
EXCALIBUR • ALMAZ
Engage. Explore. Inspire.

Over the past 7 years EA has:

- Purchased four RRVs and two Station Pressure Vessels
- Performed numerous technical feasibility and design studies related to the RRVs and their subsystems as well as launch vehicle compatibility and overall program architecture
- Acquired State Department licenses for the hardware and for the technical services and export licenses from Russia to use the equipment in space.
- Performed tasks in response to our NASA Space Act Agreement
- Performed several recent market studies that indicate the ability to earn a reasonable return on investment by selling the crew positions and space services, as we progress from LEO to Lunar.

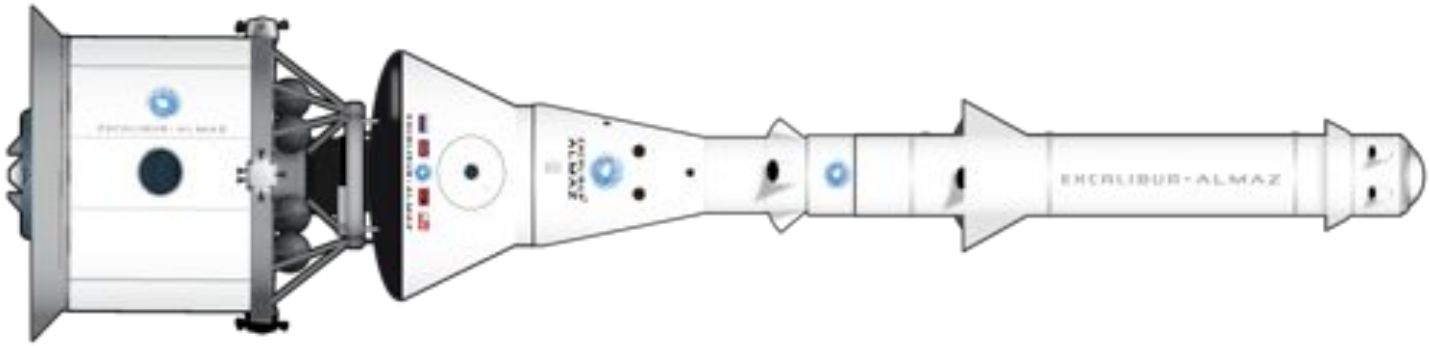
Excalibur Almaz Approach

Excalibur Almaz approach is to leverage the billions of dollars of past investment by spacefaring nations and apply advanced technology on an as needed basis to develop a space architecture that provides efficient access to space for commercialization, research and exploration.

Excalibur Almaz's Approach is Unique

Our approach

- Begins with proven hardware
- Progresses to develop a modular transportation system based on proven equipment and launch vehicle capabilities



Critical Elements of EA's LEO Crew Transportation System Elements are at Technology Readiness Level 9

Emergency Escape System (ESS)

- Fully ground and flight tested
- Successful in-flight use (LV Explosion at L+53 sec)
- Built by same company that builds Soyuz EES
- EAI will purchase identical units to those tested

EA is the <u>only</u> commercial spacecraft program with a flight qualified EES

Non-crewed flight test program completed

- 9/9 Successful entries and soft landings
- One RRV flew three times, one flew twice
- One operational flight (175 days attached to Salyut)

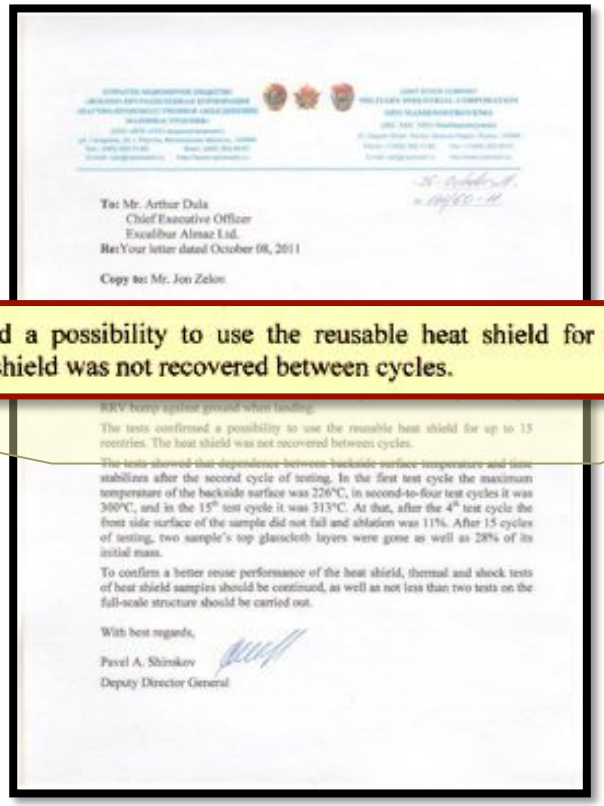
EA RRV reusability is estimated at up to 15 times per unit

Excalibur Almaz

Our goal is to create an affordable commercial space program.

Excalibur Almaz Owns Six Spacecraft

- **Four Reusable Reentry Vehicles**
  - Mass ~ 3 metric tons (capsule only)
  - Conic shape ~ 3 meters maximum diameter
  - Habitable volume ~ 4.5 cubic meters
  - Flown 9 times to orbit and returned safely
  - Spacecraft are now at EA's facility on the Isle of Man
  - Spacecraft can be reused 15 or more times



To: Mr. Arthur Dula
Chief Executive Officer
Excalibur Almaz Ltd.
Re: Your letter dated October 08, 2011

Copy to: Mr. Jon Zelon

The tests confirmed a possibility to use the reusable heat shield for up to 15 reentries. The heat shield was not recovered between cycles.

