

LABORATÓRIO DE INSTRUMENTAÇÃO E FÍSICA EXPERIMENTAL DE PARTÍCULAS partículas e tecnologia

Distributed Computing and Digital Infrastructures



Delivering IT services Computing and data

- LIP internal core IT services and networks
- LIP users support
- LIP software development for administration
- LIP web, design, awareness and communication
- LIP general computing and data storage services
- LIP WLCG Tier-2s for ATLAS and CMS
- CNCA/INCD management of HPC services
- CNCA/INCD management of HTC services
- CNCA/INCD management of cloud services
- CNCA/INCD management of data services
- CNCA/INCD user support incl. sw setup
- CNCA/INCD infrastructure development projects
- EGI, IBERGRID, WLCG, EOSC, RNCA
- Projects for innovation and research
- Contracts to provide research services
- Partnerships apply and exploit knowledge



IT services for LIP





Portuguese Tier-2 ATLAS and CMS

The **Tier-2** / **Tier-3** uses the CNCA infrastructure and is **operated by the LIP** computing team.

- Based at CNCA using the Lisbon site
- Shares the site Slurm and Lustre systems



In 2024:

- 741,737 jobs
- 169,392,970 HS23 hours
- 51.5% ATLAS / 48.5% CMS
- sw upgrades
- hw improvements



CERN / WLCG - Portuguese Tier-2 pledge since 2010



LIP in **IBERGRID** and EGI



The EGI infrastructure federates hundreds of data centres worldwide:

- **Including WLCG European sites**
- IBERGRID and EGI provide the backbone for WLCG in PT+ES

LIP responsibilities and activities:

- Infrastructure operations coordination at Iberian level \bullet
- **Interface with EGI operations**
- Software management for the EGI and IBERGRID federations
- National technical contact point
- **Security contact for Portugal**
- Support to user communities
- Developing and operating core services e.g. software \bullet repositories for the EGI federation
- Integration of thematic and/or user services

cloud+grid+data

70M



From the grid for the LHC to the CNCA More than 20 years of history in computing



LIP in CNCA

INCD had a change of name

- CNCA Centro Nacional de Computação Avançada
- National Advanced Computing Centre

Change of statutes

- Wider role and responsibilities
- Encompassing all computing models
- Encompassing research data

Enlarging associates

- Welcoming national academic and research organisations as associates
- Associates will pay a fee in-cash or in-kind
- Associates will get computing capacity
- LIP will continue being an associate

Management

- General Assembly (FCT, LIP, LNEC)
- Leading the directorate (LIP: Nuno Castro)
- Technical coordination of distributed computing in CNCA (LIP: Jorge Gomes)
 - Planning
 - Development and Innovation
 - Management and Operations
 - Support
 - Technology Transfer
 - Data Networks

• Participation in the other technical areas

- High Performance Computing
- Research Data

• Participation as CNCA in the RNCA panels

- Setup of FCT calls for computing time
- Evaluation of FCT computing projects
- Coordinating provisioning of computing time

CCA Resources inherited from INCD

Cloud Computing cloud computing

ng HTC Computing ng high throughput computing (GRID) HPC Computing high performance computing



INCD-D @ UTAD Vila Real

- High Performance Computing
- Distributed computing
 - Cloud Openstack
 - HTC
- 5000 CPU cores
- 4 Petabytes (disk + SSD)
- 2x 10 Gbps



INCD-C @ UC Coimbra

- Tape Library
- 20 Petabytes
- 10 Gbps



INCD-A @ LNEC Lisboa

- High Performance Computing
- Distributed computing
 - Cloud Openstack+K8s
 - HTC
- 7500 CPU cores
- 5 Petabytes (disk + SSD)
- 2x 100 Gbps + 1x 10 Gbps



INCD-L @ LIP Lisboa

- Tape Library
- 1 Petabyte
- 10 Gbps



Processing Time per Year (hours)



Projects and activities @ LIP

• DT-GEO (EC)

- Digital Twin of geophysical extremes dealing with geohazards earthquakes, volcanoes, and tsunamis
- Software and Service Quality assessment
- udocker integration with workflow managers in HPC
- Application containerisation
- InterTwin (EC)
 - Common approach to the implementation of DTs applicable across scientific disciplines
 - Software release and management
 - Quality and validation for applications and services
- iMagine (EC)
 - Imaging data and services for aquatic science
 - Federated computing infrastructure
 - Supporting the DEEP AI platform service

• DGT Sentinel and OrtoSat (DGT)

