

# GA Supplier Day 2022

## GA-EMS Programs Overview

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# General Atomics Electromagnetic Systems Group Programs Overview

- **GA-EMS Introduction**
- **GA-EMS Manufacturing and Operations**
- **GA-EMS Programs**
  - **Defense**
  - **Space**
  - **Nuclear Technologies and Materials**
  - **Commercial / Applied Power Systems**

# General Atomics Government Business Segments

*GA-EMS was Spun Out of GA's Fusion Division in Mid-1980's*



## ASI

Leading designer and manufacturer of proven, reliable Remotely Piloted Aircraft (RPA) systems, radars, and electro-optic and related mission systems, including the Predator® RPA series and the Lynx® Multi-mode Radar



## EMS

Develops technologies for the DoD, DOE, Agencies, IC, and commercial customers

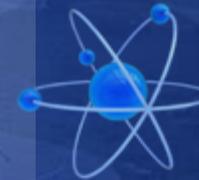
GA-EMS is a world leader in the application of electromagnetic power and energy technologies, pulse power, nuclear fission, adaptive optics, lasers, sensors, undersea systems, missile systems, projectiles, and space systems



## ENERGY

Develops sustainable and alternative energy solutions and materials

Operates the DIII-D National Fusion Facility



# GA-EMS Has Products in 68 Countries and Offices on 5 Continents

*... and Now Facilities in Eggersriet, Switzerland!*



Afghanistan	Azerbaijan	Bulgaria	Cyprus	Germany	Ireland	Lebanon	Myanmar	Pakistan	Puerto Rico	Singapore	Switzerland	United Arab Emirates	Venezuela
Albania	Bangladesh	Canada	Czech Republic	Greece	Israel	Macau	Netherlands	Peru	Romania	Slovenia	Taiwan	United Kingdom	Viet Nam
Argentina	Belarus	Chile	Denmark	Hong Kong	Italy	Malaysia	New Zealand	Philippines	Russia	South Africa	Thailand	Uruguay	Yemen
Australia	Belgium	China	Egypt	India	Japan	Mexico	Norway	Poland	Saudi Arabia	Spain	Turkey	USA	
Austria	Brazil	Colombia	France	Indonesia	Korea	Morocco	Oman	Portugal	Serbia	Sweden	Ukraine	Uzbekistan	

# GA-EMS Distributed Operations

*GA-Synopta (Eggersriet, Switzerland) Supports Many GA-EMS Initiatives*

1,800+ employees with 2 million ft<sup>2</sup> for research and innovation, engineering, manufacturing, quality assurance, testing, and lifecycle support



# Tupelo & Iuka, MS, Manufacturing Facility

- **GA-EMS has >708,000 ft<sup>2</sup> of manufacturing space in Mississippi to serve a variety of manufacturing needs**

