75 Students' Satellites Consortium: Mission 2022

Who Can Apply?

Any Interested Institutions/Universities can write to president@itca.org.in
For detailed one-to-one discussions, either at on-line/offline, contact

***Dr. K. Gopalakrishnan**, Project Director, 75 Students' Satellites Mission 2022,*
Mobile/WhatsApp: 98451 73730
***Nikhil Riyaz,** Founding Director & CEO, TSC Technologies Pvt. Ltd,*
Technical Lead, 75 Students' Satellites Mission2022, ITCA, Mobile/WhatsApp: 97418 96297
***Er. S. Shanmugam,** Manager, ITCA, Mobile/WhatsApp: 99806 10017*

FAQs:

1. How much will be the Cost to Host Institution/Engineering Educational Institutions (EEIs)?
   Rs.80 Lakhs to Rs.2 Crores for building and Launching 1U CubeSat! Including Ground Station and Industry Sponsored Nano Satellite Centre at Your Campus!*
   If single Institution feels the budget is high then 4 to 5 Institutions (from different regions, non-competitive, for obvious reasons) can together go for Joint Satellite Project and share the budget among them! Or Group of Institutions of same management can together share the Cost and Build Satellite Together under Group's Name!
2. What are all the Cost Centres of Students' Satellite Project at EEIs?
   a) *Building Actual Satellite* both Engineering Model and Flight Model*
   b) *Cost of Space Qualification Tests (Shock and Vibration Tests, Thermo-Vac Test)*
   c) *Cost of Launch: Cost of Deployer and Launch Cost @ per kg Rs.20 to 5 Lakhs in PSLV/SSLV*
   d) *Cost of Fabrication of Flight Model at ISRO Approved Industries/Facilities/Access to Clean Room*
   e) *Cost of PDR, CDR, HDR to be conducted with Qualified/Competent Space Scientists who have comprehensive and diverse Experiences with such reviews at ISRO in the past! (Superannuated Senior Scientists from ISRO)*
   f) *Cost of Ground Station (SDR Receiver, Antenna (VHF/UHF), Rotator & Rotator Control Software and TSC SatNAV MobileApp/Software Programs/Coding etc): @ Rs.15 to 150 Lakhs*
   g) *Cost of Nano Satellite Centre (ESD Tables, Magnifier Lights, Air Curtain, Special Tools and Other Necessary Accessories, Rocket/Satellite Models, Learning Resources)*
   h) *Cost of Training on Space, Satellites' Fundamentals for Students/Teachers-Hands on Training on CanSat to CubeSat/Seminar/Six Months Course on Satellite System (24 Credits)/UNISEC/WCRC Events in India/Abroad/Opportunity for International Collaborations/Internships in Europe/Russia*

   **Cost of Components for Engineering Model/Flight Model consist of On-Board Computer (OBC), Electronic Power System (EPS), Attitude Determination and Control System (ADCS), Communication System/Telemetry & Solar Panel, Software Programming/Coding of Systems/Subsystems etc.*
3. Why the Cost of Building Satellite at EEIs are expensive when we buy the imported systems/subsystems?
   Cost of Nano Satellite/Cube Satellite's Subsystems in Global Market from any of the heritage supplier like CubeSat shop or ISIS Space or EnduroSat or Pumpkin Space etc will normally cost Rs.2 to 2.5 Crores for 1U Satellite! Plus import customs duty in India need to be added @ minimum 30 to 60% of cost of each items! Plus Interface/Integration/Trouble shooting charges and/or charges of skilled manpower along with clean room charges per hour etc to be added! Hence, it is always prohibitively expensive and buying subsystems from market defeats the very purpose of learning objectives such interdisciplinary projects at Campus! More so, the bought-out systems and subsystems/ items are always liable for trouble shooting on our own is difficult and expensive and will not serve the academic/learning pedagogy!
4. How to minimize or optimize the cost of satellite project at EEIs?
   Join development with heritage company who have successfully launched "NanoSatellites" in India! Now the ITCA-TSC Technologies which have launched 3 UNITY satellites with recent Amazonia Mission of ISRO with PSLV C51 on 28 Feb 2021 from India's Space Port, Sriharikota! Here, there is an opportunity to be part of 75 Satellites initiatives and build your own Satellite in cost effective way and have your own Engineering Model of 1U Satellite, Nano Satellite Centre and Ground Control Station at your Campus a part of this initiative! 75 Satellites Consortium under ITCA has networked with India's Leading Space Companies having ISRO Approved Facilities for fabrication of Flight Model in a more frugal way!

75 Satellites: Proposed Facilities Identified for Fabrication/Testing

The Following ISRO Approved/Certified Facilities/Research Labs/Clean Rooms in India are Identified for Design/Validation/Fabrication/Assembly/Integration/Testing of the 75 Students' Satellites Consortium: Mission 2022

Space Qualification Tests: Shock, Random Vibration and Sinusoidal Vibration	ALPHA DESIGN TECHNOLOGIES
OBC/EPS/CS: Telemetry/Mother & Daughter Boards Assembly and Integration	ATL, Ananth Technologies Limited, NEW TECH SOLUTIONS
Solar Cells/Panels Integration	KARNATAKA HYBRID MICRO DEVICES LTD.
Beacon *(Proof of Life Sensor)*	TSC, KEPLER AEROSPACE
Space Grade 4-16 Layer PCBs and 2 Layer PCBs for OBC/EPS/CS Solar Panels PCBs	mp Micropack Limited, PCB POWER MARKET
Space Grade Satellite Structure Machining and Anodising	DUCOM AEROSPACE, NTTF
1U/3U Deployer for 3-in-1 SlimSatellites	TSC, इसरो ISRO, VSSC DHRUVA SPACE
Design, Development, Validation, Integration, Testing, Fabrication, Launch Integration, Programming, Firmware Coding etc; Ground Station, Antennas, Receiver, Mobile App etc.	TSC ***UNITYsat Students Team's Start-up***
Conceptual Support for UNITYsat and SATNOGS Global Network of Ground Stations, integration and overall project management	Indian Technology Congress Association, Committee for Space Programme Development
Registration of Satellite, Frequency Allocation, Thermovac Test and Launch Support with Deployer: NSIL; IN-SPACe; ISRO PSLV C 54/SSLVs	इसरो ISRO, URSC U R Rao Satellite Centre, NSIL एनसिल

Note: Individual Negotiations will be done with Each Vendor for Mutual Consent as per requirements/shortly.

