



# *Automated Testing for AUV Planning Software*

*Zeyn Saigol*

*MBARI (Summer Intern 2008)*

*and*

*School of Computer Science*

*University of Birmingham*

*Mentor: Kanna Rajan*

*Acknowledgements: Frederic Py, Conor McGann,*

*George Matsumoto, Linda Kuhnz, all the 2008 interns,*

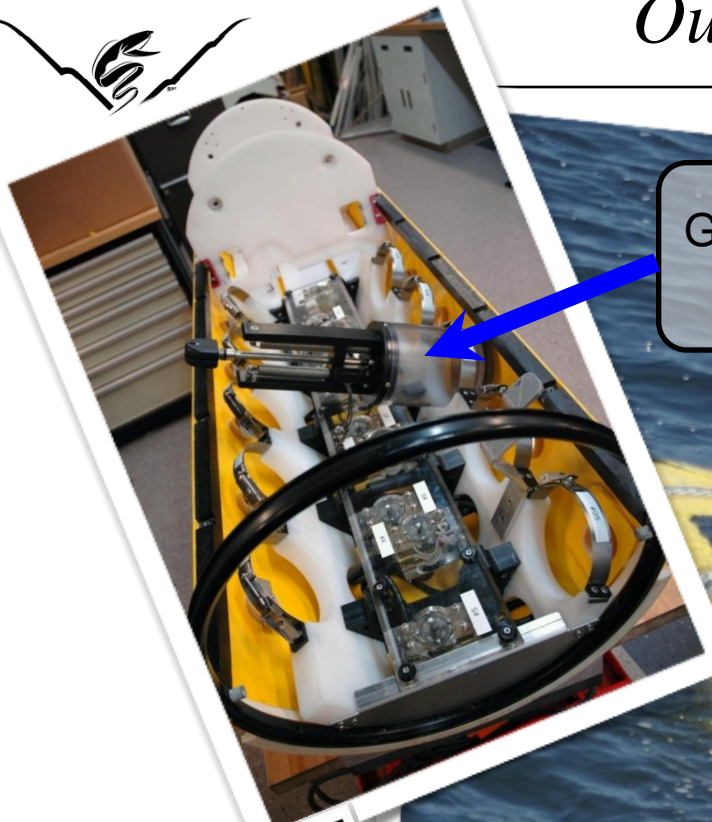
*Tom O'Reilly, Hans Thomas, Doug Conlin, Duane Thompson and the crew of the R/V Zephyr*



