



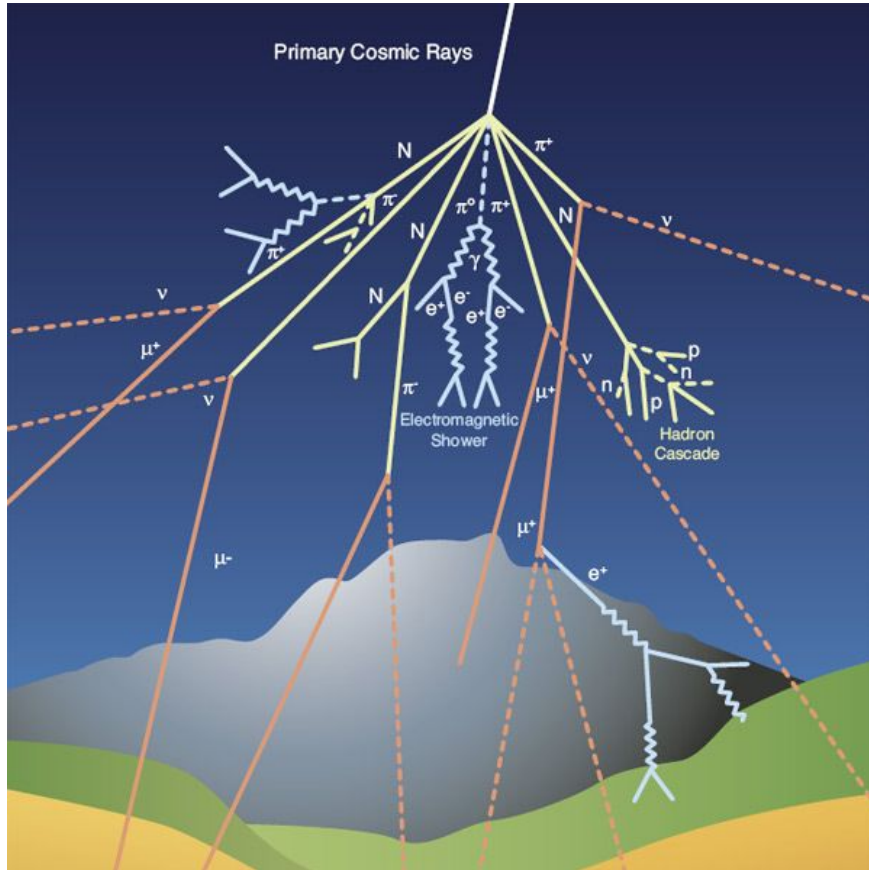
# Construcción de un telescopio de muones para hacer muongrafía al volcán cerro machín

J. Perea-Perez, C. Sarmiento-Cano, D.  
Castillo-Morales, R. A. Martinez-Rivero, J.  
Pisco-Guabave, J. Ruiz-Higuera, D. Sandoval-Galvis,  
D. Vasquez-Duran, J. Sanabria-Gomez, L. Nunez

# Contenido

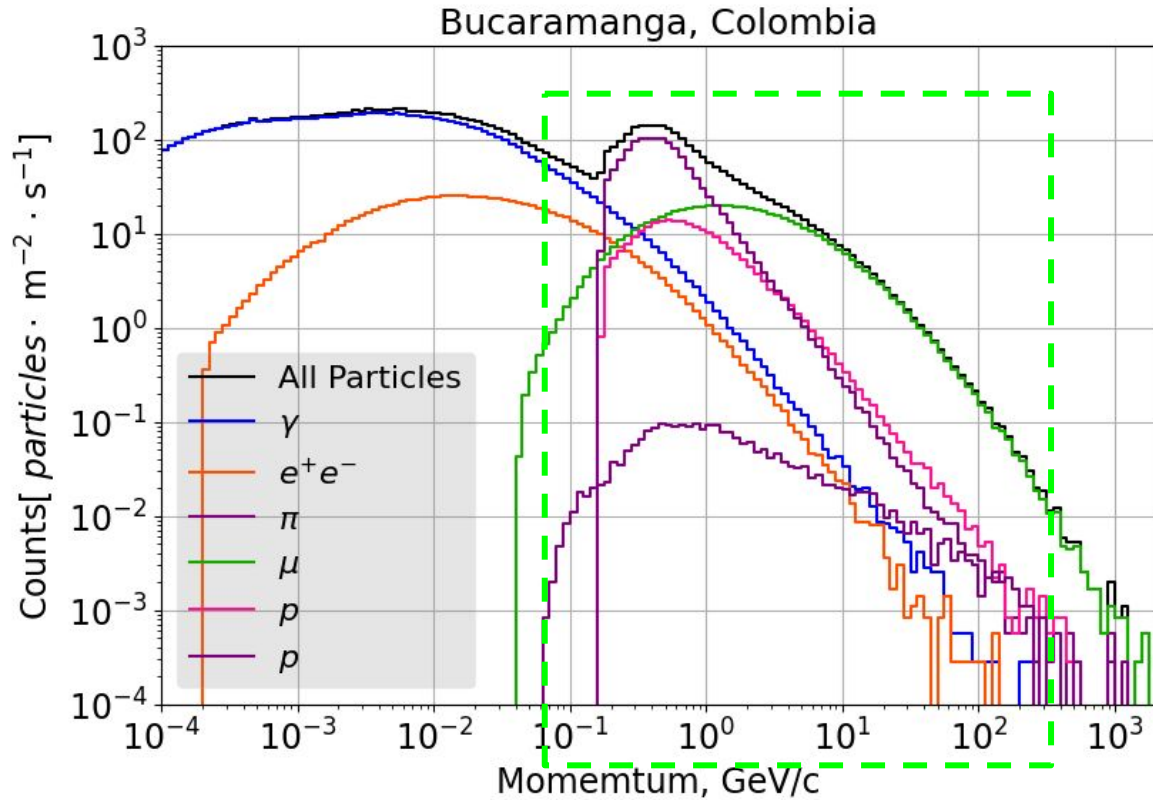
- Muones
- Muongrafia
- Volcan cerro machin
- MuTe 2.0
  - Estructura mecánica
  - Sistema de adquisición
  - Sistema de gestión de datos

