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Working Material

Consultancy Meeting on Research Reactor Coalitions and Users' Networks: Education, Science and Applications with neutron beams in East Asia – Pacific Region

Report of the IAEA Consultants Meeting

27-29 October 2010

KAERI, Daejeon, Korea

Vienna, Austria, December 2010

CONTENTS

1. BACKGROUND AND OBJECTIVES

Foreword

The East Asia – Pacific region is about to benefit from multibillion dollar investments in the most advanced neutron beam equipment in the world. The present consultancy follows the "Consultants Meeting on Strategic Planning and Regional Networking for Sustainability: Concerted Actions on Neutron Scattering in Asia-Pacific Region" (Sydney, Australia, August 2009) (IAEA F1-CS-36916) and was to plan for the best regional outcomes from the huge investments being made. Indeed, through the construction of the CARR reactor (China), the new instruments and cold neutron source at HANARO (Korea), the J-PARC spallation neutron source (Japan) and the OPAL reactor in Sydney (Australia) the East Asia – Pacific region has opened a new page in the area of neutron beam research and applications. Finally, one should mention in this connection that the construction of China Spallation Neutron Source (CSNS) is also breaking the ground.

European experience, stemming from the construction of the Institut-Laue Langevin (ILL) in Grenoble (France) in the early 1970s, the ISIS spallation neutron source in 1980s (UK) and most recently the FRM2 reactor in Munich (Germany) illustrates how a large community of users rapidly develops to use the neutron beams produced for fundamental and applied understanding in biology, chemistry, physics, materials science and engineering. The new neutron sources in the East Asia – Pacific region have the same potential and should develop in a similar manner through multi-national multi-user shared facilities.

In the last three years, the new network – such as the Asia-Oceania Neutron Scattering Association (AONSA) (http://www.aonsa.org/) have established some training and networking processes to respond in socio-economic terms to the opportunity ahead and spread its worth region-wide. Much more needs to be done by involving already established research reactor facilities in Bangladesh, China, India, Indonesia, Malaysia, Philippines, and Vietnam.

The response of the IAEA to the recommendations of F1-CS-36916 (a) ANSTO's continuing status as an IAEA's Collaborating Center for neutron scattering applications and (b) in recognizing AONSA as a regional network of user groups, was noted with thanks and as a basis for the consultancy. The AONSA Executive Committee, composed of representatives of neutron scattering associations from many countries in the region has been effective and becomes robust. The three regional neutron schools held in Korea, Australia and India, have taught about 120 young scientists. The first Asia-Oceania Conference on Neutron Scattering (AOCNS) Japan 2011 will feature neutron beam applications from the whole range of national contributors and the whole spectrum of applications from fundamental environmental and engineering sciences.

Background

The IAEA promotes networking, coalitions and regional collaboration to improve the efficient and sustainable utilization of research reactors (RR). A number of RR coalitions and networks have developed with IAEA support as a new model to better utilize RR and facilitate access for the Member States without such facilities. The coalition/network concept involves putting in place cooperative arrangements between RR operator and user entities that can use the unique neutron based capabilities available at the RR facility. Ideally, a sustainable partnership is formed.

Today only a few RR institutions worldwide can offer to run experiments using the most sophisticated neutron beam techniques. At the reactors: OPAL (Australia), ILL (France), FRM-2 (Germany), and NIST (US) advanced neutron scattering and diffraction experiments can be performed with exceptional finesse and with a broad range of neutron energies. HANARO (Korea) with its newly installed cold neutron source is entering the above list of leading RR-based neutron beam centres.

With already mentioned OPAL and HANARO, neutron beam facilities at J-PARC (Japan) and future CARR (China), will offer very promising possibilities for expanded cooperation between well established neutron scattering institutions and emerging user communities in the East Asia-Pacific region and beyond. In this context one should mention other RRs in Japan, India, and Indonesia that also have the capability to perform neutron scattering & diffraction experiments. While these experimental facilities cannot match those of the major neutron laboratories in terms of resolution, neutron brightness or energy range, valuable data still can be collected using the beam-lines and equipment at these RRs. Other countries have maintained a level of nuclear expertise with some skillful use of TRIGA Mark-II reactors servicing local isotope needs, student training and the retention of know-how related to long term national needs.

The new opportunity and need has arisen with the new investments in the East Asia-Pacific region to promote collaborations across all neutron centers – both bilateral and multilateral - as a means of empowering developing of the national-regional training and engineering expertise in neutron beam research and applications.

Objectives
The main objectives of this meeting were:

- Review the current status and future trends of neutron sciences and neutron beam facilities in the East Asia – Pacific region, assess the regional inventory of neutron scattering laboratories and discuss requests for access and application process for neutron beam-time

- Discuss and draft a model project on RR network for education, science and applications with neutron beams taking into account regional needs and research reactor features

- Review the current status and future initiatives of AONSA (Asia-Oceania Neutron Scattering Association) as a regional network of user groups in neutron scattering and applications

- Propose concrete actions and recommendations related to stronger utilization of ANSTO as an IAEA Collaborating Centre for neutron scattering applications

- Promote outreach to potential new user communities in academia and industry (e.g. interdisciplinary use of neutron beams in the fields of physical and life sciences)

2. WORK DONE AND RESULTS ACHIEVED

The meeting was attended by 15 international experts from 11 Member States within the East

Asia-Pacific region (Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Philippines, South Korea, and Vietnam). After the official host opening remarks by Mr Jae Joo Ha, Vice President of KAERI, and Mr Kye Hong Lee, Director of Neutron Science Division at KAERI, welcome address was given by Mr Danas Ridikas, the IAEA Scientific Secretary. The self presentation of all meeting participants followed afterwards. Mr John W. White (Australian National University, Australia) was nominated as a chair person and Mr Edy Giri Rachman Putra (BATAN, Indonesia) was appointed as a *rapporteur* of the meeting. Right after followed a brief presentation by Mr Danas Ridikas, the IAEA Scientific Secretary, on specific regional background and main objectives of the meeting. The meeting continued with a presentation by Mr John W. White on the developing role of AONSA in the Asia-Oceania region and its plans for future training initiatives, linkages and conferences.

