Human Brain Project

HBP CodeJam #10

University of Heidelberg

November 28, 2019

Co-funded by
he European Union

Axel von Arnim, Stefano Nardo

Knowledge Graph - Neurorobotics Platform Integration

A step forwards towards integrated HBP EBRAINS

Integrating physics and neural simulation

Embodiment is the key to artificial brain research

Towards more diverse embodiment scenarios

Knowledge Graph integration

Human Brain Project

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Integrating physics and neural simulation
Architecture

The hard way

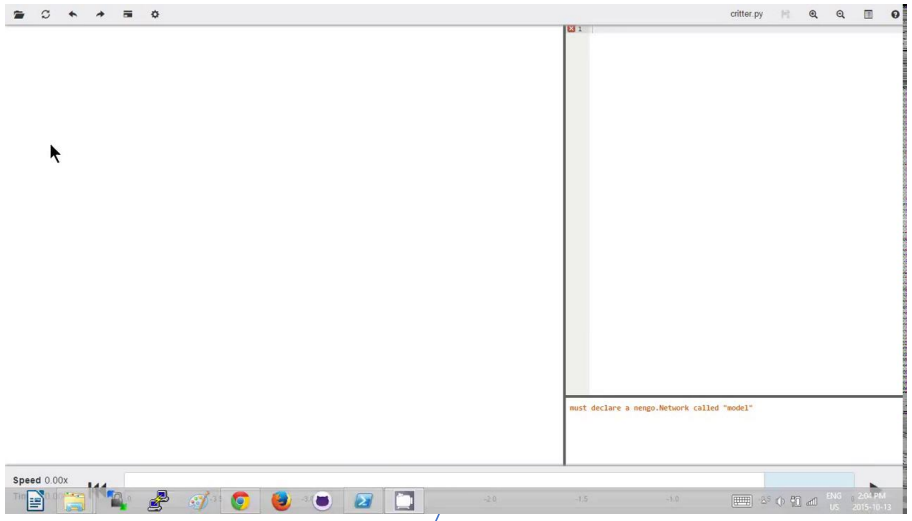
GAZEBO

OPEN DYNAMICS ENGINE™

BULLET PHYSICS LIBRARY

nest ::

