Ball Aerospace

Scott Whitehill

Director, Supply Chain Management

Ball Aerospace

NASA HBCU/MI Technology Infusion Road Tour

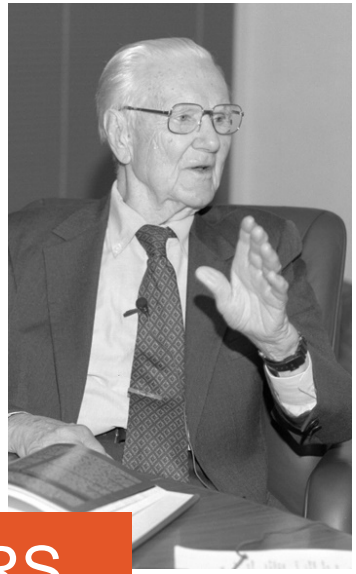
Aug. 14-15, 2018

GO BEYOND WITH BALL.®

9/24/18

The Ball story

A history of innovation & customer partnership.

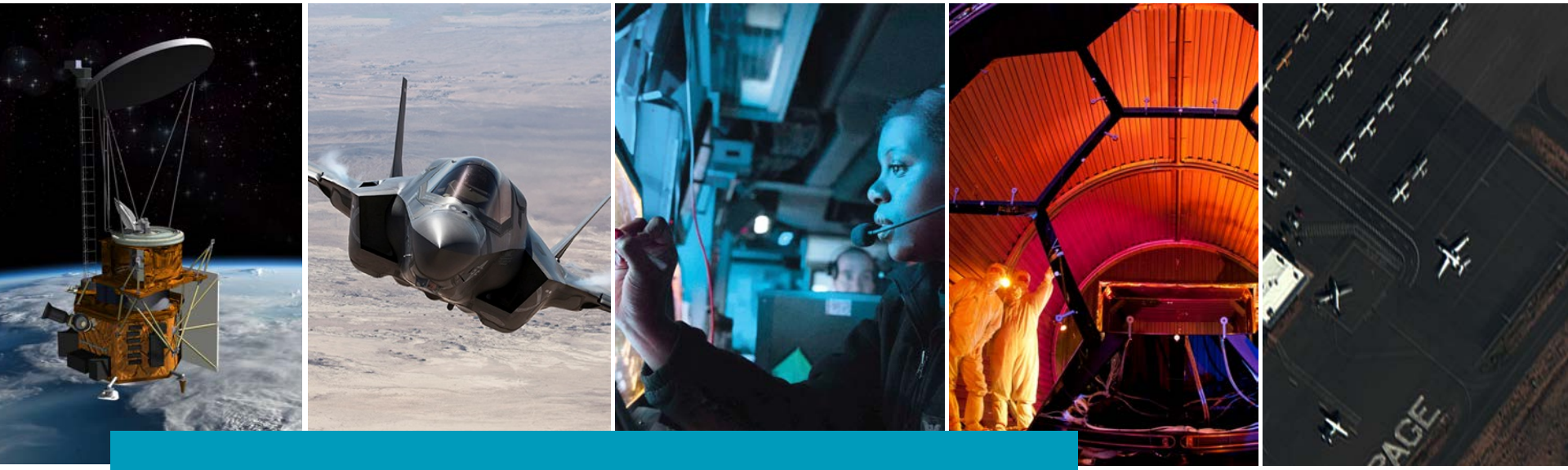



JARS TO STARS

From sustainable metal packaging products to ground-breaking aerospace and defense solutions, we enable our customers to succeed – no matter the challenge or mission.

Ball Aerospace

Who we are is in all we do.



GO BEYOND WITH BALL®

We pioneer discoveries that enable our customers to perform beyond expectation and protect what matters most.

Capabilities & Products

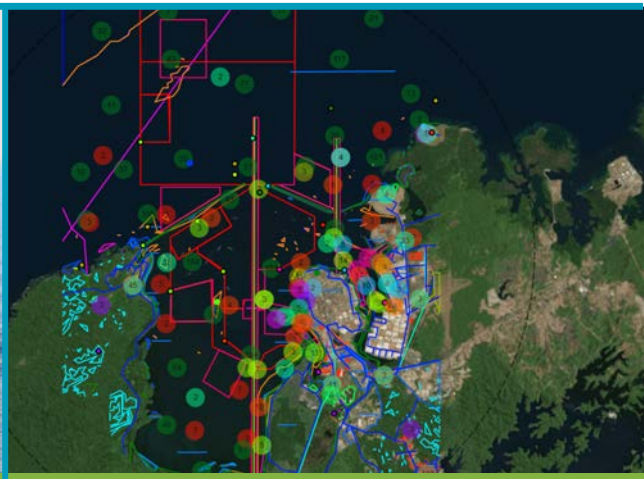
Our technologies deliver mission success.

AEROSPACE

- Missions
- Sensors & Instruments
- Spacecraft
- Ground Systems
- Components

TACTICAL

- Antenna Systems
- Electro-optical Systems
- Anti-jam Systems
- Mission Systems Analysis
- Pointing and Tracking
- Cryogenic Fuel Storage



INTELLIGENCE

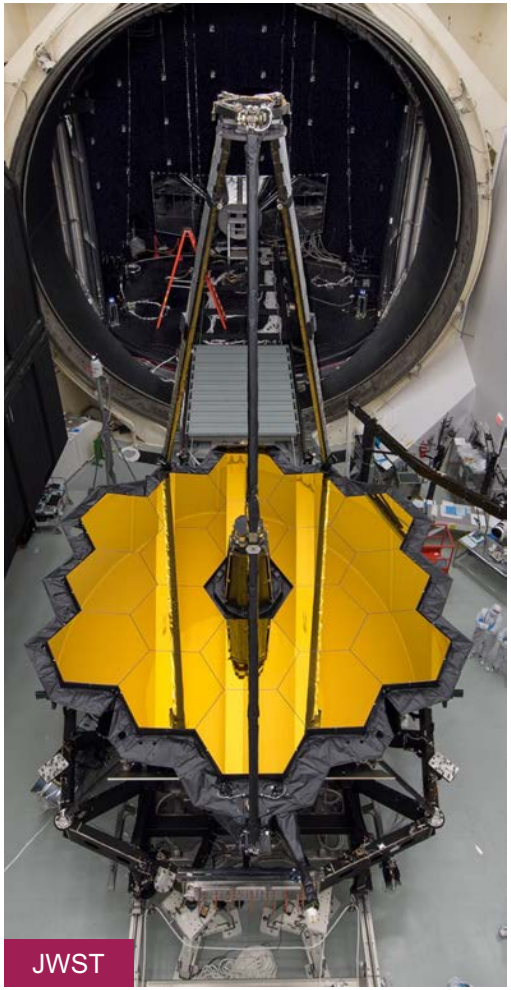
- Data Processing & Analytics
- Cyber Security
- Human-Machine Teaming
- Laser Effects Research
- Modeling & Simulation
- Enterprise Data Management

