



Report from LNF

Fabio Bossi INFN-LNF

113° P-ECFA Meeting

CERN, Nov. 16 2023

The Laboratori Nazionali di Frascati (LNF) is located about 20 km south-east of Rome, 2 km away from the town of Frascati

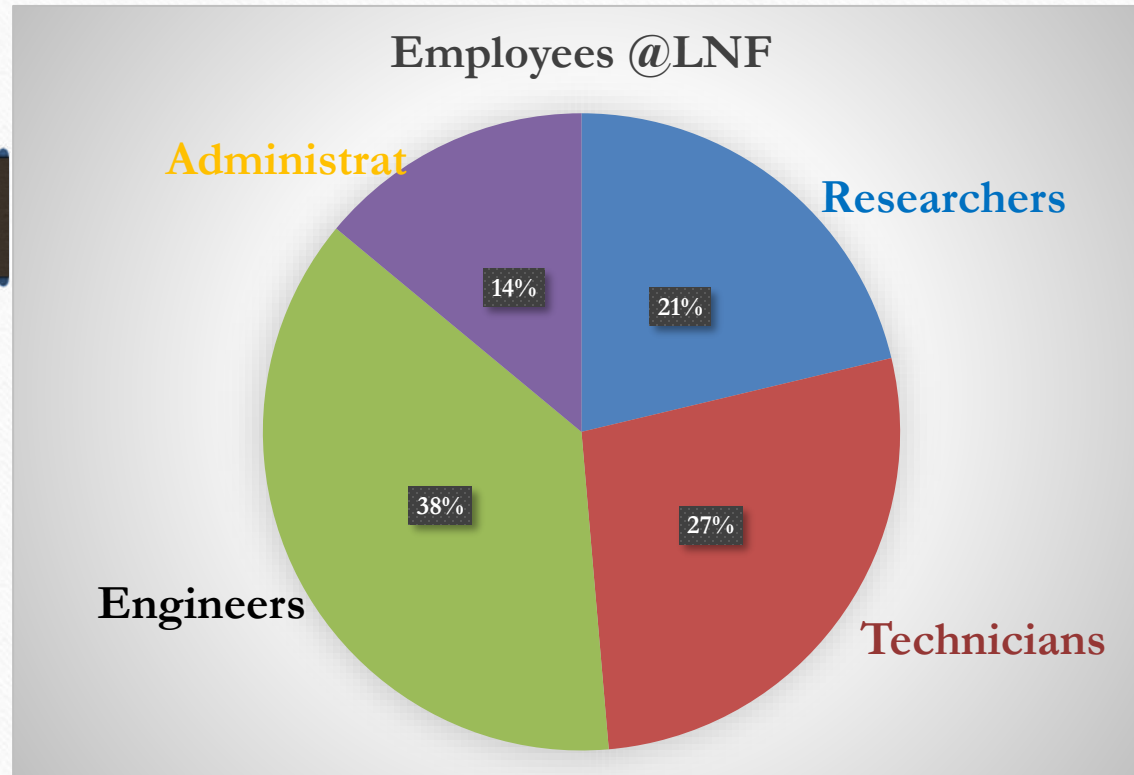


The area hosts the largest concentration of scientific institutions of the country, mainly in physics, astrophysics, space science



We are preparing to host all of you for the next Plenary ECFA meeting on July 4-5 2024!

As of November 1, 2023 there are **330** permanent or fixed-term employees (researchers, engineers, technicians, administratives) and about **50** doctoral and postdoctoral students

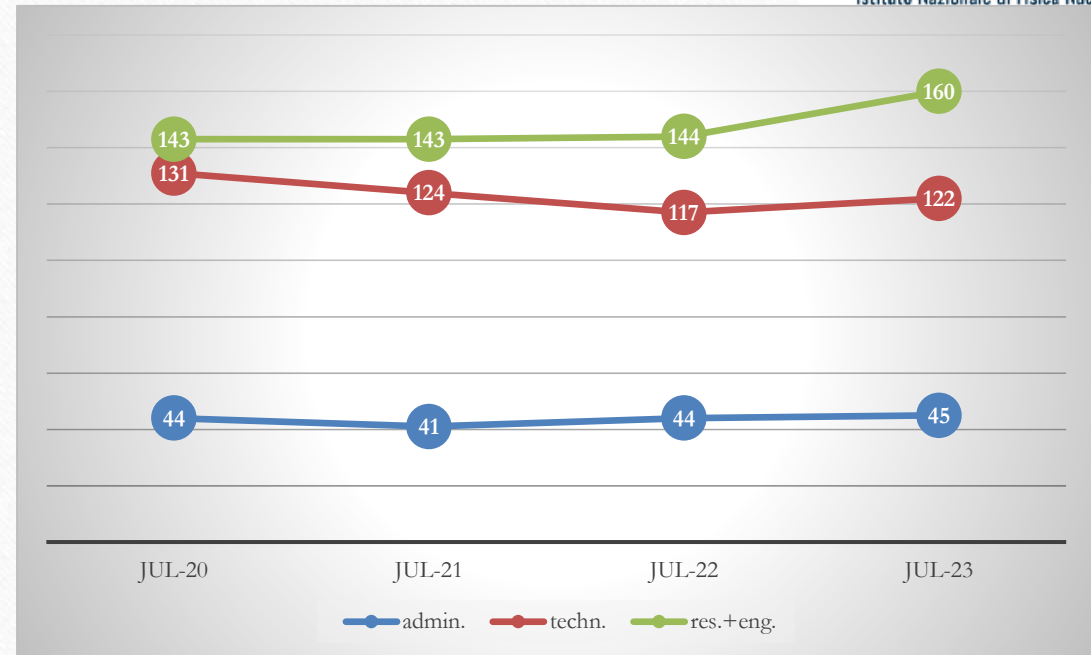
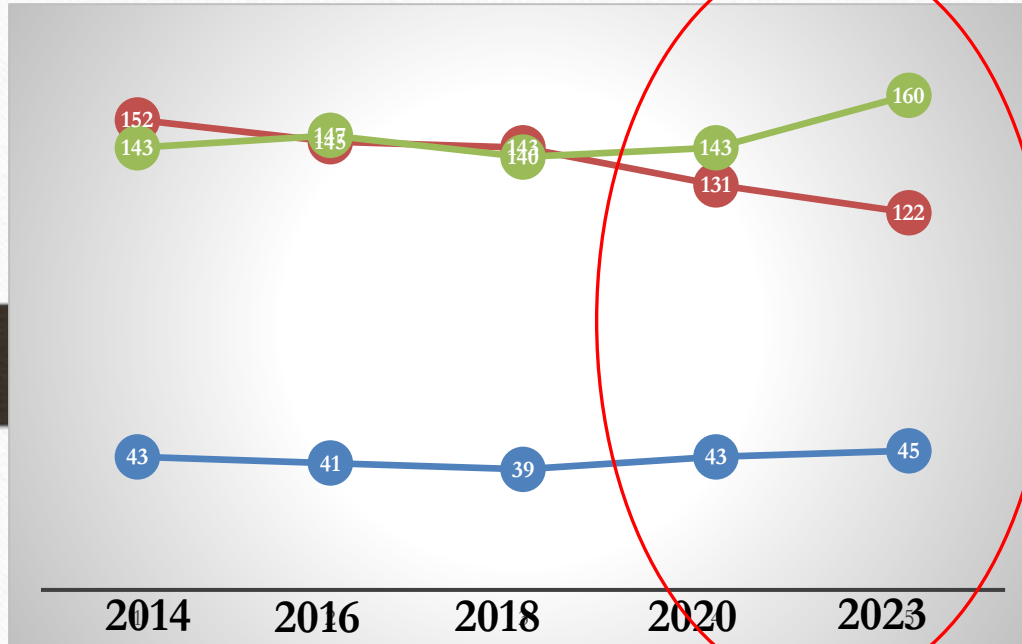


Year 2023 budget

Item	k€
General expenses (*)	13360.00
Ordinary Research	3884.00
External Funds	14542.00
PNRR (Next Gen. EU)	21005.00
Total	52791.00

(*) Electricity and salaries **NOT** included

LNF employees along years



After several years of constant decrease, the number of employees has recently increased. We have still difficulties in hiring technicians, though.