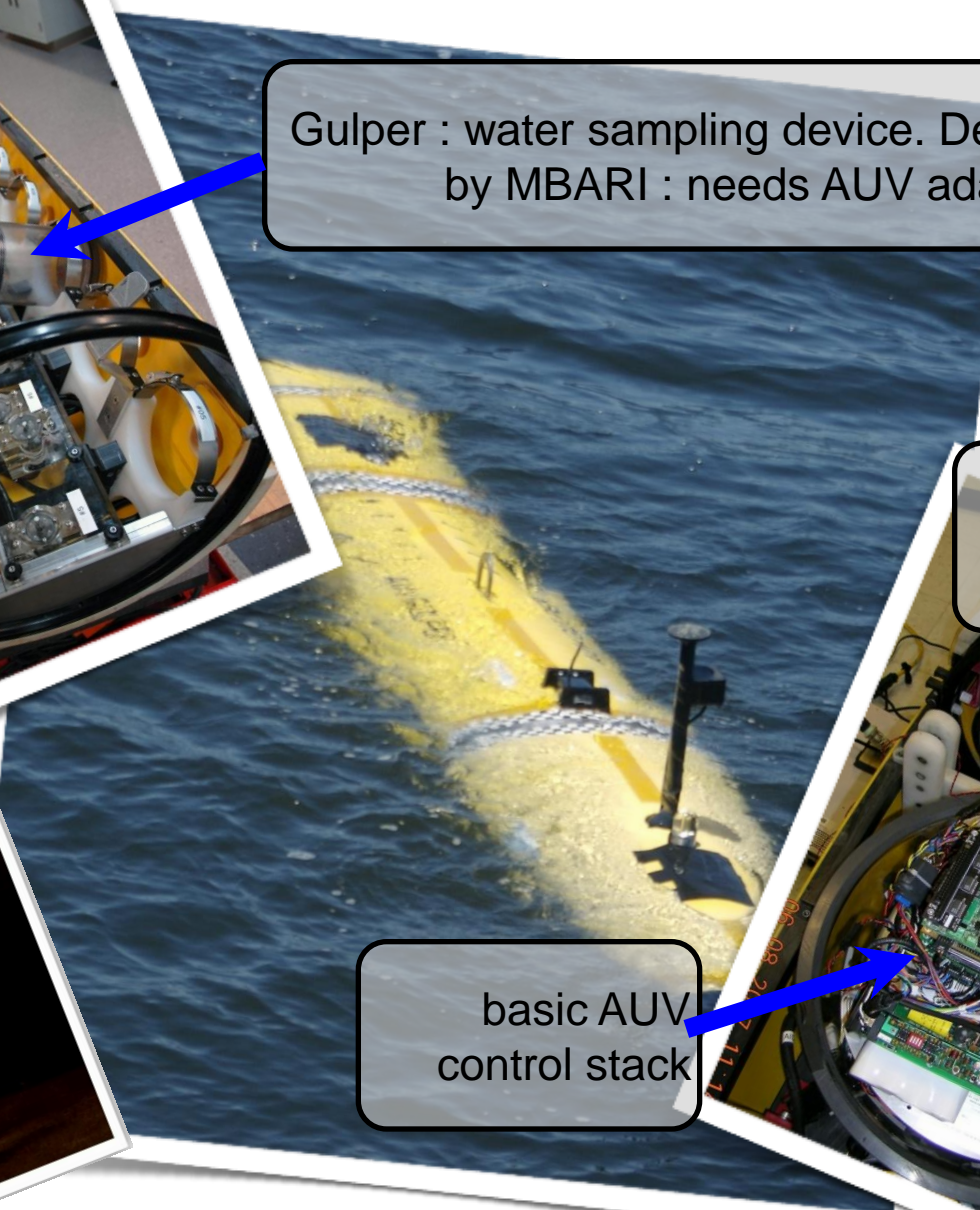
- Overview of T-REX<sup>†</sup>
- Motivation for a Monte-Carlo testing system
- Implementation summary
- Results and conclusion



