UNISEC-Global The 31st Virtual Meeting

March 18, 2023, 22:00-24:00
(Standard Japan time GMT +9)

The following report was prepared by UNISEC-Global Secretariat
March 18, 2023
Japan

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1. Opening Remarks

Garvey Mcintosh, NASA

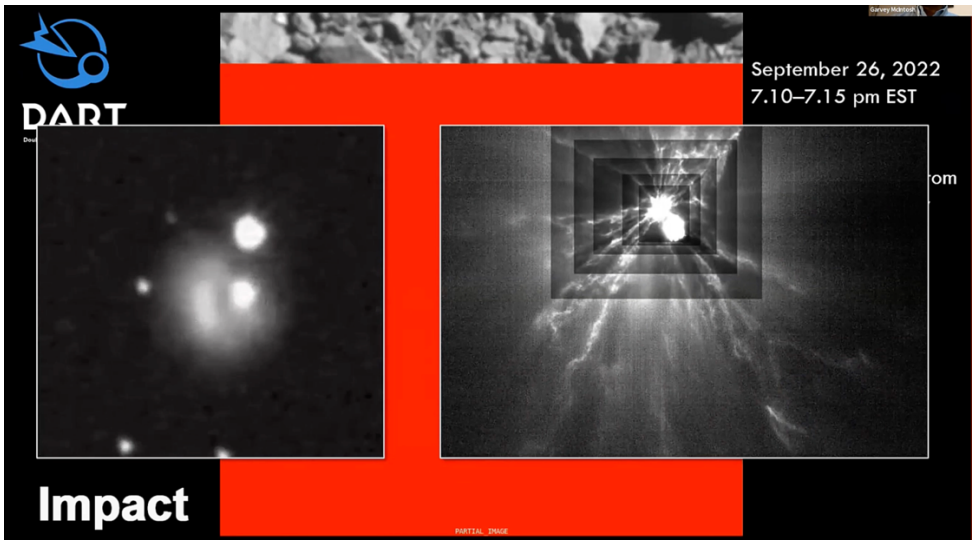
Garvey McIntosh is currently the NASA Attaché based at the U.S. Embassy in Tokyo. He is responsible for the coordination of NASA's programs with Japan and other countries in the Asia Pacific Region. Since joining NASA in the Office of International and Interagency Relations (OIIR) over 15 years ago, he has supported international cooperation on the Space Shuttle and the International Space Station, high-energy physics and astronomy, and collaboration with India on the Chandrayaan-1 lunar mission. He also played a major role in the formation and work of the 26-member nation International Forum for Aviation Research (IFAR). Garvey has served as the OIIR Europe Team lead and lead for India, France, and the U.K. He also served as the Executive Officer to the former NASA Deputy Administrator Lori Garver. Prior to joining NASA, Garvey studied economic policy and language in Vietnam as a distinguished Boren Fellow, and spent 4 years in Nagasaki, Japan, where he taught English. He received his graduate degree from the Monterey Institute of International Studies in California and his undergraduate degree from Northeastern University in Massachusetts.

Pictured: Garvey giving his opening remarks focusing on NASA's DART Mission

<u>Highlights:</u>

- Administrator for NASA is Bill Nelson
- 10 NASA Centers spread across the USA
    - Ames Research Center, San Jose, CA
    - Jet Propulsion Laboratory, Pasadena, CA
    - Johnson Space Center, Houston, TX
    - Stennis Space Center, Bay Saint Luis, MS
    - Kennedy Space Center, Merrit Island, FL
    - Marshal Space Flight Center, Huntsville, AL
    - Langley Research Center, Hampton, CA
    - NASA Headquarters, Washington, DC (McIntosh is based here)
    - Goddard Space Flight Center, Greenbelt, MD
    - Glen Research Center, Cleveland, OH
- Four main research:
    - Aeronautics Research Mission Directorate (how NASA actually began)
    - Human Exploration and Operations Mission Directorate (largest)
    - Science Mission Directorate (second largest), presentation focus
        - Earth science, space science, helio-physics and planetary science
    - Space Technology Mission Directorate (most recent)

