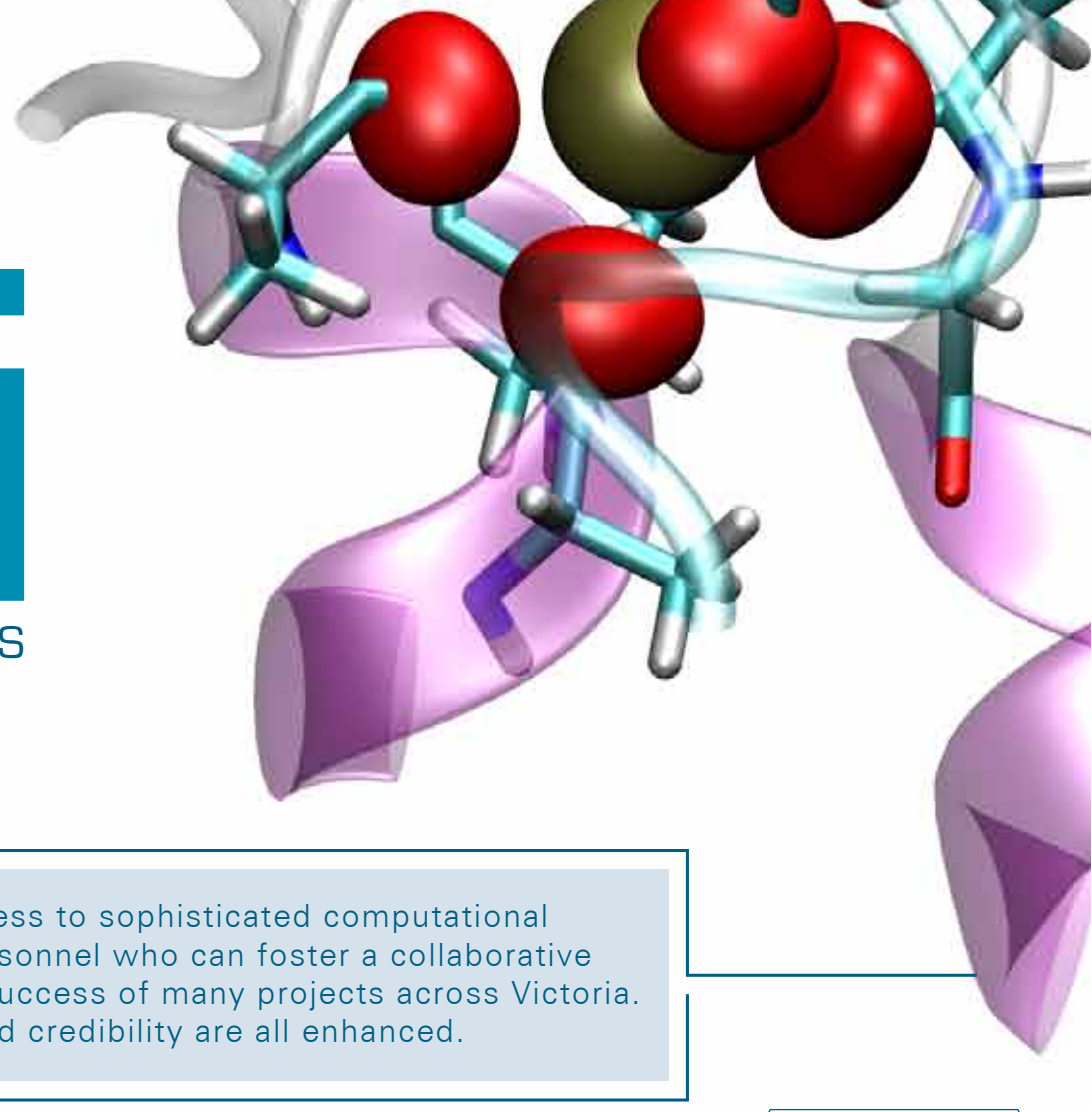
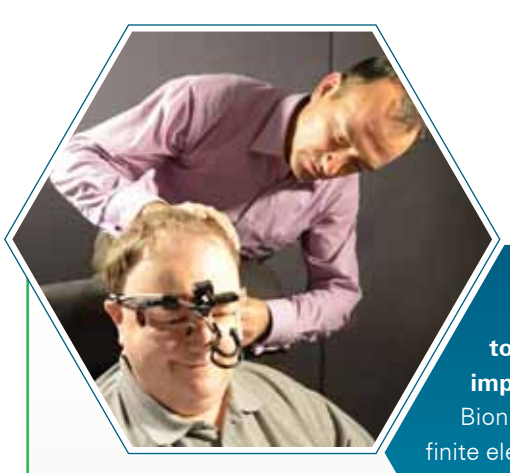
THE vlsci

DELIVERING IMPACT TO RESEARCHERS



The role of the VLSCI in providing access to sophisticated computational infrastructure as well as experienced personnel who can foster a collaborative research approach has been critical to the success of many projects across Victoria. Project outcomes, throughput and credibility are all enhanced.



