UNIVERSITY OF Southampton
School of Engineering Sciences

The Aladdin-2 Launchpad

Engaging the User Community and Broadening Access to the GENIE Model on Local and Remote Computing Resources

Andrew R. Price, Sudipta Goswami, Martin Johnson, Ibrahim Almajai, Gethin Williams, Simon Müller, Will Rawes, Simon J. Cox and Neil R. Edwards

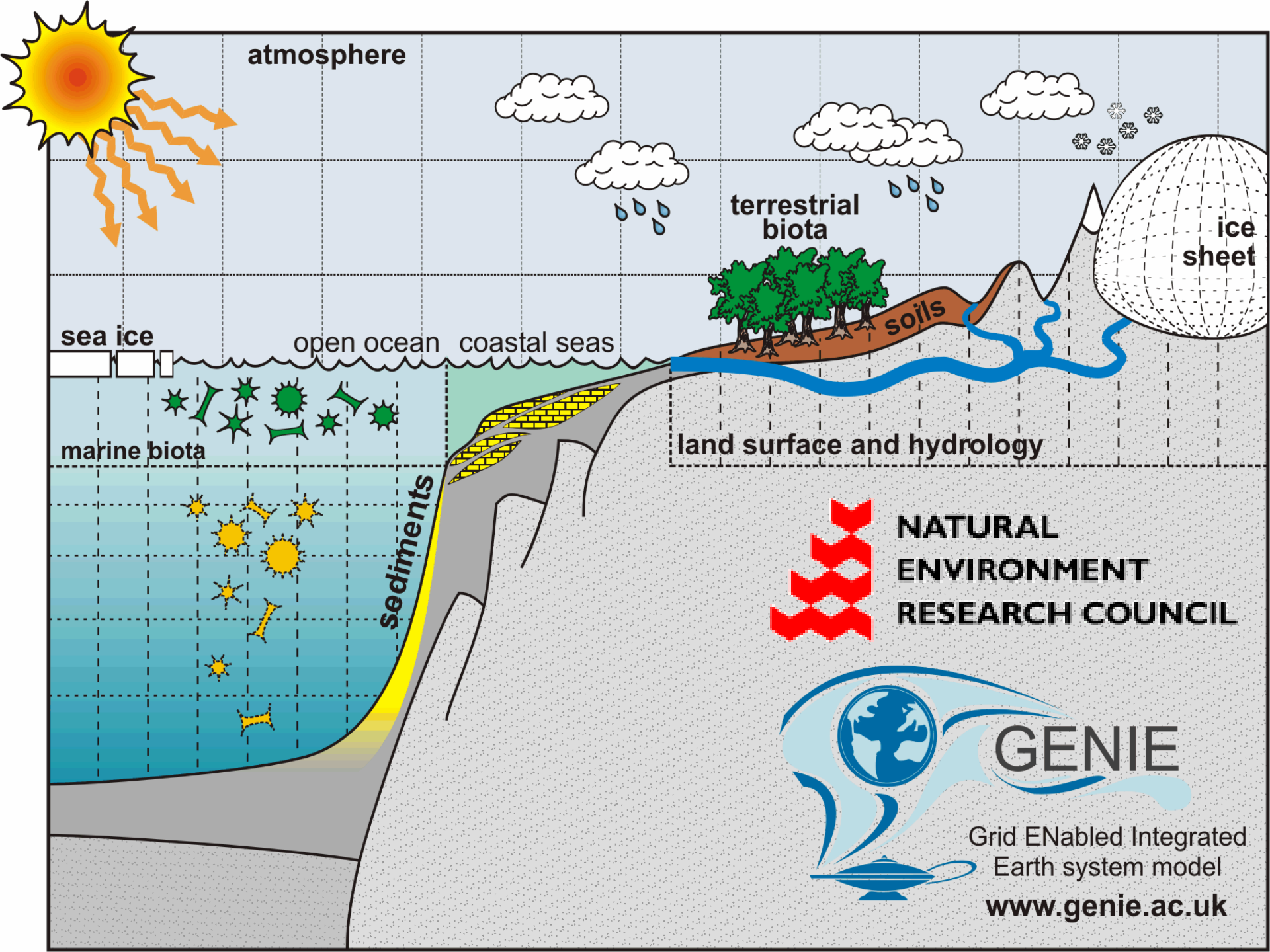
07 Dec 2009

Overview

- GENIE
- User's view of GENIE
- The Open University Climate Simulator
- ENGAGE Project: Aladdin2 launch-pad
- Research Support Tool Development
- Conclusions

GENIE

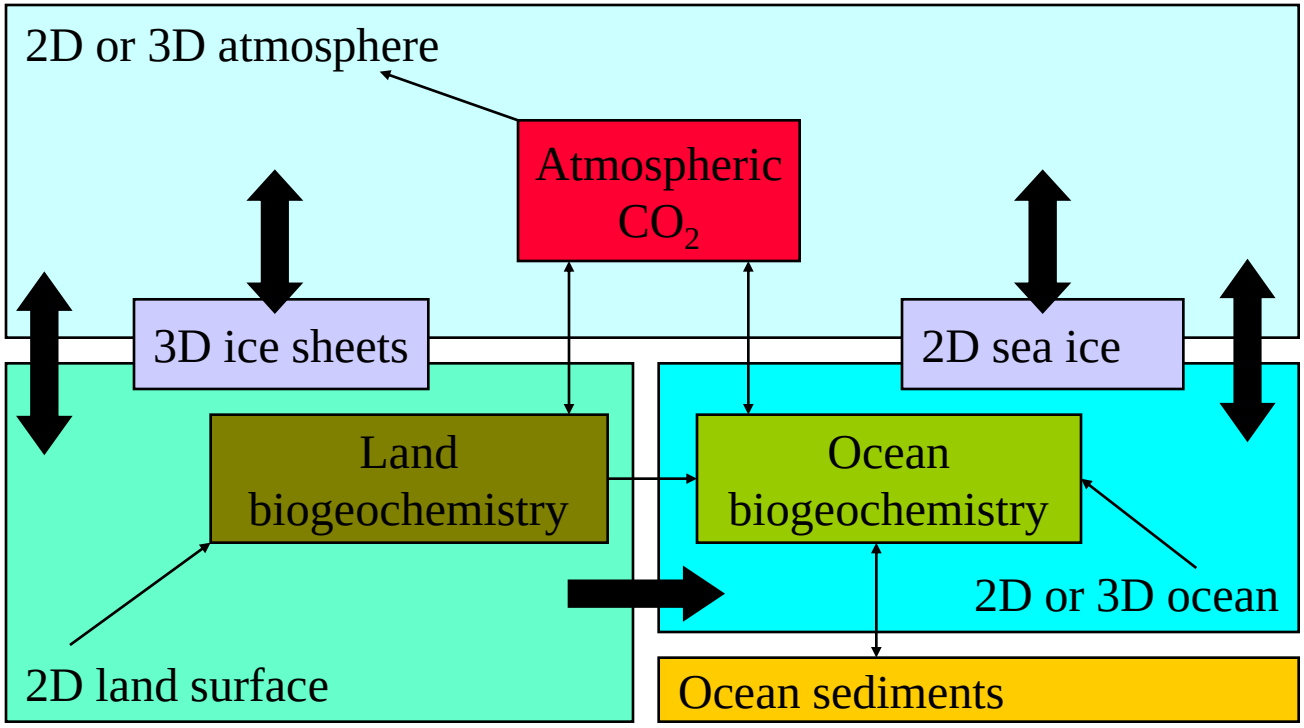
- Grid ENabled Integrated Earth system model
- GENIE is a Grid-enabled computing framework enabling users to:
  - Flexibly couple together state-of-the-art components to form a unified Earth System Model (ESM)
  - Execute the resultant ESMs across computational Grid infrastructure
  - Share the resultant data produced by simulation runs
  - Provide high-level open access to the system, creating and supporting virtual organisations of Earth System modellers
- The central scientific goal of the GENIE project is to study the forcing and feedbacks driving the glacial-interglacial cycles that dominated the Earth's climate over the last 1 million years
- By better understanding the processes (physical and biogeochemical) which regulated these cycles in the past, we can be more confident about the predictions climate models make for the future


atmosphere
terrestrial biota
ice sheet
soils
sea ice
open ocean
coastal seas
marine biota
sediments
land surface and hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL
GENIE
Grid ENabled Integrated Earth system model
www.genie.ac.uk

UNIVERSITY OF Southampton
School of Engineering Sciences

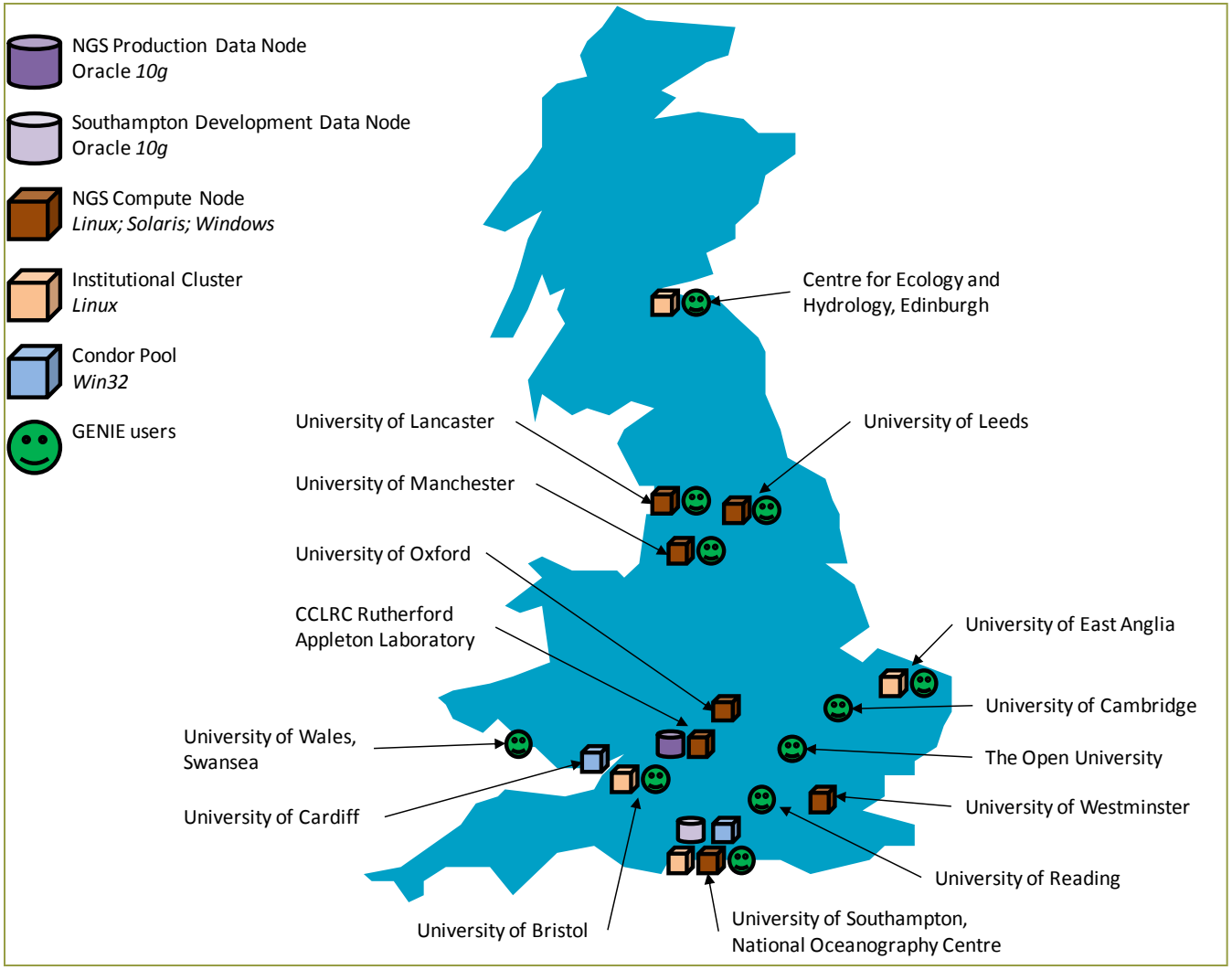
GENIE Modelling Framework

- Integrates component models of varying resolution, dimensionality & complexity
- Modular, scalable and traceable to more complex models



Schematic of the major component codes that are integrated to form climate models in the GENIE framework.

