



## HOW NOT TO DO A VLB EXPERIMENT\*

Ken Kellermann

Following the successful completion of the Green Bank-Sweden 6 cm VLB experiment in February 1968, the VLB group began to look for new, exotic places to visit. A U.S.-Australia baseline appeared attractive as being the longest reasonable physical baseline where on the earth a radio source could be simultaneously seen from both ends. However, it was clear that to obtain really high resolution it was necessary to go to short centimeter wavelengths. But, the only radio telescopes of sufficient collecting area capable of operation at short centimeter wavelengths located far from Green Bank are in the USSR.

So in February 1968 we wrote a letter to Professor Victor Vitkevich, director of the radio astronomy department of the Lebedev Physical Institute, proposing a VLB experiment between the 140-foot and the 22-meter precision reflector located at Serpekhof near Moscow. Although we were aware that there might be some political and practical problems in doing a VLB experiment in the USSR, I don't think any of us anticipated just how difficult it would actually be.

At first it looked as though we would get no response from the USSR, but five months after our original letter we received a telegram from Moscow followed by a letter from Dr. Leonid Matveyenko saying that Vitkevich did not answer because he was on vacation! And somewhat to our surprise he replied that the USSR Academy of Science had given tentative approval to the proposed experiment, except that they recommended we use the new 22-meter telescope in Crimea rather than the one in Serpekhof because (a) it was a better telescope, (b) it is a better baseline, and (c) the weather is better in Crimea than Moscow. Also, he proposed an exchange of personnel to discuss plans for the experiment.

Somewhat encouraged, we invited Matveyenko and Dr. Ivan Moiseyev, director of the radio

astronomy station in Crimea, to visit us at NRAO. At the same time Dr. Heesch wrote to the NSF asking permission to bring our VLB experiment to the USSR. A few weeks later Russia invaded Czechoslovakia and the NSF told us to hold off. In January of this year Matveyenko and Moiseyev arrived in Green Bank. We tentatively agreed on doing two experiments — one at 6 cm and one at 3 cm. Because the weather in Crimea is said to be poor in late autumn we decided to do the experiment in October of 1969.

By this time Russia was behaving itself politically, so we moved ahead with making firm plans. We immediately ran into difficulty with the U.S. Commerce Department trying to get an export license to allow us to ship the VLB equipment to the USSR. The main cause of concern was that one of the by-products of a VLB experiment is that the distance between the two antennas may be determined to an accuracy of about 100 feet, and it is expected that future improvements will reduce this uncertainty to a few inches. And the experts at the Defense Department were afraid that a 100 megaton bomb which landed a few inches from the 140-foot telescope could do more damage than one which landed a few hundred feet away. We later learned that the Soviet government was similarly concerned. But as a result of frequent prodding by Bill Howard, Ted Riffe, and Bill Powell, the Commerce Department finally granted us an export license in August, only a few days before I was scheduled to leave NRAO.

On September 10 I arrived in Moscow with my wife and was met at Moscow's Sheremetevo Airport by Leonid Matveyenko. After retrieving our luggage, Matveyenko told the Customs man "AkademyNauk" (Academy of Science) and we passed through Customs without any inspection or formality. We later found much use for the phrase "Akademy Nauk" which indicated that we were guests of the Academy of Science and would open any and all doors from the Crown Jewels to last minute reservations on a Russian airplane.

We spent the next few days discussing plans (about 1 hour); seeing Moscow; and trying to learn a bit of Russian since it became immediately

\* Part 1 — to be continued in March 1 issue.



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apparent that except for the scientists no one in Moscow speaks English, in particular waitresses in restaurants. So if you want to eat you must speak Russian.

Our equipment was scheduled to arrive September 15 and Matveyenko was dispatched to the airport to collect it. He returned that evening and reported that he needed the "baggage ticket". I tried to explain that you don't get a baggage ticket with freight and that in any case I was already in Moscow when the shipment left the United States, and I would not possibly have any of the papers prepared when the shipment left. This appeared to cause some concern amongst the Russians.

The following day we obtained a letter from the Academy of Science to the cargo and customs people saying that it was o.k. for me to collect our equipment, and Matveyenko and I drove to the airport in a car and were supposedly followed by a truck which was to carry everything back to Moscow. Following about an hour of being sent from one office to another and several heated discussions, we were led to a shed that contained the equipment (or as all Russians insisted on calling it, the "aperture"). Matveyenko appeared to be a little surprised at the size and weight of our "aperture" which consisted of three, large wooden crates plus 25 boxes of magnetic tapes weighing a total of 3,000 pounds.

