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Report of the
Advisory Group Meeting

on the

Establishment of Regional Ion Accelerator Centers and User Networks

17 - 20 November 1997

IAEA Headquarters, Vienna

Executive summary

During the Advisory Group Meeting (AGM) the attendees concluded:

In light of the important and increasing role that accelerators are playing in various facets of life in developed countries, it is crucial that developing countries have both the knowledge of accelerator capabilities and the ability to access appropriate accelerator facilities, to enable them to explore and exploit regional opportunities in science and technology. This report addresses this issue and recommends ways in which the IAEA may facilitate the improvement of accelerator know-how and accessibility in developing countries.

Ion Accelerators are used for a number of purposes, but the most widespread by far is for Ion Beam Analysis (IBA). Typically, small electrostatic accelerators of about 2MV are used. These do not have stringent requirements for beam current, beam stability or even beam energy in many cases. The target chambers and detection electronics can also be very simple. This, together with the utility of the techniques, accounts for the widespread application of IBA. Therefore, IBA and related accelerator technology should be the entry point in establishing centers, networks and training programs related to the use of ion accelerators by developing countries.

The other areas of utilization includes radioisotope production, modification of materials, accelerator mass spectrometry and hadron therapy.

Summary of recommendations given by the attendees of the AGM:

According to the recommendations, the structure of regional networks should be determined locally by the user community according to their needs.

Where the regional user groups propose the establishment of centers to enhance regional access to accelerator facilities and ion beam applications, the IAEA should facilitate their establishment.

These centers should satisfy the established criteria before being considered for recognition.

The IAEA should actively pursue direct collaboration with accelerator facilities in developing countries with established credibility in their own field of expertise to promote development of accelerator methods, wide-spread competence and technical awareness. This will assist the growth of active collaborative Centers.

The IAEA should strengthen mechanisms for partial funding support for personnel from developing countries to attend major conferences/meetings in the field.

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Preface

In this report it is shown that ion accelerators have had a tremendous economic and technological impact on most developed countries, and are beginning to have a significant impact on developing countries. Through the formation of Accelerator Centers and User Networks (which may be national, regional or inter-regional) a mechanism will be outlined by which scientists and other users from developing countries can receive the necessary training and have available the necessary accelerator facilities to use these machines for economic improvement and technological development in their countries.

Although electron accelerators have an important role in industry, in research and development of new applications ion accelerators dominate. Therefore this report concentrates on ion accelerators.

Introduction

Accelerators have very diverse applications in science and technology. They have had, for instance, a major role to play in the modification and processing of materials. In this context they have had a significant impact on the economy of developed countries and have contributed in a major way to the development of high technology products. For example, accelerators called ion implanters are now used in the manufacture of all advanced chips produced by the semiconductor industry for current computers, information technology and communications systems. To date 7000 ion implantation accelerators, costing more than a million US dollars each, have been sold to the semiconductor industry alone. Products which utilize these chips represent an annual market of over 60 billion dollars.

Other accelerator applications involving radiation processing for food preservation, medical sterilization and industrial processing contribute an annual income of 11 billion dollars. Indeed, 25% of the wire manufactured in the US has been radiation processed with accelerators.

The use of accelerators for isotope production for in-vivo diagnosis is also an established market which is undergoing rapid expansion, for example, in the area of radioisotopes for positron emission tomography (PET), such as ^{18}F FDG and ^{123}I - based radiopharmaceuticals. In addition, the 6000 radiation therapeutic accelerators give a further income of over 2 billion dollars in the US alone. In an article published recently in the International Herald Tribune, which outlined the major advances in medicine this century, it was stated: "Radiation therapy is perhaps the most important therapeutic tool for cancer treatment....side effects have almost disappeared thanks to a better understanding of normal tissue tolerance and the availability of the linear accelerator to produce precisely controlled fluxes of X-rays of the proper energy".

However, such high impact accelerator applications usually require the most sophisticated equipment and capabilities. Developing countries do not have, in general, such facilities or know-how, and consequently have not had the opportunity to share in the economic benefits. Nevertheless, there is a rapidly growing interest in developing countries in accelerator technology and applications. Quite appropriately, accelerator groups in developing countries have concentrated on less demanding accelerator applications, such as materials analysis, which can be carried out on less sophisticated equipment.

Accelerators also have major applications in such analysis and testing areas which are the logical entry points to accelerator technologies by developing countries. For example, ion beam analysis (IBA) techniques are an integral part of analytical laboratories servicing the semiconductor and other high tech industries. For many crucial analytical requirements IBA methods are the most sensitive and efficient techniques available, such as for quantification of hydrogen contamination in semiconductor chips and in aluminum welds for the aircraft industry.

Other diverse IBA applications include analysis of fine particles to quantify environmental pollution, aerosols, liquids and soils for contaminants, radioactive wastes and toxins. Accelerators can also readily measure toxins in body tissue, such as determination of aluminum content in the brain in Alzheimer patients and detection of minute traces of benzine in bone tissue. Furthermore, accelerator mass spectrometry (AMS) has now become a key analytical technique in several fields requiring extremely high sensitivity (parts per trillion). Examples here are radiocarbon assaying, where AMS laboratories (50 in total) are hard pressed to keep up with the flow of samples for analysis, and in the pharmaceutical industry to test the effectiveness of certain drugs.

In light of the important and increasing role that accelerators are playing in various facets of life in developed countries, it is crucial that developing countries have both the knowledge of accelerator capabilities and the ability to access appropriate accelerator facilities, to enable them to explore and exploit regional opportunities in science and technology. This report addresses this issue and recommends ways in which the IAEA may facilitate the improvement of accelerator know-how and accessibility in developing countries.

Background

This AGM was called as one of the tasks specified for 1997/8 for the Agency project G.4.02.: *Utilization of Particle Accelerators.* It is a continuation of several previous consultants' meetings related to the use of low energy accelerators.

The task of the AGM was to analyze a questionnaire which was sent to a number of institutes in developing countries in Europe and West Asia (Appendix 1), to discuss the advantages or otherwise of the establishment of regional accelerator centers, user networks and other possibilities for collaboration, and to make clear recommendations.

Ion Accelerators are used for a number of purposes, but the most widespread by far is for Ion Beam Analysis.

Application Areas for Accelerators

The results of the survey are given in Appendix 2. There are six clear areas which have emerged from this survey, which are outlined below.

Ion beam analysis

Different processes of interaction betwen the ion beam and the material are the basis of the ion beam analysis (IBA) techniques. PIXE (Particle Induced X-ray Emission) and RBS (Rutherford Backscattering Spectrometry) are the most widespread techniques. In the terms of energy and ions that these methods use, a few MeV is the most frequently used energy of protons for PIXE, while α-particles and heavier ions of a few MeV are used for RBS. Some techniques such as ERDA (Elastic Recoil Detection Analysis) employing heavier ions of MeV energies for the analysis of light elements (hydrogen), or the different variations of NRA (Nuclear Reaction Analysis) have unique properties.