- Build storage and caching infrastructure for Sentinel data
- Create new derived products from Sentinel data
- Platform for data products delivery
- ML applied to OrtoSat for soil occupancy identification
- DGT LIDAR (DGT)
 - Platform for delivery of LiDAR data from 1st national coverage
 - API for LiDAR data access and exploitation
 - Visualization of LiDAR data 3D/2D

- AI4EOSC (EC)
 - \circ \qquad Advanced services for AI, ML and DL models and applications.
 - Software quality, data FAIRness
 - Integration of udocker for serverless computing
- EuroCC 2 (EuroHPC JU)
 - Awareness and communication
 - Training and skills
 - Interaction with academia and public sector
 - Support to public administration and research
- Research Data Management Centre (FCT)
 - \circ \qquad Open data for HEP, Social Sciences and compute intensive sciences
- Contract with FCT data repositories (FCT)
 - Pilot for a national research data repository
 - Integration and service provisioning
- AGRISPACE (FCT)
 - Pilot of a data space for agriculture related data
 - Use cases exploiting and demonstrating the data space
 - Includes ML applications
- EOSC Beyond (EC)
 - Release management and Software Quality Assurance
 - Process, CI/CD tools and support for QA
- ENVRI-Hub NEXT (EC)
 - CI/CD integration, including agile software development
 - \circ \qquad Release process, automated QA, environment for integration

Directorate General for Territory (DGT) Contracts for research on new and improved geospatial services

Sentinel and OrtoSat contract

- Storage and caching infrastructure for Sentinel data
- Develop a product of Sentinel 2A images without clouds
- Develop products of Sentinel 2A images for Vegetation Indexes
- Quality control for Sentinel 2A data products
- Integration of a new product from ISA for vegetation loss
- Identification of soil occupancy with OrtoSat images (Inês Ochoa)

LiDAR contract

- Develop platform for the data from the 1st LiDAR national coverage
- Development of API for LiDAR data access and transformations
- Development of 2D/3D visualization (Henrique @ LIP Minho)

Transversal

- Packaging and automated deployment
- Training, dissemination





EGI UMD / CMD software repository is managed by LIP + CNCA



repository.egi.eu Developed by LIP Housed at CNCA



Software Quality LIP in EC projects



- Development of the platform core
- Cooperation with CSIC and UPV
- Being exploited in projects
- interTwin
- DT-Geo
- EOSC Beyond
- CESSDA
- etc

Research data LIP + CNCA + ICS

FCT contract under INCD/CNCA activities. National catchall data repository (LIP+CNCA):

- Leverage EOSC-Synergy work on thematic data repositories and FAIR quality indicators.
- Productization and automation of Dataverse based data repositories.
- Integration (Ciência ID, Ciência Vitae, OIDs, etc)

FCT contract under PNCADAI. Research Data Management Centre (LIP+ICS+CNCA):

- Creation and improvement of area specific repositories (social sciences, physics, etc)
- Curation of datasets
- Training on research data management

New FCT data management services built on CNCA:

- Expansion of FCT data storage capacity
- New services (Data management Plans, sync&share, long term storage etc)





EUROCC PORTUGAL

EuroCC HPC Competence Center

EuroHPC supported project (2020-2022-2025 ...)

High Performance Computing National Competence Center in EuroCC.

- Boost European HPC knowledge
- European network of 33 national HPC competence centres (NCCs)
- Support public administration, research and private
- Bridge the skills gaps and promote cooperation

LIP participation

- Technology transfer and consultancy
- Training and skills development
- Awareness and collaboration
- Access to expertise and knowledge
- Research, industry and public sector

Centro Nacional de Competências

O Centro Nacional de Competências no EuroCC 2 é coordenado pelo Fundação para a Ciência e a Tecnologia (FCT), e integra várias entidades que, através deste centro, disponibilizam a sua experiência e capacidades no apoio à adoção e utilização de tecnologias HPC.











