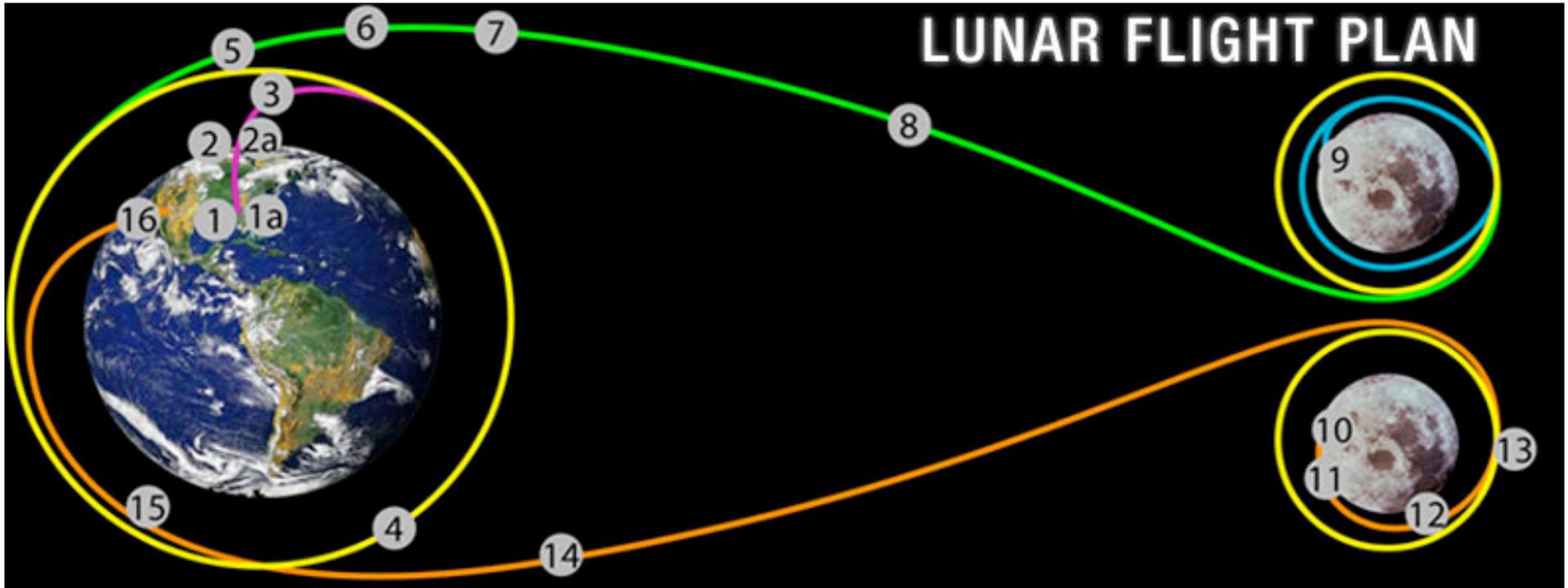
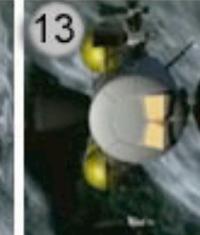
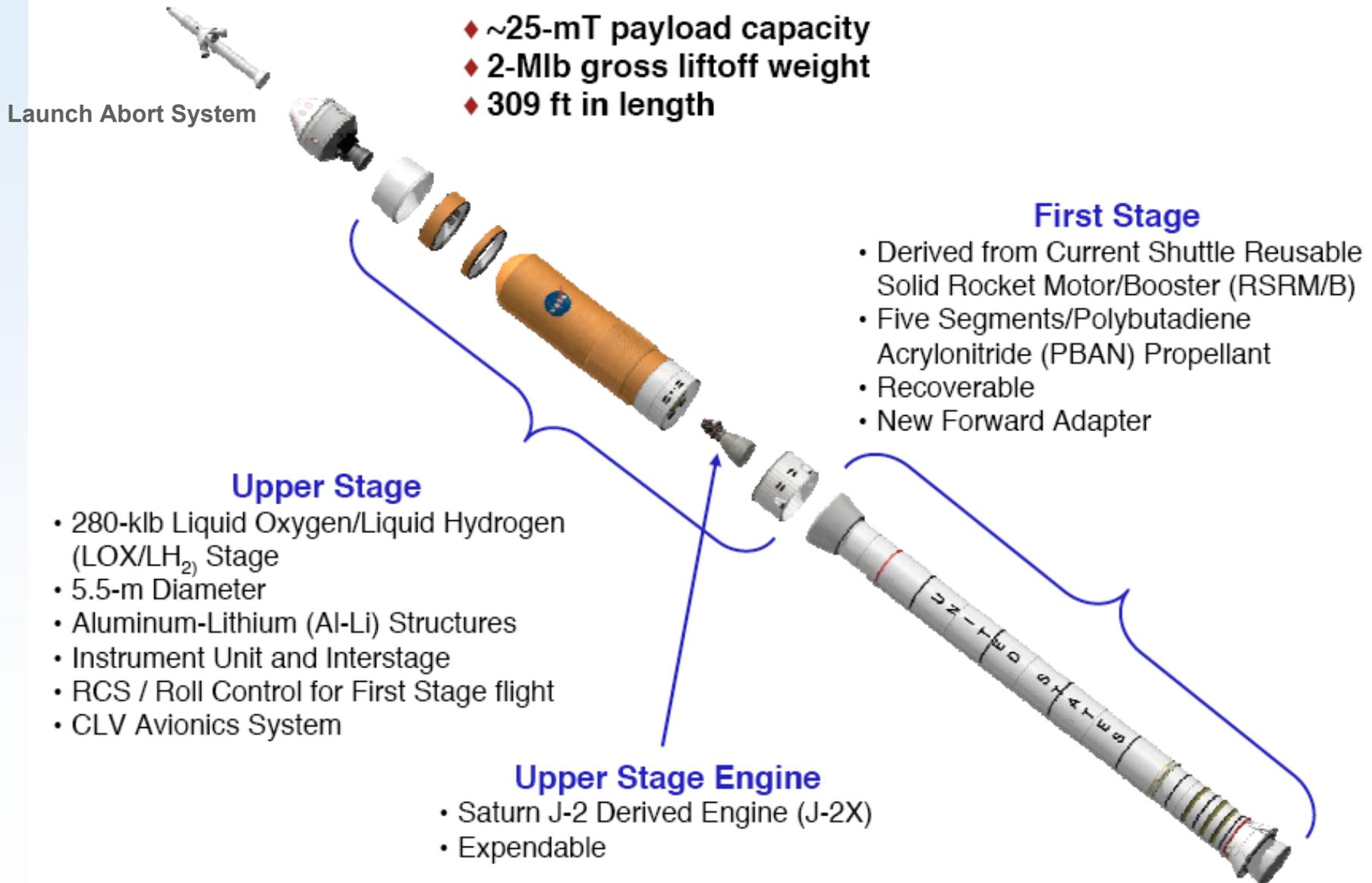


