The SYSTEM Challenges in the 21st Century

A Brief Look at Yesterday Enables A Look to Tomorrow

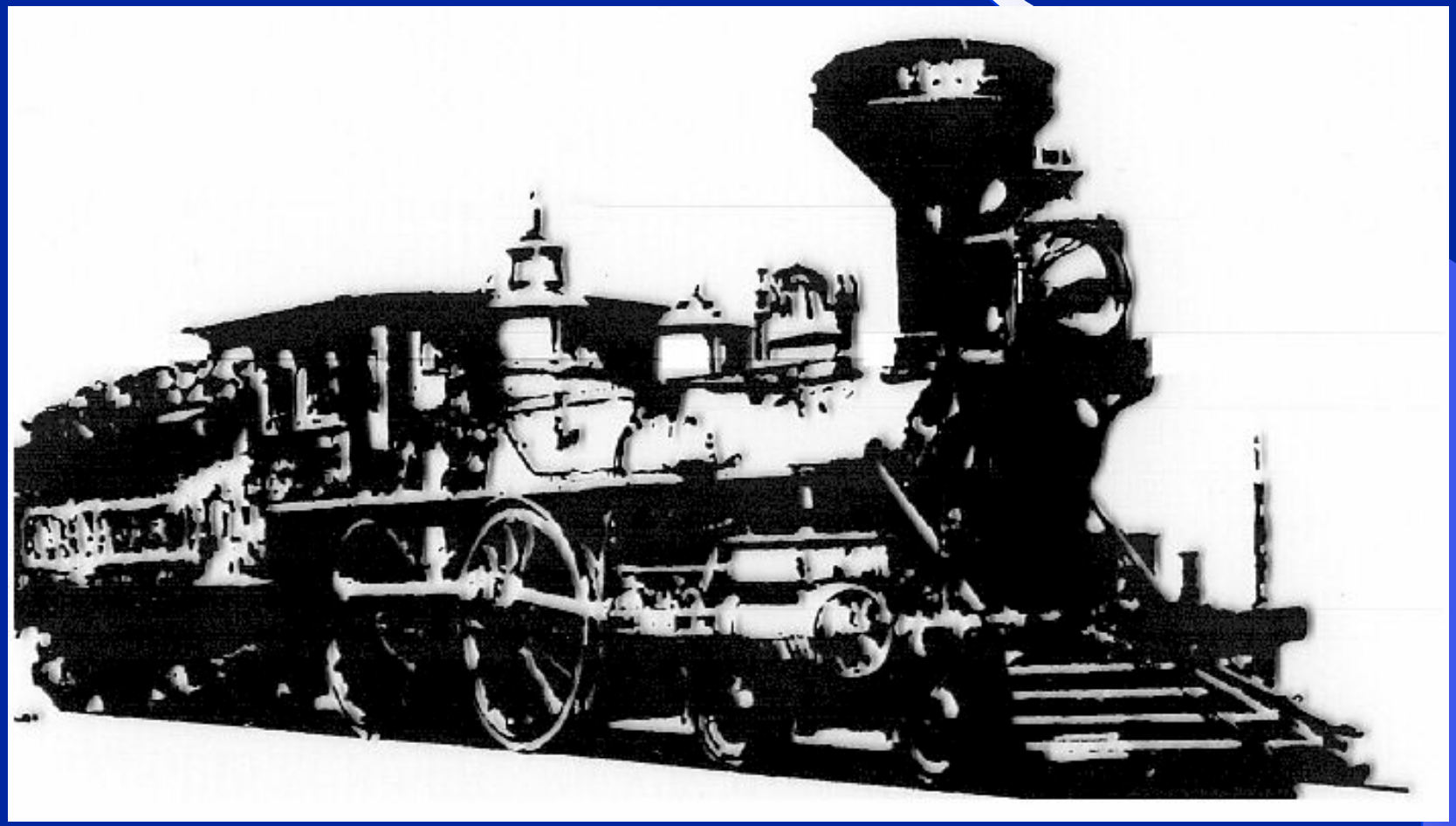
NASA Institute for Advanced Concepts
Georgia Center for Advanced Telecommunications Technology
Atlanta, Georgia
November 7-8, 2000

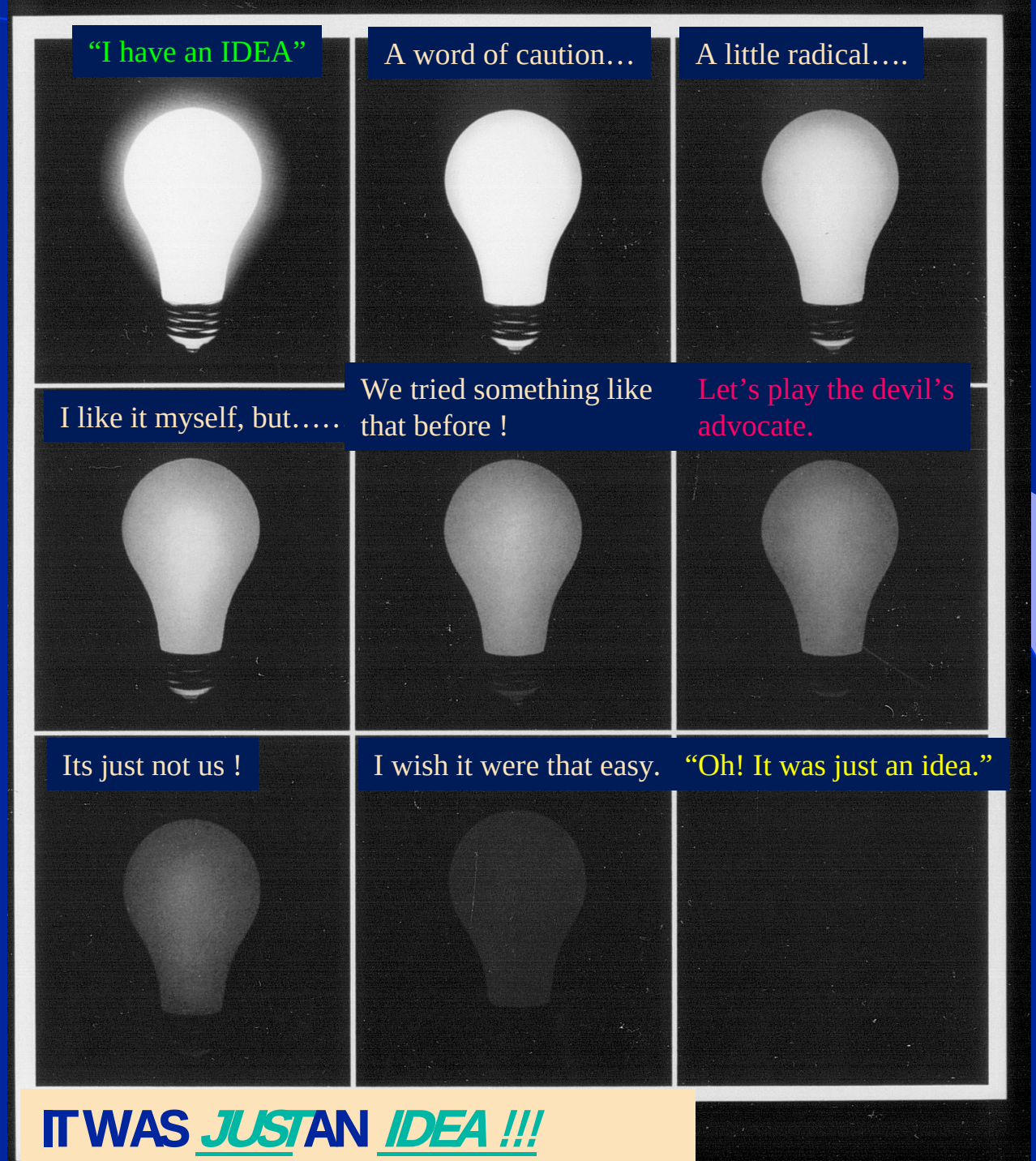
Professor Paul A. Czysz
Parks College of Engineering & Aviation
Saint Louis University
St. Louis, Missouri

Expendable vehicles are for one way pioneers/explorers

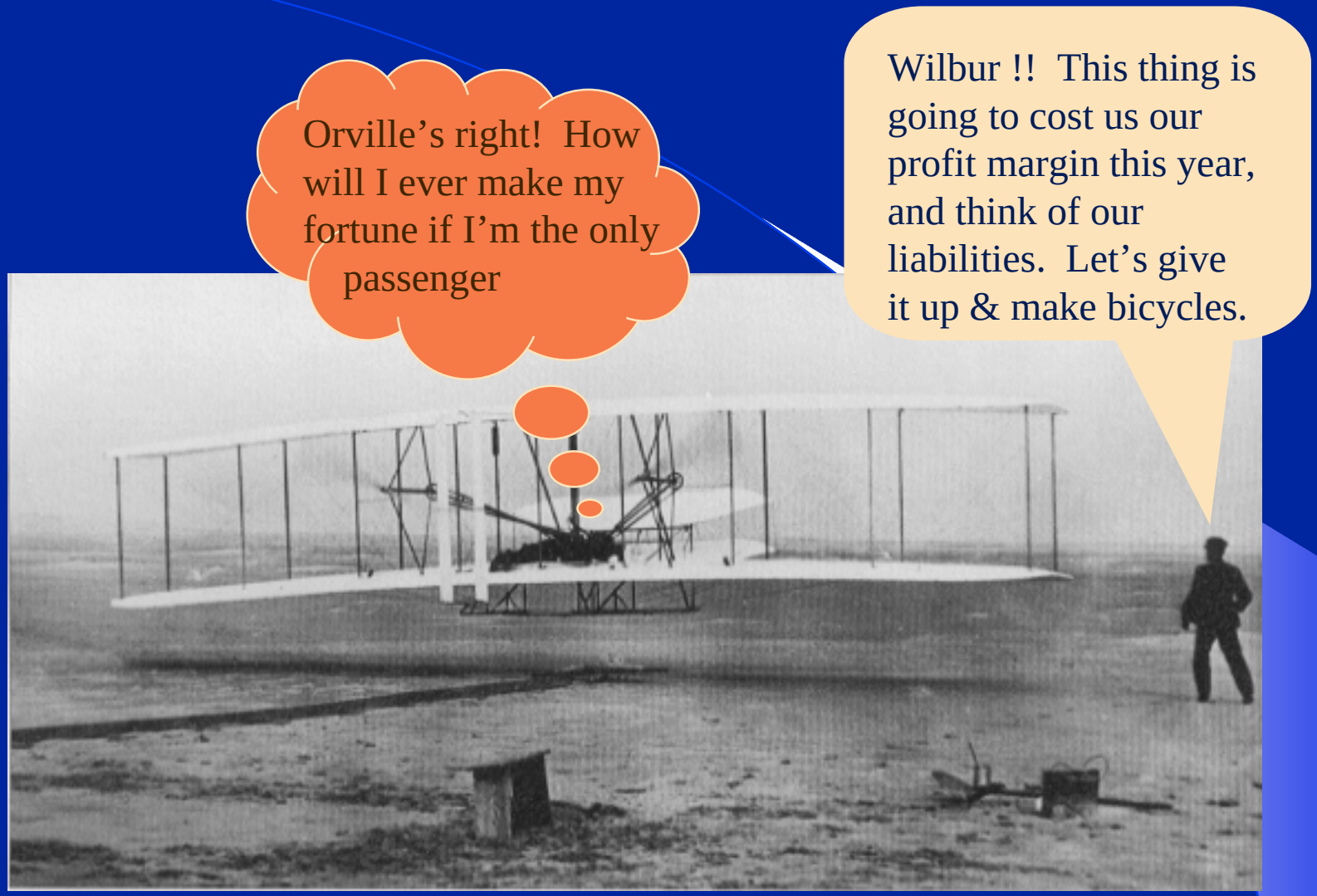
None ever returned, most were building materials for structures at the destination

Sustained use, maintained, & scheduled vehicles enabled business incubation & growth





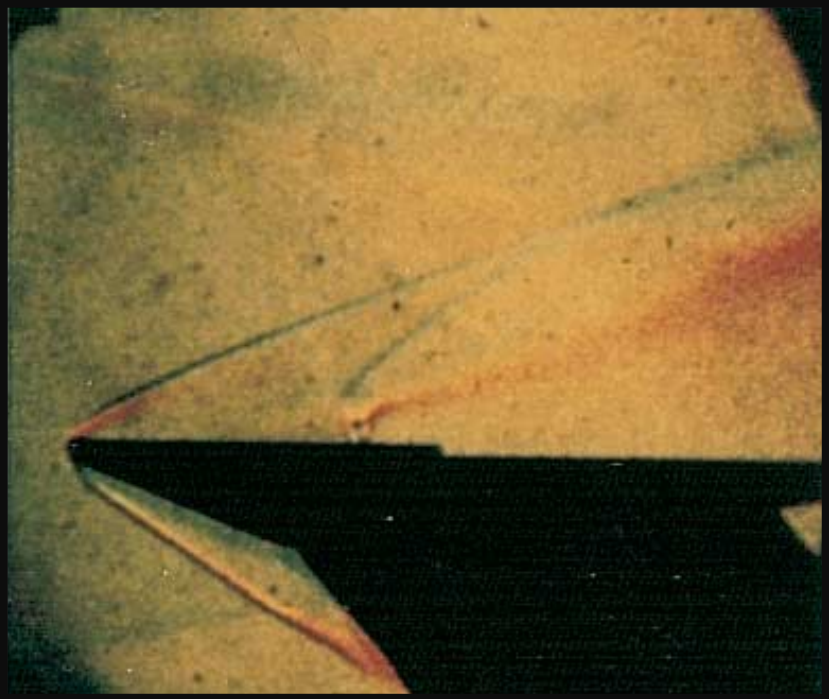
IT WAS *JUST* AN *IDEA !!!*



IN TODAY'S ENVIRONMENT, THE WRIGHT'S FIRST, LAST AND ONLY FLIGHT

Test Conditions Equal to SCRAMJET Combustor Pressure, Temperature and Velocity for Mach 8 Cruise Flight

Color Schlieren

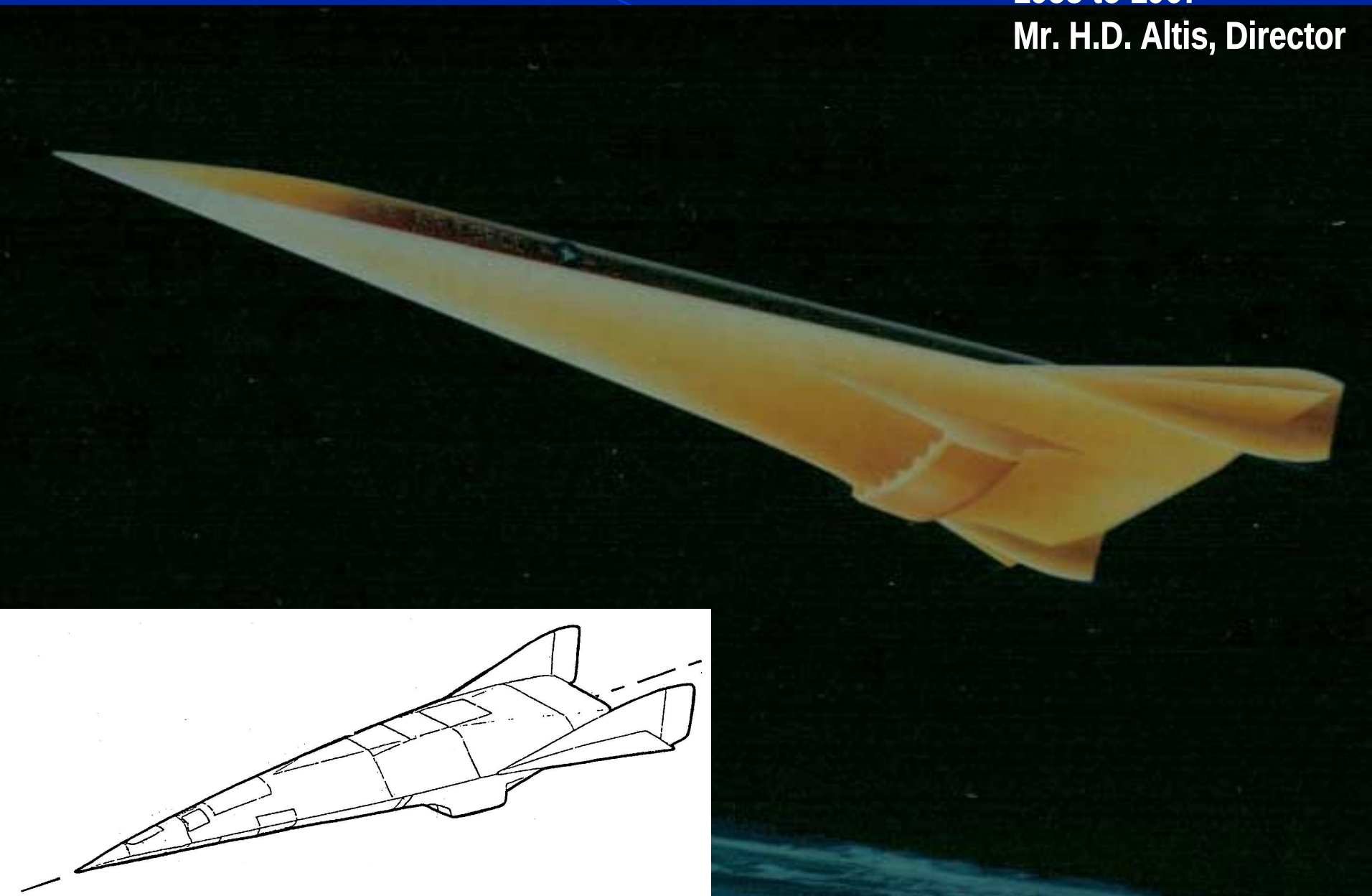


IR Photograph in H_20 bands

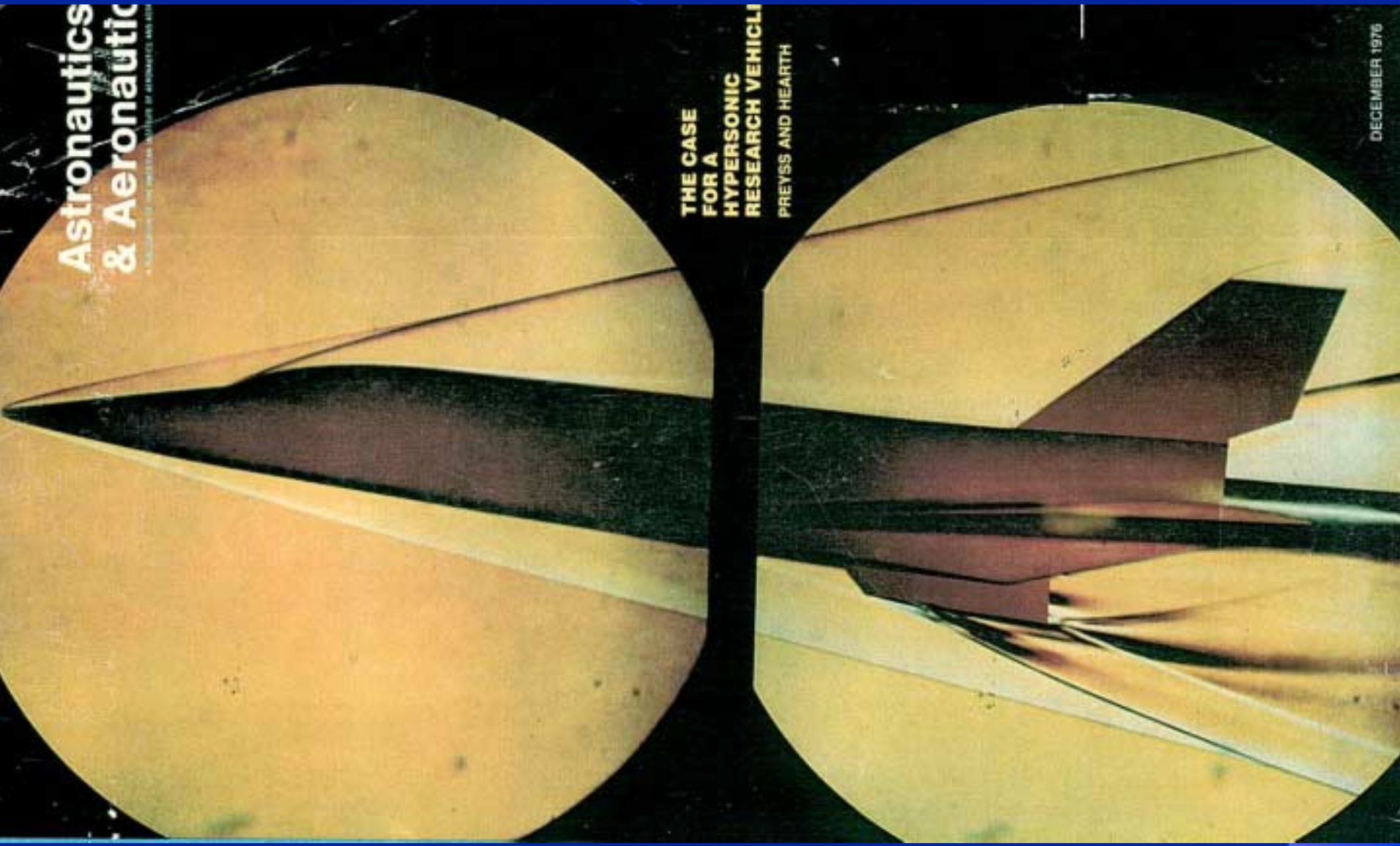
See ASD-TDR-63-236 and 63-131

MDC McAir 1960's

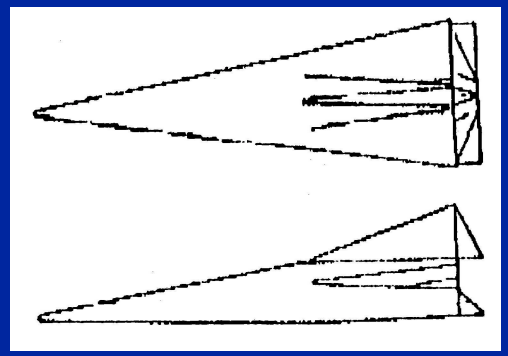
McDonnell Aircraft
Advanced Design Dept.
1958 to 1967
Mr. H.D. Altis, Director



