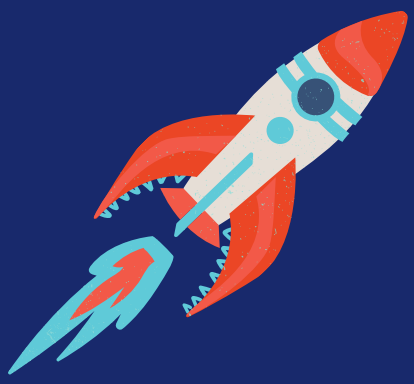
Proposal of internship subjects

Thales Alenia Space Belgium

2022-2023



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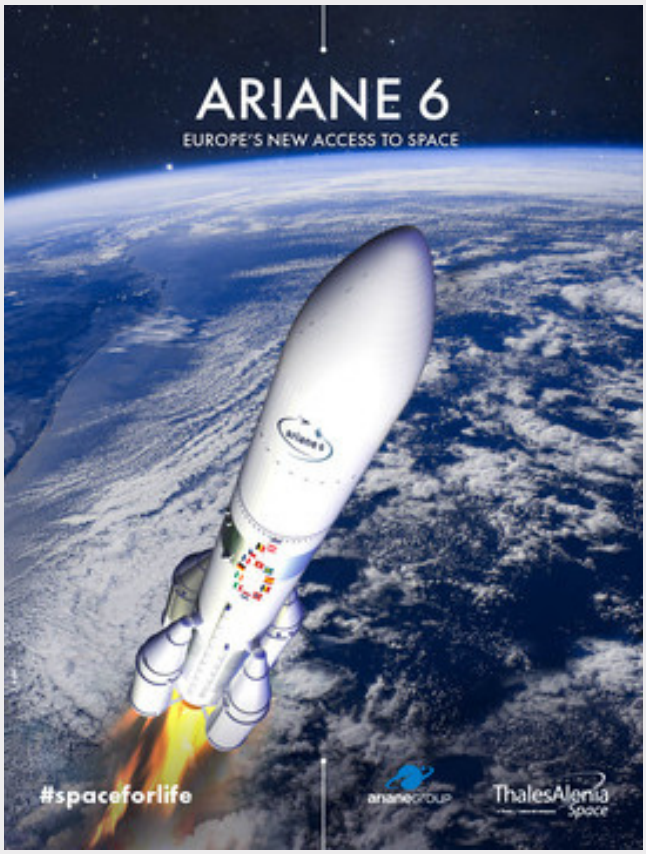
For your information:

Don't worry if you don't find what you are looking for, this is a non-exhaustive list of the open internships at Thales Alenia Space Belgium.

If you wish to apply to one of these opportunities or to propose an innovative idea you might have, please contact:
DSP-BE-STAGE@thalesaleniaspace.com

We would be happy to welcome you in our team.



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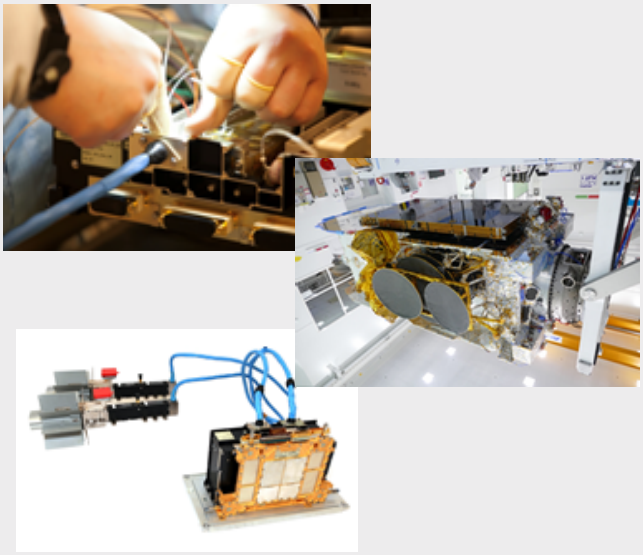
Design and validation of 300W DC/DC 28V-10kV

Promotors	A. Gadeyne, X. Lismonde
Guidance	A. Gadeyne, X. Lismonde, P. Fayt
Keywords	Space, satellite, EPC, DC/DC, High voltage converters
Required skills	Power electronics, or electronics
Contact person(s)	arnaud.gadeyne@thalesaleniaspace.com xavier.lismonde@thalesaleniaspace.com



WHY

Thales Alenia Space Belgium (TAS-B) is one of world-wide leaders in developing electrical energy conversion systems for the space industry.

More particularly TAS-B is one of very few companies who master the Linearized Channel Travelling Wave Tube Amplifier (LC-TWTA) products. This product is mainly build with an Electrical Power Conditioner (EPC) and Traveling Wave Tube (TWT). TAS-B makes and builds the EPC which is designed to cope with the TWT and is able to perform all the radio-frequency tests in order to validate the whole LCTWTA satellite product.

It is remarkable to highlight the fact that TAS-B has a long heritage on this product: more than 40 million hours have been up to now accumulated for our in-orbit (LC)-TWTA and more than 1000 EPCs were delivered to many customers.

So TAS-B is necessary in search of following the TWT market evolution. This because of an increasingly demanding market for satellite equipment. Nowadays TWT market is demanding to have a power supply (EPC) able to cope a 10kV TWT which will be powered with a 28V power bus.

The thesis subject aims to study the actual DC/DC topology included in the EPC which has been used to reach the 10kV based on a 100V power bus. However, due to high voltage complexity as well as stringent bus power requirements, the need of other DC/DC topology could be necessary.

Selected candidate(s) will have a chance to exercise their knowledge in edge-cutting technology of power converter, particularly in space industry, the highest qualified engineering beyond others.

Design and validation of 300W DC/DC 28V-10kV

WHAT

This proposed stage offers an internship position (3 months – could be extended to 6 months) for under-graduate/Master student(s). Intern(s) who will mainly work with DCDC design team to build and evaluate the performance of a new 300W power converter 28V-10kV which is intend to fit the TWT / power bus requirement.

HOW

The work is planned in three main milestones:

1. **Warm-up round: (5%)**
   - Introduction of LCTWTA products and more particularly to Electronic Power Conditioner which supply the TWT.
   - Review the actual DC/DC topology.
   - Review of alternative DC/DC topology.
2. **Fighting round: (75%)**
   - Define and design DC-DC converter with actual DC/DC topology.
   - Study of new DC-DC converter to cope with 28V bus and 10kV TWT requirements.
   - Implement hardware if possible to consolidate the new topology (15%) (under support of supervisor) - Applicable for 6 month internship only.
3. **Winning round: (20%)**
   - Evaluate performances of designed converters to obtain a competitive product to 10kV TWT.
   - Reflect on perspectives and lessons learnt from the internship.

