Particle Physics labs in UTFSM

Hayk Hakobyan
(Physics department & CCTVal)

Fifth International Workshop
for the Design of the
ANDES Underground Laboratory
June - 2017

EX UMBRA IN SOLEM

CCTVal

Centro CientíficoTectológico de Valparaiso

- CCTVal is a world class scientific research center dedicated to research and innovation
- Collaboration between three departments of UTFSM (more than 130 integrands)
- Joint projects of Particle Physics, Computer Science & Electronics.

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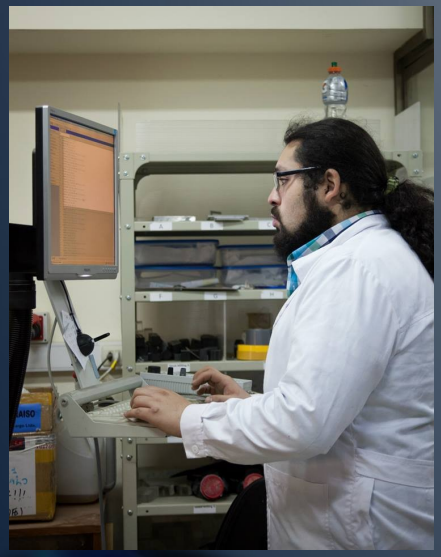
CCTVal director – Ivan Schmidt

Laboratories

CCTVal counts with multiple Laboratories, each one with state of the art equipment:



-SiLab, Silicon Laboratory

-Powerlab

-Signals and systems Laboratory

-HPC Data Center, Computer Science Lab

SiLab was born in 2008

Exp. group head - William Brooks

Head of labs - Sergey Kuleshov

Head engineer: Alam Toro, Rimsky Rojas, David Kouyoumdjian, Juan (Iñaki) Vega, Lautaro Narbaez

Physics: Orlando Soto, Rene Rios, Pablo Ulloa

Project engineering: Orlando Soto, René Rios, Pavlo Bazalyeyev, Elias Rozas, Sebastian Cepeda, Esteban Zambrano, Alejandro Guijardo, Jorge Opitz, Michael Gomez, Sebastian Rodrigez, Matias Liz, Rodrigo Diaz, Renato Casas Cordero, Francisco Martinez

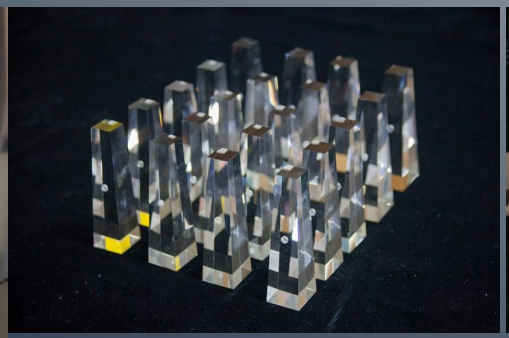
Software engineering: Ricardo Oyarzún, Orlando Soto, Juan Pavez

Administrative: Cynthia Sánchez, Nikol Milla, Katherine Jaldes

Etc ... Etc ... Etc

The three main areas in SiLab:

- **Mechanized work center:** Design and fabrication of electronic and mechanical parts
- **Particle detection and Spectrometry:** Spectrometry analysis and particle detection.
- **Microelectronics:** Fabrication of specialized semiconductors



International Collaborations

At present time, CCTVal collaborates directly with some of the most important Laboratories and scientific research centers around the world in different experiments

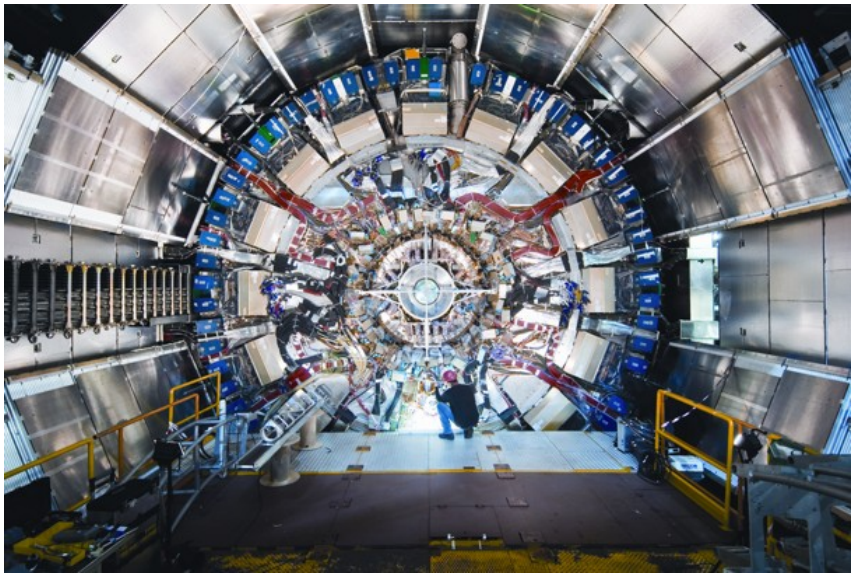
CERN:
- Atlas experiment
- RD51

Jefferson Lab
- CEBAF Large Acceptance Spectrometer (CLAS/CLAS12)
- GlueX

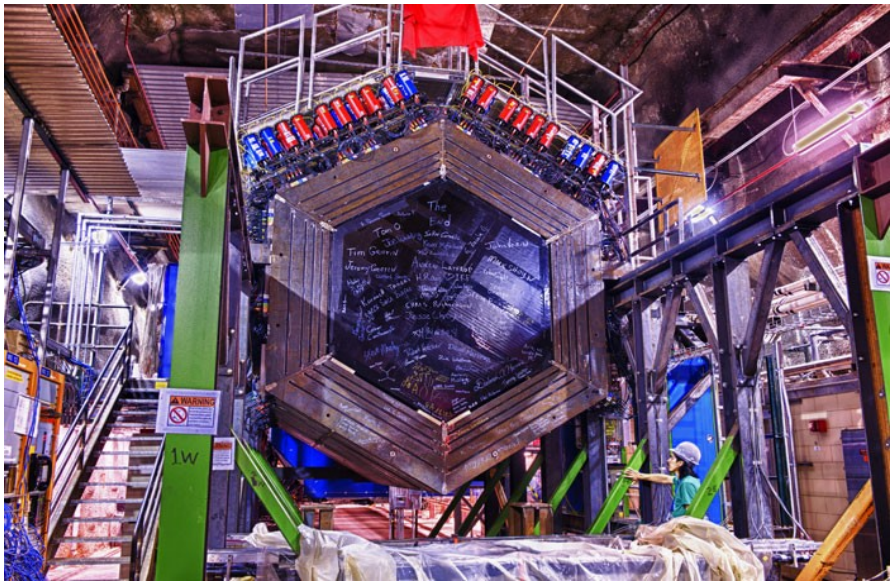
Fermi Lab
- MIVERvA Main Injector Experiment vor v-A

