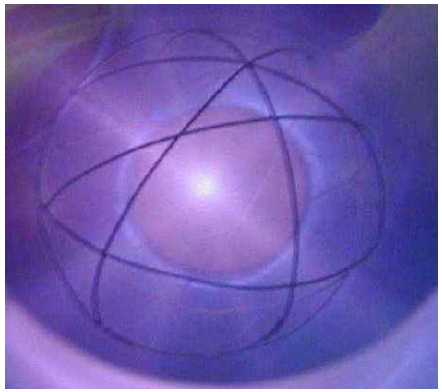


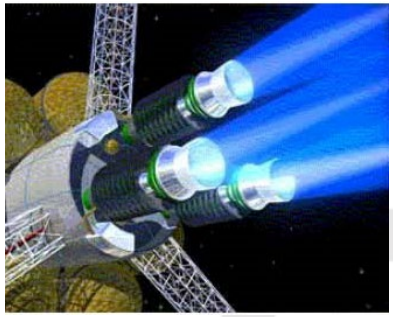
# SPHERELAB

ARES INSTITUTE
AEROSPACE RESEARCH & ENGINEERING SYSTEMS INSTITUTE

## Space, Plasma & High-energy Electrostatics Research & Engineering Laboratory

**Matthew Travis, CEO**
**ARES Institute, Inc.**

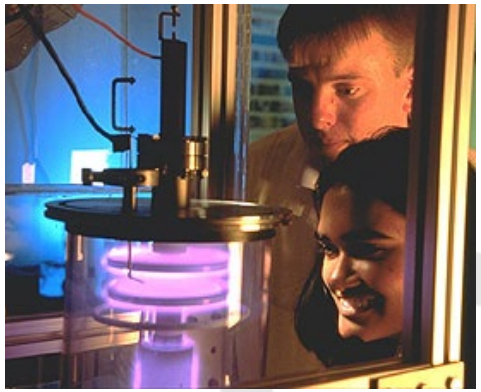
*A Proposed Center of Excellence for Regional, National, and Global Collaboration*



# Vision

ARES INSTITUTE
AEROSPACE RESEARCH & ENGINEERING SYSTEMS INSTITUTE

*Create Unique Proprietary Research Capabilities and Commercialization Opportunities in the Disciplines of Plasma Science & Engineering, Desirable Enough to Attract Esteemed Visiting Researchers, University Students, and Commercial Clients, for the Opportunity to Use its "Signature Instruments" in their Own Investigations.*



# Potential Resources

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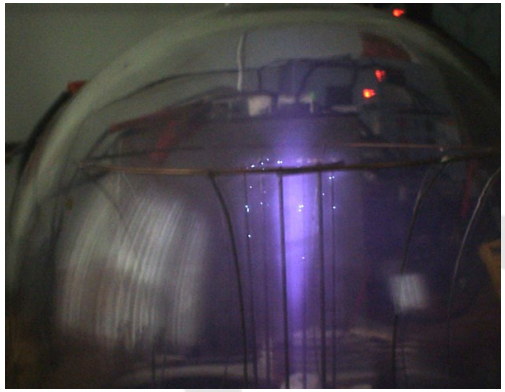
***Mining Illinois' High-Tech Ecosystem***

- Activities Relevant to the Plasma Lab Include:
  - Inertial-Electrostatic Confinement Fusion Research
  - Homegrown Plasma Vapor Deposition Units
  - Multi-pumped CO2 Laser Plasma Studies
  - High $Q_e$ Photokinetic Combustion Technology
  - High Energy Accelerator Programs (Int'l.)
  - Hydrogen Photochemistry Research
  - BioEnergy Alternative Fuels