Many IBA methods allow concentration depth profiling with depth resolutions from few nm to several μm. Using a finely focussed beam of ions (down to 0.1 μm spatial resolution) in the nuclear microprobe most of the IBA methods are used for the imaging of elemental concentrations. Some of these (e.g., low beam current methods), can be used as the probe for the imaging of some other properties of the test structures like the morphology, crystal structure, density, or to study the properties of electronic devices such as charge collection, single event upsets etc.

Among the many fields of the IBA applications, the most widespread are applications in materials development, environmental pollution studies and biomedical research. Significant contributions in geology and archaeology have to be mentioned as well. Commercial exploitation of IBA is a growing field.

Typically, small electrostatic (single ended or tandem) accelerators of about 2MV are used. These do not have stringent requirements for beam current, beam stability or even beam energy in many cases. The target chambers and detection electronics can also be very simple. This, together with the utility of the techniques, accounts for the widespread application of IBA reflected in the Questionnaire.

Accelerator mass spectrometry (AMS)

Of all the accelerator based analytical techniques AMS is without any question the most sensitive trace analysis technique. Trace impurity sensitivities of parts per trillion have been realized with this technique. The main customers for AMS are: the semiconductor industry, the carbon dating community and recently the pharmaceutical industry.

As the dimensions of chips becomes smaller and smaller, the purity of the silicon substrate material becomes more important. For example iron impurities at the fraction of parts per billion level in the silicon used for chip manufacturing can produce problems for sub-micron chip production. AMS is one of the only techniques available that can easily show sensitivity at this level and hence identify problems such as these.

AMS has proven to be one of the best and fastest methods for carbon assaying. As was mentioned in the introduction there are 50 fully utilised accelerator based laboratories in the world. The main reason for this is that the AMS method is very fast (aproximately 30 minutes, as compared to conventional dating techniques that require several weeks) and only milligram samples are required. Conventional carbon dating requires several grams of sample.

Recently the AMS technique has made significant in-roads in the Pharmaceutical industry because of its high sensitivity. For example ^{14}C can be used as a tracer in a biological system with a sensitivity increased by a factor of one million beyond that possible with conventional methods of scintillation counting. Ivan Proctor from Lawrence Livermore National Laboratory has estimated that by the year 2000 the utility of AMS for the pharmaceutical industry will generate the need for over 2 million samples per year to be analysed.

The machines required for AMS are similar to those for IBA, but much more sophistication is required at the ion source and at the high energy end. Typically AMS machines are dedicated to this purpose.

Ion beam modification

Ion beam modification of materials involves using an ion beam to alter the composition, structure or properties of the near-surface of materials. Ion implantation requires special accelerators, able to implant ions of most elements of the periodic table at high beam currents (>> 1μA), scan the beam uniformly over a sample and typically cover energies from the keV to MeV range. To do competitive work in this field requires accelerators of much higher specification than for IBA.

Radioisotope production

Accelerator produced short-lived radioisotopes are widely used in Nuclear Medicine because of the reduced dose to the patient. These included PET isotopes, such as ^{18}F, used in diagnosis and pharmaceutical research, development and testing. Others include ^{67}Ga in citrate, $^{81}Rb/^{81m}Kr$ generators for lung imaging and various forms of several iodine isotopes in particular ^{123}I. The radiopharmaceuticals using these isotopes produce maximal diagnostic information with minimal radioactive waste involved in their production.

New accelerator methods for the radioisotope production are being developed, as alternatives to reactor produced radioisotopes, where reactors are no longer available.

Research radioisotopes such as the positron source ^{22}Na, are also produced. These radioisotopes are used in both pure and applied research into the properties of condensed matter.

The machines required for the production of these isotopes are cyclotrons producing proton beams of typically 30-60MeV.

Hadron therapy

Although most radiation therapy is carried out with ^{60}Co sources and MeV photons from electron linacs, some conditions are best treated by using neutron or proton beams themselves.

Neutron therapy has considerable radiobiological advantage. This can be crucial in the case of certain slow growing cancers. Proton therapy is used in the cases where carcinoma or malformations are located very close to the vital organs.

Neutron therapy uses beams of 30-60MeV protons with currents of about 30μA. Proton eye therapy requires nA beams at about 70MeV. General proton therapy uses beams of 170-240MeV with initial beam currents of a few hundreds of nA. Sophisticated patient treatment planning and physical location facilities are also needed.

Accelerator Technology

There is a general requirement to initiate a facilitating programme of training at all levels to support and enhance the ability to implement IBA techniques by professional attention to all aspects of accelerator technology. These involve technical issues covering all aspects of the accelerator system, including vacuum technology, ion source requirements, the accelerator beam and energy stability, beam line design, target chamber requirements for different types of samples, and techniques of current integration. Detailed knowledge is needed to be able to make good use of the flexibility of IBA techniques when extending the scope of a laboratory to do a different type of analysis.

Conclusions

Not surprisingly, in the light of our observations in the Introduction, the survey (Appendix 1) indicated that the less demanding applications of accelerators were by far the most widely used in developing countries. These applications are the logical entry point into accelerator technologies and hence should be considered as a high priority for initial IAEA support (*Recommendation 1*).

Training

Throughout the discussions the importance of manpower was emphasized. Moreover, it became clear that many laboratories could support considerable training activity provided funding was available for travel and subsistence of people from other institutions.

It is widely understood that scientists need experience of well-equipped centers to broaden and deepen their knowledge.

Students are a very important resource for developing countries: they should be encouraged by all means to bring vigor and new ideas to scientific and industrial programmes in these countries. Therefore particular attention should be paid to provision for student travel to regional centers.

Technicians should not be overlooked: the operation and maintenance of these sophisticated machines and their associated instrumentation requires extensive appreciation of many fields, and it is important to spread detailed information widely.

For all these groups of people, one important consideration in training programmes is the active fostering of an attitude of independence. The expectation is that people should have control of the operation of their own equipment, which is critical in actually keeping machines and experiments working, often in difficult environments.

We therefore recommend (Recommendation 2) that *the IAEA should utilize all appropriate funding avenues to support the education and training of scientists, students and technicians in developing member states either at (preferably) regional or national accelerator centers or elsewhere as appropriate.*

Clearly, much relevant training has to take place at an established facility. However, some short courses (for example) may occur at some other convenient location.

Networks

There was considerable discussion of issues of accelerator utilization. We concluded that there was a very large potential user community, which is currently only partially developed. The idea of *networks* usefully captured the view that a user community should be able to collaborate effectively with the accelerator scientists to obtain good solutions to their particular problems. In this report a network involves accelerator and user groups among developing countries within the five designated regions (and in some cases across regional boundaries). We believe that there are many potential users who could make good use of accelerator facilities, and that such capital equipment should be used by the widest possible constituency. There are a number of conditions for this sort of use, some of which must be addressed at a local level, including the availability of access to ion beam facilities at acceptable prices. However, some conditions can be facilitated by IAEA, including help in establishing the network organization, and initial funding for the network coordination (see paragraph on Criteria).