Brookhaven National Lab:
- sPHENIX

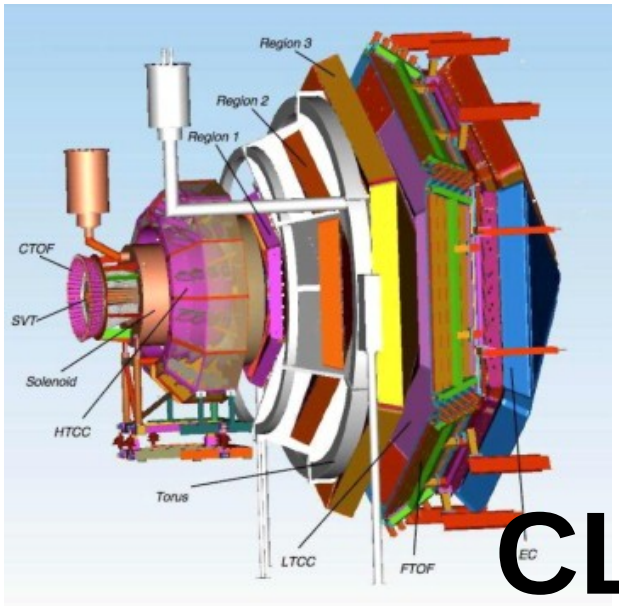
ATLAS



MINERvA



GlueX

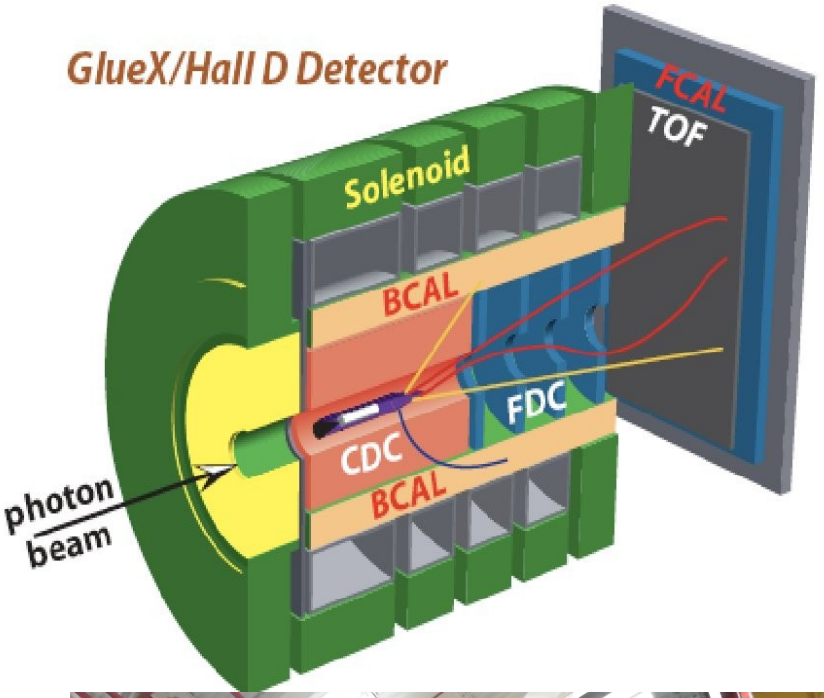


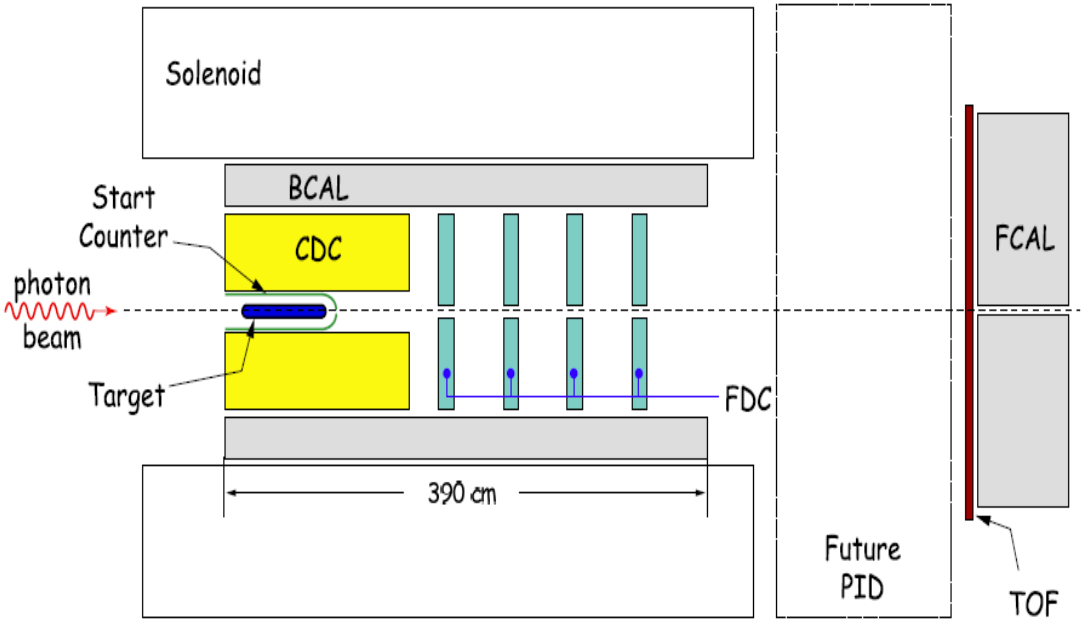
CLAS1

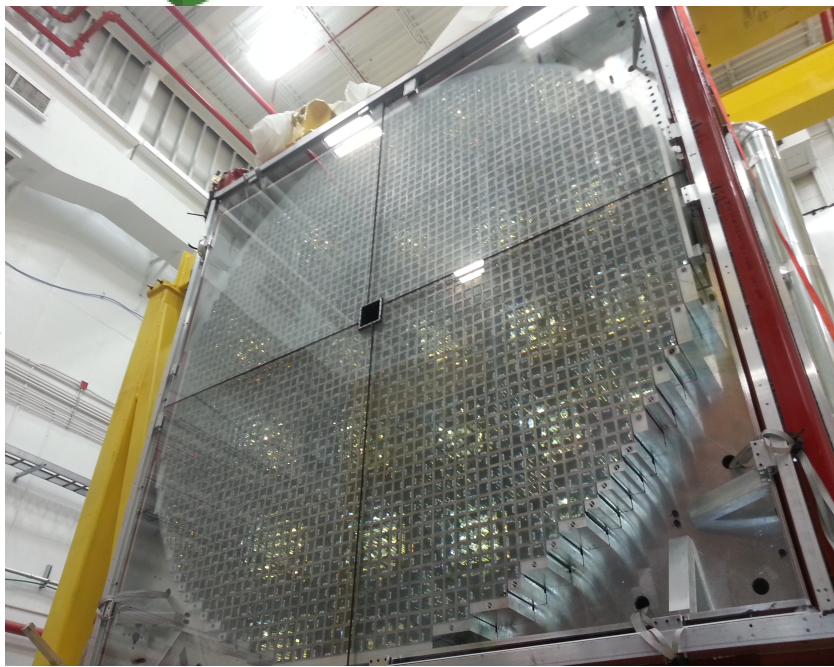
Some of our projects

- Characterization of 2800 multi pixel photon Counter (mppc) for GlueX in Jefferson Lab. (COMPLETED).
- Fabrication of 4000 light guides for GlueX in Jefferson Lab. (COMPLETED).
- Pre-shower detector for forward electromagnetic calorimeters for EIC.
- ATLAS Upgrade, Small-Strip Thin Gap Chambers (sTGC) Replacement.
- New EG2 Target for the CLAS12 detector at Jefferson Lab for nulear hadronic studies.
- Fabrication of ultralight mirrors to build RICH detectors for CLAS12 in Jefferoson Lab
- Gamma Camera for Single-photon emission computed tomography (Spect).
- Neutron Activation Analysis
- Nuclear Densimeter
- Radon Detector
- Gamma Probe
- 3d Scanner Densimeter
- Port Monitor System for radioactive materials
- Etc.

Hall-D/GlueX

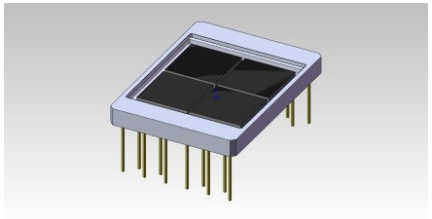

GlueX/Hall D Detector
FCAL
TOF
Solenoid
BCAL
FDC
CDC
BCAL
photon
beam

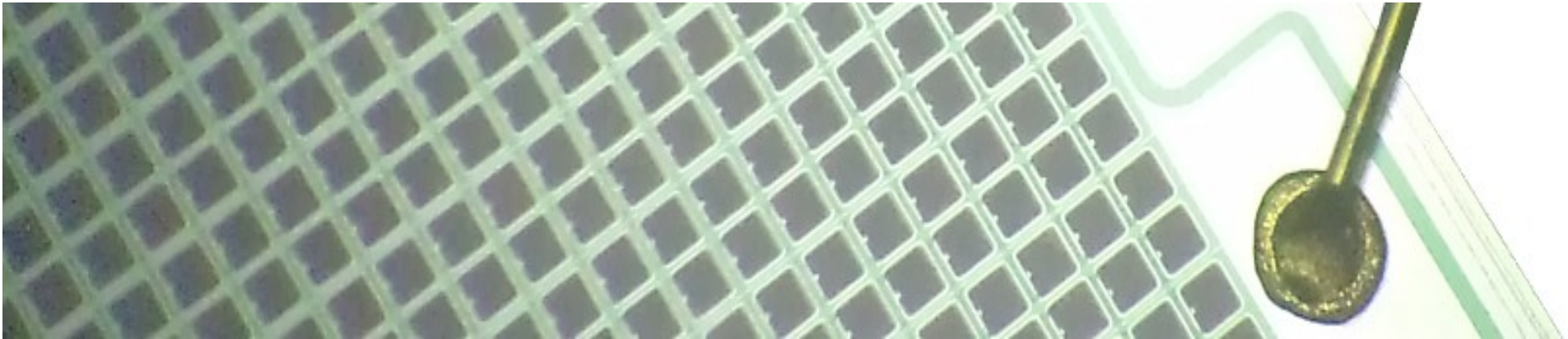

Solenoid
BCAL
Start
Counter
CDC
photon
beam
Target
FDC
390 cm
FCAL
Future
PID
TOF



Characterization of 2800 multi pixel photon Counter (mppc)

- This project consisted on characterizing 2800 multi pixel photon counters fabricated by for three different temperatures.
- Incorporated to the electromagnetic Calorimeter (BCAL) of the GlueX experiment at Jefferson Lab.





HAMAMATSU product MPPC

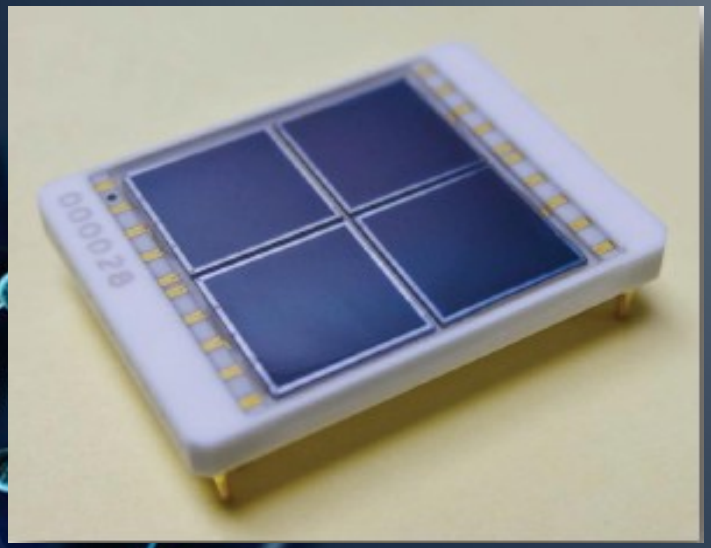
Multi Pixel Photon Counter (MPPC) is a solid state photon counter using Geiger-mode APD and self-quenching resistance.

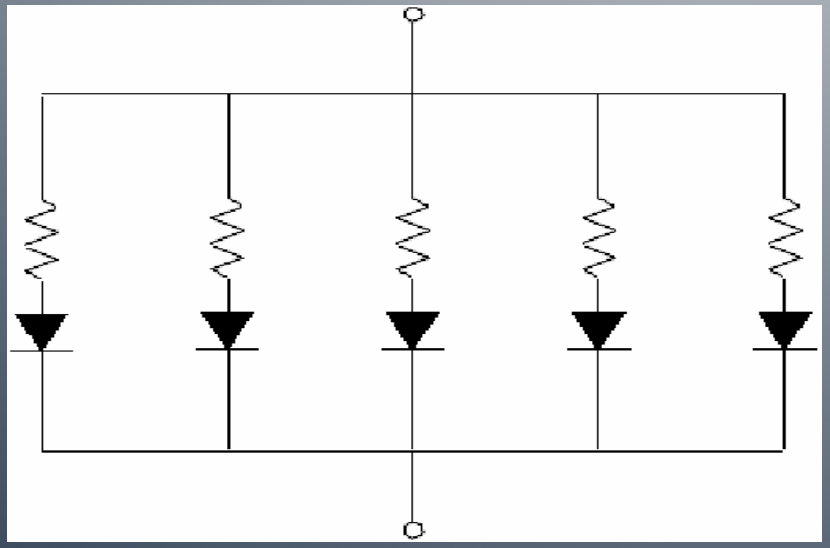
Main features:

- low bias voltage operation
- high gain
- insensitivity to magnetic fields

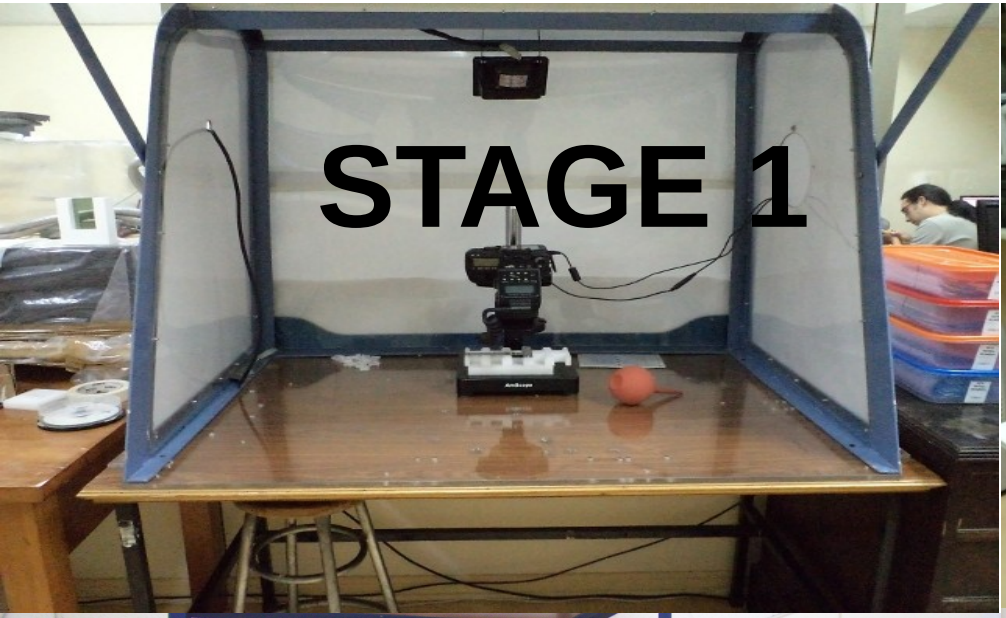
Three kinds of MPPCS with effective area 1mm x 1mm each:

