

Experimental Physics Division

<http://epd.yerphi.am/EPD.htm>

- Yerevan Physics Institute had an electron synchrotron (ARUS) with energy of up to 6 GeV, which was put in operation in 1967.
- During 1968-1991 years the Yerevan synchrotron operated productively and many scientific results have been obtained in the energies range up to 4,5 GeV
- Since 1991 because of an economic crisis in Armenia the accelerator has been stopped. However, its maintenance continues till now and short- time experiments are periodically performed.

The YerPhI experimental physics program includes following researches: study of

- properties and structure of baryons (nucleons and nucleon resonances)
- few nucleon systems properties
- excited nuclear systems properties
- nuclear matter in short distance
- electron interaction with crystals and methodical studies
- material science



Brief History

➤ LUE – 75 (Electron Linear Accelerator Facility)



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➤ Cyclotron C18/18

General view of CYCLONE C18/18



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➤ Underground Laboratory (Avan salt mine)

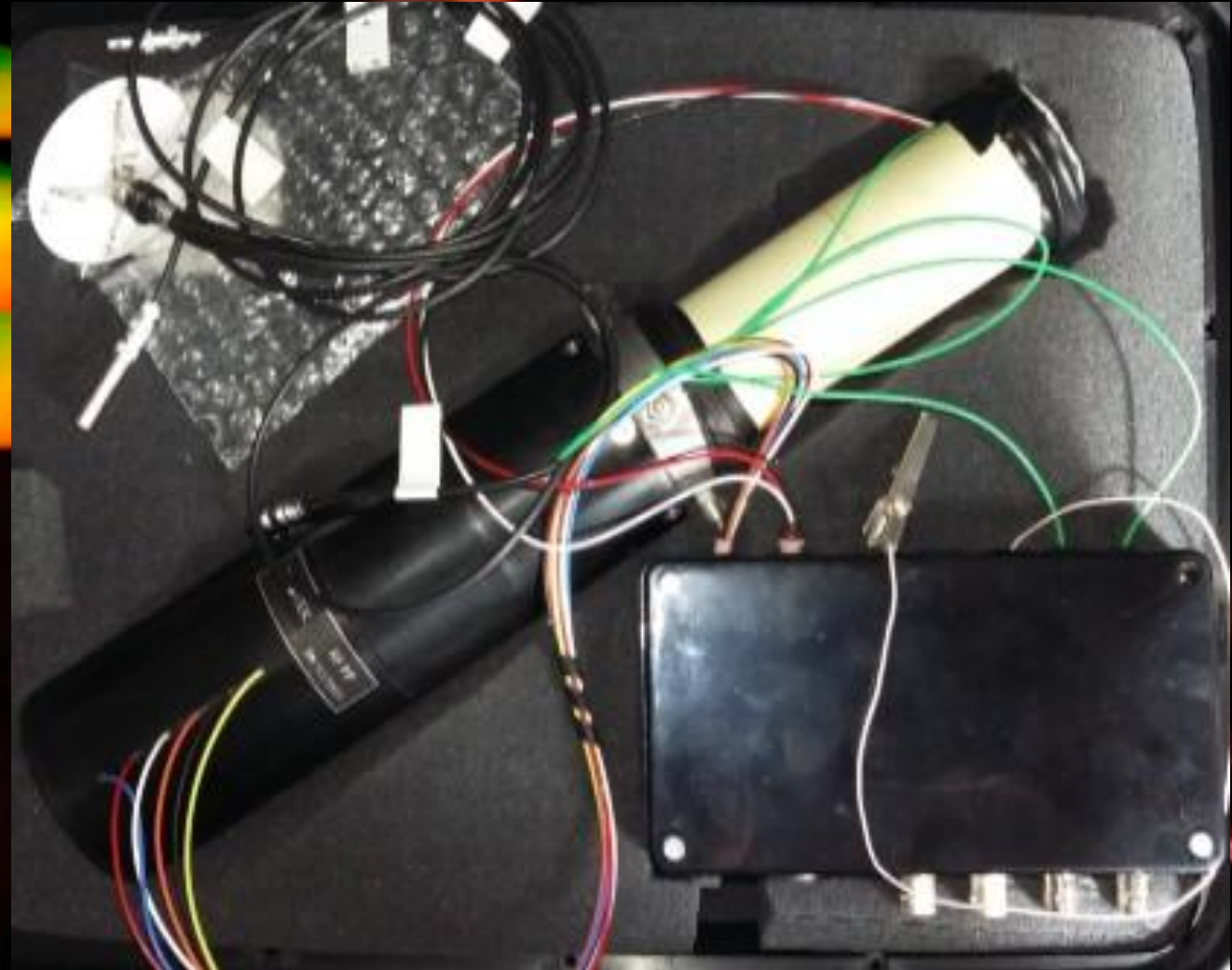


➤ **LUE – 75** (Electron Linear Accelerator Facility)

➤ **Cyclotron C18/18**

➤ **Underground Laboratory** (Avan salt mine)

➤ **ELI – NP** (Extreme Light Infrastructure – Nuclear Physics)



