



BOOSTER
SPACE INDUSTRIES

Actively Flying a High Quality Microgravity Trajectory in the BOOSTER Sub Orbital Aircraft

NSRC 2012... Palo Alto – California, USA: 27 February 2012

James Murray: **BOOSTER**
Hans Petscher,
Sebastian Deubler: **v-plane** Engineering

BOOSTER is building..

- a Sub orbital Aircraft
- Type Certificated
- Airline-like operations
 - Up & down,
and up & down,
again and again
 - Mothership: 2014
 - Suborbital: 2016-2017

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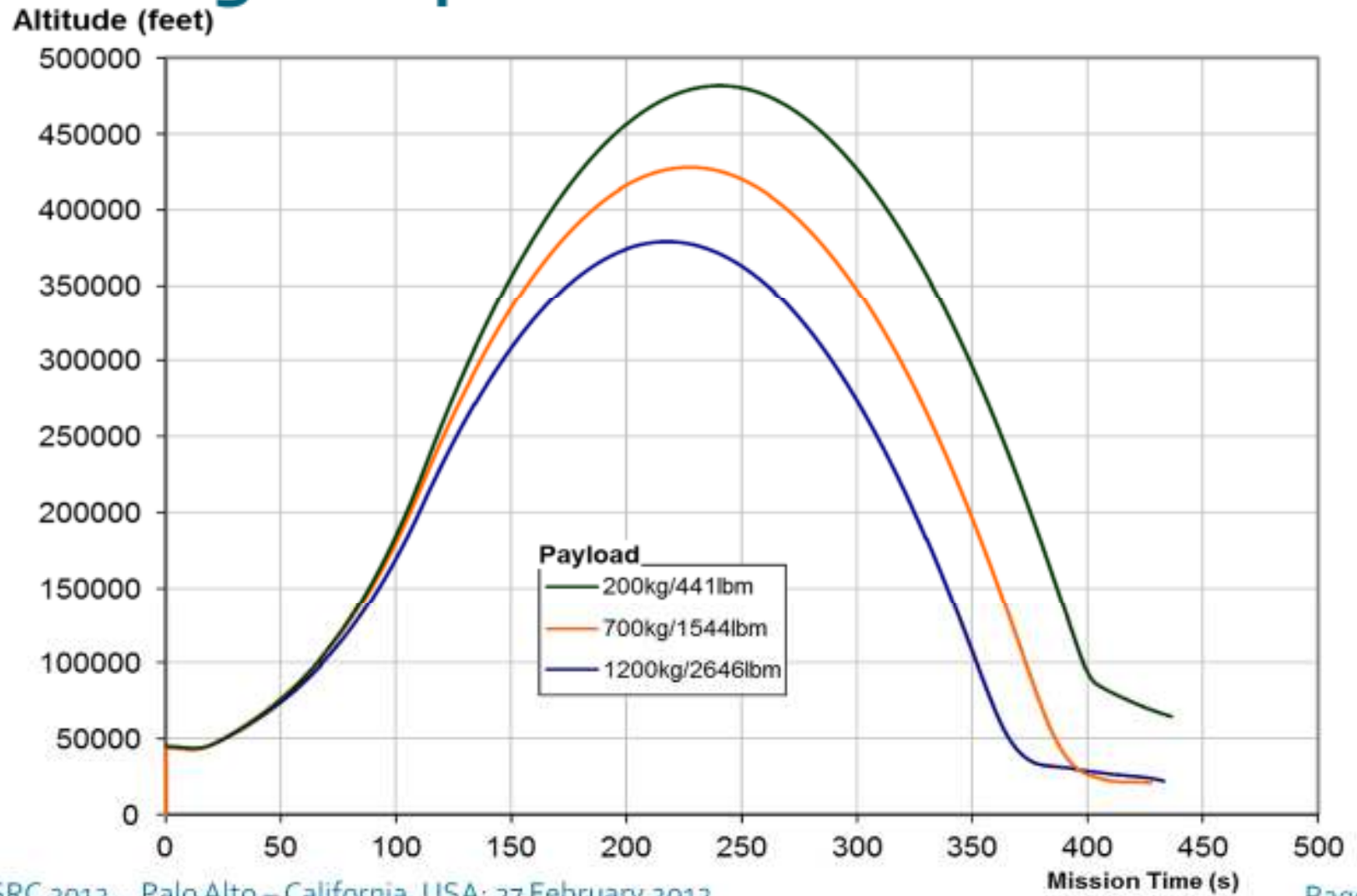
SOA Capabilities

