NASA

# TECHRISE

STUDENT CHALLENGE

**Step 2** Pick a Vehicle: Choose Rocket or Balloon

# Step 2: Choose Rocket or Balloon

Next, you will need to pick a flight vehicle (rocket or balloon).
The following slides will give you more info on both types of vehicles to help you with your decision.

Think about the following questions when learning about the vehicles

- What environment does the vehicle provide? How long will your experiment/payload be in that environment?
- What types of experiments can you conduct on that vehicle?
- What kind of data can you collect on each vehicle? (ex. Can you collect temperature, pressure, altitude, visual data etc…?)

# About High-Altitude Balloons Video

# High-altitude Balloons

High-altitude balloons are large, helium-filled balloons that carry scientific payloads and experiments up into the Earth's atmosphere and closer to the edge of space.

They can sustain long periods of time in the Earth's atmosphere. NASA's TechRise payloads will float for 4+ hours. This means if you pick a balloon, your experiment will get a minimum of 4 hours of float time!

# Raven Aerostar Cyclone Zero Pressure Balloon

Once the flight vehicle reaches float altitude, the system takes advantage of stratospheric wind patterns to steer the balloon. Using altitude control maneuvers like venting lift gas (causing the balloon system to descend) or dropping ballast (causing the balloon system to ascend), the Raven flight engineer will find the best wind layer to steer the platform in the desired direction.

