UNISEC-Global The 29th Virtual Meeting

January 21, 2023, 22:00-24:00
(Standard Japan time GMT +9)

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Japan

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1. Opening Remarks

George Maeda, UNISEC-Global

George Maeda graduated from the University of Maryland in 1981, with a BS degree in electrical engineering. He then received a master's degree in the same field from Cornell University in 1982. George has worked in AT&T Bell Laboratories, Panasonic and Kyushu University. At Kyushu Institute of Technology, he worked with Prof. Mengu Cho to bring the multi award-winning BIRDS program to over 15 countries helping to launch their first satellites for at least half of those nations. Currently, he works for a space startup ArkEdge Space as a business developer and is one of the regional coordinators for UNISEC-Global.

Pictured: Maeda-sensei gives the opening remarks for 29th UNISEC-Global

Highlights:

- Overview of 29th UNISEC-Global Virtual Meeting, also first virtual meeting of 2023
- First speaker is the chairperson of UNISEC, Dr. Toshinori Kuwahara who is an Assc. Prof at Tohoku
- Prof. Kentaro Kitamura of Kyushu Institute of Technology who is the Director of LaSEINE
- Dr. Shuji Abe from Kyushu University and represents i-SPES
- Prof. Iku Shinohara from JAXA representing Institute of Space and Astronautical Science
- Dr. Necmi Orger from Kyushu Institute of Technology who was the project manager for 6U KITSUNE
- Prof. Mengu Cho from Kyushu Institute of Technology talking about BIRDS-X competition
- Total of five speakers talking about space weather and one speaker talking about competition
- Full details of the slides and presentations can be found:
    - Details: http://www.unisec-global.org/virtual-meeting.html
    - Full poster: http://www.unisec-global.org/pdf/virtual-meeting/2023/29th/29th_Virtual_UNISEC-Global_Meeting.pdf

2. Speech on “New Year Greeting Speech”

Toshinori Kuwahara, Tohoku University

Toshinori Kuwahara received his M.S. degree from Kyushu University, Japan in 2005 and PhD degree from the University of Stuttgart, Germany in 2009. He served as a Research Associate of the University of Stuttgart from 2009 to 2010. From 2010 to 2015, he was appointed as Assistant Professor, and since 2015, he is an Associate Professor in the Department of Aerospace Engineering, Tohoku University, Japan. His research topics include space development, utilization, and exploration of small spacecraft technologies. He is a member of JSASS since 2010. Currently, Dr. Kuwahara is the chairperson of UNISEC-Japan.

Pictured: Dr. Kuwahara gives the opening speech through his greetings of the new year

Highlights:

- Joined UNISEC in 2002 and is now the chairperson of UNISEC
- 20 years celebration this year, world's first two satellites were UNISEC CubeSats (XI-IV and CUTE-1)
- UNISEC-Global established in 2013
    - Vision 2030, by end of 2030, all university students can participate in space projects
- Projects include Hands-on training (CLTP), Practical Implmentation (UNISEC-Academy) and Academic Research and Advancements (MIC, Frequency allocation support, Lessons learnt group)
- Rocket and Satellite working groups are becoming commercial programs
- HEPTASat is occurring worldwide, including annual CLTP
- Pre-Mission Idea Contest recently held in Turkey, MIC will be held this year
- UNISEC-Academy is available in Japanese (http://unisec.jp/service/lecture), lecture series
- **More than 70 nano and micro satellites developed in the past 20 years**
- 6U EQUULEUS deep space missions, the development from 1U to deep space missions
- Vision 2030-ALL has activities in training, conference, debris program and global support projects
- UNISEC has been developing opportunities and cooperation between members for space technology
- UNISEC improved micro and nano satellite technologies bringing business development in NewSpace
- UNISEC promotes practical and rapid space development, utilization, and exploration