# Near-Term Goals

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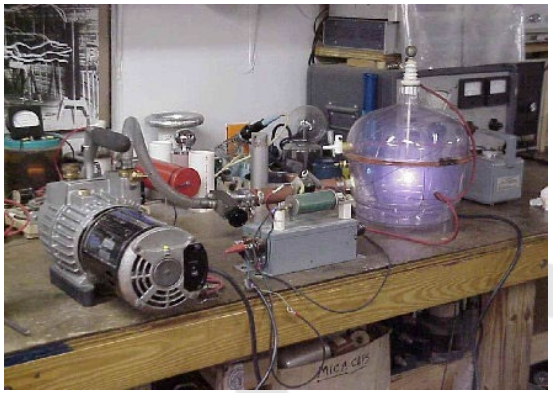
***Building a Funding Pipeline for Future Research***

- Functional 500Kv+ IEC and PMK Reactors
- >$500,000 in Grants/Contracts in Year 1
  - Recruit/Initiate Support for 1 PhD Dissertation
  - Initiate Support for 3 M.S. Thesis Projects
  - Two Papers for Publication in Peer-reviewed Journals
  - Minimum 4 SBIR/STTR Proposals and 1 NIAC Proposal
- Novel Proprietary MHD/MPD Spectrometer
- >$2,000,000 Grants/Contracts in Year 2
  - Second PhD and Two Additional Grad Students
  - Six Papers for Publication w/ Three Presented
  - Begin planning for a “Plasma Frontiers” Conference



# Lab Development

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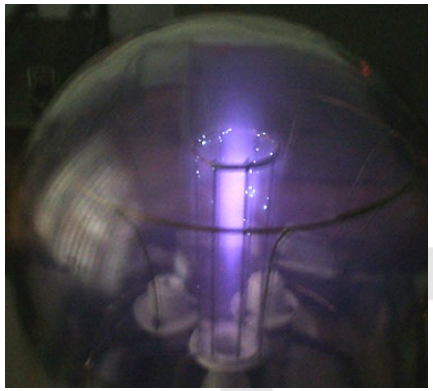
***Plasma Research Can Be Economical***

Economically Creating a World Class Facility to Attract Leading Researchers:

- Unique Instruments which Perform Unusual Experiments, Custom Fabricated as Senior Project, MS Thesis, PhD Dissertation Research in EE, MAE, PSS, Chem/E
- Capabilities of Machine Shop Facilities Through New/Used Equipment Donations In-Kind Donations Could Include (Examples only):
  - 27,000 Volt DC Transformers
  - Mercury-filled Ignitron Tubes
  - IEC "Fusor" Test Unit Prototype
  - Near Net Shape 304 Stainless Components
  - Load Bearing Metal Desks, Shelving & Computers
- Potential acquisition of surplus equipment from Aphelion Aerospace



# Plasma Experiments

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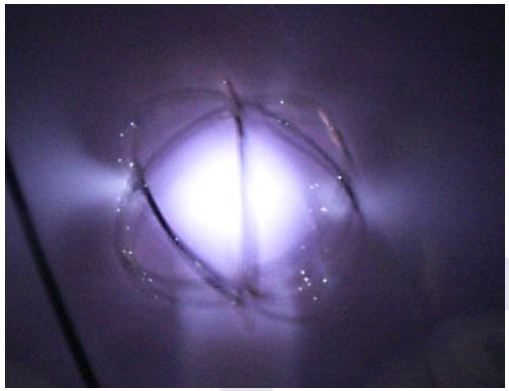
***Knowing Which Envelopes to Push***

- Plasma-driven high-efficiency electric thrusters for spacecraft
- Directly using IEC fusion products to produce thrust in a rocket engine
- Hypersonic applications of IEC fusion
- Deeper High Voltage Potential Well for Inertial Electrostatic Confinement
- Production of Larger, More Stable Autoconfining Magnetoplasmoids
- Quantum Analysis of Photocombustion for Kistiakowski's Photokinetic Catalysts



# Electrostatic Potential Well

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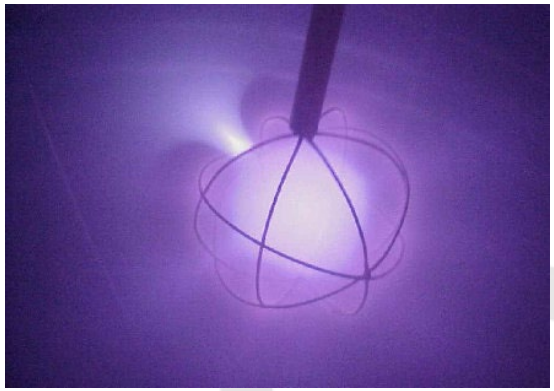
***Inertial-Electrostatic Confinement Fusor***

