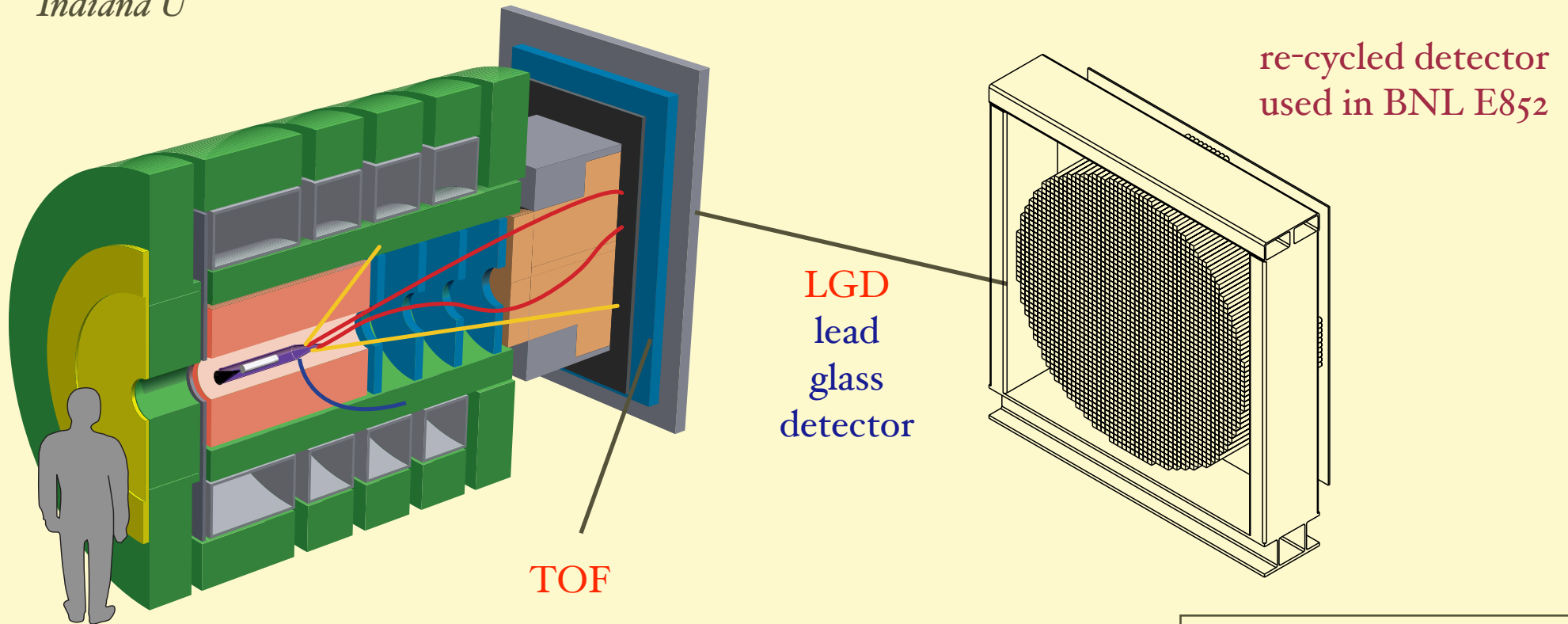


# Forward Calorimeter in the GlueX Experiment

Alex Dzierba  
*Indiana U*



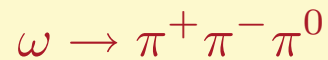
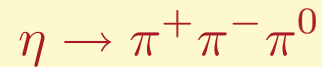
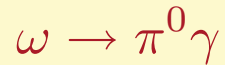
- Purpose
- Experience with E852 (BNL) & RADPHI (JLab)
- Multi-photon states: resolution & reconstruction
- Radiation issues
- Assessing components for GlueX use
- Status

## Responsible Groups:

- IHEP (Protvino)
- Indiana U

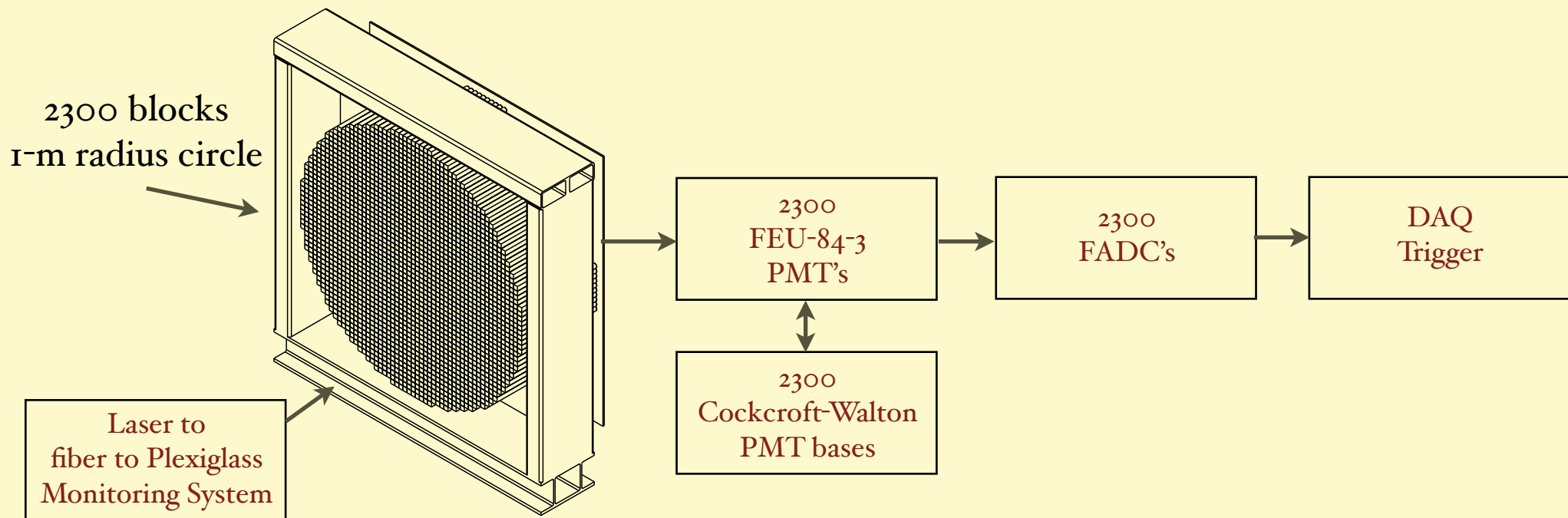
# Purpose of the Forward Calorimeter (LGD)

- Detect and measure photon from the decays of mesons, e. g.:



photons  
+  
charged particles

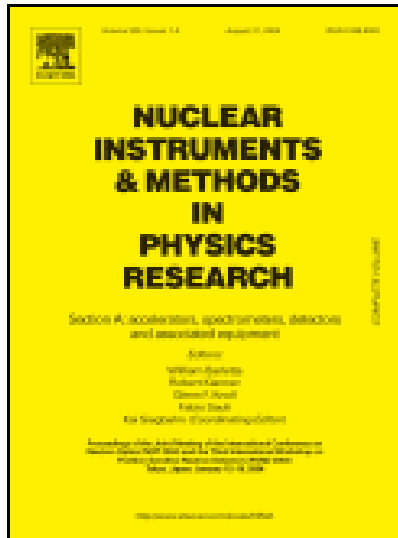
- Provide an energy sum for the level-one trigger



