

Workshop on Simulation & EGSE for Space
Programmes 2015

SS-E2ES: Mission Performance Simulators for Space Science Missions

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AGENDA

- I. Background and Work Objectives
- II. E2ES Added Value for Space Science
- III. Missions and Instruments' Survey
- IV. Missions and Instruments' Categorisation
- V. Analysis of Commonalities
- VI. Reference Architecture Definition
- VII. Conclusions and Future Work

BACKGROUND AND WORK OBJECTIVES

■ ESA ITT AO7814: E2E MISSION PERFORMANCE SIMULATORS FOR SPACE SCIENCE MISSIONS



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KOM: 01/10/2014

PCR: 16/04/2015

EoP: 30/10/2015

- Categorize past, current and planned ESA SS missions, in terms of mission application, observation requirements and techniques, instruments and products
- Define which science missions can benefit from the E2ES concept
- Define a SS E2ES generic user requirements, RA and building blocks, which could then be used for different payloads and planetary bodies
- Apply the reference architecture to the design of two demo missions
- Evaluate the reference architecture concept and based on this evaluation, make recommendations for future activities

BACKGROUND AND WORK OBJECTIVES

■ Differences between EO/SS missions in E2ES use:

- EO high launch frequency / SS few very specialised missions → different need of reusability
- In EO ESA is responsible for the instrument data processing / in SS the scientific team is → EO: ESA driven practices and standards for harmonisation and reusability / SS: less common standardization and information or models sharing

■ Similarities between EO/SS missions in E2ES use:

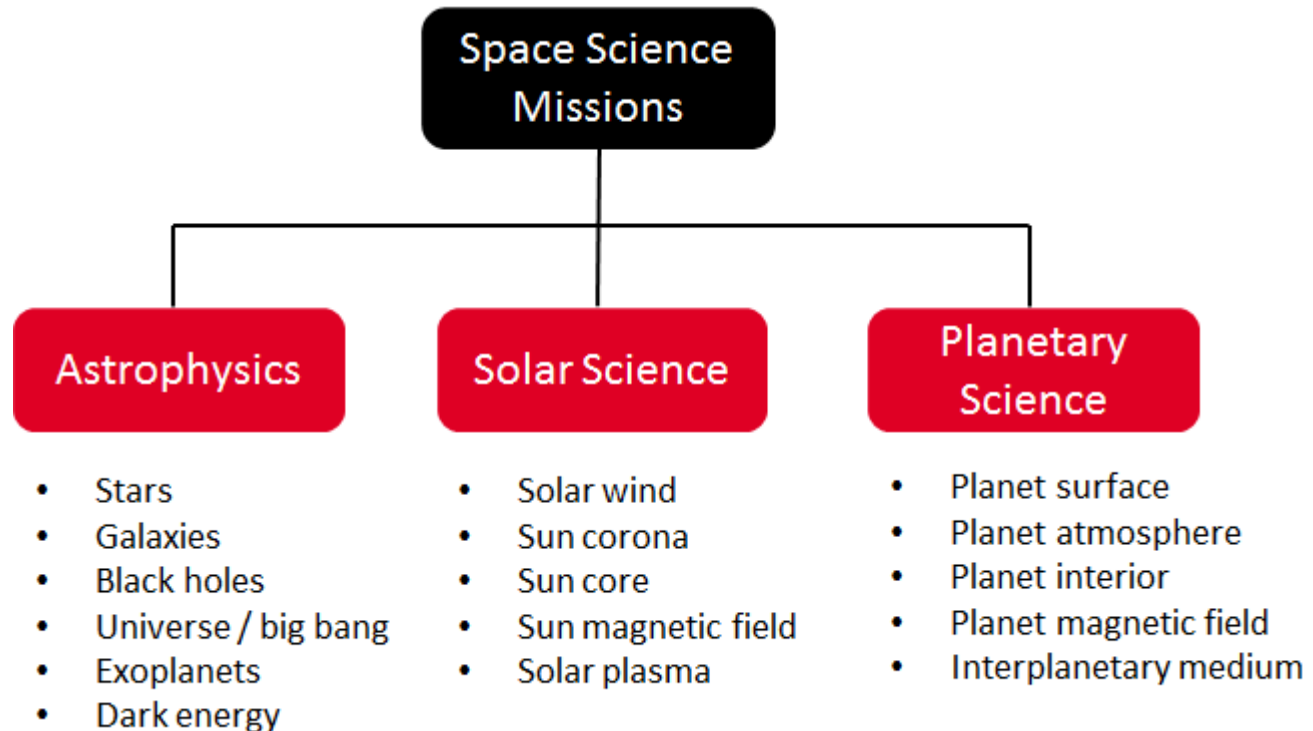
- Use of competition for missions selection (Earth Explorer / Cosmic Vision) → need of mission performances evaluation at early design phase

■ E2ES Added Value for Space Science:

- Mission performances evaluation at early design phase, when mission plan could be unclear and little funding is available
- Reusability of the simulator modules and RA to face early design phase difficulties