# Rayos cósmicos

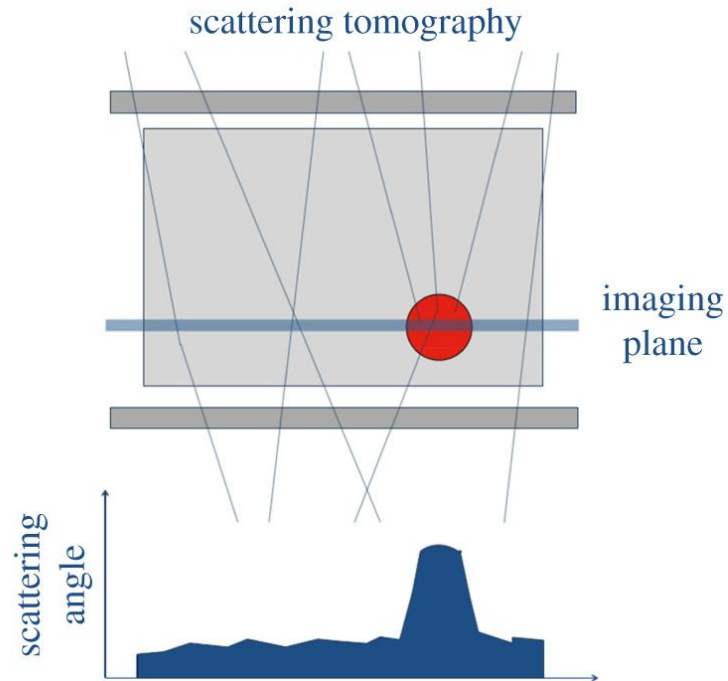
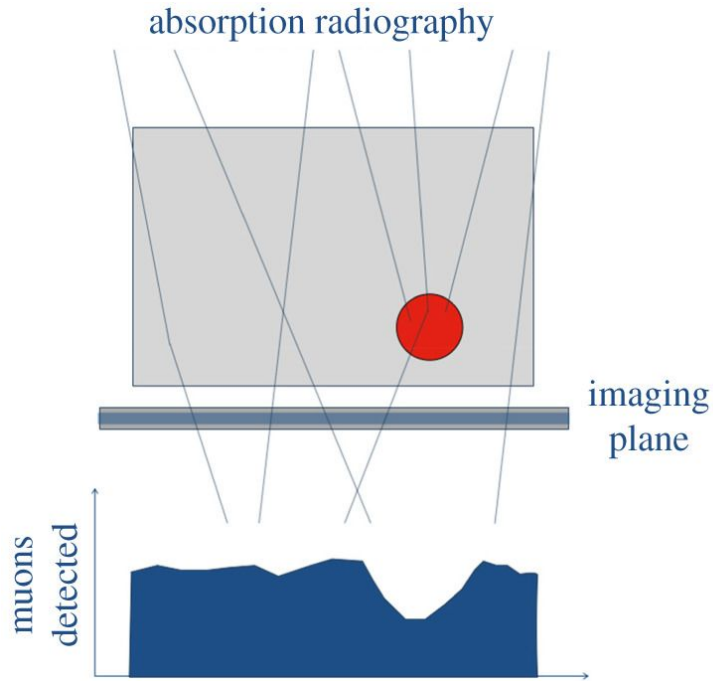


Particle	charge $q$	mean life $\tau$	mass $m$
$e$	$-e$	$> 6.6 \times 10^{28}$ yr	0.511 MeV
$\mu$	$-e$	$2.2 \times 10^{-6}$ s	105.7 MeV

