FLOATing DRAGON Balloon Challenge

Q&A Session #2
September 27, 2022

https://floatingdragon.nianet.org

(please mute your mic)

National Institute of Aerospace

FLOATing DRAGON is managed by the National Institute of Aerospace on behalf of NASA's Wallops Flight Facility's Balloon Program Office.

AGENDA

- Welcome & Introductions
- Background
  - Balloon Program Office overview
  - Balloon sizes
  - Challenges with large datasets
- DRAGON overview
  - Overview of the challenge
  - CONOPS of the flight demonstration
  - Preliminary timeline
  - Design requirements
  - Trident TRIG Trackers
- General Programmatic Remarks
- Questions
- Wrap Up

NIA PROGRAM TEAM

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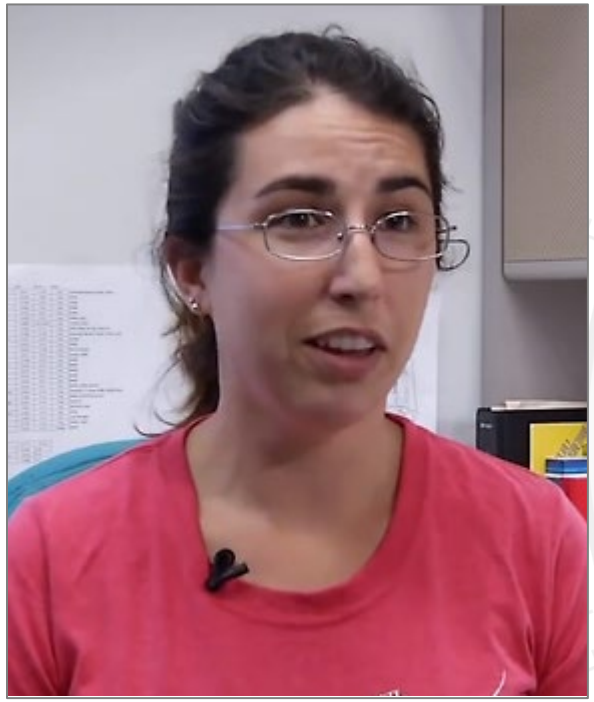

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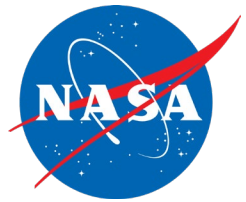
NASA SUBJECT MATTER EXPERTS