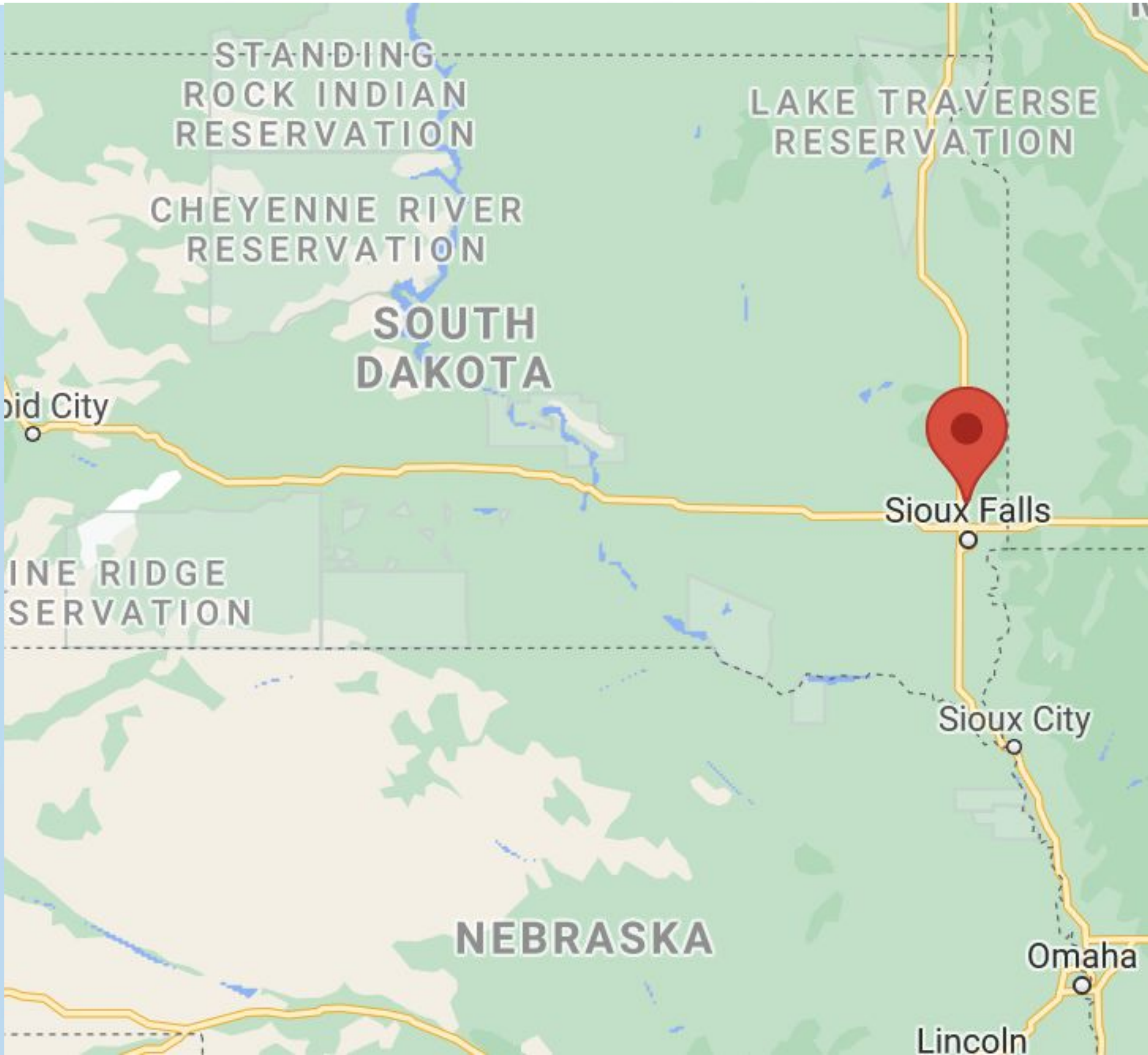
Credit: Raven Aerostar

# Pre Flight

Before flight, all NASA TechRise experiments will be hooked up to the balloon's power and data, mounted to a frame called a "gondola", and launched from Baltic, South Dakota.

If it's after sunrise, not raining, and cloud cover is less than 30%, then we are a GO for launch.

(Google, n.d.)



