FAPESP

ICTP SAIFR | International Centre for Theoretical Physics South American Institute for Fundamental Research

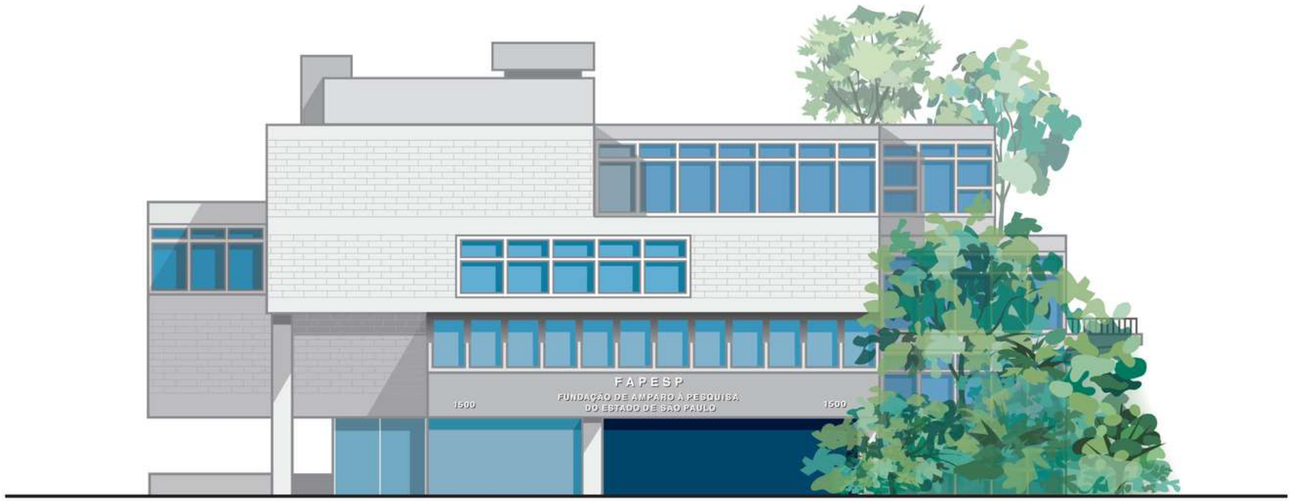
INSTITUTO PRINCIPIA

III LASF4RI FOR HECAP SYMPOSIUM: UPDATE OF THE STRATEGIC PLAN

LAA-HECAP

August 26 – 29, 2024

at Principia Institute, São Paulo, Brazil



São Paulo, August 26, 2024.

- CERN
- ICTP-SAIFR
- FAPESP support to Project DUNE (Fermilab-FAPESP-FINEP/FNDCT)

02

Estrutura da DC

Coordenadorias Gerais de Grandes Áreas

Coordenadores Gerais

Coordenadoria Geral de Ciências, Humanidades e Artes

Marta Teresa da Silva Arretche

Sylvio Roberto Accioly Canuto

Coordenadoria Geral de Tecnologias e Parcerias em Inovação

Rodolfo Jardim de Azevedo

Douglas Eduardo Zampieri

Coordenadoria Geral de Programas Estratégicos e Infraestrutura

Carlos Frederico de Oliveira Graeff

Sergio Costa Oliveira

02

Estrutura da DC

Coordenadoria Geral de Programas Estratégicos e Infraestrutura

Gestores

Celio Fernando Baptista Haddad

Luiz Vitor de Souza Filho

Nina Beatriz Stocco Ranieri

Programas orientados a temas específicos	Programas de Infraestrutura	Programas de Políticas Públicas e Educação
BIOTA, BIOEN, PMCG, Amazônia +10, eScience e Data Science	EMU, HPC, Telescópios, CERN, REDNESP	PPPP, CCD, EDI, Ensino Público, Mídia e Ciência

Assessores (para programa)

- CERN
- ICTP-SAIFR
- FAPESP support to Project DUNE (Fermilab-FAPESP-FINEP/FNDCT)

Instrumentação avançada para grandes colaborações em Física de Altas Energias:
Purificação de LAr e Fotodetecção para o LBNF-DUNE
(2024/07128-7)

Responsável: Pascoal Jose Giglio Pagliuso
Programas Especiais / Projetos Especiais - Fluxo Contínuo
Instituto de Física Gleb Wataghin/IFGW/UNICAMP
Pres

Objetivo do projeto: O principal objetivo desta proposta é realizar P&DI, testes, construção e comissionamento de equipamentos do Sistema de Purificação, Regeneração e Condensação de LAr para Criogenia do LBNF-DUNE.