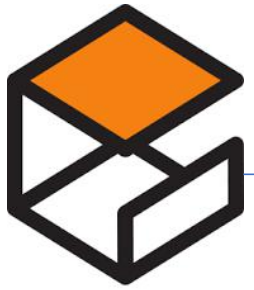
Nengo



ROS

YARP

The NRP way



ROS

Transfer functions

Closed-Loop Engine

Transfer functions

REST

ROS

Nengo

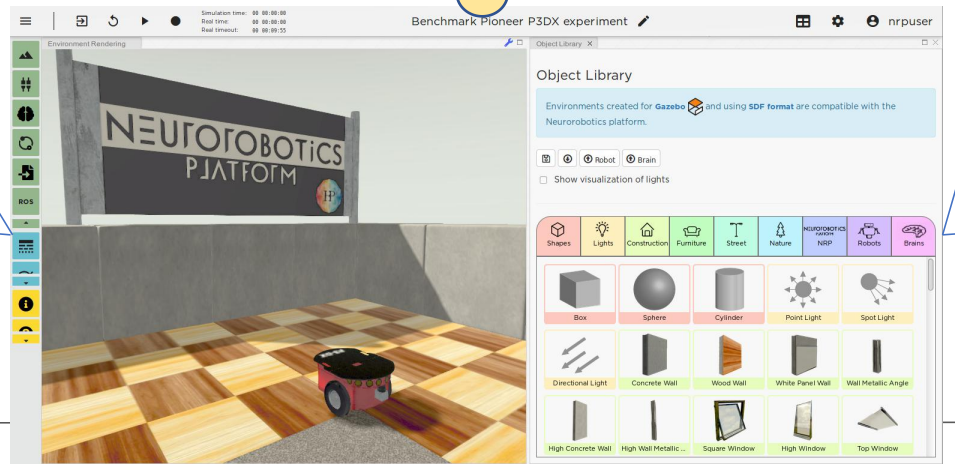
websocket

REST

websocket

Experiments and models library

REST

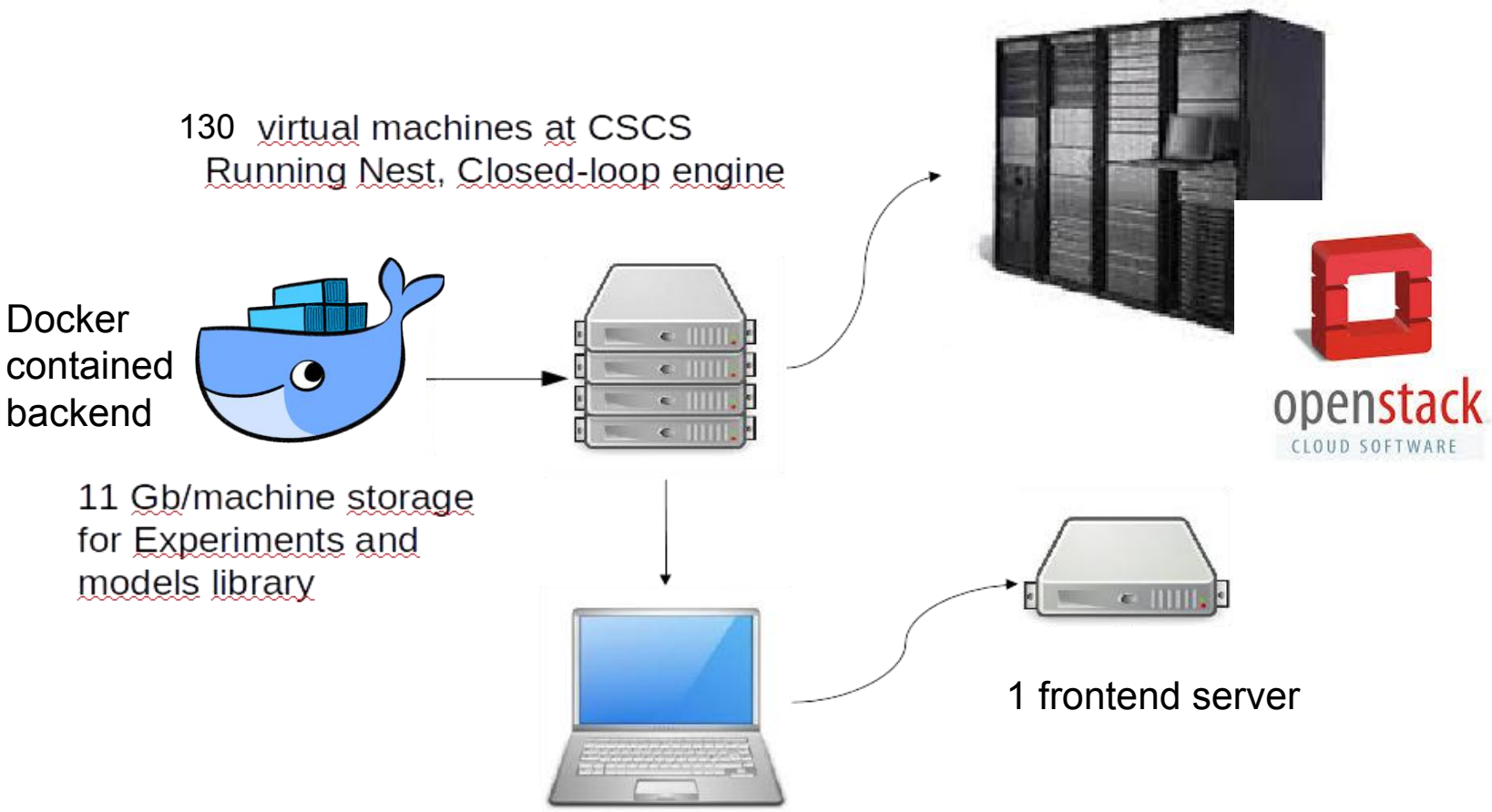


REST

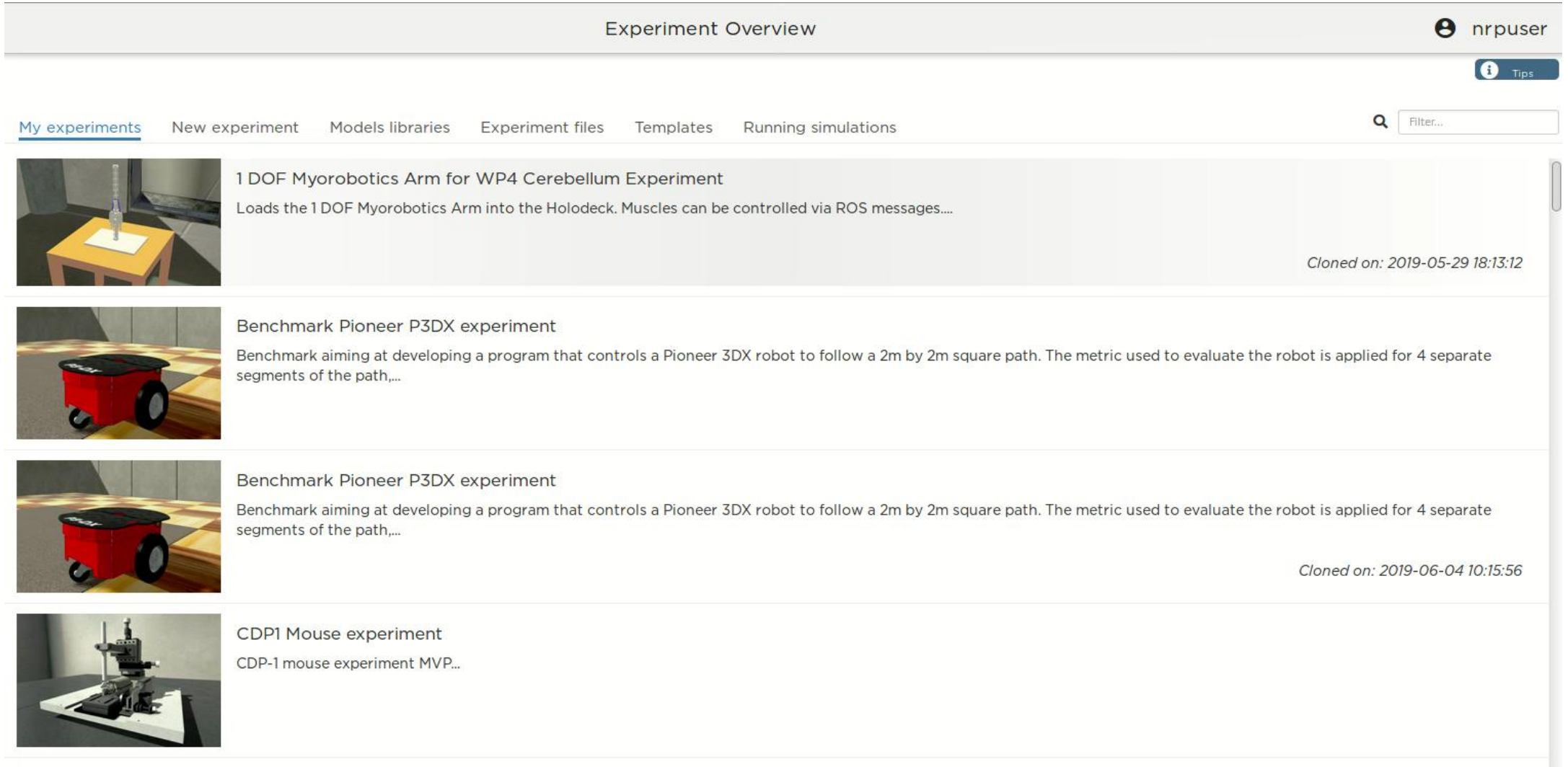
User storage