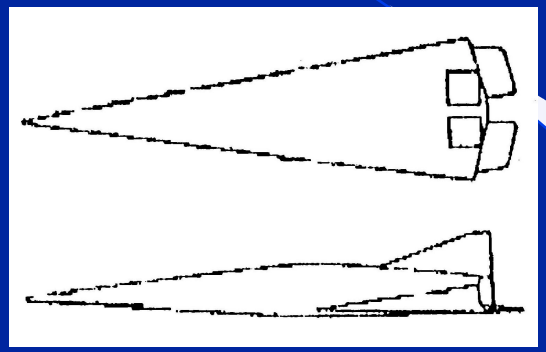
AA December 1974



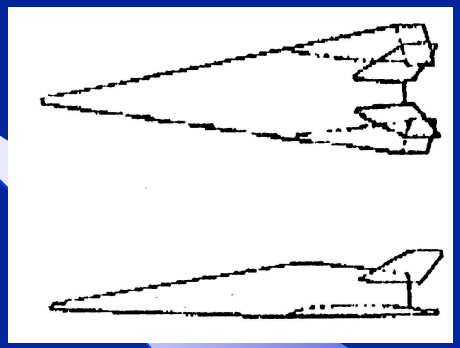
Hypersonic Gliders, AFFDL
VTOHL, Rocket Boosted, circa 1960



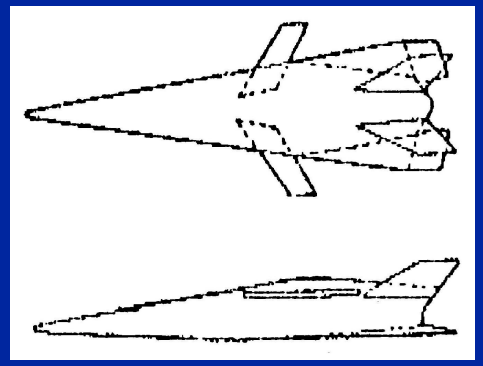
FDL-5



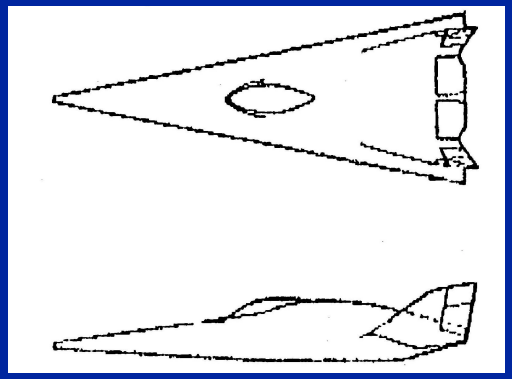
FDL-6



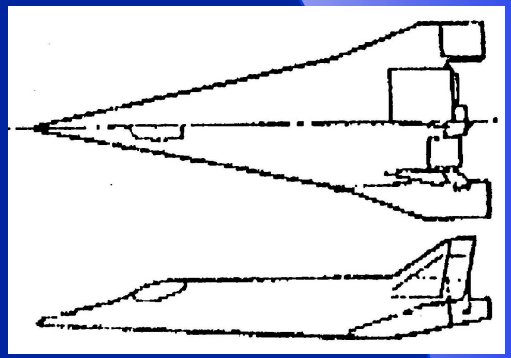
FDL-7



FDL-7MC

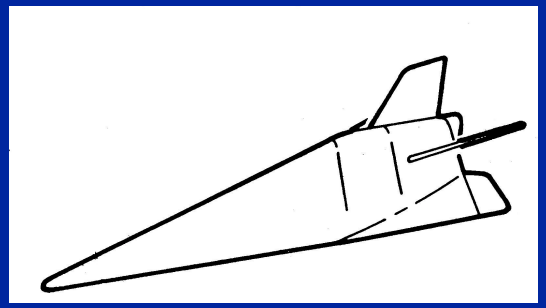


FDL-8
X-24B

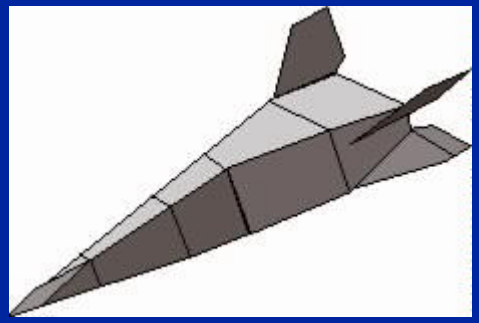


X-24C

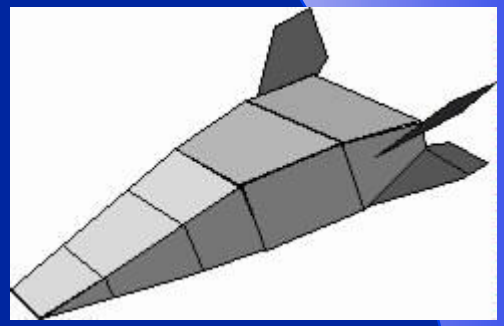
Evolution of a Hypersonic Glider Based on AFFDL FDL-7C



MDAC R. Masek

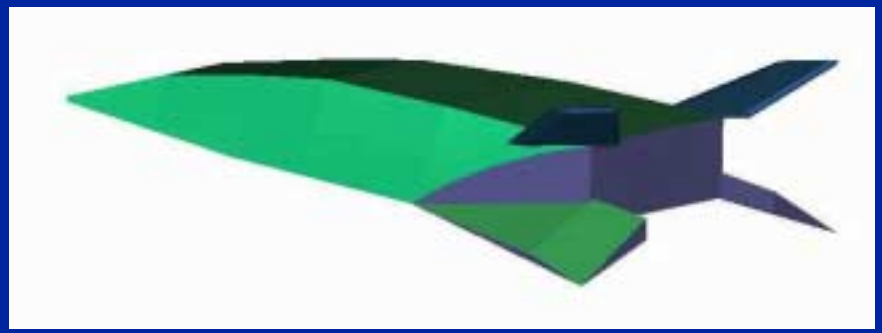


MDC P. Tanabe

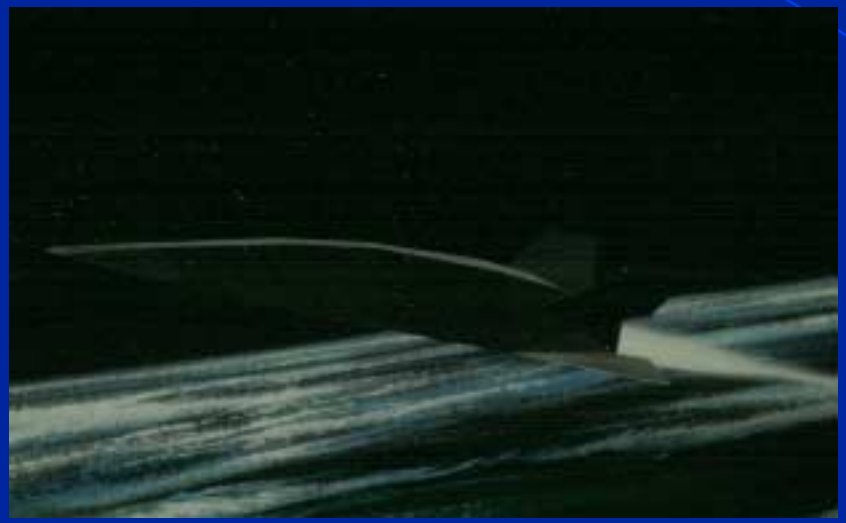


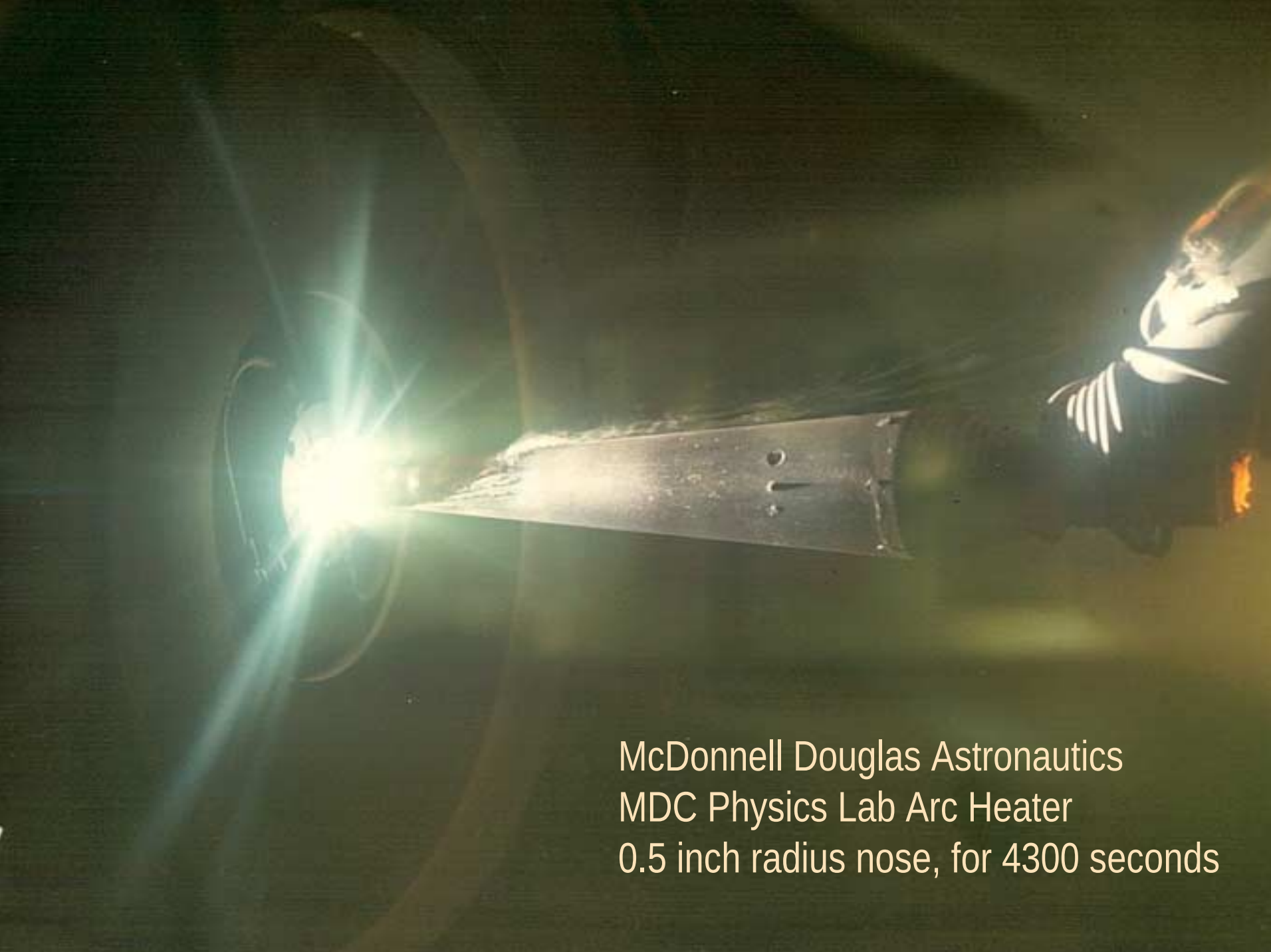
MDAC R. Krieger

HyperTech Concepts KLIN



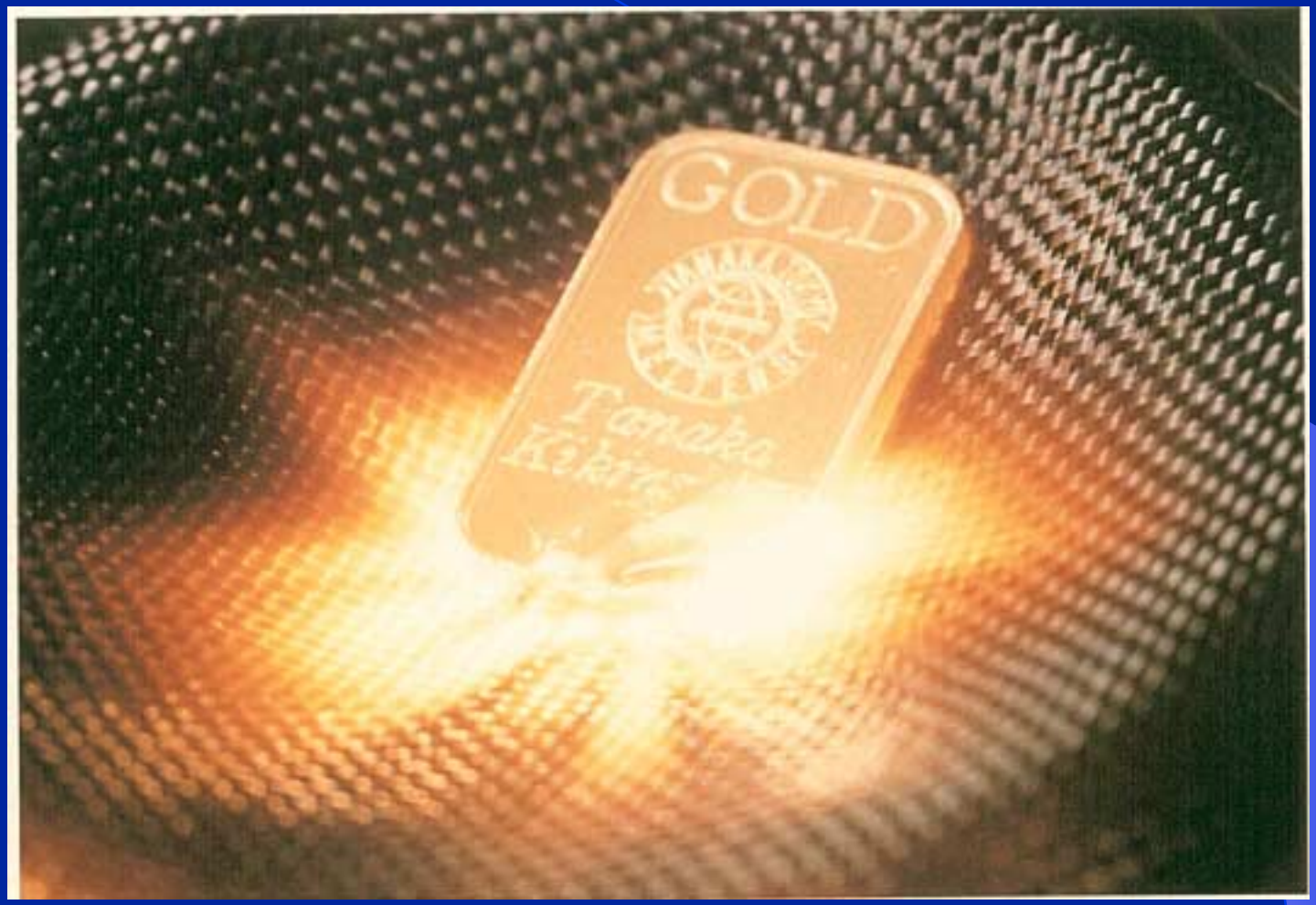
Spectrum of Operation




McDonnell Douglas Astronautics
MDC Physics Lab Arc Heater
0.5 inch radius nose, for 4300 seconds

McDonnell Douglas Astronautics, circa 1967

Tyranno Cloth, Ube Corp.



Tokyo, Japan,1988

Tyranno Cloth Metal Matrix Composites

Ube Corp. Tokyo, Japan,1988

What About Today's Scientists ?

NIKOLA TESLA, circa 1934

"The scientists from Franklin to Morse were clear thinkers and did not produce erroneous theories. The scientists of today think deeply instead of clearly. One must be sane to think clearly, but one can even think deeply and be quite insane."

"Today's scientists have substituted mathematics for experiments and they wander off trough equation after equation and eventually build a structure that has not relation to reality."