- Accelerations <4g
- 2 pilots
- 1200kg(2800 lb) payload or up to 8 passengers (or a mix in-between), on a sub-orbital trajectory
 - 115 km to 150 km
 - 380kft
 - 490kft
- Pressurized cabin:
 - Volume = 40 m³
 - 1400cu.ft
 - Ø3 m x 6 m length
 - 10ft
 - 20ft

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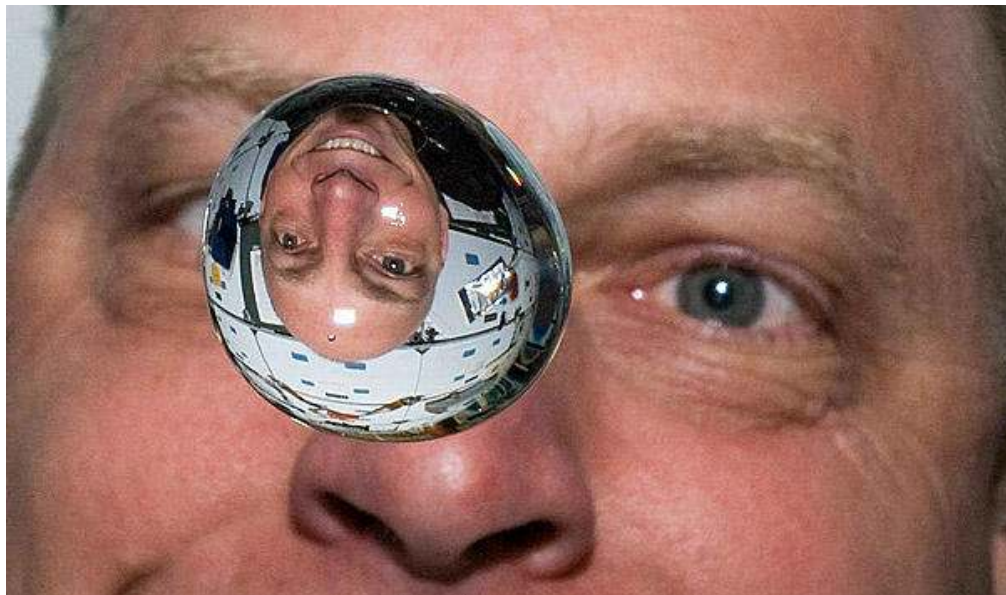


SOA Flight Capabilities




SOA Commercial Capabilities

- Carry passengers into the “Edge of Space”
∴ a free-fall portion that can present a low disturbing acceleration platform
i.e. for Microgravity Research



Thanks to astronaut Clayton Anderson of the Discovery STS-131 mission for a great photo. Courtesy of NASA 2010.