# Lead Glass Detector Experience



## Technical publications:



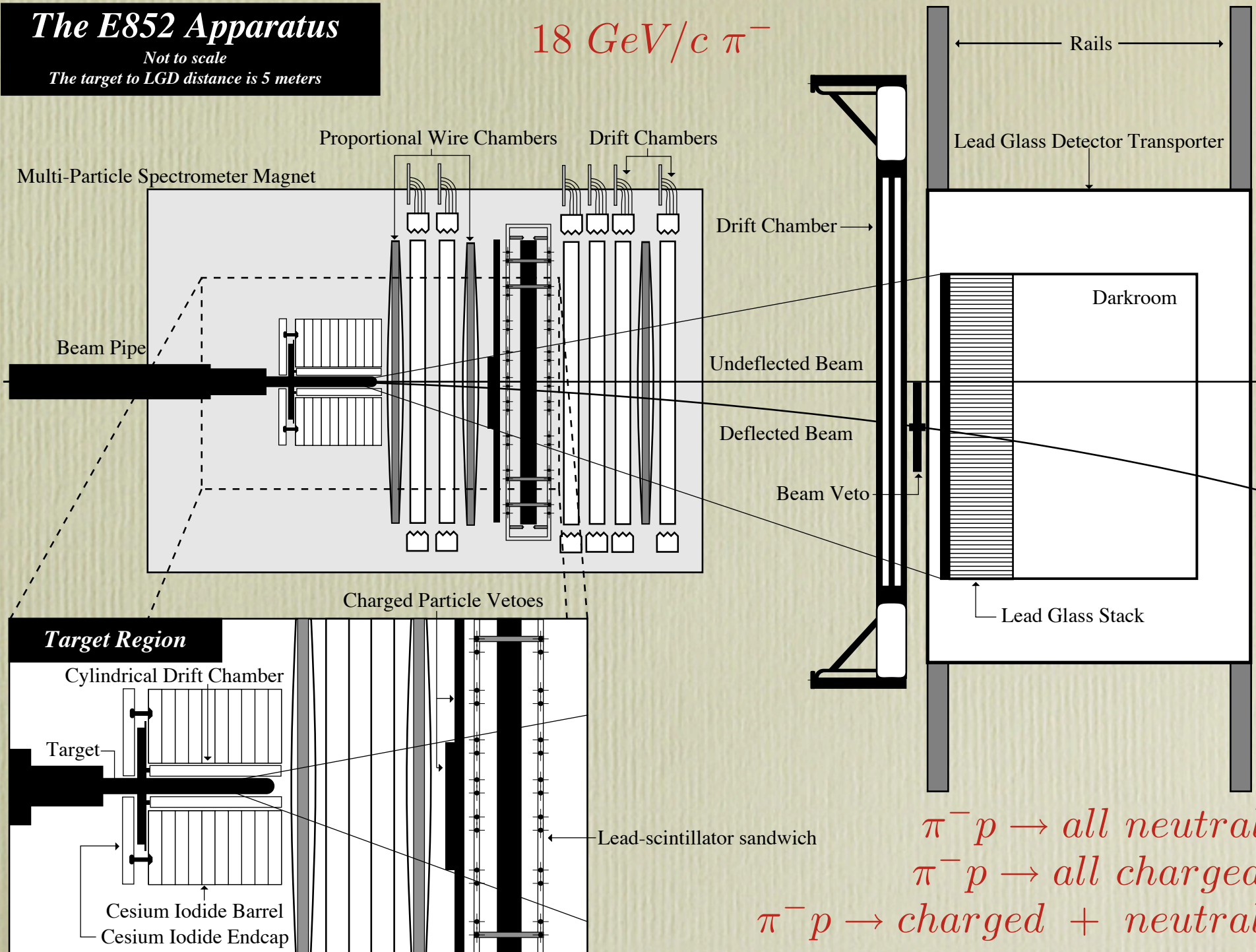
1. Nuclear Instruments and Methods in Physics Research A 332 (1993) 419–443  
A study of two prototype lead glass electromagnetic calorimeters
2. Nuclear Instruments and Methods in Physics Research A 387 (1997) 377–394  
A 3000 element lead-glass electromagnetic calorimeter
3. Nuclear Instruments and Methods in Physics Research A 414 (1998) 466–476  
A Cockcroft–Walton base for the FEU84-3 photomultiplier tube
4. Studies of magnetic shielding for phototubes<sup>☆</sup>  
accepted, in press
5. The Radphi Detector  
accepted

# The E852 Apparatus

Not to scale

The target to LGD distance is 5 meters

$18 \text{ GeV}/c \pi^-$



$\pi^- p \rightarrow$  all neutral

$\pi^- p \rightarrow$  all charged

$\pi^- p \rightarrow$  charged + neutral



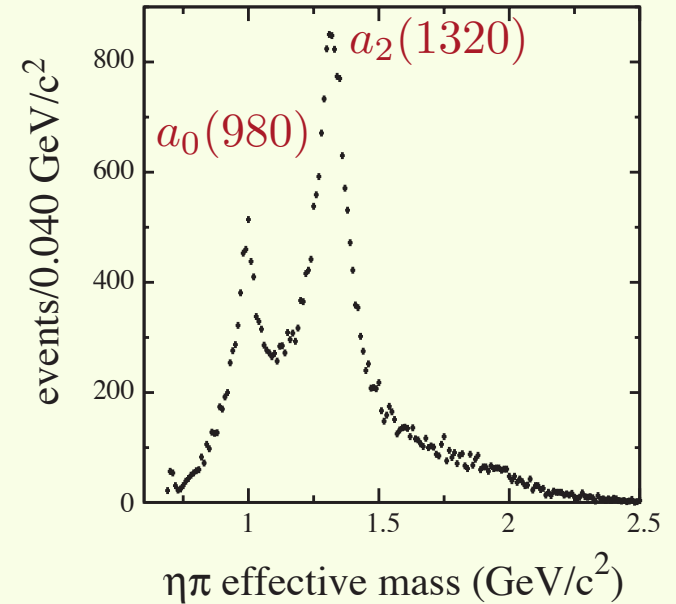
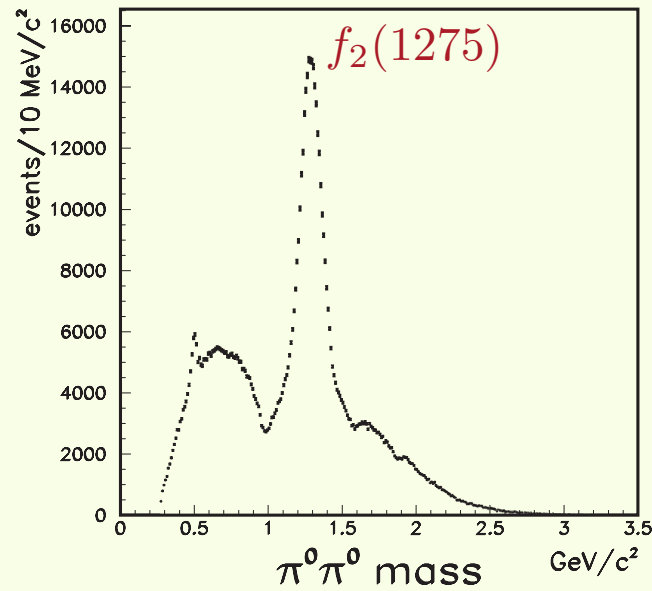
# LGD in E852