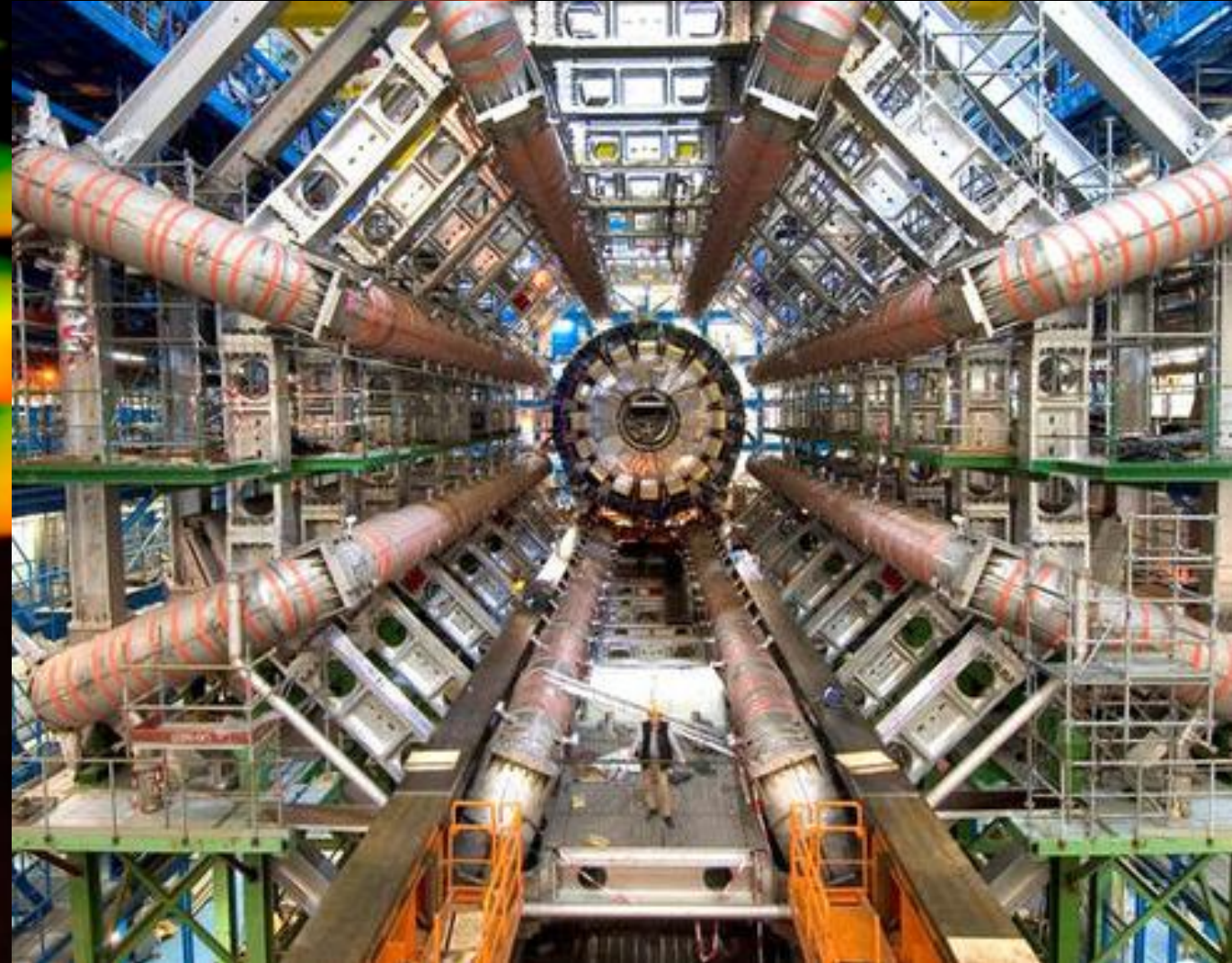
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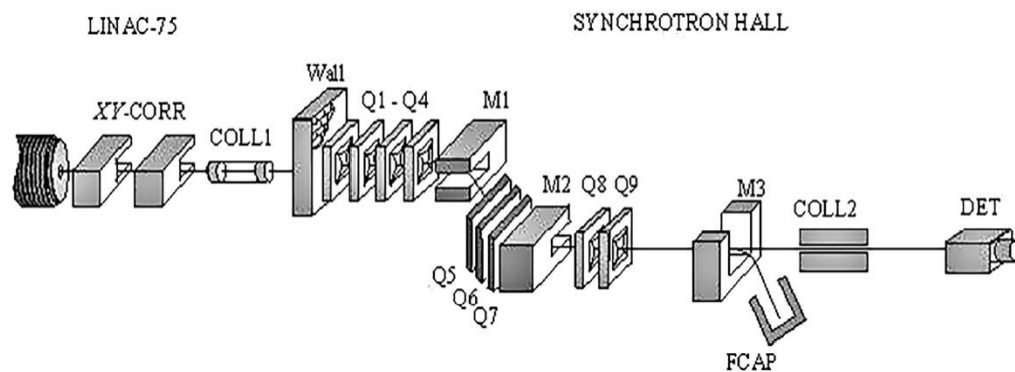
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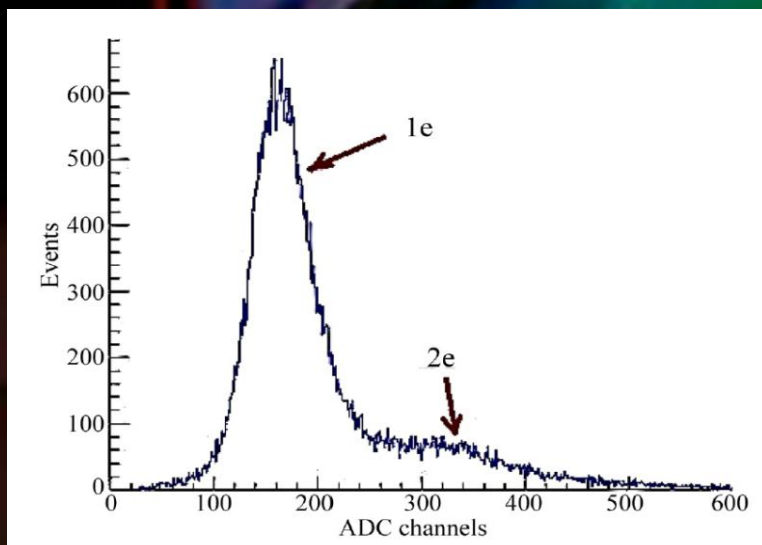
➤ HESS, CTA



LUE - 75

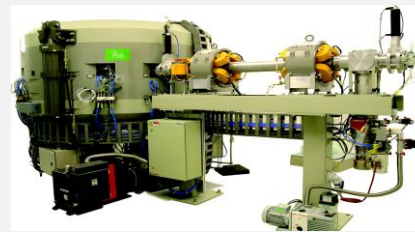


- ❑ LUE-75 provides electrons with energy 10-75 MeV in the large limits of beam currents 10^{-18} - 10^{-5} A
- ❑ Assembly of 3x3 CsI crystals for the calorimeter foreseen for Mu2e experiment were successfully calibrated (Dubna - AANL collaboration).



