

The 4th UNISEC-Global Meeting - Kamchia, October 18-23, 2016

ITALY-KENYA UNIVERSITY NANO SATELLITE (IKUNS)

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**S5-Lab Sapienza Space Systems and
Space Surveillance Laboratory**



**University of Nairobi
School of Engineering**

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University of Nairobi – Sapienza Agreement in 1962

Kenya's participation in the utilization of space has a long history starting in 1962 when an agreement between the University of Nairobi (Formally Royal Technical College) and University of Rome "La Sapienza" were signed for using Kenyan territorial waters at Malindi to build the San Marco satellite launch platform and base camp for ground stations.



University of Nairobi – Sapienza

Memorandum Of Understanding in 2002

- Between 1962 and 1987, 27 satellites were successfully placed in orbit. The ground stations at the Malindi base camp (renamed Broglio Space Centre) are currently operated by Italian Space Agency (ASI) and European Space Agency (ESA).
- In an MOU dated 20 June 2002 the University of Nairobi and University of Rome, Sapienza, established a Memorandum of Understanding (MOU) to collaborate in education and research activities of common interest, including cooperation in the utilization of space resources and exchange of both students and faculty staff.



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ASI – Sapienza Agreement for the Broglio Space Centre (BSC)

The Italian Space Agency and the University of Rome La Sapienza signed an Agreement dated 20 December 2013, with these main contents:

- 1) ASI holds the management of BSC and assumes the use of all the assets in the Centre (facilities, systems and equipment of both ASI and Sapienza).**
- 2) ASI coordinates the research and training activities referred to the Additional Protocols of the Italy/Kenya Intergovernmental Agreement**
- 3) ASI is committed to involve Sapienza in these activities**
- 4) The involvement of Kenya Universities and Research Institutions will be encouraged**



University of Nairobi – Sapienza on-going cooperation

- However, during the life of these agreements, there has been limited progress in the past in using these agreements to **build local capacity and skills for Kenyans** to fully participate in harnessing space resources.
- To start addressing this gap, the University of Nairobi has renewed the partnership with University of Rome in July 2015, with a **new focus on cooperation to build local capacity and skills to design and operate space missions** for peaceful use of space resources.
- The whole activity is supported by the Italian Space Agency in **the framework of the ASI-Sapienza Agreement for the BSC.**



The ASI-Sapienza Meetings with Kenya Universities

Joint conferences are organized on a yearly basis to share research findings, management and utilization of space resources, with participants from:

- Kenya Universities and research institutions
- National Space Secretariat of Kenya
- University of Rome, Sapienza
- Italian Space Agency

The **First ASI-Sapienza Meeting with Kenya Universities** was held at University of Nairobi, January 27th 2015

The **Second ASI-Sapienza Meeting with Kenya Universities** was held at University of Nairobi, January 26th 2016

The **Third ASI-Sapienza Meeting with Kenya Universities**, will be held in January 2017



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The second ASI-Sapienza meeting with Kenya Universities University of Nairobi – 26th January 2016



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First set of activities under the renewed MOU

- Design and launch a **Kenyan University Nanosatellite** to enhance and **build capacity** for Kenyan Universities to utilize space resources for sustainable development goals especially in the area of agriculture, animal habitat and forest conservation.
- Starting in 2016-17, mount a **joint Post-Graduate Course in “Space Mission Design and Management”** between **University of Nairobi and Sapienza**.



The Italy-Kenya University Nano-Satellite program: IKUNS and 1KUNS-PF nanosatellites

- The Italy-Kenya University Nano-Satellite (IKUNS) program was established in September 2015, in a partnership between Sapienza and University of Nairobi, with the main goal of **designing, building and launching a “student-built” 6U Cubesat in a three year timeline**
- The opportunity to have a **“precursor flight”** for this mission was envisaged, by applying to the UNOOSA/JAXA Announcement of Opportunities for 1U Cubesat Launch from the ISS Japanese Module “KiboCube”.
- The **1KUNS-PF (First Kenya University NanoSatellite-Precursor Flight)** was indeed selected.
- **Launch from the ISS in 2017!**



