

W Powell

LONG BASELINE INTERFEROMETRY
BETWEEN THE UNITED STATES AND THE SOVIET UNION:
SCIENTIFIC BACKGROUND AND POTENTIAL PROBLEM AREAS

Very little information can be obtained about the discrete radio sources; we may measure only the amount of radio power we receive from them (their spectral flux density) at various frequencies, their position, and their angular size (or in more detail, their brightness distribution on the plane of the sky). Interferometry is concerned with the measurement of the last of these quantities.

Interferometry is a widely-used technique in radio astronomy. Interferometry involves a technique of using two widely-separated telescopes that observe sources simultaneously in time. Each interferometer may conveniently study radio sources in only a fairly narrow range of angular size. The physical length of the interferometer baseline is directly proportional to the wavelength, and inversely proportional to the angular size of interest. For instance, the National Radio Astronomy Observatory (NRAO) interferometer, with baselines up to 2.7 km, can only work with sources larger than about 3 seconds of arc in angular size.

Radio sources of very small angular size are also of great interest, because radio sources are apparently born small and expand with increasing age. In order to understand the physical processes associated with the birth of a strong radio source it is necessary to know more about the properties of radio sources of extremely small angular diameter. To study these objects requires interferometers with extremely long baselines--comparable with the diameter of the earth.

The NRAO has, in the last two years, developed an interferometer receiver capable of operating with no physical connection between the two ends of the baseline. The signals from the radio sources are recorded on digital magnetic tape, and the two tapes are taken to a general purpose digital computer which reconstructs the signals and synthesizes the remainder of the interferometer receiver. In order that the signals may be reconstructed with sufficient accuracy, very stable timing information is needed at the two ends of the interferometer.

We propose to observe with the long baseline interferometer with the two ends located at the 140-foot radio telescope at the NRAO, Green Bank, West Virginia, U.S.A., and the 22-meter radio telescope of the Crimean Astrophysical Observatory R.S.F.S.R. We wish to observe at wavelengths of 6 cm and 3 cm, allowing us to measure sizes of sources in the range 0.0005 to 0.0010 seconds of arc at 6 cm and 0.0003 to 0.0005 seconds of arc at 3 cm.

We hope to observe eventually at still shorter wavelengths to measure angular sizes of still smaller sources. It is necessary to use the Crimean telescope for this work, because there is no other radio astronomy telescope outside the United States with such large collecting area of sufficient precision to operate at wavelengths shorter than 6 cm.

In order to operate the long baseline interferometer, very accurate timing information must be available at the two ends of the baseline. These requirements are as follows:

1) Timing stability over the length of time required for a single tape (3^m) to better than the reciprocal of the observing frequency (0.2 ns for 6 cm wavelength).

2) Timing stability over a day of better than 1 μ s.

3) Timing of the two clocks relative to each other (or to an absolute standard, such as UTC) of 30 μ s.

We attempt to meet the first requirement by the use of Hewlett-Packard rubidium vapor controlled atomic frequency standards. These are not sufficient at wavelengths shorter than 6 cm, and our sensitivity suffers as a result (though not the accuracy of measurement on the sources we can see). NRAO has on loan from NASA, for use at Green Bank, a hydrogen maser frequency standard, which is an order of magnitude better than the rubidium controlled standard, and if a device of comparable stability could be used on the far end it would enhance the usability of the instrument.

The second requirement follows easily for any standard good enough to meet the first. The third requirement must be met by carrying a running clock either from Green Bank, or from some other place where UTC is known to an accuracy of a few microseconds (Geneva, Switzerland, has a standard which is compared on a regular basis with other UTC clocks; we are told that there is a clock in Leningrad synchronized with UTC by monitoring the North Sea Chain LORAN C emissions). Monitoring LORAN emissions as a secondary check on timing is also highly desirable.

We propose to send the following equipment from NRAO to the Crimea for this experiment. This equipment is for the most part the standard long baseline interferometer terminal, and has already operated at four different sites in the U.S., and in Sweden, Germany, and Australia.

Item	Manufacturer	Serial Number	U. S. Govt. Tag Number
Freq. Synthesizer XUC	Rohde & Schwarz	444466	4629
Crystal Oscillator	Rohde & Schwarz	4444291	4630
Tape Transport	Ampex	C-102	4631
VLB Delay Unit	AUI	2	4632
VLB Control Unit	AUI	2	4633
Loran-C Receiver	AUI	2	4634
Freq. Standard	Hewlett-Packard 5065A	836-00109	5064
VLB IF Converter	AUI	2	4637
Freq. Doubler	Telonic	4254	4638
3 cm Receiver and/or	AUI	1	5063
6 cm Receiver	AUI	1	1018

Plus additional power supplies, amplifiers, and spare parts as needed.

The equipment sent to the U.S.S.R. should be accompanied by two scientists or engineers from the NRAO--apparently no one man has sufficient familiarity with the whole system to be able to fix everything which might go wrong with it. In addition, one or two Soviet scientists will wish to come to Green Bank during the run, in order to attain sufficient familiarity with the equipment and procedures to better enable them to run a further experiment without the assistance of NRAO personnel in the U.S.S.R.

Our Soviet colleagues have indicated that weather is unsuitable for observing at 3 cm wavelength during the winter months; therefore we would like to perform this initial experiment in the fall of 1969, preferably

no later than October. We would hope to perform further interferometer experiments on this baseline the following spring or summer, possibly at still shorter wavelengths.

We anticipate that problems may occur in the following areas and desire to set up procedures that will minimize their occurrence:

1. Easy exchange of personnel between countries on relatively short notice.
2. Ease of communications, telephone or teletype (connections should be established within 1/2 hour).
3. Permission to take equipment and magnetic tapes, separately perhaps, into and out of the Soviet Union.
4. Permission to transport a running clock across the Soviet border, if no satisfactory UTC time standard is available in the Soviet Union.
5. Technical and mechanical assistance to mount NRAO equipment on the Soviet telescope.
6. A clear understanding of the nature of the experiment by officials in the corresponding Academies of Science and government organizations, so that a clear line of aid is available in case "red tape" troubles occur at either site or within either country.

NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia

July 30, 1968

MEMO TO: D. S. Heeschen

FROM: K. Kellermann

We have received a letter and telegram from Russia (finally) about the proposed VLB experiment. The letter seems to say the following:

a) Vitkevich did not answer our letter of February 23 because he has been on vacation!

b) They are interested in doing the VLB experiment and the Soviet Academy of Science has given approval.

c) They want to send people to Green Bank to become familiar with the equipment and technique. The USSR Academy will pay their travel expenses to the U. S. Will we be able to provide lodging, etc. at Green Bank? And can we arrange their visa's, etc?

d) How many people from the U.S. will go to the U.S.S.R.? They will provide reciprocal accommodations in Crimea.

e) They have maser receivers at 8.2 m and 8 cm and can obtain masers at 3 and 5 cm.

I suspect we must make some formal arrangements via the U.S. Academy to bring the equipment into Russia. What shall I reply? This may be a good idea to get a Russian here for an extended time. Kuzmin was to go to Caltech this year, but that fell through. He might be one of the ones they are planning to send.

5

АКАДЕМИЯ НАУК СОЮЗА ССР
ФИЗИЧЕСКИЙ ИНСТИТУТ имени П. Н. ЛЕБЕДЕВА

Москва, Ленинский проспект, 53

ACADEMY OF SCIENCES OF THE USSR
P. N. LEBEDEV PHYSICAL INSTITUTE

Moscow, Leninsky prospect, 53, USSR.

Доктору Келлерману
Национальная радиоастрономическая
обсерватория Грин-Бэнк США

Дорогой доктор Келлерман!

Доктор В.В.Виткевич в настоящее время находится в отпуске. В связи с этим он просил меня сообщить Вам результаты обсуждения Вашего предложения от 23 февраля 1968 г. по интерферометру со сверхдлинной базой.

