DUNE IN THE CONTEXT OF LAS4RI: THE COLOMBIAN CASE

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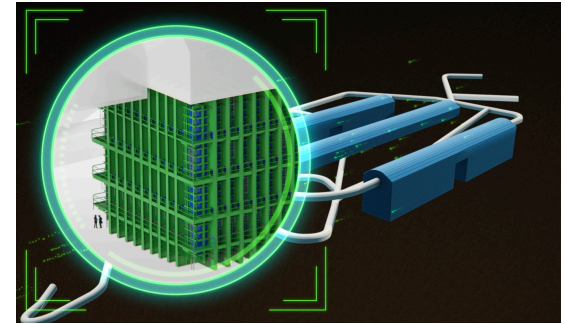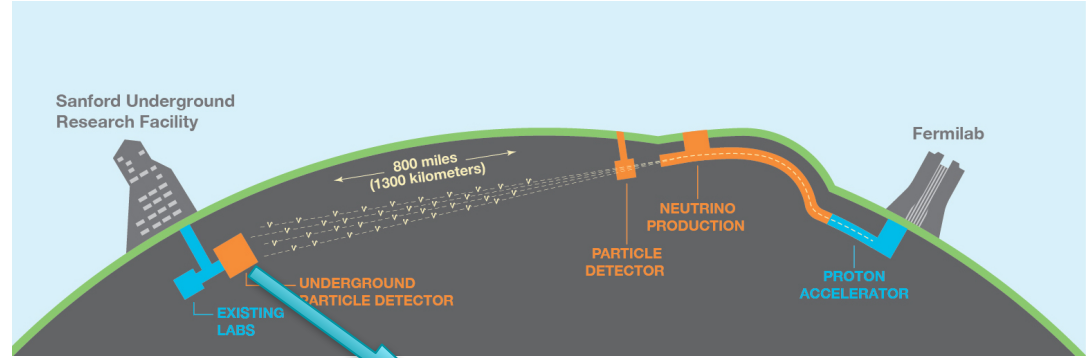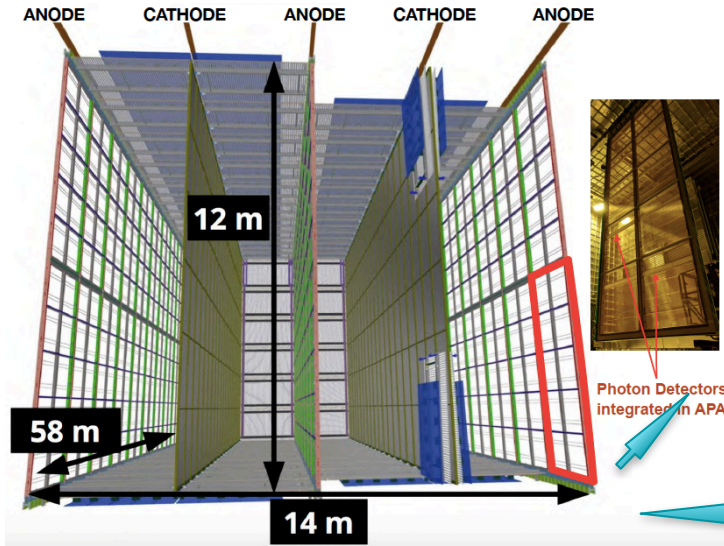
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DUNE: Deep Neutrino Experiment

ANODE   CATHODE   ANODE   CATHODE   ANODE

12 m

58 m

14 m

Photon Detectors integrated in APA

Sanford Underground Research Facility

800 miles (1300 kilometers)

Fermilab

NEUTRINO PRODUCTION

PARTICLE DETECTOR

PROTON ACCELERATOR

UNDERGROUND PARTICLE DETECTOR

EXISTING LABS

DAPHNE

- <u>D</u>etector electronics for <u>A</u>cquiring <u>PH</u>otons from <u>NE</u>utrinos
  - Warm readout electronics for the DUNE SP-PD

- Developed as a partnership between FNAL and Latin America based off of the FNAL design of the Mu2e cosmic ray veto FEB
  - Visits to FNAL by Javier Castaño and Juan Vega Martinez in 2019

DAPHNE

Design

- 40 Channels/65 MSPS/14 bits

- Slow controls interfaces to Microcontroller
- Gigabit link up to 6.6 Gbp to DAQ
- Artix-7 FPGA
- Timing interface
- Bias-Trim Voltage
- Optical interfaces

