ROOT Status and Prospects

D. Piparo (CERN EP-SFT) for the ROOT Project

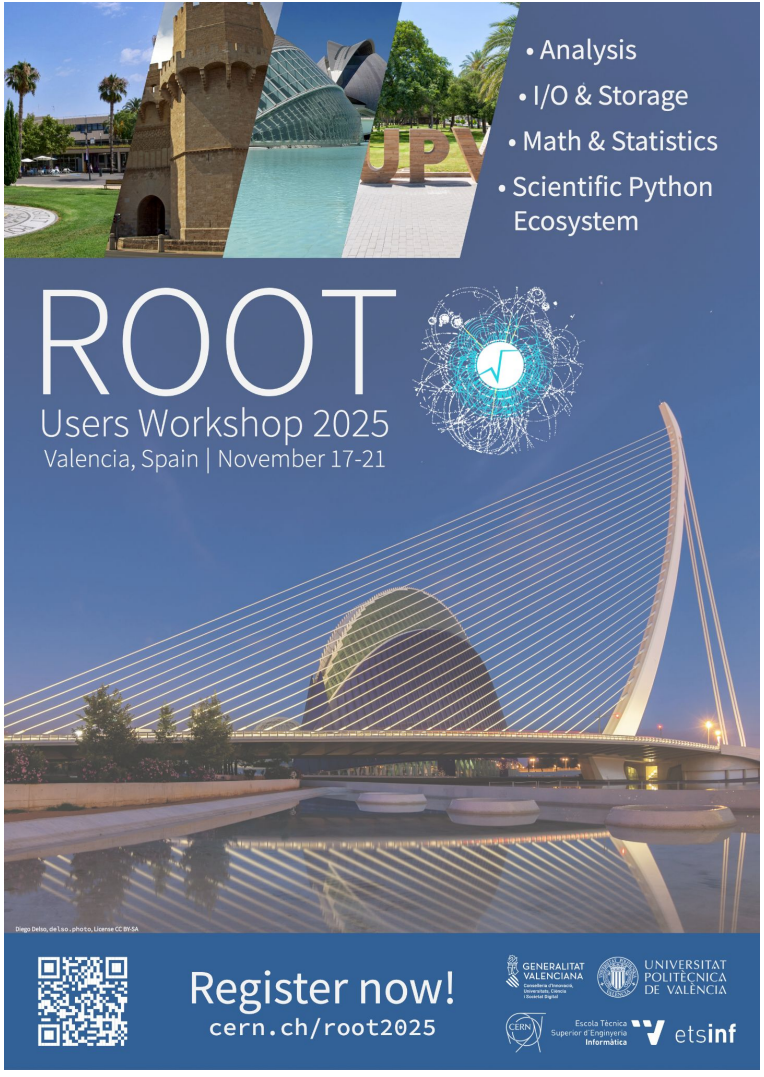
https://root.cern

XVII CPAN Days - Valencia
19-11-2025

Thanks for the opportunity to give a talk today, and for your answers to our survey!

1. `99 FNAL
2. `00 CERN
3. `01 FNAL
4. `02 CERN
5. `03 Montreal
6. `04 SLAC
7. `05 CERN
8. `07 CERN
9. `13 Saas-Fee
10. `15 Saas-Fee
11. `18 Sarajevo
12. `22 FNAL*
13. **`25 Valencia**
14. ? `2X ????????

*Pandemic, hybrid at CERN



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ROOT: An Open International Collaboration

Open-source and open-development

- On GitHub, LGPL 2.1
- PR-based model with a public review process

Open-planning: the Program of Work (PoW)

- Can be influenced with active engagement and contributions!
- Usually presented publicly in January
- Quarterly public reports to check progress, e.g. Q3 2025

ROOT is its user community, contributors and core developers

Get to know the team here

ROOT's Strategic goals

Provide a unified software package for the storage, processing, visualisation and analysis of scientific data that is reliable, performant, supported and sustainable, that is easy to use and obtain, and that minimises computing resources and scientists' time needed to achieve results.

The success of experiments and all ROOT users at large is our priority

Much More than the LHC Community!