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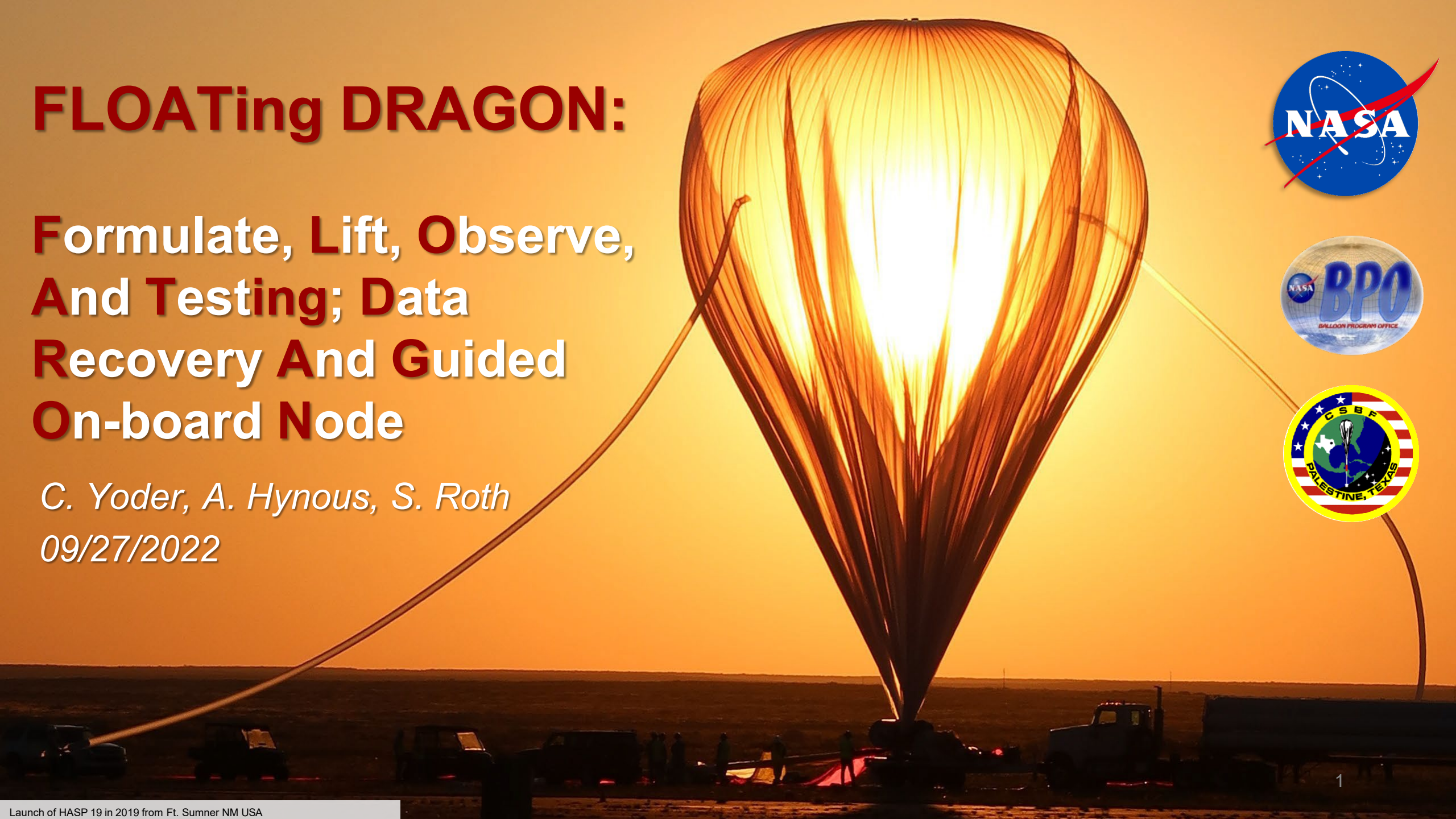
FLOATing DRAGON:

