Workshop EBRAINS

A Platform for Collaboration in Digital Neuroscience

CDTI – Madrid, Spain
12 November 2019

Demo session IV: Presentation of the Brain Simulation Platform

Luca Leonardo Bologna

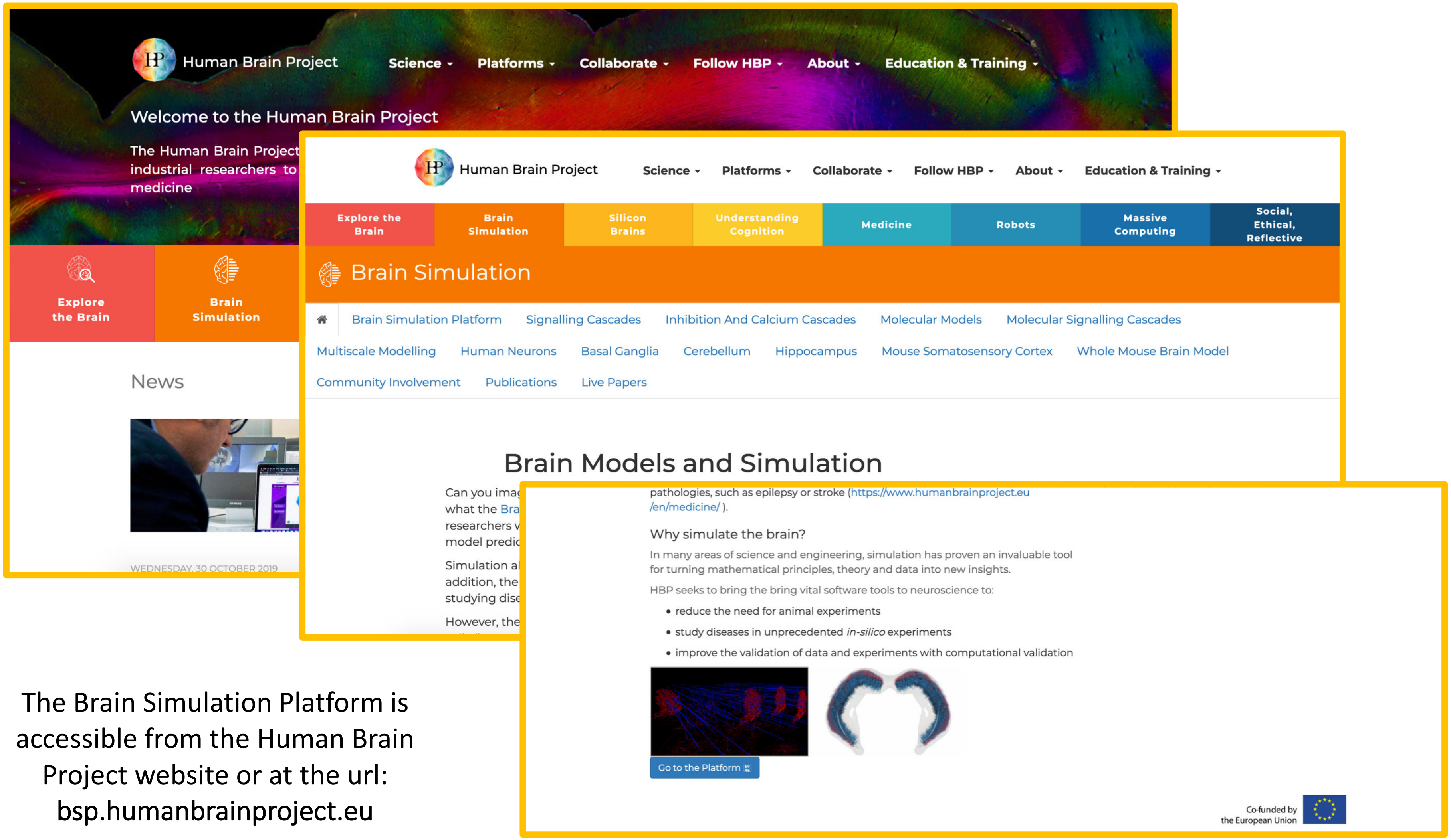
CNR Institute of Biophysics

lucaleonardo.bologna@cnr.it

Human Brain Project FET FLAGSHIPS

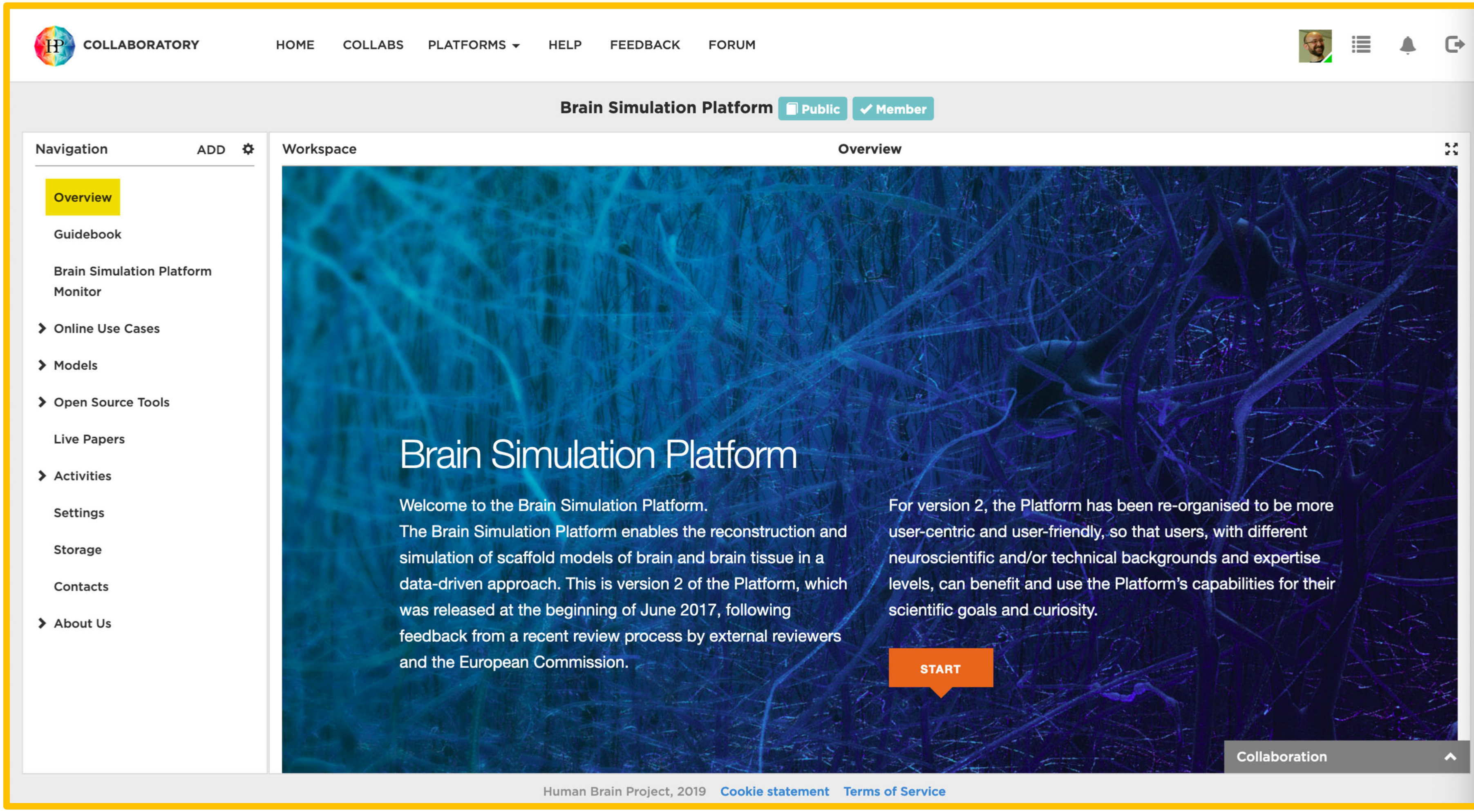
