# SPACEMAURITIUS

## OUR JOURNEY INTO SPACE

COMMEMORATIVE MAGAZINE
OCTOBER 2021

**Hon. Pravind Kumar Jugnauth**
*Prime Minister*
*Minister of Defence, Home Affairs and External Communications Minister for Rodrigues, Outer Islands and Territorial Integrity Republic of Mauritius*

The deployment of a Mauritian nanosatellite in orbit is a matter of pride for all of us. Our country has joined the league of space-faring African nations.

I hope that this first step in space for our Small Island State will increase students' motivation and engagement in science, technology, engineering, and mathematics (STEM).

This pioneer initiative, on which the Mauritius Research and Innovation Council has embarked, is in line with Government's Innovation Strategy to develop new pillars of sustainable development. Our policy is to encourage research and business that promote innovation.

I am convinced that it is an opportune time for knowledge-oriented sectors to grow. In the post-Covid era, new technologies will take center-stage and help countries achieve their digital transformation.

A thrilling adventure starts now for Mauritius.

**Hon. Deepak Balgobin,**
*Minister of Information Technology, Communication and Innovation*
*Republic of Mauritius*

We are proud to state that the first Mauritian satellite is now in orbit around the earth and fully operationalized. It is, for a small island state like Mauritius, an important landmark and milestone in the development of the vision of the Government and that of our Prime Minister, Pravind Kumar Jugnauth to digitalize our economy.

We are now embarked on a new era where space and satellite technologies can potentially positively contribute to the wave of digital innovation which our country is currently experiencing.

Indeed, our first nanosatellite prompts a number of promising avenues for Research Development and Innovation in this field.

We look forward to seeing space and satellite technology bring a new thrust to the socio-economic development of the Republic of Mauritius.

**Dr. Kaviraj Sharma Sukon, PFHEA**
*Chairman*
*Mauritius Research and Innovation Council*

A Giant Step for Mauritius! Watching MIR-SAT1 moving alone was a thrilling experience for all of us at the MRIC as we knew that Mauritius had just made a giant step successfully. Even if all the ingredients were there to ensure that the Mauritian flag would fly high in space, it was difficult to get rid of the fear that anyone of the large number of occupants of the space might hamper the progress of our priceless small cube. We were all relieved when the dedicated team of experts at MRIC showed us the stream of data emanating from our own satellite. Indeed, the ground station at MRIC, with the necessary equipment, is vital to remain connected to MIR-SAT1. It helps us to track the movement of the device around the globe. I am grateful to all the members of staff of the MRIC for their endeavours. I know that we can rely on their collaboration to take our space exploration project to even greater heights.

I could not hold my tears of joy when the students from the secondary school, who were trained by MRIC to build their antenna, reported that they were able to establish contact with our national satellite. Space exploration was a dream for these learners who are always eager to learn more about satellites, as it is a concrete application of the theory that they have learnt at school. Today this dream has come true. They are not only able to interact with an object located far away but they are able to do so with the instrument that they have built. Thus, this project has also contributed to promote Science and Technology among youngsters. I would like to thank the educators who have been able to instil this desire to understand space among the teenagers.

Such a laudable project could not have materialised without the support of the authorities. I would like to express my sincere gratitude to The Honourable Pravind Kumar Jugnauth, Prime Minister, Minister of Defence, Home Affairs and External Communications, Minister for Rodrigues, Outer Islands and Territorial Integrity for his support. It shall always be remembered that The Hon. Prime Minister gave the orders for MIR-SAT1 to be deployed in space. I wish to place on record the guidance and unflinching support of the Hon Deepak Balgobin, Minister of Information Technology, Communication and Innovation throughout this project.

**Professor Theesan Bahorun, PhD, G.O.S.K**
*Executive Director,*
*Mauritius Research and Innovation Council (MRIC)*

The year 2021 marks a significant milestone for the Republic of Mauritius with many 'firsts' and 'beginnings' as we enter the restricted circle of space faring nations.

For the first time in our history, thanks to the collaborative endeavors with the United Nations Office for Outer Space Affairs, Clyde Space, Japan Aerospace Exploration Agency internationally, the Ministry of Information Technology, Communication and Innovation, Mauritius Research and Innovation Council in house satellite team and local collaborators, notably Mr Jean MarcOmplé and ICTA, the MRIC is boarding a new initiative geared towards exploring the potential of space/satellite technology for the socio-economic benefits of our country. The adventure, which started in 2017, has led to the development, launch and deployment of the country's own nanosatellite, MIR SAT 1 for scientific earth observation. These pioneering activities are now hinged to a complementary a state-of-the-art ground infrastructure for the processing, archiving and distribution of satellite images and other space borne data. The incurred investments are providing Mauritius with a capacity to create and add value from space, specifically through the generation, processing, dissemination and utilization of data obtained by satellites and space infrastructure.

What next? With the background of what has been achieved so far, our appetite for more science adventure and innovation is lured towards the development of a consistent space program which would certainly leverage on existing and new collaborations to develop a comprehensive road map that will trigger the emergence of a novel business pillar based on space related activities. We envision a space unit as a spinoff of the MIR SAT 1 project. This would undoubtedly be coupled to the cherished initiative to build and launch a bigger satellite. The dream perpetuates!!! Let's make it happen!!!

**Simonetta Di Pippo**
*Director*
*United Nations Office for Outer Space Affairs (UNOOSA)*

On behalf of the United Nations Office for Outer Space Affairs, I would like to congratulate the Mauritius Research and Innovation Council and the country of Mauritius on their successful development and deployment of MIR-SAT 1. Not only was this an opportunity to acquire technology, knowledge and skills for future space development, but it was also a wonderful project to raise awareness and interest from the public and national authorities on the benefits of space science and technologies.

With this giant first step, I am truly confident that Mauritius will keep developing its space sector, leading to prosperous activities in the future. The Office stands ready to continue supporting Mauritius in the development of space activities and we look forward to our continuous collaboration.

**SHOJI Yoshikazu**
*Director of International Relations and Research Department*
*Japan Aerospace Exploration Agency (JAXA)*

On the occasion of publication of this magazine, I would like to congratulate the Mauritius Research and Innovation Council for the successful deployment of MIR-SAT1 in June this year. We feel privileged to be a part of this project by delivering the first satellite of Mauritius in Space. It was indeed our honour to celebrate the moment of deployment with the attendance of Hon. Prime Minister Pravind Kumar JUGNAUTH, H.E. KAWAGUCHI Shuichiro, Ambassador of Japan in Mauritius on the 22nd June 2021. We were also happy to note the wide interest of people in Mauritius for this event.

The KiboCUBE program is organized in collaboration with UNOOSA to offer an opportunity of deploying CubeSat from the Japanese Experiment Module "Kibo" of the International Space Station. MIR-SAT1 marks the third successful deployment under this program. I seize this opportunity to express my sincere respect to the members of the MIR-SAT1 project team from the Mauritius Research and Innovation Council for their great achievement. I also express my appreciation to UNOOSA for their continued support.

MIR-SAT1 has various significant missions including technology demonstration of image acquisition and communication transmission. I hope all the mission MIR-SAT1 will have a huge success and contribute to capacity building in Mauritius, as well as raising awareness in the field of space technology.

# OUR JOURNEY INTO SPACE

# ABOUT **MRIC**

The Mauritius Research and Innovation Council (MRIC) is a corporate body set up on the 1st of September 2019 through the proclamation of the Mauritius Research and Innovation Council Act 2019. The MRIC operates under the aegis of the Ministry of Information Technology, Communication and Innovation (www.mric.mu).

Apex body Advising Government on Applied Research and Innovation

Promotes collaborative and inclusive Innovation

Fosters high quality R&D and innovation in the Republic of Mauritius

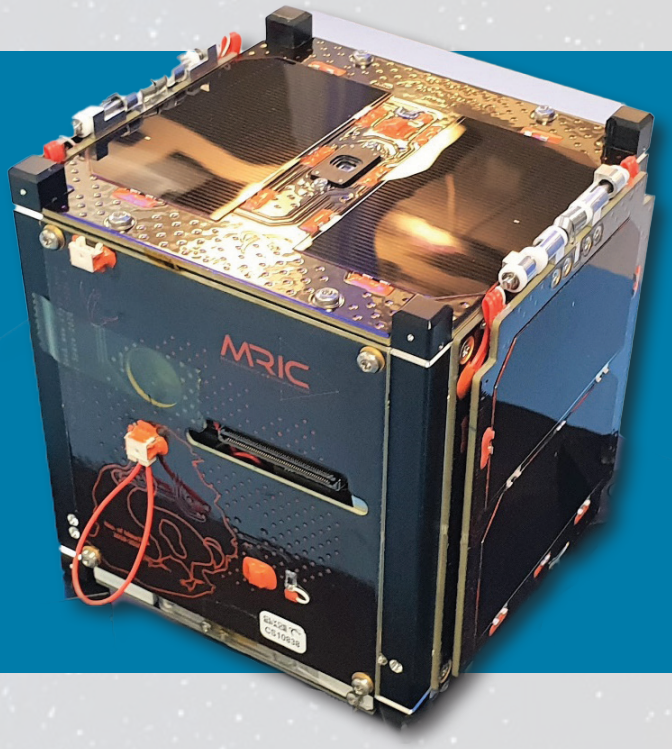
The MRIC is an Apex Body, advisor to Government on all matters pertaining to Science, Research Technology and Innovation. The MRIC is also responsible for fostering research, development and innovation in the Republic of Mauritius through the operation of some 10 part-funding research and innovation grant schemes. The MRIC strives towards incentivizing and strengthening the collaboration between Public Sector, Private Sector, academia and the society in view of contributing to the socioeconomic development of Mauritius through research, development and innovation.

## Specific objectives of the MRIC

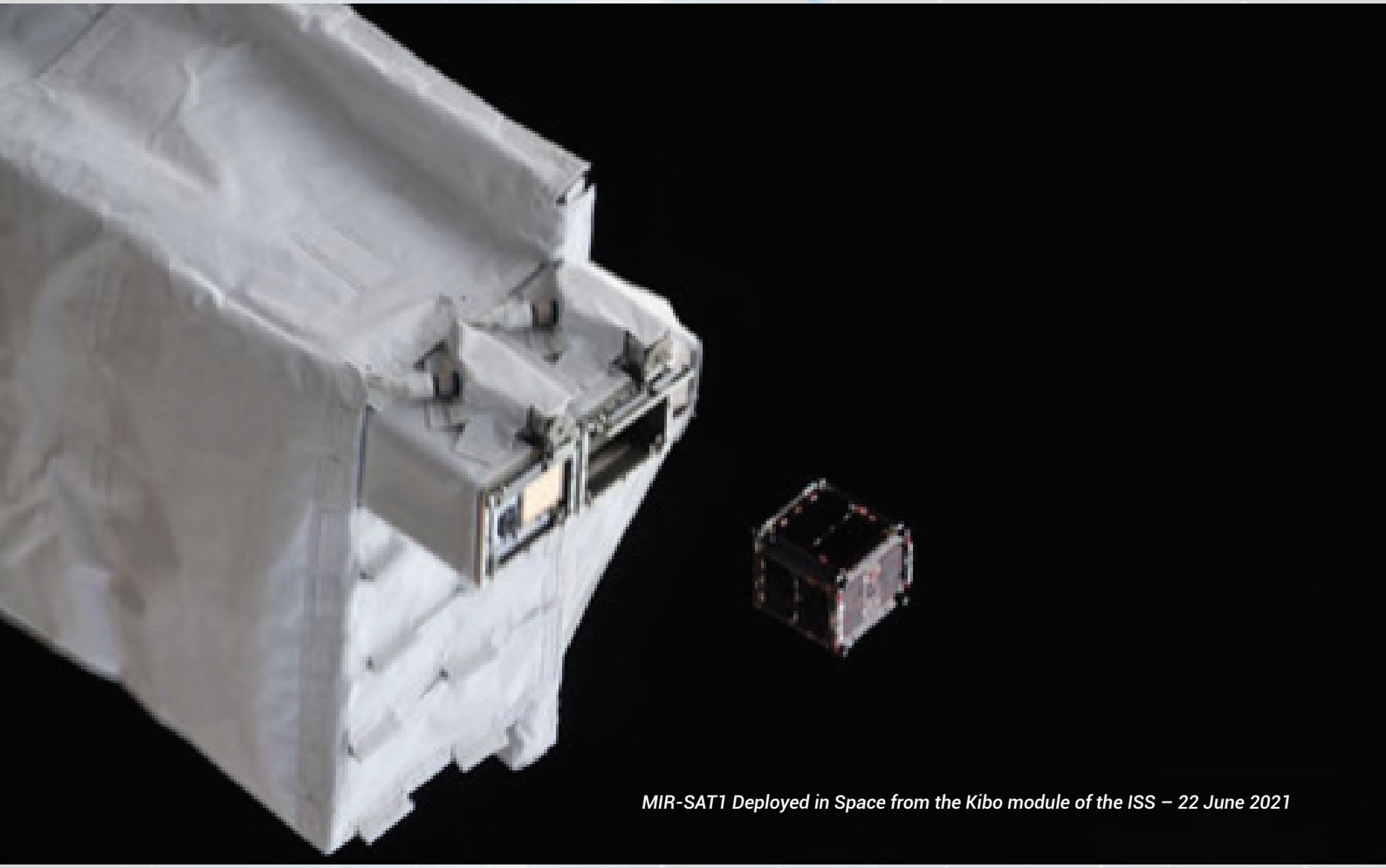
- promote and coordinate applied research, innovation and research and development according to the needs of the country and to improve the quality of life;
- foster a research, innovation and entrepreneurship culture;
- encourage the development and application of advanced and innovative technology to meet the needs of industries;
- enhance private sector participation in research and development and innovation; and promote commercial utilisation of the results of research and development and innovation, in the national interest;
- conduct research in priority strategic areas.

# The Republic of Mauritius
# A Space Faring Nation in 2021

Mauritius was the winner of the 3rd round UNOOSA/JAXA KiboCube Programme in 2018 . This program allows members of the United Nations to initiate their first mission in space for peaceful exploiting. It focuses on capacity building and aims ultimately at setting up a sustainable space related activity in the winning country. The nanosatellite, called the **Mauritius Imagery and Radio Communications Satellite 1 (MIR-SAT1)** was successfully built, tested, and sent to JAXA in January 2021. On the 3rd June 2021 MIR-SAT1 was launched to Space from the Kennedy Space Centre in Florida USA onboard Space X22 Rocket Falcon 9. On the 22nd June 2021, MIR-SAT1 was deployed in space.




*MIR-SAT1 completed with the infographic printing of the Dodo and the Contour of Mauritius symbolizing the uniqueness of the nanosatellite.*



*MIR-SAT1 Deployed in Space from the Kibo module of the ISS – 22 June 2021*

# The MIR-SAT1 Team

The project was implemented by a Team of multidisciplinary scientists of the MRIC. The relentless efforts of this Team brough this project to completion.

*The MIR-SAT1 Team*
*From L to R:* Mr Faraaz Shamutally, Mr Ziyaad Soreefan, Mr Jean Marc Monplé, Dr Vickram Bissonauth, Mr Koushul Narrain & Mr Kiran Tatoree.