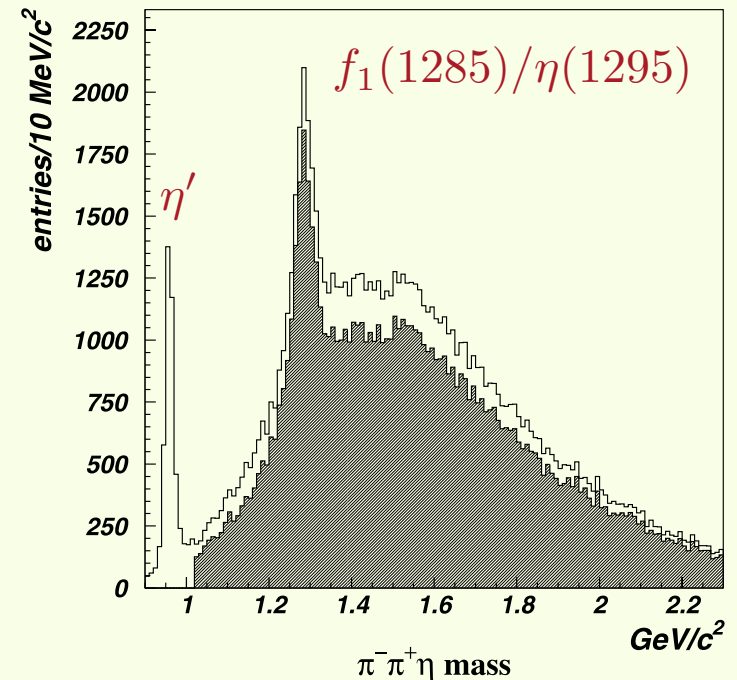
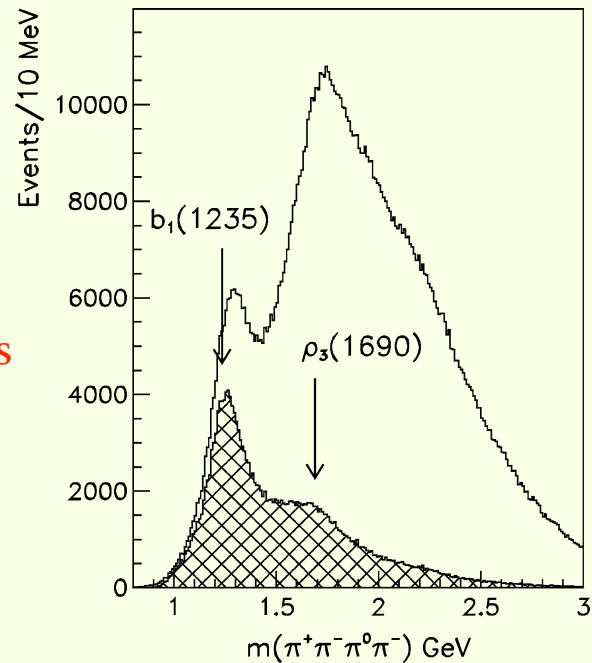


# Some Published Spectra from E852

all neutral final states



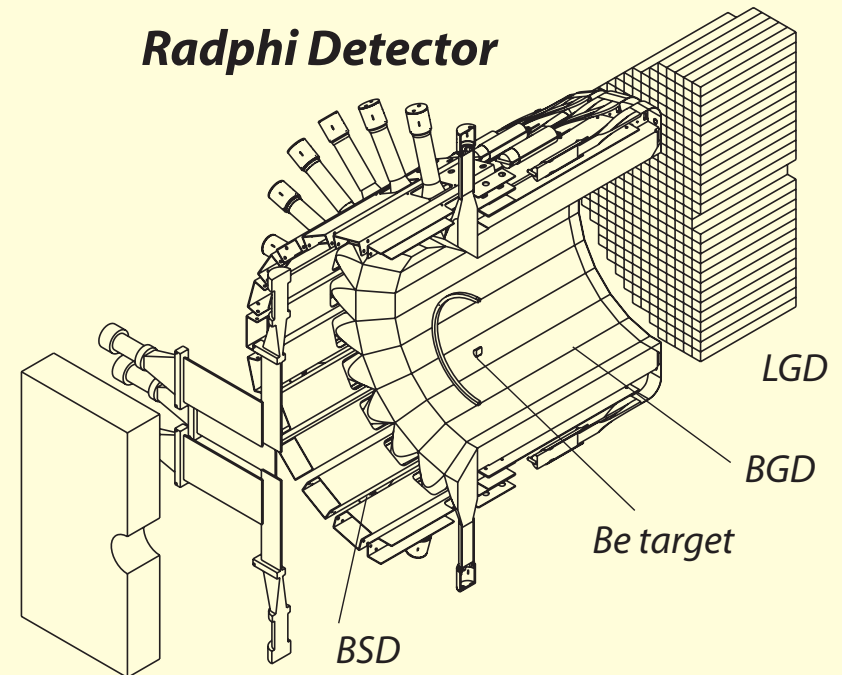
charged + neutral final states



# RADPHI Experiment

- Located in tagged photon beam in Hall B
- Photon beam energy: 3 to 5.4 GeV
- Took data in 2000
- LGD located 1 m from 1 m diameter LGD
- Experience invaluable for GlueX
- Information on:

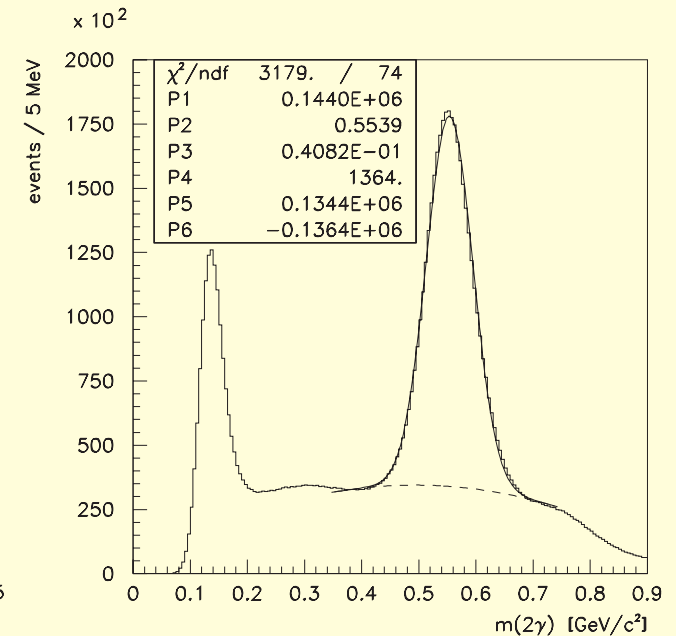
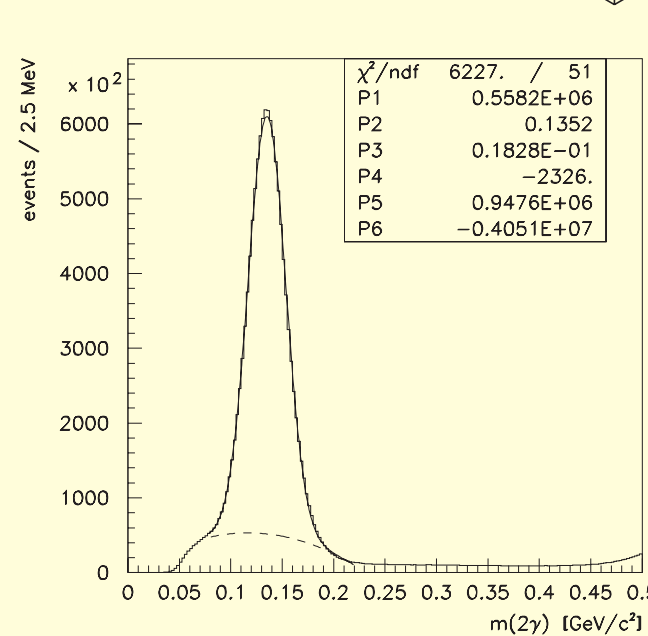
## Radphi Detector



$$\gamma p \rightarrow \pi^0 p$$

$$\gamma p \rightarrow \eta p$$

$$\gamma p \rightarrow \omega p$$



- Ultimate goal:

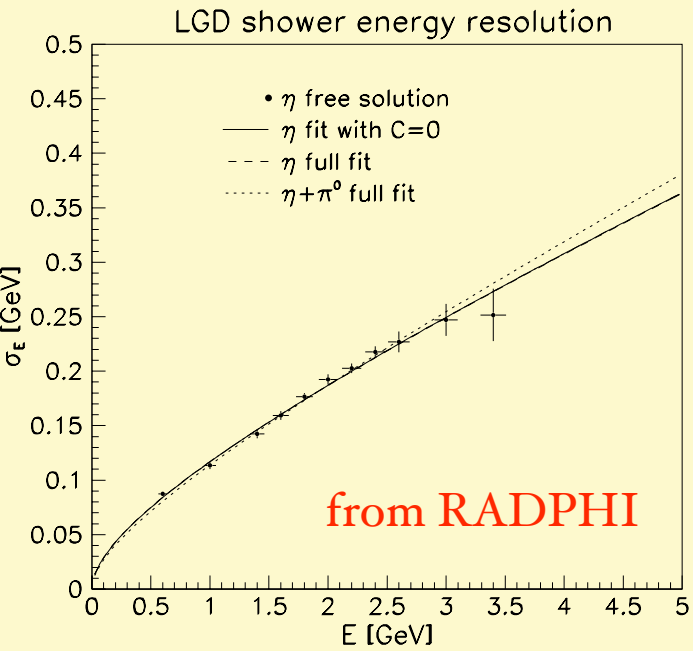
$$\gamma p \rightarrow \phi p$$

$$\phi \rightarrow f_0(980)\gamma \rightarrow \pi^0\pi^0\gamma$$

$$\phi \rightarrow a_0(980)\gamma \rightarrow \eta\pi^0\gamma$$

these are 5-photon final states

# Understanding LGD Resolution

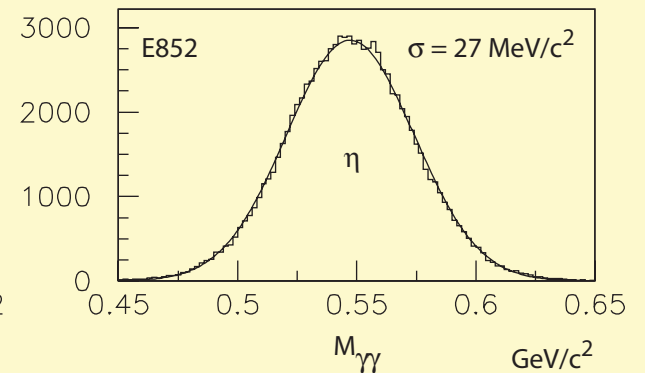
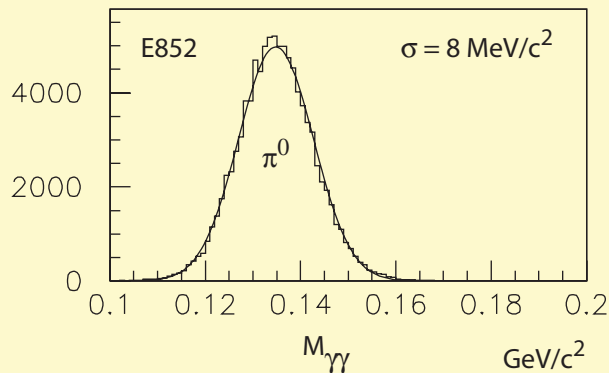
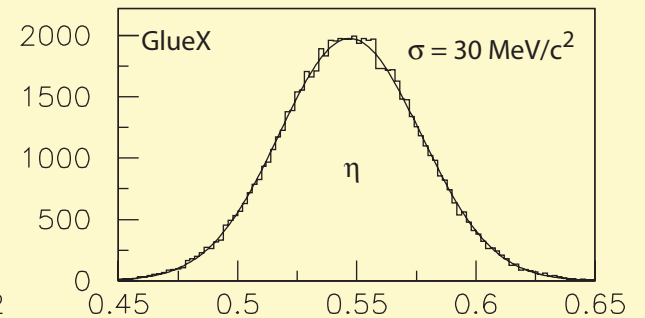
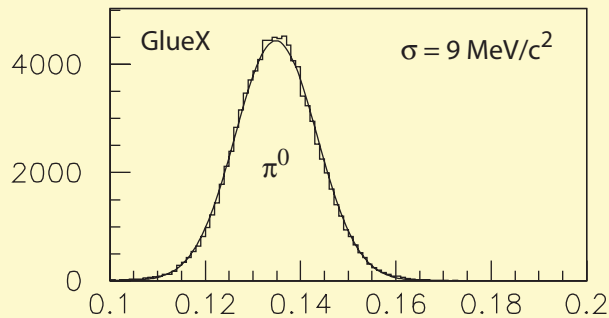
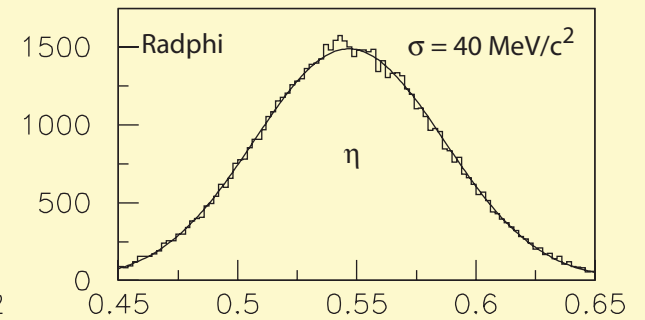
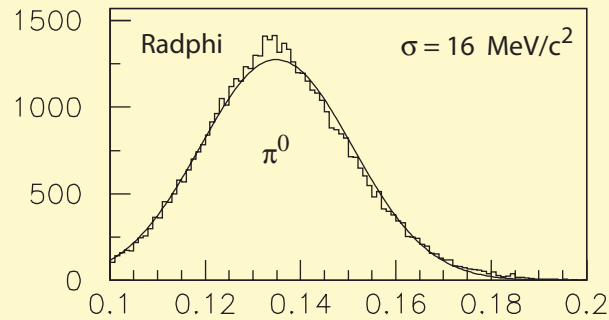


$$\frac{\sigma_E}{E} = 0.036 + \frac{0.073}{\sqrt{E}}$$

$$\sigma_\rho = \sqrt{\left(\frac{7.1}{\sqrt{E}}\right)^2 + (X_0 \sin \theta)^2}$$

