

Far Horizons

Democratizing Space Exploration
from High Altitude Balloons to
Asteroid Missions

Geza Gyuk & Mark Hammergren
Adler Planetarium

NIAC Spring Symposium 2013

Adler Planetarium

- Leader in STEM public outreach and education
- Significant research wing
 - Approximately dozen astronomers engaged in research ranging over VHE gamma-ray, asteroid compositions, star formation, AGN populations
- Dedicated to engaging *public in research*

Your conference ID will get you free admission into the Adler (+1 show) through this weekend

Citizen Science

- “New” model of Citizen Science
 - members of general public can engage in real scientific inquiry
 - Two modes
 - “Data-taking”
 - “Data-reduction” – “Big Data”
 - Zooniverse at Adler
 - ~800,000 participants

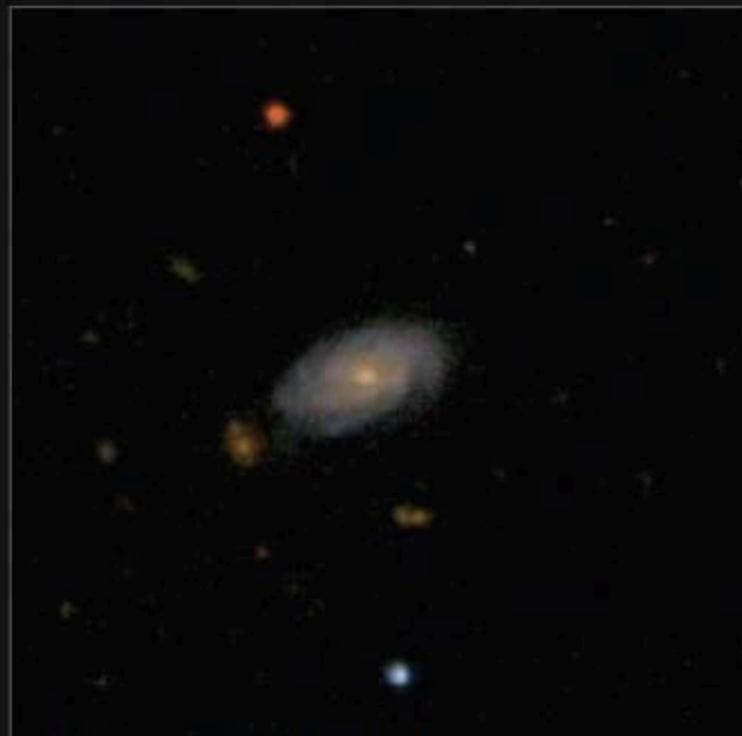


GALAXY ZOO.org

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Galaxy Analysis

Welcome to Galaxy Zoo's view of the Universe. If you're here you should already have seen the [Tutorial](#), but feel free to go and remind yourself. There's no need to agonise for too long over any one image, just make your best guess in each case.