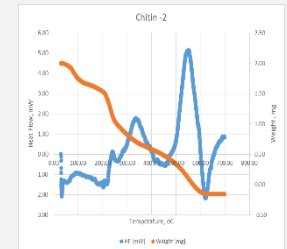
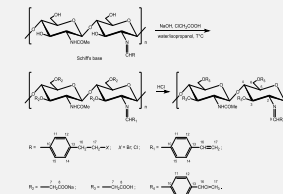
Cyclotron C18/18

- ❑ Study of excitation functions
- ❑ ICR measurements
- ❑ Neutron beam formation on Cyclotron C18: study of astrophysical reactions, radiation resistance of materials.



Material Science

- ❑ Synthesis and characterization of new carboxymethylated chitosan (application particularly in radiation medicine).



Radio-Frequency Photo Multiplier Tube

LPMWPC – low background, high time resolution (~450 ps), high coordinate resolution (~1mm) highly efficient non-destructing nuclear fragment detector. To be used for:

- ❑ Studying Hole-like states 15.1 MeV in ^{16}O in Yerevan Cyclotron and ELI-NP facility;
- ❑ Measure $^{16}\text{O}(\gamma, \alpha)^{12}\text{C}$ cross section at HIγS with a LPMWPC based Active Target;
- ❑ Studying decay pion spectroscopy of light hypernuclei at electron- and proton-beam facilities

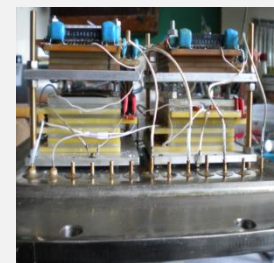


Demountable version

Low Pressure Multi-Wire Proportional Chambers

RF PMT – picosecond resolution timing detector with THz bandwidth
Applications include:

- ❑ High Energy Physics (bunch length detection, TOF measurements, particle ID)
- ❑ Medical Imaging (PET, DOT, Fluorescence Lifetime Imaging)



About the Laboratory

The laboratory is placed in the Avan salt mine, which is located in precincts of Yerevan, at the depth of 650 m w.e. (meters of water equivalent). The low-background conditions allow to investigate rare processes and could be used for fundamental, as well as for applied tasks. The fig.1 demonstrates the low-background conditions in our laboratory.

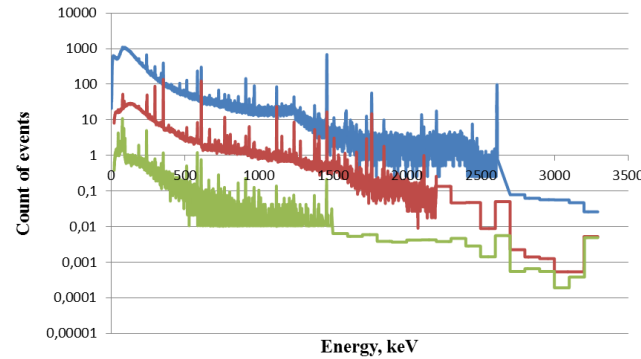


Fig. 1. Number of background events per hour in the detector without shielding on the ground (a) and in the underground laboratory (b), respectively, and (c) in the detector with the shielding in the underground laboratory.

Future plans:

- Search for rare modes of ^{252}Cf nuclei fission :
 - ✓ Measurement of the yields of short-living ($T_{1/2} < 1 \text{ min}$) isotopes
 - ✓ Measurement of the yields of long-living isotopes
 - ✓ Measurement of the yields of a number of fission products with $88 \leq A \leq 158$
 - ✓ Measurement of isomeric ratios
 - ✓ Search for cluster radioactivity
 - ✓ Search for the ternary fission
- Investigation of photonuclear reactions on LINAC.
- Nuclear astrophysics tasks:
 - a) Investigation of (p, γ) and (p,n) reaction in ROI of astrophysics
 - b) Supernova “archeology”
- Investigation of (p, α) reactions
- High energy (>150 GeV) cosmic muons monitoring
- R&D for searching for Dark Matter
- Applied tasks: dating of archaeological samples, earthquake forecast, ecological tasks.