Earth-to-Orbit SYSTEM Challenges in the 21st Century

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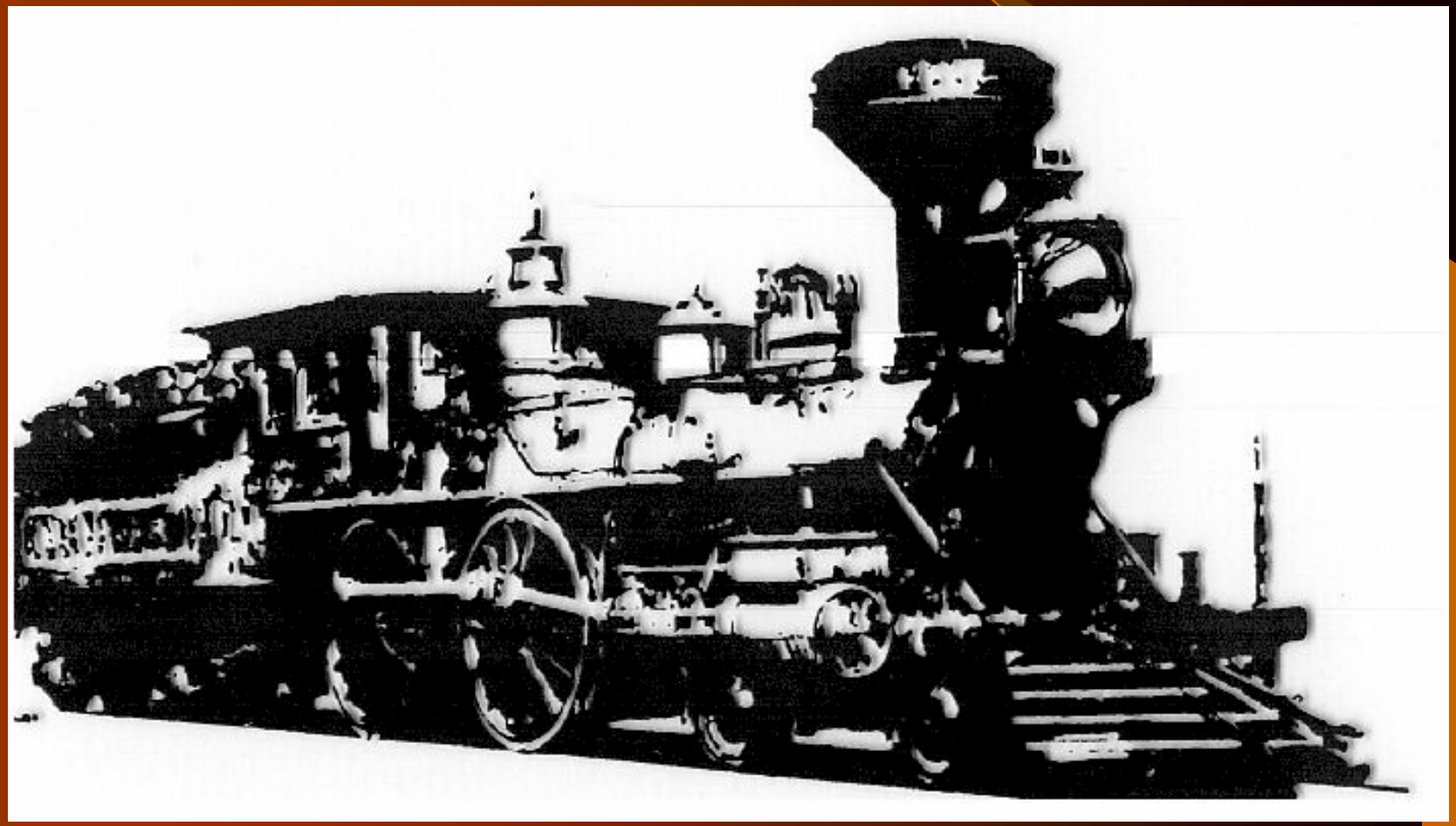
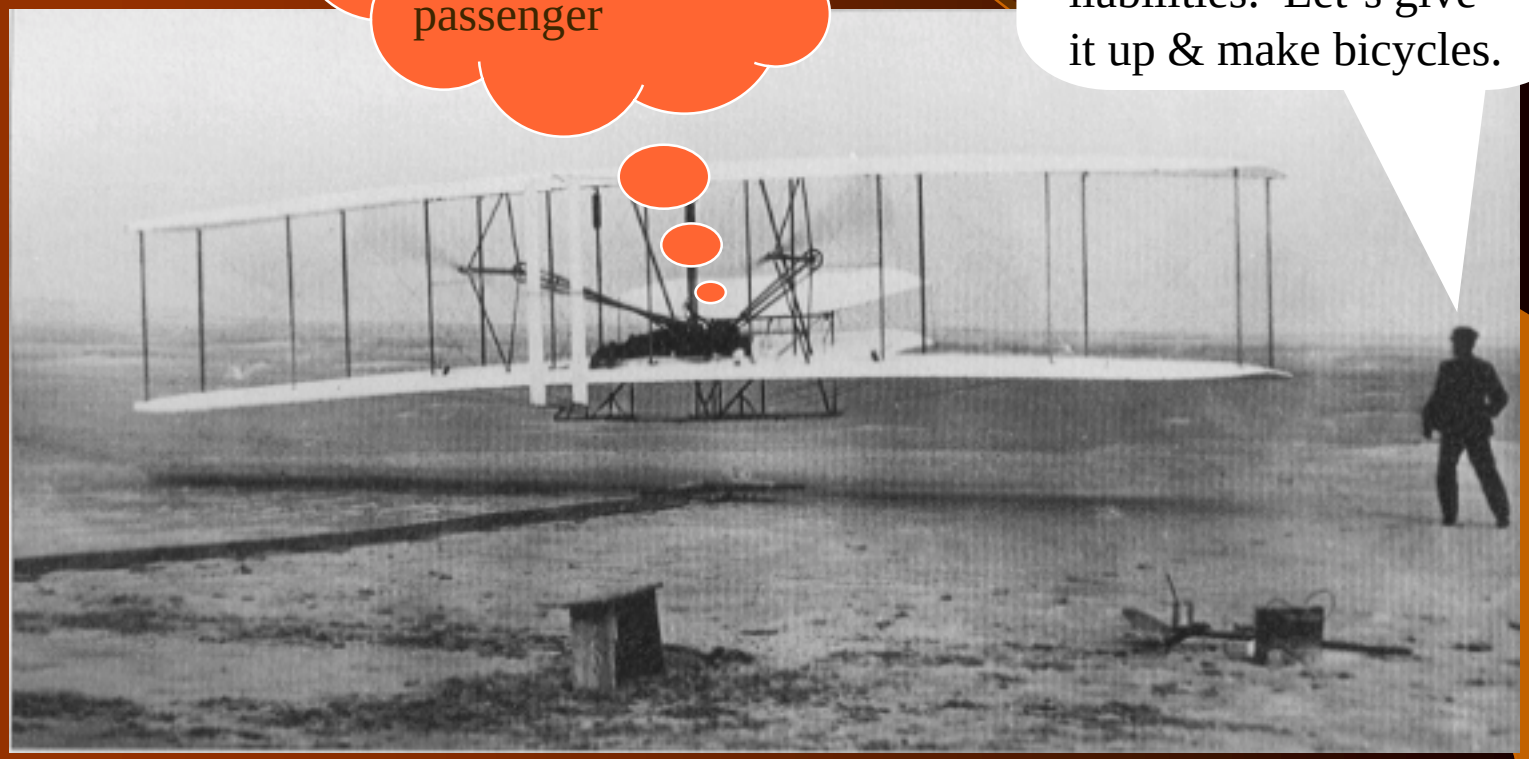
None ever returned, most were building materials for structures at the destination

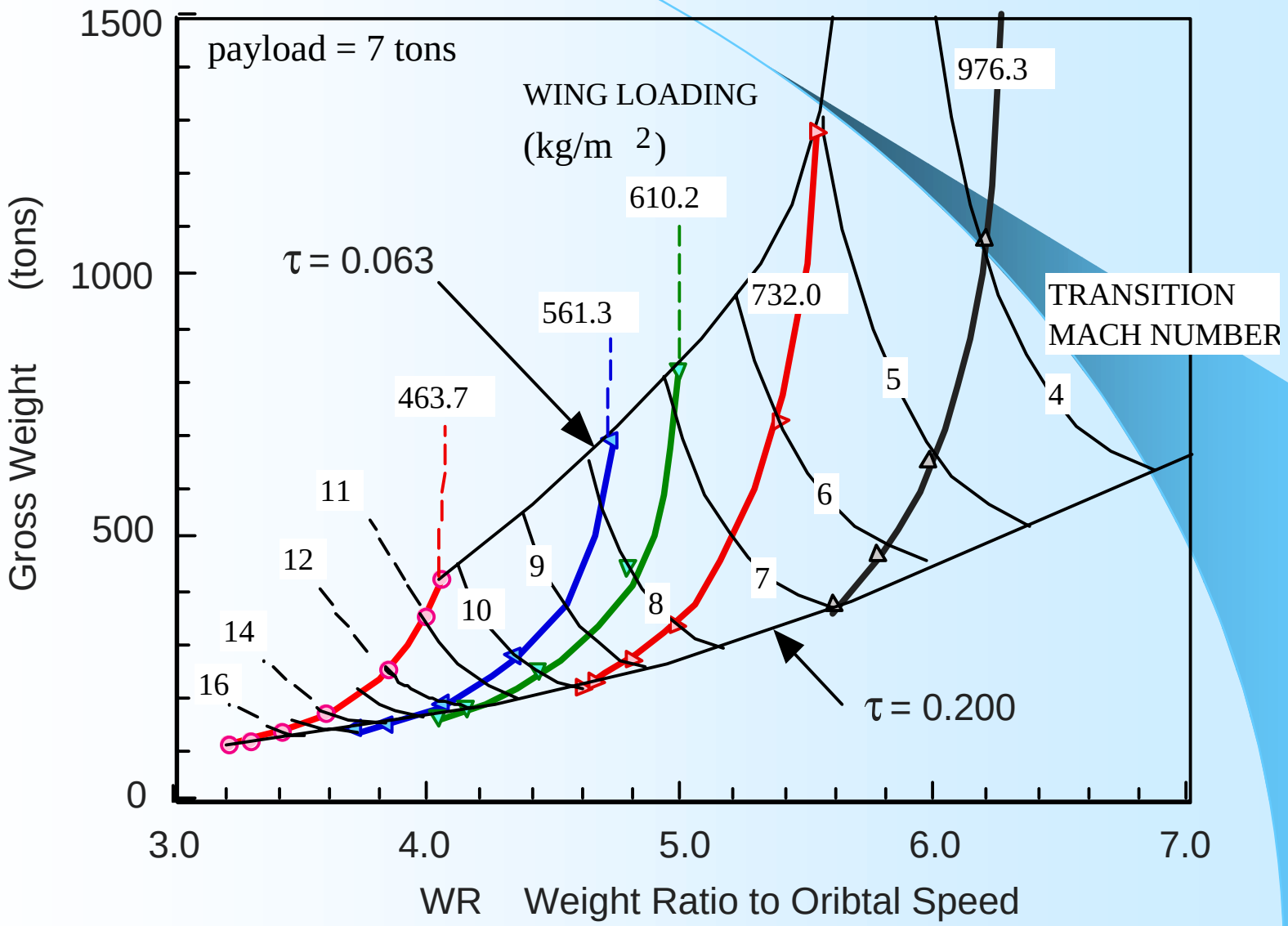
Sustained use, maintained, & scheduled vehicles enabled business incubation & growth

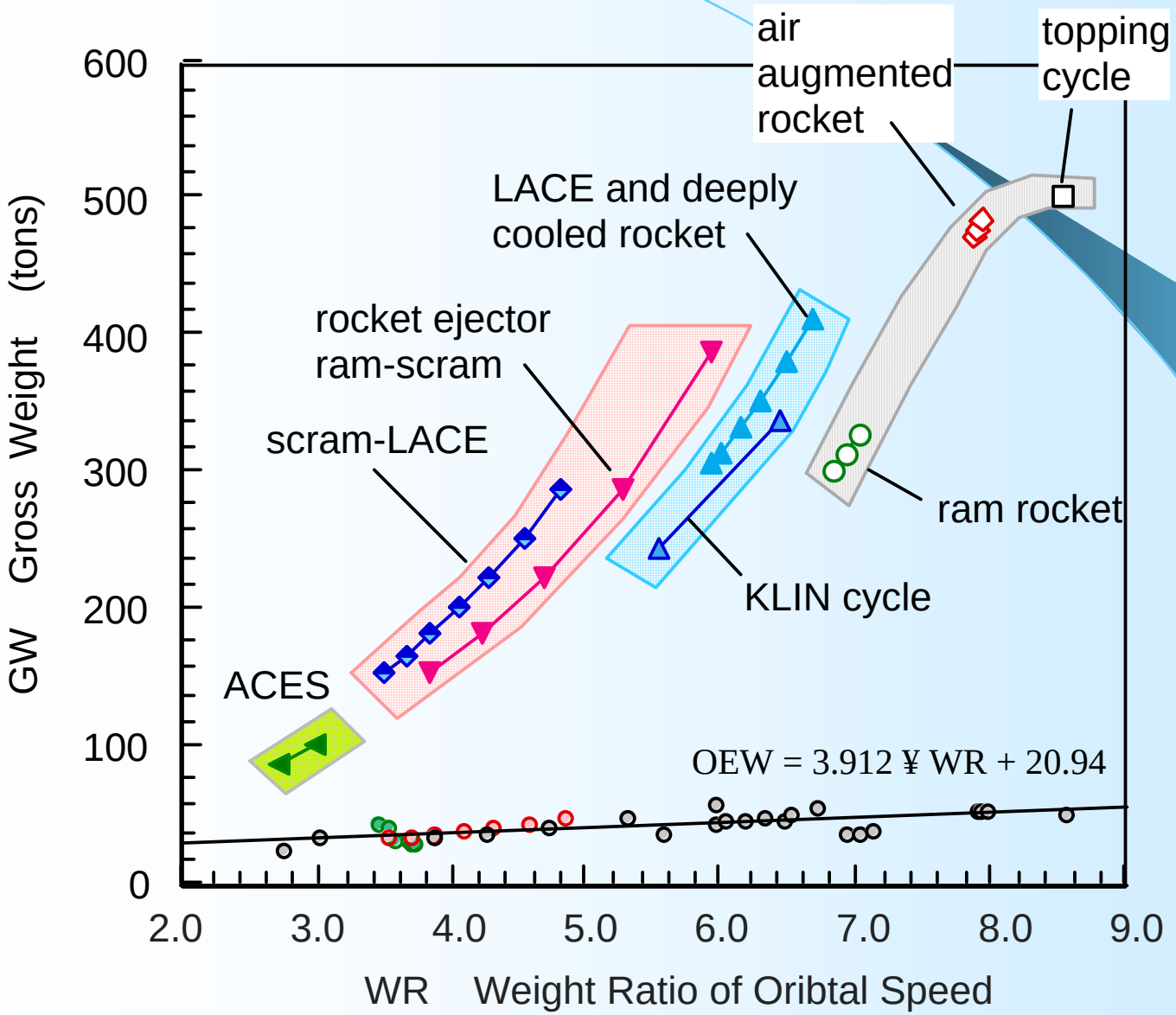




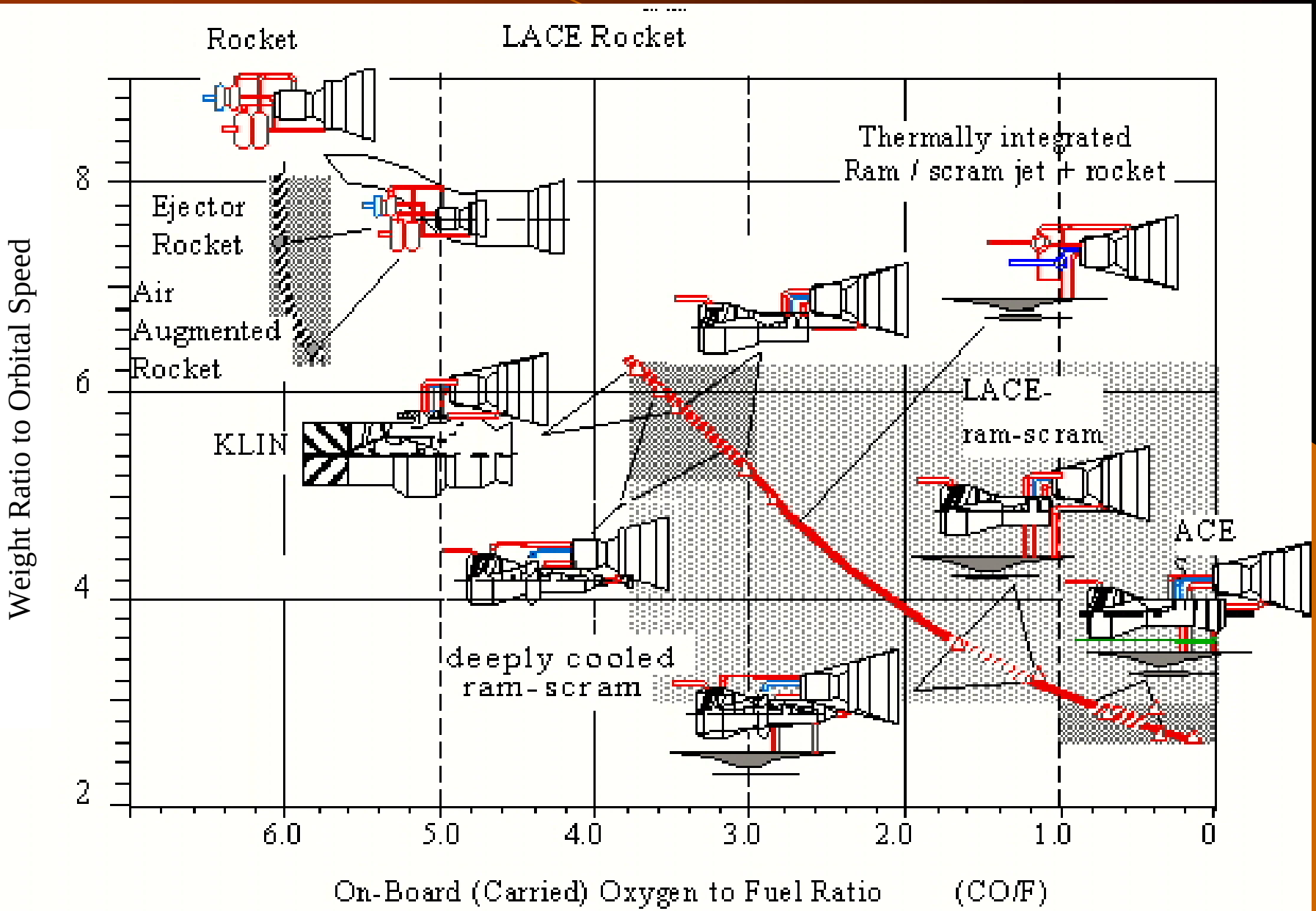
IN TODAY'S ENVIRONMENT, THE WRIGHT'S FIRST, LAST AND ONLY FLIGHT

Avoid Ápriori Launch Assumptions




air
augmented
rocket
topping
cycle
LACE and deeply
cooled rocket
rocket ejector
ram-scram
scram-LACE
ram rocket
KLIN cycle
ACES
OEW = 3.912 ¥ WR + 20.94
GW Gross Weight (tons)
600
500
400
300
200
100
0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
WR Weight Ratio of Oribtal Speed

The Less Carried LOX the Less the WR

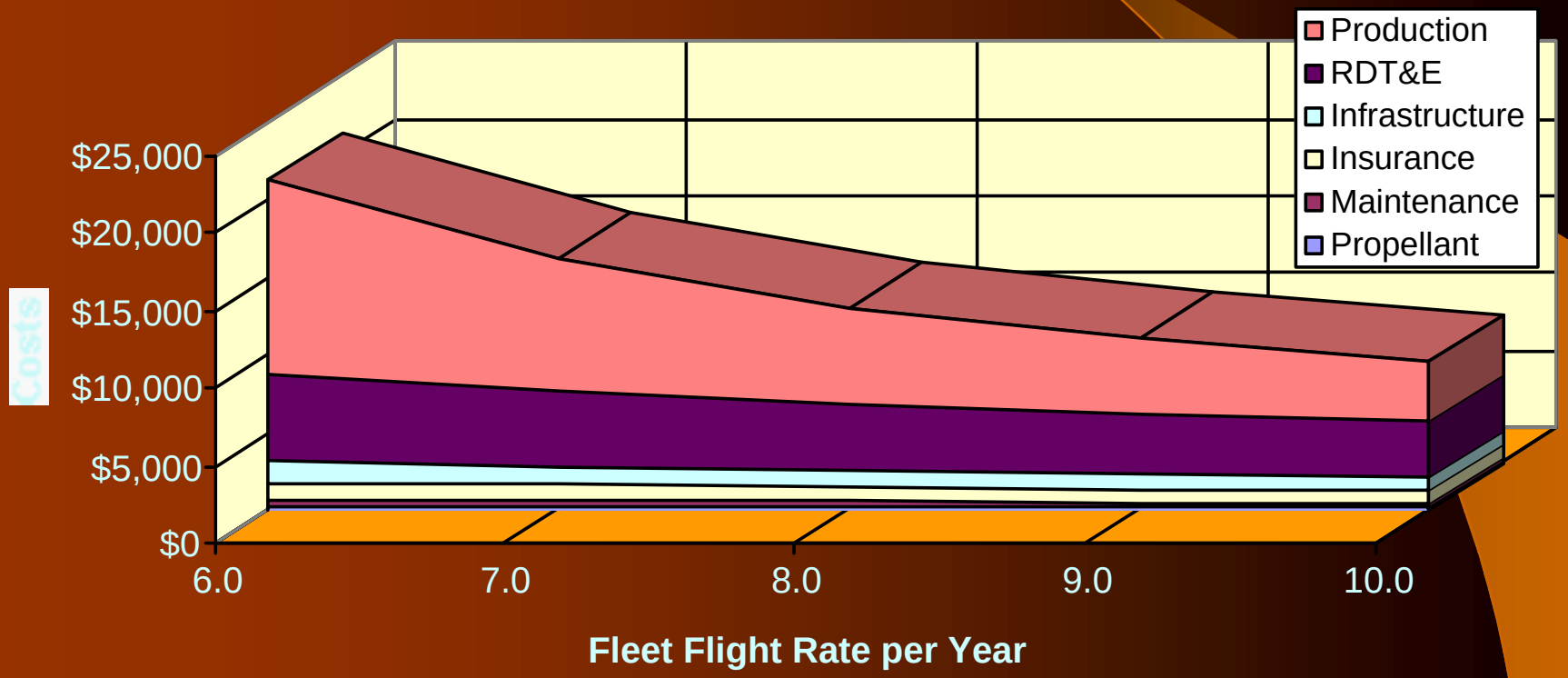


GET THE LOX OUT !

