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INTERNATIONAL AFFAIRS

CSSR CONTRIBUTION TO SPACE RESEARCH

CSSR Experiments on Salyut 6

Prague RUDE PRAVO in Czech 4 Mar 78 p 3

Article by Vaclav Bumba, corresponding member of the CSAV (Czechoslovak Academy of Sciences), scientific secretary of the Czechoslovak Interkosmos Commission, director of the Astronomical Institute of the CSAV: "Czechoslovak Experiments on Salyut 6"

Text In addition to its political importance, the joint flight of the Czechoslovak cosmonaut-flight deck engineer with the Soviet commander is also important because it initiates a new stage in the development of cooperation by socialist countries in peaceful research and utilization of outer space--the Interkosmos program--the stage of piloted flights. By joint effort of several work groups and primarily of a number of scientific collectives and dedicated individuals, and thanks to the assistance rendered by party and Svaz organizations, experiments were prepared to be conducted by our cosmonaut during the flight to properly represent the activity of the Czechoslovak Interkosmos Commission. These experiments are important not only because they help solve some fundamental research problems, but primarily because their results are very important for future piloted flights and because they are introducing for Czechoslovakia the era of space technology, a new method of space flight exploitation which in the near future can gain considerable importance in some branches of the national economy.

The first medical experiment Heat Exchange 2 is a continuation of the joint Soviet-Czechoslovak experiment conducted in 1977 on the biological satellite Kosmos 936. The experiment, using an electric dynamic katathermometer for the measurement of skin temperature produced in our country, is designed to study, for example, how the cosmonaut's organism is expending heat in a weightless state, in an environment lacking natural air circulation. These measurements are also being conducted with various degrees of forced circulation. The aim is to insure the physiological level of the expenditure of heat by artificially induced air circulation and changes in the expenditure of heat caused by radiation in order to keep the organism from perspiring. Therefore, the objective of the experiment is to compare the cosmonaut's

subjective feelings and the objective data indicating changes in his skin temperature with the objective expression of microclimatic conditions in the cabin of the spaceship which the above instrument measures.

The instrument consists of an electric dynamic katathermometer developed at the Biophysical Institute of the CSAV in Brno from a numerical thermometer developed at the Research Institute of Sanitary Technology of the national enterprise Chirana in Brno and the six-point temperature recorder developed and built at the Department of Physiology of the Medical School of the J. E. Purkyne University in Brno. The instruments were produced in the developmental workshops of the Czechoslovak Academy of Sciences in Prague, their vibration tests were performed in the authorized testing laboratory of the A.S. Popov Research Institute of Communications Technology, national enterprise Tesla in Prague, and calibration was performed at the Department of Physiology of the Medical School of the J.E. Purkyne University in Brno. Of course, a number of problems had to be resolved by consultation with the Biomedical Institute of the USSR Ministry of Health in Moscow.

The second medical experiment, called the Oxygen Regime, is designed to measure the effect of long-term weightlessness on the oxygen supply of tissues. The measurements, which are performed on the skin of the cosmonaut's left hand forearm, are undertaken before entry into space, during the space flight, and following its completion. The experiment will yield the badly needed answer to the question whether changes in blood circulation occurring during weightlessness have a deleterious effect on the amount of oxygen supplied to tissues. Especially critical is the acute phase of transition from terrestrial gravitation to the state of weightlessness and the readaptation velocity of the cosmonaut's blood circulation after his return to Earth.

A unique instrument, the tissue oximeter, was developed and built to make the measurements possible; the instrument works on the polarograph principle: the reduction of oxygen takes place on a needle electrode-cathode with the current generated proportional to the concentration of dissolved oxygen in the measured environment. The principal institutes which participated in developing and building the instrument were: The medical electronics workshop of the Institute for Clinical and Experimental Medicine in Prague, the Research Institute of Sanitary Technology in Brno, the Research Institute of Medical Bionics in Bratislava, the J. Heyrovsky Institute of Physical Chemistry and Electrochemistry of the CSAV in Prague and the Biophysical Institute of the CSAV in Brno acting as the production coordinator.

The psychological experiment Pruzkum Exploration studies the structure and dynamics of the cosmonaut's actual mental states in the course of flight preparation, during the flight and following its completion. This involves for example the cosmonaut's reaction velocity and readiness, movement coordination, reaction intensity, the quality of the decisionmaking process, the velocity, precision and focus of mental processes etc. The results should lead to the optimization of mental states and their desired control and turning in the course of various space flight stages. The cosmonaut's mental

state and its dynamics are being monitored by various methods based both on physiological and medical as well as psychological data. Also psychological tests are used, obtained for example by means of SVPOS 8 /expansion unknown/ questionnaires. The principal work places participating in this experiment are the Psychiatric Research Institute in Prague and the Research Institute of Aviation Medicine.

The objective of the joint Soviet-Czechoslovak experiment called Chlorella is to determine the effect of weightlessness on the population increase of unicellular green algae of the Chlorella family and of some related families. In this instance the growth of the algae is not stifled; on the contrary, the algae will exhibit active growth for the first time in space. Of course, their growth will simultaneously be monitored on Earth. The algal inoculum is added to a nutrient medium on board the spaceship and following termination of the flight part of the algae is preserved for detailed examination, part is allowed to grow for further study. Important in the experiment is the growth velocity measurement and the behavior of various algal populations since several generations will grow during the period of weightlessness.

Cooperating in the experiment are scientists from the Biomedical Research Institute of the USSR Ministry of Health, the Institute of Molecular Biology and Genetics of the USSR Academy of Sciences who designed and built the cultivation instrument and worked out the scheme of the experiment, staff members of the Institute for Microbiology, the Institute for Experimental Botany and the Botanical Institute of the CSAV and the Department of Botany of the College of Natural Sciences of Charles University who were especially helpful in selecting the algal strains.

Two space technology experiments which place Czechoslovak scientists into the forefront of this latest technology have to do with the study of the growth of crystals.

The experiment Morava-Splav deals with the solidification of the eutectic state of the silver-lead chloride and the copper-lead chloride systems which exhibit unusual acoustic, elasto-optical and optical characteristics. The resulting substances will be tested in the construction of specialized instruments for industrial and other practical applications. The experiments were prepared by the Institute of Physics of Solid Substances of the CSAV in cooperation especially with the Space Research Institute of the USSR Academy of Sciences.

The last, visual, experiment Star Extinction, conceived at the Astronomical Institute of the CSAV, is designed to increase the exactitude of measurement in future flights. It concerns the observation and timing of the setting of stars below the horizon of the Earth and therefore the altitude above the Earth's surface when the light of the star suddenly dims, brightens or changes color or begins to quiver strongly. The objective of the measurement is to determine the altitude and number of dust strata primarily of meteoric origin in the upper atmosphere.

All the experiments were prepared in an exceptionally short time: the building of the instruments, the elaboration of the methods, the compilation of base data, all that is the collective work of many teams of workers, technicians and scientists.

We would not have succeeded without the enthusiasm, dedication, experience, erudition and the awareness of the political importance of the first joint flight by a Soviet and Czechoslovak cosmonaut of all male and female comrades who participated in this work. They worked after working hours, on Saturdays and Sundays, mobilized all their strength and resources of their work places in order to succeed with honor.

The experiments conducted by our cosmonaut on board the orbital station Saljut 6 are the visible result of the first stage of the work of dozens of collectives whose members--even though their names will mostly remain anonymous--can be justly proud of their accomplishments.

CSSR Geophysical Institute's Contribution

Prague RUDE PRAVO in Czech 7 Mar 78 p 3

/Article by Eng Pavel Triska, CSc., head of the Ionospheric Department of the Institute of Geophysics of the CSAV: "Space and Earth Physics"/

/Text/ For more than 10 years now the Institute of Geophysics has been participating in the multilateral cooperation of the academies of sciences of socialist countries in the peaceful use of space within the framework of the INTERKOSMOS program. We have participated in the measuring and processing of telemetric data from the Soviet geophysical satellites Kosmos 261 and Kosmos 348 already before the launching of the first satellites of the Interkosmos series.

The study of the Earth as a planet and of its closest surroundings in space and of course also the study of the effects of the sun and other space factors affecting the Earth are among the principal objectives of geophysics. Before the space era we had to rely on research tools available at geophysical observatories on Earth and on theories about physical processes taking place in close proximity of the Earth's body, especially in the upper atmosphere.

It is obvious that the tools used in space research--high altitude rockets, satellites and interplanetary space probes--constitute a qualitative change in a number of scientific disciplines.

Today, in a whole number of specialized geophysical disciplines further progress is unthinkable without the use of space technology methods. Therefore, we are exploiting all the possibilities which the Interkosmos program offers. Our instruments for the study of the upper atmosphere of the Earth and of geophysical phenomena occurring in the ionosphere and the magnetosphere have performed successfully already in three geophysical Vertical rockets

and in 9 satellites of the Interkosmos series--Interkosmos 3, 4, 8, 10, 12, 13, 14, 15 and 17. The instruments are still in operation in the last one and also in the satellite Kosmos 900 launched within the framework of the Soviet national space research program in the spring of 1977.

They helped collect new data about electromagnetic fields generated in the close proximity of the Earth and about their connection with streams of charged particles reaching the Earth's atmosphere primarily from the sun, as well as data about the density of the ionized component in the outer ionosphere, its composition, temperature, the manner of propagation of electromagnetic waves in this environment and other geophysical phenomena and parameters which cannot be recorded by instruments from laboratories on Earth but which are important, frequently "vitaly" important, if progress is to be made in the study of our habitat in the wider sense.

Together with the development of research methods the standard of the measuring technique is also rising. The specialized geophysical instruments developed and built in workshops and laboratories of the institute are constantly being perfected.

An important result of the Interkosmos program are not only new geophysical, technological and methodological findings but also new forms of international cooperation between scientific facilities of socialist countries. Team work on international scale and division of labor among the participating institutes and research collectives facilitates the highly efficient utilization of the available means and forces for the common goal. This involves very close cooperation beginning with joint preparation of the research task and ending literally with the last screw on the satellite instrument. Hundreds of workers from various countries of the socialist camp participate directly in the implementation of such a satellite project, beginning with the assignment of the task, the development and testing of the apparatus, the launching of the satellite, the performance of the instruments in the orbiting satellite and ending with the processing and scientific evaluation of the collected data.