The entire 1st day and the morning session of the 2nd day of the meeting were exclusively dedicated to evaluate needs and/or availability of neutron beams in East Asia-Pacific region. In this regard, individual presentations from both neutron beam facility host countries and non-RR/facility countries were given (see Annex I for more details). Before the lunch break in the 2nd day of meeting, Mr In Cheol Lim (HANARO/KAERI, Korea) presented the current status of HANARO research reactor related future plans. This presentation was followed by Mr Ki Bong Lee (KNBUA, Korea) on activities carried out by the national Korean Neutron Beam Users Association (KNBUA).

A technical tour to the HANARO Reactor and Neutron Guide Hall was organized and guided by Mr Chang He Lee (KAERI) in the afternoon session of the 2nd day. The tour showed the impressive array of modern instruments, detectors and peripheral equipment largely built by the staff of the HANARO reactor with some collaborative advice from international institutes. The HANARO reactor is celebrating its 15th anniversary and, with its new cold neutron source – inaugurated on the 1st November 2010 – has promise of being a leading international institute for materials science and neutron beam applications.

During the 3rd day, round table discussions established:

- Ways to improve the implementation of the new regional TC project on neutron beam applications proposed at the 2009 consultants meeting.

- The need for closer collaboration among all the neutron centres in the region and their individual national IAEA representatives in matters concerning this major project of coordinating the national interests and the regional interests to promote harmonious long term collaborations and socio-economic benefits.

- The desirability of enhanced operations in AONSA and its retention of independence from the national nuclear institutes but with a close linkage region-wide to those institutes.

- A recommendation that a meeting of directors of those institutes should be aligned in proximity to AONSA Executive meetings as they moved systematically from country to country. This would be the preferred way to coordinate AONSA and institute cooperation for the strategic developments needed in the region.

In the procedure, a matrix of the needs of the large and small centres was constructed to define the most desirable ways for all reactor- and spallation-based neutron source centres to contribute expertise, share of the beam time and needed training. The meeting agreed that

spallation neutron centres should be counted as equal participants to research reactor centres. This process established the value to the large new facilities of international collaboration.

As demonstrated by the European and USA experience, for example at ILL (Grenoble), IPNS (Argonne) and NIST (Gaithersburg) the contestable (peer reviewed) entry of projects from other countries to a particular facility is an excellent stimulus to the science and technology of that facility and a net benefit to the nation hosting it. For the medium flux centres, the needs were concerned more with prioritized instrument development to reach the highest standard of performance and to install new instruments and applications of neutron beams to match with local demand (for example from universities and local industry).

Good examples of long term bilateral collaborations illustrate the value to both the users and the centres who have a clear need to extend these processes. Despite strong demand for access to instruments in the new institutes of Australia, Korea and Japan, a clear willingness was found to accommodate new international users chosen competitively in the peer review process. There was also a willingness to accept a mentoring role for those applicants and exchange personnel in both instrument construction and science/engineering programs.

At the very end of the 3rd day, the meeting conclusions and recommendations were prepared, including a common work-plan for future actions.

The Annexes of this report include:

I. book of individual contributions
II. supporting letter for the IAEA regional TC project
III. meeting agenda, and
IV. list of participants.

Copies of the presentations, papers and administrative information were distributed during the meeting to all participants and may be obtained from the Scientific Secretary on request. The full meeting report as a working document is also available on request from the Scientific Secretary.

3. SUMMARY AND CONCLUSIONS

The meeting participants concluded that:

- It was now urgent to initiate the elements of the regional TC project concept for the next cycle 2012- 2013 as the lead-time to involve students, young scientific staff, engineers and technicians from the developing countries in the sharing and development programs envisaged, will take time to start and the need is great.

- To this end, all means for an early start were to be investigated through the IAEA channels, national RCA representatives, the national-regional nuclear institutions, and universities.

- Actions of highest priority are in “the education, training, and mobility of researchers, especially from developing countries, in order to have access to the technical expertise and applied neutron programs at operational neutron scattering centres”. The potential

engagement of this by the IAEA activities with AONSA's similar plans is a high priority and AONSA is willing to accept this.

- The HANARO example shows how much can be achieved by careful planning for future funding availability and the "one by one" construction to perfection of instruments of the highest quality in each step.

We reiterate and paraphrase the needs:

- "Smaller and medium facilities need to have at least one high quality well-operated (high availability, with good quality measurements) standard neutron beam instrument that can help develop an expanded user base"

- "Instrument development is an area with good potential for substantial cooperation, as there is a real need and potential for a better collaboration on instrumentation"

- AONSA is willing and will collaborate as fully as possible with the IAEA (e.g. choice/priorities of projects).

4. RECOMMENDATIONS

The consultancy considers that the IAEA Coordinated Research Projects (CRP) and regional Technical Cooperation (TC) projects will be of very great value to developing countries in the East-Asia Region if applied now. This is to avoid formation of a disparity of socio-economic opportunity from neutron beam applications in our region. The benefits are already becoming clear from Japanese, Korean and Australian experience.

The meeting participants therefore recommend to the IAEA, AONSA and Member States

- Support regional neutron beam networks and cooperation through AONSA (users) and neutron beam facilities

- Support and organize a further regional IAEA CM in 2011 on the topic of neutron beam networks in the region

- Continue support of the AONSA neutron school

- Prepare and publish a catalogue of neutron instruments and associated expertise available in the region including contact information and procedures of how to access the beam (web based and hard copy)

- Prepare and publish the promotional brochure or other IAEA's publication on applications of neutron beams in various areas

- Through future regional TC projects, put in place exchange programmes of long-term scientific visits of early-career scientists, students, postdocs, technicians and engineers.

- Organize parallel regular meetings of Directors of neutron facilities, to be held in conjunction with the AONSA Executive meeting to assist in co-ordination and planning details of technical and scientific exchanges.