# Our Modified AUV Platform

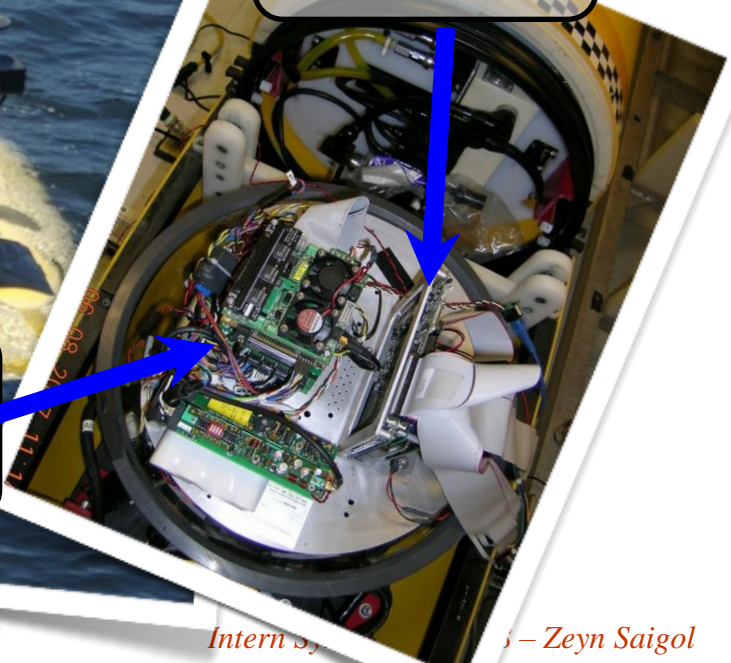


Gulper : water sampling device. Developed by MBARI : needs AUV adaptability



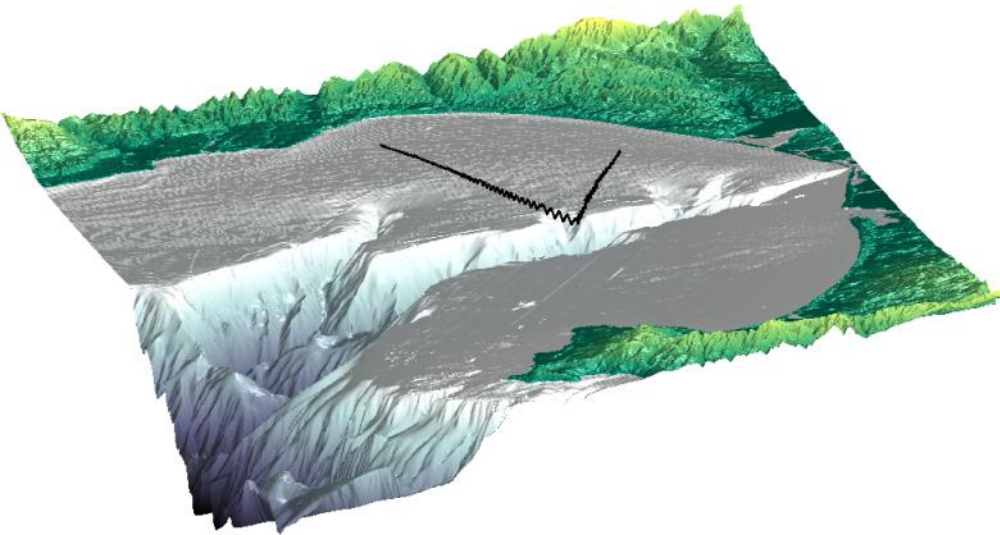
autonomy computer stack

basic AUV control stack



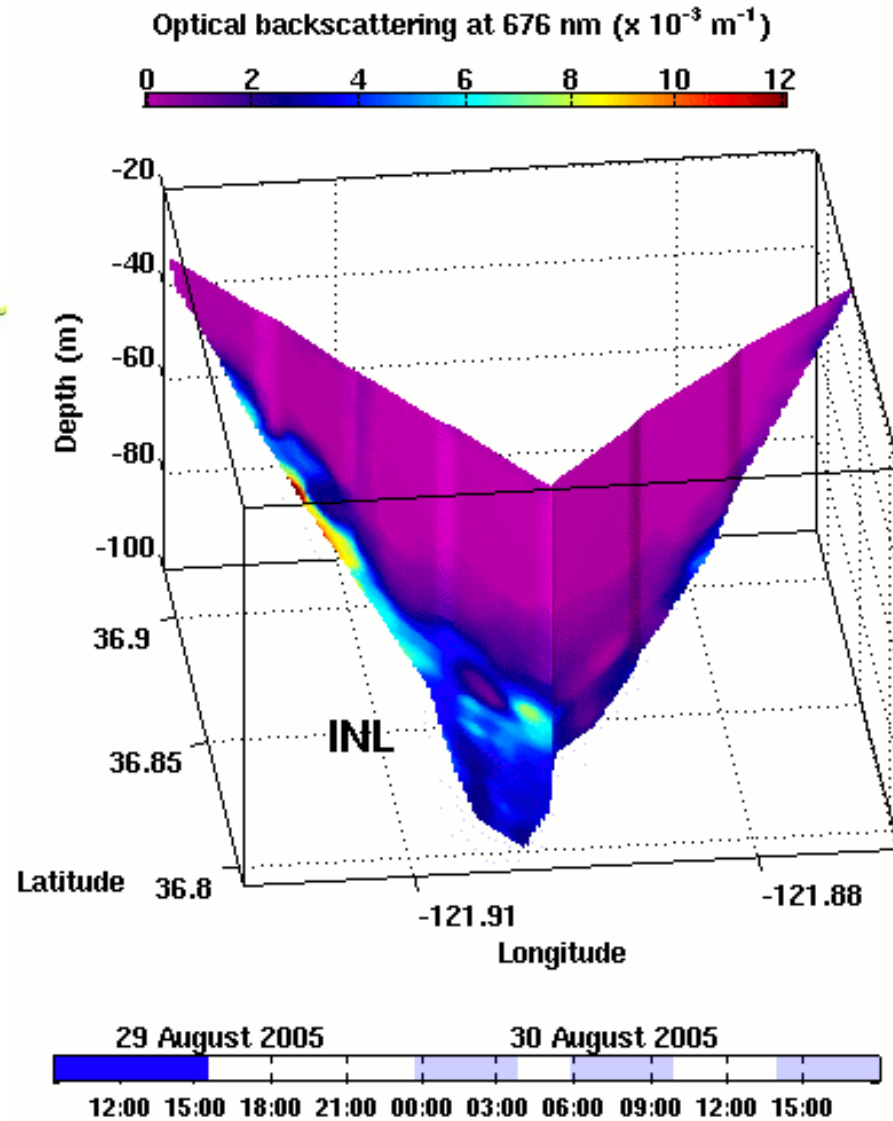


