THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

AUCKLAND BIOENGINEERING INSTITUTE

12 Labours
Enabling development and clinical translation of virtual human twins

FAIRDOM User Meeting – 16th September 2025

Thiranja Prasad **Babarenda Gamage** (tp.babarendagamage@auckland.ac.nz)

12 Labours Project – Translation of Virtual Human Twins

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

AUCKLAND BIOENGINEERING INSTITUTE

2021-2025

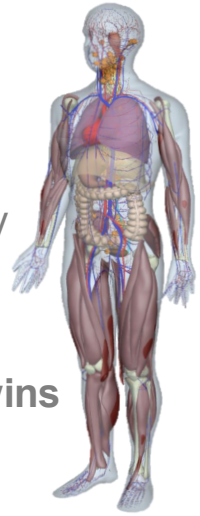
12 Labours

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HIKINA WHAKATUTUKI

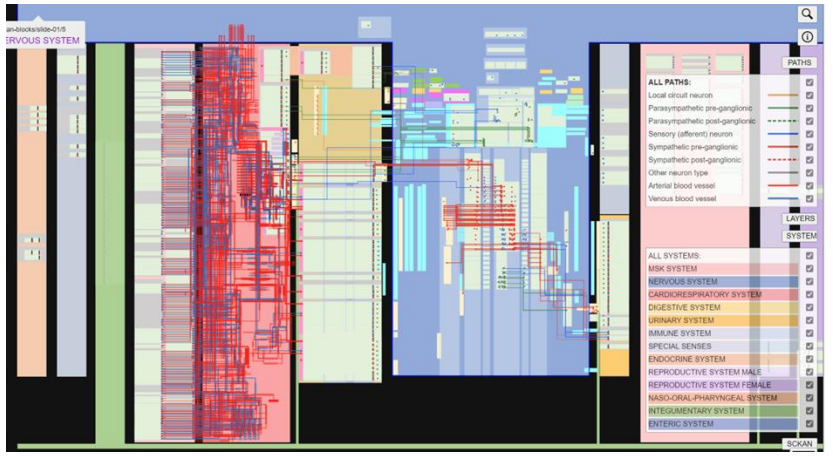
Integrate our existing knowledge

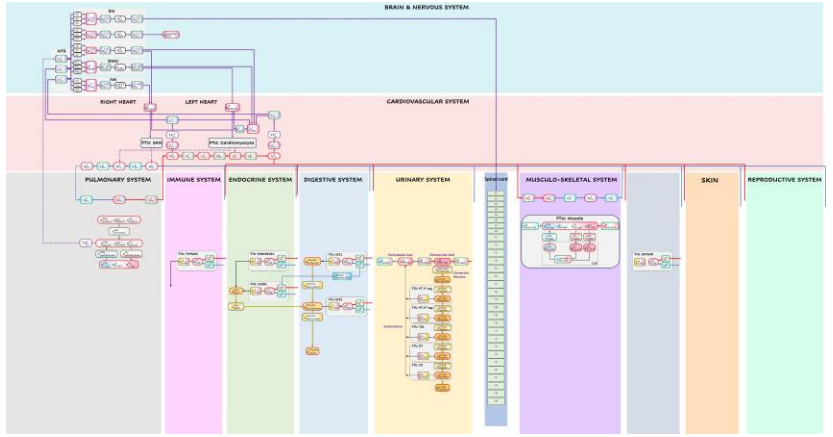
- Molecular & Cellular Biology
- Anatomy & Physiology
- Physics

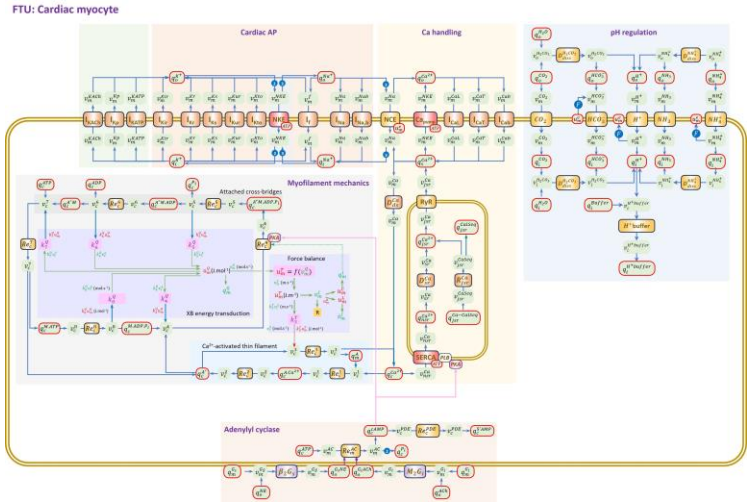
Assembling virtual human twins



Generic
Digital Twin
Tech Platform 1







Physiome Project

SPARC

NIH The Common Fund

VITAL

Horizon Europe

12 Labours Project – Translation of Virtual Human Twins

2021-2025

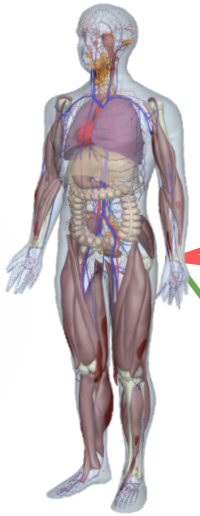
MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HIKINA WHAKATUTUKI

