The AMSAT® Journal

Volume 38, Number 1 January/February 2015

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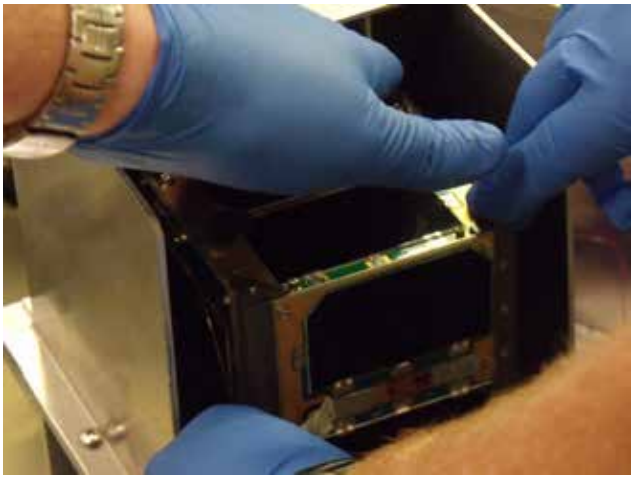

Fox-1A Flight Model Passes Environmental Testing

Report from the 2014 AMSAT Space Symposium

AMSAT-NA
10605 Concord St., Suite 304
Kensington, MD 20895-2526

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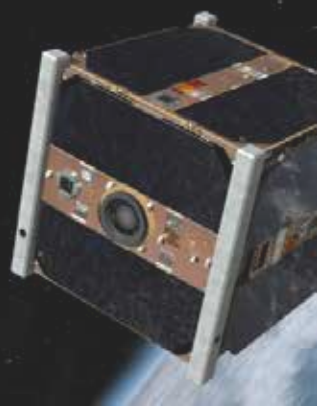
and at additional
mailing offices

Commit to the Future of AMSAT

- **AMSAT has committed to launching Fox-1C in 3Q 2015.**
- **We teamed with SpaceFlight, Inc. for integration and launch utilizing SpaceFlight's SHERPA System to sun-synchronous orbit in third quarter of 2015 and we have already paid the launch fee.**
- **AMSAT must now raise the funds to recover those funds to re-establish our reserves.**
- **Along with serving as a "rainy day fund", these reserves provide the "seed money" for future satellite projects.**
- **It takes real dollars to develop real satellites.**
- **As a result, AMSAT has initiated a $125,000.00 campaign to raise the capital needed to provide the resources to maintain our ability to initiate future projects.**

Please consider these donation options

- **Donate to the AMSAT President's Club**
- **Cash gifts with your credit card, PayPal, or check**
- **Gift of life insurance by naming AMSAT as a beneficiary**
- **Gift of stocks or other securities**
- **Bequest to AMSAT in your will or trust**
- **AMSAT is a 501(C)(3) non-profit organization**
- **Call the AMSAT-NA office at 301-822-4376 for questions on any or all of these ways to keep Amateur Radio in space.**



Support AMSAT-NA http://www.amsat.org

AMSAT Announcements

Dayton to Host 2015 AMSAT Space Symposium October 16-18

AMSAT- NA announces that the 2015 AMSAT Space Symposium will be held on Friday through Sunday, October 16-18, 2015 in Dayton, Ohio at the Crowne Plaza in downtown Dayton.

The annual AMSAT Space Symposium features:

- Space Symposium with Amateur Satellite Presentations
- Operating Techniques, News, and Plans from the Amateur Satellite World
- Board of Directors Meeting open to AMSAT members
- Opportunities to Meet Board Members and Officers
- AMSAT-NA Annual General Membership Meeting
- Annual Banquet, Keynote Speaker and Door Prizes !!

Several members from the Dayton Amateur Radio Association as well as many other local clubs will be participating in helping with this event.

Additional information about the 2015 AMSAT Symposium will be posted on the AMSAT website, http://www.amsat.org, as it becomes available.

AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy satellite systems with the goal of providing wide-area and continuous coverage. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.

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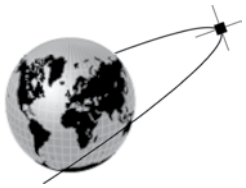
The AMSAT Journal staff is always interested in article submissions. Whenever possible, submissions should be sent via e-mail to journal@amsat.org using plain text or word processor files; photos or figures in TIF, GIF or JPEG formats. Kindly do not embed graphics or photos in your manuscript - we prefer receiving those as separate files. AMSAT-NA reserves the right to select material for *The AMSAT Journal* based on suitability of content and space considerations. The editors of this publication are volunteers giving freely of their talents, time and efforts to produce *The AMSAT Journal*.

by Barry Baines, WD4ASW • wd4asw@amsat.org



Happy New Year! I'm excited that 2015 looks to be an outstanding year for AMSAT. First, we expect to launch Fox-1 class satellites (Fox-1A and Fox-1C) later this year. Second, we're looking forward to evaluating future project opportunities as the Fox-1 program starts to wind down. The 2015 AMSAT Space Symposium is now scheduled, and we'll discuss the details below.

Fox-1A

As I write this column the week of January 19, 2015, AMSAT's engineering team is in Orlando, FL, certifying the Fox-1A flight unit for launch. The vibration testing and environmental testing are nicknamed "shake and bake" and are designed to certify the satellite for flight on the ELaNa-XII launch, now scheduled during the third quarter from Vandenberg AFB. The testing is required by NASA to prove that the satellite itself is not a danger to other cubesats or the launch vehicle during the flight (e.g., the vibration test confirms that the satellite will not "shake" apart nor experience a mechanical failure due to launch vehicle vibration while the "bake" is the process to remove contaminants from our satellite to ensure the main payload does not become contaminated.) The specifications for this testing are listed in the Launch Services Program (LSP) documentation with testing being done at a certified testing facility (Qualtest). The results have met NASA expectations. Satellite completion is the last week of January with the Mission Readiness Review (MRR) scheduled for mid-February. Delivery of the satellite to SRI is now scheduled for mid-March.

Prior to the tests in Orlando, the Fox-1A satellite went through "Day in the Life" (DITL) testing to certify that the satellite will not deploy the antennas or start transmitting before 45 minutes after deployment from the P-POD orbital deployer once in orbit. Fox-1A is set for 50 minutes delay. It's actual time to first deployment (TX antenna) was 56 minutes 21 seconds (better to err on the safe side), The RX antenna deployed at 56 minutes 32 seconds with the first transmission at 59 minutes 12 seconds.

AMSAT VP-Engineering Jerry Buxton, N0JY shot a video of the "DITL" test which can be seen on You Tube:

http://youtu.be/TjGAYvMyz4Q

The Fox-1A flight unit does have the Penn State MEMS Gyro experiment and a Low Energy Proton Experiment from Vanderbilt University, so there is significant scientific benefit in the mission. The flight unit does not have the Virginia Tech camera as it wasn't ready in time to be included; software development issues prevented timely completion. In addition, several temperature sensors ended up with issues; while the loss of these sensors is regrettable, it does not impede our ability to properly manage the spacecraft.

Further details on Fox-1A's operational configuration as well as launch schedule can be found on the AMSAT website.

Fox-1C

Once the team has put Fox-1A into its storage container (we can't open the spacecraft once the environmental testing is complete, but we do have the ability to keep the battery charged until delivery), our intrepid team of engineers will start the process of preparing Fox-1C for flight on the Spaceflight,Inc. "Sherpa" deployer. At this point we don't have a specified delivery date, but the lessons learned in preparing Fox-1A for flight will be adopted for Fox-1C later this year.

One expectation is that the Virginia Tech camera will be on this spacecraft as their team takes advantage of the later deliverable date for Fox-1C to complete their software development.

A "Thank You!" to everyone who responded to AMSAT's donation letter that was sent in December. Many responded to our request for support of the Fox program (including the $125,000 Launch Campaign for Fox-1C) or to designate their gift for other areas of support, such as ARISS, Future Projects, or General Fund. In 2014, including the December campaign, over $75,000 in donations were given for the Fox program. My thanks to all for your support!

We still have a ways to go in fulfilling the $50,000 still needed for launch. If you haven't already donated to support the launch of our second Fox-1 class satellite, please consider making such a donation. A variety of donation options are available through the AMSAT Web Store, and we're still offering the Fox "Challenge Coin" to those who donate at the $100 level or more to the Fox campaign. See page 24 of the November/December 2014 issue of your *AMSAT Journal* for details.

continued on page 4...

Apogee View - continued from page 3 ...

Evaluating Future Flight Opportunities

Our announcement at the 2014 AMSAT Space Symposium that AMSAT is taking time to re-evaluate our future spacecraft options provides us with an opportunity to look at a variety of new ideas. The "Design AMSAT's Next Satellite" program provides an opportunity for AMSAT members and others to propose future satellite missions. The deadline for submitting proposals is May 31, 2015, details about the program can be found in ANS-313 released on November 9, 2014 as well as the November/December 2014 issue of the *AMSAT Journal*, pages 8-9.

There are significant benefits towards following this process. First, it opens the door for creative ideas. Second, it encourages membership participation/input into what AMSAT should focus on with our next satellite program. Third, it reinforces the desire to seek input from capable individuals outside the AMSAT leadership and makes us aware of who might be in position to support AMSAT Engineering. Fourth, it defines a process for evaluation ("a checklist") that helps everyone understand how we go about defining our next project. Lastly, it provides the potential for combining ideas into one "better" idea, taking the best of what is offered. Even if we don't receive one proposal, the fact that we're taking this approach reinforces our desire to encourage input before decisions are made by the Leadership Team (Engineering and the Board) as to what our next satellite program should accomplish.

In my "Apogee View" column in that same issue, I also noted the interest expressed by a group of volunteers to pursue a 6U Cubesat for HEO that would utilize a K/X band digital system. This concept continues to draw interest as a possible future AMSAT project. Now there is another opportunity where such a system design might be applicable: NASA's "Cube Quest Challenge" which will place selected 6U Cubesats into a trans-lunar trajectory during NASA's first Exploration Mission (EM-1). That mission is scheduled as the second flight of Space Launch System (SLS) in 2018 where the cubesats will fly as secondary payloads.

NASA envisions two competitions from this program: 1) a "Lunar Derby" which would require spacecraft propulsion to slow down the spacecraft to allow the spacecraft to be placed in lunar orbit, and 2) a "Deep Space Derby" competition to demonstrate the ability to transmit specified data formatted information as measured for both "sustained periods" as well as "peak periods" from at least 4 million kilometers from Earth. According to the Operations and Rules released by NASA's Space Technology Mission Directorate (STMD), both competitions are designed to encourage non-profits, academia and industry to "stimulate innovation in technologies that have benefit to NASA and the nation." The program includes prizes being awarded for both competitions to the top performing spacecraft based upon certain technical criteria (each criteria has its own prize) as well as prizes for the five highest competitive teams as scored during the four "Ground Tournaments," which are ever increasing design reviews. A more thorough overview of this program may be found at:

http://www.nasa.gov/cubequest .

I note this NASA program because AMSAT has been approached by a team that intends to compete for the prizes offered by this NASA program and has asked us whether AMSAT might be interested in providing the communications package for their 6U spacecraft. We are just starting to look at the potential benefits of such a collaboration as well as the obligations and risks associated with such an endeavor. The fact that AMSAT has been approached about such a possible collaboration speaks well of AMSAT's reputation.

The R&D benefits to AMSAT, coupled with the opportunity to collaborate with other organizations on a significant spacecraft project would have to be compelling enough to outweigh any identified risks. Such collaboration might well provide benefits in developing future spacecraft utilizing higher frequencies due to the size constraints of cubesats. We would also have to make a determination whether AMSAT has the resources (finances, volunteers, and time) to allow involvement in such a program while simultaneously initiating a new spacecraft program that directly benefits amateur satellite operators. We'll see how this develops over the next few months.

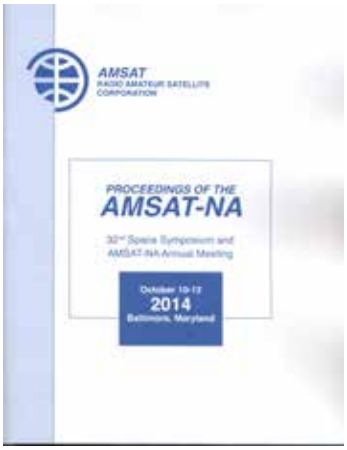
AMSAT Activities

It isn't too early to mark your calendars upcoming AMSAT activities. The Dayton Hamvention is scheduled for May 15-17, 2015. We expect to have a major presence there as we have in the past.

In ANS-011 dated January 10, 2015, we announced that the 33rd AMSAT Space Symposium and AMSAT Annual Meeting will take place the weekend of October 16-18, 2015, in Dayton, OH. The meeting will take place at the Crown Plaza in downtown Dayton (33 East Fifth Street). Symposium Chair Steve Coy, K8UD, is arranging activities/tours that will be announced once plans are finalized. The hotel has been recently renovated, and free airport shuttle service to the hotel is available.

Dayton is centrally located and accessible. About two-thirds of the US population is within 12 driving hours of Dayton. Many of us attend Hamvention, but don't necessarily have time to enjoy what Dayton has to offer. With our being downtown for Symposium, a variety of nearby restaurants are available. The Air Force Museum is world renowned for its collection. Dayton also celebrates the Wright brothers, whose bicycle shop is in Dayton. With aviation being a key to Dayton's identity, we're looking forward to making Sunday of Symposium a day for exploring this aviation heritage.

Mark your calendar now for these two key events in Dayton!



Proceedings of the AMSAT-NA 32nd Symposium and Annual Meeting

October 10-12, 2014, Baltimore, MD

The book contains over 20 articles on subjects ranging from current satellite operations to detailed updates on the Fox Project.

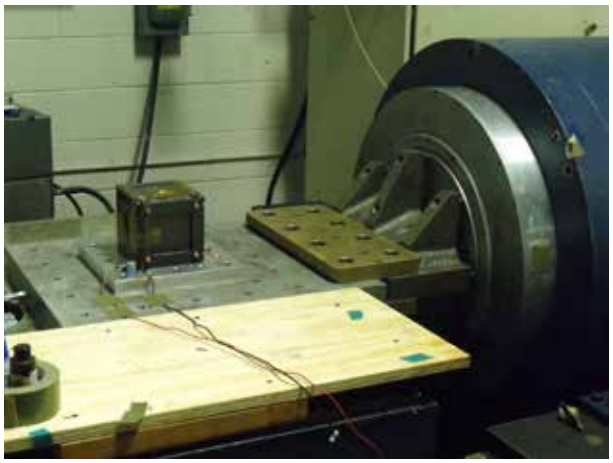
If you could not make the meeting, this is a great source of the latest information.

Price is $25 +Shipping on-line at:

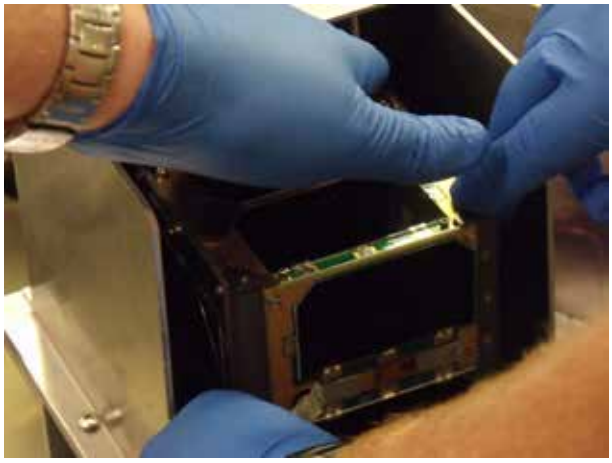
http://store.amsat.org/catalog/

Fox-1A Flight Model Passes Pre-flight Environmental Testing Ready for Launch!

The Fox-1A Flight Model passed all of its pre-flight environmental testing in Orlando, Florida during the week of January 19. Shown above are the Fox-1A test team (L-R): Bob Davis, KF4KSS; Burns Fisher, W2BFJ; Jerry Buxton, N0JY (not pictured). Also shown are: Lou McFadin, W5DID; Dave Jordan, AA4KN, and Ed Krome, K9EK, who supported the test team.



The Fox-1A Flight Model mounted to the vibration table for the X-axis phase of the 3-axis vibration testing. The test produces high G force vibrations that emulate the expected accelerations that will be experienced during launch.



Fox-1A shown under preparation for thermal-vacuum testing to very low pressure and high temperature in order to remove any contaminants left over from construction and handling.

Fox-1A shown under preparation for thermal-vacuum testing with (L-R) Steve, the Qualtest operator, and Jerry Buxton, N0JY.

Shown monitoring the Fox-1A thermal-vacuum testing are (L-R): Lou McFadin, W5DID; Bob Davis, KF4KSS; Burns Fisher, W2BFJ; and Steve, the Qualtest operator.

Fox-1 has passed all tests and is literally in the bag, ready for launch!