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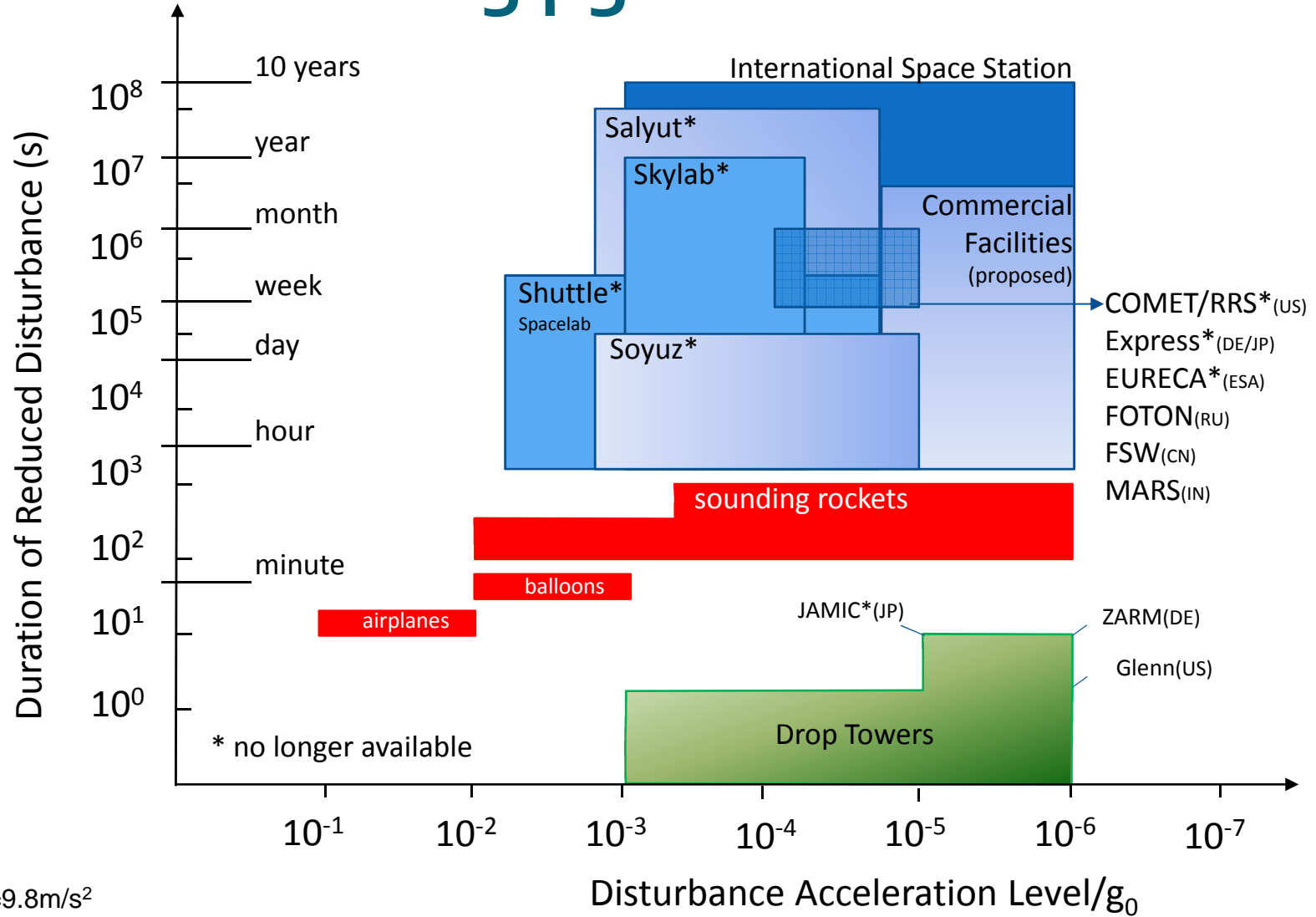