Workers of the Geophysical Institute of the CSAV participate in this whole chain of individual work stages to the extent of our current possibilities and primarily in directions which permit the solving of tasks assigned by the state research plan. We participate also in monitoring and processing telemetric data. A satellite telemetering station at the ionospheric observatory Panska Ves in the Ceska Lipa okres was monitoring radio signals and scientific data already from the satellites Interkosmos 2 and 3 during 1969-1970 and subsequently from a whole series of other satellites. This station is currently being modernized for work with the new unified telemetric system Interkosmos which will be operational beginning in 1978.

The joint flight of a Soviet and Czechoslovak cosmonaut, just under way, is the culmination of the Czechoslovak participation in the Interkosmos program. This can be viewed as the hitherto highest expression of appreciation and recognition of Czechoslovak space research. For us and our whole country

this represents a very important step forward not only in research but primarily in the practical utilization of outer space and of space technology tools in a number of scientific disciplines.

Astronautics is part of the research and the peaceful utilization of outer space and today at the same time its most advanced form. It is not necessary to explain in detail the well-known fact that no automat has so far been able to replace man completely. In the future astronautics will undoubtedly become a quite practical branch of human activity just like for instance aeronautics. And it is therefore extremely valuable that we too have the opportunity to acquire experience and new knowledge by our work in space.

It is also an encouragement and new inspiration for all who participate today in space research in the CSSR. We, Czechoslovak geophysicists can also see the future new possibilities of utilizing the results of Earth research acquired with the help of instruments serviced by spaceship crews.

Our institute's plans for the coming period have already been worked out and form part of a plan of cooperation of the Space Physics work group of the Interkosmos program for the Sixth Five-Year Plan. The preparation of our apparatus for two extensive geophysical experiments on Interkosmos satellites of a new generation, the automatic guided orbital stations AVOS: is now in full swing. One is designed to study the Earth's magnetosphere and the other to study and send probes into the ionosphere.

Instruments developed in cooperation with other research facilities in our country, primarily with VUST /Research Institute for Communications Techniques/ Tesla and VZLU /Aeronautical Research and Testing Institute/ Letnany constitute a very important part of the scientific equipment of both these satellites which are a joint project of countries participating in the Interkosmos program. The main phase of work with these satellites awaits us after their launching into their orbital trajectory: keeping up radio communication between our telemetric station at Panska Ves and the satellite several times a day, recording and processing data, evaluating them and participating in the operational control and functioning of satellite instruments.

We are now also preparing research task proposals for the upcoming five-year plan which will be submitted at the annual session of the Space Physics group to be held in 1978 in Prague.

In the near future the practical application of the findings of astronautics and space research in general can be expected to develop much faster than hitherto. In spite of this the physical study of space which introduced the space age and so far always preceded every practical application of the findings of space research and the penetration of man into space will preserve their fundamental importance also in the future.

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INTERNATIONAL AFFAIRS

BRIEFS

PHYSICIANS' COOPERATION--USSR and U.S. artificial heart specialists have arrived in brno. A delegation of the Moscow Institute of the Transplantation of Organs and Tissue, led by the institute's Deputy Director Vladimir Kremnev, and a leading U.S. specialist in artificial heart research, Prof Don Birt Olsen from Salt Lake City. The meeting and exchange of practical experience among well-known world researchers represents a further important progress in biological utilization of artificial heart. /Prague RUDE PRAVO in Czech 14 Apr 78 p 2 AU/

CSO: 2402

CZECHOSLOVAKIA

CONTRIBUTION TO COSMIC RESEARCH DISCUSSED

Interkosmos Secretary's Evaluation

Prague TVORBA in Czech No 7, 15 Feb 78 p 11

[Article] by corresponding member of the Czechoslovak Academy of Sciences [CSAV] Vaclav Bumba, director of the Astronomic Institute of the CSAV, scientific secretary of the Czechoslovak commission Interkosmos: "Our Men in the Exploration of the Cosmos"

[Text] When the first reports appeared in the fifties of the American preparations for launching an artificial earth satellite, we astronomers carefully gathered fragmentary data and dreamed of how astronomy might succeed in throwing light on some of the secrets which man has longed to discover for a long time. This involved, of course, not only puzzles which readers of popular scientific literature and fantastic novels were curious about, i.e. about the other side of the moon, the canals on Mars, etc. We hoped that we would learn about the radiation of the sun and stars, those facts which the earth's atmosphere shields us from and which perhaps contain information not only about unknown states of matter in the universe, but also can give us a more comprehensive picture of the universe as a whole.

I myself was then a witness of the unlimited joy and satisfaction of Soviet citizens at the launching of the first sputnik and also the subsequent satellites during my graduate studies at the Crimean astrophysical observatory of the Academy of Sciences of the USSR. The first point of reference appeared in our dreams. We neared it, of course, first only through passive observation of satellites and their rocket carriers. From these photographs and especially from visual observation, we calculated the dynamics of the changes of their paths and also their primary causes--the composition of matter in the earth and also the shape of the earth. Czechoslovak astronomers and geodesists obtained their first spurs and priority results already in this set of problems.

Then for several years we tried in vain to create the possibilities of placing our own active experiment on the deck of a rocket of one of the first international programs. The magnanimous offer of the Soviet government in 1965 which put at the disposition of the socialist countries its

cosmic technology and also services, the forming of the Czechoslovak commission Interkosmos in 1966, and the formulating of the first joint, real space programs in space physics, space meteorology, space communications, and space biology and medicine during 1967 all first opened the path to the stars for Czechoslovak basic research.

Those scientific fields grasped these opportunities first which were the closest to the cosmonauts' activity and whose tradition and results obtained by classical methods were a sufficient guarantee for new methods of research, as well as giving them credit for partnership in cooperation with comrades from the Soviet Union and also from the other socialist countries.

Already before the launching of the first Interkosmos satellite and our own space experiments, staff members of the Geophysical Institute of the CSAV participated in complex earth-based observations of the ionosphere during the year of the geophysical satellite Kosmos 261--"the friendship sputnik"--in December 1968 and in the first months of 1969. The first Czechoslovak X-ray photometer for the study of the sun and the photometer for the finding of dust layers in the earth's atmosphere, with the help of the observation of sunsets from the deck of a satellite which was launched on 14 October 1969 with the name Interkosmos 1, were also prepared in this period. The staff members of the Astronomical Institute of the CSAV and the Tesla Research Institute for Communications Technology VUST, among other workplaces supplying measuring cosmic radiation, which the Institute of Experimental Physics of the Slovak Academy of Sciences prepared together with the department of electronics and vacuum physics of the mathematical-physical faculty of Charles University, and of a telemetric transmitter for the transmission of the parameters of low frequency signals in cooperation with the CSAV Geophysical Institute and Tesla VUST for the Interkosmos 3 satellite.

Each of these initial phases confronted a different kind of difficulty; new collectives of staff workers from different institutes and institutions were born and cohered; the first consultations of specialists, always from several socialist countries, took place. And each of the teams being formed relied on the experiences and advice of its Soviet partners--the first friendly ties developed which today link the entire complex, flexible, and efficient organization of this exemplary program of socialist integration and cooperation, which is the kind of program that Interkosmos is.

The space experiments of the working group on space physics quickly gained in intensity. Practically every year two Interkosmos satellites were launched. They were the standard small scientific satellites of the first generation. They carried several dozen kilograms of scientific instruments, were equipped either with chemical fuel or with sun batteries, without orientation or with the possibility of orientation by the magnetic pole of the earth or by the sun. They served alternately solar physicists or mostly together geophysicists and physicists studying the earth's ionosphere and magnetosphere and particles of solar origin caught by the magnetosphere.

In all 15 such satellites flew in a circular orbit around the earth. Since last year satellites of a new generation, much larger, orbit on higher and thus also more stable paths. To date, two such automatically directed orbital stations have been launched. We have taken part in the program of all 17 Interkosmos satellites so far. We have also participated in the launching of all six Vertikal rockets taking off so far. Instruments produced by staff workers of the Czechoslovak working group Space Physics have also been launched on several satellites and cosmic probes of the Soviet national program. Special instruments have been produced for the precise tracking of the position of satellites. One example was the laser radio, for the introduction of which onto a worldwide network the staff workers of the faculty of nuclear and physical engineering of the CVUT /Czech Institute of Technology/ have special credit.

A second Czechoslovak working group very active from the beginning was space biology and medicine, which concentrated its work in three basic directions: on the tracing of the influences of the factors of space flight on various physiological indicators of living organisms and also of man, on the tracing of the biological effects of cosmic radiation and the search for preventive protection against it, and on the development of sealed ecological systems. Even though the first space experiments in this group occurred much later--the first biological satellite, Kosmos 690, was not launched until 1974--the results of the work of Czechoslovak space physicians and biologists received recognition above all practical utilization, for instance, in flight and in medicine in general.

Broad international teams of staff workers took part in the experiments on the biological satellites Kosmos 690, 782, and 936, not only from the socialist countries; scientists from France and the USA also participated in them. The Czechoslovak participants played both in the preparation and also in the evaluation of the experiments a very substantial role. During the experiments, various biological objects were subjected for a period of about 20 days to a weightless condition and also to various artificial influences, for instance, to additional radiation. Special de-microbed rats of Czechoslovak breeding were studied immediately upon landing and again 2 or 3 weeks after returning. A part of them was, lastly, during the final experiment on the deck subjected to artificial weight in a special centrifuge on the deck of the satellite, etc. Special medical instruments and methods were constructed for the study of the reaction of the body and also the psyche of the cosmonaut to the conditions of space flight.

The successful fulfillment of all the tasks of this extensive research activity was and is possible only thanks to the immeasurably broad and mutually linked cooperation of many institutes and working places of the CSAV in Brno and Prague, the SAV in Bratislava, the universities and also other institutions of our medical system on one side and the Soviet working places and also institutes of other socialist countries on the other side.

In cosmic meteorology we are, it is true, not participating in measurements on meteorological rocket probes, but daily information on the state of the

cloud cover have been received by our hydrometeorological service from satellites since as early as 1969. It serves not only for the improvement of weather reports but also for the safeguarding of our air connections, including transatlantic ones. Information from satellites on the differentiation of temperatures according to altitude is used in calculating forecasts.

The results of the statistical processing of satellite pictures of cloudiness for a longer period of time are also interesting. They enable us to find different periods in the occurrence of types of clouds, etc. Theoretical works, aimed especially at the investigation of the shape of atmospheric fronts and various factors influencing their development and also progress on the earth's surface, have also brought many new results useful in practice.