3. Presentation on "Brief Introduction on Importance of Space Weather Research with CubeSat"

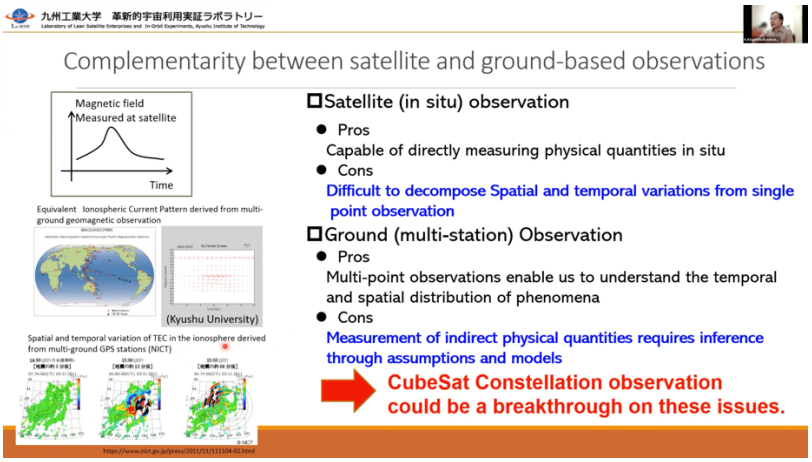
Kentaro Kitamura, Kyushu Institute of Technology

Prof. Kentaro Kitamura completed his PhD degree from Kyushu University in 2001. He worked at Tokuyama College of Technology at the Department of Mechanical and Electrical Engineering. Prof. Kitamura joined Kyutech in 2020 as a full Professor and is currently working at Kyutech's Labaratory of Lean Satellite Enterprises and In-Orbit Experiments (LaSEINE).

Pictured: Prof. Kitamura providing insights into how CubeSats can be used for space weather

Highlights:

- Space weather is the electromagnetic environment of space caused by solar activities
- Issues include charging, single event latch up, GNSS error, power grid blackout and aircraft exposure
- Fundamental science through Solar Terrestrial Physics (how is it transported, coupled, accelerated)
- **Accurate forecast of space weather forecasting which will be more important in near future**
- ARASE (ERG) satellite (2017-) has 9 kinds of satellites to measure plasma, electric and magnetic field
- CubeSats can be useful to measure spatial and temporal weather variations by launching constellation
- Ground based (ex-situ) and space based (in-situ) are complimentary
- Space weather missions by CubeSat in Japan
    - Yotsuba-KUlover uses COTS magnetometer for geomagnetic observation
    - BIRDS-5/PINO uses miniaturization of high energy electron measuring instrument
    - KITSUNE/SPATIUM uses new approach for Ionospheric TEC observation



Pictured: Prof. Kitamura mentions that CubeSat constellation is the breakthrough needed for space weather monitoring

4. Presentation on "Geomagnetic Observation by Yotsuba-KUlover"

Shiju Abe, Kyushu University

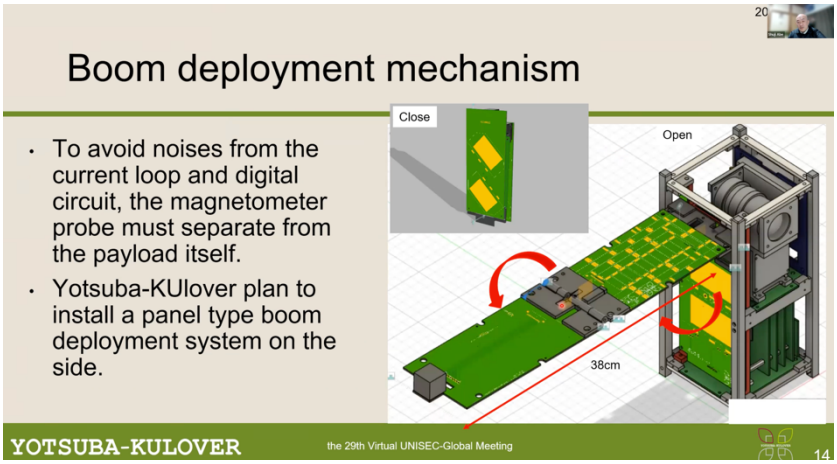
Dr. Shiju Abe did his PhD from Department of Earth and Planetary Sciences, Kyushu University in 2005. Since 2012, he has been working as a researcher at International Center for Space Weather Science and Education, Kyushu University. His research is primarily focused on geomagnetism.

