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THE WWV AMATEUR RADIO CLUB

The WWV Amateur Radio Club has just completed a re-organization, elected a board of directors, and embarking on launching the club to promote WWV, WWVB, and WWVH broadcasts, education, public awareness, science, and metrology.



Roadside Rest Area highlighting WWV soon after it moved to Fort Collins in 1966.

Originally formed to bring together Colorado amateurs and others to celebrate the WWV 100th Anniversary, club activities dropped off dramatically after the event. Shortly into 2020 everything changed with COVID, and re-organizing the group was not on the radar.

A handful of the original WWV Committee members put together a May 2020 SES celebration of the May 1920 NBS audio concert broadcasts. The WWØWWV call was used for the first time since October, with over 4000 QSOs throughout the month of May, and a unique QSL card sent out.

During the summer of 2020, Dave Swartz, WØDAS, suggested reforming WWV ARC to continue advocacy for the stations as well as provide outreach to the public and help the amateur science community and advocate for WWV.



The WWVB Time Controller gets its timecode from the clocks at WWV a few hundred yards away, so the bumper sticker is pretty accurate! The bumper sticker is sent out with each QSL card from WWØWWV.

In October 2020, the WWØWWV call was once again on the air celebrating the 101st anniversary of WWV, this time soliciting operators from the 2019 WWV event to operate from their home QTH as WWØWWV, and to share the stories and experiences of WWV over the decades through QSOs with like-minded hams. The event ran 5 days again, but of course didn't have the hype involved with the first.

Since that last SES operation in October 2020, a steady group of 5 to 8 of us have wrestled with defining a Constitution and By-Laws more accurately reflecting where the WWV ARC was headed, and to potentially open membership to all amateurs and radio enthusiasts.

Just this past week, we agreed on the new Constitution and By-laws and also elected a new Board of Directors. They are Dave Swartz, WØDAS, President; Kevin Utter, N7GES, Vice-President; Darren Kalmbach, KE0ZIE, Secretary; Tim Annable, WW8L, Treasurer; and Mark Holbrook, WS7M, Communications Director. WWV ARC is registered as a nonprofit LLC in Colorado.

We are not quite ready to accept membership in the organization and have more work to do to further establish the club infrastructure.

We will have updates on when we are accepting new members at the WWV ARC club website: <https://wwvarc.org> (<https://wwvarc.org>) .

THE WWV 100TH ANNIVERSARY, SEPTEMBER 28 – OCTOBER 2, 2019

The WWV 100th Anniversary in October 2019 was the result of a successful collaboration between Amateur Radio Operators from across the country and the facilities staff at NIST radio station WWV in Fort Collins, CO, and the NIST labs in Boulder, CO and Gaithersburg, MD.

The idea for a celebration of the 100th anniversary was suggested by Douglas Sutton, Field Technician at WWV, while giving a tour to a northern Colorado IEEE chapter in October 2018. Dave Swartz, WØDAS, happened to be on that tour, and a life-long “fan” of WWV and the NIST Time and Frequency services. Dave shared the idea of hosting a celebratory Amateur Special Event Station (SES) with the Northern Colorado Amateur Radio Club (NCARC) in November 2018 and the board agreed to pursue the event.

Kevin Utter, N7GES, had arranged for tours for NCARC in the past, and contacted Matt Deutch, NØRGT, Chief Engineer, about the possibility of a SES, and the WWV 100th Committee met for the first time at the beginning of December 2018 to float the idea. Committee members also included Darren Kalmbach, KCØZIE, and James Cizek, KIØKN. The whole WWV NIST staff was very supportive, and Matt carried the idea up the ladder to his superior, Station Manager John Howe.



Matt Deutch, WWV/WWVB Engineer and amateur NØRGT, points out the extent of the 15-acre site he suggests for the SES during the first planning visit to WWV/WWVB, December 2018.

No sooner had the planning begun, the US Government was forced to shut down for the longest recorded stretch in history, and it took another month after re-opening for many agencies to get fully running.

The WWV 100th Committee decided to form the WWV ARC as a rallying group for the many different hams and amateur clubs that would come together to produce the SES, and the call sign WWØWWV was assigned to the new club in February 2018.

At a March meeting following the government re-opening, WWV, WWVB, WWVH Station Manager John Howe discussed the need for an MOU and had NIST officials prepare the document. Joining the committee in March were Mark Holbrook, WS7M and Eric Tamme, KKØECT. The Committee reached out to two major manufacturer's, Flex Radio and Elecraft, and secured equipment loans for the event.

Applications for the event were opened in March, and the event was announced via QRZ and also through the ARRL Letter. Dave travelled to Dayton for Hamvention 2019 along with Matt from WWV to promote the event with the assistance of US Army MARS and Col. Paul English (ret), WD8DBY. Dave also secured antenna loans from SteppIR while in Dayton.



Dave Swartz, WØDAS, traveled to HamVention in May 2019 to promote the WWV 100th Anniversary and SES WWØWWV.

David Kazdan, AD8Y, got in touch with the Committee and Dave via Matt at WWV. David suggested the Festival of Frequency Measurement run concurrent with the WWV 100th. In the end, a unique, unassigned "Special" station was created to carry out NIST traceable frequency measurements, make school and museum contacts, and coordinate the Festival of Frequency Measurement. Case Amateur Radio Club came in force and manned the Special station operations.



Case Amateur Radio Club at the WWV 100th Anniversary ceremony. L to R: Aidan Montare, KB3UMD, Nathaniel Vishner, KB1QHX, NIST Director Dr. Walter Copan (a Case alumni), Kristina Collins, KD8OXT, John Gibbons, N8OBJ

As word got out, interest in participating grew, and before you knew it, there were 100 operator volunteers. The difficult task of building an operator schedule was accomplished by Eric Tamme by the end of June, throughout the summer, and up to the start of the event. Eric was also instrumental in operations and is one heck of a sharp CW operator.

Mark took charge of setting up operations, logistics for computer networking, all automated station logging, and upload to LOTW and OQRS in nearly real time. Mark also wrote a program for tracking and displaying the real-time activity of the various bands, operators, and statistics. Mark kept us all focused and moving forward and was a core member of the Committee.



Mark Holbrook, WS7M, and Eric Tamme, KKØECT monitor the status of the camp network and logging software in camp command center tent.

Darren, KCØZIE was the site manager and coordinator, established the campsite for operations, coordinated with WWV staff, and ran the camp logistics for over a week, with hardly a break. Darren also handled treasurer duties, he is the NCARC treasurer as well, and a NCARC Board member.

James, KIØKN was technical support for operations and linked the SES site via microwave to the NCARC repeater site on Horsetooth Mtn for a 30Mb/s wireless network in camp. James troubleshooted numerous issues during the week of operations, is the Technical Advisor to NCARC, and also is a NCARC board member.



Doug Sharp, K2AD, operating 6m meteor scatter from the RMHAM communications trailer.

Doug Sharp, K2AD, of RMHAM joined in planning mid-summer 2019, and brought substantial equipment and logistical support in the way of the RMHAM Communications Trailer, a 50-ft telescoping tower, a 15kW diesel generator, and more, as well as his technical know-how and experience. RMHAM support was vital to the success of the event.



Jeff Carrier, KØJSC and Amanda Alden, K1DDN, operate 20m during the WWV 100th Anniversary.

Amanda Alden of Ham Nation, K1DDN, helped immensely with publicity, getting the event covered on two shows in the summer, and coaching Dave on social media (the one area the event was weak). She was a great supporter of the event, and she and husband Jeff Carrier, K0JSC, were able to attend the event and operate as well.

Ham Talk Live!, hosted by Neil Rapp, WB9VPG, hosted two programs with Dave and Matt Deutch in June 2019 and then just weeks before the event in September 2019.



John Gibbons, N8OBJ and Greg Ella, NØEMP discuss configuration of the equipment to make frequency measurements NIST traceable during the Festival of Frequency Measurement.

Greg Ella, NØEMP, helped provide technical support and configuration of equipment for the Festival of Frequency Measurement and ongoing support for just about anything that came along. Greg is the at-large NCARC Board member.

