Advanced Rocket Engines Development: A Research Project

1 Introduction: Originality of the Research Project

1.1 Contextual Background

The University of Luxembourg, through its Research Unit in Engineering Science (RUES), is committed to addressing the socio-economic needs and challenges of society and industry by becoming a leader in education and research in the Greater Region and globally. The unit focuses on three main research areas: Construction and Design, Energy and Environment, and Automation and Mechatronics. These areas encompass research into civil and mechanical engineering structures, energy efficiency, renewable energies, and dynamic testing methods, among others. The university aims to seamlessly integrate research and education to cultivate future leaders and critical thinkers.

In collaboration with over 70 private and public organizations through SnT's Partnership Programme, the university addresses key challenges in ICT, contributing to the European Strategic Technology Plan and the Innovation Union in Europe. Since its launch in 2009, the Centre has rapidly developed, launching over 100 EU and ESA projects, protecting intellectual property, and creating a dynamic interdisciplinary research environment with around 480 people.

For AFR individual applications, a detailed project idea must be submitted, outlining the hypothesis, research questions, innovation, expected outcomes, and methodology. The FNR encourages the dissemination of research to the public and media, emphasizing the value and impact of research outputs. This approach ensures that research activities are aligned with industry, policymakers, and societal needs, fostering an innovation-driven environment that supports sustainable growth.

1.2 Research Environment

The FNR places significant emphasis on the impact of research outputs across science, industry, policy making, and society. To maximize this impact, FNR-funded research results are expected to be disseminated through high-quality, Open Access publications, in line with the FNR Policy on Open Access. The FNR also supports the deposition of preprints in open access repositories and offers an Open Access Fund to cover publication costs. Additionally, the FNR encourages activities aimed at generating impact from the initial project planning stage, including engaging with the general public and media.

Through initiatives like SnT's Partnership Programme, researchers collaborate with over 70 private and public organizations to tackle key challenges in ICT, contributing to the European Strategic Technology Plan and the Innovation Union. This program fosters a dynamic interdisciplinary research environment, integrating research and education to develop future experts. Public-private partnerships are also a focus, with research projects jointly developed by applicants, companies, and public partners, ensuring real-world application and innovation.

LuxProvide enhances this ecosystem by offering a platform that combines data science and supercomputing resources, supporting research and business players in Luxembourg and the Greater Region. Their approach emphasizes design thinking and co-creation, providing insights for better decision-making. Creaction further supports Luxembourg-based start-ups and SMEs by integrating space applications to meet innovation needs, offering a holistic suite of services for feasibility studies and demonstration projects.

1.3 Innovation and Impact

The Greater Region is positioning itself as a leader in education and research, with a global focus on core areas such as energy, environment, and sustainable growth. This aligns with the European Strategic Technology Plan and the EU's Innovation Union initiative. The aim is to create an innovation-driven research environment that integrates research and education, preparing future industry leaders, policymakers, and society at large. Applicants are encouraged to demonstrate the value and impact of

their research outputs, including publications, data, and intellectual property, and to engage in public dissemination activities.

The SnT Partnership Programme exemplifies this approach by collaborating with over 70 private and public organizations to tackle ICT challenges. Since its inception in 2009, SnT has rapidly developed, launching numerous EU and ESA projects, protecting IP, and creating spin-offs, fostering a dynamic interdisciplinary research environment.

LuxProvide complements these efforts by offering a platform that combines data science and supercomputing resources, supporting research and business innovation through a design thinking and co-creation approach. Additionally, Creaction, as an ESA BASS broker, assists Luxembourg-based start-ups and SMEs in integrating space applications to meet their innovation needs, offering a holistic suite of services from ideation to commercialization.

Programs like FIT4GROW and ERASMUS Utop'Textile further support innovation by exploring new paths in sectors like utilities and textiles, while the SPACE CREATIVITY CENTRE provides workshops to pre-incubate innovation projects. These initiatives collectively contribute to a robust ecosystem that supports sustainable growth and technological advancement in the Greater Region.