Show Grid Overlay on the next Image

Galaxy Ref:
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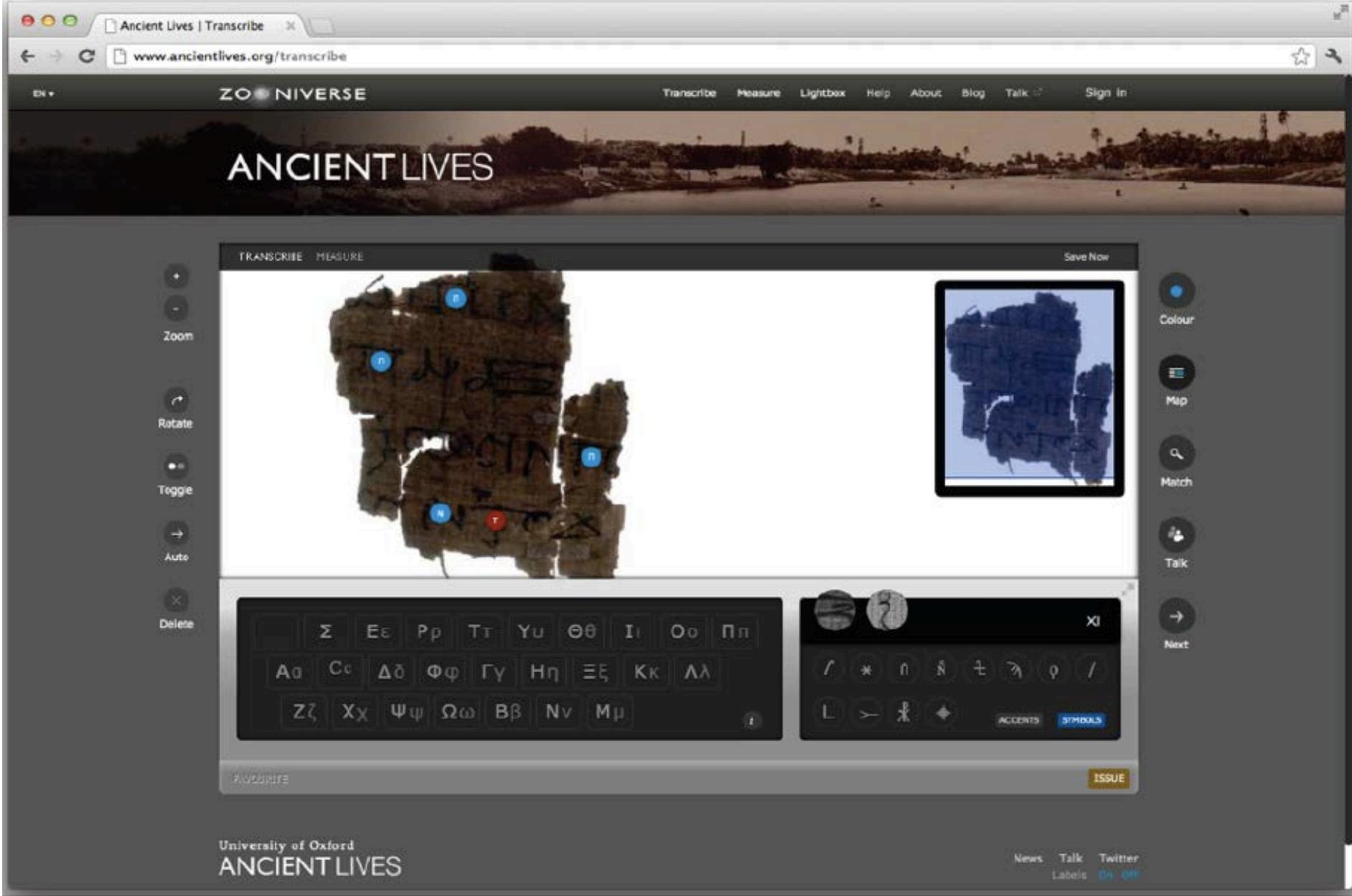
Choose the Galaxy Profile
by clicking the buttons
below



If you find something REALLY unusual or strange and it does not look like anything in the [how to get started section](#) or in the [FAQ](#), then post it up on the [Forum](#) or drop us an email with the reference number.