Peter Hunter

David (Andre) Nickerson

Generic Digital Twin
Tech Platform 1

Personalisation Workflows



Personalised Digital Twin
Tech Platform 2

Clinical Healthcare

Poul Nielsen

Implantables Wearables
Tech Platform 3

Surface Imaging

Clinical Recordings

Lab Tests

Prasad Babarenda Gamage

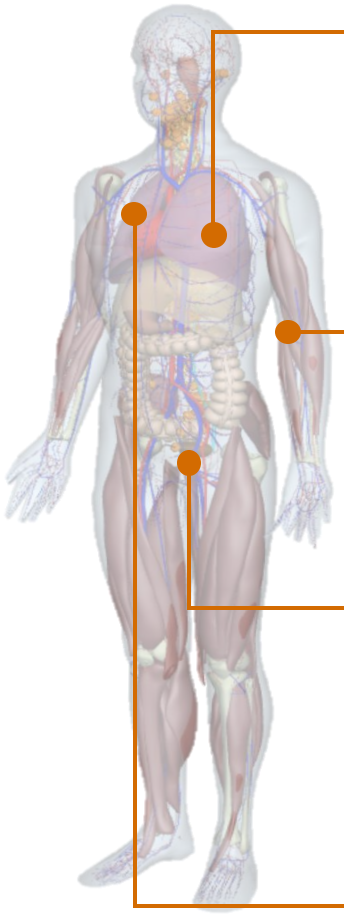
Home-based Healthcare

12 Labours – Exemplar Personalisation Workflows

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

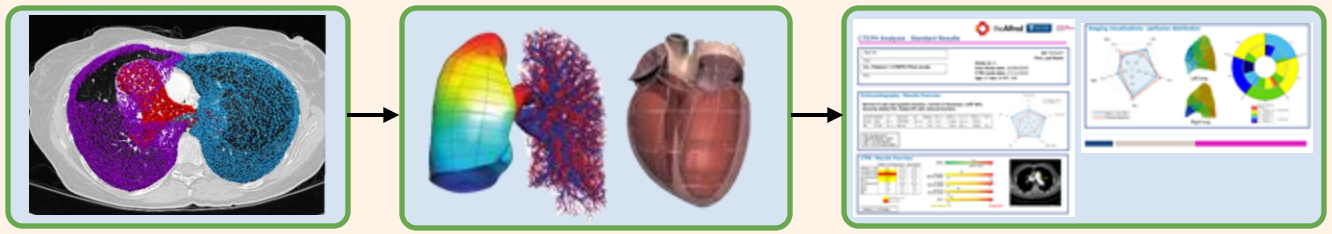
AUCKLAND BIOENGINEERING INSTITUTE

Generic Digital Twin



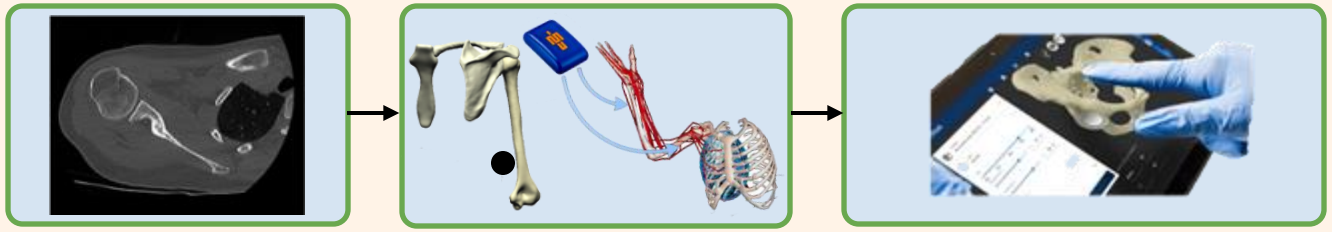
Personalisation **Application**

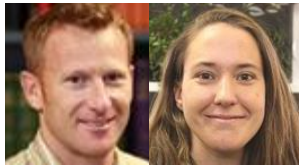
Project 1
Biomarkers for pulmonary hypertension



Merryn Tawhai | Martyn Nash

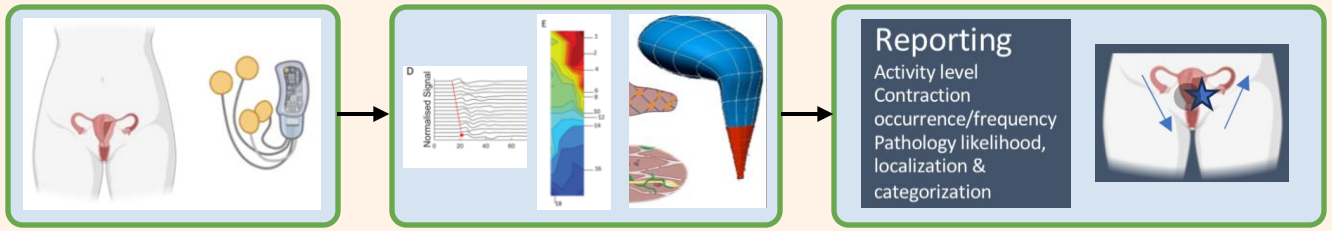
Project 2
Rehabilitation of upper limb disorders





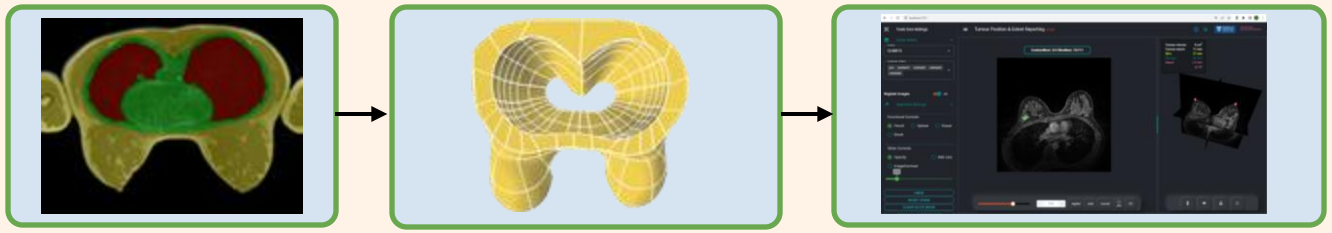
Thor Besier | Julie Choisne

Project 3
Monitoring of Uterine health



Alys Clark | Leo Cheng

Project 4
Automated reporting of breast cancer



Prasad Babarenda Gamage | Martyn Nash | Poul Nielsen

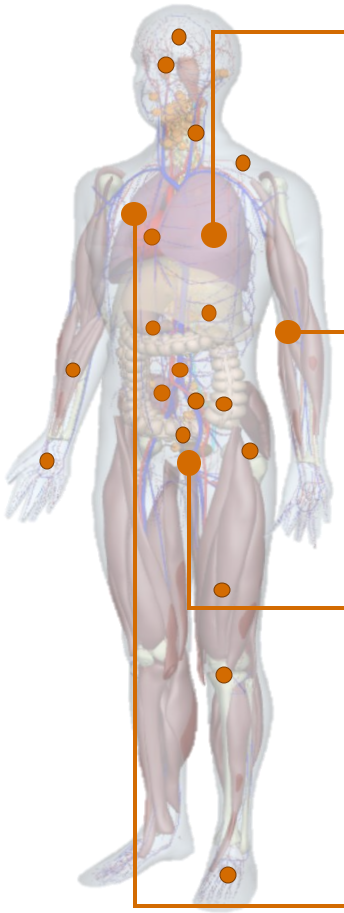
See 12 Labours Cassyni seminar series for development updates

