Impact and Crashworthiness Characteristics of Venera Type Landers for Future Venus Missions

By

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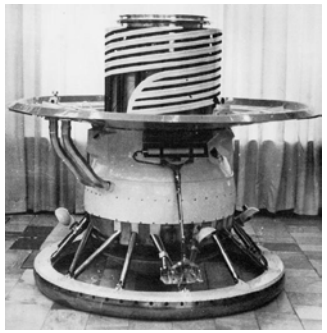
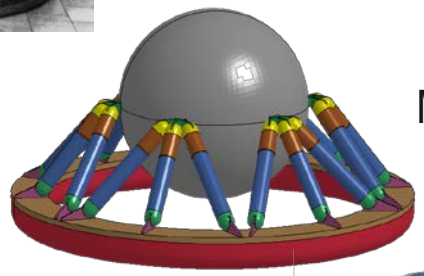
Presented by Kevin Schroeder

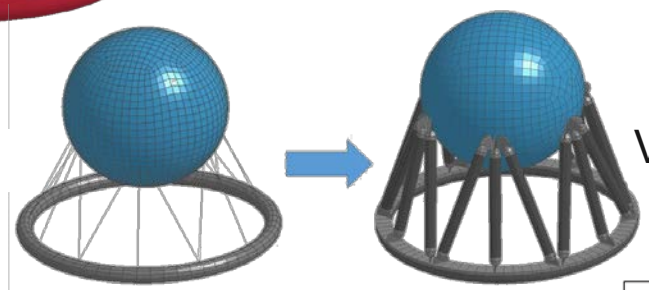
Presentation Overview



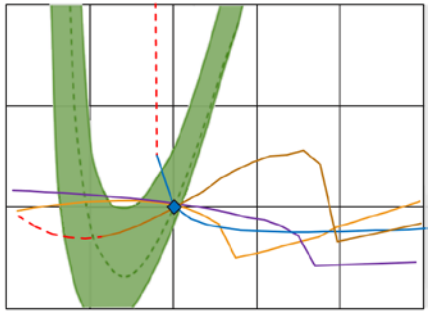
Background



Multi-Fidelity Design Tool



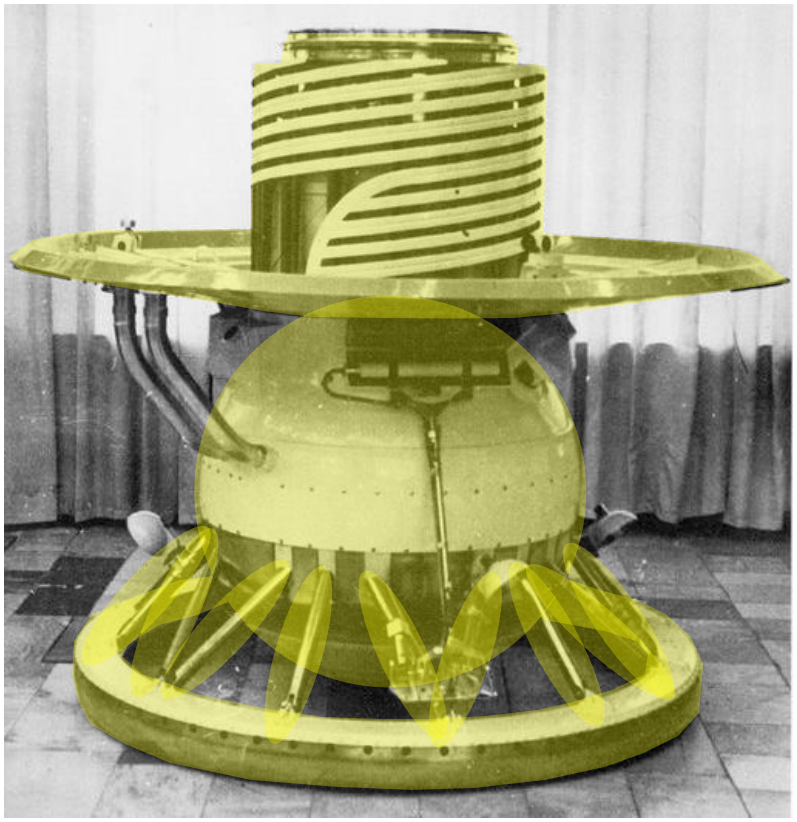
Verification



Results

Background

The Venera Lander was an Entry Probe (EP) whose *general* designed was used by the Soviet Union for 8 mission to Venus.