- Reduce or Eliminate the carried Oxygen
- Enable Global airport operations
- Increase the relative speed fraction of airbreathing propulsion
- Let requirements set configuration and launch attitude not bureaucracy
- DO NOT ASSUME A COMBINATION OF ENGINES IS A COMBINED CYCLE ENGINE
- Avoid believing the status quo is best

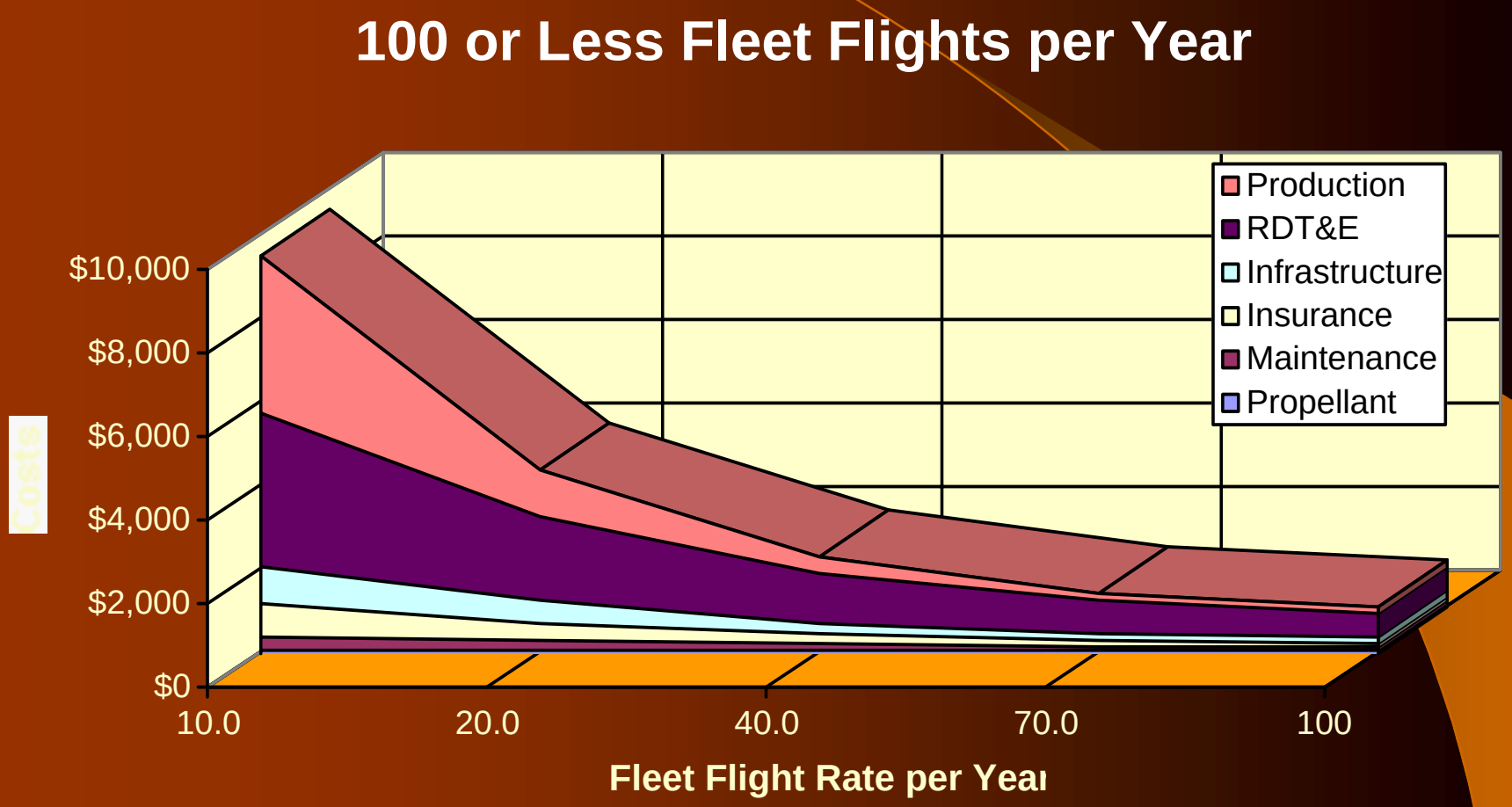
Launch Costs, Hydrogen

10 or Less Fleet Flights per Year



From Lindley and Penn

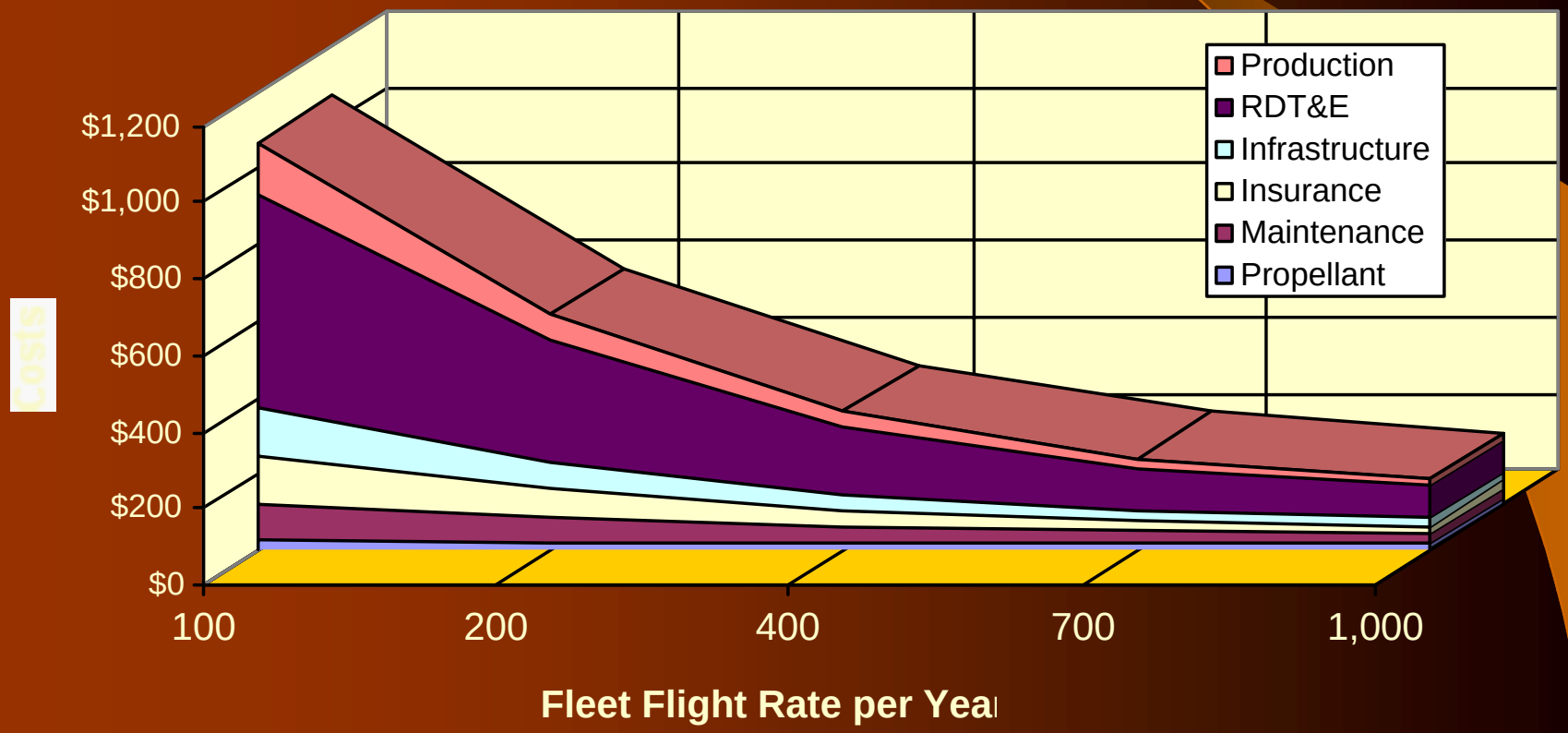
Launch Costs, Hydrogen



From Lindley and Penn

Launch Costs, Hydrogen

1,000 or Less Fleet Flights per Year

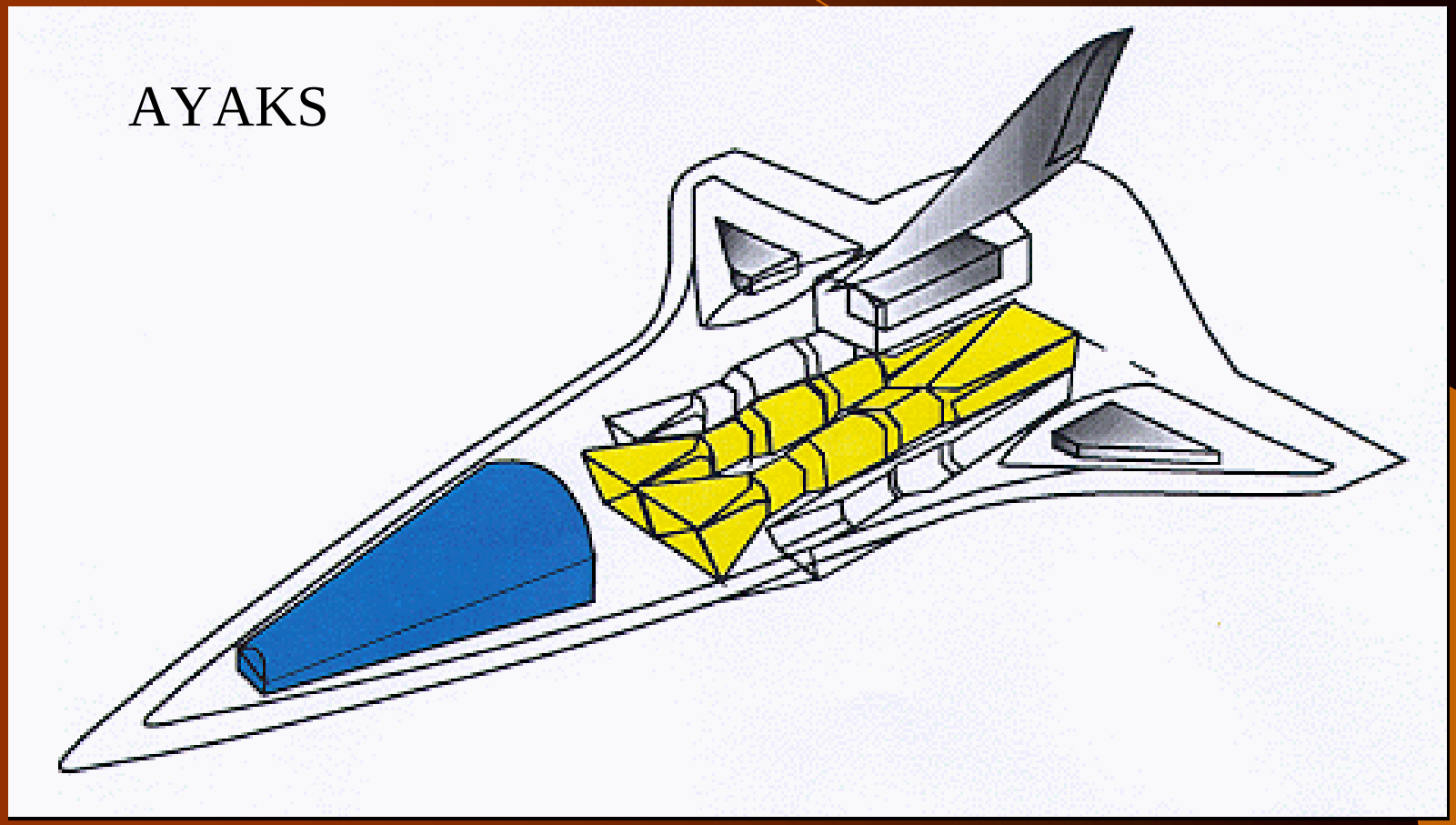


From Lindley and Penn

New Propulsion System

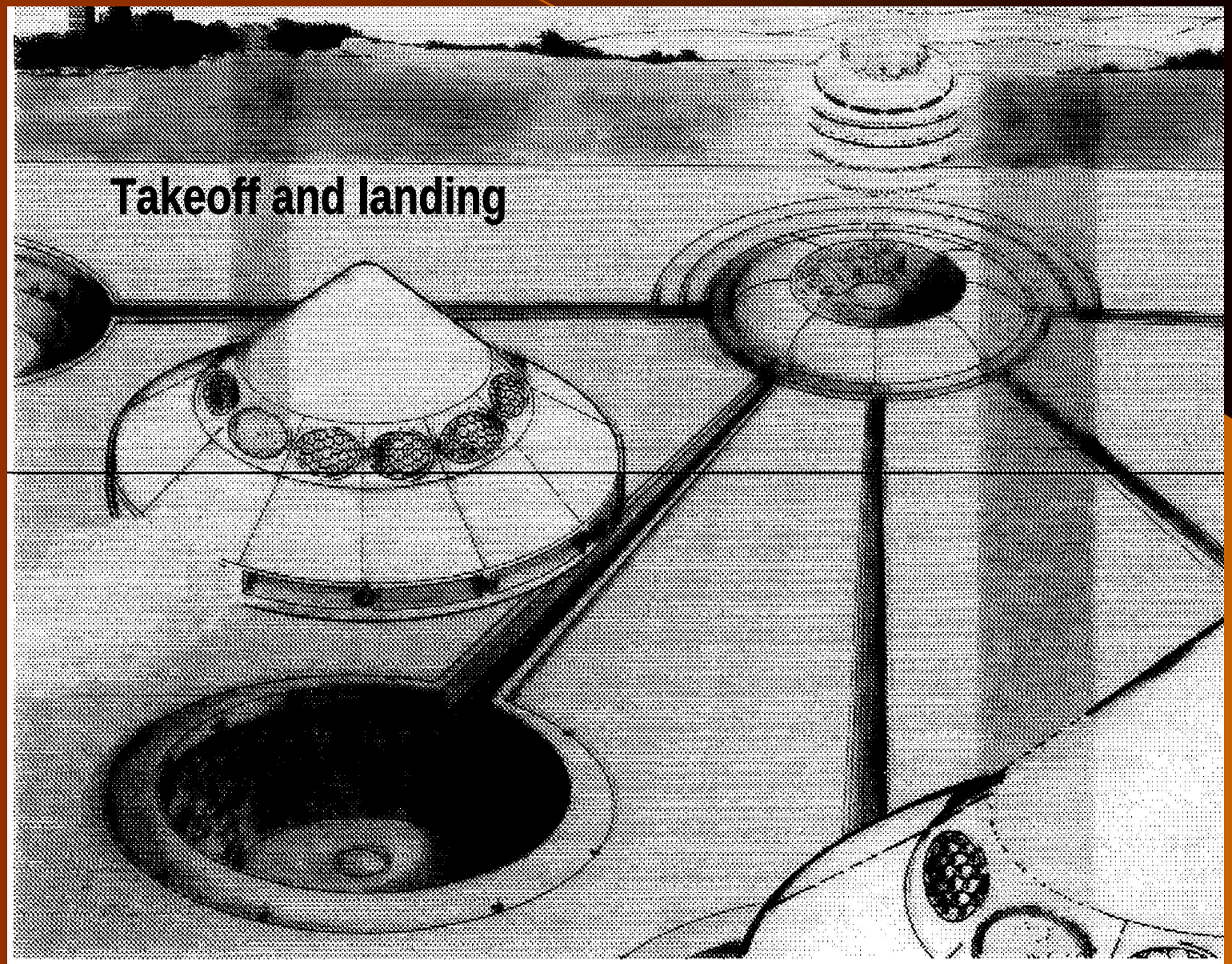
ATREX running on test stand at Kakuda, Japan

