

# Data & Analysis Preservation: current work items

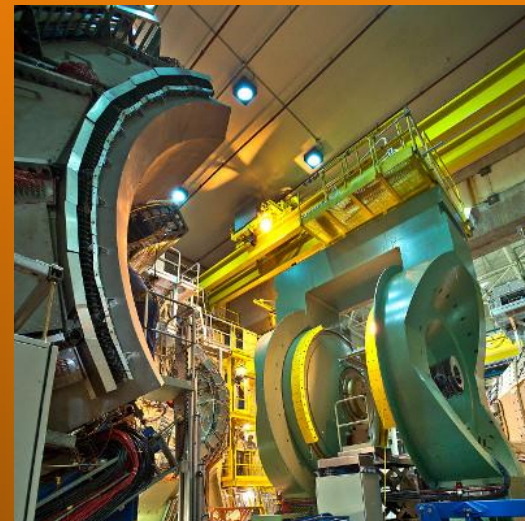
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*Nuclear and Particle Physics Software Group*



***PHENIX DAP Meeting***

**02/25/2021**



# Overview

- Zenodo
- The legacy DB situation
- GitHub repo plans
- OpenData
- HEPData
- Docker development
- Website updates
- Analysis notes redux

# Zenodo

- Uploads happening at a brisk pace
- 300+ items as of today
- Thanks to Gabor for taking care of conference presentations and to Stacyann for the theses
- More keywords added to the official list as necessary

The screenshot shows the Zenodo website interface. At the top, the Zenodo logo and navigation links are visible. The main header is 'PHENIX Collaboration'. Below it, a search bar and filters are present. An orange arrow points from the 'PHENIX Collaboration' header to the 'Access Right' filter, which is set to 'Open (291)'. The main content area displays a list of uploads, including 'ROOT5 SL7 Docker Image' and 'Recent Heavy Flavor Results Utilizing the FVTX in PHENIX at RHIC'. A sidebar on the left shows a list of conference presentations categorized by year from 2016 to 2021.

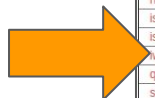
| Year | Conference Presentation  | PHENIX Presentations   |
|------|--|--|
| 2021 | Workshop on forward physics and QCD 2021<br>Initial Stages 2021  | PHENIX Presentations<br>PHENIX Presentations   |
| 2020 | Zimányi School 2020<br>17th International Workshop on Hadron Structure and Spectroscopy<br>The 36th Winter Workshop on Nuclear Dynamics<br>Santa Fe Jets and Heavy Flavor Workshop 2020<br>DNP Fall 2020 Meeting<br>Hard Probes 2020 | PHENIX Presentations<br>PHENIX Presentations<br>PHENIX Presentations<br>PHENIX Presentations<br>PHENIX Presentations<br>PHENIX Presentations |
| 2019 | Quark Matter 2019<br>Zimányi School 2019<br>DNP Fall 2019 Meeting<br>International Symposium on Multiparticle Dynamics 2019<br>2019 RHIC & AGS Annual Users Meeting<br>Strangeness in Quark Matter 2019                              | PHENIX Presentations<br>PHENIX Presentations<br>PHENIX Presentations<br>PHENIX Presentations<br>PHENIX Presentations<br>PHENIX Presentations |
| 2018 | XIII Workshop on Particle Correlations and Femtoscopy<br>Hard Probes 2018  | PHENIX Presentations<br>PHENIX Presentations   |
| 2017 | Strangeness in Quark Matter 2017   | PHENIX Presentations   |
| 2016 | Strangeness in Quark Matter 2016   | PHENIX Presentations   |

# The legacy database situation

- Upload of conference presentation is broken
- Fixing that will likely take too much time for our budget
- For some months now we've been uploading conference materials to Zenodo while maintaining the keyword list (including keywords for conferences)
- A lot of effort invested by Gabor
- Is this a good time to switch to the new process?
- It's not difficult to set up a workflow with GitHub, BNLbox for revisions etc
  - ...since uploading drafts to Zenodo is not a good idea

| Results <input checked="" type="checkbox"/> Detectors  Software  Analysis |  |                      |
|---|--|----------------------|
| Select Conference Presentations   |  |                      |
| 2021  |  |                      |
| Workshop on forward physics and QCD 2021                                  |  | PHENIX Presentations |
| Initial Stages 2021   |  | PHENIX Presentations |
| 2020  |  |                      |
| Zimányi School 2020   |  | PHENIX Presentations |
| 17th International Workshop on Hadron Structure and Spectroscopy          |  | PHENIX Presentations |
| The 36th Winter Workshop on Nuclear Dynamics                              |  | PHENIX Presentations |
| Santa Fe Jets and Heavy Flavor Workshop 2020                              |  | PHENIX Presentations |
| DNP Fall 2020 Meeting   |  | PHENIX Presentations |
| Hard Probes 2020  |  | PHENIX Presentations |
| 2019  |  |                      |
| Quark Matter 2019   |  | PHENIX Presentations |
| Zimányi School 2019   |  | PHENIX Presentations |
| DNP Fall 2019 Meeting   |  | PHENIX Presentations |
| International Symposium on Multiparticle Dynamics 2019                    |  | PHENIX Presentations |
| 2019 RHIC & AGS Annual Users Meeting                                      |  | PHENIX Presentations |
| 2018  |  |                      |
| XIII Workshop on Particle Correlations and Femtoscopy                     |  | PHENIX Presentations |

