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University of Arizona WFC Testbed

02/12/2015

UA Wavefront Control Testbed

- CLOWFS
- Non-specific coronagraph architectures
- Supercontinuum source + filters => bandpass frequencies
- 2 DMs (multiple aperture configurations)
- 3 CMOS cameras for CLOWFS

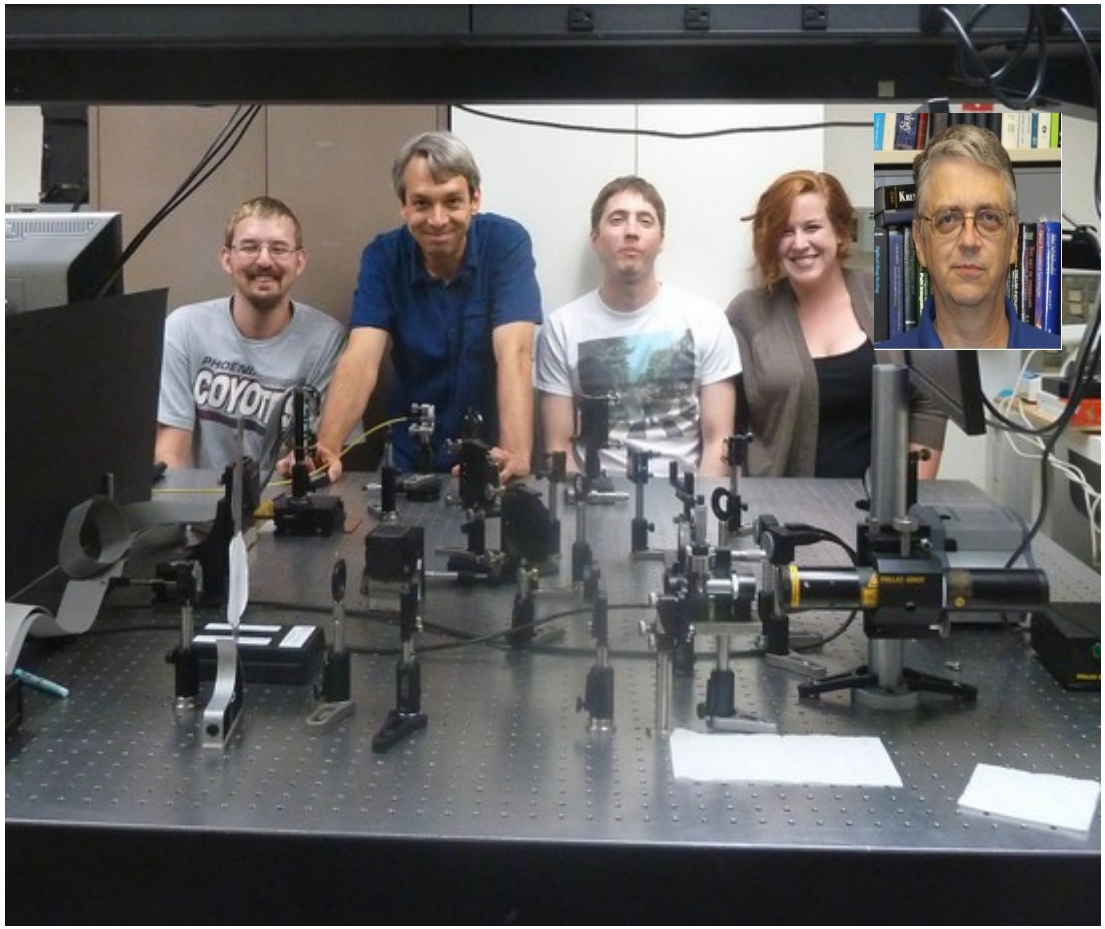
Why are we here again?