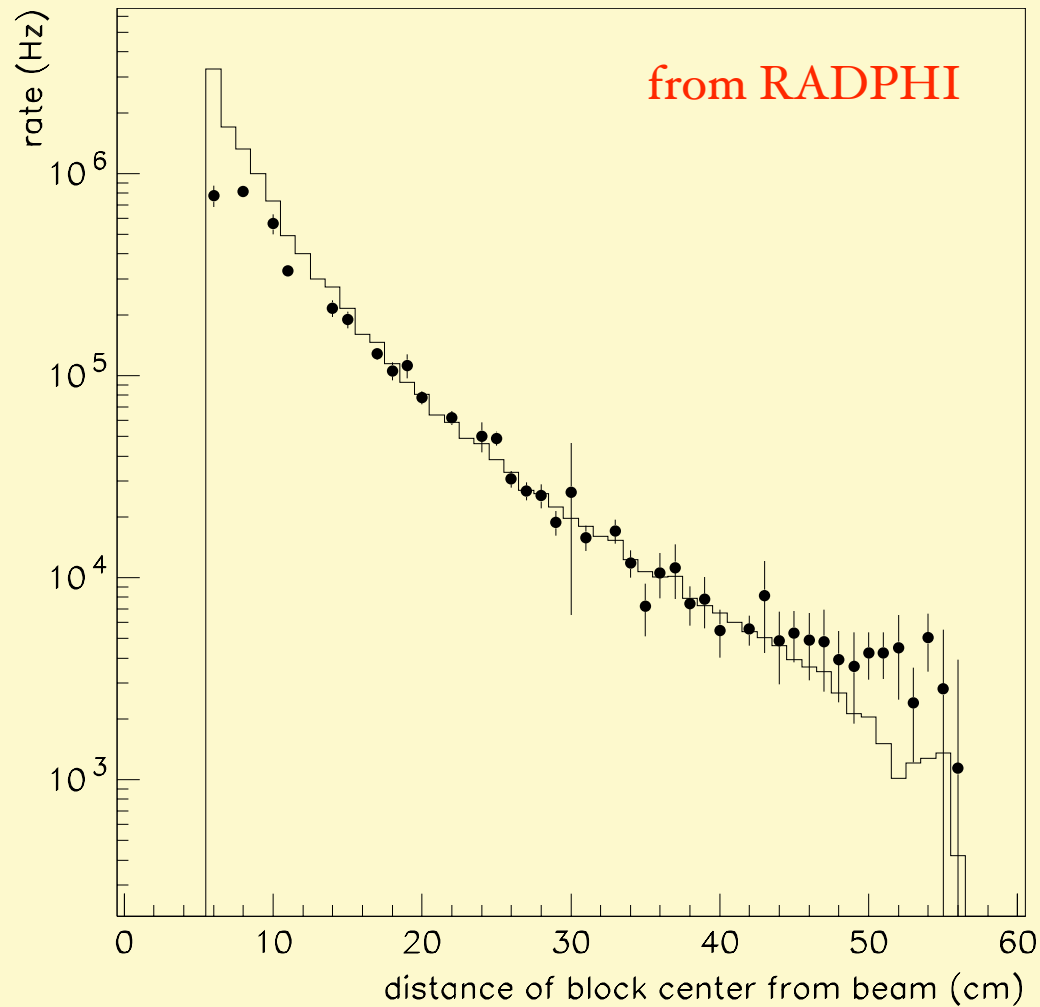
energy resolution (%)  
and spatial resolution (mm)

## RADPHI - GlueX - E852





# Electromagnetic Backgrounds

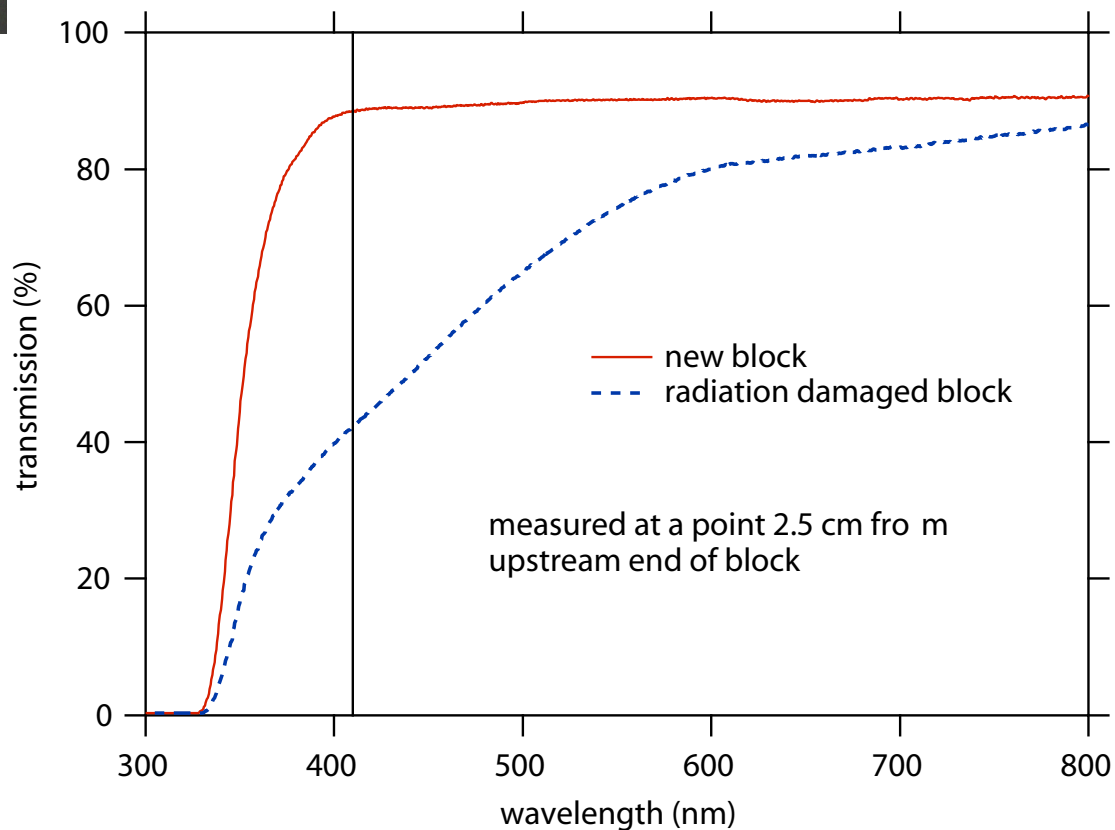
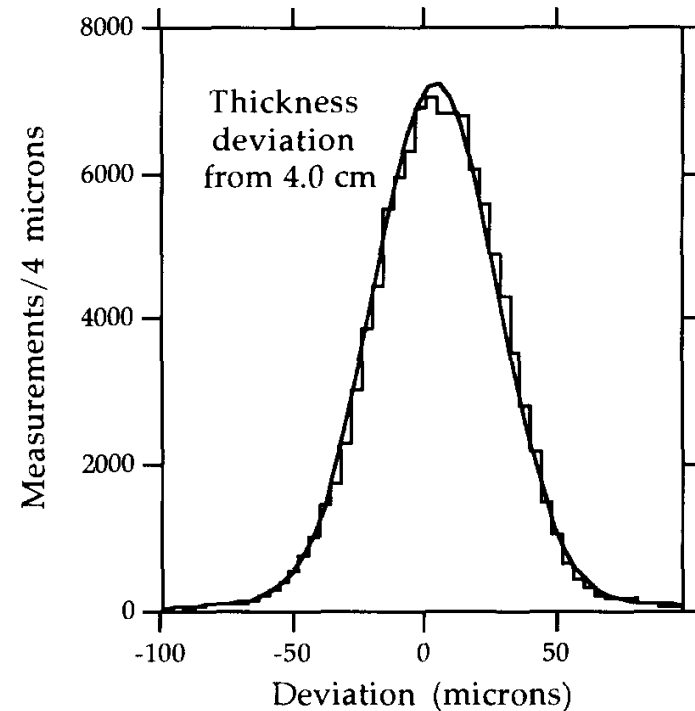


Characteristics of unbiased flux observed in individual blocks in the LGD as a function of distance from the beam. The points are derived from data and the histograms from a Monte Carlo simulation of the electromagnetic background coming from the beam and target.