Supporting Organisations: 75 Students' Satellites Consortium: Mission 2022

75 Satellites 1947 2022, इसरो ISRO, NSIL एनसिल, AICTE, Government of Karnataka, Azadi Ka Amrit Mahotsav

INDIAN TECHNOLOGY CONGRESS, CHANDIGARH UNIVERSITY Discover. Learn. Empower., WCRC World Cansat & Rocketry Championship, World Cansat Rocketry Championship, Freakspace Labs, TSC

MIsat The Maz Israel Satellite and Aerospace Technologies Ltd, SYMBA-MAZ Business Consortium, КРСП/CSPD Комитет за развој свемирског програма, BRICS Federation of Engineering Organisations, UNISEC INDIA

5. How to justify the investments incurred on Students' Satellite Project at Self Financing Colleges/Universities?

Satellite Project is always a feather on the cap of any Institution among their competitors. In India, during last 74 years of free India, only 12 Institutions alone able to build and launch their own Satellites! In that 7 are degree awarding institutions (Universities and IITs)! Only 5 Engineering College alone have launched their own satellites! Now, there is an opportunity to become TOP Institutions to have the capacity to launch its own Satellite to Orbit under 75 Satellites Consortium! This will help to attract the best talents/bright students/best faculty members to your institution! Which in turn add values in many more aspects including better outcomes/placement/visibility and better NBA/NAAC/NIRF Results etc. Kindly refer the attached "Media Watch" documents which has the compilation of media highlights in terms of coverage in print and visual media which is worth of Rs.3 to 5 crores during 6 months of the project in 2021! which is self-explanatory to understand the cost-benefits of satellite project at EEIs!

Indian Space Research Organisation (ISRO) Launched Students Satellites of India

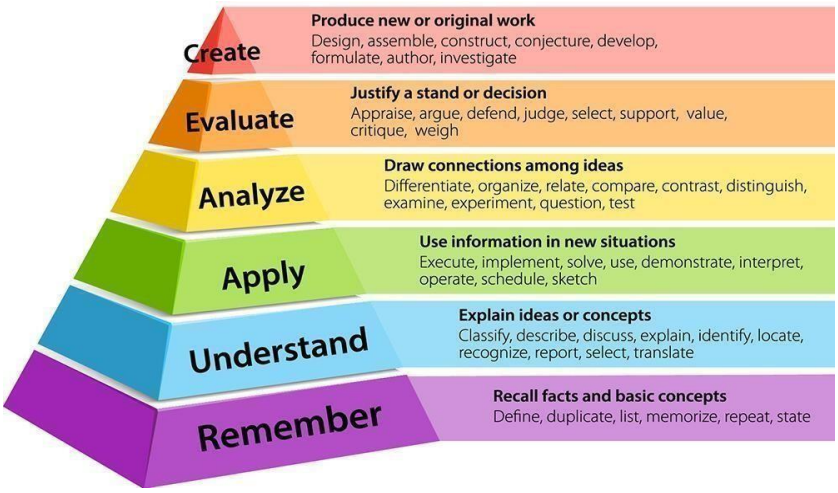
List of University/Academic Institute Satellites/Budget/Duration/Free Launch by ISRO etc

Sl. No	Name of Satellites	Launch Date	Launch Mass	Launch Vehicle	Project Duration	Project Cost in Rs.	Name of University/EEIs
10	UNITYsat *(3 Sats: JITsat, GHRCEsat & SriShakthiSat)*	Feb 28, 2021	1.4 kg	PSLV-C51 Amazonia Mission	12-18-24 Months	1.8 Cr.-2.5 Cr-3 Cr	JIT, GHRCE and SIET/TSC Tech)
9	NIUSAT	Jun 23, 2017	15 kg	PSLV-C38 / Cartosat-2 Series Satellite	10/13 Years	37 Cr (US$5.2 million)	Noorul Isalm University
8	PRATHAM	Sep 26, 2016	10 kg	PSLV-C35 / SCATSAT-1	10 Years	1.5 Cr + 1.75 Cr	IIT-Bombay
7	PISAT	Sep 26, 2016	5.25 kg	PSLV-C35 / SCATSAT-1	5 Years	1.25 Cr+ 1 Cr	PES University & Others
6	SATHYABAMASAT	Jun 22, 2016	1.5 kg	PSLV-C34 / CARTOSAT-2 Series Satellite	7 Years	2 Crores (Cr)	Sathyabama University
5	SWAYAM	Jun 22, 2016	1kg	PSLV-C34 / CARTOSAT-2 Series Satellite	8 Years	60+35 Lacs	College of Engg, Pune
4	SRMSat	Oct 12, 2011	10.9 kg	PSLV-C18/Megha-Tropiques	2/3 Years	1.5 Cr+60 Lacs	SRM University
3	Jugnu	Oct 12, 2011	3 kg	PSLV-C18/Megha-Tropiques	2/3 Years	2.5 Cr	IIT-Kanpur
2	STUDSAT	Jul 12, 2010	≤1 kg	PSLV-C15/CARTOSAT-2B	1-2 Years	55+45+35 Lakhs	NITTE 7EEIs of KAR & AP
1	ANUSAT	Apr 20, 2009	40 kg	PSLV-C12 / RISAT-2	3/5/7 Years	5.5 Cr	Anna University

Rare Opportunity to be in the TOP 15 or 75 Educational Institutions who have Launched their Satellites in India!

6. Is there any need for EEIs to go for Students' Satellite Project at their Campus?

Promoting the Interdisciplinary Research and Launching Satellite will Provide Opportunity for Learning by Doing



The goal of the Nano Satellite/SlimSat Project is to provide opportunity for interested students and faculty members to lead and participate in the development of a spacecraft payload through its life cycle in a frugalway. *The learning experience will be enhanced with CanSat/Rocketry Competitions and development of PocketQube/CubeSat by the team through learning by doing and creating/fabricating their own* ***"satellite"*** ***(which is the Highest in RBT Level of Learning Pedagogy***) right from manufacturing, environmental testing, satellite integration, spaceport, launch vehicle, range and spacecraft operations etc at any **Host Institution!**

Revised Bloom's Taxonomy (RBT Level: Low Order to Higher Order Thinking Levels)

Facts as of 2022 January 19 *(Nanosatellite Database by Erik: https://www.nanosats.eu/)*

Nanosats Launched: 1802	*Most Nanosats on a Rocket: 120*
CubeSats Launched: 1663	*Countries with Nanosats: 76*
Interplanetary CubeSats: 2	*Companies in Database: 558*
Nanosats Destroyed on Launch: 102	*Forecast: Over 2500 Nanosats to Launch in 6 Years*

7. What is NewSpace Era and Space 2.0? Why and how it is relevant to EEIs?
   Democratization of space and affordable access to space are the characteristics of the NewSpace era. A few years ago, space activities were in the realm of national space agencies, and investments for space programmes would come largely from the governments. Today, space has become accessible to citizens-students and researchers in academic institutions and universities, entrepreneurs and venture capitalists, government supported/funded organizations, and private sector users for commercial endeavor. The advent of what is being called Space 2.0 offers the valley a fresh opportunity to craft new companies and technologies that help solve some of our biggest challenges. And rebuild its sagging reputation.

