

Richieste di Calcolo per il nuovo Data Center dell'Osservatorio Pierre Auger

V. Verzi
INFN – Roma “Tor Vergata”



C3SN, Bologna
04-09-2024



Sezioni INFN
CT LE
LNF MI
NA RM2 TO

PIERRE AUGER OBSERVATORY

Surface Detector
1660 stations on a
1500 m triangular grid

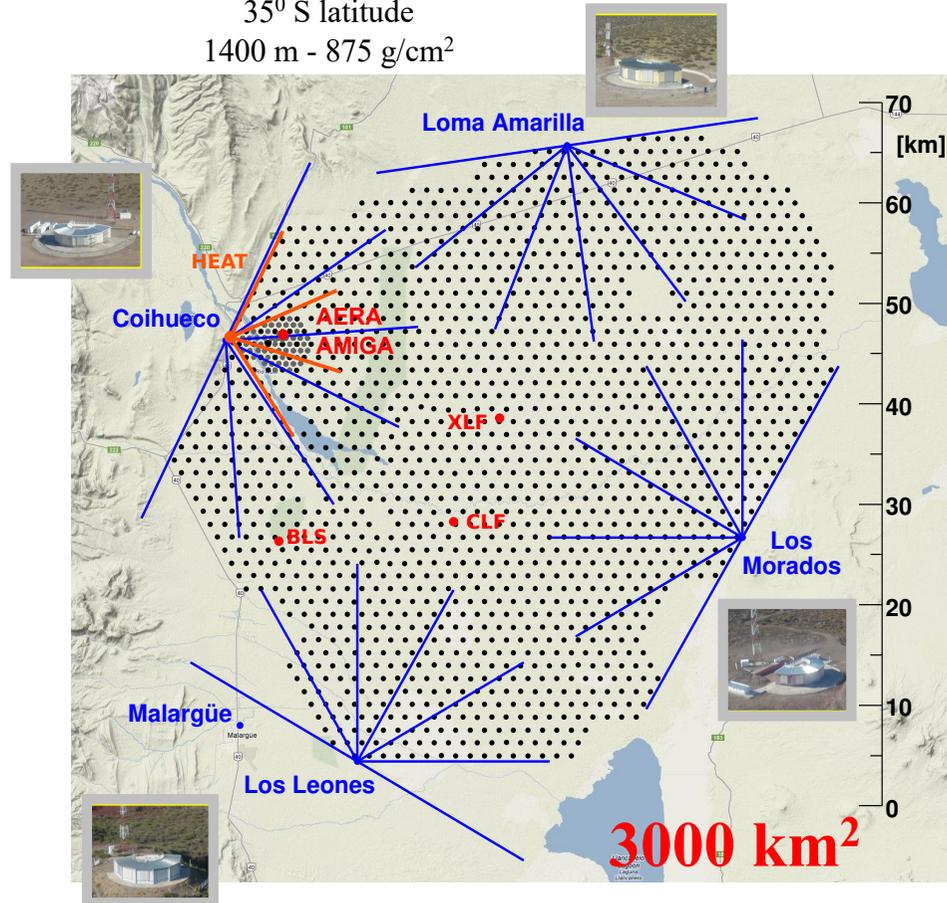
Water Cherenkov tank Antenna Radio Detector Scintillator