12 Labours – Exemplar Personalisation Workflows

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

AUCKLAND BIOENGINEERING INSTITUTE

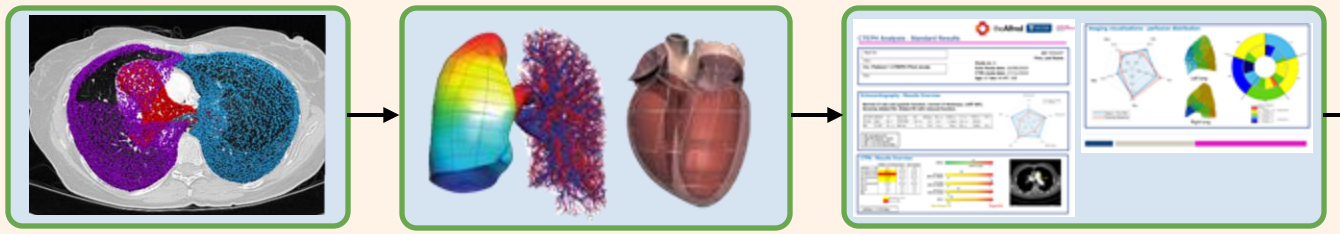
Generic Digital Twin



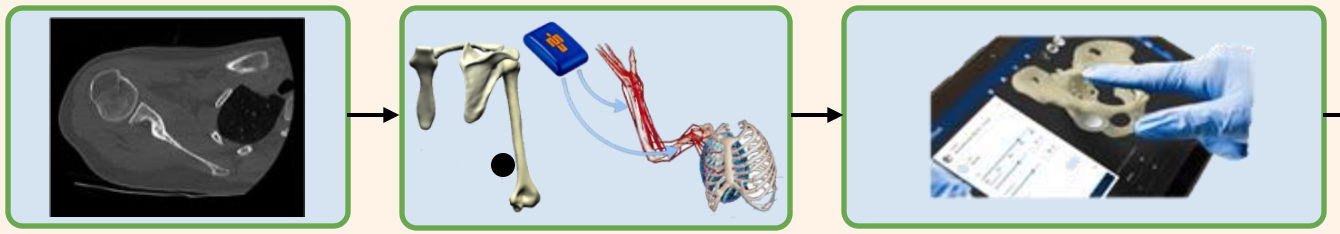
Personalisation

Application

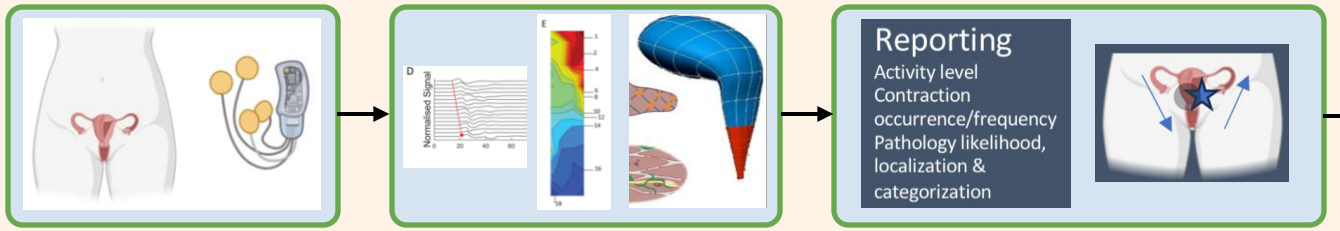
Project 1
Biomarkers for pulmonary hypertension



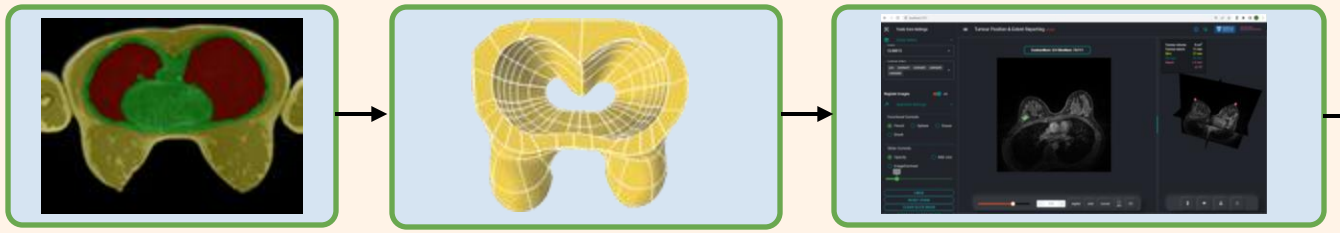
Project 2
Rehabilitation of upper limb disorders



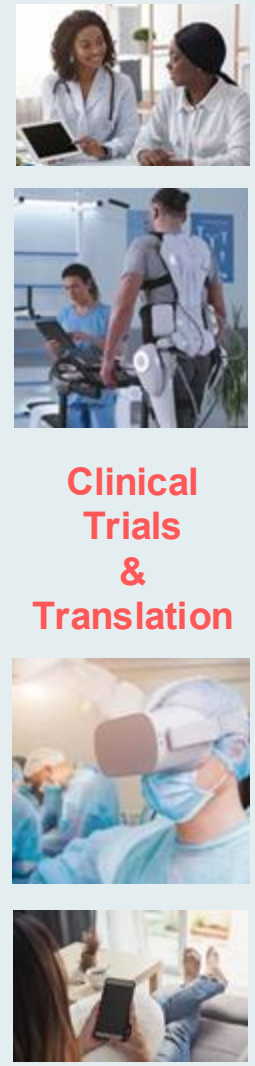
Project 3
Monitoring of Uterine health



Project 4
Automated reporting of breast cancer



Clinical Trials & Translation



300+ ABI researchers → 30 research groups → 100s of Workflows

Anatomy of workflows and their relation to studies

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

AUCKLAND BIOENGINEERING INSTITUTE

Investigation: Estimate Vascular Remodelling in Pulmonary Hypertension

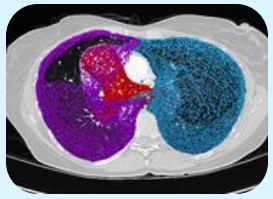
Study 1: Develop Workflow for predicting lung function in CTEPH Patients

