Submission to the ICSU Foresight exercise from AONSA, the Asia-Oceania Neutron Scattering Association

Preamble

This submission prepared for the ICSU Foresight exercise 2010 is from the Asia-Oceania Neutron Scattering Association, AONSA, recently formed by the coming together of associations in Australia, China, Chinese Taipei, India, Indonesia, Japan, Korea, Malaysia and Singapore. The large investment being made in nuclear and material science using nuclear facilities in Asia-Oceania has brought these associations together, through them AONSA reaches more than 1400 members.

AONSA's program is to support student summer schools, international conferences and promote collaboration across the region in the effective and complementary use of the new facilities that are being created or are available to all countries in our membership. It is our hope to intersect with the ICSU regional office in this work.

This submission wishes to recognize the important overarching benefits of ICSU in the past and suggest, for the Foresight exercise, the strategic importance in our region of the promotion of science through unrestricted international collaboration according to the general principles of the ICSU charter.

Outline of submission:

1. ICSU's agreed principle of universality of science
2. Potential for International collaboration in research through new networks
3. Benefits of international research collaborations
4. Drivers of scientific research into the future
5. "Collaboration in science, its progress and benefits to the societies"
6. Appendices (Introduction to AONSA, Regional Strengths)

1. The Asia-Oceania Neutron Scattering Association, AONSA, has as its primary aim, the promotion of science in the Asia-Oceania region in the most open and free way and AONSA wholeheartedly endorses the ICSU principle of the Universality of Science:

> "This principle embodies freedom of movement, association, expression and communication for scientists, as well as equitable access to data, information and research materials…. (and ICSU) opposes any discrimination on the basis of such factors as ethnic origin, religion, citizenship, language, political stance, gender, sex or age."

As the range of scientific disciplines expands, so does the need for this overarching body of ICSU to promote the unfettered interaction of international scientists in research, at meetings and conferences, and also to support the work of associations of scientists set up in specific discipline areas. This principle has been of great value to the Scientific Unions. We advocate closer ties to them and cooperation with newly formed Associations.

2. The current and projected, advanced neutron scattering facilities in the Asia-Oceania region offer potential for international cooperation which closely resembles that present in Europe in the 1960s and 1970s. Then, the science of neutron scattering was showing its scientific promise in physical, chemical and biological sciences. The Institut Laue Langevin, ILL, in Grenoble was established jointly by the French and German governments in 1967 and became a major focus bringing their *scientists and nations* together in the then early stages of the European Community. Other nations collaborated, the ISIS spallation neutron source and UK partnership followed. Now, ten European countries have ‘scientific membership’ and durable international collaborations between universities, other nuclear centres and ILL flourish. Access through contestable “user-oriented' scientific programs make Europe a prime example of the way in which long-term scientific collaborations between nations flow from such investments.

3. The ILL’s experience of putting into practice ‘the universality of science’ demonstrates the value of international research collaboration for breaking down barriers of ethnicity, gender, political or religious background as well as promoting the exciting and free interchange of scientific ideas through close cooperation during the progress of experimentation. The AONSA executive is committed to this same principle of universality through its member associations and intends that the parent organization will be seen as an effective mechanism for harmonious investigation and exploitation of neutron-based research in the region.

AONSA anticipates similar success in the Asia-Oceania region. International collaborative research, through scientific and technological access to the new and existing national facilities will be facilitated. Two international ‘summer schools’ (Korea and Australia) have already been held since AONSA’s formation in 2008, with planning for a third in India in 2010 in hand. The practice has been developed whereby the host association has about half of the students with the other half coming from all over the region, on a competitive basis and supported financially through AONSA.

Appendix 1 sets out the current Membership of the Asia-Oceania Neutron Scattering Association together with an extract from its Articles of Association setting out its aims. Appendix 2 outlines some of the facilities of the AONSA member countries.

4. Science and technology drivers

We identify as major scientific drivers of the next 20 years, human sustenance and world energy needs. The training and international cooperation in nuclear-related science and technology provided through AONSA is relevant to both of these. The materials and life sciences and nuclear transmutation thrusts, for example of J-PARC illustrate the relevance to:

- Environmental cleanup and water resources, improved solar energy capture in artificial photosynthesis, and solar power, all of which need deeper understandings and mimicry of natural processes through new materials.

