

Coaxial Velocimetry Probe Development

Brent Frogget

National Security Technologies, LLC, Los Alamos Operations

4th Annual PDV Workshop

Austin, Texas

November 5, 2009

This work was done by National Security Technologies, LLC,
under Contract No. DE-AC52-06NA25946 with the U.S. Department of Energy.

Approved for public release. Distribution unlimited.

Contributors

National Security Technologies, LLC

- Brent Frogget
- Cenobio Gallegos
- Douglas DeVore
- Paul Flores
- Vince Romero
- Britany Stokes*

Los Alamos National Laboratory

- Michael Furlanetto

* summer student

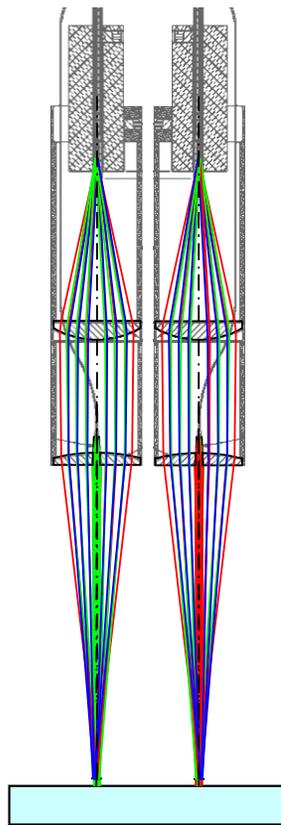
Motivation

A coaxial velocimetry probe would have several advantages over other velocimetry probes.

- It could interrogate the same target material with two forms of velocimetry measurements and would eliminate spatial offset as a source of uncertainty in the measurement comparison.
- It could enable a measurement of the relative accuracies of both VISAR and PDV.
- Because the coaxial velocimetry probe occupies less space, it would allow more space for other diagnostics.