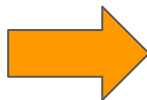
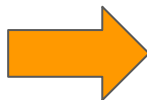
| Results <input checked="" type="checkbox"/> Detectors  Software  Analysis |  |  |
|---|--|--|
| Conferences (15 items)  |  |  |
| Keyword   | Description  |  |
| aum19   | 2019 RHIC & AGS Annual Users Meeting                             |  |
| dnp19   | DNP (2019)   |  |
| dnp20   | DNP (2020)   |  |
| fwph21  | Workshop on forward physics and QCD (2021)                       |  |
| hp18  | Hard Probes 2018   |  |
| hp20  | Hard Probes 2020   |  |
| is21  | Initial Stages (2021)  |  |
| ismd19  | International Symposium on Multiparticle Dynamics (2019)         |  |
| whss2020  | 17th International Workshop on Hadron Structure and Spectroscopy |  |
| qm2019  | Quark Matter (2019)  |  |
| sfjhf20   | Santa Fe Jets and Heavy Flavor Workshop (2020)                   |  |
| wpcf2018  | XIII Workshop on Particle Correlations and Femtoscopy            |  |
| wwnd2020  | The 36th Winter Workshop on Nuclear Dynamics (2020)              |  |
| zs19  | Zimányi School (2019)  |  |
| zs20  | Zimányi School (2020)  |  |



# GitHub: the “documentation” repo

- The repo was created a long time ago as a general container for all kinds of documents used in the PHENIX DAP effort
- The HEPData component was factored out to a separate repo to make it lightweight and agile - this is a team effort and multiple people are doing the “git pull”
- Now, upload and backup of the PHENIX theses is close to finish
  - Many thanks to Stacyann Nelson
- The resulting volume of the theses folder in the “documentation” repository is somewhat larger than expected - O(GB) - and makes it harder to access smaller sets of other types of files if needed
- It makes sense to create a dedicated repo for the theses, stay tuned
  - Will make decision/proceed after all theses are uploaded