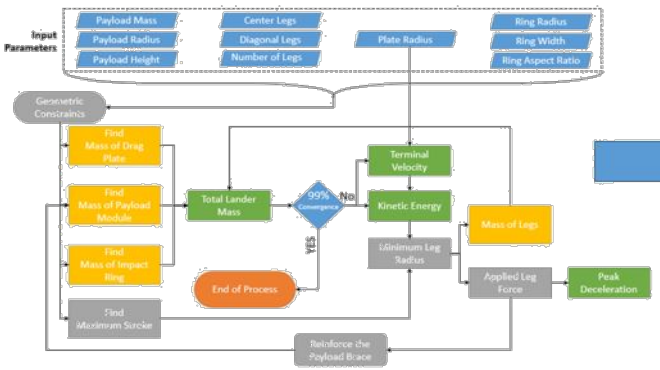


The Lander can be broken into four basic components:

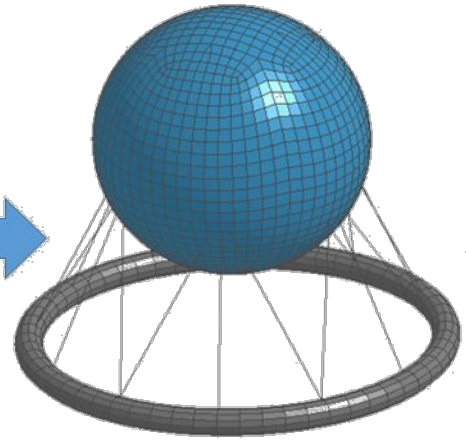
- Parachute and Drag Plate
- Payload Module
- Legs
- Impact Ring

Although a number of papers are dedicated to the results of the Venera Landers, few details can be found about the design of the EP.