- Machining
- Assembly
- Test
- Fabrication
- Print Circuit Board Assembly



GA acquired 78 acres with expansion capability of 1.1 million ft<sup>2</sup>

**2006**  
30,000 ft<sup>2</sup>



**2007**  
5,000 ft<sup>2</sup>



**2008**  
37,500 ft<sup>2</sup>



**2009**  
2,500 ft<sup>2</sup>



**2010**  
50,000 ft<sup>2</sup>



**2011**  
5,000 ft<sup>2</sup>



**2012**  
140,000 ft<sup>2</sup>



**2013**  
88,000 ft<sup>2</sup>



**2016**  
66,000 ft<sup>2</sup>



**2017**  
2,000 ft<sup>2</sup>



**2018**  
128,000 ft<sup>2</sup>



**2018**  
100,000 ft<sup>2</sup>



**2019**  
50,000 ft<sup>2</sup>



**2020**  
78 acres



**2021**  
66,000 ft<sup>2</sup>



**Submarine Large Deck Fabrication Improvements**



# State-of-the-Art Machining Center

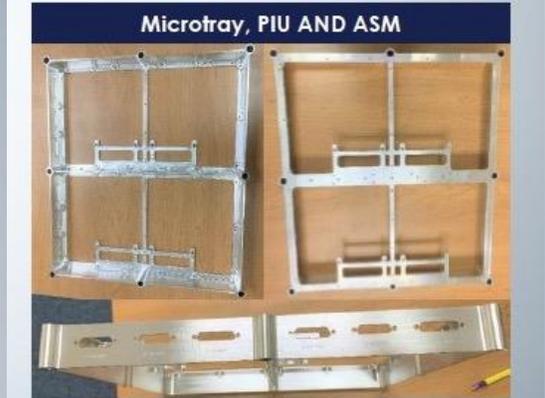
*From 3 Grams to 78,000 lbs to Printed Circuit Board Assemblies to Satellite Bus Structure*



**Onboard Computer**



**Argos-4 Structural Manufactured Parts**



GA-EMS has 2 EDM machines and >40 CNC machines and a 66,000 ft<sup>2</sup> facility located near barge shipping

# GA-EMS Fabricates Titanium to High Strength Steel

## Weldment Type

- Material Types
  - Aluminum
  - Steel & HY100
  - Stainless Steel
  - Titanium
  - NiCu
  - CuNi
  - Inconel
  - Hastelloy
  - Nickel
- Fusion Welding of Plastics

## Examples



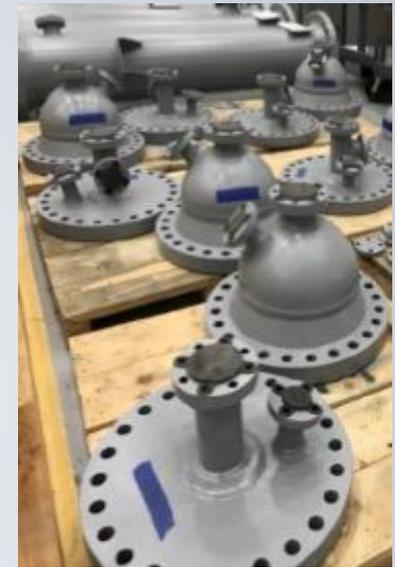
32,000 lbs 5-inch Thick High Strength Steel



Large High Strength Steel Foundations



ASME Section VIII Pressure Vessels



Aluminum Process Tubing



X-ray Carbon Steel Piping

# Spacecraft Manufacturing & Operations Facilities

## Rancho Bernardo, CA Facilities



## Englewood & Centennial, CO Facilities



## Huntsville, AL Facilities



Interior Space of Clean Room Space A



- GA-EMS has 100,000 ft<sup>2</sup> Clean Rooms with new 7,500 ft<sup>2</sup> in Rancho Bernardo, CA & 12,750 ft<sup>2</sup> in Centennial, CO
- GA-EMS is installing new integration and test cells & back up power systems in Centennial, CO
- 4 Space Mission Operations Centers (SMOCs) (Englewood and Centennial, CO, Herndon VA)
- GA-EMS is has new engineering & innovation Space center for 125 engineers in Centennial

# EMALS & AAG

## A New Era in Naval Aviation

EA-18G



T-45C



C-2A



F/A-18E



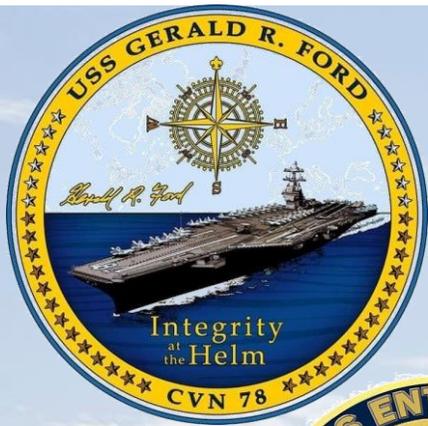
E-2D



F-35C



# USS Gerald R. Ford Class Carriers



USS Gerald R. Ford: First launch & recovery July 28, 2017  
>11,800 successful arrestments & launches completed at sea

