NIST Civil Infrastructure Showcase

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Overview of TIP Project

Project Abstract

- CyPhy Works and Georgia Institute of Technology will develop the novel technologies that will enable the creation of a small, hovering, Unmanned Air Vehicle (UAV) for inspection and monitoring of civil infrastructure. The proposed research will break new ground in the areas of UAV stabilization in natural environments, flight control in wind, and power systems. These new UAV capabilities will enable two new paradigms in the civil infrastructure domain: Robotic Assisted Inspection (RAI) and Autonomous Robotic Monitoring (ARM).

- RAI envision a UAV inspection tool that inspectors can use to perform consistent, repeatable, thorough, frequent, fully documented inspections, which will in turn lead to more effective prioritization of maintenance and repairs. RAI will expedite infrastructure inspections because it will not require the setup of snooper trucks or climbing harnesses and will save money by eliminating direct costs associated with infrastructure inspections, as well as the indirect costs incurred as a result of lane closures. Safety will improve for inspectors because they will not have to place themselves in precarious locations clinging to bridges and dams.

- ARM envisions an installed insitu civil infrastructure monitoring system. ARM will monitor our civil infrastructure without the need for an inspector onsite. This capability is critically needed bridges and dams rated as substandard to warn of impending catastrophic failure. ARM requires the technologies developed for RAI, but has even higher risks and rewards associated with it.

Project Organization

- Stage A – Flight in Real World Conditions
- Stage B – Robotic Assisted Inspection
- Stage C – Automated Inspection Robot

Requirements For UAV Inspections

- System must be:
  - Small
  - Light
  - Safe
  - Operate in tight spaces
  - Deliver Great images
  - Long Flight Duration
  - Reliable Comms
  - Easy to use

