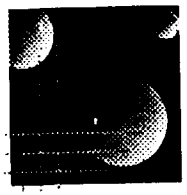

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INTERFEROMETER TESTBED: OVERVIEW AND HARDWARE SUMMARY

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Reference Mission & Science Requirements

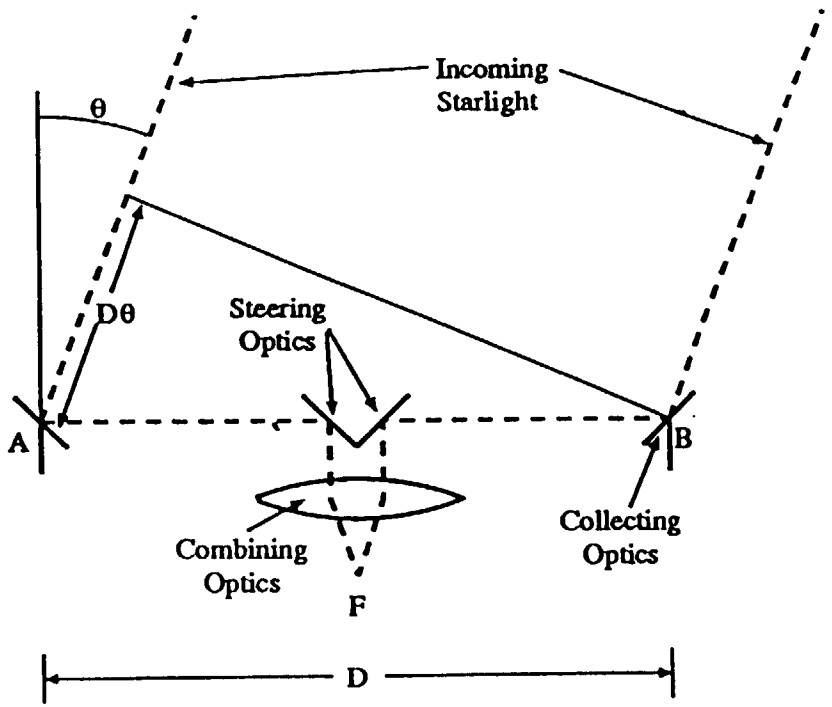
- Needed scientific reference mission to define stringent CST goals: Optical Interferometer Spacecraft
- Consultation with astronomers produced the set of mission objectives shown below. The science requirements were then derived from the mission objectives.

Mission Objectives

Description	Value
resolution	3 m-arcsec (0.014 μrad)
wavelength	0.5 micron
stellar magnitude	10
imaging	100% u-v plane coverage 95% image quality

Science Requirements

Description	Value
baseline	35 meters
high freq. DPL error	25 nm > 0.005 Hz
low freq. DPL error	10 nm < 0.005 Hz



Schematic of a two dimensional interferometer

Science Requirements Derivation

- Baseline derived from resolution objective

$$\rho = \frac{\lambda}{D} = 0.003 \text{ arcsec}$$

- High frequency DPL limit derived from maximum intensity function

$$I_{max} = I_T + V(u)\cos\left(2\pi\frac{\partial\ell}{\lambda}\right)$$

$$\approx I_T + V(u)\left(1-\frac{1}{2}\left(2\pi\frac{\partial\ell}{\lambda}\right)^2\right)$$

