



EGI Council Participant: CERN

Participating in EGI Impact Report: CERN

2023

egi.eu

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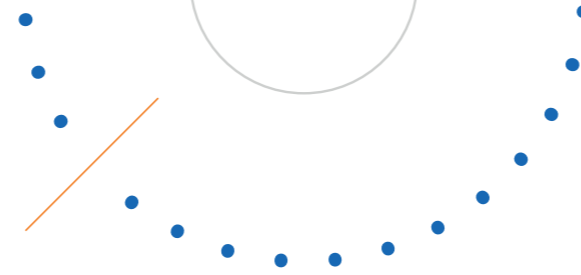
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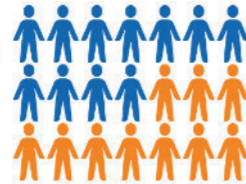
Infographic



Country overview

+10,000 service users

In 2023, +10,000 researchers from CERN used the services provided by the EGI Federation



+330 publications

The research communities, projects and scientific collaborations from CERN supported by the EGI led to more than 330 peer-reviewed scientific publications

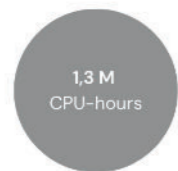
12 Supported communities

In 2023, the infrastructure from CERN supported 12 research communities in Physics



Projects

CERN participates in 3 collaboration projects + EGI-ACE and interTwin



Number of supported publications 331

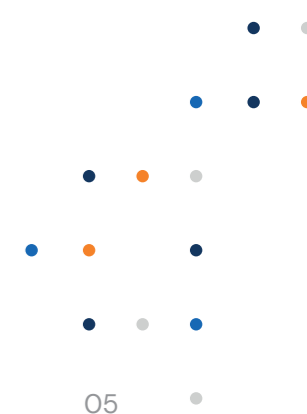
Number of total service users 10,109

Scientific Communities supported 12

Data Centres contributing to the Federation 1

Collaboration projects 3

Total CPU hours delivered 1,344,816,693



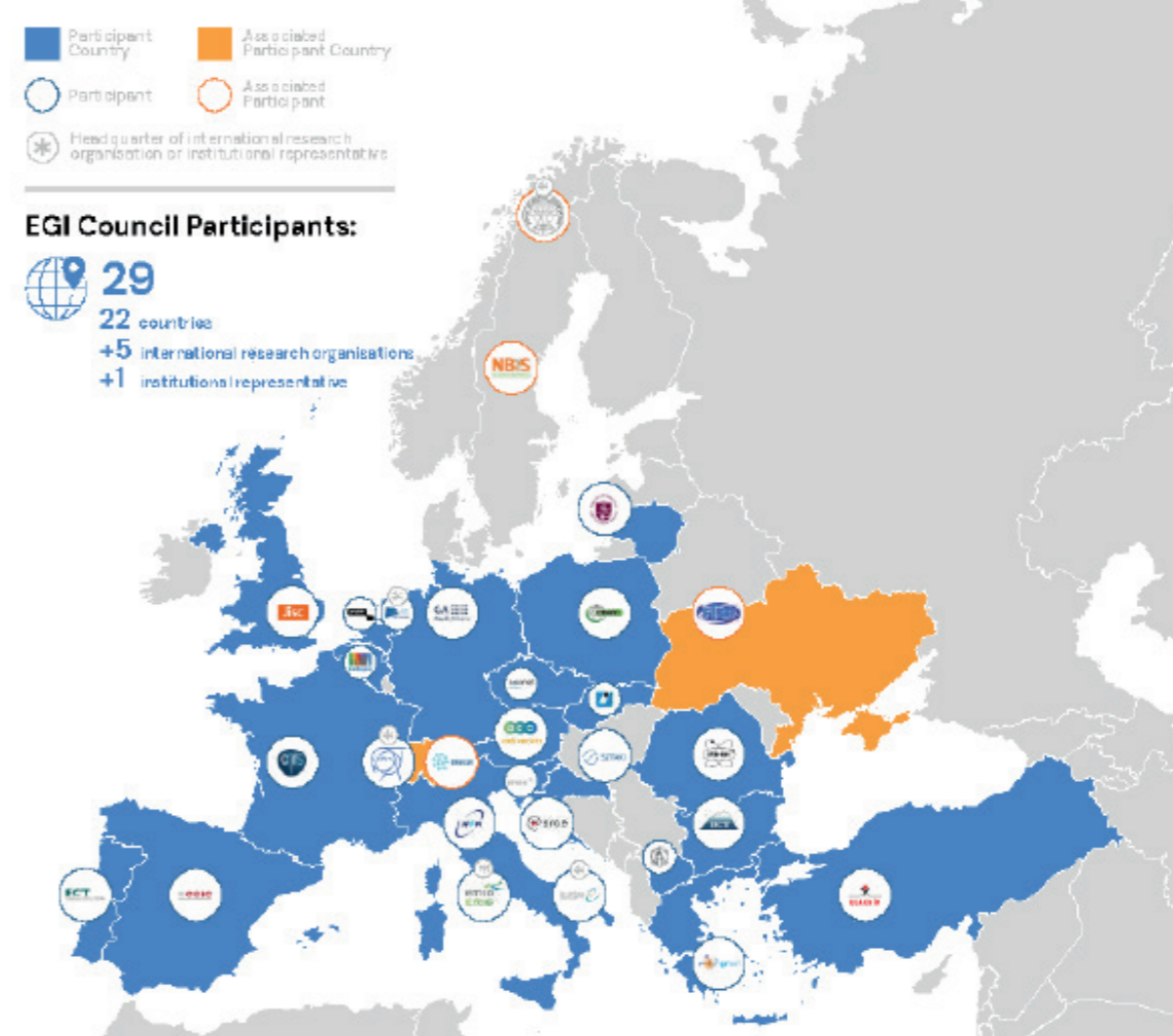
About EGI

EGI is the federation of computing and storage resource providers united by a mission of delivering advanced computing and data analytics services for research and innovation.

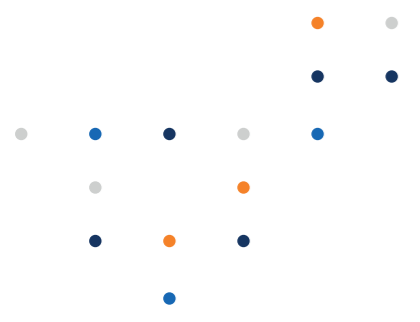
The EGI Federation believes that all researchers should have seamless access to services, resources and expertise to collaborate and conduct world-class research and innovation. The EGI Federation is coordinated by EGI Foundation, an organisation with headquarters in Amsterdam. The Foundation offers a service federation and management platform, enabling the data centres to harmonise and integrate their services by connecting to a common hub. Moreover, it engages with international research communities using these services in order to understand and satisfy their demands for advanced computing for research.

