FIRST DRAFT

(January, 1980)

A 5-YEAR PLAN

FOR THE

HERZBERG INSTITUTE OF ASTROPHYSICS

"A society that does not stretch its horizons will soon shrink them. The argument that we must solve all our problems on earth before venturing beyond our planet will confine us for eternity. The world will never be without problems; they will become an obsession rather than a challenge unless mankind constantly expands its vision."

Henry Kissinger

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INTRODUCTION

The Herzberg Institute of Astrophysics, named in honour of NRC's Nobel Laureate, was formed in 1975 and brought together under one direction all of the Council's activities in astronomy and related research. The aim was to create a center of scientific excellence to serve as a focal point in Canada for research in the rapidly advancing field of astrophysics.

The Institute is engaged in two types of activities:

(1) the operation and maintenance of national facilities for research in astronomy (NRC Activity V)

(2) a program of basic and exploratory research (NRC Activity I) in astronomy, space science and spectroscopy

For the purposes of this plan the activities of the Institute have been grouped into three major programs:

1. Space Science
2. Astronomy

   Sub programs: a) Dominion Astrophysical Observatory
   b) Radio Astronomy
   c) Solar Physics
   d) Meteor Physics

3. Laboratory Spectroscopy

Although not a part of the Institute, HIA has responsibility for the financial contributions towards operation of the Canada-France-Hawaii Telescope Corporation. A forecast of the requirements of the Corporation are outlined in an appendix.

1. Program in Space Science

2. Objective: The research objectives of the program are to understand the physical processes involved in the energization and transport of plasmas in the earth's magnetic field and the processes associated with aurora in the upper atmosphere. Measurements are made in the region of space around the earth using ground-based, rocket and satellite techniques. The work contributes directly to NRC's role in basic and exploratory research in the areas of 'Advancement of Knowledge' and 'Space'. Indirectly, it also contributes to NRC's role in Support of Industrial Innovation and Development in the area of 'Space'.

3. Description:

(i) Background

Auroral studies started at the NRC in 1954 and were expanded considerably during the IGY period (1957-59). Involvement in space hardware began in the early 60's when NRC suggested to DND that it participate in their rocket program and in the Alouette I satellite program. Since that time expertise in the area has been developed by participation in the NRC rocket program, the ISIS satellite program, and a number of NASA and ESA space projects.

(ii) Rationale

The motivation for doing this work is to generate new knowledge about the earth's space environment and its dependence on solar phenomena. The research is carried out in close collaboration with scientists in other government departments and Canadian universities as well as with scientists in a number of foreign institutions. The knowledge gained by this program, and the knowledge to which foreign collaboration gives us access, will be needed to make decisions about Canada's future use of space - an area in which many countries are moving very rapidly at present. A second motivation is to support Canada's space industry by providing opportunities to industry to participate in a high technology area and in particular in the development and construction of sophisticated space instrumentation.

(iii) Technical Elements

A number of new projects, to be carried out in the next 5 years, have either been started or are presently in the planning stage. These correspond to a minimum viable program in the area of space physics for this time period. The following is a brief description of the projects:

'Falcons' is a project to study the relationship between field-aligned currents, local electric and magnetic fields and energetic particle precipitation. Three independent latitudinal cuts through the magnetic perturbations associated with the current systems will be taken in the same plane but at different altitudes. Two rockets launched nearly simultaneously on the same flight azimuth, one to an apogee of 350 km and the other to 800 km will be used along with a chain of ground-based magnetometers. The

rockets will be instrumented with thermal and energetic charged particle detectors (NRC) and vector electric (U. of Sask.) and magnetic (Rice Univ.) field sensors. The project is planned for 1981.

'Solar Polar Mission' is a joint NASA-ESA program in which two satellites will swing by Jupiter and then go into orbits which take them over the poles of the sun. NRC is collaborating with groups in the US and Europe in the design and construction of a comprehensive cosmic ray experiment which will make measurements in a region of space hitherto unexplored. The satellite launch is planned for 1983.

'Spacelab Wave Injection Facility' is a facility-type H.F. backscatter system which has been accepted by NASA for a number of Spacelab flights. This is a joint US-Canadian project in which both the hardware development and the science will be carried out jointly by scientists from both countries. The system will initially consist of a transmitter/receiver/antenna combination under the control of a dedicated microprocessor. Experiments will be carried out on wave propagation, resonances, ionization density distributions, non-linear effects, wave particle interactions and antenna impedances. The first flight of the facility is planned for 1983.

'Spacelab Mass Spectrometer' is a facility-type energetic ion mass spectrometer which has also been accepted by NASA for a number of Spacelab flights. The instrument was proposed by NRC and its design and construction will be carried out in collaboration with a group in the US. The spectrometer will be used (1) to investigate the source region for the energetic ion population in the magnetosphere, (2) to investigate ion energization, transport and loss mechanism, (3) to detect the minor constituents of the ion population, and (4) to develop and flight qualify the ion detection instrumentation required for future missions for which active tracer experiments are planned. The first flight of the spectrometer is planned for 1984.

NASA 'OPEN' (Origins of Plasmas in Earth's Neighbourhood) program will involve 4 spacecraft taking simultaneous measurements in different parts of the magnetosphere as well as a coordinated set of ground-based measurements. It is planned to propose two experiments for one of the satellites in collaboration with scientists in the US and at Canadian universities. One proposal involves a visible and ultraviolet auroral imager and the other consists of a new type of detector to measure the energy and angular distribution of magnetospheric electrons. NASA plans to launch the 'OPEN' satellites in 1985.

Ground-based and rocket support for the OPEN program is also being proposed. The ground-based support, in which HIA is involved, includes coordinated optical and radar measurements which would form part of a comprehensive set of ground-based measurements carried out in Canada. In particular the radar measurements would involve a bistatic auroral radar system which will continuously measure the ionospheric/magnetospheric electric fields over a large segment of the ionosphere which is of importance to the OPEN program.

(iv) Future Direction

All of the projects listed above will involve collaboration with US scientists and in some cases they will be part of a cooperative NRC-NASA program. It is likely that most future work in this area will involve collaboration with groups in other countries in projects which use the launch capability of the other country. By establishing good cooperative relationships with foreign groups we should be in a position to take advantage of future opportunities as they arise. The exact nature of these opportunities will be determined by recommendations made by the space science community to such organizations as NASA and ESA.

At the same time that new projects are started during the next 5 years the following projects will be phased out: (1) ISIS satellite studies, (2) certain rocket studies, (3) the 'Firewheel' project, (4) 'Magsat' studies, and (5) certain ground-based cosmic ray and auroral studies.

(v) Resources

The projects mentioned above will require new resources, some of which are included in the SRFB/SSCO 5-year plan. However, the main factor limiting the scope and possibly the success of these projects is scientific manpower, which is not included in the SRFB/SSCO plan, and which in the next few years is going to become extremely critical.

It is assumed that most of the instrumentation development and construction would be done in Canadian industry and that the funding for this could be provided through a SRFB/SSCO-type of organization. In addition, new resources for the research component of this work will be required in HIA as follows:

	80/81	81/82	82/83	83/84	84/85
P.Y.	2	4	4	8	12
Operating (K$)	300	450	550	650	750
Minor Cap. (K$)	0	100	200	200	200

(Note: The entries for each year in this table are the resources required in excess of those available in FY 1979-80. Funds are quoted in 1979 dollars.)

1. Program in Astronomy

Sub-program: Dominion Astrophysical Observatory

2. Objective: The objective of the program is twofold:

a) to operate the Dominion Astrophysical Observatory as a National Facility for astronomical observations and for the reduction of observations and a national center for the development of optical instruments and detector systems for the Canada-France-Hawaii Telescope and the telescopes of the DAO.

b) to undertake a program of astronomical research as a contribution to NRC's activities in Basic and Exploratory Research

3. Description:

(i) Background

The Dominion Astrophysical Observatory was founded in 1918 and has been the major government facility for research in optical astronomy ever since. The Observatory and its research programs were transferred from the Observatories Branch of DEMR in 1970 and in 1975 became a part of the Herzberg Institute. In recent years Observatory staff have played an important role in the development of the Canada-France-Hawaii Telescope, particularly in the finishing of the main mirrors and in the design and development of auxiliary instrumentation.

(ii) Rationale

It is a function of NRC, as specifically mentioned in the National Research Council Act (and in the Redefined Role as outlined by the President) to operate astronomical observatories as national facilities. The research program is a necessary adjunct to this operation but, more importantly, is a major part of Canada's contribution to the advancement of knowledge in astronomy.

(iii) Technical Elements

The elements of the DAO program are:

- operation and maintenance of the 1.8 meter (72-inch) and 1.2 meter (48-inch) telescopes of the Observatory as national facilities

- operation of an optics laboratory capable of finishing mirrors up to 4 meters in diameter. (The DAO had responsibility for figuring and polishing the mirrors for the Canada-France-Hawaii Telescope.)

- design and construction of optical instruments for the Observatory's telescopes, the CFHT and other telescopes

- original research in the fields of stellar, galactic and extragalactic astronomy using data obtained with the DAO telescope, the CFHT and other large telescopes, including orbiting optical and X-ray telescopes.

The past decade has witnessed an explosive growth of the research and development effort at the Dominion Astrophysical Observatory. Much of this work is on subjects such as galaxy evolution, X-ray sources, black holes and bizarre (yet fundamentally important) types of celestial objects, the very existence of which was not even suspected a few years ago. This rapid growth at DAO has, however, produced an entirely new class of problems that will have to be faced squarely in the 1980's:

1. The number of scientific papers published each year by the staff of the DAO has increased from 16 in 1969 to $\sim$75 in 1979. This has placed severe strains on the secretarial, computer programming, drafting and photographic laboratory staff.

