Submission
2016 National Research Infrastructure Roadmap
Capability Issues Paper

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Question 1: Are there other capability areas that should be considered?

Question 2: Are these governance characteristics appropriate and are there other factors that should be considered for optimal governance for national research infrastructure.

Question 3: Should national research infrastructure investment assist with access to international facilities?

Yes, we believe this should be one of the primary considerations driving infrastructure investment.

Research infrastructure underpins our national experimental science and technology capability. However, epochal research endeavours such as the search for gravity waves or the quest for controlled fusion power are beyond the resources of any single nation. Modest national investment in related research infrastructure can leverage Australian participation in these huge multi-billion-dollar enterprises. Also, we need national facilities (in support of international) to attract excellent researchers to come to work in Australia and to develop our researchers to international standards. International access ensures Australia remains prepared to take advantage of next step innovations that can lead to new commercial opportunities and enhancement of national prosperity.

By way of example, ongoing NCRIS support of Australian fusion science now sees Australia's formal participation in the world's largest science experiment, the ITER tokamak. ITER is a $20B fusion device that will generate ten times more power than it consumes, heralding an age of inexhaustible and clean baseload power for future generations. A collaborative agreement between the ITER Organisation (IO) and ANSTO, on behalf of a consortium of Australian universities and organisations working in fusion science, will be formally signed on September 30th at Cadarache in France.

Highly prized port space on ITER has been reserved for a novel optical imaging system conceived and developed at the Australian Plasma Fusion Research Facility (APFRF). The APFRF presently has IO-linked funding to develop a conceptual design. In addition, a fusion-materials program that involves multiple institutions across Australia is now also attracting wide international attention. These activities significantly underpin the ANSTO-IO agreement.

Through its investment in the APFRF, Australia has an opportunity to contribute to this largest of science ventures and benefit from the new knowledge, opportunities and kudos that this brings.

Question 4: What are the conditions or scenarios where access to international facilities should be prioritised over developing national facilities?

It would make sense to prioritise access to international facilities when the scale of the required research infrastructure becomes larger than the nation can support, there is an opportunity and a means for such access, and the research benefits (or the opportunity cost) are deemed in the national interest. As access to international facilities is to a large part contingent on national expertise and capability, it would generally be necessary to retain the necessary level of complementary and/or supporting infrastructure. National infrastructure helps to inspire, nurture and train young scientists, while allowing ongoing access to, and leverage of large scale devices that would be otherwise beyond the reach of Australian science.

In the case of Australian fusion science, it is no longer feasible for Australia to host an independent high power fusion program. In response, the Australian Plasma Fusion Research Facility is re-orienting around a more sustainable, accessible and generic high power plasma physics facility. This new device supports wide domestic collaboration in advanced fusion materials, basic plasma physics and instrumentation development. It is also a platform for industry engagement (plasma treatment of materials, steel industry etc) and advanced training for graduates. It will underpin our efforts to engage practically with ITER and the major fusion institutes around the world.

Question 5: Should research workforce skills be considered a research infrastructure issue?

Question 6: How can national research infrastructure assist in training and skills development?

National facilities harbor a cohort of highly trained STEM professionals with both specific and broadly-based skill sets. Certain scientific, engineering and technical skills can only be won on unique facilities and infrastructure such as the synchrotron, SKA etc. Specific skills are generally developed through on-site training and peer mentoring. Skills and expertise are also enhanced through personnel exchange, secondments and collaborative linkages with other international and national facilities. Given the relative scale sizes of Australian and international facilities and their respective domestic communities, such exchanges are essential to retain currency.

Retaining a presence in international fusion science will ensure Australian scientists are ready and prepared to exploit advances in this important field.

Question 7: What responsibility should research institutions have in supporting the development of infrastructure ready researchers and technical specialists?

Research institutions and universities are nurseries for the next generation of researchers and technicians. Fusion, in particular, is a field that inspires and motivates young scientists. Facility scientists and academics working at the APFRF and associated institutions are challenged to meet student demand.