There's an App for That: Smart Phone Applications for Satellites

Mark D. Johns, KØMDJ
k0mdj@amsat.org

LEO satellites, small portable rigs, and light-weight yagi antennas have combined to call many amateurs out into the wide open spaces to put that rare grid on the air, or simply to set up in the driveway to overcome antenna restrictions. But even out in the wild, with the simplest of stations, a ham needs to have and to save certain information in order to operate. Lugging a laptop along isn't always easy or practical, and there's seldom wi-fi available in the woods. Wouldn't it be great if you could carry a tiny computer in your pocket? If you carry a smart phone, you already have one! All you need is the right app.

Tracking

Searching for satellite apps in Google Play or Apple app stores yields several dozen variations of applications that will help point your home TV satellite dish at the proper geosynchronous point in the sky. A few more will help you spot the ISS visually as it flies overhead at dusk. There aren't many that will tell you where to point your Arrow during an SO-50 pass.

One that will is "Satellite Explorer Pro" by Thomas Doyle, W9KE. This app is available for iOS and Windows phones and tablets, and it's completely free. This is a deceptively simple-looking program, and doesn't appear very impressive at first glance. But Tom has made many improvements since the earliest version ("Satellite Explorer," which is still available for download in the iTunes store, but you'll want to go "Pro"), and there are a number of neat features hidden in the app that aren't obvious at first glance. The clean and simple interface keeps clutter out of the way, but the goodies are only a touch of the screen away - depending on which spot on the screen you touch. It might be wise to listen to him walk you through it in one of his YouTube videos, or at least to read his web page at

http://www.tomdoyle.org/SatExpPro/SatExpPro.html .

Satellite Explorer Pro will tell you where you are, using your phone or tablet GPS. It will calculate your grid square and put you on the map. Before you leave home, when you still have a wi-fi connection, you'll probably want to update all your Keplerian elements, which the app will do for you very quick and automatically at the touch of a button. Satellites are presented in several groups, but you can create your own group of "Favorites" for the satellites of primary interest. Among the latest additions is the ability to have the phone notify the user of an upcoming pass so that it's not missed.

Another very pretty and quite useful set of tracking apps for iOS has been created by Craig Vosburgh, W0VOS.

See: http://www.vosworx.com/ .

The Satellite Explorer Pro home screen is clean and simple

Satellite Explorer Pro has added notification functions

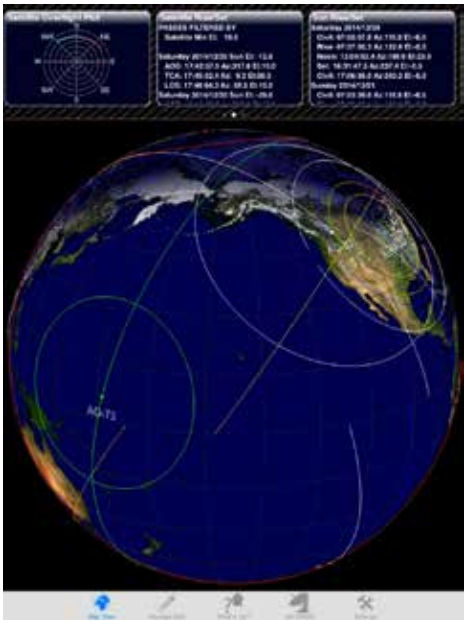
These programs have most of the same features described above, but with an enhanced graphical interface. Craig is in business as an app developer, so except for the "Lite" version of his ISS-only tracker, his work carries a price tag. "HamSat," the version focused only on amateur satellites, is a couple bucks cheaper than "ProSat," which seems to track everything in orbit. Unfortunately, the iPhone versions do not play well with the iPad, and vice versa, so one must pay again for "HamSatHD" or "ProSatHD," which display properly on the tablet. For the money, one gets an array of beautifully rendered, real time, color displays. Spinning the 3D globe with the touch screen is fun, and the "radar screen" overflight plots are exceptionally useful during a pass. Pass predictions can be selectively passed to the Calendar, allowing more flexibility with notifications.

Android users will be able to enjoy some of the same benefits in a free app by G4DPZ called, "AmsatDroid FREE." I did not have the chance to use this app myself, but it gets high marks from reviewers in the Google Play Android app store. There's also "PocketSat3" for Android and iOS, which looks nice in the app stores, but comes at a price even higher than "ProSat" in iOS.

Other Utilities

In addition to tracking, the smart phone or tablet can assist with a variety of other functions during a satellite pass. Perhaps you have extra hands, or are better at juggling than I, but I find it difficult to track the antenna, keep up with Doppler shift, listen to the downlink, talk, and keep a log all at once. Most phones have a built in voice memo app that will make an audio recording. Start the recording at the beginning of the pass and speak the exact time for the record. With the starting time and real-time recording -- even of just one's own side of the QSO, it's easy to reconstruct a log later, even if contacts were fast and furious during the pass.

For those wishing to keep a more traditional log,



ProSatHD on the iPad provides 3D globe and overflight plot

AmsatDroid FREE map display

Android users will benefit from "Ham Radio Log" by Talixa Software, a free app that will output data in ADIF format for import into your full-function log program on your Mac or PC. Users of iOS will find utility in "HamLog" by N3WG. For only 99 cents, this app provides a veritable Swiss Army knife of radio-related tools, one of which happens to be a log program. Also included is propagation data, DX cluster access, various calculators, contest calendars, etc.

If you need filters, alarms and other features on your DX cluster, "iCluster" by DL8MRE will provide all that you need for just $2.99. This program still has a few bugs, but Marcus is working hard to fix things. "Callsign Search" by K4FV provides access to the QRZ database for subscribers and is similar to "QRZDroid" on Android.

Because there is no standard search term for apps related to the odd assortment of things we do on the air, you'll want to query your favorite app store for "ham radio," "amateur radio," "amateur satellite" and any other search combinations you can think of. When you do, you'll find a plethora of apps related to all aspects of the hobby, from exam study guides to CW tutors to remote control of your rig. Next time you head out into the wild to catch a satellite pass, don't go without your pocket computer and the apps that will help you get the best from the birds.

AMSAT Fox-1 Challenge Coin Available for Donations at $100 or Higher

Donations may be made via the:

- AMSAT website at **http://www.amsat.org**
- FundRazr crowdsourcing app at: **http://fnd.us/c/6pz92**
- AMSAT office at (888) 322-6728

AMSAT is excited to announce that a new premium collectable is now available for qualifying donations to the Fox satellite program. AMSAT has commissioned a unique challenge coin for donors who have contributed at the $100 level or higher. This challenge coin is shaped as an isometric view of a Fox-1 cubesat, complete with details such as the stowed UHF antenna, solar cells, and camera lens viewport. Struck in 3mm thick brass plated with antique silver, and finished in bright enamel, the coin is scaled to be approximately 1:4 scale, or 1 inch along each of the six sides. The reverse has the AMSAT Fox logo.

The coins are scheduled for delivery just prior to the 2014 AMSAT Space Symposium, and will be first distributed to donors attending the Symposium. Coins will also be made available to qualifying donors that have contributed since the Fox-1C announcement on July 18, 2014 *upon request*.

Further information on the Fox project can be found at:

http://www.amsat.org .

Paul Stoetzer, N8HM
n8hm@amsat.org

Welcome to a new column in the AMSAT Journal reviewing the latest happenings on the satellites, including grid expeditions, new operators, notable achievements, and general tips for getting the most excitement out of your satellite operations. While I will share my observations from operating satellites, submissions from readers are greatly encouraged. Please send reports of your satellite activity, including grid expeditions, photographs, and any other general observations to:

n8hm@amsat.org .

The past several months have seen quite a bit of activity on the satellites and I look forward to the upcoming year with several new satellites, either on-orbit awaiting activation or yet to be launched, expected to become available for amateur use.

Fall 2014 Grid Expeditions

Over 85 grid squares were activated by satellite operators operating outside of their home grids between September 1st and mid-December. A very notable operation was undertaken by K8YSE, who operated in 27 grids in the Western United States during this time, many of which are extremely rare. He worked 33 passes from 27 grids and made 352 QSOs while traveling 7,300 miles. Other operators, including KA6SIP, W5PFG, CO6CBF/W5CBF, AC0RA, WN8QGV, KG5CCI, KA4H, N2COP, KX9X, AA5PK, K8BL, WN9G. KD8CAO, VE3RCN, DJ8MS, WD9EWK, K1IU, VO1ONE, AD7DB, N7JY, PV8DX, and others, also operated outside their own grid squares and provided many operators with needed grid squares. (I apologize if I left anyone out). Figure 1 shows a map of the North American grids that were activated.

Paulo, PV8DX, traveled to GJ03ci near the Brazil/Guyana border in early December and provided many with a new grid. He produced an excellent video of this trip that can be viewed at:

http://youtu.be/Rj3ZLEc2iGA .

ARRL Centennial QSO Party

Another exciting event on the satellites during all of 2014 was the ARRL Centennial QSO Party, including operations as W1AW in many states. As of this writing, 25 states and the District of Columbia have put W1AW on the satellites, with at least one more state operation planned. In addition, satellite QSOs count for the ARRL Centennial QSO Party points challenge. As of to date, I have accumulated 1,337 points solely from satellite QSOs, enough to qualify for the First Level Award. See:

http://www.arrl.org/centennial-qso-party

for further details.

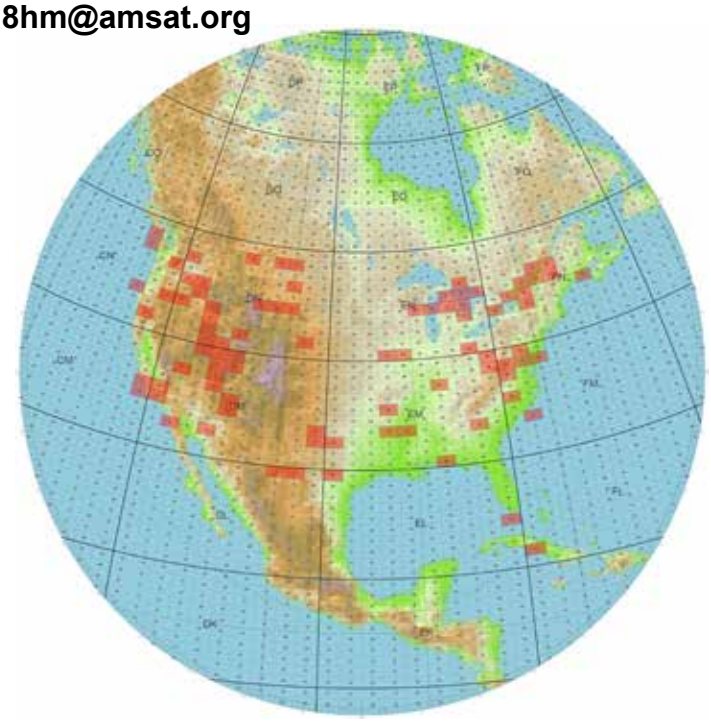


Figure 1: Grid Expeditions 9-1 to 12-16. This map shows North American grids activated by operators outside their home grid between September 1, 2014 and December 16, 2014. (produced with GcmWin)

New Operators

I'd like to highlight a few new operators who have just become active on the satellites. Many of them have dived head first into the grid roving arena, providing many with new grids. It's great to see new hams and hams new to satellite operations excited about this fun facet of the hobby.

Bill Skriba, WN8QGV, is not only new to the satellites, he's a new ham. He was first licensed on September 4th and made his first satellite contact on SO-50 on October 15th and since then, he has operated from EN74, EN75, EN76, EN84, EN85, and EN86 in Northern Michigan. He has also acquired a pair of old Icom rigs (the Icom IC-290H and Icom IC-490H) and has started to listen to the linear satellites. He writes, "My first SO-50 contact was with N2PPL who took the time (wee morning hours) to make contact with me when I was using a Baofeng UV-5R with just a 15 inch whip. I actually made my first 11 contacts that way. Can you say contortionist?

I have worked from grids EN74, 75, 76, 85 and 86. My LoTW shows 161 QSOs with 59 QSLs and I have a stack of 42 QSL cards from others who don't use LOTW. I have to say, for the under $200 I have invested in the Baofeng and Arrow II, it has been far some of the best dollars in entertainment value I have ever spent in my 51 years. The other note that I would like to add is the miles per watt on some of my QSOs. It amazes me that I have QSLs from San Diego and Washington State on those 4 watts coming from that Baofeng here in Mid-Michigan."

Dave Swanson, KG5CCI, is also a new ham. He was first licensed on June 5th and since becoming active on the satellites in August, has activated numerous grids throughout Arkansas and the Midwest on SO-50. He has also become active on the linear satellites with his FT-857 and an old Icom IC-290 he found at a hamfest.

Carlton Noll, KA4H, has been a ham for about 10 years, but just became active on the satellites earlier this year and has already activated 10 grids throughout southern Virginia and other areas.

Pierre Guillard, FM5EP, has recently been active on FO-29 and AO-7 from Martinique (grid FK94) and has provided many with a new DXCC entity and grid. Pierre lives on the south side of a volcano in Fort-de-France, the capital city of this overseas department of France. Unfortunately, this volcano limits his visibility to the north, so those trying to work him from the United States need to find and work him early during ascending passes and late during descending passes.

All 488 USA Grids Worked

Congratulations to Doug Papay, KD8CAO, for becoming the second satellite operator to work all 488 grids in the continental United States on the amateur satellites. This is quite an incredible achievement! He follows in his father, John Papay, K8YSE's footsteps. K8YSE's grid expedition this past fall was planned in large

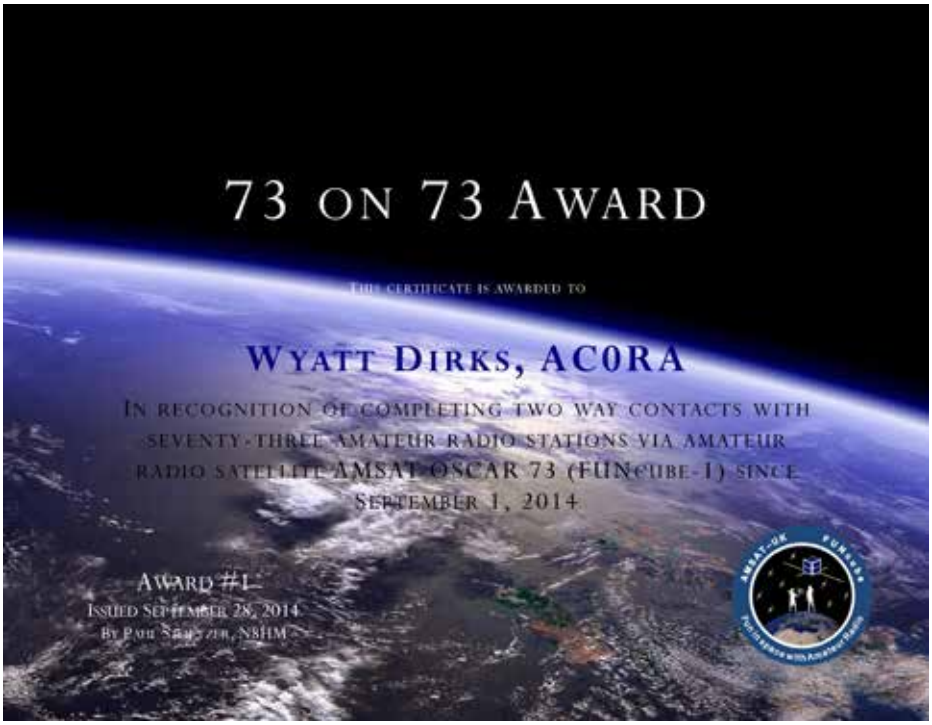


Figure 2: The first 73 on 73 Award certificate, issued to Wyatt Dirks, AC0RA (credit N8HM)

part to fill in the empty spaces on his son's map. The final grid needed was FM13, and he worked N2COP on Bald Head Island, NC, on SO-50 at 12:52 UTC on December 15, 2014, to fill in that final gap.

73 on 73 Award

The 73 on 73 Award is an award that I created to encourage operating on AMSAT-OSCAR 73 (FUNcube-1), which I have found to be an under-utilized resource. The award is free and has simple requirements: work 73 different callsigns after September 1, 2014, on AO-73. Email a list of the callsigns, times, and dates of the QSOs to:

n8hm@amsat.org .

The following operators have received the award as of December, 2014:

1. Wyatt Dirks, AC0RA
2. Željko Ulip, 9A2EY
3. Bernhard (Ben) Klink, DG1EA
4. Manuel D. Ruiz Carrasco, EA5TT

Figure 2 shows the first certificate awarded.

AO-73 has a very strong signal, though the transponder's local oscillator drifts with temperature. It can be tricky to initially find your signal on the satellite and keep up with the drift. But, with practice, it is a very easy satellite to work. The transponder is not available all of the time but is available while the satellite is eclipsed and on most weekends. Check the amsat-bb mailing list for schedule updates.

Other notes

Several frustrations encountered on working the satellites boil down to three points: operators who do not listen (either due to deficiencies in their receiving system or poor etiquette); those who run too much power on the linear satellites; and crowding the center of the passband on the linear satellites.