# Assessing Lead Glass for GlueX

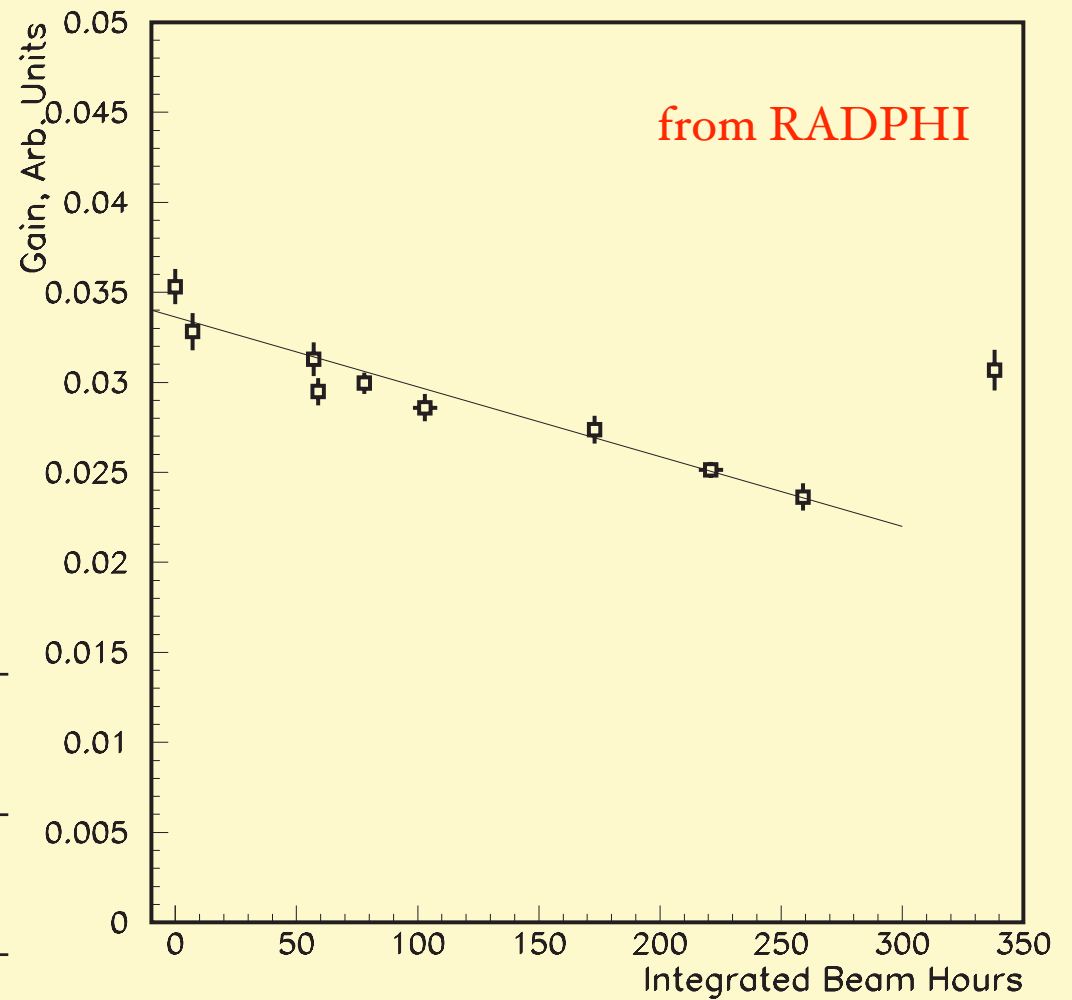
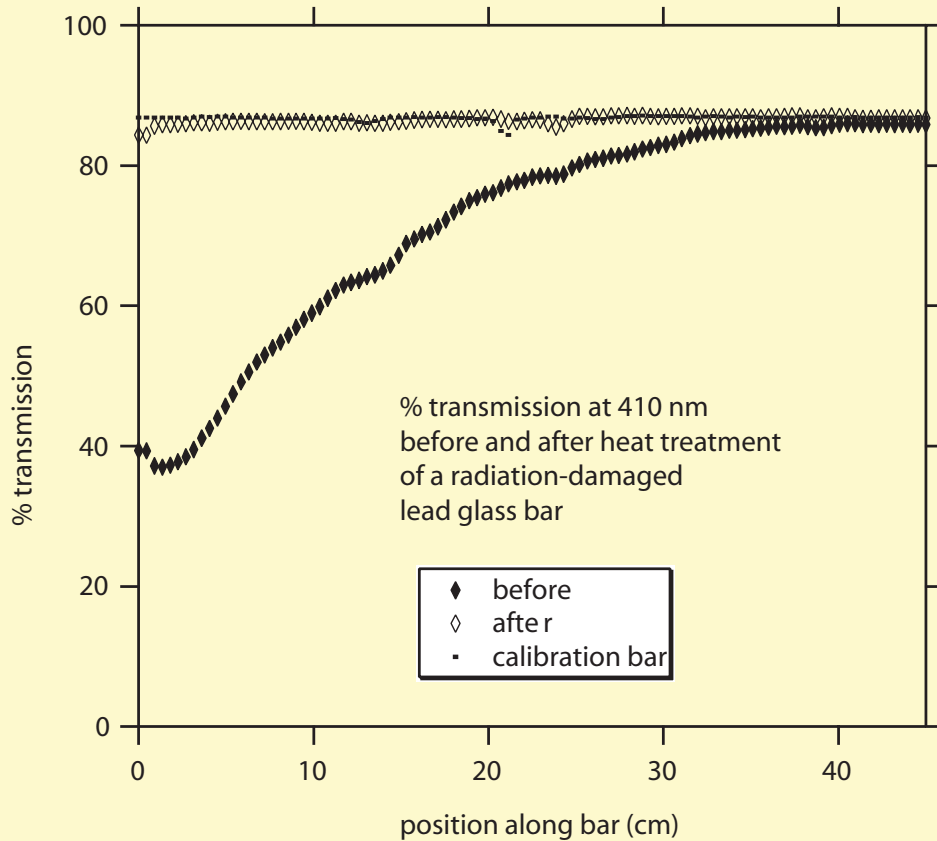


Each block used in E852/RADPHI is examined for damage and transmission measured at 410 nm.



# Radiation Damage

The effect of radiation damage on the central part of the detector. The last point shows the gain after an adjustment of the phototube high voltage.