Formulate, Lift, Observe, And Testing; Data Recovery And Guided On-board Node

C. Yoder, A. Hynous, S. Roth

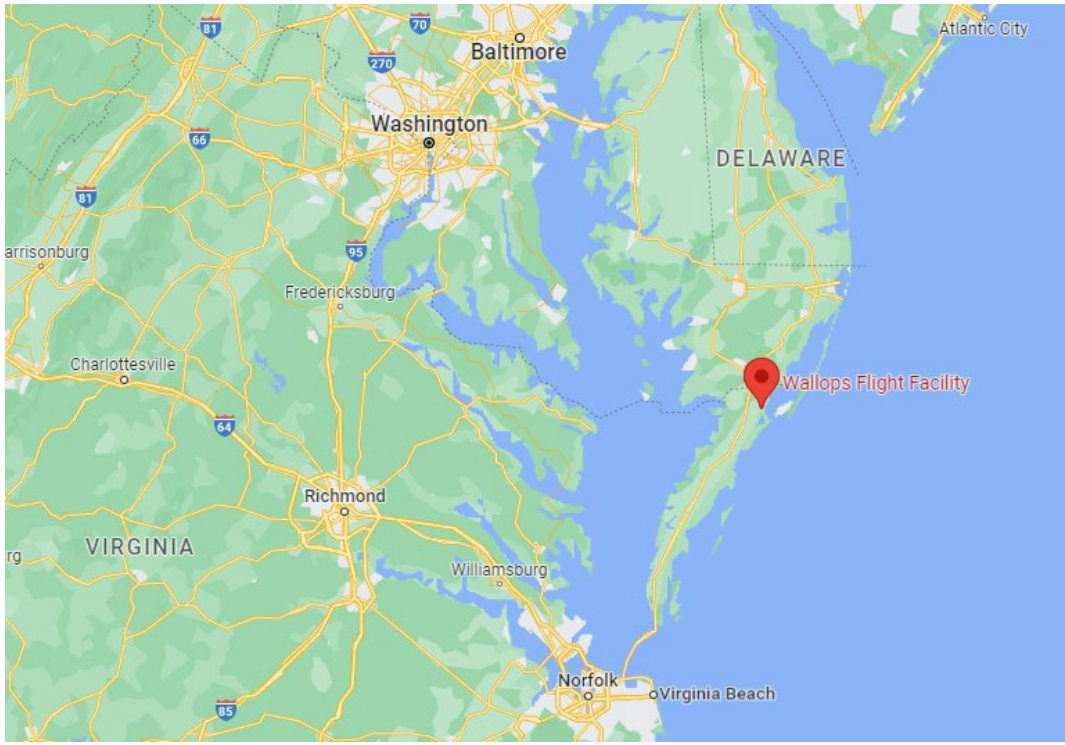
09/27/2022



Launch of HASP 19 in 2019 from Ft. Sumner NM USA

Balloon Program Office

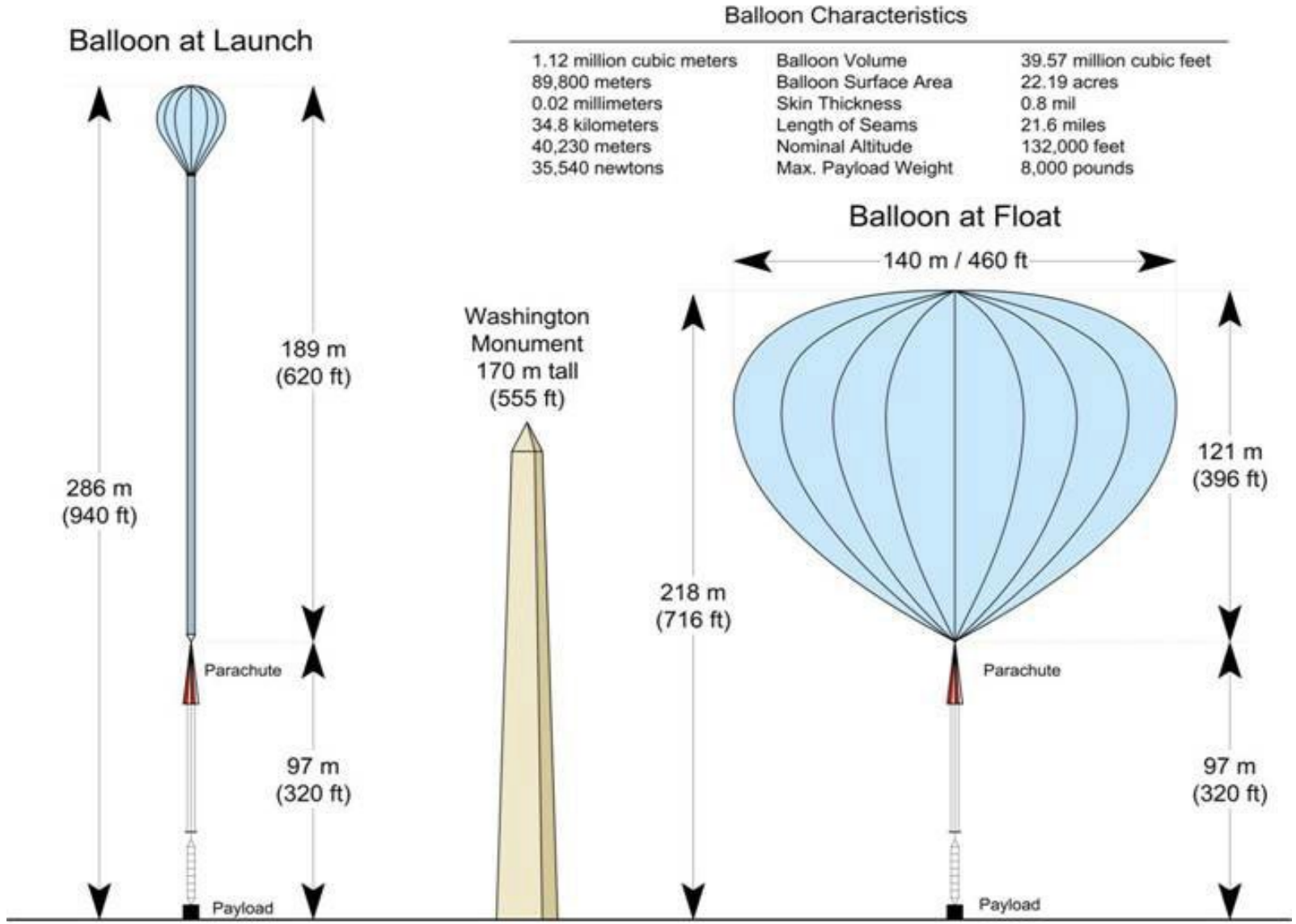
- *NASA's Balloon Program Office is managed by Goddard Space Flight Center (GSFC) out of Wallops Flight Facility (WFF).*
- *Launch 10-20 scientific balloon missions every year from all over the world, including:*
  - *CONUS (Texas, New Mexico)*
  - *Long Duration Balloon (Sweden, Antarctica)*
  - *Ultra Long Duration Balloon (New Zealand)*
- *Two types of balloons*
  - *Zero Pressure Balloon*
    - *Helium lift gas, open at the base, limited by diurnal cycles due to venting lift gas*
  - *Super Pressure Balloon*
    - *Helium lift gas, closed volume, good altitude stability over diurnal cycles, longer duration*