   Global technological advances, including high-quality semiconductors from the extremely price-sensitive mobile phone industry, 3D printing of parts, access to the spare capacity of large rockets through ridesharing, have helped grow the use of Commercial-of-the-shelf (COTS) high-performance and affordable-cost hardware including miniaturized optics for mobile cameras, Micro-Electro-Mechanical Systems (MEMS) devices-sensors and accelerometers, advanced lightweight materials, high efficiency batteries (Li-Ion) and high-efficiency solar cells (multi-junction GaAs-gallium arsenide semiconductor) have established the standards for enhanced reliability of operational nanosatellites. The usage of COTS subsystems has helped in reducing the complexities associated with traditional satellites, thereby making them easy to assemble and test.

   The standardization of CubeSats and small satellites has facilitated the transformation of the satellite industry, with missions' development costs dropping to fractions of the price of conventional satellites and development time reduced to about 6-12 months from the time the need is assessed to the time the satellite is placed in orbit. In addition, small satellite constellations can ensure continuous renewal of the satellite system, which translates to the delivery of optimum technological services at all times. EEIs can provide the contemporary knowledge required for growing space industries and enlighten their own students/faculty members on growing global market in space industries!

8. What is Indian Government's Viewpoint on Space Technologies and privatization of Space Sector?
   The Government of India's aggressive policies and Hon'ble Prime Minister Shri Narendra Modi's Vision for a $ 5 trillion economy to achieve self-sufficiency in a wide range of industries have given rise to a slew of innovative initiatives, including those in the space industry. One of the government's objectives is to encourage start- ups and academic institutions in the space sector to reach their full potential and make India a space hub. ISRO's tremendous achievements in the global space arena, and Department of Spaces agencies NSIL and IN-SPACe, have paved the way for the rapid deployment of SmallSats produced by next-generation enterprises.

   "On the occasion of 75 years of independence (Azadi Ka Amrit Mahotsav), India is going to launch 75 satellites into space made by Indian students in schools and colleges," Prime Minister mentioned at the meeting of the world leaders at the United Nations General Assembly (UNGA) session. These positive actions enable Indian society to embrace the new space era of Space 4.0.

9. How to start our own Satellite Development Team at our Campus?
   Identify the passionate students/faculty members for your satellite project who are willing to learn space technologies on their own/collectively with the help of mentors/industries! Commitment from your top-level management with adequate budget or as a self-supporting project of entire campus/Group of Institutions etc. Signing MoU with ITCA-75 Satellites Consortium to be part of 75 Satellites to be launched during Aug-Dec 2022. Read the below link for more details:
   https://www.aero.iitb.ac.in/satelliteWiki/index.php/Starting_a_Student_Satellite_Project

10. What is very important factor to start our own satellite development at our campus?
    Proactive decision of Top-Level management and Cost-Benefits of Satellite Project and Facilities are going to be with the EEI during/after the Implementation of Satellite Project at your campus! Kindly read the answers of above questions 5 to 8, as you are all aware that, getting Top 25 or 50 ranks in NIRF 2022 is very difficult or impossible for any Self-Financing College as of now, due to various reasons known to you all! However, by launching your own Satellite, every one of the Self-Financing Colleges can straight way can aim to be Top 25 or 50 or 75 Institutions which have launched its own satellites in India! Utilizing the present opportunity provided by 75 Satellites Consortium: Mission 2022 and PM of India/ISRO Now!

11. Do we need have clean room at our campus at the beginning of design and development of Satellite?
For initial design of systems and subsystems of satellite till PDR, existing laboratories and laptops with legal design software is enough! Of course, you need to have a passionate students team guided by motivated Faculty members! Engineering Model of your satellite (1U or 2U or 3 U etc) can be designed and fabricated at your existing facilities with COTS components; you can also outsource the PCB manufacturing activities outside. For fabricating Flight Model, clean rooms of various ISRO approved facilities are available across India. May be after your successful completion of your FIRST satellite, your management may have confidence and then you can establish small clean room later with or without funding from Industries/government funding agencies etc.

12. How to make or identify unique or different or very rare "payload" for our Satellite in such a way to crate "wow" factor and outsmart all the satellites launched so far to space? We do not want to launch a satellite for the sake of launching or to say we have also launched satellite?

a) *There is no need to launch satellite for the sake of launching: If the Institute is really serious about "learning by doing" and has faith on "theory and practice should go together" etc and if strongly believes in Revised Bloom's Taxonomy of Learning/Outcome Based Education (OBE) etc then can think of what is the highest level of Bloom's Taxonomy etc. Based on true realization of all these then can go for "satellite" project!*

b) *One should bear in mind that, satellite projects are luxury! When we think of car with 4 wheels to carry 4 persons, we have wide variety of choices from small cars (Maruti Alto, Hyundai Santro etc). If someone conscious of safety, luxury, comfort, social esteem and wish to demonstrate their superiority or wealth etc then naturally they will go for BMW, Audi, Volvo, Lexus etc.*

c) *What we have proposed 1U (1.4 kg) Satellite is entry level basic model with economy/budget satellite, yet has its own novelty, frugal innovations etc.* ***Always, you can go for 3U (3kg+) satellite with variety of payloads etc if you have convinced; it is a sensible intervention in the learning science! If you go for 3U/3Kg satellite will cost Rs.2-3 Crore plus! Yet it is worth to pursue, if you have interest and affordability and wish to demonstrate your superiority among other institutions!***