2 Hypothesis, Research Objectives, and Envisaged Methodology

2.1 Research Hypothesis

The FNR-funded research activities emphasize the importance of the value and impact of research outputs on industry, policymakers, and society. Applicants are expected to list the impact of various research outputs, including preprints, publications, data, reagents, software, intellectual property, and the training of young scientists. The FNR encourages the dissemination of research to the general public and media, highlighting the need for impact-generating activities from the project's inception. The focus should be on the content and quality of scientific outputs rather than their quantity, publication venue, or journal metrics. It is crucial to consider a diverse range of outputs, which may extend beyond research articles to include data, software, mentoring, and societal outreach. Research activities must adhere to ethical principles and the FNR Research Integrity Guidelines, with non-compliance potentially leading to proposal rejection. The FNR values the impact of research on science and society, and applicants should be mindful of legitimate delays in research activities due to personal factors.

2.2 Objectives

The FNR emphasizes the importance of evaluating research proposals based on the quality and impact of scientific outputs rather than relying on journal-based metrics like Journal Impact Factors. As a signatory of the DORA Declaration, the FNR encourages applicants to highlight a diverse range of research outputs, including datasets, software, intellectual property, and the training of young scientists. This approach aligns with the FNR's commitment to fostering a positive research culture that values diversity and inclusion, as well as the dissemination of research to the general public and media. The FNR's merit review process adheres to international standards of transparency, impartiality, confidentiality, and integrity, as outlined in the Statement of Principles for Scientific Merit Review. Additionally, the FNR supports collaboration through initiatives like SnT's Partnership Programme, which connects researchers with over 70 private and public organizations to address key challenges in ICT. This collaborative model provides researchers with access to real-world data and systems, facilitating the development of prototypes and innovative solutions. Overall, the FNR's approach underscores the importance of capturing, preserving, and sharing knowledge to enhance the effectiveness and efficiency of research endeavors.

2.3 Methodology

Our research and educational initiatives aim to seamlessly integrate to form future leaders and critical thinkers, focusing on three main areas: Construction and Design, Energy and Environment, and Automation and Mechatronics. We emphasize the value and impact of research outputs, encouraging dissemination to the public and media. Our approach prioritizes the quality of scientific content over publication metrics, recognizing diverse outputs beyond research articles, such as data, software, and mentoring. Collaboration is key, as demonstrated by our partnership with over 70 organizations through SnT's Partnership Programme, addressing ICT challenges and launching numerous projects. We also

engage in major space projects like MILAN and ECOSTRESS, leveraging past studies and expert interactions for design convergence. Our efforts are supported by peer-reviewed journals with high citation scores, focusing on recent research findings. This comprehensive strategy ensures impactful research and education, fostering innovation and addressing societal challenges.

3 Expected Outcomes / Impact

3.1 Scientific and Technological Impact

The FNR places significant emphasis on the impact of research outputs on science, industry, policy making, and society at large. To maximize this impact, FNR-funded research results are expected to be disseminated through high-quality, Open Access publications, in line with the FNR Policy on Open Access. The FNR also supports the deposition of preprints in open access repositories and encourages the dissemination of research to the general public and media. Applicants are expected to list the value and impact of all research outputs, including preprints, publications, data, reagents, software, intellectual property, and the training of young scientists. The FNR discourages the use of journal-based metrics, such as Journal Impact Factors, as a measure of quality, urging a focus on scientific content instead. Public-private partnerships are encouraged, with a significant portion of research time spent in industry settings. The FNR is committed to the principles of the European Charter for Researchers and requires applicants and host institutions to agree to the terms and conditions that form the basis of the grant agreement. The evaluation of proposals involves a panel of generalists who review and recommend projects for funding. Activities aimed at generating impact should be planned from the project's inception, and any major changes during implementation must be communicated.