The emergence of the Interkosmos program has also enabled the CSSR to utilize the area of space for the purposes of telecommunications links. The bulk of the work of the working group for space communications has concentrated in the seventies primarily on the creation of the Intersputnik international system and organization of space telecommunications. In order that we might actively utilize space communications in practice, in 1971 the government of the CSSR asked the government of the USSR for help and cooperation in the construction of a terrestrial telecommunications station in the CSSR. Its opening took place on 30 April 1974. Since that time we are not only utilizing this newest space technology for the solution of the practical tasks of our national economy, television transmissions in the framework of Intersputnik, etc., but we are also trying theoretically and experimentally to perfect the conditions of space communications. Simultaneously, we are devoting great attention to the theoretical preparation of the first broadcasting of television programs from satellites and increasing the efficiency and transmitting capacity of satellite systems. For this it is, of course, necessary to resolve a number of questions touching on the propagation of radio waves in the area of very high frequencies, ordinarily around the frequency of 12 GHz.

The Czechoslovak commission Interkosmos of the CSAV coordinates the entire breadth of the set of problems of basic research in space in the CSSR. The last two sessions of the representatives of the national coordinating organs had a great significance for us. In the penultimate, which took place in July 1976 in Moscow, the offer of the Soviet government to expand the Interkosmos program to piloted flights was put forward. In December 1976 the first citizen of the CSSR, the Polish People's Republic, and the GDR entered the Gagarin center for the training of cosmonauts in Star Village not far from Moscow. At the session in Ulaanbaator last year, it was announced that the training of all the cosmonauts from the three countries mentioned was proceeding very successfully.

Czechoslovak blue-collar workers, engineers, and scientific workers have acquired during the more than 10 years of the existence of the Interkosmos program a plenitude of experiences. Equipment produced in the CSSR has also

functioned reliably enough that we can say that we are prepared to utilize the new stages of the Interkosmos program--manned flights--in the maximal degree possible.

On the bases built, it will be necessary to create conditions which will enable us to exploit the results acquired for the closer linking of space methods and space technology to the service of our national economy. Even though we shall with the same intensity use satellites for basic research in all the above-mentioned fields and even though it will be possible still longer to apply the results of this research in a similar way directly in practice, nonetheless it is only possible to expect that space methods will perfect themselves most rapidly in fields which permit their direct application in practice.

In 1975, for instance, in the framework of the Interkosmos a new working group emerged that interested itself in the study of the earth, its natural wealth, and its living environment with the help of aerospace methods. This group has been organized in our country also. It is concerned, for example, with questions of the study of the morphological structure of the earth's surface, especially of its plate tectonics and recent movements (they have significance for practical utilization in geology, geophysics, geography, etc.), with the investigation of the moisture of soil, the dynamics of the snow and ice covers, with the investigation of changes of agricultural landscapes, etc. Here, of course, not only questions of basic research are involved. For this reason organizational structures have been prepared which ensure that the results of applied space research can also be transmitted as rapidly as possible into our economic practices.

Several results of space technology can also have the same significance in the future for our national economy. Already experiments which have been carried out during Soviet and American piloted flights and also during the joint Soyuz-Apollo flight have shown that, despite high operational costs, several technological processes taking place in the state of weightlessness, thus in conditions where, for example, convection and also other results of the earth's gravitation do not operate, can have great practical significance. Experiments with the growing of crystals of special materials, the mixing or the separation of materials in solutions, etc., arouse the intense interest of metallurgists, optics experts, drug producers, and also other professionals.

Our participation in world research and utilization of space has a great political significance in that it is one of the fronts of the scientific-technological revolution, a front that in the near future will strongly influence not only our material and technical base but also our culture.

'TRIBUNA' s' Editorial

Prague TRIBUNA in Czech No 7, 15 Feb 78 p 11

/Editorial by Milena Vesela and Martin Repik: "The Cosmic Ambassadors of our Science//

/Text/ In 1965 the Soviet government unselfishly offered its space technology and services to the socialist countries. Among other things, it thereby facilitated the emergence in 1966 of the Czechoslovak commission Interkosmos. Gradually the first joint programs, which also opened to Czechoslovak investigation in the following years the path to knowledge of the cosmos, began to take shape. One of these programs is cooperation in space meteorology.

Whereas research in the field of space physics primarily serves basic knowledge and enters into the practical life of people more or less secondarily (for example, when some apparatus developed for space is used by industry for new machines or medicine for new medical instruments), fields exist for which space is not just the laboratory but the actual workplace. It is nearly a matter of course for us that we can watch color television transmissions from the other side of the globe just as practically daily we see shots from satellites in televised weather forecasts. Space meteorology, communications, and long-distance investigation of the earth have already become firmly settled in space.

Above our planet cross or "stand" a significant number of satellites transmitting to terrestrial stations an inexhaustible multitude of signals, photographs, connecting continents instead of undersea cables.

Cosmic Treefrogs

It seems as if for a long time still we shall jest at the expense of weathermen or shall get angry at them to the extent that their weather forecasts do not work out. Various not, indeed, too well-founded and substantiated assertions that meteorological satellites will make an ironclad certainty out of the probability of weather forecasting have also poured oil on the fire. In this the fact was somehow forgotten that the system of meteorological satellites is far from being perfected yet--and also the fact that as a science meteorology has blank spaces so far in its theoretical knowledge. Meteorologists know the principles and also the main features of the circulation of the earth's atmosphere. Nevertheless, they can predict according to them only when no unforeseen, sharp, and sudden change occurs, about the origin of which they so far can only guess. And so even satellites are only one of the splinters of the great mosaic essential for the weather forecasting service.

At present a worldwide system of geostationary satellites (that is, such as appear to stand above one spot on the earth's surface), designated actually solely for meteorology, is being built. Five satellites manufactured in the Soviet Union, the USA, Japan, and Western Europe are thus supposed to "hang" at an altitude of 36,000 kilometers above selected spots on the earth's equator and uninterruptedly follow the state of the weather around the entire globe. This new system will similarly probably serve as a prototype of a new system of satellites for long-range photography of the earth's surface which are being discussed at the present time in the forum of the scientific-technological and legal subcommittee and committee of the U.N. for the peaceful use of cosmic space.

The center of attention of space meteorology has become, for example, the study of fields of cloudiness according to the data of meteorological satellites; the study of the regime of temperatures at altitudes around 100 kilometers above the earth's surface, with the help of the tracks of meteorites, and in the atmosphere; and the study of the wind regime in the upper layers of the atmosphere with the aid of artificially shining clouds. The construction of scientific measuring equipment and theories of methods for rocket measurements and the development of terrestrial equipment for the reception of data transmitted by satellites are being worked on; altitudinal profiles of temperature, ozone, and water vapor in the atmosphere by means of infrared photography from satellites and so on are being determined.

Our space meteorology, it is true, does not directly participate in satellite experiments, although our experts are intensely concerned with the evaluation of satellite photographs. In this way, for example, they have succeeded in clarifying several questions of the origin, movement, development, and also structure of frontal cyclones, of large mobile air vortices, which has a significant importance precisely for the prediction of weather. Photographs made in both visible and infrared light very well prove themselves also in forecasts determined for the needs of the transatlantic flights of our airplanes.

Faster Than Lightning

The satellite Moyniya 2, which the Czechoslovak terrestrial station of the Intersputnik system has been using since 1974, bears the name of lightning with complete justice. There exists no more advantageous and perfect communication than by means of telecommunications satellites, which today accomplish a lot indeed. To be explicit, we can mention: our viewers would quite certainly not enjoy color television transmissions from great distances, especially from overseas, without telecommunications satellites. This is because classical undersea cables are in this case absolutely useless. Telecommunications satellites, that is to say, among other things permit also radio, telephone, and teletype connections. The Soviet ORBITA system is based on the Molniya satellites, circling the earth every 12 hours. These are connected with almost 70 terrestrial stations. In contrast to this, the Western INTELSAT operates with stationary satellites and connects almost 90 stations. World satellite communication systems are unceasingly developing in a qualitative sense. This was discussed very thoroughly also at the latest (the 28th) Congress of the International Astronautical Federation, held in Prague not long ago. Different systems for the utilization of telecommunications satellites already, for instance, serve frequently for the directing of sea traffic. Telecommunications satellites provide ever greater results, and together with this their mass also grows. They are ever more perfect...

But we are not only interested in how it is possible to utilize telecommunications satellites and what Czechoslovak prospects are in this direction. The Intersputnik system is for us a guarantee that Czechoslovakia will not

remain by the side of world progress. Not in the least because our specialists are actively participating in the development of satellite telecommunications.

They are concerning themselves primarily with the theoretical problems of geostationary telecommunications satellites, both scientific and also legal. They are also concentrating their interest on the principles and technical characteristics of satellite systems for direct television broadcasts. These are all projects that in the very near future will have a far-reaching practical significance. This for because the needs for communication, the transmission of information at the present time are growing literally explosively. Only the most modern technology can satisfy them, among which telecommunications satellite systems decidedly play first fiddle.

The Eyes of the Earth in Space

The working group of the Interkosmos program which is called Long-range Study of the Earth by Aerospace Means is going through boisterous development in our country at the present time. The same is happening in this field everywhere in the world. Aerospace means--although this is not a very pleasant sounding expression, nonetheless, overall it precisely indicates the reality. For long-range photographing of the earth's surface, it is also useful to use, along with satellites, airplanes, helicopters, and finally model aircraft (which is incidentally an original Czechoslovak method, very cheap and well-proven in our conditions). Nevertheless, satellites remain far more significant in this context. Precisely in the combination of photography from satellites aided by aircraft and land observations consists the substance of the majority of advantages of the long-range study of the earth. Only in this way is the obtaining of information also rapid and worthwhile. Photographs from space, made in different areas of the spectrum, regularly encompass a great part of the surface of the earth. At the same time, however, they have a differentiating capability, as we have already mentioned /sic/, up to several meters.

The utilization of photographs from space is very broad. They find use in agriculture, in following the quality of harvests and also attacks of pest cultures and diseases; according to them it is possible to establish even the degree of ripeness of crops, including yields. In forestry it is possible by means of them to monitor the state of growths, their yield--upon occasion even forest fires. Photographs from space are capable of showing even vegetation in hard-access areas. It is possible to calculate from them the quality of soils, estimate the reserves of water in snow and glaciers, determine the waterlogging of soils, water pollution in rivers, lakes, and even oceans. In the seas, the movement of ice floes, concentrations of plankton (on which fishing is dependent), oil pollution, the shape and direction of waves and also oceanic currents also are regularly and very carefully followed by means of them. The methods of long-range study of the earth also have enormous significance for the discovery of mineral resources. During the flight of Salyut 3, for example, 67 deposits of oil

and natural gas in the area of the Caspian Sea and also 84 deposits of water reservoirs in Uzbekistan were ascertained. For comparison: during 60 years of searching by land only 102 such deposits were discovered!

