The CubeSat Role in new Science and Commercial Applications

Utah CubeSat Workshop
Logan, Utah

August 10, 2008

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Overview

1. Change in PicoSat Attitude
2. Who is now looking at CubeSats?
3. Acceptance of lost launch space
4. Where do we go from here?
5. Doing outreach for the future.

1. Change in PicoSat Attitude

- CubeSat now had credibility beyond the classroom

- Accepted as a low cost way to get to space

- Seen as viable even in the small size

- Users now thinking small payloads

2. Who is now looking at CubeSats

- Other organizations recognize – not a toy

- Can do a lot of space testing at low cost

- National Science Foundation – Space Weather

- National Reconnaissance Organization – Testing new applications

- US Army – looking a new concepts

- NASA & DARPA considering CubeSats

3. Acceptance of lost launch space

- Recognize that there is almost always excess payload capacity on launches

- Mandating acceptance of secondary's by primary payloads owners

- Designing to standards to carry secondary payloads

- Recognition of need to get young engineers hands-on experience

Contract Mission Performance Summary

Mission	ILC	Final Orbit (MECO 2)	Atlas 401 Margin			Atlas 411 with a 500 lb Secondary Payload		
			Performance Margin (kg)	Performance Margin (lb)	Delta-V (feet / second)	Performance Margin (kg)	Performance Margin (lb)	Delta-V (feet / second)
DMSP-18	APR 08	848 km circ @ 98.7°	4,936	10,881	13,480	6,251	13,780	17,072
DMSP-19	FY 10	"	"	"	"	"	"	"
DMSP-20	FY 12	"	"	"	"	"	"	"
GPS-IIF-2	MAR 08	20,368 km circ @ 55°	616	1,358	2,606	1,228	2,707	5,194
GPS-IIF-3	FEB 09	"	"	"	"	"	"	"
GPS-IIF-4	JUN 09	"	"	"	"	"	"	"
GPS-IIF-6	FY 10	"	"	"	"	"	"	"
GPS-IIF-7	FY 11	"	"	"	"	"	"	"
GPS-IIF-8	2013	"	"	"	"	"	"	"
GPS-IIF-9	2013	"	"	"	"	"	"	"
GPS-IIF-10	2013	"	"	"	"	"	"	"
GPS-IIF-11	2013	"	"	"	"	"	"	"
GPS-IIF-12	2013	"	"	"	"	"	"	"
SDO	AUG 08	2500 x 35,288 km @ 28.5°	991	2,185	4,053	686	1,512	2,805
Std Com	One / Year	185 x 35,786 km @ 27.0°	91	200	251	1,033	2,277	2,858

ULA Excess Performance Delta Vehicles

|	MISSION	VEHICLE	YEAR	LAUNCH SITE	APOGEE (nmi)	PERIGEE (nmi)	INCLINATION (deg)	MARGIN (lb)
DELTA II	Kepler	7925-10L	2008	ER	994	94	28.5	350
	OSTM	7320-10	2008	WR	719	709	66.0	350
	NOAA-N	7320-10	2008	WR	467	463	98.7	350
	NPP	7420-9.5	2009	WR	445	445	98.7	350
	Wise	7320-10	2009	WR	270	270	97.4	350
DELTA IV	WGS-1	M+(5,4)	2008	ER	36246	216	27.0	368
	GPS IIF-1	M+(4,2)	2008	ER	11047	11047	55.0	1637
	GOES-P	M+(4,2)	2009	ER	18994	3576	12.0	1500
	GPS IIF-5	M+(4,2)	2009	ER	11047	11047	55.0	1637
	STSS-1	Medium	2010	ER	540	540	45.0	5163
	DMSP-19	Medium	2010	WR	458	458	98.7	9856
	AFSPC	M+(5,4)	2010	ER	19323	19323	0.0	677
	GPS IIF-9	M+(4,2)	2011	ER	11047	11047	55.0	1637
	GPS IIF-10	M+(4,2)	2011	ER	11047	11047	55.0	1637
	GPS IIF-12	M+(4,2)	2012	ER	11047	11047	55.0	1637
	WGS-5	M+(5,4)	2012	ER	36246	216	27.0	368
	NPOESS-C1	M+(4,2)	2013	WR	447	447	98.7	4808

4. Future opportunities for space community

- CubeSats allow a low cost entry into space experiments

- Do we know all of the applications for low cost space?

- Will low cost access to space build a whole new industry - like the Apple computer?

