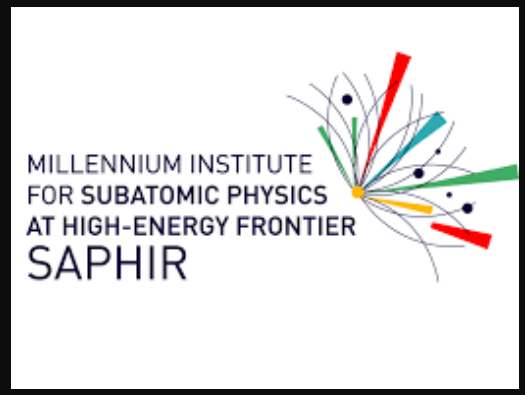
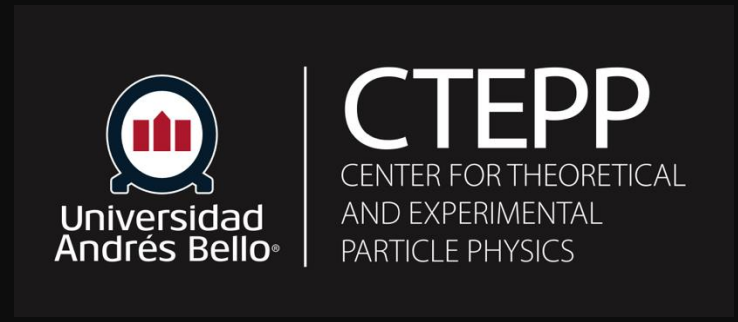
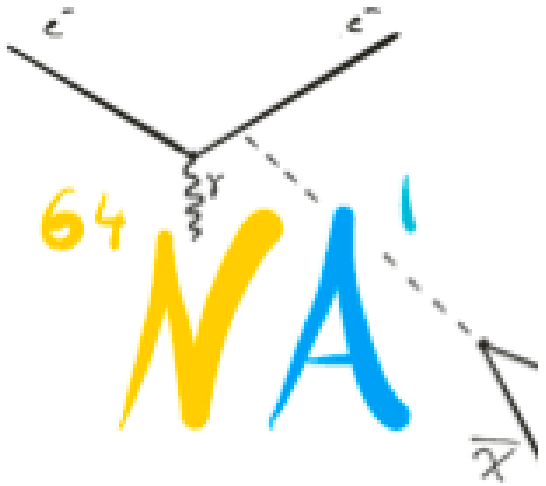
# SAPHIR hardware contributions to experiments at CERN

Jilberto Zamora Saá

Brazil 2025









# Current and future projects at CERN

- ATLAS
- SND@LHC
- NA-64
- SHiP

# ATLAS ITk

During the ATLAS phase II upgrade, the tracking system of the ATLAS experiment will be replaced by an all-silicon detector called the inner tracker (ITK) with a pixel detector as the most inner part. The monitoring data of the new system will be aggregated from an on-detector ASIC called Monitoring Of Pixel System (MOPS) and sent to the Detector Control System(DCS) using a new interface called MOPS-HUB.

## Status & next steps of MOPS-HUB production in Chile

**36 MOPS-HUB crates are required**

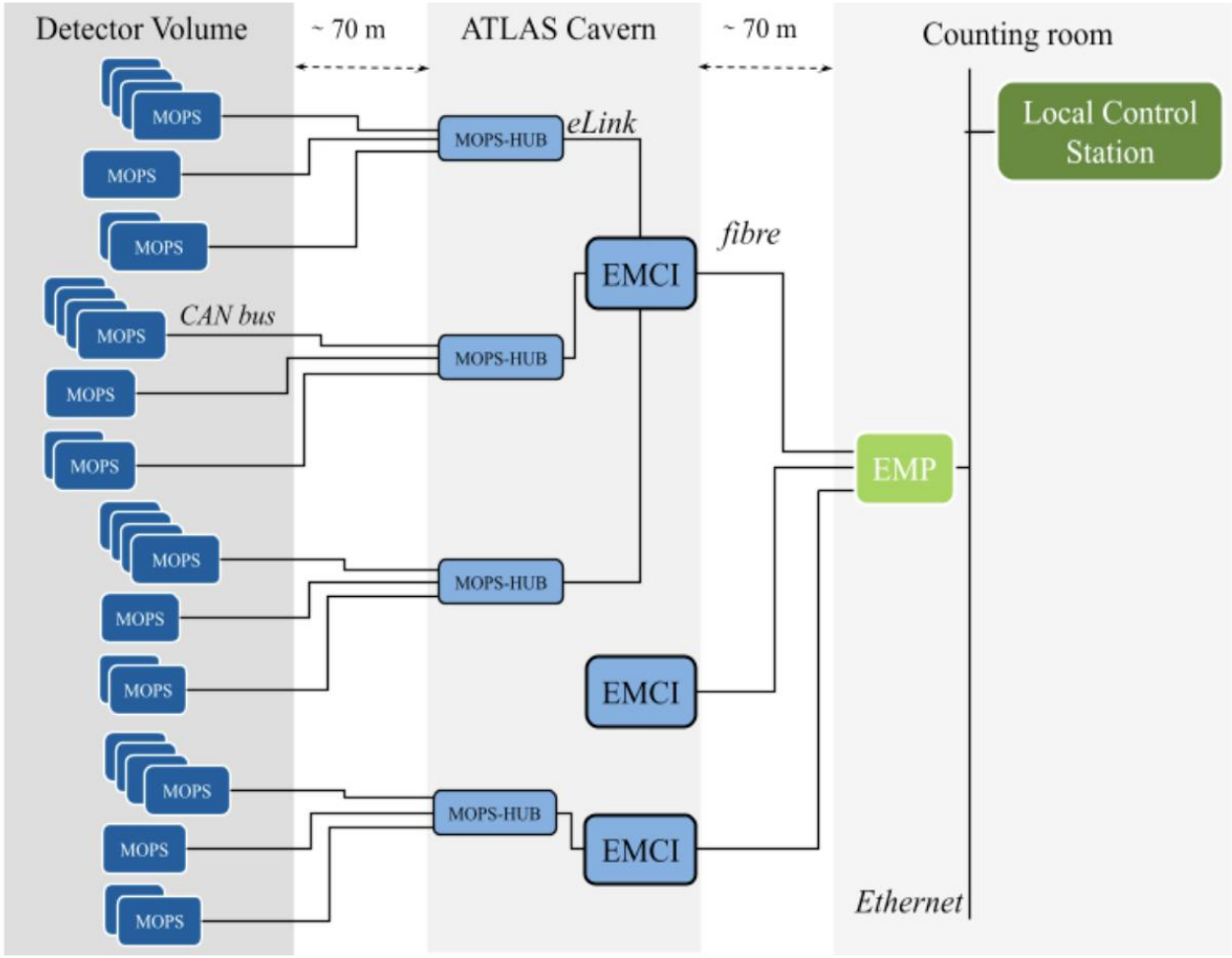
- 36 backplanes
- 72 FPGA boards
- 72 PP3 power
- 576 CIC
- 72 EMCI
- 6 EMP
- numbers for QA (+ spares) to be added