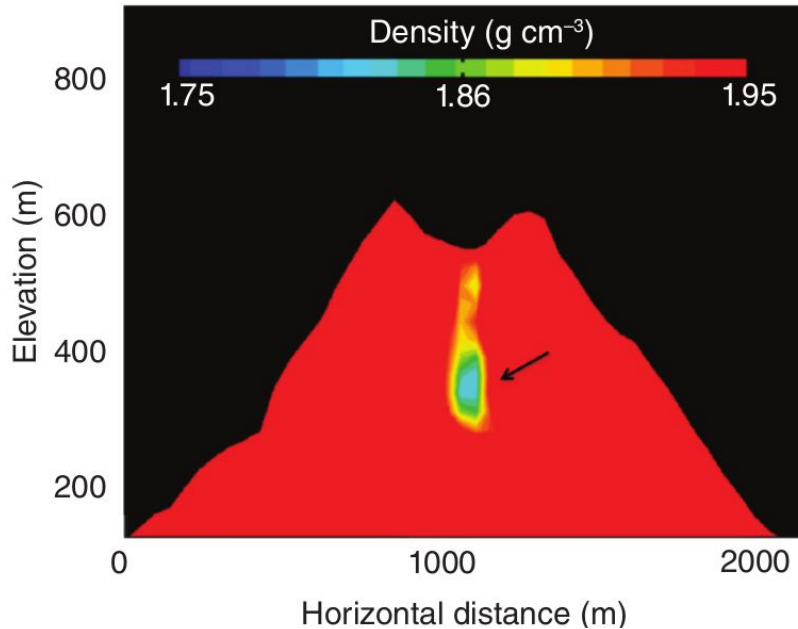
# Lluvias aéreas extensas



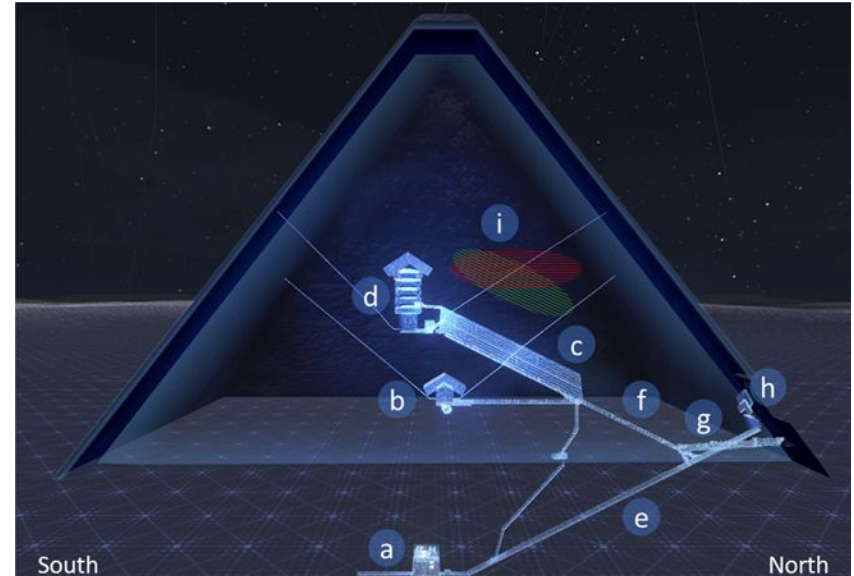
# Muongrafia



# Casos de uso exitosos de muongrafia

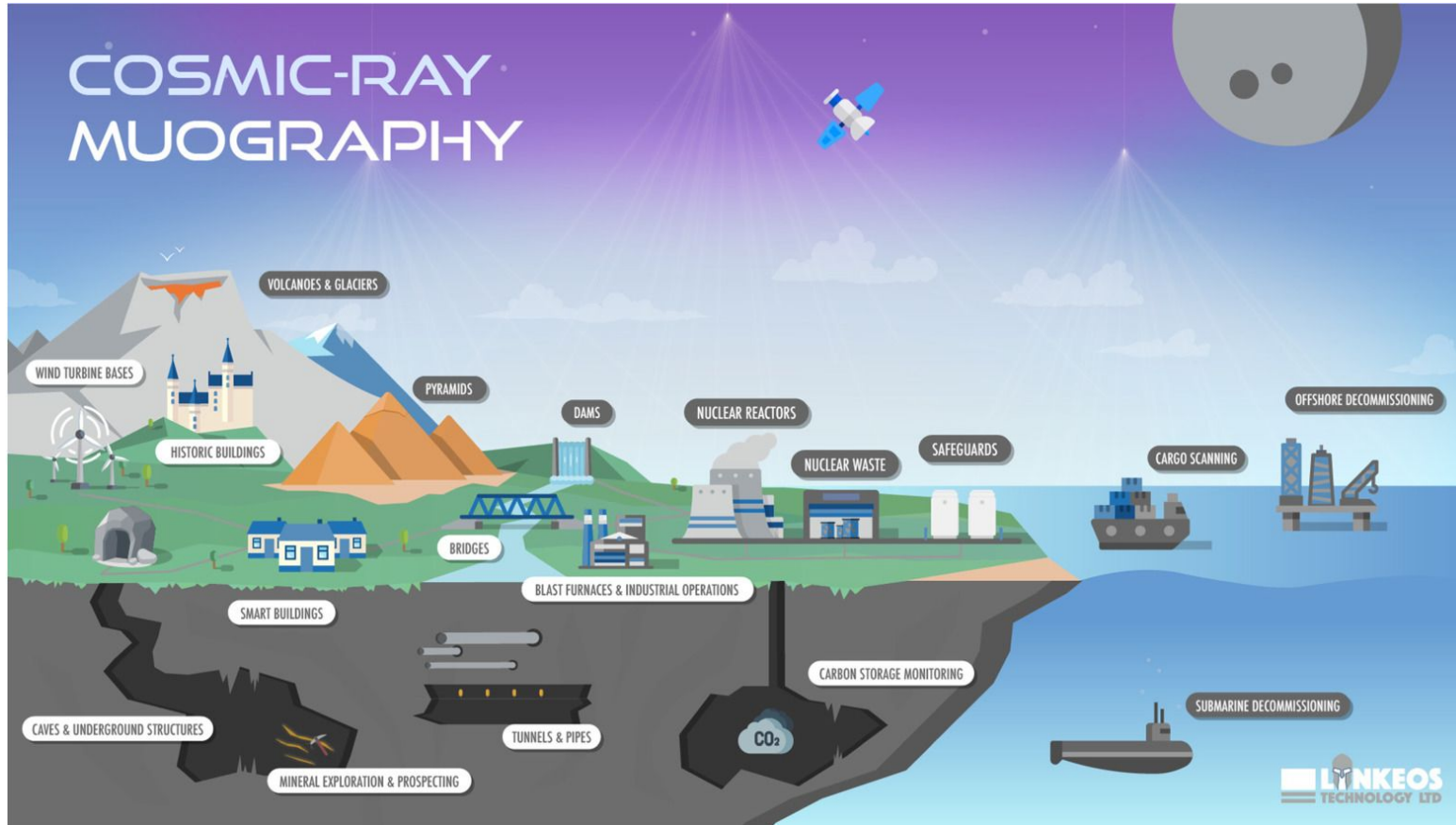


H. Tanaka et al. Japanese volcanoes visualized with muography (2019)

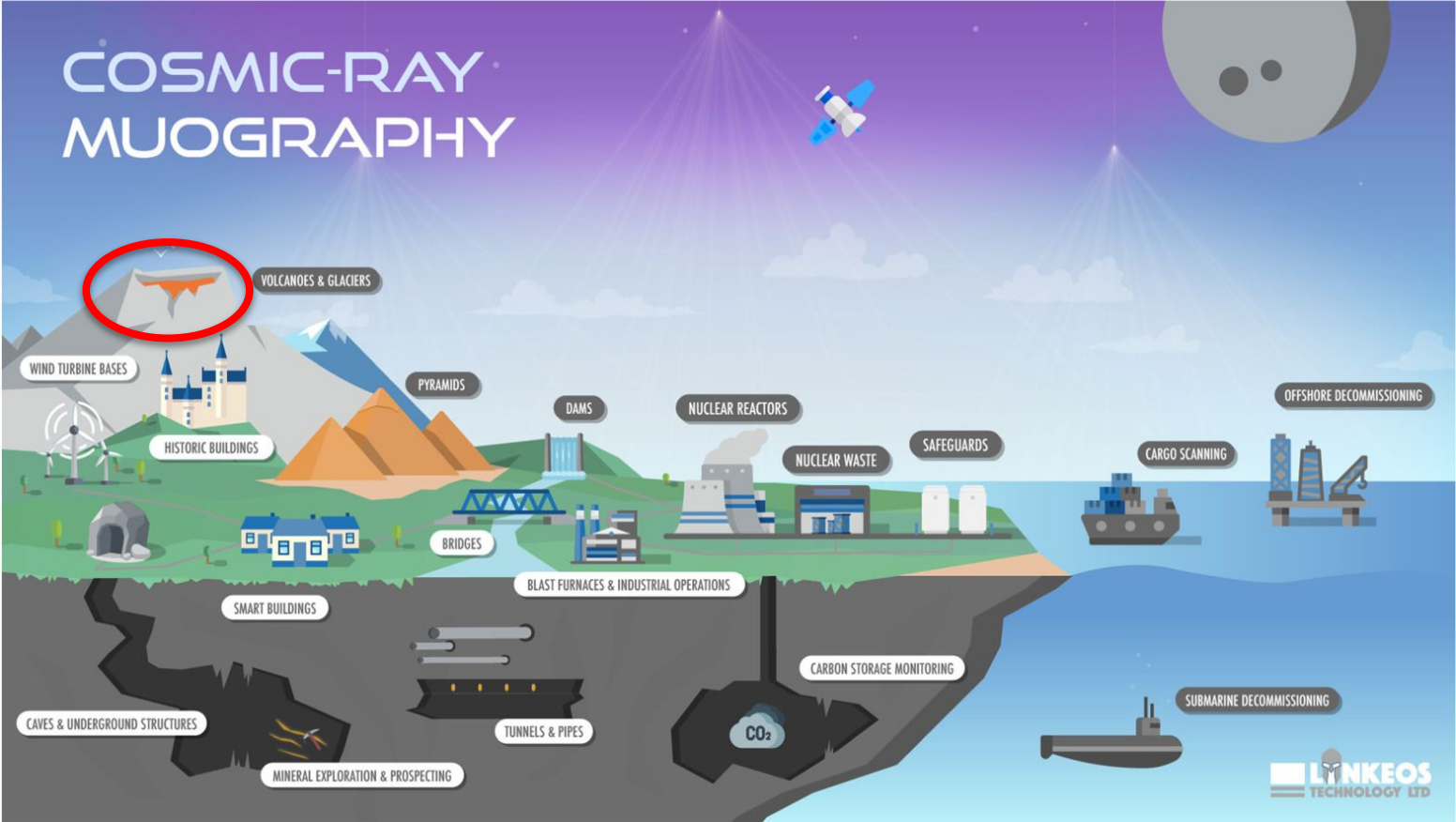


Morishima, K., Kuno, M., Nishio, A. *et al.* Discovery of a big void in Khufu's Pyramid by observation of cosmic-ray muons. *Nature* **552**, 386–390 (2017). <https://doi.org/10.1038/nature24647>