LIGO

KAGRA

BESIII

JUNO

HighLO

DUNE

Belle II

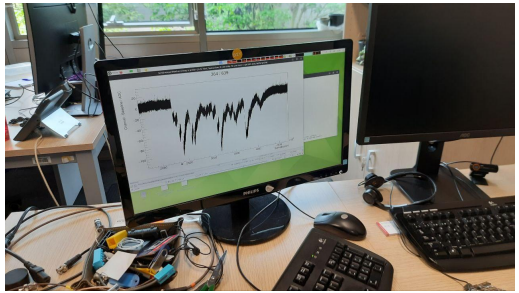
STAR

FUTURE CIRCULAR COLLIDER

VIRGO

ePIC

SHiP



And much more…

Vision Towards HL-LHC

While honouring the Strategic Goals:

- Play a **leading role in the solution of the HL-LHC resource challenge**
  - Compute, storage and network - Analysis and central data processing
- Maintain the current level of support, **actively engage with our users**, also establishing new collaborations
- Continue to be **at the center of the C++ scientific (HEP) ecosystem**
- **Prioritise the experience from Python**
  - Further improve interoperability with the (ML) Python open-source ecosystem
- **Simplify** building, packaging, installation, distribution
- **Deliver new components, keeping in check the overall cost of ownership** of the code base (e.g. through deprecations)

How can ROOT do *all* that?

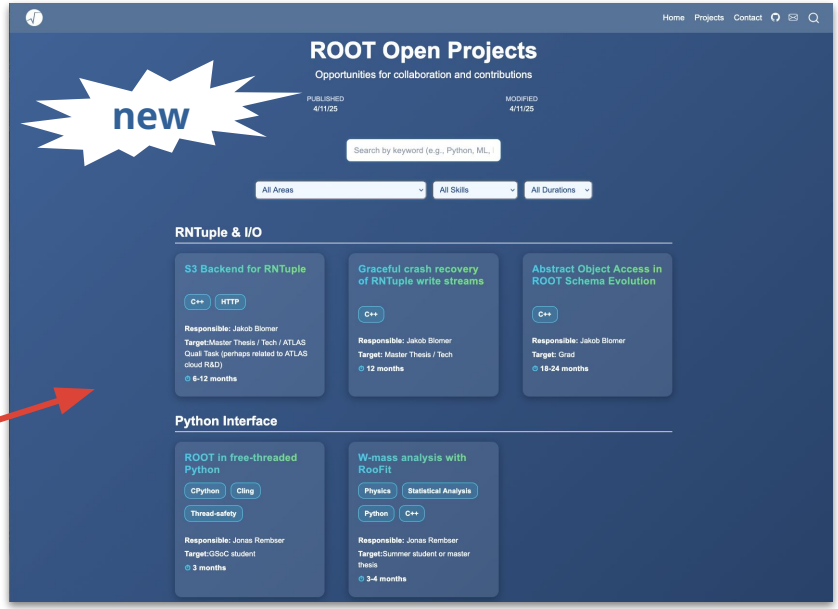
Collaborating with its community!

🚀 ~100 unique contributors per year, 10% of the commits in `24 authored outside of the core dev team

🙋 A single, motivated individual can make the difference!

It is easy to start:

- Talk to us ✉️
- good first issue on GitHub
- List of open projects
- Contribution guidelines



https://root.cern/open_projects

We Want to Collaborate with You

Two examples, on top of regular user support

🤝 ROOT-Experiment Liaisons

- A member of the core dev team, affiliated with the experiment
- Today 6 Liaisons: LHC experiments, DUNE and FCC
- Objective, in a nutshell: make ROOT work well for the experiment
- Take part in meetings, discussions, focus sessions …

👩‍💻 Participation to experiments' events, meetings and hackathons

- E.g., in 2025: CMS (2x 1 week, 2 people), SHiP (1 week, 2 people)

Can the above be interesting for your community?

From R&D to Production

The ROOT project is a veritable platform to make R&D blossom, for example

- Cling (the C++ interpreter), CppInterop
- Automatic differentiation with Clad, now in RooFit
- RNTuple – 6y of R&D, now transitioning to production
- New histograms, preview in 6.38.00 next week

ROOT: a project where result-oriented R&D activities blossom, reaching thousands of scientists.

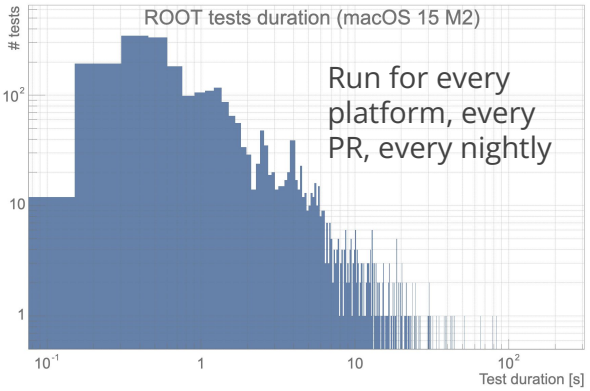
Support by supranational funding, e.g.:

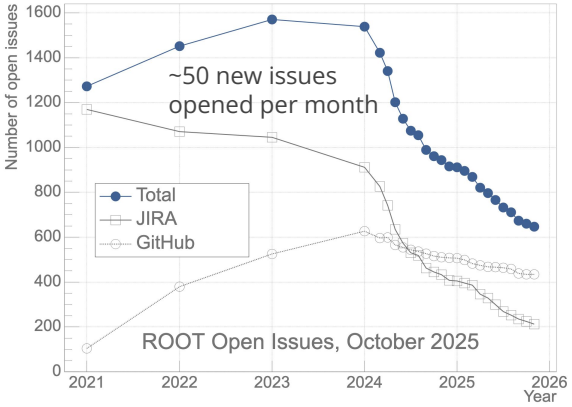
HighLO: prevent fraud on the financial market with particle physics methods and tools

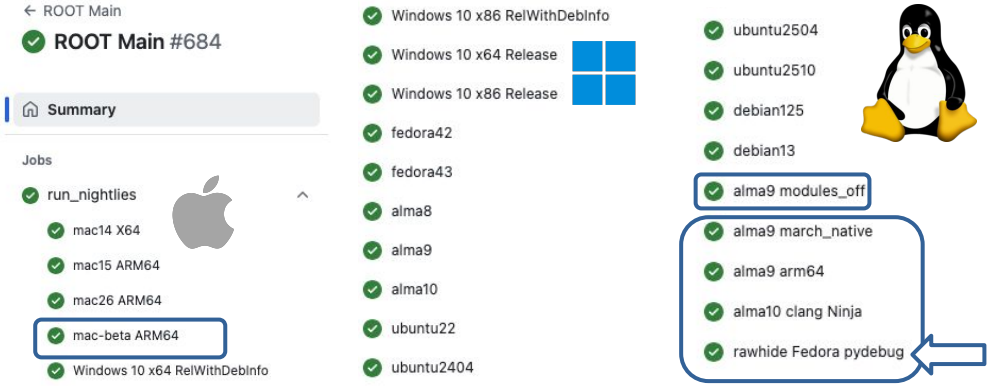
SYCLOPS: Advance AI and mining of extremely large and diverse data for EU and beyond

Experimental Physics Department R&D: innovative I/O formats (RNTuple), Python-C++ interoperability, Analysis at scale

Stability and Reliability







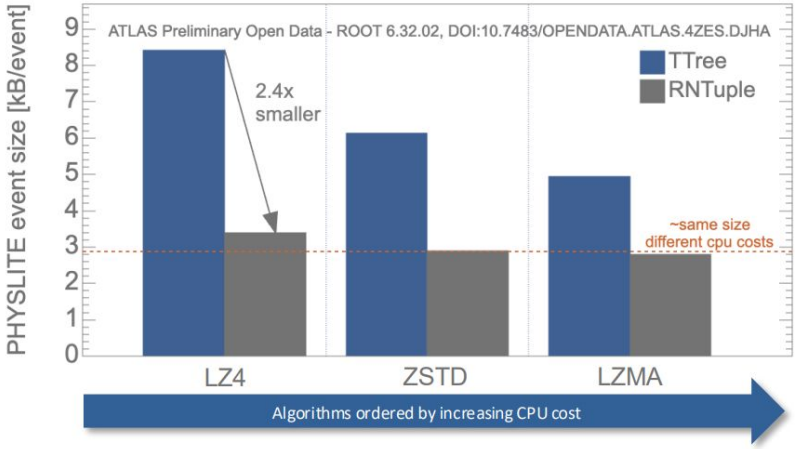
Bleeding edge Python version, dbg mode

A solid base for innovation and reliability

One Powerful Example

RNTuple: **new on-disk format** and a **new API**

- 15% – 40% smaller files for typical HEP data
- Faster reads and writes, often by factors
- Fully checksummed
- Design validated for native object store support
- Parallelism built-in
- Modern, robust, thread/type-safe API (C++, Python)
  - Externally reviewed by → HEP-CCE (DOE)



