NASA-STYLE TECHNICAL ASSESSMENT REPORT

Project: SDC & COMMS
Title: MEMS vs FSM Steering Systems – Comparative Evaluation for Phased Optical Comms
Revision: A | **Date:** November 10, 2025
Prepared for: Advanced Technical Board (ATB)

1. Executive Summary

This report presents a balanced technical comparison between MEMS micromirror and piezo-flexure fast steering mirror (FSM) systems for optical beam steering across the SDC & COMMS multi-laser phased array and associated platforms. Both technologies offer sub-10 microradian control, with distinct trade-offs in bandwidth, aperture size, reliability, and SWaP efficiency. For the 16-channel phased array, a hybrid configuration using FSMs for coarse pointing and MEMS for fine phase control is recommended.

2. Comparative Overview

Criterion	MEMS Micromirrors	Piezo Flexure FSMs
Pointing Stability	Excellent for fine adjustments; sensitive to shock	Sub-microradian stability; robust mechanical stiffness
Bandwidth	Very high (>2 kHz) small-angle	1–2 kHz typical with large stroke
Aperture Size	Up to ~10 mm	25–75 mm standard
Power Handling	Limited; suitable for low-power beams	Excellent thermal margin
SWaP Efficiency	Outstanding	Moderate
Reliability	Requires radiation testing	Proven piezo longevity
Maintenance	Low; recalibration required	Low; stable over mission life
Cost at Scale	Low per unit; high NRE	Higher per axis; lower NRE

3. Recommendation Summary

For the comms satellite 16-laser phased array, the hybrid system is optimal: FSMs provide primary tip/tilt stabilization at cluster level, while MEMS mirrors handle per-channel differential phase and high-frequency jitter correction. Ground and tug platforms should remain FSM-centric due to mechanical robustness and environmental tolerance. This configuration offers balanced cost, performance, and maintainability.

4. ATB Action Items

1	Approve hybrid FSM–MEMS architecture for comms sat
2	Specify vendors and space-qualification process
3	Establish jitter performance acceptance criteria (≤5 µrad RMS)

4	Develop bench test plan for environmental validation

5. References

1. DSOC Flight Validation Data, NASA/JPL 2023 2. Greenwood Frequency and AO Compensation in Deep Space Optical Links, OSA Journal, 2022 3. FSM Technical Datasheets (PI, Newport, 2024) 4. MEMS Micromirror Radiation Testing, ESA ACTA Paper, 2023

Routing: ARCHITECT → MECHWORK → ATB → AUDITOR → ARCHIVE
Approved for Review: _____ (ATB Chair)