*"We never stopped believing that we also can send a space craft on orbit. We are proud to have contributed to making Mauritius a space faring nation. Our Journey into Space Begins and we foresee a Space Program fostering the innovation ecosystem of Republic of Mauritius"*

**Dr Vickram Bissonauth**
**Project Manager and Research Coordinator**

*"The privilege to have served on this unique project as the Principal Investigator is indeed a matter of honour and prestige. There is no greater fulfilment than to take part in a project which combines cutting-edge research and innovation at the service of your motherland. This was a challenging journey akin to an emotional roller-coaster ride but at the same time a singular human and scientific experience. I firmly believe that together, as a nation, we can only strive to achieve greater things from here onwards."*

**Mr Faraaz Shamutally (MRAES)**
**Principal Investigator & Aerospace Engineer**

*"It is an immense privilege to be working as Co-Investigator on this project which helped Mauritius set its imprint into space. It is the ultimate dream of any Aerospace Engineer to see his project come to fruition and I am indeed humbled by this experience. This path has not been an easy one, I have had to dig deep, push myself outside my comfort zone to acquire totally new sets of skills and technical expertise hitherto unimaginable. I wish to place on record my appreciation of the knowledge imparted by JAXA (JAPAN) and AAC-Clydespace (UK). I have certainly grown from this experience. I honestly hope that this contribution will inspire the next generation of Mauritian youngsters to engage further in exploring space."*

**Mr Ziyaad Soreefan (AMRAES)**
**Co-Investigator & Aerospace Engineer**

*"Space is no longer a frontier for the development of Mauritius. This project is a testimony that Mauritian ingenuity and creativity knows no limit. It has been an honour to be part of this project for implementing the ground station and for driving the events"*

**Mr Koushul Narrain,**
**Ground Station Implementation Facilitator & Event Coordinator**

*"The quest for new knowledge has always been the most protruding form of human curiosity, and this has led the way for Mauritius to set foot into space. As the Capacity Building Coordinator of MIR-SAT1, I remain committed towards providing continual training to the younger generations of the Republic of Mauritius with a view to arousing their interests in Satellite/Space Technology."*

**Mr Kiran Tatoree**
**Capacity Building Coordinator & Resource Person**

*"In my capacity of AMSAT Ambassador, President of the Mauritius Amateur Radio Society (MARS) and as a member of the MIR-SAT 1 team I wish to say simply "BRAVO" to the team, which include MARS, the MRIC and the Government. We are now a space faring nation WoW, 14 ground stations in Mauritius received the signals from MIR-SAT1. Capacity building, knowledge sharing in the new space arena within our national scientific communities and educational institutions will surely create new business opportunities for us eventually, I have no doubt that this will be achieved with the collaboration of all parties concerned."*

**Mr Jean Marc Momple**
**Representative of MARS & Technical Resource Person**

*"As the only female team member, it has been an empowering and enriching experience to collaborate on this project. The path has not been easy, but I hope that this will inspire the new generation of female scientists."*

**Ms Siddhee Bhojoo**
**Management Support**

# MIR-SAT1 Winner

## 3rd Round of the KiboCube Award - 2018


*Official Award for the 3rd Round KiboCube winner. L to R: Simonetta Di Pippo (UNOOSA), Mr Faraaz Shamutally (MRIC, Mauritius), Mr. Sunartoto Gunadi (Surya University of Indonesia, Indonesia), Dr. Koichi Wakata (JAXA, Japan). Picture taken at the International Astronautical Congress in Bremen, Germany 2018, where MRIC was invited to participate in a press conference by UNOOSA to announce Mauritius as the winner of KiboCube 2018.*

The Mauritian quest to space started in 2017, with a solicitation from the Ministry of Foreign Affairs Regional Integration and International Trade and the Ministry of Education, Tertiary Education, Science and Technology to all universities in the country and the MRIC to consider participation in the KiboCUBE Program offering the possibility for Mauritius to design, build and deploy a CubeSat in space. The MRIC as part of its mandate to pioneer new and emerging research, took up the challenge.

The MRIC Team solicited technical assistance from several international experts, amongst which only AAC Clyde Space, a UK based company, responded positively. The first attempt submitted in April 2017 was unsuccessful. Being highly motivated, the Team attempted a second participation leveraging on the experience gained in the previous submission. The Team collaborated with Mr Jean Marc Momple, Radio Amateur from MARS who assisted by providing inputs regarding the ground station and the radiocommunication module. Together with AAC-Clyde Space, the second technical proposal was submitted at the 3rd Round of the KiboCube Programme in April 2018. Further to the deliberation of the Jury, in June 2018, the Mauritian Proposal was selected as the best among all the submissions from UN member states all over the world.

# High Level Steering Committee – A key contributor

A high-level steering committee chaired by the Honourable Minister of Information Technology Communication and Innovation was setup following the announcement that Mauritius was the winner of the 3rd Kibocube award. The steering committee consisted of representatives from key Ministries and departments and had the responsibility for overseeing and facilitating the implementation of the project. Regular, quarterly meetings were held to follow the progress of the project

## Members of the High-Level MIR-SAT1 Steering Committee:

- Ministry of Information Technology, Communication and Innovation;
- Prime Minister's Office;
- Ministry of Education, Tertiary Education, Science and Technology;
- Ministry of Foreign Affairs Regional Integration and International Trade;
- Ministry of Finance and Economic Planning and Development;
- Ministry of Social Security and National Solidarity;
- Ministry of National Infrastructure and Community Development;
- Information and Communication Technologies Authority;
- National Computer Board;
- Mauritius Amateur Radio Society;
- Mauritius Research and Innovation Council.

# Project Kick-off

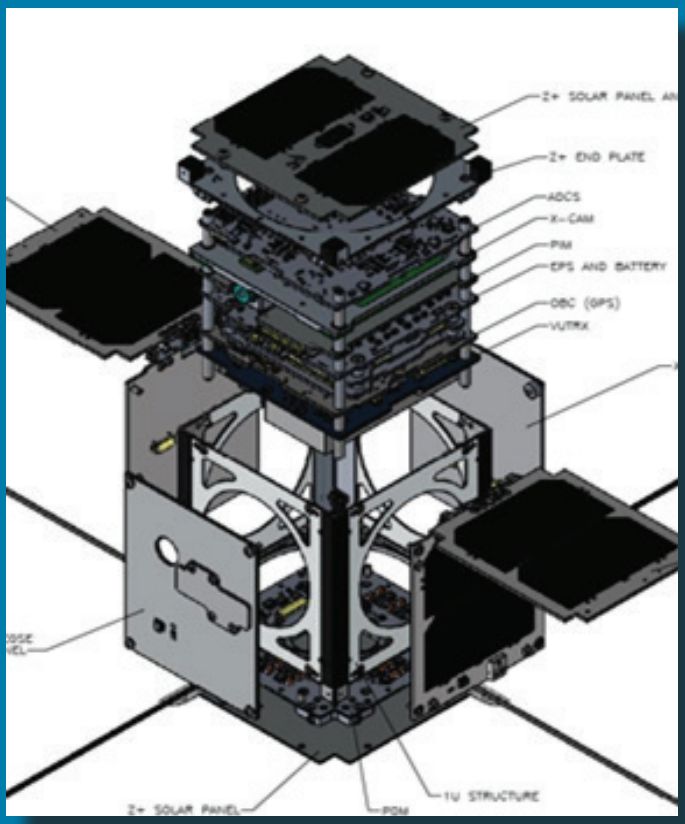
The MRIC engineers went for a first training in Glasgow in January 2019 following the official kickoff meeting with AAC-Clyde Space, in December 2018. The MIR-SAT1 mission objectives were finalised with the engineering Team at AAC-Clyde Space. The functionalities of each of the modules to be onboarded MIR-SAT1 were discussed and agreed upon, following which the project was officially initiated.


*Mr Faraaz Shamutally (Left) and Mr Ziyaad Soreefan, MRIC Engineers following a training at AAC-Clyde Space*

## Kick-off meeting in December 2018

# Innovativeness of the MIR-SAT1

The challenge was to stack highly complex and sophisticated hardware in a 10cm3 box, configure it with the right software, ensure that the whole set up works perfectly in harsh space conditions and that the space craft can be controlled from earth, 400 km away. Such a tough task was realized by the ingenuity of the Mauritian Aerospace Engineers coupled with guidance from the professionals from AAC-Clyde space. The MIR-SAT1 was thus created with a unique innovative design which allowed Mauritius to win the KiboCube Award.




*A blown-up CAD representation of the components of the MIR-SAT1 – Note the complexity of the components which needed to be stacked in a small 10cm³ box*

# The Mission of MIR-SAT1

**When fully operational in space, the MIR-SAT1 will**

- Communicate with MRIC Ground station to provide its health status (telemetry);
- Capture images of Mauritius and the surrounding ocean using on-board camera;
- Communicate with other islands in the Indian Ocean region;
- Experiment with high-speed transmission;
- Raise awareness in local schools and universities on space applications.

# Process of MIR-SAT1 design and build

**Several complex validations had to be performed prior to initiating the building process.**

Project Kick-Off

December 2018

April 2019

Preliminary Design Review (PDR)

*To review the conceptual design to ensure that the planned technical approach will meet the requirements*

Critical Design Review (CDR)

*To review the detailed design to ensure that the design implementation has met the requirements.*

June 2019

July 2019

JAXA Safety Assessment 012

IARU Coordination

August 2019

September 2019

ITU API Coordination

Assembly, Integration & Testing

September 2020

October 2020

Test Readiness Review (TRR)

*To determine if the system under review is ready to proceed into formal testing by deciding whether the test procedures are complete and verify their compliance with test plans and descriptions.*

JAXA Safety Assessment 03

January 2021

February 2021

Flight Readiness Review (FRR)

*To examine tests, demonstrations, analyses, and audits that determine the overall system readiness for a safe and successful launch and for subsequent orbit operations.*

Satellite Delivery to JAXA

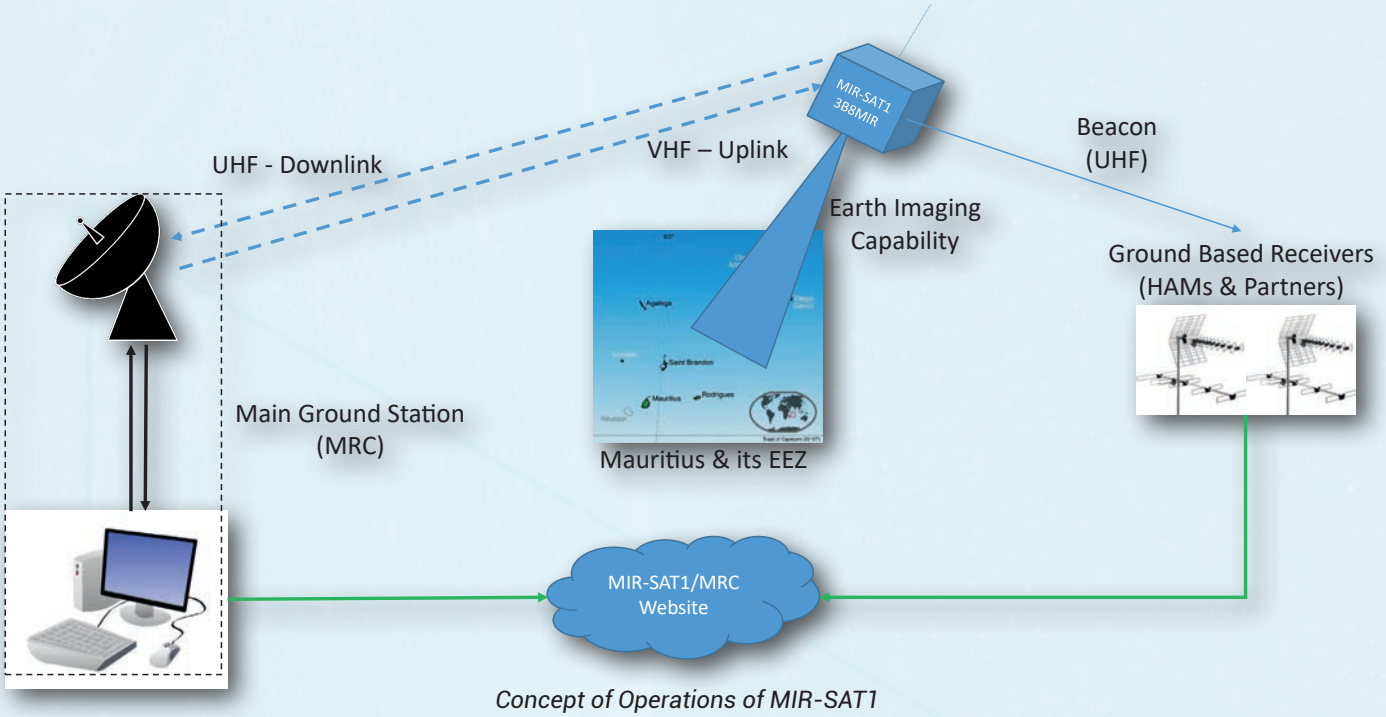
March 2021

3rd of June 2021

Satellite Launch to ISS on SpX-CRS22

# Concept of Operations (CONOPS) Validation

The MRIC Team and AAC-Clyde Space engineers drafted and validated the MIR-SAT 1 CONOPS – a key document detailing the design of the satellite, the system requirements, and the mission to be performed.




*Concept of Operations of MIR-SAT1*

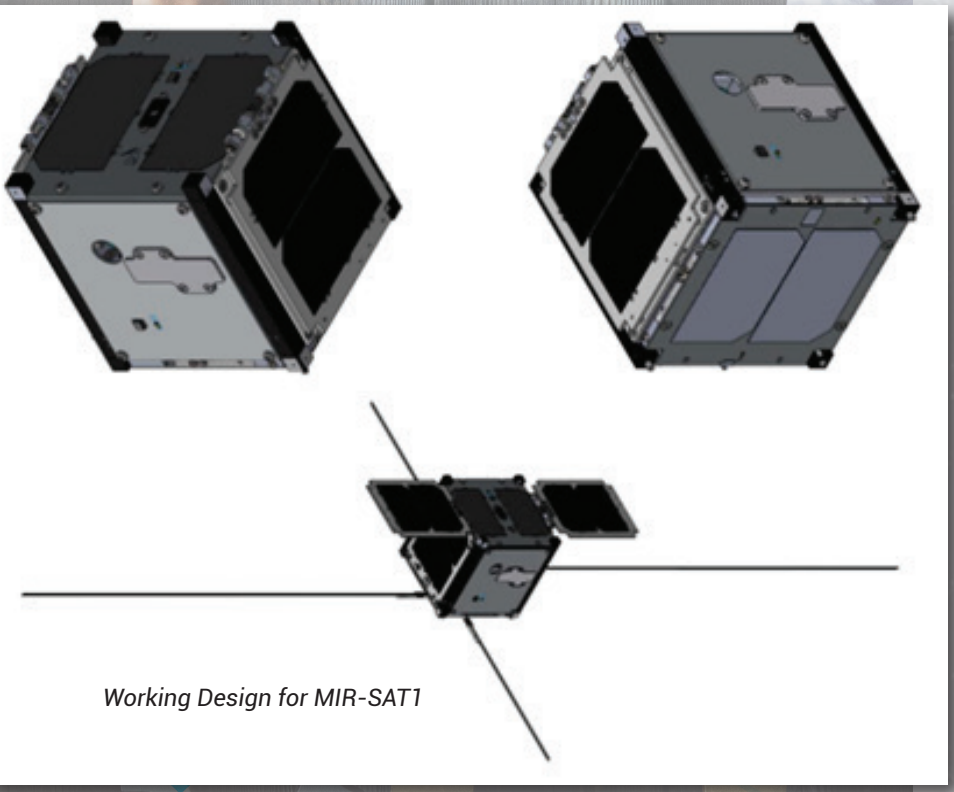
*MRIC Engineers at AAC-Clyde space working on Structural Design*

# Preliminary Design Review – Initial Design

The Preliminary Design Review (PDR) assesses the ability of the technical components onboarded on the MIR-SAT 1 to meet the objectives of the CONOPS. The technical feasibility takes into consideration the different requirements at mission, system and subsystem levels set out during the CONOPS phase.

