

Electrical Thrusters in the EC MEGA HIT* and DEMOCRITOS* Projects

*Megawatt Highly Efficient Technologies for Space Power and Propulsion Systems for Long-duration Exploration Missions

*Demonstrators for Conversion, Reactor, Radiator And Thrusters for Electric Propulsion Systems

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NATIONAL NUCLEAR
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Knowledge for Tomorrow

Overview

1) Introduction

a) 'History': DiPoP=> MEGA HIT => DEMOCRITOS

2) European-Russian MEGA HIT

a) study outputs: worldwide interests for MW NEP and high level spacecraft requirements,

b) proposal: key technology plan including stakeholders and subsystems,

c) plan for a political as well as public supportable reference space mission and

d) MEGA HIT global roadmap for international realization of NEP respectively INPPS (International Nuclear Power and Propulsion System)

3) DEMOCRITOS

4) Conclusions and Hints



1) Introduction: DiPoP

RANGE OF POTENTIAL APPLICATIONS:

Mars Manned (split) missions: humans chemical propulsion, infrastructure nuclear.

Outer Planet Exploration: Jupiter sample return, Neptune orbital survey and lander.

Heliosphere and beyond Exploration.

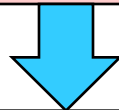
NEO management: Earth threatening deflection/destruction, survey and mining.

Planetary surface or 'space port' power generation.

High power ground penetrating radar, ice-melting laser, long distance high data rate communications.

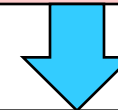
Space-based NEO tracking radar for trajectories obscured by the Sun.

Removal of 'dead' spacecraft from Earth orbit to reduce space debris.



30 kWe prioritisation:

Planetary surface power generation,
Small robotic exploration and NEO
survey, high power radar.