Pesquisadores Principais: 6 **Pesquisadores Associados:** 36

Involves researchers out of the state of São Paulo

Project evaluated by 4 reviewers

Presented at the Superior Council of FAPESP and approved on July 24th 2024

Brazilian funding agency representatives visit Fermilab

May 13, 2024 | Maxwell Bernstein

Share Tweet Email

Representatives of the São Paulo Research Foundation, including Executive Director Carlos Américo Pacheco, Scientific Director Márcio de Castro Silva Filho and General Coordinator of Humanities and Arts Sylvio Canuto, visited the U.S. Department of Energy's Fermi National Accelerator Laboratory in April to gain an overview of the lab's scientific portfolio.

The foundation, known as FAPESP, is a state funding agency in São Paulo, Brazil that supports research projects across various scientific disciplines in higher education and research institutions.

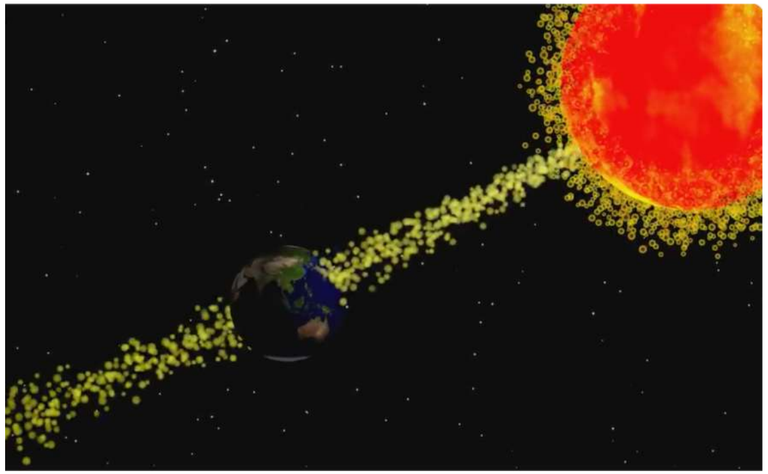
The visit commenced with a discussion led by Fermilab Director Lia Merminga along with representatives from the lab's science and engineering teams. The focus of the talk was Fermilab's Long-Baseline Neutrino Facility and the Deep Underground Neutrino Experiment.

At the Integrated Engineering Research Center, Andrew Lathrop of Fermilab shows an image of the first cosmic ray muon events in a 450 p.s.i. liquid nitrogen cooled 16 Skipper CCD to (left to right) Sylvio Canuto, Carlos Américo Pacheco, and Márcio de Castro Silva Filho of FAPESP. Photo: Dan Svoboda, Fermilab

Left to right: Dante Totani and Jennifer Raaf of Fermilab discuss neutrino detector technologies with Sylvio Canuto, Carlos Américo Pacheco, and Márcio de Castro Silva Filho. Photo: Dan Svoboda, Fermilab

FAPESP representatives stand with members of the Fermilab scientific and engineering staff at the Short Baseline Near Detector. Photo: Dan Svoboda, Fermilab

Detecting Neutrinos



DUNE (Deep Underground Neutrino Experiment):

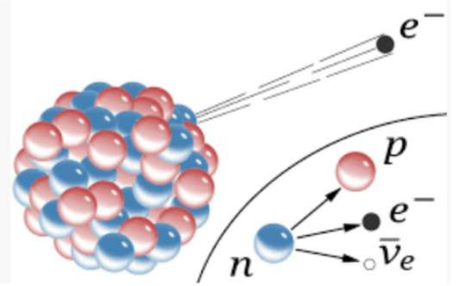
3 Billion US dollars
(35 countries, 200+ instituições)

Participation of FAPESP (joint with FINEP):

- 18 million US dollars (+18 M U$ MCTI)
- Total BR: 36 M U$)
- Arapuca (FAPESP) already financed .

Neutrinos (for the SC)

Neutrinos postulated by W. Pauli in 1930 to preserve Energy Conservation in Beta decay: should be neutral and essentially massless.



