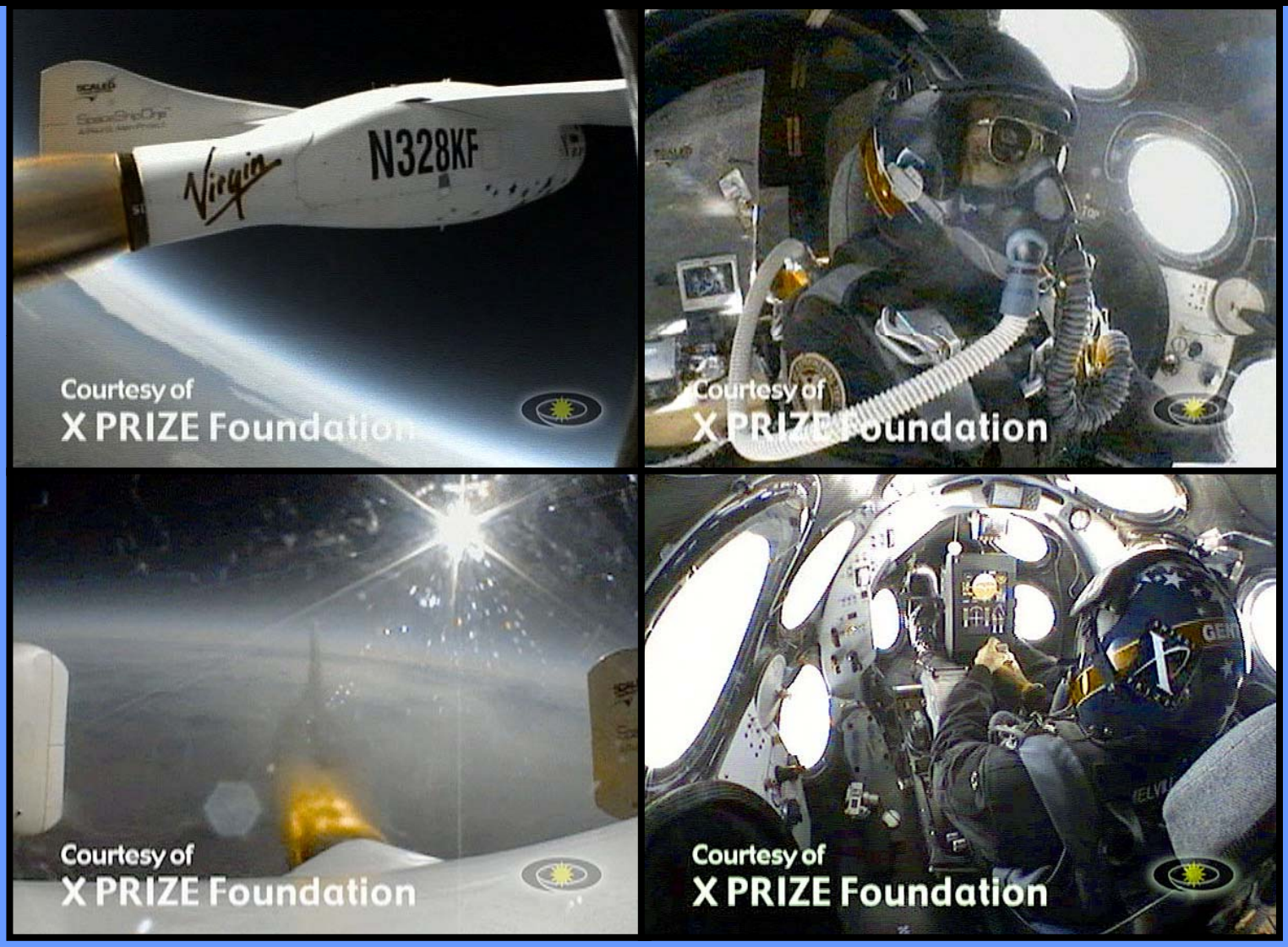
Employing Onboard Video For Enhancing Suborbital Research

Rex Ridenoure, CEO
Ecliptic Enterprises Corp.