For some unknown reason we had to wait about two hours for the truck to arrive. But this was good practice as we were to spend a good part of the next few months waiting for someone or something, and, of course, when the truck arrived, it turned out to be about the size of a VW bus (in fact, it was exactly identical to a VW bus except for the letters "VW") and it barely could hold the smallest of our three crates. It took 6 or 8 guys with a lot of pushing and groaning to get this one crate loaded onto the truck. I drove back to Moscow in the car, being assured that they would handle the rest and get it to Moscow.

Much to my surprise, all the "aperture" somehow appeared the following morning in the basement of the Sternberg Institute. I never even tried to ask how it got there. By this time John Payne had arrived in Moscow and we decided to open things up to see if it worked. We knew that Bill Vnable

had been kind enough to include a few screwdrivers in one box but it took a while to locate a local screwdriver so we could open the box to get at our own. And when one was found it was so worn it had more of a point than a blade.

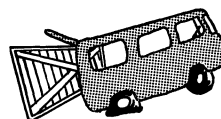
As John and I set about opening the various boxes we gathered an audience of 6 or 8 people who stood around talking and watching us try to open the boxes with this rather primitive tool. We later noted that groups of men standing around and talking seemed to be a national habit, from the farmers to street repair crews. In fact, we rarely saw anyone working for more than ten minutes at a time without stopping for a discussion or "small rest" — any man, that is. The women work very hard at such tasks ranging from carrying pails of water from the well to the house to running steamrollers and pneumatic drills, but more about this later.

A few of our audience did try to pry out a screw or turn a nail but in spite of their help we managed to get the boxes open, and much to our surprise everything seemed to be intact.

It had been pointed out to us that the boxes were too big to fit in the cargo door of an Aeroflot airplane (Aeroflot is the Soviet airline and is the largest airline in the world) to be flown to Crimea. I argued that since they had come from London by Aeroflot they must fit. But my reasoning proved incorrect since the planes flying from Moscow to Crimea have smaller doors than those flying from Moscow to London.

There then followed a big discussion (Russians seem to like big discussions) as to whether the "aperture" should be shipped by truck or railroad. To complicate the situation, it was necessary to send the rubidium clock and VLB control unit first to Leningrad to synchronize the clock with the German Loran station, while the tape recorder, front ends, and 25 cartons of magnetic tape were to go directly to Crimea. It was finally decided to send the shipment to Crimea by train and the one to Leningrad by truck.

A minor difficulty was that the maximum weight per item allowed on the Russian railroad is 100 kgms, and our tape recorder together with



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crate weighed about 500 kgms. But after obtaining a letter from the "Academy" the rule was changed, and our tape recorder departed for Crimea.

The VLB control unit was scheduled to leave by truck on the morning of September 18 for Leningrad. By noon the driver had not yet appeared at the Sternberg Institute and a subsequent investigation revealed that he had gone to the airport instead. He was quickly recalled and dispatched to Leningrad with strict instructions to proceed directly to Leningrad and not to stop for rest until he arrived (Moscow to Leningrad is about 400 miles).

That evening the whole VLB party — John Payne, Matveyenko, Leonid Kogan (a going engineer assigned to the project), my wife, and myself flew to Leningrad aboard an Aeroflot TU104 jet. We also carried in the airplane our atomic clock which we hoped to set in Leningrad with the aid of Loran which we were told was easy to receive in Leningrad. Arriving in Leningrad we were met by a delegation from the Pulkova Observatory where we planned to set up our Loran equipment.

Following a sleepless night in an unheated hotel room with the temperature near freezing, we set out for Pulkova. (The night was sleepless because one of the banks of floodlights that was used to illuminate the side of the building was located just under our window. John had a similar choice location.)

Arriving at Pulkova I was not too surprised to find that our equipment had not yet arrived. It showed up about noon and again we opened up the crate before a large audience — but this time with our own screwdriver which I had carried in my pocket to Leningrad.

The 230 V AC line turned out to be more like 200 volts, so we had to find a transformer. To insure continuous operation of the atomic clock we also had a 28 V DC battery supply with an advertized capacity to last about 75 hours.