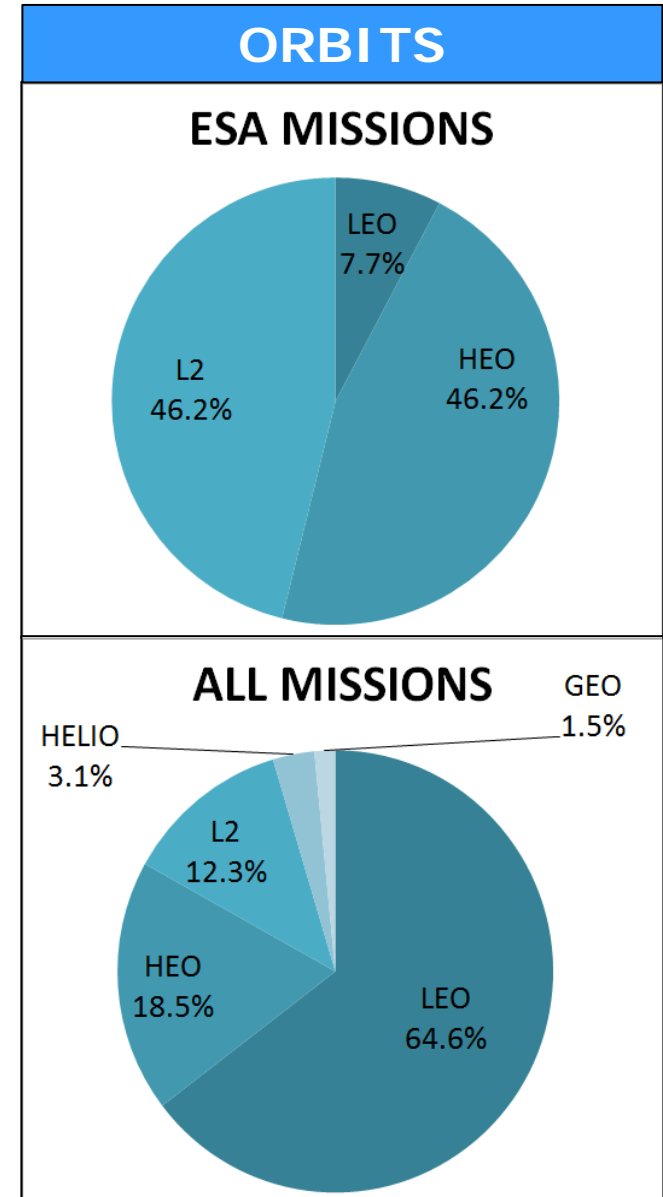
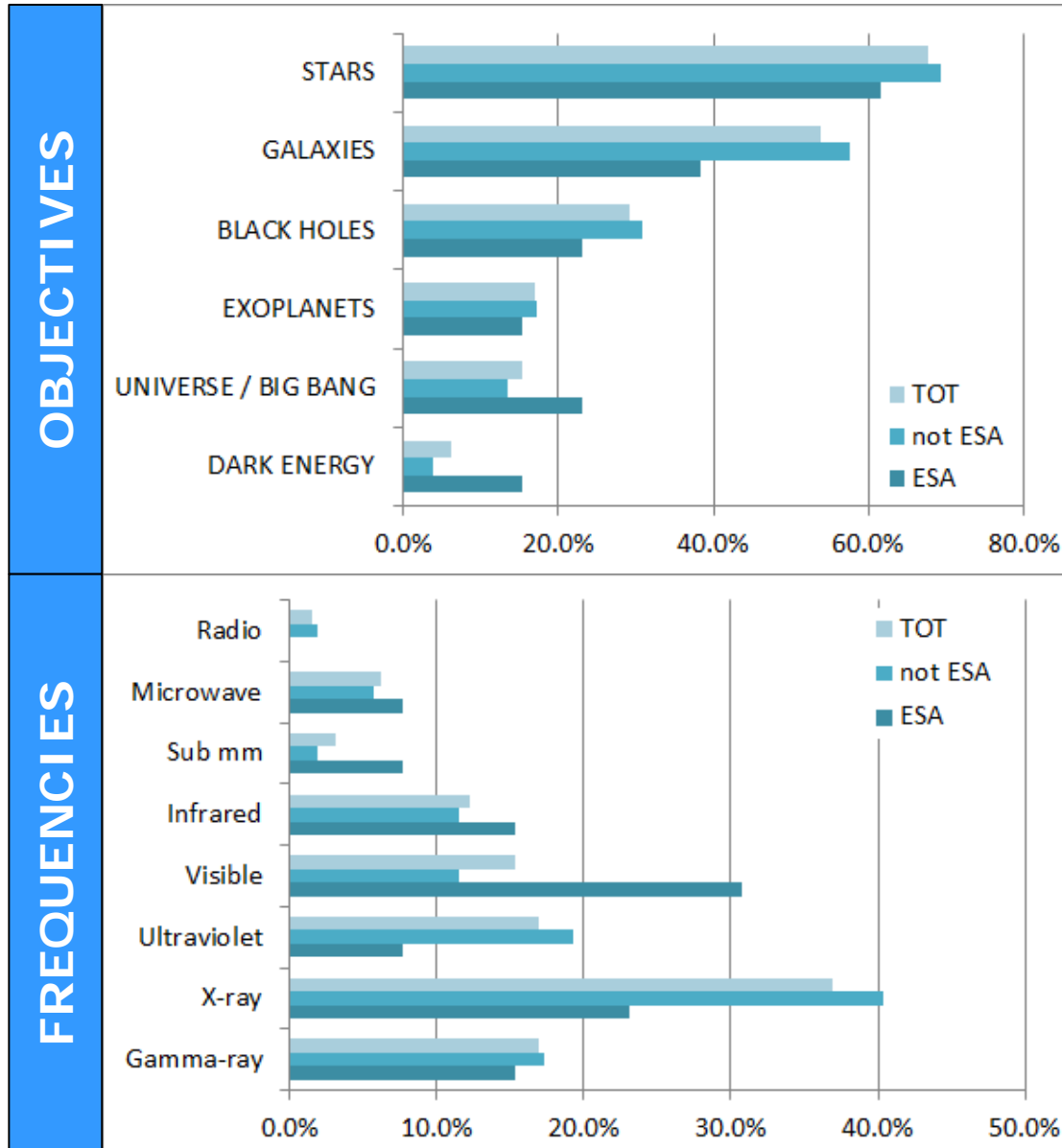
MISSIONS' AND INSTRUMENTS' SURVEY

FIRST APPROACH: survey through historical classification per objectives



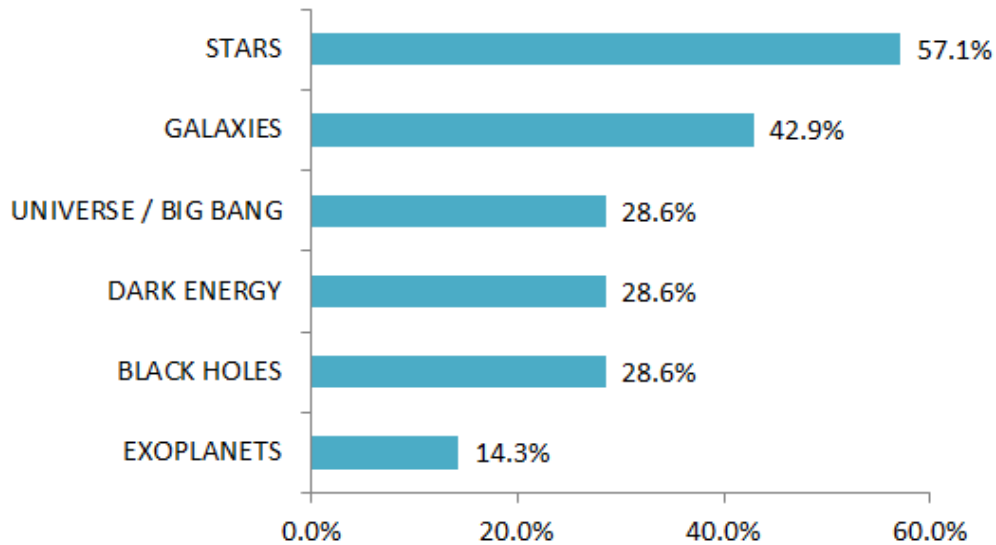
GLOBAL LIST	65 missions	33 missions	-
SHORT LIST	7 ESA missions	15 missions	25 missions

ASTROPHYSICS SURVEY: ALL MISSIONS

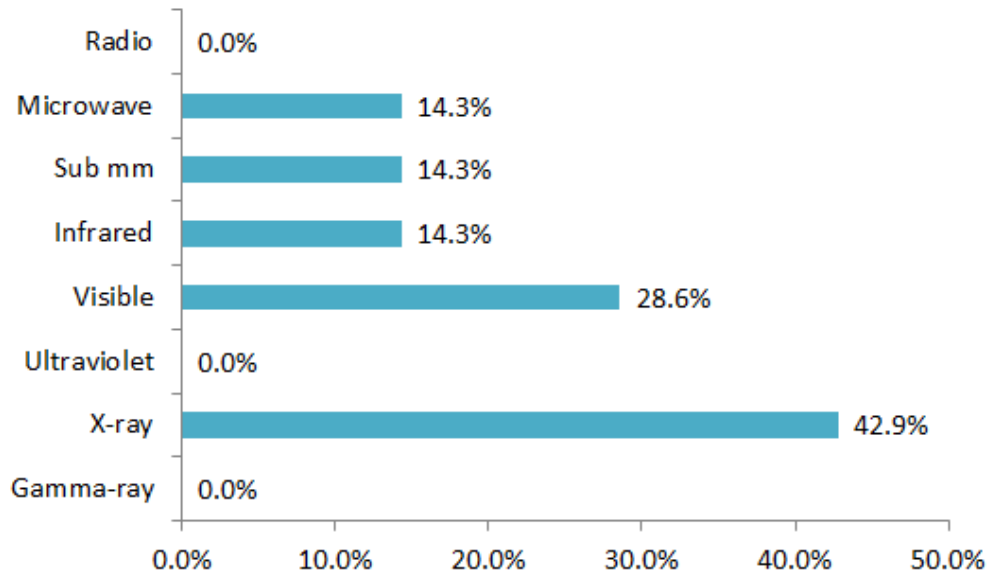


ASTROPHYSICS SURVEY: SHORT LIST (1)

