Presenter : **Benjamin Bonsu, PhD Student**

All Nations University (ANU) and Kyushu Institute of Technology (Kyutech)

bbonsu@anuc.edu.gh/q595908b@mail.kyutech.jp

Co-Authors : Ernest Matey , Joseph Quansah , Samuel Donkor , Mengu Cho, ANU-SSTL Team members, Birds project team members.

United Nations/Austria Symposium on
"Access to Space: Holistic Capacity-Building for the 21st Century"

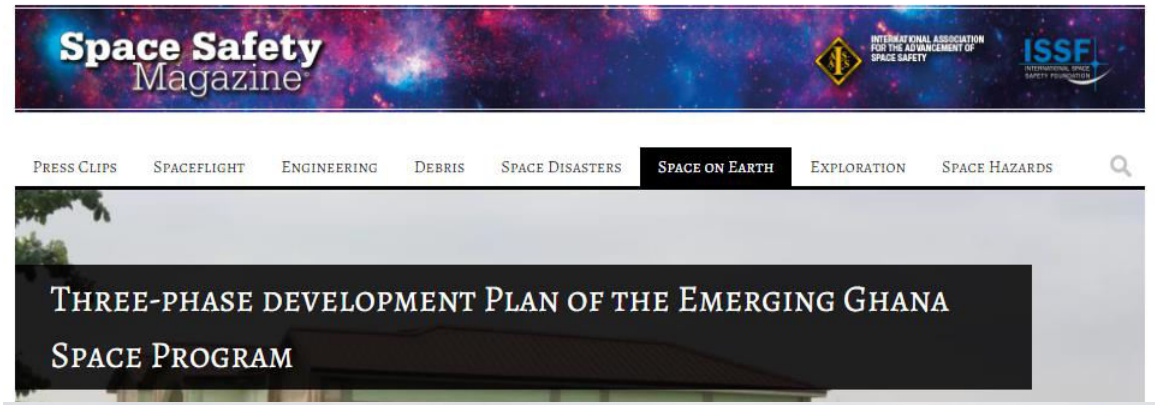
3 - 7 September, 2017 Graz , Austria

Content

- Introduction
- About All Nations University Space Activities
- Ghanasat-1 Project
- Future Plans

How did Space Start in Ghana ?

In 2009 Hon. Ms. Sherry Ayittey who first conceived the idea of a Ghana Space Agency and set up an initial three phase development plan for 2011 -2015



- **Phase 1 : Year 2011** Accomplished
  - Establish Space Technology Center
- **Phase 2 : Year 2013** Accomplished
  - Establish Space Technology Institute
- **Phase 3 : Year 2015** Not Accomplished
  - Establish Space Agency

Africa Very Long Baseline Interferometry Project

- Collaborative effort with South Africa to be part of the Africa Very Long Baseline Interferometry (VLBI) Network (2011-2017)
- Purpose : To build human capacity in radio astronomy in Ghana

Milestones for Science Operations Readiness

- **Milestone 1**: Science Commissioning Phase 1 after successful Engineering Release 1 (November 2016 – June 2017)
- **Milestone 2**: Science Commissioning Phase 2 after successful Engineering Release 2 to complete the conversion process (January 2018 – March 2018)
- **Milestone 3:** Preliminary Science operations in VLBI and non-VLBI modes (April 2018 – September 2018)
- **Milestone 4**: Successful Science operations in VLBI and Single dish modes at this stage signifies quality science readiness of the radio telescope (October 2018 – June 2019)

Officially Launched in August 24 ,2017

32M Telecom Parabolic Dish Antenna converted to Radio Telescope located at Kuntunse in the Eastern Region of Ghana

http://presidency.gov.gh/index.php/2017/08/24/president-akufo-addo-launches-ghana-radio-astronomy-observatory/

UN-COPOUS Membership and Treaties

- Ghana is a member of UN-COPOUS since 2013

UNITED NATIONS
Office for Outer Space Affairs

About Us | Our Work | Benefits of Space | Information for... | Events | Space Object Register | Docum

Our Work > Secretariat of COPUOS > Member States and Observer Organizations > Membership Evolution

Committee on the Peaceful Uses of Outer Space: Membership Evolution

2013	76	GA resolution 68/75	Albania, Algeria, Argentina, Armenia, Australia, Austria, Azerbaijan, Belgium, **Belarus**, Benin, Bolivia, Brazil, Bulgaria, Burkina Faso, Cameroon, Canada, Chad, Chile, China, Colombia, Costa Rica, Cuba, Czech Republic, Ecuador, Egypt, France, Hungary, Germany, **Ghana**, Greece, India, Indonesia, Iran, Iraq, Italy, Japan, Jordan, Kazakhstan, Kenya, Lebanon, Libya, Malaysia, Mexico, Mongolia, Morocco, Netherlands, Nicaragua, Niger, Nigeria, Pakistan, Peru, Philippines, Poland, Portugal, Republic of Korea, Romania, the Russian Federation, Saudi Arabia, Senegal, Sierra Leone, Slovakia, South Africa, Spain,

http://www.unoosa.org/oosa/en/ourwork/copuos/members/evolution.html

Year	STSC Activities	LSC Activities
2013	Present	Present
2014	Absent	Absent
2015	Absent	Absent
2016	Absent	Absent
2017	Absent	Absent

International Agreement relating to activities in Outer Space as at January 2016

State, area or organization		(1)	(2)	(3)	(4)	(5)
		1967	1968	1972	1975	1979
Ghana		OST	ARRA	LIAB	REG	MOON
		S	S	S		

R: ratification, S: signature only

OST (Outer Space Treaty)	Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies
ARRA(Rescue Agreement)	Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into OuterSpace
LIAB (Liability Convention)	Convention on International Liability for Damage Caused by Space Objects
REG (Registration Convention)	Convention on Registration of Objects Launched into Outer Space
MOON (Moon Agreement)	Agreement Governing the Activities of States on the Moon and Other Celestial Bodies

All Nations University (ANU) Space Activities

The first Private University contribution towards the sustainable Space Activities in Ghana

History of ANU

Dr Samuel Donkor , Founder and President

- Founded in April 1996
  - 3000 Undergraduate students
  - 160 Academic Staffs
- Vision
  - Provide higher education, pursued in a environment of truth and integrity.
- Mission
  - Provide quality higher education that promotes development and to raise leaders with values and ethics to serve society.