Pictured: Dr. Abe highlights how CubeSats have been used for geomagnetic observation

Highlights:

- Yotsuba-KUlover is undergraduate student led satellite project from Kyutech and Kyushu University
- 2U CubeSat will measure magnetic field, satellite charging, will take aurora images, boom deployment
- Kickoff on Nov 2021, CDR is planned on April 2023 and delivery to JAXA in March 2024
- Magnetic field measurement is an important aspect to understand geomagnetic dynamism

- CubeSat is posed to measure Geomagnetic storm, Inter-Hemispheric Field-Aligned Current (IHFAC)
- Minimum success is to acquire minute averaged magnetic field data
- Full success is to analyze the 1-munute magnetic field data and determine period of interesting changes
- **High quality science with low-cost systems** (human resource and satellite)
- Device using SpacemagLite manufactured by Bartington Instrument with plus/minus 60uT
- Boom deployment mechanism which extends by 38cm
- The development time is 18 months and will be released from ISS in FY2024
- Engineering Model is being built, and Flight Model will be built from April 2024



Pictured: Boom deployment mechanism of 2U CubeSat Yotsuba-KUlover which extends by 38cm

5. Presentation on "High-energy Electron Observation by PINO/BIRDS-5"

Iku Shinohara, Japan Aerospace Exploration Agency

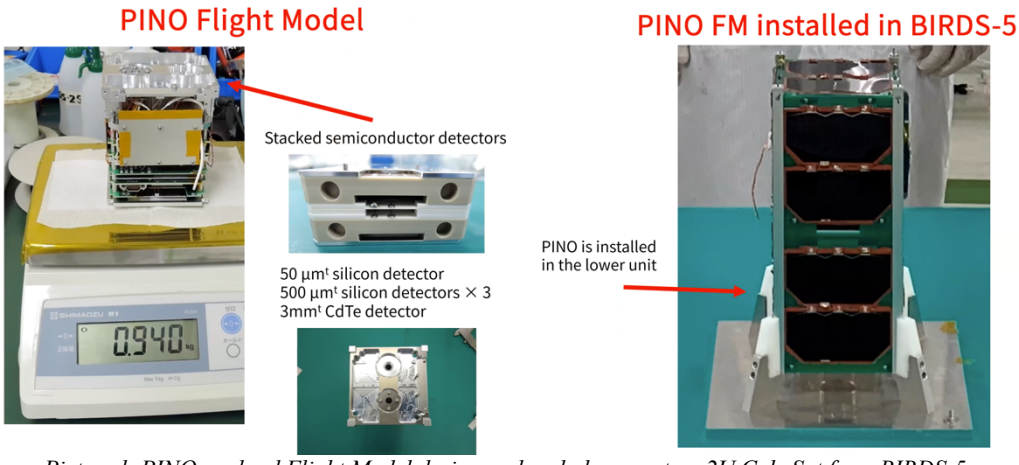
Prof. Iku Shinohara is an academic researcher from Japan Aerospace Exploration Agency (JAXA) who did his PhD from University of Tokyo in March 1997. Prof. Shinohara's interest is in space plasma physics and numerical simulations. He received the SGEPSS Obayashi Award in 2022 for his contribution to space sciences. Prof. Shinohara currently works at JAXA's Institute of Space and Astronautical Science (ISAS) and developed JAXA/ISAS payload for BIRDS-5 called PINO

