



**Jet Propulsion Laboratory**  
California Institute of Technology

# **CubeSat Or Microsat Probabilistic + Analogies Cost Tool (COMPACT)**

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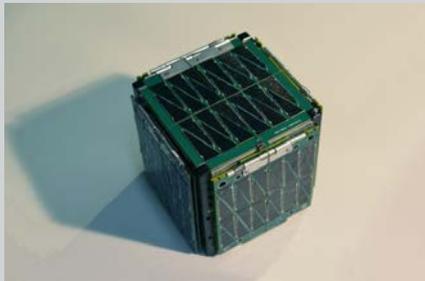


# What is a CubeSat?

**CubeSat = Extremely small (i.e. Nanosat scale 1-10kg) spacecraft of standard *dimensions* that hitchhikes to space with a traditional spacecraft.**

- **Standard Form Factors: how many “U’s” is your Cubesat? 1 to 6 U’s:**

**A “1U”  
Cubesat is  
roughly  
10x10x10 cm**



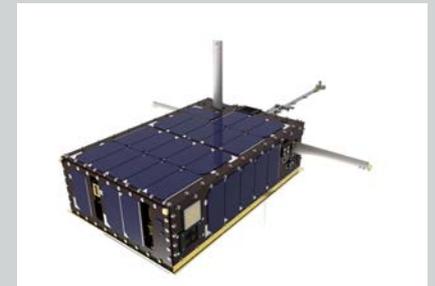
**A “2U”  
Cubesat is  
twice as big**



**3U:**



**6U!**



# What is a Microsat?

**A Microsat is simply a satellite with mass between 10 kg and 100 kg.**

**Most 1-3U CubeSats are 1 - 10 kg, and fall into the “Nanosat” range.**

**But a 6U Cubesat likely has a mass >10 kg and thus would be a microsat.**

**CubeSat Or Microsat Probabilistic + Analogies Cost Tool (COMPACT)**

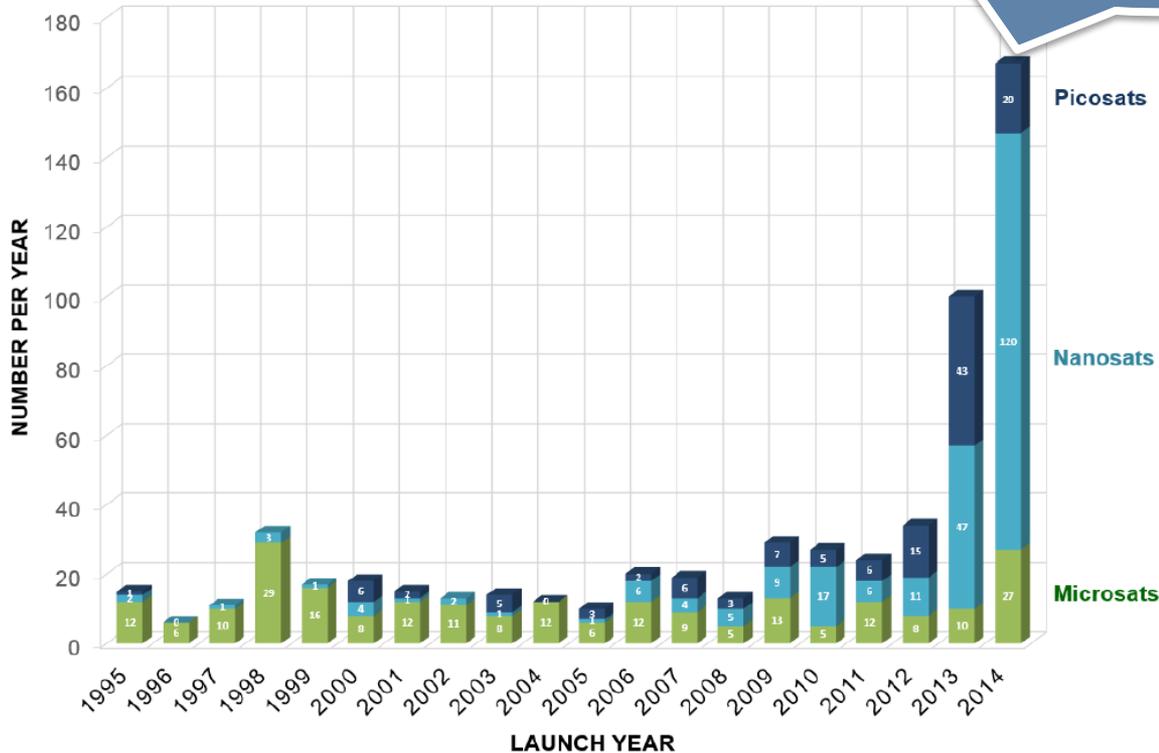


COMPACT is exploring CubeSats first.