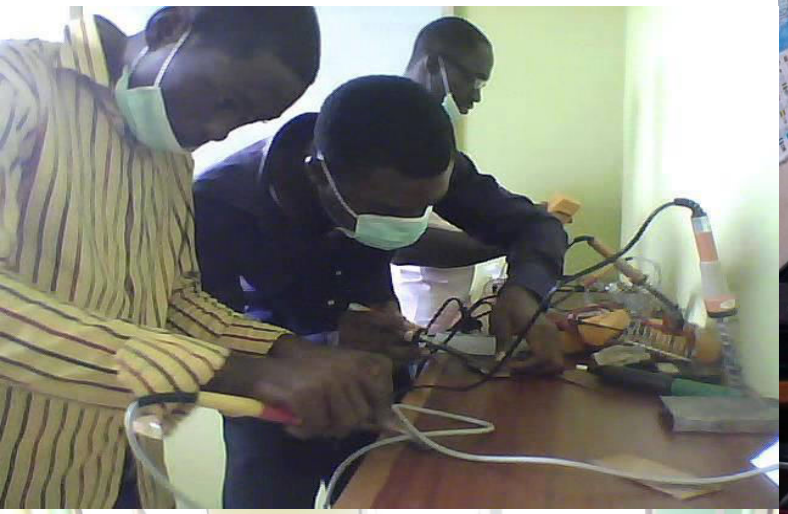
School of Engineering

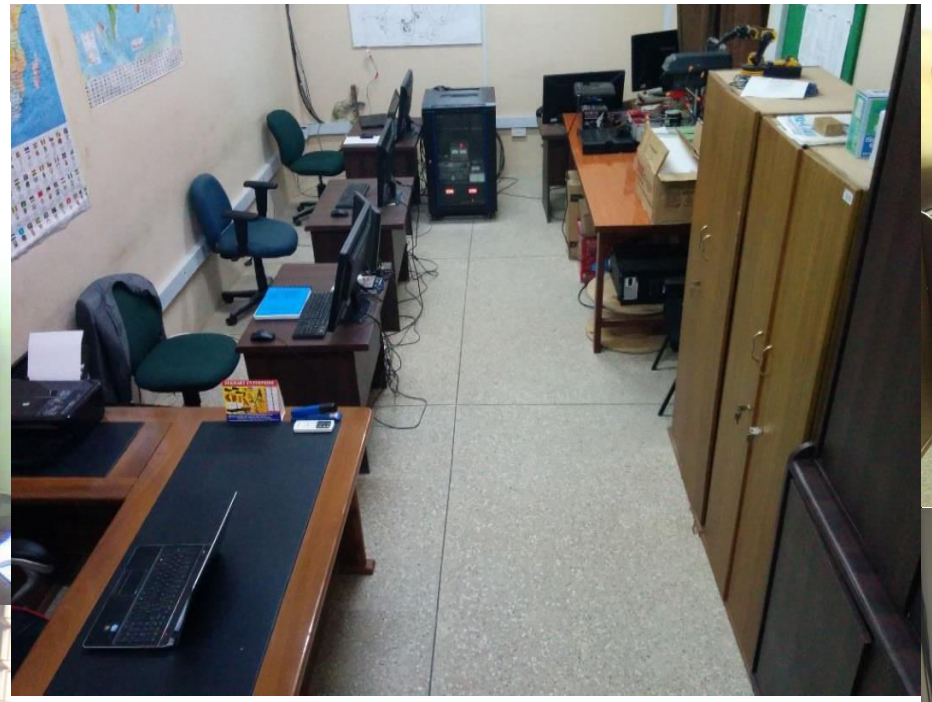
School of Business and Nursing

http://anuc.edu.gh/home/aboutus/5/aboutus.html

All Nations University Space Science and Technology Laboratory (ANU-SSTL)

- Established in February 2012
- Under the auspices of Electronic and Communication Engineering Department
- Staffs : 6





MISSION

To promote and build **human capacity** in the area of **space science and satellite technology** through innovative **research and development** of **educative projects** for the **benefit of society**

ANU-SSTL Milestones

CANSAT Project 2012-2013

VHF/UHF Amateur Ground Station 2013- 2014

Aerosol Robotic Network AERONET Project 2015-2016

Workshops

World Space Week Celebration

Conferences

Ghanasat-1 Project

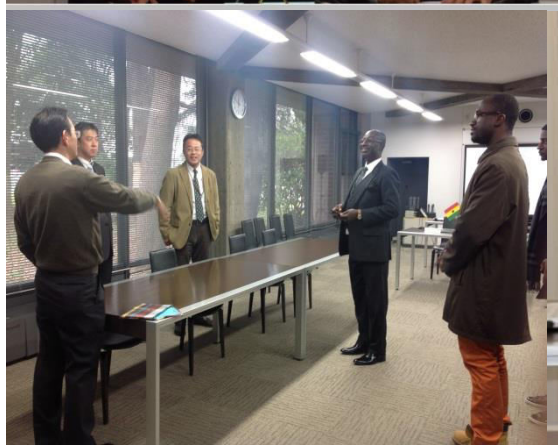
First Ghana Satellite into Orbit

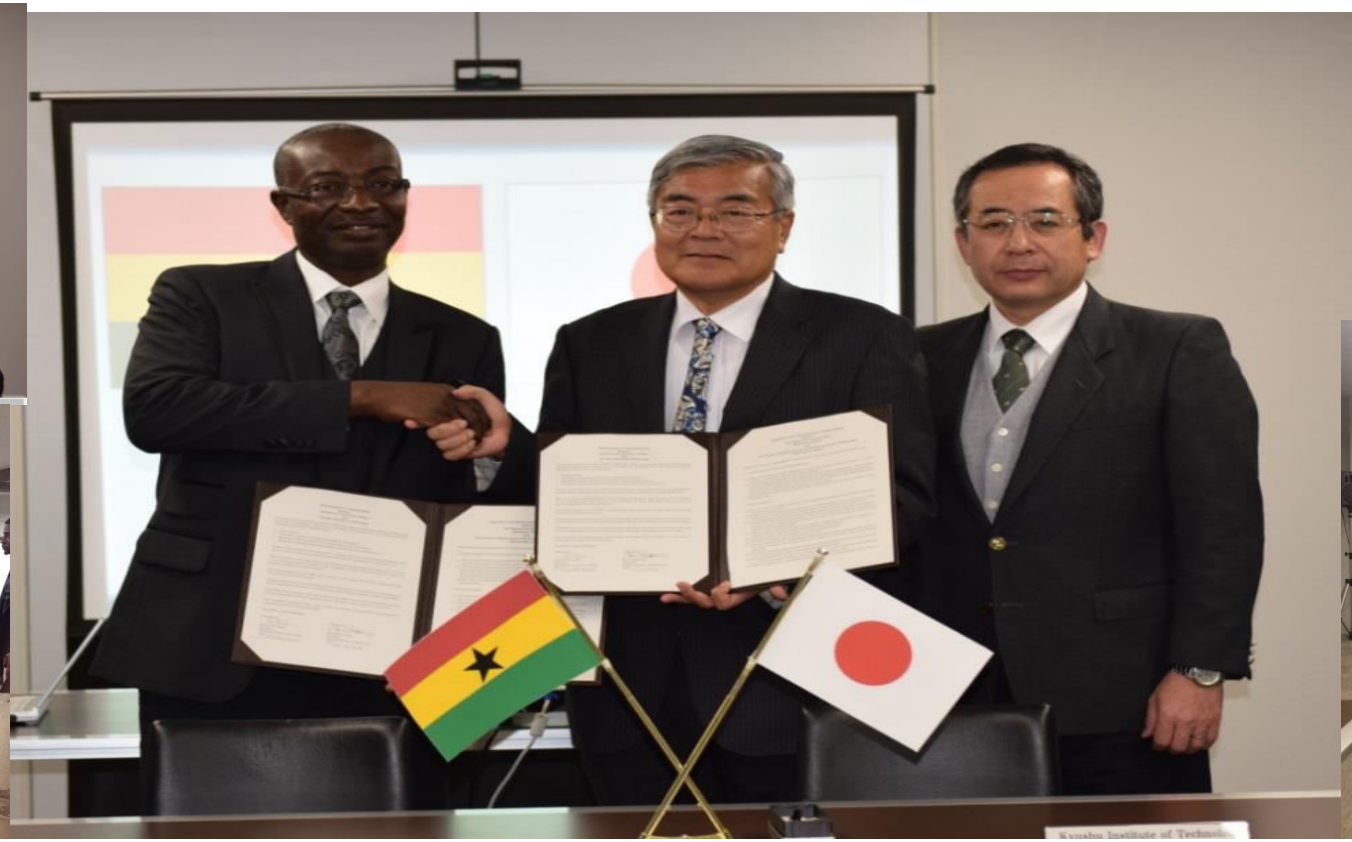
Why ANU decided to Sign MoU to choose Kyushu Institute of Technology?