Map screenshot showing Wallops relative to other well-known locations.

Balloon sizes

- *These balloons are large*
  - *Volumes range from 1 mcf (0.028 mcm) to 60 mcf (1.7 mcm)*
  - *Altitudes from 90 kft (27.4 km) to 160 kft (48.7 km)*
  - *Payload weight from ~500 lbs (227 kg) to 8000 lbs (3629 kg)*
- *Payloads are designed, delivered by scientists*
  - *Telescopes, particle physics, coronagraphs, etc.*



Comparison of a 39mcf balloon during launch and inflation to the Washington Monument.

Data collection – the issue

- *Upcoming missions are proposing to collect **A LOT** of science data during flight.*
  - *100 TB of data is prohibitively large to telemeter, especially in over-the-horizon mode.*
  - *Mitigate the risk: loss of the balloon or experiment can imply loss of data for science*
- *Science teams are requesting alternate methods for data retrieval*
  - *Common idea: drop data "vaults" from the balloon during flight.*
  - *Periodic data recovery, analysis during an LDB/ULDB mission.*
- *This type of system is coming.*
  - ***It is a question of when, not a question of if.***
  - *BPO wants to get out ahead of the need and be proactive in the design, development, testing, and implementation of such a system.*

Layout of a ZPB prior to launch in Antarctica.

Challenge overview

- *FLOATing DRAGON: Formulate, Lift, Observe, And Testing; Data Recovery And Guided Onboard Node*
  - ***Goal: to design and prototype ideas for data vault recovery systems.***
  - *Desire: a guided system which can "gracefully fall" to a pre-determined,* ***safe*** *waypoint for recovery by a ground team.*
  - *https://floatingdragon.nianet.org/*
- *Student groups have heritage flying on balloons*
  - *Cubes in space, HASP fly routinely for CONUS mission*

An image of Cubes In Space above Ft. Sumner, NM.


HASP pre-launch in Ft. Sumner, NM.

CONOPS – always fly with safety in mind

- *Issue a challenge to college student teams*
  - *Groups propose, WFF down-selects to four based on design, performance, creativity, etc.*
  - *Review team will include a collaboration between BPO, ETD, and Wallops Safety.*
  - *Prototypes have both deployer and node for flight.*
- *Deployer*
  - *Mounts to a HASP-type gondola, receives a signal from CSBF to drop node. Houses all supporting hardware.*
- *Node*
  - *Released from the deployer with data vault.*
  - *Autonomously selects waypoint, travels to the ground.*
- *In flight, teams have 1-hour post-float to release their node*
  - *We (BPO/CSBF) provide trajectory predict and sounding file, they tell us when to drop*
  - ***Waypoints are predetermined and approved by Flight Safety***

Schedule – organized around the school year

- ***10/20/2022 PDR:*** ***Preliminary Design Review and review package***
- *01/08/2022 CDR:* *Conceptual Design Review and review package*
- *01/30/2023:* *WFF will down-select to four teams, construction begins*
- *05/18/2023 SDR‡:* *Software Design Review and review package*
- *07/02/2023 MRR:* *Mission Readiness Review and review package*
- *08/15/2023 INT:* *Integration and Testing at Ft. Sumner, NM*
- ***10/16/2023:*** ***Flight complete, data returned to students***
- *12/03/2023:* *Closeout and final report with experimental results*

‡SDR requires a demonstration of 95% confidence in finding best waypoint subject to real, WFF-provided balloon trajectories.