For some years now, satellite photographs have primarily been used in our country for making very precise maps. Projects are just now beginning to diversify in the working group of the Interkosmos program. Nonetheless, even so, it is already apparent that our specialists will participate in all the main integrated programs of this research.

We shall cooperate on the very important problem of the automatic processing of satellite photographs. For it is not a problem for satellites and cameras of spacecraft and also orbiting stations to take thousands and thousands of photographs. It is much harder, however, to select from them then those which are scientifically valuable. Here our mathematicians will find a rich field of endeavor. Our scientific workers are also linked to geological exploration (in the search for deposits of minerals), in geomorphology, geotectonics, and to the study of the newest geological deposits. They will also study soils and natural resources having a connection with agriculture and forestry. With the help of space technology, the development of the study of water resources, through them the determination of the state and dynamics of rivers and water basins, snow covers, the determination of individual components of water equilibrium in our natural environment, and also the safeguarding of reserves of underground water and their mineral composition will also be not less important. The traditional utilization of space technology for mapping will find fertile application primarily in the area of thematic, geological geomorphological mapping, the mapping of vegetation, steppe, forest, and forest-steppe natural communities, cultivated plants, especially in grain regions. With all probability our scientific workers will also participate in the mapping of sea shallows with the use of these photographs in the Caspian and Black Seas, taken in different areas of the light spectrum.

9105
CSO: 2402

COOPERATION WITH DANISH ATOMIC RESEACHERS REPORTED

East Berlin SPEKTRUM in German Vol 9 No 2, Feb 78 p 3

[Unsigned article: "Closer Cooperation with Danish Atomic Researchers"]

[Text] An agreement concerning cooperation in the area of experimental and theoretical nuclear physics was signed on 15 November 1977 between the Niels Bohr Institute [NBI] in Copenhagen and the Rossendorf Central Institute for Nuclear Research [ZfK] of the Academy of Sciences. The traditionally good relations between both institutes entered a new stage by virtue of this agreement.

The NBI bears the name of a man who was decisively involved in determining the physical thinking of our century; recall Bohr's atomic model, the development of quantum mechanics and Bohr's principle of correspondence. Starting with the beginning of the twenties many well-known physicists came to Niels Bohr in order to perfect their training or to exchange scientific results with their colleague and to consult. The NBI developed into a leading international center and the so-called Copenhagen school came into being. Even after the death of Niels Bohr the Institute retained its attractiveness. Today, the international reputation of the Institute is primarily linked with the names Aage Bohr (Niels Bohr's son) and Bent Mottelson. In 1975 they both received the Nobel prize for Physics for the collective model of the nucleus.

Since 1945 the key research concern has been in the area of nuclear physics. Other directions of investigation at the NBI are elementary particle physics, solid state physics and gravitation physics. Every year between 50 and 80 foreign guests work for a rather long period of time (at least 3 months) at the NBI; over 100 scientists come for short stays in order to discuss results, to give lectures and to confer.

Traditionally the NBI has good scientific contacts with the Soviet Union. Cooperation with the USSR Academy of Sciences is contractually controlled. There is also a lively exchange of experience with the United Institute for Nuclear Research in Dubna. In the area of high energy physics the NBI cooperates mainly with the research institute in Geneva, CERN, [European Center for Nuclear Research], which is jointly supported by West-European countries.

The relations of the Rossendorf ZfK of the Academy with the NBI in Copenhagen go back to the beginning of the sixties. After the signing of the Final Act of Helsinki it was possible to intensify the scientific cooperation of countries with varying social orders for their mutual benefit. The present phase of cooperation concentrates on the physics of reactions between heavy ions. This branch of nuclear physics has been rapidly developing since the spadework in the mid-sixties.

Progress in accelerator technology now permits producing with high energy rays of heavy atomic nuclei. When these projectiles collide with other atomic nuclei, the matter of the atomic nucleus in extreme conditions (for example, high temperature and rapid rotation) can be studied. Internationally, the NBI takes a leading role in this area. The Rossendorf ZfK likewise has a good tradition in heavy ion physics, since this area of research has been worked on from the very beginning in close cooperation with Soviet institutes, especially the United Institute for Nuclear Research in Dubna.

In the last 2 years staff workers of the Rossendorf ZfK repeatedly stayed for medium periods of time, members of the NBI went to the ZfK to continue work started. The results of the cooperation were presented in the form of joint publications in international journals and in the lecture by Prof B. Mottelson at this year's international conference on nuclear structure in Tokyo.

The agreement concerning scientific cooperation between the NBI and the ZfK of the Academy of Sciences represents a step forward in the practical realization of the treaty on cultural cooperation between the governments of the GDR and the Kingdom of Denmark. Cooperation in the area of basic research between countries with varying social-economic systems for their mutual benefit is also a contribution of the realization of the Final Act of Helsinki.

12124
CSO: 2302

SELECTION, TRAINING OF HUNGARIAN ASTRONAUTS

Budapest NEPSZABADSAG in Hungarian 22 Mar 78 p 5

[Article by Laszlo Szabo: "How Were the Hungarian Astronaut Candidates Selected?"]

[Text] Two Hungarian astronaut candidates were among those who arrived at the Gagarin Astronaut Training Center in the Soviet Union last week to start training for missions in outer space within the international Interkozmos space research and flight project.

Experts at the Flight-Medical Examination and Research Center in Kecskemet informed us yesterday in detail about the methods used in the selection of the Hungarian candidates.

The Basic Requirements

Soviet scientists, together with veteran astronauts, have developed the basic requirements for space-mission personnel a long time ago. Dr Janos Hideg, colonel of the Medical Corps, told us that the health requirements are the most important selection criteria. In Hungary too, application was voluntary, and supersonic pilots were eligible. A multiple health screening eliminated several dozen volunteers; only a few candidates remained after this.

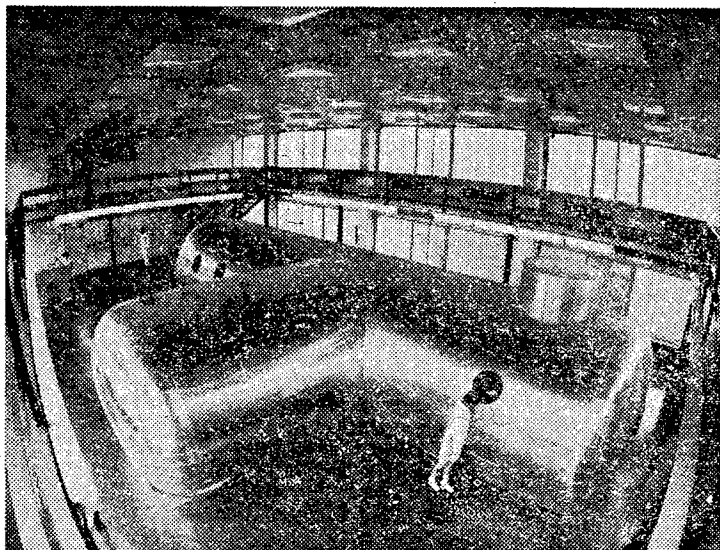
According to Colonel Hideg, head of the committee which selects the Hungarian candidates, "the Soviet and American space experiments demonstrated that only healthy individuals may be launched into outer space, those who are capable of withstanding the great psychological and physiological stresses while retaining their ability to perform their duties and to make scientific observations." "At the institution in Kecskemet, the supersonic pilots must meet very stringent standards, even if they are experienced.

The candidates are examined by many complex instruments. From the results we know those stresses which bear on the humans at altitudes of 18,000 to 20,000 meters. The astronauts are subjected to even greater psychological and physiological stresses. They must withstand very high acceleration, weightlessness, the special conditions required for living and working in outer space, and — of course — the physiological stresses.

In selecting the Hungarian astronaut candidates, special emphasis was placed on the fact that weightlessness temporarily affects all senses significantly, as it does the muscle and bone system. Only the eye remains relatively unaffected. Problems involving the equilibrium organs have so far been the greatest in space flights; all available evidence indicates that this will be the greatest problem in human space flying for the foreseeable future.

Dr Janos Hideg told us that weightlessness conditions can be created on earth only in aircraft and only for very brief periods of time. Yet it is important to be able to evaluate the candidate's tolerance of weightlessness, as well as any effects of this condition, before flight. Today we already have suitable instruments to create those circulatory changes in humans which take place while they are exposed to weightlessness. If people are held for two to three days in the head-down position, at an angle of 12 degrees, these changes will develop. The reason for this is that the needed pressure develops at the lower extremities (a negative pressure) and at the same time there is blood oversupply in the upper part of the body. The associated unpleasant equilibrium disturbances also develop. Studies are in progress — Hungary participates in them — toward the development of drugs which reduce the problems of the equilibrium organs. Colonel Dr Jozsef Szabo mentioned that Astronauts Grechko and Romanenko, who landed recently, withstood the stresses of the 96-day mission very well with the help of these drugs. However, it took them a long time to change back to the terrestrial conditions after an extended period of weightlessness.

During our visit we also learned that Hungarian scientists participate in the solution of various scientific problems within the framework of the Interkozmos program. They take part in the development of various instruments for the relevant studies also. Some of these instruments are already in use today.



The large barometric chamber

The Eye and the Response Time

Among the examination facilities shown was the so-called barometric chamber, which is unique of its kind in Europe. This large structure was originally built for the complex health testing of supersonic pilots; however, it may also be used to examine potential astronauts. It tells us whether they can withstand very high air pressure, dry heat of 120 degrees, sudden changes in pressure, and so forth. The so-called Hilov swing tells us whether they are prone to seasickness.

The supersonic pilots must tolerate one minute of such examination in the special rotating chair; the astronaut candidates must tolerate it for 10 minutes. Very extensive ophthalmological tests must also be performed on the candidates. Dr Laszlo Szekeres, major of the Medical Corps, told us that supersonic pilots acquire 85 percent of the information through their eyes; in the case of astronauts, this percentage is more than 90. This means that a perfect eye is an important prerequisite for an astronaut. Seventy-five percent of all air accidents are caused by deficiencies in the pilot's eyes.

The so-called response times were also carefully evaluated in the candidates. We want to know the time they require to acquire the unexpectedly arriving information and to react to them. Since here we measure fractions of a second, we must use precision instruments. To illustrate the stringency of the requirements, we mention that the astronauts must score 18-20 points, compared to a score of seven for ordinary people.

