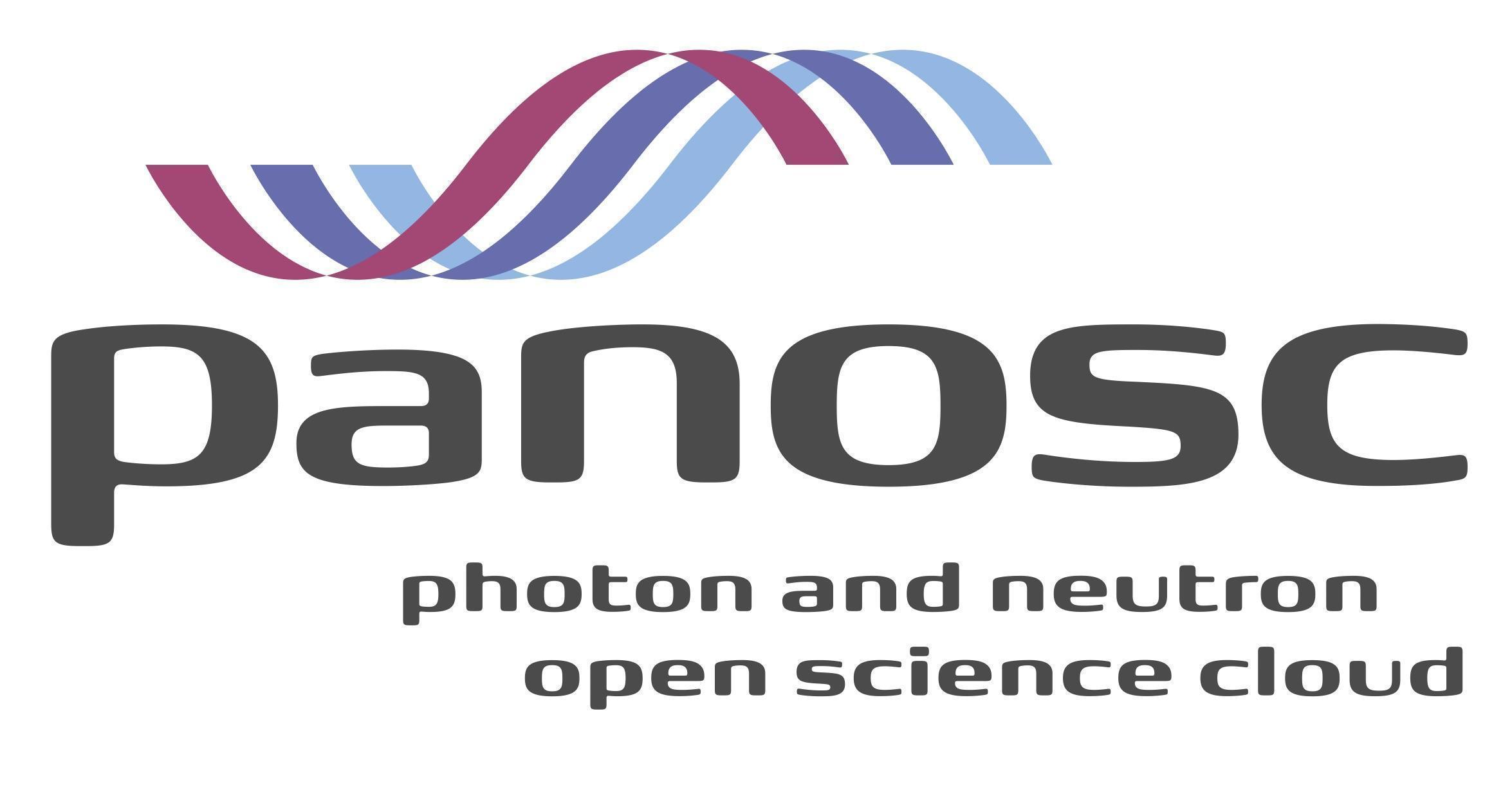
PaNOSC

Photon and Neutron Open Science Cloud

H2020-INFRAEOSC-04-2018

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Task 8.2 Integrating Jupyter Technologies

MS 8.4 Jupyter Integrated with e-learning

Milestone: IMS 8.2 Jupyter integrated with the e-learning platform

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| Authorship | Written by: T. Ivănoaica (ELI-DC), F. Gliksohn (ELI-DC), |
| Contributors: T.H. Rod (ESS), P. Willendrup (ESS) |
| Reviewed by: A. Götz(ESRF) |
| Approved: J. Bodera Sempere (ESRF) |

List of participants

|  |  |  |
| --- | --- | --- |
| Participant No. | Participant organisation name | Country |
| 1 | European Synchrotron Radiation Facility (ESRF) | France |
| 2 | Institut Laue-Langevin (ILL) | France |
| 3 | European XFEL (EuXFEL) | Germany |
| 4 | The European Spallation Source (ESS) | Sweden |
| 5 | Extreme Light Infrastructure Delivery Consortium (ELI-DC) | Belgium |
| 6 | Central European Research Infrastructure Consortium (CERIC-ERIC) | Italy |
| 7 | EGI Foundation (EGI.eu) | The Netherlands |

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# PaNOSC Work Package 8.

WP8 of PaNOSC includes as a core objective the provisioning and further development of e-neutrons.org, which is developed exclusively for the neutron scattering community, into a technically sustainable e-learning platform for the combined photon and neutron scattering community. This new platform operates under the domain name pan-learning.org and will be used to also provide training in the services provisioned in PaNOSC and is, like e-neutrons.org, based on the Moodle Open Source learning management platform.

