National Imaging Facility

A submission from the
National Imaging Facility
in response to the
2011 Review
of the
Strategic Roadmap for Australian Research Infrastructure

Exploring Inner Space

Executive Summary

The National Imaging Facility (NIF), founded in 2007, now embraces state-of-the-art imaging facilities in all mainland capital cities. Key to the NIF platform is the discovery of new biomarkers, development tools for assessing and monitoring pre-clinical models of disease, and translation of these tools to human research. As such, it is generally recognised as a key platform for the Promoting Good Health National Research Priority. Importantly, we expect our NIF imaging capabilities in multispectral imaging, microCT and microMRI to contribute extensively to imaging plants, marine specimens, fossils, chemical engineering materials, and nano-technology. The vision of NIF is to fulfil this role as a cross-cutting capability feeding all NRPs. This is a technology which gives the researcher unprecedented ability to study 'inner space'

NIF has made this technology more widely available than ever before, and importantly the sharing of expertise has resulted in a far more effective use of the available resources. But, it is still in early stages of development, and the continued investment is key to realising substantial benefits that have yet to flow.

The Governing Board and Operations Committee of the NIF are committed to collaborative research and collaborative infrastructure, including open access and sharing of expertise. The plan for the future is based on ensuring that NIF is able to deliver capability and capacity. Capability, that is equal to anything available in the world, Capacity that ensures all meritorious research has access to the technology that the scientists of Australia demand and deserve.

This is an ambitious vision. It was developed at the 2011 strategy meeting of the Operations Committee of NIF, and subsequently endorsed by the Governing Board. It was then presented to the National Characterisation Council, where it was further endorsed as part of a structured funding program to "address 'inner space', as humanity's first frontier, impacting our fundamental capacity to address National Research Priorities, enhance economic competiveness and strengthen strategic relationships."

Recommendations:

1. Recognise NIF, part of Characterisation, as a Platform Technology, crossing the boundaries of the National Research Priorities;
2. Continue to support the existing investment in NIF, as a national research capability, with capacity to provide open-access to all meritorious research;
3. Enable NIF nodes to remain at the cutting edge of technology, ensuring that all Australian scientists get access to the capability that they deserve;
4. Recognise that the infrastructure includes 'human capital, high-level expertise to ensure it is used in the most effective way.

Introduction

The National Imaging Facility (NIF) was formed in 2007, as part of NCRIS funding, establishing 5 nodes. Further EIF funding, announced in 2010 has expanded this to 10 nodes across all mainland states of Australia, and established ANSTO as an integral partner in the delivery of a radiochemistry capability across a network of facilities. The vision statement of NIF is:

- To provide for development of Imaging Science.
- To promote imaging as an integral part of research.
- To be recognised within the research community as the national interface to Collaborative imaging.
- To enhance the international competitiveness of Australian Imaging Science.

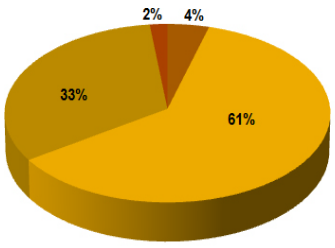
NIF is an Unincorporated Joint Venture, with a Governing Board and an Operations Committee.

In keeping with its mission "***to ensure Australia has cutting edge technology to facilitate world leading research***" the Node Directors have an annual strategic planning meeting, the most recent of which was held on 8th February, 2011. The agenda for the 2011 meeting was to establish a strategy and priorities for NIF over the next 10 years.

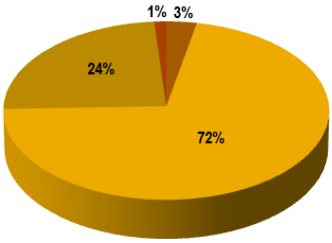
Achievements

The NIF has established a coherent national organisation to deliver imaging capability and plan for the future needs of Australian scientists, and recognised that significant progress has been made in the following:

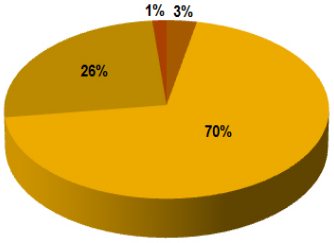
- Establishment of a network of complementary imaging facilities accessible to all Australian researchers.
- Sharing of expertise nationally.
- Large university involvement with NIF around the country – UJVA.
- NIF is recognised by CSIRO and ANSTO as a vehicle to support national research.
- NIF is being recognised by multi-national companies as a portal for multi-centre research in Australia.
- NIF is establishing a professional skill base in Imaging Science.
- NIF is successfully providing facilities for external research.
- 69% growth in user base, and 75% growth in publications over 2 years.



NIF Users (2008) = 601

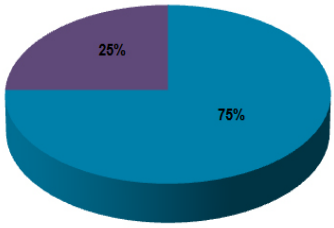


NIF Users (2009) = 883

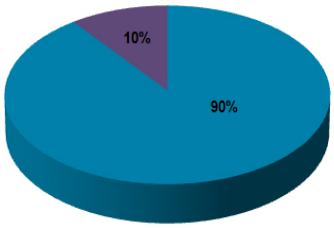


NIF Users (2010) = 1015

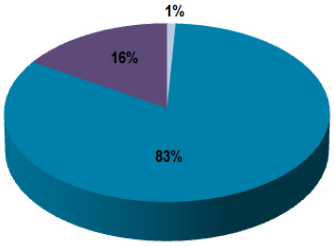
- Environmentally Sustainable Australia
- Promoting & Maintaining Good Health
- Frontier Technologies
- Safeguarding Australia



Number of Publications (2008) = 64



Number of Publications (2009) = 117



Number of Publications (2010) = 112

- Environmentally Sustainable Australia
- Promoting & Maintaining Good Health
- Frontier Technologies

The Future of NIF

The National Imaging Facility recognises that it is an emerging capability which needs to continue on its journey towards a mature network. Established 5 years ago, it has already delivered a significant research capability to the researchers of Australia. Furthermore, NIF is not an island, and needs to engage with its stakeholders and with other national capabilities. In 2007, the NCRIS committee saw benefit in four of the funded capabilities being coordinated through the National Characterisation Council (NCC). NIF was one of the founding capabilities and has participated actively in the NCC, including the response to the 2011 Review of the Strategic Roadmap – ***Characterisation Australia: Exploring Inner Space***

Rather than repeat the contents of that document, NIF would like to re-iterate the following points:

- Imaging, like the other facilities within Characterisation is a Platform Technology, underpinning research across the breadth of the National Research Priorities

- As a Platform Technology, the users are not necessarily expert in the field of imaging technology, and so it is essential that adequate high-level support be provided as part of the investment.