The young married individuals must also be capable of forcing themselves to be absolutely calm. This is a very important psychological requirement in outer space. The candidates also underwent a detailed personality test. An intelligence test is important in the selection not only because the candidates must learn the complex operation of the complicated spaceship in the 12-18 month training period but also because they must become proficient in many other disciplines. We mention in passing that perfect command of the Russian language is an important requirement for our astronaut candidates, as well as the astronaut candidates from other socialist countries.

Within the framework of the personality tests, so-called temperament tests were also carried out. Our candidates must score high here too: they must be able to regulate their emotional life, must have fast reactions, and be very active. In the character tests, the physicians and psychologists evaluated the moral level and the willpower of the candidates, and they also assessed their dedication.

It is evident from all the foregoing that from among the many volunteer astronauts only a few remained in the running. There were two. The Hungarian candidates, same as other future astronauts, faced a 40-member scientific committee in the Soviet Union. The committee, made up of renowned physicians, psychologists, veteran spacemen, and other experts, judged both our candidates fit for training in the many practical and theoretical matters required for an actual mission in outer space.

There is No First Nor Second

We were told at the institute in Kecskemet that there is no first candidate nor a second candidate! Who will fly and who will be the backup man is really decided only a few weeks before the space mission, after all examinations have been absolved. During the press information session the question was asked why the actual crew is only identified in the last minute. The answer was this: the reason is precisely the best interests of the astronaut candidates. Their training period is so long, and so much may happen to their health that the anonymity must definitively be upheld until just before the flight time. Of course, the publicity and the curiosity of the general public could interfere with their quiet training work if the decision were known much beforehand.

The Hungarian experts showed those special foods which are used to provide subsistence to the astronauts in flight. They are no longer foods squeezed out of a tube. Today, more than 80 different kinds of food are

carried for the menu of the astronauts. Grechko and Romanenko already ate hot foods during the last long space mission. Possibly, the Hungarian astronauts will also take up dishes from the Hungarian cuisine. We participate in studies on space menus. Dr Janos Hideg, colonel of the Medical Corps, also told us that the appetite in outer space is much reduced. Perhaps this is one reason why they all prefer highly spiced foods. But as a result of weightlessness, thirst is much decreased. The astronauts must practically be ordered to take liquids. This is the reason why refreshing soft drinks are issued.

More than 100 people participated in the selection and domestic preparation of the two Hungarian astronaut candidates. The families of the candidates accompanied them to the training site. They were welcomed by Astronaut Leonov.

2542

CSO: 2502

HUNGARY

HUNGARIAN ASTRONAUT CANDIDATES IN MOSCOW

Budapest MAGYAR HIRLAP in Hungarian 22 Mar 78 p 4

[Article: "From Kecskemet to Star City. Hungarian Astronaut Candidates in Moscow."]

[Text] From our correspondent.

As we reported previously, the Hungarian astronaut candidates arrived in Moscow a few days ago.

At the place of their preparation and selection, in Kecskemet, at the Aviation Medicine Testing and Research Institute of the People's Republic of Hungary, a press conference was held yesterday, where we were informed about their reception by Leonov, Bergovoi and Filipchenko and their moving into three-room apartments on the 12th floor of a brand new 16-story building. The Soviet astronauts celebrated their "conquest" and they drank to hard work and success with their future Hungarian colleagues. The next day Leonov informed them of the program and they started on the work immediately.

We found this out from Dr Col Jozsef Szabo, first deputy chief of aviation of the Hungarian People's Army, who has accompanied the candidates to the Soviet training center in his capacity as the "father of Hungarian astronauts."

He recalled that the program started with the joint space exploration treaty signed in 1965, called Intercosmos, and within the framework of this treaty the Soviet Union proposed, in July 1976, the participation of astronauts from socialist countries in space exploration.

Our "public enemy number one" was the doctor, who found out about all of our problems. The most important factor in the selection was the candidate's state of health: this factor was preceded in importance only by that of being a volunteer. There was no lack of volunteers, however. The third factor was human and moral maturity. We wanted to be able to look up to the one who will be selected within 12-15 months, in Star City, to be the first Hungarian astronaut.

The system of health qualification tests and the principles and requirements relating to the medical suitability of the candidates were described by Dr Janos Hideg, medical colonel, chief of aviation medicine of the Hungarian People's Army.

He said that they followed a beaten path and were guided by the 20-year experience of their Soviet colleagues. The increased psychological and physical load is not unknown to supersonic fighter pilots, but the candidates were subjected to one week of load tests followed by another week of specialized clinical examination, and their resistance to stress effects was measured and classified. What are these? First of all, nervous and emotional effects of acceleration, weightlessness, cosmic radiation and the artificial environment, and last but not least, habits of life and work.

The questions of the doctors were answered by incorruptible instruments; in the ideal case, the body of a pilot with the training of an engineer would have been found most suitable, but it happened otherwise. However, the training of fighter pilots is sufficient to enable them to acquire the theoretical knowledge necessary for becoming an astronaut. The chief Soviet commission of space medicine was satisfied with the candidates of the Hungarian doctors, and the most suitable ones among them were selected on the basis of Soviet proposals. Among this is the first Hungarian astronaut.

9164

CSO: 2502

STATUS OF NUCLEAR POWER RESEARCH, PERSPECTIVES

Budapest MAGYAR TUDOMANY in Hungarian No 12, 1977 pp 893-907

[Article by Denes Berenyi, corresponding academician, director of the Nuclear Research Institute of the Hungarian Academy of Sciences]

[Excerpts] As a result of the fact that the resource of natural fissionable material (uranium-235) is very limited, so that it will be soon exhausted unless replenished by new production, economic operation of facilities aimed at the utilization of the fission energy can be assured only by a complex system which breeds new fissionable material. Intensive efforts are underway everywhere in the world toward the development of fast breeder reactors, and there can be no doubt that these efforts will one day bear fruit.

However, the technological feasibility is not enough. We know very well that there are views which claim that such energy-producing systems should not be built, especially not at a large number of locations, because of the hazards inherent in the fast breeder reactors and the fuel-reprocessing plants. Those holding these views do have a point; however, if it is a fact that fission-based energetics are necessary to meet the increasing energy needs of mankind (it appears that these needs will reach a plateau eventually), then it will be necessary to concentrate the efforts toward establishing a maximum-safe system, at very high cost if need be.

But it seems that there is also another alternative, which is much more appealing, namely the development of a technology which utilizes a new source of energy: nuclear fusion. About this I say only here that the promise of a fusion-based energy generation system does not mean that we no longer need to develop fast-breeder energetic reactors or to perfect the already commonplace light-water reactors. Obviously, the proper strategy is to carry on with the research aimed at making the widespread thermal reactors more

economical to build and operate, and at making the fast reactors capable of producing energy and fissionable material in a safe manner.

Hungary can assume only a small part of this major effort, and this part must be closely related to the international research program covering the development of nuclear power plants of the kind now being built in the country. This international research program was set up under the initiative of the Soviet Union and with support from the Permanent Nuclear Energy Committee of the CEMA. If we take a quick look at Table II, which shows the expected development of the energy needs of Hungary and the increasing role of nuclear energy in this development, then we see that nuclear power plants will account for 28 percent of all power generated in the country in 1990. This percentage will increase to approximately 50 percent in 2000. This means that during the next 20-25 years the structure of the domestic energy industry will change radically. This change can be achieved only on the basis of international division of labor, primarily a scientific, technical, and industrial cooperation scheme established with the Soviet Union. It is therefore obvious that all domestic research, development, and industrial efforts must be geared toward the accomplishment of this goal.

It follows from the foregoing that Hungarian research activities must, on the one hand, ensure the required background for the systematic and logical development of the domestic nuclear-energy industry by exploring the factors involved for best results; on the other hand, they must contribute toward the realization of the long-range development concepts of the socialist countries.

It was with this goal in mind that the Hungarian Academy of Sciences has decided to make nuclear-energy studies being carried out in its institutions a ministry-level featured activity in 1976. The research program of the featured activity meets realistic needs and is in line with domestic potentialities. It is based on accomplishments already completed and on the possibilities of international division of labor. It is of interest to quote the major research tasks of the featured activity:

- Design and operation of energetic reactors, especially the determination and evaluation of the nuclear-physical data (such as effective cross sections, fission parameters, resonance parameters, and so forth) related to this;
- Development of nuclear-physical detecting methods further, with special emphasis on nuclear-energetic applications such as burnup measurements, nuclear safety, radiation protection, materials testing, and so forth;

Table 2. The energy needs of Hungary between
1950 and 2000

| | 1950 | 1975 | 1980 | 1990 | 2000 |
|--|------|-------|-------|--------|--------|
| Total annual energy consumption in 10^{12} kcal units | 63.5 | 260.0 | 323.0 | 473.0 | 660.0 |
| Percentage of electric energy of the total annual consumption | 21.1 | 29.6 | 33.0 | 43.0 | 58.0 |
| Annual electric energy require- ment in 10^6 MWhr units | 3.1 | 24.6 | 35.0 | 70.0 | 135.0 |
| Capacity of the power plant system in MW(e) units | 690 | 4,450 | 5.980 | 13,000 | 26,000 |

Percentage distribution of the
power plant system according
to fuel types

| | | | | | |
|-------------|------|------|------|------|------|
| Coal | 98.9 | 52.0 | 37.6 | 38.0 | 31.5 |
| Hydrocarbon | | 42.6 | 50.8 | 25.0 | 13.0 |
| Nuclear | | | 7.3 | 28.0 | 48.0 |
| Other | 1.1 | 5.4 | 4.3 | 9.0 | 7.5 |

- Development of an experimentally verified computation method, based on the latest nuclear information, for the optimized and safe operation of pressurized water nuclear power plants;
- Investigation of the static and transient heat-transfer and flow processes (called the thermohydraulic processes) in the zones of the pressurized water nuclear power plants for the optimum utilization of the thermal energy, and for the forecasting and localization of malfunction states;
- Investigation of the dynamic behavior of the reactor zone in malfunction states, theoretical and experimental studies on methods used for the detection of malfunction states, and establishing the fundamentals of the so-called power-plant reactor diagnostics;
- Investigation of the factors determining personal radiation exposure and the spreading of emitted radioactive isotopes in living and non-living bodies; development of sensitive and selective methods to monitor the radiation exposure of live organisms;

- Development of the computerized control system of nuclear power plants, including high-reliability measuring systems, data teleacquisition and data teleprocessing systems, process control systems, and so forth;
- Development of methods for determining the composition and burnup level of fuel elements, and for examining radiation-exposed structural, lubricating, and cooling materials.