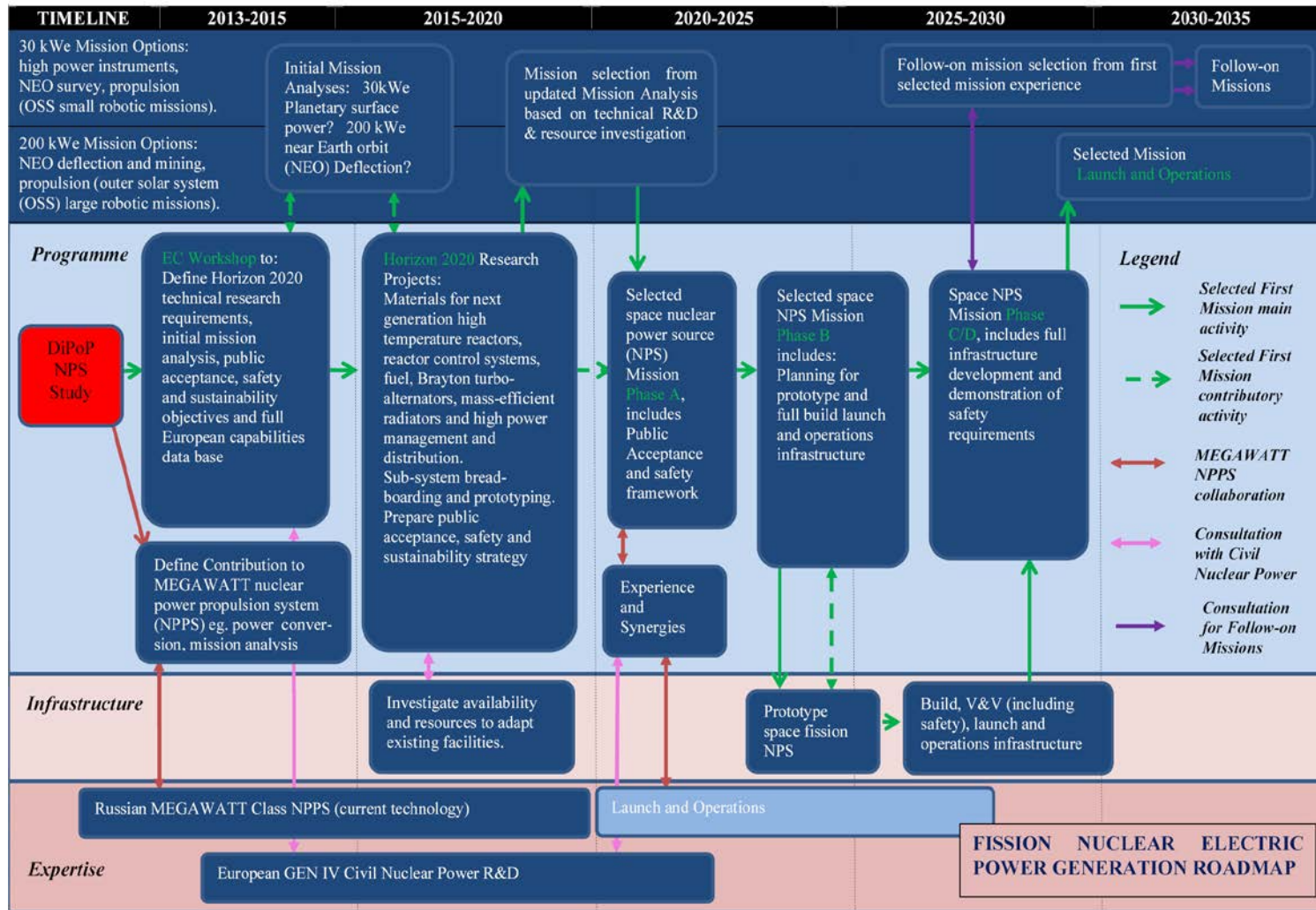


200 kWe prioritisation:

NEO deflection, survey, mining,
outer planet robotic exploration,
large infrastructure transportation.



1) Introduction: DiPoP (low power) roadmap



1) Introduction: DiPoP main conclusions

The **ENPS 2005** recommendations progressed significantly.

Advisory Board guidance leads to a coherent European NPS Roadmap.

Space and Civil/Submarine fission NPS requirements differences remain.

NPS Advisory Board advise focus on higher power in applications prioritisation of:

30 kWe: power sources for planetary infrastructure/high power instruments,

200 kWe: Earth threatening NEO deflection/outer solar system exploration.

Technical: 30 kWe and 200 kWe gas cooled or LM closed cycle Brayton

Europe has the potential capability and interest but needs:

technical and infrastructure development and

practical experience.

Collaboration: Europe Generation IV NPS, Russia MEGAWATT Class NPPS.

Public Acceptance Management integral early part of any project.

European Safety Framework for NPS and infrastructure to deliver required.

Sustainability requires long term programme of R&D for multiple missions.

NPS R&D priorities for EC Horizon 2020 (short, medium longer term) identified.

Mission analysis needs space science & exploration, R&D and nuclear organisations.

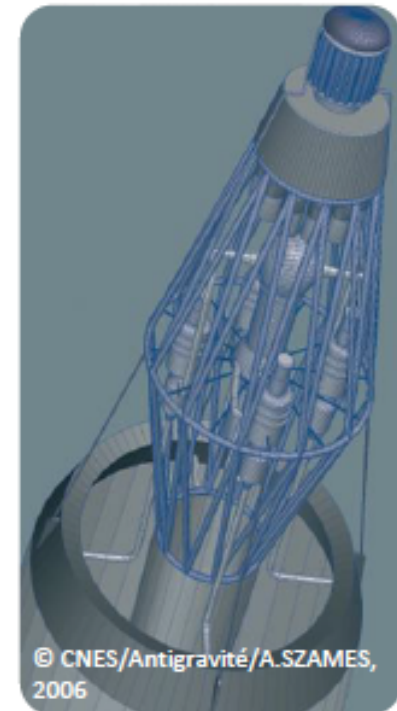


2) European-Russian MEGA HIT project

- MEGA HIT topics:

The topics addressed by MEGA HIT cover all the areas of space nuclear electric propulsion. The technological plans cover eight topics

1. **Fuel and core**, relating to nuclear technologies and including shielding.
2. **Thermal control**, addressing heat transfer and radiating devices.
3. **Conversion**, addressing the technologies of conversion of thermal energy into electricity at high power level.
4. **Propulsion**, relating to electric thrusters technologies
5. **Power management and distribution**, relating to the high power converters and distribution cables between the generator and spacecraft.
6. **Spacecraft arrangement and system architecture** addressing the system architecture, lightweight structures and assembly in-orbit.
7. **Safety and regulations**, addressing the nuclear safety and other regulations.
8. **Communication and public awareness**, addressing the necessary steps to take to successfully communicate a nuclear space project to the public.