1. ANU to build human capacity in space science and technology
2. ANU to be the first in Ghana to develop first Ghana satellite into Orbit
3. ANU to lead space activities in Ghana at the university level to contribute to the sustainable space program in Ghana

ANU visited Kyutech in **May 2015**

Memorandum of Understanding (MOU) Between All Nations University(ANU) and Kyushu Institute of Technology (Kyutech)





- Official signing ceremony : January 6 ,2016
- **Aim**
  - To train ANU sponsored students studying at Kyutech to build their **capacity** in **satellite technology** and build **the first Ghana satellite** to contribute to the sustainable space activities in Ghana

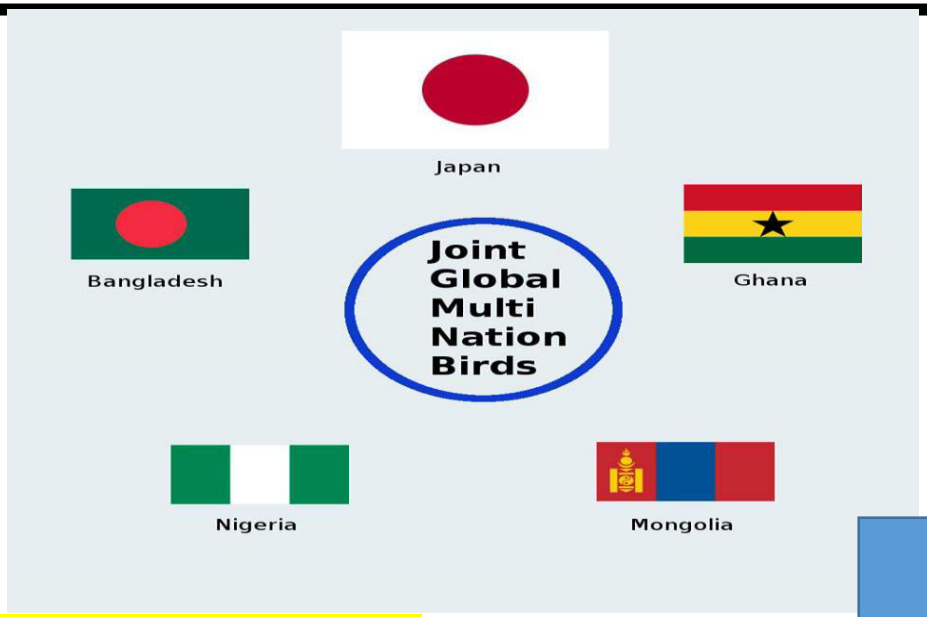
BIRDS Project

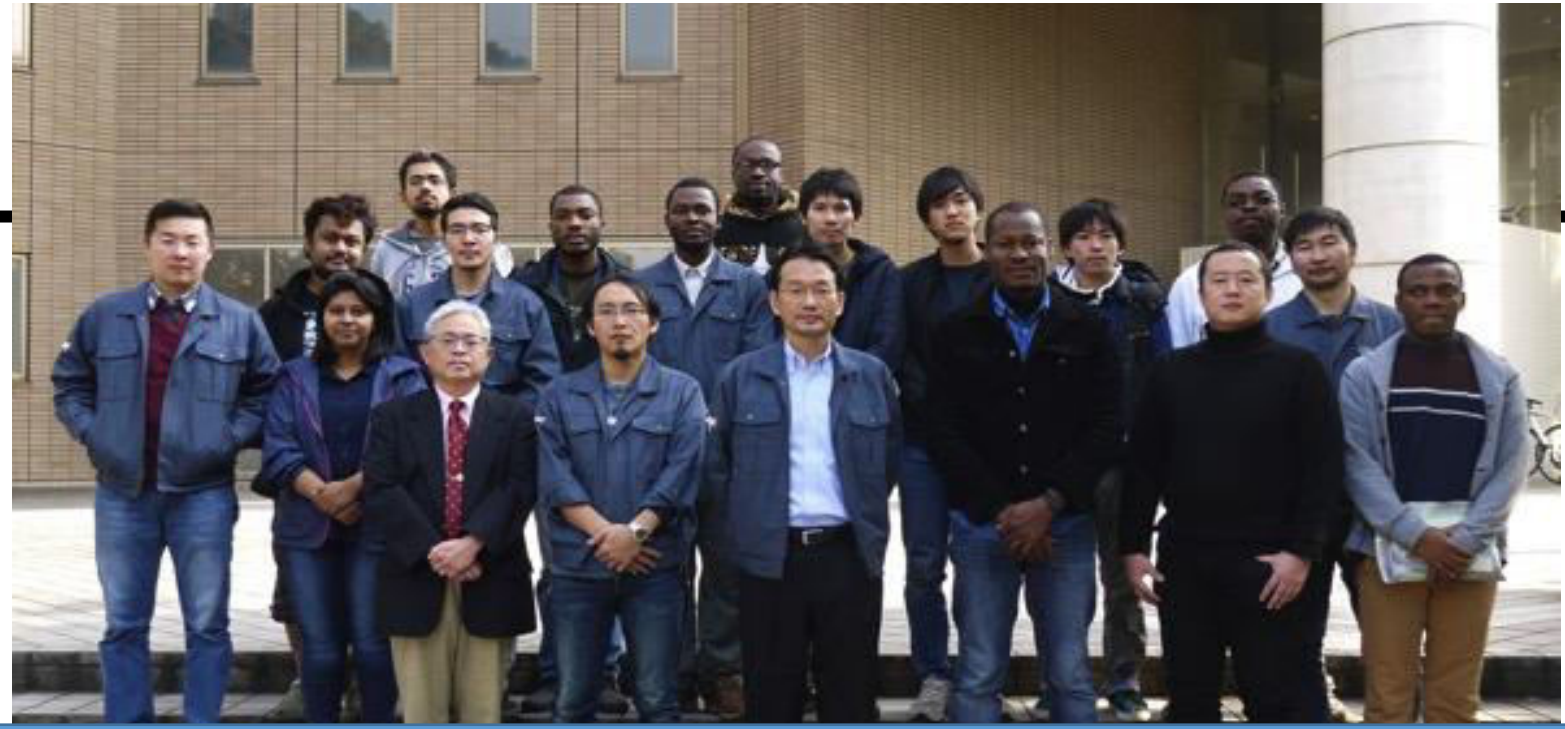
Joint **G**lobal **M**ulti-**N**ation **B**irds (JGMNB): Satellite program for non-space faring countries. *Shortly called as "BIRDS Project"*

Birds Project is initiated by Kyushu Institute of Technology (Kyutech), Japan, through its Laboratory of Spacecraft Environment Interaction Engineering (LASIENE).

Proposed Date : July 17 July , 2015

Kick Off: 22 October ,2015





Ghana was the first country in the world to sign up on the BIRDS Project"