At present we are running two accelerator facilities:

- The **DAΦNE** e^+e^- collider (1 GeV c.m.) with the annex Beam Test Facility (BTF)
- The **SPARC_LAB** linear accelerator complex devoted mainly to PWFA studies

We are working also on the construction of a new accelerator complex, within the context of the European initiative **EuPRAXIA** of which LNF is the headquarter

LNF scientists and technicians participate to the construction of several machines and experimental apparatus in outside laboratories, like CERN, FERMILAB, KEK, LNGS...

DAΦNE Operation



The DAΦNE complex can be operated to provide beams to: **A)** Collider experiments (**SIDDHARTA-2**) **B)** Dedicated LINAC experiments (**PADME**) **C)** Normal BTF-1/2 users

Operation **A)** and **B)** are mutually exclusive, while **C)** can be operated while doing **A)**

Period	Operation
Mar-June 21	A) (reduced apparatus) + C)
Sept-Dec 21	Maintenance + MD
Feb-June 22	A) + C)
Sept-Dec 22	B) (X17 run)
Mar-June 23	A) + C)
Sept-Dec 23	A) + C)
Feb-June 24	A) + C)

50 pb-1 with d target

Scan around 17 MeV c.m

200 pb-1 with d target

Further 150 pb-1 so far

Goal of 800 pb-1 total

More than 200 days of beam have also been provided to BTF users in 2023

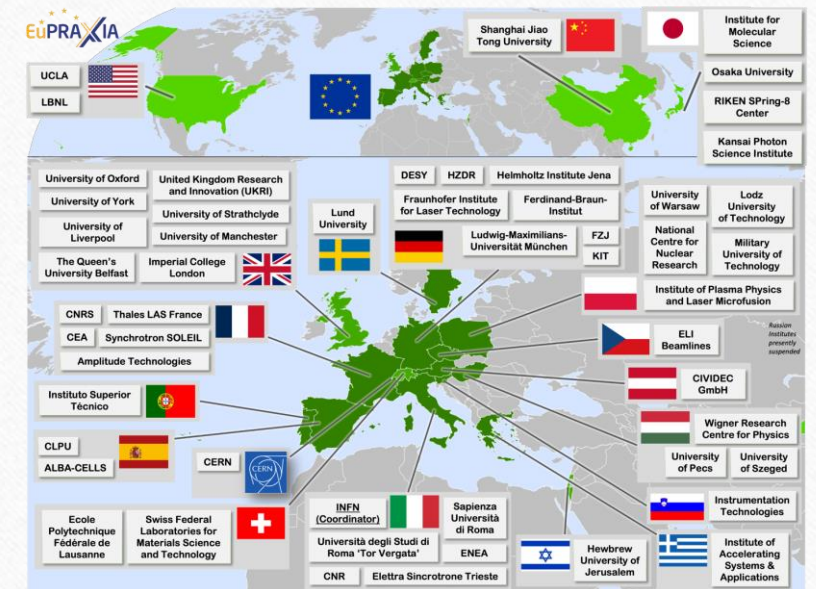
EuPRAXIA

A short vocabulary:

- **Eupraxia:** a multi-national project aimed at building two plasma-based accelerator facilities to drive a FEL for photon-science users
- **Eupraxia@Sparc_Lab:** the Italian branch of the enterprise with the aim of building at LNF one of these two facilities, using the beam-driven technique
- **Sparc_Lab:** the current infrastructure at LNF to develop R&D for the above project. The Sparc_Lab group is a leading team in Eupraxia

The EuPRAXIA Consortium Today

- **54 institutes** (*in addition 15 ask to join Preparatory Phase presently*)
- from **18 countries** plus CERN
- signed on one or several presently **active EuPRAXIA consortia**:
 - **ESFRI** consortium (funding in-kind)
 - **Preparatory Phase** consortium (funding EU, UK, Switzerland, in-kind)
 - **Doctoral Network** (funding EU, UK, in-kind)