2) European-Russian MEGAHit project

- MEGAHit roadmap: [INTERNATIONAL NUCLEAR POWER AND PROPULSION SYSTEM \(INPPS\) ROADMAP](#)

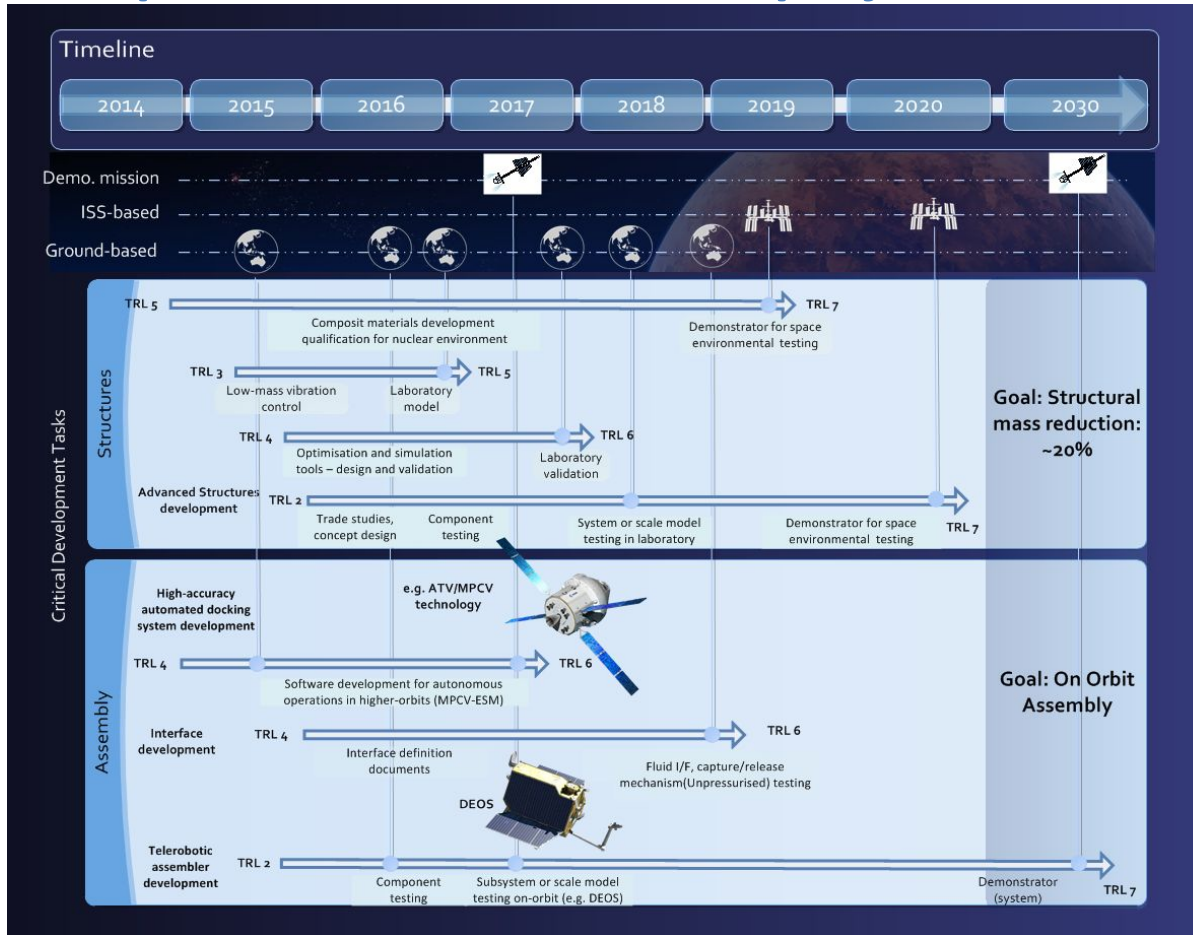
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Successful project realization is a truly global project and comparable with the Apollo and ISS projects.