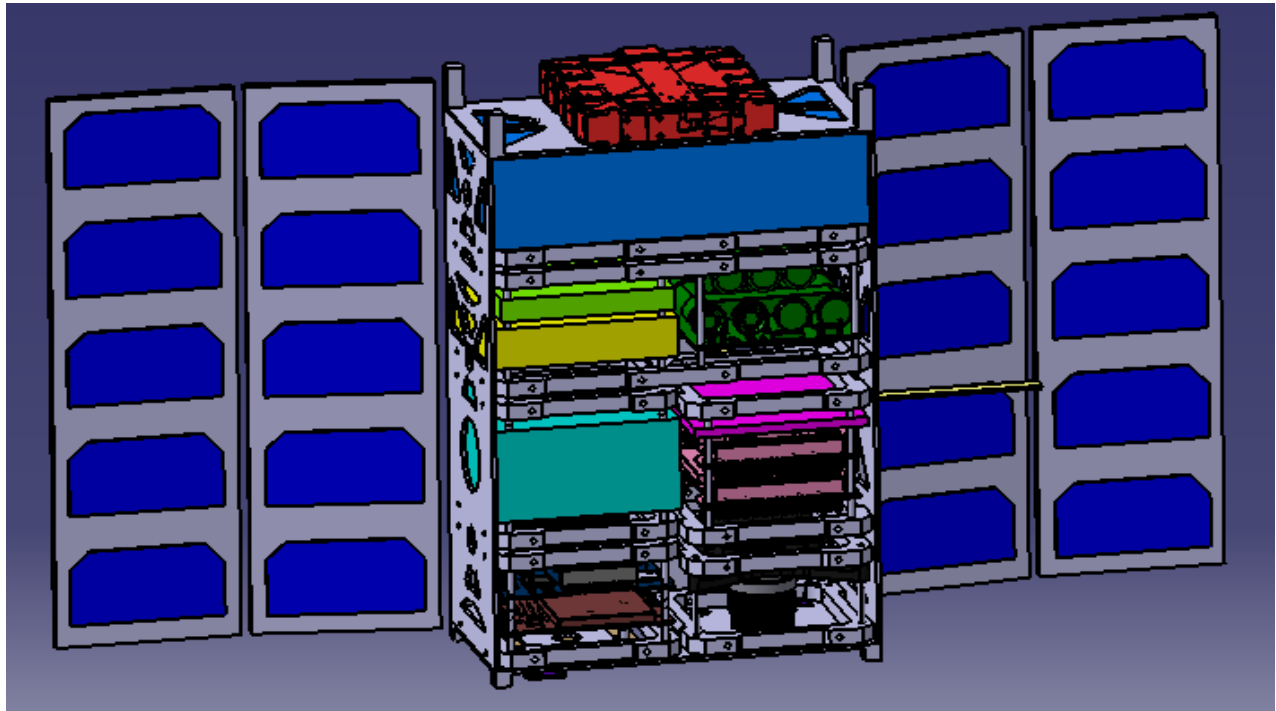
Scope of the project IKUNS (Italy-Kenya University NanoSatellite)

- The main goal of the program is **building capacity in space mission design and satellite manufacturing** in Kenya
- Student project involving Italian and Kenyan students in a common, international program. Development of a mission based on **6U CubeSat**, conceived for Earth observation in visual band.
- The main payload of the satellite will be designed and manufactured in cooperation with expertise from Sapienza and University of Nairobi.
- Great educational value both for Italian and Kenyan students, enabling **international cooperation through hands-on education**, increasing cooperative skills, learning from each other.



The IKUNS spacecraft

- The **IKUNS** spacecraft is a 6U Cubesat.
- The preliminary design was completed in the ASI Concurrent Engineering Facility (CEF)



The 1KUNS-Precursor Flight launch opportunity

- The 1KUNS-PF team responded to the announcement of a launch opportunity through the **United Nations/Japan Cooperation Programme on Cubesat Deployment from the International Space Station (ISS) Japanese Experiment Module (Kibo) “KiboCUBE”** deployed on ISS by Japan Aerospace Exploration Agency (JAXA)
- The 1KUNS-PF team application was selected by the UNOOSA (United Nations Office for Outer Space Affairs) and by using “KiboCUBE”, the 1KUNS-PF will achieve successful deployment and the mission goals.



Japanese Experiment Module (JEM)
deployed on ISS “KIBOCUBE”



The announcement of IKUNS-PF selection

- The IKUNS-PF selection for launch on KiboCube was announced at the UN/IAF Workshop on Space Technology for Socio-Economic Benefits: "Integrated Space Technologies and Applications for a Better Society" in Guadalajara, Mexico, on 25 Sept 2016



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The announcement of IKUNS-PF selection

- The President of ASI and representatives from Sapienza joining the announcement