The mission of EGI is pursued by coordinating and provisioning an international federated infrastructure that pools together service providers from both the public and private sectors in Europe to develop, integrate and deliver digital services for compute and data-intensive research and innovation. As an open initiative with a global outlook, the EGI Federation also connects service providers beyond Europe, following the collaboration needs of the served communities.

The latest Annual Report provides an extensive overview of the results that have been achieved through our collaborative efforts in 2023.



Approved EGI Council map from 2023



About CERN

The European Organization for Nuclear Research, known as CERN, is a European research organization that operates the largest particle physics laboratory in the world.

Established in 1954, the organization is based in a northwest suburb of Geneva on the Franco–Swiss border and has 23 member states. Israel is the only non-European country granted full membership. CERN is an official United Nations Observer.

Overall EGI impact

CERN, the European Organization for Nuclear Research, is a founding member of the EGI Federation. This report provides an overview of the activities of CERN in EGI, and the impact that was achieved thanks to this participation. The annual membership fee contributed by CERN to the EGI Foundation in 2022 was 75,000 EUR.

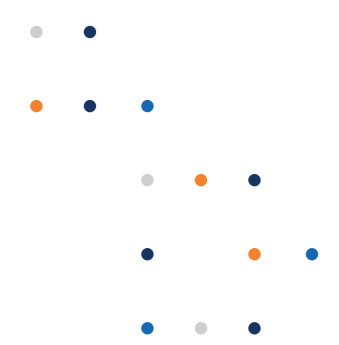
The EGI Federation is composed of e-infrastructure providers from national and community initiatives, forming one of the largest distributed computing infrastructures for researchers in the world, integrating about 1,243,400 CPU cores and over 1,4 Exabyte of storage space from hundreds of data centres.