Upgraded Unified Board
+ small PMT in the tank

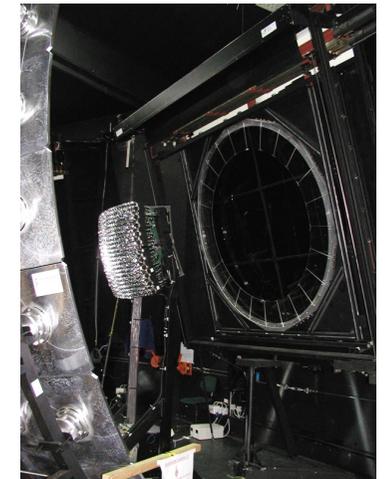
Malargüe - Argentina

35° S latitude
1400 m - 875 g/cm²



cosmic rays up to 10²⁰ eV

**Fluorescence
Detector**
24 telescopes

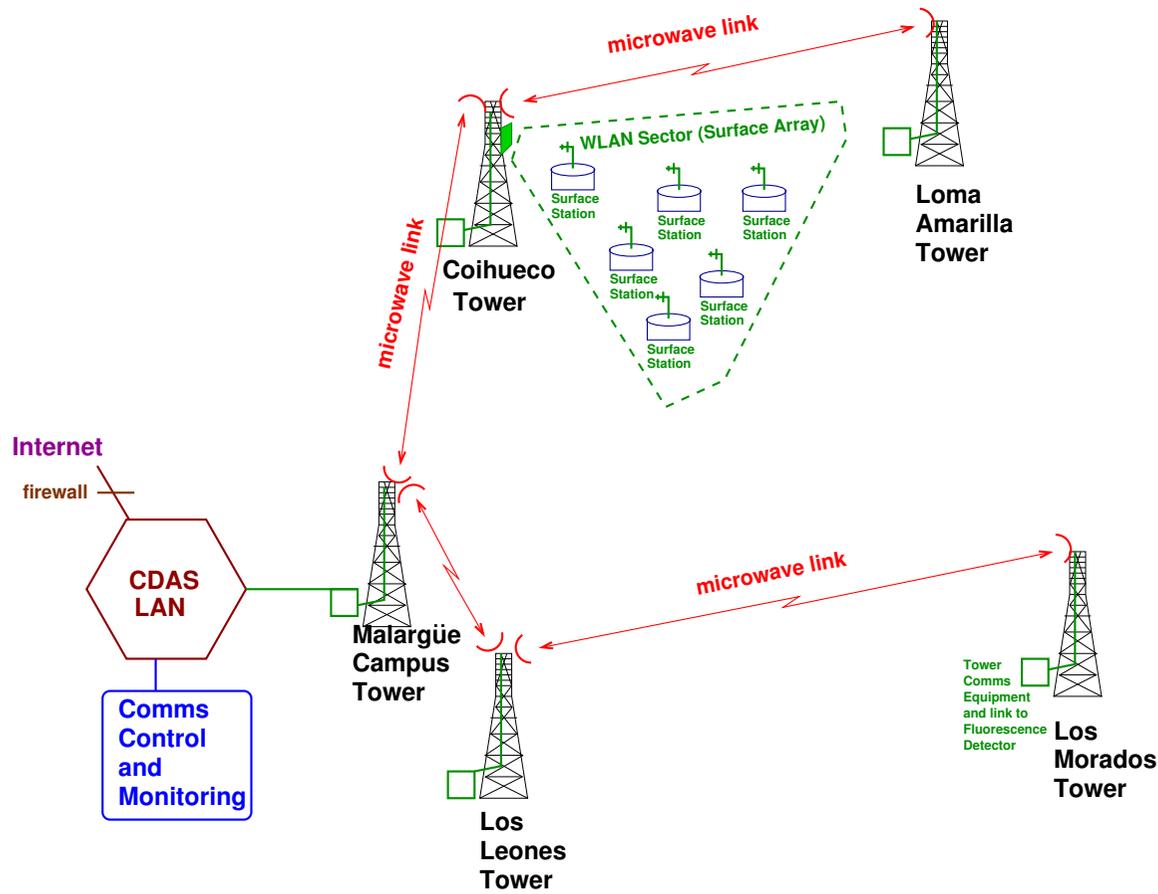


750 m array
433 m array
Auger Engineering Radio Array (AERA)
Underground Muon Detector
High Elevation Telescopes
CLF/XLF, Lidars
...

AUGER SITE



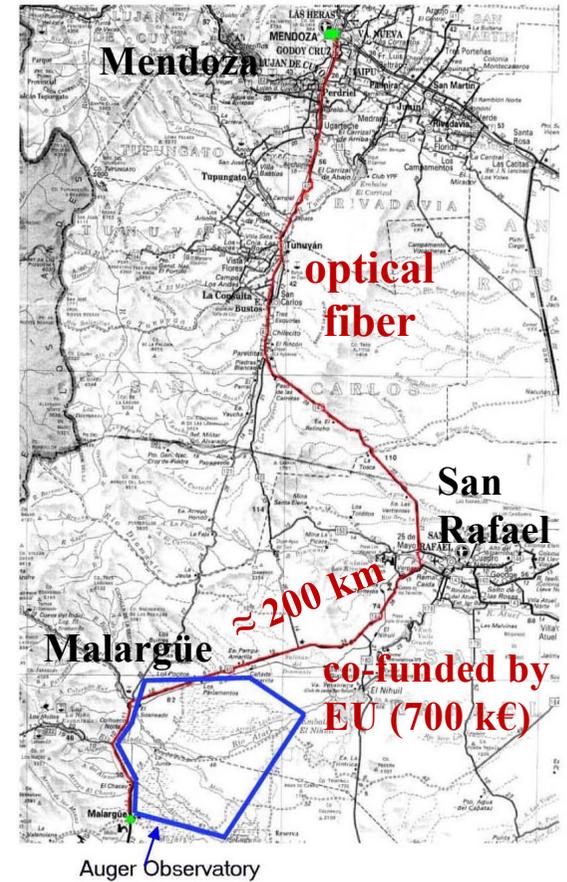
pampa amarilla



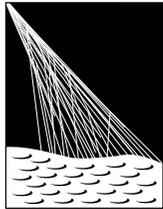
**Auger
Data Center
CC-IN2P3
Lyon, France**