- Complements NASA testbeds and instrumentation (HCIT, Ames, Subaru)
- **Not** a high contrast testbed
  - here to test and validate innovative techniques for wavefront sensing and control such as LDFC, dOTF, self-calibration
- Dedicated team
- Flexible testbed

UA team

- Dr. Olivier Guyon – PI
- Dr. Johanan Codona – CoI

- Testbed operation and experiment control:
  - Justin Knight (PhD Student)
  - Kelsey Miller (PhD Student)
  - Alexander Rodack (Masters Student)



Goals

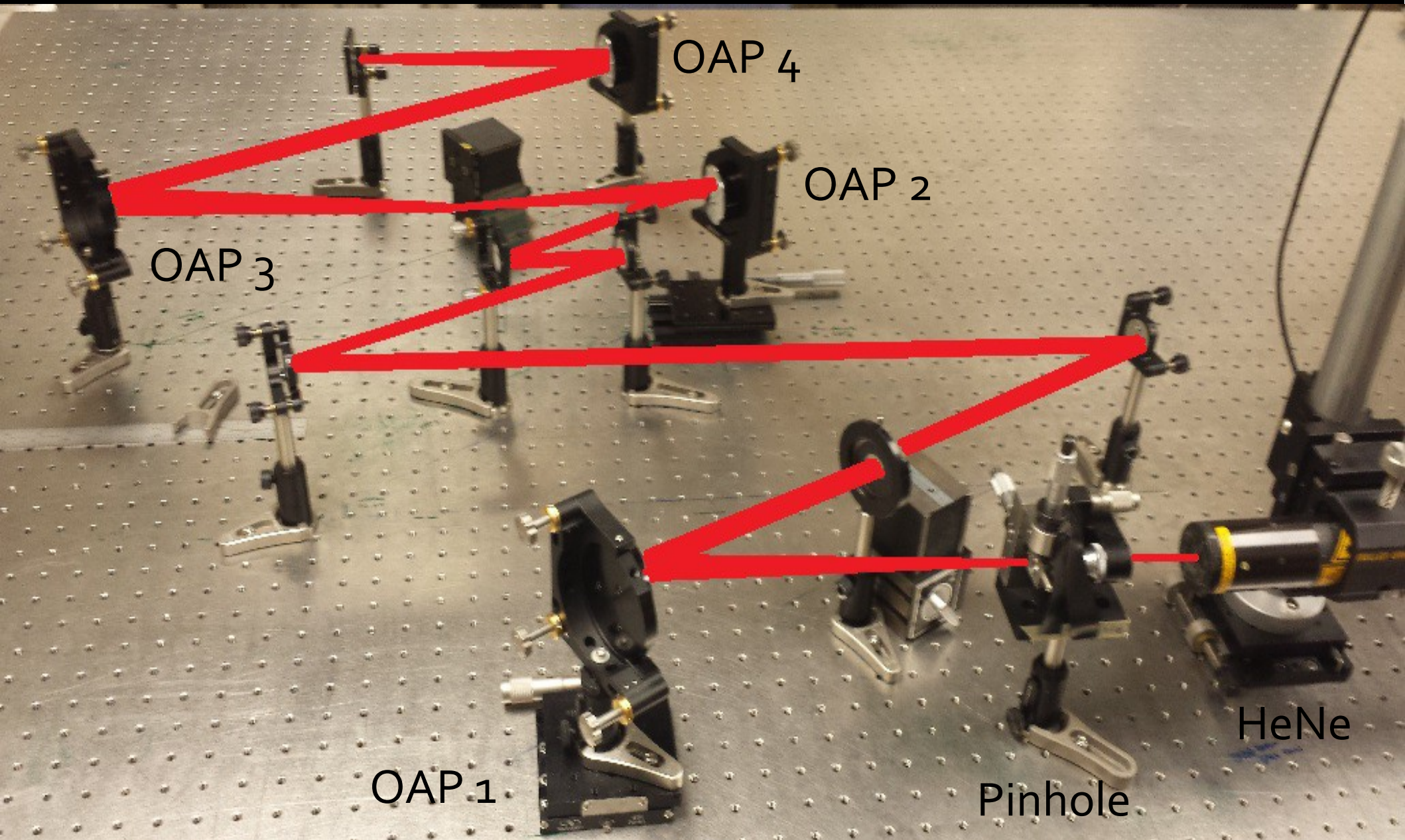
- Development of high efficiency wavefront measurement techniques on segmented/centrally obscured apertures
- Calibrate effects of segment motion and cophasing errors
- Understand how to design coronagraphs and exhibit wavefront control for these aperture types
- Explore PSF calibration techniques using wavefront telemetry (both LOWFS and focal plane images)