- Create Deeper Electrostatic Well
  - Initial Potential 675,000 Volts
  - 3.375x Greater than UWisc. Upgrade
  - Target >1,000,000 Volts in Fy'15
- Incorporate Augmenting Features
  - Magnetic Assist
  - Photo-Catalytic Chemistry
- Progression to Advanced Fuels
- Safe Neutron Source for Other Research Requirements



# Magnetoplasmoid Formation

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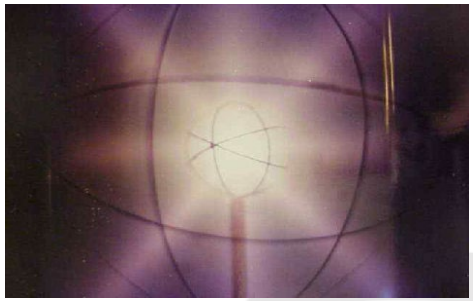
***The Plasmak Reactor***

- Larger, More Persistent PMKs
  - >25 centimeters Diameter
  - >5 seconds Stability
- Adiabatic Isobaric Compression
  - Pneumatic Architectures
  - Detonation, Acoustic, Solenoid
- Progression to Advanced Aneutronic Fuels
- Private Industry & University Teaming



# Quantum Analysis of High $Q_e$ Photokinetics

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***Photocombustion Reactor***

- Replicate HCl Plasma Reactions with DCl
  - Activation Regime above 246 Kcal/Mole
  - Reaction Kinetics >700,000 fps
  - Seeking to Drive $I_{sp}$ Beyond 1816 secs
  - Reaction Spikes $<5_u$secs.
- Control Experiments
  - Ultraviolet Decomposition of $CH_4$ w/ $O_2$
- Possible Corporate Partnerships.

# Synergistic Focus

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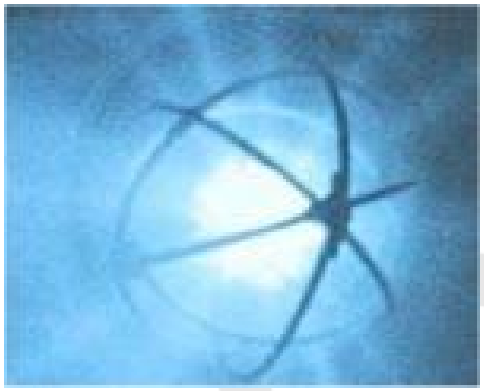
***Potential Research Thrusts***

- Confirmation of Magnecular Bonding via Plasmas
- IEC/PMK Plasma Process Integration
- $_{u}$Wave Wireless Plasma Antenna Architectures
- $_{u}$Wave $CO_2$ Plasma Dissociation/Carbon Accretion
- $Al_2O_3$ Plasma Dissociation/Deposition Studies
- Microsatellite Flight Demonstration Project
  - Collaborative with Illinois universities and colleges



# Principal Objectives

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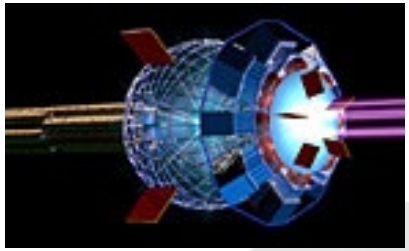
***Leveraging State, Federal, and Private R&D Contracts***

- Develop a Versatile, Low-Cost Experimentation Testbed for Alternative Plasma/Fusion Research Studies
- Conduct Key Internal Experiments
  - Papers for Publication
  - Theses & Dissertations
- Attract Funded Guest Researchers
- Obtain Industrial Applications Contracts



