AEGIS STATION INFRASTRUCTURE

Gradient One

Orbital Multi-Gravity Validation Platform

One spin. Three worlds. One baseline.

Design Dossier

350-meter 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 approximately 1.6 RPM, G1 simultaneously provides Earth gravity (1g), Mars gravity (0.38g), Lunar gravity (0.16g), and a central microgravity control hub within a single continuous rotating structure.

> G1 closes the gap between microgravity research and full-scale rotating habitat deployment by generating operational gravity environments in orbit—at scale, for long-duration campaigns.

G1 is structured for 30–90 day crewed research campaigns, or longer, 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.

Artificial Gravity | Moon (0.16g) | Mars (0.38g) | Bioregenerative Systems | Rotating Habitat Operations

2. Mission Objectives

Gradient One is designed to:

- Validate sustained partial-gravity human habitation across weeks-to-months timescales
- Compare Lunar, Mars, and 1g biological performance simultaneously under matched conditions
- Validate rotating utility systems (power, data, fluids) at large radius
- 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

3. Core Architecture

Primary Structure

Parameter	Value
Outer radius	~350 meters
Spin rate	~1.6 RPM (single fixed regime)
Configuration	Radial aluminum truss with discrete gravity bands
Hub	Central non-rotating docking / control environment (0g)
Counterbalance	Active water-based adjustable mass system

Gravity Scaling

Gravity along the rotating truss follows the standard relation:

$$a = \omega^2 r$$

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

4. Habitat Configuration

Simultaneous Gravity Bands

Band	Radius	Role
0g — Central Hub	—	Docking, logistics staging, microgravity control, contingency refuge
0.16g — Lunar Pod	~56 m	Long-duration habitat, plant growth, hydroponics, crew sleep/work
0.38g — Mars Pod	~133 m	Long-duration habitat, human physiology, closed-loop biology
1g — Outer Band	~350 m	Earth-gravity baseline, work and maintenance zone, comparison deck

Configuration supports comparative testing under identical lighting, atmosphere, instrumentation, and campaign timelines. Crew may move radially between bands via pressurized transition corridor.

5. Systems Architecture

Life Support (ECLSS)

- Integrated multi-zone atmospheric management
- CO_2 removal and O_2 supply sized for 30–90 day campaigns, with resupply for longer stays
- 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 the outer band
- Active mass redistribution for biomass growth and consumables
- Continuous torque and vibration monitoring

6. What G1 Validates

Biological Systems

- Plant growth and yield at Lunar and Mars gravity
- Hydroponic performance under partial gravity and rotation
- Microbial behavior, biofilm risk, and sanitation dynamics
- Atmospheric trace management (humidity, VOCs/ethylene) in closed growth racks

Human & Operations

- Long-duration human work at 1g in a rotating frame
- Task performance and transitions across gravity bands
- Rotating utilities: power/data routing, maintenance, inspection
- Operational procedures for rotating habitat segments

7. Campaign Model

Gradient One operates through discrete research campaigns:

- 30–90 day crewed missions, or longer
- 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 across multiple campaigns.

8. Program Scale & Cost Class

The 350-meter, multi-gravity, multi-habitat architecture represents a program class consistent with:

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

Order-of-Magnitude Program Cost (ROM)

Total program cost	$600M – $1.4B

Range is dependent on:

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

Assumes

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

Does Not Assume

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

9. Development Timeline

Phase	Activities
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

10. 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.

11. 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—and a precursor platform to large-scale rotating habitats such as Aegis Station.

12. 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.

13. Summary

Gradient One is a 350-meter rotating, multi-gravity orbital research platform generating 0g, Lunar gravity (0.16g), Mars gravity (0.38g), and Earth gravity (1g) simultaneously within a single rotating structure. It is engineered for feasibility, scientific rigor, campaign-based operations, and scalable infrastructure progression.

Neither a minimal centrifuge demonstrator nor a megastructure space station.

Gradient One is the necessary middle step.