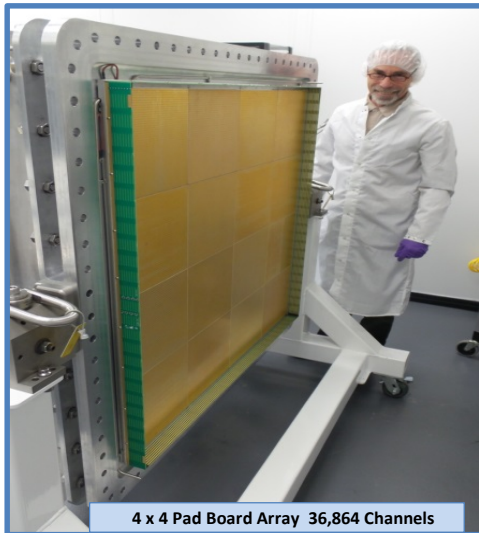


A Novel Thermal Neutron Pad Detector Operating in Ionization Mode

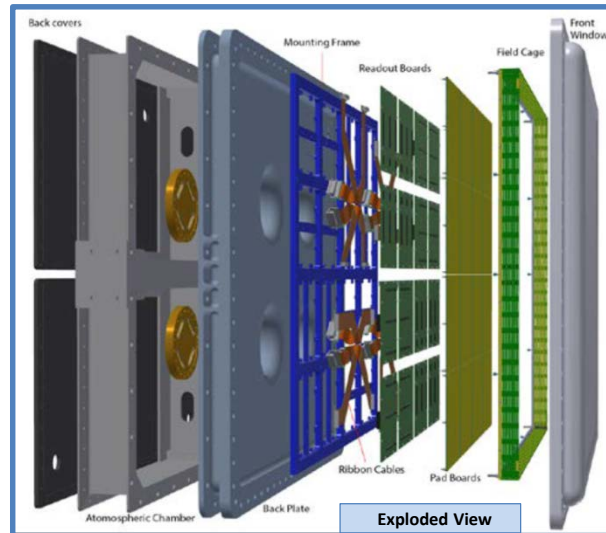
Jack Fried, George Mahler, Neil Schaknowski, Graham Smith, Bo Yu,
Brookhaven National Laboratory Instrumentation Division

Abstract:

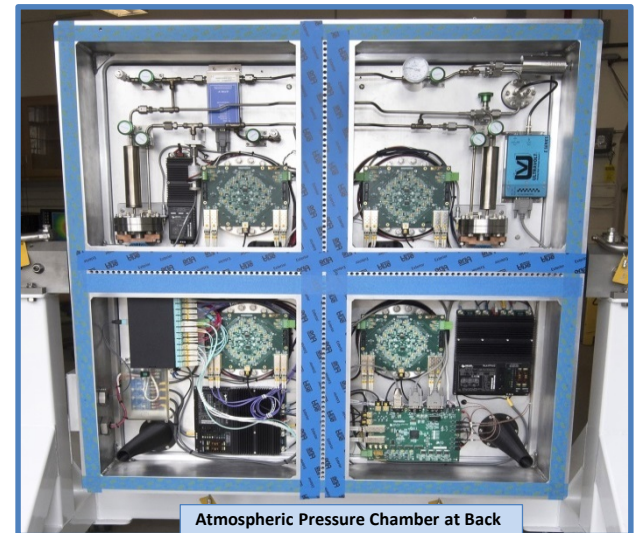
A new 1m x 1m thermal neutron detector has been developed for Small Angle Neutron Scattering (SANS), capable of rates significantly greater than present SANS detectors. The detector operates in ionization mode where electrons from the primary ionization products of the ^3He -neutron interaction are drifted to anode pads on the surface of an eleven layer printed circuit board (PCB). Low noise charge sensitive application specific integrated circuits (ASICs) are mounted directly on the back side of the PCB minimizing input capacitance to the ASIC. The result is an extremely low noise signal path between the anode pad and the ASIC preamp allowing for operation without gas gain, eliminating high voltage and aging problems which often plague current detector designs. The first detector of this type is now being commissioned at the Australian Nuclear Science and Technology Organisation