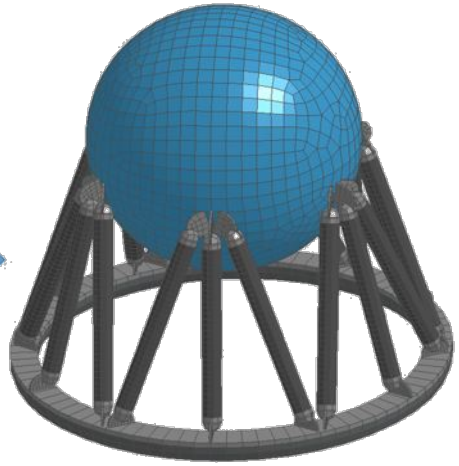
Multi-Fidelity Design Tool



Stage 1: Analytical Solution



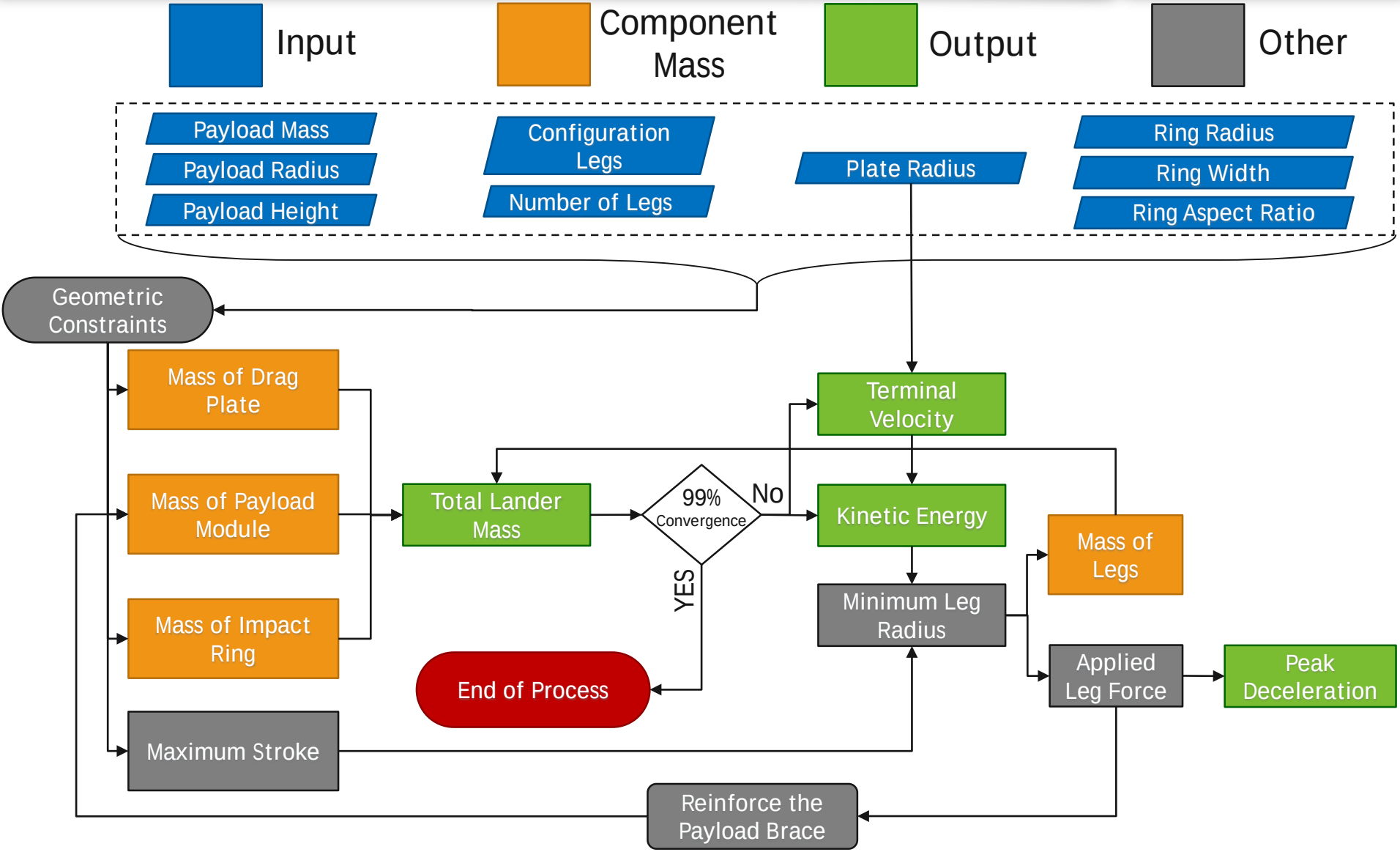
Stage 2: Preliminary FEA



Stage 3: Detailed FEA

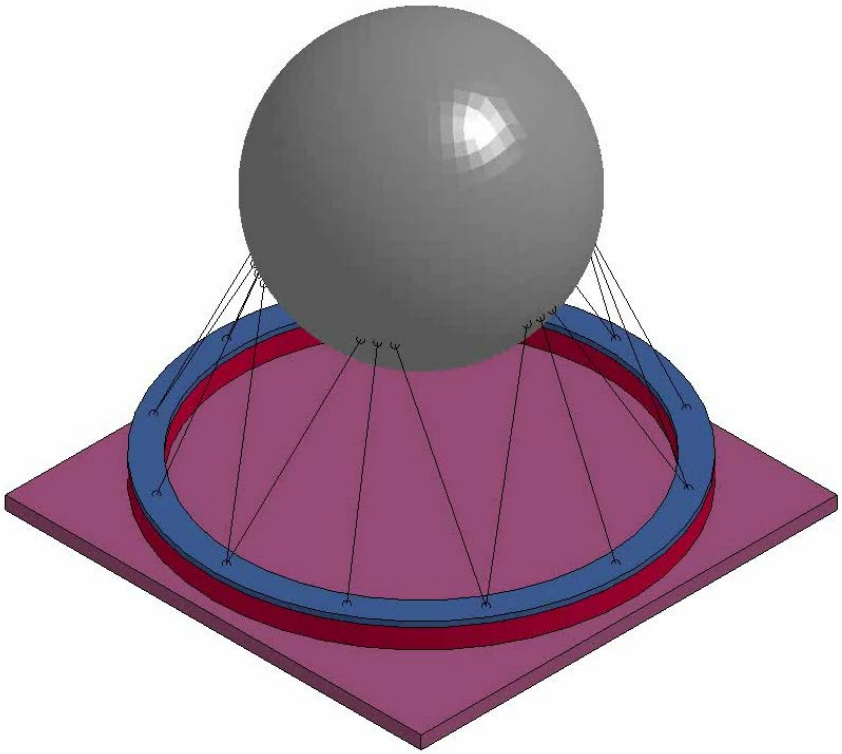
Run Time	Seconds	Minutes	Hours
Pros:	Sizes the lander based on landing conditions	Captures lander kinematics	Analyzes loads applied to each component
Cons:	Only provides estimations	Inaccurate stress concentration	Low variability