- The 2008 survey of demand for Characterisation techniques has demonstrated the need for such platform technologies across the spectrum of scientific endeavour.

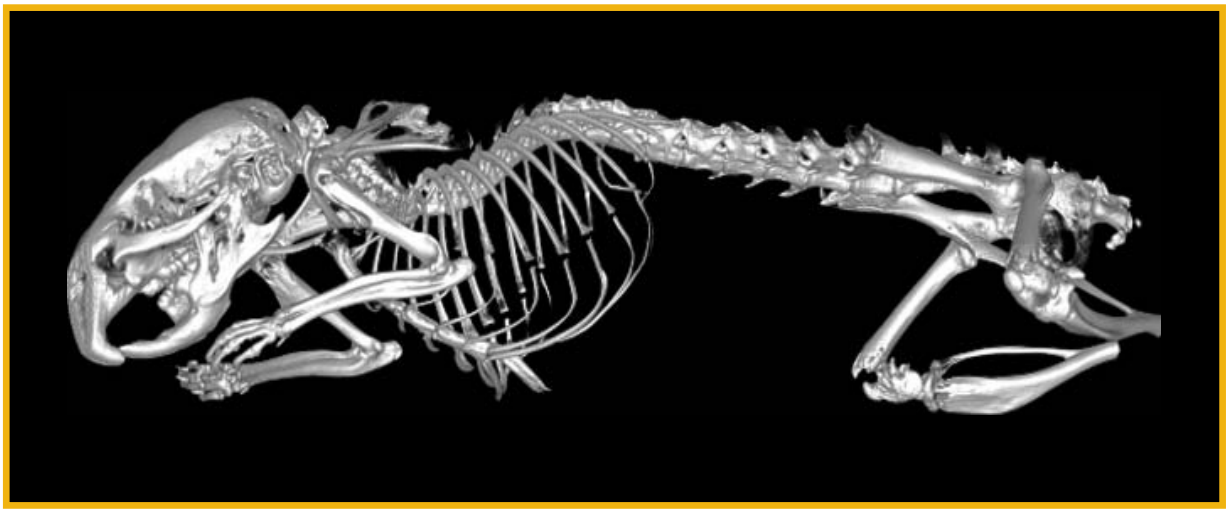
To satisfy the need for capability and capacity, NIF requires ongoing investment in the following areas:

State-of-the-art technology: Imaging is a rapidly evolving field. Sometimes hardware can be upgraded, but change is so rapid, that it is most often necessary to purchase new systems. A major advantage of a network approach is that the latest equipment can be available nationally, at one location, but the existing equipment can continue to be used for projects that do not require the latest technology. Researchers can be directed to the most appropriate system for their particular needs.

Whole-of-life costs: A major component of the cost for using this equipment is the maintenance costs. This is an unavoidable part of the infrastructure, and one that, if included in the access charges, makes use of this technology prohibitive for many researchers.

Expertise: Like any rapidly evolving technology, it is critical that users get the best advice about the most appropriate technology and the best experimental design. The users of imaging cannot be expected to possess that knowledge. NIF proposes that all flag-ship instruments have an associated Facility Fellow. This person is not an operator of the equipment, but an experienced scientist, who understands the technology and has a wide-ranging perspective of its applications.

Management and Governance: NIF is an Unincorporated Joint Venture, which, due to the very significant support of the institutional partners has a very lean operating budget. As NIF enters the next phase of growth it is critical that it has the resources to support reporting, promotion, record keeping and governance.



Platform Themes

As a platform technology, NIF has identified seven themes, which define the areas in which the capability must meet the needs of the scientific community. It is important to note that these themes span the science outcomes of the National Research Priorities.

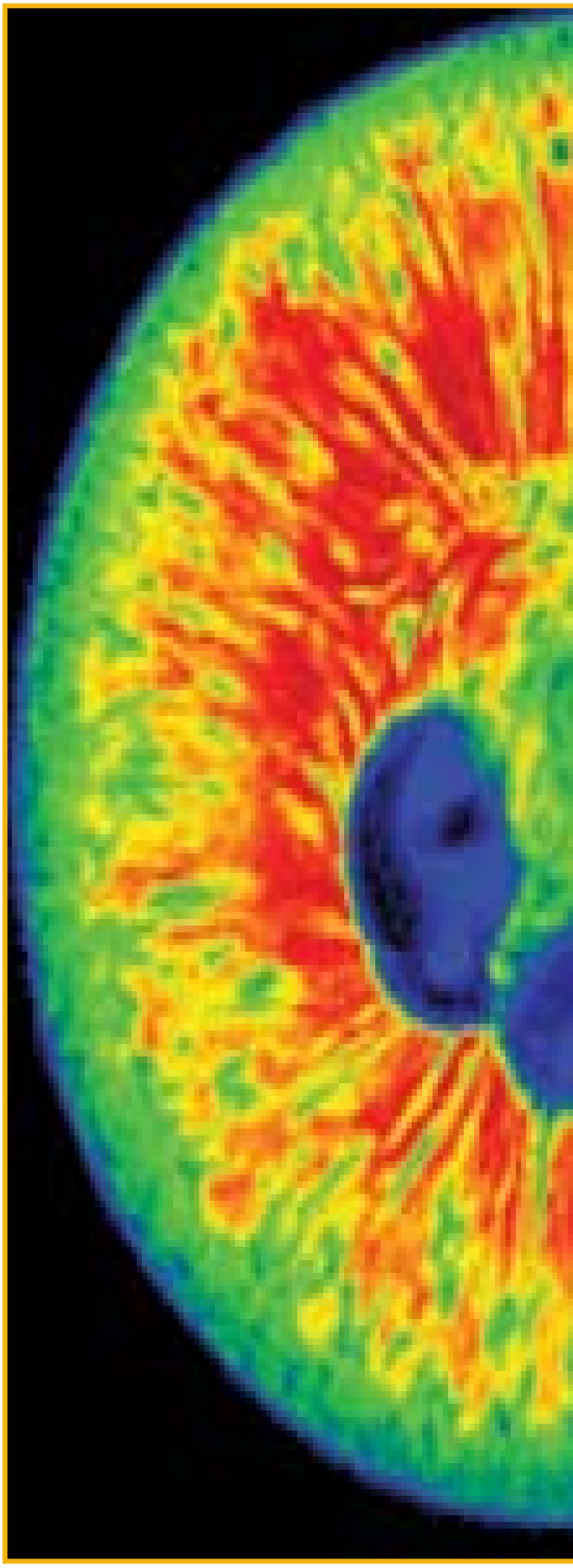
Theme 1: *Technology Development*

In addition to cutting edge applications of imaging techniques, the NIF is heavily involved in technology and technique development. For example, the UWS node of the NIF is heavily involved the development of diffusion MRI techniques. Importantly, imaging technology and equipment has very considerable requirements for its operation and training of the next generation of the imaging fraternity takes many years and requires a diverse range of backgrounds from quantum physics and electrical engineering to the biological and medical sciences. *In this sense it is important to view the NIF as not just a collection of equipment but of scientists who are constantly expanding the boundaries of what is possible with such equipment as is evident from publications in high ranking international journals and playing leading roles in the international scientific community.*

Theme 2: *Multi-modality Technology*

Multimodality imaging allows the strengths of the different imaging modalities, Magnetic resonance imaging (MRI), computer tomography (CT) and positron emission tomography (PET) to be exploited and together give more accurate diagnosis and monitoring of disease. The most common multimodal imaging is PET/CT. This allows the sensitive PET scans to be overlayed on the bony structure images of the CT to help locate where in the body the cancer has been detected by the PET radioisotope. However, the requirement for radioactive isotopes for PET imaging and x-rays for CT have serious health effect with repeated use.

