National Imaging Facility

Collaborative Infrastructure

Federation University

National Imaging Facility

NCRIS Landscape

Energy

Australian Plasma Fusion Research Facility (APFRF)

Heavy Ion Accelerators (HIA)

Nuclear Science Facilities (NSF) – Bragg Institute

Biofuels

National Deuteration Facility (NDF)

AuScope

Medical

Australian Animal Health Laboratory (AAHL)

ammrf Australian Microscopy & Microanalysis Research Facility

apn australian phenomics network

BIOPLATFORMS AUSTRALIA

EMBL Australia

PHRN Population Health Research Network

Translating Health Discovery (THD)

National Imaging Facility

Environmental

Astronomy Australia Ltd.

Atlas of Living Australia

AURIN aurin.org.au

Australian Plant Phenomics Facility

AuScope

BIOPLATFORMS AUSTRALIA

National Centre for Groundwater Research and Training

TERN

IMOS Integrated Marine Observing System

Data retention and processing services

High Performance Computing (HPC)

PAWSEY supercomputing centre

NCI National Computational Infrastructure

ARDC Australian Research Data Commons

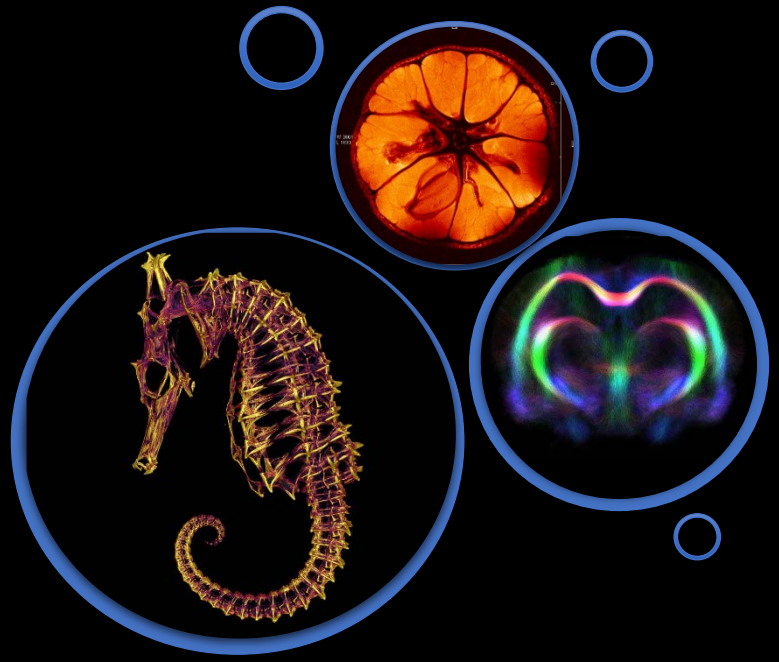
National Imaging Facility

AuScope

AURIN aurin.org.au

National Imaging Facility

Imaging for You



National Imaging Facility

The National Imaging Facility

THE UNIVERSITY OF WESTERN AUSTRALIA

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Large Animal Research & Imaging Facility
SAHMRI South Australian Health & Medical Research Institute
THE UNIVERSITY of ADELAIDE
UniSA

Australian Government
ANSTO

MONASH University

UNSW SYDNEY

SWINBURNE UNIVERSITY OF TECHNOLOGY

THE FLOREY INSTITUTE OF NEUROSCIENCE & MENTAL HEALTH

THE UNIVERSITY OF MELBOURNE

WESTERN SYDNEY UNIVERSITY

THE UNIVERSITY OF SYDNEY

National Imaging Facility

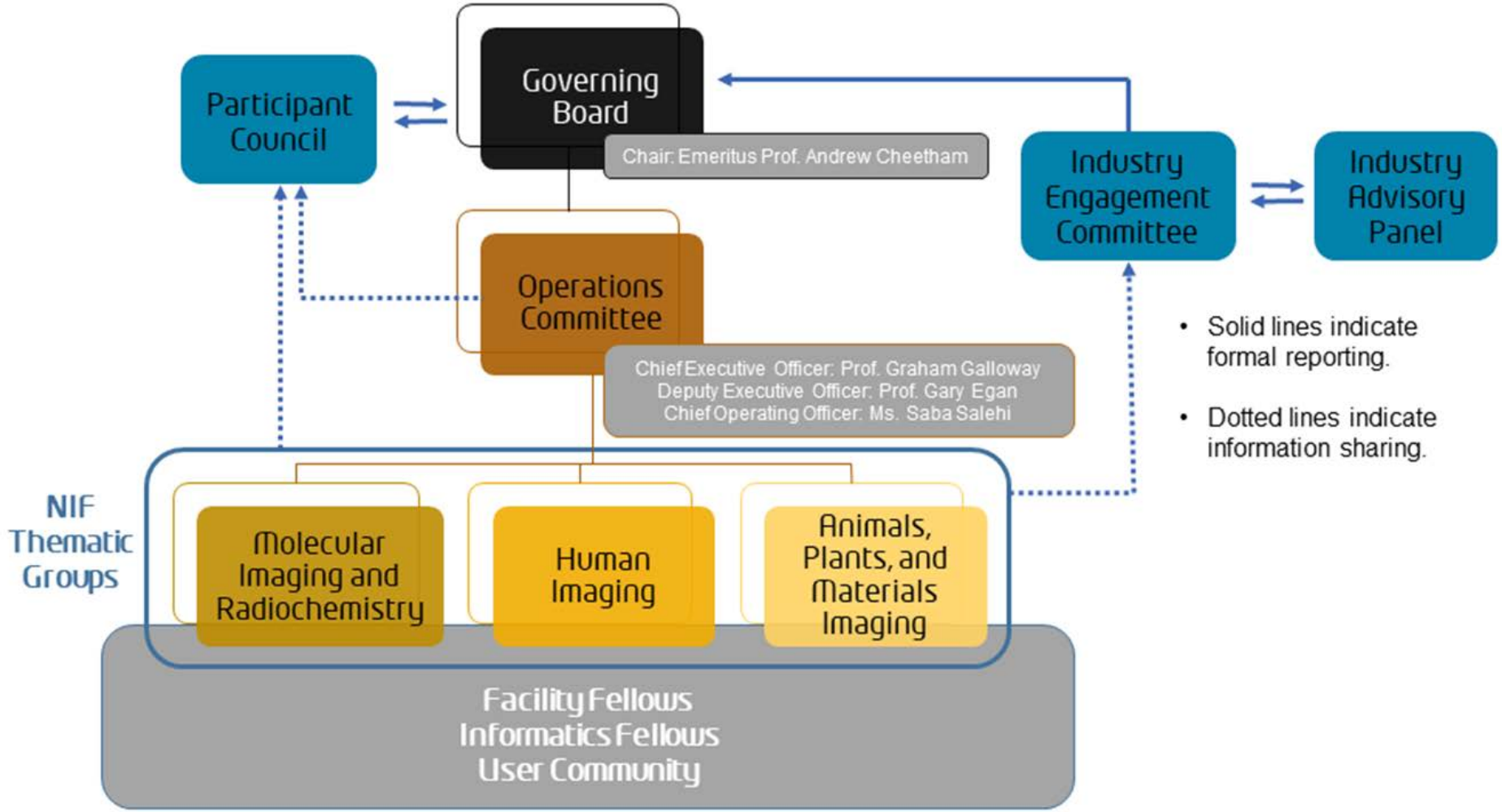
NIF Funding

- Commonwealth Funding: $120M
- 2007 NIF $7M ->$21M
- 2009 EIF $40.2M -> $106M
- 2018 RIIP $53.6M -> $150M
  - CapEx $42.8M
  - OpEx $10.7M
- Government has already committed $1,327M for 2023-2029
- This is a change in the paradigm – part of normal budget process
- Proactive rather than Reactive

2007	NIF established as one of four initiative projects implemented by the Australian Government, under the National Collaborative Research Infrastructure Strategy (NCRIS) Characterisation capabilities.	$17M funding
2009	NIF further expanded by the Education Investment Fund (EIF).	Additional $40.2M
2013		Additional $4.3M
2015	NIF funding continued as part of CRIS & then NCRIS	Additional $2.9M
2016		Additional $2.9M
2017	NIF supported by the National Innovation and Science Agenda (NISA)	Additional $3.2M
2018	Increased funding provided via NCRIS and NISA to enable capital renewal and continued growth of prioritised national research infrastructure in imaging.	Additional $16M over five years Additional $53M over five years

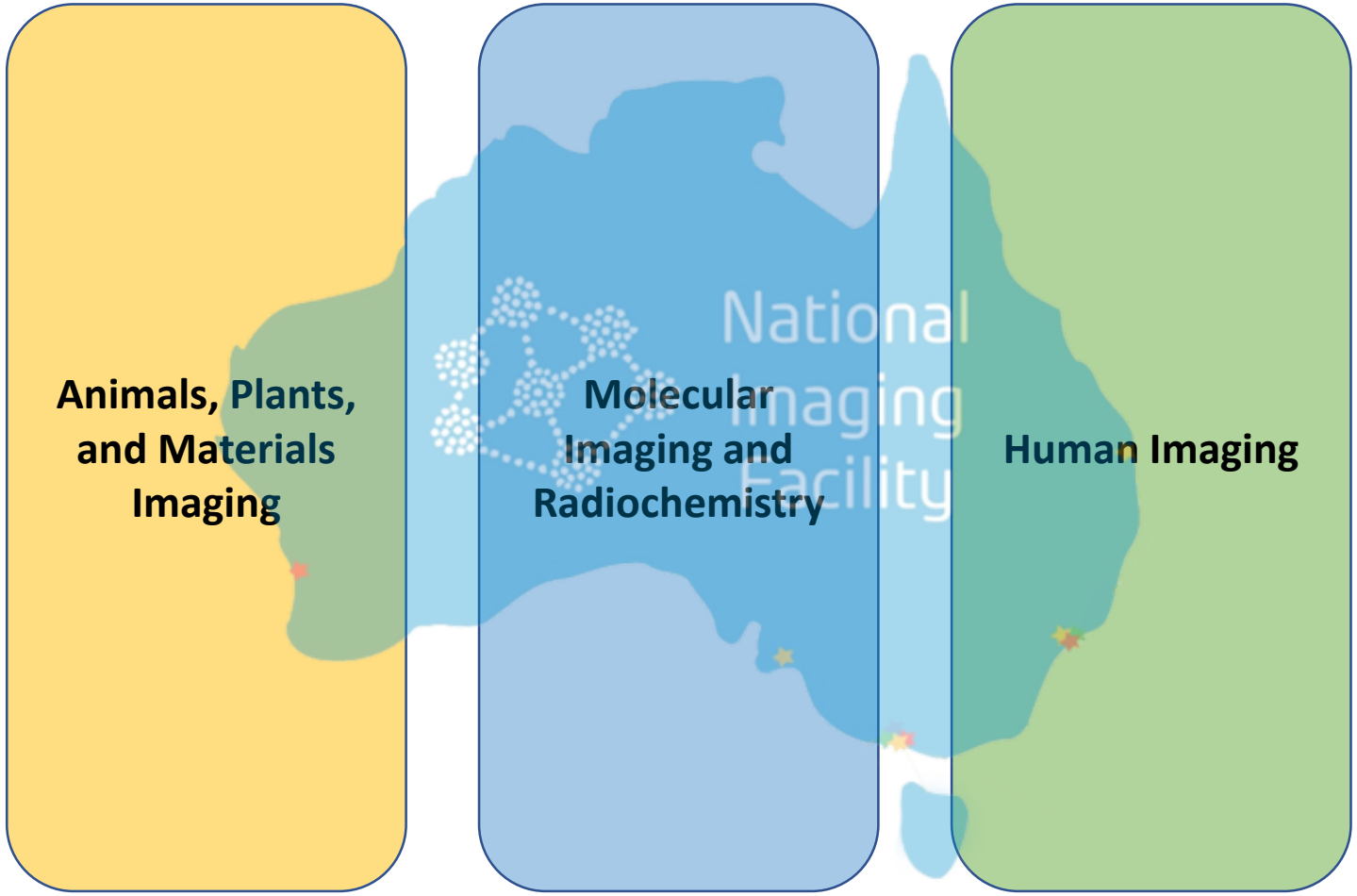
National Imaging Facility

The National Imaging Facility



National Imaging Facility

The National Imaging Facility



National Imaging Facility

NIF Vision and Mission

A national network of advanced imaging capability to deliver innovation and growth

- To enable research excellence in imaging via a world-class capability available for all Australian researchers
- To promote best practice in image acquisition, and data management and analysis
- Position NIF as the prime source of information for non-imaging scientists