Assay 1: Generate Personalised Lung Model

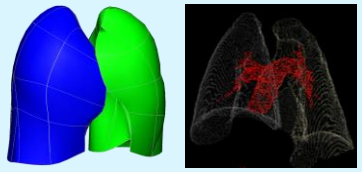
Measurements

Workflow

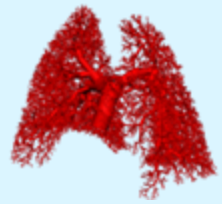
1. Tool



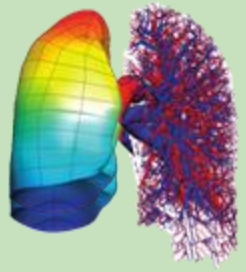
2. Tool



3. Tool

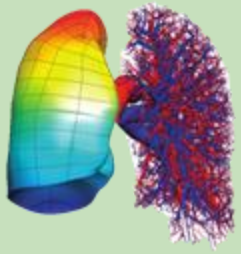


Measurements



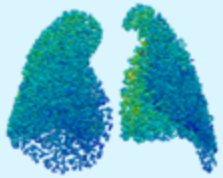
Assay 2: Report Under Perfused Regions

Measurements

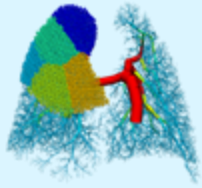


Workflow

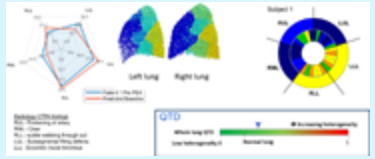
1. Tool



2. Tool



3. Tool



Measurements

Study 2: Prospective Validation Study at Alfred Hospital

Challenges

- **Infrastructure & data**
  - Fragmented tools and services
  - Siloed, non-standardised data
  - Poor discoverability & reuse of assets (“re-inventing the wheel”)
- **Processes for running workflows**
  - Manual, inefficient data management
  - Not reproducible and difficult to scale
- **Conducting studies for developing and evaluating workflows**
  - Limited services for:
    - Rapid development
    - Efficient researcher-clinician collaboration
      - Limited access in research environments to:
        - Clinician time
        - Data (e.g. for cohort selection, collecting training data, benchmarking against standard of care)

Babarenda Gamage et al 2024 (doi.org/10.52843/cassyni.3st2d2)
2023 (doi.org/10.52843/cassyni.6d6bvf)

Aim

Develop a platform that supports & accelerates the **clinical translation of virtual human twin workflows**

Objectives:

1. **Provide common infrastructure** (FAIR tools and services)
2. **Standardise & automate workflow data management**
   - Enable reproducible execution of complex research workflows and studies
3. **Streamline development & evaluation of workflows** in research and clinical environments
   - Provide services for efficient collaboration between researchers and clinicians

- Leverage 12L exemplar projects as pilot use cases

- **Digital T**ranslational **W**orkflows for **IN**tegrating **S**ystems **AI Platform**
  DigitalTWINS AI Platform

- Outline progress

Babarenda Gamage et al 2024 (doi.org/10.52843/cassyni.3st2d2)
2023 (doi.org/10.52843/cassyni.6d6bvf)

DigitalTWINS AI platform – Common Infrastructure

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

AUCKLAND BIOENGINEERING INSTITUTE

Studies
Basic Research
Clinical Research
etc

Models
Physiome Model Repository
BioModels
SPARC
etc

Measurements
Patient EHR /Wearables

etc

Tools
OpenSim
OpenCOR
etc

Workflows
BioSimulations
REPRODUCING & REUSING BIOMODELS & SIMULATIONS
Dockstore
etc

Digital twins AI Platform

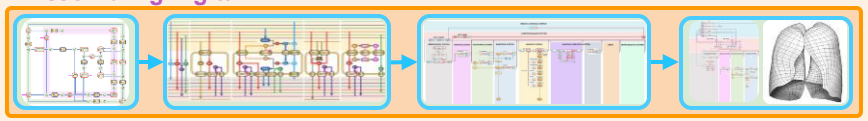
Harmonised Database
Studies
Models
Measurements
Tools
Workflows
Digital Twins
HL7 FHIR

Knowledge Base
Anatomical Connectivity Map

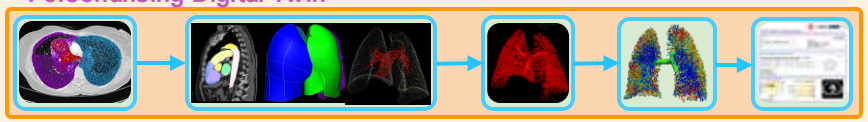
Functional Connectivity Map

Whole Person/Disease Map
Clinical Guidelines
etc

Workflow Execution
Assembling Digital Twin



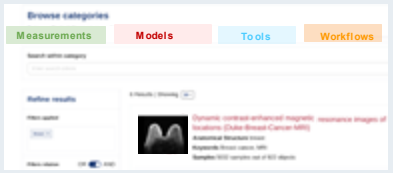
Personalising Digital Twin



Insilico Trials
etc

Data Ingress

Data Catalogues

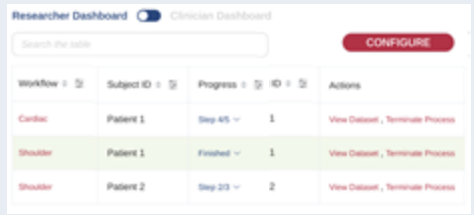


Education Dashboards

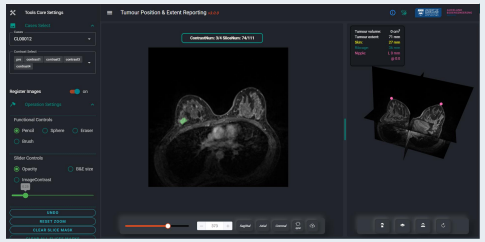
Patient Dashboards

Portal

Study Dashboards



Clinician Dashboards



End users

Clinicians

Researchers

Patients

etc

DigitalTWINS AI platform – Standards

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

AUCKLAND BIOENGINEERING INSTITUTE

Studies
Basic Research
Clinical Research
etc

Models
Physiome Model Repository
BioModels
SPARC
etc

Measurements
Patient EHR /Wearables



etc

Tools
OpenSim
OpenCOR
etc

Workflows
BioSimulations
REPRODUCING & REUSING BIOMODELS & SIMULATIONS
Dockstore
etc