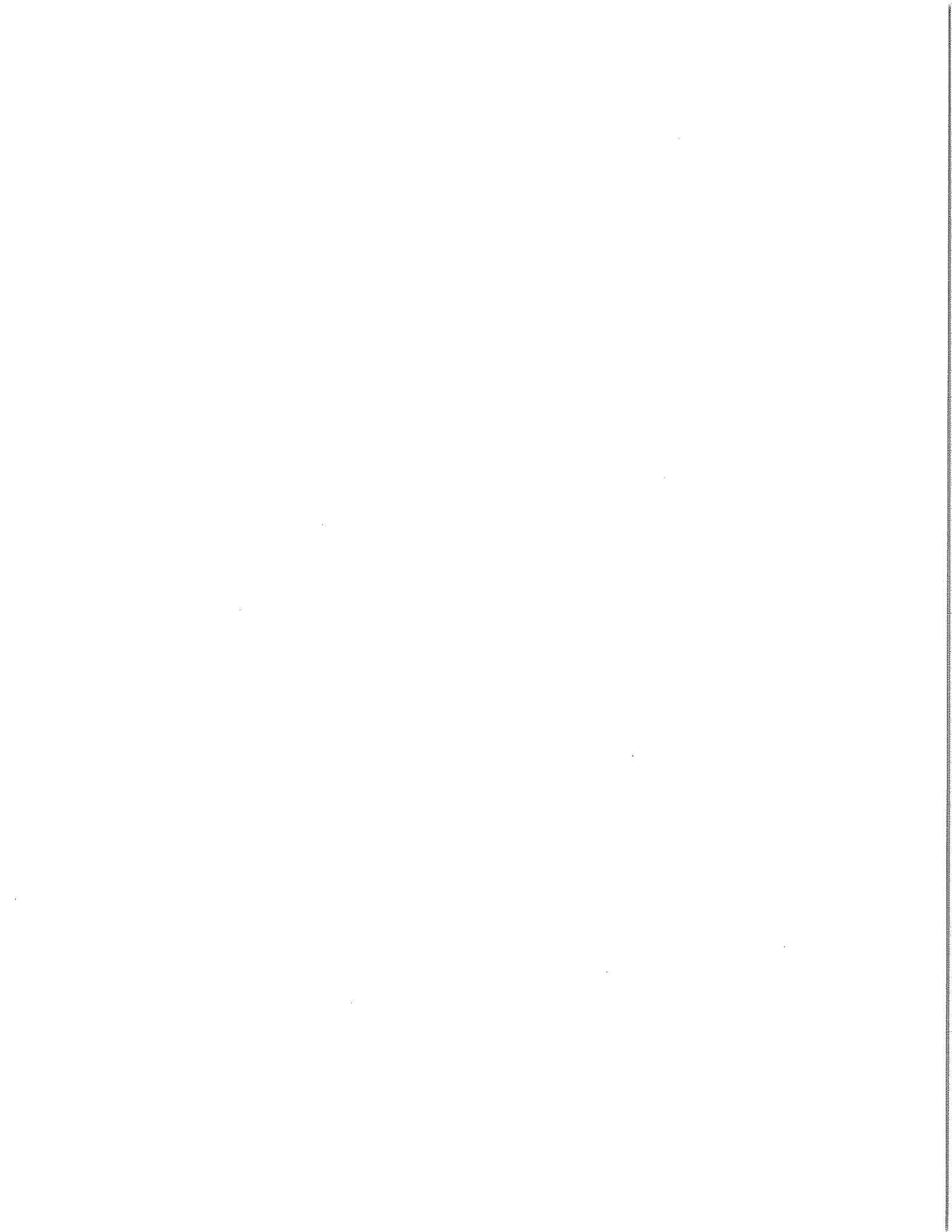
Мы заинтересованы в проведении такого эксперимента и предварительно согласовали его с Академией Наук. Мы рассмотрели наши возможности и пришли к выводу, что такой эксперимент целесообразно провести не на радиотелескопе РТ 22 (г.Серпухов), а на более совершенном радиотелескопе аналогичной конструкции, расположенном в Крыму в Симеизе. Это место имеет более благоприятные метеорологические условия и более удобно с точки зрения ориентации базы. В настоящее время на радиотелескопе начаты подготовительные работы. В связи с этим нам необходимы схемы и чертежи Вашей аппаратуры, которая будет установлена на радиотелескопе. Вышлите, пожалуйста, также препринты Ваших работ по сверхдальной интерферометрии. Для более детального ознакомления с аппаратурой и методикой наблюдений мы хотели бы

направить наших специалистов в Грин Бэнк. Сообщите нам, готовы ли Вы принять наших специалистов. В свою очередь нас интересует сколько человек и на какой срок Вы предполагаете послать в Советский Союз. Расходы по пребыванию специалистов одной и другой стороны, повидимому, целесообразно чтобы взяла на себя принимающая сторона, а расходы на проезд США - СССР направляющая сторона.

1969 → В ответ на Вашу телеграмму от 29 апреля 1968 г. сообщаю, что в настоящее время мы располагаем на радиотелескопе в Крыму мазерами на волны 8,2 мм, а также на волну 8 см. Кроме того к началу 1965 г. мы можем получить мазеры на волны 3 и 5 см. На волну 21 см мы можем иметь параметрический усилитель. Водородного стандарта частоты или стандарта с такой же стабильностью мы не имеем. Антенна РТ 22 (Крым) имеет коэффициент использования зеркала порядка 0,5 на волне 8 мм и обеспечивает точность сопровождения около 20 сек. дуги. К концу года на антенне будет установлена Кассегреновская система облучения.

С глубоким уважением

23. 7. 68, *Леонид Матвеев* Д. Матвеев



АКАДЕМИЯ НАУК СОЮЗА ССР
ФИЗИЧЕСКИЙ ИНСТИТУТ имени П. Н. ЛЕБЕДЕВА

Москва, Ленинский проспект, 53

ACADEMY OF SCIENCES OF THE USSR
P. N. LEBEDEV PHYSICAL INSTITUTE

Moscow, Leninsky prospect, 53, USSR.

July 27, 1968

Доктору Келлерману

Национальная радиоастрономическая
обсерватория Грин-Банк США

Дорогой доктор Келлерман!

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С глубоким уважением

23. 7. 68.

Лазарь Матвеев
Л. Матвеев

ACADEMY OF SCIENCES OF THE USSR

P. N. LEBEDEV PHYSICAL INSTITUTE

Moscow, Leninsky prospect, 53, USSR

Xerox 5 to
DSH
KIK
BGC

*Translation of
the contents*

July 27, 1968

Dear Dr. Kellermann:

Dr. V. V. Vitkevich is on vacation at present. Therefore he has asked me to communicate to you the results of our consideration of your suggestion of 23 February 1968 regarding very long baseline interferometry.

We are interested in conducting such an experiment and we have tentative agreement from the Academy of Sciences. We have considered our own possibility and have come to the conclusion that such an experiment would be most appropriately conducted, not with the RT 22 (Serpukhov) radio telescope, but with the more refined radio telescope of similar construction located in the Crimea at Simeis. This site has more favorable meteorological conditions, and it is more favorable from the standpoint of the baseline orientation. Preliminary work on this radio telescope has been started. It is necessary for us to have plans and drawings of your equipment which would be mounted on the radio telescope. Please also send preprints of your papers on very long baseline interferometry. In order to obtain a more detailed acquaintance with the equipment and the observational procedures, we would like to send our specialists to Green Bank. Please inform us whether you would be prepared to receive them. In turn, we would be interested in knowing how many people you propose to send to the Soviet Union and for how long a time. Expenses of residence of the specialists in both places would seem most appropriately to be borne by the host organization, while the expenses of travel between the USA and the USSR could be assumed by the parent organizations.

In reply to your telegram of 29 April 1968, at present we have in place on the radio telescope in the Crimea masers operating at wavelengths of 8.2 mm and 8 cm. Also, toward the beginning of 1969, we shall acquire masers at wavelengths of 3 and 5 cm. We can have a parametric amplifier at 21 cm. A hydrogen frequency standard or a standard of comparable stability is not in our possession. The RT 22 antenna (Crimea) has an aperture efficiency of about 0.5 at 8 mm wavelength and can be pointed with an accuracy of about 20 seconds of arc. A Cassegrain system will be installed on the antenna toward the end of the year.

With best regards,

A. Matveyenko

August 8, 1968

Dr. Randal M. Robertson
National Science Foundation
Washington, D. C. 20550

Dear Randy:

We are interested in conducting a VLB experiment between Green Bank and Russia. Such an experiment has great scientific interest from the standpoint of size and structure of quasi and variable radio sources, and is clearly a desirable scientific step in the development of the VLB program. The Russian radio telescope is the only telescope useful at short centimeter wavelengths located at a sufficiently long baseline to provide the high resolution needed to pursue the VLB investigations further.

We have had preliminary discussions with Drs. Vitkevich and Matveyenko at the Lebedev Physical Institute, Moscow. The Russians are very interested in collaborating in this experiment and the Soviet Academy of Science has given its tentative approval. They will want to send several people to the NRAO to become familiar with the equipment and techniques and take part in the experiment from this end.

To do the experiment it will be necessary for us to take some NRAO equipment, currently in Europe, to the Crimea, Soviet Union, for the duration of the observations. I presume this experiment will be agreeable to the NSF, and that you will approve our use of NRAO equipment in Russia for this experiment.

We would appreciate having NSF assistance in whatever arrangements might be necessary to facilitate the transportation of the equipment across international borders.

Sincerely yours,

D. S. Heeschen

DSK:fac

bcc: WEH

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D.C. 20550

DUPLICATE

September 9, 1968

Dr. David S. Heeschen
Director
National Radio Astronomy Observatory
Edgemont Road
Charlottesville, Virginia 22901

Dear Dave:

The scientific value of conducting a VLB experiment between Green Bank and Russia is certainly great. The experiment would surely provide some new information on the size and structure of quasars and variable radio sources and it is a very desirable step in radio astronomy.