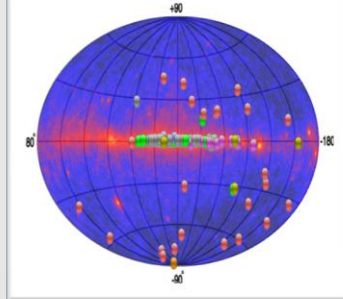
Very High Energy Gamma-Ray Astrophysics with H.E.S.S.



H.E.S.S. is a system of Imaging Atmospheric Cherenkov Telescopes that investigates cosmic gamma rays in the energy range from 10s of GeV to 10s of TeV.

TeVcat sky map of H.E.S.S.-discovered gamma ray sources, as of April 2019 (111 from total 222).

S collaboration



H.E.S.S. observatory is located in Namibia, near the Gamsberg mountain, and consist of 5 telescopes. First 4 telescopes (Phase I) were operational since 2004 and 5 telescopes (Phase II) – since 2012.

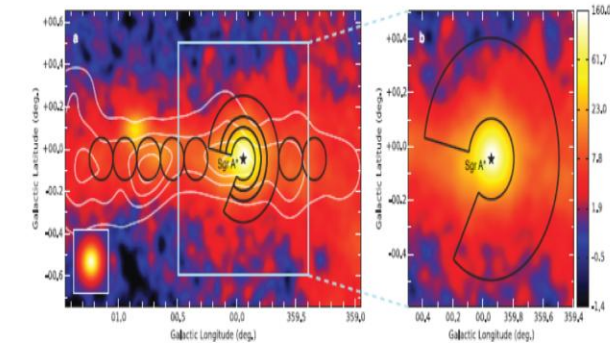


Figure 1: VHE γ -ray image of the Galactic Centre region. The colour scale indicates counts per $0.02^\circ \times 0.02^\circ$ pixel. *Left panel:* The black lines outline the regions used to calculate the CR energy density throughout the central molecular zone. A section of 66° is excluded from the annuli (see Methods). White contour lines indicate the density distribution of molecular gas, as traced by its CS line emission⁴⁰. The inset shows the simulation of a point-like source. *Right panel:* Zoomed view of the inner ~ 70 pc and the contour of the region used to extract the spectrum of the diffuse emission.

“Acceleration of petaelectronvolt protons in the Galactic Centre”, H.E.S.S. collaboration, A. Abramowski, F. Aharonian, F. Ait Benkhali et al. Nature, 531, 2016, pp. 476-479.

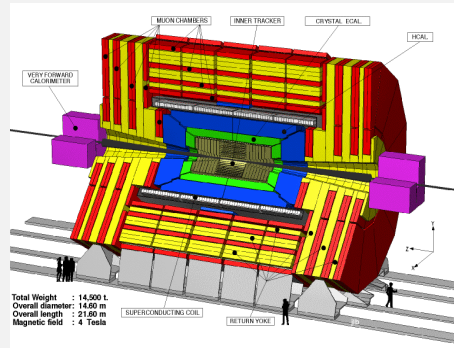


AANL in CMS (LHC)



General activity:

- MC simulations / Data analysis
- Calibration (hadron calorimeter, CASTOR)
- Jet energy scale calibration
- Detector performance / control system
- Data quality / certification
- CMS upgrade
- Triggers
- DiMuon analysis
- Diffractive processes



Total Weight : 14,500 t.
Overall diameter : 14.60 m
Overall length : 21.60 m
Magnetic field : 4 Tesla

Main ongoing physical analysis:

- $H \rightarrow bb$ decay search in Vector boson fusion (VBF) Higgs production process.