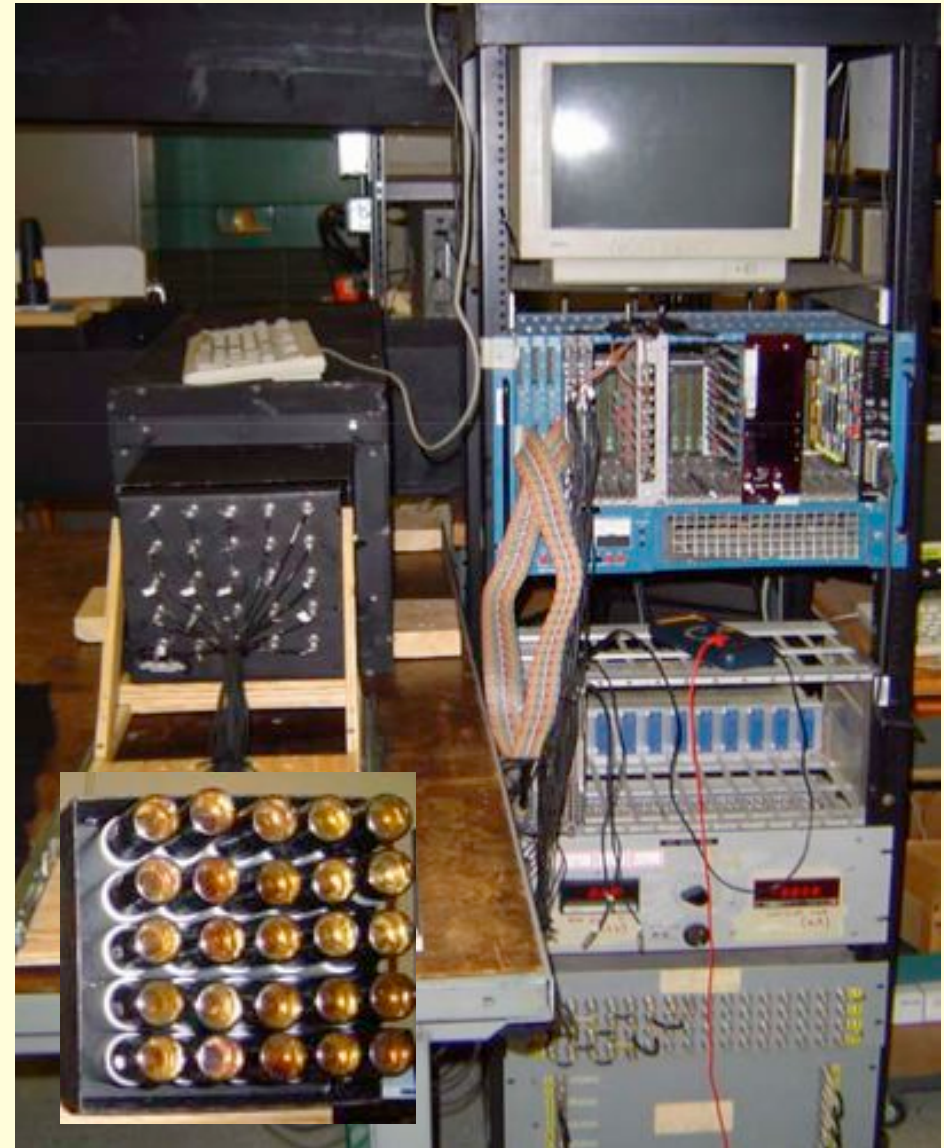
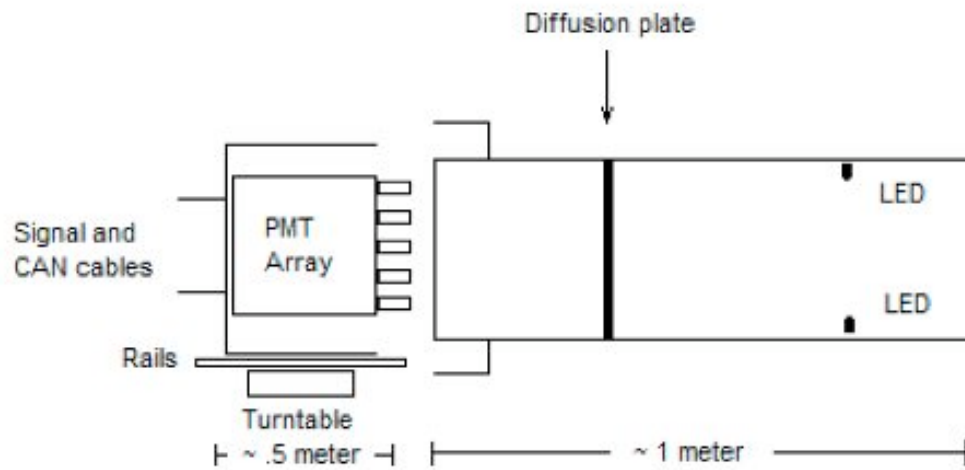
# PMT Issues:

- **Concern**  
FEU-84-3 PMT's obtained from Russia in 1993 - there is some concern about aging - in particular loss of vacuum.
- **Tests**  
All the PMT's used in E852 will be tested under computer control:  
(1) plateau curve; (2) correlated noise; (3) dark noise
- **Fall-back**  
Unused FEU-84-3 PMT's are available in Russia - they were manufactured in early 90's. Or we can purchased new FEU-115M PMT's - slightly smaller diameter photocathode - requires slightly different socket.

# Assessing PMT's for GlueX

PMT's used in E852/RADPHI will be evaluated:

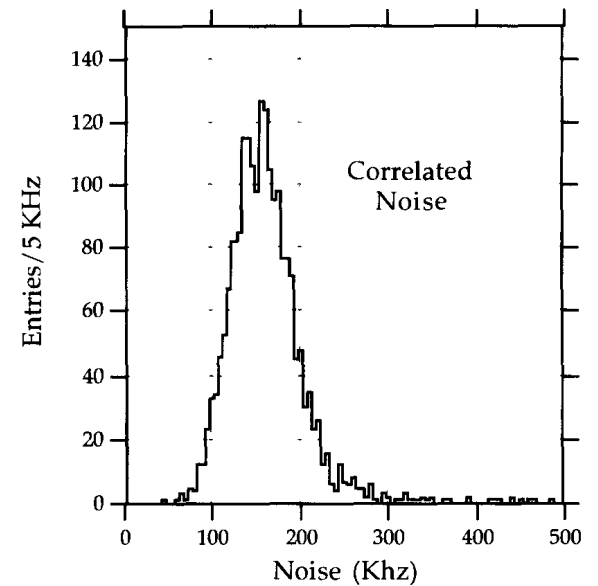
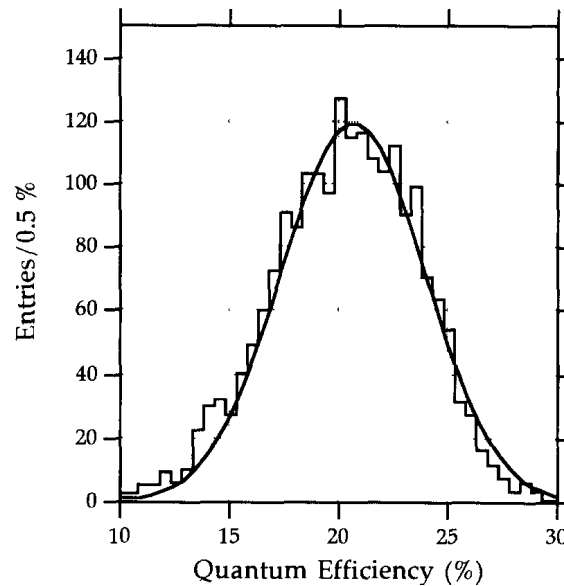
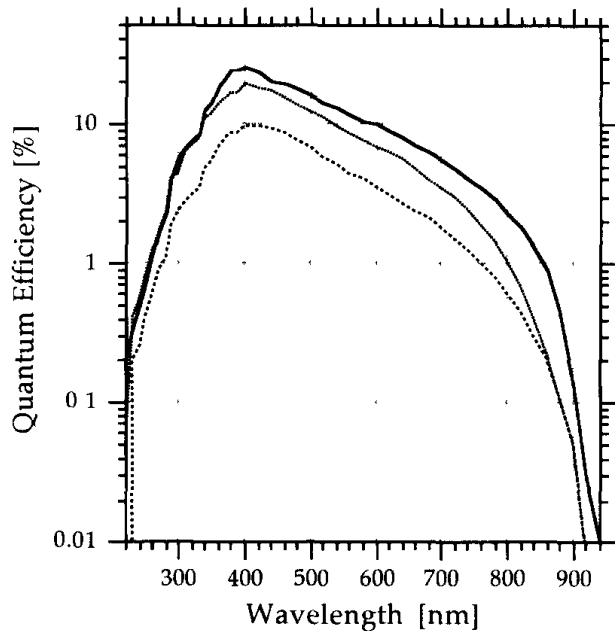
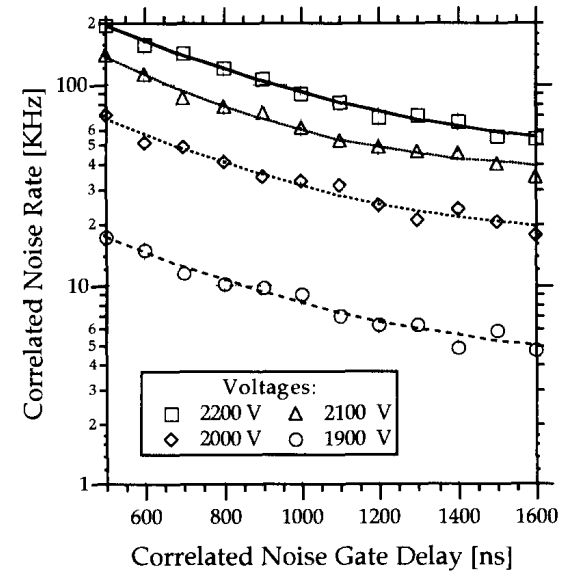
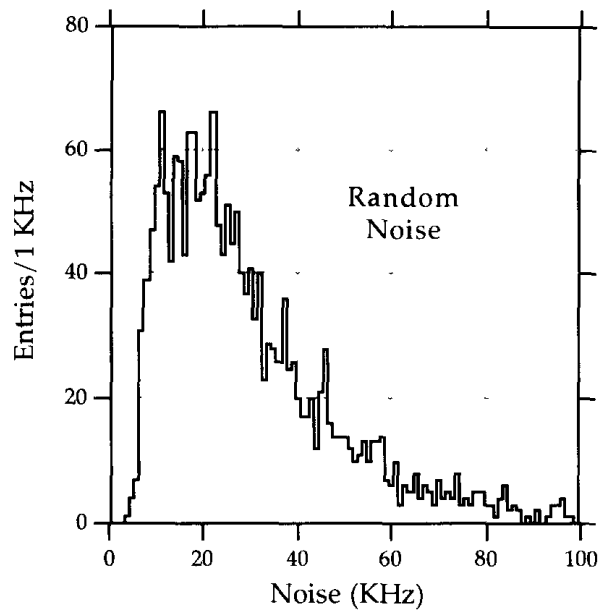
- plateau curve for each PMT
- random noise
- correlated noise