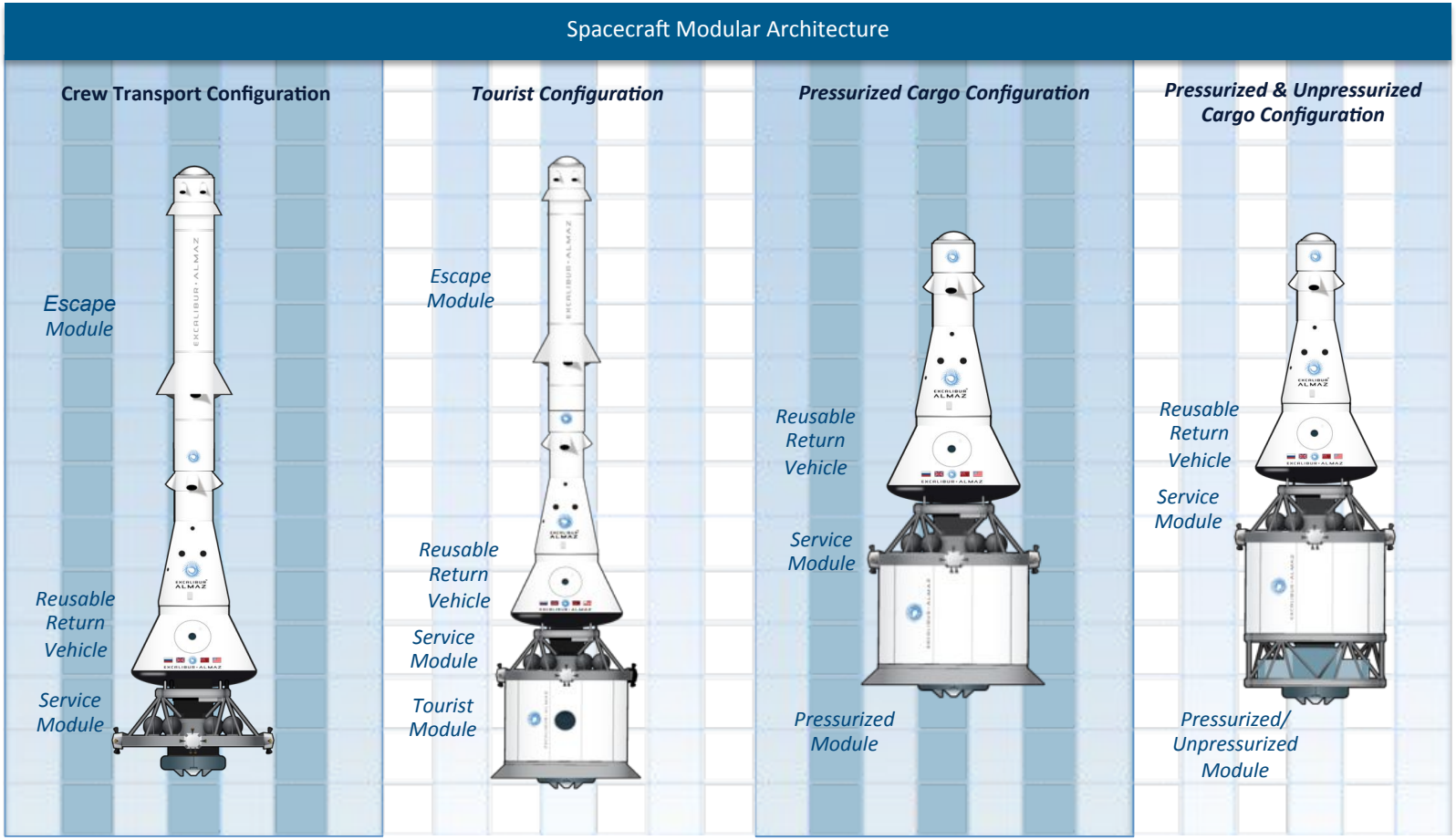
The tests showed that dependence between backside surface temperature and time stabilizes after the second cycle of testing. In the first test cycle the maximum temperature of the backside surface was 226°C, in second-to-four test cycles it was 300°C, and in the 15th test cycle it was 313°C. At that, after the 4th test cycle the front side surface of the sample did not fall and ablation was 11%. After 15 cycles of testing, two sample's top glasscloth layers were gone as well as 28% of its initial mass.

To confirm a better reuse performance of the heat shield, thermal and shock tests of heat shield samples should be continued, as well as not less than two tests on the full-scale structure should be carried out.

With best regards,

Pavel A. Shirokov
Deputy Director General

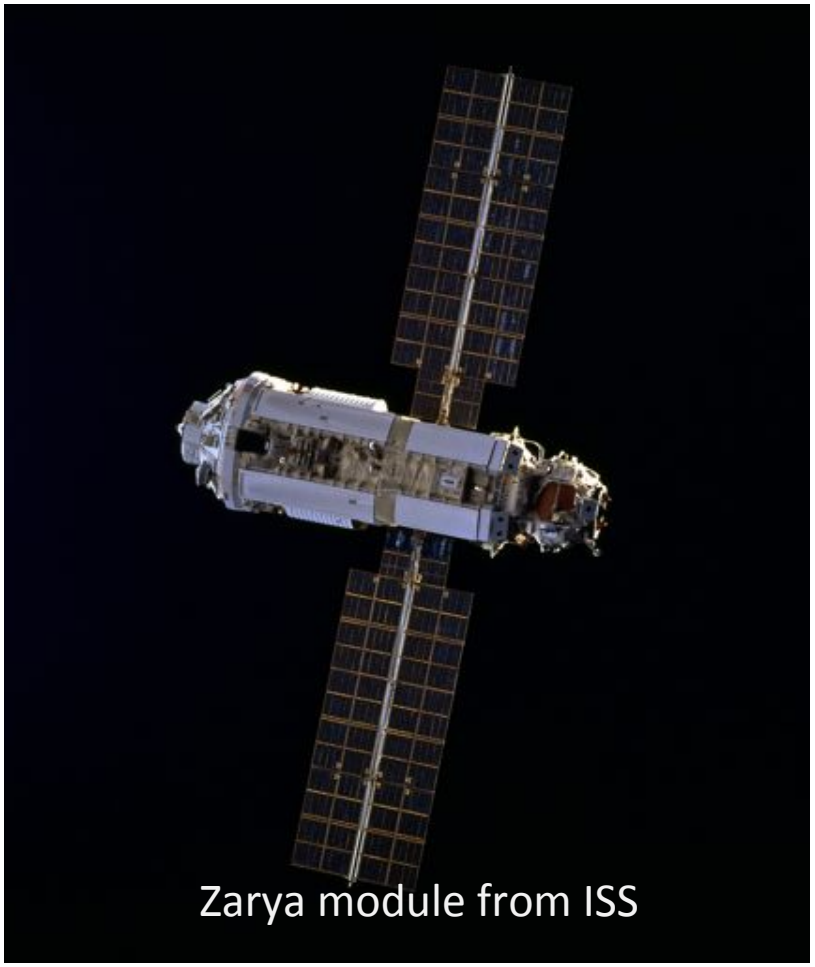
EA's Crew Transportation System for LEO is Based on a Modular Architecture Employing Proven Equipment and Design Methods



This transportation system provides the lowest development risk approach to create the first step in the infrastructure needed to meet EA's vision of providing commercially viable business activities in space, including asteroid and lunar mining, research and lunar and planetary exploration.

