# UK SciSats: The UK Satellite Programme Leading Global Space Science & Partnerships

A White Paper from the Space Academic Network

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## Vision

To establish a National programme for the development of new World-leading science using small satellite technology and missions to accelerate and demonstrate UK leadership. To help drive growth and where appropriate international relationships. To provide a National route for rapid access to space and collect new and unique data sets. To enable our scientists to compete internationally with other space faring nations with well-funded national programmes and to train the next generation of space scientists and engineers feeding the *"New Space"* economy. To feed into new international collaborations through UK contributions to bilateral missions.

## Why Now?

- Given the lack of a National programme of missions, there are limited opportunities for UK Space Research Institutions to demonstrate the leading space science we know is produced.
- Opportunities through ESA, bi-laterals and existing UK funding are too few and too infrequent – these are often focussed on a current or near-term (close to market) industrial cases rather than the science or on medium to long term development.
- Major investment is needed to provide an opportunity to lead in strategic technologies and applications of national importance such as sensing, navigation, cyber, climate (non-exhaustive)[1].
- UK Space Research Institutions can embrace *New Space* approaches with a fast, responsive, and agile programme to accelerate innovation using nanosats, micro and small satellites.
- The US, France, Germany, Italy and other countries all have established programmes, and this provides fertile ground for economic development plus bi-lateral and larger space missions.

## What are the Impacts?

- An invigorated science scene that develops novel ideas and grows existing communities.
- The programme will be a beacon for the space sector utilising UK industry and UK launch for students, graduates, researchers, entrepreneurs and investors.
- UK Space Research Institutions will be able to partner with industry in the delivery of these missions, helping to strengthen the UK space ecosystem – growing the knowledge economy.
- It will support UKSA international programmes with opportunities for international partnerships, leading to stronger trade relations and supporting Government political ambitions linked to MoUs signed with other national space agencies.
- It will provide a long-term pipeline of talent, ideas and innovation to boost the economy.
- It will provide the next generation of leading scientists, engineers, reviewers, industry leaders.
- It will deliver transformative UK expertise and capabilities with clear routes to exploitation.

[1] https://www.timeshighereducation.com/news/budget-2020-uk-research-spending-hit-ps22billion-2024-25

# Introduction

A UK Science Satellite Programme is being proposed where there will be a funnel of activities through three stages or phases. There will be an annual call for payload and platform science studies enabling broad UK participation for early mission and systems studies, bread boarding and early development activities. The response to the call will be a proposal. The science studies will provide progression of low TRL technologies and form the basis of the national SciSat programme that must deliver transformative UK expertise and capabilities with clear routes to exploitation. A key element will be development of novel and strategic technologies to enable the science, including those that may result in medium to long term exploitation following the initial science mission demonstration.

Figure 1 shows the logic and flow of the activities noting that some studies may exit from the programme to follow other routes to access space and implement their missions or will need to iterate in Phase A&B. The parallel studies will be down-selected for the following phases of Engineering Implementation and Validation (Phase C&D), and Ground and In-Orbit Demonstration (Phase E&F). A summary of these phases is in Table 1.

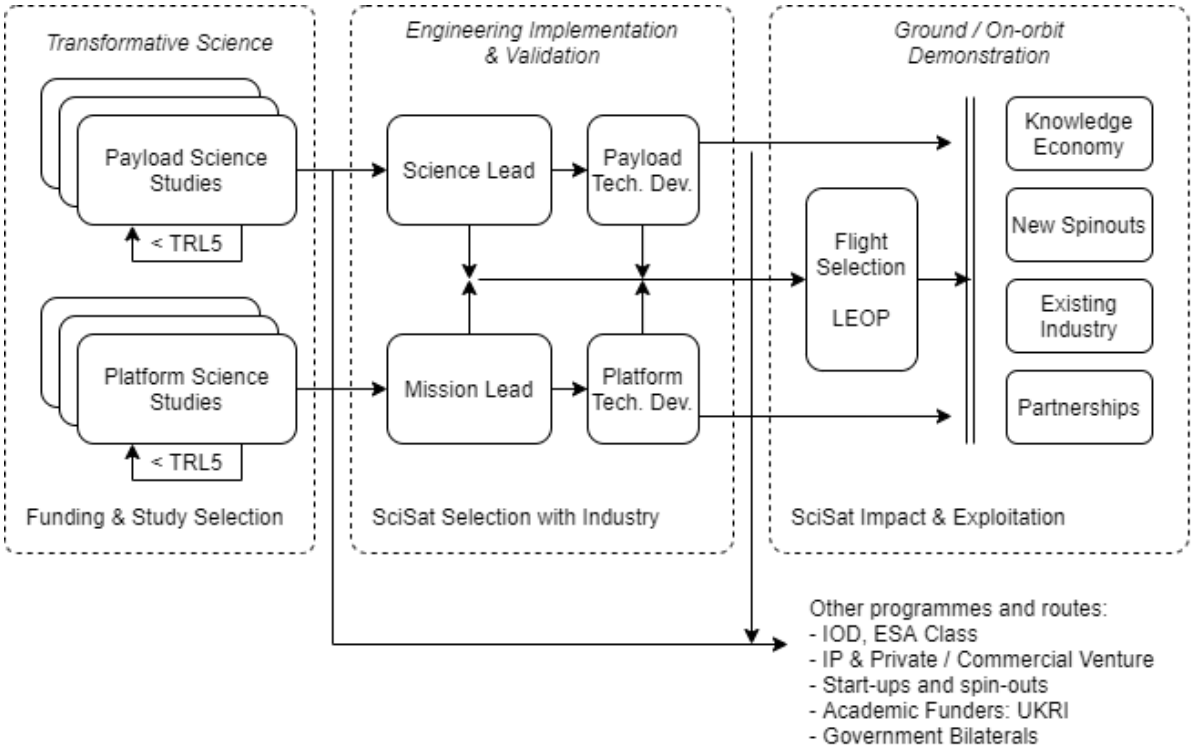


*Figure 1: SciSat Programme Structure*

Table *1: SciSat Programme Phases*

| Stage | Equivalent ESA Phase | Activity | Gate to Progress |
|---|---|---|---|
| Proposal | Phase 0 | Mission Analysis and Identification | Review Panel |
| Science Studies | Phase A and B | Feasibility and Preliminary Definition | Critical Design Review |
| Engineering Implementation and Validation | Phase C and D | Detailed Definition, Qualification and Production | Final Acceptance Review |
| Ground and In-Orbit Demonstration | Phase E and F | Utilisation and Disposal | |

The principles are:

- The Science Studies can iterate within that phase until they pass the Critical Design Review or exit into another flight programme or funding stream.
- Iteration of the studies with further funding will depend on successfully passing the proposal review panel again.
- Science Studies will inform the budgetary envelop for the Engineering Implementation and Validation, and Ground and In-Orbit Demonstration activities.
- It is expected that Science Study leads will work with industry after selection of the studies to develop technologies, define and deliver platforms, launch, operations and end-of-life activities.
- The structure has the benefit of an underlying funding level that is constant for payload and platform studies whilst forecasting the budget for the subsequent years.
- This structure allows for ambitious and challenging mission ideas to be advanced with the understanding that some will fail to reach launch. Some may launch and fail to achieve their mission objectives, but this will not be from inexperience or failure to complete ground testing, but from aiming to do challenging things.
- Some Science Studies will find other routes to fulfilling their objectives, as mentioned previously. In effect, a main objective is to provide science seeding funding and a kick starter to UK success and leadership.

The Review Panel for the science studies will be from UKRI, UKSA and SPAN.

## Selection of Science Studies

The primary aim of this programme is to progress new space science and the enabling technologies.

The applied science falls under the categories of astrophysics, astronomy and cosmology, Earth science, solar, lunar and planetary science, astrobiology, and life sciences.

The enabling science and technology must demonstrate critical advances that enable future missions and space capabilities such as engineering systems, propulsion and robotics. These Science Studies could be pathfinders for future larger missions, securing a UK leading role.

The criteria for selection are:

- The highest priority will be given to proposals for unique mission or science concepts where there is no prior measurement or technology demonstration or published result.
- Successful proposals will balance daring and ambition & risk with a credible route to the creation of transformative science, technology, or datasets.
- Proposals will demonstrate that the team has the capabilities to deliver a fully integrated satellite that can pass a Final Acceptance Review and that can complete the mission objectives.
- Proposals will outline a preliminary high-level project plan for launch and operations and will describe the contingency therein and risk retirement activities.
- Proposals will outline a preliminary financial plan and show that the mission can be completed in the budget available.
- Proposals will have identified preliminary launch, orbit and operation requirements, and will have identified a route to achieve these.

## Selection of Science Studies for Engineering Implementation and Validation

The end of the Science Studies will conclude with a Critical Design Review. To pass the CDR the following will have to be demonstrated:

- Confirmation of the feasibility of the initial proposal and demonstration of return on investment for the UK. The metrics for successful return on investment need to be defined, and any mission with commercial exploitation will exit the programme or establish co-funding in proportion to the weighting of science and commercial exploitation.
- Retirement of risk in accordance with the initial plan, or a route to recovering the position successfully within three months
- Successful completion of breadboarding and development activities in accordance with the proposal.
- A project plan for Phases C-F with a description of the contingency therein and risk retirement activities.
- A financial plan for Phase C-F demonstrating that the mission can be completed in the budget requested.
- Confirmed launch, orbit and operation requirements, and the route to achieve these.
- Allocation of resources and availability of all necessary facilities for completion of Phases C&D.

The CDR will be run by the Programme Review Board which will be from UKRI, UKSA, SPAN and Industry.

## Selection of Missions for Ground and In-Orbit Demonstration

Phases C&D will conclude with a Final Acceptance Review (FAR). To pass the FAR the following will have to be demonstrated:

- Successful build and integration of all sub-systems into the satellite
- Successful completion of all screening tests
- The team and resources are in-place to manage the operations after launch
- The plan to retrieve, store and analyse the data is in place

- All regulatory requirements are met and allocation of radio spectrum for operations has been granted.
- The plan for engagement with undergraduate teaching and postgraduate (where appropriate) training is in place through the mission operations and utilisation of the data
- A plan and means to execute a publicity campaign are in place and is coordinated with UKSA

The FAR will be run by the Programme Review Board.

## Programme Review Board

The programme review board would include UKRI, UKSA, Industry and SPAN. There is scope to invite other stakeholders such as the Satellite Applications Catapult and DSTL.

For science missions with no commercial exploitation, the role of industry will be to advise on technical, financial and operational feasibility.

For science missions with near term commercial exploitation, industry will be stakeholders in the commercial exploitation of the mission and co-funding partners.

Missions that develop a very strong near to medium term commercial exploitation will exit the programme at CDR and be funded by other means. If they exit the programme at FAR, the investment in Phases C&D will be returned to the programme.

The Programme Review Board will have at its core the review panel for the Science Studies, and will be augmented for each of the CDR and FAR meetings on a case by case and mission by mission basis.

## Timescales

Each phase will last two years.

## Costs

It is estimated that costs will be £4M p.a. for Phase A&B plus costs to run the programme. Phases C&D and E&F would be bid accordingly or sized accordingly based on the funnel of Phase A&B studies. It is hoped that the programme would grow rapidly to a multiyear steady state level of funding. The total cost of the programme would be £15M - £20M p.a.

## Signatures of Support

The following people support the proposed programme in their personal capacity, showing breath across the UK space research community:

| | | | |
|---|---|---|---|
| Prof. Malcolm Macdonald<br>University of Strathclyde | Prof. Mark sims<br>University of Leicester and SPAN Board Member | Prof. David Stupples<br>City University London | Prof. Andrew Holland<br>The Open University and Chair of SPAN |
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