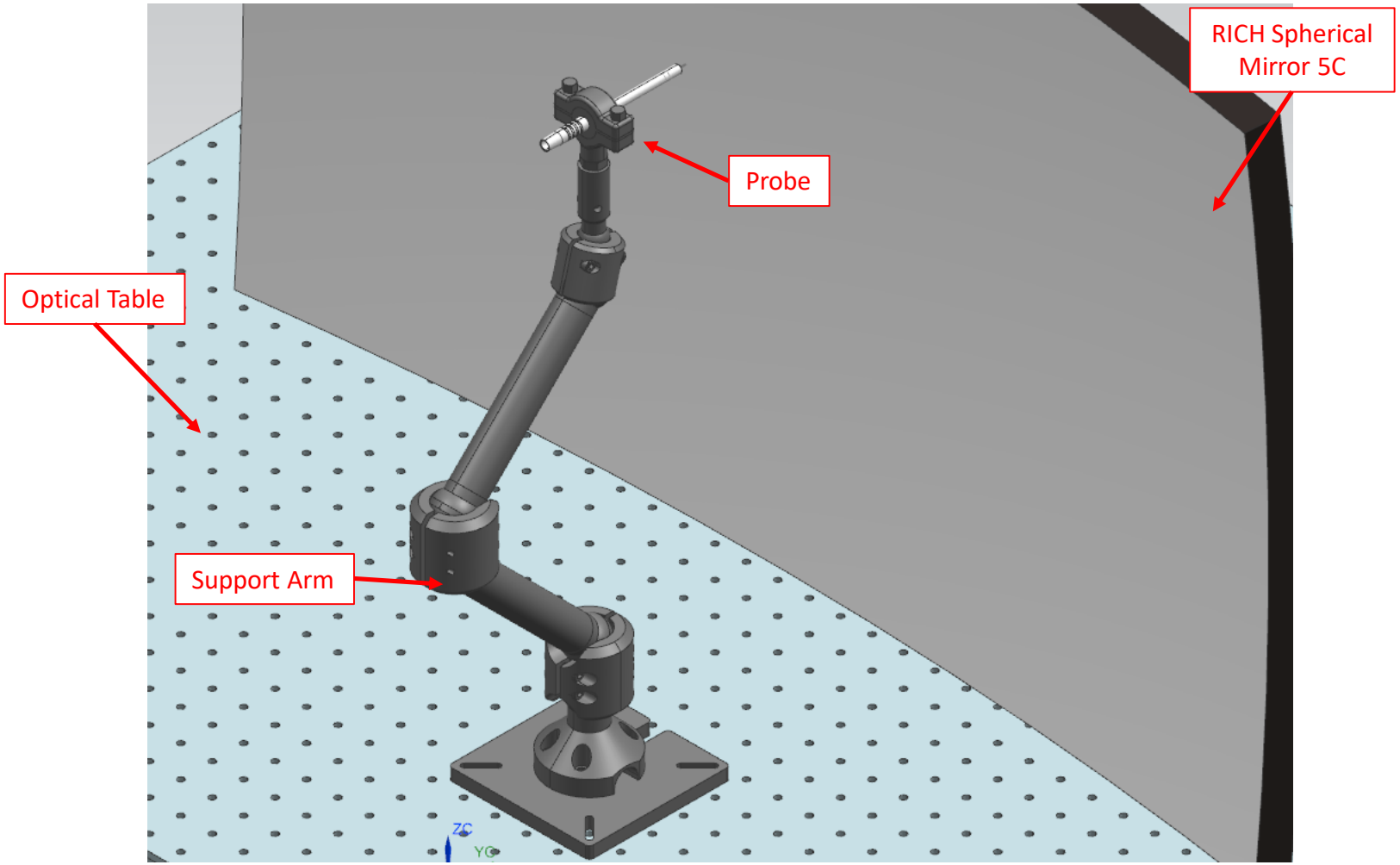
Sales photo of positioning arm from McMaster-Carr

Manual Alignment Probe Support Arm NX Model

- Base to secure support arm to 1” grid on optical table
- Two 90° pivot points
  - Can also swivel 360°
- Two telescoping arms
  - Extends from 6.75” to 10.75”
- ¼”-OD pipe holder for probe



NX Model of Manual Alignment Test System with RICH Mirror

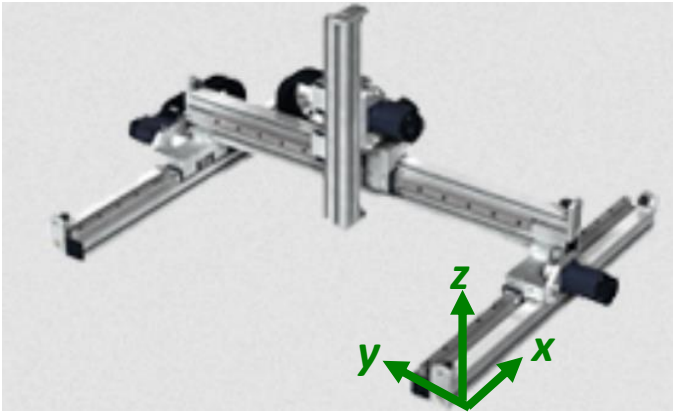


NX model of entire proposed setup. RICH Spherical Mirror 5C is largest spherical mirror.

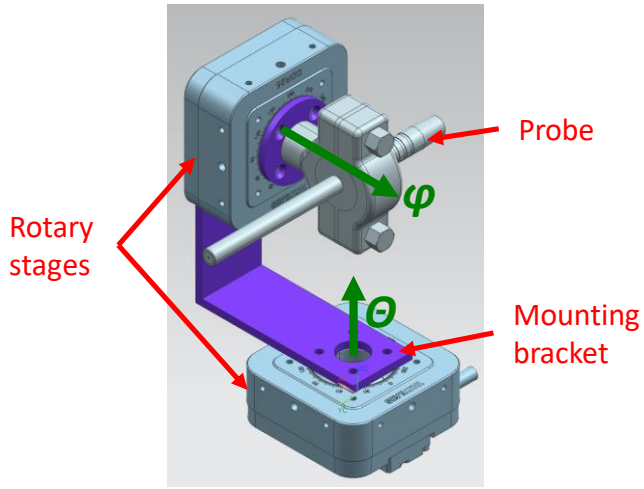
Option

Automated Gantry

- To fully-automate test-station, five axes of movement are needed
  - X, Y, and Z linear motion
    - Quote requested from two companies for a “gantry system” of stages
  - θ and φ rotation
    - Because mirrors are spherical, probe will need to be angled to be perpendicular to mirror surface if moved
    - Thorlabs rotary stages with a designed bracket could be used



Sales photo example of three axes gantry stage



Probe model on two rotary stages

Option
Robotic Arm

- Collaborative Robot (aka “cobot”)
  - Six degrees of freedom in movement
  - Small size for benchtop use
- $25K starting price
- 19.7” (500 mm) reach
- 6.6 lbs carrying capacity
- Comes with full programming software and support of company

Benefits of Proposed Test Station Upgrade

- Faster set up
- Fewer possibilities of error
- Faster results

Expansion of Upgraded Test Station Capabilities

- Adding a second UV light source expands test station to UV spectrum

- Can be configured to test transmission properties of aerogel

Conclusion

- Improved reflectivity test station can be developed using fiber optic probe, compact USB spectrometers, and a stabilized light source

- New test station advantages
  - Expedite testing
  - Decrease sources of errors

Thank You