IPPW-2018 Short Course – Small Satellites: An Emerging Paradigm for Bold Planetary Exploration

Introduction to the SmallSat Paradigm

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June 9, 2018

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Short Course Introduction and Goals

Objective:

Explore the current state-of-the-art for Small Satellites and their capabilities for deep space planetary missions

Emphasis:

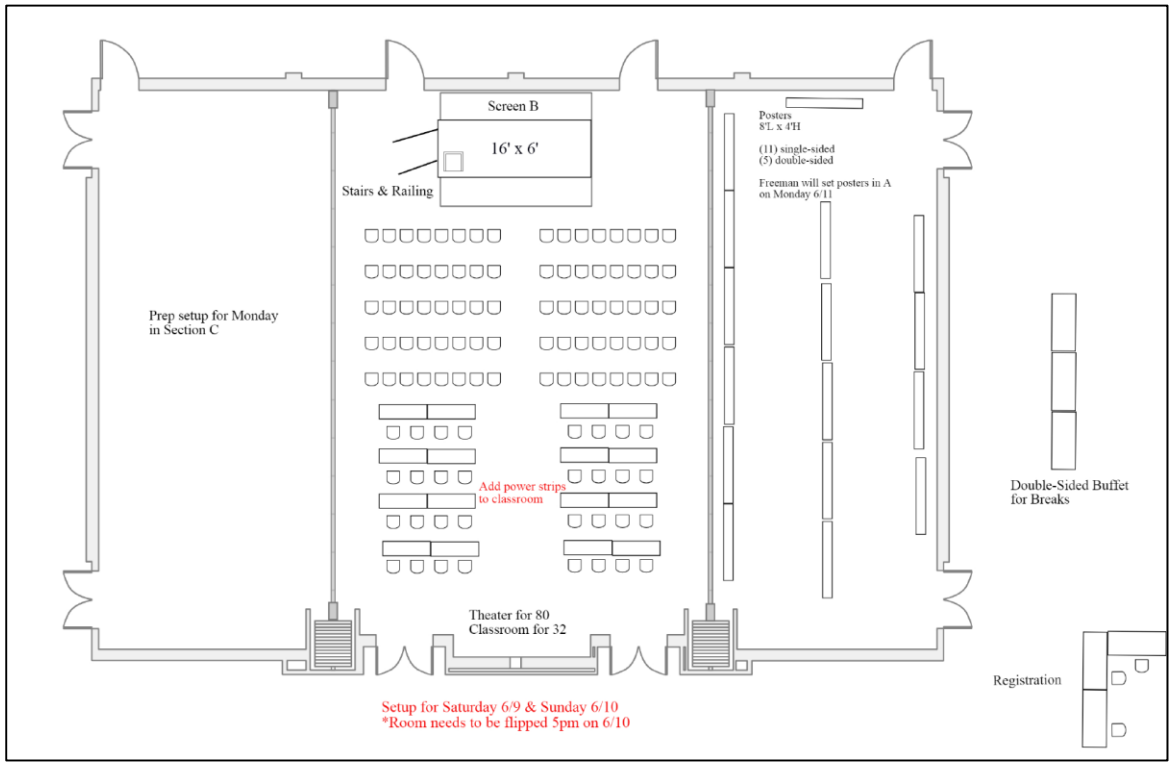
Small Satellites for *in situ* planetary exploration

Topics:

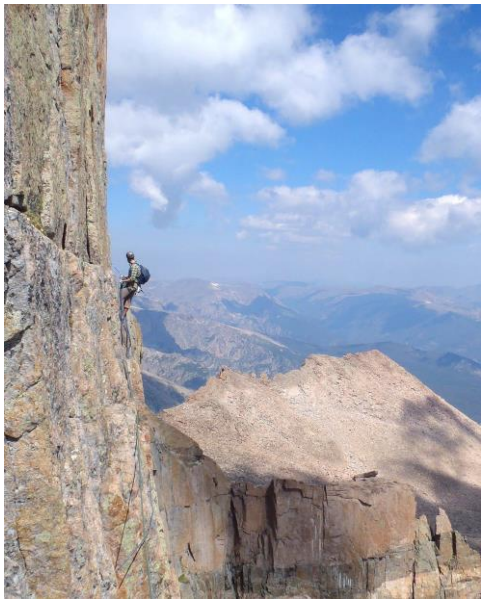
- Overview of international efforts
- Review state-of-the-art of SmallSat subsystems
- Understand past and present SmallSat missions
- Look forward toward concepts in formulation
- Explore enabling technologies