Provide users with reliable, state-of-the-art technology and highly specialised expertise that deliver advanced imaging solutions

- To understand the ongoing needs of the scientific community for imaging infrastructure
- To provide researchers with reliable, state-of-the-art technology
- To be closer to the “clinical translation” interface,
- To lead in developing and implementing the most effective imaging technologies
- To identify iconic new investments that constitute a new direction,

National Imaging Facility

NIF Scientific Fellows

- Existing: 25 (20.57 FTEs) Scientific Fellows – Partially funded
  - 20 (16.07 FTEs) Facility Fellows
  - 1 (1 FTE) Radiochemist
  - 4 (3.5 FTEs) Informatics Fellows
- New: 23 (19.5 FTEs) Scientific Fellows – 50% Co-investment
  - 13 (11 FTEs) Facility Fellows
  - 7 (5.5 FTEs) Radiochemists
  - 3 (3 FTEs) Informatics Fellows

National Imaging Facility

NIF (Infra)Structure

Molecular Imaging

- PET/CT
- PET/SPECT/CT
- Cyclotron
- Radiochemistry Laboratories

MR/PET
Imaging Informatics

Human Imaging

- Network of 3T MRIs
- Human MEG
- Set of 7T MRIs
- Imaging Informatics

Human PET/CT

Animals, Plants, Materials Imaging

- 9.4 T MRIs
- 16.4 T MRI
- FFC NMR Relaxometer
- Spectrum CT

11.7 T MRI
14.1T MRI
Large Animal 3T MRI
Imaging Informatics

National Imaging Facility

Victorian Mapping of NIF Themes

	Molecular Imaging	Human Imaging	Animals, Plants & Materials
Florey	PET, SPECT, radiopharmaceuticals	MRI	PET, SPECT, MRI
UOM	PET-CT	7T MRI	
SUT		MEG, MRI	
Monash	MR-PET	MRI, EEG	MRI, PET, SPECT, CT

National Imaging Facility

National Science and Research Priorities

Health

"Build healthy and resilient communities throughout Australia by developing treatments, solutions and preventative strategies to improve physical and mental well-being and improve the efficiency and effectiveness of Australia's health care system"

Food

"Develop internationally competitive, sustainable, profitable, high intensity and high production capacity in new and existing food products and maintain Australia's reputation for clean, safe and quality-controlled food production."

NIF supports the industry sectors of Medical Technologies and Pharmaceuticals and Food and Agribusiness as identified in the Commonwealth government's Industry Innovation and Competitiveness Agenda as a focus of research and innovation.

Environmental Change

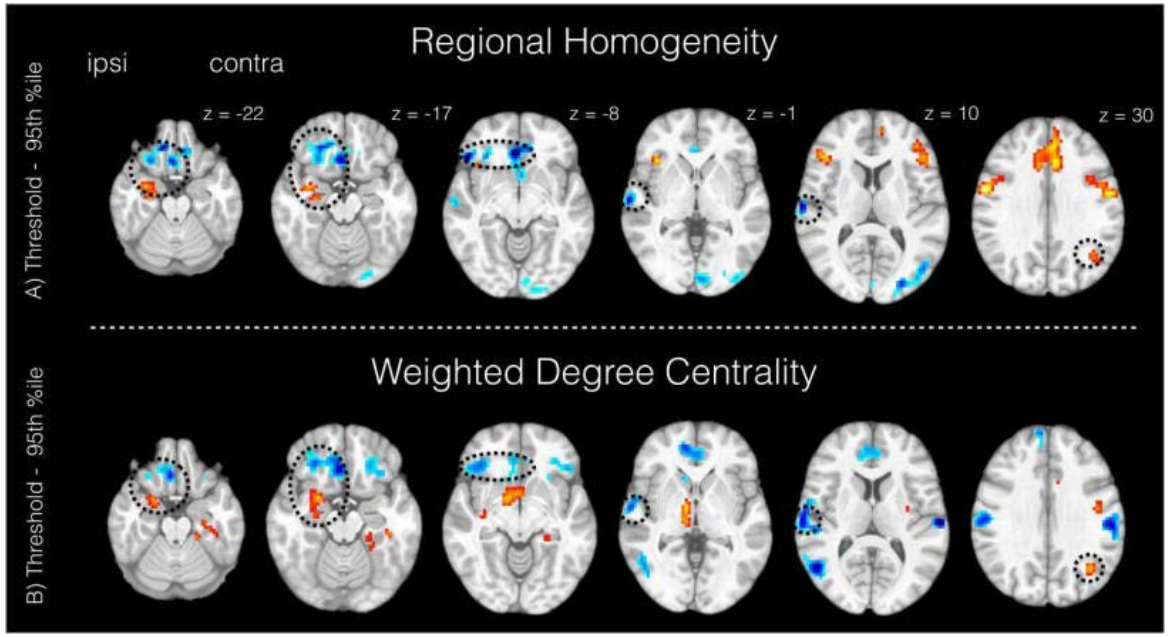
“Improved accuracy and precision in predicting and measuring the impact of environmental changes caused by climate and local factors.”

Manufacturing

“Developing and supporting existing industries while enabling the development of a new and advanced manufacturing sector. Specialised, high value-add areas such as high-performance materials, composites, alloys and polymers.”

National Imaging Facility

Abnormal brain areas common to focal epilepsies



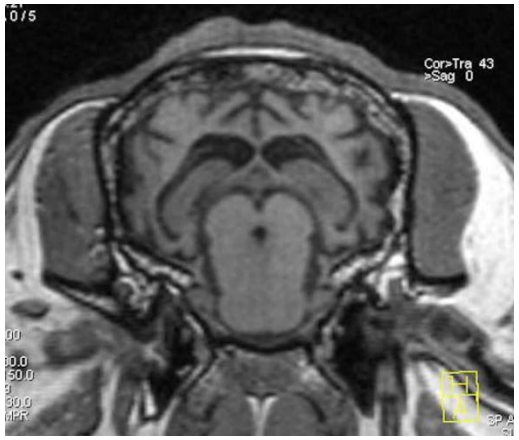
- Early detection of epilepsy to minimize risk of damage caused by seizures
- Imaging to identify common brain areas in patients
  - Early detection → immediate treatment

National Imaging Facility

Neurodegenerative Disease

- Batten disease is characterised by progressive neurodegeneration. It starts insidiously and leads to blindness, epilepsy and dementia in affected children.

- Imaging facilities and expertise at LARIF was used to assess
  - dynamics of progression of neurodegenerative changes in sheep models
  - Efficacy of therapeutic agents.

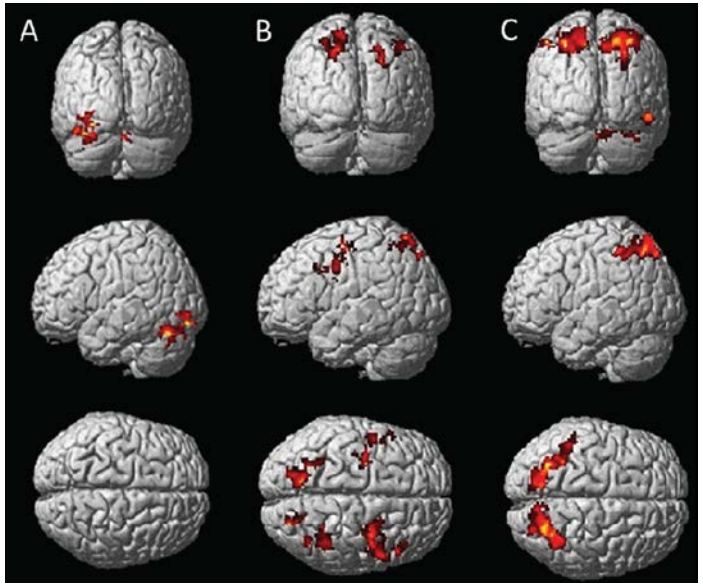


National Imaging Facility

Nutrition

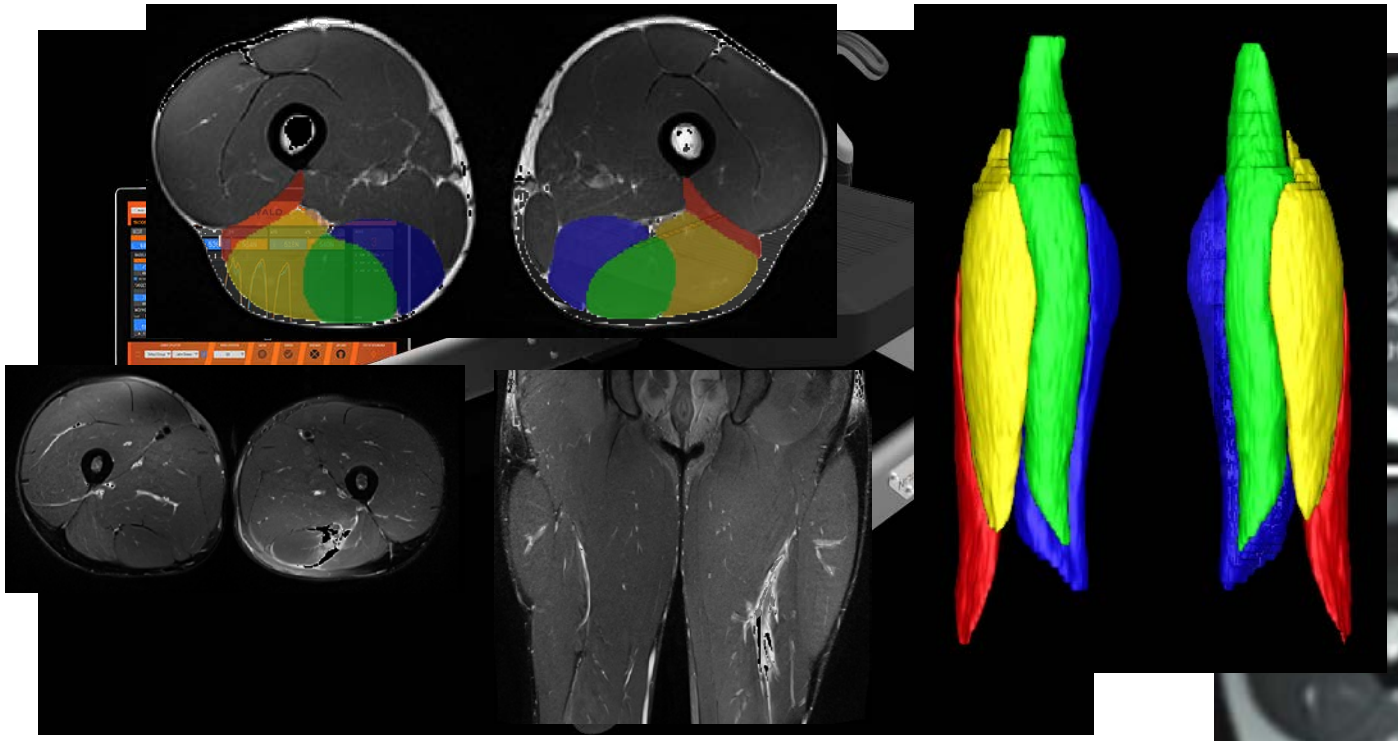
- Effects of different multi-vitamin preparations on mood, information processing & verbal ability

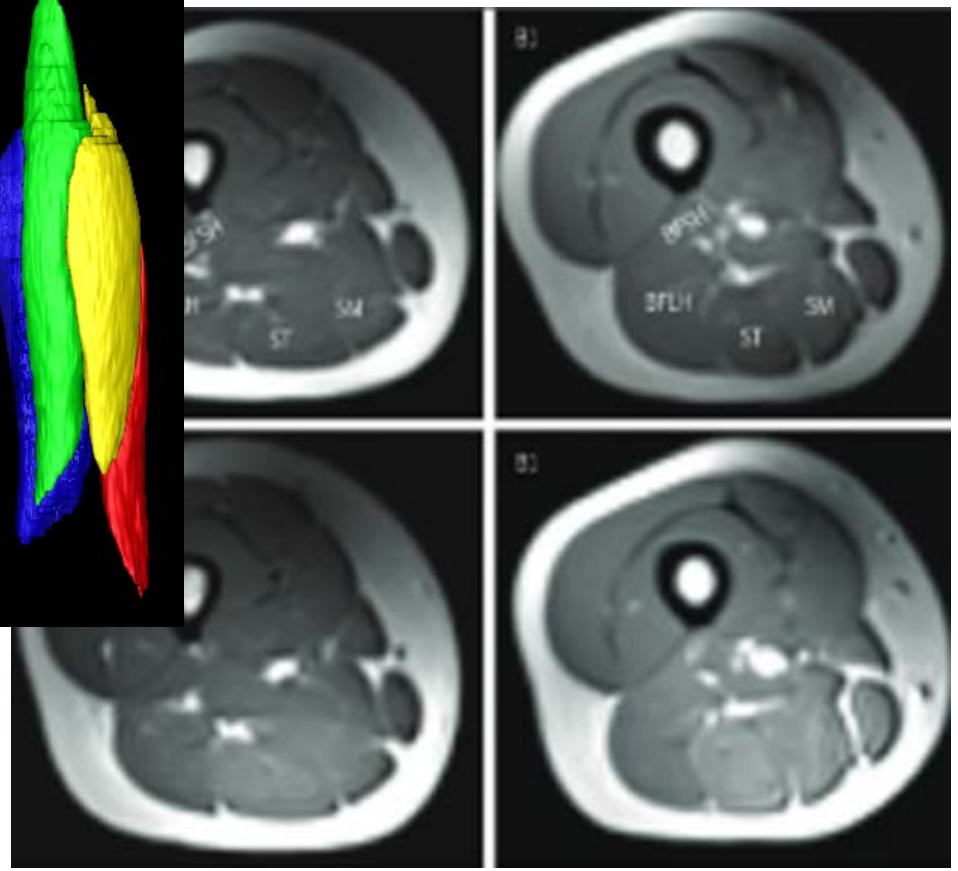
- Imaging used to understand brain activation and improvement of performance of working memory/attentional task.