However, in view of the present political uncertainties in Eastern Europe, it would seem preferable to go slowly so far as planning to send NRAO people and equipment to the Crimea, Soviet Union. As a preliminary step it would appear that you could go ahead with your plan of inviting Russian scientists to visit NRAO and become familiar with the equipment and techniques that are used.

When the Eastern European situation becomes more stabilized we will continue to work with the State Department in assisting with necessary arrangements for facilitating the experiment.

Sincerely yours,

SIGNED

Randal M. Robertson
Associate Director (Research)

NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia

February 7, 1969

MEMO TO: D. S. Haeschen
FROM: K. I. Kellermann
SUBJECT: VLB Shipment

The VLB equipment now in Sweden will be shipped about February 15 to Australia and will remain there for about 4 or 5 months.

Is someone looking into the problem of taking it into Russia?

cc: W. E. Howard
T. R. Riffe ✓

NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia

VLB EQUIPMENT

Item	Manufacturer	Serial Number	U. S. Govt. Tag Number
Freq. Synthesizer XUC	Rohde & Schwarz	444466	4629
Crystal Oscillator	Rohde & Schwarz	4444291	4630
Tape Transport	Ampex	C-102	4631
VLB Delay Unit	AUI	2	4632
VLB Control Unit	AUI	2	4633
Loran-C-Receiver	AUI	2	4634
Freq. Standard	Hewlett-Packard 5065A	836-00109	5064
VLB IF Converter	AUI	2	4637
Freq. Doubler	Telonic	4254	4638
3cm Receiver and/or	AUI Minneapolis, La AUI	1	5063
6 cm Receiver	AUI Minneapolis, La AUI	1	1018
Amplifier, Seattle	XBB Product Group		

plus spare parts for above

NATIONAL RADIO ASTRONOMY OBSERVATORY

EDGEMONT ROAD
CHARLOTTESVILLE, VIRGINIA 22901
TELEPHONE 703-296-0211

~~1/11/69~~
Copy 2/14/69
Russell

POST OFFICE BOX 2
GREEN BANK, WEST VIRGINIA 24944
TELEPHONE 304-456-2011
TWX 304-940-2481

February 13, 1969

Dr. Randal M. Robertson
Associate Director, Research
National Science Foundation
Washington, D. C. 20550

Dear Dr. Robertson:

As a preliminary step toward our planned VLB experiment between Green Bank and the Crimea, USSR, we have just concluded a visit by two Soviet nationals, Drs. Matvenko and Moiseyev, who came to Green Bank to learn our procedures and techniques.

We tentatively plan to run the experiment in mid-October 1969 and at that time two NRAO staff will be at the Crimea and one or two Russians will be in Green Bank for the observations.

As the NSF and State Department staffs have suggested, we will work with the Office of Export Control, Department of Commerce, in order to assure the smooth flow of necessary equipment to and from the USSR and we are working through the U.S. National Academy of Sciences with regard to the NRAO visits.

In your letter of September 9, 1968 you asked us to go slowly with our plans for sending NRAO personnel and equipment to the USSR in view of the political uncertainties that existed in Eastern Europe at that time. That situation has eased considerably and unless you have serious objections, we shall proceed on the time scale outlined above.

Sincerely yours,

D. S. Heeschen

D. S. Heeschen

DSH:fmc

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D.C. 20550

March 3, 1969

CC: IAK
✓ CSEH
BGO
KIK

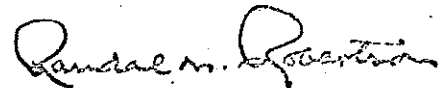
Dr. David S. Heeschen, Director
National Radio Astronomy Observatory
Edgemont Road
Charlottesville, Virginia 22901

Dear Dr. Heeschen:

I was pleased to learn from your recent letter that two Russian scientists had visited Green Bank and had become familiar with the procedures employed in carrying out the Very Long Baseline experiment between Green Bank and Russia.

If the Eastern European situation does not become more unstable in the next few months, it would seem reasonable to go ahead with your planned VLB experiment between Green Bank and the Crimea. It is understood that this experiment would probably be conducted sometime in the middle of October of this year. You will, of course, continue to work with the Office of Export Control to assure that the shipment of the equipment complies with their regulations and with the National Academy of Sciences for their help in arranging the visits of the NRAO personnel.

Sincerely yours,



Randal M. Robertson
Associate Director (Research)

Copy to:

Dr. Franklin A. Long
Chairman, Board of Trustees, AUI
Upton, L.I., New York 11973

Enclosure 3

NIGHT CABLE

MARCH 24, 1969

DR. L. MATVEYENKO
LENINSKY 53
LEBEDEV
PHYSICAL INSTITUTE
MOSCOW, USSR

OUR OBSERVATORY NEEDS LETTER OF ASSURANCE FROM SOVIET ACADEMY OF SCIENCES
THAT WE WILL BE ABLE TO SEND VLB TERMINAL EQUIPMENT BOTH INTO AND OUT OF
THE SOVIET UNION FOR OCTOBER VLB OBSERVATIONS. WE CANNOT PROCEED FURTHER
WITH ARRANGEMENTS UNTIL THIS AUTHORIZATION HAS BEEN RECEIVED BY THE NRAO.

D. S. HEESCHEN, DIRECTOR

TRR
W Powell

NATIONAL ACADEMY OF SCIENCES

2101 CONSTITUTION AVENUE

WASHINGTON, D. C. 20418

OFFICE OF THE FOREIGN SECRETARY

April 16, 1969

Dr. W. E. Howard III
Assistant to the Director
National Radio Astronomy Observatory
Post Office Box 2
Green Bank, West Virginia 24944

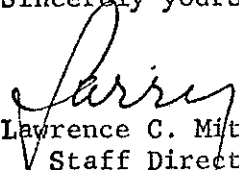
Dear Bill:

As your secretary told you, I telephoned yesterday to ask for a change in the date of the meeting in Washington about the VLB experiment because April 22 was inconvenient for at least two of the Washington participants. I proposed April 23 instead, at 10:00 a.m., Room 218, Joseph Henry Building, 21st Street and Pennsylvania Avenue, N. W. (which is located some blocks from the NAS Main Building at 21st and Constitution).

I did not leave word but am writing now instead to tell you that Bob Hull at NSF cleverly got in touch with the export control people at the Department of Commerce to find out whether the export of items listed on page 4 of your proposal would cause any problems. He was told that only the Loran-C Receiver might need an export license and special approval. Therefore, you would be advised to bring with you to Washington whatever would be appropriate in the way of specifications and the like to support a request for an export license (see enclosed application for export license). It does seem early to be worrying about that, but then it's hard to tell which bureaucracy is going to work more slowly.

I look forward to seeing you and Dr. Clark on April 23.

Sincerely yours,



Lawrence C. Mitchell
Staff Director

Section on USSR & Eastern Europe

Enclosure:

Application for Export License.

TRANSLATION

16 April 1969

Dear Dr. Heeschen:

In reply to your telegraphed inquiry of 26 March, I have the honor to communicate the following.

The Presidium of the Academy of Sciences of the USSR guarantees to the National Radio Astronomy Observatory that the American equipment for very long baseline interferometry will be permitted to enter and leave the USSR, for the experimental investigation of quasistellar objects to be carried out in October of this year.

With sincere respect

Academician (Ya. V. Peive)

Chief Scientist Secretary
of the Presidium of the
Academy of Sciences of
the USSR

Enclosure 2



АКАДЕМИЯ НАУК
СОЮЗА СОВЕТСКИХ СОЦИАЛИСТИЧЕСКИХ РЕСПУБЛИК

Москва, В-71, Ленинский проспект, 14
Тел. В 4-97-04

«16» 12 1962 г.

№ 243

D. S. HEESCHEN
DIRECTOR
NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE
VIRGINIA 22901
USA

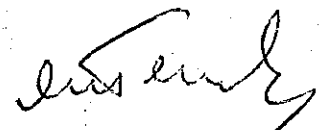
Уважаемый г-н Хишен,

В ответ на Ваш телеграфный запрос от 26 марта имею честь сообщить следующее.

Президиум Академии наук СССР гарантирует Национальной радиоастрономической обсерватории ввоз и вывоз из СССР американской аппаратуры радиointерферометра со сверхдлинной базой для проводимого в октябре с.г. эксперимента по исследованию квазизвездных объектов.

С искренним уважением

Главный ученый секретарь Президиума
Академии наук СССР
академик


(Я. В. Пейве)

При ответе ссылаться на наш № и дату
Адрес для писем: Президиум АН СССР: Москва, В-71, Наука

Dave,

This is a very official communication from the gods. Peive is an enormously big shot. If the English of the translation sounds stilted, it is because I tried to make a fairly faithful rendition of the highly formal Russian of the original. I think it should be regarded as a legal document that could be an effective hammer in your hand if difficulties arise later.

Cam 4/23/69

Mr. Keffe

CLASS OF SERVICE
This is a fast message unless its deferred character is indicated by the proper symbol.

