Crossed-Fiber 2-D Position Sensitive Scintillation Neutron Detector

Donald Hutchinson, Roger Richards, David Holcomb, James Ramsey, and Michael Wright
Instrumentation and Controls Division
Oak Ridge National Laboratory
Oak Ridge, TN 37831

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Point of Contact:
D.P. Hutchinson
Phone:423-574-4730
Fax:423-574-1249
e-mail:hutchinsondp@ornl.gov

Crossed-Fiber Scintillation Detector Design Parameters

- Size: 25-cm x 25-cm
- Thickness: 2-mm
- Number of fibers: 48 for each axis
- Multi-anode photomultiplier tube: Phillips XP1704
- Coincidence tube: Hamamastu 1924
- Resolution: < 5-mm
- Shaping time: 300 nsec
- Count rate capability: ~ 1 MHz
- Time-of-Flight Resolution: 1 μsec

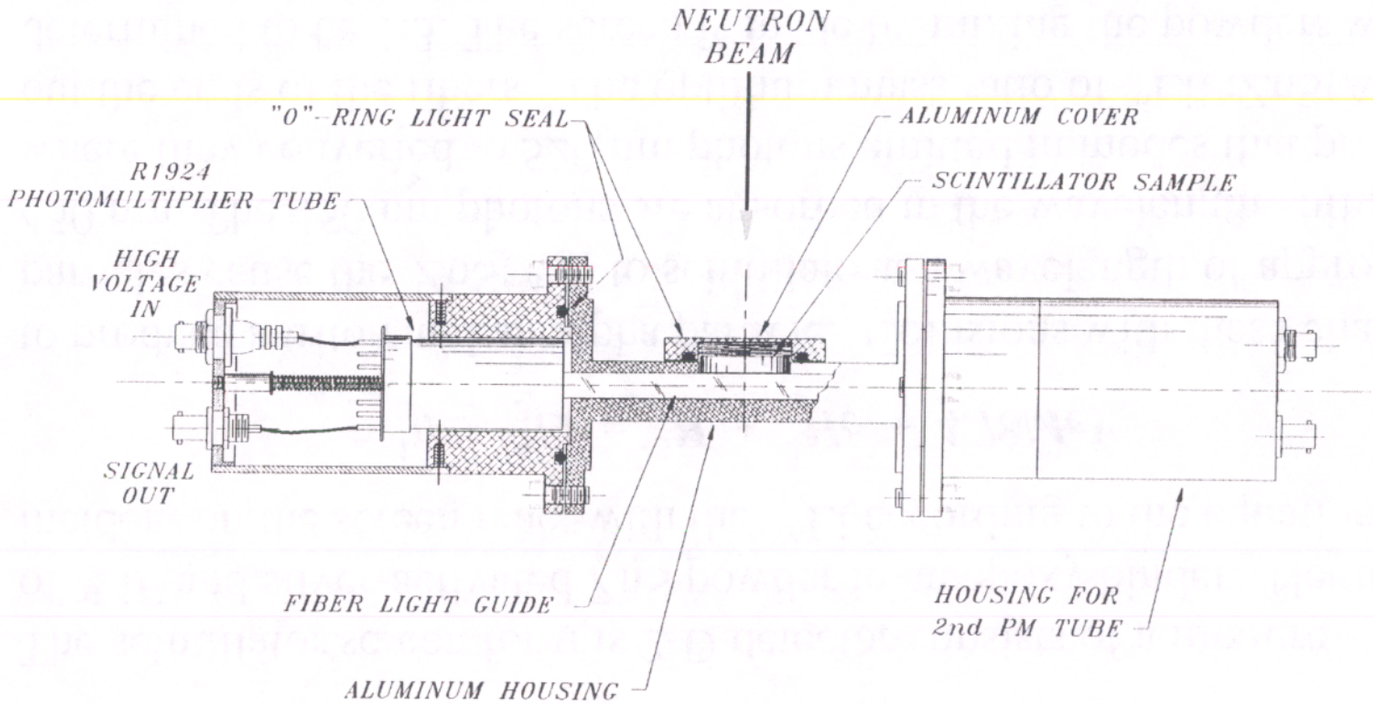
Neutron Detector Screen Design

The scintillator screen for this 2-D detector consists of a mixture of ^{6}LiF and silver-activated ZnS powder in an epoxy binder. Neutrons incident on the screen react with the ^{6}Li according to the equation

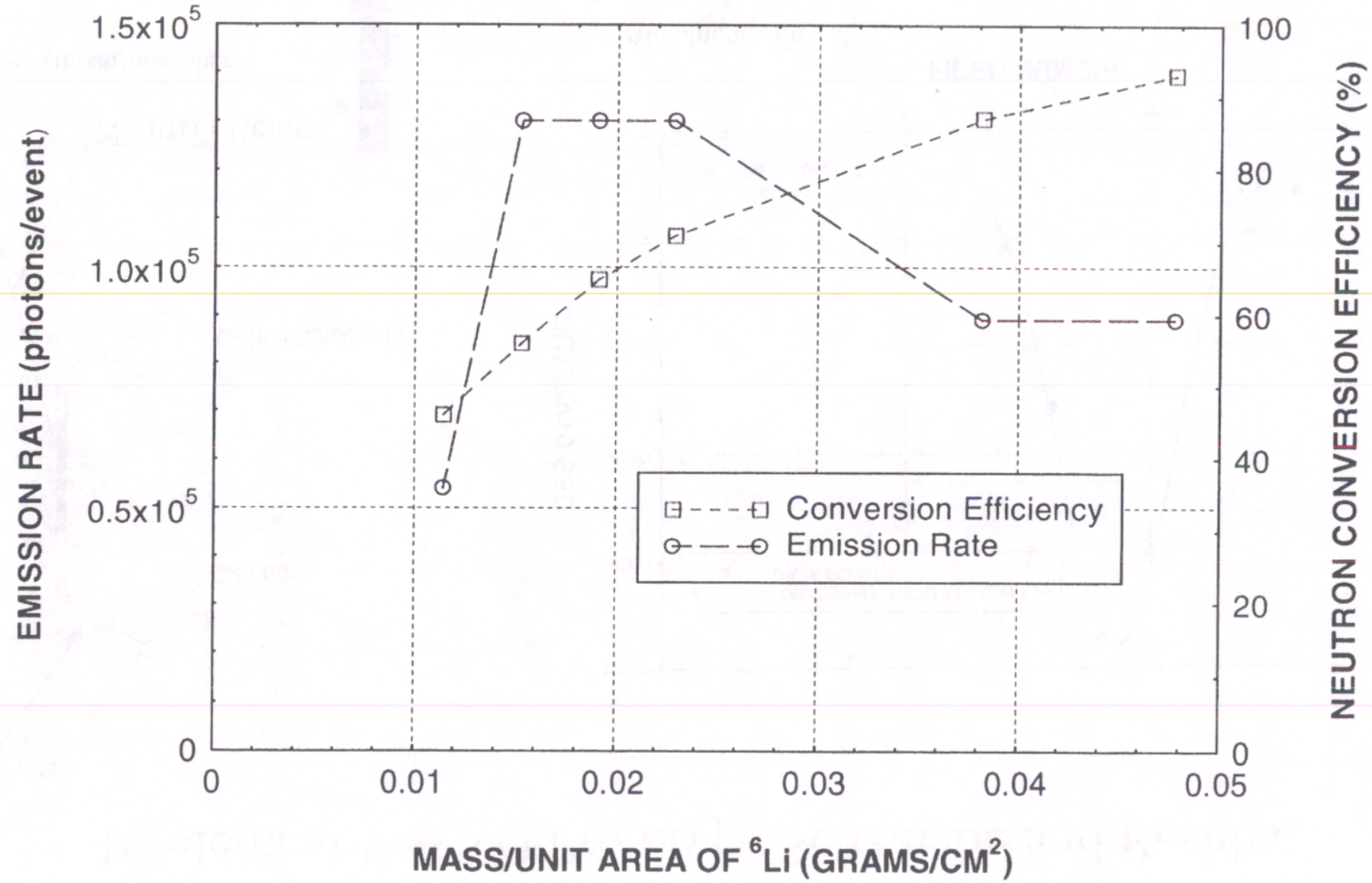
$$ {}^{1}_{0}n + {}^{6}_{3}Li = {}^{3}_{1}H + {}^{4}_{2}He + 4.78MeV $$