Co-funded by the European Union

BSP Access



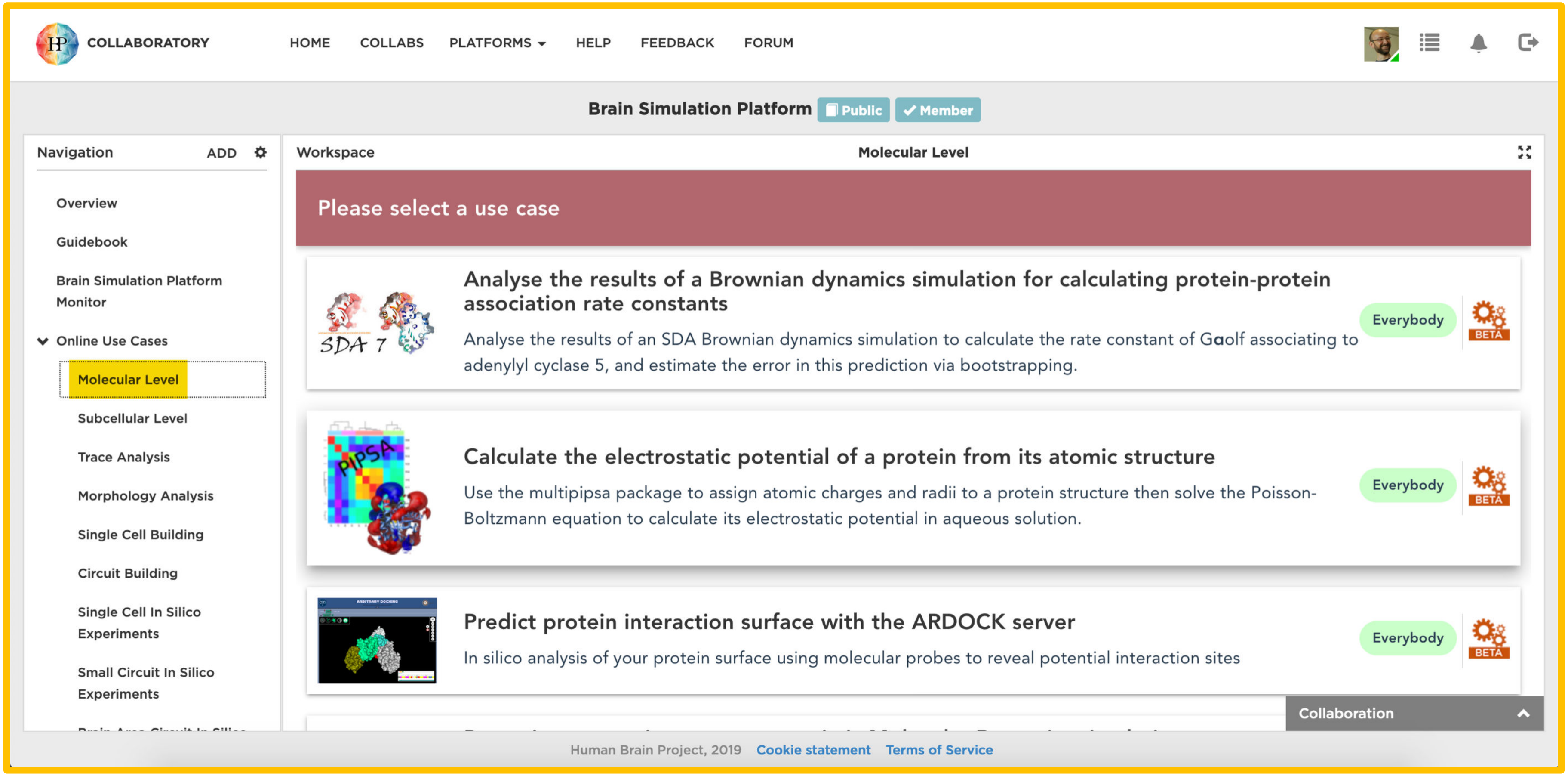
The Brain Simulation Platform is accessible from the Human Brain Project website or at the url: bsp.humanbrainproject.eu

BSP Items



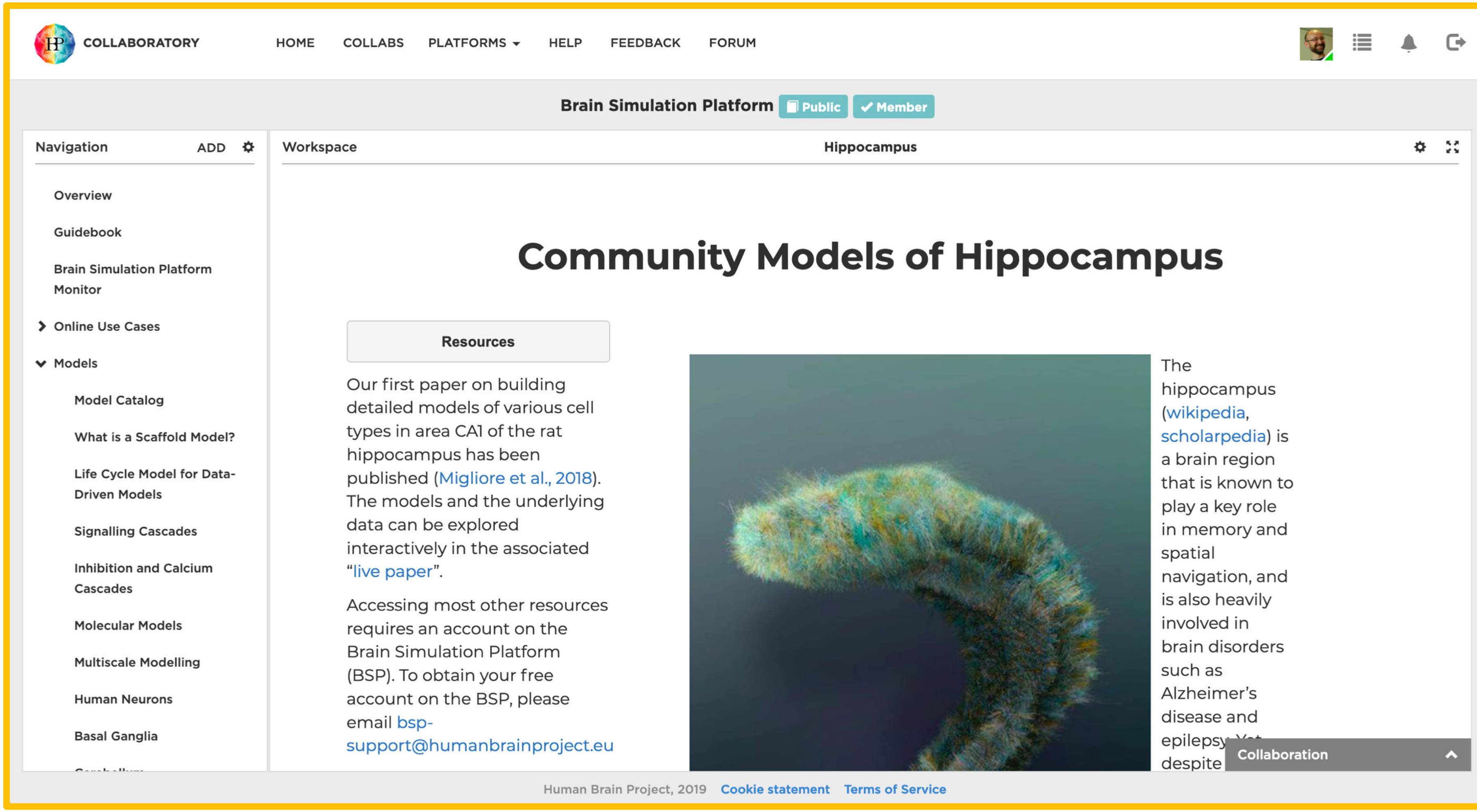
The Brain Simulation Platform can be explored through the left menu.
The core of the BSP are the Online Use Cases.