Requirements – given as design requirements

Deliverables:	**1x deployment subsystem, 1x node**
1. Weight:	10 kg (22 lbs) or less, total system mass
2. Shock:	Survive 10g shock or higher without yielding, both subsystems
3. Environment:	-70C to +65C, -30C nominal at 33.5 km (120 kft)
4. Dimensions:	Deployment subsystem must fit within 120 cm x 45 cm x 45 cm and house the node subsystem until deployment
5. Payload:	1x data vault, 12.5mm x 75mm x 100mm, 1 kg
6. Deployment:	Deploy when receiving 5-28 VDC from the gondola via pigtails, must deploy within five minutes of receiving signal.
7. Mounting:	Mount vertically to 2” Aluminum ‘L’ channel with 3x ¼-20 bolts on 100mm (~4-inch) spacing
8. Descent time:	1.5 hours or shorter
9. Accuracy:	Land within 0.25 km (820 ft) radius of the targeted coordinate
10. Communications:	If using a computer or microcontroller, one physical point of communication (e.g. USB port, Ethernet port, etc.) required on the outside of the deployment subsystem to verify operation post compatibility test.
11. Safety:	Must fail safe in the event of loss of power (to the system) **Must retain the node in the event of a failure to drop** (i.e. an attempted deployment of the node which results in the node staying attached to the deployer).
12. Prohibited items:	Thrusters, rocket motors, liquid propellants and rocket engines (i.e. no SpaceX-style or JPL sky-hook landing systems), compressed gasses (i.e. no balloons or blimps attached to the node), high-voltage sources, excessively large magnets (electromagnetic or otherwise), batteries without UL certification, or deployable objects from the node (e.g. cut lose a parachute).

13. Compliance:	• Structure
	  ○ **Must comply with the Gondola Structural Design Requirements** PG (820-PG-8700.0.1) design requirements for piggybacks (MOOs), see https://www.csbf.nasa.gov/docs.html.
	• Software
	  ○ **Must demonstrate the ability to autonomously find and guide to the selected waypoint** for simulated balloon trajectories and wind profiles (provided to the team) with >95% confidence (see SDR).

Trident TRIG trackers

- *Iridium-enabled GPS trackers*
  - *Receive GPS position, velocity and transmits at a periodic interval via Iridium network*
- *GOAL: To provide a "NASA standard" tracking capabilities for recovery operations.*
  - *Also serves as a redundant GPS dataset in the event science has a GPS failure*
  - *Utilized by SRPO for water recovery items for several years*
    - *Modification with pin used to trigger AutoStart during the descent case*
- *Plan to purchase 2-3 units for initial verification (with CSBF)*
  - *One unit will be sent to each student group to confirm no interference with the student-provided instrumentation*

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Challenge Questions

TECHNICAL QUESTIONS

- **TQ1: The guidelines prohibit excessively large magnets. What is the threshold for when a magnet/electromagnet become excessively large? Would a generic DC electric motor of 40x30mm exceed that threshold?**
- TA1: The threshold is a magnet (or collection of magnets, permanent or otherwise) with a total combined field strength of 0.01 Tesla or greater (about 10 fridge magnets). The justification for the rule is to prevent any interference with other systems on the gondola. A generic DC motor of the stated size would be considered acceptable as the magnetic field is expected to be small (and the primary use is as a motor, not a magnet).

- **TQ2: Under the prohibited items - "Excessively" is a relatively vague term describing magnets - is it describing the force due to the magnet, or the overall size of the magnet?**
- TA2: No magnets with a field strength over 2 teslas will be allowed.

TECHNICAL QUESTIONS

- **TQ3: Designs are required to "be able to survive a 10g shock or higher without yielding". What is the upper limit that the node and deployment system should be designed to survive?**
- TA3: 10g is the upper limit.

- **TQ4: Is there a specific orientation the allotted space should be in or is that up to the teams to decide?**
- TA4: The long axis of the deployer shall be vertically oriented. The node must egress from the deployer on the lower surface facing the ground.

- **TQ5: Will the node system be required to qualify for the FAA Beyond Visual Line of Sight Waiver (BVLOS)?**
- TA5: Individual teams will not be required to coordinate with the FAA.

