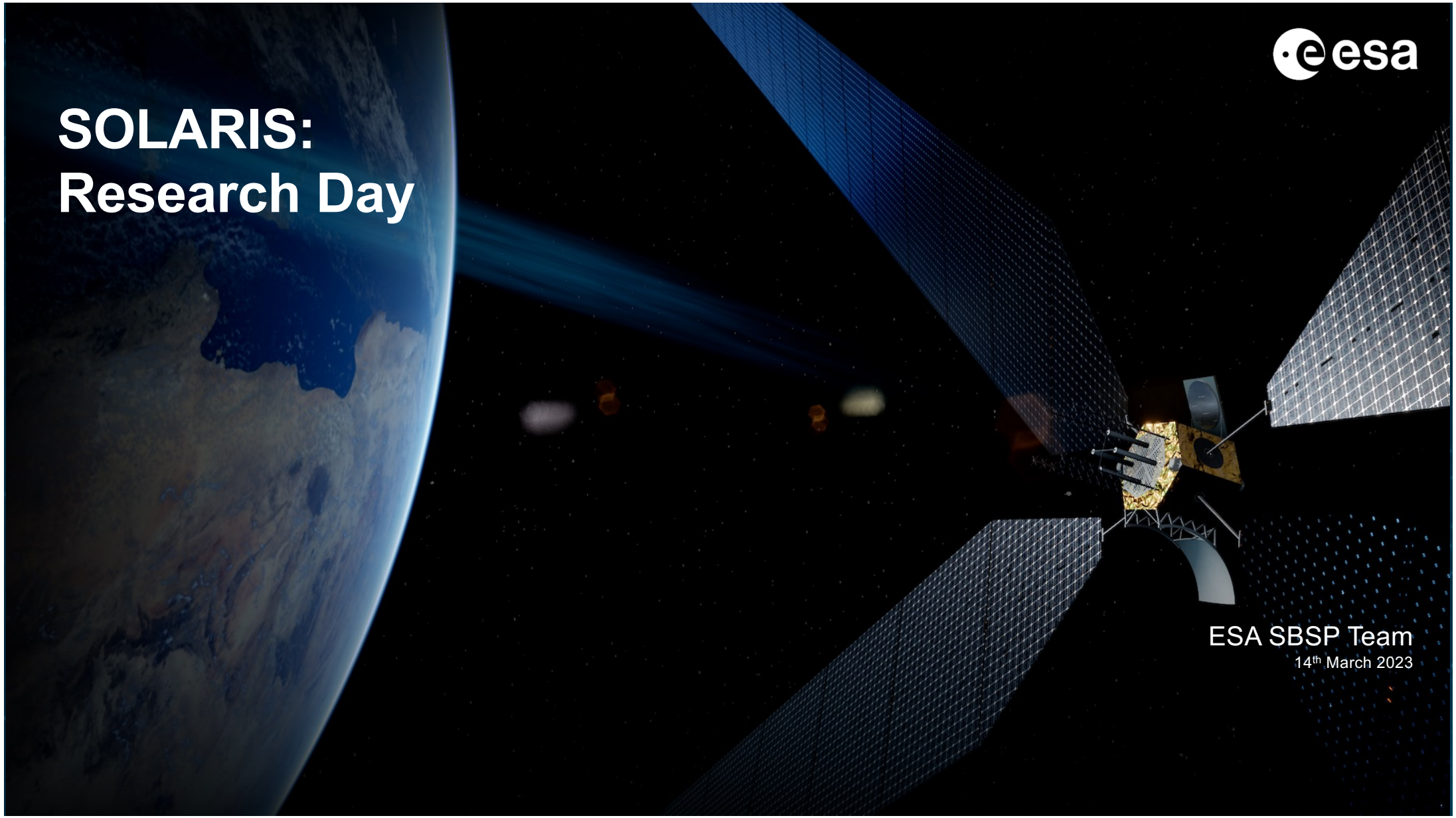

SOLARIS:
Research Day
esa
ESA SBSP Team
14th March 2023

SOLARIS RFI Objective & Research Day

1. Provide the international research community with further information on ESA's priorities with regards to SBSP research in the areas of environmental and socioeconomic effects of SBSP

- Solaris Research Activities RFI – issued Jan 2023

2. Solicit feedback from the international research community about the Solaris research plan, which will be considered in ESA's future planning for such activities.

- Overview and feedback on RFI – Aidan Cowley (ESA)

Key Research Areas

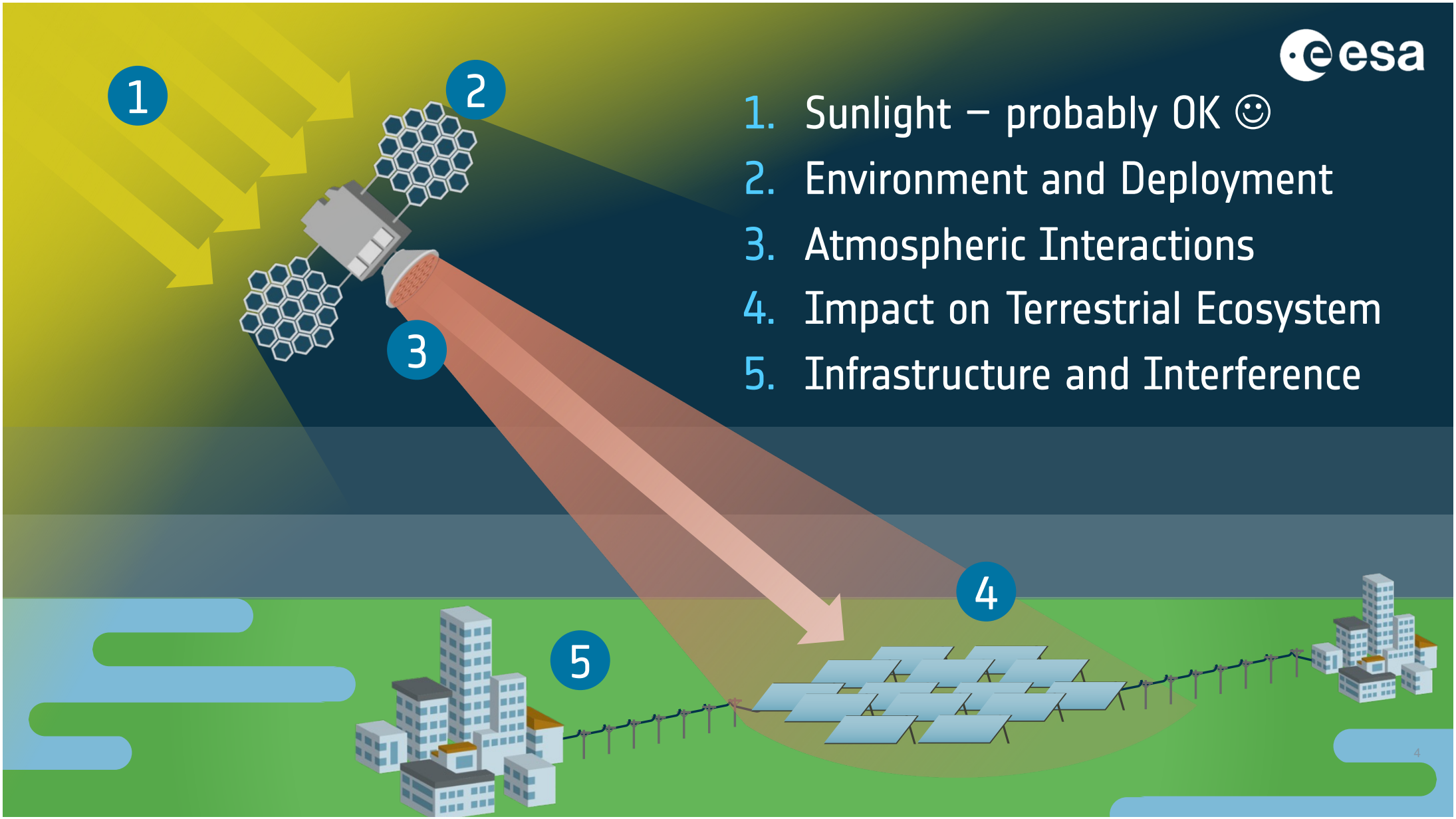
Human Health
Assessing risks to human life health

Environment
Assessing risks to flora and fauna in rectenna vicinity

Technology & Infrastructure
Understanding potential impact of beam interference on aviation, and ground infrastructure

Launch / Deployment
Understanding environmental impact and embodied carbon of deployment

Ionosphere & Atmosphere
Understanding beam interactions with ionosphere and impacts on atmosphere / weather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1. Sunlight – probably OK ☺
2. Environment and Deployment
3. Atmospheric Interactions
4. Impact on Terrestrial Ecosystem
5. Infrastructure and Interference

Infrastructure and Interference (1/2)

- **Radiofrequency interference risk assessment and mitigation for SBSP systems: Part 1** (no response) [100k Euro]
- Identify technology at risk of interference from SBSP and define relevant assumptions/boundary conditions
- Assess impact of SBSP RF parameter variations on interference likelihood/severity
- Define a risk matrix for SBSP interference with other technology, considering variations in system architecture
- Propose solutions to minimize risk of impact on other technology

