AAReST Project: Ae105 Class Involvement

Manan Arya and Sergio Pellegrino

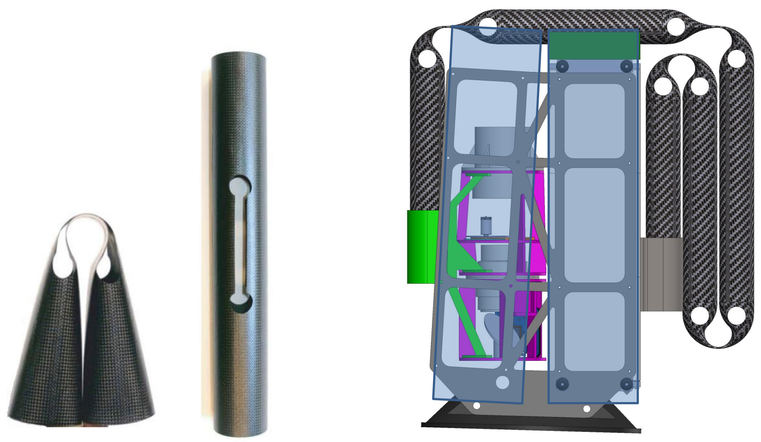
California Institute of Technology

Deployable Boom

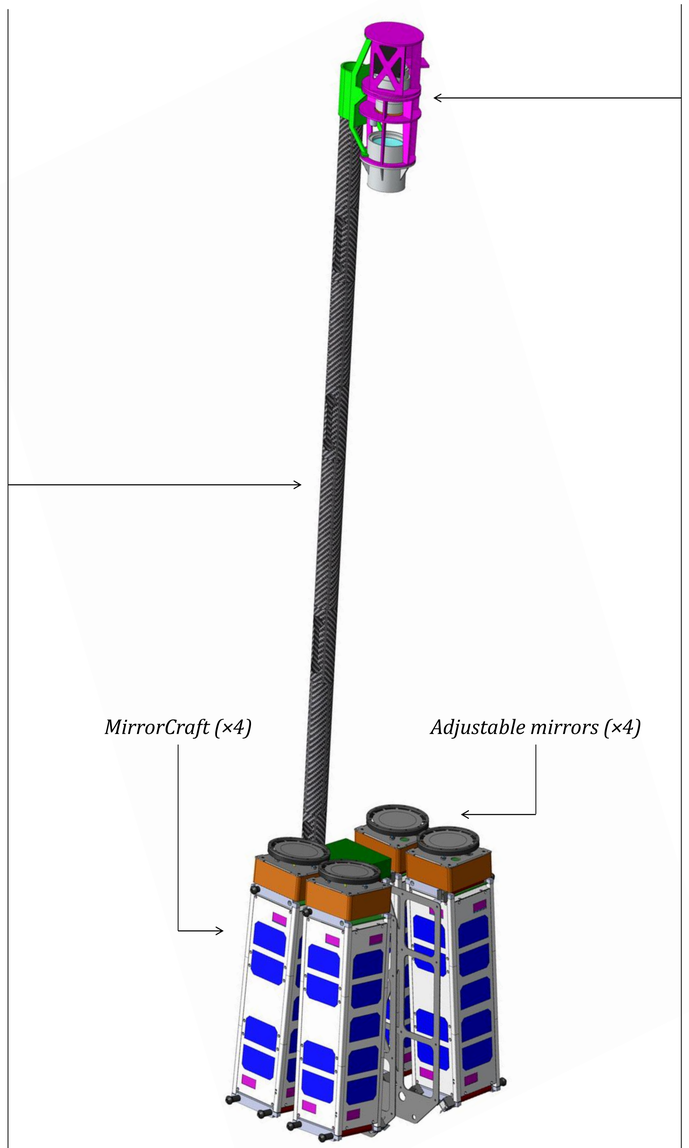
The boom is a carbon-fiber composite tube with tape-spring hinges that enable the boom to be stowed in a compact configuration for launch. In orbit, the boom unfolds to a length of 1.29m, and holds a 4kg optical detector at the end. The deployable boom is a key enabler for a prime focus telescope with a 1.2m focal length.