5. WORK PLAN* FOR THE NEXT 12 MONTHS

Action	Deadline	Coordination
Hold regular AONSA Neutron School in the region (e.g. in 2011 in Japan)	Annual action	AONSA
Collection of educational material suitable for inclusion in an online educational resource portal (e.g. AONSA neutron school lectures and exercises)	Annual action	AONSA
Collection of standardized information on facilities, instruments and contact information for neutron beam users. Publish a hard copy book also through the IAEA	2010-2011	ANSTO & IAEA

* In addition to the meeting conclusions and recommendations.

6. CONCLUDING SESSION

The participants concluded that the Meeting was a very useful and constructive event. Mr Danas Ridikas (IAEA) thanked Korean representatives for hosting this meeting, for exceptionally good local organization and assistance, and also for providing financial support for two participants from developing countries. Equally, the Scientific Secretary thanked all participants for their valuable contribution and inputs to this meeting and recommendations.

ANNEX I. INDIVIDUAL EXPERT CONTRIBUTIONS

(In the order of presentations)

1 Australia, Mr Robert A. Robinson

Neutron Beams at OPAL

The 20-MW OPAL Reactor, managed by the Australian Nuclear Science and Technology Organisation on its site just outside Sydney, is a multi-purpose reactor with strong programs in neutron beam science, transmutation doping of silicon and radiopharmaceutical production. Funding was approved in 1997, the contract for construction by the Argentinian company INVAP S.E. was signed in 2000, and the reactor went critical in 2006. The reactor features a large (20-litre) liquid-deuterium cold neutron source, supermirror guides and a large neutron guide hall. The first scientific paper was published in 2007, and as of October 2010, there have been 6 open proposal rounds, producing 57 referred scientific articles so far. Demand is typically 50% from Australian universities, 20% from ANSTO itself, and 30% from overseas, including New Zealand. There is consistent significant external demand from China (including Taiwan and Hong Kong), Singapore, USA, UK and South Africa.

As of October 2010, 7 instruments are fully available to users, with a further 6 instruments under construction or in design. These include a cold-neutron triple-axis spectrometer, being constructed with funding from the National Science Council of Taiwan, and three instruments funded in 2009 as part of the Australian Government's Super-Science initiative, in response to the Global Financial Crisis.

The user program is fully open to outsiders, for non-proprietary research intended for publication in the open literature, via a 6-monthly proposal round. Review of proposals also involves overseas researchers. The 7th round of proposals is now open, with a closing date of 22 May 2011.

In the latest proposal round, which closed on 24 October 2010, demand was 59% in excess of the supply of days, with request for almost 1000 beam days across 7 instruments. Roughly 200 proposals were received, including 14 for the chemical- and bio-deuteration facilities that we also operate as an open user facility.

Finally, further construction is under way, with the construction of a new office complex, including a laboratory wing to house the National Deuteration Facility next to the existing Guide Hall, to hold an extra 150 people, including users and visitors. We are also making plans for a second guide hall, on the other side of the reactor, which would allow a total of ~32 instruments in total, as compared to the present funded complement of 13, and a total of 18 possible in the present building configuration.

2 Bangladesh, Mr Md. Muslehuddin Sarker

Present Status of Neutron Beam Facilities and Research Programs in Bangladesh around TRIGA Mark-II Reactor Research

Experimental and Irradiation Facilities:
A 3 MW TRIGA Mark-II research reactor was installed at the Atomic Energy Research Establishment (AERE) in late 1986. This Reactor has extensive experimental facilities. It can be used to provide intense fluxes of neutrons and gammas for research, training and radioisotope production for their uses in the field of medicine, agriculture and industry. The experimental and isotope production facilities of the reactor are mentioned below:

- A central thimble that enters the center of the core lattice makes possible the extraction of a highly collimated beam of radiation or insertion of small samples into the region of maximum flux.
- A rotary specimen rack (lazy susan) to accommodate up to 81 samples simultaneously for activation analysis and isotope production is located in a circular well in the reflector assembly of the reactor.
- A pneumatically operated "rabbit" transfer system is located in the g ring of the core, which penetrates the reactor core lattice, and is used for the production of very short-lived radioisotopes.
- The reactor has three radial and one tangential beam ports for the experimental purpose.
- In-core irradiation facilities, there is a large thermal column hexagonal and triangular cutouts that has initially filled with concrete blocks.
- The space in the water around the reflector can also be used for the irradiation of the samples.

Beam Port Facilities:
The beam ports provide tubular penetrations through the concrete shield and the reactor tank water, making beams of neutrons and gamma radiation available for a variety of experiments. They also provide an irradiation facility for large (up to 15.24 cm in diameter) specimens in a region close to the core. There are four 15.24 cm diameter beam ports divided into two categories as follows: (i) Radial beam ports, and (ii) Tangential beam port.

Radial beam ports
There are three radial beam ports, each of which penetrates the concrete shield structure and the reactor water. One radial port terminates at the outer edge of the reflector aluminum can. A second radial port terminates at the outer edge of the reflector can; however, 15.24 cm diameter radial hole is drilled through the graphite at this location. As a result, this port provides a beam of neutrons originating in the core, but is physically separated from the core by the outer edge of the aluminum reflector can and the end of the beam tube. The third radial beam port pierces the graphite reflector (called Radial piercing beam port) and terminates at the inner edge of the reflector can. This beam port permits insertion of samples to a position adjacent to the core.

Neutron Scattering using Radial Piercing Beam Port
Bangladesh has stepped into the area of neutron scattering research with the installation of a Triple Axis Neutron Spectrometer (TAS) at the piercing beam port of the TRIGA Mark-II research reactor at AERE, Savar in June, 1992. The objective of establishing the facility is to carry out research in condensed matter physics using neutron scattering technique. The

technique is essential for characterizing and developing of condensed matter by studying their structural and dynamic properties. Recently we have installed a High Resolution Powder Diffractometer at the position of Radial beam port-2.

Scope of research

Triple Axis Neutron Spectrometer is mainly used for the following studies:

a) Neutron Powder Diffraction Studies
   Structural characterization of condensed matter like metals, alloys, ceramics, polymers, super conductors and various types of magnetic materials is done by these studies.
b) Small Angle Neutron Scattering (SANS) studies
   Shape, size and molecular weights of particles in various kinds of biological aggregates and polymers are determined by this method.
c) Studies of texture in materials
   Existence of texture in industry important and structural materials is identified using this technique.