Ducted Fan

Microfilament

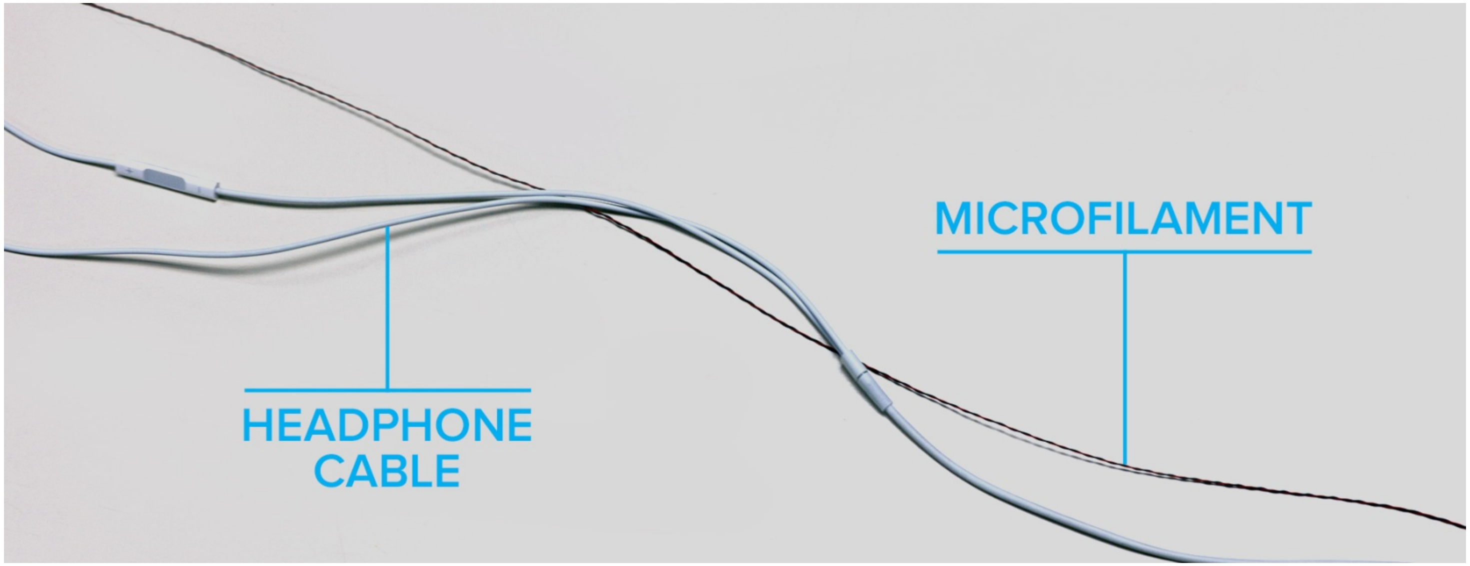
Hard Work

Problems to Solve

- Long flight durations
  - Need plenty of time to do the inspection
- Reliable communications
  - Need clear images and assurance of maintaining control of the system
- Electronics packaging and materials
  - Strength to weight ratio more critical than ever
- Navigation and orientation near bridges
  - GPS is occluded by the structure
  - Magnetometers are thrown off by steel in the structure
- Control system for close proximity
  - Winds, turbulence, and recirculating air

Microfilament

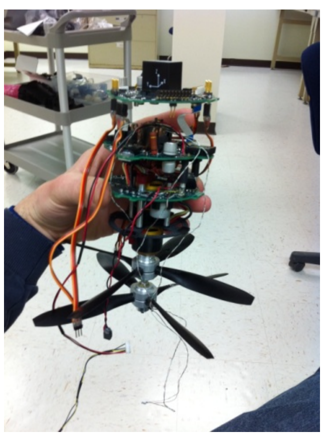
- Supplies energy from the base station
  - Provides virtually unlimited flight time
- Clean, clear, consistent, full frame rate, HD video signal
  - DVD quality video and hi-res stills for great data
- Reliable command and control of vehicle



Packaging and Materials

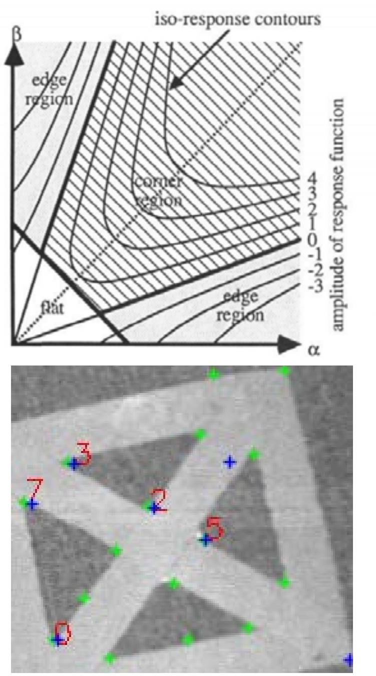
- Weight restrictions drove an “exoskeleton” approach
- Strength requirements drove use of (then) exotic Thermoplastic Carbon Fiber material