# PMT Evaluation used for E852 LGD

Nuclear Instruments and Methods in Physics Research A 332 (1993) 419–443

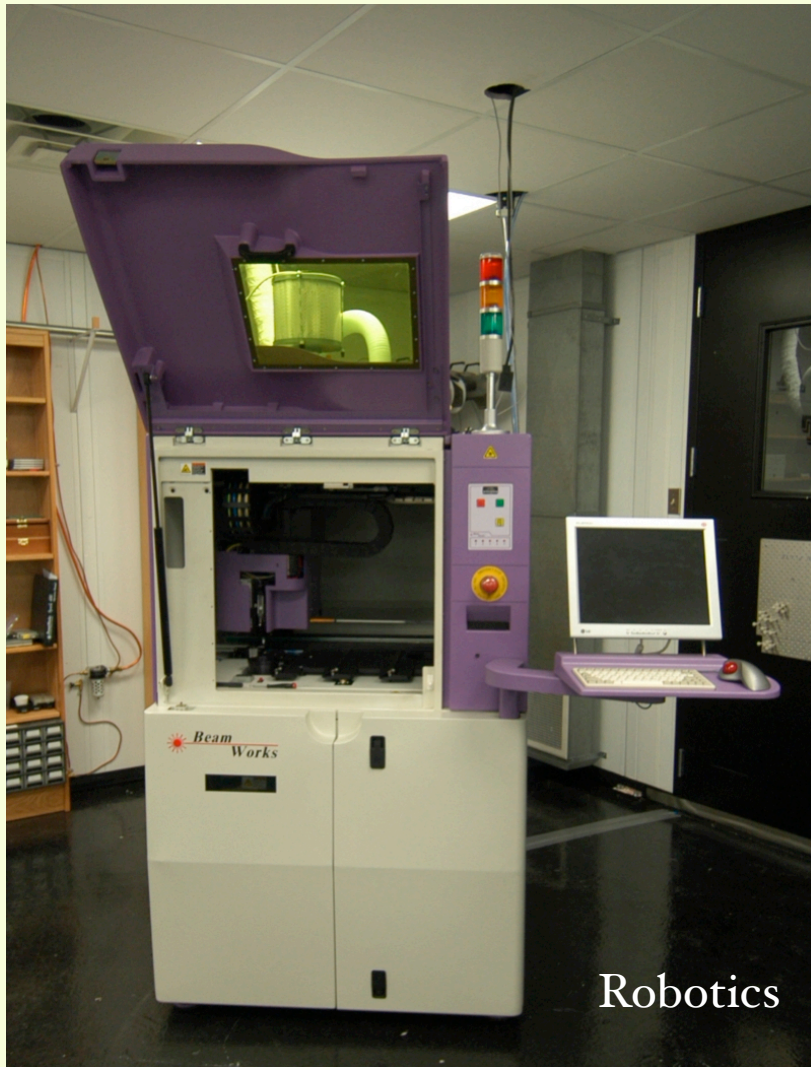
3500 FEU-84-3 PMT's were evaluated for E852



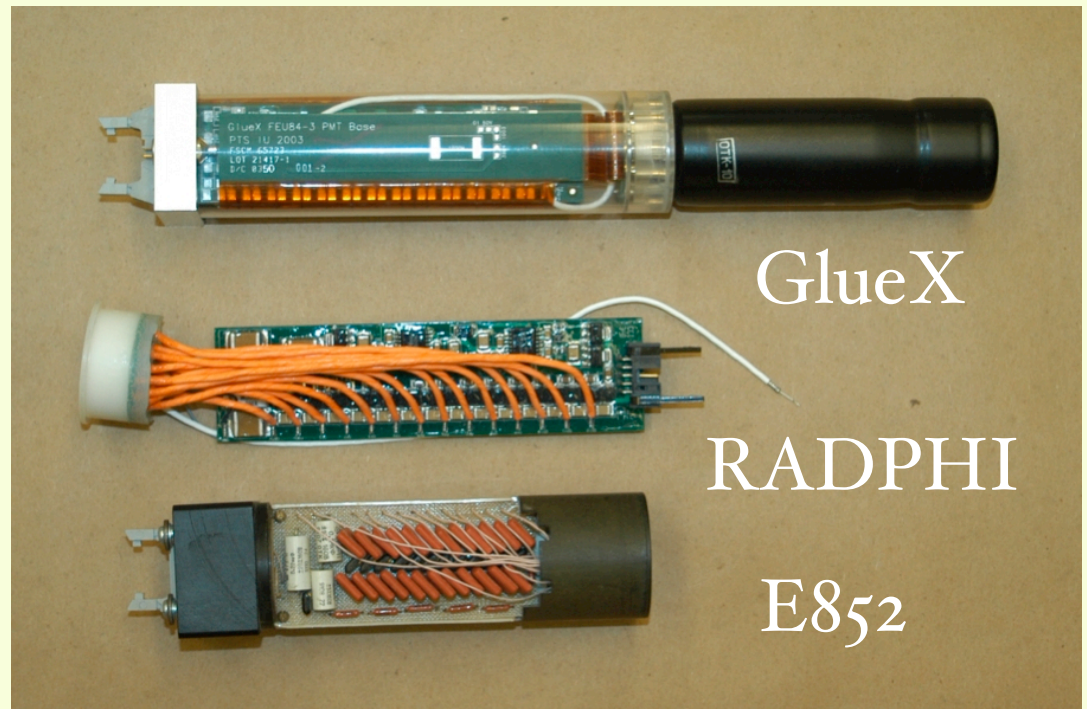


# Cockcroft-Walton PMT Bases

R&D on Cockcroft-Walton Bases in progress - 100 bases of new design built using robotics and now undergoing long-term tests at Indiana U.



Three generations of Cockcroft-Walton PMT bases



# Outstanding Issues & Conclusions:

- **Monitoring**

A laser-based system used in E852/RADPHI illuminates a Plexiglass sheet in front of glass for gain-setting and monitoring and will also be used for GlueX.

- **Magnetic shielding**

A cell-wall structure used in E852/RADPHI will also be used. Magnetic simulations of fringe field using TOSCA are underway.

- **Triggering issues**

An energy sum trigger was used in E852/RADPHI - an effective mass trigger as well in E852 - energy sum trigger will be used in GlueX level-one trigger.

- **E&M background rates**

GEANT simulations agree with what was observed in RADPHI and are being used to predict rates for GlueX. Alternate material (e.g. radiation-hard glass or lead-tungstate for example) for central region or shielding central region will be explored.

- **Reconstruction software**

Has been extensively studied.