The boom is packaged in a planar configuration that can be easily deployed quasi-statically. A quasi-static deployment system based on cable-and-pulley mechanism was successfully tested using a gravity offload system. Such a deployment allows for the use of stiffer hinges, which would otherwise produce prohibitively large accelerations during deployment.

The CTE of the carbon fiber boom is 2×10^{-6} K^{-1}; this leads to a ±200μm axial displacement of optical detector. This displacement can be compensated for by the adjustable mirrors on the MirrorCraft.



Folded and deployed tape-spring hinge (left). Packaging configuration for the boom. (right).

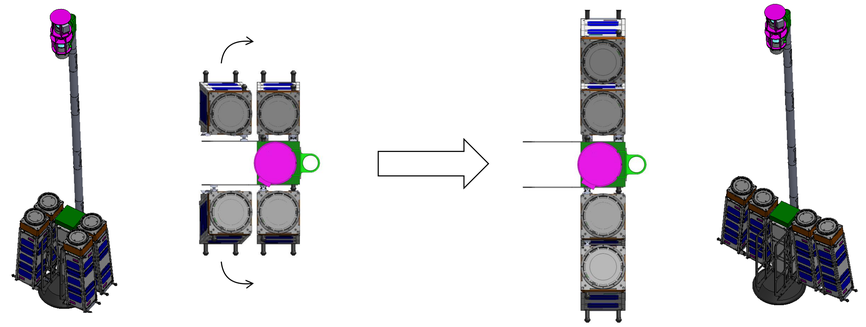


The AAReST demonstration mission is a prime focus space telescope with a 1.2m focal length. The primary mirror consists of four 10cm-diameter segments mounted on 3U CubeSats. A deployable boom provides the necessary separation between the primary mirror and the optical detector. The MirrorCraft can manoeuvre and re-dock to change the telescope aperture.

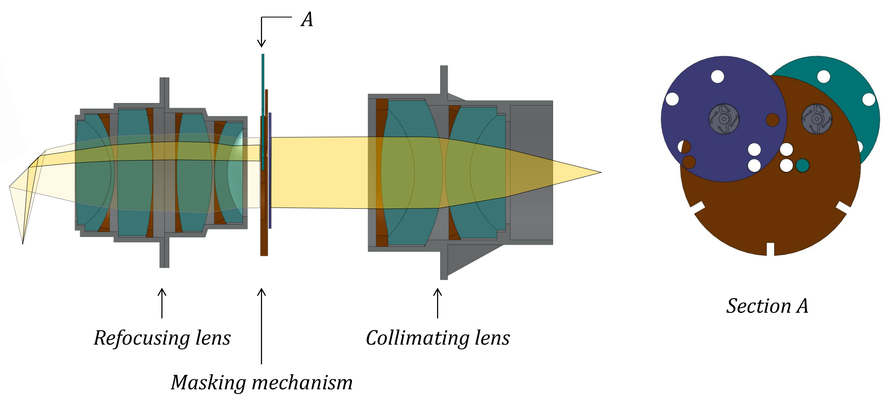
Optical Detector

The optical detector, which is mounted at the end of the boom, captures the light from the primary mirror, and focuses it onto an image sensor. The optical detector also provides shape feedback during the calibration of the adjustable mirrors.

After initial boom deployment, and after reconfiguration of the MirrorCraft, the adjustable mirror segments need to be calibrated. For calibration, light from individual segments must be isolated; this is done by a masking mechanism.



The reconfiguration manoeuvre changes the aperture, which requires a change in the shape of the aperture stop. The adjustable mirrors also require recalibration after this manoeuvre.



The lens elements were designed using Zemax. The collimating lens forms an image of the pupil on the mask (brown). The holes in the mask correspond to possible MirrorCraft positions. The selector disks (teal and blue) rotate to isolate light from individual segments.

The Ae105 2011-12 students and instructors contributed to the work presented herein. The support of the following organizations is also acknowledged: