GB3SSS — Marconi's Transatlantic Leap Revisited

Did he do what he said he did in 1901? A group attempts to reach a conclusion.

Steve Nichols, GØKYA

Club Chairman Dave Wall, 2EØGSD (left), and Club Secretary Keith Matthew, GØWYS, at the base of the GB3SSS antenna at GB2GM at The Marconi Centre, Poldhu, Cornwall, UK.

As far as the history books and the general public are concerned, Marconi is the father of radio. But Marconi's main claim to fame all rests on a simple premise — did he actually receive signals from Poldhu, Cornwall, UK at Signal Hill, Newfoundland on December 12, 1901?

Unfortunately, some say the evidence is stacked against him and people have argued about the success or otherwise of his achievement for years.

In 2001, Dr John S. (Jack) Belrose, VE2CV, of the federal Communications Research Centre in Ottawa and a respected authority on radio, is reported to have said that: "As far as I am concerned Marconi heard absolutely nothing. He deceived himself and the world into thinking he heard something."

That is why the Poldhu Amateur Radio Club at the Marconi Centre in Cornwall and the Marconi Radio Club of Newfoundland wanted to set the record straight.

In late 2006 a group of radio amateurs from both sides of the Atlantic decided to re-enact the legendary transmission. The idea came from Bart Lee, KV6LEE, an associate member of Poldhu ARC, who realized that the solar conditions in the winter of 2006/2007 would be similar to when Marconi received the signals in Newfoundland — sunspot minimum in midwinter with its attendant low ionospheric D layer absorption and minimum absorption frequency.

As Bart said: "I determined, in 1998 or so, that the sunspot number in December 1901 was exactly zero, a remarkable coincidence if nothing else.

"The D-layer daylight absorption was then much less than nowadays because the amount of atmospheric nitric oxide was less, too. Carl Luetzelschwab, K9LA, first pointed out to me the role of nitric oxide in the D-layer. What this could mean in 1901 is that a whole lot more of Marconi's 13 kW hit the F-layer to come down in St John's than would happen today. How much more is hard to say. So 1901 perhaps got a bonus in dBm relative to today."

From the start of November, the Poldhu Amateur Radio Club, based at Marconi's original transmitter site on the Lizard peninsula, Cornwall, used a 160 meter beacon — GB3SSS — to make regular one-minute transmissions on 1960 kHz while radio amateurs in Canada and the USA tried to copy and analyze the transmissions.

But why all the fuss? Why should there have been any doubt in the first place?

Keith Matthew, GØWYS, Poldhu ARC's club secretary explained:

> No one really knows for sure what frequency Marconi's transmissions were on. Marconi himself was evasive concerning the actual frequency. But in a lecture in 1903 Ambrose Fleming said that the wavelength was 1000 feet or more — 810-870 kHz is generally the quoted frequency.
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> But in 1908, Marconi said in a lecture to the Royal Institution that the wavelength was 1,200 feet, and in a recorded lecture in the early 1930s he changed his story to approximately 1,800 meters (166 kHz). At the same lecture he quoted the transmitter power as being 15 kW.
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> Whatever the frequency was, the tests took place at the worst time of day.

Marconi said he received the signals at 12:30 PM, 1:10 PM and 2:20 PM local time using a 500 foot long antenna suspended by a kite. At the time this corresponded to 1600Z, 1640Z and 1750Z.

Map these times using a modern program like *Geoclock* and you see that the complete path was in daylight at 4 PM and only the UK end of the path was in darkness at 5:50 PM.

Even though we know there were no magnetic storms at the time, or for 10 days before, the daytime skywave would have been heavily attenuated.

In Marconi's favor, it was midwinter with low sun elevation angles, but a 3500 km path in daylight on 880 kHz? Surely not.

Factor in that the receiving equipment consisted of a long-wire antenna and an untuned receiver and the odds get worse. As

Marconi used a spark transmitter he would have heard faint clicks, not the audio tone of a CW signal that we know and love today.

But as Marconi said later: "At 12:30 PM, while I was listening on the telephone receiver there came to my ear, very weakly, but with such clarity that there could be no possible doubt, a rhythmic succession of the three dots corresponding to the letter S of the Morse code..." Some signals were also received on December 13 during the brief time that a kite could be kept flying and there was a possibility that they were also heard on the 11th.