OBJECTIVES

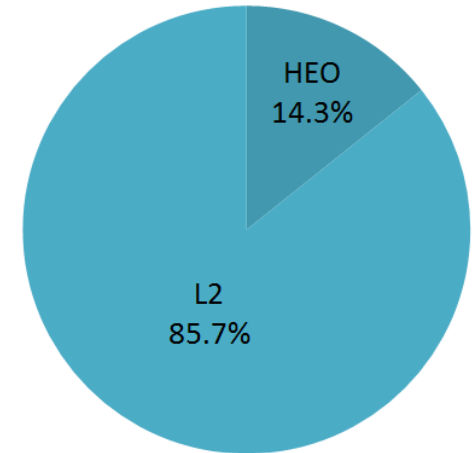


FREQUENCIES



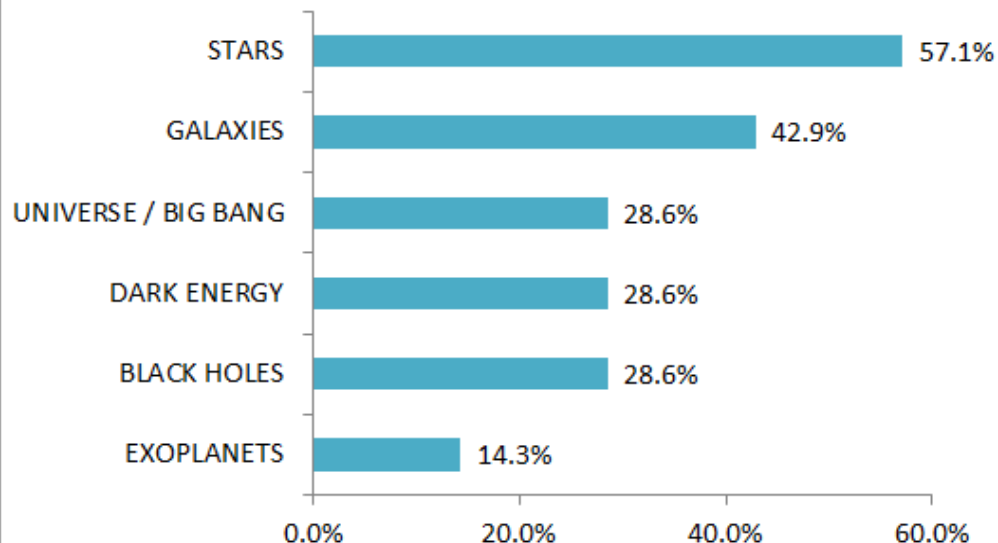
ORBITS

ESA MISSIONS

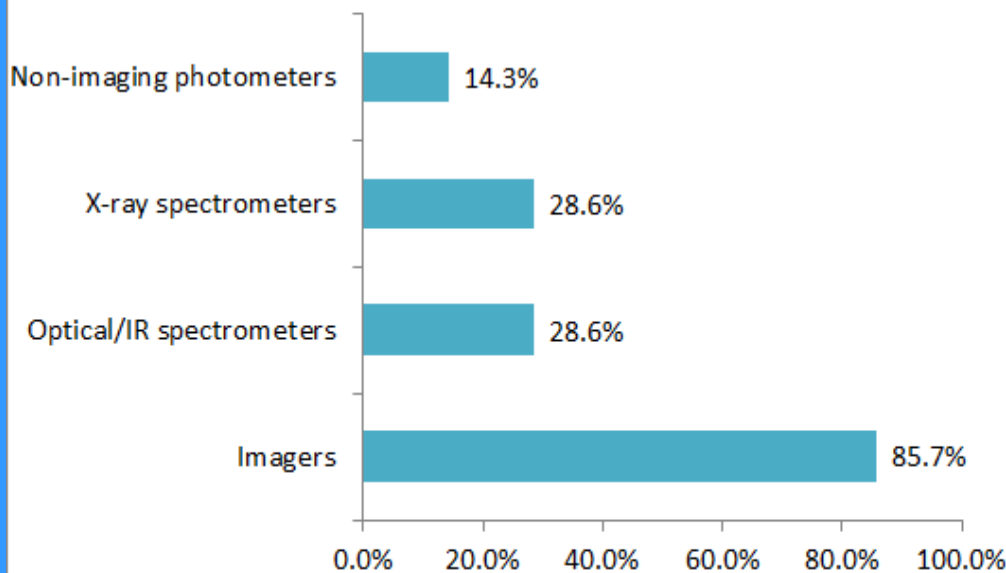


ASTROPHYSICS SURVEY: SHORT LIST(2)

OBJECTIVES

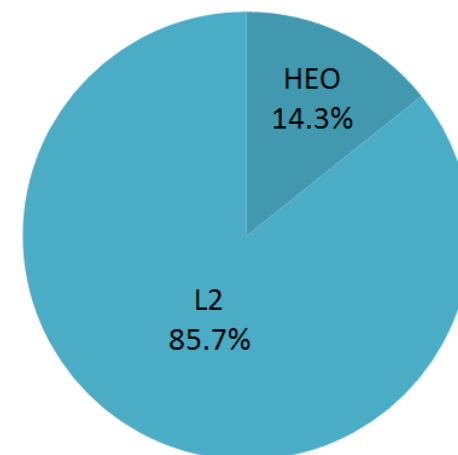


ACQUISITION

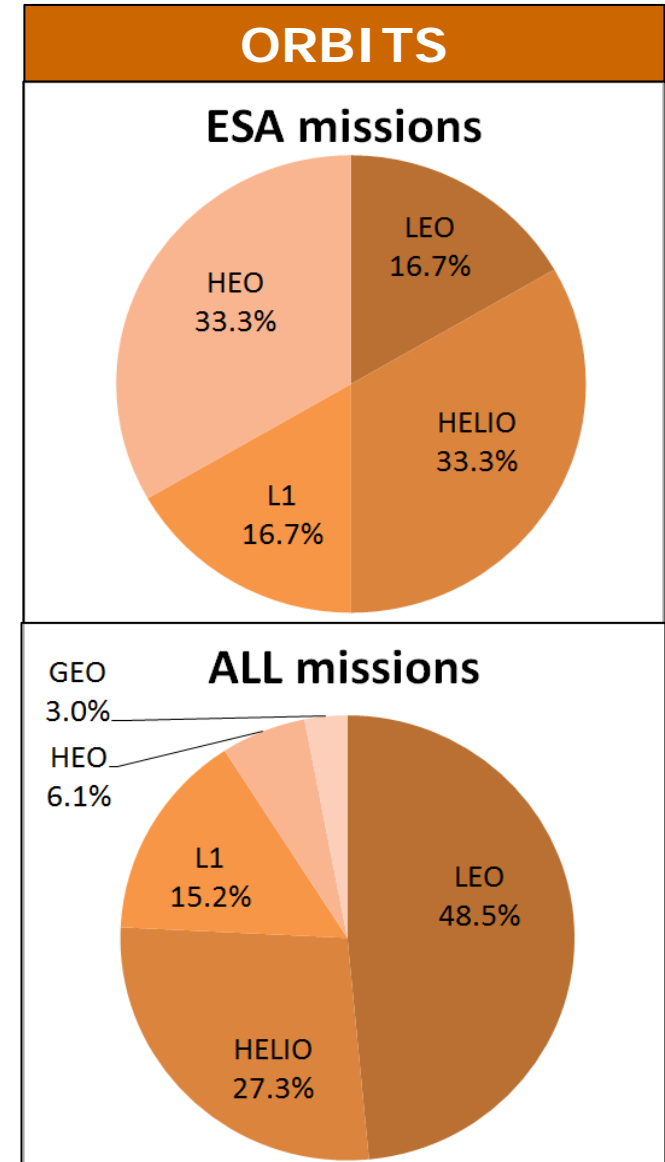
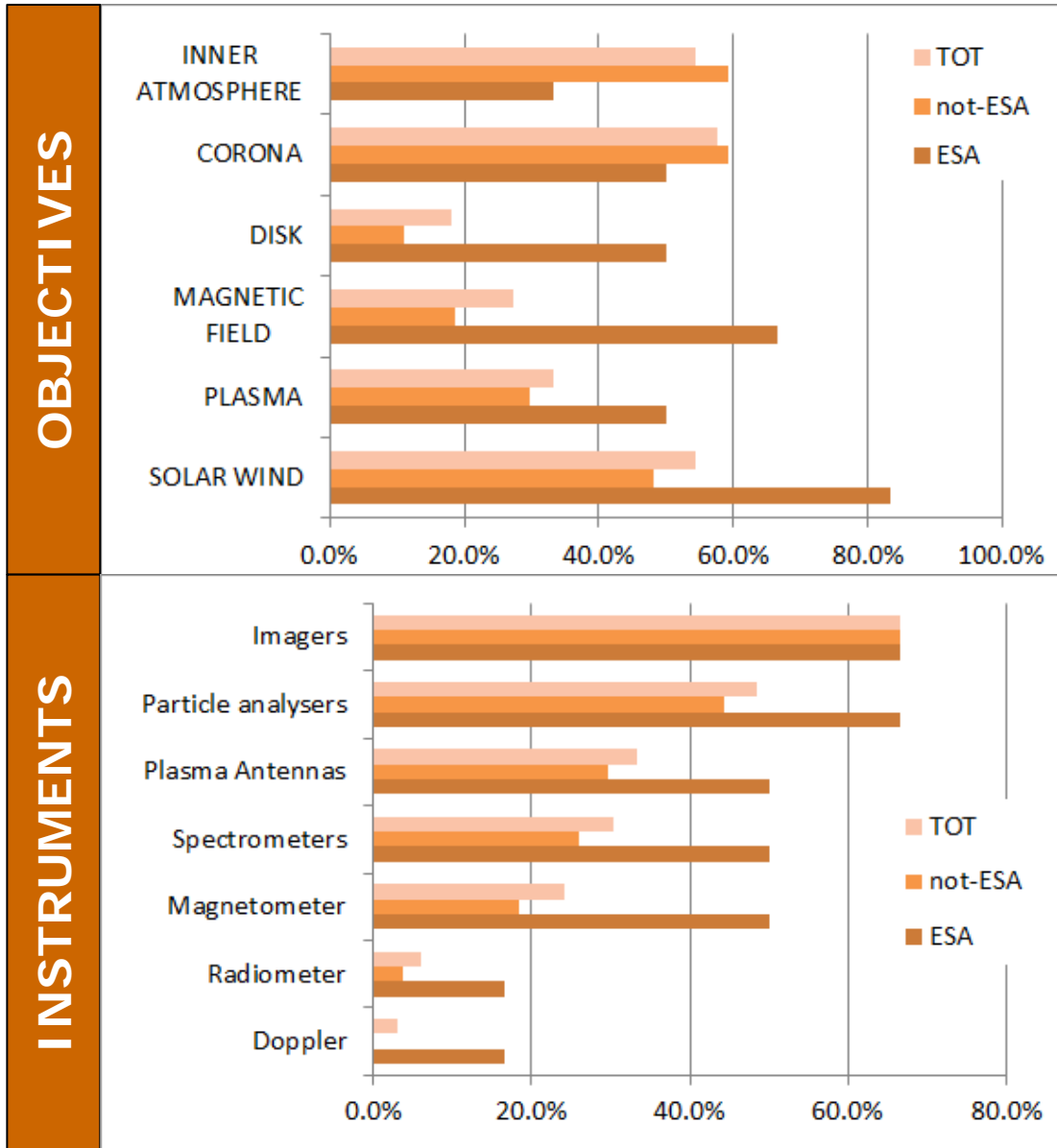