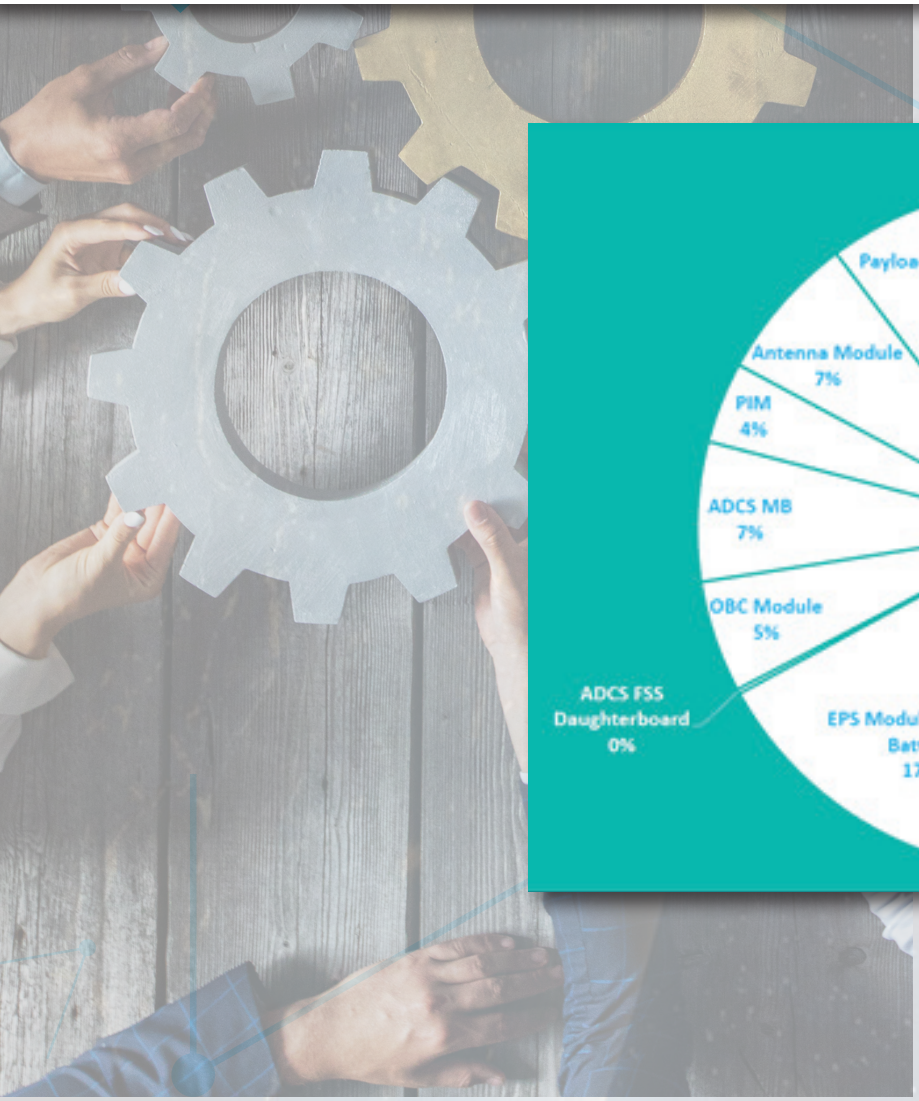
At this stage a few major issues were identified in the originally planned set up, resulting in change in the payloads embarked on the MIR-SAT1. Initially it was planned to embark an S-Band Transmitter and a Forward Looking Infra-Red (FLIR) Boson Thermal Camera on board MIR-SAT1. The S-Band transmitter would allow faster upload and download of signals while the FLIR Boson Thermal Camera would collect data of the region around Mauritius via thermal imagery. However, some technical difficulties arose prompting the replacement of the latter payloads with UHF/VHF communication module and an X-CAM C3D camera. PDR was then completed in April 2019.

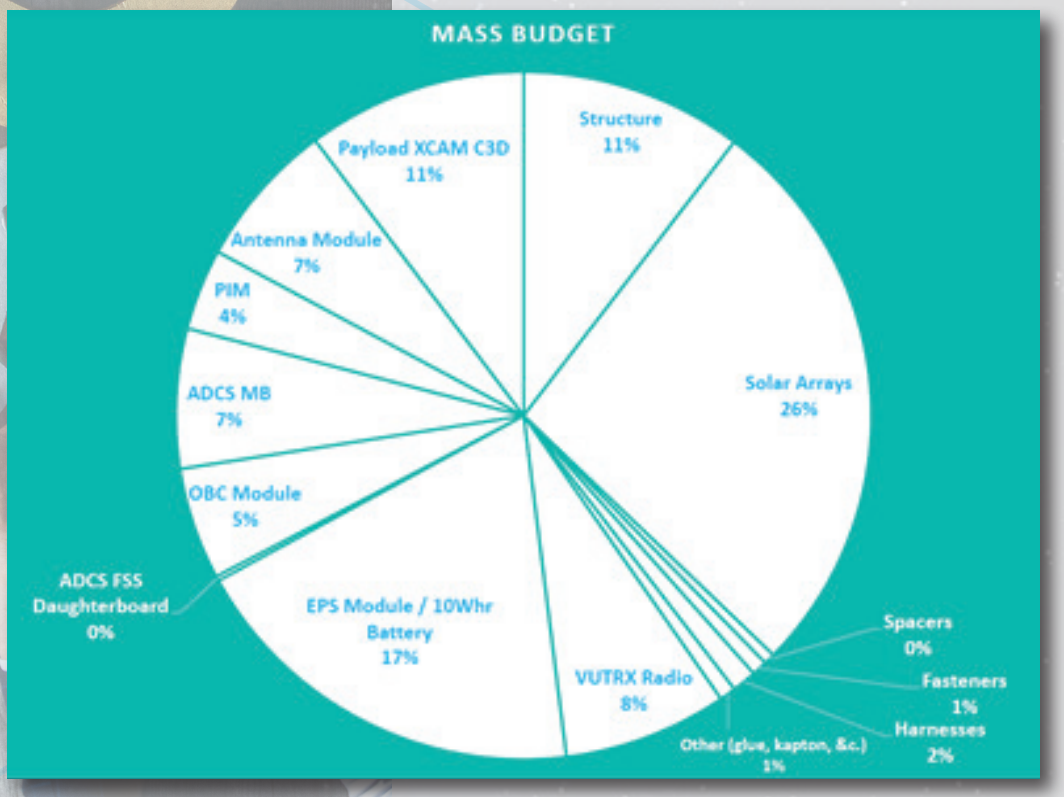
*MRIC Engineers at AAC-Clyde space during PDR*



*Working Design for MIR-SAT1*

The MIR-SAT1 will provide images in the visible spectrum. All modules on MIR-SAT1 have flight heritage. This was done in view of ensuring mission success



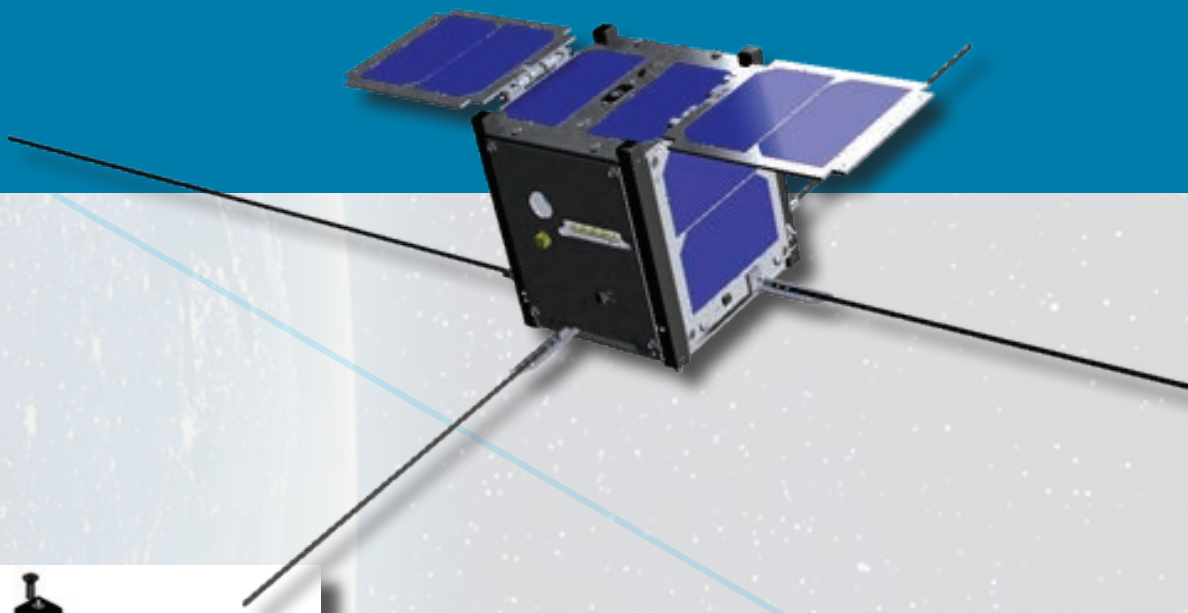


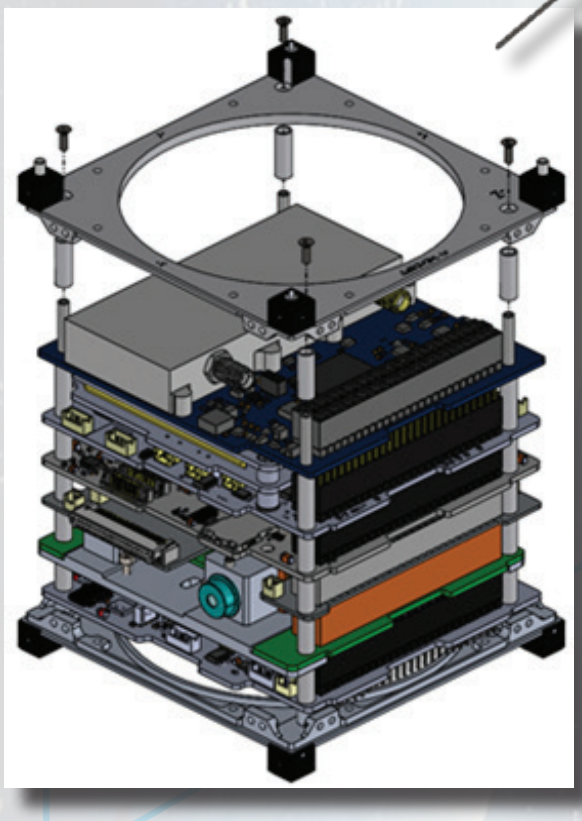

*MIR-SAT1 Mass Budget*

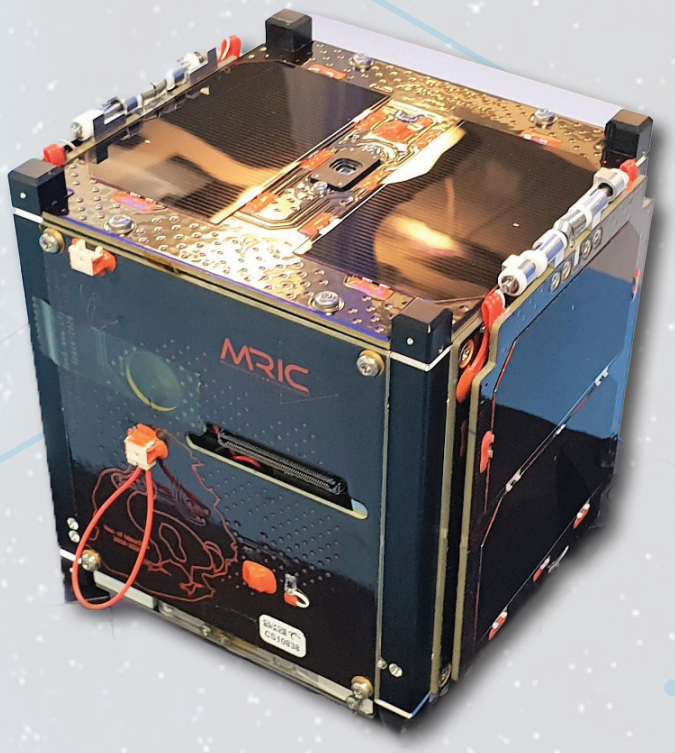
# Critical Design Review (CDR) – Final design

The design was finalised at CDR at phase with 9 subsystems, namely, (i) Antenna Deployment Module, (ii) COMM system, (iii) ADCS motherboard, (iv) ADCS daughterboard, (v) On Board Computer (OBC), (vi) EPS and (vii) Battery Structure, (viii) XCAM C3D board and (ix) PIM.The new payload consisted of the XCAM C3D imager and an island-to-island communication module.

The satellite has 5 faces with solar panels and 2 double-sided deployable panels. The UHF and VHF antennas are also deployable. The Team made sure that despite the changes in the payload, the mission objectives did not change and the MIR-SAT1 design still maintained its innovativeness. The CDR was completed in June 2019.



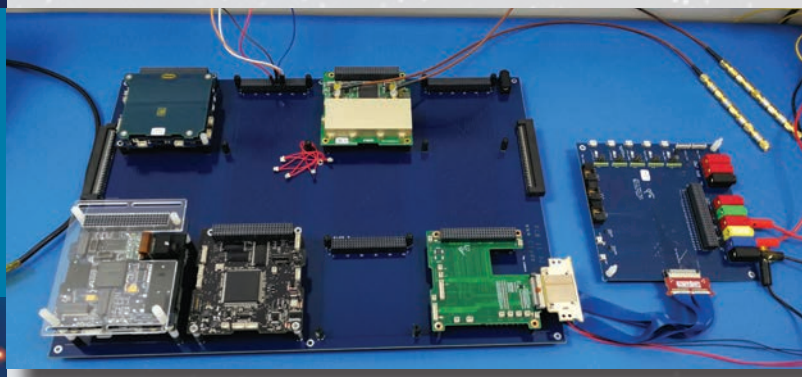





*MIR-SAT1 Exploded View and CAD at CDR and final appearance at completion*

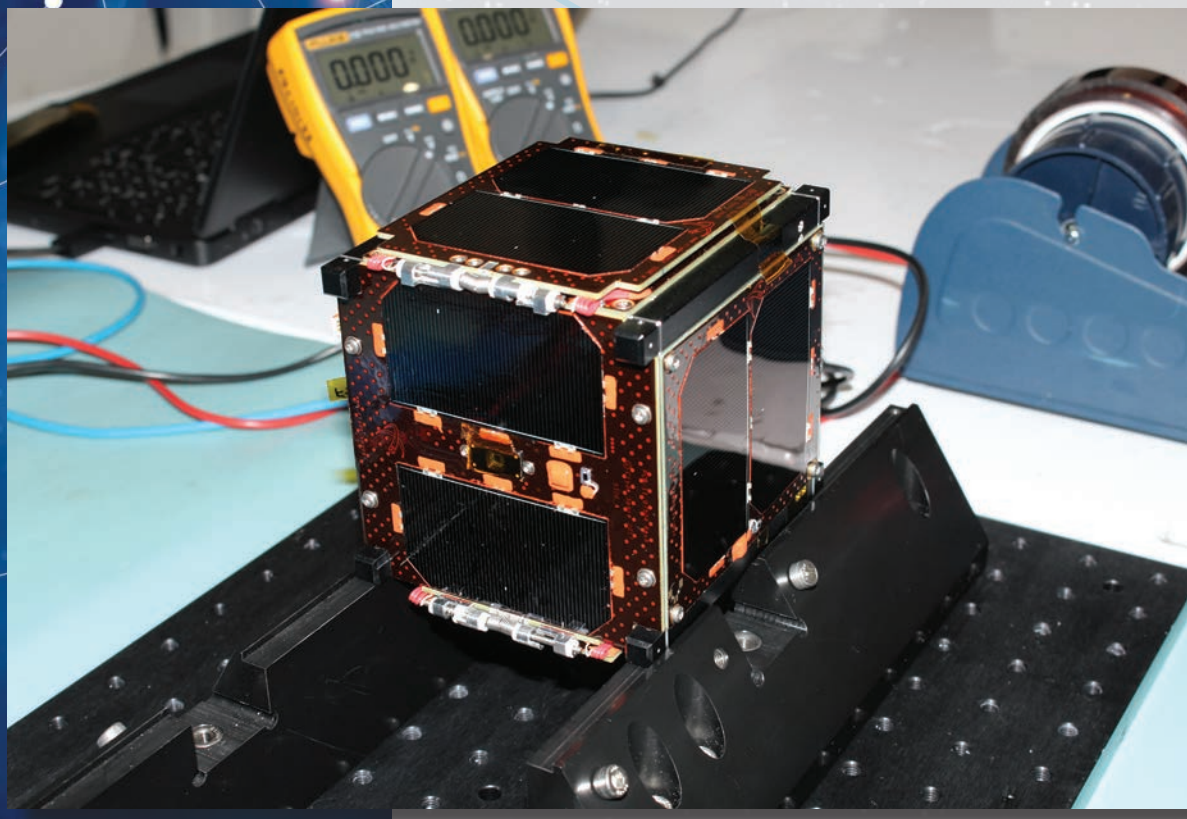
# Assembly, Integration and Testing (AIT)

Assembling all the physical components of the satellite on one board called the Flat Sat. The FlatSat was populated with the modules to be onboarded MIR-SAT1. The whole system was then tested and integrated together with the flight software.