# Muonografia (Aplicaciones)



# Muongrafia (Aplicaciones)





# Volcán cerro machín



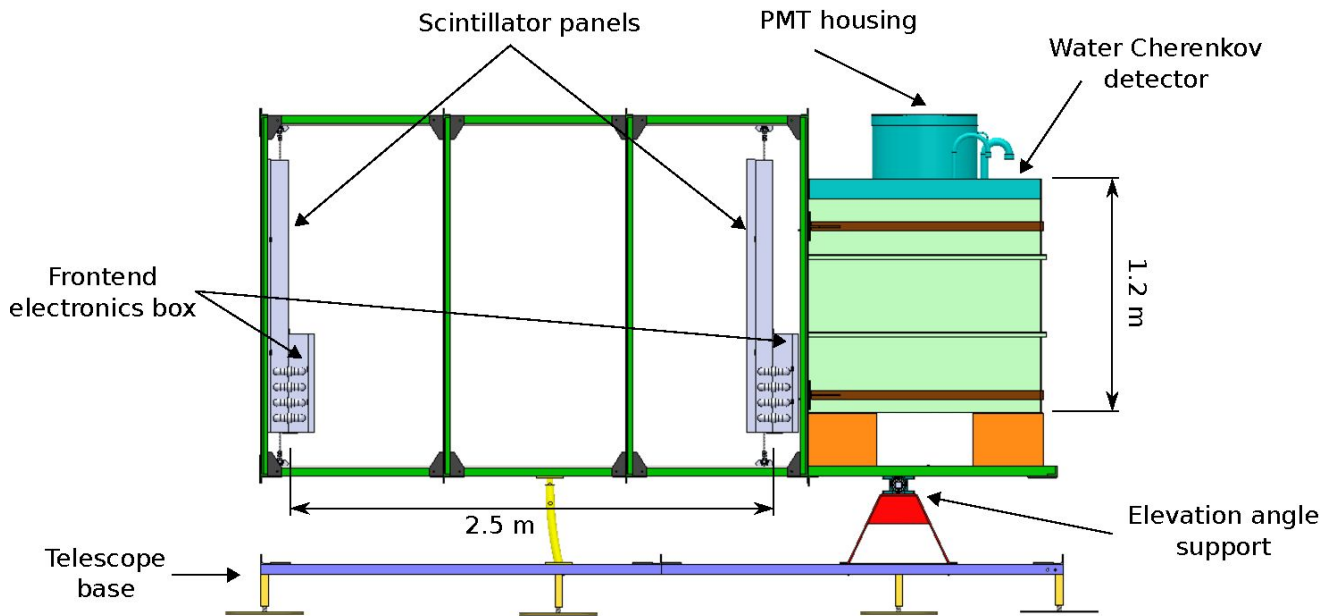
# Volcán cerro machín



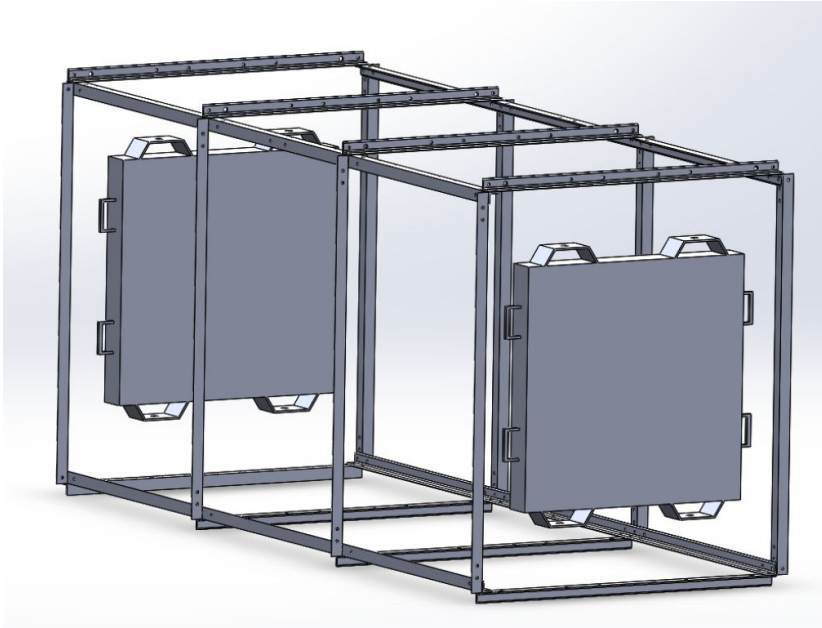


# MuTe 1

paralelepipedo de 4.2 m x 2.8 m  
x 1.8 m

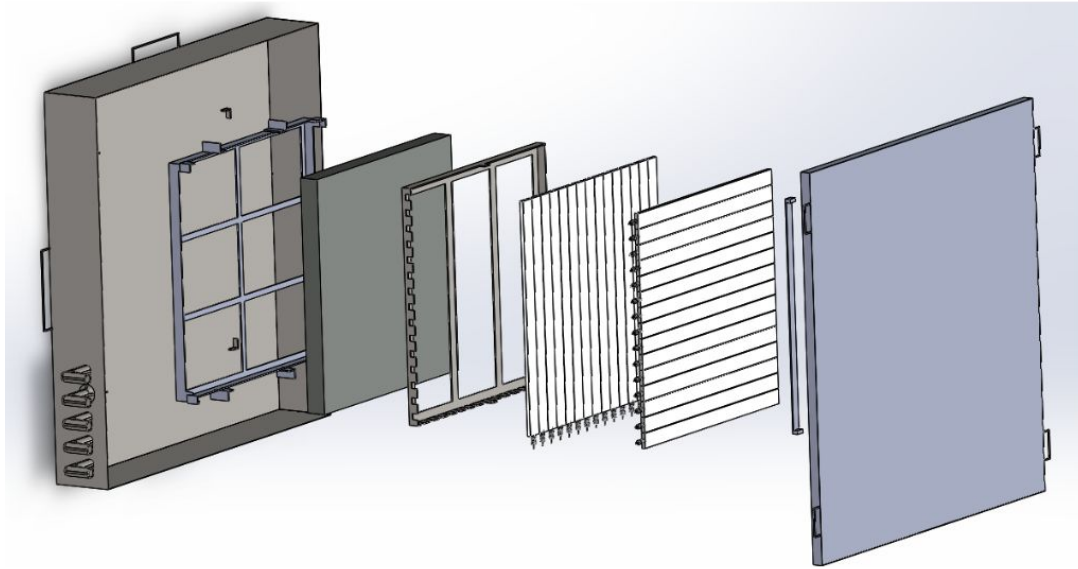


# MuTe2.0: Muon Telescope



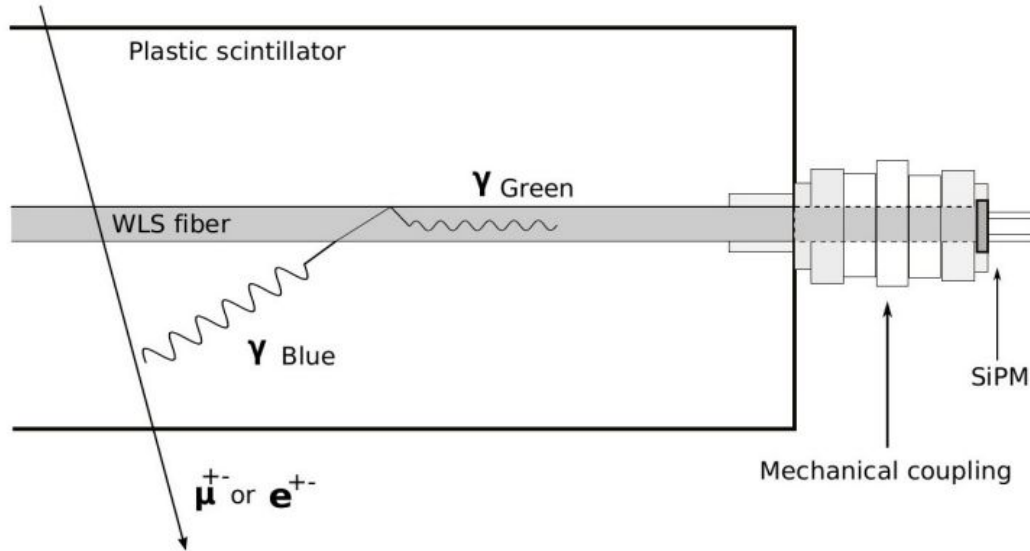
- Paralelepipedo de aproximadamente 1m x1.5mx2.5m
- Dos paneles de barras centelladoras.
- Una caja térmica con la electrónica.

# MuTe2.0(panel centellador)



- Contiene dos planos de 15 barras centelladoras c/u.
- Cada panel tiene 225 píxeles c/u.