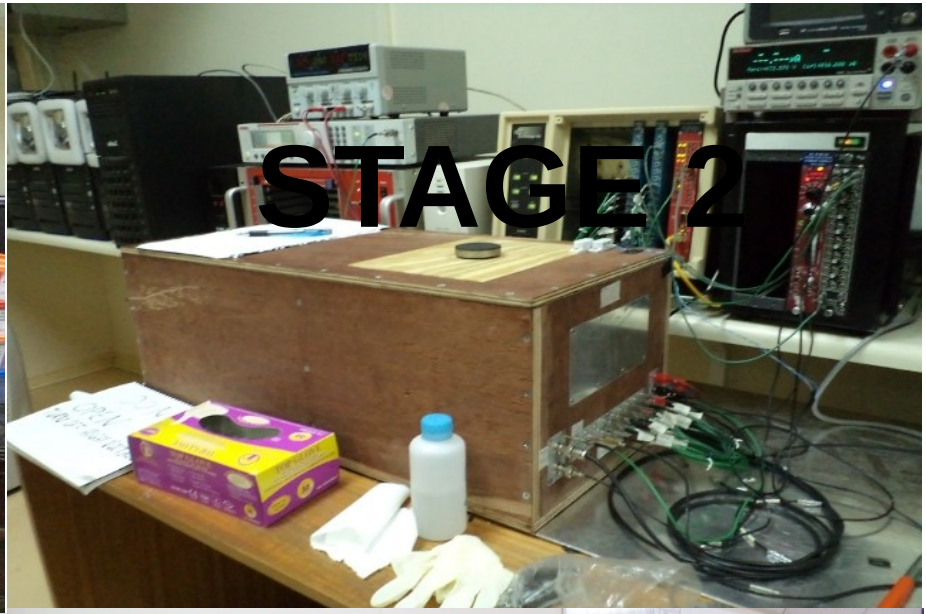
40 pixels x 40 pixels, 25um pitch, f_{geo}=30.8%
20 pixels x 20 pixels, 50um pitch, f_{geo}=61.5%
10 pixels x10 pixels,100um pitch, f_{geo}=78.5%

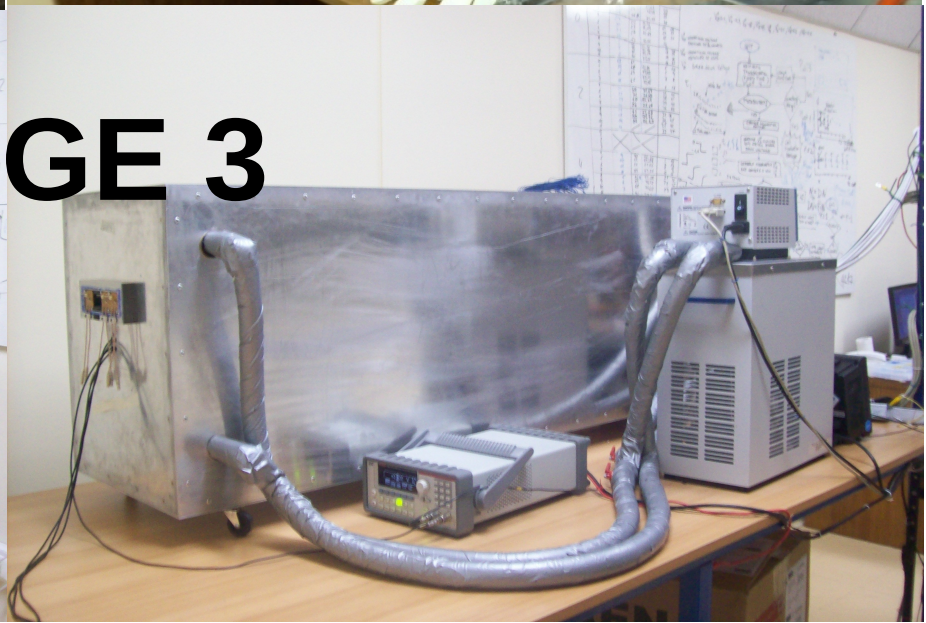




Three stages of testing







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Novel Hamamatsu Multi-Pixel Photon Counter (MPPC) array studies for the GlueX experiment: New results

Orlando Soto, Rimsky Rojas, Sergey Kuleshov, Hayk Hakobyan*, Alam Toro, William K. Brooks, Rene Rios

Universidad Técnica Federico Santa María, Valparaíso, Chile

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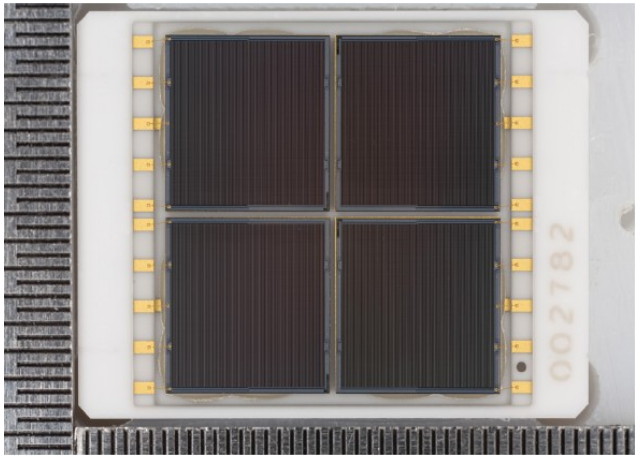
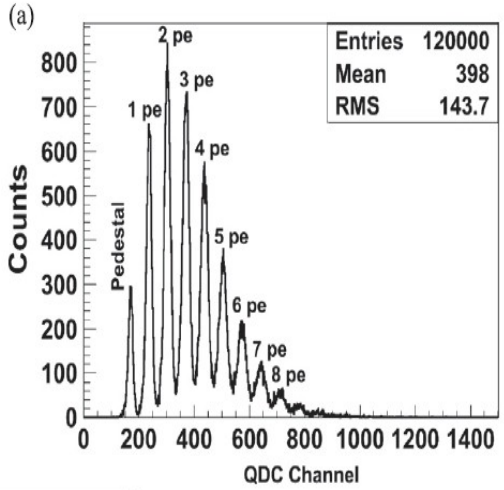
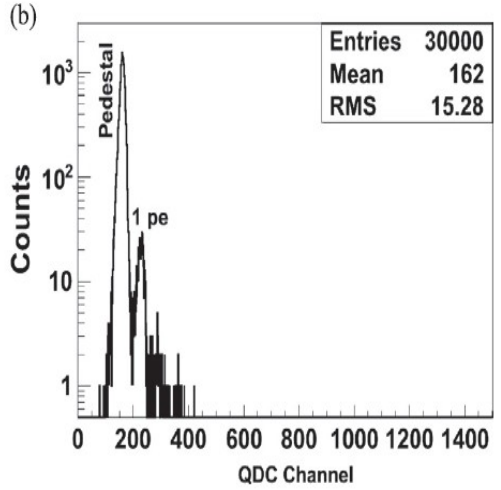
ABSTRACT

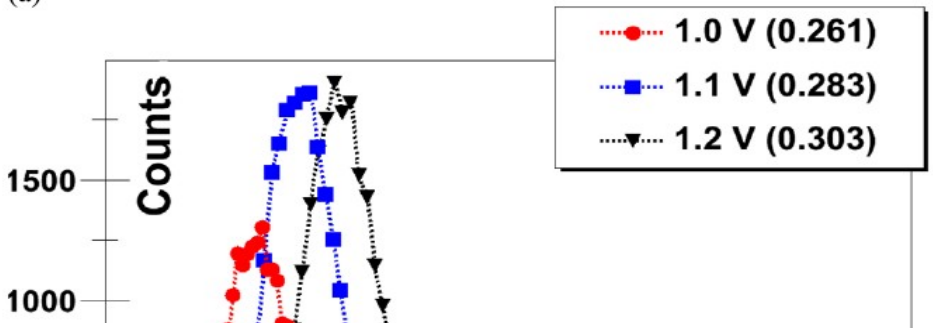
The novel Hamamatsu Multi-Pixel Photon Counter (MPPC) S12045(X) is an array of 16 individual 3×3 mm^2 MPPC devices each with 3600 Geiger-mode Avalanche Photodiode pixels of 50×50 μm^2. Each MPPC in the array operates at a reverse bias of approximately 70 V. This paper summarizes our characterization of MPPC arrays used in the GlueX experiment in Hall D at Thomas Jefferson National Accelerator Facility (Jefferson Lab). We studied the main features of each of the 16 MPPC array channels for 2800 MPPC arrays at several different temperatures. Two measurement stations were built to extract gain, breakdown voltage, photon detection efficiency, optical crosstalk and dark rate for each of the 44 800 MPPC array channels at each temperature setting. The hardware and the data analysis are described, and new analytical expressions for the mean number of photoelectrons and optical crosstalk are presented, as well as systematic trends of the performance parameters.