Flying Sub-Orbital Trajectories to Encounter Microgravity Conditions

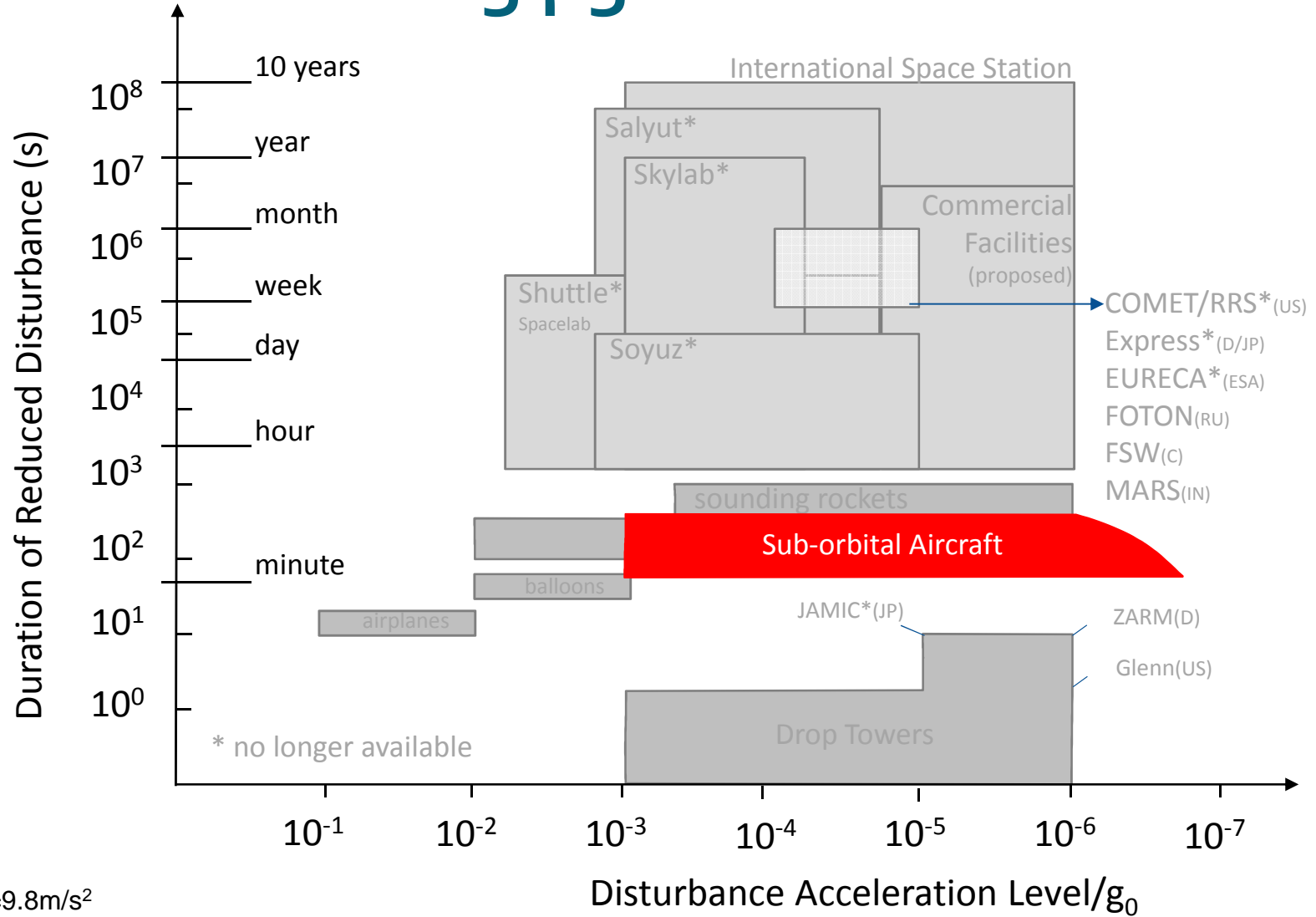
Today's Topics:

1. Benchmark μg research platforms
 - where is the potential for suborbital
2. a normal BOOSTER SOA freefall trajectory
 - Discuss Sources of Disturbing Accelerations
 - Present some Operational 'Observations'
3. Prescribe Improvements
 - to provide best quality & longest duration possible