Installation

Infrastructure



Create an experiment from scratch



Embodiment: key to artificial brain research

A tool for neuroscientists and roboticists

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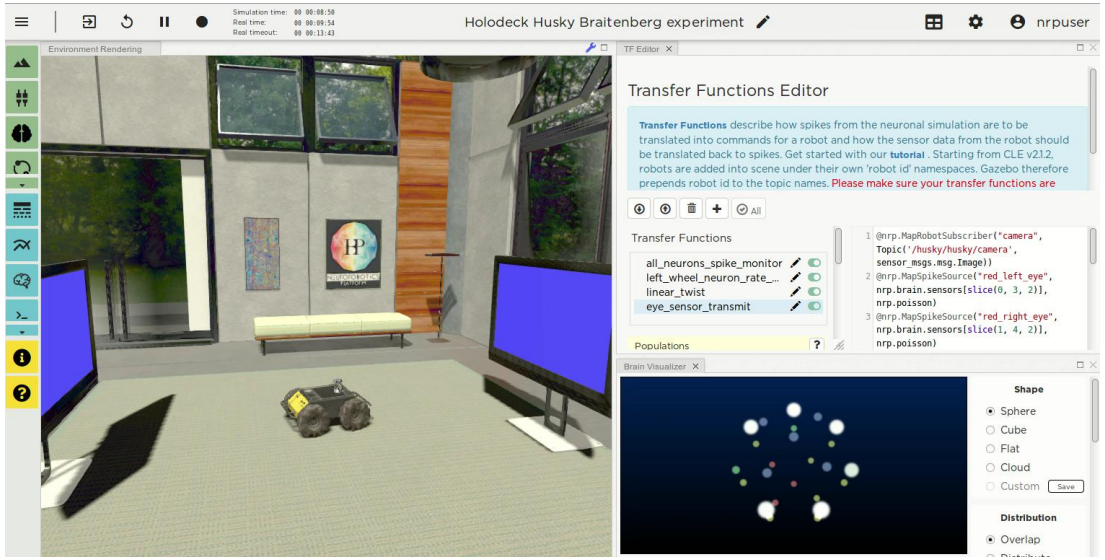
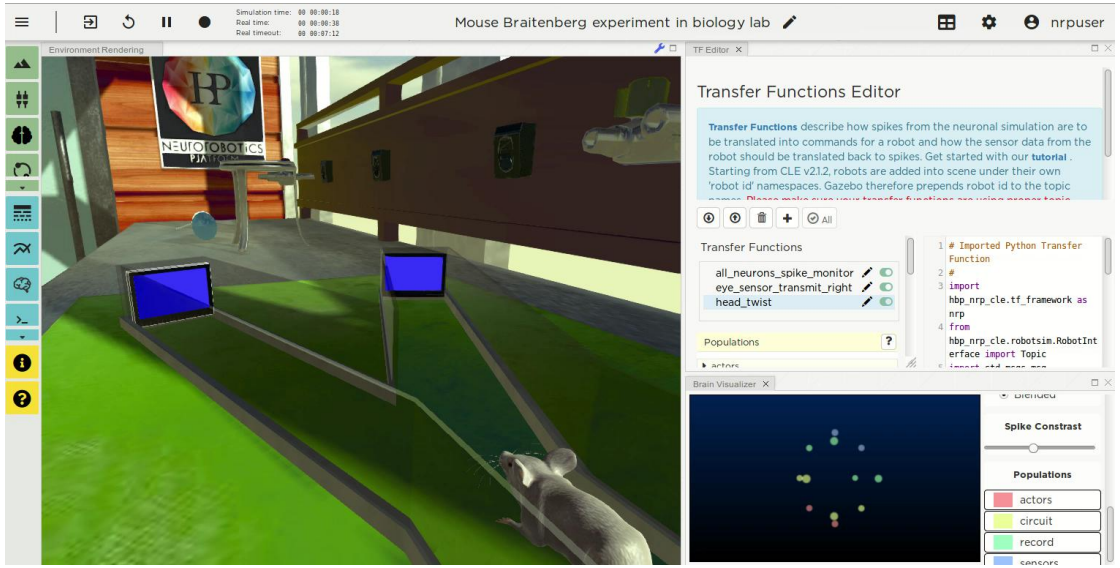
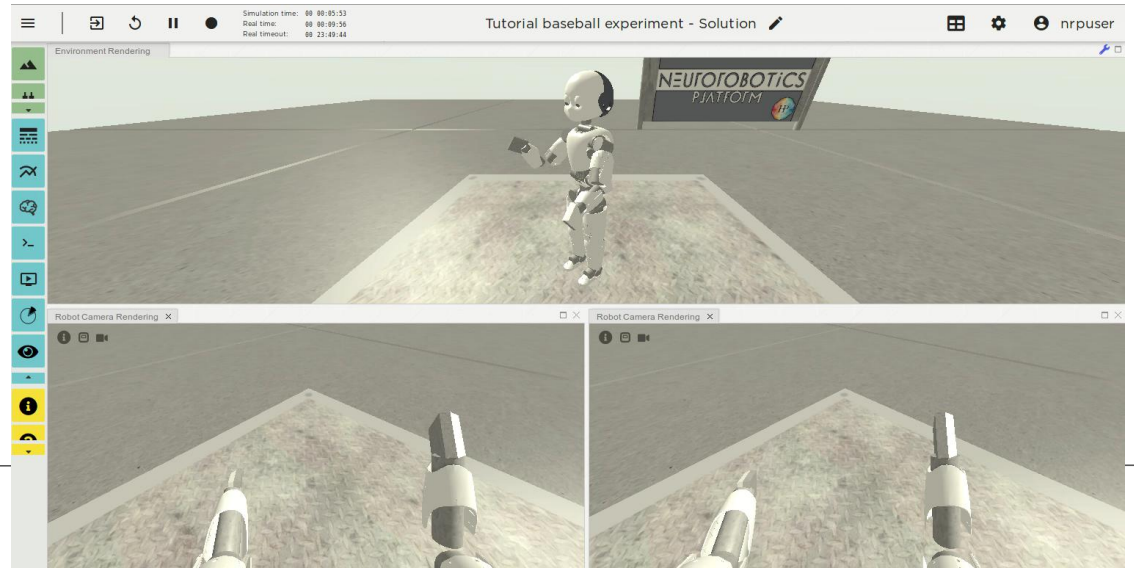
Neuroscientist's point of view