Bionic Eye

The VLSCI is critical to understanding bionic implant safety and efficacy. Bionic Vision Australia is using finite element analysis and advanced neuronal circuit modelling as part of a $43 million project to develop an Australian bionic implant.

Goal
- To understand retinal circuit and visual pathway function under both normal and implant conditions

Task
- Finite element analysis
- Neural simulation work to map neural circuits
- Inform design and integration of bionic implants

VLSCI Role
- Neuronal circuit simulations
- Computational processing for finite element analysis models
- Provides robust hypothesis testing for research testing
- Data and outputs are shared across organisation and multiple collaborations

Funding
- Project is entirely dependent on VLSCI for computational modelling beyond the pilot stage
- ARC $43m funding split between UoM and UNSW

Collaboration
- UNSW, U Western Sydney, NICTA, Centre for Eye Research Australia, Royal Victorian Eye and Ear Hospital, National Vision Research Institute

Outcomes
Directly attributable to VLSCI

Quantitative:
- 15 publications, 30 conference papers and 3 patents currently being pursued

Qualitative:
- Enabling technology for the lab's field of research
- Provides credibility for hypotheses proposed by researchers in their publications
- Allows definitive statements to be made through computation at scale (i.e. removes doubt as to presence/absence of artefacts)

Breast cancer susceptibility

The VLSCI is an essential collaborator in the effort to identify cancer susceptibility factors. *"It's much more than just a service"* says Professor Melissa Southey. A collaboration with the VLSCI has allowed University of Melbourne researchers, and their collaborators, to pioneer new approaches to identifying breast cancer susceptibility factors/genes.

Goal
- To identify key genetic traits associated with cancer risk to assist diagnosis and therapy

Task
- Develop novel approaches and techniques to sequence and interrogate genomic and epigenetic data from cancer patient germ line cells
- Use bioinformatics methods to identify heritable cancer-predisposing factors from a large total sample of patients

VLSCI Role
- Massively parallel genome sequencing data analysis
- Management and interpretation of high end genetic information
- Utilisation and development of bioinformatics techniques and software
- Collaborative approach to working with researchers from University lab

Funding
- NHMRC funding (6 grants awarded since 2009)
- RO1 grant funding ($2.5m National Institutes of Health (US) grant)
- Cancer Council Victoria, Cancer Australia, Victorian Breast Cancer Research Consortium, National Breast Cancer Foundation

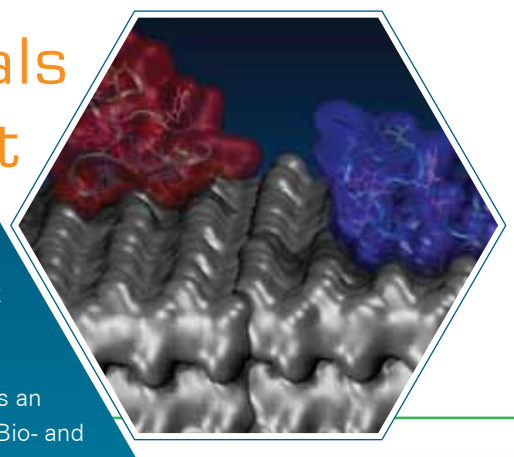
Collaboration
- Cancer Council Victoria, Peter MacCallum Cancer Centre, St Vincent's Institute of Medical Research, Baker IDI, Children's Cancer Institute Australia, Universities of Queensland, Cambridge, McGill, Utah, UCL, California, Leiden (and others)

Outcomes
Directly attributable to VLSCI

Quantitative:
- Over $3m in new NHMRC and NCI/NIH funding (a ten-fold increase in funding since 2009)
- Scientific paper on cancer susceptibility recognised by prestigious publishing house as 1 of top 8 articles of 2012 worldwide

Qualitative:
- Developed new tools and approaches for identifying cancer susceptibility factors that have been embraced by the research, clinical and diagnostic community
- Applications in other cancer types under further investigation

Nano-materials development



The VLSCI was critical in attracting a VESKI fellow back to Victoria to work on nanocomposites Associate Professor Tiffany Walsh is an internationally acclaimed researcher in Bio- and Nanotechnology. Access to the VLSCI was instrumental in Associate Professor Walsh's decision to return to Australia after 17 years working in the UK. Working with VLSCI was also essential in attracting a prestigious US Air Force grant – only the second time an Australian group has received such funding.