Outline

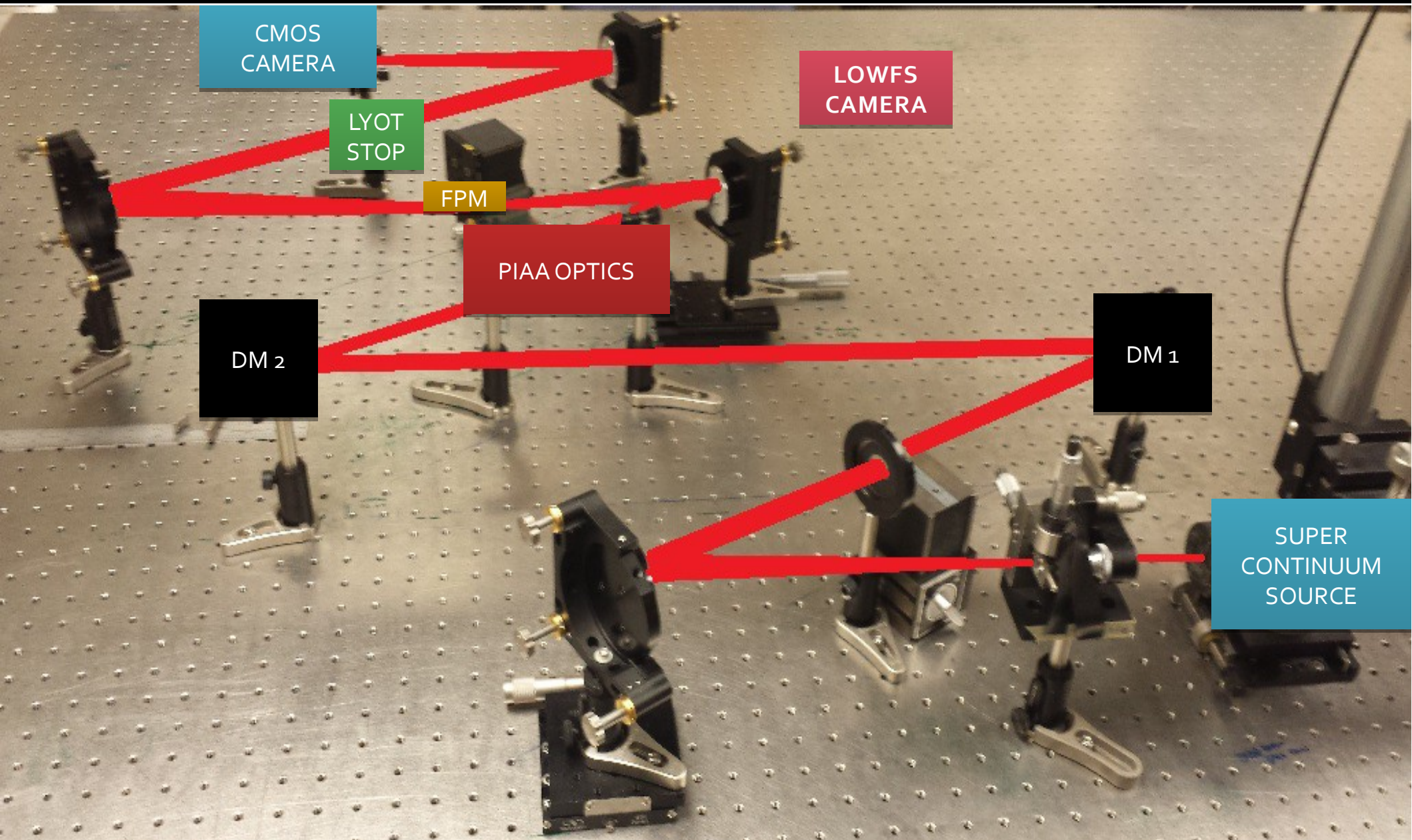
- Testbed Progress
  - Former Testbed
  - Anticipated Development
  - Current Testbed
  - Next Steps
- Key Features
  - Supercontinuum Source
  - Lyot Coronagraph
  - Deformable Mirrors
- Summary for Future NASA Missions

