# CHARA Small (lab) Deformable Mirror Optics

If funding for a large DM at M4 does not eventuate (update Jan 2012: no funding now), CHARA will need to create a cheap AO system using deformable mirrors in the lab. The typical desired pupil conjugation is a setup like W1 or E1 on POP1 (a typical POP for those telescopes), which means a pupil location ~180-260m upstream from the beam reducing telescopes. Using other POPs will push this number higher. The key parameters for the AO setup are then:

1. Pupil location 200-300m upstream from the BRTs.
2. Small actuator count – e.g. ~20 degrees of freedom OK.
3. A preference to keep the current primary for the BRTs, which has a 1280mm focal length.
4. A maximum of 400mm additional length spare between the LDCs and the metrology optics.
5. An input beam diameter of 125mm and an output beam diameter of 20mm (exact numbers?)

Some nominal parameters are described in the CHARA\_LabAO.xlsx spreadsheet. A baseline configuration consists of:

1. A -1000mm focal length mirror 70mm before the BRT focus, mounted on a Newport U100 mount.
2. A 2.0mm pupil small (i.e. medium-sized, available from Thorlabs) DM from Boston Micromachines, placed 90.5mm further downstream. This needs at least 40.4mm clearance from any beam – detailed geometry on the Thorlabs drawing.
3. A custom 238mm focal length paraboloid, 218mm further downstream. I suggest we get quotes for these, from e.g. Robert F Royce optics, and Ranbow Research Optics. We could check if a spherical mirror plus a correction term on the DM is adequate.

This doesn’t actually work, because of coma produced by the -1000mm focal length mirror. Replacing it with a flat and a lens seemed to work, as in the diagram below… but this isn’t ideal. Almost certainly there is a solution with appropriate conic constants and angle-of incidences.



*Figure 1: The beam reducing telescope, with the secondary replaced with a negative focal length lens, a flat mirror, a DM (red box) and an off-axis paraboloid.*

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*Figure 2: A zoom in to the focus region, where the 3 colors are field angles of 0 and +/- 20 arcsec (i.e. +/- 2.5 arcsec on sky). All field angles strike the DM as it is in the pupil plane.*