PROFILE

Candidate(s) should have but not limited in the following knowledge/skills:

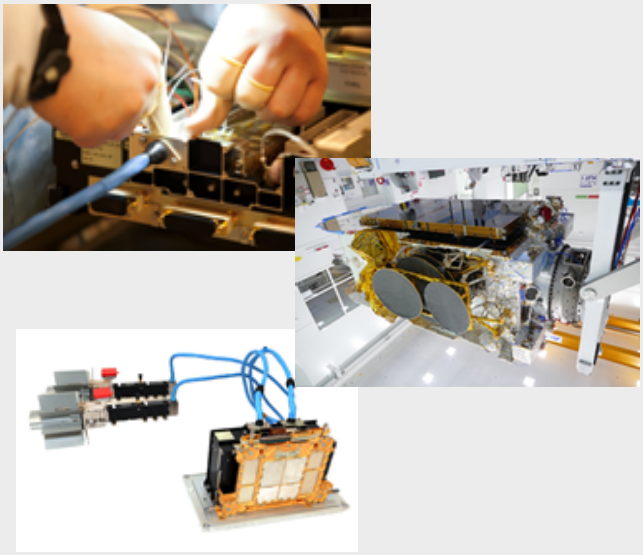
- Computer Engineering or Electrical Engineering preferable.
- Basic knowledge of power electronics.
- Passion in hands-on / lab activities, high voltage soft skills.
- English (preferable), French.
- Master degree

OTHER INFO

- Total 24 hours discussion with mentor and supporters.
- Hands-on work with electronic devices that you never met before.
- Minimum 2 months

Phase jitter characterization on a Travelling Wave Tube Amplifier (TWTA) functioning in Time-Division Multiplexing (TDM)

Promotors	A. Gadeyne, X. Lismonde
Guidance	A. Gadeyne, X. Lismonde, R. Martin
Keywords	Space, satellite, Radio-frequency, Performances
Required skills	Radio-frequency
Contact person(s)	arnaud.gadeyne@thalesaleniaspace.com xavier.lismonde@thalesaleniaspace.com



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So TAS-B is necessary in search of improving the RF performance of (LC)TWTA. This because of an increasingly demanding market for satellite equipment.

The stage subject aims to study the phase jitter effect and to characterize on a TWTA functioning in Time Division multiplexing.

Selected candidate(s) will have a chance to exercise their knowledge in edge-cutting technology of , particularly in space industry, the highest qualified engineering beyond others.

WHAT

This proposed stage offers an internship position (3 months) for under-graduate/Master student(s). Intern(s) who will mainly work with RF team to evaluate and characterize the phase jitter performance on a TWTA functioning in Time Domain Multiplexing.

Phase jitter characterization on a Travelling Wave Tube Amplifier (TWTA) functioning in Time-Division Multiplexing (TDM)

HOW

The work is planned in three main milestones:

1. **Warm-up round: (10%)**
   - Introduction of TWTA products and ATE
   - Review of RF performances notably phase jitter, TDM aspects
2. **Fighting round: (80%)**
   - Phase jitter study and characterization on a Travelling Wave Tube Amplifier
3. **Winning round: (10%)**
   - Presentation of RF performances
   - Reflect on perspectives and lessons learnt from the internship.

PROFILE

Candidate(s) should have but not limited in the following knowledge/skills:

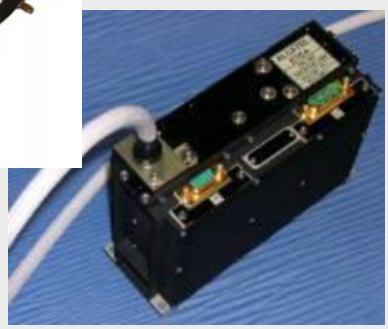
- Computer Engineering or Electrical Engineering preferable.
- Basic knowledge of radio-frequency performances.
- Passion in hands-on / lab activities.
- English (preferable), French.

OTHER INFO

- Total 24 hours discussion with mentor and supporters.
- Hands-on work with electronic devices that you never met before.

Design a new auxiliary supply for Electronic Power Conditioner (EPC)

Promotors	A. Gadeyne, X. Lismonde
Guidance	A. Gadeyne, X. Lismonde, , Q. Henneaux
Keywords	Space, satellite, EPC, converter, performances
Required skills	DC/DC converter, analogic electronic circuit
Contact person(s)	arnaud.gadeyne@thalesaleniaspace.com xavier.lismonde@thalesaleniaspace.com



WHY

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More particularly TAS-B is one of very few companies who master the Linearized Channel Travelling Wave Tube Amplifier (LC-TWTA) products. This product is mainly build with an Electrical Power Conditioner (EPC) and Traveling Wave Tube (TWT). TAS-B makes and builds the EPC which is designed to cope with the TWT and is able to perform all the radio-frequency tests in order to validate the whole LCTWTA satellite product.

So TAS-B is necessary in search the best EPC performances in terms of dissipation and efficiency. Some of EPCs used mainly for scientific satellites are fitted with unregulated bus voltage (= DC main bus of the satellite) and need to have inside a regulated voltage (called AuxiliaryRegulator) allowing to generate EPC internal needs for low level electronics through push-pull converters is generated.

The Auxiliary Regulator is implemented by a series regulator that is a simple converter but presents a very good rejection to any perturbations on the satellite bus voltage. But in terms of efficiency, the series regulator is not good at all, especially when operating on large range of bus voltage.

The goal of the internship is to propose and study a DC-DC converter instead of the series regulator, in order to save dissipated power, and then to be able to provide power supply to channel amplifier or linearizer.

Selected candidate(s) will have a chance to exercise their knowledge in edge-cutting technology of , particularly in space industry, the highest qualified engineering beyond others.

Design a new auxiliary supply for Electronic Power Conditioner (EPC)

WHAT

This proposed stage offers an internship position (3 months – could be increased to 6 months) for under-graduate/Master student(s). Intern(s) who will mainly work with EPC team to design a new auxiliary supply for EPC in order to increase its efficiency by keeping the perturbation rejection performances.