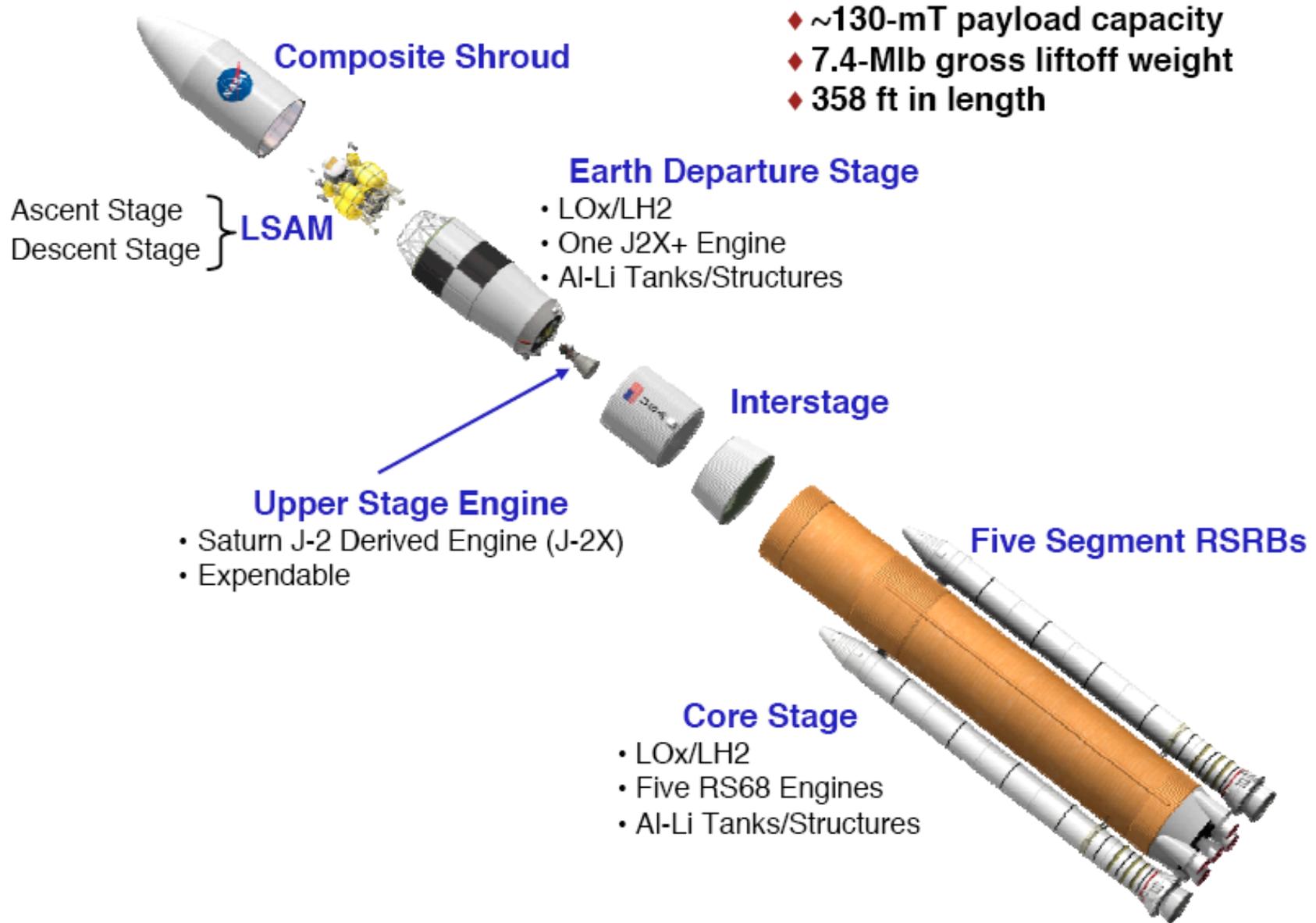
LUNAR FLIGHT PLAN



Credit: NASA/John Frassanito and Associates

								
Cargo launch	Booster Separation	2nd Stage	Cargo in Orbit	Crew Launch	2nd Stage	Docking with Lander	Departure Stage	Stage Jettisoned
								
Lunar Orbit	Lunar Landing	Crew on the Moon	Ascent Stage	Rendezvous	Lander Jettisoned	Service Module Jettisoned	Re-entry	Parachute Landing



