LIGHT BUCKET ASTRONOMY

Low-Cost Fixed and Bimorph Correctors

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2010-2011 Alt-Az Initiative Hawaii Conference on Light Bucket Astronomy

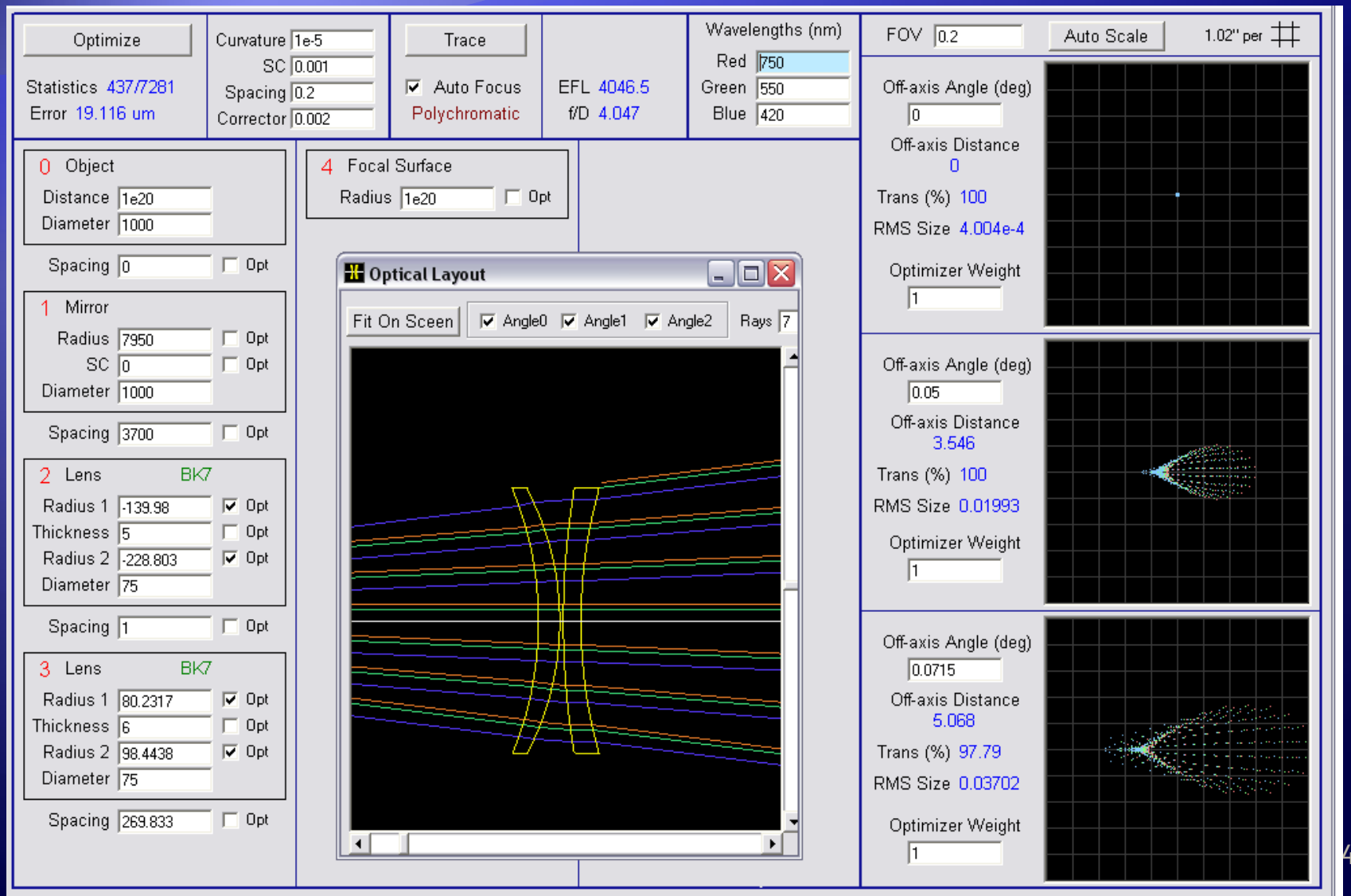
Agenda

- Fixed Correctors
  - Spherical
  - Aspherics
  - Projection lenses
- Bimorph Secondary Project

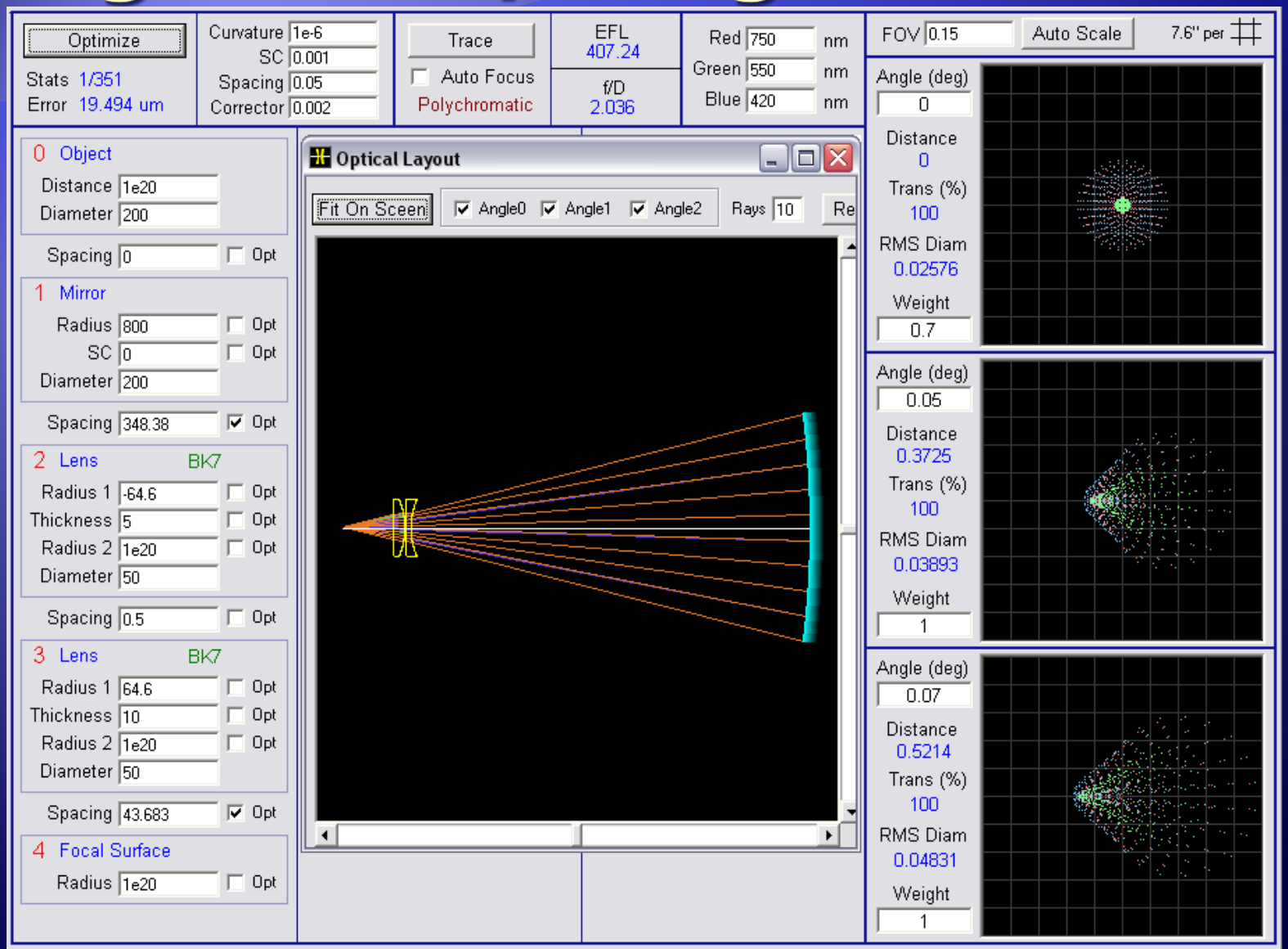
Fixed Element Correctors

- Spherical aberration problem: LBTs may be f/4, f/2, even f/1
- One & two spherical lens designs (off-the-shelf) considered
- Slumped meniscus
- Projection lenses with aspherics