Individual probes

Separated probes

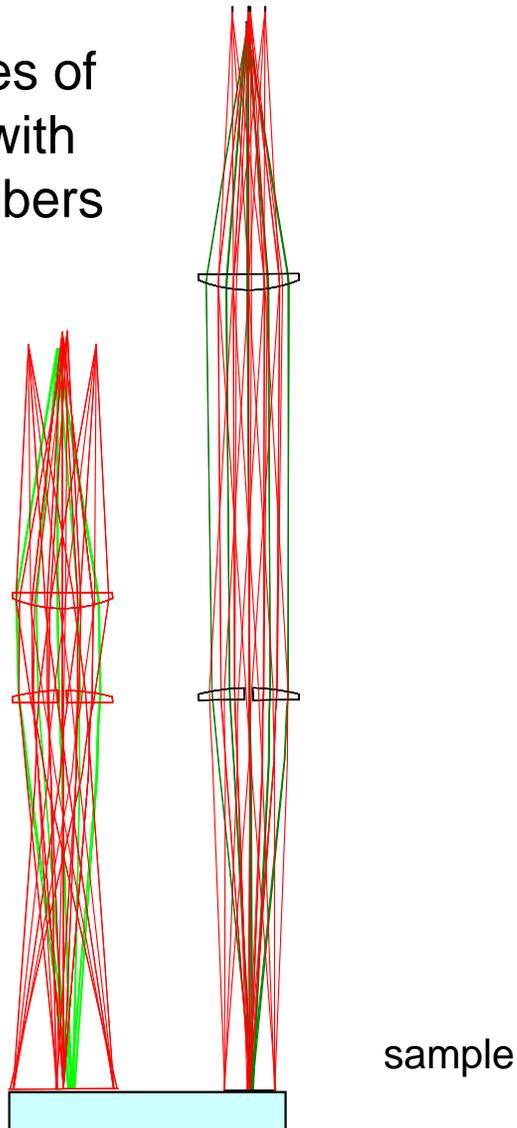


sample

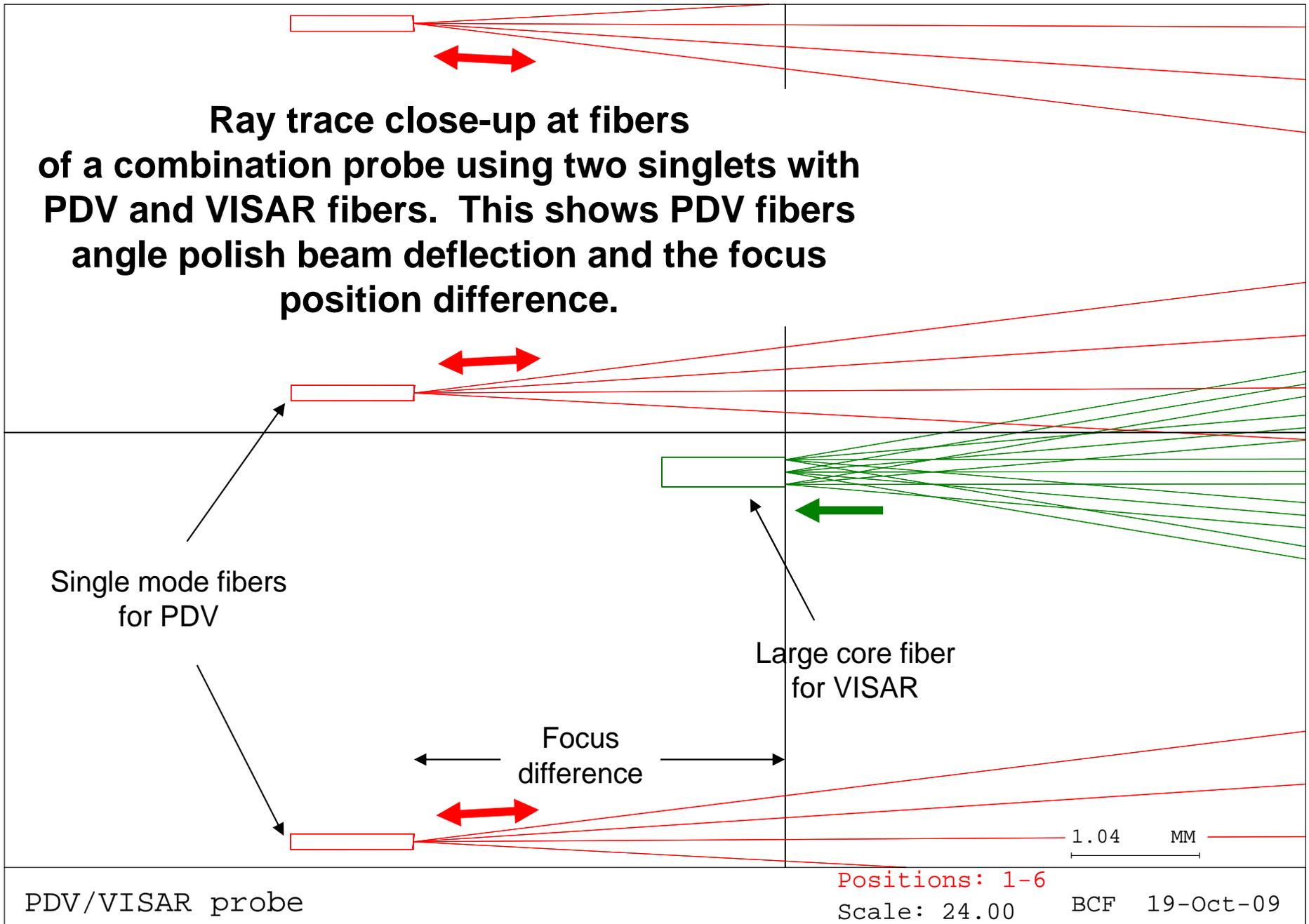
- Separation depends on probe size, which depends on collection efficiency and standoff distance needed.
- Data comparison depends on shock front and sample uniformity.

Combination probes

Ray traces of probes with multiple fibers

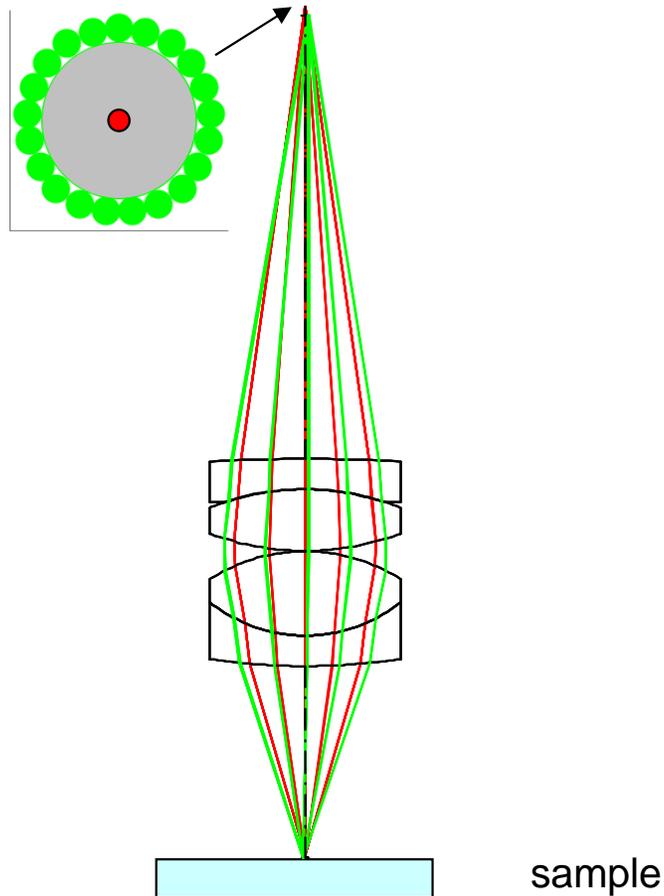


- Fibers are imaged to different points on the target. Minimum sample spot spacing is determined by lens magnification and fiber sizes.
- The target point only overlaps each when they are out of focus.
- There is a focus distance difference for the two different wavelengths. Achromats can be used to reduce that difference.
- Probe configuration determines if light is normal or angled to the surface.



Combination probes

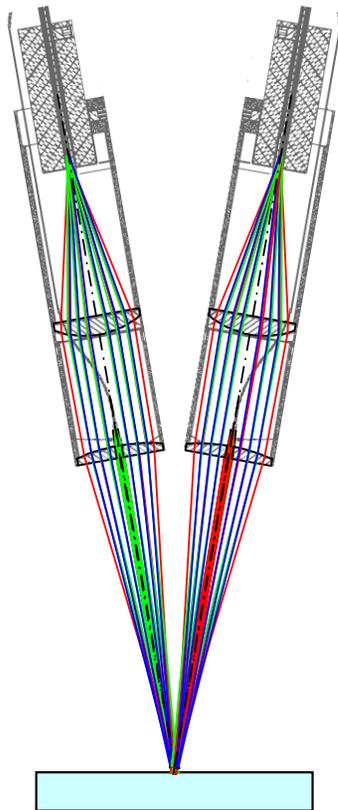
Probe with multiple fibers



- Target spot separation depends on fiber size and probe magnification. These affect collection efficiency and standoff distance.
- Data comparison from different target points depends on shock front and sample uniformity.
- Achromats are used to reduce the chromatic focus difference.