Summary:

- Over 700 collaboration papers
- Over 20 non collaboration papers
- 2 PhD thesis
- Over 10 master and bachelor degree thesis.



AANL-ATLAS team activities



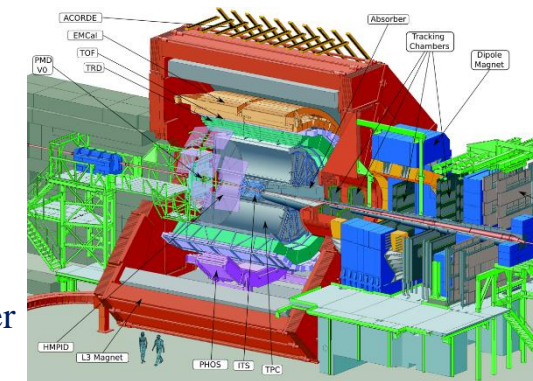
- Simulation and analysis of physics data for validation of the ATLAS TileCal Phase-II upgrade
- Maintenance, development and testing of the TileCal front-end electronics
- Development of the offline system to Monitor DCS and DQ data for the Phase II upgrade
- ATLAS NSW (New Small Whell) upgrade
- Trigger Data Acquisition System. Detector Operations.



AANL-ALICE Collaboration

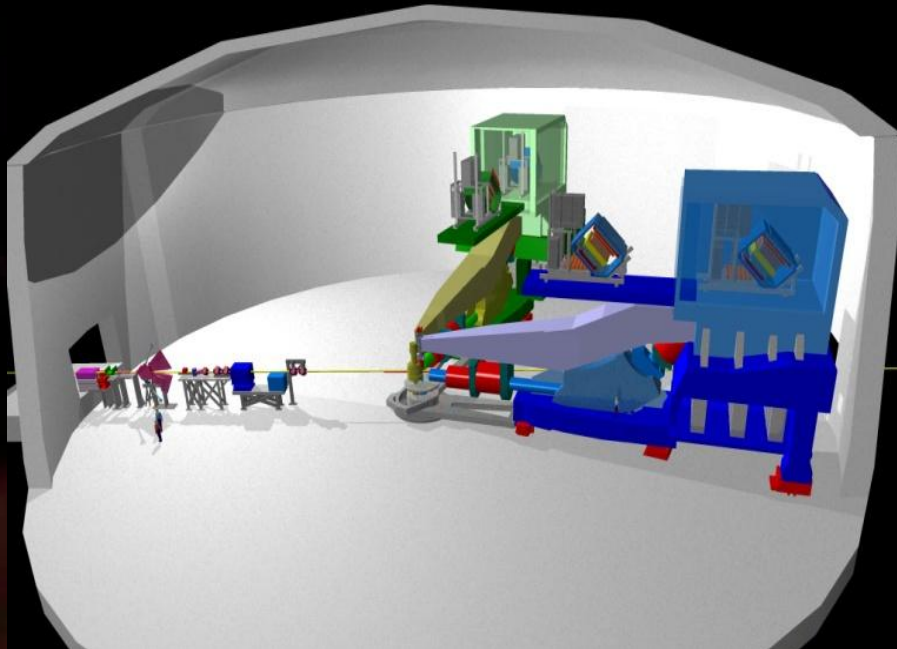


- Design, R&D study, construction and installation of the elements for ALICE setup
- Developments and upgrades for the computing environment of ALICE
- Design, simulation studies, R&D, construction and installation of Geometry Monitoring System (GMS) for ALICE Dimuon Forward Spectrometer
- Data analysis.