MagnetoHydroDynamic Propulsion & Directed Energy

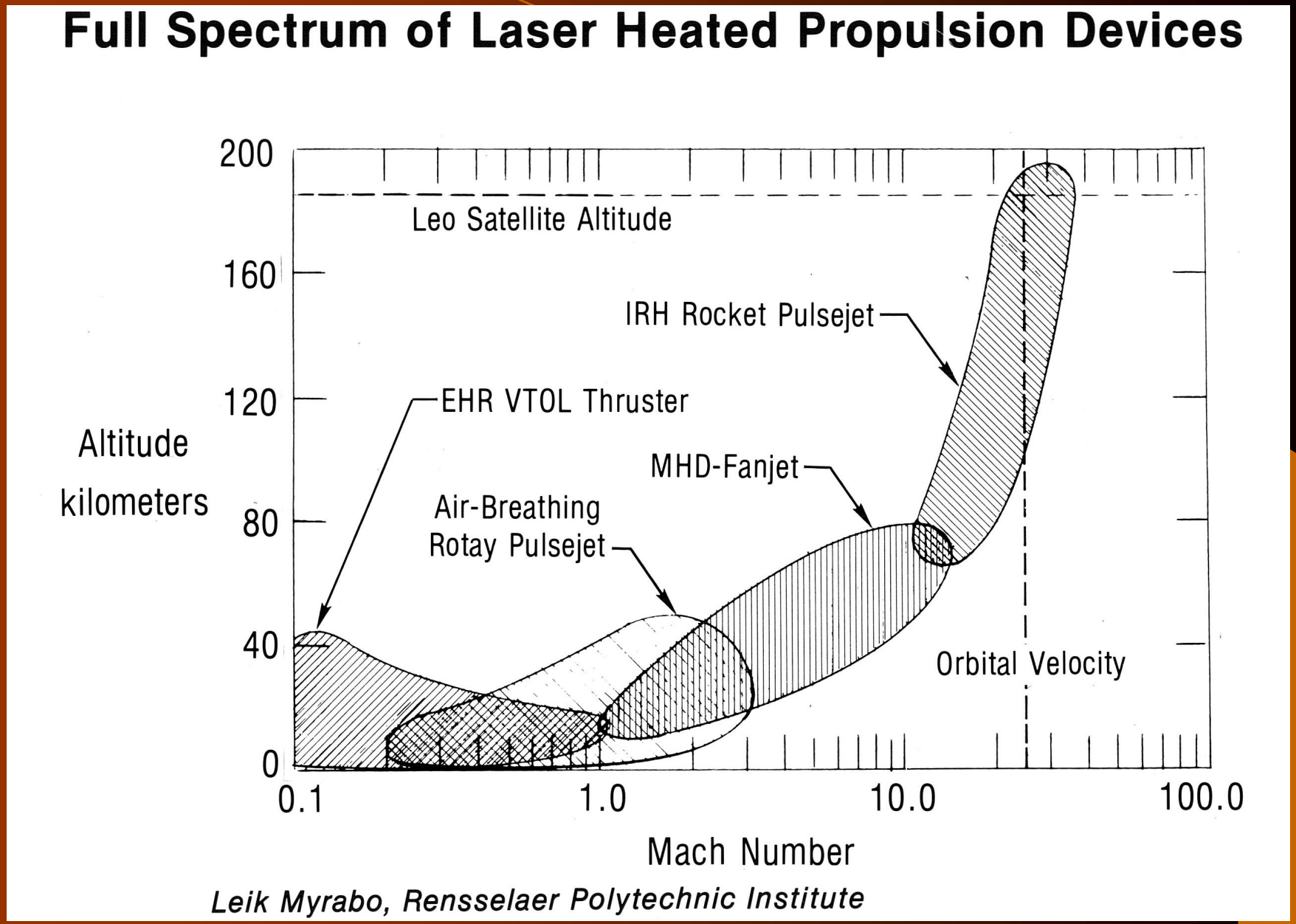


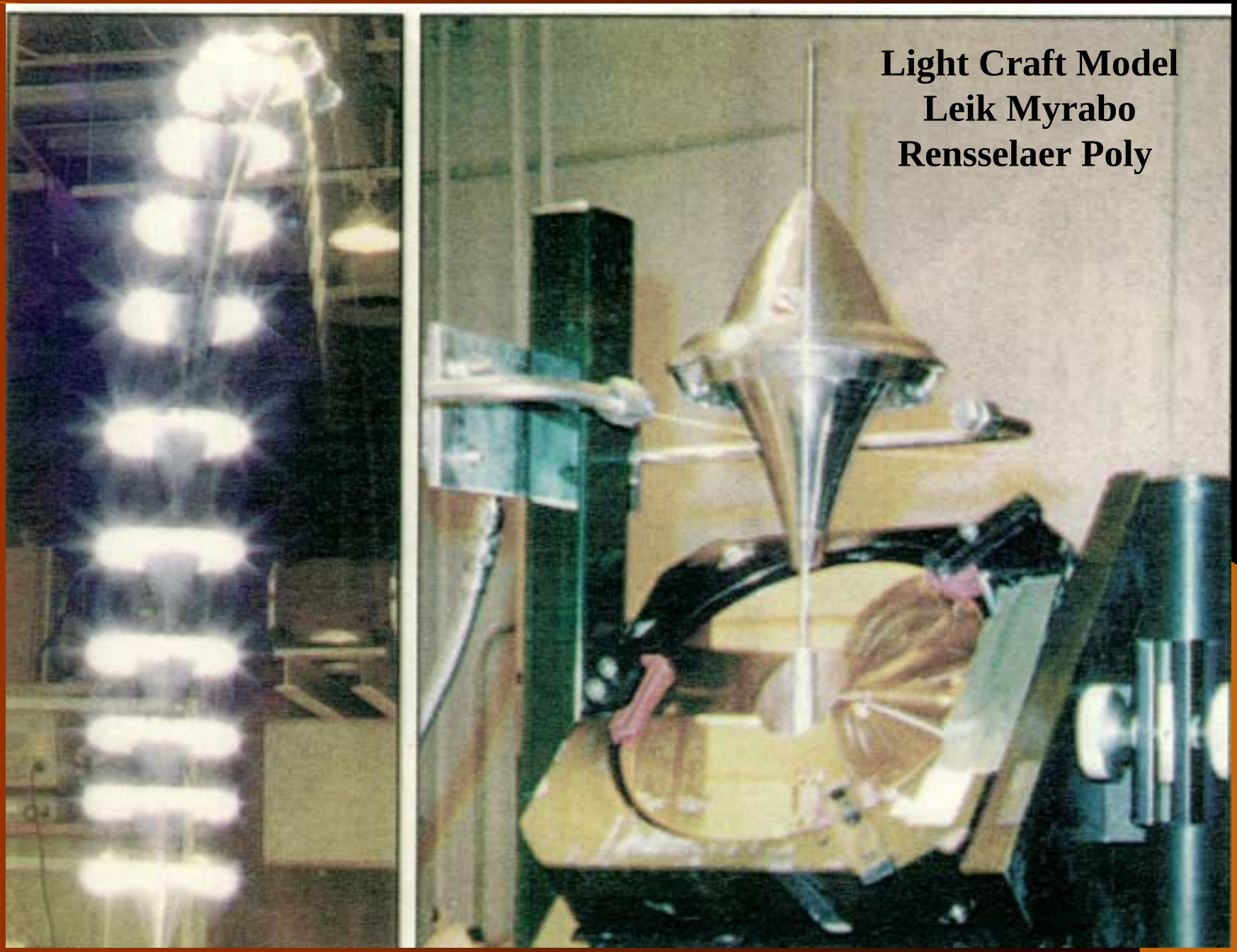
Vladimir Freistadt, St. Petersburg, Russia, circa 1993

Leik Myrabo, Rensselaer Polytechnic Institute



LightCraft operating spectrum





Leik Myrabo, US Air Force Research Laboratory Propulsion Directorate Photo

Exploration of Our Galactic Neighborhood

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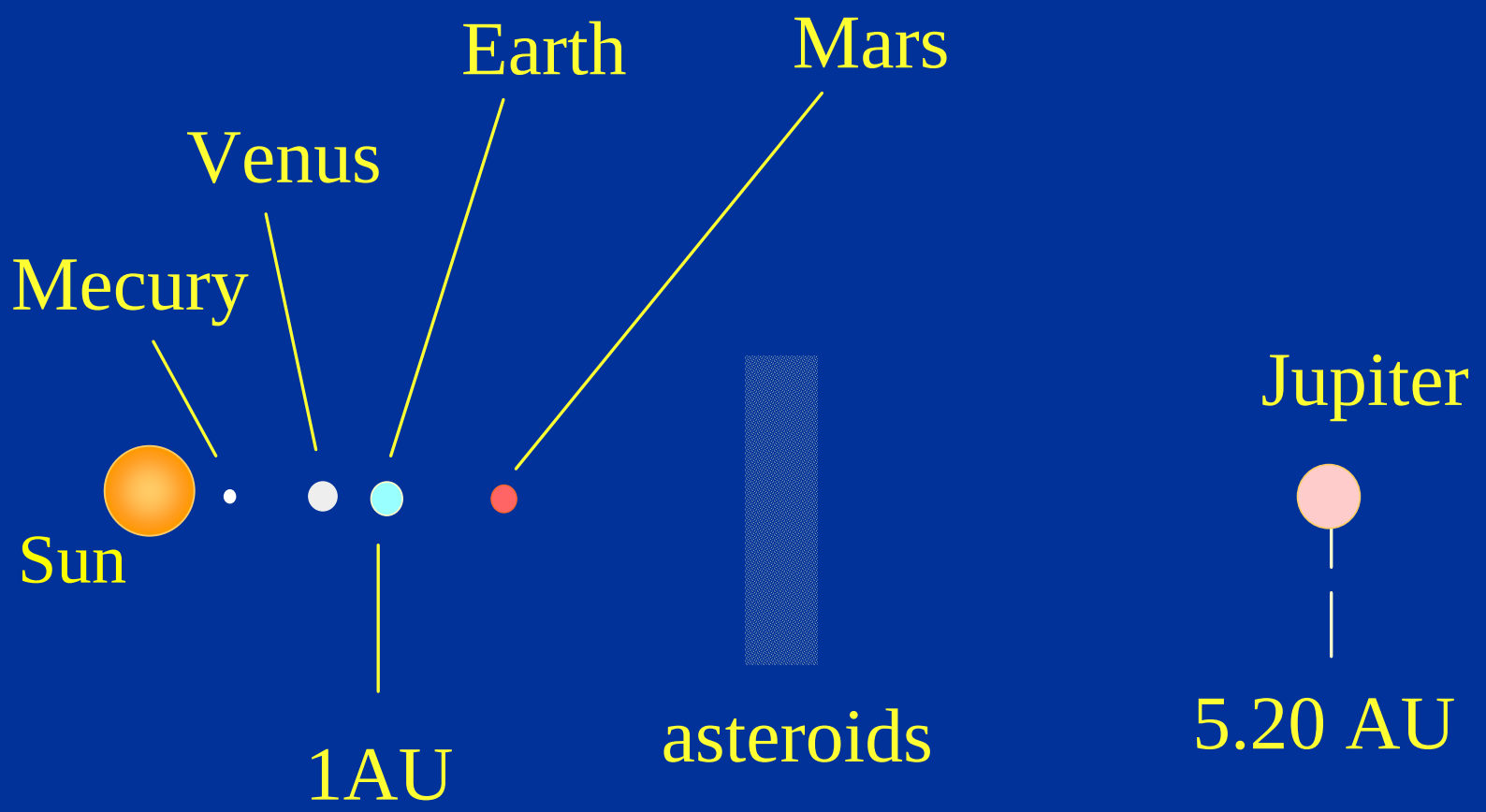
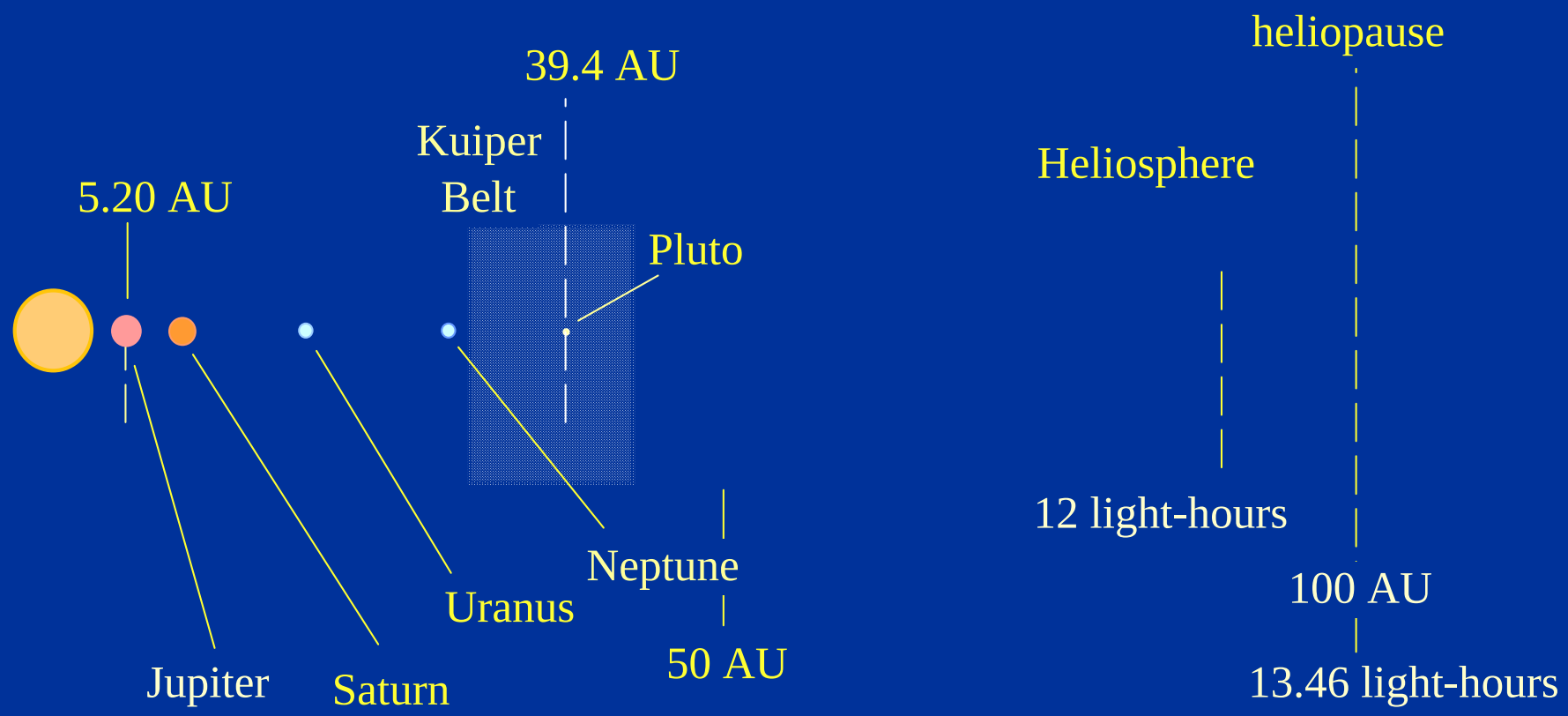
Exploring the:

- Near Earth Potentials
- Lunar base Potentials
- Terrestrial Planets
- Jovian Planets
- Heliosphere
- Nearest stars, Alpha Proxima
  Proxima Centauri
- Nearest Galaxy-like object, Magellanic cloud
- Nearest Galaxy. Andromeda

Terrestial Planets

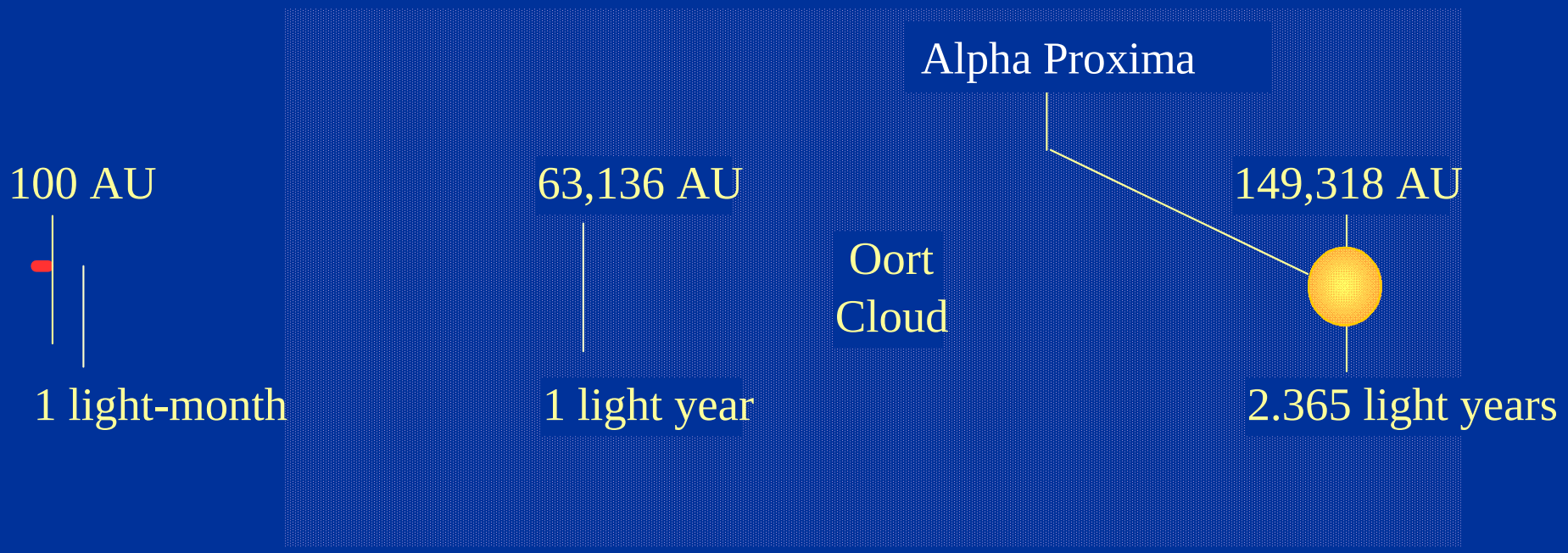


Jovian Planets



Jovian Planets

Near Galactic Space



Transit time at escape ΔV

Accelerate to 10.97 km/sec, coast, then decelerate to initial speed

	min./max. time	one-way communication
Mercury	99 / 185 days	6 - 11 minutes
Venus	40 / 244 days	2 - 15 min.
Mars	75 / 360 days	5 - 21 min.
Asteroids	240 / 525 days	14 - 31 .in
Jupiter	1.6 / 2.4 years	35 - 52 min.
Saturn	3.3 / 4.1 years	1.2 - 1.5 hours
Uranus	7.1 / 7.9 years	2.5 - 2.8 hr.
Neptune	11.3 / 12.1 years	4.0 - 4.3 hr.
Kuiper Belt	11.0 / 19.4 years	4.0 - 7.1 hr.
Pluto	14.9 / 15.7 years	5.3 - 5.6 hr.
Heliopause	38.1 years	13.46 hr.

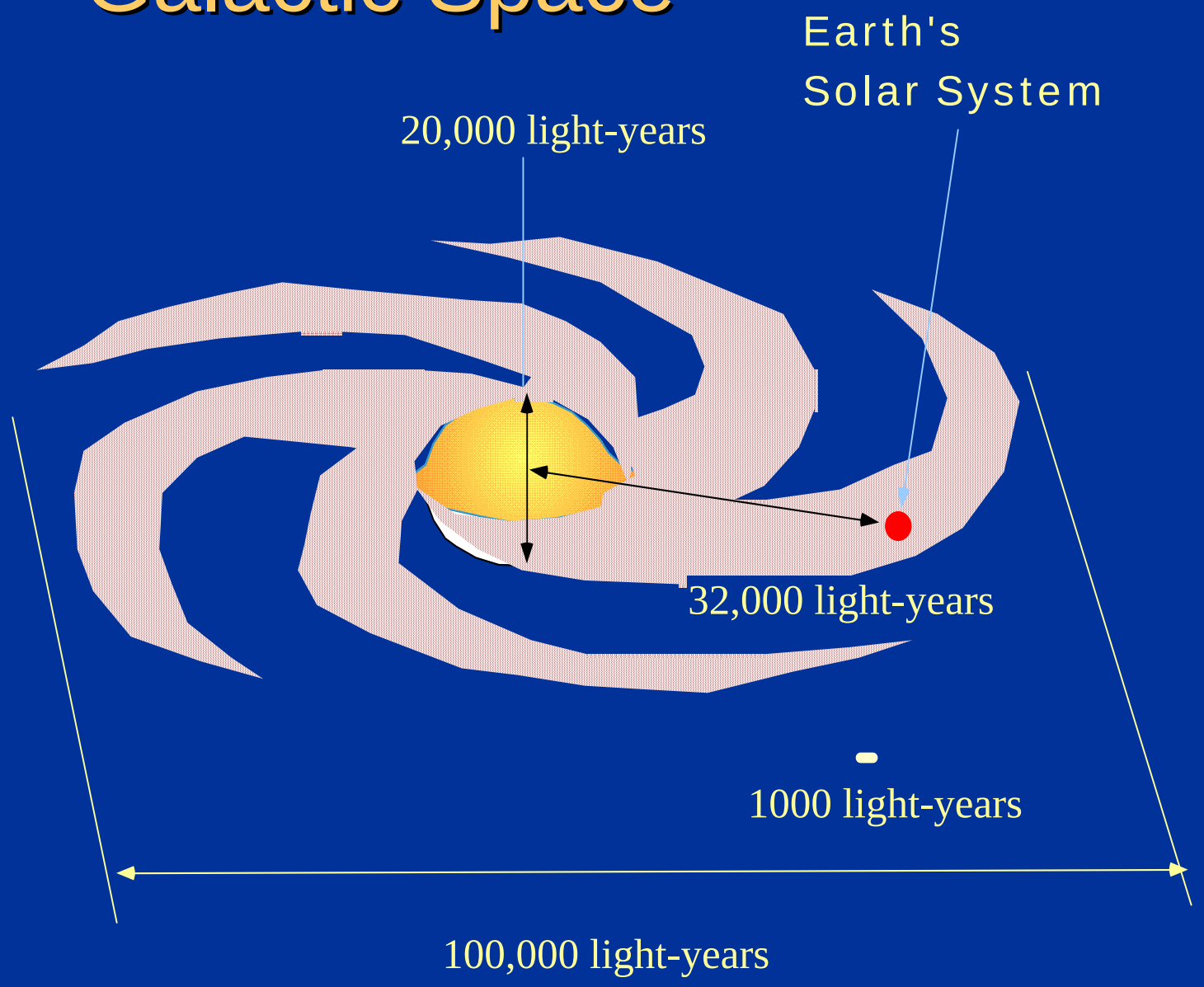
for 20 year round trip

Mass ratio for each acceleration = 8.0

	ΔV (km/sec)	Isp (sec)
Uranus	9.07 – 10.07	402 - 446
Neptune	14.50 – 15.49	642 - 686
Kuiper Belt	14.97 – 24.95	663 - 1,105
Pluto	19.17 – 20.16	848 - 893
Heliopause	49.9	2,209
Oort Cloud	500.	22,105
1 light-year	31,500.	1,396,000