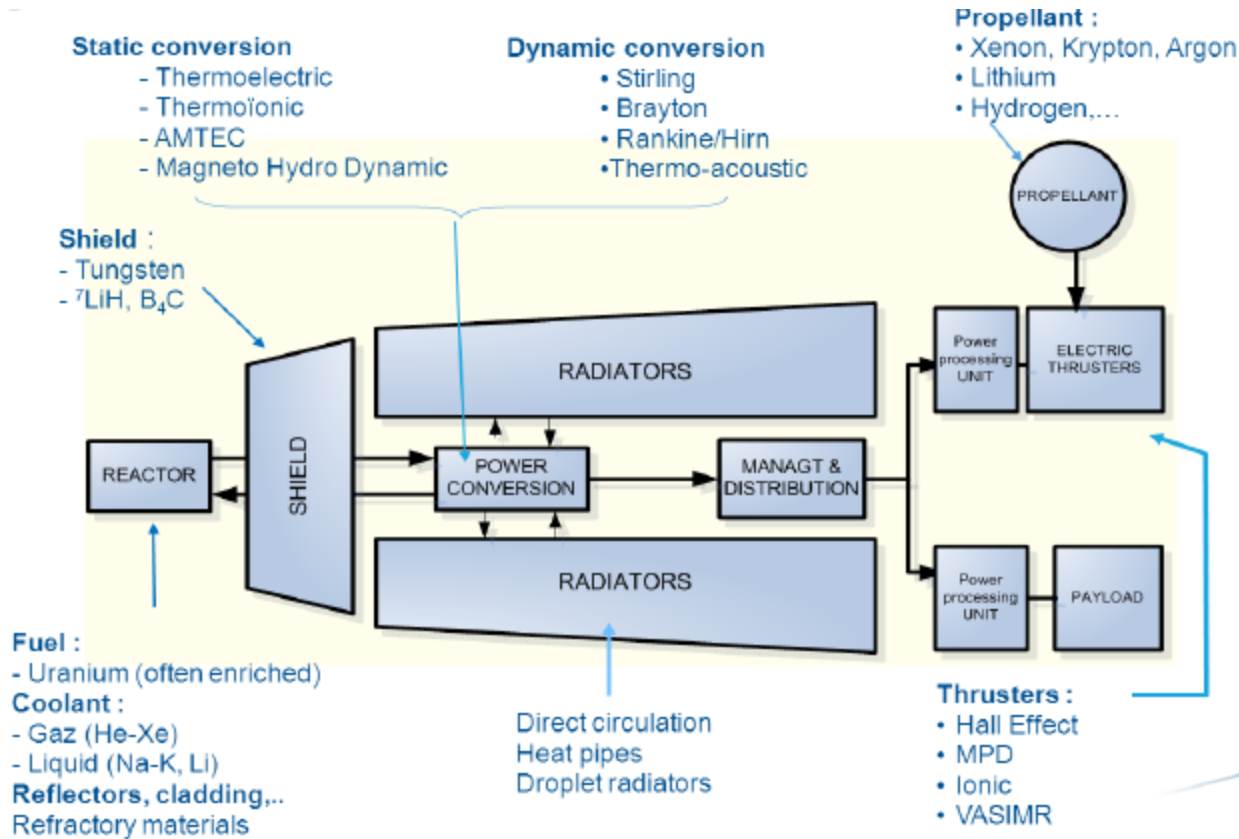
2) European-Russian MEGAHit project: roadmap



