UT-BATTELLE

Radiation Detection for Active Interrogation of HEU

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Outline

- Detection Possibilities
- Coincidence Measurements
  - Between Detector
  - With Source
- Detectors
- Matrix of Sources and Potential Measurements

Detection Possibility from Fission

- Prompt Neutrons
- Prompt Gamma Rays
- Delayed Neutrons
- Delayer Gamma Ray

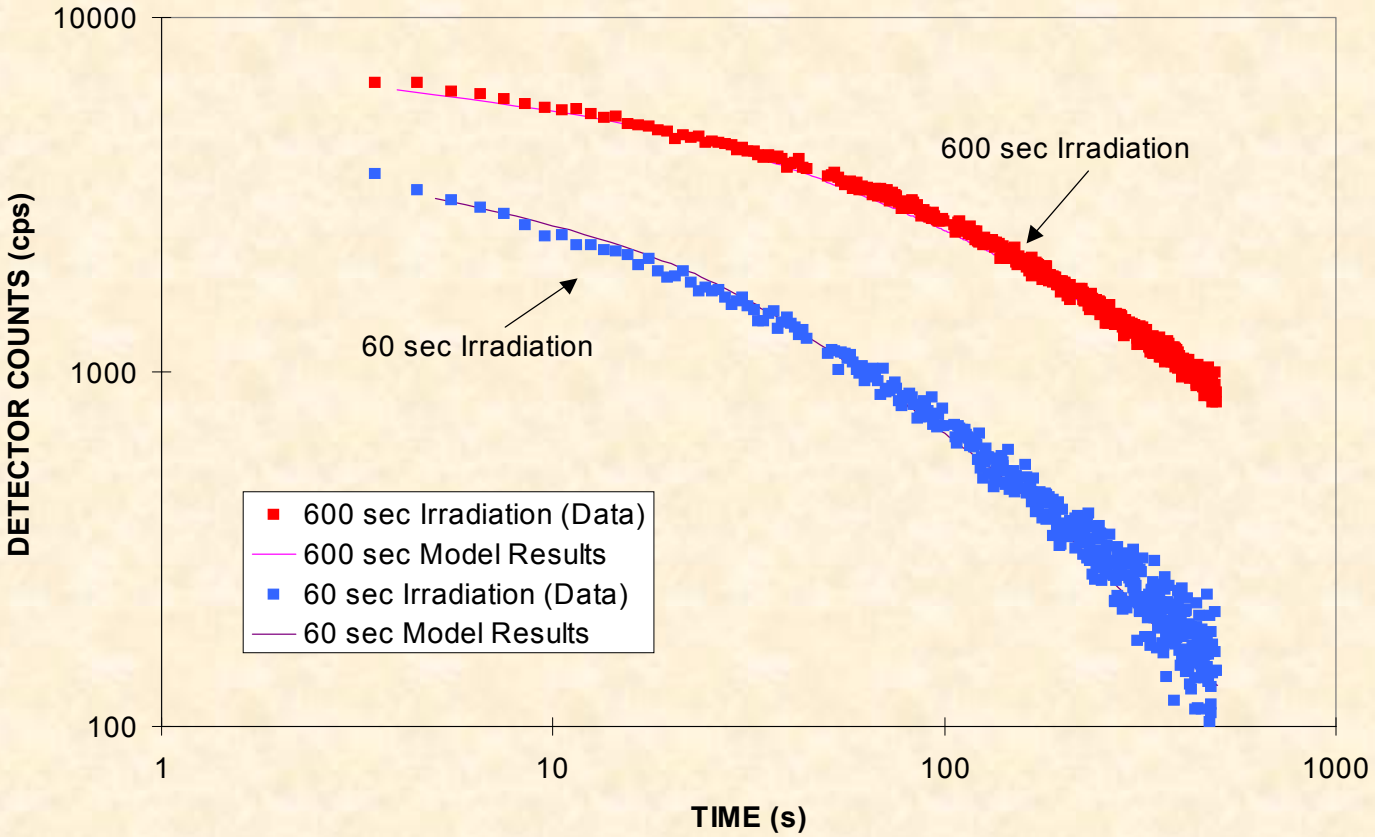
Delayed Neutron Data of Keepin, Wimmett, and Zeigler