*The flatsat is a replica of MIR-SAT1 and has the same components as the nanosatellite spread on a board. It allows simulation of maneuvers prior to uploading on MIR-SAT1.*

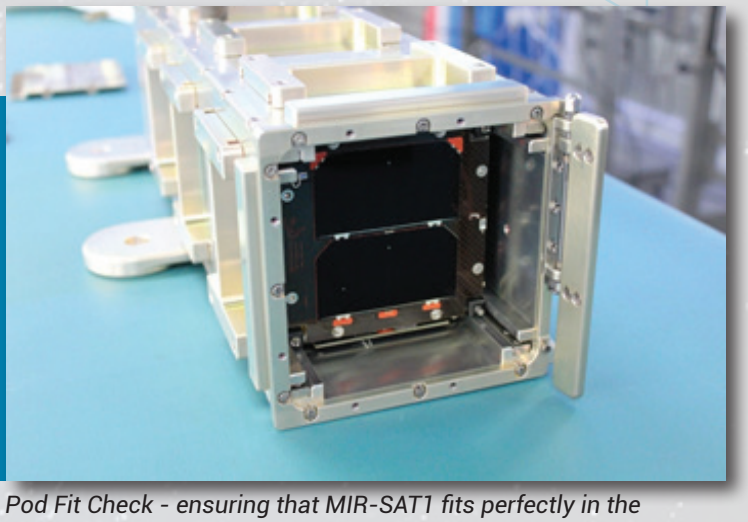
The FlatSat was populated with all the modules to be onboarded MIR-SAT1. The whole system was then tested and integrated together with the flight software. Full AIT started in January 2020 and ended in July 2020.



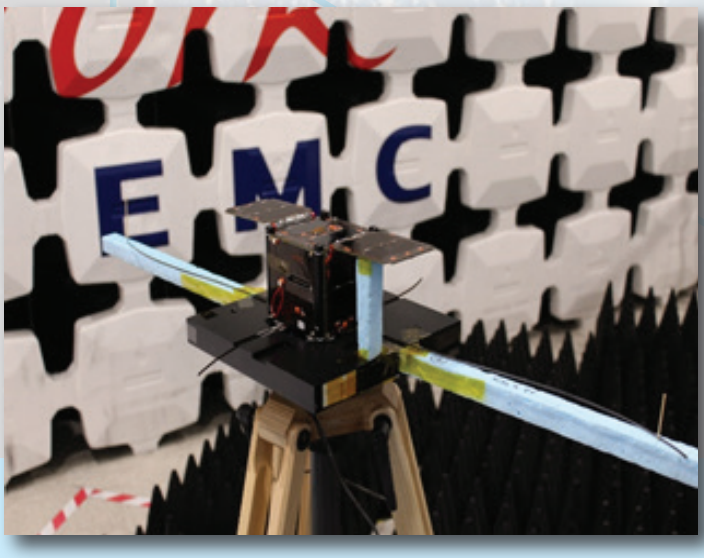
*MIR-SAT1 undergoing Battery Testing*

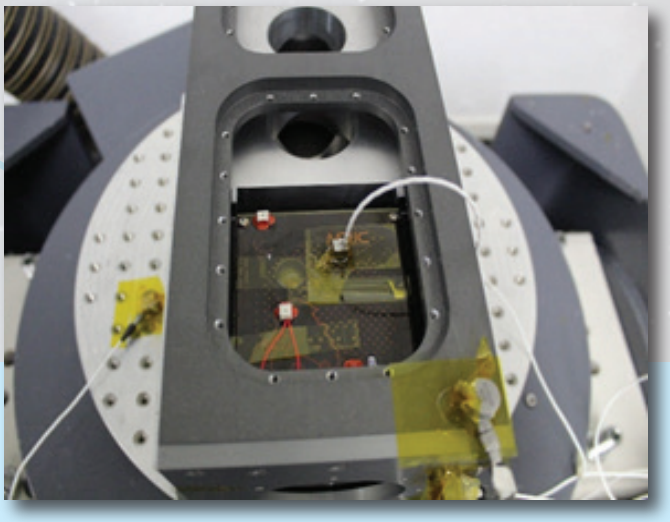
# Environmental Testing (EVT)

The satellite was assembled without locking the screws during what is called the Soft-stack phase. A pod fit-check was carried out at AAC-Clyde Space to ensure that the CubeSat fits into the J-SSOD launcher without clashing with the boundary structure. This J-SSOD pod was provided by JAXA for this specific purpose. The check was done at Clyde Space via video conferencing with UNOOSA, JAXA and MRIC in attendance.

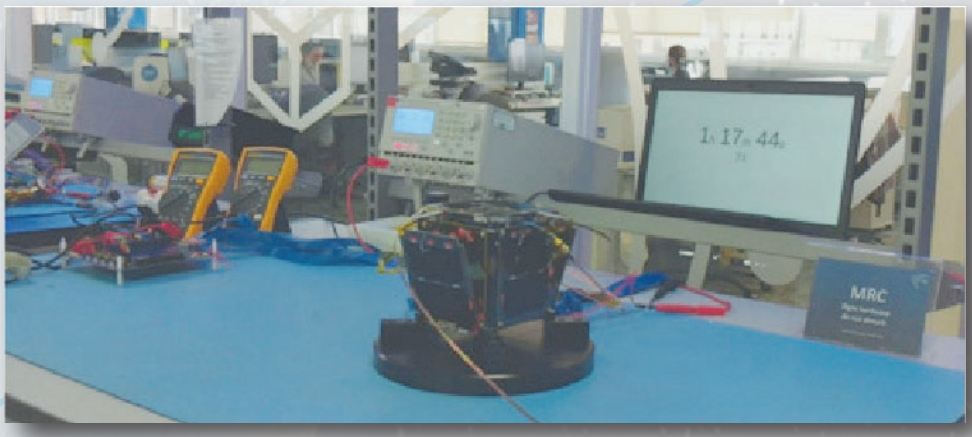


*Pod Fit Check - ensuring that MIR-SAT1 fits perfectly in the Launcher without clashing*



The satellite underwent the environmental tests which included temperature, vacuum, and vibration tests, as well as electromagnetic compatibility and Helmholtz tests. EVT was completed in August 2020.

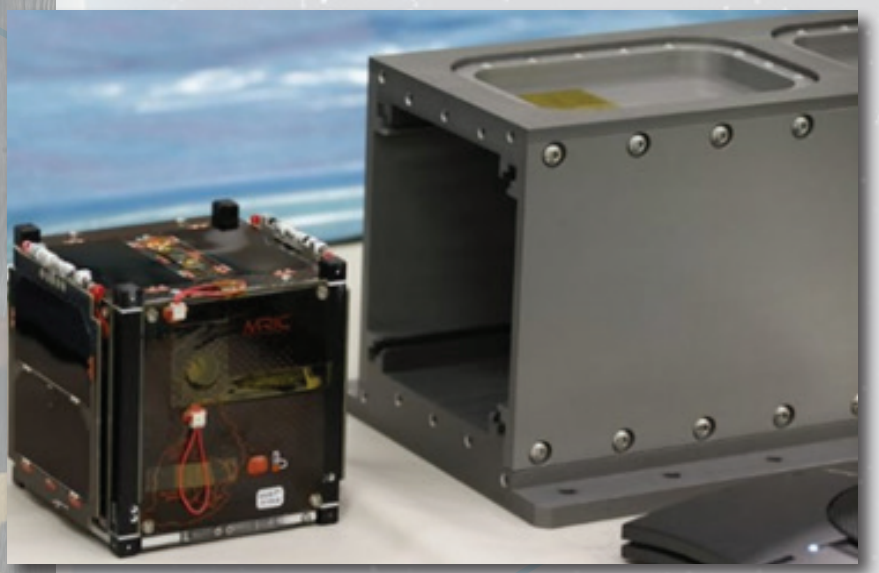


*Antenna & Solar Panels Deployment Test*

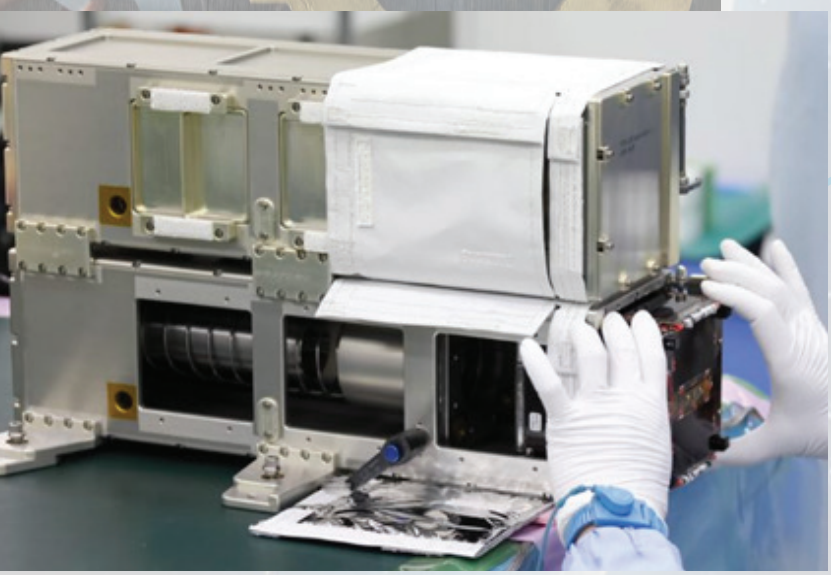
# MIR-SAT1 Delivered to JAXA in February 2021

After completing the testing phases and having passed the safety review assessments as per JAXA's requirements, MIR-SAT1 was shipped from AAC-Clyde Space in Glasgow to the JAXA, Tsukuba Space Centre in Japan in February 2021. The satellite was stowed in the JSSOD pod and packed securely to be sent to the NASA's JFK Space center USA on its way to the ISS.


*Hybrid working arrangements 'due to Covid 19 pandemic –MRIC Team, AAC-Clyde space and JAXA working together during verification tests and JSSOD integration*



*MIR-SAT1 removed from shipping pod*



*Final Integration of the MIR-SAT1 in the J-SSOD*

# Sustained efforts even during the lockdown

Mauritius was hit by two prolonged lockdowns one in March 2020 and the second one in March 2021. Despite this difficult situation, we managed to work in close collaboration with the international partners. We had to work in three different time zones together. JAXA Colleagues attended the working sessions via online videoconferences late at night Japan Time. While for our AAC-Clyde colleagues it was very early in the morning. Teamwork and communication allowed us to steer through the difficult test reviews

*A proud Moment for the MIR-SAT1 Team to have finally handed over the satellite to JAXA – Now MIR-SAT on its way to Space!*


*Official handing over certificate signed by both directors of MRIC and JAXA.*

# Registration of MIR-SAT1 with International instances

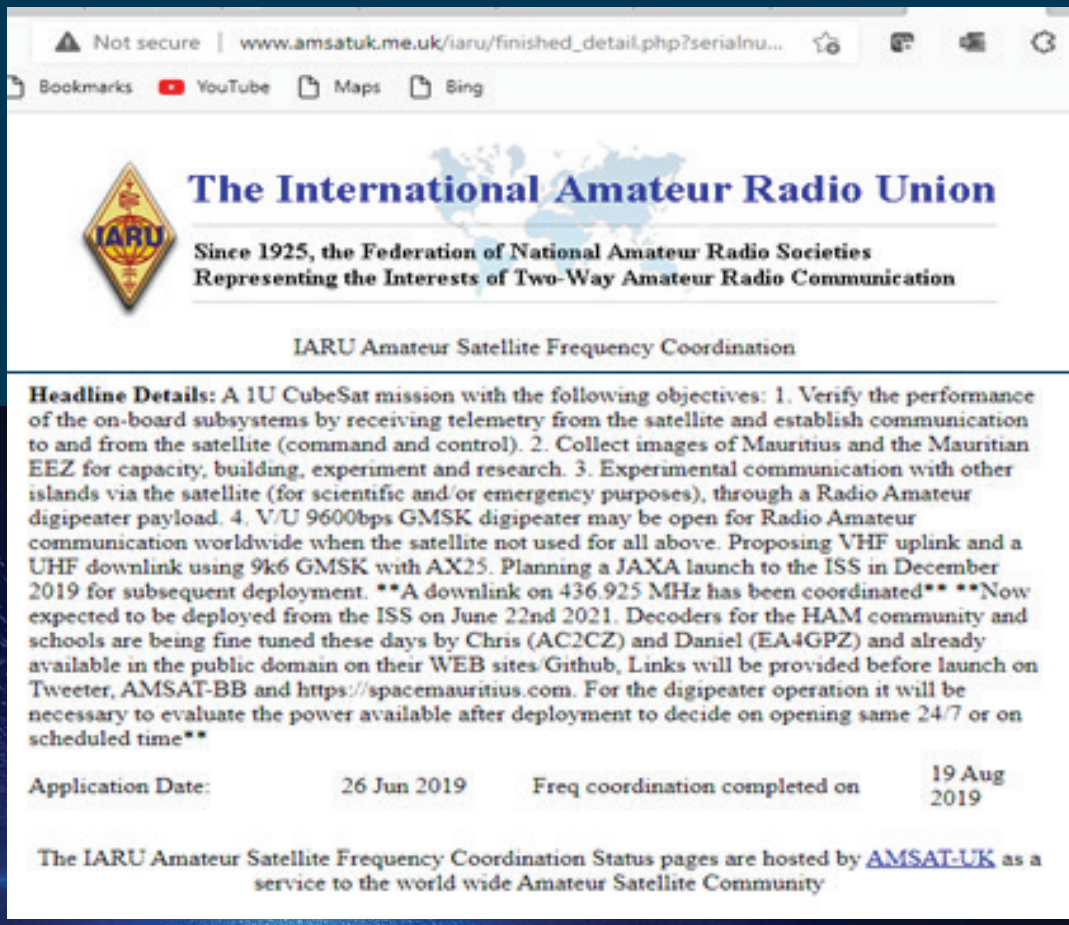
As per the KiboCube requirements, the MIR-SAT1 should communicate on the radio amateur band, and its telemetry be accessible to everyone since MIR-SAT1 is to be used for peaceful mission. MIR-SAT1 was registered with the International Amateur Radio Union (IARU) and the International Telecommunication Union (ITU). ICTA and MARS contributed significantly to this registration process and after discussions and several readjustments, the final frequencies of MIR-SAT 1 were filed and coordinated.