2. The increased efficiency of auxiliary instrumentation on the Observatory's telescopes has resulted in rapid increase of their use by guest observers. For the scheduling period January - March 1980 there are requests from 17 outside observing teams representing eight Canadian institutions and three foreign countries. If all of these requests were honoured they would require $\sim$60% of the observing time available on the two telescopes. As the efficiency of the instrumentation increases, demand by outside users is certain to increase. Taking care of these visitors, who are often unfamiliar with the sophisticated instrumentation, places severe demands on night assistants and on several members of the technical and scientific staff.

3. The quality of scientific life at the DAO has benefitted tremendously from an ever-increasing stream of visitors. Most visitors stay for only a few days or weeks but, at any one time, typically two or three are visiting for a few months or for an entire sabbatical year. This situation aggravates the existing shortage of office space. This problem will surely become more serious once the Canada-France-Hawaii telescope becomes operational in early 1980. Many CFH users will, no doubt, want to use the unique data handling facilities (PDS microdensitometer, VAX computer, COSMOS measuring machine) to reduce their observations. Others may want to use the library, which has one of the two most complete astronomical collections in Canada. Such increased use of the facilities by the rest of the Canadian astronomical community is welcomed, provided that adequate space is made available to accommodate these visitors.

4. Finally, arrangements for handling the ∿50,000 tourists who visit the Observatory each year should be upgraded by expanding public exhibits and by increasing the number of guides available on weekends.

(iv) Future Direction

a. Electronics and Detectors

Frontier research in astronomy is a highly competitive business. If we are to stay out front we shall have to improve our capabilities in electronics and in detector development. Installation of more advanced detectors on the 48-in and 72-in telescopes continues to have very high priority. The difficulties and delays that have been encountered with the electronic controls for CFH spectrograph No. 1 dramatically demonstrate the weakness of the DAO in this area. Furthermore, the DAO should have an in-house capability to develop hardware and software associated with CCD and other advanced detector systems. The enlarged electronics group should be housed in a separate building. Cost of the new electronic lab might be ∿250 K. Additional staff requirements are two hardware and two software specialists.

b. CFH Support Role

The staff of the Dominion Astrophysical Observatory has played a major role in the design of the Canada-France-Hawaii telescope and its auxiliary instrumentation. Because of the strength of its technical and scientific staff it is almost inevitable that the DAO will become the major Canadian support facility for the CFH telescope. Both its location and data reduction facilities will, no doubt, attract increasing numbers of Canadian CFH users to Victoria. These visitors could be accommodated by turning the area presently occupied by the electronics group into research offices for visiting scientists.

Data reduction facilities at DAO need to be upgraded both for use by our own scientists and for the benefit of visitors. Specifically we need to build a new improved (ARCTURUS II) radial velocity measuring machine and we need to purchase a modern blink astro-comparator. Furthermore the image processing system for use with the PDS micro-densitometer should be upgraded and an array processor, tape drives and interactive graphics computer terminals added. The combined cost of these items is ∿200 K.

c. Optical and Mechanical Shops

The DAO optical shop represents a unique national asset which will allow Canada to compete for such projects as the optical work for the proposed Saudi-Arabian telescope project. The optical shop

is presently well equipped to handle large mirrors with dimensions in the range 1 to 4 metres. Both for CFH related projects and for export business the ability of the shop to handle small items and to coat small optical components should be upgraded. No Canadian company presently has such a coating capability and U.S. suppliers frequently have difficulty meeting our stringent specifications at reasonable cost. The ability to work on such small components is not only important in its own right but also because it can guarantee continuity of work for our skilled optical staff between large telescope mirror jobs. The total cost of an electronic beam gun, small mirror grinding and polishing machine, etc. is ∿50 K.

As a result of the recent addition of a "clean room" the machine shop is in good shape to handle present and anticipated future requirements.

d. Conversion of 72-in (1.8-m) Telescope to 3.0-m Aperture

We should like to build a light-weight tube containing a thin advance technology 3-m mirror to replace the telescope tube that presently contains the 72-inch mirror. The cost of such a project is estimated at ∿750 K dollars. The fact that this total cost is so low is, of course, due to the fact that ∿75% of the cost of most telescopes is in the already existing dome building and telescope support structure. By having an f/18 secondary beam the instrumentation presently in use on the 72-inch telescope can be retained. The scientific advantages of this project are obvious. A 3-m mirror will gather 2.7 times as much light as our present 72-inch mirror. This will allow us to compete much more effectively with the other large telescopes throughout the world. In particular a 3-m telescope at the DAO would collect light at 69% of the rate of the 3.6-m telescope in Hawaii at a cost corresponding to ∿2.5% of that of the CFH installation. The relatively poor sky conditions in Victoria will not, of course, allow us to study the very faintest extragalactic objects as well as the CFH telescope can. Nevertheless it will place us in a position where we can study somewhat brighter galactic objects almost as effectively as anyone else in the world. A particular advantage of such an instrument is that it will allow us to follow objects like X-ray binaries over their entire orbital period. Due to scheduling problems such extended series of observations could not be carried out by guest observers working with the CFH telescope.

In order to make optimum use of the light gathering power of a 3-m mirror we would also have to (a) upgrade the setting accuracy of the telescope, (b) bring it under computer control and (c) provide it with an integrating TV system for setting on faint objects.

In summary conversion of the DAO 72-inch telescope to a thin-mirror 3-m instrument will:

1. Allow us to develop the expertise needed to bid on a large Saudi telescope project and

2. Give the DAO a telescope that is competitive with almost any other instrument in the world for galactic work.

(v) Resources

The new resources* required for the program outlined above are estimated to be:

	80-81	81-82	82-83	83-84	84-85
PY	2	5	8	8	8
Operating (K$)	30	90	130	150	150
Capital:					
Minor Projects	100	100	100	100	100
Major Projects:					
a) Building	-	125	125	-	-
b) 3m Tel. Tube	100	400	250	-	-

*in addition to those available in FY 79-80.

1. Program in Astronomy

   Sub-program - Radio Astronomy

2. Objectives: The objectives of the radio astronomy program are:

   a) to operate and maintain radio astronomical observatories as National Facilities

   b) to undertake a program of astronomical research based on radio techniques as part of NRC's role in basic and exploratory research for the Advancement of Knowledge.

3. Description:

   (i) Background

NRC became involved in radio astronomy shortly after World War II when it was realized that the technical knowledge and equipment accumulated for radar development during the war could be used to investigate the newly discovered radio emissions from the sun. In the early 1960's the solar program was transferred to a quiet site in Algonquin Park and the "National Radio Astronomy Observatory," now known as the Algonquin Radio Observatory, was established and facilities for general research in radio astronomy constructed there for the use of all Canadian scientists.

At about the same time the Dominion Observatory (then part of the Department of Mines and Technical Surveys) established the Dominion Radio Astrophysical Observatory near Penticton, B.C. to undertake, initially, radio studies of the Galaxy. In 1970 this activity, together with other astronomical programs, was transferred to NRC and in 1975 became, with the Algonquin Radio Observatory, a part of the Herzberg Institute of Astrophysics.

The facilities of the two observatories (which are now both operated as national facilities) are complementary and their research programs have always been planned in a co-operative manner.

   (ii) Rationale

The operation of the observatories is regarded as a service to the Canadian scientific community and their availability has enabled this country to achieve a position of world leadership in radio astronomy. The in-house research programs of HIA are carried out in close co-operation with astronomers in Canadian universities as well as those in foreign countries and form a part of Canada's contribution to the advancement of man's understanding of the universe.

(iii) Technical Elements

(1) The major instrument of the Algonquin Radio Observatory is the 46 metre telescope which is one of a half dozen in the world of comparable size. When completed it was one of the most effective in the world. However it is now more than twelve years old and surpassed by facilities in other countries in terms of spectral coverage. As a consequence Canadian astronomers, particularly from the universities, prefer, whenever they can obtain observing time, to take more and more of their observations at foreign institutions. The 46-m telescope is, however, by no means obsolete and represents a major asset whose position as a world class instrument can be greatly restored. Two, relatively inexpensive, actions are required:

(a) an accelerated program of receiver development: in general the receivers which have been developed by HIA engineers and technicians are as good as those found elsewhere. However, there are serious gaps in spectral coverage of the receivers which are presently available. In order for the 46-m telescope to fulfill its role as a national facility this disparity must be rectified as soon as possible.

(b) an upgrading of the telescope: the performance of the 46 metre telescope at short wavelengths indicates that the telescope could operate at even shorter wavelengths if the accuracy of the surface panels were improved. An engineering study of this possibility is currently under way but it seems probable that the telescope could be refurbished to permit efficient operation over a diameter of 36 metres at wavelengths three times shorter than the current limit, and with reduced performance over a smaller diameter to a wavelength 10 times shorter than the present limit.

(2) The major facilities of the Dominion Radio Astrophysical Observatory are:

(a) a recently constructed aperture synthesis telescope for detailed mapping of hydrogen-line and continuum emission from extended regions of the Galaxy. It consists of four 8.5-m diameter paraboloids in an E-W line, two of which are movable on precision rail line. To produce a map of a region of sky observations are obtained over one hour intervals with each successive days' observations being conducted with different telescope separations. The

reduction of the observations requires extensive computer processing and finally provides maps with 1 arc minute resolution over a 2° diameter region of the sky at each of 100 separate frequencies (or doppler velocities).

(b) the original 25-m telescope. Though old, it is far from being obsolescent. Its most useful application is to provide "low order spacings" for the synthesis telescope studies of extended regions. It has recently completed an extensive study of very weak hydrogen recombination line emission in a number of galactic objects. It is well suited to line searches and pulsar studies as well as long baseline interferometry. Modernization of its control system would, however, increase its usefulness.