HOW

The work is planned in three main milestones:

1. **Documentation and specification of the DC-DC converter: (5%)**
   - Input voltage range
   - Output voltage
   - Output current
   - Conducted susceptibility
2. **Identification of the state-of-the-art existing DC-DC converters: in space high reliability quality (HIREL), in commercial off the shelf quality (COTS) (10%)**
3. **Design of the DC-DC converter: (50%)**
   - Electrical schematics
   - PCB routing (for prototype but taking into account final constraints as nb of layer, available area,…)
   - Parts procurement
   - Parts stress analysis
   - Worst case analysis
   - Thermal analysis
   - Radiations analysis
   - Regulation loop stability
4. **Test of a prototype of the converter: (30%)**
   - Tuning
   - Functional Test at ambient temperature (functionality, regulation loop stability margins, CS rejection,…)
   - Temperature tests
   - Extended test (temperature, power/current)
5. **Winning round: (5%)**
   - Reflect on perspectives and lessons learnt from the internship

*Note : point 1-2-3-4 and 5 are foreseen to be completed after 6 months.

PROFILE

Candidate(s) should have but not limited in the following knowledge/skills:

- Computer Engineering or Electrical Engineering preferable.
- Basic knowledge of DC/DC converter and analogic circuit.
- Passion in hands-on / lab activities.
- English (preferable), French.

OTHER INFO

- Total 24 hours discussion with mentor and supporters.
- Hands-on work with electronic devices that you never met before.

LCD touchscreen Lab control panel

Promotors	To be determined
Guidance	Thales Alenia Space Belgium
Keywords	Electronics, use interface
Required skills	Arduino, development toolchain
Contact person(s)	To be determined

WHY

In Thales Alenia Space Belgium (TAS-B) we develop complex electronic devices that need to be tested in labs. To help the tester to configure its setup, (supply Voltage, frequency, Duty cycle,...) we need and easy wayfor the operator to configure his/her setup.

WHAT

·We need tools to allow to operator to control its test bench via a simple GUI. The challenge is not only in making the tool but also in ensuring its extensibility, maintenance, deployment and documentation in an industrial environment.

HOW

- Determine what tools are available on the market to develop LCD (or OLED) touch screen based user interface.
- Evaluate the development toolchain associated with the LCD touchscreen and associated micro controller.
- Write a deployment procedure to explain how to install the toolchain.
- Apply this procedure to deploy the toolchain on a corporate computer.
- Make a demonstrator showing the GUI on a touch screen and using it to generate test signals.

PROFILE

The candidate should have some experience in electronics and programing, and should be able to document very accurately his/her work. The candidate should be in his bachelor's degree.

Buck converter digital regulation building block

Promotors	Terence Acconci, Stéphane Fraselle
Guidance	Terence Acconci
Keywords	Space, buck converter, satellite, plasma thruster, anode supply, DC/DC switching converter
Required skills	power electronics, or electronics, regulation (analog and digital)
Contact person(s)	stephane.fraselle@thalesaleniaspace.com terence.acconci@thalesaleniaspace.com

WHY

TThales Alenia Space Belgium (TAS-B) is one of world-wide leaders in developing electrical energy conversion systems for the space industry. TAS-B has provided high-end power electronic equipment's including PCU, PCDU, PSU, TWEA, RTU, PPU, and low-power DCDC to various customers over the world.

Nowadays, very efficient and compact supplies are required and digital regulation is imposing itself by its versatility, at least where the sampling computing delays are compatible with the targeted bandwidth. A lot of projects in TAS-B have used digital regulation with various simulations circuits used to validate the regulation performance before practical implementation. We would like to formalize a simulation building block (BBK) which would address the buck converter topology (to start with). This would allow to have a good starting point for similar designs.

WHAT

The thesis subject aims first to study the buck converter regulation. Typically, the high bandwidth current loop is implemented with a hardware circuit and the voltage loop (lower bandwidth) is implemented digitally in a microcontroller. The buck model and control has been documented at TAS-B so the student would need to read and understand the available documentation.

As a second step, a buck converter building block simulation would have to be implemented (with and without switching) to allow the simulation of the open loop transfer function and the current and voltage loops, both with an analog regulator (with delay related to the sampling and computation delay) and then a digitalized version (including the ADC model).

Once all aspect are model in relevant simulation circuit, a lab validation would take place on an available and relevant breadboard. The microcontroller used would be the TAS-B DPC which is qualified for space applications and which already features a development kit.

Buck converter digital regulation building block

HOW

The work is planned in three main milestones:

1. **Theory study: (20%)**
   - Review the buck model and control strategies.
   - If enouth time, the methodology could be formalized on another topology (such as a boost or flyback).
2. **Simulation building block development: (50%)**
   - Discuss with promotor to document relevant simulations which can be used as building blocks for future designs.
   - Implement and validate the simulations.
3. **Laboratory validation: (30%)**
   - Implement the regulation scheme on a relevant breadboard with the TAS-B micro-controller in order to validate the building block simulations.

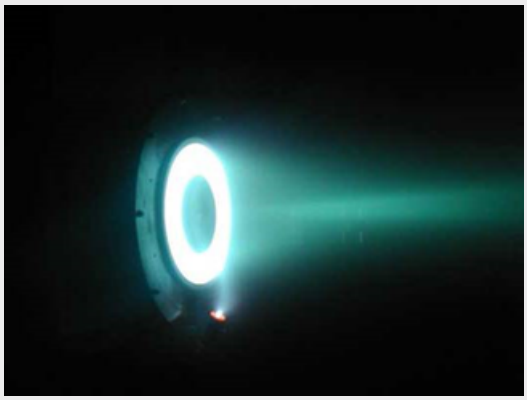
PROFILE

Candidate(s) should have but not limited in the following knowledge/skills:

- Knowledge of electronics, power electronics and analog/digital regulation .
- Passion in hands-on / lab activities, and particularly space satellites.
- Know-how of PCB design tools like Altium, AMS, Cadence OrCAD, Eagle, etc.
- English is required, French and Dutch as assets.

Optimization of a LLC converter for plasma thruster anode supply

Promotors	Clément Marlier, Stéphane Fraselle
Guidance	Clément Marlier
Keywords	Space, HEMPT, HET, LLC, satellite, plasma thruster, anode supply, DC/DC switching converter
Required skills	power electronics, or electronics
Contact person(s)	stephane.fraselle@thalesaleniaspace.com clement.marlier@thalesaleniaspace.com



WHY

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Nowadays, very efficient and compact supplies are required to operate plasma thrusters (HEMPT or HET) for small satellites for constellations.