We therefore recommend (Recommendation 3) that *the IAEA support the establishment of regional or national networks, whose structure should be determined locally by the user community according to their needs.*

Limited financial support should be sufficient to establish the network, but we see continued organizational support by IAEA as vital both for credibility, and for technical development. Mechanisms already exist in the IAEA to fund network meetings, and this would be a valuable contribution. User group meetings are a very well established means of distributing technological knowledge and encouraging serendipity.

Developed countries have an important role in supporting these networks (with IAEA assistance) with the provision of training, expert assistance, and making their own facilities accessible to pursue particular technical programmes.

Centers

The designation of one laboratory as a Center in preference to another is likely to include political as well as technical considerations. Moreover, there may not be a clear technical case for selecting only one of a number of laboratories. For example, although Mexico City clearly should be the site of any Central American Accelerator Center (since there are no other accelerators in the region), there is a good case (based on current collaborations) for a Central European Center distributed over a number of laboratories, including Zagreb, Budapest, and Debrecen.

Clearly, Centers are potentially of many different types. They could be single site or distributed. They could be regional, as in the examples above, or national. China, for example, is clearly able to support Centers serving entirely national networks. Finally, Centers could be for just one or for a combination of the various accelerator activities listed above in the paragraph on application areas..

We concluded that although existing accelerator laboratories have to be chosen as regional or national centers for ion beam facilities delivered to a wider user community, and although those same laboratories bear their own responsibility for developing their own user communities, the choice of exactly how the Centers are set up should be left to local decision. However, the IAEA can play a very valuable role, as for networks, in establishing these Centers, through, for example, being proactive in soliciting *regional* proposals for TC (technical co-operation), CRP (co-ordinated research programmes) and training programmes.

We therefore recommend (Recommendation 4) that *where regional or national user groups recommend the establishment of Centers to enhance regional or national access to accelerator facilities, and to enhance ion beam applications, the IAEA should facilitate their establishment.*

The Purpose of Networks and Centers

There are many reasons to establish these structures, and we list a number of specific purposes that we believe are the most important. This list applies to Networks and Centers, which are both means for encouraging better use of existing facilities by the user community.

The *efficient* use of the facilities includes both the optimum use of resources (in scheduling terms) and enhancing access by users. This latter could involve improving accommodation, and perhaps making travel funds available, so that users are able to spend time at the Center. It will involve seeking to widen the use of the facilities by the use of advertising and other promotional activities designed to increase the size of the user community. This in turn may involve technical development of the facilities to cope with new applications.

Centers and Networks must take *training* issues very seriously. Training should occur at various levels. The Center itself needs to develop competence at both scientific and technical levels: it also needs to carry out in-depth training of the next generation of scientific leadership. The user community needs to develop scientific and technical competence so that research at an acceptable level can be carried out throughout the Network. Also, a wider (industrial or medical) community should be cultivated to make the potential benefits of the ion beam facilities more widely appreciated.

Networks and their Centers should aim to identify and serve the *needs* of their local community. Centers locally also need information specifically for keeping up to date, such as obtaining new databases as they become available, new software where it makes no sense to develop local products, and other information needs such as effective access to the Web and to the scientific literature.

The Criteria for Networks and Centers

The recognition of Networks or Centers by IAEA can clearly be of great assistance in persuading local funding agencies to support such activities. There are a number of criteria that we have identified, which such Networks or Centers should satisfy before being considered for such recognition. Again, the list applies to both or either of Networks and Centers, and it is not necessary to specify which should precede the other. In some cases the network already exists, and the form of distributed center which is appropriate will become apparent through local negotiation. In other cases the Center already exists, and the network has to be cultivated, or indeed formed.

Clearly, a network has to make geographical sense, and there has to be a clearly identifiable user need.

There must be a laboratory capable of acting as the Center, with appropriate infrastructure in place. This infrastructure consists of the appropriate materiel, personnel and information resources. Materiel includes not only the accelerator but also the associated instrumentation with facilities for maintenance and repair. Personnel includes not only availability of scientific and technical staff, but also a demonstrable capacity for teamwork.

Teamwork is critically important for successful Networks, since good communications and a willingness to co-operate with the user community is of the essence. Teams in these Centers need to have a critical mass: they need to be of a size sufficient to actively participate internationally.

It is also essential that every Network has at least one Coordinator, who will probably be located at the Center, and whose purpose is to serve the user community, enabling them to make the best use of the Center's facilities. This Coordinator needs to be a good scientist, able to talk on equal terms to all the users, but also willing to subordinate his own interests to the needs of the Network. The assistance of the IAEA in providing initial funding for such activities will be critical in the establishment of Networks.

Centers need to be able to validate their results, in terms of being able to participate in intercomparison exercises, and to have valid Quality Assurance procedures. Ion Beam Analysis labs should also have access to a reasonable range of complementary analytical techniques.

Accelerator Support Programmes

In addition to the general recommendations by the AG to support training programmes, Networks and Centers, support programmes which can be implemented immediately were discussed at length by the AG. Within existing TC, CRP and training programmes of the IAEA there appears to be a ready mechanism for support of proposals directly from regions rather than member states (*Recommendation 5*). There is a clear need for developing countries to access the most appropriate facility for their application or training needs. This may or may not be within their regional area and hence *Recommendation 6*.

Although accelerator groups within member states can apply for TC and other projects administered by the Agency, the AG felt that priority should be given to specific accelerator-related proposals which address regional needs and support applications (*Recommendation 7*). Attendance at major accelerator conferences and meetings is vital for all accelerator practitioners. Personnel from developing countries should have every opportunity to attend these meetings, hence our recommendation that the IAEA should strengthen its mechanisms for supporting these activities (*Recommendation 8*).

The AG considered that direct interaction between the IAEA and accelerator laboratories is important for enhancing regional collaboration and training. For example, the interaction between the Agency and the laboratory at Zagreb has done exactly this. We encourage more interactions of this type (*Recommendation 9*).

To assist IAEA in developing and monitoring programmes built around the above listed recommendations we suggest that an Advisory Group meets periodically (*Recommendation 10*).