3.2 Industry and Societal Impact

The FNR places significant emphasis on the impact of research outputs on science, industry, policy making, and society at large. To maximize this impact, FNR-funded research results are expected to be disseminated through high-quality, Open Access publications, in line with the FNR Policy on Open Access. The FNR supports this by refunding costs for project-related publications through its Open Access Fund and encourages the deposition of preprints in open access repositories. Applicants are expected to list the value and impact of all research outputs, including preprints, publications, data, reagents, software, intellectual property, and the training of young scientists. The FNR also promotes the protection and economic exploitation of research results, requiring an appropriate IP protection and exploitation strategy at the host institution. Furthermore, the FNR encourages the dissemination of research to the general public and media, emphasizing the need for impact-generating activities from the initial project planning stage. The focus is on the content and quality of scientific outputs rather than their quantity or the venue of publication, recognizing the diverse range of possible outputs across disciplines.

3.3 Dissemination and Public Engagement

The FNR places significant emphasis on the impact of research outputs on science, industry, policy making, and society at large. Applicants are encouraged to list a diverse range of research outputs, including preprints, data, reagents, software, intellectual property, and the training of young scientists. The FNR advocates for the dissemination of research through high-quality, Open Access publications, and supports this through its Open Access Fund. Additionally, the FNR encourages the deposition of preprints in open access repositories.

Research outputs should focus on content and quality rather than quantity or journal metrics, and should consider the diverse range of outputs across disciplines. The FNR is sensitive to legitimate delays in research activity due to personal factors such as parental leave or disability.

The FNR also promotes a positive research culture by encouraging diversity and inclusion, and supports public-private partnerships through its Partnership Programme. This program allows researchers to collaborate with over 70 private and public organizations, providing access to real-world data and challenges, and often resulting in prototypes tested in real environments.

Overall, the FNR aims to maximize the impact of research by fostering collaboration, inclusivity, and open dissemination of knowledge.

4 Explanations on the Management of Ethical Issues and Data Protection

4.1 Ethical Compliance

The FNR-funded research activities, both inside and outside academia, must adhere to several general principles to ensure ethical and impactful research. All research activities should respect fundamental ethical principles, as outlined in the Charter of Fundamental Rights of the European Union, and comply with the FNR Research Integrity Guidelines. Any research misconduct, such as non-compliance with ethical regulations, provision of false information, plagiarism, or data falsification, may lead to proposal rejection and further actions by the FNR.

Host institutions are responsible for obtaining all necessary authorizations from ethical and data protection committees or other regulatory bodies. Any ethical misconduct can result in the immediate suspension or termination of the grant, with potential additional sanctions, including reimbursement requests and legal actions.

The FNR emphasizes the importance of research impact on science, industry, policy makers, and society. Applicants are expected to demonstrate the value and impact of their research outputs, including preprints, publications, data, software, intellectual property, and training of young scientists. Dissemination of research to the public and media is encouraged, and activities aimed at generating impact should be planned from the project's inception.

Beneficiaries must comply with the FNR research integrity guidelines and ethical charter, available on the FNR website. The FNR endorses the European Code of Conduct for Research Integrity and the Singapore Statement on Research Integrity. The merit review process follows international standards of transparency, impartiality, confidentiality, and integrity, as defined by the Global Summit on Merit Review.

Panel experts are required to read the FNR Ethics Charter and Code of Conduct for Research Assessment, sign a Participation Form, and thoroughly review assigned proposals. They should also be sensitive to legitimate delays in research activity due to personal factors, such as parental leave or disability.

All electronic materials and publications should prominently display the FNR logo and acknowledge FNR funding. This comprehensive approach ensures that FNR-funded research is conducted with integrity and contributes positively to society.

4.2 Data Protection

The FNR (Fonds National de la Recherche) has established a comprehensive framework to ensure the integrity, confidentiality, and effective management of research projects. Panel members and experts involved in the evaluation process must declare their commitment to confidentiality and are prohibited from using the data for personal purposes. They are required to read relevant documents, sign a Participation Form, and thoroughly review assigned proposals. Conflicts of interest must be declared, and any inability to fulfill obligations must be reported to the FNR immediately.