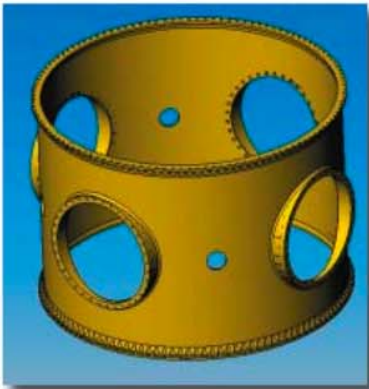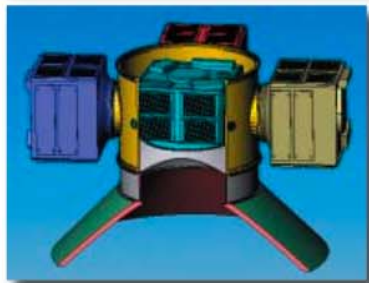- Low cost and new engineers will accelerate innovation

ARIANE ASAP 1990
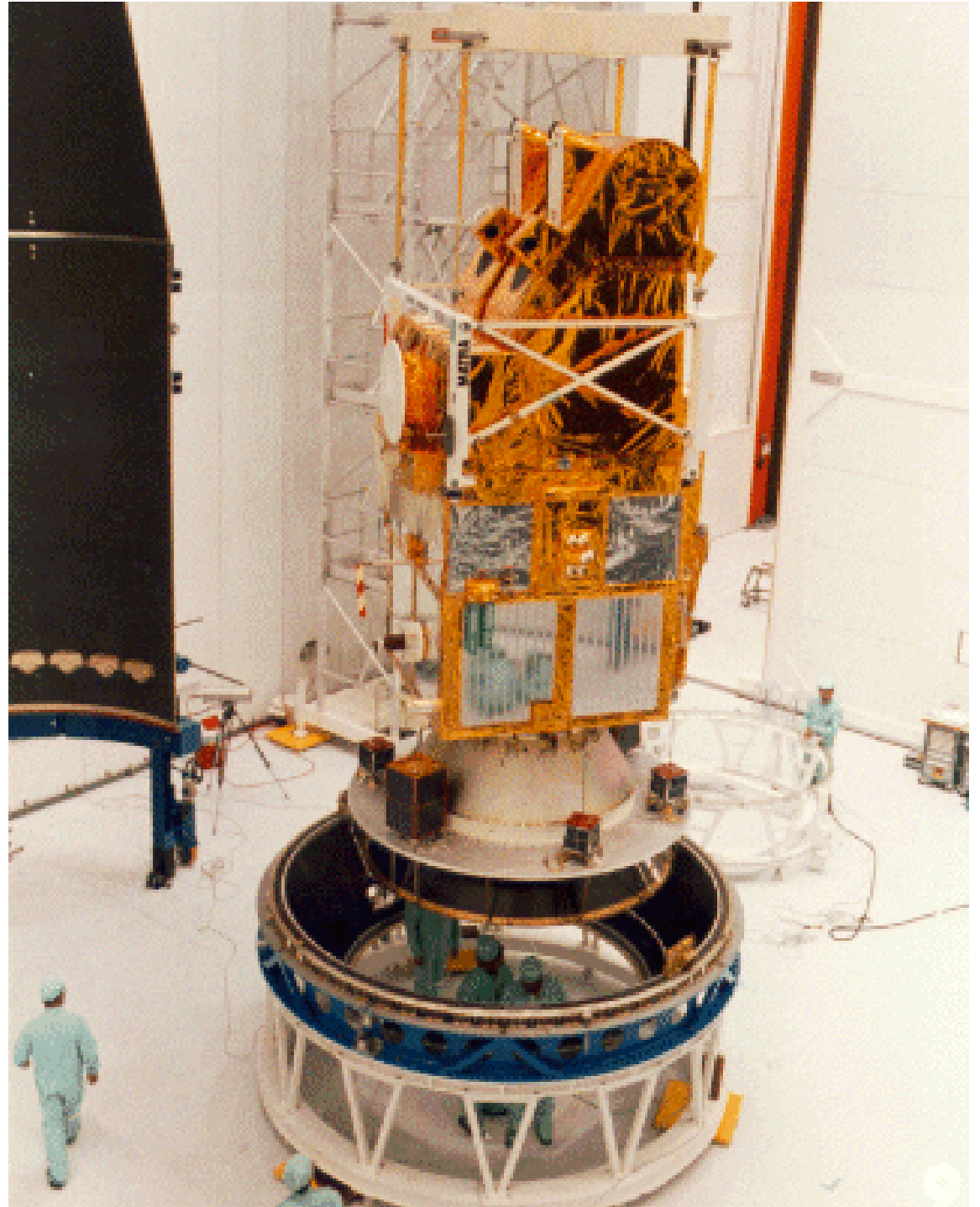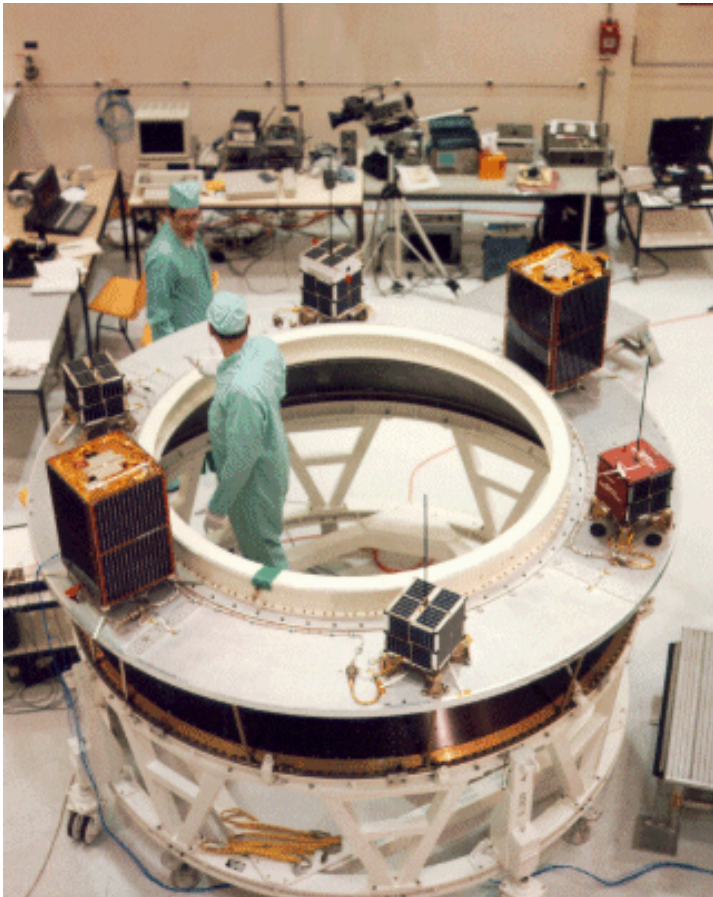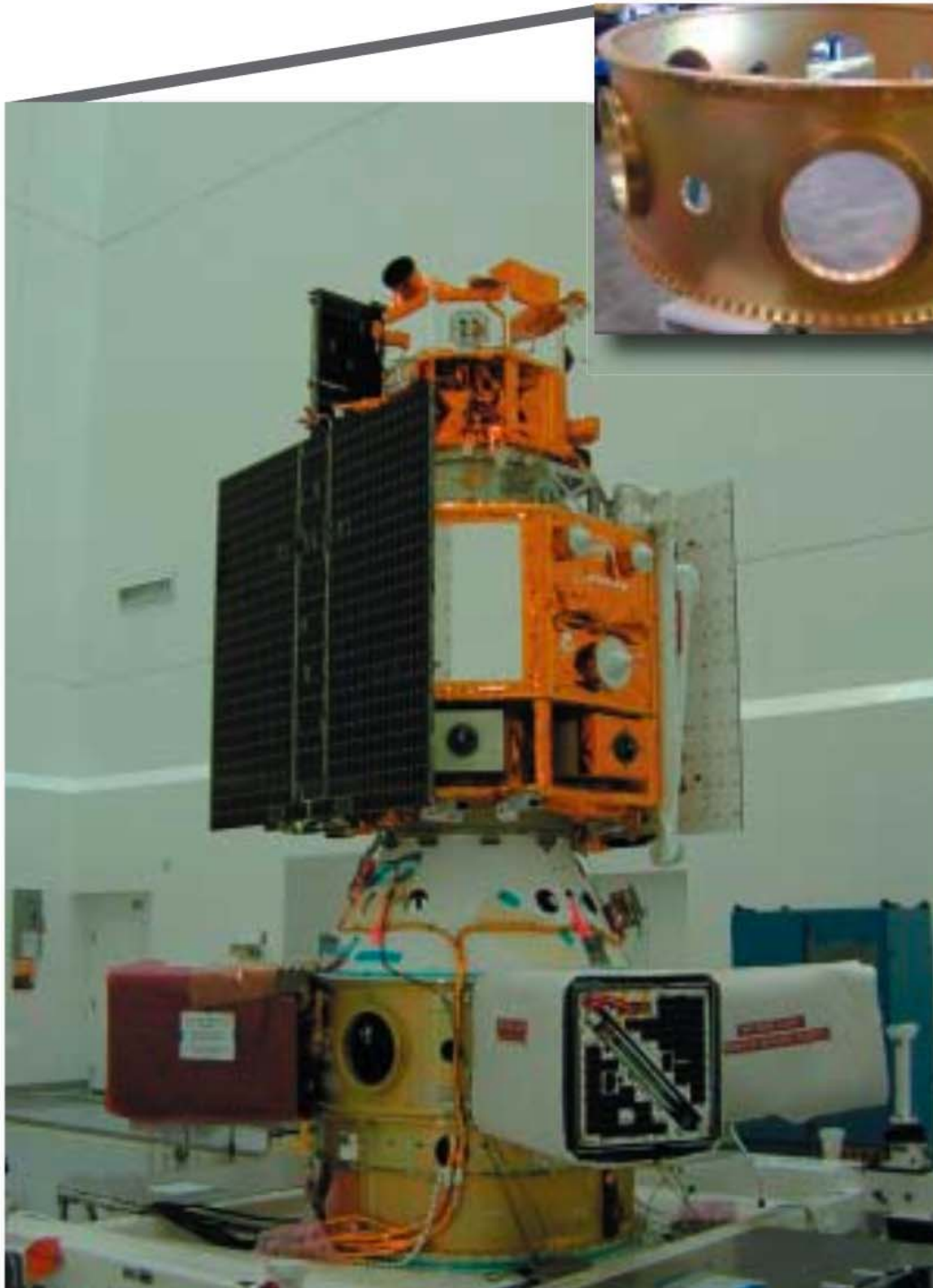
ESPA Ring