# Motivation: To Map Dynamic Events in the Ocean



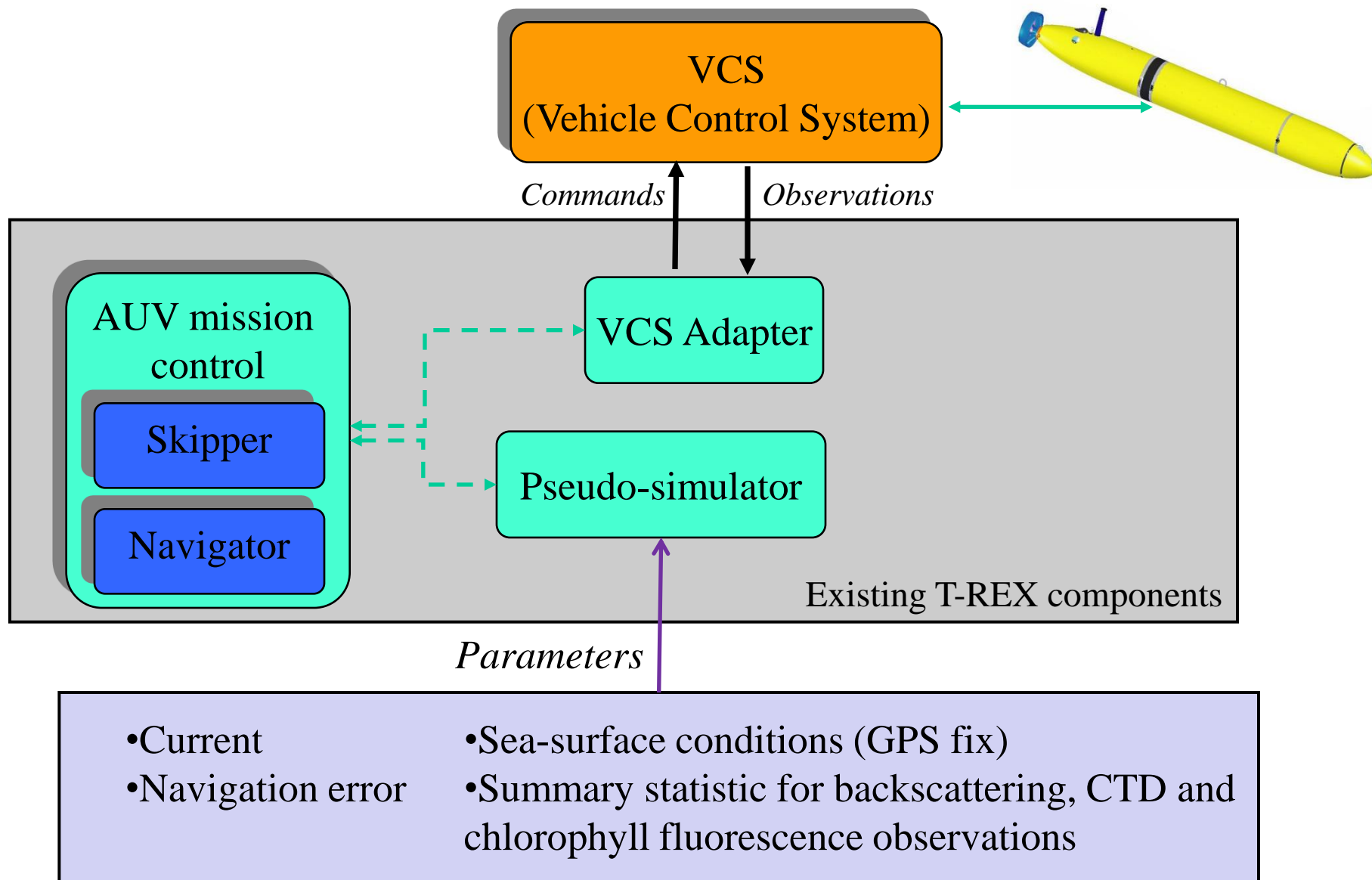
- Fluid sheets of *suspended particulates*. Originate from the *sea floor* through diverse fluid dynamics [McPhee-Shaw 2004].
- Large Horizontal Scales (Kms)
- Small Vertical Scales (meters)
- Patchy

Objective: To map, sample and thus characterize highly dynamic ocean phenomenon





# T-REX Testing Architecture





# The Testing Problem

---

Expensive if things go wrong at sea – but planner produces a wide range of behaviours!