- Low frequency DPL limited derived from phase error

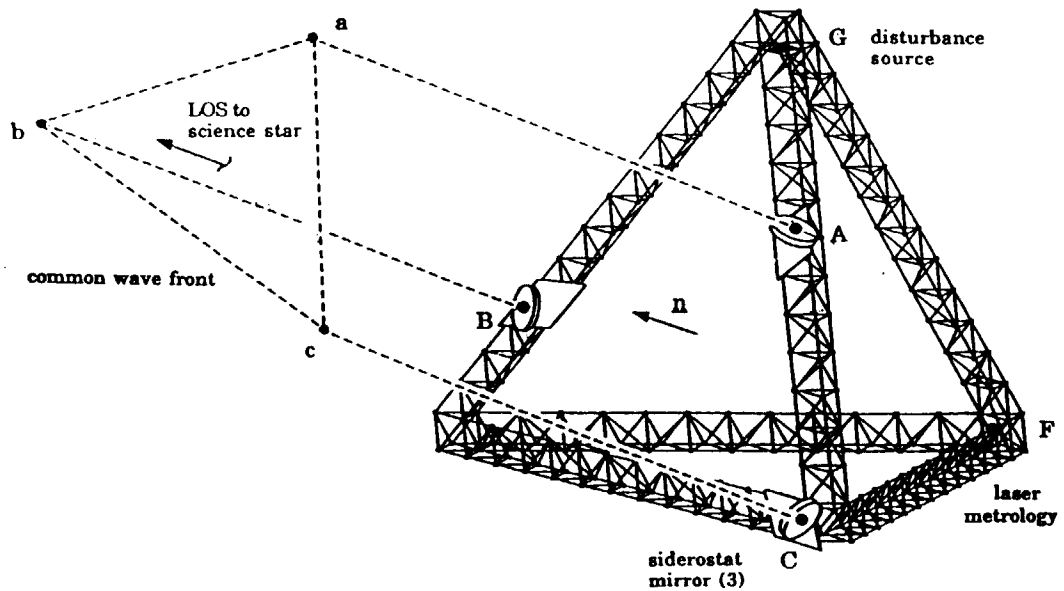
$$\phi_e = 2\pi\frac{\partial\ell}{\lambda}$$

Reference Spacecraft Design Summary

Baseline	35 meters
Architecture	Deployable tetrahedral truss structure
Spacecraft Mass	3285 kg (truss)
	12325 kg (total) incl. 25% margin
Payload Architecture	8 siderostats in non-redundant 2-D array
Telecommunications	TDRSS S-band compatible
Power Source	Body mounted solar arrays
Attitude Control	8 1200 Nms RWAs & mag. torque momentum dumping
Science Mode	217 sec integration time, continuous rotation about LOS

Testbed Requirements & Performance Metric

- Structure is 1/10th scale truss-work tetrahedron with three siderostat locations. Performance requirement of 50 nm RMS differential pathlength error (DPL) above 10 Hz is an order of magnitude improvement over expected disturbance environment.



- Decision made to address only a subset of the DPL problem. Errors due only to internal flexible motion will be considered, that due to external flexible and rigid body motion are not measured.

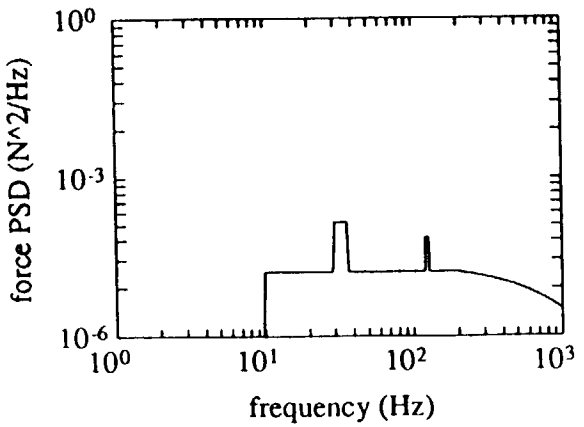
- The performance metric as defined by internal flexible motion is measured by laser legs AF, BF, and CF. The performance goals for the testbed are:

$$\max \begin{pmatrix} (AF-BF)_{RMS} \\ (BF-CF)_{RMS} \\ (CF-AF)_{RMS} \end{pmatrix} \leq 50 \text{ nm over } 10-200 \text{ Hz Bandwidth}$$