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ESA MISSIONS

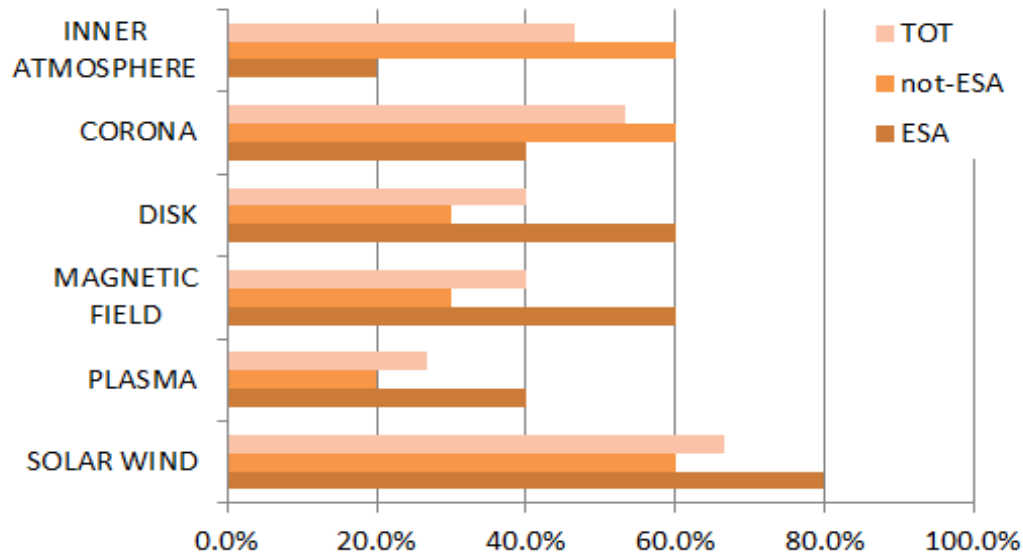


SOLAR SCIENCE SURVEY: ALL MISSIONS

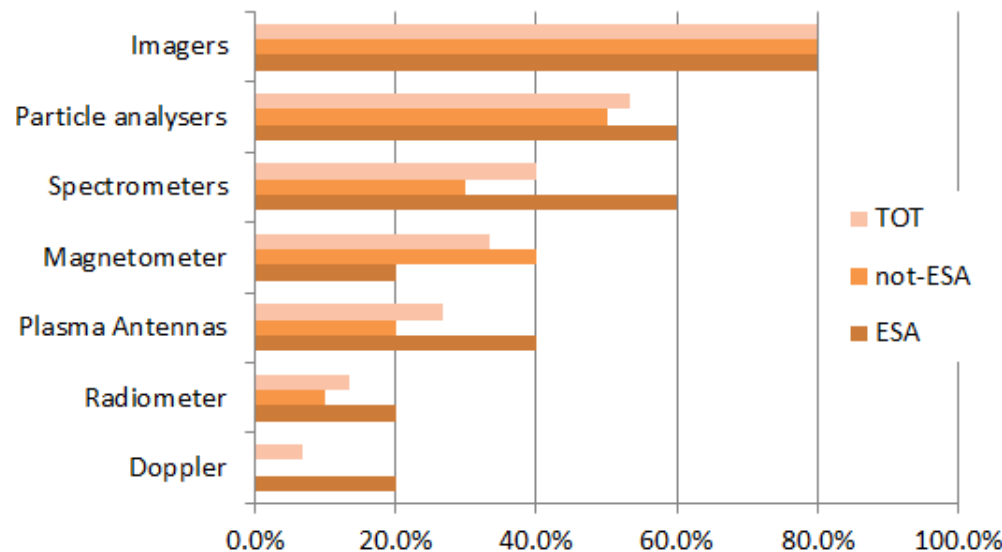


SOLAR SCIENCE: SHORT LIST

OBJECTIVES

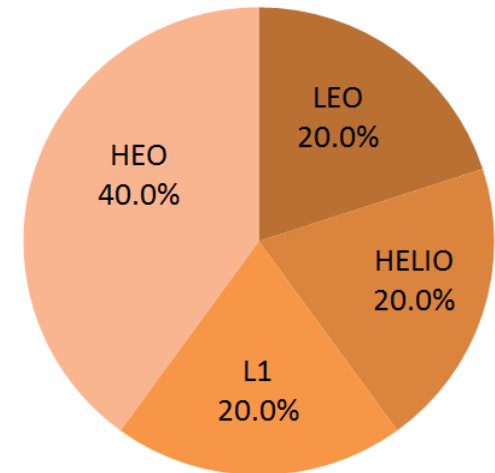


INSTRUMENTS

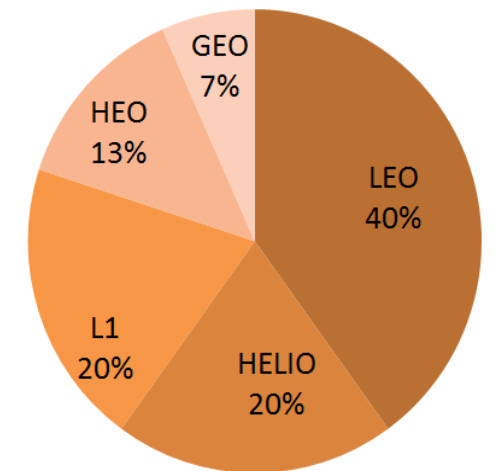


ORBITS

ESA missions

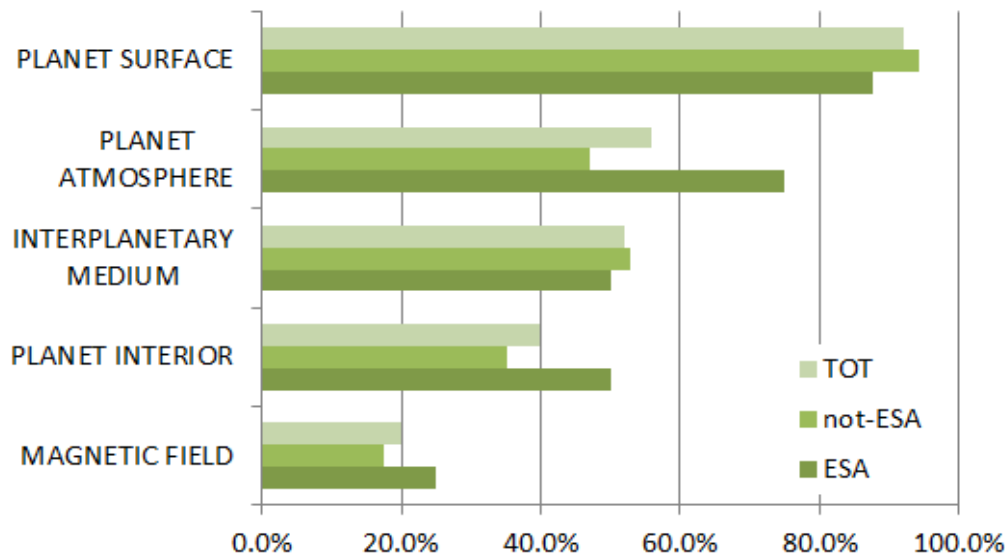


ALL missions

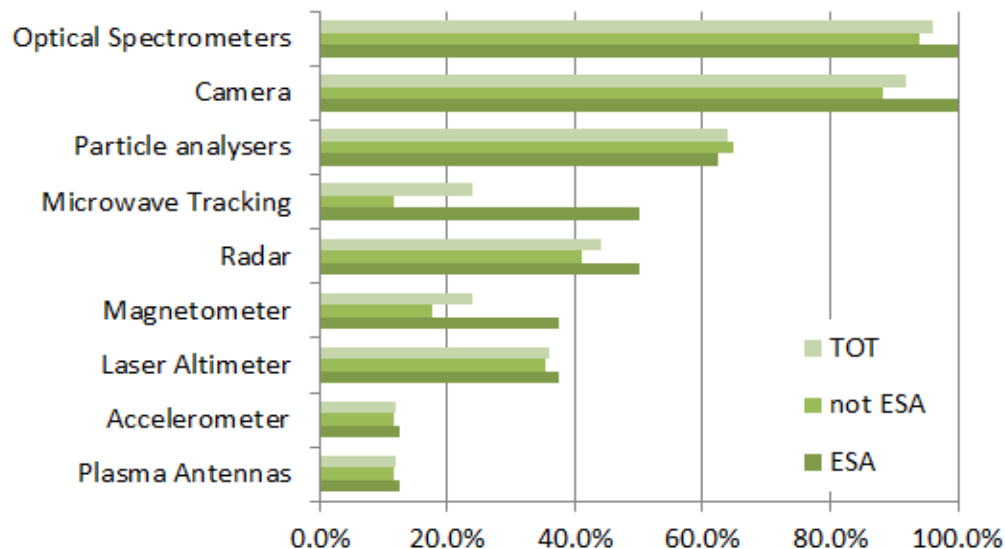


PLANETARY SCIENCE MISSIONS SURVEY

OBJECTIVES

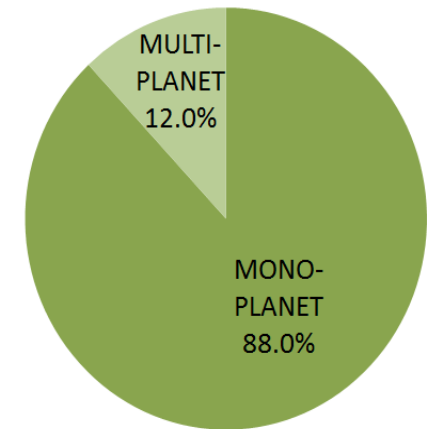


INSTRUMENTS



