Python @ CERN

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CERN – home of the Large Hadron Collider that can spit up to **1 petabyte of collisions data per second**. None of today's computing systems are capable of recording such rates, so the first level triggers are selecting only **1 in 10 000 events** (making decisions in ~3 millionths of a second), which are then send at 100 GB/second to the tens of thousands of processor cores which select **1%** of the remaining events for analysis. Even after such drastic data reduction, there are still around **50 petabytes** of data produced at CERN per year.

How does Python fit in this ecosystem? It might not be fast enough to be used for filtering this amount of data, but nevertheless, there are many great projects created with Python at CERN.

python + ROOT

Thousands of scientists every day analyse data produced by the LHC. They need a tool that works fast with gigabytes of data but also is easy to use by someone with little programming experience. And this is exactly what PyROOT is – a Python module that allows users to interact with ROOT (a data analysis framework written in C++, that is very popular in High Energy Physics community).

Users can use PyROOT directly in Python REPL. With all the ROOT classes and functions available out of the box, they can combine them with other modules like NumPy and SciPy to make make data analysis easier and faster.

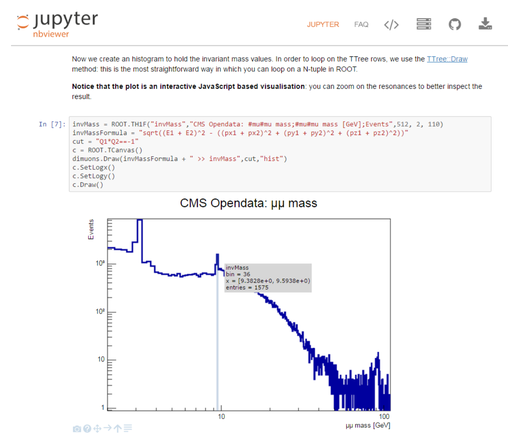
PyROOT is more than just a wrapper around ROOT. Python bindings are based on C++ reflexion information. Thanks to that, Python classes are created dynamically when needed and C++ functions and globals are available automatically in Python.

https://root.cern.ch/pyroot

SWAN

SWAN or Service for Web based Analysis aims to let anyone analyse data without the need to install any software. Currently tested at CERN, SWAN creates Virtual Machines that automatically connect CERNBox (a cloud storage built on top of Owncloud that uses EOS as a backend) with Jupyter notebook interface. Thanks to the JavaScriptRoot plugin, all visualizations in the notebooks are interactive.

With SWAN users can:
- Access the data and software available on the connected file system (EOS).
- Easily store their own results and share them with others.
- Run shell commands in the VM from the browser.



As SWAN is gaining more popularity, a container-based EOS+CERNBox+SWAN solution is being developed. It will allow to deploy SWAN on premises, providing an easy way to setup data analysis environments.

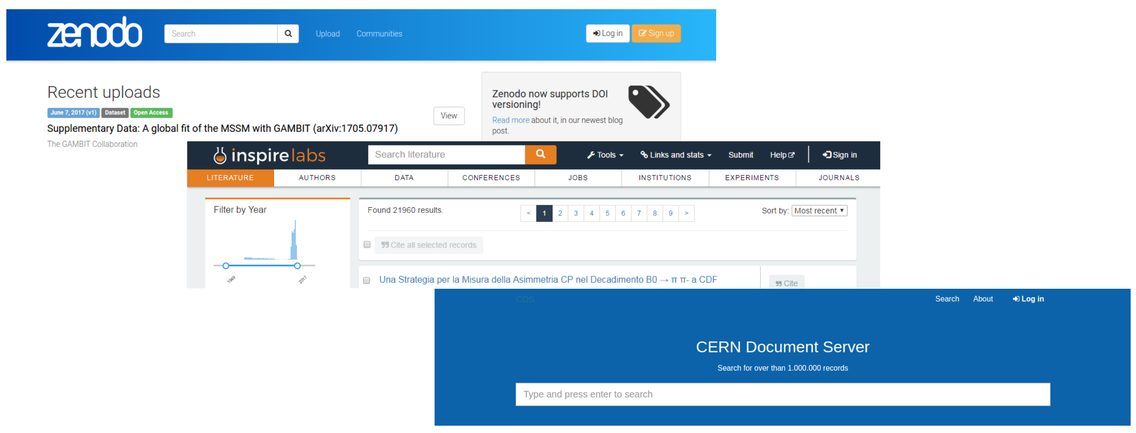
https://swan.web.cern.ch

INVENIO

All the discoveries at CERN, the big ones and the small ones, results in thousands of documents that have to go through the publication workflow. For that purpose, a digital library framework called Invenio was created back in 2002.