Experimental Hall-A

High Resolution Spectrometer Pair, (HRS) and specialized large installation experiments



- Real Compton Scattering
- Measurement of Neutron Electric Form Factor GEN at High Q²
- Polarization transfer in Wide Angle Compton Scattering

➤ 12 GeV upgrade

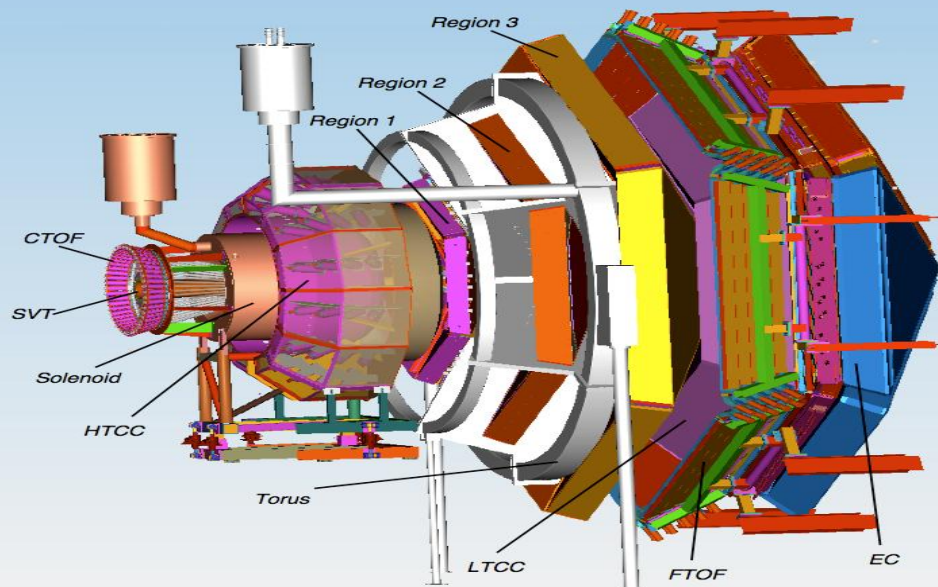
- Super BigBite Spectrometer
- GEP5 - Large Acceptance Proton Form Factor Ratio Measurements at 13 and 15 (GeV/c)² using Recoil Polarization Method GEP
- GMN - Precision Measurement of the Neutron Magnetic Form Factor up to Q²=18.0 (GeV/c)² by the Ratio Method
- Transversity - Target Single-Spin Asymmetries in Semi-Inclusive Pion and Kaon Electroproduction on a Transversity Polarized ³He Target using Super BigBite and BigBite in Hall A
- GEN2 - Measurement of the Neutron Electro – magnetic Form Factor Ratio G_E^n/G_M^n at High Q²

Super Bigbite Spectrometer

- Magnet: 48D48 - 46 cm gap, 2-3 Tesla*m
 - Solid angle is 70 msr at angle 15 deg.
 - GEM chambers with 70 μm resolution
 - momentum resolution is 0.5% for 5 GeV/c
 - angular resolution is 0.5 mr

Experimental Hall-B

*(CEBAF Large Acceptance Spectrometer)
CLAS12 – 4π scattering angle, high
luminosity, large acceptance*



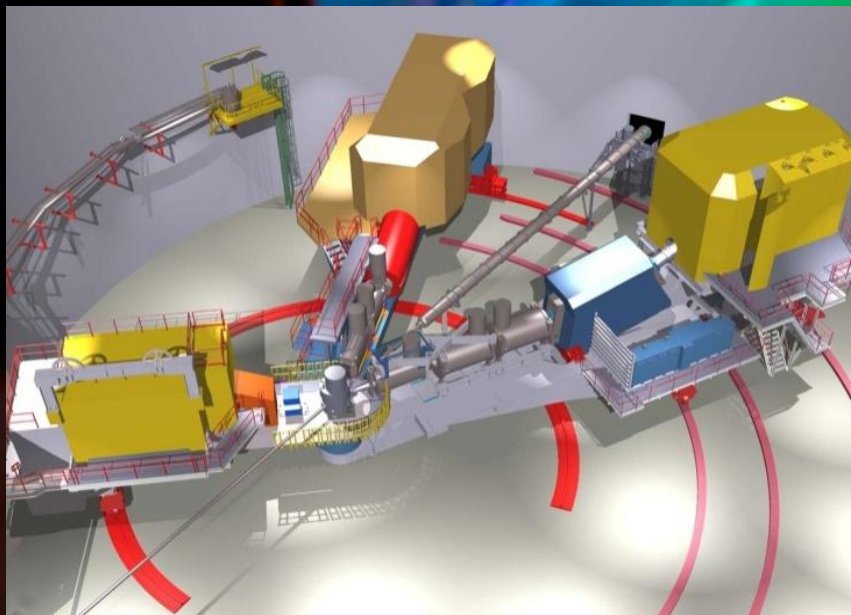
- *NN Short Range Correlations*
- *Deuteron Wave Function*
- *Timeline Compton Scattering*
- *Electromagnetic Calorimeter (EC)
construction*