Please remember to listen, listen, listen. I have heard many cases of operators stepping on others or not waiting their turn to complete a QSO on SO-50. I have also heard several cases of others firing up CQs on top of QSOs in progress on the linear satellites. Please listen before transmitting and remember that the satellite passbands, especially FO-29, have plenty of room. Spread out! If you cannot hear the beacons of FO-29 or AO-73 loud and clear or SO-50 full quieting throughout the pass, work on your receive setup and be careful not to cause interference when transmitting.

Also, remember that satellite receivers are very sensitive and do not require a lot of power. When using too much power on linear satellites, you are hogging limited transponder power that can be spread across several stations on the passband. This limits the ability of lower powered stations or those at low elevations to get into the satellite. Even 5 watts to a large antenna can be too much at times. I have worked 386 grids and 30 DXCCs on satellite with just five watts and an Arrow or Elk antenna. It does not take much power!

Observations from other operators

Patrick Stoddard, WD9EWK, provided some details about his grid operations this past fall:

12-15 September 2014 - operating from the ARRL Southwestern Division Convention in San Diego, Calif. (DM12). The convention was at a hotel north of downtown San Diego, and I was able to work SO-50 and AO-73 during this weekend. The AO-73 demonstration was well attended, since most hams attending this convention in southern California had only seen FM satellite demonstrations in the recent past. DM12 is not a rare grid, but some operators were looking for a confirmation in Logbook of the World, which I was happy to provide.

16 September 2014 - I operated from the DM04wx/DM05wa grid boundary south of Mojave, Calif. Mojave is north of metropolitan Los Angeles, and west of Edwards AFB. This was done on a request from W5PFG, who had never confirmed DM05 over many years on the satellites. I drove north from San Diego on 15 September, spent the night in Palmdale, Calif., and then drove to the grid boundary for two SO-50 passes in the morning before driving home. The boundary was an easy spot to find - a frontage road along the Antelope Valley Freeway (CA-14).

10-14 October 2014 - I operated from the AMSAT Symposium in Baltimore, Md. (grid FM19). I was not the only operator at the Symposium, as several others operated from this location. I took advantage of being in Maryland by attempting to make transatlantic QSOs via AO-7 and FO-29. On the Sunday of the Symposium weekend (12 October), I was successful in working Joe EI5EV and Eric F4EJW for two new countries and grids via satellite. Joe mentioned that he needed FM19 for his log, and I was able to send him a QSL card after I returned home.

12 October 2014 - I worked one AO-73 pass from Washington, D. C., at River Terrace Park, northeast of RFK Stadium in grid FM18. This is not a rare grid or city on the satellites these days, thanks to N8HM, but I wanted to stop and operate from DC while I was in the area. I had stopped at this park in October 2009, during the 2009 AMSAT Symposium in Baltimore, when I worked AO-51 on two occasions.

12 October 2014 - I worked several passes from grid FM28 in southern Delaware, east of Washington, D. C. I had previously operated from FM29 in northern Delaware, and wanted to make another trip to this state while at the AMSAT Symposium. I heard, and tried to work, Eric ON4HF on an AO-7 pass. We were not successful in completing the QSO. I was able to confirm contacts with Delaware and grid FM28 while operating at this location over a few hours on AO-7, FO-29, and SO-50.

8 November 2014 - John K8YSE/7 and I operated from the Tucson Hamfest in Marana,

Continued on page 11 ...

Satellite Operators Photo Gallery

1. Clayton, W5PFG, and Hector, W5CBF/CO6CBF, operating from a ridge in Lajitas, Texas (DL89) (photo credit W5PFG)

2. Tom, KA6SIP, ready to operate FO-29 from CM94 (photo credit KA6SIP)

3. John K8YSE/7, operating at the Tucson Hamfest in Marana AZ, on November 8, 2014. John used his IC-910H and Arrow Yagi to do some demonstrations during the hamfest (photo credit WD9EWK)

4. Tom, KA6SIP's portable setup in CN81 (photo credit KA6SIP)

5. John, K8YSE's QSL card for his recent grid expedition. The picture was taken on the DN21/DN22 grid line off of US-93 in Idaho (photo credit K8YSE)

6. Sunset on Pismo Beach (CM95) as Tom, KA6SIP, is about to work SO-50. (photo credit KA6SIP)

Continued from page 9 ...

Ariz. this morning, in grid DM42. We were able to show examples of a simple station that I use to work satellites, compared to the IC-910 and laptop with SatPC32 John uses. Also in attendance at this hamfest were Jack KC7MG (he lives about an hour north of the hamfest site, in Casa Grande, Ariz.) and Larry WA6DIR (he drove in from Los Angeles).

Tom Deeble, KA6SIP, also wrote with some details about his grid operations:

October 16 and 17, 2014 - Headed north to the Mt. Shasta area of northern California to grids CN81 and CN91. Operated 5 passes (2 SO-50 and 3 FO-29) for a total of 24 contacts. Two passes were on the CN81/CN91 gridline. Weather was favorable except some rain and wind near the end. Made one contact with Doug, KD8CAO, from the CN81/91 gridline.

November 4 - 7, 2014 - Headed south to the central California coast around Pismo Beach to operate grids CM94 and CM95. Operated 10 passes (6 SO-50 and 4 FO-29) for a total of 59 contacts. One SO-50 pass was just after sunset and operated just feet from the Pacific Ocean. On another SO-50 pass, I had a coast-to-coast contact with Paul, N8HM, Pismo Beach to Washington, D. C. One FO-29 pass was from sand dunes looking over the Pacific Ocean. I lucked out and had great warm clear weather. There was rain there just before and after my trip. Made two contacts with Doug, KD8CAO, from both CM94 and CM95.

Acknowledgements

Thanks to everyone who has provided material for this column, especially those who have travelled to distant and remote locations to put rare grids on the air. Thanks also to Clayton Coleman, W5PFG, for coming up with the title for this column. Please send any reports, observations, or photographs for future columns to me.

Ghislain RUY LX2RG
ruygh@yahoo.fr, ruy@luxspace.lu

The 4M mission started around the end of January 2014. I received an offer to provide a payload to ride along the Chang'e 5T1 moon probe, which would fly several months later, at end of October.

The proposed trajectory was a lunar transfer orbit, meaning that we would go to the moon, fly around it, and then come back one way or another. Limits for the payload's mass and volume were quite stringent, as were the requirements regarding the safety of the main mission.

Although we cannot go into specific details, suffice to say that the mission came about as the result of a long-lasting relationship with the China Great Wall Industry Corporation, such as with the Vesselsat 2, PathFinder 3, and Microgeo satellites.

LuxSpace is a 10 year old company with a track record of 4 commercial satellites already in orbit as well as numerous other payload projects. The question was not so much whether to go, but how we could do it and how we could finance such a project.

Professor Manfred Fuchs, founder of the OHB group, passed away in April 2014. He always had a dream of a lunar mission, so this prompted our decision, and it was decided to fund the mission with the company's own money. In his memory, the mission was christened 4M, the Manfred Memorial Moon Mission.

Given the small amount of time that was available before launch, the spacecraft had to be simple. However, it also had to allow for some return on experiment plus pay fitting tribute to the memory of Prof. Fuchs.

The required specification started out quite simply: "Ghislain: please make it work, and make it good value." Needless to say, the budget was tight, in the lower end of the 6-figure range.

Solutions: KISS (Keep It Simple, Stupid)

In order to get the public involved with the mission, the approach used for the BO-47 and BO-48 satellites was the obvious choice. Accomplishing this was a new challenge that needed to be addressed.

Broadcasting of greeting messages from all around the world was quite attractive, and we set up a website to collect the messages and raise awareness of the upcoming mission. The radio amateur community was the best choice to receive those messages and acknowledge their reception.

This was a good choice as talks and discussions were regularly taking place on potential collaboration between radio amateurs, science and industry. Eventually, it was time to give this approach a focus and direction by which all participants would benefit. The concept was presented at the EME2014 conference during the cooperation forum.

Earlier this year, the IARU was contacted for the necessary frequency coordination. We clearly explained the purpose of the mission, reached an agreement and received a frequency allocation.

(above) Photo 1: Earth and Moon as seen during the CE5T1 return to Earth.
(below) Photo 2: The Moon and Earth as seen from CE5T1 Lunar orbit.

The final payload design was constrained by limits set by the budget and schedule, the allowed mass and volume, and the qualification processes. The result was that the payload was fastened to the upper stage of the launcher and was not, therefore, a self-contained satellite. One drawback, however, was that the spacecraft would not always be illuminated while another was that the antenna system was less than optimal.

4M Unit Design

A. Spacecraft Configuration

The selected spacecraft structure was the same as that used in one of our previous PathFinder projects. The structure was rugged and thermally stable, provided adequate radiation shielding and was already qualified for a large range of launchers. It accommodated a large solar panel and had plenty of payload room inside.

B. Spacecraft Power Sources

The mission required a 100% duty cycle, so relying only on the photovoltaic array was impossible. The answer was to use a large pack of non-rechargeable cells which could both withstand the expected temperature range and meet the required payload power demand.

A set of LSH20HTS cells from SAFT were used in an assembly of 7 x 4 cells in series. This configuration was based on a 100 hour minimum mission duration at -40° C and 6 W payload power.

The secondary power source was comprised of a photovoltaic array and rechargeable batteries. The solar panel was a DB_SW_3061US from SunWare which LuxSpace had on hand. We qualified this model previously on other projects and that proved to work very well (>2.5 years at 900 km LEO). Overvoltage protection was provided by adding a simple circuit based on Zener diodes.

A bank of 4 SAFT MPS170065 rechargeable Li-ion batteries that we had on hand from a previous project completed this subsystem.

The non-rechargeable cell pack was connected 12 hours before launch. A cable was routed from the 4M to an access window in the fairing and a special connector was plugged in, connecting the negative return of the cell strings to the ground. The cable also included a RS-232 diagnosis link, mainly to check the proper functioning of the pressure sensors and the clock settings. The connector included an LED, which provided a very convenient and simple way of indicating the status of 4M.

C. Controller

The FM430 on-board controller (OBC) was also one that we had on hand. It was based on the MPS430 TI microprocessor and was qualified on a previous project. It was plugged into a custom-designed interface board.

D. Transmission Chain

The transmission chain consisted of an I/Q modulator (specifically designed for this mission) followed by a power amplifier built by RFPA. The modulator's maximum output was 5 dBm and the power amplifier had a nominal output power of 1 W (30 dBm).

The I/Q modulator was based on a MiniCircuit I/Q mixer. It was biased at the mid-supply voltage by a set of op-amps so as to avoid the need of a negative power supply to drive it. This was followed by an

Avago Technologies gain block.

The raw I/Q signals from the internal digital-to-analog converters (DACs) of the processor were filtered by a reconstruction filter based on a Sallen-Key elliptical filter with a 4 kHz cut-off. The sampling frequency is 16,384 Hz.

E. Electronic Qualification

All electronics were designed for the expected radiation environment, either by having been qualified through on-orbit operation or the appropriate selection of components. They also had to work at a 100% duty cycle between -40° C and +80° C. The RFPA engineering model was qualified at 120° C, 100% duty cycle, 150% output for 6 hours.

Figure 3: The on-board dosimeter experiment

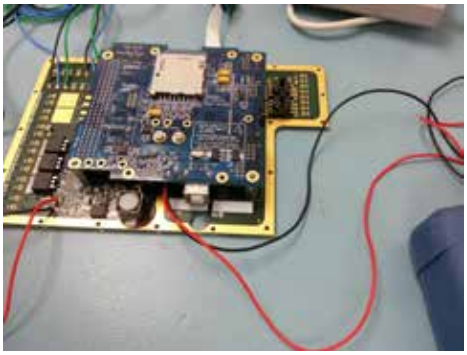


Figure 4: Interface board with pressure sensors.

Figure 5: 4M integrated next to the main passenger cone on the Long March-3C rocket.

F. Radiation Dosimeter

Finally, a chip design company named IC Malaga came up with an on-board experiment based on their new dosimeter chip. It provided a complete subsystem, which was easily integrated into the 4M unit. This experiment proved successful. Figure 3 shows the interior of this instrument.

G. Power Requirements

The total power consumption of 4M (including the DRALUX experiment) was only 3.8 W for a RF output power of 1 W.

H. Data Transmission

The link budget was of concern given the distance (>400,000 km), the available power, the expected equivalent isotropically radiated power (EIRP), and the size of the average receiving station antenna. After some thoughts, the widely-used EME mode JT65B was selected. It had the required data rate, met the link budget requirements, was proven in the field and was readily available.

I. Demodulation Software

The JT65B sequence was followed by an analog sequence, serving as boundary indicator. This also allowed easier synchronisation, as the on-board computer (OBC) clock was not known to be very stable. For this mission, the OBC clock was set up 8 days before the launch. This was to make sure the JT65B sequence would start +/-1s within the UTC minute, accounting for the measured drift. During the flight, it did exactly that.

Two of the internal DACs of the MSP430 microprocessor were used to generate the I & Q signals. The software generated the signals with a numerically controlled oscillator (NCO) approach, keeping the required phase continuity for JT65B sequence generation. It also handled the necessary Reed-Solomon encoding. The offsets and amplitude of the I & Q signals were handled in software. The 6 internal ADCs were used for monitoring the voltage, current, pressure, and internal temperature sensors.

J. Spacecraft Activation

One of the major problems we faced was the activation of the 4M spacecraft. No external command from the launcher was available, so we used a proven and qualified system based on pressure sensors and a timer.

There are two on-board pressure sensors (which you can see on the interface board in Figure 4) which are powered individually by separate point-of-load regulators. The OBC monitored both the output voltage and the supply voltage of each sensor. It is mostly in stand-by mode and checked the pressure every 5 minutes. In this configuration, the power draw is minimal and the payload could, in principle, last for weeks prior to launch using only the battery. (Figure 5 - launch configuration.)

After launch, a timer was started when the 12 km altitude threshold was detected. This timer then activated the whole payload. For this launch, it ran 4000 seconds after detecting that threshold. The simple approach of pressure sensors and a timer made the spacecraft fully independent of the launcher. Of course, both the hardware and software for this process were demonstrated and qualified with our previous PathFinder projects.

K. Antenna

Two key design points, both related to electromagnetic interference (EMI) and electromagnetic compatibility (EMC), were of major concern.

The first one was the close proximity of critical launcher equipment, and we had to ensure that the EM fields of 4M did not put it at risk. This restricted the output power and the antenna.

The second one was the close proximity of a 1 kW EIRP S-Band telemetry transmitter. This meant that we had to design the 4M carefully making sure that no EMI would occur, especially on the pressure sensor/timer activation system.

All the aforementioned equipment drove a simple antenna system. Although we would have preferred to use 435 MHz due to much lower noise at receiving stations, the location, available space, and available output power made the 146 MHz frequency more suitable. Here again, previous experience from BO-47 and BO-48 showed that the 2 metre band was well-suited in this kind of configuration.

Electromagnetic simulations of the radiation pattern of the integrated 4M Unit on the launcher were, unfortunately, approximate due to a lack of data (i. e., accurate structure and material description) as well as limited resources. Early estimates indicated an average gain of -6 dBi, while the simulation results were in the range of -10 dBi. Signals that were actually received showed around -13 dBi average gain, with some peaks at -1 dBi, which were expected. Nevertheless, the link budget had enough margins to cope with it, and actually made the challenge more interesting. The -13 dBi gain represents 50 mW EIRP on average.

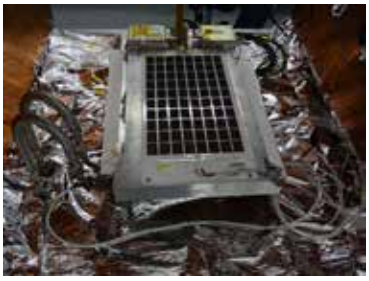


Figure 6: 4M testing included all axis vibration and shocks, thermal-vacuum chamber, long duration burn-in, EMC/EMI, and EIRP tests.

L. Full Unit Testing

The entire 4M unit underwent the following:

- Vibration and shock tests for all axes, in accordance with the LM-3C launcher user manual
- Thermal vacuum test, between -20° C and +50° C (Figure 6)
- Long-duration test burns (2 x 120 hours), of which one was conducted with a set of LSH20 cells
- EMC/EMI tests
- EIRP tests

There was one more "test" and that was the trip from Luxembourg to the launch site. During transportation, the integrated shock recorder showed bumps in excess of 60 g. The spectrum analyser for the second package demonstrated this

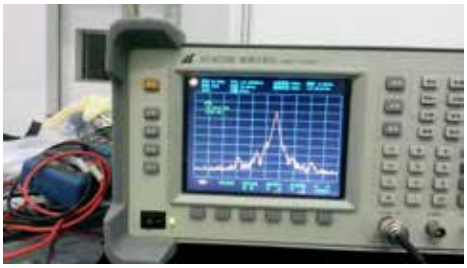


Figure 7: The Chinese spectrum analyzer

Figure 8: The author at the launch site.

Figure 9: Removal of the launch tower.

