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**Stimulating the Commercial Space Transportation Industry  
to achieve  
Low-cost and Reliable Access to Space for the Nation**

Adopting an N.A.C.A. approach

To create a new partnership between U.S. Government and Industry

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TO: JUSTSAP

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# Executive Summary



- The Obama Administration has established objective of
  - “*stimulating commercial space flight capabilities*”
- Low-Cost and Reliable Access to Space (LCRATS)
  - Is critical to nation (civil, commercial, national security)
    - Primary Issue: “How do we achieve CATS?”, not “Should we?”
    - We have tried at least 3 times in last 3 decades, and failed
- NASA is developing a new (very old) approach
  - N.A.C.A. partnership approach is proven & successful
    - *Stimulated* world-leading aeronautics industry a Century ago
- NACA Approach — “Build an industry, not a program”
  - Inclusive interagency partnership (NACA was interagency)
  - Do not pick any 1 or 2 “winners”, “concepts”, “solutions”, etc.
  - Broadly *stimulate* emerging commercial space transportation industry
  - NASA is beginning to implement NACA approach for this purpose



## ➤ **LCRATS provides:**

- Benefits to science
- Improves affordability of human space flight
  - Resource limitations are barrier to human space exploration
  - Huge costs tied up in access to orbit
  - LCRATS creates NASA savings for beyond Earth orbit
- Significant national security benefits
- Commercial industry & job growth



- **White House direction to “Blue-Ribbon” Panel (May 7, 2009)**
  - *“The review panel will assess a number of architecture options, taking into account such objectives as:*
    - *2) supporting missions to the Moon and other destinations beyond low Earth orbit;*
    - *3) stimulating commercial space flight capabilities; and*
    - *4) fitting within the current budget profile for NASA exploration activities”*



## National Security Presidential Directive 40 (NSPD-40)

- *To exploit space to the fullest extent, however, requires a fundamental transformation in U.S. space transportation capabilities and infrastructure.*
- *The United States Government must capitalize on the entrepreneurial spirit of the U.S. private sector, which offers new approaches and technology innovation in U.S. space transportation, options for enhancing space exploration activities, and opportunities to open new commercial markets, including public space travel.*
- *Further, dramatic improvements in the reliability, responsiveness, and cost of space transportation would have a profound impact on the ability to protect the Nation, explore the solar system, improve lives, and use space for commercial purposes.*



- **National Aeronautics & Space Act of 1958, as amended**
  - *“preservation of the role of the United States as a leader in aeronautical and space science and technology;”*
  - *“seek and encourage, to the maximum extent possible, the fullest commercial use of space.”*
  
- **NASA Strategic Plan:**
  - *“Encourage the pursuit of appropriate partnerships with the emerging commercial space sector.”*

# Policy Statements of New Administrator

Senate Comm on Commerce, Sci and Trans, 8 July 2009

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- *“I now dream of a day when any American can launch into the vastness of outer space and see the magnificence and grandeur of our home planet, Earth, as I have been blessed to do.*
- *Lori and I can talk forever about the necessity to involve commercial entities, what I call entrepreneurial persons in establishing where we're going.*
- *the government cannot fund everything that we need to do, but we can inspire and open the door for commercial entrepreneurial entities to become partners with NASA*
- *Together we can find innovative ways to advance space exploration, reduce the costs of access to space and further push the boundaries of what we can achieve as a nation.”*

# Administrator Bolden Announces CRuSR

Speech to Nat'l Assoc. of Investment Companies, Oct. 20, 2009\*



- *NASA must determine efficient and effective ways to leverage the power, and innovation of American industry and the American entrepreneur.*
- *In the 1920s, the U.S. Post Office became a major customer for airmail, which created the demand that justified the private investment in many airlines.*
- *NASA is doing something similar right now. We are engaged in a new program — the Commercial Reusable Suborbital Research program — that will buy space transportation services from the emerging reusable spaceflight companies to conduct science research, technology development, with a keen focus on education.”*