◀ Vertical mounting of satellites is possible with a new adapter element.

◀ **ESPA Grande**, the "stretch" version of the ESPA Ring, accommodates four large secondary spacecraft on a 23-inch-diameter bolt circle and a 1000-lb-class satellite on the interior of the ring.
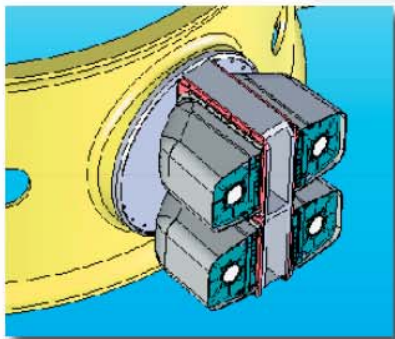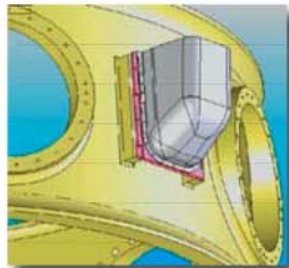

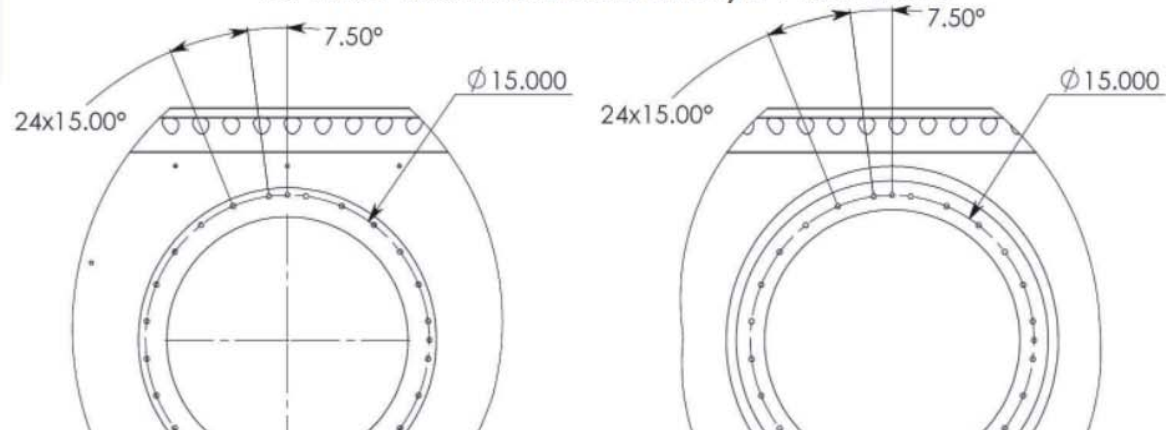▲ Investigating candidate missions for secondary spacecraft.