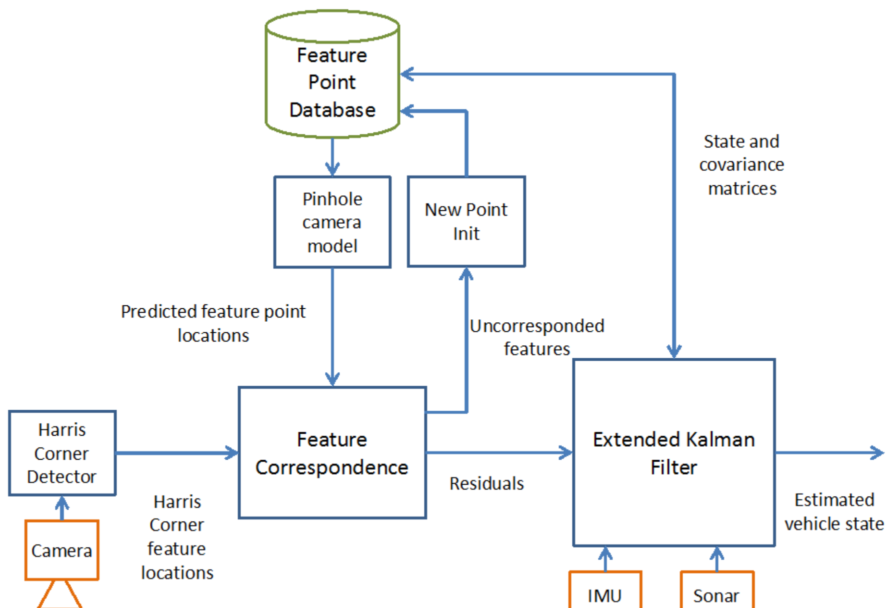


Machine Vision Stabilization

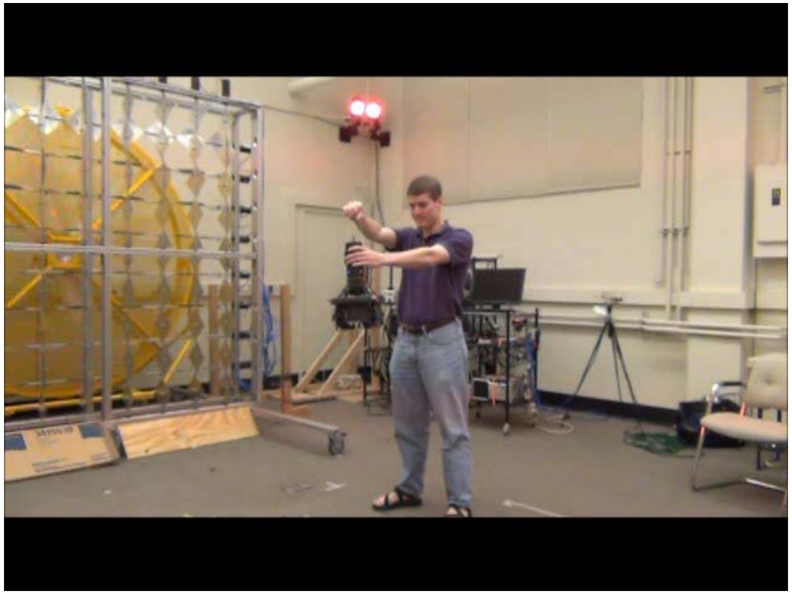
- Inner stabilization loop uses IMU; sensor drift is bounded by machine vision algorithms
- Feature Point recognition and Optical Flow algorithms feed into Kalman filter