BSP Online Use Cases



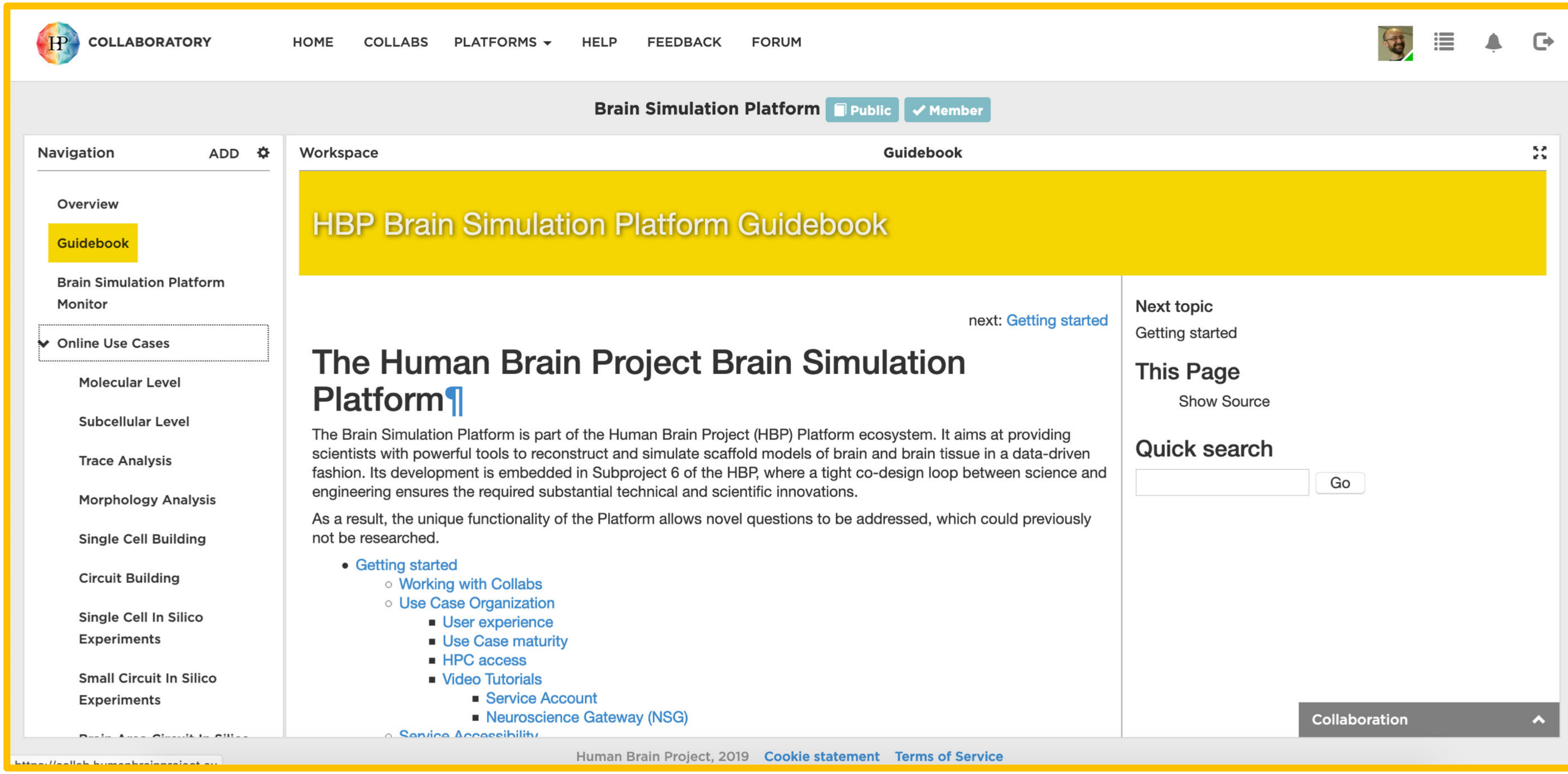
Online Use Cases are grouped by topics that span different scales of observation
(e.g. Molecular Level, Subcellular Level, Single Cells, …, Brain Regions)

BSP Models



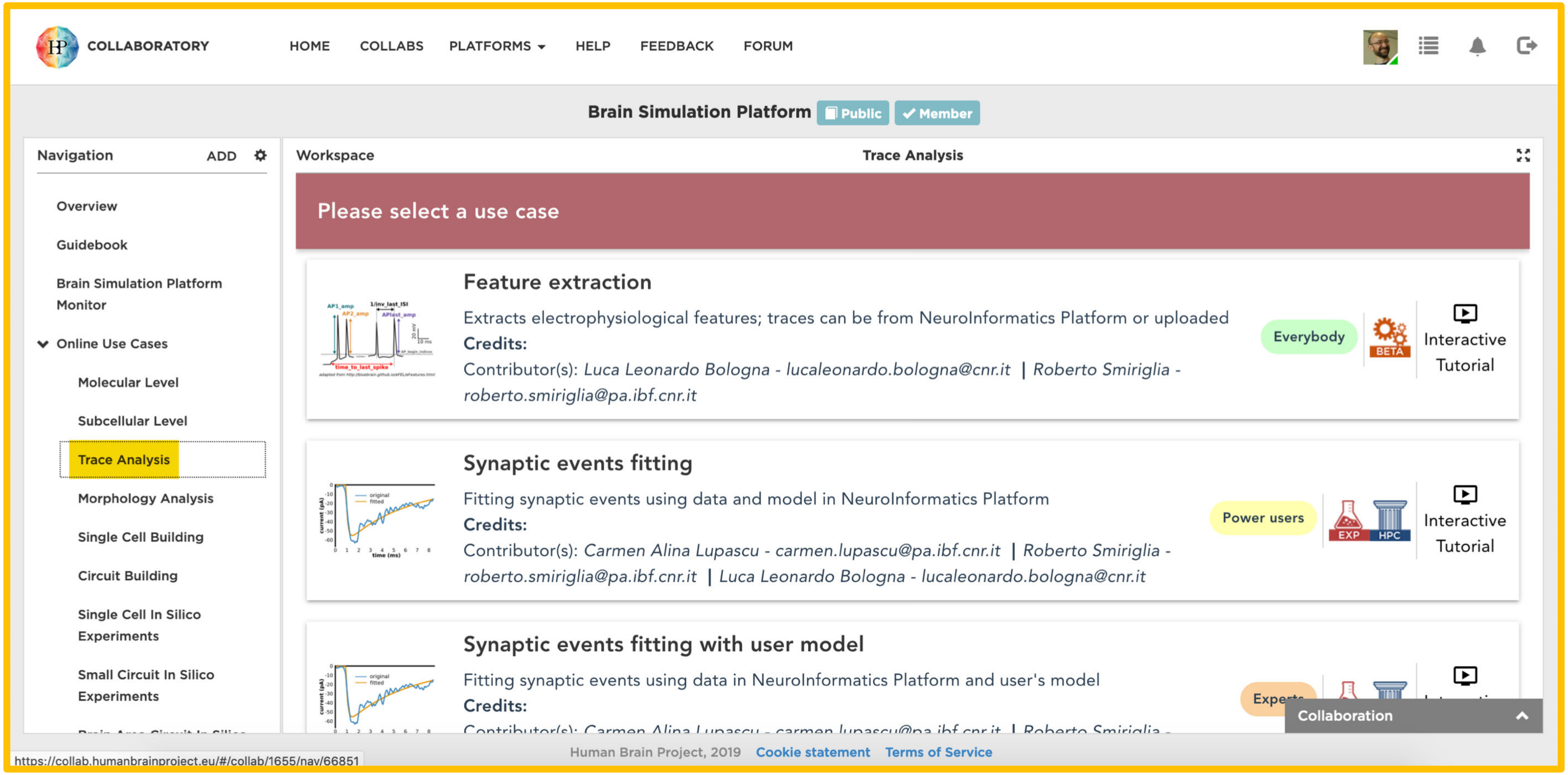
The Models pages contain general information on the approach followed for the BSP modeling work and on the brain regions being modeled with useful links to publications and resources

BSP Guidebook



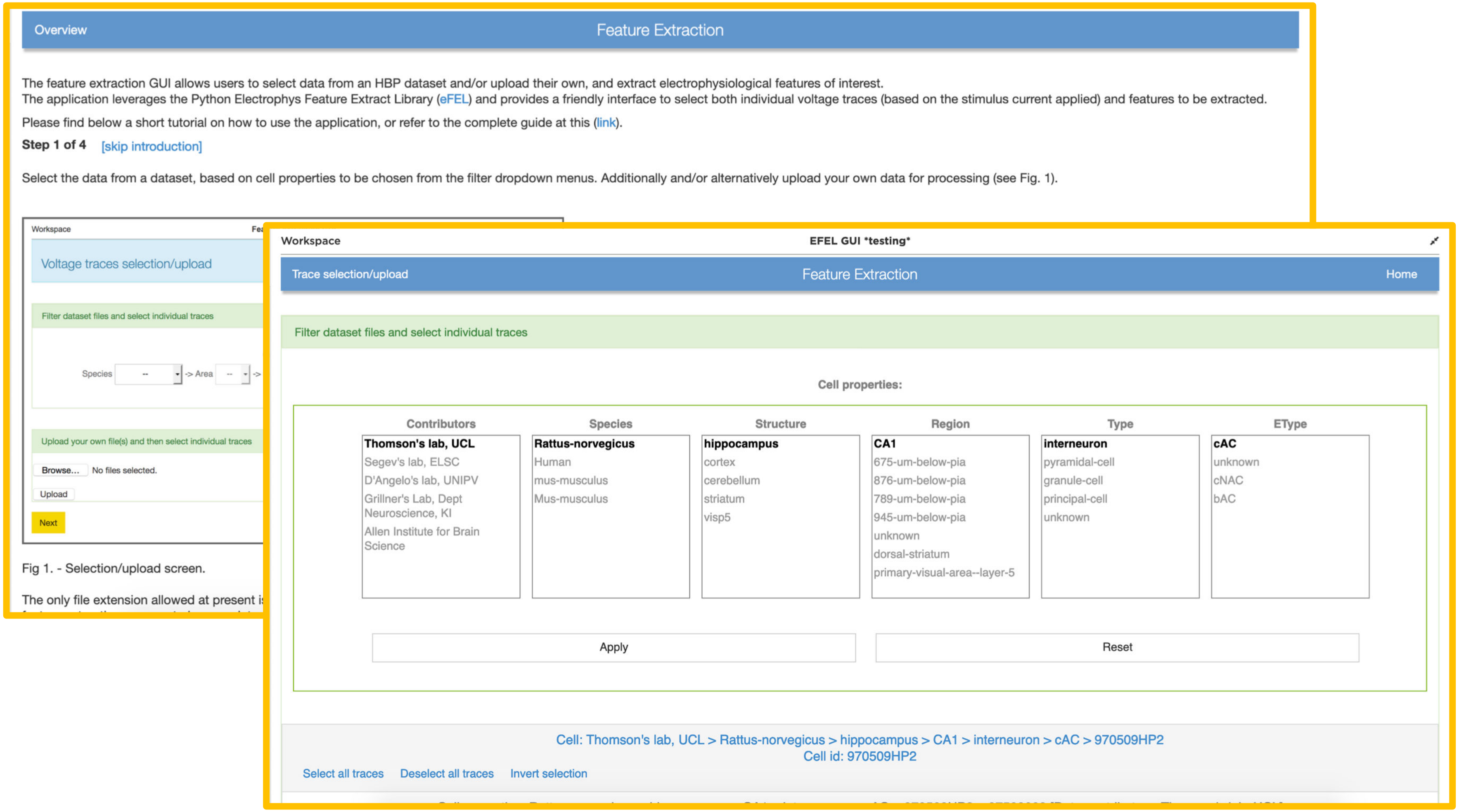
The BSP Guidebook contains detailed information on how the BSP is structured and how to use the BSP Use Cases

