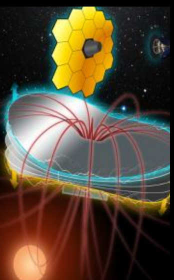
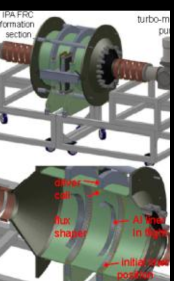
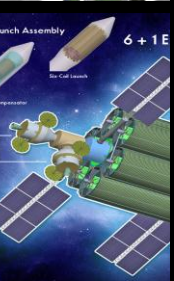
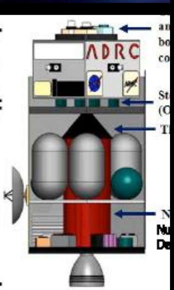
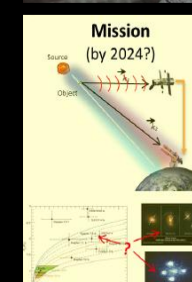






NASA INNOVATIVE ADVANCED CONCEPTS
2012 FALL SYMPOSIUM

Dr. Jay Falker
Program Executive
NASA Innovative Advanced Concepts
NASA Headquarters

November 14-15, 2012
Crowne Plaza Hotel
Hampton, Virginia



NIAC
NASA Innovative Advanced Concepts

www.nasa.gov/niac

Meeting Overview

Day One: November 14, 2012	
9:00	Introduction/Welcome
9:10	NIAC Overview
9:30	Phase I Introductions
10:15	Break
10:45	Keynote Address
11:30	Lunch
1:00	Bong Wie
1:30	William Whittaker
2:00	Shayne Westover
2:30	Break
3:00	Dmitry Strekalov
3:30	John Slough
4:00	Poster Sessions
5:00	Adjourn

Day Two: November 15, 2012	
8:00	Keynote Address
9:00	Welcome
9:15	Phase I Introductions
10:15	Break
10:45	NIAC Plans
11:30	Lunch
1:00	Kendra Short
1:30	Joe Ritter
2:00	David Miller
2:30	Break
3:00	Berok Khoshnevis
3:30	Kevin Duda
4:00	Poster Sessions
5:00	Adjourn

Day 1 Outline

- **Introduction & Welcome**
- **NIAC Overview**
- **Phase I Introductions**
- **Keynote Address: Dr. Penny Boston**
- **Lunch Break**
- **Phase II Presentations**
- **Phase I Poster Session**

INTRODUCTION & WELCOME

Wednesday, November 14, 2012

NIAC
NASA Innovative Advanced Concepts

www.nasa.gov/niac

What is NIAC ?

NASA Innovative Advanced Concepts

NASA Innovative
Advanced Concepts

A program to support
early studies of
innovative, yet
credible, visionary
concepts
that could one day
“change the possible”
in aerospace.

NIAC Program Personnel

- Program Executive: **Jay Falker***
- Program Manager: **Jason Derleth***

- Senior Science Advisor: **Ron Turner**

- Outreach Coordinator: **Kathy Reilly**

- Financial Analyst: **Anita Babb-Bascomb***

** NASA Civil Servants*

- NIAC External Council Chair: **Bob Cassanova**

Director of the original NIAC from 1998-2007

"Don't let your preoccupation with reality stifle your imagination"

BOAT ROCKERS, REBELS, RISK TAKERS, DEVIATORS FROM THE NORM, INNOVATORS, CHAMPIONS, REVOLUTIONARIES, MOVERS & SHAKERS, INVENTORS, RABBLE ROUSERS, FLY IN THE FACERS, REFORMERS, WAVE MAKERS, BOUNDARY PUSHERS & OUT OF THE BOX THINKERS...

Image: NASA, CW Leo

W E L C O M E T O...

NIAC

NASA Innovative Advanced Concepts

www.nasa.gov/niac

Office of the Chief Technologist

Integrates Technology Investment Across the Agency

Serves as Advisor to Administration

STP

Direct Technology Management and Budget Authority for the Space Technology Program

Office of the Chief Technologist

Leads Tech Transfer, Partnerships and Commercialization Activities Across the Agency

Advocates Externally NASA's R&D Programs

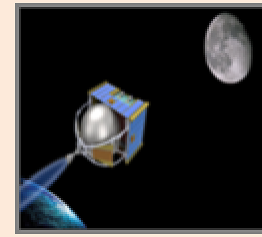
Demonstrates and Communicates Societal Impacts of NASA Technology Investments

Space Technology Programs

Transformative & Crosscutting Technology Breakthroughs

Game Changing Development Program

Technology Demonstration Missions Program



Small Spacecraft Technologies Program

Pioneering Concepts/ Developing Innovation Community

Space Technology Research Grant Program

NASA Innovative Advanced Concepts (NIAC) Program

Center Innovation Fund Program

Creating Markets & Growing Innovation Economy

Centennial Challenges Prize Program

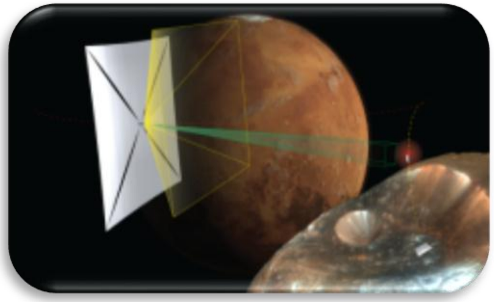
Small Business Innovation Research & Small Business Technology Transfer (SBIR/STTR) Program

Flight Opportunities Program

Guiding Principles of the Space Technology Program

Space Technology Program

- **Adheres to a Stakeholder Based Investment Strategy:** NASA Strategic Plan, NASA Space Technology Roadmaps / NRC Report and Strategic Space Technology Investment Plan
- **Invests in a Comprehensive Portfolio:** Covers low to high TRL, student fellowships, grants, prize competitions, prototype developments, and technology demonstrations
- **Advances Transformative and Crosscutting Technologies:** Enabling or broadly applicable technologies with direct infusion into future missions
- **Selects Using Merit Based Competition:** Research, innovation and technology maturation open to academia, industry, NASA centers and other government agencies
- **Executes with Structured Projects:** Clear start and end dates, defined budgets and schedules, established milestones, and project authority and accountability.
- **Infuses Rapidly or Fails Fast:** Rapid cadence of technology maturation and infusion, informed risk tolerance to infuse as quickly as possible
- **Positions NASA at the cutting edge of technology:** Results in new inventions, enables new capabilities and creates a pipeline of innovators for National needs



NIAC OVERVIEW

NIAC
NASA Innovative Advanced Concepts

www.nasa.gov/niac

NIAC Founding Philosophy

Visionaries and geniuses share common traits:

The ability to transcend life's experiences and leap vast intellectual distances to set a new course for others to follow.

Imagination and visualization are generally the first step in learning, or creating, something radically new.

Genius is the ability to transcend experience and "The Rules"

"You cannot depend on your eyes when your imagination is out of focus" -- Mark Twain

NIAC Scope, Awards, & Culture

- NIAC supports early studies of visionary aerospace concepts. These must be…
  - Aerospace *architecture*, *mission*, or *system* concepts (not focused tech.)
  - **Exciting**: offering a potential breakthrough or revolutionary improvement
  - **Unexplored**: novel, with basic feasibility and properties unclear
  - **Credible**: sound scientific/engineering basis and plausible implementation
- NIAC awards support 2 phases of study:
  - **Phase I**: up to $100K, ~9 months, for concept definition and initial analysis in a mission context
  - **Phase II**: up to $500K, 2 years, for further development of most promising Phase I concepts, comparative mission analysis, pathways forward
- NIAC networking, outreach, and inspiration are also key:
  - Fall Symposium: status presentations by the Phase II Fellows
  - Spring Symposium: mid-term presentations on the Phase I Studies
  - Conferences / Websites / Articles / Interviews / Radio Spots …

What Opportunities does NIAC Offer?