### MIR-SAT1 Communication Frequencies

VHF:145.9875 MHz and UHF:436.925 MHz[14,16].

### Call sign of MIR- SAT1

The callsigns for the spacecraft and ground station are 3B8-MIR and 3B8-MRC, respectively.



Not secure | www.amsatuk.me.uk/iaru/finished_detail.php?serialnu...

Bookmarks YouTube Maps Bing

**The International Amateur Radio Union**

**Since 1925, the Federation of National Amateur Radio Societies**
**Representing the Interests of Two-Way Amateur Radio Communication**

IARU Amateur Satellite Frequency Coordination

**Headline Details:** A 1U CubeSat mission with the following objectives: 1. Verify the performance of the on-board subsystems by receiving telemetry from the satellite and establish communication to and from the satellite (command and control). 2. Collect images of Mauritius and the Mauritian EEZ for capacity, building, experiment and research. 3. Experimental communication with other islands via the satellite (for scientific and/or emergency purposes), through a Radio Amateur digipeater payload. 4. V/U 9600bps GMSK digipeater may be open for Radio Amateur communication worldwide when the satellite not used for all above. Proposing VHF uplink and a UHF downlink using 9k6 GMSK with AX25. Planning a JAXA launch to the ISS in December 2019 for subsequent deployment. **A downlink on 436.925 MHz has been coordinated** **Now expected to be deployed from the ISS on June 22nd 2021. Decoders for the HAM community and schools are being fine tuned these days by Chris (AC2CZ) and Daniel (EA4GPZ) and already available in the public domain on their WEB sites/Github, Links will be provided before launch on Tweeter, AMSAT-BB and https://spacemauritius.com. For the digipeater operation it will be necessary to evaluate the power available after deployment to decide on opening same 24/7 or on scheduled time**

Application Date: 26 Jun 2019 Freq coordination completed on 19 Aug 2019

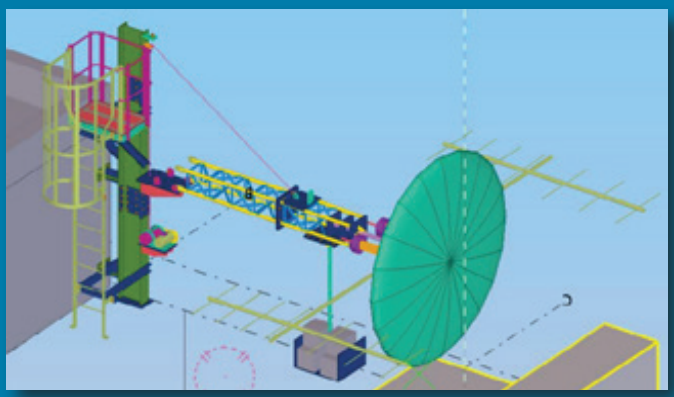
The IARU Amateur Satellite Frequency Coordination Status pages are hosted by AMSAT-UK as a service to the world wide Amateur Satellite Community

*MIR-SAT1 officially registered frequencies accessible to all Radio Amateurs worldwide. Note the in-kind contribution of Chris Thompson (AC2CZ) and Daniel Estevez (EA4GPZ) for having written a decoder allowing radio amateurs worldwide to download MIR-SAT1 telemetry. The MRIC is very thankful to Daniel and Chris. Thanks also to Jean Marc Momple 3B8DU who has been instrumental in the coordination process all through.*

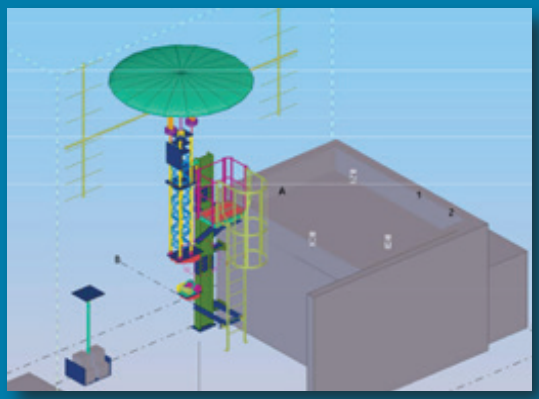
# The MIR-SAT1 Ground Station

# A state of the art set up to track and communicate with MIR-SAT1 in space

MIR-SAT1 is a 10cm3 object orbiting in space at around 400Km above the earth surface. In order of magnitude, one can visualize MIR-SAT1 as a grain of sand which we must track in a whole desert. With the help of AAC-Clyde Space, the MRIC set up a state-of-the-art Ground station with the latest relevant software, antenna structure, FlatSat and trained personnel to track MIR-SAT1, upload commands to and download information from MIR-SAT. This Ground station can will be used for future developments in Space Technology. The MRIC Engineers designed a satellite Antenna support structure which was registered as an Industrial Design with the Intellectual Property Office of Mauritius. This design was then refined and built by a professional local firm of engineers.



*CAD design done by EDCC dish stowed during cyclonic conditions*



*The Antenna in Operating Conditions*

*The MIR-SAT1 dish antenna in operation -ready to receive and send signals from and to MIR-SAT1*

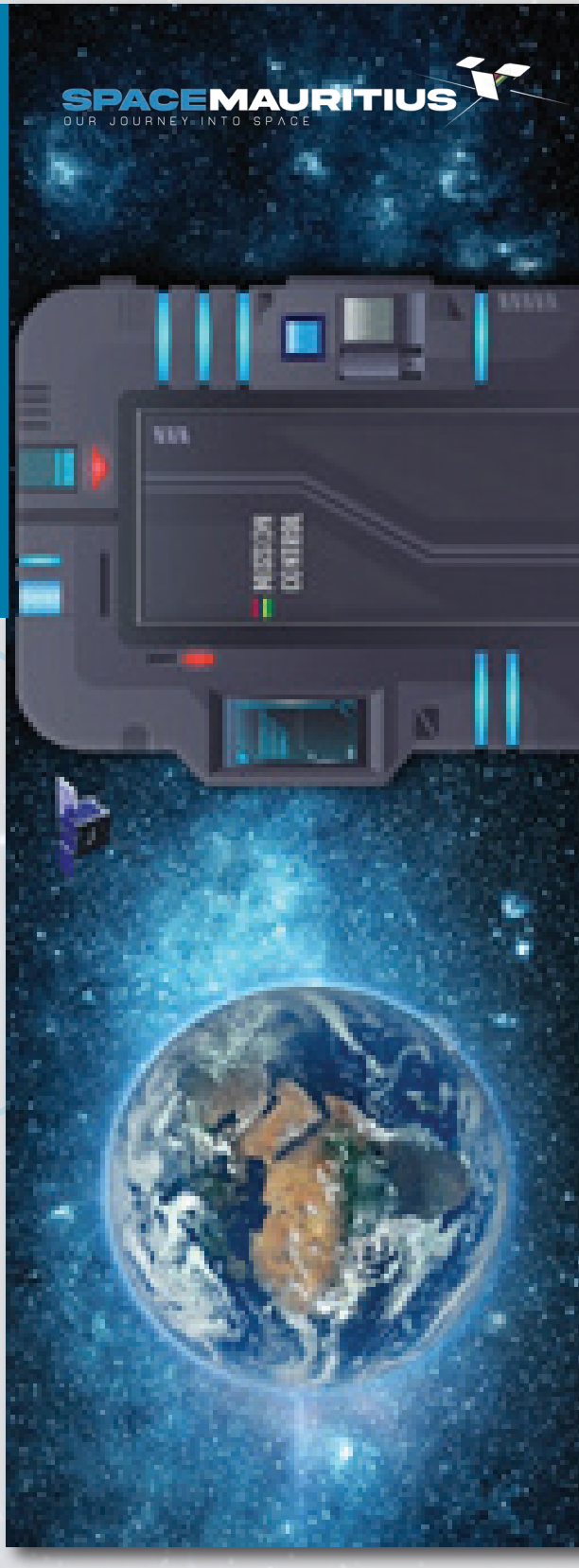
The above would not have been possible without the full collaboration of the following institutions:

Information & Communication Technologies Authority (ICTA); Mr Jean Marc Momple - MARS, Ministry of Social Security (owner of Ebene Heights building); and an expert Engineering Company (EDCC). Thanks also to EMTEL, Prodesign and Servansing Jadav & Partners for their in-kind contributions

# Mission Control Room

The Mission Control is responsible to issue commands to the spacecraft which relate to the mission objectives or for housekeeping purposes. The main activities by mission control are as follows:

- Operating the Mission Control Software
- Short and long-term trend analysis
- Orbit determination and manoeuvre planning
- Regular updating of orbit propagation
- Mission planning and scheduling
- On-board memory management
- Downlinking and storage of payload data (i.e. XCAM Imager)
- Perform software updates onboard spacecraft
- Conducting mission experiments
- Debugging of flight software in event of system errors
- Island-to-Island communication tests
- System power management




# MRIC Missions Lab

The Missions Lab consists of a FlatSat and is used in conjunction of a Flight Development Software Kit, and includes the following tasks:

- Development and testing of spacecraft procedures and manoeuvres
- Debugging of errors
- System optimisation
- Design of future missions
- Integration and testing of newly developed subsystems

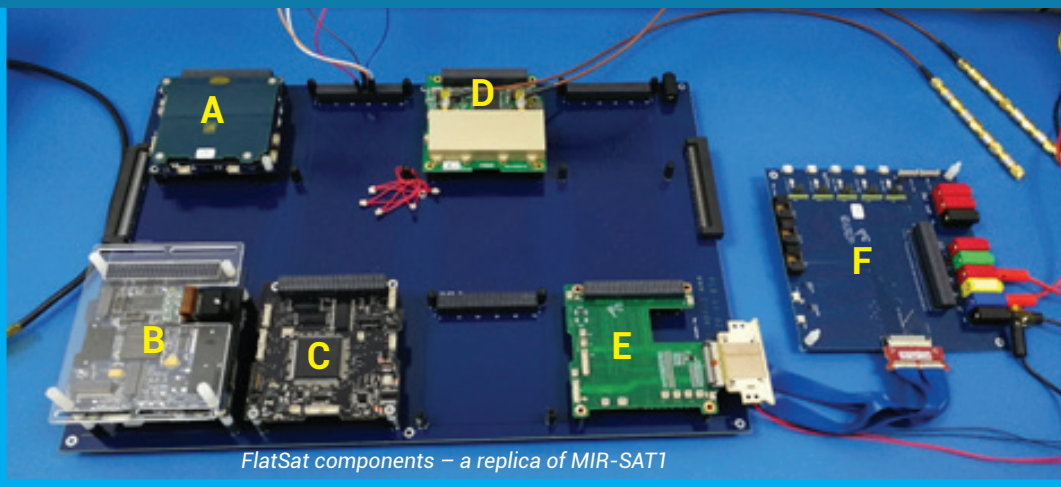
*Control Room in Operation*
*Downloading Data from MIR-SAT1*

# MRIC Missions Lab

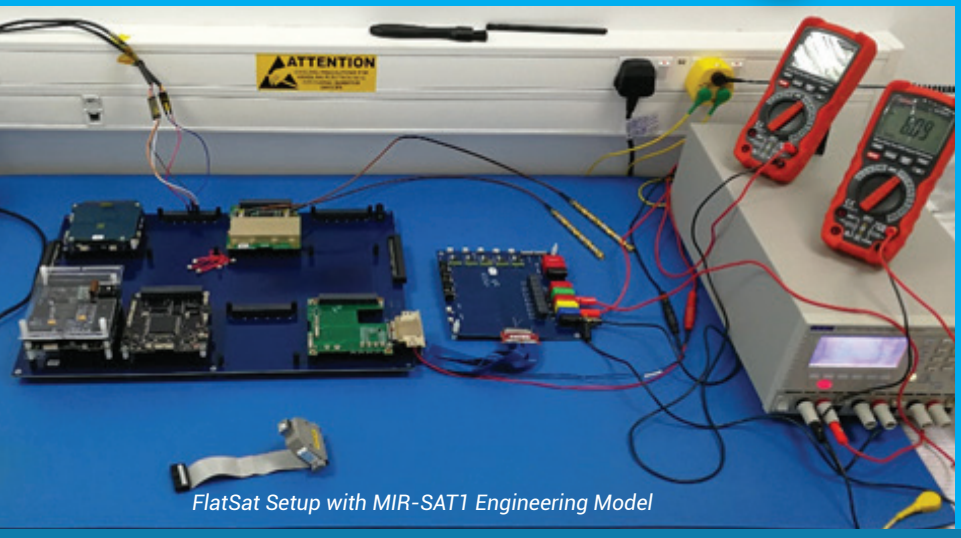
## Modules of the FlatSat

A – Electrical Power System & Battery Stack
B – C3D Imager & On-Board Computer Stack
C – Attitude Determination and Control System (ADCS)
D – Communication Module
E – Platform Interface Module
F – Power Card

*Mr F.Shamutally connecting Electric Power System and Battery*



*FlatSat components – a replica of MIR-SAT1*



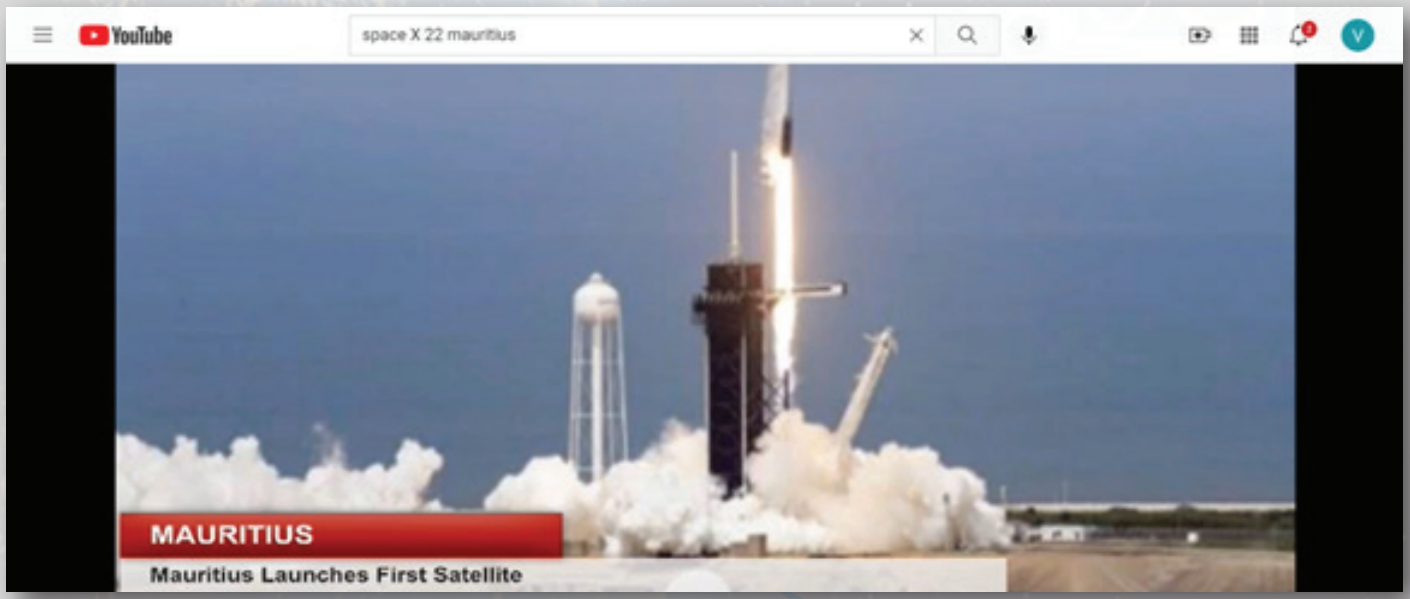
*FlatSat Setup with MIR-SAT1 Engineering Model*


*Mr Z Soreefan connecting FlatSat to Power Boarding*

# Launching

# MIR-SAT1 on its way to the ISS

MIR-SAT1 was sent to NASA's Kennedy Space Centre in Florida by JAXA. On Thursday, June 3, at 17:29 UTC (21:29 Mauritian time – GMT+4) MIR-SAT1 was onboarded the Space X CRS 22 Falcon 9 Rocket and launched towards the ISS. MIR-SAT1 was safely docked onboard ISS on the 4th June 2021. This event was covered by many worldwide media such as NASA TV and BNTv Africa[1].