Optical fiber from Malargüe to San Rafael co-funded by EU (700 k€)

Mendoza well connected to Buenos Aires and Santiago



Pierre Auger Collaboration



PIERRE
AUGER
OBSERVATORY

17 Countries
98 Institutions
~400 Scientists



Argentina
Australia
Belgio
Brasile
Colombia
Francia

Germania
Italia
Messico
Olanda
Polonia
Portogallo

Rep. Ceca
Romania
Slovenia
Spagna
USA



55 Scientists
35 FTE

Sez. INFN

Catania
Lecce
Lab. Naz. Gran Sasso.
Milano
Napoli
Roma "Tor Vergata"
Torino

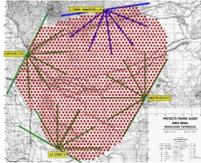
RL

R. Caruso
L. Perrone
F. Salamida
L. Caccianiga
R. Colalillo
V. Verzi
A. Di Matteo

International agreement


Professor Enzo Iarocci
President of INFN
Rome, Italy

End of construction of the Observatory



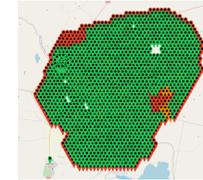
New International agreement


Prof. Fernando Ferroni
President
16 NOV. 2015
Date

20th Anniversary Symposium

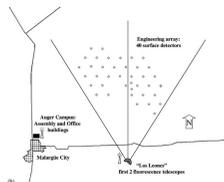


End of installation of SSD/sPMT/UUB



Foreseen end of AugerPrime construction

**Engineering Array
NIM A 523 (2004) 50-59**



PDR AugerPrime



FB approves Auger Prime

array of 77 SSDs



**Extension of data taking
(need an update of the International agreement)**

2000 2005 2010 2015 2020 2025 2030 2035

← Phase 1 → ← Phase 2 →

Next November: revision of the International Agreement to extend the data taking until 2035

Finance Board: M. Pallavicini for the INFN

INFN uno dei maggiori finanziatori del progetto



Phase 1



Phase 2

Collaborazione per realizzare il Data Center

Lorenzo Caccianiga – Università di Milano

Roberta Colalillo – Università di Napoli

Lorenzo Perrone – Università del Salento

Francesco Salamida – Università dell’Aquila

Valerio Verzi – INFN Roma “Tor Vergata”

Ringraziamo Daniele Cesini e Carmelo Pellegrino per il consulto dato per formulare la proposta e verificare la fattibilità del progetto