TECHNICAL QUESTIONS

- **TQ6: If (and how, and when) will predicted balloon trajectory be given to the teams prior to flight? What is the typical accuracy and resolution of that information?**
- TA6: NASA will provide a standard Launch Day – 1 trajectory used for safety analysis. The trajectory will be accurate +/- 10 km.

- **TQ7: How will real-time balloon location be given to the team, in order to time release of the payload? What is the latency on that information?**
- TA7: Real-time balloon location will be provided via the standard CSBF-website interface. Latency will be on the order of 10 seconds.

TECHNICAL QUESTIONS

- **TQ8: If (and how, and when) will wind data (speed and direction by altitude) be given to the teams prior to flight? What is the typical accuracy and resolution of that information?**
- TA8: Wind speed and direction as a function of altitude will be provided during the L-1 flight deliverables as estimated using the Global Forecast System (GFS) from NOAA. The teams are encouraged to also obtain data on a more frequent basis from the GFS (or other similar tools) should it be useful.

- **TQ9: Does the attachment/detachment mechanism need to endure any high winds while in its high-altitude position?**
- TA9: The balloon floats with the ambient wind at altitude. There should be little to no relative wind at altitude while attached to the balloon gondola.

TECHNICAL QUESTIONS

- **TQ10: Will more information be given about the dimensions of the items in the standardized equipment and hardware package? Similar question: Can we get Solidworks or similar definition files for the Data Vault? Similar question: Is there a data sheet/ CAD model for the data vault that is accessible by teams? If yes, when will we receive a CAD or mechanical drawing of the data vault?**
- TA11: Dimensioned drawings will be made available for the data vault and mounting system by October x

- **TQ12: Are there drawings for the mounting system? (FLOATing DRAGON Requirement 8).**
- TA12: Dimensioned drawings will be made available for the data vault and mounting system by October x

TECHNICAL QUESTIONS

- **TQ13: Will modifying a UL compliant battery cell to create a multi-cell battery disqualify its UL compliance?**
- TA13: Yes.

- **TQ14: Does the weight limit include the payload?**
- TA14: The node weight limit does not include NASA provided payload data vault

- **TQ15: Are there weight limits on individual subsystems?**
- TA15: No.

TECHNICAL QUESTIONS

- **TQ16: What exactly is considered a thruster? Are propellers allowed? And similar question: What does 'no thrusters' mean? Does an electric motor with a prop count as a thruster? Or does this imply something like cold gas propellant or pyrotechnics?**
- TA16: Thrusters are defined as pyrotechnic rocket motors. No pyrotechnics will be allowed

- **TQ17: Is black powder for parachute deployment allowed?**
- TA17: No.

- **TQ18: Can we detach components during the fall?**
- TA18: Components may be released (e.g. canopies, straps, etc.), but all components must stay attached and land with the node (I.e. a chute cannot be cutaway and land separately from a node).

TECHNICAL QUESTIONS

- **TQ19: What is the interface for data transfer between the balloon system and the vault?**
- TA19: There is no interface with the NASA provided payload

- **TQ20: With the drift of the balloon, is the target destination of all landings on land, or are some on sea?**
- TA20: All landings will be ‘feet dry’.

- **TQ21: How will landing site information be relayed? How soon will our team know of the “predetermined” landing site?**
- TA21: Predetermined targets will be provided the day prior based on the trajectory. The targeted landing points will be at a minimum flight distance of 15 km and maximum flight distances less than or equal to 45 km.

TECHNICAL QUESTIONS

- **TQ22: How will the balloon trajectory and wind data be delivered to our team, and relayed to our node?**
- TA22: Via email. Trajectories will be provided in either a csv, kml, or txt format for processing.

- **TQ23: What is the maximum distance between the potential landing points?**
- TA23: To be determined.

- **TQ24: Where is the target in relation to the balloon?**
- TA24: Targets will vary in distance from the balloon trajectory. Students will either need to select the target location prior to flight or have the node select the best target based on location, wind speed data, and commanded release time.

TECHNICAL QUESTIONS

- **TQ25: Can we modify the target area?**
- TA25: No.

- **TQ26: Is there a maximum distance that the target landing point will be from the balloon when we have the authority to drop the node?**
- TA26: There will be a designated release zone with targets located in that zone. The student teams will need to determine when to drop.

- **TQ27: What is the farthest distance in which the designated landing spot will be away from the initial launch coordinates?**
- TA27: To be determined.