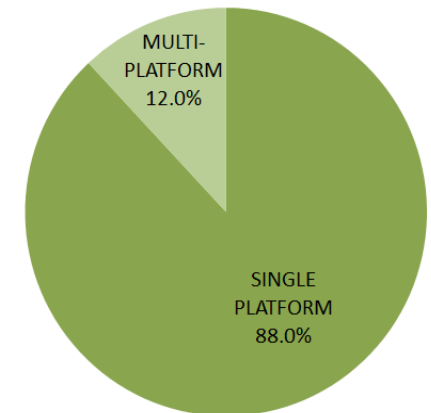
ORBITS

ALL missions

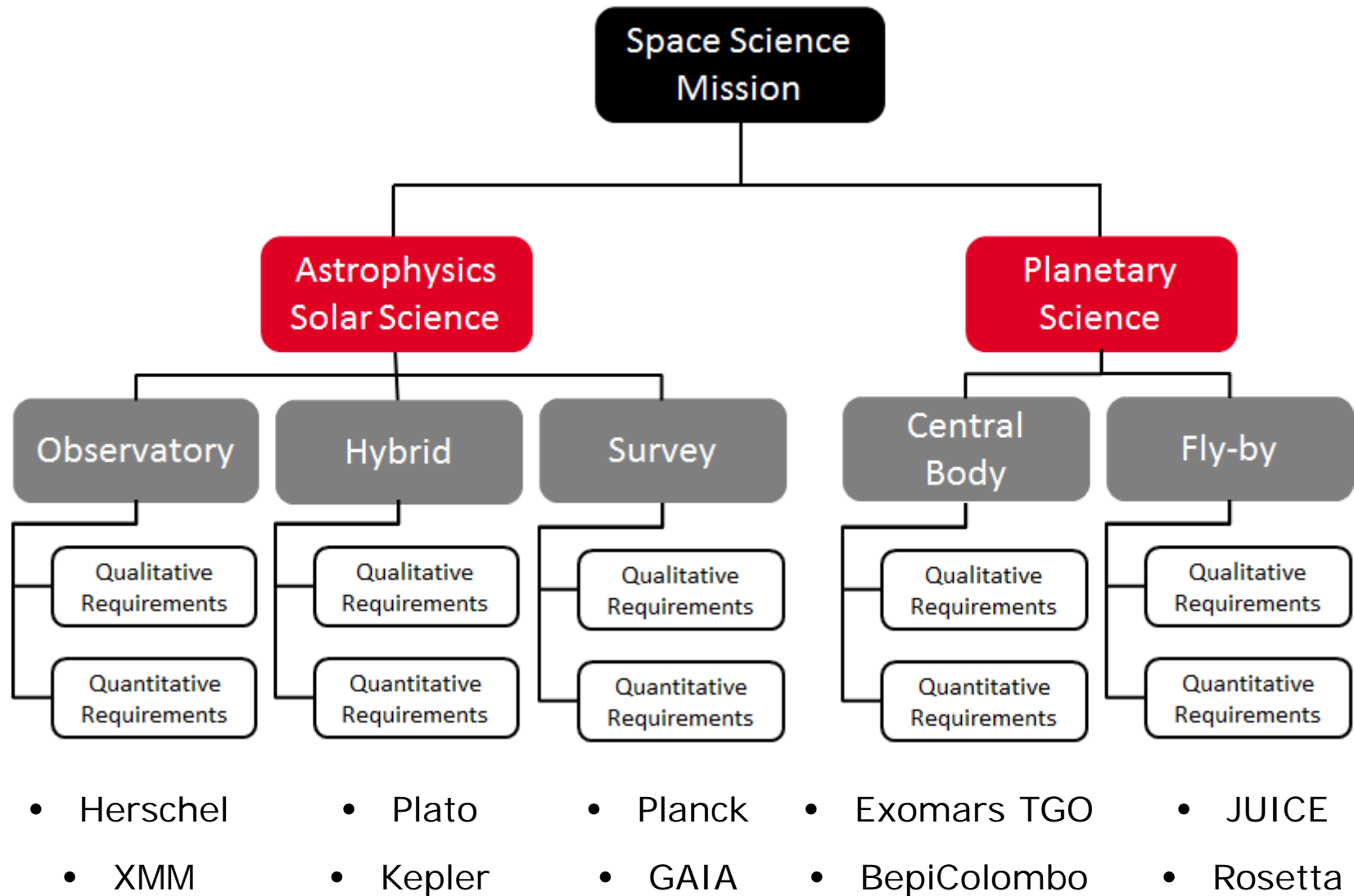


PLATFORMS

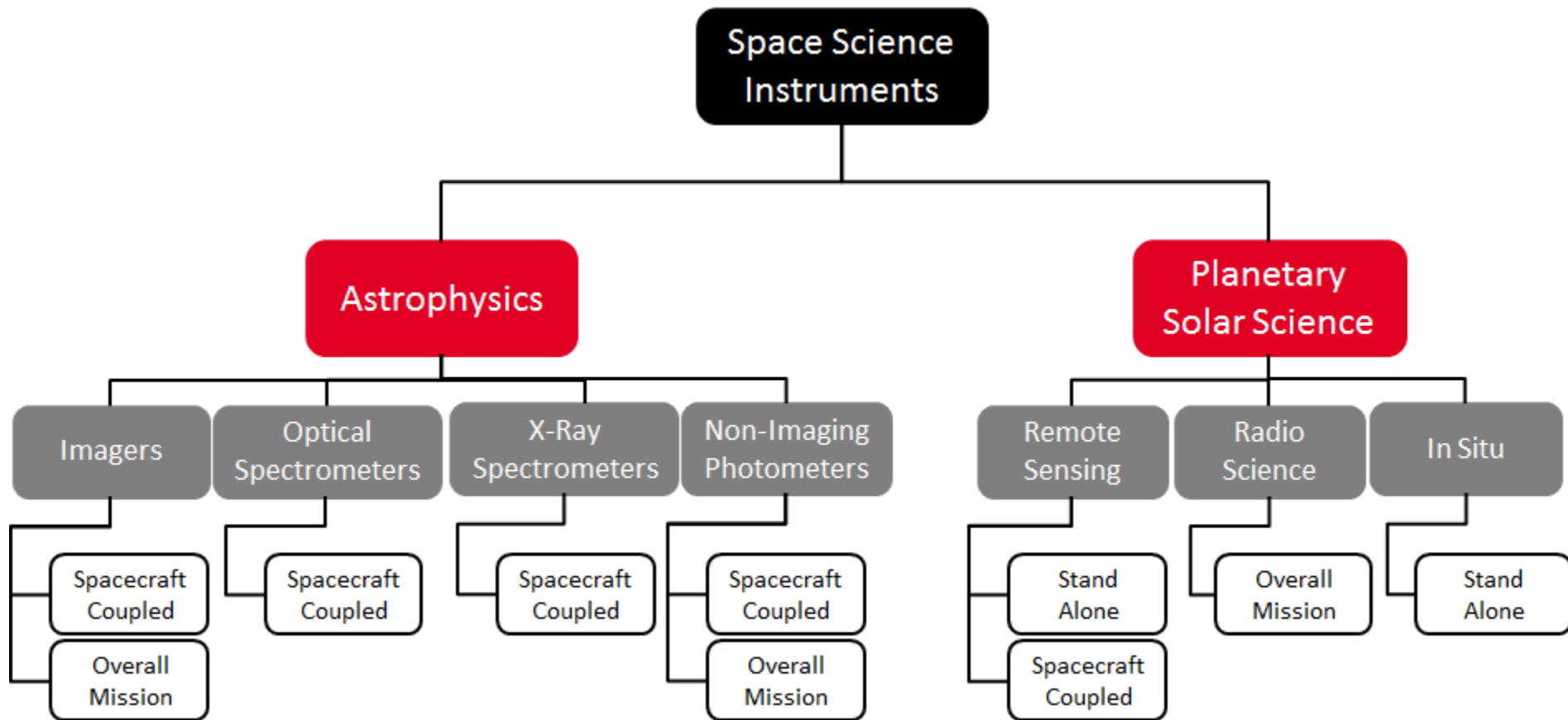
ALL missions



MISSIONS' CATEGORISATION



INSTRUMENTS' CATEGORISATION



ANALYSIS OF COMMONALITIES

**Wide variety
of targets**



Critical task

- missions belonging to different classes
- instruments belonging to different missions' classes
- missions from the same class
- instruments from the same mission class

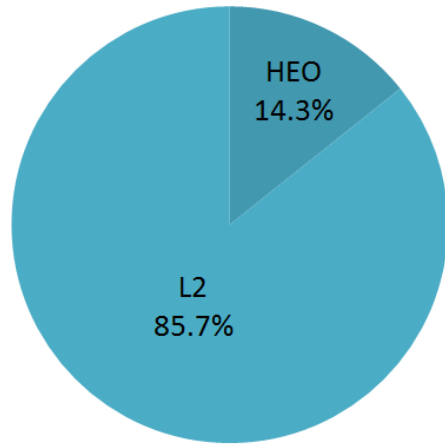


**Analysis
by module**