Phase I Solicitation
Open to everyone (US)
Date: early Jan. 2013

Phase II Solicitation
Eligible upon Phase I completion
Date: late May 2013

NIAC Spring Symposium
Open to everyone
Date: March 2013

NIAC Fall Symposium
Open to everyone
Date: November 2013

Open access to presentations/studies at:
www.nasa.gov/niac

Outreach

We encourage communication and sharing

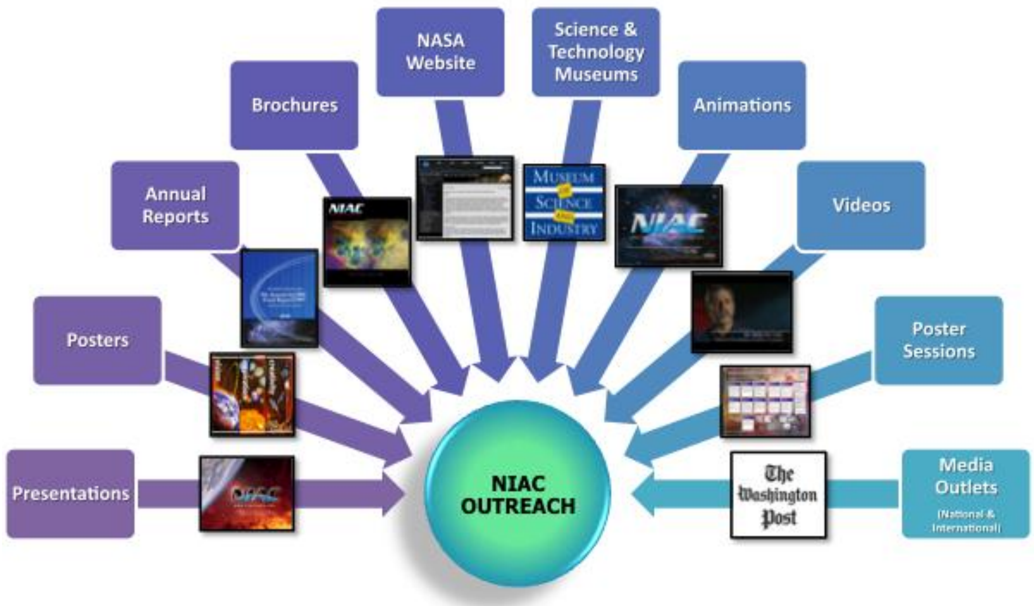
Between Fellows and with NASA, public, press, and other orgs

Your Spring presentation and Final Report will be *public*

Posted in pdf format on the NIAC website

Sensitive information can be protected (e.g., separate appendix)

Chicago Museum of Science & Industry, NIAC Education & Public Outreach Initiative: “From Science Fiction to Science Fact” Lecture Series

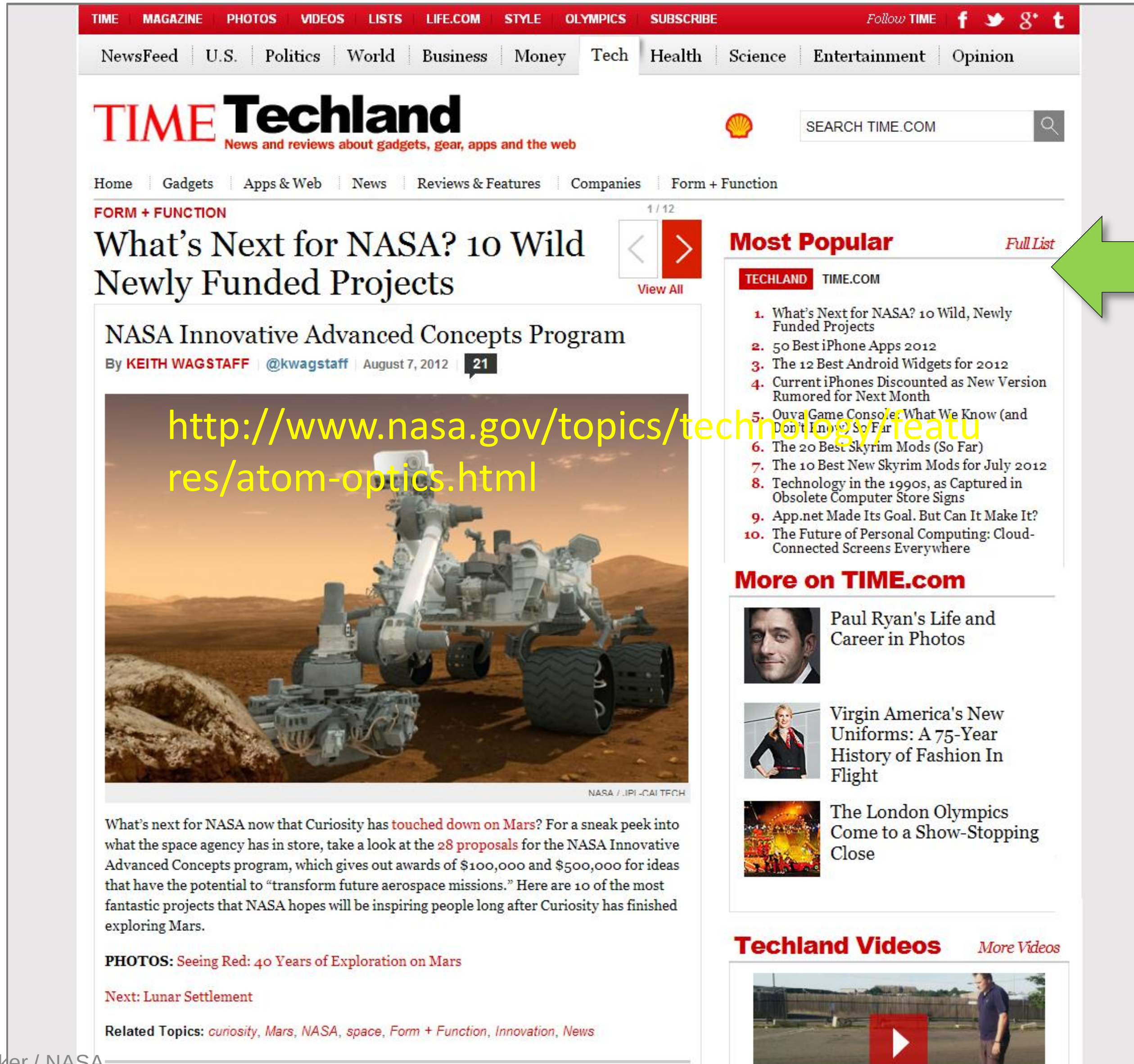


NIAC In The News

Media Coverage In Hundreds of Articles Since First Awards Announcement (08/08/11)

MSNBC
ASTROBIOLOGY MAGAZINE
NewScientist
Next Big Future
SPACE.com
UNIVERSE TODAY
AAAS ADVANCING SCIENCE, SERVING SOCIETY
POPULAR SCIENCE THE FUTURE NOW
ALL TECH NEWS
The Washington Post
NATIONAL INSTITUTE OF AEROSPACE
VOA VOICE OF AMERICA
SPACE DAILY your portal to space
USC UNIVERSITY OF SOUTHERN CALIFORNIA
INTERNATIONAL BUSINESS TIMES
Phoenix Online News
dt DIGITAL TRENDS
THE WHITE HOUSE WASHINGTON
PITTSBURGH BUSINESS TIMES
PENNSTATE 1855
SPACE POLICY ONLINE
ROCHESTER INSTITUTE OF TECHNOLOGY R·I·T 1829
U.S. Politics Today AN EIN NEWS SERVICE FOR POLITICAL PROFESSIONALS
PORTAL TO THE UNIVERSE
sculpteo
Orlando Sentinel
Iowa State University College of Engineering
CRAZYENGINEERS UNITING ENGINEERS ACROSS THE WORLD

NIAC In The News


TIME | MAGAZINE | PHOTOS | VIDEOS | LISTS | LIFE.COM | STYLE | OLYMPICS | SUBSCRIBE | Follow TIME

NewsFeed | U.S. | Politics | World | Business | Money | Tech | Health | Science | Entertainment | Opinion

TIME Techland
News and reviews about gadgets, gear, apps and the web

SEARCH TIME.COM

Home | Gadgets | Apps & Web | News | Reviews & Features | Companies | Form + Function

FORM + FUNCTION

What's Next for NASA? 10 Wild Newly Funded Projects

1 / 12
View All

NASA Innovative Advanced Concepts Program

By KEITH WAGSTAFF | @kwagstaff | August 7, 2012 | 21

NASA / JPL-CALTECH

What's next for NASA now that Curiosity has touched down on Mars? For a sneak peek into what the space agency has in store, take a look at the 28 proposals for the NASA Innovative Advanced Concepts program, which gives out awards of $100,000 and $500,000 for ideas that have the potential to "transform future aerospace missions." Here are 10 of the most fantastic projects that NASA hopes will be inspiring people long after Curiosity has finished exploring Mars.