▲ Equipment deck with SoftRide isolation to reduce launch shock environment.

RocketPod™ CubeSat launch accommodation by Ecliptic.

Standard Secondary Spacecraft Interface

15-inch-diameter bolt circle, 24 fasteners


7.50°
Ø15.000
24x15.00°

7.50°
Ø15.000
24x15.00°

ULA Secondary Payload Capabilities (cont.)

- Type-C Carrier (TCC) with P-PODs
  - Pico satellite carriers shown mounted on a Type-C Carrier plate
  - Nano satellite carrier capable to 100 lbs
  - Mounts to the standard Type-C adapter, which are flown on all Atlas V missions, similar approach to be used on Delta IV missions
  - Up to six mission unique mounting locations

Pico satellite (CubeSat™)
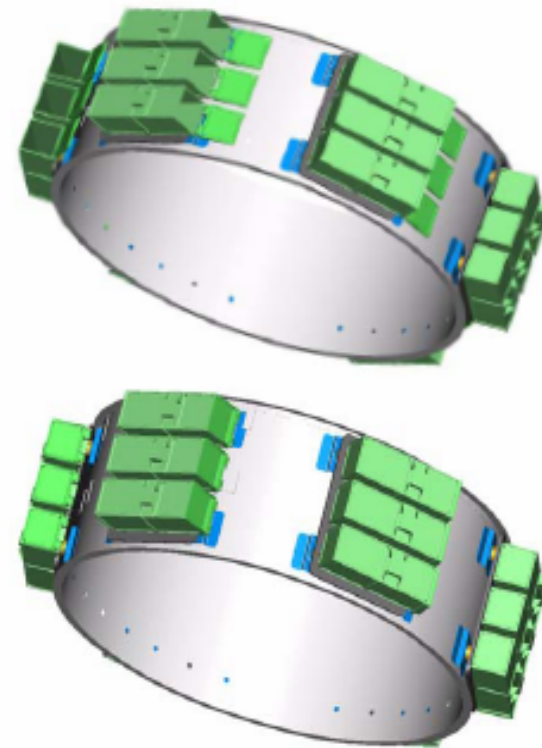
Type-C Carrier with multiple CalPoly P-PODs (Poly-Picosatellite Orbital Deployer)

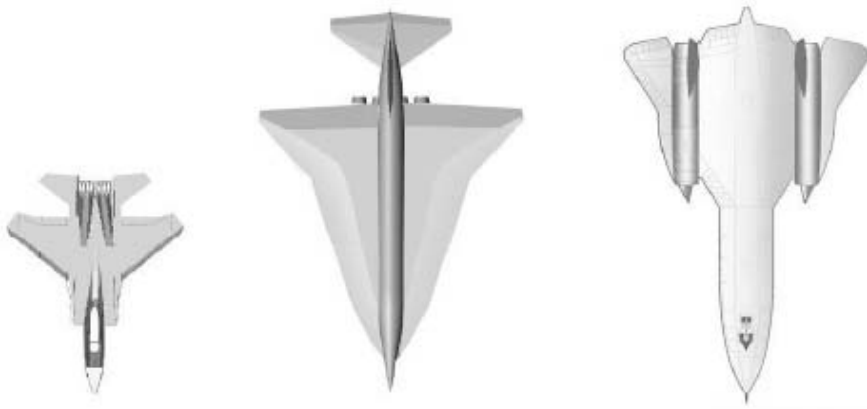**Multiple Atlas Pico and Nano Satellite Launch Options**

RASCAL

Figure 4. Aircraft size comparison: an F-15, the RASCAL aircraft, and the SR-71.

Figure 2. Final RASCAL system configuration.

Once out of the atmosphere, the rocket seperates from the aircraft first stage.