"Davey" Davey-Thomas, G3AGA, of Poldhu ARC is looking at the possibility that Marconi actually heard the signals on three-times the quoted frequency at around 2.5 MHz. The Poldhu spark transmitter emitted a wide range of frequencies and it was only the characteristic length of the transmitting and receiving antennas that favored one frequency over another. This is not to be confused with true "harmonics" of the fundamental. In truth, there was no fundamental.

If the Poldhu antenna was resonant at 860 kHz it would also have exhibited a low impedance at three times this — 2.5 MHz.

Perhaps the secret lies in the story that Marconi was allegedly using an untuned receiver. One theory is that the spectrum of the Poldhu transmitter contained significant power in the higher HF (short wave) bands — 14 MHz would be no problem for making the contact as Poldhu ARC shows every year on the anniversary of Marconi's claims when it contacts Newfoundland in a symbolic exchange of greetings.

But as Bart Lee pointed out: "Under these low sunspot conditions, the maximum usable frequency is at its lowest as well. I doubt that a harmonic or spurious signal got across in 1901. I also doubt that Marconi was listening for signals on anything other than his primary frequency where his transmitter's power was concentrated."

I visited Poldhu on the 105th anniversary of Marconi's achievement on December 12, 1901 to research this story. At 1600Z history was remade when GB2GM made CW contact with VO1MRC in Newfoundland on 20 meters as the club does every year. With Ron, GØMRH, on the key and a shack full of Poldhu ARC members it was a fitting tribute to Marconi's work.

But GB3SSS hoped to show once and for all that it could have been possible for Marconi to hear the signal transmitted on or around 880 kHz, slap bang in the middle of what is now the Medium Wave broadcast band. The closest frequency, with similar characteristics, available to radio amateurs was Top Band (160 meters); hence the selection of 1960 kHz.

Keith added: "The beacon, built by Andy Talbot, G4JNT, used a sequence of transmissions similar to that of the UK 5 MHz beacons. It used a one-minute transmission on the hour and at each subsequent 15 minutes consisting of the call sign in CW followed by a series of bursts of carrier each decreasing by 6 dB — from 100 W to 25 W, 6 W, 1.5 W, 0.4 W, and 0.1 W. There was then a burst of PSK31 at 100 W with the message: GB3SSS IO70IA POLDHU, CORNWALL GB3SSS IO70IA POLDHU, CORNWALL QSL GB3SSS@YAHOO.CO.UK.

Davey, G3AGA said: "The antenna used was a Marconi 'T' at 50 feet with eight 65-foot radials, which the National Trust would not allow us to bury. The original was a flimsy affair, but was later replaced by 16 SWG hard-drawn copper. The matching unit was a simple LC circuit feeding the 200 foot length of coax, and giving an SWR of 1:1.3, which varied between 1:1.1 to 1:1.4 depending on how much rain there was."

Thanks to John Gould, G3WKL's help, the beacon idea was steered through the RSGB beacon committee, was licensed by Ofcom and transmissions commenced. The results beat all expectations. By mid-December reception reports had been received from across the UK, Italy, Belgium, Germany, Sweden and New Zealand. There was even one possibly dubious report from Beijing, China. The transmissions continued until the end of January 2007.

But it was the transatlantic reception reports that Poldhu were interested in and it didn't take long for them to flow in.

Many US and Canadian stations heard the beacon, but mostly during the hours of darkness.

Jeff Briggs, K1ZM, author of *DXing on the Edge — the Thrill of 160 Meters*, has a holiday home on Prince Edward Island, Canada. Working as VY2ZM and using a 2×2 vertical element Top Band array with about 8 dBd of gain toward 55°, he reported hearing the beacon at 1031, 1615, 1659 and 1745Z on November 3. It was the same story the next day. Signal levels varied from ESP levels to 599+.

The Atlantic had been bridged on Top Band during daylight hours. Jeff said:

> I went back to VY2ZM from 22/11/06 through to 04/12/06 and did some actual

Ron, GØMRH (rear) and Keith Matthew, GØWYS, make the anniversary contact with VO1MRC on December 12, 2006 at GB2GM.

Part of the impressive display of wireless history at The Marconi Centre.

measuring of the GB3SSS signal at 1750Z using an HP signal generator (verified against an HP spectrum analyzer). On several days, I listened and measured the GB3SSS signal at 1750Z repeatedly at about –91 dBm strength. By way of information, I recall the signal at 0330Z was about –60 to –63 dBm in strength.

