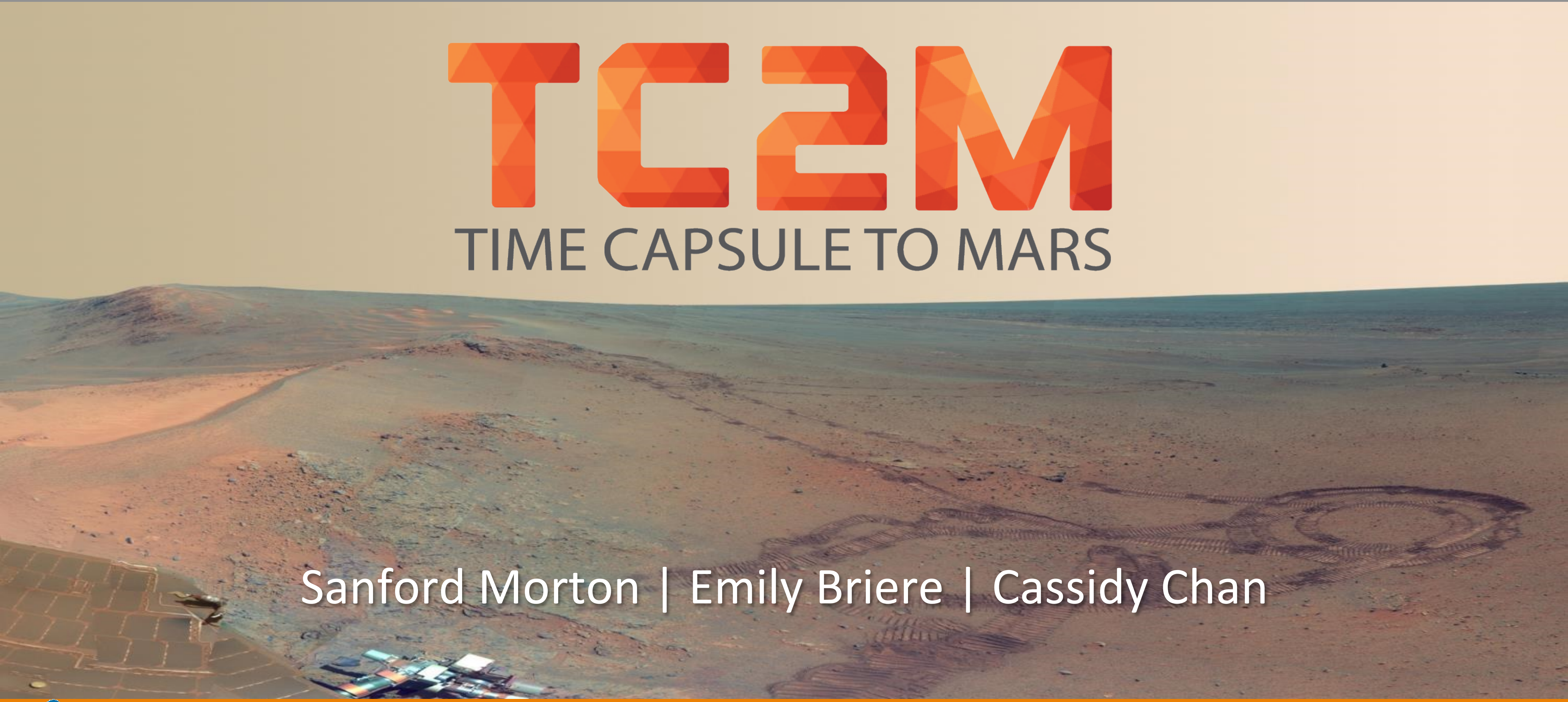
TC2M
TIME CAPSULE TO MARS



Sanford Morton | Emily Briere | Cassidy Chan

Agenda

Mission Overview

Why? How? What?

1 Mission Overview

Technology Walkthrough

A deep dive into our systems

2 Technology

Inspiration in Action

Active STEM engagement

3 Inspiration

TC2M has Bold Objectives and Strives to be a Model of Innovation

MISSION OBJECTIVE Build, launch, and land on the surface of Mars three **student** inspired, **student**-designed, **student**-built, and **student**-funded CubeSat time capsules of humanity

THREE CORE IDEALS

1 INSPIRE
Create an educational vehicle to ignite a passion among today's youth
Develop a new model for student-led innovation

2 TELL A STORY
Connect cultures and discover commonalities
Capture our collective society for current and future generations

3 PUSH THE BOUNDARIES
Pioneer cutting edge aerospace technology that advances technical readiness to support human spaceflight to Mars

DRIVEN BY THE "WHY"

3 WHAT
We're inviting people from all corners of the globe to **join the mission** and contribute to a digital "snapshot of humanity" that will one day be **rediscovered**