Digital twins AI Platform

Harmonised Database
Studies
Models
Measurements
Tools
Workflows

isa
nfdi 4 health
COMMON WORKFLOW LANGUAGE

Data Ingress

SPARC Dataset Structure*

SDS Dataset
- primary
  - dataset_Description.xlsx
  - samples.xlsx
  - subjects.xlsx
  - submission.xlsx
  - CHANGES.txt
  - README.txt
- code
- derivative
- docs
- protocol
- source

Bandrowski et al biorxiv

Findable Accessible Interoperable Reusable

SPARC-me pypi

DigitalTWINS AI platform – Data Catalogue

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

AUCKLAND BIOENGINEERING INSTITUTE

Studies
Basic Research
Clinical Research
etc

Models
Physiome Model Repository
BioModels
SPARC
etc

Measurements
Patient EHR /Wearables



etc

Tools
OpenSim
OpenCOR
etc

Workflows
BioSimulations
REPRODUCING & REUSING BIOMODELS & SIMULATIONS
Dockstore
etc

Digital twins AI Platform

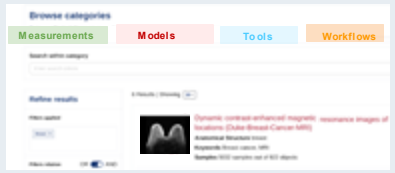
Harmonised Database

Studies
Models
Measurements
Tools
Workflows

HITS
FAIRDOM SEEK
nfdi 4 health

Data Ingress

Data Catalogues



Selected: Clinical reporting of vascular remodelling and PEA response in CTEPH pilot study (Alfred Hospital) (Study)
Description: No description
SEEK ID: http://localhost:8001/studies/2

- Estimating vascular remodelling and prediction treatment response in pulmonary hypertension
  - Clinical reporting of vascular remodelling and PEA response in CTEPH pilot study (Alfred Hospital)
    - Generate personalised anatomical model of lung on ASPIRE data
      - EP1: Generate personalised anatomical model of lung - script
    - Identify under perfused regions
      - EP1: Identify under perfused regions - script
    - Identify remodelling level to match pre-surgical PAP
      - EP1: Identify remodelling level to match pre-surgical PAP - script
    - Predict post surgery PAP (after removing occlusions)
      - EP1: Predict post surgery PAP - script
    - Generate clinical report
      - EP1: Generate clinical report - GUI

Default Project

Tumour position selection - GUI
SOP - added about 6 hours ago
Automated torso model generation - script
SOP - added about 6 hours ago
Statistical analysis of electrode measurements - GUI
SOP - added about 6 hours ago
Quantification of frequency of electrical activity

No announcements

Tags [show all]
There are not yet any tags defined

Latest additions
Clinical report visualisation - GUI
SOP - added about 6 hours ago
Automated tumour position clinical report - script
SOP - added about 6 hours ago
Efficacy assessment workflow - script
SOP - added about 6 hours ago

Find content
Browse Programmes
Browse Projects

DigitalTWINS AI platform – Running Workflows

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

AUCKLAND BIOENGINEERING INSTITUTE

Studies
Basic Research
Clinical Research
etc

Models
Physiome Model Repository
BioModels
SPARC
etc

Measurements
Patient EHR /Wearables



etc

Tools
OpenSim
etc

Workflows
BioSimulations
REPRODUCING & REUSING BIOMODELS & SIMULATIONS
Dockstore
etc