\* [http://www.nasa.gov/pdf/395165main\\_Bolden\\_NAIC\\_Speech.pdf](http://www.nasa.gov/pdf/395165main_Bolden_NAIC_Speech.pdf)

NASA Press Release 09-238, October 13, 2009

- *"NASA is committed to stimulating the emerging commercial reusable launch vehicle industry,*
- *There is a natural evolutionary path from today's emerging commercial suborbital RLV industry to growing and developing the capability to provide low-cost, frequent and reliable access to low Earth orbit.*
- *One part of our plan is to partner with other federal agencies to develop a consensus roadmap of the commercial RLV industry's long-range technology needs."*

# Everybody wants LCRATS

## Real Question is “How”

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- United States has made 3 major attempts at LCRATS
  - In 1970s, Congress gave NASA tens-of-billions for Shuttle
  - In 1980s, Congress invested billions in NASP
  - In 1990s, Congress invested \$1.2 Billion in X-33
  
- All of these attempts failed
  
- A fourth emerging attempt collapsed in 2000s
  - USAF and NASA tried to create National Aerospace Initiative
  - The NAI proposal collapsed
    - When budget estimate reached \$50 Billion, and
    - Competitor for funding emerged (Vision for Space Exploration)

# We are Repeating History\*



- In 1898, Dept of War granted Dr. Sam Langley \$50,000
  - To invent the airplane
  - Was the largest federal R&D project in U.S. history
  - Langley was the clear choice to lead such this national project
    - He was nation’s leading expert on flight research
  - Langley promised to build an airplane within one year
  - Langley took 5 years, and overran budget by \$20,000
  - When he failed, he was not close to inventing a practical airplane
  - Embarrassed, Department of War shut down the project
  - In 1903, two bicycle-shop mechanics invented the airplane
    - Wright Brothers spent \$1,000 of their own money
  
- These historical events have one thing in common
  - Centrally-planned programmatic approach to “pick a winner”
  
- **SOLUTION:**
  - Utilize an open innovation approach
  - Adopt NACA approach ... “Build an industry, not a program”

# NACA's Mission was (in part) to *Stimulate an Industry Capability*

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- “... the members of the NACA believed to a man that the future of aviation in the United States depended on a healthy and prosperous aircraft-manufacturing industry, and
- that it was the NACA's duty to help where it could.
- From the outset, the NACA was an industry booster limited only by its need to be fair and impartial in disbursing favors and assistance.”

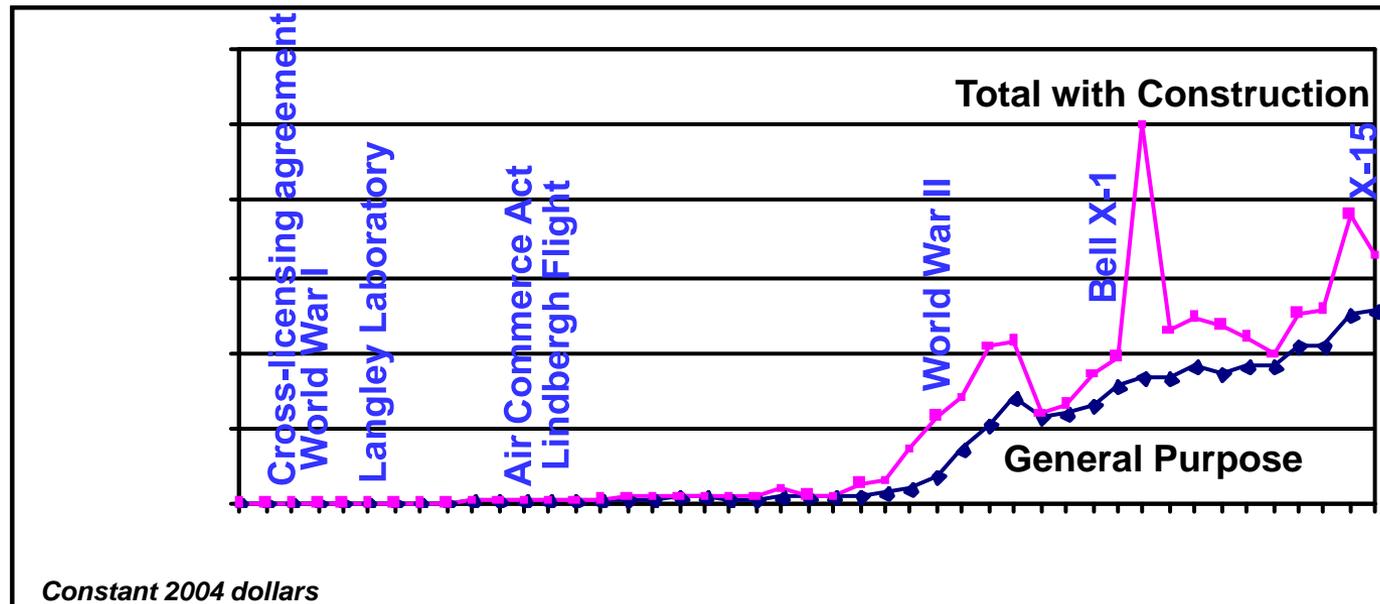
— Alex Roland, “Model Research”, NASA History SP-4103, page 34