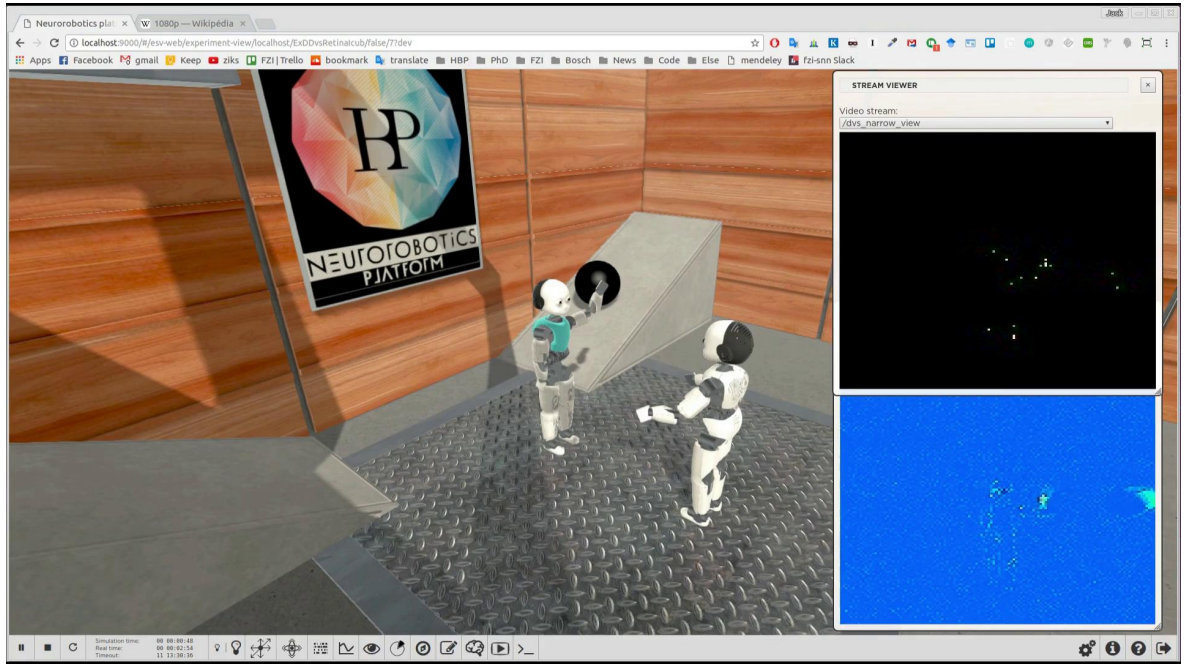


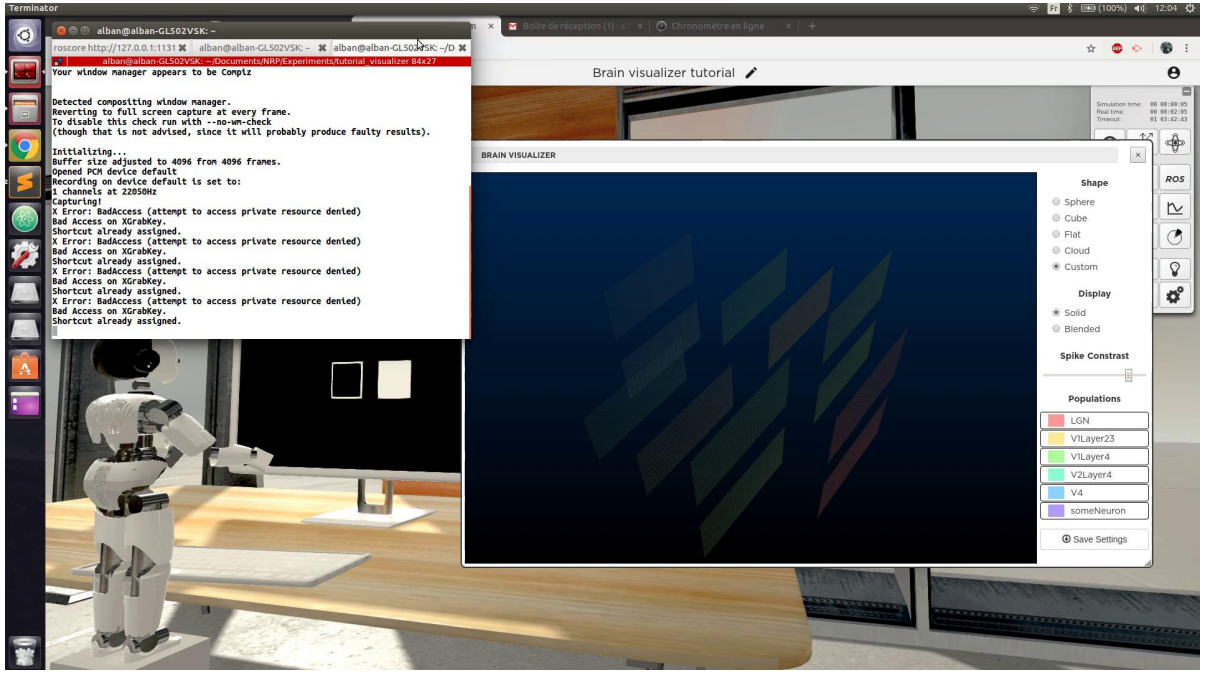


Test my neural network with different embodiments



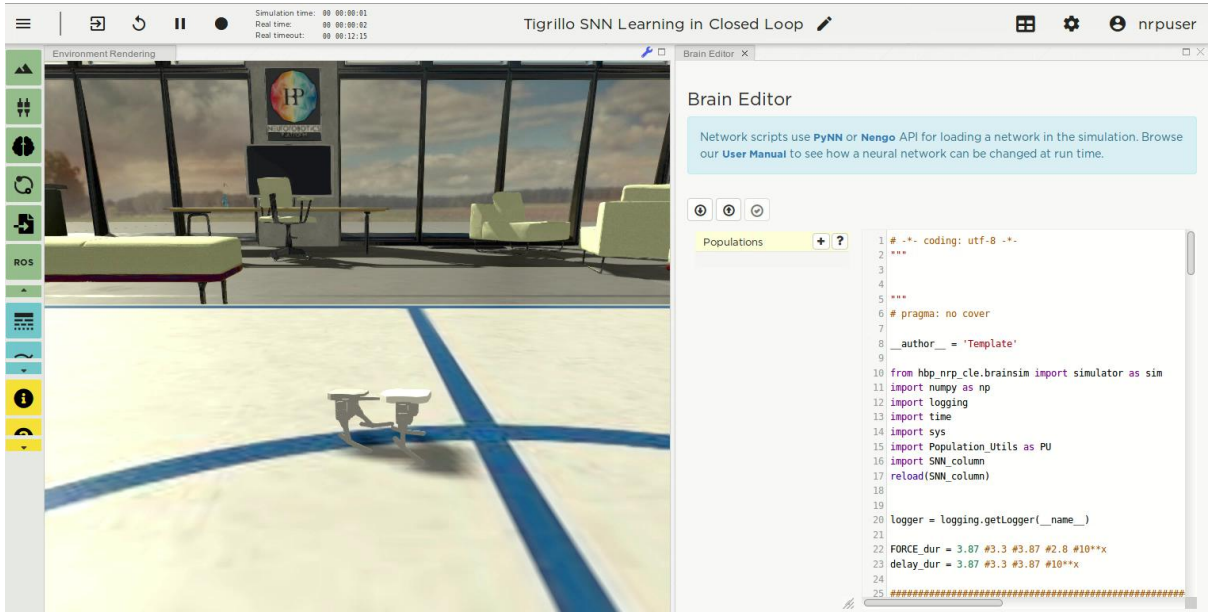
Neuroscientist's point of view





Test spiking vision systems

Neuroscientist's point of view



Test my neural network with muscles or compliant robots

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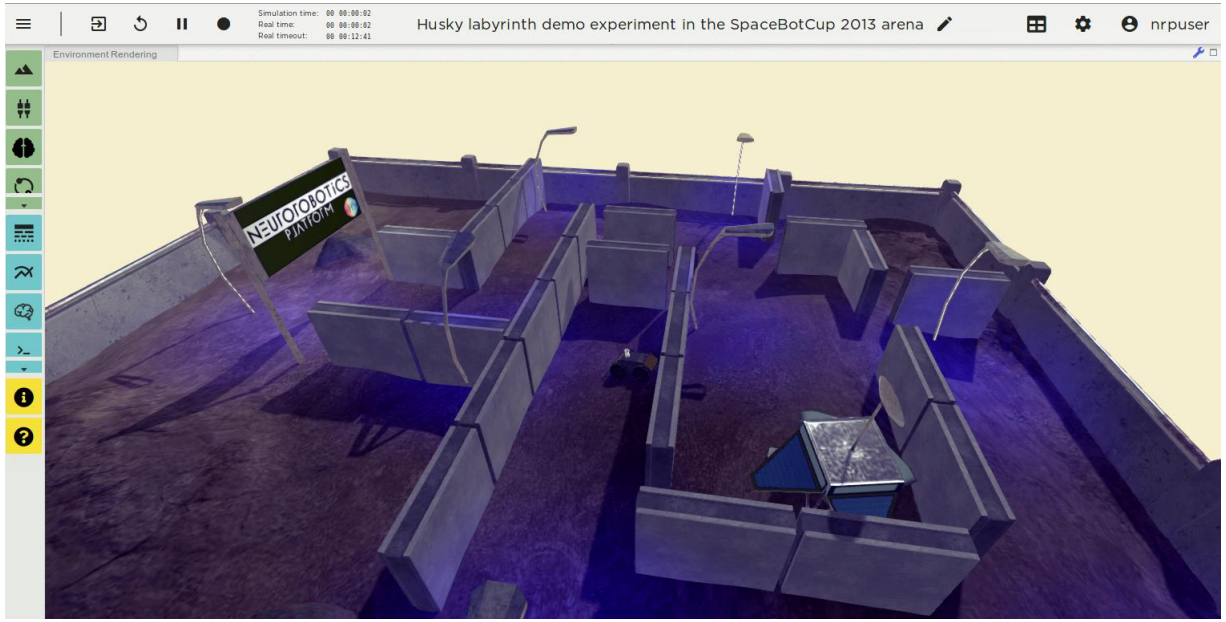
What about real time?