# PHENIX on GitHub

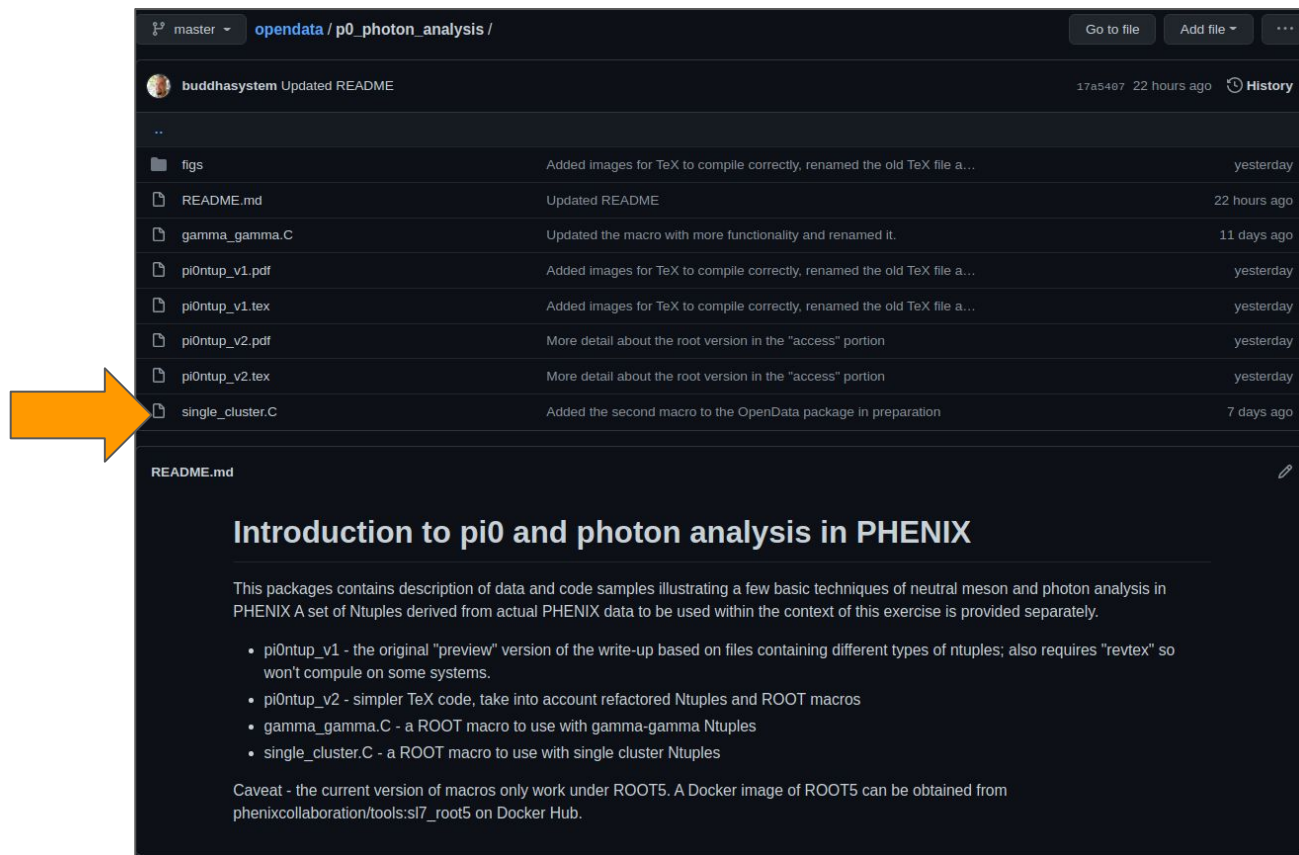


The screenshot shows the GitHub profile for 'The PHENIX Collaboration'. The profile header includes the organization's name, a description: 'Pioneering High Energy Nuclear Interaction eXperiment at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory', and a website link: 'https://www.phenix.bnl.gov'. Below the header, there are navigation tabs for Repositories (6), Packages, People (7), Teams (1), Projects (1), and Settings. A search bar and filters for repository type and language are present. The main content area lists several repositories: 'web' (HTML, Apache-2.0, 5 forks, 0 stars, updated 6 hours ago), 'opendata' (TeX, 0 forks, 0 stars, updated 23 hours ago), 'hepdata' (Shell, 6 forks, 0 stars, updated yesterday), 'documentation' (C++, 8 forks, 0 stars, updated 11 days ago), 'containers' (Private, Apache-2.0, 0 forks, 0 stars, updated 16 days ago), and 'geant4\_vmc' (C++, GPL-2.0, 13 forks, 0 stars, updated on Jan 31, 2020). On the right side, there are sections for 'Top languages' (C++, Shell, TeX, HTML) and 'People' (7 members, with an 'Invite someone' button).

# Open Data - the “ $\pi^0$ and $\gamma$ analysis” entry

- Recall: uploaded to Open Data in the of Fall’2020, comments received
  - The upload mechanism and auth/auth tested and works (XRootD)
- Survey of datasets from other experiments (i.e. the “dataset semantics” feature)
  - A built-in feature of the OpenData pages to document datasets, one table per page
- Heterogeneous datasets have to be documented in the textual description
  - Gabor’s original files had two different ntuples per file
  - Site admins suggested refactoring data (not mandatory but desirable)
- Thanks to Gabor making that extra step of splitting data
- Another recommendation from OpenData - have standalone code as opposed to snippets in the PDF
  - Has now been done, ROOT macros created and tested
- This required changes in the document - now also completed

# Our OpenData entry on GitHub



The screenshot shows the GitHub interface for the repository 'opendata / p0\_photon\_analysis'. The repository is owned by 'buddhasystem' and was last updated 22 hours ago. The file list includes:

| File             | Commit Message   | Time         |
|------------------|--|--------------|
| figs             | Added images for TeX to compile correctly, renamed the old TeX file a... | yesterday    |
| README.md        | Updated README   | 22 hours ago |
| gamma_gamma.C    | Updated the macro with more functionality and renamed it.                | 11 days ago  |
| pi0ntup_v1.pdf   | Added images for TeX to compile correctly, renamed the old TeX file a... | yesterday    |
| pi0ntup_v1.tex   | Added images for TeX to compile correctly, renamed the old TeX file a... | yesterday    |
| pi0ntup_v2.pdf   | More detail about the root version in the "access" portion               | yesterday    |
| pi0ntup_v2.tex   | More detail about the root version in the "access" portion               | yesterday    |
| single_cluster.C | Added the second macro to the OpenData package in preparation            | 7 days ago   |

An orange arrow points to the 'README.md' file. Below the file list, the content of 'README.md' is displayed:

## Introduction to pi0 and photon analysis in PHENIX

This packages contains description of data and code samples illustrating a few basic techniques of neutral meson and photon analysis in PHENIX. A set of Ntuples derived from actual PHENIX data to be used within the context of this exercise is provided separately.

- pi0ntup\_v1 - the original "preview" version of the write-up based on files containing different types of ntuples; also requires "revtex" so won't compile on some systems.
- pi0ntup\_v2 - simpler TeX code, take into account refactored Ntuples and ROOT macros
- gamma\_gamma.C - a ROOT macro to use with gamma-gamma Ntuples
- single\_cluster.C - a ROOT macro to use with single cluster Ntuples

Caveat - the current version of macros only work under ROOT5. A Docker image of ROOT5 can be obtained from [phenixcollaboration/tools:sl7\\_root5](https://github.com/phenixcollaboration/tools:sl7_root5) on Docker Hub.