Of course, the nuclear-energy studies outlined in the featured activity are closely related to the construction and operation tasks of the domestic pressurized water nuclear power plant units. As a result, a close cooperation was established with the Ministry of Heavy Industry and its basic institutions. Another important requirement is to establish a fruitful cooperation among the institutions, enterprises, and relevant research institutes involved in the domestic production of individual units of the Hungarian nuclear power plant system. Only modest achievements can be reported so far in this area. Some projects of the featured activity are related to the target program of environmental protection, as well as the featured activities on "protection of man and the biosphere" and "the biosphere requirements of man."

In order to accomplish the goals of the featured activity we must have a broad and effective international cooperation. We have a working relationship since many years with two major Soviet institutions working in the same field: the Kurchatov Nuclear Energy Institute and the Institute of Physical Energetics in Obninsk. This relationship has already resulted in many achievements. In 1972, at Soviet initiative and within the spirit of socialist integration, we concluded an intergovernmental agreement for the establishment of a temporary international research team working on the development of pressurized water nuclear power plants and some tasks associated with this goal. This team was accommodated in the Central Research Institute for Physics, where the required scientific background and metrological expertise was available. Since the beginning, seven socialist countries participated in this team; Cuba has joined recently. It should also be mentioned that as a result of the successful work a new intergovernmental agreement was concluded in 1977 to extend the life of the team by another five years. Experiences indicate that this form of international cooperation is very effective since it permits the rapid solution of problems assigned to the team by joint effort. It also ensures that each participating party obtains the results of the team for utilization in its own country.

Increasing financial and intellectual resources are assigned to these efforts because we have the realistic expectation that fusion reactors may play an important role in energy supply in the near future. Soviet and American sources agree in forecasting the steps toward the development of fusion reactors: realization of conditions close to those prevailing in the reactors between 1975 and 1980 in hydrogen plasma; experimental fusion reactor with a positive energy balance between 1980 and 1985; a reactor with the power of 20-50 MW(e) between 1985 and 1990; a power plant reactor with the power of 100 MW(e) between 1990 and 1995; and an even more powerful reactor (more than 500 MW(e)) after 1995. In the 200-2020 period, the fusion reactors are expected to be major factors in energy production.

The quarter century ahead may be used, and should be used, to develop a cadre of specialists capable of performing the work related to the new techniques of thermonuclear power plants. This basic goal can be accomplished by international cooperation: Hungarian researchers are already participating in solving some specific problems in assigned projects.

The history of reactor research gives us useful and instructive information about the volume, potentialities, and goals of domestic thermonuclear studies, since it permits us to make comparisons. The training of specialists has started in the Soviet Union even before the research reactor was started up. Later, various research projects were completed on the basis of bilateral agreements concluded with the Kurchatov Nuclear Energy Institute and the Institute of Physical Energetics in Obninsk. The Hungarian researchers have solved some important part problems independently within the framework of international cooperation. As a result of this cooperative effort, a highly skilled researcher team was created in Hungary which obtained international fame on the basis of its own achievements. The successful bilateral cooperation later evolved into a multilateral cooperation within CEMA.

Cooperation has now started between Kurchatov Nuclear Energy Institute and the Central Research Institute for Physics in the field of thermonuclear studies also, as a result of favorable experiences in the above projects. The high metrological and computer-technological background established in the Central Research Institute for Physics, as well as the use of the instruments and systems developed there, represented a major step forward for the Soviet researchers in the field of thermonuclear studies. At the same time, the Hungarian experts obtained an opportunity to become familiar with Soviet scientific accomplishments, and were able to join the studies in some part subject areas. I desire to review briefly the tasks involved in these part subject areas.

Supraconducting magnets will play an important role in the next generation of thermonuclear fusion devices (as well as in many other areas of science and technology). Domestic development of some electronic units needed for supraconducting magnets has already started earlier, and the units developed are used with success in the Soviet Union. In this area it is desirable to further strengthen domestic research and manufacturing activities.

Another promising development is the participation of Hungary in the further development of methods and techniques for plasma studies on the basis of already available experiences in this field. Experiences available in the fields of nuclear physics, development and operation of accelerators, laser physics, chemistry, and so forth may be used with advantage toward the realization of the goals of the joint program.

Theoretical plasma-physical studies are carried out not only in the KFKI but also in other institutions. It is advisable to orient theoretical studies now started on the basis of individual initiative toward the solution of specific plasma-physical problems in the future.

Nuclear-physical measurements being carried out at the Institute of Experimental Physics of Kossuth Lajos University of Sciences in Debrecen are also related to the design of fusion power plants; they are aimed at the determination and refinement of fundamental data.

Knowledge about nuclear physics and solid-state physics, as well as experiences in these areas, at the KFKI and the Nuclear Research Institute of the MTA enable us to take part in the studies of the plasma-wall interaction. The so-called "backscatter" technique adopted at the KFKI permits us the examination of the structure of surfaces which have interacted with the hot plasma. We are capable of investigating internal ionization processes taking place in the structural materials of the fusion reactor at the ATOMKI. By studying the X-ray radiation emitted after irradiation with electrons, protons, alpha particles, or heavy ions in the cascade and Van de Graaff accelerator we may determine some yet unknown effective cross sections. It is an attractive fact that there is a need not only for data collection but also for the solution of theoretical problems.

The successful realization of joint Soviet-Hungarian studies is helped by the Kurchatov Nuclear Energy Institute by presenting the Central Research Institute for Physics a small, easy-to-operate Tokamak-type thermonuclear test device (TT-3). The TT-3 is a modern device; it may be used to evaluate measuring and diagnostic methods, and devices which will be later used in

the large-scale facilities of the Kurchatov Nuclear Energy Institute. The TT-3 offers an opportunity for the investigation of small details of plasma-physical processes so as to achieve new scientific accomplishments.

A domestic start of thermonuclear studies is an approved feature of the Fifth Five-Year Plan. The most important tasks have been formulated for the main research theme of nuclear energy research of the MTA.

After all this discussion, we may raise the following question with good justification: Do we already have the lasers of adequate power and performance needed for nuclear fusion studies? If we review the high-power lasers available today from this angle, we must regretfully answer that the lasers we have do not meet the needs. I do not wish to discuss here the relevant matters concerning laser physics and technology; all I wish to state is that the development of a laser source with an energy of 5,000 joules is not an impossibility. This would permit us to perform many needed important experiments. One thing is certain: realization of energy production based on laser fusion requires much time as well as complex and expensive research/development effort.

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CSO: 2502

HUNGARY

NUCLEAR PHYSICS RESEARCH TO PROMOTE POWER PRODUCTION

Budapest MAGYAR TUDOMANY in Hungarian No 12, 1977 pp 924-934

[Article by Denes Berenyi, corresponding academician, director of Nuclear Research Institute of the Hungarian Academy of Sciences]

[Excerpts] Domestic Efforts and Potentialities

The initiatives and accomplishments of the KFKI [Central Physics Research Institute, Hungarian Academy of Sciences] in the field of the utilization of nuclear energy are well known. The studies carried out at the Department of Experimental Physics of Kossuth Lajos Academy of Sciences, primarily in the field of measuring the effective neutron cross section, are also known.

Below I desire to discuss mainly the achievements and potentialities of the ATOMKI [Nuclear Research Institute], with the domestic problems of the utilization of nuclear energy in Hungary in mind.

First of all, the achievements in the field of uranium raw material research must be mentioned. Academician Szalay contributed significantly to this matter. In a country not endowed with energy resources, such as Hungary, these studies are vital (we intend to publish this study, and related matters, in the January 1978 issue of MAGYAR TUDOMANY).

Accomplishments of the ATOMKI

There are three areas in which noteworthy achievements were made in connection with the utilization of nuclear energy.

One is the monitoring of the ^{85}Kr content of the air. This isotope becomes increasingly abundant in the atmosphere as a result of atomic bomb explosions and of peaceful uses involving the operation of reprocessing plants.

Eva Csongor of the ATOMKI regularly measures the ^{85}Kr content of the atmosphere since many years in cooperation with the Krypton Factory in Miskolc (see the article of Eva Csongor in FIZIKAI SZEMLE, Vol 20, 1970, p 249). As Fig. 1 indicates, the rate of increase of the ^{85}Kr concentration decelerated significantly in recent years. One of the reasons for this is the fact that such measurements pointed out the hazard, and that special attention is given to the retention of the ^{85}Kr in reprocessing operations. It may be mentioned in this connection that our institute is the CEMA coordinator of this subject and the measurements made.

I also desire to mention in passing that the radioactivity of precipitation is measured since 1952 in Debrecen (see the paper of E. Scherf and Gy. Meszner in ATOMKI KOZLEMENYEK, Vol 2, 1960, p 109). But this project is primarily of interest in connection with the observation of the effects of nuclear explosions. Studies have also been carried out in the general examination of natural waters and the atmosphere for radioactivity (see the paper of A. Menes and D. Berenyi in ACTA PHYSICA ACADEMIAE SCIENTIARUM HUNGARICAE, Vol 36, 1974, p 179).

The importance of these studies in connection with the utilization of nuclear energy and environmental radiation protection is obvious.

Another area in which noteworthy studies have been carried out is in the solution of problems related to energy generation by nuclear fusion. So-called internal ionization processes (such as plasma-wall interactions) assume prominence in future fusion reactors and in present experimental setups. High-energy electrons, protons, ionized nuclei, and the like, emit electrons from the inner shells of other atoms (for example the atoms of the wall of the vessel surrounding the plasma). Filling of the vacancies generated in this process is followed by the emission of X-ray radiation.

Without going into detail, I present two sets of measurements from our latest work (Figs. 2 and 3). One of the measurements was made with the Institute's 5 MV Van de Graaff generator with alpha bombardment; the other, with an 800 kV cascade generator with electron bombardment (see the paper of E. Koltai, D. Berenyi, I. Kiss, S. Ricz, G. Hock, and J. Bacso in Z. PHYSIK, 1976, p. 299, and by B. Schlenk, D. Berenyi, S. Ricz, A. Valek, and G. Hock in J. PHYS. B: ATOM. MOLEC. PHYS, Vol 10, 1977, p 1903). The diagrams show the changes in the effective cross section (probability of the occurrence of the above-mentioned internal ionization process) as a function of the bombarding particle's energy). The results available already indicate that they fill a gap which exists presently in the world literature, especially insofar as the electrons are concerned.