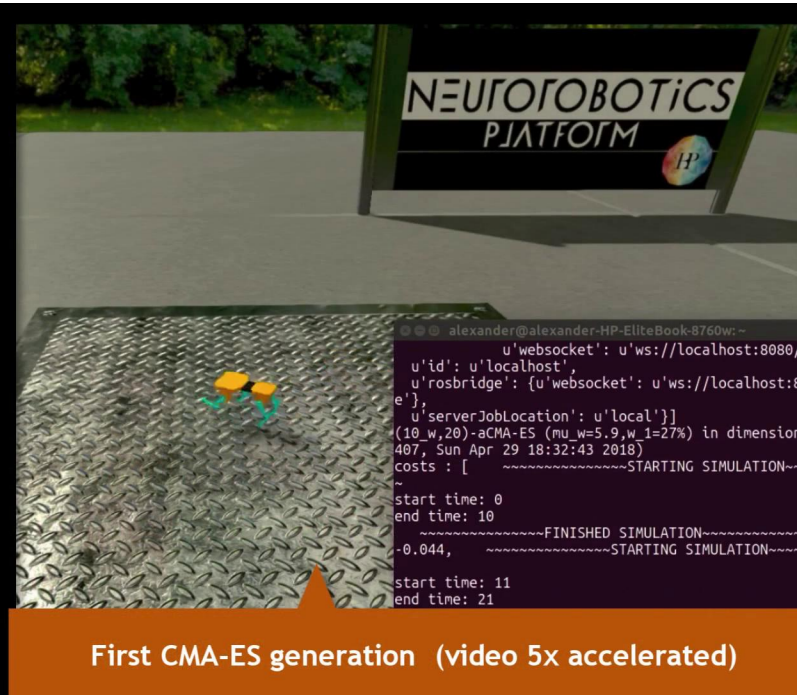
Record and replay

Log CSV data

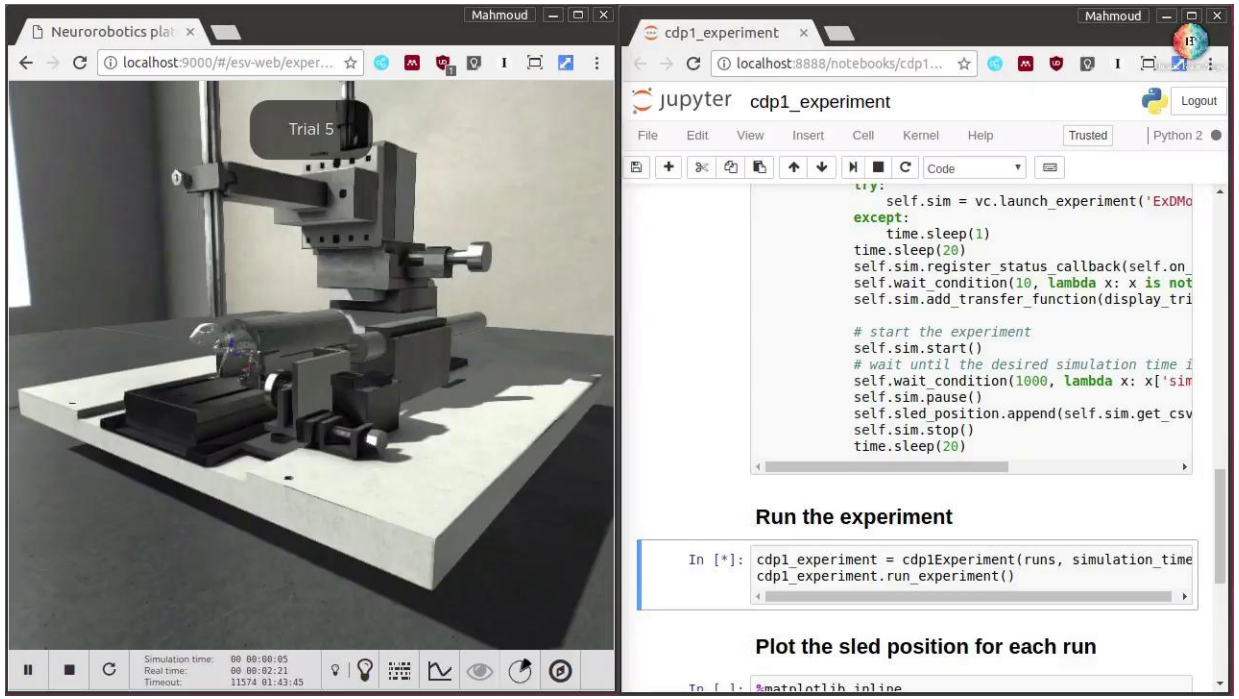
Roboticist's point of view

First,
we use CMA-ES in
the **NRP Virtual Coach**

to optimise
periodic open loop
actuation patterns

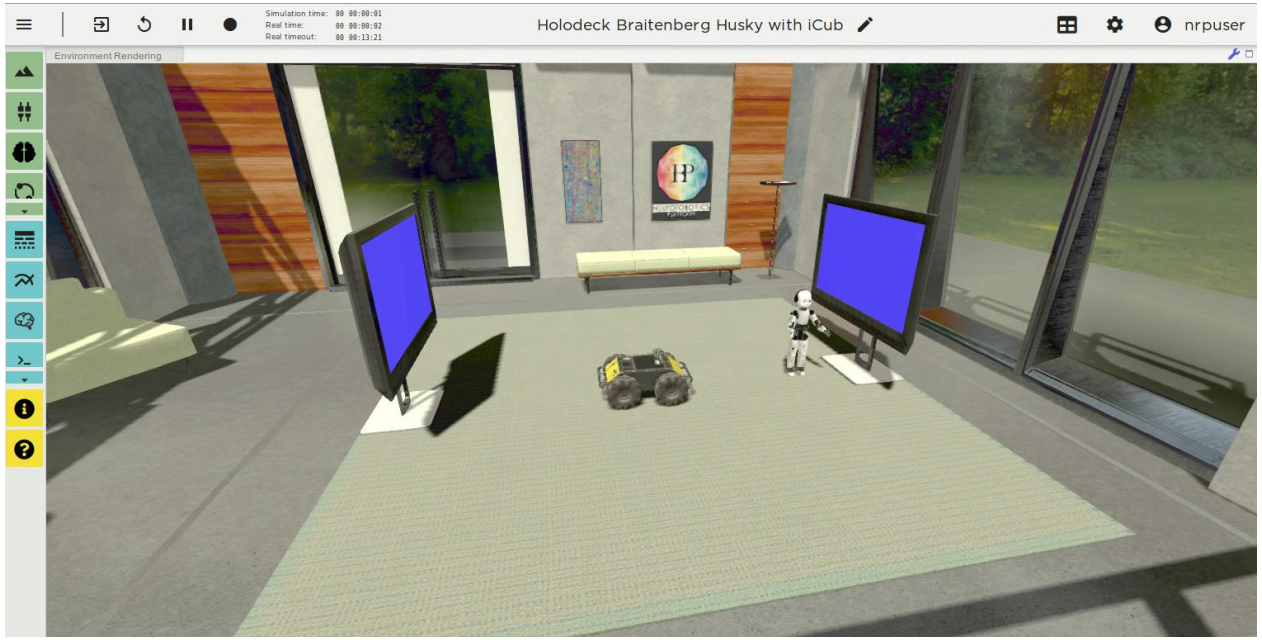


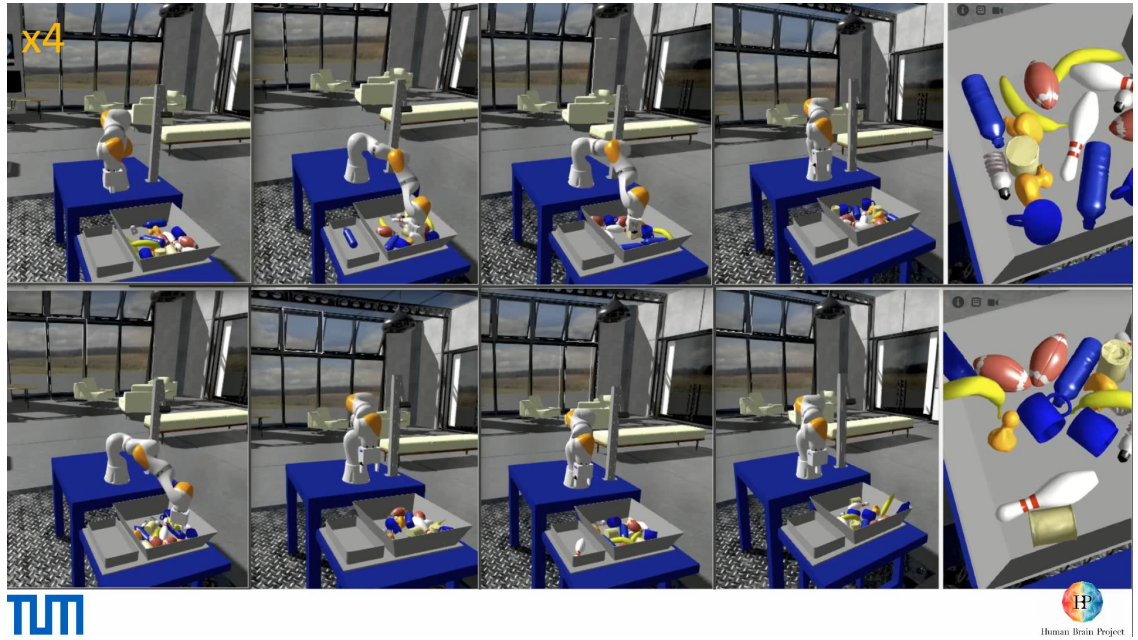
First CMA-ES generation (video 5x accelerated)



