SubMIT: getting physics things done at MIT Project overview

David Walter

23th January 2026

Workshop on Basic Computing Services in the Physics Department - subMIT

Introduction

Our mission

- Provide basic computing services in the MIT physics department

- Enable easy access for newcomers to start their physics analysis

- Support advanced customization for experiences users

- Ensure sufficient and efficient computing resources through fair sharing

We do the maintenance such that you don't have to care about

- System configuration, upgrades, security

- Software installation and management

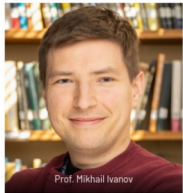- Integration with external resources and services

So you can focus on doing great physics

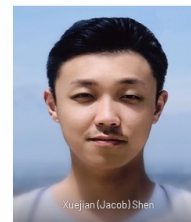# Project organization

Steering committee

- Oversight
- Funding

Prof. Mikhail Ivanov   Prof. Christoph Paus (chair)   Prof. Mark Vogelsberger

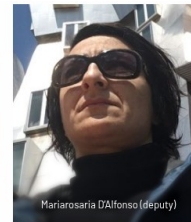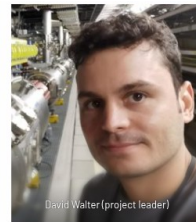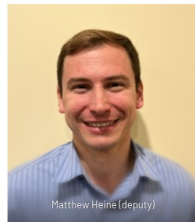Prof. Deepto Chakrabarty   Prof. Rob Simcoe   Prof. Bolek Wyslouch

SubMIT Hosting team

- LNS computing integration

Paul Acosta   David Newman

Project team

- Implementation
- Operation
- Maintenance
- Support

A2rchi

Matthew Heine (deputy)   David Walter (project leader)   Mariarosaria D'Alfonso (deputy)

Luca Lavezzo   Marianne Moore   Xuejian (Jacob) Shen

Maxim Goncharov   Alexander (Alex) Avdoshkin   Jan Eysermans
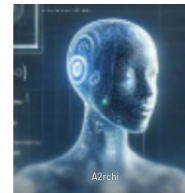
Users group

- Information flow between user community and project team
- Feedback
- Requests

Amer Ahmad Al-Hiyasat   Jordan Lang   Hans Moritz Günther

Jose Miguel Munoz Arias   Josu Aurrekoetxea   Luke Kim
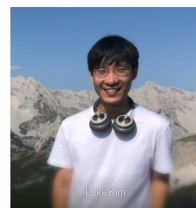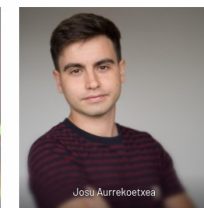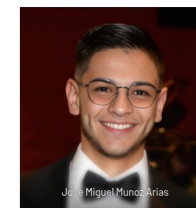
Want to be part of it?

- Contact us

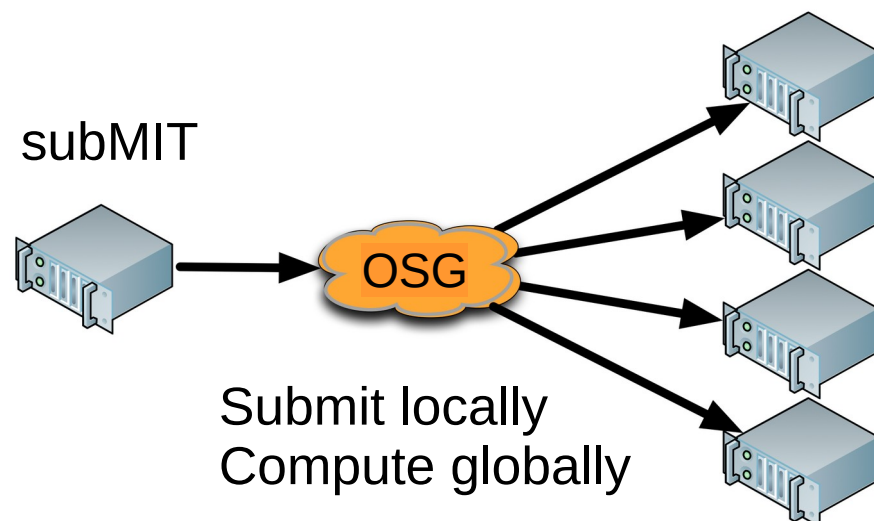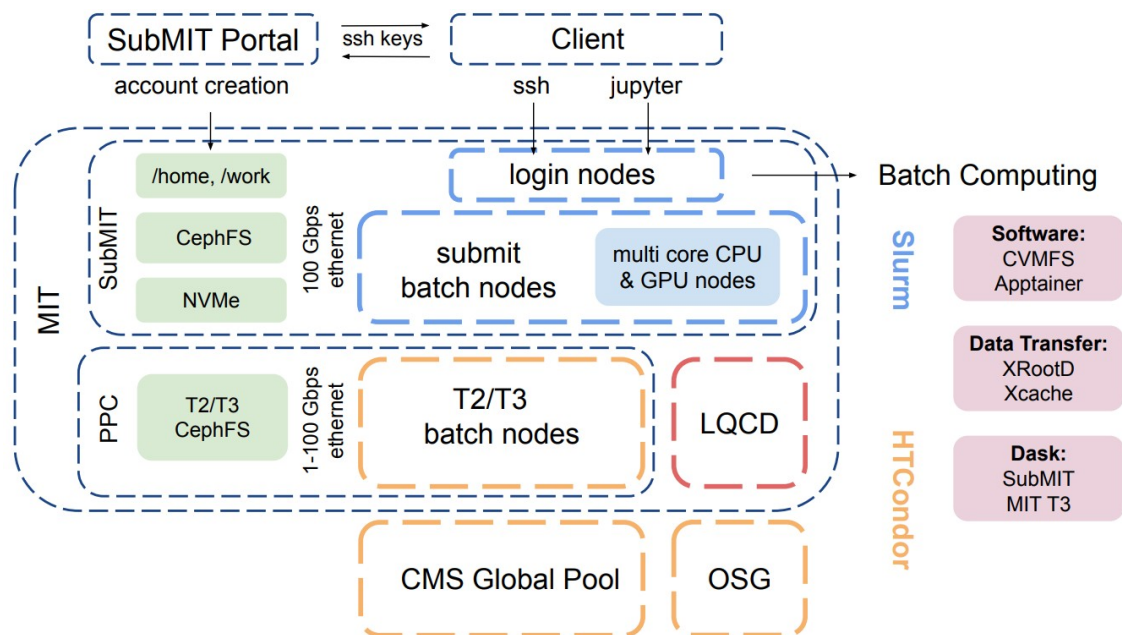# Resources