GENIE UK Community



The GENIE user base is primarily UK based with a growing number of international collaborators and users. The Grid computing software is used to exploit compute and data resources on the UK National Grid Service and institutional clusters and Condor pools.

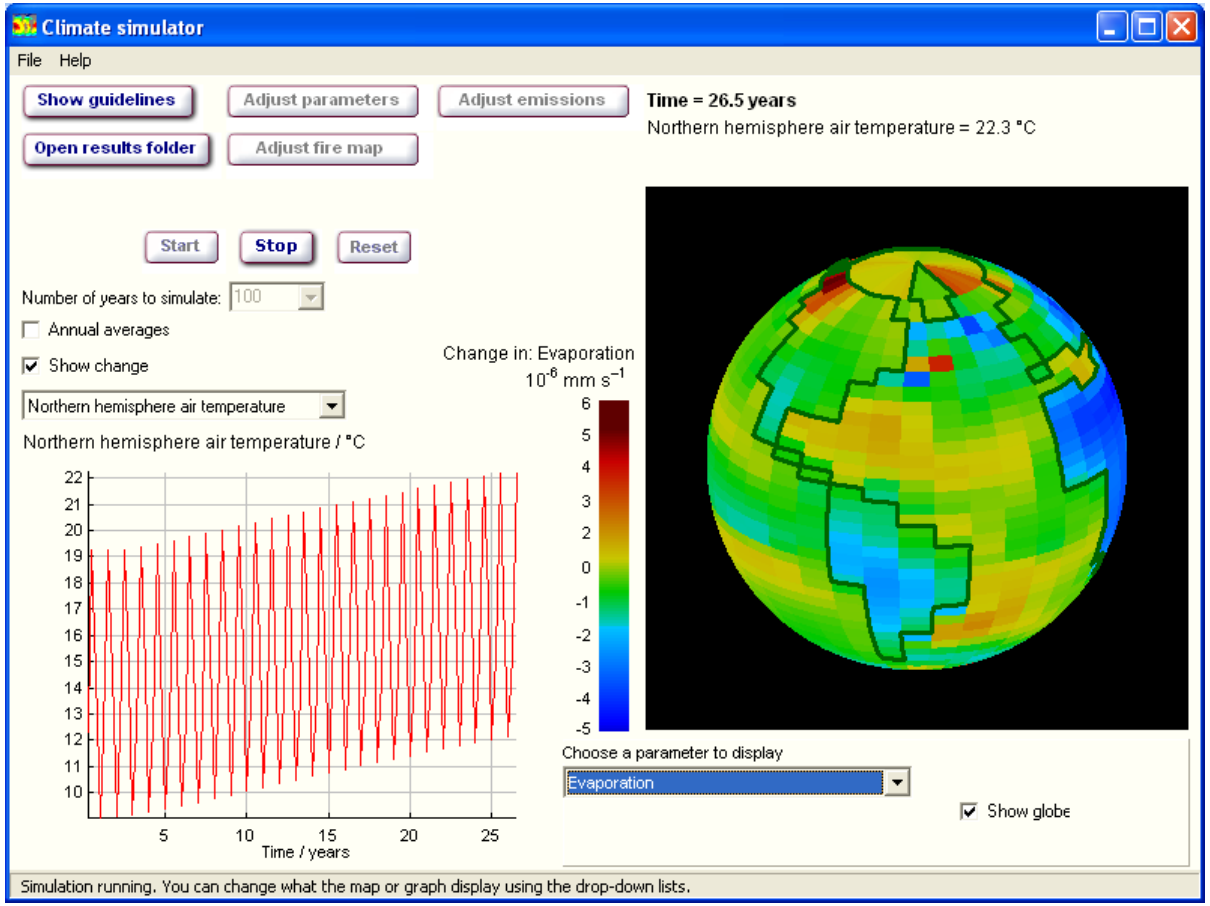
A User's view of GENIE

- GENIE code base is open to the community
  - Managed under Source Control - SubVersion
  - Users are expected to adhere to best practice
- Most research involving GENIE involves some modification of the code base
  - Users are expected to branch and tag code modifications
  - Mergers to the trunk must pass a comprehensive test suite
- Build environment
  - GNU make, Bash Shell (CygWin), C++ and Fortran Compilers, Python, Perl
- Third party library dependencies
  - NetCDF libraries often need to be built locally
  - ASCII and/or NetCDF data formats used for output
  - NetCDF data analysis tools
- Model Configuration
  - User typically selects a pre-existing XML configuration file
  - Advanced users create new XML configuration files
  - Currently about 23 model components with ~1200 configurable parameters

UNIVERSITY OF Southampton
School of Engineering Sciences

Open University Climate Simulator

- S396 Ecosystems – GENIE Earth system simulator



Open University Climate Simulator

- Provides intuitive access to a GENIE model
- Designed as a teaching tool for S396 Ecosystems course enabling users to prescribe CO2 forcing scenarios
- Visualisation of model fields to provide immediate feedback
- However, of limited use to the GENIE community:
  - Tied to a single build of a legacy GENIE model
  - Platform specific Win32 application
  - Processes ASCII based output files

engage
Engaging research with e-Infrastructure

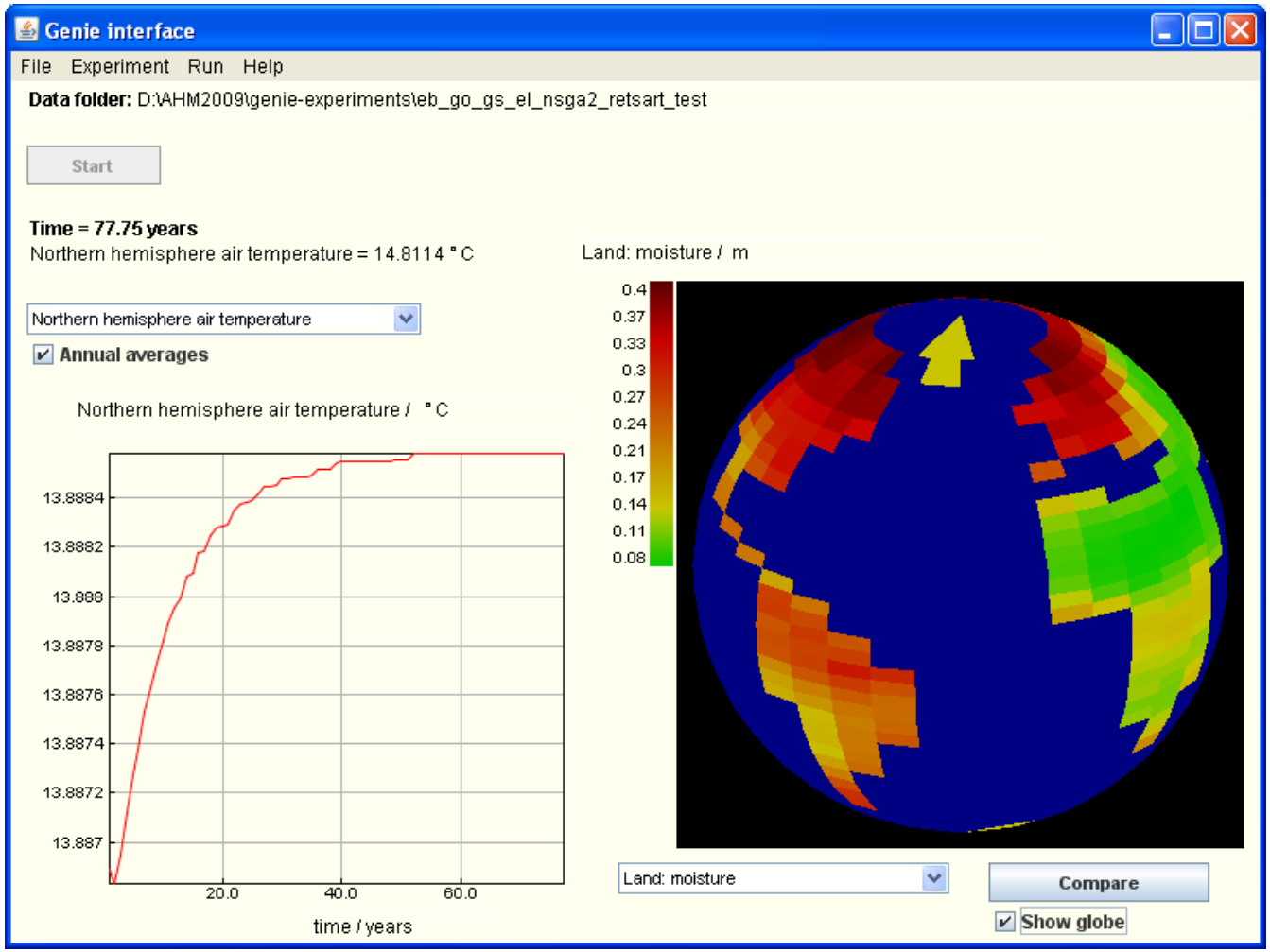
omii-uk
Software Solutions for e-Research

UNIVERSITY OF Southampton
School of Engineering Sciences

- Approached the ENGAGE project to extend the functionality of the OU Climate Simulator for wider benefit to the GENIE community
- (From the case for support) The key differences will be:
  1. it will be coded in Java for cross-platform functionality
  2. it will include a selection of model 'flavours' precompiled from tagged releases of GENIE source code
  3. dynamic selection of available parameters from XML configuration files
  4. coherent data output to NetCDF and ASCII for visualisation using other software