# USS Gerald R. Ford



# GA-EMS Capacitors Enable the World's-Largest Pulse Energy Applications



**NIF – 1200 GA-EMS  
Capacitors**



**Los Alamos ATLAS Facility  
400 GA-EMS Capacitors**



**Ford Class Launch &  
Arresting Systems**



**Sandia Z-Machine Facility  
2,600 GA Capacitors**

# GA-EMS Missile Defense Products

## Lasers & Advanced Sensors



## Missiles and Projectiles



Projectiles



Advanced Hypersonic Weapon

Low Cost Interceptor (LCI)



Compact Kinetic Energy Missile (CKEM)

# GA-EMS is Developing Next Generation Energy Storage

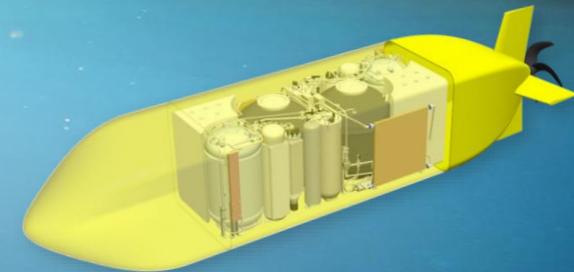
- Electrochemical Systems
  - Lithium-ion Fault Tolerant (LiFT™) battery systems: Secure Higher Energy Density System (SHEDS), LDUUV, Semi-Autonomous Hydrographic Reconnaissance Vehicle (SAHRV), Dry Combat Submersible (DCS), Extra Large Unmanned Undersea Vehicle (XLUUV), Shallow Water Combat Submersible (SWCS)
  - Aluminum/Water Power Systems (ALPS for LDUUV)



Special Operations Command (SOCOM) S301i Submersible



ALPS



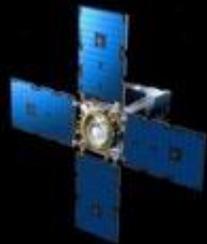
Large Displacement Unmanned Undersea Vehicles (LDUUV)

# GA-EMS Satellites Systems

## Picosatellites to Small Satellites

### OTB

Orbital Test Bed



**Launch Date**  
June 25, 2019  
**Customer**  
Jet Propulsion Laboratory

**Primary Payload**  
Deep Space Atomic Clock

**Spacecraft Size**  
139 kg

### LINCS

Laser Interconnect & Networking Communication System

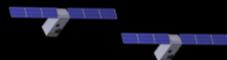


**Launch Date**  
Summer 2021  
**Customer**  
Space Development Agency (SDA)

Two 12U CubeSats hosting Infrared payloads & Laser Communication Terminals to demonstrate Optical Intersatellite Links

**Spacecraft Size**  
12U

### Manhattan



**Launch(s) Date**  
2023  
**Customer**  
SDA

Integrated optical communication terminal with beam director

**Spacecraft Size**  
40U

### GAzelle



**Launch Date**  
7 Oct 2022  
**Customer**  
US Space Force, NOAA, & CNES

Collects, processes, & disseminates environmental data worldwide

**Spacecraft Size**  
115 kg

### EWS

Electro-optical Infrared (EO/IR) Weather System



**Launch Date**  
2024  
**Customer**  
US Space Force

Collection of weather imagery & cloud characterization data for worldwide military operational use

**Spacecraft Size**  
400 kg

### TSIS-2

Total & Spectral Solar Irradiance Sensor-2

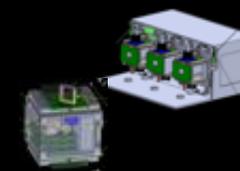


**Launch Date**  
4Q23  
**Customer**  
NASA Goddard Space Flight Center

Provides measurements of solar irradiance & high-quality data for the long term climate record

**Spacecraft Size**  
163 kg

### Special Programs



**Launch Date**  
Various  
**Customer**  
Various

Provides Special capabilities functionality to customers in various orbital regimes.