In 1932 Chadwick discovered the neutron (massive, can not explain beta decay. It must be another one, a" little neutron": neutrino (Enrico Fermi)

Quest for neutrino detection: Nobel Prizes in 1995, 2002 e 2015.

The fantastic experiments of Raymond Davis Jr detecting solar neutrinos.

Some scientific challenges:

Three types of neutrinos (electron, muon, tau); neutrino oscillation; quest for neutrino mass; what is the antineutrino? It also oscillates ? Is there a fourth neutrino? A sterile neutrino (no lepton counterpart).

Why matter dominates over antimatter? Is the fourth neutrino responsible for dark energy?

Detecting Neutrinos?

Neutrinos são produzidos no Fermilab em Chicago e detectados na Dakota do Sul, 1300 km de distância.

1) Produção de neutrinos por impacto de protons de alta energia (velocidade quase da luz) com grafite. Gera π^+ (Pions = Meson pi descoberto por Powell & Lattes, 1947) decaem produzindo neutrinos. (Produção será de trilhões de neutrinos por segundo !)
2) Neutrinos são medidos na saída e na chegada (são os mesmos, ou flutuaram?)
3) Viajam por um túnel subterrâneo 1,5 km abaixo da superfície da Terra (proteção contra agentes externos, p.ex. raios cósmicos)
4) A detecção ocorrerá quando um neutrino colidir com um átomo de Ar produzindo vários efeitos secundários (partículas e fótons).

FAPESP comes in here:

Ar estável e em alto grau de pureza em muita quantidade. O tanque terá 70 000 toneladas de Ar criogênico.

A detecção dos fótons gerados carece de um detector de alta sensibilidade (**Arapuca** desenvolvido na Unicamp venceu competição internacional)

Arapuca

ARAPUCA: Let there be light traps

Deep Underground Neutrino Experiment (DUNE): ARAPUCA photon detector test

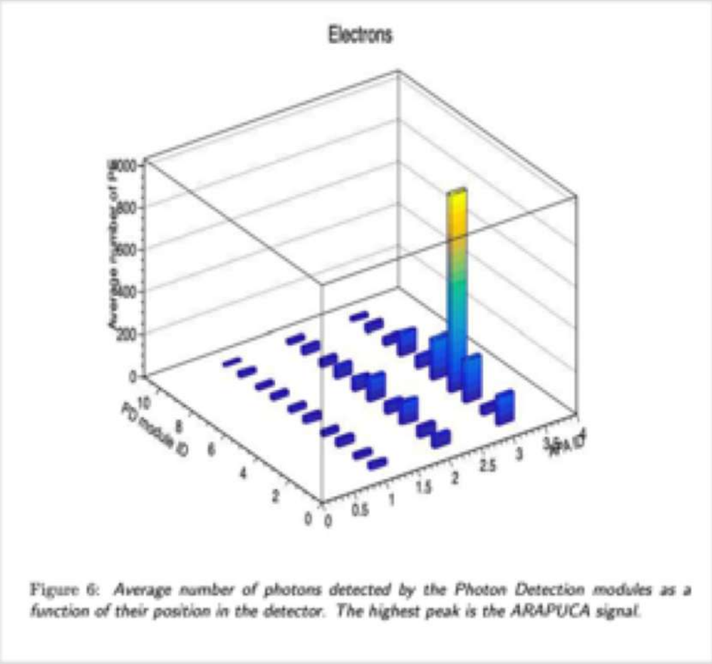


Figure 6: *Average number of photons detected by the Photon Detection modules as a function of their position in the detector. The highest peak is the ARAPUCA signal.*

- Highest peak is from the ARAPUCA detector
  - Ettore Segretto and Ana Amelia Machado, IFGW, Unicamp
- Others are from other teams (MIT, Indiana,...)