# Flight

Once the balloon and gondola start ascending into the sky, the experiments can start using their onboard sensors and cameras to collect data. The experiments will have exposure to the air around them, views down to Earth's surface, and views out to the horizon.

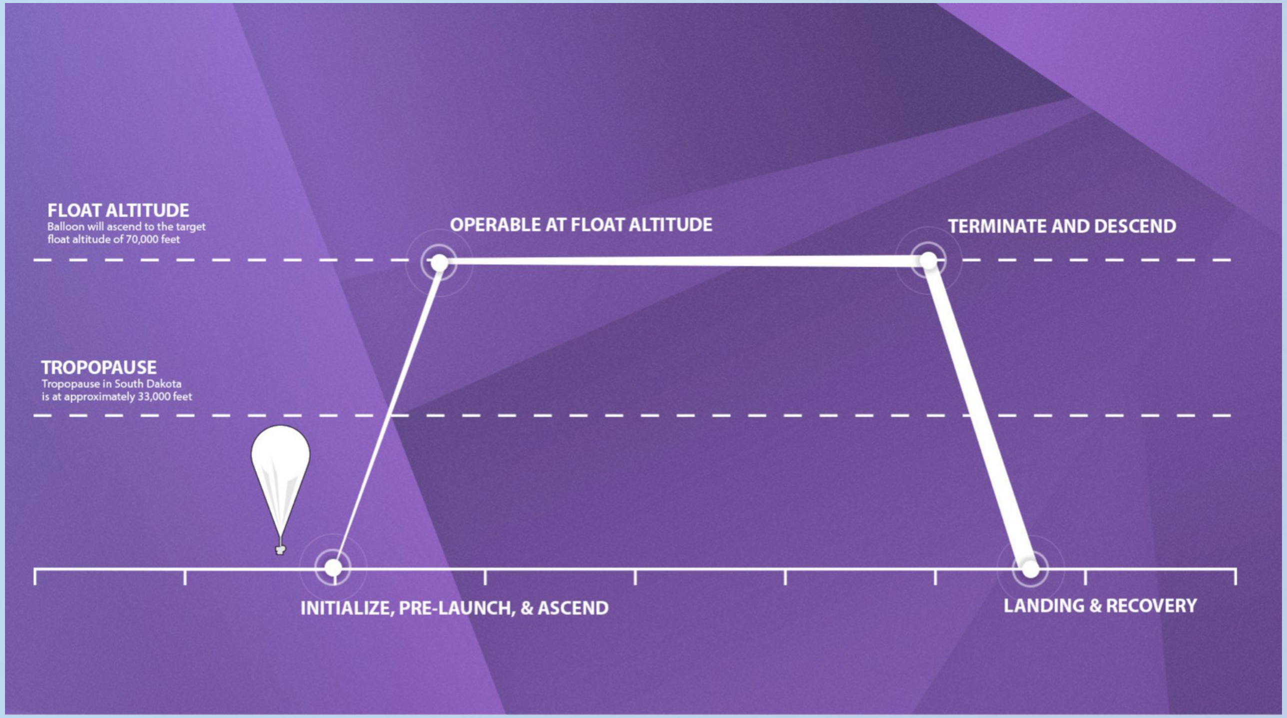
The higher the balloon goes, the colder it gets. And since air pressure decreases with altitude, the balloon will expand from big to HUGE.