**Spacecraft Size**  
Various sizes from < 500 g to > 10 kg

### Nuclear Space

Nuclear Thermal Propulsion (NTP), Nuclear Electric Propulsion (NEP) and nuclear batteries For DoD and NASA



**Launch Date**  
various

**Customer**  
various

Provides high  $I_{sp}$  for efficient cislunar and interplanetary missions/operations

**Spacecraft Size**  
Large to include  $H_2$  propellant, nuclear reactor

GA-EMS is the payload integrator for Draper Laboratories for NASA's Commercial Lunar Payload System Task Order CP-12 to be landed on the moon's far side in 2025.



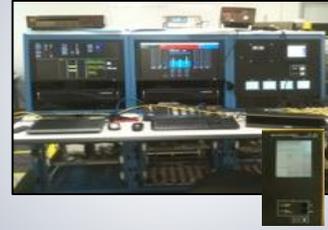
# GA-EMS Nuclear Technologies & Materials (NTM) Division

*General Atomics Delivered 66 TRIGA<sup>®</sup> Reactors: the World's Safest Reactors*

Research - Isotope Production



UZrH reactivity control

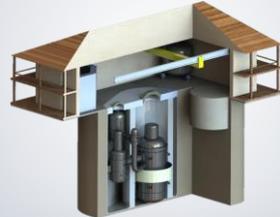


## TRIGA<sup>®</sup> Reactors, Controls & Fuels

Fort. St. Vrain Reactor



Modular Gas-Cooled Fast Reactors



UO<sub>2</sub>, UC, UN Microspheres



BISO in SiC Matrix

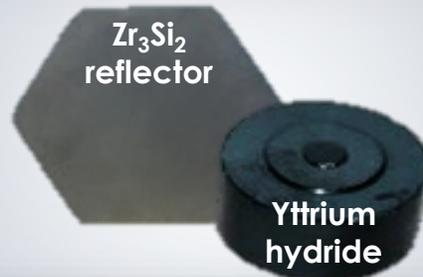


## High Temperature Reactors & Specialized Fuels

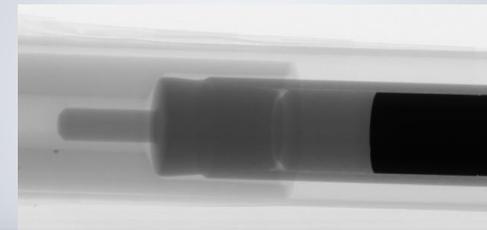