High Resolution Powder Diffractometer will be used for the following purposes:

a) Expansion and modernization of the experimental facilities of Neutron Scattering, Neutron Activation Analysis and Neutron Radiography to maximize the utilization of the neutrons produced in the TRIGA Mark-II Research Reactor.
b) Establishment of state-of-the-art research facility around the TRIGA Mark-II research reactor for providing the scope of modern and international standard laboratory facility for researchers, students and teachers of universities and other research organizations of the country to promote research & development and higher academic programs of the country.
c) Enhancement of the capability of analytical services using nuclear techniques.
d) Development of human resources for potential use & applications of nuclear science and technology.

Further plan

We have a plan to install a PGNAA system for the R & D Purposes.

To run the above activities effectively and make useful in the field of neutron beam research, it is necessary to have educational/advanced training of the young scientists from developing countries like Bangladesh through IAEA and AONSA.

3 China, Mr Yuntao Liu

Progress report of the neutron scattering facilities at CARR

A research reactor, China Advanced of Research Reactor (CARR), was built at China Institute of Atomic Energy (CIAE). CARR is a multipurpose research reactor, 60 MW, the expected maximum undisturbed neutron flux at the reflector is 8×10^{14} cm^2 s^{-1}, its main applications include neutron scattering, neutron activation analysis, fundamental nuclear physics, isotope production, silicon doping and so on. CARR has 9 horizontal beam tubes, as one of its applications, neutron scattering facilities owe 7 horizontal tubes. Among these tubes, four double beams and two single beams are available for thermal neutron scattering facilities, and one tube is for the cold source, through the four neutron guides cold neutrons are transferred to the guide hall, which is a 30 m × 60 m hall.

At the first stage ten instruments are planning to be built, which are a high resolution powder diffractometer (HRPD), a neutron residual stress diffractometer (NRSD), a neutron texture diffractometer (NTD), a neutron four-circle diffractometer (NFD), two triple-axis spectrometers (TAS), a neutron reflectometer (NR) with the vertical scattering geometry , a 30 m small angle neutron scattering (SANS) instrument, a cold neutron imaging (CNI) and a thermal neutron imaging (THNI) facilities, the location sketch is shown in Fig. 1.

HRPD is totally designed and fabricated by CIAE which will finish the set up at the end of 2010. The sample table and the test rig of NRSD was imported from the Studsvik reactor in Sweden, the other components were fabricated in China or contributed by IAEA, which will be completed at the end of this year. The CIAE-JCNS-TAS, NFC, and NTD were relocated from FZ-Jülich, Germany under an international agreement of cooperation. The primary installation had been performed. The Iop-CIAE-TAS is supported by Institute of Physics in Chinese Academy of Sciences (CAS) cooperating with CIAE and led by Prof. Pengcheng DAI, which is expected to be set up in two years. The SANS and NR were co-developed with Institute of Chemistry, CAS led by Prof. Charles Han, their construction works has been done. Furthermore, the CNI and THNI conceptual design have been finished and are waiting for the budget.

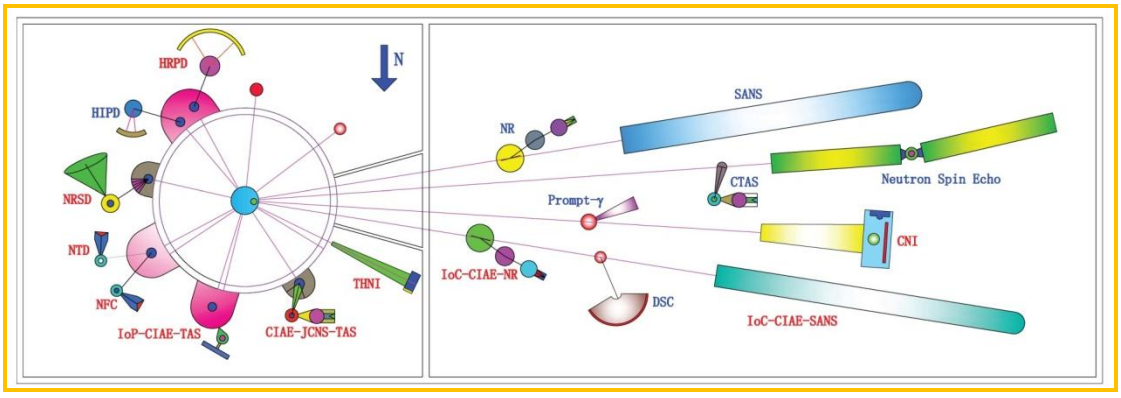

Fig. 1 The sketch of the present and future neutron scattering facilities at CARR.

4 India, Mr Samrath Lal Chaplot

BARC operate a National Facility for Neutron Beam Research at the Dhruva reactor. The National Facility is regularly utilized in collaboration with about 200 users from various universities and other academic institutions. During last five years, over 300 papers have been published in peer-reviewed international journals.

India has a formal national users' programme of the Neutron Facility operated through the UGC-DAE Consortium for Scientific Research. At present there are over 25 active projects under this programme. BARC also has a faculty of Ph.D. supervisors recognized by the University of Mumbai and the Homi Bhabha National Institute.

BARC has been regularly organizing Schools on neutron scattering in cooperation with UGC-DAE-CSR. So far 14 such Schools have been organized which involved training in basic principles and various applications in physics, chemistry, biology and materials science, often including hands-on experiments at Dhruva.

Recently we organized the 3rd Asia-Oceania Neutron Scattering Association (AONSA) Neutron School during 4-9 October 2010. This School was sponsored by Board of Research in Nuclear Sciences, Department of Atomic Energy, Government of India. It was organized in association with Indian Neutron Scattering Society and in cooperation with IAEA. The participating students were from: Australia and New Zealand (5), Japan (2), Indonesia (3), Korea (3), Taiwan (5), Malaysia (1), and India (19). The lectures were delivered by 7 Indian and 6 foreign scientists, and hands-on experiments were conducted by the respective instrument scientists at the Dhruva reactor.