NP04 summary

Momentum	Total Triggers	Expected Pi trig.	Expected Proton trig.	Expected Electr. trig.	Expected Kaon trig.
6.3 GeV/c	260K	0	0	242K	0
6.5 GeV/c	340K	1.5K	1.5K	296K	0
1 GeV/c	1000K	382K	420K	265K	0
2 GeV/c	720K	335K	129K	0	0
3 GeV/c	560K	284K	107K	113K	15K
6 GeV/c	702K	394K	0	0	29K
7 GeV/c	477K	299K	11K	0	24K

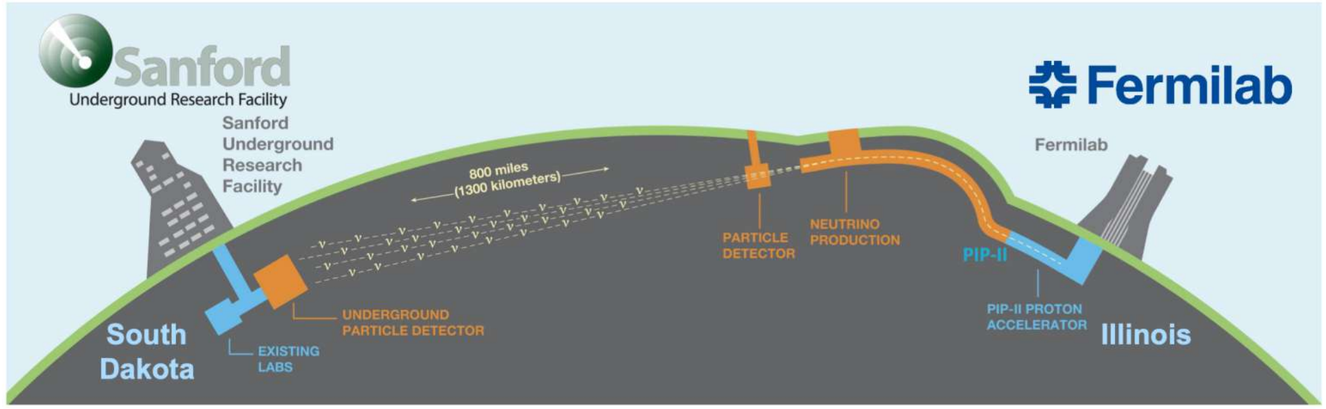
- *Very stable operation from the cryogenics point of view*
- *Operating the TPC with the cathode at -50 kV*
- *Drifting electron lifetime > 6 ms and still improving*
- *Very good signal/noise and therefore image quality*
- *3D reconstruction and analysis on real data ongoing*

Probably the best LAr TPC ever constructed !!!

Este detetor é uma enorme oportunidade para empresas em SP fornecerem centenas ou milhares. E para fazer SP visível no mundo de instrumentação científica avançada.

Leader of the Photon Detection Consortium of the Deep Underground Neutrino Experiments since 2017

The LBNF/DUNE vision is achieved by groundbreaking international partnerships



Long Baseline Neutrino Facility – facilities with partner in-kind contributions LBNF

Deep Underground Neutrino Experiment – internationally led scientific collaboration that has major contributions from multiple international funding agencies, including DOE DUNE

1) FermiLab
2) CERN
3) FAPESP/Brazil

Perspectives

- Unprecedent scientific opportunity for academy and industry.
- Enormous impact for physics and science.
- An important agreement between MCTI/FNDCT, FERMILAB, FAPESP & UNICAMP.
- **And beyond:**
- Complement this one scientific initiative of establishing a Hub/Facility for Latino-america access to effectively participate in analysis od data generated by the experiments.

Brazilian researchers discover new way to purify liquid argon for neutrino experiments