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# NACA Early History



- NACA brought together diverse federal agencies
  - Army, Navy, Smithsonian, Bureau Standards, Weather Bureau
  - Committee developed national consensus on critical problems
- NACA had greatest impact in early decades
  - When its budget was lowest
  - Coordination/cooperation function was as important as R&D



Source: Gary Oleson, Northrop Grumman IT TASC, "Toward Frequent, Affordable Space Access," Space Frontier Conference 14, Los Angeles, CA, October 2005

# NACA's Early Successes

did not involve lots of cash

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- NACA took “holistic” systems view of national priorities
    - Clearly focused on building a healthy competitive industry
  
  - Solved practical aviation problems for U.S. Govt & industry
    - Facilitated aircraft patent cross-licensing agreement
      - Ended destructive U.S. industry patent fight between Wright's & Curtiss
    - Created cooperative partnerships between government & industry
      - Intervened on WWI aircraft engine deadlock resulting in Liberty engine
    - Started advocating purchase of air mail services (beginning in 1916)
      - Leading to Kelly (Air Mail) Act in 1925
    - Persuaded commercial insurers to start insuring aviation
    - Recommended budget increase to President for Weather Bureau
      - to promote safety in aeronautics
    - Recommended the creation of Bureau of Aeronautics
      - Predecessor of the Federal Aviation Administration
    - Developed methods for mapping from planes
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# NACA Technical Successes

## Also Critical, But Came Later

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- Langley wind tunnel begins research operations in 1920
  - Produced many broad technical advancements
    - Specialized in drag reduction for all vehicles
    - Openly published test data
    - Developed low-drag engine cowling
    - De-icing, airfoils, variable pitch propeller, etc.
  - **KEY POINT:**
    - NACA focus was still on needs of external customers
      - Solving prioritized “practical problems” of DoD & Industry
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# Another Benefit of NACA Approach

## A National Consensus on Priorities



- **NACA structure generates holistic consensus on**
    - Priority problems of industry and government users
  
  - **Benefits of national consensus on priorities**
    - Breaks through the background noise of competing voices
    - Enables each USG agency to be more effective in activities
    - Clearly communicates prioritized problems
  
  - **Holistic approach eliminates gaps in problem solving**
    - Each committee member at the table will have its own focus
    - But committee “as a whole” can take broad “systems” view
      - About all the practical problems that must be solved
    - Defining the “top problems” is half the battle
    - If a top priority problem can’t be addressed by committee
      - The committee can make recommendations (as appropriate)
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# Examples of Use of NACA Model in other focus areas