Uncompromising Integrity

ACCOUNTABILITY

Every day, we **Go Beyond®** for our customers, each other and our community by delivering innovative solutions, creating a diverse and inclusive working environment and giving back.

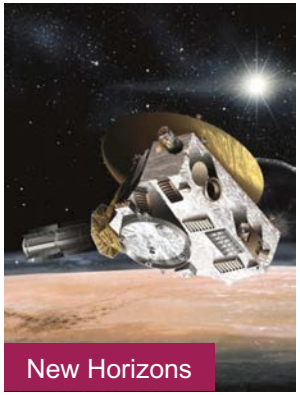
60+ Years of Collaborating with NASA


JWST


Hubble


WFIRST


Kepler/K2


New Horizons

DELIVERING NEXT-GENERATION
SCIENCE & TECH

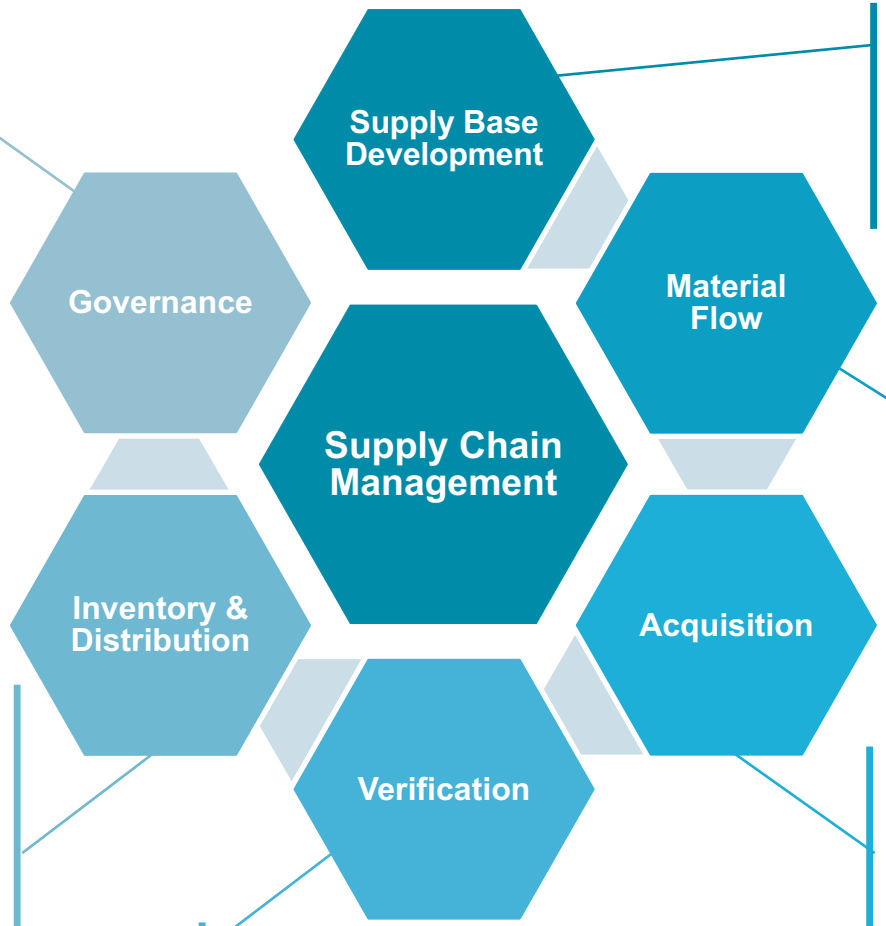

IXPE


JPSS-1


LANDSAT


GMI

Ball Supply Chain Management



- **Maintain government-approved procurement system**
- Maintain BPL compliance
- Maximize oppys to small businesses, achieve acceptable rating by DCMA/SBA
- Meet all Federal acquisition regulations
- Comply with contractual financial reporting requirements
- Maintain Environmental, Health and Safety compliance

- Define, develop, improve supply base
- Supplier assessment, approval
- Strategic make-buy process
- Technology/supply base expertise
- **Manage supplier relationships**
- Measure, report supplier performance

- Own, manage, optimize **end-end performance of the Integrated Supply Chain** (Material Flow)
- Agile data management
- Material planning
- Piece part value-add processing
- Material tracking, traceability, mgmt
- SCM data analytics

- Ensure accuracy, document all receipts
- Provide **safe, effective storage & distribution of materials**
- Ensure proper, authorized release of materials to production
- Provide required logistical support for program product delivery
- Ensure product is properly and safely prepared for shipment
- Establish cost effective shipping solutions

- **Supplier quality management**
- Verification of incoming materials
- Material traceability
- Material testing
- Dimensional measurement of hardware

- Procure Direct Materials
- Solicit, evaluate, negotiate, award & **manage subcontracts**
- Procure indirect goods & services
- Sole source of legal authority/direction
- Support new business: acquisition strategy, supplier pricing
- Plan and execute small business plans
- Manage P card program

