

LSC

Multidisciplinary Workshop at LSM



Laboratorio Subterráneo de Canfranc

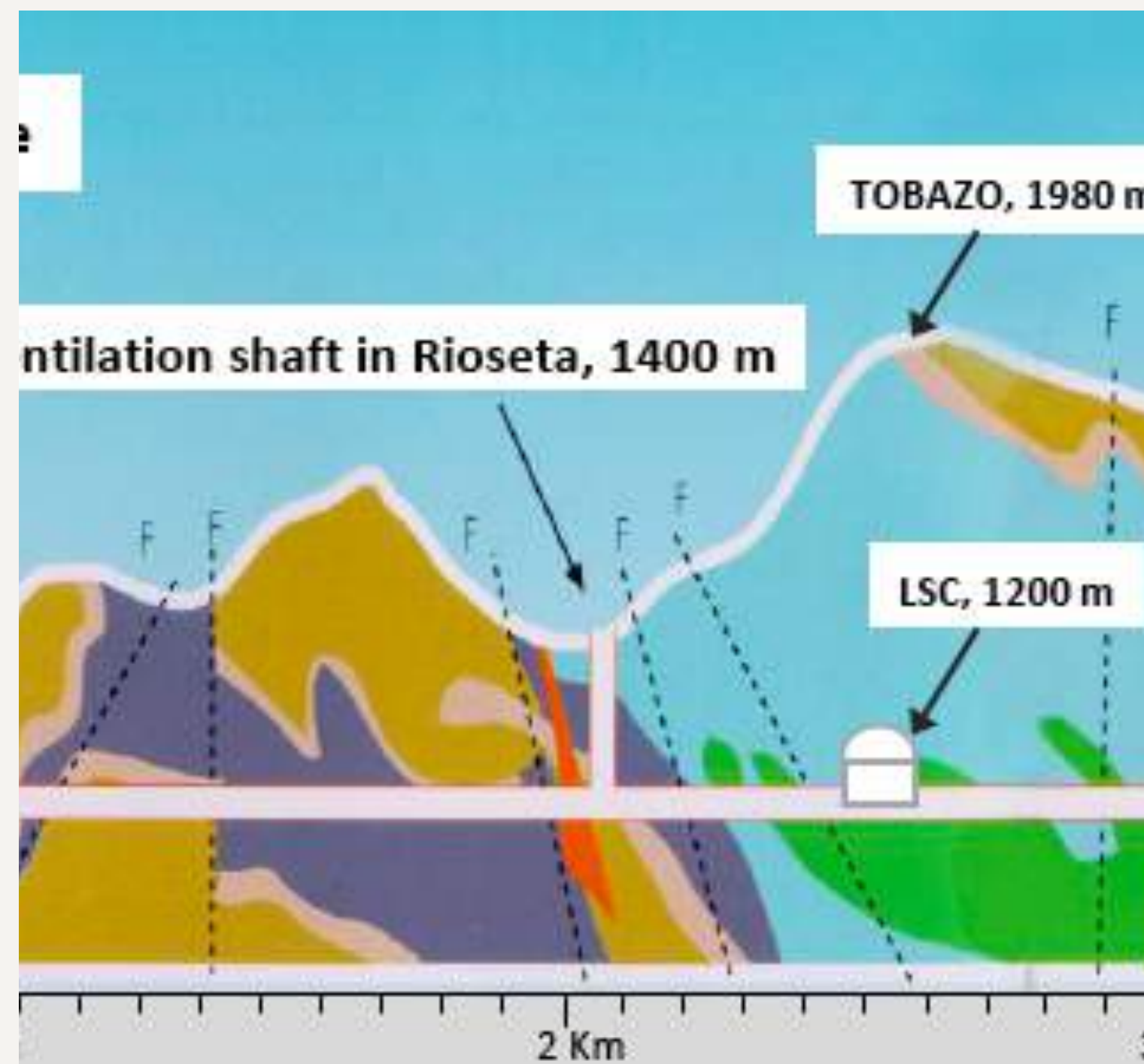
Laboratorio Subterráneo de Canfranc

Located in Spanish-French Pyrenees border. Two-way access tunnels: abandoned train tunnel and operative road tunnel.

First experiments (IGEX, ...) since 1986. Modern lab, 1600 m², operative since 2010. 260 scientists from 50 institutions.

800 meters (v) of rock - muon flux is $5 \times 10^{-7} \text{ cm}^{-2} \text{ s}^{-1}$; neutron flux ($E < 10 \text{ MeV}$) is $3.5 \times 10^{-6} \text{ cm}^{-2} \text{ s}^{-1}$; gamma flux is $2 \text{ cm}^{-2} \text{ s}^{-1}$