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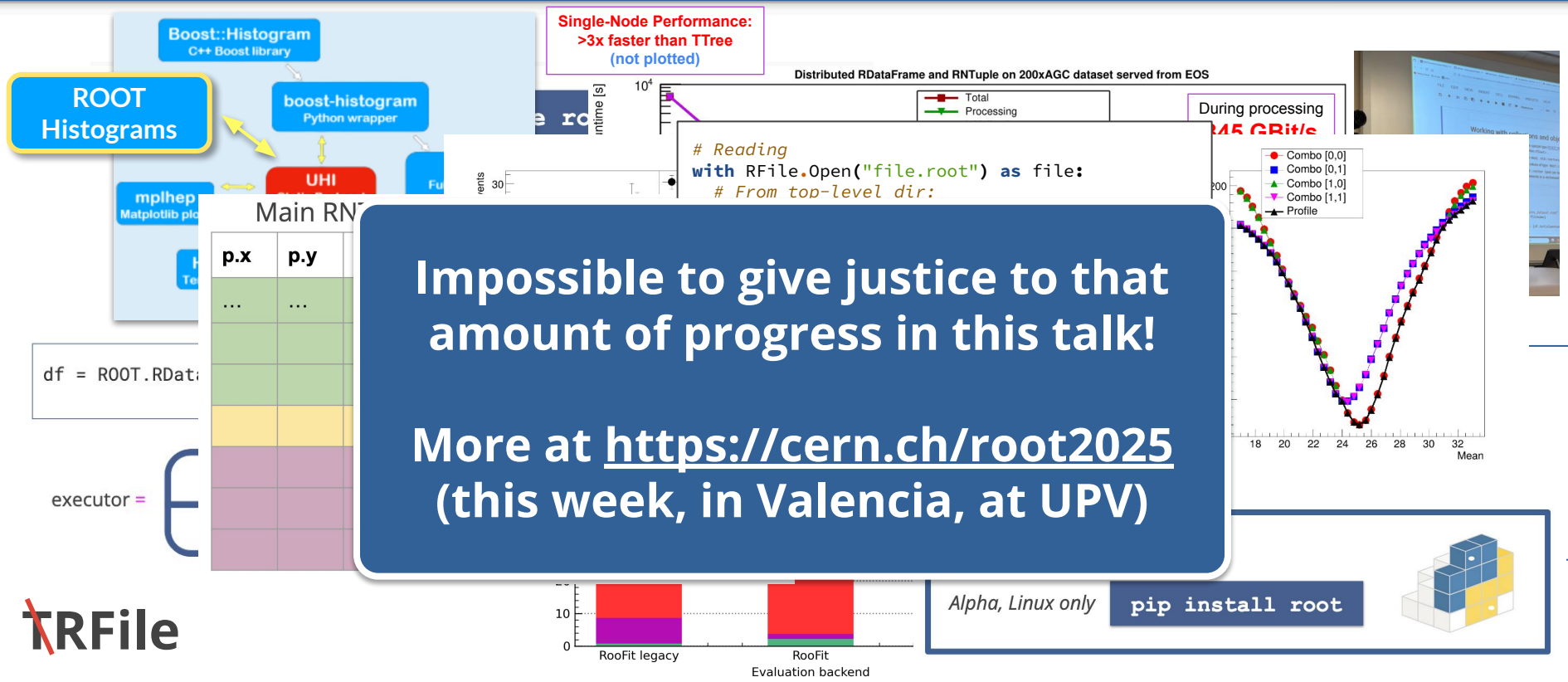
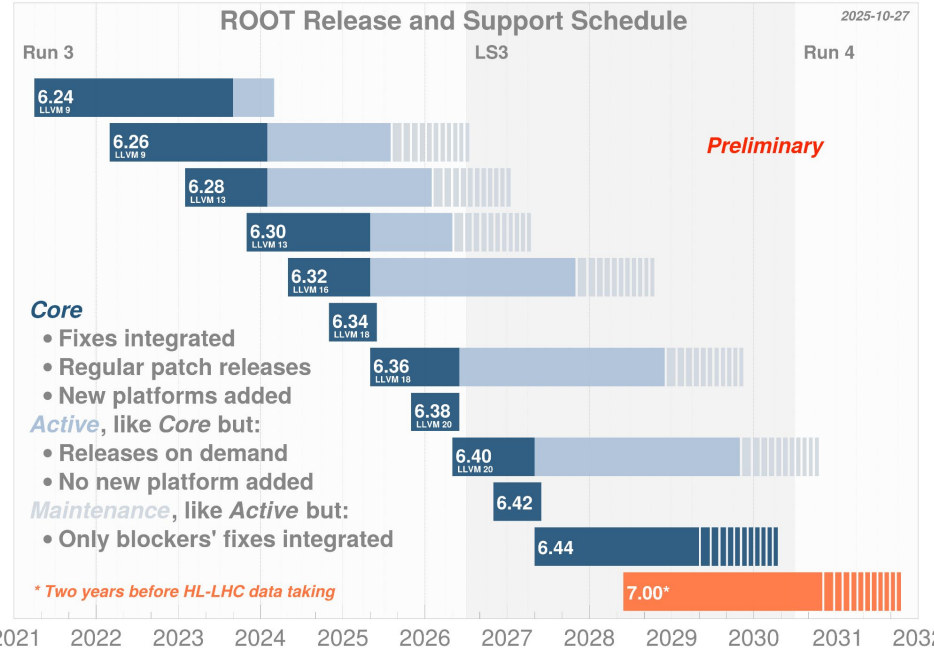
Tons of new Features