# MuTe2.0(Barras centelladoras)

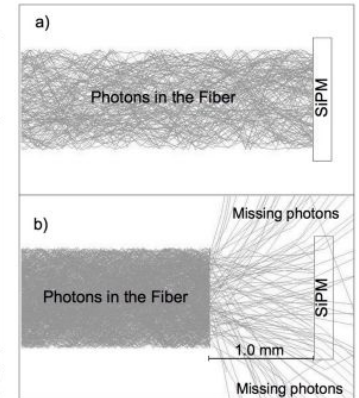
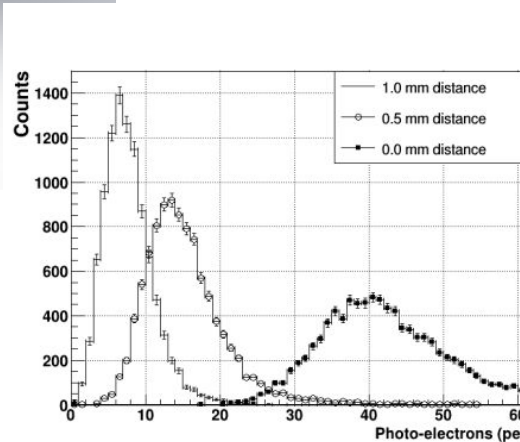
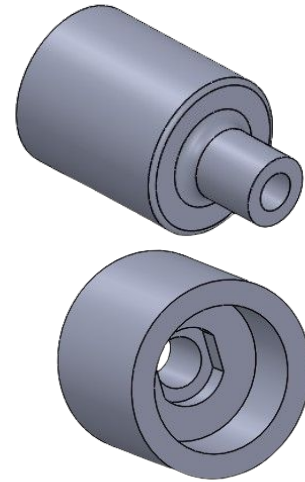
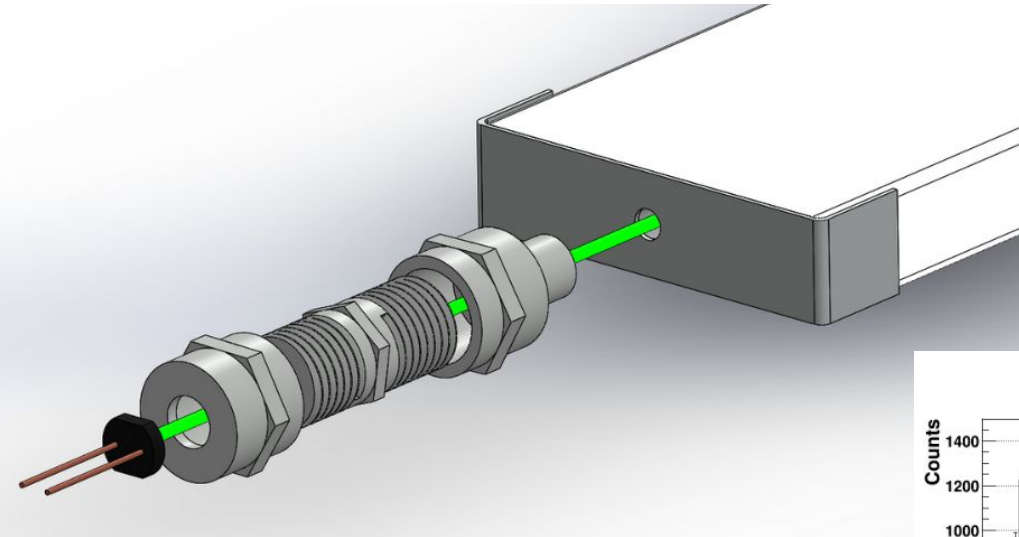


-Cada barra centelladora es de 60cm x 4cm x 1cm.

-Hilo de fibra óptica que transporta luz verde.

A. Vásquez-Ramírez et al. Simulated Response of MuTe, a Hybrid Muon Telescope.(2020)

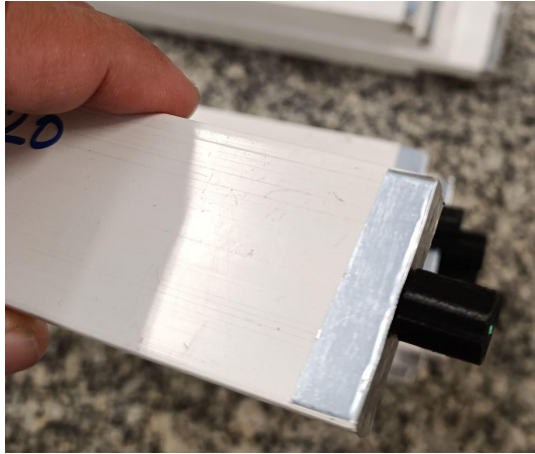
# MuTe2.0 (Acouple fibra-SiPm)



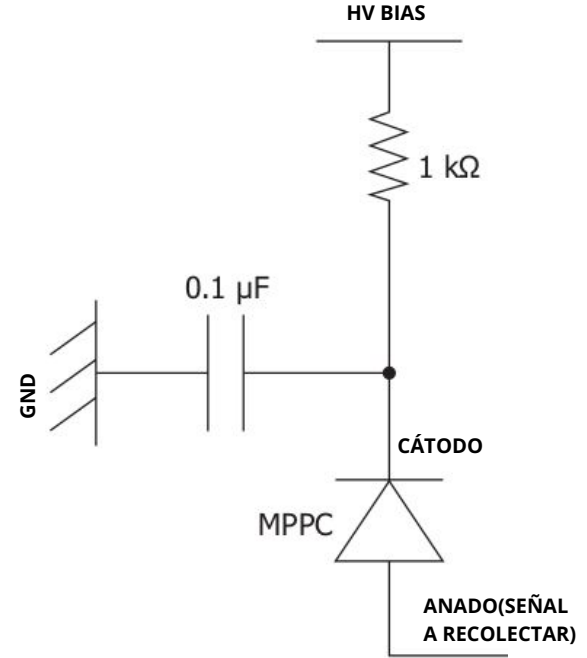
A. Vásquez-Ramírez et al. Simulated Response of MuTe, a Hybrid Muon Telescope.(2020)



