



BALANCING MOTION AND BIOLOGY

Radiation Effects On Blood And Gyroscopic Stabilized Payload

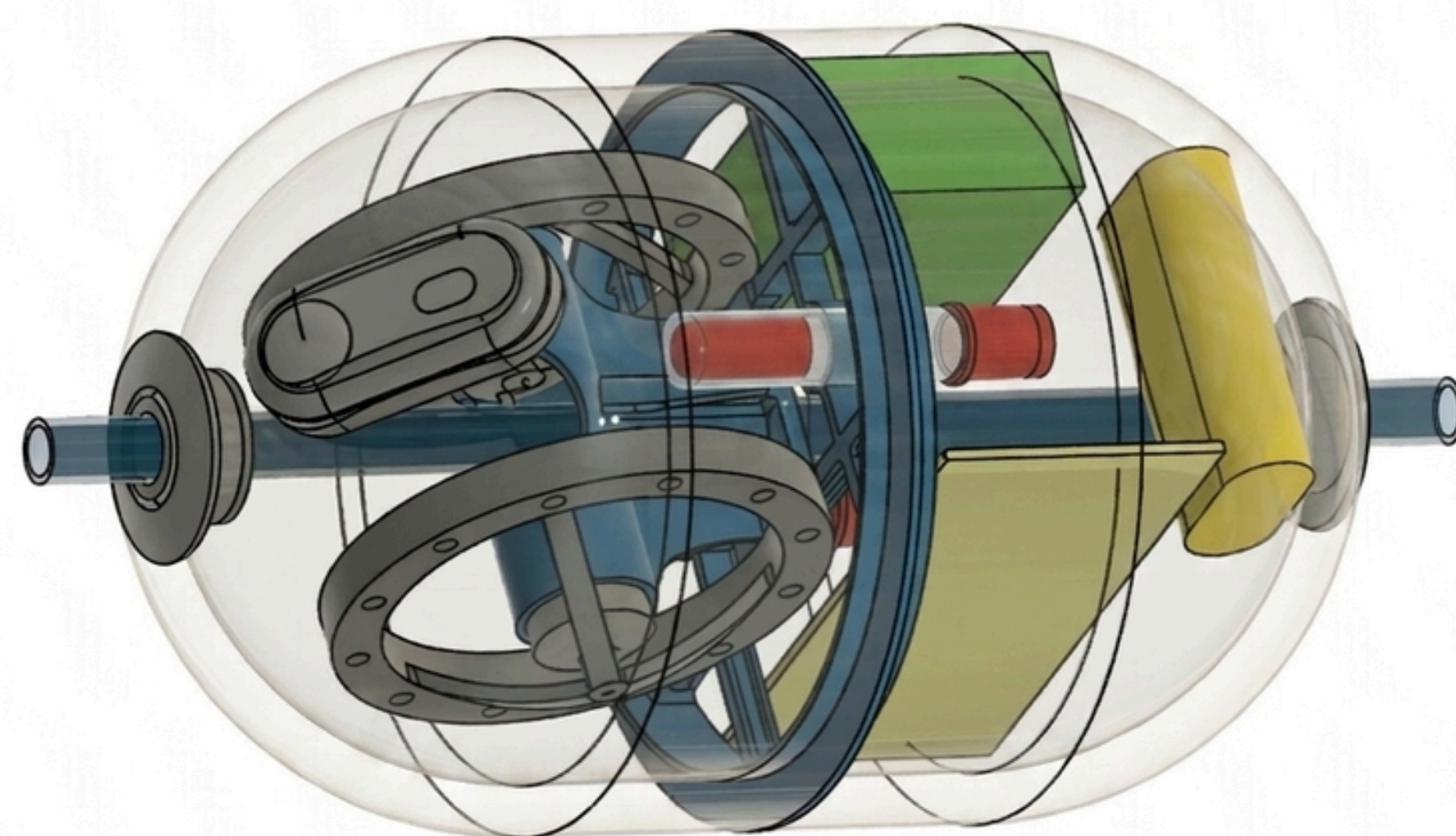


Team Sirius



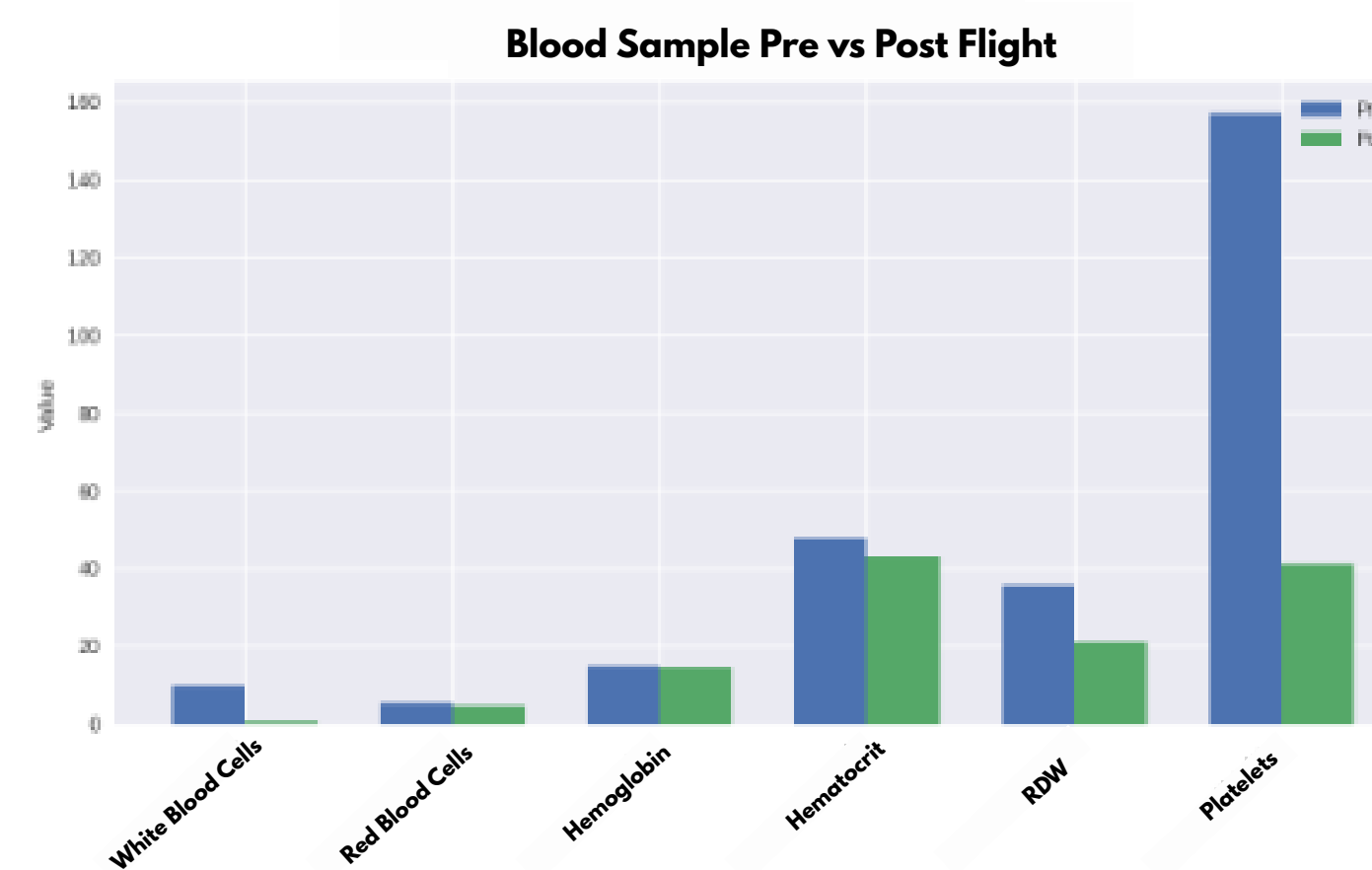