WESTERN UNION TELEGRAM

SYMBOLS
DL = Day Letter
NL = Night Letter
LT = International Letter Telegram

The filing time shown in the date line on domestic telegrams is LOCAL TIME at point of origin. Time of receipt is LOCAL TIME at point of destination

757A EST APR 19 69 CTAO 13 AA070 CTA067

SYA097 SY ZLC 172 RWL 72 INTL FR ZL MOSCOU VIA VUI 32 13 2037

(BACK DATE)

DIRECTOR D S HEESCHEN NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE VIRGINIA 22901

ACADEMY OF SCIENCES ASSURANCE SEND VLB EQUIPMENT BOTH INTO
AND OUT OF THE SOVIET UNION APRIL 16 THE LETTER SENT TO YOU
MATVEYENKO

COL 20 1 16

Dear Bill:

I am sending with this note an application for an export license for the Loran-C receiver that, according to the enclosed letter of April 16, we will have to obtain special approval for in order to send the item to the Soviet Union for the October VLB experiment. Would you please complete the application using John Payne and Barry Clark for any special information you may need and send it back by shuttle on Tuesday so that Barry Clark can bring it to our Washington meeting on April 23rd. Many thanks.

Bill Howard

(Item to be sent by shuttle Monday)

Barry knows about it but John does not. But John will know what you are talking about.

M Powell

NATIONAL RADIO ASTRONOMY OBSERVATORY

Charlottesville, Virginia

April 24, 1969

MEMORANDUM TO FILE

From: W. E. Howard

On April 23 Barry Clark and I met with the following individuals to discuss preparations for the October VLB experiment to the Soviet Union:

- Mr. Lawrence C. Mitchell, U. S. National Academy of Sciences
- Mr. Robert Hull, National Science Foundation
- Dr. Everett Hurlburt, National Science Foundation
- Dr. Ganley, Department of State, Office of Scientific and Technical Affairs
- Mr. Lee Gotzlinger, Department of State, Soviet and Eastern European Exchanges Staff.

The main results of this conversation follow.

The first step we must take is to talk with the people in the Department of Commerce concerned with export control and determine with them what equipment is to be sent, the use to which it will be put, and for how long a period we intend to leave it in the Soviet Union. Apparently we shall need the manufacturer's detailed description of every purchased item that will be sent to the U.S.S.R. The Department of Commerce will have to clear this equipment in detail and if any items are in the least bit sensitive, further clearance will have to be obtained from an office called COCOM, an international agency of western nations which controls commerce to and from the eastern nations. Even if the Commerce Department gives us permission to ship a sensitive piece of equipment, COCOM must also do so before it can be shipped to the Soviet Union. It will be virtually impossible to arrange to ship

material to the Soviet Union and leave it there for any extended period of time with an NRAO staff member not in attendance. Consequently, we will probably want to ship the equipment in, run the experiment, and ship it out right away.

Only after we have complete certainty that all the necessary pieces of equipment have these authorizations for shipment to the Crimea will it be possible to start an agreement between the U.S. and Soviet Academies of Science. Larry Mitchell is prepared to do this once the shipping problems have been cleared up. After the two Academies have agreed, such problems as exchange of personnel between the two countries, the rapid establishment of communications during the experiment, and technical and mechanical assistance to mount our equipment on the Soviet telescope can be discussed.

Bob Hull has already had preliminary discussions with the export control people at the Department of Commerce and Mr. John Shepard and Mr. Ron McGee are the names of the people with whom he has discussed the problem so far.

Hull has no objection to our dealing directly with the Department of Commerce but has volunteered his services and those of the NSF should problems arise during the discussions.

It is my understanding that Bill Powell will be contacting the Department of Commerce next week about this problem and I hope that these details can be ironed out quickly so that we can proceed toward the inter-Academy agreement that will permit us to carry our plans further. Considering the steps that need to be taken, the time between now and September-October when the experiment will be run is short and I think we should pursue all these negotiations as quickly as possible.

cc: D. S. Heeschen (for information)
T. R. Riffe
W. Powell

B. G. Clark
K. I. Kellermann

*Marked 5-30-69 to:
Copy of this letter
C. W. Douglas
Electronic Section
Office of Export Control
Dept. of Commerce
Wash, DC 20730*

May 8, 1969

Director, Office of Export Control
Department of Commerce
Washington, D C. 20230

Dear Sir:

The National Radio Astronomy Observatory (NRAO), a wholly-owned Government research facility, operated by Associated Universities, Inc., a non-profit corporation, under contract with the National Science Foundation, has tentatively scheduled an experiment in radio astronomy for mid-October involving the Observatory at Green Bank, West Virginia, and the Crimea Astrophysical Observatory, Simferopol, Crimea, U.S.S.R. The purpose of this letter is to request the Office of Export Control's assistance in obtaining the necessary permits and clearances in order to ship certain electronic receiving and recording equipment to Russia in order to perform this experiment (a listing of the principal elements of the equipment is attached hereto as Enclosure 1).

In the course of our activities, we have developed techniques in very long baseline interferometry (VLB) which require simultaneous observations from widely spaced radio telescopes. To obtain the necessary spacing, we conduct programs with principal radio astronomy observatories throughout the world. In order to obtain compatibility between the NRAO and the participating observatory, we provide the equipment necessary to essentially duplicate the Green Bank system. At the conclusion of the experiment, usually lasting from one to two months, the equipment is returned to the United States or moved to another observatory for further studies utilizing the VLB technique.

All of the equipment is the property of the U. S. Government and none of it is classified for security purposes.

It is our hope that the Department of Commerce will find it possible to issue a Letter of Authorization for the shipment of this equipment to the U.S.S.R., including any replacement parts which might be needed because of malfunction or because of lack of knowledge of just what our requirements might be until after the equipment is set up at the Crimean Observatory.

Among the people with whom we have consulted regarding the experiment and the agency each represents, are:

Mr. Lawrence C. Mitchell - US National Academy of Sciences
Mr. Robert Hull - National Science Foundation
Dr. Everett Hurlburt - National Science Foundation
Dr. Ganley - Department of State, Office of Scientific and Technical Affairs
Mr. Gotzlinger, Department of State, Soviet and Eastern European Exchanges Staff
Mr. Douglas, Department of Commerce, Office of Export Control
Mr. Brooks, Department of Commerce, Office of Export Control

In addition to the above, we have been assured by the U.S.S.R. Academy of Sciences that no difficulty will be interposed by the Soviets in moving the equipment in or out of that country (see Enclosure 2 with translation).

A letter from the National Science Foundation concurring in the desirability of conducting such an experiment as we propose is included as Enclosure 3.

Since other arrangements connected with this project depend upon approval of this proposal by the Office of Export Control, we request your earliest, convenient consideration of this matter, and if further information is required, please let us know.

Very truly yours,

W. W. Powell
Property Officer, Administration

WWP/imp/im

Enc. 3

NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia

VLB EQUIPMENT

<u>Item</u>	<u>Manufacturer</u>	<u>Ser. No.</u>	<u>Value</u>	<u>Tag No.</u>
Freq. Synthesizer XUC ✓	Rohde & Schwarz	444466	4,089.38	4629
Crystal Oscillator ✓	Rohde & Schwarz	4444291	4,089.38	4630
Tape Transport	Ampex	C-102	14,849.50	4631
VLB Delay Unit	AUI	2	3,500.00	4632
VLB Control Unit	AUI	2	3,900.00	4633
Loran-C-Receiver	AUI	2	180.88	4634
Rubidium Vapor Standard ✓	Hewlett-Packard	836-00109	8,800.00	5064
Microwave Amplifier	Hewlett-Packard	811-01038	2,250.00	4880
VLB IF Converter ✓	AUI	2	1,000.00	4637
Freq. Doubler ✓	Telonic	4254	1,150.00	4638
Mixer, Preamp	Lel	13799	752.38	3386
Preamp	Lel		753.15	2822
Amplifier	Lel		5,885.00	3339
Freq. Multiplier	Telonic	4252	950.00	
Klystron VA-92C	Varian	4923	1,225.00	
Receiver, 3 cm	AUI	1	16,136.59	
Receiver, 6 cm ✓	AUI	1	17,634.59	
" 13 "	NIT			
		Total	87,145.85	

Plus attendant wiring and connecting apparatus and approximately 75 magnetic computer tapes.

Enclosure 1

TRANSLATION

16 April 1969

Dear Dr. Heeschen:

In reply to your telegraphed inquiry of 26 March, I have the honor to communicate the following.

The Presidium of the Academy of Sciences of the USSR guarantees to the National Radio Astronomy Observatory that the American equipment for very long baseline interferometry will be permitted to enter and leave the USSR, for the experimental investigation of quasistellar objects to be carried out in October of this year.

With sincere respect

Academician (Ya. V. Peive)

Chief Scientist Secretary
of the Presidium of the
Academy of Sciences of
the USSR

Enclosure 2

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D.C. 20550

March 3, 1969

CC TRK
✓ WSEH
BGO
KIK

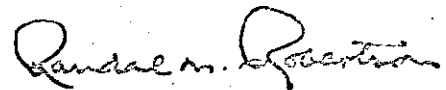
Dr. David S. Heeschen, Director
National Radio Astronomy Observatory
Edgemont Road
Charlottesville, Virginia 22901

Dear Dr. Heeschen:

I was pleased to learn from your recent letter that two Russian scientists had visited Green Bank and had become familiar with the procedures employed in carrying out the Very Long Baseline experiment between Green Bank and Russia.