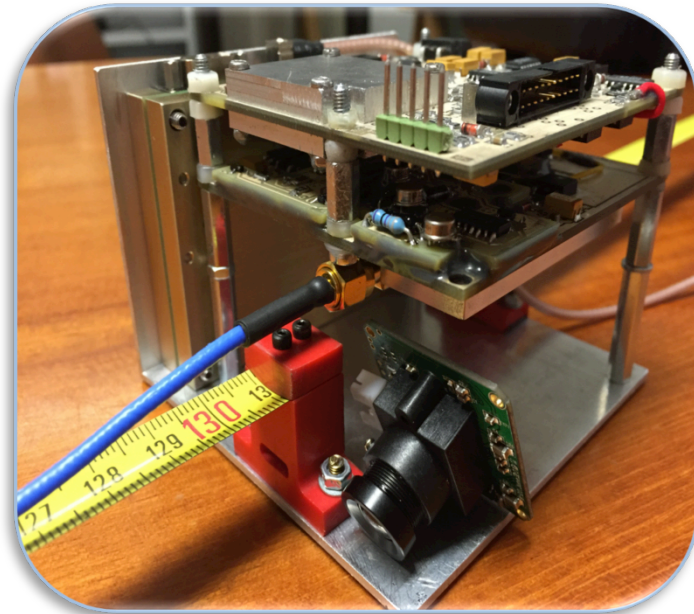
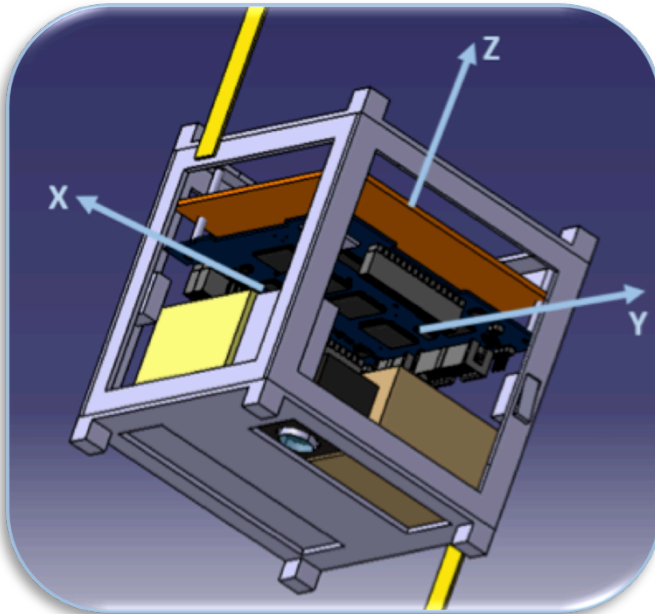


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The 1KUNS-PF spacecraft

- The 1KUNS-PF spacecraft is 1U Cubesat. The design has been completed. Preliminary testing on critical parts is on-going



The 1KUNS-PF program at UoN

(1st Kenya University NanoSatellite-Precursor Flight)

The University of Nairobi has utilized a 3 year EPSRC grant to develop the human skills and a prototyping **Internet of Things (IOT) Laboratory** for the design and manufacture of **smart and intelligent sensors**.

The 1KUNS-PF **mission design and choice of the Kenyan payload** focuses on local capacity building to utilize the IOT Lab to develop the smart sensors technologies for the following space applications.

- DC power monitoring and algorithms to maximize battery life.
- Communication with smart ground sensors to monitor animal migration patterns or agricultural potential in selected areas of Kenya.
- Imaging to determine human activity and degradation of forest cover in selected areas of Kenya.
- General broadcasts, data analysis and presentation for informed decision support in livestock and wildlife management, agriculture extension services



Building capacity in satellite manufacturing

- Skills in satellite manufacturing can only be gained in a **“learning by doing”** perspective, using **“hands-on” education** methods.
- The traditional approach to capacity building in developing countries is mainly based on fellowships granted to single selected students, to attend Courses and/or obtain a Degree in industrialized countries
- In this way the gained know-how is spread in several **“isolated” skilled individuals**
- We realized that, for us, the real challenge is:

How do we set up a process locally, so that the capacity is maintained and kept at an Institution level and not merely at the individuals level.



A joint Postgraduate Course as a tool for building capacity in satellite manufacturing

Bearing in mind the question on how we can set up a process to build capacity locally, we decided to establish a **joint Postgraduate Course in “Space Mission Design and Management”**, with these main objectives:

- **Make the process Institutional, not individual**
- **Make the process “active” locally. Not just “transfer” know-how, but “build” know-how locally**

To achieve these goals, not only students, but **Professors** at University of Nairobi are directly involved in **designing and setting a higher education program** together with professors from Sapienza.