Radon abatement system: 220 m³/h radon-reduced air at 1 mBq/m³





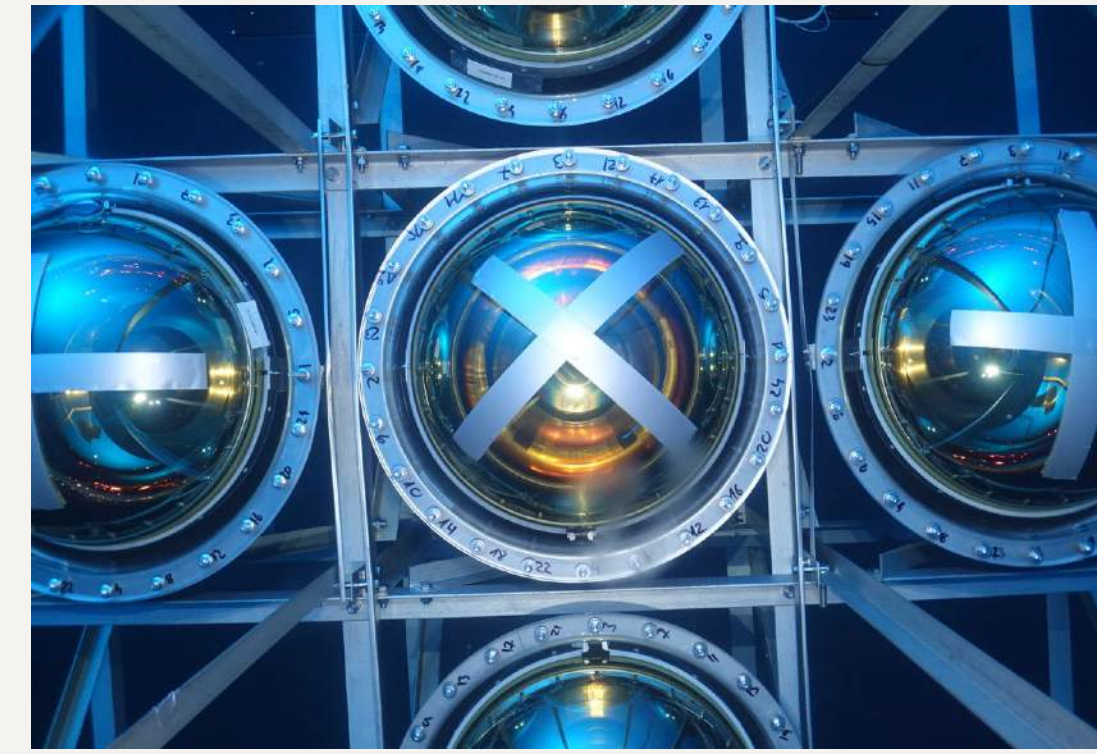
Recent Highlights from LSC



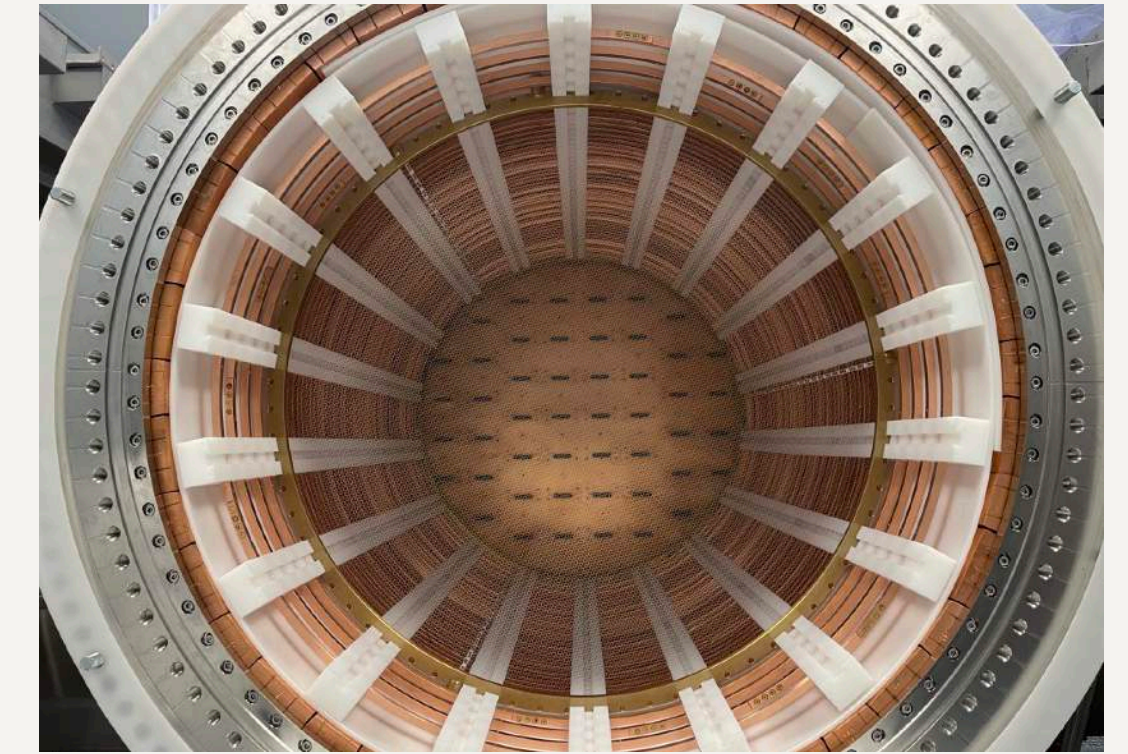
HPGe detector GeRysy



ICPMS-QQQ



HK Experiment



NEXT-100 interior

GeRysy: **New** lowest background world **record** in **HPGe** gamma screening with **$\mu\text{Bq/kg}$ sensitivity** (led by **G. Zuzel**).