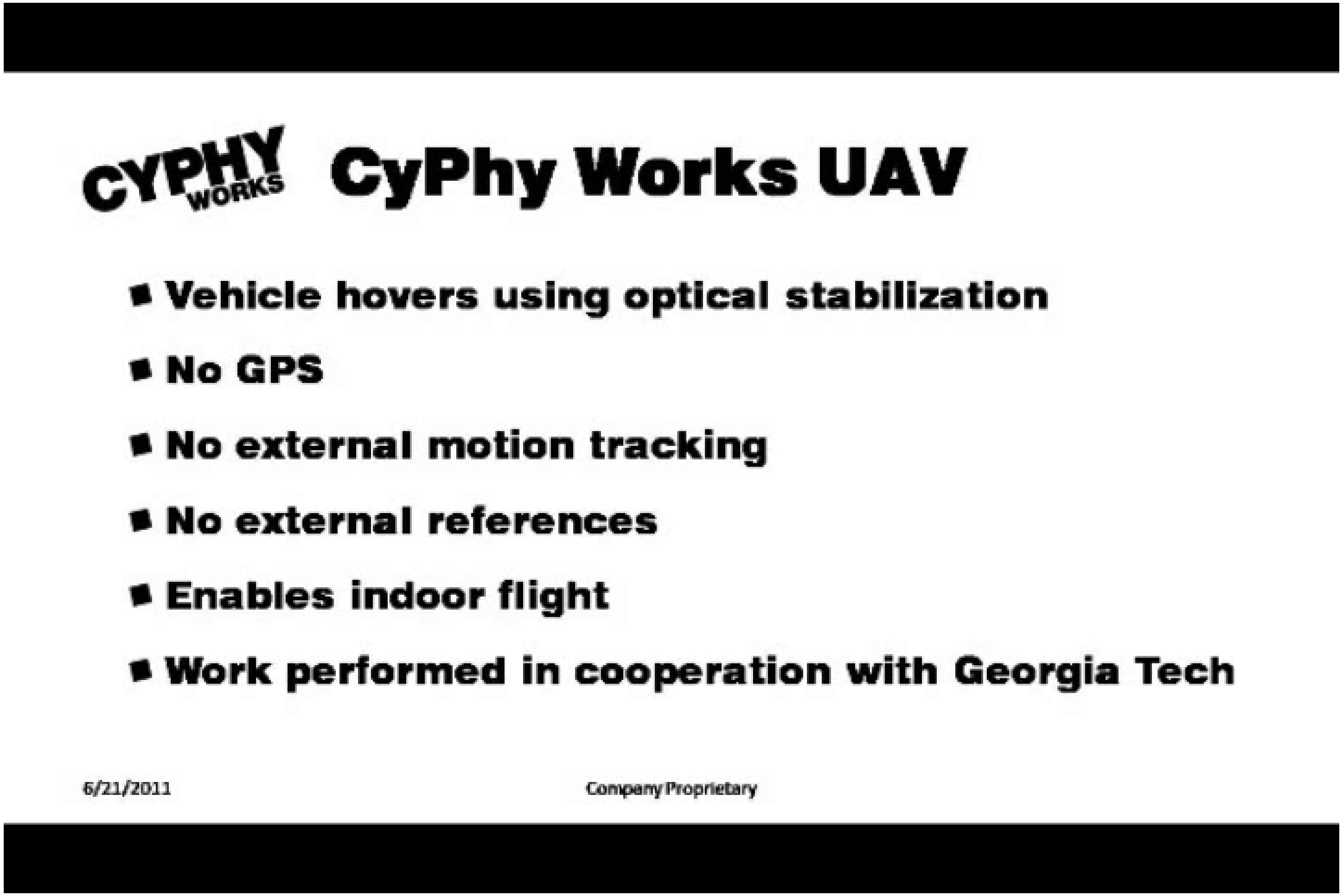
Advanced Control System

- Developed adaptive non-linear controller
- Extensive testing in confined spaces
- Extensive testing in wind simulations