# OpenData: next steps

- Request to Gabor - is it possible to create macros compatible with ROOT6?
- Final overview of the new version of the write-up
- Do we have any other analysis cases suitable for Open Data submission?
- Combination of data hosting/access plus code/documentation makes it very suitable for training and educational purposes cf. PHENIX Schools, while also being a part of DAP
- Can we get any volunteers to consider making more packages?
- Caveat: to be useable the software included in a package must be portable, which is - either amenable to a build, or to containerization; cf. in our first entry we used ROOT macros which are portable by definition

# HEPData

- Ongoing HEPData preparation and management
  - Quite a few items are being worked on, a sizable work item, takes time
  - Our **new workflow/review process does work**:
    - Uploader <--> Reviewer
    - GitHub at the center
  - Please see the spreadsheet (reformatted a little bit for compactness) - also next slide:  
[https://docs.google.com/spreadsheets/d/1rABxzuM-h9Rukz08ut\\_m8xnMo0B\\_J1LKre8bM7B7264/edit?usp=sharing](https://docs.google.com/spreadsheets/d/1rABxzuM-h9Rukz08ut_m8xnMo0B_J1LKre8bM7B7264/edit?usp=sharing)
- Progress in the past three weeks:
  - PPG023, PPG235 - **initial stubs/sandboxing**
  - PPG083 - correction of an existing prior HEPData entry - **done**
  - PPG081 - correction of an existing prior HEPData entry - **work in progress**
  - Scientific notation/decimal places in PPG209 - **work in progress**
  - PPG210 - **done**, made corrections to PNG images

# HEPData: the spreadsheet

| PPG | Contact           | Contact e-mail                     | PPG Uploader name      | PPG Uploader e-mail            | IRC Reviewer name | IRC Reviewer e-mail       | Status/Comments  | arXiv      | InspireHEP ID | HEPData ID          |
|-----|-------------------|------------------------------------|------------------------|--------------------------------|-------------------|---------------------------|--|------------|---------------|---------------------|
| 023 | Abdulla Alsayegh  | abdullah.alsayegh@protonmail.com   |                        |                                |                   |                           | Early draft  | 308006     | 625472        |                     |
| 071 | K.Smith           | kis15k@my.fsu.edu                  |                        |                                |                   |                           | An older entry, corrections/Conflict: Inspire and Phys.Rev abstracts | 801.022    | 776624        | 57327               |
| 081 | Reem Alreshdi     | reemalreshdi@outlook.com, cnattras | Zaida Conesa del Valle | zaida.conesa.del.valle@cern.ch |                   |                           | Under sandbox review by Zaida  | 903.2041   | 815217        | 57350               |
| 083 | C.Nattrass        | cnattras@utk.edu                   | Jiangyong Jia          | jiangyong.jia@stonybrook.edu   |                   |                           | Resubmitted and finalized. Done.                                     |            | 778396        | 96764               |
| 115 | C.Nattrass        | cnattras@utk.edu                   |                        |                                |                   |                           | Complete/Done by Dylan Rotunno at UTK                                |            |               |                     |
| 119 | M.Wysocki         | matthew.g.wysocki@gmail.com        |                        |                                |                   |                           | In preparation   | 1910.14487 | 894560        |                     |
| 147 | Takahito Todoroki | todoroki@bni.gov                   | Takahito Todoroki      | todoroki@bni.gov               |                   |                           |  | 1412.1038  | 1332239       |                     |
| 173 | C.Nattrass        | cnattras@utk.edu                   | Takahito Todoroki      | todoroki@bni.gov               |                   |                           | Assigned: Christine Nattrass -> Jason Spriggs; decimal places        | 1803.01749 | 1658594       |                     |
| 202 | Gabor             |                                    |                        |                                |                   |                           | In preparation, IRC is unclear                                       |            |               |                     |
| 209 | S.Zharko          | zharkosergey94@gmail.com           | S.Zharko               | zharkosergey94@gmail.com       |                   |                           | Discussion of round off/Pending Sergei's additional edits            | 1805.04389 | 1672859       | 100192 (not public) |
| 210 | C.Nattrass        | cnattras@utk.edu                   | C.Nattrass             | cnattras@utk.edu               | A.Hodges          | ahodges21@student.gsu.edu | PNG's corrected for quality. Done.                                   | 2005.14270 | 1798493       | 101752              |
| 235 | N.Lewis           | nialewis@umich.edu                 | Nicole Lewis           | nialewis@umich.edu             | Xiaochun He       | xhe@gsu.edu               | Comment period ended   |            |               |                     |

