



I Laboratori di Frascati dell'INFN

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A glorious history!

The **Laboratori Nazionali di Frascati** (LNF) are the oldest and largest laboratory of the INFN, the first to build a particle accelerator in Italy, and the protagonist over the years of numerous world-class enterprises in this field.



First italian particle accelerator, world record energy(1.1 GeV)

World-first electron-positron collider , from an idea of Bruno Touschek

Electron-positron collider with 3 GeV CoM energy, took part to the 1974 J/ψ revolution

All the colliders built in the following years in the USA, Russia, China, Japan, Europe, including those at **CERN**, descend from ADA!



LNF: present

Today we have two accelerators in operation, **DAFNE** and **SPARC_Lab**, plus **numerous infrastructures** dedicated to accelerator research and development.





The **DAFNE** complex



Entered into operation in 1999, it is a high-intensity electron-positron collider operating at 1019 MeV, the ϕ mass

INFN DAFNE experiments: 1st generation

Istituto Nazionale di Fisica Nucleare Laboratori Nazionali di Frascati



KLOE and KLOE2: **K LO**ng Experiment: fundamental symmetries and SM tests with kaons

FINUDA: FIsica **NU**cleare a **DA**FNE: study of weak interactions through the decays of Lambda hypernuclei

Le Scienze Edizione italiana di scientific american

La fisica di DAFNE

La prima fabbrica di particelle, costruita a Frascati, permettera' lo studio delle simmetrie fondamentali della natura con precisione e dettagli finora irraggiungibili franzini paolo, franzini paula j., lee-franzini juliet







DAFNE experiments: 2nd generation



PADME Dark photon search via positron annihilation at the DAFNE LINAC

SIDDHARTA

Study of strong interactions through the decays of kaonic atoms





Recent results from PADME on X17

New 17 MeV particle decaying as $X_{17} \rightarrow e^+e^-$ proposed to explain anomalies in nuclear excitation experiments at ATOMKI (Hungary) PRL 116 (2016) 042501



More to come with the ongoing PADME run!!!



The SPARC_Lab complex

Started in 2005, it is a laboratory for research and development of new-concept accelerators and radiation sources, and is made up of:

- SPARC high brightness photoinjector
- FLAME high-power laser

Self-LWFA

TNSA



FLAME A facility based on the unique combination of a high brightness electron beam high-intensity ultra-short laser pulses



In recent years, there has been a great development of new acceleration techniques based on plasma \rightarrow high gradient, small size

plasma section



Plasma acceleration at SPARC_Lab

The very strong fields generated inside an ionized gas allow transition from acceleration gradients of tens of MV/m, typical of RF cavities, to tens of GV/m.





In **2023**, the first experiment in the world with a 3 cm long cell, which integrates the acceleration and focusing functions of the electron beam with 2 mm plasma capillaries. In **2024**, the first experiment at SPARC_Lab of beam deviation in curved plasma capillaries

A new generation of ultra-compact accelerators is born in Frascati!



LNF future: EUPRAXIA

The success of SPARC_Lab paves the way for the next great scientific undertaking of LNF: the realization of a multidisciplinary FEL radiation source produced by a plasma-accelerated beam: **EUPRAXIA@SPARC_LAB**



Topics of research: proteins, viruses, bacteria, cells, metals, semiconductors, superconductors, magnetic materials, organic molecules

WILL OTO

Delivers 10-100 Hz **ultrashort** pulses

- Electrons (0.1-5 GeV, 30 pC)
- Positrons
 (0.5-10 MeV, 10⁶)
- Positrons (GeV source)
- Lasers

 (100 J, 50 fs, 10-100 Hz)
- Betatron X rays (1-110 keV, 10¹⁰)
- FEL light (0.2-36 nm, 10⁹-10¹³)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 653782.





EUPRAXIA international collaboration

34 institutes from12 countries,project co-fundedby EU



LNF has been chosen to host one of the 2 experimental sites where the accelerators will be built, the Italian government has already approved the related funding

Construction of the main building will start next year





Not just accelerators: detector technology!

LNF is a global hub for the development and construction of particle and gravitational wave detectors, for experiments in Frascati and to be installed in all major laboratories in the world, starting from CERN and Fermilab



LNF researchers participate in all of the major experiments all over the world







LHCb Muon detector



MWPC, GEM

ATLAS Muon detector



New Small Wheel, Micromegas

INFN Detector technology for particle experiments

Mu2e electromagnetic calorimeter

Laboratori Nazionali di Frascati



CsI calorimeter

NA62 large-angle photon detector



Lead-glass calorimeter

Detector technology for particle experiments

KLOE2 cylindrical GEM (world-first)



BESIII cylindrical GEM



Ongoing: ATLAS ITK pixel tracker → construction of Outer Endcap)





Detector technology for axions and GW



Ongoing axion-search experiment with QUAX@LNF haloscope at the Frascati COLD_Lab

Will exploit quantum sensing with superconducting qubits to boost sensitivity



Future evolution: FLASH experiment, reuse the existing FINUDA superconducting magnet to build a very large resonant cavity for high-frequency gravitational waves search (GravNet EU project)





Excellence in accelerator physics

Large infrastructure for detector development and construction Wide network of research activities