Group	Relative Yield	Decay constant (sec^{-1})
1	0.038	0.0127
2	0.213	0.0317
3	0.188	0.115
4	0.407	0.311
5	0.128	1.40
6	0.026	3.87

Delayed Gamma Data

Group #	α_i (γ/s per fission)	λ_i (s^{-1})
1	0.35	0.4
2	0.06	0.04
3	0.015	0.008
4	0.0015	0.0008
5	0.0002	0.00005

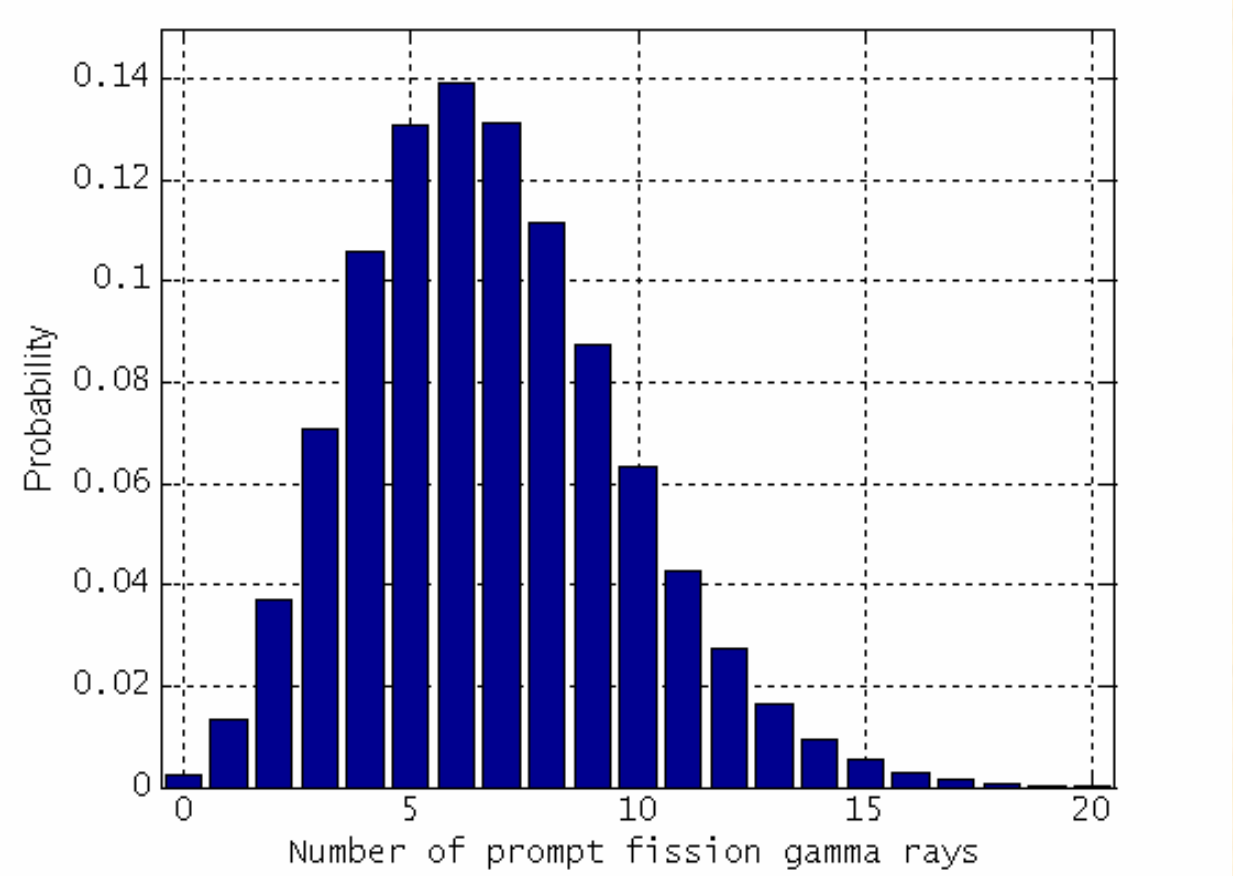
Comparison Between ORNL Irradiation Measurements and Delayed Gamma Decay Model Predictions