Recommendations

The AG recommends that:

1) Ion beam analysis (IBA) and related accelerator technology should be the first priority areas for the IAEA in establishing Centers, Networks and Training programs related to the use of ion accelerators by developing countries. This will be the entry point for other exploitation possibilities for ion beams such as materials modification and radioisotope production.
2) The IAEA should utilize all appropriate funding avenues to support the education and training of scientists, students and technicians in developing member states either at (preferably) regional accelerator Centers or elsewhere as appropriate.
3) The IAEA should support the establishment of regional Networks, whose structure should be determined locally by the user community according to their needs. These Networks should satisfy the criteria before being considered for recognition.
4) Where the regional user groups propose the establishment of Centers to enhance regional access to accelerator facilities and ion beam applications, the IAEA should facilitate their establishment. These Centers should satisfy the criteria before being considered for recognition.
5) The IAEA should actively promote applications for TC and CRP programmes from regional accelerator/user groups to facilitate the establishment of Centers and Networks. The Agency should provide an increased focus on interregional and regional training programmes in IBA techniques and other accelerator-based technology.
6) The IAEA, through their various TC, CRP and Training programs, should facilitate access to appropriate facilities by personnel from developing countries, whether such facilities are within or outside designated regions or in developed countries. Provision for travel, accommodation and partial accelerator access costs would be necessary. Access requirements may be for special training, or for undertaking specific accelerator-based research or user applications.
7) The IAEA should give priority to proposals which address particular needs of regional accelerator groups in developing countries, such as collection of ion-beam data (e.g. cross-sections and stopping powers) or specific aspects of accelerator technology (detectors, beam line construction, current integration).
8) The IAEA should strengthen mechanisms for partial funding support for personnel from developing countries to attend major conferences/meetings on applications of accelerators.
9) The IAEA should actively pursue direct collaboration with accelerator facilities in developing countries with established credibility in their own field of expertise to promote development of accelerator methods, wide-spread competence and technical awareness. This will assist the growth of active collaborative Centers.
10) The IAEA should commission a brief overview of opportunities and potentials for ion beam applications in developing countries.
11) The AG recommends that the Agency seek external guidance again in the future to assist with the development of these ideas.

Appendix 1: The Questionnaire

Before the AGM, the following Questionnaire has been sent to all persons in charge of accelerator facilities in developing countries, as registered by the IAEA Database of small accelerators. Due to the fact that this database at the moment covers only ion accelerators in Europe and West Asia, the Questionnaire has been sent to the accelerator laboratories in the developing countries of only these two regions.

Questionnaire:

1. What accelerator-based methods are utilized at your institution ?
2. What is your primary interest in the field (accelerators development, applied research with various collaborators, services to outside groups, ...) ?
3. What services do you provide to outside groups (such as industry, universities, labs.)?
4. What are the additional markets for accelerator services in your country ?
5. Which of the following would you recommend to promote utilization of accelerators, and what support would be needed from the IAEA for your recommended choice:
    a. establishment of a single regional center (if yes where ?),
    b. establishment of several specialized regional centers (if yes where ?),
    c. a consortium of various national laboratories,
    d. several specialized consortia (if yes, which members, specialties),
    e. status quo,
    f. other ideas ?
6. Would a database of accelerator customers be useful ?
7. What kind of help from accelerator laboratories in advanced countries would be valuable to laboratories in developing countries ?

Appendix 2: Answers to the Questionnaire

The questionnaire was sent to 56 accelerator laboratories. The answers to the Questionnaire were rçceived from 29 laboratories (52%). The answers are listed below.

Question 1: What accelerator based methods are utilized at your institution?
Answers:

1. IBA (PIXE, RBS, ERD, etc.); radioisotope production (diagnostic application, PET); neutron source (mutation, radiation hardness test, neutron activation); Thin Layer Activation (wear measurements); Activation Analysis (charged particle); basic nuclear physics (in-beam nuclear spectroscopy, astrophysical nuclear reactions).
2. --
3. A. Radioisotope production by 30 MeV Cyclotron: 201Ta, 67Ga, 18F, 4. 81mKr/81Rb generator, 111In.
   B. Sterilization, food irradiation and heat shrinkable tape & tube production by 10 MeV electron accelerator (Rodothron).
   C. Nuclear analytical techniques such as PIXE, RBS, NRA, PIGE by Van de Graaff.
4. Accelerator mass spectrometry (AMS); Space radiation effects (SEU); Coulomb explosion imaging (CEI); Free electron laser (FEL); Nuclear resonance absorption (NRA), Rutherford backscattering (RBS); High Tc superconducting defects.
5. - Implantation, sputter deposition, ion beam assisted deposition for modification parameters or for creation of the thin coating surface layers - on 75 Dual Beam Ion Implanter.
   - Material investigation by RBS, NRA, ERDA, channeling, PIXE/PIGE - on Van de Graaff.
6. Production of radionuclides, the radiation tests of materials, the dense plasma diagnostic by proton beam.
7. a) Fast Neutron Activation Analysis (using D-T reaction).
   b) Rutherford Back Scattering (mainly film thickness measurements, and some material characterization).
   c) Laboratory Training.
8. Applications of electron and gamma irradiation by electron accelerators:
   - radiation technologies of oil refining, including radiation-induced heavy oil residua destruction, worked-off oil products regeneration, desulphurization techniques, etc.,
   - radiation technologies in powder metallurgy.
9. PIXE, PIXE induced XRF, RBS, PIGE, NRA, ERDA, Channeling.
10. The main application of Tandem van de Graaff accelerator is ion beam analysis (PIXE, RBS, PIGE, microbeam applications, etc.) As the minor applications occasionally performed is ion beam modifications and applications in dosimetry.
11. Ion implantation with an ion accelerator ILU-4 (100keV) as follows: High doses ion implantation for materials modification and synthesis of novel compound materials, etc.; Low doses ion implantation for doping semiconductor materials, studying of ion beam included defects, etc.; Low energy ion sputtering for obtaining highly clean surfaces, surface topography studies, etc.; Combinations of (i)-(iii), etc.
12. Cross-linking and polymerization in plastics, radiation sterilization of medical and pharmaceutical materials (el. acc.).
13. PIXE, PIGE, RBS, Channeling, NRA, microbeams.
14. Production of neutron deficit isotopes (under development), fast neutron radiotherapy, proton eye melanoma radiotherapy (planned).
15. We utilize linac URAL-30 for injecting the 30 MeV proton beam into the booster of the IHEP 70 GeV proton synchrotron. URAL-30 is the linear accelerator with the RFQ focusing. Linac I-100 was utilized to product medicine radioisotopes: 82Sr, 123J, 204Ta and others and to investigate the radio equipment resistance to radiation. Linear Proton Accelerator DV-1 is used as a base pattern for designing small size accelerators with space-uniform RFQ focusing and space-periodic RFQ focusing for medicine and industry. It is possible to study interaction of different systems of the small size accelerator using DV-1.
16. Nuclear filters production line - in a stage of completion. Pilot irradiations were performed in collaboration with outside groups. Irradiations of solid state samples - studies of heavy-ion induced amorphisation. Medical radioisotopes - production cave now being completed, investigation of possible production channels of exotic radioisotopes using heavy ion beams.
17. RBS, PIXE and methods of Resonance nuclear reactions.
18. It will be Isochronous, Cyclon - 30.
19. Novel Neutron -induced Elastic Recoil Detection (NERD) method have been developed and utilized for all hydrogen isotopes simultaneous determination and deep concentration depth profiling in very possible objects and processes, based on NG-150 neutron generator (150 keV C-W acc.). Novelty of the NERD method comparing to available IBA techniques based on small accelerators is in that monochromatic neutrons used instead of ions provides probing depth 2-3 order of magnitude as large that very important for hydrogen determination in the bulk of material and especially for direct study of hydrogen isotope mass transfer processes by means of concentration depth profile time evolution measurements immediately in the course of hydriding-dehydriding of solid state membranes and electrodes. However low power NG-150 allow to use only 14 MeV neutrons (~ 5E10n/s) and not provides high enough flux of ~ 3 MeV neutrons which are necessary for analyses at better depth resolution. Therefore, we are planning to build the NERD method on base of one order more intensive NG T-400. There is the second NG at this Lab. (430 keV, 20 mA)

