

TechS - The e-newsletter of the PlanetS Technology Innovation Platform (TIP)

No. 6, March 22

Editorial

Welcome to the 6th issue of TechS, an electronic newsletter reporting the information and updates on the activities of the Technology Innovation Platform (TIP) of PlanetS. In the current issue we have invited the CoRES group at the HEPIA, HES-SO Geneva, to present their activities. The spotlight is on a PlanetS alumnus, Dr. Patricio Becerra, who was offered a position at Micro-Cameras & Space Exploration (MCSE), after he successfully completed an externship with them, sponsored by our TIP Knowledge Transfer program.

To make the newsletter a success, we are relying on you, the subscribers, to send us news and updates about what you think is important to share within our community in terms of **Seed funding, Networking, Training, Participating, Infrastructures and Competences**. Let us know [here](#).

Best wishes,

The Technology Innovation Platform (TIP)

- Webpage of the TIP: [link](#).
- To subscribe or unsubscribe to the TechS newsletter: [link](#).

In this edition

Updates from the TIP	2
New executive officer	2
Spotlight on a project of the TIP	3
Externship at Micro-Cameras & Space Exploration (MCSE), Neuchâtel	3
Focus on a company/external institute	5
CoRES Group (HEPIA, HES-SO)	5
News and events	8
Congratulations Ewelina!.....	8
ELT Instruments Day 2022 for Industry – 7 th April.....	8
Telescopic innovation – end of May	8
Funding programs of the TIP	9
Permanent call for seed funding.....	9
Knowledge transfer with a short-term project	9

Updates from the TIP

New executive officer

Many thanks [Piero!](#)

At the end of September 2021, our Executive Officer, Piero Pontelandolfo, left TIP for a new challenge at Almatech SA, a private company specialised in space projects and high-end technology development – a company well known to us for their contributions to the BELA instrument on BepiColombo and to CHEOPS. The Executive Board of PlanetS is deeply grateful for Piero's personal and professional investment in the TIP over the past years. He has been, without any doubt, the main architect of our success in implementing pragmatic and effective programs such as the “Seed funding” and the “Externships”, from which many PlanetS members and associates have benefitted. He has also been very active in developing a broad network and proposing training events, as for instance Bench2Biz. We will certainly miss his constant pro-active and friendly attitude. We are also very proud of his positive career development. We wish him a lot of personal and professional success in his new position.

Welcome [Elena!](#)

There is no need to worry, however! Even before Piero had left, we had the chance to meet Elena Benedetto who officially started in the function of TIP Executive Officer (50%) on December 1st, 2021. A short description of her profile can be found in the box below. A smooth and efficient transition between Piero and Elena could be ensured by Piero's willingness to pursue some activities beyond his formal leave date and by Elena taking over some of the activities even before her official starting date. We are very grateful to Elena for having accepted this position and extremely glad to see how well she has been able to 'jump on the moving train'. We are very confident that the services of the TIP to PlanetS can continue seamlessly. Welcome Elena!



Bringing technology excellence from the research world to the society is what motivates me, in both my jobs! Indeed, in parallel with my new functions of TIP Executive Officer, I'm devoting the other 50% of my time to the development of medical accelerators, within a small team based at CERN.

I moved to Geneva 19 years ago, to join CERN and do my PhD in accelerator physics, which is my area of expertise. Four years ago I started working on medical accelerators, and I'm leading the design of a new compact synchrotron to treat tumors by “bombarding” them with charged particles (protons and light ions) accelerated to a proper energy. The technique is already in use at PSI (near Zurich) since the '90ies, the technology will be different.

I've always felt that working in research, in international environments and multidisciplinary teams, where curiosity, continuous learning and striving for excellence are encouraged, is a privilege. Designing medical accelerators and joining the Technology Innovation Platform, is my way to 'give back' to the society! ...And it is fun! ;)

Many thanks for the warm welcome to those of you that I have already met at PlanetS and at the Geneva Observatory! And I'm looking forward to meeting the rest of you in person soon!