Advanced Control System

- Tested aggressive movements in open space

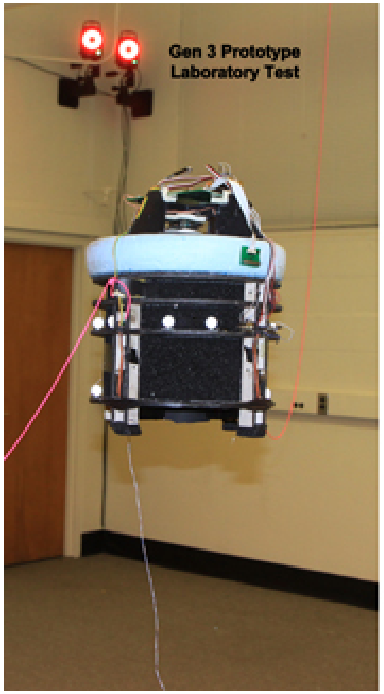


Built Indoor Test Facilities

- Modeled after 93 FAST 14 Rapid Bridge Replacement Project

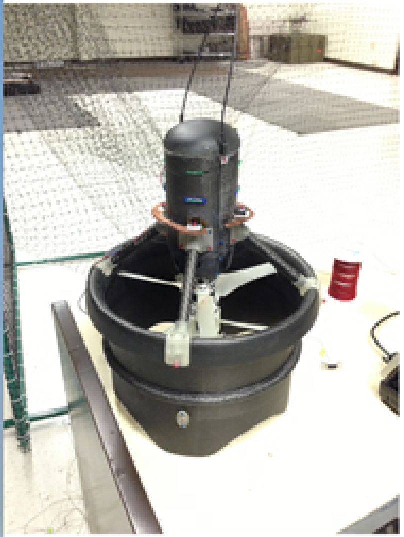
Tested Inspection Scenarios

EASE Airframe Development

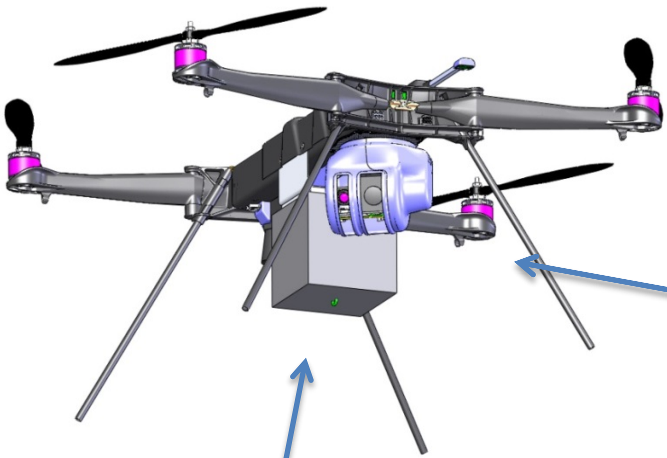


Gen 4 Prototype
Laboratory Test

EP2 Prototype
Laboratory Test



PARC - Surrogate Vehicle