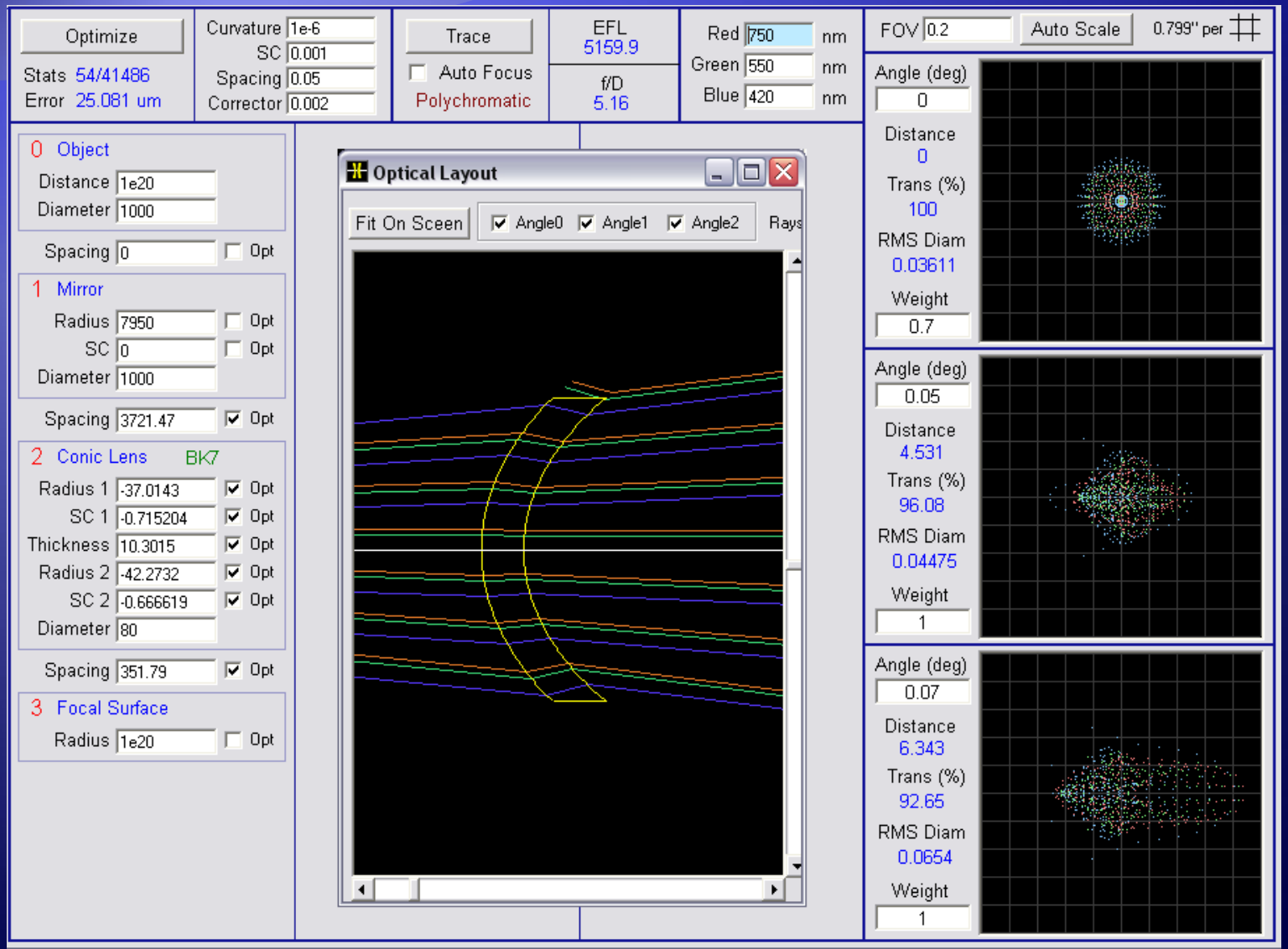
Dave Rowe's 1-m, f/4 Corrector



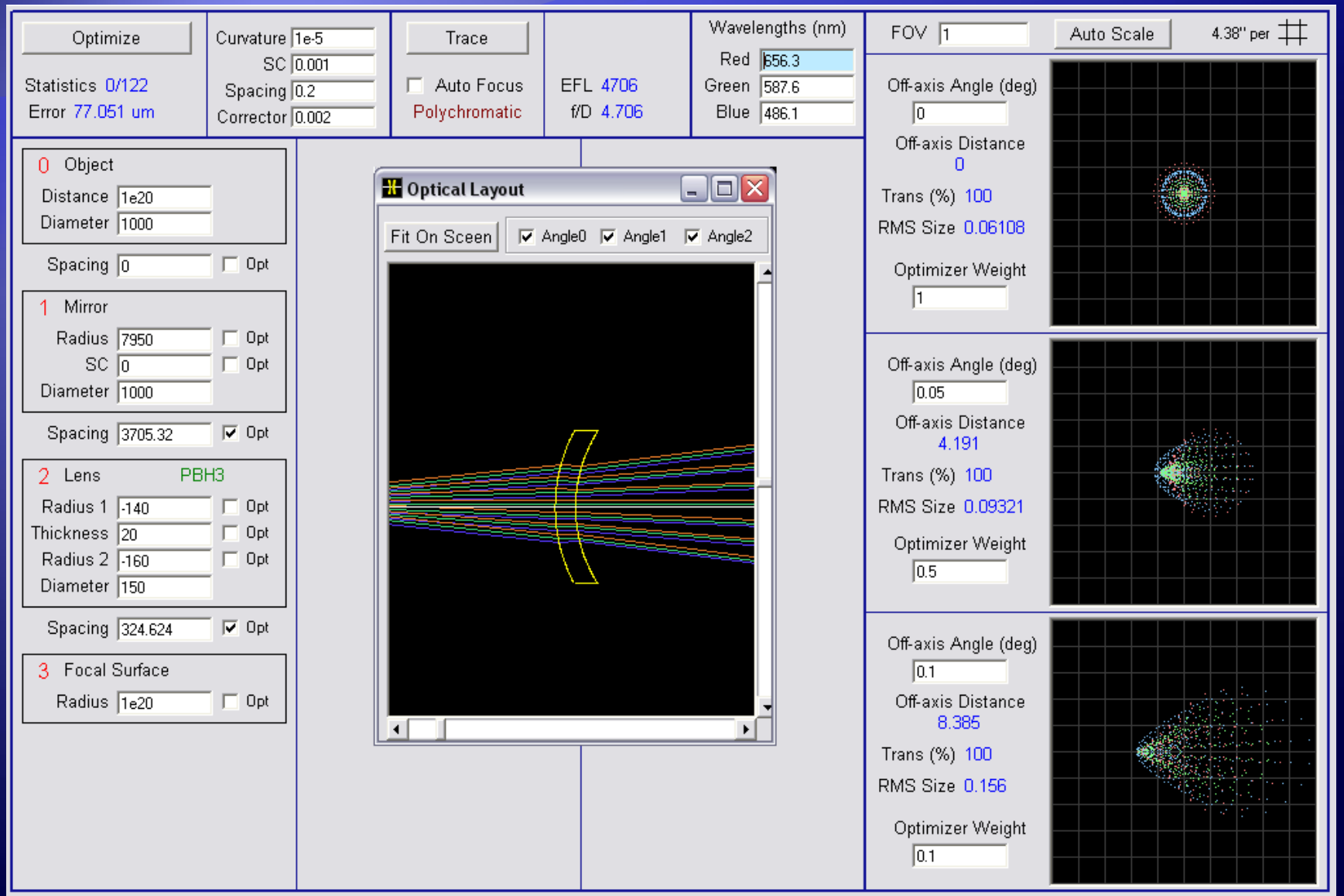
Tong Liu's f/4 design on f/2 8"