Small Business Program

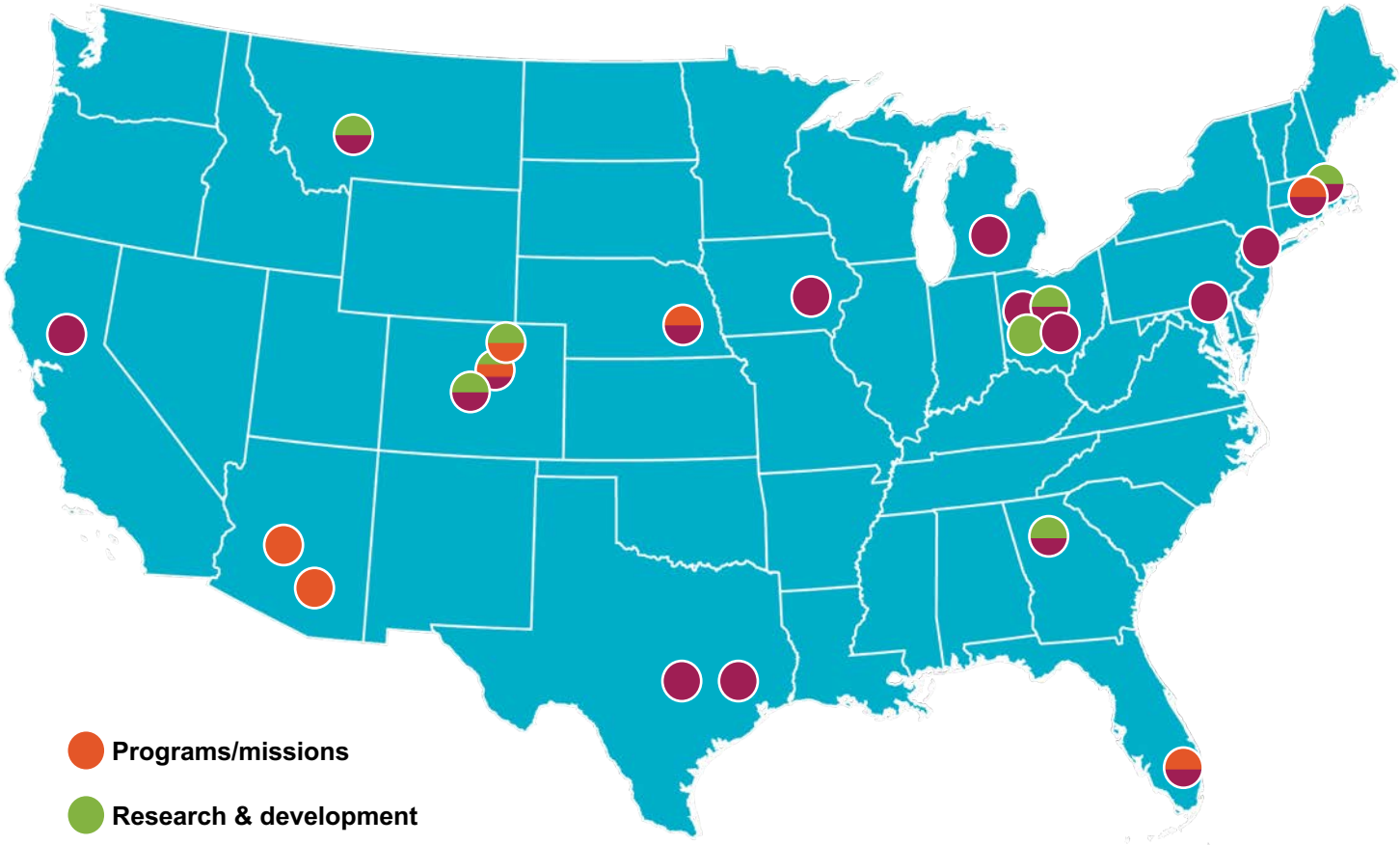
- 2012 NASA Small Business Industry Award (SBIA) winner
- 2011 DoD Nunn-Perry Mentor Protégé Award winner
- Completed NASA Mentor/Protégé agreement in support of OLI
- Actively participate in Small Business conferences

AUDIT PERFORMANCE HISTORY	
Year	**Audit Result**
2018	Very Good
2016	Satisfactory
2014	Highly Successful
2009	Outstanding
2004	Outstanding

5-YEAR PERFORMANCE HISTORY				
Type of Small Business Concern	**5-Year Overall Performance History***	**5-Year NASA Performance History***	**5-Year NASA Performance History***	**Statutory Goals**
SDB	2.7%	2.2%	2.9%	5.0%
WOSB	6.3%	7.0%	6.2%	5.0%
HBCU	0.0%	0.0%	0.0%	0.0%
HUBZone	0.4%	0.6%	0.3%	3.0%
VOSB	1.9%	2.5%	1.5%	0.0%
SD/VOSB	0.2%	0.3%	0.2%	3.0%
Total Small Business Content	**32.4%**	**37.7%**	**30.5%**	**33.0%**

**Percent of Subcontracted Work*

Engaging with Universities/Colleges



- Arizona State
- Boston University
- Colorado School of Mines
- Colorado State
- Columbia
- Florida International
- Georgia Tech
- Johns Hopkins
- Harvard
- Michigan State
- Montana State University
- Ohio State
- Ohio University
- Prairie View A&M
- U of Arizona
- U of California, Davis
- U of Colorado, Boulder
- U of Iowa
- U of Nebraska, Lincoln
- U of Texas, Austin
- Wilberforce University
- Wright State

How Do We Work Together?

