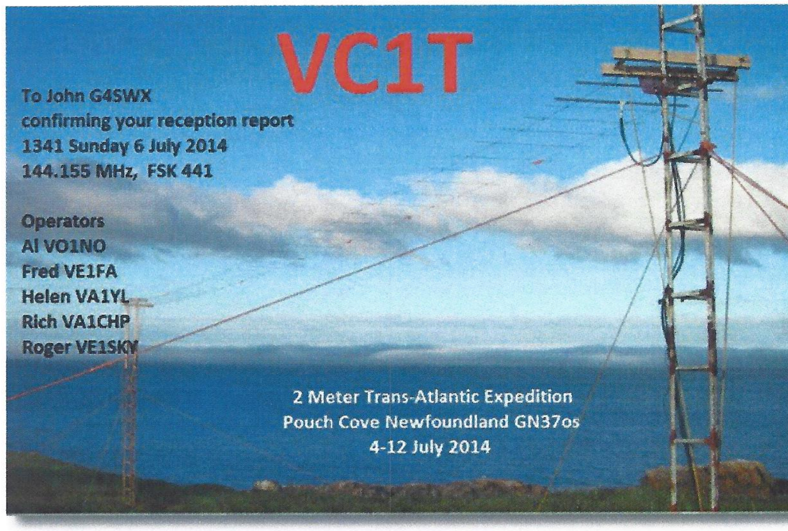
Across the North Atlantic on 2 Meters

In their quest for a Brendan Award, this team completed a trans-Atlantic transmission in an unexpected way.

Rich Pieniaszek, VA1CHP;
Roger Sturtevant, VE1SKY;
Al Penney, VO1NO; Helen Archibald, VA1YL, and Fred Archibald, VE1FA



The North Atlantic Ocean has always been a challenge for the daring and competitive. In 1921, the first ARRL trans-Atlantic tests from North American medium-wave Amateur Radio stations were heard in Ardrossan, Scotland. In 1946, G5BY and W2HXD had the first trans-Atlantic VHF contact on 50 MHz. Recent 4 meter/6 meter crossband contacts suggest that trans-Atlantic 4 meter contacts are prevented only by the absence of an amateur 4 meter band in North America. Except for moonbounce (EME), there have been no confirmed all-natural (not reflected from man-made things, like satellites) trans-North Atlantic 2 meter contacts in the 68 years following 6 meter success.

In 1995, the Irish Radio Transmitters Society (IRTS) promoted a 2 meter challenge by offering the Brendan Awards. St Brendan was an Irish monk who reportedly sailed his sheepskin coracle to Newfoundland around 510 AD. The IRTS will award its Brendan Trophies to the first pair of stations completing a trans-Atlantic CW or voice two-way contact. They will award the Brendan Shields for the first digital-mode contact, and the Brendan Plates for the first verified all-natural path one-way contact.

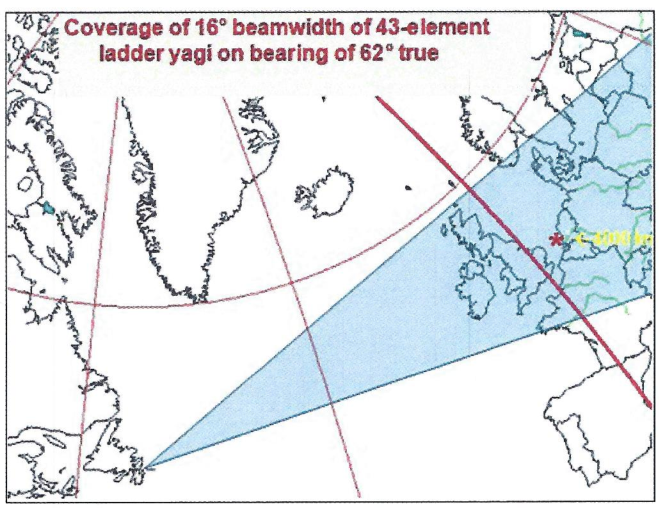


Figure 1 — The ultra-light 43-element Yagi coverage at its half-power beamwidth points on the 62 degree bearing from Pouch Cove, Newfoundland. We estimate that the maximum double-hop VHF distance using sporadic E (E_s) or meteor scatter (MS) is 4000 km, as marked by the red asterisk.

