Gradient One (G1)

Design Dossier — 350m Multi-Gravity Campaign Platform

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1. Overview

Gradient One (G1) is a 350-meter rotating orbital research platform designed to validate sustained artificial gravity and mission-relevant partial-gravity environments in space.

Operating at ~1.6 RPM, G1 simultaneously provides:

- 0g central hub (microgravity control + docking)
- 0.16g Lunar gravity band (~56 m radius)
- 0.38g Mars gravity band (~133 m radius)
- 1g Earth baseline (~350 m outer band)

G1 is structured for 30–90 day crewed research campaigns to generate comparative biological and operational data across gravity environments within a single rotating system.

It is a mission-duration validation platform — not a permanent settlement station.

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2. Mission Objectives

Gradient One is designed to:

- Validate sustained partial-gravity human habitation (weeks to months)
- Compare Lunar, Mars, and 1g biological performance simultaneously
- Validate rotating utility systems (power, data, fluids)
- Retire mechanical and operational risk associated with large-radius rotation
- Generate longitudinal datasets to inform lunar surface and Mars mission architecture
- Serve as a scalable precursor to Aegis Station-class infrastructure

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3. Core Architecture

Primary Structure

- ~350-meter radial aluminum truss
- Single fixed rotation regime (~1.6 RPM)
- Central non-rotating hub (docking, logistics, contingency)
- Active water-based counterbalance system

Gravity follows:

$$a = \omega^2 r$$

With fixed angular velocity, gravity scales linearly with radius, enabling discrete gravity bands without changing spin state.

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4. Habitat Configuration

Multi-Gravity Ladder Layout

0g Hub

- Docking interface
- Logistics staging
- Microgravity control experiments
- Centralized contingency refuge capability

0.16g Lunar Pod (~56 m)

- Long-duration capable habitat
- Plant growth racks
- Fluid and hydroponic systems
- Crew sleep/work capability

0.38g Mars Pod (~133 m)

- Long-duration capable habitat
- Human physiology experiments
- Closed-loop biological systems testing
- Crew habitation and operations

1g Outer Band (~350 m)

- Rotational adaptation baseline
- Control environment

- Work and maintenance zone
- Operational comparison deck

Crew may move radially between bands via pressurized transition corridor.

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5. Systems Architecture

Life Support (ECLSS)

- Integrated multi-zone atmospheric management
- CO_2 removal and O_2 supply sized for 30–90 day campaigns
- Humidity and condensate recovery
- Waste management and storage
- Maintainable modular subsystem layout

Highest redundancy and contingency capability is centralized to avoid unnecessary duplication across pods.

Power

- Truss-mounted solar arrays
- Zoned distribution per gravity band
- Central battery storage in hub

Thermal

- External radiator arrays

- Zoned heat rejection per pod
- Thermal isolation between gravity bands

Stability & Balance

- Water-based counterweight beyond outer band
- Active redistribution for biomass growth and consumables
- Continuous torque and vibration monitoring

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6. Campaign Model

Gradient One operates through discrete research campaigns:

- 30–90 day crewed missions
- 2–4 crew typical
- Controlled experimental protocols
- Repeatable biological datasets
- Post-campaign refurbishment and recalibration

Between missions:

- Data review and protocol refinement
- Hardware updates
- Maintenance cycles

This approach avoids permanent station overhead while enabling meaningful longitudinal data generation.

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7. Program Scale & Cost Class (Revised)

The previously published single-habitat demonstrator estimate (~$67M) reflected an earlier, minimal configuration.

The current 350m multi-gravity, multi-habitat architecture represents a higher program class consistent with:

- Three habitable gravity bands
- Multi-launch assembly
- Crew-rating and verification
- 30–90 day sustained campaigns
- Integrated systems validation

Order-of-Magnitude Program Cost (ROM)

$600M – $1.4B total program cost

Dependent on:

- Pressurized volume per habitat
- Launch vehicle architecture
- Redundancy philosophy
- Ground operations model
- Certification pathway

This cost class assumes:

- 3–6 launch vehicles
- On-orbit robotic assembly
- Full crew-rating validation
- 8–10 year development timeline

It does not assume:

- Continuous permanent occupation
- 250–500 ton megastructure scale
- Tourism-driven infrastructure buildout

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8. Development Timeline

Years 0–1
Concept finalization, structural validation, vendor selection

Years 1–3
Detailed engineering design, subsystem development

Years 3–6
Habitat fabrication, truss manufacturing, systems integration

Years 6–8
Launch and on-orbit assembly

Year 8+
First 30–90 day research campaigns

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9. Technology Readiness

Gradient One integrates flight-proven subsystems:

- ISS-derived life support architectures
- Existing solar power systems
- Proven docking systems
- Established robotic assembly methodologies

The innovation lies in system integration and sustained multi-gravity operational validation — not speculative technology.

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10. Strategic Role

Gradient One bridges the gap between:

- Microgravity-only research
- Ground centrifuge testing
- Full-scale rotating habitat deployment

It enables:

- Empirical partial-gravity biological validation
- Operational risk retirement for rotating infrastructure
- Informed lunar surface design decisions
- Mars mission architecture refinement

G1 is a disciplined progression step toward scalable orbital habitat systems.

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11. Ownership & Partnership Model

Developed under Aegis Station Infrastructure LLC (ASI).

Potential engagement models:

- Cooperative agreements
- Agency campaign partnerships
- International research participation
- Commercial biological payload contracts

Full title remains with ASI unless otherwise negotiated.

Summary

Gradient One is a 350-meter rotating, multi-gravity orbital research platform generating:

- 0g
- Lunar gravity (0.16g)
- Mars gravity (0.38g)
- Earth gravity (1g)

simultaneously within a single rotating structure.

It is engineered for:

- Feasibility
- Scientific rigor
- Campaign-based operations
- Scalable infrastructure progression

It is neither a minimal centrifuge demonstrator nor a megastructure space station.

It is the necessary middle step.