New ICPMS-QQQ placed in Class ISO5 clean room underground: **2 (20) ppq** sensitivity in $^{238}\text{U}(^{232}\text{Th})$ [**ppb** in ^{40}K].

HyperKamiokande: Coordination of the Spanish contribution to the construction of HK (PMT covers, ventilation and geomagnetic compensation systems, electronic components, calibration sources, ...).

NEXT-100 experiment: All **elements in place**. TPC installed. Detector closed by **November 30, 2023**. Budget assigned to start NEXT-1ton detector design and materials R&D in Jan 2024

LSC Biology Platform

Muons and radiation ionize our cells. How does ionization change cellular processes? We equipped two biolabs (on surface & underground). Two calls for proposals every year, applying for lab time. 8 independent experiments (9 institutions, 40 scientists) approved: life in heavy water, viral infection, stochasticity and determinism in cellular aging, origin of multicellularity, ...

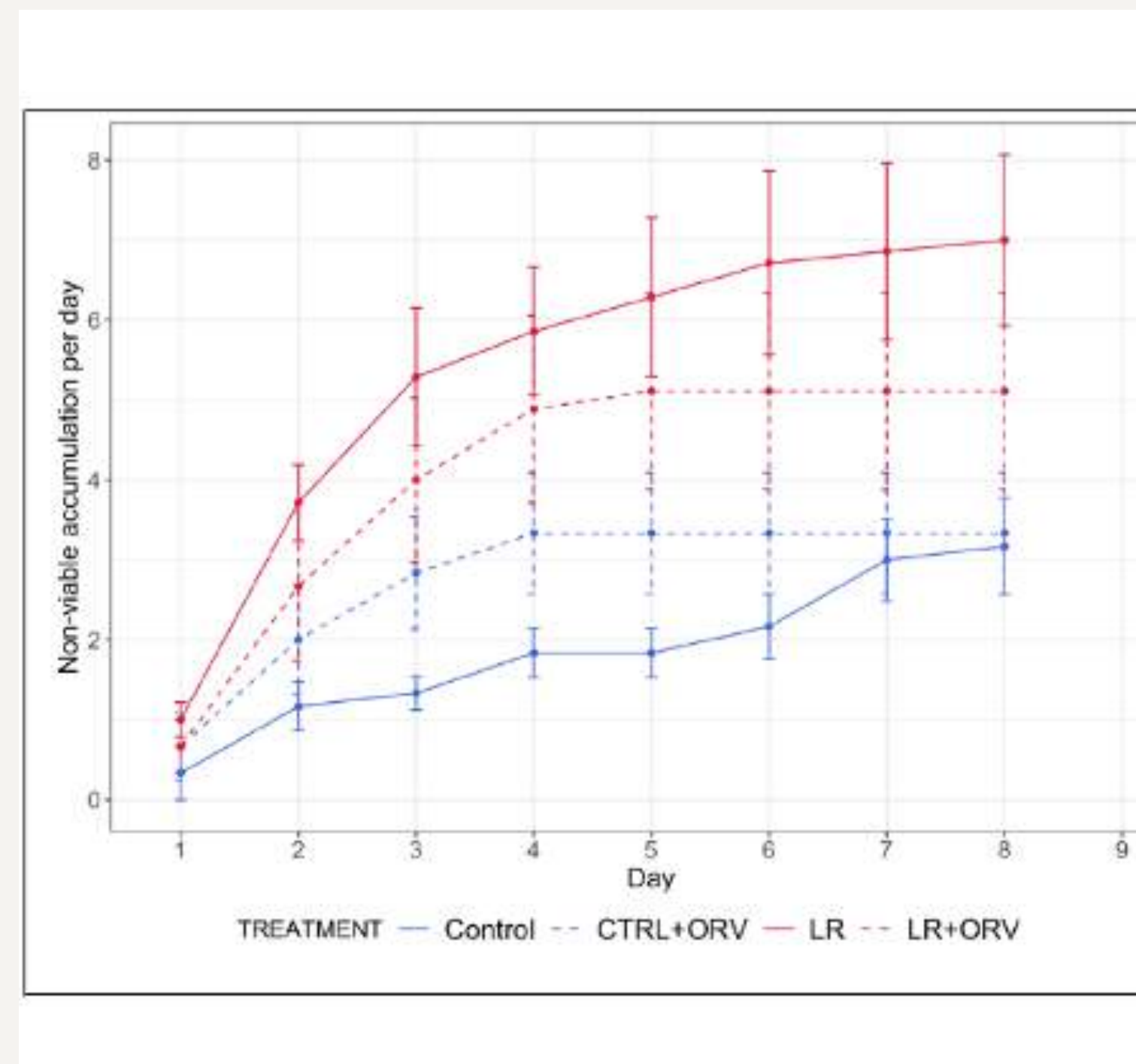


First experimental results in LSC Biology Platform

Eol 33 - Does stress-induced by low-radiation background affect the interaction between host and viral pathogens? A test study with *Caenorhabditis elegans* and Orsay nodavirus.

Experiments analyzed in LR (and/or microgravity): increase of progeny, increase of non-viable eggs, higher viral load, ...