Top stage burn provides orbit insertion and trim

3rd stage rocket burn

Re-entry of spent expendable 2nd stage

Ballistic coast out of the atmosphere after zoom maneuver

2nd stage rocket burn

Coast

Zoom

200 KFT

Aircraft follows a ballistic path back into the atmosphere

Supersonic zoom maneuver
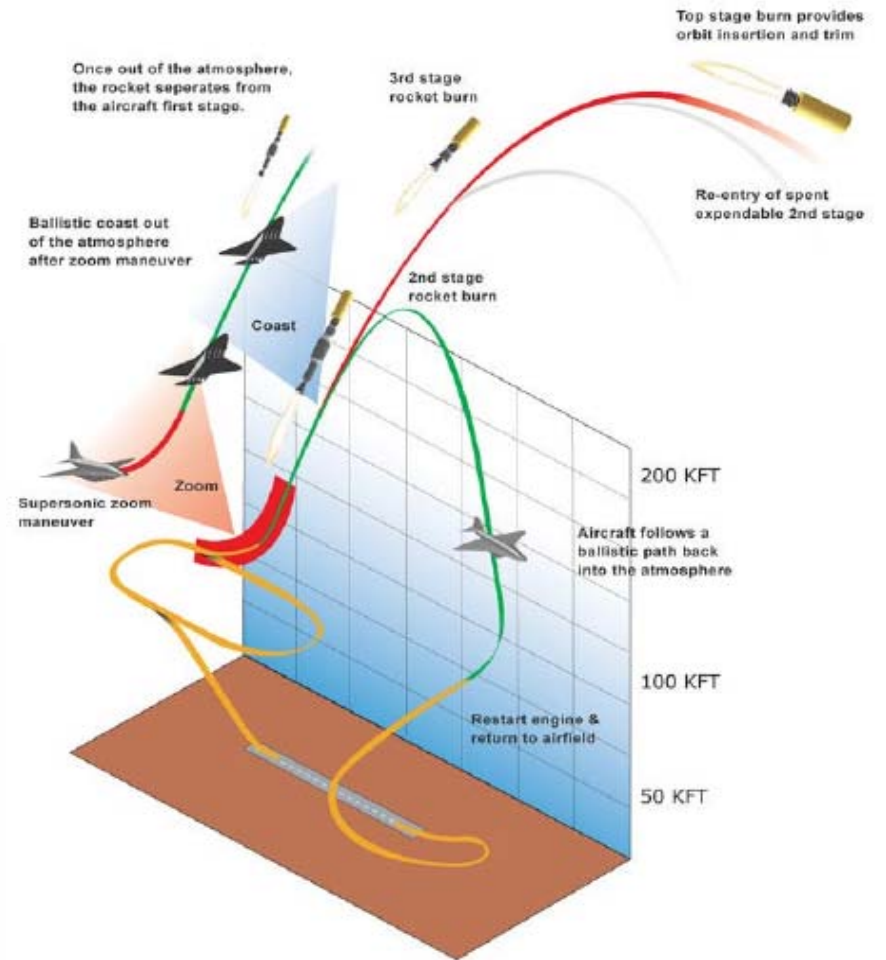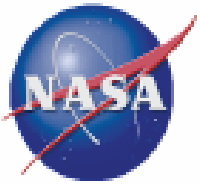
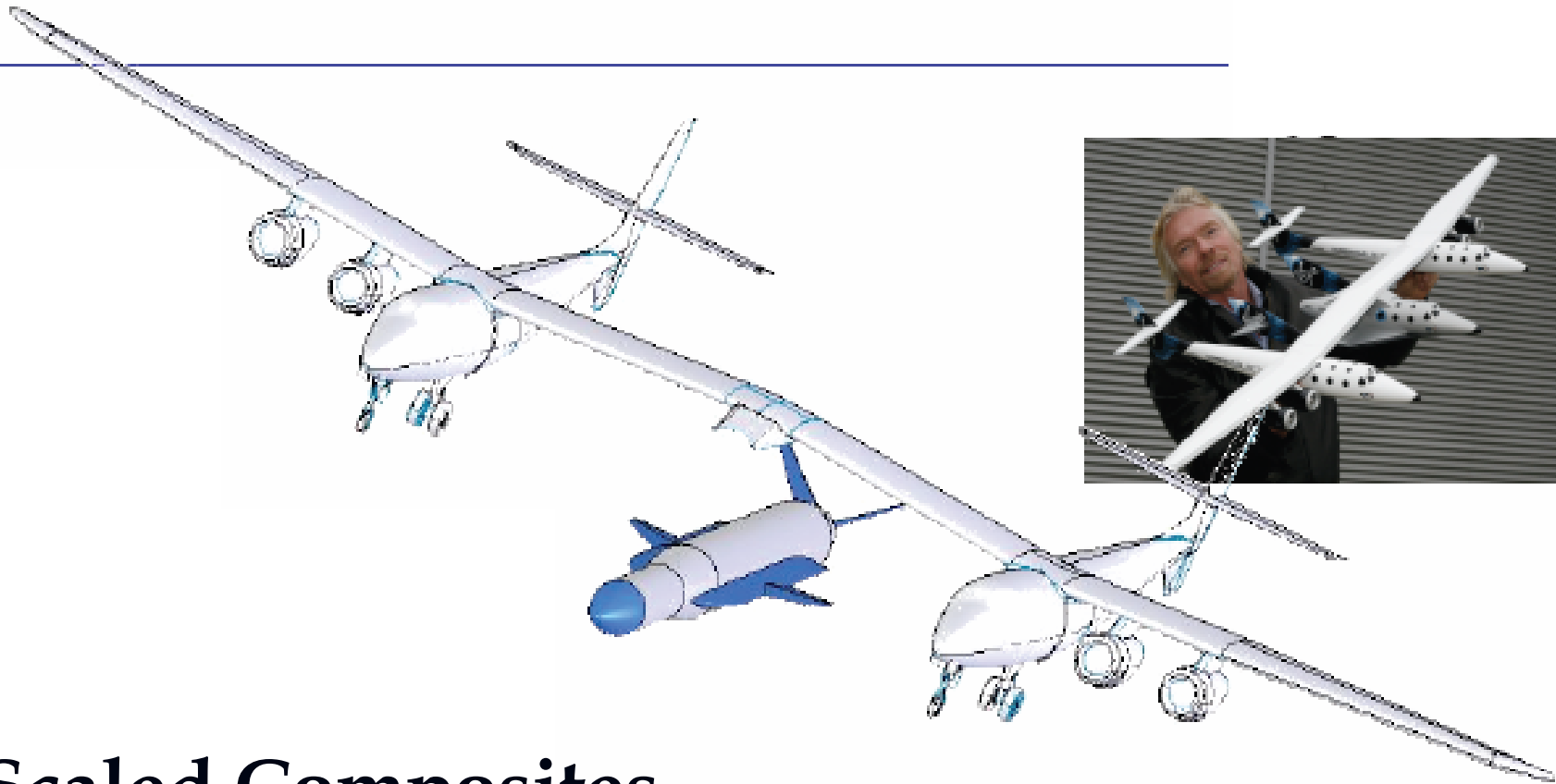100 KFT