PET/MRI imaging has unlimited potential to revolutionize diagnostic imaging by combining the safety and soft tissue contrast of MRI with the sensitivity of PET imaging. This is critical for tracking cancer in soft tissue, such as the brain and lymph nodes.



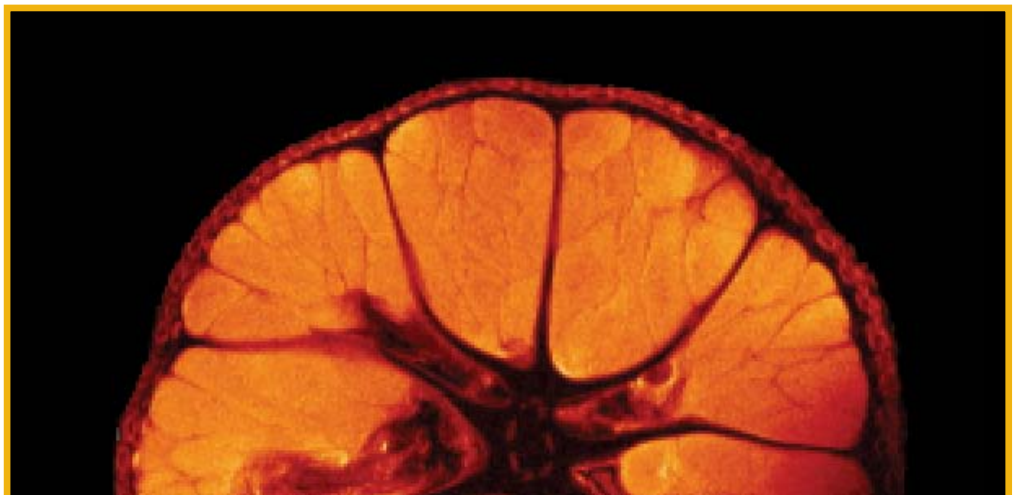
In addition, many PET radioactive isotopes commonly used e.g., flourine and copper are also detectable by MRI. Therefore, the sensitivity of PET imaging could be used to confirm the presence of cancer and then MRI could be used to track the changes of the cancer without the potential long terms negative health effects of PET imaging. NCRIS provided funding to install the world first commercial animal PET/MRI to lead the world in this new combined multimodal imaging. The research and development on this animal system can be directly applied to a human PET/MRI multimodal imaging. The preclinical Inveon PET/CT is an essential tool to study noninvasively the molecular mechanisms involved in cancer using animal tumour models. One in two Australians will be diagnosed with cancer by the age of 85. The development and evaluation of new radiotracers using the multimodality preclinical PET/CT is an essential step toward a better understanding and an earlier diagnosis of cancer. The Australian population is ageing and neurodegenerative diseases are becoming main health issues. Currently it is estimated there are over 250,000 people with dementia in Australia which could increase to almost 500,000 by 2040. The preclinical multimodality PET/CT will help to evaluate the brain abnormalities in different animal models of neurodegenerative diseases either for the diagnosis or as a monitor of disease progression.

NIF is committed to complementary use of different imaging technologies and providing researchers with advice about the best technology for their research.

Theme 3: *Extreme Field MRI*

The investment in Extreme Field MRI, both animal (>21T) and human (>12T) would support biomedical research, but also provide a platform where Australia would lead the world in Frontier technology development at this cutting edge of physics, engineering and imaging applications. Extreme field imaging has proven beneficial in animals above 12T and these advantages will translate to Human imaging but will require innovation to enable MRI and dual modalities using MRI at or above 12T to function to its maximum capability and do that safely. A major consideration is the interaction with the myriad of magnetic and electromagnetic (EM) fields generated in an MRI scan with the patient. All tissue has EM properties and tends to interact more strongly with fields at higher strengths. The effects of these interactions are to distort images and to decrease safety margins. A significant advantage of ultra high-field MRI is the ability to acquire images from other physiologically important nuclei such as sodium. Changes in cellular sodium concentration are in some cases, early markers of disease processes.

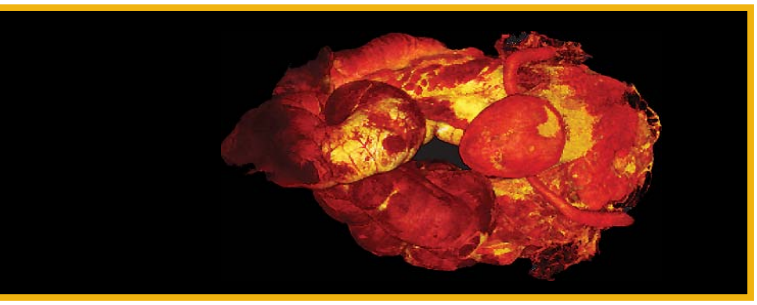
A Frontier engineering discovery program is required to identify new transceiver radiofrequency array technology. These systems allow individual section of tissue to receive different EM excitation and this can be achieved in a computationally controlled manner so as to negate the effects of tissue-field interactions. This requires highly developed computational models of the patient, inverse solutions of the required excitations to result in high quality final images and advanced RF array technology. The method is enabled simultaneously across multiple channels and multiple regions and while challenging, is theoretically possible. Similar approaches can be taken in multi-modality systems based on extreme field MRI*. This has not been attempted nor achieved at 12T anywhere in the world and would put Australia as the world leader in the extreme field sector.*