to produce a triton and an alpha particle. Collisions with these charged particles cause the ZnS(Ag) to scintillate at a wavelength of approximately 450 nm. The 450 nm photons are absorbed in the wavelength-shifting fibers where they converted to 520 nm photons emitted in modes that propagate out the ends of the fibers. The optimum mass ratio of ^{6}LiF:ZnS(Ag) was determined to be 1:3. The screen is made by mixing the powders with uncured epoxy and pouring the mix into a mold. The powder then settles to the bottom of the mold before the binder cures. After curing the clear epoxy above the settled powder mix is removed by machining. A mixture containing 40 mg/cm^2 of ^{6}LiF and 120 mg/cm^2 of ZnS(Ag) is used in this screen design. This mixture has a measured neutron conversion efficiency of over 90%.

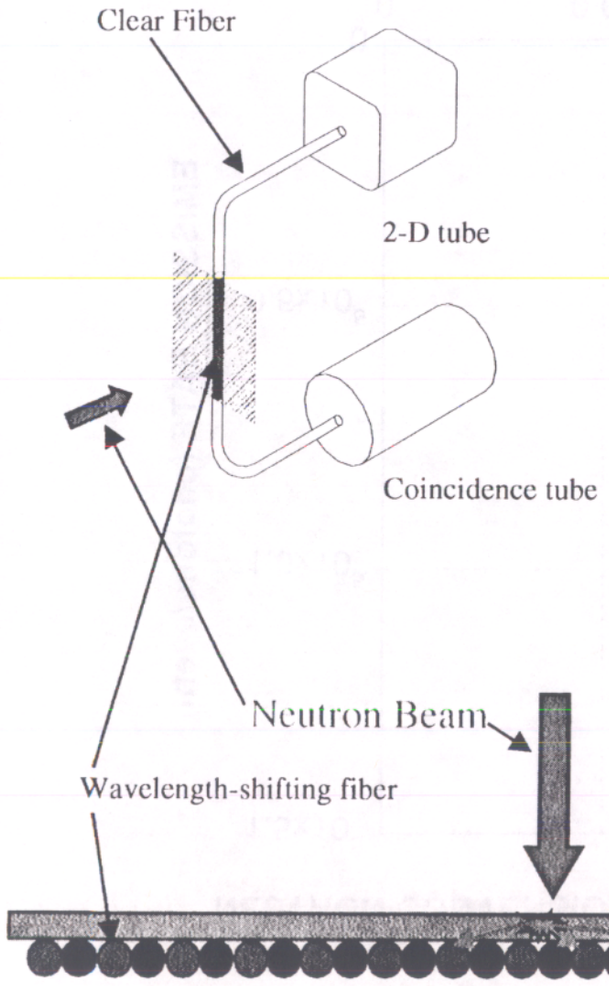
Test Fixture to Measure Characteristics of Scintillator Samples