Short Course Logistics

- Every presentation is 20 minutes
- Presenters will be given a 5 minute and a 1 minute warning
- Coffee and snacks will be provided at each coffee break



Adam Nelessen – About Me



Jet Propulsion Laboratory (3 years)

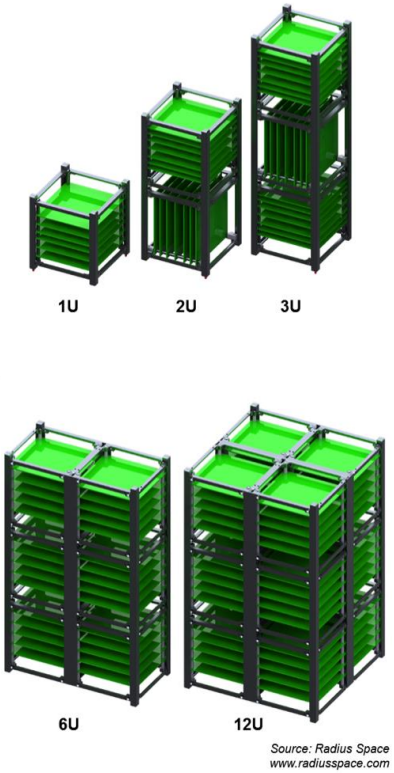
- Mars 2020 EDL Systems Engineer
- Aerocapture R&TD Principal Investigator
- Former Mars Program Systems Engineer
- Former Team-X/Xc Lead Systems Engineer

Education

- MS, Aerospace Engineering, Georgia Institute of Technology
- BS, Mechanical Engineering, Northern Arizona University

What is a Small Satellite?