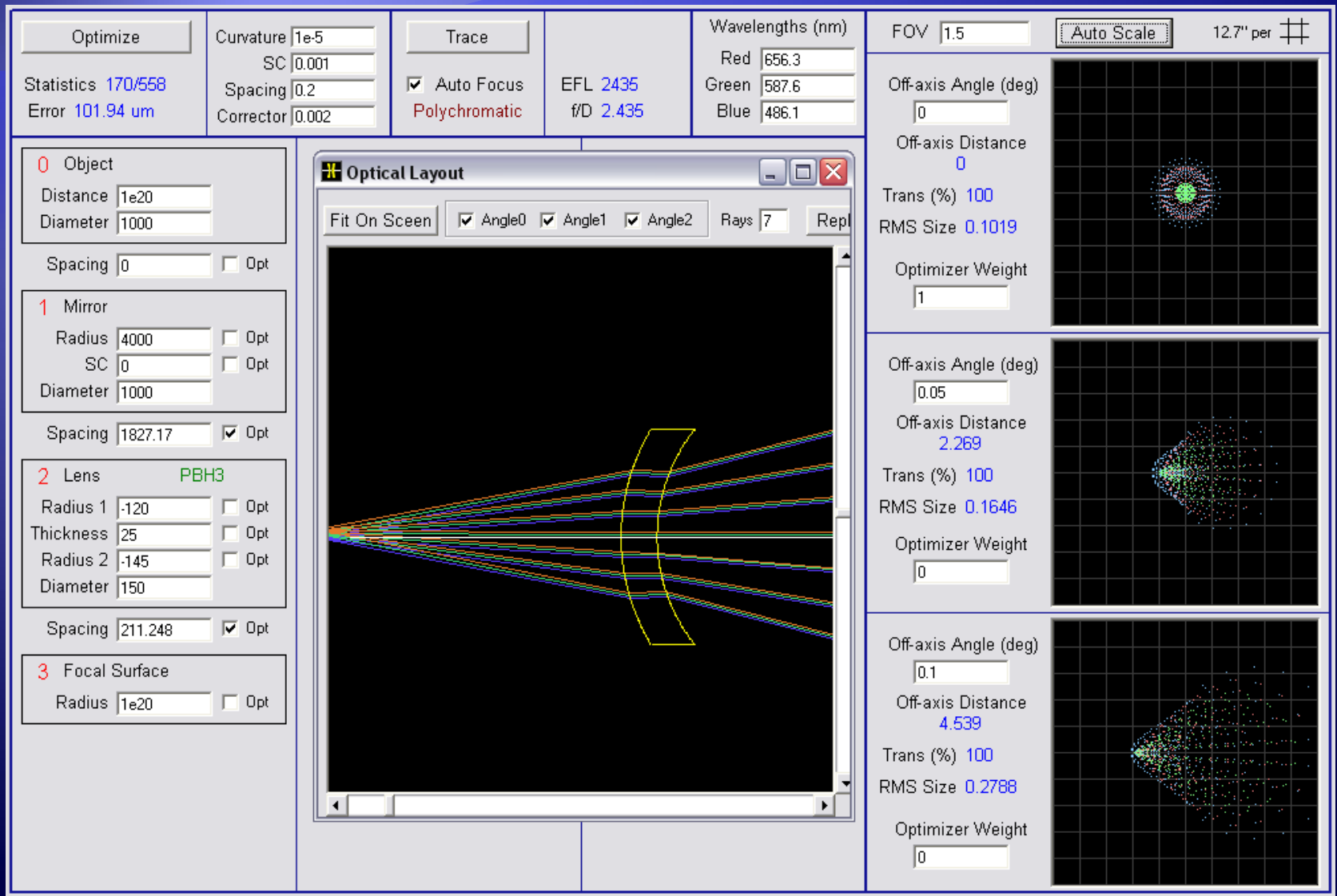
1-m f/4 BK4


Optimize
Stats 54/41486
Error 25.081 um
Curvature 1e-6
SC 0.001
Spacing 0.05
Corrector 0.002
Trace
Auto Focus
Polychromatic
EFL 5159.9
f/D 5.16
Red 750 nm
Green 550 nm
Blue 420 nm
FOV 0.2
Auto Scale
0.799'' per
0 Object
Distance 1e20
Diameter 1000
Spacing 0 Opt
1 Mirror
Radius 7950 Opt
SC 0 Opt
Diameter 1000
Spacing 3721.47 Opt
2 Conic Lens BK7
Radius 1 -37.0143 Opt
SC 1 -0.715204 Opt
Thickness 10.3015 Opt
Radius 2 -42.2732 Opt
SC 2 -0.666619 Opt
Diameter 80
Spacing 351.79 Opt
3 Focal Surface
Radius 1e20 Opt
Optical Layout
Fit On Sceen
Angle0 Angle1 Angle2
Rays
Angle (deg) 0
Distance 0
Trans (%) 100
RMS Diam 0.03611
Weight 0.7
Angle (deg) 0.05
Distance 4.531
Trans (%) 96.08
RMS Diam 0.04475
Weight 1
Angle (deg) 0.07
Distance 6.343
Trans (%) 92.65
RMS Diam 0.0654
Weight 1