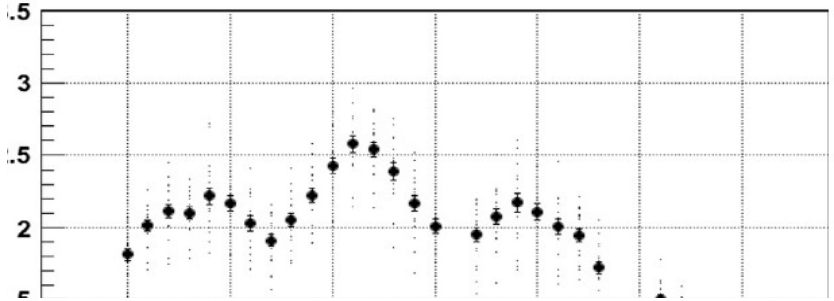


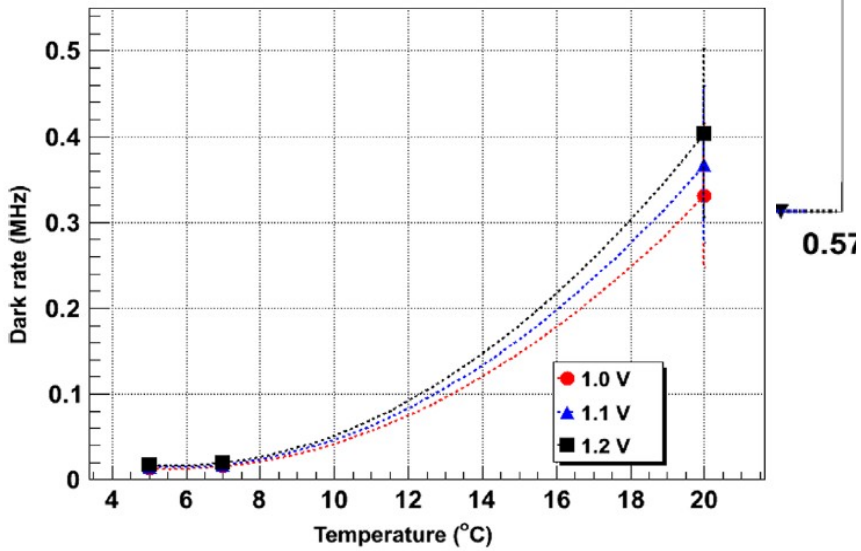
(a)

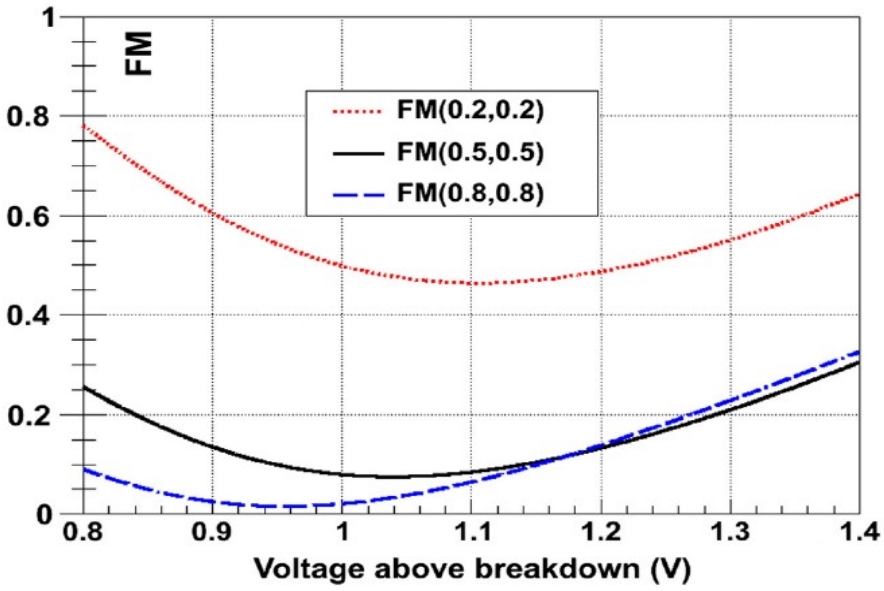

(a)
Entries 120000
Mean 398
RMS 143.7
Pedestal
1 pe
2 pe
3 pe
4 pe
5 pe
6 pe
7 pe
8 pe
Counts
QDC Channel


(b)
Entries 30000
Mean 162
RMS 15.28
Pedestal
1 pe
Counts
QDC Channel


1.0 V (0.261)
1.1 V (0.283)
1.2 V (0.303)
Counts

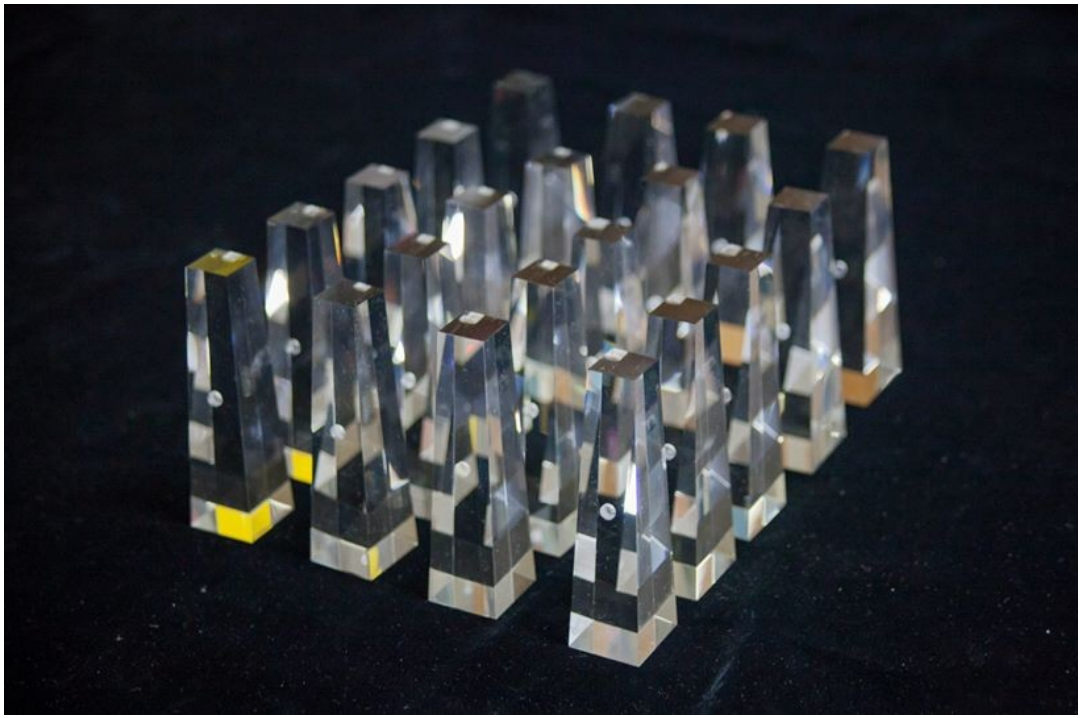



Dark rate (MHz)
Temperature (°C)
1.0 V
1.1 V
1.2 V


FM
FM(0.2,0.2)
FM(0.5,0.5)
FM(0.8,0.8)
Voltage above breakdown (V)

Light-Guide Fabrication

- 4,000 light guides were fabricated in our laboratories for the Glue-X experiment at Jefferson Lab.



Jefferson Lab
Thomas Jefferson National Accelerator Facility

3 Stages of Production

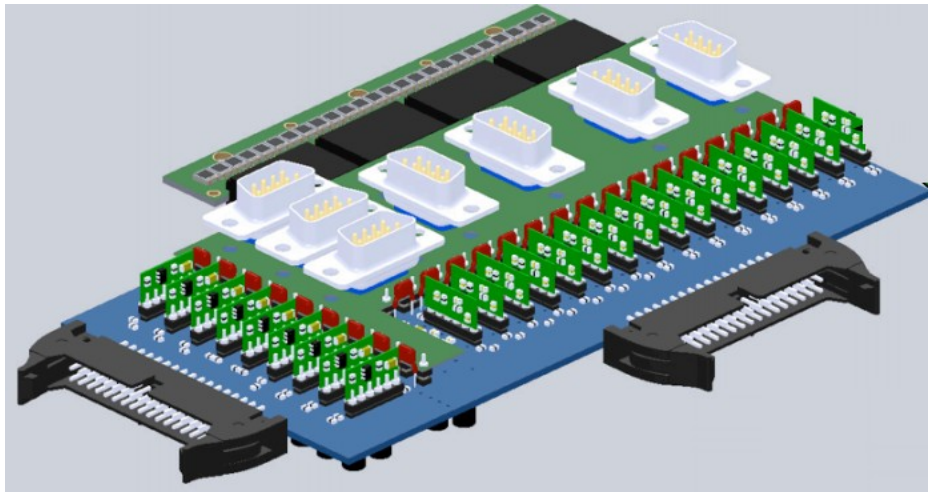
STAGE I

STAGE II
Polishin

STAGE III
Quality Control

Pre-shower detector for forward electromagnetic calorimeters

- This project addresses the need for distinguishing neutral pions from other particles using a crystal-based electromagnetic preshower detector.