Local batch system

- ~2000 CPU cores; ~60GPUs

- Interactive SSH login pool

- Jupyterhub access

Convenient software environment

- Alma Linux 9 native

- Python, C++, Java, ...

- Containers (singularity/ podman)

- Virtual environments (Conda)

Access to larger external resources

- Open Science Grid (OSG)

- CMS Tier-2 and Tier-3

subMIT

Submit locally
Compute globally

SubMIT overview

Website

- Overview and general information
- Account creation
- Events (like this today)
- Direct JupyterHub access
- A2rchi (chatbot)
- Documentation: User guide
- Monitoring systems

SubMIT documentation

Website

- Overview and general information

- Account creation

SubMIT machines

Campus_Submits   Submits-Login

submit20	submit21	submit22	submit23
submit30	submit37	submit50	submit51
submit52	submit53	submit54	submit55
submit56	submit57	submit58	submit59
submit60	submit62	submit63	submit64
submit65	submit66	submit67	submit68
submit71	submit72	submit73	submit75
submit76	submit77	submit80	submit81
submit82	submit95	submit96	

submit00	submit01	submit02	submit03
submit04	submit05	submit06	submit07
submit08			

...IT login pool is designed to let users login safely, prepare and test their research, and submit to the large computing resource of their choice. Check it out!

Get your SubMIT Account   SubMIT Users Guide   Events

Access

ssh <user>@submit.mit.edu   jupyterhub

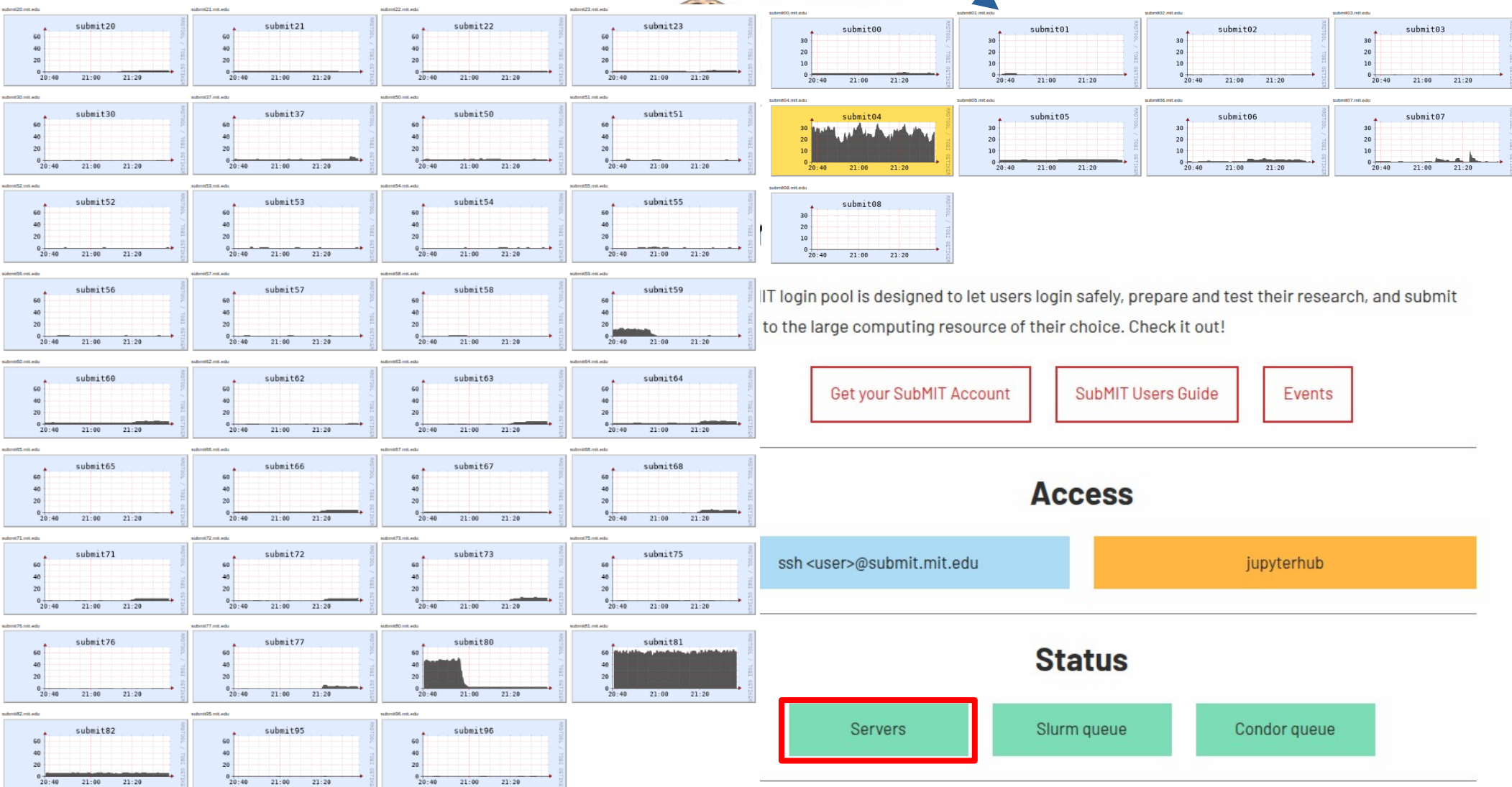## Status

Servers   Slurm queue   Condor queue

SubMIT monitoring

User base

1000 total users!

01/19/26, 15:20

Everything public

interactive	
batch	

ssh only	
slurm interactive jobs	
JupyterHUB	
condor	
slurm batch jobs	
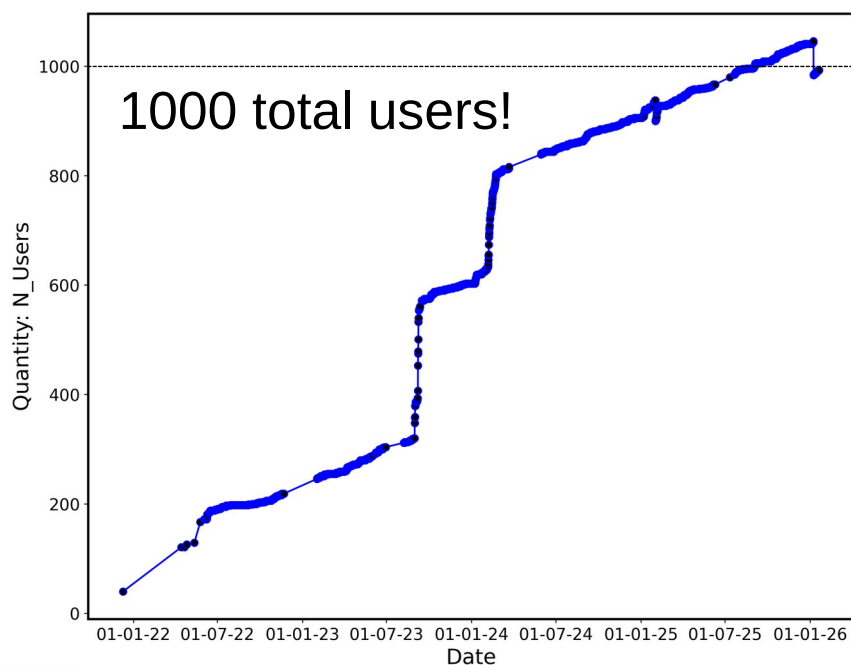
Active users of last 90 days (163)