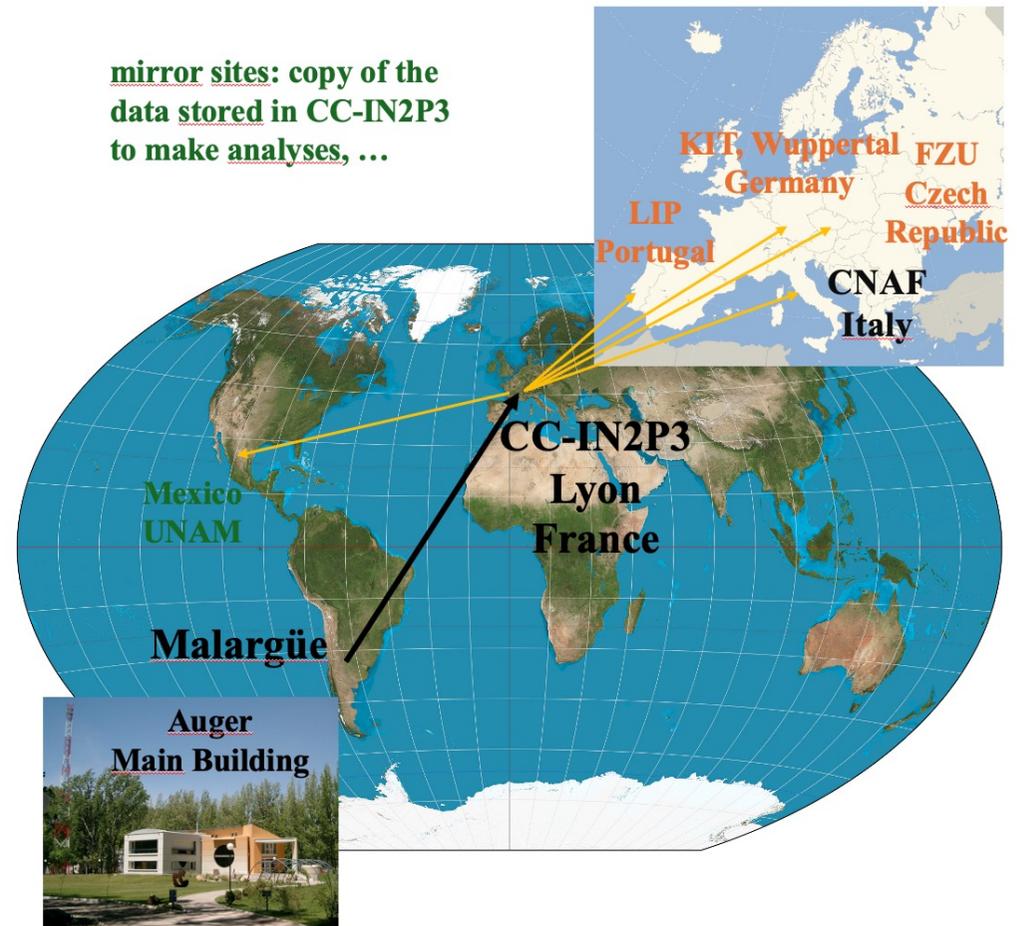
Auger Data Center

I dati di Auger vengono trasferiti da Malargüe al Computing Center dell'IN2P3 (CC-IN2P3) in Lione (Francia)

- la Collaborazione ha accesso ai dati salvati al CC-IN2P3
- siti mirror presso alcuni istituti (e.s. CNAF)

IN2P3 non sarà disponibile a mantenere il data center a partire dal 2025

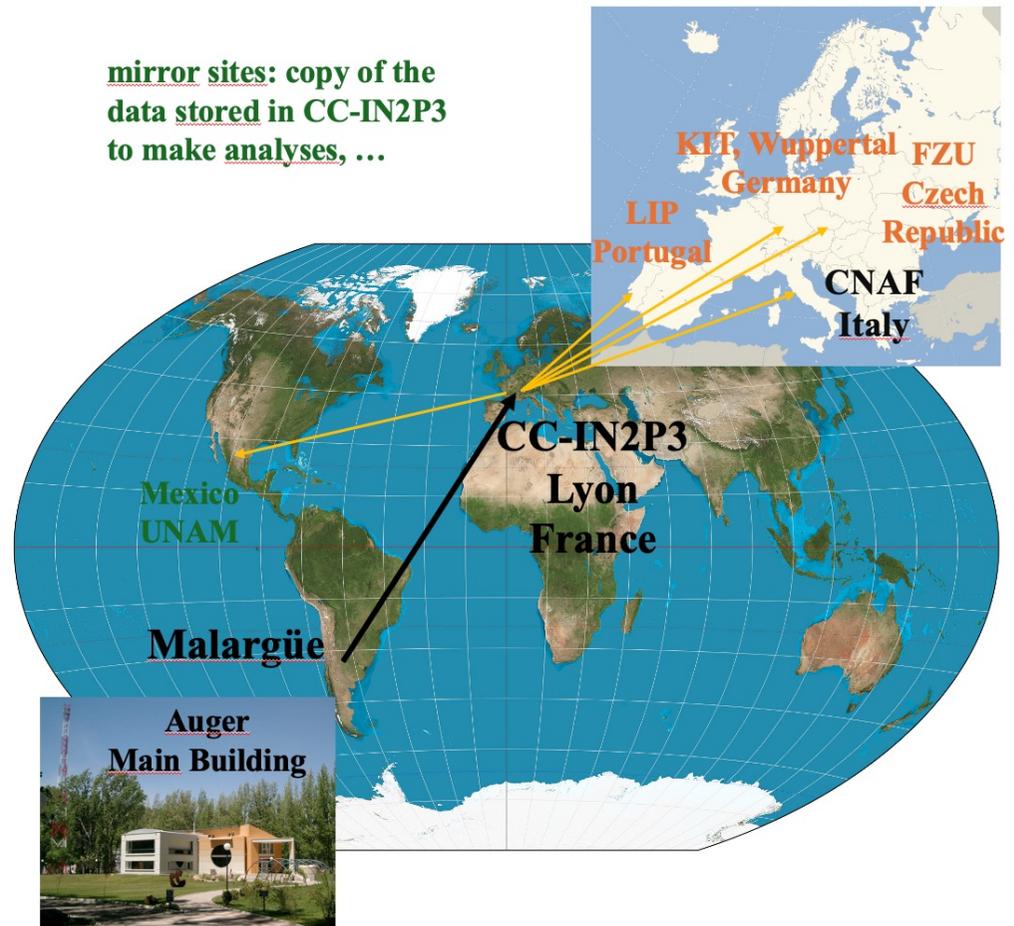
Approvazione da parte del Collaboration Board per ospitare il nuovo Data Center al CNAF/Centro Nazionale



Auger Data Center

CC-IN2P3 in Lione (Francia)

- corretto trasferimento dei dati da Malargüe
- storage dei dati raw con ridondanza
- primo processamento dei dati raw
 - merging of events (SD,FD,...)
 - physics trigger (T4,T5)
 - small PMT calibration (CT)
 - first preliminary reconstruction with Offline tasks sotto la responsabilità di INFN-MI
- SD shifts
- storage di alcune simulazioni
- accesso ai dati: ogni membro della Collaborazione può richiedere un account a Lione