➤ **12 GeV upgrade**

- *Heavy Photon Search experiment (HPS)*
- *Preshower Calorimeter construction (PCAL)*
- *High Threshold Cherenkov Counter (HTCC)*
- *Slow Control System for HPS*

Experimental Hall-C

*Super High Momentum Spectrometer
(SHMS)
at high luminosity and forward angles*



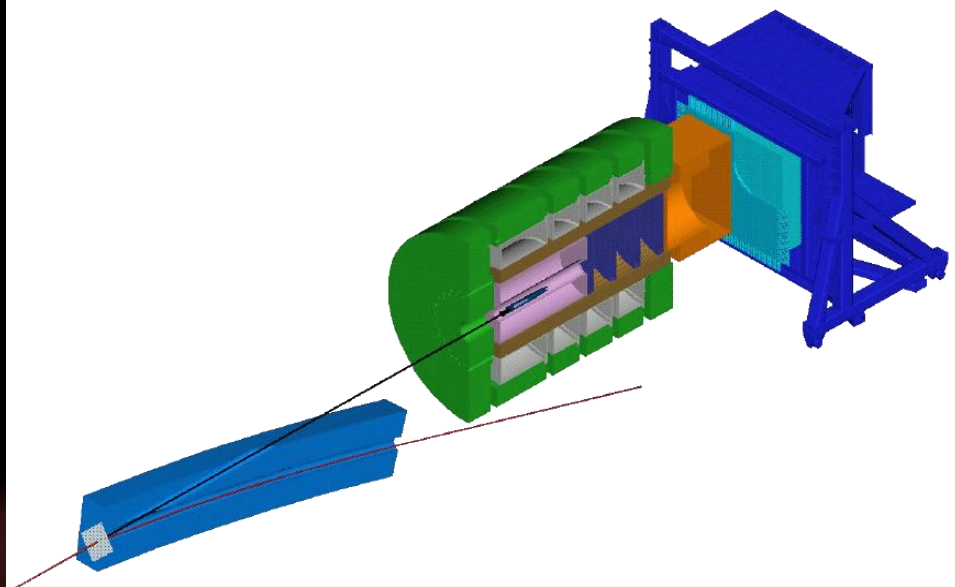
- HMS and SOS electromagnetic calorimeters
- HMS Aerogel detector
- SHMS electromagnetic calorimeter (*SHMS*)
- PMT's gain monitoring system for the calorimeters and Neutron Detector
- Co-spokesperson in "Meson Duality" experiment

➤ 12 GeV upgrade

- Measurement of the Ratio $R = \sigma_L / \sigma_T$ in Semi-Inclusive Deep-Inelastic Scattering
- Transverse Momentum Dependence of Semi-Inclusive Pion Production
- Measurement of Semi-Inclusive π^0 Production as Validation of Factorization

Experimental Hall-D

*9 GeV tagged polarized photons
and a 4π hermetic detector*



12 GeV upgrade

- **GlueX** detector system construction
- Design, development and implementation of controls system within the EPICS framework of the **GlueX** detectors
- Voltage controls of FDC, CDC, TOF, TAGH, TAGM PSC, BCAL, ST, PS detectors
- Motion (motorized) controls of Goniometer, Beam Profiler, Collimator, Compton Calorimeter, TPOL, Amorphous Radiator, Microscope, PS Converter
- Tagger electron harp scan program
- Photon harp scan
- **GlueX** experiment participation