UNIVERSITY OF Southampton
School of Engineering Sciences

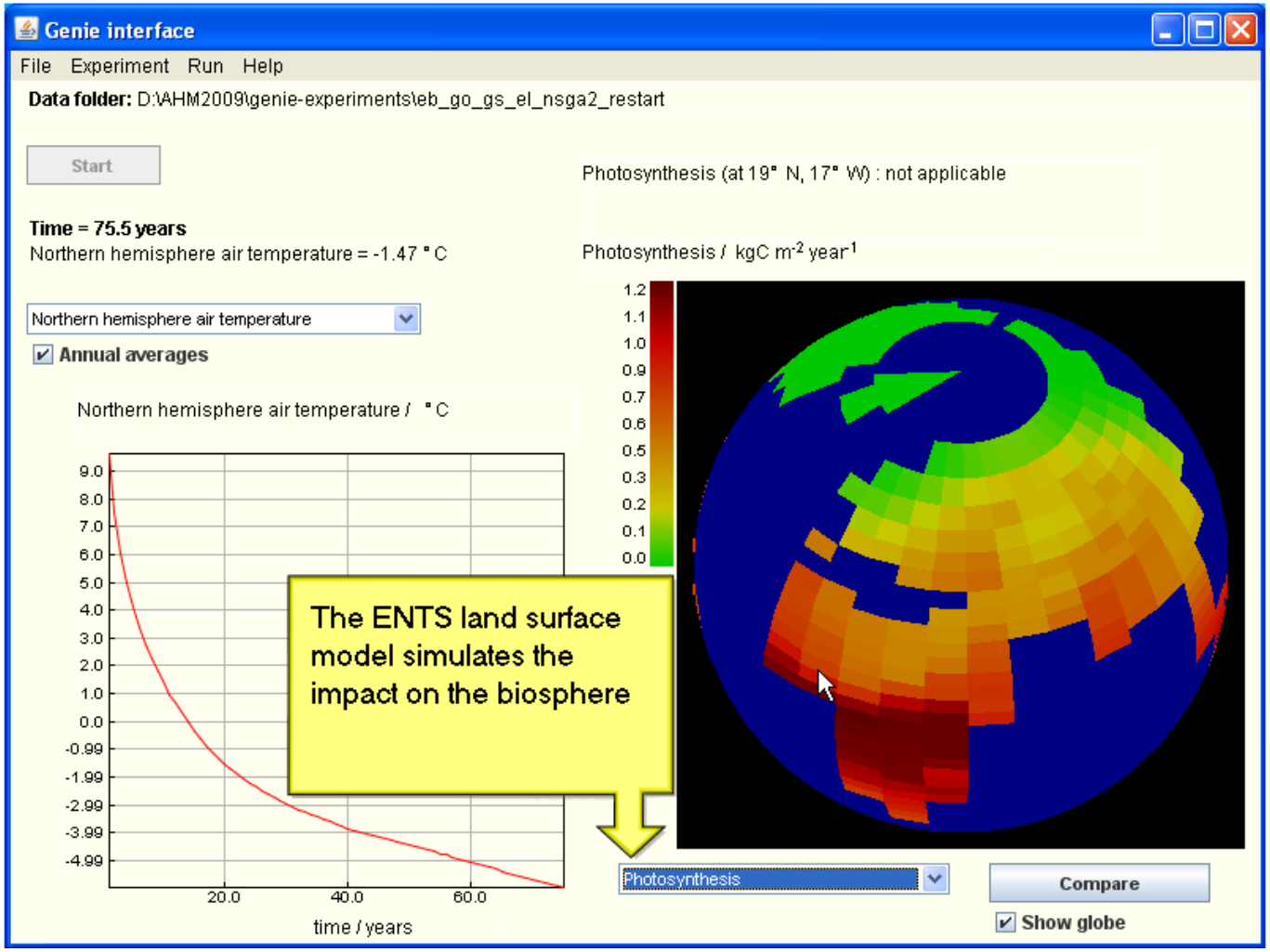
Aladdin2 Teaching Tool



Primary development carried out by Will Rawes and Simon Müller, Open University.

UNIVERSITY OF Southampton
School of Engineering Sciences

OMII-UK Booth Demonstration



Key gains for the GENIE User Community

- Immediate appealing out-of-the-box usability for standard GENIE builds
- Platform independence
- Supports various ‘flavours’ of GENIE model
- Real-time visualisation of model output
- Configurable to target specific teaching tasks
  - Instructor exposes a subset of configurable parameters
  - Enables simple forcing scenarios to be investigated

e-Science Considerations

- Models are a community asset
  - Users often augment the code for their own needs
  - Requires an accessible Fortran code base
  - Science carried out with tagged releases of the code
- Must remain possible to build and execute in a standard working environment (Fortran compiler + libraries)
- e-Science infrastructure therefore provides additional functionality but is not integral to the framework

UNIVERSITY OF Southampton
School of Engineering Sciences

GENIELab

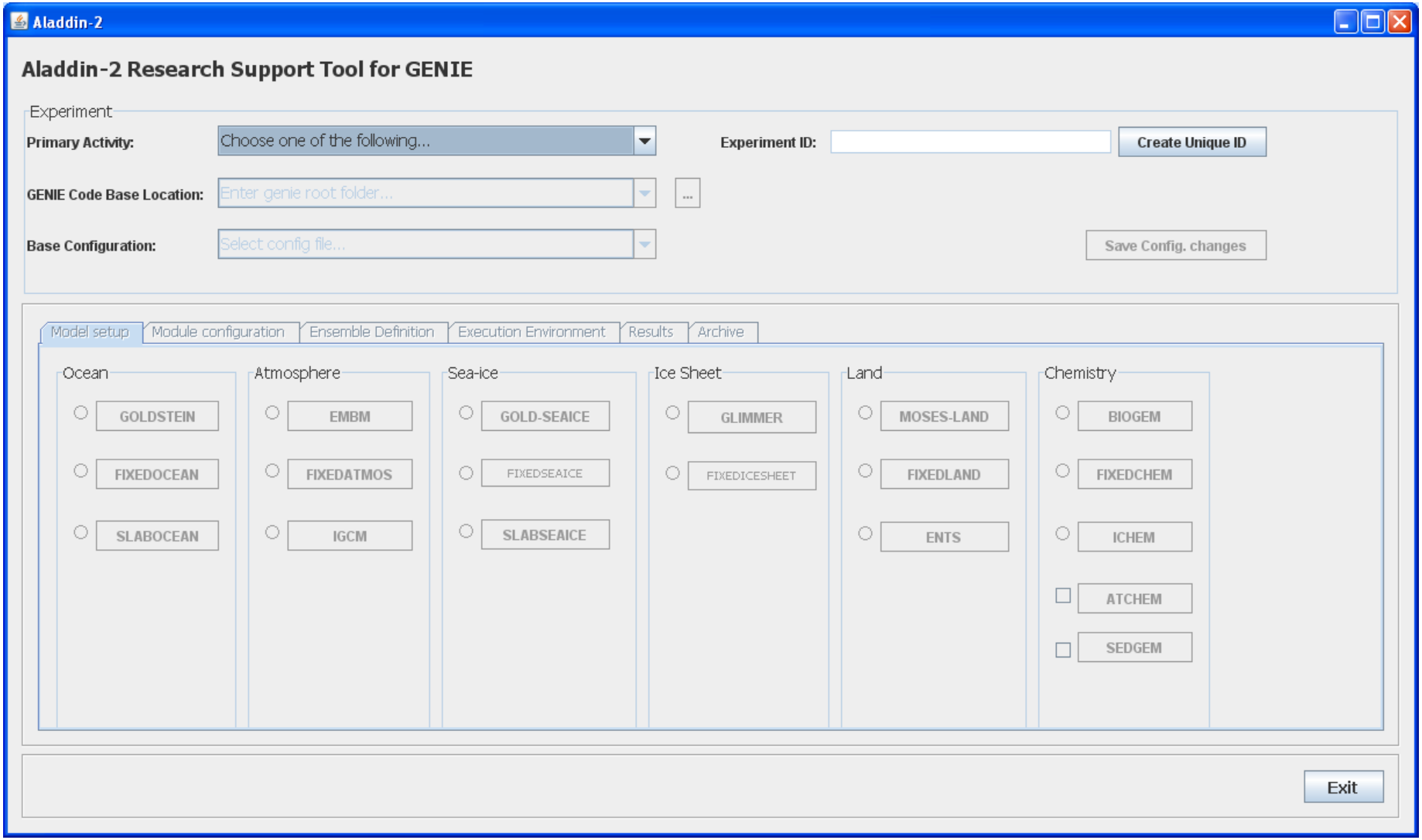
- GENIELab provides a set of Matlab functions to manage GENIE models on the Grid
- Built upon the Geodise toolboxes
- Provides routines to automatically manage metadata creation for archival of simulation output
- Scripted workflows available for
  - collaborative study of ensembles of simulations
  - parameter estimation studies exploiting OptionsMatlab
  - visualisation of simulation and ensemble output

Research Support Tool Development

- Java GUI code base being extended into a research support tool
  - Research Support Tool will enable users to compose and configure the model 'flavour' and generate portable experiment builds
  - XML configuration libraries and visualisation routines can be directly exploited
  - ASCII I/O replaced with NetCDF routines
  - Support for definition of ensembles (the primary need for distributed computing)
- GENIELab
  - Port of GENIELab scripted workflows for job submission, job monitoring and results retrieval to Java GUI
  - Integration of GEODISE Java classes to interface with the National Grid Service