A solid plan ahead



Presented at the 3rd ROOT Quarterly Report meeting

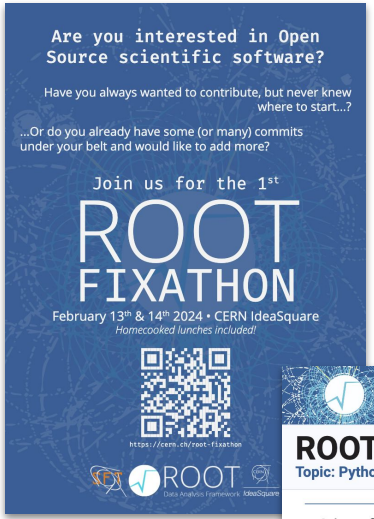
ROOT:

- An end-to-end framework, **from core sw to data analysis, Python and C++**
- Open source, open development, open planning
- Collaborate and contribute: many opportunities
- Drive innovation with R&D that will reach thousands of scientists

Play a central role in addressing future scientific computing challenges

Talk to Us

- 🤝 Here, at the Workshop
- [ROOT Users Forum](), our main support channel
- [ROOT's Mattermost Team]()
- [GitHub](): issue or PR
- ✉️ [root-dev@cern.ch]() (GitHub and Forum preferred)
- 🧑‍💻 At a ROOT Hackathon, you are all warmly invited!



Backup - The Survey

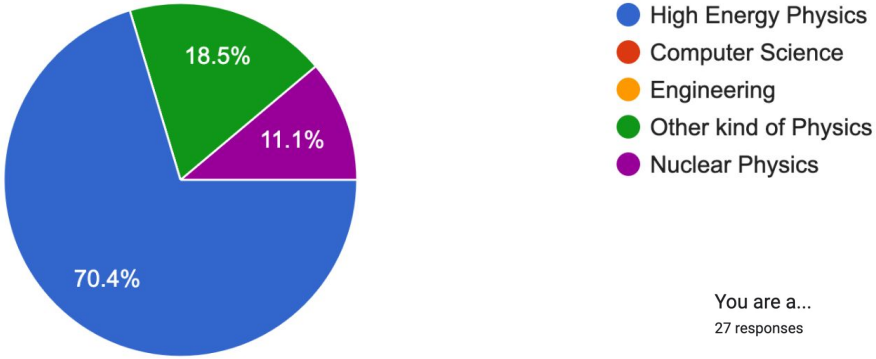
ROOT Survey

- A Survey about ROOT was advertised through the COMCHA Network a few weeks ago
- General questions about the project, aiming to distill useful information about the usage patterns
- 27 responses provided: thanks for that!
- An in-depth analysis is not available yet, however a few useful insights can be distilled already!

Overview 1/2

What is your field of study or scientific research?

