

Istituto Nazionale di Fisica Nucleare

INFN and scientific computing CNAF role in INFN activities

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Let me introduce myself

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Let me introduce myself

2016 - 2022

Bachelor & Master degrees in **High Energy Physics (HEP)**

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Both thesis on track reconstruction performances



Let me introduce myself

2016 - 2022

Bachelor & Master degrees in High Energy Physics (HEP)

2022 - 2023 Research fellow at INFN-CNAF

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User-Support team CMS contact person @ CNAF





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User-Support team CMS contact person @ CNAF Farming team HTCondor cluster administrator



Outline

- INFN and research lines
- The role of computing in Physics research
- INFN CNAF
 - structure
 - activities
- Personal Experience







What is INFN? Istituto Nazionale di Fisica Nucleare

Founded in 1951 with Enrico Fermi and his school I Ragazzi di Via Panisperna

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INFN Main Goal

Understand the Universe in the first moments after the Big Bang



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INFN Facilities

4 National Laboratories
 20 Divisions

6 Associated groups

3 National Centres and Schools

1 International consortia

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Research activities are divided in 5 main lines

INFN Research lines CSN1 - Subnuclear Physics







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Research of new particles and rare events

- Collision of High Energetic Particles
- Production of Secondary particles

40x10⁶ Collisions per second





INFN Research lines CSN2 - Astroparticle Physics

Study of messages coming from space

- Cosmic rays
- Neutrinos
- Gravitational waves
- Gamma rays



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The international journal of science / 13 February 2025

nature



COSNIC CATCHER Deep-sea telescope detects

Deep-sea telescope detects neutrino with highest energy ever recorded

Particulate matters What effects are microplastics having on human health?

MONIVIRG

Focal points Why Japan needs to rethink its science funding priorities afety catch ow immune gene laptations help bats





INFN Research lines CSN3 - Nuclear Physics



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Study of the internal structure of nuclei and molecules

- Heavy lons collisions
- Study of nuclei internal decays



INFN Research lines CSN4 - Theoretical Physics

Development of new models and theories

- validate experimental results
- propose new physics scenarios
- research on nature of dark matter
- study on gravitational theory

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$$\begin{aligned} \mathcal{L} &= -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} F^{\mu\nu} \\ &+ i \mathcal{F} \mathcal{B} \mathcal{F} + h.c. \\ &+ \mathcal{F}_i \mathcal{G}_{ij} \mathcal{F}_j \mathcal{P} + h.c. \\ &+ \left| \mathcal{D}_{\mu} \mathcal{P} \right|^2 - \mathcal{V} \left(\mathcal{O} \right) \end{aligned}$$

Standard model



INFN Research lines CSN5 - Technological Research

Research and development of new technologies to improve INFN operations



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INFN CNAF - Datacentres







Computing in Physics

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Lets think about which are the steps of a "simple" experiment

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Lets think about which are the steps of a "simple" experiment 1. design

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Lets think about which are the steps of a "simple" experiment 1. design $\sqrt{\frac{t}{\sqrt{t}}}$

2. build

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Lets think about which are the steps of a "simple" experiment

- design 1.
- build 2.
- 3. data taking

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Angle (deg)	Parallel force (N)
10	1,74
20	3,42
30	5,00
40	6,43

Lets think about which are the steps of a "simple" experiment

- design 1.
- 2. build
- 3. data taking
- data analysis 4.

1 2 3

+

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	Angle (de	g)	Parallel force (N)
		10	1,74
M888 12 🛙	IGITS	20	3,42
4567	89012	30	5,00
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Lets think about which are the steps of a "simple" experiment

- design
- build 2
- 3. data taking
- data analysis 4.
- 5. report

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Lets think about which are the steps of a "simple" experiment

- design
- ? build
 - data taking 3.
 - data analysis 4.
 - 5. report

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🖻 Chat

Lets think about which are the steps of a "simple" experiment

- design
- ? build
 - data taking 3.
 - data analysis 4.
 - 5. report

Computing is (almost) everywhere

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Computing in Physics State of art

Computing has become one of the founding elements of Physics research

- prototiping
- store experiment data
- data analysis
- long-term data preservation
- provide software and services

Experiments and collaborations have grown bigger

computing has grown as well

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Computing in Physics Kind of resources

Computing power

- CPUs
- GPUs

Storage Supports

- Disk fast access
- Tape long-term data preservation

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WLCG World-wide LHC Computing Grid

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What is LHC?

LHC - Large Hadron Collider

- Located at CERN
- Collider of High-energy protons
- **Biggest Physics experiment in the world**
 - 27 km circumference
 - worldwide collaboration
- 4 main experiments
 - ALICE
 - ATLAS
 - CMS
 - LHCb

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WLCG **WLCG collaboration**

Worldwide collaboration

- more than 170 computing centres in 40 countries
- Storage and computing resources to distribute and analyze LHC data ~200 PB each year (maybe even more)
- Computing centres are classified according to their role
 - Tier O only CERN
 - Tier 1 11 in total (including CNAF)
 - ► Tier 2 several in each country
 - Tier 3 usually local to single universities

WLCG Tier 0 - CERN

The Tier O is the main centre of the whole WLCG collaboration

- Stores a copy of each event from LHC experiments
- Provides computing resources to CERN users and LHC researchers
 - ► CPUs
 - Disk storage
 - Tape storage

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videoconferencing use equipment based here.