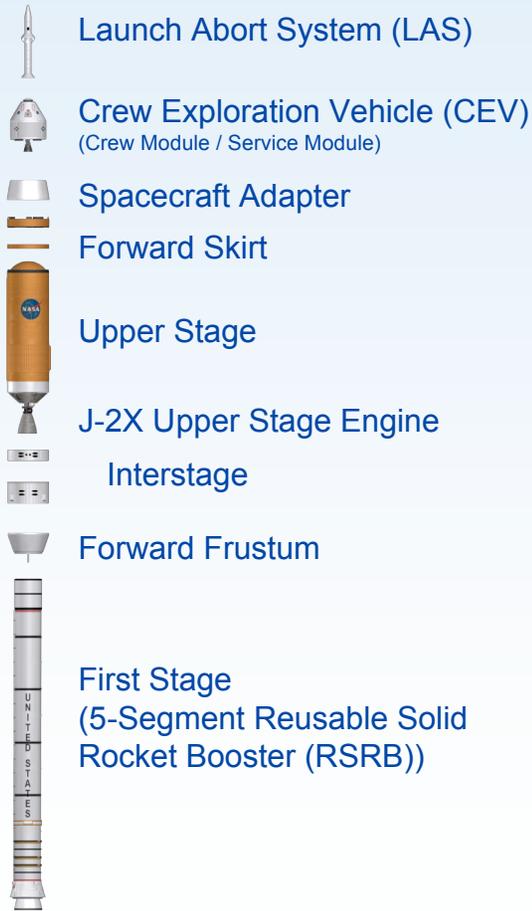




Constellation Launch Vehicle Elements



Instrument Unit



Crew Launch Vehicle

Cargo Launch Vehicle

Glenn Research Center at Lewis Field

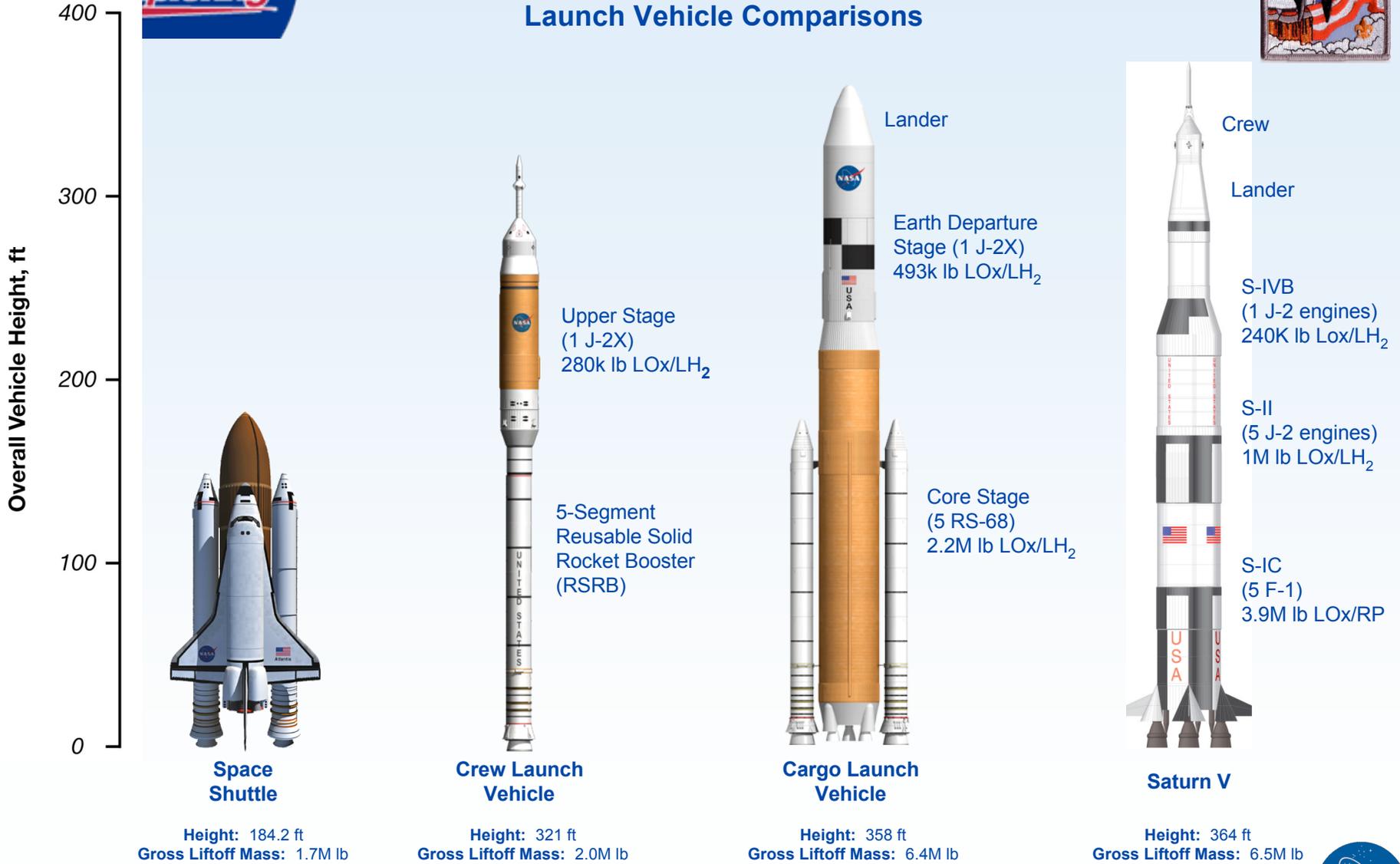




Building on a Foundation of Proven Technologies



Launch Vehicle Comparisons



Glenn Research Center at Lewis Field