BUSINESS SYSTEMS

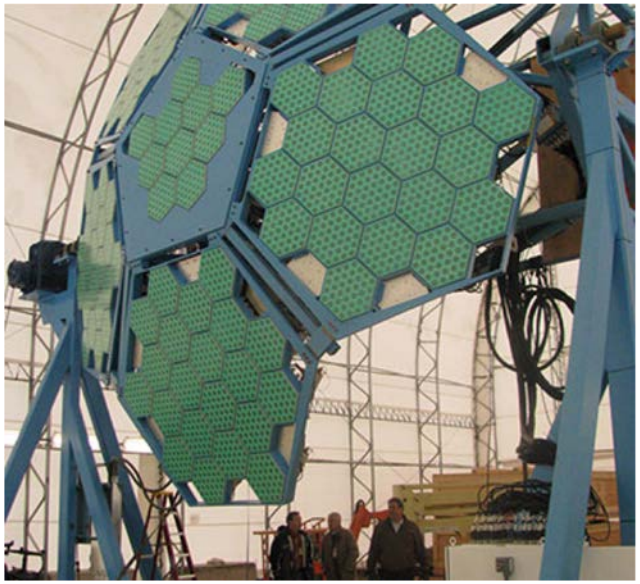
- Robust accounting system
- Delineate costs
  - Labor
  - Material
  - Other direct costs
- Track labor hours, personnel
- Specified Labor Rates
- Ability to invoice
- Contracting
  - NDAs
  - Agreements
  - Intellectual Property
  - Conflicts of Interest
- Understanding of ITAR limitations
- Facility clearance for classified collaborations

TECHNICAL AREAS OF INTEREST

- Optical engineering
- Spacecraft engineering
- Instrument engineering
- Cyber
- Robotics
- 3D printing
- RF antennas
- Small satellites
- Artificial intelligence
- Mission analysis
- Algorithm development
- Advanced electronics

Example: Working with FIU

- Ball Aerospace subcontracted to Florida International University (FIU), a Minority Institution
- Worked with FIU on two mentor/protégé agreements



PROJECTS WITH FIU

Colorado Engineering, Inc. (CEI)

- FIU & Ball mentored CEI in the implementation of a Quality Management System
  - Readiness for AS9100 certification
  - International Traffic in Arms Regulations (ITAR) Training
  - Security Indoctrination Training including understanding the SF312
  - Electro-Static Discharge (ESD)
  - Lean Manufacturing Technology
  - Internal Audit Training (AS9100C)
  - Joint Personnel Adjudication System (JPAS)

Princeton Microwave Technology (PMT)

- FIU & Ball mentored PMT to improve delivery and enhance manufacturing performance
  - Enterprise Resource Planning (ERP) technology transfer and Manufacturing process technology support, including Selection of Enterprise Resource Planning tool
  - Readiness for AS9100 certification
  - Development of a layout for the protégé's new facility that improved manufacturing efficiency and workspace utilization
  - Full and comprehensive Electro-Static Discharge training to improve workspace efficiency and safety

Let's collaborate!

WE WANT TO GET TO KNOW YO

Tell us more about:

- Your expertise
- Your business models
- Your desires
- What's working/what's not

CONTACT US

Scott Whitehill
Director, Supply Chain Mgmt
303-939-5762
swhitehi@ball.com

Caroline Grant
College Relations Lead
303-533-5337
cgrant1@ball.com

Visit us online at ball.com/aerospace

LOCKHEED MARTIN

Deep Space Exploration Overview

Chris McCaa
Lockheed Martin Space
Deep Space Exploration

August 15, 2018

Lockheed Martin Business Areas

Aeronautics

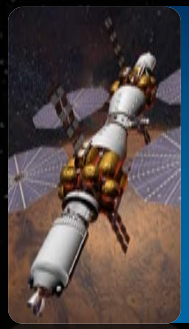
- Tactical Fighters
- Tactical /Strategic Airlift
- Advanced Development
- Sustainment Operations

Missiles and Fire Control

- Air and Missile Defense
- Tactical Missiles
- Fire Control
- Combat Maneuver Systems
- Energy

Rotary and Mission Systems

- Naval Combat Systems
- Radar and Surveillance Systems
- Aviation Systems
- Training and Logistics Solutions
- DOD Cyber Security



Space

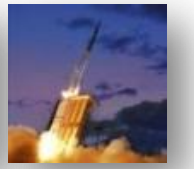
- Surveillance and Navigation
- Global Communications
- Human & Robotic Space Exploration
- Environmental Observation Systems
- Strategic and Defensive Systems
- Strategic / Operational Command & Control Systems