In late summer, Dave Winnett, WØDDZ, NCARC Public Affairs Officer and Board member, connected the Committee with The Great Outdoors RV in Evans, CO, and they generously loaned the event two huge fifth wheel campers for the week to round out the needed operation space.

Bob Schmid, WA9FBO, helped raise funds through his associations with the Poudre Valley REA, the electrical supplier to the WWV and WWVB stations. He also helped coordinate volunteers for the set-up and tear-down of the site. Bob brought needed perspective and helped in asking the right questions at the right time.

Trial Run Weekend - August 2019

Because of the complexities of getting everything up and running for the 5-day event, the Committee decided to run a trial set-up the weekend of August 24-25, 2019. Although the Flex and Elecraft radios would not arrive until close to the event, SteppIR delivered the loaner antennas in time for the trial. David Kazdan and his wife Laura Gooch, N8NFE, flew in via private plane from Cleveland, and joined the Committee and other local hams.



David Kazdan, AD8Y, assists with coax as one of the 2-element SteppIR beams is prepared to be lifted, August 24, 2019.

One of the two element SteppIR 20-6m beams was assembled and tested on the RMHAM tower trailer. The trailer was used during the 100th event for the 6m stacked array. Adjustable SteppIR verticals were also tested, but the team decided fixed verticals for 80m and 40m would be better. The microwave networking was tested from the site which helped identify potential knife edging at 3GHz. The trial run was an important opportunity to shake out some bugs and get a better feel for the site and how operations would be accomplished.

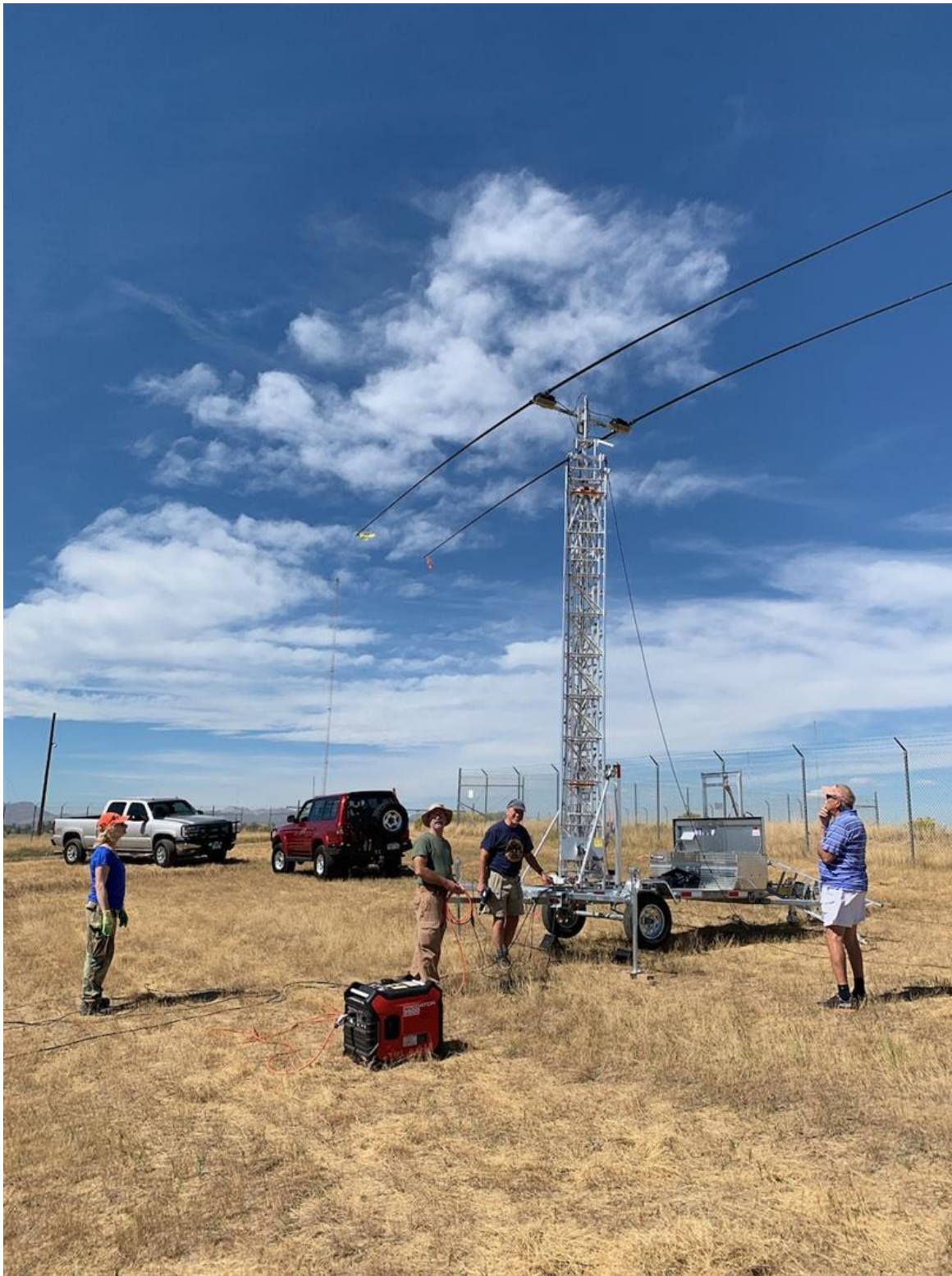
The WWV 100th Anniversary begins – September 25 – October 2, 2019

Wednesday, September 25 was the start of camp assembly, with the positioning of the 5th wheel Toy Hauler RVs (very nice!), the arrival of the camp sanitation Port-a Johns, and arrival of the generator, RMHAM Comm trailer, telescoping 50' mast van, 25' tower trailer, and crank up 50' tower for the three beams. Camp Central was established, and equipment deployed.



2 of the Elecraft K3S Transceivers await deployment during set-up September 25, 2019. Flex Radio, SteppIR, and Heil Sound also provided loaner equipment.

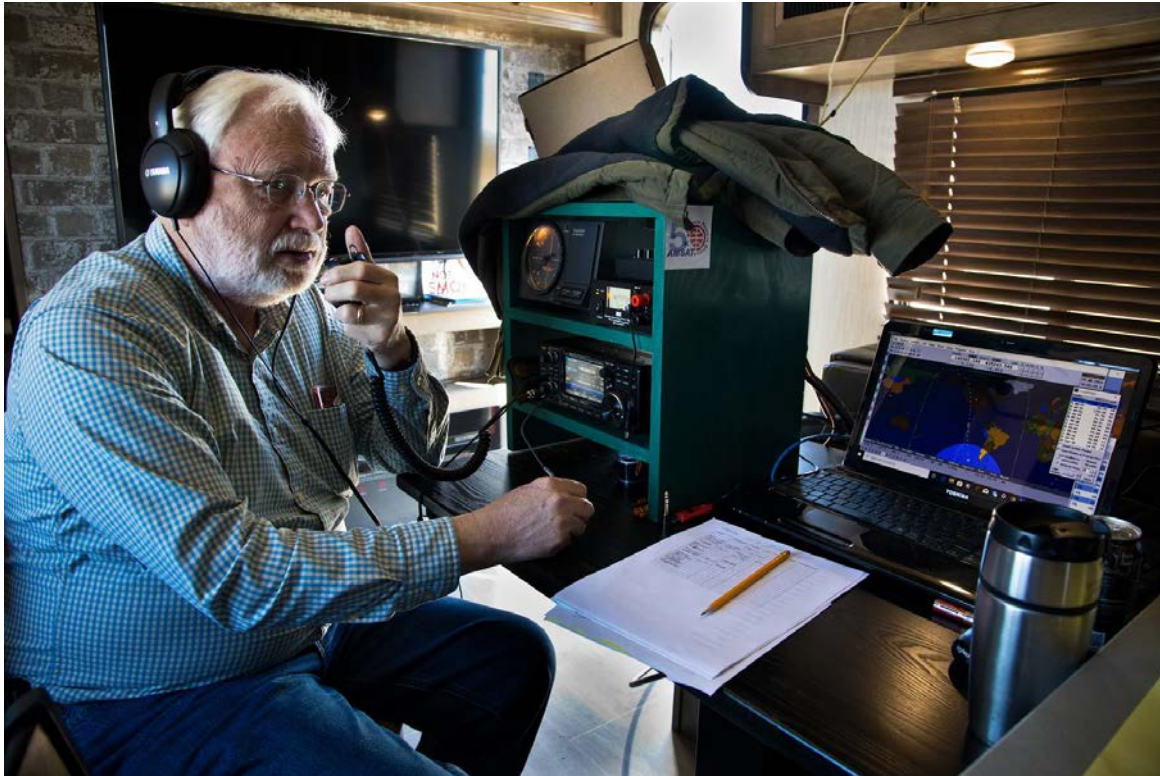
Thursday, September 26 saw the completion of the verticals and beams as well as the entire computer network and all radios installed and troubleshot. The goal was to have the station completed 24 hours before operations were to start, and we accomplished that for the most part.