- from different physics departments

- using subMIT in different ways

other	
Experimental Nuclear & Particle Physics	
External to the physics department	
Atomic, Biophysics, Condensed Matter, & Plasma Physics	
Astrophysics	
Theoretical Nuclear & Particle Physics	
not_specified	
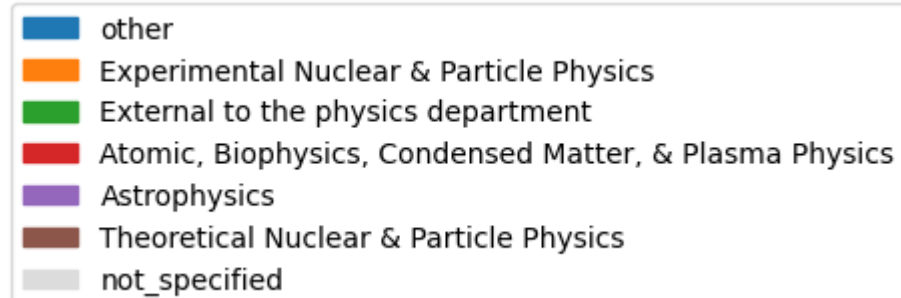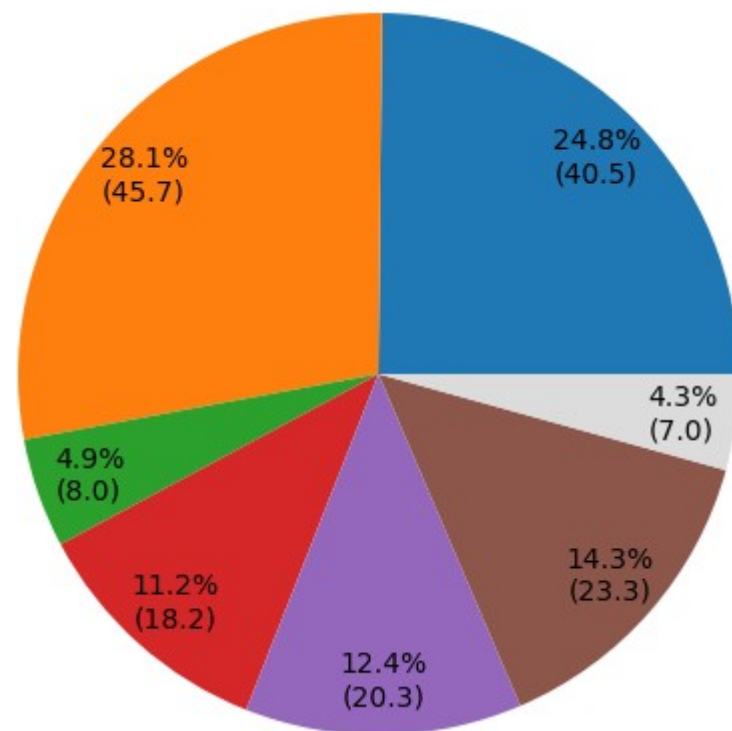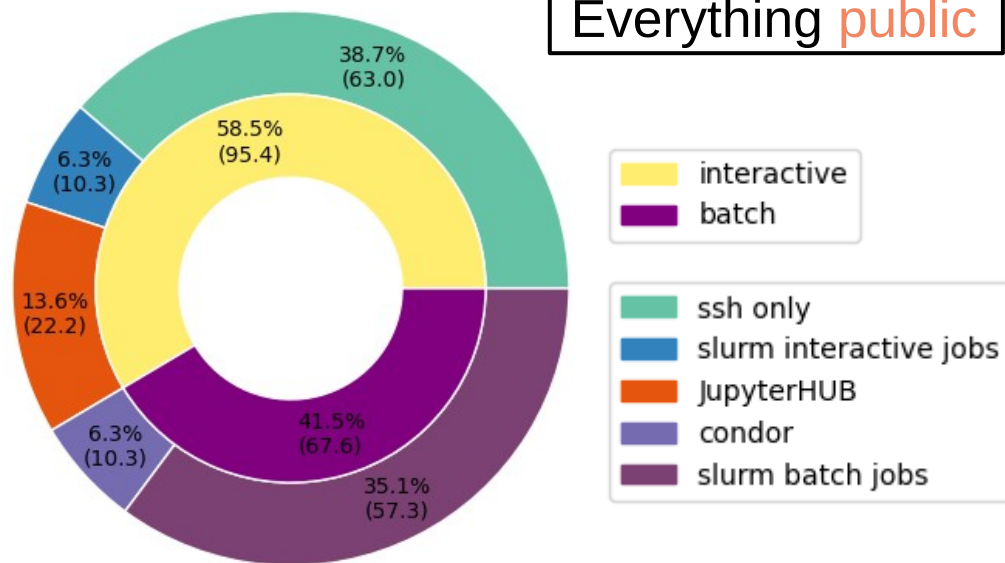
User base

Everything public

Expert information

On SubMIT we want to provide full transparency while keeping privacy. On this page, interested users can find inside information of the system. Please get in touch if you find something missing.

User support	System metrics	Backups

When users send us a mail to submit-help@mit.edu a ticket is created in our redmine system. Here you can find a meta data analysis of our tickets.
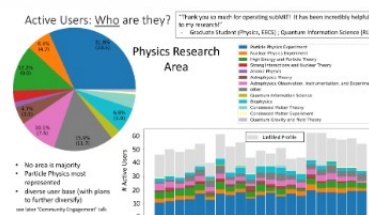
Are wondering who are the people you share the system with? Have a look at our users, what career stage, center and department they are. You can also find the information from the poll you filled when creating the account. And which resources are used.

All home directories on SubMIT are daily backed up incrementally, and fully each weekend. Have a look if your home directory got backed up correctly and how much space it consumes!

More plots: submit summary

User support

User support is a key feature of the system

- Contact: submit-help@mit.edu

- Slack workspace: https://mit-submit.slack.com/

  - "help-desk" channel

- Personal office hours on demand

Beyond basic troubleshooting

- Help users make optimal use of the available resources

- Expert advice on designing/improving workflows

- Customize and evolve system configuration, accommodate user needs as appropriate

Voluntary (anonymous) survey

- Please tell us what you like or don't like

User support

Don't hesitate to contact us

- We receive about 1 email every other day

Year	Tickets
2023	186
2024	243
2025	242
2026	15 ...