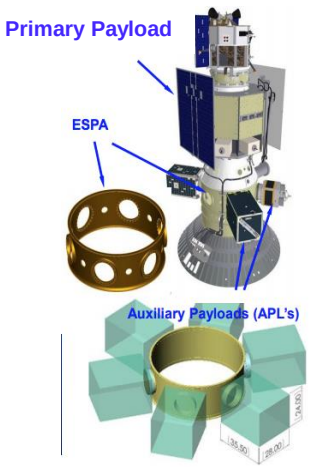
There are a variety of definitions



CubeSats

Defined in U's, where
1U =
10cm x 10cm x 10cm

Rough mass rule-of-thumb:
1U ~= 2kg



ESPA-Class

Support
24" x 28" x 35.5"
SmallSats

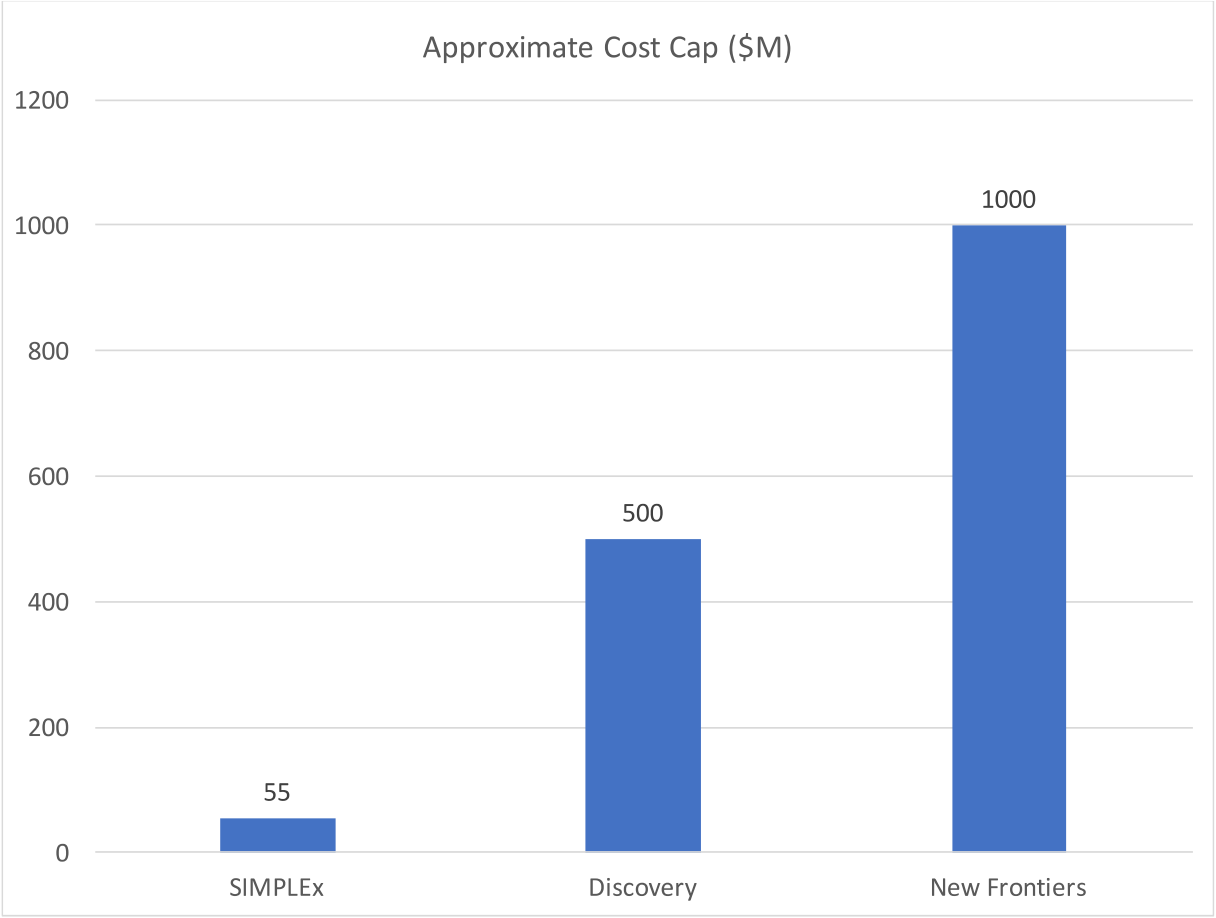