## Problems with existing pseudo-simulator

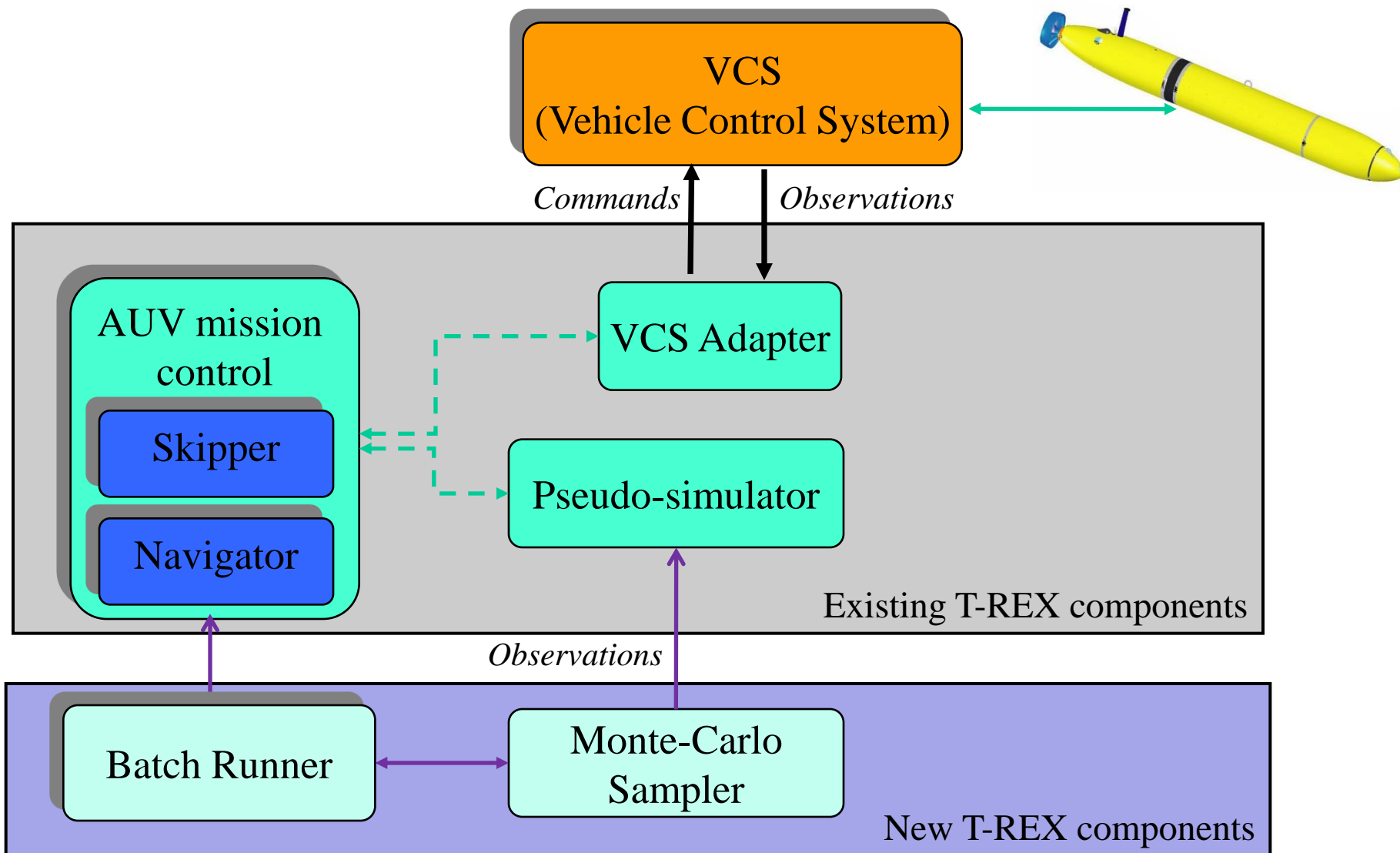
- Parameters need to be set by hand
- Running the system will only test one set of potential conditions