In 2023, the EGI Federation served around 95,000 users (+12%) from over 260 research communities. EGI users consumed 7 Billion HTC CPU hours (-1.04%), 12 Million Cloud CPU hours +17%), ran over 372 M computational jobs (+13.4%) and published over 2,900 open access publications.

As of the previous year, the research community with the largest number of users is Medical and Health Sciences (+43% annual increase in 2023), while the community with most extensive HTC CPU/h consumption is WLCG.

From the scientific communities engaged in 2023, the one with most extensive Cloud CPU/h consumption is Pangeo (+2959% annual increase in 2023).

Moreover, EGI engaged with a total of 265 scientific communities (10 new communities); 19 SMEs and business pilots, and 1 additional Research Infrastructure included in the ESFRI Roadmap, raising the total of number of ESFRI partners/users of EGI to 23.



EGI's contribution to CERN excellence in science

Research Infrastructures and multi-national research collaborations are the largest adopters of EGI Services, the main contributors of thematic portals, and operate community-specific compute, storage and data systems based on EGI federation capabilities.

The services of the EGI federation have been used by over 10,000 researchers from CERN in 2023. The estimated annual scientific output in 2023 produced by research communities, projects and scientific collaborations from CERN and supported by the EGI Federation is estimated to amount to more than 330 peer reviewed scientific publications.

The EGI Federation is currently working with over 40 Research Infrastructures, 12 of which include CERN. These EGI-enabled research infrastructures, CERN

and their 2023 scientific output (publications) are detailed in the following pages of the report

CERN research collaborations in EGI

AMS-02 (Particle Physics)

- CERN

EGI supported activities and services

The AMS-02 experiment on the International Space Station has been using compute resources from EGI for more than a decade. The services from the EGI federation that AMS-02 uses include:

- EGI HTC services from sites in Italy and CERN
- Software distribution services (UMC, CMD, operations documentation)
- Operations coordination (middleware deployment campaigns, procedures, innovation of tools)
- Security services and activities (CSIRT, Software vulnerability group, international security coordination, policies, IGTF distribution)

Number of scientific papers published in 2022

3

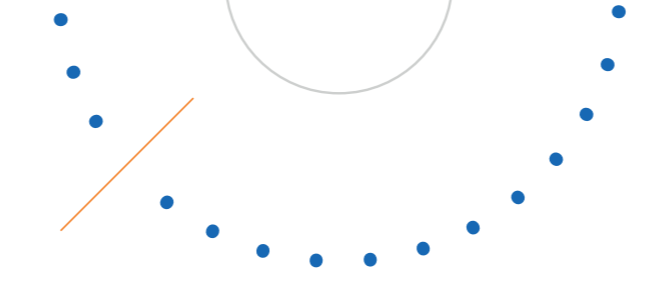
ALICE (High-Energy Physics)

- CERN

ALICE has been supported since 2012 as part of the EGI WLCG collaboration, formally agreed in an MoU. Federated services delivered in the context of the WLCG MoU, including:

- Software support (consultancy to users and system administrators, (software maintenance and validation)
- Infrastructure and operations Services (infrastructure catalogue, accounting repository and portal, helpdesk, monitoring, operations portal, AAI)
- Software distribution services (UMC, CMD, operations documentation)
- Operations coordination (middleware deployment campaigns, procedures, innovation of tools)
- Security services and activities (CSIRT, Software vulnerability group, international security coordination, policies, IGTF distribution)

65



CERN research collaborations in EGI

EGI supported activities and services

Number of scientific papers published in 2022

ATLAS (High-Energy Physics)

- CERN Tier-0

ATLAS has been supported since 2012 as part of the EGI WLCG collaboration, formally agreed in an MoU. Federated services delivered in the context of the WLCG MoU, including:

- Software support (consultancy to users and system administrators, (software maintenance and validation)
- Infrastructure and operations Services (infrastructure catalogue, accounting repository and portal, helpdesk, monitoring, operations portal, AAI)
- Software distribution services (UMC, CMD, operations documentation)
- Operations coordination (middleware deployment campaigns, procedures, innovation of tools)
- Security services and activities (CSIRT, Software vulnerability group, international security coordination, policies, IGTF distribution)