Power electronics for space applications is not outside of the new technology revolution. Besides the recent success of GaN which is a brilliant alternative for HiRel power solutions, switching technique of power supplies is also studied to meet challenges in high power, high density products.

For the anode supply, the resonant LLC topology has been selected after a trade-off and a breadboard has been manufactured and tested. This topology provides the required isolation, good efficiency thanks to ZVS and ZCS possibilities but poses challenges in particular for the transformer and L tank implementation (Eddy losses….) and transparency (rejection of thruster noise).

Optimization of a LLC converter for plasma thruster anode supply

WHAT

The thesis subject aims to study the LLC topology for a 700W output power and 300 to 400V output (variant with 600 to 800V output), study it's associated losses and try to optimize it's efficiency.
Current designs do not use the regulation capability of the LLC: it is used at a fixed operating point to ensure galvanic insulation and voltage ratio between input and output. The LLC is fed by a regulating buck converter. The optimization of efficiency would be implemented by the right choice of components (rectifying diodes), clever magnetic configurations and resonant waveform optimization to reduce the switching losses.
A second step of efficiency optimization of such a converter is to use its regulation capability and remove the whole buck converter. In such a configuration, the great challenge is to implement the proper regulation targeted performances (bandwidth, stability, noise rejection, ...).
This proposed thesis offers an internship position (3-9 month max.) for under-graduate/Master student(s). Intern(s) will mainly work with DCDC design team to study and optimize the performance of a 700W LLC. Final topology will be discuss in details when the candidate(s) start(s) his/her internship.

HOW

The work is planned in two main milestones:

1. **Theory study and simulations: (60%)**
   - Review the topologies used in TAS-B products of which the rectification stage is possibly converted to active switching.
   - Evaluate the trade-off between gain of efficiency versus control complexity and volume gain.
2. **Engineering study: (40%)**
   - Discuss with promotor to select a configuration for the efficiency improvement experimental demonstration.
   - Implement hardware under supports of supervisor(s).
   - Conduct experimental validation on a representative breadboard.

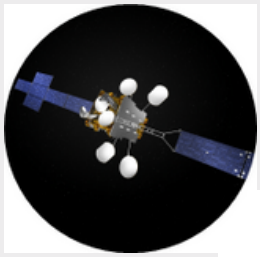
PROFILE

Candidate(s) should have but not limited in the following knowledge/skills:

- Knowledge of electronics, power electronics and know-how of magnetics like inductors and transformers.
- Passion in hands-on / lab activities, and particularly space satellites.
- Know-how of PCB design tools like Altium, AMS, Cadence OrCAD, Eagle, etc.
- English is required, French and Dutch as assets.

Space Flight Firmware

Promotors	Bolsee Jean-Louis
Guidance	Thales Alenia Space Belgique
Keywords	embedded, software, micro-controller, cross-development toolchain, CI/CD
Required skills	Computer science, embedded software, C & Python languages.
Contact person(s)	jean-louis.bolsee@thalesaleniaspace.com



Konnect VHTS, the most powerful telecommunication satellite in the world, hosts more than 50 micro-controllers provided by TAS-B. Each of those micro-controller performs a dedicated firmware. This is a typical example of the importance of firmware within our equipments.

4 internships subjects available in the firmware team !

WHY

Digital technology is a key differentiator in Space domain in term of competitiveness, efficiency, and flexibility. Thales Alenia Space Belgium (TAS-B) has thus deployed this technology in all of its product lines thanks' to an in-house developed micro-controller dedicated to Space applications [1].

A dedicated software team is in charge to take benefits of this platform by designing Critical Embedded Real-Time Firmware applications:

- Critical because failure is not an option: due to the role of those firmwares (in interaction with most of the satellite equipments such as On Board Computer, Thrusters, Batteries, Solar Arrays, Thermal Control, Attitude control, Payloads,...), a strong and error-safe development process is applied.
- Embedded because the development targets consists in in-house designed PCA (Printed Circuit Assembly), without any direct human interactions.
- Real-Time because time constraints could be as stringent as a few micro-seconds.
- Firmware because the software is extremely close to the hardware (e.g. bare-metal), just at the border between analog & digital worlds.

Space Flight Firmware

WHAT

Several internships subjects are open in the firmware team:

- Evaluation of new cross-development toolchain generation: the purpose being to perform a market survey followed by a comparison study of state-of-the-art cross-development toolchains able to optimize usage of the available resources utilization (memory, CPU,…) while providing large range of services (debugging, profiling, tracing,…).

- Definition of a real-time schedulability analysis approach tailored to firmware applications: the purpose is to identify and deploy an efficient methodology to perform WCET (Worst Case Execution Time) analysis which proves that time-constraints are always fulfilled during firmware execution, independently from the load & events.

- Deployment of a coding & security rules standards: developing critical software always rely on strict rules & conventions aimed to reduce the risk of coding errors, facilitate the code maintainability, prevent risk of security flaws, ease the co-development,… The purpose of this subject is to make evolve the current coding referential by a new one, resulting in an improvements of all of the preceding points.

- Improvements of the CI/CD pipeline: continuous integration & deployment is a major contributor to development efficiency. However it needs to continuously evolve to maximize benefits from the different development & test tools. The purpose of this subject is twofold:
  - Revisit current pipeline.
  - Develop new software test means.

HOW

Depending on internship duration & candidate profile, the subjects can be treated independently, gathered, or split in sub activities.

Anyway, each candidate will be closely followed & supported by a mentor with a strong experience within the firmware team. In addition of the mentor, the candidate will be integrated within the team, resulting in many interactions with other developers.

Subject generally consist of the following phases:

- **Subject & domain introduction:**
  - Discovery of the subject field
  - Gap filling (if missing skills)

Space Flight Firmware

- **Evaluation:**
  - Comparative study
  - Trade-off analysis
  - Solution selection

- **Development & deployment:**
  - Development of the solution
  - Installation & configuration
  - Verification

- **Anchoring:**
  - Documentation (user manual, PowerPoint, Wiki, training material,…)
  - Diffusion to users

PROFILE

Candidate(s) should have, but not limited in the following, knowledge/skills/qualification:

- Bachelor or Master in Computer Science.
- Passion for C based embedded low-level development.
- Proven interest in related fields as robotics, IoT, domotic, RPI, Arduino like,… is an asset.
- Interest for all the phases of the software development cycle.
- Awareness of state-of-the-art cross-development technos.
- Basic knowledge of Python.
- English is required, French and Dutch as assets.

