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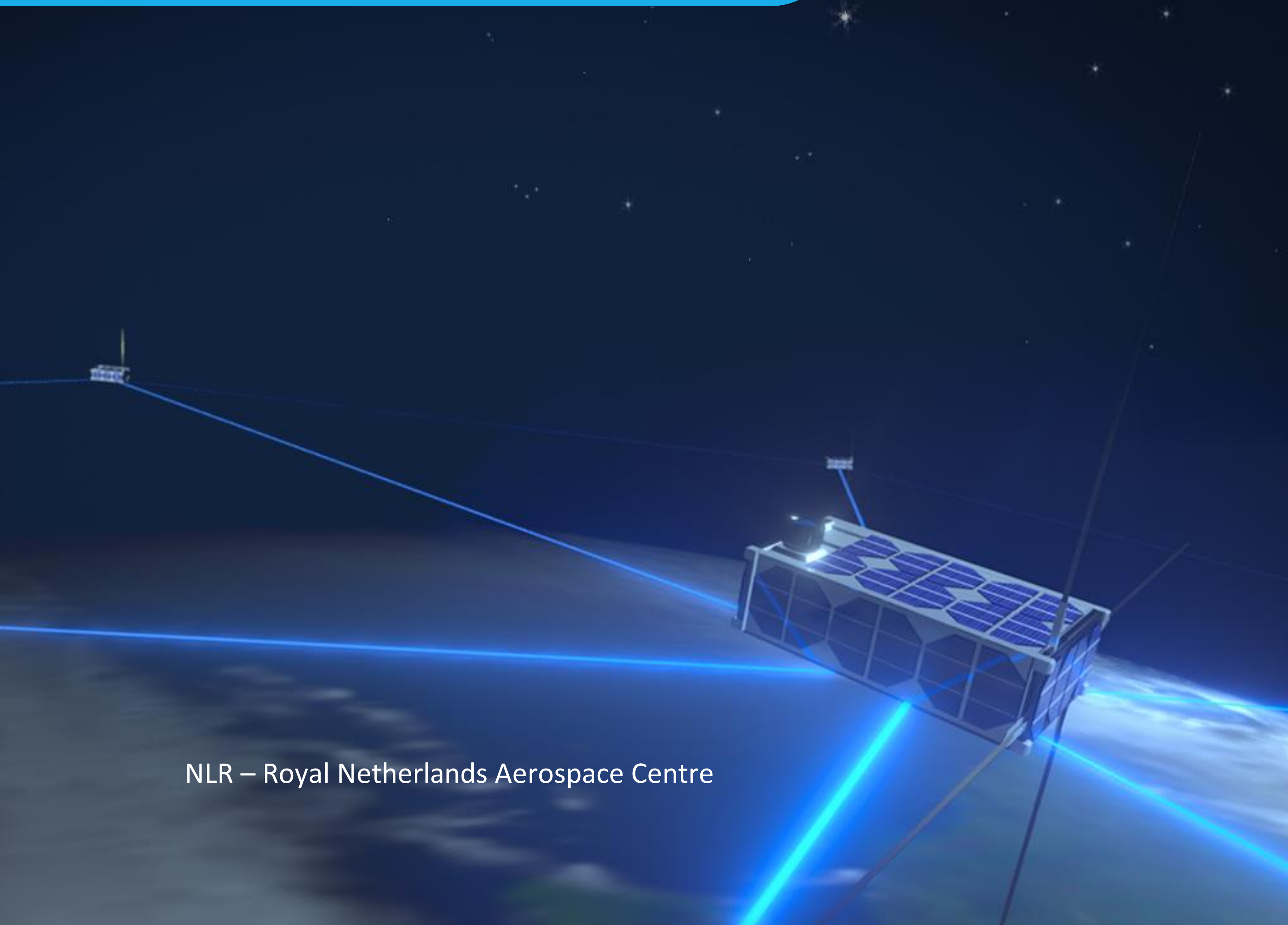
NLR-TP-2020-284 | August 2020

Thermal Modelling of CubeSats in ESATAN-TMS: A Modular Approach

An ICES2020 Conference Proceeding

CUSTOMER: Royal Netherlands Aerospace Centre



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EXECUTIVE SUMMARY

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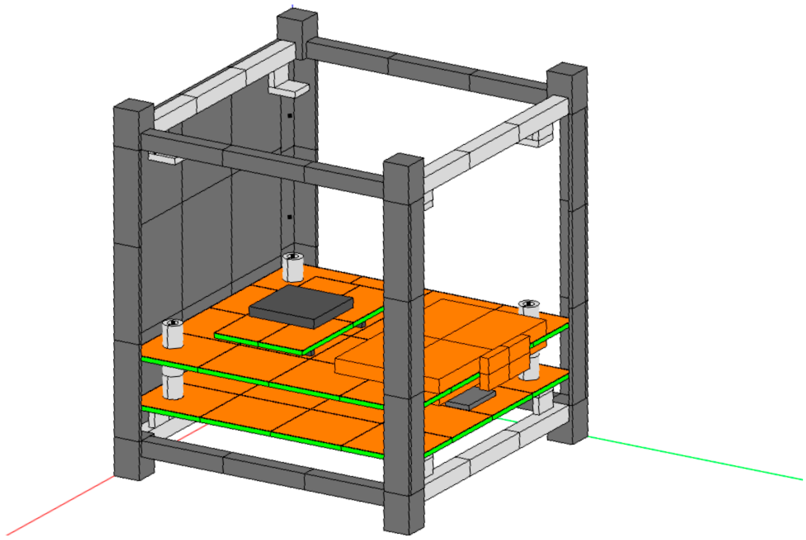

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Problem area

Miniaturization has allowed CubeSats to enter the domains of Earth observation, RF-oriented missions, and astronomy, surpassing its original intention of being an educational instrument. With the increase in power density, thermal control measures are needed for CubeSats, requiring low-cost hardware and software solutions, which are currently hardly available. The deficit of thermal control solutions for CubeSats is inherently related to their short development time resulting in suboptimal thermal designs. Miniaturization and application of thermal control systems is being worked on, however evaluating design iterations is hindered by the lack of thermal analysis imposing large uncertainties in the thermal design of CubeSats. The conventional method of validation and model correlation to reduce model uncertainties takes too much time and is therefore excluded for CubeSats.