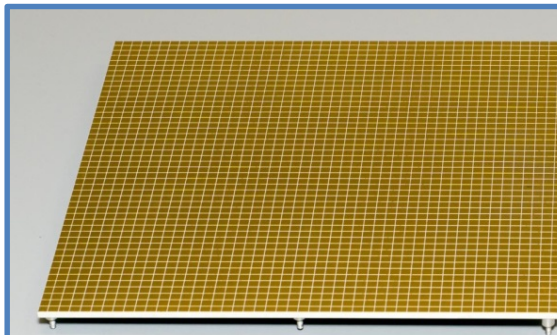
4 x 4 Pad Board Array 36,864 Channels



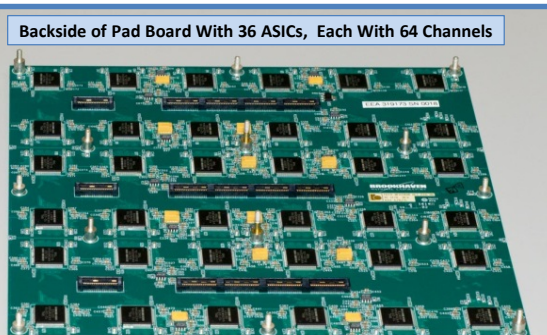
Exploded View



Atmospheric Pressure Chamber at Back



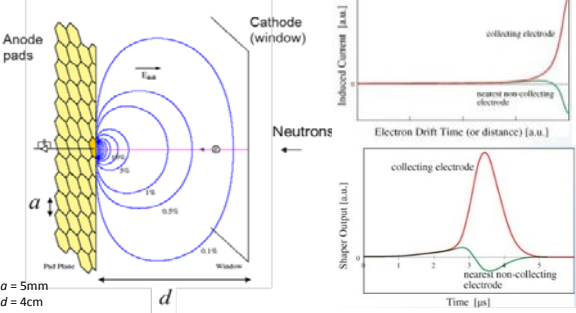
24 x 24cm Pad Board with 2,304 Anode Pads



Backside of Pad Board With 36 ASICs, Each With 64 Channels

Signal Formation on Pad Detector – No Electron Multiplication

Weighting potentials of a single pad in a parallel plate geometry where $d/a = 8$



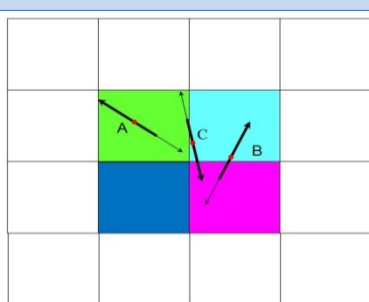
Physical Characteristics

- Active Area: 96 x 96cm
- Active Area is 16 pad Boards in a 4 x 4 Array
- Each Pad Board is a 48 x 48 Pad Array
- Total of 36,864 Independent Anode Pads
- Gas Fill: 2 Atm. ^3He with 0.75 Atm. CF_4
- 60 Liter Gas Volume
- 4cm Drift Depth, Drift Field < 500V/cm

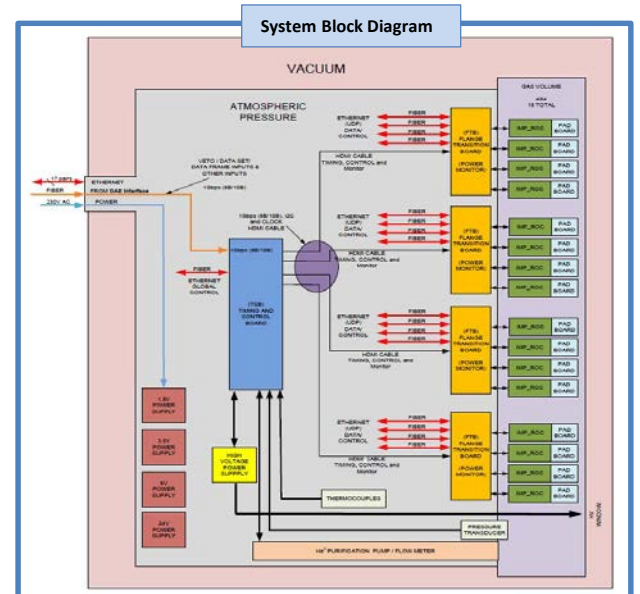
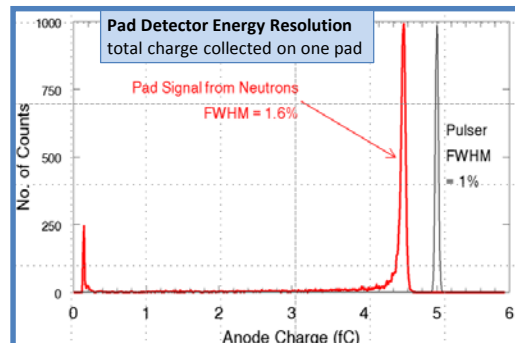
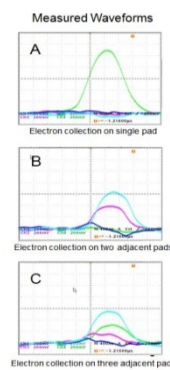
Performance Characteristics

- Position Resolution: $\leq 5\text{mm}$
- Timing Resolution: $\approx 5\mu\text{s}$
- Energy Resolution: $\leq 10\%$
- Individual Pad Rate Limit: $2.5 \times 10^3 \text{ n/s}$ (without analog signal distortion)
- Individual Pad Board Rate Limit: $2 \times 10^7 \text{ n/s}$ (limited by DAQ Gbit data rate)
- Whole Detector Rate Limit: $3 \times 10^8 \text{ n/s}$ (16 boards each @ 2×10^7)

Charge Collection on Anode Pads Restricted to No More Than Four Pads

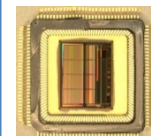


Proton/triton tracks in ^3He and 1 bar CF_4



ASIC Characteristics

- 64-channel ASIC, 2.3 mW/ch.
- 6.6mm x 8.5mm, 315k MOSFETs.
- Fabricated in CMOS 2.5V 0.25 μm .
- Electronic resolution < 120 electrons rms at 5 pF Energy, timing, address per event. (48 bits/event)
- Simultaneous measurement and readout.
- Current mode peak detector and digitizer (PDAD).
- Peak-detection and A/D conversion in real-time



Cd Mask (BNL) and 1mCi ^{252}Cf Source Close to Detector