Malargüe



*Control and Data
Acquisition System
(CDAS)*

AUGER DATA CENTER

*raw data
merging of events (SD,FD,...)
physics trigger (T4,T5)
sPMT calibration
...*

MIRROR SITES

*Czech Republic, Germany,
Italy, Mexico, Portugal*

DATA PROCESSING

*Offline Framework
<https://gitlab.iap.kit.edu/>*

*Advanced Data Summary Tree
(ADST)*

*sftp -o Port=443
gaugo@augerlogin.iap.kit.edu*

MONITORING

<http://paomon.physik.uni-wuppertal.de/>

*MySql and SQLite databases
FD calibration
atmospheric data
...*

Auger Data Center: accounts

Connection to Lyon: personal accounts, ssh

Auger user → group «pauger»

- total of ≈ 350 accounts
- 7 accounts are generic for data management and production

Private/user

- for each user: allocate a «home» disk space of 20 GiB (/pbs/home). It is backed-up.
- 400 GiB used (→ several users not using their allocated space)

Active users ≈ 140

- most of them probably active only for SD shifts
- active users beyond SD shifts: $\approx 50 + 7$ generic ones

Shared storage for users

- common area of 100 GiB (/pbs/throng/pauger) where users may share important data to be backed-up regularly

Auger Data Center: storage

Permanent Backed-up Storage (/pbs) – 5 TiB

- users: «home» disk space and common area

Semi Permanent Storage (SPS) – 100 TiB

- non-backed-up area designed to host large volumes of data that users access regularly → access to raw data and first processing (saved on TSM)

Large data files storage: disk/tape - 300/1000 TiB

- disk:
 - iRODS – 300 TiB raw data including AERA, ...
- tape:
 - HPPS – 900 TiB include simulations
 - TSM – 100 TiB backup of raw data in two different buildings

Other

- XRootD – 10 TiB dCache – 30 TiB

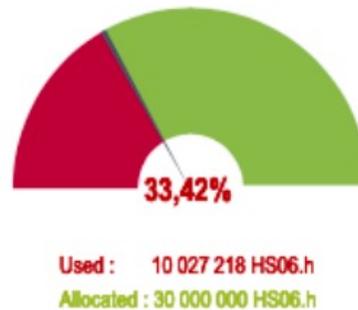
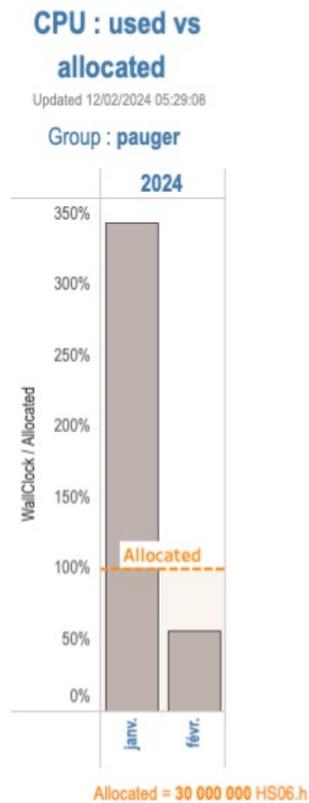
note: AERA data \approx 100 TiB in iRODS too large to be stored in SPS
iRODS not available at CNAF

Auger Data Center: computing

2024: allocated 3400 HS06

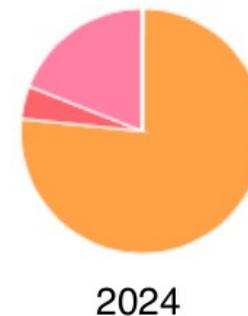
requests tend to exceed those allocated. Similar trend in the past years

CPU mainly used by few users



In 2023, CPU used by 26 users (in 2022: 27 users)

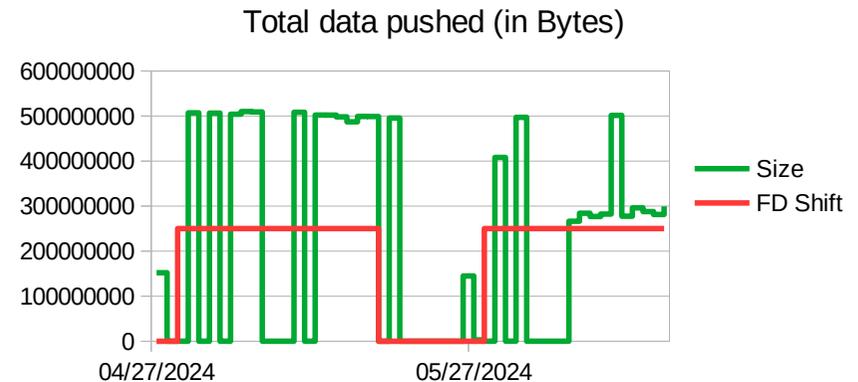
CPU mainly used by 3 users (not Auger Prod)