# Docker: the purpose and the challenges

- To keep/capture snapshots of individual stages of analyses
- To aid in capturing workflows with REANA
- To preserve the software environment (at least some of it)
- Challenge: building the software - regardless whether it's for Docker images or other purposes
- If you can build it, you can containerize it

# Docker

- Created a new GitHub repository for PHENIX: “[containers](#)”
  - For management of [Dockerfiles](#) and configuration materials needed to build various images
  - Keeping it as “private” for now - let me know if you need access
- Current ROOT 6+ versions are provided by the ROOT team - but not ROOT5
  - <https://hub.docker.com/u/rootproject>
- Built a ROOT 5.34/36 image - the current standard on interactive nodes
  - Configuration kept on GitHub
  - PHENIX organization created on Docker Hub
  - Custom images built and deposited to the PHENIX repository on Docker Hub
  - Also uploaded to Zenodo (as tarballs)
  - They also include compatible versions of gcc and g++, same as on interactive nodes
  - Available to anyone
- A few caveats (X11 etc) documented in detail on the new pages on the website
  - Please see slides on the topic of the website, later in this presentation

# Docker - GitHub and Docker Hub

The image shows a Dockerfile on the left and its corresponding Docker Hub repository page on the right. An orange arrow points from the 'sl7\_root5' section of the Dockerfile to the 'sl7\_root5' entry in the Docker Hub repository's 'Tags and Scans' section.

**Dockerfile (Left):**

```
FROM ubuntu:16.04
MAINTAINER buddhasystem
CHECKPOINT Work in progress - no shared memory option works for ROOT ...

ENV /tmp /tmp
Dockerfile:sl7_basic
CHECKPOINT Work in progress - no shared memory option works for ROOT ...
Dockerfile:sl7_root5
Added an option to build from a local tarball as opposed to a download
16 days ago
README.md
CHECKPOINT Work in progress - no shared memory option works for ROOT ...
16 days ago
dummy.gz
Added an option to build from a local tarball as opposed to a download
16 days ago
```

**Docker Hub Repository (Right):**

phenixcollaboration / tools

PHENIX Tools

Last pushed: 6 days ago

**Tags and Scans**

This repository contains 2 tag(s).

| TAG       | OS    | PULLED     | PUSHED     |
|-----------|-------|------------|------------|
| sl7_root5 | linux | 6 days ago | 6 days ago |
| sl7_basic | linux | 6 days ago | 6 days ago |

[See all](#)

**Docker commands**

To push a new tag to this repository,

```
docker push phenixcollaboration/tools:tagname
```

**Recent builds**

[Link a source provider and run a build to see build results here.](#)

**Readme**

Repository description is empty. [Click here to edit.](#)

Can run in the familiar SL7 on  
any version of Linux, MacOS  
and Windows

# Docker on Windows

- Reasonable installation procedure (a couple of updates and restarts)
- Runs under WSL 2 - a Linux environment - closer to the kernel than a VM
- Features a desktop application plus full command-line functionality

The screenshot shows the Docker Desktop application interface. The top bar is blue with the Docker logo, an 'Upgrade' button, and icons for settings, Docker status, and the user 'buddhasystem'. The main area is titled 'Images on disk' and shows '3 images' with a 'Total size: 776.61 MB'. A progress bar indicates 'IN USE' and 'UNUSED' space. Below this, there are tabs for 'LOCAL' and 'REMOTE REPOSITORIES'. A search bar and a 'Sort by' dropdown are present. A table lists the images:

|                           |        | TAG           | IMAGE ID     | CREATED           | SIZE      |                     |
|---------------------------|--------|---------------|--------------|-------------------|-----------|---------------------|
| phenixcollaboration/tools | IN USE | sl7_basic     | f75f15125872 | 17 days ago       | 688.57 MB | <a href="#">RUN</a> |
| phenixcollaboration/reana | IN USE | ubuntu_test_1 | 65d963acfc7c | about 1 month ago | 63.25 MB  |                     |
| docker/getting-started    | IN USE | latest        | 3c156928aeec | 10 months ago     | 24.78 MB  |                     |


An orange arrow points to the 'phenixcollaboration/tools' row.

# Docker on Mac

- I don't have a Mac so can't report on experience
- Many users have Macs
- Volunteers to try it out?
- Can have a complete SL7 environment without installing complex software
  - Same gcc, g++, emacs, xterm, ROOT as on the RACF nodes