Spotlight on a project of the TIP

Externship at Micro-Cameras & Space Exploration (MCSE), Neuchâtel

By [Patricio Becerra](#)

My KT project, named “RadCam Colour Chart and Image Processing” (RadCam CC/IPS), was conceived to develop colour correction and calibration capabilities for MCSE’s RadCam camera, which will be used for ESA’s JUpiter ICy moons Explorer (JUICE) monitoring cameras. These cameras will monitor the health of the spacecraft and its appendages during the various mission phases, and take spectacular, wide-angle, colour views of the Jupiter system during the mission.

In a typical digital colour camera, each pixel has either a red, blue or green filter, and standard, so-called demosaicing algorithms are used to find RGB values at each pixel so that a full colour image can be displayed. The RadCam has a custom Red-Green-Yellow-Blue pattern, so it required a calibration tool with colour standards in its field of view (FoV) to convert images to the standard RGB values. The main objectives of the project were therefore to design, manufacture, and space-qualify a colour calibration chart (CC) with colour standards; and to develop an image processing software (IPS) that would retrieve colour from the raw images using the CC, but also correct noise sources from the sensors.

In addition to the design, manufacture, and space-qualification tests, work also included mechanical and thermal stress simulations, and ionising radiation experiments to test the performance of the colour standards. The design and a photo of the final colour chart delivered to ESA are seen in figure 1. The materials for the colour standards are aluminium silicate ceramics like those used for a colour chart on NASA’s Mars2020 rover, and the ionising radiation tests were performed in the Bern Inselspital cyclotron through a collaboration with the University of Bern. As a result of these studies, I am submitting abstracts to materials and planetary science conferences, and a paper is being prepared for peer-reviewed publication.

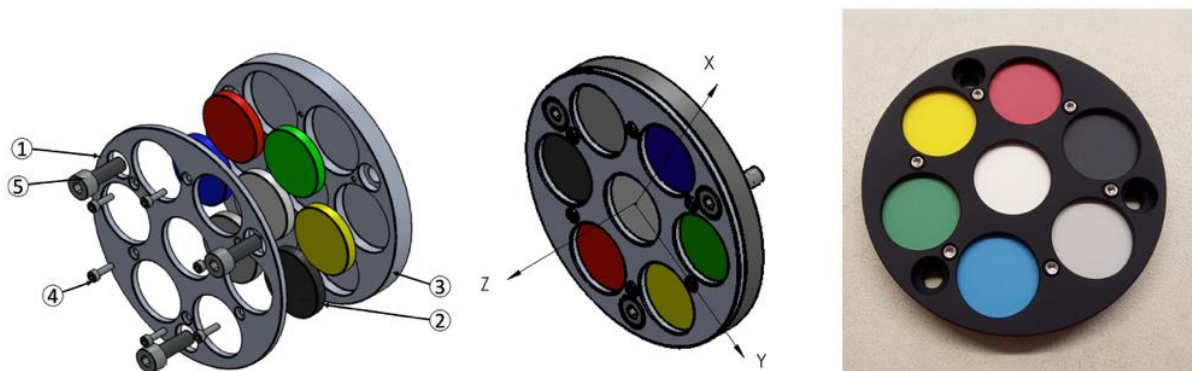


Figure 1: CAD (left) and photo (right) of the RadCam CC. The ceramic colour patches are 18.9 mm in diameter and 3 mm in thickness.

The IPS was developed concurrently with the CC and concluded a few months after CC delivery. Figure 2 shows a comparison between a raw JMC image, and one corrected by the IPS using the CC.



Figure 2. Left: Raw image taken by the RadCam/JMC PFM01 in the laboratory. The square patterns of the CFA are visible. Right: Final image after complete processing with the RadCam IPS.

My main contribution in terms of knowledge transferred to MCSE for this project was my experience in the use and conception of instruments for space missions, specifically my knowledge of the physics of spectral reflectance and of appropriate characterisation and calibration experiments. In addition, MCSE vastly benefited from my scientific network, as the collaborations that made this project possible were all founded on my prior academic collaborations with colleagues at the University of Bern, and external researchers at the University of Copenhagen.

In terms of knowledge transferred to me by MCSE, the transfer is also extensive. I have learned a huge amount about project management; product and quality assurance; space project requirements and verification; assembly, integration, and testing procedures; and resources and team management.