STS mission



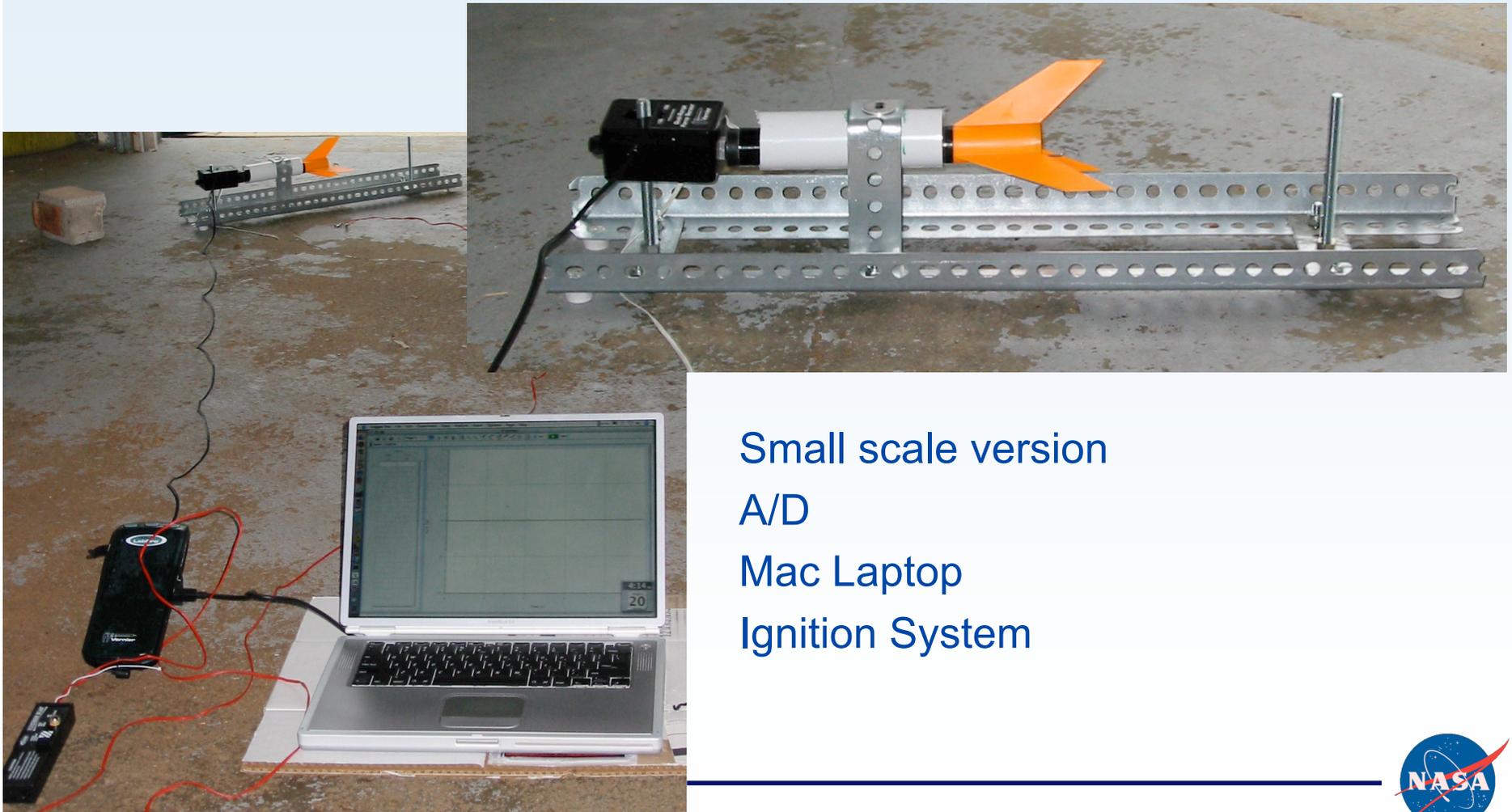


SRM test firing





Thrust Stand



Small scale version

A/D

Mac Laptop

Ignition System

Field





Advisor Comments



- Melted 6 parachutes performed 10 successful launches ! (3 Altimeter data points)
- All rockets recovered
- All of them flew straight !
- Congratulation to all for job well done!