Data transfer from Malargüe

Total amount of data 640 GiB/month

- T2DUMP 326.5 GiB
- AERA 167.0 GiB
- CALIB 82.3 GiB
- CDAS 72.8 GiB



Data transfer done by the system manager of the Observatory

→ «Mirror administrative account»

- rsync over ssh
- ftp for AERA files (100 GiB each)
- bash scripts in Malargue e in Lyon

note: increase of the amount of data (< factor 2) once AugerPrime will be fully operative

Auger Data Center: richieste di risorse di calcolo

CPU			DISCO		TAPE		Infrastruttura (Tier1, Cloud,...)
HS06	kEuro	Range temporale mesi	TB	kEuro	TB	kEuro	
3000	30	12	300	30	1000	10	Tier1-CNAF
-	-	-	-	-	300	3	ReCaS

CPU (€/HS06)	Disk (€/TB-N)	Tape (€/TB)
10	100	10

nota: ridondanza dei raw data su TAPE al CNAF e a ReCaS

- **user interface “carrozzata” con 32 core, 2 GB di RAM e 200 GB di disco**
necessaria per permettere agli utenti di Auger di operare al CNAF
- **HPC: 1 nodo con 4 GPU H100**
ricostruzione degli eventi con algoritmi di machine learning

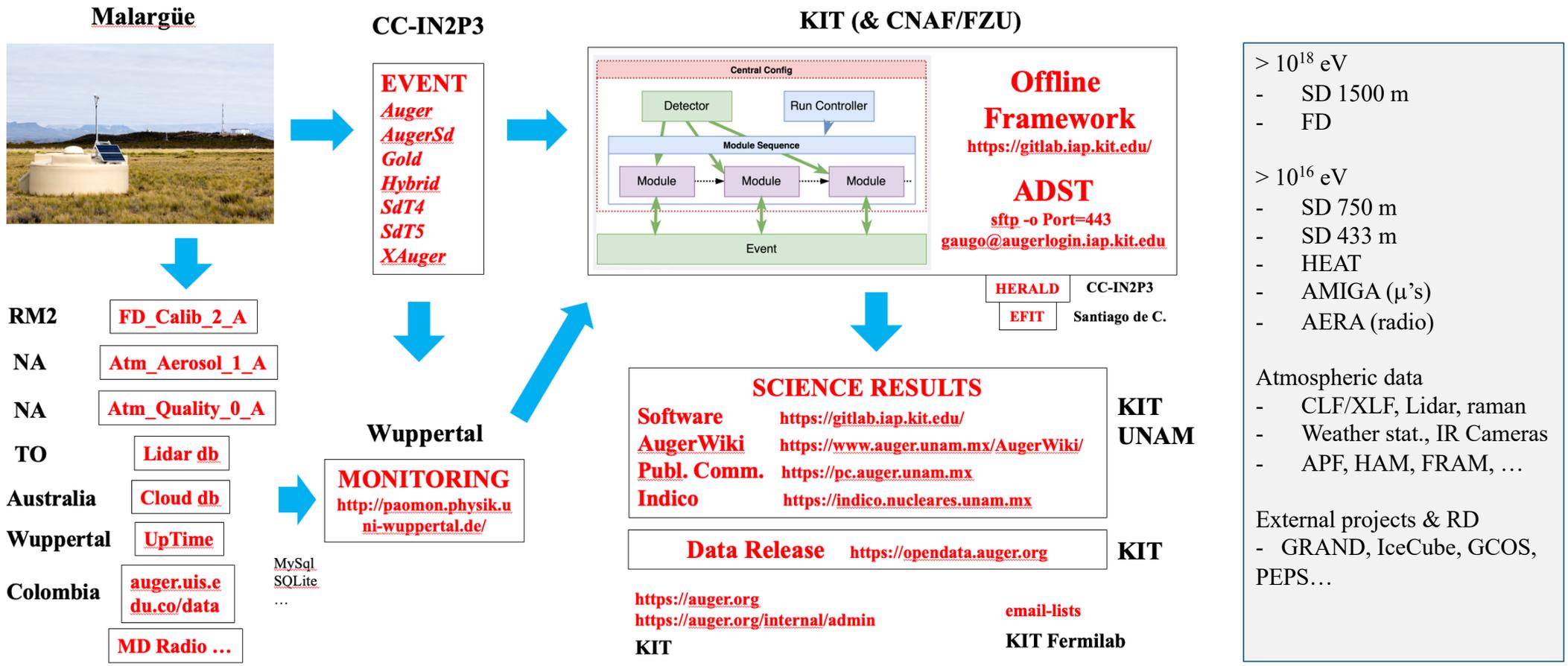
Auger Data Center: richieste di risorse di calcolo

	2024	2025	2026	2027	2028
CPU [HS06]		3000	4000	5000	6000
Disco [TB]		300	350	400	450
Tape [TB]		1300	2000	2500	3000

Il profilo temporale delle richieste è meramente indicativo e sarà riformulato in modo più puntuale quando il Data Center sarà operativo.