It was suggested to me by K1ZZ of the ARRL that I try to copy the EU broadcast stations at 9 kHz spacing and note how early and at what signal levels I could hear them.

I did this and copied signals from Norway, Sweden, UK, Spain, Canary Islands and Switzerland — with their carriers heard as early as 1630Z and *copiable* audio from programming content as low as 855 kHz (Radio Nacional de Espana) by 1750Z.

Joe Craig, VO1NA, of the Marconi Radio Club of Newfoundland also received the signal in daylight. He said the MRCN receiving station comprised a one-wave Beverage aerial feeding a stable DDS (direct digital synthesized) receiver with the automatic gain control disabled and whose line output was connected to the sound card of a computer running the GB3RAL software.

Joe said: "We mitigated noise by selecting a quiet location for the aerial, decoupling both ends of the line to the Beverage and running the computer and radio from a linear power supply. The system operated from the start of the experiment with only four days of downtime."

Joe also reenacted history by receiving the beacon at 2130Z and 2330Z on a short active antenna from the top of Signal Hill in Newfoundland. "I think this was the first time that MF signals have been received from Poldhu at this point since 1901," he said.

But the tests have now thrown up a new dilemma. If the signals could have been propagated across the Atlantic at the time and frequency logged by Marconi, was his receiving equipment sensitive enough to have heard them?

Marconi was using a Bose/Solari Mercury Detector (coherer) — sometimes called an Italian Navy coherer.

Coherers use a direct current (dc) voltage across them to work, the so-called bias voltage. Radio frequency (RF) energy from the antenna changes the dc resistance of the coherer from high to low. Once "triggered" the dc current causes a click to be heard in the headphones.

The coherer is believed to have used a carbon and iron electrode with mercury in between, but as Keith Matthew points out there was mention in Marconi's notes about the use of "dirty mercury."

"Could this have given a layer of mercury oxide in the coherer?" said Keith. "Did the voltage 'punch through' the mercury oxide which would then reseal? If it did then a lot more research needs to be done," said Keith.

The GB3SSS Top Band beacon at the Marconi Centre.

Ron, GØMRH (rear) makes the anniversary contact with VO1MRC on December 12, 2006.

Bart Lee added:

The Solari/Bose detector has been shown, recently by Lane Upton, IEEE, to be about as sensitive as a germanium diode in rectifying mode. My suggestion is that it, like a Branly filings coherer, acts as a pulse amplifier when shocked with RF energy — a very small amount of RF energy and power triggers a much larger amount of power as a dc pulse of the bias voltage and current.

The filings coherer was regarded at the time as very insensitive compared to the mercury oxide detector, which is why Marconi used the mercury oxide variant.

It is hard for us to imagine how quiet the ether was in those days. No QRM, only atmospheric QRN (then far away in the southern hemisphere), very few electrical devices to make noise (especially in Newfoundland!) and for this test, QSB if any was irrelevant.

All Marconi and Kemp had to hear was some timed clicks, and they heard about 38 triple-clicks over two days. Fleming designed the transmitter as double-spark to send only sharp pulses, and Marconi designed his receiver to hear only clicks, taking advantage of the sensitivity (and filtering ability) of the human ear.

Jeff Briggs added:

My own conclusions suggest that Marconi may well have heard what he said he did — if his receiver was about 25 dBm more sensitive than most modern experts think it was, say about –25 dBm.

The eastern coast of VO1 is radically closer to the west coast of G than I am here on Prince Edward Island — so I would have to assume that with similar Rx capabilities, GB3SSS would be even more reliably received there.

If it were actually able to detect a –50 dBm signal — and if we factor in the additional daylight path losses to VY2ZM versus Signal Hill, Newfoundland — it begins to enter the realm of true feasibility, especially when we note I could copy reliably EU BC carriers as early as 1630Z.

Marconi was able to copy Poldhu on 272 kHz at night about several months later in 1902 as he entered North Sydney, Nova Scotia, on a ship. If his receiver was good enough to do that (and this is without question) — then how was it incapable of hearing a signal on or about 850 kHz (or higher) during the day on Signal Hill?

So is this the end of the story? I doubt it. We will never really know whether Marconi heard the signals that day in 1901, although the evidence supporting the claim is beginning to mount up. In any event, we cannot change history or destroy Marconi's memory and legacy. In our heart of hearts do we really want to?

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Photos by the author.

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