- Nuclear energy in our region - which will play a significant role in the balancing the energy "budget". The large investments in the Asia-Pacific region made since 2000 in nuclear technology and in infrastructure will give the region a *leading edge* in science and training to underpin long term scenarios.

5. "Collaboration in science, its progress and benefits to the societies"

This charge in the Foresight exercise was expressed as:

> "Fundamentally, such science requires (large scale) international collaboration of scientists in research and in research infrastructures. The evolving nature of international science is one of the key areas to be explored in this foresight. The term 'science' is understood to include all domains of science (i.e., natural, social, human, medical and engineering sciences)."

One of the first outcomes from sustained international collaboration is cross-fertilisation of ideas by merging cultural perspectives of importance and scientific style. The evidence is that this trend is good for scientific productivity and quality.

AONSA's strategic plan in this area to boost collaborative research "productivity". In Asia Oceania such cooperation already has a strong base. The recently released *OECD STI Scoreboard 2009* noted that:

> "Researchers are increasingly networked across national and organization borders. Moreover, international co-authorship has been growing as fast as domestic co-authorship…. Scientific articles from Latin-America have more than tripled since 1993 and *those from south-east Asian economies (Indonesia, Malaysia, the Philippines, Thailand and Vietnam) expanded almost three times over the period.*

A second and equally important outcome is the mutual comprehension and cultural understanding that comes from collaborative work. This has been particularly remarkable in collaborations which have needed to use large central facilities in astronomy, nuclear physics, neutron scattering, synchrotron radiations, Antarctic research etc. The intergenerational consequences of this social outcome from the current developments in the Asia Oceania may be of great value in a common approach to the societal stresses that our region is bound to face in the next 30 years.

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APPENDIX 1

AONSA is an Association of Associations – our constitution is framed to minimize national distinctions.

Membership of AONSA (2010) **http://j-parc.jp/MatLife/en/AONSA/index.html**

Members (from Affiliated Societies)

- Australian Neutron Beam User Group (ANBUG)
- India Neutron Scattering Society (INSS)
- Japanese Society for Neutron Science (JSNS)
- Korean Neutron Beam User Association (KNBUA)
- Taiwan Neutron Science Society (TWNSS)

Observers (from major facilities, new projects, non-paying societies etc.)

Australian Nuclear Science and Technology Organization (ANSTO)

China Spallation Neutron Source (CSNS)

China Advanced Research Reactor (CARR)

Bhabha Atomic Research Centre (BARC)

Indonesian National Nuclear Energy Agency (BATAN)

Japan Proton Accelerator Research Complex (J-PARC)

Japan Research Reactor -3 (JRR-3)

Korean Atomic Energy Research Institute (KAERI)

Malaysian Nuclear Agency

Membership and observer status will be extended as appropriate in the region after consideration by AONSA. Other important sources exist or are under construction in the region. For example in China CPHS and Japan, Hokkaido University has a neutron source based on their electron linac and Kyoto Univeristy (KUR) has 5MW Research Reactor and 60 staff.

Extract from its Articles of Association

Article 1: Status

The Asia-Oceania Neutron Scattering Association (hereafter referred to as the Association) is an affiliation of neutron scattering societies, which directly represent users in the Asia-Oceania Region. The overriding purposes of the Association are to provide a platform for discussion and a focus for action in neutron scattering and related topics in the Asia-Oceania Region.

Article 2: Aims

(i) To identify the needs of the neutron scattering community in Asia and Oceania.

(ii) To promote optimised use of present neutron sources in the region.

(iii) To stimulate and promote neutron scattering activities and training in the Region, and in particular to support the opportunities for young scientists.

(iv) To support long-term planning of future neutron sources.

(v) To assist with the co-ordination of the development and construction of instruments for neutron scattering.