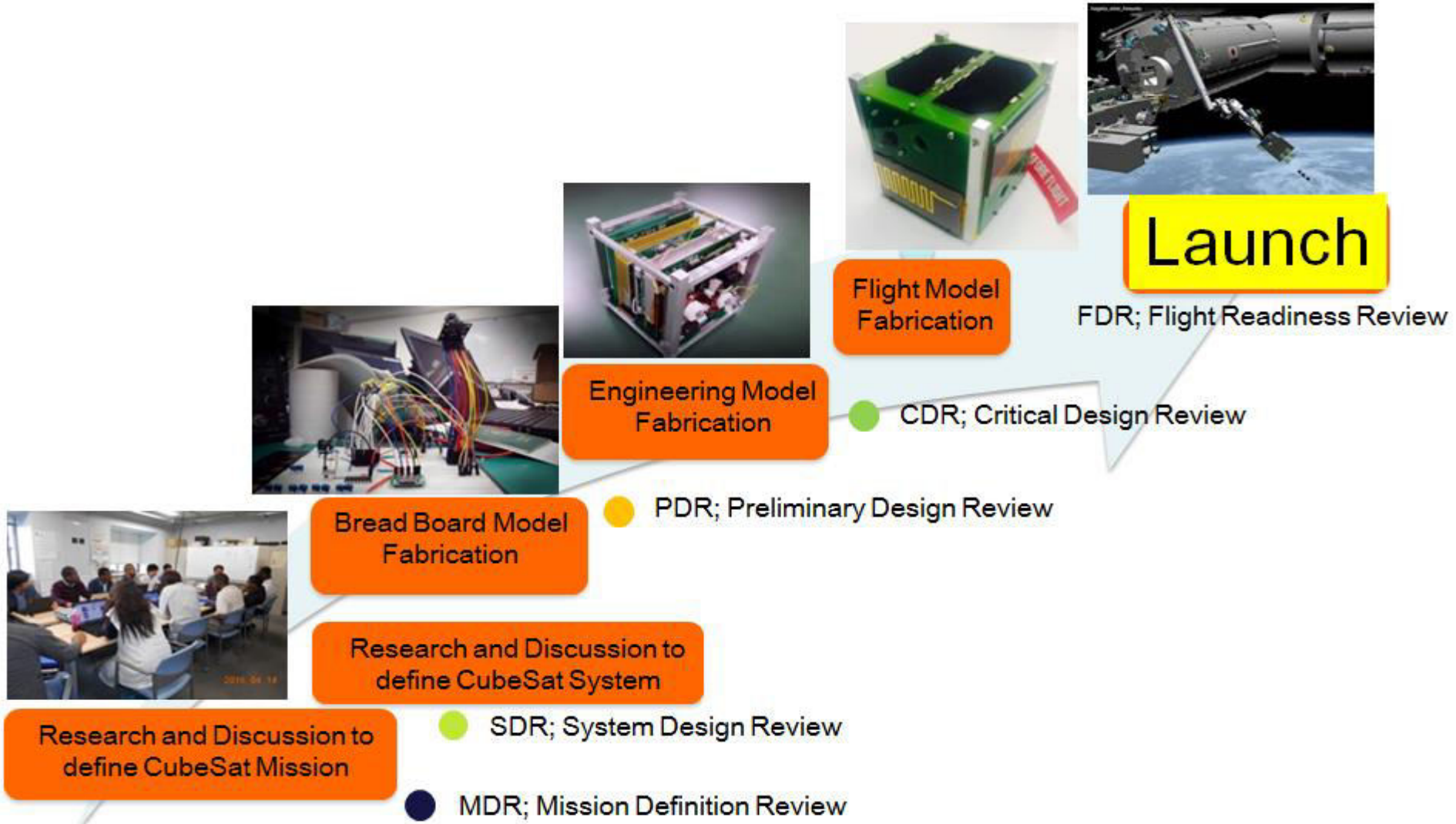
Mission Statement

Successfully building and operating the first national Cubesat and making the foremost step toward indigenous space program at each nation.

Objectives of Birds Project

- Demonstrate that a 1U CubeSats can be built and operated successfully in a time frame shorter than 2 years even for countries with limited (or zero) satellite experience with proper design and planning.
- Demonstrate that a constellation of 1U CubeSats can have synergetic mission value and capability via international Co-operation.
- Demonstrate that a sustainable and robust space program can be started with minimum budget at universities in emerging or developing countries.
- Demonstrate that competition and collaboration among student members accelerate satellite development process and enhance the satellite quality.
- Obtain key experiences regarding operation of satellite constellation.

Birds Project Life Cycle and Timeline



BIRDS project is student-driven with LESS supervision.

Mission of GhanaSat-1 and other Birds Satellites

- **Take monitor the coastal belts of Ghana and other neighboring countries**
  - -Employed 2 Cameras (SCAMP at 0.3MP, OV5642 at 5MP).

- **Digi-singer Mission (SNG)**
  - -Exchange of voice data from satellites to Ham Radio receivers (UHF band)
  - -An initiative aimed at stimulating interest in science, technology, engineering and mathematics (STEM) education in high schools and tertiary institutions.

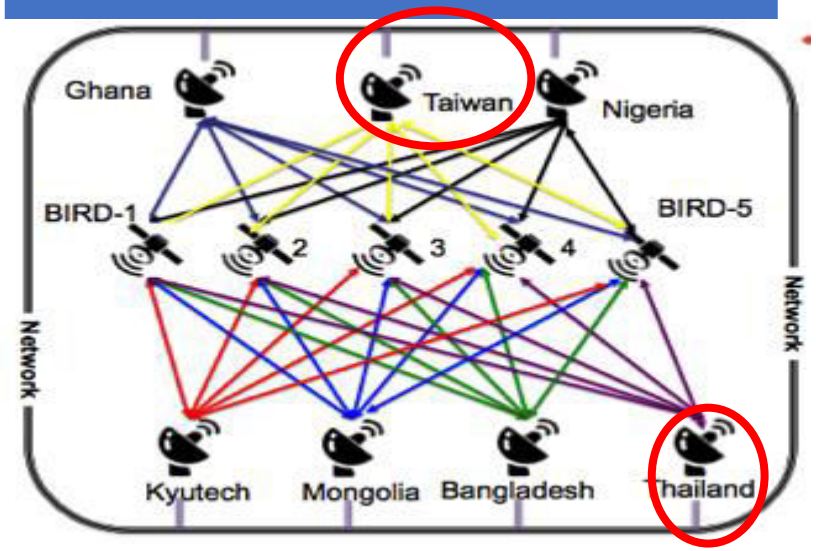
- **Measure Single Event Latch-up in orbit (SEL)**
  - -By taking log of microcontroller reset events over period of time.

Mission of GhanaSat-1 and other Birds Satellites

- **Determination of Satellite Precise Location (POS) without GPS**
  -Using analysis of Time Of Arrival (TOA) from time lag among multiple ground stations

- **Atmospheric Density Measurement (ATM)**
  -Using Orbital analysis from precise satellite tracking information (POS).

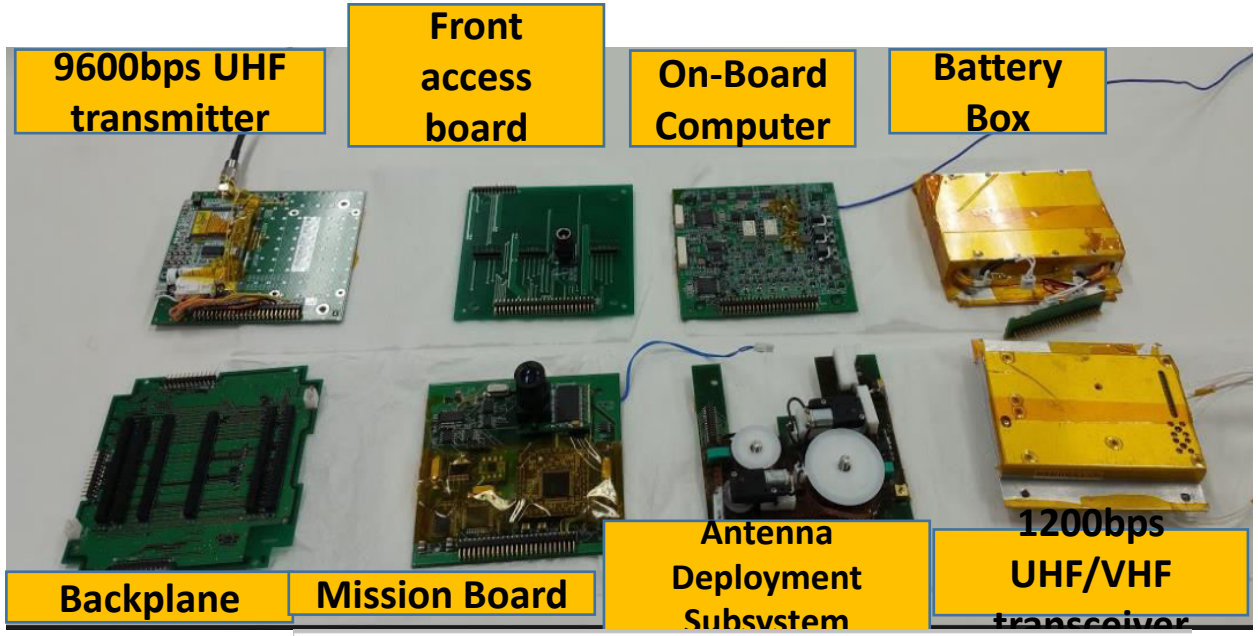
- **Demonstrate Ground Station Network for CubeSat Constellation (NET)**