Lockheed Martin Space

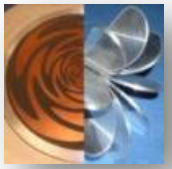
Strategic & Missile Defense

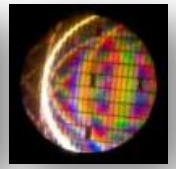

Adv Programs

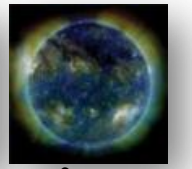

Strategic Missiles


Missile Defense

Advanced Technology Center


Optics, RF & Photonics

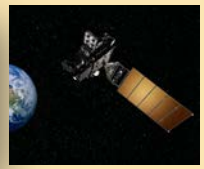

Adv. Materials & Nano Systems


Space Sciences & Instruments

Commercial Civil Space


Human Exploration


Deep Space Exploration


Weather & Environment


Remote Sensing


Commercial SATCOM


Wind Energy Management

Special Programs

Mission Solutions


End-to-End Mission Systems

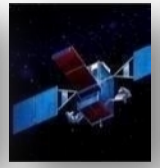

Geospatial Technologies

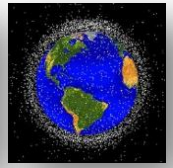
Military Space


Protected Comms


Narrowband Comms


Navigation

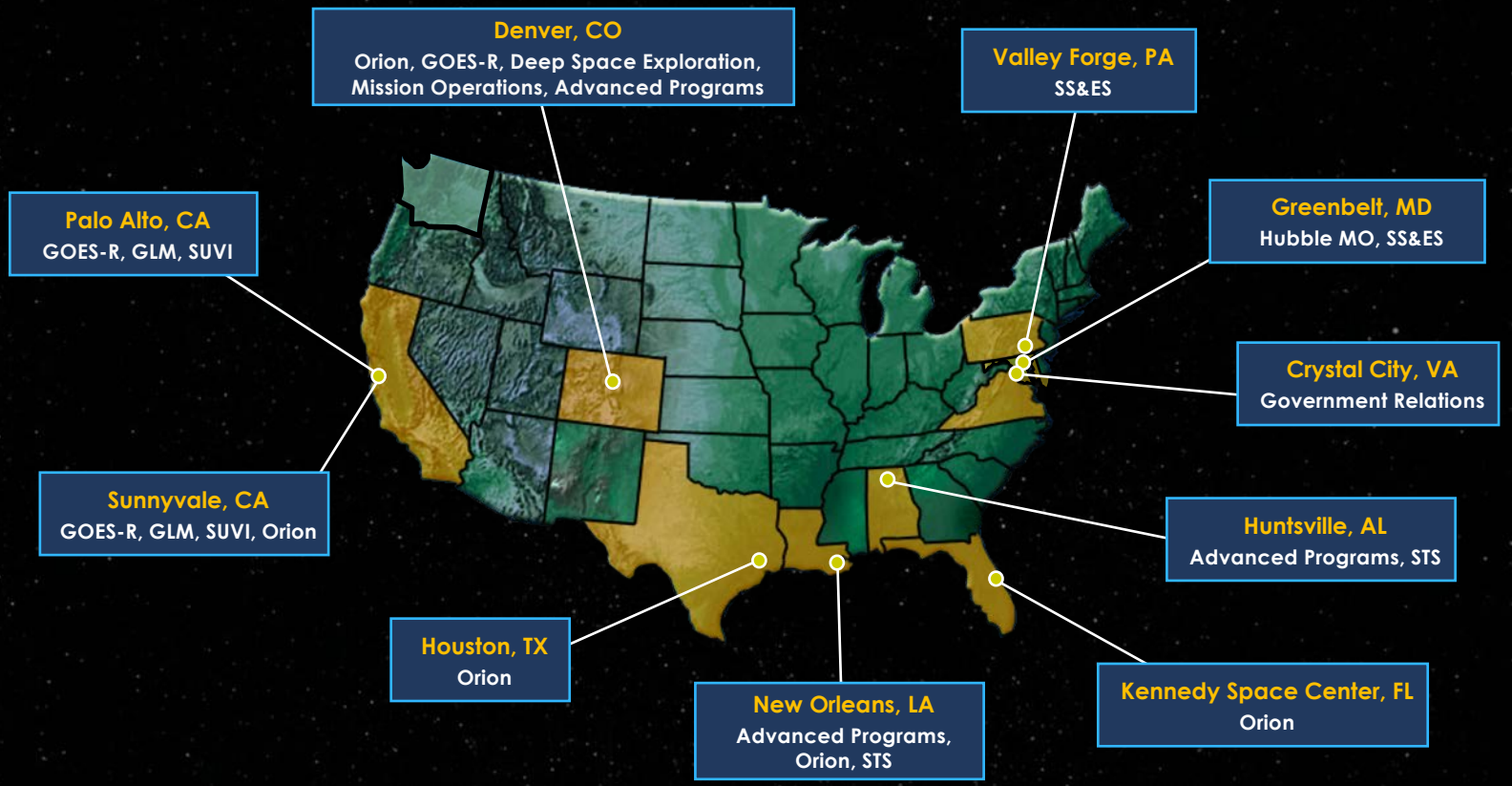

Early Warning


Space Protection

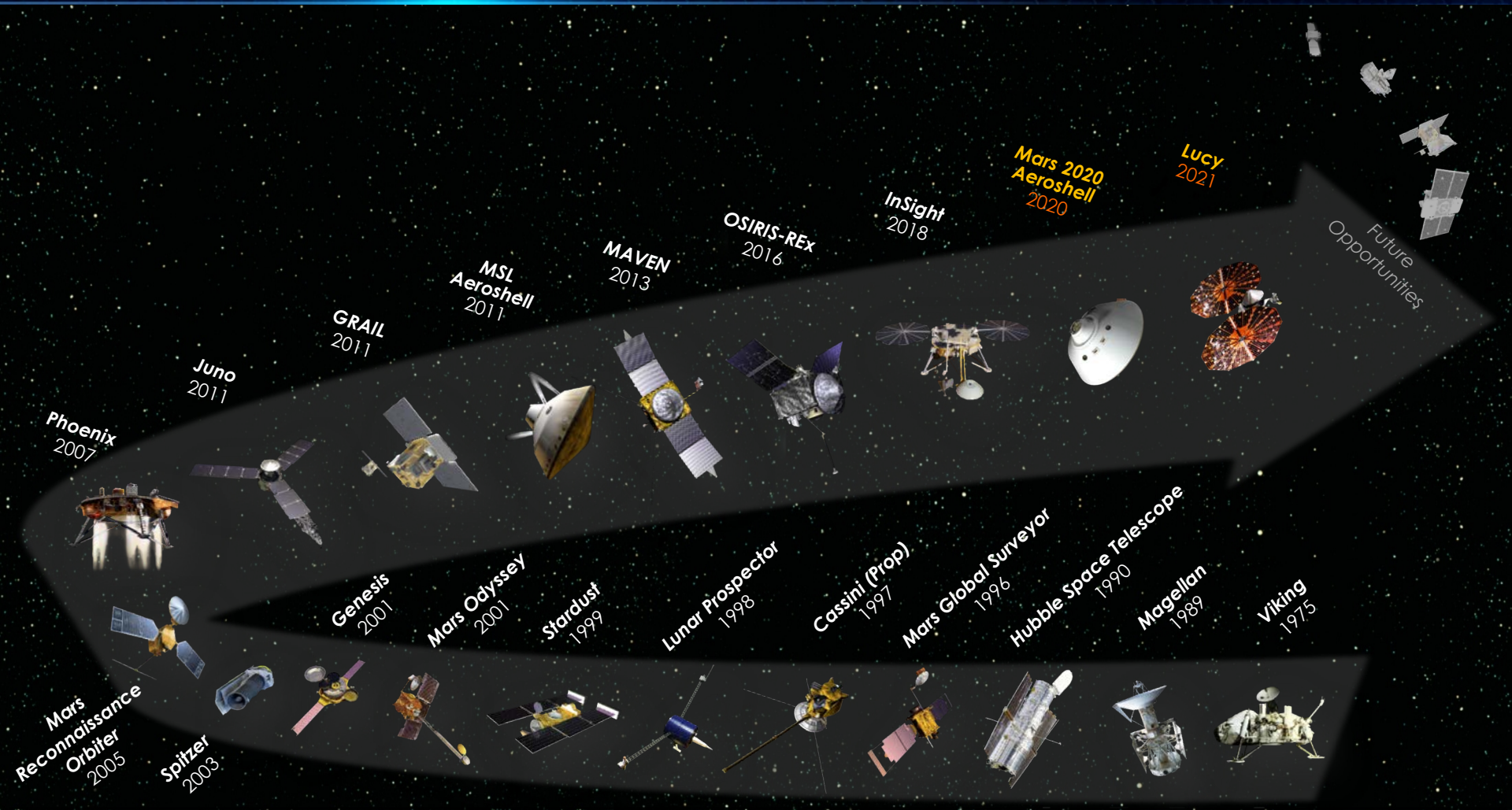
Subsidiaries

- Sandia National Laboratories
- Atomic Weapons Establishment
- Astrotech Space Operations
- Zeta Associates

Civil Space Locations



Deep Space Exploration Mission History



How to Partner with LM – Mission Team

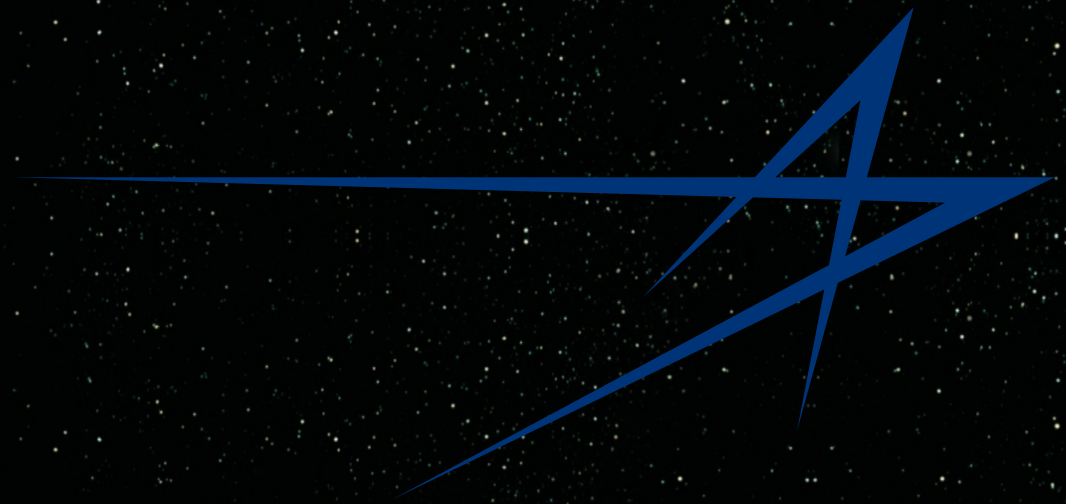
- Prime Investigator (PI)
  - Responsible for the overall content and execution of the mission
    - Typically determined around initial Announcement of Opportunity (AO)
- Co-Investigator Roles (Co-I)
  - Instrument contribution
    - Typically determined prior to final Announcement of Opportunity (AO)
- Mission Science Team member
  - Material testing / Data Analysis
    - Determined anytime from AO to post-mission
- How to partner with LM
  - Important to develop reputation in science community
    - Write papers on science, instruments or analysis capabilities
    - Become part of deep space assessment groups and steering committees (terrestrial planets, small body, outer planets, etc)
  - How/who to contact at LM
    - Beau Bierhaus (LM Advanced Programs Scientist): edward.b.Bierhaus@lmco.com, 303-971-4240
    - Tim Linn (LM Advanced Programs Sr. Mgr.): timothy.m.linn@lmco.com, 303-977-0659