**Organization of boards production and assembly of boards**

**Qualification assurance (quality control + …) of boards**

**Contribution to software**

**Training before pre-production: Chilean team is producing 3 crates with non-halogen free components and materials. The work is in process with SAPHIR funding. DONE!!**

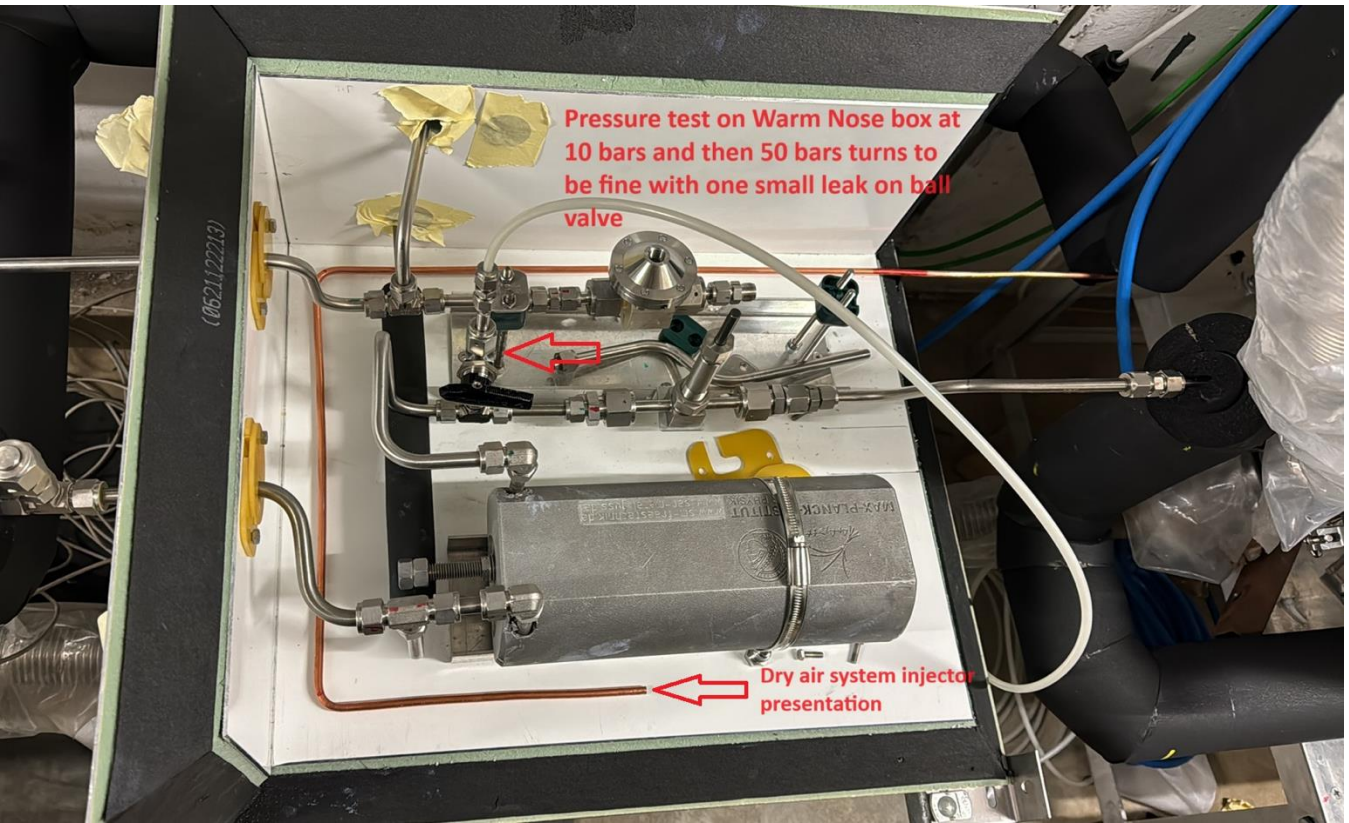


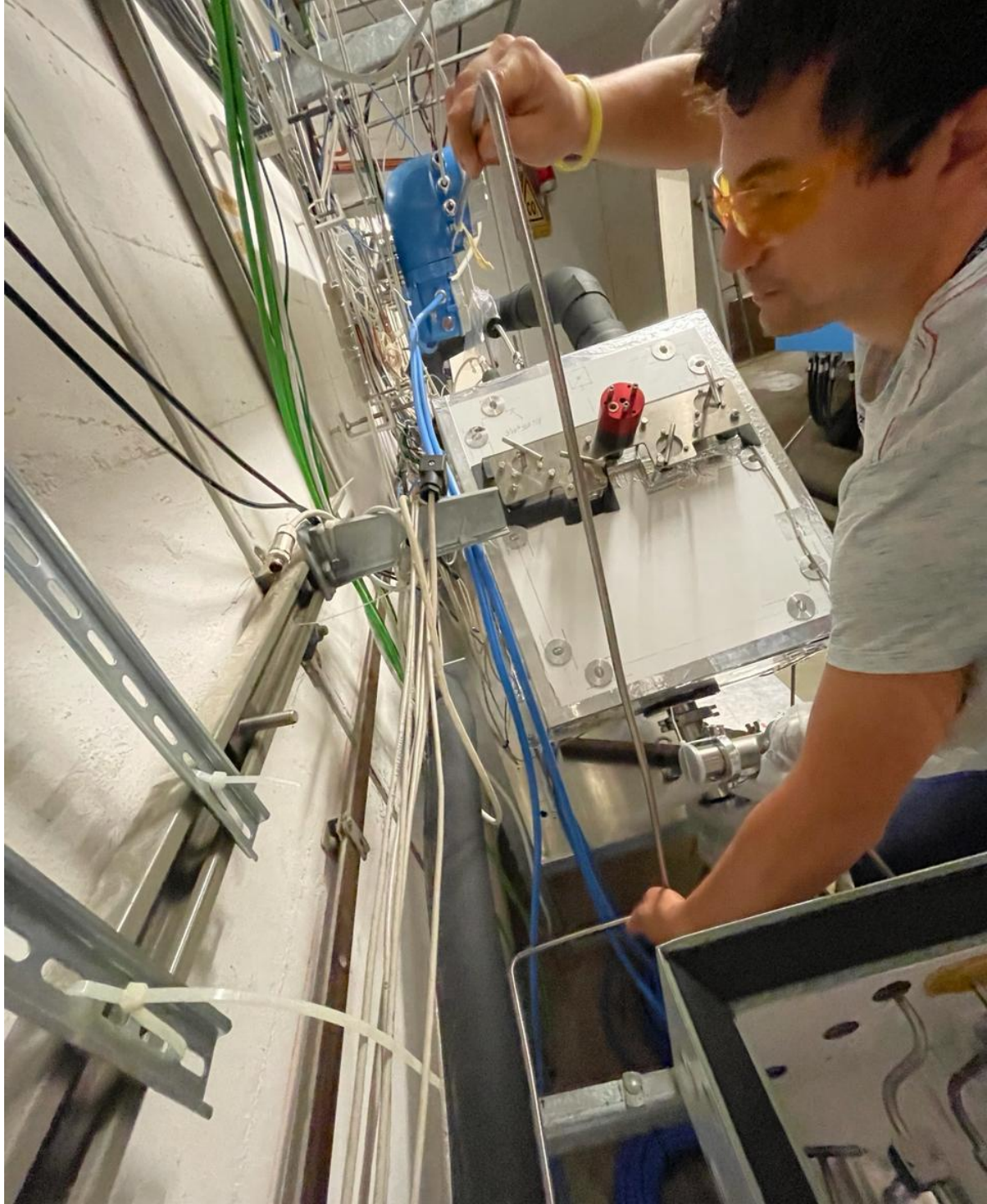

MOPS-HUB and TGC production will take place in SAPHIR/UNAB laboratories at CERN and in UNAB laboratories in Chile.

# ATLAS ITk

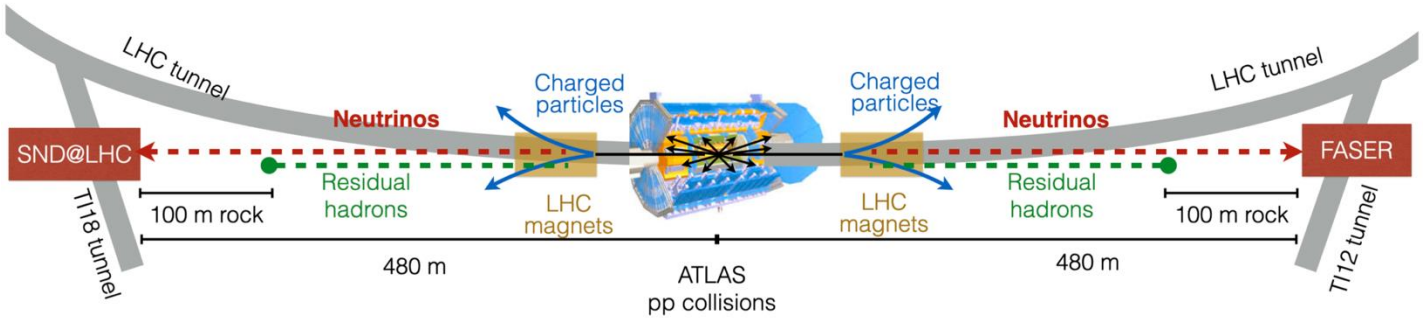
- Colling system

- Pressure testing for piping on the heat exchanger
- Design and install a new dry-air injection system inside the third manifold box also called "Warm Nose Box"(WNB).