To better serve the community, a task in WP8 is dedicated to the integration of Jupyter in pan-learning.org. Project Jupyter [Perez2015, Jupyter2018] is one of the key technologies leveraged in PaNOSC. Project Jupyter is a set of open-source software projects for interactive and exploratory computing and data analysis that helps making data analysis, data science and scientific computing reproducible and multi-language (Python, Julia, R, Haskell, Bash, ...). The main component offered by Jupyter is the Jupyter Notebook: a web-based interactive computing platform that allows users to create data- and code-driven narratives that combine live (re-executable) code, equations, narrative text, interactive dashboards and other rich media.

Jupyter notebook documents provide a complete and executable record of a data analysis that can be shared with others in a way that has not been possible before [Kluyver2017]. Furthermore, Jupyter has been designed to optimise a data analysis environment for the most expensive resource involved: human time. Finally, it is a tool designed by active users of the tool, ensuring there is no divergence between the design and requirements of the science users. These points, among other things, have led to a huge boost in reproducible, interactive research and education documents in recent years. A paradigm that Fernando Perez, creator of the project, has referred to as “literate computing” [Perez2017].

Jupyter notebooks are particularly suitable for tutorials on data science-related topics and are one of the main user interfaces for the PaNOSC services. For this reason, Jupyter will be integrated with the e-learning platform as part of the PaNOSC project (WP8). The successful integration is indicated with this milestone.

## Task 8.2 Integrating Jupyter technology

The purpose of integrating Jupyter into pan-learning.org is to make it possible for teachers to integrate notebooks into their courses. This has been achieved by two different approaches, namely a simple launch of JupyterHub from pan-learning.org and by using IllumiDesk. However, in both cases, the Learning Tools Interoperability (LTI) protocol is used for communication between Moodle and Jupyter. LTI is developed by IMS Global Learning Consortium and is the standard way of integrating rich learning applications for most e-learning platforms, including Moodle.

### Simple launch of JupyterHub

In this approach, the course developer can provide in a course a link or button that launches JupyterHub using the user’s login details for Moodle. Once the student clicks the button, JupyterHub launches with a set of preloaded notebooks fetched from a GitHib repository. The student can then choose to open one or more of those notebooks. Thus, the teacher should indicate in the course which notebook to open.

Disadvantages with this approach are in its current implementation that 1) all students see all notebooks made available in this way 2) the course developer would have to ask a sysadmin to upload the notebook to the system in order to make it available for students, and 3) it is not possible to communicate between Moodle and Jupyter apart for the login details. Options for how to get rid of these restrictions are currently being investigated.

The approach has been developed by ESS as a backup solution to the solution based on IllumiDesk. Nonetheless, it has been successfully used to provide Python training at ESS (pan-learning course: *IKON Python Workshop;* see also <https://indico.esss.lu.se/event/2568/>) and training in McStasScript at Forschungszentrum Jülich in Germany (see use case on https://www.panosc.eu/use-cases/).

### IllumiDesk with nbgrader

In order to enable course developers to upload their own notebooks and make them available only for students of select courses, we have also implemented a solution based on IllumiDesk (<https://www.illumidesk.com/>) and nbgrader (<https://nbgrader.readthedocs.io/en/stable/>). This allows course developers to make only one notebook available at a time and to add **interactive Jupyter Notebook exercises that can be manually or automatically graded.** Whilst nbgrader enables creating and grading assignments in Jupyter notebooks, IllumiDesk enables those assignments and grades to be communicated between Jupyter and Moodle via LTI.

Whereas IllumiDesk is a commercial company, their service is based on open-source software (<https://github.com/IllumiDesk>), which the current implementation for pan-learning.org is based on. Modifications had to be made in order to make the IllumiDesk software work with pan-leaning.org starting out with v0.8.1 of IllumiDesk for the proof of concept and upgrading to v0.8.2 for the solution in production. The code and full documentation of all fixes and workarounds developed for this integration project are available in ELI ERIC GitHub ([HTTPs://github.com/eli-eric/illumidesk/](https://github.com/eli-eric/illumidesk/)).

A small course, *Python IllumiDesk Test* is available in pan-learning.org that can be used for testing out the functionalities of this solution.

The advantage of IllumiDesk over JupyterHub is that teachers can easily create (although deleting it is not as simple) an Illumidesk for their moodle course as an external tool without any additional passwords. The teachers can then upload their own notebooks and release them to students, all without the help of a sysadmin. Only students enrolled on that course will be able to access these notebooks. A current disadvantage of Illumidesk is that it implies the student has to submit the notebooks for some level of grading. Although neat, notebook grading is unlikely to be popular with teachers or many students outside university settings. Grading can be manual or the teacher can write tests which autograde a submitted student notebook. However, even autograding is not immediate and requires the teacher to ‘manually’ fetch submitted notebooks and run the autograder. Solutions to mitigate these disadvantages are being investigated.

One disadvantage of both Jupyterhub and Illumidesk, is the inability for teachers to install any modules themselves. Hence, for example, each time McStas script is required for a course, sysadmin would have to make sure it is installed. Ultimately, we only consider maintaining one implementation.

ELI has developed the solution based on IllumiDesk and integrated the solution on the production server jointly with ESS, the solution was used and presented in the “Train the Trainer Workshop” (<https://indico.esss.lu.se/event/2499/>). The modifications to the Illumidesk codebase are available at:<https://github.com/eli-eric/illumidesk/commits/wp8/deploy_0.8.2>.