# The Ultimate Goal

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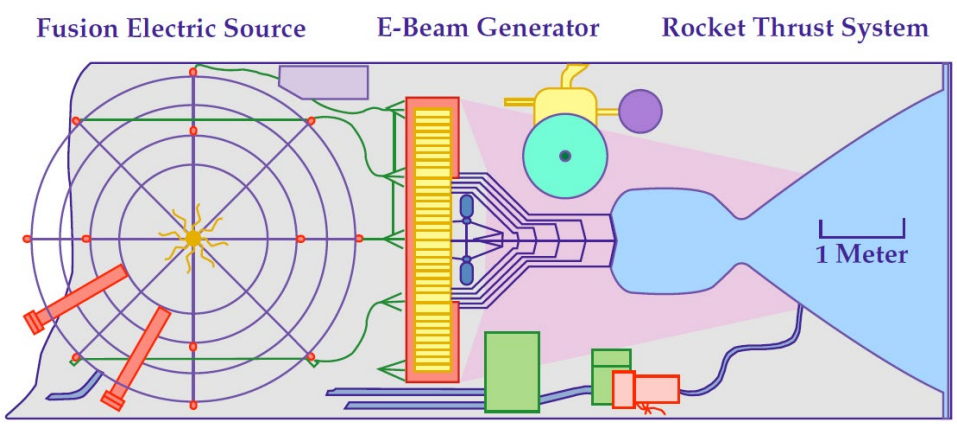
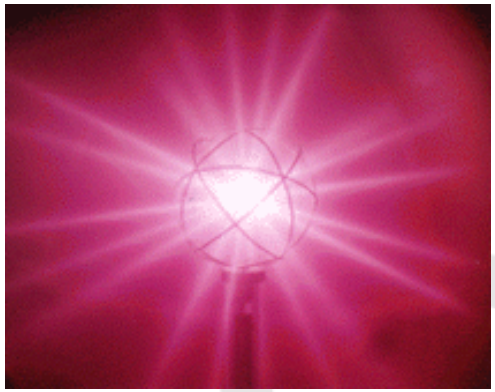
***Develop Enabling Technologies for Rapid Interplanetary and Interstellar Transportation***

| Parameter | Mars | Saturn | Pluto |
|---|---|---|---|
| Propellant Tanks (kg) | 1962 | 11238 | 35158 |
| Propellant (kg) | 19617 | 112377 | 351575 |
| Final Planetary Orbit Radius | 1.5 | 2 | 1.5 |
| Initial Mass in LEO (kg) | 73379 | 191188 | 491704 |
| Mass in Destination Orbit (kg) | 53765 | 78803 | 140121 |
| Total Travel Time (days) | 17.5 | 101 | 324.5 |




Conceptual "Quiet Electric Discharge" rocket engine.



# Timetables

ARES INSTITUTE
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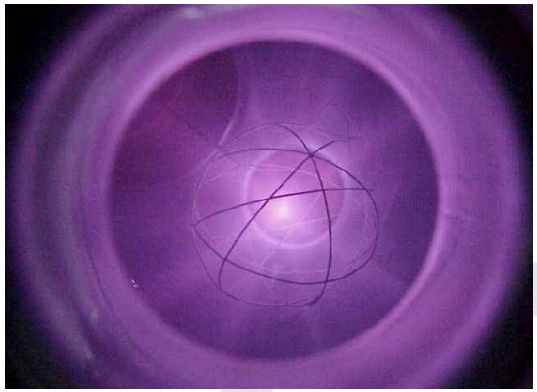
***Very Rapid Ramp Up to Funding***

- Complete Funding for Lab Build-Out by End of FY 2023 With Built-Out Beginning in Q2 2023
- IEC Reactor IOC & Supporting Equipment by Beginning of 2023-24 Academic Year
- Substantial Body of Work in Progress by Q2 2024 (Grad Students, Papers, Proposals Pending Review)
- Detailed Project Management Plan in Preparation