Figure 10: Liftoff of the Long March C-3 rocket with the Chang'e 5T1 Moon probe and 4M.

pretty well, arriving with a broken screen. This resulted in us using its Chinese counterpart.

By the way, this instrument is of very high quality, something I would have not discovered otherwise. The fun, however, was in understanding the labels on the display (Figure 7). Further information on the unit can be found at:

http://www.siwi.com.cn/en/Products/Test%20&%20Measurement%20Equipments/3.html .

Results

A. Launch and Activation

The 4M spacecraft was mated to the main payload at the launch site.

The launch itself took place at the very scenic Xichang Satellite Launch Centre, located in Sichuan Province, one of the 4 launch centres in China. (Figures 8 - 10). It was scheduled for a very narrow window and went off smoothly and perfectly on time. The credit for this goes to the Chinese launch team which was highly professional.

The 4M spacecraft was activated at the exact planned time of October 23, 2014 at 1918 UTC. First signals were received by two stations in Brazil, soon followed by Australia and New Zealand. Stations along the U. S Pacific coast also received signals.

B. Downlink

The JT65B sequence was well synchronized with the UTC minute, eliminating a time offset search. Signal levels at apogee were received consistently at levels up to -17 dB SNR (in JT65 convention) and were consistently decoded down to -160 dBm at receiver input, -24 dB SNR, showing the quality of the generated signal. There was unavoidable QSB due to the rotation of the last stage and the resulting uncontrolled radiation pattern.

The 4M spacecraft was visible in Europe on October 24, and its signals were readily received. Some hams went to incredible lengths to receive those signals. For at least the first day, they succeeded with an Eggbeater antenna and a FUNcube dongle without any preamplifier.

Given the trajectory and the commitment of stations, we received 100% of the messages up to the Moon flyby, which occurred the night of October 28.

C. Spacecraft Trajectory

A word of explanation is required here about the post-flyby trajectory, as it is of interest.

Errors can be magnified during a flyby. A slight deviation in the injection vector can lead to a wide difference between the actual final trajectory and the one that was predicted. In our case, this is what happened.

The launcher's trajectory was amazingly accurate. However, since 4M was located on the last stage, its trajectory had some uncertainties. The main reason is that it's common practice for all launchers to vent their tanks after they are finished. This is done to avoid possible explosions and, therefore, avoid, as well, the production of debris. The remaining quantity of propellant in the tanks of the last stage introduced a margin of uncertainty, but we were provided with good estimates of the trajectory. Until the lunar encounter, the actual trajectory was barely distinguishable from the nominal one--the tracking was very good.

However, a surprise did come after the lunar flyby. We observed a Doppler shift that was higher than expected. This was initially attributed to the 5 ppm temperature compensated crystal oscillator (TCXO) of the modulator local oscillator, as well as, the decrease in temperature of the payload. It soon appeared, however, that it was not the case and that the return to Earth had occurred somewhat sooner than expected. Some stations received the signal purely by chance at a time when they weren't expected to.

The actual orbit still needed to be determined. Acquiring Doppler data was easy and the team of Scott Tilley, VE7TIL, and Dr. Cees Bassa, Radboud Universiteit Nijmegen, made a first estimate of the orbit.

This was made possible by the automated data collection provided by LSE Space. As more Doppler data came in, we refined our estimate. The automated data collection system made it easy to access the data (Figure 11). In this figure, the "zero Doppler" is at 355 Hz. The unexpected temperature stability of the payload became apparent through consistent measurements.

After the lunar fly-by, the orbit had an apogee of 386,000 km, a perigee of 90,000 km, and inclination of 60°. It is not likely to remain stable as each encounter with the Moon will change the orbit.

D. Radiation Experiment

The radiation experiment operated for 215 hours, demonstrating the quality of the dosimeter chip, as well as producing data which matched extremely well with simulated radiation doses, particularly during the first hour. The rapid rise of the doses impressively exemplifies the harsh environment encountered during the crossing of the van Allen radiation belts.

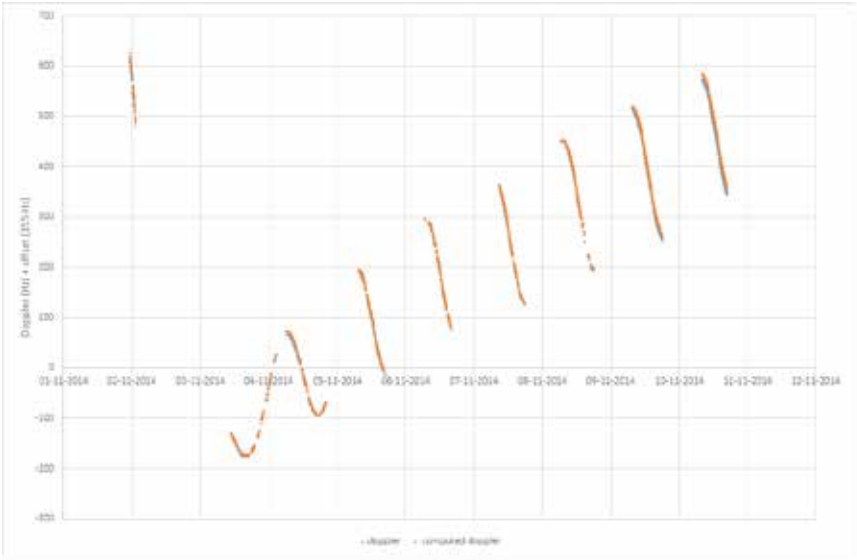
The radiation experiment stopped working due to an apparent software bug, but the performance IC Malaga's device was both impressive and highly effective.

E. Data Reception Contest

The contest for data reception was very successful--we expected 20 stations but 75 entered. The number of greeting messages was deliberately set so that there was a cycle of about 50 hours in order to be broadcast at least twice during the minimum mission time. The contest duration was set at 151.5 hours and 6 stations were quite active: F1TE, VK5APN, LU1HKO, DG0OPK, ES5PC, and ZL2MQ. The maximum number of messages that could be collected during that time was 9090.

I had hoped that an international team would register, but only individual stations entered. The idea for a team was to foster intercontinental cooperation for continuous reception. However, the random hand-over from station to station allowed consistent reception, particularly after the moon flyby when the trajectory determination allowed the publication of good orbital elements.

4M stopped transmitting on November 11 at around



(left) Figure 11: Doppler determination showing 'zero Doppler' at 355 Hz.

(below) Figure 12: The position of M4 when it's last transmission was received.

0135 UTC, with the last messages received by Rein Smit, W6SZ. By that time, 4M had already passed its second apogee (Figure 12).

F. Secondary Experiments

As a secondary experiment, it was initially planned to perform in time difference of arrival (TDOA) experiments. For more information on this, also known as multilateration or delta-differential one-way ranging (delta-DOR), see:

http://www.nsti.org/procs/MSM2000/5/T51.03 .

Rein, W6SZ, also referred me to:

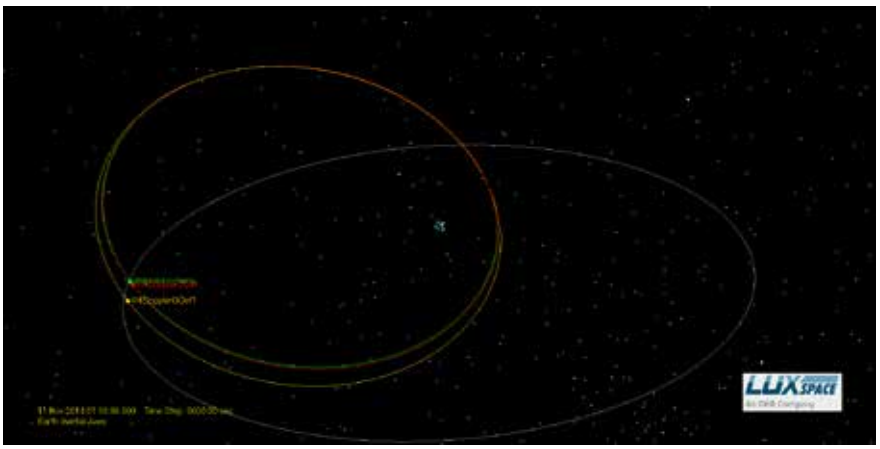
http://www.ham-radio.com/sbms/presentations/N5BF/courtney%20duncans%20talk.pdf .

For this, we set up the necessary routines using MATLAB. The objective was to provide a more accurate estimate of the trajectory before the fly-by. We weren't optimistic about this, since measurement accuracy shorter than 1 ms was required, and the Windows operating system does not readily lend itself to such accuracy and precision.

The result of the multilateration was even worse. If many stations used time synchronisation systems based on network time protocol (NTP), the configuration of the NTP was generally poor, rendering it useless. However, it at least clearly indicated the way to improve this.

Also considered was frequency difference of arrival (FDOA), though we were not optimistic about it, either. It came, however, as a real surprise to see it working properly. The reason was that the frequency offset of the stations was rather stable and so, also, was the frequency of 4M. The process included the minimization of a cost (i. e., objective) function that computed the difference between the measured and computed Doppler values. The stability of the frequency offset allowed it to be considered as an input variable (which had to remain fixed during the process) in that minimization.

Results were very good until the transmissions from 4M ended.



At the beginning of October 2014, Michael Johnson, M0MJJ, also came with a proposal to use the LOFAR radio telescope network in Europe as a means of accurately determining the position and trajectory of 4M. We worked together to set up the experiment, but due to software errors, the LOFAR array was not pointing in the right direction and the 4M signal was not acquired before lunar fly-by. Another attempt was scheduled after the fly-by, but 4M stopped transmitting before this was possible.

Future Plans

Another mission to the moon is being planned for near the end of 2017, and we've already booked a place on it.

The planned trajectory is similar to that of Chang'e 5T1, albeit much better controlled, plus the probe will be an independent spacecraft. The plan is for a scientific mission with the objective being the study of the far magnetosphere and magnetopause, and, possibly, the detection of near-Earth objects (sometimes referred to as NEOs). Our plan right now is to use our rugged and successful extended Triton1 platform, which presently is in commercial service on other missions.

Currently, we are searching for funding and investigators willing to contribute experiments.

AMSAT has been able to preserve our publications from 1969 through 2013 on a DVD disk. The DVD contains the AMSAT Newsletters, Orbit Magazine, Satellite Report, and the AMSAT Journal. Introduced at the 2014 AMSAT Symposium in Baltimore, the DVD is now available in the AMSAT on-line store :

http://store.amsat.org/catalog/ .

Ballistically Reinforced Communications Satellite (BRICSat-P): The Enhancement of the APRS Amateur Radio Network through Micropropulsion

ENS Christopher Dinelli, USN, MIDN 1/C Ian Maloney, MIDN 3/C Edward Hanlon, Samudra Haque, George Teel, Joseph Lukas, Dr. Michael Keidar, Captain Kristen Castonguay, USAF, Mr. Robert Bruninga, WB4APR, Dr. Jin Kang, KB3UKS

Up until recently, CubeSats have often been seen as a secondary payload on launch vehicles and used to perform amateur science experiments. With the establishment of the amateur radio network, CubeSats found a new purpose to support this capability for users worldwide to have access. With this access, students from anywhere around the globe can perform different experiments and share scientific studies in accordance with the Amateur Radio License regulations. This establishment of the Automatic Packet Reporting System (APRS) brought an even greater capability for establishing the network and ultimately CubeSats as an education force multiplier. In 2002, the idea of the PSK-31 Linear/FM satellite transponder was born consisting of a PC sound card and radio to transmit weak narrowband digital communications to allow for an easy application to CubeSats. Many users can take advantage of the narrow bandwidth without hindering the normal operations of satellites.

The researchers at the United States Naval Academy have been working on integrating the PSK-31 radio onto two of their satellites: PSat and BRICSat-P. The main mission objective for the Ballistically Reinforced Communications Satellite (BRICSat-P) is to research different ways to increase the lifetime of satellites in orbit. One of the ways to do this is through propulsion for attitude dynamics and control (ADCS) maneuvers as well as orbit changing. CubeSats have become an important part in keeping the APRS network alive that was established by the United States Naval Academy. The remaining Naval Academy satellite, PCSAT, is unreliable, and ARISS which resides on the ISS is weak on the downlink. Another CubeSat APRS capability is needed in order to continue to provide amateur radio service for users worldwide. More importantly, in order for the CubeSat technology to continue to meet mission demands and progress in the phases set forth by the AMSAT phase system, a feasible propulsion system is needed to support CubeSat operations. In order to reach the high level of phases for future CubeSats (4 and 5) that demand orbit changing and interstellar travel, an advanced propulsion system is needed to make these phases attainable, opening the community to develop higher level CubeSats and further expand the amateur radio network.

CubeSat Propulsion is not a new idea, and the concept has been explored by many engineers in the past. There have been many different designs for propulsion for CubeSats. However, very few have proven to be feasible for CubeSat applications in areas of attitude control, orbit changing, and deep space travel. Many chemical propulsion systems often incorporate the use of toxic propellants such as hydrazine and have extremely low specific impulse values (usually around 200 – 500 seconds), which indicate that they can only burn for a relatively short amount of time. Recently, the Micro-propulsion and Nanotechnology Laboratory (MpNL) at The George Washington University, has developed a micropropulsion subsystem, generating quasi-neutral plasma, called Micro-Cathode Arc Thruster (μCAT). The final thruster system delivered to BRICSat-P is shown in Figure 1.

Figure 1. μCAT Thruster System for the BRICSat-P mission.

The thrusters have specific impulse values of approximately 3,000 seconds, which indicate that they can fire for a much longer time (ten years) compared to the best chemical micropropulsion systems which last only several hours. The thrusters also only draw 0.1 Watts of power while being fired at 1 Hz. With the incorporation of a duty cycle, the power requirement can further be reduced. The mass of the entire thruster subsystem is approximately 300 g, and it can produce impulse-bits of 1u-Ns per pulse, giving it the potential to perform complex attitude dynamics and control (ADCS) maneuvers as well as orbital changes and deep space travel capabilities. The thrusters have been fired in the vacuum chamber and shown to work experimentally. The thruster works by creating an arc of current between the anode and cathode that is separated by an insulator. This erodes the titanium cathode which is accelerated by the magnetic field to produce thrust. A diagram is shown in Figure 2.

With this new technology, the researchers at the United States Naval Academy and The George Washington University have collaborated to work on integrating the propulsion system onto a 1.5U CubeSat in order to perform orbital maneuvers in space to fully characterize the system and show that it is capable of supporting CubeSat class missions. The main objective was to integrate as many thruster systems in the 1.5U CubeSat that would be able to support attitude dynamics and control simulations without drawing too much power to prevent the use of the PSK31 radio for the Amateur Radio Network and communicate with the Naval Academy ground station

The BRICSat-P satellite consisted of four full thruster systems successfully integrated onto a 1.5U CubeSat that will demonstrate three maneuvers in space: de-tumbling, controlled rotation, and a delta-V scenario seeking an orbit increase of five degrees. Figure 4 shows the final satellite design, and Figure 5 shows the final satellite that was constructed by the Naval Academy. The command data and handling systems, PSK31 radio, and power systems composed half of the CubeSat volume, leaving 6 cm available for the thruster systems. A camera has also been integrated onto the CubeSat in order to take pictures of the plume to be sent to the Naval Academy ground station. The entire system was constructed, tested, and flight qualified at the United States Naval Academy.

After initial expulsion from the launch vehicle, the CubeSat will autonomously de-tumble and stabilize its rotation about each axis to

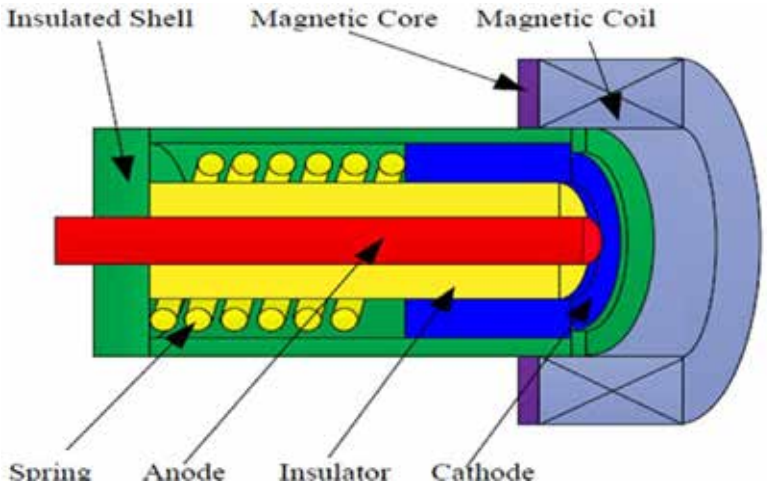


Figure 2. This shows the breakdown of the propulsion system.