- **Radiofrequency (or other frequency) interference risk assessment and mitigation for SBSP systems: Part 2** (input received) [300k Euro]
- Study typical signals used in SBSP and potential interferences with wireless transceivers in close frequency bands.
- Investigate interference in different frequency bands, including the impact on nonlinear jamming of LNA's and potential objects in the line of sight across different atmospheric layers
- Develop mitigation proposals for electromagnetic interference

Infrastructure and Interference (2/2)

- **Susceptibility of SBSP systems to external interference and identification of mechanisms for improved resilience** (input received) [200k Euro]

- Initial wording of our RFI focused on RF interference, but a larger scope of susceptibility was suggested
- Key technical and security concerns should be addressed at an early stage
- Security and IT aspects were highlighted as potential risk factors
- Impacts of other satellites operations and inclement space weather were highlighted as factors impacting resilience

Deployment and Environment

- **Environmental impact assessment of SBSP deployment** (input received) [300k Euro]

- Although CO2e is crucial to measure, solely focusing on it may overlook other significant impacts
- This approach may result in accusations of 'carbon tunnel vision' or 'greenwash.'
- Recommended to broaden the scope to include an environmental footprint analysis
- The analysis should go beyond the life cycle carbon impact and consider other environmental impacts as well
- Little information known on high cadence launch by-products within the atmosphere

Human Health

- **Review of human exposure data and assessment of risk factors applicable to varying beam characteristics** (no response) [100k Euro]

  • Identify key beam characteristics or exposure risks affecting human health and safety in SBSP systems
  • Recommend measures for human health protection to be integrated into the SBSP design phase
  • Identify gaps in knowledge that pertain to the interaction of SBSP with human health and safety

- **Model based and experimental assessment of exposure limitations for public and occupational interaction relating to SBSP ground stations** (no response) [500k Euro]

  • Assess all routes of exposure & metrics for EMR from long-range wireless power transfer from space based on selected SBSP architectures
  • Evaluate the physical and biological effects that a given SBSP architecture may have on human health resulting from public or occupational EMR exposure at relevant wavelengths, including at-risk populations.
  • Conduct targeted experimental studies to address knowledge gaps in existing models' applicability to SBSP, potentially using artificial tissue emulating materials.
  • Evaluate proposed safety mechanisms, such as exclusion zones, to ensure human safety
  • Propose additional factors to lower risk to human safety

Impact on the Terrestrial Ecosystem

- **High-risk species identification and SBSP system characteristic dependent impact assessment** (no response) [150k Euro]
- Identify beam and rectenna characteristics that are more/less likely to cause negative responses in natural ecosystems
- Identify sensitive species and attributes that may be impacted by SBSP deployment in Europe and define realistic interaction characteristics for each subset of the ecosystem
- Identify knowledge gaps relevant to SBSP interaction with the natural ecosystem

- **Targeted experimental assessment of SBSP impact on relevant fauna** (no response) [400k Euro]
- Identify knowledge gaps related to the impact of SBSP systems on fauna
- Conduct experiments to fill knowledge gaps and assess specific species or attributes
- Quantify the impact of each SBSP architecture on the natural ecosystem
- Compare predicted impacts with other energy generation infrastructure
- Propose specific SBSP characteristics or measures to mitigate any identified impact on fauna

- **Targeted experimental assessment of SBSP dual land use** (no response) [300k Euro]
- Assess potential non-agricultural dual uses for ground station land
- Conduct experiments to determine viability and limitations of dual land use for each SBSP concept, for a relevant period of time.
- Recommend the most beneficial application or combination of applications

Impact on the Atmosphere

- **Identification and modelling of SBSP atmospheric and ionospheric interactions** (no response) [200k Euro]

- Identify phenomena (ohmic heating, scattering, self-focusing effects) which can notably impact the atmosphere at power beaming levels relevant to SBSP
- Initial modelling of these effects as they apply to SBSP power beaming
- Derive technical requirements to be considered in future SBSP studies

- **Targeted experimental study of possible SBSP atmospheric and ionospheric interactions** (no response) [400k Euro]
- Using the developed model as a baseline for the possible interactions of interest, derive a set of empirical tests that will help to validate and further develop the models predicting beam interactions
- Using the beam characteristics identified in the Phase 0 system study, carry out targeted experimental work and input the findings into the existing model
- Consider the impact of abnormal atmospheric conditions (e.g., weather events, electrical storms, magnetic storms, atmospheric pollution) on beam interactions

Additional Research Topics

- **Again, should be targeted on giving us a better understanding towards enabling an informed decision to proceed with a further development programme after 2025**

Next Steps:

- Planning an OSIP campaign on calls for proposals to address the first set of activities (phase 1) in the Research roadmap.
- Funding for later activities (phase 2) still TBD.
- The OSIP campaign itself is still TBC internally but in preparation an expected to be issued early April.

Results of webex poll