- Usually answered within a day
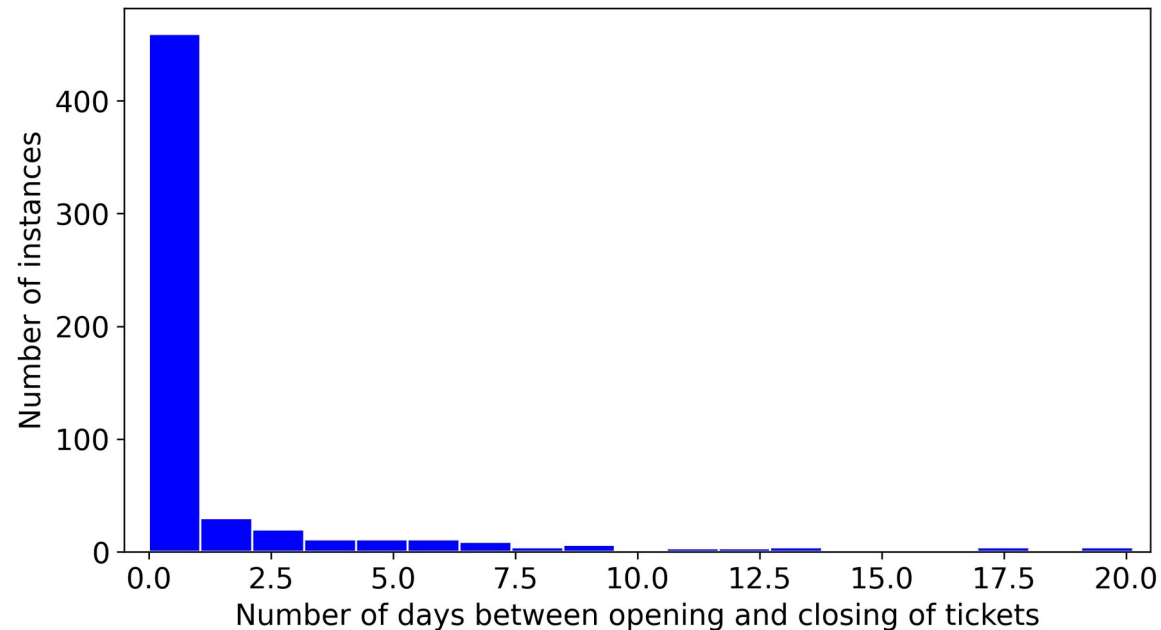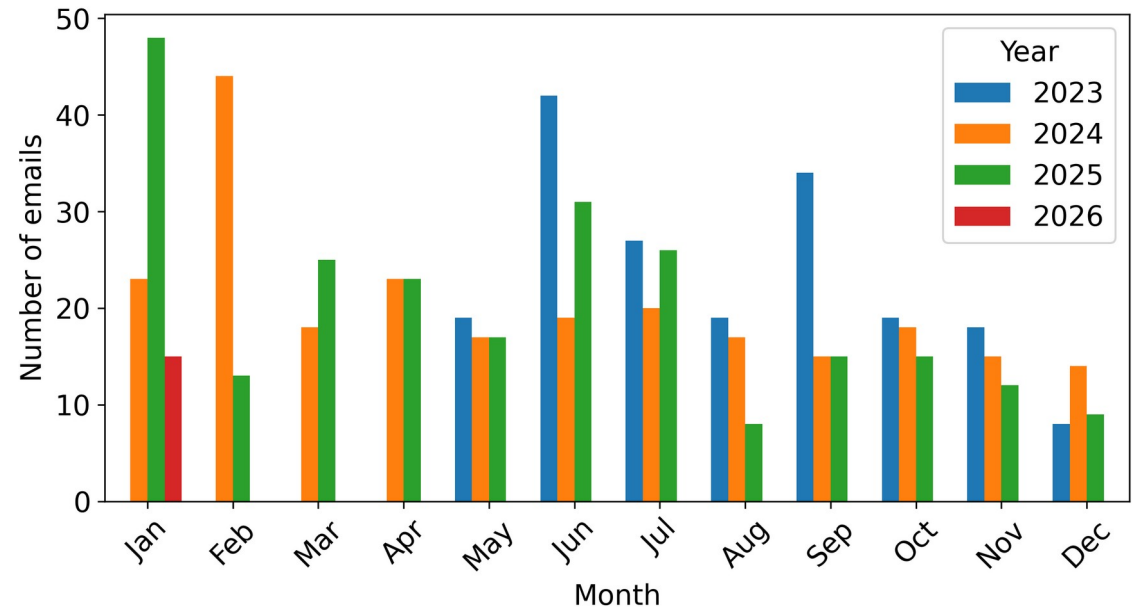
Classroom usage

Introductory undergraduate courses: 8.01, 8.02

- Technology-Enabled Active Learning (TEAL)

Advanced courses, junior lab: 8.13, 8.14

Workshops/ Hackathons

- FCC month, Gaia Hackathon, ...