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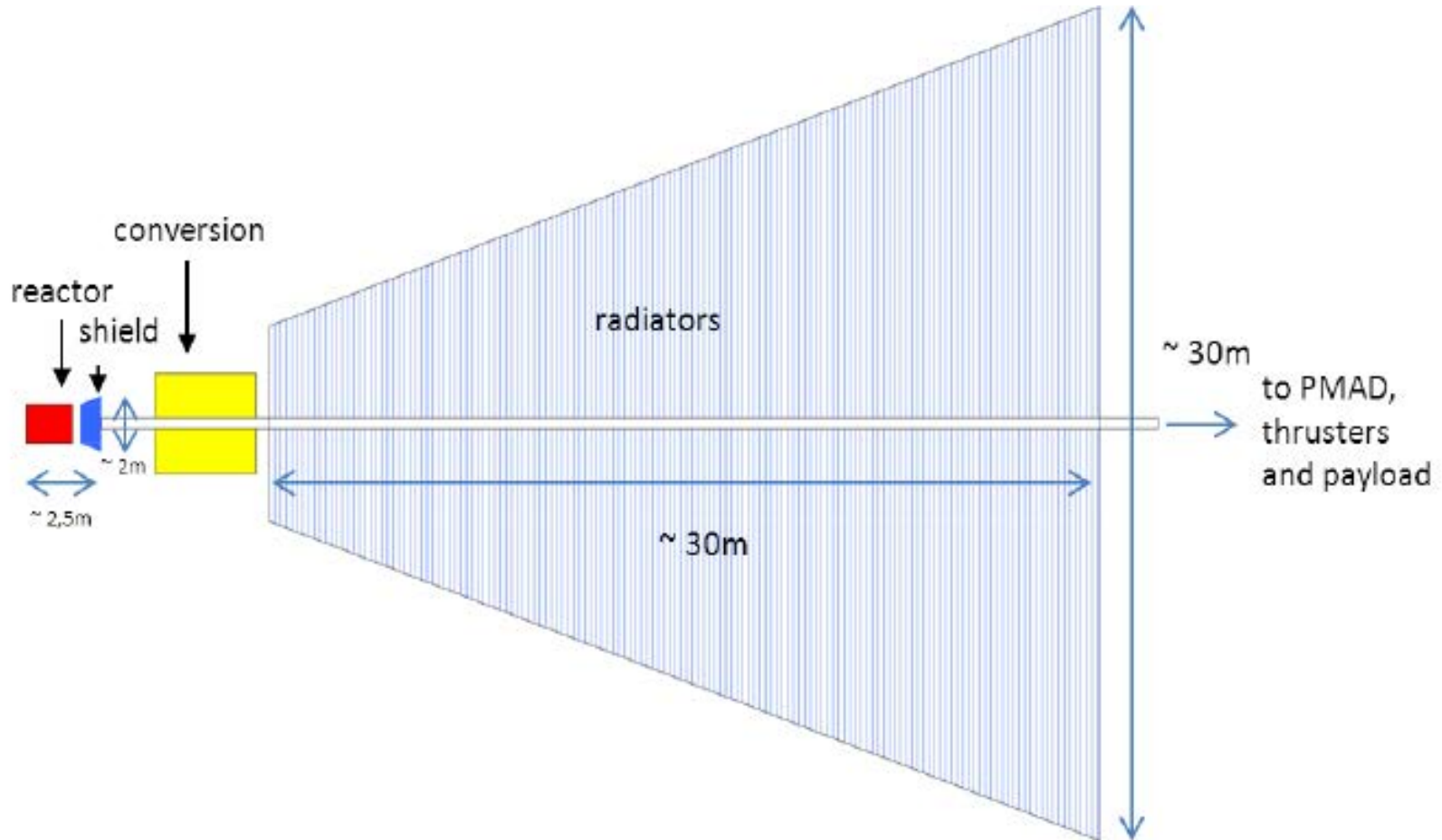
2) European-Russian MEGAHit project: INPPS General Architecture / Subsystems



Successful project realization is a truly global project and comparable with the Apollo and ISS projects.