Ceramic Matrix Composites



Zr<sub>3</sub>Si<sub>2</sub> reflector



Ceramic Joint



## Engineered Materials

# GA-EMS Leverages Commercial to Defense



**15,000 RPM Megawatt-Class  
Motor/Generator**



**Supersynchronous  
Motor Drive**



**3 GPM Super-Critical Water  
Oxidation (SCWO) skid**



**Capacitors**



**Electric Drive for  
Mine Haul Trucks**



**Gulfronic® Electrostatic  
Separators**



**Terminal Automation  
Products (TAP)**



**Radiation Monitoring  
Systems (RMS)**

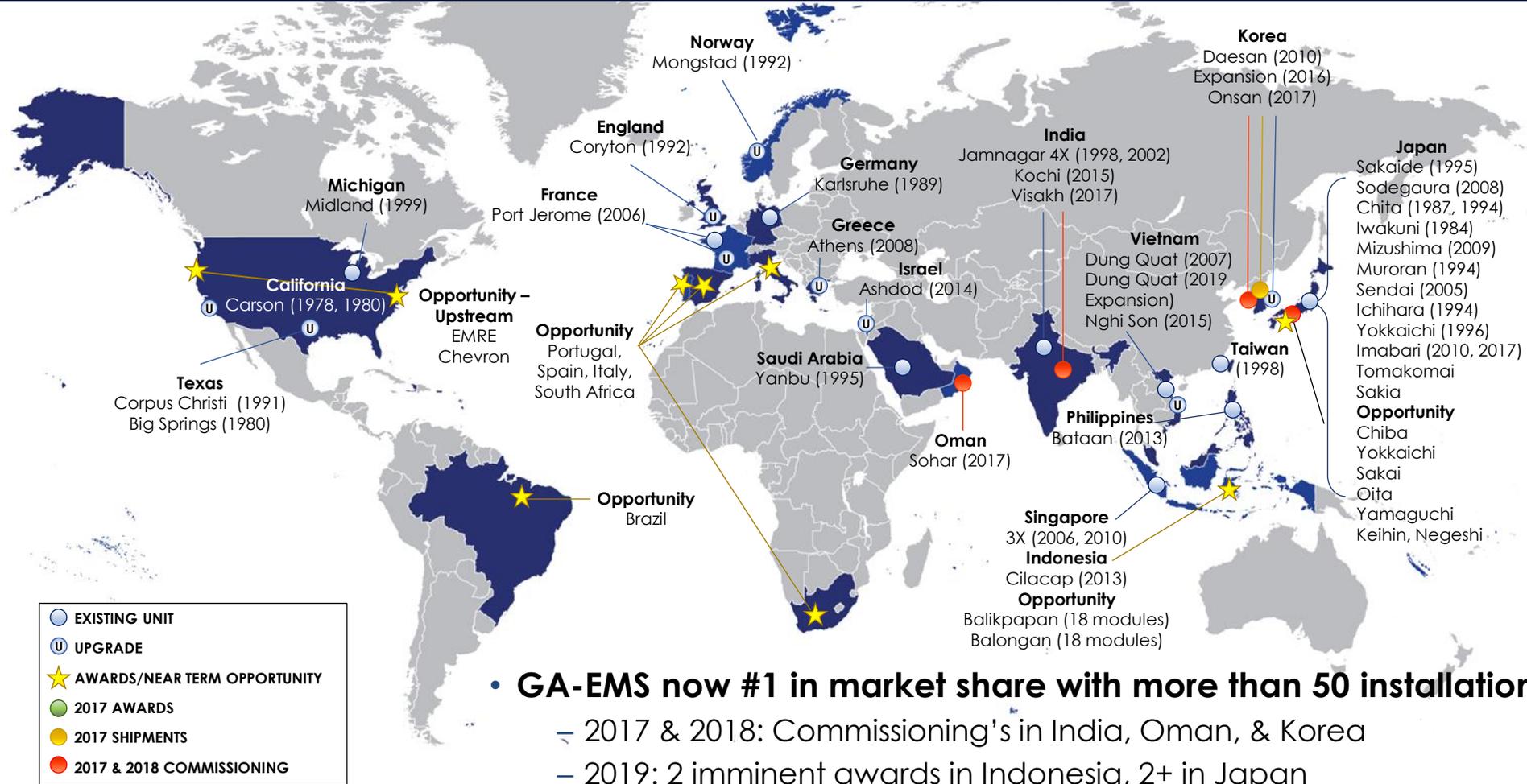
# High-Speed, High-Power Permanent Magnet Motor



Testing of integrated 8 MW motors and drives at GA-EMS test facility

# Gulfronic® Market Share: Install Base, Awards, & Near-Term Opportunities

More than 300 Modules in Operation Worldwide  
 More than 65M Barrels of Slurry Processed Annually by Gulfronic®



- **GA-EMS now #1 in market share with more than 50 installations**
  - 2017 & 2018: Commissioning's in India, Oman, & Korea
  - 2019: 2 imminent awards in Indonesia, 2+ in Japan

# GA-EMS: Disruptive High Technology Systems