EA Spacecraft (Cont'd)

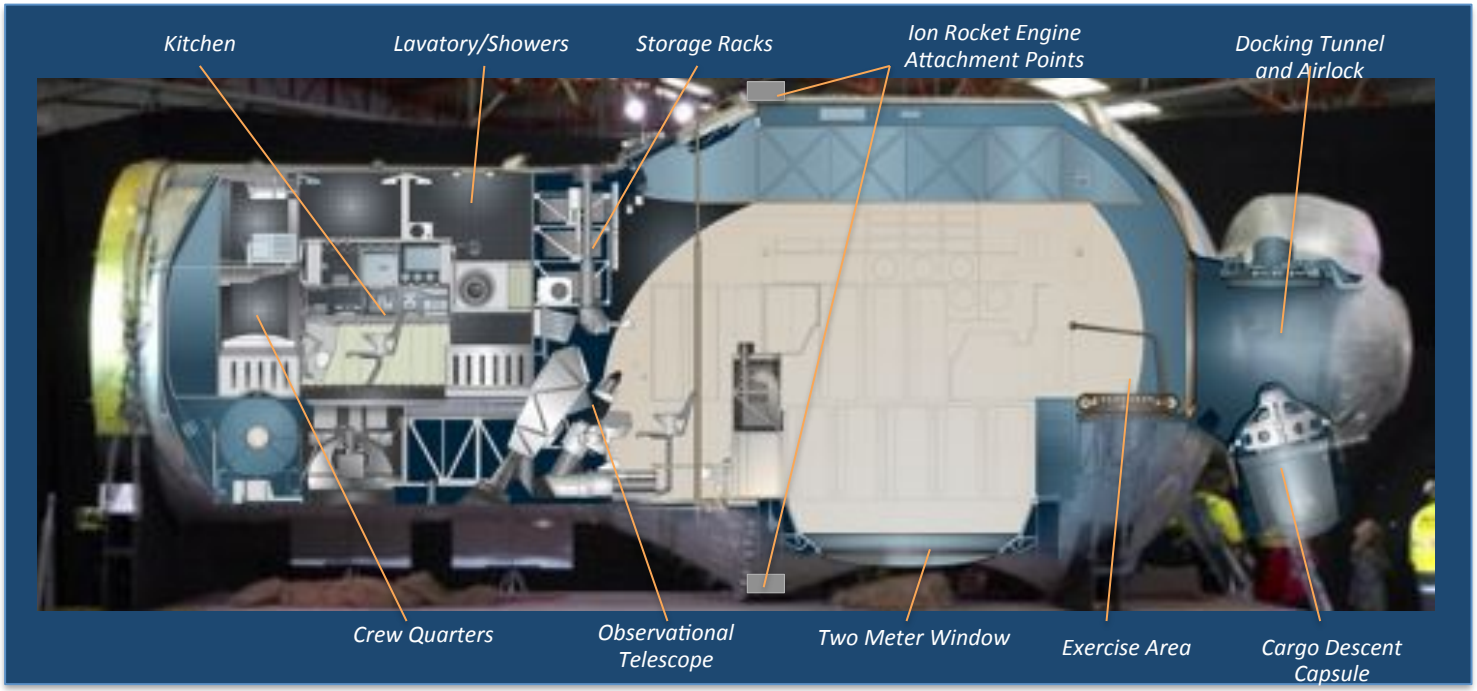
- **Two Space Station frames**
  - ~ 20 metric tons at launch
  - ~ 14 meters long
  - ~ 4.2 meters maximum diameter
  - ~ 90 cubic meters habitable volume
  - ~ 10 to 15 year useful life
  - Spacecraft are now at EA's facility on the Isle of Man
  - Similar space station frames have operated continuously in LEO for many years – e.g. the Salyut & MIR modules and the ISS Zarya module.



Zarya module from ISS

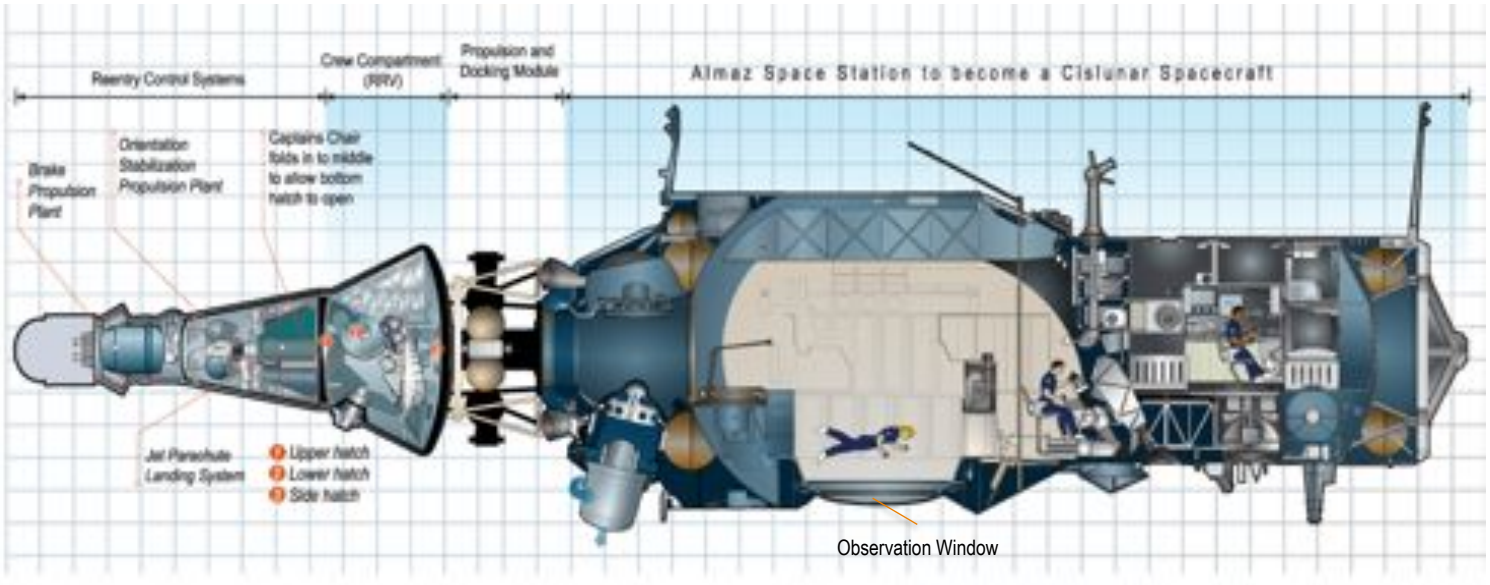
Our Space Station spacecraft modules are comparable to those utilized for MIR and ISS

- EA will verify flight readiness of our existing structures through non-destructive testing, upgrade on-board environmental control, flight control and communication equipment, provide required laboratory equipment and replace the original propulsion system with Hall thrusters, augmented by hypergolic/monopropellant fine attitude control thrusters
- Power will be provided by state of the art solar arrays and batteries



EA Business Objectives (Cont'd.)