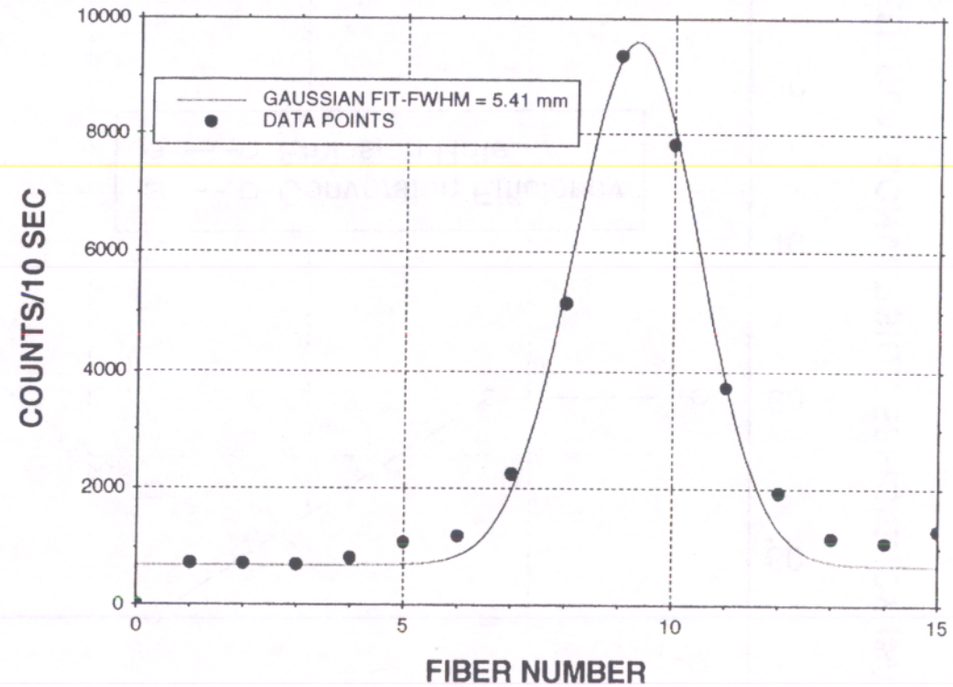


NEUTRON CONVERSION SCINTILLATOR SCREEN EFFICIENCY AND EMISSION RATE

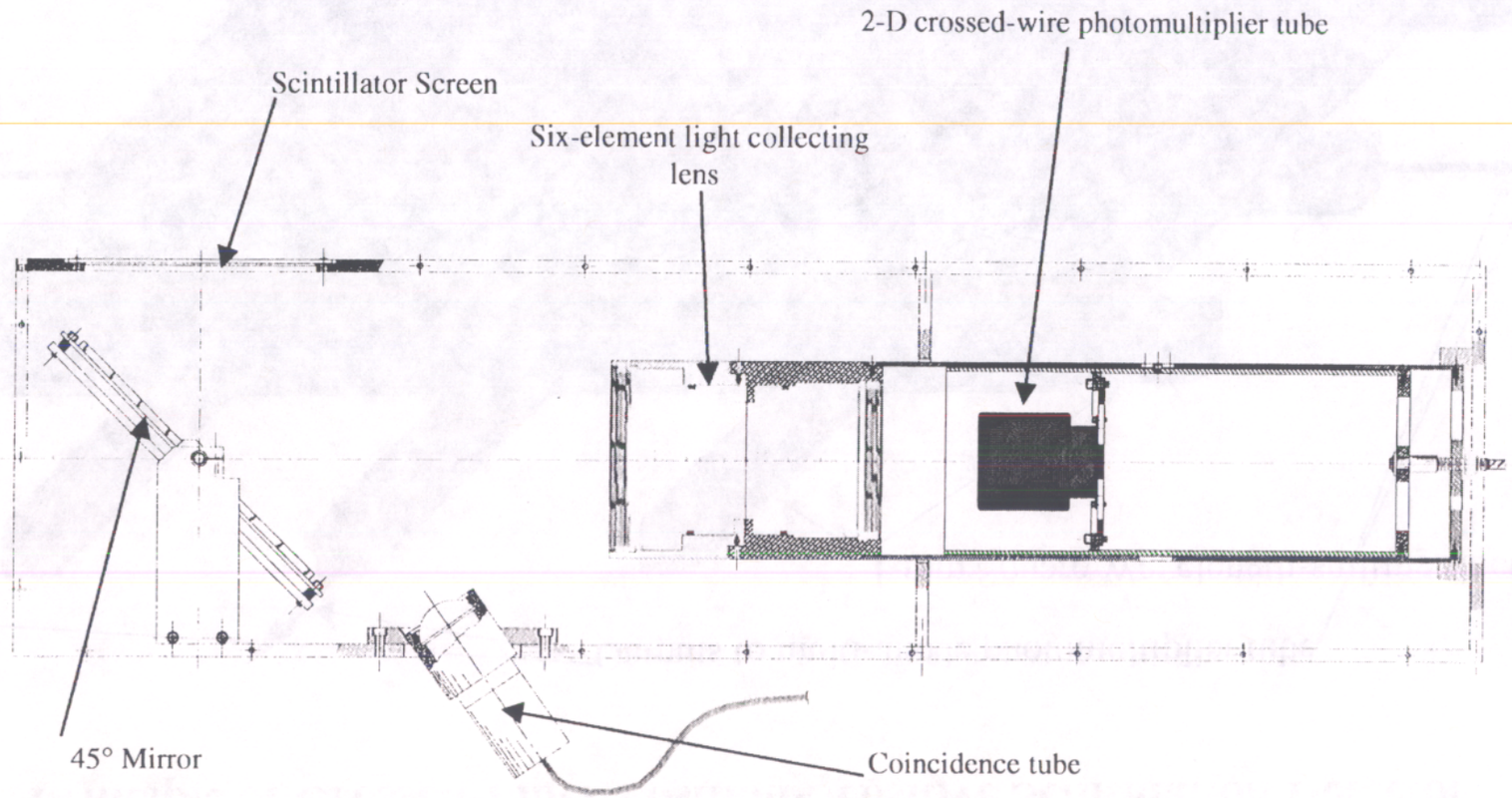


16-element WAND Prototype Schematic and Results