# NASA does not have a CubeSat Cost Estimating Capability...

...But NASA clearly needs one -- ASAP!

Twenty Years of Small Satellite Launches



Most of these "Nanosats" are Cubesats

*The sudden increase in small satellite launch rates is primarily due to CubeSats.*

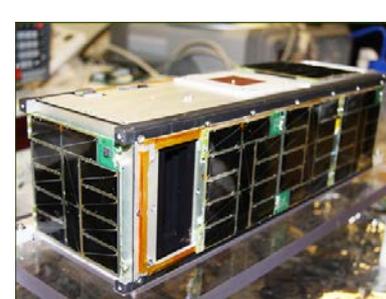
Graphic from: "CubeSat Technology and Systems," Janson, S., Presentation to USGIF Small Satellite Working Group, 27 May 2015

# COMPACT just completed Phase 1 to begin addressing this cost estimating capability gap

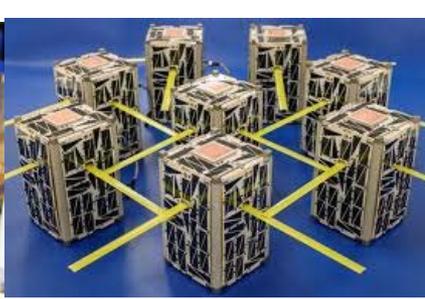
Phase 1 Requirement: Collect & Normalize Key Cost Driver Data for