Resource reservation via slurm

Software distribution and robust usage for O(100) students

- Kernel with customized python environment accessible through JupyterHub
- CVMFS for specialized programs or environments

Monthly user group meetings

Information flow between user community and project team

- Advertised and open to the broader community
- Tuesdays 10:00-11:00 EST
- Hybrid: Kolker room + Zoom

Topical presentations from

- Users and community members
- User group representatives
- Project team

Room for discussions and feedback

User	Talk
Josu Aurrekoetxea (02/11/2025)	Solving Einstein's Equations on the computer
Richard Nally (03/11/2025)	Computing Calabi-Yau Manifolds
Scott Hughes (04/22/2025)	Modeling gravitational waves using highly distributed parallel computing
Jean Du Plessis (06/03/2025)	Simulating heavy quarks in quark gluon plasma
Max Geier (07/01/2025)	Is attention all you need to solve the correlated electron problem?
Ivan Paus (09/16/2025)	A2rchi – An Open Source LLM Framework
Benedikt Maier (10/28/2025)	Multimodal training of jet taggers on subMIT

Monthly user group meetings

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Topical presentations from

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Room for discussions and feedback

Latest meeting:

- October 28

Contact us if you like to present!

- submit-help@mit.edu

News articles

New users automatically added to receive SubMIT news articles ~1 per week/month

- Keep updated about SubMIT

News

Changes in the Project Team – Farewell, Qier and welcome Jan!

by **David Walter** – January 5, 2026

The new year begins with the farewell of a valued member of our project team: Zhangqier Wang (Qier), a founding

Continue reading »

GPU Resources Update at SubMIT

by **Alexander Avdoshkin** – December 10, 2025

The GPU resources at SubMIT have recently been updated to increase overall capacity and an express queue has been introduced.

Continue reading »

Passing the magical 1000 users mark

by **Christoph Paus** – November 21, 2025

According to our records, SubMIT has passed the magical 1000 users mark on September 1, 2025. Users include everybody who

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Annual SubMIT review

by **Marianne Moore** – May 23, 2025

On May 22, SubMIT had its annual review where the project team presented to the steering committee a summary of
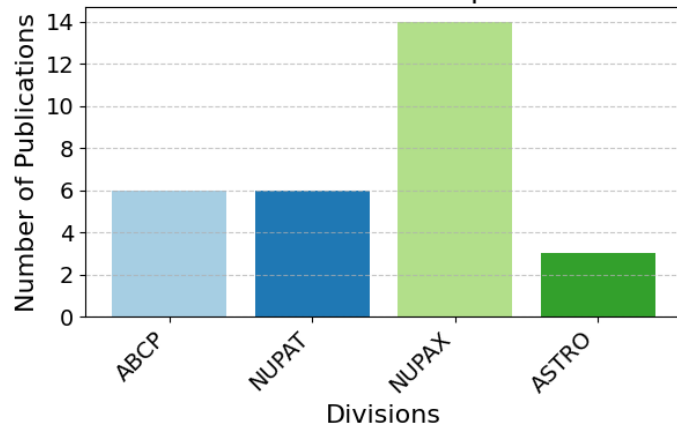
Continue reading »

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Publications using SubMIT

Increasing number of publications with significant use of SubMIT

- Let us know about your publication!

Number of Publications per Division

2023 (4)

- H. Günther, P. Cheimets, E. Miller et al., *SPIE Proceedings Volume 12678, UV, X-Ray, and Gamma-Ray Space Instrumentation for Astronomy XXIII*, SPIE Proceedings, 12678, 126781D. DOI.
  Division: Astrophysics | **Center:** MKI
- S. Liu, J. Miné-Hattab, M. Villemeur et al., *In vivo tracking of functionally tagged Rad51 unveils a robust strategy of homology search*, Nature Structural & Molecular Biology, 30, 1582–1591. DOI.
  Division: Biophysics | **Center:** Physics of Living Systems
- CMS Collaboration, *Search for direct production of a GeV scale resonance decaying to a pair of muons in proton-proton collisions at √s = 13 TeV*, JHEP, 070. DOI.
  Division: Experimental Particle Physics | **Center:** LNS
- CMS Collaboration, *Measurement of $B_s^0 \to \mu^+\mu^-$ decay properties and search for the $B^0 \to \mu^+\mu^-$ decay in proton-proton collisions at √s = 13 TeV*, Phys. Lett. B, 842, 137955. DOI.
  Division: Experimental Particle Physics | **Center:** LNS

2024 (12)