Learning and running on different simulators

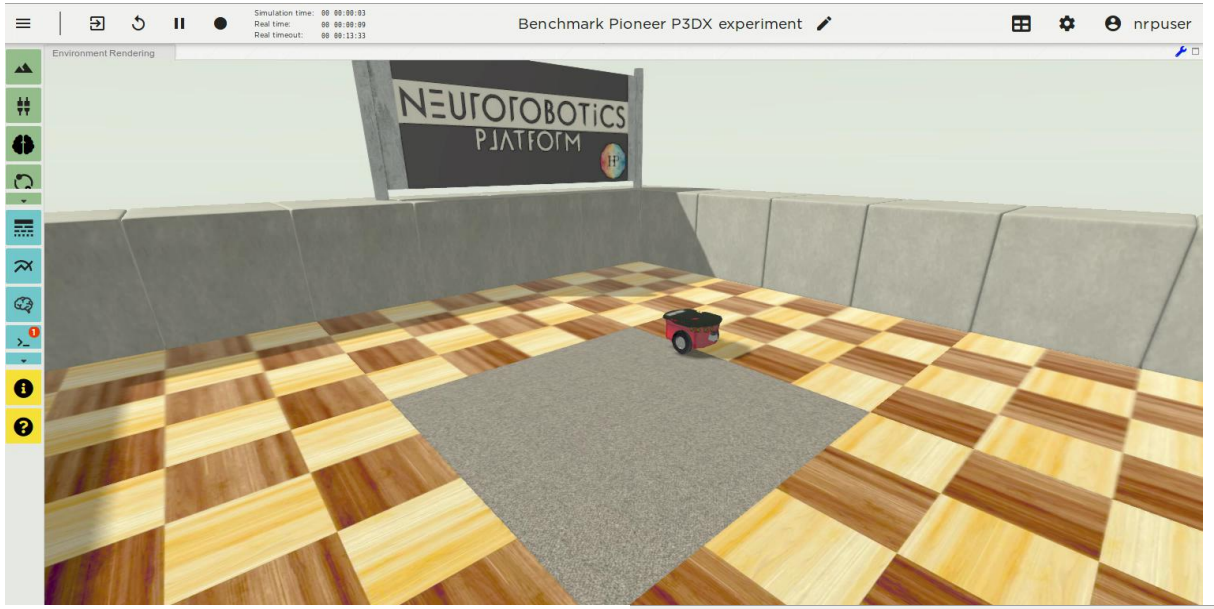
Roboticist's point of view

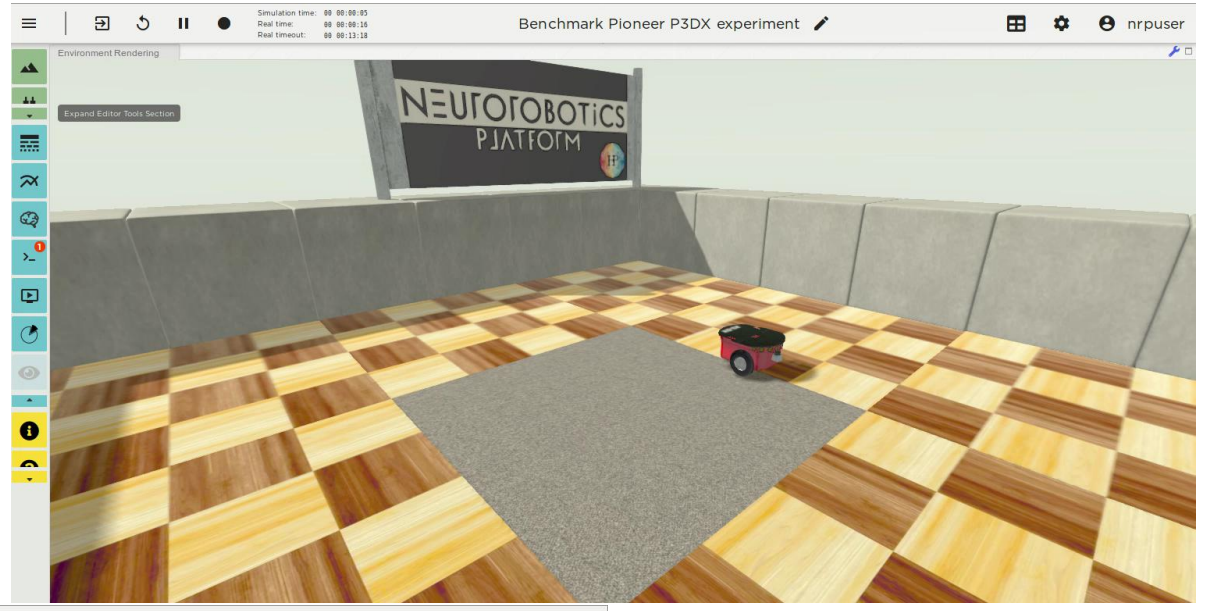




Test my neural network on multiple robots in the same experiment

Perturb the simulation





Towards diverse embodiment scenarios
The vision

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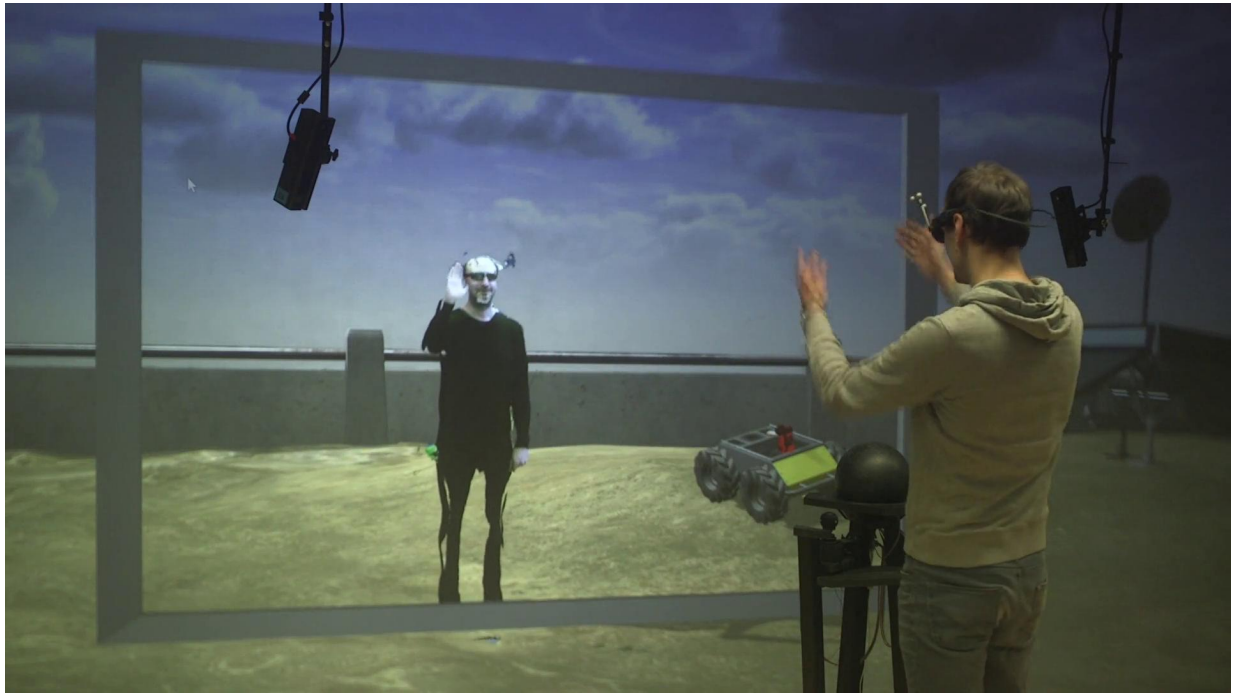
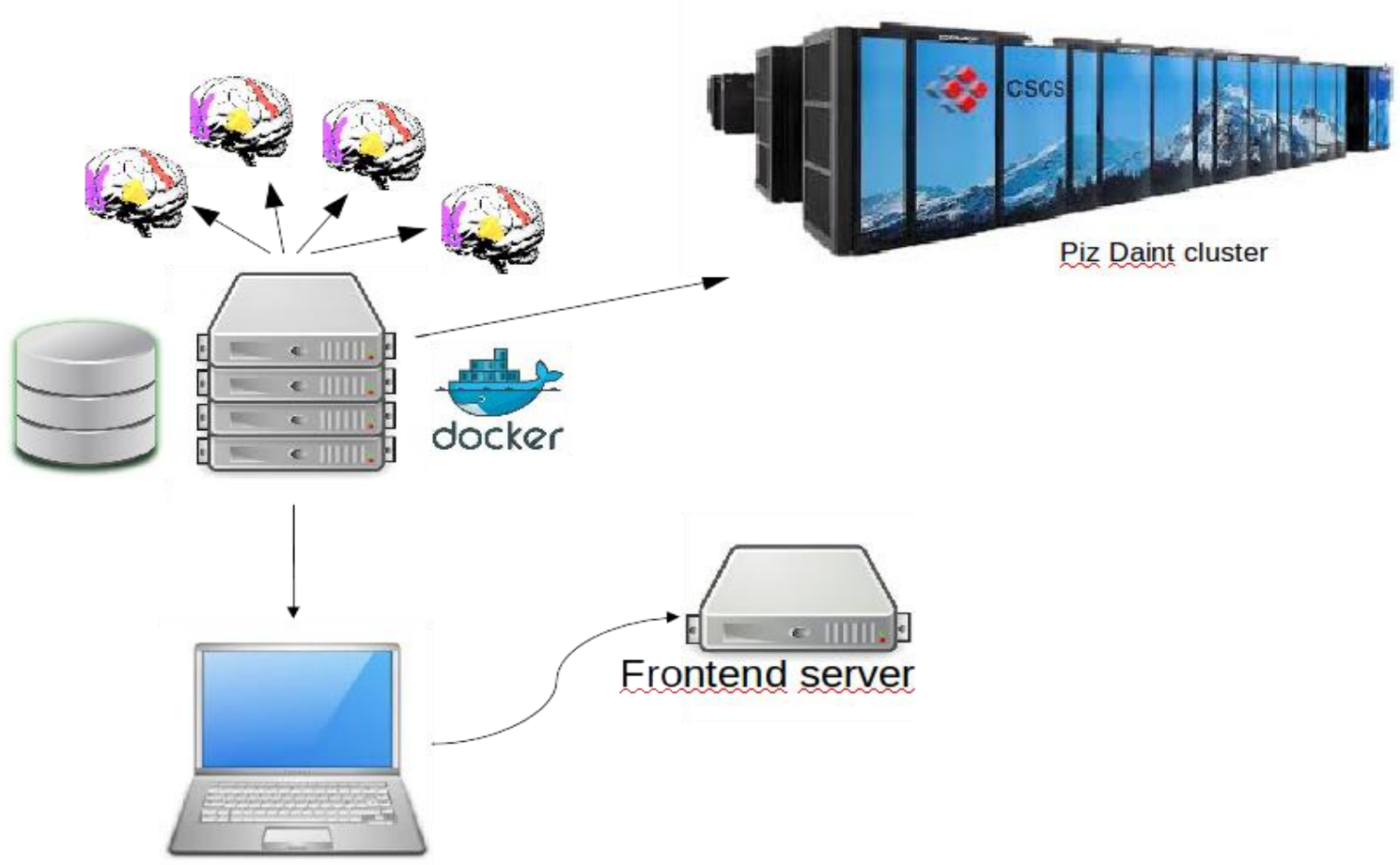
Human in the loop