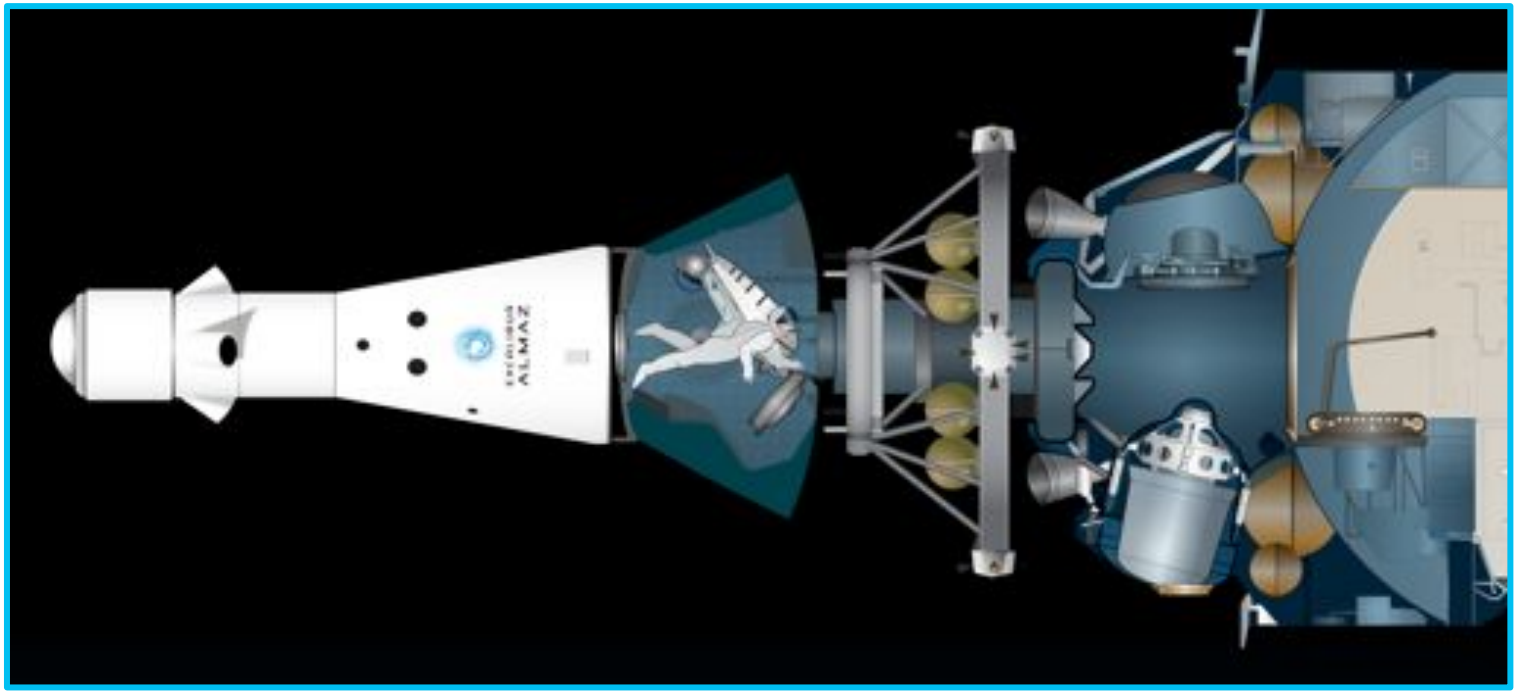
- EA will upgrade and modify our current assets for long-term multi-purpose use
- EA will create a transportation system for products, payloads, logistic support supplies and crew between:
  - Earth and Low Earth Orbit
  - Earth Orbit and Moon/L2



EA Business Objectives (Cont'd.)

Exploration and Scientific Research

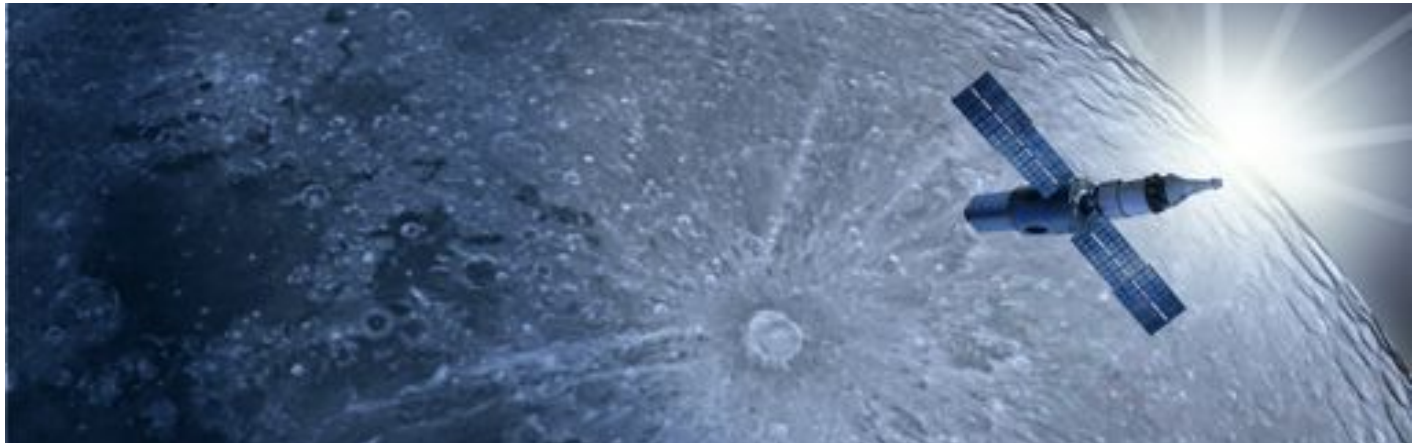
- Provide facilities within the L2 Station and transportation spacecraft to support exploration and scientific research including:
  - Ability to launch and retrieve Lunar and L2 payloads, remote sensing capability, laboratory facility