- DART mission is NASA's technology demonstration mission for Kinetic Impact Tech
- Double Asteroid Redirection Test (DART) targeted at binary "Dimorphis" and "Didymos"
- Launched on November 2021 and intentionally crashed on asteroid in September 2022
- Live feed showed that DART mission was successful, crashed into asteroid "Dimorphis"
- Low cost with 325 million USD
- Idea is to defend earth from asteroids by deflecting it using Kinetic Impact Technology
- Live impact feed from Sep 26, 2022: https://www.youtube.com/watch?v=-6Z1E0mW2ag
- LICIACube (developed by Italians) was used to provide feed of the impact
- DRACO camera onboard DART took over 250,000 images for study
- World's first demonstration of such technology, was successful
- Asteroid impact on earth has occurred multiple times in Earth's history
- Scientists believe that asteroid crash wiped out the dinosaur population
- Space Agency like NASA can use Kinetic Impact Tech to deflect asteroid and save earth
- ATLAS: asteroid impact early warning system by Uni of Hawaii with NASA funding
- Cutting edge technology with self-path correction used by DART
- HERA by ESA will examine the impact of DART on the binary asteroid system by 2026
- Such follow up missions through international cooperation is important
- Primarily developed by Johns Hopkins University Applied Physics Laboratory



Pictured: Livestream of the impact by DART on the binary asteroid system

2. Presentation on “Near Earth Object Research and Planetary Defense Activities”

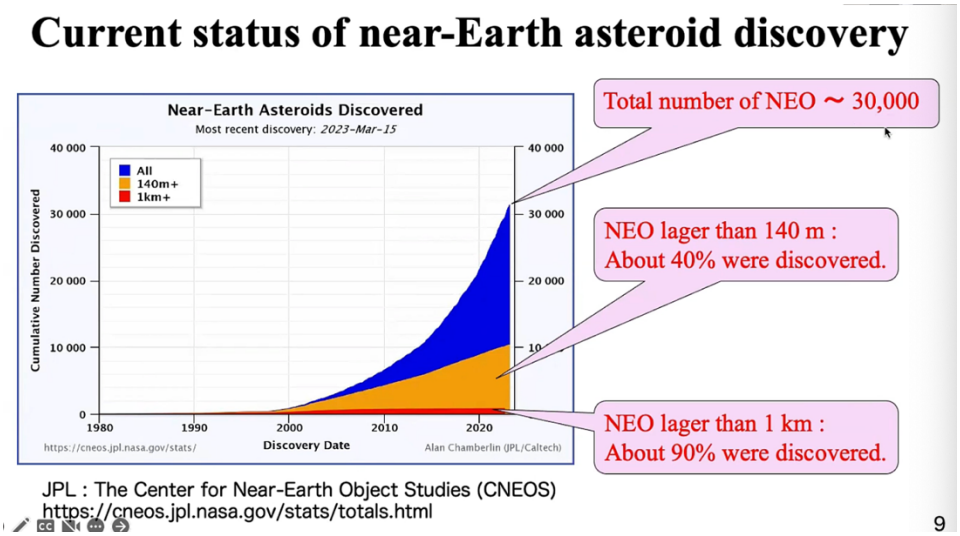
Makoto Yoshikawa, JAXA

Prof. Makoto Yoshikawa was born February 6 1962. He is a Japanese scientist, most notable for being project manager and later mission manager of Hayabusa2, an asteroid sample-return mission operated by the Japanese space agency, JAXA. In 2018 Prof. Yoshikawa was recognized in Nature's 10, a list of "people who mattered" in science by the journal Nature. His research specializes in celestial mechanics, particularly in orbital analysis of small Solar System bodies such as asteroids and comets. After completing his PhD, Prof. Yoshikawa worked as a researcher at the Japan Society for the Protection of Science and then from 1991 was senior researcher at the then Communications Research Laboratory of the Ministry of Posts and Telecommunications. He joined the Institute of Space and Astronautical Science in 1998, which since 2003 has been part of the JAXA. As part of the orbital determination group at ISAS, he was involved with the Hayabusa and Akatsuki missions.

Pictured: Prof. Yoshikawa stressing the importance of planetary defense for future of humanity

Highlights:

- 2304 potentially hazardous asteroids (PHAs) discovered as of Nov 2022
- US Decadal Survey recommended DART mission by 2023
- NEO surveyor by 2026 and rapid response fly by mission by end of 2032
- Rapid response mission is extremely important for planetary defense
- First necessity is to understand characteristics of potentially dangerous asteroids
- Second necessity is to explore interstellar objects, such objects
- Interstellar object first discovered flying from outside solar system on Oct 19, 2017
- Rapid response exploration scenarios
    - Direct launch: launch spacecraft just after target object is found
        - Rocket must be ready at any time, launch vehicle must be ready
        - Micro satellites can work
    - Lagrange Point Loitering: keep at halo and aim at object after discovery
        - Large acceleration required, medium size spacecraft is fine
    - Earth Resonant Flyby: Keep at flyby orbit and target with gravity assist
        - More than 10 probes necessary
        - Micro satellites can work
- Asteroid Flyby Circular Orbits, possible to fly one NEO with delta-V 10m/s per year
- Alternating between asteroid flyby and earth swing by
- JAXA's Deep Space Exploration Technology Demonstrator DESTINY+
- DESTINY+ earth-centered, sun-earth fixed rotating frame
- Phaethon Flyby on 2028 January 03, 2005 UD Flyby on 2028 November 11
- DESTINY has more than 154 candidate asteroids with no operational constraints
- Two types of new small body exploration strategy by ISAS
- Flyby mission which is one off but can access multiple bodies
- Rendezvous-type which collects sample from return mission, detailed exploration
- Explorative DESTINY+ is multiple flyby, detailed Hayabusa 2 is sample return
- Multiple asteroid flyby exploration using deep space constellation
    - CubeSats can be used, one asteroid flyby/month for a 12-spacecraft config
    - Orbit correction by earth's gravity assist for rapid response exploration
- Conceptual study on spacecraft system
    - Science payload of 3-8 kg, perhaps feasible using 12U CubeSat
    - Propulsion system capable of min 10m/s delta-V needed
    - Autonomous orbit determination and operation tech, build constellation of 10
    - Communication of 0.5 au distance from earth, deep space communication
- Deep Space Constellation Importance
    - Protects the earth through planetary defense
    - Continuous technology demonstration by pushing limits of deep space tech
    - Planetary science exploration of interstellar objects, multiple flybys of asteroid
    - World's first direct exploration of interstellar object and/or long period comet
- Work together to achieve technically difficult work of protecting asteroid impact



Pictured: Current database of Near Earth Objects (NEO)

3. Presentation on "Nano-Micro Satellite's Contribution to Planetary Defense"

Naoya Ozaki, JAXA

Prof. Naoya Ozaki works at Institute of Space Astronautical Science, JAXA. He received his Ph.D. in 2018 in aerospace engineering from the University of Tokyo, working on trajectory optimization under uncertainties. His current research interests include trajectory design of spacecraft, robust optimal control theory, and small spacecraft. Prof. Ozaki is currently working on JAXA's DESTINY+ and MMX missions as a mission analysis expert. He was also the winner of the Young Researcher Award in the Conference on Space Science and Technology of the Japan Society for Aeronautical and Space Science in the 60th Space Sciences and Technology Conference.

Pictured: Prof. Ozaki outlining some of the work to study NEO by small spacecrafts

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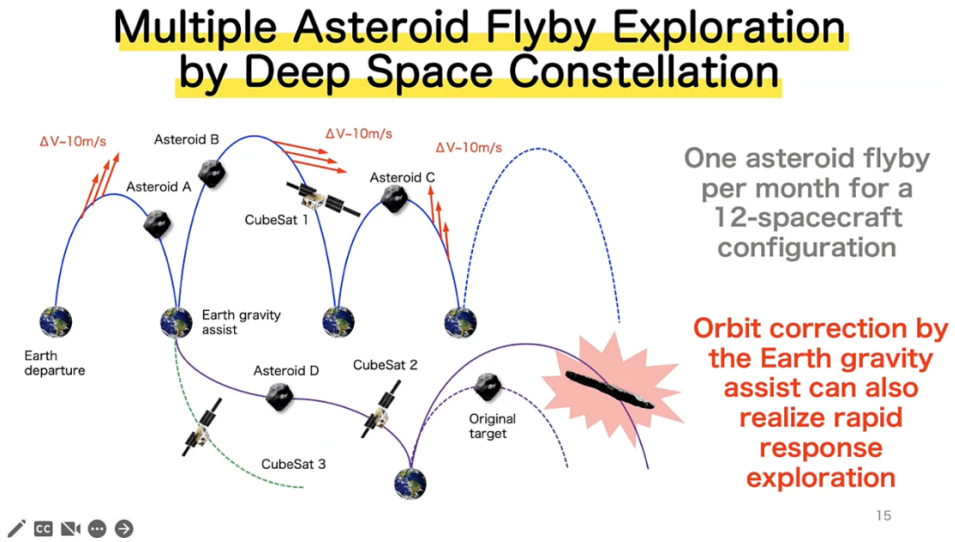


Pictured: Prof. Ozaki explains how deep space constelations can study an asteroid per month

4. Q&A Session

Moderator: Nate Taylor

Nate: **You mentioned that for anyone to handle this in the future, is that we need more international collaboration and laws for this to take place. What do you think is needed, and how can this be addressed in that platform?**

Prof. Yoshikawa: This is difficult, of course we need international collaboration but for example, if some country tried to mitigate a colliding asteroid and is successful, it is no problem. But if it failed, and the asteroid collides to another country, what can we do? We need to address this beforehand through international collaboration and is rather difficult. But already many people are discussing this issue.