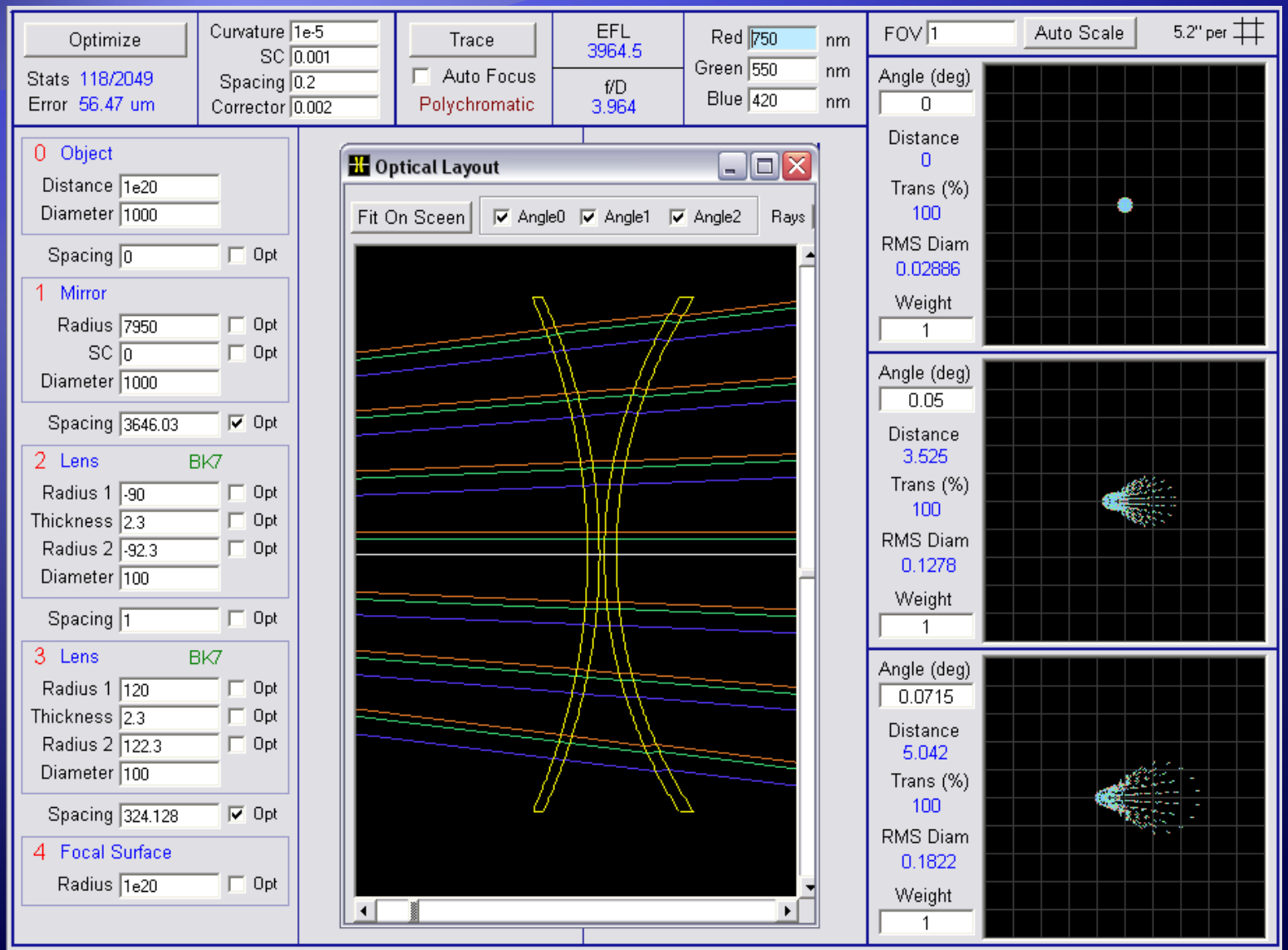
1-m f/4 Plastic



1-m f/2 Plastic

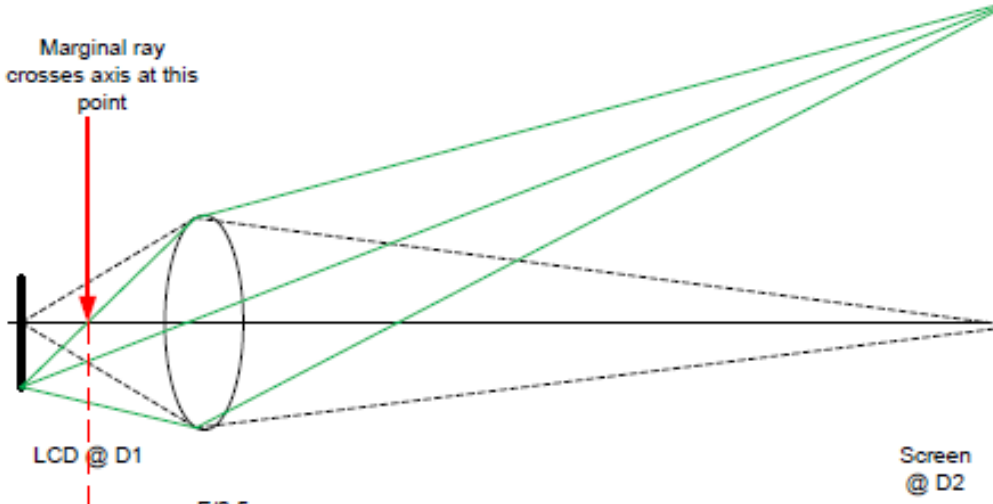


1-m f/4 Meniscus

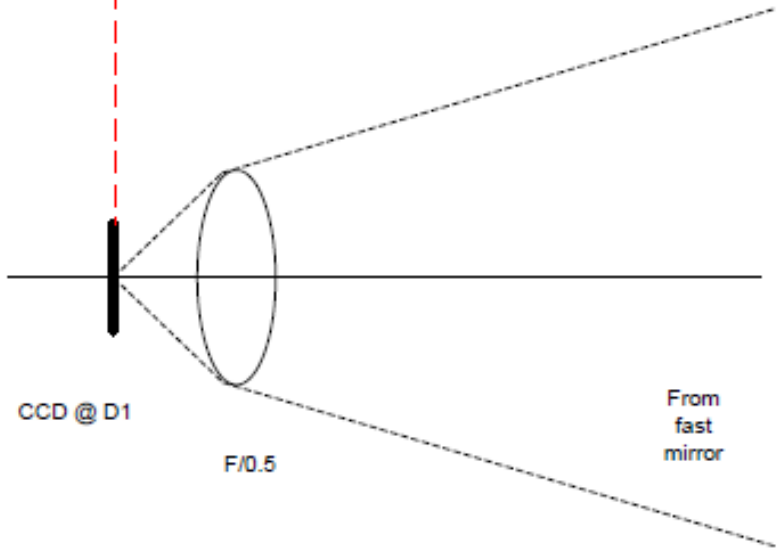


Aspherics

- Olive3 is out-of-date
- Projection lenses
  - Movie
  - LCD ~f/2
  - Rear Proj. TV ~f/1



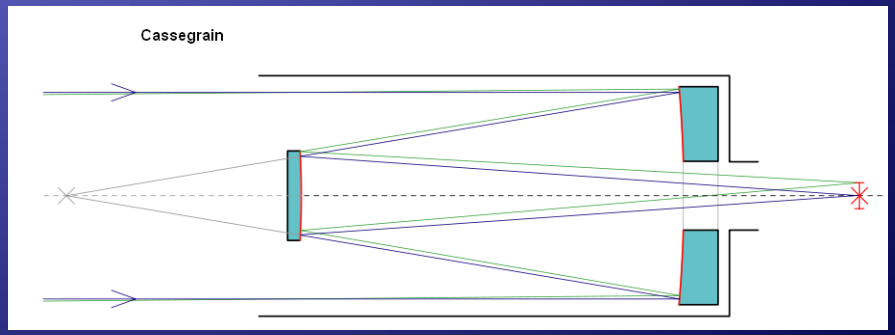
Normal Projection
1/f = 1/D1 + 1/D2,
D1 and D2 both positive, D2 is large