PHOTOS: Seeing Red: 40 Years of Exploration on Mars

Next: Lunar Settlement

Related Topics: *curiosity, Mars, NASA, space, Form + Function, Innovation, News*

Most Popular *Full List*

TECHLAND | TIME.COM

1. What's Next for NASA? 10 Wild, Newly Funded Projects
2. 50 Best iPhone Apps 2012
3. The 12 Best Android Widgets for 2012
4. Current iPhones Discounted as New Version Rumored for Next Month
5. Ouya Game Console: What We Know (and Don't Know) So Far
6. The 20 Best Skyrim Mods (So Far)
7. The 10 Best New Skyrim Mods for July 2012
8. Technology in the 1990s, as Captured in Obsolete Computer Store Signs
9. App.net Made Its Goal. But Can It Make It?
10. The Future of Personal Computing: Cloud-Connected Screens Everywhere

More on TIME.com

Paul Ryan's Life and Career in Photos

Virgin America's New Uniforms: A 75-Year History of Fashion In Flight

The London Olympics Come to a Show-Stopping Close

Techland Videos *More Videos*

http://www.nasa.gov/topics/technology/features/atom-optics.html

#1 Most Popular Article on TIME.com (08/14/12)

Publicity

- **Please be sure to credit NASA and NIAC in all articles or products associated with your NIAC studies**
  - Include the logos if possible (downloadable from our website)
  - Mention your NIAC award as funding/contributing to your effort

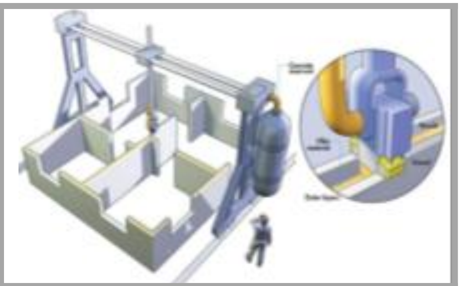
- **Please notify Kathy Reilly of any publicity activities**
  - Just to be aware (never to interfere)
  - We can help point others to your work

- **You may be contacted by someone offering an article or short radio spot about your NIAC study**
  - Leonard David (journalist for Space.com, Space News, AIAA Aerospace America) is supporting NASA HQ, increasing awareness about STP projects
  - Tim Allen, Communications Director for the ***Innovation Now*** radio program, is interested in featuring NIAC studies
  - These opportunities are purely optional

NIAC- Inspiring Economic Benefits for the Nation

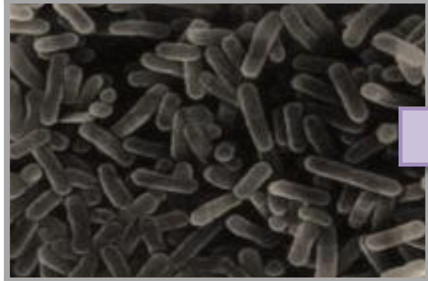
3-D Printing the Home of the Future

Emergency Construction for natural disasters, eradicate slums in developing countries



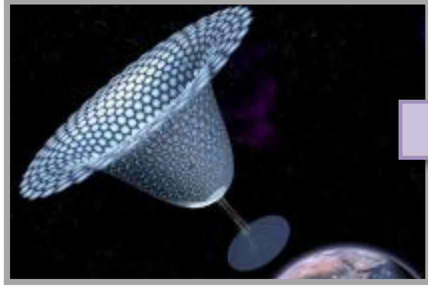
Improving Health With Spacesuit Technology

Medical rehabilitation and physical therapy for individuals affected by stroke, spinal cord injuries, brain injuries, and the elderly.



Bacterial Batteries

Novel Energy Source: Bacterial Microbes to power up robots



Space-Based Solar Power

Power transmission to Earth for use during power outages, after natural disasters, to those in remote areas or by the military.

2012 NIAC Studies: 5 Group Overview

Revolutionary Construction
SpiderFab
Orbiting Rainbows
ISRU Robotic Construction
E-M Deployment/Structures
OCCAMS
Printable Spacecraft

Human Systems
Water Walls
Solid State Air Purification
V2Suit
Magnetic Radiation Protection

Sensing/Imaging
HOMES
NIST in Space
Atom Interferometry
Ghost Imaging

Autonomous Exploration
Super Ball Bot
RAP
Regolith Biters
Venus Landsailing Rover
EUROPA
Cavehopping Planetary Tunnels
Extreme Environmt. Sample Return

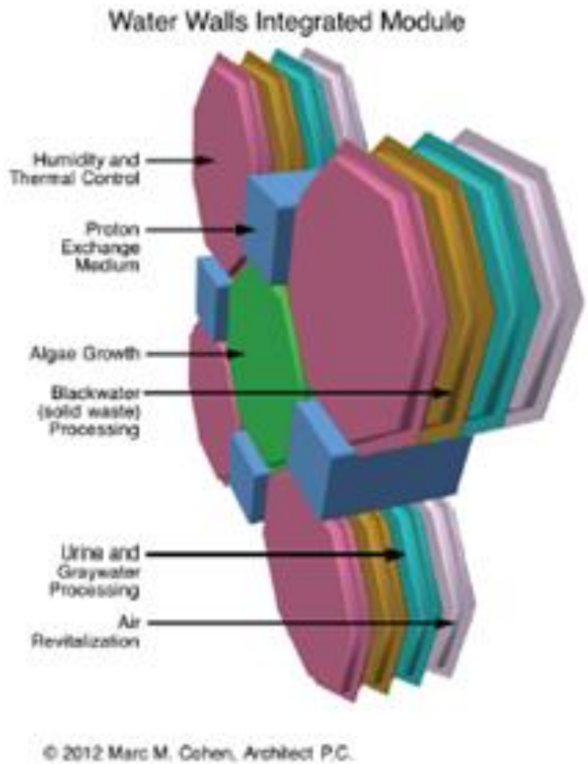
Transportation/NEO Mitigation
NanoTHOR
Plasma Aerocapture & Entry System
SSEARS
MAGNETOUR
Bi-Directional Flying Wing
Fusion Driven Rocket
NEO Impact Threat Mitigation

*Blue denotes Phase II Studies

PHASE I INTRODUCTIONS (Part I)

Water Walls: Highly Reliable and Massively Redundant Life Support Architecture

Michael Flynn, NASA ARC



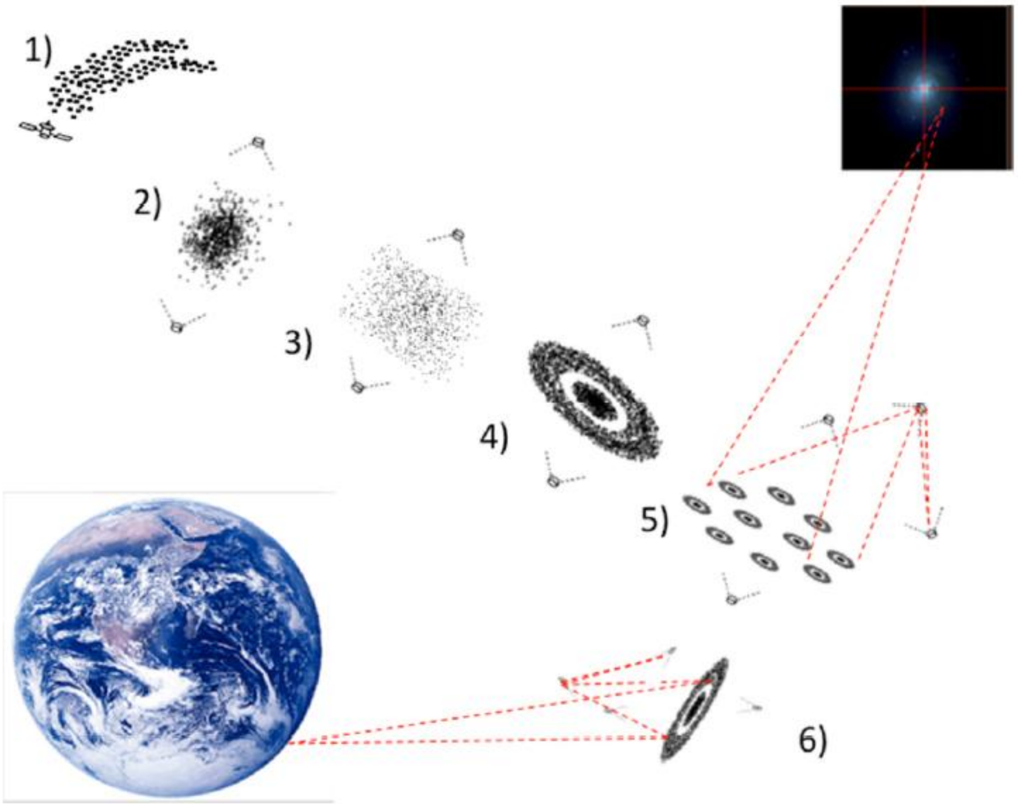
WATER WALLS (WW) takes an analogous approach to providing a life support system that is biologically and chemically passive, using mechanical systems only for plumbing to pump fluids such as gray water from the source to the point of processing. The core processing technology of Water Walls is FORWARD OSMOSIS (FO). Each cell of the WW system consists of a polyethylene bag or tank with one or more FO membranes to provide the chemical processing of waste. WW provides four principal processing functions in four different cell types:

- Gray water processing for urine and wash water
- Black water processing for solid waste
- Air processing for CO_2 removal and O_2 revitalization
- Food growth using green algae

WW also provides radiation protection to the crew habitat (all cells).