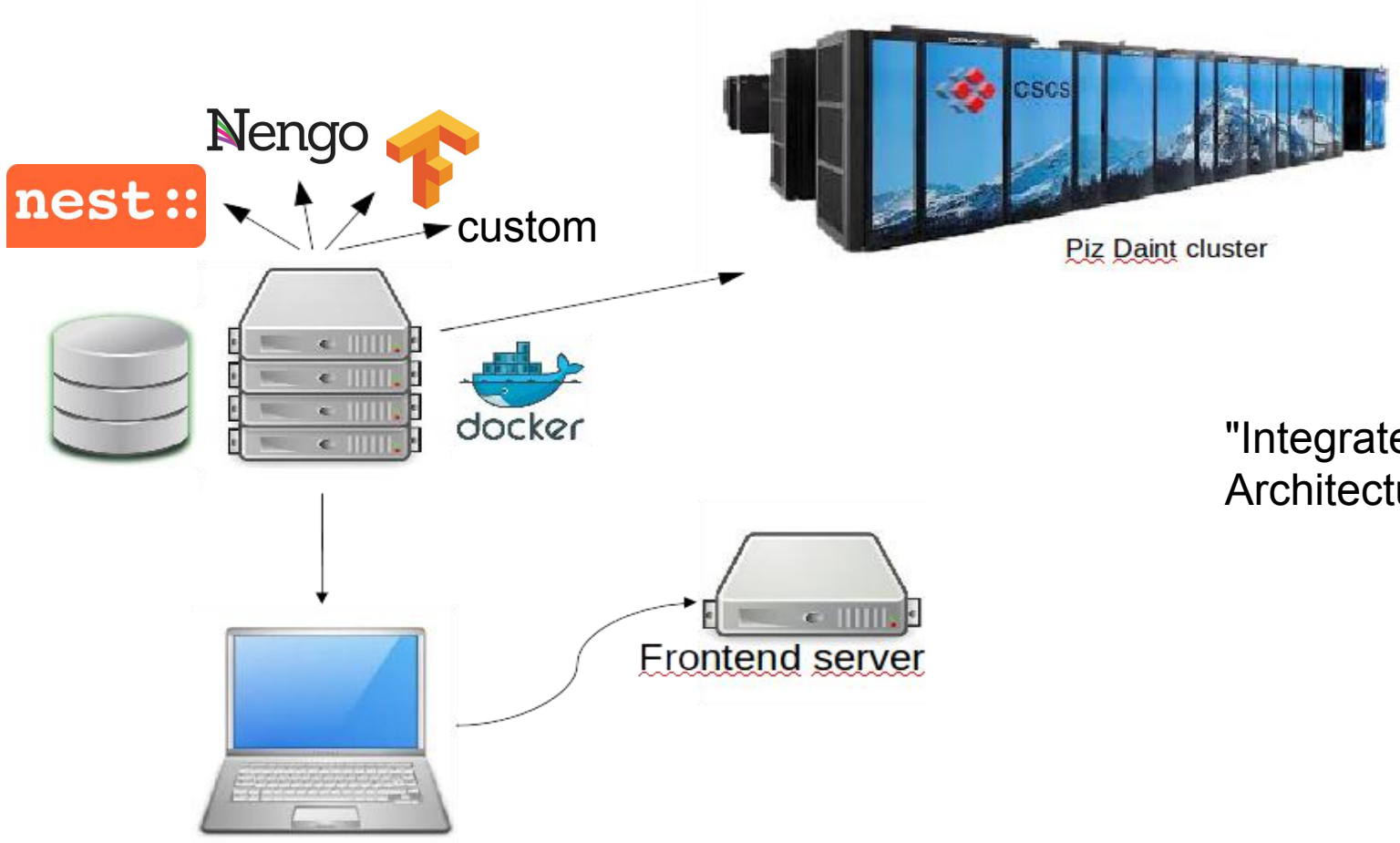
Particles simulation

Particles simulation for new behaviour use cases

Massive brain distribution

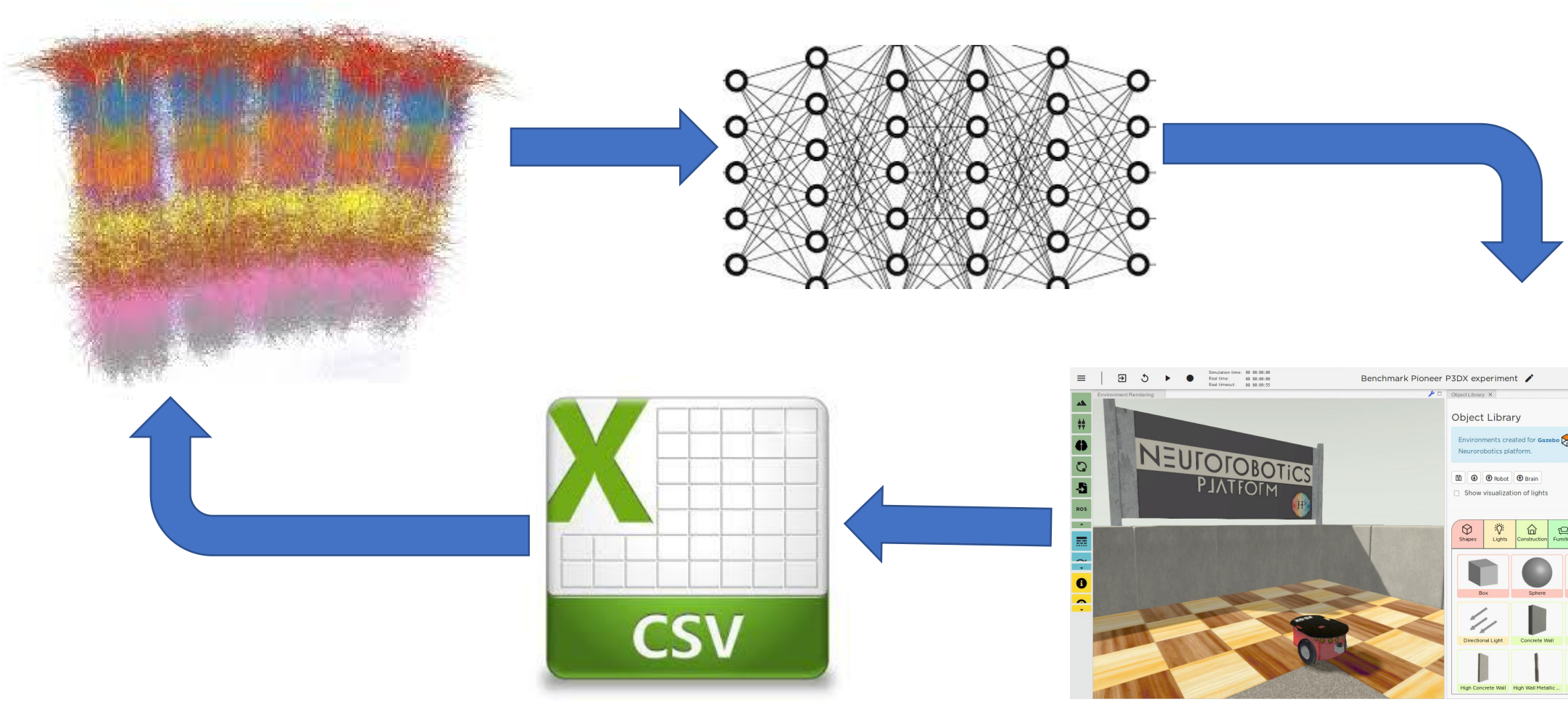


Run different brain types in parallel



"Integrated Behavioural Architecture"