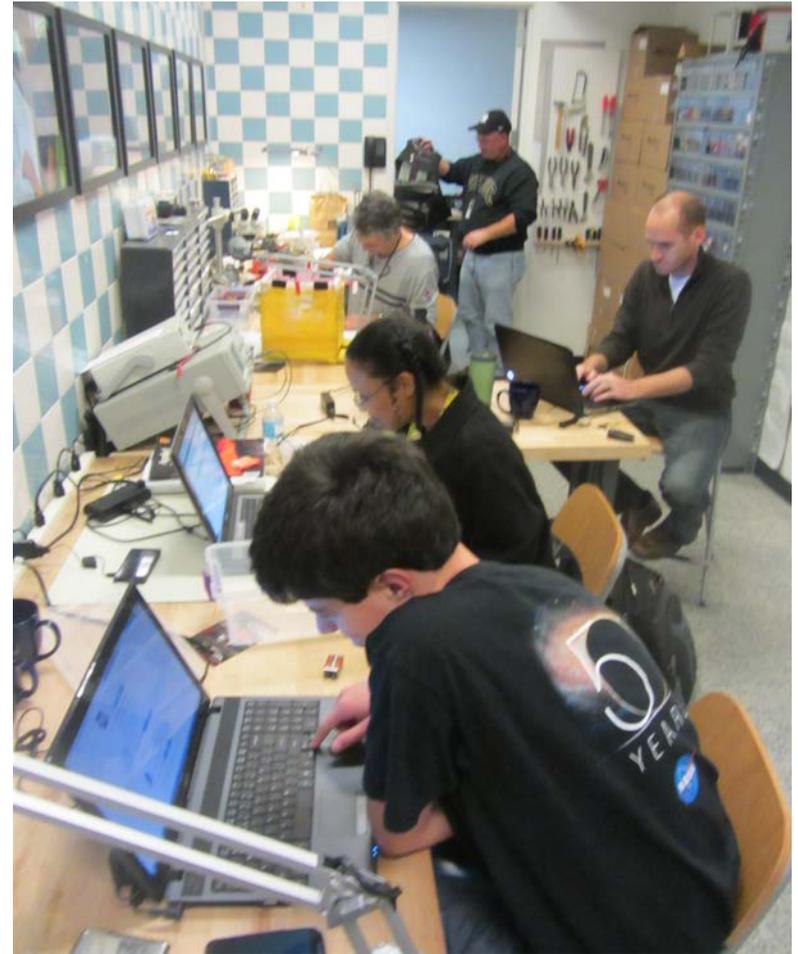
Dear Galaxy Zoo users,

Thanks for making Galaxy Zoo such a success!



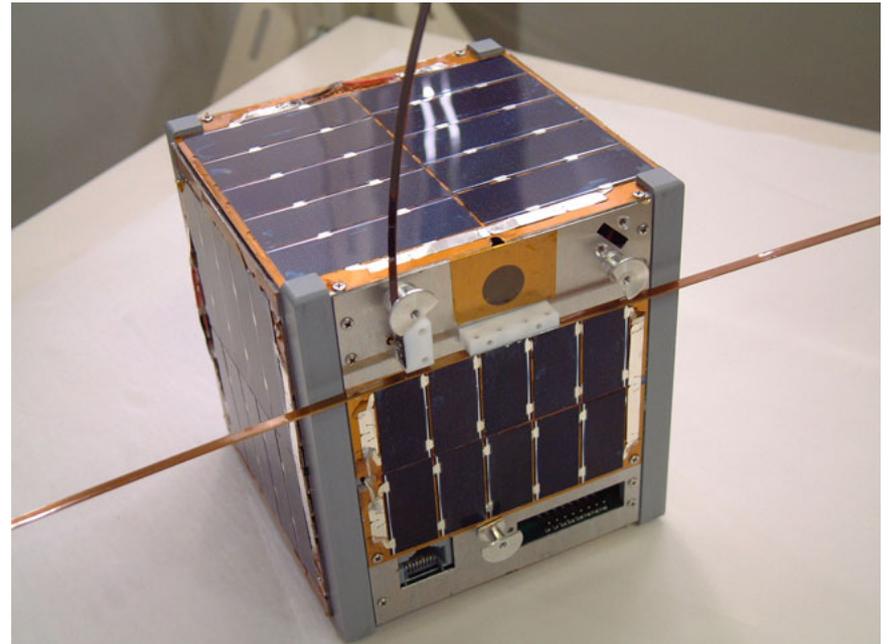
Far Horizons

- Relatively new program aimed at actively involving the public in space exploration
- We want to enlist the public in performing cutting-edge science **in space**



Nanosats

- Scale is about right
 - ~\$100K
- Resource level right
 - Universities
 - Small companies
 - Even a high school
 - (h)AmSat
- Timescale about right
 - ~5 year



but...

- Steep learning curve
 - Institutionally
 - Individually
- Ballooning as “on-ramp” to space
 - “NASA” model



Ballooning

- “NASA model” cut technology teeth and PI teeth on high-altitude balloons
- Costs
 - \$few thousand investment
 - ~\$500/mission (helium, chase vans, balloon, etc.)
- Month development timeline
 - Days re-flight timeline
 - Flexible
- Accessible
 - Hard to mess up....



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PLANETARIUM

Geza Gyuk, "Far Horizons: Democratizing Space Exploration",
NIAC Spring Symposium 2013, Chicago