BSP Online Use Cases - implementation



Use Cases are mainly developed as either full-stack (or frontend) web applications or Python Jupyter Notebooks

BSP Feature Extraction Use Case



Example: Feature Extraction Use Case implemented as a full-stack web application
(i.e. point-and-click friendly interface)

BSP Rebuild a Single Cell Model Use Case - code

File Edit View Insert Cell Kernel Widgets Help Not Trusted Python 2

Markdown

Using this notebook

- You have to execute this notebook by running each cell consecutively.
- To retain any changes made, you need to save the notebook.

For detailed information about the notebook interface see *Help -> User Interface Tour* in the menu, and the Guidebook for working with Collabs.

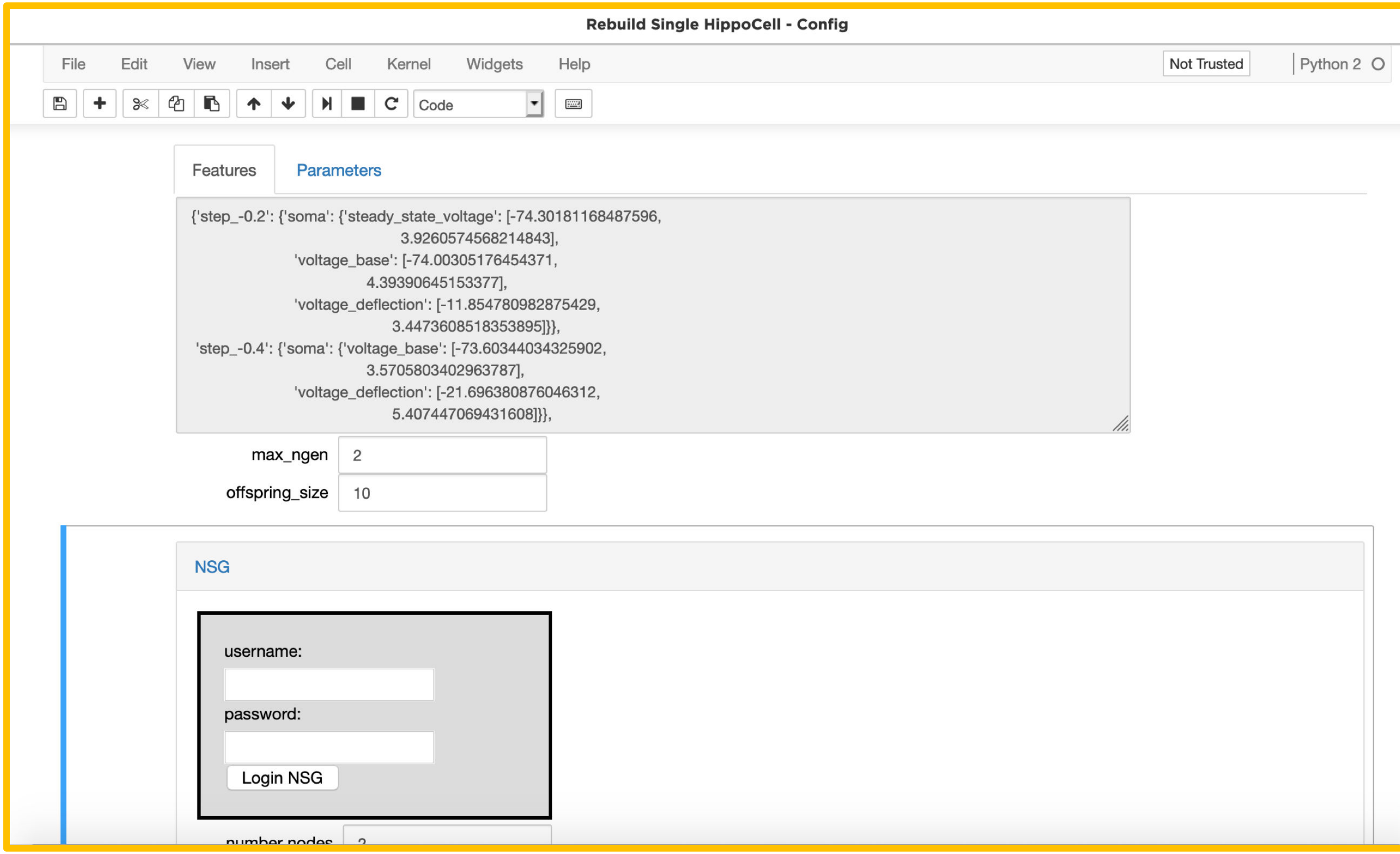
In [1]:
```
!pip install -q -i https://bbpteam.epfl.ch/repository/devpi/simple notebook-version-check
notebook_id = '6266b5d3f91be2897aadc522db7f7718b825f7bb'
notebook_url = 'https://api.github.com/repos/antonelepfl/usecases/contents/production_notebooks/singlecellmodeling/Rebu
from notebookchecklib.nbversioncheck import NBVersionCheck
check = NBVersionCheck(notebook_id, notebook_url, get_hbp_service_client(), get_collab_storage_path())
check.check()
```

In [ ]:
```
from IPython.display import HTML

HTML('''<script>
code_show=true;
$('.widget-area .prompt .close').hide()
function code_toggle() {
 if (code_show){
 $('div.input').hide();
 } else {
 $('div.input').show();
 }
 code_show = !code_show
}
$( document ).ready(code_toggle);
</script>
<form action="javascript:code_toggle()">
<input type="submit" value="Click here to toggle on/off the raw code."></form>''')
```