Goal
- To understand and augment the properties of biological materials through the development of new-to-world nanocomposites that are both multi-functional and high-performance

Task
- To predict structures and properties of nanocomposite materials
- To develop new manufacturing platforms (i.e. new materials and new methods of manufacture) with reduced environmental impact

VLSCI Role
- The PCF provides a state-of-the-art system to run the lab's computationally intense programs
- System and computational/optimisation support to the lab

Funding
- US Airforce funding (only 2nd grant ever awarded to Australian research)
- Engineering and Physical Sciences Research Council (UK) Programme Grant ($8m)
- VESKI fellow

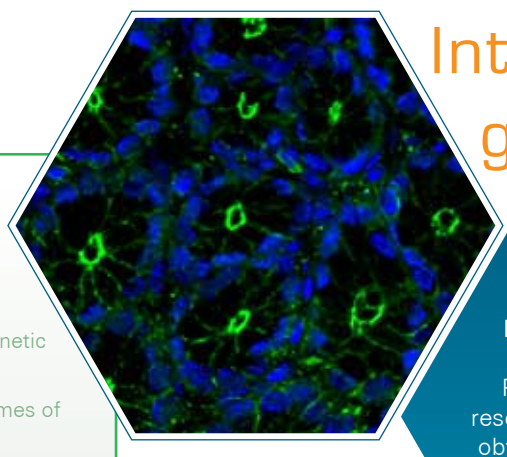
Collaboration
- US, UK and Italian research collaborations

Outcomes
Directly attributable to VLSCI

Quantitative:
- One high impact publication currently in preparation
- Lab expected to grow by 5-10 researchers within next few years to meet demand

Qualitative:
- International funding attracted to Victoria
- Enabling an entire platform of manufacturing technologies to be developed from solar panels to car doors and prosthetics
- High-profile researchers prompted to return to Victoria

International cancer genomics consortium



Goal
- Large scale genomic/epigenetic characterisation of ovarian and gastric cancer types by clinical cohorts

Task
- To analyse, integrate, compare and catalogue genomic and epigenetic data from over 300 normal and cancerous patient samples
- To establish a cooperative pipeline that can handle the huge volumes of raw data that will be generated in the first instance

VLSCI Role
- Collaborative development of systems and processes to handle raw data
- "Essential" computational power and support to work with large datasets

Funding
- NHMRC (partial recipient of $28m grant and also other funding)
- US DoD ($1.5m), Cancer Australia, Cancer Council Victoria, AICR

Collaboration
- ICGC consortium consists of Australian, Canadian, Mexican, US, Chinese, Japanese, UK, German, Spanish, French, Italian and Saudi Arabian research collaborations

The VLSCI is essential to managing the massive data-flow generated from the International Cancer Genomics Consortium Professor David Bowtell is a lead researcher within the ICGC, seeking to obtain comprehensive analyses of 50 different tumour types of clinical and societal importance. This project is critical to the next generation of therapies and treatments for the disease.

Outcomes
Directly attributable to VLSCI

Quantitative:
- NHMRC funding attracted to lab
- Full sequence analysis of over 300 patient samples/genomes

Qualitative:
- Victorian participation in high-profile international research consortium
- Local capability around genomic/epigenetic sequencing that paves the way for personalised medicine and the next generation of cancer therapies

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LIFE SCIENCES COMPUTATION

The Victorian Life Sciences Computation Initiative (VLSCI) combines collaborative research expertise with high end computing. The critical infrastructure and expertise offered by VLSCI has become essential to local life science research through its support and growth of the thriving specialities of Bioinformatics, Computational Biology and Computational Imaging.

As the biggest supercomputer dedicated to life sciences in the world, the specialist focus of the VLSCI complements the NCI and Pawsey Centre in driving Australia's research impact.

INFRASTRUCTURE

IBM Blue Gene/Q supercomputer - 4 racks

High memory X86 systems for Genomics, Proteomics, Imaging applications

Complemented by over 240 licensed software applications specific to life sciences

Petascale computing

EXPERTISE

Scientific and technical advice

Scientific and technical collaboration

IBM Research Collaboratory for Life Sciences

Formal training and documentation

Depth of life science project experience within team

Skills development, community capacity building and educational resources

High end computing supercharges the scientific process by enabling researchers to ask bigger, bolder questions

Why has the VLSCI achieved success?

The state-of-the-art equipment and high-level experience and expertise enables Australian research to compete globally and attract international funding.

Peak Computing Facility includes the biggest supercomputer dedicated to life science research in the world. Staff offer specialist technical expertise including hardware and software documentation and services to maximise user experience and ensure efficient access to computing resources appropriate to life sciences research.

Life Sciences Computation Centre (LSCC) has built specialist teams to support researchers and drive capacity-building activities. Active across Australia, these expert teams have been spread across multiple research institutions to accelerate life science computation:

The University of Melbourne
- High Throughput Genomics

Monash University
- Computational Bio-imaging

La Trobe University
- Molecular Modelling

Outreach & Training provides a diverse program of events and activities to engage researchers, students, stakeholders, experts and the public in life sciences computation.