which could provide up to 5xE12 of 14 MeV neutrons/s. Unfortunately, this second powerful machine which are able to provide 10 times better depth resolution for H,D,T depth profiling by the NERD method is now not in operation due to absence of funds.

20. At our institution the following accelerator-based methods are utilized:
    - production of radioisotopes (cyclotron),
    - ion beam analysis : NRA, RBS, PIXE, microbeam techniques (tandem),
    - ion implantation (high voltage accel.), material modification (ELV-4).
21. RBS, NRA, ERD, Chanelling with RBS, PIXE.
22. Under a TC project a VdG accelerator is approved by the IAEA for 1997-98 cycle. It is an Ion Beam Accelerator for analytical purposes: PIXE, RBS, PAA, ...
23. RBS, NMR, PIXE, PIGE
24. RBS, Channeling, ERDA, PIXE, PIGE, H, S profiling, Secondary proton induced XRF
25. The answers in this Questionnaire relate to the electron linac which is not yet fully operative, and the answers reflect the intentions for the future.
26. - neutron spectrometry,
    - nuclear data measurements with neutrons and charged particles,
    - neutron gas physics,
    - elemental analysis by activation and prompt radiation methods,
    - PIXE,
    - irradiation effects of neutrons.
27. The answers in this Questionnaire relate to the 2 MV VdG, which is not yet fully operative, and the answers reflect the intentions for the future. We are finishing the installation and testing of the VdG now. We are designing the microprobe facilities for our accelerator too. Our intention is to use it for PIXE, RBS, CCM, STIM, etc.
28. - RBS, PIXE, NRA associated also to channeling,
    - ion implantation in random and in aligned directions.
29. PIXE, RBS, ERDA, NRA, PIGE.

Question 2: What is your primary interest in the field?

Answers:

1. Applied research and service to outside groups.
2. --
3. Services to outside groups and applied research.
4. Services and collaboration with institutes and outside groups
5. Applied research with collaborations (now established with 13 universities and institutes within the country)
6. It is necessary to find collaborators for:
    - finishing the construction of the driver of multipurpose irradiation test facility (that is now ready 60-70 %) with subcritical multiplying blankets
    - R&D high-intensity CW linac for neutron generator and ADS, ADTT and similar projects (to continue our new proposal of radiation safe and faultiness 10-100 mA - 1 GeV proton linac)
7. a)Applied research by using accelerators as radiation source for Medical and Industrial Applications.
    b) Service to other groups such as the Solid State Group of Physics Dept., Food Engineering and Chemical Engineering Departments.
    c)Laboratory Training for Nuclear Engineering students.
8. Many aspects of out technological work in mentioned above fields can be of interest for joint development together with foreign collaborators in the frames of international foundations. In particular, our project "Radiation processing of petroleum wastes at oil extraction, refining and storage sites" is under IAEA consideration now.
    A series of our developments is ready for industrial application, appropriate interest is displayed by industrial circles.
9. Applied research with various collaborators in material science, biology, biochemistry, medicine, art and archeometry. Advanced laboratory practice for university students, diplomawork and PhD supervising.
10. Primary interests in the field are:
    a. Basic research through the Ministry of science programs
    b. Applied research through collaborations with other research groups or international collaborations.
    c. Analytical service to various users (industry, other institutes...)
11. Together with some services to outside groups, applied research with various collaborators are amongst our main objectives. Especially the last, as we are collaborating with a number of groups in our country as well as abroad. With the aim to address some more specific demands and applications, certain technical developments of the implanter were made, and others were in progress, when the grave funding problems in our country over the last few years have rendered this impossible.
12. Applied research with various collaborators.
13. Applied research in biology, geology, medicine, surface analysis, material science. Student training.
14. After finishing reconstruction of the AIC-144 cyclotron (planned for 1998), it will be mainly used for applied research, isotope production and radiotherapy.
15. Our interest is in the development of accelerators with RFQ focusing.

16. Although our Cyclotron is primarily dedicated to basic research an amount of time is reserved for the applications. Especially important is the solid-state physics in which a number of outside groups participate. At present the installation of a 10GHz ECR ion source is under way. The completion of this task will extend the range of available beams up to Xe, expanding largely the potential of the machine for solid-state applications.
17. Fundamental and applied research in field of surface modification of metals and semiconductors by ion implantation.
18. In the field of research and development.
19. Fundamental and applied research with various collaborators (we are working with Nagasaki University in the study of H.D separation and isotopic exchange inside palladium electrodes during electrolysis process and with JET Joint Undertaking in the study of H isotope retention in plasma-facing components of JET fusion reactor) and services to outside groups.
20. Our interests in the field are: accelerator development, applied research with various collaborators, services to outside groups if it is possible.
21. Applied research with various collaborators.
22. Applied research for environment, health, agriculture and industry.
23. Applied research with collaborations
24. - services to groups
    - development and optimization of presently used techniques
    - interdisciplinary research
25. - Research on the behavior of toxigenic or therapeutic compounds of relevance to biological systems.
    - Radiation processing of polymers, food, pharmaceuticals etc. for the interested respective industries.
26. - accelerator development,
    - basic and applied research in collaboration with the IAEA and a number of outside labs,
    - IAEA expert missions to a number of countries for the upgrading, maintenance and utilization of neutron generators.
27. Design, installation and use of the new compact scanning nuclear microprobe (MP) at VdG. In future we will use the MP in common experiments in materials science, solid state physics, biophysics and physics of the environment...
28. Applied research (I would say fundamental oriented research) with various collaborators (national and international)
29. Applied and basic research for science and technology development, services and expertise.

Question 3: What services do you provide to outside groups?