2 HOW
We lead by example – together we're designing new technology and launching a **student-led mission to Mars**

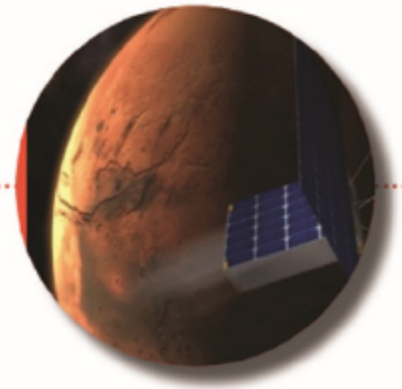
1 WHY
We believe a better tomorrow is achieved through **inspiring youth** to discover their passion

TC2M in a Nutshell

Collect

- Collect **digital content** (text, photo, and video) from across the globe
- Utilize **social media** and STEM partners to reach vast audiences

Launch



- **3 CubeSat spacecraft** will thrust to Mars using **ion-electrospray propulsion**
- We want to fly **new experiments** crowdsourced through students

Arrive

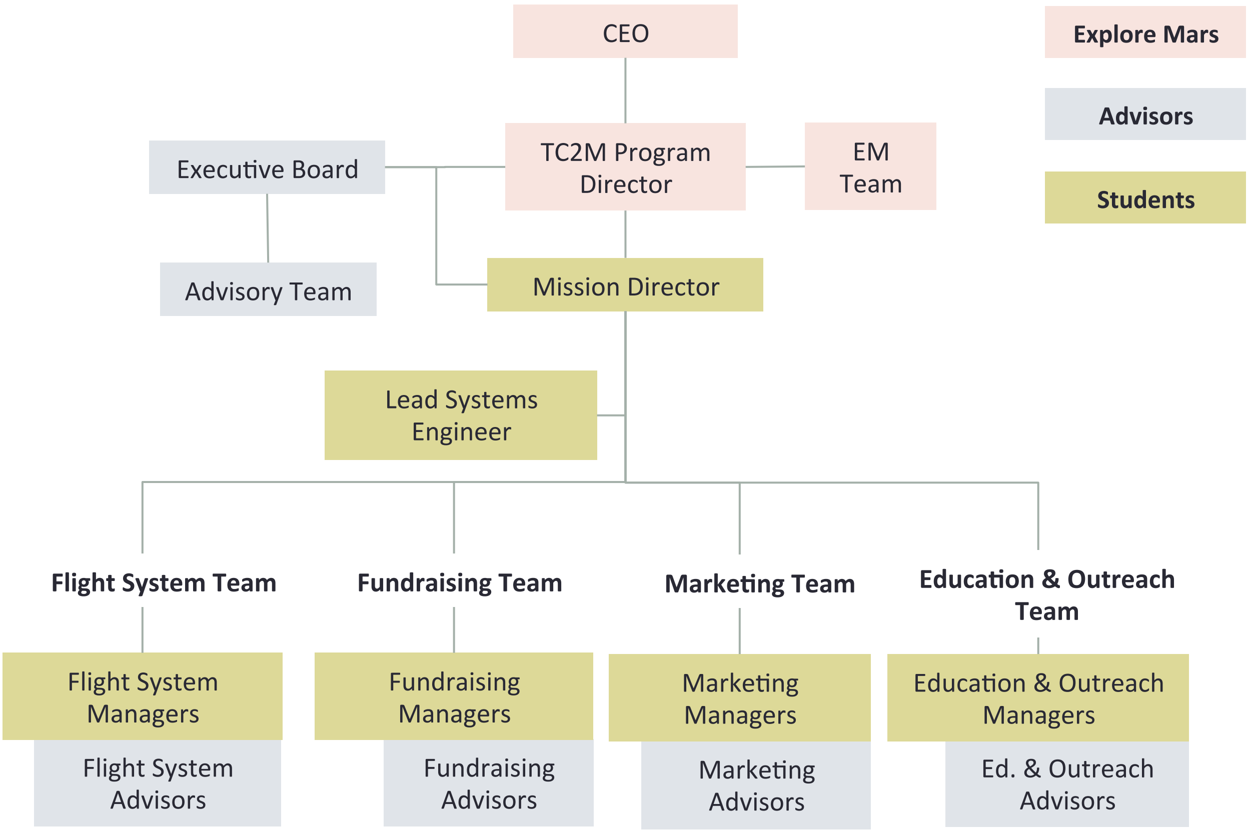
- Enter Martian atmosphere and **deploy time capsule payloads**
- **Signal home** that the landing was a success!