Applicants and Host Institutions (HI) agree to the publication of certain information, such as the beneficiary's full name, nationality, and email address, on the FNR website. The project abstract, which should not contain confidential information, may be used to contact external experts. The full application form, including personal data, will be shared with expert panel members for evaluation purposes.

In case a beneficiary cannot pursue their project due to unforeseen circumstances, they must inform the FNR Programme Manager within 30 days. The FNR must be notified without delay of any events affecting the project timeline, along with full justification and an estimated date for resumption.

The FNR emphasizes the importance of ethical compliance, requiring all necessary authorizations from ethical and data protection committees. Misconduct may lead to suspension or termination of grants, with potential additional sanctions or legal actions. Beneficiaries have the right to access and modify their personal data under GDPR regulations.

The FNR is committed to maximizing the impact of research outputs and may introduce measures such as anonymized surveys to ensure proper documentation and development of personal, educational, and career plans. Beneficiaries are expected to be present at their Host Institution in accordance with the work plan outlined in their proposal.

4.3 Institutional Responsibilities

The FNR (Fonds National de la Recherche) emphasizes the importance of data management, protection, and open access in research projects. Researchers and host institutions are required to ensure proper stewardship and curation of research data, adhering to the FNR Policy on Research Data Management and the FAIR principles. Compliance with the EU's General Data Protection Regulation (GDPR) is mandatory, granting beneficiaries the right to access and modify their personal data. A data management plan must be established and regularly updated, ensuring data is deposited in a trusted archive and made accessible according to the principle of "as open as possible, as closed as necessary," unless it conflicts with legitimate interests or obligations. The FNR also values the impact of research outputs on various sectors and requires applicants to permit data sharing for evaluation and management purposes. Confidentiality is maintained, with panel members and experts required to treat data confidentially. The FNR's commitment to data protection aligns with international standards, such as the Singapore Statement on Research Integrity.

5 Comment on Resubmission (if applicable)

5.1 Evaluation Process

The evaluation process for research proposals involves several key steps to ensure a thorough and fair assessment. Initially, panel experts are required to complete and submit their reviews, providing comments and scoring the proposals at least 10 working days before the panel meeting. During the meeting, these experts present their synthesis of the written evaluations, focusing on the proposal's objectives, strengths and weaknesses, and overall assessment. They also highlight any conflicting statements from reviewers and suggest necessary modifications if applicable.

The panel meeting, organized by the FNR, begins with a ranking of proposals based on the reviews received. Proposals that do not meet the minimal quality criteria are not discussed further, although the justification for their low scoring is verified by the panel. Panel members are reminded to declare any conflicts of interest before proceeding with the discussion of proposals.

The discussion aims to readjust the ratings if necessary, with panel members participating actively. After rating all proposals, the panel deliberates on which should receive funding, considering the potential impact on industry, policy makers, and society. The FNR encourages the dissemination of research to the public and media, emphasizing the importance of planning for impact from the project's inception.

For proposals accepted for funding, the applicant and the Host Institution (HI) must agree to the Terms and Conditions, which form the contractual basis of the grant agreement with the FNR. They also commit to the principles of the European Charter for Researchers. The panel concludes by preparing a 'Panel Conclusion' for each project, summarizing the evaluation findings and decisions made during the meeting.

5.2 Panel Review and Decision Making

The evaluation process for proposals involves a comprehensive review and discussion by a panel nominated annually by the FNR. Each proposal is initially reviewed by two experts who are closest to the domain of the proposal, although the panel members are generalists and not necessarily experts in the specific domain. The panel meeting begins with the presentation of a synthesis of the written evaluations by the assigned panel expert, focusing on the proposal's objectives, fulfilment of selection criteria, and any conflicting statements from reviewers. The strengths and weaknesses of the proposal are highlighted, and an overall assessment is provided, including necessary modifications if applicable.