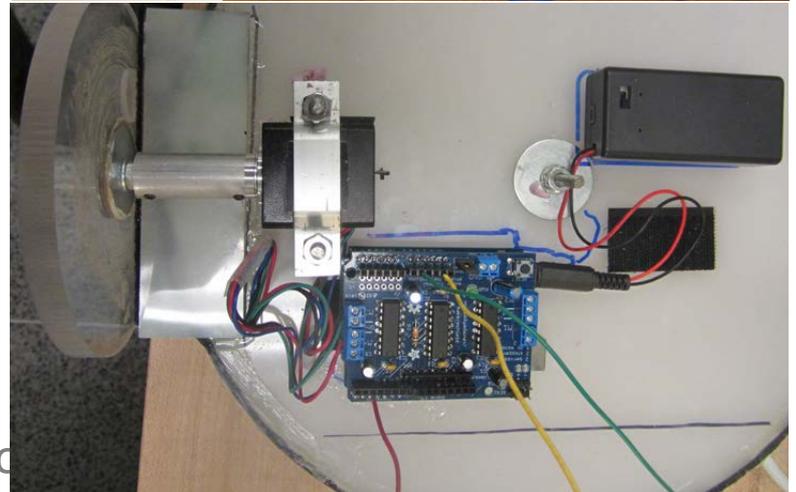
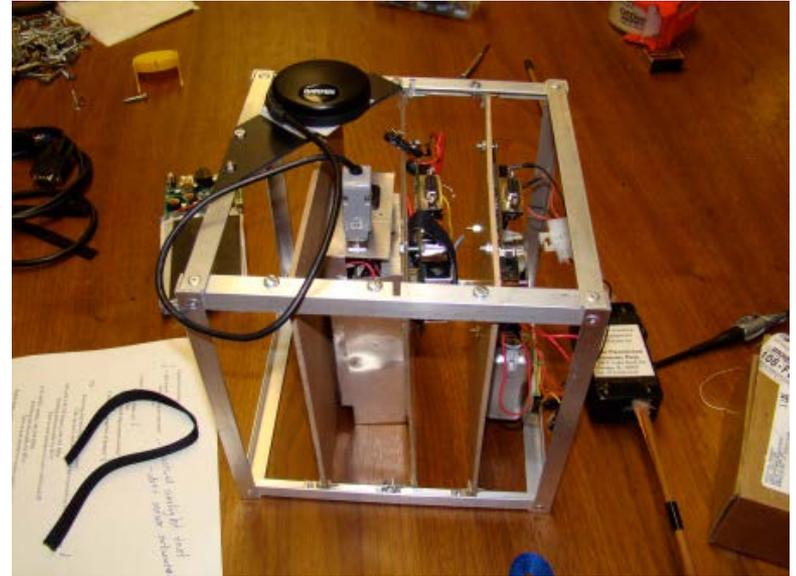






Development

- Hardware groups
 - Cutdown system
 - Comm system
 - Ballasting system
 - Stability
- Missions
 - Aurora Borealis
 - SPARK



- Pursuing ballooning for 5 years now
 - Healthy community
 - Students
 - Interns
 - Volunteers
 - Online and physical community
 - 50+ missions
- Next step is satellite missions



Sample Missions

- Simple Sputnik – OTS components
 - Light Pollution Monitor
 - Transient Sky Survey
 - AGN Monitoring
-
- Earth Shine Monitor – GTO and above

Planetary Missions

- Planetary missions are complex and expensive
 - Must communicate over large distances
 - Orbital rendezvous and especially landing require lots of fuel
 - Must carry entire suite of scientific instruments, unless it's a sample return mission (which increases complexity, mass, and cost)

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=> Why not let solar system targets come to us?

NEAs

- Near-Earth asteroids pass within the orbit of the Moon more frequently than is popularly believed.
 - 2012 DA14: discovered one year prior to close approach, position known to within 2 km days prior to perigee.
 - LSST and PanSTARRS will find several targets per year that pass within 0.5 lunar distance.
 - Relics of the formation of the Solar System
 - Represent a significant long-term risk
 - Chelyabinsk superbolide is a recent example