# Docker on Windows - CLI, ROOT



```
eabb785359ea: Pull complete
Digest: sha256:368dc0b59de676cffffac6468cb9eae54fdc54f700842a71b11d0c5bdaac7a6a
Status: Downloaded newer image for phenixcollaboration/tools:sl7_root5
docker.io/phenixcollaboration/tools:sl7_root5

24/02/2021 19:52:19 /home/mobaxterm docker image ls
REPOSITORY          TAG          IMAGE ID      CREATED       SIZE
phenixcollaboration/tools  sl7_basic    f75f15125872  2 weeks ago  689MB
phenixcollaboration/tools  sl7_root5    156b05cbb23c  2 weeks ago  3.16GB
phenixcollaboration/reana  ubuntu_test_1 65d963acfc7c  6 weeks ago  63.3MB
docker/getting-started    latest       3c156928aeec  10 months ago 24.8MB

24/02/2021 19:52:55 /home/mobaxterm docker run -it --rm phenixcollaboration/tools:root5
Unable to find image 'phenixcollaboration/tools:root5' locally
docker: Error response from daemon: manifest for phenixcollaboration/tools:root5 not found: manifest unknown: manifest unknown.
See 'docker run --help'.

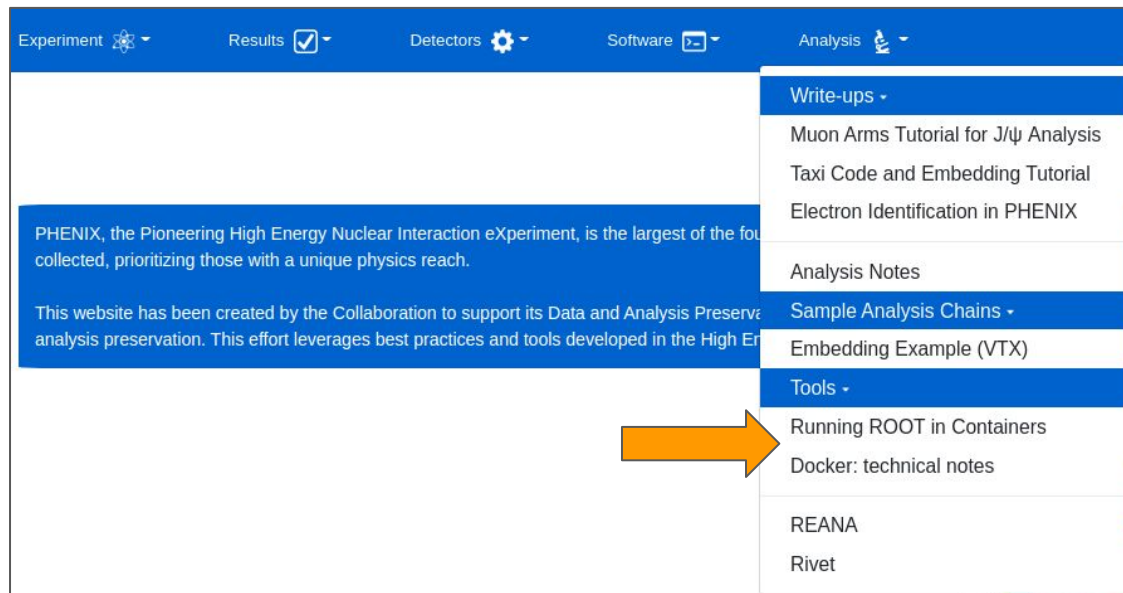
24/02/2021 19:54:23 /home/mobaxterm docker run -it --rm phenixcollaboration/tools:sl7_root5
*****
*                               *
*      W E L C O M E  t o  R O O T      *
*                               *
*   Version   5.34/36      5 April 2016   *
*                               *
*   You are welcome to visit our Web site *
*   http://root.cern.ch *
*                               *
*****

ROOT 5.34/36 (v5-34-36@v5-34-36, Apr 05 2016, 10:25:45 on linuxx8664gcc)

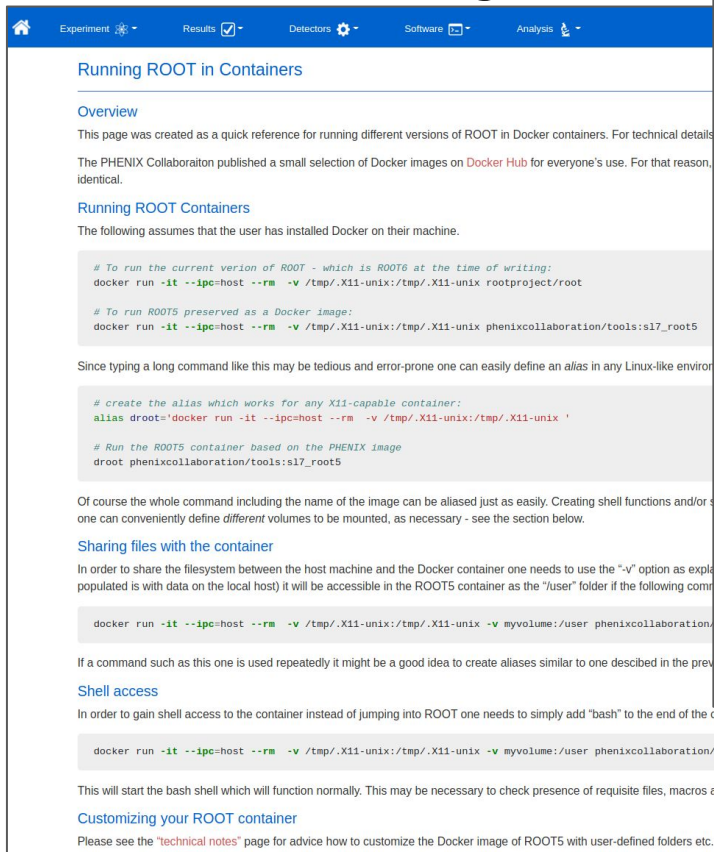
CINT/ROOT C/C++ Interpreter version 5.18.00, July 2, 2010
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0] tb=TBrowser();
root [1] █
```