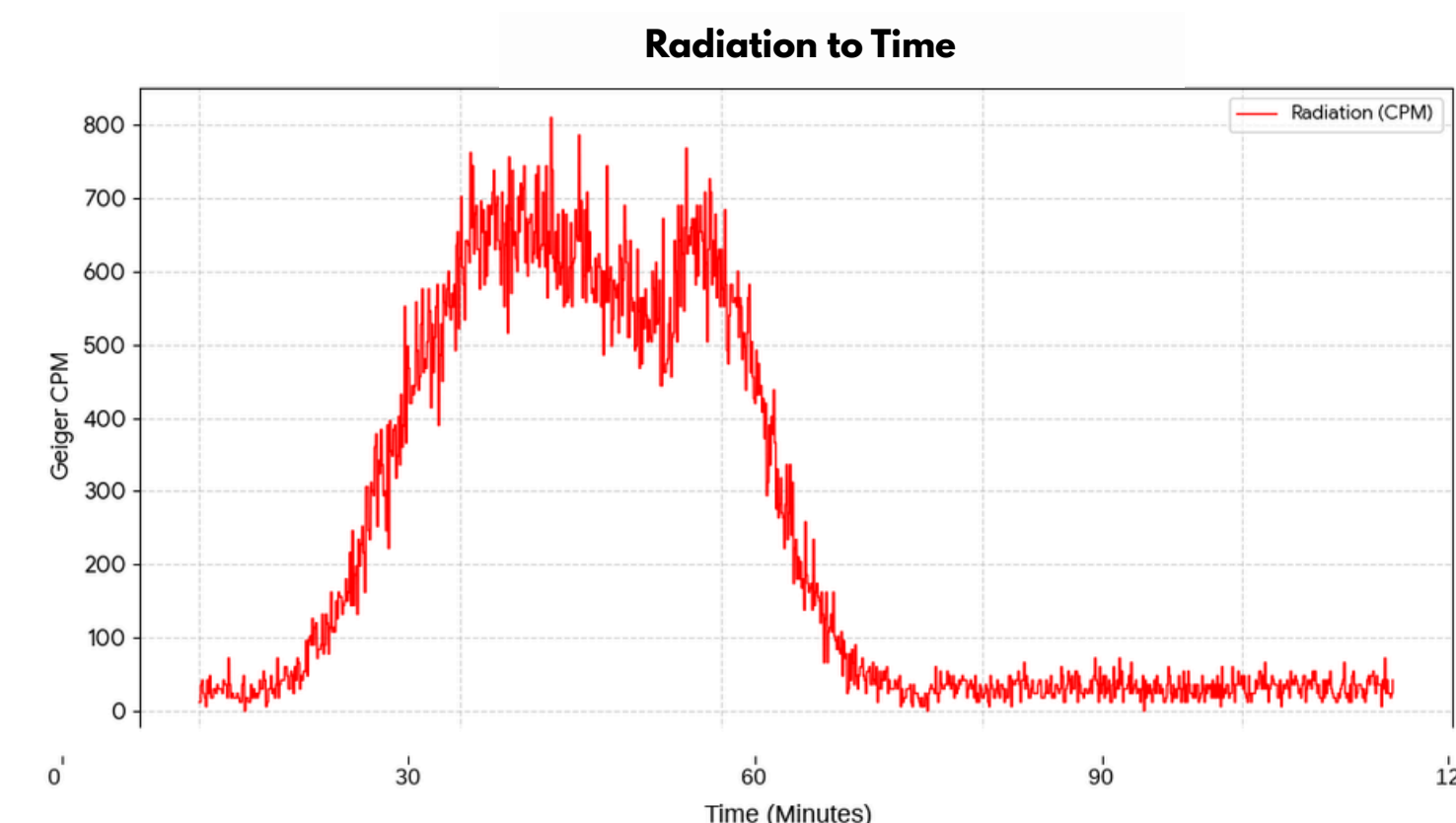
The Challenge: Biological Fragility