1. Benchmarking μg Platforms

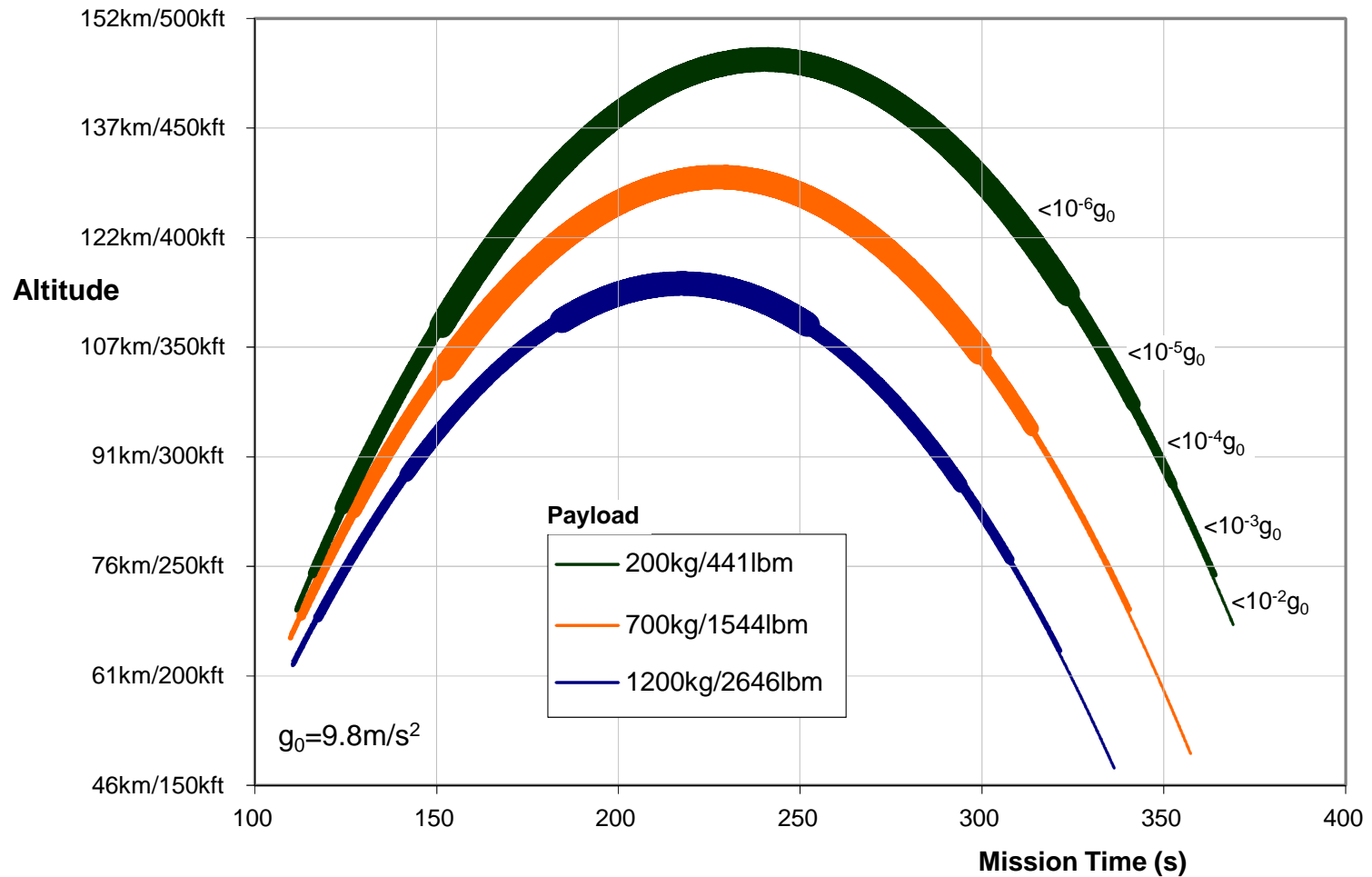


1. Benchmarking μg Platforms

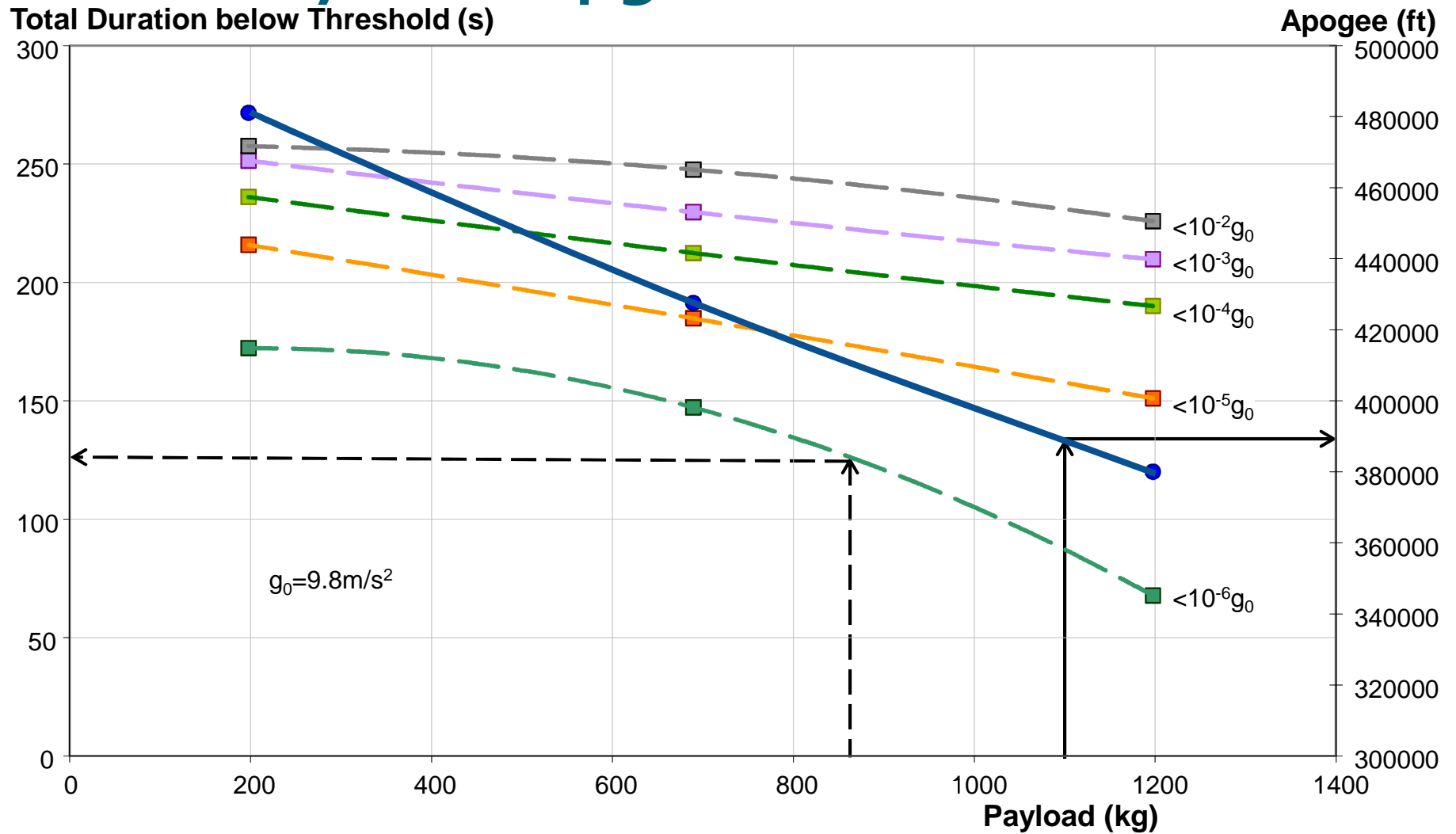


$g_0=9.8\text{m/s}^2$

2. Freefall Part of our Suborbital Trajectory



2. Quality of our μg Environment



2a. Real μg Environment is Degraded → work to mitigating its sources

- Classify Sources of Disturbance into 2 Categories:
 - CAT. 1: Quasi-static
 - Space-Time fabric
 - Atmosphere
 - CAT. 2: Vibration
 - Flexure
 - Systems
 - People
- decades of effort to mitigate these in spacecraft design
- compromises between: engineering limitations, operational requirements, and competing objectives

2b. Operational Rules can often be pretty detrimental to productive μ g research

- Safety Matters
 - But many of today's platforms are prohibitively restrictive for breakthrough/pioneering research
 - clearing an experiment for flight is much harder than conducting it
 - vast majority of human discovery has been accidental
 - from un-programmed & unscripted research: what if, what would happen if...
- Foster such an environment with 4 objectives:
 1. Reduce safety analysis back to something logical and reasonable
 2. Have a flight environment where precision diagnostic equipment originally designed for use on the ground can be attached to a 'homemade' experiment with minimal mods.
 3. Provide an 'uh-oh'/'accident' tolerant environment
 4. Fly the geniuses with their contraptions or at least give them real time tele-control