Remain

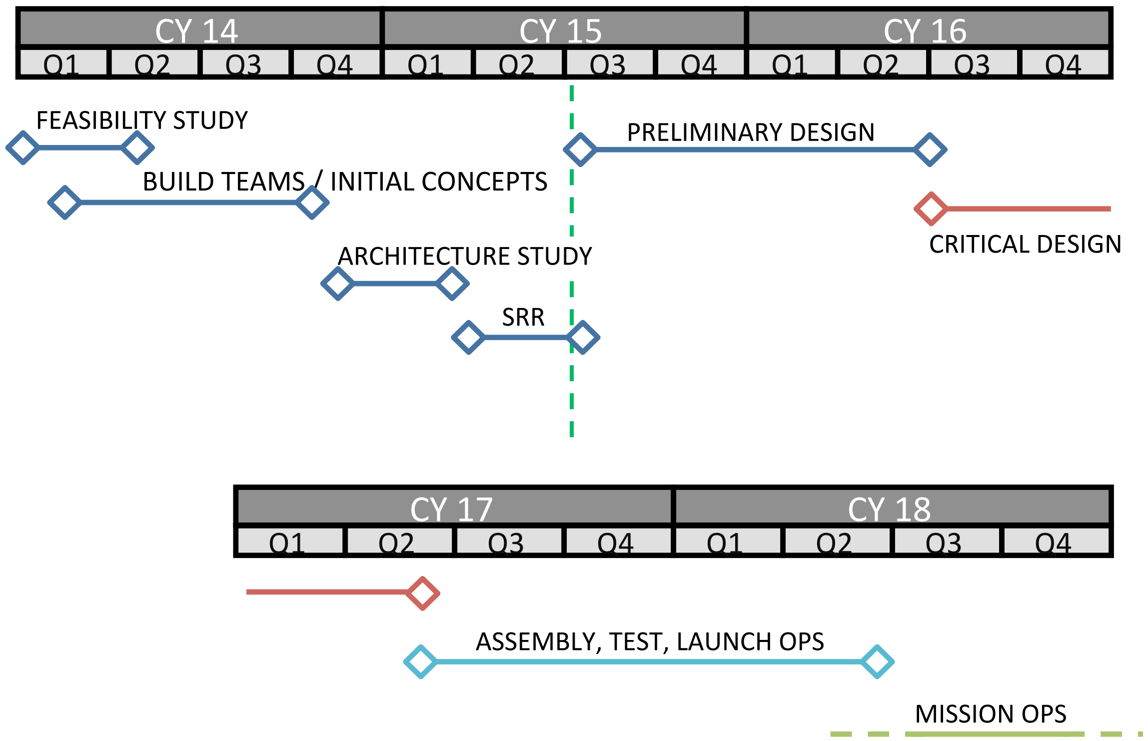
- Payloads land, remain intact for future human **colonists to rediscover**
- Plan to share the same **gallery of digital content** here on Earth to continue to inspire