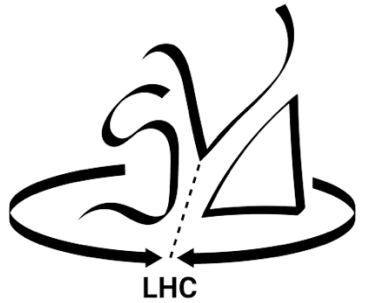


# The neutrino physics program at LHC experiments



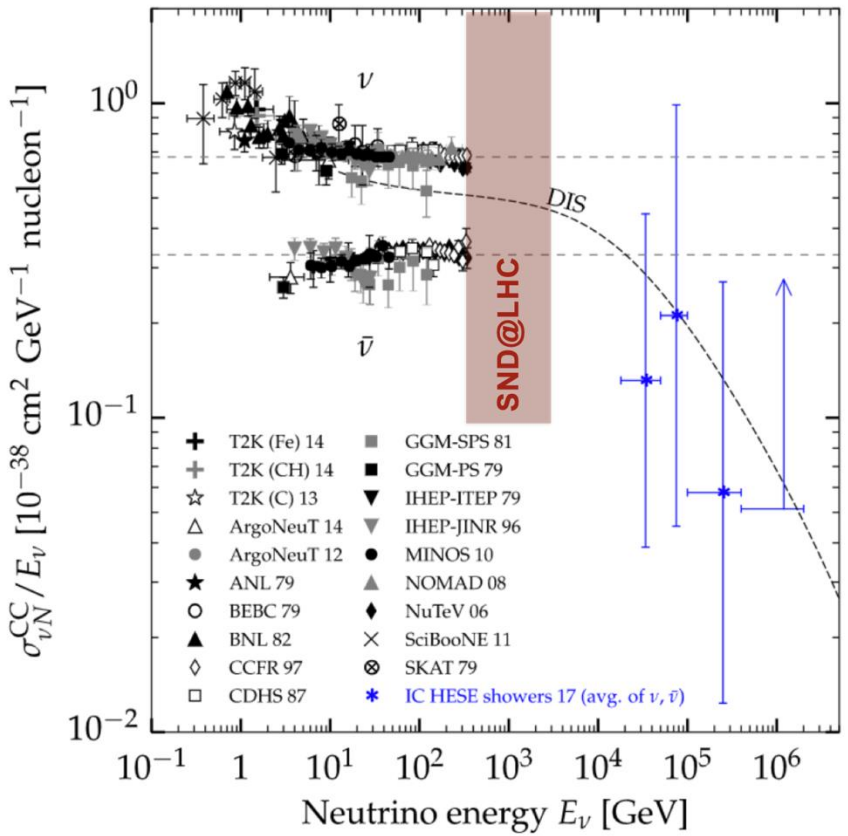
# MOTIVATION




Neutrino physics at the LHC

- Klaus Winter, 1990, observing tau neutrinos at the LHC
- A. De Rùjula, E. Fernandez and J. J. Gòmez-Cadenas, 1993, Neutrino fluxes at LHC
- F. Vannucci, 1993, neutrino physics at the LHC
- http://arxiv.org/abs/1804.04413 April 12th 2018

PRL 122 (2019) 041101




CERN is unique in providing energetic **ν** (from LHC) and measure pp →**ν**X in an unexplored domain

OPEN ACCESS
IOP Publishing
Journal of Physics G: Nuclear and Particle Physics
J. Phys. G: Nucl. Part. Phys. **46** (2019) 115008 (19pp)
https://doi.org/10.1088/1361-6471/ab3f7c

**Physics potential of an experiment using LHC neutrinos**

OPEN ACCESS
IOP Publishing
Journal of Physics G: Nuclear and Particle Physics
J. Phys. G: Nucl. Part. Phys. **47** (2020) 125004 (18pp)
https://doi.org/10.1088/1361-6471/aba7ad

**Further studies on the physics potential of an experiment using LHC neutrinos**

# Experiment concept: Hybrid detector optimized for identification of all three neutrino flavours

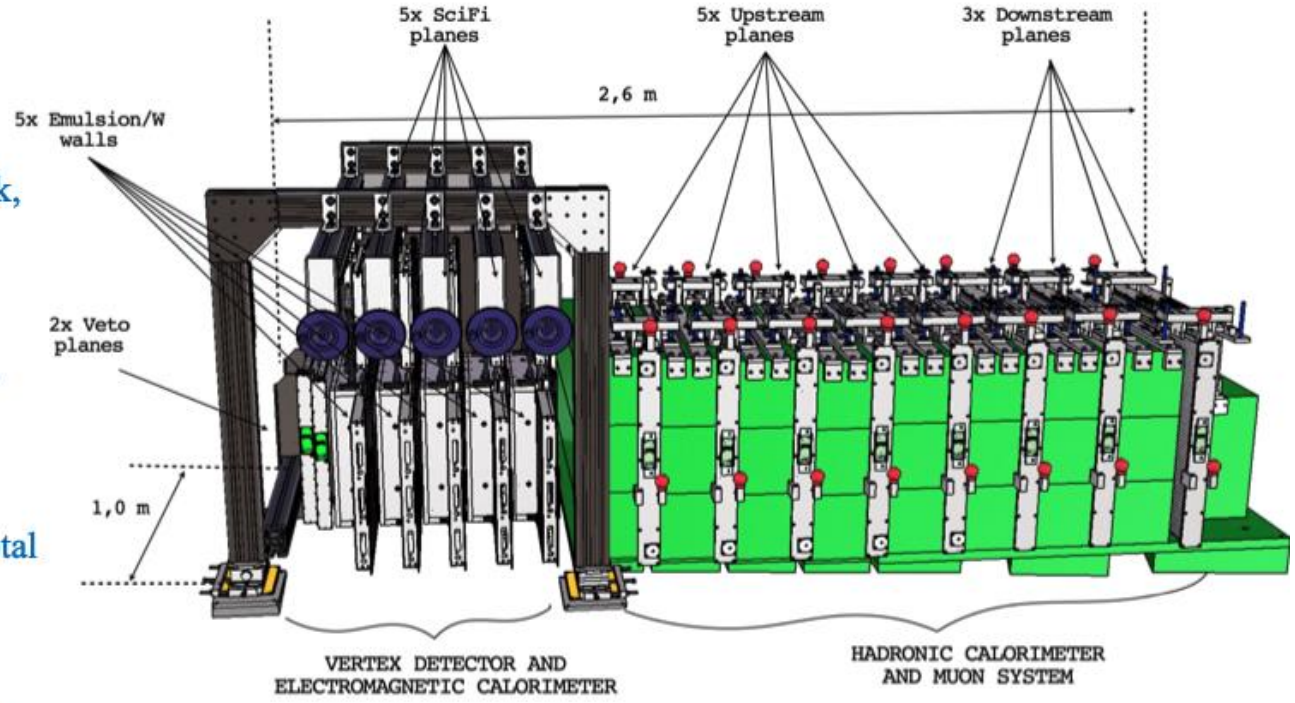
VETO PLANE:
tag penetrating muons

NEUTRINO TARGET & VERTEX DETECTOR:
- Emulsion cloud chambers (60 emulsion films, 300$\mu$m thick, interleaved by 1mm thick tungsten plates)