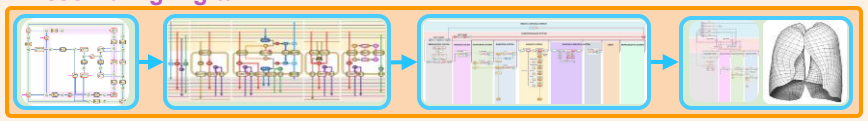
Digital twins AI Platform

Harmonised Database
Studies
Models
Measurements
Tools
Workflows

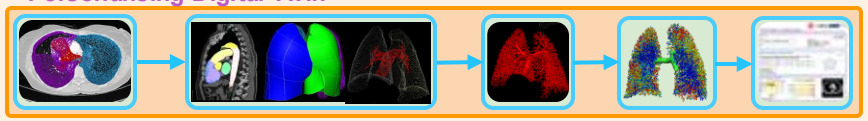
- Automated data management

Apache Airflow

Workflow Execution
Assembling Digital Twin



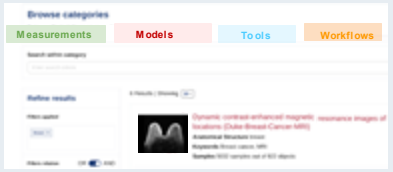
Personalising Digital Twin



Insilico Trials
etc

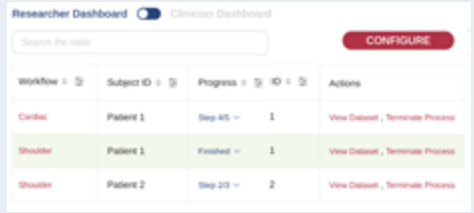
Data Ingress

Data Catalogues

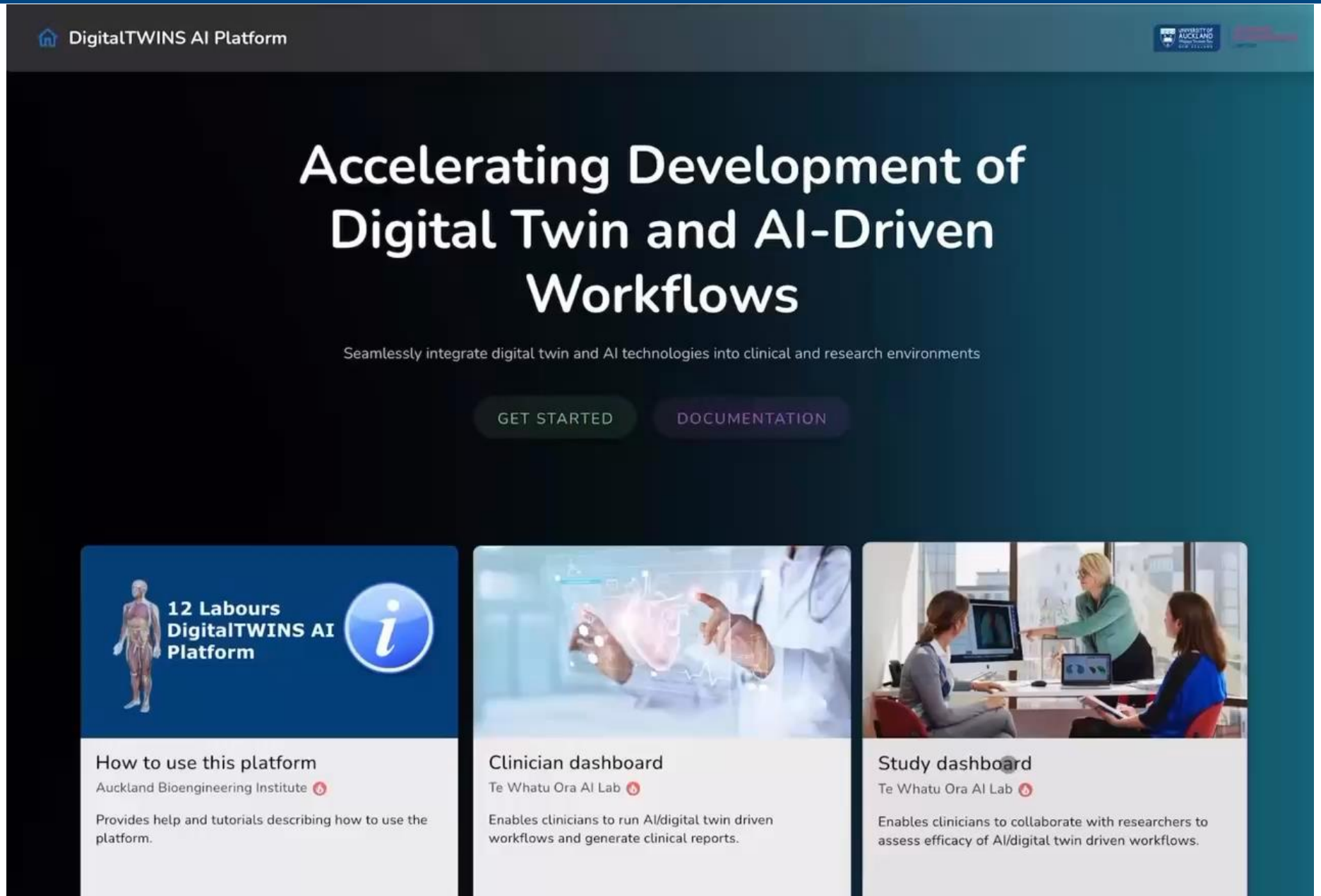


Portal

Study Dashboards

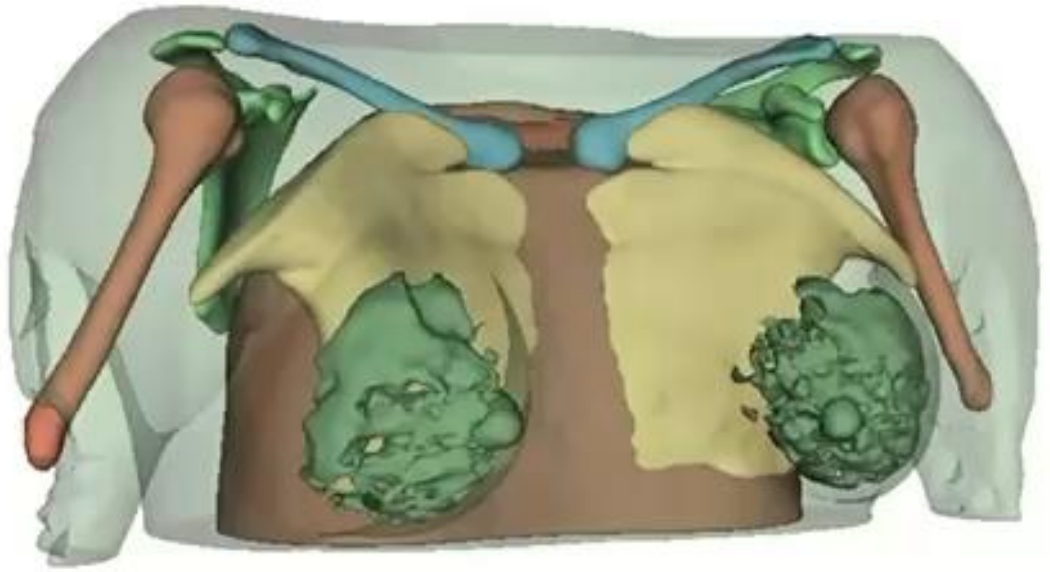


DigitalTWINS AI platform - Study Dashboard



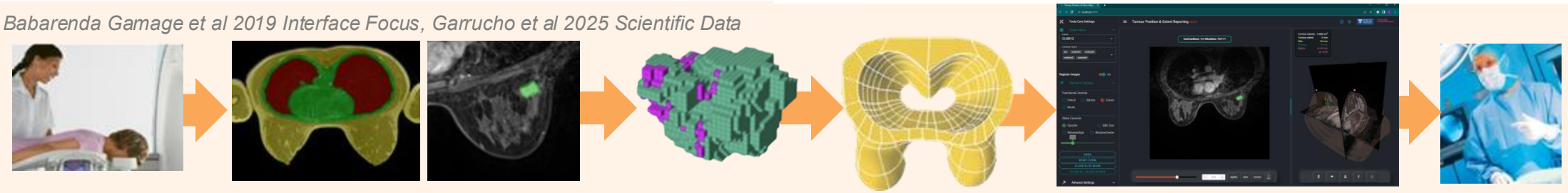
DigitalTWINS AI platform - Clinical Deployment

- Deploying within Te Whatu Ora Health New Zealand
- Run on existing infrastructure (e.g. Databricks)
- Single-sign on for researchers & clinicians
- Access to 3m de-identified radiology records
- Study – 900 breast cancer patients
  - Cohort selection
  - Compare results with standard of care
  - Fine tuning & independent validation