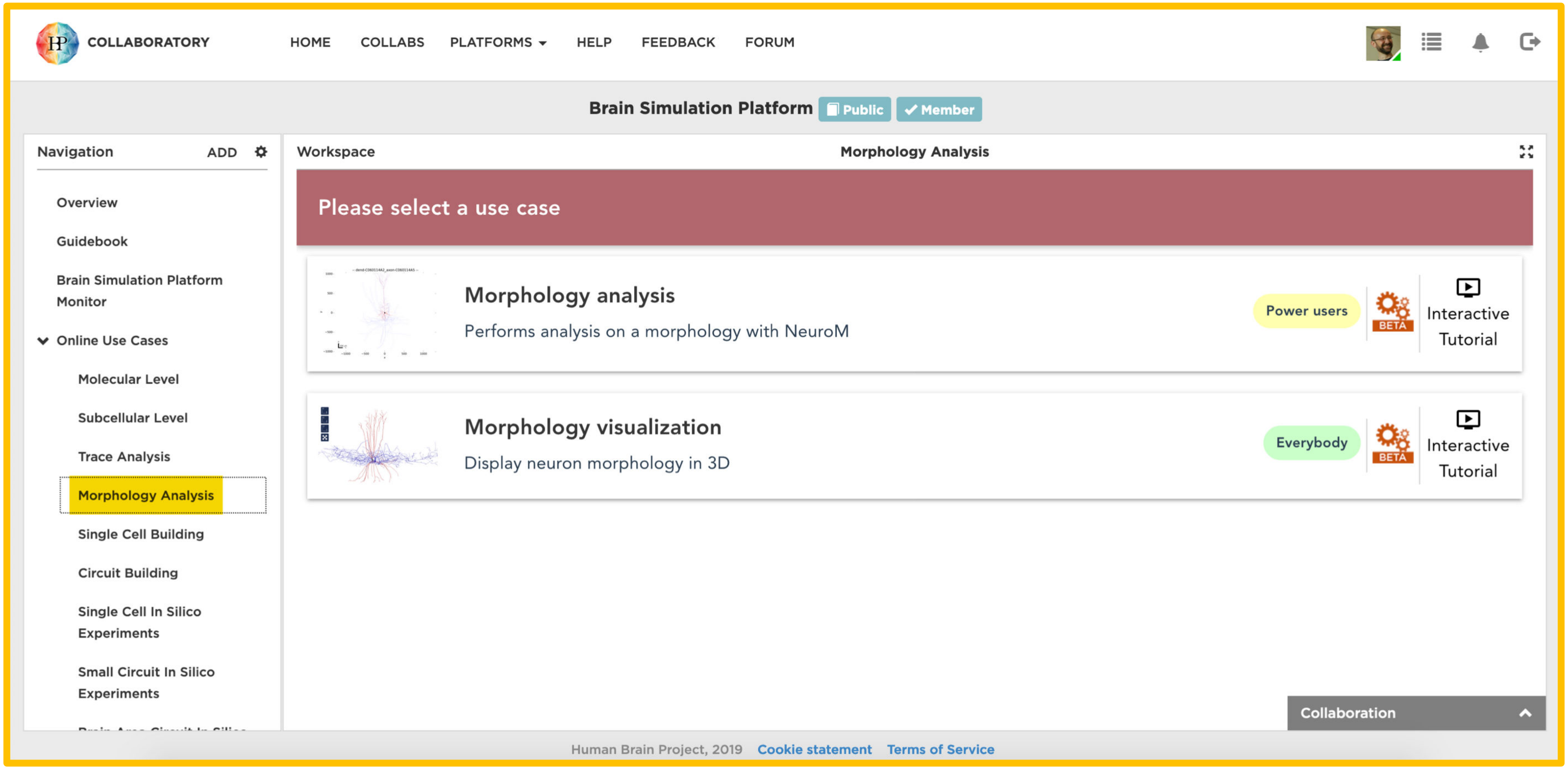
Example: Rebuild a Single Cell Hippocampal Model Use Case implemented as a python Jupyter Notebook
The python code is entirely available to the user who can modify it following her/his needs

BSP Rebuild a Single Cell Model Use Case - GUI



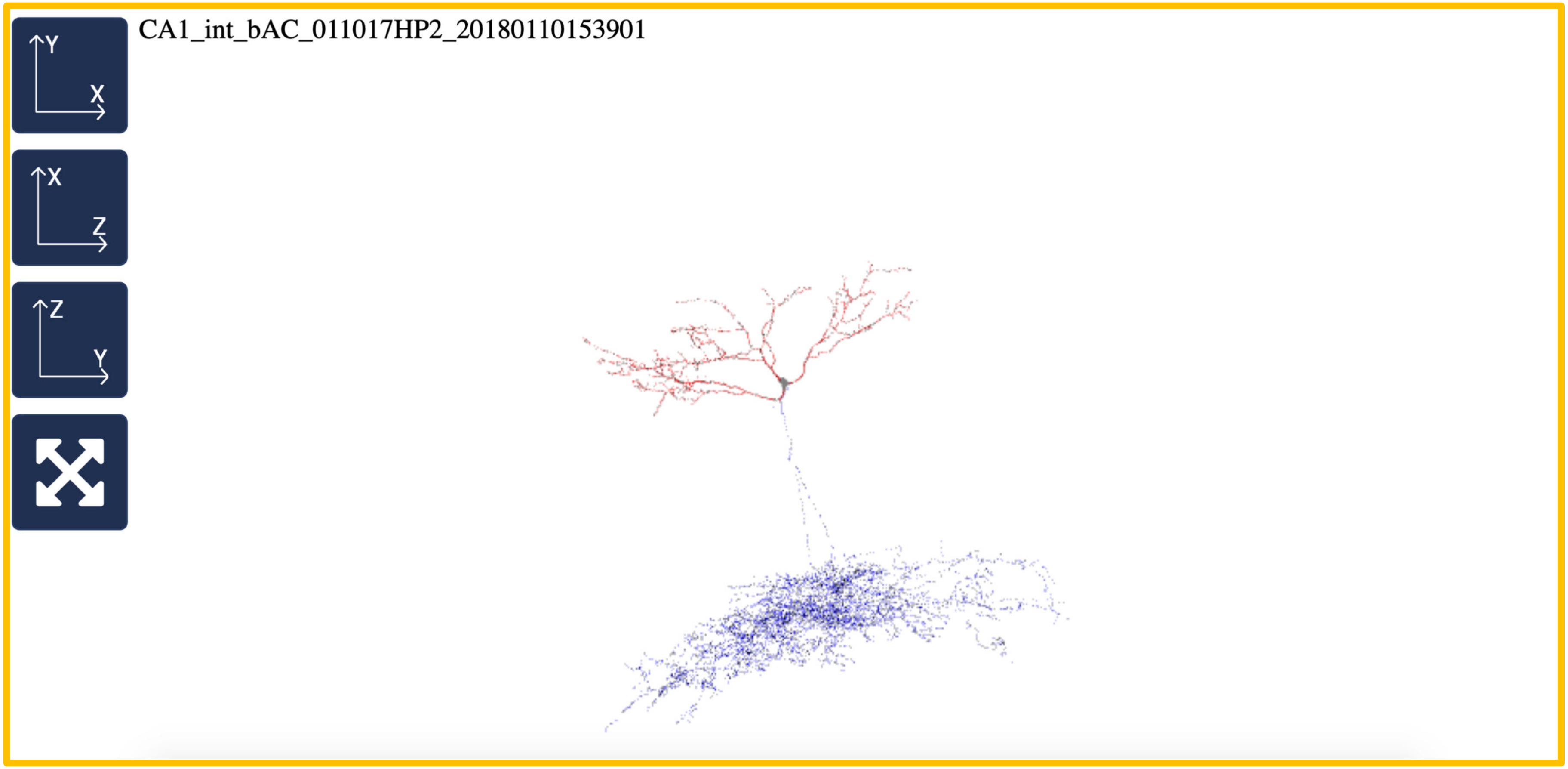
Thanks to the python module ipywidgets, the code can be enriched with graphical elements (e.g. buttons, edits, forms, …) and can be hidden and re-shown according to the user preferences

BSP Morphology Online Use Cases



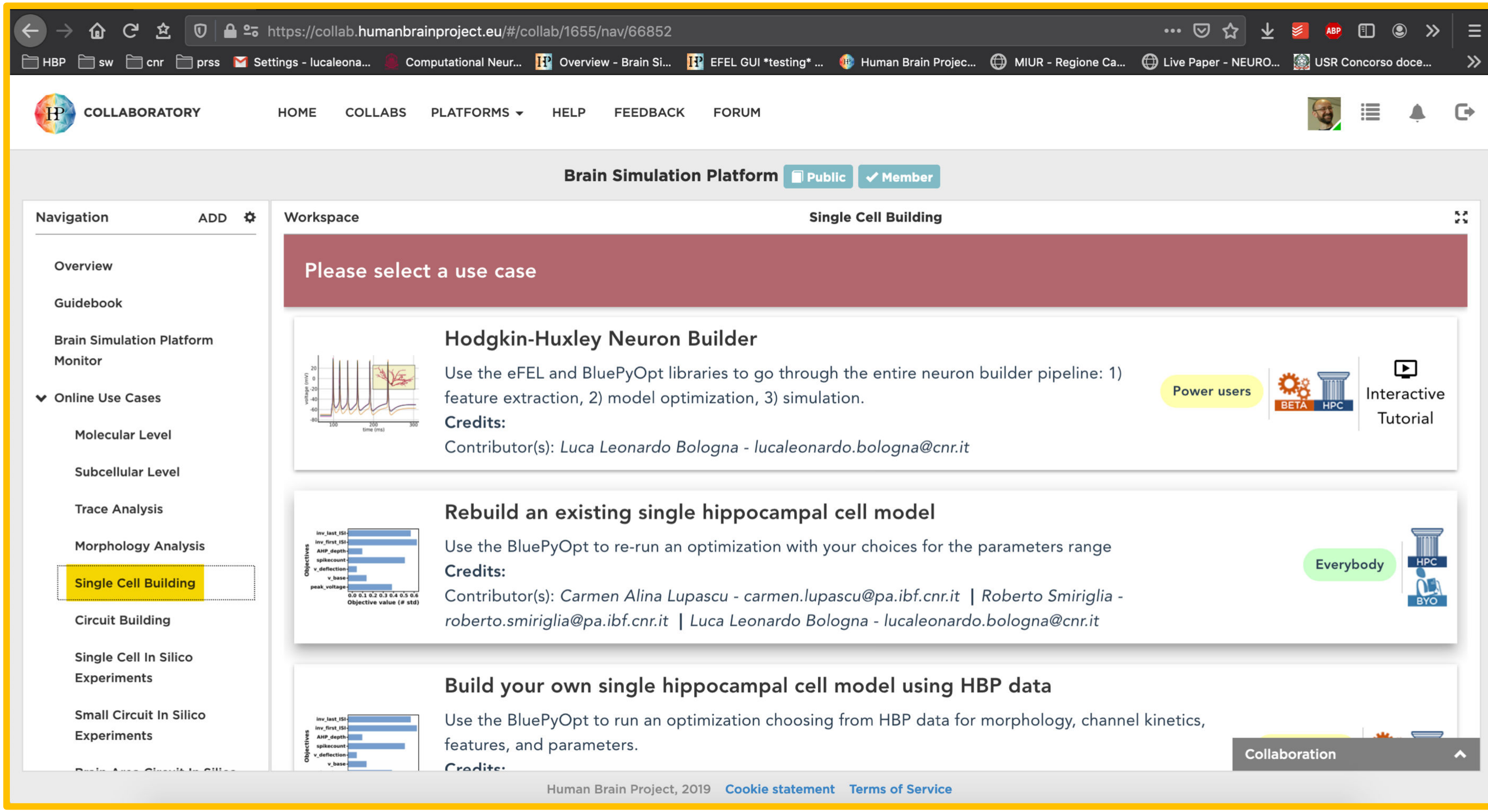
Example: the Morphology Analysis group contains two different Use Cases - the first one is implemented through a Jupyter Notebook while the second one relies on the HTML and Javascript technologies

