

EXCALIBUR  
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# SEAVEA: Software Environment for Actionable and VVUQ-enabled Exascale Applications

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UK Research  
and Innovation



# SEAVEA project



- ❑ Aim is to develop an exascale-ready toolkit that allows applications to apply VVUQ techniques in a mutually repurposable way:
  - ❑ Verification and Validation (VV),
  - ❑ Uncertainty Quantification (UQ).
- ❑ In addition, SEAVEA provides tools for
  - ❑ Sensitivity analysis (SA),
  - ❑ Surrogate models,
  - ❑ Model coupling,
  - ❑ Ensemble forecasting.

August 2021 - October 2024

<https://www.seavea-project.org>



RAMP  
Continuity  
Network



# SEAVEA toolkit: <https://www.seavea-project.org/seaveatk>

- ❑ EasyVVUQ → UQ+SA,
- ❑ FabSim3 → VV + automation,
- ❑ MUSCLE3 → Code coupling + UQ,
- ❑ QCG-PilotJob → Run 1000s of jobs in a single allocation,
- ❑ EasySurrogate → Surrogate modelling for multiscale simulations,
- ❑ mogp\_emulator → Surrogate modelling for fitting Gaussian Process Emulators,
- ❑ RADICAL-Cybertools → Abstraction-driven approach to HPC.



FabSim<sup>3</sup>



MUSCLE<sup>3</sup>



The SEAVEA toolkit is open source and freely available to use with any application, using any programming language.

# Applications

## Fusion modelling

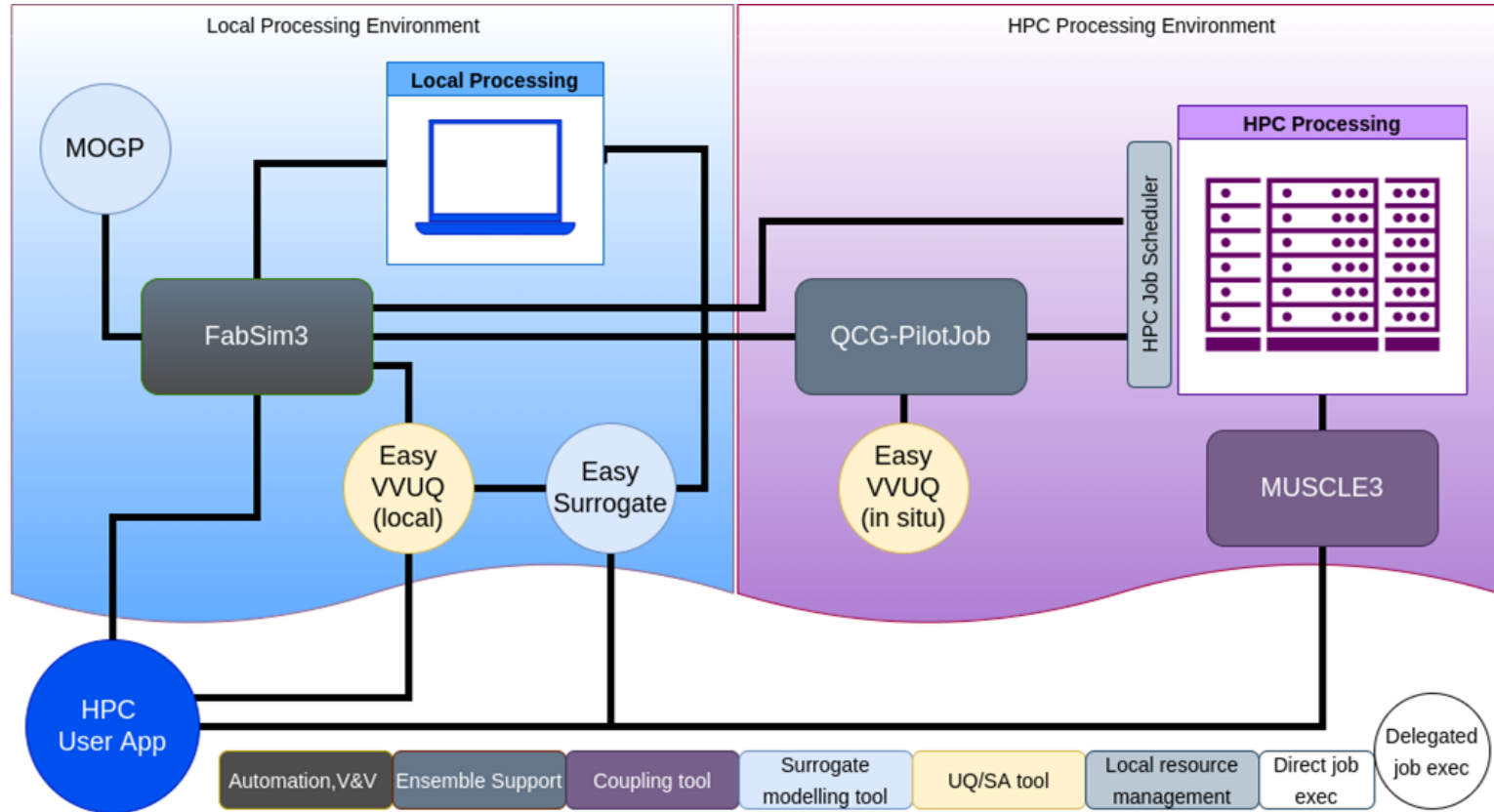
With exascale performant simulations key to advancing fusion knowledge and especially tokamak design or "Whole Device Modelling (WDM)", VVUQ deployment is essential for successfully creating models that can reliably guide highly expensive procurement decisions for future commercial fusion reactors. Our primary exemplar will deploy our toolkit to quantify the uncertainty characteristics of a suite of algorithms being developed to build a highly coupled, multi-physics and multi-scale exascale class simulation of the tokamak plasma "exhaust" (or "divertor" region of the tokamak) that is "actionable".

## Weather and climate forecasting

The UCL Met Office Academic Partnership led by Serge Guillas, Co-I of the SEAVEA project, is devoted to Data Sciences for weather and climate. It gathers within four working groups experts from eight departments of UCL and across the Met Office. It covers multiple domains of modeling such as the ocean, sea-ice, paleoclimate, climate change, atmospheric turbulence, space weather, air quality as well as Data Assimilation, Machine Learning for nowcasting, and UQ methods.

<https://www.seavea-project.org/applications>

# SEAVEA toolkit map



# SEAVEA project events



- ❑ Online Toolkit Hackathons,
- ❑ “Uncertainty in Mathematical Modelling of Pandemics” (w/ RAMP),
- ❑ VVUQ On The Exascale Workshop and SEAVEA Hackathon at ICCS 2022,
- ❑ CompBioMed - SEAVEA Hackathon 2023,
- ❑ Applications Hackathons.

We have submitted our first papers and are growing the consortium and the user base.

# Summary

## Toolkit uptake:

- ❑ We're happy to support users currently outside of SEAVEA and organize dedicated sessions to bring them up to speed.
- ❑ We're happy for other projects to integrate parts of SEAVEAtk in their own software stacks.

## Toolkit expansion:

- ❑ We're keen to include external optimisation or VVUQ-related algorithms within the toolkit.

## Development and Event alignment:

- ❑ We're happy for other ExCALIBUR projects to provide advice on our development priorities.
- ❑ We're keen to organize workshops, tutorials or hackathons with other ExCALIBUR projects.

# Questions?

<https://www.seavea-project.org>

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