Both, development of *C. elegans*, as well as the interaction with the virus, are different under LR conditions

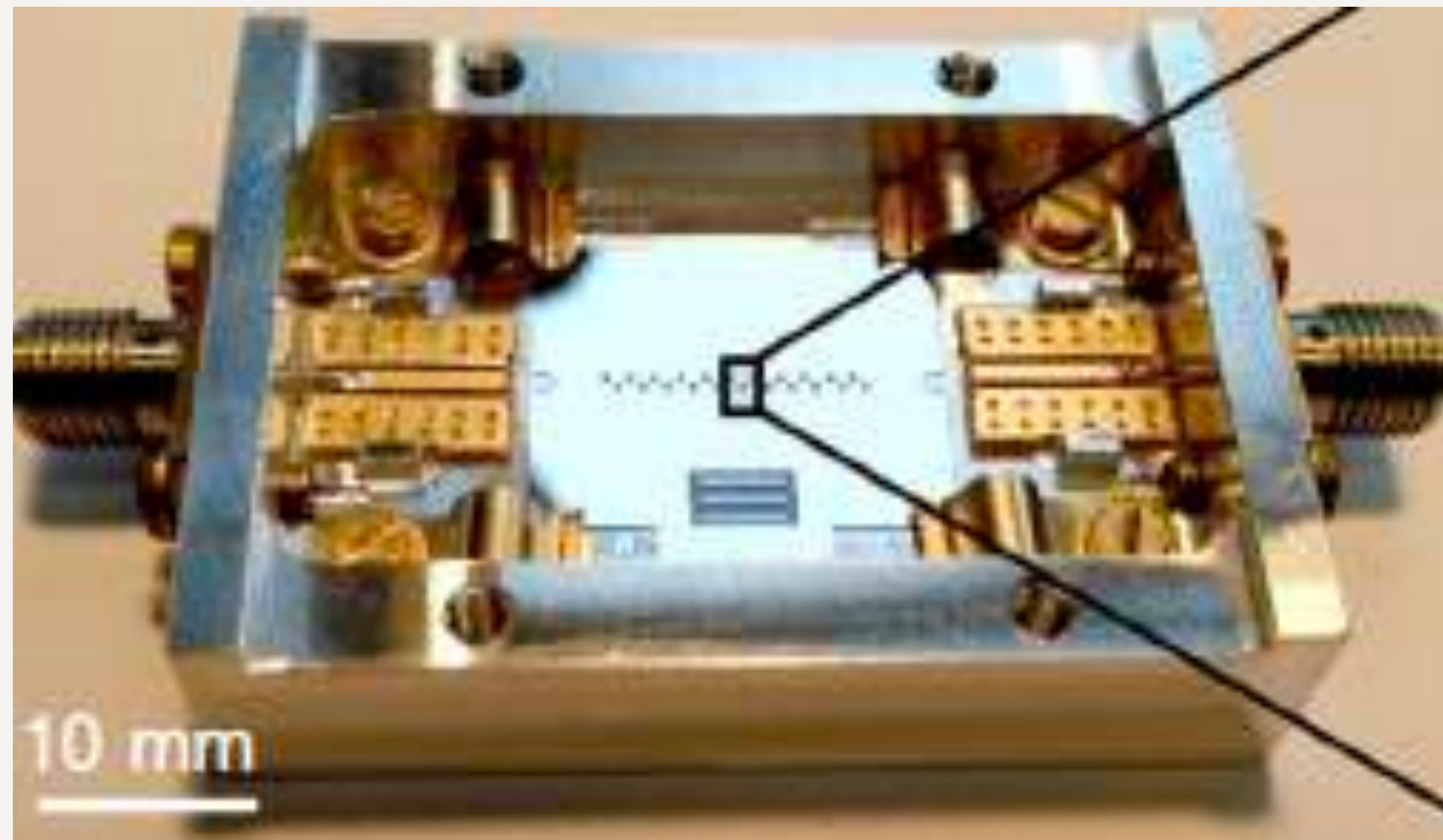


Genomic and Transcriptomic analysis being performed to understand the modified mechanisms (gen expression) in LR conditions.

Mitigation of Radiation in SC circuits

Exploitation of a Multipurpose Dilution refrigerator underground:

Project ICRQ (IFAE/CNM/LSC): Impact of muons and radioactivity on coherence times of transmons.
Project CADEX (12 institutions) - Axion detector experiment in the W-band: based on resonant cavities in a magnet, optical system and Kinetic Inductance Detectors.