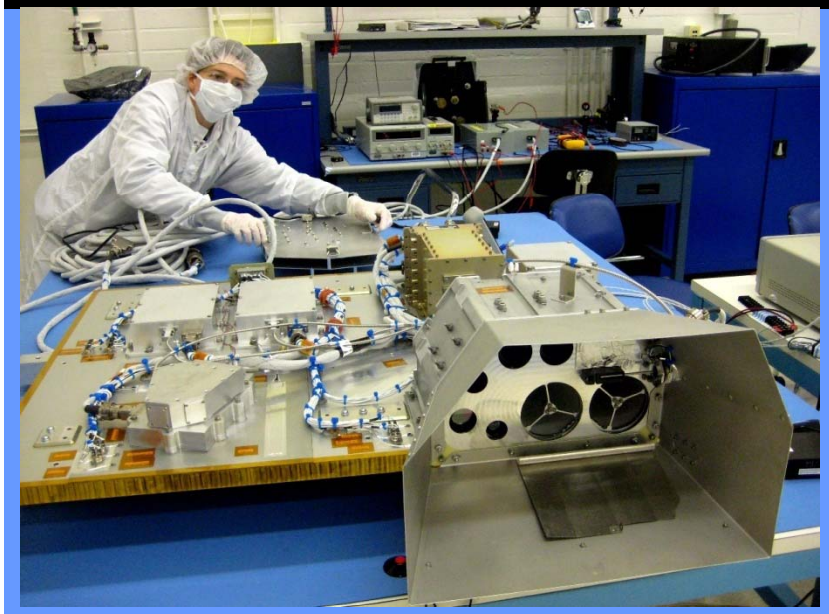
Next-Gen Suborbital Researchers Conference
Boulder, CO 2010 Feb 18-20