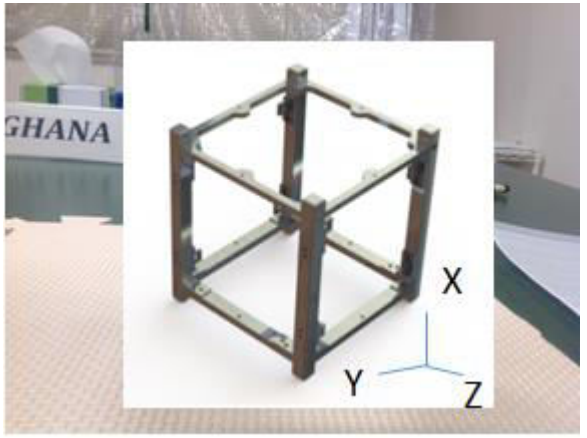


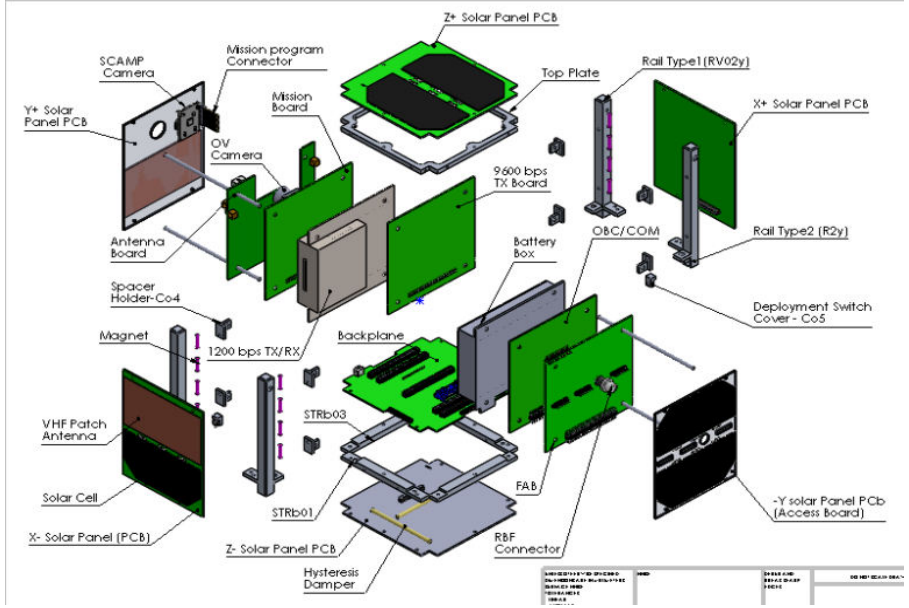
Ghanasat-1 Development Phases

Ghanasat-1 Parameters

- Ghanasat-1 is an educational satellite
- Ghanasat-1 is a 1U Cubesat
- Mass : 1.11kg
- Size: 10cm x 10cm x 10cm
- Operating Frequency: VHF /UHF
  - VHF: 145MHz-146MHz (Uplink)
  - UHF:435MHz – 438MHz (Downlink)
- Modulation Scheme
  - AFSK
  - GMSK
- Data Throughput
  - 1200bps
  - 9600bps
- RF Transmit Power
  - Modulation:27dBm (0.5W)
  - Unmodulated: 30dBm (1W)

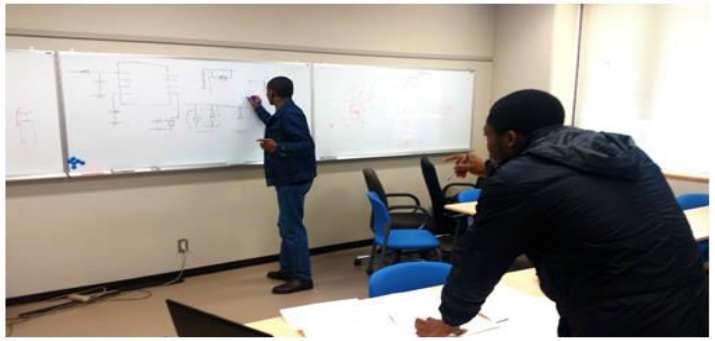




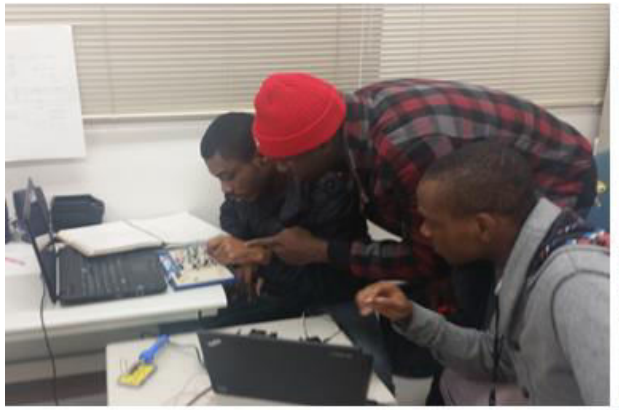


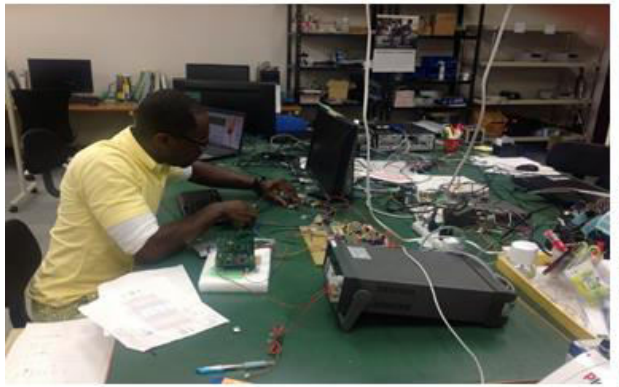
Bread Board Model (BBM) Development Phase (Activities)

Brainstorm session



Design , Development and Functionality Test





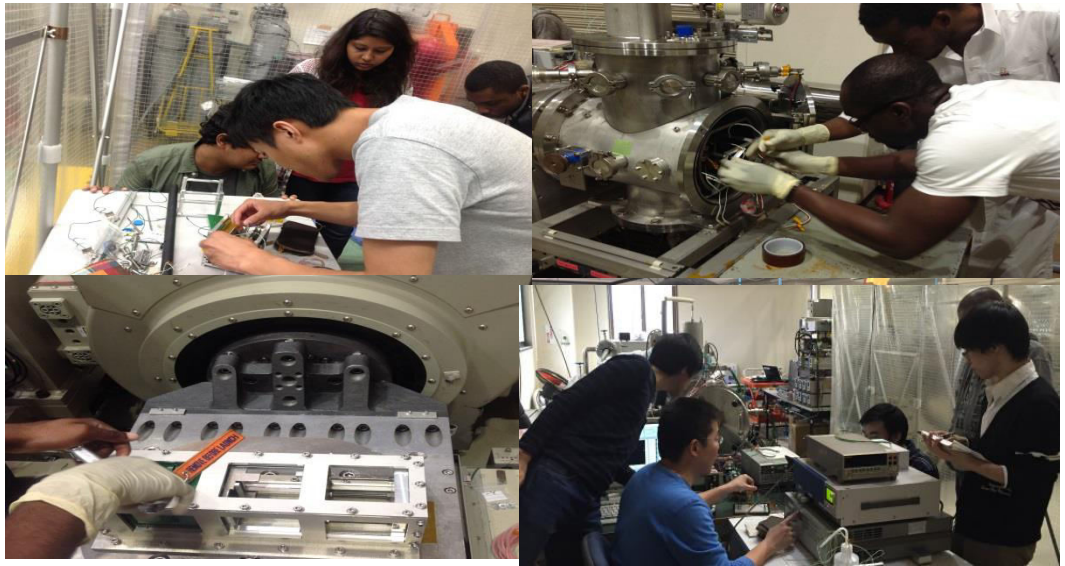
Results are been presented during the Birds Meetings and the team should be ready to face questions , and comments .