Our Plan

During the summer of 2014 Al, VO1NO; Fred, VE1FA (ex-VE2SEI); Roger, VE1SKY; Helen, VA1YL, and Rich, VA1CHP, attempted the 2 meter trans-Atlantic path. We chose the Red House, on a cliff overlooking the North Atlantic in beautiful Pouch Cove, Newfoundland (grid square GN37os) for our station. It's within a few kilometers of the closest approach of North America to Ireland, and is 23 kilometers north of Signal Hill, the site of Marconi's 1901 trans-Atlantic success. This location allows the maximum meteor scatter (MS) or sporadic E-layer ionization patch (E_s) double-hop distance (about 4000 kilometers) to cover all Ireland, the UK, and bits of the Netherlands and France.

MS and E_s double hops are the most likely mechanisms for 2 meter propagation across the North Atlantic at latitudes greater than 45°. We decided to use *WSJT* JT65B mode, which is able to copy signals to –24 dB (referenced to a 2500 Hz bandwidth), and *WSJT* FSK441 mode, which has 23 dB less sensitivity, but can capture much shorter and faster signals, as propagated by MS. We received the special experimental call sign VC1T.

For good communication with European VHF DXers, Sebastian, W4AS, set up a very handsome "Brendan Quest" web page, **www.brendanquest.org**. We also have a Facebook page, which can be found

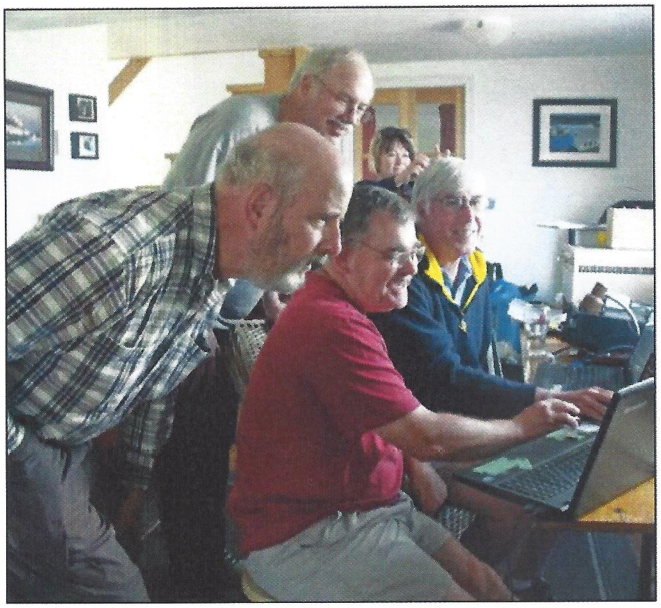


Figure 2 — Hours of monitoring and mouse-clicking on possible signal peaks, combined with a few moments of excitement.