Common-point PDV and VISAR

Angled probes

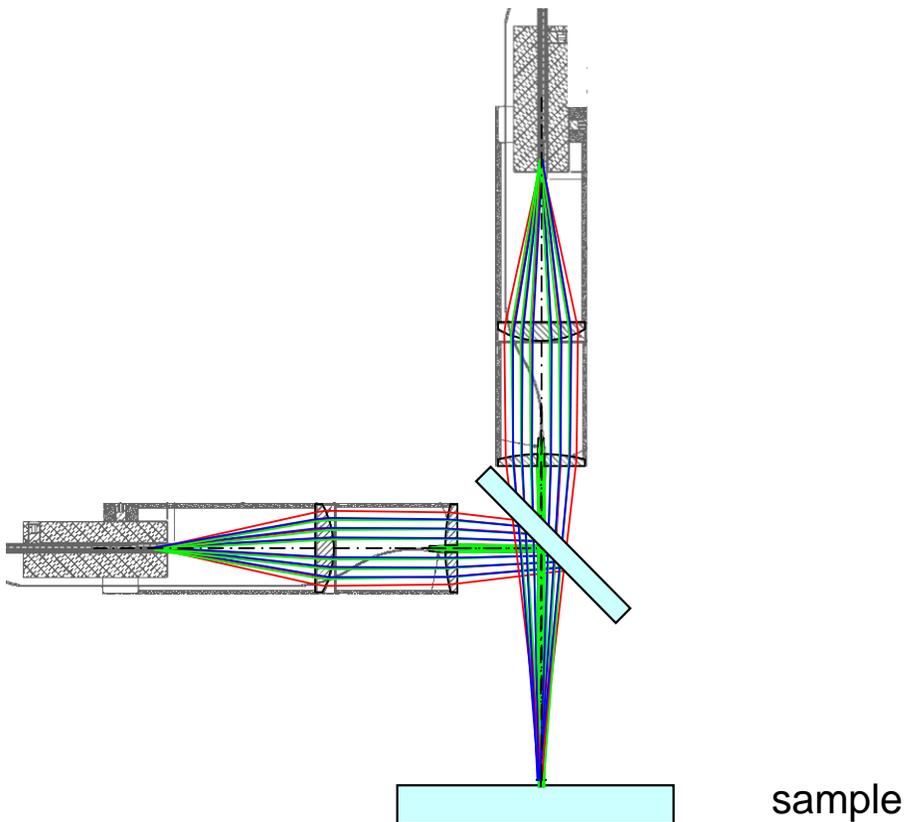


sample

- Velocity measured at an angle.
- Data comparison depends on sample staying flat and level.
- Most of the signal reflects or scatters away from probe.
- Common point only lasts a short distance.

Common-point PDV and VISAR

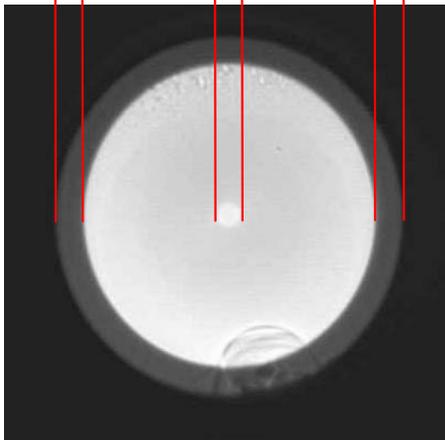
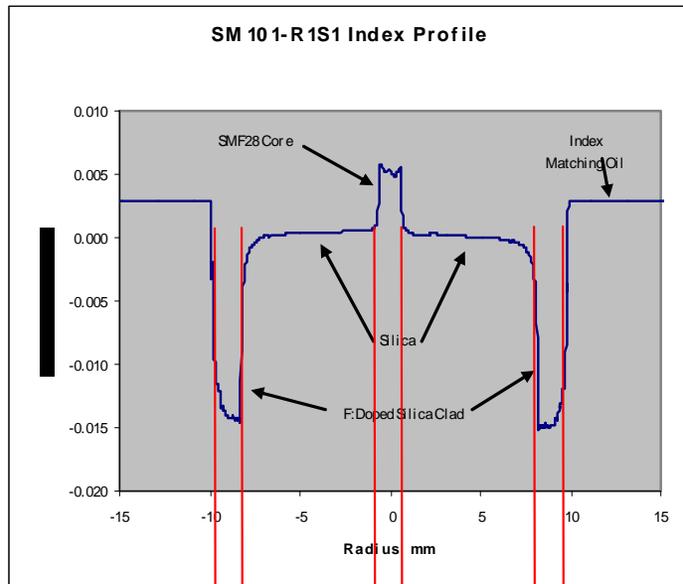
Beam split probes



- Velocity measured normal to surface.
- Beam splitter efficiency may still be high for different wavelengths.
- Reduced standoff distance.
- Beam splitter can add aberration to focused spot.
- Increased alignment time.