If the Eastern European situation does not become more unstable in the next few months, it would seem reasonable to go ahead with your planned VLB experiment between Green Bank and the Crimea. It is understood that this experiment would probably be conducted sometime in the middle of October of this year. You will, of course, continue to work with the Office of Export Control to assure that the shipment of the equipment complies with their regulations and with the National Academy of Sciences for their help in arranging the visits of the NRAO personnel.

Sincerely yours,



Randal M. Robertson
Associate Director (Research)

Copy to:

Dr. Franklin A. Long
Chairman, Board of Trustees, AUI
Upton, L.I., New York 11973

Enclosure 3



АКАДЕМИЯ НАУК
СОЮЗА СОВЕТСКИХ СОЦИАЛИСТИЧЕСКИХ РЕСПУБЛИК

Москва, в-71, Ленинский проспект, 14

Тел. В 4-97-01

«16» 1969 г.

№ 243

999363

MAY 20 69

D. S. HEESCHEN
DIRECTOR
NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE
VIRGINIA 22901
USA

Уважаемый г-н Хишен,

В ответ на Ваш телеграфный запрос от 26 марта имею честь сообщить следующее.

Президиум Академии наук СССР гарантирует Национальной радиоастрономической обсерватории ввоз и вывоз из СССР американской аппаратуры радиointерферометра со сверхдлинной базой для проводимого в октябре с.г. эксперимента по исследованию квазизвездных объектов.

С искренним уважением

Главный ученый секретарь Президиума
Академии наук СССР
академик

(Я.В.Пейзве)

При ответе сослаться на наш № и дату
Адрес для телеграмм с Президиум АН СССР: Москва, В-71, Наука

NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia

MAY

VLB EQUIPMENT

<u>Item</u>	<u>Manufacturer</u>	<u>Ser. No.</u>	<u>Value</u>	<u>Tag No.</u>
✓ Freq. Synthesizer XUC	Rohde & Schwarz	444466	4,089.38	4629
✓ Crystal Oscillator	Rohde & Schwarz	4444291	4,089.38	4630
✓ Tape Transport	Ampex	C-102	14,849.50 ✓	4631
VLB Delay Unit	AUI	2	3,500.00	4632
VLB Control Unit	AUI	2	3,900.00	4633
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✓ Klystron VA-92C	Varian	4923	1,225.00	
Receiver, 3 cm	AUI	1	16,136.59	
Receiver, 6 cm	AUI	1	17,634.59	
Total			87,145.85	

Plus attendant wiring and connecting apparatus and approximately 75 magnetic computer tapes. ✓

Enclosure 1

Checked items (excluding tapes) = \$ 44,793.79

TRANSLATION

999363

MAY 20 69

16 April 1969

Dear Dr. Heeschen:

In reply to your telegraphed inquiry of 26 March, I have the honor to communicate the following.

The Presidium of the Academy of Sciences of the USSR guarantees to the National Radio Astronomy Observatory that the American equipment for very long baseline interferometry will be permitted to enter and leave the USSR, for the experimental investigation of quasistellar objects to be carried out in October of this year.

With sincere respect

Academician (Ya. V. Peive)

Chief Scientist Secretary
of the Presidium of the
Academy of Sciences of
the USSR

Enclosure 2

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D.C. 20550

March 3, 1969

CC TRR
✓ WSEH
BCC
KIK

999363

MAY 20 60

Dr. David S. Heeschen, Director
National Radio Astronomy Observatory
Edgemont Road
Charlottesville, Virginia 22901

Dear Dr. Heeschen:

I was pleased to learn from your recent letter that two Russian scientists had visited Green Bank and had become familiar with the procedures employed in carrying out the Very Long Baseline experiment between Green Bank and Russia.

If the Eastern European situation does not become more unstable in the next few months, it would seem reasonable to go ahead with your planned VLB experiment between Green Bank and the Crimea. It is understood that this experiment would probably be conducted sometime in the middle of October of this year. You will, of course, continue to work with the Office of Export Control to assure that the shipment of the equipment complies with their regulations and with the National Academy of Sciences for their help in arranging the visits of the NRAO personnel.

Sincerely yours,

Randal M. Robertson

Randal M. Robertson
Associate Director (Research)

Copy to:
Dr. Franklin A. Long
Chairman, Board of Trustees, AUI
Upton, L.I., New York 11973

Enclosure 3

Minto file

5-23-69

Mr Eric Fane, Dept of Commerce
called & reviewed our request
he was told that we would
like to ship around 9-15-69 and
the equipment would be returned
about 10-20-69.

I told him we would need
to have charmers not later
than 7-15-69 in order to
complete other necessary
arrangement



COPY

Xerox's to TRK
W.P. ...
S. ...
J. Payne
DSH
B. Clark

NATIONAL SCIENCE FOUNDATION
WASHINGTON 25, D.C.

June 3, 1969

The NSF did write this letter I dictated to them May 27. I hope it will help! - WSH

Mr. Rauer H. Meyer
Director, Office of Export Control
Department of Commerce
Washington, D.C. 20230

Dear Mr. Meyer:

On May 8, 1969, the National Radio Astronomy Observatory wrote you requesting permission and clearance to ship various electronic equipment to the Crimea, U.S.S.R., for the purpose of running a "very long base-line experiment" simultaneously between and jointly with radio telescopes located in the Crimea and at Green Bank, West Virginia. No classified equipment is to be shipped. The National Radio Astronomy Observatory submitted to you with its letter a list of equipment to be shipped for the experiment. Shipment will occur on or about September 15, 1969.

We understand that the necessary permission and clearance to ship the equipment will take approximately one month from the May 8 date of the National Radio Astronomy Observatory letter, (i.e., about June 8, 1969) and if this is a realistic estimate, we anticipate that there will still be sufficient time for all the formal arrangements that remain to be done such as an inter-academy agreement, etc. However, if permission and clearance will take beyond mid-June to be achieved, the necessary and time-consuming steps that remain will be much more difficult to accomplish.

The Soviet Academy of Sciences have given their permission to move the equipment both into and out of their country, and the National Science Foundation has given its approval and endorsement to this joint scientific program. The National Science Foundation will appreciate whatever steps you or your office might take in order to assure the National Radio Astronomy Observatory of your prompt and timely permission and clearance to ship their equipment to the Soviet Union.

Sincerely yours,

Robert Fleischer
Head, Astronomy Section

cc: Mr. Carl W. Douglas
Office of Export Control
Department of Commerce

✓ Dr. William Howard, NRAO

informally against the
Defense People of the inner,
ghetto, etc. of V.D.R.
As of today the meeting
will be held in New York

6-12-69

Memo to file —

Received call from
Walter McLaughlin, ^{Officer} ^{10/14/68} ^{to}
the Russian V.D.R. experiment.
Defense has cleared the
Appointment; however, there
is a great deal of interest
in the potential of the techniques.
We have arranged a meeting
on Thurs. June 19. With
McLaughlin, Troy & Frederick
of Defense and Clark and
Kellerman of the V.D.R. the
purpose of which is to

13 June, 1969

Dear Dr. Heesch:

In due accordance with the agreement which has been reached between Soviet and American scientists regarding the conduct of simultaneous work on quasi-stellar radio sources at extremely high resolution with the Simeis-Green Bank interferometer, I have the honor to communicate the following.

The Presidium of the Academy of Sciences of the USSR accepts three American scientists for a period of two months (September-October 1969) and, in particular, Dr. Kellermann and Dr. Clark;

The Presidium of the Academy of Sciences will render assistance in obtaining visas for your specialists;

The Presidium of the Academy of Sciences of the USSR is ready to assume the expenses of maintaining three of your scientists in the Soviet Union for a period of two months, and also those of transporting the American equipment from the Soviet Union to the USA on Aeroflot aircraft.

With sincere regards,

(Academician Ya. V. Peive)



АКАДЕМИЯ НАУК
СОЮЗА СОВЕТСКИХ СОЦИАЛИСТИЧЕСКИХ РЕСПУБЛИК

Москва, В-71, Ленинский проспект, 14

Тел. В 4-97-04

« 13 » VI 1969 г.

№ 387

D.S. Heeschen
Director
National Radio Astronomy
Observatory
Charlottesville
Virginia 22901, USA.

Уважаемый г-н Хишен,

В соответствии с достигнутой договоренностью между советскими и американскими учеными о проведении совместной работы по исследованию квазизвездных источников радиовызлучения со сверхвысоким разрешением на радиоинтерферометре Симмонз - Грин Банк имею честь сообщить следующее.