One of the SteppIR 2-element 20-6m beams is readied for lifting atop a 75' crank-up tower.

We also learned that Thursday that some miscommunication between NIST Boulder and Gaitherburg had occurred, and that camping on NIST property was prohibited. We continued on unabated and figured that 24-hour on-site supervision was required for 24-hour SES operations, and that would be our explanation for what some might mistake as camping. Operators did not camp on site, although some working the night shifts may have slept a wink or two in their cars. Fort Collins is just 8 miles to the south, and Wellington about 6 miles to the northeast, with motels/hotels and some camping in the area.

With the hard work put in on the previous two days, Friday, September 27, was a chance to work out the kinks, play radio, visit with numerous hams, and start tours of WWV and WWVB. All operators were given tours of the WWV and WWVB radio station by the station staff, who conducted several hours-long tours multiple times over the 5-day SES operation. What a great opportunity to see the HF transmitters for WWV, and the massive transmitters, antennas, and tuning systems of WWVB. Having direct access to the operators and their experiences made the tour very personal, and a highlight for many of the visiting amateur operators.



Roger Johnson, KG0I, operates SSB satellite out of the same toy hauler the 20m station used.

With 10 months of hard work behind the Committee, Amateur Radio Special Event Station WW0WWV went on the air at 6pm MDST September 27; 0000UTC September 28, 2019. There were 7 stations on the air; 20m and 160m, 80m and 15m, 40m, 30m, 6m, satellite, and the Special multiband station. 2m and 70cm were also conducted from mobile vehicles and handheld yagis. Conditions were not favorable with the solar activity at a minimum, and night communications stymied. But over the 5 days there were 10,600 QSOs logged, breaking our goal of 10k.



Night under the stars and in the fog with the WWVB South Array lights gave the whole scene that surrealistic feel.

Besides HF, operations on both FM and SSB satellite were conducted, as well as 6m meteor scatter. The Special station was used for the Festival of Frequency Measurement, scheduled school and university contacts, as well as communications to the local Fort Collins Museum of Discovery.

Phil Burk, KØPRB, and Luann Barnes, KØLAO, set up their “StarDrive” mobile astronomy and ham radio rig, and the museum promoted the event by publishing their own unique QSL card handed out to patrons. Kids had a chance to talk on the air, the youngest just 2!



Luann Barnes, KØLAO and Phil Burk, KØPRB with StarDrive at the Fort Collins Museum of Discovery, September 29, 2019.

October 1, 1919 – October 1, 2019

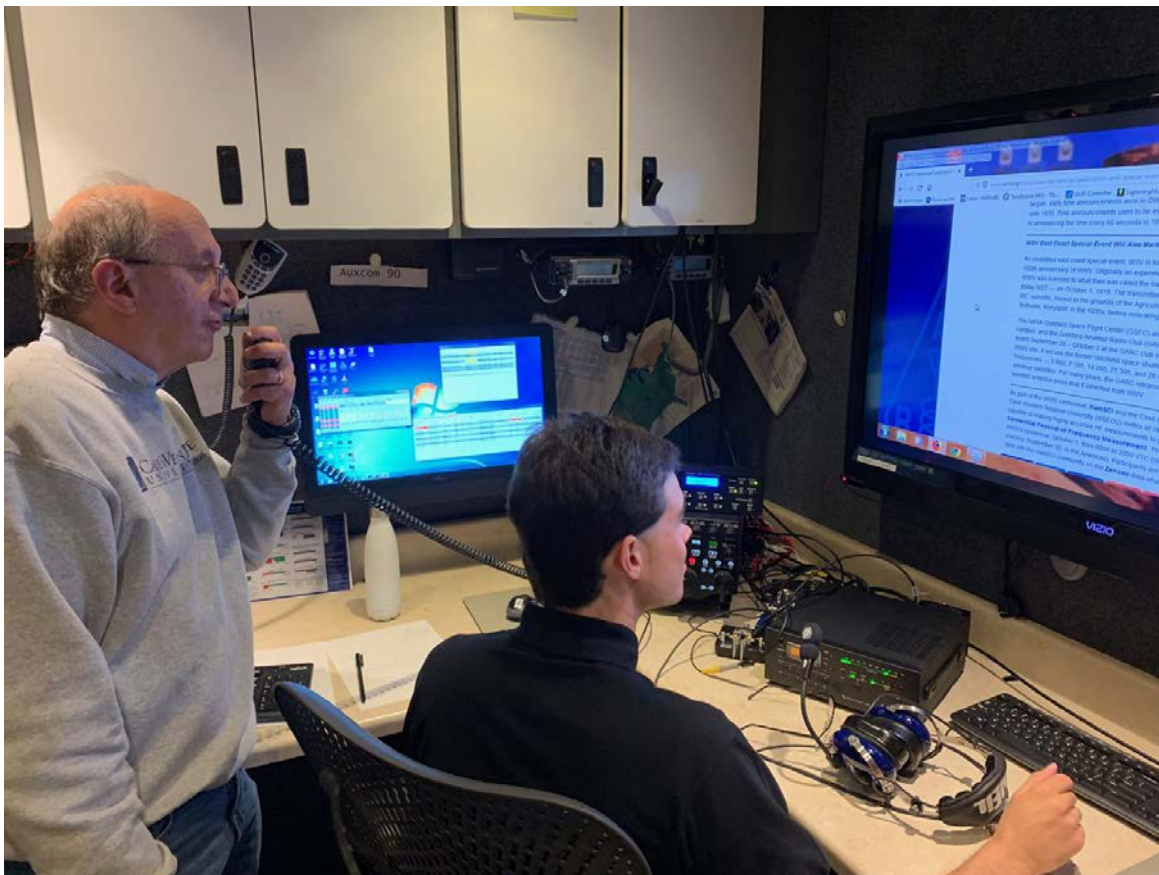
The Colorado weather didn't disappoint during the 5 days and varied from warm and clear blue skies and starry nights, to foggy mornings, and of course a constant rain on October 1 for the official 100th anniversary ceremony. Dr. Walter Copan, NIST Director, had made plans to attend, so security was heightened, and the NIST police and other security present all day. About 100 guests from NIST Boulder, NIST Gaithersburg, and a number of amateurs attended the event held in a large tent, complete with a birthday cake and a historic talk by Glenn Nelson, AEØGF, Dr. Phil Erickson, W1PJE, representing HamSci, and Dr. Walter Copan.



Kevin Utter, N7GES, was asked by NIST to record a couple of announcements that were broadcast on WWV and WWVH. The first announcement ran the day of the 100th anniversary, soliciting reception reports for a special commemorative QSL card. The second ran for three weeks prior to the event during the MARS hourly timeslot announcing the SES. What an honor for Kevin to use his vocal talents on such an important occasion, and he may be the first amateur to record an announcement like this for NIST.

Over air audio recording of Kevin Utter, N7GES, from October 1, 2019, announcing both the 100th anniversary of WWV and the WW0WWV SES. The SES announcement ran for three weeks prior to the event in the MARS timeslot on WWV and WWVH.

The Goddard Amateur Radio Club joined in the celebration as well, operating SES W3V during much of the same period, and we even managed a QSO during the busy week. The NASA Goddard Space Flight Center Visitor's Center is built in the building WWV occupied prior to moving to Colorado in 1966. They held a simultaneous celebration and using cell phone video from Colorado projected the ceremony in the Visitor's Center auditorium for the NASA staff.