Orbiting Rainbows: Optical Manipulation of Aerosols and the Beginnings of Future Space Construction

Marco Quadrelli, NASA JPL



Our objective is to investigate the conditions to manipulate and maintain the shape of an orbiting cloud of dust-like matter so that it can function as an ultra-lightweight surface with useful and adaptable electromagnetic characteristics, for instance, in the optical, RF, or microwave bands.

NanoTHOR: Low-Cost Launch of Nanosatellites to Deep Space
Robert Hoyt, Tethers Unlimited, Inc.

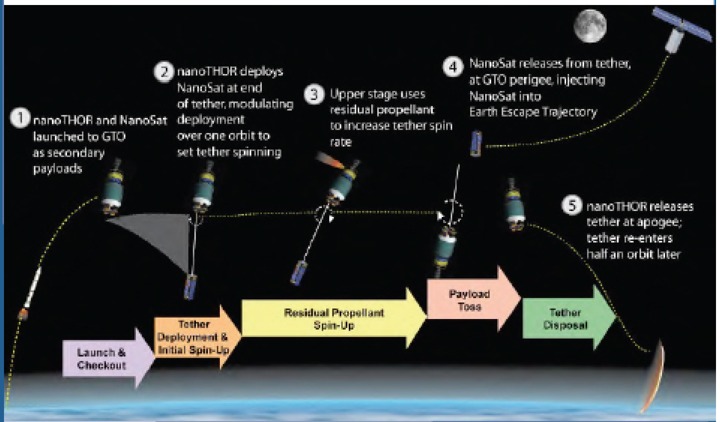
nanoTHOR
Low-Cost Launch of Nanosats to Deep Space

Organization: Tethers Unlimited, Inc
PI: Dr. Robert Hoyt

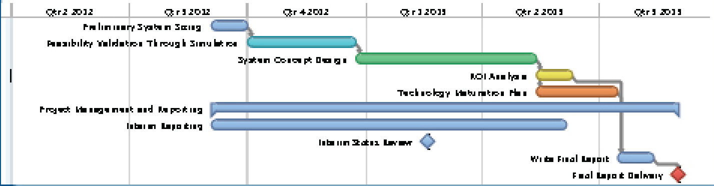
TETHERS UNLIMITED
Advanced Propulsion, Power, & Comm. for Space, Sea, & Air

- **Challenge Addressed:**
  - Emerging nanosat and CubeSat technologies could enable NASA to perform Exploration missions at lower cost, but ride-share opportunities to Earth escape are very rare
  - Restrictions on secondary payload stored energy limit opportunities to use conventional rockets to boost nanosats
- **Proposed Innovation:**
  - The "Nanosatellite Tethered High-Orbit Release" (nanoTHOR) system will use a simple high-strength tether to scavenge the orbital momentum and residual propellant of GEO upper stages to 'sling' multiple nanosatellites to Earth-escape
  - nanoTHOR enables *fast* (e.g. few hours) transfer of multiple nanosats to escape trajectories with effective specific impulse comparable to EP thrusters that would require many months

nanoTHOR CONOPS



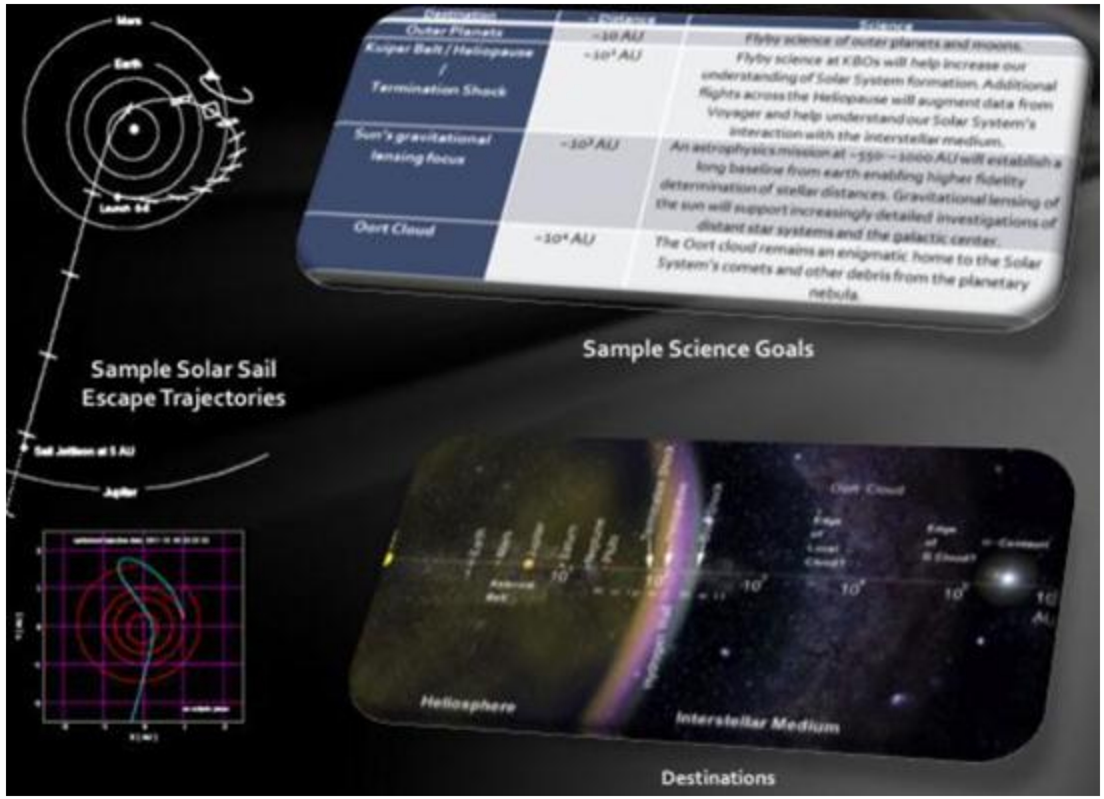
- **Proposed Effort**
  - Develop concept design and detailed CONOPS for nanoTHOR system
  - Validate feasibility of all key operations using detailed physics-based simulations
  - Compare cost, SWaP, and risk of nanoTHOR to conventional rocket-based technologies
- **Schedule**



- **Benefits**
  - Enables delivery of secondary payloads to deep space trajectories without requiring chemical rockets that would pose a risk to the primary payload
  - nanoTHOR tether is re-usable, and can boost multiple nanosatellites with a much lower total required mass than rocket technologies
- **Payoff**
  - nanoTHOR enables NASA to use low-cost nanosats and CubeSat platforms and inexpensive secondary ride-share opportunities to conduct missions to Near Earth Objects, Mars, & the Moon as well as to serve as communications relays for an 'interplanetary internet'

Solar System Escape Architecture for Revolutionary Science (SSEARS)

Jeffrey Nosanov, NASA JPL



The Voyager Spacecraft have reached the Heliopause and greatly improved our understanding of the region. This journey took 35 years. A total of 10-12 probes will be needed to explore the heliopause and truly understand the 3d structure of the region. We will design a mission architecture that makes this scenario realistic from both a cruise time and mission cost perspective by using solar sail-enabled trajectories and designing a probe that can be manufactured by industry.