# Website updates

- Docker pages created, fair amount of material added
  - Quick start + Technical details



# Website: Docker Pages



The screenshot shows the 'Running ROOT in Containers' page. It includes an overview, a section on running ROOT containers with terminal commands for ROOT6 and ROOT5, a section on creating aliases for these commands, a section on sharing files with the container, a section on shell access, and a section on customizing the ROOT container. The page is part of a larger website with a blue header and navigation menu.

## Running ROOT in Containers

### Overview

This page was created as a quick reference for running different versions of ROOT in Docker containers. For technical details The PHENIX Collaboration published a small selection of Docker images on [Docker Hub](#) for everyone's use. For that reason, it is not possible to provide a full list of all the images.

### Running ROOT Containers

The following assumes that the user has installed Docker on their machine.

```
# To run the current version of ROOT - which is ROOT6 at the time of writing:
docker run -it --ipc=host --rm -v /tmp/.X11-unix:/tmp/.X11-unix rootproject/root

# To run ROOT5 preserved as a Docker image:
docker run -it --ipc=host --rm -v /tmp/.X11-unix:/tmp/.X11-unix phenixcollaboration/tools:s17_root5
```

Since typing a long command like this may be tedious and error-prone one can easily define an alias in any Linux-like environment.

```
# create the alias which works for any X11-capable container:
alias droot='docker run -it --ipc=host --rm -v /tmp/.X11-unix:/tmp/.X11-unix '

# Run the ROOT5 container based on the PHENIX image
droot phenixcollaboration/tools:s17_root5
```

Of course the whole command including the name of the image can be aliased just as easily. Creating shell functions and/or one can conveniently define *different* volumes to be mounted, as necessary - see the section below.

### Sharing files with the container

In order to share the filesystem between the host machine and the Docker container one needs to use the "-v" option as explained above. If the container is populated with data on the local host) it will be accessible in the ROOT5 container as the "user" folder if the following command is used:

```
docker run -it --ipc=host --rm -v /tmp/.X11-unix:/tmp/.X11-unix -v myvolume:/user phenixcollaboration/tools:s17_root5
```

If a command such as this one is used repeatedly it might be a good idea to create aliases similar to one described in the previous section.

### Shell access

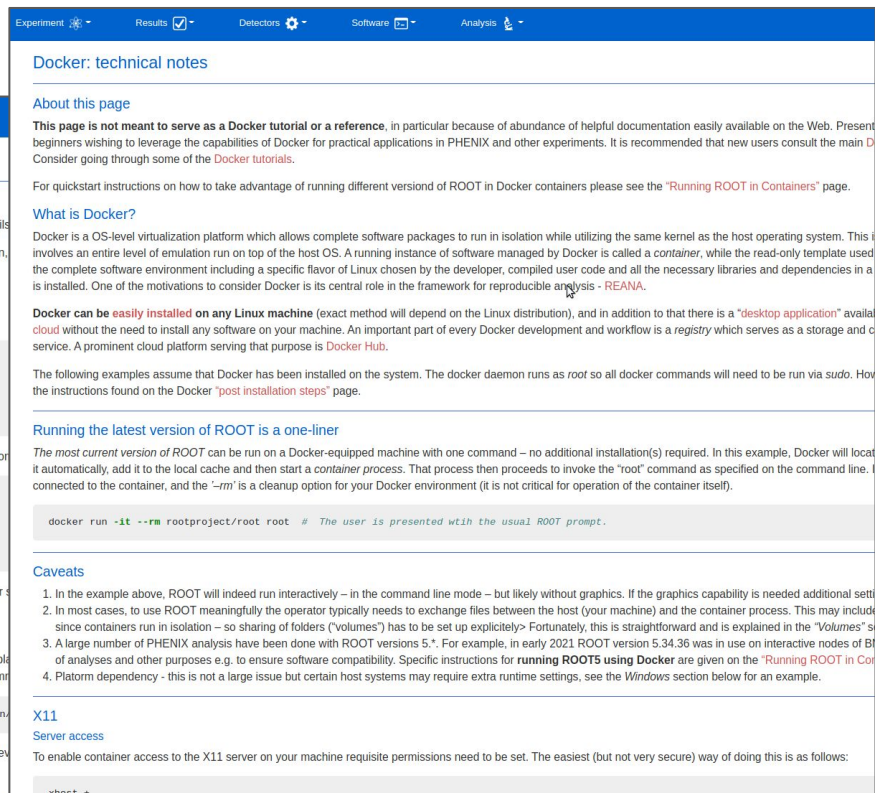
In order to gain shell access to the container instead of jumping into ROOT one needs to simply add "bash" to the end of the command line:

```
docker run -it --ipc=host --rm -v /tmp/.X11-unix:/tmp/.X11-unix -v myvolume:/user phenixcollaboration/tools:s17_root5 bash
```

This will start the bash shell which will function normally. This may be necessary to check presence of requisite files, macros and other settings.