(3) The radio astronomers on the staff of the Dominion Astrophysical Observatory at Penticton and in the Astronomy Section in Ottawa are engaged in two types of activities. They are responsible for a) ensuring that the telescopes and auxiliary equipment of the national facilities are of the highest calibre and functioning properly, b) personal programs of original research. The research projects cover a wide range of topics and techniques. They usually involve radio astronomers from Canadian universities and foreign institutions and collaboration with astronomers in other fields e.g. optical, infrared and X-ray. One group of projects which use the technique of very-long-baseline interferometry involves simultaneous observations with several telescopes located at different observatories (including the two Canadian ones) in a half dozen countries around the world. Other exciting researches include studies of interstellar molecular clouds and emission nebulae, radio emission from peculiar and double stars, distant galaxies and quasars, supernova remnants etc.

(iv) Future Direction

a. Very Long Baseline Array

The Canadian Astronomical Society has proposed, and the Associate Committee on Astronomy has supported the building of a major new facility for Canada, a very long baseline array. (Details are contained in "A Proposal for a Canadian Very-Long-Baseline Array prepared by the CASCA Committee on Radio Astronomy.) We strongly support this proposal. The instrument, an array of eight radio telescopes stretching from Newfoundland to Vancouver Island, would be capable of forming images of the radio sky showing angular detail as small as

4×10^{-4} arc sec at a wavelength of 1 cm, far surpassing the resolution of optical telescopes including proposed space telescopes. It would be an outstanding and unique national facility which could not be duplicated in either the United States or Europe.

The technique on which the proposed telescope is based, long-baseline interferometry, was pioneered by a group of Canadian scientists and Canada is still a leader in the development of the technique. The expertise therefore exists in Canada for the design of this exciting project and Canadian industry has competence in the construction of its parts.

Cost of construction of the VLB Array is estimated at 23 million dollars spread over a construction period of about 5 years. Annual operating costs are estimated at $890 K, exclusive of salaries. A staff of 29, some of whom would be diverted from other projects, would be required to operate the facility.

b. Upgrading of ARO

The VLB Array project outlined above, even if approved almost immediately, could not be realized for almost ten years. To provide an adequate national facility in the interim it is imperative to proceed with the resurfacing of the 46-metre telescope at ARO - provided, of course, that the report of the engineering consultants is favourable. In addition to the surfacing it will be necessary to provide new receivers to cover not only the new millimeter spectral range which will become accessible but also to fill the gaps in the existing coverage. The combined cost is estimated to be $1,650 K. To carry out this development additional staff will also be required in the engineering support group.

c. Personnel for the DRAO

The Dominion Radio Astrophysical Observatory, which was constructed during a period of cut-backs in the number of public servants, was not adequately staffed at the outset and circumstances have continually prevented growth of the staff to an adequate level. In particular the ratio of scientific to technical staff is far too high. With very few technicians and no computer programmers on the staff the scientists have to spend a disproportionate amount of time at relatively routine tasks. As a result the scientific programs take a long time to complete and the scientific staff is consequently not as productive as it could be.

The recent Ad Hoc Committee recognized this situation and recommended the addition of several members to the support staff. The minimum requirements over the next five years are: one computer programmer, 2 engineers, 4 electronic technicians and one draftsman-photographer.

d. Improvement of Synthesis Telescope at DRAO

Although the synthesis telescope is in routine operation it has not yet fully reached the status of a "facility" which can readily be used by outsiders. The immediate task is to complete the software which will require the services of the full-time computer programmer mentioned above. The additional hardware required is relatively minor - approximately $40 K.

In future years consideration should be given to upgrading the instrument. Expansion by the addition of new paraboloids would increase the angular resolution and make equatorial and southern regions of the sky available for study. (The present instrument is limited to declinations north of -20°.) The cost of the expansion would be about $500 K spread over about three years. However this expansion cannot be contemplated without the increases in staff outlined above.

e. Addition to Building for the DRAO

As early as 1965 it was obvious that the DRAO building (built in 1959-60) was woefully inadequate. As a stop-gap measure temporary trailers were installed to relieve congestion. These have proved most unsatisfactory; they are wasteful of fuel, unsuitable for laboratories and a fire hazard. Even with the present staff, numbers of visitors and summer students, the situation is chaotic; there is no space at all for the additional staff which are considered necessary for the proper operation of the facility. A doubling of the floor space must be given high priority. The capital cost is of the order of $500 K.

(v) Resources

Although some radio astronomy programs such as the operation of the low frequency array at the DRAO, are in the process of being terminated, the programs outlined above will require considerable new resources.*

*Entries in table are additions required to resources available in FY 79-80.

	80-81	81-82	82-83	83-84	84-85
PY	3	5	7	9	11
Operating (K $)	50	100	150	200	250
Capital					
Minor Projects	100	120	140	140	140
Major Projects:					
Bldg. Addn. at DRAO	-	250	250	-	-
Upgrading 46-m Telescope	100	350	400	50	-
VLB Array*	-	-	100	500	6,000

*Total capital cost $23 M.

1. Program in Astronomy

   Sub-program - Solar Physics

2. Objectives: The objectives of the program are:

   a) to provide daily measurements of the solar flux at a wavelength of 10 cm. as a service to the international scientific community. These measurements are the best available indicator of solar activity and are used for such practical applications as the prediction of magnetic storms and the optimum frequencies for radio communication, and the timing of manned space flights.

   b) to undertake a program of combined optical and radio observation of active solar regions in a continuing study of the physical processes involved in solar phenomena.

3. Description

   (i) Background

   Observation of the sun at radio wavelengths was begun at NRC immediately after the war. The equipment used at that time was converted 10 cm. radar gear. By a fortuitous coincidence measurements of the solar flux at a wavelength of 10 cm. were later shown to be reliable indicators of the level of solar activity. The NRC records now represent the longest continuous series of radio measurements of solar activity in the world, dating back more than 32 years.

   Optical observations of the sun were undertaken for many years at the old Dominion Observatory. In the late 1960's the Observatory started construction of a small new solar observatory, the Ottawa River Solar Observatory, on a site west of Ottawa overlooking the Ottawa River. The project was completed by NRC following the transfer of all astronomical activities from DEMR in 1970. This optical instrumentation is complementary to the radio equipment and a program of combined optical and radio studies of the sun has developed.

   (ii) Rationale

   The routine measurement of the solar flux at 10 cm. is primarily a service which NRC provides to the international scientific community. The long series of NRC records is unique and we have been urged on several occasions by the International Astronomical Union to continue the program. The recent Ad Hoc Review Committee on Radio Astronomy strongly supported its continuation. The observations have practical applications in the areas of radio communication and space.

   The program of research into the structure, motions and magnetic fields in the solar photosphere and chromosphere - in particular in active regions - is a basic research program aimed at a better understanding of the physical processes operating in the sun. Ultimately, however, studies of this kind could lead to the reliable prediction of solar disturbances (flares etc.) which would have immense practical significance.

(iii) Technical Elements

Daily measurements of the solar flux at 10 cm. are taken with small radio telescopes located at ARO and DRAO. The data on the average flux level and on radio flares are transmitted daily to the World Data Center at Boulder, Colorado. Steps are currently under way, through the use of computers for control and on-line data processing, to make these patrol observations as automatic as possible. The aim is to retain the reliability for which the NRC observations are noted while at the same time release manpower for other projects.

The high quality of the observations taken at the Ottawa River Solar Observatory attest to the excellence of the site and the quality of the equipment. These optical observations, combined with radio observations taken with the 46 metre and array telescopes at ARO, have resulted in valuable scientific contributions. At the present time a major undertaking is participation in the "Solar Maximum Year", an international program of coordinated solar observations. However, the program is fragile since it is based on only one full time Research Officer working with two technicians. Under these circumstances operation of the Observatory and analysis of the large amounts of data flowing from it present serious problems. The addition of another astronomer to the group would result in a significant increase in scientific productivity.

(iv) Future Direction

(1) It is planned to continue the routine measurement of the solar flux at 10 cm. while at the same time proceeding with automation of the telescope control and data processing.

(2) The Ottawa River Observatory is a valuable, physical asset capable of producing much more science than it does at present. The high quality of the continuum and H-alpha photographs taken there is internationally acclaimed, with the result that there is a high demand for prints by other workers in the field. To reap the scientific benefits ourselves one additional solar astronomer should be added to the continuing staff. Analysis of the accumulated data would also provide worthwhile projects for a Research Associate.

(v) Resources

As explained above the most urgent requirement is additional staff. Only modest increases are foreseen in operating expenses.

	80-81	81-82	82-83	83-84	84-85
PY	1	2	2	2	2
Operating (K $)	20	40	40	40	40
Capital (K $)	0	0	0	0	0

(Entries are additional to resources available in FY 79-80.)

1. Program in Astronomy

   Sub-program - Meteor Physics

2. Objective: The objectives of the program are the determination of the physical and chemical properties of meteoroids through studies of meteor spectra and the analysis of recovered meteorites, and an understanding of the interactions involved in the passage of meteor particles through the earth's atmosphere. Since meteoritic material is the debris of comets and asteroids, believed to be the most pristine remnants of the original material from which the solar system was formed, their investigation relates directly to studies of the history of the solar system. The work therefore contributes to NRC's role in basic and exploratory research in the area of "Advancement of Knowledge."

3. Description

   (i) Background

   Studies of meteors were begun at NRC in 1946 and combined the new radar techniques with the older visual and photographic methods. With the commencement of the NRC-sponsored Canadian research rocket program in 1963 a powerful tool was added for in situ investigation of micrometeorites. In 1970 the meteor research program of the Department of Energy, Mines and Resources, including the Meteorite Observation and Recovery Project (MORP) was transferred to NRC.

   (ii) Rationale

   The aim of the research is the search for new knowledge leading to an understanding of the history of the solar system. There has been, however, and there will continue to be technological fall-out in the areas of radar and radio communication and of optical instrumentation and detector systems.