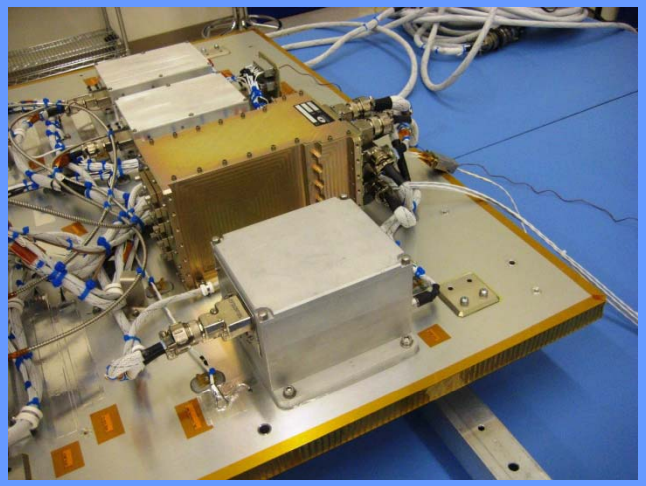
Situational Awareness

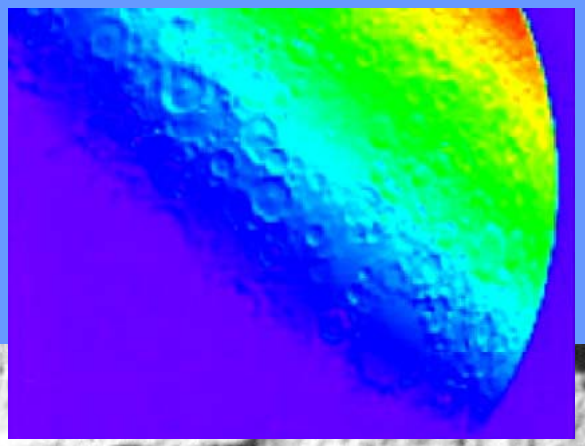
SpaceShipOne

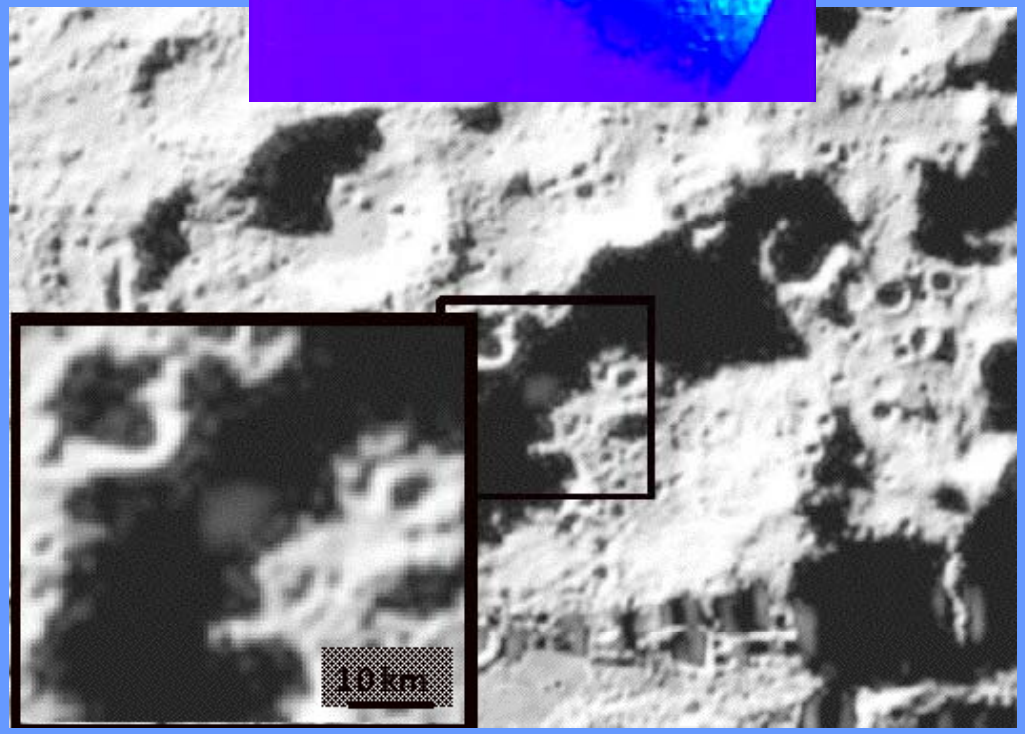


NASA's *LCROSS* Lunar Impactor

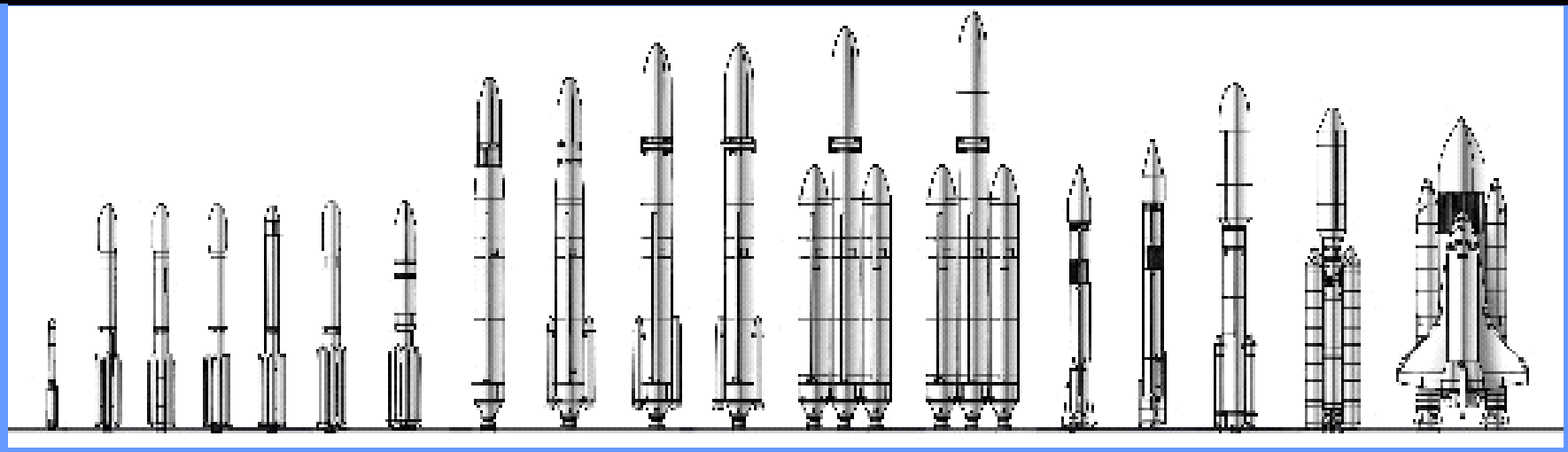






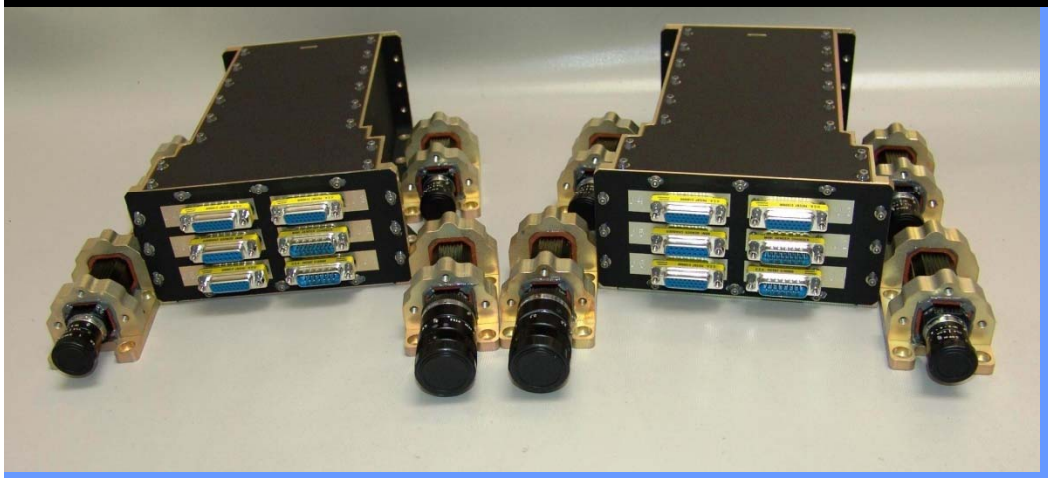


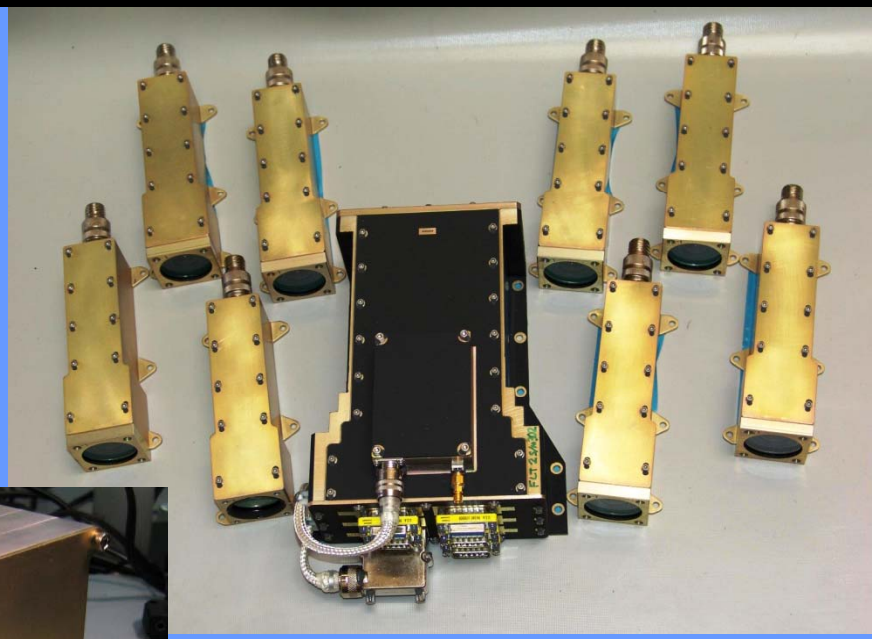
Broad Acceptance

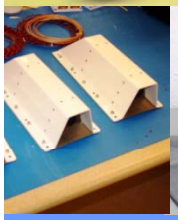


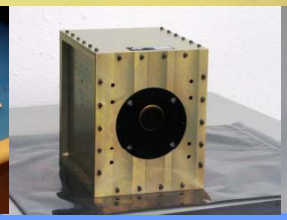
82 RocketCam systems launched: 77 rockets; 5 spacecraft
All successful
A launch ~every 4-6 weeks

Many Options









Key Questions

- Why video?
- Who provides capability?
- Who controls equipment?
- Which sensors needed?
- Data handling?
- Architecture?
- Programmatics?