TECHNICAL QUESTIONS

- **TQ28: What are the predicted landing conditions for the predetermined landing site? Similar questions: Is the target point in a nominally flat and unobstructed area? Will the landing waypoints be at different altitudes?**
- TA28: The target points will be open, flat areas with minimal objects or obstructions (e.g. a field). All landing altitudes are assumed to be at ground level, but the ground level altitude (above sea level) will vary with terrain. Predicted landing conditions will vary with time of day, season, etc, and should be considered as an unknown.

- **TQ29: Is there a temperature control requirement that we need to implement for the data vault that we are given?**
- TA29: No.

TECHNICAL QUESTIONS

- **TQ30: If there are known icing conditions that our vehicle would have to traverse on the way down, will we still perform the drop or would you drop another day?**
- TA30: All moisture will sublimate during ascent and will not be an issue. Launches will occur on clear days with no rain in the area. There still may be a chance of icing on descent. The student teams will need to determine if any mitigations are warrented.

- **TQ31: Does the gondola frost while at target altitude? If so, how much weight in frost does the gondola gain while at sustained altitude?**
- TA31: All moisture will sublimate during ascent and will not be an issue.

TECHNICAL QUESTIONS

- **TQ32: Does the data vault start out in the gondola or in our vehicle? If in the gondola, how is it to be transferred to our vehicle? If in our vehicle, are there any USB or other cables to disconnect before dropping?**
- TA32: The data vault will be provided to the student teams prior to start of the payload integration.

- **TQ33: Regarding the "GPS tracker" supplied by NASA – is this for NASA's use to monitor our flight or is there a data stream available to us in real-time from that tracker? If data stream is available, is the GPS unlocked to operate up to the balloon's float alt?**
- TA33: Assume that the GPS tracker is not open for use.

TECHNICAL QUESTIONS

- **TQ34: Is atmospheric data concerning the HASP available for temperature/pressure available?**
- TA34: Historic data for prior missions will be provided by October x

- **TQ35: In terms of atmospheric conditions, do we need to consider abnormal environmental hazards (hurricane, tornado, etc.) as a possible environment throughout flight performed by this device?**
- TA35:No.

- **TQ36: Does the attachment/detachment mechanism need to endure any high winds while in its high-altitude position?**
- TA36: The balloon floats with the ambient wind at altitude. There should be little to no relative wind at altitude while attached to the balloon gondola.

TECHNICAL QUESTIONS

- **TQ37: Is there a preferred software that is to be used for the development of an autopiloting feature of the vault?**
- TA37: No preference, but software choice should be justified in the design review package.

- **TQ38: How long is the flight time of the test mission? Battery life?**
- TA38: Total flight duration of the balloon mission will be 4 hours or less. Battery life will be dependent on the anticipated descent time of the student designed system

TECHNICAL QUESTIONS

- **TQ39: Do foldable wings that extend past the deployment dimension constraints fail that said constraint?**
- TA39: The volumetric envelope of the stowed, folded vehicle must be within deployment dimension constraints. Foldable wings that deploy during descent will not violate dimension constraints.

- **TQ40: How far will the vehicle be expected to glide to get to the target zone?**
- TA40: Determined by the student team.

- **TQ41: Will there be any equipment for videography or special coordination supplied to document the test drops or is it all reliant on the group selected?**
- TA41: NASA will capture video of the node deployments for verification of drop.

TECHNICAL QUESTIONS

- **TQ42: Are there any requirements regarding any motor being used?**
- TA42: No.

- **TQ43: Can the node be remotely guided from the ground by an operator?**
- TA42: No, the node must be self-guided through descent.

MISCELLANEOUS QUESTIONS

- **MQ1: Item 9 in "Prohibited Items": what are the specific FAA regulations that you have in mind in this statement?**
- MA1: The items have been determined by NASA as not allowed per our Ground Safety rules.

- **MQ2: Are there any FAA requirements that need to be adhered to?**
- MA2: Individual teams will not be required to coordinate with the FAA see questions TQ5 and TQ43

- **MQ3: Will we be required to comply with Remote ID for FAA compliance?**
- MA3: Individual teams will not be required to coordinate with the FAA see questions TQ5 and TQ43. The node provided will have a transponder built in.