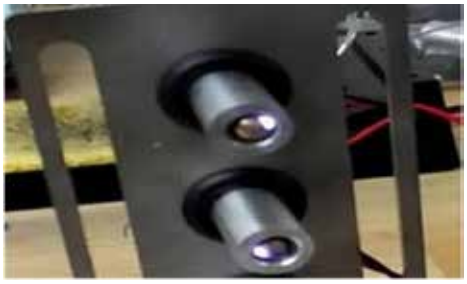


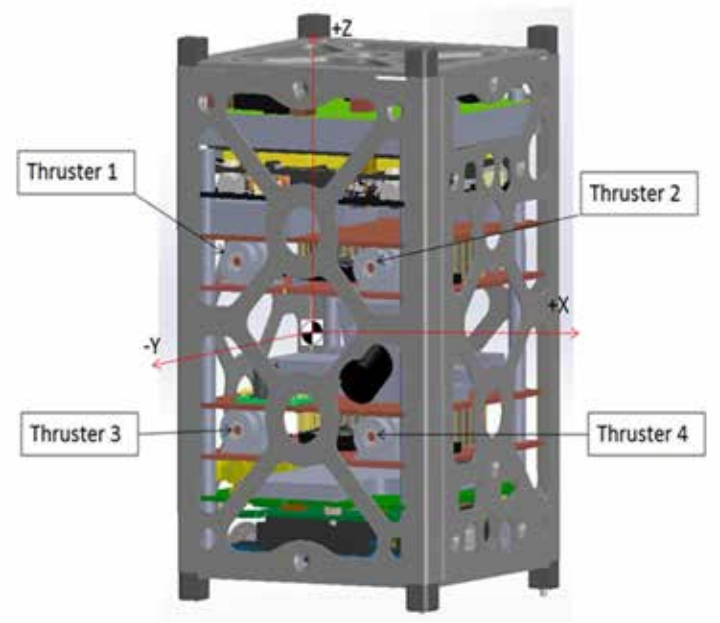
Figure 3. This shows the successful firing.

approximately 1 deg/sec using the thruster systems. The gyro will take measurements, and the control board will fire different configurations of thrusters based on firing algorithms developed by the Naval Academy to fully stabilize the satellite. The entire de-tumbling operation will be performed autonomously. MATLAB Simulink was used to model the environmental effects that the satellite will experience and predict the thruster's performance in orbit. The results for de-tumbling at a 4.5 cm separation are shown in Figure 6.

Different configurations and placements were analyzed to determine the optimum performance for the thrusters in orbit. It was determined that an X-wing configuration shown in Figure 2 provides the best results for de-tumble while making the delta-V scenario less complex at a 4.5 cm separation straddling the CubeSat's center of mass. Once stabilized, the satellite will provide radio communications for users and communicate the results to the Naval Academy ground station.

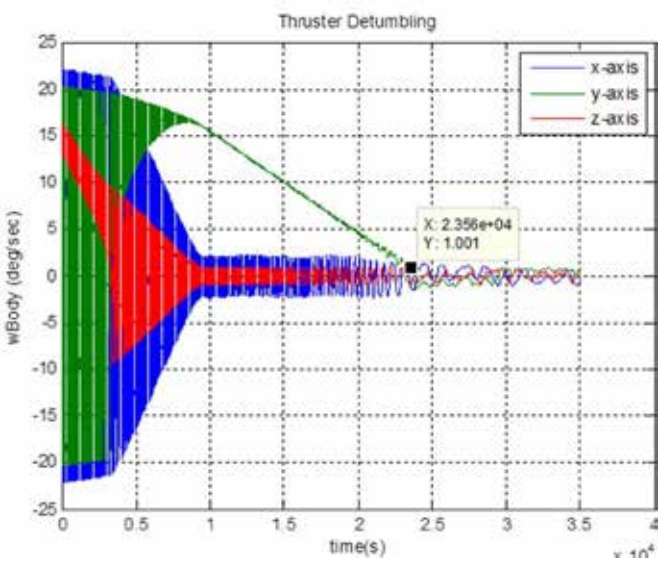
The thrusters will then proceed to spin the satellite around both the major (x) and the minor (z) axes at a rate of 20 rev/min and stabilize the structure per orbit while taking pictures of the thruster plume and relaying the images back to the Naval Academy ground station. Power analysis was performed to determine the amount of power that will be needed during these operations. The thrusters have been designed to only require 1 Watt of power to fire at 10 Hz. Using the power numbers generated from the Systems Tool Kit, each orbit would provide an average orbit power of 3.25 Watts. Thus, the operations can be supported on pure solar power especially when incorporating a 50% duty, which the BRICSat-P thrusters will operate on during the de-tumbling. The novelty is that the thrusters are capable of performing ADCS operations without an over consumption of power to prevent the communications using the PSK-31 radio, which is unlike most electric propulsion systems that require large amounts of power.

Lastly, the final mission to fully characterize the thruster system is to demonstrate an orbit change maneuver. The four thruster system integrated onto the 1.5U CubeSat has an effective delta-V of 2.454 km/sec. With this delta-V, the satellite has the potential of making significant orbital altitude changes greater than 2,000 km and inclination changes greater than 5 degrees through a gentle spiral transfer. Both of these maneuvers have



(above) Figure 4. Final BRICSat-P Satellite Design

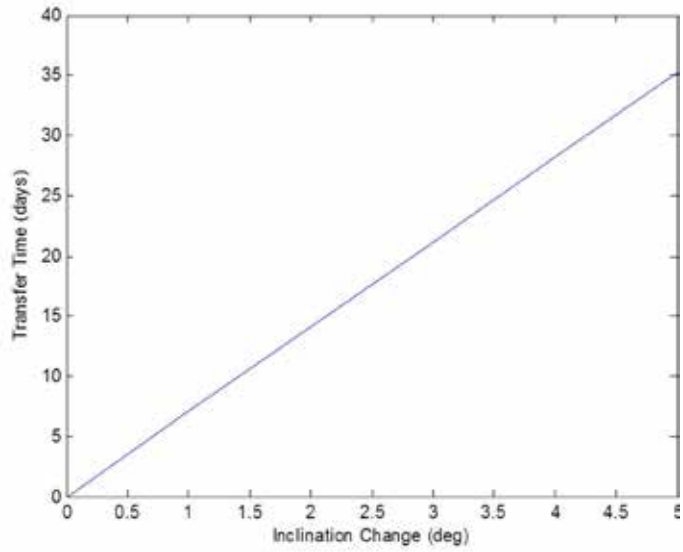
(below) Figure 5. This is final construction of BRICSat-P.



(left) Figure 6. This plot shows the de-tumbling when the thrusters were placed at the optimum configuration.

(below) Figure 7. This plot shows the 5 degree inclination change performed by the µCAT thrusters.

yet to be demonstrated for an electric propulsion on a CubeSat. A simulation was performed in MATLAB for the current satellite to perform a 5 degree orbit transfer. The results are shown in Figure 7 that indicate the transfer is possible within 35 days, which is quick compared to most electric propulsion systems. This calculation was done when operating at only one hemisphere of orbit in sunlight. Thus, the propulsion is capable of performing complex attitude control and orbital change maneuvers while not draining too much power to hinder the use of communications. This feature adds a new capability to the AMSAT network to further expand its reach. The maneuvers will be performed in orbit to fully validate the thrusters next year.



Satellite operators after working AO-73 from the AMSAT Symposium in Linthicum, Maryland (FM19) on October 11, 2014. Left to Right: Hector Martinez, CO6CBF/W5CBF, Paul Stoetzer, N8HM, Michael Kirkhart, KD8QBA, Clayton Coleman, W5PFG, and Wyatt Dirks, AC0RA

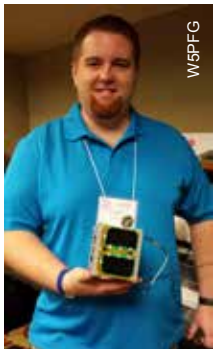
Report From the 2014 AMSAT Space Symposium and Annual Meeting

AMSAT held its 32nd Annual Space Symposium and Annual General Meeting and Board of Directors meeting in Baltimore, Maryland, from October 9 to October 12, 2014. A huge vote of thanks and congratulations are in order to the organizing team led by Frank Bauer, KA3HDO and Janet Bauer. The Symposium committee included Martha Saragovitz, Martin Cadirola, NV3V; Tom Clark, K3IO; Art Feller, W4ART; Perry Klein, W3PK; Marilyn Mix; Dan Schultz, N8FGV, John Shew, N4QQ; Lou McFadin, W5DID, and Dave Jordan, AA4KN.

The Symposium featured:

- AMSAT Board of Directors Meeting - October 9 - October 10
- 30th Annual 2012 AMSAT Space Symposium October 10 - October 11
- AMSAT Annual Group Meeting - October 11
- Field Coordinator's Annual Breakfast - October 12
- Tour of the Udvar-Hazy Air and Space Museum – October 13

2014 marks AMSAT's 45th anniversary and AO-7's 40th anniversary.



Clayton Coleman, W5PFG with the Fox-1 engineering model. The model was on the air during the Symposium.

Summary of the Board of Directors Meeting

The Board of Directors meeting on October 9 - October 10 was open to all AMSAT members. Full details of the Board's actions and department status will be documented in the released meeting minutes in a future issue of the AMSAT Journal. Here is a summary of the Board's discussions. These were also shared with all of the attendees at the Annual General Meeting on October 11.

Barry opened by welcoming the Board members, officers, and visitors. He then presented the slate of AMSAT-NA Officers who were approved by a vote of the Board.

After the vote, Barry added that in addition to the open positions, there are positions which will become vacant in the near future, and that AMSAT-NA needs to plan for succession to insure continuity. Director Tom Clark, K3IO mentioned that the Executive Vice-President position is a particularly important one to be filled.

AMSAT President, Barry Baines, WD4ASW presented the 2014 President's Report. To focus the discussion on AMSAT's goals and accomplishments Barry reminded us of AMSAT's Mission and Vision designed to "Keep Amateur Radio in Space"

Barry's President's Report was shared again with the membership during the annual general meeting. AMSAT's list of accomplishments for 2014 is impressive. Watch for an announcement via the AMSAT News Service for news of the release of the video.

Barry's discussion included:

- The 2014 AMSAT Office Move
- Upcoming launches
- ARISS Program Changes and Educational

AMSAT Board Members Present at the 2014 Meeting in Baltimore
Barry Baines, WD4ASW, President
Alan Biddle, WA4SCA, Corporate Secretary
Jerry Buxton, N0JY Vice-President for Engineering
Tom Clark, K3IO, Clarksville, MD
Drew Glasbrenner, KO4MA, Vice-President for Operations, First Alternate Board Member
JoAnne Maenpaa, K9JKM, Vice-President for User Services
Lou McFadin, W5DID, Orlando, FL
(Board Member Mark Hammond, N8MH and Second Alternate Board Member Frank Griffin, K4FEG were unable to attend)
Other Officers Present
Frank Bauer, KA3HDO, Vice-President for Human Space Flight
Keith Baker, KB1SF/VA3KSF, Treasurer
EMike McCardel, KC8YLD, Vice-President for Educational Relations
Patrick Stoddard, WD9EWK, Director of Field Operations
Martha Saragovitz, Manager

The following officer positions were voted upon and filled:	
Barry Baines, WD4ASW	President
Drew Glasbrenner, KO4MA	Vice-President Operations
JoAnne Maenpaa, K9JKM	Vice-President User Services
Jerry Buxton, N0JY	Vice-President, Engineering
Frank Bauer, KA3HDO	Vice-President Human Spaceflight
Alan Biddle, WA4SCA	Corporate Secretary
Keith Baker, KB1SF/VA3KSF	Treasurer
Manager, Martha Saragovitz	Manager
Senior Officer positions remaining open awaiting appointment	
Executive Vice-President	
Vice-President Marketing	
Key leader positions filled by Presidential appointment included:	
E.Mike McCardel, KC8YLD	Vice-President Educational Relations
Patrick Stoddard, WD9EWK	Director Field Operations
Steve Belter, N9IP	Dayton Hamvention Operations
JoAnne Maenpaa, K9JKM	Editor AMSAT Journal (new editor to be appointed)
Lee McLamb, KU4OS	Editor AMSAT News Service
David Taylor, W8AAS	ARISS International Delegate
Stefan Wagner, VE4NSA/VE4SW	ARISS International Delegate
Joe Fitzgerald, KM1P	IT Team Leader

AMSAT President Barry Baines, WD4ASW.

AMSAT Vice President Human Spaceflight, Frank Bauer, KA3HDO.

AMSAT Vice President Educational Relations, E. Mike McCardel, KC8YLD.

Outreach
- Transition from ITAR to EAR
- Experimental Licensing vs. Amateur Radio Satellite Licensing
- The Continuing Slow Membership Decline
- Events in AMSAT-IT

The 2014 AMSAT Office Move

Martha and Barry reviewed changes and concerns for the AMSAT office. The first move by AMSAT in 30 years was carried out with the help of AMSAT members. Bob McGwier, N4HY, was recognized for transporting and storage of AMSAT's archives. The new facilities are safer and in much better repair than the old Silver Spring office, though somewhat smaller.

Upcoming Launches

- AMSAT continues to work on the Fox-1 launch schedule as planned. New launch opportunities have also been identified.
- Fox-1A will launch on a NASA ELaNa flight during the 3rd quarter of 2015 from Vandenberg AFB.
- Fox-1B will fly with the Vanderbilt University radiation experiments expected in 2016.
- Fox-1C will launch on Spaceflight's maiden mission of the SHERPA multi-cubesat deployer during the 3rd quarter of 2015.
- Fox-1D is a flight spare for Fox-1C. If not needed as a spare it will become available to launch on any open launch slot which becomes available and be submitted in a Cubesat Launch Initiative (CSLI) proposal in 2015.
- Fox-1E is built as a flight spare for Fox-1B but has been included in a student science proposal as part of the November, 2014 CSLI for an ELaNa flight slot. If selected the Fox-1B spare will fly as Fox-1E.

ARISS Program Changes

During 2014, NASA budget issues resulted in NASA Education no longer funding the ARISS program. New funding has been secured to keep this key school program operational. Led by Frank Bauer, KA3HDO, ARISS was able to work with NASA Space Communications and Navigation (SCaN) to provide funding for one-half of requirements in FY 2015 . Additionally, ARISS submitted a proposal to become a Center for the Advancement of Science in Space (CASIS) ISS Payload. CASIS is a non-profit organization to help facilitate U.S. National Laboratory opportunities aboard the space station. There remains a need to find outside funding sources.

Educational Outreach

AMSAT's Educational Outreach includes finding new opportunities to bring space communications to the classroom. During the past year, this has included collaboration with ARRL Education's Teacher Institute Process.

Collaborations with university partners to expand Educational Outreach were announced. AMSAT and Virginia Tech's Hume Center will develop educational outreach in the form of lesson plans in conjunction with teachers who are amateurs. Initially the concept will be trialed with outreach to public schools in southwest Virginia.

AMSAT Vice-President Educational Relations, E. Mike McCardel, KC8YLD, reviewed his work involved in building relationships, outreach to assist others with the ultimate purpose of Keeping Amateur Radio in Space. He mentioned that his outreach included many traditional groups such as the ARRL, Virginia Tech's Hume Center, and NASA, but also unconventional groups such as the Star Trek Science Club.

He moved on to the various events where he gave presentations. The principle ones were at the annual Dayton Hamvention, the ISS Research and Development Conference, and the ARRL Centennial. Each provided an opportunity to interact with and develop working relations with various groups with common educational interests.

Transition from ITAR to EAR

While changes in the ITAR regulations in November, 2014 removed amateur radio satellites from the U.S. Munitions List (USML), the concept of "Deemed Exports" was retained for former ITAR items. A deemed export still includes any technical exchange of covered items, even if it takes place within the US, whether by e-mail, teleconference or face-to-face conversations. An export license will be required under Export Administration Regulations (EAR). While the process changes are still evolving, it is hoped that gaining permission to collaborate with foreign nationals "should" be easier.

Dr. Kira Gantt and Zack Leffke reviewed the Virginia Tech-Hume Center programs, and their need to comply with ITAR and now the EAR regulations. Kira reported that VT Office of Export and Secure Research Compliance (OESRC) has dedicated personnel and resources and, if a formal relationship can be developed, can be of use to AMSAT.

Issues of Licensing CubeSats

The Federal Communications Commission (FCC) expressed concerns that university satellites are operating under amateur radio licensing solely for forwarding telemetry to their ground station as a "convenience",_with no amateur radio community involvement. ARRL's Dave Sumner, AMSAT's Tony Monteiro and Barry Baines met with the FCC Wireless Bureau (Amateur Radio), FCC International Bureau (Satellite Licensing), and the FCC Office of Technology (Experimental Licensing) regarding the applicability of Experimental Licensing vs. Amateur Radio Satellite Licensing.

The ARRL, AMSAT and the National Science Foundation (NSF) endorse the use of the Amateur Satellite Service by non-commercial, university CubeSats. AMSAT recognizes significant positive impact of university CubeSat programs toward affording launch opportunities as NASA and other government policies encourage development of university satellite programs. Students and staff are encouraged to embrace amateur radio through obtaining new licensees and establishing amateur radio ground stations. This provides the potential for more amateur radio communications satellites as the Fox-1 design is made operational, allowing both scientific payloads and amateur radio operations to be supported through a robust and dependable RF design.