Special fibers

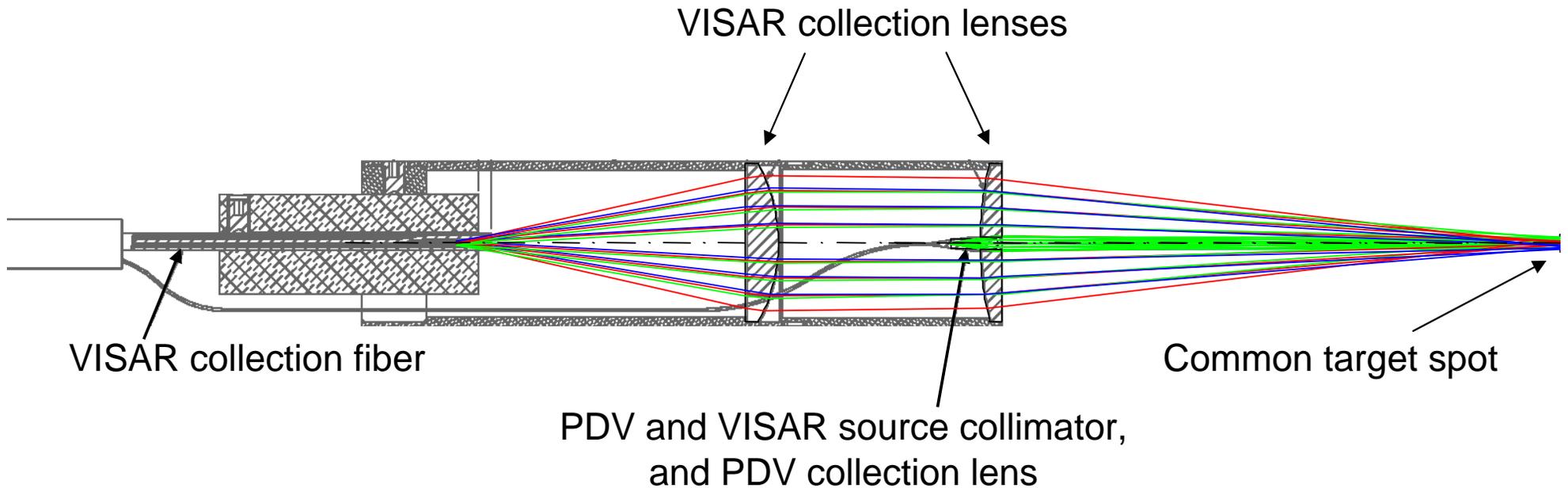
Dual-core fiber



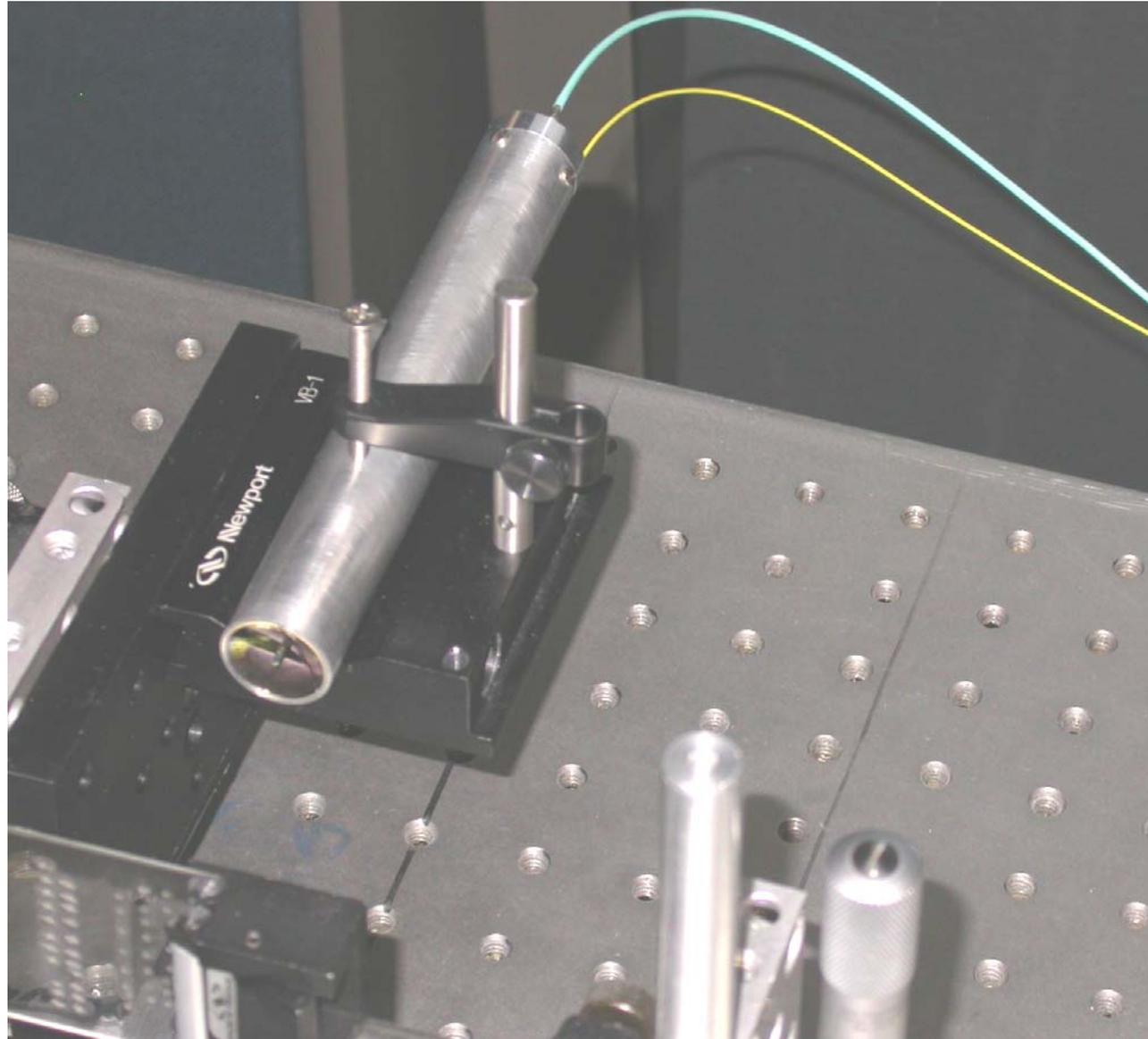
- Could be used as a bare-fiber probe with send light in single-mode core, greater receive signal with the large outer core.
- Achromats can be used to reduce the focus difference for two wavelength bands
- Fiber cores are imaged to same axis point on the target, but with different areas.