**10 CubeSats**

# Phase 1 Delivery: Normalized Data for 18 CubeSats



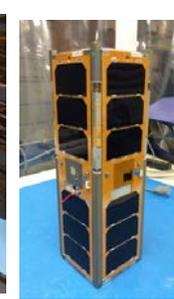
CINEMA



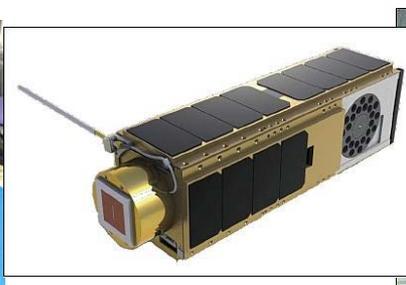
EDSN



GRIFEX



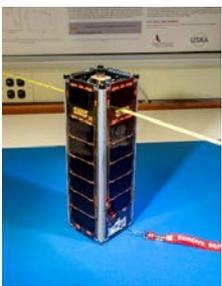
LMRST



O\_OREOS



KickSat



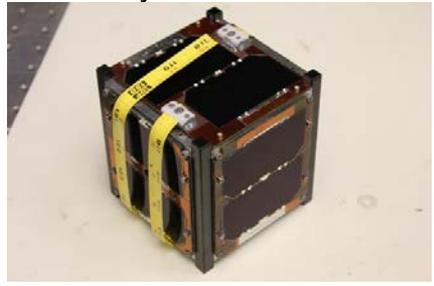
Firefly

# Phase 1 Delivery: Normalized Data for:

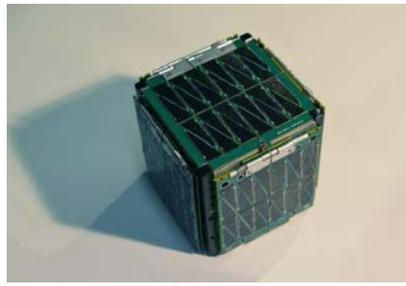


IPEX

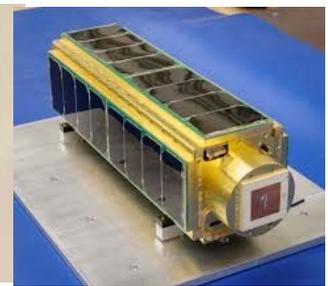
# 18 CubeSats



M-Cubed 2



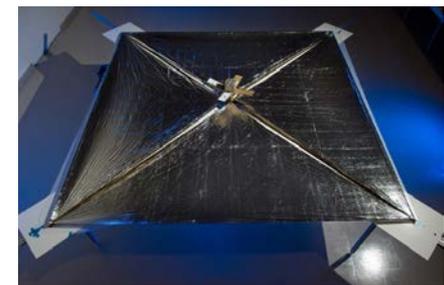
SkyCube



SporeSat-1



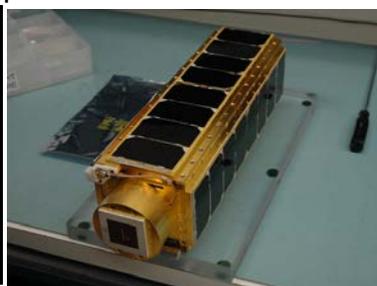
PSSC-2



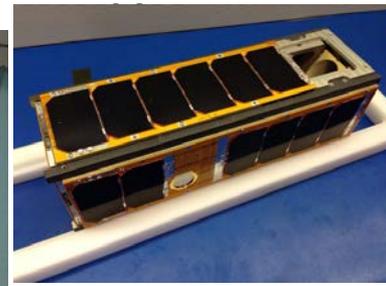
NanoSail-D



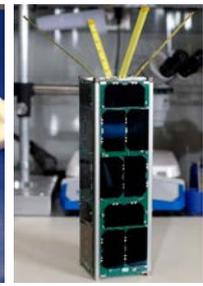
M-Cubed



COMPACT PharmaSat



RACE



RAX 1

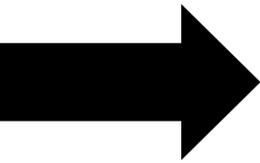
# Key Data

i.e. parameters likely to drive cost

CubeSat	Launch Date	Developer Type	Mass (kg)	Power (W)	U's	# of Spacecraft	Total Cost:(R¥\$K)
KickSat (1)	4/18/14	University	6		3	1	75
NanoSail-D (2)	11/20/10	Civil	4		3	1	250
SkyCube	1/9/14	Commercial	1.3	4	1	1	273
M-Cubed/COVE 2	12/6/13	University	1	1.2	1	1	300
LMRST	10/8/15	JPL	4.6	8	3	1	800
RAX 1 (USA 218)	11/20/10	University	3	8	3	2	1,053
CINEMA (1)	9/13/12	University	3.15	2.9	3	4	1,068
M-Cubed/COVE (1)	10/28/11	University	1	1.2	1	1	1,100
PolySat (CP8) "IPEX"	12/5/13	University	1	1.5	1	1	1,200
PSSC-2	7/10/11	Civil	3.7	5	2		1,200
GRIFEX	1/31/15	University	4		3	1	1,900
Firefly (1)	11/20/13	Civil	3.51	3.62	3	1	2,578
RACE	10/28/14	University	5	1.5	3	1	2,700
PharmaSat (1)	5/19/09	Civil	5		3	1	3,000
SporeSat-1	4/18/14	Civil	5.2		3	1	4,282
EDSN	11/3/15	Civil	2	1	1.5	8	5,196
O/OREOS	5/19/09	Civil	5.2		3	1	7,278
MarCO	5/5/18	JPL	12.7	64	6	2	10,200

# Lessons Learned so far

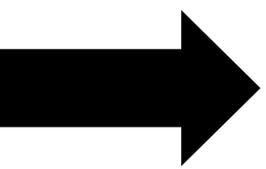
- Two classes identified
  1. Student built (pizza money or course credit)
  2. Non-student (paycheck and a 401K please).