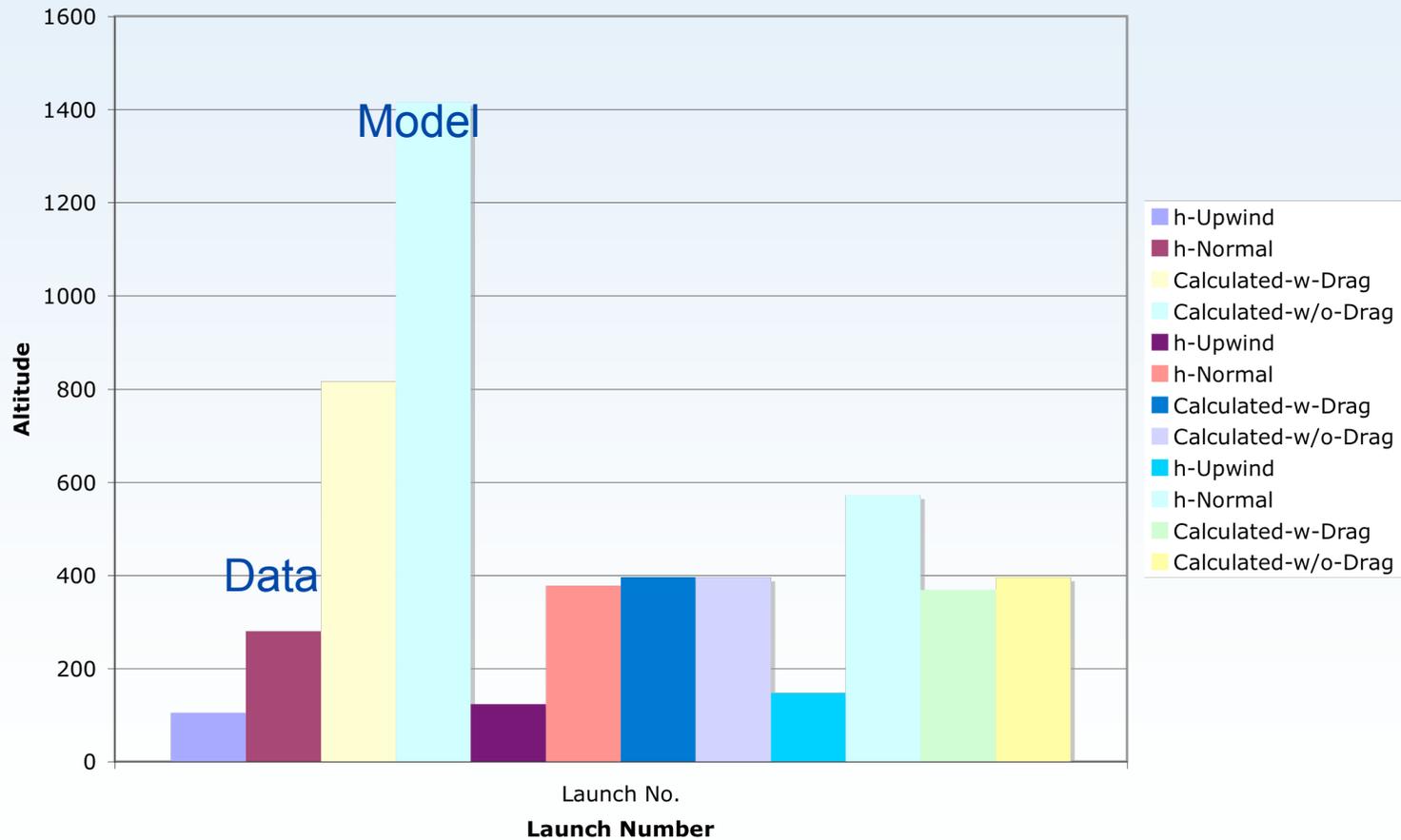
Glenn Research Center
Field





Altitude measured vs. Computed

Nov-Demo Launch Data





Post 630 Rocket Design Mission



All must be accomplished with original vehicle configuration

- **Photographic (Video) from Altitude**
- **High altitude (motor size fixed)**
- **Safe recovery of fragile payload get to a fixed altitude (motor may vary based on load)**
- **Most accurate telemetry prediction**
- **+ Open ideas ?**

Must have a performance model

- **At Least 1D spreadsheet model of the Newton's Law! or**
- **<http://exploration.grc.nasa.gov/education/rocket/rktsim.html>**





Explorer Rocket Design Mission



Constraints:

- **Specific Impulse of < 13 per seconds.**
= $\text{Newton/FuelFlow} = 1 \text{ Newton}/(.1 \text{ Newton/sec})$
(Estimated burn out mass rate))
- **Total Thrust (≤ 5 Newtons-Seconds (TBD!))**
- **Total Mass < .1 kg**
- **Must have Payload capability (Volume and Size)-
Instrumentation are provided!**
- **All of launch accessories such as launch logs are not optional!**
- **Must have a design and safety both peer and advisor review**





Explorer Rocket Design Mission



Teams

- Get to know each other.
- Pick a mission
- Pick a name for their launch system
- Assign roles/Start a discussion and assign roles
- Should do some calculations and see if what is possible
- Develop a plan of how to build what to test for and what it would look like
- Develop a story (Design) for a peer review