While humanity's future lies among the stars, our biological fragility remains a hurdle to deep space exploration. The Sirius project tackles this challenge by integrating advanced mechanical stabilization with biological research in the extreme environment of near space. By launching human blood samples to the edge of the atmosphere within a custom fabricated hull and a gyroscopic correction wheel system, our team investigated how to mitigate the violent rotational forces and collect radiation data that threaten delicate biological cargo. We aren't just logging environmental data; we are proving that through smarter payload design and active stabilization, we can mitigate damage and protect the most sensitive "materials" of all—life itself.



The Mission: Analyzing Life in Near-Space

The primary goal of this research was to design and evaluate a payload system capable of protecting delicate biological samples from the extreme mechanical and environmental stressors of near space flight. Specifically, the project aimed to assess the effectiveness of a custom engineered active/passive correction wheel system in reducing rotational movement and to analyze the resulting impact on the cellular integrity of human blood samples subjected to high altitude conditions.



The Data Is In

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| <p>1 Flight Time:</p> <ul style="list-style-type: none"> Total: 1 hr 46 min Ascent time: 1 hr 3 min Descent time: 43 min <p>2 Altitude :</p> <ul style="list-style-type: none"> Apex: 84,489 ft Base: 5,222 ft <p>3 Payload Stabilization:</p> <ul style="list-style-type: none"> No correction: 73% Active correction: 81% Passive correction: 74% <p>4 Terminal Impact Force:</p> <ul style="list-style-type: none"> 10.6 G's | <p>5 Blood Damage (flight):</p> <ul style="list-style-type: none"> White blood cell: -40.7% Red blood cell: -12.1% Platelets: -27.7% <p>6 Blood Damage (control):</p> <ul style="list-style-type: none"> Pressure: 0% Radiation: 0% <p>7 Environment Extremes:</p> <ul style="list-style-type: none"> Temp: [58°] - [-49°] F Pressure: [12.3] - [0.31] psi <p>8 Radiation Exposure:</p> <ul style="list-style-type: none"> 3.52 μSv (Total Dose) |
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The Verdict: Motion Controlled, Impact Isolated

1. Mechanical Stability Index
The performance of the active stabilization system was quantified using a Stability Index. This calculation compared the payload's actual angular deviation against the target orientation over the total flight duration:

$$S = \left(1 - \frac{\sum |\theta_a - \theta_t|}{n \cdot \theta_{max}}\right) \times 100$$

Taking the top 50% of maximum rotation and creating a baseline, we get a active stabilization of 81%. If we take the top 30%, we get a stabilization of 95%