It may be recalled that India has been actively contributing towards the IAEA-RCA programme in education, science and applications of neutron beams since its inception. IAEA and AONSA may be expected to have a complementary role in promoting the regional cooperation in their capacity at the Governmental and users levels respectively. Travel support is an important requirement in promoting the regional cooperation and IAEA could consider providing some financial support to AONSA for this purpose.

5 Indonesia, Mr Edy Giri Rachman Putra

Neutron Beam Instruments at RSG-GAS BATAN

The neutron scattering facilities at the Science and Technology Research Center Complex in Serpong, Indonesia which is operated by the National Nuclear Energy Agency of Indonesia (BATAN) located about 30 km from the Jakarta International Airport and has 7 neutron beam instruments. Regarding to the current status, performance, and future works, etc. at least 3 – 4 instruments are available and ready to be utilized and shared to other member states in the region (Malaysia, Philippine, Thailand, Vietnam, Singapore) for medium-level of scientific research or preliminary works and education.

What we have at present:

1. The Research Reactor operating at (only) 15 MW with maximum flux ~ 1×10^{14} cm^{-2} s^{-1}.
2. Seven neutron beam instruments are running or in operation (3 – 4 instruments are ready to be utilized).
3. Experienced and skilled-scientists and technicians for maintaining the instrument and doing neutron experiment.
4. The young and eager personnel staff member.
5. Two IAEA CRP and TWAS projects, for enhancing the performance of instruments and for characterizing nuclear materials and also biological materials.
6. "Informal" collaboration with the scientists from Japan, Malaysia and India.
7. Local/national level symposium on neutron and X-ray scattering is organized regularly every 2 years. In 2007 (ICNX2007), a 5-days workshop was held prior to the conference and the events were at the regional/international level supported by IUCr, ICTP, IAEA and Indonesian government.

What we offer:

1. 170 days yearly of beam time.
2. Open for regional users/member states, based on the scientific interest (research collaboration under the IAEA or other schemes).
3. Training the postgraduate students or young scientists from the region (educational program).
4. Preliminary studies (medium level research works) on neutron scattering experiment using; diffractometer for residual stress measurement (RSM), SANS spectrometer (SMARTer), high-resolution powder diffractometer (HRPD), texture diffractometer (FCD/TD), and neutron radiography (NRF), as well as for neutron instrument development.

Challenges:

1. Under-utilized instruments.
2. Lack in scientific aspect in application of the instruments for conducting real research.
3. Old-fashion detecting and controlling system that constraints our activities in maintenance, repair even developing the instruments.
4. About 3 - 5 young scientists (in total) are joining the laboratory.
5. Chemist, Biologist, Pharmacist, materials scientist, etc. are not really exposed with neutron scattering techniques.

The goals:

1. Enhancement of the utilization of the reactor and the neutron scattering instruments as well.
2. Improvement of the capacity and the capability of personnel attached to each instrument.
3. To be the "collaborating center" in the Southeast Asian region by strengthening collaboration in the region by sharing the modalities (samples, simulation, etc.) with others, i.e. Malaysia, Philippine, Thailand, Vietnam, Singapore, etc.

What we need:

1. Training/formal education for young staff members (scientists and technicians) in doing neutron sciences and experiment, including instrumentation development in the established laboratories/universities.
2. Regular meeting/workshop for providing information sharing and exchange to maintain and to increase the use of the instruments.
3. The experts from the established neutron scattering facilities/universities in the region who regularly visit and meet the members on the particularly research project, under the IAEA or other schemes.
4. A strong user group including the regional user group (elastic, low-*Q*, radiography, instrumentation and modeling/simulation).

Commitment:

1. The Instruments are available for other member states.
2. Support the possibility of improving the capability of other member states in developing their instruments by providing the chance of using our instruments (resource sharing).

The actions:

1. Providing the information of facilities: beam time schedule, instruments specification, main purposes, contact person, etc. (in standard form) in the website/portal.
2. Listing the common research interest from other member states who are willing to use BATAN's facilities.
3. Listing the Indonesian scientists who have been exposed or are still doing neutron scattering experiment in abroad.
4. Proposed National and Regional Project Concept for IAEA TC program in Neutron Scattering for 2012 – 2014 cycles, and following cycles regularly.
5. Promoting the neutron sciences for students/young staff members to study abroad as well as to other scientific societies/associations/research groups in Indonesia.
6. Organising the workshop for nanostructure studies using SANS in March/April/May 2011, joint activity with the Indonesian Nanotechnology Society.
7. Organising the AONSA EC meeting in May 2011.
8. Organising the IAEA Coordinated Meeting in September/October 2011.
9. Organising the "AONSA? Neutron School" in 2012 (for student).
10. Organising the "IAEA Neutron School/On Job Training" in 2012, 2013, 2014 (for regional scientists/ researchers).

6 Japan, Mr Wataru Utsumi

Overview of the Status of J-PARC, JRR-3, and JRR-4

A pulse neutron source (J-PARC) and two research reactors (JRR-3 and JRR-4), which are actively used for neutron science and technology, are located at the Tokai site of the Japan Atomic Energy Agency.

J-PARC (Japan Proton Accelerator Research Complex: joint project between JAEA and KEK) is a multipurpose accelerators that employ various types of secondary particle beams (neutrons, muons, kaons, neutrinos, etc.) generated by proton-nucleus reactions. Neutron experiments can be performed at the MLF (Materials and Life Science Experimental Facility), which began user operations in December 2008. Nine neutron instruments (beamlines) such as a 4D Space Access Neutron Spectrometer, Super High Resolution Powder Diffractometer, Cold-Neutron Disk-Chopper Spectrometer, Engineering Materials Diffractometer, etc. are available for general use, and three are currently in the commissioning stage. In addition, six more instruments have been budgeted or under construction. Thus, of the 23 available ports, 18 beamlines are either working or budgeted. Since November 2009 accelerators have been operating at 120 kW with a very high availability (～90%) for user programs. The beam power will realize the designed goal of 1 MW by 2015. Of the approximately 200 proposals collected in FY2009, more than 30% were from industrial users. The "J-PARC Users Office" provides user support related to the procedures for working at J-PARC, including accepting proposals, registering, issuing ID cards, providing Visa application support, etc. Moreover, the English speaking staff provides daily life supports for foreigners (accommodations, car rentals, and general information).