From detailed brain model to robotic sim



Knowledge Graph - NRP
Integration and application

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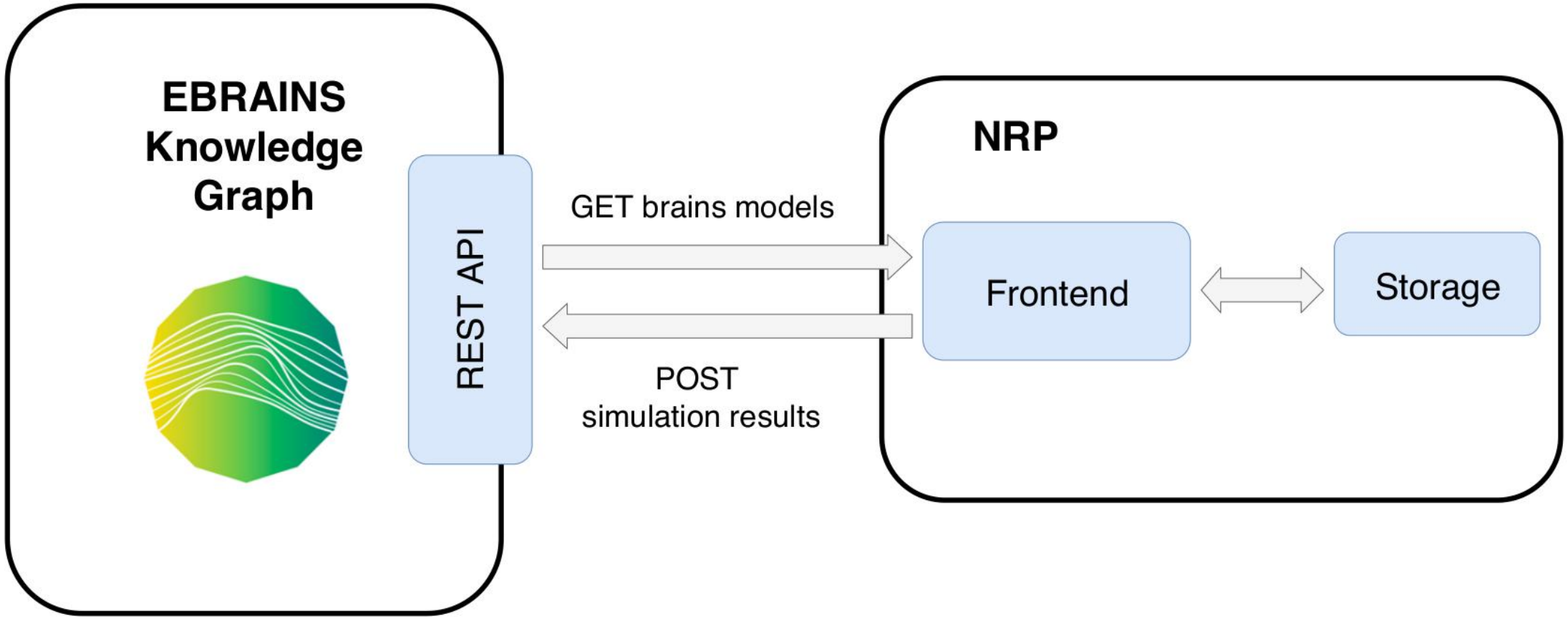
SGA2 work plan (SSSA - fortiss)

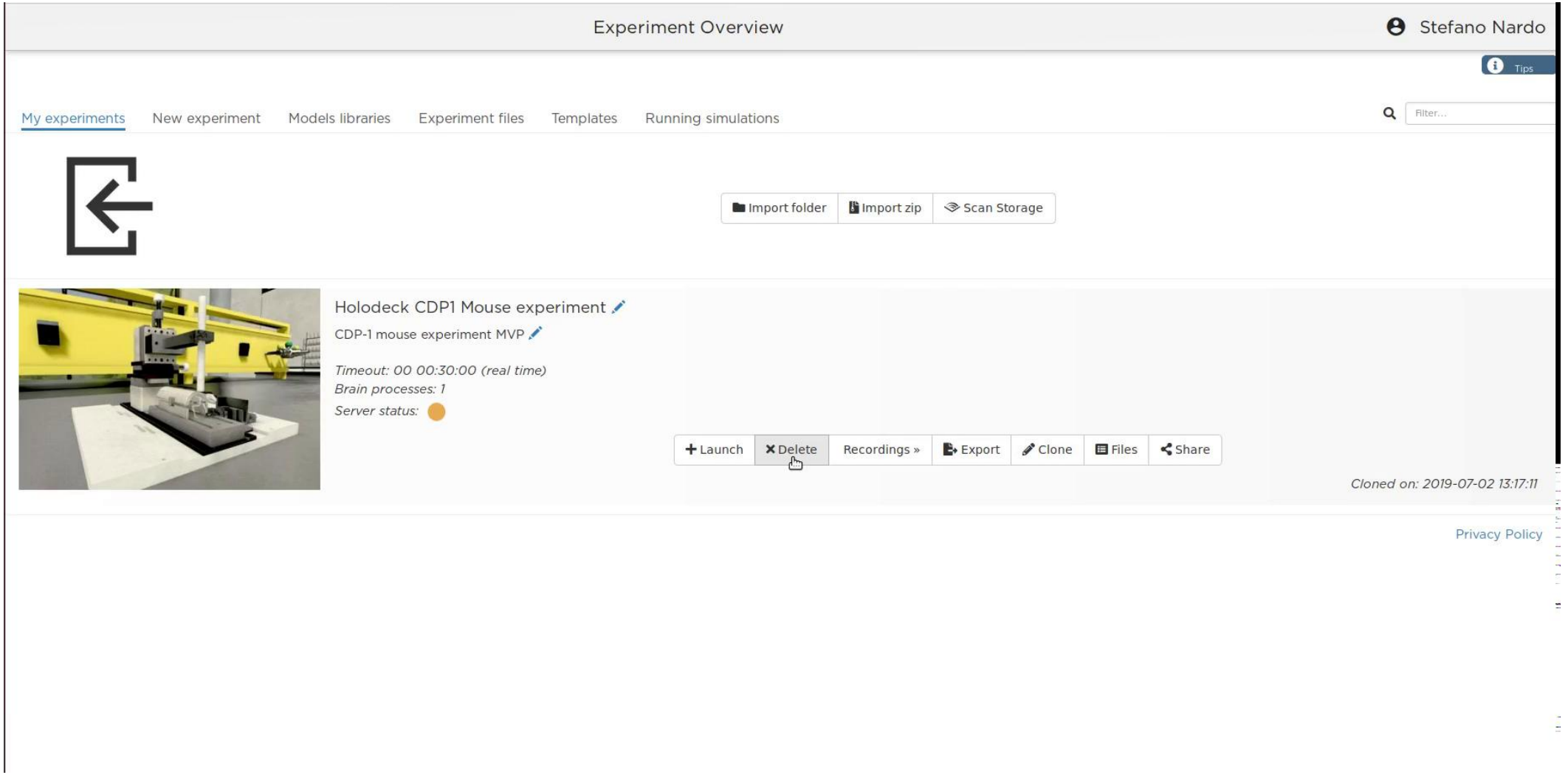
- SGA2 prototype
  - Add a category (schema) in the Knowledge Graph for our currently used brain format (PointNeuronModel)
  - Get brain model instances from KG and download them from public URL
  - Run neurorobotics simulation and upload results (logs) into the KG
    - link to a public location
    - add schemas for every logs type

- Application on SP6 Cerebellum (Prof. Egidio D'Angelo, UPavia)
  - A simplified cerebellum (30k neurons) model in Sonata format loaded in the NRP from the Knowledge Graph
  - No real neurorobotics experiment in SGA2, just loading
  - SGA3 -> full use case with NRP experiment and closed loop with the KG

Integration architecture



Knowledge Graph - NRP Demo



The development team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