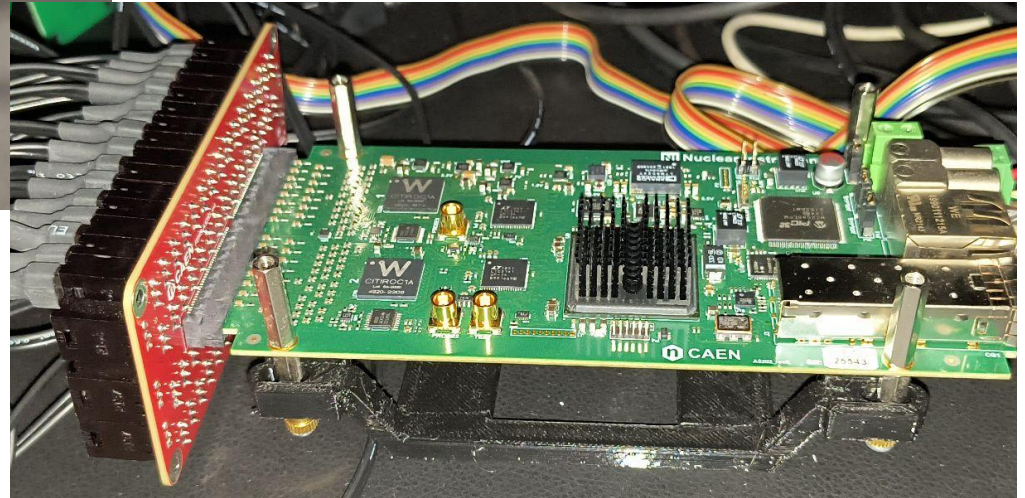
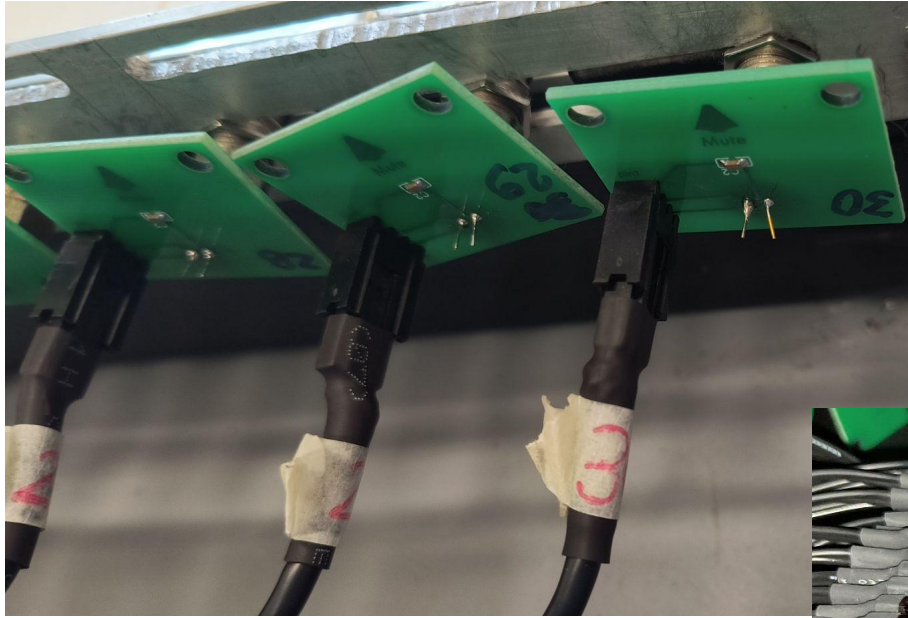
# MuTe2.0(Acople Barra-PCB)



SiPm de la serie s13360 de hamamatsu



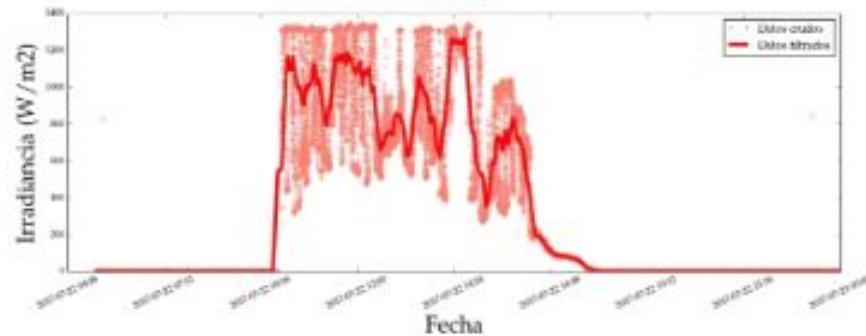
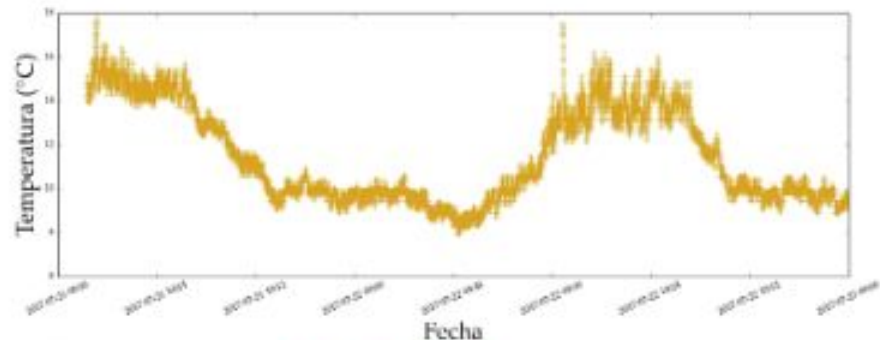
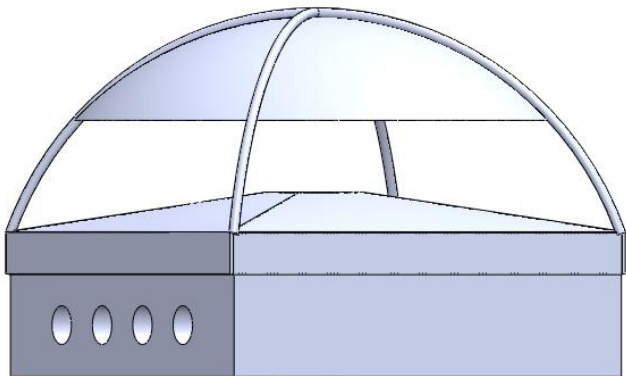
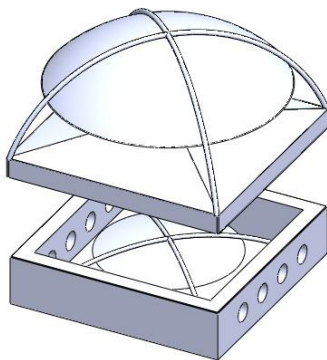
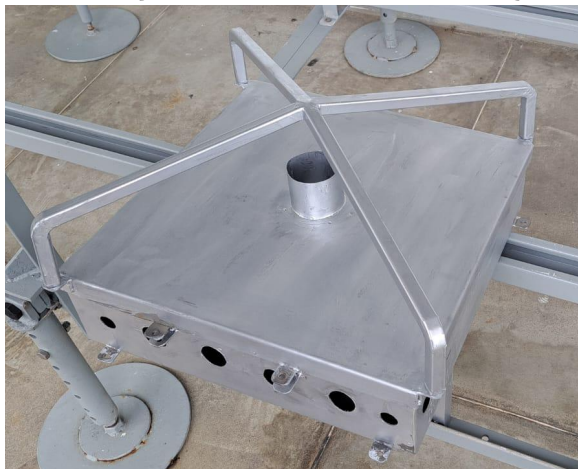
# MuTe2.0(DAQ)