David Kazdan, AD8Y, and Aidan Montare, KB3UMD during a QSO with the Goddard ARC operating as SES W3V in Maryland, site of WWV prior to moving to Colorado.

After the official hoopla and tours of WWV completed, the WWØWWV Special Event Station had a visit from Dr. Liz Donaly, NIST Time and Frequency Division chief and Dr. Walter Copan, NIST Director. They toured through the soggy camp, visited the various operators on air at the time, and were impressed by the amateur community's efforts.

All good things come to an end . . .

Wednesday, October 2, saw our 5-day operations coming to a close at 6pm that evening. Earlier in the day, we broke the 10,000 QSO mark. We finally had a chance to look back at the week and realize what we had accomplished over the last 10 months, and all of us were happy and proud of the job we'd done. We started breakdown shortly after 6, and completed the next day and had the site cleared by late afternoon October 3.

QSL cards

It took a few weeks to get images from various amateurs and attendees of the event together in a QSL card, and after production we tackled responding to the hundreds of surface mail as well as OQRS requests. The initial mass production was done by 5 people working for 4 hours, stamping, labelling, authenticating, and finally mailing over 500 requests. Since that original mailing, an additional 500 requests have trickled in.



The Radio Laboratory Section of the Electricity Division of the National Bureau of Standards was established in 1913, with the formal callsign WWV assigned on October 1, 1919. In early 1919, the NBS demonstrated to an audience what the Washington Times called the wonders of "music through the air." Improvements led to regular Friday evening music broadcasts in the Washington, DC area, in May 1920.

Agricultural market reports soon followed, and by 1923 the frequency service was established. Public outcry in 1926 saved WWV from closure, and in 1931 the station moved to College Park, MD.

In 1932 the station moved to Beltsville, MD, where a standard 440 tone was added to the frequency broadcasts. A major fire in 1940 and WWII resulted in new facilities in 1943, with time service added in 1945, and voice announcements in 1950.

The station moved to its present location north of Fort Collins, CO, in 1966.

Today, WWV continues frequency and time broadcasts as well as space weather and other announcements on 2.5, 5, 10, 15, 20, and 25 MHz. The site also houses WWVB, the 60kHz time code pulse used by automated clocks throughout the country and western hemisphere.

For a complete history of WWV, visit <https://www.nist.gov/publications/century-wwv-100th-anniversary-commemoration>



In retrospect

The WWV 100th Anniversary production was a tremendous amount of work. We had our challenging and difficult moments, but looking back at all involved, the Colorado and broader Amateur Radio community came together to produce a class special event station, one that would be difficult to duplicate. There were no issues, no serious injuries, no lost equipment. Everyone had a tremendous time and the best of memories.

Now, after more than a year of COVID, we realize how lucky we were to pull off this kind of event. Our hope is that we can one day return to WWV, set up a SES, and share this unique part of radio history and science with the amateur community another time.

73 !

CELEBRATING THE 100TH ANNIVERSARY OF RADIO STATION WWV

A newer Ham's journey to WWV, Ham Radio, and back to WWV.

Story and photos - Fred Schwierske, W9KEY

Originally published in *The Beacon*, West Mountain Radio Newsletter, Quarter 4 – 2019

Every so often, you experience one of those big “life changing moments”. Maybe it was graduating from school, meeting your significant other, or getting a new job. Or just maybe, it was that moment you decided to become a ham! Many reading this article may not remember exactly when the amateur radio bug bit them – but I do – because I am still a pretty new ham. In fact, three short years ago the ham radio hobby was not even on my radar screen.

All that changed in October 2017. My wife and I had just arrived in Colorado to visit our kids. Sunday afternoon, driving down from an enjoyable family day in the mountains, my phone rang. It was old college buddy Bob Schmid, WA9FBO. We became friends many years ago in engineering school. Bob has lived most of his adult life in Colorado and runs S-COM, LLC. If you’ve ever talked on a 2-meter repeater, there is a pretty good chance one of his controllers handled your traffic. I assumed he was calling to set up lunch.

But instead, Bob said, “If you can be in Ft. Collins tomorrow at 10:00 AM, you can have the one remaining open spot on a very special technical tour of Radio Station WWV that is scheduled with our local amateur radio club!” He explained the station is not open to the general public, and such events were quite rare. Although I was not a ham at the time, Bob remembered my interest in radio, and knew I regularly attended local swapfests, looking for that next great electronic gem. Of course, I jumped at the chance and my life changed.

Arriving in Ft. Collins that fateful Monday morning, the group was greeted by massive towers, huge transmitters, antenna tuners befitting an epic science fiction movie, all patiently explained by an extremely knowledgeable staff that had been doing “big radio” their entire lives. Departing several hours later – little did I know I’d been bitten by a crazy radio bug!



One of WWV's Single Band, Half-Wave, Vertically Polarized, Center Fed Dipoles (aka: modified sleeve antenna).

Several months later and now severely infected with “radio” – I had passed all three amateur license exams, made countless trips to our HRO Milwaukee store drooling over equipment, and finally managed to convince a few backyard trees that antenna wires were not their enemy. It took a while, but eventually I was on HF and talking to the world. What a great hobby!

In March 2019, when the Northern Colorado Amateur Radio Club (NCARC) issued a general “Call for Operators” to work a Special Event Station commemorating the 100th Anniversary of radio station WWV, friend Bill Schnell, AC9JV and I quickly submitted our applications. Still pretty new to the hobby, I was not sure I would be accepted, and was thrilled when confirmation arrived. Now we just had to wait six long months for the celebration to begin. During the wait, I honed my operating skills working local special event stations for Field Day and the International Lighthouse weekend.

Summer finally passed, and on September 27, 2019 after an intense year of planning - the incredible NCARC technical team, with help from other Colorado area ham radio clubs and several major equipment vendors went “On the Air” with Special Event Station WWØWWV. Over the next five days, they were heard around the world and worked by thousands of hams eager to log that unique station.



WWØWWV Special Event Station (looking north), with WWV in the background. Four transmitters covering 160–10 meters (all modes), three additional specialty stations, and more than a dozen antennas!

It was not without its challenges, though – both technical and bureaucratic. WWV is part of the National Institute of Standards & Technology (NIST) - an arm of the Department of Commerce – which, of course, is part of the US government. They don’t let just anybody set up a radio station outside their perimeter fence. And even if they did, there is a pretty good chance much of that new station’s equipment would severely object to operating in the impressive 120,000 watt near field radiation from WWV (time signals) and WWVB (which sets your “atomic clocks”).



Capturing the exact time of our visit - one of WWV's redundant Time Code Generators.

So, after a lot of bureaucratic wrangling, with able assistance from WWV's Engineer- In-Charge Matt Deutch, NØRG and his ham-populated staff; the paperwork gods smiled down - and the stations went up.

And what an event it was! Four primary, frequency agile, all mode stations covering 160 to 10 meters on CW, SSB Phone, and Digital FT-8. Three more specialty stations for Satellite, 6M meteor scatter, and Case Western University's propagation study. Transceivers from Elecraft (K3S) & Flex (6600M), Elecraft KPA500 watt amplifiers for all stations (except 30 meters), two SteppIR beams, a large assortment of verticals, dipoles, and yagi's covering all bands. At least a dozen, maybe as many as fifteen antennas. And tying it all together were networked computers running N1MM Logging Software and WSJT-X. Think of it as a Field Day site on steroids – with all equipment somehow operating harmoniously inside the previously mentioned 120,000 watt near-field radiation from WWV & WWVB. A remarkable accomplishment and testimony to the care, technical skill, and extraordinary planning of WWØWWV's capable staff.



W9KEY and AC9JV – Relaxed and Working the Pile-Up at Special Event Station WW0WWV. Thanks to everyone who “called” that day – It was a blast!

So what was it like to operate a highly desirable Special Event Station from 5000 feet above sea level, running state of the art transceivers, 500 watt amplifiers and beam antennas? One word - “Intense”!! Both Bill, AC9JV and I were “pretty busy”, being fortunate to have generally good band conditions on 40 & 20 meters for much of our operating shifts. Yes, there were lulls, but nothing like those experienced by the “night shift” crews.