Engineering Model (BBM) Development Phase (Activities)

Brainstorm Session

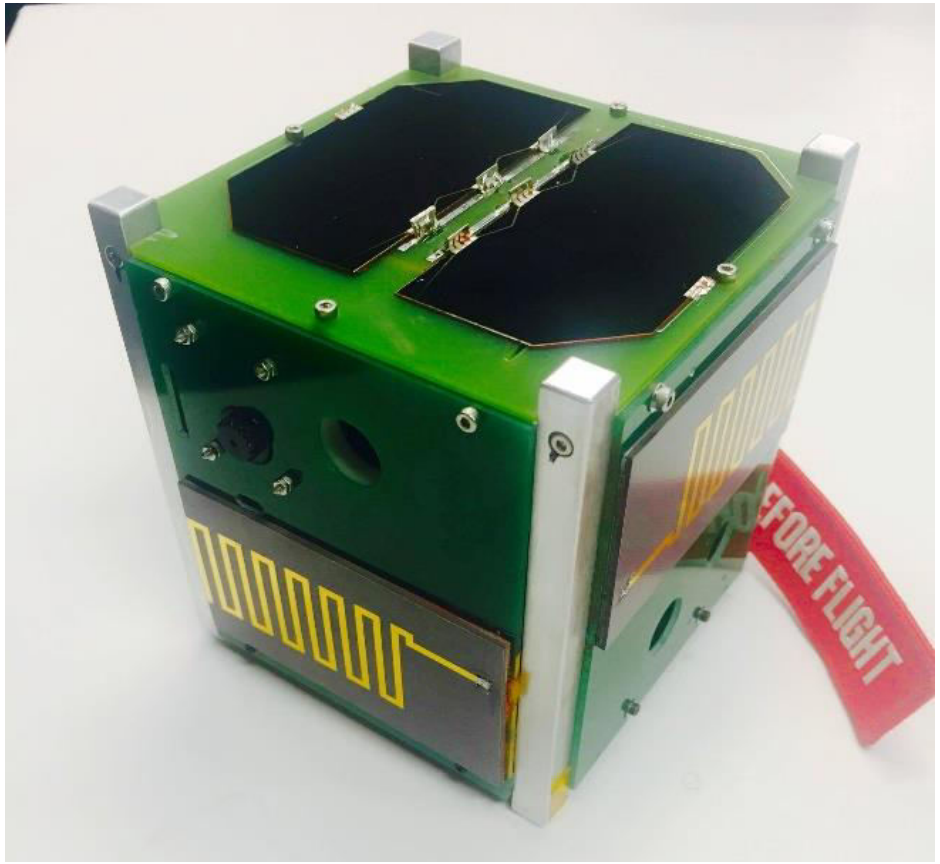
Assembly and Integration

Thermal Vacuum and Vibration Test



Long Distance Communication Test (Link Margin 27dB)

Engineering Model (EM) of Birds Satellite



EM of Birds-Satellite is a demonstration of team work among non-space faring students to build a satellite through international collaboration

Flight Model Development Phase (Activities)

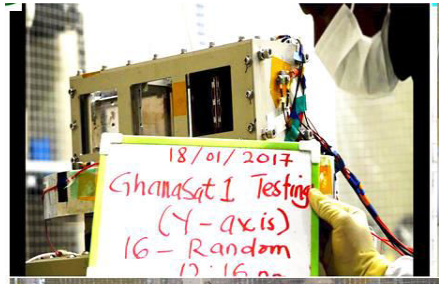
Assembly , Integration and Functional Test



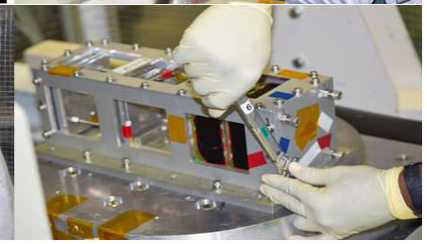
Solar Simulation Test



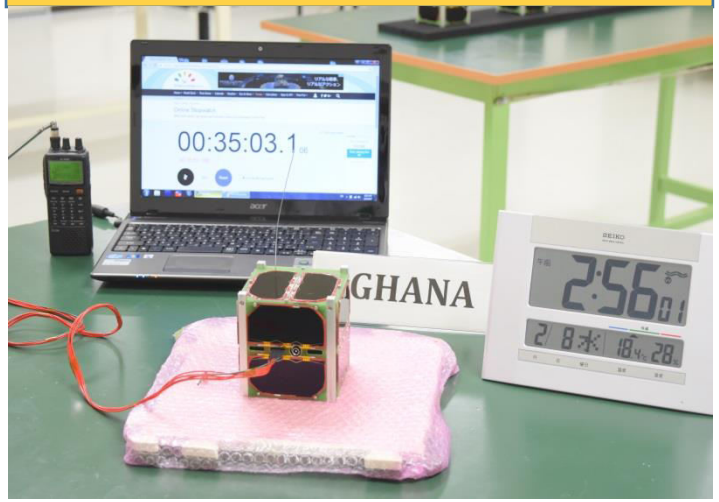

Vibration Test







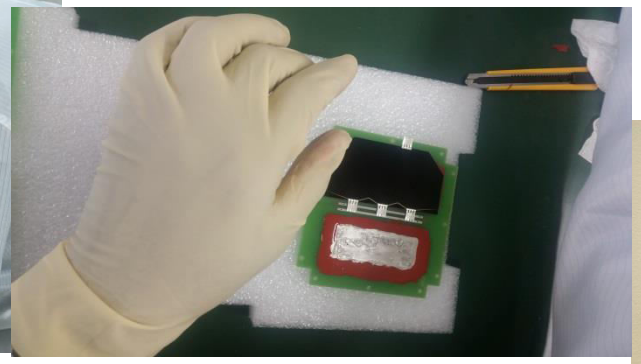
Antenna Deployment Test



Fit check and Safety Review by JAXA Officials



Problem Encountered and Lesson Learned



Solar Panel Attachment , three solar panel was broken in the FM development phase

Structure Assembly and Fit check Acceptance Test

❖**Lesson Learned**

1. Don't use broken components for FM development
2. Time and schedule is very critical in satellite development

First Birds International Workshop

- Date: June 27 -29 , 2016
- 3 days Workshop
  - Day 1: Presentation of Future Plans for Space Research and Education
  - Day 2: Press Conference
  - Day 3 : Signing Ceremony and Reception (Letter of Intent)

Mission Statement

To advance the **Peaceful Use of Outer Space** for the **Benefit of Humanity** by using a **Network of Universities** conducting **Space Research and Education**

First Birds International Workshop

Day 1

Thailand Team
(Dr Pom, Dr Ammarin, Apiwat)

Infostellar

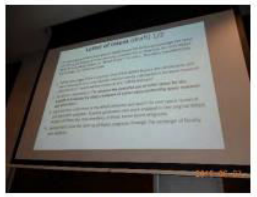
President of Kyutech
(Prof. Oie, far right)

Mr. Oikawa
of JAXA.