Coaxial velocimetry probe diagram

Side View

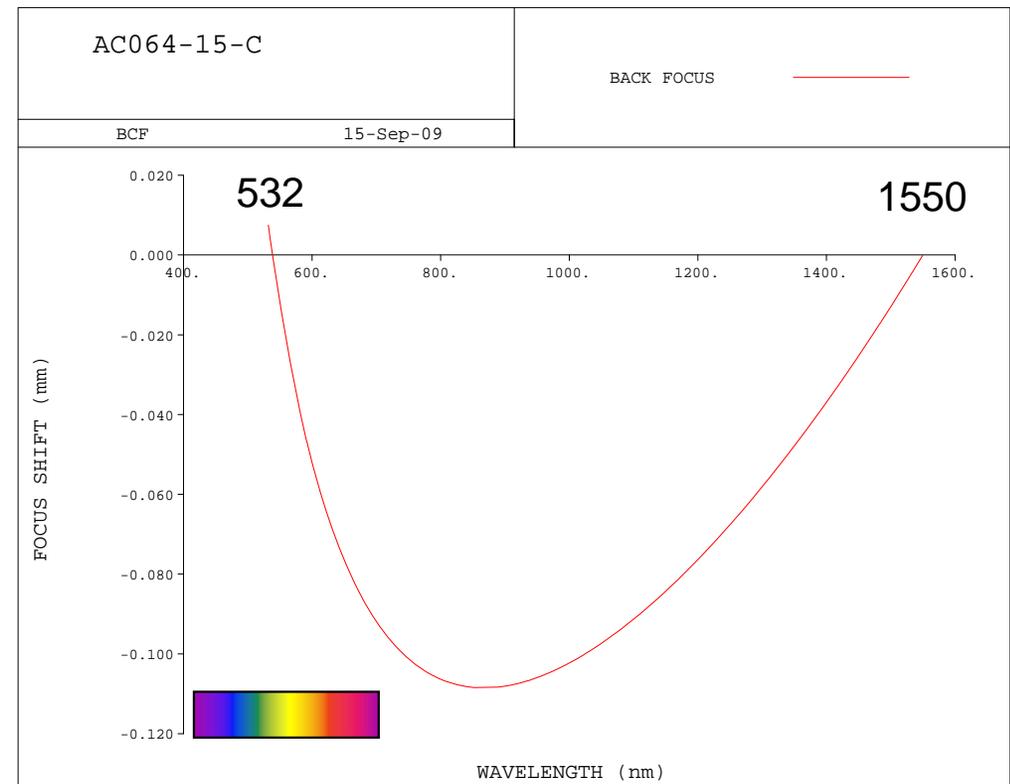
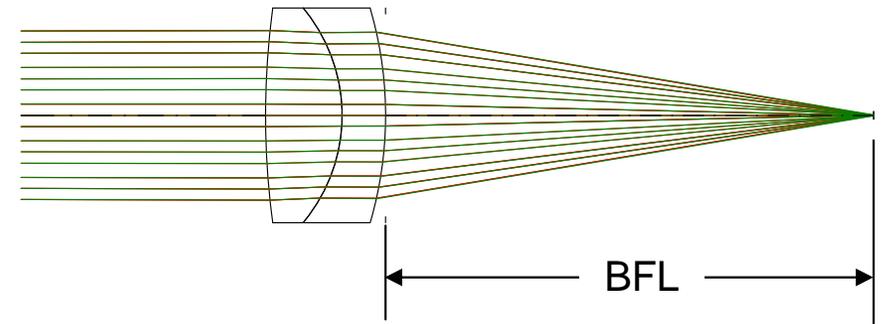