560 USERS **28** INSTITUTES

Building capacity across a research community eager to collaborate.

The original vision is validated...

VLSCI was originally conceived as a 5-year Victorian Government initiative designed to stimulate interest and activity in the growing field of computational biology.

In four years, VLSCI has created a centre of activity to attract bright students and researchers to this industry; nurturing networks, funding conference attendance, sponsoring conferences, running courses, hosting special interest groups and offering programs to inspire young students. The Life Sciences Computation Centre now has paid subscriptions from over 20 research groups who see the value in getting direct access to both expertise and computers. This significant supercomputer facility demonstrates serious and sustained investment in the life science industries. The concentration of resources helps to excite young people to consider a career in computational biology and it delivers results – including clinical implementation of new knowledge to which our people have contributed.

Transitioning to capitalise on the benefits...

- VLSCI has become integral to life sciences computation, with services eagerly taken up by researchers.
- VLSCI has made Victorian research more competitive by enabling faster, smarter, practical research outcomes and industry links, ready for wider application.
- VLSCI already contributes 15% of the Blue/Gene/Q capacity to the National Merit Allocation Scheme, meeting the same contribution of generally available resources committed nationally by the other two major supercomputing facilities in Australia – Pawsey and NCI.
- VLSCI has secure foundations and is ready to scale-up to become the national peak computing facility for the life sciences.

The inception of VLSCI was driven by the anticipated exponential growth in data arising from the Human Genome Project and other technologies that make up the 'Biological Revolution', such as bio-imaging and molecular modelling. As predicted back in 2009, the data explosion is driving innovation. Key industry player, *Illumina*, announced in January 2014 that its new genomic sequencing system "Breaks barriers with world's first $1,000 genome, enabling 'factory' scale sequencing for Population and Disease Studies.

What does the VLSCI do?

The VLSCI empowers the life science research community through access to state of the art resources, centralised computational expertise, know-how and training services.

- provides a world-class computational service that supports the transformation of life sciences research through high end computing
- provides a leading computing facility with the capability to address much larger life sciences research problems than previously addressed in Australia
- facilitates greater research collaboration within Victoria, nationally and internationally
- develops skills in computational biology, bioinformatics, advanced simulation and modelling, data management and more generally the application of advanced computing in life sciences
- supports industry development through the uptake of computational research in life sciences
- collaborates with Australia's major infrastructure and networking activities such as NeCTAR to support and increase access for researchers across Australia
- works with Australia's other high-end computer centres to promote Australia's capacity in high-end computing and to create standard access processes.

Some subscribers to LSCC services in 2014

- **Cancer Council Victoria**
  Genetic and epigenetic risk factors in breast, colorectal, prostate cancer
- **Eastern Hill Precinct (St Vincent's Institute, St Vincent's Hospital, CERA)**
  EMPathy (breast cancer cell plasticity), genetic risk factors in eye disease, various others
- **International Cancer Genome Consortium, Peter MacCallum Cancer Centre**
  Tumourigenesis and drug resistance in ovarian cancer
- **Monash University Central Clinical School / Alfred Hospital**
  Biomedical genomics
- **Royal Melbourne Hospital: Department of Surgery**
  Understanding metastasis in prostate cancer
- **Monash Health Translation Precinct**
  Biomedical genomics
- **Victorian Comprehensive Cancer Centre**
  Cancer genomics
- **NeCTAR Endocrine Virtual Laboratory**
  Genomics workflows and variant registries for endocrine disease

THE vlsci SOLVES REAL ISSUES FACED BY RESEARCHERS

ISSUE EFFICIENCY
Data management and processing associated with high end computing projects require dedicated resources and expertise.

VLSCI enables faster, smarter, practical research outcomes.

ISSUE COST
High end computing capital expenditure and operating costs prevent go-it-alone approaches by researchers.

VLSCI makes research cost-effective – researchers don't need to attempt to buy, run, develop and understand their own clusters.

ISSUE EXPERTISE
Constant changes to best practice approaches, resources available and what can be achieved through computational research.

VLSCI is delivering effective support for new tools and disciplines including bioinformatics, molecular dynamics and imaging in Victoria.

ISSUE STAFFING
Costs for a full-time computational researcher are likely to exceed the budget (or need) for any one particular research project, and scarcity of computational researchers makes direct recruitment difficult.

The VLSCI provides entry point expertise without the difficulty and expense of engaging an in-house dedicated expert in these fields, and can help recruit the right expert as the research team's need grows. VLSCI creates jobs that inspire and retain Australian computational biology talent, attracts top international bioinformaticians and nurtures the training of new experts.

VLSCI provides the infrastructure, scale, expertise and scope to meet the biosciences industry's needs.