Description of work

ISIS - Innovative Solutions in Space and the Royal Netherlands Aerospace Centre, NLR have worked together on an innovative modular approach for CubeSat thermal analyses in ESATAN-TMS. Key of this approach is the interchangeability and scalability of validated thermal sub-models allowing for fast and more accurate analysis for LEO missions. Any design of a CubeSat can be quickly evaluated in ESATAN-TMS by implementation of a combination of validated and correlated thermal sub-models in the CubeSat frame model. Over time a library of validated thermal sub-models will be created in ESATAN-TMS, allowing for fast and accurate orbital analysis, which results in improved thermal designs of CubeSats.

The presented work is a result from the Memorandum of Understanding signed between NLR and ISIS in 2018. The article consists of the findings in the first phase of the project. The second phase of the project is currently (2020) ongoing.

This report is based on a presentation that was planned to be held at the 50th International Conference on Environmental Systems, in Lisbon, 12th -16th of July 2020. However, due to COVID-19, the conference was postponed to 2021, but the proceedings for 2020 were still published.

Results and conclusions

The need for validation of CubeSat thermal analyses is presented. ISIS and NLR identified this need and by combining thermal experience, methods, and tools of NewSpace and Conventional Space companies a research project to investigate the potential of a modular approach for thermal modelling of CubeSats in ESATAN-TMS was initiated. The set up and intermediate results of this project is presented. The result of Phase I, a successful methodology for quickly creating reliable CubeSat ESATAN-TMS thermal models, is shown and an outlook on how this methodology will be improved, verified and validated in Phase II and Phase III of the project, is given.

GENERAL NOTE

This report is based on a presentation that was planned to be held at the 50th International Conference on Environmental Systems, in Lisbon, 12th -16th of July 2020. However, due to COVID-19, the conference was postponed to 2021, but the proceedings for 2020 were still published.

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Thermal Modelling of CubeSats in ESATAN-TMS: A Modular Approach

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Nomenclature

CDR	=	Critical Design Review
CSKB	=	CubeSat KitBus Connector
ESATAN-TMS	=	ESATAN Thermal Modelling Suite
ISIS	=	Innovative Solutions In Space
LEO	=	Low-Earth Orbit
NLR	=	Royal Netherlands Aerospace Centre
OBC	=	On Board Computer
PCB	=	Printed Circuit Board

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PDR = Preliminary Design Review
TXS = ISIS S-band Transmitter

I. Introduction

The CubeSat industry is alive, kicking, and growing rapidly. Due to miniaturization CubeSat capabilities have been enhanced to such an extent that their original purpose of demonstration and education has been surpassed.[1] CubeSats are now used for large-scale data collection and seen as a means rather than an end. CubeSats being used as infrastructure rather than an end product has become apparent through the rise in mission-applications such as Internet-of-Things provision and Earth observation.[1,2]

Within ISIS there is a clear trend observed in which a rise in requests has become apparent for the use of CubeSats for Earth Observation and setting up CubeSat constellations.

Earth Observation more often than not involves the usage of cameras operating in the infra-red wavelengths, requiring not only cooling of their detector but also a stable thermal environment while performing acquisitions. Although within the majority of these missions the aspect of cooling is taken up by the payload developer there always remain several interfaces to the platform which impact the thermal environment and stability of the imagers. This is where accurate thermal modelling of CubeSats comes into play.

Setting up CubeSat constellations, often involves a requirement on thrust capabilities and thus the inclusion of a propulsion system. While there are different types of propulsion systems slowly becoming available for CubeSats, more often than not it is found they also require a large amount of power and specify requirements on the thermal interfaces to the platform.

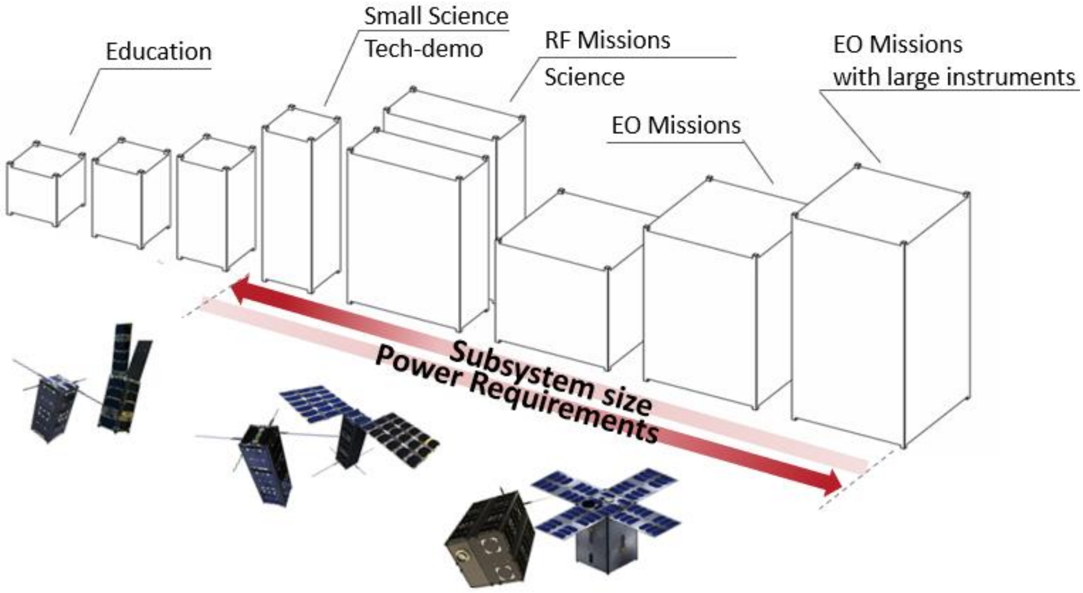

Figure I-1. General CubeSat form-factor and power trend observed by ISIS within the CubeSat industry.

While the industry developments have led to an increase in CubeSat form-factor usage as expected, launch costs remain a significant portion of the total costs and the 'launch-by-the-numbers'-philosophy (a key aspect that was predicted to make CubeSats more cost effective than conventional satellites) has therefore forced space companies to scale down satellite size as much as possible. The latter, obviously happening without decreasing demand for performance. The increased performance-demand is a synonym for a request for more power, which has been answered by the introduction of deployable solar panels. This trend is depicted in Figure I-1, where for the different CubeSat sizes (ranging from a 1U up until a 16U) the typical mission-application is mentioned.

With the introduction of deployable solar panels, peak and orbit average powers have approximately doubled leading to an overall increase in power-density for CubeSats. This trend is supported by Figure I-2, which shows the mass versus power trend for CubeSats and conventional, larger satellites.[3] While the conventional satellites follow a clear trend, the CubeSats fall outside of this, which is providing evidence of the increase in power density.