Answers:

1. Irradiation possibility, radioisotopes and labeled compounds and irradiation for further processing (measurement, ...)
2. --
3. a) We have provided to all the hospitals and medical centers with the above radiopharmaceuticals.
   b) In the near future we furnish the Cyclotron Dept. with PET and Gamma camera, which will be used for research as well as clinical application.
   c) Most of the university students (post graduates, Doctorates) in the field of accelerator research will receives.
4. Heavy ions at variable energies, target preparation and chemistry lab., vacuum and electronic services - cryogenics, computer and data acquisition facilities, scientific collaboration, ion beam operation.
5. Modification or creation of the thin surface layers by ionic methods and investigation of materials by nuclear methods (RBS, NRA, ERDA, channeling, PIXE/PIGE)
6. 3, 10 and 25 MeV pulse proton beams (100-200 mA, 10 i s, 1 Hz) for any user.
7. Apart from the academic interest, there was not much demand for the accelerators at the beginning. However the demand is increasing fast especially from medical circles and the privet industry (nondestructive testing and radiation processing). But our apparatus in the University is old and insufficient to meet the demand. It is not at all feasible to run the old machine any more. So we cannot give proper service to outside groups any more.
8. Optimization of oil products radiation processing conditions for specific types of initial oil feedstock and required final products at the consumer's wish and metal powder radiation processing optimization to obtain specific metal or alloys.
9. The laboratory is the part of the OTKA (National Research Fund) experimental facilities centers providing expertise and beam time for other research institutes and universities through collaborations.
10. a) Elemental analysis using PIXE of various kinds of samples for different users: regular analyses of geological samples for petrol industry and some particular environment monitoring tasks in our city and occasional services for the local electronic industry, hospitals, other institutes,...
    b) Accelerator beam time lease to research groups from neighboring countries (Italy, IAEA).
11. Our services to outside groups have been mainly technological, as mentioned in (1), together with some patents for industry. The lack of good computer-based facilities in the group makes it difficult to contribute also with some highly required computer modeling. Recently we have submitted an application to the IAEA Research Contract Proposal Programme for 1997/98, where this is one of the points.
12. Applied research in radiation modification of polymer materials.
13. Strong collaboration with various scientific groups from universities, Academy, hospitals and industry.
14. Close collaboration with many research groups. The range of services will depend on availability and quality of the beam (energies, particles, intensities).
15. We will be able to provide designing linacs according customer demands.
16. Irradiations for solid-state research, irradiations for biology, nuclear filters irradiations, participation of students in experiments, PhD and MSc theses supervision, educational activities on the high-school and University level.

17. Experiments of ion implantation and structure investigation of implanted layers.
18. Will provide isotopes for nuclear medicine.
19. Hydrogen and its isotopes determination and their concentration deep depth profiling in various objects up to depth of hundreds microns at depth resolution of a few microns and sensitivity of ~ 100 atomic ppm.
20. Elemental analysis, depth profile determination.
21. Investigations of the solids by the nuclear methods in collaborations with other universities and labs.
22. Our objectives are to provide to such groups analytical services and some demonstration on coating.
23. Services for university and academic institutions (analysis and evaluation of measurements, development of physical models of processes studied).
24. Universities and research institutes: analysis of thin films, composition of alloys and catalysts determination, zeolites studies, metabolism of tree elements, archeometry.
    Industry and public: determination of alloys composition, check of aluminum can specs, toxic elements determination in biological samples, air filter analysis, gold and jewelry spec determination.
25. Joint research by the method of pulse radiolysis, service irradiations for sterilization of medical supplies, polymer modification, other applications.
26. Upgrading and maintenance of low voltage (100 - 400 kV) accelerators and neutron generators, utilization of neutron generators in teaching, research and industrial applications.
27. Design and installation of scanning nuclear microprobe (we have established collaboration with outside institutions). My group has a good experience in calculation, designing and manufacturing the main elements of the MP (i.e. lenses, slits, scanning system, target chamber, etc.). In addition, we have some "know how" for modernization of the main parts of the VdG (i.e. ion source, injector) and the analyzing system for successful utilization the accelerator in typical MP applications.
28. We supply the ion beam facilities to all research groups of the universities needing these techniques. At this moment our Laboratory stands as the unique ion beam facility in the Iberian peninsula. We have very strong collaboration with Spanish research groups.
29. Depth profile analysis of hard coatings and thin layers, aerosol studies, university curricula.

Question 4: What are the additional markets for accelerator services in your country?

Answers:

1. Nuclear medicine
2. --
3. --
4. Material modification and diagnostics for industry and research; environmental monitoring by AMS and PIXE; archeological and geological diagnostics and study; production of radioisotopes.
5. In principle yes. The preliminary talk with a factory of furniture and with a factory of electronic switches for telecommunication.
6. --
7. a) Presently most demanding market is the Radioisotope Production for Medical Applications (mainly diagnosis). In fact the TAEK, with technical support of IAEA made a feasibility study. And has a project (I hope it is still going on) to establish a "neutron deficient radioisotope production facility" based on a 30 MeV cyclotron.
   b) Gamma and Electron irradiation of materials in industry to improve their characteristics, is fast gaining interest in as well. Food irradiation and sterilization of surgical material for medical applications however are not going as well as it was hoped at the beginning. I think this is due to the lack of national regulatory measures on these field. This market would flourish as well if and when the necessary regulatory arrangements are made.
8. Conventional radiation technologies applications, such as sterilization of polymer articles for medical purposes, and unwashed sheep fells irradiation to sterilize them and to obtain green lanolin.
9. Contacts for industrial institutions are in rather preliminary stages mainly because of the fundamental transformations in economy in our country.
10. Ion beam analysis could have much larger market than now if appropriate campaign can be organized. Other accelerator services such as radiation facilities or medical treatment could have in our country much larger market.
11. As an only one implanter for scientific purposes in our country, ILU-4 would be hardly advisable to be used in other industrial markets (e.g. like surface hardening of steels, etc., as these are often utilized in other more developed countries with more than one implanter). Yet a certain additional market, with great importance for the future, is the education of new scientists in this area while expecting to acquire some more facilities of this kind. Also, some of our industrial patents, prepared with the use of ILU-4, have met great interest and are suggested to be backed-up abroad by the relevant institutions. Hopefully in the future, when our own economy will recover, such patents could be made use of also here.
12. Irradiation of food.
13. --
14. --
15. Because of the absence of funding there are no any additional markets.
16. Nuclear medicine, solid state applications, material research.
17. Potential markets may be connected with thin-film solar cells production.

18. In plus of future facility for medical radioisotopes, the creation of a center for utilization of electron beam in industry such as sterilization, polymerization in plastics, etc...
Will promote the industry in our country.
19. Control of metals and alloys hydriding during their working in aggressive surroundings such as gas-petrol industry having a purpose to develop an effective way of metals protection against hydrogen embrittlement. The study of charging-discharging processes inside new type batteries with MH electrode.
20. Elemental map of the different samples.
21. There aren't any markets for accelerator services in Russia.
22. Cable industries.
23. No ! There is yet no serious interest from industry!
24. Different government agencies (Customs, Police dept.)
25. --
26. Irradiation of agricultural samples, irradiation of electronic components and isolating materials by fast neutrons, ion implantation.
27. --
28. None.
29. Archeometry, medical and biomedical studies, material analysis.