National Imaging Facility

Sports Injuries and Training





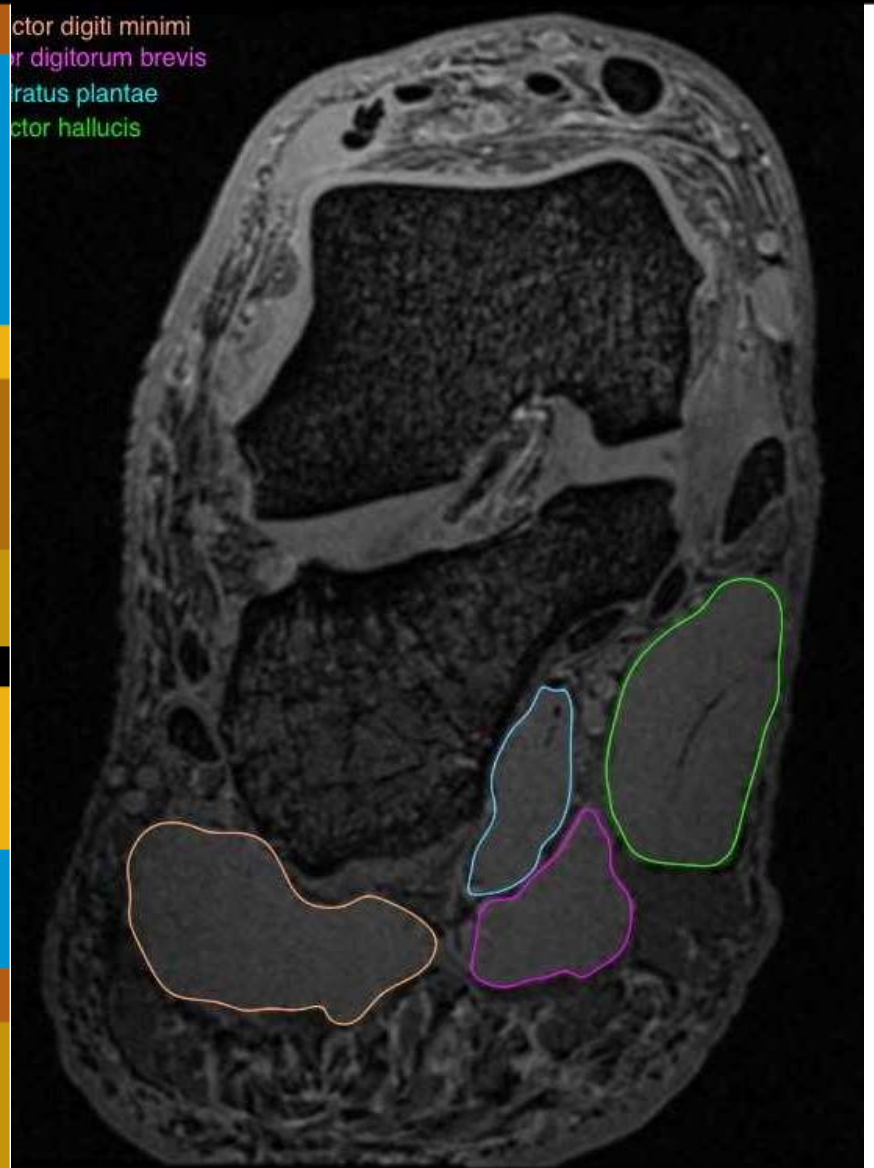
Nordbord Hamstring Testing & Muscle Training and Balance

Anthony Shield and David Opar
QUT

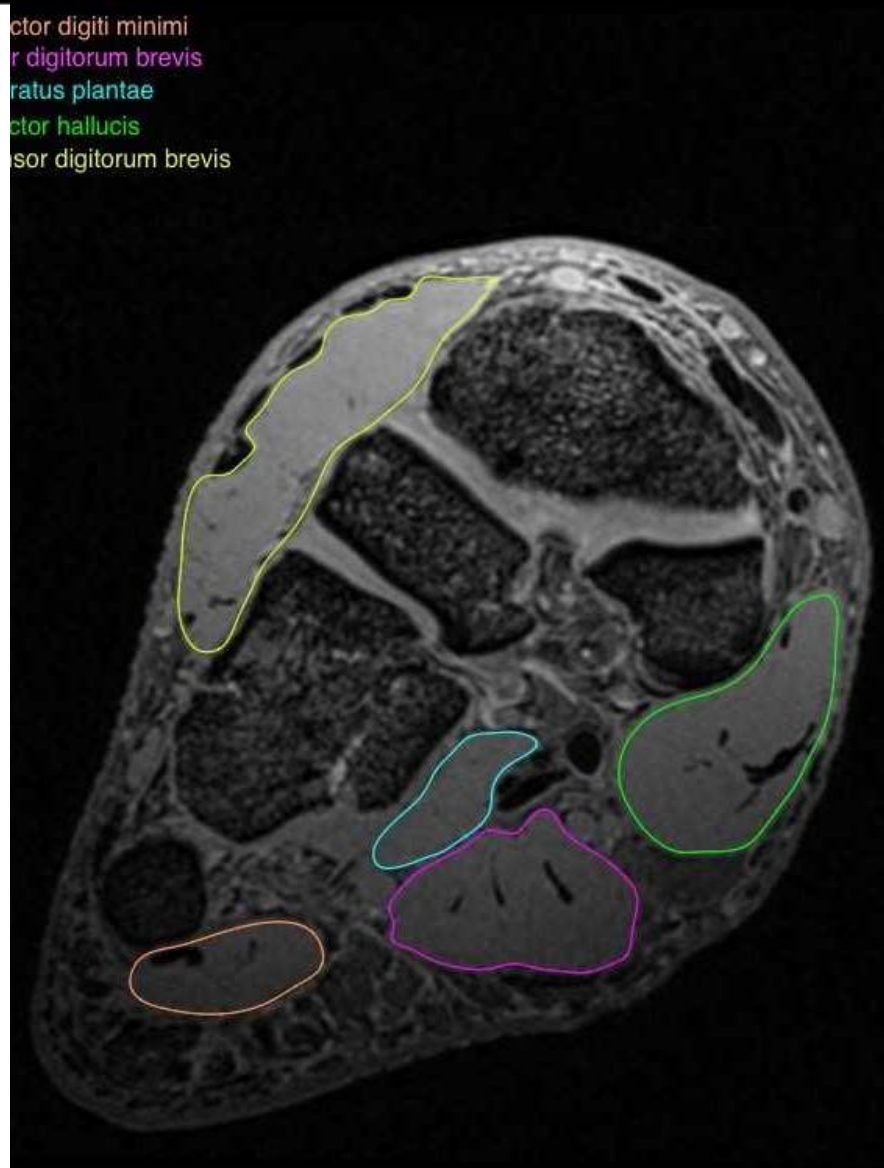
Craig Engstrom
UQ

National Imaging Facility

Exploration of the deep foot muscles at ultra-high field

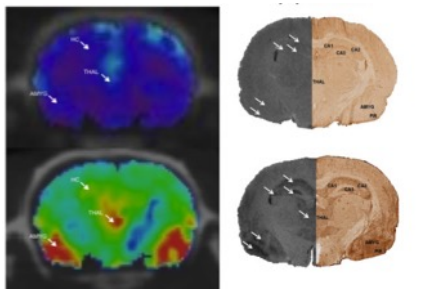


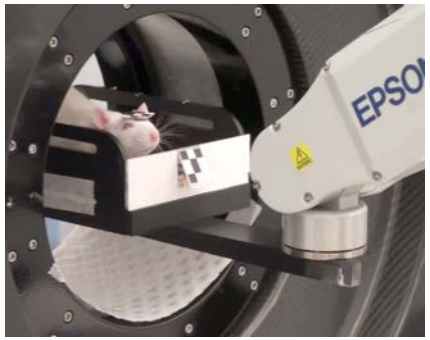
- 7T MRI, shearwave elastrography and electromyography
- Muscle architecture of the foot
- Investigation and modelling of the force-generating capacity of the deep foot muscles