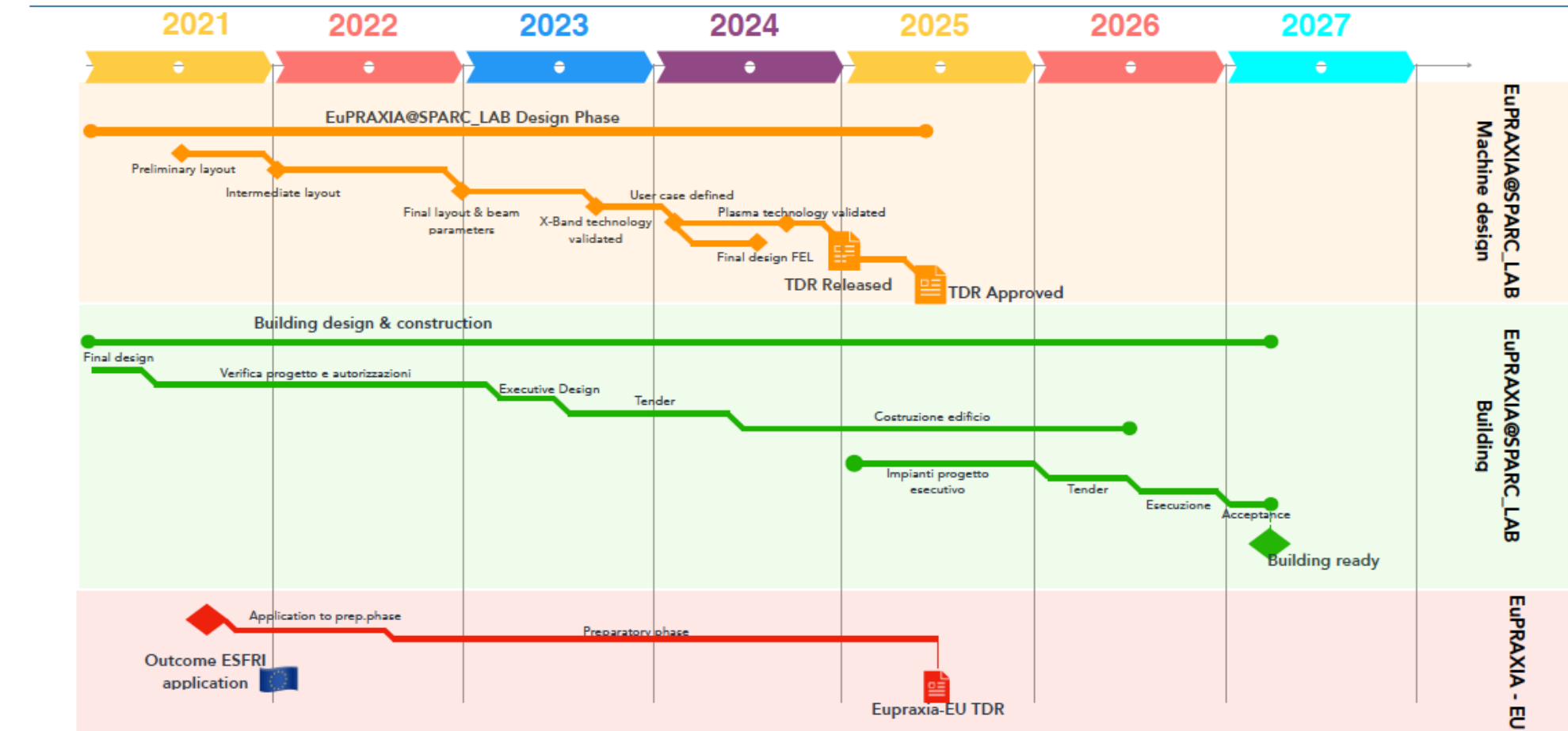


From: R. Assmann

Main EuPRAXIA@SPARC_LAB progress

- Authorization to build obtained
- Executive design of the building started
- **SPARC_LAB** lasing experiment succeeded (*Nature* 605 (2022) 7911, 659-662)
- **TEX** facility fully operational for the test of X-band RF components
- RF design of X-band waveguide components completed
- Procurement of CPI and SCANDINOVA Klystrons ongoing. Delivery expected by end of 2024
- Injector studies frozen and completed
- Plasma Module 40 cm long successfully tested in the lab
- LINAC RF prototype produced and under test
- Undulator design and prototyping progressing

Road map



EuAPS



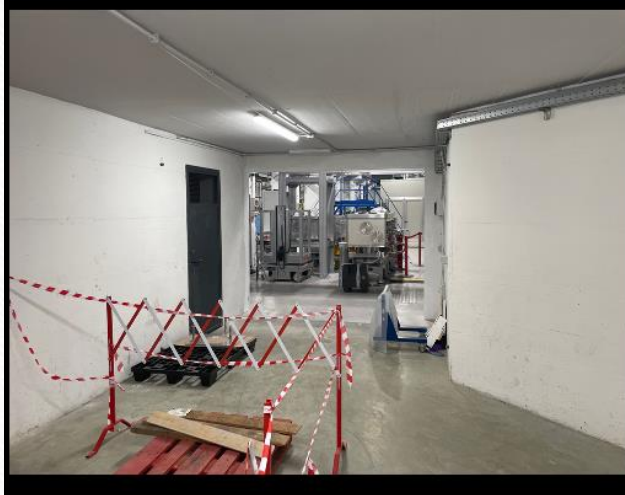
The EuPRAXIA Advanced Photon Source (EuAPS) project has received financial support worth **22.3 M€** in the context of the **PNRR** plan (Next Gen. EU), being ranked 1st among the projects of the ESFRI research infrastructure call

The project consists in:

- The construction of a betatron radiation source for X-ray imaging (LNF-INFN) (~ 6 M€)
- The development of a high-power (1 PW) laser (LNS-INFN) (~ 8 M€)
- The development of a high repetition rate (1000 Hz) laser (CNR-INO Pisa) (~ 7 M)

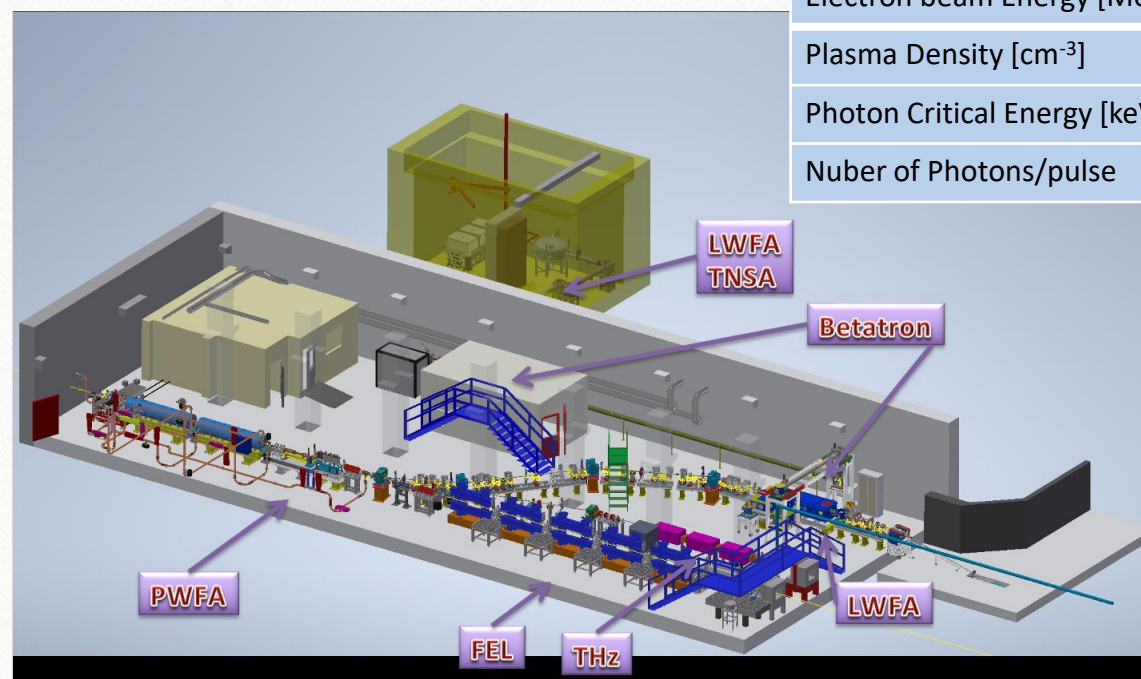


**EuAPS Kick-off meeting,
Rome 28/2/2023**



Betatron Source

Electron beam Energy [MeV]	50-800
Plasma Density [cm^{-3}]	$10^{17} - 10^{19}$
Photon Critical Energy [keV]	1 - 10
Nuber of Photons/pulse	$10^6 - 10^9$



From design to reality in 30 (+6) months

Extension of the Laboratory

On Dec. 20, 2022, we have acquired a new estate consisting of a large ($\sim 3000 \text{ m}^2$) warehouse and about the same area of free land, formerly used as a parking lot

We intend to use part of this area ($\sim 600 \text{ m}^2$) to build a new computing centre, within the context of the ICSC PNRR initiative, for which we have been granted funds for $\sim 4\text{M€}$.

Further and urgent investments are however needed to be found outside PNRR money.