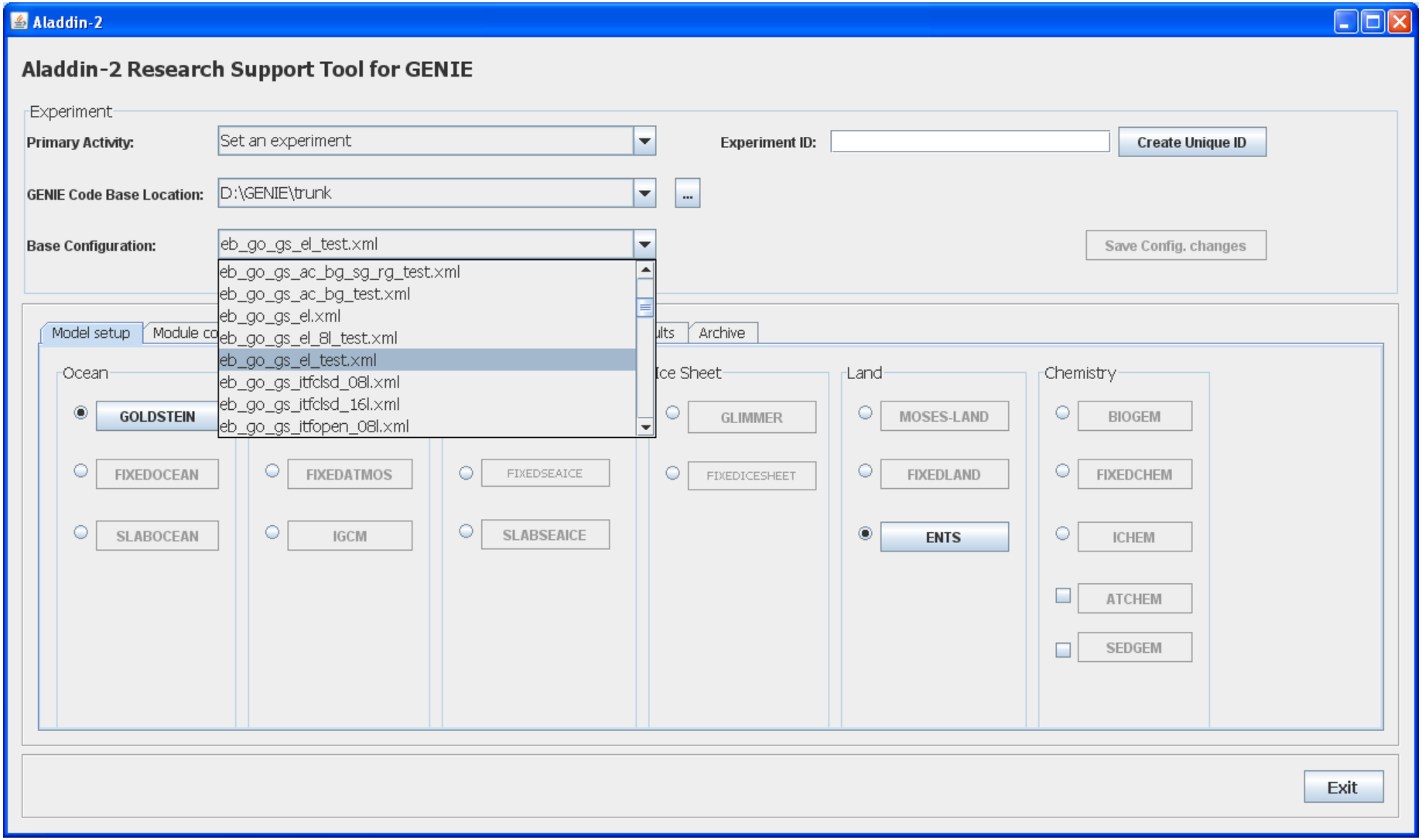
UNIVERSITY OF Southampton
School of Engineering Sciences

Research Support Tool Prototype



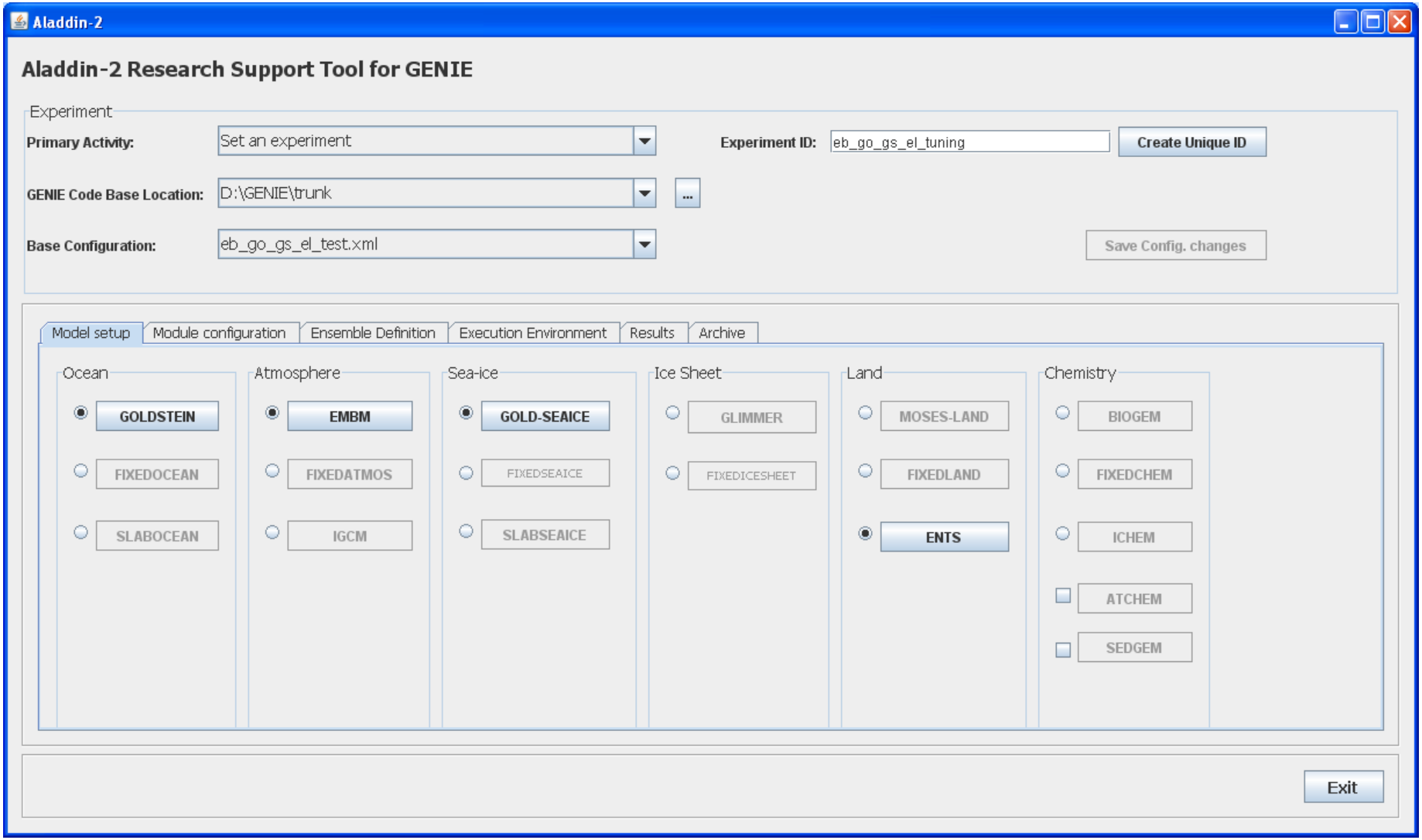
UNIVERSITY OF Southampton
School of Engineering Sciences

Research Support Tool Prototype



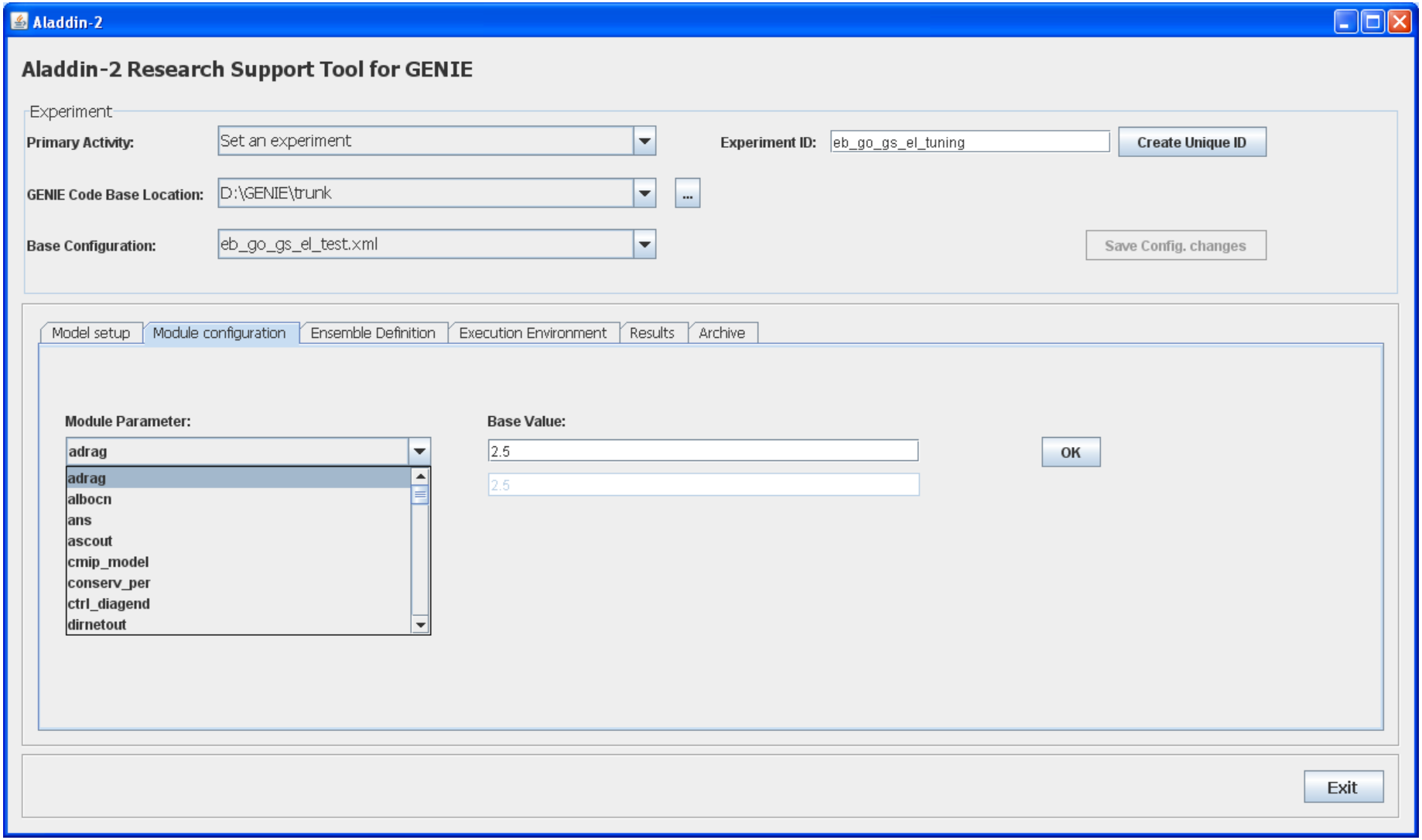
UNIVERSITY OF Southampton
School of Engineering Sciences