National Imaging Facility

USyd-ANSTO Node





Australian Government

THE UNIVERSITY OF SYDNEY

ANSTO

National Imaging Facility

Radiotracer Production

Research Cyclotron

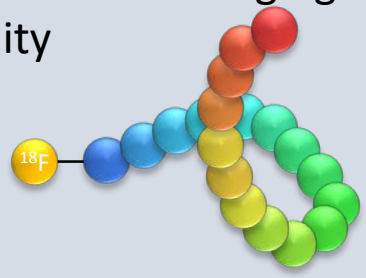
^{18}F ^{11}C

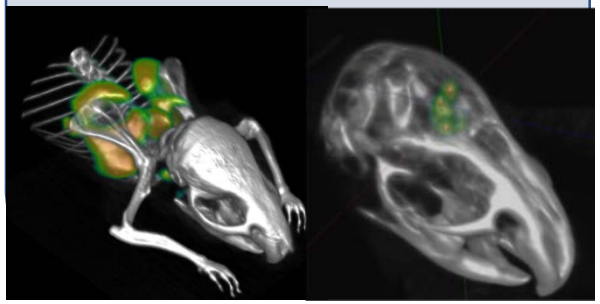
Preclinical Radiotracers

Radiolabel small molecules

Peptides, proteins

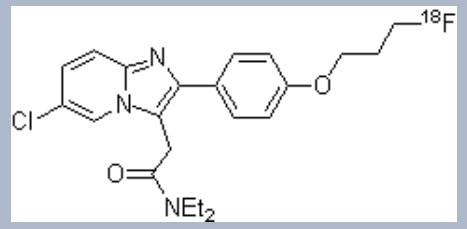
Small animal imaging facility





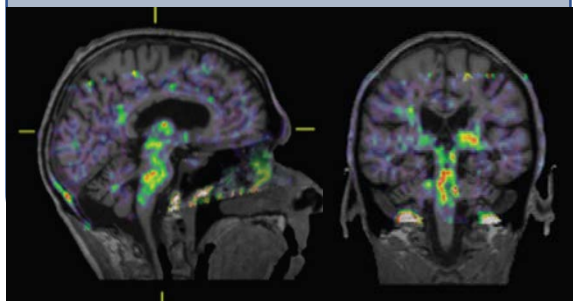
Clinical Radiotracers

Example



[^{18}F]PBR111

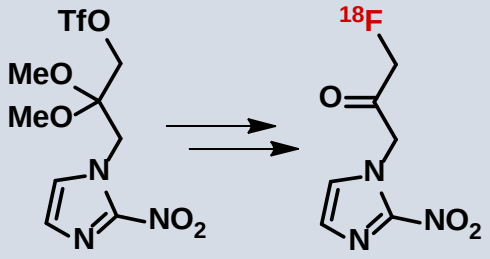
for neuroinflammation



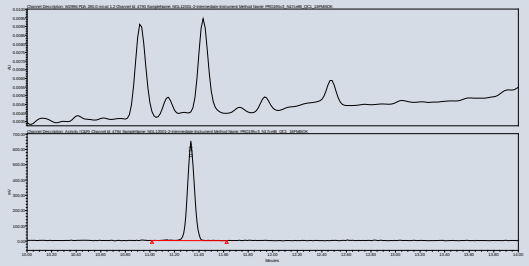
National Imaging Facility

Radiochemistry

Research Radiotracers

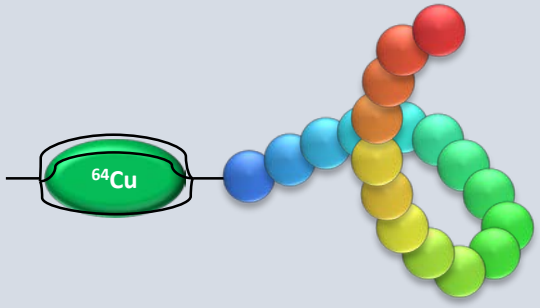


[^{18}F]FMK

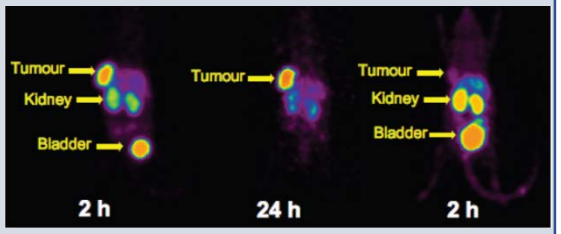


MONASH University

Preclinical Radiotracers

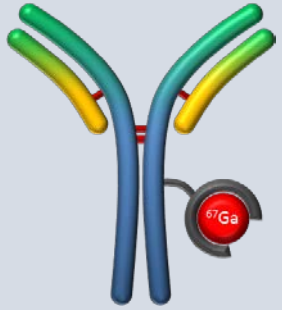


[^{64}Cu]peptides

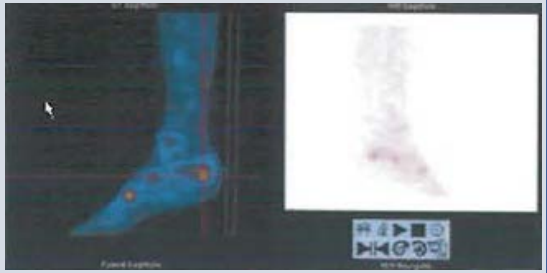


Clarity Pharmaceuticals

Clinical Radiotracers



[^{67}Ga]Multixamab™



minomic™

^{18}F	^{57}Co	^{64}Cu	^{67}Ga	^{68}Ga	^{89}Zr	^{90}Y	^{99m}Tc	^{1XX}I	^{153}Sm	^{177}Lu

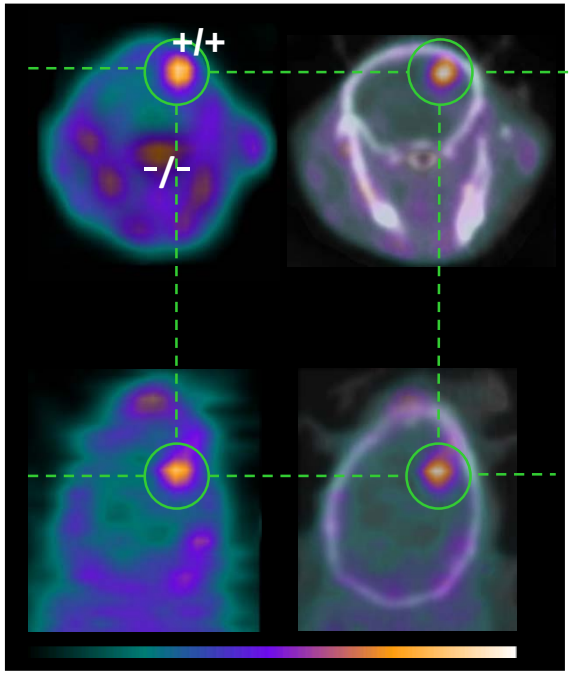
National Imaging Facility

In vitro *Imaging*

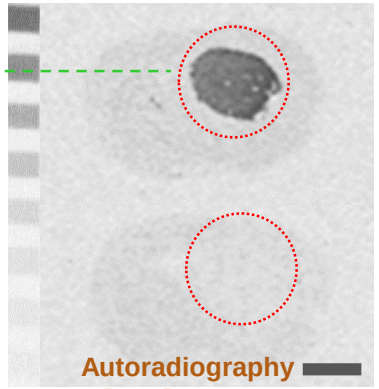
Post-mortem autoradiography images of TSPO expression in U87 glioma xenograft

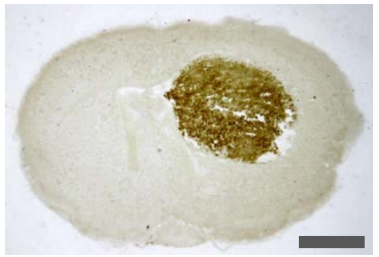
PET/CT *in vivo* imaging

***In vitro* Imaging**



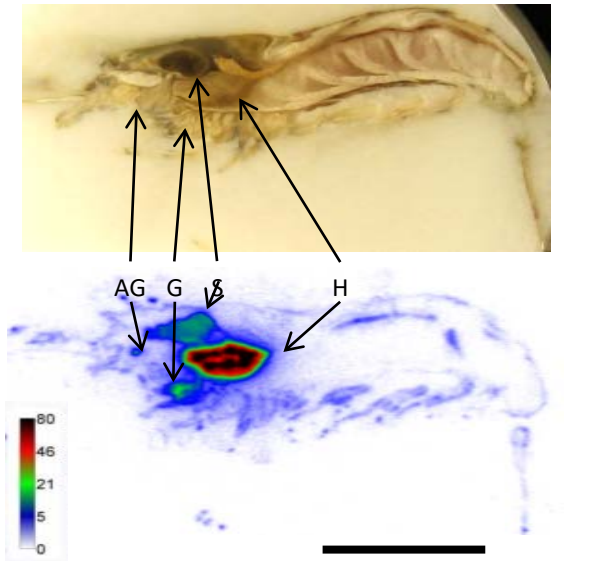
PET - [^{18}F]PBR111 PET/CT



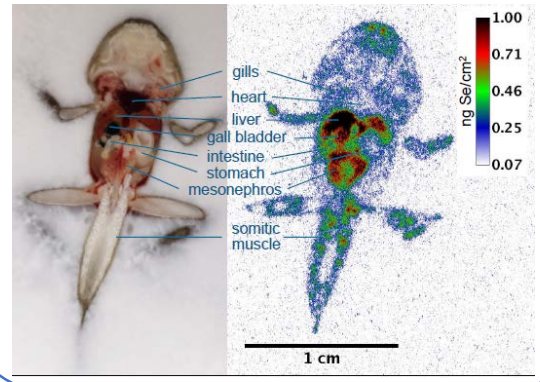


Immunohistochemistry
TSPO-antibody

In vitro imaging in aquatic ecosystems

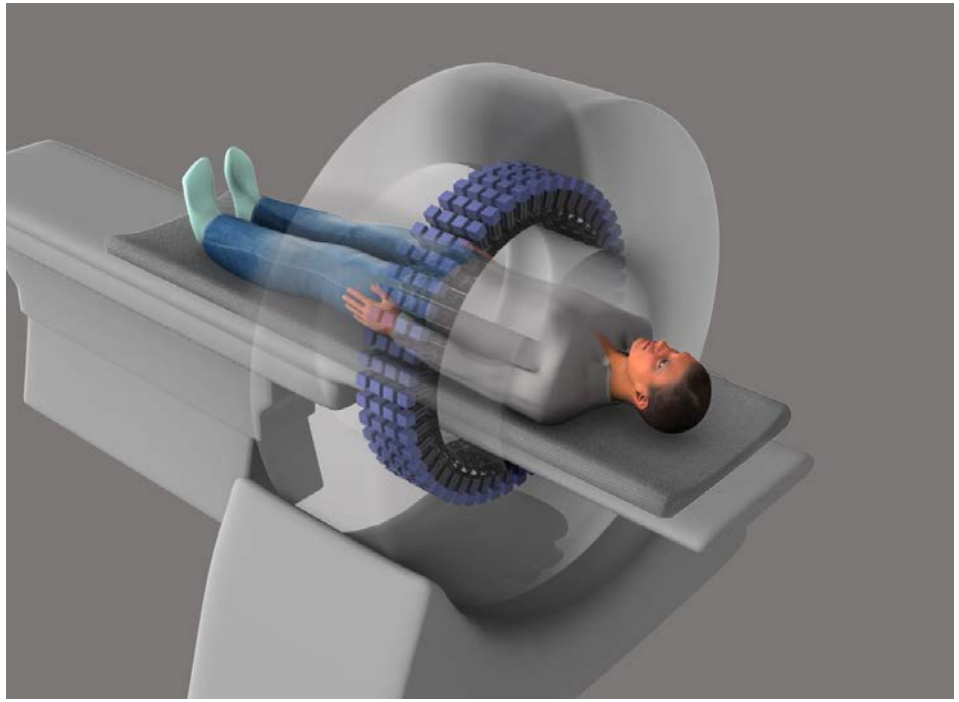


Cd109 accumulation in prawns/tadpoles

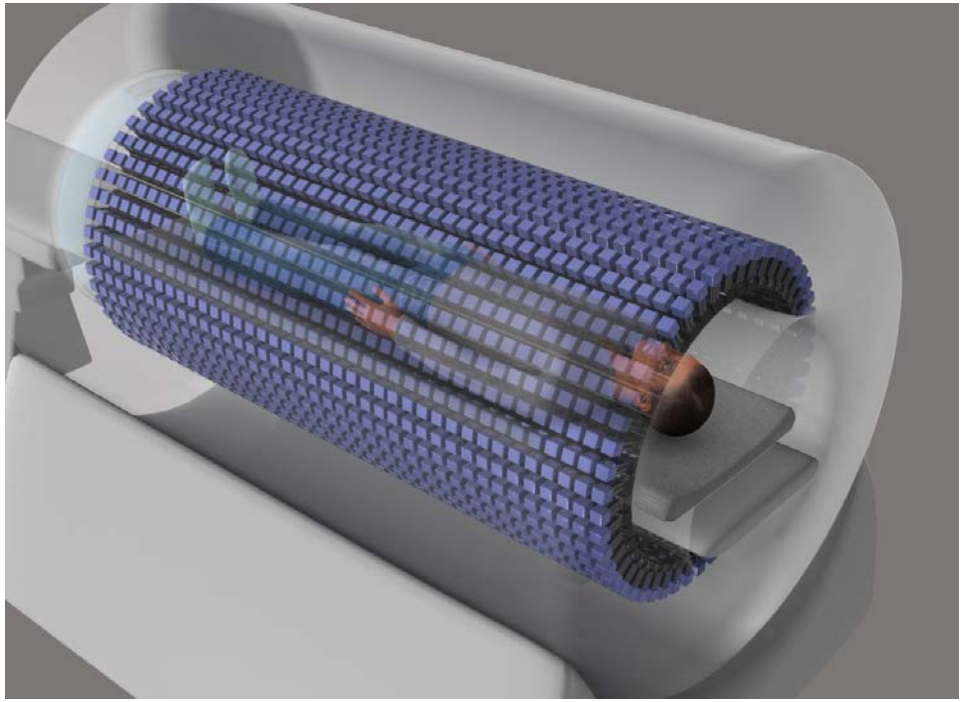


National Imaging Facility

Total Body PET



Current state-of-the-art PET



Total Body PET (aka EXPLORER)

Cherry SR, Badawi R. EXPLORER: Changing the Molecular Imaging Paradigm with Total Body PET, NIH Transformative RO1 – NIH High Risk High Reward Program, ***USD $15.5M***

Penn UCDAVIS UNIVERSITY OF CALIFORNIA THE UNIVERSITY OF SYDNEY ANSTO

National Imaging Facility

Applications of Total Body PET

Systemic disease and therapies:

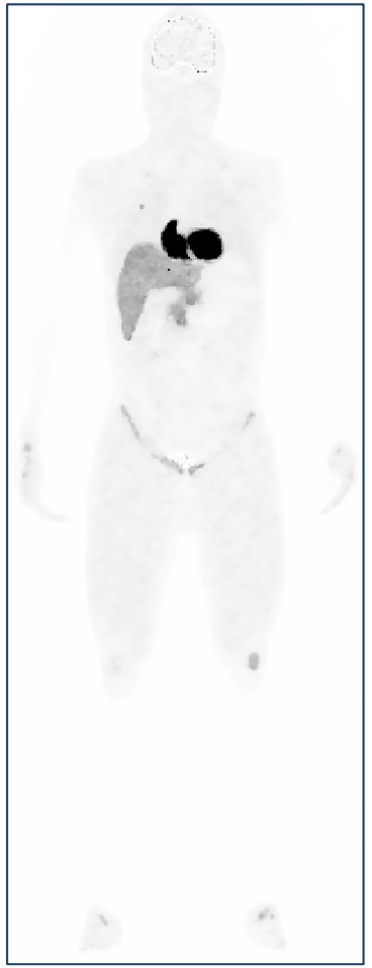
- Cancer: Ultra-staging and micrometastasis
- Metabolic diseases
- Brain-gut signaling
- Inflammation
- Infection
- Cellular therapy and trafficking