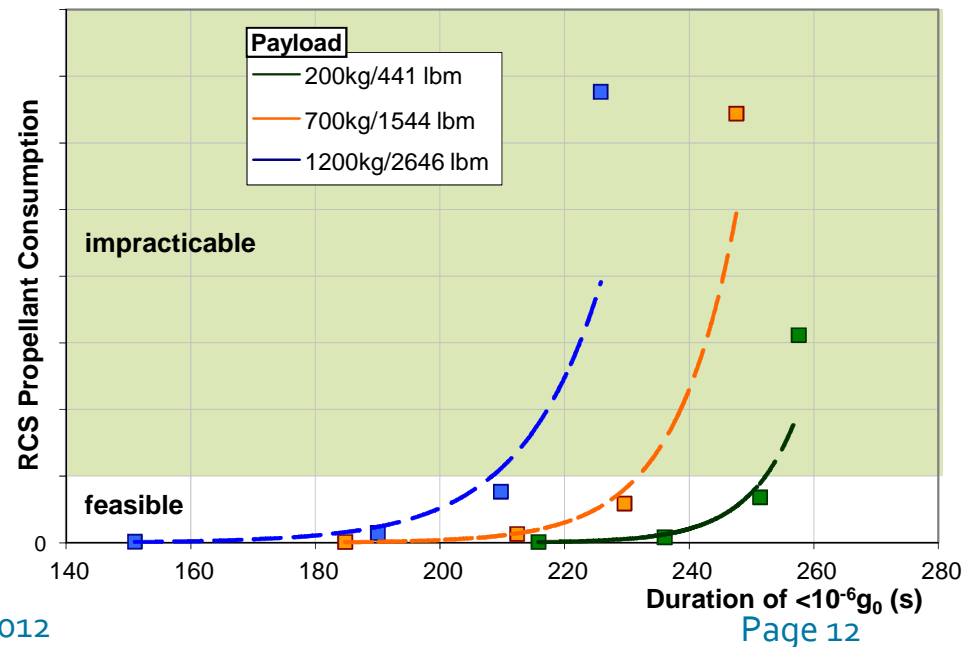
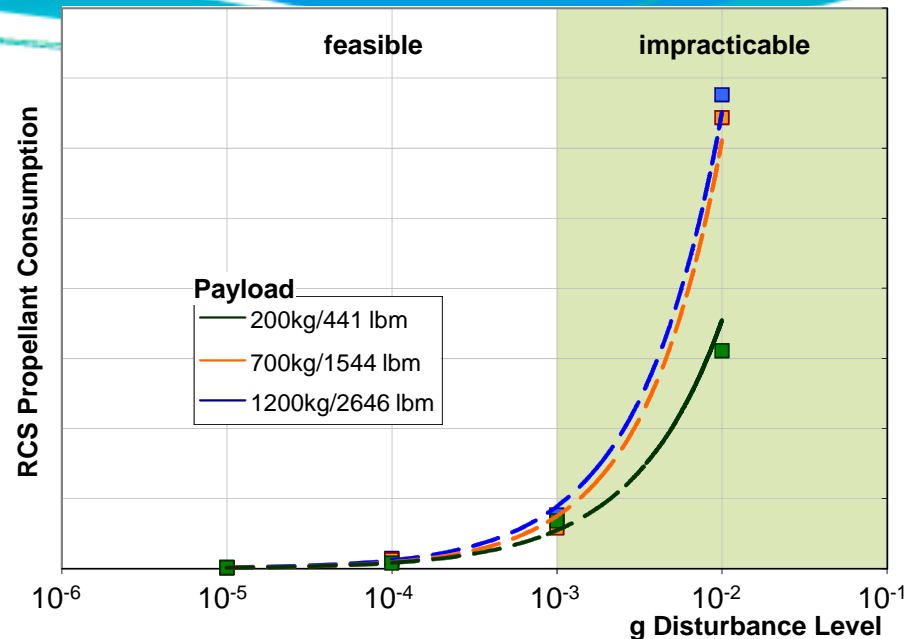
3a. Mitigating CAT. 1 disturbances

- lower velocities => smaller gradients => lower disturbances
- drag(force) compensation:
 - lowest drag flight path orientation
 - variable thrust Reaction Control System (RCS) to compensate atmospheric effects
 - disturbed $<10^{-3} g_0$ reduced to $<10^{-6} g_0$
 - Extend μg duration to 210-250s