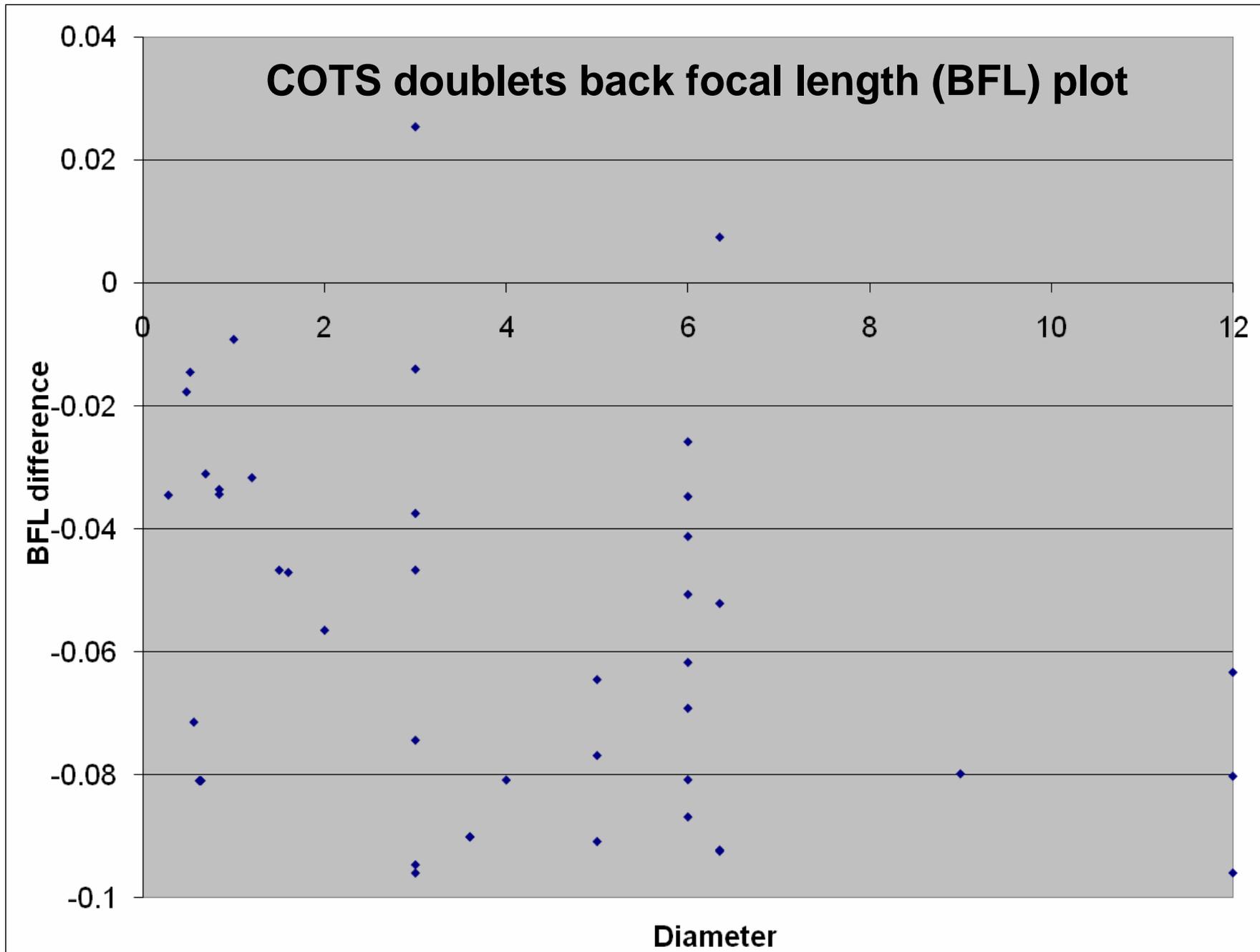
Coaxial velocimetry probe prototype



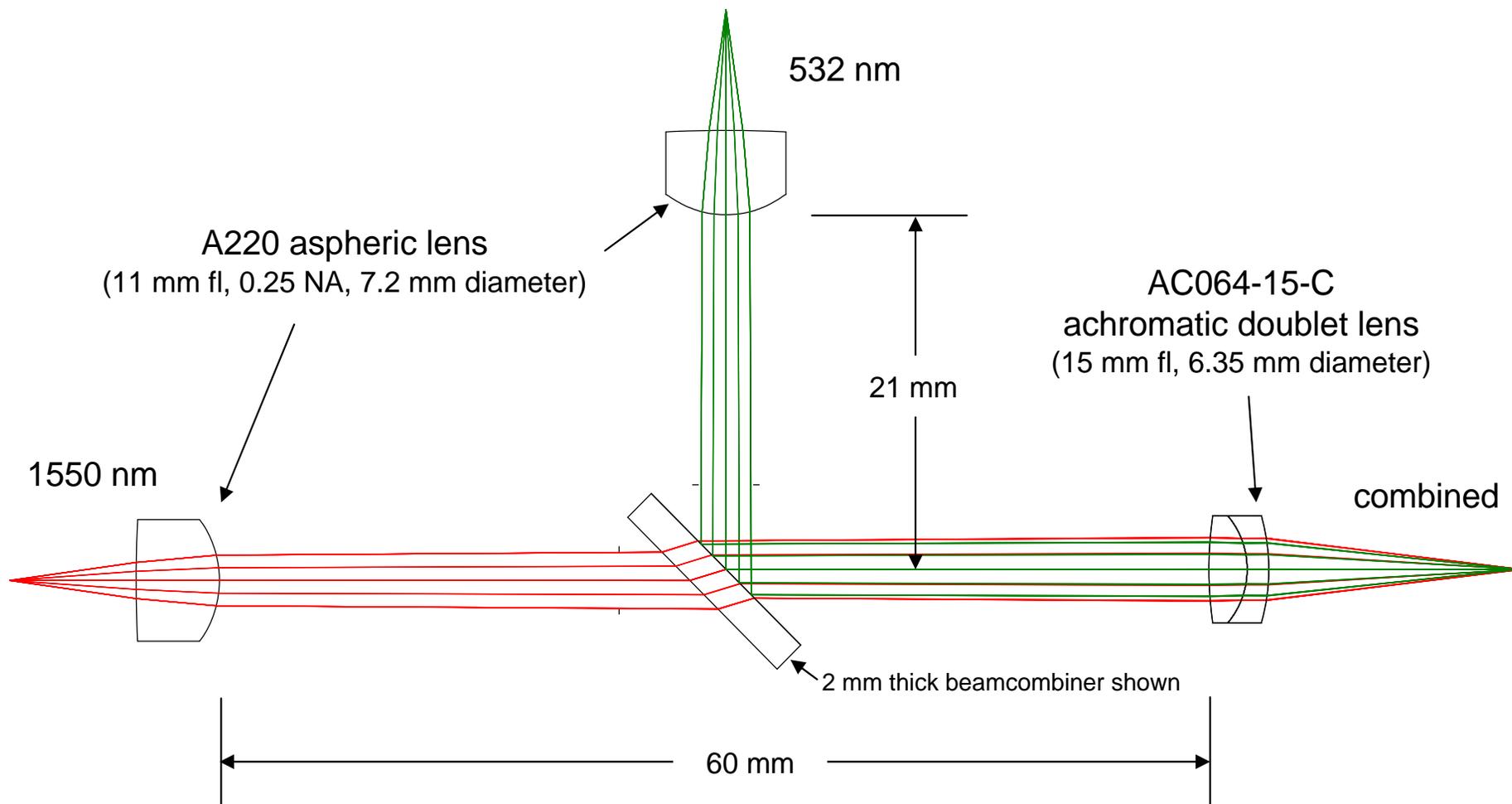
NIR doublet back focal length (BFL)

- Many catalog achromat doublets are designed for visible wavelengths and have a large BFL difference for 532 to 1550 nm.
- Cemented achromats with an absolute BFL difference of less than 0.1 mm are plotted on the next page.