Question 5: Which of the following would you recommend to promote utilization of accelerators, and what support would be needed from the IAEA for your recommended choice:

- **establishment of a single regional center (if yes, where?),**
- **establishment of a several specialized regional centers (if yes, where?),**
- **a consortium of various national laboratories,**
- **several specialized consortia (if yes, which members, specialities),**
- **status quo,**
- **other ideas?**

Answers:

1. b) Yes, Debrecen, Hungary (cyclotron application)
2. --
3. a) West & central establishing a regional center in Asia. Iran with having three accelerators (Cyclotron, Rodothron, Van de Graaff) perhaps is the best place for this regional center.
   c) Usually in developing countries only one national lab. may exist
   f) Since we are in production phase now, we like to be linked with other similar radiopharmaceutical producing countries so that become backup for each other
4. b) Each regional center will be based on its facilities and personnel. Our lab. is most suitable for being one of the centers which can provide services and training in all of the techniques listed in answer to the question 1.
5. b) Yes. Up to date such centers do not exist formally although the scientific staff of INP cooperates with all related groups in Poland. Thus, Krakow should be considered as one of the proposed regional centers.
6. e) status quo: do not change on next two years.
7. b) Yes.
   Definitely one CENTER in or around Istanbul would be suitable. Because, Istanbul is at the crossing point of international see, air, and land roots joining the three continents of Asia, Europe and Africa. It is fast becoming an international business center, very near to regional
   industrial and scientific centers. It has a very good communication system with the World and it is an internationally attractive town. This center would be more suitable for applied research, industrial, environmental and marine pollution applications.
   Proposed TAEK cyclotron will be more suitable for Ankara. Ankara is placed more centrally in the region. This makes the distribution of short lived isotopes rather easy. And Ankara has the scientific and technical support of six major universities, and four large medical centers with long experience and infrastructure in the field of nuclear medicine.
8. a) We offer to establish a single regional center for radiation technologies based on ELV-type electron accelerator in Almaty
9. b) Hungary (joint center Budapest-Debrecen) and Zagreb.
10. d) Several specialized consortia of various national laboratories e.g. ion beam analysis and modification consortium or network
    - to link users and needs with laboratory with best expertise,
    - to improve collaborations, enable training, exchange of information or equipment (sometimes secondhand not needed equipment might very helpful for other groups).
11. a) Efforts have been going, unsuccessful so far, to extend the so-called Nuclear Research Center in Sofia, which houses ILU-4, to be completed with a higher energy accelerator (e.g. VdG) in order to meet certain scientific and industrial requirements in our country. Several offers have arrived from abroad for a (or almost) free contribution in this respect, but transportation problems, as well as some related to the housing here, have left the problem open so far.

b) The establishment of 2 regional centers for high energy electron beam accelerators have been started outside the capital Sofia - in Plovdiv and Burgas, and they would both require some additional funding to be completed and to make full use of the high level educated people there.

c) Organizing a consortium, comprising the labs discussed above (5a and 5b), would be the step to follow on the road of serving industrial and environmental problems in our country in the nearest future.

d) Accelerator-based consortia in neighboring countries, in the discussed regions, should account for the countries' priorities and the combination of the existing facilities in these countries (e.g. group has received a number of invitations by other labs in the region to address common problems.

e) We lack enough info about the Agency's Research Regional Programme RER/4/008: "Small Accelerators for Science and Technology" which suggested, when started, some support for such cases as "Co-operation subcontracts".

f) We would like to renew our proposal for closer collaboration with the N.C.S.R. Democritos, Athens, where they have a very modern and well equipped accelerator lab. They have kindly invited people from our group, provided the financial support is supplied by some international funding, e.g. IAEA.

12. c) Yes.

13. --

14. --

15. I think the time is needed to promote utilization of ion accelerators. During this time ion accelerators must be transformed into compacted devices with easy and simple service. The same must be done for target complexes. Then ion linac markets will be similar to markets of the electron linacs.

16. a) The Warsaw K=160 Cyclotron is the only such machine in Central Europe. It seems quite natural that it should attract the users from the region. Heavy Ion Laboratory is a member of Central European Centers of Excellence. HIL may serve as a regional center provided that a support from international agencies, such as IAEA, is granted to the outside researchers planning to run their projects in Warsaw.

b) Heavy ion beams from the Warsaw Cyclotron can be complemented by protons, deuterons and alphas from not yet operational AIC-144 cyclotron in Krakow. After completion of AIC-144 both laboratories can provide a full scope of beams.

17. Establishment of the unique center of Radiation technologies in Kazakstan. Purpose: a consortium of national laboratories working in field of radiation technologies and coordination of the activity.

Support from IAEA: (i) Aid in organization of Center, (ii) quest for industrial partners to solve their scientific or technological problems, (iii) information supply, (iv) convene a meeting to discuss these issues further.

18. a) Yes.

19. a) Establishment on base of two neutron generators T-400 and IRELEC at Institute of Nuclear Research in Moscow of a single center in the world for the study of hydrogen isotope behavior in materials by the NERD method. Financial support would be needed from IAEA for accelerators and technique operation as well as to fill up staff vacancies.

20. a) Establishment of a single regional center (Russia)

21. Establishment of a single regional center in Obninsk, Russia (Institute of Physics and Power Engineering).

22. b) We are for this alternative. The existing activities in the countries must indicate the locations of these centers:
- NCSR, Demokritos, Athens, Greece, for Ion Beam Analysis
- Bulgaria or Portugal for Ion Implanter
- Our knowledge of the countries activities in industrial and cable industry application is very limited. We can not propose any of the countries to host such a center.

c) This alternative can be considered also.

23. c) Consortium and more intense collaboration between existing laboratories in Central Europe is preferred.

24. b) Where? It is a matter of serious decision.

25. a) Yes, Rudjer Boskovic Institute, Zagreb.

26. b)
- Debrecen, Hungary
- Dubna, Rusia
- Kazakstan, Almaty

It is recommended to support exchange of specialists by the IAEA.

27. I recommend to establish:
- a single regional center (in IAEA, for example),
- a specialized regional center (in INP,Cracow,Poland),
- a consortium of various national labs.

28. I think we have at Sacevem good conditions to establish a very good facility to be used mainly by Portuguese and Spanish research groups. This facility needs to be upgraded. I think each country must have its own facility in the fields of ion beams. And a strong collaboration or network should be established between them through exchange of researchers, common projects, etc.

29. c) The most important is to promote stronger exchange of ideas and experiences between the laboratories to strengthen communications.

f) To facilitate the access to the international research founds (European Union, etc.) by offering IAEA technical help.