   (iii) Technical Elements

   The program is composed of several elements:

   - studies of meteor spectra for determinations of the chemical composition of meteoritic particles and the physical processes which occur as they penetrate the earth's atmosphere
   - radar studies of meteor statistics and meteor ionization
   - optical studies of meteor orbits
   - rapid recovery of fallen meteorites for radio isotope dating and studies of historical conditions of the interplanetary environment

(iv) Future Direction

The meteor program in the next five years will concentrate on the problem of describing the primordial constituents of the solar system as evidenced in the cometary and asteroidal material which strikes the earth in the form of meteors and meteorites. In collaboration with US scientists, sensitive TV-type spectrographs are being used to observe faint meteors to determine the relative chemical abundances and the distribution of the meteor orbits. These rely heavily on the experience gained from present studies of bright meteors. Using the prairie MORP facility (which has resulted in the photographic recording and subsequent recovery of the Innisfree meteorite in 1977), the recovered meteorites together with their orbital data can be analyzed for the high energy radiation and solar heating to which they were subjected during their lifetime in the solar system. Since the accurate flight path determination and recovery permits a calibration of the ablation theory, it should be possible to provide better criteria for differentiating the cometary and the three types of asteroidal material from observations of their dynamical behaviour in the atmosphere. A new study of the MORP data which will require three to five years of reduction and analysis of the velocity and orbital characteristics of many meteors will lead to the distribution of large meteoroids and improved estimates of the frequency of meteorite falls.

Radar provides observation of meteors down to much fainter magnitudes than the visual methods, and under all weather conditions. Continuous observations over a number of years can provide knowledge of the particle streams associated with comets and the distribution of comet debris around the orbit. To provide full global coverage, international cooperation among Canada, Australia, and Czechoslovakia is being pursued to develop simple automatic radars with similar characteristics to be used at these global locations. The aim is to study meteor streams and in particular the return of Halley's comet in 1986.

NASA is likely to fly a comet mission to Halley's comet and comet Temple 2 in the next five to seven years. This mission will obtain maximum benefit if it is well supported by terrestrial investigations of meteor streams in general and these two comets in particular. Since no space mission to an asteroid is planned, earth observations and recoveries will remain the principal source of research on these objects.

(v) Resources

The dominant problem in continuing this program in future years will be manpower. Government staffing policies in the past decade have severely weakened our ability to do effective, competitive research in this (and other) areas. In particular it has created an imbalance in types of personnel. There is a lack of engineering support at a time when the rapid advance and new and sophisticated instruments and techniques

require a much greater innovative and design capability than in the past. The new resources required are as follows:

	80/81	81/82	82/83	83/84	84/85
P.Y.	1	2	2	2	2
Operating ($K)	25	50	50	50	50
Minor Capital ($K)	0	0	0	0	0

(Entries are additional to resources available in FY 79-80.)

1. Program in Laboratory Spectroscopy

2. Objectives: The major objectives of the spectroscopy laboratory are the recording of the spectra of atoms and molecules and the interpretation of the spectra in terms of the structure and dynamics of these species. In order to further these objectives, it has been necessary to build instruments, to develop new techniques, to undertake studies of the interaction between radiation and matter, and to engage in theoretical studies of atomic and molecular behaviour. The spectroscopy section expects to continue these basic studies in atomic and molecular physics.

3. Description:

(i) Background

Following the wartime activities of the National Research Council Laboratories, which were almost totally devoted to short-range objectives, the President, Dr. C.J. Mackenzie, wrote regarding the Division of Physics, "The need was obvious; reorganization of the research units and strengthening work on fundamental research. The immediate decision was to find a distinguished and active research physicist to stimulate original work and possibly succeed the Director when the latter retired." To implement this decision, in 1948, Dr. G. Herzberg, who was an established authority on molecular spectra, was invited to join the laboratories and to set up a spectroscopy section. Thus the section was set up to give the National Research Council a stronger basis in fundamental research, and it has continued with such studies up to the present time.

(ii) Rationale

As noted above the spectroscopy section has devoted its efforts to experimental and theoretical studies aimed at obtaining data on particular molecules and at understanding molecular structure, molecular dynamics and the interaction of atoms and molecules with radiation. These studies have provided basic information for many new developments in the application of atomic and molecular physics. The design of lasers, the determination of minor constituents of both the upper and lower atmosphere, new methods of studying chemical kinetics, the identification of features in the spectra of interstellar clouds and of the atmospheres of stars and planets, and the calculation of molecular properties and intermolecular processes are among the areas which depend almost completely on the basic data provided by atomic and molecular spectroscopy.

Although the results of the work of the section are applied in many areas of science, for many years a number of the members of the staff have had a special interest in molecules which are of importance for astronomical investigations. When the section became a part of the Herzberg Institute of Astrophysics, the effort devoted to the astronomical aspects of the work was increased. This change in emphasis has come at a time when a knowledge of molecular spectra is becoming an increasingly important aspect of astronomy. For many decades molecular features observed in the spectra of the cooler stars and the planets have been the major means of determining the temperature, pressure and composition of their atmospheres. More recently, radio astronomy has shown the presence of many molecular species in interstellar and circumstellar clouds. Astronomical observations in

the infrared and in the far ultraviolet region, which are rapidly becoming more important with the advances in satellite astronomy, depend heavily on laboratory studies of molecular spectra for their interpretation. Laboratory experiments designed to meet these astronomical requirements now constitute a substantial portion of the work of the section.

(iii) Technical Elements

The spectroscopy section has built up equipment suitable for the study of spectra lying anywhere between the vacuum ultraviolet and the radio frequency region. Some of the world's largest spectrographs were the major instruments in the early years of the laboratory and these still play an important role in the laboratory. More recently the major emphasis has been on equipment suitable for laser and double resonance spectroscopy. Spectral analysis combining the output of the large conventional spectrometers with that of laser spectrometers now constitutes a significant portion of the laboratory's work.

Some examples of the work which has been carried out in the laboratory in the past few years are listed below.

1) The spectrum of the water ion H_2O^+ was observed for the first time and analysed. Following this work, it was possible to detect H_2O^+ in cometary spectra.

2) The infrared spectra of a number of molecules have been observed by means of laser spectroscopy. These spectra have given much new data which could not be obtained by conventional infrared spectroscopy.

3) A model of molecules with large amplitude vibrations has been analysed theoretically. The results have led to a simpler treatment of the spectra of a number of molecules such as HCNO and C_3O_2 which show such large amplitude vibrations.

4) The interaction between high intensity radiation and matter, such as that which occurs in a laser cavity, has been studied both theoretically and experimentally. The results of this study have led to an understanding of the shapes of spectral lines observed in laser spectroscopy.

5) The vacuum ultraviolet spectra of a number of molecules such as HF, HCl, SiO, H_2 and F_2 have been photographed at high dispersion and analysed.

6) The pressure shifts and pressure broadening of the lines of the infrared overtone bands of HD have been studied experimentally and the results have been used to re-evaluate the amount of HD in planetary atmospheres.

7) The first known spectrum of the H_3 molecule has been recorded and a partial analysis of the spectrum has been carried out.

(iv) Future Direction

For thirty years, Ottawa has been regarded on the international scene as the Mecca for spectroscopists. In order to maintain this unique position it is necessary to have (a) high quality personnel and (b) adequate support facilities. The quality of the present staff is first-class but numbers have dwindled in recent years. Further, many instruments, e.g. grating spectrographs, which were among the best in the world in the 1960's and 1970's, and which are still very useful, have been superseded by other instruments, e.g., Fourier transform spectrometers and lasers. With these powerful new tools, previously unobservable spectra can be recorded, and previously known spectra can be recorded with much higher resolution. New theoretical developments together with new computer programs have made it possible to interpret spectra previously considered too complex for a complete analysis. Thus recent developments have greatly improved the ability of spectroscopists to deal with a number of existing and emerging problems in astronomy, physics and chemistry.

To maintain a leading position in the field, it is important to build on existing strengths and to expand into regions which are at present underdeveloped. The following objectives are therefore projected for the period 1980-85:

1. Addition of Fourier transform spectrometers for work in the visible, ultra-violet, near infrared and infrared regions of the spectrum (estimated cost $400,000).

2. Extension and updating of existing laser facilities for work in the visible, ultra-violet and vacuum ultra-violet regions of the spectrum (estimated cost $300,000).

3. Additional microwave equipment for carrying out microwave-optical and microwave-infrared double resonance experiments (estimated cost $300,000).

4. Establishment of a diode laser facility for infrared studies of transient species (estimated cost $300,000).

5. Re-establishment of a microwave laboratory (estimated cost $500,000).

(v) Resources

New funds will be required to carry out the rebuilding program outlined above. A modest increase in staff is also required to restore the strength of the group and to provide expertise in the areas of Fourier transform spectroscopy and microwave spectroscopy:

	80-81	81-82	82-83	83-84	84-85
PY	1	3	5	6	6
Operating	50	100	100	100	100
Minor Capital (K $)	150	150	100	0	0

(Entries are additional to resources available in FY 79-80.)

SUMMARY OF FINANCIAL AND STAFFING REQUIREMENT

The effect of implementation of the programs outlined above on the HIA budgetary and person-year allotments is as follows:

	Base	5-Year Plan				
	79-80	80-81	81-82	82-83	83-84	84-85
PY	226(1)	236	247	254	261	267
Operating (K$, 1979)	2,002(2)	2,527	2,772	3,012	3,132	3,232
Minor Capital (K$, 1979)	830(3)	1,200	1,340	1,410	1,310	1,310

(1) Staff target as of 1/1/80.