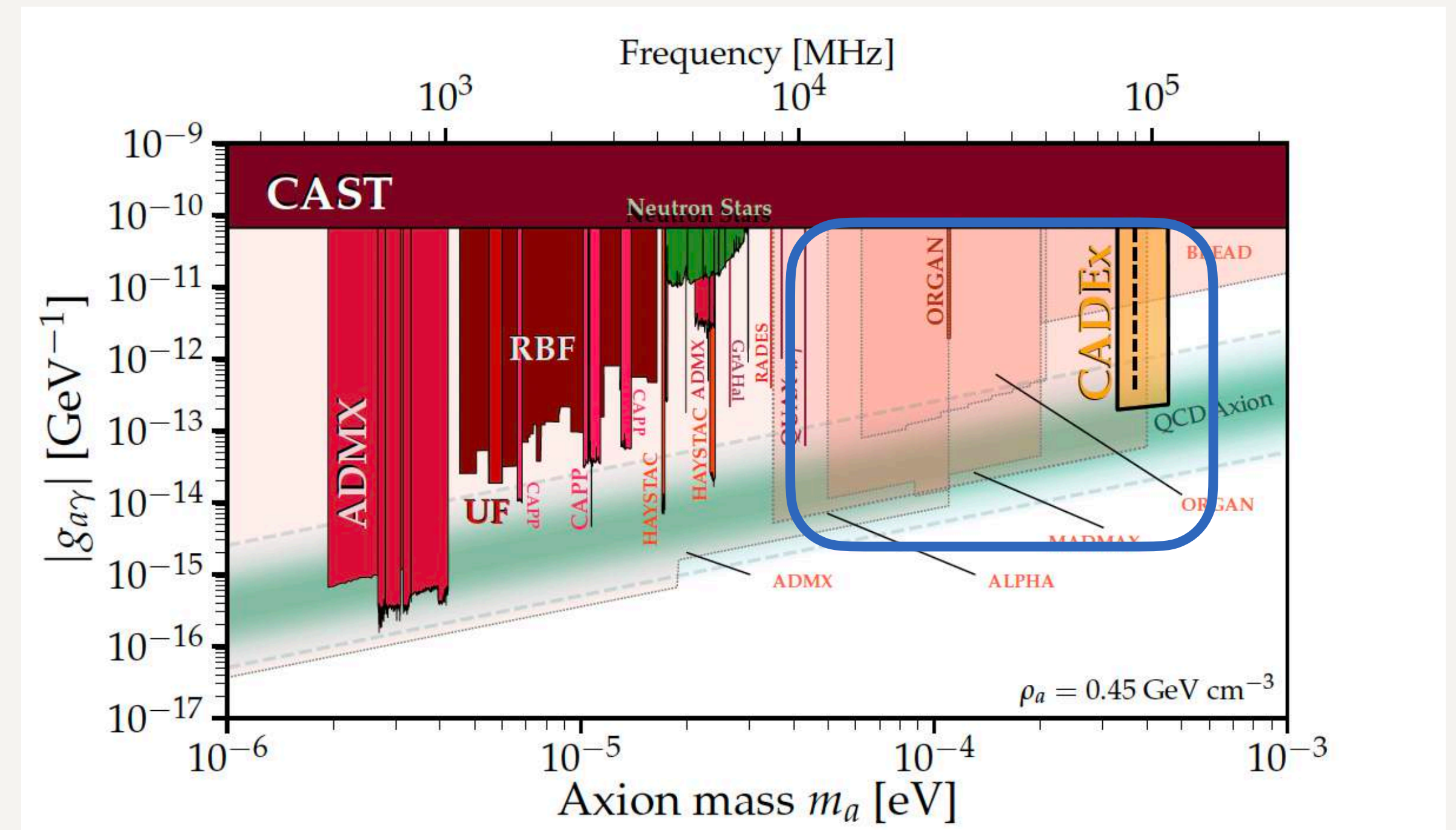
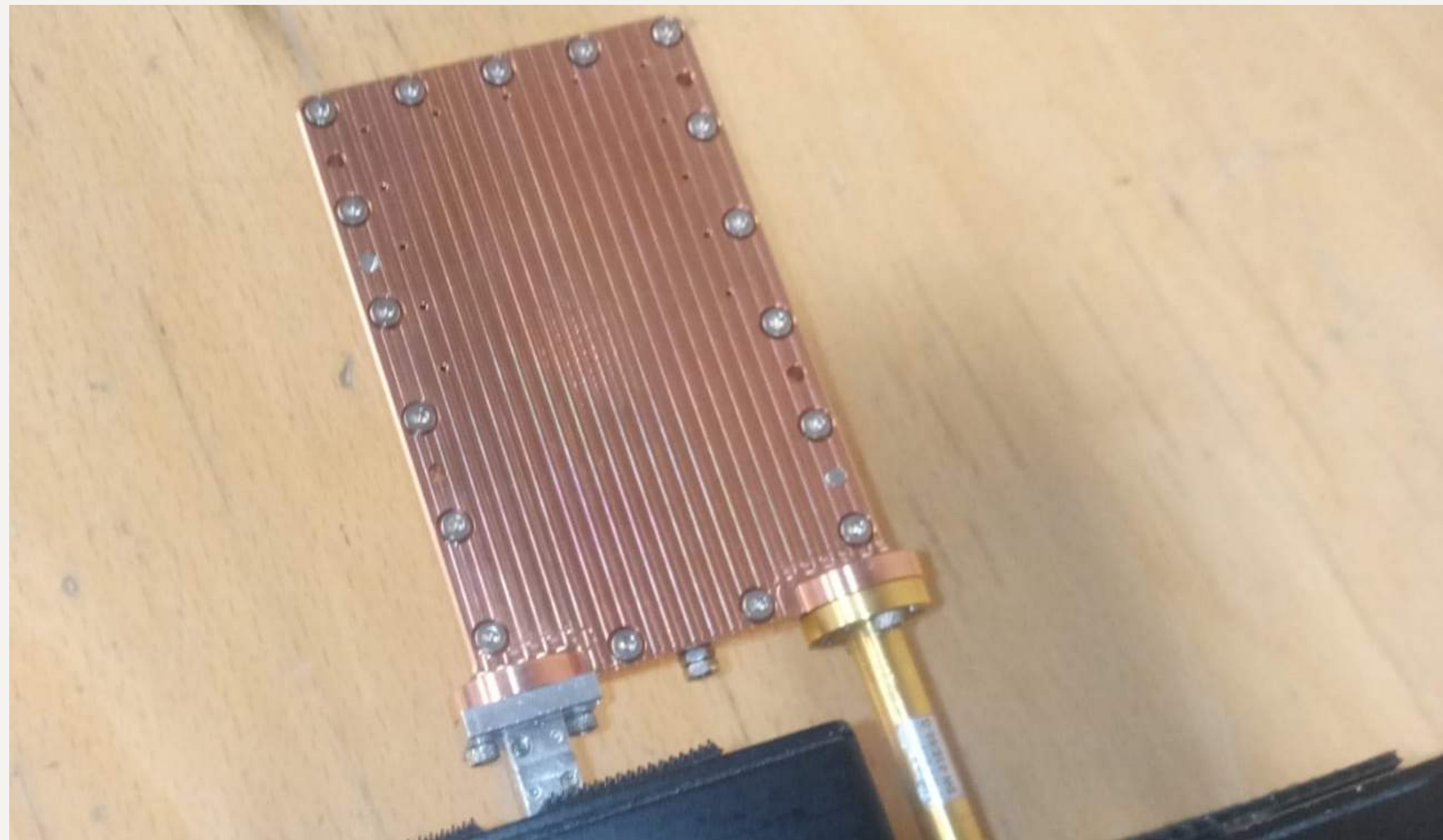
Cadex- Haloscope search for 330-460 μeV axions