Imaging Payload

- Pan/Tilt/Zoom Camera Gimbal

Fuselage

- Graphite composite w/ Plastic rain-cover

Customer Payload

- Data and Power Connector provided

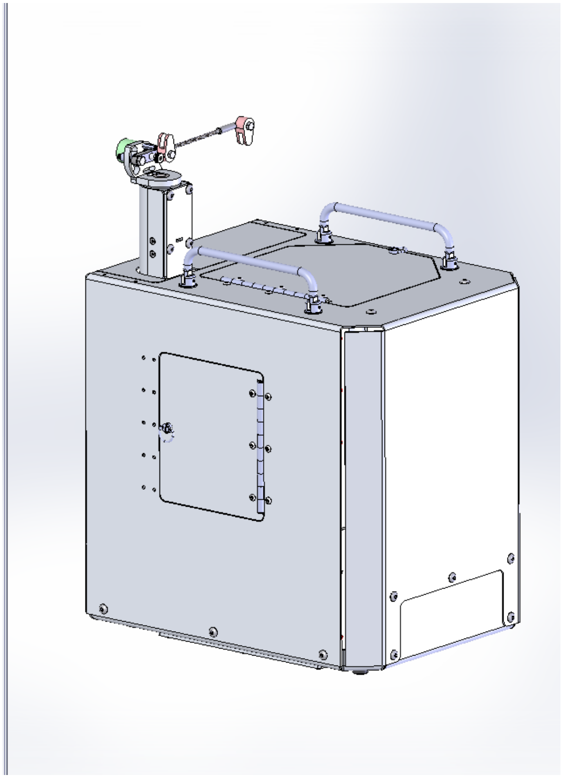
Struts

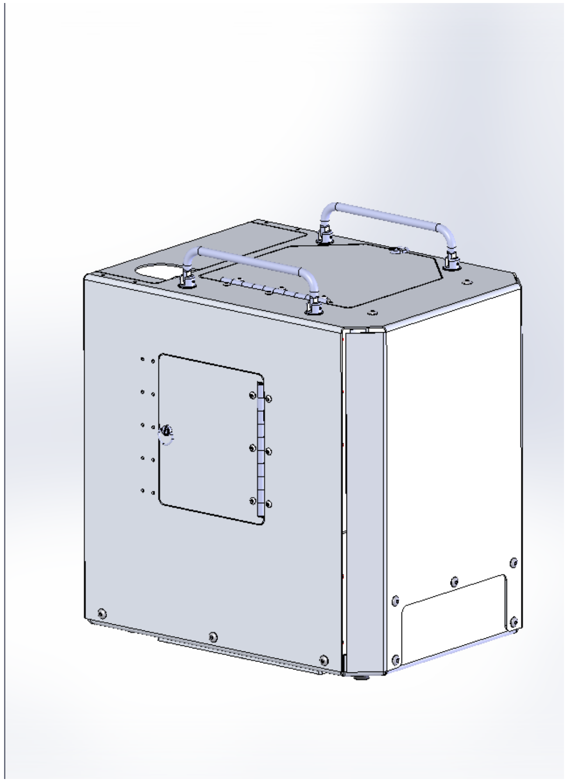
- Foldable
- Easily / Rapid Replacement

CYPHY WORKS

Microfilament Management

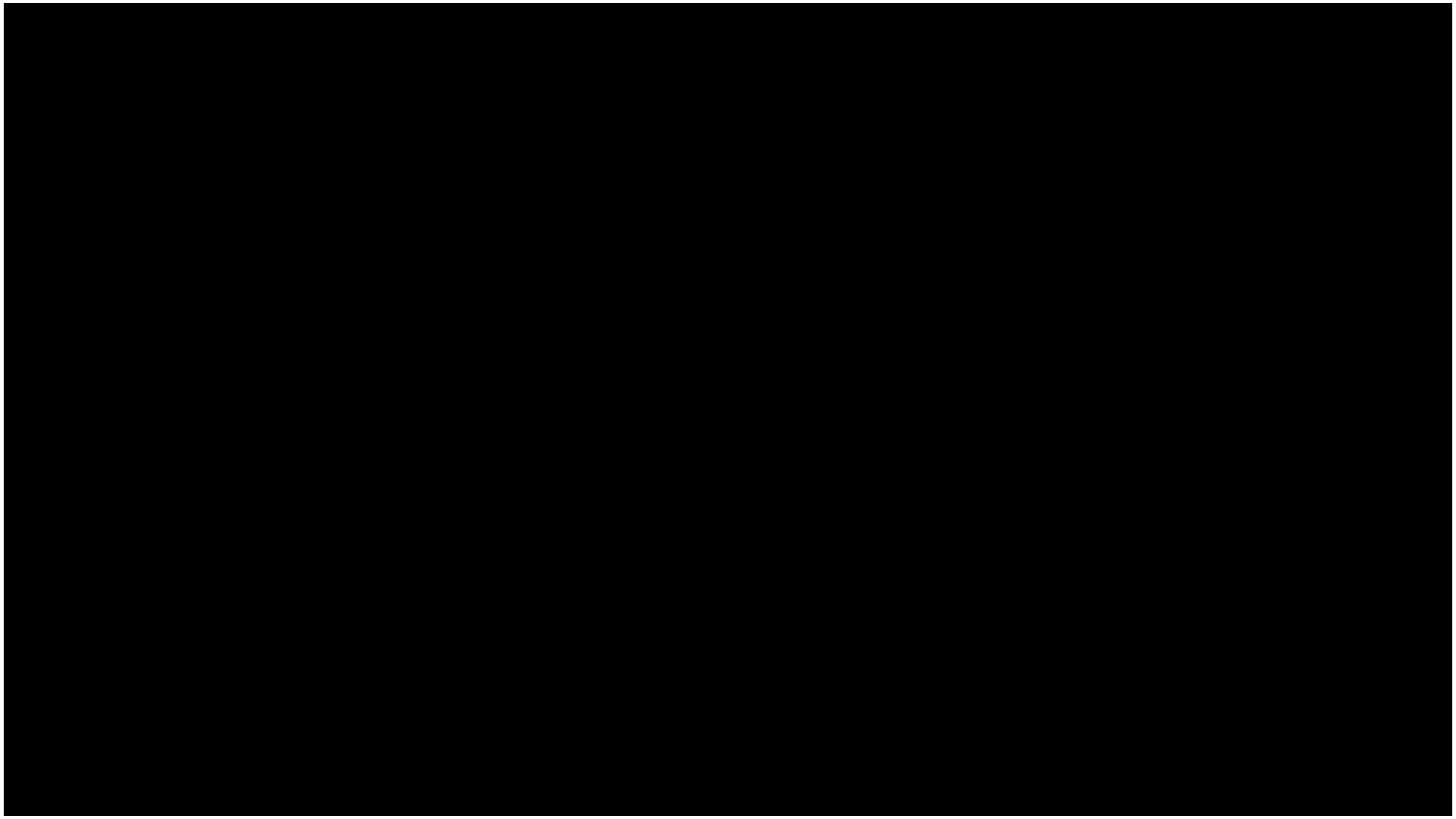
- Weight: ~25 lbs
- Dimensions: 13.5” x 13.5” x 10”