Президиум Академии наук СССР принимает трех американских ученых сроком на два месяца /сентябрь-октябрь 1969 г./ и, в частности, доктора Келлермана и доктора Кларка;

Президиум Академии наук окажет содействие в получении виз Вашим специалистами;

Президиум Академии наук СССР готов взять на себя расходы по содержанию трех Ваших ученых в Советском Союзе в течение двух месяцев, а также по доставке американской аппаратуры из Советского Союза в США самолетами Аэрофлота.

С искренним уважением,

Академик Я.В. Лейбе

Главный ученый секретарь
Президиума Академии наук СССР

Копия: Frederick Seitz, President
National Academy of Sciences
2101 Constitution Avenue
Washington, D.C. 20418
USA.

При ответе сослаться на наш № и дату
Адрес для телеграмм в Президиум АН СССР: Москва, В-71, Наука

Meeting in Green Bank with DOD Representatives

June 19, 1969

Present: Walter McGough Charles Frey Doyle Fredrick Leonard Dykes	}	DOD	Barry Clark Ken Kellermann Bill Powell Bill Howard	}	NRAO
--	---	-----	---	---	------

ISA in the DOD is a member of COCOM. They desire to keep separate information that locates the North American Continent from Eastern Europe. They want to understand our methods of VLB reduction and desire not to have NRAO give a geodetic tie into the two systems.

B. Clark gave a resumé of the theory of VLB work. Errors of 30 m may be obtained by us with a minimal trouble. To fit a sine wave and to follow a source knowing the telescope locations to a few hundred meters will usually suffice. To do this aspect of the experiment much more carefully, one could get this 30 m error down by a factor of 1.5 to 2 (i.e., to 20 m-15 m). The projection of the baseline on the equator of the earth is the 30 m figure above. Within 3-4 years we should be able to get locations to an accuracy of 3-4 cm. Techniques: Use a slightly different frequency to resolve the sine wave ambiguity or use 2 antennas at each end. Problems: How to change the frequency without destroying the phase relationships. Currently there are signal-to-noise ratio problems with present terminals. One needs a large number of observations to get good positions since we get now the projection of the baseline on the vector pointing to the radio source. We do not know the latter well enough; we need to know the earth's rotation and constants of motion to much better accuracy than at present. The uncertainty in the radio thickness of the atmosphere (a few cm) is the primary uncertainty in all this. Today's main limitation is in the local oscillators. Better L.O. stabilities than 1 part in 10^{12} are needed. The drift rate in the L.O. is a limitation (< few hundred picoseconds/day) are needed. The best clocks that exist have accuracies of 2-3 nanosec/day now (a few meters on the earth's surface), e.g., using H masers. Ours is less accurate than that. We are limited by the need for portability. To date we have published only information about the radio source and receiver. The Soviets would have access to the data unless specific steps were taken otherwise. DOD is concerned w/ \approx 10 m accuracy. They don't know how well USSR is tied into North American datum, but if this experiment could allow them to tie Crimea into it to a 10 m accuracy, thereby significantly refining their grid, DOD would be concerned. 10^{-7} sec/day is the accuracy of clocks we intend to send to USSR. We have promised not to publish geodetically critical information, but without further discussion could not guarantee (now) that information would not be communicated privately; otherwise the situation could be potentially embarrassing. We might wish to build into the Academy agreements an agreement not to exchange data on geodesy. KIK feels it would be virtually impossible not to give them geodetic data. We should decide how we wish to handle this, plus future experimental interactions with the USSR in order to tell the NSF what we are willing to do--acceding to future DOD restraints. DOD does not object to the October 1969 VLB experiments, but may do so for future ones when it will be possible to refine the intergrid geodetic measurements.

W. E. Howard

cc: D. Heeschen, T. Riffe, K. Kellermann, B. Clark, W. Powell

NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

June 23, 1969

*Copy to
C. W. Powell
Her file*

MEMORANDUM

To: W. E. Howard, T. R. Riffe, K. I. Kellermann, B. G. Clark
From: D. S. Heeschen
Subj: VLB Experiment - Russia

See attached translation of letter from Peive. I want to answer this soon and have several questions:

Returned - as sent by Pau-bur.

1. Do we want to send our equipment on Aeroflot -- and if so, will NSF, State Department, etc., agree to this?

2. Are any Russians coming here for the experiment? If so, we should reciprocate the offer of maintenance expenses. *Yes!*

3. Who specifically is going to Russia? I have heard that Clark, Kellermann, and Payne all plan to go. If so, who will be in Green Bank for the observing?

4. What generally is the status of things? Are we cleared to ship the equipment? *In process - cleared / 2 weeks*

DOD returned

Anyone with any answers please let me know soon.

State + NSF get together! DSH

/pj

7-10-69

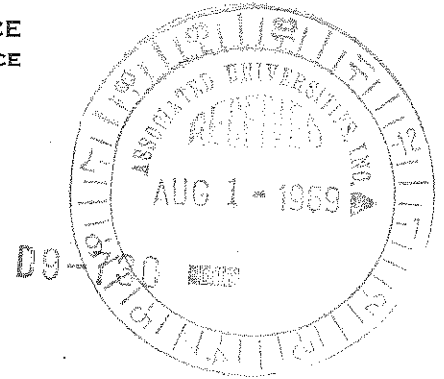
Called McLaughlin (Defense)
and Fine (Commerce) to
find out what's going on.
Neither knew but Fine is
to check & call back.

Fine called & said DOD
had the problem at a policy
level & as far as he knew, it
was still under consideration
there.



U.S. DEPARTMENT OF COMMERCE
BUREAU OF INTERNATIONAL COMMERCE
WASHINGTON, D.C. 20230

JUL 30 1969



BIC Case No. 999363

Mr. W. W. Powell,
Purchasing/Property Officer,
National Radio Astronomy Observatory
Post Office Box 2
Green Bank, West Virginia 24944

Dear Mr. Powell:

In accordance with your request in your letter of May 8, 1969, you are hereby authorized to ship temporarily to the Soviet Union electronic receiving and recording equipment as set forth on the enclosure to your letter which has been reproduced and made a part of this letter.

The equipment is to be used in your participation in an experiment in radio astronomy involving the Observatory at Green Bank, West Virginia, and the Crimea Astrophysical Observatory, Simferopol, Crimea, U. S. S. R.

This authorization is based upon the representations made in your letter and all other information furnished the Office of Export Control in connection with this proposed export transaction, as well as the following conditions:

1. Shipments made under this authorization will not include any equipment or technical data bearing a security classification.
2. No technical data relating to the design and production of the equipment will be shipped under this authorization, or otherwise disclosed to persons abroad.
3. Those items of equipment listed on the enclosure to this authorization will remain under the direct control of a United States citizen associated with the National Radio Astronomy Observatory or the National Science Foundation while the equipment is outside the United States.
4. Any interference with the operation or safeguarding of the equipment will be reported promptly to the Office of Export Control, Bureau of International Commerce, U. S. Department of Commerce, or the United States Embassy.

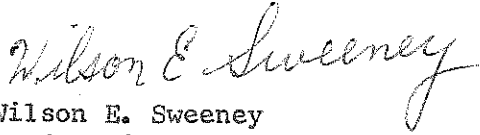
5. All equipment exported under this authorization will be returned to the United States upon the conclusion of this experiment.

The shipment of replacement parts for the subject equipment is not authorized by this letter. If the need for shipment of replacement parts arises, it should be reported promptly to the Office of Export Control.

A shipper's export declaration covering the shipment of equipment under this authorization need only show a general description of the products involved. It will not be necessary to show an individual Schedule B number or value. However, your declaration must be marked: "TEMPORARY EXPORT. PRODUCTS BEING EXPORTED FOR USE IN THE PERFORMANCE OF AN EXPERIMENT IN THE U. S. S. R. THESE PRODUCTS WILL BE RETURNED TO THE UNITED STATES AT THE CONCLUSION OF THE EXPERIMENT."

This authorization expires November 30, 1969.

Sincerely,



Wilson E. Sweeney
Acting Director
Office of Export Control

Lucas

NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia

VLB EQUIPMENT

<u>Item</u>	<u>Manufacturer</u>	<u>Ser. No.</u>	<u>Value</u>	<u>Tag No.</u>
Freq. Synthesizer XUC	Rohde & Schwarz	444466	4,089.38	4629
Crystal Oscillator	Rohde & Schwarz	4444291	4,089.38	4630
Tape Transport	Ampex	C-102	14,849.50	4631
VLB Delay Unit	AUI	2	3,500.00	4632
VLB Control Unit	AUI	2	3,900.00	4633
Loran-C-Receiver	AUI	2	180.88	4634
Rubidium Vapor Standard	Hewlett-Packard	836-00109	8,800.00	5064
Microwave Amplifier	Hewlett-Packard	811-01038	2,250.00	4880
VLB IF Converter	AUI	2	1,000.00	4637
Freq. Doubler	Telonic	4254	1,150.00	4638
Mixer, Preamp	Lel	13799	752.38	3386
Preamp	Lel		753.15	2822
Amplifier	Lel		5,885.00	3339
Freq. Multiplier	Telonic	4252	950.00	
Klystron VA-92C	Varian	4923	1,225.00	
Receiver, 3 cm	AUI	1	16,136.59	
Receiver, 6 cm	AUI	1	17,634.59	
			<hr/>	
		Total	87,145.85	

Plus attendant wiring and connecting apparatus and approximately 75 magnetic computer tapes.