Challenging project to be completed within 2025



The FLASH Proposal



A proposal for searching galactic axions in the mass range **0.49-1.49 μeV** using the magnet of the FINUDA experiment has been recently put forward

The magnet, of 1.1 T, has not been in use for more than 15 years. Therefore a campaign of refurbishing old/repairing broken components, has been carried out during the last few months. We are now almost ready to try to power the magnet ON

The test is planned for the end of this year

arXiv:2309.00351v1 [physics.ins-det] 1 Sep 2023

The future search for low-frequency axions and new physics with the FLASH resonant cavity experiment at Frascati National Laboratories

David Alesini^a, Danilo Babusi^c, Paolo Beltrame^b, Fabio Bossi^a, Paolo Ciambione^a, Alessandro D'Elia^a, Daniele Di Gioacchino^a, Giampiero Di Pirro^a, Babette Döbrich^e, Paolo Falferi^a, Claudio Gatti^a, Maurizio Giannotti^{d,f}, Paola Gianotti^a, Gianluca Lamanna^a, Carlo Ligi^a, Giovanni Maccarrone^a, Giovanni Mazzitelli^a, Alessandro Mirizzi^{h,i}, Michael Mueck^j, Enrico Nardi^{a,k}, Federico Nguyen^l, Alessio Rettaroli^a, Javad Rezvani^{m,n}, Francesco Enrico Teofil^o, Simone Tocci^a, Sandro Tomassini^a, Luca Visinelli^{a,p}, Michael Zantedeschi^{a,p}

^aINFN, Laboratori Nazionali di Frascati, via Enrico Fermi 54, Roma, 00044, Italy
^bUniversity of Liverpool Department of Physics, Oxford St, L69 7ZE, Liverpool, , England

^cMax-Planck-Institut für Physik (Werner-Heisenberg-Institut), Föhringer Ring 6, München, 80805, Germany

^dFondazione Bruno Kessler, Via Sommarive, I-38123, Povo, Trento, , Italy
^eDepartment of Chemistry and Physics, Barry University, 11300 NE 2nd Ave., Miami, 33161, USA

^fCentro de Astropartículas y Física de Altas Energías (CAPA), Universidad de Zaragoza, Zaragoza, 50009, Spain

^gINFN and University of Pisa, Largo Pontecorvo 3, Pisa, 56127, Italy

^hDipartimento di Fisica "Michelangelo Merlini", Via Amendola 173, Bari, 70126, Italy
ⁱINFN sezione di Bari, Via Orabona 4, Bari, 70126, Italy

^jsz SQUID, Herkener Strasse 9, Simn, 35764, Germany

^kLaboratory of High Energy and Computational Physics, HEPC-NICPB, Rõvala 10, 10143, Tallinn, Estonia

^lENEA Centro Ricerche Frascati, Via E. Fermi 45, Frascati, I-00044, Italy

^mPhysics Division, School of Science and Technology, Università di Camerino, Via Madonna delle Carceri 9, Camerino, 62032, Italy

ⁿUniversity of Pisa, Largo Pontecorvo 3, Pisa, 56127, Italy

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^pSchool of Physics and Astronomy, Shanghai Jiao Tong University, 800 Dongchuan Road, Shanghai, 200240, China

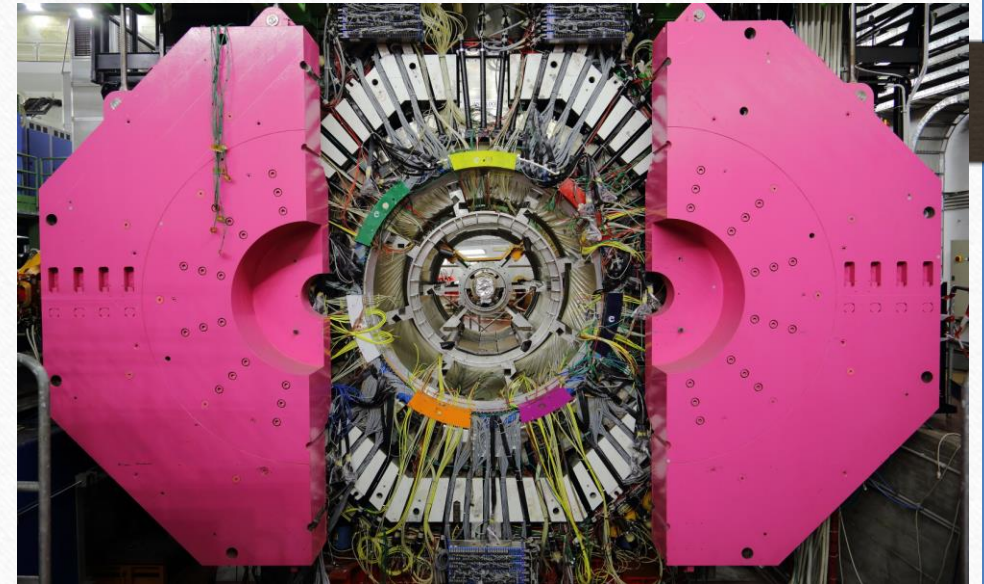
Email address: alessandro.delia@lnf.infn.it (Alessandro D'Elia)

The FLASH Proposal

If the test is successful, we will start the process of consolidation of the project in terms of both manpower and financial resources

Besides the magnet, the other big component of the apparatus will be a large, 4.15 m^3 , copper resonant cavity, for which expertise is already present in the laboratory

Note that the magnet and its cryogenic plant reside inside the DAΦNE hall. Operation of FLASH could therefore be conflicting with the usage of DAΦNE as at present

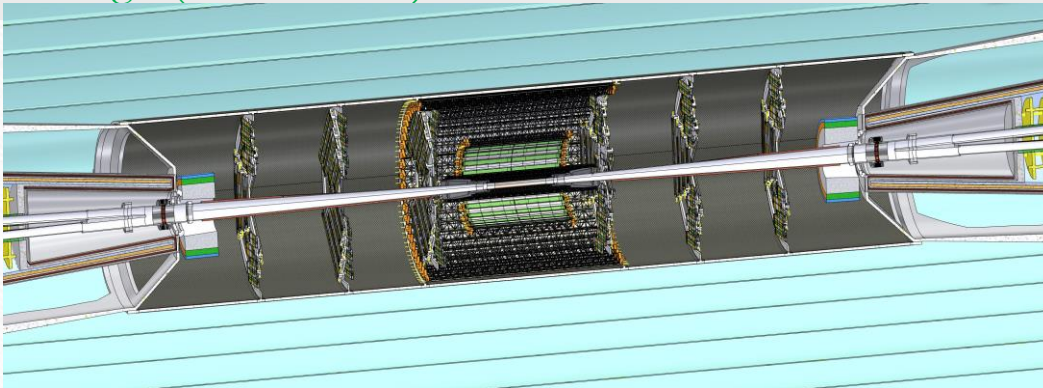


LNF oversees the INFN FCC-related accelerator activities in the context of a dedicated INFN project (RD_FCC).