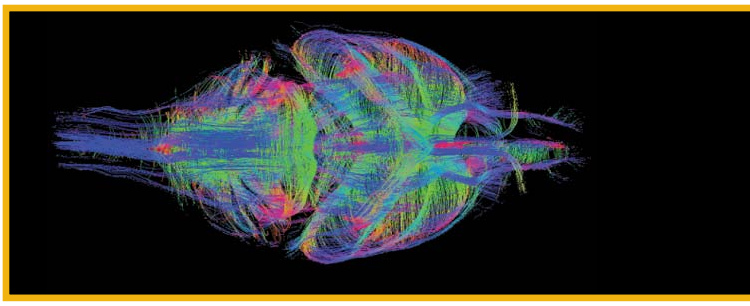
Theme 4: *Imaging Biomarkers*

Designing imaging platforms with the ability to improve diagnosis and probe the underlying physiological mechanisms of normal and disease processes *in-vivo* requires the development of novel biomarkers, which target abnormal brain function at the molecular and cellular level, in concert with state-of-the-art neuroimaging technology capable of detecting subtle changes in the profile of the biomarker itself. It is important to emphasise that much of the new advances are targeted at giving dynamic, as well as structural information. This allows the researcher to better understand function as well as morphology. A key goal of NIF is to merge the development of novel biomarkers of disease processes with new generation high field MRI, PET and MEG technology. Such a strategy significantly changes how we investigate many of the debilitating neurological conditions such as dementia, stroke and psychiatric disorders and provide a guide for future national-based studies relating to brain development and neurodegenerative disorders and improved understanding of brain function and plasticity in general. While there has been recent excitement about possible treatments for the symptoms of Autism, advances in understanding the underlying neuroscience of abnormal brain function that underlies autistic tendency are still painfully slow. The facilities made available through NIF aims to establish fully a physiological mechanism for altered autistic perception, to see if it can be applied to early diagnosis in infants and young children and to establish whether in such plastic young brains it is possible to guide perceptual learning to permanent improvement.

Degenerative disease in both neurosystems and musculoskeletal systems are a major cause of non-traumatic deterioration in quality of life, especially in an ageing population. As such they are seen by the community as areas requiring major investment in understanding the causes and amelioration of these conditions. Cardiac disease and cancer present a significant burden on our society.



They are the leading causes of death within the Australian community and have a major impact on the health budget. MRI has significantly aided in the early diagnosis and understanding of these diseases. The infrastructure and combined knowledge provided by this community would enable innovative research in neurology, musculoskeletal disease, cardiology and oncology at the cutting edge, especially in the rapidly expanding area of molecular imaging. This would enable the improved monitoring of new stem-cell therapy to revive damaged heart tissue and promising new dendritic cell-based immunotherapies for cancer treatment. These approaches take advantage of the added sensitivity and new contrast mechanisms and would complement the innovative cancer vaccine research programs being conducted at a number of centres in Australia *NIF makes biomarkers and use of the high field imaging, molecular imaging and MEG available to all Australian researchers.*



Theme 5: *Computational Image Analysis*

Computational imaging is the application of algorithms and computing techniques to analyse and manage the data produced by traditional and new generation imaging hardware. Australia's imaging facilities, including specialised microscopes, CT, MRI, PET and the Imaging Medical Beam Line at the Australian Synchrotron, will produce terabytes of highly valuable 2D, 3D and 3D+ data. To store, process and visualise such large volumes of data, biomedical imaging researchers will inevitably require access to high performance computing resources, and complementary expertise in computational image analysis.

To store, process and visualise such large volumes of data, researchers require access to high performance computing resources, imaging informatics and data workflows, and

computational image analysis expertise at each of the NIF nodes. In particular, the nodes must:

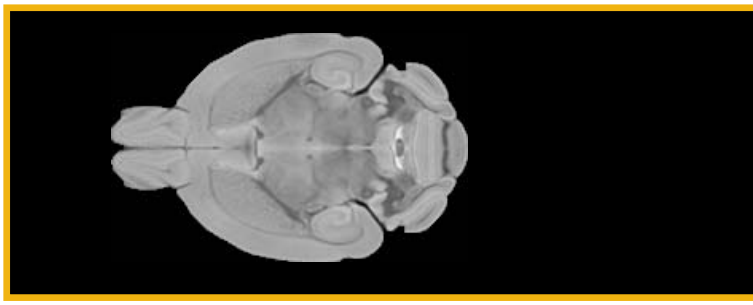
- Provide to researchers the capability to analyse their images by establishing an image analysis knowledge bank particularly for very large dataset reconstruction and visualisation; and
- Connect NIF instruments, high performance computing facilities and research institutes by developing imaging workflows and managed image repositories.

NIF provides a complete research solution and is committed to the sharing of normative data and supporting the Australian Research Data Commons.

Theme 6: *Translating Discovery to Application*

There is increasing recognition nationally of the benefits of further developing therapeutic lead discoveries within Australia. The recently funded SuperScience initiative will establish a Translating Health Discovery capability, as a major national infrastructure project. Biomedical imaging is a key technology in translational studies between animal models of disease and human clinical trials, and can be used for studies from bio-distribution to efficacy and identification and assessment of side-effects.

The National Imaging Facility, since its inception, has recognised the role that imaging can play in Translational Medicine.