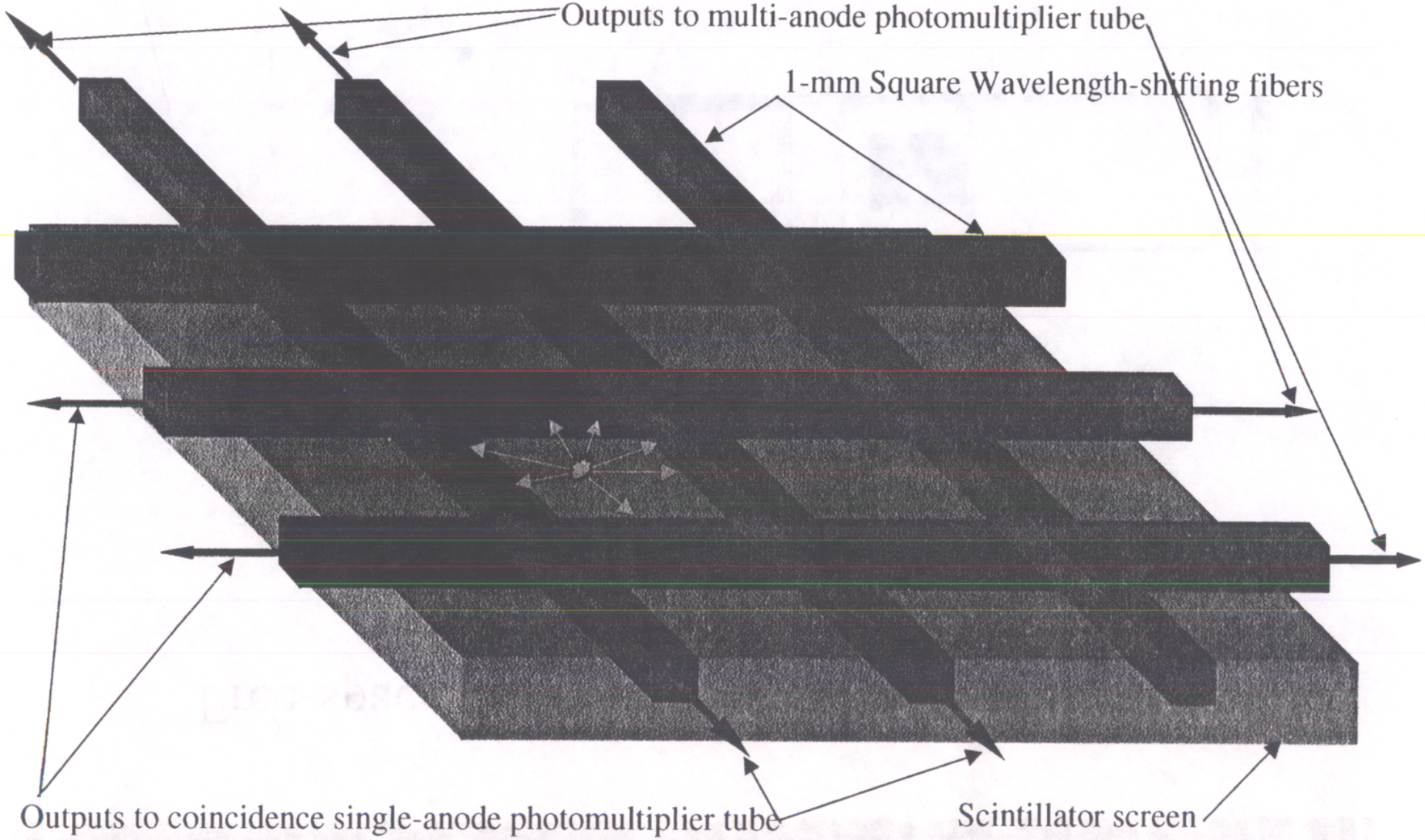




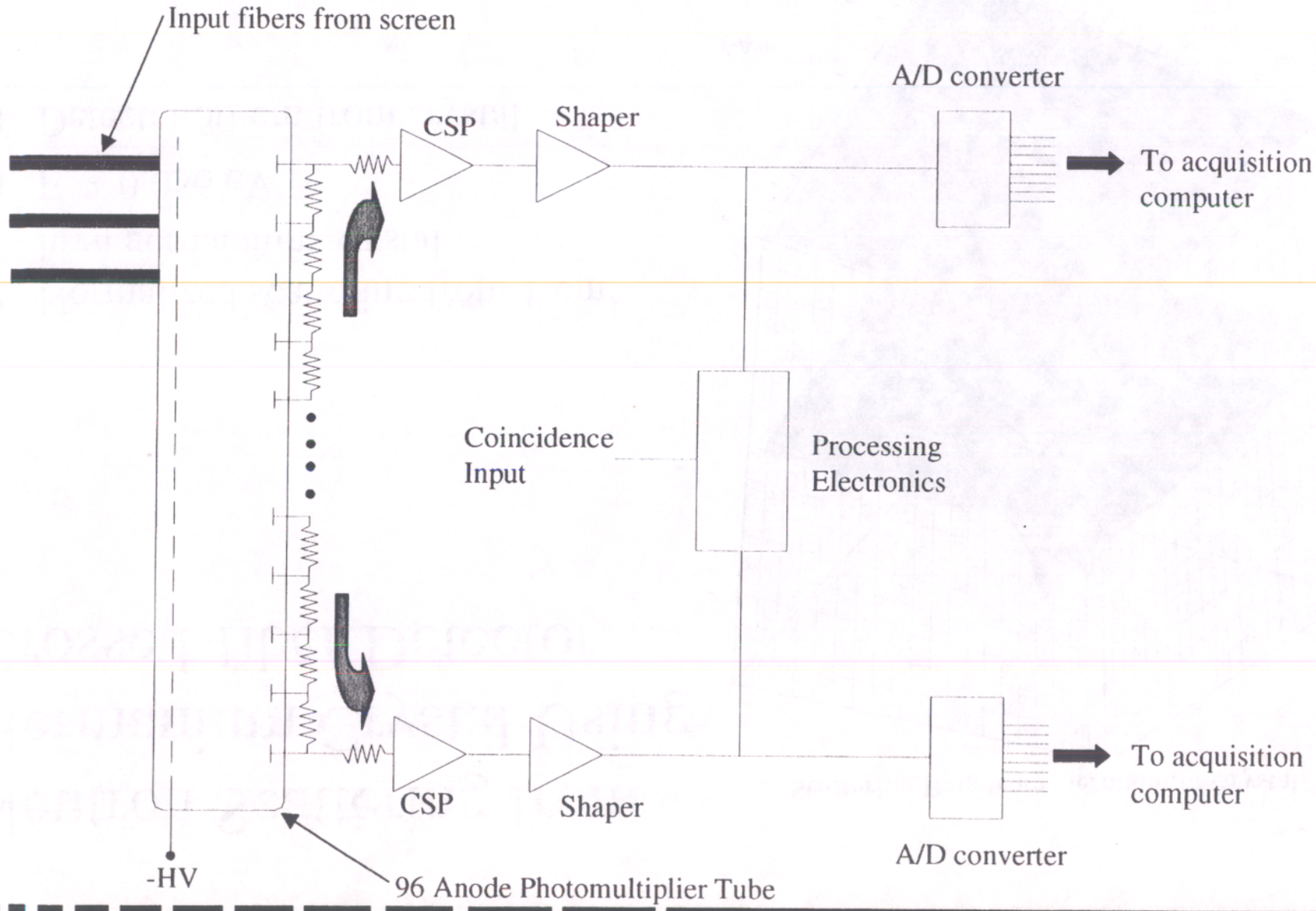
Free-space 2-D position sensitive detector



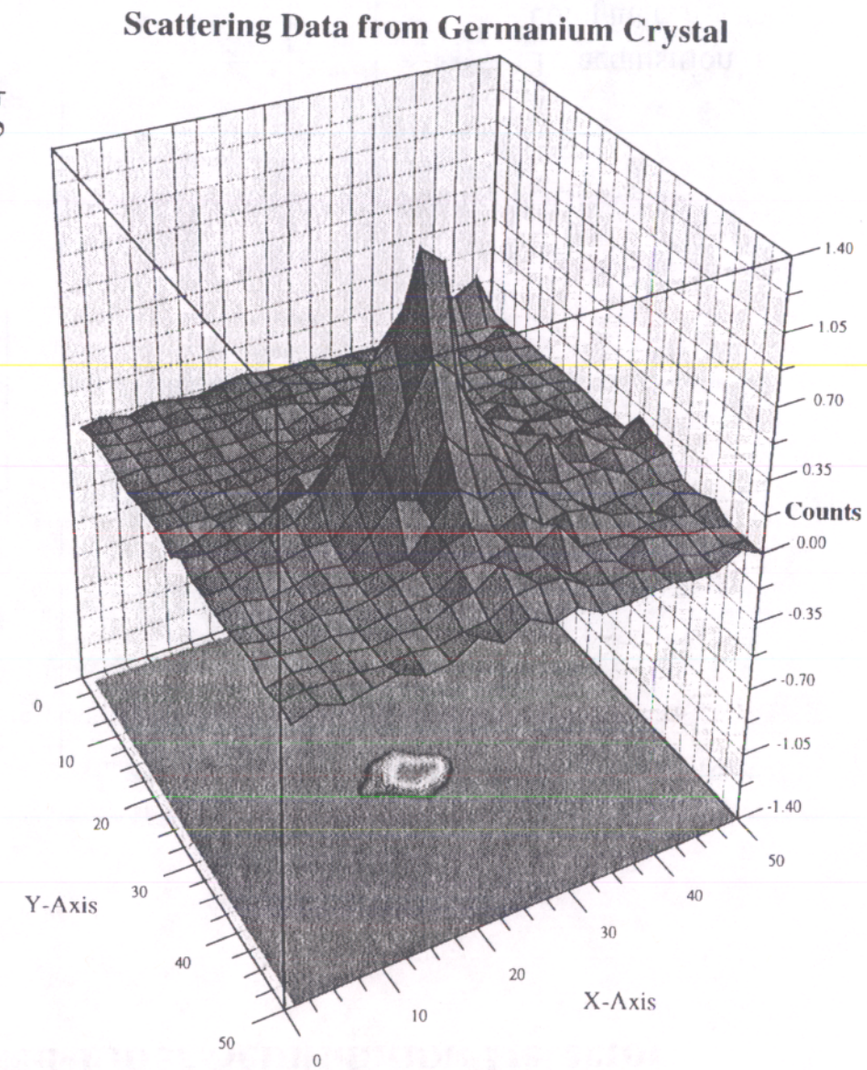
Principle of Crossed-Fiber Position-Sensitive Scintillation Detector