Events in AMSAT-IT

AMSAT's IT Team Leader, Joe Fitzgerald, KM1P, reported our servers have completed the full migration to the AMSAT site in Michigan. Features including the Pass Prediction page are running on our site with updated graphics and

links. ARISS support also has transitioned to the new server.

Continued improvements of the AMSAT web site, along with additional content, is planned during the coming year as the web page and editorial content team comes together.

Secretary's Report

Corporate Secretary Alan Biddle, WA4SCA, reported that there have been five formal Board meetings held by teleconference calls this year. The minutes of three have been approved and published in the AMSAT Journal with publication of the remaining minutes pending room in upcoming issues of the Journal.

Key points of discussion are summarized as:

- Authorization for Drew as Vice-President for Operations to negotiate with Spaceflight, Inc. for the commercial launch of a Fox-1 series CubeSat;
- A second meeting authorized the change to AMSAT's accounting procedures from yearly to biannually, the approval of earlier minutes;
- Additional issues involving the Spaceflight, Inc. negotiations of which some issues remain confidential due to the non-disclosure agreement with Spaceflight, Inc.

Alan reported that the secondary AMSAT logo, to be used along with the traditional one which serves as the basis of logos used by AMSAT organizations around the world, has been recognized as an official trademark.

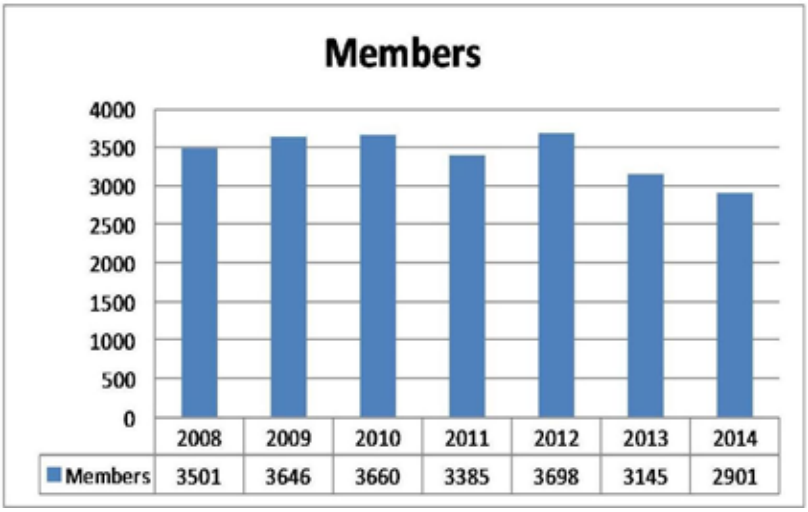
Satellite Operations Report

AMSAT Vice President Operations, Drew Glasbrenner, KO4MA, reported on the current state of existing satellites. AO-7, approaching its 40th anniversary, continues to be used due to its wide coverage. FO-29, especially after the loss of VO-52 continues to be popular, but is nearing 20 years of service. The only functioning FM satellite, SO-50, is in heavy use despite its low output power and one or more replacements are badly needed. AO-73 has attracted many users despite its relatively limited availability for amateur use. He added that UKube-1, EO-79 and EO-80 will have capabilities of interest to amateurs, but have not been released for amateur use.

Lou McFadin, W5DID, reported on the AMSAT-NA facilities in Central Florida. The facility, suitable for storage as well as development and testing, is air conditioned and secure. The thermal vacuum test equipment operation has been upgraded with a "hot and cold plate" needed to cycle the temperature in component testing.

User Services Report

AMSAT Vice President User Services, JoAnne



The Continuing Slow Membership Decline

Barry noted the flat/declining AMSAT membership as a major concern. Various causes identified as contributing factors include an aging amateur population, a relative lack of satellites, lagging interest in AMSAT, and the impact of social media and the internet causing younger amateurs different expectations toward joining organizations.

The result is that an overall membership decline has had major impact that income from dues and other sources are not sufficient to cover day-to-day expenses. The projected operating deficit in 2015 approx. $61K. AMSAT will need 1,386 additional members @ $44.00/year to break even. At present operating losses covered by reserves, non-designated donations. Since growing membership is critical to sustaining AMSAT members are encouraged to recruit others to join AMSAT in order to increase cash flow to pay the bills.

Funding issues for the Fox-1C satellite include the fact that this launch was paid for by borrowing from AMSAT's reserve funds. We must now pay ourselves back to replenish the reserve funds which are used for seed money to develop new satellite projects.

AMSAT's IT Team Leader, Joe Fitzgerald, KM1P.

AMSAT Corporate Secretary, Alan Biddle, WA4SCA.

Maenpaa, K9JKM, reported on *The AMSAT Journal*, AMSAT News Service, Electronic Services, Field Operations, and the Dayton Hamvention. In light of the rapidly expanding new media where information is often released in minutes, the *Journal* is becoming more a source of reference and in depth articles rather than breaking news.

The AMSAT News Service continues to be the official voice of AMSAT for breaking stories with other news services looking to it for verification.

A new DVD developed by Les Rayburn, N1LF containing the AMSAT Journal and other historical publications since 1969 is now available through the AMSAT Store.

AMSAT's use of social media is expanding through the use of Twitter, Google+, YouTube and Facebook. Followers of these AMSAT-NA accounts are increasing rapidly, and exceed those using the older communication outlets.

Dayton 2014

Steve Belter, N9IP reported this year we had 52 volunteers which is possibly a record. Everybody enjoyed the opportunity to participate. There were several adjustments for 2014. The new "Beginner's Corner," staffed by highly experienced operators, was a popular place for new and potential members and operators to ask questions without impeding the other booth activities. We also made a concerted effort to

Continued on page 25 ...

Rotor Controller Box/Boards Available

LVB Tracker Box

- Reasonably priced and all profits go to AMSAT
- Serial interface standard
- USB interface may be easily added by user
- Open software
- Open architecture
- Built-in rotor interface cable with DIN connector
- Power supplied via the rotor controller cable
- Bi-directional interface allows the unit to read the rotor position
- LCD position readout
- Front panel manual control
- Self-programmable, allows for easy software upgrades
- Supported by the major tracking programs
- Uses GS-232A or Easycomm I/II protocols

Contact Martha at the AMSAT office 301-822-4376 to order.

The complete units will be built in groups, so get your orders in early. Units will be shipped as they become available.

Minimum donations requested for various configurations:

1) Bare board - $20 + S&H – no parts kits available
2) Custom Enclosure powder coat, silk-screened, drilled/punched - $50 + S&H
3) Complete unit - board, serial output, rotor cable, LCD, enclosure - $200 + S&H **our most popular

Documentation for the LVB Tracker can be found at: http://www.LVBTracker.com

Boards and complete units may be ordered from the AMSAT office at 301-822-4376 or from martha@amsat.org

Visit the AMSAT On-Line Store for details on the updated LVB Tracker Box: http://store.amsat.org/catalog

AMSAT Fox-1C $125,000 Launch Initiative Goal ... Your Help is Needed!

AMSAT is excited to announce a launch opportunity for the Fox-1C Cubesat. AMSAT has teamed with Spaceflight for integration and launch utilizing Spaceflight's SHERPA system to a sun-synchronous orbit in the third quarter of 2015.

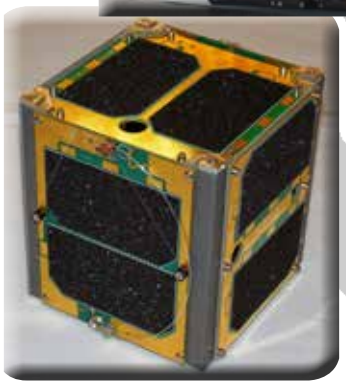
Fox-1C is the third of four Fox-1 series satellites under development, with Fox-1A and RadFXsat/Fox-1B launching through the NASA ELaNa program. Fox-1C will carry an FM repeater system for amateur radio use by radio hams and listeners worldwide. Further details on the satellite and launch will be made available as soon as released.

AMSAT has an immediate need to raise funds to cover both the launch contract and additional materials for construction and testing for Fox-1C. We have set a fundraising goal of $125,000 to cover these expenses over the next 12 months, and allow us to continue to keep amateur radio in space.

Spaceflight's SHERPA will deploy multiple cubesat payloads on-orbit

Spaceflight's SHERPA System

ISIS QuadPack Nanosatellite Dispenser



Your help is needed to get the AMSAT Fox-1C 1U Cubesat launched on the Spaceflight's initial SHERPA flight in 3Q 2015.

For the latest news on Fox-1 watch our website at www.amsat.org, follow us on Twitter at "AMSAT", or on Facebook as "The Radio Amateur Satellite Corporation" for continuing news and opportunities for support.

Donations may be made through the AMSAT webpage at www.amsat.org, by calling (888) 322-6728 or by mail to the AMSAT office at 10605 Concord Street, Kensington, MD 20895, USA. Please consider a recurring, club, or corporate donation to maximize our chance of success with this mission.

AMSAT President's Club
Support Fox-1C ... Join Now!

Contribute to AMSAT directly through easy, automatic charges to your credit card. Since AMSAT is a 501(C)(3) organization donations may be USA tax deductible. (Check with your tax advisor.) To join contact Martha at the AMSAT Office by phone (888) 322-6728 in the US, or (301) 822-4376; e-mail martha@amsat.org.

Titanium Donors contribute at least US $400 per month	❒	$400 / month
	❒	$4800 one time
Platinum Donors contribute at least US $200 per month	❒	$200 / month
	❒	$2400 one time
Gold Donors contribute at least US $100 per month	❒	$100 / month
	❒	$1200 one time
Silver Donors contribute at least US $50 per month	❒	$50 / month
	❒	$600 one time
Bronze Donors contribute at least US $25 per month	❒	$25 / month
	❒	$300 one time
Core Donors contribute at least US $10 per month	❒	$10 / month
	❒	$120 one time

Support our 2014 Prize Donors!

AMSAT thanks our prize donors for the 2014 Symposium. These were drawn during the Saturday evening banquet. Keep our sponsors in mind over the coming year.

AMSAT Thanks Our 2014 Prize Donors	
Company	Donation 2014
Flex Radio Systems	Flex 1500
Bird Technologies Group/ TX RX Systems	Bird Model 43 Thruline Wattmeter & certificate for 1 element
NCG-COMET	Comet CAA-500 Antenna Analyzer, 1.8 - 500 MHz
PEET Brothers Company Inc.	Ultimeter 2000 Weather Station
M2	2M/70CM VHF 3ele/UHF 6ele Yagi Model no. 2M-440 XPSS
Arrow Antennas	Arrow Antenna with Carrying Bag
West Mountain Radio	Computerized Battery Analyzer
Ten-Tec. Inc	Ten-Tec DX Pro Headset-Stereo
Elk Antennas	2M/440 L5U Dual band
Directive Systems	Certificate for $100 off of any antenna or related accessory
InnoVantennas	Certificate for $100 on any yagi or other antenna
High Sierra Microwave (Bill Ress - AMSAT member)	70 cm low noise Pre-amp Model LNAA-432-NFBF
Diamond	2M/70CM Hi Performance Gain Vertical antenna, 2m/70CM Mobile P/N NR77CA 0HB, (2) 2M /70CM Broad band RCV P/N SRH 77CA
QSL Man	(2) 250 QSL packages
ARRL	(1) $50 gift certificate and (2) $25 gift certificates
Down East Microwave	(1) $50 gift certificate and (2) $25 gift certificates
RT Systems	1 - RT Systems Software gift certificate
HRO Ham Radio Outlet	Amateur Radio Astronomy book and The ARRL Satellite Handbook
AMSAT	DVD with AMSAT Journal archives
Wireman Inc.	25 ft 8X Low Loss Cable, Wirebook V, 12 pk Silver/Teflon PL259 Connectors
AES amateur Supply	(2) $25 gift certificates
Quicksilver Radio Products	Precision Wattmeter and Power Analyzer
Budwig	(2) HQ1 dipole ctr. Insulators and HQ-pair of dipole end insulators
R & L Electronics	JTSeal Weather Proofing Kit
Nifty Accessories	(3) E-Z PSK31 Guide Books
Skycraft Parts and Surplus	Qtest Analog meter, ITT Security Bit Set,Exacto Hobby Knife Set, SE Precision Screwdriver set, Perfect Tool - Acces. Kit, Magnifier table
Bongo Ties	Bongo Ties - 24 packages of 10 ea.
Pittsburgh	6 piece screwdriver set
Cen-Tech	(4) 7 Function Multimeter #98052
HFT	(2) 3.5 in mini flashlight P/N 69052

Congratulations to our Grand Prize Winners	
John Shew, N4QQ	Peet Brothers Inc. Ultimeter 2000 weather station
Shamai Opfer, 4Z1WS	Bird Technologies Model no. 43 Wattmeter w/choice of band element
Damian E. Schumacher, AG9P	Flex Radio Systems Flex Radio 1500
Jan A. King, W3GEY	M2 Antenna Systems Inc. 2m/70cm yagi Model no 2M-440 XPSS
Perry L. Klein, W3PK	Comet CAA-500 Antenna Analyzer

AMSAT President Barry Baines, WD4ASW has posted a copy of the slides he presented during the AMSAT Annual Meeting in Baltimore, MD on the web. Go to:

http://www.amsat.org/?page_id=1512

Scroll to the bottom and click the link, “2014 Presidential State of the Organization Presentation.”

AMSAT Vice President Operations, Drew Glasbrenner, KO4MA.

AMSAT Vice President Engineering, Jerry Buxton, N0JY.

AMSAT Director Field Operations, Patrick Stoddard, WD9EWK.

... Continued from page 21

recruit new members, primarily through the basic step of asking interested people to join or renew. This simple step was very effective and will be further developed next year. The basic layout of the booth proved to be functional, and the modest expenditure for carpeting to join both sides of the aisle resulted in an eye-catching, professional presentation. People were more likely to browse both sides. Demand for AMSAT books and equipment was unusually high this year, with several items sold out by early Saturday afternoon. The AMSAT Forum continues to draw well, and the presentations are being recorded and placed on the AMSAT YouTube channel.

Field Operations

Director of Field Operations Patrick Stoddard, WD9EWK, discussed the activities of Field Operations over the past year. There has been representation at 28 different events. There are currently 82 Area Coordinators, with approximately 25 in regular contact. He mentioned he is considering having Area Coordinators reapply to insure all those listed are still actively involved. One of the factors in the loss of Coordinators is that those who became active when High Earth Orbit satellites were the norm are not as invested in the current Low Earth Orbit missions.

AMSAT Engineering

AMSAT Vice President Engineering, Jerry Buxton, N0JY, reported the Fox project's launch provider had slipped the launch date but not the satellite delivery date, and introduced a requirement for a helium purge which has significant implications for the Penn State gyro experiment. The remainder of the schedule for Fox-1A is on time to be delivered in March 2015. Fox-1B, accepted, not manifested but with a very tentative July 2016 launch date. Fox-1C ,which is being launched in the 3rd quarter of 2015 under contract with Spaceflight, Inc. Fox-1D will be a flight spare, but available for a later opportunity.

Jerry discussed the upcoming Fox-2 series. We need a steady supply of fresh contributors, and a core group who will stay the course and provide support throughout the lifetime of existing satellites.

The next generation of satellites will involve much more demanding requirements for power, antennas, and pointing systems. Because of this, we need to examine proposals carefully, and insure when contacting launch providers and other institutions that we speak with a unified voice.

Jerry introduced the "Design The Next AMSAT Satellite" initiative to seek proposals from engineering teams for Implementation of future AMSAT satellites on a Cubesat platform. Proposals are due by May 30, 2015. Those proposals will be evaluated on the basis of technical merit, cost, user interest, and regard for how it fits into AMSAT's long term strategy. Proposals will be reviewed by the Engineering Team, Senior Officers/BOD, and "outsiders" (to be determined). One or more ideas will be selected for projects that satisfy our goals and strategy and for an ELaNa proposal to be submitted in November 2015.

Amateur Radio on the International Space Station

Dave Taylor, W8AAS, AMSAT-NA's U.S. delegate to the ARISS-International working group, discussed the April 2014 meeting at the European Space Research and Technology Centre (ESTEC) in the Netherlands. All 5 regions were represented. The primary theme was to improve international cooperation while enhancing enthusiasm. He finished with a review of changes in equipment in use. School contacts have been somewhat more challenging due to the switch to the Ericsson VHF HT with somewhat lower available power. Both the TM-D700s are no longer in service, and the TM-D710 in the Russian section is not programmed. He also discussed briefly the commissioning of the new Ham TV system, which is currently sending blank test transmissions.

Lou McFadin, W5DID, gave the Board an overview of the history of the AMSAT-Italia Digital Amateur Television (DATV), sometimes called "Ham Video" now installed in the Columbus module. This included the technical issues requiring the use of digital rather than analog systems. He reviewed the development process for the equipment, and the current state of testing. Frank explained that a there were several 2.4 GHz downlinks being tested and evaluated due to concerns with Wi-Fi and other terrestrial sources. They reported that initial testing is going well.