Two main activities in Frascati: design of the Interaction Region design and of the e⁺ Damping Ring

FCC-ee Interaction Region Design

- The LNF leads the Feasibility Study WP **MDI** to design the IR including its mechanical model. The team is involved on the mechanical model, background simulations, IR optics, bellows, vacuum connection, IR impedance, etc.
- IR and MDI full-scale mockup at Frascati – co-funded project by CERN & INFN (~700 kEuro) 2023-25
- LNF (solely in INFN) in **FCCIS** EU-H2020, Task Leader in MDI design (~280 kEuro) 2020-24

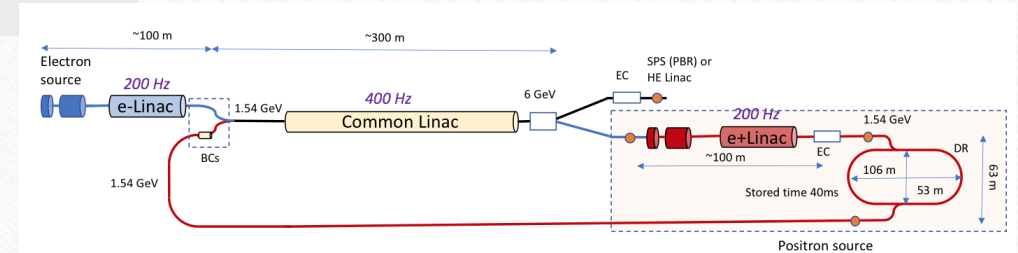


Positron Damping Ring and transfer lines

LNF leads this design within the **CHART** program

Task of the Feasibility Study WP Injector

- 1.54 GeV & 240 m circumference ring
- TL from the DR to the common linac



Courtesy of M. Boscolo

Detector construction for outside experiments

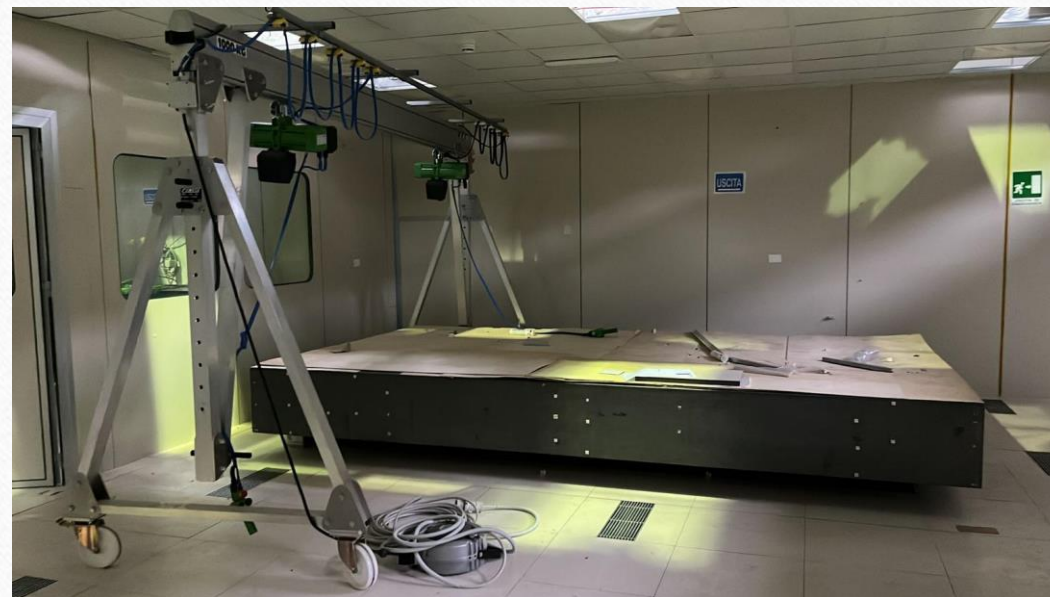
In the course of the last couple of years important detector installation have been completed or are being completed by LNF personnel

- The New Small Wheels Muon detectors of the ATLAS experiment at CERN
- The RICH detector of the CLAS12 experiment at TJNAF
- The Crystal Calorimeter of the Mu2E detector at FERMILAB

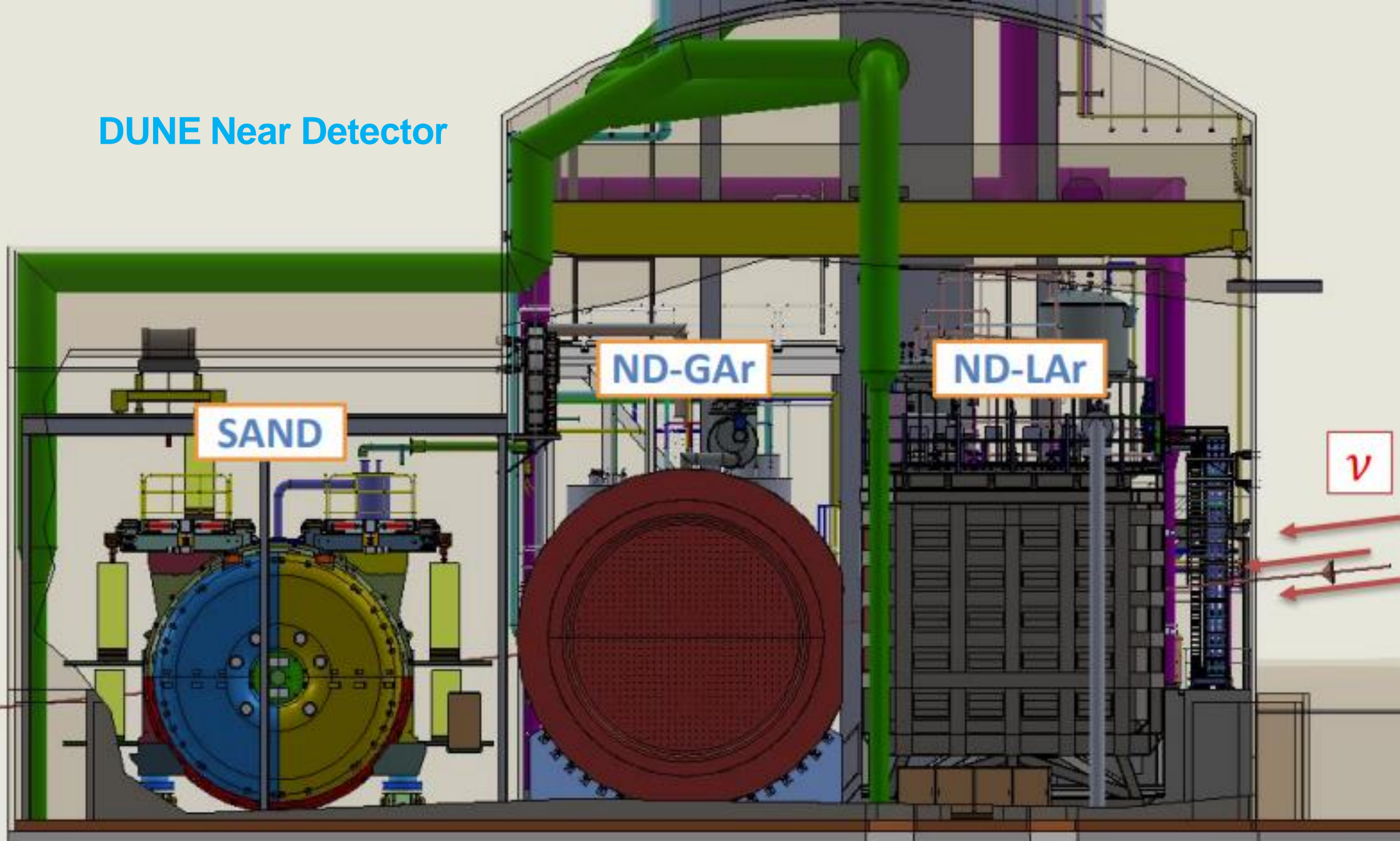
Other big detector construction and/or installation have started and will be use a relevant fraction of manpower of the RD, among which the most ambitious one are