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- **National Defense Research Committee (WWII)**
    - Led by Vannevar Bush, Chairman of NACA
    - To improve coordination/cooperation among scientists
    - Produced critically needed innovation in War War II
      - Radar, sonar, proximity fuses, bomb sights, amphib. vehicles
      - Set up Manhattan Project
  
  - **Advanced General Aviation Transport Experiments (AGATE)**
    - Led by Bruce Holmes & NASA Langley RC (1994-2001)
    - Problem: Decline of American general aviation (small planes)
    - Formed consortium of more than 70 organizations
      - Conducted consensus-based research of broad utility to industry
    - Utilized NASA “Joint Sponsored Research Agreement”
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- <http://www.nasa.gov/centers/langley/news/factsheets/AGATE.html>

# NASA Beginning an NACA Approach for LCRATS

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- 1) Commercial Responsive Access to Space Tech Exchange**
  - a) A technology exchange between NASA, USAF and industry
  - b) Government acts as a “marriage broker” to bring RLV industry together
  - c) Annual event, rotating between USAF/NASA locations
  
- 2) Commercial Reusable Launch Vehicle Tech Roadmap**
  - a) Study beginning now.
  
- 3) Commercial Reusable Suborbital Research (CRuSR)**
  - a) To purchase “space transportation services” from commercial RLV industry as soon as they are available. — perhaps as soon as 2010.
  - b) Intended to stimulate RLV industry as airmail stimulated airplane industry
  - c) Will initially purchase automated experiments for research, education, and technology development purposes.



- NASA partnership with USAF and FAA-AST
  - Focused primarily on understanding “commercial industry needs”
- Primary Goal:
  - Accelerating development of Commercial Reusable Launch Vehicles
    - that have significantly lower cost, and improved reliability, availability, launch turn-time, and robustness compared to current launch systems.
- Planned Outputs:
  - Roadmaps with recommended government technology tasks and milestones for the four different vehicle categories
    - Including initial budget and resource requirement estimates
  - Final roadmap ready for publication in May 2010
- For more information, <http://csi.arc.nasa.gov/crlv>

# Commercial Reusable Suborbital Research prog (CRuSR) — Why Suborbital?



	<b>Sounding Rocket s</b>	<b>Commercial Suborb ital</b>	<b>Parabolic Flights</b>
<b>Cost</b>	\$0.5 M - \$1.2M	\$200K	\$8K
<b>Time in Microgra vity (Contin uous)</b>	20 minutes	4 minutes	23 seconds
<b>Quality of Microgra vity</b>	High	High	Com parat ively Low
<b>Lau nch Freq uency</b>	Once every 6 months	Multiple flights per day poss ible	Multiple flights per day poss ible
<b>Maxim um g-Loading</b>	20 g	2 Š 4 g	2 Š 4 g
<b>Human Tended Scie nce</b>	No	Yes	Yes
Comparing commercial suborbital rese arch platfor ms with two oth er micrograv ity rese arch platfor ms			