August 2, 2024 | Emily Driehaus

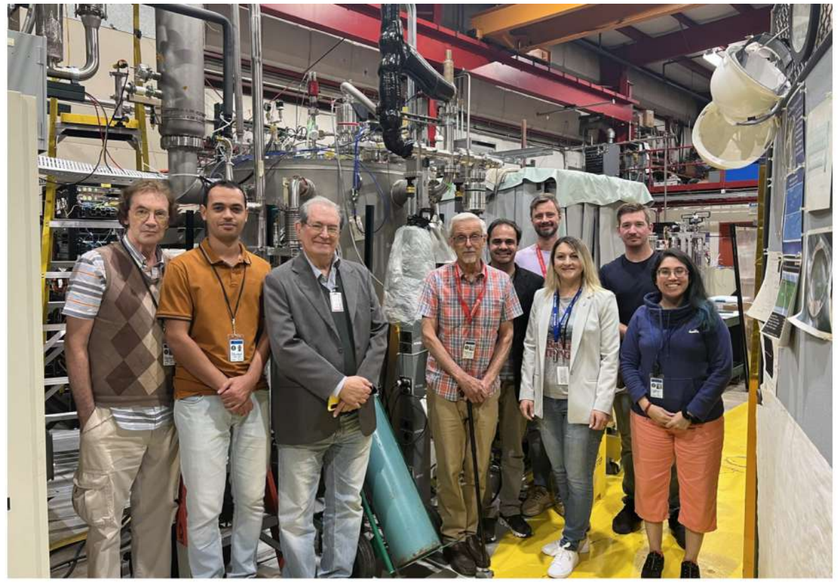
Share Tweet Email

Construction workers have finished the excavation of the huge caverns that will house the international Deep Underground Neutrino Experiment. While engineers and technicians are preparing for the installation of the gigantic neutrino detectors into these caverns a mile underground, scientists around the world are working to optimize DUNE's particle detector technology.

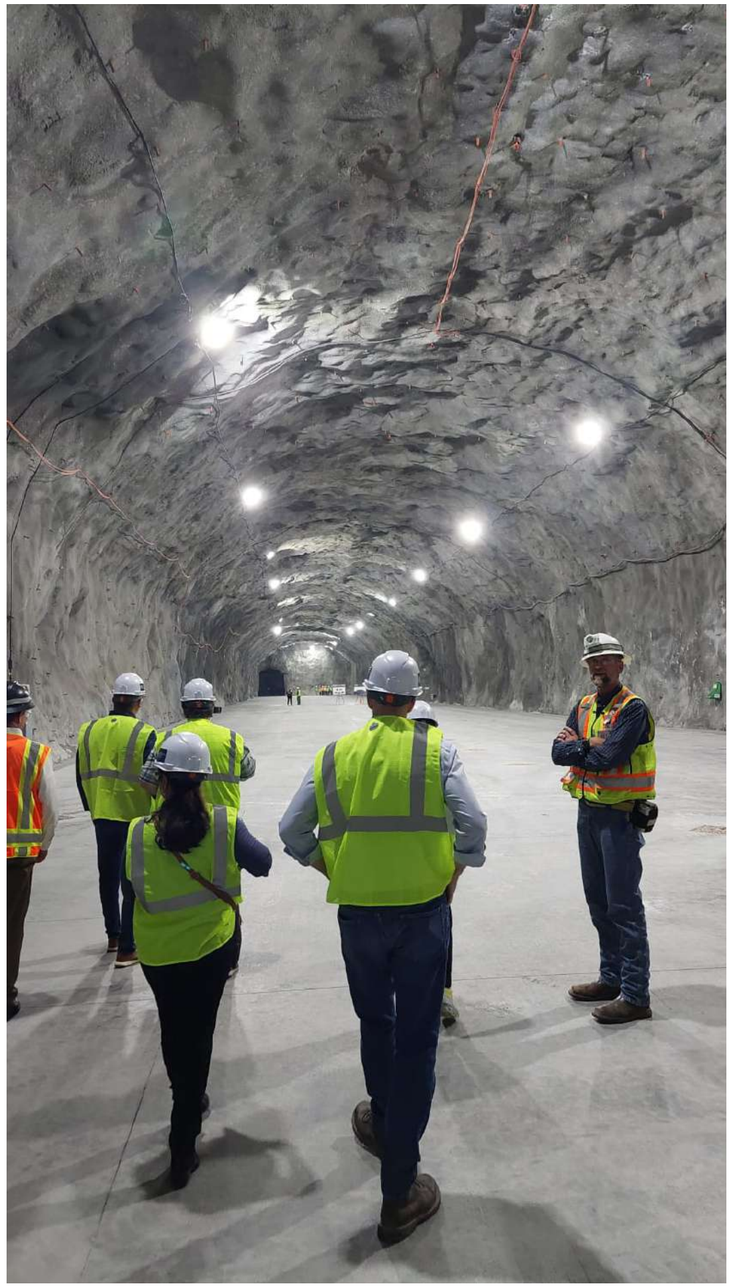
From new photon detection systems to improved detector designs, researchers are refining devices and technologies to make DUNE's neutrino detectors — liquid-argon time projection chambers — the best they can be for the most precise neutrino measurements.