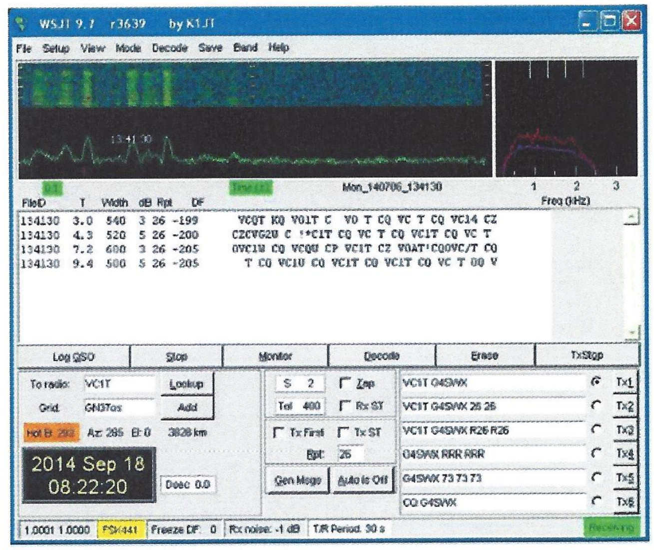


Figure 3 — John, G4SWX, in eastern England (Lat. 52.228°, Long. –1.457°), received the VC1T FSK-441 144.155 MHz signal at 13:41:30 on July 6, 2014. We were sending "CQ VC1T" continuously at that time. The screen image shows the date and time when John retrieved the data from his *WSJT* files.

by searching for "Brendan Quest 2m Trans-Atlantic Attempt 2014."

The Station

We first prepared and tested the station hardware at the radio shack of VA1YL and VE1FA. Filtering with Cor-Com and Shaffner potted RFI filters kept dc and ac lines free of RFI and switching transients. An Icom IC-746 Pro transceiver with an ovenized master oscillator drove the linear amplifier through a 6 dB attenuator. This permitted the IC-746 to run at 75 W, high enough for stable internal ALC, and still able to deliver 17 W to the linear amplifier, whose MRF-151G power FETs can be damaged by excessive drive. Warren, VO1KS, converted two Larcan "lo-lo" continuous-duty commercial VHF (TV) amplifiers to 144 MHz and kindly loaned them to us. We built a control-RFI filter-monitor box for the Compaq 3 kW server switching power supply that converted 240 V ac to 51.4 V dc at 57 A for the amplifier. Without filters, this 3 kW supply generated strong RFI on 144 MHz. A station diagram is available on the *QST* in Depth web page.[1]

The Yagi Antennas

With the help of *EZNEC* modeling software, we built the Pouch Cove 43-element ultra-light ladder Yagi seen in the lead photo.[2] Our antenna was inspired by a Jim Ford, N6JF, 2 meter "rope ladder quagi" design.[3] Our antenna is 29.7 meters (97.4 feet) long and on average 6.4 meters (21 feet) above ground, with 24.5 meters (80 feet); average height over the sea, making the sea horizon 17.7 kilometers distant. The forward gain is 23.9 dBd (26.0 dBi) with 32 dB front to back ratio. The main lobe half power beamwidth is 4.6° in the vertical plane and 15.6° in the horizontal plane. Figure 1 shows the coverage over our intended path. All 41 directors plus 220 feet of Kevlar boom weighed 1.6 pounds (730 grams). The copper reflector and driven element were not included in this weight. When properly tensioned, sag was just a few inches, and the antenna barely moved in gale-force winds. The ultra-light 43-element Yagi's dimensions, modeling, and construction are described in the March/April 2016 issue of *The Canadian Amateur*.

Our second Yagi, a rotatable 17-element Cushcraft A-17B2, was set up beside the Red House on a 15-foot guyed mast with a supporting top stay. It allowed us to operate outside the fixed bearing (62+/–8°) of the 43-element Yagi. In strong winds it moved far more than our ultra-light 43-element Yagi, which was firmly tensioned between its two towers on the grassy clifftop meadow nearby.

Operation

European operators knew from our "Brendan Quest" web page and many e-mails that we would use JT65B and FSK441 modes on alternating days on 144.155 MHz. Optimized for short duration MS paths, FSK441 transmits the information many times in its 30 second transmit and 30 second receive cycle. We operated in 4-hour shifts starting at 19:00 UTC on July 4 using FSK441, then JT65B at 00:00 UTC on July 5 — all the while pumping 750 W into the 43-element Yagi. JT65B is used by several trans-Atlantic 2 meter beacons and many EME operators. We set up the 17-element Yagi on July 5, just in time for a system test. At 16:22 UTC we made an easy ocean horizon EME (moonbounce) QSO with John, G4SWX, demonstrating that VC1T was working well!