TESTBED PROGRESS

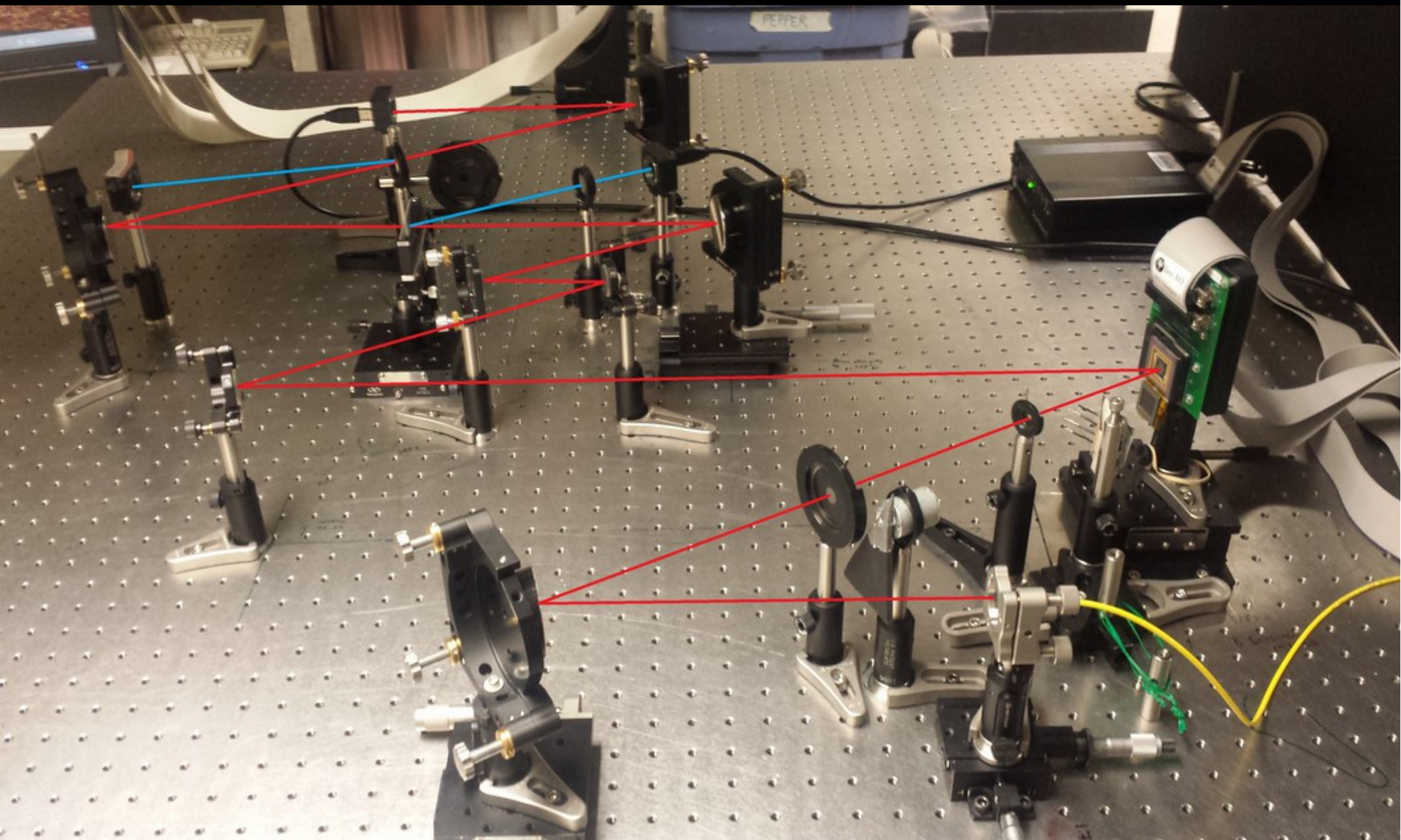
Last time we talked…



Anticipated Development



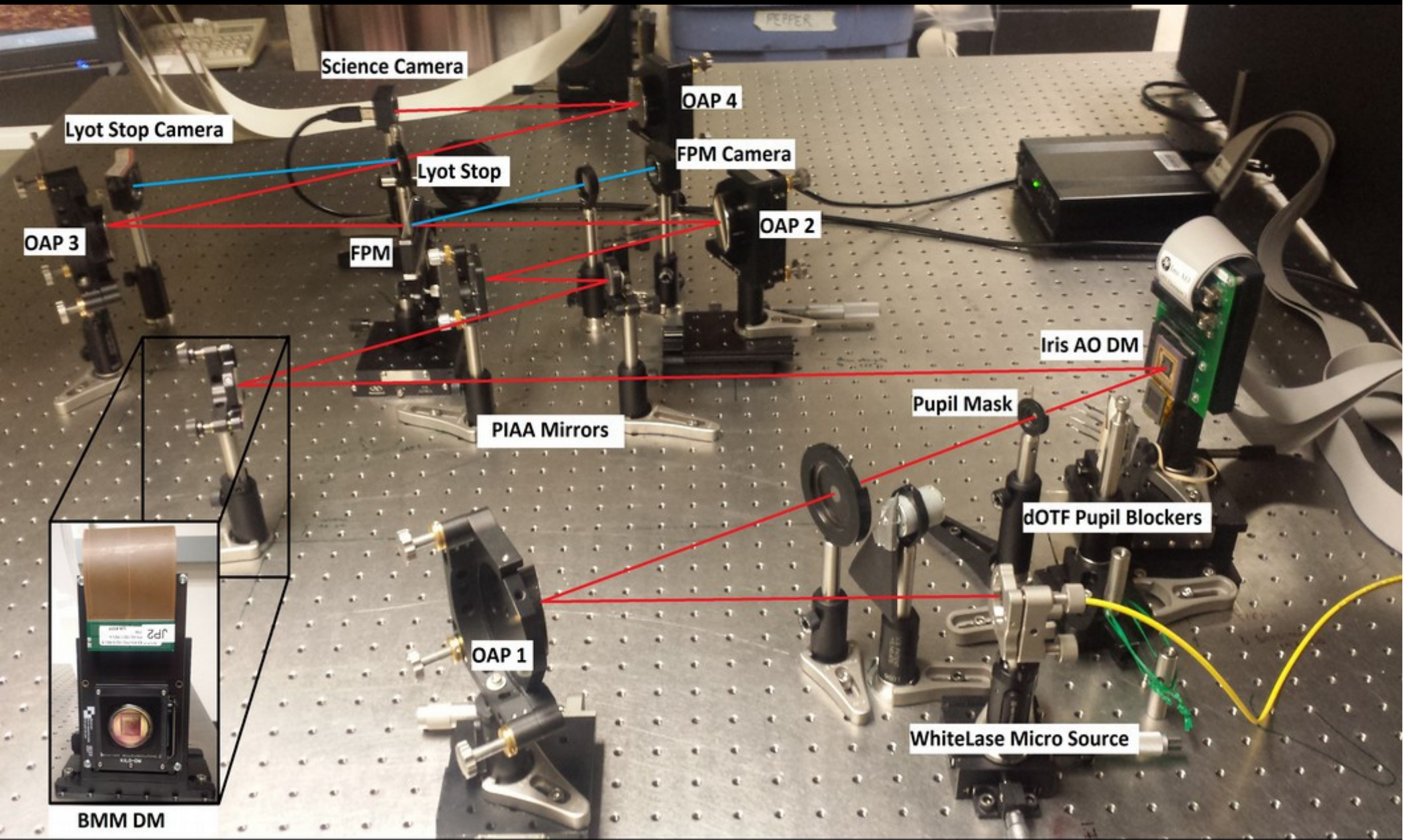
Current Testbed



Next Steps

- Placement of a 32 by 32 actuator MEMS Boston Micromachines Mirror