NOTE: Compensating $>10^{-3} g$ CAT.1 disturbances is impracticable

- fuel use becomes substantial
- time gain is negligible

$g_0=9.8m/s^2$



3b. Mitigating S.O. Cat. 2 disturbances and some Operational Restrictions

'The Lab'

1. Physical & Electromagnetic Insulation of the Experiment

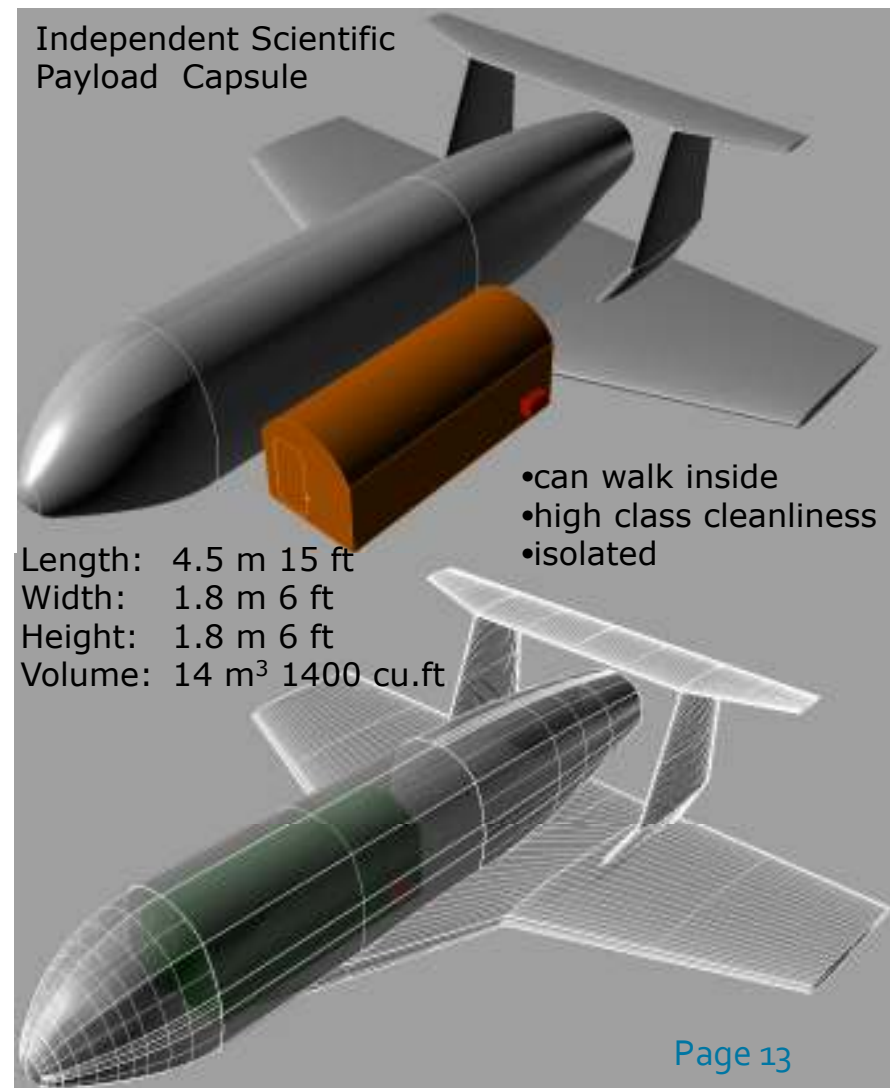
- Firewall from the Aircraft and its Systems

2. Physical Isolation

- can add floating shell within
 - like in some drop towers
 - $<10^{-5} g_0$ on airframe, within the shell experiences: $<2 \times 10^{-7} g_0$ for >1 minute

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Conclusions

- High Quality μg environment Platform being developed
 - >4 minutes continuous $<10^{-5}g_0$, 1200kg, 14 to 40m³, on-line by 2016
 - develop market by using preparatory campaigns with parabolic aircraft flights from 2014
- Realistic & Achievable safety criteria that favor experimentation and tolerate discoveries
- Competitively Priced

- Presentation/Paper Objective:
Present Customer Driven Technical and Operations Solution
 - Continue dialogue with the Community
 - Don't be shy; get in touch with us; what are your needs; what do you want to do; how can we serve you...

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