111

CMS (High-Energy Physics)

- CERN

CMS has been supported since 2012 as part of the EGI WLCG collaboration, formally agreed in an MoU. Federated services delivered in the context of the WLCG MoU, including:

- Software support (consultancy to users and system administrators, (software maintenance and validation)
- Infrastructure and operations Services (infrastructure catalogue, accounting repository and portal, helpdesk, monitoring, operations portal, AAI)
- Software distribution services (UMC, CMD, operations documentation)
- Operations coordination (middleware deployment campaigns, procedures, innovation of tools)
- Security services and activities (CSIRT, Software vulnerability group, international security coordination, policies, IGTF distribution)

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CERN research collaborations in EGI

EGI supported activities and services

Number of scientific papers published in 2022

DUNE (Astroparticle Physics)

- CERN

The DUNE experiment has been using compute resources from EGI partners for more than a decade. The services from the EGI federation that DUNE uses include:

- EGI HTC services from 6 EGI participant countries (CH, CZ, ES, FR, NL, UK)
- Software distribution services (UMC, CMD, operations documentation)
- Operations coordination (middleware deployment campaigns, procedures, innovation of tools)
- Security services and activities (CSIRT, Software vulnerability group, international security coordination, policies, IGTF distribution)

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ELI-BEAM (Physical Sciences)

- CERN

ELI works with EGI since 2016 on exploring and validating approaches for off-site computing and data management. ELI-Beams setup a High Throughput Compute Service on EGI resources and works with EGI providers on

- Refining the user requirements and translating these to e-infrastructure requirements, and
- Identifying and validating services from EGI that can be relevant for ELI (besides HTC and compute).
- Mobilising already existing HTC compute, cloud compute and storage resources from EGI for ELI piloting and demonstration activities.

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Icarus-exp.org (Physical Sciences)

- CERN

The IceCube experiment has been using compute resources from EGI partners for more than a decade. The services from the EGI federation that IceCube uses include:

- EGI HTC services from 8 sites of 4 EGI participant countries (Belgium, Denmark, Germany and UK)
- Software distribution services (UMC, CMD, operations documentation)
- Operations coordination (middleware deployment campaigns, procedures, innovation of tools)
- Security services and activities (CSIRT, Software vulnerability group, international security coordination, policies, IGTF distribution)
- EGI is currently expanding its resource pledge to IceCube with an increase of GPU capacity.

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CERN research collaborations in EGI

EGI supported activities and services

Number of scientific papers published in 2022

ILC (High-Energy Physics)

- CERN

The ILC experiment has been using compute resources from EGI partners since 2004. The services from the EGI federation that ILC experiments uses include:

- EGI HTC services from 27 EGI federated sites from IL, DE, FR, ES, NL, PL, UK
- Software distribution services (UMC, CMD, operations documentation)
- Operations coordination (middleware deployment campaigns, procedures, innovation of tools)
- Security services and activities (CSIRT, Software vulnerability group, international security coordination, policies, IGTF distribution)

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LHCb (High-Energy Physics)

- CERN

LHCb has been supported since 2012 as part of the EGI WLCG collaboration, formally agreed in an MoU. Federating services delivered in the context of the WLCG MoU, including:

- Software support (consultancy to users and system administrators, (software maintenance and validation)
- Infrastructure and operations Services (infrastructure catalogue, accounting repository and portal, helpdesk, monitoring, operations portal, AAI)
- Software distribution services (UMC, CMD, operations documentation)
- Operations coordination (middleware deployment campaigns, procedures, innovation of tools)
- Security services and activities (CSIRT, Software vulnerability group, international security coordination, policies, IGTF distribution)

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CERN research collaborations in EGI

EGI supported activities and services

Number of scientific papers published in 2022

LZ (Physical Sciences)

- CERN

The LZ survey federates High Throughput Compute (HTC) resources from UK. The LZ compute federation benefited from the following EGI services:

- Software support (consultancy to users and system administrators, (software maintenance and validation)
- Infrastructure and operations Services (infrastructure catalogue, accounting repository and portal, helpdesk, monitoring, operations portal, AAI)
- Software distribution services (UMC, CMD, operations documentation)
- Operations coordination (middleware deployment campaigns, procedures, innovation of tools)
- Security services and activities (CSIRT, Software vulnerability group, international security coordination, policies, IGTF distribution)