Over the 5-day period, WW0WWV logged over 10,600 contacts. I am confident that decent nighttime band conditions during a better part of the solar cycle would have easily doubled, if not tripled that number. Bill and I had an absolute blast with impressive pileups during much of our on-air time. In an extraordinary coincidence, Bill, Amanda (from Ham Nation), and I all exactly tied for the 18th spot on the QSO list, putting us in the top 20% of the Operators. An acceptable result considering we each only worked a single 2-hour shift and shared the hot seats with some very capable operators from across the country - who often battled challenging band conditions.



NIST station employee Bill Yates, KE0UZZ, explains the operations of one of WWVB's three Continental Electronics 50 kW transmitters.

Although we made the long trek from Wisconsin to Colorado specifically to operate WW0WWV, we also managed to secure a coveted ticket (only 100 issued) to attend the 100-year anniversary party on the exact date WWV turned 100 years old – October 1, 2019. The lucky ticket holders, including scientists from NIST's Boulder, CO facility, as well as government officials and visiting hams were treated to three excellent presentations by NIST Director and Undersecretary of Commerce, Dr. Walter Copan, followed by Dr. P. J. Erickson W1PJE, Assistant Director of MIT's Haystack Observatory, and finally WWV Staff member Glenn Nelson, who presented a fascinating look back over WWV's 100-year history.

WWV's powerful signals continue to be an important tool in the ongoing study of atmospheric science and radio propagation. Hams can learn more about current activities and directly participating in a massive propagation data collection project slated to coincide with the next total solar eclipse in 2024. See the Ham Radio Science Citizen Investigation website at www.HamSCI.org for more details.

And finally, my personal thanks to WWV's Bill Yates, KE0UZZ for his comprehensive WWV facility tours that were specially provided to the almost 100 ham radio operators from around the USA that arrived to work WW0WWV's Special Event Station.

It was a real treat to see such incredibly powerful transmitters and massive antenna arrays "up close". And for me – this return to WWV two years after my first visit was a true "pilgrimage back to Mecca", from a ham radio perspective. Because without that fateful encounter with the NCARC group and their special 2017 technical visit to WWV, I would not be a ham today. I only wish it would have happened 10 or 20 years earlier. One thing I have already learned about amateur radio – there's an awful lot to learn. I should have started sooner!!

73,

Fred, W9KEY

If you want to learn more about WWV/WWVB's fascinating history or impressive technical details, check out these two papers written by Glenn Nelson, AEØGF:

1) WWV 100 Year History Paper (2019):

<https://www.nist.gov/publications/century-wwv-100th-anniversary-commemoration>
(<https://www.nist.gov/publications/century-wwv-100th-anniversary-commemoration>)

2) NIST WWV / WWVB / WWVH Technical Paper (2005):

<https://tf.nist.gov/general/pdf/1969.pdf> (<https://tf.nist.gov/general/pdf/1969.pdf>)

CONNECTING WITH NIST

As WWV ARC has been re-organizing, one of the more important goals was to establish a dialogue with NIST. Dave Swartz, WØDAS, and David Kazdan, AD8Y recently wrote a letter to NIST Time and Frequency Director Dr. Elizabeth (Liz) Donaly and NIST station manager Mike Lombardi and were elated to receive a warm response.

NIST is interested in learning how the amateur radio community, specifically HamSci, is using WWV in their ongoing ionospheric studies.

Long story short, what quickly evolved are plans for Dr. Phil Erickson, W1PJE, and Steve Cerwin, WA5FRF to address the Time and Frequency Division on March 25, 2021, and to answer questions from the NIST Time and Frequency Division scientific team. The presentation and subsequent interaction will be recorded and available via HamSci and WWV ARC.

Current Upgrades at WWV/WWVB, Fort Collins, Colorado



WWVB North Array towers and capacitive "top hat" network of wires. Aerial drone photography by Dave Winnett, WØDDZ

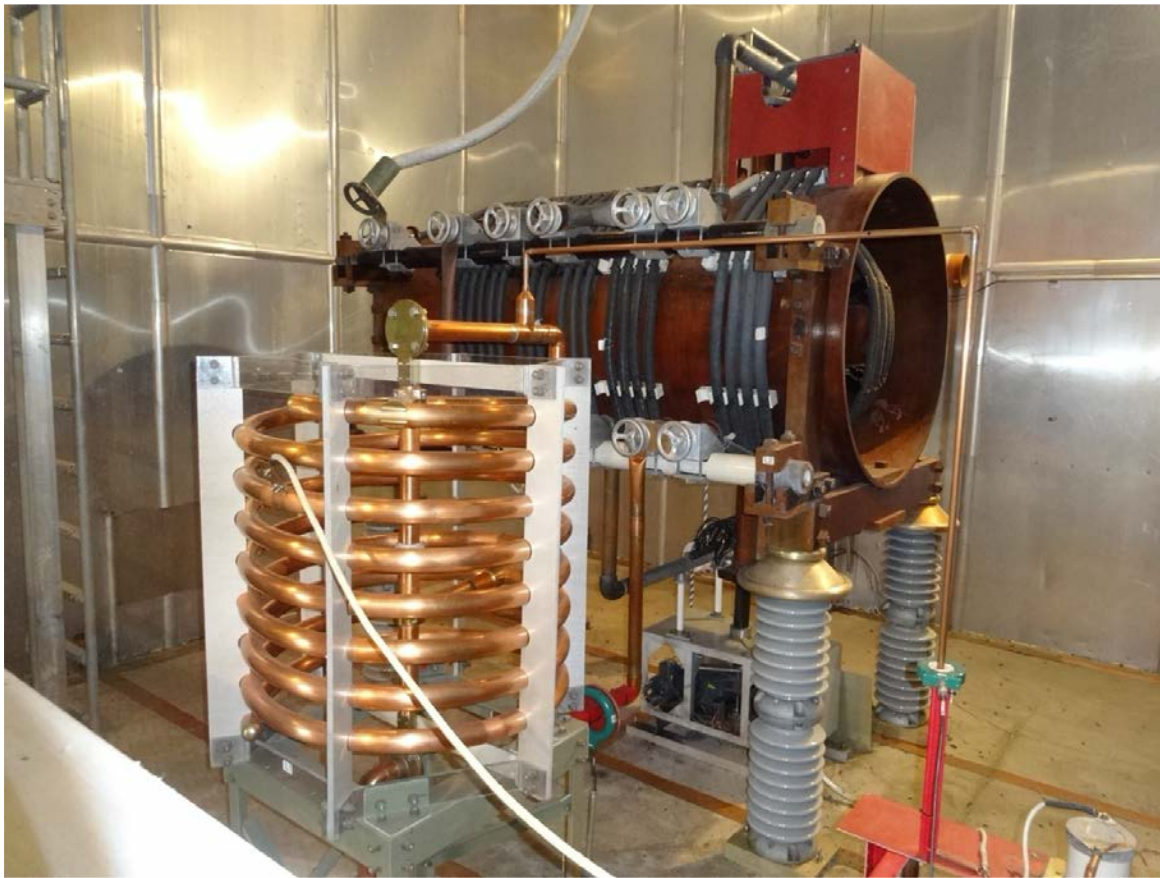
Improvements continue this week at NIST radio station WWVB, the 60kHz time standard used throughout the western hemisphere for automated clocks and controllers.

WWVB has two of three transmitters feeding into two antenna arrays during optimal operation, and the ability to reconfigure the equipment is done through a matrix switch, a physical device that up until now required a human to physically push-in and pull-out slide switches directing the 50kW output of each of the transmitters to the antenna arrays and a dummy load.



The WWVB dummy load (left) and the Matrix Switch (right) which is being replaced with an automated switch. photo by Fred Schwierske, W9KEY

Contractors from Kentronics continue working with the station staff to replace the human interface matrix switch with an automated matrix switch, allowing remote control and improving station reliability.



The variometer that controls tuning of the WWVB antennas inside the Helix House. The antenna feed line can be seen coming off the horizontal variometer on its left side and leaving the photo at the top center. photo by Fred Schwierske, W9KEY

Additionally, the matrix switch replacement also opened up an opportunity to upgrade the remote control of the variometer automatic tuning system feeding each of the antenna arrays. Station staff are replacing the current 2-phase AC motors with DC motors that will speed up switching the direction of tuning as well as the rate of tuning. Tuning is required because of changing sunlight and weather conditions that physically change the size of the antenna, requiring constant adjustment. Installing the DC motors will reduce stress on the transmitters by improved matching which will result in improved overall reliability.