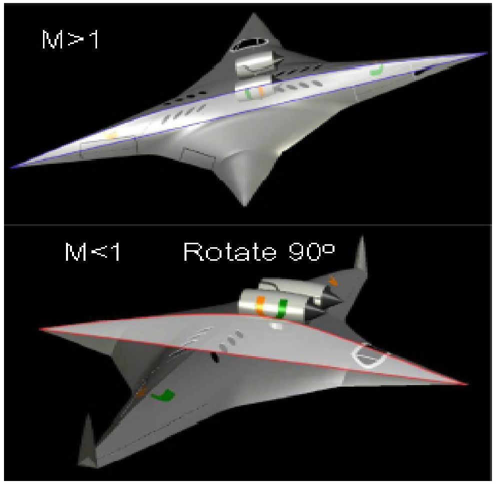
Silent and Efficient Supersonic Bi-Directional Flying Wing
Gecheng Zha, University of Miami

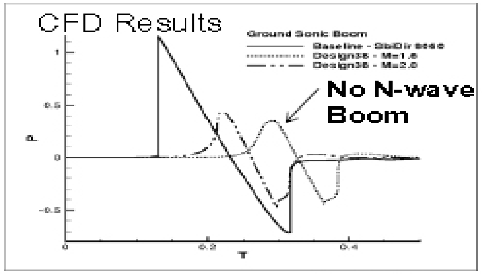
Silent and Efficient Supersonic Bi-Directional Flying Wing

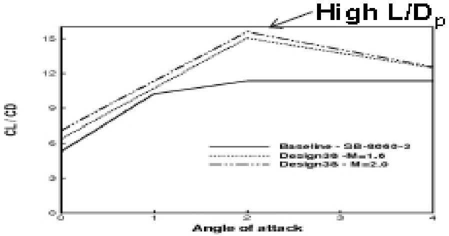
G.-C. Zha, L. Cattafesta, F. Alvi

Concept:
- Revolutionary Concept for Supersonic Flight
- Symmetric about both longitudinal and span axes
- Flying Wing Rotate 90° between supersonic & subsonic
- Remove aerodynamic conflict between low speeds and high speeds
- Slender supersonic configuration naturally translates to high subsonic aspect ratio
- High performance at both subsonic & supersonic speeds
- Preliminary Business Jet Configuration (M=1.6-2.0) achieves High L/D_p with high aerodynamic efficiency
- Remove sonic boom due to smooth ground over pressure signature (no N-wave)

Proposed Tasks:
1) Design refinement with CFD;
2) Mission analysis;
3) Wind tunnel testing verification







Robotic Asteroid Prospector (RAP) Staged from L-1: Start of the Deep Space Economy

Marc Cohen, Marc M. Cohen, Architect

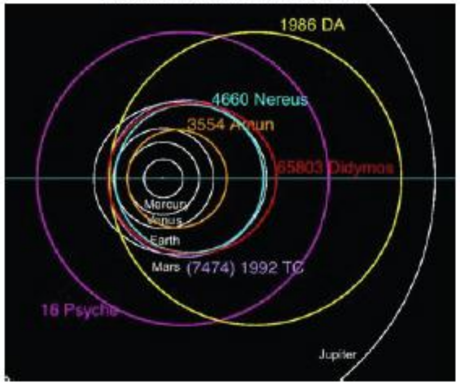
Robotic Asteroid Explorer (RAP) Staged from a Lagrange Point: Start of the In-Space Economy

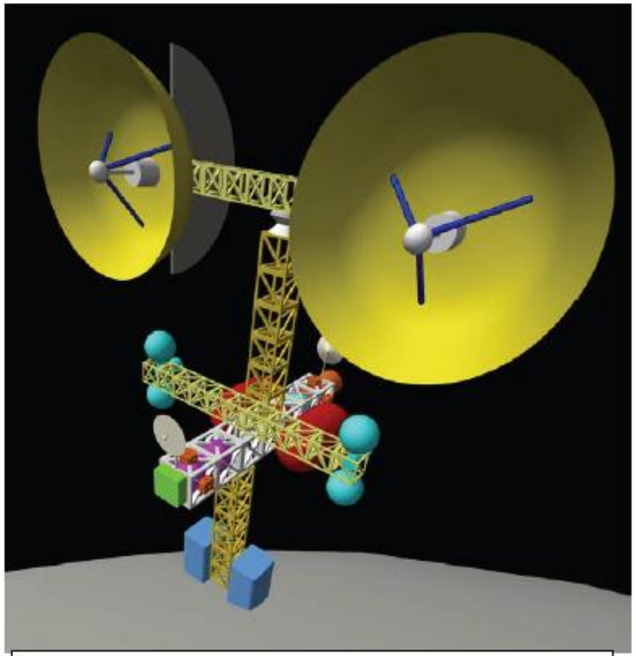
Marc M. Cohen, Architect   The Orbital Mechanic   Honeybee Robotics   Planetary Resource Engineering

The Challenge:
Asteroid Prospecting and Mining Requires:

1. Accessible, valuable minerals, and perhaps H20,
2. Prove Market Demand,
3. Transformational Mission Design
4. Robotic extraction, and processing technologies
5. Innovative Spacecraft Design
6. Overcome "***When*** you go determines ***Where*** you go."

Orbits of Near-Earth M-Type Metallic Asteroids

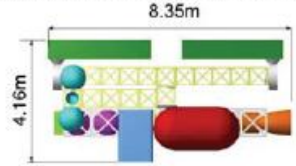




The RAP Spacecraft places the Solar-Thermal Engine (red-orange) on the longitudinal axis and the two smaller solar-electric engines (turquoise) on booms port and starboard.

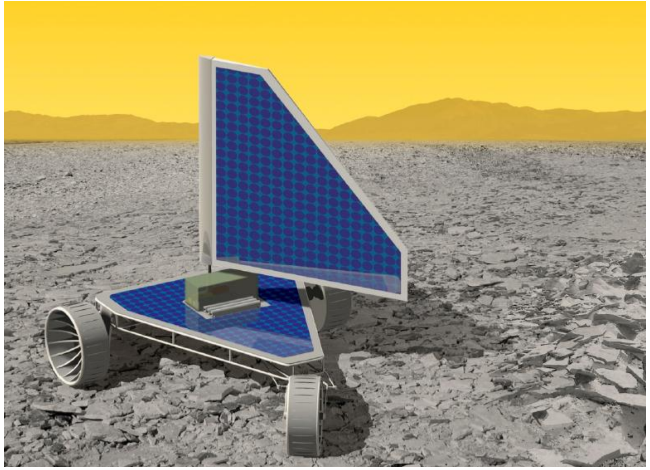
The Solution:

1. RAP prospects to confirm metals & minerals.
2. Economic Modeling to Confirm Market Demand
3. Mission Design:
   - Lagrange Point Staging
   -Innovative Trajectory Design,
   -Solar-Thermal & Solar-Electric Propulsion.
4. Advanced Space Mining:
   - Pneumatic Excavation and Mining Techniques,
   - High heat processing with thermal from the Solar Dynamic Array.
5. Spacecraft for repeatable missions:
   -Two types of engines:
   --Solar Thermal for Earth-Moon Departure
   --Solar Electric for Deep Space
   --High ISP propulsion opens t space for industrial activities.



Venus Landsailing Rover

Geoffrey Landis, NASA GRC

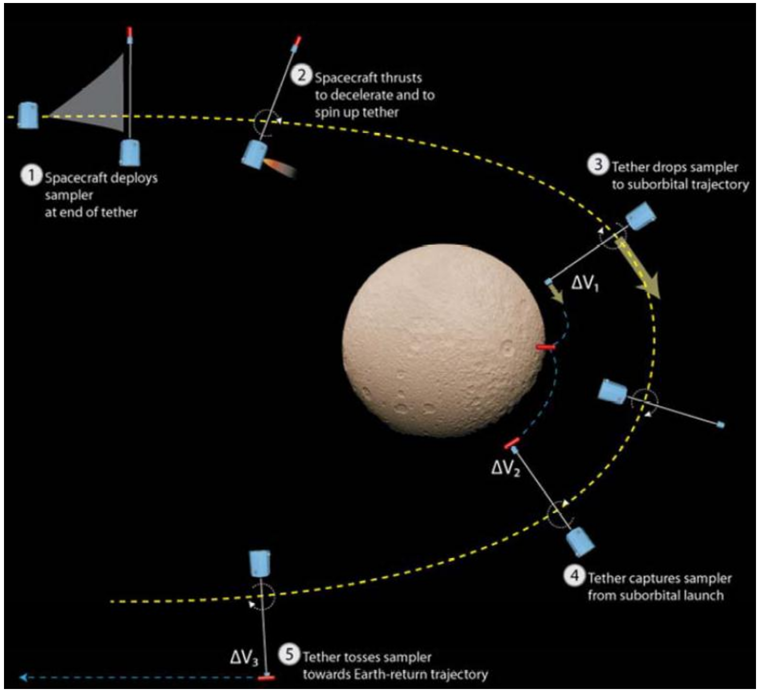


The surface of Venus is the most hostile environment in the solar system, with a surface temperature hotter than an oven, and a high-pressure, corrosive atmosphere.