Total body pharmacokinetics

- Drug development
- Toxicology
- Biomarker discovery

Low dose opens up new populations:

- Expanded use in paediatrics
- Use in chronic disease
- Studies of normal biology

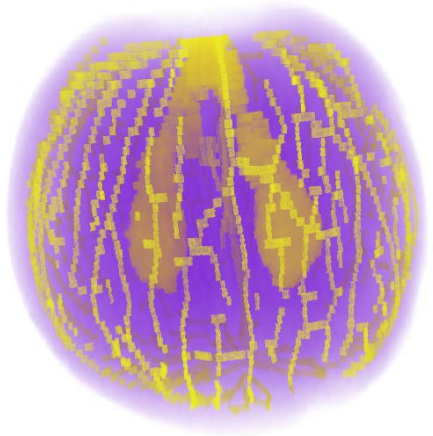


1/40x dose

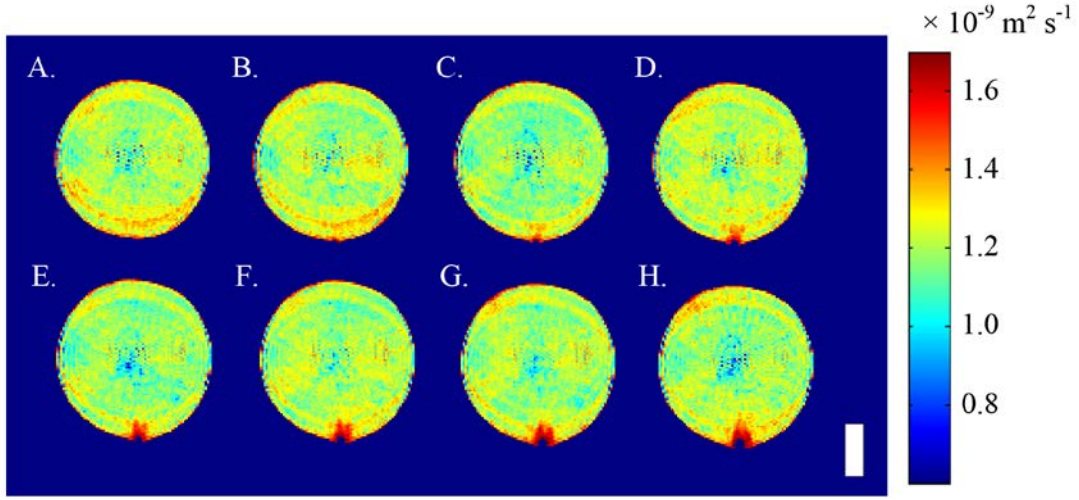
National Imaging Facility

With the National Wine and Grape Industry Centre

The Western Sydney University (WSU) Node in collaboration with the National Wine and Grape Industry Centre and the NSW Department of Primary Industries are using MRI to study grape berry structure and pathologies (such as berry splitting, a costly problem).



3D reconstruction of a grape showing the berry vasculature and seeds.



Berry splitting or fruit splitting is a costly issue for industry.

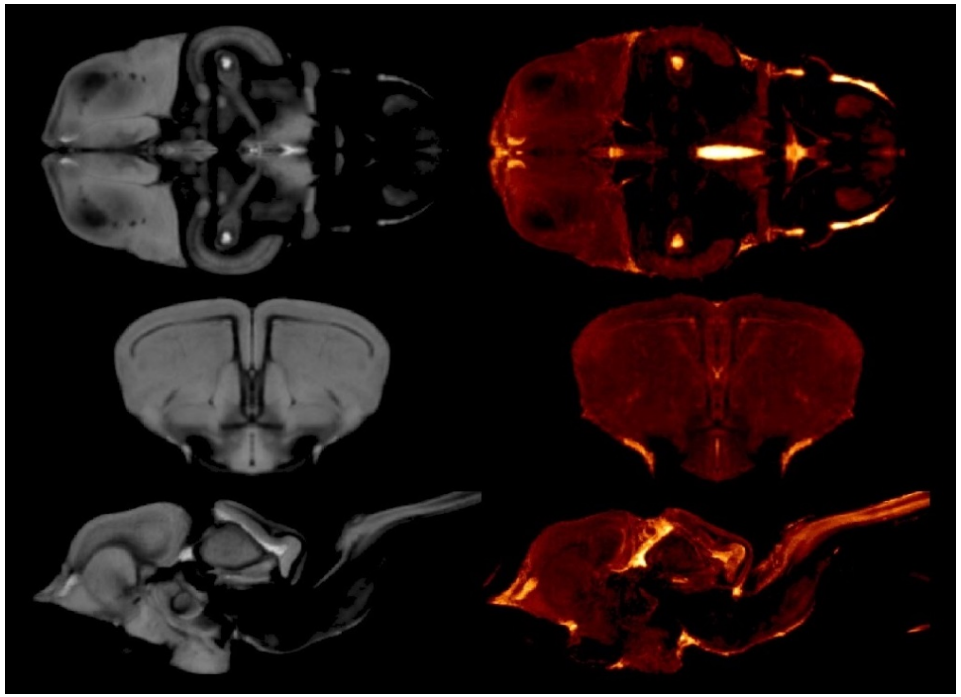
- Diffusion MRI: development of a single split in a mature grape
- Acquired an hour apart

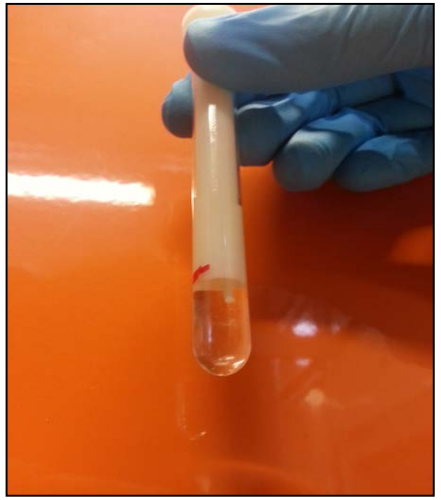
WESTERN SYDNEY UNIVERSITY

Nanoscale Organisation and Dynamics Group

National Imaging Facility

With the Australian National University





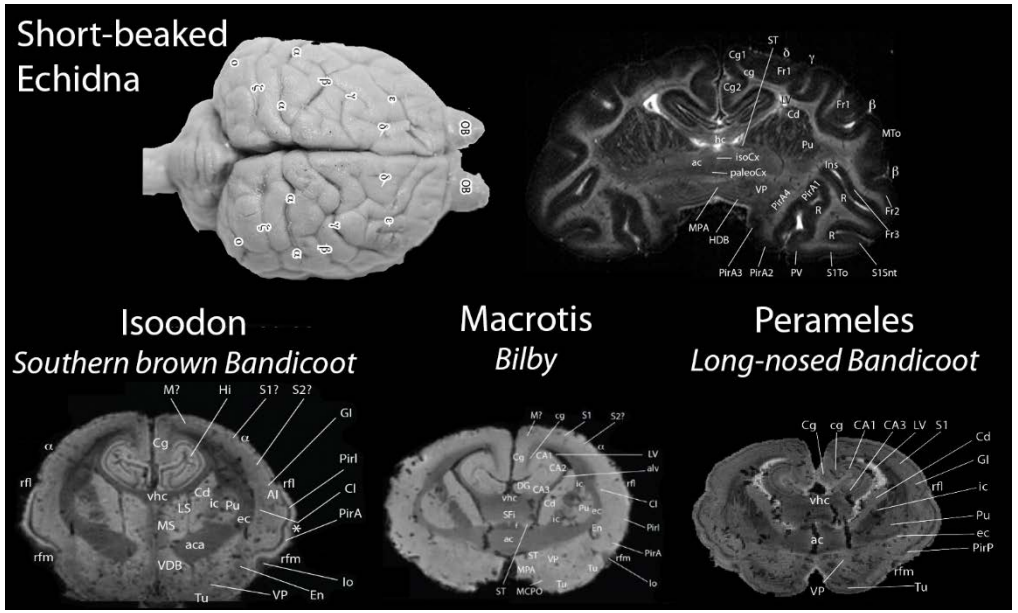
WESTERN SYDNEY UNIVERSITY

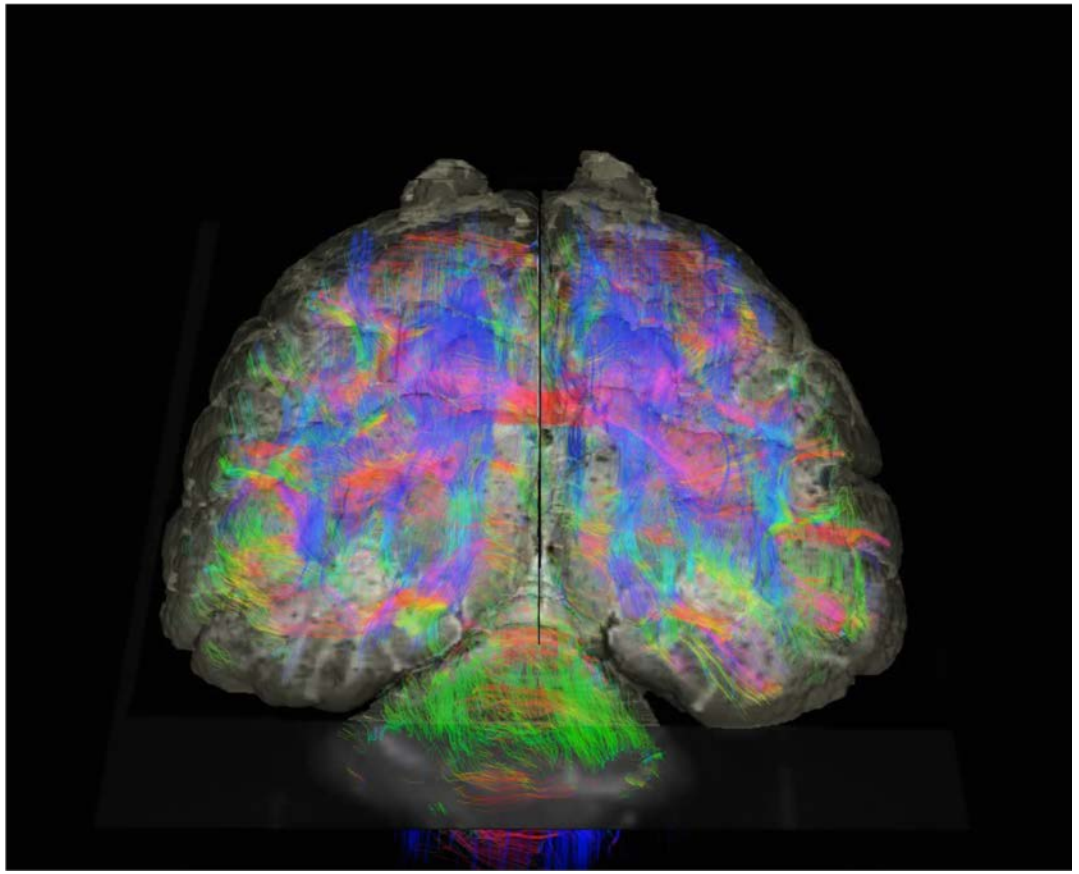
Nanoscale Organisation and Dynamics Group

National Imaging Facility

Australia's National Treasures

- Evolution of brain structures in endemic Australian mammals
- Non-invasive approaches for rare, endangered and even extinct species
- Building a unique database of brain structure for Australian fauna