Zhong et al 2025 (in prep)

Babarenda Gamage et al 2019 Interface Focus, Garrucho et al 2025 Scientific Data



Diagnostic DCE- MRI

1. Tumour and breast tissue segmentation

2. Tumour classification

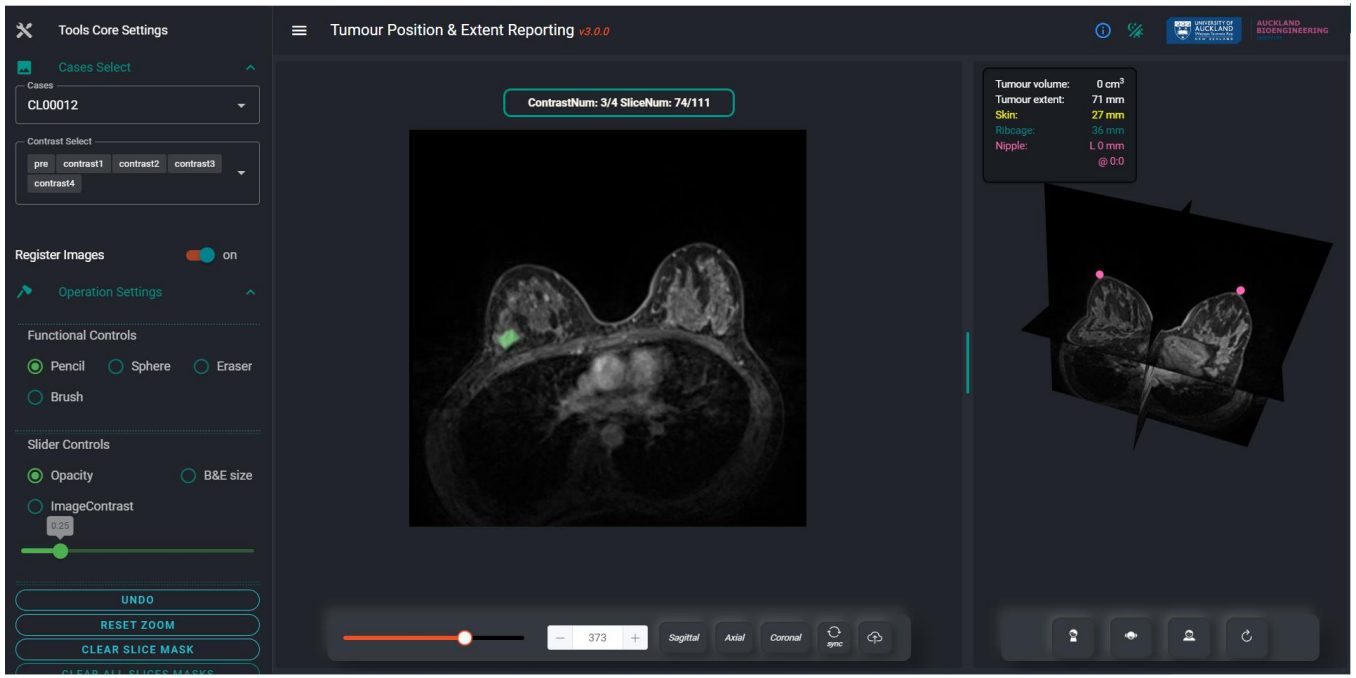
3. Anatomical modelling

4. Reporting dashboard

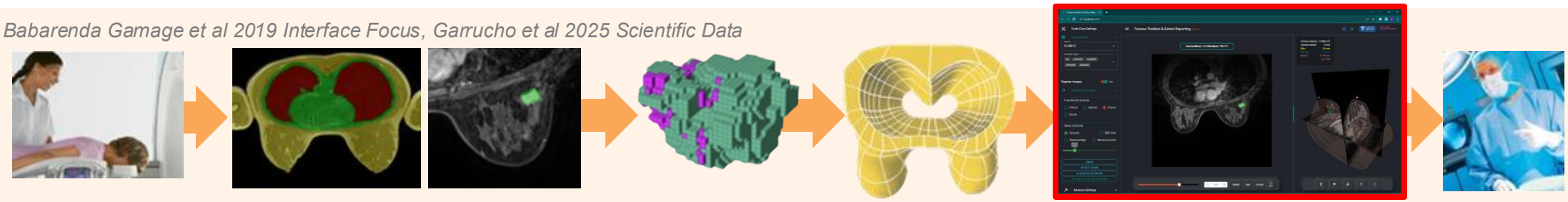
Inform treatment procedures

DigitalTWINS AI platform - Clinical Deployment

- Deploying within Te Whatu Ora Health New Zealand
  - Run on existing infrastructure (e.g. Databricks)
  - Single-sign on for researchers & clinicians
  - Access to 3m de-identified radiology records
  - Pilot study – 900 breast cancer patients
    - Cohort selection
    - Compare results with standard of care
    - Fine tuning & independent validation
- Include interactive GUI tools in workflows



Babarenda Gamage et al 2019 Interface Focus, Garrucho et al 2025 Scientific Data



Diagnostic DCE- MRI

1. Tumour and breast tissue segmentation

2. Tumour classification

3. Anatomical modelling

4. Reporting dashboard

Inform treatment procedures

DigitalTWINS AI platform – DigitalTWINS on FHIR

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

AUCKLAND BIOENGINEERING INSTITUTE

Studies
Basic Research
Clinical Research
etc

Models
Physiome Model Repository
BioModels
SPARC
etc

Measurements
Patient EHR /Wearables
etc

Tools
OpenSim
OpenCOR
etc

Workflows
BioSimulations
REPRODUCING & REUSING BIOMODELS & SIMULATIONS
Dockstore
etc