# Atmospheric Layers

It will also travel through different layers of the atmosphere.

It will take about 30 to 45 minutes to ascend through the troposphere, which is the layer we live in, AND the layer that has almost all of our planet's weather, like clouds and water vapor, which are constantly moving. About 75% of the air from our atmosphere is in the troposphere and it is by far the wettest layer.

Next, is the stratosphere, which is above the clouds and where the winds are calm and dry. This is where commercial airplanes typically fly and where you'll find the ozone layer. Ozone molecules in the stratosphere absorb a lot of the Sun's harmful UV radiation, and in the process generate heat. Unlike the troposphere, it actually gets warmer the higher up you go in the stratosphere!

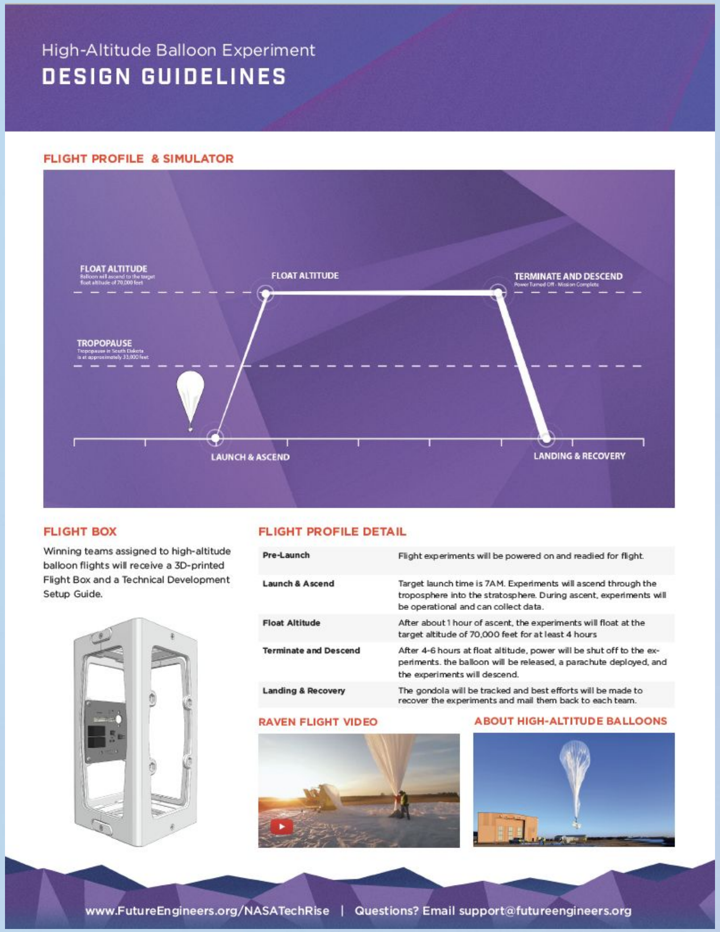


NASA TECHRISE STUDENT CHALLENGE

# Flight Data

Experiments can also use the balloon's vehicle telemetry. The balloon's onboard flight computer will send messages to the experiments including GPS data of where it is, altitude data of how high it is, or acceleration data of how fast it is changing speed.