Nate: We still have the international space laws which are outdated. We still have the moon treaty for instance, which not all countries are signatories to. Such laws prohibit mining from asteroid and even the moon and this is an issue where not everybody sees eye to eye on in terms of the commercial interest. You are right, if something goes wrong, we need to be able to handle that as well. Very very challenging, but this is also what brings us together for an internationally defined solution. Thank you very much Prof. Yoshikawa.

Rei: **Is there a chance that emerging countries can contribute to the constellation mission that you propose?**

Prof. Ozaki: Absolutely yes. I think this the good point of the concept. The size will be a CubeSat or a 50kg microsatellite, once you gain the technology to develop that micro spacecraft, nano spacecraft in the LEO mission, I think it is a good step up of doing a deep space mission. And this concept challenges to work together with people who have also attained better satellite development techniques.

Nate: You will know this from MIC7, there were some very ambitious proposals for a few flyby missions to Apophis which Yoshikawa-sensei mentioned in his presentation. Obviously with CubeSat. This is approaching NEO and is entering LEO when it is closest to the earth. Being able to demonstrate LEO technology first and then building sophistication -because this is a long-term project- would be a good one for students to get involved in.

Lawrance: **If we were to impact a NEO, perhaps would have missed earth but the impact outputs it into collision course that would have perhaps missed earth. But the impact analysis puts it in a collision course. How accurately can we know the exact trajectory of the NEO before and after the collision.**

Prof. Yoshikawa: This is a very good question, this is why DART mission tried to change the orbit. If the asteroid is very simple, and the spacecraft hits the asteroid, we can calculate the trajectory change. But the asteroid structure is complicated. When the spacecraft impacts the asteroid, there are many fragments coming out, so we don't know how much fragments come out from the asteroid. That is why DART tried to check this. Maybe we need to experiment to estimate the orbit after impact.

Nate: We also have to think with DART, this is very specific and fortunate binary asteroid. You have the smaller asteroid, it's not that much mass so you can send the small spacecraft to do these things. If you have a larger body, that would, most likely, not be binary system. The angle of approach to the body so that you don't fracture it and is smaller and is in the same trajectory, that is a different approach that you need to take. We can learn from this but we need to take this and apply it to a different set of circumstances where use it to a real thing approaching Earth. How we might use that could be different.

Nate: **You mentioned that you could use solar cells for this 50kg satellites that you are proposing. What are the propulsion system options would you have?**

Prof. Ozaki: So far I have just done the very preliminary conceptual study. I have done some basic propulsion system but we can basically use any propulsion system. DeltaV 10m/s is very small so cold gasket or some kind of advance electric propulsion. Solar sail is also fine as I mentioned but basically most of the propulsion system would be fine.

5. Announcement and Acknowledgement

Rei Kawashima, UNISEC-Global

Pictured: Kawashima-san announcing the latest updates from UNISEC

- **Internship Graduation of Rio Kawate and Sam Ndayizeye**
  - UNISEC congrats both on completing their internship at the organization

- **New Point of Contact (POC)**
  - Dr. Agfianto Eko Putra

Pictured: Dr. Putra is happy to be part of the UNISEC community

  - PhD in electronics and instrumentation from Gadjah Mada University
  - Graduated from CanSat Leadership Training Program (CLTP) in 2011

- **9th UNISEC-Global Meeting**
  - Venue: Tokyo, Japan, in-person event
  - November 27 – December 1, 2023
  - Details: to be announced
  - Same time as 8th Mission Idea Contest final presentation, will be held during meeting

- **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
    - Local competitions can be held in their own topics as well

- **J-CUBE**
    - Special discount launch opportunities for 1U-3U (almost 1/3rd discount)
    - Need to collaborate with UNISEC-Japan's university
    - Full information: http://unisec.jp/services/j-cube

