UCLA’s Technical Capabilities and Resources

Vahe Ghazikhanian

UCLA Dept. of Physics & Astronomy
UCLA Team Members

Vahe Ghazikhanian, George J. Igo,
Dylan Thein, Stephen Trentelange,
Charles A. Whitten
Scope of the STAR related Detector R&D at UCLA

- STAR TPC Gating Grid Driver system.
- STAR TPC Pad plane Gain Monitoring system.
- STAR Magnet Mapping.
- PMT testing and characterization.
- Production of PMT high voltage system.
- Production of PMT housing components.
- Shower Maximum Detector Module Production and Testing.
STAR Detector
Brazil: Sao Paolo  
England: Birmingham  
Germany: Frankfurt, MPI - Munich  
U.S.: Argonne, Berkeley, Brookhaven National Laboratories

China: IHEP - Beijing, IPP - Wuhan  
France: IReS - Strasbourg, SUBATECH-Nantes  
Poland: Warsaw University, Warsaw U. of Technology  
Russia: MEPHI - Moscow, JINR - Dubna, IHEP - Protvino

~ 400 collaborators  
34 institutions  
8 countries
PMT Testing/ Characterization

- An automated test system was designed and built to test linearity, dark current, and measure gain as a function of HV (see Figure 1-3).

- Gain, linearity and dark current are measured for each PMT using the PMT test system.

- Data obtained from tests is analyzed, gain vs. HV for each PMT is parameterized, and along with all other characteristics is made available as a database. Quality control procedures are applied (See figures 3-8).
Pmt Test and Characterization Setup

- LED assembly
- Motor Driver
- Variable optical attenuator
- Fiber optic bundle
- PMT with CW base
- RS232-RS485 converter
- Oscilloscope
- Picoammeter
- CAMAC-PC dataway
- PC running LabView
- CAMAC ADC
- Analog I/O
- PMT output
- GPIB bus
- PMT Test DB
non-linearity

Pulse Height (pC)

Deviation from Linearity (%)
Normalized Gain vs. External Magnetic Field
(Shielding Efficiency)

Outer Shield (Soft Iron) OD = 1.75", t = 0.064"
Inner Shield (mu-metal) OD = 1.54", t = 0.04"

$g(B)/g(0)$

$B$(gauss)
A New PMT HV System

- A new HV system based on Cokcroft Walton (CW) voltage multiplication scheme has been developed (*HV is generated inside the base. Only low voltage DC power is supplied externally*).

- PMT bases use microcontrollers to control and monitor HV and temperature.

- Over 500 CW bases have been produced and tested so far. Production efficiency is 95% and is expected to improve (improvements in stuffing, shipping, and QC ~98-99%). Production rate is 250-300/month.

- No HV cables or connectors-safer to use.

- Overal system cost is typically ½ that of a conventional HV systems (system includes LabView based control/monitoring system).
Block Diagram of PMT High Voltage Control System
(only one out of two network segment shown)
CW BASE CHARACTERISTICS.

- Linearity: better than 0.5%
- Long term stability: $0.5 \text{ V}_{pp} (0.05\%)$ (after 12 hours initial warm-up).
- Ripple: $0.2 \text{ V}_{pp} @ 1 \text{ uA load on photocathode}$.
- Noise: same as conventional base (measurements limited by ADC resolution).
- HV range: 0 to -1500 volts.
- Setting resolution: 0.6 volts.
- Each base individually addressable (12 bit address), current and voltage are limited via hardware.
- The firmware on each base is programmable for future improvements. The HV division ratio for PMT base may be altered to fit any PMT.
Comparison of pedestals taken with Conventional base and CW base.

*Noise Studies*

Pedestal taken with conventional base (blue) vs. CW base (red) with the same PMT and at the same gain (same voltage division ratio).
Gain Non-linearity vs. output signal

- CW base without 10K resistor
- Conventional base
- CW base with 10K resistor
- Linear (CW base without 10K resistor)
- Poly. (Conventional base)
- Linear (CW base with 10K resistor)

EMC dynamic range
Photomultiplier non-linearity vs. Signal Amplitude

EMC Dynamic Range
Automated PMT Gain Measurements

PMT 9125 No'230205' Gain, Charge vs HV

![Graphs showing PMT gain measurements](image_url)
Arrangement of PMTs in STAR EMC boxes
Resources

- Our group has Electronics and Mechanical Design experience.

Resources available at UCLA:

- Full Machine Shop with several CNCs and Scintillator work experience.

- Electronics Shop with Design and Fabrication capabilities.

- Graduate and Undergraduate student pool.