You can program a microcontroller to use this data to start or stop your experiment at a certain altitude, or to map where you took a particular photo, or to log how far your experiment traveled.



High-Altitude Balloon Experiment

DESIGN GUIDELINES

FLIGHT PROFILE & SIMULATOR

FLOAT ALTITUDE
Balloon will ascend to the target float altitude of 70,000 feet

FLOAT ALTITUDE

TERMINATE AND DESCEND
Power Turned Off - Mission Complete

TROPOPAUSE
Tropopause in South Dakota is at approximately 33,000 feet

LAUNCH & ASCEND

LANDING & RECOVERY

FLIGHT BOX

Winning teams assigned to high-altitude balloon flights will receive a 3D-printed Flight Box and a Technical Development Setup Guide.

FLIGHT PROFILE DETAIL

| | |
|---|---|
| Pre-Launch | Flight experiments will be powered on and readied for flight. |
| Launch & Ascend | Target launch time is 7AM. Experiments will ascend through the troposphere into the stratosphere. During ascent, experiments will be operational and can collect data. |
| Float Altitude | After about 1 hour of ascent, the experiments will float at the target altitude of 70,000 feet for at least 4 hours |
| Terminate and Descend | After 4-6 hours at float altitude, power will be shut off to the experiments. the balloon will be released, a parachute deployed, and the experiments will descend. |
| Landing & Recovery | The gondola will be tracked and best efforts will be made to recover the experiments and mail them back to each team. |

RAVEN FLIGHT VIDEO

ABOUT HIGH-ALTITUDE BALLOONS

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# Experiment Retrieval

And once the mission is complete, the experiment will be shut off from power before the gondola separates from the balloon and parachutes back down to Earth.

It could land in a field, or in a tree, but no matter where the gondola lands, a crew will try to retrieve it and send your experiment home.

# Key Points: High Altitude Balloons

- Flight Time: 4+ hours at 70,000 feet
- Experiment will have line of sight in two directions during flight - Down to Earth (Nadir) and out to the horizon (Horizontal)
- Exposed to ambient atmospheric temperature and pressure
- Acceleration up to 6 g in any direction
- Vehicle telemetry (data) is streamed to each experiment

# Possible Experiments Topics
# High Altitude Balloon

- Comparing Atmospheric Layers
- Ozone
- Temperature, Pressure & Humidity
- Greenhouse Gases
- Air Quality
- Radiation
- Thermodynamic Experiments
- Remote Sensing/Imaging of Earth
- Materials Experiments
- Landing Systems
- Earth’s Magnetic Field Measurements
- You Choose!

# Now, let’s check out the suborbital rockets...

# About Suborbital Rockets Video

# Suborbital Rockets

NASA uses suborbital flights to test new space technologies and experiments a little closer to Earth.

When something goes around the Earth, it is in orbit. So when a rocket goes up and comes back down without going around the Earth, it's called a suborbital rocket.

At the peak of flight, a suborbital rocket goes beyond the edge of space where it experiences a few minutes of microgravity – sometimes referred to as zero-g or weightlessness.

The NASA TechRise challenge winners will be awarded flight for their experiment on one of two rockets. One rocket is small (UP) and the other is big (Blue Origin). Each of these rockets will experience approximately 3 minutes of microgravity.

It is also important to know if your team is awarded the prize, the NASA TechRise Team will select a rocket for you. So, your proposal plan should be a design for suborbital rockets in general.

Let's take a look at the two rockets!

# Up Aerospace Rocket

Up Aerospace SpaceLoft flights can provide a microgravity environment in excess of 3 minutes. Lift-off begins with a solid rocket motor ignition after which the vehicle is spun aerodynamically using its four canted fins. At about one minute into flight, the vehicle is despun. Microgravity experimentation begins after the de-spin is complete. As the vehicle re-enters Earth's atmosphere, the payload section is separate from the booster before deploying the parachutes.