Enclosure 1

NATIONAL RADIO ASTRONOMY OBSERVATORY

MEMORANDUM

July 31, 1969

To: S. Weinreb
K. Kellermann
B. Clark
M. Balister
B. Vrable
I. Jefferies
W. Powell

From: J. Payne

Subject: VLB Experiment with Soviet Union

This memo is an attempt to list all equipment that will be taken to the Soviet Union for the Green Bank-Crimea VLB experiment. If anyone has any comments, please let me know.

A summary of what we intend to do will probably be helpful. We will be observing at two frequencies (~~10711 MHz and 5011 MHz~~) using the portable VLB front-ends and the VLB terminal (No. 2) which will shortly be returning from Sweden.

The main problem in the experiment will be to establish time synchronization between the two stations. There are several possibilities here and we will probably use as many methods as possible to reduce the chance of error. Loran-C transmissions will be available in the Crimea from the Mediterranean chain. This chain is not synchronized to the East Coast chain in the U.S. but the difference is monitored and we are assured that this difference will be available to us.

Loran-C transmissions that are synchronized to the U.S. East Coast stations will probably be available in Leningrad, so another possibility will be to transport time from Leningrad to Crimea using a rubidium vapor clock. The most direct method is to carry a clock from the U.S. direct to the Crimea, and Barry Clark intends to do this using the Tracor crystal clock. A useful back-up would be for Ken Kellermann or myself to carry our rubidium clock to the Crimea from either London, Paris or Geneva. We will order a battery pack for the rubidium clock in any case.

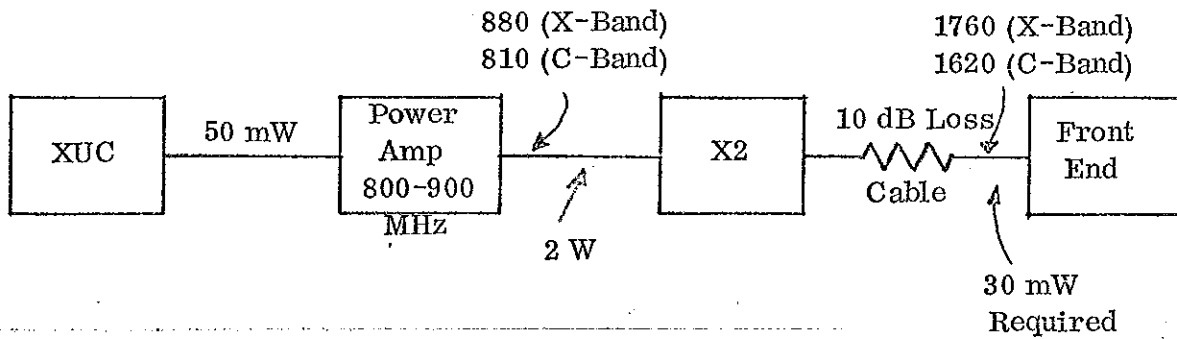
I think we should make ourselves as independent as possible as regards test equipment. Bill Vrable is making two small swept oscillators for tuning the front-ends and we will take our own frequency meters and an oscilloscope.

At 3 cm we would have pointing problems if we attempted to use total power. We have ordered a front-end switch that will fit directly on the paramp input, enabling us to beam switch using another horn. We are building a small synchronous detector that operates from 28 V DC to use with this system.

No problems are anticipated in pointing on total power at 6 cm.

Telescope cabling could present a problem and we should take enough cables to make us independent of the present cabling.

The LO system is outlined below and should present no problem. If we are short on power the Telonic multiplier could be moved to the focal point. The power amplifier should be here by August 10.



JMP/cjd

Attachment
List of Equipment

NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia

VLB EQUIPMENT
NRAO-USSR EXPERIMENT

<u>Item</u>	<u>Manufacturer</u>	<u>Serial</u>	<u>Tag</u>
Frequency Synthesizer XUC	Rohde & Schwarz	444466	4629
Crystal Oscillator	Rohde & Schwarz	4444291	4630
Tape Transport	Ampex	C-102	4631
VLB Delay Unit	AUI	2	4632
VLB Control Unit	AUI	2	4633
Loran-C Receiver	AUI	2	4634
Rubidium Vapor Standard	Hewlett-Packard	836-00109	5064
Microwave Amplifier	Hewlett-Packard	811-01038	4880
VLB IF Converter	AUI	2	4637
Frequency Doubler	Telonic	4254	4638
Frequency Multiplier	Telonic	4252	----
Receiver - 3 cm	AUI	1	----
Receiver - 6 cm	AUI	1	----
Crystal Oscillator	Tracor	----	4639
Test Equipment	----	----	----
Gain Modulator	AUI	----	----

SPARE PARTS

3 cm Front-End

Klystron

Mixer Diodes

Transistors and Diodes

Power Supplies

DC Fan and Brushes

Spare Parts (continued):

6 cm Front-End

Klystron

Mixer Diodes

Transistors and Diodes

Power Supplies

DC Fan and Brushes

VLB Terminal

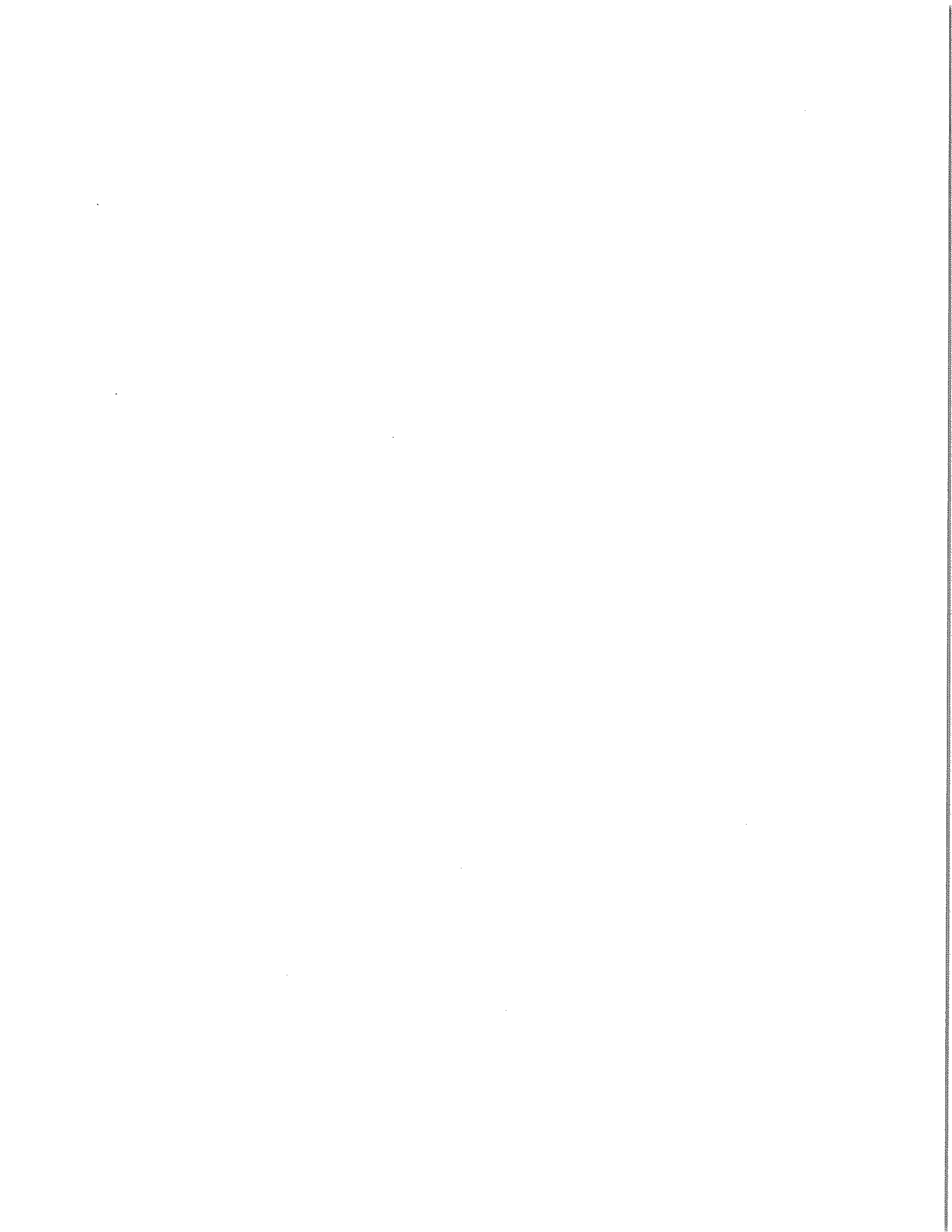
Spare cards for digital electronics and tape unit.

Spare lamps for tape unit.

Transistors and diodes.

Fuses.