Overall, the project was a success. Though there were, of course, many delays and difficulties, I learned a vast amount of new information in a short time. After conclusion of the project, I was hired by MCSE as full-time Project Scientist and Manager. I believe this experience has been invaluable and will without a doubt help me in my future career.

The externships financed through the Technology Platform's "KT with a short term project" program offer the possibility to postdocs and engineer, which are PlanetS members or associate, to have a work experience in industry or in another (external) research institute while still being employed by PlanetS or partners.

More details about the program:

<https://nccr-planets.ch/platforms/technology-transfer/funding-of-a-short-term-project/>

Focus on a company/external institute

This section presents an overview of a selected company which is active in domains related to the PlanetS' activities. This month we want to present the Communicating Embedded and Reconfigurable Systems group of University of Applied Sciences of Western Switzerland (CoRES, HES-SO), located in Geneva.

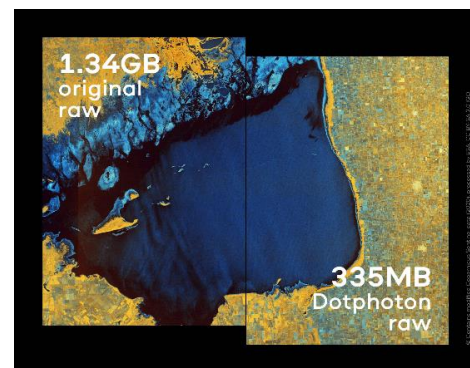


CoRES Group (HEPIA, HES-SO)

The Communicating, Reconfigurable, Embedded Systems group (CoRES) is a research group from the HES-SO in Geneva. The group is composed of 5 professors and 15 research engineers working on diverse projects including astronomy, space, IoT, software engineering, biomedical devices, and reconfigurable computing architectures. The research activities of the CoRES group are mainly driven by a strong collaboration with industrial and academic partners. These activities take diverse forms as research mandates, Innosuisse funded projects, or SNF funding among others. Here below a brief list of current and past projects.

Efficient Information-Preserving Image Compression for Space Applications (EIPICSA)

EIPICSA is a project in collaboration between Dotphoton and HEPIA, funded by ESA. This project focuses on implementing Dotphoton's image compression technology for high-resolution earth-observation systems based on FPGA. The tight coupling between the physical models and information theory developed at Dotphoton, combined with high-efficient FPGA implementation competences at CoRES, allows achieving unbeatable performance in terms of compression ratio, throughput, and power consumption. Increasing performance and reducing costs each by a factor 2x to 5x. In the use-case scenario, the compression is performed on an in-flight satellite, and the decompression in software on-ground. Reducing the images' transmission bandwidth for supporting the next generation of high-resolution, high-throughput earth-observation satellites. CoRES members involved: Phillip Geier, Andrea Guerrieri, and Andres Upegui.

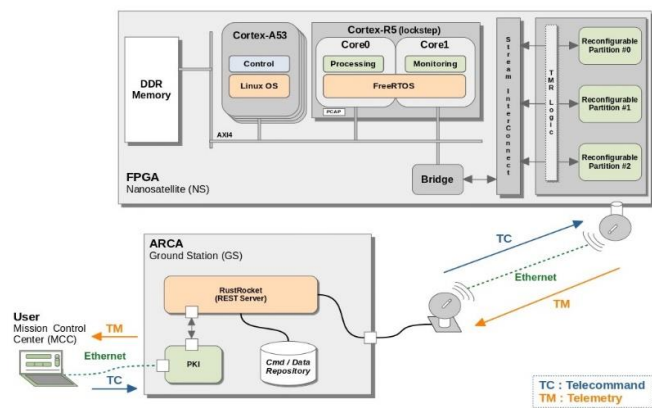


Dynamically Reconfigurable Cryptographic Engine (DyReCte)

DyReCte is a collaboration between HEPIA and CYSEC funded by Innosuisse. The project aims at building a novel solution of Dynamic Partial Reconfiguration of FPGA on post-quantum cryptography (PQC) for all critical applications requiring high reliability and security. The finalist algorithms competing in the NIST standardization process such as SPHINCS+, Saber, Crystals Kyber/Dilithium, and NTRU have been implemented on FPGA [1]. In the frame of the project, advanced and innovative techniques for hardware design such as HLS (High-Level Synthesis) have been adopted, reducing development costs without compromising performance. CoRES members involved: Quentin Berthet, Laurent Gantel, Gabriel Da Silva Marques, Andrea Guerrieri, and Andres Upegui.