Project Management & Schedule

STRONG ADVISORY STRUCTURE & FEEDBACK LOOP



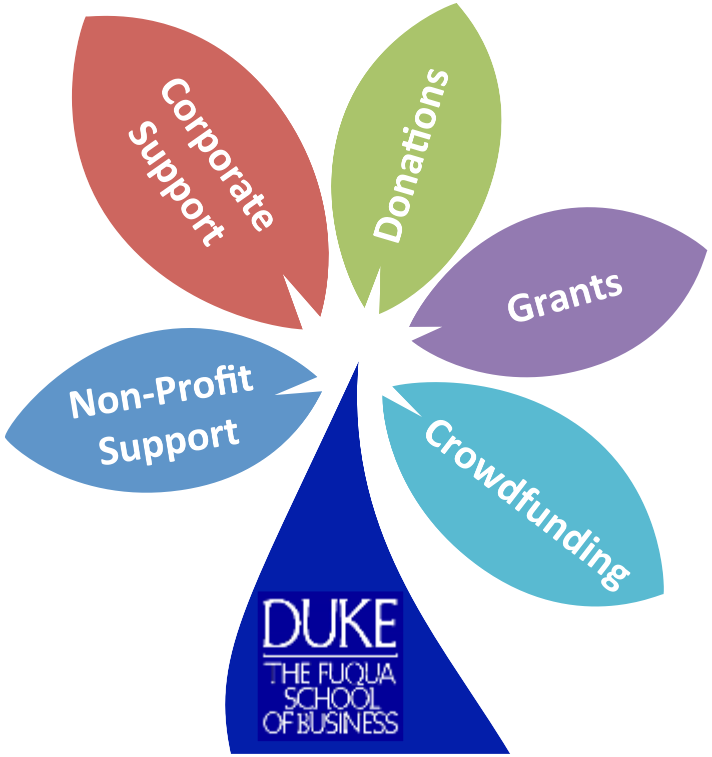
WHERE WE ARE… WHERE WE'RE GOING

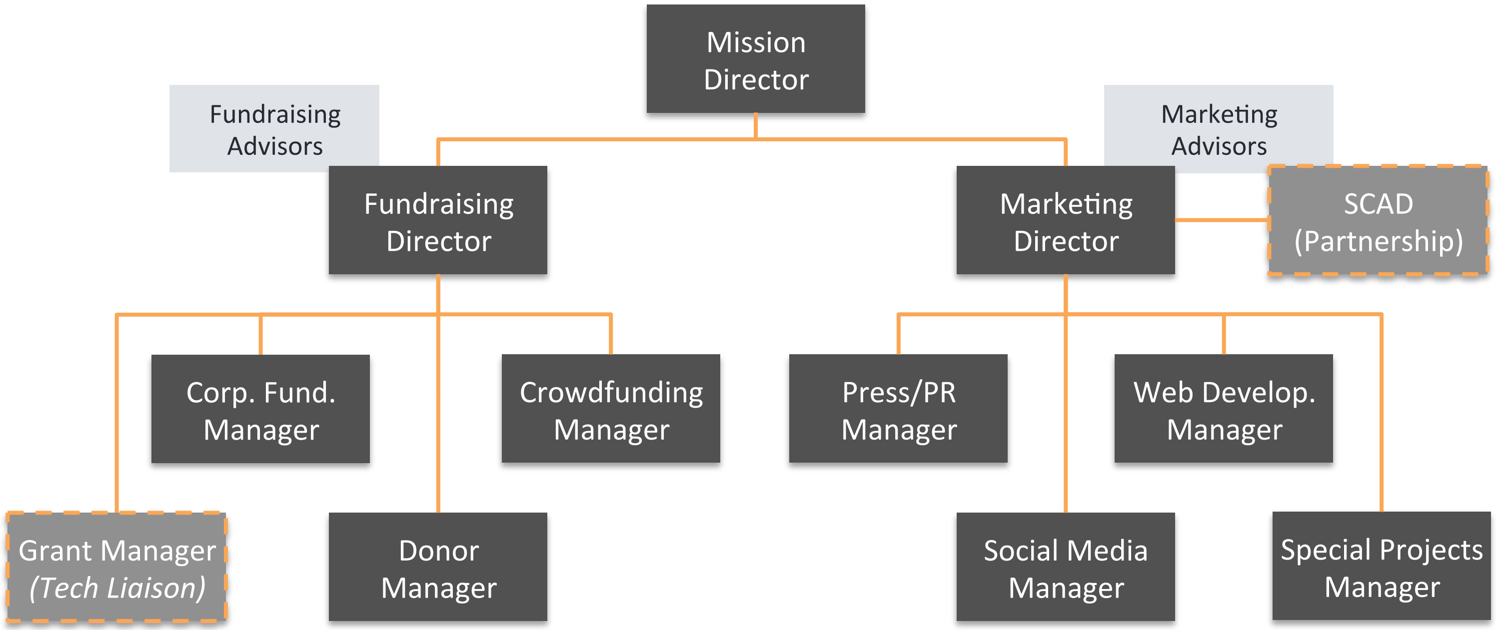


Organizing for Financial Success

SOURCES OF SUPPORT

STRONG COMMERICAL TEAM & PARTNERSHIPS





Strong Partners for Unique System Requirements

AVIONICS (Embry-Riddle Aeronautical University)

Engineer memory that is single event upset and latch up tolerant

Develop method to capture images of objects in and on the spacecraft during flight

ENTRY DESCENT LANDING (Georgia Tech)

Separate the lander from the main spacecraft without re-contact

Design 1U CubeSat entry, descent, and landing system

GNC PROPULSION (MIT)

Create propulsion system capable of producing 5.5 km/s ΔV within our limited spacecraft size

Develop semi-autonomous guidance, navigation, and control scheme

LANDER PAYLOAD (UConn)

Confirm successful landing on Mars

Protect the lander from dust storms and abrasive environments

TEST ASSEMBLY LAUNCH OPS (Florida Institute of Technology)

Abide by all planetary protection requirements throughout the duration of the mission

Develop a system that is compatible with multiple launch vehicles and trajectories

COMMS MISSION OPS (CU)

Optimize trajectory for efficient propellant use while minimizing the time of flight

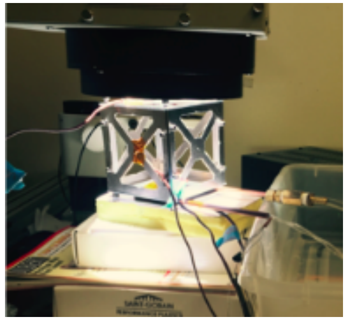
Develop a CubeSat compatible interplanetary communication system

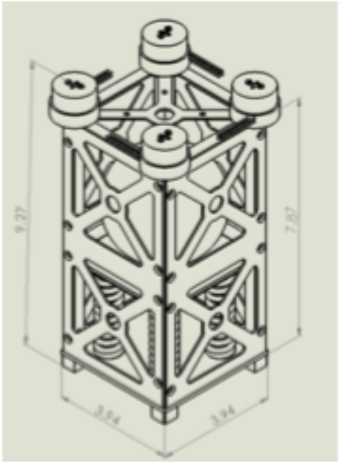
STRUCTURE MECHANICAL (Duke University)