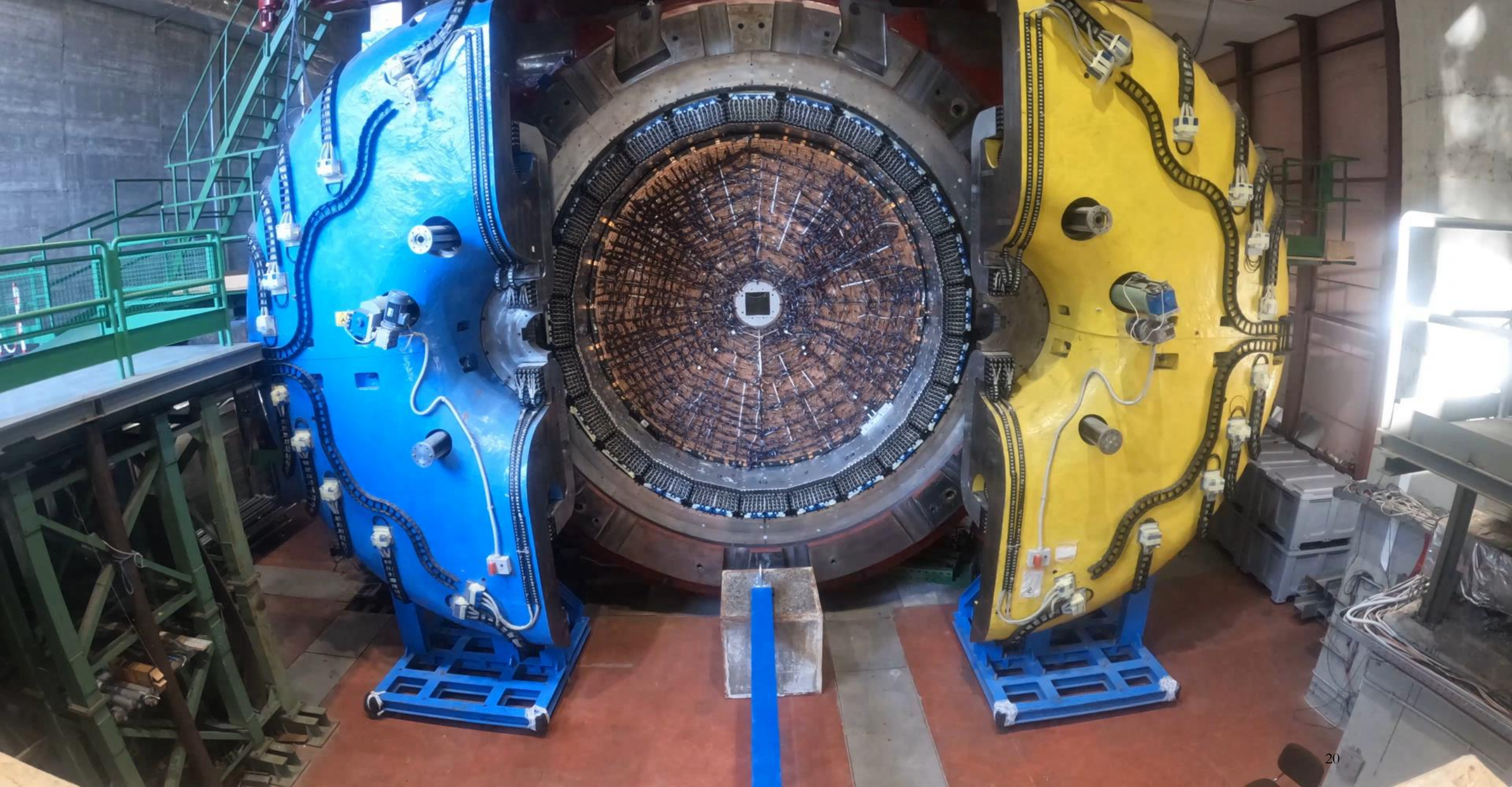
- Building part of the **ITK** internal tracker for **ATLAS** Phase II
- Shipping the KLOE detector to FERMILAB as a part of the **DUNE** near detector

Preparation for ATLAS ITK construction



DUNE Near Detector





SPARE SLIDES

Authorization received May 2023

694



MINISTERO DELLE INFRASTRUTTURE E DEI TRASPORTI PROVVEDITORATO INTERREGIONALE PER LE OO.PP. PER IL LAZIO, L'ABRUZZO, LA SARDEGNA *****

VIA MONZAMBANO, 10 - ROMA

AVVISO

ai sensi dell'art. 29 del D.Lgs. 18 aprile 2016, n. 50

OGGETTO: C.d.S. n.6/2023 - Realizzazione di un nuovo complesso edilizio EuSPARC per ospitare la facility EuPRAXIA presso i Laboratori Nazionali di Frascati INFN.

Amministrazione Proponente: INFN Istituto Nazionale di Fisica Nucleare

Si comunica che ai sensi dell'art. 14-bis comma 5 della L. 241/90 e ss.mm. e ii., è da considerarsi acquisito l'assenso sul progetto in argomento da parte delle Amministrazioni invitate alla Conferenza. Si **DICHIARA**, pertanto, sulla scorta degli atti acquisiti, perfezionata l'intesa per la localizzazione e realizzazione dell'opera indicata in progetto e, di conseguenza, **AUTORIZZATO** il relativo progetto definitivo.

Gli atti del procedimento sono in visione presso la Segreteria dell'Ufficio Conferenze di Servizi di questo Provveditorato

IL DIRIGENTE

Dott. Ing. Carlo Guglielmi

Firmato digitalmente da
CARLO GUGLIELMI
O = MIMS
C = IT

Roma, lì _____

PUBBLICATO _____

RITIRATO _____

IL RESPONSABILE DEL PROCEDIMENTO

Dott. Arch. Alessia Costa

Alessia Costa
MIMS
19.05.2023 13:22:39
GMT+00:00

IL PROVVEDITORE

Dott. Ing. Vittorio Rapisarda Federico

VITTORIO
RAPISARDA
FEDERICO
Ministero delle
Infrastrutture
e dei Trasporti
23.05.2023
11:37:37
GMT+01:00





Final design for the building delivered. We are now starting to work on the authorisation procedures and on the executive design



Overall cost of the building estimated to be **32 M€**, including all the accessory plants