### Customizing your ROOT container

Please see the ["technical notes"](#) page for advice how to customize the Docker image of ROOT5 with user-defined folders etc.



The screenshot shows the 'Docker: technical notes' page. It includes an 'About this page' section, a 'What is Docker?' section, a 'Running the latest version of ROOT is a one-liner' section, a 'Caveats' section, and an 'X11 Server access' section. The page is part of a larger website with a blue header and navigation menu.

## Docker: technical notes

### About this page

This page is not meant to serve as a **Docker tutorial** or a **reference**, in particular because of abundance of helpful documentation easily available on the Web. Presently, beginners wishing to leverage the capabilities of Docker for practical applications in PHENIX and other experiments. It is recommended that new users consult the main [Docker page](#). Consider going through some of the [Docker tutorials](#).

For quickstart instructions on how to take advantage of running different versions of ROOT in Docker containers please see the ["Running ROOT in Containers"](#) page.

### What is Docker?

Docker is an OS-level virtualization platform which allows complete software packages to run in isolation while utilizing the same kernel as the host operating system. This involves an entire level of emulation run on top of the host OS. A running instance of software managed by Docker is called a *container*, while the read-only templates used to create the complete software environment including a specific flavor of Linux chosen by the developer, compiled user code and all the necessary libraries and dependencies in a container is called an *image*. One of the motivations to consider Docker is its central role in the framework for reproducible analysis - [REANA](#).

Docker can be **easily installed on any Linux machine** (exact method will depend on the Linux distribution), and in addition to that there is a *"desktop application"* available without the need to install any software on your machine. An important part of every Docker development and workflow is a registry which serves as a storage and distribution service. A prominent cloud platform serving that purpose is [Docker Hub](#).

The following examples assume that Docker has been installed on the system. The docker daemon runs as root so all docker commands will need to be run via `sudo`. However, the instructions found on the Docker ["post installation steps"](#) page.

### Running the latest version of ROOT is a one-liner

The *most current version of ROOT* can be run on a Docker-equipped machine with one command – no additional installation(s) required. In this example, Docker will locate it automatically, add it to the local cache and then start a *container* process. That process then proceeds to invoke the "root" command as specified on the command line, connected to the container, and the "-rm" is a cleanup option for your Docker environment (it is not critical for operation of the container itself).

```
docker run -it --rm rootproject/root root # The user is presented with the usual ROOT prompt.
```

### Caveats

1. In the example above, ROOT will indeed run interactively – in the command line mode – but likely without graphics. If the graphics capability is needed additional settings are required.
2. In most cases, to use ROOT meaningfully the operator typically needs to exchange files between the host (your machine) and the container process. This may include the use of *"volumes"* – so sharing of folders ("volumes") has to be set up explicitly. Fortunately, this is straightforward and is explained in the *"Volumes"* section of the [Docker documentation](#).
3. A large number of PHENIX analysis have been done with ROOT versions 5.\*. For example, in early 2021 ROOT version 5.34.36 was in use on interactive nodes of BNL's [PHENIX computing resources](#) and for other purposes e.g. to ensure software compatibility. Specific instructions for [running ROOT5 using Docker](#) are given on the ["Running ROOT in Containers"](#) page.
4. Platform dependency - this is not a large issue but certain host systems may require extra runtime settings, see the [Windows](#) section below for an example.

### X11 Server access

To enable container access to the X11 server on your machine requisite permissions need to be set. The easiest (but not very secure) way of doing this is as follows:

```
sudo xhost +
```

# Analysis notes options: a redux

- Any type of file sharing option - with encryption
  - Passwords can be circulated to select participants only
  - Finding a truly portable solution may be a bit of a challenge, openssl is a strong contender (all platforms)
- Zenodo - private access option
  - Access on demand, decided by the PHENIX Zenodo curators
  - The only solution offering proper built-in indexing and search capabilities
- GitHub - a private repository
  - Accessible to users on a managed list
  - GitHub tags can be used for indexing (like keywords)
- BNLbox
  - Broadly speaking, an equivalent of Dropbox with vastly larger storage available
  - Web UI
  - File upload and download using a CLI script is possible
  - A fairly capable access control system

# Status and Plans

- Look at the overlap of the PHENIX School and DAP work
- Open Data - make our first entry final
- Ongoing HEPData work
- The hard part - build useable Docker images for DAP - engagement with the Collaboration is required
  - Prerequisite to REANA