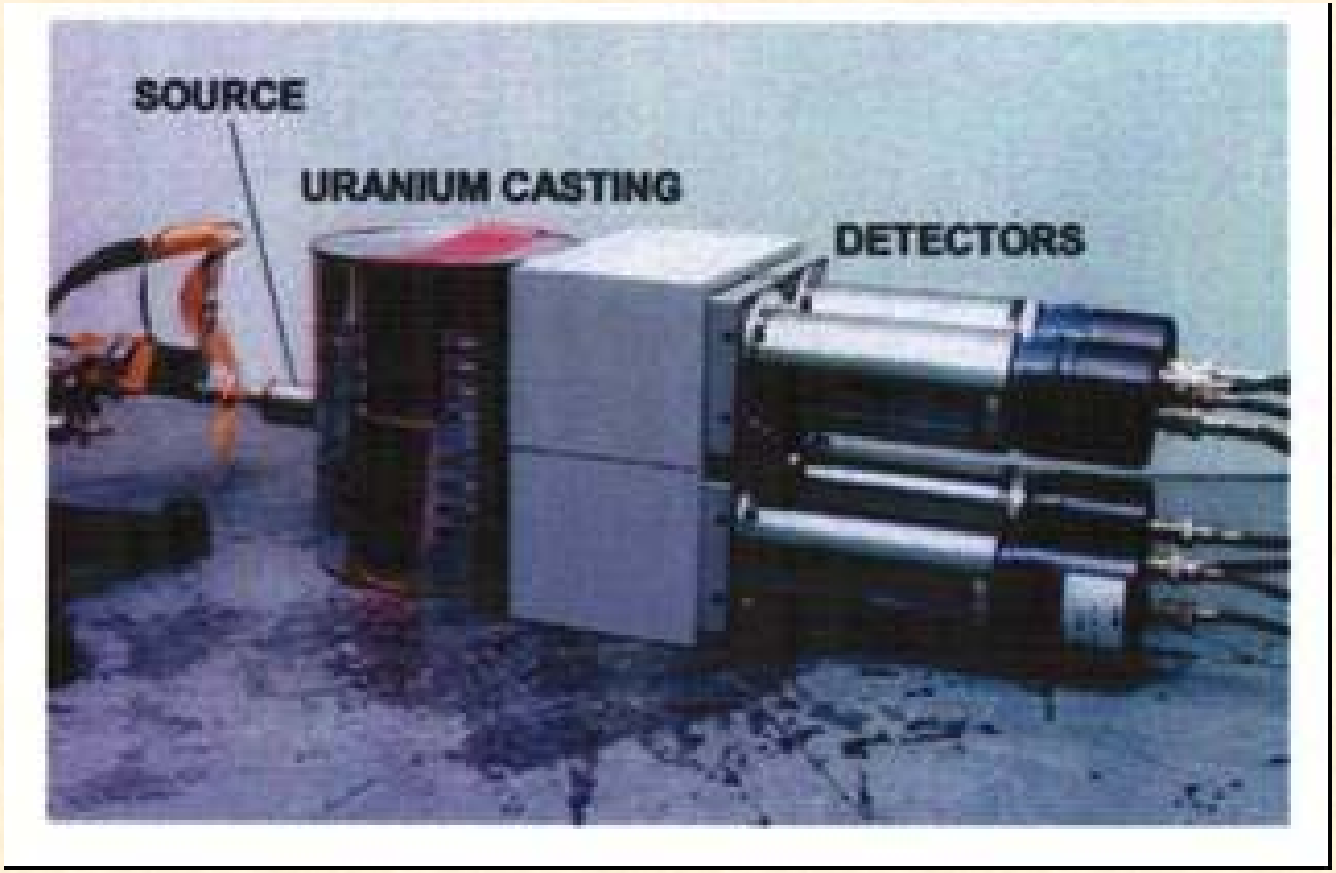
Distribution of Prompt Neutron Numbers for Thermal Fission of 235U