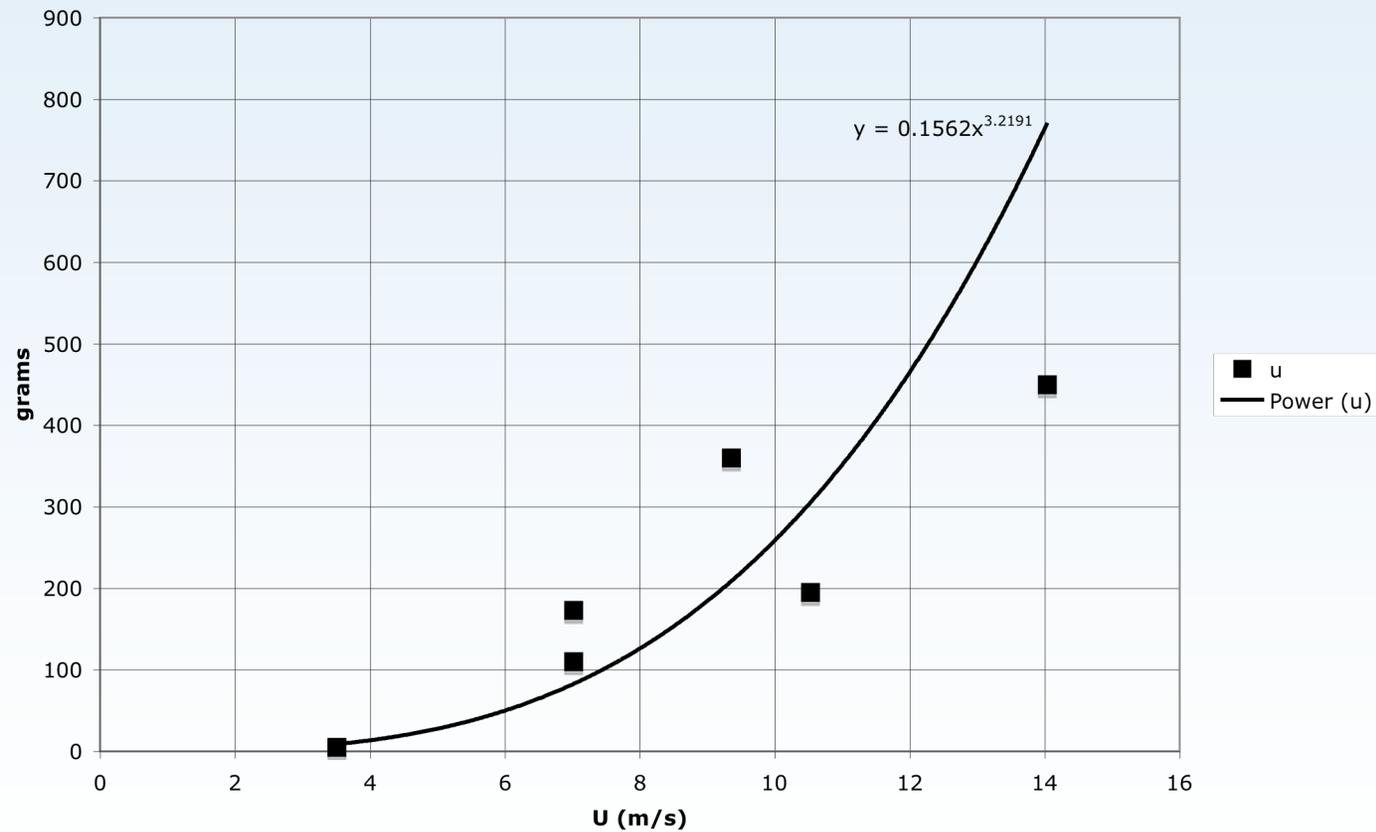
- Assign **lead** responsibility for Performance, Aerodynamic Design, Structural Design, Fabrication, Data Acquisition and System Readiness.
- Everyone contributes !

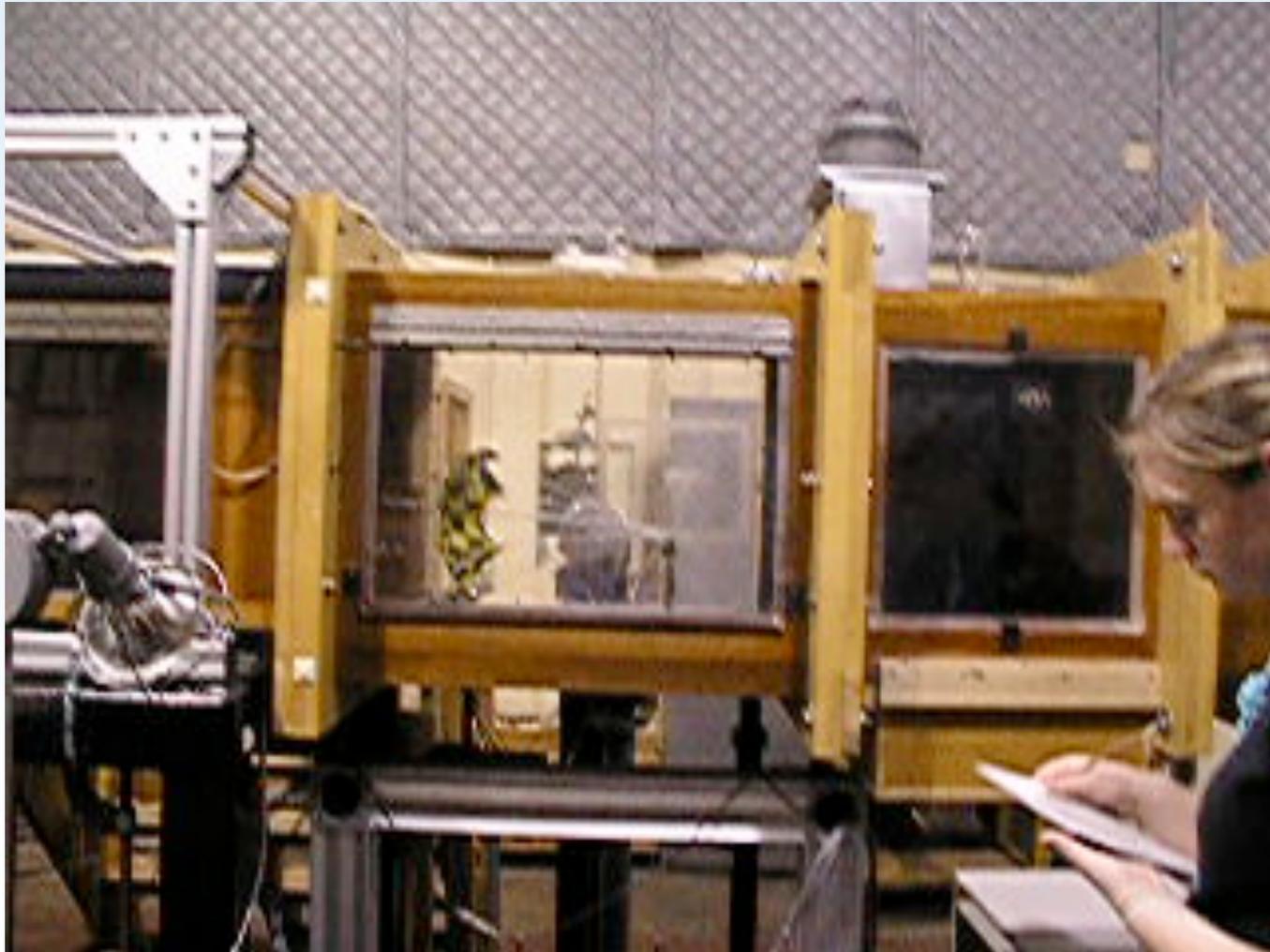


Raw Data

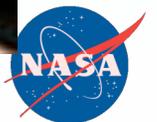


Parachut Experimental Data (May/06)