Research Support Tool Prototype



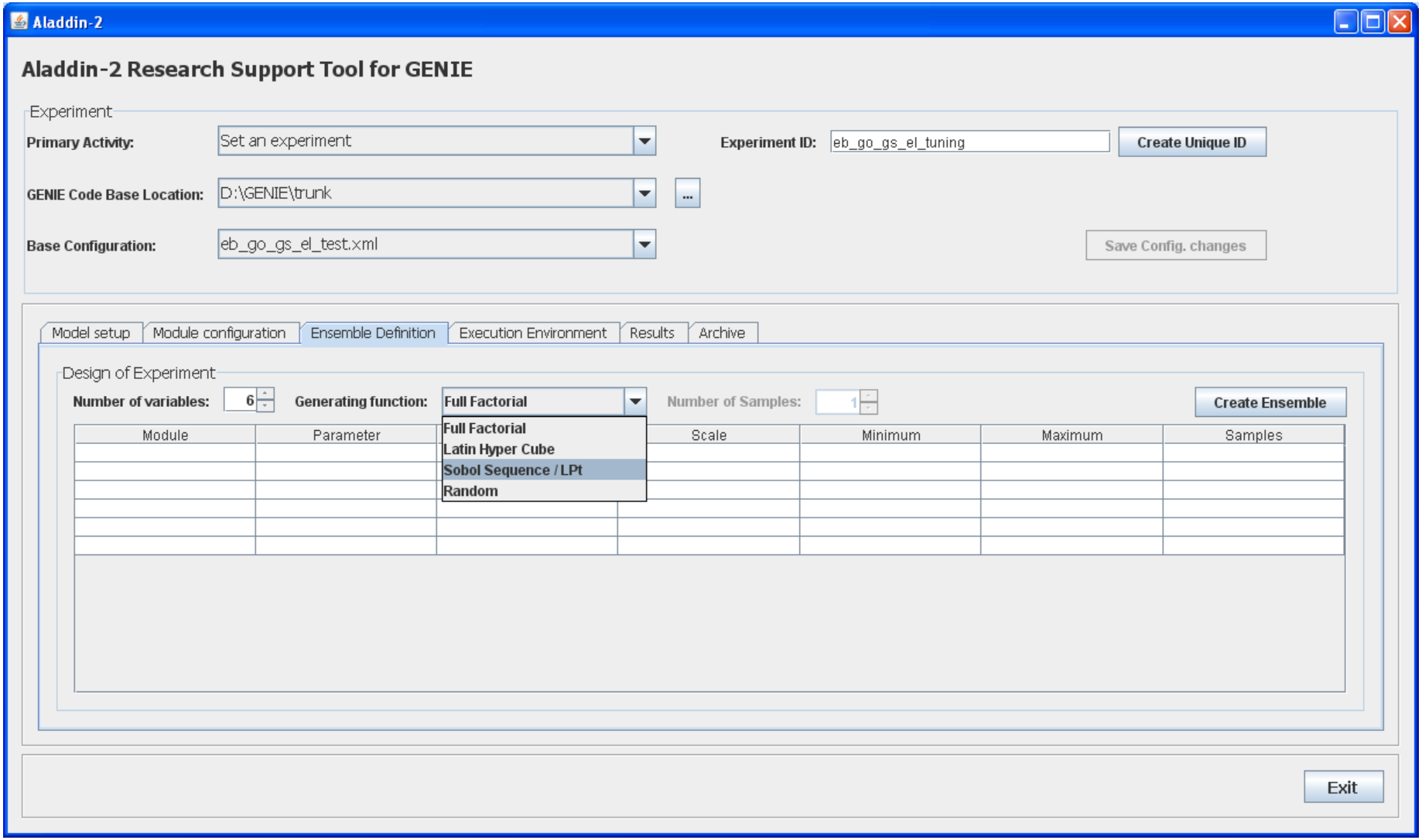
UNIVERSITY OF Southampton
School of Engineering Sciences

Research Support Tool Prototype



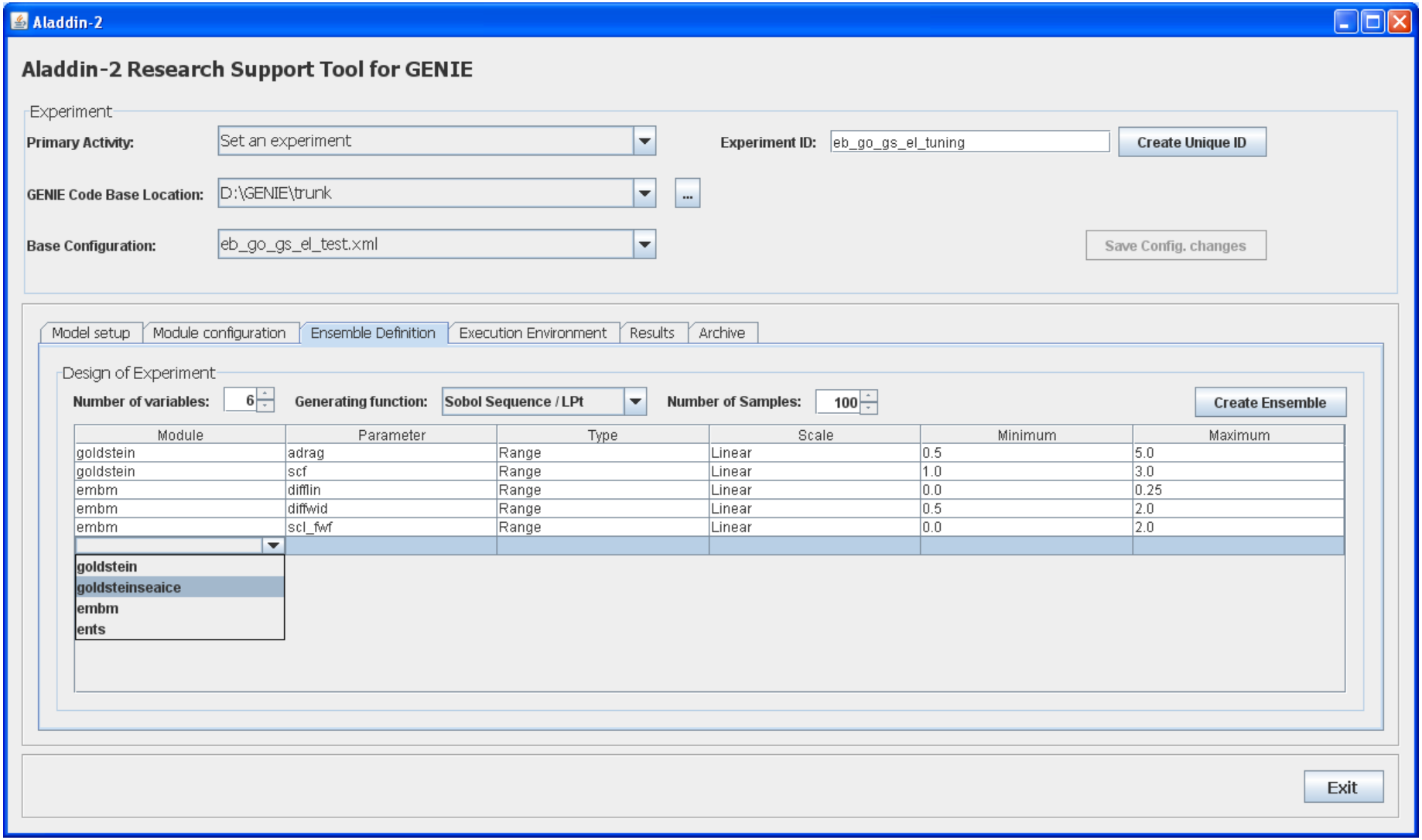
UNIVERSITY OF Southampton
School of Engineering Sciences

Research Support Tool Prototype



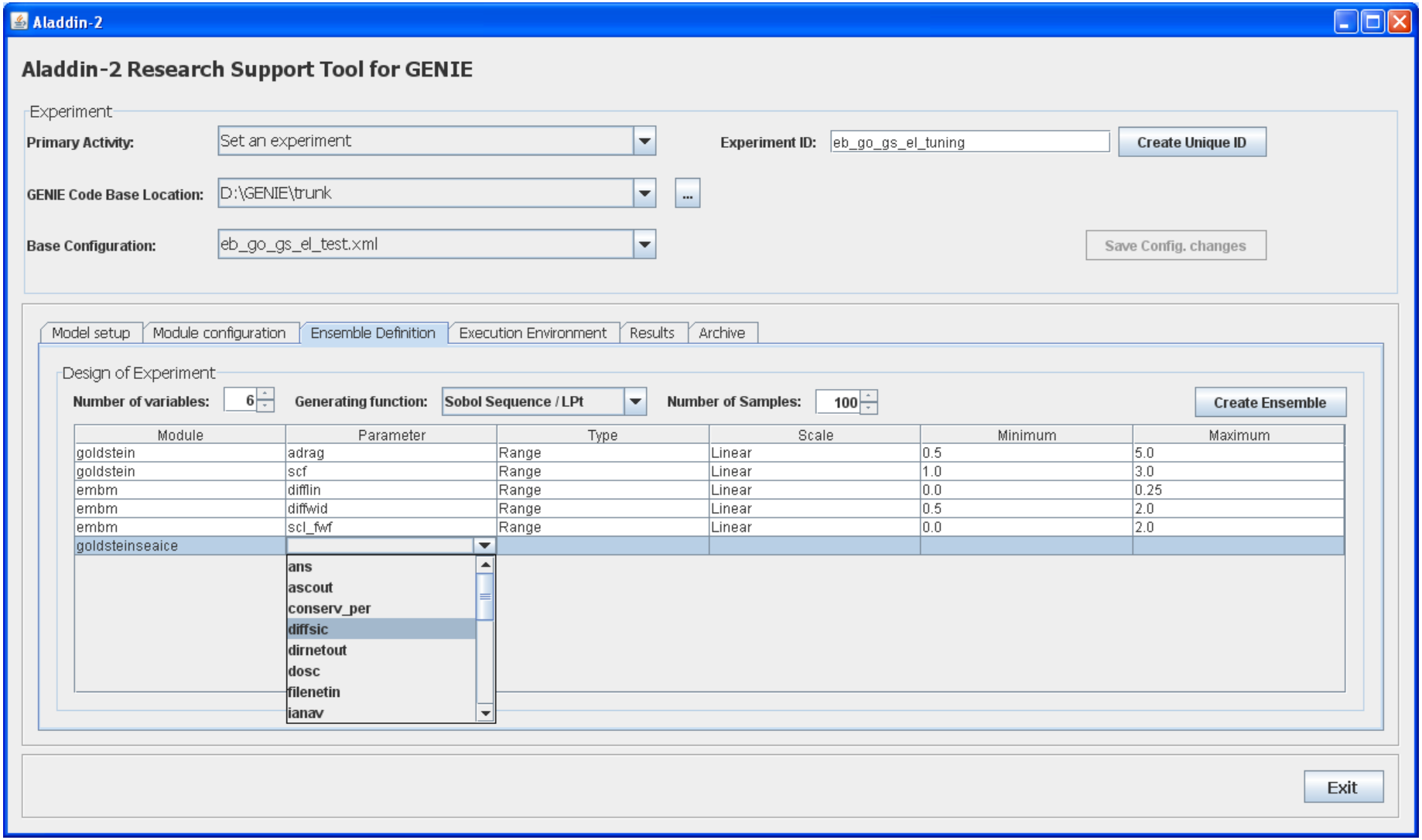
UNIVERSITY OF Southampton
School of Engineering Sciences