Telescope
1/f = 1/D1 + 1/D2, D2 negative

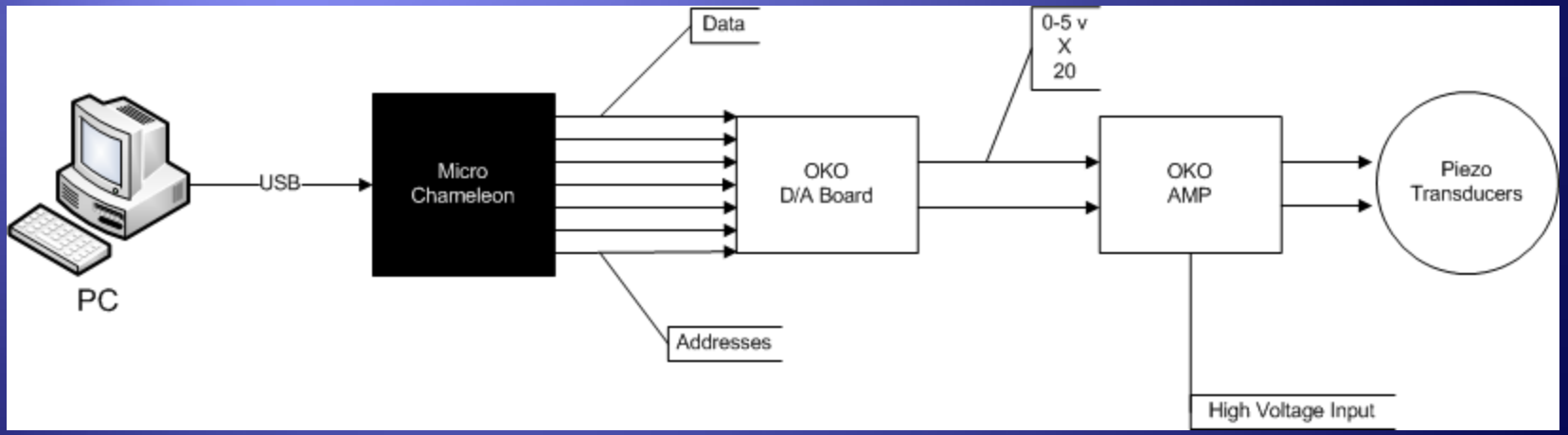
Bimorph Secondary Project

- Goals
  - Active, not adaptive, correction for LBTs
  - Low-cost & replicable
  - Explore relationship between prediction and experiment
- Current State
  - Deformable Cass-like secondary (not 45° Newt.)
  - 40 actuators