Panel members are encouraged to engage in discussions of all applications, regardless of their field, and to raise any concerns or questions. Ethical considerations are addressed if the proposal raises any issues, and the assessment of selection criteria ranges from excellent to fair/poor. The panel chair invites members to discuss the evaluation findings and adjust the proposal's rating if necessary, with argumentation provided.

After rating all proposals, the panel discusses which should receive funding, taking into account the content and quality of scientific outputs rather than their quantity or publication metrics. A consensus on funding recommendations requires a two-thirds majority vote. Panel members must declare any conflicts of interest, and the final decision, along with the 'Panel Conclusion,' is communicated to the applicant and their supervisor(s). Proposals not meeting minimal quality criteria are not discussed,

but the justification for low scoring is verified by the panel. The process ensures a fair and thorough evaluation, with feedback provided to applicants to guide future improvements.

5.3   Feedback and Future Improvements

The text collection for the study is built on four heterogeneous data sources: ESA feasibility reports generated during CDF studies, academic publications, books, and Wikipedia pages. These sources are peer-reviewed and contain content verified by humans, with CDF reports being a primary source of information as cited by experts during the 2018 survey. The study involves the integration of AI in space mission design, utilizing a combination of Natural Language Processing (NLP) and Knowledge Graphs (KG) for heritage analysis. The research outputs, including preprints, publications, data, and software, are expected to demonstrate value and impact on industry, policymakers, and society. The FNR encourages dissemination of research to the public and media, emphasizing the need for impact-generating activities from the project's inception. The study also explores the use of mapping rules, migration validation, and integration of additional metadata, with a focus on applications like automatic mass budget generation and crisis management through Earth observation and social media mining. The findings and contributions are evaluated, with limitations acknowledged and future research directions proposed. The data and findings are openly available from the University of Strathclyde KnowledgeBase.

6   Bibliography (max. 15 references, not included in character limits)

6.1   Reference Selection Criteria

The FNR places significant emphasis on the impact of research outputs on science, industry, policy making, and society at large. To maximize this impact, FNR-funded research results are expected to be disseminated through high-quality, Open Access publications, in line with the FNR Policy on Open Access. This includes the encouragement of depositing preprints in open access repositories. The FNR also supports the dissemination of research to the general public and media, ensuring that activities aimed at generating impact are integrated from the initial project planning stages. Costs for project-related publications can be refunded through the FNR's Open Access Fund. Additionally, the FNR values a diverse range of research outputs, including data, reagents, software, and the training of young scientists, recognizing that important outputs vary across disciplines and individuals. The SnT's Partnership Programme exemplifies this approach by collaborating with over 70 private and public organizations to address key challenges in ICT, fostering a dynamic interdisciplinary research environment. The Centre has rapidly developed since its inception in 2009, launching numerous projects, protecting intellectual property, and creating spin-offs. The dissemination of research is further supported by various text sources, including ESA feasibility reports, academic publications, books, and open-source platforms like Wikipedia, ensuring that research findings are accessible and impactful.

6.2   Open Access and Dissemination

The FNR (Fonds National de la Recherche) has implemented a comprehensive approach to evaluating research proposals, emphasizing the quality and impact of research outputs over traditional journal-based metrics. As a signatory of the Declaration on Research Assessment (DORA), the FNR encourages applicants to focus on the scientific content of their work rather than relying on metrics like Journal Impact Factors. This approach values a diverse range of research outputs, including preprints, datasets, software, intellectual property, and the training of young scientists. The FNR also promotes the dissemination of research to the general public and media, highlighting the importance of planning for impact from the project's inception.

The selection process for AFR grants involves several stages, starting with an administrative eligibility check. Proposals are then rated based on scientific quality, originality, clarity of objectives and methods, feasibility, and the applicant's profile and potential. Ethical considerations and research integrity are crucial, with misconduct such as plagiarism leading to proposal rejection. The FNR's merit review process aligns with international standards, ensuring a fair and thorough evaluation of each proposal.