Question 8: What principles should be applied for access to national research infrastructure, and are there situations when these should not apply?

Question 9: What should the criteria and funding arrangements for defunding or decommissioning look like?

Question 10: What financing models should the Government consider to support investment in national research infrastructure?

Question 11: When should capabilities be expected to address standard and accreditation requirements?

Question 12: Are there international or global models that represent best practice for national research infrastructure that could be considered?

Question 13: In considering whole of life investment including decommissioning or defunding for national research infrastructure are there examples domestic or international that should be examined?

Question 14: Are there alternative financing options, including international models that the Government could consider to support investment in national research infrastructure?

Health and Medical Sciences

Question 15: Are the identified emerging directions and research infrastructure capabilities for Health and Medical Sciences right? Are there any missing or additional needed?

Question 16: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 17: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Health and Medical Sciences capability area?

Environment and Natural Resource Management

Question 18: Are the identified emerging directions and research infrastructure capabilities for Environment and Natural Resource Management right? Are there any missing or additional needed?

Question 19: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 20: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Environment and Natural Resource Management capability area?

Advanced Physics, Chemistry, Mathematics and Materials

Question 21: Are the identified emerging directions and research infrastructure capabilities for Advanced Physics, Chemistry, Mathematics and Materials right? Are there any missing or additional needed?

Notwithstanding that the Australian Plasma Fusion Research Facility is presently funded by NCRIS, there is little or no emphasis on plasma and fusion science in the issues paper. Given the essential importance of plasma science in modern technological applications, and the renaissance in fusion research around the world, we would like to raise awareness of this omission and outline recent important developments at the APFRF that warrant consideration by the NCRIS panel.

In mid-2014, the Australian fusion science community announced its five-year plan for Australian fusion science, entitled "Powering ahead: A national response to the rise of the international fusion power program". Around the same time, the Research School of Physics and Engineering at ANU, home to the APFRF, released the results of its review into ANU fusion science.

In view of the rapidly changing international context, both of these reports envisage a staged transition in the research emphasis of the APFRF Facility from toroidal confinement physics, based around the H-1 heliac, to a more broadly-based program founded on a high-power linear magnetised plasma machine.

In preparing for this change in direction, the APFRF constructed a smaller prototype device, MAGPIE I (Magnetised Plasma Interaction Experiment). This device has engendered strong user support in Australian Universities (e.g. University of Newcastle, University of New South Wales, Deakin University) and research institutions (e.g. ANSTO), which will expand in the MAGPIE II era making it an important multi-institution capability. Current examples of international recognition of the MAGPIE I program are engagement with the International Energy Agency (IEA) Plasma Wall Interaction Collaboration Program and the International Tokamak Physics Activity (ITPA) Divertor and Scrape-Off-Layer Topical Group (normally only for ITER partners). MAGPIE II will support a diversity of research interests providing outcomes across a range of fields linked to fusion such as material processing, precision measurements, astrophysics, and materials in extreme environments.

The APFRF is decommissioning the H-1 heliac over the next six to twelve months and will redeploy its considerable infrastructure for the support of the new high power MAGPIE II facility. The ANU is contributing significant funds and manpower for MAGPIE II whose construction is now well underway.

Building on the program established on its smaller predecessor MAGPIE I device, the high-power MAGPIE II will

- host a multi-institutional research program into Materials for Extreme Environments that harnesses the technical resources of ANSTO, the Australian Synchrotron, and the Australian Positron Beamline Facility,
- provide an accessible and flexible user-facility for basic plasma and fusion research,
- support partnerships with high-tech Australian enterprises and business, and
- underpin an Australian science program on the $20B ITER fusion program (Q 22).