Glenn Research Center at Lewis Field





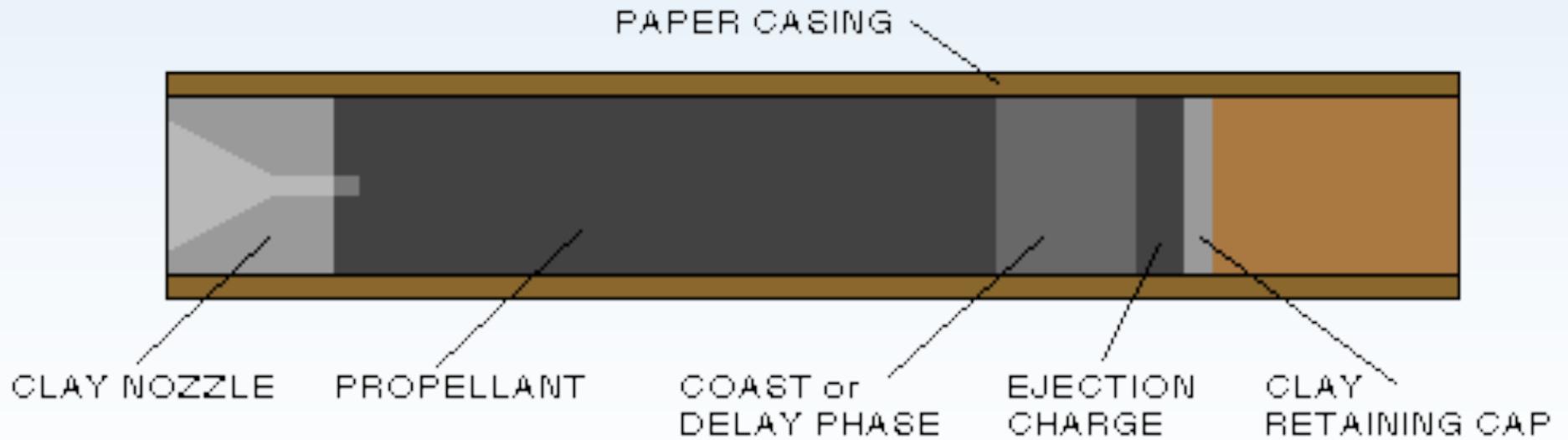
Model Rocket Engines

J. Lee





Model Rockets





Chemistry/Combustion



- $21\text{NH}_4\text{ClO}_4 + 10(\text{C}_4\text{H}_6) \rightarrow 21\text{HCl} + 34.5 \text{H}_2 + 27 \text{H}_2\text{O} + 23 \text{CO} + 17 \text{CO}_2$
- Ammonium perchlorate
- Note: Far more interesting than
 - $\text{H}_2 + 1/2 \text{O}_2 \rightarrow \text{H}_2\text{O}$





Published Motor Data

A	1.26-2.5	N-s
B	2.51-5	N-s
C	5-10.	N-s
E	20-40	N-s

A 6 -4

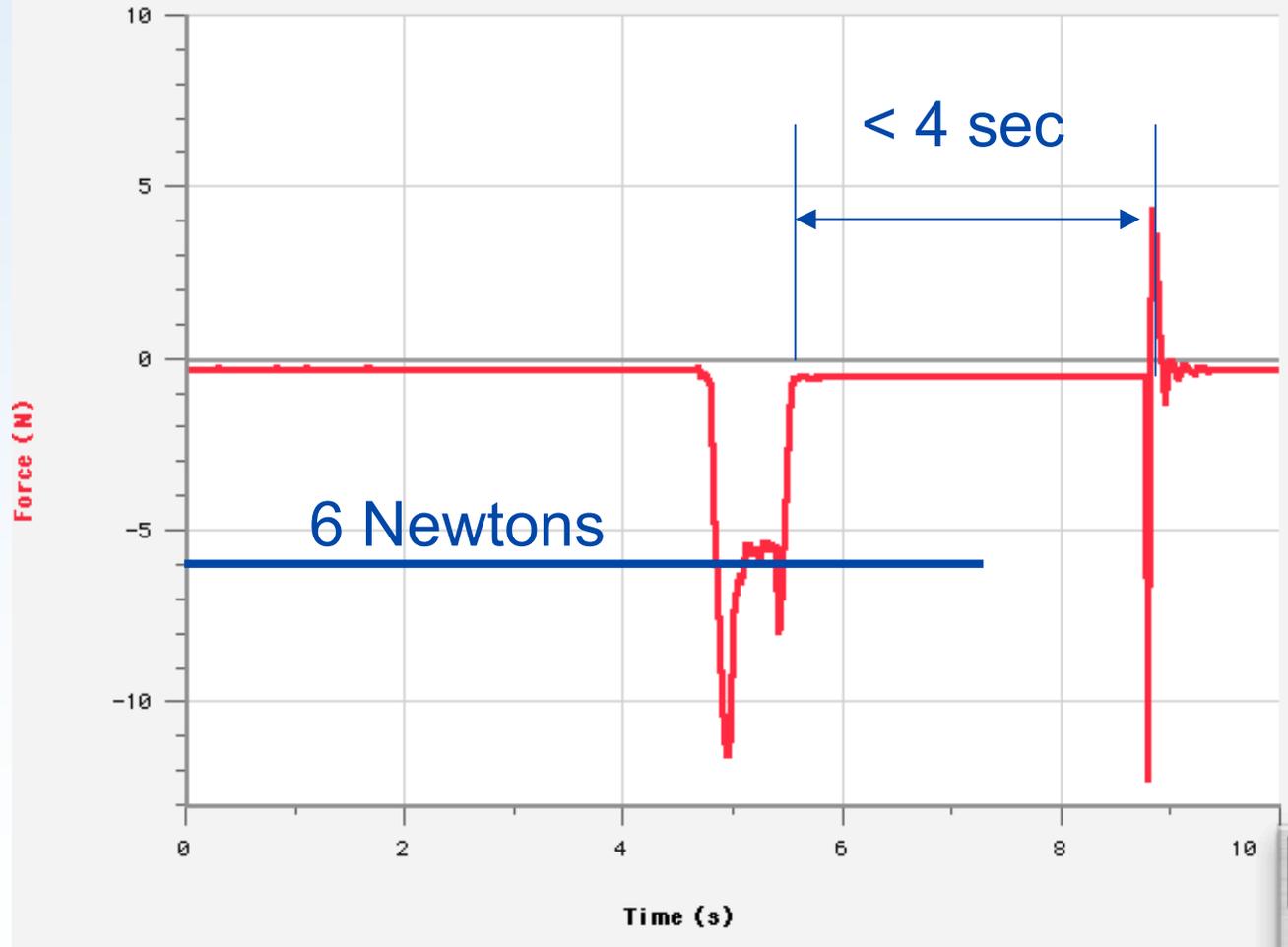
Class Thrust (Newtons) Delay (sec)