Excalibur Almaz's Approach is Unique

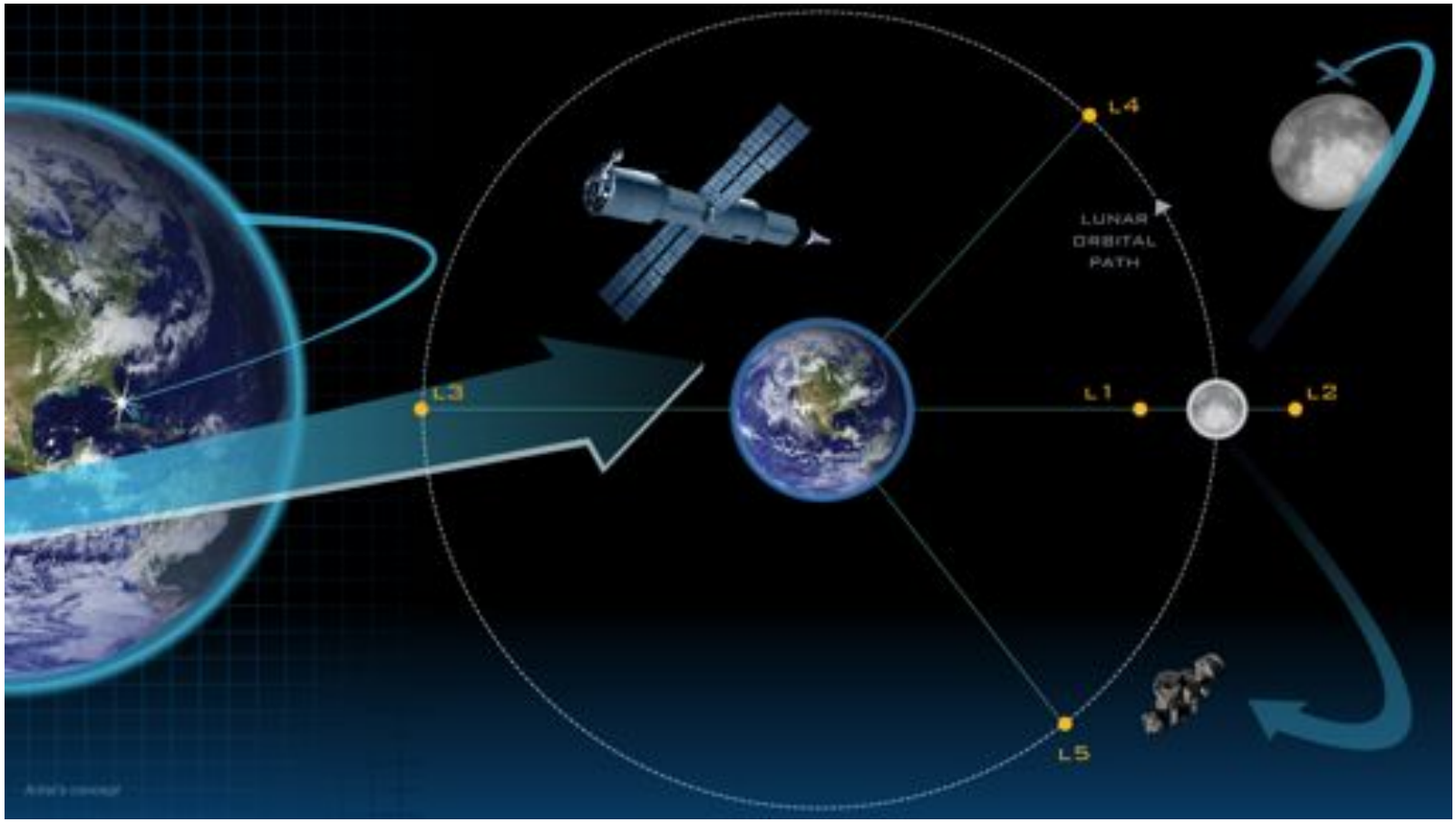
Our approach (cont'd.)

- Utilizes our space station pressure vessel to provide:
  - crew/autonomous access to low earth orbit, lunar transfer orbit, low lunar orbit, L2 and beyond for all forms of space commercial activities