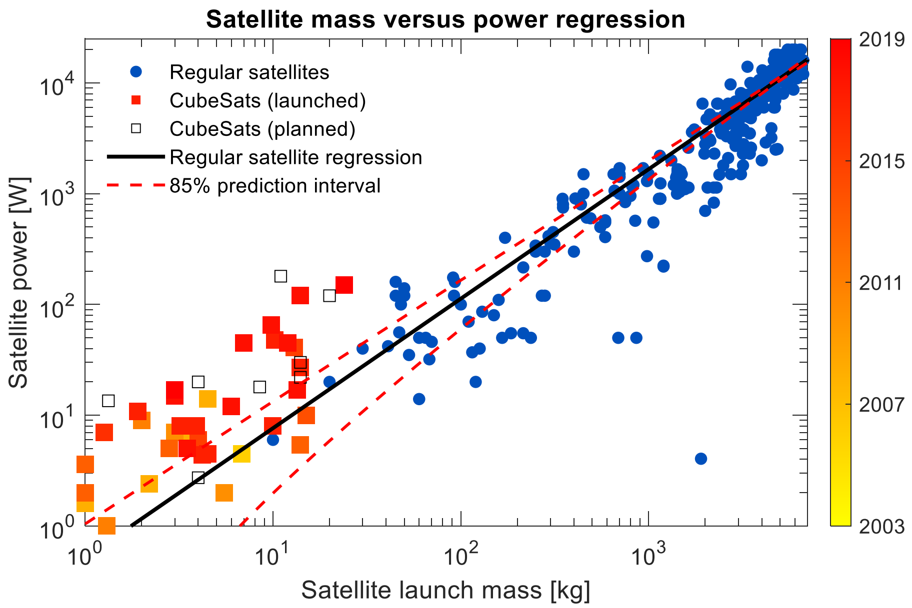

Figure I-2 Mass-power trendline for CubeSats and conventional (larger) satellites. The color-coding of the CubeSats is based on launch year, as represented by the colorbar. Red squares indicate the latest launches (2019) and yellow squares indicate the first launches (2003).[3]

Inevitably, with an increased power density, thermal challenges have started to rise that need to be countered in order to continue exploiting CubeSats for high-end missions. Two main challenges have been identified:

- Tackling the increased power density – Larger power dissipations lead to local hotspots that need means for temporary storage (heat sinks), heat transport, and heat removal (radiation). While the CubeSat sizes do increase, the surface area remains insufficient for radiating heat to deep space.
- Solving the lack of thermal control knowledge and experience within the CubeSat industry

The first challenge is currently being taken on by the industry. Hardware proven on conventional satellites is being adapted to CubeSats or new concepts are presented.[3,4,5,6,8] These solutions are (or can be) properly modelled on their own and tested for in order to ensure sufficient performance. However, it is when one moves to the CubeSat integration phase where challenge two comes around the corner: a lack of thermal data on CubeSats such as conductive couplings between common CubeSat elements. It is not always clear what type of materials are used (and their purity), what the contact conductance is, or even surface properties. This imposes a large uncertainty on the outcome of any analysis.

Solving the second challenge remains difficult though as it foremost requires CubeSat developers to put effort into thermal control analysis, verification, and validation. So far, this has been (for the larger part) absent due to the lack of strict thermal requirements and experience with thermal control. Furthermore, any analysis that may have been performed during the design phase has often not been verified and validated, mainly because of the short lifetimes of CubeSats and their low-cost nature.[7] It is not uncommon to have thermal analyses performed only up to the PDR phase, where the goal is to simply identify critical thermal issues without being able to build up a full thermal model. In this phase the design is usually subject to significant change still. An example breakdown of a 2U CubeSat into a thermal model is shown in Figure I-3. With the absence of technical information such a simplification is necessary but automatically leads to uncertainties in the outcome.

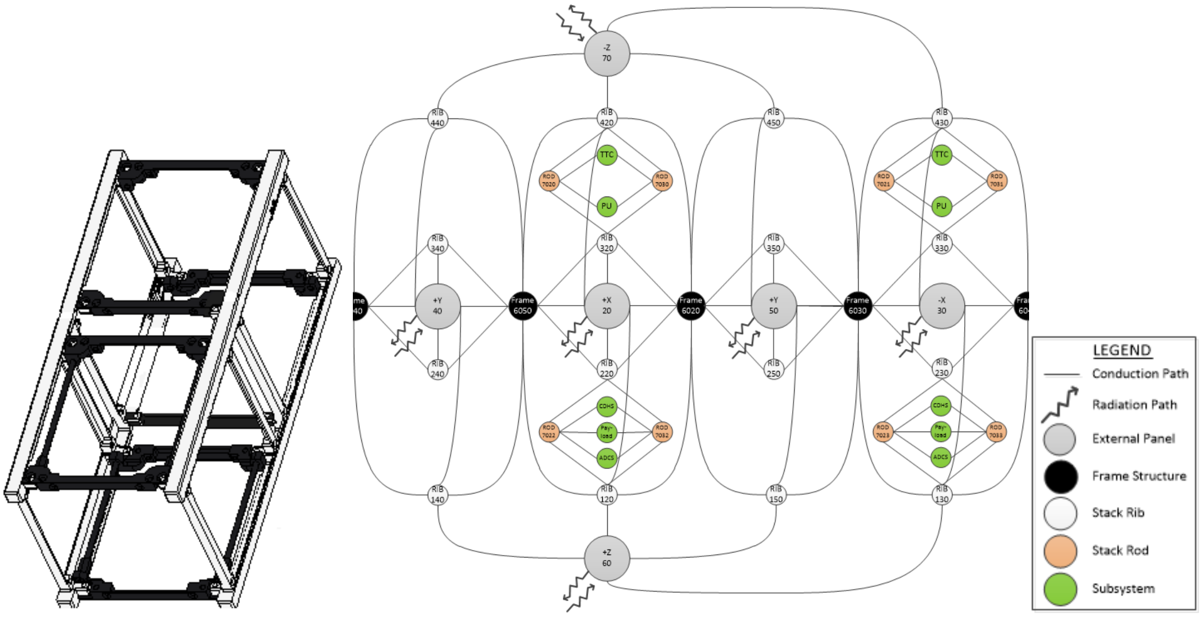

Figure I-3 Simplified thermal breakdown of a 2U CubeSat representative of a model used during PDR phase.