Ci attendiamo un aumento graduale delle risorse per via dei nuovi dati che saranno raccolti dai rivelatori e nell'aspettativa dell'aumento delle attività di computing.

L'aumento delle risorse non contempla i possibili futuri sviluppi del Data Center.



- molte possibilità di estendere il ruolo del Data Center
- grande valore aggiunto in «data and knowledge preservation» di un esperimento unico di durata trentennale che ha anche un carattere fortemente multidisciplinare

Auger Italia: richieste di risorse di calcolo

I gruppi italiani Auger già usufruiscono delle risorse di calcolo al CNAF (cluster creato nel 2010)

- CNAF è tra i CE della VO Auger per le simulazioni GRID
- mirror dei dati raw per la ricostruzione degli eventi ibridi (coincidenza tra rivelatore di superficie e telescopi a fluorescenza)
- simulazioni RealMC (eventi ibridi) per analisi condotte dai gruppi italiani

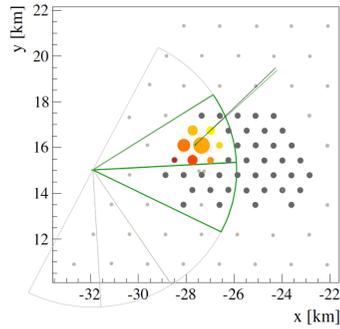
Le richieste per «Auger Data Center» sono aggiuntive rispetto a quelle per «Auger Italia». Unica sovrapposizione sono i dati raw necessari per la ricostruzione degli eventi ibridi (40 TB)

	CPU			DISCO		TAPE		Infrastruttura (Tier1, Cloud,...)
	HS06	kEuro	Range temporale mesi	TB	kEuro	TB	kEuro	
INCREMENTO	0	0	0	0	0	0	0	
PLEDGE (attuale + incremento)	5430	54,5	12	1100	110	300	3	CNAF-Tier1

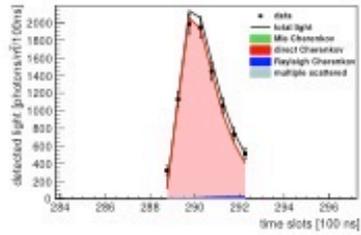
END

Auger events

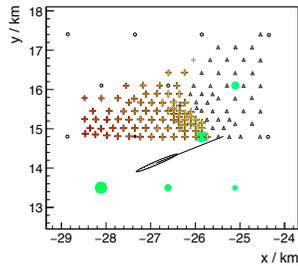
750 m array events



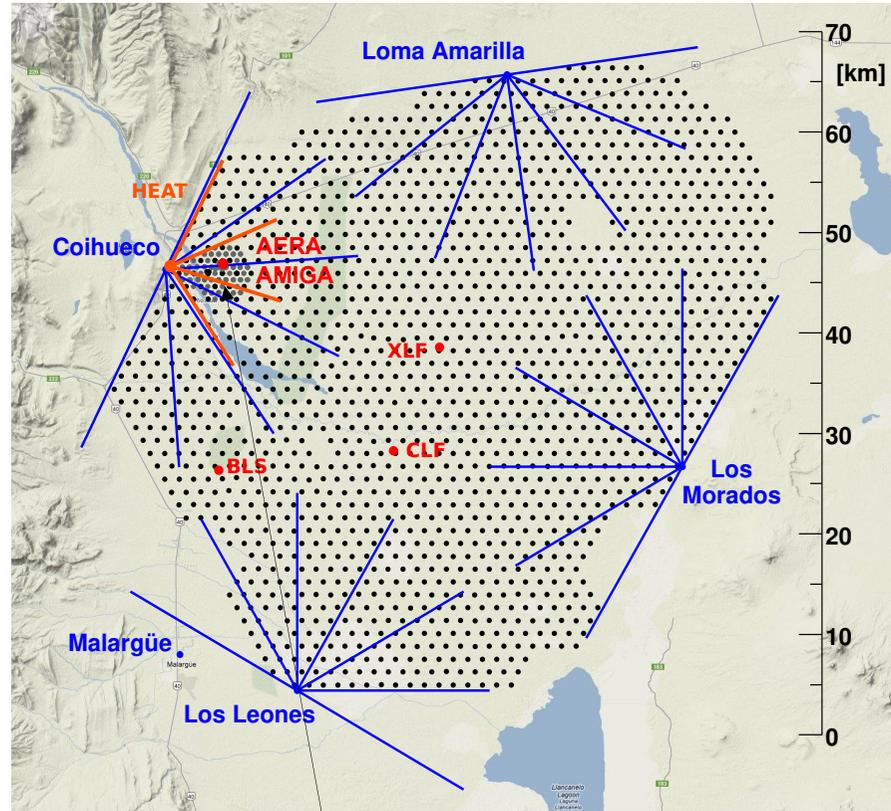
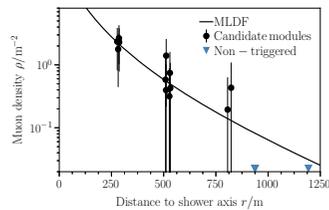
Cherenkov events
HEAT