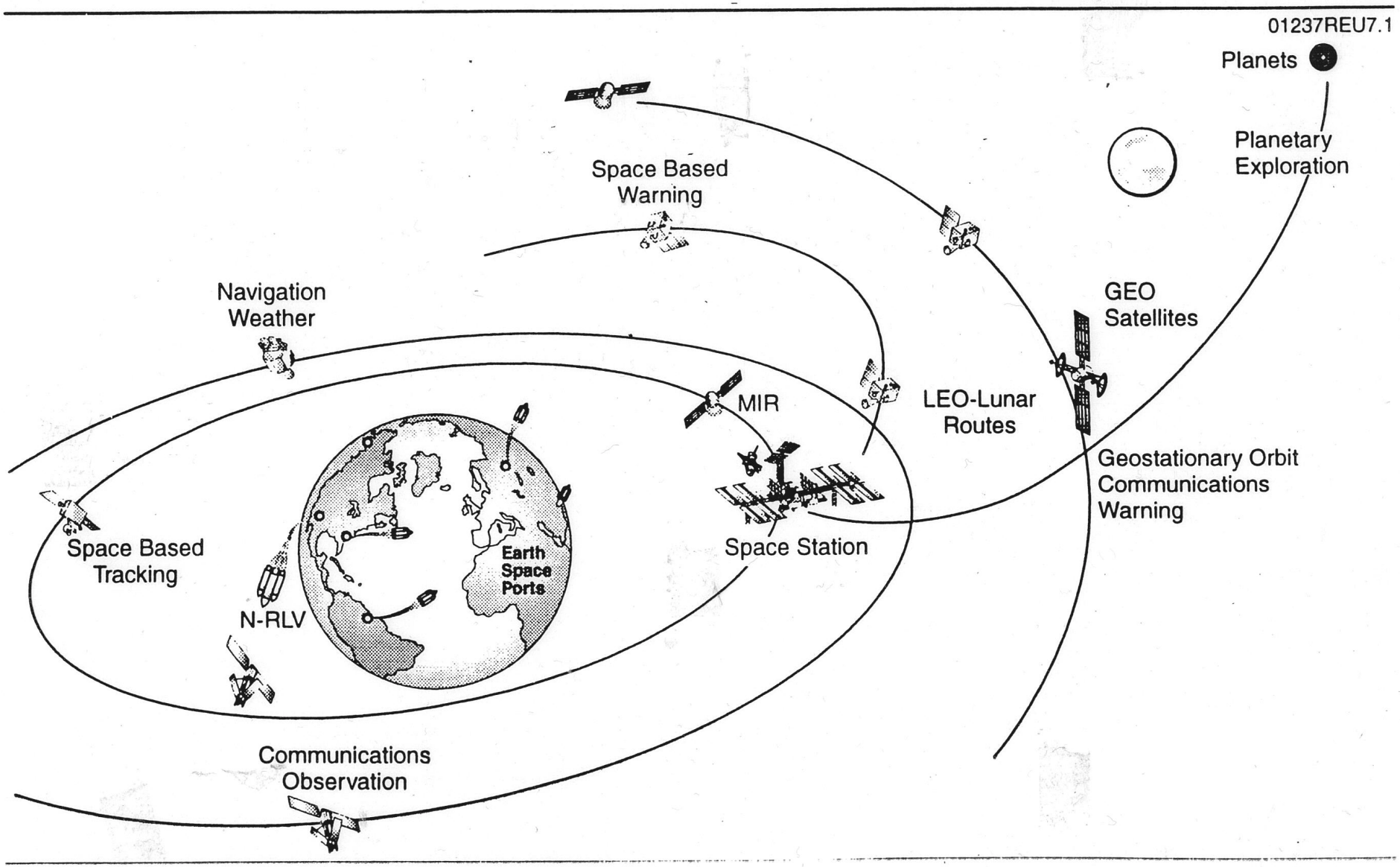
Time to one light-year

Galactic Space



Exploring:

- Near Earth, 150 to 1800 km
- Lunar base, 400,000 km
- Terrestrial Planets, 0.5 AU to 2.5 AU
- Jovian Planets, 4 AU to 40 AU
- The Heliopause, 100 AU
- Stars, Alpha Proxima, 2.36 light-years,
  Proxima Centauri, 4.3 light-years
- Magellanic clouds, 200,000 light-years
- Andromeda, 2,000,000 light-years



Spaceways Entering the 21st century

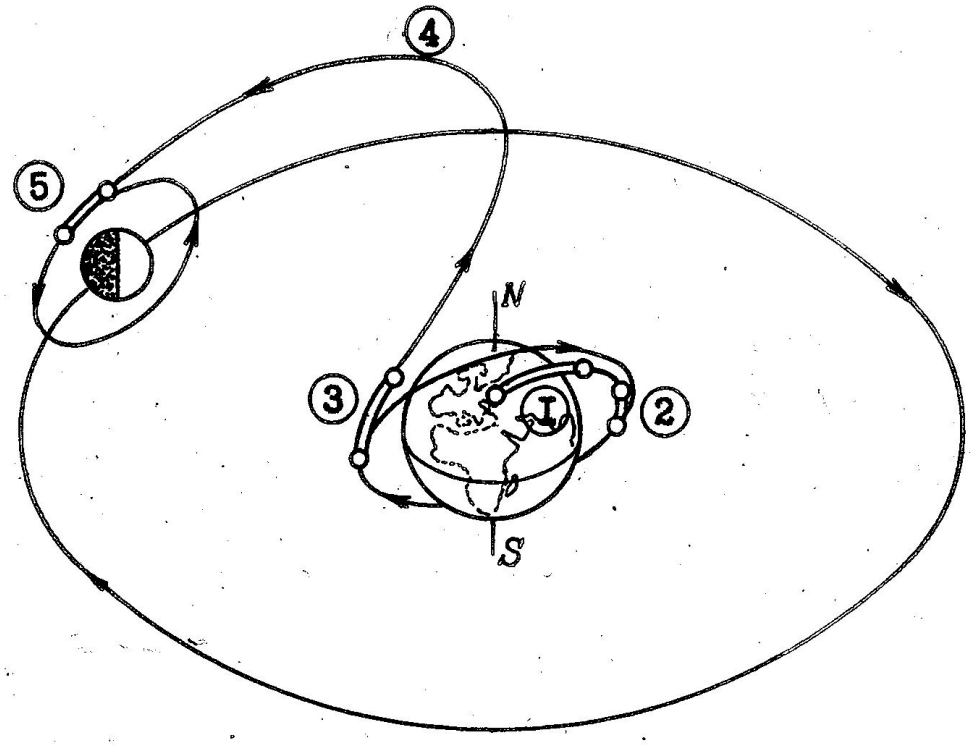
Chart by Bill Gaubatz

4. ДОСТАВКА МНОГОЦЕЛЕВОГО КОСМИЧЕСКОГО АППАРАТА ИЛИ ДОЛГОВРЕМЕННОЙ ОРБИТАЛЬНОЙ СТАНЦИИ НА ОРБИТУ ИСКУССТВЕННОГО СПУТНИКА ЛУНЫ.

Средства доставки: УРКТС "Энергия" + КРБ

Масса КА: 21,5 + 23 т

Время полёта: 5 суток



Этапы полёта

I Старт УРКТС "Энергия".

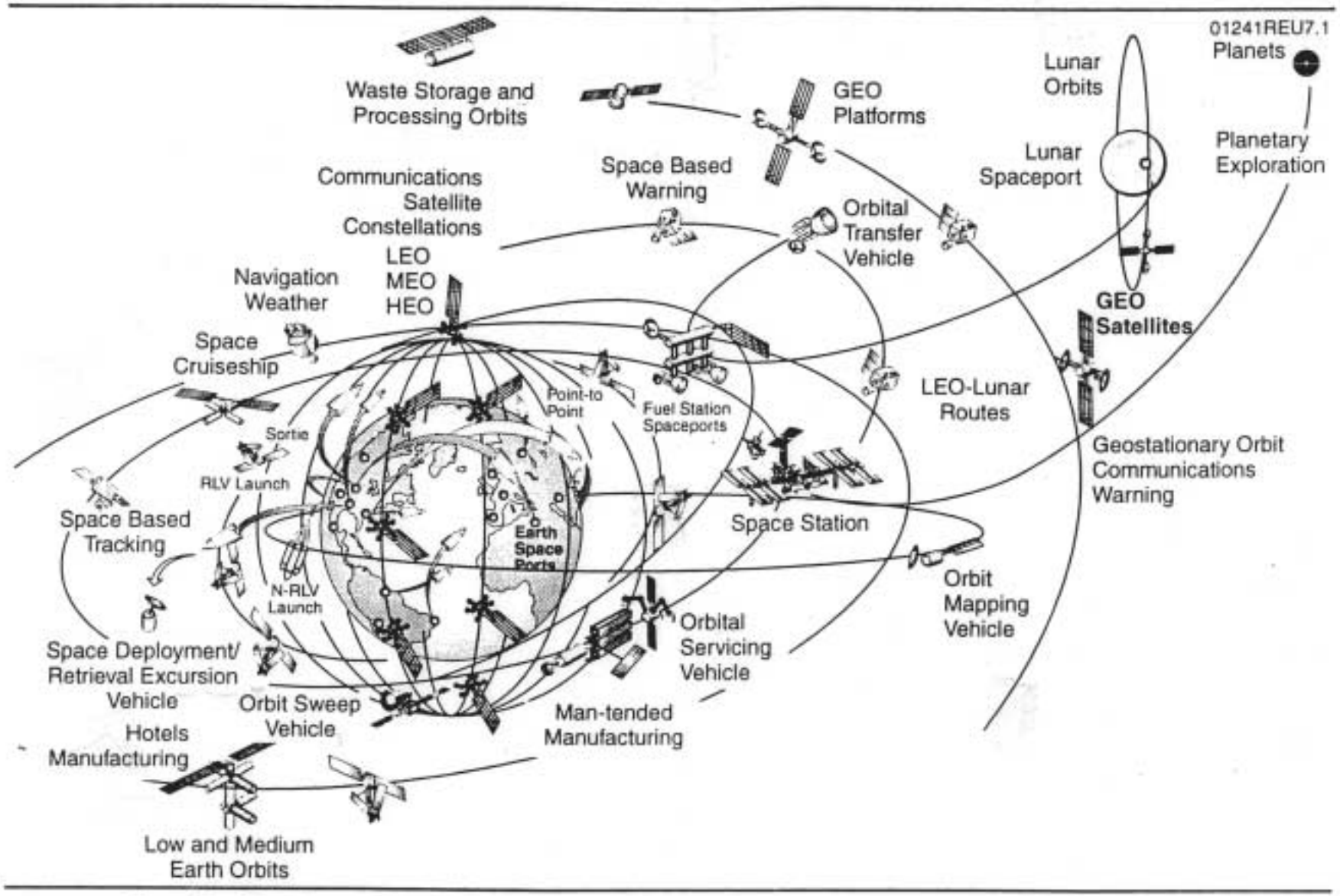
2 Довыведение на круговую орбиту ИСЗ с помощью КРБ.

3 Разгон к Луне с помощью КРБ.

4 Перелёт Земля – Луна.

5 Переход на орбиту ИСЛ с помощью КРБ.

Chart by Vladimir Gubonov



Growth of the Spaceways Routes

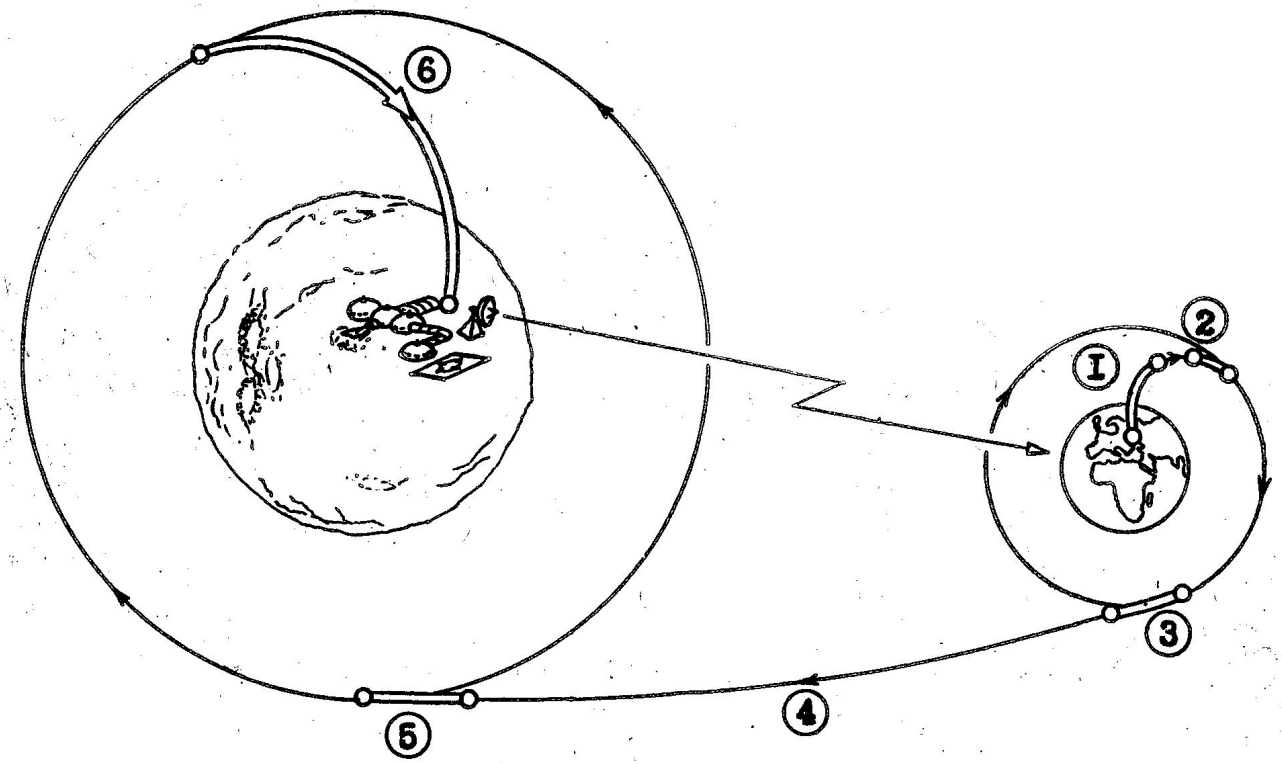
Chart by Bill Gaubatz

5. ДОСТАВКА МОДУЛЕЙ ПОСТОЯННО-ДЕЙСТВУЮЩЕЙ ЛУННОЙ БАЗЫ.

Средства доставки: УРКТС "Энергия" + КРБ + БТК

Масса модулей: 9 ÷ 10 т

Время полёта: 5 ÷ 7 суток



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4 Перелёт Земля – Луна.

5 Переход на орбиту ИСЛ с помощью КРБ.

6 Торможение и спуск на Луну с помощью БТК.

Chart by Vladimir Gubonov

In-Space Operations

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Professor Paul A. Czysz
Parks College of Engineering & Aviation
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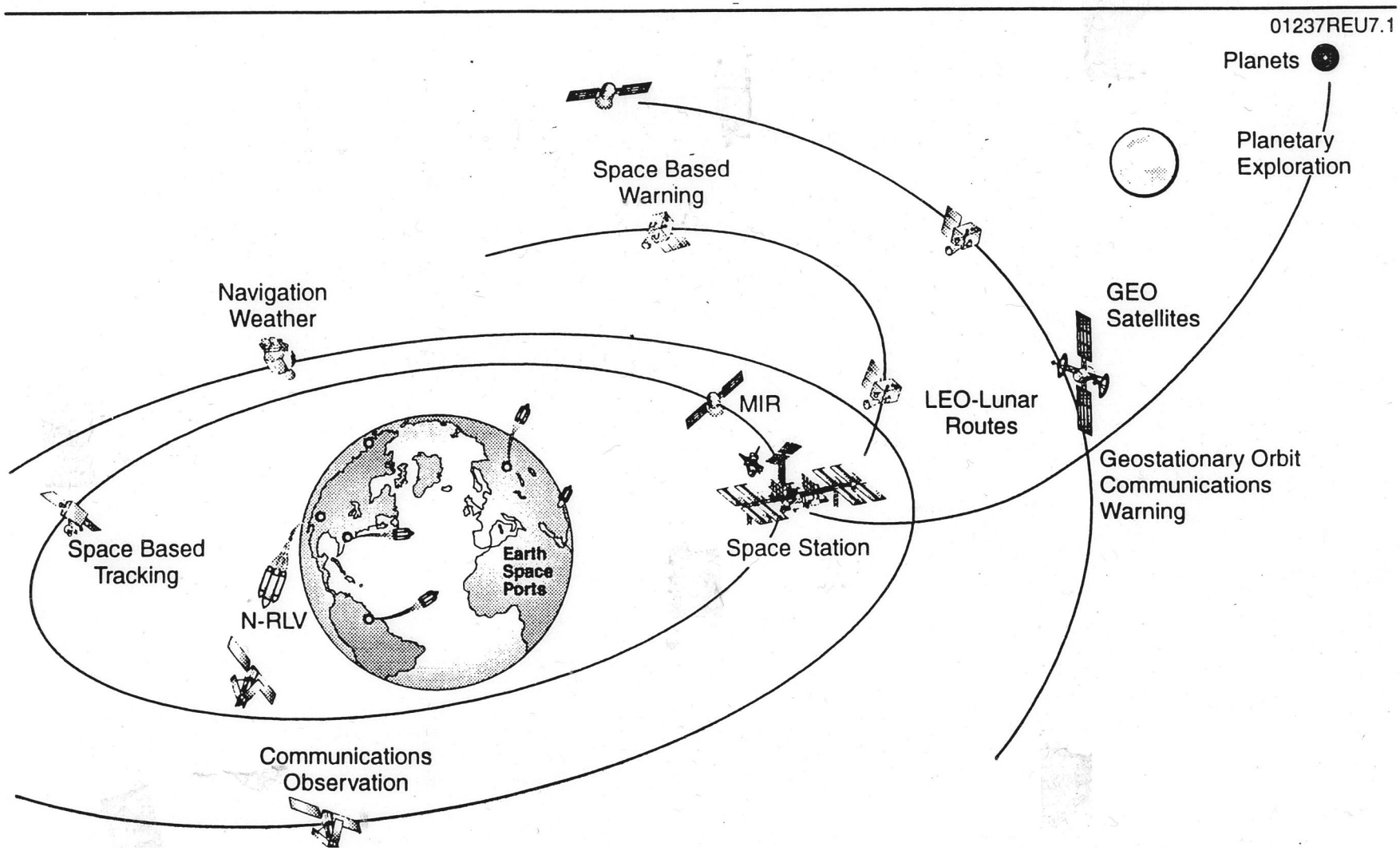
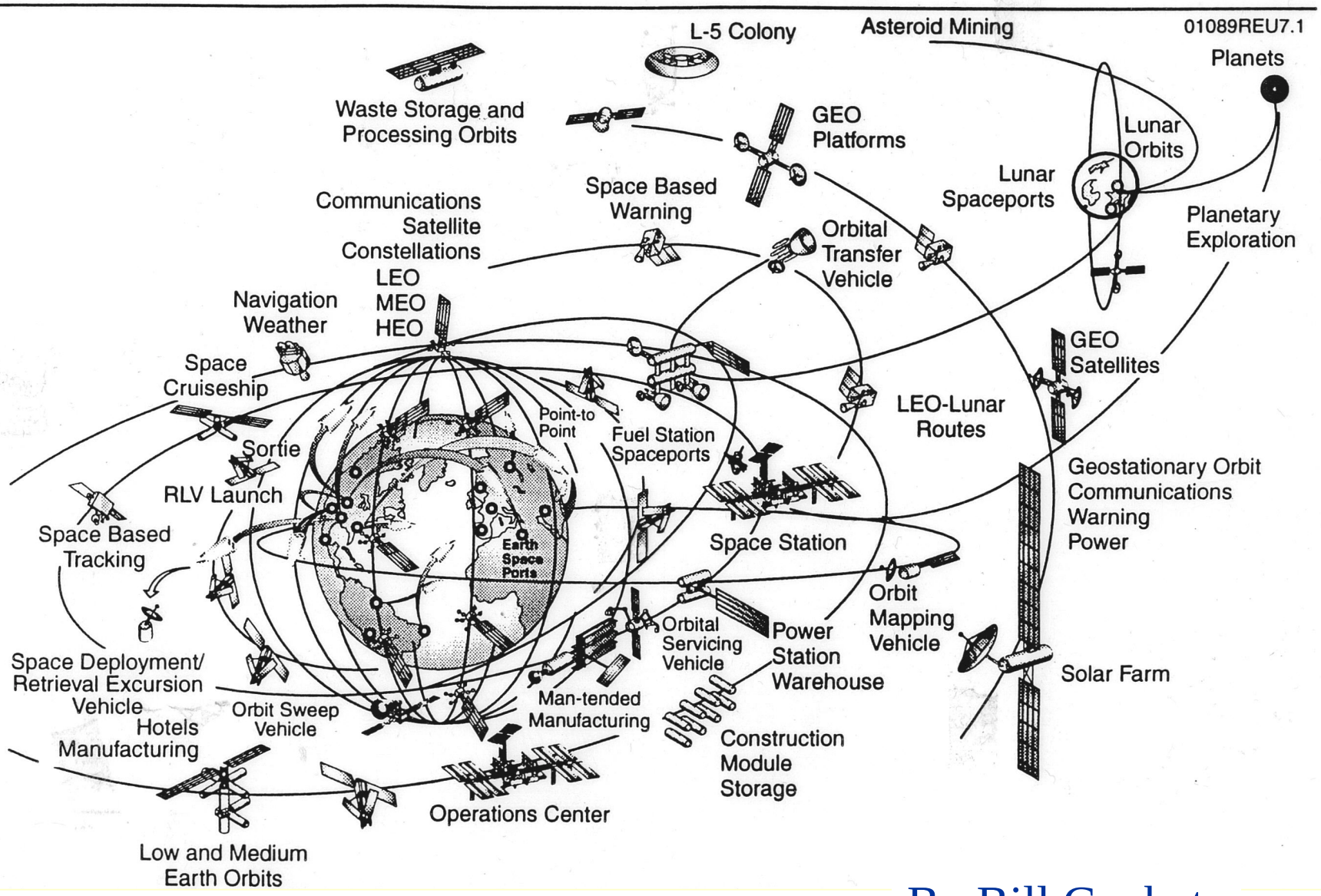
Where we almost are 2000