Combining 532 and 1550 nm light into single mode fibers

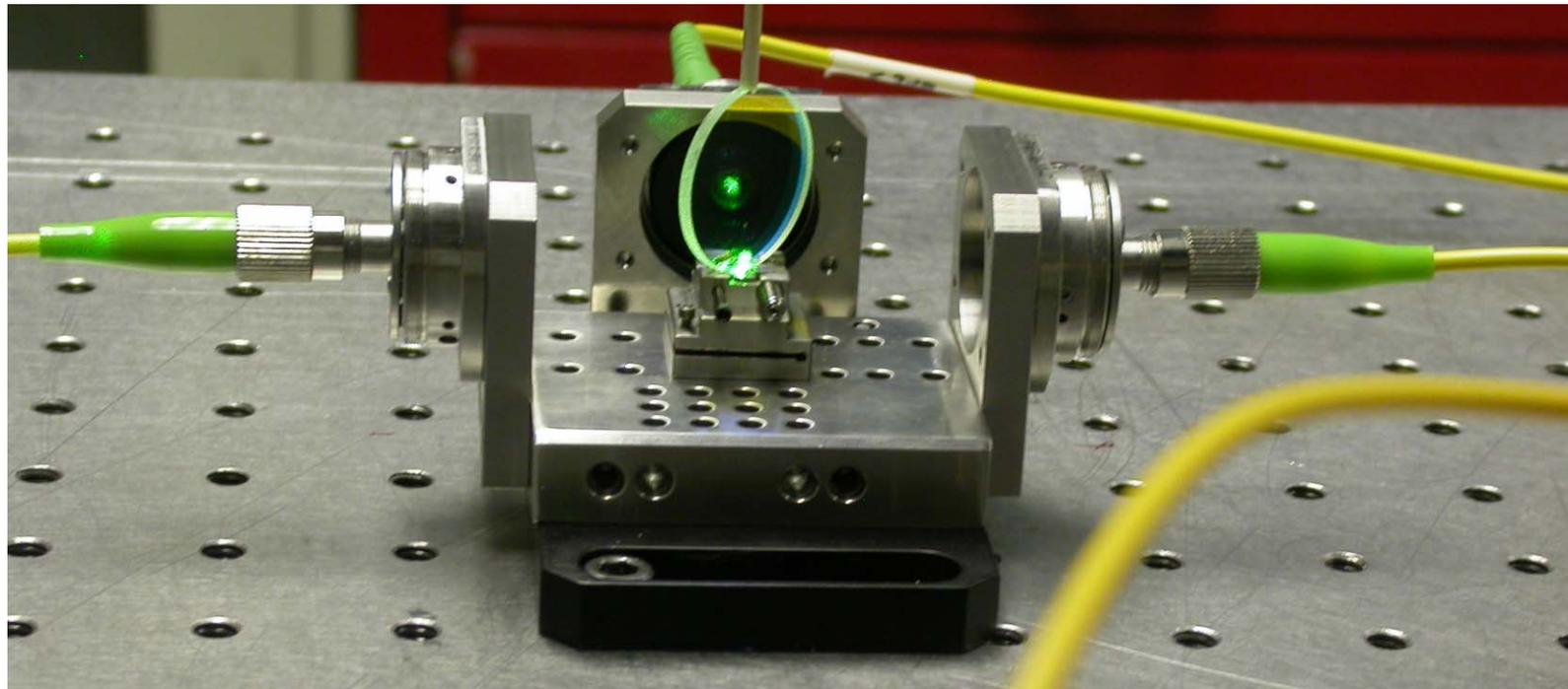


Combining 532 and 1550 nm light into single-mode fibers

Side View

532 nm

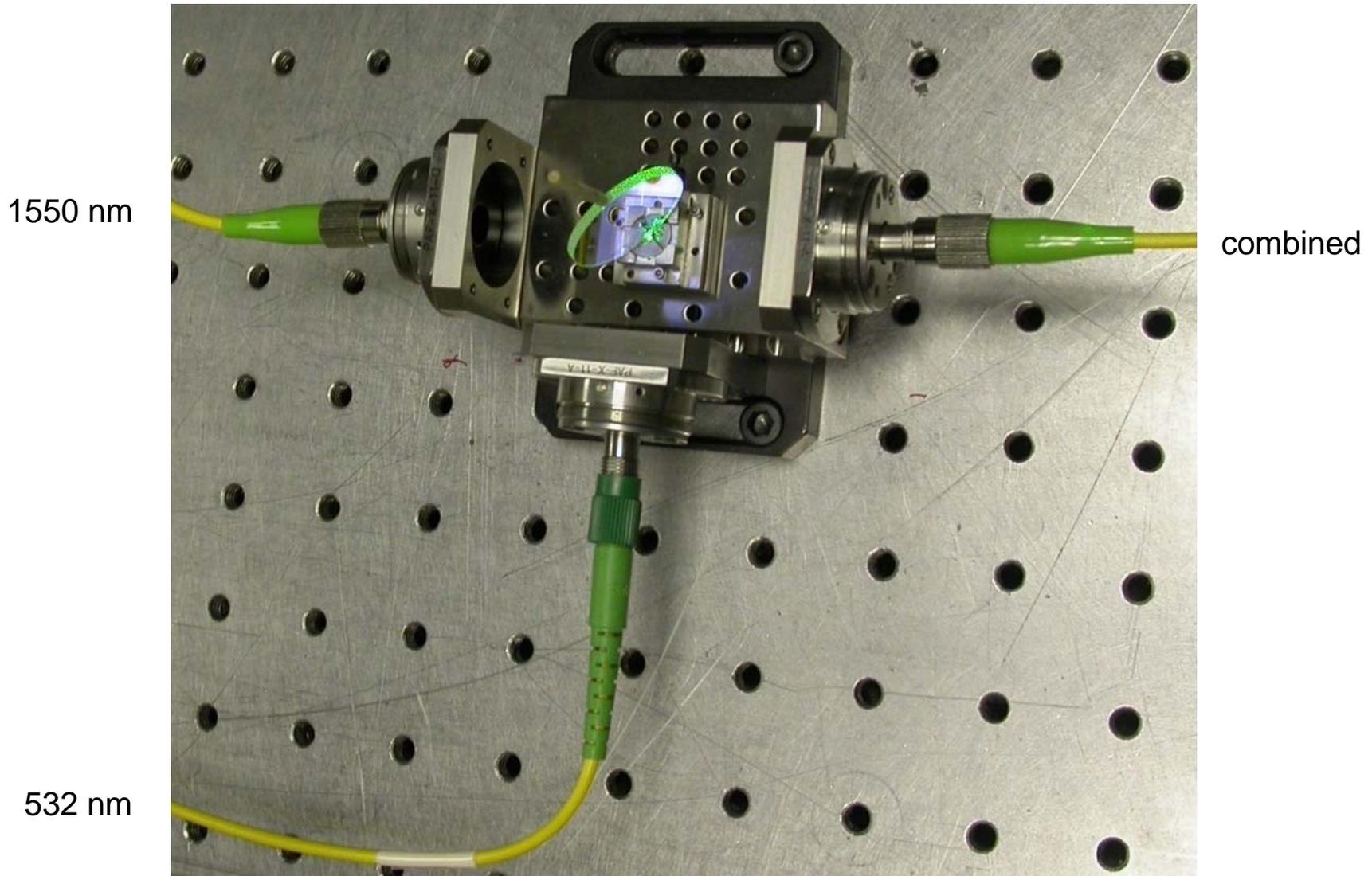
combined



1550 nm

Combining 532 and 1550 nm light into single-mode fibers

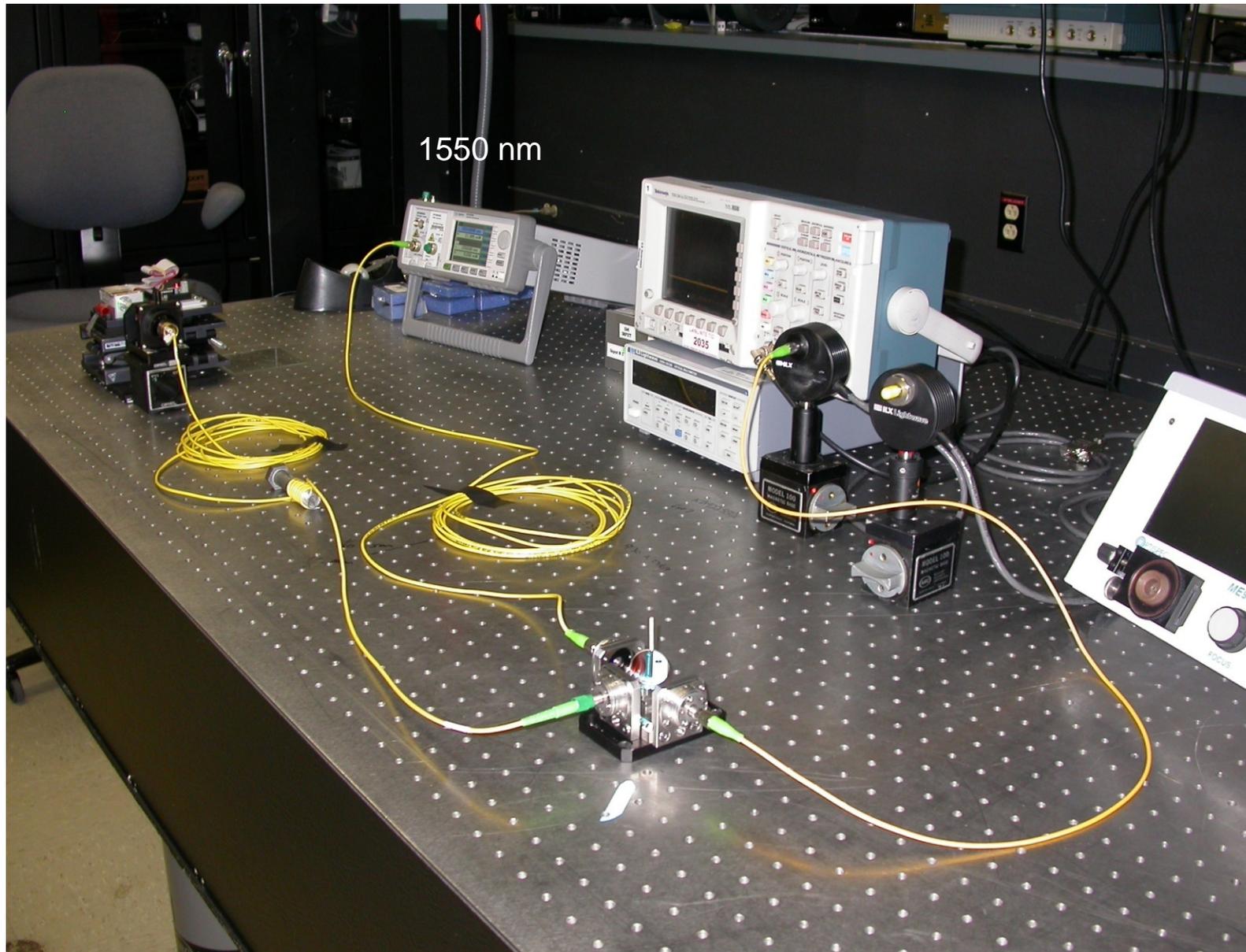
Top View



Combining light measurement setup

532 nm

1550 nm



Summary

We are developing methods of combining VISAR and PDV measurements at the same spot on a target and along the same axis. We expect these will allow improved comparisons between VISAR and PDV measurements.

We have successfully combined 532 nm and 1550 nm light into single-mode fibers using well-corrected doublet lenses.

We are beginning tests using a prototype coaxial velocimetry probe.