*MIR-SAT1 launched from Earth to the ISS on June 3rd 2021. A historical moment for Mauritius – followed by the international Community* [2, 3]

1 https://www.youtube.com/watch?v=wJWbasxbGLU
2 https://www.youtube.com/watch?v=4h5CM_gp_K0&t=239s
3 https://www.youtube.com/watch?v=xd4VcoVuQxE

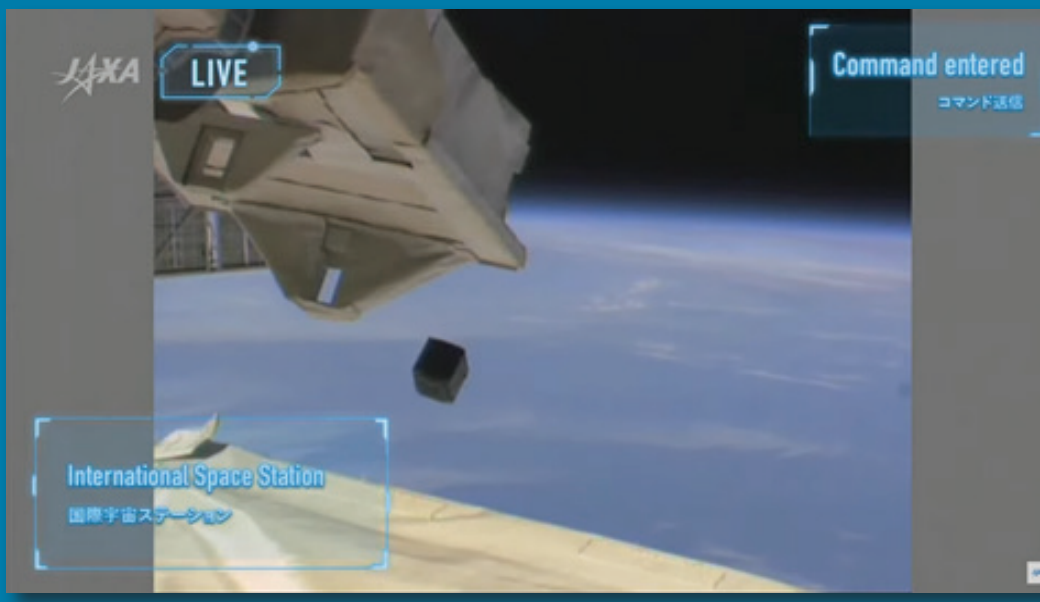
# Deployment

MIR-SAT1 was deployed into space from the ISS Kibo module on the 22nd June 2021. This Event was broadcasted live on JAXA's youtube channel in the presence of **The Hon Pravind Kumar JUGNAUTH.**


*Opening Speech of the Prime Minister of Republic of Mauritius*
**The Hon Pravind Kumar JUGNAUTH**


*UNOOSA and JAXA representatives assisting the Deployment Live from Vienna and Japan respectively.*

**Prime Minister of Republic of Mauritius The Hon Pravind Kumar JUGNAUTH** *giving the 'Go' signal to the Flight Director in Japan for deployment of MIR-SAT1.*




**MIR-SAT1 deployed from the ISS ©JAXA/NASA**

**Prime Minister of Republic of Mauritius The Hon Pravind Kumar JUGNAUTH** witnessing the deployment of MIR-SAT1 (In front left) ©Government of Mauritius


Ambassador of Japan to Mauritius
**H.E. KAWAGUCHI Shuichiro**
witnessing the deployment of MIR-SAT1
(In front left) ©Government of Mauritius


Certificate of Deployment

# Mauritius now proudly part of Space Faring African Countries

## SATELLITES LAUNCHED BY AFRICAN COUNTRIES

African countries have launched 44 satellites from 1989 until the present day. 41 of these satellites were launched by 13 countries while the remaining three involved several african countries in a multilateral project.

**1. ALGERIA**
1. ALSAT1 - 2002
2. ALSAT1 2A - 2010
3. ALSAT 1B - 2016
4. ALSAT 2B - 2016
5. ALSAT 1N - 2016
6. ALCOMSAT - 1 2017

**2. ANGOLA**
1. Angosat - 1 2017

**3. GHANA**
1. Ghanasat - 1- 2017

**4. EGYPT**
1. NILESAT 101 - 1998
2. NILESAT 102 - 2000
3. EGYPTSAT 1 - 2007
4. NILESAT 201 - 2010
5. EGYPTSAT 2 - 2014
6. EGYPTSAT - A - 2019
7. NARSSCube - 2 - 2019
8. NARSScube - 1 - 2019
9. TIBA - 1 - 2019

**5. ETHIOPIA**
1. ETRSS - 1 - 2019
2. ET-SMART - RSS - 2020

**6. KENYA**
1. 1KUNS - PF - 2018

**7. MAURITIUS**
1. MIR-SAT1 - 2021

**8. MOROCCO**
1. Maroc - TUBSAT - 2001
2. MOHAMMED VI-A - 2017
3. MOHAMED VI-B - 2018

**9. MULTILATERAL**
1. RascomStar - QAF-1
2. RascomStar - QAF - 1R
3. Newdawn

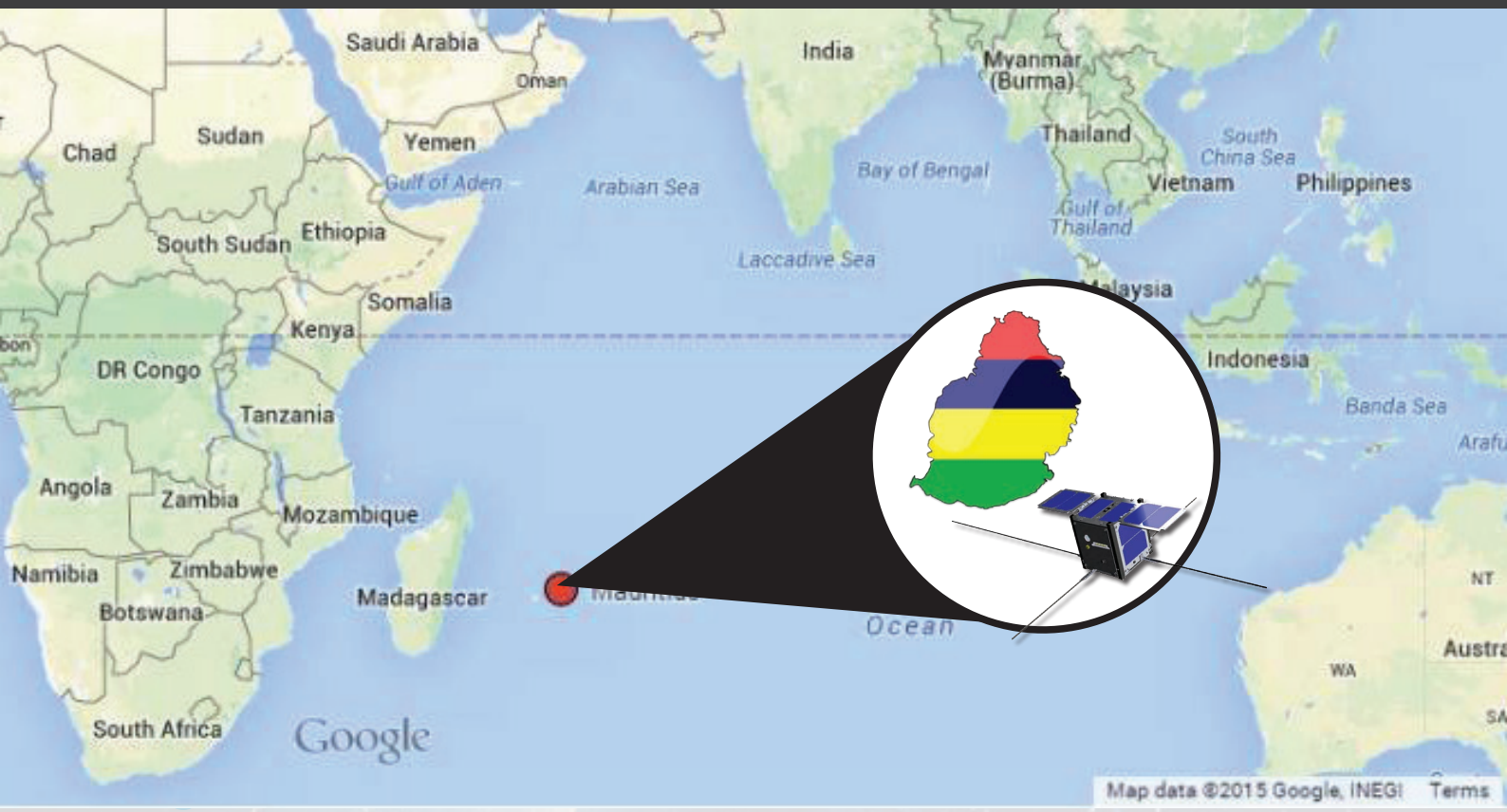
**10. NIGERIA**
1. Nigeriasat - 1 - 2003
2. NIGCOMSAT1 - 2007
3. NigeriaSat - 2 - 2011
4. NigeriaSat - X - 2011
5. NIGCOMSAT 1R - 2011
6. NigeriaEduSAT - 1 - 2017

**11. RWANDA**
1. RwaSat - 1 - 2019

**12. SOUTH AFRICA**
1.SUNSAT - 1999
2. ZACUBE -2003
3. SUMBANDILA - 2009
4. KONDORE - 2014
5. nSight1 - 2017
6. ZA- AEROSAT - 2017
7. Zacube - 2 - 2018
8. XinaBox ThinSAT - 2019

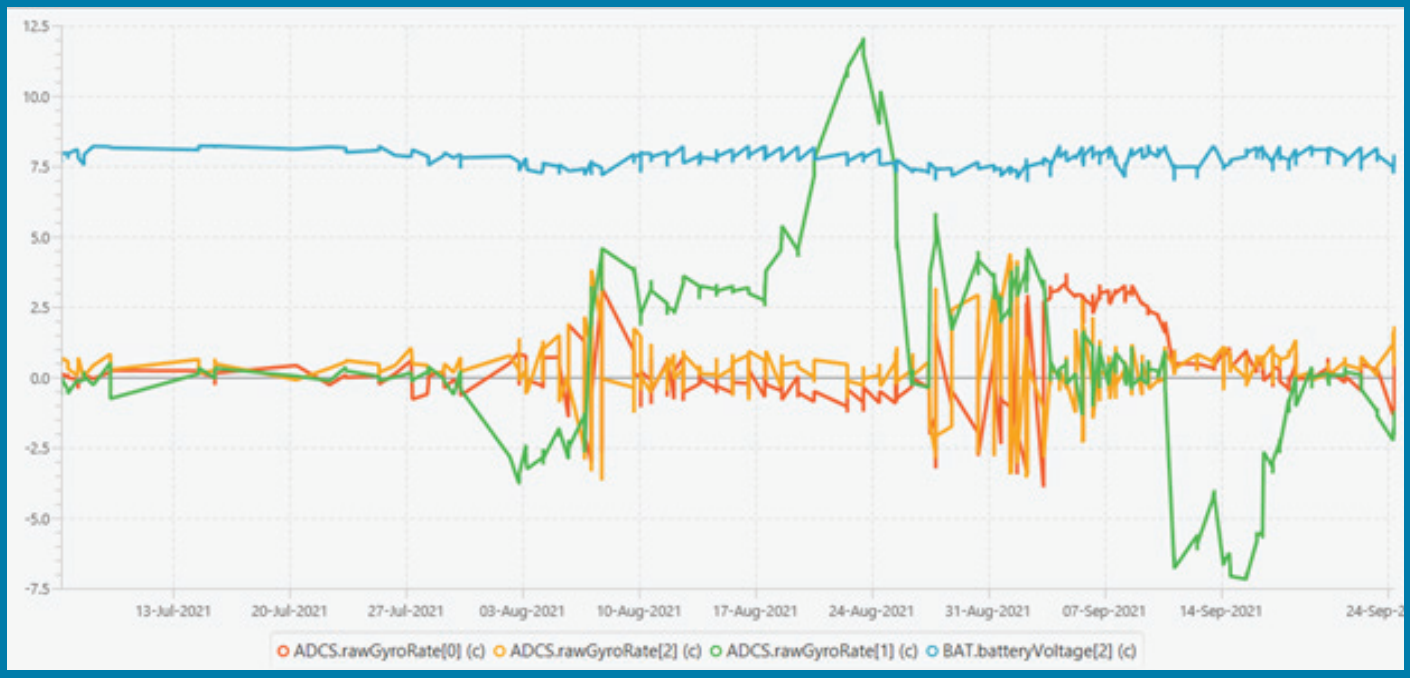
**13. SUDAN**
1. SRSS - 1 - 2019

**14. TUNISIA**
1. Challenge ONE - 2021



# MIR-SAT1 is 'Alive' in Space

MIR-SAT1 was deployed on the Low Earth Orbit at an inclination of 51.6 degrees and as programmed, it automatically switched on after 45 minutes. Its first signal was captured over east coast of Australia. The first telemetry was decoded over the United State of America. The MRIC engineers successfully captured the satellite during its first pass over Mauritius on the 22nd June 2021 at around 16h. MIR-SAT1 was commissioned over a period of 2 month to ensure that all subs-systems were operating as expected.




MIR-SAT1 Telemetry – giving clear indications that the Satellite is 'Alive' in space

# Images captured by MIR-SAT1 from space

After nearly 2 months of Commissioning and finetuning of the software, the MIR-SAT1 started to take pictures of the region around Mauritius. The first pictures taken by MIR-SAT 1 are illustrated below. This is a proud moment for Mauritius as for the first time we are taking picture of our country from space using our own satellite!