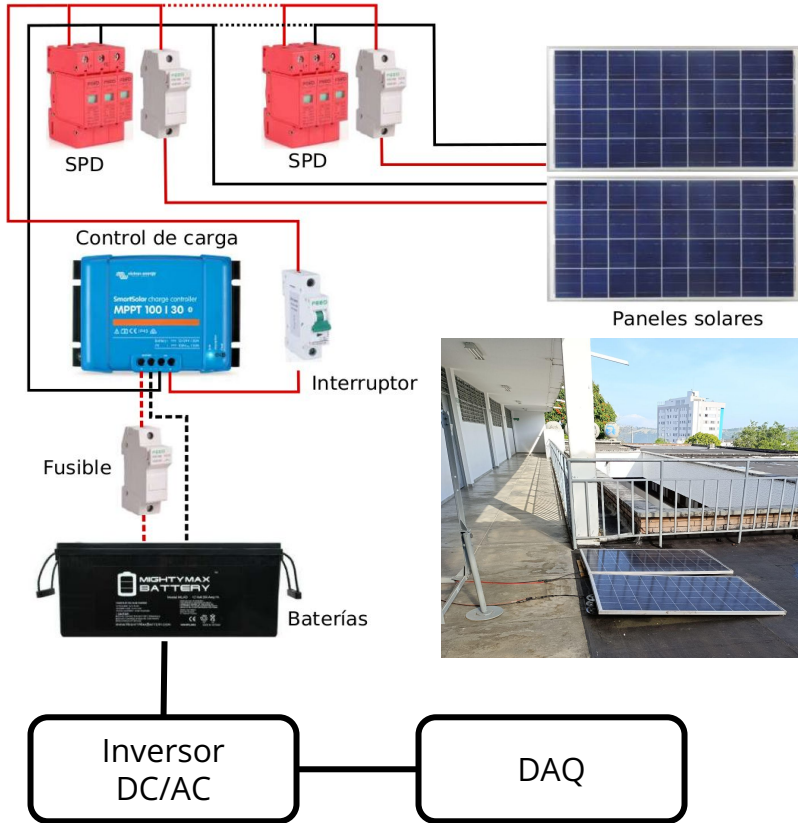
-FERS A5202 de CAEN instruments

- MiniPC

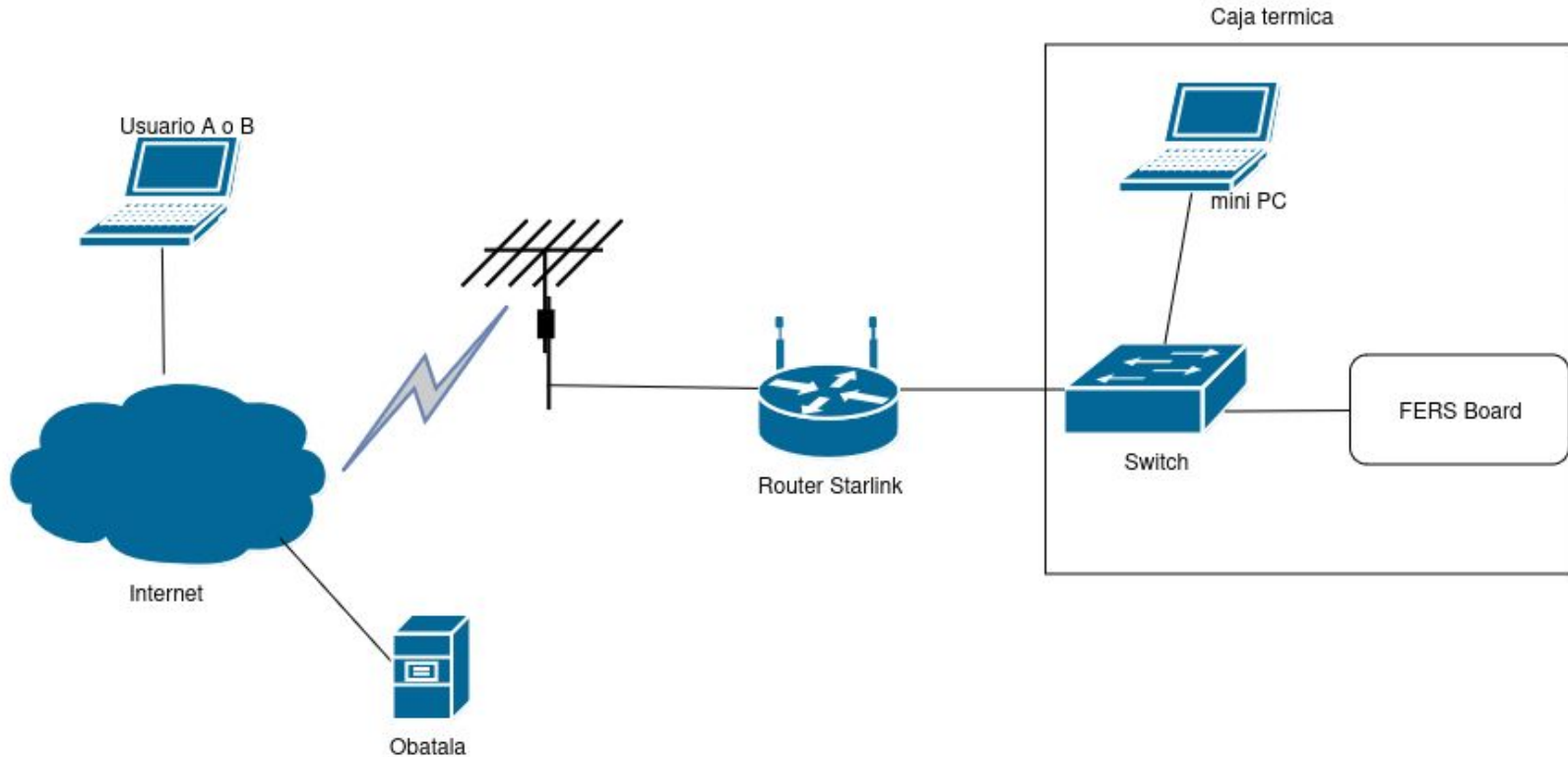
# Caja térmica para el DAQ



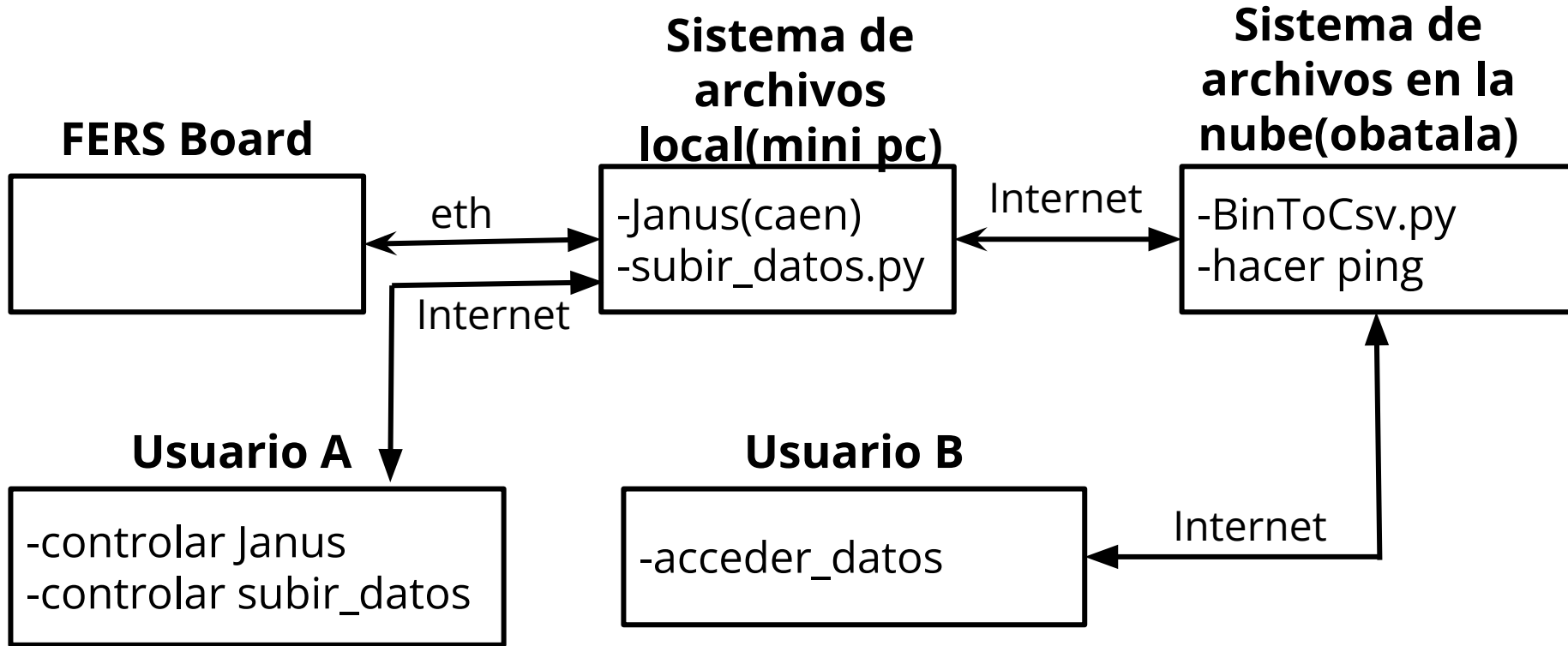
# Sistema de alimentación eléctrica de respaldo