d) *No academic institution can match ISRO/NASA/ESA/JSA! Even, without launching any satellite, any institution can access any other satellite data/image with due permission from satellite owner or paying money/royalty one can get required data! Like public transport system, we can travel very economically. However, private transport is essential for our own convenience/privacy/safety/comfort, when we can afford to pay for it.*

e) *Variety of airlines offer comfortable International Travels and Domestic Travels by connecting many destinations, yet Celebrities/Industrialists/MNCs are having their own private Jets! Private Yachts! It is status/comfort/privacy etc. Same logic is for launching Your Own Institutional Satellite!*

f) *In knowledge industry, among Educational Institutions, launching our own satellite is a Pride. Status, It is a Proof of concept that we can prove our capability! Similar to NIRF Ranking, QS Ranking, Times World Ranking, ABET Accreditation etc (each one of these has its own issues and challenges and criticisms/limitations/even its all having debatable credentials)! Yet many Institutions/Universities are behind all these rankings! Simply it helps in their brand building and marketing to attract best students and affordable students to pay the premium fees etc! Same logic can be applied to "Satellite Project of Respective Institution/University". Hence, any institutions that failed to launch their own "satellite" sooner or later; they will be looked down by others who are able to launch it!*

g) *It is the question of demonstrating Institution's intellectual capacity/supremacy and affordability/ wealth/financial health etc. Satellite is always an exciting interdisciplinary project! Space is always a fantasy! Why Dr. Mylswamy Annadurai was invited by thousands of Universities and Colleges as Chief Guest for Convocation/Conference etc, Just because of his Successful Moon Mission "Chandrayaan 1"! as its Project Director! Achieved the Mission Objectives with a Frugal Budget! He has achieved it with an Unbelievable Budget in Global Space Inter-Planetary Missions till today! It was the Successful Space Project! Why Abdul Kalam was celebrated across the Universities, just because, he was from ISRO/Missile Project/DRDO which in turn again Launch Vehicles/Rockets! Explored Space! Hence, every difficult or complicated Science/Engineering/Technologies were called as "Rocket Science"!*

13. What are all items and services included in the AO proposal? *Items are listed in 2 above.*

14. How long will it take to build and launch 1U CubeSat? *6-9 Months and Launch Window: 3 Months (ISRO)*

15. Whether the scheme provides any opportunity for collaboration with any agency/countries?
Yes! The participating Institution will become the Institutional Member of "75 Students' Satellites

Consortium: Mission 2022, Indian Technology Congress Association, University Space Engineering Consortium-India, World CanSat/Rocketry Consortium (WCRC)" etc. Also can host/participate in WCRC World Championships to be held in any parts of World including Israel, Serbia, Japan, Russia, Italy, Germany, Canada, USA, UK etc

16. Whether any direct MoU/Collaboration Agreement will be signed? *Yes! Also Collaborative Credit Courses can be offered with all Consortium Members listed above in answer to question 15!*

17. What is the benefit host institution/our institution will get from the satellite project?
Takeaway for Host Institution/EEI implementing Satellite Project:
Joint Development of Your Satellite with ITCA, CSPD, Serbia & TSC Technologies, Bangalore
    a) *Learning by Doing: Design, Development, Integration, Qualification Testing and Launching 1U UNITYsat Jointly. Heritage Status for the Institution by Launching the Satellite to Space/LEO!*
    b) *Joint Development of One U Functional Cube Satellite (similar to the one which has been launched in to space) will be with Institution/University!*
    c) ***Real Time Space Lab in-Orbit*** *to teach Satellite Communications: TSC-CSPD Ground Control Station to monitor majority of LEO Satellites including Your Own Satellite Launched! GCS Comprises of the following:*
    Client Computer, Client Software, Radio Receiver (Software Defined Radio-SDR), Antenna System (Antenna (VHF/UHF), Rotator, Rotator Control Software & Mobile App) ***Space Lab on Mobiles of Your Institution's Students!***
    d) *Inter-disciplinary Electives/Open Electives: Opportunity to offer/teach elective subject/course across disciplines with hands-on experience to students at your campus. Even MTech in Space Engineering or Satellites can be offered by as per requirements at your campus!*

18. Will ISRO which is having the main control over the satellite give Full data collected by the satellite?
    a) *The above statement is a wrong perception. ISRO does not have control of the satellite! Whoever the original owner or own their satellite and send their satellite will have the control on the data received from the satellite! Your institution will have its own Ground Control Station to receive and send data! We need ISRO/NSIL service, only to launch the satellite as one-time paid service (similar to availing courier service from DTDC or DHL to send our satellite to orbit) using PSLV/SSLV launch opportunities!*
    b) *They do not have any control over your Satellite data! We will get our frequency allocated for YOUR Sat by IN-SPACe/ITU/ISRO/NSIL and then independently Your Own GCS can communicate to its own satellite as and when they want!*

19. Will you get assurance that the total control over the satellite is given to Your Institution/EEI?
    a) *Read the above answer to Q-18:*
    b) *It is an official procedure to get frequency allocation to communicate to your satellite in orbit from ground!*
    c) *It is obvious that data and control of your satellite is always with your Institution only!*

20. With the data obtained from the satellite what tangible/profitable output Our Institution will get?
    a) *Learning by Doing: Design, Development, Integration, Qualification Testing and Launching 0.3U SlimSat Jointly. Heritage Status for the Institution by Launching the Satellite to Space/LEO!*
    b) ***Real Time Space Lab in-Orbit*** *to teach Satellite Communications: TSC-CSPD Ground Control Station to monitor majority of LEO Satellites including Your Own Satellite Launched! GCS Comprises of the following:*
    Client Computer, Client Software, Radio Receiver (Software Defined Radio-SDR), Antenna System (Antenna (VHF/UHF), Rotator, Rotator Control Software & Mobile App) Even, ***Space Lab on Mobiles of Your Students!***
    c) *Inter-disciplinary Electives/Open Electives: Opportunity to offer/teach elective subject/course across disciplines with hands-on experience to students at Your Institution. Even MTech in Space Engineering or Satellites can be offered by Your Institution! Additional Revenue can be generated!*
    d) *Additional "Fees" can be charged from the students who wish to be part of the Satellites Projects. Even additional courses can be offered for "Honours Degree" (24 Credits) as add-on opportunity to Students from ECE or any other branches of study! Both Your Campus and other outside students can be admitted and they will pay fees for additional Credit Courses as an external candidate!*
    e) *It will have very good "PR" Value for Promotions in Social Media, Print & Visual Media which has brandbuilding ability which in turn will provide more scope for increase the existing fees!*