PARC System In Action With Spooler

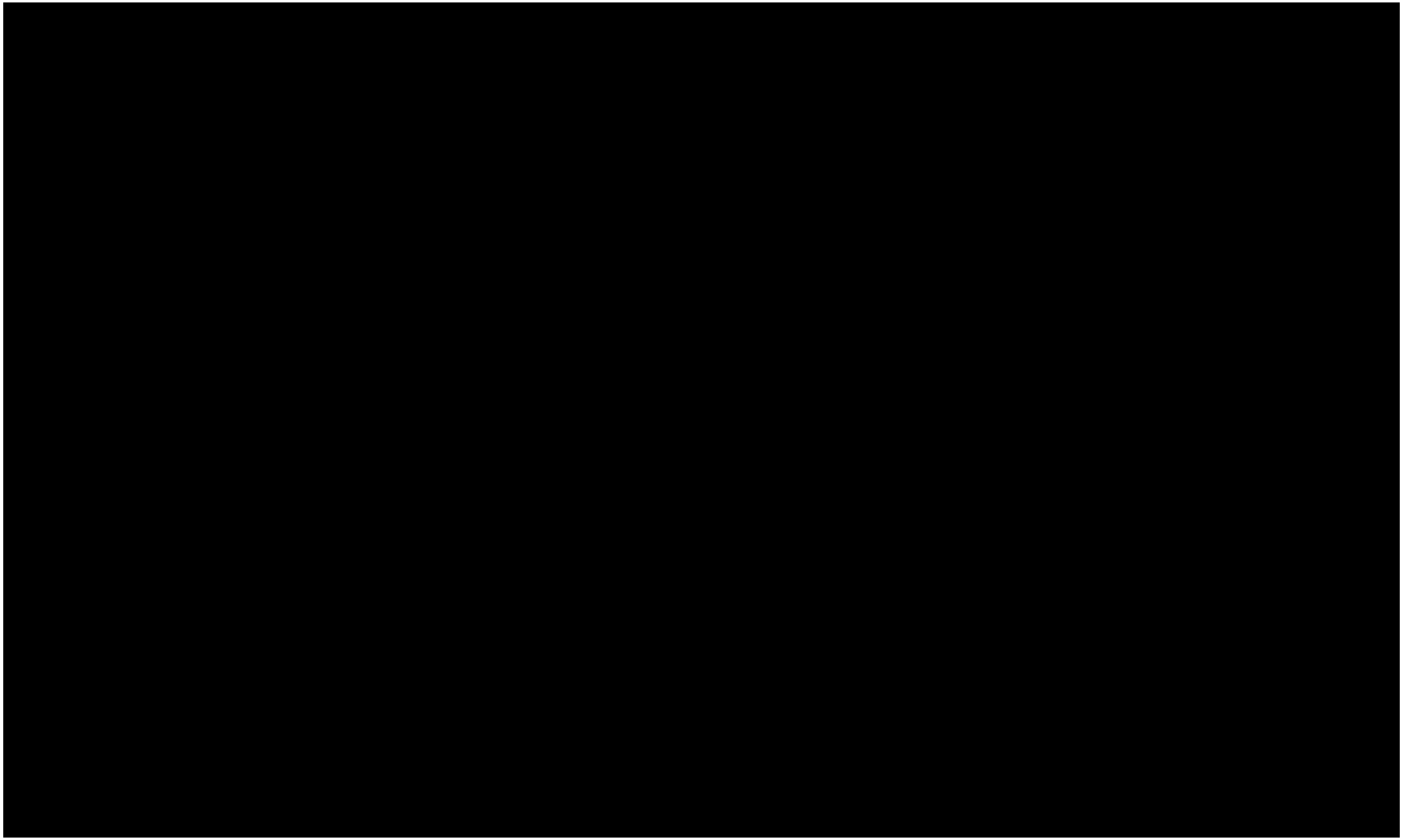
- PARC system test



Latest PARC System

- PARC Version C

PARC Test Flight



Questions