16 cavities of (17,680) mm with TM_{110} resonant at 90 GHz. Tunable range [86,111] GHz (10 yrs).

Work in progress: cavity design and fabrication, characterization of prototype KIDs.

16 horn antenna apertures will focus signal on KIDs sensors (10^{19} W/ $\sqrt{\text{Hz}}$ sensitivity).

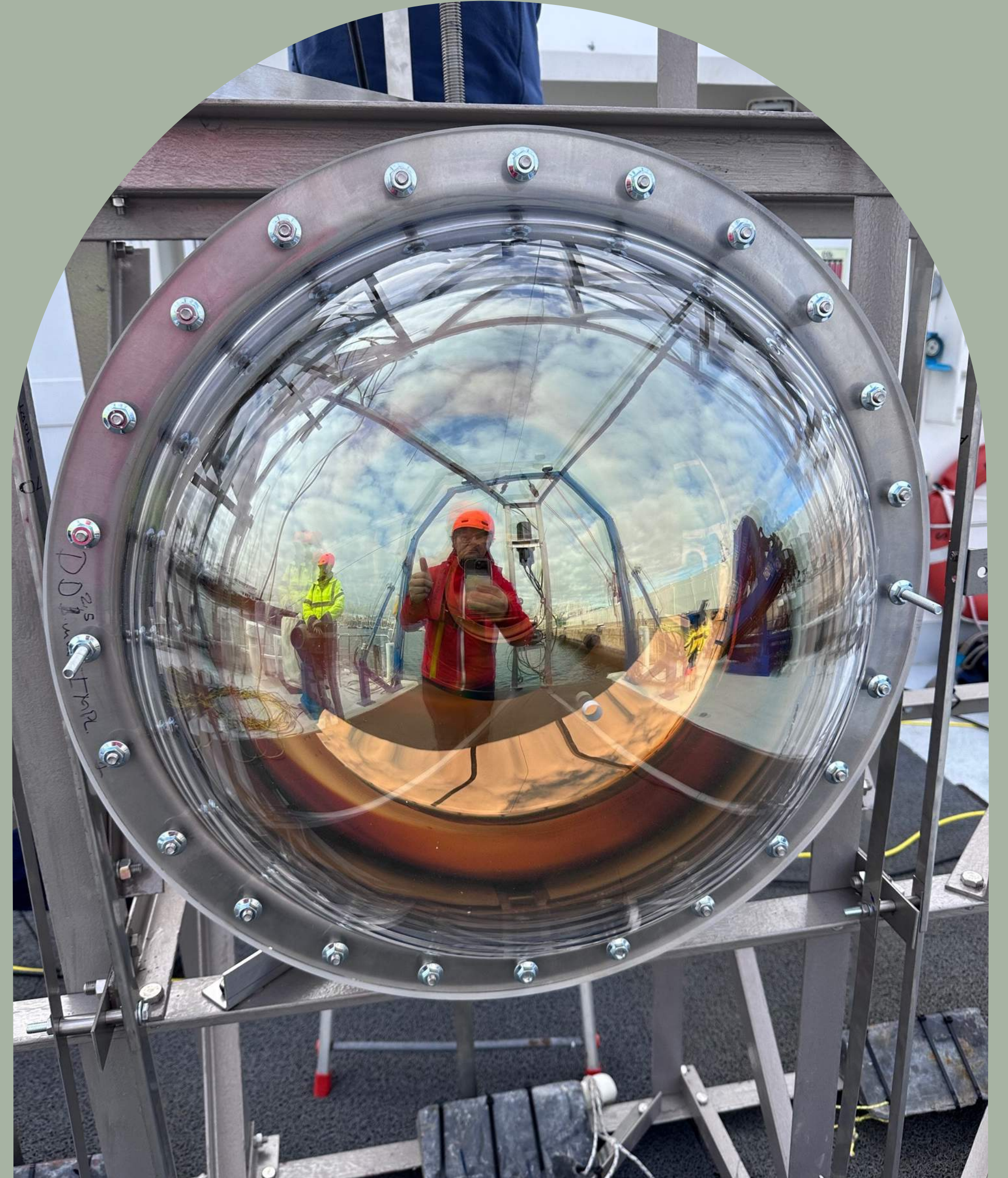
Dilution refrigerator underground, hosting magnet and optical system at 01.K and KIDs at 10 mK.