Spaceways Entering the 21st century

By Bill Gaubatz

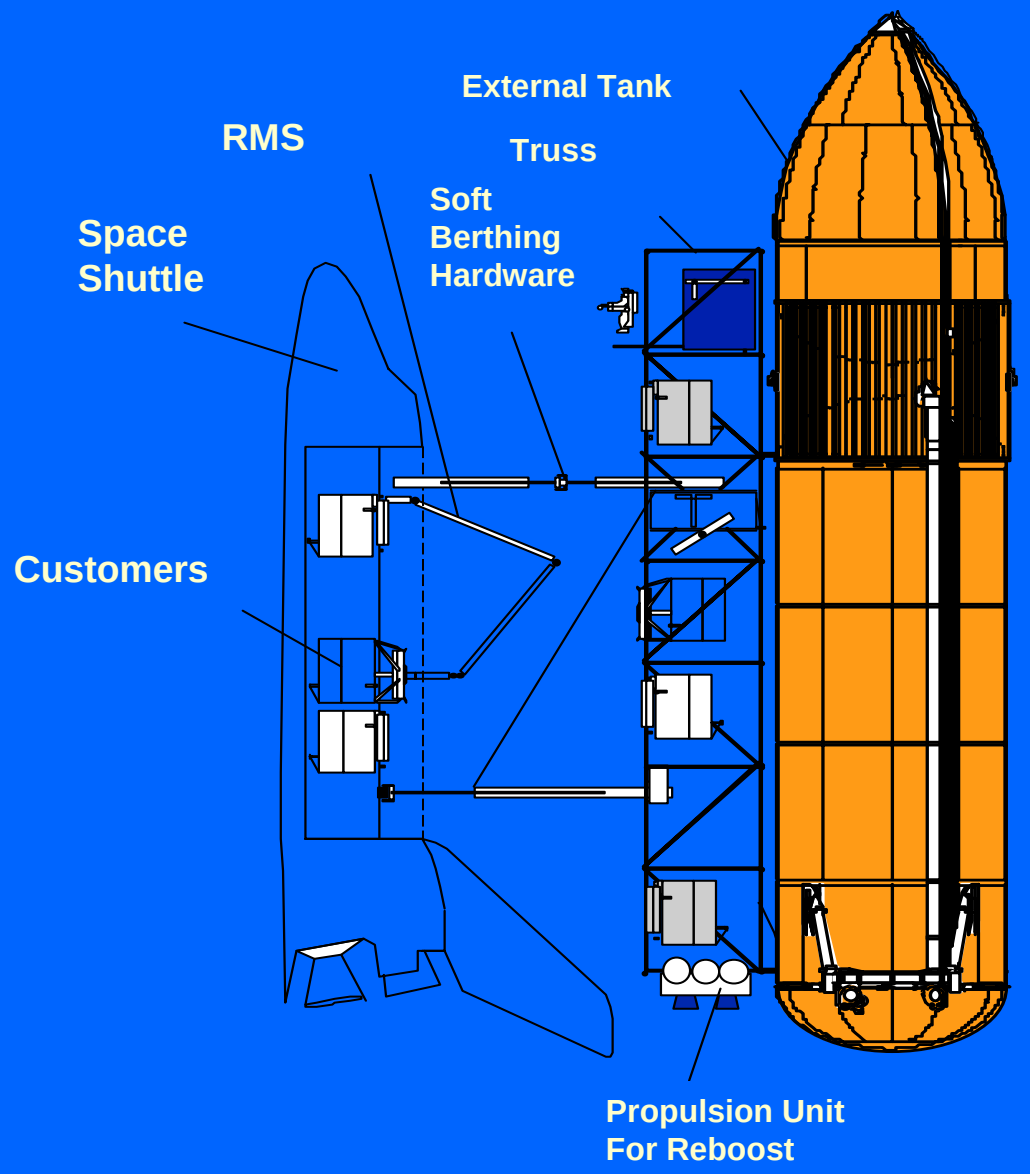
Where we need to be



Spaceways Servicing the Space Frontier

By Bill Gaubatz

Commercial Services in Orbit

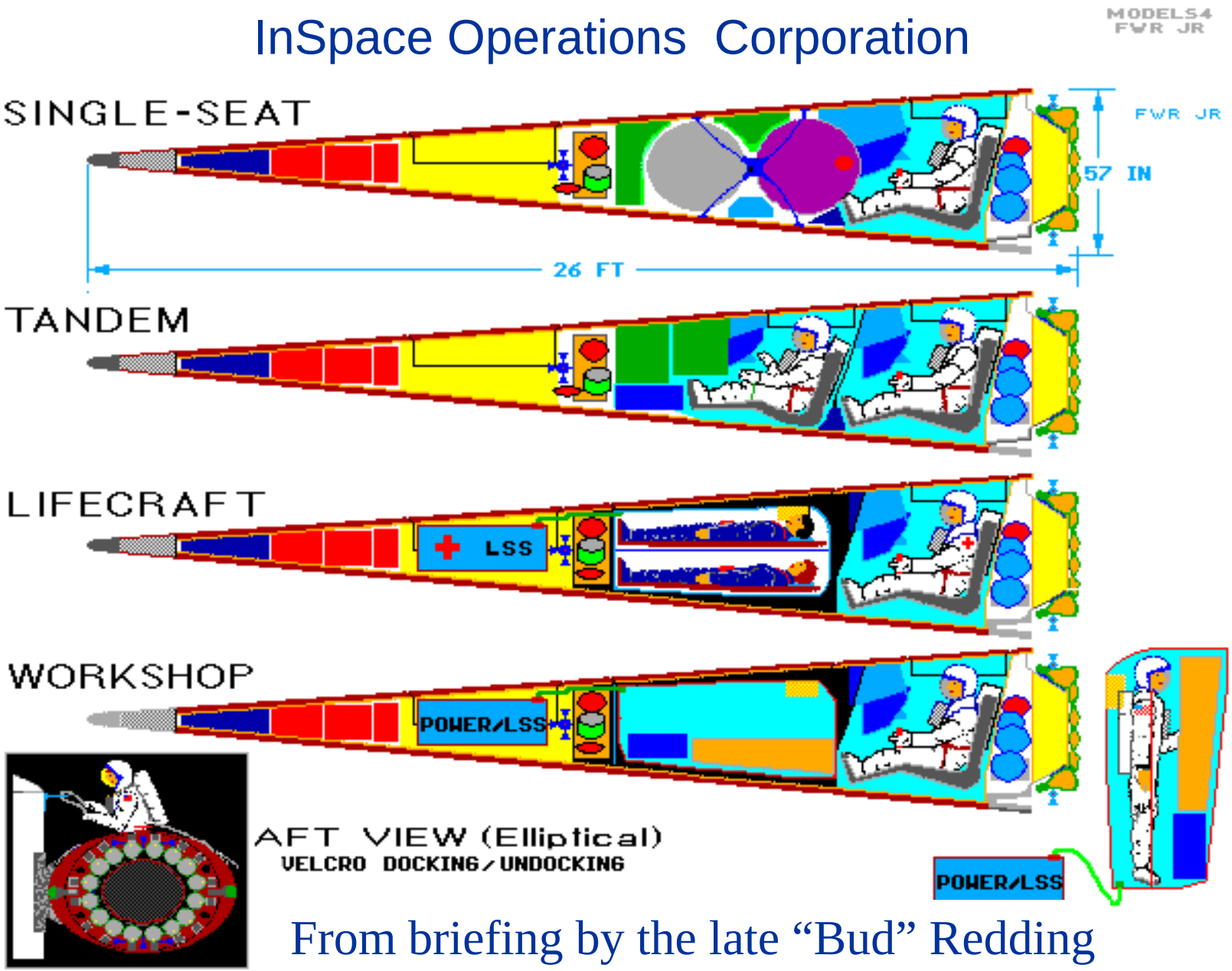


GLOBAL OUTPOST Platform

Tom Taylor
Global Outpost

InSpace Operations Corporation

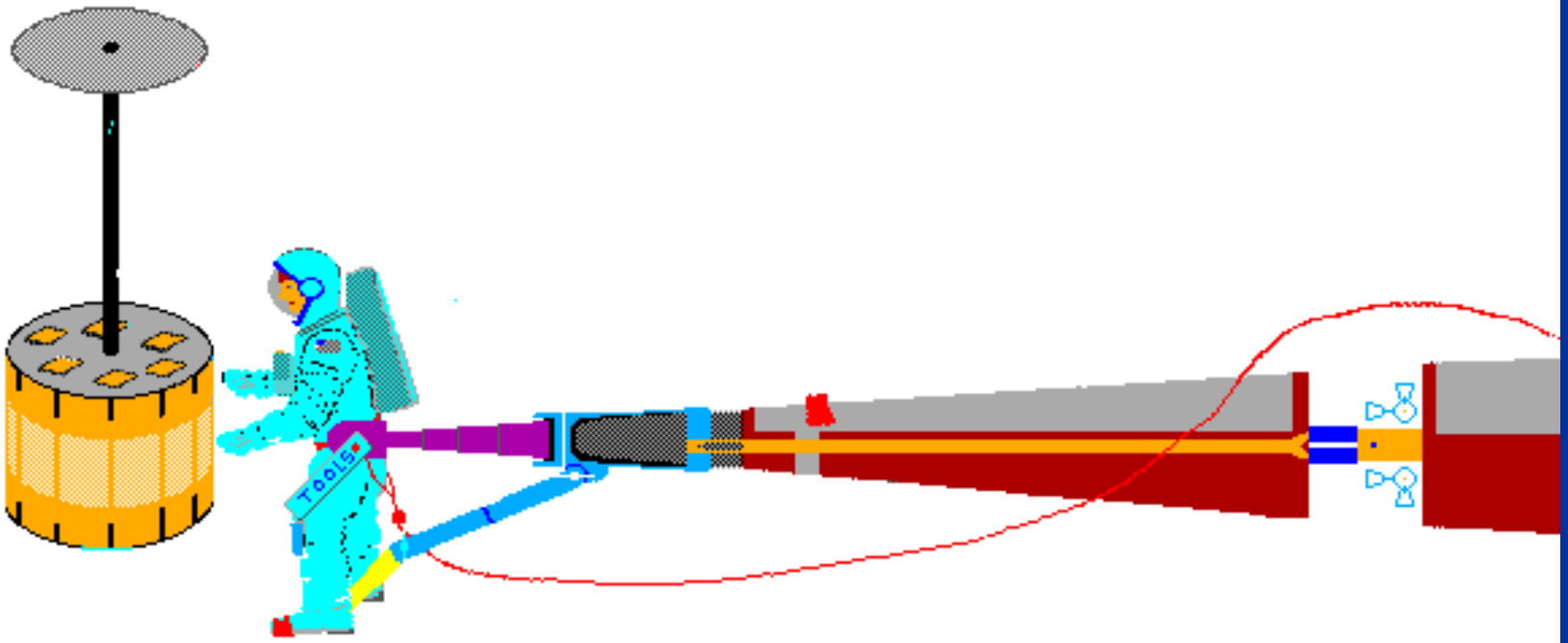
InSpace Operations Corporation



From briefing by the late “Bud” Redding

FWD-FIX

InSpace Operations Corporation



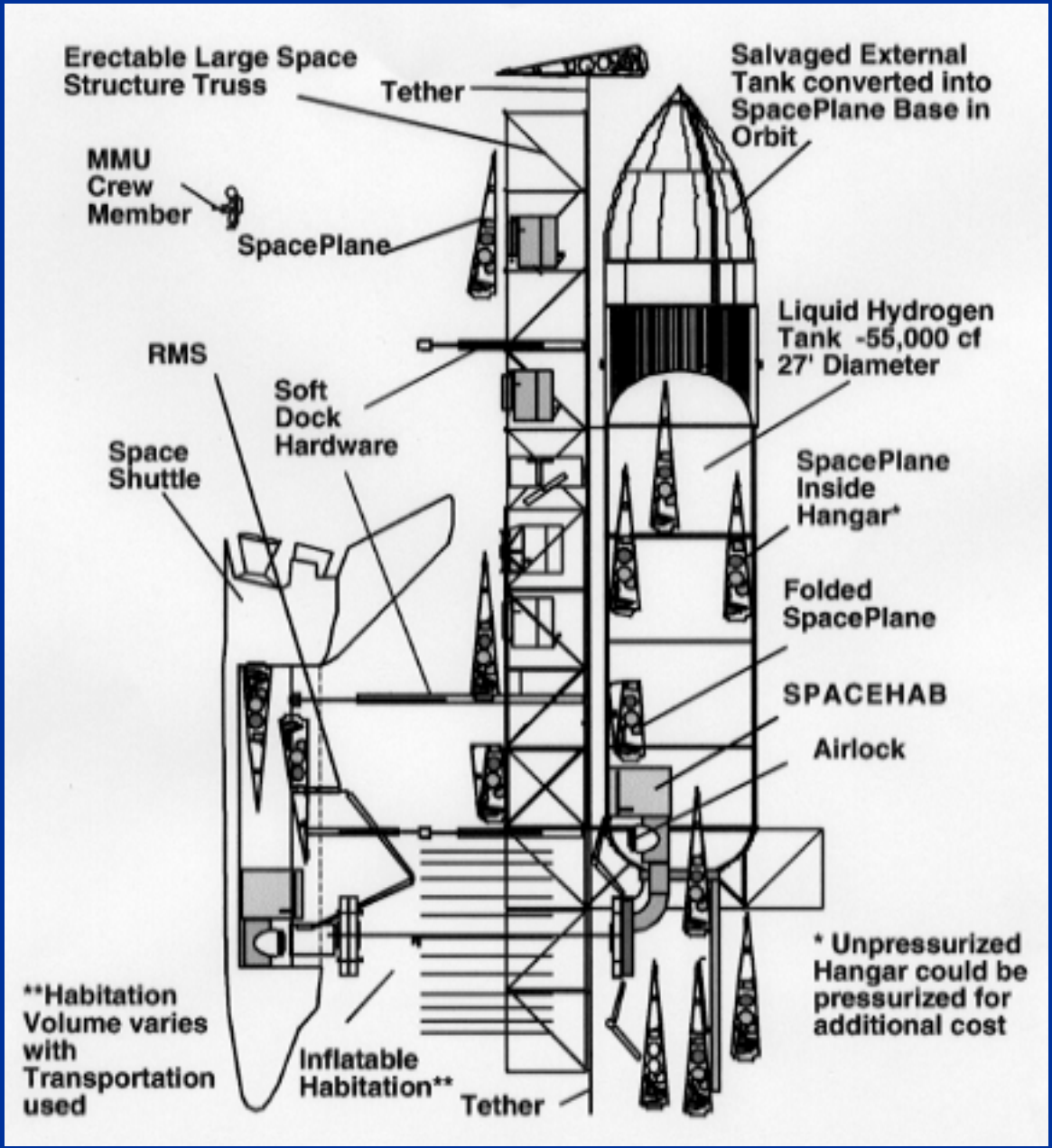
HYPER-MMU

- MASS STABILITY
- ACS
- POWERFUL COMPUTER-SUPPORT
- HELMET DISPLAY & VOICE
- 2ND CREWMEMBER SUPPORT MODE

From briefing by the late “Bud” Redding

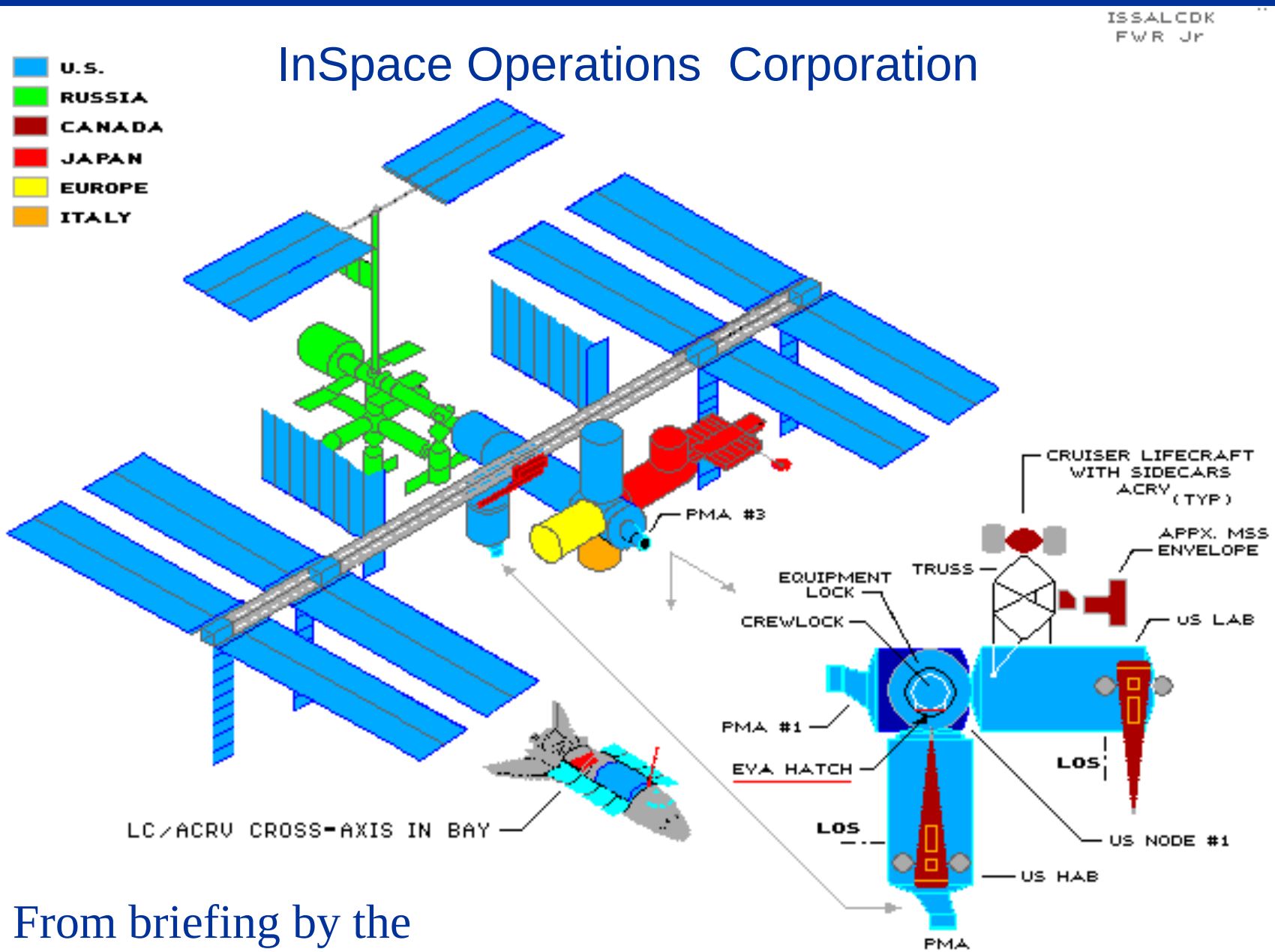
Commercial Services in Orbit

Global Outpost Platform incorporating Space Cruisers

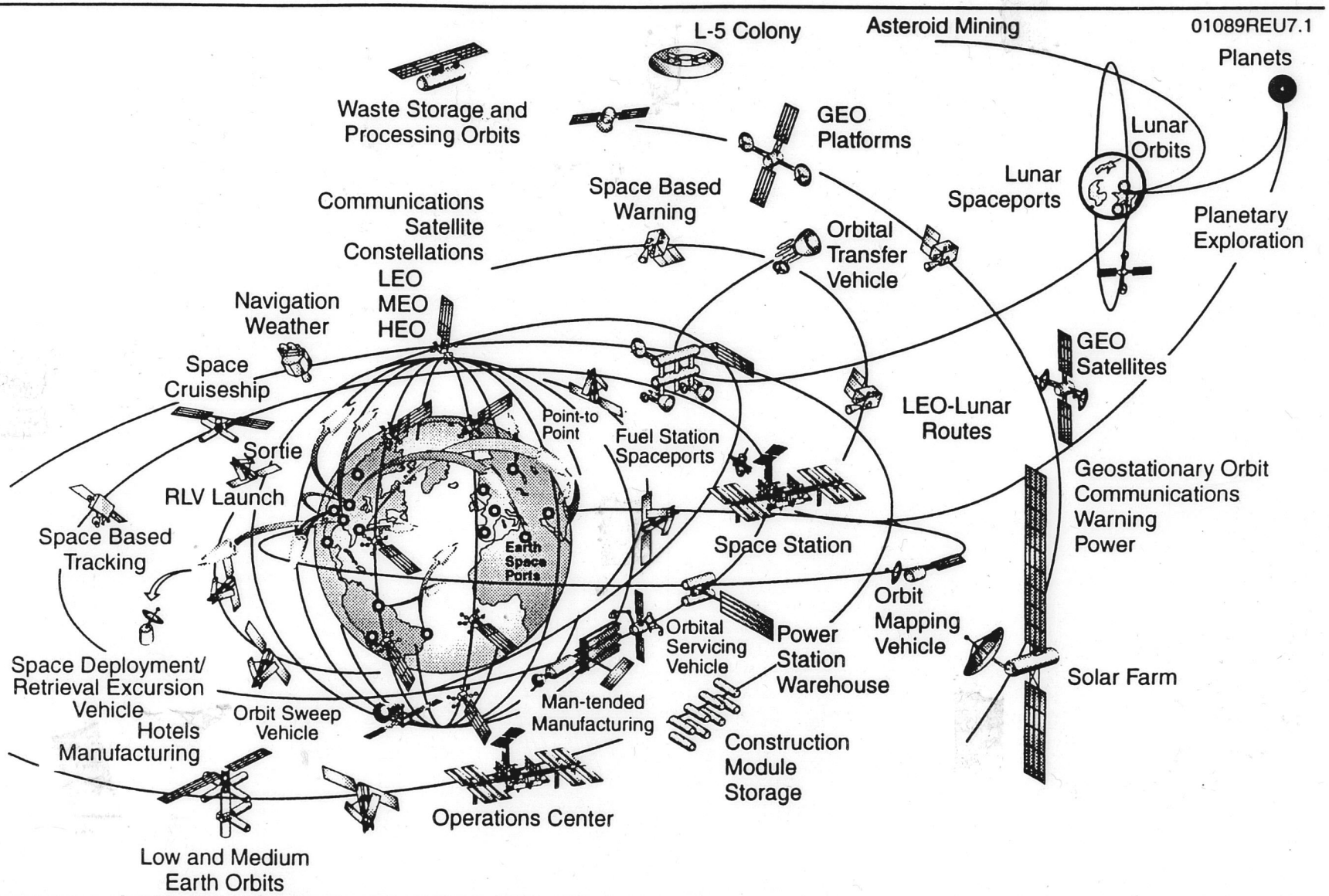


Tom Taylor
Global Outpost

InSpace Operations Corporation



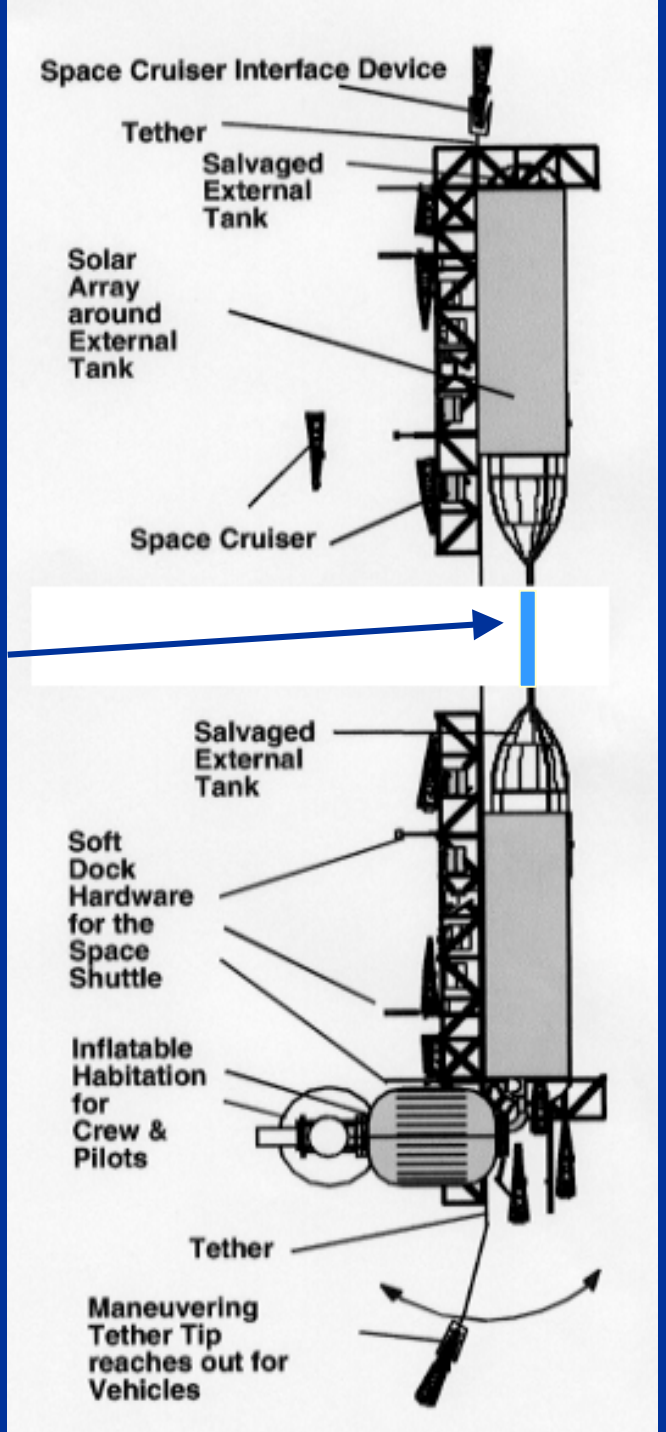
From briefing by the
late “Bud” Redding



Spaceways Servicing the Space Frontier

Global Outpost Platforms incorporating ElectroDynamic Tethers and Space Cruisers

Electrodynamic Tether for Orbital Markup & High Speed Tether - Vehicle Momentum Exchange on Both Ends, Length Varies.



Tom Taylor
Global Outpost

As Tom Stafford Said, “Back to the Moon”