Electronics Scheme for Crossed-Fiber Scintillation Detector

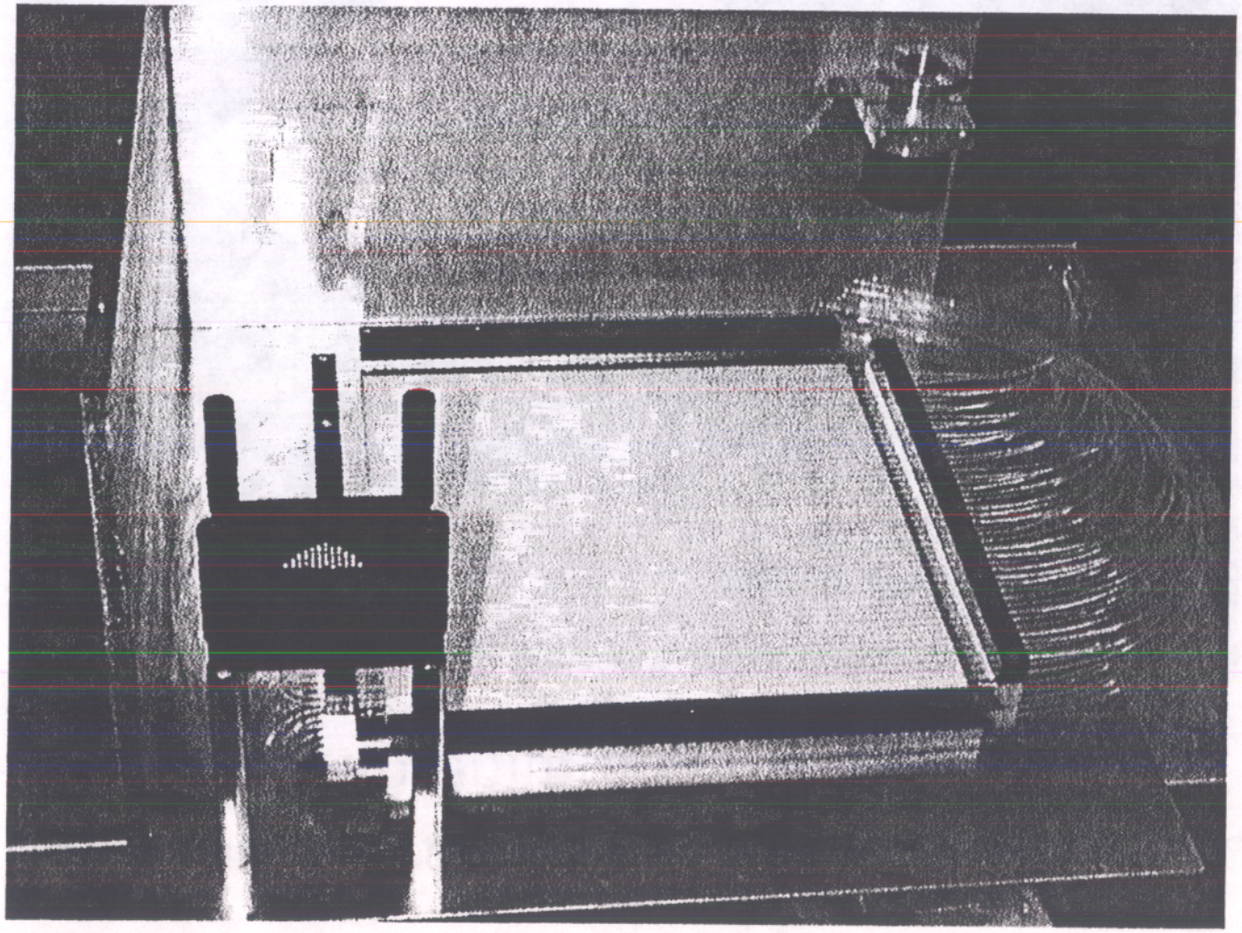


Neutron Scattering from Germanium Crystal Using Crossed-fiber Detector

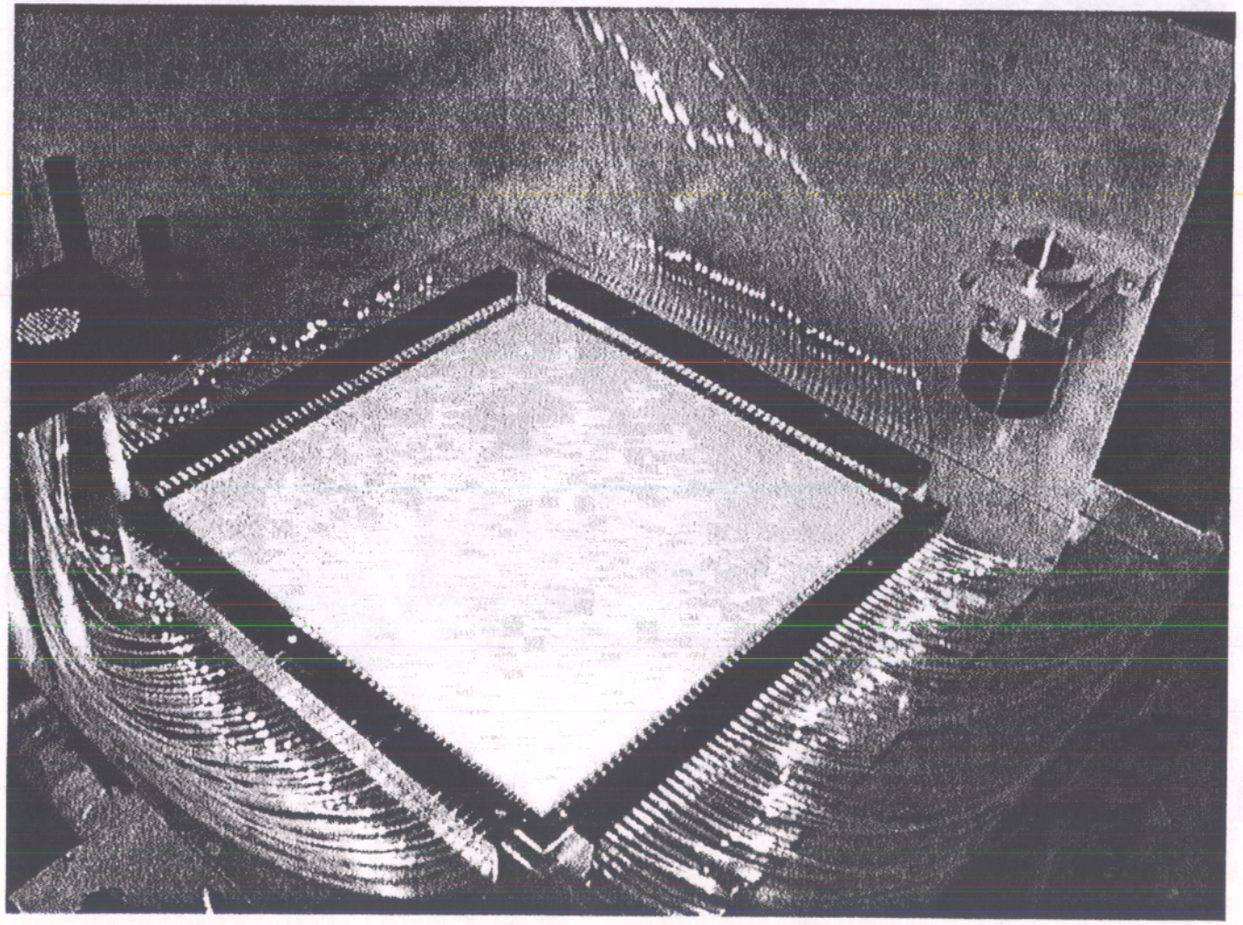


- Normalized scattering from 1-cm high germanium crystal