21. How to get the funds for Satellite Project at Self-Financed EEIs?
    a) *Self-Supporting Model: All the students of EEI or its Group of Institutions, 2000-10,000 students can contribute @ Rs.1,000/- to Rs.5000/- per student per year etc or @ Rs.500/- to Rs.1,000/- per Semester etc as per the affordability of Students and strength of Students/location of the campus etc. all the students can be involved from the awareness Programmes on Space, Rockets and satellites and will be conducted Quiz/Online Evaluation etc and issued with Participation Certificates to all who have participated and Registered for such programmes! Ensure the Participations of Students in National/Regional/International Competitions on CanSat/CubeSat/Rocketry etc. Alternatively, 50% can be mobilized from Students and 50% as matching Grant from management also can be planned!*
    b) *Collaborative Credit Courses (24-30 Credits) can be offered with all Consortium Members listed above in answer to question 15! @ Rs. 1000-2000 can be charged as fees per Credit or Course or month, then Rs.6000 to 24,000 can be collected from interested students! Or as per the model of the host Institution as Self-supported Activities/Opportunities for Students/EEIs!*
    c) *We will facilitate financing options^ (^*Subject to terms and conditions as may be applicable) *for Satellite Project, Establishment of NanoSatellite centre and Ground Control Station at EEIs/Universities! Interested institution can directly interact with ITCA for more details.*
    d) *Crowdfunding for your Satellite!*

    Crowdfunded Satellites: Crowdfunded satellites are artificial satellites that have been funded by using crowdfunding, rather than more traditional methods of financing.

    Several crowdfunded satellites have been launched in the 2010s, including SkyCube,[1] KickSat,[2] ArduSat,[3] all of which resulted from successful Kickstarter campaigns, and the Russian Mayak,[4] which used the Russian Boomstarter platform. Crowdfunded satellites are an example of public participation to research.

    References:

    1. ^ *"NASA - NanoRacks-SkyCube". www.nasa.gov. Retrieved 2019-01-05.*
    2. ^ *Fish, Elizabeth (14 November 2011). "Explore Space With A Spacecraft The Size Of A Postage Stamp". PCWorld. Retrieved 2019-01-05.*
    3. ^ *Plait, Phil (15 June 2012). "Kickstart your way to an experiment on a satellite!". Bad Astronomy. Retrieved 2019-01-05.*
    4. ^ *Morton, Elise (17 July 2017). "Russian students launch crowdfunded satellite". The Calvert Journal. Retrieved 2019-01-05.*

    Kickstart your way to an experiment on a satellite!
    https://www.discovermagazine.com/technology/kickstart-your-way-to-an-experiment-on-a-satellite
    June 15, 2012 Launch of the ArduSat crowdfunding campaign on KickStarter. The goal was to obtain $35000 in funding.
    July 15, 2012 After 30 days of campaign, the project obtained a total pledge of $106330, from 676 "backers".

22. Those who have already started building their own Satellite at their campus with or without the support of Industries and currently at various stages of its progress/completion: How can we participate in this 75 Satellites Consortium: Mission 2022 and launch our Satellite?
    Yes! You can complete your own development of satellite on or before June-July 2022 with all necessary Space Qualification Tests Completion Certificates from ISRO authorized facilities can be part of 75 Satellites Consortium and can Launch your satellite with ISRO/NSIL/PSLV/SSLV along with applicable cost as proposed by NSIL. However, provide the reports of your PDR, CDR. HDR if done already. Also provide Launch vehicle Interface Document as required by NSIL/VSSC/PSLV/SSLV etc as applicable.

23. Registration with IN-SPACe, Frequency Clearance, Qualification Tests, Deployer, Launch Integration Services, Launch Opportunity/Contract etc
    Yes! You can get assistance in Registration of Your satellite with IN-SPACe, Applying for Frequency Clearance with ITU, Space Launch Qualification Tests, Deployer, Launch Integration Services, Launch Opportunity and signing Launch Contract with NSIL etc will be done by ITCA-75 Satellites Consortium.

24. How can we be partner with other like-minded Institutions (4 or 5) to share overall cost of development of Satellite and keep it affordable Project?

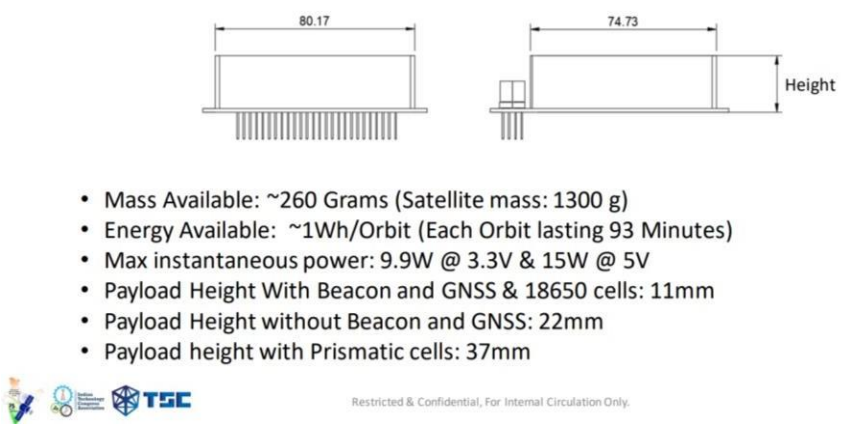
If single Institution feels the budget is high for building satellite, then 4 to 5 Institutions (from different regions, non-competitive institutions, for obvious reasons) can together go for Joint Satellite Project and share the budget among them! For Example, 1U Satellite Cost of Rs.80 Lakhs can be divided among 4 or 5 EEIs @ Rs.20 or 15 Lakhs per Institutions for 4 or 5 Institutions respectively! Other details can be evolved reasonably among the partner institutions about Ground Stations at Each Institution etc.

25. Can we establish NanoSatellite Centre/GCS alone at our campus with the support of Industry/ITCA-TSC?
Yes! You can establish either Nano Satellite Centre and/or Ground Station alone at your campus with the support of ITCA-TSC-75 Satellites Consortium. Cost of such Centres/GCS varies from Rs.15 Lakhs to Rs.90 Lakhs based on your budget and space available at your campus.