- **32nd Virtual Meeting**
    - Date: April 15, 2023 22:00 – 24:00 (JST)
    - Theme: Introduction to Space Projects in Tunisia
    - Host: UNISEC-Tunisia
    - Virtual UNISEC-Global Meetings takes place third Saturday of almost every month of 2023

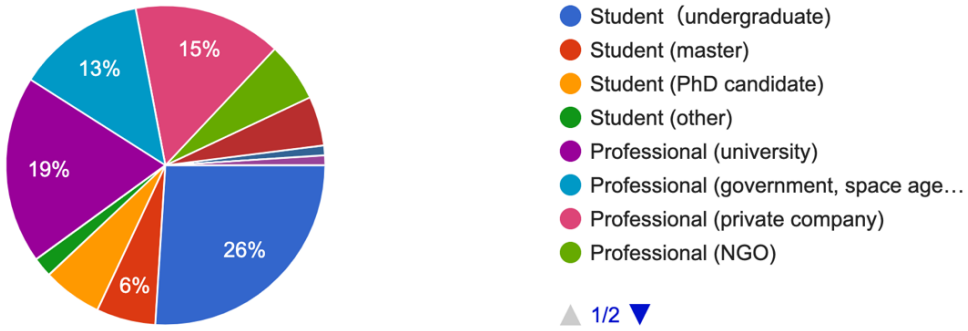
6. Participant Statistics

100 registered participants from **30** countries and regions for the 31st Virtual UNISEC-Global Meeting.

Country/Region	Number of registrations	Country/Region	Number of registrations
Argentina	1	Nepal	2
Bangladesh	6	Netherlands	1
Bulgaria	1	Pakistan	1
Canada	1	Peru	3
Colombia	2	Philippines	19
El Salvador	1	Romania	9
Ethiopia	1	Rwanda	2
France	1	Taiwan	3
Germany	2	Thailand	1
Central America.	1	Taiwan	3
India	1	Thailand	1
Indonesia	2	Tunisia	3
Japan	25	Turkey	1
Namibia	1	USA	3
Philippines	1	Zimbabwe	1

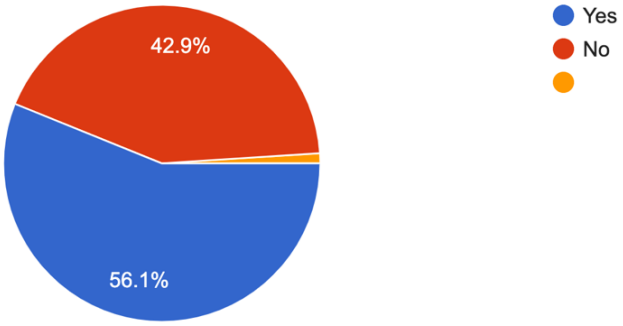
Student or professional?

100 responses



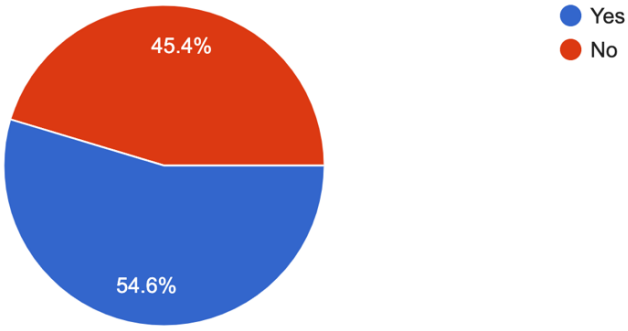
Have you participated in the UNISEC-Global Meeting previously?

98 responses



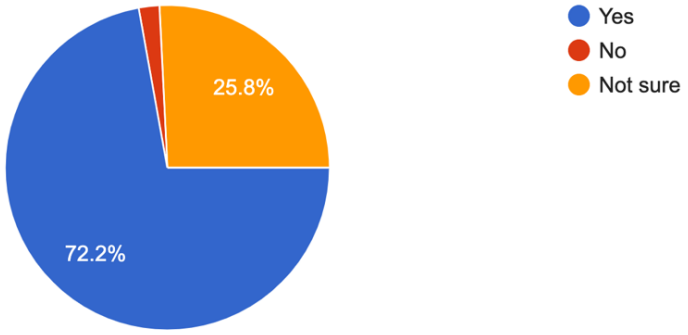
Are you familiar with "Planetary Defense"?

97 responses



Do you think nano/micro satellites can contribute to "Planetary Defense"?

97 responses



Thank you