180kg maximum

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?filename=0&article=1232&context=smallsat&type=additional

Arbitrary mass and volume limits

"Less than 50kg and 24U"

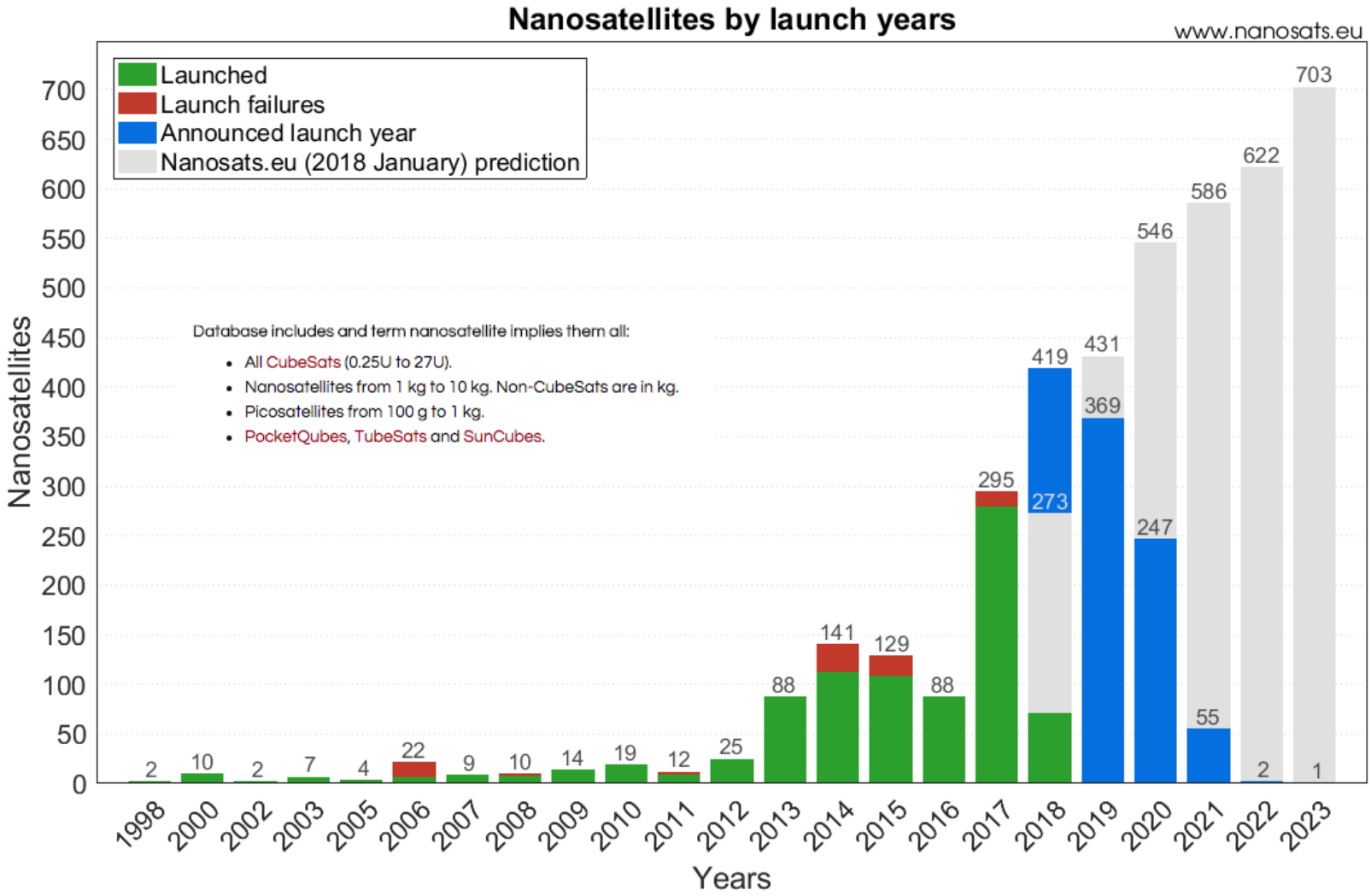
What is a Small Satellite?