OTHER INFO

Major part of the internship has to be realized on-site.

References:
[1] https://artes.esa.int/projects/digital-controller-power-management

Measurement using an IR Camera

Promotors	To be determined
Guidance	Thales Alenia Space Belgium
Keywords	Electronics, test
Required skills	Software, electronics, test
Contact person(s)	To be determined

WHY

In Thales Alenia Space Belgium (TAS-B) we develop complex electronic devices that need to be tested. Among other things to test we need to ensure that each component on the board tested handles power correctly. E.g. if two or more components are placed in parallel to ensure redundancy and to increase power handling capacity, it is hard to determine if the power is indeed well balanced among the components.

WHAT

- To determine if a component is dissipating heat, we can use a thermal camera to measure its temperature.
- We need to develop a tool based on a thermal camera that could be used to identify automatically hot spots (i.e. point where and abnormally high amount of power is dissipated) and cold spots (i.e. components that are not dissipating the right amont of heat) compared to a reference image.

HOW

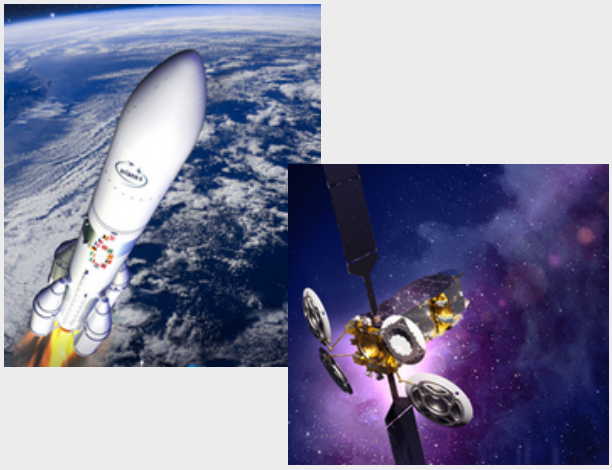
- Determine what tools are available on the market: what camera are available, what associated software exists, what are the software licenses and the associated costs.
- Determine how to interface the camera software with the test toolchain used in TAS-B.
- Determine in which conditions the camera can be used (it probably cannot be used during tests in vacuum but can it be used reliably during thermal cycling tests).
- Make a prototype including a camera, a board with components that can become hot when activated, and a software that identifies automatically hot and cold spots.

PROFILE

The candidate should have some experience in electronics and programing, and should be able to document very accurately his/her work.

Power & Analog Electronic Design Engineer

Promotors	Nicolas Chapuis
Guidance	Thales Alenia Space Belgium
Keywords	Power electronics, analog electronics
Required skills	Power Electronics, Analog Electronics, Regulation/Automatics, Spice simulations
Contact person(s)	Nicolas.chapuis@thalesaleniaspace.com



WHAT

Power & Analog Electronic Design Engineer:

Activities:

- Trade-off between a few technical solutions (analyze of electrical performances).
- Improvement of the electrical design using Microcap Spice software.
- Electrical schematics drawing using Eagle software.
- Layout/rooting of the PCB using Eagle software.
- Components (BOM) ordering using Excel and follow-up.
- Breadboard tests preparation (test plan, test procedure, test setup, ...).
- Breadboard tests realization in the laboratory & design optimization .
- Test report writing and oral presentation to the team.

PROFILE

Candidate(s) should have, but not limited in the following, knowledge/skills/qualification:

- Languages: French or English.
- Studies : min. BAC+3 (1st or 2nd Master year on-going).
- Current studies : engineering studies in Electronics, Electricity or equivalent.
- Hard skills: Power Electronics, Analog Electronics, Regulation/Automatics, Spice simulations.
- Soft skills : curious, autonomous, technical.

OTHER INFO

Minimum 3 months, full-time.

Replacement of the active circuit breaker in the LCL

Promotors	David Vandromme, Mourad Merabtene
Guidance	Thales Alenia Space Belgium
Keywords	Power electronics, analog electronics
Required skills	·Power Electronics, Analog Electronics, Loops, Stability, Regulation, Simulation
Contact person(s)	david.vandromme@thalesaleniaspace.com

WHAT

Power & Analog Electronic Design Engineer:

Activities:

- Replacement of the active circuit breaker in the LCL (Latching Current Limiter) function.
- We currently use MOSFET active components to break the available current for the users on board the satellite. These are to be replaced by GaN components.
- It's required to understand the GaN operating and equivalent schematic, and simulate the component and the global function with Spice software.
- The final step is the simulation in a demonstrator model at laboratory and comparison with the simulation. This requires to define the breadboard model and test plan.

PROFILE

Candidate(s) should have, but not limited in the following, knowledge/skills/qualification:

- Languages: French, Basic English.
- Studies : 1st or 2nd Master year on-going.
- Current studies : engineering studies in Electronics, Electricity or equivalent.
- Hard skills: Power Electronics, Analog Electronics, Loops, Stability, Regulation, Simulation.
- Soft skills : curious, autonomous, technical.

OTHER INFO

Minimum 3 months, full-time.

Matlab Toolbox Development for the simulation of launcher trajectories (Ariane, Vega, Callisto, etc.). Application to launcher safeguard system units.

Promotors	Thierry Sartenaer
Guidance	Thales Alenia Space Belgium
Keywords	Aerospace, Launchers, Navigation, GPS
Required skills	Algorithmic, Matlab, Navigation
Contact person(s)	thierry.sartenaer@thalesaleniaspace.com

WHY

Thales Alenia Space Belgium (TAS-B) is mainly active in the development of power electronics systems for the space industry.

The launcher activity of TAS-B includes the design, development, manufacturing and test of the safeguard system used onboard European Launchers (Ariane 5, Ariane 6, Soyuz, Callisto) launched from CSG (Centre Spatial Guyanais). The goal of the safeguard system is to neutralize the launcher (destruction or engine cutoff) in case of a significant deviation from the expected trajectory that compromises the security of the population on ground. This requires real-time estimation of the launcher localization (position, velocity, attitude) usually obtained via radar triangulation.

In the context of new reusable launchers whose lower stage(s) have to come back to ground after the mission, localization means are progressively replaced by onboard systems including GNSS (GPS, Galileo) and Inertial Navigation Systems. This represents a new class of activity for TAS-B.