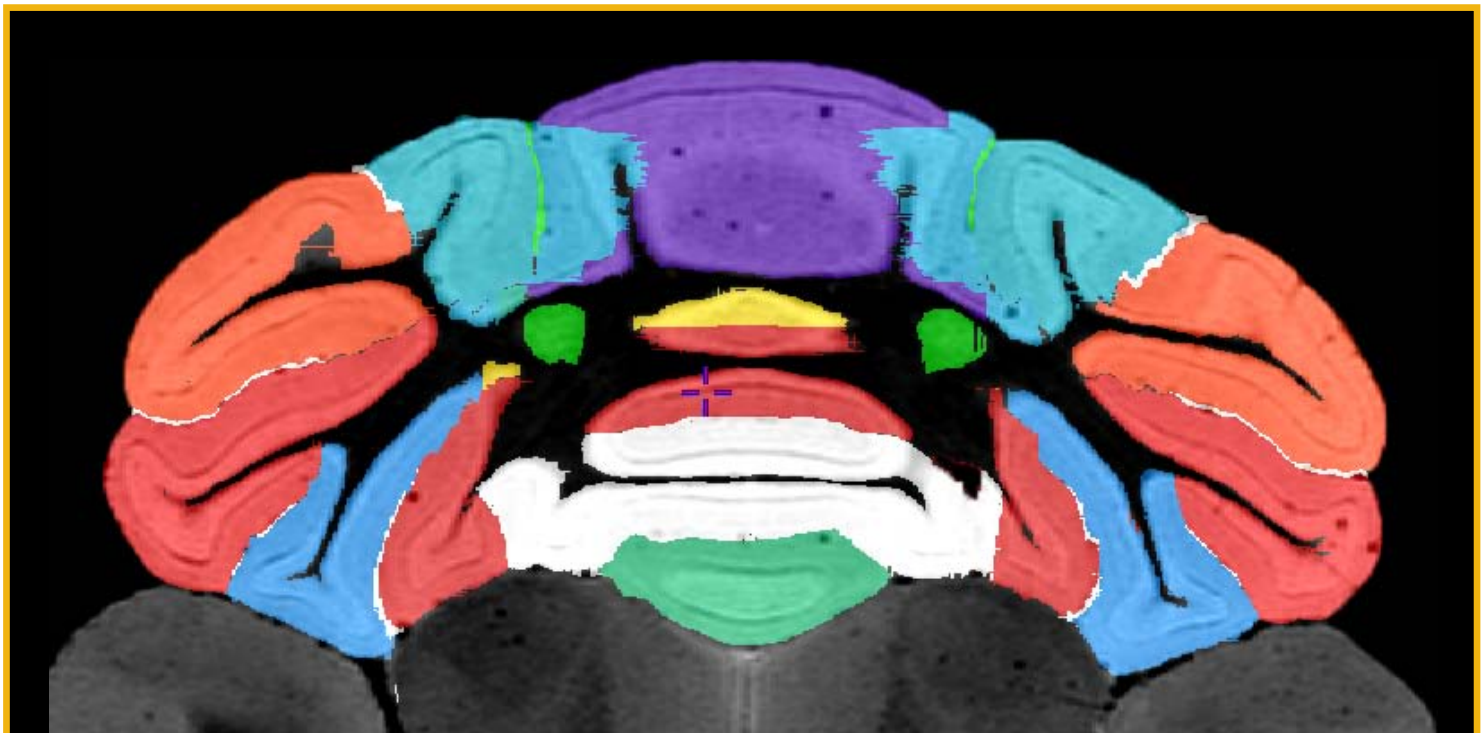


It is engaged in understanding the pathogenesis of disease, which involves the development of animal models, toxicity and other safety studies, biodistribution imaging studies, and pre-clinical targeting studies. Successful compounds can then be progressed to first-in-man studies, human biodistribution imaging studies, and bioimaging marker development for clinical trials.

As a national infrastructure network, NIF is in a position to co-ordinate the biomedical imaging component of multi-centre clinical trials in conjunction with the SuperScience project.

Theme 7: *International Credentials & Linkage*

The Euro-Bioimaging Project, as part of the European Strategy Forum on Research Infrastructures, is a reflection of the NIF vision for infrastructure and we are committed to building a collaborative relationship with this initiative. Equally, NIF is committed to further developing our relationships in the region, specifically with the Neuroscience Research Institute at Gachon, Korea, and the Singapore Bioimaging Consortium at A-Star Biopolis. *In the same way that NIF is not an island within Australian science, NIF is committed to working together with international partners.*



Investment for the Future

The submission from Characterisation Council outlined a vision for the whole characterisation capability with a range of scenarios, from survival to world-leadership. The Operations Committee and Governing Board of NIF have embraced this vision, and submit the following scenarios for Imaging over the ensuing 5-10 years:

Platinum: Investment at this level would place Australia amongst the top 3-4 countries in the world in the field. It adds a $100M landmark facility to the Gold scenario. This would be a single iconic facility, a multi-modality imaging and therapy research capability, which would be a platform for Translating Health Discovery, in which biomedical and clinical scientists could implement new therapies and assess their efficacy and side-effects using the most advanced imaging technology available. This would be a magnet for large multinational pharmaceutical companies, attracting international investment. But more importantly, it would give Australian biotech companies the opportunity to further develop Australian leads.

Gold: Investment at this level would make Australian imaging science globally significant, and give Australian imaging scientists access to world-leading technology. Australia has been internationally competitive in the field of MRI for many years. The investment in Extreme Field MRI, both animal (>21T) and human (>12T) would support biomedical research, but also provide a platform where Australia would lead the world in Frontier technology development at this cutting edge of physics, engineering and imaging applications.

Silver: Australian scientists would have a platform for internationally competitive research using well-established technology. Research at the cutting edge would require Australian scientists to access oversees facilities for their high-end investigations.

Bronze: This is the minimum required to maintain this capability as a national research infrastructure. There is some allowance for upgrading existing equipment, but provides no new capability, nor does it meet existing unmet demand.

The NIF recognises that such a price-tag may seem daunting, but reminds the government that this is a capability that would service at least 2000 Australian scientists, and would allow much of the discovery technology to be kept in Australia.

	Platinum	Gold	Silver	Bronze
State of the Art Technology	**Total ($M)**	**Total ($M)**	**Total ($M)**	**Total ($M)**
Human MR/PET	12.000	12.000	6.000	
Hyperpolarised Gas Facility	3.000	3.000	3.000	
Tomographic Synchrotron	3.000	3.000	3.000	
International linkages (e.g. Korea/Europe)	5.000	5.000	5.000	
Human PET/CT	3.000	3.000	3.000	
Large animal PET	2.000	2.000	2.000	
PC3/4 Animal Facility (DERL)	6.000	6.000	6.000	
High throughput small animal imaging (MR)	3.000	3.000		
High throughput small animal imaging (PET)	3.000	3.000		
Extreme high field (800 wide bore)	3.000	3.000		
Extreme high field MR (whole body)	25.000	25.000		
Extreme high field small animal imaging	10.000	10.000		
Accelerator/Imaging	25.000			
Landmark Imaging Facility	100.000			
Operational Costs				
12 to 24 FTE Specialised Facility Fellows	31.200	14.300	11.050	7.800
Administration & Governance	16.800	5.400	5.400	4.900
Maintenance Contracts	32.165	13.083	11.083	7.000
TOTAL	**283.165**	**110.783**	**55.533**	**19.700**

Response to EWGs

Environmentally Sustainable Australia

1.E.1 The EWG has noted that Characterisation is an underpinning requirement. The facilities of NIF are already being used in a range of projects to support research in sustainability. The expertise provided by NIF makes this research possible, as MRI and PET are not standard tools for scientists in the environmental space. The network available through NIF means that researchers have access to a range of modalities and size, across the nation. This would facilitate multi-site studies.

Observation of how plants adapt to different climatic conditions or pest invasion is important to understanding the impact of environmental changes ensuring the environment is managed in a way that is sensitive to the ecosystem. The ability to study processes such as germination, sprouting and growth in a longitudinal study of plants exposed to varying conditions opens new horizons for the plant biologists.

Due to the collapse of global fish stocks, Aquaculture is the fastest growing industry in Australia. As new fish species are identified for farming there is a need for an accurate method of establishing which sensory systems fish use for feeding. In an ARC Linkage project, MRI was used to provide an efficient and quantitative technique for visualizing the brain and identifying the importance of each sensory modality. Thereby increasing growth and reducing feed costs.