PCB

- Developed on Altium Nexus Using Fermilab Vault

- Developers: Javier Castaño (UAN), Juan Vega (CONIDA, Peru), Sten Hansen, Miguel Marchan, Nina Moibenko (Fermilab)
- A Final prototype: 6-layers PCB 12"x7.2"x0.092""
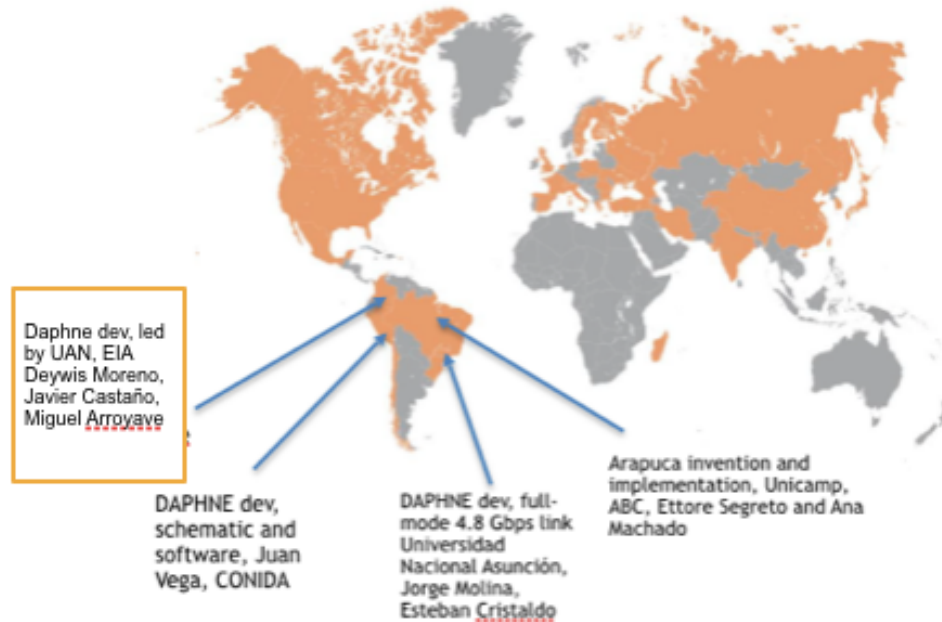- About 2000 partsANSI/IPC-A-610 Standard

Firmware/Software

- **32-bits Microcontroller STM32H753**
  - Zephyr RTOS C/C++ programming
  - Developers:Juan Vega (CONIDA, Peru), Miller Santos and Javier Castaño (UAN), Mauricio Henao, Santiago Jiménez, Manuel Arroyave (EIA)

- **FPGA Artix-7**
  - Developers: Manuel Arroyave,Javier Castaño Diego Aranda, Carlos Montiel (U. de Asunción)
  - Gateware: developed on Migen/Litex using co-design Python/Verilog/VHDL
  - OPCUA Slow Control
  - Full-mode 4.8 Gbps module

How to go forward

- Keep research and innovation policy on the political agenda.

- Find and create communication channels for translating new research into industry.

- Increase the transfer of scientific knowledge into industry.

- Promote startups and spin-offs besides big industries.

- Holding meetings that promote participation at different levels with discussions focused on technology transfer

- Develop a training program for researchers to find the social problems that need solutions where they can apply the acquired knowledge is needed

- Create the critical mass beyond experts, interested in high energy physics, to link other areas of knowledge that can communicate with the industry, like engineers, economists and mathematicians

Remarks

Daphne dev, led by UAN, EIA Deywis Moreno, Javier Castaño, Miguel Arroyave

DAPHNE dev, schematic and software, Juan Vega, CONIDA

DAPHNE dev, full-mode 4.8 Gbps link Universidad Nacional Asunción, Jorge Molina, Esteban Cristaldo

Arapuca invention and implementation, Unicamp, ABC, Ettore Segreto and Ana Machado

- 2020: First DAPHNE prototypes to be tested

- 2021: Test of DAPHNE boards at ProtoDUNE II

- 2024: Start installing first SP module

- Plenty of room for more Colombian and LA participation.

- The participation in DUNE experiment is an unprecedented opportunity to make a contribution of great responsibility at the regional level; also to understand the challenges related to community work.