ISIS has carried out a thermal validation in the past for the ISIS-built 2U QB50 precursor satellite (p1), of which the results are shown in Figure I-4. In-orbit data were gathered and information relevant for thermal modelling was collected. This information consisted primarily of properties of materials, surface coatings, contact areas, dissipating components, and PCB layers. The model was built in the Microsoft Office Excel plugin ThermXL, a software subset from the ESATAN modelling suite.

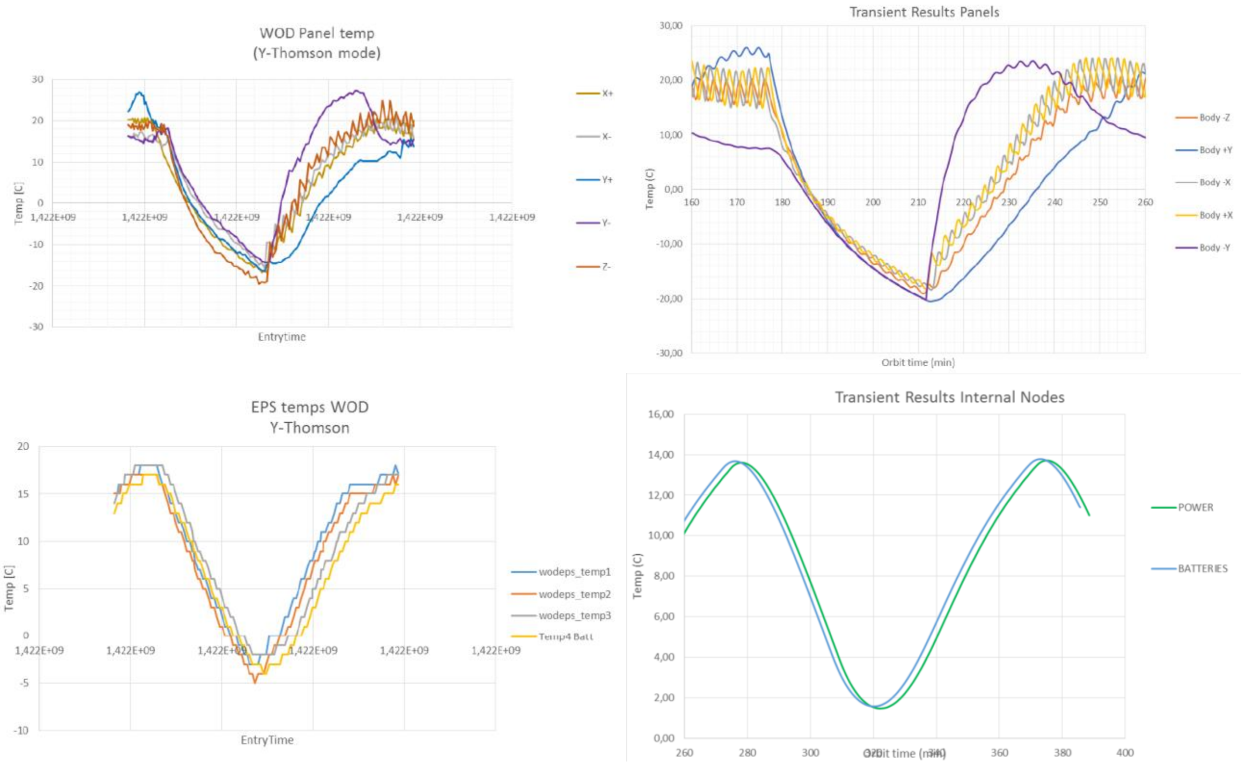

Figure I-4 Thermal validation results of the QB50p1 precursor satellite. Measured in-orbit panel temperature data (top-left), simulated panel temperature data (top-right), measured battery and power boards temperatures (bottom-left), and simulated battery and power board temperatures (bottom-right).

Although the validation process resulted in a tool that was able to model the panel temperatures of the CubeSat with an accuracy of 5°C, it showed larger uncertainties for internally modelled subsystems. From sensitivity analyses it was found that contact conductance severely affected the internal temperatures. This blocked further modelling due to two reasons:

1. **Absence of information on contact conductance of common CubeSat interfaces**
   With validated thermal control data being absent, large uncertainties are inevitable. Therefore, large uncertainty factors need to be applied on the outcome of any of these analyses. In a past ISIS 6U mission a 15°C uncertainty factor was applied on a thermal analysis performed at PDR, based on ESA feedback. Such temperature differences can be problematic for the missions where the instrument performance is directly related to the thermal environment and the acceptable thermal range is smaller than such an uncertainty factor. Moreover, the engineers working in the CubeSat industry are generally younger of age and will therefore have less experience with thermal modelling and testing. The thermal control division of the European Space Agency (ESA) recently conducted specific CubeSat thermal tests supporting the identification of this need.[7] Moreover, it concluded not only that the uncertainty in material properties led to large error bars in the measurements but also that the measured conductances are significantly lower than values predicted by analytical models from literature. This shows, that for CubeSat thermal modelling we cannot simply rely on historical measurements carried out for larger satellites.

2. **User-friendliness of ThermXL modelling plugin and the cost of thermal software**
   While setting up the model and performing the analyses it was found that the ThermXL modelling plugin became cumbersome to work with when the number of required nodes became significant (e.g. in the order of 100 or more). Especially having many nodes representing vastly different elements challenges the user in keeping track of them. For achieving higher accuracies more detailed thermal models were desired forcing a change of thermal modelling tool. This in turn led to cost being a blocking point: CubeSat projects being (or needing to be) low-cost, also brings in the issue of thermal control tools being (relatively) expensive. On top of that, considering also the limited amount of thermal control work that is present it is difficult for CubeSat companies to justify the investment.

II. Answering the Call for Fast but Accurate Thermal Modelling of CubeSats

The craving for thermal knowledge, experience in thermal modelling and testing, and low-cost tool availability by the CubeSat industry can actually be (partially) stilled by transfer knowledge from the so-called conventional space institutes. The conventional space industry has built up lots of experience over time with thermal modelling and testing of larger satellites. The test methodologies developed and lessons learned can provide key benefits for CubeSat thermal engineers and save a lot of time. This is depicted in Figure II-1, with NLR and ISIS taken as an example.