Plus attendant wiring and connecting apparatus and approximately 75 magnetic computer tapes.



Air Way Bill

026-4-578-640

Itinerary - K. Kellermann

Aug. 11-15

Sands of Tim Motor Inn
P. O. Box 743
Woods Hole
Cape Cod, Mass. 02543
(Telephone 548-6300)

Aug. 16-28

Chateau Laurier Hotel
Major's Hill Park
Ottawa, Ontario

Aug. 28 - Sept. 10

c/o Mr. F. W.P. van't Hof
51 Rotti Rijweg
Rotterdam 8
The Netherlands
(Telephone 010 15-31-68)

Sept. 10 ~ 15

c/o Dr. L. Matveyenko
Lebedev Physical Institute
Leninsky 53
Moscow, U.S.S.R.
(Telephone 137-0003)

Sept. 15 - Oct. 30

c/o Dr. I. Moiseev
Simeis Observatorja
Crimea, U.S.S.R.
Telephone 77-3-96 Moiseev
77-3-76 Telescope
77-3-66 Secretary

NATIONAL RADIO ASTRONOMY OBSERVATORY

POST OFFICE BOX 2
GREEN BANK, WEST VIRGINIA 24944
TELEPHONE 304 - 456 - 2011
TWX 304 - 940 - 2481

EDGEMONT ROAD
CHARLOTTESVILLE, VIRGINIA 22901
TELEPHONE 703 - 296 - 0211

August 19, 1969

Memorandum

To: Customs Officials - United States, Sweden, and Russia
Subj: Electronic Equipment - Explanation of Shipment

The piece of equipment hand carried by Mr. John Payne, a British subject and an employee of the National Radio Astronomy Observatory, is required to provide precise timing for an experiment in radio astronomy jointed performed between the United States and Russia Observatories.

The clock is identified as a Frequency Standard, Serial No. 166, manufactured by Varian, a United States company. This device is the property of the US Government, identified by US Government Tag No. 4636. Upon completion of the experiment in Russia, it will be returned to the United States.

We request your cooperation in expeditiously handling any formalities which might be required to pass this device through customs.

The experiment for which this is required has been approved by the governments of both the U. S. and the U.S.S.R.

Sincerely,

W. W. Powell
Purchasing/Property Officer



U.S. DEPARTMENT OF COMMERCE
BUREAU OF INTERNATIONAL COMMERCE
WASHINGTON, D.C. 20230

SEP 2 1969

08-02

BIC Case No. 999363

Mr. W. W. Powell
Purchasing/Property Officer,
National Radio Astronomy Observatory
Post Office Box 2
Green Bank, West Virginia 24944

Dear Mr. Powell:

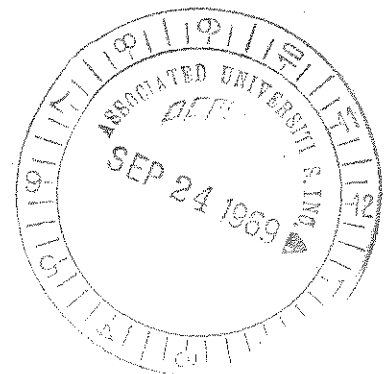
Please refer to your letter of September 4, and your telephone conversation with Mr. Williams on September 3, in which you requested that our letter authorization dated July 30, 1969 be amended.

In accordance with your request, our July 30, 1969 letter is hereby amended in that the number of magnetic computer tapes that may be shipped to the U. S. S. R. under that letter is increased from "approximately 75" to 250.

All other conditions of that letter remain unchanged.

Sincerely,

Rauer H. Meyer
Director
Office of Export Control



September 4, 1969

U. S. Department of Commerce
Office of Export Control
Washington, D. C. 20230

Attn: Mr. Al Williams

Gentlemen:

BIO Case No. 999363

In accordance with your letter of July 30, 1969, and our telephone conversation on September 3, 1969, relative to a shipment of equipment from the Observatory to the USSR, we request authorization to increase the number of magnetic computer tapes from approximately 75 to 250. This increase is a result of final studies of the requirements for satisfactorily completing the experiment in Russia.

The shipment, collectively called a 3 and 6 cm Radiometer, is scheduled for delivery to Pan America World Airways at Dulles Field on Tuesday, September 9, 1969.

If further information is required, please let me know.

Sincerely,

W. W. Powell
Purchasing/Property Officer

WWP/im

October 3, 1969

Re: BIC Case #999363

Office of Export Control
U. S. Department of Commerce
14th & Constitution Avenue, N. W.
Washington, D. C. 20230

Gentlemen:

The purpose of this letter is to request amendment of your letter authorization dated July 30, 1969, to include one Tracor Crystal Clock Model A-5, at a cost of approximately \$5,000, in the shipment to the U.S.S.R.

It is further requested that authorization be granted to permit this equipment to be hand-carried to the U.S.S.R. by Dr. Barry Clark of the National Radio Astronomy Observatory.

This shipment will be returned to the United States upon the completion of the experiment referred to in this case.

Sincerely,

W. W. Powell
Purchasing/Property Officer

NATIONAL RADIO ASTRONOMY OBSERVATORY
P. O. Box 2 Green Bank, W. Virginia
24994 Telephone: 304-456-2011

October 3, 1969

Re: BIC Case #999363

Office of Export Control,
U. S. Department of Commerce,
14th & Constitution Avenue, N. W.,
Washington, D. C. 20230

Gentlemen:

The purpose of this letter is to request ~~for~~ amendment of your letter authorization dated July 30, 1969 to include one Tracor Crystal Clock Model A-4 at a cost of approximately \$5,000. ~~to be included~~ in the shipment to the U.S. S.R.

It is further requested that authorization be granted to permit this equipment to be hand-carried to the U. S. S. R. by Dr. Barry Clark of the National Radio Astronomy Observatory.

This shipment will be returned to the United States upon the completion of the experiment referred to in this case.

Sincerely,

W. W. Powell
Purchasing/Property Officer

Taken on telephone by A. Williams 10/3/69. Signed letter to follow.



ALFRED WILLIAMS
CHIEF, EXPORTERS' SERVICE SECTION

U. S. DEPARTMENT OF COMMERCE
OFFICE OF EXPORT CONTROL
WASHINGTON, D. C. 20230

TELEPHONE
(202) 967

Bill Powell:
This is the
copy of your letter
you dictated. Would
you please forward
me a signed
original and your
check commitment.
Al Williams
10/3/69

October 8, 1969

Dr. Barry Clark

W. W. Powell

Tracor Clock - VLB Experiment with U.S.S.R.

Customs clearance through JFK Airport has been obtained for the Tracor clock. The Office of Export Control has notified Mr. John Lomando, of JFK Customs, of your trip, and if you encounter any trouble, Lomando is the man to see.

The enclosed Export Declaration is required in triplicate by Customs - keep a copy and return it to me when you return. We may need some reference if the clock is in the return shipment of the VLB equipment to the U. S. If you bring it back, a copy of the Declaration will be a big help.

Good Luck!



U.S. DEPARTMENT OF COMMERCE
BUREAU OF INTERNATIONAL COMMERCE
WASHINGTON, D.C. 20230

OCT 21 1969

BIC Case No. 999363

Mr. W. W. Powell,
Purchasing/Property Officer,
National Radio Astronomy Observatory
P. O. Box 2,
Green Bank, West Virginia 24944

Dear Mr. Powell:

Please refer to your letter of October 3, 1969 in which you request that our letter authorization dated July 30, 1969 be amended.

In accordance with the request contained in your letter, our July 30, 1969 letter authorization is hereby amended to authorize Dr. Barry Clarke of the National Radio Observatory to handcarry from the John F. Kennedy International Airport one Tracor Crystal Clock Model A-4, having a value of approximately \$5,000.00 to the U. S. S. R. It is understood that the clock is being taken to the U. S. S. R. for use in the experiment described in your May 8, 1969 letter, and that it will be returned to the United States when it has served its purpose.

All other conditions of our July 30, 1969 letter authorization remain unchanged.

Sincerely,

Rauer H. Meyer
Director
Office of Export Control

100 143143

59 452

Memorandum

October 31, 1969

To: Customs Officials - John F. Kennedy Airport

The equipment held in the Customs warehouse addressed to the National Radio Astronomy Observatory, Green Bank, West Virginia, from the U.S.S.R., is the property of the United States Government of U. S. origin. It was shipped to the U.S.S.R. from Washington under the authority of the Office of Export Control's BIC Case No. 999363 on Pan American Air Waybill #026-4-578-640, copies of both attached.

It would be appreciated if this equipment could be released to the Observatory's driver, the bearer of this note, who will return it to Green Bank.

W. W. Powell
Purchasing/Property Officer

November 18, 1969

Vernitron Corporation
2440 West Carson Street
Torrance, California 90501

Attn: Mr. Loveman

Dear Mr. Loveman:

These papers were included with the documents covering a shipment to us from Moscow.

They may be of value to you so we are sending them along with this note.

Sincerely,

W. W. Powell
Purchasing/Property Officer

WWP/im

Enc. 1