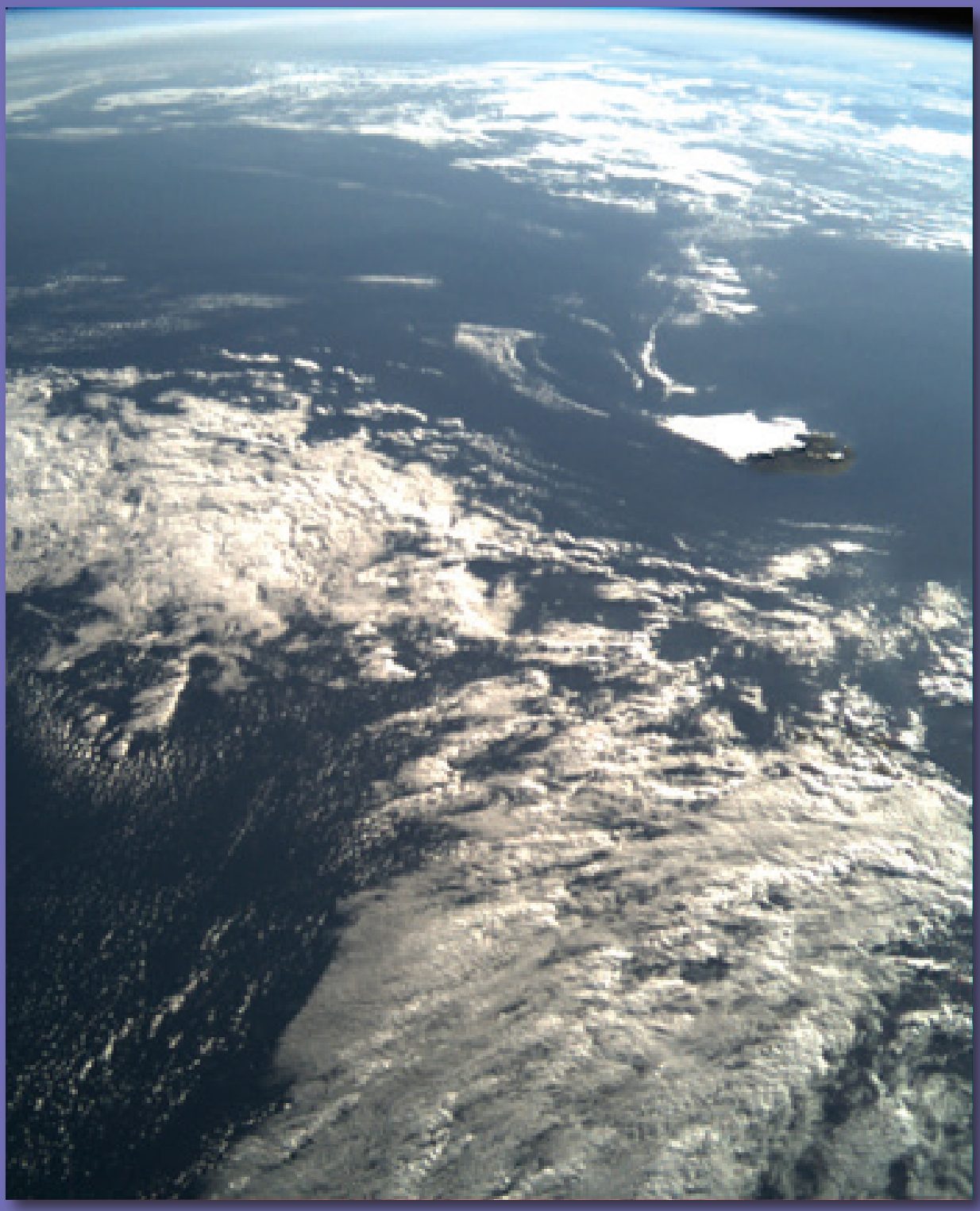
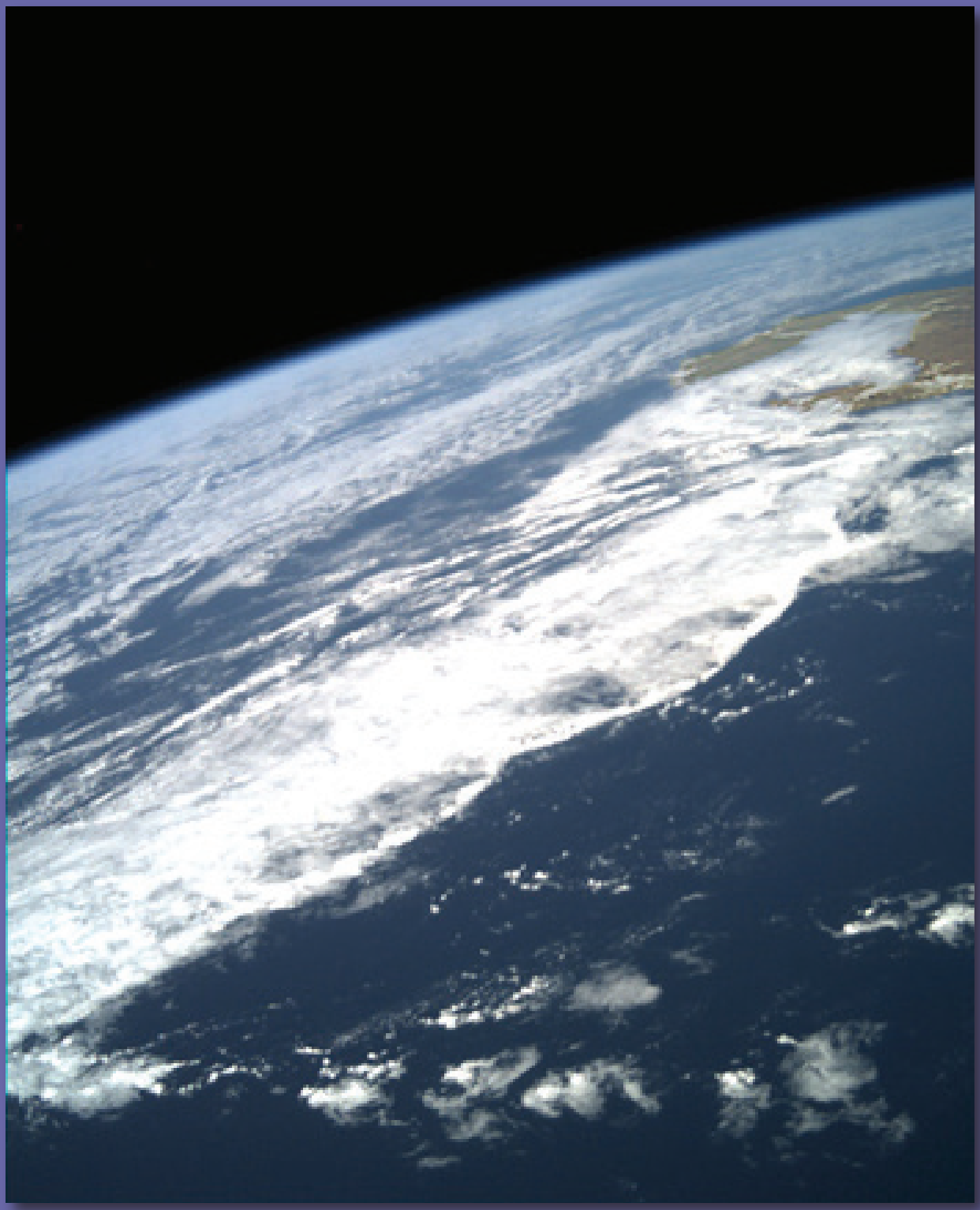


**Image of Reunion Island and Mauritius. Reunion Island (seen in the center) is half visible with the rest covered in clouds. Mauritius is completely covered in clouds at the bottom and therefore not visible.**

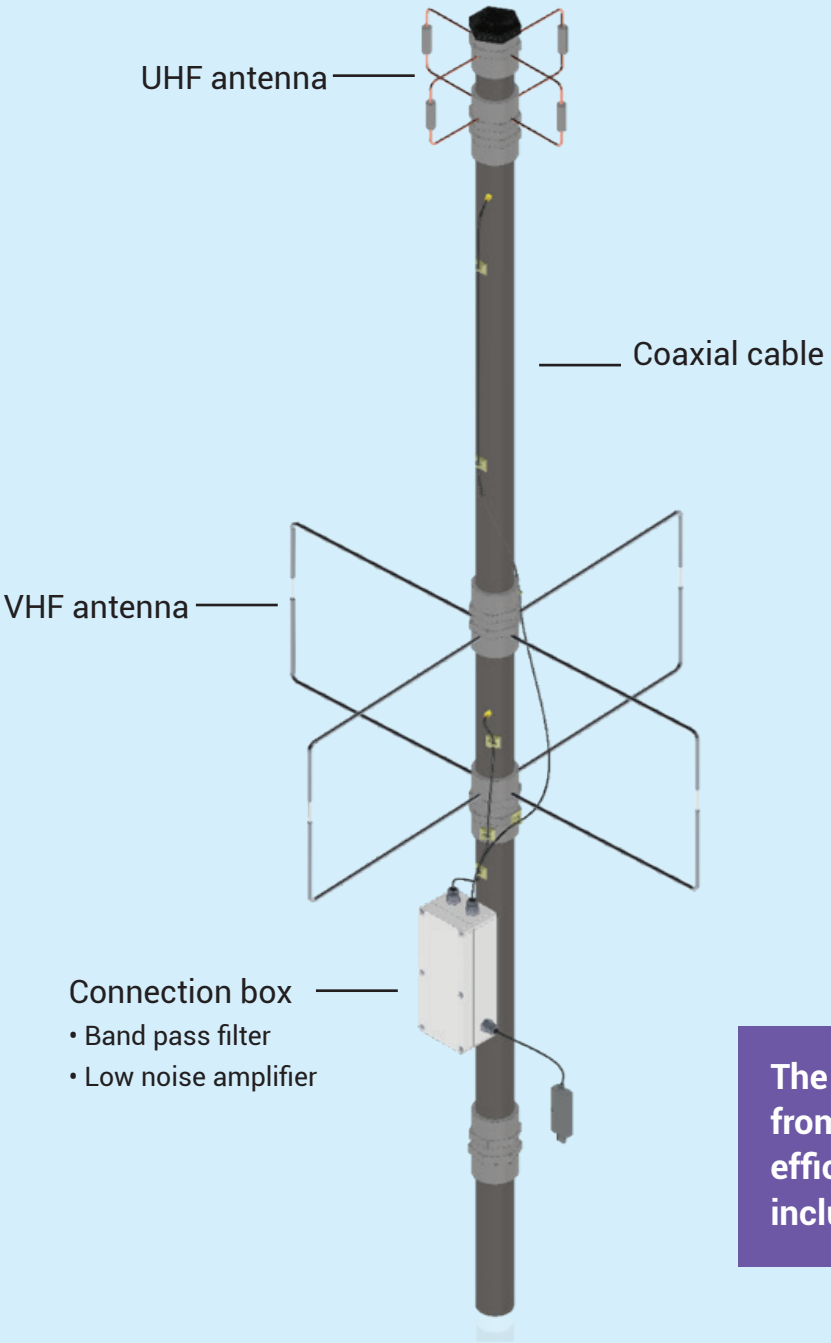
# Images captured by MIR-SAT1 from space

Image taken over Mauritius with satellite pointing towards Madagascar. The south coast of Madagascar can be seen on the top right of the photo.



# Outreach and Capacity Building

The MRIC, in collaboration with the Ministry of Information Technology, Communication and Innovation, the Ministry of Education, Tertiary Education, Science and Technology, and the Mauritius Amateur Radio Society (MARS) gave a one-week training course on satellite antenna building for communication with low earth orbiting satellites. The initiative aimed to raise awareness of secondary and tertiary level students from 15 to 25 years of age on the opportunities offered by Space and Satellite Technologies and satellite data applications.



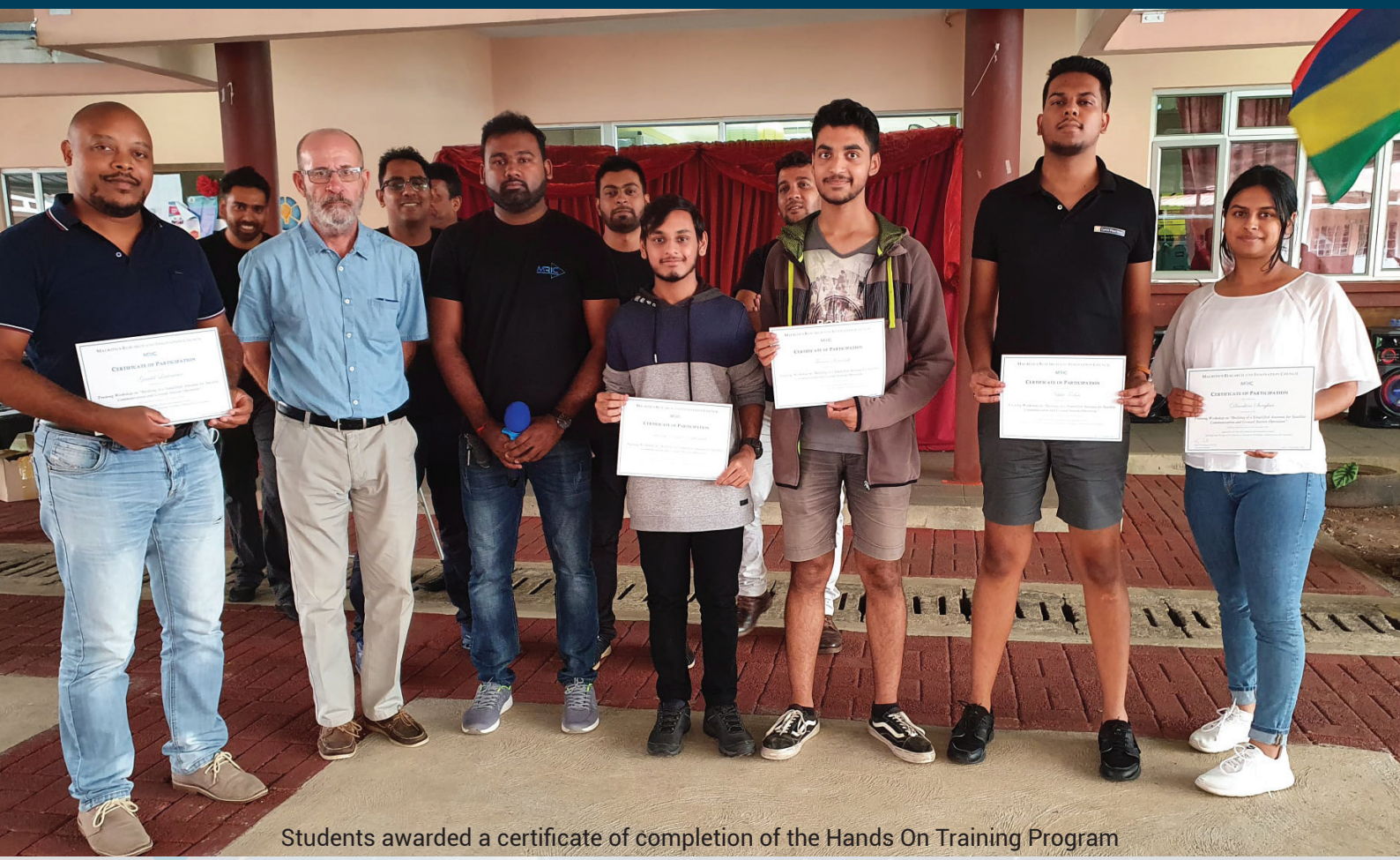

**The Simplified Antenna – built from locally available materials. An efficient receiver for LEO signals including signals from MIR-SAT1**

# CAPACITY BUILDING WORKSHOP

Students and their teachers participating in the building of the antenna – November 2020. – Boys and Girls – show high interest in the training