Monitoring both *WSJT* modes and web pages required two laptops and three screens. We checked the Hepburn tropospheric maps, DX Maps, and Pascal's, F5LEN, custom propagation forecasts for VC1T. We also monitored the ON4KST web reflector and the G4CQM Shoutbox (a real-time web reflector for trans-Atlantic 2 meter attempts).

At 00:00 UTC on Sunday, July 6, we went back to FSK441, and at 13:00 the ON4KST site suggested that the maximum usable frequency (MUF) had reached at least 60 MHz over the North Atlantic due to strong E_S. DX clusters reported many 6 meter trans-Atlantic contacts. Emil, W3EP, and Robert, K1SIX, in New England made their first 4 meter/6 meter crossband contacts with the Canary Islands

(EA8DBM) at about 12:00 UTC, indicating a MUF of at least 70 MHz.

We announced on the ON4KST page that all Europeans should call us in the first 30 seconds of the FSK441 sequence and listen in the second 30 seconds of each minute. We employed this collective "shout out" strategy to best hear any 144.155 MHz signals. We used our 17-element Yagi and a second IC-746 Pro to listen to parts of Europe not covered by the big Yagi.

Received in Europe

At 13:41 UTC on July 6, 2014, with Roger, VE1SKY, in the VC1T operator's chair, we were heard in Europe! Radio Society of Great Britain VHF manager John Regnault, G4SWX, received and perfectly decoded our "CQ VC1T" message several times in Suffolk, UK, on England's east coast, a distance of 3840 kilometers (2831 miles) from Pouch Cove! This historic signal was successfully received, decoded, and recorded in an FSK441 .wav file. Reception (see Figure 3) was clear. John tried to complete the contact with us within 4 hours to qualify for the Brendan Shields (for a full digital QSO), but no signal peaks or G4SWX decodes appeared on our FSK441 screen.

Congratulations poured in for G4SWX and VC1T from various online forums. Europeans redoubled their efforts to work us! Joe Taylor, K1JT, developer of FSK441, was monitoring and sent congratulations. Sebastian, W4AS, posted on our Brendan Quest web page that we would transmit only FSK441 until further notice. We wanted to continue with what had just worked.

By the afternoon of July 6 it was clear that the MUF peak had passed. We continued our 4-hour shifts around the clock until shutdown at 12:32 UTC on July 11, 2014. Propagation never returned to the MUF levels of July 6.

We Did It! However...

While our reception by G4SWX is unequivocal (see Figure 3), the path that our trans-Atlantic signal followed has been much debated. At the "magic moment" that G4SWX received VC1T (13:41:32 UTC on July 6, 2014), the International Space Station (ISS) was over the North Atlantic, almost exactly equidistant between VC1T and G4SWX, and close to the shortest path between the two stations. Furthermore, at its orbital altitude of 422 kilometers, the ISS had clear line-of-sight to both stations, raising the possibility of a single-hop path from VC1T to G4SWX, via ISS bistatic reflection. The ISS orbital speed of 27,589 kilometers/hour would also ensure that contact would be brief, which it was.

To qualify for the Brendan Plate, the propagation must be by "all natural" mechanisms only. So, the million-dollar question became: did the ISS participate in our trans-Atlantic 2 meter contact?

There was excellent E_s and possibly MS over the Atlantic at the time of contact. Meteor trails could easily raise that to 144 MHz. From Pascal's, F5LEN, tropo-ducting charts, we knew that there was an area of weak ducting in the mid-Atlantic. Although not large enough to play a direct role in the signal path, its presence suggested calm seas, good for reflecting double-hop E_s or MS signals skywards.

In addition to the good propagation, VC1T was using a 26 dBi antenna and about 150 kW of effective radiated power directed at Ireland and the UK, and we were only a few kilometers from the closest approach of North America to Ireland. To our knowledge, there had never previously been such an effective North American station trying for a trans-Atlantic contact under particularly good E_s conditions, with many top-flight European VHF DX stations, like that of John, G4SWX, alerted, listening, and calling on our frequency. Why couldn't the reception be by all-natural means?