Pictured: Prof. Shinohara providing information about PINO payload on BIRDS-5 satellite

Highlights:

- CubeSats allow future in-situ multi-point observation of space environment
- Miniaturized payload for measuring high-electron particle using PINO instrument
- BIRDS-5 allowed integration and space environment testing of the PINO payload
- 10 MeV around earth's magnetic field was measured at some points, need to measure more
- Radiation belt is extremely dynamic, focus on when, how and where the high electrons appear

- Wave-particle interactions in space greatly contribute to the radiation belt's dynamic variation
- High electron particles trapped in geomagnetic field and is sometimes scattered/precipitated
- These **scattered electrons are to be measured by PINO**
- The precipitation of outer radiation belt's electrons is thought to be important loss process
- Observations of higher energy electrons above 100 keV at LEO are less common
- Lack of information on High energy electrons >4 MeV and simultaneous multi-point measurement
- PINO's mission to improve info on the high energy electrons for future multipoint-measurement
- PINO's objective is to demonstrate a compact high-energy electron detector using Si/CdTe semi
- PINO has heritage from high-energy electron detector (PARM/HEP) onboard sounding rocket
- PINO's power consumption reduced to 5W from 6.7W weighing less than 1kg
- Only 5-minute observation in target area only, that allows duty cycle to be reduced
- PINO's Flight Model functional tests shows that all the tests on the ground was successful
- Awaiting results from BIRDS-5, currently the satellites are not functional in orbit



Pictured: PINO payload Flight Model design and and placement on 2U CubeSat from BIRDS-5

6. Presentation on "Technology Demonstration Mission of SPATIUM-II Towards Ionospheric TEC Mission Measurement"

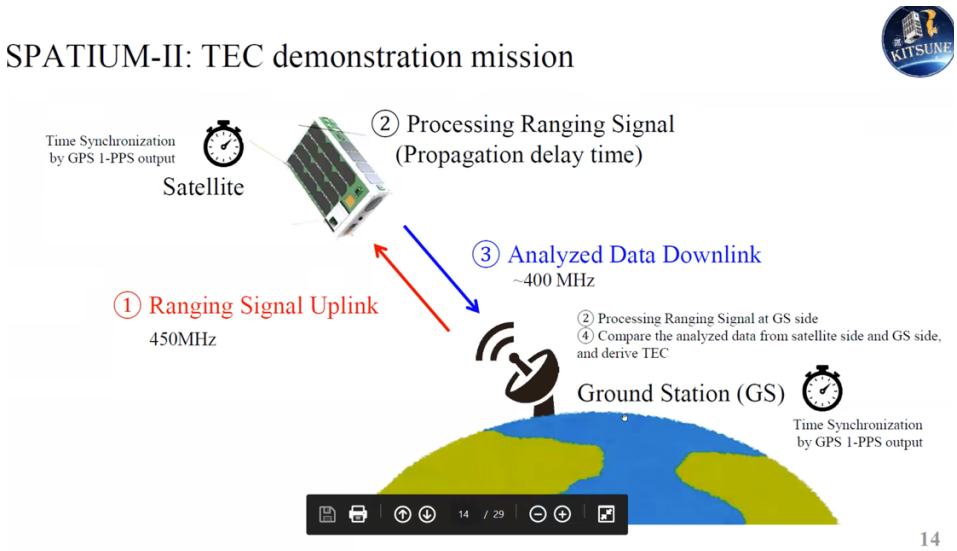
Necmi Cihan Orger, Kyushu Institute of Technology

Dr. Necmi Cihan Orger is an Assistant Professor in Laboratory of Lean Satellite Enterprises and In-Orbit Experiments (LeSEINE) at Kyushu Institute of Technology (Kyutech). He did his PhD at Kyutech before he started working there. His main research area focuses on understanding electrostatic dust lofting on the lunar surface. Additionally, he works on small satellite R&D in order to perform future lunar missions using CubeSats. Currently, he is the project manager of Kyutech's 6U KITSUNE satellite. KITSUNE was launched in 2021 in LEO and is operational.