The purity of the liquid argon inside the DUNE cryostats, which is crucial to observing particles and light created by neutrino interactions in the liquid, might get an upgrade too. An interdisciplinary team of researchers in Brazil discovered that a filter media typically used in industrial applications can filter out nitrogen contamination in liquid argon. Future large-scale tests will help determine whether this promising method might be applicable for DUNE.

"We started with the goal of finding new materials that could capture oxygen and water in a more efficient way," said lead researcher Pascoal Pagliuso, a physics professor at "Gleb Wataghin" Institute of Physics, Unicamp in Campinas-São Paulo. "We decided to try and find a way to capture nitrogen, too. And we succeeded."



Researchers from Fermilab and Brazil pose with the ICEBERG test stand at Fermilab to commemorate the testing of a new filter technology for removing nitrogen from liquid argon. From left: Helio Da Motta, Daniel Souza Correia, Dilson Cardoso, Carlos Escobar, Pascoal Pagliuso, Sergey Koshelev, Roza Doubnik, Robert Mrowca and Flor de Maria Blaszczyk. Photo: Courtesy of Roza Doubnik



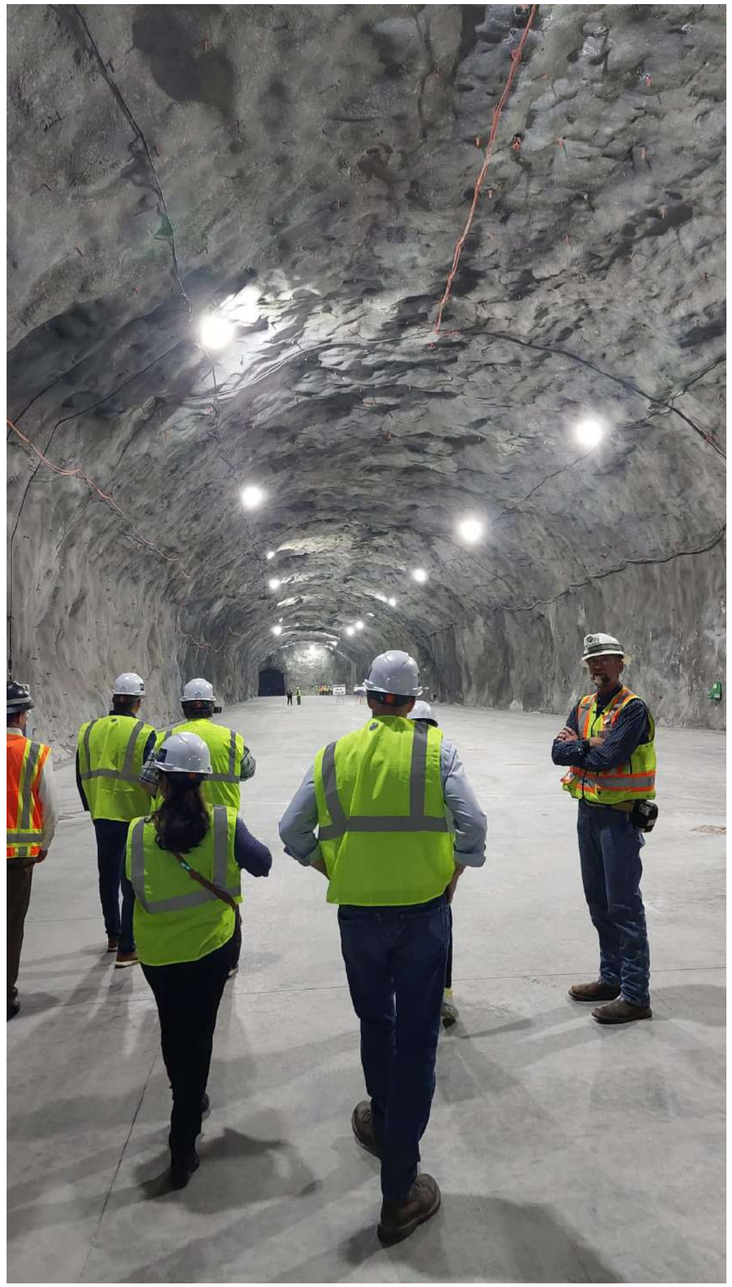
Into the Depths of Discovery

DEEP UNDERGROUND NEUTRINO EXPERIMENT

August 15, 2024

Sanford Underground Research Facility | Lead, South Dakota

Excavation work for the international Deep Underground Neutrino Experiment is now complete.