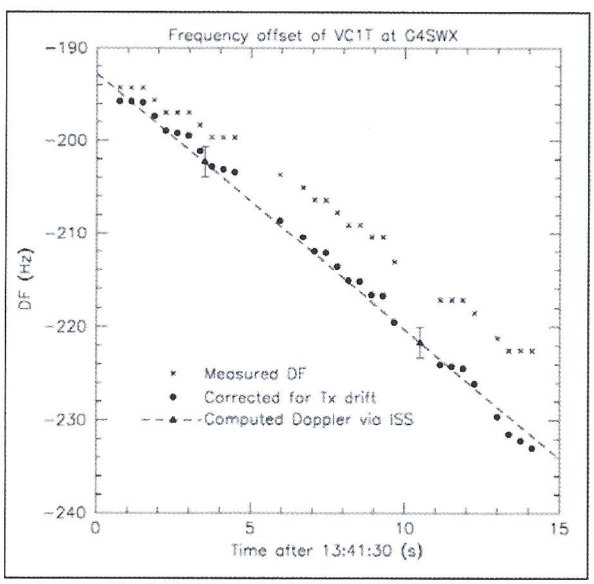


Figure 4 — Computed and measured Doppler shifts of the VC1T signal received at G4SWX. DF is the difference in frequency between the receiver acquiring the signal and the transmitter sending it. 'X' are measured data from the .wav file (available on the Brendan Quest web page) of the signal received by G4SWX, prior to correction for the frequency drift of our IC-746 Pro during transmitting. Graph courtesy of Joe Taylor, K1JT.

The Outcome

We sent our Brendan Plate application, claiming a successful one-way trans-Atlantic reception to the IRTS, and awaited their decision. Months passed, and we began to examine the available evidence more closely.

FSK441 not only records contacts, but their exact transmit-receive frequency *differences* (DF in Figure 3), and tiny Doppler and transmitter or receiver frequency *shifts or changes* over time. Doppler shift is the change in frequency that occurs when the transmitter, or something reflecting the transmitted signal, is moving relative to the receiver. What could the VC1T signal Doppler shift tell us?

We sent the FSK441 .wav file received by John, G4SWX, in the "magic moment" along with ISS orbital data for the same time to astrophysicist Joe Taylor, K1JT. After correcting for external influences, and using Fourier analysis, Joe found a small and changing Doppler shift in the FSK441 .wav file data. He then used the ISS orbital data to calculate the ISS induced Doppler shift relative to G4SWX's station, at the moment of VC1T reception. The Doppler magnitude and drift of our actual signal and what it would have been if it were a bistatic reflection off the ISS matched almost perfectly (see Figure 4). In other words, the VC1T signal received by John, G4SWX, had exactly the Doppler characteristics to be expected if it had been reflected from the ISS, so we did not qualify for the Brendan Plates.

Although disappointed that we did not leap the North Atlantic in an "all natural" way, reflecting a 2 meter signal off the ISS to cross the North Atlantic to England, and 3840 kilometers is still a first. We sent a QSL card (see the lead photo) to John, G4SWX, for the first-ever reception of a non-EME trans-North Atlantic 2 meter transmission. The card shows our ultra-light 43-element Yagi pointing east across the Red House cliff meadow toward Ireland and the UK.

Our group (shown in Figure 5) mounted the largest and best-equipped expedition to date for a trans-Atlantic 2 meter contact. Perhaps our experience will help the next group that tries for a Brendan Award. Who will take up the challenge?

Figure 5 — The VC1T team on the Red House deck in Pouch Cove, Newfoundland. From left to right: Helen, VA1YL; Fred, VE1FA; Roger, VE1SKY; Al, VO1NO, and Rich, VA1CHP.