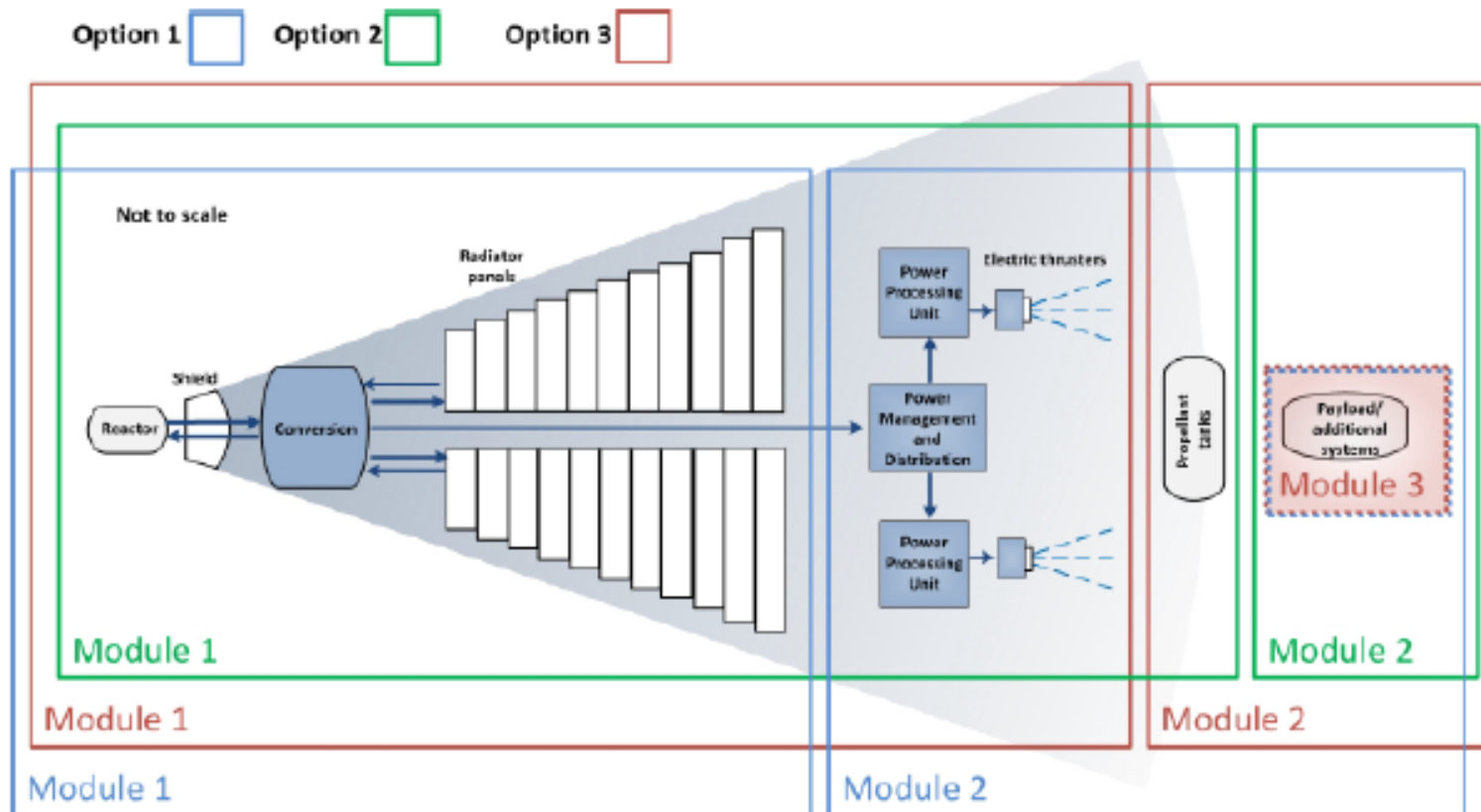
2) European-Russian MEGAHit project: reference



Successful project realization is a truly global project and comparable with the Apollo and ISS projects.