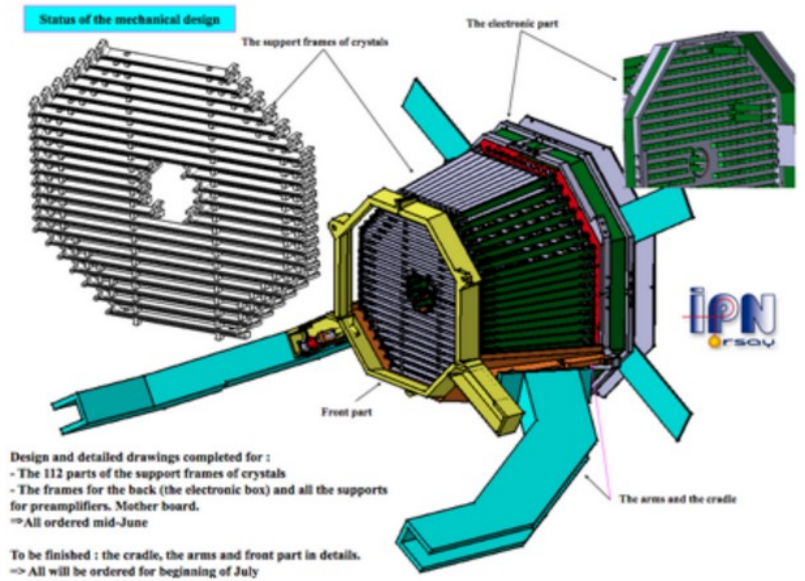
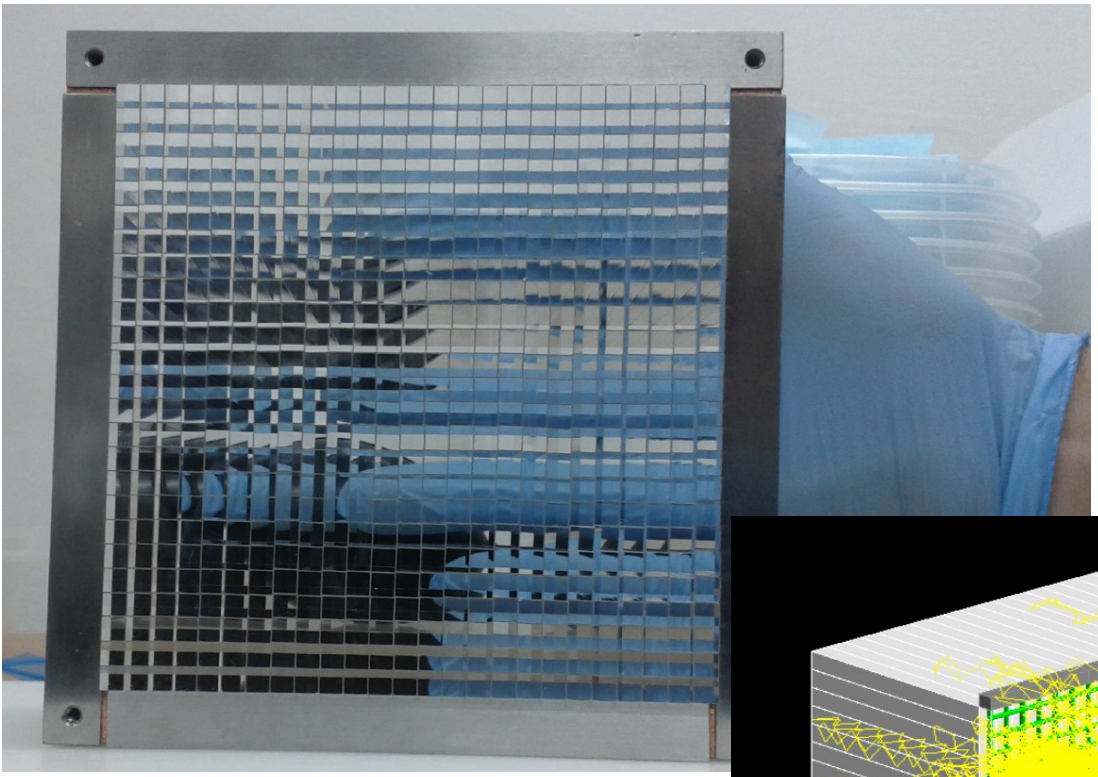
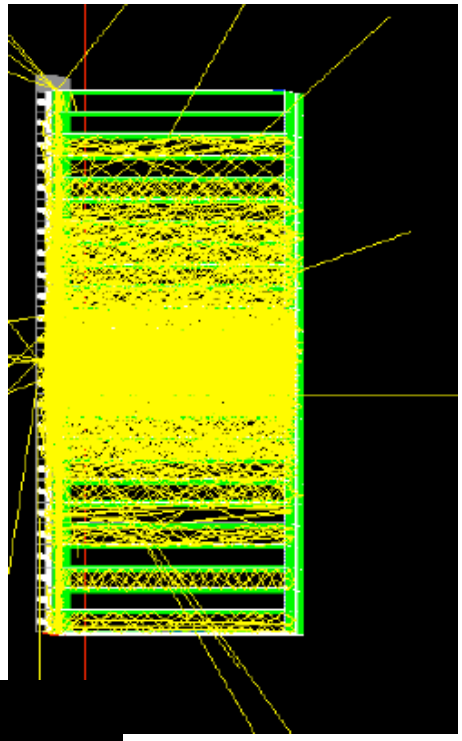
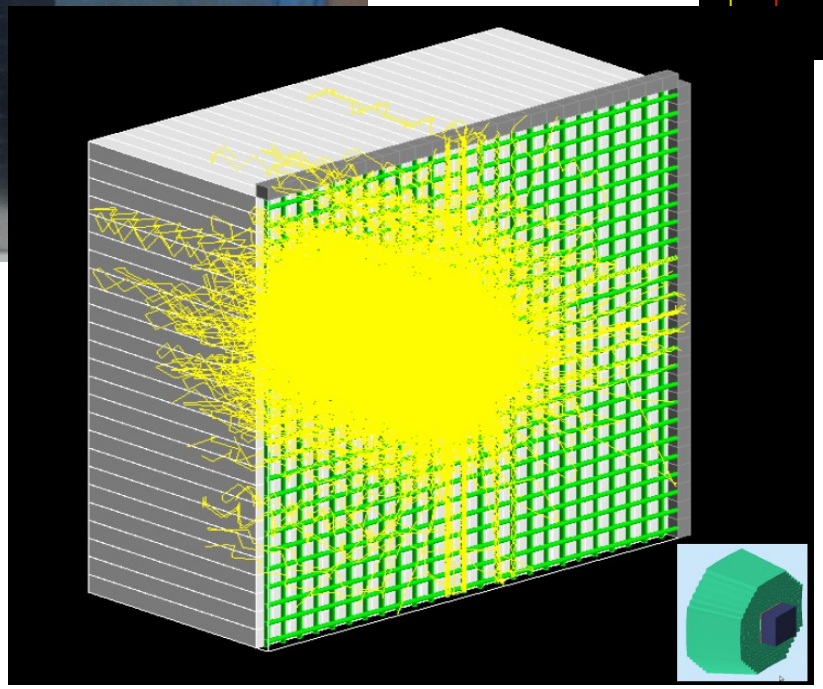


Figure 2. A three-dimensional view of the CLAS Inner Calorimeter (IC).