Likely to require 2 separate cost models

## Lessons Learned so far

- “Older” CubeSats had to design and build their own buses, avionics, power subsystem, etc.
- “Newer” CubeSats can purchase cheap COTS parts – and just focus on the payload

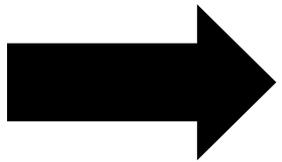


Models may need to weigh newer CubeSats more heavily

# Phase 2

## Phase 2 Todos

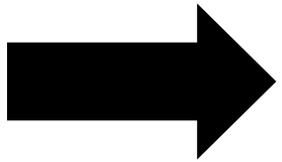
- Preliminary work on 9 additional CubeSats has already begun as part of Phase 1.



Phase 2 at a minimum should continue the normalization of this CubeSat data.

## Phase 2 Todos

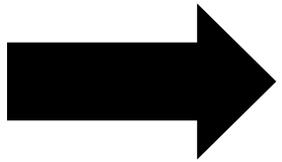
- We have gathered enough cost and technical data, and have compiled considerable CubeSat expertise, to begin building cost estimating relationships (CERs)



Phase 2 should include  
CER development

## Phase 2 Todos

- We know that NASA needs a cost estimating tool ASAP to support the exponential growth in CubeSats being pitched



Phase 2 should also include the development of a cost estimating tool.

This tool would be distribute to two sets of customers: Proposal Managers and Proposal Evaluators

# Stay Tuned!

# Questions?

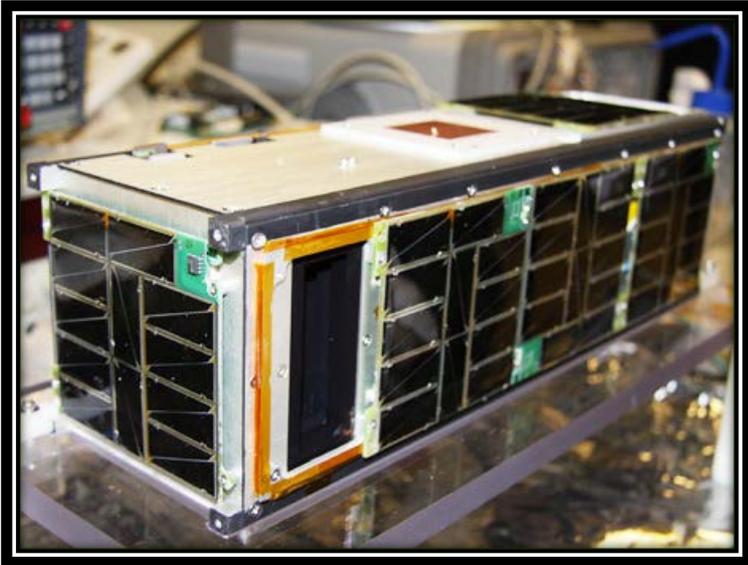


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[jpl.nasa.gov](http://jpl.nasa.gov)