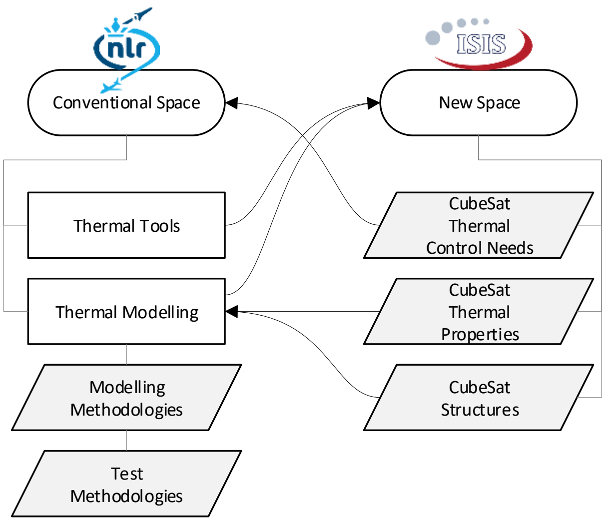

Figure II-1. Potential information exchange between conventional space (NLR) and NewSpace (ISIS).

Combining forces between NewSpace and conventional space companies is seen as a win-win situation: the CubeSat industry will benefit from the experience gained over all those years, while the conventional industry will be able to enter the CubeSat market with the gained knowledge on CubeSats when working together. However, there is a little more to it than just combining forces and, for example, let non-CubeSat space companies do the thermal analysis of CubeSats. It is the aforementioned lack of thermal (test) data and interface properties that continues to throw a spanner in the works and leads to high uncertainties in any outcome of an analysis. It is exactly for this reason that this project has been established. The need for accurate thermal modelling of CubeSats is justified and offers enough reason to set up a dedicated project. The following needs have been identified, flowing directly into the project as project-goals:

1. **Perform rapid execution of thermal analyses**
   Being able to perform thermal analysis quickly and at an early stage of the project allows for a significant decrease in project risk. Not being able to identify thermal criticalities during the Preliminary Design Phase (PDR) will severely impact the time required to make up for this during the Critical Design Phase (CDR).
2. **Obtain accurate thermal analyses results**
   Accuracy is key but knowledge thereof is even more important. Currently, both are lacking. Being able to perform (preliminary) thermal analyses for which the result has a known (and verified and validated) accuracy will provide the required confidence to a CubeSat thermal engineer.
3. **Build up a CubeSat thermal library or database**
   The CubeSat philosophy of standardization (and sharing of information) is something that is gladly upheld by ISIS and NLR. For this reason, building up a database or library along the way consisting of verified and validated thermal models and information could be a game-changer for CubeSat thermal modelling and the industry. While it can be argued that no two CubeSat missions are the same, CubeSats commonly fly similar subsystems from one mission to the other. This shows the usefulness of having thermal models available for subsystems similar to how step files are offered.

The project is foremost based on the usage of ESATAN-TMS as this is a common thermal control software tool used within the industry and both ISIS and NLR are familiar with it. In order to tackle the aforementioned goals, the project has been divided into three phases: Exploration (I), Verification (II), and Validation (III). Figure II-2. shows a visual representation of the project.

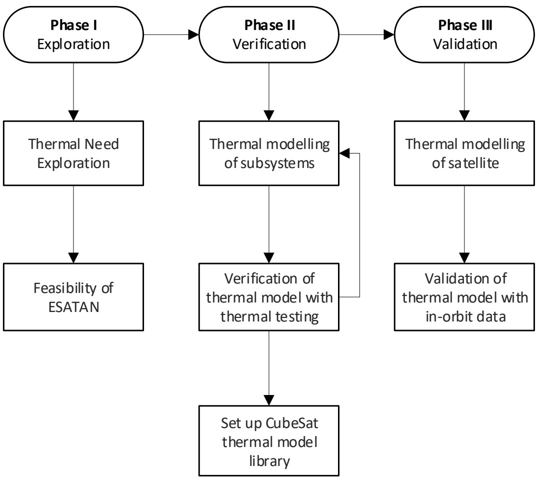

Figure II-2. A high-level representation of the three phases of the project set up by ISIS and the NLR: Exploration, Verification, and Validation. Each phase consists of dedicated tasks.

The first phase is marked as the exploration phase in which the need and viability of modular thermal modelling is investigated along with using ESATAN-TMS as a thermal control tool. This phase now being concluded, it specifically focused on exploring and defining a methodology to quickly achieve high confidence CubeSat ESATAN-TMS thermal models by building up and using a library of validated ESATAN-TMS CubeSat submodules.

The second phase is focused on the effort of improving and verifying this methodology and at the same time starting to build the library of validated submodules. It provides the verification part of the project in which the thermal modelling is taken a notch higher and a selection of commonly used CubeSat subsystems is modelled within a CubeSat structure. The analysis will be done as part of the verification process. Actual thermal (vacuum) tests are planned after which the obtained test-data will be correlated with the simulation results. The flow of events during this phase is shown in Figure II-3.

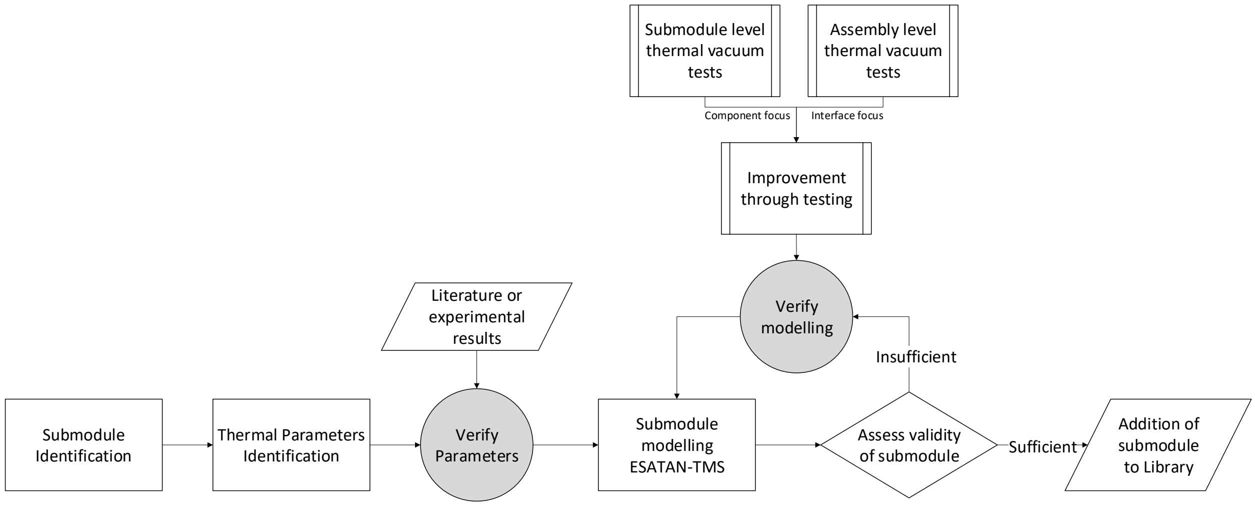

Figure II-3. Phase II flow of events showing the process put in place in order to verify CubeSat subsystems from a thermal point of view.