utad UNIVERSIDADE DE TRAS OS MONTES E ALTO DOURO

U. PORTO univers

ie UNIVERSIDADE BEIRA INTERIOR



UNIVERSIDADE DE ÉVORA

https://eurocc.fccn.pt / contacto@eurocc.fccn.pt

LIP Projects and funding in 2024 and ongoing

LIP Computing Projects	Source	Start	End	Funding
Contract FCT for catchall research data repository	FCT	2022	2023/2024	19 999€
EOSC-Future	EU	2022	2024	160 375€
Support for the Tier-2 WLCG (FCT CERN fund)	FCT	2022	2024	29 999€
iMagine	EU	2022	2025	222 125€
DT-Geo	EU	2022	2025	542 875€
AI4EOSC	EU	2022	2025	350 250€
interTwin	EU	2022	2025	342 812€
EuroCC 2 - possibly will be extended until mid 2026	EU/FCT	2023	2025	146 000€
Research Data Management for Open Science	FCT	2025	2025	120.000€
SMOS Sentinel and OrtoSat data delivery/processing	DGT	2025	2025	167.272€
SMOS LiDAR data delivery and visualization	DGT	2025	2025	200.194€
AGRISPACE - Partnership Agriculture of data pilot	FCT	2025	2026	125.000€
EOSC-beyond	EU	2024	2027	182 750€
ENVRI-Hub NEXT	EU	2024	2027	225 302€

Human resources 2024 / 2025

Staff / Contracted Personnel

ПР

EXTERNAL

	Lígia Melo	Communication	LIP Lisboa - Communication, dissemination, outreach for computing & LIP (NEW)
	Davi Parma	Technician	LIP Lisboa - Web development for internal and administrative services
hel	Carlos Manuel	Technician	LIP Lisboa - Design, web development, events, multimedia, communication
	Hugo Gomes	Technician	LIP Lisboa - Web development, IT support, events, multimedia, communication
Sui	João Martins	Researcher	LIP Lisboa - Fabric mgmt, storage, computing, HPC, grid, virtualization, support
Pe	João Pina	Researcher	LIP Lisboa - WLCG Tier-2, software management, user support, grid
ed	Jorge Gomes	Researcher	LIP Lisboa - Projects mgmt, network mgmt, computing, sw development, security
act	Mário David	Researcher	LIP Lisboa - Cloud computing, containers, sw quality assurance, development
ntr	Nuno Dias	Researcher	LIP Lisboa - Security, data protection, network services, desktops, laptops
Ō	José Aparício	Engineer	LIP Lisboa - Datacenter, networks, notebooks, desktops, hw maintenance, support
	Samuel Bernardo	Engineer	LIP Lisboa - Development, sw quality, AAI, computing, cloud, containers, DevOps
aff	Zacarias Benta	Engineer	LIP Minho - HPC, fabric mgmt, computing, virtualization, support, data services
S	Miguel Viana	Engineer	LIP Minho - Cloud, containers, softw. integration and validation (going to industry)
	Henrique Carvalho	Engineer	LIP Minho - Multimedia and GeoSpatial (partial time)
	Gonçalo Barradas	Engineer	LIP Lisboa - AGRISPACE contract, GeoSpatial (short term contract)
	Pedro Pinheiro	Engineer	LIP Lisboa - AGRISPACE contract, GeoSpatial (short term contract)
ົ	Catarina Ortigão	Administration	INCD - Administrative and managerial support
ato	César Ferreira	Engineer	INCD - HPC/HTC, fabric mgmt, computing, virtualization, containers, support
o r	João Machado	Researcher	INCD - Data repositories, open science, data services, software development
lab	António Esteves	Researcher	University of Minho - Application of machine/deep learning techniques
Col	António Pina	Researcher	University of Minho - Application performance analysis, parallel programming
	José Rufino	Researcher	Polytechnic Institute of Bragança - Parallelization strategies for GPU algorithms

INCD

LIP

Human resources

• LIP staff

- INCD staff
- Collaborators

Staff salaries

88%

2%

10%

- LIP (computing **projects**)
- LIP (own funds)
- INCD (projects and RNCA)

• 7x PhDs

- 2x LIP staff
- 2x INCD staff
- 3x Collaborators
- 9x Engineers
 - 6x LIP staff
 - 2x LIP short term contracts
 - 1x INCD staff
- 3x Technicians
 - 3x LIP staff
- High sustainability risk
- Services on best effort



IBERGRID 2024 conference in Porto https://ibergrid.eu





EGI 2025 conference is organised by the EGI Foundation, and hosted by CSIC and LIP in Santander. https://www.egi.eu/event/egi2025/



HEPiX brings together worldwide IT staff from High Energy Physics and Nuclear Physics laboratories and institutes, to foster learning and sharing of experiences between computing centres. https://hepix.org



LABORATÓRIO DE INSTRUMENTAÇÃO E FÍSICA EXPERIMENTAL DE PARTÍCULAS partículas e tecnologia

Thanks!