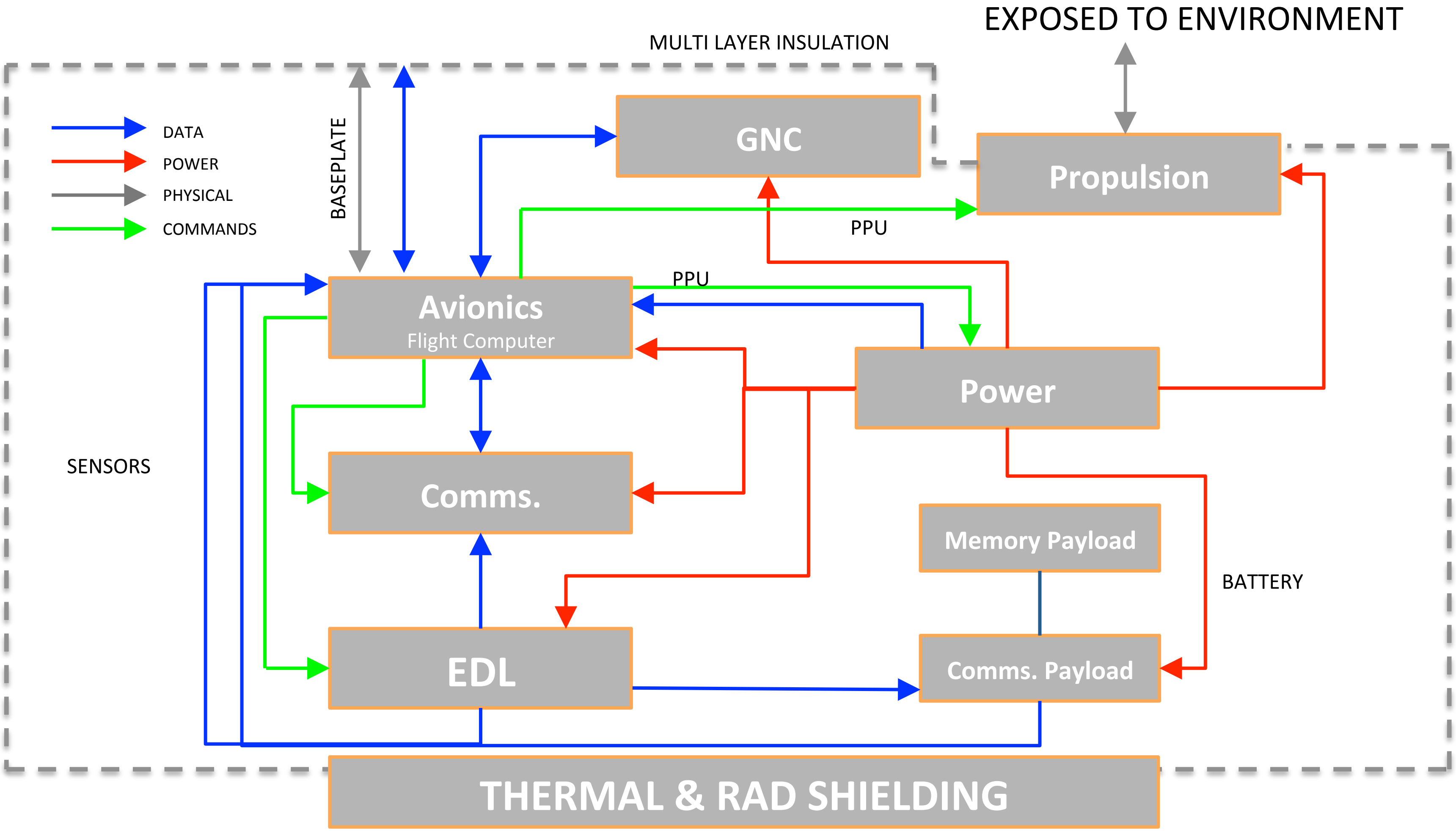
Engineer a passive vibration isolation system

Design thermal control system to maintain temperature of each component within the specified range during all mission phases

System Architecture & Interfaces



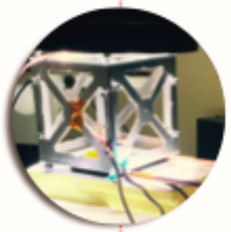




Unique Challenges

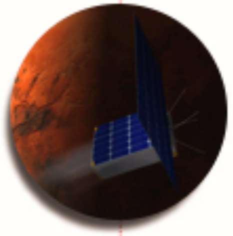
GUIDANCE & NAVIGATION CONTROL

With limited power available for the comms system, and thus limited frequency of communication with Earth, how will we **maintain our intended trajectory?**



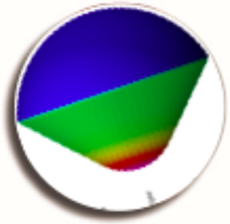
PROPULSION

Given the relatively small size of our spacecraft and room for payload how will we meet **the minimum required ΔV to reach mars**?



SURVIVING THE SPACE ENVIRONMENT

How will we **block out high energy solar particles** and background cosmic radiation? How will we **moderate S/C temp**. to survive a dynamic mission environment?