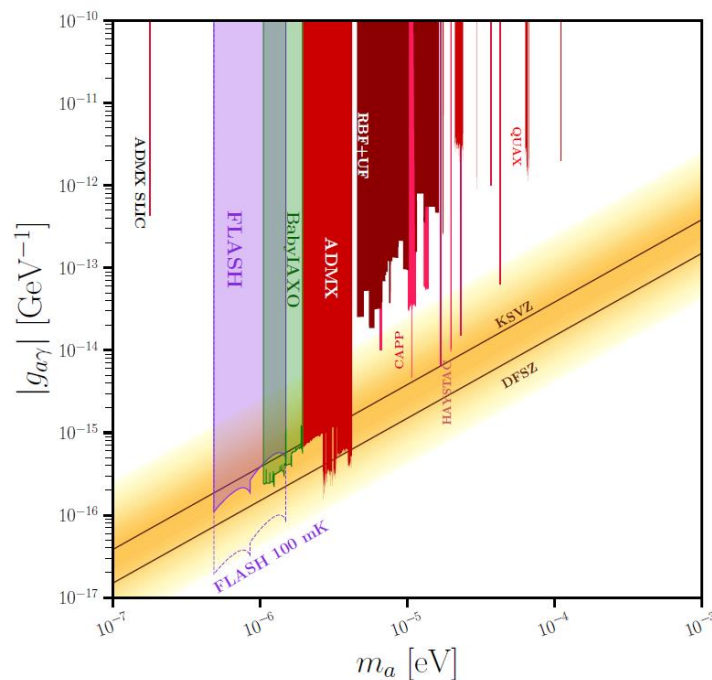
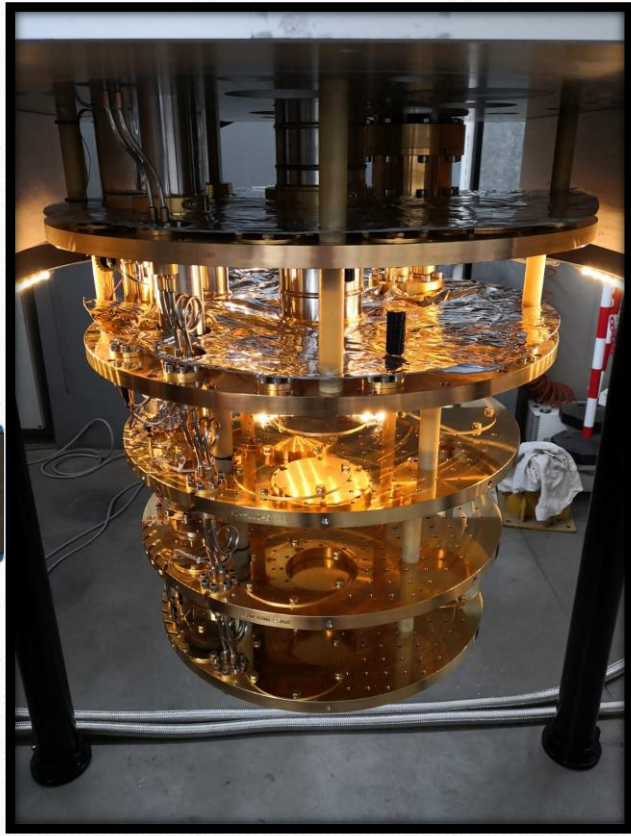


Figure 2: The FLASH discovery potential (90% confidence level or c.l.) compared to existing experimental limits. The brown lines with yellow error-band show the theoretical predictions for the KSVZ and DFSZ axions [25, 26, 28, 27]. The forecast reach of FLASH is compared with experimental limits from other haloscopes [32, 33, 40, 41, 45, 46, 118, 119, 120] as well as a projection from [48] labelled ‘babyIAXO’ in green, which is expected to be realized somewhat later than FLASH. Image realized with [121].

QUAX haloscope at LNF

Probe KSVZ axions in 1 GHz band at 9 GHz

- Multi cavity for fast scanning rate
- Wide band TWJPA quantum amplifier
- Superconducting cavities



Operate at 10 mK inside LNF dilution refrigerator to reduce thermal noise.

9 T magnet for axion conversion

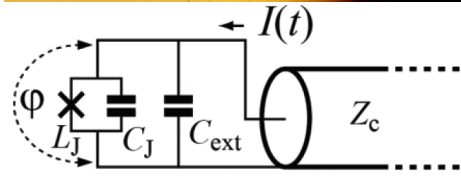
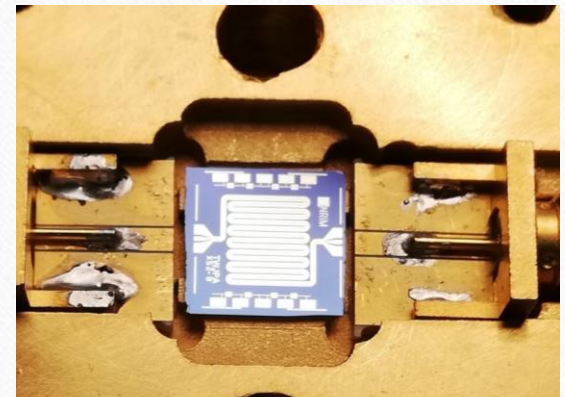
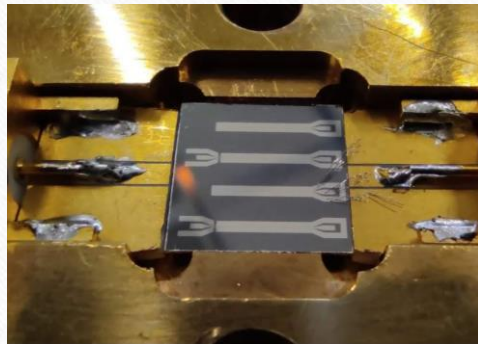
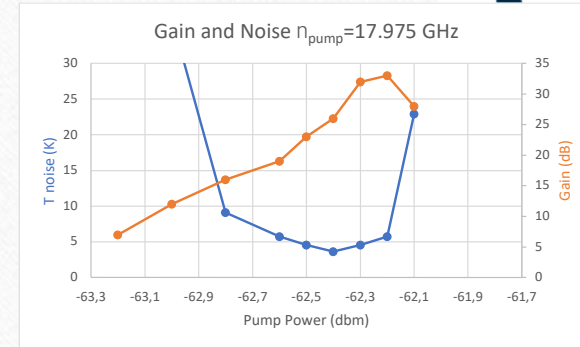
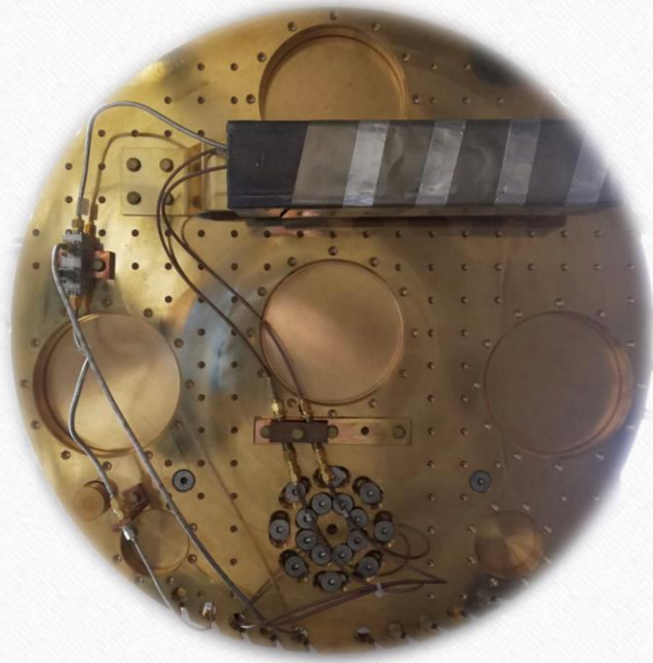
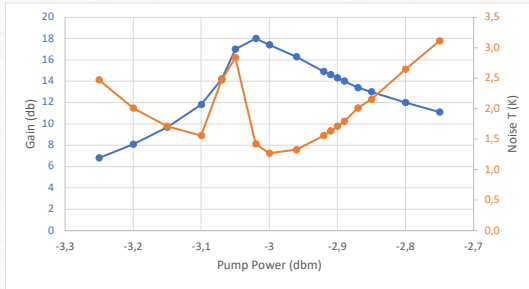