Secure and Reliable In-Orbit Reconfiguration (SeRIORe)

SeRIORe takes part of the call “Mesures de Positionnement 2020” from Swiss Space Office and Space Innovation (former Swiss Space Center). The main motivation for the proposed activity is to offer small satellite operators the possibility to perform in-orbit reconfiguration in a secure and reliable way. In this project have been explored, implemented, and tested fault-tolerant mitigation techniques against Single Level Effects (SEE). To list a few, Triple Modular Redundancy (TMR), Lock-step execution, and configuration memory scrubbing combined with the Design Isolation Flow dynamic-partial reconfiguration for FPGAs. For secure communication, the data payload is encrypted with AES-256 and authenticated using the post-quantum signature scheme SPHINCS+ [2]. Part of the system developed in this activity has been launched in orbit on Falcon 9 (B1058.10) from SpaceX, along with 105 microsattellites, CubeSats, PocketQubes, and orbital transfer vehicles. The rocket lifted off on 13th January 2022 from SLC-40, Cape Canaveral Space Force Station, Florida [3]. CoRES members involved: Gabriel Da Silva Marques, Laurent Gantel, Andrea Guerrieri, Andres Upegui, and Fabien Vannel.



Scaling intensity interferometry to higher frequencies

This project is part of academic cooperation between HEPIA, the Astronomy Department of the University of Geneva, and EPFL. Since 1957, Hanbury Brown and Twiss proposed a technique leveraging interferometry, evaluating the correlation of the intensity of the light signal of two telescopes to infer the size of a star. This technique is still adopted today, but more powerful computers are needed for big telescopes. The precision of the results depends strongly on the accuracy of the arrival times of the photons. This project aims to implement the correlation on a high-performance reconfigurable system on chip (SoC) with an integrated radio-frequency acquisition front-end, the Zynq UltraScale+ RFSoc. This cutting-edge SoC technology improves the data transfer between the ADC and the logic, allowing sampling

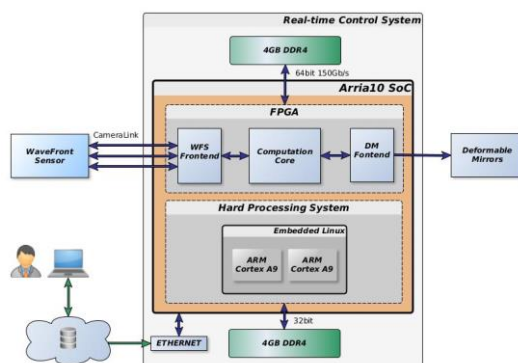
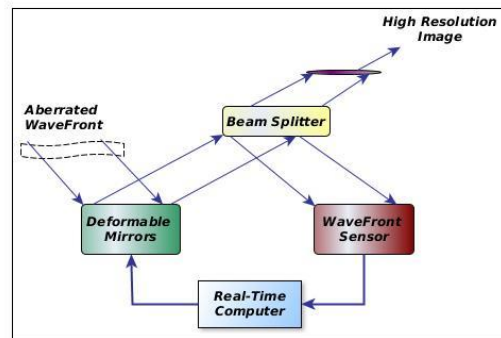
rates up to 4GS/s. This allows a higher sampling frequency than today’s specialized acquisition systems, enabling also to scale-up the system to more than two telescopes. The telescope where the prototype is installed is the MAGIC (Major Atmospheric Gamma Imaging Cherenkov), located in La Palma. It is a system comprised of two telescopes, including an array of mirrors, reflecting the light to a sensor mounted on the focal point. The sensor used in MAGIC is an array of photomultiplier tubes.



CoRES members involved: Philipp Schuler (EPFL student), Andrea Guerrieri, and René Beuchat.