Research Support Tool Prototype



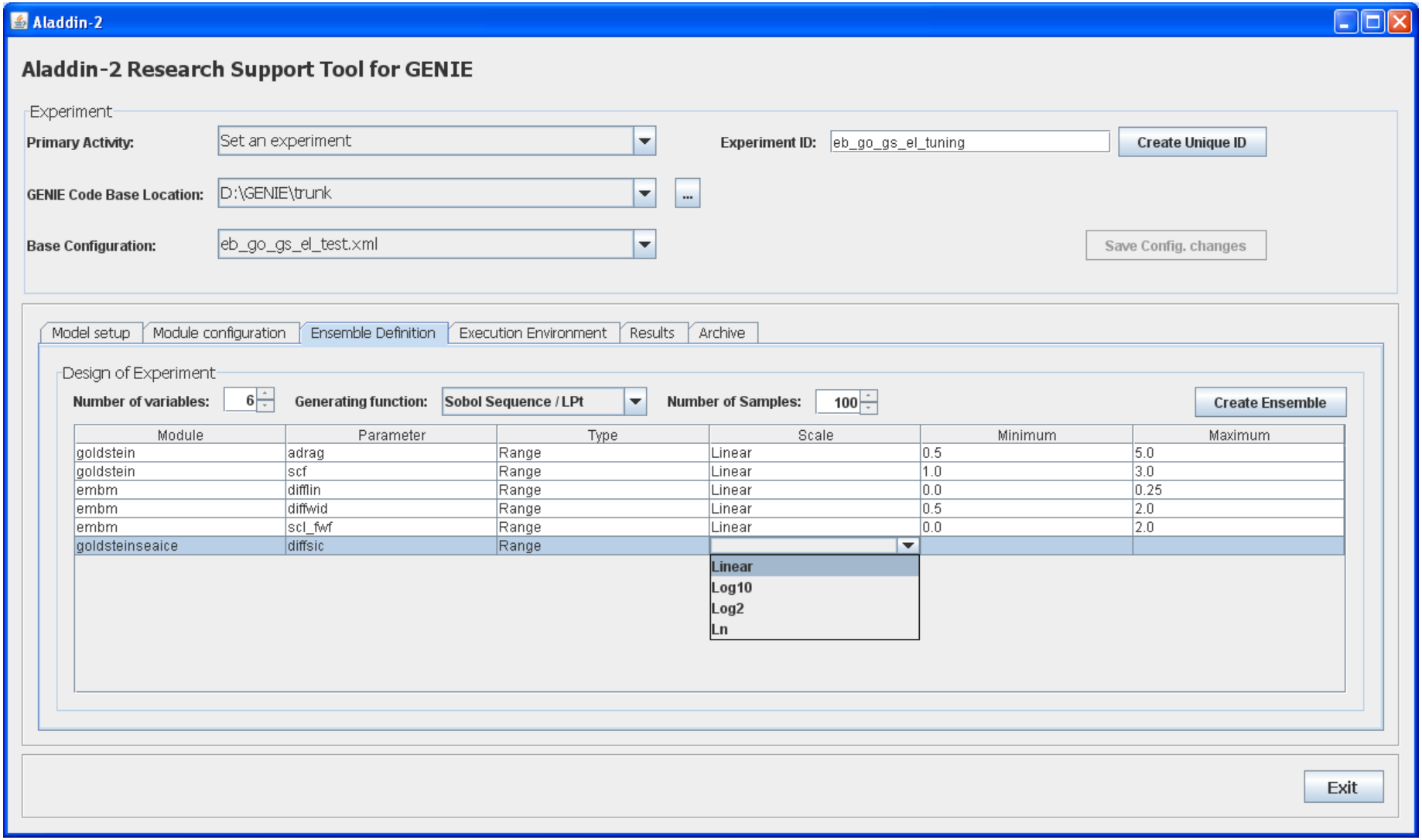
UNIVERSITY OF Southampton
School of Engineering Sciences

Research Support Tool Prototype



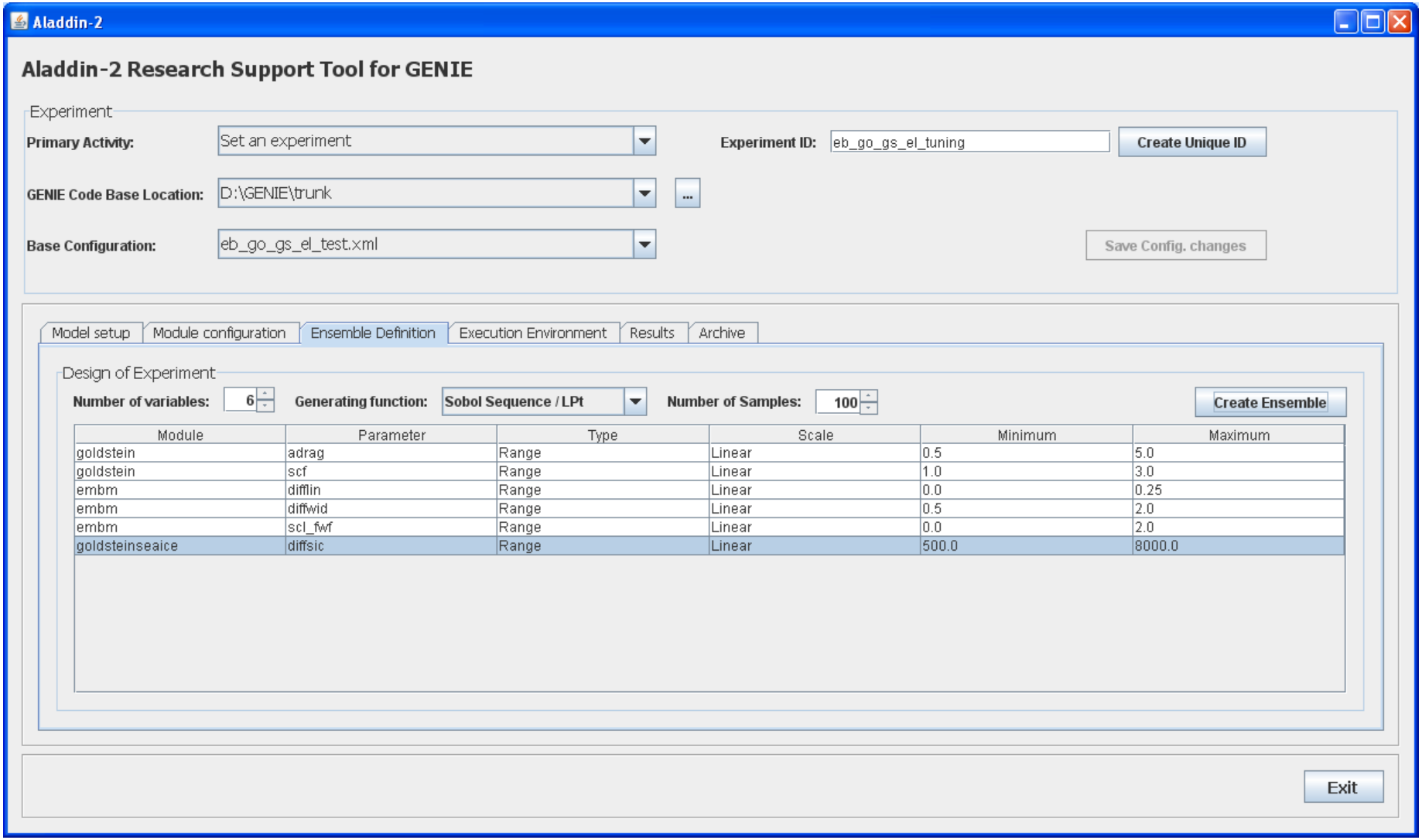
UNIVERSITY OF Southampton
School of Engineering Sciences

Research Support Tool Prototype



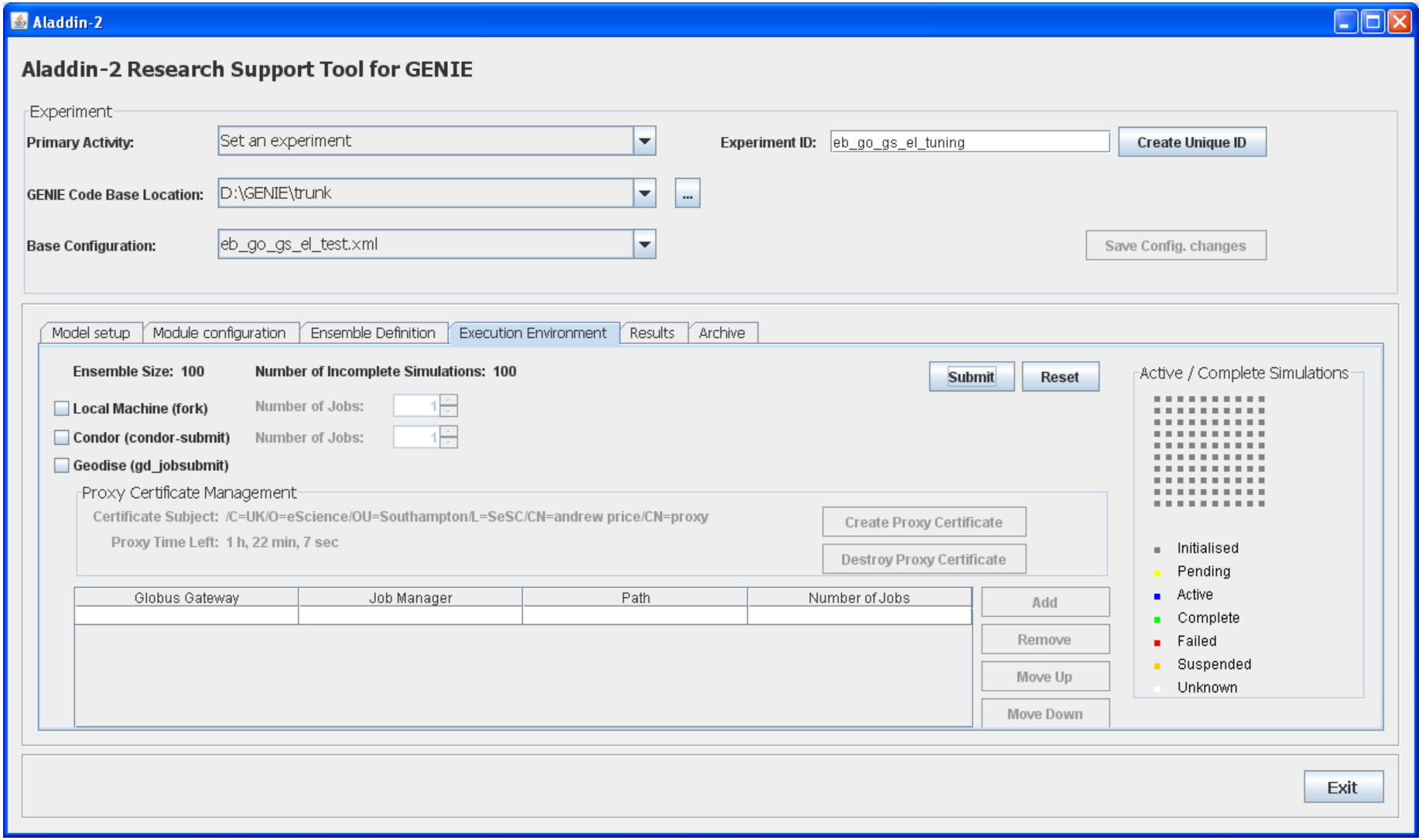
UNIVERSITY OF Southampton
School of Engineering Sciences