How to Partner with LM – Supplier

- How to partner with LM
  - LM is always looking for flight proven, low mass, low power, low cost hardware options for deep space missions
  - Visit the Lockheed Martin Portal to get started
    - https://lockheedmartin.com/en-us/suppliers/information.html
  - If you have questions getting started:
    - Michelle Butzke, LM Supplier Relations Manager: michelle.butzke@lmco.com
- Recent examples of procured hardware
  - Command and Data Handling avionics hardware (processors, interface cards, etc.)
  - Guidance, Navigation and Control hardware (star trackers, inertial measurement units, sun sensors, etc.)
  - Telecom hardware (small deep space transponders, power amplifies, antennas, switches, etc.)
  - Propulsion hardware (tanks, thrusters, latch valves, pyro valves, etc.)
  - Solar arrays

Phoenix Descent Captured by MRO

Image: NASA



THE VALUE OF PERFORMANCE.

NORTHROP GRUMMAN

Competing in the AO Process: An Industry Perspective

NASA HBCU/MI Technology Infusion Road Tour

August 13-14

Kendall Nii

Senior Director, Program Management

Four Operating Sectors at a Glance

NORTHROP GRUMMAN

Aerospace Systems


- Autonomous Systems
- Strike Operations
- Military and Civil Space Systems
- Aircraft and Spacecraft Design, Integration and Manufacturing
- Intelligence, Surveillance and Reconnaissance
- Protected Communications
- Battle Management
- Missile Defense
- Space Exploration
- Advanced Technologies

Innovation Systems


- Launch Vehicles
- Propulsion Systems
- Aerospace Structures
- Missile Products
- Defense Electronic Systems
- Armament Systems
- Small Caliber Systems
- Commercial Satellites
- Science and National Security Satellites
- Human Space and Advanced Systems
- Space Components
- Technical Services

Mission Systems


- Airborne C4ISR Systems
- Cyber and Intelligence Mission Solutions
- Land and Avionics C4ISR Mission Solutions
- Missile Defense and Protective Systems
- Navigation and Maritime Systems
- Space ISR Systems
- Engineering, Sciences and Technology
- Civil Security and Public Safety Systems