- O. Kitouni, N. Nolte, V. Samuel Pérez-Díaz, et al., *From Neurons to Neutrons: A Case Study in Interpretability*, ICML. DOI.
  Division: Experimental Nuclear & Particle Physics | **Center:** IAIFI, LNS
- S. Abe, T. Araki, K. Chiba et al., *Search for Majorana Neutrinos with the Complete KamLAND-Zen Dataset*. arXiv.
  Division: Experimental Nuclear & Particle Physics | **Center:** LNS
- J. Du Plessis, Z. Janelidze, B. Wessels, *A Primer on Chainmails: Structures for Point-free Connectivity*. arXiv.
  Division: Theoretical Nuclear & Particle Physics | **Center:** CTP
- B. Binks, H. Guenther, *TESSILATOR: a one-stop shop for measuring TESS rotation periods*, MNRAS, 533. DOI.
  Division: Astrophysics | **Center:** MKI
- H. Guenther, P. Cheimetz, C. DeRoo et al., *Arcus X-ray telescope performance predictions and alignment requirements*, JATIS, 11. DOI.
  Division: Astrophysics | **Center:** MKI
- J. Han, E. Lake, S. Ro, *Scaling and localization in multipole-conserving diffusion*, Phys. Rev. Lett., 132, 137102. DOI.
  Division: Atomic, Biophysics, Condensed Matter & Plasma Physics | **Center:** Physics of Living Systems
- M. Geier, F. Nathan, *Self-correcting GKP qubit in a superconducting circuit with an oscillating voltage bias*. arXiv.
  Division: Theoretical Condensed Matter Physics | **Center:** CMT
- CMS Collaboration, *Search for soft unclustered energy patterns in proton-proton collisions at 13 TeV*, Phys. Rev. Lett., 133, 191902. DOI.
  Division: Experimental Particle Physics | **Center:** LNS
- CMS Collaboration, *High-precision measurement of the W boson mass with the CMS experiment at the LHC*, Submitted to Nature. arXiv.
  Division: Experimental Particle Physics | **Center:** LNS
- G. Billis, J. Michel, F. Tackmann, *Drell-Yan q_T spectrum at N^3LL' and approximate N^4LL with SCETlib*. arXiv.
  Division: Theoretical Nuclear & Particle Physics | **Center:** CTP
- J. Villarreal, D. Winklehner, D. Koser and J. M Conrad, *Neural networks as effective surrogate models of radio-frequency quadrupole particle accelerator simulations*, Mach. Learn.: Sci. Technol., 5, 025009. DOI.
  Division: Experimental Nuclear & Particle Physics | **Center:** PSFC
- J.R. Pybus, T. Kolar, B. Devkota et al., *Search for axion-like particles through nuclear Primakoff production using the GlueX detector*, Phys. Lett. B, 855, 138790. DOI.
  Division: Experimental Nuclear & Particle Physics | **Center:** LNS

2025 (15 ...)

- A. Abouelkomsan, M. Geier, L. Fu, *Topological Order in Deep State*, arXiv
  Division: Theoretical Condensed Matter Physics | **Center:** CMT
- F. Abbasi, R. Nally, W. Taylor, *Classifying Fibers and Bases in Toric Hypersurface Calabi-Yau Threefolds*, arXiv
  Division: Theoretical Nuclear & Particle Physics | **Center:** CTP
- CMS Collaboration, *Identification of low-momentum muons in the CMS detector using multivariate techniques in proton-proton collisions at √s = 13.6 TeV*, JINST 20, P04021, DOI
  Division: Experimental Particle Physics | **Center:** LNS
- CMS Collaboration, *Search for the rare decay D0 → μ+μ- in proton-proton collisions at √s = 13.6 TeV*, Phys. Rev. Lett. 135, 151803, DOI
  Division: Experimental Particle Physics | **Center:** LNS
- D. Aglus, T. R. Slatyer, *Boosting the cosmic 21-cm signal with exotic Lyman-α from dark matter*, arXiv
  Division: Theoretical Nuclear & Particle Physics | **Center:** CTP
- A. Beraudo, J. F. Du Plessis, D. Pablos, K. Rajagopal, *Heavy Quark Energy Loss in the Hybrid Model*, arXiv
  Division: Theoretical Nuclear & Particle Physics | **Center:** CTP
- A. Belley, J. Munoz, R. Garcia Ruiz, *Global Framework for Emulation of Nuclear Calculations*. arXiv
  Division: Experimental Nuclear & Particle Physics | **Center:** LNS
- R. Abbott, D. C. Hackett, D. A. Pefkou, et al., *Lattice evidence that scalar glueballs are small*. arXiv.
  Division: Theoretical Nuclear & Particle Physics | **Center:** CTP
- F. E. Taylor, *Determination of FL at x=Q2/s with HERA data*, Phys. Rev. D 111, 052001. DOI.
  Division: Experimental Nuclear & Particle Physics | **Center:** LNS
- J. F. Du Plessis, D. Pablos, and K. Rajagopal, *Holographic Heavy Quark Energy Loss in the Hybrid Model*. arXiv.
  Division: Theoretical Nuclear & Particle Physics | **Center:** CTP
- M. Geier, K. Nazaryan, T. Zaklama, and L. Fu, *Is attention all you need to solve the correlated electron problem?* Phys. Rev. B, 112, 045119 DOI
  Division: Theoretical Condensed Matter Physics | **Center:** CMT
- CMS Collaboration, *Search for the Higgs boson decays to a ρ^0, ϕ, or K^{*0} meson and a photon in proton-proton collisions at √s = 13 TeV*, Phys. Lett. B, 862, 139296. DOI.
  Division: Experimental Particle Physics | **Center:** LNS
- CMS Collaboration, *Measurement of inclusive and differential cross sections for W+W- production in proton-proton collisions at √s = 13.6 TeV*, Phys. Lett. B, 861, 139231. DOI.
  Division: Experimental Particle Physics | **Center:** LNS
- M. Kim, A. Timmel, L. Ju et al., *Topological chiral superconductivity beyond pairing in Fermi-liquid*, Phys. Rev. B, 111, 014508. DOI.
  Division: Theoretical Condensed Matter Physics | **Center:** CMT
- J. Munoz, S. Udrescu, R. Garcia Ruiz, *Discovering Nuclear Models from Symbolic Machine Learning*, Commun Phys 8, 101. DOI.
  Division: Experimental Nuclear & Particle Physics | **Center:** IAIFI, LNS

Publication about SubMIT

Detailed description about SubMIT on arxiv

- Citations very welcome!