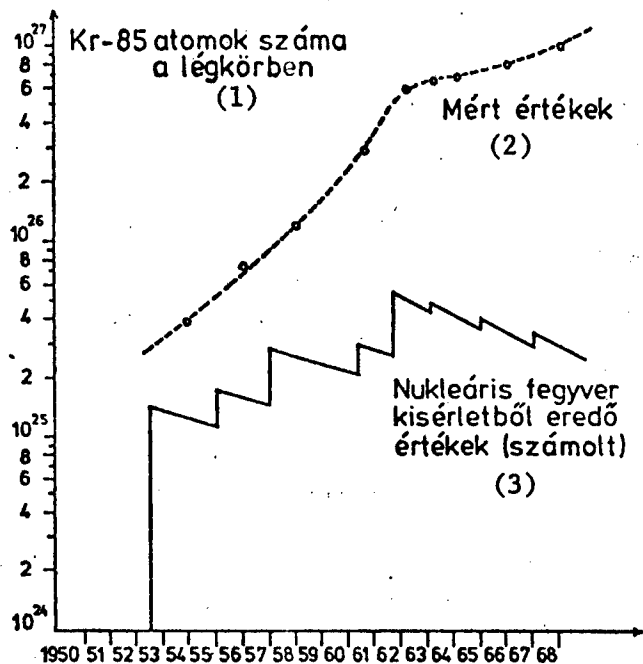


Fig. 1. Changes in the ^{85}Kr content of the air over the years

Key: 1 = Number of ^{85}Kr atoms in the atmosphere
 2 = Measured values
 3 = Attributable to nuclear weapon experiments (calculated values)

It should be noted that these measurements are carried out under an agreement concluded with the International Atomic Energy Agency in Vienna, specifically within the framework of the fusion research program of this institution. Ultimately, they are parts of the Hungarian program initiated by the KFKI (described by Pal Lenard in his paper).

The third subject worth mentioning is dosimetry. Laszlo Medveczky and Gyorgy Somogyi made significant contributions in the field of the use of photo-emulsion and solid-state trace detector types in dosimetry, specifically neutron dosimetry (see the paper of L. Medveczky in IZOTOPTECHNIKA, Vol 19, 1976, p 348). These results and experiences find direct use in the setting up of the dosimetric service in the nuclear power plant at Paks.

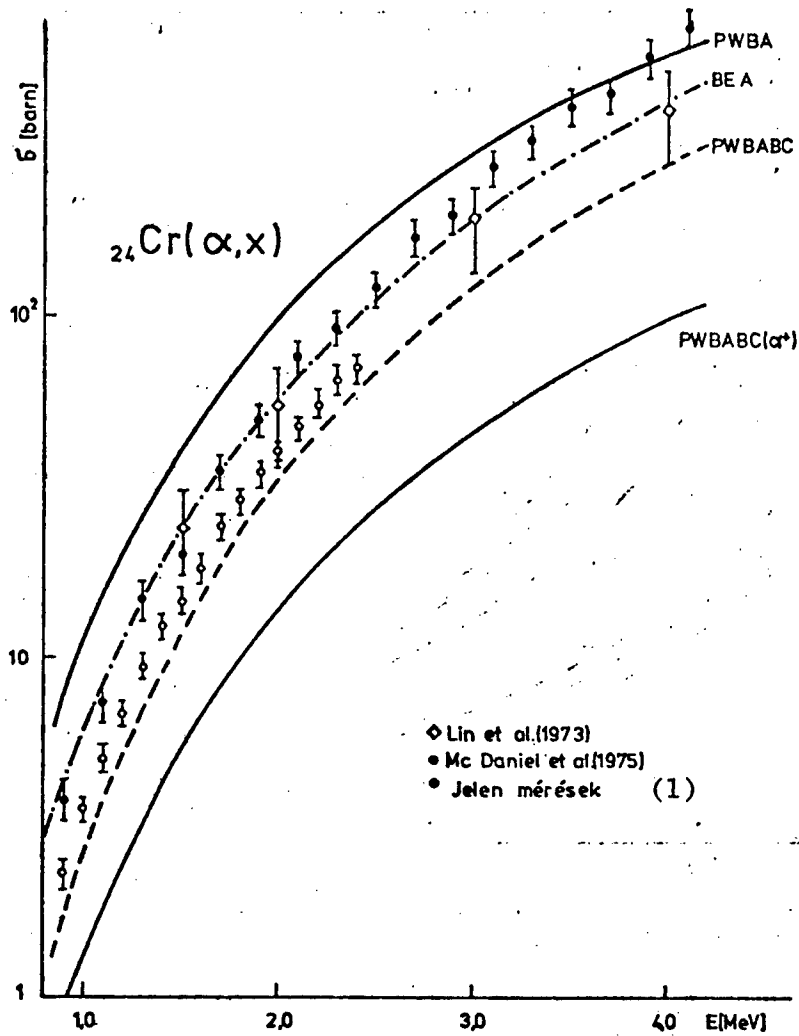


Fig. 2. X-ray radiation of the K type is emitted if a chromium target is bombarded with alpha particles. This diagram shows the changes in the effective cross section of the process as a function of the bombardment energy

Key: 1 = Current measurements

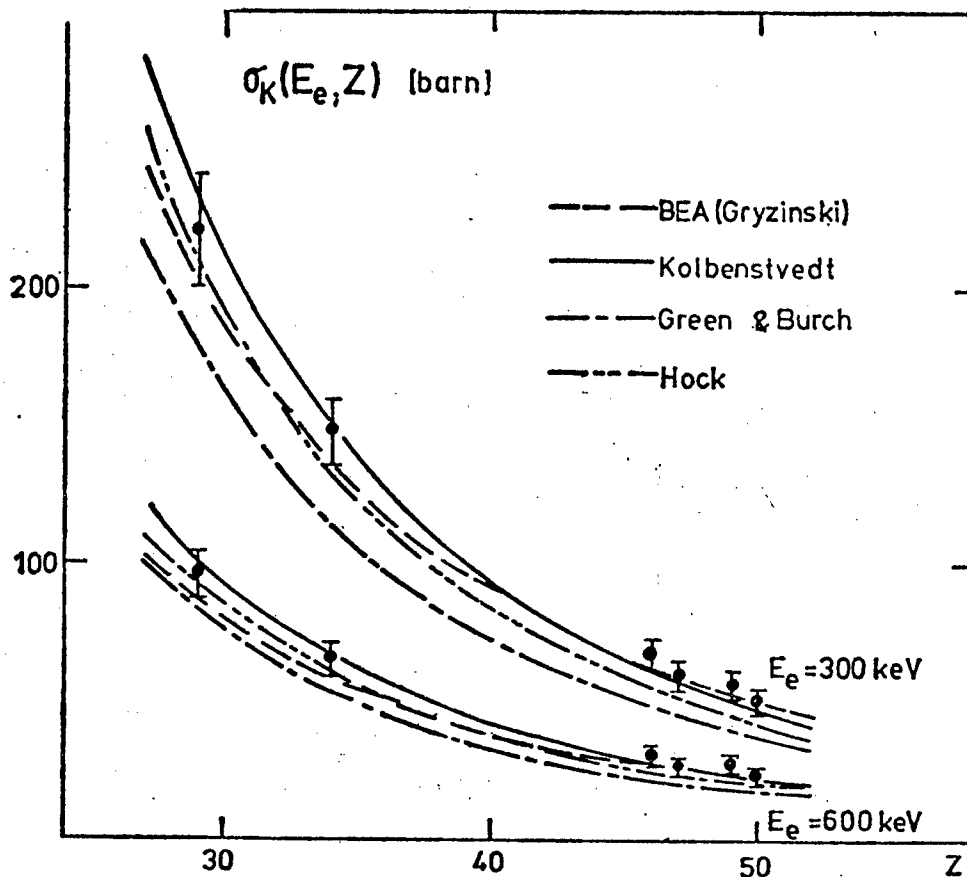


Fig. 3. Effective cross section of the K X-ray radiation process triggered by electron bombardment (in the cascade generator) as a function of the atomic number of the steel material

Additional Potentialities

In addition to the achievements directly related to the utilization of nuclear energy, we also accumulated experience in a number of areas which, if properly pursued, could contribute to the utilization of nuclear energy in Hungary. I shall below briefly mention them,

The study of surfaces is very important both in fission-type and fusion-type reactors, as is the study of corrosion-caused and other changes on various surfaces of the reactor components. In this connection, significant contribution is made to the subject by the utilization of our achievements

in the field of photoelectron spectroscopy (ESCA-XPS)* The method may be used specifically for the study of problems related to observations on reactor surfaces. It should be noted also that the photoelectron spectroscopy method is a very sensitive means for measuring the contamination of solutions (with appropriate auxiliary techniques).

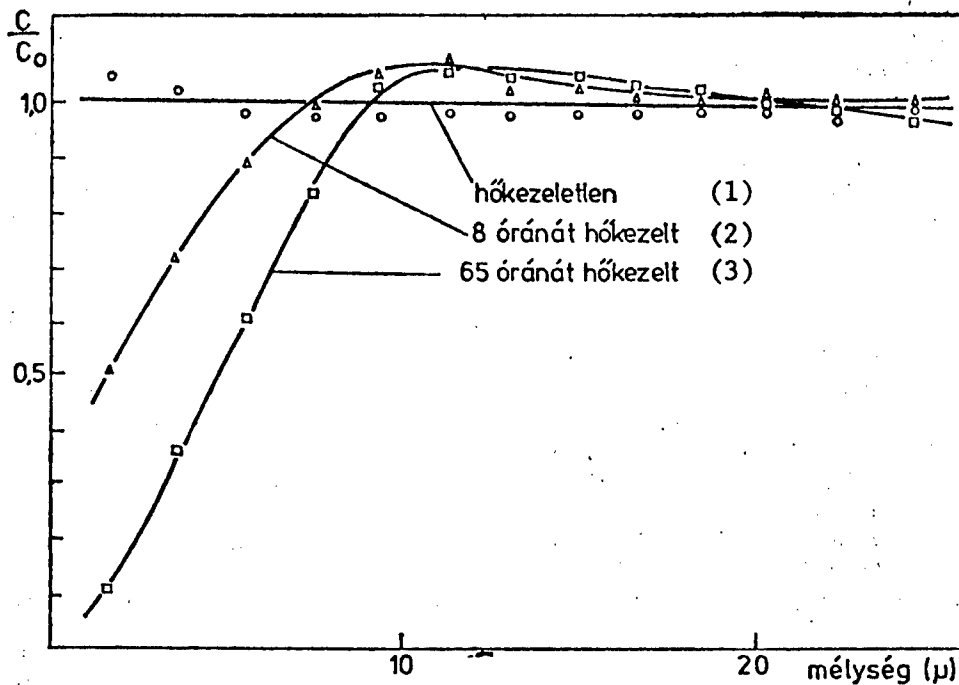


Fig. 4. Distribution of Zn concentration over the surface of an Al sample as a function of the depth from the surface. The parameter is the duration of heat treatment. The distributions were plotted with the aid of the (p,x) process in the beam of the Van de Graaff generator

Key: 1 = Not heat-treated
 2 = Heat-treated for 8 hours
 3 = Heat-treated for 65 hours

* D. Varga, D. Kadar, A. Kover, and L. Kover: scheduled for publication; L. Kover, D. Varga, Cs. Ujhelyi, J. Miller, A. Kover, and D. Berenyi: scheduled for publication; D. Berenyi: "Metal Labeling"; Round-Table Discussion, edited by J. Lelszerfalvy and F. Kedves, Debrecen, 1975, p 9.