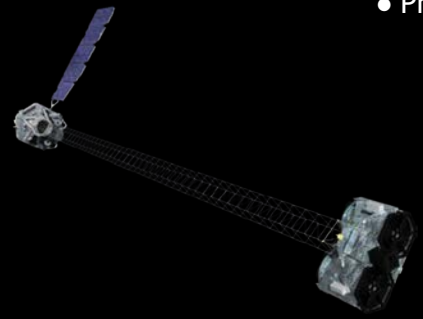
Technology Services


- Technology-differentiated, Mission Services and Training Systems
- Logistics and Modernization of Military Equipment
- Global Sustainment Engineering and Support
- New Innovative Logistics Products
- Health IT

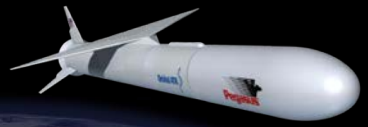
Our Products and Services for NASA's AOs

NORTHROP GRUMMAN

Dedicated Launch Free Flyer Spacecraft
- Astrophysics, heliophysics, planetary and Earth science



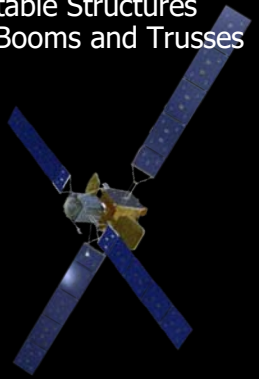
Shared Ride Free Flyer Spacecraft
- ESPA ring mounted
- Propulsive ESPA rings



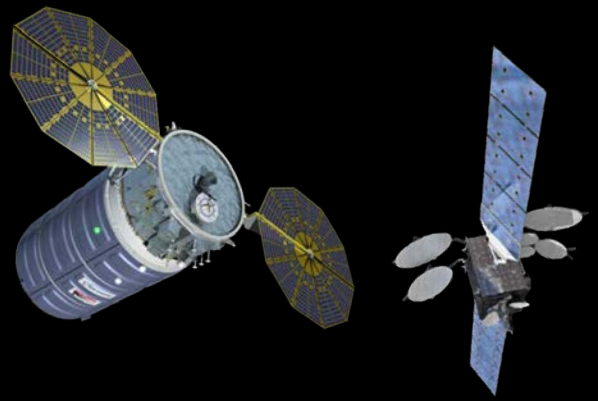
Launch Services
- Dedicated Pegasus
- Dedicated Minotaur-C
- Dedicated Antares

Observatory and Integration and Test Mission Integration

Thermally Stable Structures
Deployable Booms and Trusses



Cygnus Hosted Payload
- Frequent flights to ISS orbit: 350 km, 51.6 °
- Up to 1 year mission duration



Sounding Rockets and Scientific Balloons
- Management and execution
- Integration, test, operations

Mission Operations
- Complete suite of mission operations options from turn-key systems to on-site support

MEV Hosted Payload
- Geosynchronous or geosynchronous transfer orbit
- Mission duration up to 15 years
- Data delivered directly to SOC

GEOStar Hosted Payload
- Geosynchronous orbit
- Mission duration up to 15 years
- Data delivered directly to SOC

Working with PIs from Concept to Flight

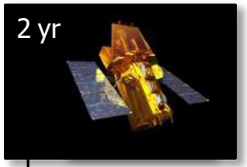
NORTHROP GRUMMAN

MIDEX

IMAGE
Heliophysics
PI: J. Burch
Mass: 536 Kg
Power: 250 W
Orbit: 1000 x 46004 km 90°
LV: Delta 7326
SC: L-M
Launch: 03-2000

WMAP
Astrophysics
PI: C. Bennett
Mass: 840 Kg
Power: 419 W
Orbit: L2 Lissajous
LV: Delta 7425
SC: GSFC
Launch: 06-2001

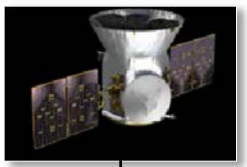
Swift
Astrophysics
PI: N. Gehrels
Mass: 1470 Kg
Power: 650 W
Orbit: 600 km Cir 20°
LV: Delta 7320
SC: NGIS
Launch: 11-2004



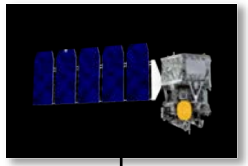
THEMIS
Heliophysics
PI: V.Angelopoulos
Mass: 126Kg x 5
Power: 37 W x 5
Orbit: 1.5R_e x 10-30R_e
LV: Delta 7295
SC: NGIS
Launch: 02-2007

WISE
Astrophysics
PI: N. Wright
Mass: 661 Kg
Power: 301 W
Orbit: 525 km Cir SS
LV: Delta 7320
SC: Ball
Launch: 12-2009

TESS
Astrophysics
PI: G. Ricker
Mass: 324 Kg
Power: 249 W
Orbit: 17 R_e x 59 R_e
LV: Falcon 9
SC: NGIS
Launch: 2018



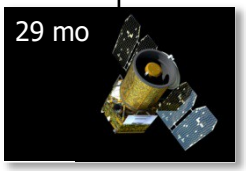
ICON
Heliophysics
PI: T. Immel
Mass: 258 Kg
Power: 240 W
Orbit: 550 km Cir 24°
LV: Pegasus
SC: NGIS
Launch: 2017



2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020

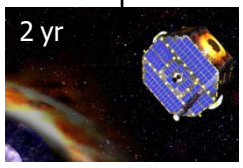
SMEX

RHESSI
Heliophysics
PI: R. Lin
Mass: 293 Kg
Power: 414 W
Orbit: 600 km Cir 38°
LV: Pegasus
SC: NGIS
Launch: 02-2002

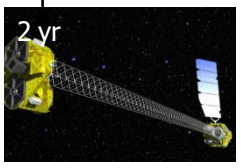


GALEX
Astrophysics
PI: C. Martin
Mass: 280 Kg
Power: 290 W
Orbit: 700 km Cir 29°
LV: Pegasus
SC: NGIS
Launch: 04-2003