A winter storm hits Colorado, WWV, and WWVB

Matt Deutch, NØRGT, WWV/WWVB Station Engineer, was a guest on Ham Talk Live! hosted by Neil Rapp, WB9VPG last Thursday, March 18, 2021 (program #251). Matt discussed the upgrades to WWVB, but I wanted to know how the station had fared during our wild winter storm last weekend, March 13 and 14. Poudre Valley REA, the utility that provides power to WWV and WWVB, reported numerous outages in the vicinity of the station, so I gave Matt a call after Ham Talk Live! to find out more.

Sure enough, the stations did lose power. When the station goes off the air due to a power outage the back-up generators kick in after about a minute. Circuit breakers switch between the main line and generators, and the system comes back up. Everything worked as it should at WWV, which has its own generator. But when the power came up, a WWVB circuit breaker failed to fully switch from the generator back to the main, taking WWVB off the air and alerting the staff to the fault. The only solution – physically throw the switch by hand.



WWV 250 kW back-up generator. photo by Fred Schwierske, W9KEY



WWVB 500 kW back-up generator. photo by Fred Schwierske, W9KEY



WWV/WWVB Station Engineer Matt Deutch, NØRGT, self portrait as Glenn Nelson, AEØGF, trudges toward the WWVB building in the distance. A classic upslope storm brought 2-3 feet of snow at WWV March 14, 2021.

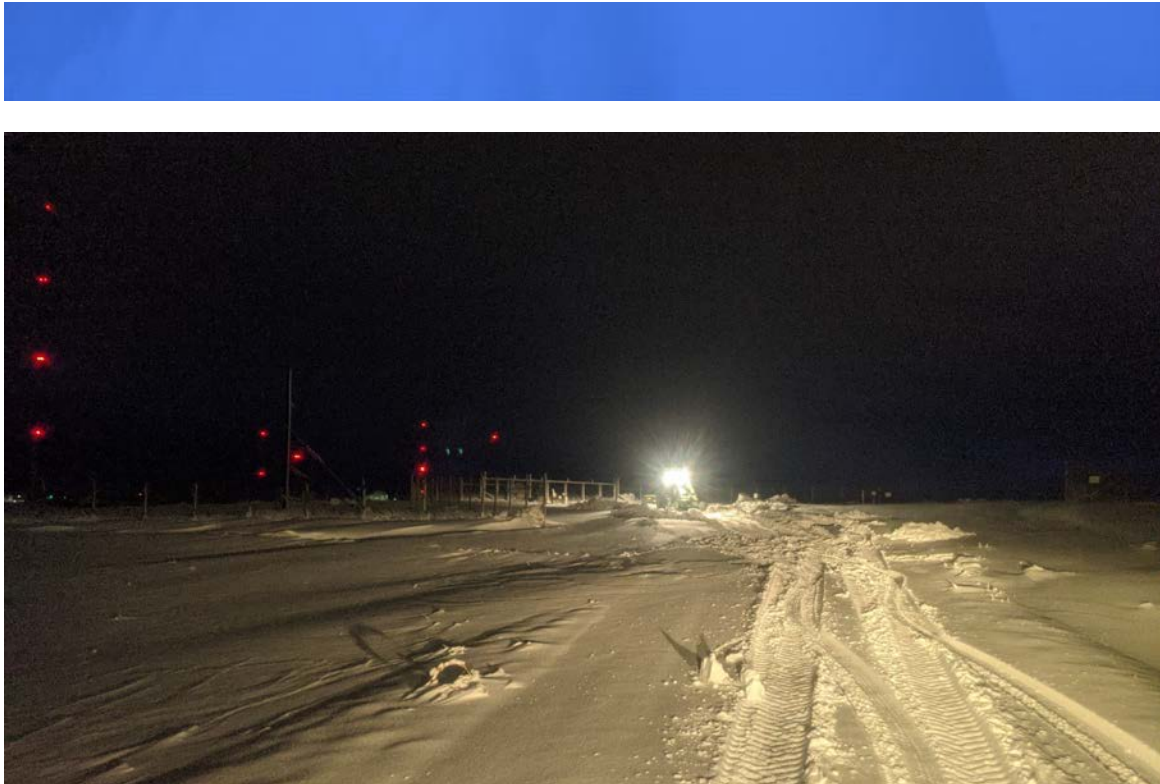
This is a clear case of Murphy's Law. This April a replacement and upgrade of the circuit breakers between the generators and the main service is planned to improve reliability. Go figure.

The NWS had declared the storm an official blizzard, but Matt and station employee Glenn Nelson, AEØGF, drove 8 miles north of Fort Collins to the station, through 2 feet of snow on the local roads, only to hit drifts on the WWV property that stopped and stuck their 4-wheel drive. A quarter mile trek into a screaming headwind and they finally reached the WWVB building. Glenn was able to trip the breaker and reconnect to the main service and WWVB was back on the air.

Matt and Glenn used the stations tractor to get back to Glenn's 4-wheel and started digging it out. As night descended, they finally freed Glenn's vehicle and made it back to town. The pictures below tell the whole story pretty well!







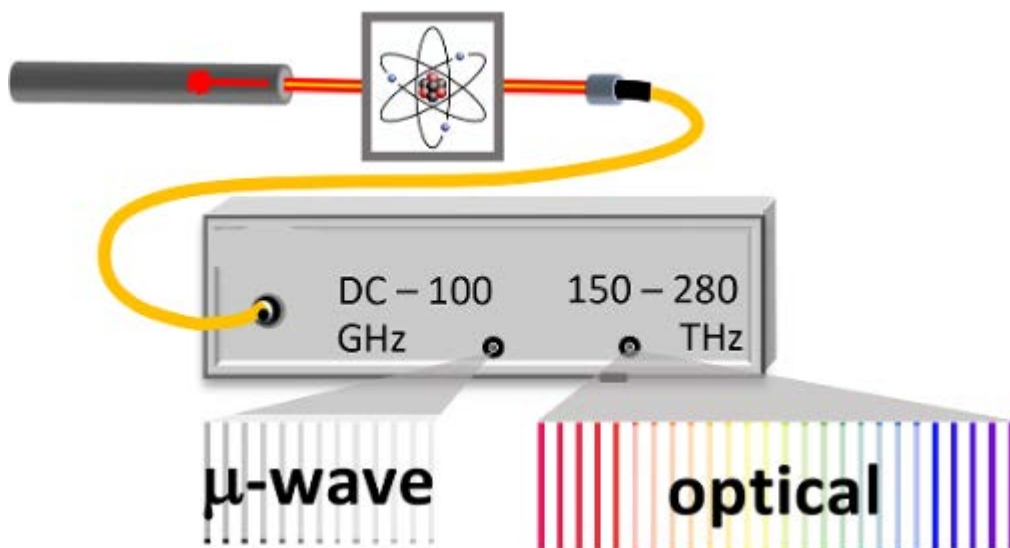
Pictures from Matt Deutch, March 14, 2021

NIST Time and Frequency Division Current Research

In our communications with NIST, Dr. Donaly shared highlights of the research and science the Time and Frequency Division have been examining.

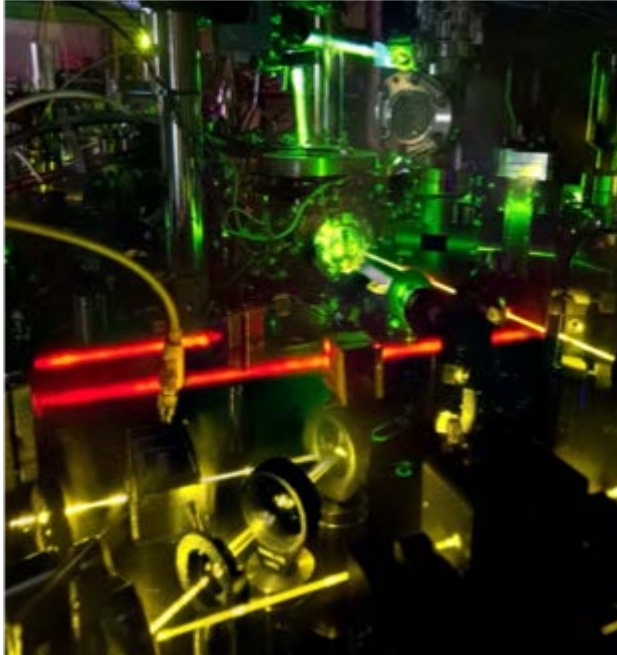
Here are 8 examples provided by Dr. Donaly, with her explanations (unpublished synopsis). Much of the research sounds like science fiction, but it is very real, and will lead to new insights on the workings of the Universe.