- AFTA-like Pupil plane mask placement near the Iris AO DM
- Automated shutter
- Automated pupil blockers for dOTF experiments
- Implementation of coronagraphic architectures:
  - PIAA optics
  - Lyot stop to match AFTA-like pupil masking

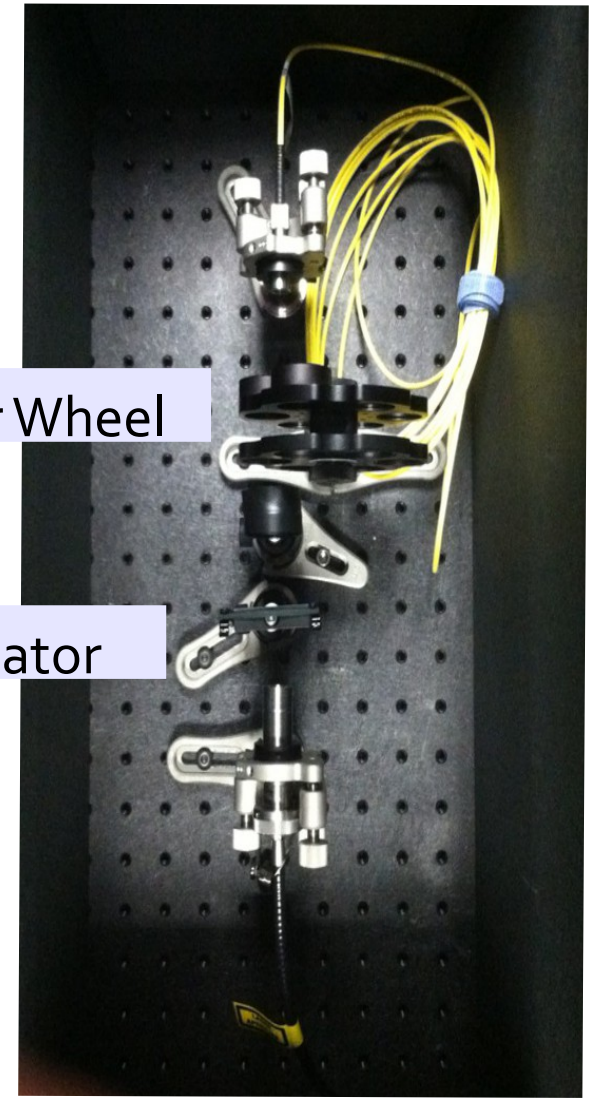
Next Steps


Science Camera
OAP 4
Lyot Stop Camera
FPM Camera
Lyot Stop
OAP 3
OAP 2
FPM
Iris AO DM
Pupil Mask
PIAA Mirrors
dOTF Pupil Blockers
OAP 1
WhiteLase Micro Source
BMM DM