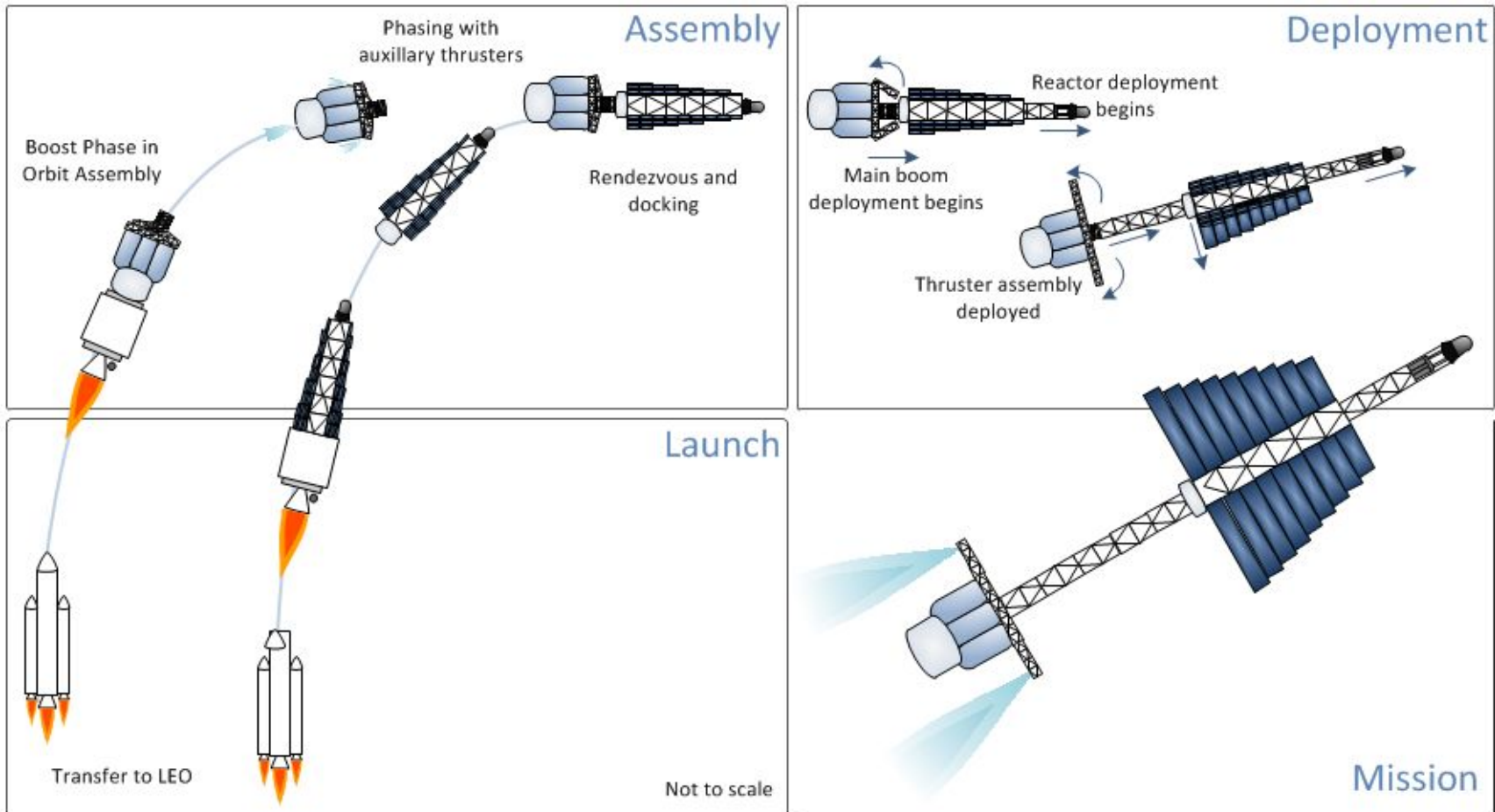
2) European-Russian MEGAHit project: Robotic Autonomous Assembly



Successful project realization is a truly global project and comparable with the Apollo and ISS projects.



2) European-Russian MEGAHit project: mission



Successful project realization is a truly global project and comparable with the Apollo and ISS projects.



3) DEMOCRITOS project

- 2015-2016: EC Horizon 2020 DEMOCRITOS
(**D**emonstrators for **C**onversion, **R**eactor, **R**adiator And **T**hrusters for Electric Propulsion **S**ystems)
- DEMOCRITOS very good content + schedule: DiPoP + MEGAHIT roadmaps + Russian NPPS
- Demonstrator Concepts regarding NEP
 - 1) DEMOCRITOS-GC (Ground Component): a) interaction of the major subsystems (thermal, power management, propulsion, structures and conversion) between each other and with a (simulated) nuclear core providing high power (~100kW) and b) preliminary designs of all INPPS subsystems and ground based test benches
 - 2) DEMOCRITOS-CC (Core Component): concepts of nuclear space reactor, specification of a core demonstrator including analysis of the regulatory and safety framework
 - 3) DEMOCRITOS-SC (Space Component): preliminary design of INPPS, detailed assembly and servicing strategy in orbit



DEMOCRITOS CEF study (DLR Bremen)

- forming a cluster around NEP (invitation to external stakeholders plus workshop + PSA/SRC EPIC)
- propose ideas for ground and flight demonstrator realizations
- expanding international cooperation Europe/Russia + Brazil, other nations - demonstrators realizations





4) Conclusions and Hints

DiPoP: www.DiPoP.eu (documents and roadmap)

MEGAHIT: www.megahit-eu.org (documents, roadmap/recommendations)

In the focus for INPPS demonstrations and realization:

politics (strong guidance),

public,

space industry,

space organisations and related organisations,

space & space facing nations and

ground and hardware tests

INPPS – PROMOTE and TAKE PART!

Successful project realization is a truly global project and comparable with the Apollo and ISS projects.