(2) Not including special allotments for repair, upkeep and renovation of buildings (277K), EDP at Computation Center (88K) and SPAR design contract (125K)

(3) Total of A- and B-Capital budget

Major Projects	5-Year Plan					Project Total
	80-81	81-82	82-83	83-84	84-85	
Upgrading of 46m radio telescope	100	350	400	50	-	-
3m optical telescope tube	100	400	250	-	-	750
Addition to building at DRAO	-	250	250	-	-	500
Building for DAO	-	125	125	-	-	250
VLB Array	-	-	100	500	6,000	23,000
Totals	200	1,125	1,125	550	6,000	

APPENDIX

THE CANADA-FRANCE-HAWAII TELESCOPE CORPORATION

Operating Costs

The size of the NRC contribution to the Canada-France-Hawaii Telescope Corporation for FY 80-81 is dictated by the terms of the Tripartite Agreement among NRC, CNRS, and U. of Hawaii. The agencies are aware, however, that the funds required for efficient operation of the facility are likely to exceed the ceiling imposed by the Agreement. A review of the situation will be made at the end of the first full year of operation. The estimates for the years 80-81 onward are based on the requirements as foreseen by the administration of the Corporation.

	80-81	81-82	82-83	83-84	84-85
Contribution (CV 33) (K $ 1980)	1,366	1,500	1,500	1,500	1,500

(Note that these estimates are given in 1980 Canadian dollars.)

Major Project

It has long been recognized that the Canadian astronomical community requires an intermediate-size telescope (about 2 meter aperture) at a good site. (Cf "The Future of Ground and Space Based Astronomy in Canada" prepared by the NRC Associate Committee on Astronomy in 1974.) Originally it was suggested that the telescope might be located in Chile but there are several reasons why it would be better placed in Hawaii under the auspices of the Canada-France-Hawaii Telescope Corporation. First, costs of operating in Chile have been escalating rapidly recently. Secondly, if located on Mauna Kea it would provide direct support for the 3.6 meter telescope. Finally, CNRS of France has indicated its desire to place a medium-sized telescope there but could do it only under the umbrella of the CFHTC, in which case the costs of the installation would be shared with Canada. The cost to Canada would be 1 to 2 million dollars spread over 2 or 3 years. The starting date of such a project would depend, among other things, on the completion of negotiations with the University and State of Hawaii.

METHOD OF SELECTING PROPOSALS - 5 YEAR PLAN

BACKGROUND

The preparation of the first 5-year plan for NRC has proceeded without any formal mechanism for the selection of new or enlarged projects and programs. The initial 5-year plan will request large new resources from government and it is expected that the 5-year plan will be rolled-over year by year as a means to request new resources (effectively replacing the previous Program Forecast mechanism).

NRC must be in a position to defend its requests to government for new resources and hence a traceable procedure for selecting new proposals is required. The procedures used in the past in selecting B-budget items to be included in Program Forecasts have been well established for proposals coming from the laboratory divisions; all such proposals have been collated and sorted by the Tactical Studies Committee prior to consideration by Management Committee and Council. However, proposals for new projects or programs coming from non-laboratory parts of NRC have not had the same degree of examination and comparison with other proposals.

In the following a brief outline is presented of a method for selecting and ranking proposals for inclusion in a 5-year plan. The procedure has two salient new features-

a) *all* proposals from any part of NRC requiring new resources will be subject to the same procedure for evaluation, collation and ranking.

b) the champion, or spokesman, for any proposal will be responsible for making the case for the proposal at all the steps in the selection process within NRC.

PROPOSED PROCEDURE

- Directors and Branch Heads will identify proposals for new or enlarged activities requiring new resources in their areas of responsibility, taking advice from all relevant and competent sources including: NRC staff, industry, academia, Advisory Committees, Council of NRC. Proposals will be identified with the six themes of the five-year plan and proposals within any one theme will be ranked.

- In their corresponding areas of responsibility, the Group and Executive Directors will examine and select the proposals originating in the Divisions in their

group. The Vice-Presidents (Industry), (Personnel), and (External Relations) will perform the same function for their areas of responsibility. Proposals within any one theme will be ranked.

- A Program Selection Committee will examine all proposals that have survived prior screening and present ranked sets of proposals to the Management Committee for possible inclusion in the 5-year plan.

The membership of the Program Selection Committee will consist of:

- The Group, Executive and Regional Directors. (5)

- One representative of the Vice-President (Industry) the Vice-President (Administration) and the Vice-President (External Relations). (3)

- One research scientist or engineer from each of the three Groups (Engineering, Biosciences, Physical Sciences) appointed for a 1-year term. (3)

(11)

- The Secretary will be C.D. Doucet who will also represent the Chief Financial Officer.

PROPOSAL FORMAT

It is intended that the procedure should involve the minimum of paper work necessary to assure traceability and that a champion(s) would defend each proposal, in the main verbally, at the various steps in the selection process.

The champion will prepare a title and abstract of the proposal. The abstract should contain a description of the proposed new project or program, it should address the evaluation criteria and questions listed below, and should indicate required funds, positions and space.

The following questions should be considered in preparing scientific or engineering proposals:

- Champion

  - Who will make the case for the proposal?

  - Who will be responsible for the technical strategy and results?

- Technical Strategy
  - What are the scientific or technical trends of the proposal?
  - What major technical approaches will be used?
  - What concepts and phenomena will be examined?
  - What are the scientific or technical consequences of success?
- Expectations
  - What are the objectives?
  - What is the estimated probability of success?
- Collaboration
  - Who are the current leaders in the field?
  - Will NRC work with other organizations? (Industry, other departments, universities)
  - How will the NRC efforts compare with the efforts of other groups?
  - What is the role for NRC in the field?
- Management Considerations
  - How many new staff will be needed? With what qualifications? Where will the new staff be found? What existing NRC staff will be involved?
  - What new equipment or space will be needed? What will it cost?

EVALUATION CRITERIA

The criteria against which the new proposals will be judged are:

1. Potential for contributing to achievement of NRC objectives.
2. Potential for contributing to one, or more, of the themes in the 5-year plan.
3. Estimated probability of success.

4. Contribution to the effectiveness or institutional health of NRC.

5. Quality of the personnel and equipment.

It would be considered essential that a proposal meet criterion 1 and 2 and desirable to meet criteria 3, 4 and 5. The more criteria that are met by a proposal the greater its chance of being approved. The champion(s) for a new proposal must be prepared to argue for their proposal with respect to the above criteria.

GENERAL COMMENTS ON PROCEDURES

The forms for initiating a proposal will be provided by the T.S.C. secretariat. A statement of NRC objectives and salient themes will be attached.

The selection system will be iterative; i.e., at any level of examination, proposals that have been discarded at a low level can be reexamined. This will require that each level pass forward the abstracts of ranked proposals and also a list of those rejected.

Proposals that are rejected in the selection process prior to consideration by the Management Committee can be appealed to the Management Committee by the champion with the concurrence of the appropriate Group Director or Vice-President.

Ranking of proposals will be done only for consistent sets, i.e., apples will not be ranked against oranges.

The decision concerning any proposal, at any level in the selection process, will be communicated to the champion of the proposal at the earliest opportunity.

The intent of the proposed process is to keep paper work to a minimum and to concentrate on an oral examination of the scientific or technical merits of a proposal.

This procedure is experimental and will be modified as experience indicates. The proposed format and criteria have been developed with laboratory proposals in mind, these will be modified to accommodate proposals from the non-laboratory parts of NRC as necessary.

Tactical Studies Committee
17 October 1980

TABLE IV 12

Core Support: New Initiatives

Proposed Initiatives	Resources Required 1980-81 to 1985-86	
	Expenditures: $ Millions constant 1980 dollars	Personnel: Person-Years
Astronomy & Astrophysics	26	100
Basic Engineering	12	46
Biological Sciences	18	67
Chemistry	14	54
Physics	11	40
Space Science	8	28
Expansion of TRIUMF	15	-
Very Long Baseline Array	19	20
Total	123	355

DRAFT
(For discussion purposes only)

HERZBERG INSTITUTE OF ASTROPHYSICS

I. BASIC AND EXPLORATORY RESEARCH

New Resources Required

Proposal	Personnel Additions by 1986	Annual Operations Budget in 85/86	Minor Capital Requirement 1981-86	Major Capital Requirement 1981-86
1. Upgrading of 46m Tel.	7	100	1,050	3,750
2. LBI	5	50	150	-
3. ARO Operations	11	100	-	-
4. Solar Physics	7	50	100	-
5. DRAO	12	150	500 (equip) 250 (bldg)	-
6. 3m Tel (DAO)	-	-	800	-
7. Data Reduction Facility at DAO	13	150	275	-
8. DAO Operations	5	50	-	-
9. Instrument Development at DAO	11	150	200 (equip) 250 (bldg)	
10. Lab Spec.	9	50	200	-
11. RA Program	12	100	-	-
TOTALS	92	950	3,775	3,750
12. VLBA				
13. CFHTC Contribution				

24.10.80
JLL

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

☐ Industrial Expansion		☒ Core Support
☐ Regional Development		☐ Social Impact
☐ Energy		☐ Effectiveness

2. ☒ New Proposal and ☒ Expanded Effort

3. PROJECT/PROGRAM TITLE: UPGRADING OF 46-M RADIO TELESCOPE AT ARO

4. RESPONSIBLE OFFICER: J.L. Locke CHAMPION: N.W. Broten

5. PROPOSAL:

(a) Objective(s)

To improve the performance of the telescope so that it will be useful at considerably shorter wavelengths.

(b) Rationale

An engineering study of the existing telescope has shown that the 46-m telescope could be used at much shorter wavelengths if the accuracy of the surface panels were improved. Among other advantages the extension of the telescope's usefulness to shorter wavelengths would allow Canadian radio astronomers to study important molecular spectral lines such as CO. This improvement is required to keep the Canadian facility competitive and to extend its useful life. It would, in fact, give to Canadian astronomers the largest millimeter telescope in the world.

(c) Approach

It is planned to resurface the telescope, upgrade the pointing controls and develop radiometers for the millimeter wave region which will become accessible. In addition new receivers are required to fill gaps in the existing spectral coverage. To do this will require a major increase in the group responsible for engineering support of ARO (which is now badly understaffed).