In work to develop sensors to work inside of jet engines, NASA Glenn has developed electronics that will continue to function even at the Venus temperature of 450°C. These electronic components represent a breakthrough in technological capability for high temperatures.

We thus propose an innovative concept for a planetary rover: a sail-propelled rover to explore the surface of Venus. Such a rover could open a new frontier: converting the surface of a new planet into a location that can be explored by robotic exploration.

Sample Return Systems for Extreme Environments
Robert Winglee, University of Washington, Seattle



Sample return missions have been primarily limited to asteroid sampling. More comprehensive sampling could yield critical information on the formation of the solar system and the potential of life beyond Earth. Hard landings at hypervelocity (1-2 km/s) would enable sampling to several feet below the surface penetration while minimizing the Delta V and mass requirements.

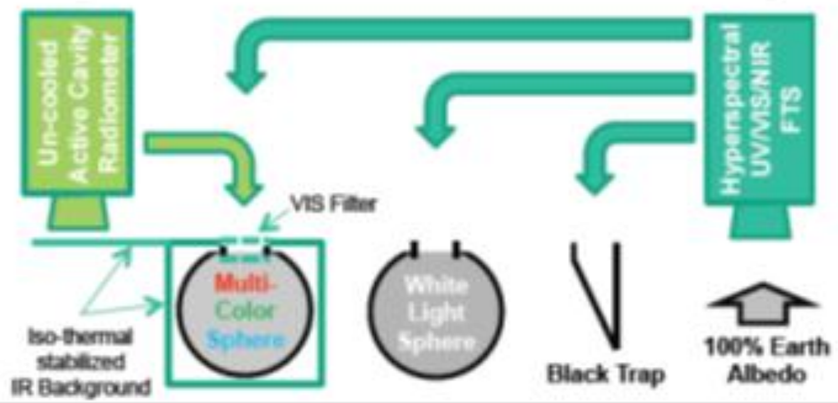
Combined with tether technology a host of potential targets becomes viable. This work seeks to design, develop and test a penetrator/sampler that can withstand the hard impact and enable the sample to be returned to orbit. Tether technology for release of the penetrator and capture of the sample eliminate many of the restrictions that presently inhibit the development of sample return missions.

Successful development of sample return capabilities will provide a major impetus for solar system exploration.

NIST in Space: Better Remote Sensors for Better Science
Joseph Predina, ITT Space Systems, LLC

Objectives
- ✓Develop breakthrough UV/VIS/NIR remote sensor calibration concept
- ✓Improve accuracy one order-of-magnitude over current technology
- ✓International Standard (SI) traceable
- ✓Enable laboratory-type calibration accuracy in a space-based environment
- ✓Spectrally resolved over full solar range

VIS FTS & ACR Calibration Transfer



Approach:
- Combine 4 subsystems
  1. Un-cooled Active Cavity Radiometer (ACR) for 0.1% calibration of UV/VIS/NIR sources
  2. Un-cooled integrating sphere with multi-color LED sources & ultra-stable infrared background
  3. White light integrating sphere
  4. Low noise hyperspectral UV/VIS/NIR Fourier Transform Spectrometer
- SI traceable ACR & multi-color integrating sphere used to recalibrate white light source daily
- Advanced thermal control stabilizes subsystem
- FTS used as transfer standard

Key Milestones

• Project Start	9/10/12
• Define UV/VIS/NIR sources	11/30/12
• Show feasibility for 100% earth albedo radiance	1/31/13
• 0.1% un-cooled ACR feasible in space	3/1/13
• Thermal stability concept feasible	3/29/13
• System architecture for high impact mission (Earth Radiation Balance Monitor)	4/30/13
• Final Report	5/31/13

TRL_{in} = 2
TRL_{out} = 3

BREAK

NASA Innovative Advanced Concepts

www.nasa.gov/niac

KEYNOTE ADDRESS

Dr. Penny Boston

New Mexico Tech

“What's a Nice Girl Like You Doing in a Place Like This?
Looking for Life in All the Wrong Places
from Caves to Mars and Beyond”