SubMIT: A Physics Analysis Facility at MIT

J. Bendavid[1,2], M. D'Alfonso[1], J. Eysermans[1], C. Freer[1], M. Goncharov[1], M. Heine[1], L. Lavezzo[1], M. Moore[1], C. Paus[1], X. Shen[1], D. Walter[1], Z. Wang[1]

[1]Massachusetts Institute of Technology (MIT), Cambridge, USA.
[2]CERN, Geneva, Switzerland.

Contributing authors: josh.bendavid@cern.ch; mariadlf@mit.edu; jaeyserm@mit.edu; chadwfreer@gmail.com; maxi@mit.edu; mheine@mit.edu; lavezzo@mit.edu; mamoore@mit.edu; paus@mit.edu; xuejian@mit.edu; david_w@mit.edu; wangzqe@mit.edu;

Abstract

The recently completed SubMIT platform is a small set of servers that provide interactive access to substantial data samples at high speeds, enabling sophisticated data analyses with very fast turnaround times. Additionally, it seamlessly integrates massive processing resources for large-scale tasks by connecting to a set of powerful batch processing systems. It serves as an ideal prototype for an Analysis Facility tailored to meet the demanding data and computational requirements anticipated during the High-Luminosity phase of the Large Hadron Collider. The key features that make this facility so powerful include highly optimized data access with a minimum of 100 Gbps networking per server, a large managed NVMe storage system, and a substantial spinning-disk Ceph file system. The platform integrates a diverse set of high multicore CPU machines for tasks benefiting from the multithreading and GPU resources for example for neural network training. SubMIT also provides and supports a flexible environment for users to manage their own software needs for example by using containers. This article describes the facility, its users, and a few complementary, generic and real-life analyses that are used to benchmark its various capabilities.

Keywords: Analysis facility, High-performance computing, SubMIT, High-energy physics, High-Luminosity LHC, Research infrastructure

Previous work

New/recovered hardware

- Recommissioning of ~10 servers with 4 Nvidia 1080 GPUs

- Included one server with 2 RTX 6000 and one with 4 Nvidia V100 GPUs

- Almost doubled CPUs available in Slurm to ~2000 cores

- Added additional storage space: HDD and NVME

Add software support: Dask gateway, OpenMPI, Globus, ...

Continuous software upgrades and maintenance

- Operating system (Alma linux 9), Ceph FS, Slurm, HTCondor, …

- Re-configured slurm

Provided stable operations

- Improved alarm system to notify if services crash

Whats next

Ensure stable long term operations

- Establish software upgrade policy

- More complete alarm system to provide continous operations

Exploration of new software

- Pixi, pelican, ...

Analyze user experience

- Understand frequent causes why jobs/ jupyterhub sessions/ ... fail

- Find cases of inefficient use of resources

→ Dedicated actions: Give recommendations, adapt system configuration, ...
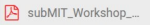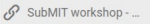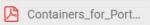
Implement user requests - please let us know what you need!

Today's Workshop

- Overview of subMIT project, resources, software environment

- Hands-on tutorials

- User talks on research usage

- **Open coding & help desk session!**

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Backup

Interactive use

Accessible through website:

- jupyterhub

Documentation

User's guide

- How to interact with the system

- Recommendations

- Tutorials & examples

A2rchi (chatbot)

- Ragging of users guide

- Interactive user support

- Support ticket handling

subMIT v1 documentation » User's Guide - subMIT

User's Guide - subMIT

Contents:

- User's guide – subMIT login pool
- Getting started
- Access to subMIT
- Best practices
- Available software
- Batch computing
- User quota and storage at submit
- Monitoring at submit
- GPU resources
- Data backup
- Conda and its benefits beyond python
- Acknowledging subMIT

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Tutorials and Examples
Search tool and tags
Contributing
Archive - subMIT

Next topic

User's guide – subMIT login pool

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Show Source

Quick search

[   ] [Go]

Tutorials and Examples

Tutorials:

- Tutorial 0: Introduction to the UNIX terminal
- Tutorial 1: Common software packages (python, Julia, MATLAB)
- Tutorial 2: Batch Job (HTCondor and Slurm)
- Tutorial 3: Containers (Podman and Singularity)
- Tutorial 4: Source Control (Git/Github) with Visual Studio Code (VSCode)
- Tutorial 5: Debugging Fortran code with Visual Studio Code (VSCode)
- Tutorial 6: Introduction to Pytorch Lightning
- Tutorial 7: Introduction to Snakemake

Examples of scripts can be found on our submit-examples GitHub repository.

A2rchi

Start a conversation and explore the power of A2rchi, specially trained on the SubMIT Cluster.
Your chat history will be displayed here.

By using this website, you agree to the terms and conditions.

Enter your question for A2rchi