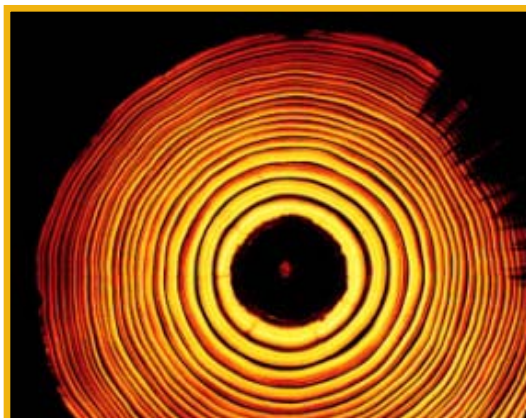
In addition to understanding the environment for production of sustainable resources, it is important to understand the processing of these resources. CSIRO has used imaging to understand drying processes in renewable, plantation timber. Drying of the harvested timber is a slow expensive process and can result in distortion of the timber reducing its quality. The ability of MRI to image the location and movement of water in whole wood samples allows the optimization and improvement of drying methods for a sustainable wood industry.

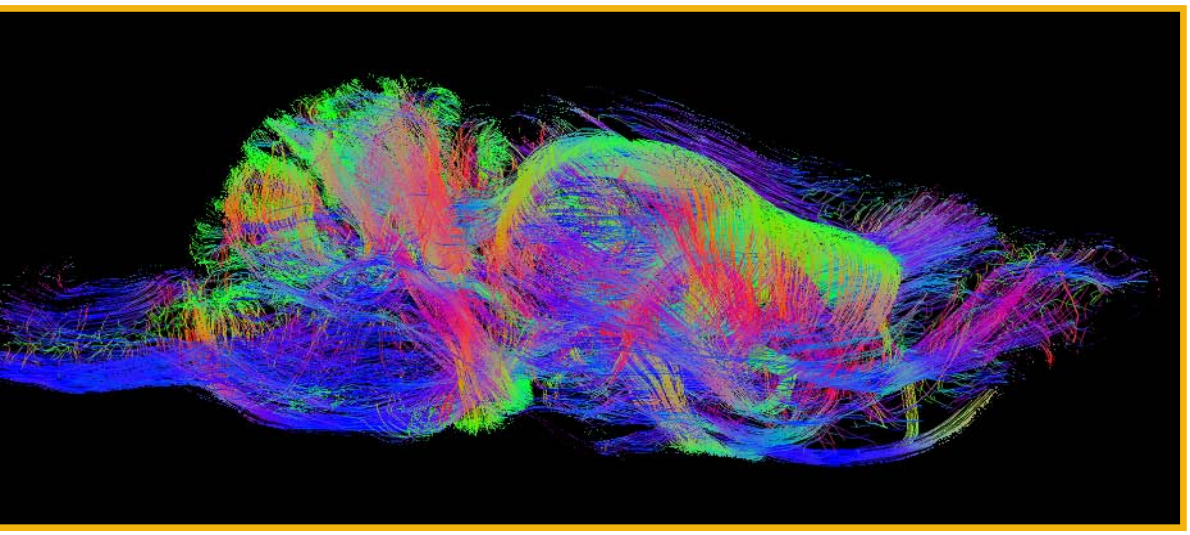
Promoting & Maintaining Good Health

2.A.1 The EWG refers to the possible value of a Hadron therapy facility. Such a research facility requires imaging to guide the therapy and to assess the efficacy of the intervention. As a landmark research facility, NIF would emphasise the importance of integrating next generation imaging technologies and expertise within such a facility. This is consistent with the proposal for a landmark therapy and imaging facility arising out of the NIF strategic planning and proposed investment plan.

2.B.1 The EWG identified need for continuing investment in biomedical imaging, and that state-of-the-art equipment needs to be freely available. We strongly recommend that these investments build on the existing capabilities of the NIF, which would not only contribute the equipment but the high level technical expertise. The outcomes in biomedical science are most readily translated to clinical research and in turn, clinical practice, when common technologies are used to identify disease and assess efficacy of treatment. The investments in imaging infrastructure for clinical research should be directly associated with existing pre-clinical imaging facilities to maximise utilisation of expertise and supporting infrastructure (cyclotrons, radiochemistry etc).

2.C.1 As outlined above NIF has capability in 11 facilities across 5 states. Collectively, the nodes cover the full range of biomedical infrastructure and expertise in Australia, all of which is open access to any researcher. The strategy of NIF is to optimise the capability and capacity of the available infrastructure, crossing technological and geographical boundaries. There is need for growth, and it is only through a coordinated approach that the correct balance of technology, capacity and geography can be delivered.





Promoting & Maintaining Good Health cont'd

2.E.1 The EWG has identified a growing and unmet demand for many analysis platforms ('omics, imaging etc) presently available for animal-based and cellular-based research to become available and accessible for clinical research". From its inception, NIF has identified one of its strengths as the ability to bridge the gap between biomedical discovery and clinical research. For this reason, large pharmaceutical companies have adopted imaging as a key technology platform for 20 years. One of the founding precepts of NIF is the complementary use of imaging technologies, including cellular, morphological, dynamic and functional imaging. The NCRIS business plan was based on provision of biomarkers, be they structural or molecular. One of the major flagship instruments was the pre-clinical MR-PET, a world leading technology, that didn't just cross disciplines, but brought them into the same instrument. NIF has invested in 2 cyclotrons, and through its partnership with ANSTO, will enable access to radiochemistry across the nation. NIF is able to more rapidly address the unmet demand. Through its expertise base NIF is able to support the introduction of the technology into new centres e.g. LARIF is able to draw on the technology expertise from other NIF nodes, enabling it to concentrate on the animal models. UWA will soon establish the first imaging research facility in the west, with support from the expertise available through NIF.

2.F.1 The EWG has recognised that there are a range of programs funded by federal and state health. It is neither feasible, nor advisable for these programs to develop their own imaging capacity. It is only through investments such as NIF, that the latest technology and the highly specialised expertise can be made available. NIF nodes have worked closely with a number of these programs:

- NHMRC Enabling Grant – *Australian Mouse Brain Mapping Consortium*
- NHMRC Centre for Clinical Research Excellence – *Spinal Pain, Injury & Health*
- NHMRC Australian Schizophrenia Research Bank

NIF is keen to work with THD project to help translate basic scientific discovery to the treatment and prevention of disease.

Frontier Technologies

3.A.1 We wish to emphasise here the role of the NIF in technology development. It not only provides a crucial capability and service to the research community. It also actively advances the field through the sort of integration of emerging frontier technologies with existing commercial systems referred to by the EWG.