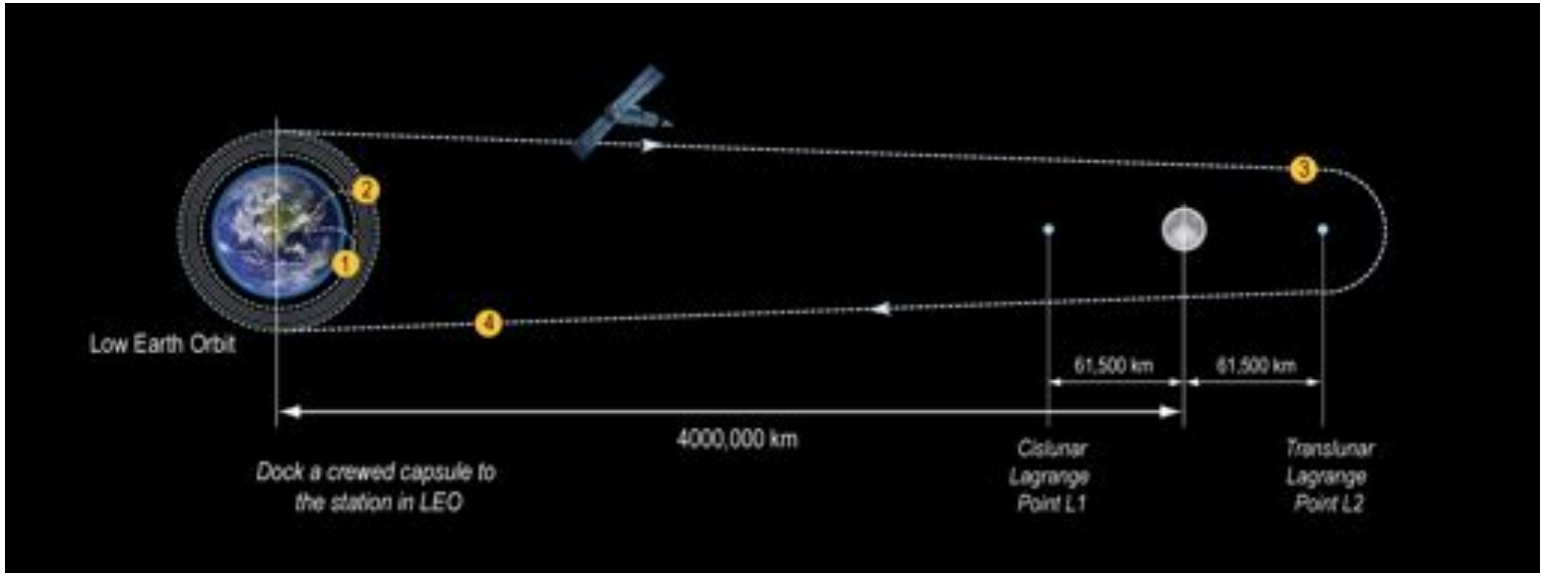
EA Business Objective

Beyond Low Earth Orbit



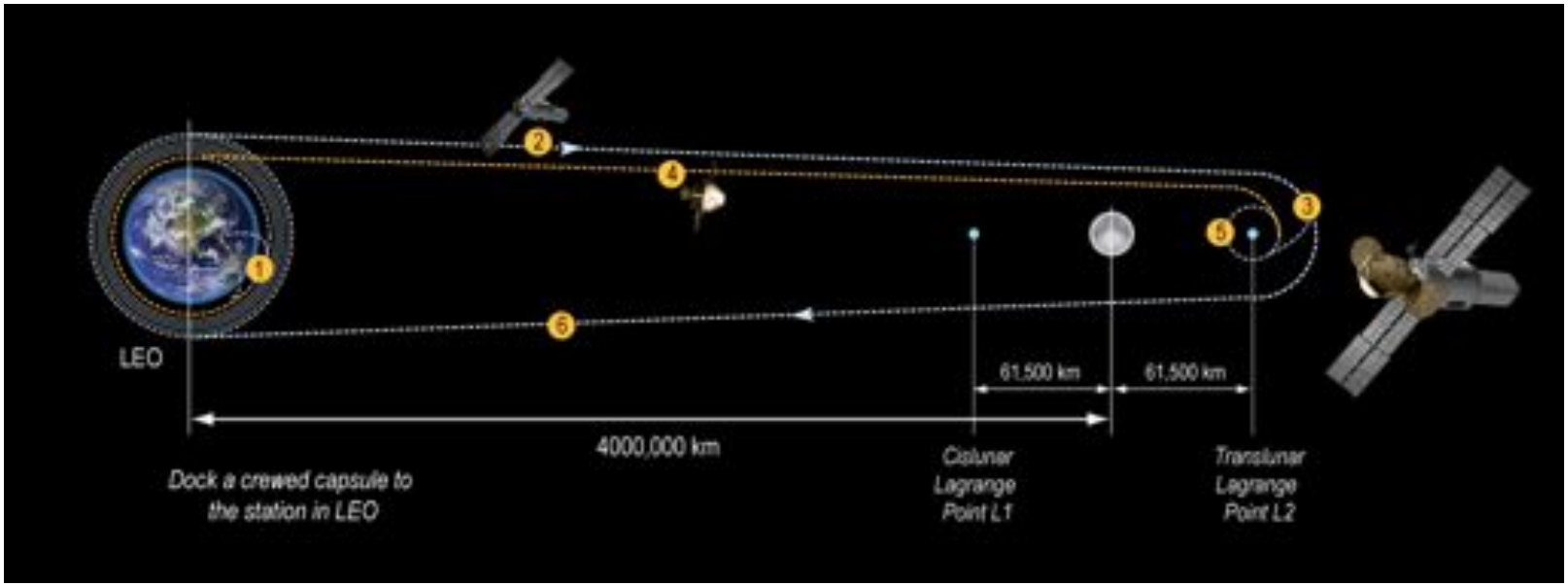
Earth – L2 Moon with Crew All the Way

1. Launch space station spacecraft outfitted for Earth – L2 cycle into LEO
2. Launch, rendezvous and dock a crewed capsule to the station in LEO
3. Utilize low energy spiral transfer orbit for transfer to L2 of combined docked spacecraft
4. Return to Earth using slow trajectory. Upon Earth arrival, capsule separates and returns crew, other payloads returned to Earth and Station is placed in a temporary circular orbit, then begins return trip to L2



Earth-L2 Crew Arrives at Lunar Orbit

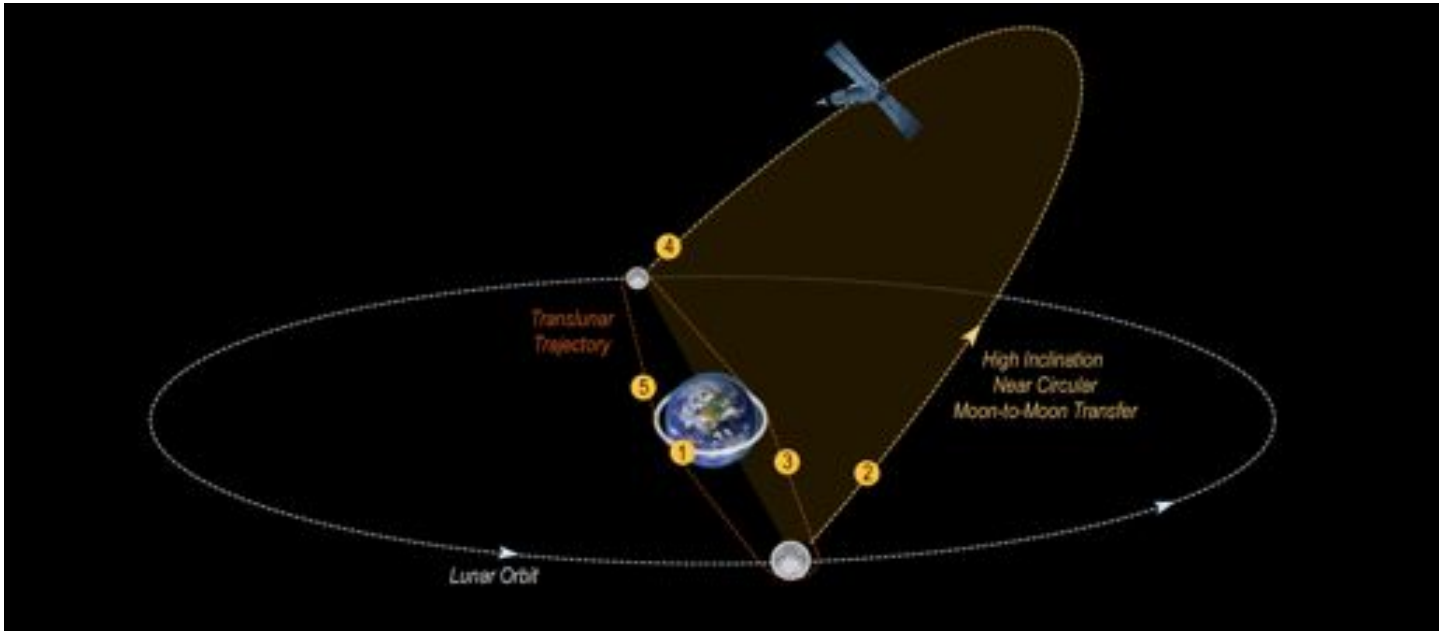
1. Launch space station spacecraft outfitted for Earth – L2 cycle into LEO
2. Utilize low energy spiral transfer orbit for transfer to L2 of space station/spacecraft (~90 days)
3. Once space station/spacecraft arrives at L2 and is placed in a parking orbit, launch a crewed capsule to LEO
4. Verify operational status of crewed capsule and use a traditional chemical injection stage and Hohmann transfer technique for a rapid trip to L2 (~4 days)
5. Rendezvous and dock with spacecraft at L2 and perform crew portion of mission
6. Return from L2 in a similar manner – Spacecraft takes spiral trajectory, capsule follows direct path to earth (~4 days)



Earth-L2 Moon to Moon Transfer Orbit

Cycle the Moon Twice a Month

1. Launch space station spacecraft outfitted for Earth – L2 cycler orbit into LEO
2. Utilize low energy spiral transfer orbit for transfer to Earth-Moon cycler orbit to fly by the Moon every two weeks.
3. When the spacecraft in cycler orbit flies past the Earth (once per Lunar month), launch a crew capsule to the Space Station
4. Rendezvous and dock the crew capsule with the station spacecraft in cycler orbit and perform crew portion of mission (includes two passes near the moon.)
5. When the combined spacecraft fly by the Earth in cycler orbit in one Lunar month; undock and de-orbit the crew capsule; launch the next mission's crew capsule, rendezvous and dock
6. Perform next mission.