Research Support Tool Prototype



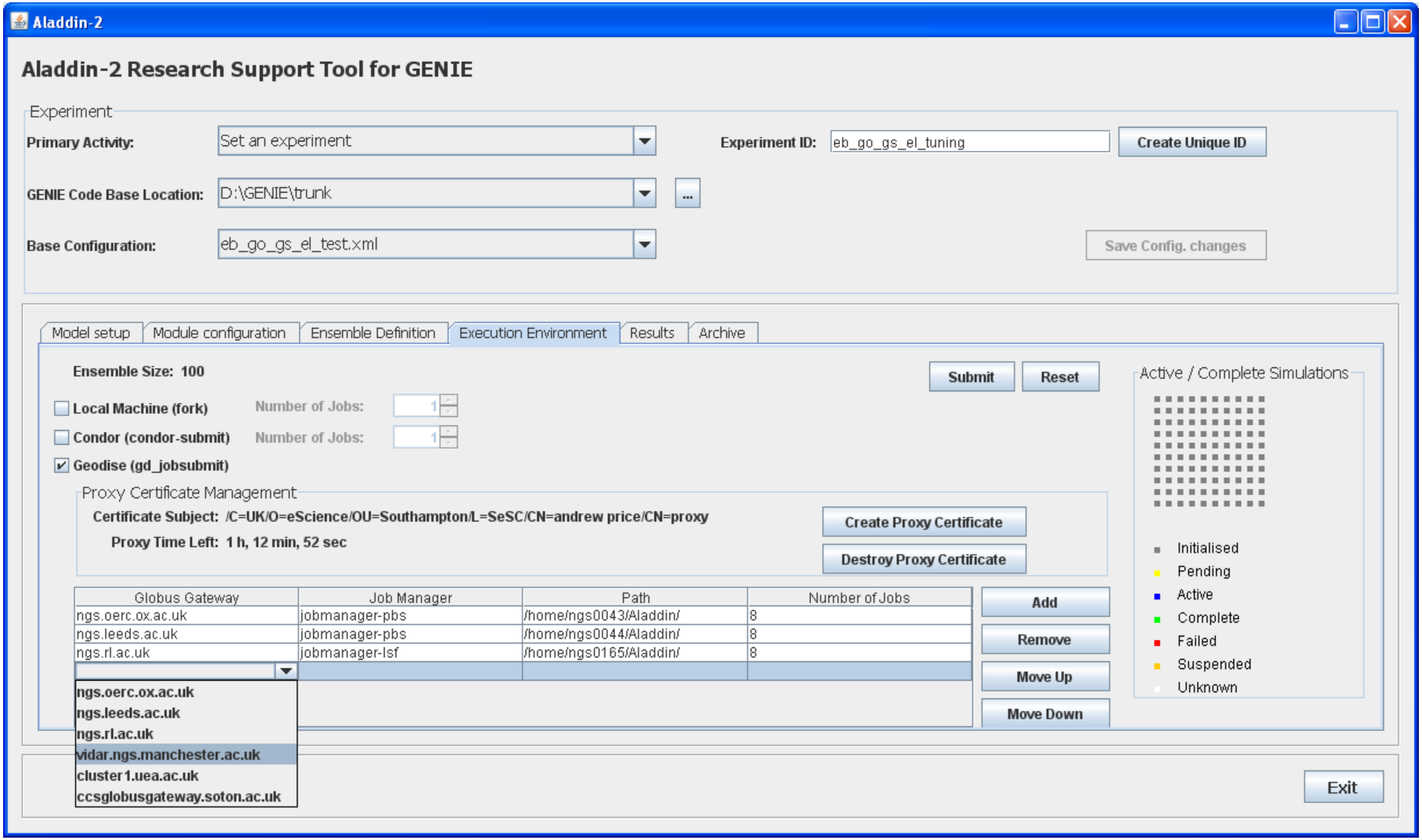
UNIVERSITY OF Southampton
School of Engineering Sciences

Research Support Tool Prototype



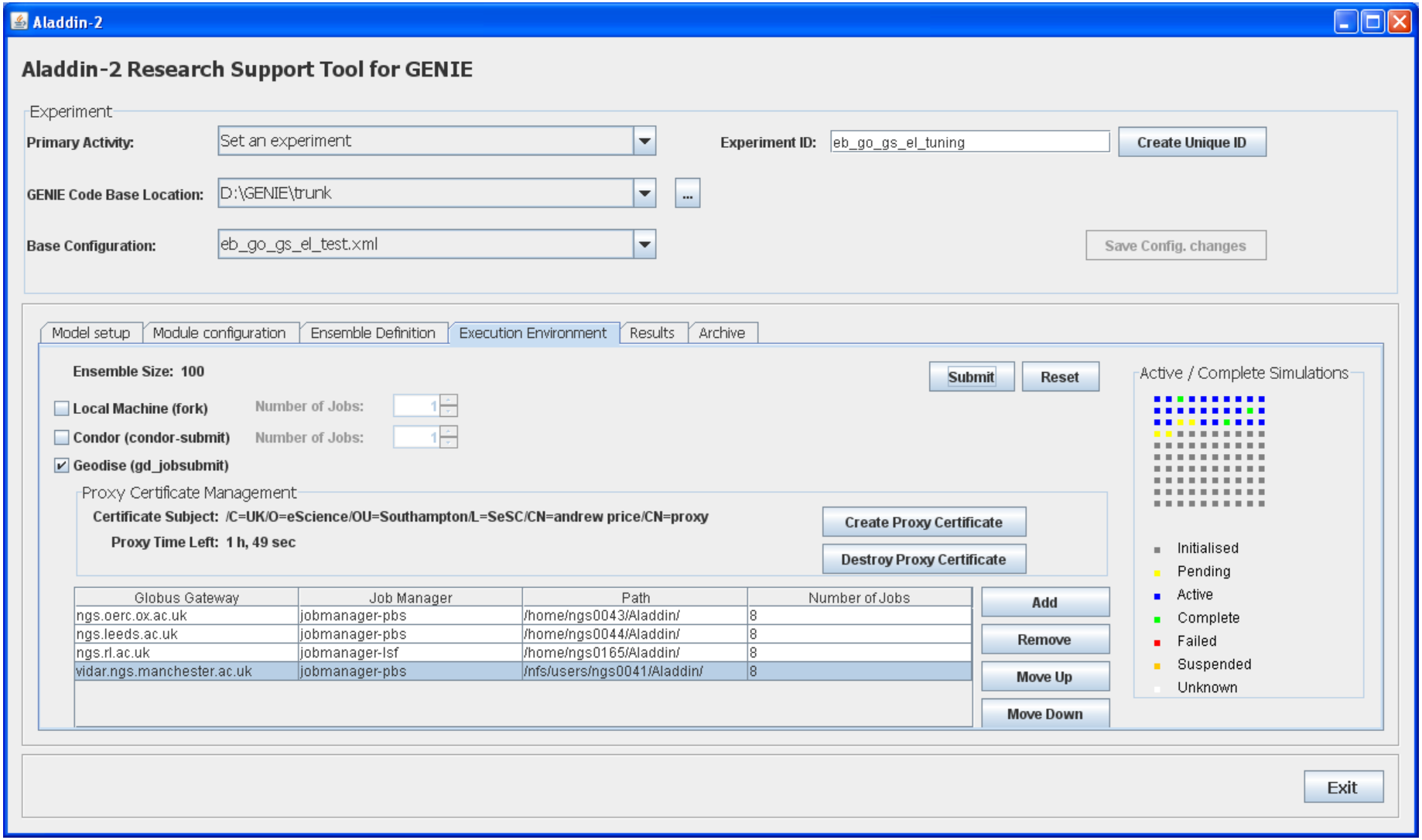
UNIVERSITY OF Southampton
School of Engineering Sciences

Research Support Tool Prototype



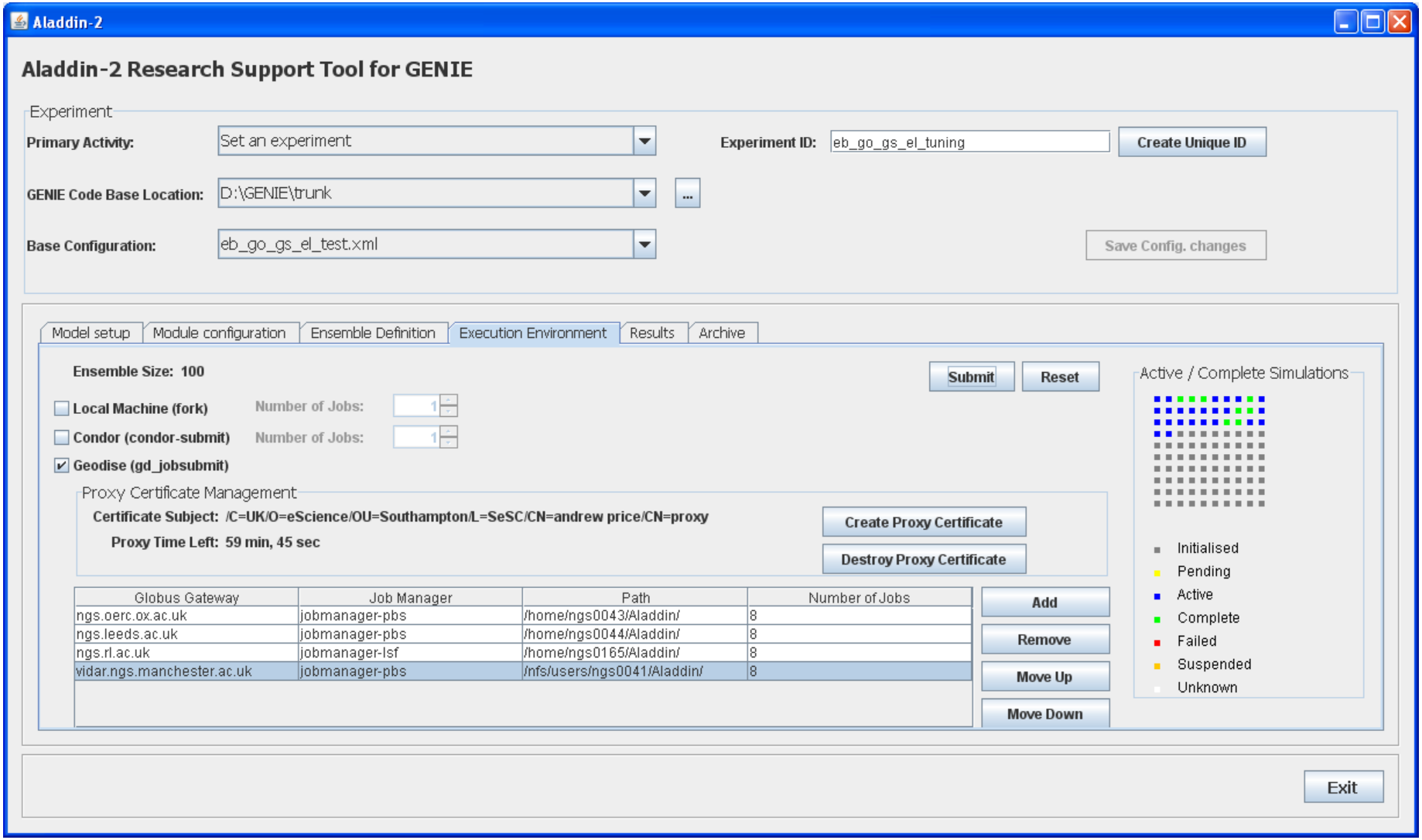
UNIVERSITY OF Southampton
School of Engineering Sciences