Ultralow-Noise Frequency Synthesis (Microwave and optical)



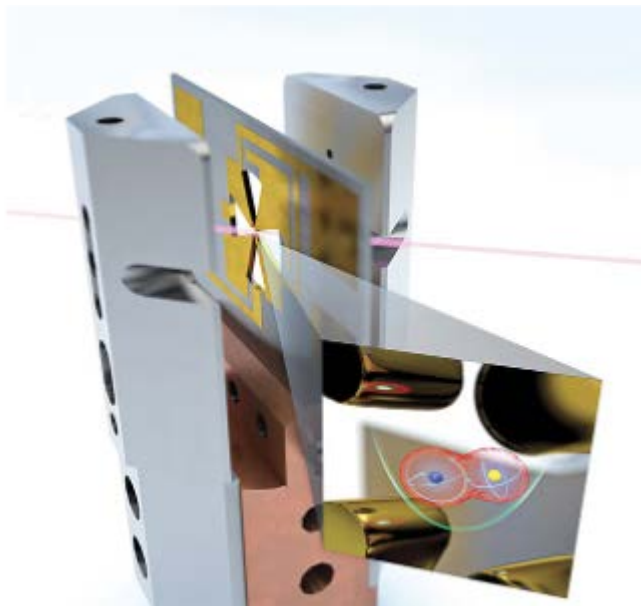
Optical Frequency Combs are an important part of the Time and Frequency division that enable direct clock comparisons from the optical to the microwave, low noise frequency synthesis, precision spectroscopy, and more.

Record Stability in Optical Clock (Yb lattice clock, $< 1 \times 10^{-18}$)



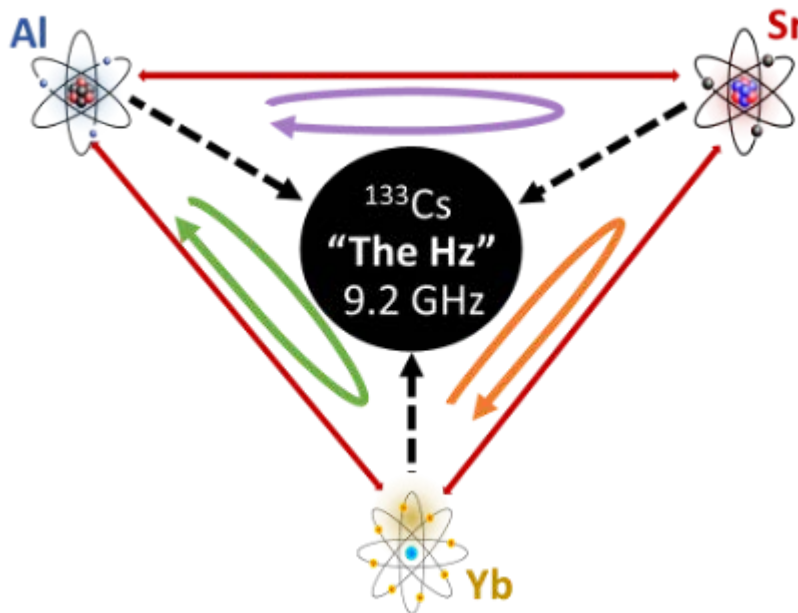
The Ytterbium optical lattice clock holds the current world record for clock stability. It was used to calibrate TAI in 2019 and the team plans to submit frequency evaluations to the BIPM again this year.

Record Accuracy in Optical Clock (Al Ion Clock, $< 1 \times 10^{-18}$)



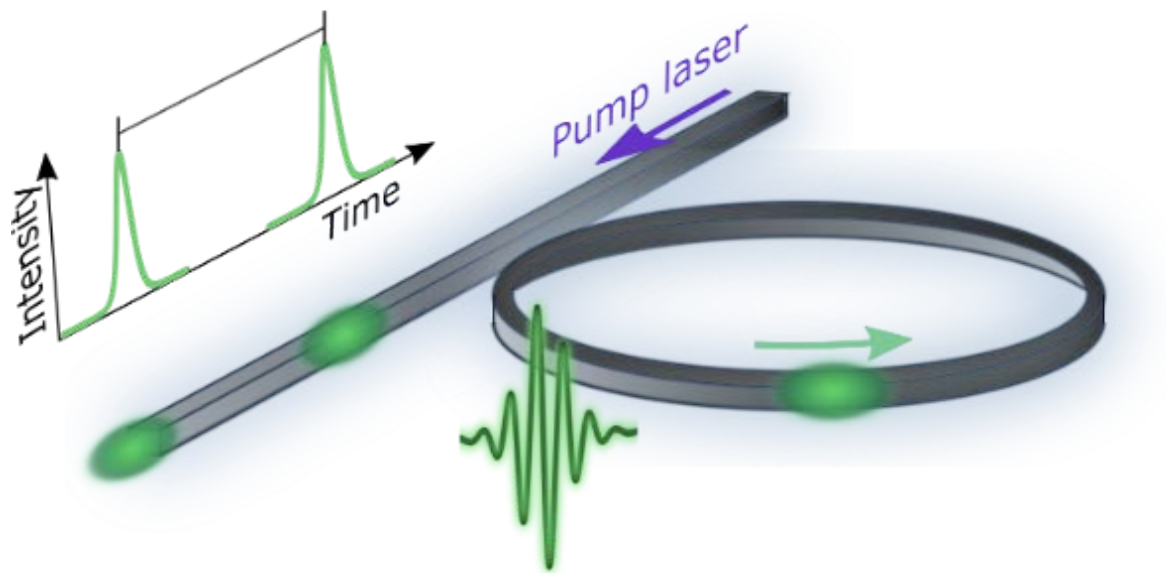
The Aluminum ion clock is based on quantum logic spectroscopy. It has very small systematic frequency uncertainty and holds the world record for clock accuracy. New correlation spectroscopy techniques have reduced the quantum noise limits on the Al⁺ clock, enabling optical clock frequency ratios at new levels.

Optical Clock Comparisons (Redefinition of the SI Second)



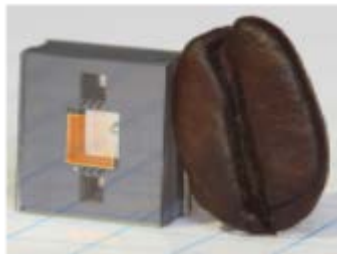
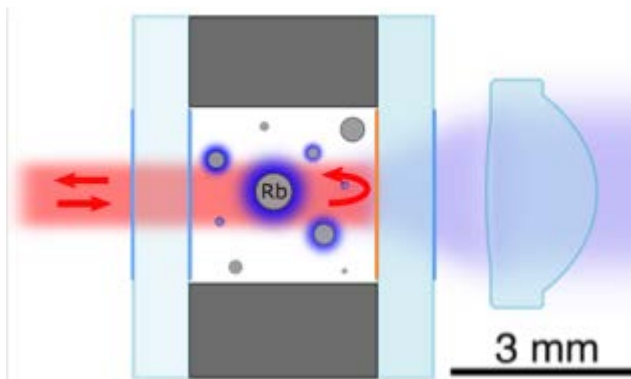
Intercomparison between the ¹⁷¹Yb, ²⁷Al and ⁸⁷Sr optical clocks (secondary standards) and the ¹³³Cs microwave clock (primary standard), enables a consistency check between the local measurement of optical secondary standards, as well as a consistency check in the evaluation of the optical frequency of one secondary standard in Hertz, via an optical ratio measurement against a second secondary optical standard. The measurement consistency is evaluated by calculating the fractional frequency loop misclosures, δ , between 3 atomic frequency ratio measurements. The calculation takes into account the frequency ratio and its corresponding measurement uncertainty. Optical frequency ratio measurements are consistent to better than 1 part in 10^{17} . Absolute frequencies are consistent to within their measurement uncertainty. Optical Frequency ratio measurements 5-10x more accurate than any previous measurements have been accepted for publication by Nature. The measurements have also gone to the BIPM for updating the frequencies and uncertainties for optical standards for the next official update of the optical frequencies of secondary standards.