Credit: UP Aerospace

Credit: UP Aerospace

# Blue Origin New Shepard

Named after astronaut Alan Shepard, the first American in space, New Shepard is Blue Origin’s fully reusable suborbital rocket system. It is designed to take astronauts and research payloads on an 11-minute journey to space past the Kármán Line (100 km), the boundary of space. Near the top of its flight, the capsule separates from the booster and experiences 3 minutes of clean microgravity before returning to Earth. This flight profile will enable NASA TechRise students to use New Shepard as a platform to conduct microgravity experiments and technology demonstrations.

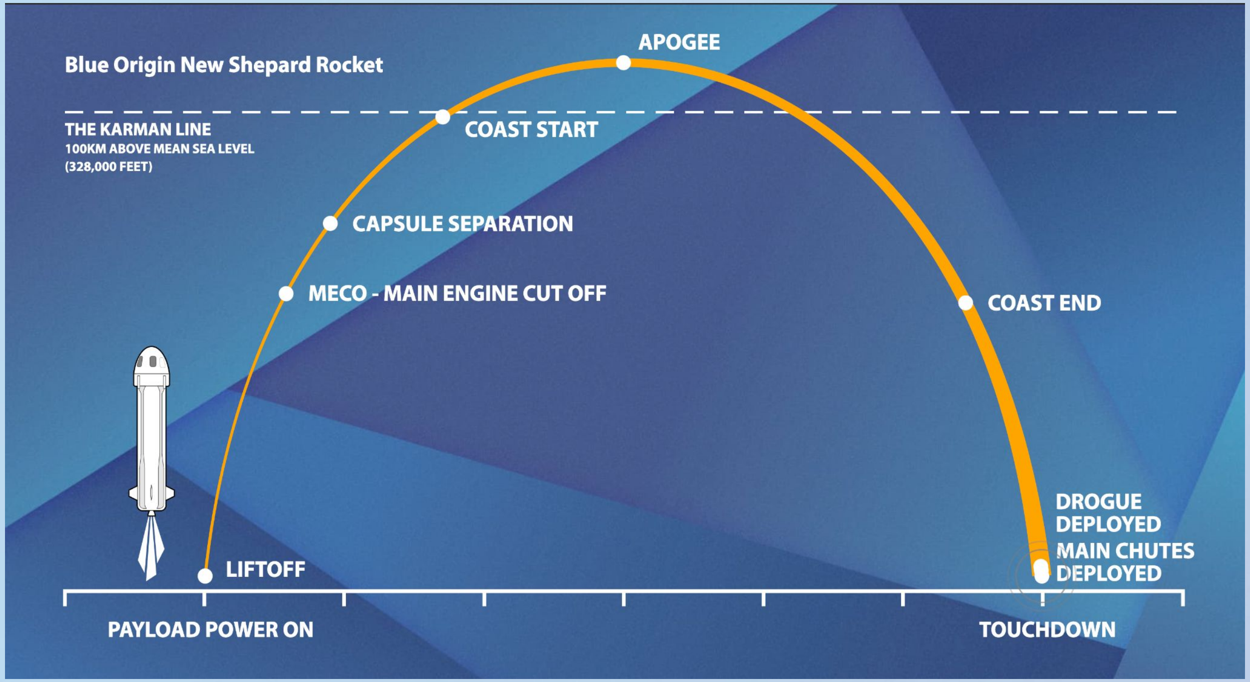

Credit: Blue Origin


Credit: Blue Origin

# Flight

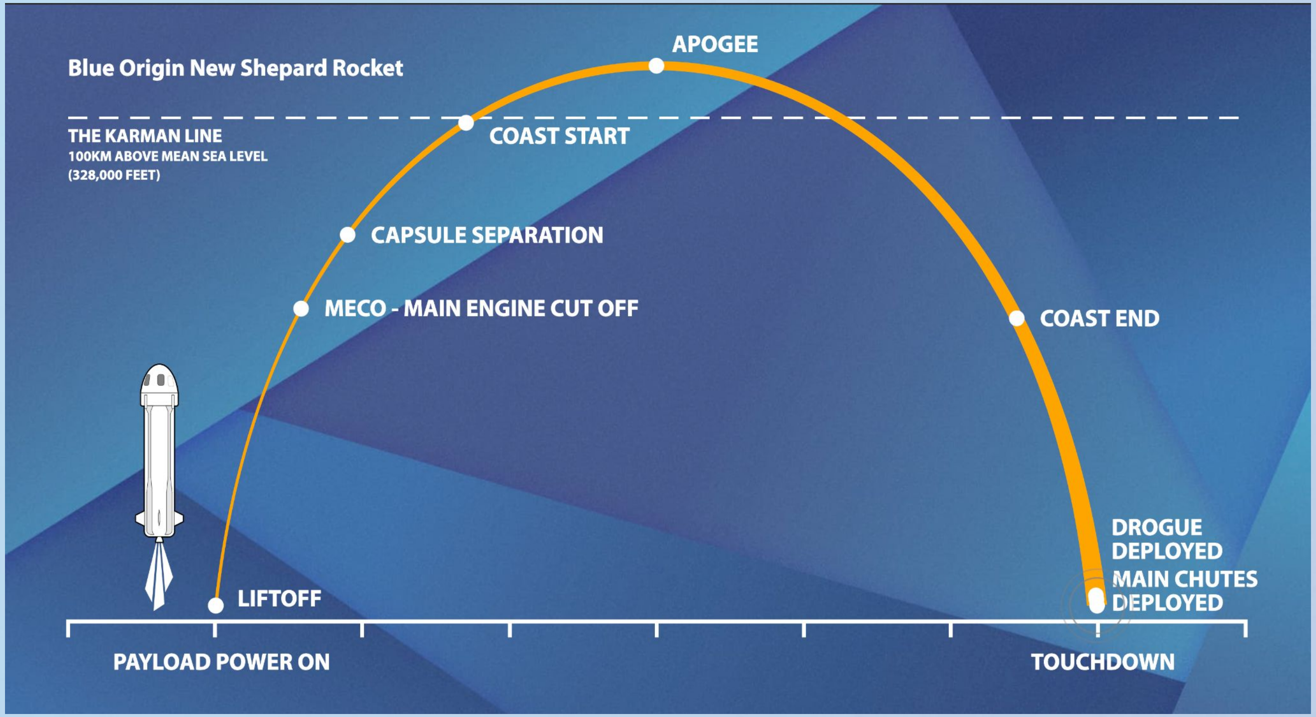
Before flight, your experiment will be put inside the rocket and plugged in to receive power and data from the vehicle. And that data is REALLY important. Because you'll need to use that data to tell your experiment to start at *just* the right time.

During the ride on the rocket, that data stream will tell your flight experiment about the excitement of what's going on – like how fast the rocket is accelerating or how high up it is. Your experiment will also get messages when key events happen – like when microgravity starts.



# Microgravity

And when microgravity starts, the 3 minutes of scientific fun begins! Everything inside your payload will become weightless and start to float – just like astronauts on the space station. AND – it's GO time. Not only will you want to run your microgravity experiment, you will want to take photos or video too, so that when it comes back down to Earth, your experiment can be mailed back to you, and you can then see what happened when it was <u>**in**</u> space!