27 responses

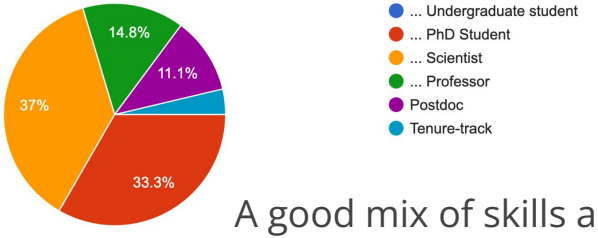


A clear confirmation of the fact that ROOT is not only HEP

Proton decay searches, neutrino oscillations, LHC precision physics, data preparation, calibration, alignment, Higgs physics, medical applications…

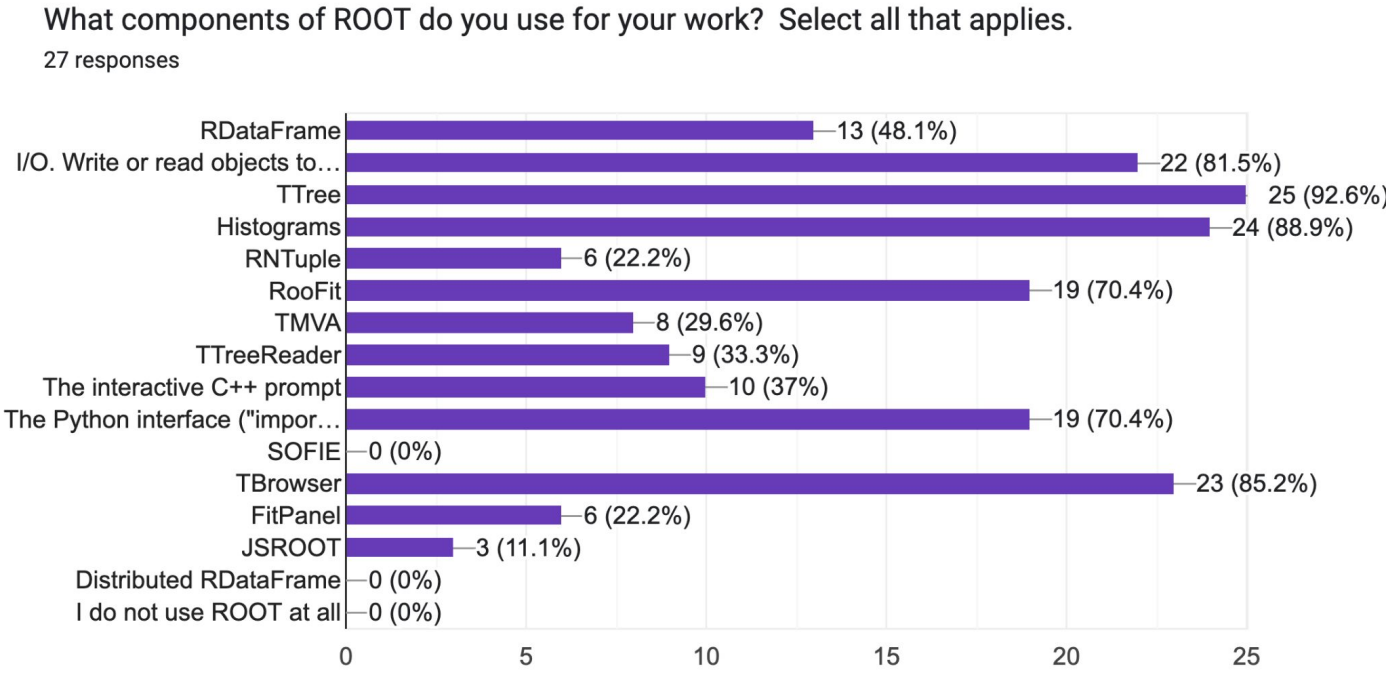
You are a...

27 responses



A good mix of skills and level of experience

Overview 2/2


What components of ROOT do you use for your work? Select all that applies.
27 responses
RDataFrame
13 (48.1%)
I/O. Write or read objects to…
22 (81.5%)
TTree
25 (92.6%)
Histograms
24 (88.9%)
RNTuple
6 (22.2%)
RooFit
19 (70.4%)
TMVA
8 (29.6%)
TTreeReader
9 (33.3%)
The interactive C++ prompt
10 (37%)
The Python interface ("impor…
19 (70.4%)
SOFIE
0 (0%)
TBrowser
23 (85.2%)
FitPanel
6 (22.2%)
JSROOT
3 (11.1%)
Distributed RDataFrame
0 (0%)
I do not use ROOT at all
0 (0%)
0
5
10
15
20
25

Some Preliminary Thoughts

We appreciated the written answers provided to us: thank you!

They were attentively considered and discussed. Some preliminary thoughts can be formulated a this point

- There is appreciation for the active community and development
- Users noticed the direction ROOT took and like it, e.g. transparent multithreading, Python interoperability, ergonomic interfaces
- Investments made in documentation, examples and simplification of some components (e.g. plotting) can have a high return.