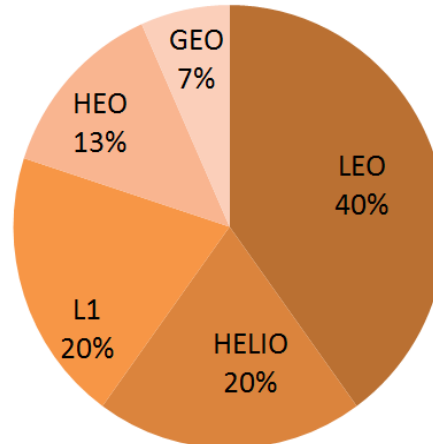
- ☐ Orbit simulation
- ☐ Attitude simulation
- ☐ Scene generation
- ☐ Instrument simulation
- ☐ Data Processing
- ☐ Performance evaluation
- ☐ Survey strategy

I.E. ORBIT SIMULATION COMMONALITIES

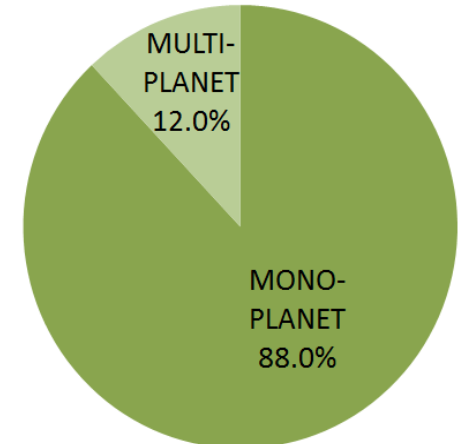
ESA MISSIONS

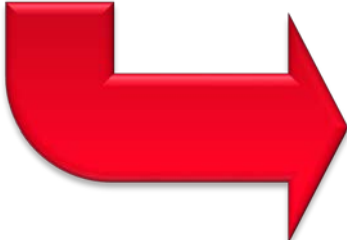


ALL missions




ALL missions



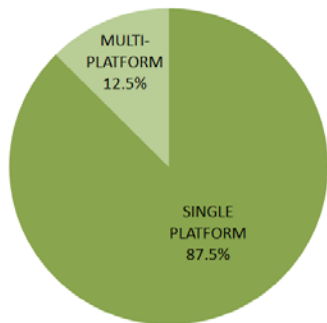
- 
- Geo centric orbit
 - Lagrangian orbits
 - Solar System Bodies

As ARCHEO

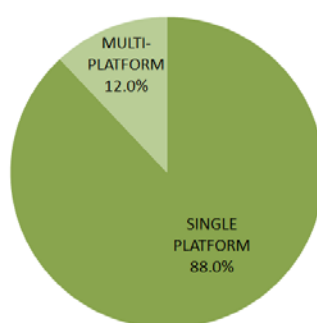
Geometric (TBC)