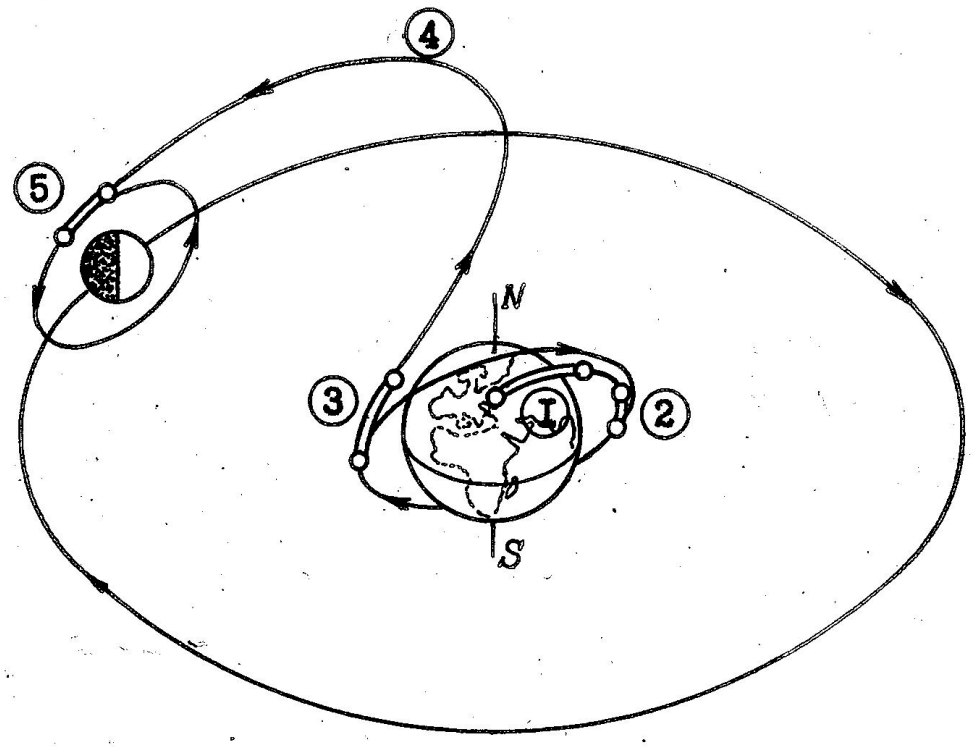
From a briefing
by V. Gubonov

4. ДОСТАВКА МНОГОЦЕЛЕВОГО КОСМИЧЕСКОГО АППАРАТА ИЛИ ДОЛГОВРЕМЕННОЙ ОРБИТАЛЬНОЙ СТАНЦИИ НА ОРБИТУ ИСКУССТВЕННОГО СПУТНИКА ЛУНЫ.

Средства доставки: УРКТС "Энергия" + КРБ

Масса КА: 21,5 + 23 т

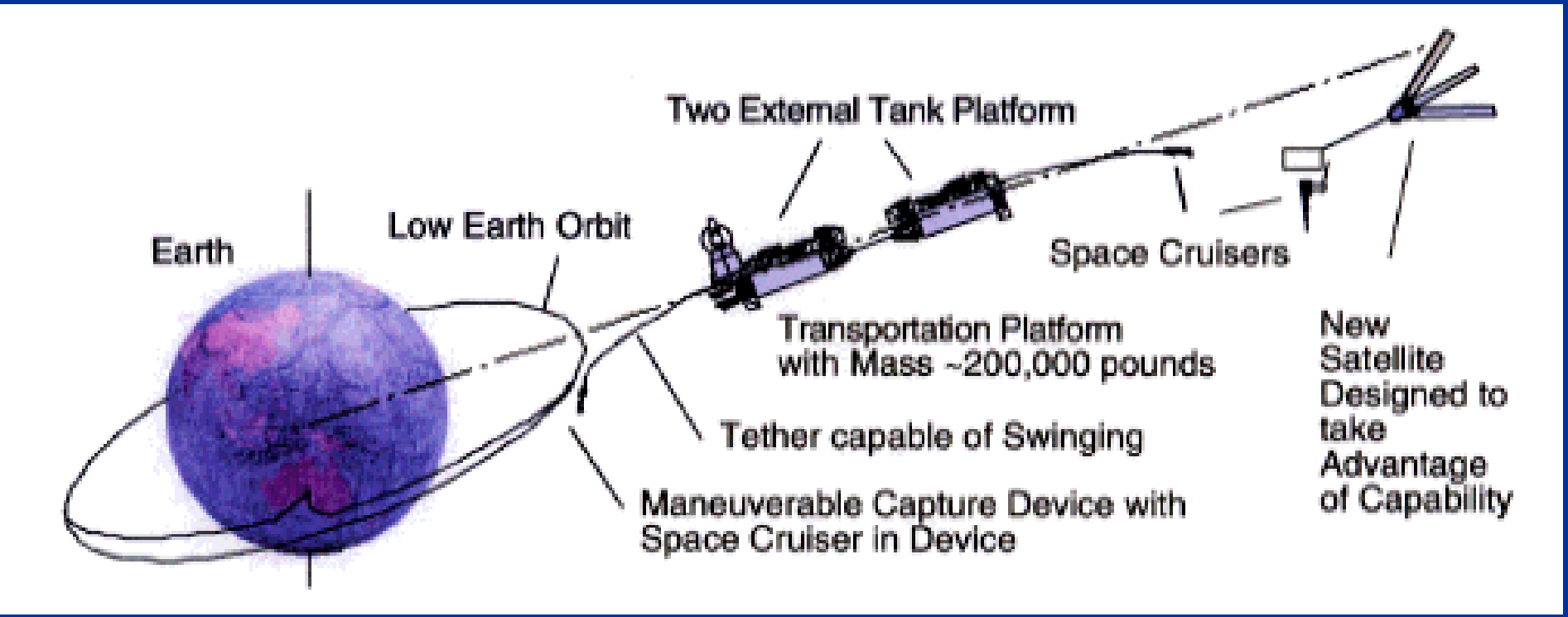
Время полёта: 5 суток



Этапы полёта

I Старт УРКТС "Энергия".
2 Довыведение на круговую орбиту ИСЗ с помощью КРБ.
3 Разгон к Луне с помощью КРБ.
4 Перелёт Земля – Луна.
5 Переход на орбиту ИСЛ с помощью КРБ.

Emerging Commercial Space Frontier Around Earth and Moon



Tom Taylor
Global Outpost

A Moon Base Enables Exploration

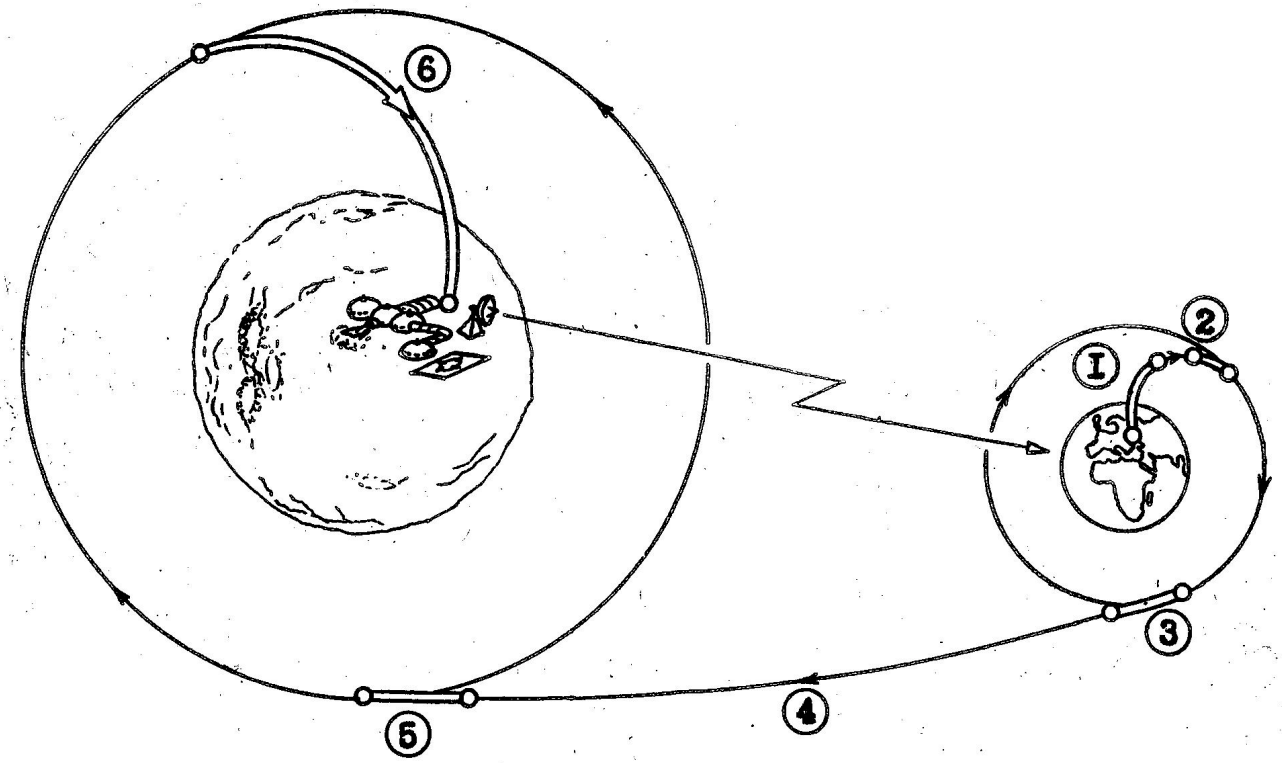
From a briefing
by V. Gubonov

5. ДОСТАВКА МОДУЛЕЙ ПОСТОЯННО-ДЕЙСТВУЮЩЕЙ ЛУННОЙ БАЗЫ.

Средства доставки: УРКТС "Энергия" + КРБ + БТК

Масса модулей: 9 ÷ 10 т

Время полёта: 5 ÷ 7 суток



Этапы полёта

I Старт УРКТС "Энергия".

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4 Перелёт Земля – Луна.

5 Переход на орбиту ИСЛ с помощью КРБ.

6 Торможение и спуск на Луну с помощью БТК.

We Have a Long Road Ahead to Achieve Sustained Self-Sufficiency

- Habitats for Factories and Services
- Power Generation for Orbital Systems
- Power Generation for Earth
- Fueling Stations
- Repair Bases
- Orbital Switch Engine to Move Material
- Orbital Transfer System