Lacking a proper Loran antenna we strung a wire across the floor and promptly received what appeared to be the Loran transmission from Sylt, Germany. Only the Sylt station was supposed to transmit with a 79.6 millisecond period and the signal we were receiving had an apparent period

of 80.0 milliseconds. There seemed little doubt that this was an actual Loran signal since it clearly had the characteristic 8 sub-pulses per main pulse, with each sub-pulse separated by the usual 1 millisecond. We therefore decided that something must be wrong with the VLB counting circuitry and spent the next two days trying to isolate the trouble. In the course of checking the VLB unit we used a variety of Russian test equipment which often turned out to be identical (except for the lettering on controls) to some piece of American (usually Hewlett Packard) equipment. After wasting two days and convincing ourselves that everything was working properly, and rejecting the unlikely possibility that Loran had changed its period without announcement, the light finally dawned — we were not receiving Loran at all, but an unadvertized Russian copy. The real Loran appeared to be buried in interference from the most powerful transmitter in the USSR located only a few miles away broadcasting entertainment to the Soviet ships all over the world. John considered building a filter but it was clear that it would take a week to dig up the necessary parts. We did manage to find a very ancient receiver which had fair selectivity which we tried to use unsuccessfully as an RF preamplifier. Another few days were wasted trying a variety of antennas in various locations and orientations trying to dig the Loran signal out of the background. Most of the time, however, was spent in repairing the Pulkova receiver we were using as a preamplifier, which kept breaking down in one way or another. It was rumored that at various odd hours of the night on certain days of the week the interfering station would temporarily stop broadcasting, but this never materialized, and it was becoming clear that we were getting no where fast.

We had previously explored the possibility of flying a running clock into the USSR but our Russian colleagues in Moscow indicated that this would be "impossible". But, in Leningrad Pariskii was more optimistic and thought that it might be arranged. On Saturday, September 21, I telephoned Bert Hansson in Sweden, one of our collaborators on previous VLB experiments, to see if he could arrange to synchronize their clock



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in Stockholm and send it to Leningrad. But I was told that (1) they had no batteries, (2) it was a weekend and there was no one around to prepare a proper box nor was it possible to buy batteries on the weekend, and (3) Sweden had just experienced a major storm which blew down an antenna at their observatory and had damaged the director's yacht. Nevertheless, Bert promised to "see-what-he-could-do".

Meanwhile, the first observations were only about a week away and we hadn't even been to the Crimea site yet. So John decided to go alone to Crimea to set up the VLB equipment, install the front ends and check out the TWX machine that was supposed to be installed. I stayed behind in Leningrad to struggle with the Loran receiver and await the clock from Sweden.

The VLB control unit was scheduled to be shipped by train to Crimea at midnight on September 23. I planned to spend all that day in a last minute attempt to receive the Loran signals. Kogan told me that the railway people required that the box be at the station not later than 10 p. m. in order to make the 12 p. m. train, and then he went off to make the final arrangements for the train shipment. About 3 o'clock he burst in while I was still unsuccessfully struggling to receive Loran and announced we had to be at the RR station by 5 p. m. There then followed an unprecedented flourish of activity and in the record time of 15 minutes the 6-foot high, 300 pound rack was nailed shut into its crate, placed in the truck, and off we sped to the Leningrad RR station. And speed, we did, because we were immediately stopped by the police for speeding (this was the second time out of a total of five that I was in a car in the USSR that was stopped for speeding). But Kogan explained that we had a visiting American delegation and we were let off with a warning. Of course, then we got lost trying to find the station for cargo and drove all around Leningrad. We finally arrived a few minutes before the deadline.

It took a crew of about 8 rugged looking Russians to move the crate from the truck to the RR car. They struggled, moving it in short spurts singing a "heave-ho-tovarishch" before each shove. To make things a bit miserable for all, it was cold and raining.

Finally getting the crate in the RR car, they broke out in a big happy smile and someone produced a little, square bottle (we would become very used to this bottle in the coming weeks) and everyone took a quick drink. I asked Kogan what it was they were drinking and he replied "alcohol". I said I know but what kind of alcohol? And he repeated "alcohol". And it turned out that is exactly what it was — pure alcohol. Well, not quite pure, but 90% pure.