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	7	7	7	7	7	7
Reallocation		-	-	-	-	-
Additional New Resources		1	3	5	7	7
Total	7	8	10	12	14	14

Personnel:

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	70	70	70	70	70	70
Reallocation		-	-	-	-	-
Additional New Resources		20	50	75	100	100
Total	70	90	120	145	170	170

Intramural Operations:

Nonpaylist Operations (contract)
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Contract Operations:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	-	-	-	-	-	-
Reallocation						
Additional New Resources		150	250	250	250	150
Total		150	250	250	250	150

Minor Capital:

Major Capital:

Total $3,750 K

Major Capital

1981/82	1982/83	1983/84	1984/85	1985/86
250	1,500	1,500	500	-

7. LOCATION:

8. DURATION OF PROJECT/PROGRAM:

major capital expenditures are [x] short term [ ] medium term operation is [x] long term

9. COLLABORATION:

This proposal is strongly supported by the Associate Committee on Astronomy and the Canadian Astronomical Society.

10. COMPETITION:

None

11. IMPACT POTENTIAL:

12. PROBABILITY OF SUCCESS:

[ ] high risk [ ] fair [ ] good [X] assured

13. ADDITIONAL SUPPORTING COMMENTS:

The 46-m telescope represents a major asset whose position as a world class instrument can be restored at relatively modest cost.

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

☐ Industrial Expansion	☒ Core Support
☒ Regional Development	☐ Social Impact
☐ Energy	☐ Effectiveness

2. ☐ New Proposal ☒ Expanded Effort

3. PROJECT/PROGRAM TITLE: LONG BASELINE INTERFEROMETRY

4. RESPONSIBLE OFFICER: CHAMPION:

5. PROPOSAL:

(a) Objective(s)

To expand the effort in Long Baseline Interferometry.

(b) Rationale

Although a team of Canadian scientists was the first to demonstrate the technique of long baseline interferometry, most of the exciting astronomical discoveries resulting from its use are now being made elsewhere notably by U.S. groups. It is the usual case of not being able to follow up a Canadian breakthrough through lack of the necessary resources, both human and financial. If constructed the Canadian Very Long Baseline Array will reverse this situation. However, in the intervening years greater support of the VLBI group will pay rich dividends.

(c) Approach

To bolster the effort in Long Baseline Interferometry by

1) the addition of two dedicated radio astronomers, an engineer and two technicians

2) the upgrading of instrumentation in the playback and data reduction centre.

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	5	5	5	5	5	5
Reallocation		–	–	–	–	–
Additional New Resources		2	4	5	5	5
Total	5	7	9	10	10	10

Personnel:

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	50	50	50	50	50	50
Reallocation		–	–	–	–	–
Additional New Resources		20	40	50	50	50
Total	50	70	90	100	100	100

Intramural Operations:

Nonpaylist Operations (contract)
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Contract Operations:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	10	10	10	10	10	10
Reallocation		–	–	–	–	–
Additional New Resources		50	100	100	25	25
Total	10	60	110	110	35	35

Minor Capital:

Major Capital: Space Building Needs

7. LOCATION: HIA (Ottawa and Penticton)

8. DURATION OF PROJECT/PROGRAM:

☐ short term ☐ medium term ☒ long term

9. COLLABORATION:

10. COMPETITION:

11. IMPACT POTENTIAL:

12. PROBABILITY OF SUCCESS:

☐ high risk ☐ fair ☐ good ☒ assured

13. ADDITIONAL SUPPORTING COMMENTS:

This program has the strong support of geodocists in both government and university since LBI observations can be used to determine accurate baselines over very long distances on the earth's surface. DEMR has made grants to York University for this purpose.

(3)

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

☐ Industrial Expansion	☒ Core Support
☐ Regional Development	☐ Social Impact
☐ Energy	☐ Effectiveness

2. ☐ New Proposal ☒ Expanded Effort

3. PROJECT/PROGRAM TITLE: OPERATION AND MAINTENANCE OF ARO, A NATIONAL FACILITY

4. RESPONSIBLE OFFICER: CHAMPION:

5. PROPOSAL:

(a) Objective(s)

To improve the services offered by the Algonquin Radio Observatory.

(b) Rationale

The proper operation of ARO is hampered by the lack of sufficient numbers of support staff. The Observatory operates on a 24 hour, 7 days a week schedule and with the present operating and maintenance staff this is only possible if they work a great amount of overtime. In addition the support staff in Ottawa is inadequate with the result that modifications and construction of new equipment for users take far too long.

(c) Approach

The following staff increases are required:

a) one engineer and three technicians at ARO

b) two engineers and two technicians to the Receiver Development Group in Ottawa

c) two machinists to the HIA Instrument Development Services Shop in Ottawa

d) one computer-programmer in Ottawa

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	27	27	27	27	27	27
Reallocation		–	–	–	–	–
Additional New Resources		3	6	9	11	11
Total	27	30	33	36	38	38

Personnel: 4 professional
7 technical

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	350	350	350	350	350	350
Reallocation		–	–	–	–	–
Additional New Resources		30	60	90	100	100
Total	350	380	410	440	450	450

Intramural Operations:

Nonpaylist Operations (contract)
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Contract Operations:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Minor Capital:

Major Capital: Space Building Needs

400 m^2 in Ottawa

7. LOCATION: HIA/ARO

8. DURATION OF PROJECT/PROGRAM:

☐ short term ☐ medium term ☒ long term

9. COLLABORATION:

10. COMPETITION:

11. IMPACT POTENTIAL:

12. PROBABILITY OF SUCCESS:

☐ high risk ☐ fair ☐ good ☒ assured

13. ADDITIONAL SUPPORTING COMMENTS:

We are constantly being criticized by the university community for not providing adequate support for ARO.

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

☐ Industrial Expansion	☒ Core Support
☐ Regional Development	☐ Social Impact
☐ Energy	☐ Effectiveness

2. ☐ New Proposal ☒ Expanded Effort

3. PROJECT/PROGRAM TITLE: EXPANSION OF PROGRAM IN SOLAR PHYSICS

4. RESPONSIBLE OFFICER: J.L. Locke CHAMPION: Dr. V. Gaizauskas

5. PROPOSAL:

(a) Objective(s)

To increase substantially the scientific potential of the Ottawa River Solar Observatory (ORSO).

(b) Rationale

The high quality of the continuum and H-alpha photographs being taken at the Ottawa River Solar Observatory has earned international acclaim with the result that prints of them are in high demand by other workers in other countries who use them for their own researches. We should be reaping the benefits of this valuable physical asset ourselves, but are unable to do so for lack of staff - both continuing staff and research associates.

(c) Approach

To increase the staff involved in the Solar Physics Program to a viable size by the addition over 5 years of 5 scientific and 5 technical staff.

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	3	3	3	3	3	3
Reallocation		–	–	–	–	–
Additional New Resources		1	3	5	7	7
Total	3	4	6	8	10	10

Personnel: 5 professional
5 technical

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	10	10	10	10	10	10
Reallocation		–	–	–	–	–
Additional New Resources		10	30	40	50	50
Total	10	20	40	50	60	60

Intramural Operations:

Nonpaylist Operations (contract)
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Contract Operations:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	10	10	10	10	10	10
Reallocation		–	–	–	–	–
Additional New Resources		20	20	20	20	20
Total	10	30	30	30	30	30

Minor Capital:

Major Capital: Space Building Needs

600 m^2 in Ottawa

(5)

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

☐ Industrial Expansion	☒ Core Support
☒ Regional Development	☐ Social Impact
☐ Energy	☐ Effectiveness

2. ☐ New Proposal ☒ Expanded Effort

3. PROJECT/PROGRAM TITLE: OPERATION OF THE SYNTHESIS RADIO TELESCOPE FACILITY AT DRAO

4. RESPONSIBLE OFFICER: CHAMPION:

5. PROPOSAL:

(a) Objective(s)

To improve the quality of service to astronomers provided by the Synthesis Radio Telescope facility.

(b) Rationale

Although the synthesis telescope is in routine operation it cannot be readily used by outside astronomers due to lack of support staff. Plans exist for improvement of the instrument to make it useful for the observation of equatorial and southern regions of the sky. While the capital cost of this improvement is modest it cannot be contemplated with the existing staff.

(c) Approach

1. Increase the number of engineers, technicians and computer programmers on the staff of the DRAO, and then (and only then).

2. Expand the synthesis telescope by the installation of additional paraboloids to increase its effectiveness.

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	12	12	12	12	12	12
Reallocation	-	-	-	-	-	-
Additional New Resources	-	4	8	12	12	12
Total	12	16	20	24	24	24

Personnel: 5 professional
7 technical

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	100	100	100	100	100	100
Reallocation		-	-	-	-	-
Additional New Resources		50	100	150	200	250
Total	100	150	200	250	300	350

Intramural Operations:

Nonpaylist Operations (contract)
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Contract Operations:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	70	70	70	70	70	70
Reallocation	-	-	-	-	-	-
Additional New Resources	-	-	-	100	100	300
Total	70	70	70	170	170	370

Minor Capital: Total capital cost of improvement $\leq$ 500 K

Major Capital: Space Building Needs additional 700 m^2

Note: An addition to the very overcrowded laboratory building of 300 m^2 is required whether this proposal is accepted or not. Cost of an addition is not included in Minor Capital requirements above.

7. LOCATION: HIA/DRAO (British Columbia)

8. DURATION OF PROJECT/PROGRAM:

☐ short term ☐ medium term ☒ long term

9. COLLABORATION:

With all radio astronomers in Canada.
Telescope is a national facility.

10. COMPETITION:

Although similar telescope exists in other countries, the characteristics of this telescope are unique.