WHAT

New Simulation Tools are needed to help in the development and testing of new GNSS / Inertial localization equipment to be used onboard European Launchers.

The simulation tool should include at least the possibility to generate representative trajectory data of usual launcher missions. Generated trajectories shall be used as inputs for multiple purposes :

- To generate inputs for the testing of launcher localization algorithms
- To generate rules for the automatic destruction of a launcher during flight (in case of potential danger)

Matlab Toolbox Development for the simulation of launcher trajectories (Ariane, Vega, Callisto, etc.). Application to launcher safeguard system units.

HOW

- Understand and analyze the launcher safeguard systems under development, especially the onboard equipment in charge of launcher localization.
- Understand and analyze the GNSS systems (GPS, Galileo).
- Understand and analyze the Inertial Navigation systems.
- Understand and analyze the hybrid navigation algorithm (based on Kalman filter for the hybridation of GNSS and Inertial Navigation data).
- Collect Trajectory data of European launchers (Ariane 5, Ariane 6, Vega, Soyuz, Callisto, Themis), in various formats.
- Design a Matlab Toolbox to generate launcher localization (position, velocity, attitude) in various formats and reference systems.
- Demonstrate the use of the developed toolbox for at least one of its target operational uses :
  - Performance simulation of localization algorithm.
  - Derivation of simple rule for the automatic decision of neutralization (eg: over-propulsion, off-nominal rotation speed, attitude reversal, etc.).
  - Generation of test data in support to automatic test sequence.

Study and Development of electronic building blocks for satellite applications (aka pico/nano RTU (Remote terminal Units))

Promotors	To be determined
Guidance	Thales Alenia Space Belgium
Keywords	Space, satellite, avionics, RTU, ASIC
Required skills	Analogue electronics
Contact person(s)	To be determined

WHY

Thales Alenia Space Belgium is mainly active in the development of power electronics systems for the space industry.

It is necessary to increase the agility and flexibility of avionics. This because of an increasingly demanding market for satellite avionics equipment. Particularly in terms of cost and lead times. (the offer phase). Knowing that customer requirements are often (re)defined in a later stage.

WHAT

To increase flexibility, TAS-B proposes an avionics architecture that is decentralized.
Specific or potentially late-defined functionalities can be split into standard "building blocks". Also known as ”nano RTU’s”.

This universal analog front end will bring a lot of flexibility to our customers as it allows to connect any type of acquisition, such as:

- Thermistors
- Analogue Signal Monitor
- Bi-level Switch Monitor
- Wien Wheatstone Bridges

Generic functionalities, such as communication with the on board computer, can remain centralized (inside the RTU equipment).

Study and Development of electronic building blocks for satellite applications (aka pico/nano RTU (Remote terminal Units))

HOW

- Understand and analyze the different types of acquisition.
- Defining a decentralized satellite architecture (functional diagrams).
- Defining the analog front end Building blocks (Define electrical schematics based on available partlist).
- Designing the analog front end Building blocks:
  - Modeling the electronic circuits (Spice-like simulator).
  - Simulating the electronic circuits (Spice-like simulator).
  - Perform analyses (worst case, parts stress, failure cases).
- Development and test of the first prototypes:
  - Define scope of prototypes of the building blocks.
  - Design PCB schematics and layout (eagle).
  - Procure PCB and parts.
  - Build the prototypes.
  - Validate and test the prototypes.

The Master Thesis proposal consists in:

- Defining the architecture and the global system.
- De-risking critical analog functions, i.e. designing, modeling, validating prototypes of these critical functions that will later be integrated in an analog asic.
- Building a prototype in a discrete version of the "dream" component.

Control study for synchronous rectification in switching power supplies

Promotors	Jean-Pierre DELPLANQUE, Pierre HALLET
Guidance	Jean-Pierre DELPLANQUE
Keywords	Space, satellite, avionics, DC/DC switching converter
Required skills	power electronics, or electronics
Contact person(s)	nicolas.rigot@thalesaleniaspace.com jean-pierre.delplanque@thalesaleniaspace.com

The 1,000th electronic power conditioner (EPC) built by Thales Alenia Space in Belgium was on the SES-17 satellite. EPC is one of product of which the performance can be improved from this internship study [1].

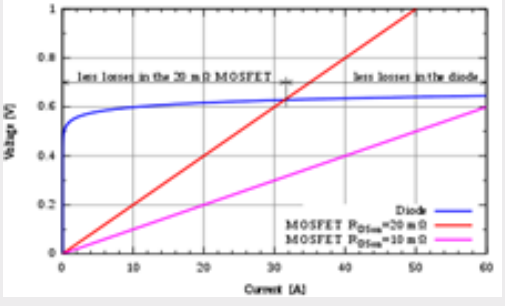
WHY

Thales Alenia Space Belgium (TAS-B) is one of world-wide leaders in developing electrical energy conversion systems for the space industry. TAS-B has provided high-end power electronic equipment's including PCU, PCDU, PSU, TWEA, RTU, and low-power DCDC to various customers over the world.
Nowadays, more power is demanded in every new satellites and spacecrafts. While these "New Space" companies like SpaceX and Virgin Galatic are making headlines, "Old Space" organizations keep pushing the technology boundaries of outer space[2].
Power electronics for space applications is not outside of the new technology revolution. Besides the recent success of GaN which is a brilliant alternative for HiRel power solutions, switching technique of power supplies is also studied to meet challenges in high power, high density products.

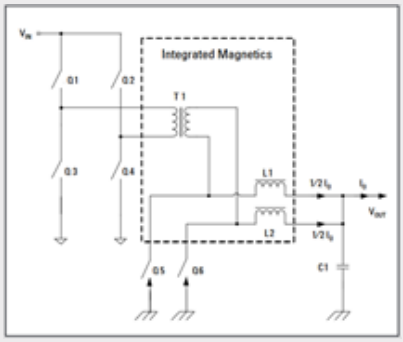
Synchronous rectification replacing diodes with actively controlled switches [3]

All switching power converters consist of rectification stage which rectify pulse current to DC power for the load. The rectification is by diode or power switches which are namely passive or active rectification, respectively.
Although the diode rectifier solution is simple and low-cost, the voltage drop causes some heat losses[4,5]. Additionally, it is not a good idea for some point-of-load applications where the output is from 1V-3V3 like EPC modules.