JRR-3 (Japan Research Reactor-3) is a light-water–moderated and cooled pool type reactor. JRR-3 was built in 1962 as the first domestically produced reactor. After a large-scale modification in 1990, it has been operating seven cycles per year (175 days) with a thermal output of 20 MW, and has been utilized for various neutron beam experiments and neutron irradiation (production of silicon semiconductors and radioisotopes, tests of fuels and materials, etc.). For neutron beam experiments, 19 instruments owned by JAEA and 13 instruments constructed by universities are in operation. These instruments are used for structural determination of crystals and proteins, dynamical studies of materials, radiography, residual stress measurements, prompt gamma-ray analysis, etc. Most instruments are open to general users through "the JAEA Common-Use Facility Program" or "the Inter-University Research Program". In FY2010, more than 600 proposals were accepted. To encourage industrial applications, a special program, designated as "Trial Use", has been in effect since 2006. This program allows beginners in neutron experiments from the industrial community to receive technical support from neutron specialists and to use the facilities free of charge. Thanks to this program, the number of the industrial users has greatly increased. Most users of JRR-3 are Japanese. However, international collaborations with researchers at JAEA or Japanese universities would be the proper way for the foreigners to access it.

JRR-4 (since 1965) is a light-water–moderated and cooled swimming pool type reactor with a thermal output of 3.5 MW. It has been utilized for medical irradiation (BNCT: boron neutron capture therapy), biological irradiation experiments, activation analyses, and radioisotope production. Additionally, JRR-4 has been used to educate university students and to train reactor engineers.

J-PARC is an international public facility open to various users around the globe. In particular, it is expected to become the Regional Research Center of Asian/Oceanic Area for neutron science. Therefore, international collaboration is a key to the success of J-PARC. Proposals from Asian/Oceanic countries and collaboration at J-PARC are greatly welcomed. Previously, Japan has been contributed to the development of research reactors and neutron sciences in many Asian countries (consultant and/or technical support for the construction of reactors and neutron instruments, education and training of engineers, dispatch of technicians, reception of students or young scientists, international collaborations in various neutron experiments, hosting conferences and workshops, etc.). We will continue these good partnerships to create the coalitions and users' network in neutron science and technology, and make a positive contribution to the activity of AONSA.

7 Malaysia, Mr Abdul Aziz Mohamed

MALAYSIA NEEDS AND SUGGESTION

Since the first Malaysian neutron beam instrument i.e. neutron radiography was comission in 1987, and then followed by small angle neutron scattering (SANS) facility in 1995, neutron beam activities in Malaysia has reasonably progressed through IAEA technical programmes and scientific meetings. To further strenghten the development, Malaysian Nuclear Agency has established a national networking group called Reactor Interest Group (RIG) in 2002 to help drive the Malaysian neutron beam applications and reactor operation groups. This group comprises of researchers and acedemia from the Malaysian Nuclear Agency and other Malaysian research institutes, universities and other related research institutes.

The main aim of this group is to improve and enhance on the usage of neutron beam methods in science and engineering. With support from the government through Ministry of Science, Technology and Innovation of Malaysia (MOSTI), RIG has achieved some of its core objectives mainly for training and educating students from higher learning institutions – undergraduate and postgraduate, scientists and engineers (especially young people) in the field of neutron beam. Both experimental and simulation approaches have been implemented, to a certain level of standards, in the upgrading and enhancement of the neutron beam facilities and the researches carried out using these facilities. Users of these facilities include from non physical sciences, e.g. biotech, nanotech and greentech, are currently being sought and consultation with these groups are actively engaged. A number of dissertations and journal papers have been also produced from researches carried out using these facilities.

To upgrade the neutron beam research to the next level, RIG realised that it has to form regional networking with high flux research reactors or neutron sources or neutron sources to further improve data quality and analysis and bring the research skills to a higher level. Currently, international collaborations on using neutron beam techniques is carried out is mainly on ’ad-hoc’ or ’piggy-back’ basis, that rely on personal and peer-to-peer connections. TC and CRP projects/programmes through IAEA platform seemed to be the effective mechanism to strengthen the international/regional networking and collaborations.

Malaysia has actively involved and participated in AONSA meetings (as an observer member) and in AONSA neutron summer school. From observation through these involvement, Malaysia would like to recommend that AONSA plays a more effective role in promoting the neutron science to relevant government bodies and scientific associations in the Asia-Pacific region, in particular countries with low flux reactor and no reactor facility. The promotion on neutron science activities in the region could be undertaken by AONSA and IAEA contact persons in the member states countries.

RIG sees the importance of establishing collaboration with synchrotron, x-ray and other related fields to further support the development of neutron beam applications in Malaysia. RIG also believes that a collaboration with advanced computing and ICT communities would bring the neutron science to a next level of scientific recognition and acceptance by the society and industrial sectors in Malaysia. The strong support by big facilities in software and hardware on instrumentation is really needed by Malaysian neutron beam research group. We recommend that IAEA to be the facilitator in coordinating and recommending the needs proposed by Malaysian RIG members.

8 Vietnam, Mr Nhi Dien Nguyen

NEUTRON BEAM UTILIZATION AT THE DALAT RESEARCH REACTOR

The 500-kW Dalat Research Reactor was upgraded from 250-kW TRIGA reactor. Since March 1984 the reactor has been used mainly for radioisotope production, neutron activation analysis, neutron beam utilization for fundamental and applied researches, education and training. There are four beam ports and one thermal column that were retained from the original TRIGA design. At present only two beam ports and a thermal column are used. Because of low power and low neutron flux, neutron scattering technique cannot be properly used at the Dalat RR. Some experimental facilities have been installed at two beams, including: a) + Two-HPGe detector spectrometers at tangential channel No.3 for fundamental and applied researches; b) + Prompt gamma neutron activation analysis (PGNAA) system at piercing horizontal channel No. 4.