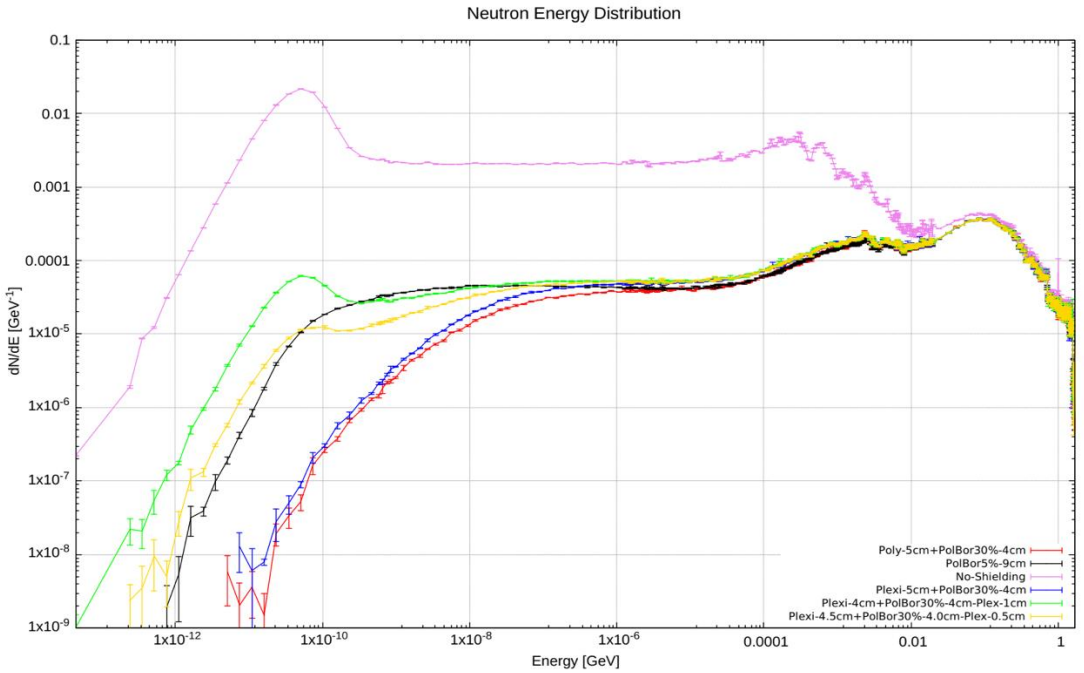
E.M. CAL
- 250$\mu$m Scintillating fibres for timing information and e.m. energy measurement

HADRONIC CALO:
iron walls interleaved with plastic scintillator planes for a total of about 11 $\lambda$

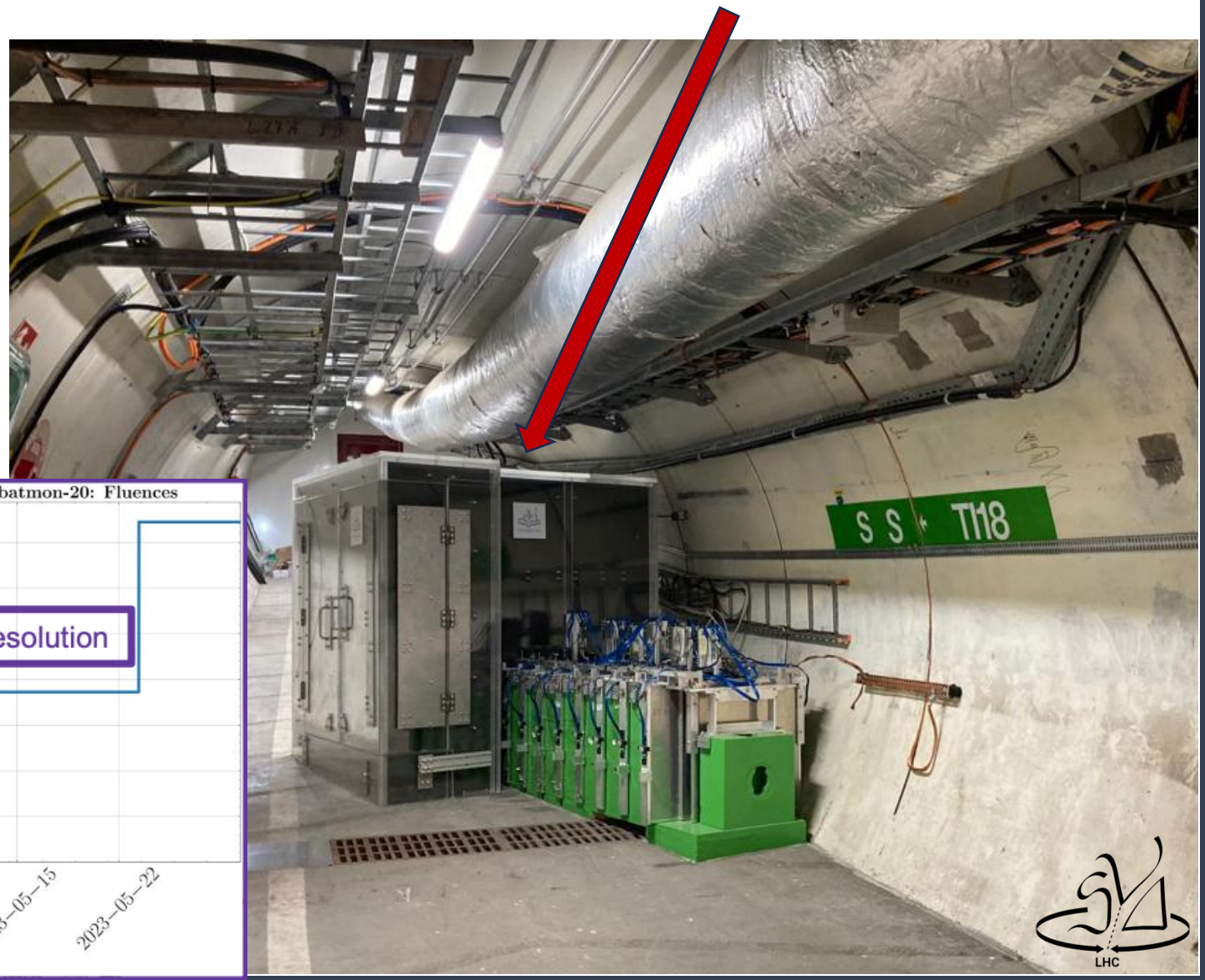
MUON IDENTIFICATION SYSTEM:
3 most downstream plastic scintillator stations based on fine-grained bars, meant for the muon identification and tracking