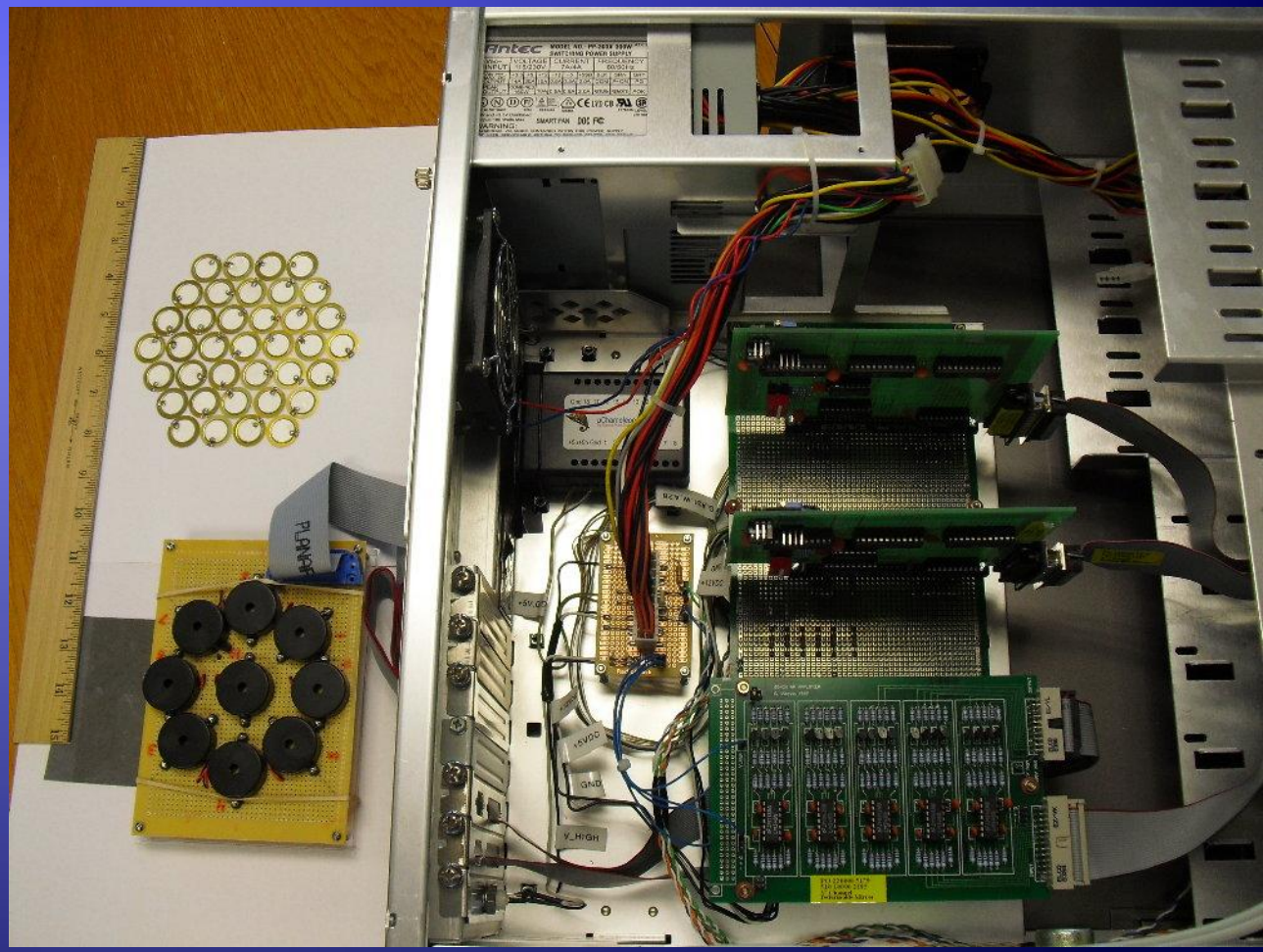
Bimorph Secondary II

- Controller



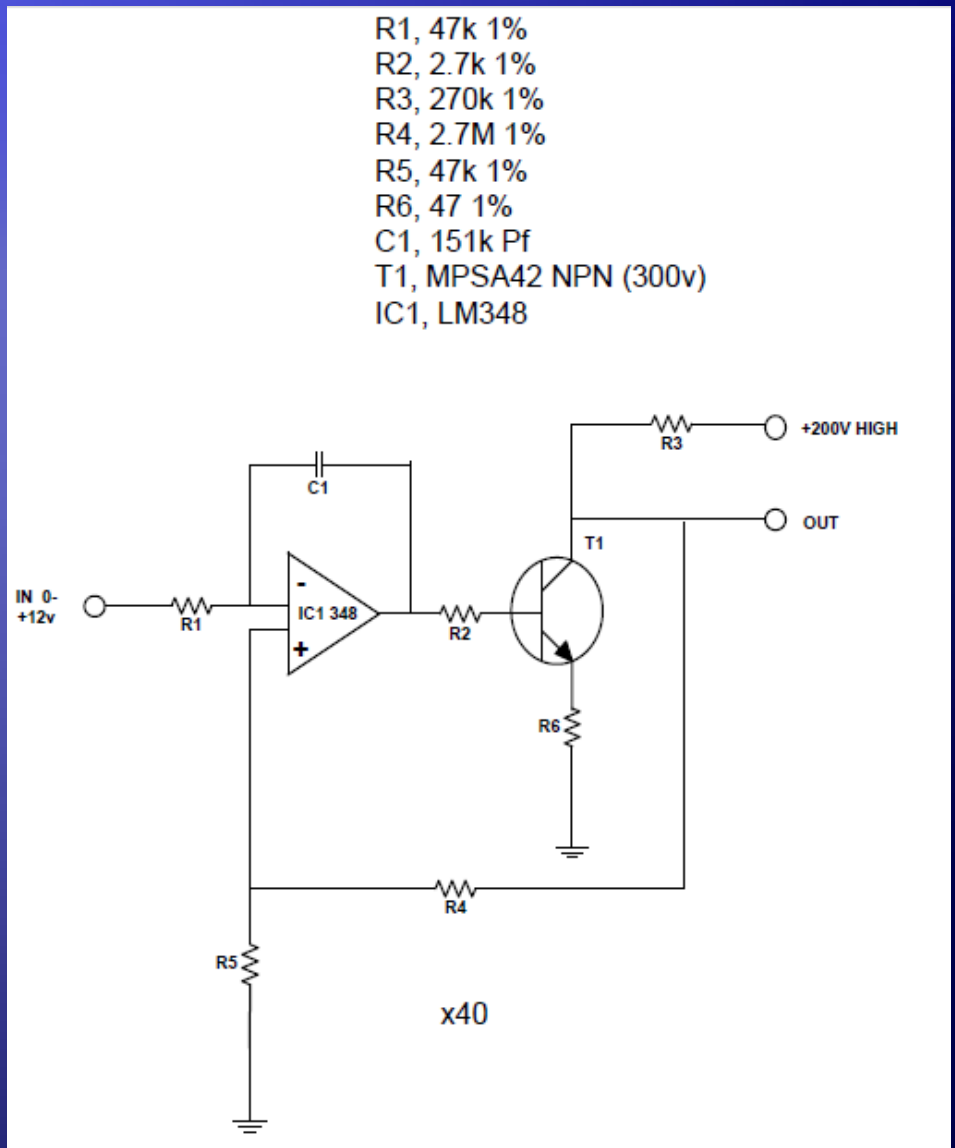
Bimorph Secondary III

- Re-used old ISA OKO boards
- USB µChameleon
- 500Hz update rate
- 40-channel
- 0-200v Out