Finally, the last phase governs the validation aspect as shown through Figure II-4. This effort will naturally expand the library of submodules further to ensure all thermally relevant submodules in the selected satellite are available. With several subsystems verified through onground testing a complete CubeSat model will be built in ESATAN-TMS representing a currently flying satellite for which abundant thermal data is available. The results of the simulation will be correlated with the in-orbit thermal results in order to achieve a validated thermal model.

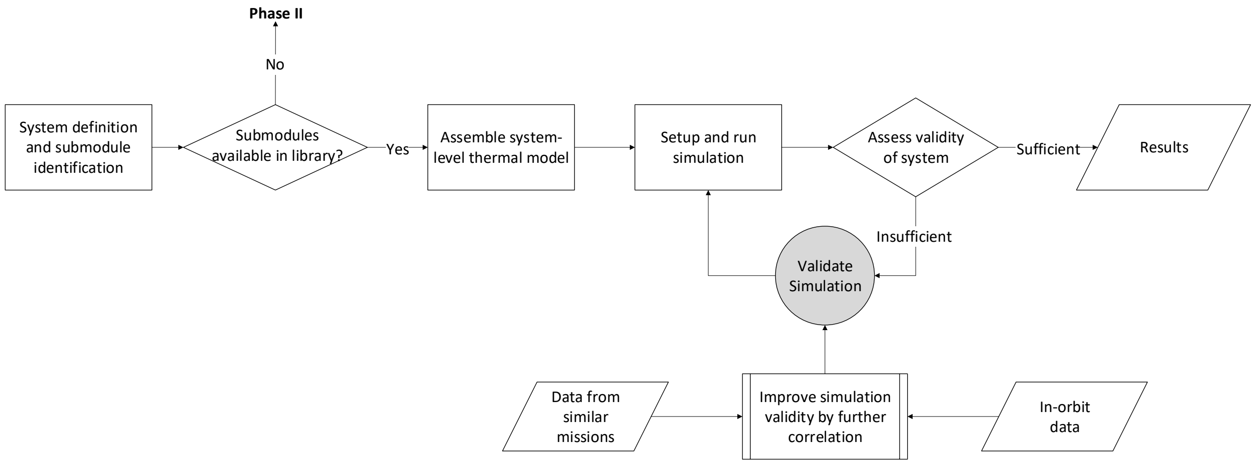

Figure II-4 Phase III flow of events covering the validation process of the project.

The entire verification and validation process will be captured and optimized where needed in order to offer a tool allowing streamlining of future verification and validation of new subsystems (thereafter to be added to the thermal library). Currently the project resides at the start of phase II. Phase I has been successfully completed last year and its results will be shared in the next section. Subsequently, an outlook on phase II and III will be provided.

III. PHASE I: Modular Thermal Modelling

In order to decrease the assembly time for a CubeSat thermal model, a modular approach for thermal modelling of a CubeSat is created in ESATAN-TMS. During this first stage of the project, a feasibility study was done, to investigate whether we can reach our goal of quick and accurate submodelling with ESATAN-TMS. By means of combining predefined submodels and applying minor corrections to transformations and to the geometry of the submodels, the assembly of a CubeSat can be obtained within a shorter time than building up the CubeSat model from scratch. It is emphasized that the modular approach discussed below is applied to CubeSat elements of the ISIS product line, but has been set up as generic as possible, in order to support modular thermal modelling of subsystems of other manufacturers as well. They are even encouraged to follow the same process allowing them to offer their modular thermal models to the community.

The process of modular thermal modelling consists of several steps, in which the first step is to identify a thermally relevant submodel. Submodels can be, for example, structural CubeSat elements, dedicated pieces of electronics (like PCBs), panels, and thermal solution devices. The thermal relevance of a submodel can be classified based on the power dissipated in the submodel, its thermal inertia, its material properties like thermal conductivity and heat capacity, and connections to other parts of the CubeSat. The dissipated power and thermal interfaces are regarded as most critical.

The designs of the thermally relevant submodels are simplified based on identification of the parts that have a large heat capacity, dissipate power, or have thermal connections to other submodels. A simplification of the ISIS TXS S-Band Radio is shown in Figure III-1 on the right.

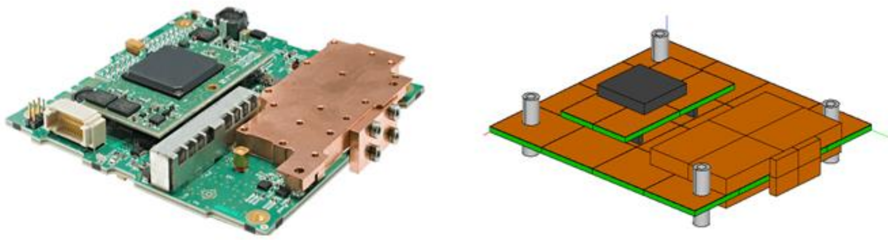

Figure III-1. ISIS TXS S-band Radio (left) and simplified ESATAN-TMS submodel (right).

In Figure III-1, on the right side of the TXS the copper heat sink is located. The copper heat sink has a large thermal inertia and interfaces with other submodels. Most importantly, the heatsink is on top of a heat dissipating element, that dissipates approximately 8W in the operational case (transmission mode). A daughterboard is mounted on top of a motherboard, and hosts a component that dissipates approximately 2W. The connection between the daughterboard and motherboard is modelled, as it is the main means of heat transfer from the daughterboard to the rest of the system. The Printed Circuit Board (PCB) is assembled in a stack in the CubeSat by threaded steel rods that go through the holes at the corners of the PCB. Aluminum spacers and washers provide the right height for the PCB in a stack.