11. IMPACT POTENTIAL:

12. PROBABILITY OF SUCCESS:

☐ high risk ☐ fair ☐ good ☒ assured

13. ADDITIONAL SUPPORTING COMMENTS:

The synthesis telescope has capabilities which are not duplicated or surpassed anywhere. Steps must be taken to ensure that its potential for the advancement of science are realized. The need for additional personnel was stressed by the Ad-hoc Review Committee on Radio Astronomy which also supported extension of the telescope array.

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

☒ Industrial Expansion	☒ Core Support
☒ Regional Development	☐ Social Impact
☐ Energy	☐ Effectiveness

2. ☒ New Proposal ☐ Expanded Effort

3. PROJECT/PROGRAM TITLE: CONVERSION OF THE DAO 1.8-M TELESCOPE TO 3.0-M APERTURE

4. RESPONSIBLE OFFICER: Dr. S. van den Bergh (DAO) CHAMPION: Dr. E.H. Richardson (DAO)

5. PROPOSAL:

(a) Objective(s)

(i) To increase light gathering power of telescope 2.7 times.

(ii) To develop the technology of thin mirrors applicable to both retrofitting of existing telescopes and new "next generation" telescopes.

(b) Rationale

The rationale for the first objective is obvious. It would make the DAO telescope competitive with almost any other telescope in the world for galactic work (although because of the quality of the site not for extra-galactic work).

The significance of the second objective, however, is that expertise would be developed in Canada in the polishing and support of thin mirrors (which will undoubtedly replace the thick mirrors in telescopes of the future). This expertise will be essential if Canada is to bid successfully on future large telescope projects - such as the proposed Saudi Arabian. The successful conversion of the DAO telescope will also open possibilities for the retrofitting by Canadian industry of many similar telescopes throughout the world.

(c) Approach

To design and manufacture in Canadian industry a new tube for the DAO telescope; to develop the technique of polishing thin mirrors at the DAO through the production of 3.0-m aperture mirror (approx. 12 cm thick); to develop a practical thin-mirror support system. No change to the telescope mounting will be necessary since the aim will be to keep the overall weight of the new tube identical to that of the old. It will be necessary, however, to upgrade the setting accuracy of the telescope and bring it under computer control.

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	0	0	0	0	-	-
Reallocation	-	3	4	4	-	-
Additional New Resources	-	0	0	0	-	-
Total	-	3	4	4	-	-

Personnel:

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	0	0	0	0	-	-
Reallocation	-	0	0	0	-	-
Additional New Resources	-	20	20	20	-	-
Total	0	20	20	20	-	-

Intramural Operations:

Nonpaylist Operations (contract)
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	0	0	0	0	-	-
Reallocation	-	0	0	0	-	-
Additional New Resources	-	10	10	10	-	-
Total	0	10	10	10	-	-

Contract Operations:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	0	0	0	0	-	-
Reallocation		0	0	0	-	-
Additional New Resources		100	400	300	-	-
Total	0	100	400	300	-	-

Minor Capital:

Major Capital: Space Building Needs

Nil

7. LOCATION: HIA
Dominion Astrophysical Observatory, Victoria

8. DURATION OF PROJECT/PROGRAM:

[xx] short term [ ] medium term [ ] long term

9. COLLABORATION:

With Canadian industry

10. COMPETITION:

Other countries, notably USA, UK and possibly Australia

11. IMPACT POTENTIAL: If the demonstration is successful the impact in terms of foreign contracts to Canadian companies could be enormous. If we do nothing, the future for Canadian involvement in large, expensive telescope projects is threatened.

12. PROBABILITY OF SUCCESS:

[ ] high risk [ ] fair [xx] good [ ] assured

13. ADDITIONAL SUPPORTING COMMENTS:

(7)

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

☐ Industrial Expansion	☒ Core Support
☐ Regional Development	☐ Social Impact
☐ Energy	☐ Effectiveness

2. ☐ New Proposal ☒ Expanded Effort

3. PROJECT/PROGRAM TITLE: NATIONAL FACILITY FOR REDUCTION OF CFH TELESCOPE DATA (DAO)

4. RESPONSIBLE OFFICER: Dr. S. van den Bergh (DAO) CHAMPION: Dr. J. Kormendy (DAO)

5. PROPOSAL:

(a) Objective(s)

To expand the facilities available in Canada for the reduction of data obtained by Canadian users of the CFHT.

(b) Rationale

Recent advances in panoramic digital detectors have dramatically increased the efficiency of astronomical telescopes. Such devices are being used on the CFHT with the result that the power of the completed telescope is far greater than envisaged during the planning stage. The price of this increased efficiency is a phenomenal increase in the volume of digital data to be processed. Photographic plates will still be used for certain observations because they allow observation of orders-of-magnitude more pixels at a time. However, most analysis requires that the plate first be digitized using a microdensitometer, which results in a further dramatic increase in digital data to be processed.

(c) Approach

To provide at the DAO plate measuring equipment and an interactive picture processing system capable of handling the large quantities of data obtained with the CFHT and performing complicated reduction procedures. These facilities, adequately staffed, will be maintained as a national reduction centre available to all Canadian astronomers.

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	5	5	5	5	5	5
Reallocation	–	–	–	–	–	–
Additional New Resources	–	3	7	9	11	13
Total	5	8	12	14	16	18

Personnel:

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	50	50	50	50	50	50
Reallocation		–	–	–	–	–
Additional New Resources		30	75	90	120	150
Total	50	80	125	140	170	200

Intramural Operations:

Nonpaylist Operations (contract)
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Contract Operations:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	75	75	75	75	75	75
Reallocation	–	–		–	–	–
Additional New Resources	–	100	100	25	25	25
Total	75	175	175	100	100	100

Minor Capital:

Major Capital: Space Building Needs approx. 800 m^2

7. LOCATION: DAO (Victoria)

8. DURATION OF PROJECT/PROGRAM:

☐ short term ☐ medium term ☒ long term

9. COLLABORATION: To be planned in cooperation with Canadian university astronomers and relying heavily on the experience of other institutions, particularly the Kitt Peak National Observatory in the U.S.

10. COMPETITION:

11. IMPACT POTENTIAL: Provision of this facility is essential if Canada is to take full advantage of its partnership in the CFHT.

12. PROBABILITY OF SUCCESS:

☐ high risk ☐ fair ☐ good ☒ assured

13. ADDITIONAL SUPPORTING COMMENTS:

The requirements outlined in this proposal have been recognized by all major astronomical institutions and approximately two dozen institutions throughout the world have or are currently developing data reduction centres with interactive picture processing facilities.

(8)

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

☐ Industrial Expansion		☒ Core Support
☒ Regional Development		☐ Social Impact
☐ Energy		☐ Effectiveness

2. ☐ New Proposal ☒ Expanded Effort

3. PROJECT/PROGRAM TITLE: OPERATION AND MAINTENANCE OF THE DAO

4. RESPONSIBLE OFFICER: CHAMPION:

5. PROPOSAL:

(a) Objective(s)

To improve the service to astronomers at the DAO.

(b) Rationale

The DAO is severely understaffed in secretarial, clerical and other support categories with the result that publication of papers (the number of which has increased dramatically in recent years) is delayed and the time of professional staff wasted. Further, the branch librarian provided by CISTI is frustrated by the lack of clerical and typing assistance.

(c) Approach

Additions to the DAO staff are required as follows:

3 clerk-typists
1 secretary
1 draftsman

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	5	5	5	5	5	5
Reallocation		-	-	-	-	-
Additional New Resources		3	5	5	5	5
Total	5	8	10	10	10	10

Personnel:

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	50	50	50	50	50	50
Reallocation		-	-	-	-	-
Additional New Resources		30	50	50	50	50
Total	50	80	100	100	100	100

Intramural Operations:

Nonpaylist Operations (contract)
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Contract Operations:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Minor Capital:

Major Capital: Space Building Needs

7. LOCATION: HIA/DAO (British Columbia)

8. DURATION OF PROJECT/PROGRAM:

☐ short term ☐ medium term ☒ long term

9. COLLABORATION:

10. COMPETITION:

11. IMPACT POTENTIAL: The addition of support staff will have a profound effect on the scientific output of Observatory.

12. PROBABILITY OF SUCCESS:

☐ high risk ☐ fair ☐ good ☒ assured

13. ADDITIONAL SUPPORTING COMMENTS:

(9)

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

- ☒ Industrial Expansion
- ☒ Core Support
- ☒ Regional Development
- ☐ Social Impact
- ☐ Energy
- ☐ Effectiveness

2.

- ☐ New Proposal
- ☒ Expanded Effort

3. PROJECT/PROGRAM TITLE: DEVELOPMENT OF ELECTRO-OPTICAL INSTRUMENTATION FOR ASTRONOMY (DAO)

4. RESPONSIBLE OFFICER: CHAMPION:

5. PROPOSAL:

(a) Objective(s)

To develop an in-house capability in the technology associated with advanced detector systems for optical astronomy and transfer appropriate expertise to Canadian industry.

(b) Rationale

To be competitive in astronomical research today an observatory must have an active program of instrumental development. Although the DAO is strong in the areas of optical design and manufacture it is woefully weak in electronics and the development of hardware and software associated with CCD and other advanced detector systems which are rapidly being put into use in astronomy. There is proven potential for the sales to other observatories of instruments designed for the DAO.

(c) Approach

The instrumentation group of the DAO is to be increased by the addition, in particular, of hardware and software specialists. A new laboratory building adjacent to the already overcrowded office building would be required to house the enlarged group.

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	15	15	15	15	15	15
Reallocation	-	-	-	-	-	-
Additional New Resources	-	3	5	7	9	11
Total	15	18	20	22	24	26

Personnel:

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	150	150	150	150	150	150
Reallocation		-	-	-	-	-
Additional New Resources		50	100	120	140	150
Total	150	200	250	270	290	300

Intramural Operations:

Nonpaylist Operations (contract)
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Contract Operations:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Minor Capital:

Major Capital: Space Building Needs Approx. 300 m^2 for this expanded program. However, the proposal is to construct a new building at Victoria of approx. 600 m^2 to house the electronics part of the instrumentation group, relieving the overcrowded situation in the main building.