MISCELLANEOUS QUESTIONS

- **MQ4: Item 11 in "Requirements and Constraints": Can you spell out what you mean by "verify operation post compatibility test"?**
- MA4: During NASA operations prior to flight, all missions conduct a Compatibility Test. This is an end-to-end test of all systems on a given balloon mission. This requirement states that there must be a point of access for the student team once the mission is fully integrated onto the gondola. Once the mission has gone through compatibility, students will not be able to remove or modify their systems.

- **MQ5: Is there any example of premature mission failure from the gondola or balloon?**
- MA5: There have been premature failures of balloon missions in the past. Most failures involve the mission being terminated prior to the target duration.

MISCELLANEOUS QUESTIONS

- **MQ6: Is there a certain kind of imaging documentation that you seek in this project for those selected, if applicable? (Video log, photo album, etc.)**
- MA6: Students are expected to provide a technical report and poster. Pictures and video are greatly encouraged.

- **MQ7: What is the overall budget for the program?**
- MA7: There is no budget cap but the winning teams will receive $5,000 and the standard hardware.

MISCELLANEOUS QUESTIONS

- **MQ8: Can the team gain funding from other sponsored sources for the development of the deliverables?**
- MQ8: Absolutely! Under "Eligibility," the Challenge Guidelines state: "*Teams may enlist the support of industry in the form of mentorship, access to facilities, donation of in-kind materials, and/or sponsorship, so long as the core prototype and concept is a product of the university.*" This extends to any type of fundraising.

- **MQ9: Is there a certain range that the system needs to stay in while it is in the air?**
- MA9: No.

MISCELLANEOUS QUESTIONS

- **MQ10: At what height does GPS turn on and become available to use, or will it be available at any altitude?**
- MA10: The balloon mission will have its own onboard GPS that can be provided, but the student provided nodes will need to be self-sufficient.

PROGRAMMATIC REMARKS (NIA)

- **At a minimum, teams must contain one (1) faculty advisor** at an accredited U.S.-based academic institution, **and two (2) students from that institution** who work on the project and are able to participate in the on-site testing activities in Ft. Sumner, NM in August 2023.

- There is no limit to the number of participants on each team, however, **a maximum of four (4) students and one (1) advisor can attend the on-site testing activities in Ft. Sumner, NM.**

- **Change Made 8/2/22:** Students attending foreign universities can participate ***only*** as team-members/collaborators with a U.S.-led collegiate team. The U.S. team's primary advisor and student team lead will be the main point-of-contact between the joint team and FLOATing DRAGON staff. All foreign partnering universities must have a faculty advisor whose role is to facilitate the relationship between the U.S.-based university and the international university.
  - Please note that due to prohibitive restrictions and ever-changing security regulations, **foreign nationals will not be able to attend the on-site activities at Ft. Sumner, NM.** There will be no exceptions to this policy.

PROGRAMMATIC REMARKS cont'd…

- One faculty advisor is **required** to attend the on-site testing activities in Ft. Sumner with each team and is a condition for acceptance into the FLOATing DRAGON Balloon Challenge. Teams who do not have a faculty advisor present during the testing will be disqualified from competing and stipends will be subject to return to NIA.

Next Deadline

Preliminary Design Review (PDR) Submission Deadline
(Oct. 20, 2022)

Teams Receive PDR Feedback
(Nov. 7, 2022)

Conceptual Design Review (CDR) Package Submission Deadline
(Jan. 8, 2023)

Selection Announcements are made
(Jan. 30, 2023)

Challenge Guidelines PDF

EXISTING RESOURCES

Visit the FLOATing DRAGON FAQs page for the following resources:

- **April 29, 2022**
  - Q&A Session Recording
  - Q&A Session Summary Document
  - Q&A Session Presentation Slides

- This Q&A Session and associated documents will be posted on the FAQs for future use.

https://floatingdragon.nianet.org/faqs

QUESTIONS?

1. Raise hand in WebEx to ask verbally.
   - You will be called on to pose your question.
   - If possible, please turn on your camera while speaking.

OR

2. Type questions into the chat.
   - The host will pose questions to sponsors during the call.

FUTURE QUESTIONS?

PLEASE SEND ALL FUTURE QUESTIONS TO:

robin.ford@nianet.org

Each question will be responded to directly, as well as posted on the website for everyone to see.

We encourage you to visit the website frequently for updates:
https://floatingdragon.nianet.org

View the complete
FLOATing DRAGON Balloon Challenge Guidelines PDF