1

NA62 (High-Energy Physics)

- CERN

The NA62 experiment has been using compute resources from EGI partners since 2012. The services from the EGI federation that NA62 uses include:

- EGI HTC services from sites in the UK, Italy, Belgium and CERN
- Software distribution services (UMC, CMD, operations documentation)
- Operations coordination (middleware deployment campaigns, procedures, innovation of tools)
- Security services and activities (CSIRT, Software vulnerability group, international security coordination, policies, IGTF distribution)

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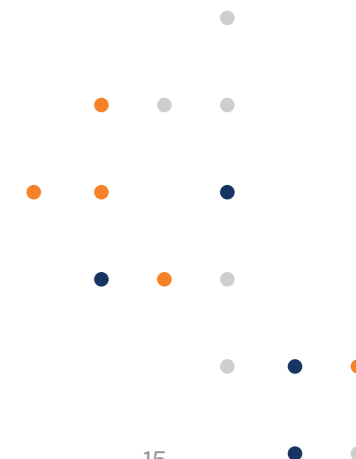
Solidexperiment.org (High-Energy Physics)

- CERN

The collaboration with EGI started back in 2017. The services from the EGI federation that the experiment uses include:

- EGI HTC services from 2 EGI federated sites from BE and UK
- Software distribution services (UMC, CMD, operations documentation)
- Operations coordination (middleware deployment campaigns, procedures, innovation of tools)
- Security services and activities (CSIRT, Software vulnerability group, international security coordination, policies, IGTF distribution)

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Participated projects

The EGI Foundation coordinated one Horizon 2020 projects, EGI ACE (January 2021–June 2023). Moreover, it leads two Horizon Europe Projects, iMagine (September 2022–December 2025) and interTwin (September 2022–August 2025).

Furthermore, the EGI Federation was involved in 8 additional projects, increasing the innovation potential of its participants.

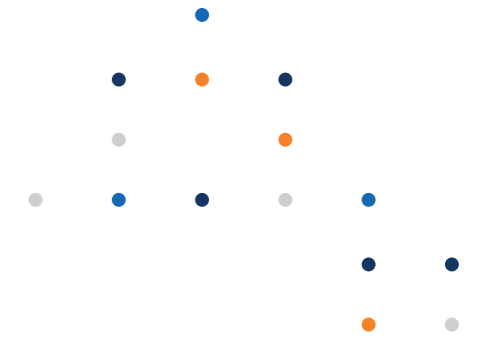
The EGI Federation participates in Horizon 2020 and Horizon Europe projects together with Swiss institutions to facilitate the uptake and use of e-infrastructure services for science. A summary of these projects, the involved institutes and the scope of the collaboration is provided in the next table.

Project title **Scope of collaboration** **Participating beneficiaries from the country**



EGI contributed to the design, operation and interoperability of EOSC Core services, to running the EOSC Digital Innovation Hub, as well as to resource strategy and the processes for onboarding new groups to EOSC. EGI was responsible for requirements collection and analysis for both the EOSC Back Office and Front Office. It also leads all operational aspects of the EOSC Portal. Finally, EGI played a leading role in developing the EOSC SMS.

- CERN



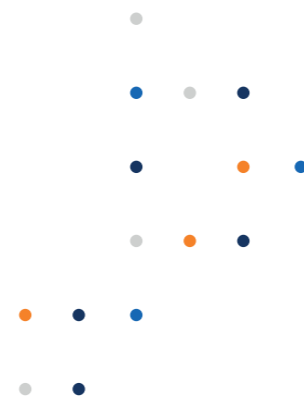
Infrastructure contributions

The EGI Federation offers two complementary compute capabilities: the High-Throughput Compute (HTC) federation and the Cloud federation. 1 Swiss data centre contributes to the HTC Federation: CERN-PROD.

The data centres provided 34 service endpoints and delivered 1,344,816,693 CPUhours in total to EGI communities in 2023. The data centres responded to 113 support tickets through the EGI Helpdesk.

The most active international user groups of the CERN compute resources were:

- alice 30.65%,
- cms 30.24%,
- atlas 27.61%,
- lhcb 11.5%



Methodology

Data for this impact report has been collected from the following sources.