Question 6: Would a database of accelerator customers be useful?
Answers:

1. Yes.
2. --
3. Certainly would be useful
4. Yes, in order to be able to provide services to new customers.
5. Yes. Full database can be very useful.
6. Yes, of course.
7. Certainly YES
8. Yes, it would be useful.
9. Yes.
10. Yes.
11. Such database could be vital for applied projects aiming to address up-to-date industrial problems. It will also be of value for the establishment of contacts between labs with close project programmes which could be approached from different angles with the specific equipment available at both sides.
12. Yes, it would be useful.
13. Yes.
14. Yes.
15. Yes, it would be.
16. Certainly yes, it will help in planning accelerator development.
17. Yes.
18. --
19. I think yes.
20. A database of accelerator customers will be useful.
21. A database of accelerator customers may be useful if the customers there are.
22. Such database is very useful.
23. Yes.
24. --
25. Not particularly.
26. A database on the main working parameters of accelerators and on the fields of application would be very useful for the customers.
27. I think that a database of accelerator customers would be useful.
28. Of course, it will be quite interesting to have it.
29. Yes.
    - database of accelerators and their use,
    - database of accelerator customers with the information about the subjects studied.

Question 7: What kind of help from accelerator laboratories in advanced countries would be valuable to laboratories in developing countries?
Answers:

1. Exchange of knowledge, training, common research, to transfer the equipment not used any more.
2. --
3. Exchange of technical information, providing training to the scientists from developing countries is quite valuable.
4. If a developing country has an accelerator or planning to have one, the best will be to train the accelerator staff in one or more advanced countries and later on to be able to count on a few years of this country's supervision. If a country wants to use an accelerator in other advanced country, financial support for traveling, training and operation is needed.
5. - Support in participation (and organization) of seminars, especially dedicated to the new application areas.
   - Supply of parts and equipment (also second hand).
   - Collaboration within research projects, especially help in the use of sample diagnostic methods which are not available in the developing countries.
6. Choice of parameters, R&D and constructions proton or heavy-ion linacs for any sci., med., or industrial use. Mutual exchange of specialists.
7. Training of the skeleton technical staff, know-how, technical support.
8. - joint projects in IAEA programs
   - rendering technical help for joint work (spare parts for the accelerator ELU-4, maybe used)
9. "On spot" demonstration workshops for specialized topics (sample preparations, data evaluation, etc.), short courses at the regional centers.
10. Mostly expertise. Also, since the accelerator parts are sometimes very specific and expensive, some secondhand market or data base on available items might be of great help.
11. Here I am tempted to quote again the Agency's Research Programme RER/4/008, where the answer to this question was extended and fully presented. And I would also like to add that the Agency's part in this process has been substantial over the years and hopefully will continue to be. (The only point that I would like to stress upon ref. this

programme is perhaps the priority which should be given to the experts' visits (extended to 3-4 weeks, so that a series of lectures, consultations, etc. be performed), rather than the form of fellowship, where only quite a limited number of people from the developing countries will be supported (even though this form will be essential as well).

12. Transfer of radiation technologies.
13. Technical assistance during constructions, reconstruction, modifications, testing and training. Staff training, workshops, advising.
14. Technical assistance in the phase of reconstruction and testing.
15. Kinds of help will be different in each specific situation I think so.
16. Mutual contacts to consult adopted solutions.
17. Software of accelerator-based methods.
18. G.M.P. and Q.C. of radiopharmaceuticals and research and development in the field of accelerators in general.
19. Possibility for members of staff to be invited to advanced laboratories for work during some period.
20. Organization of regular seminars and meetings; sending of information in this field and among them, proceedings of conferences on application of accelerators (Texas and European); and may be support by equipment if possible.
21. A participation in joint conferences.
22. Training and expertise, reference sample, ...
23. - Advanced software + database.
    - Obsolete accelerator and measuring components (magnet chambers, sample manipulators, etc.)
24. It is a matter of round table discussion.
25. - Training of personnel from developing countries,
    - Assistance of experts from developed countries,
    - Exchange of information.
26. - Expert's missions to developing countries especially in the starting phase of an accelerator project.
    - Training of users and operators (technicians) in advanced countries.
27. --
28. Some training for students.
29. - non expensive access to the used equipment,
    - experiences with how to sell the accelerator services.

ADVISORY GROUP MEETING ON ESTABLISHMENT OF REGIONAL ACCELERATOR CENTERS AND USER NETWORKS
17-20 NOVEMBER 1997
IAEA HEADQUARTERS, ROOM C07-6

PROGRAMME

Monday, 17 November 1997

8:45 - 9:15	Registration
9:15 - 10:00	Opening formalities Election of Chairperson and Rapporteur Discussion and adoption of the Agenda Meeting Announcements, administrative arrangements
10:00 - 10:30	Introduction, background
10:30 - 11:00	Coffee Break
11:00 - 12:30	Presentations and discussion J. Duggan, *Research and industrial applications of accelerators, State of the Art 1997*, USA C. Jeynes, *The operation of the UK Ion Beam Analysis Centers*, UK
12:30 - 14:00	Lunch
14:00-15:30	Presentations and discussion (cont.) J. Williams, *Ion Beam Modification of Materials*, Australia J. Sharpey-Schafer, *The South African National Accelerator Center*, South Africa
15:30-16:00	Coffee Break
16:00-17:30	Utilization of low energy accelerators in developing countries Round table discussion and short presetation by the participants

Tuesday, 18 November 1997

09:00 - 11:00 Questionnaire

11:00 - 11:30 Coffee break

11:30 - 12:30 Questionnaire (cont.)

12:30 - 14:00 Lunch

14:00 - 16:00 General discussion, proposals

16:00 - 16:30 Coffee break

16:30 - 17:30 General discussion, proposals (cont.)

Wednesday, 19 November 1997

9:00 - 10:30 Drafting proposed recommendations

10:30 - 11:00 Coffee Break

11:00 - 12:30 Drafting proposed recommendations

12:30 - 14:00 Lunch

14:00 - 15:30 Discussion on the draft report, report editing

15:30 - 16:00 Coffee Break

16:00 - 18:00 Continued discussion on the draft report, report editing

Thursday, 20 November 1997

Drafting of the AGM report
Final considerations
Adoption of the meeting report
Presentation of draft report and recommendations, closing of the AGM

Department of Research & Isotopes RI)
Division of Physical & Chemical Sciences (RIPC)

Issue No. 1
1997-11-5

NOTIFICATION OF AN AGENCY-SPONSORED MEETING

Title of meeting: Advisory Group Meeting on Establishment of Regional Accelerator Centres and User Networks (F1.AG-820.2)

Dates of meeting: 17-20 November 1997

Scientific Secretary: S. Fazinic (A2310, x21706)

Place of meeting: IAEA HQ, Room C07VI
Telephone extension 21361 (internally)
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Secretary: L. Uyaan (A2374, x21754)

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