Extremely fast computer system for the next generation of adaptive optics systems: A Swiss Technology R&D Initiative Towards the Direct Detection of Nearby Exoplanets

This project is part of an academic cooperation between HEPIA, the Astronomy Department of the University of Geneva, EPFL, and ETH Zurich, funded by NCCR PlanetS. Being at the forefront of exoplanet research, the observatory of Geneva has started a feasibility study for an instrument that would allow to characterize the atmosphere of the exoplanet discovered in the habitable zone of Proxima Centauri [4]. This instrument includes a powerful Adaptive Optics (AO) system to provide wavefront correction, capable of turn at 4KHz in a closed loop.



This project focus on demonstrating the feasibility, designing and prototyping the RTC for AO to execute the correction algorithm in less than 50us and control up to 4'000 actuators in a closed loop. To meet the hard real-time constraints, an FPGA-based custom computer machine with a high parallel-computation capacity has been deployed. The control algorithm on the RTC runs in 37us, with a speedup >108x in respect with 4ms on a classical CPU. The

prototype has been realized on Arria10SX660 [5]. Recently, we ported the RTC on Stratix10, a newest high-end FPGA family from Intel, increasing performance to compute the correction algorithm for larger images. CoRES members involved: Orphée Antoniadis, Andrea Guerrieri, and René Beuchat.

Call for collaborations/exchange information

Do you have an interesting idea about astronomy, space, IoT, or communication systems that you want to explore, and you need some help? **Do not hesitate to get in touch with us!** We can discuss a potential collaboration under different forms, such as student projects, funded research, or mandates. Alternatively, just having a proficient discussion with our team of experts in the specific domain can help. We are looking forward to hearing from you about the next challenge.



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News and events

Congratulations Ewelina!

Congratulations to Dr. Ewelina Obrzud, who has been awarded one of the European Astronomical Society (EAS) MERAC Prizes 2022 for the Best PhD Thesis in *New Technologies*. She conducted her PhD thesis at the Centre Suisse d'Electronique et Microtechnique (CSEM) in Neuchâtel and at the Department of Astronomy of the University of Geneva, under the supervision of Prof. Francesco Pepe, Dr François Wildi, and Dr Tobias Herr. Her work led to the development and test of a novel laser frequency comb for the accurate calibration of infrared extreme-precision radial-velocity spectrographs (EPRV), an activity that triggered the SkyRuler, a project partially seed-funded by the TIP of PlanetS (<https://nccr-planets.ch/platforms/technology-transfer/sky-ruler/>).

ELT Instruments Day 2022 for Industry – 7th April



The event will take place on the 7th of April, at the Geneva International Conference Center CiCG, for the ESO Member state industry suppliers to the Extreme Large Telescope (ELT) Instruments:

<https://indico.cern.ch/event/1095734/>

It is organized by the Swiss ILO Office, with the support of PlanetS @ University of Geneva.

Besides ESO keynote speakers, the ELT Instrument project team leaders will provide an overview of their activities, including status updates and procurement opportunities.

More than 50 companies from different ESO member states will join the afternoon poster session (in the spirit of a scientific conference) to present their technology offer and show their previous or on-going projects with research facilities.

Registrations are moderated. Please get in touch with us if you are interested!

Telescopic innovation – end of May

Are you interested in entrepreneurship?

Stay tuned for an event that we will organize toward the end of May in Geneva, together with the UniGE Science Innovation Hub. Details will follow on the TIP website.

Funding programs of the TIP

Permanent call for seed funding

The TIP proposes a permanent call for seed funding called “Call for Ideas”. The call promotes activities and strategies that aim at strengthen the knowledge and technology transfer between PlanetS Members, industry, technical universities and other research laboratories.

The call is open to every company, institute or research laboratory, and the rules have been kept as simple and flexible as possible. Would you like to know more about the call? Have a look [here](#).

Knowledge transfer with a short-term project

The TIP proposes a program for PlanetS Members or Associates (postdoc or engineer) who have developed competences or ideas that could be applied to areas outside their specific research activities. The PlanetS TIP provides with up to 3 months of financial support (like a salary compensation) in order to pursue your project. Would you like to know more about the opportunity? Have a look [here](#).

If you are the company or the research laboratory which would like to propose a project, let us know about your interest and fill out the following: [proposal of a short-term project for the external partner](#).