Pictured: Dr. Orger sheds light on KITSUNE's SPATIUM-II tech demonstration mission

Highlights:

- Two satellite in one structure, amateur and non-amatuer radio (SPATIUM) satellites
- KITSUNE developed in collaboration with international academic institutions and private sectors
- **Kyutech** standardized bus, **Imaging Technology System**, **Utilization** of **Networking** and **Electron** content measurments (KITSUNE), electron content measurement is SPATIUM part
- Space Precise Atomic Timing Utility Mission (SPATIUM) between NTU and Kyutech
- SPATIUM's eventual goal is to do 3D mapping of ionosphere
- SPATIUM-I conducted Chip Scale Atomic Clock (CSAC) mission successfully
- SPATIUM-II conducts onboard processing, TEC, CSAC on orbit performance
- Estimate TEC values from time delay at the ground station side (1 MHz for tech demonstration)
- Time synchronization done by GPS 1-PPS output both in satellite and ground
- TEC uses Raspberry Pi Compute Module 3+ for computation and LimeSDR mini
- GNURadio linux used on the LimeSDR mini
- GNSS 1-PPS has 50-100ns erorr, digital transistor has 100-120ns error and RF switch 5-10ns error
- Signal is cut for 800ns, time stamp is used during signal cut
- Onboard results include:
    - SDR received and demodulation done correctly
    - Gold code sequence for every 4ms is demonstrated
    - 1-PPS output data received, currently checking for accuracty
    - Preparing CSAC monitoring system
- Hardware sampling frequency was limited to 1MHz but using GNU radio, RPi CM3+ was good
- 300MHz sampling required for better accuracy
- GPS receiver should be improved
- Algorithm can improve significantly as well



Pictured: SPATIUM-II's TEC demonstration mission visualized

7. Q&A Session

All Speakers

Highlights:

What is the basic concept of space weather?
Prof. Kitamura: Space weather is the electromagnetic disturbance in space. The concept of space weather is part of natural science that affect human infrastructure like satellites and ground systems. We need to monitor by using satellite as well as ground observations.

Monitoring solar flare?
Prof. Kitamura: Not only solar flare but monitoring magnetosphere, plasma and electromagnetic environment as well as solar wind.

For Spatium utilizing 1-PPS, is there a periodic variation in the signal? Usually due to 1-PPS, the construction might shift register or similar issue?
Dr. Necmi: There is one statistical thing that we made for this detection, because of the RF switch sometimes the amplitude does not directly goes to zero and can create some errors. We are developing this part to improve. What we are doing is testing in space, its behavior, we tried to detect deviation but also we downlink the RF signal itself around these points so that we can look at the data to detect it correctly or not.

(Comment) Steven Knudsen: I would like to respond, since it's my question. I did a lot of timing work, especially with GPS. There is a long-term shift in the accuracy of the signal. You may be doing in a differential fashion which may not matter if you are just looking at instantaneous differences. If you really take good time source and plot 1-PPS time respect to it, over the time of the day, you will get quite a saw tooth in terms of error deviation. And that's a cyclical thing due to reconstruction done by typical receivers. So maybe it might be of interest but maybe if you are interested, I will put my email in the chat and I can send you a presentation that explains much better than I can right now.

(Response) Dr. Necmi: One thing that we were comparing it with Chip Scale Atomic Clock (CSAC) output because it also has 1-PPS output and when we look at on-orbit results, daily accumulated error is like 0.1us. We also look at the comparison between the output of two 1-PPS; one is coming from the GPS and another from the CSAC. And we try to monitor this output difference. Very c

(Comment) Steven Knudsen: There-in lies the problem because CSAC computes the signal very differently than GPS. The rise time of 1-PPS should be in order of 15ns that's well under your current accuracy that's why you probably won't see this error. But if you improve your technique and get under that .10us that's when the error will probably come in. If you are interested, I will be very happy to provide that for you through email.