7. LOCATION:

8. DURATION OF PROJECT/PROGRAM:

☐ short term ☐ medium term ☒ long term

9. COLLABORATION:

10. COMPETITION:

11. IMPACT POTENTIAL:

12. PROBABILITY OF SUCCESS:

☐ high risk ☐ fair ☐ good ☒ assured

13. ADDITIONAL SUPPORTING COMMENTS:

It is essential that the instrument development group of the DAO be strong enough to compete with the French for the development of new instrumentation for the CFHT because of the benefits which will accrue to Canadian high-technology industries.

(10)

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

☐ Industrial Expansion	☒ Core Support
☐ Regional Development	☐ Social Impact
☐ Energy	☐ Effectiveness

2. ☐ New Proposal ☒ Expanded Effort

3. PROJECT/PROGRAM TITLE: EXPANSION OF HIA PROGRAM IN LABORATORY SPECTROSCOPY

4. RESPONSIBLE OFFICER: CHAMPION:

5. PROPOSAL:

(a) Objective(s)

To maintain the internationally recognized excellence of the HIA Spectroscopy Laboratories.

(b) Rationale

For thirty years the laboratory founded by Dr. Herzberg and Douglas has been regarded on the international scene as the Mecca for spectroscopists. In recent years, however, the size of the staff has dwindled as a result of general cutbacks. Further, many of the laboratory instruments which were among the best in the world in the 1960's and 1970's have to some degree been superseded by other instruments employing new techniques. The present staff is first-rate but to retain and enhance its international position the laboratory urgently requires additional high quality people and the upgrading of its instrumentation.

(c) Approach

The quality of the Spectroscopy Laboratories should be upgraded over the next five years by

(1) the addition of carefully selected continuing scientific personnel, research associates and technical officers
(2) the acquisition of Fourier Transform Spectrometers for various regions of the spectrum
(3) the establishment of a diode laser facility for infrared studies of transient species
(4) the acquisition of microwave equipment for carrying out microwave, microwave-optical double resonance and microwave-infrared double resonance experiments.

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	24	24	24	24	24	24
Reallocation		–	–	–	–	–
Additional New Resources		1	3	5	7	9
Total	24	25	27	29	31	33

Personnel:

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	200	200	200	200	200	200
Reallocation		–	–	–	–	–
Additional New Resources		10	20	30	40	50
Total	200	210	220	230	240	250

Intramural Operations:

Nonpaylist Operations (contract)
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Contract Operations:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	80	80	80	80	80	80
Reallocation		–	–	–	–	–
Additional New Resources		50	100	50	0	0
Total	80	130	180	130	80	80

Minor Capital:

Major Capital: Space Building Needs

Additional 500 m^2 of laboratory and office space in Ottawa

7. LOCATION: HIA Ottawa

8. DURATION OF PROJECT/PROGRAM:

☐ short term ☐ medium term ☒ long term

9. COLLABORATION:

Extensive collaboration with Canadian universities and foreign laboratories will be maintained.

10. COMPETITION:

11. IMPACT POTENTIAL:

International recognition for the Spectroscopy Laboratory is one of the major success stories of Canadian science. Its impact on the world scene is difficult to overestimate.

12. PROBABILITY OF SUCCESS:

☐ high risk ☐ fair ☐ good ☒ assured

13. ADDITIONAL SUPPORTING COMMENTS:

(11)

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

	☐ Industrial Expansion	☒ Core Support
	☒ Regional Development	☐ Social Impact
	☐ Energy	☐ Effectiveness

2. ☐ New Proposal ☒ Expanded Effort

3. PROJECT/PROGRAM TITLE: RESEARCH ASSOCIATESHIP PROGRAM IN HIA

4. RESPONSIBLE OFFICER: CHAMPION:

5. PROPOSAL:

(a) Objective(s)

To increase the number of young scientists in the Herzberg Institute of Astrophysics.

(b) Rationale

An organization, such as the HIA, engaged in basic research must have a constant flow of young, energetic scientists passing through it if it is to continue to be vibrant and scientifically productive. This is, of course, the aim of the Research Associateship Program. However, the number of Research Associateships we can offer has never been large enough and has, in fact, decreased in recent years.

(c) Approach

To increase the number of RA's in the Herzberg Institute from the present 15 to 27. The distribution of these additional positions among the six research sections would, at any given time, depend upon the quality of the applications received.

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	15	15	15	15	15	15
Reallocation		–	–	–	–	–
Additional New Resources		2	5	8	12	12
Total	15	17	20	23	27	27

Personnel:

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	150	150	150	150	150	150
Reallocation		–	–	–	–	–
Additional New Resources		20	50	80	100	100
Total	150	170	200	230	250	250

Intramural Operations:

Nonpaylist Operations (contract)
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Contract Operations:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Minor Capital:

Major Capital: Space Building Needs

Nil

7. LOCATION:

8. DURATION OF PROJECT/PROGRAM:

☐ short term ☐ medium term ☒ long term

9. COLLABORATION:

10. COMPETITION:

11. IMPACT POTENTIAL:

12. PROBABILITY OF SUCCESS:

☐ high risk ☐ fair ☐ good ☒ assured

13. ADDITIONAL SUPPORTING COMMENTS:

(12)

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

☐ Industrial Expansion	☒ Core Support
☒ Regional Development	☐ Social Impact
☐ Energy	☐ Effectiveness

2. ☒ New Proposal ☐ Expanded Effort

3. PROJECT/PROGRAM TITLE: VERY LONG BASELINE ARRAY (VLBA)

4. RESPONSIBLE OFFICER: J.L. Locke CHAMPION: N.W. Broten

5. PROPOSAL:

(a) Objective(s)

To construct and operate, as a national facility, a telescope capable of forming images of the radio sky with better than milli-second of arc resolution.

(b) Rationale

The technique of long baseline interferometry, which was pioneered by a group of Canadian scientists, can be used to combine the signals of a widely spaced array of radio telescopes to produce an instrument with spatial resolution far surpassing that of optical telescopes, including space telescopes. Canada has the ideal geography and technical expertise to build an instrument which would place Canada amongst world leaders in a frontier area of a fundamental science.

(c) Approach

Construction of an array of up to eight radio telescopes stretching from Newfoundland to Vancouver Island with appropriate laboratories for telescope control, data reduction and maintenance. The instrument would be a national facility available to all Canadian scientists.

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base Reallocation Additional New Resources						
Total						

Personnel:

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base Reallocation Additional New Resources						
Total						

Intramural Operations:

Nonpaylist Operations (contract)
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base Reallocation Additional New Resources						
Total						

Contract Operations:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base Reallocation Additional New Resources						
Total						

Minor Capital:

Major Capital: Space Building Needs

100 500 6,000 8,000

Note: Total capital cost spread over 6 years - $23 M
Annual operating costs (excluding salaries) upon completion $1 M
Operating staff required 29

7. LOCATION: From coast to coast in Canada

8. DURATION OF PROJECT/PROGRAM:

☐ short term ☐ medium term ☒ long term

9. COLLABORATION: The instrument is being planned in cooperation with Canadian university astronomers. The majority of the instrumental development and manufacture would be undertaken by Canadian industry.

10. COMPETITION: A proposal, still in a very early stage, to build an array in the U.S. is complementary, but does not duplicate, this proposal.

11. IMPACT POTENTIAL: The proposed array would be a unique national facility, having a long useful life, which could not be duplicated in either the United States or Europe.

12. PROBABILITY OF SUCCESS:

☐ high risk ☐ fair ☐ good ☒ assured

13. ADDITIONAL SUPPORTING COMMENTS:

This is a proposal developed by the Canadian Astronomical Society and supported by the Associate Committee on Astronomy as its highest priority for major new instrumentation. Details are contained in "A Proposal for a Canadian Very Long Baseline Array" prepared by the Radio Astronomy Committee of the CAS.

NEW PROPOSAL - 5-YEAR PLAN

1. THEME

- ☐ Industrial Expansion
- ☐ Regional Development
- ☐ Energy
- ☒ Core Support
- ☐ Social Impact
- ☐ Effectiveness

2.

- ☐ New Proposal
- ☒ Expanded Effort

3. PROJECT/PROGRAM TITLE:

Contributions to the Canada-France-Hawaii Telescope Corporation

4. RESPONSIBLE OFFICER: CHAMPION:

5. PROPOSAL:

(a) Objective(s)

To improve operation of the CFH Telescope

(b) Rationale

At present the terms of the Tripartite Agreement impose a ceiling on the annual operating budget of the CFHT Corporation and hence on the contribution NRC makes to the Corporation. It is widely recognized that this budget (approx. $2.5 M U.S. in 1980) is too small to provide for proper and efficient operation of the observatory. It is therefore hoped that agreement can be reached among the agencies - CNRS, U. of Hawaii and NRC - to provide more adequate funding

(c) Approach

On the assumption that agreement can be reached among the partners to increase the annual contributions of the agencies to the CFHTC by 50%.

6. RESOURCE REQUIREMENTS:

Person-Years

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Personnel:

Nonpaylist Operations (intramural
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Intramural Operations:

Contributions
~~Nonpaylist Operations (contract)~~
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base	1,500	1,500	1,500	1,500	1,500	1,500
Reallocation						
Additional New Resources		750	750	750	750	750
Total	1,500	2,250	2,250	2,250	2,250	2,250

~~Contract Operations~~: Contributions:

Minor Capital
Constant 1980/81 $000's

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Base						
Reallocation						
Additional New Resources						
Total						

Minor Capital:

Major Capital: Space Building Needs