CubeSat Proposal for HEO

Bill Tynan, W3XO; Dan Shultz, N8FGV; Jan King, W3GEY; Phil Karn, KA9Q; and Tom Clark, K3IO, presented a proposal to develop a cubesat mission to high earth orbit (HEO). Bill began with an introduction to an innovative AMSAT response to NASA's interest in receiving proposals for a six unit (6U) cubesat projects to be deployed to either a Geosynchronous Transfer Orbit (GTO) or directly to a Molniya such as used by Oscar 10, 13, and 40. He explained that it would be advantageous to submit a proposal by the November 2014 deadline since there is a significant lead time involved, and launch slots are expected to fill rapidly. Nick Pugh, K5QXJ said that a HEO satellite is needed to reignite the AMSAT membership, while Dan said that anything innovative in orbit would be adequate to satisfy both members and launch providers.

Jan discussed with a significant amount of technical detail of the various technologies needed to operate a 6U cubesat in a high orbit. The driving technologies involved deployable solar arrays, precision three axis attitude control, 10 GHz and 24 GHz RF systems since traditional VHF and UHF frequencies are impractical, and as traditional analog technologies are inadequate to provide the required performance, adequate computer processing power to enable digital signal processing. Phil volunteered that adequate computing power required modest advances in the state of the art and could be a significant limitation. There were several questions about various aspects of the project. Drew expressed the concern that no existing amateur ground stations would meet the minimum equipment requirements and would require a significant expenditure on new equipment. He suggested that they should consider including a more traditional VHF-UHF transponder for the low and intermediate part of the orbit with the proposed microwave transponder used near apogee. This would allow significantly better communication range for those using existing equipment while allowing adequate scope for technical experimentation and innovation.

Goals and Expectations for 2015

Barry concluded his President's Report with a list of goals for the coming year:

- Recruit individuals to become members/ rebuild the 'base'
- Member's "word of mouth" is the most effective recruiting tool available
- Recognize that satellite projects are multi-year projects that require financial support each year
- Capital campaign programs provide specific funds for satellite projects
- Donate to our launch campaign for Fox-1C and future opportunities in 2015 and beyond as you are able
- Use the existing satellites—rebuild interest in amateur radio in space
- Write articles for the *AMSAT Journal*
- Provide content for website/webpage updating
- Volunteer your time and talent-identify a need and work to resolve it

In Conclusion ...

It is impossible to capture in words a gathering of the size and scope of an AMSAT Symposium. We will try to show as much as possible on a printed page with the photos included here for you to enjoy.

Last, but certainly not least, we are impressed by the 2014 AMSAT awards citations. This outstanding list demonstrates how our dedicated volunteers make AMSAT the best ham radio club in the world!

The AMSAT 2014 Space Symposium Photo Gallery

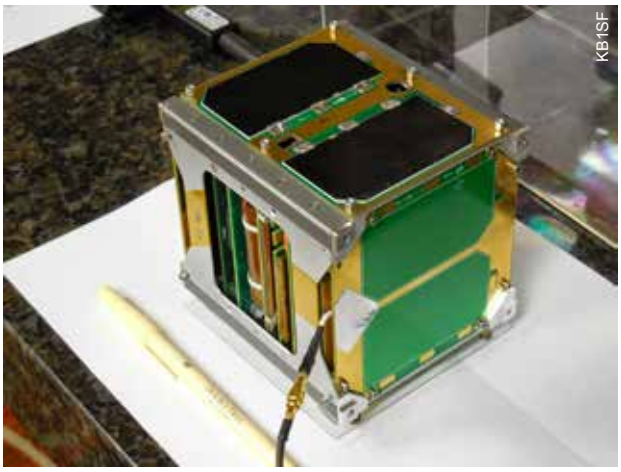
Our 2014 Symposium Co-Chairs Frank Bauer, KA3HDO, Janet Bauer, and daughter Michelle. Thank you for a superb meeting!

The weekend included a Board of Directors meeting, the Space Symposium, Friday night reception and auction, our annual banquet, Area Coordinator's breakfast, and a tour of the Udvar-Hazy Center at the National Air and Space Museum.

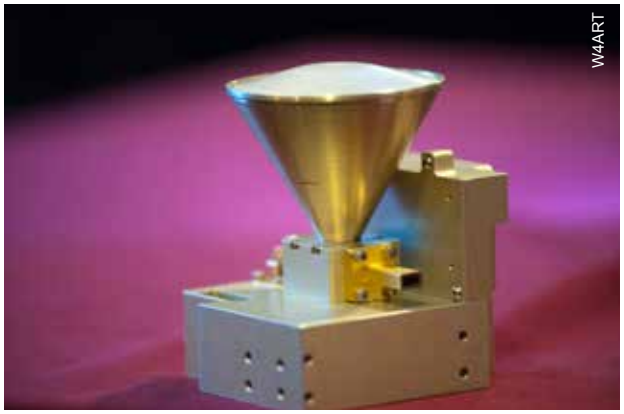
AMSAT's 45th anniversary included past presidents (L-R) Perry Klein, W3PK; Tom Clark, K3IO; Bill Tynan, W3XO; Keith Baker, KB1SF/VA3KSF; Rick Hambly, W2GPS; and current president Barry Baines, WD4ASW.

Frank Bauer, KA3HDO with Tuskegee Airman Col. Charles E. McGee, our special "Living Legend" speaker on Friday.

Barry Baines, WD4ASW shown presenting Mrs. Montiero, widow of Tony Monteiro, AA2TX (SK) with a framed copy of the inscription in honor of Tony which will fly on Fox-1A. It reads, "In Memory of Anthony Monteiro, AA2TX - May you rest with the stars".



The Fox-1A Engineering Unit transponder was on the air at 2014 Space Symposium. Attendees were able to work each other through the transponder and pose for pictures while holding the actual engineering unit. In addition, the slow speed telemetry that accompanies every voice ID beacon and transponder conversation was being received, decoded, and displayed for all to see.



The Symposium included opportunities to learn of current satellites such as $50sat (MO-76), one of the first four PocketQubes - the Next Small Thing in Satellites presented by (L-R) Michael Kirkhardt, KD8QBA and Howie DeFelice, AB2S, Possible future missions to high orbits on-board a 6U cubesat with microwave uplink and downlink were presented by Bill Tynan, W3XO, Jan King, W3GEY; Phil Karn, KA9Q, Dan Schultz, N8FGV; Nick Pugh, K5QXJ.

Other presentations included Fox Team Satellite Development, Changes to the ARISS program, the HAMTV system aboard the ISS, STEM education development with Virginia Tech, the high school STEM program at Shaftesbury High School with its newest ARISS ground station VE4ISS, grid operating, the U.S. Naval Academy BRICsat-P with microthrusters and PSAT - a PSK-31 satellite transponder, and a d emo of the 6U CubeSat Deployer by Ryan Henver, Planetary Systems Group.

The Friday evening reception featured a fund raising auction of AMSAT, NASA, and Russian spaceflight memorabilia. (left) Dave Taylor, W8AAS, Ken Ransom, N5VHO, Frank Bauer raise bids on Russian cosmonaut collectibles. (right) Ken Ransom, N5HVO displays the sign from the original AMSAT Lab at the Goddard Spaceflight Center. Other items for auction included autographed astronaut photos, satellite models, mystery radio parts, a lab coat from the original AMSAT Lab.

Recognition and Thanks to Our Dedicated Volunteers In 2014!

We are pleased to recognize our volunteers who have helped with the AMSAT mission during 2014.
Thank you for all you do for keeping amateur radio in space!

Presidential Recognition for Contributions to the AMSAT Mission		
Keith Baker	KB1SF	Thank you for your service as AMSAT Treasurer, guiding AMSAT through a transition to a different investment advisor, and working with our accountant on a an appropriate strategy for annual review of AMSAT finances.
Frank Bauer	KA3HDO	Thank you for successfully developing and implementing a strategy to keep ARISS functioning despite the loss of ARISS funding support from NASA Education. Your leadership has successfully dealt with the myriad of bureaucracies that impact the ARISS program. Your dedication and passion for it continues to inspire those whom you work with on ARISS. Your chairmanship of the 32nd AMSAT Space Symposium combined with your efforts to secure noteworthy speakers to help celebrate AMSAT's 45th Anniversary are appreciated. Finally, your help in updating the ISS chapter of "Getting Started" keeps this fascinating part of our hobby fresh and exciting.
Alan Biddle	WA4SCA	Thank you for your leadership in a number of critical AMSAT areas, including IT development, managing the AMSAT Forum at the Dayton Hamvention, and service as Corporate Secretary. Your advice and counsel are greatly appreciated. Thank you, as well, for co-chairing the AMSAT Dayton booth, and for helping to update the "Getting Started" book.
Jerry Buxton	N0JY	Thank you for assuming leadership of the AMSAT Engineering Team following the death of Tony Monteiro, AA2TX. Your leadership by example has inspired the Engineering Team and your countless man-hours focused on completing the Fox-1A project are deeply appreciated.
Wayne Estes	W9AE	Thank you for serving as an AMSAT consultant on the configuration and use of SATPC32. When an individual contacts the AMSAT office with questions, Martha depends upon you to provide expert guidance and assistance.
Burns Fisher, Jr.	W2BFJ	Thank you for your participation as an instructor at the AMSAT Satellite Workshop held in conjunction with the ARRL Centennial Convention in Hartford, CT this past July, and as a presenter at the AMSAT Forum. Thank you, as well, for your outstanding contributions to AMSAT Engineering for the Fox-1 Project as IHU software and software team co-leader.
Andrew Glasbrenner	KO4MA	Thank you for negotiating a contract with Spaceflight, Inc. to fly Fox-1C in Third Quarter 2015. Your persistence in successfully securing an alternative flight opportunity for the Fox-class satellites is a significant accomplishment for AMSAT.
JoAnne Maenpaa	K9JKM	Thank you for your continued leadership of the AMSAT Journal, a key membership benefit that is greatly appreciated by the AMSAT membership, and which is recognized as an outstanding publication by those in the amateur satellite community. Your leadership of the Assistant Editors ensures coverage of amateur radio in space and enables communication between the Officers and Board members with our membership. Your updates to the AMSAT web site keep it fresh, vibrant, and current. Your subsequent participation as a full member of the AMSAT Board of Directors earlier this year following the resignation of WA4SXM is also appreciated.
E. Mike McCardel	KC8YLD	Thank you for leading AMSAT's efforts on Educational Outreach. You have developed effective relationships with ARRL Education and other groups to create opportunities to use space-based assets in support of STEM. Your services as a presenter at the AMSAT Satellite Workshop held in conjunction with the ARRL Centennial Convention is deeply appreciated, as is your outstanding support to ARISS at the ISS Utilization Conference. Your networking with NASA and other stakeholders at the meeting helped lead to an historic restructuring of the ARISS program within NASA. Your hard work and dedication as a Weekly Editor of the AMSAT News Service in the publication of the weekly ANS Bulletins with its worldwide reach helps make it a highly regarded, quality publication.
Robert McGwier	N4HY	Thank you for handling the challenging task of protecting the fledgling "AMSAT Archives". You came to Silver Spring with a U-Haul truck and moving equipment to take filing cabinets and AMSAT objects of archival interest for safe-keeping when AMSAT was forced to locate to a different location that does not have the space to retain these items. Your dedication to protecting AMSAT's heritage is appreciated.
Peter Portanova	W2JV	Thank you for your leadership in guiding AMSAT's strategy for dealing with ITAR and the Export Administration Regulations as changes are taking place in how the exporting of communications satellites is controlled. You successfully developed relationships with key industry lobbying groups and, as well, established a line of communication with the Bureau of Industry and Security that will be helpful in the future as these regulations evolve. In addition, your participation in the AMSAT Satellite Workshop held in conjunction with the ARRL Centennial Convention as an instructor and, also, a presenter at the AMSAT Forum is appreciated.
Martha Saragovitz		Thank you for the significant effort in finding a suitable home for AMSAT and handling the transition to a new facility. Going through over 30 years of accumulated "AMSAT treasures" to identify what must be retained and what should be discarded, coupled with the challenges of preparing for and making the move, and then setting up a new office placed a significant burden on you. Thank you for handling this so well while maintaining a level of support for our members during the transition, and your outstanding support as a member of the 2014 AMSAT Space Symposium Committee. You were instrumental in ensuring Symposium success and guiding the team.
Gould Smith	WA4SXM	Thank you for your 25 years of dedicated service to AMSAT as VP-User Services, Director-Field Operations, Board Member, AO-51 Command Team member, Project Manager for the SuitSat-2/ARISSat-1 Project, and prolific writer of AMSAT books and periodicals. Your dedication to AMSAT coupled with your enthusiasm and willingness to go "beyond the call" are deeply appreciated.
Joe Spier	K6WAO	Thank you for your participation in the AMSAT Satellite Workshop held in conjunction with the ARRL Centennial. Your presentation at the Workshop, coupled with your time spent manning the AMSAT Booth, provided significant encouragement to both students visiting as well as those wishing to get started in working the satellites. Your hard work and dedication as a Weekly Editor of the AMSAT News Service in the publication of the weekly ANS Bulletins makes it a highly regarded for the quality of publication. Finally, thank you for your commitment to AMSAT's educational mission as Director of Educational Outreach, and your outstanding leadership and presentation at the AMSAT presence at the Dayton Hamvention.
Patrick Stoddard	WD9EWK	Thank you for your participation in the AMSAT Satellite Workshop held in conjunction with the ARRL Centennial Convention in Hartford, CT this past July. Your presentation coupled with live satellite demonstrations (which included a contact with the International Space Station) during the ARRL Convention generated significant interest in satellite communications. You help in updating the popular "Getting Started" book aids both the new and seasoned satellite operators.
Paul Williamson	KB5MU	Thank you for your 25+ years of service. Your critical support of AMSAT's Internet mail and information lists helped knit together individuals and organizations worldwide by allowing the rapid dissemination of news and information important to the amateur satellite community. In addition, your technical expertise kept the AMSAT IT infrastructure functional as technology evolved. AMSAT depends on volunteers like you to move us forward and to help keep amateur radio in space.
Michael Young	WB8CXO	Thank you for your dedicated time and expertise in building and testing the LVB Tracker offered by AMSAT. You have spent countless hours obtaining parts and building these items as a "labor of love" over the years. Thank you, as well, for spending the majority of the Dayton Hamvention helping AMSAT. Each year your coordination of the AMSAT hardware and software exhibitions at the Dayton Hamvention makes it possible to show current and future satellite operators how the new technology can be integrated into their stations. Your production, testing and supporting the popular LVB Tracker boxes has supported AMSAT and delighted many operators by seeing how this can be done.