- $E_n \sim 0.056$ eV
- Detector 50-cm from crystal

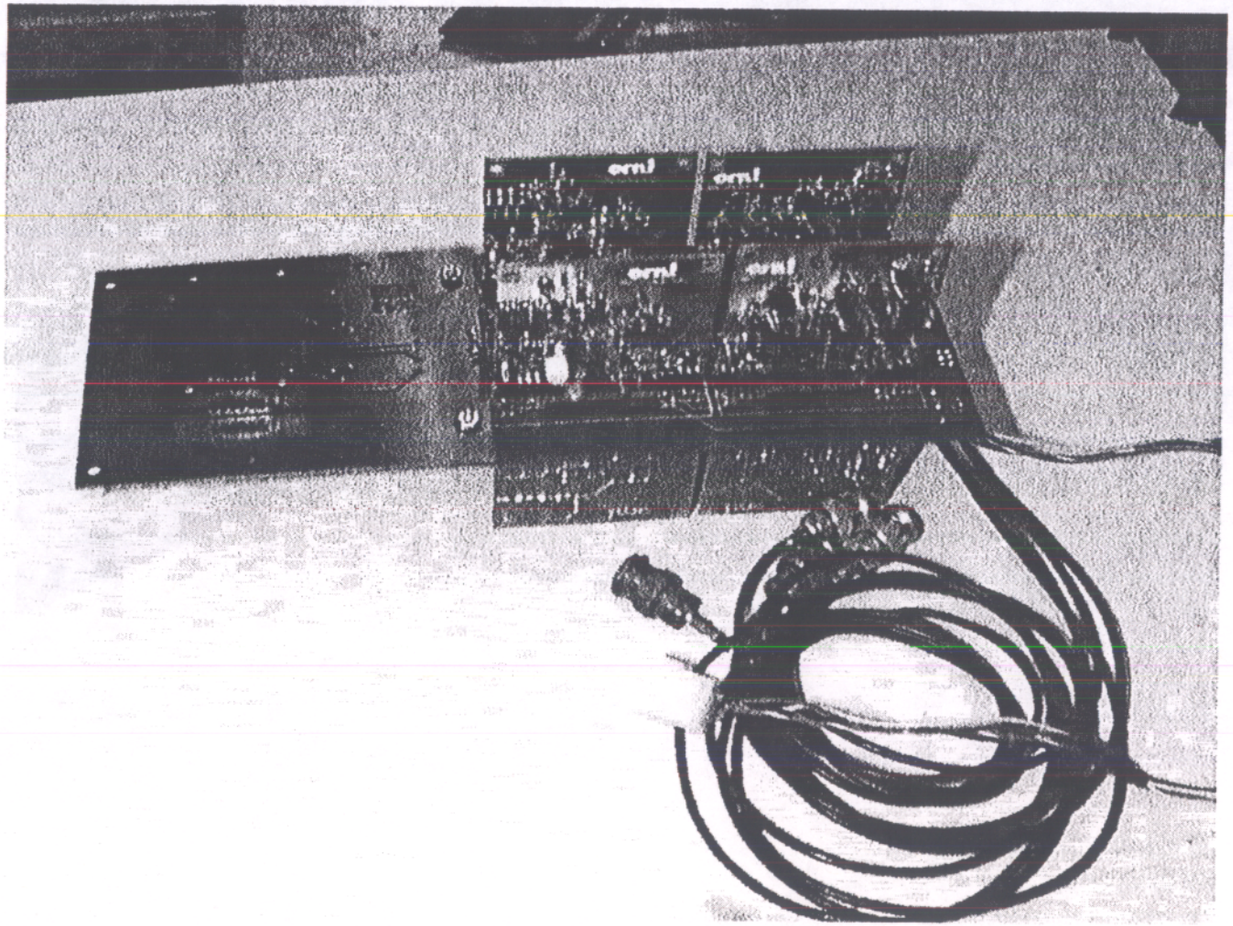
Crossed-fiber detector with Y-Axis fibers installed



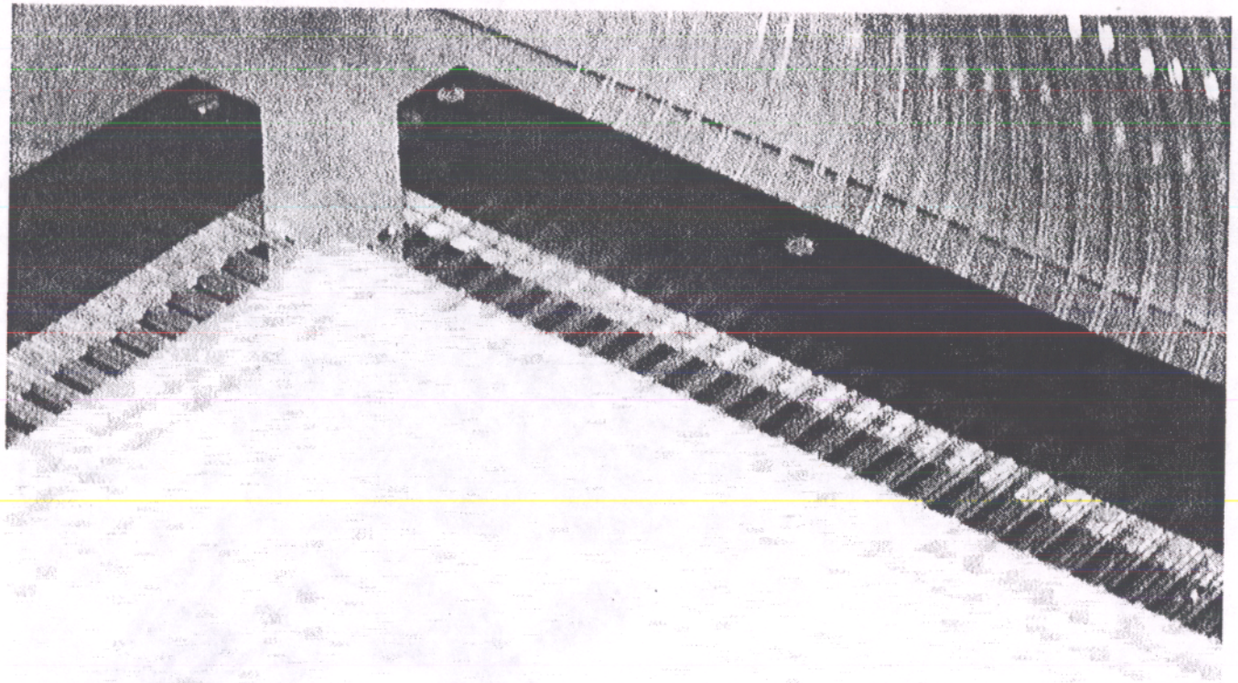
All fibers installed and connected to multi-anode photomultiplier mount