EA Business Objectives (Cont'd.)

- EA will develop a L2 Space Station for research, processing and communications
  - L2 station to act as a transportation hub destination for lunar and asteroid materials

EA will purchase the most cost effective launch service

- Current analysis shows our crew/ cargo spacecraft appears compatible with several operational vehicles including:
  - Atlas V, Falcon 9 and Zenit
- Immediate candidate launch vehicles for EA's space station class spacecraft are:
  - Proton, Delta IV, Atlas V Heavy, Liberty and Ariane V
- EA continues to monitor the development of other emerging launch vehicles for our applications

Excalibur Almaz Approach (Cont'd.)

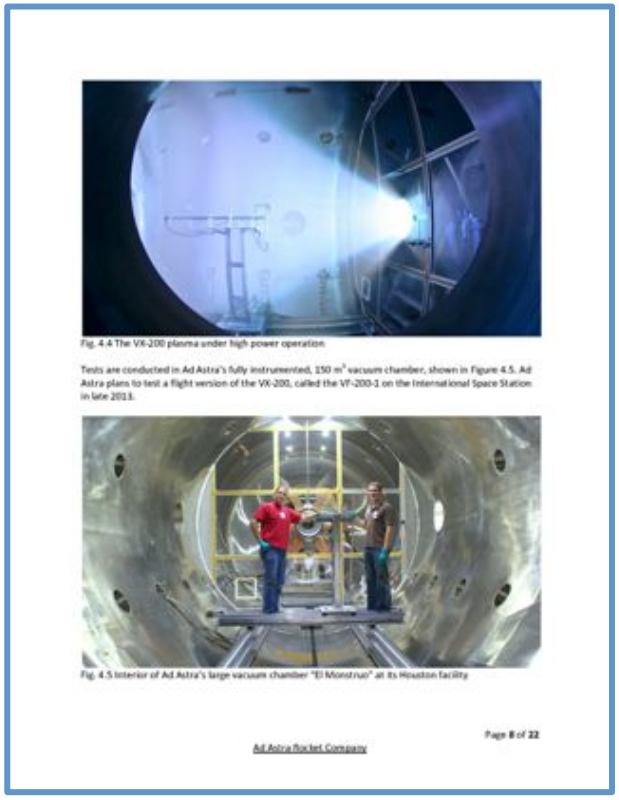


Fig. 4.4 The VX-200 plasma under high power operation

Tests are conducted in Ad Astra's fully instrumented, 150 m^3 vacuum chamber, shown in Figure 4.5. Ad Astra plans to test a flight version of the VX-200, called the VF-200-1 on the International Space Station in late 2013.

Fig. 4.5 Interior of Ad Astra's large vacuum chamber "El Monstruo" at its Houston facility

To achieve our vision EA continues work on its commercial interests while supporting NASA's Commercial Crew Development program through an unfunded Space Act Agreement focused to establish the capability to deliver crew on a commercial basis to the International Space Station.

EA is seeking Partners, Customers and Investors

EA will offer the following services:

Core Services

- Passenger sales
- Crew and Cargo transportation
- Payload transportation, deployment and recovery
- Tele-science/research
- Remote sensing
- Geological evaluations/ mapping

Additional Services

- Charter missions
- Advertising/Sponsorship
- Entertainment
- Astronaut training

EA Supports Commercial Space

EA is presenting its technical heritage and mission plans at the International Space Development Conference of the US National Space Society in Washington (May 27).

EA will present its business and marketing plans and exhibit its twice-flown spacecraft at the Royal Aeronautical Society Conference in London (June 19).

EA will exhibit both of its 90 cubic meter cis-lunar spacecraft at the SPACE Conference on the Isle of Man (July 10).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BACK UP SLIDES

Mission Critical Elements are at Technology Readiness Level 9:

Spacecraft Aerodynamics, Thermal Shield, Deorbit and Landing Rocket Motors, Emergency Escape System, Landing System, Parachutes and Pyrotechnic Devices

Human Space Vehicle	TRL Status	Human Space Vehicle	TRL Status
HSV		**Reusable Reentry Vehicle (continued)**	
Emergency Escape Motor	9	Pilot control panels	5
Retro Rocket Retainer	9	Manual controls	5
Retro Rocket	9	Radio complex	6
Nose Compartment		Pyro/separation devices	9
Structure and thermal protection	9	Electrical power generation system	6
Attitude Control Subsystem	9	Crew Equipment	5
Nose Compartment Separation motor	9	Stability augmentation system	9
Avionics	6	Balance weights	n/a
Thermal shield	9	**RRV Equipment Fairings Jettisoned**	
Pyro/separation devices	9	Front fairing	9
Search and communications radio equipment	9	Wire tunnel fairing	9
Telemetry equipment	6	**Intermediate Stage (IS)**	
Depressurization and drain system	9	Structure and ground/pad umbilicals	5
Parachute and Landing System		Propulsion system	6
Parachute system	8	ECLSS components	5
Soft Landing Engine (SLE)	9	Tunnel	5
JPLS frame with parachute release unit	9	Docking Mechanism	5
Reusable Reentry Vehicle		Docking Electronics	5
Structure and thermal protection	8	Batteries	7
Equipment and cargo mounts	8	Fairing	5
Crew	n/a	Adapter	6
Shock-absorbing seats	8	**Ground and Flight SW**	
LSS and temperature-control system, thermal shield	5	Ground SW	5
Spacesuit ventilation and temperature control system	5	Flight SW (Post LV sep.)	5
Onboard Control Complex (OCC)	6		