Postgraduate Course in Space Mission Design and Management teaching modules and credits

Sapienza		Title	Location	Credits
	Module 1	Space missions and space systems	Sapienza	2,5
	Module 2	Spacecraft Design	Sapienza	2,5
	Module 3	Concurrent Engineering Tools for space mission design	Sapienza	2,5
	Module 4	Space mission management	Sapienza	2,5
	Module 5	International Cooperation in Space	Sapienza	2,5
	Module 6	Remote sensing and Earth Observation from space	Sapienza	2,5
	Module 7	Coastal erosion analysis using satellite data	Sapienza	2,5
	Module 8	Telemedicine	Sapienza	2,5
University of Nairobi	Intermediate Exam		Sapienza	1
	Module 9	Embedded systems	UoN	2,5
	Module 10	Digital Image Processing	UoN	2,5
	Module 11	Satellite Telecommunications	UoN	2,5
	Module 12	Telemedicine applications in Africa	UoN	2,5
	Module 13	Satellite Remote Sensing Applications	UoN	2,5
	Module 14	GIS/GPS applications	UoN	2,5
	Module 15	Satellite Ground Station and Mission Operations (support from BSC-Malindi)	UoN	2,5
	Module 16	Space debris observation (BSC Malindi)	UoN	2,5
	Intermediate Exam		UoN	1
	Team work project	Preliminary Design and Management Plan of a space mission	Sapienza UoN	4
	Stage	Stage at ASI (Rome and BSC)		10
	Final exam		4	



Postgraduate Course timeline

The students enrolled in this Postgraduate Course will be required to gain at least 30% of the credits in the partner University.

- Kenyan (and Italian) students will attend courses at Sapienza for **three months**
- Italian (and Kenya) students will attend courses at University Nairobi for **three months**
- **All the students will have a 6 month internship at ASI, BSC or a Space Company**

Funding for the Postgraduate Course will be provided by ASI and European Companies. Students enrolled in the Postgraduate Course will participate in the 1KUNS-PF and IKUNS nanosatellite design, realization and operation in orbit as part of the curricular activity.



S5LAB - Main research activities

Sapienza Space System and Space Surveillance Laboratory

Satellite systems design:

- Mission analysis
- On-board systems/sub-systems
- Ground station operation
- Data handling and processing
- UNISAT1-4, **URSA MAIOR**

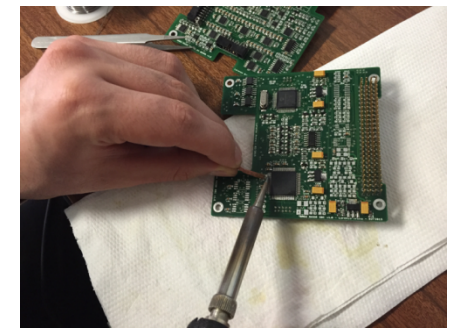
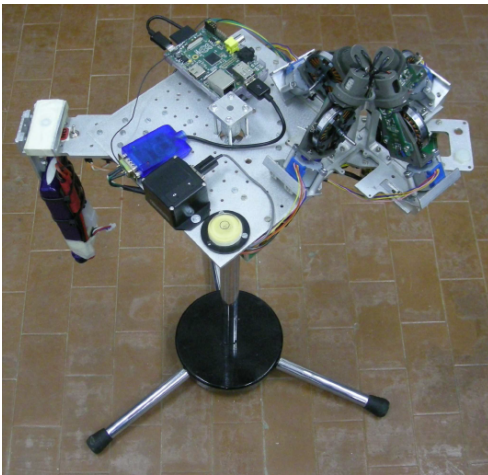
Space surveillance systems:

- Optical observation systems
- Data analysis
- Orbit determination
- Active debris removal systems
- EQUO



S5Lab facilities for satellite testing

- Electronic laboratory
- Mechanical workshop
- 3-axis CNC milling machine
- Attitude control testing equipment
- Vacuum chamber



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Conclusions

- **Sapienza University of Rome** and **University of Nairobi** are involved in the design, manufacturing and test of IKUNS, a 6U student CubeSat project developed in the framework of the **ASI (Agenzia Spaziale Italiana) - Sapienza University of Rome agreement** for the management and activity at the **Broglia Space Centre (BSC)** in Malindi, Kenya.
- The aim of the project is to develop an Earth observation mission.
- A precursor flight will be deployed from the ISS, thanks to the support from **UNOOSA** and **JAXA**, in the framework of the **KiboCube program**
- A joint Postgraduate Course between Sapienza and University of Nairobi was established, as a capacity building tool, enhancing active participation from kenyan professors and keeping the know-how at an Institution level.