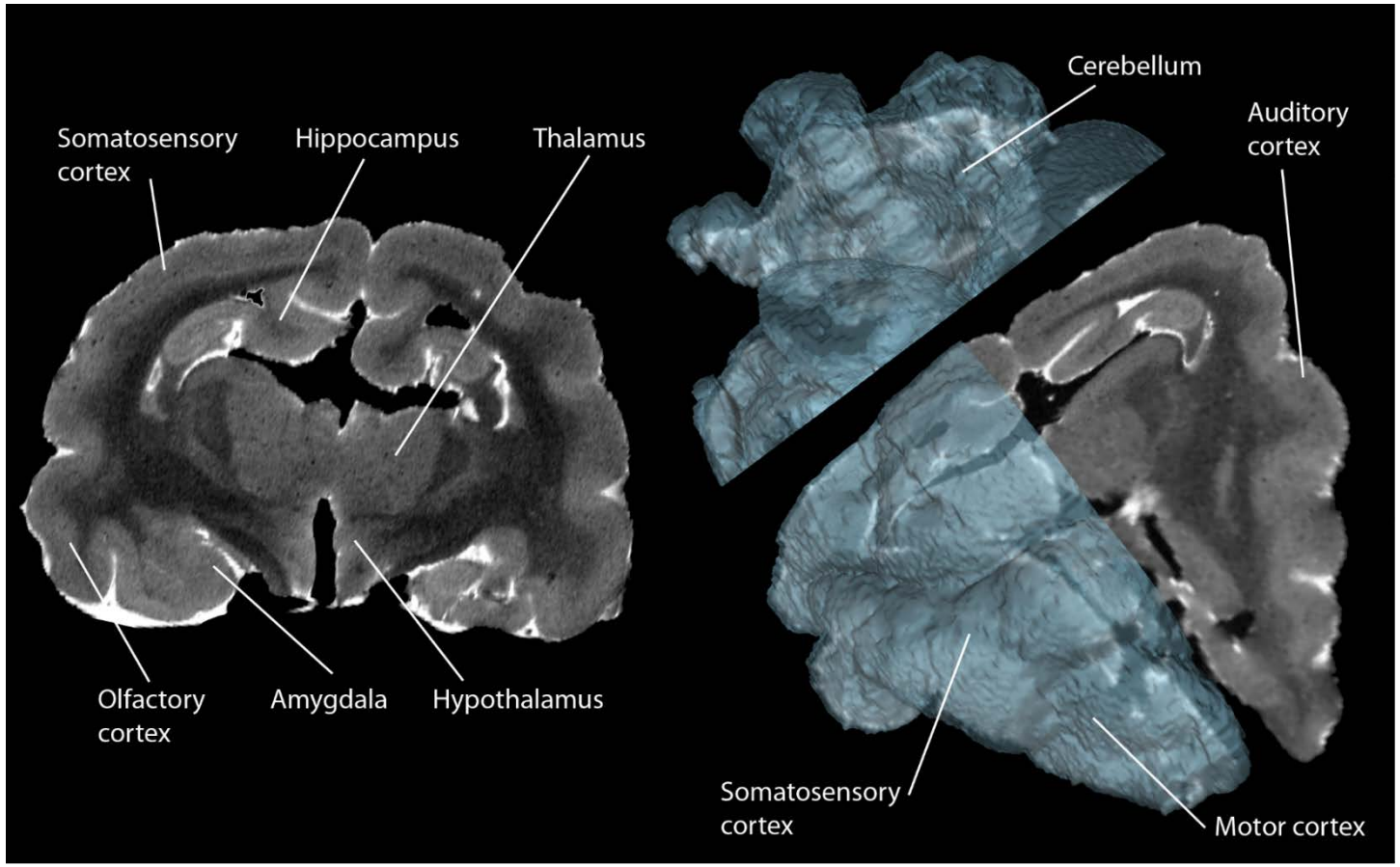


Reconstruction of echidna brain imaged with MRI system

UNSW

National Imaging Facility

Imaging Extinct Species

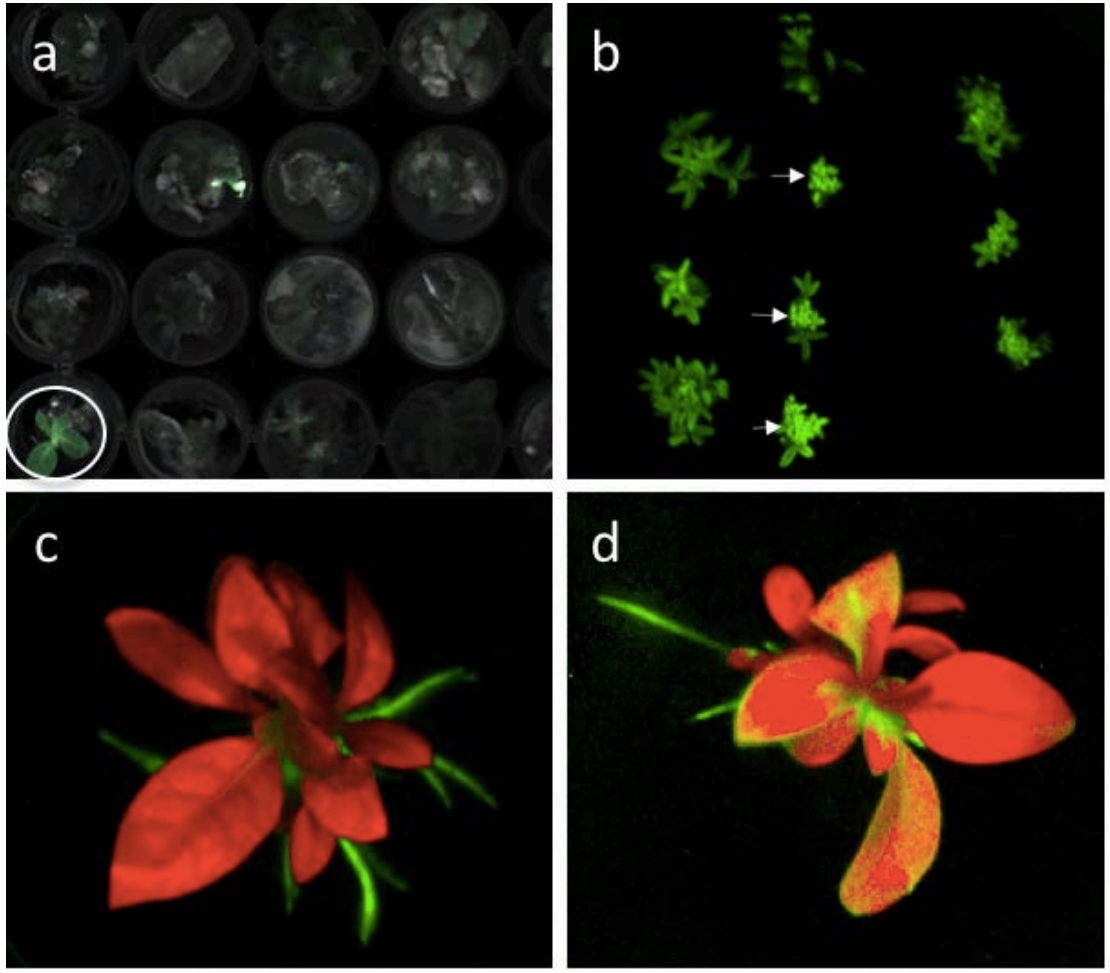


UNSW

National Imaging Facility

Transgenic plants

- CRi Maestro 2
- Targeted GFP Expression
  a) Tobacco samples
  b) Narrow-leafed lupin explants
  c) Tobacco transgenic plants: GFP in roots only
  d) Tobacco transgenic plants: GFP in roots and leaves
- 1st-gen shoots chimeric
- Further subculturing to propagate chimeric explants



Meastro filter: Blue (excitation filer: 435-480 nm) Emission: 500 – 720 nm. Chlorophyll (red) and GFP (green)

National Imaging Facility

The Future of NIF (2019-2030)

- NIF will participate in the development of a national network of radiotracers/radiochemistry capabilities as identified in the 2016 Roadmap including additional investment in infrastructure
- NIF will continue to invest in MRI including ultra high-field and hyperpolarised MRI. Human Connectome MRI
- NIF will use its resources to support and leverage initiatives of the Medical Research Future Fund and the Biomedical Translation Fund to drive innovation and improve health outcomes
- NIF Implementation plan includes stronger collaboration with Bioplatforms Australia, Therapeutic Innovation Australia and Australian Phenomics Network
- NIF will build synergies through collaborations on informatics, image analysis, trusted data repositories…

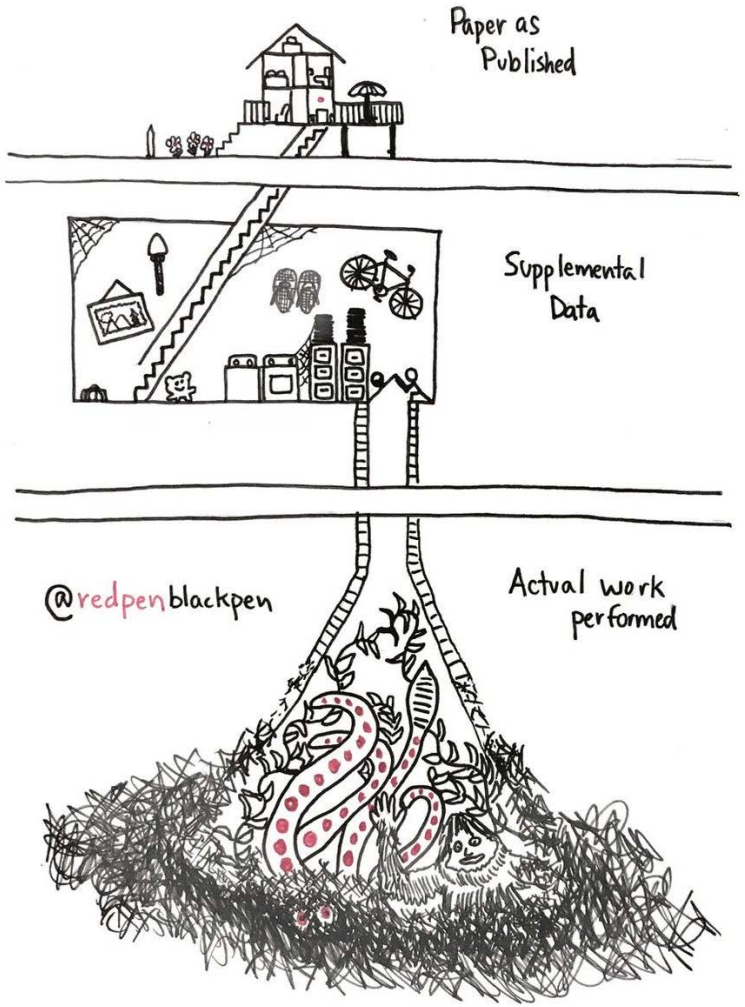
National Imaging Facility

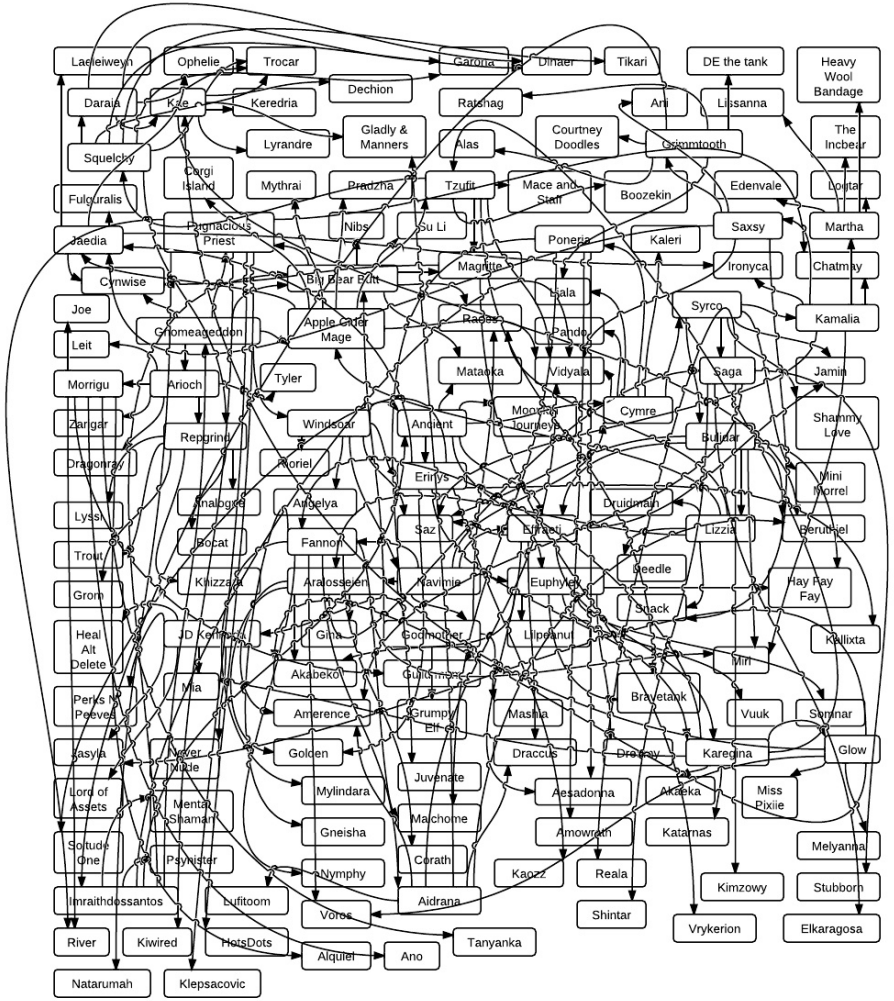
Data
Is it important?
Or Valuable?