When EPC is multiplied for multiple loads, the reduction of loss across rectifier diodes allows to simplify the cooling solution which is a critical point in space products. Power FET (Si/SiC/GaN) has much lower Rds than that in diode. Therefore improving converter efficiency by synchronous(active) rectification is a prominent solution space-grade power supplies[6]



Synchronous rectification replacing diodes with actively controlled switches [3]



Control study for synchronous rectification in switching power supplies

WHAT

The thesis subject aims to define the synchronous rectification solution for a 100W modular converter. Selected candidate(s) will review the state-of-the art of methods used to control transistors which drive the synchronous rectification in switch-mode power supplies.

Then an appropriate solution for an implementation in a space environment is identified and validated by experiments in TAS-B laboratory in Leuven/Louvain.

This proposed thesis offers an internship position (6-9 month max.) for under-graduate/Master student(s). Intern(s) will mainly work with DCDC design team to build and evaluate the performance of a 100W active rectification stage. Final topology will be discuss in details when the candidate(s) start(s) his/her internship.

HOW

The work is planned in three main milestones:

- **Theory study: (40% TBC)**
  - Review the topologies used in TAS-B products of which the rectification stage is possibly converted to active switching.
  - Evaluate the trade-off between gain of efficiency versus control complexity and volume gain.
- **Engineering study: (50%)**
  - Discuss with promotor to select a topology for the experimental demonstration.
  - Implement hardware under supports of supervisor(s).
  - Conduct experimental validation.
- **Evaluation: (10%)**
  - Evaluate obtained results and compare to competitive products.
  - Reflect on perspectives and lessons learnt from the internship.

PROFILE

Candidate(s) should have, but not limited in the following, knowledge/skills/qualification:

- Knowledge of electronics, power electronics and know-how of magnetics like inductors and transformers.
- Passion in hands-on / lab activities, and particularly space satellites.
- Know-how of PCB design tools like Altium, AMS, Cadence OrCAD, Eagle, etc.
- English is required, French and Dutch as assets.

OTHER INFO

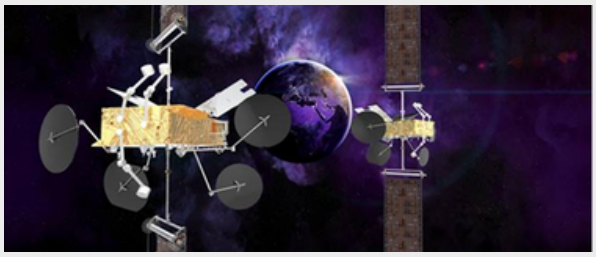
- Minimum 80 hours lab-work in Leuven for 6-9month intern(s).
- Minimum 24 hours discussion with mentors, supporters, and technician.
- Hands-on work with electronic devices that you may never met before.

References:
[1] https://www.thalesgroup.com/en/worldwide/space/news/1000th-epc-thales-alenia-space-belgium-orbit-ses-17
[2] https://gansystems.com/newsroom/space-jpl-nasa/
[3] https://en.wikipedia.org/wiki/Active_rectification
[4] https://www.all-electronics.de/wp-content/uploads/2018/11/AN6608.pdf
[5] C. Blake, D. Kinzer and P. Wood, "Synchronous rectifiers versus Schottky diodes: a comparison of the losses of a synchronous rectifier versus the losses of a Schottky diode rectifier," Proceedings of 1994 IEEE Applied Power Electronics Conference and Exposition - ASPEC'94, 1994, pp. 17-23 vol.1, doi: 10.1109/APEC.1994.316424.
[6] http://www.irf.com/product-info/hi-rel/tp-espc.pdf

Soft-switching converters using TAS-B in-house GaN portfolio

Promotors	Marc FOSSION, T-D MAI, Pierre HALLET
Guidance	T-D Mai, Marc FOSSION
Keywords	Space, satellite, avionics, GaN, converters
Required skills	power electronics, or electronics
Contact person(s)	nicolas.rigot@thalesaleniaspace.com tuandat.mai@thalesaleniaspace.com

GaN power controller made by TAS-B



Intelsat-41 and 44: a satellite family empowered by TAS-B's GaN products

WHY

Gallium Nitride (GaN) semiconductor is proven an alternative for Si-semiconductor in power converters below 10kW. Additionally, GaN-based devices are more resistant under radiation effects due to wide-band gap characteristics. Therefore, using GaN in future power converter is becoming an inevitable trend not only in domestic and automotive industries, but also in satellite and spacecraft industry.

Thales Alenia Space Belgium (TAS-B) is one of world-wide leaders in developing electrical energy conversion systems for the space industry. Products using GaN have been kicked-off since 2014 and is continuously growing to maintain the competitiveness of TAS-B among global space industry. We successfully developed in-house GaN products including controllers, drivers, power switches and integrated power switches.

It is remarkable to highlight that TAS-B is one of very few companies who master the GaN rad-hard devices in EU. TAS is also the unique satellite manufacturing company in EU who realizes both GaN device production and converter production.

The thesis subject aims to address soft-switching technique which has been proven to raise the overall efficiency in Si-based converters. However, due to its control complexity as well as stringent requirements of long-term robustness in satellites, the soft-switching technique is rarely applied in space-grade converters. Nowadays, thanks to recently obtained success in rad-hard integrated GaN half-bridge (GaN ½), it is essential to explore soft-switching for GaN converters at all engineering levels.

Selected candidate(s) will have a chance to exercise their knowledge in edge-cutting technology of power converter, particularly in space industry, the highest qualified engineering beyond others.

Soft-switching converters using TAS-B in-house GaN portfolio

WHAT

This proposed thesis offers an internship position (3-6 months max.) for under-graduate/Master student(s). Intern(s) will mainly work with DCDC design team to build and evaluate the performance of a 34W power converter which will supply a galvanized isolated power for low-voltage devices. The heart of converter is an TAS-B in-house GaN ½ and current-mode controller.

HOW

The work is planned in three main milestones:

- **Warm-up round: (5%)**
  - Review the differences of Si and GaN devices, hard-switching and soft-switching.
  - Summarize possible topologies for soft-switching, preferring half-bridge/full-bridge with multi-level extension.
  - Study the operation of developed converter in satellite architecture (functional diagrams).
- **Fighting round: (75%)**
  - Define the controller technique for enabling soft-switching, then validate by simulation (30%).
  - Implement hardware (15%) (under support of supervisor). [1]
  - Conduct experimental validation (30%). [2]
- **Winning round: (20%)**
  - Evaluate obtained results and compare to competitive products.
  - Reflect on perspectives and lessons learnt from the internship.