Restart engine & return to airfield

50 KFT

Figure 1. A typical RASCAL zoom-climb maneuver.
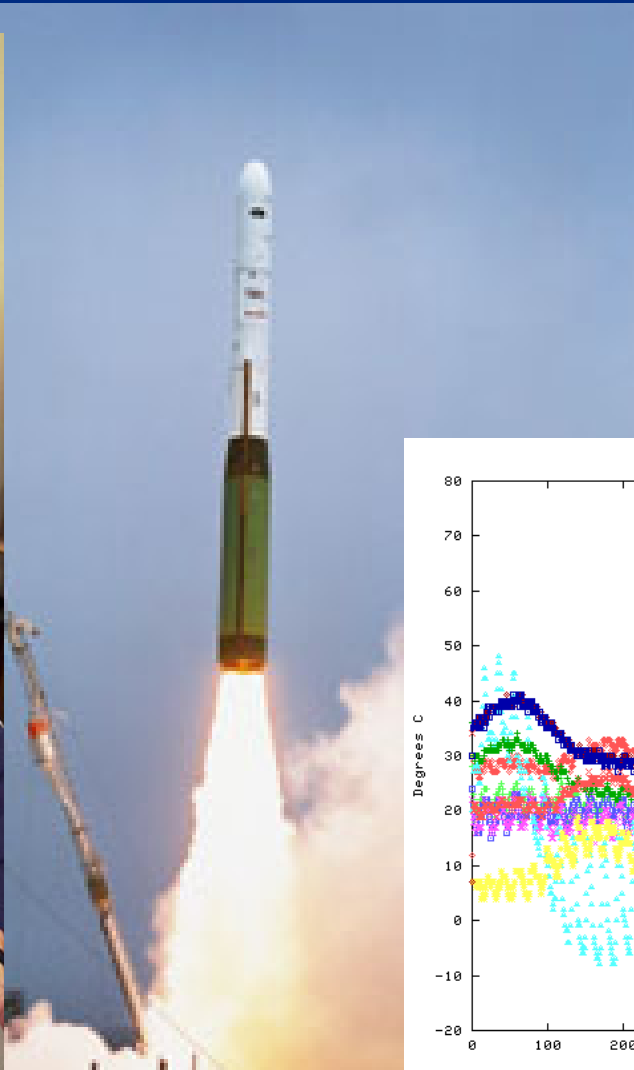
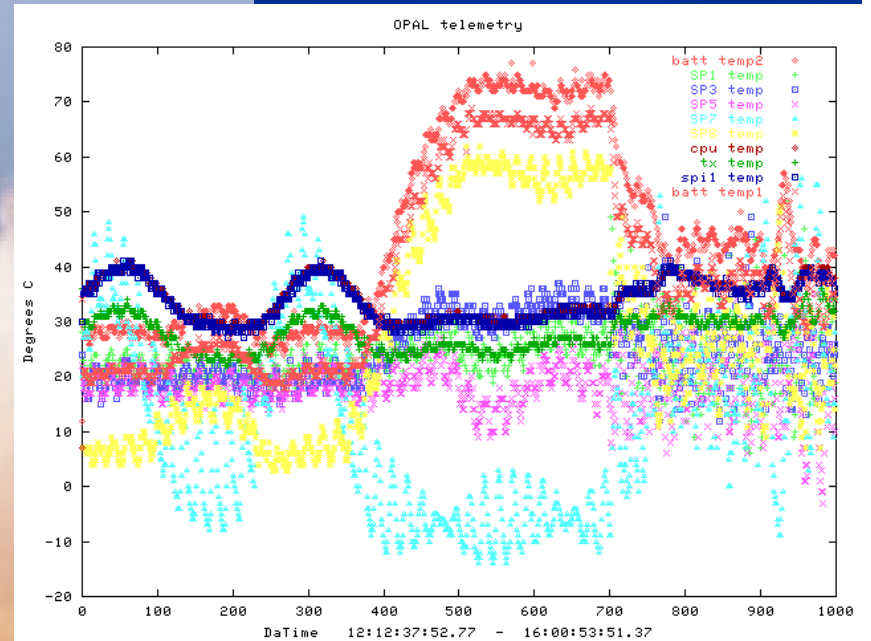# Sprite System Overview