# Key Points Suborbital Rockets

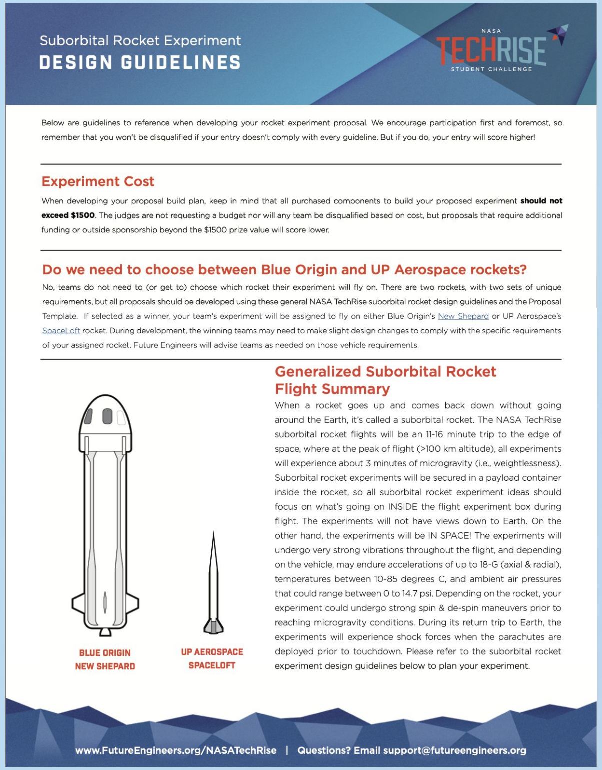
- Flight Time: 11 - 16 minutes
- Approximately 3 Minutes of Microgravity
- No line of sight to the exterior. Your experiment won't be able to see outside of the rocket.
- Air Pressure 0 - 14.2 psi
- Acceleration up to 18.5 g
- Liquids limited to 150 ml or less
- No plants or animals!

# Possible Experiment Topics
# Suborbital Rocket

- Living in Microgravity
- Medical in Microgravity
- Spacecraft Structures
- Organization in Microgravity
- Small Propulsion Systems
- Liquids
- Acceleration Exploration
- Farming Tech
- Lunar Dust
- You Choose!

# Design Guidelines

The NASA TechRise Student Challenge website has the Rocket and Balloon Design Guidelines with more information.



Suborbital Rocket Experiment

**DESIGN GUIDELINES**

Below are guidelines to reference when developing your rocket experiment proposal. We encourage participation first and foremost, so remember that you won't be disqualified if your entry doesn't comply with every guideline. But if you do, your entry will score higher!

**Experiment Cost**

When developing your proposal build plan, keep in mind that all purchased components to build your proposed experiment **should not exceed $1500**. The judges are not requesting a budget nor will any team be disqualified based on cost, but proposals that require additional funding or outside sponsorship beyond the $1500 prize value will score lower.

**Do we need to choose between Blue Origin and UP Aerospace rockets?**

No, teams do not need to (or get to) choose which rocket their experiment will fly on. There are two rockets, with two sets of unique requirements, but all proposals should be developed using these general NASA TechRise suborbital rocket design guidelines and the Proposal Template. If selected as a winner, your team's experiment will be assigned to fly on either Blue Origin's New Shepard or UP Aerospace's SpaceLoft rocket. During development, the winning teams may need to make slight design changes to comply with the specific requirements of your assigned rocket. Future Engineers will advise teams as needed on those vehicle requirements.

BLUE ORIGIN NEW SHEPARD

UP AEROSPACE SPACELOFT

**Generalized Suborbital Rocket Flight Summary**

When a rocket goes up and comes back down without going around the Earth, it's called a suborbital rocket. The NASA TechRise suborbital rocket flights will be an 11-16 minute trip to the edge of space, where at the peak of flight (>100 km altitude), all experiments will experience about 3 minutes of microgravity (i.e., weightlessness). Suborbital rocket experiments will be secured in a payload container inside the rocket, so all suborbital rocket experiment ideas should focus on what's going on INSIDE the flight experiment box during flight. The experiments will not have views down to Earth. On the other hand, the experiments will be IN SPACE! The experiments will undergo very strong vibrations throughout the flight, and depending on the vehicle, may endure accelerations of up to 18-G (axial & radial), temperatures between 10-85 degrees C, and ambient air pressures that could range between 0 to 14.7 psi. Depending on the rocket, your experiment could undergo strong spin & de-spin maneuvers prior to reaching microgravity conditions. During its return trip to Earth, the experiments will experience shock forces when the parachutes are deployed prior to touchdown. Please refer to the suborbital rocket experiment design guidelines below to plan your experiment.