Having no success with the Loran receiver and not hearing from Sweden, things looked a bit grim, but on the night of September 24 we went anyway to the Leningrad airport to meet the Aeroflot flight from Stockholm. To our pleasant surprise there was a heavy wooden box addressed to me, strapped in a first class seat with a safety belt. Of course, the Customs man (customer, as Kogan called him) wanted to see what was inside. We handed him some official looking papers of explanation, and opened the box. He took a quick look, saw a few glowing lights, looked with astonishment at the clock ticking loudly, and said o. k. We quickly left before he could change his mind.

At Pulkova, we synchronized the NRAO clock to the Sweden clock, attached the Russian batteries in case of power failure, and left it to run at Pulkova. We had the batteries supplied with the Swedish clock recharged, and set off for the airport to fly to Crimea. In order to preserve the nickel-cadmium batteries supplied with the Swedish clock, we also carried two 6-volt car batteries and an inverter to supply 230 V AC. This combination gave us a battery capacity which was good for about 25 hours, more than enough (we thought) for a two and half hour plane trip.

The whole load weighed about 200 pounds and it took some explaining to get it on the airplane.

The flight was uneventful and upon arriving in Simferopol, the capital of Crimea, we were met by Moiseyev and set off on a two and half hour winding drive through the mountains to Yalta (this was the first of 10 such trips I made between Simferopol and Yalta). In Yalta we were greeted by John with the news that :



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1) The TWX machine could not be connected because the lines were not good enough.

2) The 50 ohm, 10 dB loss LO cable they promised us was 72 ohms and had 20 dB loss so we could not get enough LO signal from the control building to the antenna.

3) He could not receive the Loran timing signals from Turkey.

But the real blow came when the box was opened: the clock had stopped on the airplane half way between Leningrad and Crimea. The batteries had lasted only about an hour.

This was by far the low point of the expedition. We had no time, no LO, and the first observations were only 5 days away. By this time I was so confused; I had lost track of the days and told everyone we had to observe in 4 days.

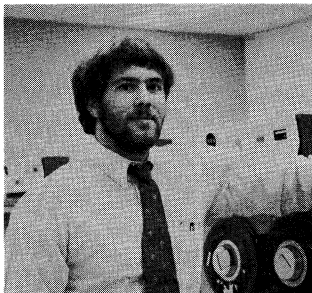
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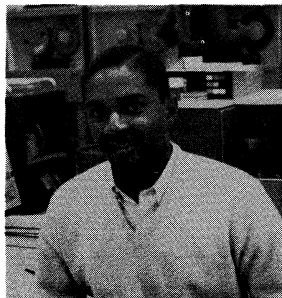
**NEW EMPLOYEES**

Mary Ann Starr



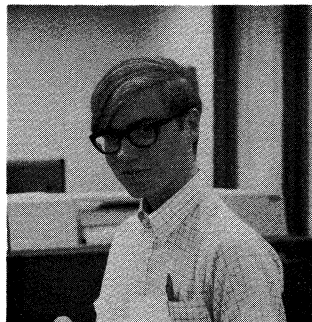
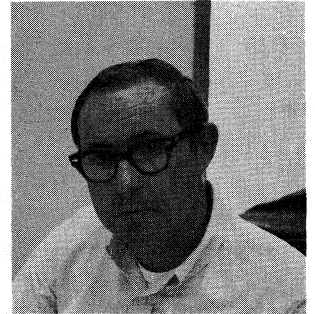
John M. Copper, Jr.  
Computer Division - CV

Lemuel T. Lewis  
Computer Division



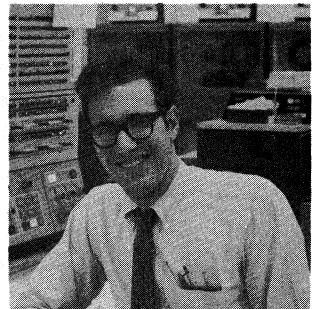
Jozef Maslowski  
Basic Research - CV

Billy L. Meredith  
Basic Research - CV  
(Welcome back, Bill!)



Glenn E. Strickland  
Computer Division - CV

Charles Udell  
Computer Division - CV



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**TERMINATIONS**

Thomas L. Wilson, Basic Research, Adolphus T. Shears, Maintenance, Daniel Suggs, Computer, George T. Wren, Computer, and Janice Mullenax, Bus. and Services.

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**PROMOTION**

John Hawkins to Head, Green Bank Administrative Services - Congratulations!

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