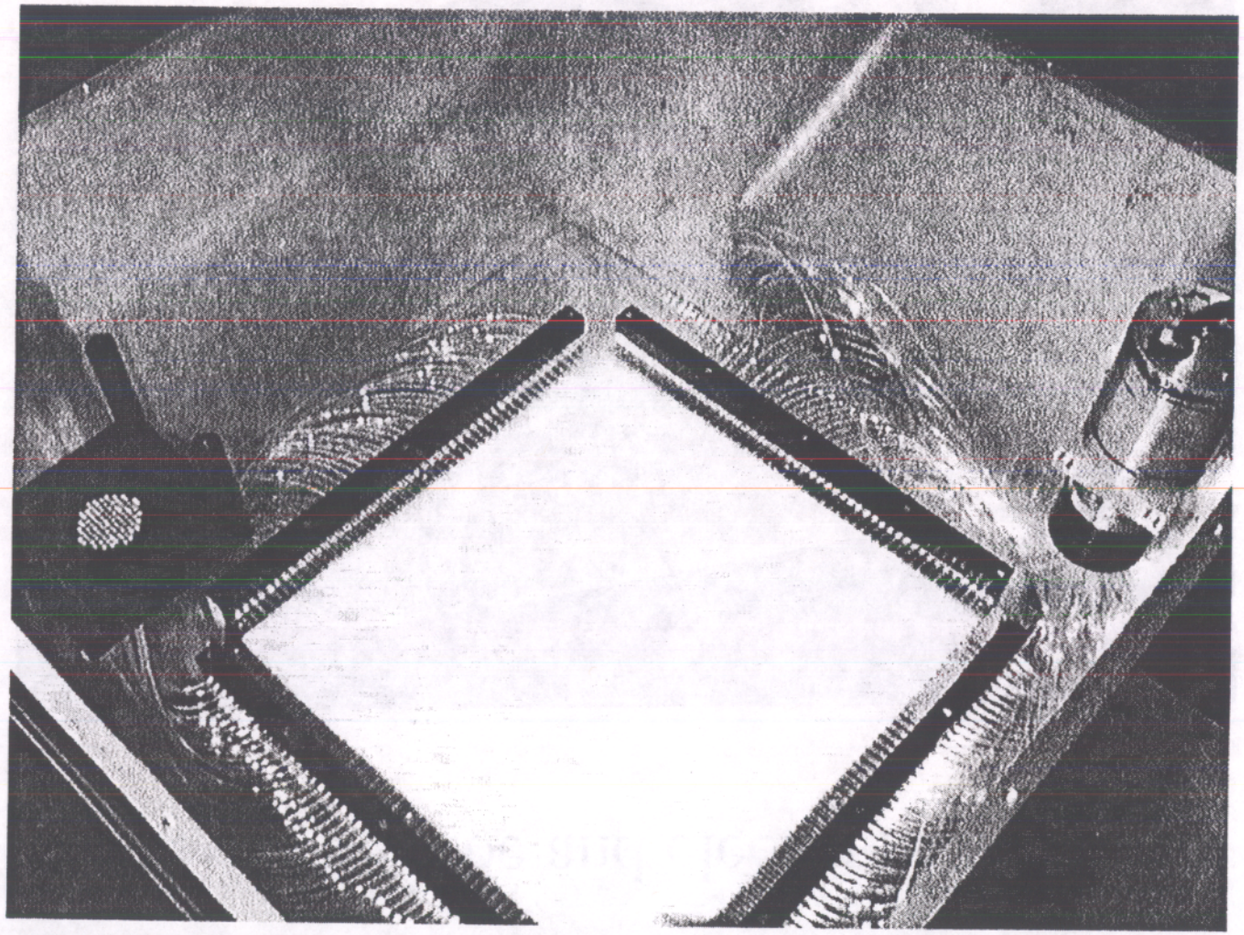
Charge-Sensitive Pre-Amp and Shaping Amplifier for Crossed-Fiber Detector