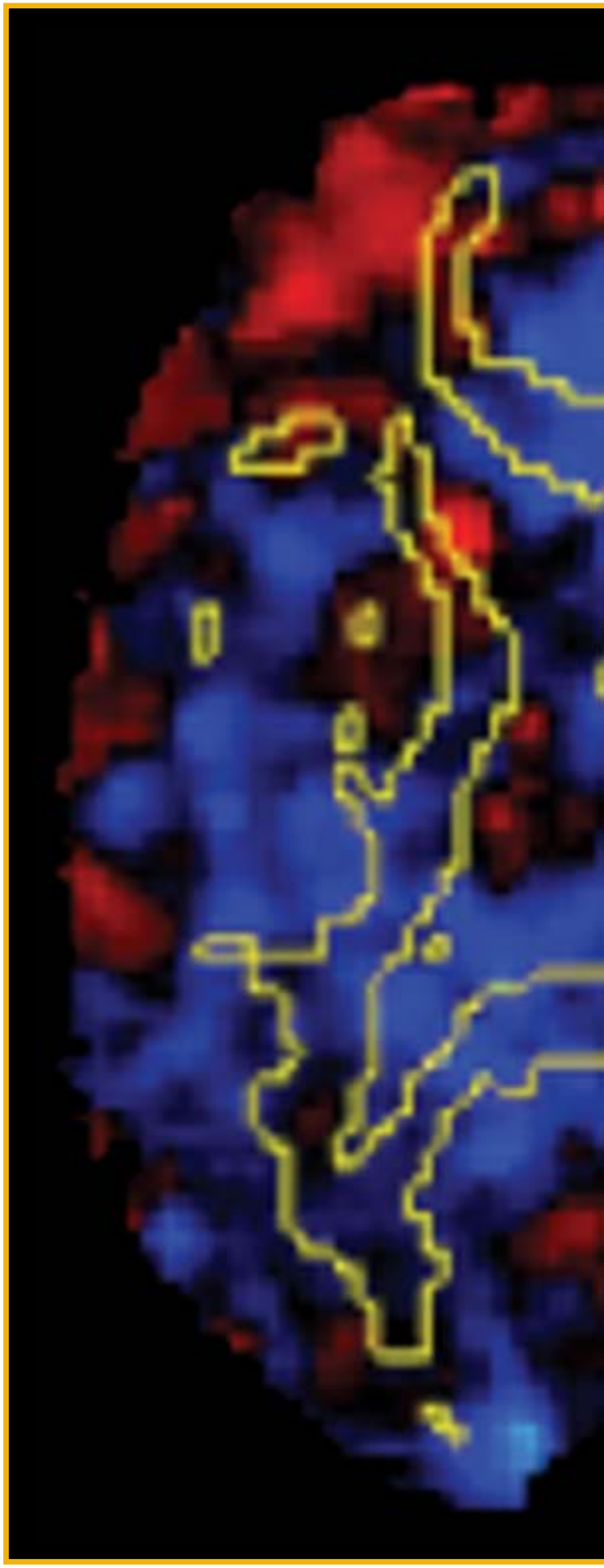
3.B.1 Radiochemistry R&D is currently a very slow and expensive bottleneck for the development of new imaging biomarkers. This is an excellent example of where "high-throughput and combinatorial methods" could be employed to speed up the "discovery chain". Further, we wish to highlight the important role of computational and simulation science in

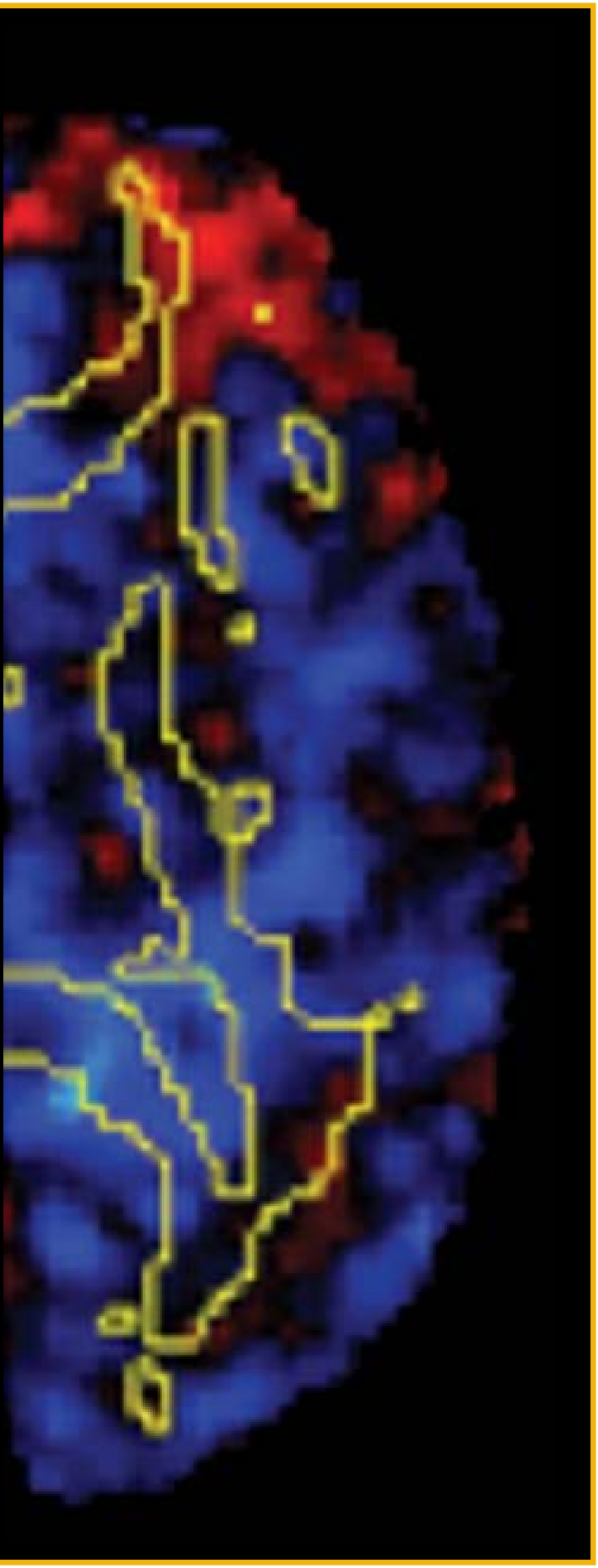
imaging technology R&D. There is a critical need for more efficient computational platforms for Monte Carlo simulation and modelling of developmental imaging systems since most of the currently available HPC platforms and access schemes are poorly suited to these sorts of problems. We strongly support the priority given to “Sensors and Measurements Systems” as it relates to next generation imaging technologies.

3.E.1 Imaging detector research and product development is an excellent example of an embryonic capability at the “interface between commercial/off-the-shelf biotechnologies and sensor and bionics development and engineering”. Once again, we see NIF playing a lead role in the advancement of Imaging Science through the development and integration of these emerging technologies.