The first system is used for research on (n, 2γ) reactions for nuclear data measurement and nuclear structure study, such as:

- Total neutron cross section measurements for U^{238}, Fe, Al, Pb on filtered neutron beams at 144 keV, 55 keV, 25 keV and evaluation of average neutron resonance parameters from experimental data.
- Gamma ray spectra from neutron capture reaction of some reactor materials on filtered neutron beams at 55 keV, 144 keV.
- Average neutron radiation capture cross sections of U^{238} for 55 keV and 144 keV neutrons.
- Isomeric ratio of $Br^{82m,g}$ created in the reaction $Br^{81}(n,\gamma)Br^{82}$ for 55 keV and 144 keV neutrons.

The PGNAA system has been used for

- Analysis of Fe, Co, Ni, C in steel samples; Si, Ca, Fe, Al in cement samples; Gd, Sm, Nd in uranium ores; Sm, Gd in rare earth ores; trace elements of B, S, N, P, Cd, Cl, … in biology samples;
- Measurement of Hydrogen Index in base-rock for oil field;
- In-vivo activation analysis of essential elements Ca, Cl, N and P in the whole body and of the toxic elements Cd, Hg in a body organ for medical diagnosis of various diseases.

In order to meet the requirements on research, education and training, one more beam port (No. 2) has planned to open in next year for installation of new PGNAA system using Compton suppression gamma spectrometry system with BGO detectors.

So far, there are groups using neutron beam, they are polymer production group and nuclear physics data group. Due to lack of neutron scattering facilities at DRR, polymer samples for its characterization have been sent to measure on SANS of RSG-GAS reactor in Serpong, Indonesia and JRR-3 reactor, Japan. Some our staffs have been supported for training at HANARO and JRR-3 facilities.

Participating in the East Asia-Pacific regional cooperation we are willing to send our young staff of these two groups to training and doing experiments at advanced neutron scattering centers, such as OPAL (ANSTO); HANARO (KAERI), JRR-3 and J-PARC (JAEA), RSG-GAS (BATAN), CARR (China) for 6 to 12 months, as well as for Master and PhD courses. In this case, the support from IAEA, regional co-operation and Government of Vietnam is important for such collaboration.

9 New Zealand, Mr Duncan McGillivray

In New Zealand we are growing a neutron user community, a similar situation to that of several other countries in the region. Neutron-based research covers techniques that are applicable to a wide range of problems throughout society. There are, however, a number of activation barriers to creating active and regular users, which I summarise as a) lack of familiarity, b) lack of opportunity, and c) momentum.

a) Lack of familiarity

Potential users who are unaware of the possibilities can be reached in several ways:
Outreach: Exposure of potential users to regular users of neutron-based research. This may involve organisation of workshops, visits from experts, coordination with X-ray societies, and proactive efforts from neutron sources.
Scope for regional improvement: regionally there are concentrations of neutron specialists based around facilities. A scheme should be organised to enable ***mobility of these experts*** *to potential user communities in the region, particularly long term.*
Education: Initial exposure is almost always through *mentoring* - typically with instrument scientists - followed by training leading to independence.
Scope for regional improvement: mentoring requires access to experts, with expertise in neutron techniques, willingness to collaborate, and interest in the science involved. A regional ***database of experts****, meeting these criteria, could be established with contact details. For users wishing to develop their skills more fully, the regional* ***neutron school*** *(AONSA school) is useful, but needs to supplemented by local schools.*

b) Lack of opportunity

Use of neutron facilities for research has particular needs. Amongst these are access to instruments suitable to measurements, access to beamtime, and money for travel.
Scope for regional improvement: a ***database of instruments****, with their capabilities, that are both functional and available to external (international) users, has been previously agreed upon and needs to be implemented. This needs to be linked to* ***information on applying for beam time****. One of the major impediments to performing facility research is obtaining travel money.* ***A regional fund*** *providing travel money, not linked to a particular facility, especially for new facility users, should be established.*

c) Momentum

External users based in academic institutions, are strongly motivated by student timelines and research grant schedules. This is hampered by significant delays between experiment conception and allocated experiment time, hindering research momentum.
Scope for regional improvement: to maintain momentum, the time between idea conception and full experiment performance needs to be minimised. This can be achieved through ***coordination of proposal rounds*** *between major facilities, in order to minimise time to beam time. A significant advantage would be achieved by enabling* ***preliminary and test measurements*** *at facilities outside the major centres, on suitable instruments.* ***Access to travel funds*** *for new research programmes to enable test measurements outside research funding schedules is important as well.*

10 Philippines, Mr Pablo P. Saligan

The Philippine Nuclear Research Institute recognizes the need for maintaining knowledge and expertise in nuclear technology in order to support the country's strategy regarding the benefit that could be derived from nuclear energy in a safe manner. In the 1960's the country started manpower development centered on the neutron research and applications using the Philippine Research Reactor I. The present PNRI program for human resource development in nuclear technology is based on the operation and utilization of small neutron equipments/facilities and making them available to Filipino science workers. The PNRI anticipates that its neutron facilities and expertise would be insufficient to cover the training and applications in the broad aspects of nuclear science. Thus the PNRI program envisions to enable local users to perform advanced neutron applications through international technical linkage, cooperation and collaboration with countries that possess advanced neutron sources, and also with countries that are in similar position with the Philippine.

Every country has its own national nuclear program. Each is aware that the international sharing of knowledge, expertise and resources is the best way to address concerns especially on issues and aspirations that are common to everybody. So it is important that an international organization such as the IAEA supports networking and cooperation between member states especially among those who are geographically near to each other and thus share to some extent common customs and traditions, and scientific cooperation. The Philippines supports that the present neutron consultancy meeting be extended to a regional technical cooperation program for establishing a regional neutron center for collaboration, training and education. Considering that the Philippines present neutron program is still in the developing stages, international cooperation is a big part of its nuclear manpower strategy in terms of advanced training, education, and mentoring to a new generation of Filipino neutron workers.