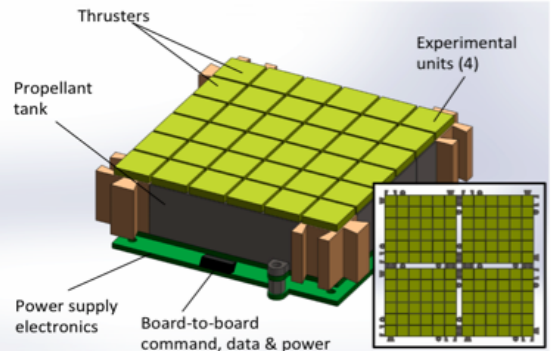


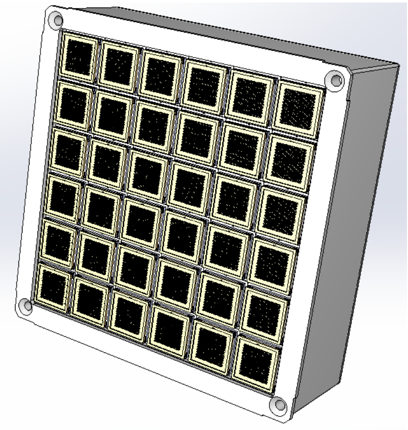
ENTRY DESCENT & LANDING

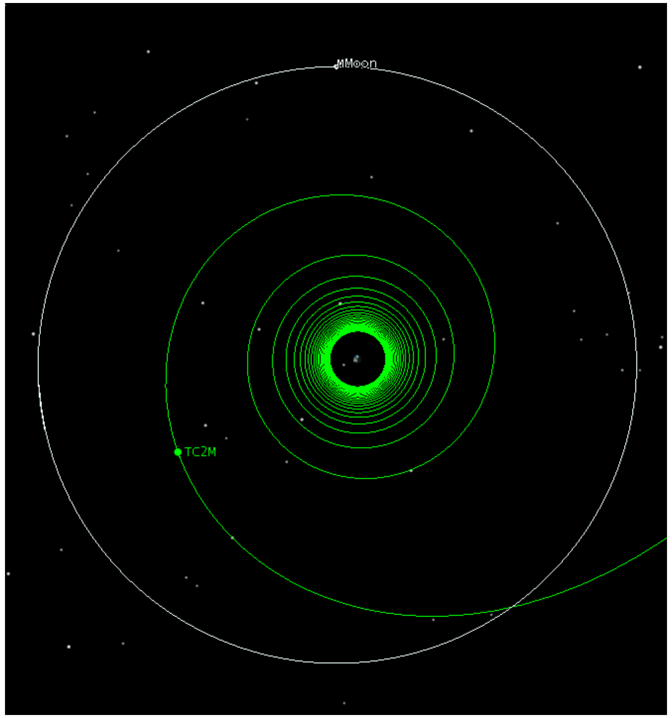
Given that Mars has a thin and variable atmosphere with idiosyncratic densities how do we **survive entry and land** in a region of our choosing with relative accuracy?