Disturbance Source & Signal

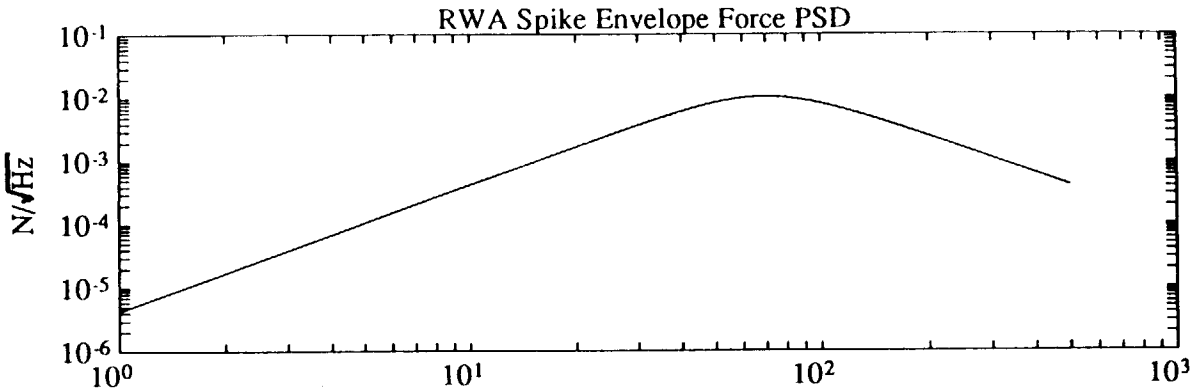
- Reference mission design identified typical spacecraft disturbances and determined DPL response of ~500 nm RMS on structure with nominal level of damping (~1%).
  - Narrow band spikes (reaction wheel imbalances)
  - Broadband (fluid flow noise)
  - Transient (solar array or antenna drives)

- Disturbance Signals Applied To Piezo-Shaker:
  - A signal to represent low broadband noise with slowly varying spikes produced insufficient excitation in structure.