So – why don't we look after it?

National Imaging Facility

We've all been here! It works, but is it reproducible





National Imaging Facility

Key points

- Extraordinary growth in data generation and usability has enabled a kaleidoscope of new business models, products and insights. Data frameworks and protections developed prior to sweeping digitisation need reform. This is a global phenomenon and Australia, to its detriment, is not yet participating.
- Improved data access and use can enable new products and services that transform everyday life, drive efficiency and safety, create productivity gains and allow better decision making.
- The substantive argument for making data more available is that opportunities to use it are largely unknown until the data sources themselves are better known, and until data users have been able to undertake discovery of data.

considerable value for growing the economy, improving service delivery and transforming policy outcomes for all Australians. Greater use and sharing of public data facilitates increased economic activity and improves productivity.

Existing data sharing arrangements across the public service are complex and hinder the use of data. Barriers include:

- a dense web of legislative requirements which lack consistency
- a culture of risk aversion, leading to overly cautious legislative interpretation and approval process complexity, and
- lack of a whole-of-government approach.[1]

New data sharing and release arrangements will benefit Australians by streamlining the way public data is shared and released within government and with trusted users. New arrangements will provide efficient, scalable and risk-based trusted data access to datasets that have substantial and community-wide benefits for research, innovation and policy.

National Imaging Facility

What is F.A.I.R.?

Findable **I**nteroperable
Accessible **R**eusable

- Findable requires database of Metadata that describes the data, and the purpose for which it was collected.
- Accessible is not the same as open, and for sensitive data access does need to be controlled. So it needs to be credentialed.
- Interoperable: We keep hearing about big data. For that to work, data needs to be in common, preferably open formats
- Reusable: Data should be able to be shared. But in accordance with any ethics permissions and the wishes of the patients and legislation.

National Imaging Facility

Findable – Meta Data

- What is the data?
  - Description of subject
    - Species
    - Age
    - Health
  - Why was it collected
    - Normative control
    - Development
    - Disease progression
    - Efficacy of therapy
  - How was it collected
    - Often this data can be extracted from the header from the instrument
    - How was the microscope setup – light source, filter, enviro nmental conditions,
  - Provenence
    - What was done to the data????

National Imaging Facility

Findable - DOI

- Finding your socks

National Imaging Facility

Findable

- Index in a database
  - Private
  - Institutional
  - Public
- What is in the data base
  - Links Meta data to DOI
  - Research Data Australia
    - A searchable database
    - Data can be published to RDA
      - Library
      - Tools such as ImageTrove, an extension to myTardis

National Imaging Facility

Accessible

- Standard Protocols
  - Pointing to a proprietary database won't cut it
  - Need to export the meta data and data
- Restricted Access
  - Intellectual Property
  - Sensitive Data
    - Privacy – governed by ethics and informed consent
    - Better if this is included in meta data
  - Embargoed
  - Needs an authentication system that manages multiple users
- Open Access
  - Is the data store accessible?
  - Persistent Identifier

National Imaging Facility

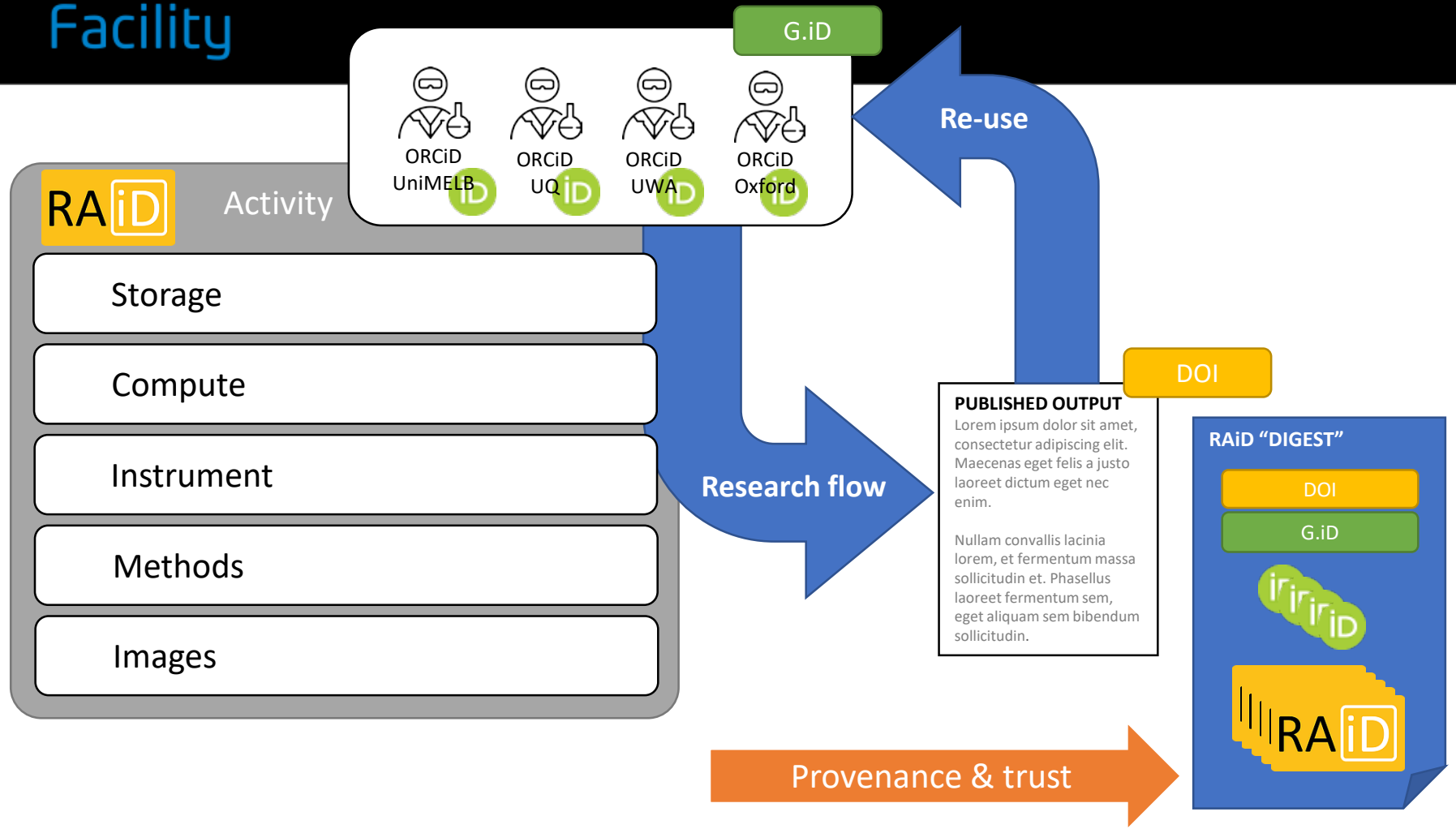
Interoperable

- (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation
- (meta)data use vocabularies that follow FAIR principles
  - **Getting started:** Controlled vocabularies for data description
  - A controlled vocabulary provides a consistent way to describe data - location, time, place name, subject.
  - Controlled vocabularies significantly improve data discovery.
- (meta)data include qualified references to other (meta)data
  - Identifiers are crucial to disambiguation of people, accurate attribution and impact metrics. We look at identifiers for people - specifically the global people identifier: ORCID, and stray into the fascinating world of linked data.
  - Persistent Project ID - RAiD
  - Persistent Instrument ID – changes when major change to instrument

reusable

- (meta)data are released with a clear and accessible data usage license
  - Copyright, data and licensing
  - Licensing and copyright for data reuse
- (meta)data are associated with their provenance
  - Data provenance
- (meta)data meet domain-relevant community standards
  - Stored in an open format
  - Meta data includes a reference to a converter

National Imaging Facility



National Imaging Facility

Benefits

RAiD enables the collection of precise data for measuring and auditing:

- Collaborations
- Facility and instrumentation use
- Research output amounts and locations
- Research impact
- Project funding valu
- Research practices

National Imaging Facility

Introducing Trusted Data Repositories

National Imaging Facility

ands AUSTRALIAN NATIONAL DATA SERVICE

RDS Research Data Services

Delivering durable, reliable, high-quality image data

Project Plan

National Imaging Facility

Why?

- Data is valuable
- Resources are limited
- Data is evolving, how do we compare old with new
- Data is the cornerstone of collaboration
- The future is in analytics,
  - we can’t collect enough data on our own
  - Big data, Deep Learning, Artificial Intelligence, Precision Medicine
- Data must be connected to COMPUTE

  In all its guises – HPC, GPU, Cloud
  - CVL – NeCTAR collaborative platform, interoperable, deployable

National Imaging Facility

What we want, what we need

- AND Discoverable
  - when the researcher wants to get it out there
  - Accessible – enduring identifiers
  - Reliable storage
- AND connectable
  - Genomics
  - Clinical data
  - Multimodality, multiscalar, longitudinal

National Imaging Facility

What we want, what we need

- Instrument to Repository
  - Automated
  - Quick
  - Credentialled
  - Shareable – with those in our team – multiple credentials
- BUT Only if we know what it is
  - Meta data
  - QC
  - Provenance

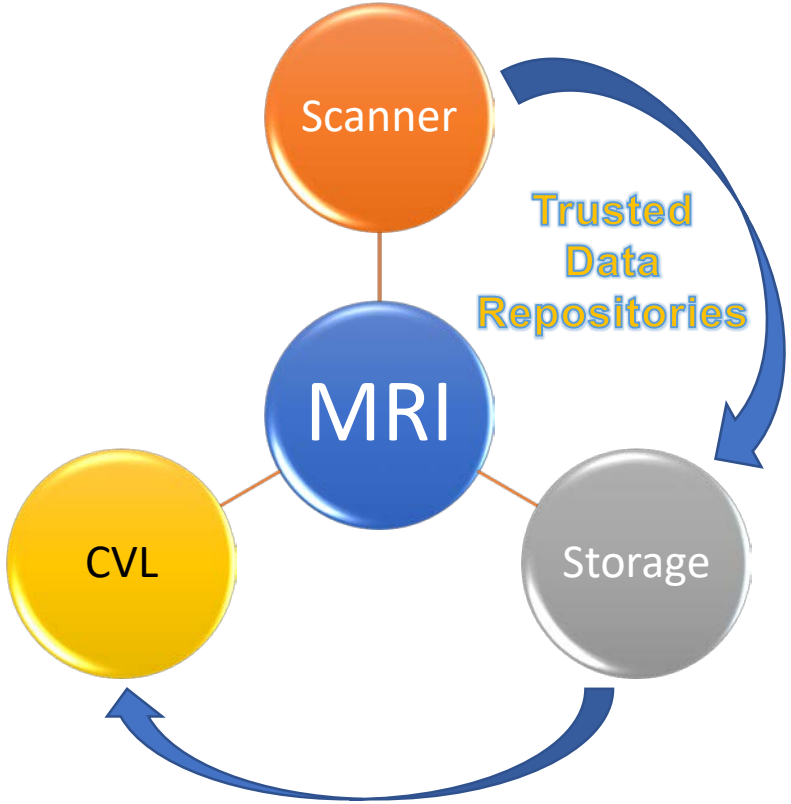
Instrument to Repository - automated, credentialed and shareable

Findable – when the researcher wants to get it from storage. Includes persistent identifiers and rich metadata to ensure it is findable