# Sistema de gestión de datos



# Sistema de gestión de datos

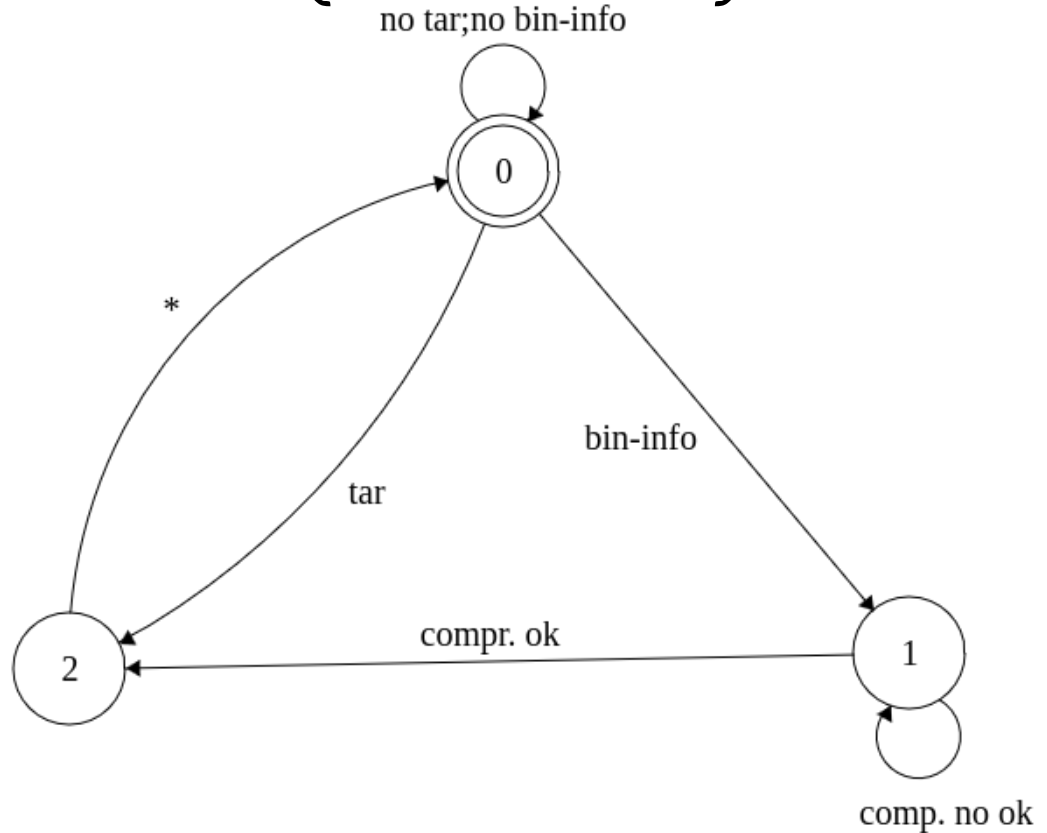


# Sistema de gestión de datos(subir datos)

0:revisar folder /entrada.

1:comprimir pareja bin-info  
en un tar.

2:subir archivo tar.



# Sistema de gestión de datos(traducir datos)

0:revisar folder /entrada.

1:descomprimir tar.

2:mv sobre archivos bin-info.

3:./BinToCsv --bfile Runxx.dat

4: generar mute\_csv en /salida.

5:comprimir archivos.

6:borrar caen\_csv.

-1:mv a folder /problematic.

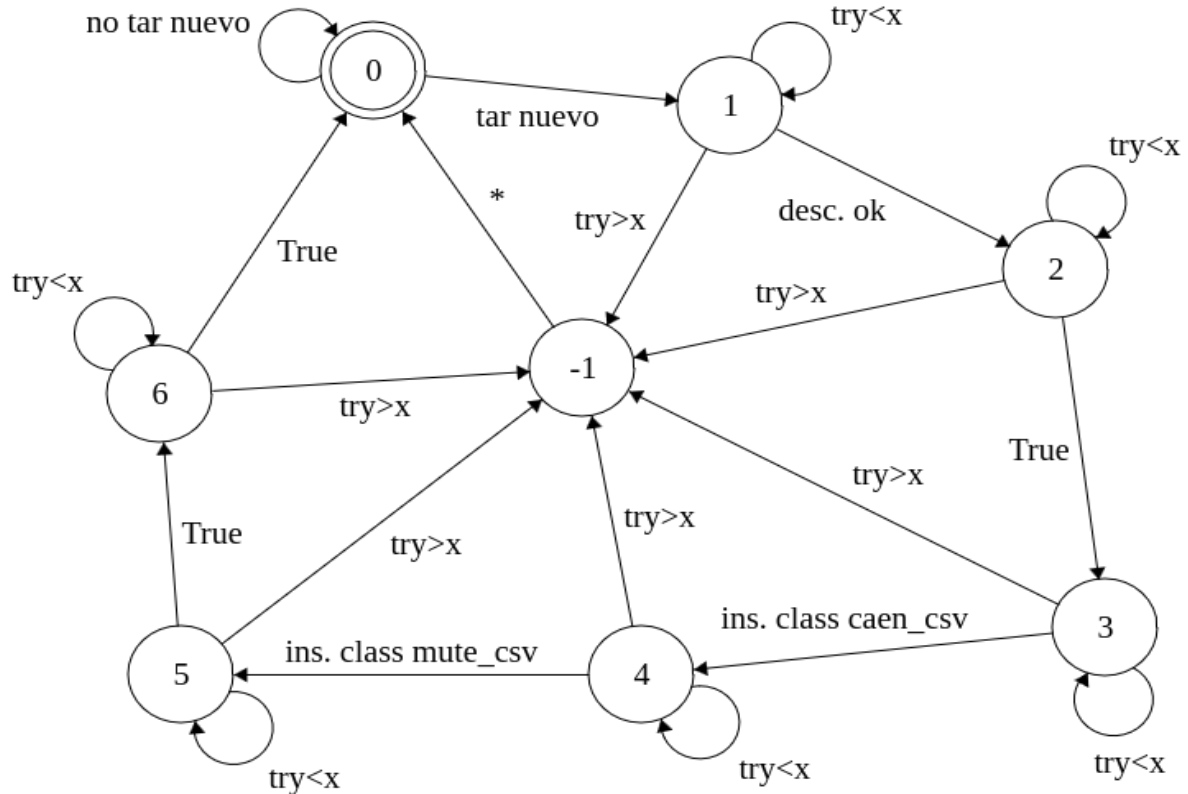






Foto del  
instrumento  
armado



**¡GRACIAS!**