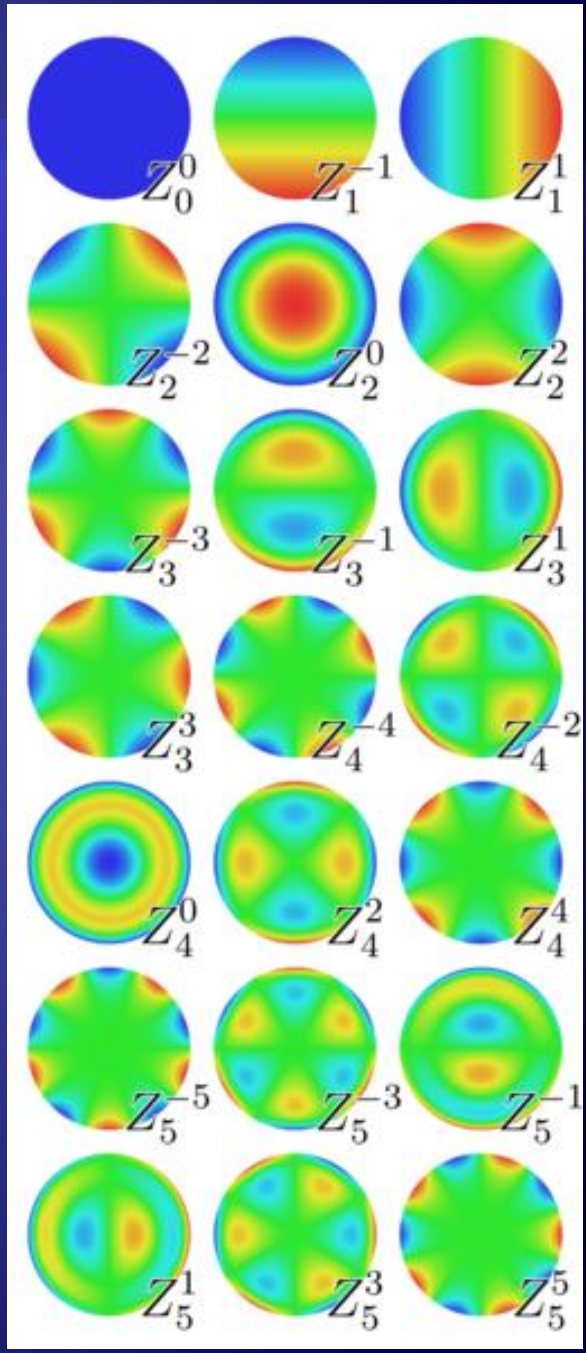
Bimorph Secondary IV

- HV amp: 0-3v in, 0-200v out
- 500Hz update rate
- MPSA42 @ $0.05ea. Qty. 2k



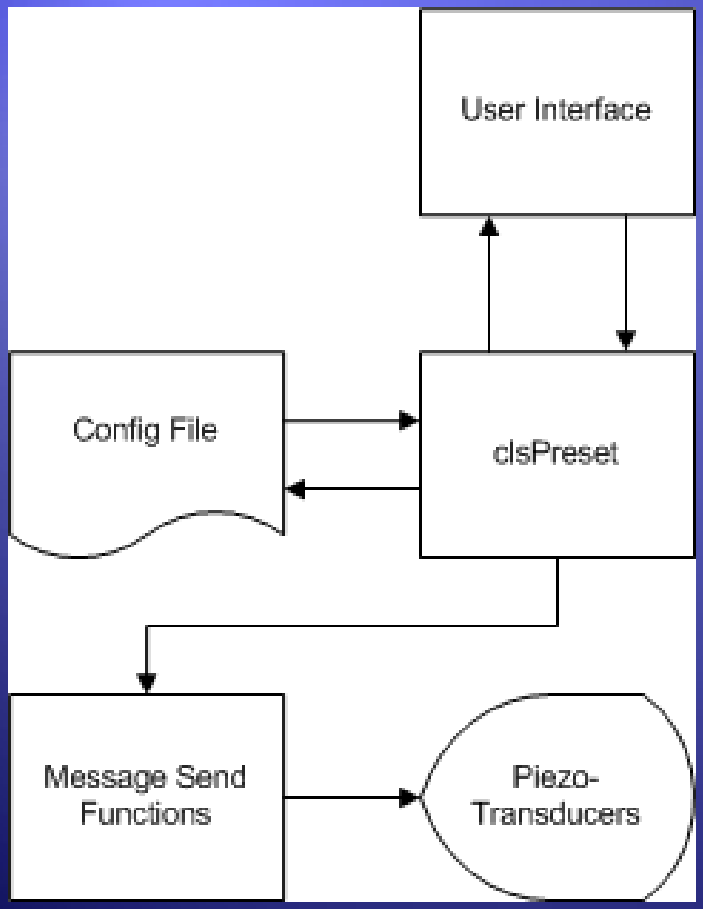
Bimorph Secondary V

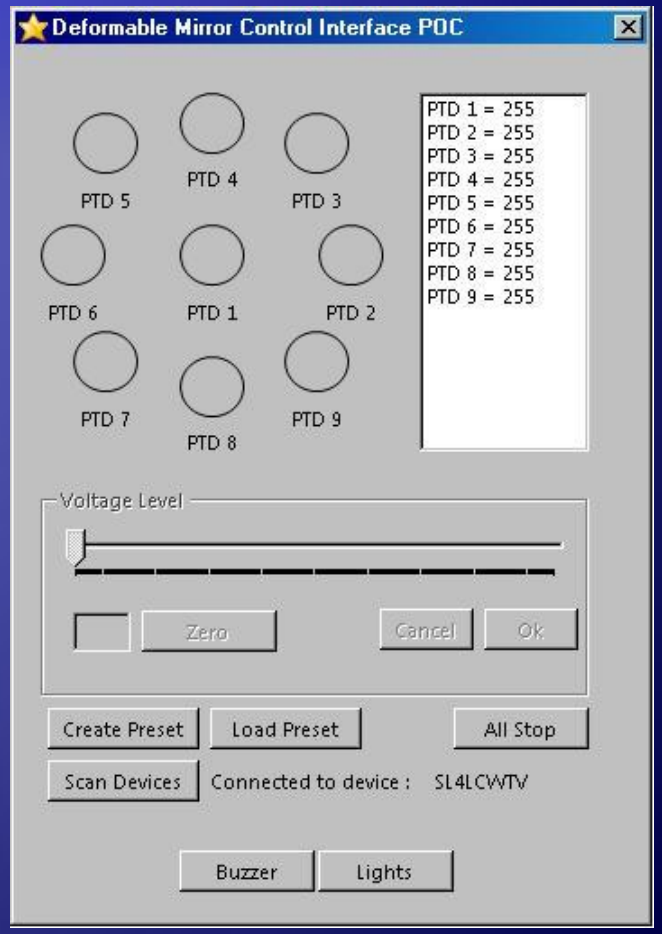
- Zernike orthonormal functions
- Closed loop
  - Wavefront sampling
  - Active correction
- Open loop
  - Minimize PSF (simulated annealing)
  - Lookup table