BSP Morphology Visualization Use Case



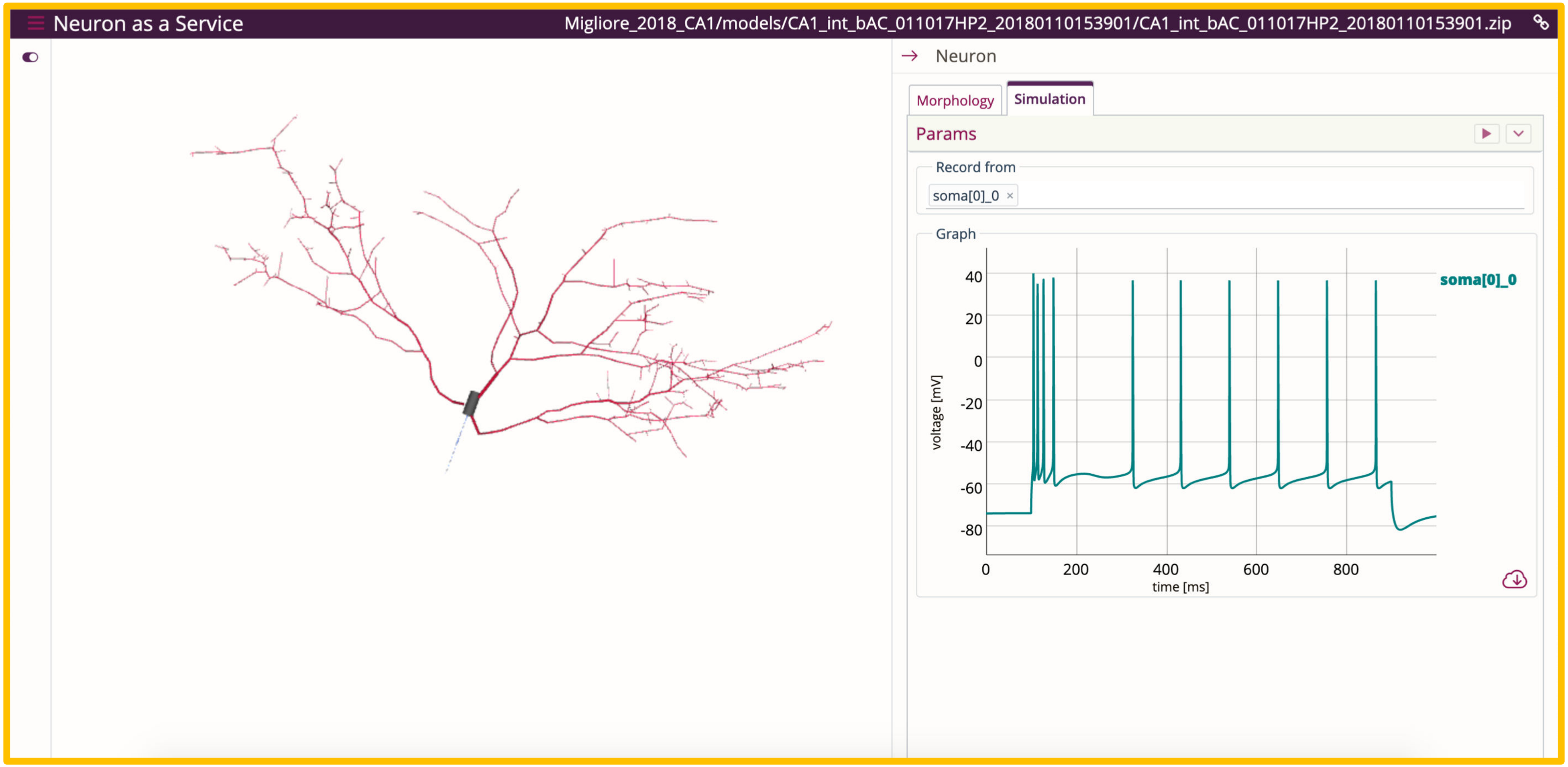
Example: 3d structure of a single neuron morphology displayed with the Morphology Visualization Use Case

BSP Single Cell Building Use Cases



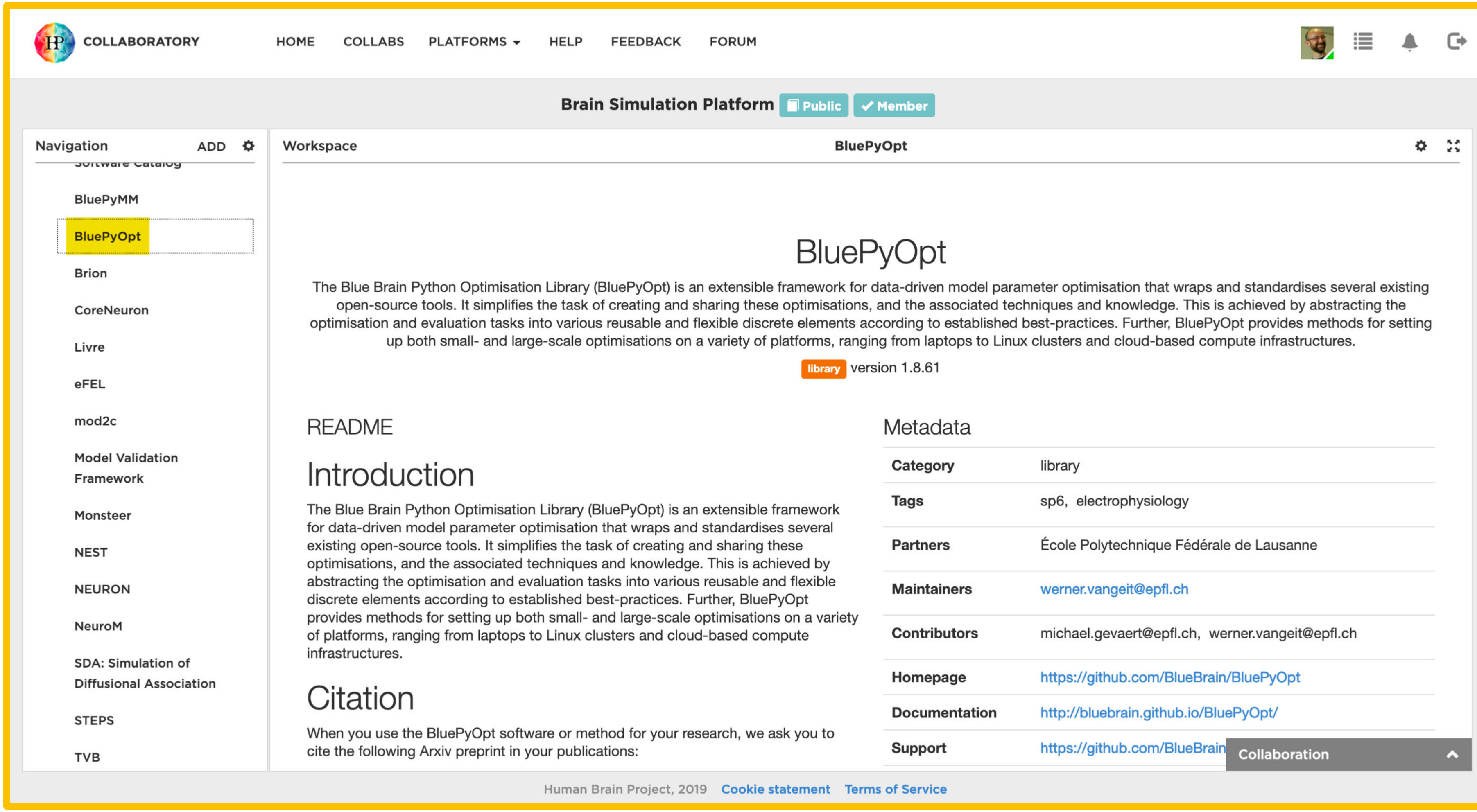
The Single Cell Building Use Cases allow to build single cell neuron models of different brain regions (e.g. hippocampus, cerebellum, striatum, …)