# First-Year Financials

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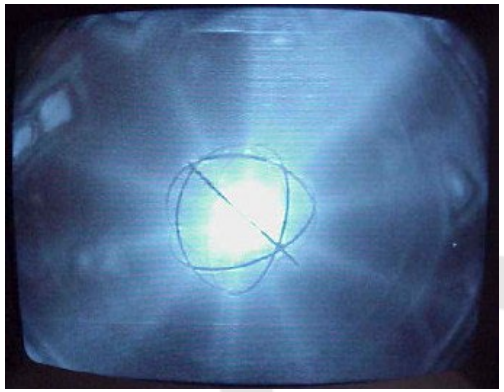
***Initial Investment: < 3 Mo. From Project Start***

| | |
|---|---|
| Labor | $ 242,460.00 |
| Rent | $ 18,000.00 |
| Utilities | $ 6,000.00 |
| Office Equipment | $ 40,000.00 |
| Laboratory Tools | $ 50,000.00 |
| Software Licensing | $ 75,000.00 |
| G & A | $ 12,000.00 |
| Consumables | $ 6,000.00 |
| | |
| **TOTAL** | **$ 449,460.00** |

- High leverage from investments in instrument construction and new grants and contract awards
- Internal commitment to support funding for research
- Would attract strong student volunteer support for lab construction
- Potential sharing of resources and attendant costs with partners



# Potential Sources of Funding & Partnerships

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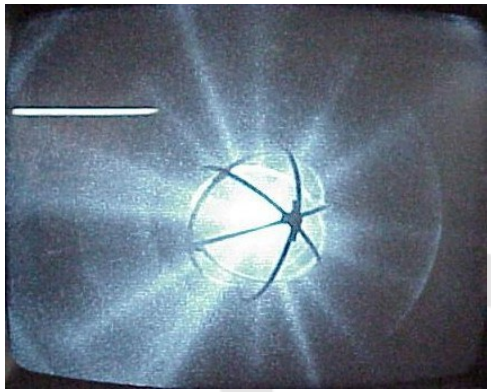
***Aggressive Proposal & Pitch Efforts (examples only):***

- **Federal:**
  - National Science Foundation
  - NASA (NIAC / SBIR)
  - DoD (AFWERX / SpaceWERX / SBIR)
  - Department of Energy
- **State of Illinois:**
  - Illinois Innovation Network
  - Illinois Dept of Commerce & Economic Opportunity
  - Illinois Space Grant Consortium
- **Corporate:**
  - Siemens
  - Pratt & Whitney
  - Lockheed Martin Ventures
  - Northrop Grumman
  - Boeing HorizonX
  - General Electric
  - Raytheon
  - Airbus Ventures



# Other Material Sources

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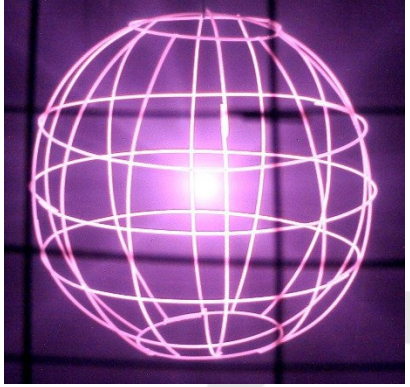
***Purchase, In-Kind, Licenses or Non-Contract Grants (examples only):***

- Local Industry
  - Ball Aerospace
  - Boeing
  - Aeropac, SA
  - C-U Aerospace
- Foundations
  - F.W. Olin
  - Guggenheim
  - UI Alumni Foundation
  - Others

*Upon Authorization & Logistics, Substantive Private/Foundation Fundraising will be Undertaken*



# Follow-up Strategies

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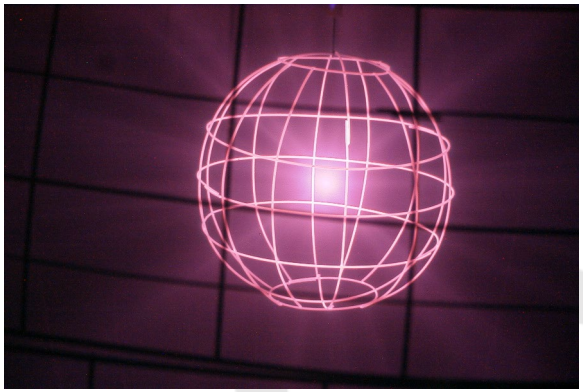
***Widening the Circle of Collaboration***