Research Support Tool Prototype



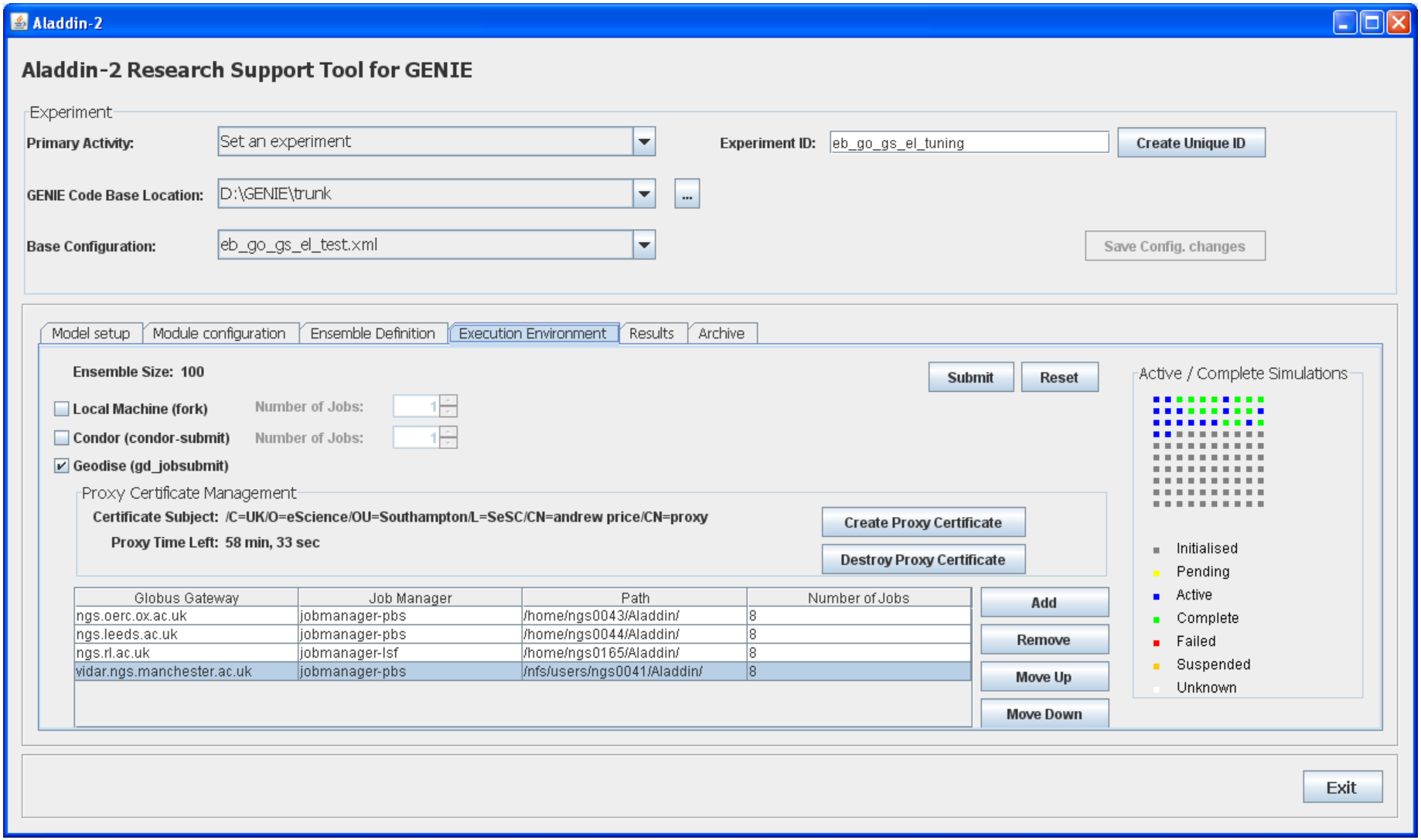
University of Southampton
School of Engineering Sciences

Research Support Tool Prototype



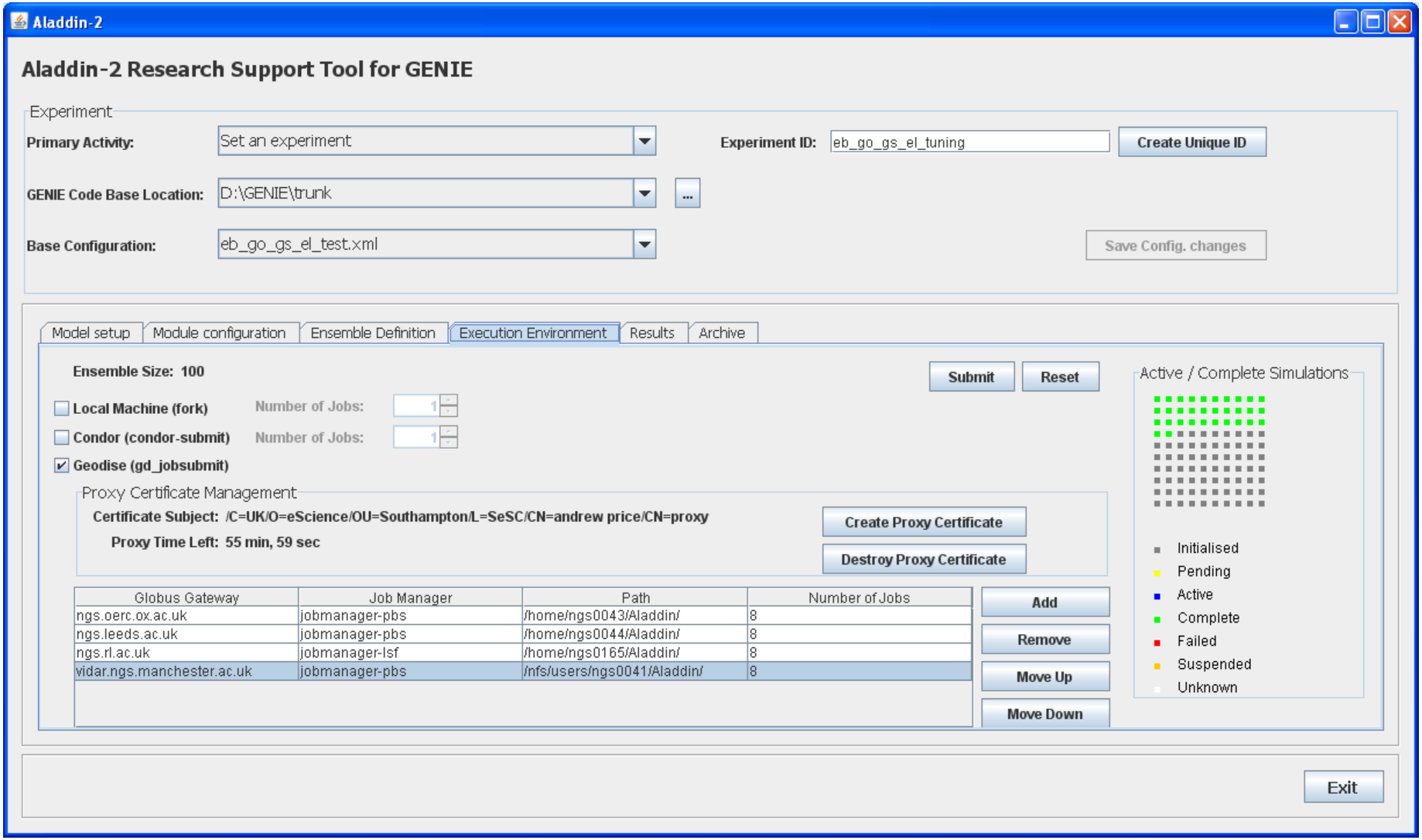
University of Southampton
School of Engineering Sciences

Research Support Tool Prototype



University of Southampton
School of Engineering Sciences

Research Support Tool Prototype



Future Work

- Development under way to deliver NetCDF data visualisation methods for the Research Support Tool
- Continuing timeline:
  - Q1 2010 → Continue development to deliver software beta
  - GENIE-LAMP Entry-level workshop (Easter 2010)
    - Obtain feedback on the alpha release
  - Q2 2010 → Respond to feedback to deliver beta release
  - GENIE-LAMP Intermediate level workshop (Summer 2010)
    - Obtain feedback on RST beta release

Summary

- GENIE lacks immediate “out-of-the-box” usability
- New users face a steep learning curve to make use of the models
- Distributed and Grid Computing is an added complication
- ENGAGE funded activities have enabled us to develop a platform independent front-end for standard builds of the model
- Work is on-going to extend this tool to support research activities requiring remote computing services

UNIVERSITY OF Southampton
School of Engineering Sciences

The GENIE Team (2002 – 2009)

Principal Investigator – GENIEfy (2005-2009):

Tim Lenton – *UEA Norwich*

Research Team and Collaborators:

Ibrahim Almajai – *UEA Norwich*
James Annan – *FRSGC, Japan*
Chris Armstrong – *Manchester*
Chris Brockwell – *UEA Norwich*
David Cameron – *CEH Edinburgh*
Peter Cox – *Hadley Centre (UKMO)*
Neil Edwards – *Open University*
Sudipta Goswami – *UEA Norwich*
Robin Hankin – *NOC Southampton*
Julia Hargreaves – *FRSGC, Japan*
Phil Harris – *CEH Wallingford*
Zhuoan Jiao – *Southampton e-Science Centre*
Martin Johnson – *UEA Norwich*
Eleftheria Katsiri – *London e-Science Centre*
Valerie Livina – *UEA Norwich*
Dan Lunt – *Bristol*
Simon Müller – *Open University*
Richard Myerscough – *NOC Southampton*
Kevin Oliver – *NOC Southampton*
Sofia Panagiotidi – *London e-Science Centre*
Andrew Price – *Southampton e-Science Centre*
Will Rawes – *Open University*
Andy Ridgwell – *Bristol*
Ian Rutt – *Bristol*
Gethin Williams – *Bristol*
Mark Williamson – *UEA Norwich*
Gang Xue – *Southampton e-Science Centre*
Andrew Yool – *NOC Southampton*

Principal Investigator – GENIE (2002-2005):

Paul Valdes – *Bristol*

Co-Investigators / Management team:

Peter Challenor – *NOC Southampton*
Trevor Cooper-Chadwick – *Southampton e-Science Centre*
Simon Cox – *Southampton e-Science Centre*
John Darlington – *London e-Science Centre*
Rupert Ford – *Manchester*
Eric Guilyardi – *Reading*
John Gurd – *Manchester*
Richard Harding – *CEH Wallingford*
Robert Marsh – *NOC Southampton*
Tony Payne – *Bristol*
Graham Riley – *Manchester*
John Shepherd – *NOC Southampton*
Rachel Warren – *UEA Norwich*
Andrew Watson – *UEA Norwich*

The Open University