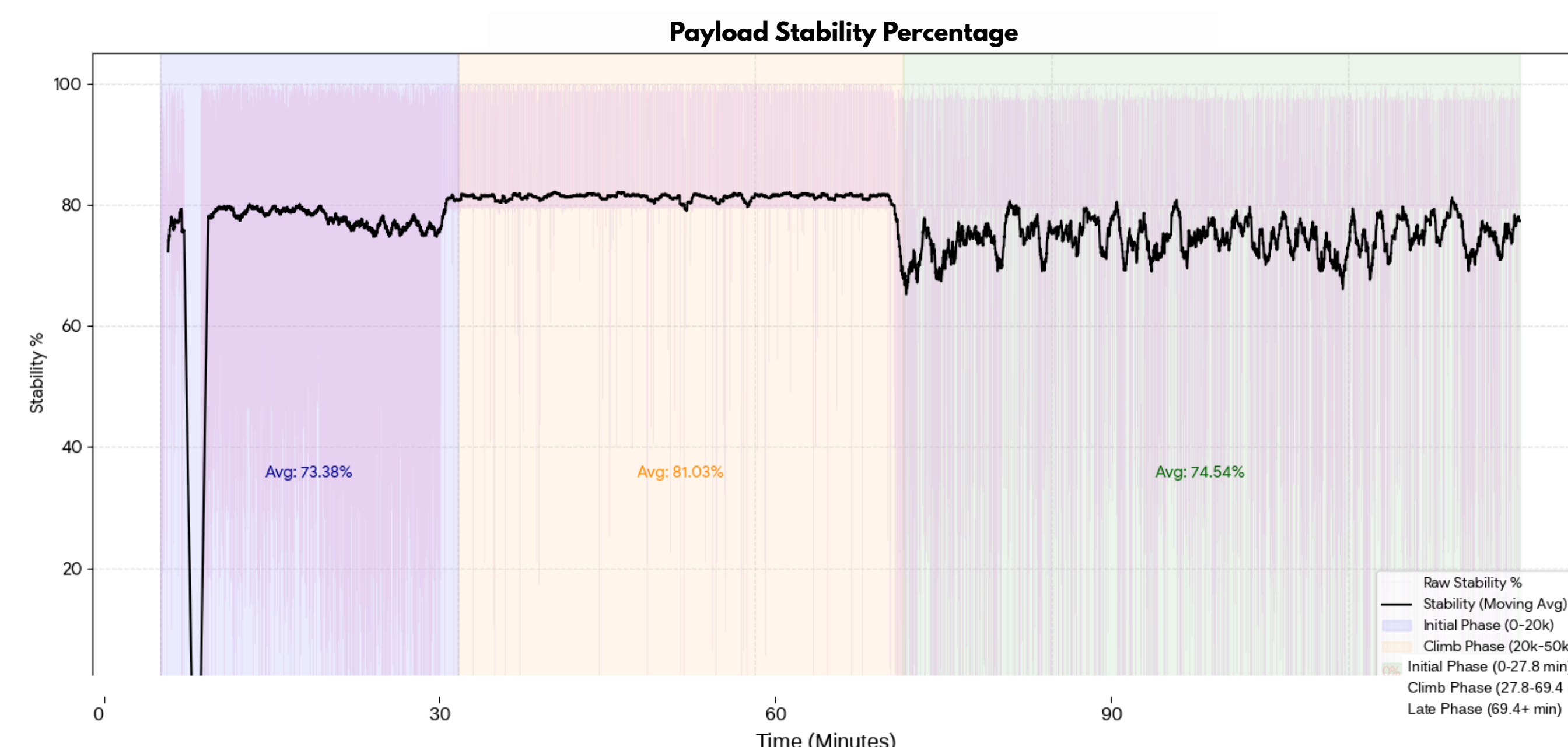
2. Kinetic Impact Dynamics
Because the Individual Pressure and Radiation controls returned from flight with no detectable damage, the observed biological trauma was isolated to the ground impact. The peak deceleration force (G) was calculated using the Work-Energy theorem, correlating descent velocity (v) and the stopping distance (d) upon impact:

$$G = \frac{v^2}{2 \cdot d \cdot g}$$

By applying the measured descent velocity of 18.46 ft/s against an estimated stopping distance of 6 inches, the analysis identifies a high magnitude G event as the primary cause of hemolysis.

Biological Outcomes & System Efficiency

The flight data revealed a distinct correlation between the physical rigors of the mission and biological degradation. While post flight analysis confirmed significant damage to the blood samples, the individual pressure and radiation controls showed no detectable damage, effectively isolating these as possible contributors, but not primary. Consequently, the observed hemolysis and cellular trauma are attributed to the G-forces experienced upon impact. Despite the landing forces, the payload's mechanical performance was highly successful; the active stabilization system maintained overall payload stability in the 80th-90th percentile throughout the corrected flight's duration.



Key Sources & Acknowledgements

EOSS, Front Range Community College, Boulder Community Health Hospital

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