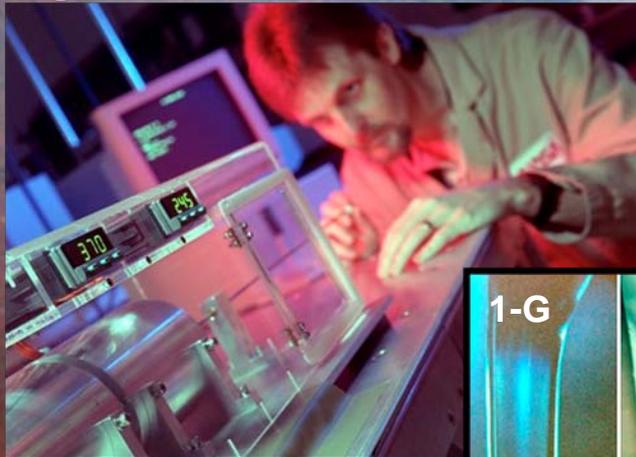
# 4 Minutes of Microgravity



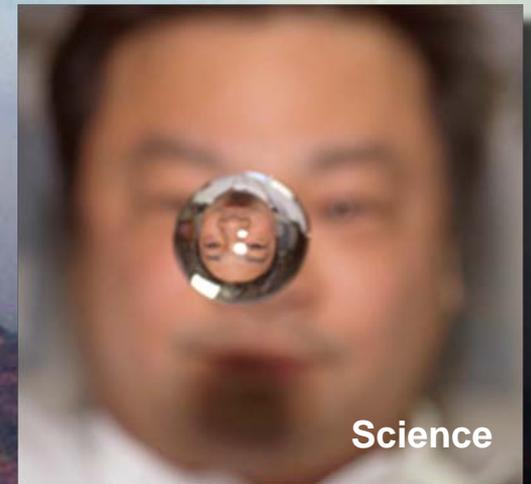
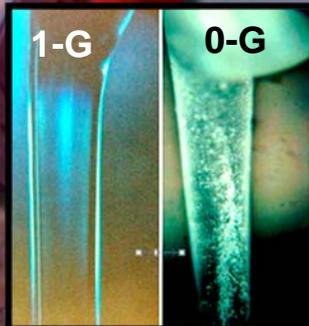
Testing



Emergency Procedures



Technology Development



Science

# NASA Sponsored Two Workshops With Researchers in 2009



NASA has started asking scientists and researchers

- “What could you do with 4 minutes of frequent, low-cost, microgravity”?

**Human Suborbital  
Provider-Investigator  
Workshop**

**Dec. 15, 2008**

**AGU Fall mtg**



**Human Suborbital  
Provider-Investigator  
Workshop**

**May 3, 2009**

**AMA 80<sup>th</sup> Annual mtg**

# Commercial Reusable Suborbital Research (CRuSR) — Some Areas of Interest

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- ***Sensing***
- ***Climaterics***
- ***Vertical Atmospheric Sampling***
- ***Gene Expression***
- ***Fluids***
- ***Physiology***
- ***Emergency Procedures***
- ***Countermeasures***
- ***Cardiovascular Deconditioning***
- ***Workforce Development***
- ***Resistive Exercise Devices***
- ***Inner Ear Neural Signal***
- ***Dust Particle Agglomeration***
- ***Metal Alloy Phase Separation***
- ***Glovebox Investigations***
- ***Combustion***
- ***IR and NIR Optics***
- ***Technology Testing***
- ***STEM Education***
- ***Cell Cultures***

# 4 Minutes to Save a Life in Microgravity

## A is for Airway

*The human body has 4 minutes of useful brain function in a deoxygenated state*

### Airway Pack - Example of Medical Challenges in Microgravity:

#### Contact Surfaces

- ◆ Power ports and batteries
- ◆ Airway instruments
- ◆ Timers
- ◆ Tape and Velcro
- ◆ Writing instruments and boards
- ◆ Hardware attachment points
- ◆ Data capture and downlinks
- ◆ Software and monitors
- ◆ Sensors and contact points
- ◆ Trash containment
- ◆ Restraints, tethers
- ◆ Light bulbs
- ◆ Stethoscopes
- ◆ Inflated Masks

#### Fluid Management

- ◆ Tubings
- ◆ Seals and gaskets
- ◆ Water-sealed plastic casings
- ◆ Connectors
- ◆ Fluids and gels
- ◆ Ventilation bag and balloons
- ◆ Portable ventilator and suction devices
- ◆ Syringes and sharps safety