- Infrastructure contributions, infrastructure usage by research communities: [EGI Accounting System](#)
- List of research publications by supported research communities (table 1)

AMS-02

<https://ams02.space/publications>

ILC

https://inspirehep.net/literature?sort=mostrecent&size=25&page=1&q=international%20Linear%20Collider%20&earliest_date=2021--2021

ALICE

<https://alice-publications.web.cern.ch/publications>

INSTRUCT

<https://instruct-eric.eu/content/publications-list>

ATLAS

<https://cds.cern.ch/collection/ATLAS%20Papers?ln=en>

JUNO

<https://inspirehep.net/>

AUGER

<https://www.auger.org/science/publications/journal-articles>

KM3NET

<https://www.km3net.org/about-km3net/publications/publication/>
https://inspirehep.net/literature?q=collaboration:KM3NeT_year:2021

BELLE

<https://belle.kek.jp/belle/publications.html>; https://inspirehep.net/literature?q=collaboration:belle_year:2021

LifeWatch

<https://www.lifewatch.eu/catalogue-of-virtual-labs/medobis/publications/>



BIOMED

<https://vip.creatis.insa-lyon.fr/documentation/>

LOFAR

<http://old.astron.nl/radio-observatory/lofar-science/lofar-papers/lofar-papers>; <https://lofar-surveys.org/publications.html>, or [https://ui.adsabs.harvard.edu/search/q=full%3A\(%22designed%20and%20constructed%20by%20ASTRON%22\)%20OR%20title%3A%22LOFAR%22%20year%3A2021-2021%20property%3Arefereed%20-bibstem%3A\(%22AN%22%20OR%20%22MNRAS.tmp%22\)&sort=date%20desc%2C%20bibcode%20desc&p_0](https://ui.adsabs.harvard.edu/search/q=full%3A(%22designed%20and%20constructed%20by%20ASTRON%22)%20OR%20title%3A%22LOFAR%22%20year%3A2021-2021%20property%3Arefereed%20-bibstem%3A(%22AN%22%20OR%20%22MNRAS.tmp%22)&sort=date%20desc%2C%20bibcode%20desc&p_0)

CTA

<https://www.cta-observatory.org/science/library/>

LCHb

<https://cds.cern.ch/collection/LHCb%20Papers?ln=en>

CLARIN

<https://beta.clarin.openaire.eu/search/advanced/research-outcomes?sortBy=resultdateofacceptance,descending&type=publications&year=range2021:2021>

LSST

<https://ui.adsabs.harvard.edu/> with year:2021 author:("LSST*" OR "Vera C. Rubin*") collection:astronomy property:refereed

CMS

<http://cms-results.web.cern.ch/cms-results/public-results/publications/CMS/index.html>

NA62

<https://cds.cern.ch/collection/NA62%20Papers?ln=en>

DUNE

<https://inspirehep.net/literature?q=collaboration:DUNE year:2021>

OPENCOASTS

http://opencoasts.inec.pt/index_en.php

EISCAT_3D

<https://eiscat.se/scientist/publications/>

PANOSC

<https://www.panosc.eu/publications/>

ELI-BEAM

<https://www.eli-beams.eu/publikace/>

SeaDataNet

<https://www.seadatanet.org/Publications/Scientific-publications>

ELI-NP

https://www.eli-np.ro/scientific_papers.php

SKA

[https://ui.adsabs.harvard.edu/search/fq=%7B!type%3Daqp%20v%3D%24fq_database%7D&fq_database=database%3A%20astronomy&q=pubdate%3A%5B2021-01%20TO%202021-12%5D%20title%3A\(SKA\)&sort=date%20desc%2C%20bibcode%20desc&p_0](https://ui.adsabs.harvard.edu/search/fq=%7B!type%3Daqp%20v%3D%24fq_database%7D&fq_database=database%3A%20astronomy&q=pubdate%3A%5B2021-01%20TO%202021-12%5D%20title%3A(SKA)&sort=date%20desc%2C%20bibcode%20desc&p_0)