The achievements concerning the determination of the concentration profiles which form near the surface (J. Vegh, D. Berenyi, E. Koltay, J. Kiss, L. Sarkadi: SURFACE SCIENCE, in press) also contribute to our knowledge of surface phenomena. By using this method, we irradiate the sample with protons of various energies and/or alpha particles in a Van de Graaff generator and measure the emerging X-ray radiation. In Fig. 4, I show the results obtained in Al samples for the distribution of the Zn concentration near the surface (at a depth of 30 μ) as a function of heat treatment.

In the field of X-ray fluorescence analysis we have the outstanding achievements of Janos Bacso and his team; in the field of solid-state trace detectors techniques those of Gyorgy Somogyi and his team. These achievements and the experiences we have gained indicate definitively that the methods may be used in the determination of the burnup level of reactor fuel elements (they are already used in uranium research projects). Also, use may be made of this field in several Hungarian institutions, including the ATOMKI, for the analysis of gamma spectra on the basis of already existing instrumental and computer-technology knowledge.

Finally, I should mention the fact that we have several methods available in Hungary for examining material purity — which is highly important in reactor technology — by means of trace-analytical techniques. We also have basic data which permit us the development of additional such methods. The methods include various versions of activation analysis (including activation analysis involving irradiation with charged particles from the existing accelerators and from the cyclotron to be built), X-ray fluorescence analysis (which we already mentioned), resistance measurements at the temperature of liquid He, and so forth.

What Next?

We must, no doubt, solve many more problems and accomplish many more tasks which we are obligated to do even if we purchase a complete nuclear power plant.

For example, we must still solve the problem concerning the measurement of the burnup level. In this area it is not sufficient to simply take over an already developed method since the methods constantly undergo updating and perfection. Yet, the extent to which we allow our fuel elements to burn up is a very important matter in terms of its economic ramifications. Or let us mention personal dosimetry, environmental protection, and so forth: these are all matters for which we might purchase formulas and instruments from abroad, but this would be more expensive than using domestic experience.

The importance of the research tasks is even more understood if we consider the following factors: Today, at a time of power shortage, when it is very difficult to buy nuclear power plants on the market, we cannot expect the Soviet Union to perform all the studies needed to develop nuclear power plants. For example, Hungarian institutions were recently asked a question concerning the reprocessing of burned-up fuel. The Khlopin Radium Institute in Leningrad proposed 11 items for joint research. Obviously, full CEMA cooperative efforts are needed over the entire subject area of nuclear energy utilization, and we must find our place in this joint endeavor.

This matter has another aspect: if we undertake appropriate studies, we will become not only "positive recipients" of the nuclear-energy industry but would also become active participants through the production of various reactor parts (in order to accomplish this we would have to equip ourselves for the manufacture of materials in the required degree of purity and with the required properties), control instruments, dosimetric units, and so forth. We could then become active members of the nuclear-energy team of the socialist countries.

In my opinion, the recently established coordination council for "nuclear energy research," designated as a major function of the MTA [Hungarian Academy of Sciences], plays an important, albeit not decisive, role in this entire subject area.

This coordinating council should think carefully to set down its policy in close cooperation with the appropriate CEMA organs and the program of the Ministry of Heavy Industry, so as to establish the areas in which domestic research is required. In deciding this, we must keep several considerations in mind, for example the areas in which we have the needed scientific prerequisites and experience, and the areas where these are associated with industrial facilities and existing CEMA needs. In this connection, the valuable experiences of the KFKI, specifically in the field of nuclear energy research, will certainly be of great value.

Finally, a major task for the coordinating council is to find the best means for management and incentives for achieving that the existing scientific experience is best utilized for solving the really important problems in the field of nuclear energy utilization.

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CSO:2502

INSTITUTE DEVELOPS LASER-EQUIPPED LINE PRINTER

Budapest NEPSZABADSAG in Hungarian 16 Apr 78 p 15

[Excerpts] The ever-growing Hungarian computer park requires more and faster data recording equipment than currently on hand to permit rational, convenient utilization of this park. The demand for data recording equipment is so great that where and for how much such equipment is obtained is not a matter of indifference.

The laser-equipped data and symbol recording device developed by SZTAKI /Computer Technology and Automation Research Institute/ of the Hungarian Academy of Sciences with the support of the National Technical Development Committee provides a good solution to the problem. The device is based on original Hungarian patents and is fast, reliable and relatively cheap. It differs in an ingenious, original way from other equipment on the market in the manner in which it records characters. In this rapid printer, the seven horizontal lines of characters on one line are written in a single step rather than seven separate steps. The laser beam is broken up into seven, slightly spaced beams which are activated by equipment controlled by the computer.

The essence of the device is the controlling acousto-optical equipment. It contains a tellurium dioxide single crystal which has the unusual property of diverting light in various directions depending on pitch. The seven lines of the character are guided to the desired place by ultrasound waves generated by radio waves of varying length. On instructions from the computer the light beams flash on and off, and the characters are formed in this way.

The other operations, printing, duplication, are the same as those of other laser-equipped rapid printers.

The laser-equipped data and symbol recording device has an output of 18,000 lines per minute. At present this amounts only to 6,000 lines, because the rapid printer available has a speed of only 33 cm/per second which slows it down. Fifty duplicates can be prepared from a cylinder without re-inscription. There are 136 characters in a line. Their height and width can be

adjusted within a given matrix through optical adjustments. The device has a stock of 90 character: latin or cyrillic letters. The present seven-line breakdown could easily be converted to 25 lines. The more delicate breakdown could then be used to print diagrams, pictures. In other words the laser-equipped rapid printer would become suitable for press purposes.

The device is an ideal export item, because it combines minimum use of materiel with great know-how. A whole series of recent, often basic, scientific research results were used in the course of its development--crystal and solid state physics, computer technology, electronics, etc.

The laboratory sample device contains only \$5,000-\$6,000 worth of parts obtained through capitalist imports. Half of these can be replaced with products made in Hungary or in the CEMA countries.

With this device Hungarian research and industry are in the front line of competition. Laboratory development work began at the same as it did at leading foreign firms. According to the estimates of the researchers, Hungarian industry, which will need about 1 year for construction and going into production work, has a good chance of joining the competition.

The low-output helium-neon gas laser is already being produced in series by the Hungarian Optical Works. The optical devices which direct the laser are simple and cheap. The crystals of the acoustico-optical equipment are grown by the Crystal Physics Laboratory of the Academy. The electronic components were developed at SZTAKI which made use of the most modern microprocessors. The rapid printer is obtainable on the world market; it remains for Hungary to evolve and produce a Hungarian version.

The electronic mechanism which operates the printer and connects it to the computer is designed to be compatible with any of the RYAD computer systems. With minimal alterations it can be connected to any other machine as well. The researchers also carried out economic calculations: use of thin, cheap paper would result in exceptionally great savings in both paper and costs in Hungary. On the basis of 1975 figures, the savings today would be more than 100 million forints per year. This is without even taking into consideration that the cost of paper has increased since then, and there are more computers.

CSO: 2502

HUNGARY

OFFICIAL NOTES EXPERIENCES OF COMPUTER TECHNOLOGY RESEARCH INSTITUTE

Budapest NEPSZAVA in Hungarian 12 Mar 78 p 6

[Article by Dr Janos Gertler, deputy director of the Computer Technology and Automation Research Institute: 'Computer Technology Research and Practice at Academy Institute']

[Excerpts] The Computer Technology and Automation Research Institute [SZTAKI] of the Hungarian Academy of Sciences is one of the nation's most important research and development institutions. Of its more than 700 employees nearly 300 are university graduates. Most of them are mathematicians or electrical engineers. Naturally, an applications oriented research-development outfit achieves its true goal only if its achievements are actually used. This requires effort on the part of both the researcher and the user.

For years the institute has maintained close cooperation with the Machine Tool Factory of the Csepel Iron and Metal Works in developing computer controls for machine tools. The work is financed by the factory and supported by the National Technical Development Committee. The factory has used the research results successfully on its machine tools and thereby greatly increased their exportability.

The institute established a computerized information system at the request of the Danubian Iron Works. The work was done in close cooperation with specialists of the Iron Works. Today this system serves as the basis of the management of the huge factory. Introduction of the system led to dissemination of computer techniques at the factory. Today it has its own large computer center and plans extension of computer applications to other levels of control.

At its own risk, the institute developed a computer-controlled set of machines for the automated production and checking of printed circuits. For years, FOK-GYEM [Precision Mechanics and Electronics Instrument Manufacturing Cooperative] has been making in series and exporting one automatic unit of the set. However, the system as a whole was given but limited use

for quite some time. Two years ago a sample set was turned over for testing and for advertising purposes to one of the large establishments of the instrument industry. Since then, the establishment has found the system indispensable and plans to produce one unit in series.

The institute developed a valuable computer peripheral, the graphic display, on contract for a large communications engineering firm. This device was not available on the socialist market and was unobtainable from capitalist countries, because it was on the embargo list. The factory paid for the development but failed to manufacture the product. Later the institute bought back the manufacturing rights and offered them to another large firm. Since this experiment was also unsuccessful, it has been making the device in small series in its own shop. Most of the displays are exported.

In the foregoing we attempted to illustrate what a rapidly developing academy research institute working in a growing, research-demanding field can do to make its activity serve the economy. We reported some good results. At the same time we pointed out that research results often take years to be adopted or are not adopted at all. We also indicated that their adoption requires too much effort on the part of the researchers. We feel that the difficulties are due to the technical standards of industry, to limitations in the economic regulators and the relative security provided by the economic environment. At the same time, subjective factors such as limited viewpoints, instinctive resistance to the new, and the inadequacy of personal economic incentives should not be overlooked.

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END