Laboratorio Subterráneo Canfranc



Hosting experiments and technologies from
all disciplines benefiting of Cosmic Silence



**AGREEMENT BETWEEN**

Ezio Previtali@TAUP2023

Laboratorio Subterráneo de Canfranc (Huesca, SPAIN)**and****Laboratori Nazionali del Gran Sasso, Istituto Nazionale di Fisica Nucleare, (Assergi, ITALY)**

*In the framework of an international collaboration among research underground laboratories and in the framework of the international effort on searches for rare events, this Agreement defines the terms of **Research Collaboration (RC) and Transnational Access (TA)** between the **Laboratori Nazionali del Gran Sasso (INFN-LNGS)** and the **Laboratorio Subterráneo de Canfranc (LSC)** to reflect the rapid increase of collaboration and synergy between the two research infrastructures. Users at LNGS and LSC will benefit from a dedicated agreement to access experimental surface and underground areas, ultra-low background instrumentation, and facilities to support research in both sites.*

*.....LNGS staff and associated personnel (**within experimental collaborations or approved research activities**) can access the LSC by applying to the Safety Office and after undergoing appropriate training as required by the internal rules in effect at LSC. Similarly, for **LSC staff and associated personnel accessing LNGS** by applying to the User Office and demonstrating appropriate knowledge of LNGS safety rules as detailed in the INFN General Conditions attached to this document*

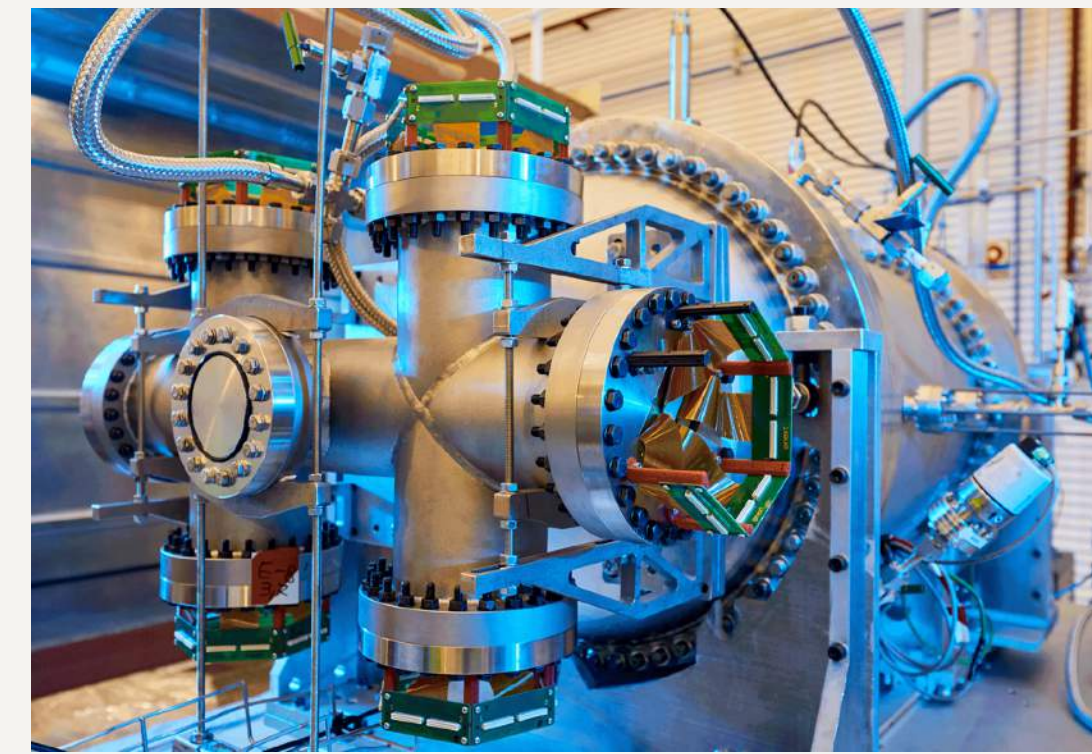
Experiments running/completed at LSC



ANAIS Experiment



DArT in ArDM



NEXT-W Experiment



CROSS demonstrator

ANAIS experiment: Modulation excluded at 3 sigma. Started **last (7th) year** of data taking **to reach 5 sigma** exclusion.