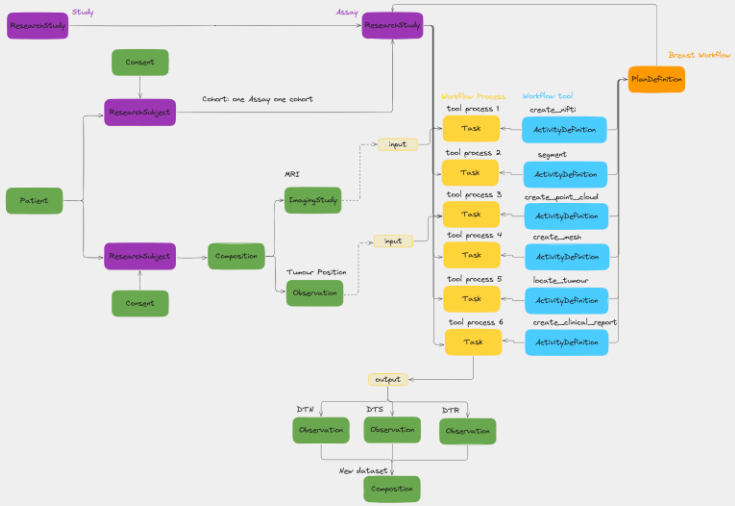
Digital twins AI Platform

Harmonised Database

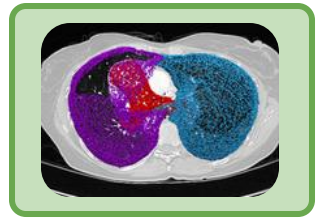
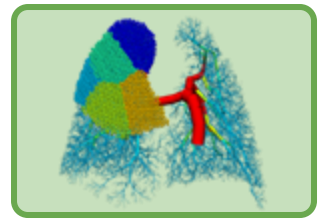
Studies
Models
Measurements
Tools
Workflows
Digital Twins
HL7® FHIR®

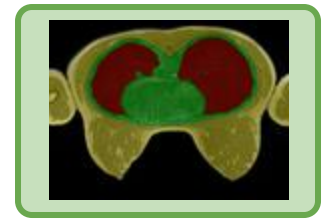
Data Ingress

- Define a new **digital twin** data object for each individual
- Organise & link all measurements related to that individual
  - Primary **Measurements** (e.g. MRI)
  - Derived **Measurements** generated from **Workflows**



- Captures provenance
  - Which **models**, **tools**, **study** generated a given **derived measurement**
  - Links to consent
- Search all available measurements




Next steps with SEEK

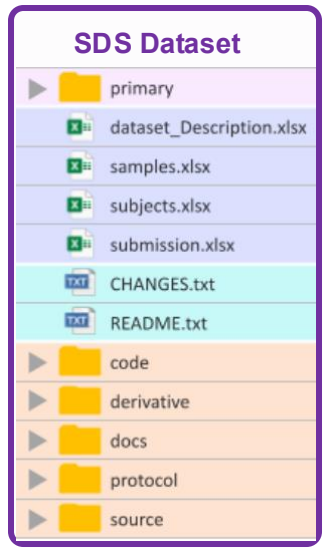
- Populate catalogue with resources at ABI (and nationally through MedtechIQ)

- Use SEEK to:
  - Query workflows and tools in CWL (currently using DigitalTWINS API)
  - Query measurement datasets (currently using DigitalTWINS API and SPARC-me)

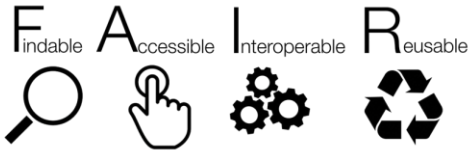
  - Integrate DigitalTWINS on FHIR to search available data per individual
    - Allow cohort selection

  - Provide easy to use interfaces for non-experts e.g. clinicians to do searches
    - E.g. through plugins?

SPARC Dataset Structure*



*Bandrowski et al biorxiv



SPARC-me pypi

Summary

- 12 Labours DigitalTWINS platform
  - Provide common infrastructure to support:
    - FAIR & reproducible research
    - Automate data management
    - Streamline development & evaluation of workflows for accelerating translation
- Building best practice resources & guidelines to support these efforts
- Keen to collaborate
- Infrastructure presented is opensource/permissive license
  - github.com/ABI-Software

Timeline:

2021-2025

1. Develop & deploy prototype
   - Core services
   - Guidelines & resources
2. Demonstrate its clinical application in exemplar projects
3. Define platform specifications

2026-

- Production deployment
- Adoption across ABI

  300+ Researchers,

  30+ Research Groups
- Adoption nationally

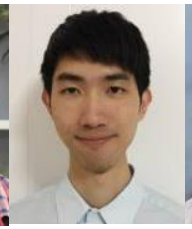
Thiranja Prasad *Babarenda Gamage* (tp.babarendagamage@auckland.ac.nz)

DigitalTWINS AI Platform - Networks

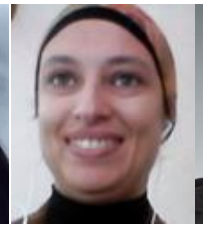
ABI Clinical Translational Technologies (CTT) Group


Prasad Babarenda Gamage (lead)


David (Andre) Nickerson


Chinchien Lin


Jiali Xu

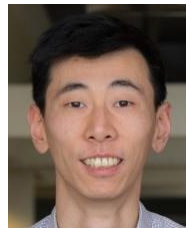

Ayah Elsayed


Linkun Gao

Clinical Collaborators & Advisors


Greg Sands (Platform 3)


Alan Wu


Cheng Kai Jin


Robyn Whittaker


Penny Andrew


Anthony Doyle

Te Whatu Ora Health New Zealand

MINISTRY OF HEALTH MANATŪ HAUORA

Research/Community Collaborators & Advisors


Diana Siew (ABI)


Merryn Tawhai


Koray Atalag (GALATA DIGITAL)


Alistair Young (KCL)


Martin Golebiewski (HITS)

NeSI New Zealand eScience Infrastructure


Nick Jones


Claire Rye


Nathalie Giraudon


Jun Huh


Kent Lee


Pau Medrano-Gràcia

uniservices IDEAS TO LIFE RANGAHAUA KIA WHAI HUA

EDITH

VPH Institute Building the Virtual Physiological Human

GEN3 DATA COMMONS

HITS


Misty Edmonds


Cris Print


Annette Lasham


Nick Knowlton

12 Labours

Physiome Project

- ABI Research Groups
- ABI Software Team

Centre for eResearch

SPARC

Center for Translational Data Science AT THE UNIVERSITY OF CHICAGO

Funding

Iwi United Engaged Limited

THE UNIVERSITY OF AUCKLAND MEDICAL AND HEALTH SCIENCES

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT HIKINA WHAKATUTUKI