Discovery through science

Innovation through technology

Sharing with People

SWOT

Strengths

- Expertise in scientific computing, software integration, management and quality assurance, etc.
- Participation in international research e-infrastructures and initiatives (WLCG, EGI, IBERGRID and EOSC).
- Participation in European projects.
- Operating the Portuguese WLCG Tier-2 under the CERN LHC computing MoU.
- Partnership with FCT-FCCN and LNEC and other organisations via CNCA.
- Technological partner of CNCA managing computing and data services.

Weaknesses

- Lack of compute and storage resources.
- Too many activities supported on a voluntary and/or best effort basis.
- Highly overworked team.
- Huge dependency on projects and external contracts to pay staff salaries.
- Heavy administrative burden.
- Capacity wise becoming irrelevant at national level.
- Less influence in the future CNCA.

Opportunities

- Participation in activities related to High Performance Computing.
- Participation in open data and digital repositories related activities.
- Potential for public sector applications.
- Evolution from INCD to CNCA.

Threats

- Lack of proper hardware capacity for ATLAS, CMS and other experiments.
- Competitive market makes difficult contract and retain IT personnel.
- Lack of sustainable funding for human resources.
- Exacerbated focus on supercomputing at national and European level.
- Increasingly higher competition in projects, funding and infrastructure.
- Risks in the restructuring of CNCA.

LIP Usage at INCD

Used	Hours/year	~ CPU cores	Allocated usable	Terabytes (df -H)
Computing farm T2	14.800.000	2.000	T2 + T3 (INCD used by LIP)	1.514
Computing farm LIP	6.935.920	800	LSTORE (INCD used by LIP)	245
Cloud	3 700 000	450	450 SHARE (LIP for group disks)	
Tatal	25.000.000	2.250	CMS (group acquired)	85
ΙΟΙΑΙ	~ 25.000.000	~ 3.250	Pheno (group acquired)	254
			Titan (group acquired)	176
		Usage is not	CERN-cloud (group acquired)	87
constant we have a capacity of about 3.600 CPU cores			HOMES (LIP)	44
			Cloud computing (INCD)	40
			Others (INCD and LIP)	30
			Total	~ 3.000

Goals and strategy

• Participate in R&I projects, mainly EU

- To develop new competences and service functionalities
- To obtain funding to sustain the IT personnel
- To establish a good reputation and links at international level
- To have interesting activities to help retain the IT personnel
- Participate in e-infrastructure initiatives at international level (EGI, WLCG, IBERGRID)
 - To federate, operate and maintain the compute and data intensive services
 - To support LIP users and other research communities and bring added value to these activities
 - To establish and develop international networking and long term collaborations
- Participate in e-infrastructure initiatives at national level (research infrastructures, RNCA, CPCA, CNCA ...)
 - To support the operational costs and improvement of the computing and data infrastructure
 - To support other research communities hence further justifying the need of funding for OPEX and CAPEX
 - To establish LIP as a relevant stakeholder in the area

LIP strategy and WLCG

- Follow computing CERN/WLCG activities towards the HL-LHC
- Enlarge the Tier-2 capacity according to the pledges closing the gap as much as possible
- Having the Tier-2 as a flagship service provided by CNCA
- Ensure the Tier-2 sustainability via CNCA
- Promote distributed computing as an essential service
- Collaborate with other research and academic organisations
- Seek for complementary opportunistic computing capacity from e.g. CLOUD and HPC
- Align our actions with the funding authorities strategies to facilitate access to funding
- Collaborate with FCT and with FCT-FCCN in delivering computing and data services

LIP strategy and CNCA

- CNCA as the main provider for compute and data intensive services for LIP
- Consolidate CNCA as a reference organisation with sustainability
- Promote CNCA in the scope of the creation of a national advanced computing center
- Seek for a common umbrella for distributed computing, HPC, cloud and data infrastructures with support at national level
- Expand the LIP capabilities through a tight collaboration between the CNCA and LIP teams
- Collaborate with other research and academic organisations in the scope of CNCA
- Collaborated with the funding agencies in the scope of CNCA
- Support other communities via CNCA and make visible the LIP value and impact

CA Projects and funding

INCD Projects	Source	Start	End	Funding
iMagine	EU	2022	2025	50 414€ / 3 years
Climate-Adapt4EOSC	EU	2024	2027	193 500€ / 4 years

INCD Protocols	Source	Start	End	Funding
Institutional scientific employment position	FCT	2023	2029	285 000€ / 6 years
RNCA Protocol 3rd and 4th CPCA calls	FCT	2025	2025	€000 08
RNCA Protocol housing	FCT	2025	2025	243 000€
RNCA Protocol data services	FCT	2025	2025	40 000€

- The LIP computing and data intensive resources are largely owned and/or operated and housed by CNCA.
- The CNCA housing costs including the LIP WLCG Tier-2 have been until now supported by FCT.