[1] Applicable for 6-9 month internship only.
[2] Applicable for 6-9 month internship only.

PROFILE

Candidate(s) should have, but not limited in the following, knowledge/skills/qualification:

- Computer Engineering or Electrical Engineering preferable.
- Basic knowledge of power electronics and automatic control.
- Passion in hands-on / lab activities, RC hobbies, and particularly space satellites.
- Know-how of PCB design tools like Altium, AMS, Cadence OrCAD, Eagle, etc.
- DSP/µC programming is a plus.
- English (preferable), French(preferable), Dutch.

OTHER INFO

- Minimum 80 hours lab-work in Leuven for 6-9month intern(s).
- Total 24 hours discussion with mentor and supporters.
- Hands-on work with electronic devices that you never met before.

References:
[1] Vankayalapati, Bhanu Teja, et al. "Comparison of Si and GaN power devices based SMPS for satellite application." 2018 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES). IEEE, 2018.
[2] D. Reusch and J. Strydom, "Evaluation of Gallium Nitride Transistors in High Frequency Resonant and Soft-Switching DC–DC Converters," in IEEE Transactions on Power Electronics, vol. 30, no. 9, pp. 5151-5158, Sept. 2015, doi: 10.1109/TPEL.2014.2364799.
[3]https://indico.esa.int/event/300/contributions/6075/attachments/4161/6273/GANIC4S-TASB-XR-0027-02-AMICSA.pdf
[4] https://www.eetasia.com/power-design-with-gan-for-space-apps-qa-with-epc-ceo-alex-lidow/
[5]https://www.esa.int/Enabling_Support/Space_Engineering_Technology/Improved_gallium_nitride_recipe_could_spark_space_communication_revolution.

Embedded processor upgrade

Promotors	To be determined
Guidance	Thales Alenia Space Belgium
Keywords	Electronics, embedded, MCU
Required skills	Software, electronics, embedded
Contact person(s)	To be determined

WHY

In Thales Alenia Space Belgium (TAS-B) we develop specific test equipment used in automated production lines. Those devices use embedded controllers (MCU) to perform high accuracy acquisitions, real time regulations and other auxiliary functions. Currently those MCU are Silicon labs processors based on the obsolete Intel 8 bits architecture 8032/8051, we need to upgrade them to newer architecture.

WHAT

- List current MCU architectures (ARM Cortex, RISC-V,etc).
- Identify all the requirements for the MCU (number of ADC and DAC channels, speed accuracy, availability, multiple sources, Package surface, etc).
- Identify among the available products which one are the most appropriate.
- Demonstrate the performance of the selected processor.

HOW

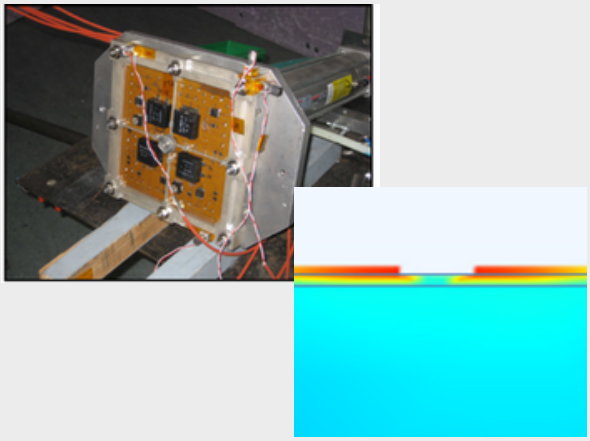
- Write a requirement document for the device control embedded processor.
- Write a list of processor compliant with the requirements.
- Identify the trade offs and select one MCU.
- Request / build a demonstrator board using the selected processor.
- Install a toolchain to compile programs to run on the selected processor.
- Convert an existing 8032/8051 assembler program into a higher level real time language (C?, C++?, RUST ?).
- Deploy the compiled program and demonstrate that the performance in speed and measurement accuracy.

PROFILE

Candidate should have some experience in embedded design, micro controller and assembler and C programing, and should be able to document very accurately his/her work.

Internship Techno

Promotors	To be determined
Guidance	Thales Alenia Space Belgium
Required skills	Electronic components, manufacturing means
Contact person(s)	HASLINGER Michael



WHY

In Thales Alenia Space Belgium (TAS-B), the reliability, performance and cost of our equipment's are the important factors to take into account during the complete product cycle: From early development to manufacturing and testing. Space grade electronics are submitted to a broad set of environmental constrains, the most famous being mechanical stress (vibrations and shocks during launch), radiations and thermal stress while in orbit. Despite this challenging environment, our product has very long-life expectancy: From a few years, up to fifteen years without failure.

WHAT

To succeed we work on electronic design reliably but also on technologies and assembly processes. We study new technologies to improve our current products or work on concepts and ideas for the future. In our facilities on the Charleroi site, we have the industrials means for manufacturing and testing such technologies.

HOW

Depending on the item to validate we will use different testing means.
Typically:

- Internal knowledge gathering and literature study
- Simulations
- Discussion with technology/quality experts
- Manufacturing of test vehicles
- Environmental testing

The purpose can be an early estimation to cover the most critical aspects (called derisking) or the complete qualification following the standard of the industry (ESA specifications most of the time). In this context: testing will include so-called environmental aspects (thermal cycles, vacuum, vibrations..) and/or electrical validation.

Internship Techno

PROJECTS

Technology engineers at Thales Alenia Space have different backgrounds (Thermal engineering, metallurgy, micro-electronics, high-voltage, packaging, chemist, etc) all oriented toward space product manufacturing. The choice of the internship subject will be done in concertation with the technology manager to match our needs and possibilities with the applicant's background.

Examples of subject (to be discussed)

High efficiency thermal substrate validation and derisking
Objective: Early validation of a new substrate technology for space applications

Component brazing reliability evaluation
Objective: Study the reliability of component brazing after various stress

Ageing law estimation for electronic assembly
Objective: Define experimental plan to validate ageing models

Technology performance evaluation through thermal simulations
Objective: Accurate thermal simulation of new structures

PROFILE

- Languages: French and English (basic)
- Studies: min. BAC+3 (1st or 2nd Master year on-going).
- Current studies: engineering studies in materials science, physics, electronics.
- Hard skills: Materials sciences, base knowledge about electronic components and manufacturing means is a plus.
- Soft skills: autonomous, technical, creative.
- Min. 3 month is required, full time.