BSP Naas Use Case



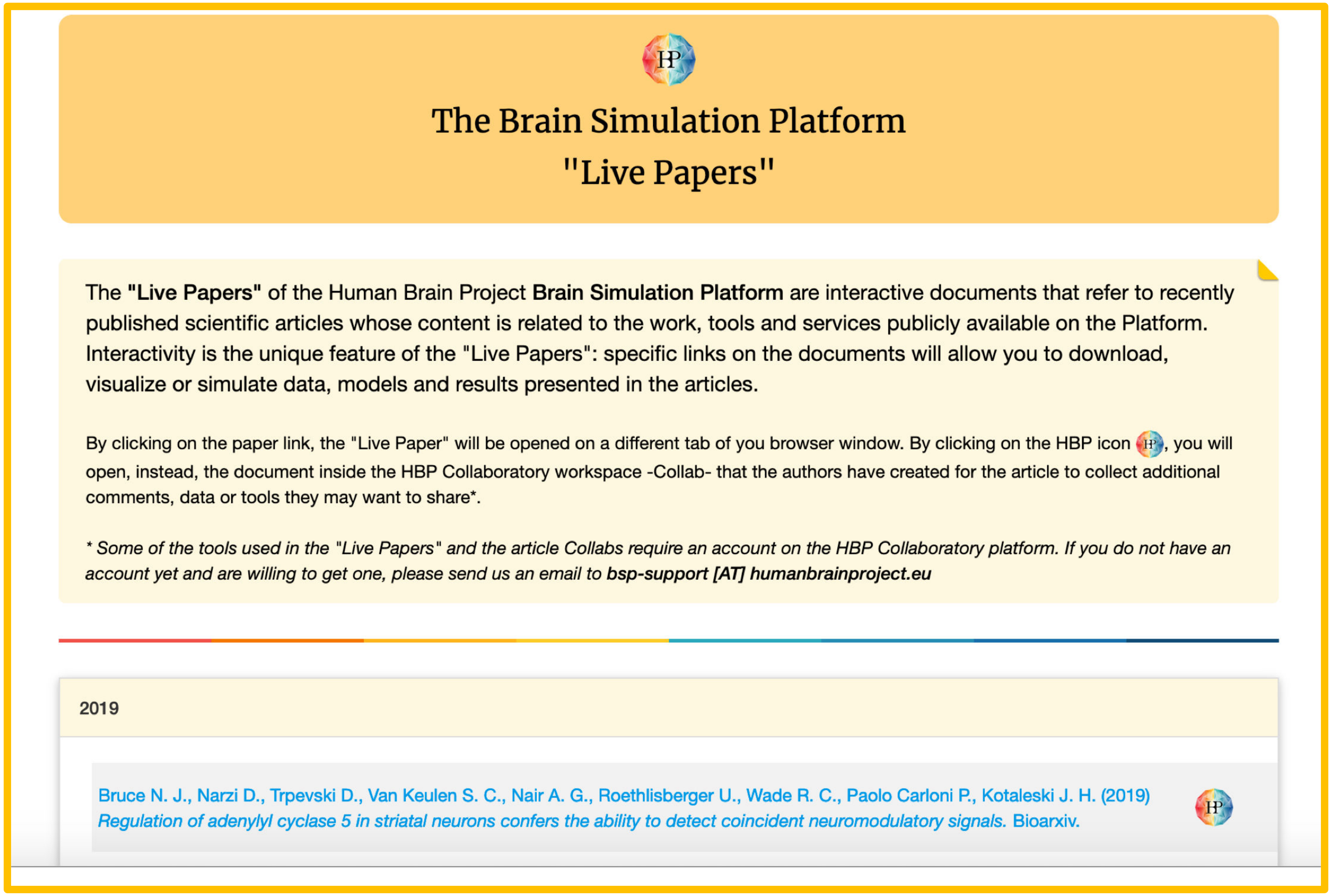
The Single Cell In Silico Experiments Use Case allows to choose a model from the HBP database, visualize the related neuron morphology, configure and run a single neuron simulation and download the simulated activity

BSP Open Source Tools



The Open Source Tools provides a list of tools the BSP Online Use Cases rely on

BSP Live Papers



The Brain Simulation Platform
"Live Papers"

The **"Live Papers"** of the Human Brain Project **Brain Simulation Platform** are interactive documents that refer to recently published scientific articles whose content is related to the work, tools and services publicly available on the Platform. Interactivity is the unique feature of the "Live Papers": specific links on the documents will allow you to download, visualize or simulate data, models and results presented in the articles.

By clicking on the paper link, the "Live Paper" will be opened on a different tab of you browser window. By clicking on the HBP icon, you will open, instead, the document inside the HBP Collaboratory workspace -Collab- that the authors have created for the article to collect additional comments, data or tools they may want to share*.

** Some of the tools used in the "Live Papers" and the article Collabs require an account on the HBP Collaboratory platform. If you do not have an account yet and are willing to get one, please send us an email to **bsp-support [AT] humanbrainproject.eu***

2019

Bruce N. J., Narzi D., Trpevski D., Van Keulen S. C., Nair A. G., Roethlisberger U., Wade R. C., Paolo Carloni P., Kotaleski J. H. (2019) *Regulation of adenylyl cyclase 5 in striatal neurons confers the ability to detect coincident neuromodulatory signals.* Bioarxiv.

The BSP Live Papers are interactive documents that contain information and links to the resources concerning recently published journal articles related to the Brain Simulation Platform

BSP Live Papers - Info

The Brain Simulation Platform "Live Papers"

The physiological variability of channel density in hippocampal CA1 pyramidal cells and interneurons explored using a unified data-driven modeling workflow

Authors: Rosanna Migliore [1], Carmen A. Lupascu [1], Luca L. Bologna [1], Armando Romani [2], Jean-Denis Courcol [2], Stefano Antonel [2], Werner A.H. Van Geit [2], Alex M. Thomson [3], Audrey Mercer [3], Sigrun Lange [3,4], Joanne Falck [3], Christian A. Rössert [2], Ying Shi [2], Olivier Hagens [5], Maurizio Pezzoli [5], Tamas F. Freund [6,7], Szabolcs Kali [6,7], Eilif B. Muller [2], Felix Schürmann [2], Henry Markram [2], and Michele Migliore [1]

Author information: [1] Institute of Biophysics, National Research Council, Palermo, Italy, [2] Blue Brain Project, École Polytechnique Fédérale de Lausanne, Campus Biotech, Geneva, Switzerland, [3] University College London, United Kingdom, [4] University of Westminster, London, United Kingdom, [5] Laboratory of Neural Microcircuitry (LNMC), Brain Mind Institute, EPFL, Lausanne, Switzerland, [6] Institute of Experimental Medicine, Hungarian Academy of Sciences, Budapest, Hungary, [7] Faculty of Information Technology and Bionics, Pázmány Péter Catholic University, Budapest, Hungary.

Corresponding author: Rosanna Migliore (*rosanna.migliore@cnr.it*)

Journal: Plos Computational Biology

Download Url: https://doi.org/10.1371/journal.pcbi.1006423

Citation: Migliore R, Lupascu CA, Bologna LL, Romani A, Courcol J-D, Antonel S, et al. (2018) The physiological variability of channel density in hippocampal CA1 pyramidal cells and interneurons explored using a unified data-driven modeling workflow. PLoS Comput Biol 14(9): e1006423.

DOI: https://doi.org/10.1371/journal.pcbi.1006423

The Live Papers are structured in two parts: the top sections contain the title and the abstract of the main manuscripts as well as information about the authors, the download url and the paper licence

BSP Live Papers - Data

Abstract:

The peak conductance of many ion channel types measured in any given animal is highly variable across neurons, both within and between neuronal populations. The current view is that this occurs because a neuron needs to adapt its intrinsic electrophysiological properties either to maintain the same operative range in the presence of abnormal inputs or to compensate for the effects of pathological conditions. Limited experimental and modeling evidence suggests this might be implemented via the correlation and/or degeneracy in the function of multiple types of conductances. To study this mechanism in hippocampal CA1 neurons and interneurons, we systematically generated a set of morphologically and biophysically accurate models. We then analyzed the ensembles of peak conductance obtained for each model neuron. The results suggest that the set of conductances expressed in the various neuron types may be divided into two groups: one group is responsible for the major characteristics of the firing behavior in each population and the other more involved with degeneracy. These models provide experimentally testable predictions on the combination and relative proportion of the different conductance types that should be present in hippocampal CA1 pyramidal cells and interneurons.

