

**Association of Space Explorers
Committee on Near-Earth Objects
Trip Report on Meetings at COPUOS, United Nations
Vienna, Austria
June 11-13, 2014**

I attended three days of meetings on the topic of planetary defense, held in conjunction with the Committee on the Peaceful Uses of Outer Space sessions at the United Nations complex in Vienna, Austria, from June 11-13. Mr. Andy Turnage effectively arranged my credentials to attend the UN and associated sessions.

The meetings consisted of one afternoon session of the Action Team 14 on Near-Earth Objects, and two day-long sessions of the Space Mission Planning Advisory Group, holding its second meeting. The SMPAG is one of the functional groups recommended by ASE to deal with planning and decision-making in anticipation of a future asteroid impact threat.

AT-14 sessions are regularly held during the winter meetings of the Science and Technical Subcommittee of COPUOS; this session was a brief tag-up to keep members informed of current NEO developments.

AT-14 was chaired by Sergio Camacho of Mexico. He provided this agenda:

Meeting(s) of the Action Team on Near Earth Objects (AT-14)

11 June 2014, on the margins of the
57th session of the Committee on the Peaceful uses of Outer Space
Room C-5 (7th floor of the C-Building)

I. Draft Agenda

1. Welcome and introductions
2. Approval of the draft agenda
3. Briefings¹ by members on recent developments in NEO related programmes
4. Briefings on progress and future work on:
 - a. The International Asteroid Warning Network
 - i. Statement of intent to participate in IAWN - to provide guidance on the operational principles of IAWN, to establish guidance by which IAWN would operate and to acknowledge the participation of each partner in IAWN;
 - ii. Preparations for a two-day workshop to be in 2014 on communication strategies regarding NEO impact hazards.
 - b. Space Mission Planning Advisory Group
 - i. Preparations for the SMPAG meeting on 12 and 13 June

¹ Note that presentations on ongoing and planned activities relevant to SMPAG are included in the draft agenda for the SMPAG meeting.

5. Preparation of the report to COPUOS
6. Any other business

The AT-14 members made several presentations on NEO-related topics, including:

- The Space Generation Advisory Council (SGAC), a group of young professionals in the space industry, continued its global space outreach efforts. They continue their efforts to participate in NASA's Asteroid Grand Challenge and have created a "move an asteroid" contest. The SGAC website contains details of these activities.
- Secure World Foundation (SWF) distributed copies of its new guide called "Near-Earth Objects: Responding to the International Challenge." The booklet is an excellent introduction to the impact hazard and is available at: [http://swfound.org/media/170684/SWF_NEOs-Responding_to_the_International_Challenge_2014.pdf]. On page 26, SWF thanks ASE for its long-term support of the effort to deal with the impact hazard.
- The Austrian Space Research Institute, a national institution, is trying to link observed meteor/fireball events with global infrasound records. The goal will be to characterize the signature of such impact events, and thus detect new impacts using infrasound records alone. Peter Brown from Canada is a good source of infrasound data from the CBTO (test ban treaty organization), and Sergio suggested that he might be a good candidate to join the IAWN (international asteroid warning network) through his institution.
- NASA's Lindley Johnson stated that data from bolides and fireballs, detected from space by USAF, are now being posted more regularly at the NEO program office at JPL. Almost 20 events are now listed.

Sergio proposed that in February 2015, the AT-14 include in its agenda:

- briefings on IAWN and SMPAG
- a summary of the Jan. 2014 Minor Planet Center meeting of the IAWN. That meeting showed the need for a public communications workshop, hosted by IAWN, to discuss how to effectively communicate NEO news to the public.
- NASA and SWF agreed to hold such a workshop, to be held in late 2014. Initial plans include dates of 9-10 Sept 14 for a workshop in Flagstaff. The conference will have a limited invitation list, and international representation. Ray Williamson and Linda Billings (NASA contractor) can field nominations.

Lindley introduced a draft of the terms of membership for IAWN. He invited comments and aims for a month of editing, then finishing it up by summer's end.

Gerhard Drolshagen of ESA summarized the plan for the ensuing SMPAG meetings, citing 4 main points:

- Finalize terms of reference, including the text on membership
- Presentations from agencies on NEO deflection missions
- Logistics for future meetings
 - Future workplan topics: e.g. future deflection criteria, and reporting to UN COPUOS

Sergio noted the content for the report to COPUOS this week from AT-14:

- NEOs are not an item for this current session
- But the report from last February's STSC IS on the agenda
- Thus NEOs will be addressed here in June, at least obliquely
- We reviewed language via committee comments
- Sergio proposed a relaxed deadline for the work of IAWN this year, without pressure of having something all ready for reporting in SCST next winter, in Feb. 2015.

SMPAG Meeting: June 12-13

The Space Mission Planning Advisory Group, chaired by ESA, met at the UN complex in Vienna on June 12-13, 2014. The SMPAG examines the requirements and technology needed for actual NEO deflection campaigns. Twenty-seven space agency representatives and independent observers attended this second full meeting of the "Same Page" -- the SMPAG.