Presentation by BRAC
(Prof. Rhaman calls in from

Presentation by Taiwan
(Prof. Ivh-Ching Juang)

Meeting Room



Discussion of the LOI
(Letter of Intent)

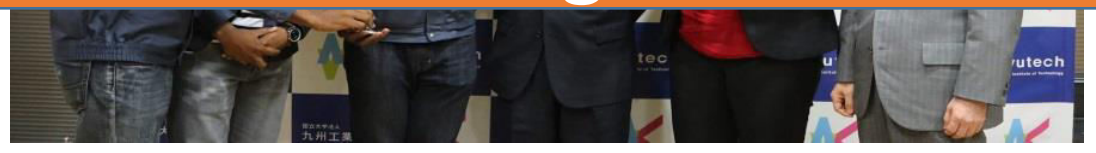
Day 2

2nd Birds International Workshop shall be hosted by All Nations University

November 20 -23 , 2017

Koforidua , Ghana

Contact : drckyeremeh@anuc.edu.gh



Birds Stakeholders Press Conference before Birds Satellites Delivery to JAXA

- Date : February 8 ,2017

Dr. Carlene Kyeremeh (ANU rep) thanked Kyutech Management and Birds Management for such an honor and priviledge for Ghana to join the Birds Project

Dr Werner Balogh , UNOOSA and JAXA officials congratulated the Birds Stakeholders for funding the Birds Project and their effort to build an international human network to build capacity in space technology in developing countries

3. UNOOSA recognizes Kyutech's capacity building achievements, including BIRDS
(with this official letter)

UNITED NATIONS
Office for Outer Space Affairs

15 October 2016

Dear Prof. Cho,

I would like to take this opportunity to express the appreciation of the United Nations Office for Outer Space Affairs (OOSA) to you and your staff at Kyushu Institute of Technology (Kyutech) for your contributions to international space cooperation and to the peaceful uses of outer space.

Your participation in the recent United Nations/International Astronautical Federation Workshop on Space Technology for Socio-Economic Benefits, held in Guadalajara, Mexico, 23-25 September, helped to highlight the ongoing efforts of OOSA and Kyutech to support capacity building in space technology development in emerging space nations.

We are especially delighted to see the successful evolution of the United Nations/Japan Long-term Fellowship Programme (PNST), which since its initiation in 2011 has allowed more than 20 Master and PhD

The presentations by Kyutech and PNST graduates at this year's session of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) in Vienna has been met with strong interest by Member States and as a result we have to date already received more than 700 applications for the 2017 round of the PNST.

We are pleased to see that PNST and other Kyutech students participating in the Space Engineering International Course (SEIC) are not only taught about the theoretical aspects of space technology development, but, through hands-on activities, are directly participating in the development, testing, launch and operation of satellites, including for operational applications. In particular we note the BIRDS projects in which Kyutech students are presently developing the first satellites for Ghana, Bangladesh, and Mongolia. This aspect of the SEIC, that students at the end of their studies return with the complete theoretical and practical knowledge to initiate satellite development activities in their own countries, makes Kyutech's activities unique and stand out among other satellite development capacity building activities in the World.

We congratulate you for your success in developing PNST into a leading space technology capacity building programme, recognized by the United Nations. We look forward to continue working with Kyutech, and, by building on these achievements, open outer space activities for a growing number of emerging space nations.

Yours sincerely,

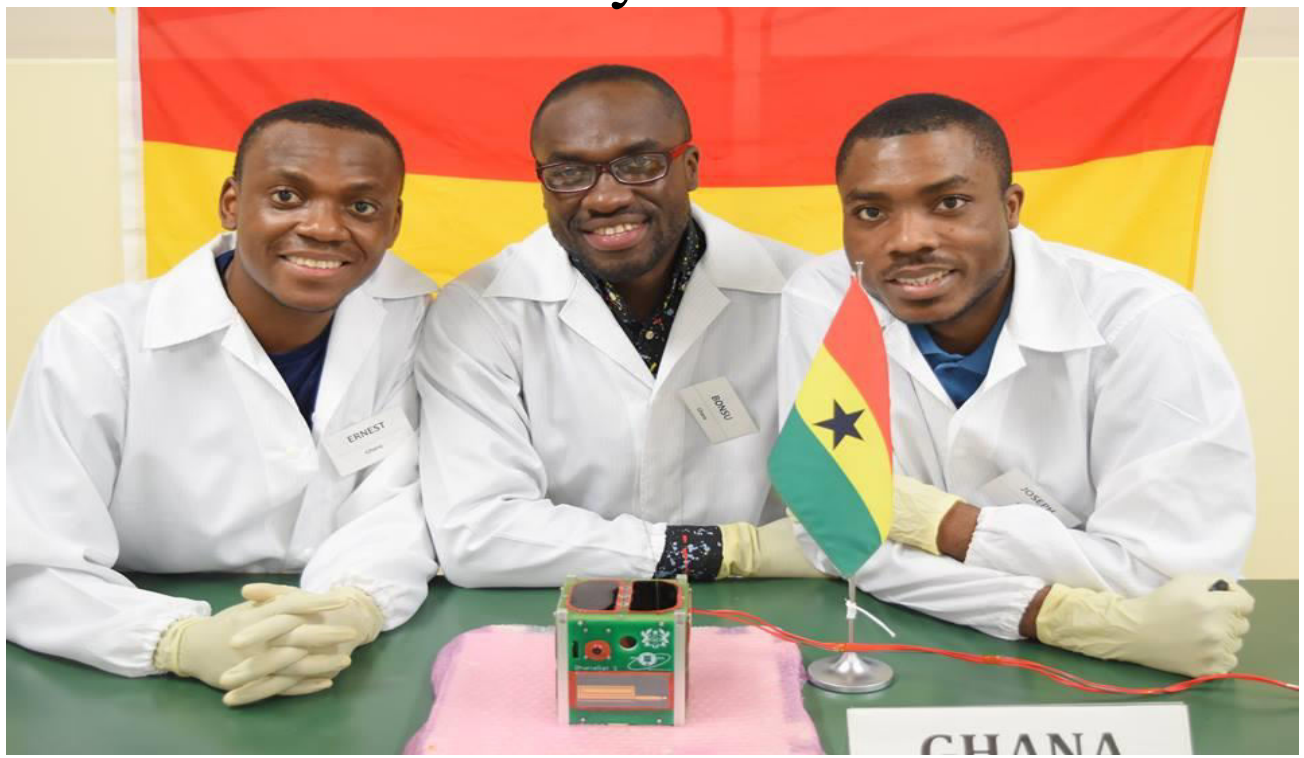
Werner Balogh

Werner Balogh
Programme Officer
Space Science and Technology

UNOOSA recognize Kyutech's capacity building achievement including BIRDS Project

GhanaSat-1 Team and BIRDS Project Team Members before satellites delivery to JAXA

- Date : 8th February 2017



Ernest Matey (Left), **Benjamin Bonsu** (Middle), **Joseph Quansah** (Right)

Birds Project Team Members

Birds Satellites Delivery at JAXA

- Date of Delivery : 9th February 2017

© JAXA

Birds Team Members

JAXA Team

© JAXA

Launch to International Space Station

- Launch : June 3, 2017 @ 5:07pm GMT
- Launch Vehicle: SpaceX Falcon-9 CRS 11
- Launch Site: Kennedy Space Center LC-39A

Ghanasat-1 team and Birds Team celebrating after a successful launch of Birds Satellites to the International Space Station

SpaceX CRS -11 Dragon docked to ISS on June 5 , 2017

Deployment of GhanaSat-1 into Orbit

- Deployment
  - Date: July 7 , 2017
  - Time: 9:05 am UTC

Dr Donkor , Founder of ANU delivers speech during JAXA press conference after Ghansat-1 Deployment into Orbit