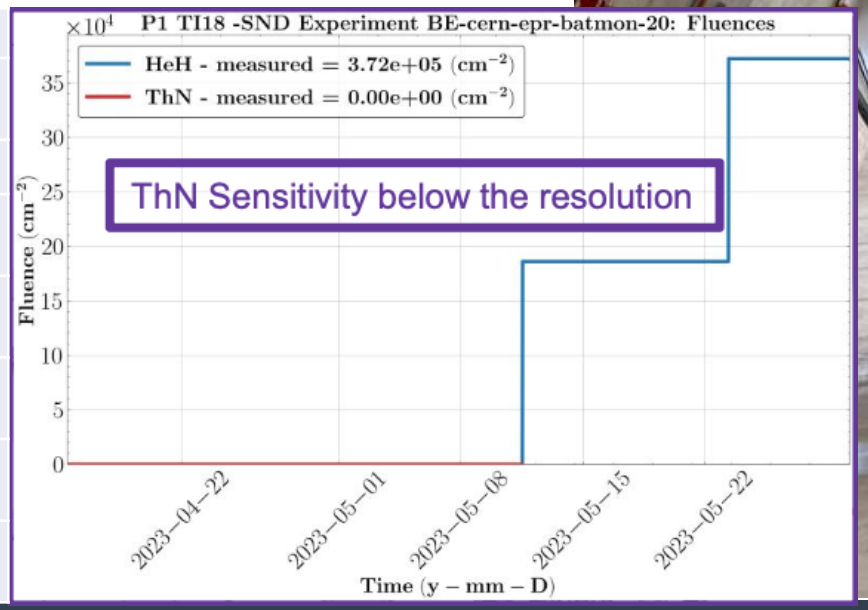
# SND@LHC Chilean contribution




ColdBox: room covered with Borated Polyethelen and acrylic plastic.




| | Ratio |
|---|---|
| 1.0E-14 < R < 1ev | 7.3E-05 |
| 1eV < R < 100 eV | 0.0085 |
| 100 eV < R < 10 keV | 0.0204 |
| 10 keV < R < 2 MeV | 0.0331 |
| 2 MeV < R < 20 MeV | 0.3249 |
| 20 MeV < R < 200 MeV | 0.8194 |
| 200 MeV < R < 1 GeV | 0.8400 |