EMSO-ERIC

from the community representative; SLA <https://documents.egi.eu/document/3539>

SNO+

<https://snoplus.phy.queensu.ca/results/collaboration-papers.html>

FUSION

<https://documents.egi.eu/public/ShowDocument?docid=3484>

VIRGO

<https://pnp.ligo.org/ppcomm/Papers.html>

HESS

<https://www.mpi-hd.mpg.de/hfm/HESS/pages/publications/>

WeNMR

<https://explore.openaire.eu/> advanced search project outcomes. field to search "project" enter project name; Citation of HADDOCK web server: https://scholar.google.nl/scholar?hl=en&as_sdt=2005&cites=10355645612647046441&scipsc=&as_ylo=2021&as_yhi=2021; Citations of the AMBER web portal publication: https://scholar.google.com/scholar?as_ylo=2021&hl=en&as_sdt=0.5&scioldt=0.5&cites=6696812766870837905&scipsc=; Citations of the FANTEN web portal publication: https://scholar.google.com/scholar?as_ylo=2021&hl=en&as_sdt=0.5&scioldt=0.5&cites=10578718345045994565&scipsc=; Citations of the DISVIS/POWERFIT web portals publication: https://scholar.google.com/scholar?as_ylo=2021&hl=en&as_sdt=2005&cites=6482114501244947208&scipsc=; Citations of the SpotON web portal: https://scholar.google.com/scholar?as_ylo=2021&hl=en&as_

Ice-Cube

<https://icecube.wisc.edu/science/publications/>

XENON

<https://inspirehep.net/literature?q=collaboration:XENON year:2021>

National institutional members of supported research communities (table 2)

AMS-02 https://ams02.space/collaboration/institute	ILC https://linearcollider.org/team/	CMS https://cms.cern/collaboration/cms-institutes	NA62 https://greybook.cern.ch/experiment/detail?id=NA62
ALICE https://alice-collaboration.web.cern.ch/General/Members/List_Institutes.html	INSTRUCT https://instruct-eric.eu/countries	DUNE https://lbnf-dune.fnal.gov/about/countries-and-institutions-participating-in-dune/	OPENCOASTS http://opencoasts.lnec.pt/index_en.php
ATLAS https://atlas.cern/discover/collaboration	JUNO https://juno.ihep.ac.cn/collaboration.php	EISCAT_3D https://eiscat.se/wp-content/uploads/2016/12/EISCAT-Organogram-202x.jpg ; https://eiscat.se/scientist/document/information/	PANOSC https://www.panosc.eu/partners/
AUGER https://www.auger.org/collaboration/institutions ; https://www.auger.org/collaboration/funding-agencies	KM3NET https://www.km3net.org/about-km3net/collaboration/members/	ELI-BEAM https://www.eli-beams.eu/about/cooperation/science/	SeaDataNet https://www.seadatanet.org/About-us/SeaDataNet-AISBL/Members
BELLE https://belle.kek.jp/bdocs/collaboration.html	LifeWatch https://www.lifewatch.eu/organisation-governance/	ELI-NP https://www.eli-np.ro/scientific_collaborations.php	SKA https://www.skatelescope.org/participating-countries/
BIOMED https://vip.creatis.insa-lyon.fr/	LOFAR https://www.astron.nl/telescopes/	EMSO-ERIC http://emso.eu/organization/	SNO+ https://snoplus.phy.queensu.ca/collaboration.html
CTA https://www.cta-observatory.org/about/cta-consortium/	LCHb https://lhcb-public.web.cern.ch/en/collaboration/Collaboration-en.html	FUSION https://documents.egi.eu/public/ShowDocument?docid=3484	VIRGO https://apps.virgo-gw.eu/vmd/public/institutions
CLARIN https://www.clarin.eu/content/participating-consortia	LSST https://www.lsstcorporation.org/international-contributors	HESS https://www.mpi-hd.mpg.de/hfm/HESS/pages/collaboration/	WeNMR https://documents.egi.eu/document/2751
		Ice-Cube https://icecube.wisc.edu/collaboration/institutions/	XENON https://science.purdue.edu/xenon1t/?page_id=27



EGI Membership Impact Report

Contact us

Science Park 140
1098 XG Amsterdam
Netherlands

Phone:
+31 (0)20 89 32 007

Email:
contact@egi.eu

 [egi_einfra](https://egi.eu)

 [EGI Foundation](https://egi.eu)

 [EGI](https://egi.eu)

www.egi.eu