Into the Depths of Discovery

DUNE DEEP UNDERGROUND NEUTRINO EXPERIMENT

August 15, 2024

Sanford Underground Research Facility | Lead, South Dakota

Excavation work for the international Deep Underground Neutrino Experiment is now complete.

Thank you !

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
Secretaria-Executiva

OFÍCIO Nº 8186/2024/MCTI

June 28th, 2024

Dr. Lia Merminga
Director of the Fermi National Accelerator Laboratory
P.O. Box 500
Batavia, IL 60510-5011
USA

Dear Dr. Merminga,

I am pleased to inform you that the Governing Board of the Brazilian National Fund for Scientific and Technological Development – FNDCT, the main source of investments of the Ministry of Science, Technology, and Innovation – MCTI, has approved a grant, in a total amount equivalent to US$ 18 million, for the University of Campinas – Unicamp, intended to guarantee its participation in the *Deep Underground Neutrino Experiment* – DUNE, through a partnership with Fapesp.

As you well know, the project involves the accurate detection of neutrinos produced in Fermilab's *Long-Baseline Neutrino Facility* -LBNF at the Sanford Underground Research Facility, in Lead, South Dakota, 1300 km away. The Board understands that the Brazilian contribution to the detection system, led by Unicamp, which comprises the development of its purified liquid Argon part and the construction of a set of "*Arapuca*" photodetectors, is essential for the success of the project.

The fact that many components of the detection system will be built by Brazilian companies, under the guidance of Unicamp researchers and using their prototypes, played an important role in convincing the Board that, besides groundbreaking scientific discoveries, the project will result in technological developments and innovation.

We believe that the collaboration involving Finep/MCTI, Fapesp, Brazilian companies, research groups led by Unicamp, and the many international partners led by Fermilab, will certainly contribute to advancing our understanding of the properties of neutrinos, and to the solution of several mysteries of our universe.

With best wishes,

Luis Manuel Rebelo Fernandes
Executive-Secretary of MCTI

Documento assinado eletronicamente por **Luis Manuel Rebelo Fernandes**, **Secretário-Executivo**, em 28/06/2024, às 15:55 (horário oficial de Brasília), com fundamento no § 3º do art. 4º do Decreto nº 10.543, de 13 de novembro de 2020.

A autenticidade deste documento pode ser conferida no site https://sei.mcti.gov.br/verifica.html, informando o código verificador **12062087** e o código CRC **58A3CF38**.

FAPESP
FUNDAÇÃO DE AMPARO À PESQUISA DO ESTADO DE SÃO PAULO

Of. DPCTA nº 05/2024

São Paulo, 28 de junho de 2024.

Ao
Prof. Dr. Antonio José de Almeida Meirelles
Reitor
UNICAMP

Ref.: Projeto DUNE

Senhor Reitor,

O Projeto foi considerado excelente pelos assessores externos e pela equipe interna da FAPESP. Neste sentido a Diretoria da FAPESP reafirma nosso compromisso em apoiá-lo na forma de um projeto especial, posicionamento que será submetido ainda em junho ao Conselho Superior da Fundação.

Nosso compromisso pressupõe que ocorra um suporte da mesma magnitude e com cronograma similar por parte do Governo Federal (MCTI/FNDCT), com cada parte contribuindo com US$ 18 milhões, a serem utilizados de acordo com o cronograma do projeto, como já manifestamos para todas as partes envolvidas e que é, em nossa interpretação, o mesmo posicionamento do MCTI.

Para este fim consideramos importante firmarmos um acordo de cooperação entre todas as partes (MCTI/FNDCT, FERMILAB, FAPESP e UNICAMP), de maneira a formalizar estas decisões.

Por fim, consideramos, como discutido previamente, muito relevante complementar o projeto com uma iniciativa adicional de instituir um Hub/Facility, de abrangência latino-americana, de acesso ao projeto DUNE em Campinas e de preparação para uma efetiva participação na análise futura dos dados gerados pelo experimento.

Atenciosamente,

Carlos Américo Pacheco

Marcio de Castro Silva Filho

Rua Pio XI, 1500 Alto da Lapa
05468-901 São Paulo / SP
Fone: + 55 11 3838-4000