# INSTALLATION OF THE ANTENNA

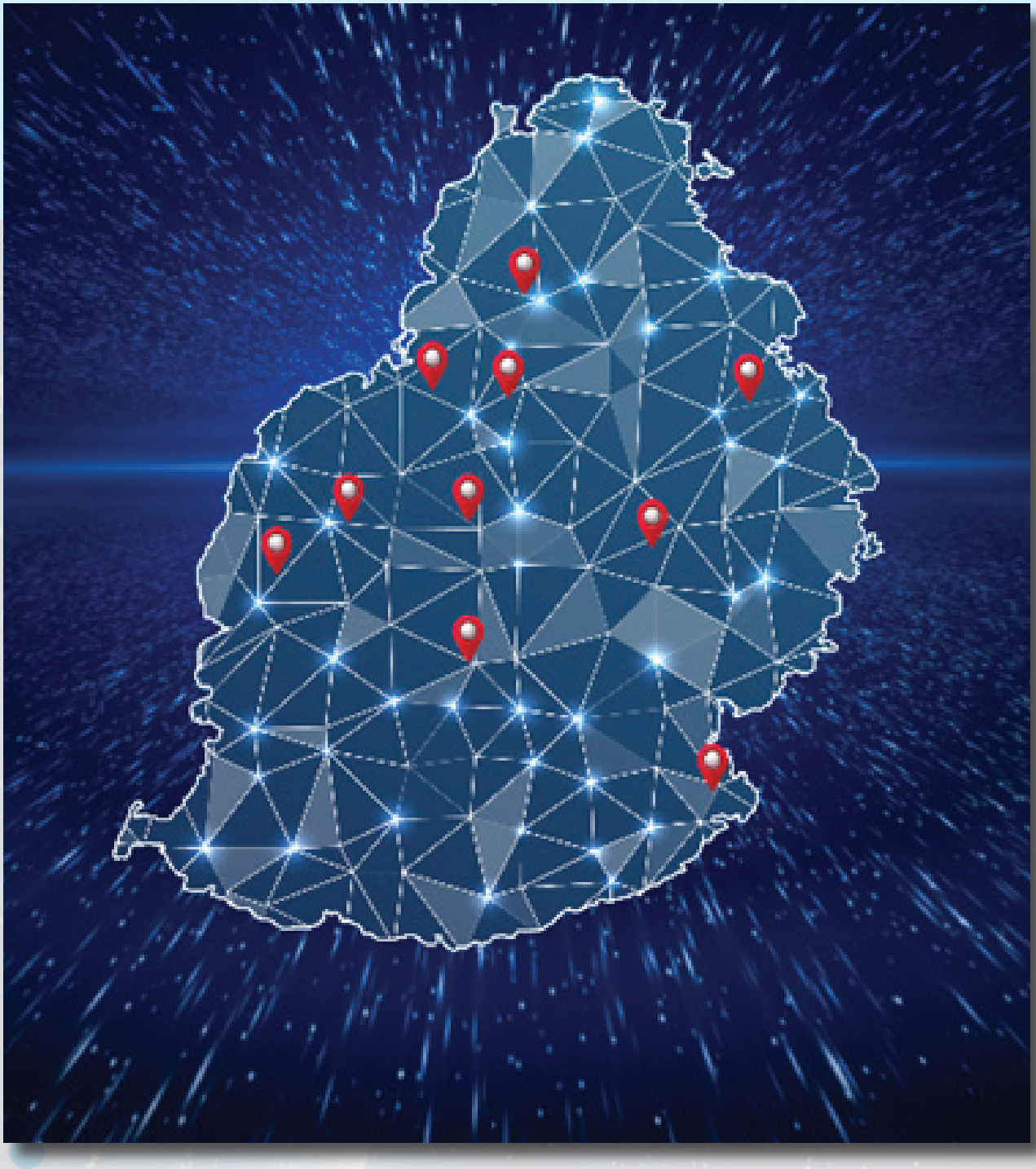
Installation of the antenna on top of the educational institutions once built- Currently 7 secondary schools & 3 tertiary institutions have a functional antenna – 7 have already received telemetry from MIR-SAT1



Students awarded a certificate of completion of the Hands On Training Program

# Educational institutions having set up their simplified satellite antenna and Ground Station

1. Prof Hassan Raffa SSS
2. Forest Side SSS (Girls)
3. John Kennedy College
4. Rajcoomar Gujadhur SSS
5. Université des Mascareignes
6. Droopnath Ramphul State College
7. University of Mauritius
8. Sir Abdool Razack Mohamed SSS
9. Polytechnics Mauritius Ltd
10. Hamilton College- Girls Dept A

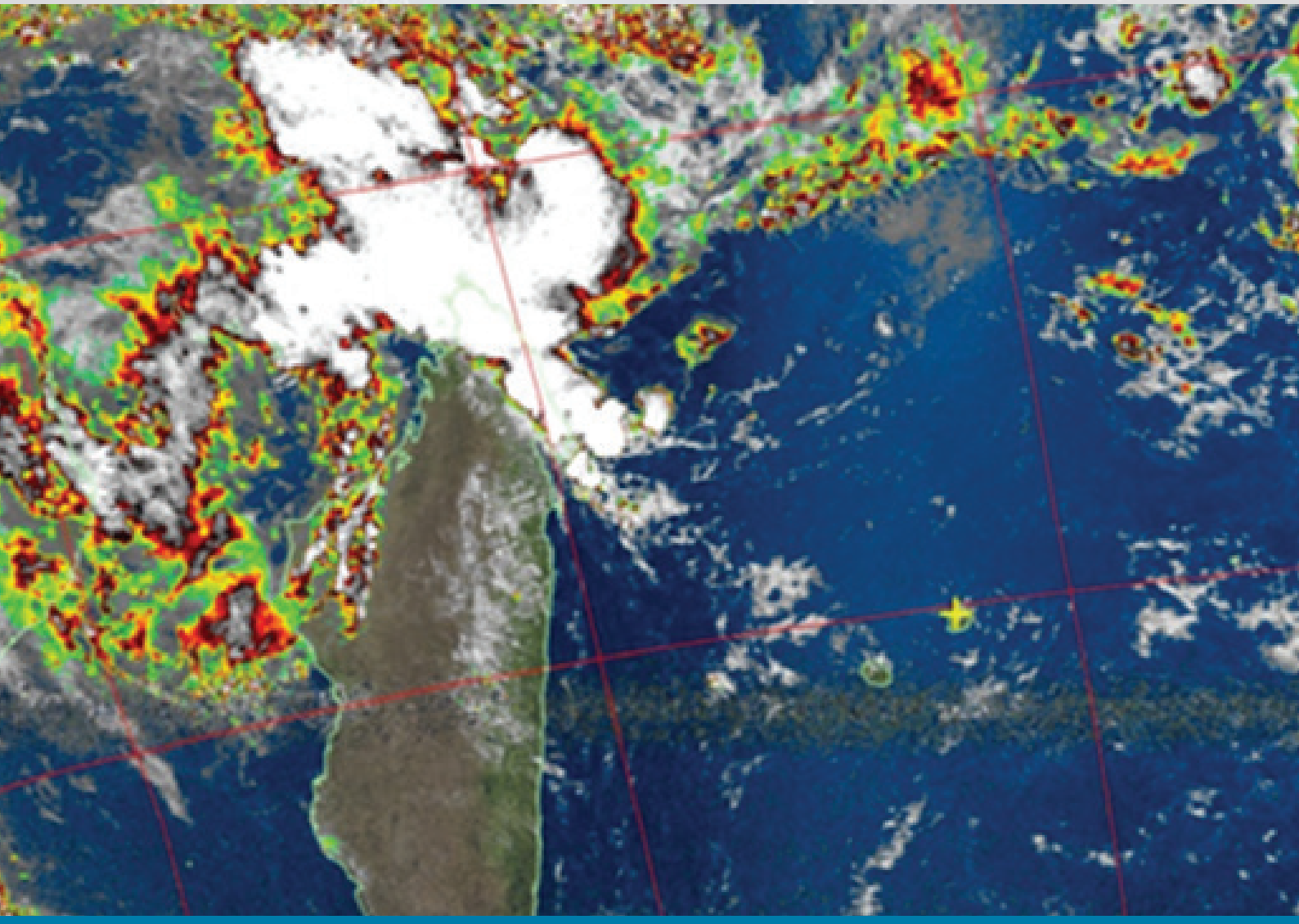


# Official launching of the Antenna training workshop


Official launching of the Antenna training workshop by Hon. Minister D. Balgobin, Minister of Information Technology, Communication and Innovation.

# Satellite image captured by trained students

Image from a Low Earth Orbiting Satellite obtained by trained students using the simplified antenna. A cyclone can be seen on top of Madagascar. Mauritius is highlighted with a Cross



The Satellite Antenna Building Workshop – a first of its kind in Mauritius. Students in Mauritius being taught how to build a simplified satellite antenna, install necessary software to create a receiving station and use this set up to capture signals from Low Earth Orbiting Satellites. Some Schools have already captured MIR-SAT1 Telemetry – Another proud moment for the Country

# THE FUTURE OF THE MAURITIAN SPACE ADVENTURE

SPACEMAURITIUS
OUR JOURNEY INTO SPACE

**MIR-SAT1 has come at an opportune time at the dawn of the New Space Era paving the way for Mauritius, for the first time in its history, to step into Space. With a view to ensuring sustainability of the MIR-SAT1 initiative, the MRIC is proposing to develop a Space Program which seeks to become a socio-economic pillar in the coming decades.**

The MRIC foresees that the Space Program will help the Republic of Mauritius become the first Small Island Developing State in the Indian Ocean to leverage on space and satellite technologies to foster innovation for the socioeconomic benefit.

For the above to happen, there need to be much efforts directed towards creating the conducive environment for initiation and implementation of space related activities. The specific actions envisaged could be as follows:

1. Promote capacity building in space/satellite technologies
2. Leverage on international collaboration for future developments in space initiatives
3. Exploring the applications of space data to advise policy makers
4. Incentivizing creation of new space/satellite related startups in Mauritius

# COMMEMORATIVE STAMP

The Mauritius Post Ltd launches a first day cover of the commemorative stamp on MIR-SAT1. This is a major recognition for the first Mauritian initiative in space.


Courtesy of Mauritius Posts Limited

# Acknowledgements

This project was fully funded by the Government of Mauritius. The MIR-SAT1 Team has benefitted from constant support and guidance from the High-Level Steering Committee Chaired by Hon. D. Balgobin, Minister of Information Technology, Communication, and Innovation.

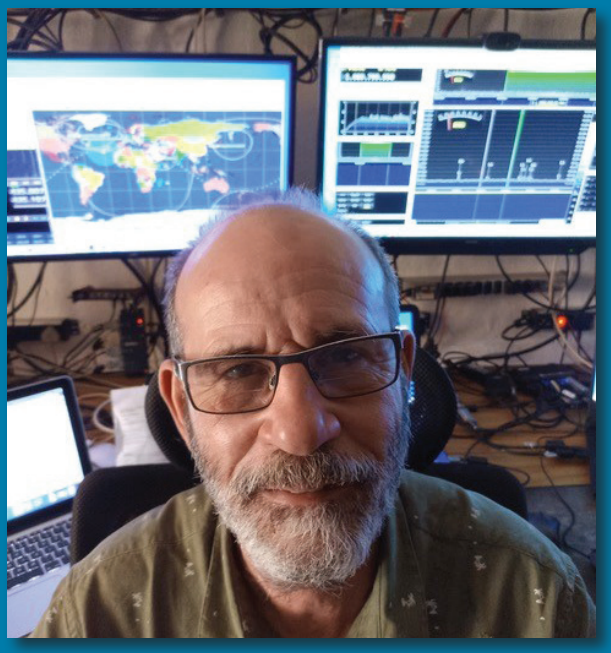
We are thankful to:

- the valuable contributions of Prof T. Bahorun, Executive Director of the MRIC and Dr K.S. Sukon, Chairperson of the MRIC who believed in and encouraged the MIR-SAT1 Team all through the process.
- our Collaborator from the Mauritius Amateur Radio Society, Mr J.M Momple (3B8DU) for his assistance and advice on the communication aspect of the MIR-SAT1, for his help in setting up the antenna for the Ground Station and for his efforts to introduce us to two world known Radio Amateurs C. Thompson (AC2CZ) and D Estevez (EA4GPZ). We wish to put on record our appreciation for the in-kind contribution of the latter two experts for having written a decoder allowing radio amateurs worldwide to download MIR-SAT1 telemetry;
- AAC-Clyde Space Team, in particular: Sandy Provan, Ryan Mackenzie, Andrew Boyd, Stephen Smith, Jayson Quibell, Peter Anderson and John Charlick
- ALL the MRIC staff who have contributed to the success of MIR-SAT1 from the very beginning.

Finally, a special thought goes to our former Executive Director Dr A. Suddhoo, who encouraged the MIR-SAT1 Team to continue believing the project and to sustain our efforts.

**Dr V. Bissonauth,**
**Project Manager & Research Coordinator,**
**MRIC**

# OUR COLLABORATORS



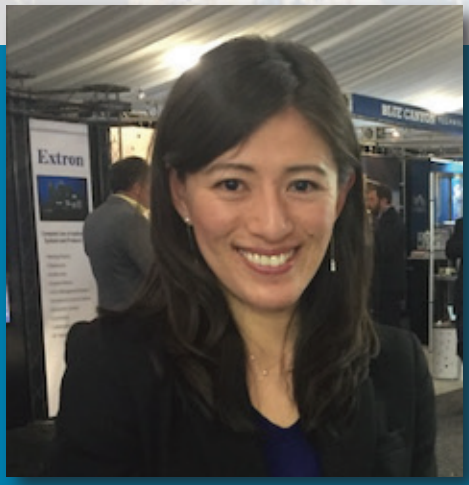
The Mauritius Amateur Radio Society (MARS), has been deeply involved with the MIR-SAT 1 project in different stages including (i) during the drafting of the application to KiboCube, (ii) at the stage of finalization of the radiocommunication module of MIR-SAT1, (iii) in the implementation of the satellite training workshop (MARS has also donated 3 ground station to schools), (iv) coordination with local and international authorities for regulatory matters, (v) carrying special radio amateur examination for the MIR-SAT 1 project, and (vi) helping to install the MRIC command ground station. MARS has also coordinated the implementation of the software decoders created by RadioAmateur Collaborators in Spain and USA. These decoders have enabled schools and radio amateurs to decode the telemetry of MIR-SAT 1 after deployment.

As an end note and wishful thinking why not a Mauritian astronaut in space soon... hopefully we local radio amateurs will see this happen soon as space is the future of humanity, and our small country must be part of this great adventure with the younger generation at the forefront.
***Jean MarcOmplé (Radio amateur station 3B8DU and voluntary member of the MIR-SAT 1 Team)***

MIR-SAT 1 is an example of how hard work can turn dreams into reality. MIR-SAT 1 is also the proof of the effectiveness of international cooperation, in this case of Japan, Mauritius and the United Nations. Students from all over Mauritius are listening to the signals that MIR-SAT1 sends back to Earth. I am sure that, one day, their space experiments and satellites will also be sending signals back to Earth.

**Jorge Del Rio Vera**
**Scientific Affairs Officer,**
**United Nations Office for Outer Space Affairs (UNOOSA)**

# OUR COLLABORATORS

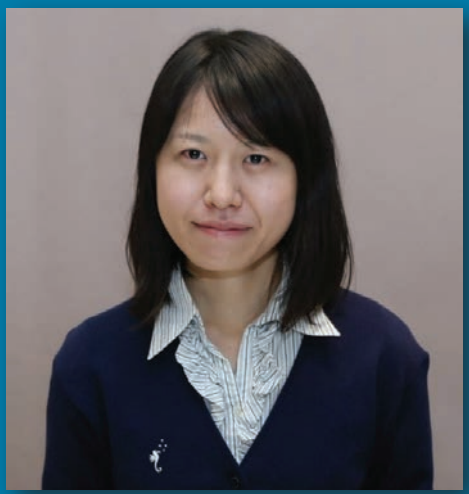



It was a privilege to have the opportunity to work with the highly professional and hardworking MRIC Team through the coordination of this project. We hope to keep working with MRIC to keep the momentum of MIR-SAT 1 going.

**Hazuki Mori**
**Expert, Space Applications**
**United Nations Office for Outer Space Affairs (UNOOSA)**

It was an honour to be able to join MIR-SAT1 project. I was impressed by MRIC's sincere and earnest work during the many difficulties encountered during the satellite development. This project is more than just a satellite mission since it has a greater vision of contributing to higher education in Mauritius using the CubeSat. I hope this project will produce great results and space development will expand in Mauritius. I also wish that JAXA will be able to cooperate with Mauritius in the next mission again

**GOTO Masayuki**
**Lead Engineer**
**KiboCUBE Team**
**Japan Aerospace Exploration Agency (JAXA)**



By working together with MRIC Team through the safety review, satellite handover, and overall satellite deployment, I learned a lot from the Team. It was a very valuable experience for me, and I am glad that the operation is going well since the deployment.

**SHIBANO Yasuko**
**Engineer, KiboCUBE Team,**
**Japan Aerospace Exploration Agency (JAXA)**

# MEDIA COVERAGE






# OUR SPONSORS

## We are thankful to the following sponsors

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