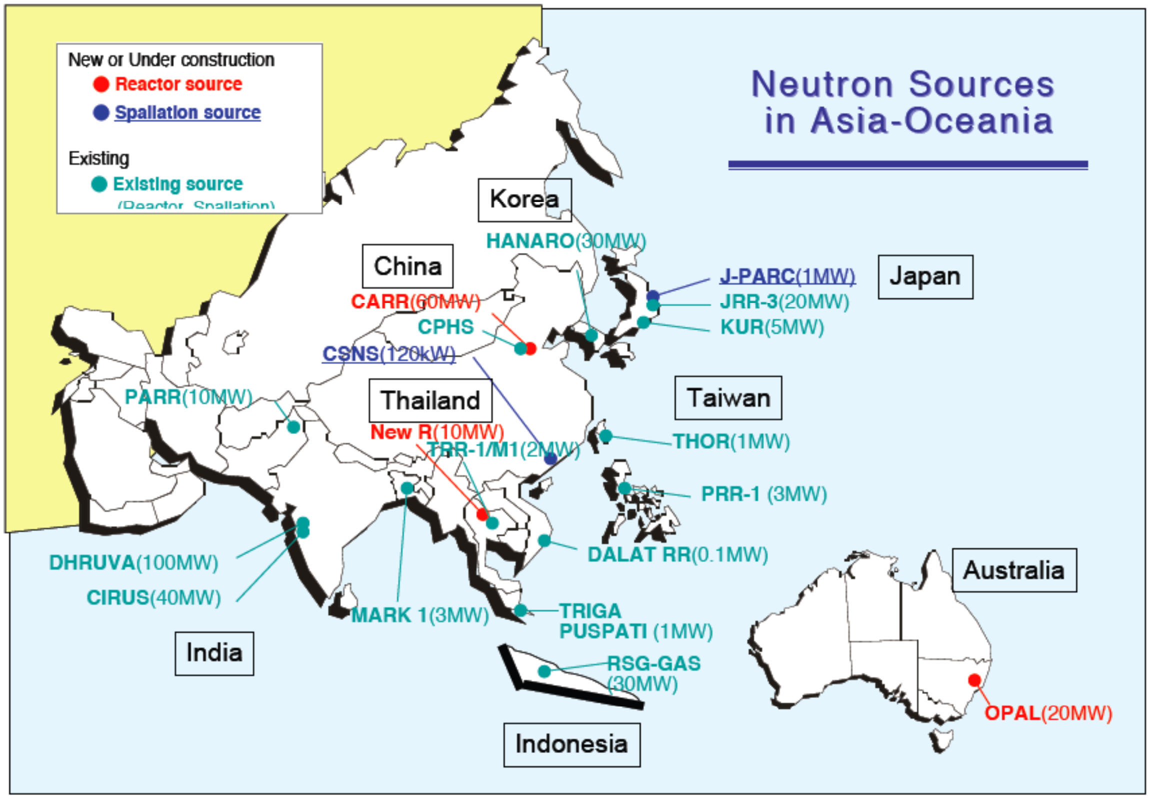
(vi) To promote channels of communication with industry.

(vii) To disseminate to the wider community information which demonstrates the powerful capabilities of neutron scattering techniques and other neutron methods.

(viii) To assist, if appropriate, affiliated bodies in the pursuit of their own goals.

(ix) To facilitate cooperation and networking amongst the neutron sources in the region.

APPENDIX 2 – Some major facility investments in Asia Oceania



Extracts from websites

Australia:

OPAL – the Open Pool Australian Light water reactor was opened in 2007. It is a 20MW reactor using low enriched uranium and cooled by water. OPAL is used by members of the scientific, medical, environmental, industrial and security communities, as well as Australian universities mainly for:

- Irradiation of target materials to produce radioisotopes for medical and industrial applications
- Research in the field of materials science using neutron beams and associated instruments
- Analysis of minerals and samples using neutron activation techniques - and delayed neutron activation techniques
- Irradiation of silicon ingots (termed Neutron Transmission Doping or NTP) for use in the manufacture of electronic semiconductor devices.

Built at an initial cost of AU$328M, the Australian Government subsequently provided AU$ 46M and AU$37M for instrumentation.