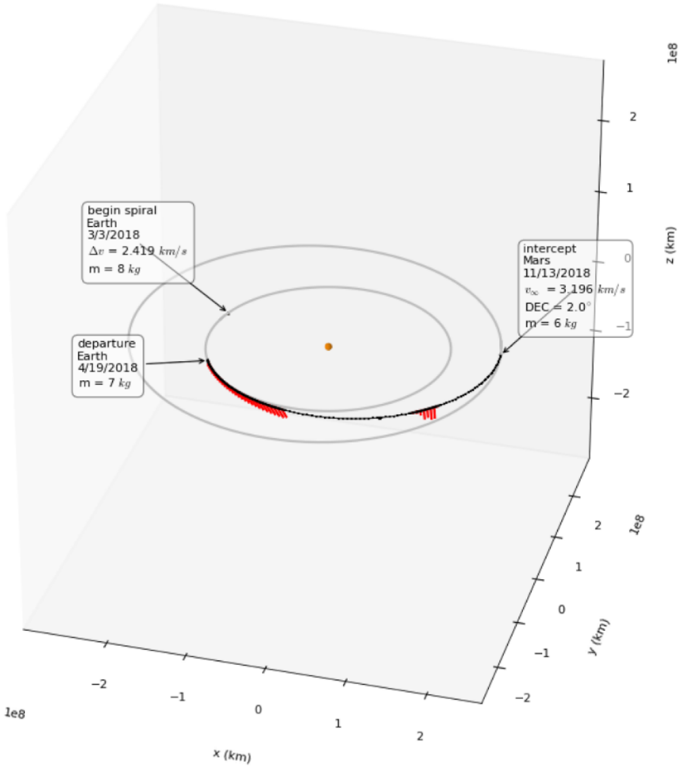
Propulsion & GNC

PROPULSION → **EARTH SPIRAL OUT** → **MARS ENTRY**









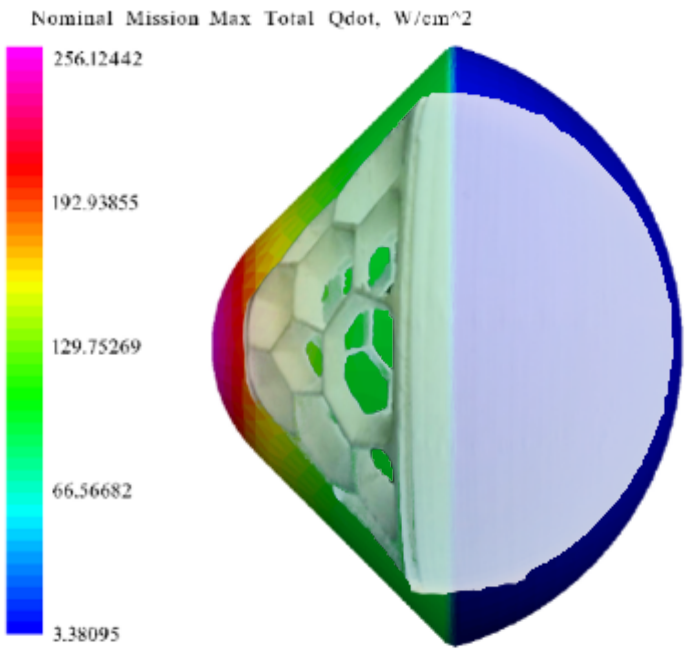
EDL & Payload

LOW MASS, LOW VOLUME PASSIVE EDL SYSTEM

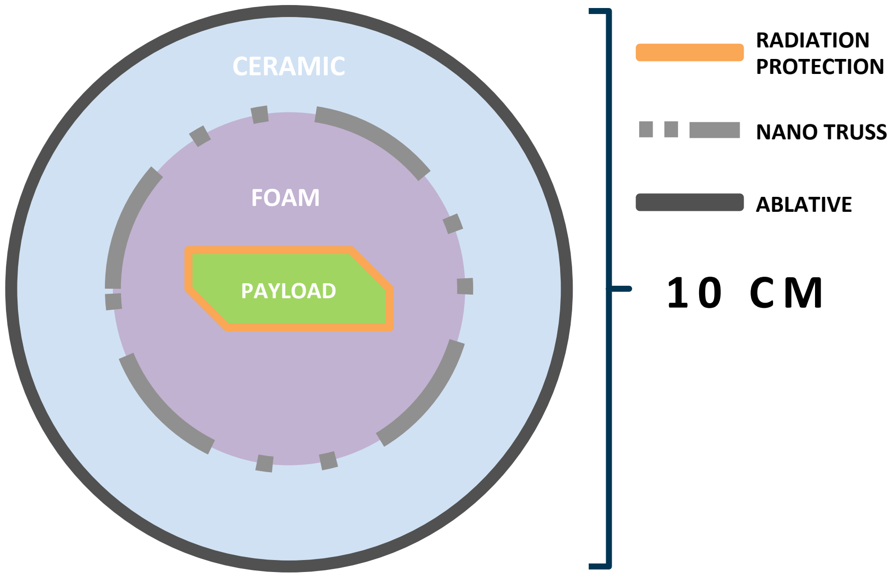
CHALLENGES

1. **Incorporate** EDL system into small volume and mass
2. **Analyze** potential atmospheric entry conditions
3. **Design** long term storage of large memory capacity in a small volume
4. **Ensure** data payload survives the passive descent

EXTERIOR DESIGN



INTERIOR DESIGN



Science Payload Consideration

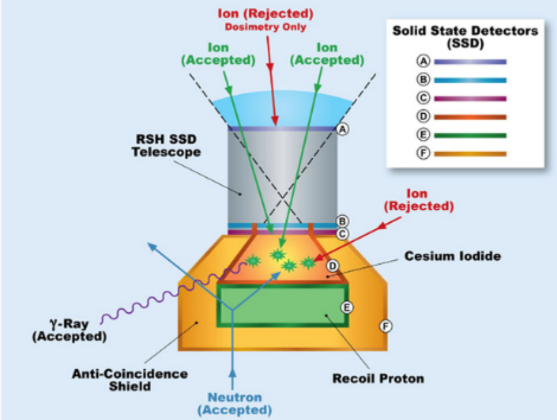
TC2M and Explore Mars are interested in science investigations that advance knowledge needed for future human missions to Mars

