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TU Delft

ISIS Company case Joint Interdisciplinary Project

Air Quality Instrumentation for Small Satellites

ISIS

1 Introduction

About ISIS

ISIS – Innovative Solutions In Space was founded on January 6th, 2006 as a spin-off from the Delfi-C3 nanosatellite project from Delft University of Technology in The Netherlands and it's one of the leading companies in the fast growing small satellite market. The company is vertically integrated and combines research and development, testing, launch services, and operation of small space systems in a single organization. This allows ISIS to provide the right solution for every customer, from subsystems to full turn-key missions and custom solutions.

ISIS operates globally and serves a variety of customers in accomplishing their projects and space missions. Our main site is in Delft in the Netherlands, while we also have an office in Somerset West in South Africa. ISIS works closely together with technology partners, suppliers and space companies from the Netherlands, South Africa, and elsewhere in the world.

Our focus is primarily on solutions involving satellite systems in the range of 1 to 30 kilograms, although sometimes we use our expertise in this field in other domains. This can be in the area of microsatellites, miniaturized payload systems, and miniaturized satellite components as well as specialized product areas such as hold-down and release systems. ISIS employs about 90 specialist employees most of which have a background in space technology and engineering.

www.isispace.nl

Recent Developments

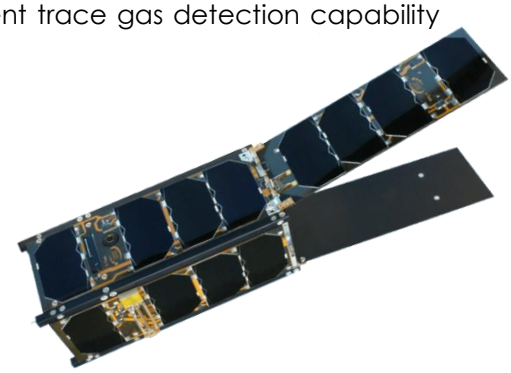
The Netherlands has an leading position in both small satellite system and scientific instrumentation for space based atmospheric research (e.g. most climate monitoring satellites contain Dutch instruments or Dutch instrument technology). Recently activities have started to try to combine these two strengths and focus on the accommodation of miniaturized climate and air quality instruments onboard small satellites. This offers opportunities to not only serve the scientific market, but also more operational measurements of emissions such as NO2, SO2, CO2 and CH4 (Methane) to provide insights in local air quality issues and provide the ability to catalogue and track emissions that impact our climate.

Problem Statement

The idea that ISIS and its partners have come up with is a modular instrument concept based around a miniaturized spectrometer that can result in a *suite* of small space instruments based around a common architecture, but each instrument type optimized for a specific trace gas (e.g. a single instrument to detect NO2, and a very similar instrument to detect SO2). This way it is believed that an optimum is reached between affordable small instruments (and subsequent small host-spacecraft) as well as obtaining maximum flexibility in the monitoring capability in different spectral ranges (and thus different trace gases) as the final need of the emerging market for remote monitoring of air quality and emissions is still young and very much in motion. ISIS and its partners would like to see this hypothesis tested and obtain an answer to the question:

Does the development of a suite of modular, miniaturized Air Quality Instruments for small satellite provide sufficient advantages in terms of system flexibility, cost and implementation time over more classic, highly integrated atmospheric instruments?

Such an instrument suite could have a real price/performance benefit compared to more traditional remote sensing instruments in terms of a much lower implementation cost versus decent performance, a great reduction of instrument complexity and the opportunity to keep adding new variants of the instruments with a different trace gas detection capability to the line of instruments (e.g. CO, O3, aerosols, etc.).