Accessible – shareable, when appropriate

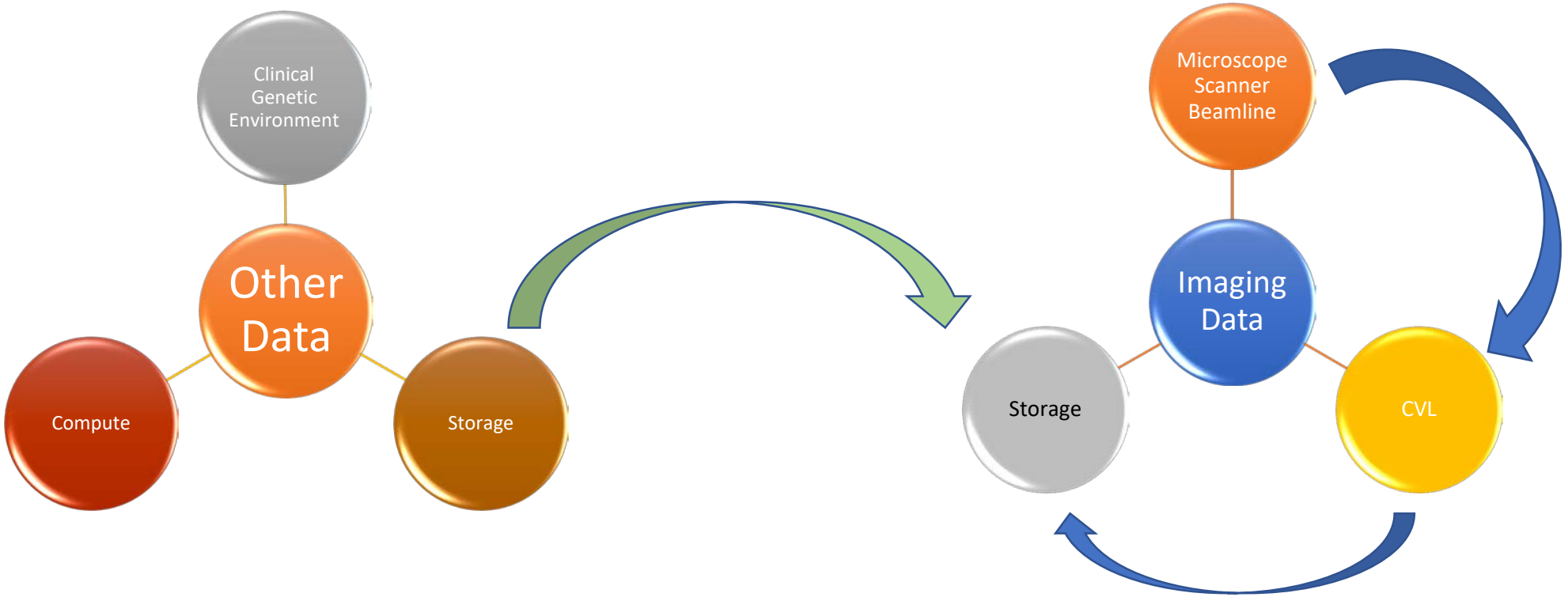
Interoperable – community agreed formats, standards, language and links to other related information

Reusable – maintains value with metadata, QC and provenance information



National Imaging Facility

Connecting Capabilities

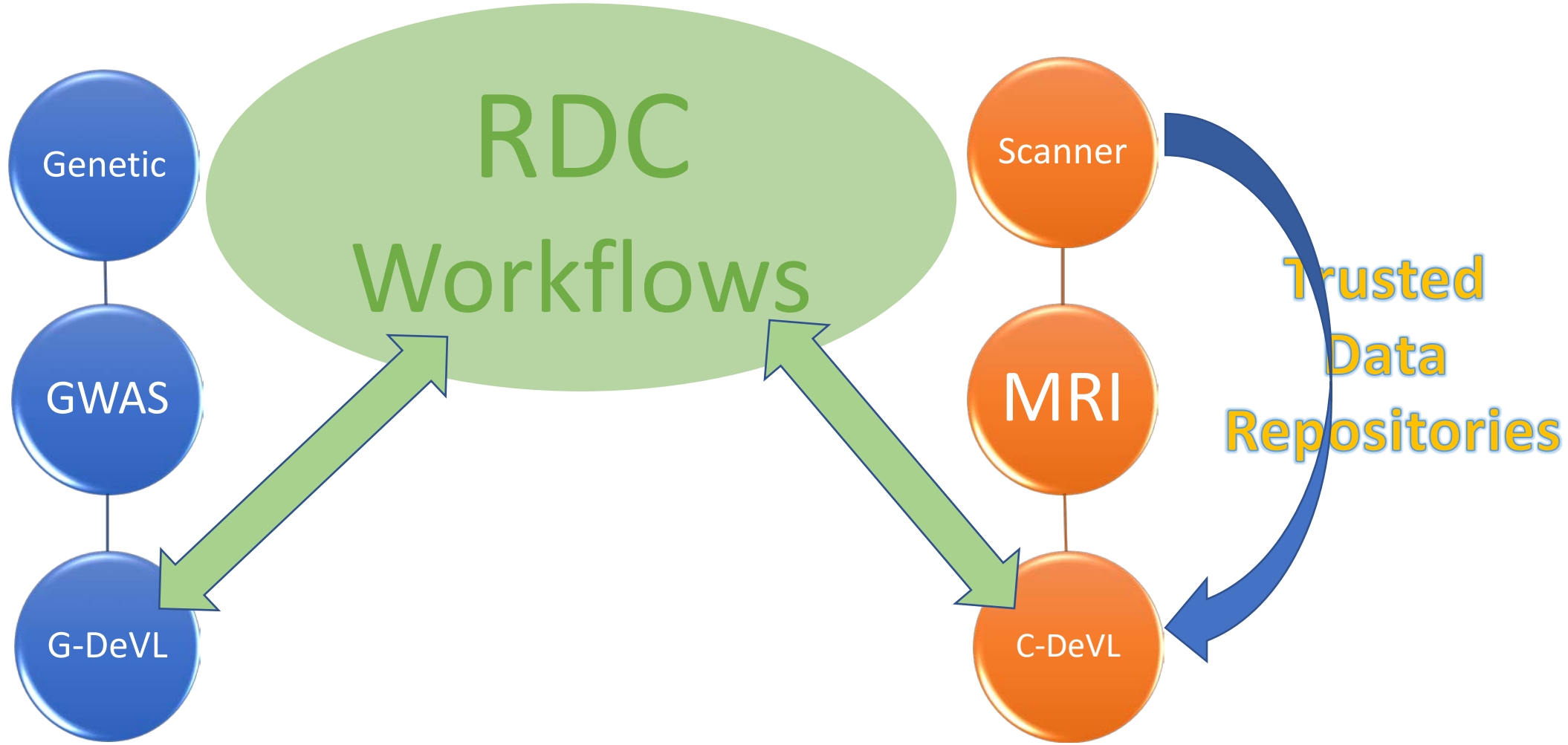


- Enabling multimodal, multi-scalar, longitudinal studies
- Connecting genomics, clinical data, imaging

ARDC
Australian Research Data Commons

National Imaging Facility

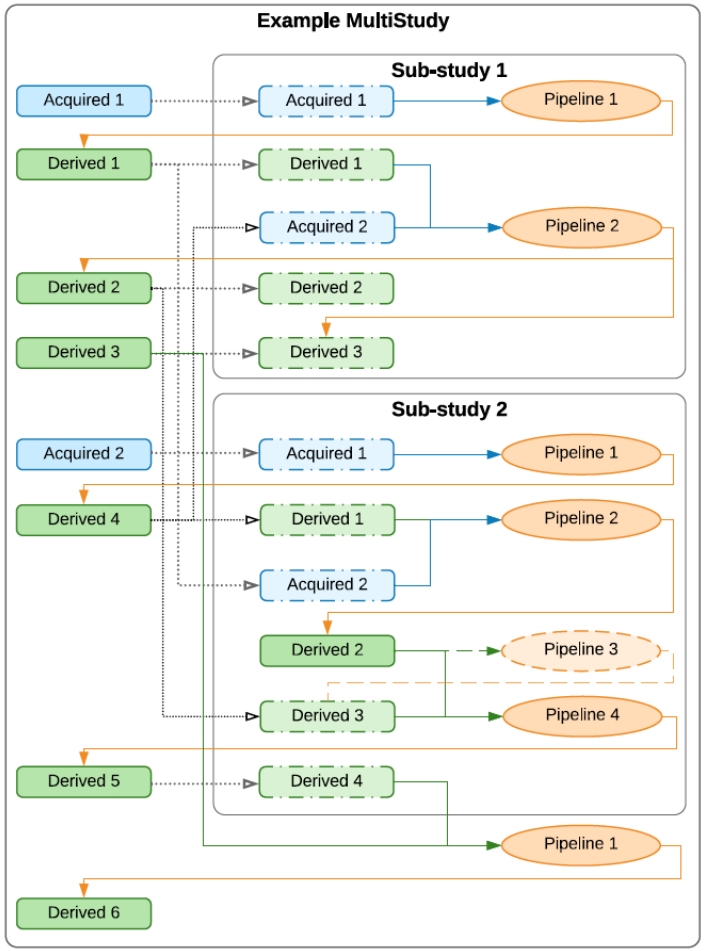
Practical Implementation

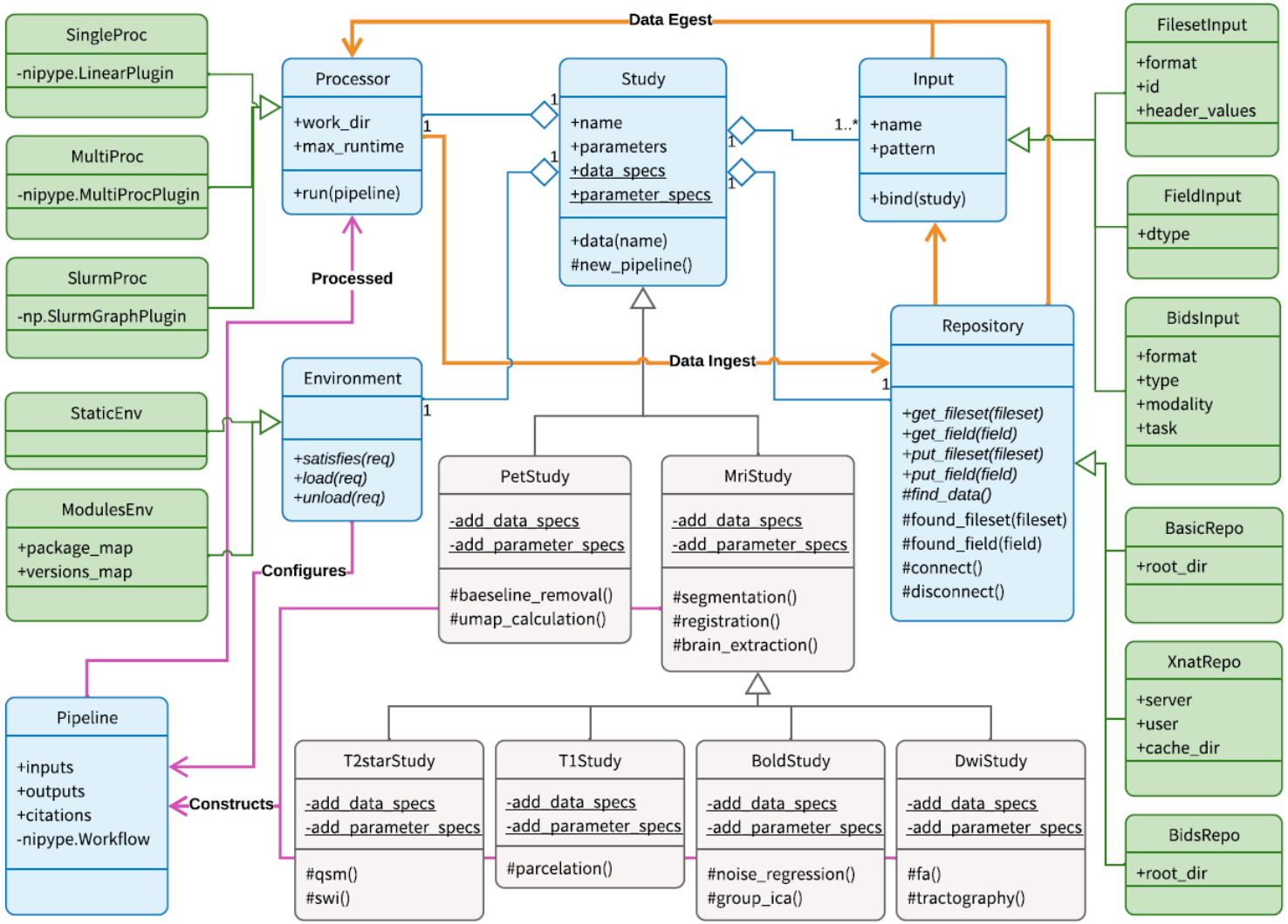


National Imaging Facility

Abstraction of Repository-Centric Analysis (Arcana) analysis workflow framework

https://arcana.readthedocs.io/





National Imaging Facility

International Connections

EURO-BIOIMAGING

15th September, 2018

GLOBAL BIOIMAGING growing collaboration

National Imaging Facility

National Imaging Facility

To find out more about NIF: www.anif.org.au

To subscribe to NIF Newsletter: admin@anif.org.au

LinkedIn	**National Imaging Facility**
Twitter	**@NIFAus**
Instagram	**National Imaging Facility**