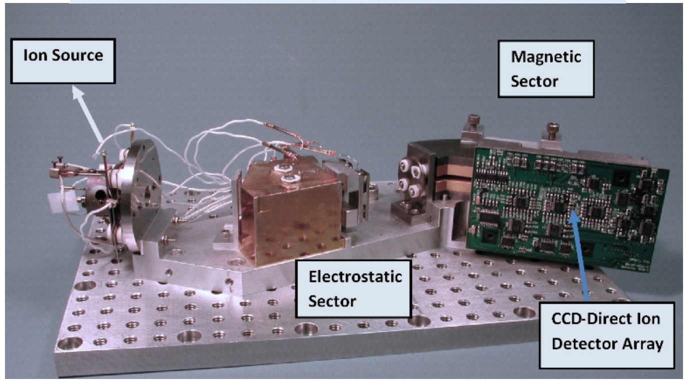
POSSIBILITIES

RADIATION MEASUREMENTS

In route between Earth and Mars

On surface measurements timeline, total dose variations, uplink to Mars orbital assets (NASA, ESA)





MARS RESOURCE DETECTION

Spectral imager for precipitation of water and CO_2 in form of snow or frost with daily relay frequency

Electrodynamic dust properties experiments

ASK

CANDIDATE

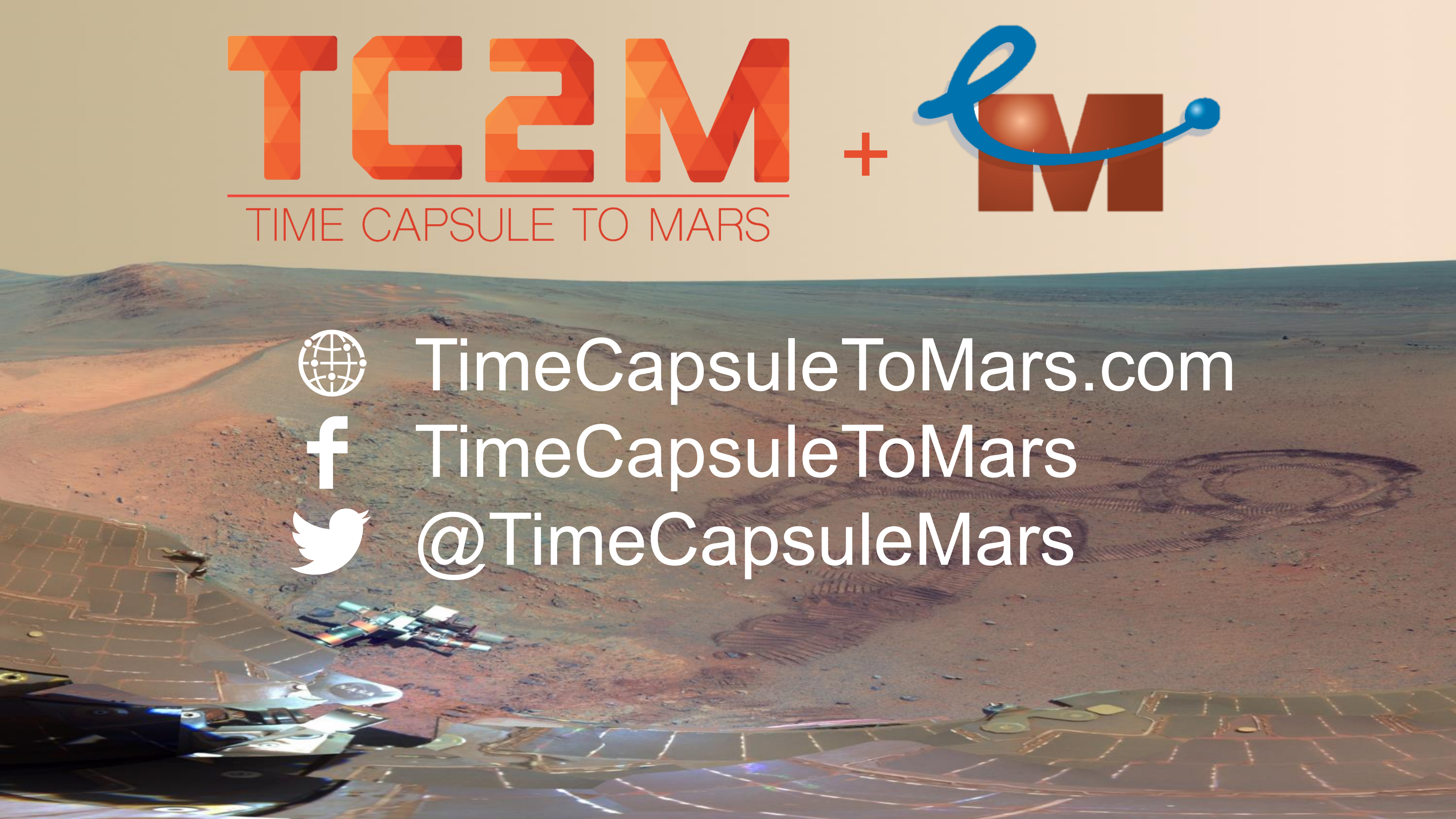
University or undergraduate students

PROPOSAL

Submit a planned experiment that could fit within the spacecraft's limited resources and return viable data

It’s More Than Just Getting to Mars

We’ve been connecting and inspiring schools, students, mentors, and professionals around the country and soon the world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