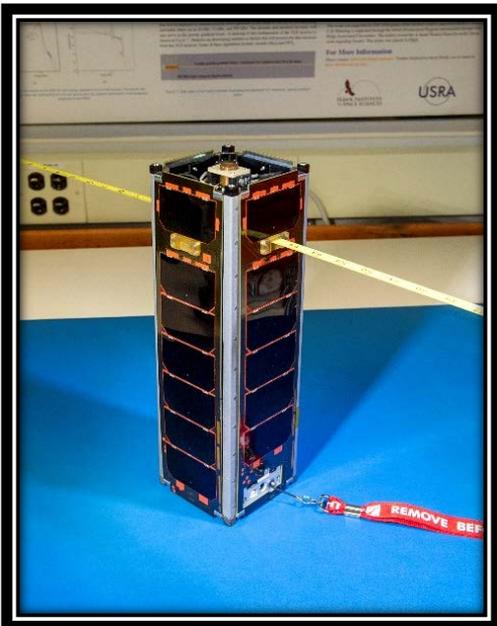
# APPENDIX – COMPACT CubeSat Pictures



CINEMA



EDSN



Firefly



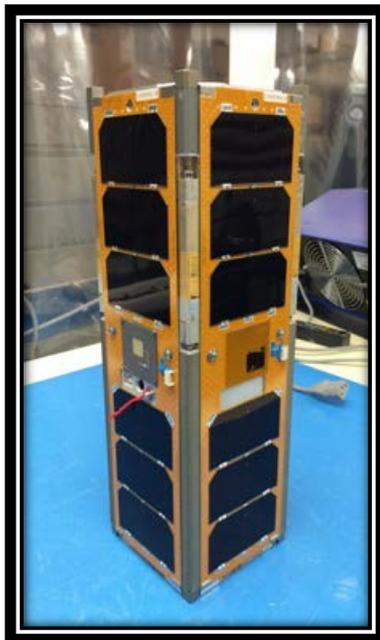
GRIFEX



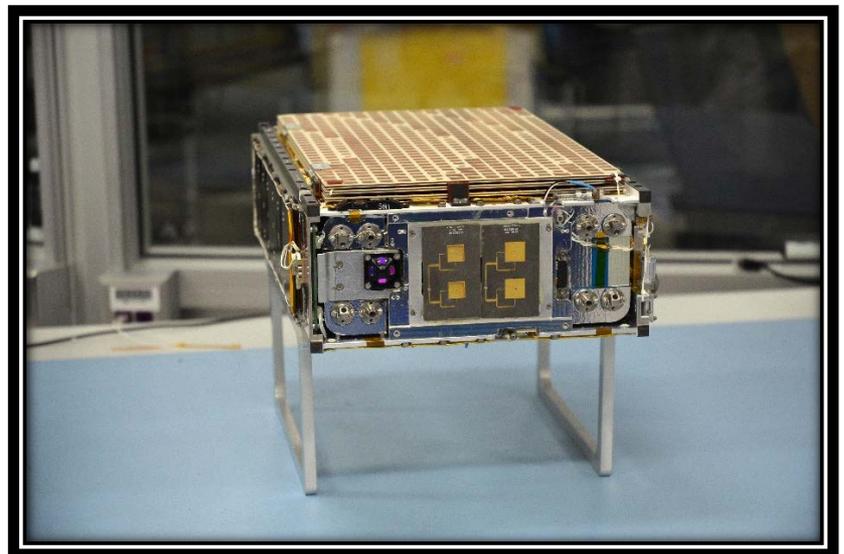
IPEX