(Response) Dr. Necmi: Yes, we are. Thank you.

8. Announcement of "BIRDS-X APRS Mission Competition"

Mengu Cho, Kyushu Institute of Technology

Mengu Cho received the B.S. and M.S. degrees from the University of Tokyo and the Ph.D. degree from Massachusetts Institute of Technology, in 1992. After working at Kobe University and International Space University, he joined Kyushu Institute of Technology (Kyutech) in 1996. Since 2004, He has been a Professor. Currently, he is the director of Laboratory of Lean Satellite Enterprises and In-Orbit Experiments. His research interests include spacecraft environmental interaction and satellite systems. He has supervised 11 university satellite projects, among which 9 projects, 16 satellites, were already launched. In 2019, he received Frank J. Malina Astronautics Medal from International Astronautical Federation.

Pictured: Prof. Mengu Cho provides information about the BIRDS-X competition

Highlights:

- BIRDS project has 1,2,3,4,5 and now next project is BIRDS-X (2U) expected to be launch 2024
- Bring in diversity to the space sector and democratize the usage of space
- Promotion of the satellite usage and Amateur Radio Community
- Amateur Radio Digital Communication (ARDC) is the stakeholder for BIRDS-X
- Automatic Packet Reporting System (APRS) uses amateur radio through UHF/VHF and is relayed
- Can be any data through packets
- AFSK modulation with AX.25 protocol with 1200bps at VHF
- UHF is telemetry and VHF is for APRS
- APRS competition through competition for 5/6 slots, can apply if you have amateur radio license
- APRS ground station (ground terminal) and board has to be designed by competing teams
- Two competitions: APRS Payload (APRS-P) and APRS ground terminal (APRS-G) competition
- Electrical and mechanical ICD will be distributed
- Phase I, selection of 10 teams in Phase II and Phase III needs hardware, selection of five teams
- Phase I will be open until end of Feb 2023, no need to create hardware for now
- For APRS-G, anyone can build ground station and uplink
- All information here: https://birds-x.birds-project.com

Q&A

What is the last date to have the amateur radio license?
Prof. Cho: Before you emit radio, that is Phase II (before 5th May). If you do not have amateur radio, then you will be disqualified.

9. Announcement and Acknowledgement

Rei Kawashima, UNISEC-Global

- **MIC 8 Overview**
  - Theme: "Missions by multiple nano-satellites"
  - Constellation mission or formation flying, constellation should be 6U or smaller
  - Clear benefits of having each satellite
  - Abstract submission due: **June 30, 2023**
  - Notification: August 8, 2023
  - Full Paper submission due: October 3, 2023
  - Final presentation: TBD (Nov or Dec, 2023, in Japan) at 9th UNISEC-Global Meeting
  - Full information: http://www.spacemic.net
  - Can also conduct national/regional competition to improve the quality of the MIC

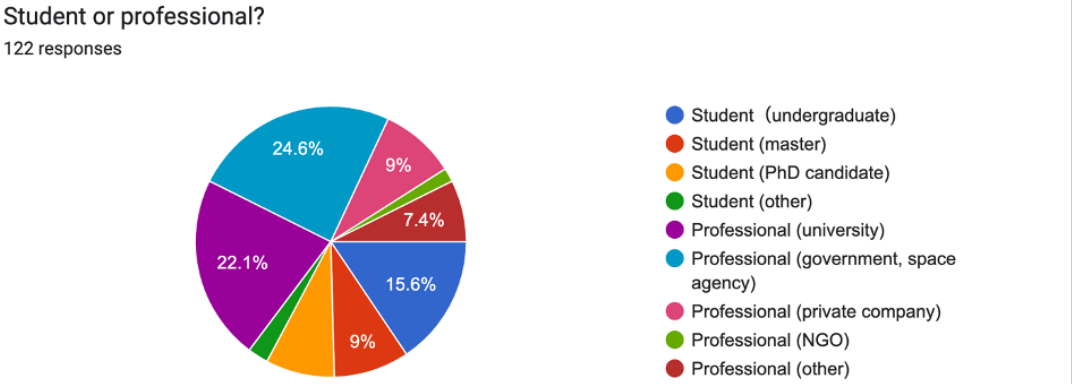
- **J-CUBE Launch Opportunity**
  - Special (discounted) launch opportunity for 1U-3U CubeSats
  - Need to collaborate with UNISEC-Japan's university
  - Full information: http://unisec.jp/serviceen/j-cube