China – CSNS

The China Spallation Neutron Source (CSNS) is an accelerator based multidiscipline user facility to be built in Dongguan, Guangdong, China. The CSNS complex consists of an negative hydrogen linear accelerator, a rapid cycling proton synchrotron accelerating the beam to 1.6 GeV, a solid tungsten target station, and initially 3 instruments for neutron-scattering applications. The facility operates at 25 Hz repetition rate with an initial design beam power of 120 kW and is upgradeable to 500 kW. The primary challenge is to build a robust and reliable user's facility with upgrade potential at a fraction of "world standard" cost as constrained by a tight budget. The strategy is to glean the knowledge and knowhow that are currently lacking through international cooperation so that the responsible organizations of the project, the Institute of High Energy Physics (IHEP) and the Institute of Physics (IoP) of the Chinese Academy of Sciences, can develop and test prototypes of all the major components. Eventually, the technology will be transferred to domestic industry for production at lower costs. Meanwhile, IHEP and IoP will establish a scheme to work with universities in seeking external funding for building additional world-class scattering instruments. Construction of the CSNS is expected to begin in 2010 and will take 78 months to complete.

CARR

The CARR of the China Institute of Atomic Energy (CIAE), located in the southwest suburb, Fang Shan, of Beijing, is to succeed the Heavy Water Research Reactor (HWRR) that retired in 2007 after 50 years of operation. Currently with all major construction completed, CARR is expected to reach criticality in 2010. It is a 60 MW tank-in-pool type reactor using a D_2O reflector for inverse neutron trap, designed to yield an optimal thermal neutron flux of $8x10^{14}$ n/cm^2/s. The Neutron Scattering Laboratory (NSL)—a user facility—under CARR is to conduct neutron-scattering for fundamental research utilizing 7 horizontal beam tubes, 4 of them accommodating dual ports, of the reactor. One of these beam tubes will transmit neutrons from a cold source to the guide hall via four neutron guides that were purchased abroad. Installation of all major reactor components except the cold source has been completed. Through collaborative agreements a number of instrumental components have been relocated to CARR: a triple-axis spectrometer, a four-circle diffractometers and a texture diffractometer from Jülich Center for Neutron Science, Germany and a residual stress diffractometer from Studsvik Neutron Research Laboratory, Sweden. Participation research teams (PRTs) also play a key role in development of additional beamlines and scientific programs. For example, a PRT from the Institute of Chemistry of the Chinese Academy of Sciences (CAS) is building a small-angle scattering instrument and a reflectometer. Another PRT from the Institute of Physics of CAS is building a triple-axis spectrometer. These beamlines in conjunction with two in-house powder diffractometers will constitute a suite of instruments offering a broad range of capabilities to users starting in 2010.

CPHS

The CPHS is a newly approved project led by the Department of Engineering Physics of the Tsinghua University in Beijing, China. The primary parameters of the CPHS proton-accelerator are: power on target 16 kW, energy 13 MeV, average and peak beam current

1.25 and 50 mA respectively, pulse repetition rate 50 Hz, and pulse width ~0.5 ms. Phase I of the neutron source consists of a neutron target station (Be target, a solid-methane moderator and a H_2O reflector), and two beamlines: a small-angle neutron scattering instrument and an imaging/radiography station. The first phase of the CPHS Project is to be completed in 2012. Phase 2 will expand to include additional neutron beamlines and a proton research platform.

India

The Indian Neutron Scattering Society (INSS) was formed in June 2008 with an objective to promote the research and development activities of neutron-scattering science and applications and with members from both academic institutions and industry. A *National Facility for Neutron Beam Research* has been operating for nearly two decades at Bhabha Atomic Research Centre for basic and applied research in condensed matter science.

A national facility for neutron beam research is operated at the research reactor Dhruva at Trombay in India. The national facility comprises eight neutron-scattering spectrometers in the reactor hall, and another four spectrometers in the neutron-guide laboratory.
The national facility is utilized in collaboration with various universities and other institutions.

Indonesia

BATAN has the following functions:

- To assess and prepare the national policy in the field of research, development, and the beneficial uses of nuclear energy,
- To coordinate functional activities in implementing all the duties of BATAN,
- To support and foster activities of government institutions in the field of research, development and beneficial uses of nuclear energy,
- To conduct general administrative services in the field of general planning, administration, organization and procedures, personnel management, financing, archiving, procurement as well as education and training.

In 1965, the operation of the first research reactor (Triga Mark II) was inaugurated in Bandung. In order to improve mastery of nuclear science and technology, several research & development and engineering facilities were built, including the Nuclear Technology Research Centre of Pasar Jumat, Jakarta in 1966, and the Nuclear Technology Research Centre of GAMA, Yogyakarta in 1967, where the Kartini research reactor was then built in 1979.