Key: 9 | 8 | 7,6 | 5 | 4,3,2,1

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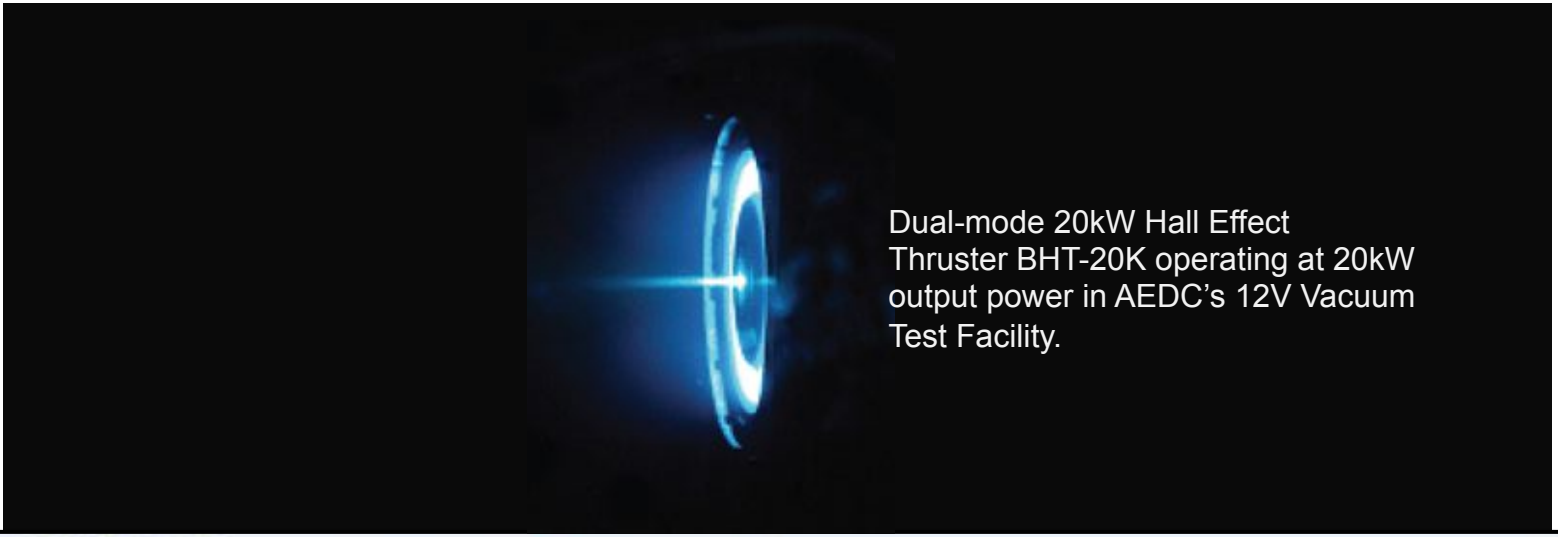
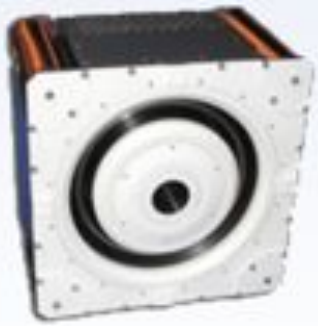
20kw Hall Thruster



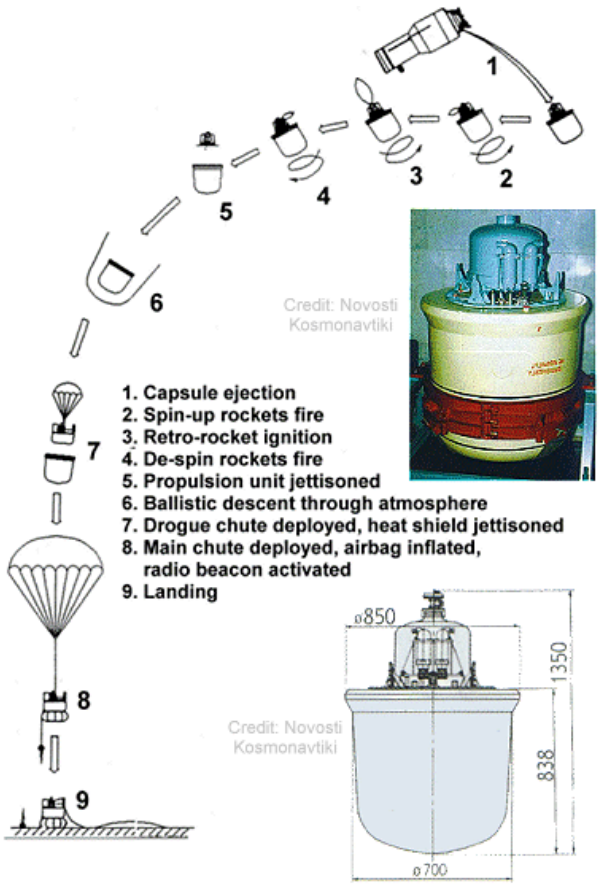
Dual-mode 20kW Hall Effect Thruster BHT-20K operating at 20kW output power in AEDC's 12V Vacuum Test Facility.

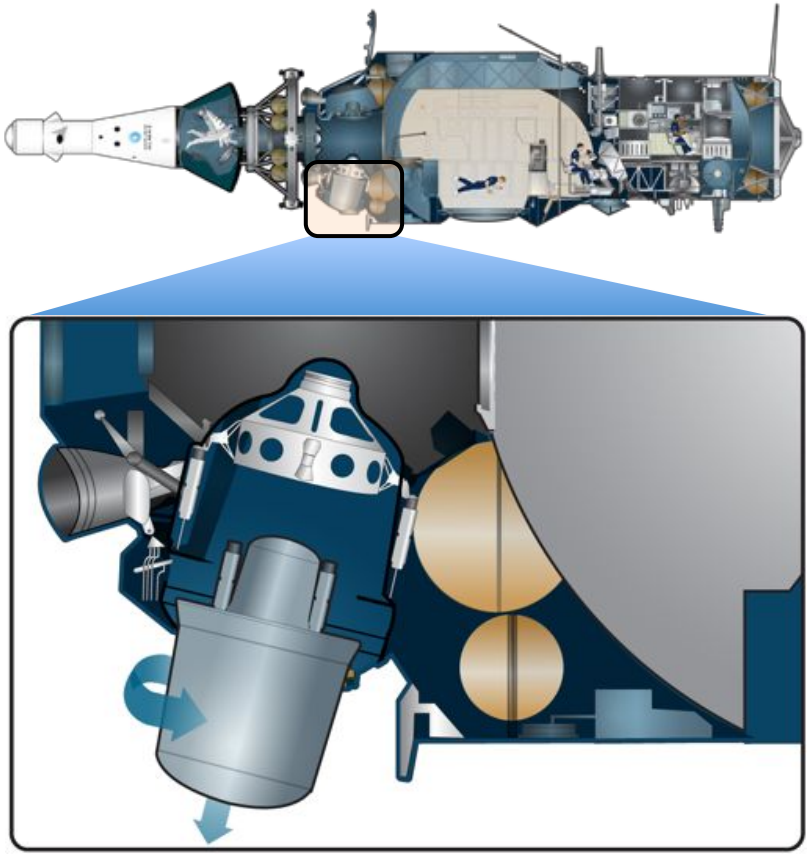
BHT-20k



Discharge Input Power	20 kW
Discharge Voltage	500 V
Discharge Current	40.5 A
Propellant Mass Flowrate	40.0 mg/sec
Thrust	1.08 N
Specific Impulse	2750 sec
Propulsive Efficiency	70.0%

128kg Cargo Descent Capsule





Descent Capsule Detail

Experimental results and other cargo could be returned to Earth for analysis using this space proven ejection and recovery system.