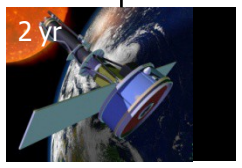
AIM
Heliophysics
PI: J. Russell
Mass: 225 Kg
Power: 300 W
Orbit: 600 km Cir SS
LV: Pegasus
SC: NGIS
Launch: 04-2007



IBEX
Heliophysics
PI: D. McComas
Mass: 122 Kg
Power: 80 W
Orbit: 7000 km x 50 R_e
LV: Pegasus
SC: NGIS
Launch: 06-2008



NuSTAR
Astrophysics
PI: F. Harrison
Mass: 330 Kg
Power: 250 W
Orbit: 550 km Cir 6°
LV: Pegasus
SC: NGIS
Launch: 02-2012



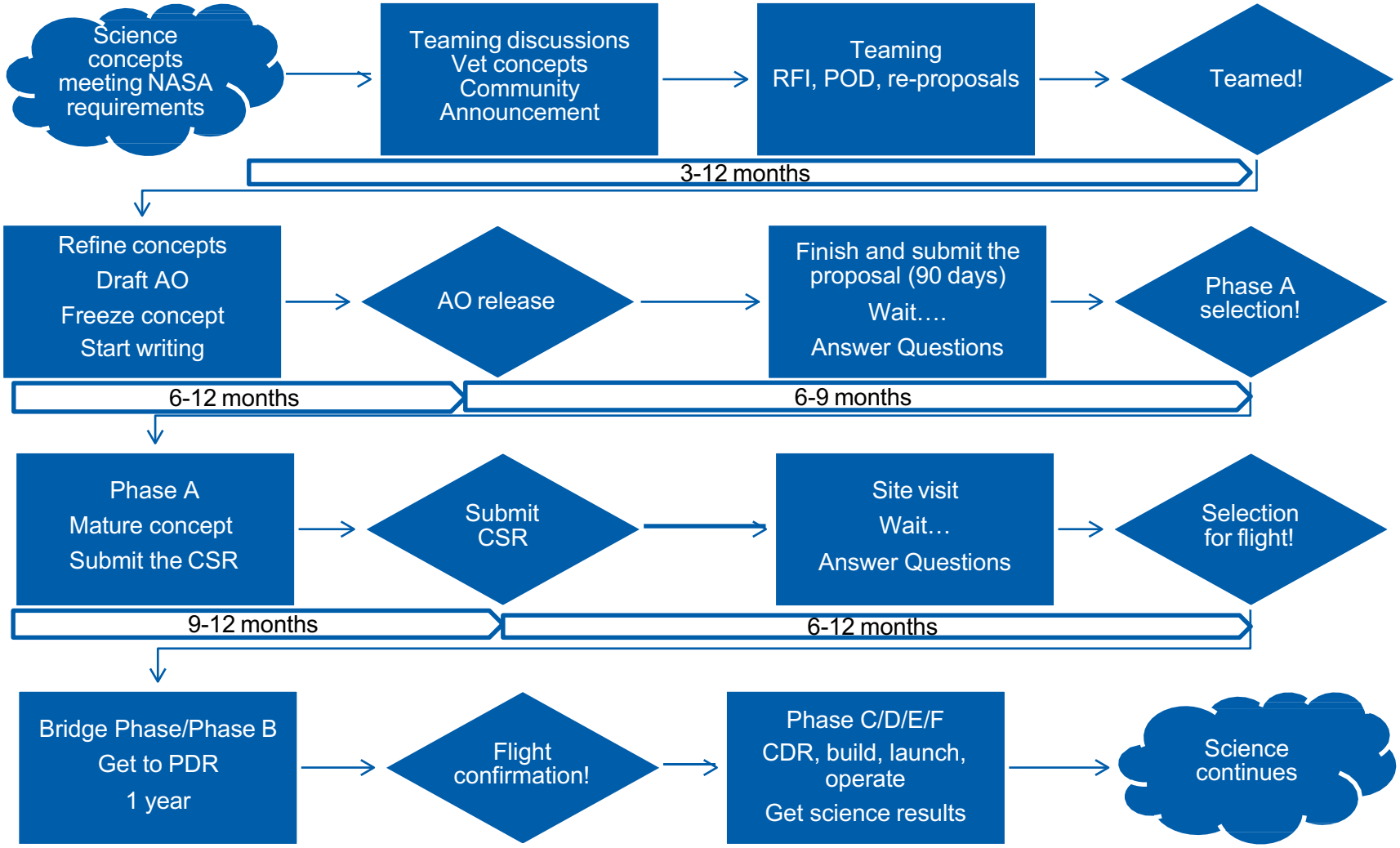
IRIS
Heliophysics
PI: A. Title
Mass: 167 Kg
Power: 226 W
Orbit: 596 x 666 km SS
LV: Pegasus
SC: L-M
Launch: 06-2013

IXPE
Astrophysics
PI: M. Weisskopf
Mass: 292 Kg
Power: 257 W
Orbit: 540 km Cir 0°
LV: Pegasus
SC: Ball
Launch: 2020

9 of the last 14 Explorer missions use our spacecraft

Industry Perspective on NASA AO Process

NORTHROP GRUMMAN



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- Responding to an AO is a marathon not a sprint
  - Getting an investigation selected for implementation takes several years
  - Great science is necessary to win, but
  - High risk always loses
- Examples of risk raisers
  - Poor traceability – unclear if instrument performance or mission design supports science objectives
  - Immature technology without good maturation plan
  - Proposed costs do not match cost models
- Engage with industry early in the process
  - Solicit industry input around the community announcement or before
  - Engagement can be formal (RFIs) or informal
    - Solicit our inputs to help define the mission and mission trades
    - Solicit our inputs to identify risks, costs, and fit
  - Select your team before the Draft AO release

Early engagement allows risk mitigation

Contact

NORTHROP GRUMMAN

- Kendall Nii
  - Senior Director, Program Management
  - 480-355-7787 or 480-261-4689
  - kendall.nii@ngc.com
- John Dyster
  - Senior Director, Business Development
  - 480-355-7739 or 480-435-5114
  - john.dyster@ngc.com

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