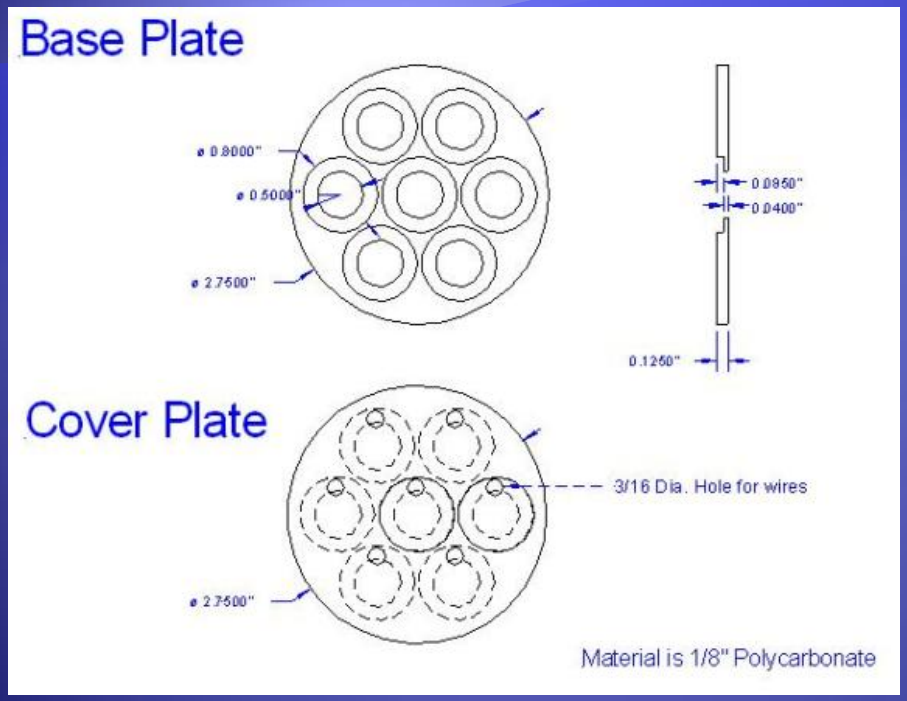
Bimorph Secondary VI

- Control Software



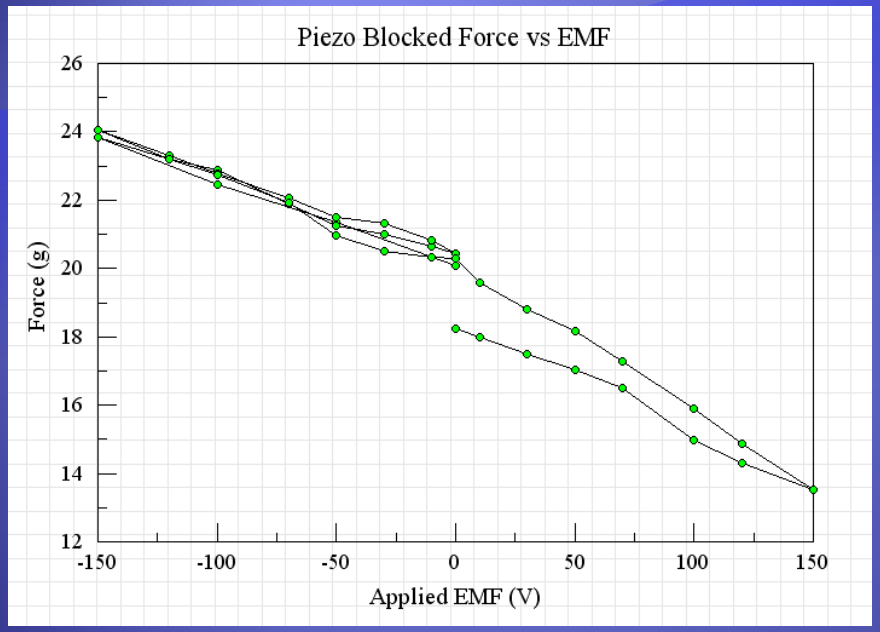


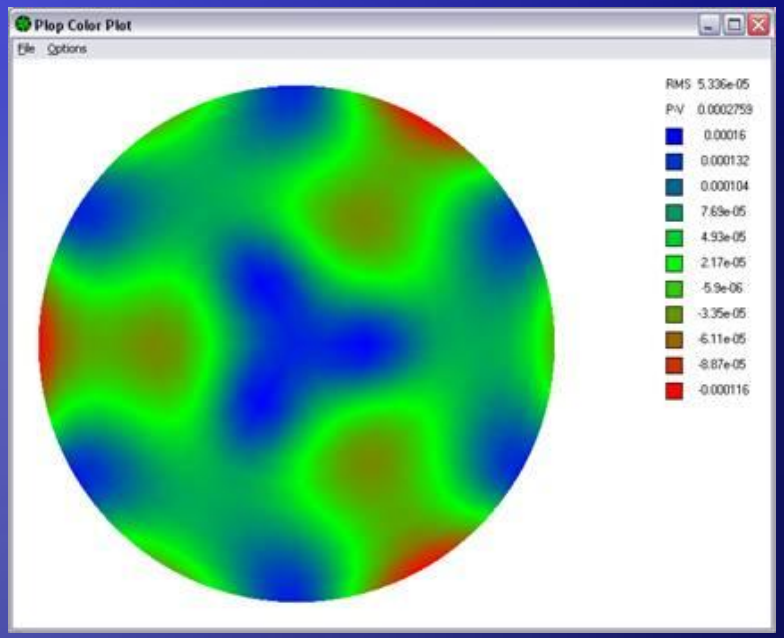
7-piezo prototype I



- Unblocked deflection of+/-35 microns over 120VAC (340Vpp)
- About 0.2microns/Volt

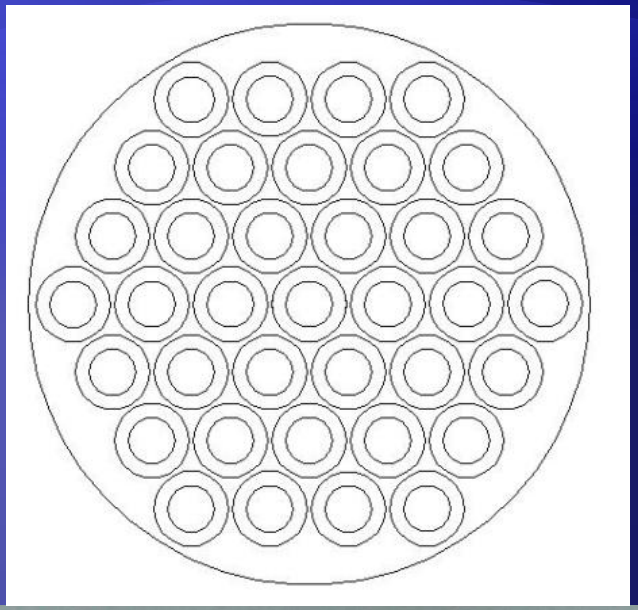
7-piezo prototype II

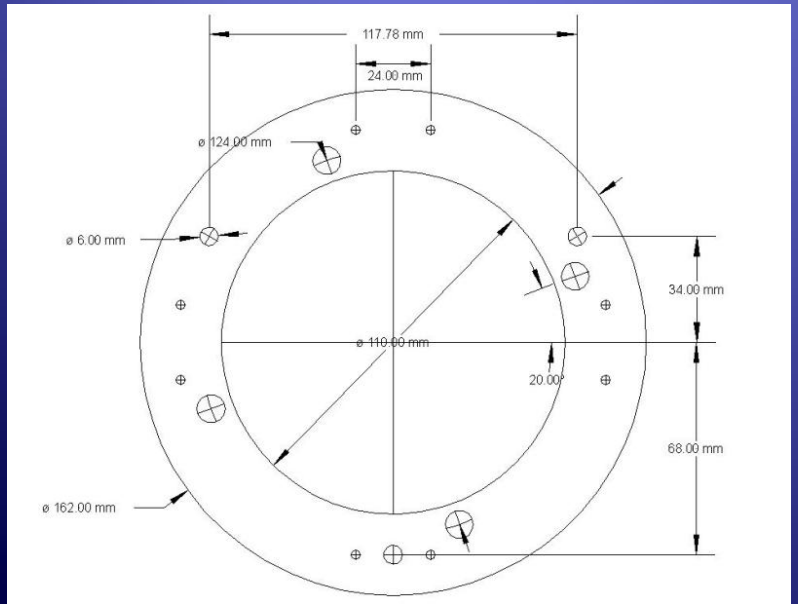


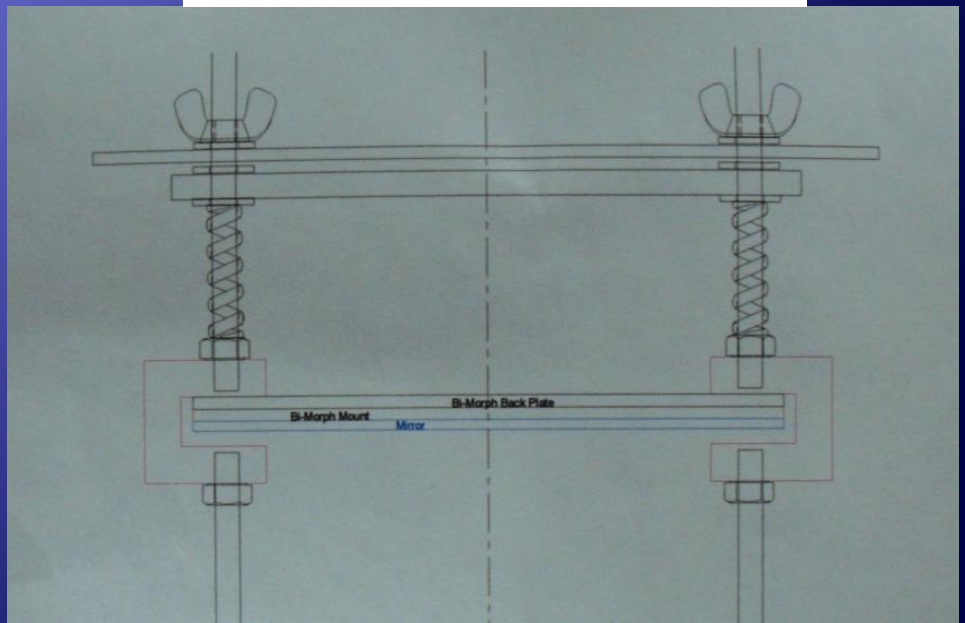


- 10-g swing from +/- 150V
- Some hysteresis
- >200V force reversal!
- Plop for 0.5-mm glass shows 1/5 wave from 0.5-g support

Bimorph Secondary Mount – 37 piezo







Conclusions and further work

- Low-cost piezos design can deform 3-mm plate glass sufficiently & repeatably
- Need to finish 37-piezo secondary
- Test under a variety of circumstances
  - Determine hysteresis & temperature affects
  - Try PSF-size feedback

Contact

- Email: bholenstein@gravic.com
- Initiative Website - www.AltAzInitiative.org
- Yahoo Discussion Group - http://groups.yahoo.com/group/AltAzInitiative

More details:
The Alt-Az Initiative: Telescope, Mirror, & Instrument Developments, eds. Genet, Johnson, & Wallen, (Payson, AZ: Collins Foundation Press) 2010