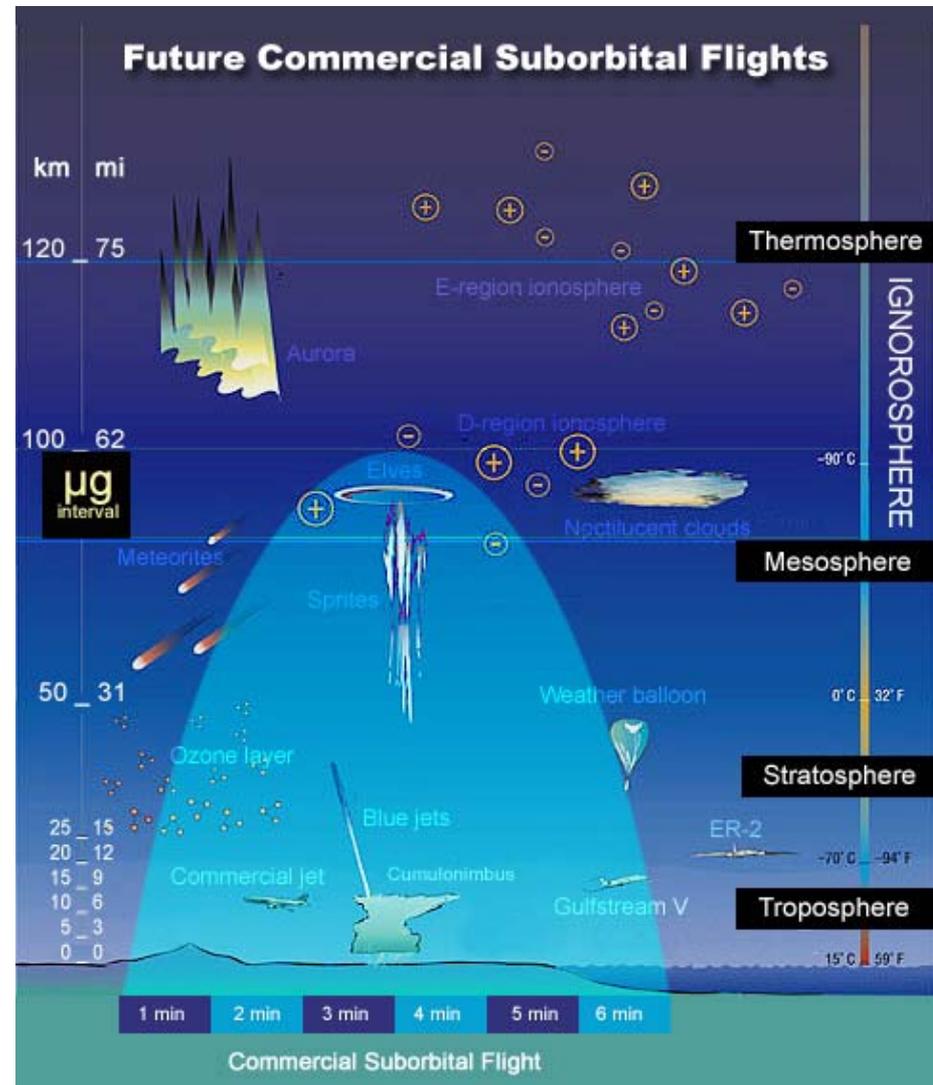


# CRuSR and the Earth's Ignorasphere

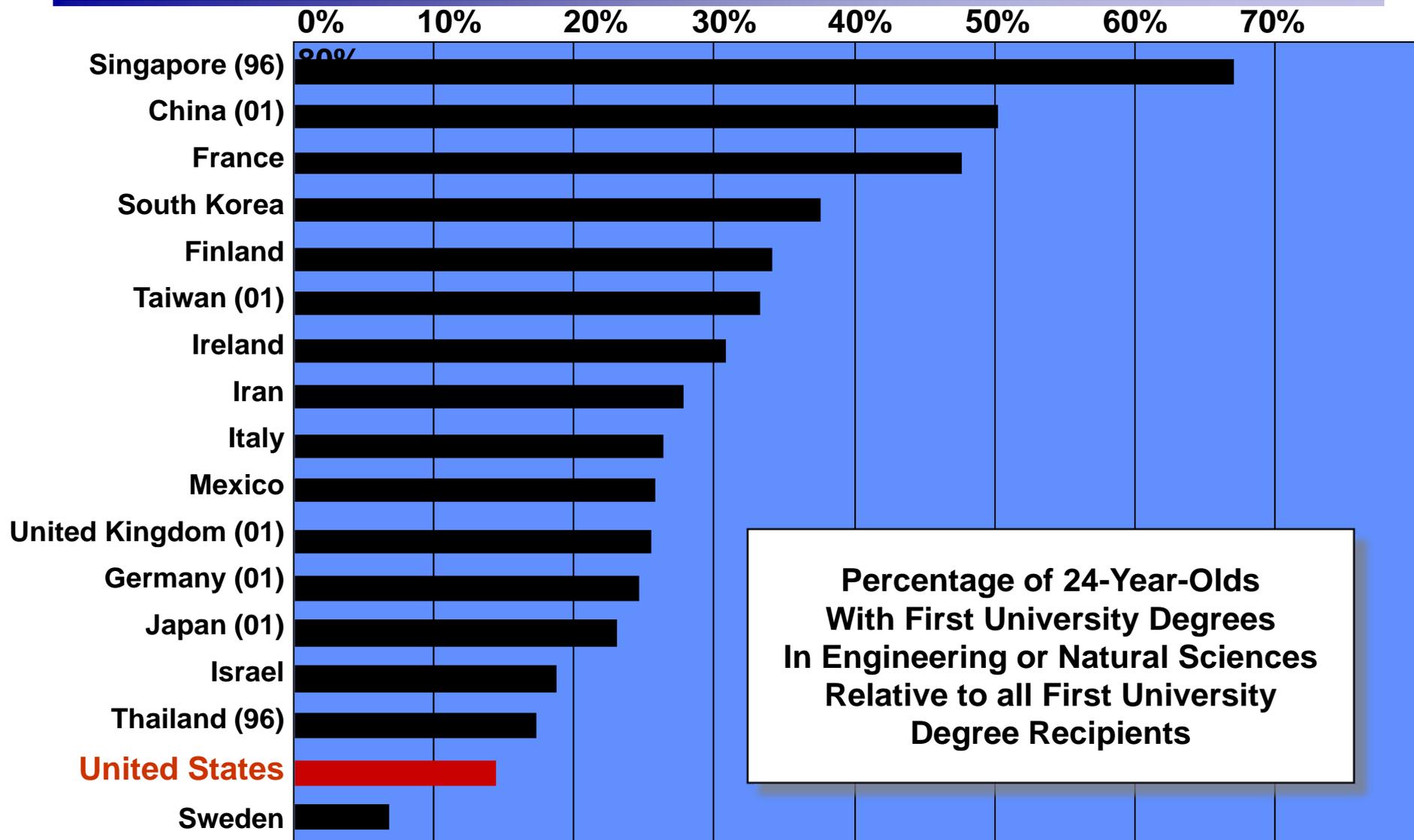


## Ignorasphere

- Above high-altitude balloons
- Below satellites
- Generally 80-120 km



# U.S. has a STEM education problem



Percentage of 24-Year-Olds With First University Degrees In Engineering or Natural Sciences Relative to all First University Degree Recipients

# Commercial Suborbital RLVs Could Be a Gamechanger for Education

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- President has asked NASA to “inspire” again
- If Commercial Suborbital RLVs succeed
  - Could be a gamechanger for inspiration & education
- Some possibilities to consider:
  - Young children will see hundreds, if not thousands,
    - Of people travelling to space each and every year
  - Low-cost frequent predictable flights to space enable
    - Incorporation as a baseline experiment in semester courses
    - Likely to be used in research courses nationwide
  - Private non-profits are proposing:
    - Nation should fly hundreds of teachers per year into space, and
      - Put them right back into the classroom
    - National competitions w/ grand prize for students to fly in space

# Leave Behind Questions for JUSTSAP

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- What are JUSTSAP's ideas for inspiring the next generation?
- How might JUSTSAP support the emerging open innovation agenda at NASA to stimulate commercial space transportation?
- What are JUSTSAP's ideas to encourage and promote innovative commercial space partnerships between the U.S. and Japanese industry, and their governments?

# For More Information

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