For Outstanding Technical Contributions to AMSAT Operations		
Erich Eichmann	DK1TB	Thank you for your development and continued support of SatPC32. The software allows radio amateurs to fully enjoy satellite communications in all its many facets by providing a reliable means of controlling their antennas and radios. Your gracious support has helped many hams over the initial obstacles which could discourage new satellite users. The funds raised by your contributions through registration of SatPC32 have supported the continued multi-national development of new amateur spacecraft.
For Outstanding Contributions to AMSAT Educational Relations		
Mark Hammond	N8MH	Thank you for your service, assistance and cooperation in the transition of the duties of the V. P. for Educational Relations. Your help and behind-the-scene support and encouragement is much appreciated.
Mark Spencer	WA8SME	For Your Outstanding Contributions to AMSAT Educational Relations. Thank you for your commitment to AMSAT's educational mission. Thank you as well for your tireless efforts in producing numerous beneficial educational tools and your ability to promote them through your leadership of the Teachers' Institute and the ARRL's Education and Technology Program.
For Outstanding Contributions to AMSAT Engineering		
Corey Abate	K8SPN	For the Fox-1 Project solar panel design.
Andrew Abken	KN6ZA	For the Fox-1 Project engineering and flight unit structure machining.
Bryan Baker	N4DTV	For the Fox-1 Project Command and Control RF uplink.
Jonathan Brandenburg	KF5IDY	For the Fox-1 Project IHU software--experiment telemetry and control.
Arlen Cordoba		For the Fox-1 Project Flight unit structure machining.
Don Corrington	AK2S	For the Fox-1 Project power supply design and testing.
Bob Davis	KF4KSS	For the Fox-1 Project spacecraft mechanical design and construction, environmental testing, and qualification.
Paul Finch	WB5IDM	For the Fox-1 Project engineering and flight unit RF testing.
Joe Fitzgerald	KM1P	Thank you for your work on the Fox-1 Project information technology support for file storage, email lists, and ITAR compliance. Your on-going efforts and contributions in the areas of server administration, new web development, and the AMSAT Store have allowed AMSAT to maintain its Store and technical presence on-line. The overall importance of your work is reflected by the number of AMSAT memberships handled as well as the volume of AMSAT publications, software, and other materials that are processed on-line.
Bob Fitzpatrick	KB5SQG	For the Fox-1 Project IP camera for virtual testing and live on the air testing of transponder.
Bdale Garbee	KB0G	For the Fox-1 Project IHU and command and control hardware design.
Dan Habecker	W9EQ	For the Fox-1 Project RF design and testing.
Bryan Hoyer	K7UDR	For the Fox-1 Project battery and EXP4 system design.
Dick Jansson	KD1K	For the Fox-1 Project thermal design.
Mark Kanawati	N4TPY	For the Fox-1 Project solar cell procurement, mounting, and testing.
Phil Karn	KA9Q	For the Fox-1 Project downlink forward error correction design and support.
John Klingelhoeffer	WB4LNM	For the Fox-1 Project RF design and command and control system design.
Taylor Klotz	K4OTZ	For the Fox-1 Project command and control RF uplink.
Dino Lorenzini	KC4YMG	For the Fox-1 Project solar cell procurement, mounting, and testing.
Steve Lubbers	KE8FP	For the Fox-1 Project IHU software POST design.
Mike McCann	KB2GHZ	For the Fox-1 Project IHU, telemetry, and camera experiment software.
Brian McCarthy	N1ZZD	For the Fox-1 Project IHU software solar panel spin rate detection.
Lou McFadin	W5DID	You have supported the Fox-1 Project conformal coating and project support, provided US leadership and support to the Ham TV and S-Band beacon payload development efforts this past year, and given outstanding support as a member of the 2014 AMSAT Space Symposium Committee.
Larry Phelps	K4OZS	For the Fox-1 Project RF, engineering unit and flight unit construction.
Fred Piering	WD9HNU	For the Fox-1 Project RF system design.
David Ping	WB6DP	For the Fox-1 Project RF antenna system design.
Douglas Quagliana	KA2UPW	Thank you for your work on the Fox-1 Project ground telemetry design and software, and your hard work as an Assistant Editor of The AMSAT Journal. The importance of the AMSAT Journal as a key benefit of AMSAT membership is reflected in your support of the content, reflecting key advances in technology and operations as well as highlighting the achievements of the organization. Your editorship and close support of the content and appearance of the articles improves the quality of the AMSAT Journal.
Bill Reed	NX5R	For the Fox-1 Project IHU DSP software and software team co-leader.
Brenton Salmi	KB1LQD	Thank you for your work on the Fox-1 Project MPPT power supply design. Your efforts to define the structure and initial framework for the software supporting AMSAT's on-line presence at its website have given us a professional representation.
Bryce Salmi	KB1LQC	Thank you for your work on the Fox-1 Project MPPT power supply design. Your efforts to define the structure and initial framework for the software supporting AMSAT's on-line presence at its website have given us a professional representation.
Kelley Shaddrick	W0RK	For the Fox-1 Project battery system testing, web based inventory, and IHU software.
Ron Tassi	N3AEA	For the Fox-1 Project power supply design and testing, RF design.
Chris Thompson	AC2CZ	For the Fox-1 Project testing documentation and ground telemetry software development.
Damon Wascom	KC5CQW	For the Fox-1 Project engineering and flight unit PCB construction.
Melanie Wascom	KF5TNK	For the Fox-1 Project engineering and flight unit PCB construction.
Dan Welch (SK)	W6DFW	For the Fox-1 Project machining of prototype structure.
Everett Yost	KB9XI	For the Fox-1 Project battery cells and matching.

For Outstanding Contributions to AMSAT Human Spaceflight		
Gaston Bertels	ON4WF	Thank you for your sustained, dedicated service to the ARISS program as an international leader, school group mentor, and Chairman of ARISS-Europe and ARISS-International. AMSAT is indebted to you for your multi-decade efforts to help inspire students to pursue science and engineering careers through your volunteer support and leadership in the ARISS and SAREX programs. AMSAT also thanks you for your leadership and coordination of the ARISS 2014 International meeting at ESA ESTEC.
Tim Bosma	W6MU	For your outstanding support to AMSAT and ARISS as leader and principal coordinator of the W6SRJ telebridge station.
Gene Chapline	K5YFL	For your sustained, outstanding service to AMSAT and ARISS as a school mentor. Your support and leadership have inspired countless students and boy scouts to pursue STEM careers.
Don Dalby	KE6UAY	For your outstanding support to AMSAT and ARISS as one of the W6SRJ telebridge station operators
Joerg Hahn	PA1MUC	For your sustained service to the ARISS program and our sincerest thanks to you for your leadership and coordination of the hardware session held on Saturday April 5 as part of the ARISS 2014 International Meeting at ESA ESTEC.
Bill Hillendahl	KH6GJV	For your outstanding support to AMSAT and ARISS as one of the W6SRJ telebridge station operators.
Tony Hutchison	VK5ZAI	For your sustained, dedicated service to the ARISS program as a key telebridge station and through leading and sponsoring countless school contacts in Australia. AMSAT, ARISS and the SAREX teams are eternally indebted to you for your outstanding, multi-decade human spaceflight support.
Debra Johnson	K1DMJ	For your outstanding support to enhance ARISS Educational Outcomes and your leadership as an executive of the ARISS-U. S. A. team. Your careful guidance and leadership during this year's budget challenges and threats of cancellation within NASA were particularly noteworthy.
Dave Jordan	AA4KN	Thank you for your outstanding support to ARISS through your international leadership of the Public Relations committee, your efforts to relay ARISS information to the general public and to NASA, your support as a school mentor, and your leadership on the 2014 AMSAT Space Symposium Committee as the Prize Chairman.
John Kludt	K4SQC	For your outstanding support to AMSAT and ARISS as a school group mentor. The ARISS team also thanks you for your thoughts and ideas to improve ARISS school group operations and its impact to inspire students to pursue STEM careers.
Keigo Komuro	JA1KAB	For your sustained, dedicated service to the ARISS program as one of the ARISS-Japan delegates. Your consistent support, guidance and mentoring over the years has proved to be critically important to the success of the ARISS program's international activities.
Shane Lynd	VK4KHZ	For your outstanding support to the ARISS team as a telebridge station operator in Australia.
Ken McCaughey	N3FZX	For your outstanding support to AMSAT and ARISS as leader and principal coordinator of the K6DUE telebridge station. You have done a superb job in organizing the station and ensuring it is continually operational for ARISS contacts.
Bob McCown	N3IYI	For your outstanding support to AMSAT and ARISS as one of the principal coordinators of the K6DUE telebridge station.
Steve McFarlane	VE3TBD	For your outstanding service to AMSAT and ARISS as a school mentor and current ARISS operations team leader.
Steve Michalski	KB9UPS	For your sustained, outstanding support to AMSAT and ARISS as a school group mentor and For your donation of your equipment to AMSAT and schools to ensure that ARISS maintains a vibrant educational outreach program for the future. Your passionate support of ARISS has inspired countless students to pursue STEM careers. AMSAT salutes you for all your support and efforts over the years.
Bill Pasternak	WA6ITF	For your outstanding support in making the 30th Anniversary Human Spaceflight panel session at 2013 AMSAT Space Symposium such a huge success. Your archival video clips brought life to the many facets of the SAREX and ARISS program on the Shuttle, Mir and ISS. Along with the astronauts and panel, your videos provided an inspiring view of this outstanding educational outreach program.
Keith Pugh	W5IU	For your outstanding service to AMSAT and ARISS as a school mentor and operations team leader and your superb operations team reports for the ARISS-U. S. team meetings.
Kenneth Ransom	N5VHO	For your phenomenal dedication and critical support to ARISS despite the contract challenges of this past year. Our heartfelt thanks and admiration on a job very well done.
Mark Steiner	K3MS	For your outstanding leadership as the ARISS-U. S. Program Deputy, your superb support as a U. S. Executive team member and your tireless support to ARISS international hardware development and coordination. Your careful guidance and leadership during this year's budget challenges and threats of cancellation within NASA were particularly noteworthy.
Charlie Sufana	AJ9N	Thank you for your long-standing operations service and leadership to ARISS and SAREX since the early 1990's, including your outstanding school mentoring and operations team coordination. You have inspired countless students to pursue careers in science, engineering, technology, and mathematics.
Dave Taylor	W8AAS	Thank you for your outstanding leadership as AMSAT's ARISS-US delegate at the 2014 ARISS-International meeting at ESA ESTEC, your superb support as a US Executive team member, and your tireless support to ARISS operations. Your careful guidance and leadership during this year's budget challenges and threats of cancellation within NASA were particularly noteworthy. Thank you also for spending the majority of the Dayton Hamvention helping AMSAT.
Stefan Wagener	VE4NSA	Thank you for your outstanding leadership as AMSAT's ARISS-Canada delegate at the 2014 ARISS-International meeting at ESA ESTEC and your leadership in guiding the development of the new Canadian telebridge station in Winnipeg. Your international perspectives and guidance to ARISS-I and AMSAT-NA have been noticed and are most appreciated. You have also continued development and support of the popular paper Fox-1 kits. These allow enthusiasts of all ages to assemble a lifelike model of a satellite they will soon be using for communications. Your extensive time at the AMSAT booth communicates the enthusiasm to our many visitors.
Rosalie White	K1STO	Thank you for your outstanding leadership as one of the ARISS-US delegates at the 2014 ARISS-International meeting at ESA ESTEC and your superb support as a US Executive team member. Your careful guidance and leadership during this year's budget challenges and threats of cancellation within NASA were particularly noteworthy.
For Outstanding Contributions to the AMSAT 2014 Space Symposium		
Janet Bauer		For your outstanding support as a Co-leader of the 2014 AMSAT Space Symposium Committee.
Martin Cadirola	NV3V	For your outstanding support as a member of the 2014 AMSAT Space Symposium Committee.
Tom Clark	K3IO	For your outstanding support as a member of the 2014 AMSAT Space Symposium Committee.
Art Feller	W4ART	For your outstanding support as a member of the 2014 AMSAT Space Symposium Committee.
Perry Klein	W3PK	For your outstanding support as a member of the 2014 AMSAT Space Symposium Committee.
Marilyn Mix		For your outstanding support as a member of the 2014 AMSAT Space Symposium Committee.
Dan Schultz	N8FGV	For your outstanding, sustained, dedicated support to AMSAT's symposium efforts for over a decade as the symposium technical chairman, for soliciting papers, and developing the proceedings.
John Shew	N4QQ	For your outstanding support as a member of the 2014 AMSAT Space Symposium Committee.

For Outstanding Contributions to the AMSAT User Services		
Steve Belter	N9IP	Thank you for leading the video coverage at both the Dayton and AMSAT Symposium events. Your professional productions made it possible for those who could not be present to receive the latest information about AMSAT's projects. Your support at the AMSAT booths, regardless of what was needed, helped to make the presentations professional, representing that which defines AMSAT.
Bob Carpenter	W3OTC	Thank you for your support of AMSAT and the AMSAT office. Your continued work on the AMSAT member database has enabled the support of planned membership benefits. Your constant availability to solve computer or software problems that arise in the office allows it to run smoothly.
Ray Hoad	WA5QGD	You continue to provide key information in the weekly releases of Keplerian elements as well as serving as AMSAT's liaison with US Space Command. Your attention to detail, coupled with timely releases of element data, is an important service for many amateurs, who benefit directly by your efforts.
James Howard	K3JPH	For your hard work as an Assistant Editor of The AMSAT Journal. The importance of the AMSAT Journal as a key benefit of AMSAT membership is reflected in your support of the content, reflecting key advances in technology and operations as well as highlighting the achievements of the organization. Your editorship and close support of the content and appearance of the articles improves the quality of the AMSAT Journal.
Bernhard Jatzeck	VA6BMJ	For your hard work as an Assistant Editor of The AMSAT Journal. The importance of the AMSAT Journal as a key benefit of AMSAT membership is reflected in your support of the content, reflecting key advances in technology and operations as well as highlighting the achievements of the organization. Your editorship and close support of the authors of featured technical articles improves the quality of the AMSAT Journal.
Lee McLamb	KU4OS	Thank you for your outstanding efforts and dedication in leading the AMSAT News Service. The ANS Bulletin is a critical line of communication for AMSAT. Your efforts continue to enhance the stature of the ANS as its reach continues to expand. AMSAT appreciates your hard work and dedication for coordinating the publication of the weekly editions of the Bulletin as the Senior Editor. The ANS Bulletin has significant worldwide reach and is highly regarded for the quality of publication.
Bruce Paige	KK5DO	Thank you for continuing support of AMSAT through your management of AMSAT's Award Program as well as helping to get the new AMSAT Store properly configured. Your enthusiasm for AMSAT's Awards Program is reflected by the number of certificates that are applied for and enthusiasm that the program creates. You also make the weekly Houston AMSAT Net available to operators worldwide, enhancing our sense of community.
Chuck Pinkham	K3PER	Thank you for being an essential part of AMSAT's presence at the Dayton Hamvention. You provide transportation and other service which help make it possible for the many other activities to function smoothly and tell the wider amateur community the AMSAT story.
Les Rayburn	N1LF	Thank you for your outstanding efforts in leading the AMSAT publications archiving project. Your very important contribution in locating, scanning, and file preparation added most of the missing issues of the AMSAT Newsletter, Orbit Magazine, Satellite Journal, AMSAT Technical Journal, AMSAT Satellite Report, and AMSAT Journal. When the AMSAT Archive DVD is released, the amateur radio community will have access to a very valuable historical archive of documents which were compiled by both you and Phil Karn KA9Q.
Paul Stoetzer	N8HM	Thank you for spending the majority of the Dayton Hamvention helping AMSAT communicate the excitement of our satellite mission.

(right) The AMSAT Space Symposium's Keynote Speaker was Jan King, W3GEY, a founding member of AMSAT and former member of the Board of Directors & V.P. of Engineering. Jan's keynote speech, entitled "Never, Never, Never Give Up!" urged AMSAT to continue to aim higher.

(below, left) Paul Stoetzer, N8HM presented Wyatt Dirks, AC0RA with the "73 on 73" award certificate #1.

(below, right) Shown at the Udvar-Hazy Center tour are (L-R) Patrick Stoddard, WD9EWK; Wyatt Dirks, AC0RA; Paul Stoetzer, N8HM; Hector Martinez, W5CBF/CO6CBF; and Clayton Coleman, W5PFG.

AMSAT is Amateur Radio in Space
... and YOU are AMSAT

Here are opportunities to launch your amateur radio experience to new heights ...

ARISS Development and Support

AMSAT's Human Space Flight Team is looking for volunteers to help with development and support of the ARISS program:

- Mentors for school contacts
- Support for the ARISS web
- Hardware development for spaceflight and ground stations
- Help with QSL and awards certificate mailing.

To volunteer send an e-mail describing your area of expertise to Frank Bauer at: ka3hdo@amsat.org.

AMSAT Internet Presence

AMSAT's information technology team has immediate needs for volunteers to help with development and on-going support of our internet presence:

- Satellite status updating and reporting.
- Add/delete satellites to ANS and the web as needed.
- Research and report satellite details including frequencies, beacons, operating modes.
- Manage AMSAT's Facebook and Twitter presence.

To volunteer send an e-mail to Drew Glasbrenner, KO4MA at: ko4ma@amsat.org.

AMSAT's web presence needs a site content editor and authors for content development for technical articles and feature development.

To volunteer send an e-mail to Alan Biddle, WA4SCA at: wa4sca@amsat.org.

AMSAT Engineering Team

We need volunteers with a commitment to deliver in the design and construction of our satellites, "keeping amateur radio in space"!

- Thermal design
- Power systems design
- RF systems design
- Internal Housekeeping Unit (IHU) systems, command, and control hardware
- IHU software design and development: Especially SDR and DSP
- PC board layout and construction
- Systems Engineering
- Test planning and system testing
- Mechanical design and construction
- Ground station software development

Send an e-mail describing your area of expertise and experience to Jerry Buxton, N0JY at: n0jy@amsat.org. Please include your AMSAT member number..

AMSAT Publications

AMSAT has immediate needs for volunteers to help with publications on the web, weekly bulletins, and printed materials.

- Join the AMSAT News Service (ANS) team as a weekly editor on a rotating basis.
- Be an assistant Editor for the AMSAT Journal magazine developing and publishing print articles on amateur radio in space.
- Graphics and photo editor

To volunteer send an e-mail to JoAnne Maenpaa, K9JKM at: k9jkm@amsat.org

AMSAT Educational Relations Team

AMSAT's Educational Relations Team needs volunteers with a background in education and classroom lesson development ...

- Engage the educational community through presentations of how we can assist teaching about space in the classroom.
- Create scientific and engineering experiments packaged for the classroom.
- Create methods to display and analyze experimental data received from Fox-1.

To volunteer send an e-mail describing your area of expertise to E. Mike McCardel, KC8YLD at: kc8yld@amsat.org.

AMSAT Field Operations

AMSAT's Field Operations Team is looking for satellite operators to promote amateur radio in space with hands-on demonstrations and presentations.

- Promote AMSAT at hamfests
- Setup and operate satellite demonstrations at hamfests.
- Provide presentations at club meetings.
- Show amateur radio in space at Dayton, Pacificon, Orlando Hamcation.

To volunteer send an e-mail to Patrick Stoddard, WD9EWK at: wd9ewk@amsat.org

You can find more information on the web ...
www.amsat.org ... click AMSAT ... then click Volunteer