- 
- Ephemeris
 - Gravitational models
 - Rotational parameters
 - Perturbations

ESA missions



ALL missions



ANALYSIS OF COMMONALITIES

POSSIBLE COMMONALITIES WITHIN MISSIONS OF THE SAME CATEGORY		GEOMETRY - PROPAGATION	GEOMETRY - ATTITUDE	SCENE GENERATOR	INSTRUMENT	DATA PROCESSING	PERFORMANCE EVALUATION	SURVEY STRATEGY
ASTROPHYSICS SOLAR SCIENCE	Observatory	Y	Y	N	P	N	Y	P
	Survey	Y	N	P	N	P	N	Y
	Hybrid	Y	Y	N	N	N	N	N
PLANETARY SCIENCE	Central Body	Y	Y	P	P	P	P	Y
	Fly-by	P	Y	P	P	P	P	N

■ E2ES Added Value for space science:

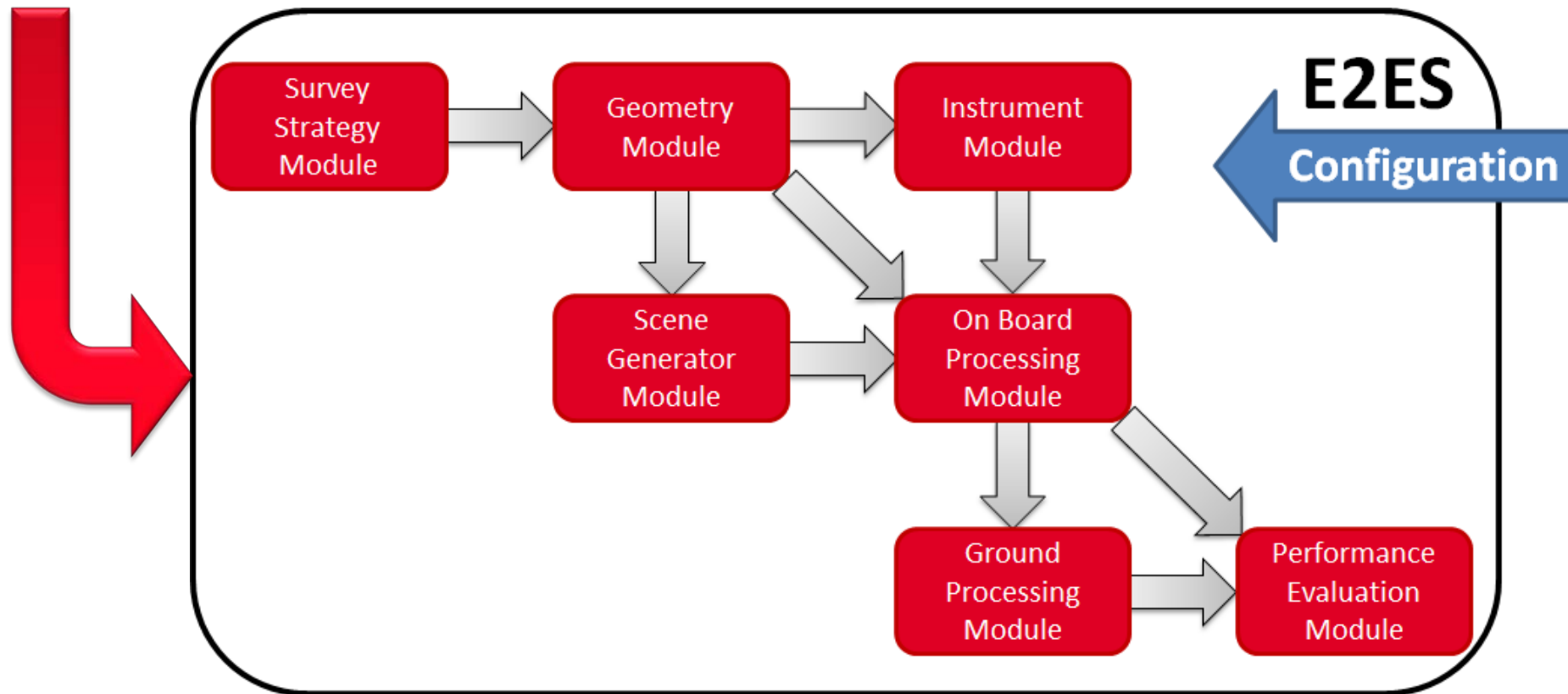
- Mission performances evaluation at early design phase
- Margin for modules reusability demonstrated

■ Remarks:

- Global application for all mission is impossible: dedicated analysis needed
- E2ES for SS has necessarily to include skilled scientific teams

REFERENCE ARCHITECTURE

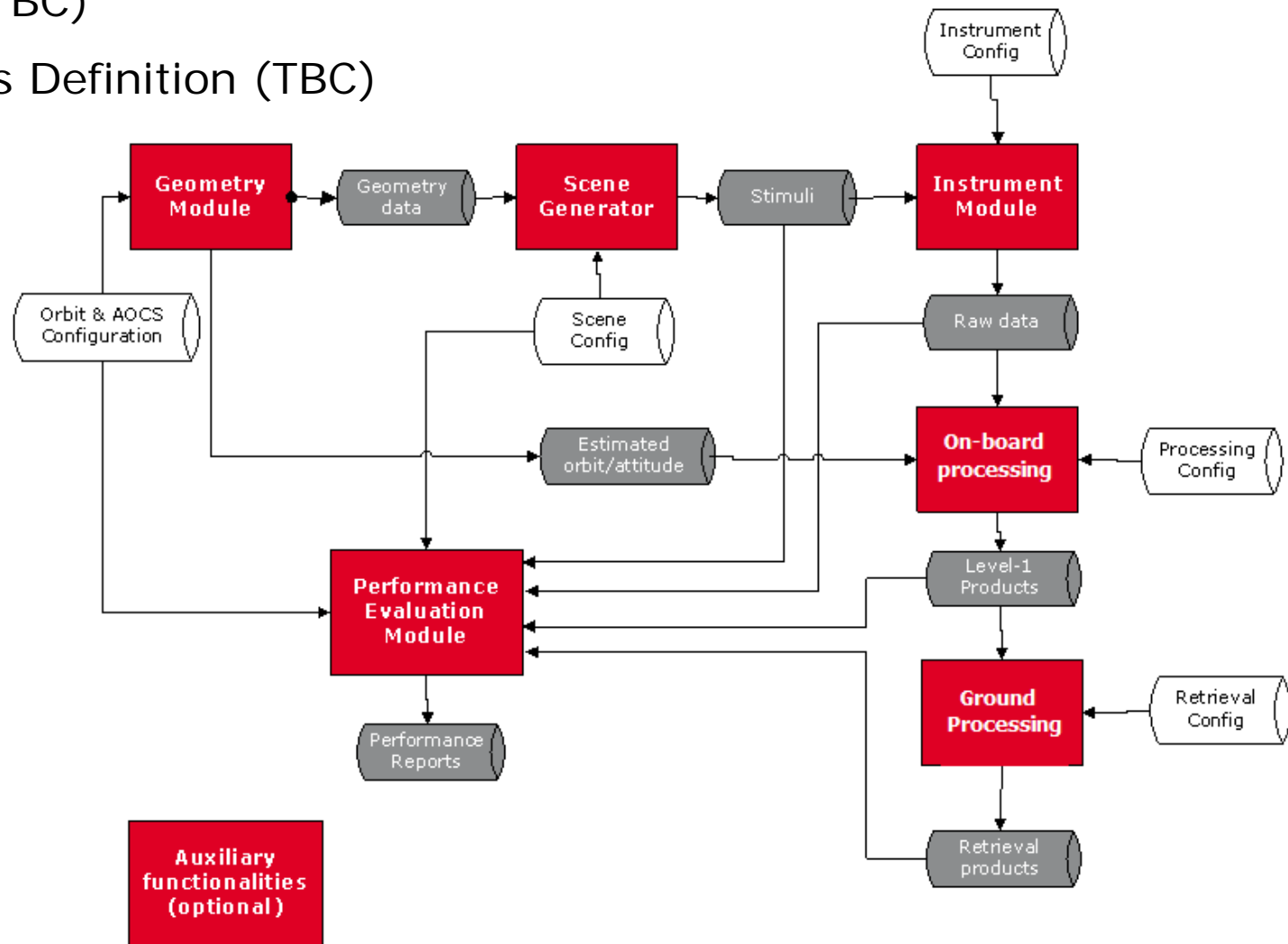
- ARCHEO project heritage
- Survey and Categorization
- Commonalities analysis
- Team expertise