## My project: A Monte-Carlo test harness

- Run many missions
- Stochastically change parameters of the system



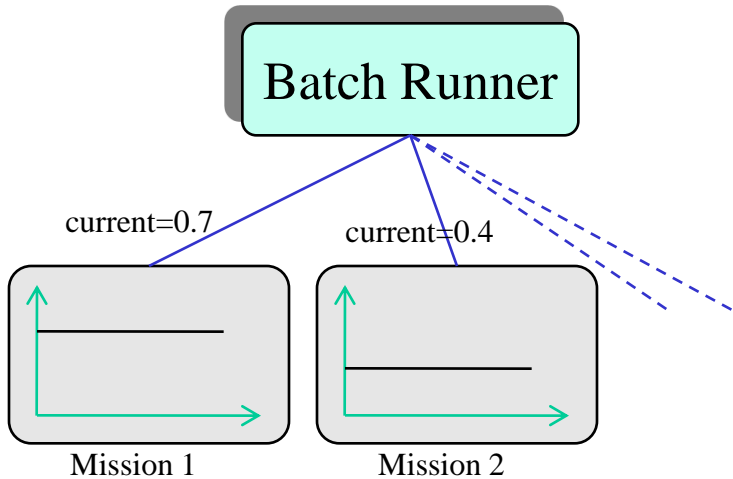
# Integration of the Monte-Carlo System



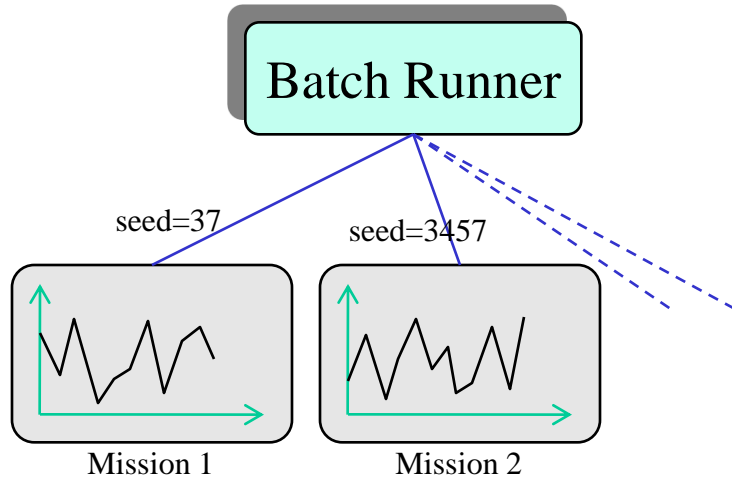


# Sampling Strategies

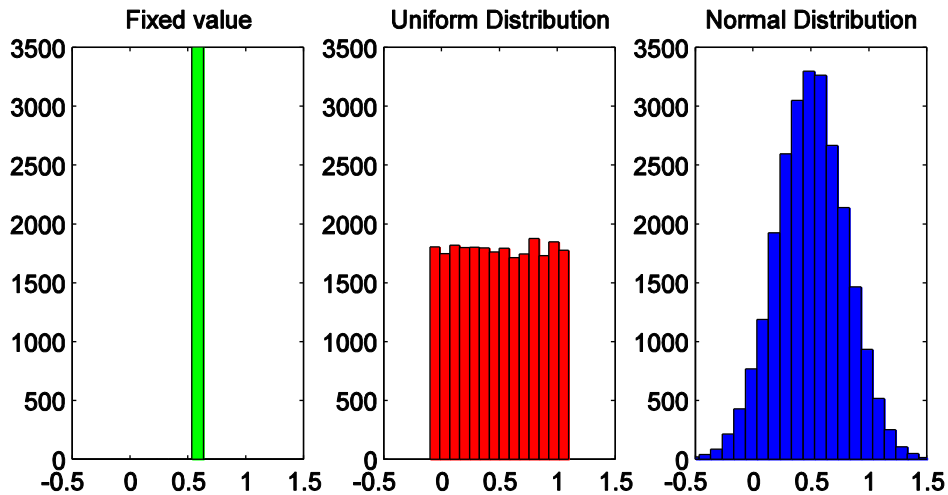
## Inter-mission



## Intra-mission



## Distributions





## *Results and Future Work*

---

### Results

- The tool was able to detect and identify two previously unknown bugs in T-REX
- Experiment – re-inserted 4 bugs in system, which had previously only shown up on sea trials
- Monte-Carlo system was able to detect 3 of the 4 bugs
- Indications that uniform distn works better than Normal

### Future work

- Enable the system to alter more simulation parameters
- More intelligent sampling techniques, e.g. random walk, model weakness testing, previous failures analysis
- Automated analysis of failures, grouping of related failures



## *Conclusions*

---

### Monte-Carlo System

- Good testing is vital for complex autonomous systems!
- Monte-Carlo based batch testing looks very promising
- The tool should be valuable for future T-REX development

### Relevance to my PhD work

- Especially useful experience for me, as my PhD topic is to develop intelligent software for AUVs
- My work at MBARI means
  - First-hand experience of observations and inputs to vehicle control software
  - Some software I wrote is actually running on an AUV!
  - Much more knowledgeable of the requirements and pitfalls of deploying AI software on an AUV