TESTBED KEY FEATURES

Supercontinuum Source

- Model starlight incident to the system
- Explore broadband application of techniques
  - Deconvolving radial blur from dOTF
- Explore different bands with range of 400-1200 nm wavelengths

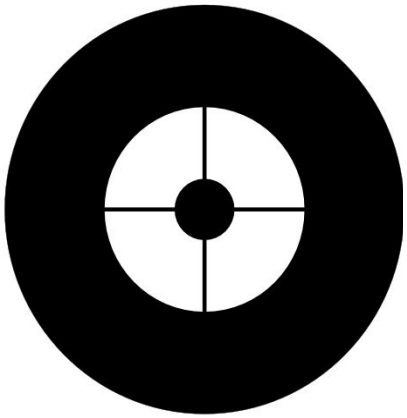


Deformable Mirrors

- 2 Deformable Mirrors
  - 37 Segment (111 actuator) Iris AO Mirror for simulation of a segmented aperture
  - 1024 actuator continuous face MEMS BMM DM
- PSF calibration of the Iris AO via dOTF – closing the loop on the testbed
  - Segment cophasing, Phase Apodization Corongraphy
- Inducing aberrations with the BMM
  - LOWFS, speckles for LDFC

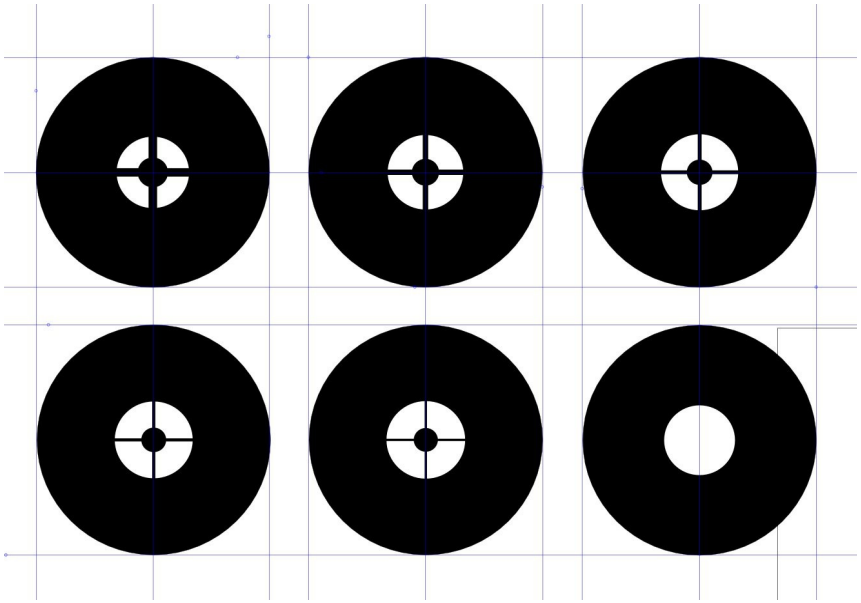
Pupil Plane Mask

- Chrome etched onto fused silica substrate
- Opaque pattern
- Placed as close to the Iris AO DM as possible (pre DM)
- Centrally obscured
- Created to model an AFTA-like pupil



Coronagraph: FPM, Lyot Stop

- Focal Plane Mask (FPM)
  - 3" glass slide, 21 equally spaced opaque masks
  - Sizes of λ/D for λ = 633 nm, D = 7 mm
  - Scale from 1 – 3 λ/D
- Reflective Lyot Stops
  - Ranges from no pupil matching to scaled diameters/spiders by powers of 2 of the entrance pupil diameter



APPLICATION TO FUTURE MISSIONS

WFIRST-AFTA

- Explore wavefront control and coronagraph capabilities for any pupil geometry
  - Centrally obscured
  - Segmented
  - Unobscured
    - Depends on the choice of the DM
- Currently designed to match 2.4 m AFTA pupil