This PCB has several ways to transfer heat to its environment which are, in expected order of magnitude, clamping of the TXS heatsink to the CubeSat-frame or a panel that is connected to a radiator (optional), via conduction through the aluminum spacers, and through CubeSat internal radiation. For the majority of subsystems, the heat conduction through the aluminum spacers is expected to be critical during the thermal design of a CubeSat, and is mainly dependent on the contact conductance which is a function of e.g. applied torque between the spacers and their contact area. Because the contact conductance relies on a lot of parameters, it is hard to define the exact value. Recent experimental efforts show a large uncertainty measure in contact conductances.[7] One of the objectives for Phase II will be to test and verify conductive values for these interfaces in a representative manner within a CubeSat frame.

The half aluminum spacers are modelled for each submodel, in order to be able to quickly assemble a stack of PCBs on top of each other. The interface between PCB and aluminum spacer is defined by a specified heat conductance. The geometric location where the parts of the aluminum spacers of different submodels contact each other in the thermal model, is in reality just one aluminum spacer that covers the vertical length between two PCBs, hence the interface in the thermal model is labelled as a “fused connection”. Note that it is not necessary to model the steel rods that run through the aluminum spacers, because the inner diameter of the spacers is larger than the outer diameter of the steel rods, and therefore these concentric, coaxial cylinders hardly make any contact. Figure III-2 shows the transformation of the ISIS 1U CubeSat structure into a thermal model, including the aluminium spacers.

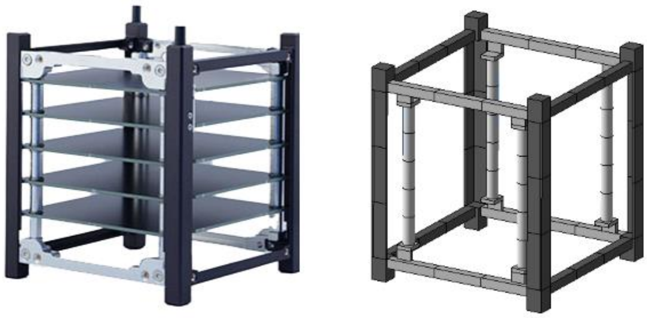

Figure III-2. Transforming a 1U ISIS CubeSat structure into an ESATAN-TMS thermal model.

In Figure III-3 the ISIS On Board Computer is shown on the left. Its thermal counterpart is shown on the right. The two smaller black boxes in the thermal model are processors and dissipate a combined heat in the order of 0.3W. Furthermore, the half aluminum spacers are also present in the submodel, similar to the submodel of the TXS as shown in Figure III-1. The CSKB provides electrical connections between PCBs. The CSKB mostly consists of plastic, but the 104 metal pins offer a way of heat transfer between PCBs on top of their purpose of electrical connection.

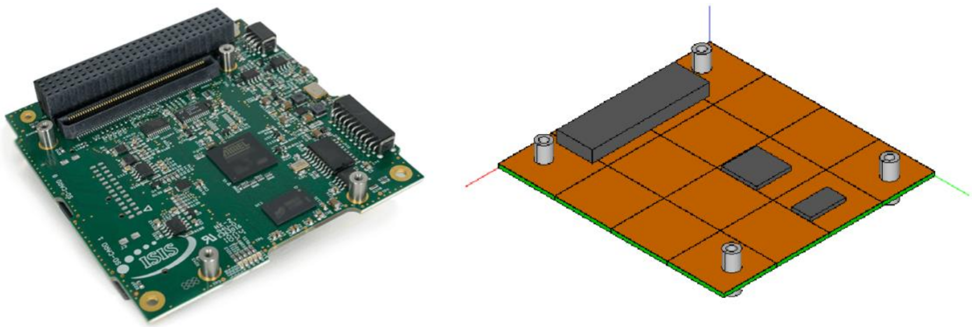

Figure III-3. ISIS On Board Computer (left) and simplified ESATAN-TMS submodel (right).

Applying the method as used above, all other submodels can be defined, e.g. PCBs, structural elements, deployable panels, and devices that serve as thermal control system.

The next step in the modular thermal modelling of a CubeSat is to assemble the submodels in ESATAN-TMS. Before assigning the model, the models need to be loaded into an empty slot. A bunch of properties of every submodel can be transferred from the submodel into the assembly, amongst which are the bulk material, optical properties, boundary conditions, conductive interfaces, user-defined conductors and specified property variables. After including the submodel into the target model, the target model can be assigned.

To correctly assemble the submodels, a transformation needs to be done to place the submodel at the right spot in the CubeSat-frame. In ESATAN-TMS this can be done by defining a point on the frame, where the origin has to be placed at, or by means of numbers in the Cartesian coordinate system. Since the aluminum spacers have different lengths per PCB in the stack, which is based on the PCB stack division, adaptations to the length of the aluminum spacers is common. The transformation is shown in Figure III-4 on the left and the resulting assembly after the transformation and geometry adaptation is shown on the right.

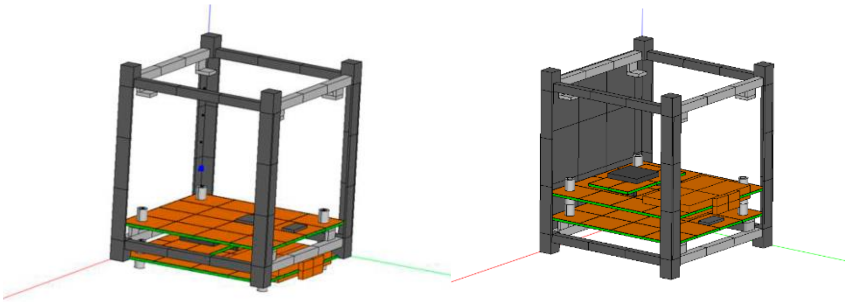

Figure III-4. 1U CubeSat assembly in ESATAN-TMS. The PCBs are the TXS (top) and OBC (bottom).

The last step of the submodelling procedure is to label the conductive interfaces between submodels correctly. As mentioned, the interfaces between the two parts of aluminum spacers of the PCBs are classified as “fused”, since they represent the upper and lower part of a single aluminum spacer. The fused connection has infinite contact conductance, whereas the connection between the aluminum spacers of a PCB with the frame is defined as “contact” with a specified value for the contact conductance. In Figure III-5 a 1U CubeSat is shown, with the conductive interfaces highlighted. Note that the PCBs consist of a layer of FR-4 and Copper, with a contact interface in between; that the aluminum spacers have a finite contact conductance with the PCBs; and that the aluminum spacers have a fused interface in the middle, because of the method used for the submodelling.