With this free and open source software you can create:
- Your own integrated digital library system (with module for borrowing books and tools for data curation).
- A multimedia archive or research data repository.
- An institutional repository (with easily defined ingestion and approval workflows to store publications of your institute).

Invenio first started as a monolithic application, but with the recent version 3, it shifted to a more modular approach, built with technologies like Flask, ElasticSearch, Celery or SQLAlchemy.



Invenio powers projects like:
- **CERN Document Server** - CERN's institutional repository for publications, articles, reports and multimedia content.
- **Inspire** - the main literature database for High Energy Physics, managed by a collaboration of CERN, DESY, Fermilab, IHEP, and SLAC.
- **Zenodo** – a research archive to share and preserve data, software and publications in any size, any format and from any research area (with easy GitHub integration, you can make your software citable).

CERN Analysis Preservation

CERN Analysis Preservation – a project to capture all the elements needed to understand and rerun an analysis even after several years. Preserving only data is often not enough - once the software becomes obsolete, the research data analyses can no longer be reproduced. CERN Analysis Preservation is trying to solve this problem by collecting not only the data, but also the software, information about the environment, workflow, context and documentation.

opendata CERN

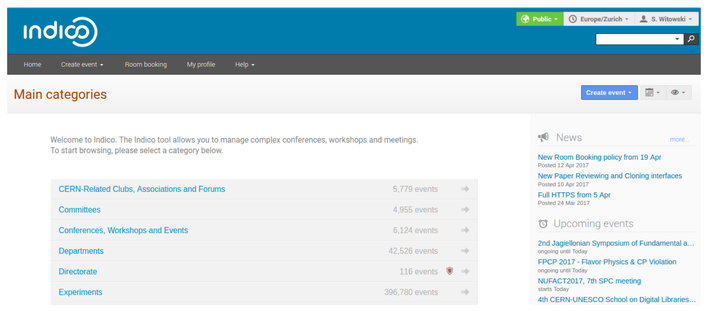
CERN Open Data Portal makes the data from different experiments at CERN accessible to the world. You can visualize events from the LHC directly in the browser. For more advanced analysis, you can create a Virtual Machine, import the data sets and start your own analysis. And who knows, maybe you will discover something that thousands of scientists missed?

http://invenio-software.org

indico

With thousands of users at CERN (people working on site and visiting scientists), organizing meetings can be a daunting task, but thanks to Indico, it's actually not that hard.

Indico is an open source tool for event organization, archival and collaboration. You can easily manage the whole event, starting from the registration process, abstract submission, reviewing process up to proceedings submission. It comes with a room booking module, integration with video conferencing tools and few other open source plugins.



Indico at CERN managed its first conference - Computing in High Energy and Nuclear Physics (CHEP) - in 2004 and since then, there have been almost 500 000 events organized with its help. Every week, 25 000 users are using it to organize or participate in meetings.

http://indico-software.org

CERN does not only focus on physics. Some of the technologies developed here can be applied to other areas. Many diagnostic and therapeutic techniques (like the cancer radiotherapy with beams of protons) used in the medicine were developed based on the research results obtained at CERN. CERN is also involved in space missions dedicated to fundamental physics.

Many open source projects are used at CERN and when it's possible, developers try to contribute to those projects. GitLab is used as version control software, open community versions of MySQL, PostgreSQL and InfluxDB are used by the DB on demand service, ElasticSearch is used throughout many projects. CERN has created it's own Linux distribution called Scientific Linux CERN (based on Scientific Linux), it's own storage system (EOS) or Dropbox-like cloud synchronization service (CERNBox).

https://home.cern