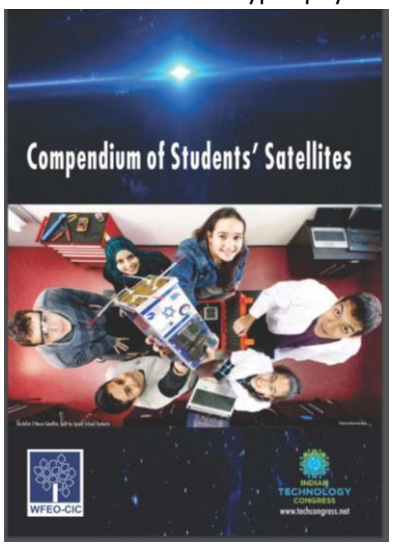
26. How can ITCA/75 Satellites' Consortium will help us to launch our satellite?

Sl. No.	***Nature of Activity to be Completed/Deliverables/Milestones***
a.	***Preliminary Design Review (PDR)*** *with Complete Specifications of 1U CubeSat Including On-Board Computer (OBC), Electronic Power System (EPS), Attitude Determination and Control System (ADCS), Communication System/Telemetry & Solar Panel, Software Programming/Coding of Systems/Subsystems etc.*
b.	***Selection of Interested Students from Your Campus/group of Institution****; Offering Orientation/Training Programme on Space Environment/Satellites, Visits to Space Museum at Bangalore (to and fro of your students shall be done by Your campus) for Better Understanding/Awareness etc. (On-line/Off-line Events)*
c.	***Training on Space, Satellites'*** *Fundamentals for Students/Teachers-Hands on Training on CanSat to CubeSat/Seminar/WCRC Events in India/Abroad-****Six Months Course (24 Credits)*** *for Interested Students from Engineering/Polytechnic Colleges (On-line).*
d.	***Critical Design Review (CDR)*** *with Engineering Model of 1U CubeSat including Ground Control Station (GCS), SDR Receiver, Antenna (VHF/UHF), Rotator & Rotator Control Software and MobileApp/Software Programs/Coding etc*
e.	***On Readiness of Flight Model*** *- Launch Environment/Qualification Test of CubeSat Successfully Completed before Launch Integration*
f.	***Registration of Your 1U CubeSat with IN-SPACe/ DOS****. The Directorate of Space Situational Awareness and Management (DSSAM), ISRO-HQ and applying for Frequency Allocation: Orbit Spectrum Coordination & Acquisition (OSCA), Satellite Communication Programme Office (SATCOM-PO) - Launch Agreement with NSIL*
g.	***Establishment of Ground Station (GS) and NanoSatellite Centre*** *at Your Campus and adequate Trainings to operate the GCS by your Students/faculty Members.*
h.	***Your 1U "CubeSat" Ready for Dispatch to Space Port of India, Sriharikota for Launch*** *Integration with Deployer and Launch Vehicle*
i.	***Your CubeSat Integrated with Launch Vehicle during Launch Window at Sriharikota-Launching of CubeSat Successfully!*** *Handing Over Engineering Model, Post Launch Training on Ground Station to Students/Techers. Assisting in Post Launch Operations and utilizing the experiences for future satellite by your own students etc*
j.	***Special Publications on NanoSatellites and New Space: Joint Publications in Journals/Conferences and Offers Space related Courses*** *for School Students/Polytechnic/College Students (24 Credits: Course Materials) etc*
k.	***Assist the Participation of CanSat Teams of Your Students from your Campus to National/Continental/ International Championships to be held in Europe/Russia/USA/UK/Japan etc***
l.	***Submission of PDR & CDR Documents, GS Manuals and Closure Report***

28. Can we add/participate with our own payload/experiment with ongoing Satellite?
Yes! You can add your payload/experiment in any one of the 75 satellites of the consortium, provided if your payload or experiment fit in to the following requirements of available space/power constraints of the proposed satellites! Of course, the launch cost of the satellite proportionate to the mass of your own payload/experiment has to be borne by your institution!



29. What are all different types payloads or mission objectives are possible with 1U to 3U+ Cube Sats?



So far, Nanosats Launched: 1802;
CubeSats Launched: 1663 as on 19 January 2022
(Ref: Nanosatellite Database by Erik: https://www.nanosats.eu/).

ITCA have Published the Database of interesting academic Satellites (CubeSats) built in the past across the world to get an idea about Payloads used, OBC, EPS, Communication Modules, Antennae and Mission Objectives etc for having better clarity for the beginners of EEIs in India. Kindly click the link below to access the "Compendium of Students' Satellites" for your reference.

http://75satellites.org/assets/Compendium-of-Students-Satellites.pdf

30. How much will it cost for our Payload to be on board with Satellite for launch?
The cost of Launch of satellite or your Payload includes the cost of deployer + mass of the deployer + mass of the satellite + cost of integration services/clean room charges etc. Based on our experiences with ISRO/ NSIL/PSLV launch Services as piggyback co-passenger, NSIL may charge @ Rs.10 to 20 Lakhs per kg and also Rs.5 Lakhs per kg etc. Based on the Total Launch Cost of 1U Satellite will be arrived at for PSLV or SSLV as per the availability of launches during July -Dec 2022! Even, ISRO/NSIL is considering the dedicated launch of all 75 Satellites with SSLV during Aug 2022! We are yet to get the Quote for Launch from NSIL/ ISRO. Normally, the 260 gm Payload will cost one fifth of total launch cost of 1U Satellite (Approx. Rs.10-15 Lakhs). It may be free, if the Deployer and Launch Services provided to all 75 Satellites by ISRO-NSIL. Any changes to the current understanding leading to a change in the cost of launching, will have to be borne by the participating institution.

31. How to get tie-ups or signing MoU with International Space Industry/Organisations? WCRC, Israel, Serbia, Italy, Russia etc.
ITCA-75 Satellites Consortium will facilitate such MoUs with UNISEC India, WCRC, CSPD-Serbia, TMISAT-Israel etc. Interested Institutions/Universities can Sign MoU with majority of the WCRC Member Countries (65+ Countries are already part of WCRC)
32. How to get opportunities for our Students/Faculty Members to participate in Global Space Competitions outside India?
ITCA-75 Satellites Consortium will facilitate through its network among WCRC, TMISAT-Israel, CSPD-Serbia
33. How and where will you get the technical knowledge required to build a satellite at EEIs? *Read below a-r!*
34. How do you recruit team members for our satellite project at EEIs? *Read below link "c"! ITCA will assist you.*
35. How to understand the requirements of hostile space environments at Low Earth Orbit?
https://en.wikipedia.org/wiki/Low_Earth_orbit Also read Our paper "Era of Small Satellites: Pico, Nano and Micro-satellites (PNM Sat)—an Over View of Frugal Way to Access Low Earth Orbit" Published by Springer: https://link.springer.com/chapter/10.1007/978-981-33-4687-1_35 (Original Copy of Paper Attached Separately)

36. How to start the design of Satellite? Sequence of activities and prerequisites? PCB Design? Numbers of layers of PCB? Routing?