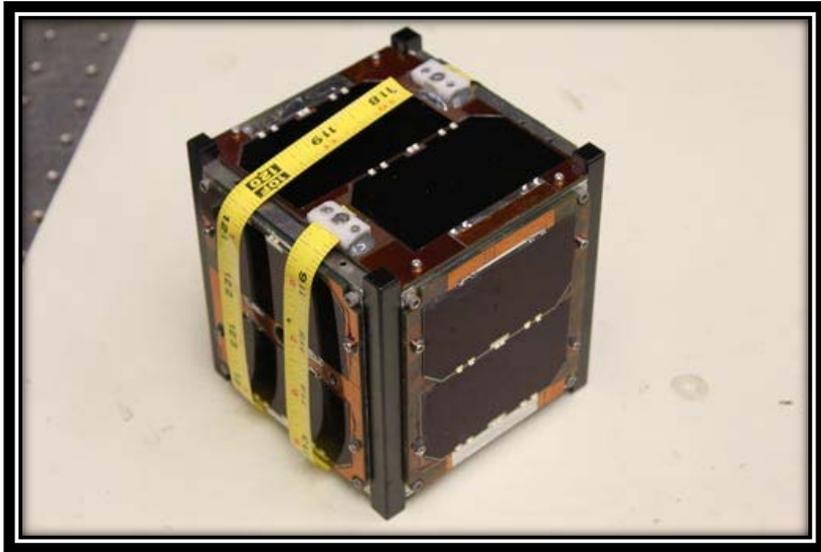
KickSat



LMRST



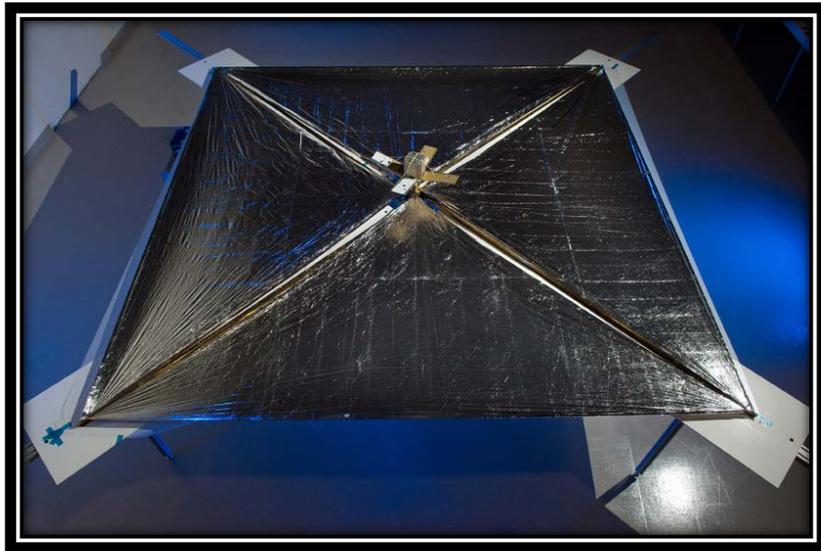
MarCO



M-Cubed 2



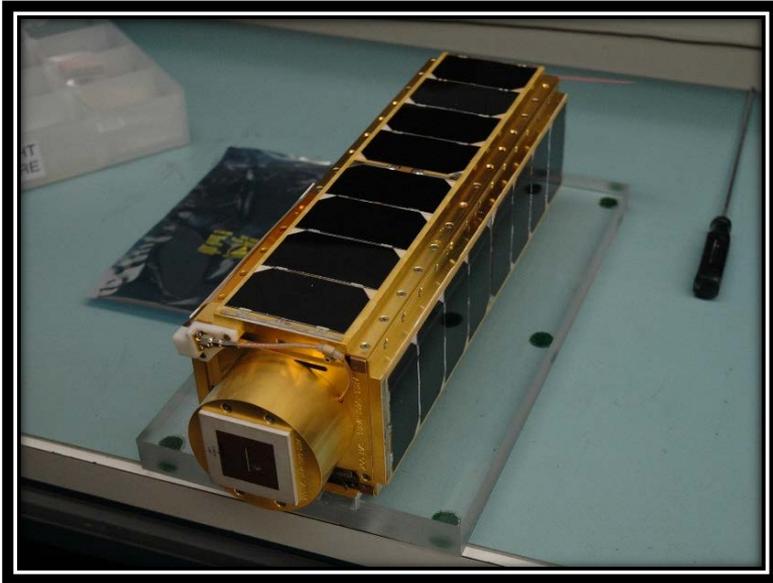
M-Cubed



NanoSail-D



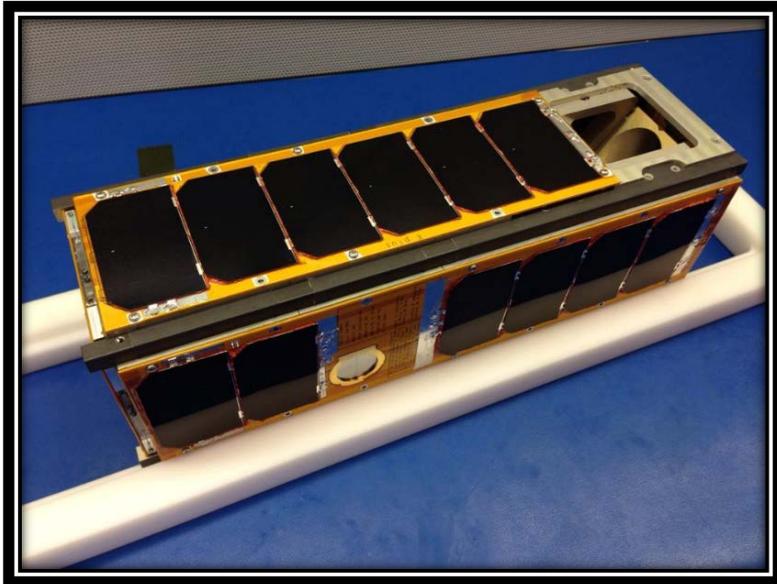