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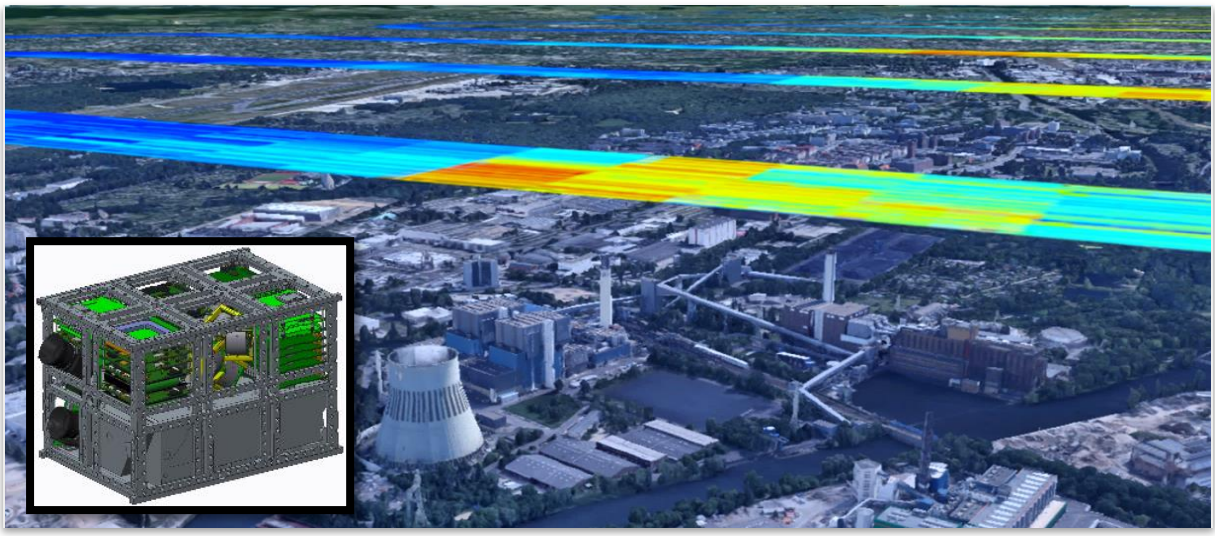

2 Objective

- The objective of the activity is to assess various concepts for a modular, cost-effective suite of small (<10kg) Air Quality Instruments for Small Satellites and to suggest the best possible candidate for implementation
- The final report shall conclude its assessment based on key criteria including:
    - Technology Readiness and implementation risk
    - Measurement Quality and system performance
    - Lifecycle Cost for the full instrument suite
    - Time-to-market
- A detailed trade-off shall be presented that is based on the above criteria
- Key technologies and system drivers shall be identified, and a development roadmap shall be presented
- The output of this study shall be used in the technical and business planning of a new satellite system for air quality monitoring.

3 Scope

- There is an initial baseline design for NO2 available with information on the optomechanical design, spectrometer concept and principles, information (NO2 concentration) retrieval concept, programmatics and costing.
- The scope is mainly to analyse key system drivers and perform both quantitive and qualitative assessments on the impact that design changes will have on the ability to build various types of instruments with minimal non-recurring design impact. This can include, but is not limited to:
    - Use of advanced manufacturing techniques for optemechanical elements such as additive manufacturing, automatic assembly, etc,
    - Use of low-cost, commercial off-the-shelf optical components and detectors, versus customized designs for optimized performance,
    - Effect of production series size on trade-off scoring,
    - Trade-off between pre-flight or in-flight calibration and post-processing for enhancing final data quality,
    - Lifetime (risk) versus costs trade-offs,
    - Simple Instrument concepts versus complex operational concepts (Push-broom imager, scanning mirrors, constellations)

- This activity runs in parallel with an internal project at ISIS on the establishment of a potential commercial activity regarding air quality monitoring from space and as a result may have some interactions with the current ongoing activities on the space segment design (interfaces, commonality of instruments) and programmatics (development timeline, costs (recurring and non-recurring)).

4 Student selection

This project is open to students from the following faculties:

- Aerospace Engineering
- Mechanical. Maritime and Materials Engineering
- Civil Engineering and Geosciences
- Technology, Policy and Management
- Electrical Engineering, Mathematics and Computer Science
- Chemical Engineering

5 Business coaching

- Within ISIS projects are typically run by a multidisciplinary team of specialists managed by lead systems engineer and a project manager. For this project the ISIS systems engineer, and project manager are the main coaches of the project team.
- ISIS' specialist teams including systems engineering, mechanical engineering, production and test, business development, electronics, control and software are available for support and are already working on related projects in the field of small satellites for Air Quality monitoring.
- ISIS upper management is available as well for support on business cases and operational aspects during the study.

6 Partner companies and research organisations

- ISIS is working together with other companies as well on this Air Quality Monitoring initiative: Airbus Defense and Space in Leiden, and Science&Technology from Delft.
- The research organisations TNO in Delft and Utrecht and KNMI are involved as well.


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