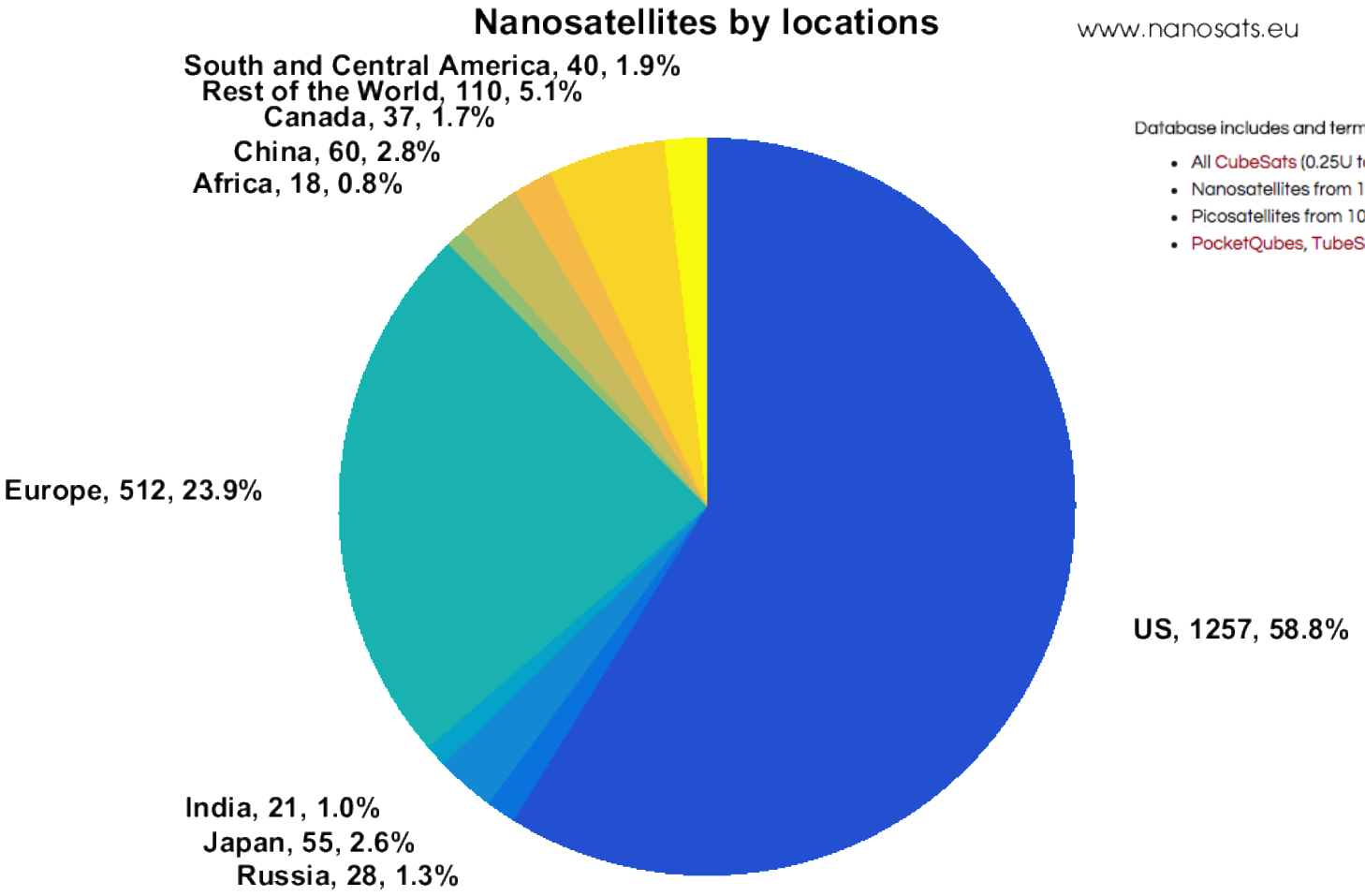
"Small Satellite" Philosophy

- ***Risk Tolerant:*** A whole new mission class, with accompanying design principles, is emerging
- ***Low-Cost:*** Simplicity of these systems can lower costs
- ***Focused Science Objectives:*** Small missions commonly accommodate only 1-2 science payloads
- Best-suited for ***short-duration objectives, sacrificial elements,*** and ***networks & constellations***

SmallSats are Trending



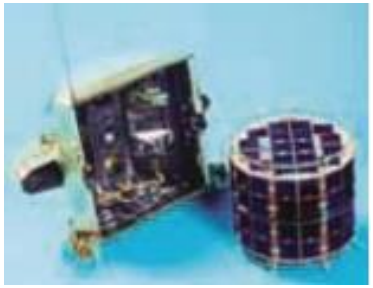
SmallSats Expand Access to Space



New Frontiers in Small Probe Exploration

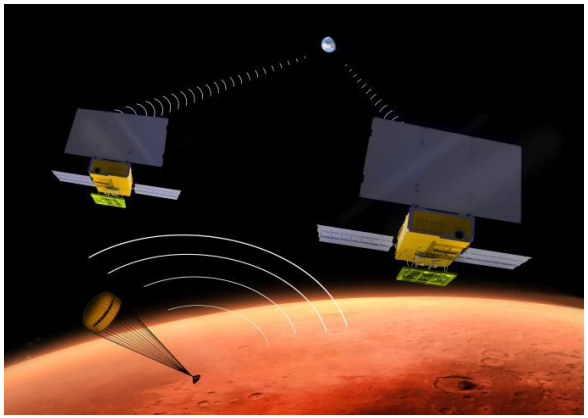
Recent efforts highlight the potential for
Small Spacecraft probes and landers

Minerva



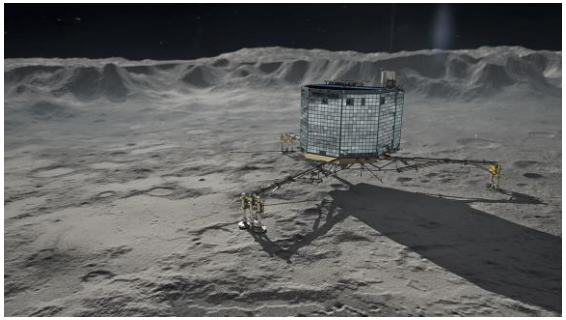
Credit: JAXA
http://global.jaxa.jp/projects/sat/muses_c/files/hayabusa_return.pdf

MarCO



Credit: NASA
https://photojournal.jpl.nasa.gov/catalog/PIA19388

Philae



Credit: ESA/ATG Medialab
https://www.flickr.com/photos/europeanspaceagency/10796307373/

Key Challenges for Deep Space SmallSats

Propulsion

- There is currently no proven orbit insertion method at SmallSat scales
- Safety concerns have so far limited propellant options
- Cold gas offers low thrust and I_{sp}

Radiation

- Most commercial-off-the-shelf hardware is developed for the LEO environment
- More R&D is needed to mature small spacecraft hardware for the environments of deep space

Power, Telecom, Science Instruments

- Inverse square laws demand area and aperture
- SmallSats are more sensitive to solar distance

Cost

Some high-cost items do not scale with size:

- Interplanetary navigation
- Ground systems