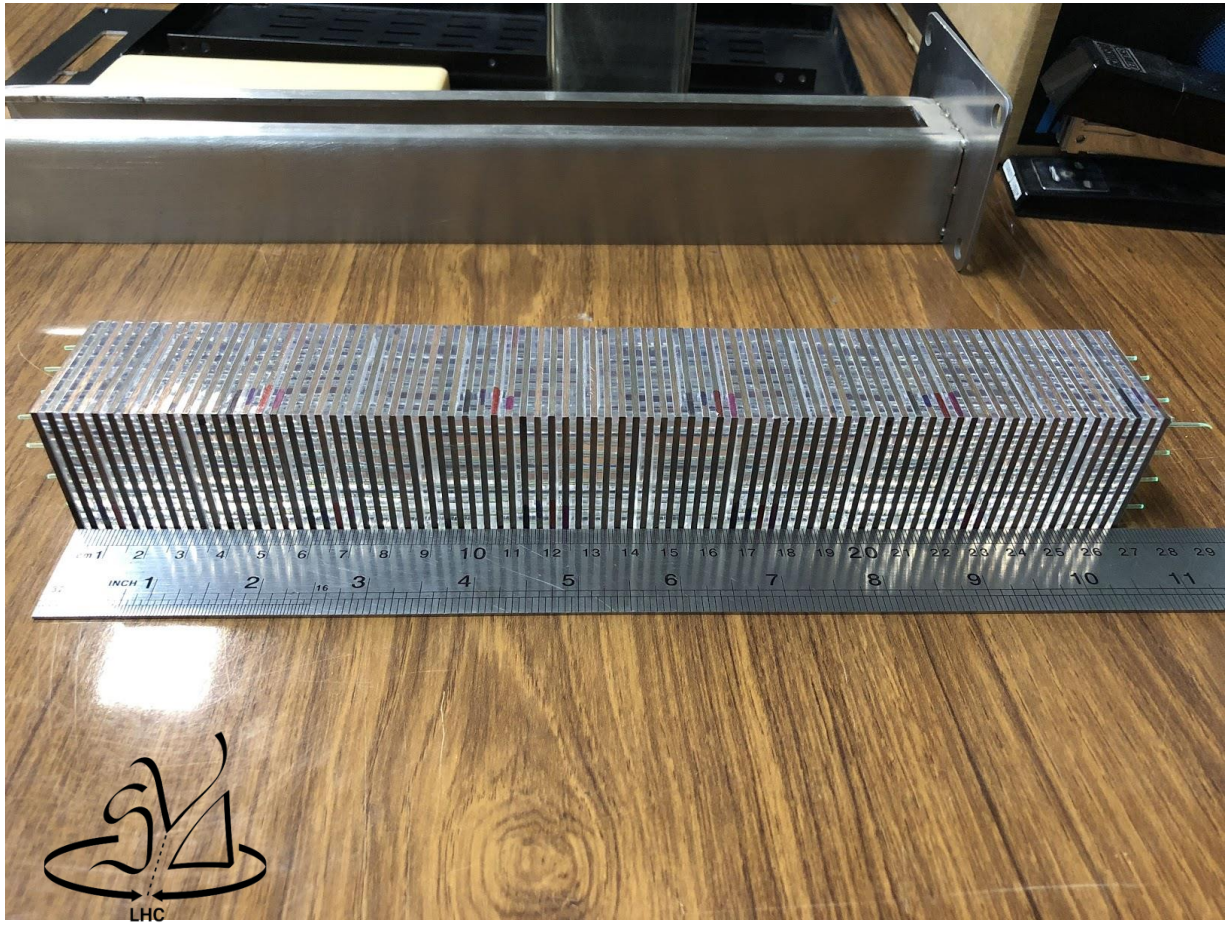


# Main activities and contributions in SND@LHC for the next 5 years

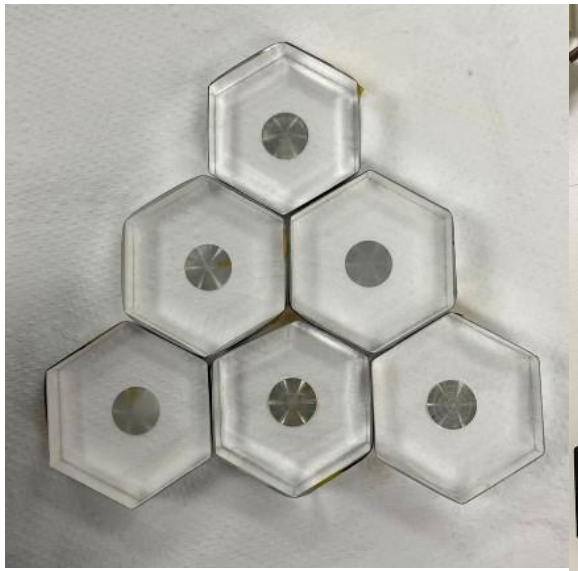
- Participation in data analysis. The nuclear emulsion scanner station of UNAB gives possibilities to involve students and young scientists in physics analysis, AI and modern data science.
- Take shifts in data taking and work with scanners at CERN.
- Provide neutron flux measuremnts (CCHEN & SAPHIR).
- Create prototypes of detectors for new SND version, advSND (ecal, tof).
- Test prototypes with beams at PS and SPS.
- Create common R&D of SND and NA-64 on “pi0 beam” using pion charge exchange reaction. This work could bring a new experiment at NA. Discussions with theoreticians are ongoing.
- Participation in advSND construction.