The first step to designing a satellite begins with the design of the mission also known as 'mission definition'. Once the mission has been defined, a clear idea of the electronic systems and software requirements to accomplish the mission have to be defined. Once all the components of the system have been defined teams must be formed to design each component. The "components" being referred to here can be divided into the major subsystems of a satellite, namely, the Electrical Power System, Communication system, Command and Data handling system, Structural and thermal system, Attitude and orbit control system and most importantly the payload. Although the satellite can be divided into these subsystems, each subsystem can be further subdivided into more subsystems, and depending on the complexity, more members may be needed to design these components.

Managing such a project requires a hierarchy to be formed where activity of each team is monitored on a regular basis by a system engineer. The systems engineer assigned to monitor each team must report to a lead system engineer who oversees the entire design and development activity.

Alongside the design activity a team needs to be formed to coordinate logistics activities. The primary role of this team will be to coordinate with multiple vendors and make sure all hardware or software components or tools are made available to the designers as and when required. The role of this team is critical as any falsely reported lead times or lapse in coordination could derail the project due to the lack of availability of critical components.

Once the teams have been formed and a clear overview of the mission is in place, the design activity must proceed with the following sequence:

i. *Component selection: This activity involves selection of high-reliability COTS components capable of catering to the needs of the mission.*
ii. *High-level system design: Block diagram level designs need to be put in place giving a high-level view of the functionality of the system.*
iii. *Designing: Preliminary PCB schematics, Structural design, and other design related activities need to be started. All teams need to coordinate so systems being designed by individual teams are compatible with each other.*
iv. *Design rules check: All systems after a certain level of designing must be reviewed to make sure they meet the standards for space grade design.*
v. *Testing: A preliminary model of the system must be designed and tested to make sure all designs are functioning as expected.*
vi. *Rework: it is very common to have some rework post testing and any planned rework must be done prior to the final fabrication of the satellite hardware.*
vii. *Fabrication: Final fabrication of the satellite must be done*
viii. *Testing: The final flight model must be tested to be able to handle the vibration and thermal stress associated with launch and operation of the satellite in orbit.*

37. What are the preliminary requirements in terms of physical infrastructure at EEIs?

The Institution must be equipped with dedicated working space for project teams including of small discussion rooms and a board room to facilitate regular discussions with the management and design teams. Additionally, the EEIs must have labs set up with computers capable of supporting compute and graphics intensive tasks. Licensed software for PCB design like Eagle or Altium, Simulation tools like Ansys or MATLAB, 3D design tools like Solid Works or Fusion 360 must be purchased.

Additionally, A well-equipped ground station must be set up. This ground station must be equipped with radios capable of operating between a wide range of frequencies and different modulation schemes. This will allow students to experiment with different communication hardware so they can select the best hardware for use on the satellite. Being able to receive a broad spectrum of frequencies also opens up the possibility for students to receive and decode signals from existing open-source satellites.

38. How to get the required infrastructure for designing and building our own Satellite at our campus?

By joining the 75 students' satellite mission we will establish an industry-sponsored satellite assembly lab and ground station. This infrastructure will enable your students to track satellites in real-time and demonstrate practical satellite communication. Ground station established will provide industry-grade antennas and antenna rotators capable of tracking and transmitting both in VHF and UHF bands along with a mobile app that your students can use to track various LEO satellites without accessing the ground station physically. The lab will be an ideal place to safely build and test various satellite subsystems.

39. Building the Team *(Read below link "c")*
40. Planning the mission and finalizing the Payload *(Read below link "d")*
41. Obtaining the required Infrastructure *(Read below link "e")*
42. How do you decide what kind of satellite to build and what it's payload should be? *(Read below link "a-r")*
43. Even after the payload is decided, how do you go about realizing your satellite? *(Read below link "f-r")*
44. How complicated of a satellite will you be able to build when starting from scratch? *(Read below link "d-r")*
45. When will you know is the right time to start making a physical prototype/model? *(Read below link "f-r")*
46. How do you ensure that you're not making a mistake in matters technical/non-technical over time? *(Read below link "a-r")*

Suggested Readings:

a) Satellite 101: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Satellite_101

b) Starting a Student Satellite Project: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Starting_a_Student_Satellite_Project

c) Building the Team: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Building_the_Team

d) Planning the mission and finalizing the Payload: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Planning_the_mission_and_finalizing_the_Payload

e) Obtaining the required Infrastructure: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Obtaining_the_required_Infrastructure

f) Identifying the System and Introduction to Systems Engineering: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Identifying_the_System_and_Introduction_to_Systems_Engineering

g) Systems Engineering Life Cycle: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Systems_Engineering_Life_Cycle

h) Concept Phase: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Concept_Phase

i) Development Phase: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Development_Phase

j) Production Phase: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Production_Phase

k) Utilization and Support Phase: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Utilization_and_Support_Phase

l) Retirement Phase: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Retirement_Phase

m) Quality Assurance: https://www.aero.iitb.ac.in/satelliteWiki/index.php/Quality_Assurance

n) NASA Jet Propulsion Laboratory - California Institute of Technology: CLASSROOM ACTIVITY: Build a Satellite: https://www.jpl.nasa.gov/edu/teach/activity/build-a-satellite/

o) **Essential Reading (and Viewing)** https://www.rs-online.com/designspark/build-a-cubesat-satellite-that-actually-works-part-1-make-it-resilient

p) NASA's **CubeSat 101 Beginners Guide**, Basic Concepts and Processes for First-Time CubeSat Developers. AMSAT and NASA have recently created a useful Educational tool: **The AMSAT CubeSat Simulator: A New Tool for Education and Outreach**. The following video presentation on the **ArduSat** project in 2014 is well worth watching to get a feel for the size of the task placing a CubeSat in Earth orbit:

q) https://www.nasa.gov/sites/default/files/atoms/files/nasa_csli_cubesat_101_508.pdf

r) https://countingfromzero.net/amsat/CubeSatSimPaper.pdf

SWOT/SWOC Analysis of Nano-Pico Satellites Development in India

	HELPFUL *to Achieving the Objectives*	HARMFUL *to Achieving the Objectives*
INTERNAL ORIGIN *Attributes of the Organisation/Collaborators*	**STRENGTHS:** • *Passionate Team of ITCA-TSC Technologies P Ltd* • *ITCA-TSC Team has the Active Support, Patronage and Mentorships of Eminent/Outstanding Space Scientists of India/Abroad!* • *ITCA-TSC Team has been Trained in Russia, Israel, Serbia, Japan, France, Italy, Canada and Mentored by Outstanding Scientists of ISRO/Roscosmos!* • *Affordable, Innovative, Frugal Solutions to Access to Space with Learning Opportunities provided by ITCA-TSC Consortium!* • *All-in-one Package of Services and opportunity for collaboration. No Hidden Cost, Yet, it is Joint- Development with ITCA-TSC Team* • *Vibrant Support of Indian Technology Congress Association, CSPD, Serbia, ISRO and NSIL. Registration of Satellite & Launch Opportunity in India!* • *Support of University Space Engineering Consortium (UNISEC) India/ World CanSat/Rocketry Consortium (WCRC) for Academic Institutions/CanSat/ CubeSat Workshops & Competitions!* • *Support of Top Management @ Institution*	**WEAKNESSES:** • *Absence of Suitable Nano-Pico Satellite Systems/Sub-systems in India!* • *Absence of Structured Training Facilities and Hand Holding by Professional Organisations/Companies in India to help EEIs in developing CubeSats.* • *Lack of Awareness, Knowledge and Expertise on Nano-Pico Satellites in India! (Addressed by ITCA-TSC Team now)* • *Heritage Suppliers are not available in India in Nano-Pico satellites' Segments! (Addressed by ITCA-TSC Team now)* • *Launch Cost of Satellite based on Cost of Deployer, Launch Mass of Deployer and Mass of Satellite also to be paid!* • *Space Environmental and Launch Environmental Testing/Qualification etc* • *Cost of Solar Panels/Fabrication, Testing and Qualification etc* • *Rare to find out Adequate Handholding and Troubleshooting Experts/Personalities in the Area of Nano-Pico Satellites in India*
EXTERNAL ORIGIN *Attributes of the Environment*	**OPPORTUNITIES:** • *ISRO, IN-SPACe and NSIL are Open to Support private initiatives due to recent proactive Policy Decisions of Government of India!* • *ITCA has Launched 75 Students' Satellites Consortium: Mission 2022!* • *Technology/Intellectual Support from India, Russia, Israel, Serbia, Japan, France, Italy, Canada etc.* • *Open Support /Encouragement from CSPD, Serbia and World CanSat/ Rocketry Championship Founding Countries. Satellite Networked Open Ground Station (SatNOGS) to help and Monitor Small Satellites, across the Globe!* • ***TSCSatNav:** Amateur Radio and Weather Satellite Tracker and Passes Predictor for Android TSCSatNav (Mobile App) for Monitoring LEO Satellites using Mobile Phones of Students/Faculty Members!* • ***More than NIRF Ranking, Institution/University can Attract Best Talents to their Campus after you Build and Launch of Your Own Satellite!***	**THREATS/CHALLENGES:** • *Prohibitively Expensive Cost of Satellite Systems/Sub-systems, if Imported from Abroad!* • *Expensive: Cost of Import, Customs Duty on Imported Items 30-60% Extra!* • *Appropriate Expertise/Knowledge of Integration of systems and sub-systems and its Associated Cost! Expert Technical Manpower!* • *Expensive Cost of Trouble Shooting and Launch Integration Support Services!* • *Undue Delay in Getting Frequency Allocation and Registration of Satellite before Launch with Foreign Services!* • *Expensive Cost of Launch Services and Integration Services at Launch Pad/Spaceport etc* • *Absence of Coordination with Multiple Ground Stations/Various Countries located in different Geographies with different Time Zones!*

ACRONYMS AND ABBREVIATIONS

Al	*Aluminium*	*HSCOM*	*High-speed communication*
AA	*Aluminium alloy*	*ITCA*	*Indian Technology Congress Association*
ADCS	*Attitude Determination and Control*	*ITU*	*International Telecom Union*
AOCS	*Attitude and orbit control subsystem*	*IFA*	*Inverted-F antenna*
ASD	*Acceleration spectral density*	*LV*	*Launch vehicle*
ATOX	*Atomic oxygen*	*LEO*	*Low Earth orbit*
CAD	*Computer-aided design*	*MoS*	*Margin of safety*
CDR	*Critical Design Review*	*MEO*	*Medium Earth orbit*
COM	*Communication subsystem*	*OBS*	*On-board Computer*
CoG	*Center of gravity*	*PDR*	*Preliminary Design Review*
CoM	*Center of mass*	*PSD*	*Power spectral density*
EO	*Earth observation*	*PCB*	*Printed circuit board*
EPS	*Electric power subsystem*	*PDF*	*Probability density function*
E-sail	*Electric solar wind sail*	*PNMsat*	*PicoSat, NanoSat and Micro Satellite*
EMC	*Electromagnetic compatibility*	*PR*	*Public relations*
EPS	*Electrical Power System*	*RF*	*Radio frequency*
ESD	*Electrostatic discharge*	*RW*	*Reaction wheel*
EM	*Engineering model*	*SDOF*	*Single-degree-of freedom*
ESA	*European Space Agency*	*SDR*	*Software Defined Radio*
FEA	*Finite element analysis*	*SPL*	*Sound pressure level*
FPGA	*Field-programmable gate array*	*SS*	*Stainless steel*
FH	*Flight hardware*	*ST*	*Star tracker*
GCS	*Ground Control Station*	*SATNOGs*	*Satellite Network of Ground Stations*
GEO	*Geosynchronous orbit*	*STR*	*Structure subsystem*
CG	*Gold gas*	*Ti*	*Titanium*
HW	*Hardware*	*TSC*	*TSC Technologies P Ltd*
HDR	*Hardware Design Review*	*UHF*	*Ultra-high frequency*
HS	*High-level sine*	*VHF*	*Very high frequency*