Why Video?

- Document events
- Provide situational awareness
- Understand technology
- Capture phenomenology
- Support mission debriefings and training
- Provide stakeholder benefit
- Support marketing and business development
- Support media relations
- Facilitate serendipitous occurrences
- Support regulatory, legal and insurance requirements

$200,000/20 min = $10,000/min…or >$150/sec!

Provider(s)

- **Host platform?**
  - Inside, outside, both?
- **Researcher?**
  - Inside, outside, both?
  - Integral to equipment or separate?
  - Any shared resources (between researchers)?
- **Both?**
  - Any shared resources (between host and researchers)?
- **Interfaces?**

Control

- **If provided by host:**
  - Flight crew?
  - Onboard researchers?
  - Autonomy…or semi-autonomy (event-driven)?
  - Mission controllers or ground crew?
- **If provided by researchers:**
  - Flight crew?
  - Onboard researchers?
  - Autonomy/semi-autonomy?
  - Mission controllers or ground crew?
- **Operational constraints**

Sensor(s)

- Type(s) of camera(s)?
- Number of each?
- Placement? Fixed or movable?
- Ruggedness of each?
- Lenses (fields of view)?
- Optical treatments?
- Lights?
- Displays?
- Supporting engineering data?

Data Handling

- Recorded or live feeds? Or Both?
- How many simultaneous feeds?
- Camera switching?
- Memory management?
- Playback and/or editing?
- Transmit frequencies and bandwidth?
- Required receive assets?
- Display requirements?

Video Data Volume

	30 fps NTSC	30 fps HD (1080p)	HD / NTSC
Sensor Array	720 x 480 pixels	1920 x 1080	~6
Image Size	~0.35 Mpixels	~2 Mpixels	
Poor	2 Mb/s	12 Mb/s	
Moderate	4 Mb/s	24Mb/s	
High	8 Mb/s	48 Mb/s	
Visually Lossless	>10 Mb/s	>60 Mb/s	

- **Compression techniques:**
  - **Plan carefully!**
  - **Throw out frames**
  - **Compress individual frames**
  - **Transmit in lower quality; store in higher quality**

Architecture

- **Centralized or distributed?**
- **Single or recurring use?**
- **Fixed or variable platforms (or equipment)?**
- **Degree of integration with host?**
  - Esp. power and data
- **Scalability and adaptability?**
- **Technology evolution?**
- **Testability?**
- **Modularity and maintainability?**
- **Use of standards?**

Standards

- **Why not!!**
- **Camera bodies and lenses already standardized**
- **Camera-to-data handling system interfaces are key**

Type	Max. Rate	Cable	Image Format	FPGA/IP Core?
NTSC	<10 Mb/s	>50 m	Analog/Fixed	No
RS422	<40 Mb/s	<10 m	Digital/Custom	No
USB2	<500 Mb/s	<5 m	Digital/Fixed	Yes
LVDS	<700 Mb/s	<10 m	Digital/Custom	No
FireWire	~800 Mb/s	<5 m	Digital/Fixed	Yes
Gig-E	~1 Gb/s	<100 m	Digital/Fixed	Yes
CameraLink	~2 Gb/s	Very thick	Digital/Fixed	Yes

Programmatics

- **Cost (non-recurring and recurring)?**
- **Heritage?**
- **Procurement timeline?**
  - Qual/Testbed vs. flight vs. flight spare units
- **Integration timeline?**
- **IP protection?**
- **Licensing, policy or ITAR issues?**

Current Trends

- **Need**
  - Desirable → required
- **Cameras**
  - NTSC, manual → HD, feature-rich
  - Smaller, lighter, cheaper
  - Multi-spectral sensors
- **Data handling**
  - JPEG2000 and MPEG-4 compression
  - Plug-and-play interfaces
  - Improved workflow and editing tools
  - Web-ready applications

Summary

- **“A video is worth a million words…”**
- **Identify needs, then think hard about architecture and operations**
  - Involve platform operators and researchers
  - Build in options and flexibility
- **Assume sensors will continue to evolve rapidly**
  - Standards less so
- **Assume memory/storage issues will diminish over time**
  - For now, compression is your friend!

What Do You Want?