The 450 000 processor cores and 10 000 servers run 24/7. Over 90% of the resources for computing in the Data Centre are provided through a private cloud based on OpenStack, an open-source project to deliver a massively scalable cloud operating system.

WLCG Tier 1

The Tier 1 are the main sites of each WLCG country

- Data from LHC experiments are preserved in at least one Tier1
- All Tier 1 are connected via a dedicated network to the TierO
- Provides computing resources to CERN users and LHC researchers
 - Computing power
 - Disk storage
 - Tape storage

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LHC PN

WLCG Tier 2

Each country has several Tier 2

- Mainly provide
 - Computing power
 - Disk storage
- Connected with all Tier 1 and 2 around the world

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Centro Nazionale Analisi Fotogrammi

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INFN - CNAF History

Started with track analysis done by hand

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INFN Facilities

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INFN Facilities

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INFN - CNAF Facilities

Currently we have 2 active facilities

- Old datacentre Berti-Pichat
- New datacentre Tecnopolo
 - inauguration on last year
 - Iots of activity to allow a live-migration
 - still in progress but almost done

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INFN - CNAF Facilities

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Contributori di OpenStreetMap Y Fai una donazione. Condizioni di utilizzo del sito

INFN - CNAF Activities

We provide several resources and services for scientific communities

• Tier-1

since 2003 provides computing resources for WLCG communities

• SD-DS

R&D department to find new solutions for efficient operations and computing

 Technological Transfer handles outreach of our solutions to other communities

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INFN - CNAF Tier-1 - Farming

2k machines with high performance **CPUs and GPUs**

- 60k cores managed via a Batch system
- Cloud on-demand services
- Certified site for Health data

HEPScore usage					
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	400K HS				
	300K HS				
	200K HS				
	100K HS				
	0 HS	03:	:00	06:	:00
	Name				
-	running - multi_core				
_	running - single_core				
_	idle - multi_core				
-	idle - single_core				
_	pledge				
_	available				

09:00

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		Idle							
12:00 15:00 18:00 21:0 Last * 282K HS	00 00:00 Mean 315K HS	Running							
626K HS	599K HS	Removed							
656K HS	697K HS								
150K HS	142K HS	Completed							
851K HS	851K HS								
887K HS	912K HS	Held							

INFN - CNAF Tier-1 - Storage

Manages storage supports 90PB of disk space 210PB of tape

also services to access the storage

~ General info	
GPFS servers	
	56
StoRM servers	
	5
HSM servers	
	5
~ Data traffic	
All servers network	traffic
1 TB/s	
800 GB/s	
600 GB/s	
400 GB/s	
200 GB/s	
0 B/s	5/00
0	5/08

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INFN - CNAF Tier-1 - Network

This department handles both inside and outside connectivity

• Inside

all machines are connected with each other via optic fibers

- Outside
 - LHCOPN with CERN, 400Gbps upscalable to 1.6Tbps
 - LHCONE with Tier-2s, 200Gbps
 - General Internet 4x10Gbps

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Full optic fiber, one of the most performing in Europe

INFN - CNAF Tier-1 - User Access and Support

Users access all our resources via command line may seem difficult but is not :)

All procedures are documented in our user-guide

Support team always available to our mailing list user-support@lists.cnaf.infn.it

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Welcome to ui-tier1.cr.cnaf.infn.it - AlmaLinux 9.5 This node is under the control of Puppet 7.34.0

Last login: Wed May 14 00:59:24 2025 from 131.154.8.12

Schedd: sn01-htc.cr.cnaf.infn.it : <131.1</p> SUBMITTED DONE RUN

Total for query: 0 jobs; 0 completed, 0 remo Total for apascolinit1: 0 jobs; 0 completed, Total for all users: 26986 jobs; 16180 compl

pascolinit1@ui-tier1 ~/htc_test/local 50000 job(s) submitted to cluster 5430818. pascolinit1@ui-tier1 ~/htc_test/local

Schedd: sn01-htc.cr.cnaf.infn.it : <131.1</pre> BATCH_NAME SUBMITTED DONE apascolinit1 Stress-Test 5/14 01:00

Total for query: 1000 jobs; 0 completed, 0 Total for apascolinit1: 1000 jobs; 0 complet Total for all users: 27994 jobs; 16195 compl

apascolinit1@ui-tier1 ~/htc_test/local

- 2 Tier-1
- 3 How to request a CNAF account
- 4 Bastion & user interfaces
- 5 Farming
- 6 Storage
- 7 The HPC cluster

INFN' CNAF

🗠 Analytics

INFN-CNAF Tier-1 User Guide (Febr

Running jobs: 365118 Active CPU cores: 795836 Transfer rate: 18.35 GiB/sec

INFN-CNAF Tier-1 user guide

- 1 CNAF
- 2 Tier-1
- 3 How to request a CNAF account
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My Personal experience

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Local

26.5 k

Working at INFN-CNAF

Coming from a Physics background I've always been motivated to do my best to support users

- understanding of how a researcher works/thinks
- ease new Physics discoveries

CNAF environment allows good progress in knowledge and competences

- 1 year @CNAF ~ 3/4 years in some IT company
- always facing new challenges

Working in an international collaboration is really stimulating

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Working at INFN-CNAF

Working in an international collaboration is really stimulating

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Working at INFN-CNAF

We are more than happy to have you working with us!

- Bachelor or Master Thesis
- Trainership
- Post-Graduate roles

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