REFERENCE ARCHITECTURE

Generic RA diagram

- Specific RAs (TBC)
- Building Blocks Definition (TBC)



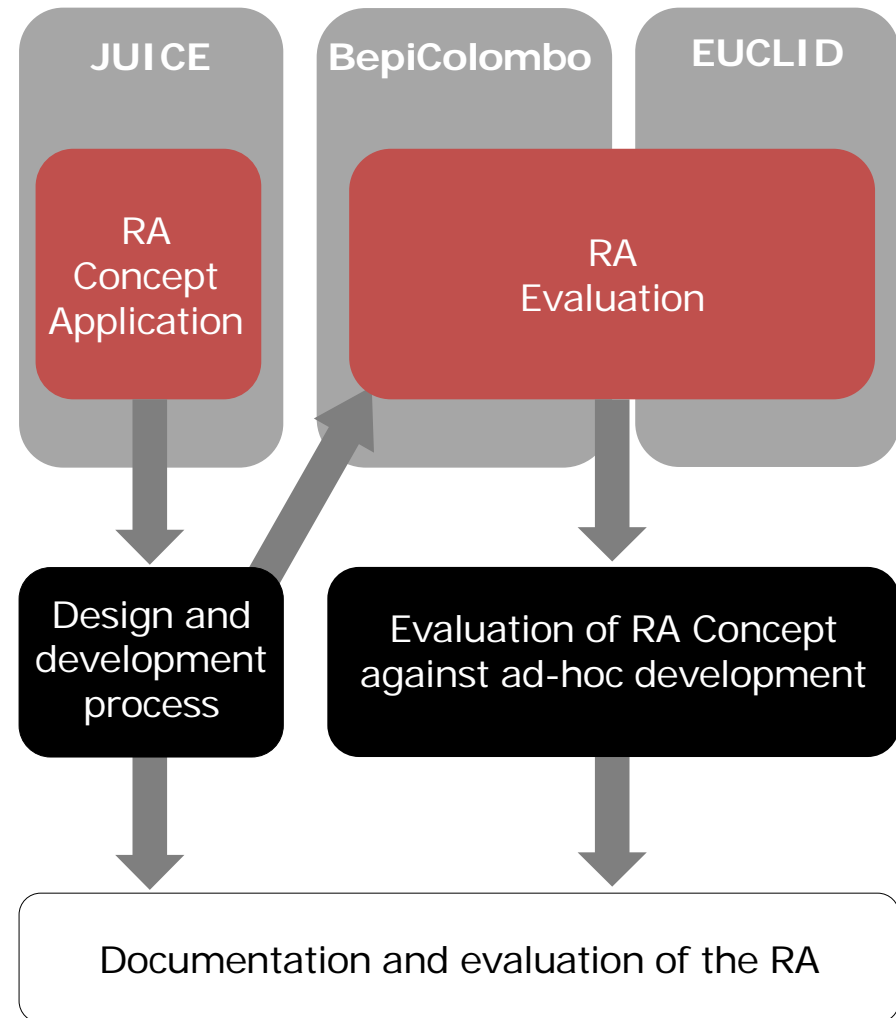
NEXT STEPS: RA EVALUATION THROUGH MISSION APPLICATION + ROADMAP

■ RA EVALUATION

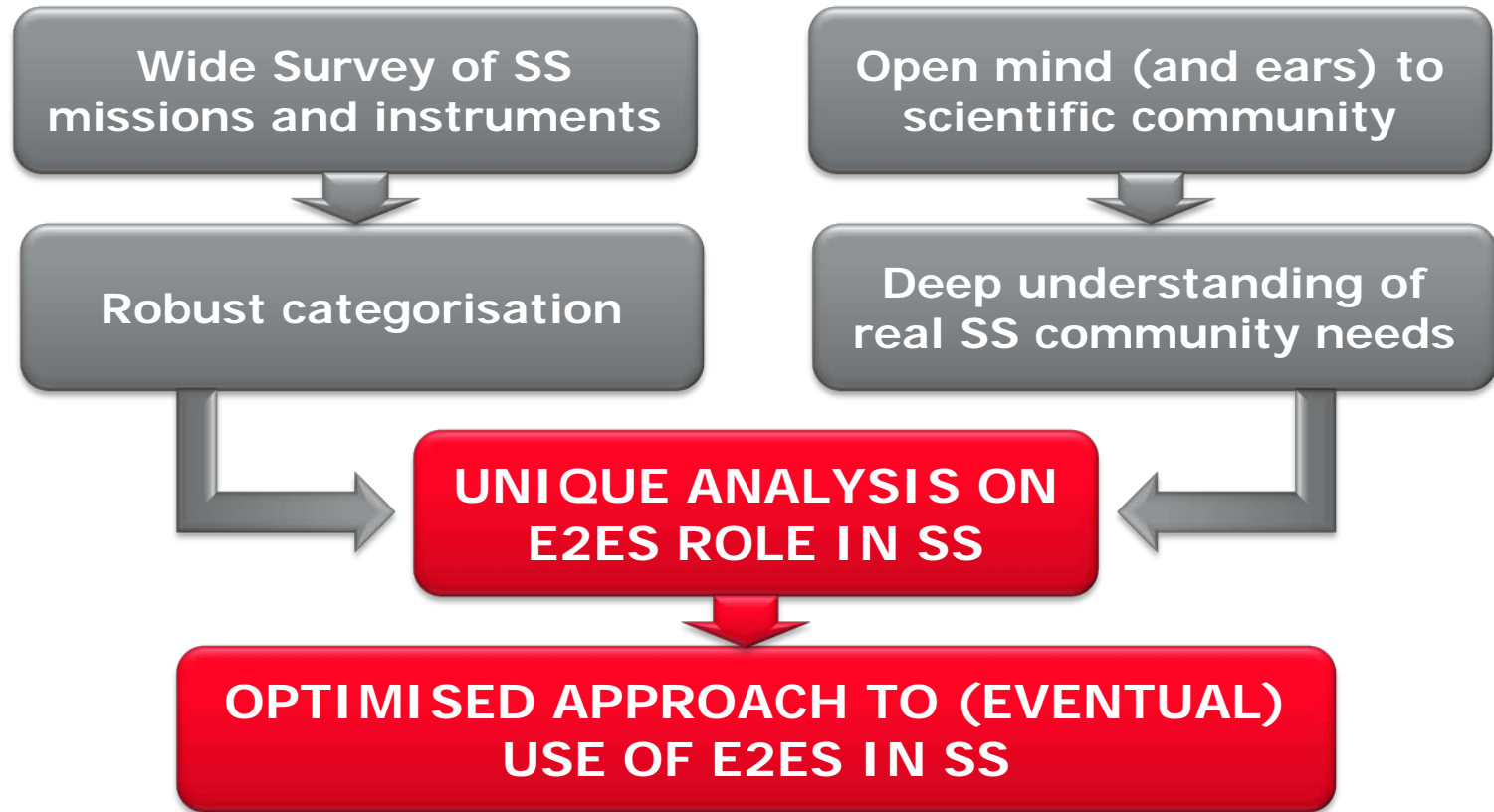
- Evaluation criteria definition
- Simulator design analysis through RA application. Case study: **JUICE**.
- Evaluate proposed RA compared to ad-hoc development. Case studies: **BepiColombo** and **EUCLID**.

■ ROADMAP

- Reach operation E2E Reference Architecture
 - Roadmap for development of future E2ES for science missions
 - Roadmap for building up a repository of building blocks



CONCLUSIONS AND FUTURE WORK



■ FUTURE ACTIVITIES

- Reference Architecture definition completion
- Building Block definition completion
- Proposed Reference Architecture evaluation
- Roadmap definition



Thank you

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