Preshower for EIC

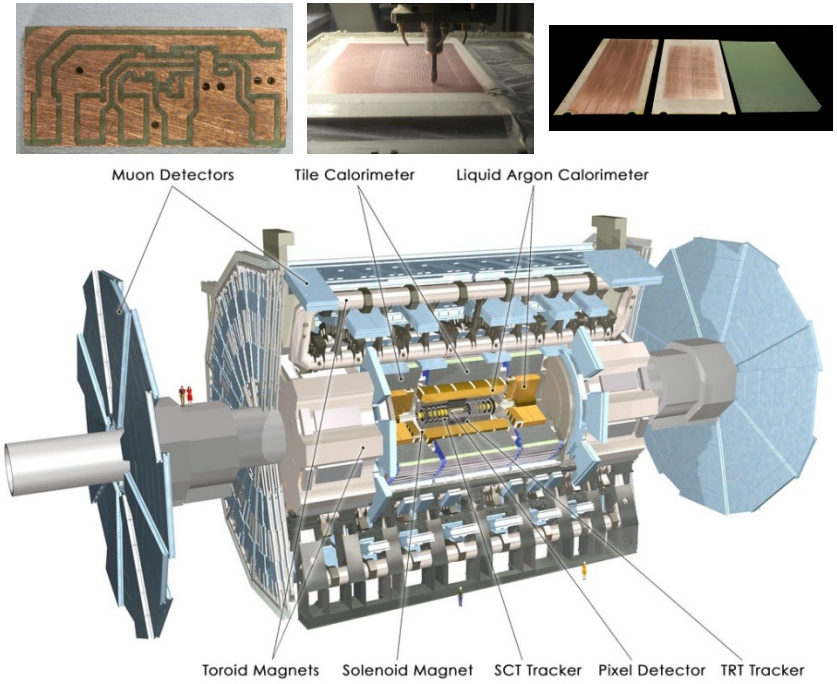




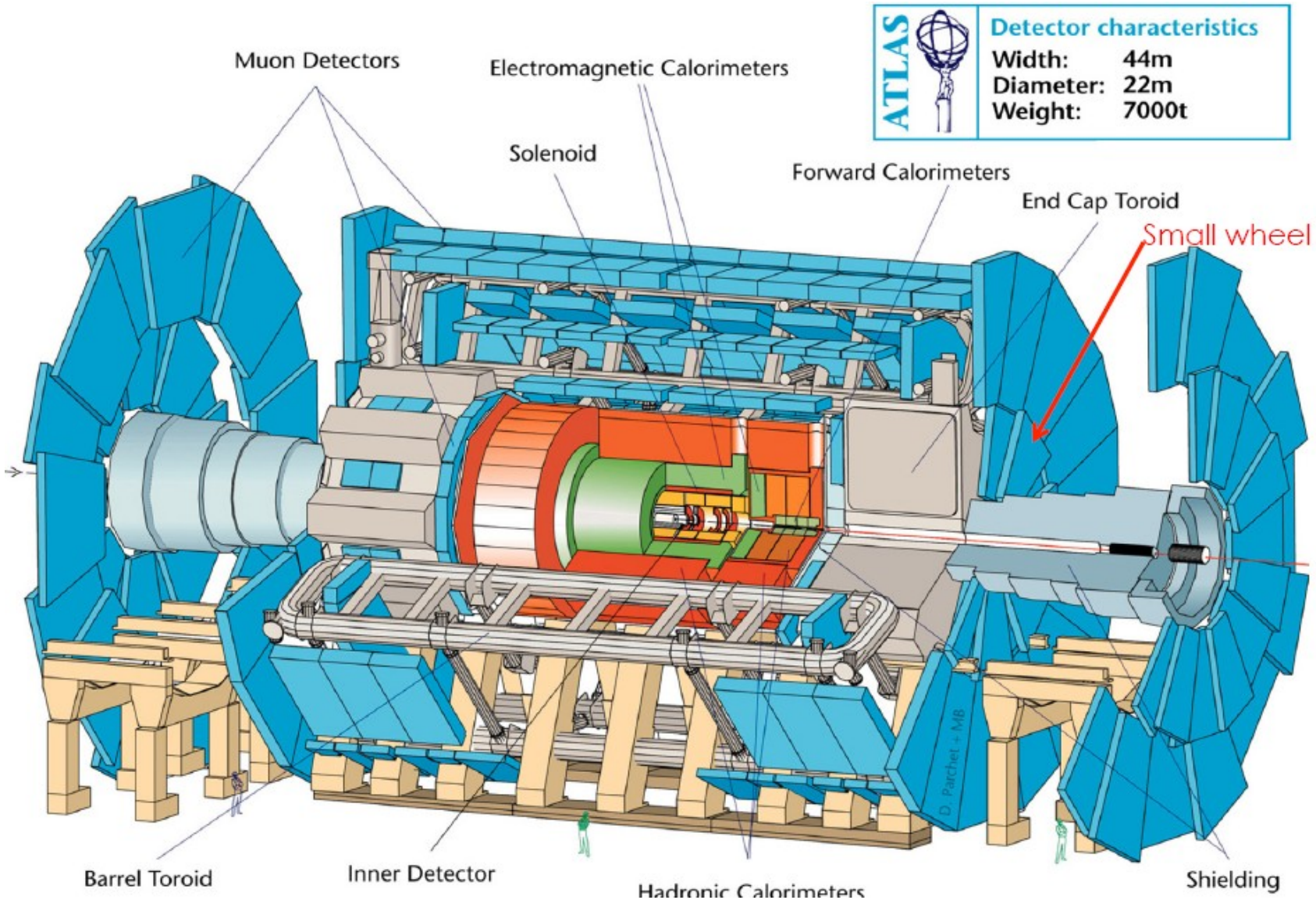


ATLAS Upgrade

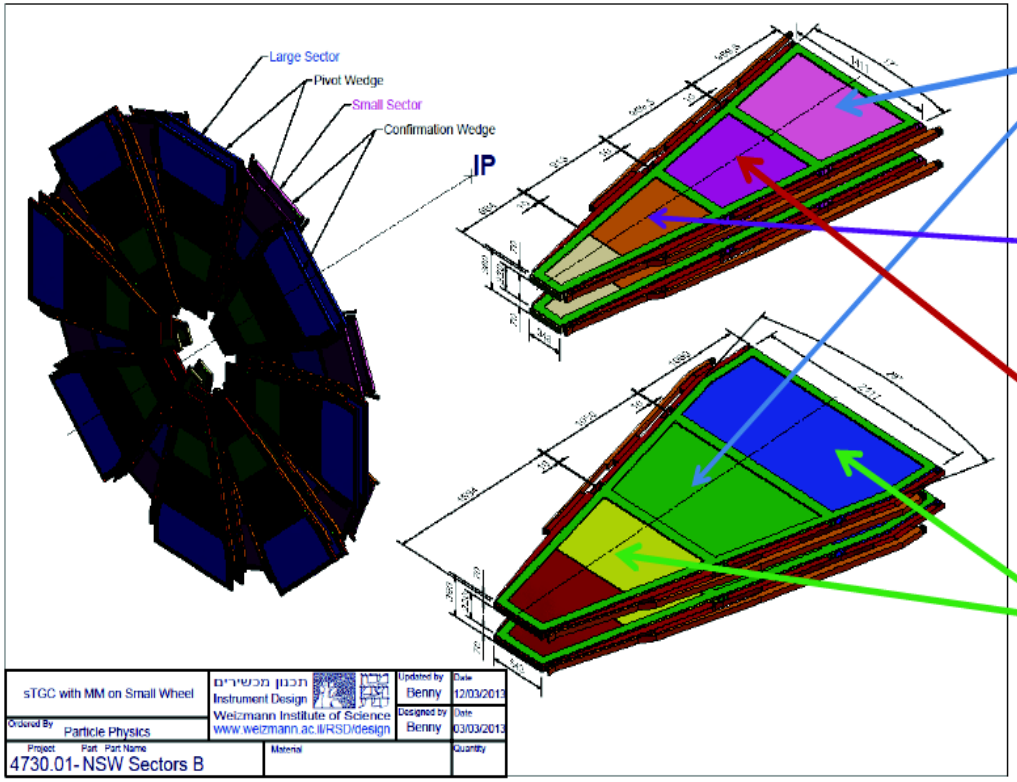
- In the year 2012, operations at the Large Hadron Collider (LHC), where Atlas, the largest particle detector is installed, came to a halt so that improvements could be made to increment it's power (from 8 to 14 Teraelectron Volts).



Muon detector for ATLAS



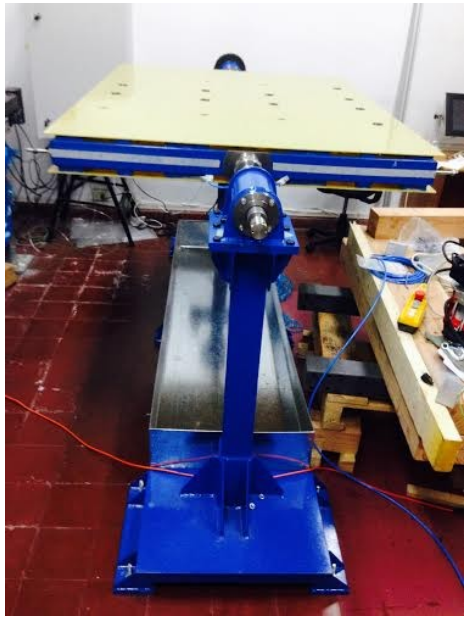
Fabrication of 140 “small wheels” for ATLAS

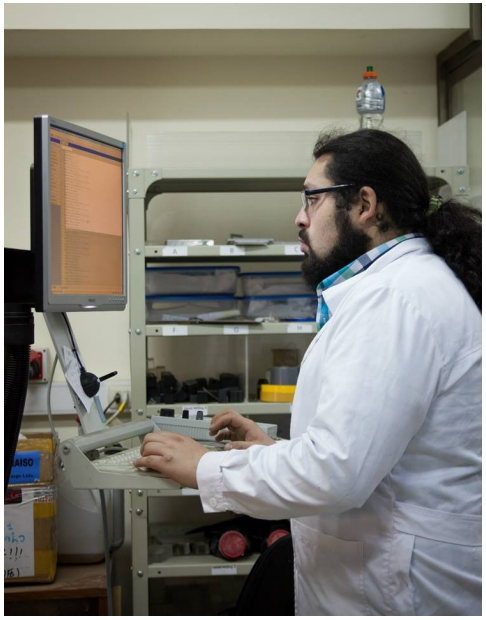


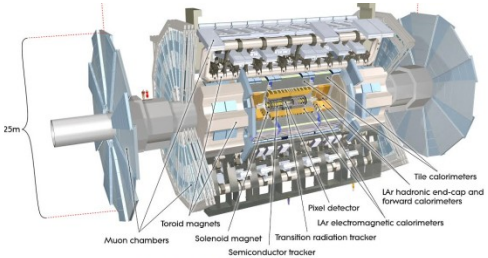
- **Canada**
  64 quadruplets +
  6 spares
- **Chile**
  32 quadruplets +
  3 spares
- **China**
  32 quadruplets +
  3 spares
- **Israel**
  64 quadruplets +
  6 spares

ATLAS Upgrade, Small-Strip Thin Gap Chambers(sTGC)Replacement

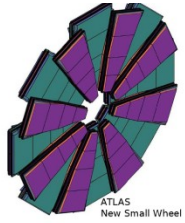
- CCTVal is collaborating with this upgrade by providing 140 small-strip Thin Gap Chambers (sTGC), which can detect muons with high precision.



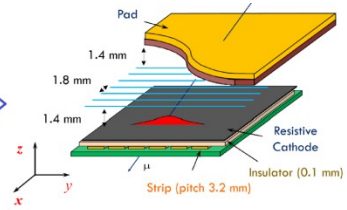




The ATLAS Detector



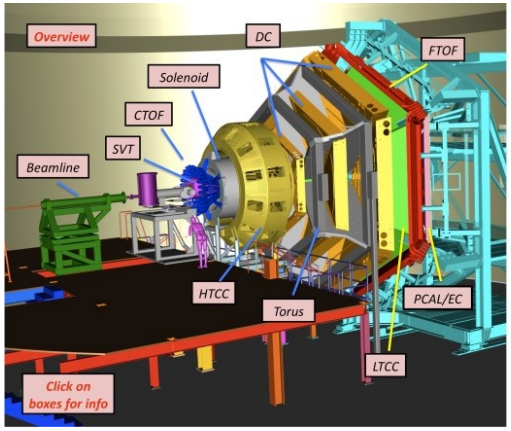
New Small Wheel

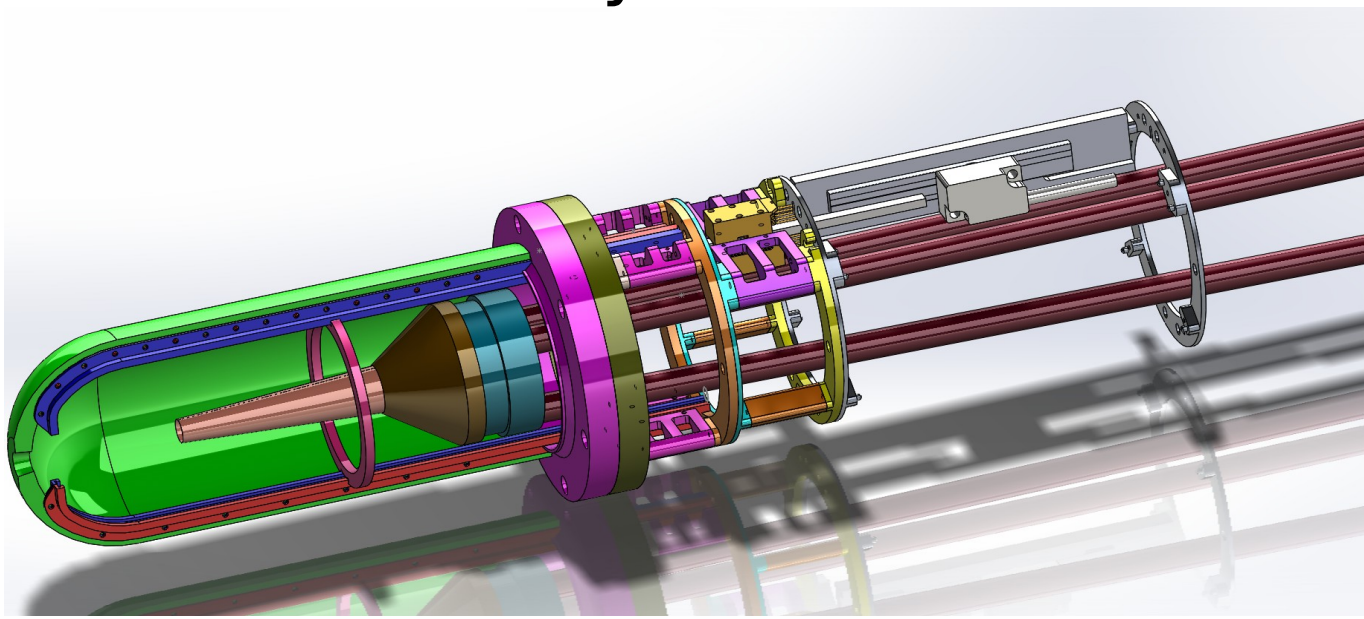


Thin Gap Chamber (TGC)

EG2 Target Fabrication

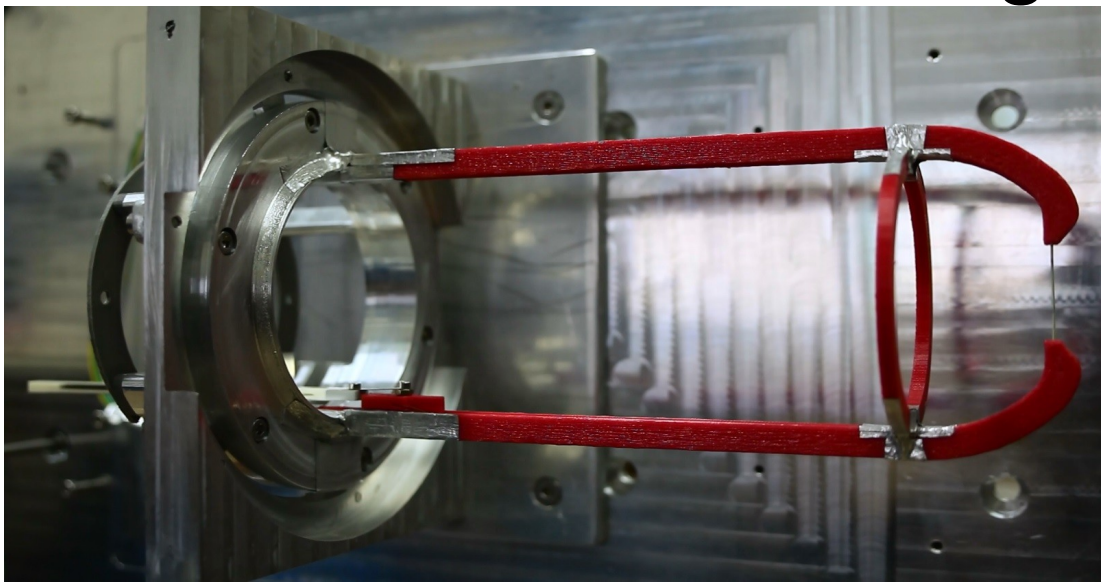
- This project consists in designing and fabricating a new double target for the CLAS12 Detector at the Thomas Jefferson National Accelerator Facility.