The group discussed the terms of reference instituting the SMPAG last winter, and edited those terms for final release. The SMPAG meeting agenda and presentations are posted at:

www.cosmos.esa.int/web/smpag

Space agencies present were invited to make presentations describing their current analyses of NEO deflection missions and technologies.

The French CNES described initial results of a study of a proposed mission to Apophis in 2029. Some major points:

- Apophis still presents some impact worries later in the century...2068
- The threat depends on keyhole passage
- Should we have a spacecraft go along with it during the 2029 close approach (keyhole)?
- Mission's 1st priority is planetary defense, mitigation studies; science is 2nd
- Goals:
 - Provide mitigation mission design info
 - Internal structure characterization
 - Trajectory precision
 - Impact risk assessment, mitigation mission, reentry modeling
- Payload described: general features of Apophis, surface analysis, sub-surface analysis, sounding, long-term tracking
- Radar – tomography and regolith characterization (deep and shallow)
- The probe closes to 20-30km during the Earth close approach in 2029; no need for landing
- Launches from Korou, use SEP, 50kg prop, VIS/IR camera and radars
- 2029 is unique opportunity to fly along with Apophis as it passes close to Earth
- The study will resume in early 2015 after Rosetta comet encounter

Alan Harris from DLR in Germany described the progress of the NEOShield project:

- NEO Observations with Spitzer
- Remote Spanish observatory for NEO observations is coming online
- Construction of the MASCOT surface lander for Hayabusa

- NEO database (EARN) on NEO physical properties—supported by ESA SSA project
- Crater modeling via DLR Berlin
- European fireball camera network
- NEOShield roadmap (~E6 million over 3 years)
 - Search, characterize, and do a deflection demo mission
 - main themes: science, mitigation precursor recon, lab experiments on impacts, numerical simulations of impacts
 - mitigation demo missions—suitable targets, space mission design
 - global response campaign roadmap—impact threat response strategy
 - coordinated from Berlin/DLR by Alan Harris
- The public-aimed website is: www.neoshield.net
- Top priorities for mitigation: NEO physical properties, NEO targeting, novel techniques for NEO mitigation, space missions to test mitigation techniques (considered essential)
- examples of results: hypervelocity gas gun impact experiments, measuring momentum transfer; modelling and computer simulations of impact effects into various materials; interpretation of NEA thermal model to find metal-rich NEOs;
- priorities: exploration of NEOs; operations close to a small NEO; development of techniques for robotic exploration (surface ops)
- How can we deal with rubble piles? (We've seen breakup of a rubble pile NEA)

The AIM Mission from ESA was described by Johann Schoenmaekers:

- Asteroid impact mission (Don Quijote was too costly).
- AIM is posed with a view toward international cooperation
- AIM is the ESA part of AIDA, with DART (rendezvous, impactor)
- binary target 65803 Didymos
- Hit the secondary asteroid; can track the secondary asteroid very accurately to measure the change in its period, and thus its velocity, and thus momentum transfer
- Impact in Oct. 2022, fixed date due to need for Earth observations.
- AIDA -- Goals of planetary defense, human exploration, science, resource utilization
- Firsts: 1st NEA deflection, 1st rdz with binary, 1st sizeable impact on an NEA
- DART hits Didymos at near 1 AU from Sun, 0.11 from Earth, in 10/22 @6.25 km/sec
- AIM would be a prospector, cost < 150M Euro, observe impact from ~100 km
- Deep space optical link planned
- AIM spacecraft in internal study
- Power and comm are relatively simple
- Only a month of intense operations
- Chemical propulsion ~ 1 km/sec
- No mechanisms
- Deploys surface payloads from a fly-by pass near the NEA
- Didymos is well-characterized, a pair, 850 and 150 m diameters
- Close approach in 2022 to Earth with great observing conditions
- Radar and photometry will determine change in period of secondary to about 10%

Mokata Yoshikawa described the JAXA Hayabusa II (H2) mission:

- H2 is to sample a small, C-type NEO
- Launch later this year

- Study of origin of solar system
- Make a small crater, gather sample, return to Earth in Dec. 2020
- Will gather info needed for deflection missions
- Made modifications to improve over Hayabusa 1
 - New impactor package, firing an EFP slug toward surface from hundreds of meters
 - Separation camera to show the firing and impact
 - Small rover, Minerva II (3)
 - Small lander (MASCOT)
- Complex prox ops needed to avoid impact debris
- Ground tests of projectile completed

UK Space Agency activities were described by Richard Crowther:

- Have been involved in NEOs since 1999, especially at UN
- UK industrial experience, interests:
 - Interplanetary: Airbus defense and space, SSTL, etc.
 - Software and simulation
 - Trajectory optimization
 - Nuclear power sources
- Has supported many ESA interplanetary missions
- NEO Mitigation Studies
- A few charts show their areas of expertise

NASA activity was described by Lindley Johnson:

- LINEAR has begun using the SST from DARPA, in New Mexico
- PanSTARRS, Catalina Sky Survey (PanSTARRS is moving toward full NEO survey time; # 2 aperture on Mauna Kea should see first light by end of the year)
- NEOWISE – using “warm” mode to search for small NEOs
- MPC receives NASA funding and does initial orbit determination
- Showed image of Toutatis via Goldstone
- Funding pie chart: 41% of funding goes to search projects; then radar; infrastructure; then characterization; etc. -- \$40M annually
- Finding about 100 NEOs a month
- 11,138 NEOs to date; 863 > 1 km
- 97% complete on the search for objects > 1km
- Challenge is the ~100m size bin; see graph
- ARM:
 - Identify, Redirect, Explore strategy for ARM
 - Asteroid Redirect Mission summary:
 - Enhance detection, tracking, and characterization of NEOs
 - Planetary defense demonstration
 - Discussion of capture system; inflatable vs. spaceframe robotic “snatcher”
 - GT, ion beam deflection,
 - On a small NEO, <500 t, could impart 1mm/sec in 1 hour

- GT takes longer but also works.
- On Option B, could do kinetic impactor demo, enhanced GT, GT, or IBD.
- Would produce a measurable velocity change in 180 days, on Itokawa-size impactor
 - Discovery rate on targets is about $7+3/\text{yr}$ = a dozen or so
 - Larger, boulder targets should total ~10 parent objects with boulders
- AIDA concept overview:
 - Run out of JHU/APL
 - DART is the US element; the impactor
- NIAC Asteroid Deflection Concept
 - Hypervelocity NEA intercept vehicle
 - Bong Wie and team
 - Uses kinetic impactor, followed by nuclear explosive in the crater to disrupt the NEA
 - Typical target is 100m size, using ~ 11 km/sec intercept velocity
 - More than 20 times as effective at disruption by using a subsurface nuclear blast
- NASA and FEMA ran a NEO impact exercise – May 2014 results
 - Similar to Chelyabinsk; 2021 impact
 - Used kinetic impactor to deflect, but left one fragment remaining on impact trajectory.
 - Radar narrowed the impact site to downtown Houston
 - FEMA brought in all its component agencies to participate

Gerhard D noted that there was a request from ESA's Int'l Relations Committee that SMPAG should inform ESA directors of its activities with an annual report. The SMPAG will discuss how such a request can be met.

Sergio Camacho proposed a workshop on the legal aspects of deflection, e.g. liability issues, "good Samaritan" indemnification. The SMPAG steering committee discussion was to be completed later off-line.

The SMAPG website is at: www.cosmos.esa.int/web/smpag

- can also go to the SSA ESA NEO page, where there is a link
- various internal documents
- charts from presentations

Quite a few space agencies are signing up; the list is on the SMPAG webpage. Successful at enlisting agencies in this effort; it's REAL.

- http://cosmos.esa.int/web/smpag/smpag_members

Observer status for outfits like ASE seems to be viewed favorably by the agencies. ASE would attend SMPAG only when its sessions are held in conjunction with other meetings, to minimize expenses. Gerhard D. proposed that observers can apply to the steering committee stating an intent to observe an upcoming SMPAG session. Delegations can invite experts. The SMPAG could also hold open meetings. The next SMPAG will be just before the Planetary Defense Conference in Rome; 9-10 Apr 15 (Thurs-Fri).

The next STSC (of COPUOS) will be from 2-13 Feb 15 in Vienna. SMPAG's Steering committee will meet at STSC for half a day. Sergio suggested that AT-14 be shifted so as to be back-to-back with the SMPAG steering committee.

The work plan for future SMPAG meetings was discussed:

- Derived a list of topics from the terms of reference
- About ten items for prioritization
- We agree on these work items, contained in the work plan outline.
- This should be a real document rather than an internal list.
- Ukraine proposed setting up working groups and assigning action items, due dates, etc.
- Items on the future work list:
 - Recommend criteria and thresholds for action
 - Develop reference missions
 - Develop an action plan for SMPAG in case of a credible threat
 - Develop communications guidelines for SMPAG to be followed in case of threat
 - Produce a road map for research needed to support planetary defense
 - Develop decision and event timelines for a variety of impactors and trajectories from the reference missions
 - Evaluate technical maturity and consequences of mitigation campaign, including failures of same.
 - Recommend criteria for deflection targeting, e.g. minimum Earth miss distance
 - Study the nuclear device option and how to deal with it
 - Identify a toolbox for a characterization payload
- Proposals were made for keeping up action item log on the work plan
- The group solicited volunteers for each of the ten tasks from SMPAG members

NASA will sponsor a NEO communications workshop in Boulder, in Sept 2014. SWF will contribute to developing item #4, the communications plan.

The SMPAG concluded by preparing a public statement for release. I'll forward this to ASE when complete.

The SMPAG session ended at 5:30 pm on June 13, and will reconvene at the Planetary Defense Conference in Frascati, Italy, next April.

The ASE NEO Committee will most probably attend next winter's STSC AT-14 sessions in Vienna via telecon. I would advise that the Committee attend the Planetary Defense Conference in Italy next spring to contribute to the wide-ranging discussions there on the impact hazard.

-- Tom Jones
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