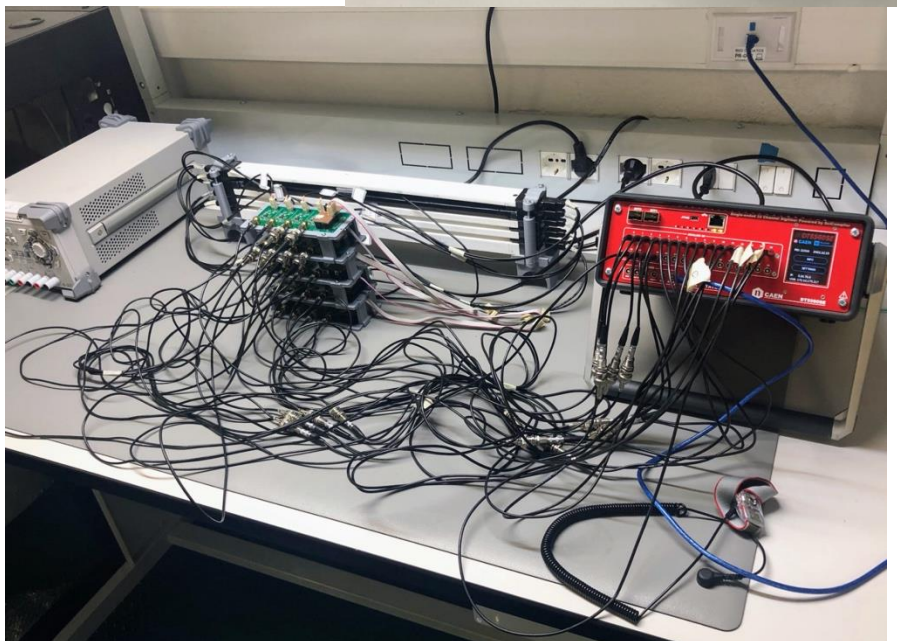
# Shashlik module for advSND@LHC

- 9 modules assembled and delivered to CERN. Already tested.



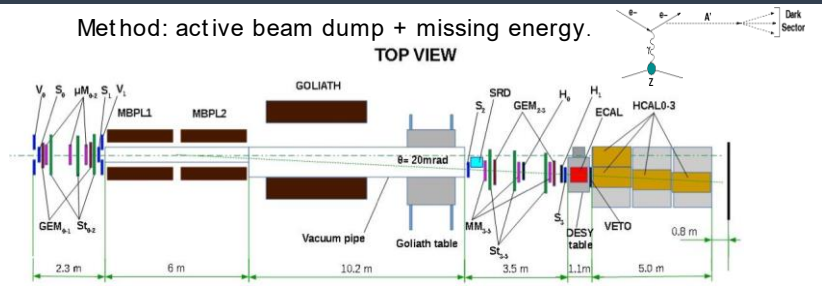
# TOF planes for advSND





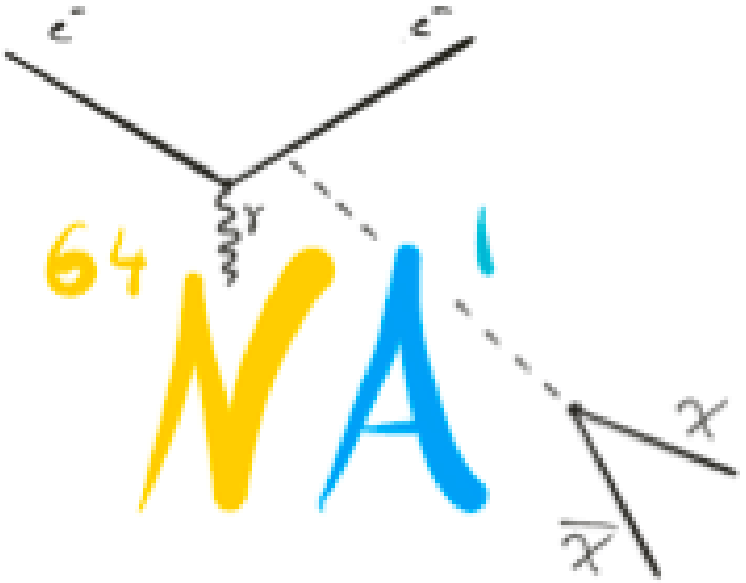
# NA-64: dark photon search experiment

Method: active beam dump + missing energy.




**Chilean contribution:**

- Detector construction
- Data analysis + fluka simulations
- Moving table (Calibration platform)
- SRD based on LYSO crystals
- This SRD could be used at all NA beam lines




# HCAL Calibration Platform for NA64

Calibration platform designed/produced by SAPHIR/UNAB/UTFSM & TALLERES ARTIFICIO

## Manufacturing Process

- Material: ASTM A572 Gr 50 (Yield strenght 38% more than ASTM A36).
- Thickness= 12,20,30,40,50 mm
- HEB 180 Beam.