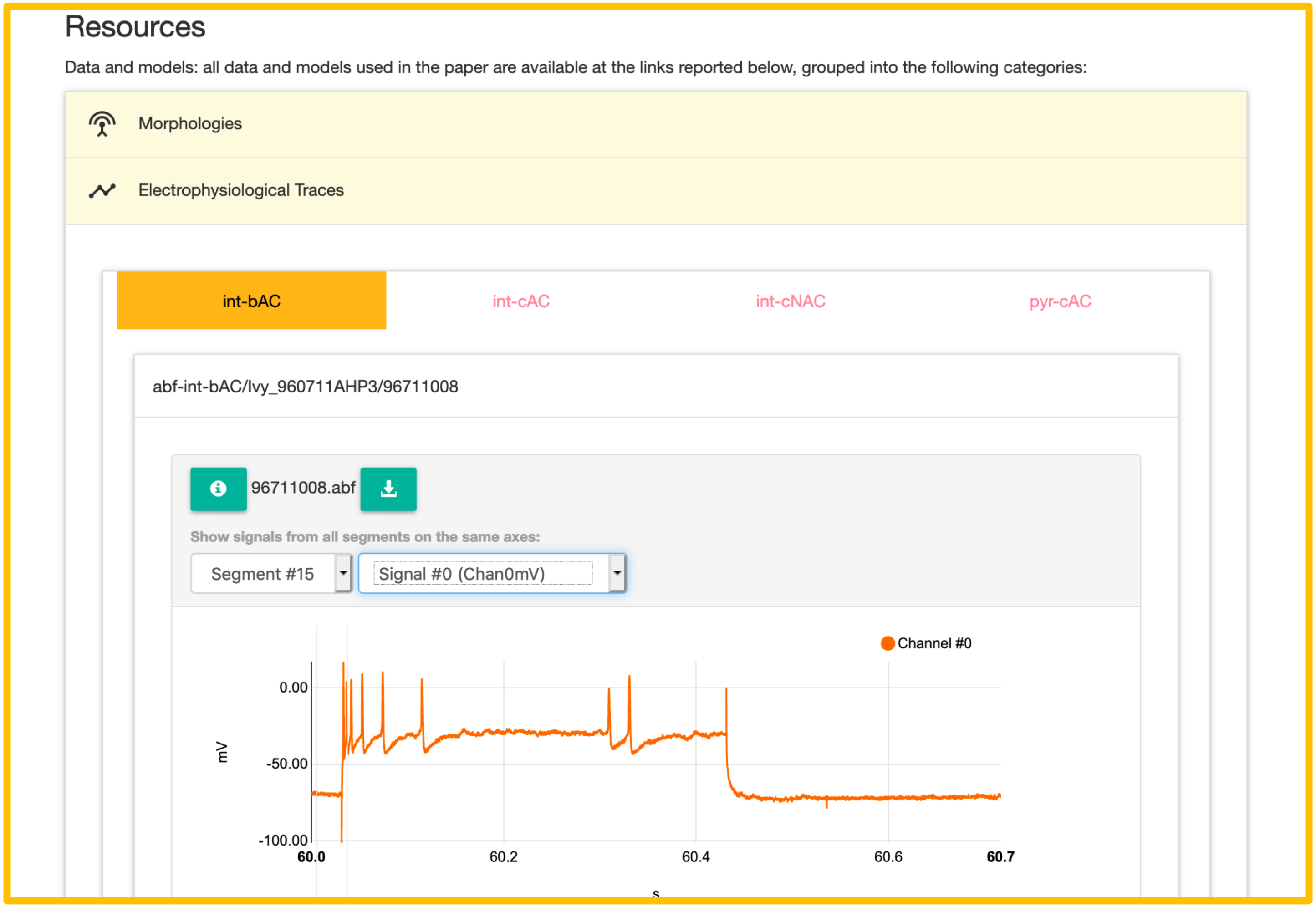
Resources

Data and models: all data and models used in the paper are available at the links reported below, grouped into the following categories:

- Morphologies
- Electrophysiological Traces
- ModelDB link and test simulations
- Optimizations

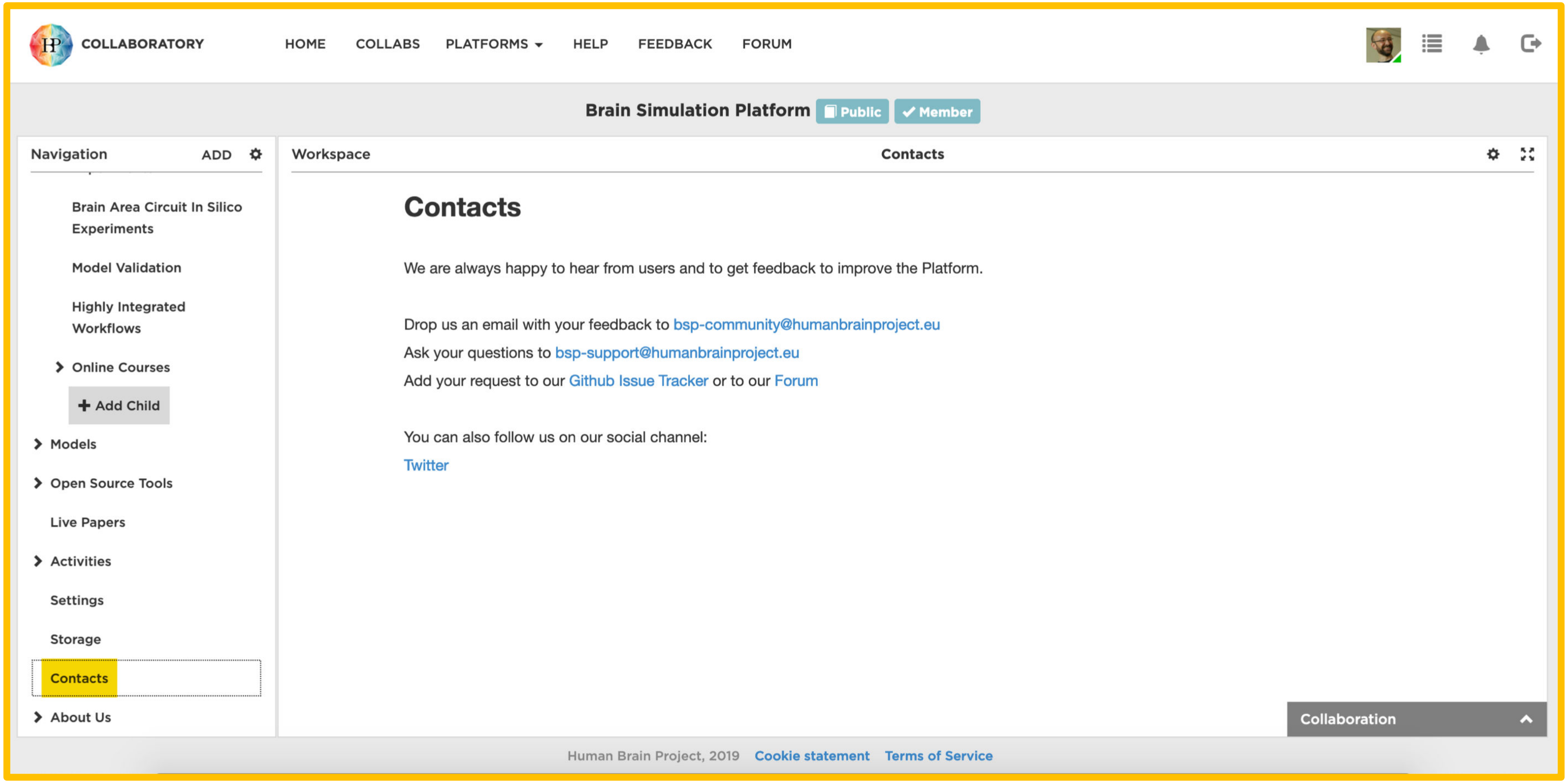
The bottom sections contain links to all the data used for and referenced in the paper
Data can be downloaded and displayed and neuron models can be simulated thanks to tools provided by the BSP

BSP Live Papers - Resources



Example: the users are given the possibility to visualize and download the electrophysiological traces thanks to an *ad-hoc* developed visualizer integrated in the Live Paper document

BSP Contacts



Refer to the Contacts page for any request or question you may have

Workshop EBRAINS
A Platform for Collaboration in Digital Neuroscience

CDTI – Madrid, Spain
12 November 2019

Thanks for your attention!

Luca Leonardo Bologna

CNR Institute of Biophysics

lucaleonardo.bologna@cnr.it