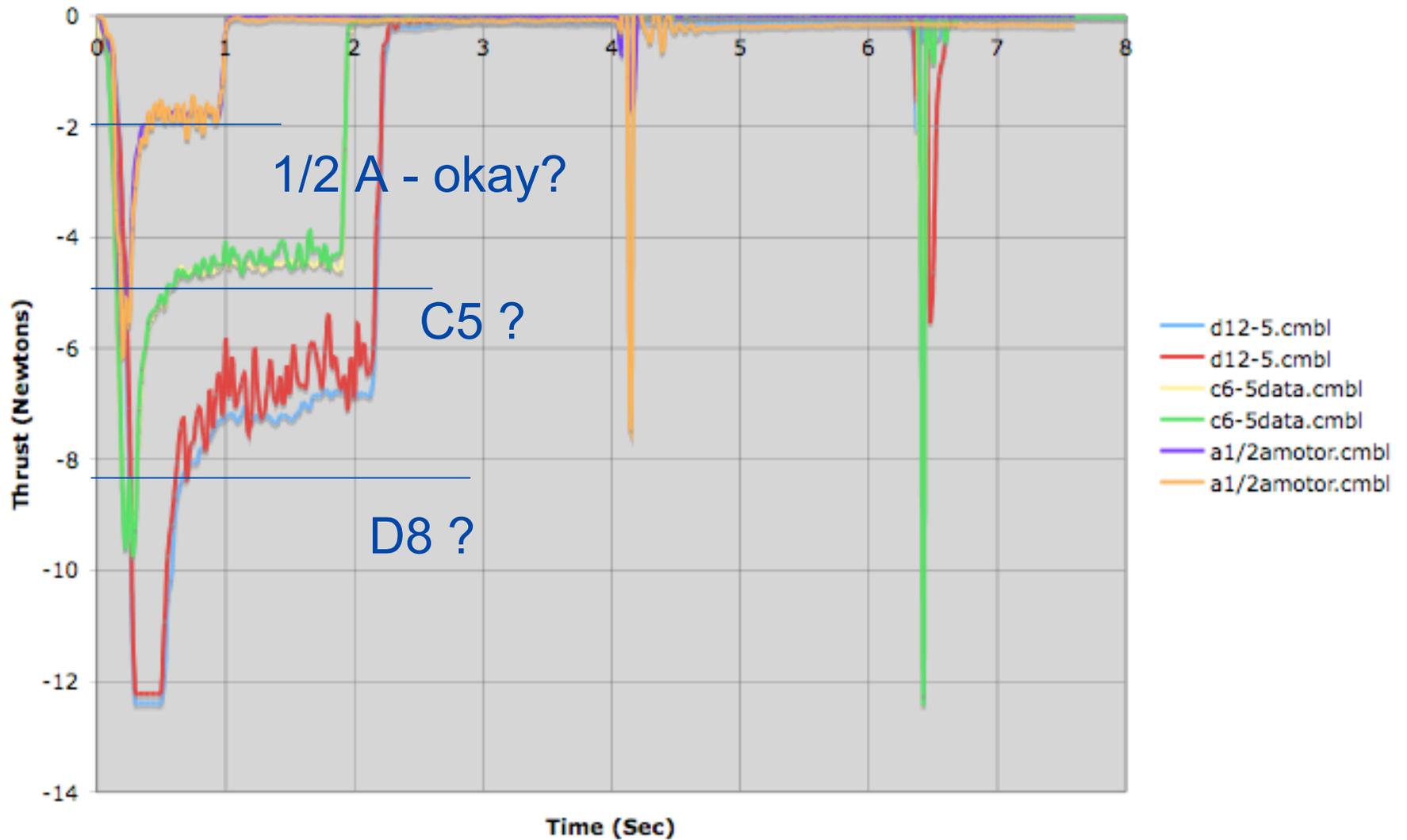
Measured Motor Data

B 6 -4



Measured Motor Data

Thrust Data





Test Runs



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Test Runs





Test Run