	2017	2018	2019	2020	2021	2022	2023	Total
Papers direct	52	79	59	97	89	126	111	613
Conference papers	24	30	47	25	32	22	21	201
Books	0	0	0	2	0	0	0	2
PhD Thesis	8	4	3	7	9	5	11	47
MSc Thesis	10	5	17	12	19	23	49	135
Conference posters	9	12	2	24	39	8	42	136
Patents					2	1	0	3
Datasets				1	2	19	11	33
Total	103	130	128	168	192	204	245	1170

Integration of Deucalion in CNCA New FCT datacenter will have space for CNCA





- 2 floors:
 - 2nd floor: server rooms
 - 1st floor: datacenter support functions: staging, storage, mechanical, electrical
- Separate mechanical building, for cooling
- Generators and new power lines
- 200m² for advanced computing

Software from LIP

User tool to execute docker containers in user space. Developed at LIP:

- Fully user space.
- No root privileges required to use or install.
- Does not require compilation.
- Download and execution of docker containers by non-privileged users.
- Suitable for Linux batch systems and interactive clusters managed by other entities such as grid infrastructures.
- Does not require Linux namespaces.

	https://g	<u>ithub.com/i</u>	<u>ndigo-dc/udocker</u>
--	-----------	--------------------	-------------------------

0			Sign up 🗮
indigo-dc/udocke	Public Public	Q Notifications	😲 Fork 105 🛱 Star 945 👻
Code 🕥 Issues 28	8 Å\$ Pull requests 4 ⊙ Actions	🗄 Projects 🖽	Wiki 🕐 Security
₽ master -	Go to	file Code -	About
jorge-lip Update code	emeta.json ···· × on	Feb 4 🕲 1,660	A basic user tool to execute simple docker containers in batch or interactive systems without root
🖿 .sqa	Remove sqa configuration block not requir	12 months ago	privileges.
docs	improve quality assurance section	12 months ago	
etc	update variables in udocker.conf	12 months ago	docker grid hpc containers
paper	paper.md	11 months ago	emulation batch user chroot
tests/unit	allow-root in umain	12 months ago	indigo docker-containers runc
udocker	fix linting line too long	12 months ago	deep-hybrid-datacloud eosc-hub
utils	improve tests	12 months ago	M Readma
gitignore	add to gitignore, remove link	13 months ago	Apache-2.0 license
🗅 .mailmap	add mailmap	6 years ago	公 945 stars
.travis.yml	prepare for test and travis	3 years ago	 33 watching
AUTHORS.md	update several documents, markdown styl	12 months ago	¥ 105 forks
CHANGELOG.md	lint changelog markdown, add changelog	12 months ago	Releases 16



Software from LIP SQAaaS

Quality Assurance as-a-Service platform (SQAaaS)

- Enables the on-demand creation of CI/CD pipelines making quality verification and validation easily accessible to developers.
 - The **Pipeline as a Service** building block allows you to compose and test customized CI/CD pipelines in accordance with reference criteria.
 - The **Quality Assessment & Awarding** building block analyses, the level of compliance to the quality baselines.
- Integrates a wide range of quality verification tools that are made easily available through a friendly web interface.
- Being applied in **DT-Geo**, **interTwin** and other projects.



SQA baseline dynamic stages	Environment Setup	qc_style o3api	qc_coverage o3api	qc_functional o3api	qc_security o3api	qc_doc o3api	Push Images to Docker Registry	Docker Compose cleanup
14s	5s	1min 43s	23s	1min 50s	10s	1min 14s	7s	5s
14s	5s	1min 43s	23s	1min 50s	10s	1min 14s	7s	55



Software from LIP JePL

Jenkins Pipeline Library (JePL)

- The library that powers the SQAaaS platform.
- Especially suitable for complex setups, you can use directly the JePL instead of the SQAaaS.
- Tech-savvy users tend to favor code over a graphical interface for the task of managing their CI/CD pipelines.
- JePL uses pipeline descriptions written in YAML.
- Just add JePL to your software repository and build your software or service quality assurance using YAML descriptions to benefit from the full set of features.
- JePL implements the software and service baselines maintained by EOSC-Synergy.



https://github.com/indigo-dc/jenkins-pipeline-library