- Market Research Study of Potential Lab Users
  - 400 Telephone Interviews with Researchers Nationwide
- Build Consortium with other universities & Regional Counterparts' Departments of Physics/EE. For example:
  - Illinois State University
  - Northwestern University
  - Purdue
- Educational Outreach to Feeder Institutions, for example:
  - CompTIA Spark
  - Champaign County Public Schools
  - Richland Community College
- Integrated Telescience and Public Outreach Capabilities

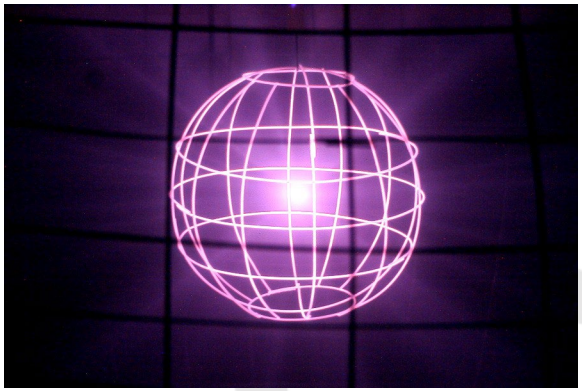


# Proposed Team

ARES INSTITUTE
AEROSPACE RESEARCH & ENGINEERING SYSTEMS INSTITUTE

***Internal Steering Committee***

- Matthew Travis, Acting Director
- Chief Scientist (Actively Recruiting)
- Faculty Reps from Physics/Space Sciences, Mechanical/Aerospace Engineering, Chemistry, Chemical Engineering, Civil Engineering
  - Actively Recruiting
  - Special Invitations to Emeriti
- Select First Grad Student (BSEE/BSME)



# Proposed Team

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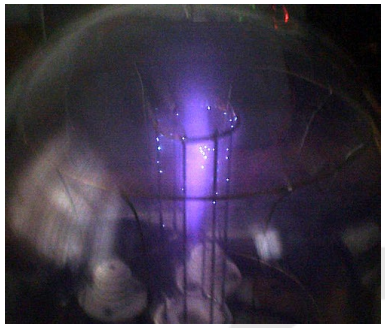
***External Advisory Board for Initial Work***

We are currently in the process of recruiting the initial leadership team and Advisory Board for establishing the laboratory.



# Organization

ARES INSTITUTE
AEROSPACE RESEARCH & ENGINEERING SYSTEMS INSTITUTE

University Partner

Commercial Clients

ARES INSTITUTE
Lab Co-owner

SPHERELAB

INTERSTELLAR EXPLORATION CONCEPTS
The Future. Today.
Lab Co-owner

Academic / Research Clients

APHELION

Supply Chain

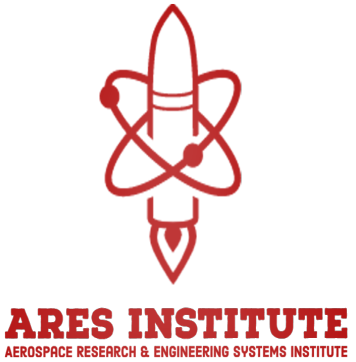
# Summary

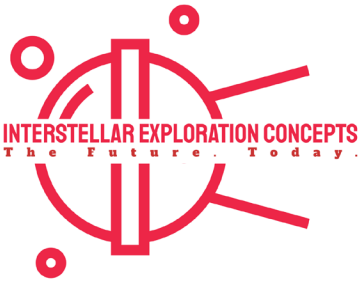
ARES INSTITUTE
AEROSPACE RESEARCH & ENGINEERING SYSTEMS INSTITUTE

***Strategic Points***

- SPHERELAB's *Signature Instruments* will put partner organizations and companies on the map as essential institutions for plasma physics and green power & propulsion research and commercialization
- Broad benefits in hands-on undergraduate education, graduate studies, recruitment
- Focus for high priority federal R&D funding

# For More Information




***Matthew Travis, CEO / Executive Director***

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