A reconstituted board that is attuned to the goals and needs of the MAGPIE II research program will position the new activity to take advantage of emerging opportunities for engagement with Australian industry and ensure the Facility meets user expectations. To mark these changes, we plan to rename the Facility 'AusFusion'.

These bold steps will fulfil the aspirations of our five-year plan, and ensure ongoing return on the nett $35M Australian Government investment in fusion infrastructure. For an ongoing operational cost of less than one million dollars, the new high power device will be Australia's only resource for high-power plasma physics research and fusion science. It will open opportunities for collaboration with other NCRIS facilities such as the ANFF. It will continue to leverage access to billion-dollar international fusion science facilities, including ITER, and will underpin our growing our links with Australian hi-tech industry.

Question 22: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

With the construction of the international ITER tokamak reactor in France, the world has committed to the practical realization of fusion energy - essentially undertaking to build our own sun – to deliver effectively inexhaustible and safe base-load power at little cost to the environment.

In the past decade, researchers at the APFRF have developed uniquely powerful optical "coherence imaging" systems that are now deployed on frontline fusion devices all over the world. At the instigation of the ITER Organisation, the APFRF is now contracted to undertake a design study to assess the options available to coherence tomographic imaging systems for understanding plasma exhaust flows and temperatures on ITER. The approach from ITER indicates a genuine need for Australian technology and expertise, and signals a desire to engage the wider Australian fusion science community. The focus on plasma edge and exhaust issues also complements the high-profile APFRF-ANSTO research collaboration into advanced fusion-materials.

Based on these developments, and with support from a number of Australian institutions with interests in fusion science, ANSTO and the IO will jointly sign a formal collaborative research agreement on Sept 30th in Cadarache in France.

This is a momentous and once-only opportunity to secure, at small cost, an Australian involvement with the ITER project. It will deliver a high-impact Australian physics program on ITER - in a similar way that our contribution to the ATLAS detector allows us to be a part of the Large Hadron Collider enterprise.

A costed plan for Australian engagement will be developed in consultation with the ITER management in September/October 2016. It would also require ongoing support for the APFRF. Wherever possible, the plan would employ Australian staff, and would outsource work to Australian high-tech industry. This could include, for example, custom optical manufacturing and coating, mechanical design and engineering, and software development. In turn, this could open wider business opportunities internationally through the ITER agencies by having Australian companies listed in the register of high-tech providers for ITER componentry and hardware.

NCRIS support for an Australian program on ITER would:

- Leverage access to the world's largest science experiment at relatively low cost, ensuring knowledge-sharing and future high-impact outcomes for Australian science,
- Secure an Australian readiness and technical capability in fusion science,
- Enhance the ANU-ANSTO collaboration on advanced materials for fusion,
- Open new opportunities for Australian industry, and
- Inspire the next generation of Australian scientists and engineers.

Question 23: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Advanced Physics, Chemistry, Mathematics and Materials capability area?

Understanding Cultures and Communities

Question 24: Are the identified emerging directions and research infrastructure capabilities for Understanding Cultures and Communities right? Are there any missing or additional needed?

Question 25: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 26: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Understanding Cultures and Communities capability area?

National Security

Question 27: Are the identified emerging directions and research infrastructure capabilities for National Security right? Are there any missing or additional needed?

Question 28: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 29: Is there anything else that needs to be included or considered in the 2016 Roadmap for the National Security capability area?

Underpinning Research Infrastructure

Question 30: Are the identified emerging directions and research infrastructure capabilities for Underpinning Research Infrastructure right? Are there any missing or additional needed?

Question 31: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 32: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Underpinning Research Infrastructure capability area?

Data for Research and Discoverability

Question 33 Are the identified emerging directions and research infrastructure capabilities for Data for Research and Discoverability right? Are there any missing or additional needed?

Question 34: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 35: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Data for Research and Discoverability capability area?

Other comments

If you believe that there are issues not addressed in this Issues Paper or the associated questions, please provide your comments under this heading noting the overall 20 page limit of submissions.