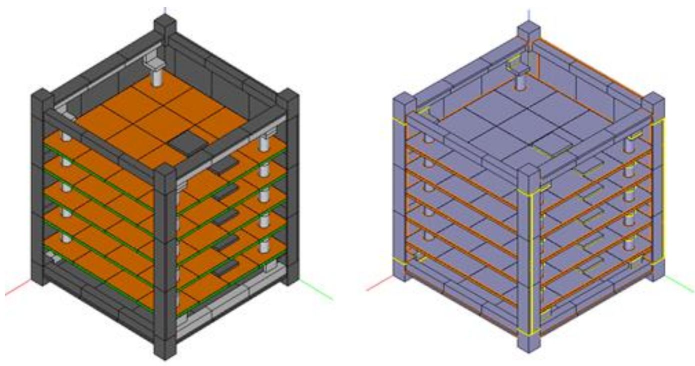

Figure III-5. PCB assembled in a 1U CubeSat-frame. Default ESATAN-TMS view (left) and view of conductive interfaces (right). The orange lines represent "contact" interfaces, yellow lines represent "fused" interfaces.

During this phase support has been provided where needed by ITP Engines, the developer of ESATAN-TMS. After the assembly has been set up, the radiative and thermal analyses can be done.

IV. PHASE II: The Verification Process

During the second phase of the project, the focus lies on verification. Verification is the aspect of confirming whether the system has been built right. In this case this means confirming that the thermally relevant parameters are modelled correctly, i.e. the right values are taken, and the thermal response is as expected for the different simplified models (not representing a fully assembled 2U satellite yet). This is done by correlating the results of simulations in ESATAN-TMS with the results of thermal vacuum tests, both on submodule level and for engineering model assemblies of several submodules. The environment in the simulation will be tailored to the thermal vacuum test set up.

Before the thermal vacuum tests take place, a sensitivity analysis will be performed on the simulation model, to judge the critical aspects in the model. By varying properties like contact conductances, geometrical features and radiative properties the criticality of the properties on the temperature distribution over the CubeSat will be investigated, which helps optimizing the thermal model after the thermal vacuum test results have been gathered.

The final engineering model that will be assembled in ESATAN-TMS as well as in the lab is a 2U CubeSat, with aluminium panels, including a TXS and OBC, which have both been discussed earlier.

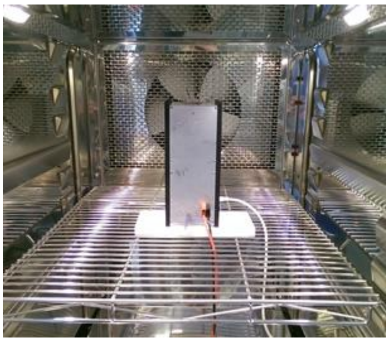

Figure IV-1 Foreseen thermal test setup.

The foreseen thermal vacuum tests resemble various cases of environmental temperatures and different orientations of the satellite, since the latter is relevant for the radiative heat transfer. The set of environment temperatures depends on the orbit of the chosen mission and critical temperatures of the OBC and TXS. During the tests, the CubeSat will be in a representative state of operation, hence the OBC and TXS will dissipate heat that is transferred to the frame and panels. The placement of temperature sensors in the test environment is crucial for the success of the thermal vacuum tests and the correlation with simulations. Several thermocouples will be placed at the faces of the CubeSat, as well as in the interior of the CubeSat, to be able to get a clear view of the temperature distribution in the CubeSat. In particular the heat transfer at critical interfaces of the CubeSat, identified in the early-stage simulations, will be evaluated by means of thermocouples. The interfaces between the aluminum spacers and PCBs will be a point to focus on.[7] Furthermore the CubeSat will be connected to electronic ground support equipment to be able to have the CubeSat in an operational representative state while it is situated in the thermal vacuum chamber. Figure IV-1 shows a CubeSat test-set up made in the past in a thermal ambient chamber. The foreseen tests are going to be executed in a thermal vacuum chamber but will be similar in set up.

V. PHASE III: The Validation Process

Phase III will tackle the validation aspect: Did we build the right system? An actual satellite will be fully modelled in ESATAN-TMS with the correct orbital properties and satellite attitude. In-orbit thermal data needs to be gathered as well as the state of the satellite at those moments in time.

ISIS has multiple missions flying (or flown in the past) from which thermal data is available. Data is available from the 2U QB50p1 satellite as well as data from the 6U Hiber-1 and Hiber-2 satellites.[2] An example of available data for this validation process is presented through Figure V-1 and Figure V-2. These data originate from the Hiber-1 6U satellite launched Q4 2018. The temperatures from both the panels and different subsystems are available and have been downloaded on a regular basis during the launch- and early operations phase and the commissioning phase.

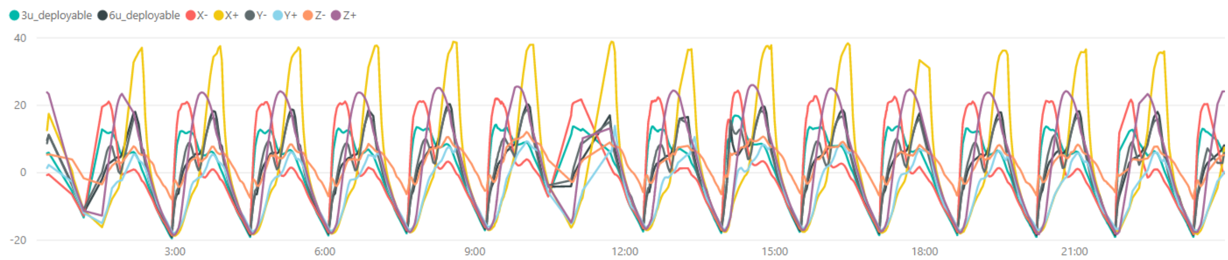

Figure V-1. Hiber-1 6U satellite panel temperatures measured for a full day on the 2nd of October 2019. The temperatures are visualized for 8 panels (+X, -X, +Y, -Y, +Z, -Z, and the 3U and 6U deployables).

Figure V-2. Hiber-1 6U satellite On Board Computer temperature measured for a full day on the 2nd of October 2019.

VI. Conclusion

The need for validation of CubeSat thermal analyses is presented. ISIS and NLR identified this need and by combining thermal experience, methods, and tools of NewSpace and Conventional Space companies a research project to investigate the potential of a modular approach for thermal modelling of CubeSats in ESATAN-TMS was initiated. The set up and intermediate results of this project is presented. The result of Phase I, a successful methodology for quickly creating reliable CubeSat ESATAN-TMS thermal models, is shown and an outlook on how this methodology will be improved, verified and validated in Phase II and Phase III of the project, is given.

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