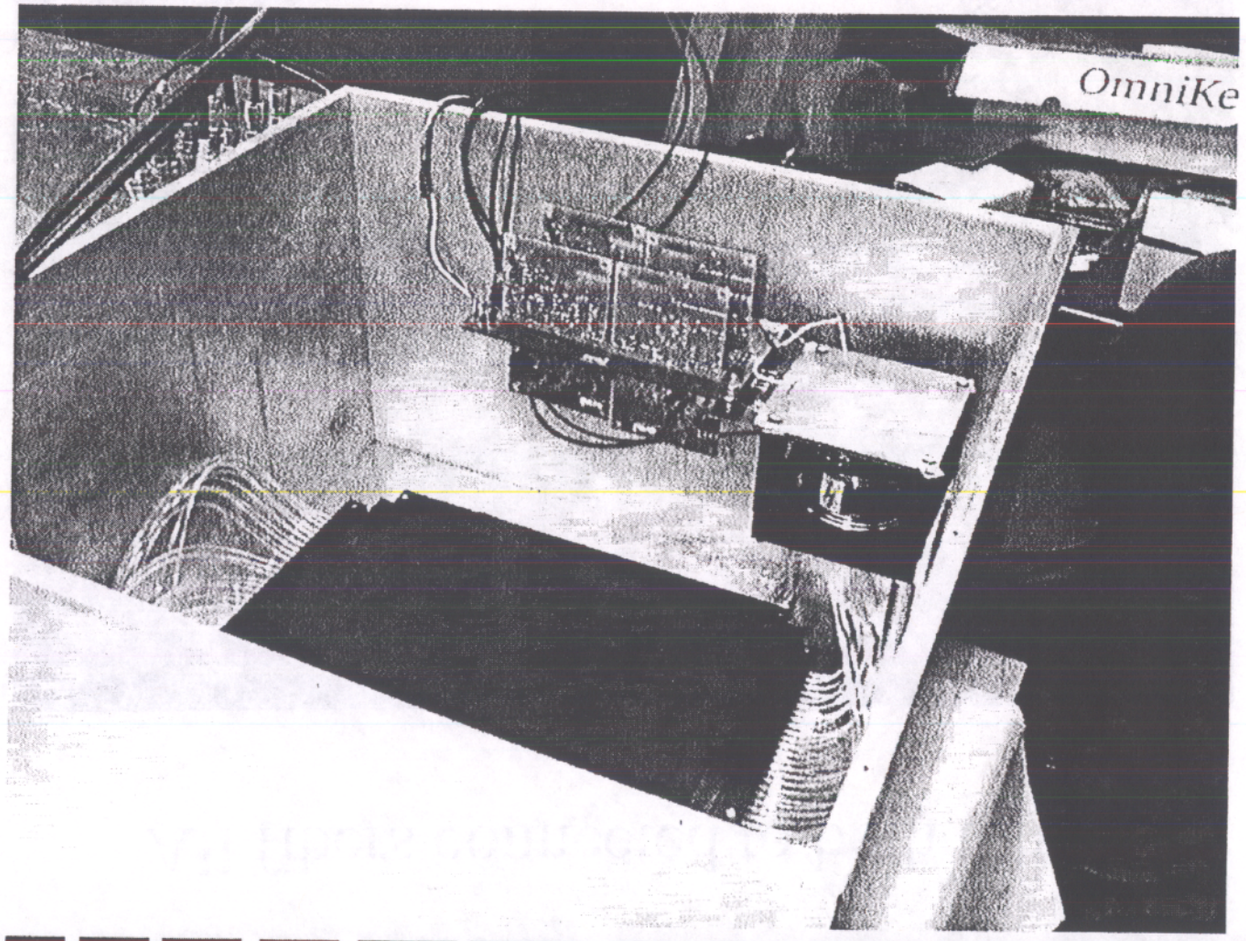
Close-up view of installed fibers on scintillator screen



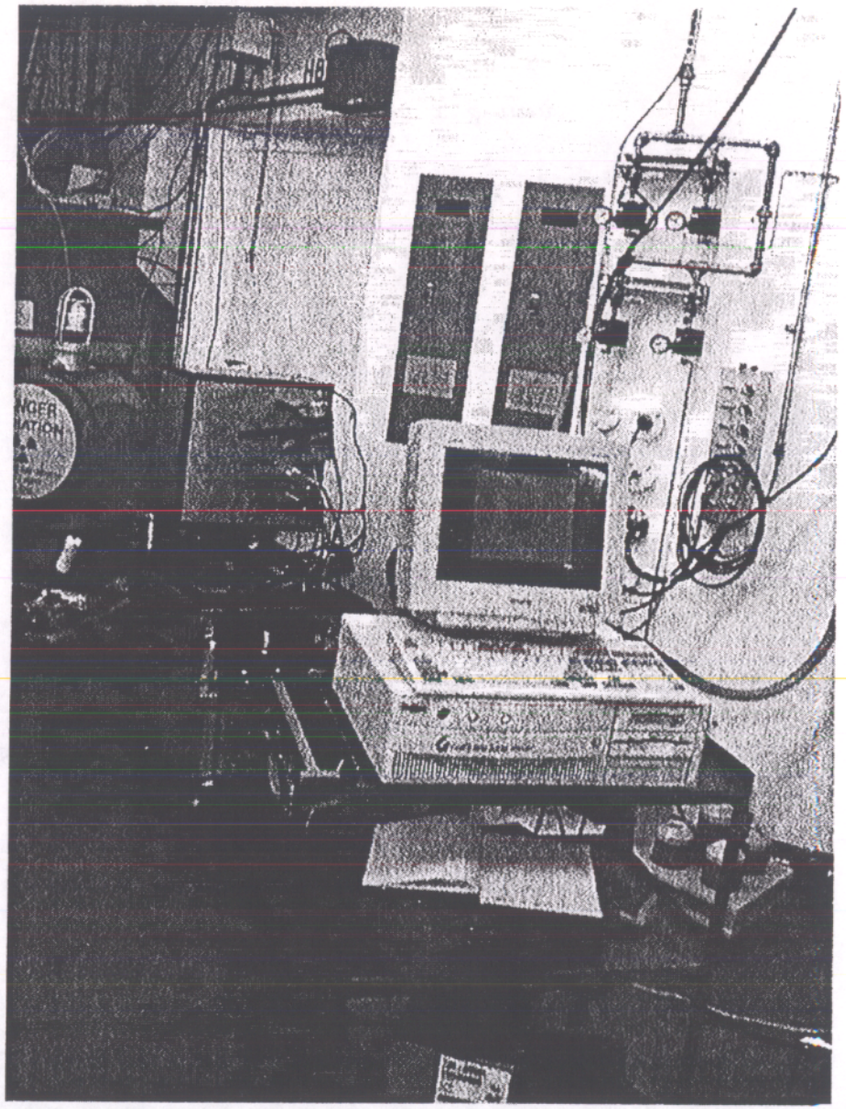
All fibers connected to both tubes

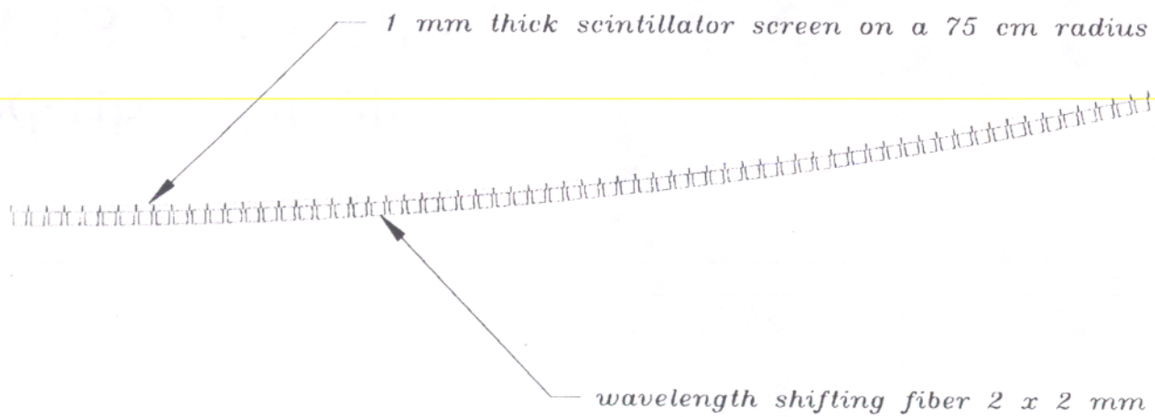


Multi-anode tube and electronics installed



Crossed-fiber detector at the HB-1B port at HFIR for testing.



Edge view of 64-element WAND prototype design

64 CHANNEL WAND SCREEN SECTION
WIDTH = 12.8 DEGREES