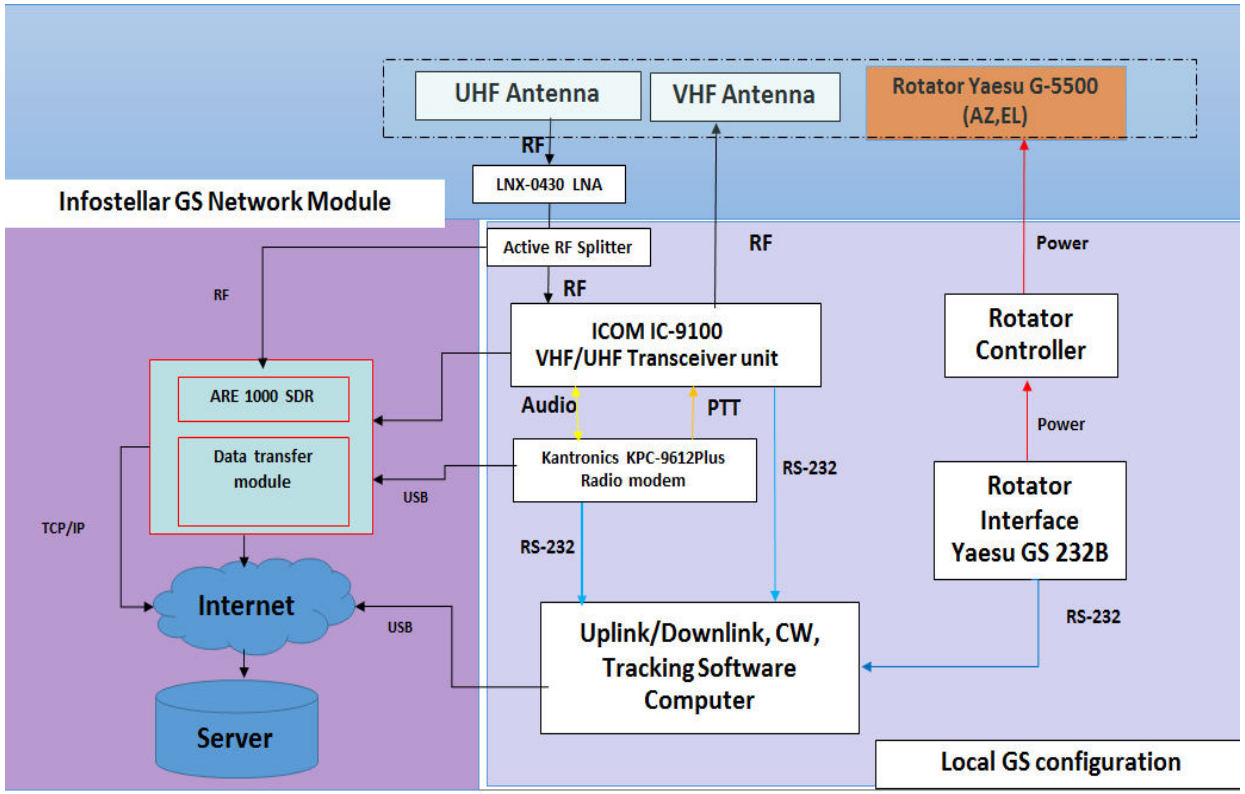
Deployment of GhanaSat-1 into Orbit via ISS /Japan Kibo Deployment System

Ghana Ambassodor, H.E Allotey Parker (in white) with JAXA president and other dignitaries at JAXA VVIP control room

Hon. Ursula Owusu , Ghana Minister of Communication congratulated the Ghanasat-1 team , Kyutech and JAXA for making Ghana recognize in the global space community

Ghanasat-1 Operational Status (Ghana Ground Station)

- GS Call Sign : 9G2AA
- Location :
  - Latitude: 6.1090 N , Longitude : 0.30210 W
- Part of Birds Ground Station Network



Ghanasat-1 Operational Status

- Reception of Beacon Signal
  - Health Status Data
- Signal Strength reception is very weak
  - Patch Antenna pointing to ground
  - Passive attitude Control
- No mission Performed

Next Action Plan

- Upgrade Ghana Ground Station
  - Add Preamps to compensate for weak signal reception
  - Replace old Ground station Antennas with Higher Gain Yagi Antennas(more than 20dBi)
  - Reduce antenna coaxial cable length
    - Distance from rooftop to control room is more than 100 meters
    - Or better relocate the GS antenna location near to the GS control room (less than 90 meter cable length is preferable)

GhanaSat-1 signal reception decoded by Software Define Radio Interface

GhanaSat-1 signal QSL card

Publications of Ghanasat-1

More than 70 articles has been published about Ghanasat-1 in both local and international media

Future Plans

Registration of GhanaSat-1 under United Nations Register of Objects Launched into Outer Space

Dr Samuel Donkor (Founder of ANU) met with Dr Werner Balogh ,UNOOSA to discuss about registration of Ghanasat-1 and other matter at the control room of Laboratory of Spacecraft Environment Interaction Engineering (LaSEINE) ,Kyutech. in January 25 ,2017

Proposal draft

ACT

Authorization of Space Activities and the Establishment of Ghana Space Registry

(Ghana Outer Space Act 2017)

Proposal draft was reviewed by Dr Werner Balogh (middle) and Dr Pauline Faure (second from right) and Ghanasat-1 team in 27th February 2017

Future Plans

- **2017- 2019_Establish sustainable International and Regional Cooperation for space activities**
  - Establish Ghana Space Agency
  - Sign and Ratify United Nations five Outer Space Treaties
  - Active Participants in UN-COPOUS meetings, and many more
  - Establishment of Ghana Outer Space Act
  - Ghana Space Policy Act

Proposals to the government

- **2018 - 2020_ Run Accredited Bachelor Degree Space Program**
  - **Opportunities for private universities to run space programs in Ghana**
- **2018-2021_ Ghanasat-2, 3U Cubesat**
  - **Mission :**Monitor illegal mining and Detect Water Pollution activities in Ghana
- **2018 – 2024_Assembly , Integration and Testing Facilities**
  - Vibration Shaker
  - Thermal Vacuum Chamber (Up to 3U Cubesat)
  - Anechoic Chamber
  - Clean Room
- **2019-2020_Augmentation of Ground Station**
  - S-band Ground station

Future Plans

❖**2019 - 2028_Human Capacity Development Program**

- Establish Space Research Clubs in High Schools across the 275 constituencies in Ghana
- Establish Ghana Amateur Radio Station Network
- Regional and National Competition of Launching and Deployment of CANSAT
  - High Schools , Colleges and Tetiary Institutions
  - International Collaboration
- Space Meseum
- Workshops and Conferences
- Outreach Programs

Future Building of All Nations University Space Science and Technology Laboratory (ANU-SSTL)

To be commenced in the year 2019

Conclusion

- GhanaSat-1 is the first Ghana satellite launched into orbit

- The successful launch and deployment of the GhanSat-1 is a huge technological demonstration breakthrough for Ghana as a nation after 60 years of her independence

SUPPORT

ANU future plans seek support through international cooperation to strengthen the human capacity building towards the indigenous space program in Ghana and Africa as a whole.

Recommendation

- The vision of **Birds Project** should be supported by UNOOSA and other Organization to continue its effort in building human capacity especially for non – space faring nations in the peaceful use of outer space for the benefit of humankind.

Appreciation

- All Nations University Management Board
- Birds Project Team Members and Management
- UNOOSA
- ANU – SSTL Staff and Directors
- Kyutech
- Birds Network

United Nations
Office for Outer Space Affairs

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BIRDS PROJECT

Kyutech
Kyushu Institute of Technology

Thank you for your Attention