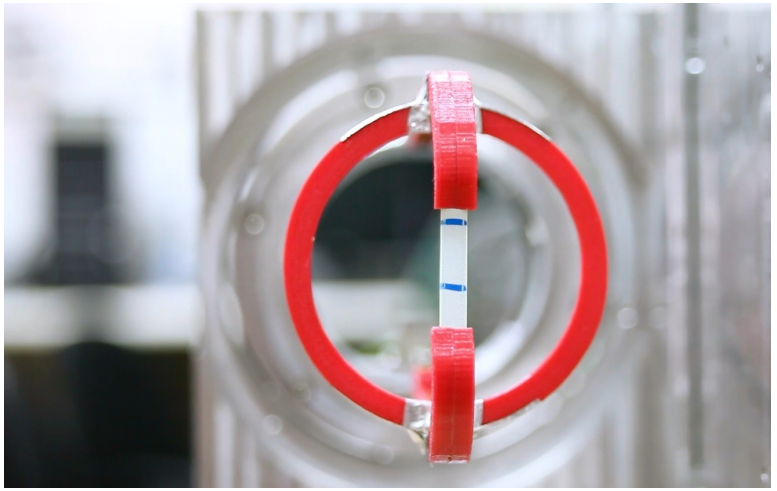


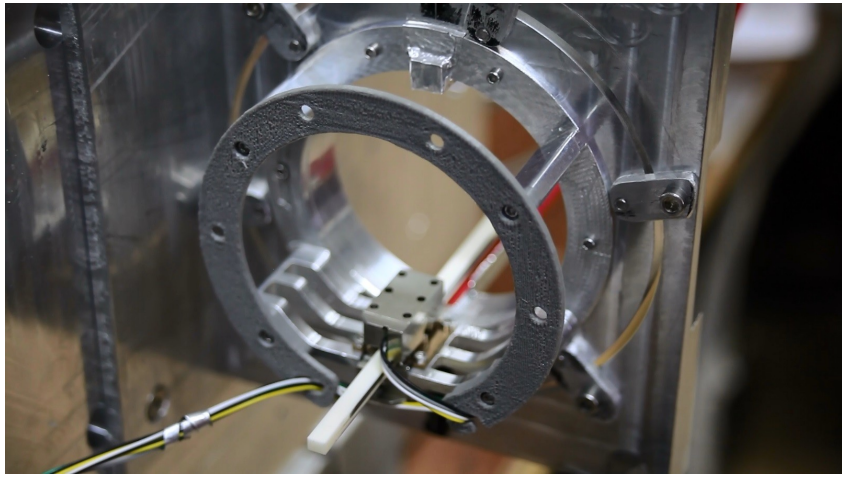


Solid Target

1:1 working model

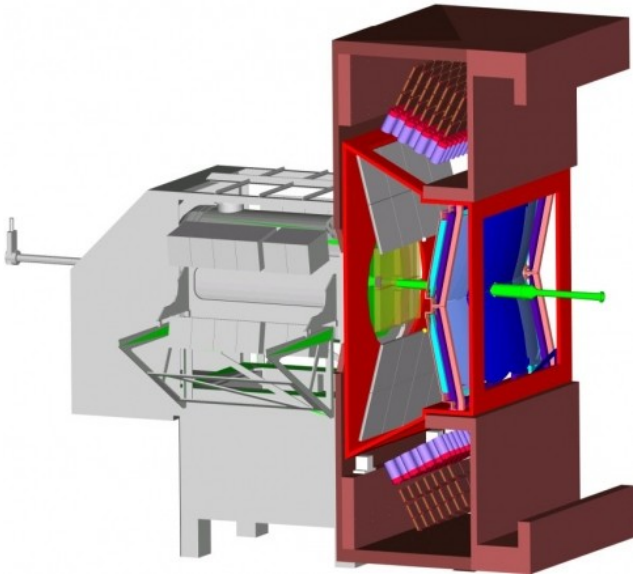


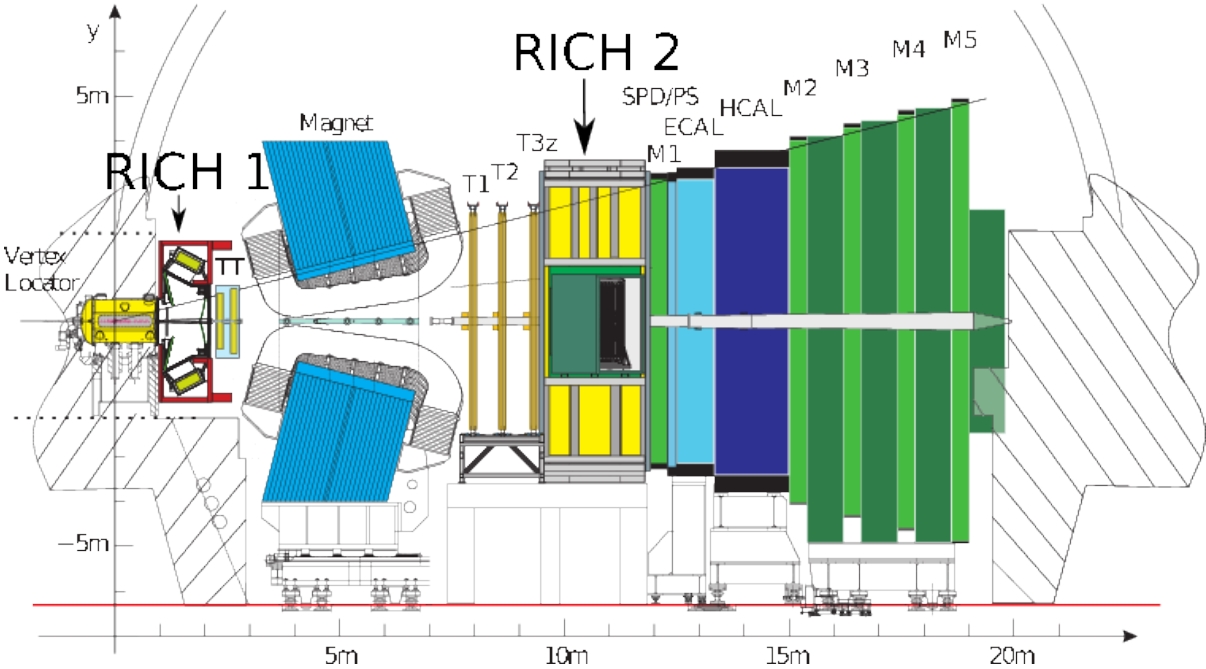




Mirror Fabrication

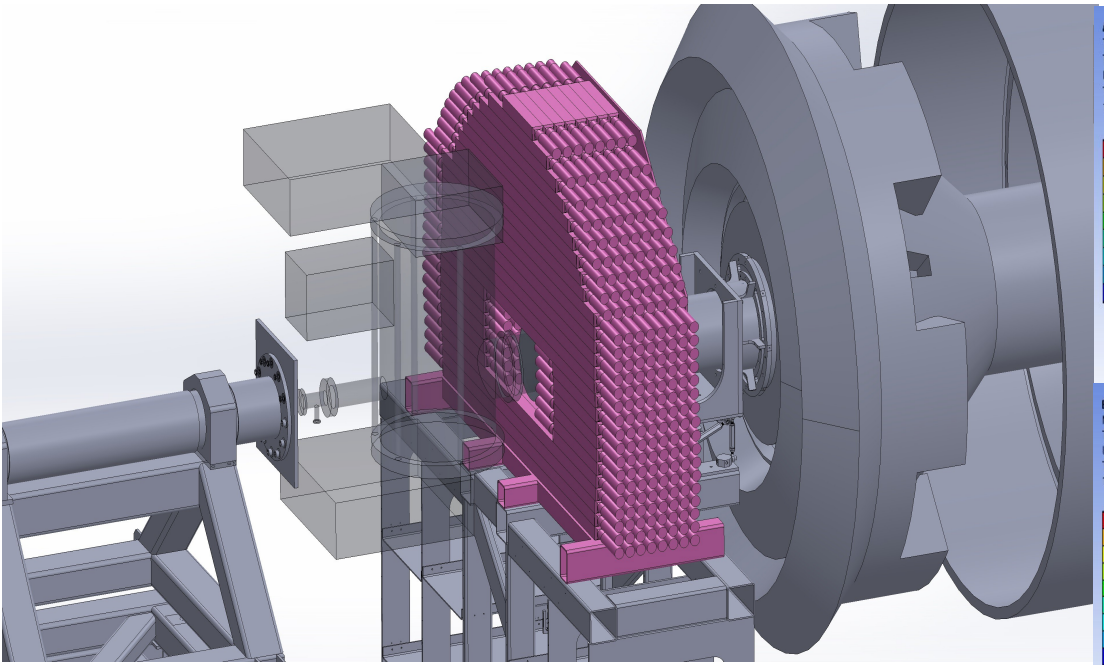
- We are currently working on determining the technological parameters for the design and fabrication of an ultra-light mirror for the RICH particle detector for CLAS12 at Jlab.