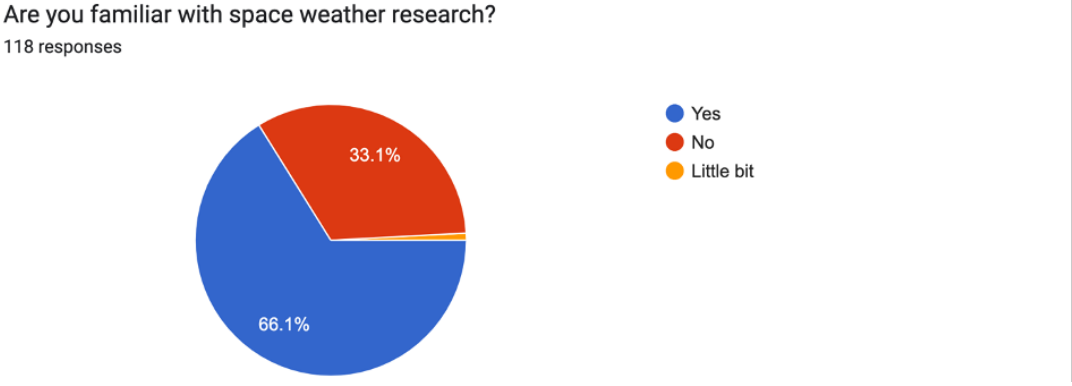
- **30th Virtual Meeting**
  - Date: February 18, 2023 10:00 pm – 0:00 am (JST)
  - Theme: TBC
  - Program: TBC
  - Host: UNISEC-Colombia
  - Virtual UNISEC-Global Meetings takes place third Saturday of almost every month of 2023
  - Seeking local chapters for March 18, April 15, May 20, ..

10. Participant Statistics

122 registered participants from **34** countries and regions for the 29th Virtual UNISEC-Global Meeting.

Country/Region	Number of registrations	Country/Region	Number of registrations
Algeria	2	Oman	1
Argentina	2	Pakistan	2
Australia	1	Paraguay	1
Austria	1	Peru	5
Bangladesh	2	Philippines	11
Bulgaria	3	Romania	1
Canada	4	Singapore	1
Egypt	13	South Africa	2
Germany	3	Sudan	1
India	2	Taiwan	2
Indonesia	1	Thailand	4
Japan	34	Turkey	3
Kazakhstan	3	Uganda	2
Kenya	4	United Kingdom	3
Mexico	2	USA	2
Mongolia	1	Vietnam	1
Nepal	1	Zimbabwe	1



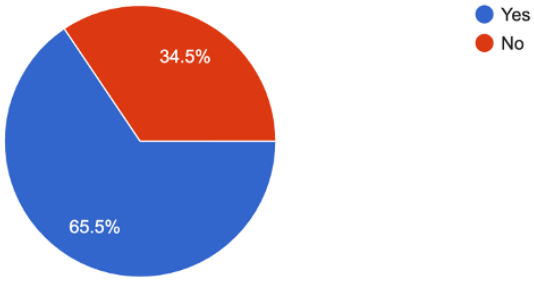


Do you think nano-satellites can contribute to space weather research?

120 responses

Have you participated in the UNISEC-Global Meeting previously?

119 responses



Thank you