First 8.5 GHz cavity for LNF pilot run

Superconducting Quantum Devices

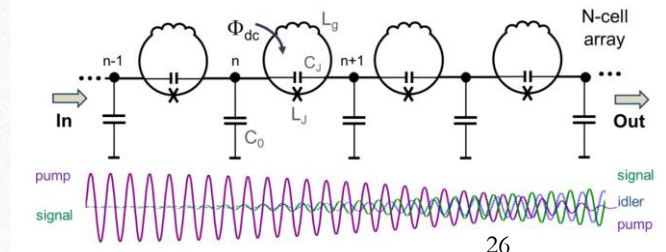


onale di Fisica Nucleare
Nazionali di Frascati



First LNF results of a JJ coupled to a transmission line operated as a Josephson parametric amplifier and as a microwave photon detector (SIMP collaboration with CNR-IFN)

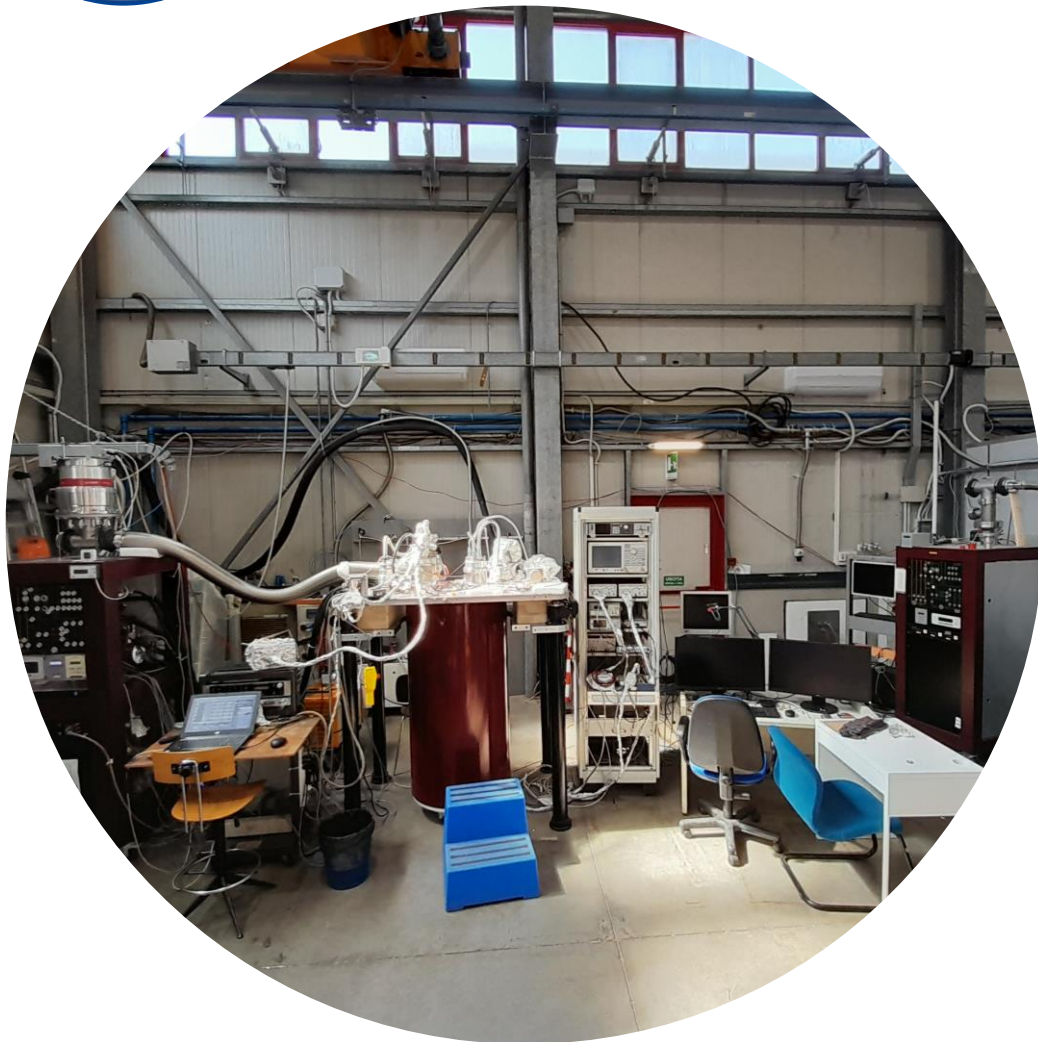
Characterization at LNF of first production of TWJPA from INRiM (Dart Wars)





COLD - Cryogenic Laboratory for Detectors

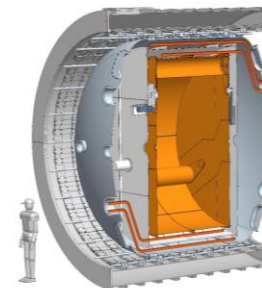
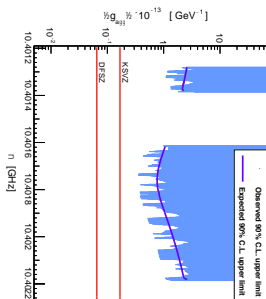
- Axion Experiments
- Superconducting Quantum Devices
- Superconducting Cavities
- Magnetic Measurements



EXPERIMENTS

QUAX – QUest for AXions

Search for galactic axions with Sikivie's Haloscopes at 10 GHz (Ongoing experiments at LNL and LNF).



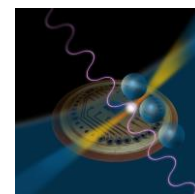
(K)FLASH

Search for galactic axions with a Sikivie's Haloscope at 100 MHz (Design Study).

Superconducting Devices



DART WARS (Detector Array Readout with Travelling Wave Amplifiers)
Development of wide band quantum amplifiers for multi-channel detector readout (Ongoing).



SIMP (Single Microwave Photon detectors)
Development of single-microwave photon detector (Ends 2021)

Qub-IT Quantum Sensing with superconducting qubits (Starts 2022).



Supergalax FET H2020 Project
SC-qubits array photon-detector for axion experiments

KLOE-TO SAND Rough Operation List

- ✓ Removal of all the cables and the FEE+HV racks
- ✓ Extraction of the Drift Chamber
- Calorimeter
 - Extraction of Barrel (24 modules)
 - Dismounting of EndCaps
 - New tape wrapping
 - Operational test
 - Dismounting of PMTs
- Magnet and Yoke
 - Installation of new Power Supply
 - Cooling of coil
 - Operational test of magnet
 - Extraction of Magnet
 - Dismounting of Iron Yoke
- Packaging & Shipping