1. Dimensioning:
   - CNC Laser cut (12 mm).
   - CNC Plasma cut (20 mm).
   - Oxygen cut (30,40 and 50 mm).
2. Joining and welding.
   - MIG 70s6
3. Machining.
   - Milling and boring machine.

## Main components and their validation

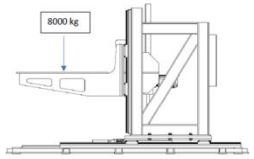



Figura 2: Vista lateral Mesa móvil con definición de ubicación de carga.

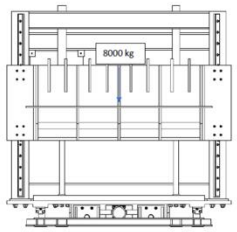
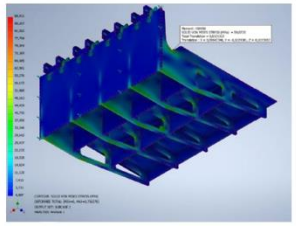
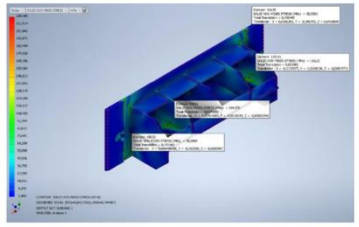
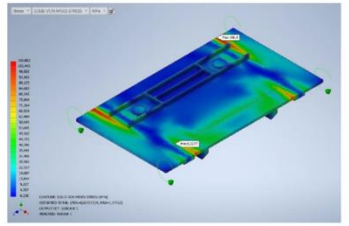
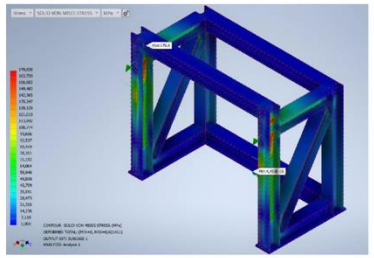


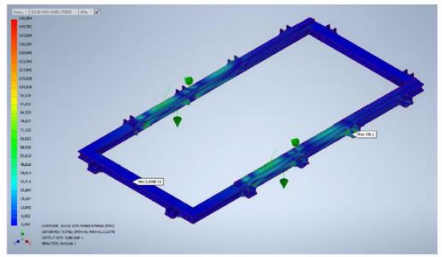

Figura 3: Vista frontal Mesa móvil con definición de ubicación de carga.












**Characteristics**

- Maximal weight ~ 8 tons
- Vertical move ~ 900 mm
- Horizontal move ~ 1200 mm
- Accuracy of moving ~ 1 mm
- Automatic control of moving

In summary: we are improving the Chilean contribution and participation at CERN. In addition, we are helping Chile in the development of science, education, and technology.

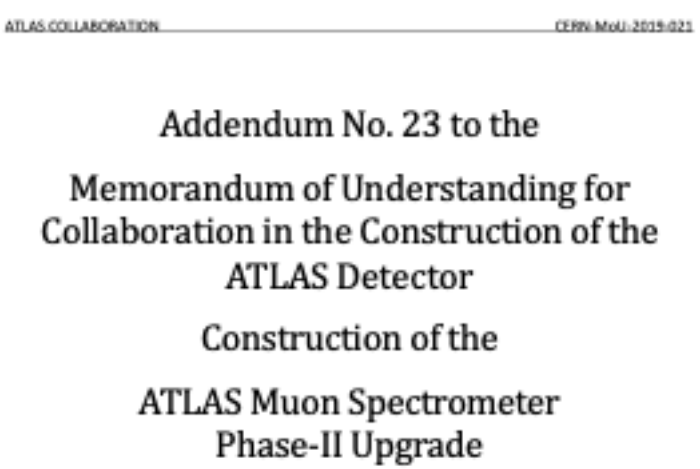

# Thank you very much

# BACKUP

# TGC Charge Monitor board. (TGC CHMon. board)

S.Kuleshov with G.Mikenberg and A.Abusleme

The project for the Chilean Cluster


ATLAS COLLABORATION CERN-MoU-2019-021

Addendum No. 23 to the

Memorandum of Understanding for Collaboration in the Construction of the ATLAS Detector

Construction of the

ATLAS Muon Spectrometer Phase-II Upgrade

Feb.19th of 2019

ATLAS COLLABORATION CERN-MoU-2019-021

MoU Item 5.6: TGC Trigger readout electronics

**Description**: Design and construction of TGC trigger and readout front-end electronics including the optical fibre system for connections between on-detector electronics and Trigger and Data Acquisition (TDAQ) electronics in USA15. The PS board is a main TGC frontend board, it receives discriminated signals from the TGC ASD boards and transmits the collected hit data to the trigger and readout modules in USA15. The Patch-Panel ASIC's are mounted on the PS board and process hit signals from ASD Boards. The Service Patch-Panel board is an interface board between PS boards and a controller board in USA15.

**Deliverables:**

| PBS | Item | CORE Value [kCHF] |
|---|---|---|
| 5.6 | TGC Trigger readout electronics | 3'165 |
| 5.6.1 | Patch-Panel ASIC | 500 |
| 5.6.2 | PS Boards | 2'260 |
| 5.6.3 | Service Patch-Panel Boards | 51 |
| 5.6.4 | Charge Monitoring Boards | 354 |

**Contribution by Funding Agency:**

| | |
|---|---|
| **Japan** | Patch-Panel ASIC, PS boards and Service Patch-panel boards production, testing, installation and commissioning. |
| **Chile** | Charge Monitoring boards, design, production, testing, installation and commissioning |

**Deliverable Sharing:**

| | Patch Panel ASIC | PS Boards | Service Patch-Panel Boards | Charge Monitoring Boards | Total |
|---|---|---|---|---|---|
| | **5.6.1** | **5.6.2** | **5.6.3** | **5.6.4** | **5.6** |
| **Japan** | 100% | 100% | 100% | - | 100% |
| **Chile** | - | - | - | 100% | 100% |
| **Total** | 100% | 100% | 100% | 100% | 100% |