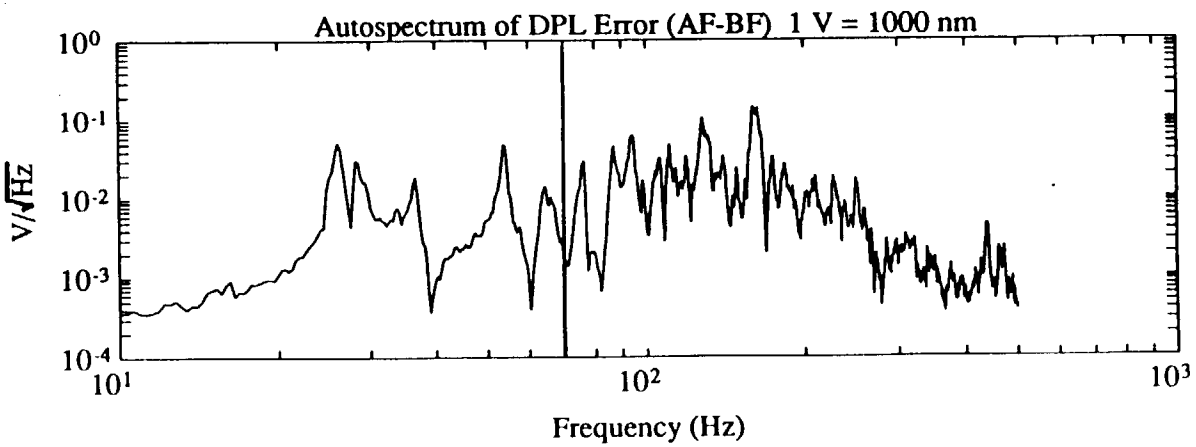


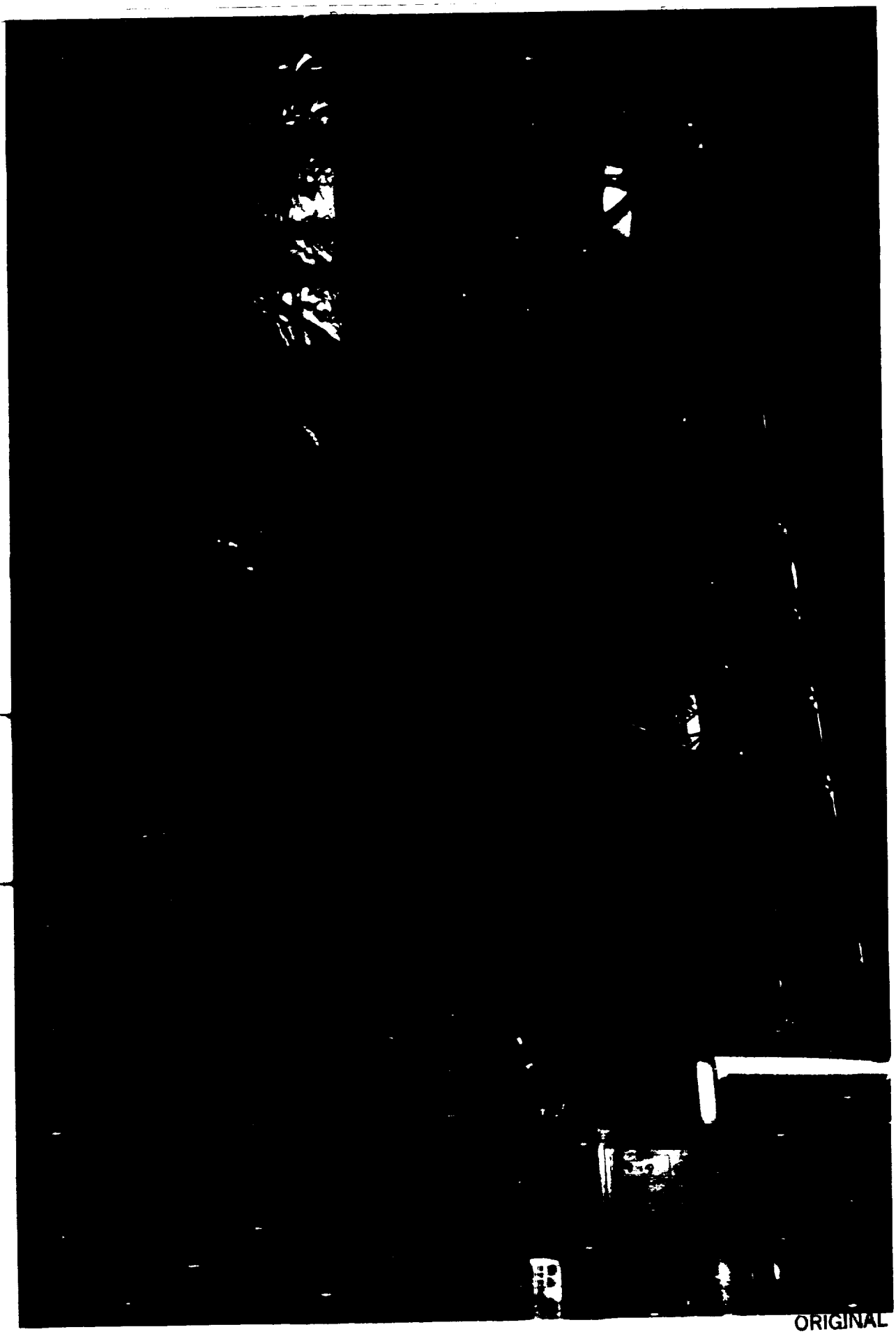
Response: only 80 - 100 nm RMS predominantly in 20 - 50 Hz band

- Disturbance Signal (con't):
  - Signal representing RWA spike envelope which increases with the square of the frequency up to wheels speed limit at 70 Hz. Some tail on the spectrum due to harmonics.



  - This signal produces the following response with the desired level of disturbance (770 nm RMS). 96% of the total is below 200 Hz.





Testbed Architecture