Cheap Impact

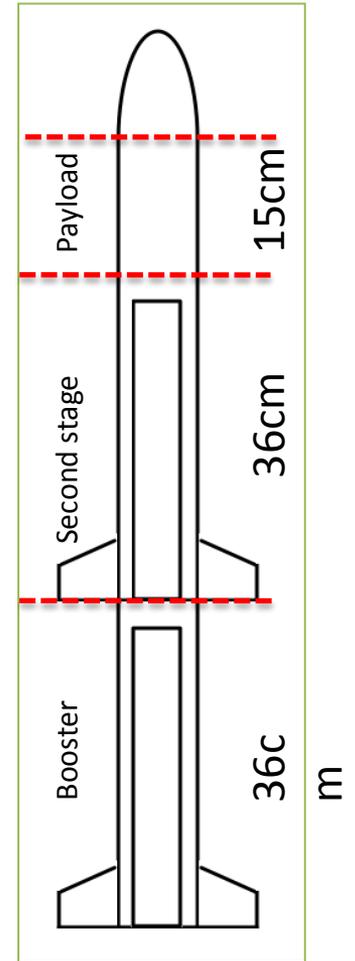
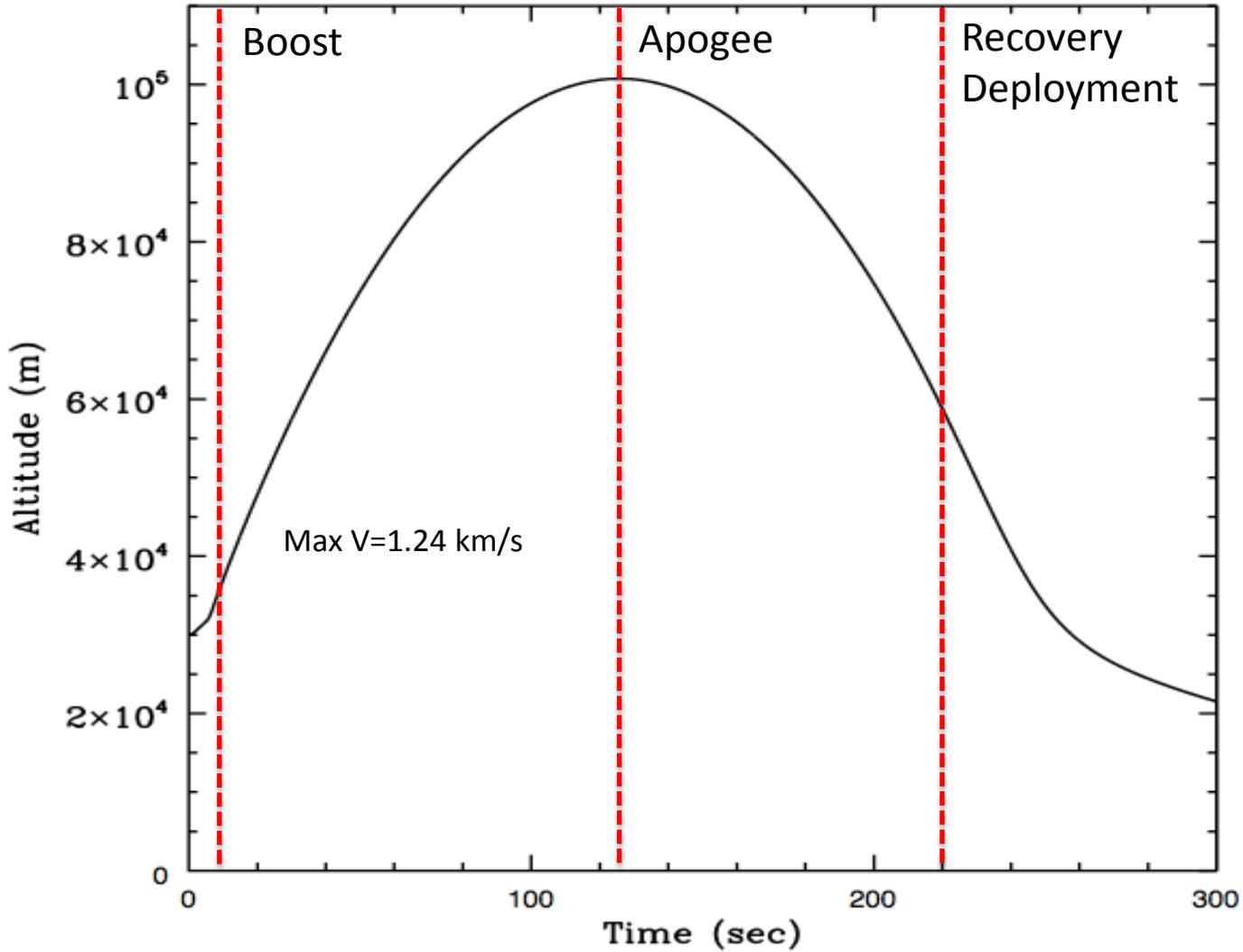
- Nanosatellite mission to 50-100m near-Earth asteroid
 - Privately Funded
 - Live test of asteroid impact mitigation
 - Mission design underway
 - Within amateur capabilities
- Two part vehicle:
 - Mother Ship uses solar-electric propulsion (tether?) to raise its apogee from GTO orbit to ~ 0.5 lunar distance; carries long-distance communication system, primary data storage, and camera;
 - Impactor separates several days prior to encounter, and uses cold-gas thrusters to adjust its orbit to impact

FAR



HORIZONS

SPARK



location",

SPARK

Zooniverse examples

- Planet Hunters 1
- “Green Peas”
- Many dozens of papers