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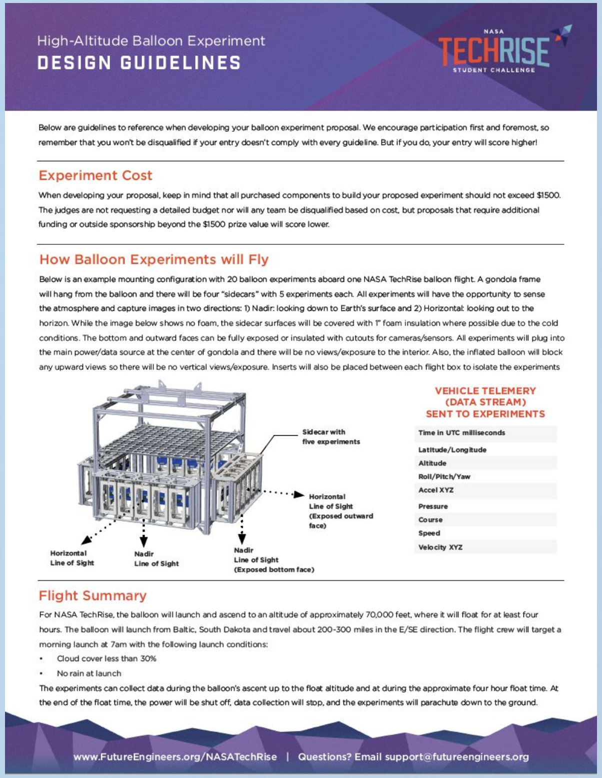

High-Altitude Balloon Experiment

**DESIGN GUIDELINES**

Below are guidelines to reference when developing your balloon experiment proposal. We encourage participation first and foremost, so remember that you won't be disqualified if your entry doesn't comply with every guideline. But if you do, your entry will score higher!

**Experiment Cost**

When developing your proposal, keep in mind that all purchased components to build your proposed experiment should not exceed $1500. The judges are not requesting a detailed budget nor will any team be disqualified based on cost, but proposals that require additional funding or outside sponsorship beyond the $1500 prize value will score lower.

**How Balloon Experiments will Fly**

Below is an example mounting configuration with 20 balloon experiments aboard one NASA TechRise balloon flight. A gondola frame will hang from the balloon and there will be four "sidecars" with 5 experiments each. All experiments will have the opportunity to sense the atmosphere and capture images in two directions: 1) Nadir: looking down to Earth's surface and 2) Horizontal: looking out to the horizon. While the image below shows no foam, the sidecar surfaces will be covered with 1" foam insulation where possible due to the cold conditions. The bottom and outward faces can be fully exposed or insulated with cutouts for cameras/sensors. All experiments will plug into the main power/data source at the center of gondola and there will be no views/exposure to the interior. Also, the inflated balloon will block any upward views so there will be no vertical views/exposure. Inserts will also be placed between each flight box to isolate the experiments

Sidecar with five experiments

Horizontal Line of Sight (Exposed outward face)

Horizontal Line of Sight

Nadir Line of Sight

Nadir Line of Sight (Exposed bottom face)

**VEHICLE TELEMERY (DATA STREAM) SENT TO EXPERIMENTS**

| |
|---|
| Time in UTC milliseconds |
| Latitude/Longitude |
| Altitude |
| Roll/Pitch/Yaw |
| Accel XYZ |
| Pressure |
| Course |
| Speed |
| Velocity XYZ |

**Flight Summary**

For NASA TechRise, the balloon will launch and ascend to an altitude of approximately 70,000 feet, where it will float for at least four hours. The balloon will launch from Baltic, South Dakota and travel about 200-300 miles in the E/SE direction. The flight crew will target a morning launch at 7am with the following launch conditions:

- Cloud cover less than 30%
- No rain at launch

The experiments can collect data during the balloon's ascent up to the float altitude and at during the approximate four hour float time. At the end of the float time, the power will be shut off, data collection will stop, and the experiments will parachute down to the ground.

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# What vehicle will you pick?