O/OREOS



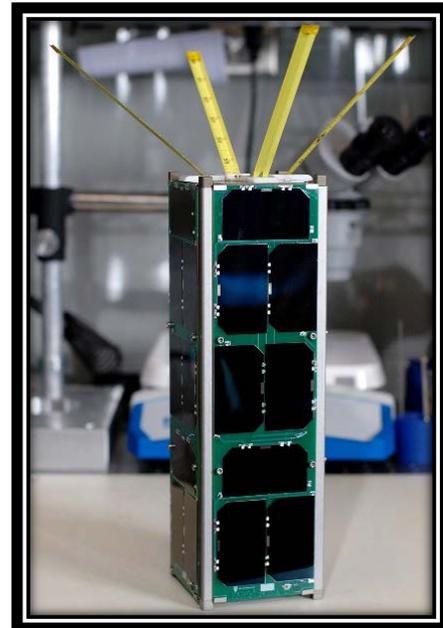
PharmaSat



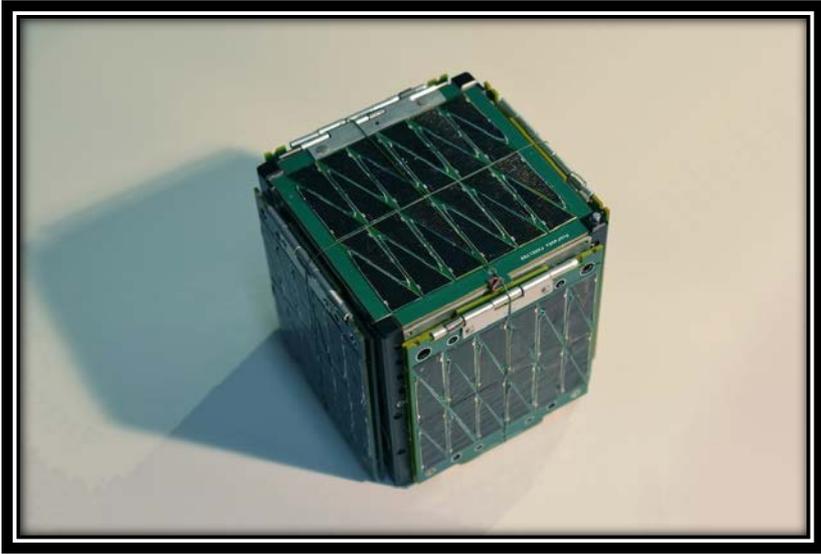
PSSC-2



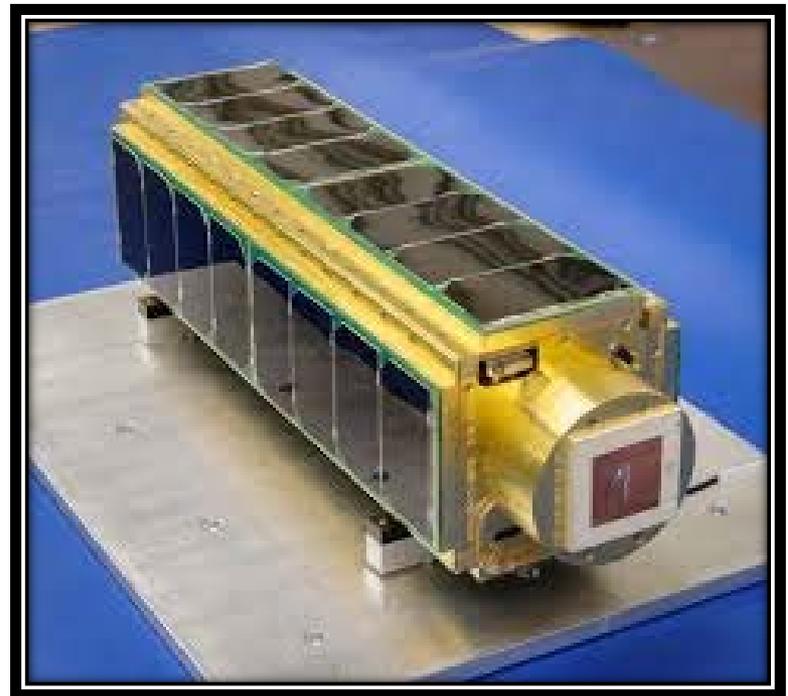
RACE



RAX 1



SkyCube



SporeSat-1