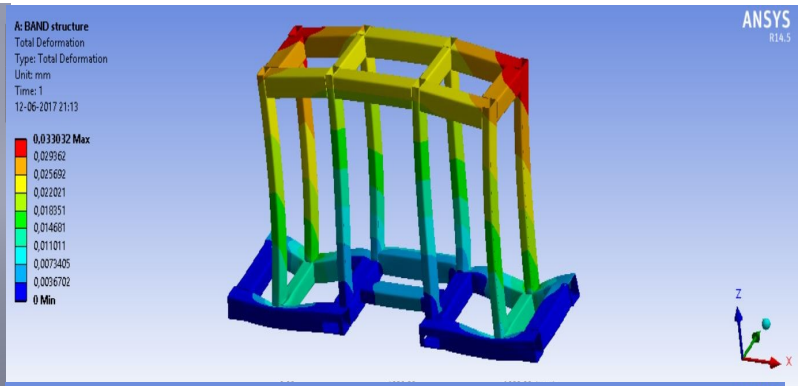


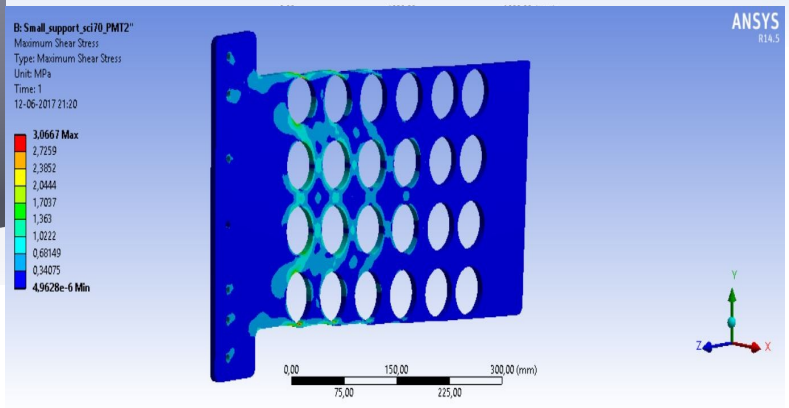


BAND (Back Angle Neutron Detector)

with Iñaki Vega, Milan Ungerer, William Brooks & collegues from ODU, TAU y MIT

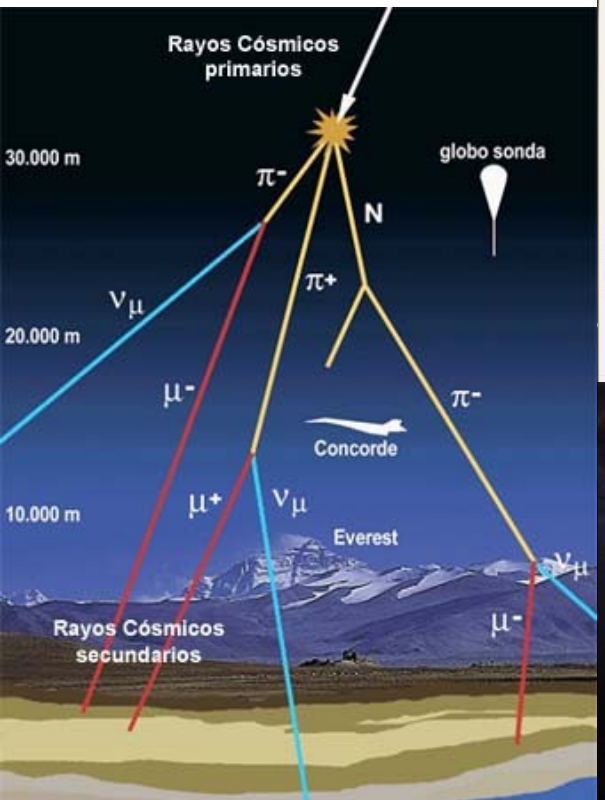


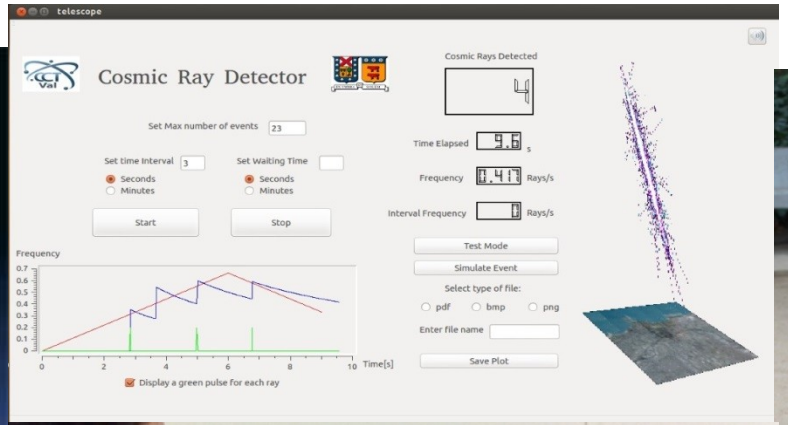


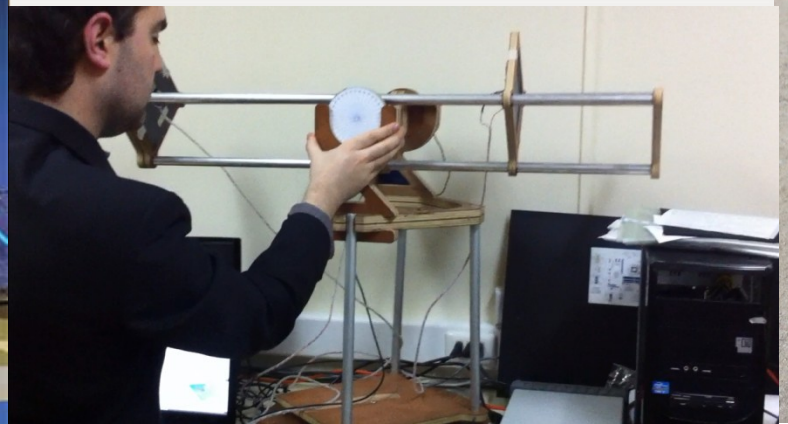


Cosmic Ray Telescope

- CCTVal designed and fabricated a Cosmic Ray detector that will be used by school students of the region as a way to promote physics and science.



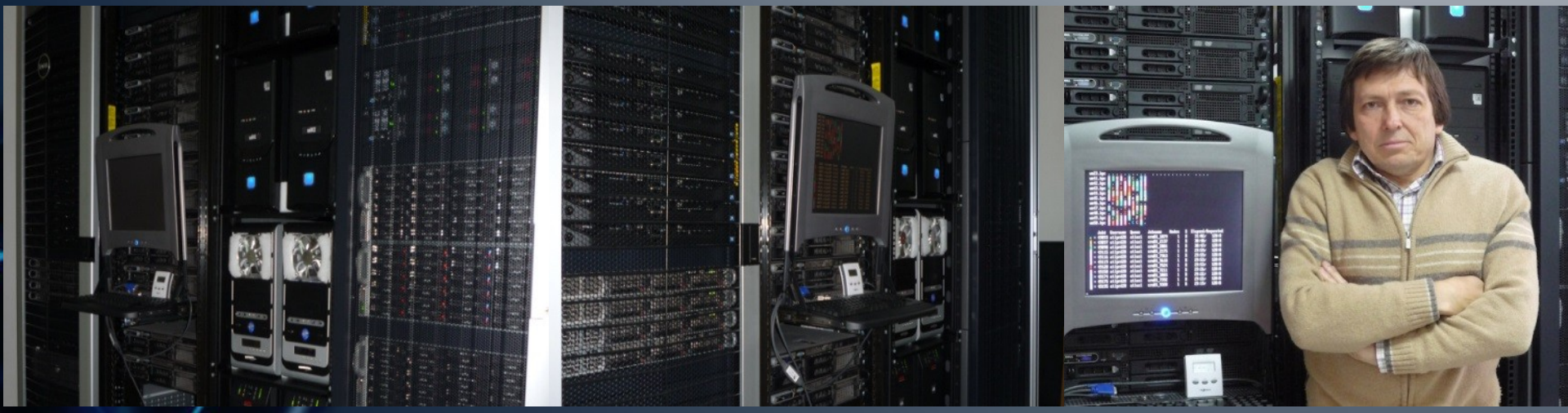




HPC Data Center

The High performance Computing Data center contains the computational farm of CCTVal. It serves four main purposes:

- Executing specialized programs in physics and engineering (data analysis, particle reaction simulation, etc).
- Develop applications in high performance computing.
- Serve as a node for experiment calculations made in CERN (LHC and ATLAS).
- Provide a network infrastructure and cluster operation (security, “batch “ system, “grid” services, etc).



HPC Data Center Equipment

Currently the lab has the following equipment:

HPC CPU: 24 work nodes(448 CPU cores)
16 nodes x 16 CPU cores 2.80 GHz
8 nodes x 24 CPU cores 3.06 GHz
HPC GPU: 4 work nodes (80 CPU cores, 2752 GPU cores)
2 nodes x 16 CPU cores 2.27 GHz, 480 GPU cores 0.80 GHz (2 x nVidia Tesla C1060)
2 nodes x 24 CPU cores 2.67 GHz, 896 CPU cores 1.15 GHz (2 x nVidia Tesla M2050)
HPC service servers(80 CPU cores)
10 nodes x 4 CPU cores 1.60 GHz
2 node x 2 CPU cores 2.66 GHz
2 nodes x 4 CPU cores 2.33 GHz
6 nodes x 4 CPU cores 3.07 GHz
1 nodes x 4 CPU cores 3.30 GHz

HPC storage

-Grid Storage (200 TB):
head 20 TB (30 TB raw disk)
pool 1 60 TB (72 TB raw disk)
pool 2 60 TB (72 TB raw disk)
pool 3 60 TB (72 TB raw disk)
-Local Storage (54 TB):
pool 1 40 TB (48 TB raw disk)
pool 2 8 TB (12 TB raw disk)
pool 3 8 TB (12 TB raw disk)

In the field
WITH RESEARCH & EDUCATION NETWORKS

https://www.inthefieldstories.net/

https://www.inthefieldstories.net/chile-and-cern-communicating-closely/

"Even if you are a researcher living in the most southern country in the world, you can still be an important participant in groundbreaking global research. As an example, the Science and Technology Center of Valparaíso (CCTVal) based at the Technical University Federico Santa María (UTFSM) in Chile is part of international initiatives of great importance such as the ATLAS project at CERN in Switzerland. In addition, the Center collaborates with world-class centers such as NASA, the Jefferson Laboratory and the Brookhaven National Laboratory in the US."...

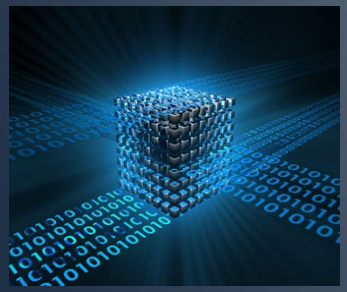
Published yesterday

NAIADS project

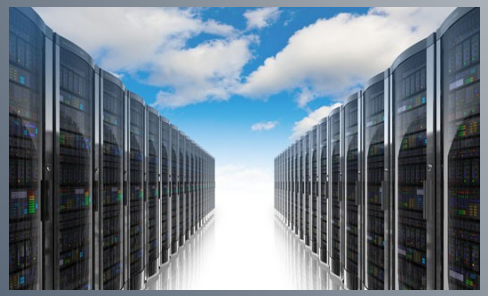
(collaboration between UTFSM-Jlab-NASA)

CLARA Is a distributed data flow processing tool.

Inicially developed for CLAS12 data reconstruction in Jlab, found its Implimentation in **NASA space satelital observation program**.



Agile data processing



Horizontal and vertical scalabilityl

Operational elasticity

Productivity and maintenance

https://claraweb.jlab.org/clara/

More information?

www.cctval.cl

Thank you for Attention!