11 Korea, Mr Kye Hong Lee

The goal which the HANARO Neutron Science Facility is aiming eventually is to become a world competitive user facility producing outstanding research outcome using excellent neutron instruments. Raising research and operating fund, hiring intellective scientists and engineers/technicians, fostering potential users, maintaining good user program and outreach will be key factors to fulfil this goal. In this context, it is natural for HANARO to support user associations not only KNBUA but also AONSA and IAEA because their vision is aligned with what the user facility is aiming for.

The role of HANARO in the Asia – Pacific region is sharing the neutron source, experience, service, and knowledge that the facility is maintaining. First of all, however, HANARO has to prepare an appropriate system for the international users to carry out their research in HANARO. It will be established step by step as the number of international user increases to become an internationally open user facility. Exchanging staffs and holding a regional conference periodically will definitely contribute to the good circulation of neutron science within the region.

In parallel, bi-lateral collaboration within the region is essential to promote broadening and strengthening its own user community communicating with corresponding country’s user community through closer sharing.

ANNEX II. DRAFT SUPPORTING LETTER FOR THE IAEA REGIONAL TC PROJECT

IAEA's Consultancy Meeting on Research Reactor Coalitions and Users' Networks: Education, Science and Applications with Neutron Beams in the East Asia-Pacific Region

Daejeon, Korea, 27-29 October 2010

Experts from eleven member states* in the Asia-Pacific region (representing facilities and user networks) request your attention to the need for IAEA Technical Cooperation (TC) support to allow critical developments now - in applied neutron beam methods in the eligible developing countries.

The meeting recognised:

- The strategic opportunity for the region from the multi-billion dollar investment in neutron facilities over the last 10 years, in particular in China, Korea, Japan and Australia.

- That this investment, if correctly coupled to the existing Asia-Pacific of research reactor capability, will produce new international co-operations, cultural and industrial benefits to all nations in the region.

- The urgent need for improved transfer of technical and scientific information between nuclear centres, improved training of students, post-doctoral fellows, engineers and technicians - by exchange mechanisms and by neutron schools in the region.

- The growing effectiveness of the Asia-Oceania Neutron Scattering Association (AONSA) through its neutron schools, executive planning meetings and intended major international conference in Japan 2011.

- A significant step taken at the meeting was the decision to coordinate regular meetings of directors of neutron facilities of the region in conjunction with the AONSA Executive meeting.

* Australia, Bangladesh, China, India, Indonesia, Japan, Malaysia, New Zealand, Philippines, South Korea, and Vietnam (also see Annex IV for the full list of participants)

ANNEX III. MEETING AGENDA

The IAEA Consultancy Meeting on
Research Reactor Coalitions and User's Networks:
Education, Science and Applications with Neutron Beams in
the East Asia – Pacific Region

October 27 – 29, 2010

KAERI, Daejeon, Korea

Wednesday, 27 October 2010

08:00-09:00	**Registration**
09:00-09:45	**Welcome & Opening Remarks**
	Mr. Jae Joo Ha (Vice President of KAERI)
	Mr Kye Hong Lee (Director, Neutron Science Division, KAERI)
	Mr Danas Ridikas (Scientific Secretary, Research Reactor Officer, IAEA)
	Self introduction of the participants; Selection of the Chairperson & *Rapporteur*
	Approval of the Agenda, Discussion & Administrative Arrangements
09:45-10:30	**Mr Danas Ridikas**, IAEA: Introduction & Objectives of the Meeting
10:30-11:00	*Coffee break*
11:00-12:30	**Mr John W. White,** ANBUG/AONSA, Australia
	Mr Robert A. Robinson, ANSTO, Australia
	Mr Md. Muslehuddin Sarker, INST/AERE, Bangladesh
12:30-14:00	*Lunch break*
14:00-15:30	**Mr Yuntao Liu,** CIAE, China
	Mr Samrath Lal Chaplot, BARC, India
	Mr Edy Giri Rachman Putra, BATAN, Indonesia
15:30-16:00	*Coffee break*
16:00-17:30	**Mr Wataru Utsumi,** JAEA, Japan
	Mr Abdul Aziz Mohamed, Nuclear Malaysia, Malaysia
	Mr Nhi Dien Nguyen, NRI/VAEC, Vietnam
17:30-18:00	**Discussion,** end of the 1st day

Thursday, 28 October 2010

09:00-10:30	**Mr Duncan McGillivray**, University of Auckland, New Zealand
	Mr Pablo P. Saligan, PNRI, Philippines
	Mr Kye Hong Lee, KAERI, Korea
10:30-11:00	*Coffee break*
11:00-12:30	**Mr Ki Bong Lee**, KNBUA, Korea
	Mr In Cheol Lim, HANARO/KAERI, Korea
12:30-14:00	*Lunch break*
14:00-15:30	**Technical Tour to HANARO RR and neutron beam facilities**
15:30-16:00	*Coffee break*
16:00-17:00	**Discussion: Development of Matrix of Common Interests**
	Discussion: Drafting of conclusions & recommendations
17:00	End of the 1st day
19:00	**Hospitality Event**

Friday, 29 October 2010

09:00-10:30	**Discussion: Regional role of ANSTO as an IAEA CC**
	Discussion: Drafting of conclusions & recommendations
10:30-11:00	*Coffee break*
11:00-12:30	**Discussion: Role of AONSA as a regional RR Users' Network in the area of neutron beams**
	Discussion: Drafting of conclusions & recommendations
13:00-14:00	*Lunch break*
14:00-15:30	**Discussion: Finalizing of conclusions & recommendations**
15:30-16:00	*Coffee break,* ***end of the Meeting***

ANNEX IV. LIST OF PARTICIPANTS

The IAEA Consultancy Meeting on
Research Reactor Coalitions and User's Networks:
Education, Science and Applications with Neutron Beams in
the East Asia – Pacific Region

October 27 – 29, 2010

KAERI, Daejeon, Korea

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Other participation from Korea on observer status:

Prof. Ki Bong Lee, KNBUA President, POSTECH

Prof. Sung Min Choi, AONSA Secratary, KAIST

Prof. Man Ho Kim, former KNBUA President and former AONSA President, KAIST

Photo of Meeting Participants