Safeguarding Australia

4.E.1 Imaging has been recognised as a key technology in understanding living systems, identifying pathology and assessing efficacy of therapies. It should be obvious that the same technology could contribute greatly to the understanding of threats to our biosecurity. However, it is not safe to take the samples from contained facilities to the existing imaging facilities. The only solution is to establish a PC3/PC4 Imaging Facility, within a bio-containment facility such as AAHL. AMMRF has already established a linked microscopy laboratory; NIF has identified the need to establish a whole-animal imaging capability within AAHL. This is not a trivial exercise as the technology is not traditionally compatible with the isolation and sterilisation requirements for PC3/PC4, but it is within the capability of Australian researchers and Australian industry. This will require close cooperation of expertise in containment, with expertise in imaging technology, along with the support from the equipment vendors. New concepts in probe design and animal handling will need to be developed, and high cost components will need to be either remote or isolated from the animal, so that in the event of a pathogen release, the equipment can be sterilised or incinerated. Such a facility would be internationally unique, placing Australia at the forefront of this type of





research, and providing opportunities for Australian technology to be exported.

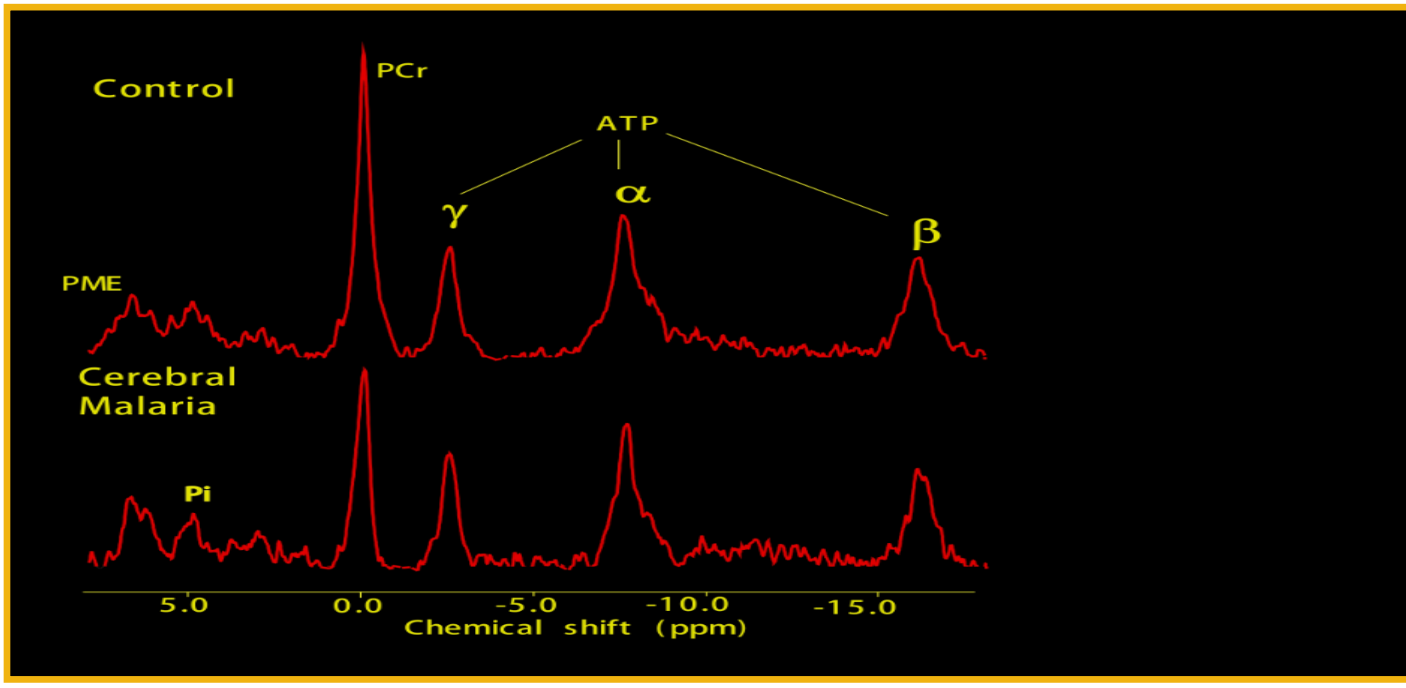
eResearch

4.E.1 eResearch has much to offer the research community, but there is a need for far better stakeholder engagement. The investment to date, has not always delivered what the research community required, and when it did, it has been too abstract, with minimal support for adapting it to the immediate needs of the researcher. At the recent EU/Australia Infrastructure workshop in Brussels, a key point that emerged strongly is the provision of capability in data analysis and modelling as essential research infrastructure. While, in part, such needs are driven by the data-deluge, they are also driven by the increasing specialisation in dealing with data and the increasing sophistication and need for quantitation emerging in most disciplines, especially in biology and medicine. Such capability needs a matrix approach to work effectively - it needs to be embedded in core facilities such as the NIF, but at the same time be connected into a disciplinary network (eResearch). It is vital that the accountability of such capabilities, however, is to the enduser community - i.e. to produce outcomes through visualisation/analysis/modelling of microscopy data or imaging data etc. NIF has recognised this requirement in the appointment of two Informatics Fellows, who work closely with the NIF nodes, and with the various activities of the Platforms for Collaboration.

Thus, NIF wishes to emphasise the importance of continued investments in national collaborative eResearch tools to support the sharing of image data and advanced analysis, modelling and visualisation tools. A crucial aspect of this is the development of sustainable centralized data storage facilities working cooperatively with managed data repositories that have the ability to distribute and replicate content between nodes. In addition, high speed on-ramps (ideally through integrated workflows) between these repositories and the imaging facilities will ensure the relatively large 3D and 4D datasets in Imaging Science can be easily and rapidly moved to local data analysis clusters. We also need advanced repository

query capabilities so that searches can be performed on both meta-data and image content and ultimately through high-level symbolic queries. It is important that the meta-data, animal model data or clinical data (potentially de-identified patient health records), so that cross correlation can be readily performed.

Finally, operational support for informatics systems, image computational techniques and platforms is essential so that the value of investments in equipment can be fully realised.



Conclusion

- NIF embraces excellence in research across the National Research Priorities
- NIF delivers capacity across the nation, so that our best scientists have access to the best infrastructure
- NIF delivers expertise to the world-class non-imaging research scientists who need imaging as a tool
- NIF engages in platform development, to ensure that Australian imaging strives to be world-leading
- NIF delivers a capability that is world class
- As part of the national research infrastructure, the Governing Board and Operations Committee would contend that the funding of the National Imaging Facility is the most cost effective way to ensure that all researchers in Australia have the option to use world-leading imaging technology as a platform technology.

For a printable version of the NIF submission to the Strategic Roadmap please visit: www.anif.org.au/roadmap.html

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National Imaging Facility

An Australian Government Initiative
National Collaborative Research Infrastructure Strategy

The University of Queensland Australia

The University of Sydney

Australian Government
ansto
Nuclear-based science benefiting all Australians

University of Western Sydney

UNSW

Florey Neuroscience Institutes

The University of Melbourne

Monash University

Swinburne University of Technology

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Achieve International Excellence

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