Acknowledgements

This was by far the most difficult of our many expeditions, due to the sheer amount of learning, designing, building, and coordinating with others. VC1T happened because many (too many to list here) generous and skilled people helped. Thanks especially to Warren, VO1KS, and Paul, N2EME, (Larcan amps); Jim, VE1JF, (components, advice, data analysis); Dick, PA2DW, (advice, refreshments); Peter, PA3BIY (LNA); Sebastian, W4AS (web page, advice); Joe, K1JT (Doppler analysis: big thanks); Emil, W3EP (advice); Paul and Nola Murphy (helped with everything in Newfoundland); Pascal, F5LEN (custom tropo-ducting forecasts); Barry, VE1QY; Phil, VE1WT; Kurt, VE1TT(SK), (JT65, FSK441, and Yagi construction); Joe, VO1NA, (towers), and John, G4SWX, for an enormous amount of advice and discussion, along with many other VHF DXers for their suggestions and participation. And finally, thanks to the warm hospitality of the Newfoundland hams and people of Pouch Cove.

Notes

[1]**www.arrl.org/qst-in-depth**

[2]Several versions of *EZNEC* antenna modeling software are available from developer Roy Lewallen, W7EL, at **www.eznec.com**.

[3]J. Ford, N6JF, "A 'Rope Ladder' 2-Meter Quagi," *QST*, Mar 1995, pp 25 – 27.

Photos courtesy of the authors.

Fred Archibald, VE1FA, is a retired research scientist and professor of microbiology at McGill University, Montreal. He was first licensed as VE2SEI in 1988 and enjoys DXing, island expeditions, ragchewing, restoring and operating old radios, and introducing "newbies" to our wonderful hobby.

Helen Archibald, VA1YL, was first licensed as VE2YAK so she could talk to her husband, VE2SEI, and son Andrew, VE2WHO, when they went on DXpeditions. Since then she has been on more than 15 expeditions, is net controller for a Canadian Ladies Amateur Radio Association (CLARA) net, and has done four stints as president of CLARA. She has introduced hundreds of young YLs (Girl Guides) to ham radio.

Alphonse Penney, VO1NO, is a retired naval officer who was first licensed in 1977. He enjoys contests, DXpeditions, and teaching. Al has served as the president of five clubs in Canada and the US, and is currently Chair of the Radio Amateurs of Canada 0 – 30 MHz Band Planning Committee.

Rich Pieniaszek, VA1CHP, is a retired California Highway Patrol officer who was first licensed in 1978 as KA6NQK. In 2003 he moved to Nova Scotia and became VA1CHP. He enjoys contests, DXpeditions, and geocaching.

Roger Sturtevant, VE1SKY, spends most of his radio time operating the weak-signal modes of the WSJT suite. An urban planner, he was Director of Planning for a large Alberta-based multi-disciplinary firm for 12 years. Before retiring in 2010, Roger served for 25 years as Executive Director with the Annapolis District Planning Commission in the historic Annapolis Valley of Nova Scotia.

Contact the team at 25 Canard St, RR#1, Port Williams, B0P 1T0, Nova Scotia, Canada or **hfarchibald@ns.sympatico.ca**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

New Products

Ground Braid from ABR Industries

ABR Industries has introduced a new version of their ½-inch ground braid. This design, which includes nickel grommets spaced every 4 inches, allows for easy attachment to a vehicle body or truck bed to create a ground plane. In addition, this ground braid can be used for a "bus-bar" in a home station. Standard lengths are 1.5, 3, 5, and 10 feet. Available from Ham Radio Outlet stores. Prices start at $6.95. For more information, visit **abrind.com** or **www.hamradio.com**.

Dual Time Zone App for the Pebble Smartwatch

Robert Morris, AG6ZZ, has developed a watch face for the Pebble smartwatch that displays local time and UTC. For accuracy, smartwatches synchronize with smartphones, which ultimately are set by the US Atomic Clock. The Dual Time Zone app offers 12- and 24-hour formats, and includes the date for each time zone. Currently it supports the Pebble Time and Pebble Time Round model watches. Dual Time Zone can be downloaded for free from the Pebble store directly using the Pebble app in an Android or iPhone. For more information, visit **apps.getpebble.com/applications/55e8cd0cb35ee6a595000076**.