NASA Innovative Advanced Concepts

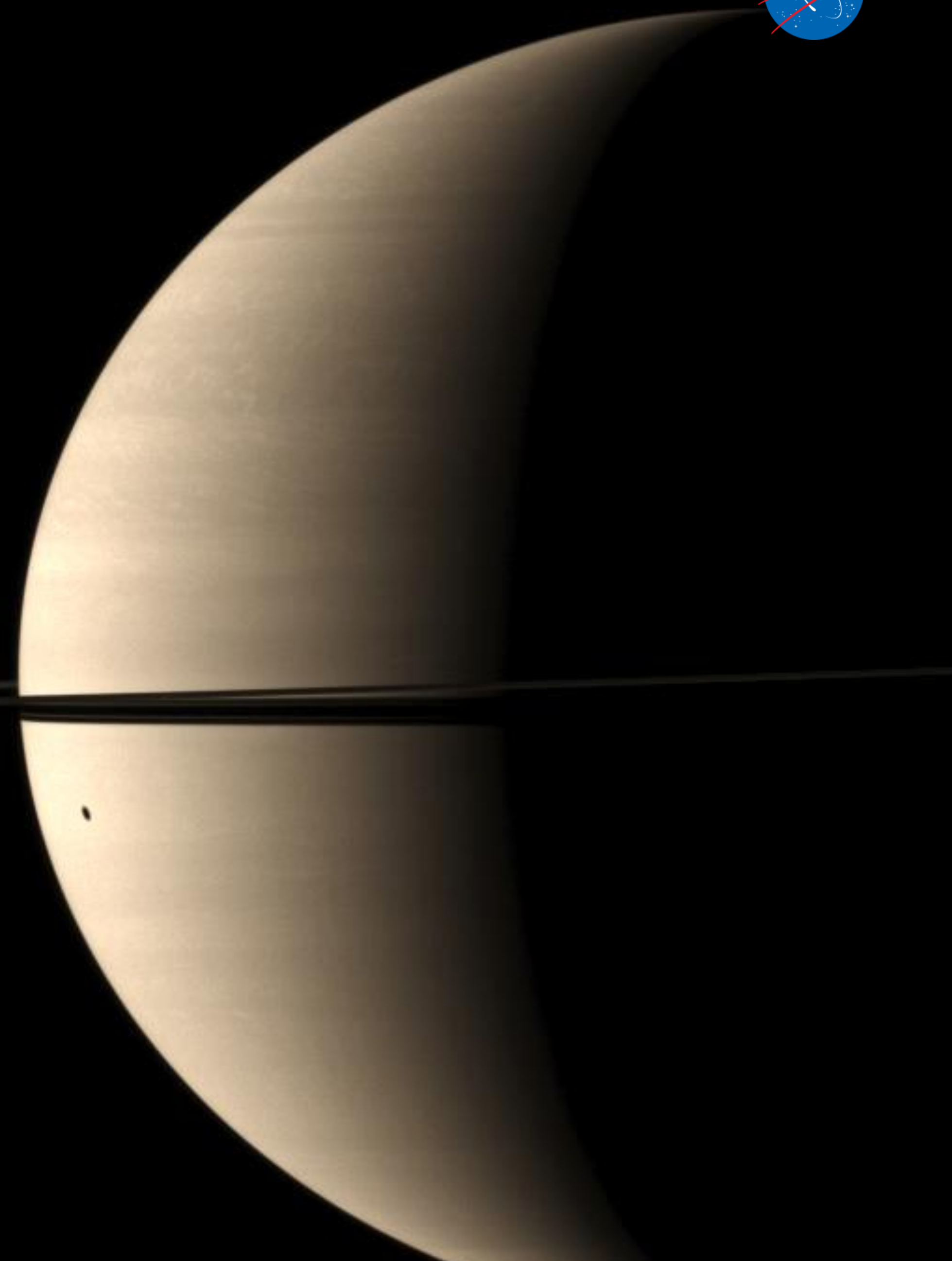
www.nasa.gov/niac

LUNCH

NASA Innovative Advanced Concepts

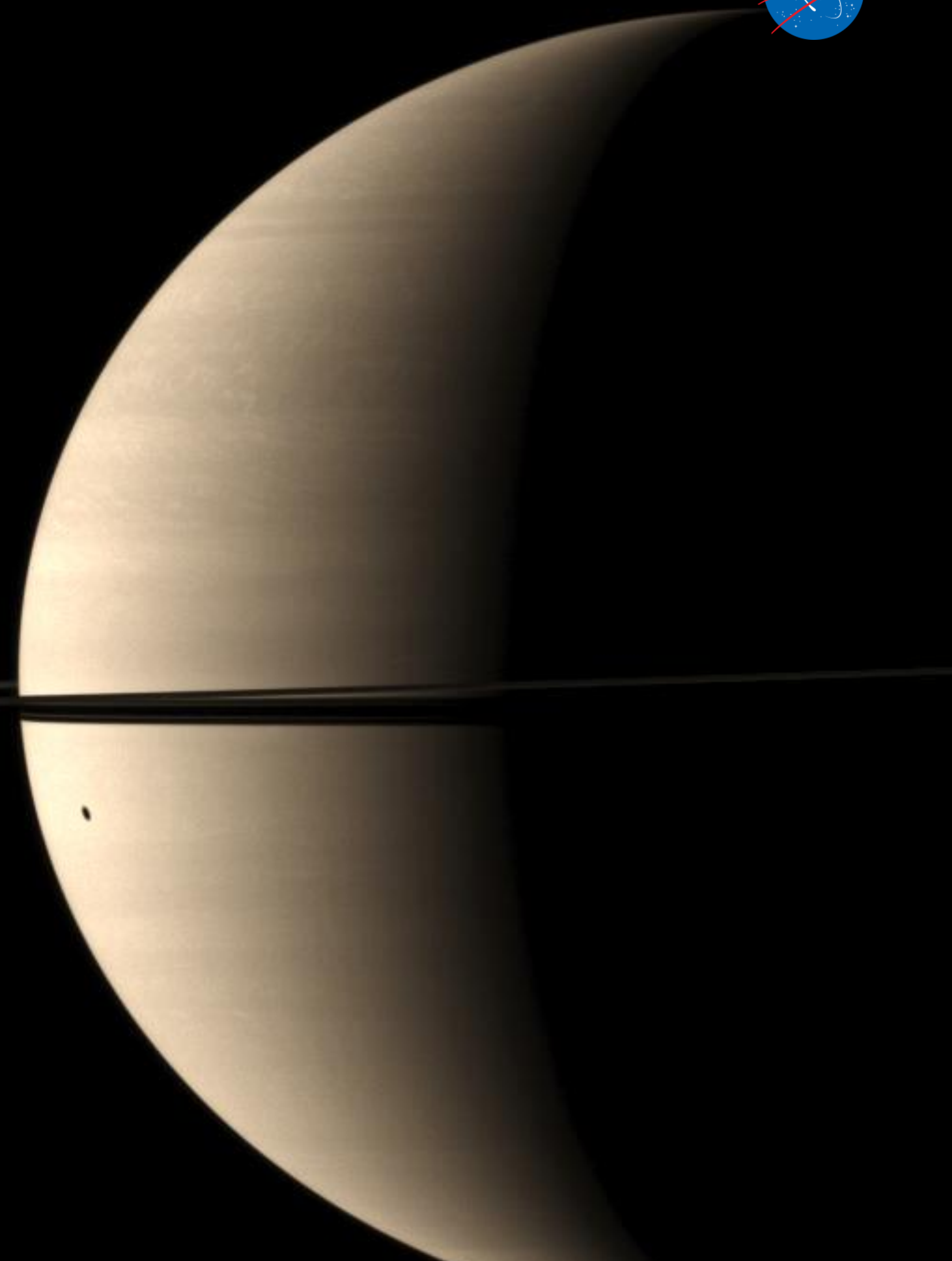
www.nasa.gov/niac

BONG WIE



WILLIAM WHITTAKER

SHAYNE WESTOVER

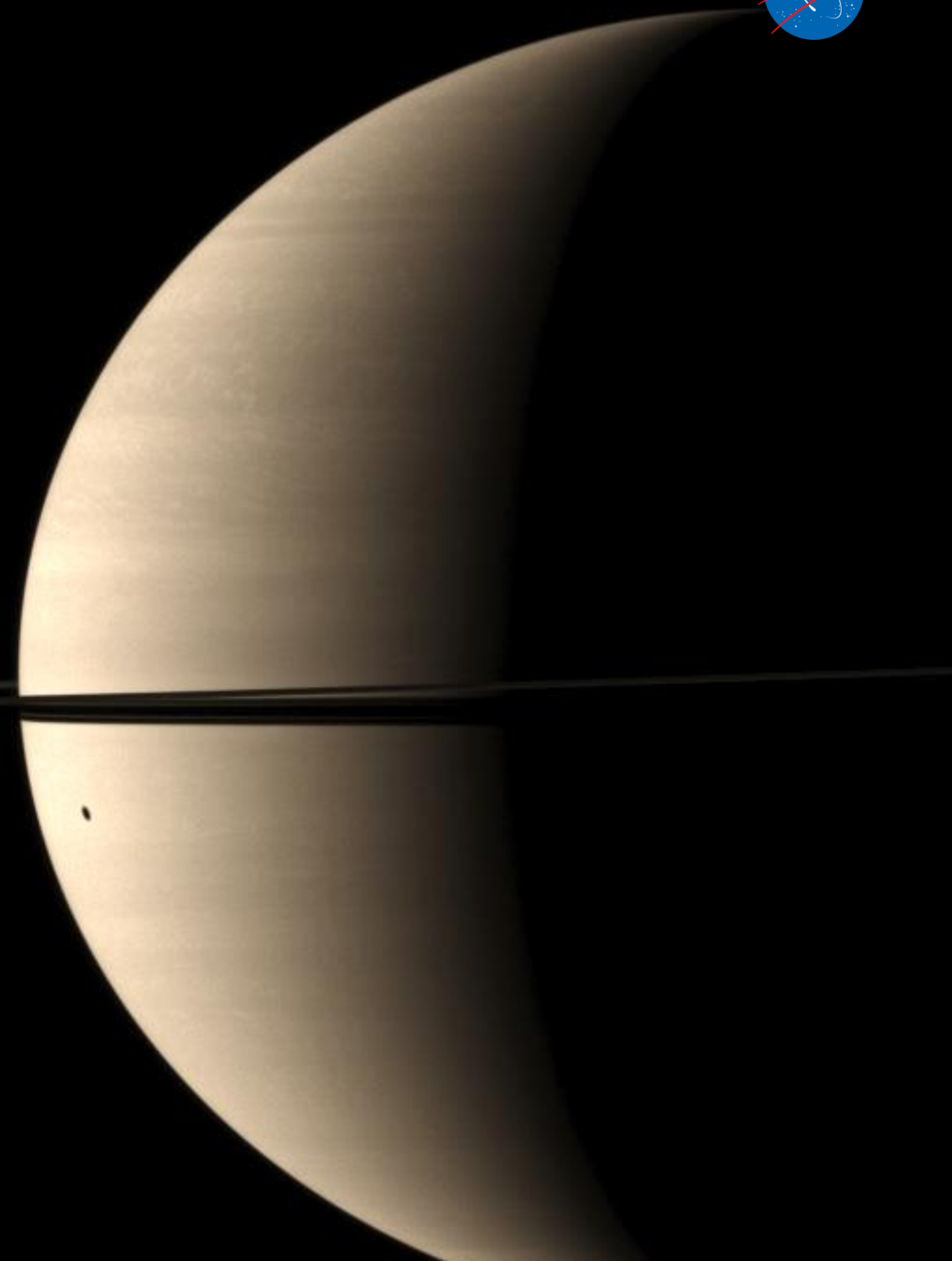


BREAK

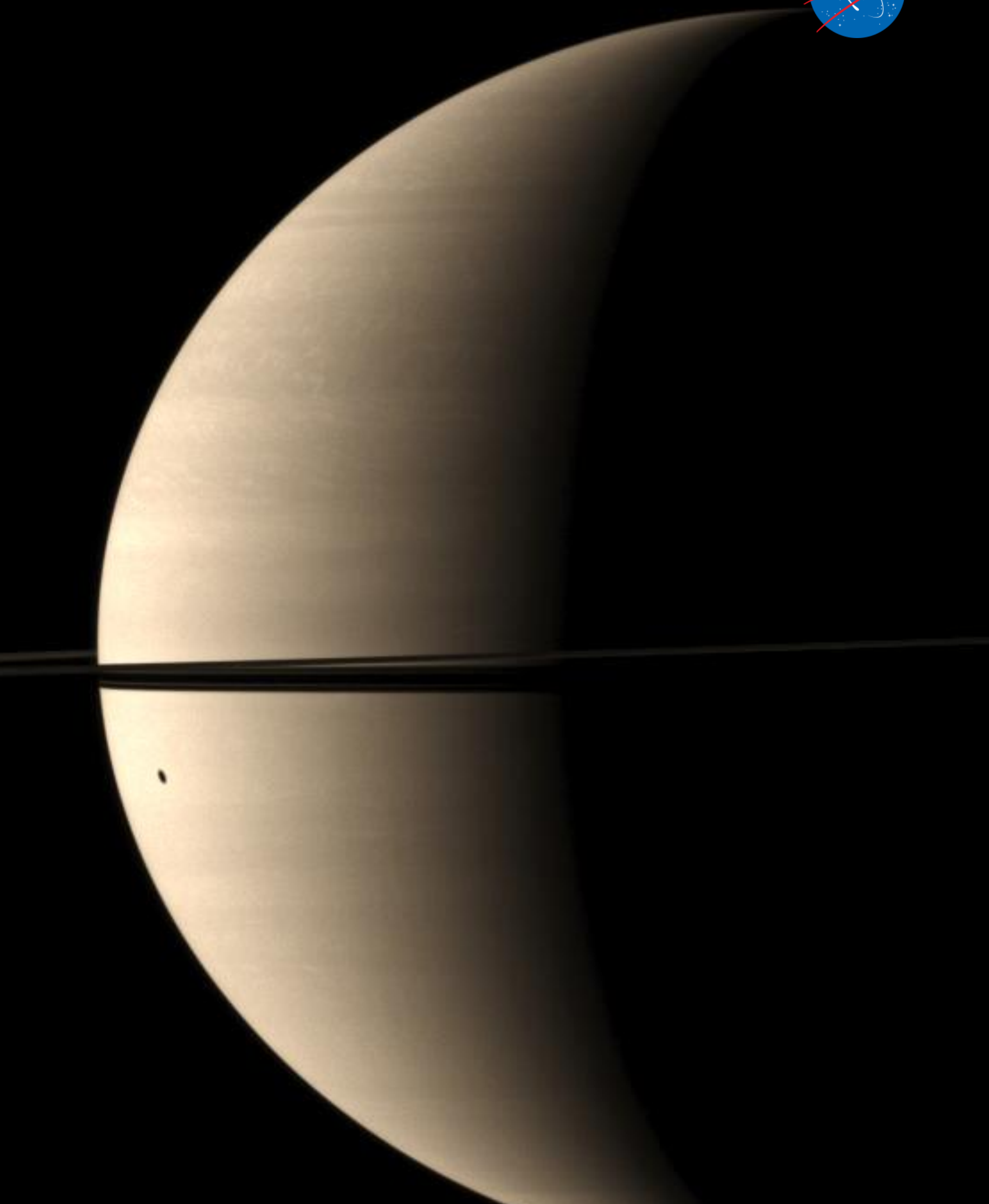
NIAC
NASA Innovative Advanced Concepts

www.nasa.gov/niac

DMITRY STREKALOV



JOHN SLOUGH



POSTER SESSIONS

NASA Innovative Advanced Concepts

Three Stages of Reaction to Revolutionary Ideas

1 – It's completely impossible

2 – It's possible, but it's not worth doing

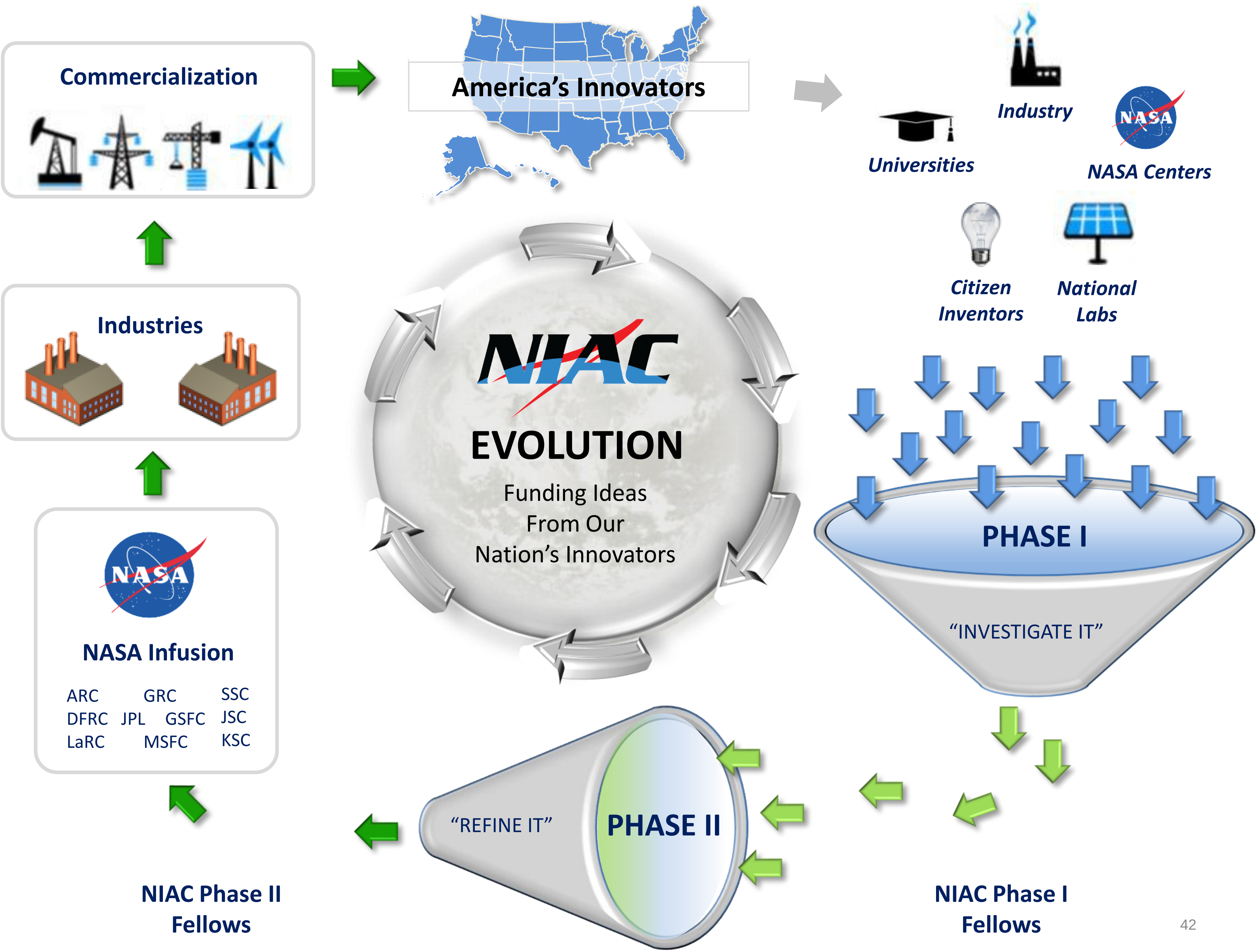
3 – I said it was a good idea all along

Arthur C. Clarke

ADJOURN

NASA Innovative Advanced Concepts

www.nasa.gov/niac


Commercialization
America's Innovators
Industry
Universities
NASA Centers
Citizen Inventors
National Labs
Industries
NIAC
EVOLUTION
Funding Ideas
From Our
Nation's Innovators
PHASE I
"INVESTIGATE IT"
NASA Infusion
ARC GRC SSC
DFRC JPL GSFC JSC
LaRC MSFC KSC
"REFINE IT"
PHASE II
NIAC Phase II Fellows
NIAC Phase I Fellows

To inspire and set the scene - 3 minute NASA video (from March 2012):

“WALKING ON AIR”

http://www.npr.org/blogs/thetwo-way/2012/04/23/151208875/video-space-out-with-nasas-walking-on-air