Scaled Composites

Pegasus?

The Picosat

The Launch

It Worked!

4. Where do we go from here?

- CubeSats allow a low cost entry into space experiments

- Do we know all of the applications for low cost space?

- Will low cost access to space build a whole new industry - like the Apple computer?

- Low cost and new engineers will accelerate innovation

5. Doing outreach for the future.

- CubeSats allow a low cost entry into space experiments

- Do we know all of the applications for low cost space?

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5. Doing outreach for the future.

You Can Make a Difference

Be a Mentor

I have Questions

Is your work interesting?

Would it inspire students?

Can you make a difference?

Challenge – GO DO IT

What does it take?

1. *Pick a class of 4th graders – we can help you find a willing class*
2. *Visit the class initially to tell them what you do*
3. *Get a picture roster of them*
4. *Call their class once a week for a ½ hour for an update on your work*
5. *Have them call you some weeks for ½ hour to tell you what they are doing or what they learned from your last call*
6. *Do this for the full class year*
7. *Next year, same students -5th grade*
8. *Do you remember them, do they remember you?*
9. *Do it with them in the 6th grade ….. thru ….. 12th grade*

What do you get from this?

✓*You are now doing the pay back for your inspiring teachers, your best professors and those that helped you along the way*
✓*You will make a significant difference in those students lives*
✓*It will be of benefit to their teachers in their classroom interest*
✓*It will be of benefit to their parents with better performing and interested children.*
✓*The students will be better citizens contributing to society*
✓*You will have a whole class of students that will always remember you*

What do they get from this?

✓ *The inspiration that will make their school work much more meaningful*

✓ *They have found someone outside the classroom and their parents that really cares about their education*

✓ *They can now see the connection and relevance of the subjects that they are learning*

✓ *Your caring will change their lives – much for the better*

✓ *They will find your ½ per week one of the highlights of their school to look forward to every week*

✓ *They now have a big window to the world to see and learn things that may not have had the opportunity to experience*

Ok?

✓ *Can you spare ½ hour per week (maybe a little more for some prep)?*

✓ *Do you like your job and the things that excite and motivate you enough that you would want to share it?*

✓ *We can guarantee that this will become a time to look forward to in your week.*

✓ *It is for sure that ---*→ *see the next slide*

You Have the Key to Make a Difference

Thanks

Please contact me if you can and want to do this

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Go do it
Have Fun

Thanks