DArT in ArDM: Measurement of ^{39}Ar activation in UAr from Colorado drilling site (^{40}Ar). In operation until 2026.

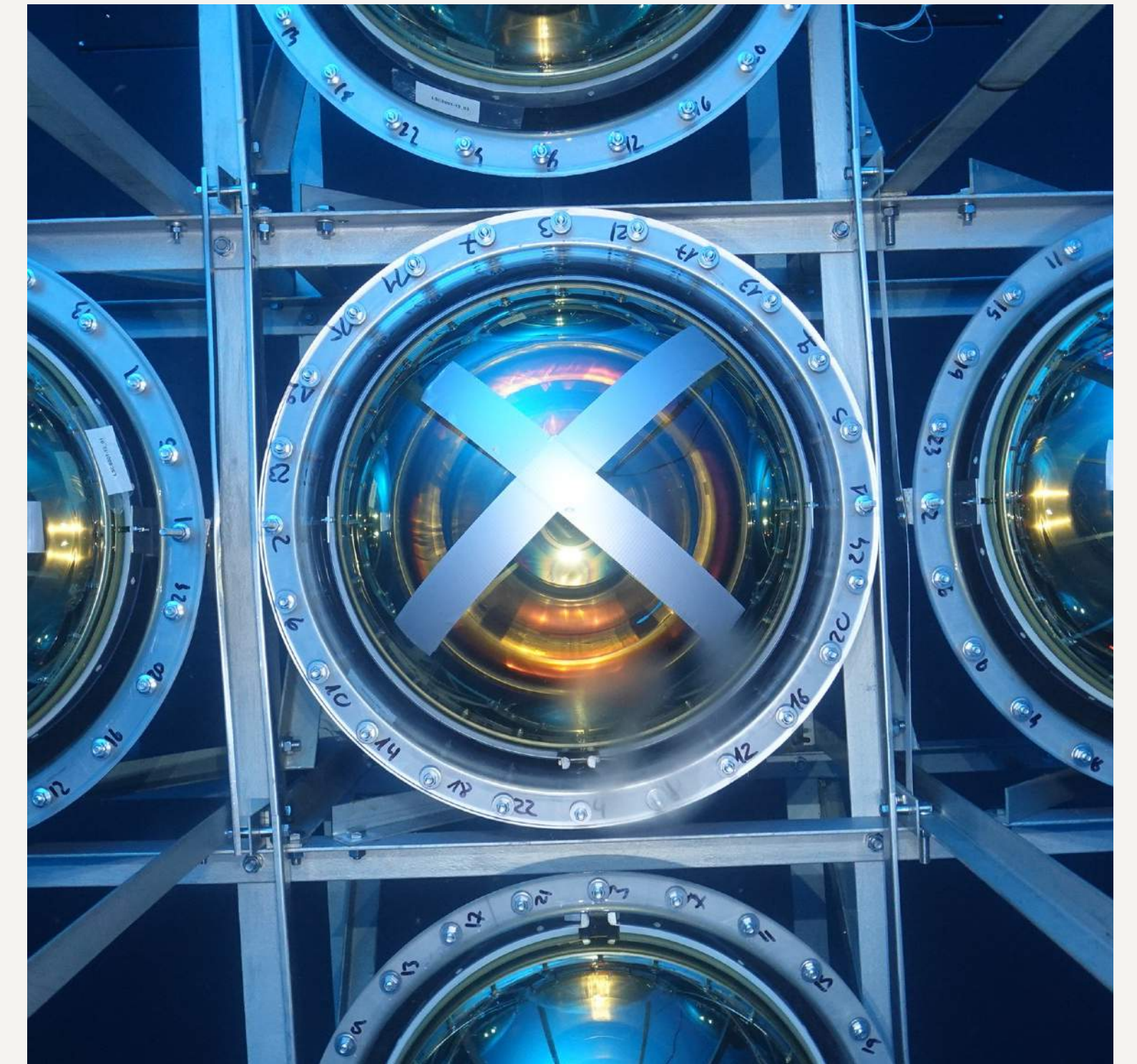
NEXT-White experiment: Finished in 2021. ^{136}Xe Gas electroluminescent TPC at 10 bar (3.5 kg). Best Xenon energy resolution (0.9% FWHM, at 2.6 MeV). Electron track reconstruction improves double beta events (27 factor rejection with 57% efficiency). Neutrinoless double beta decay $T_{1/2} > 10^{24}$ yr [KamLAND-zen limit is 2.3×10^{26}] at 90%CL.

CROSS demonstrator: Low background dilution refrigerator studying surface beta events in TeO_2 and $\text{Li}_2^{100}\text{MoO}_4$ crystals.

Spanish Contribution to the Construction of HK

Motivation: Protect PMTs from chain reaction in case of PMT spontaneous implosion in 9 bar hydrostatic pressure.

Design, prototype & **validate** mass production of PMT covers in Spain within HK requirements: safe to chain reaction, transparency (>70% @300 nm), mass production on time (June 2026) within budget, fast assembly (20'),...



ICRR and LSC signed an agreement (08/22) on the Spanish in-kind contributions: 20" PMT covers, ventilation and geomagnetic systems, electronic components and IT with a value of 7.3 M€ (2021 & 2022 Diet).