To further support the nuclear energy program, R&D and engineering facilities, the 30 MW Multipurpose Research Reactor was inaugurated in 1987. It's supporting laboratories, including facilities for fuel fabrication of research and power reactors, reactor safety testing, production of radioisotope and radiopharmaceuticals, management of radioactive wastes and other nuclear facilities have been built in the PUSPIPTEK science and technology research complex in Serpong.

In 2000 was the inauguration of the upgrading of the Triga Research Reactor to 2 MW at the Bandung Nuclear Complex and in 2003 saw the beginning of operation of the 350 keV, 10 mA Electron Beam Machine in the Yogyakarta Nuclear Complex.

Japan

(a) Japan Research Reactor – JRR-3

This reactor was originally built in 1963 and fully refurbished in 1990 as thermal power 20MW, thermal neutron flux $3x10^{14}n/cm^2/sec$ and with a cold neutron source accompanied with a guide hall building. Currently it has accommodated 30 neutron scattering, 2 neutron radiography and 2 prompt γ-ray analysis instruments and a total number of users is about 17,000 person x day / year. Two major users programs have been conducted by JAEA for general users including industrial researchers and by the University of Tokyo for university users based on its own 14 neutron scattering instruments out of 34.

(b) J-PARC (Japan Proton Accelerator Research Complex)

The J-PARC is a joint project, located in Tokai-Mura, between two organizations, Japan Atomic Energy Agency (JAEA) and High Energy Accelerator Research Organization (KEK). The construction of this facility represents an investment of > US$1B. The J-PARC uses MW-class high power proton beams at both 3 GeV and 50 GeV.

Construction of both accelerators and experimental halls was completed in early 2009 after 8 years. The usage of various secondary particle beams (neutrons, muons, kaons, neutrinos, etc.) that are produced in proton-nucleus reactions is the prime purpose of J-PARC. The particle beams will achieve the highest intensities possible with modern accelerator technology. In the case of neutron and muon beams (of great interest to AONSA) the goal is to produce beams from a target which will ultimately have a power of 1MW. This is at the leading edge of neutron beam production and technology.

With these secondary particle beams, three major scientific goals will be attained:
a) nuclear-particle physics
b) materials and life sciences, and
c) later, in Phase 2, R&D for nuclear transformation.

Republic of Korea
High-Flux Advanced Neutron Application Reactor (HANARO)

HANARO is a 30 MW (thermal) multi-purpose research reactor built in 1995 with a maximum thermal neutron flux of 5.4×10^{14} $n/cm^2/sec$. It is currently being used for neutron beam applications for materials research, fuel and material irradiation, nuclear fuel testing, neutron activation analysis, radioisotope production, and neutron transmutation doping. To strengthen the capability of HANARO, a cold neutron research facility project was started in 2003 and will be completed in mid 2010. Currently, it has 10 thermal neutron instruments and once the cold neutron facility with a guide hall becomes operational, it will have 17 neutron instruments including 7 cold neutron instruments. All these instruments are open to users from universities, national laboratories, and industries.

Malaysia

Malaysian Nuclear Agency (Nuclear Malaysia) has a role to introduce and promote the application of nuclear science and technology for national development.
Established in 19 September 1972, Malaysian Nuclear Agency was then known as Centre for Application of Nuclear Malaysia (CRANE) before it was formally named as Tun Ismail Atomic Research Centre (PUSPATI).

In June 1983, PUSPATI was placed under the patronage of Prime Minister Department and was called Nuclear Energy Unit (UTN). It was then placed under Ministry of Science, Technology and Environment in October 1990. In August 1994, its name was changed to Malaysian Institute for Nuclear Technology Research (MINT).
On 28 September 2006, following its restructuring, MINT was given a new identity, which is Malaysian Nuclear Agency (Nuclear Malaysia). Its strategic location, near higher learning institutions, besides its close proximity to the National Administration Centre, Putrajaya, and the Multimedia Super Corridor, Cyberjaya, has stimulated Nuclear Malaysia to meet its aspirations.

Chinese Taipei (Taiwan)

In addition to a successful synchrotron facility and a new one to be completed in 2014, neutron scattering science is developing at a number of universities and a collaboration is in place with the Australian Nuclear Science and Technology Organisation to build new instruments on the OPAL reactor.