Low Fidelity: Analytical Model

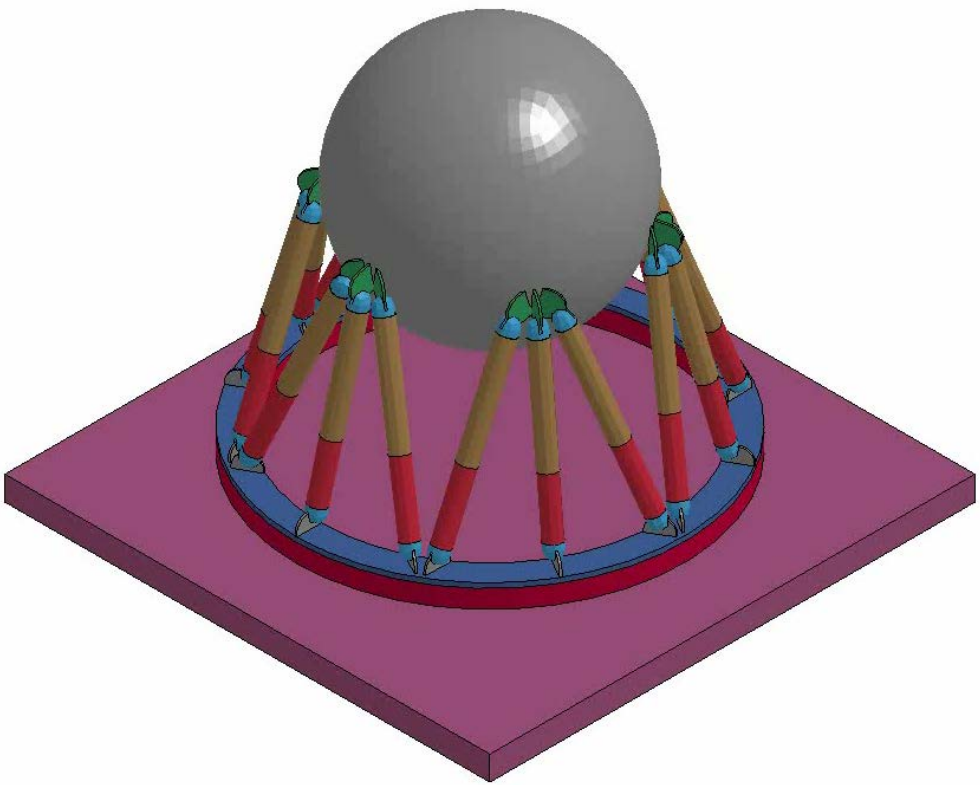


Comparison of Medium and High Fidelity Models

Medium Fidelity Model

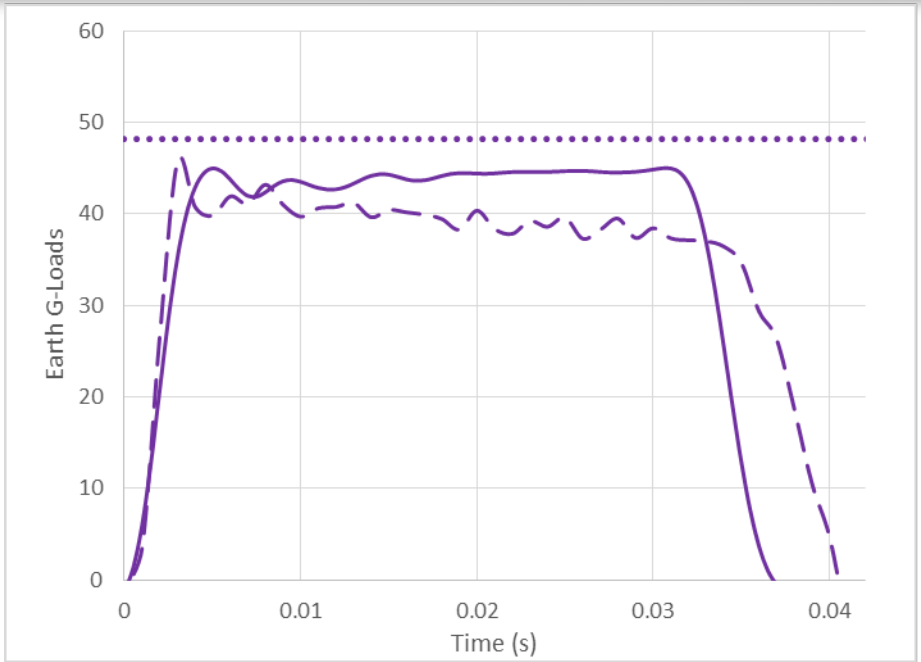


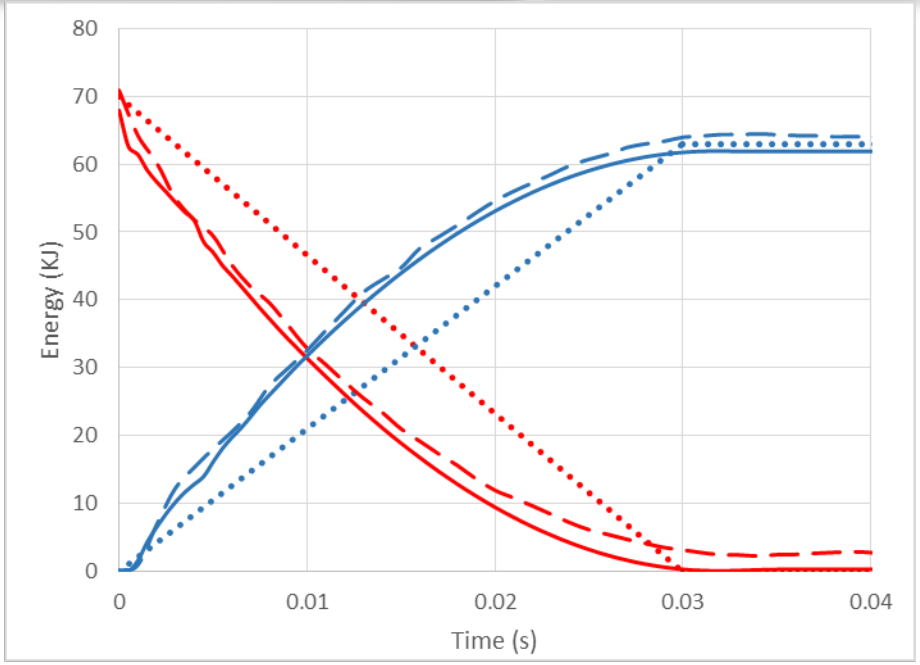
High Fidelity Model



Both models will yield the same kinematics

Comparison of All Three Models





Low Fidelity

Medium Fidelity

High Fidelity

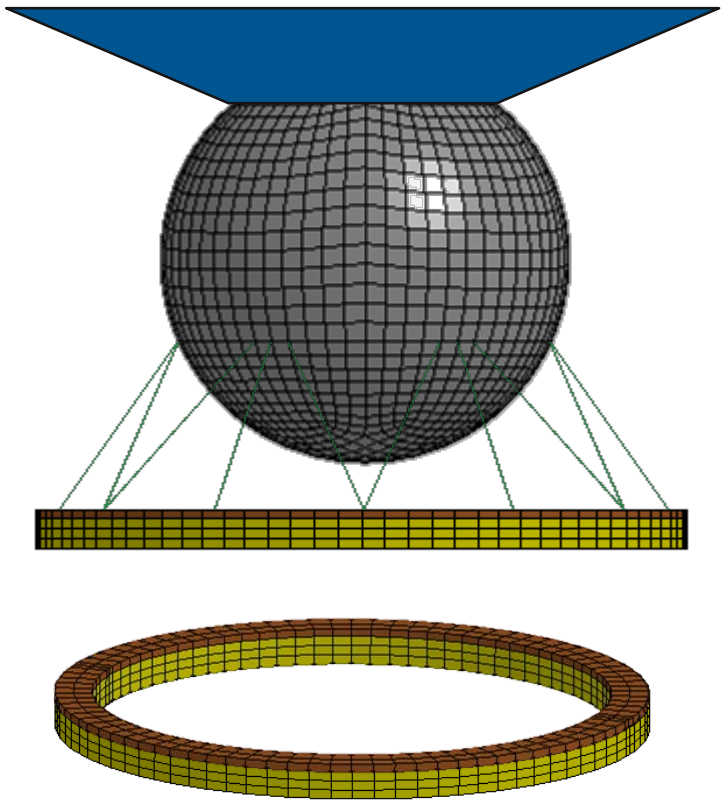
Error from the High Fidelity Model

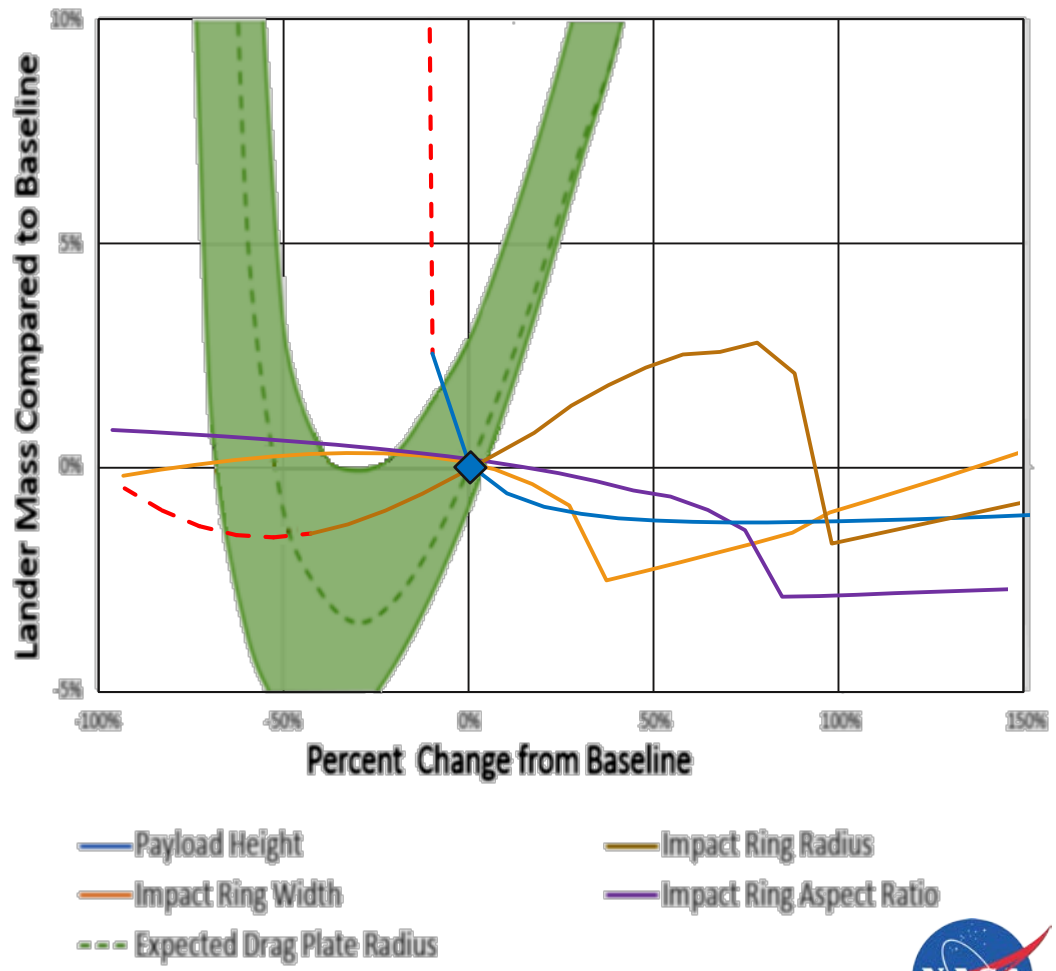
	Low Fidelity	Medium Fidelity
Deceleration	4.8%	1.0%
Kinetic Energy	3.1%	4.4%
Internal Energy	1.8%	4.0%

VirginiaTech CRASHLAB

NASA

Mass Sensitivity Analysis





Mass Sensitivity Analysis

	Original	Optimized
Payload Density	500 kg/m^3	500 kg/m^3
Payload Radius	0.5 m	0.5 m
Drag Plate Radius	1.08 m	0.715 m
Payload Height	0.65 m	0.65 m
Impact Ring Radius	0.9 m	0.55 m
Impact Ring Width	0.05 m	0.125 m
Impact Ring Aspect Ratio	1:1	1:1.35
Total Number of Legs	18	8
Configuration	Tri-Leg	Oblique
Total Mass	**660 kg**	**580 kg**
Structural Mass	**400 kg**	**320 kg**

20% savings in the Lander's Structural Mass

Conclusion

While this work focused on Venera-Type Landers, the methodology created in this study can be used to efficiently analyze various configurations of any lander.

From the Mass Sensitivity Analysis, the optimal configuration for a given amount payload can be found.

While the legs provide additional protection to the payload from penetration from large rocks, both the size and the number of legs can be reduced in order to find a substantial mass savings.

Additional results were expounded on in my paper.