Integrated Photonics (Microresonator Frequency Combs)



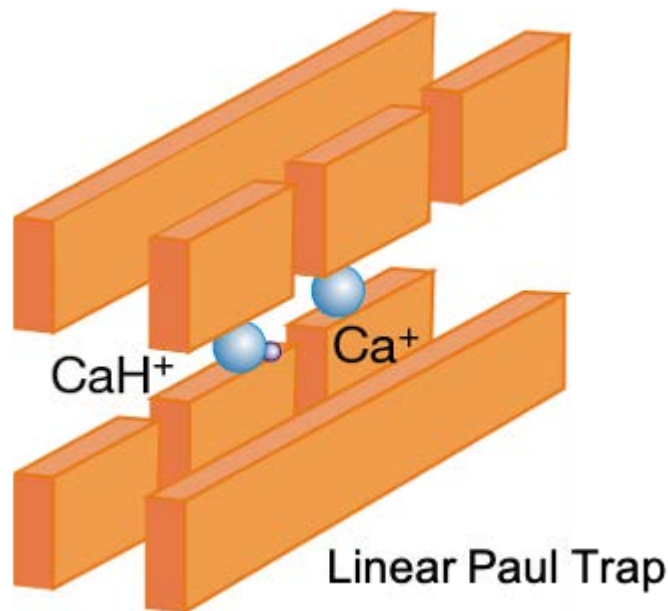
Time and Frequency has a strong program in integrated photonics, including microresonator frequency combs.

Optical Chip-Scale Clocks (Two-photon optical clock)



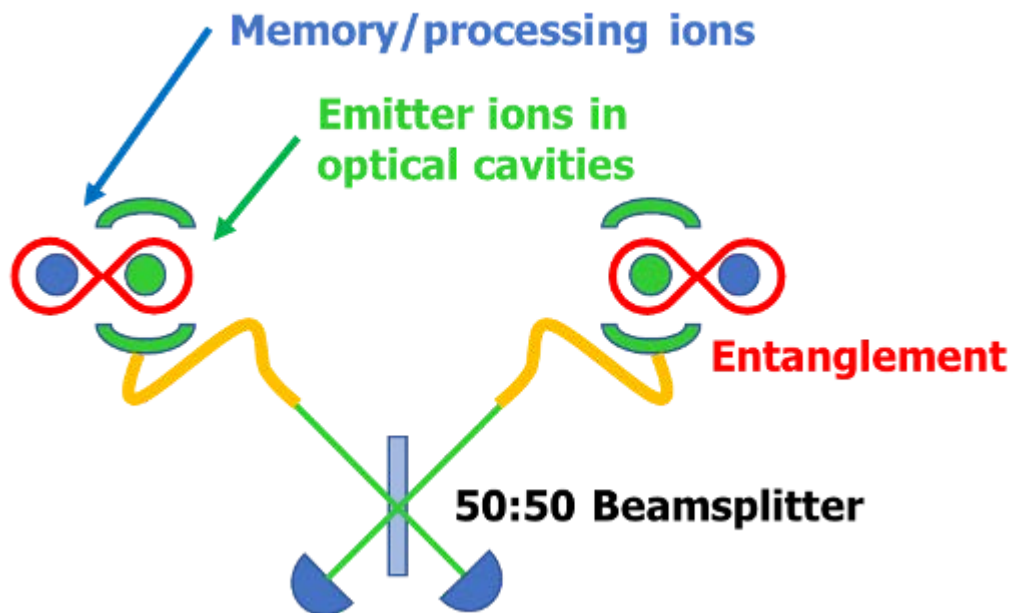
The microresonator frequency combs are one of the things that will enable compact optical clocks, including a 2-photon version that has been built from a microfabricated vapor cell shown here that has short-term stability that rivals that of a hydrogen maser.

Single Molecular Ion Spectroscopy (Ca^+/CaH^+ entanglement)



One of the coolest new things in the division is the achievement of quantum entanglement between an atomic and molecular ion, and performing spectroscopy on the pair with a frequency comb. They resolved rotational transitions to 11 significant digits!

Quantum Information Processing (Quantum Repeater Development)



Research is beginning towards practical devices that create entanglement over geographical distances as part of the Quantum Network Grand Challenge. The ISG will combine existing capabilities in the creation and manipulation of the quantum states of trapped ions with high efficiency transduction of quantum information from ions to photonic “flying” qubits in the telecom wavelength range by developing high finesse cavities that are directly integrated with ion traps and can enhance ion-photon coupling by orders of magnitude. NIST has a long history of high-performance quantum information processing with trapped ions, and these also have good quantum memory on the timescale of light travelling long distances. Our repeater will connect stationary qubits (in this case ions) to qubit photons in the telecom regime, where long-distance links with low loss can be established. We’re exploring a range of options for this, but one approach is to entangle memory and processing ions with molecular emitter ions, which emit photons in telecom regime.

How does this research impact our understanding of science and how can it be applied?

On the more research-y side of the Time and Frequency division, there is a lot of work on the development of optical clocks and related technology, quantum information science, and sensing. One use NIST looks forward to is their optical clocks applied for relativistic geodesy.

Bloomberg Moonshots recently produced “Atomic Clocks Are Reinventing Time,” a wonderful synopsis of how metrologic science can be applied to study the Earth through the relativistic effects of general relativity and time dilation.

Bloomberg Moonshots:

Atomic Clocks Are Reinventing Time. <https://youtu.be/hzLTgtFaPLY> (<https://youtu.be/hzLTgtFaPLY>)

AUTHOR INFORMATION

Dave Swartz is a retired High School Science teacher who lives in Fort Collins, Colorado.

I grew up in southwestern Pennsylvania and got turned on to radio when I was 8 years old playing with my future brother-in-law's shortwave. There was that crazy beat - always on the exact frequency - always strong - WWV had me hooked. Why the need for precession? What can you learn by being precise? How big an army base is in Fort Collins?

I got my Novice license at 14, WN3YNF, and my General at 16, WA3YNF, and then went off to college, in all places, Fort Collins, with all its distractions, and drifted away from Ham Radio about 1982. I re-licensed in 2014 and retired from teaching in 2015,

Since then I've been a tour guide in a major western cave complex for 4 seasons, a photographer, and a volunteer Naturalist for the City of Fort Collins leading Astronomy programs and telescope viewings for the public.

In 2018 I helped organize the WWV 100th Anniversary celebration, and in 2021 I was elected President of the WWV Amateur Radio Club.

ABSTRACT

The WWV Amateur Radio Club recently reorganized and looks forward to promoting the Time and Frequency Services of NIST, helping raise public awareness of WWV and its purpose, help with outreach through education, and support the amateur community in general and the amateur scientific community in particular.

In 2019 the WWV ARC helped organize and run the WWV 100th Anniversary celebration. The event brought together amateurs from across the country to celebrate this iconic radio landmark.

WWV has inspired new hams as well as old, and you can read how an older retiree became a new ham, and fell in love with WWV and amateur radio.

We're also excited about opportunities the WWV 100th Anniversary has opened up. The Time and Frequency Division of NIST is very interested in assisting the amateur scientific community, including HamSci, and would like to discuss the possibilities. NIST scientists will attend a presentation by HamSci and exchange questions and ideas about the ongoing HamSci research.

WWVB is getting upgrades and survived a wild winter storm fairly intact. The storm dumped 2-3 feet on the high plains adjacent to the foothills during an upslope event, and power issues required a mid snow storm visit.

The NIST Time and Frequency Division is doing some incredible research in what appear to be science fiction topics, but are very, very real issues involving time dilation and the effects of relativity.