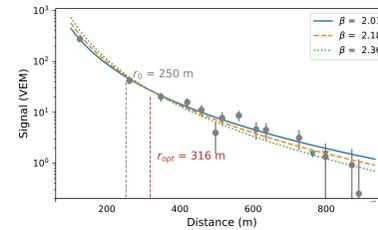
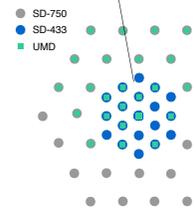
AERA events
(radio ≈ 100 MHz)



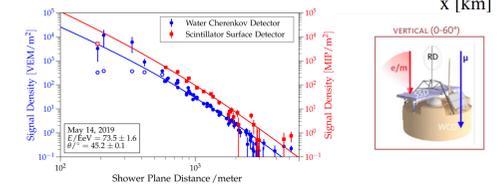
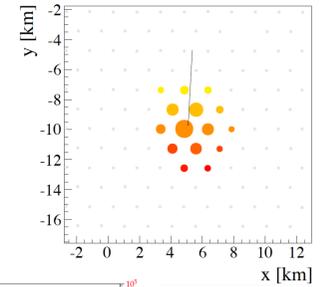
AMIGA events
(muons)



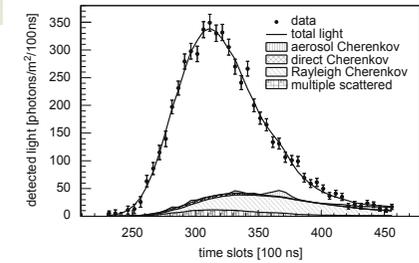
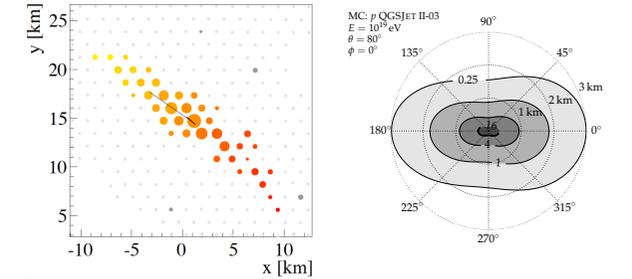
433 m array events



1500 m array vertical events
 $\theta < 60^\circ$

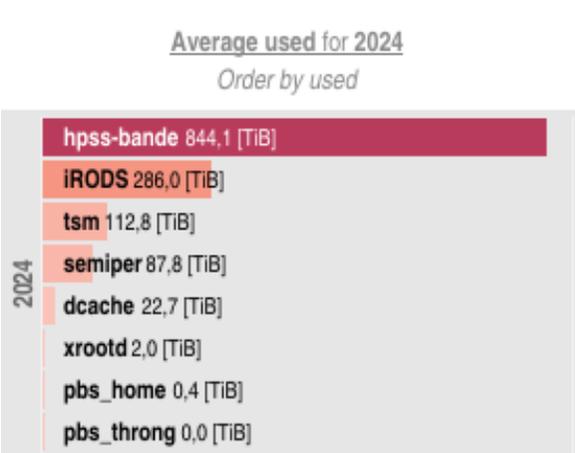


1500 m array inclined events (muons)
 $\theta > 60^\circ$



fluorescence events

iRODS and HPSS



Directory	Usage	Usage (%)	Space
/hpss/in2p3.fr	866.6 TiB	no quota	HPSS
/pauger/AugerPrimeAux	3.8 TiB	no quota	iRODS
/pauger/DataProd	58 TiB	no quota	iRODS
/pauger/Papers	122 GiB	no quota	iRODS
/pauger/Productions	10.1 GiB	no quota	iRODS
/pauger/Radio	96.6 TiB	no quota	iRODS
/pauger/Simulations	36.6 TiB	no quota	iRODS
/pauger/T2Dump	2.8 TiB	no quota	iRODS
/pauger/home	192.5 GiB	no quota	iRODS

To be clarified: which part of iRODS used space counted in HPSS one

Too large size
→ not on /sps