Number of neutrons	Fraction of emissions
0	0.0313
1	0.1729
2	0.3336
3	0.3078
4	0.1232
5	0.0275
6	0.0038

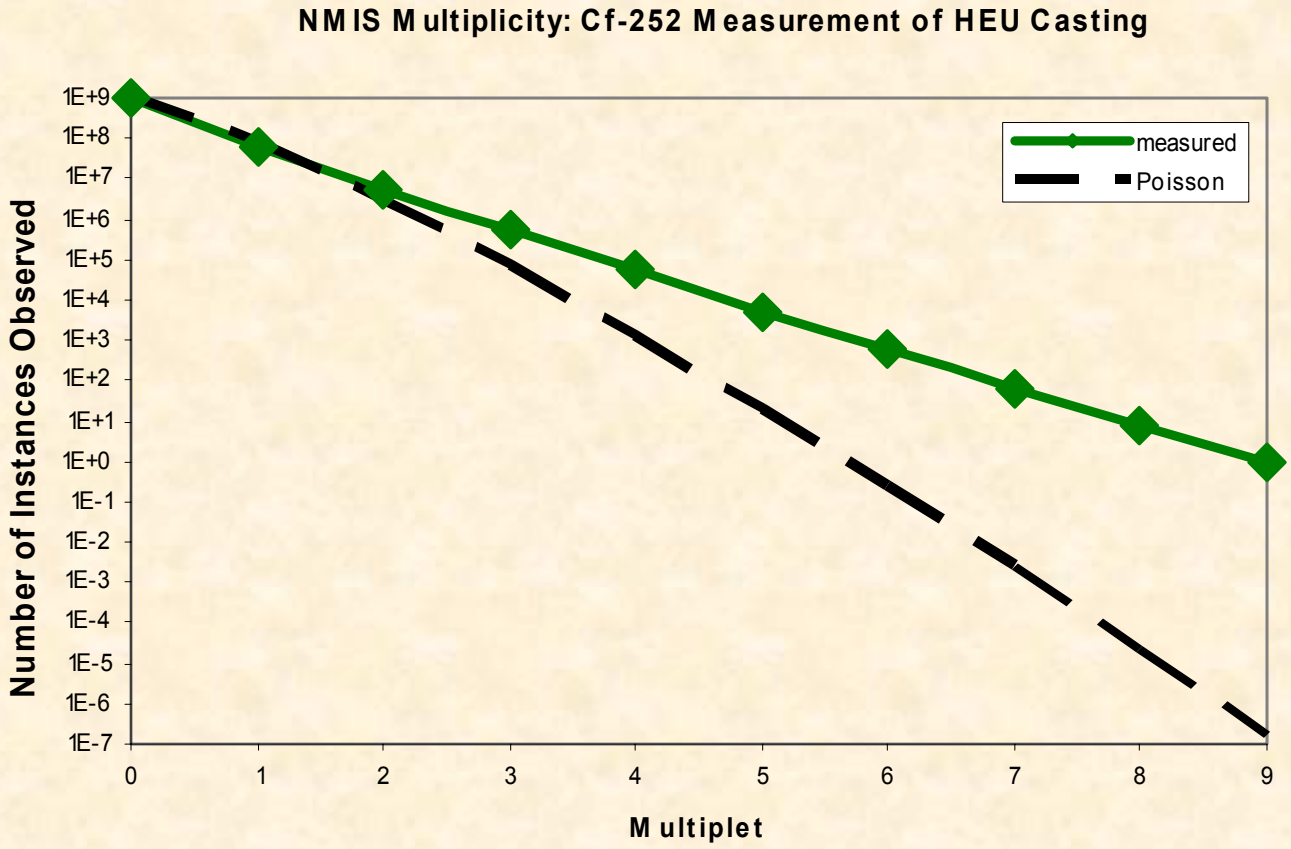
Thermal Neutron Induced 235U Multiplicity of Prompt Gamma Rays from the Negative Binomial Distribution of Valentine



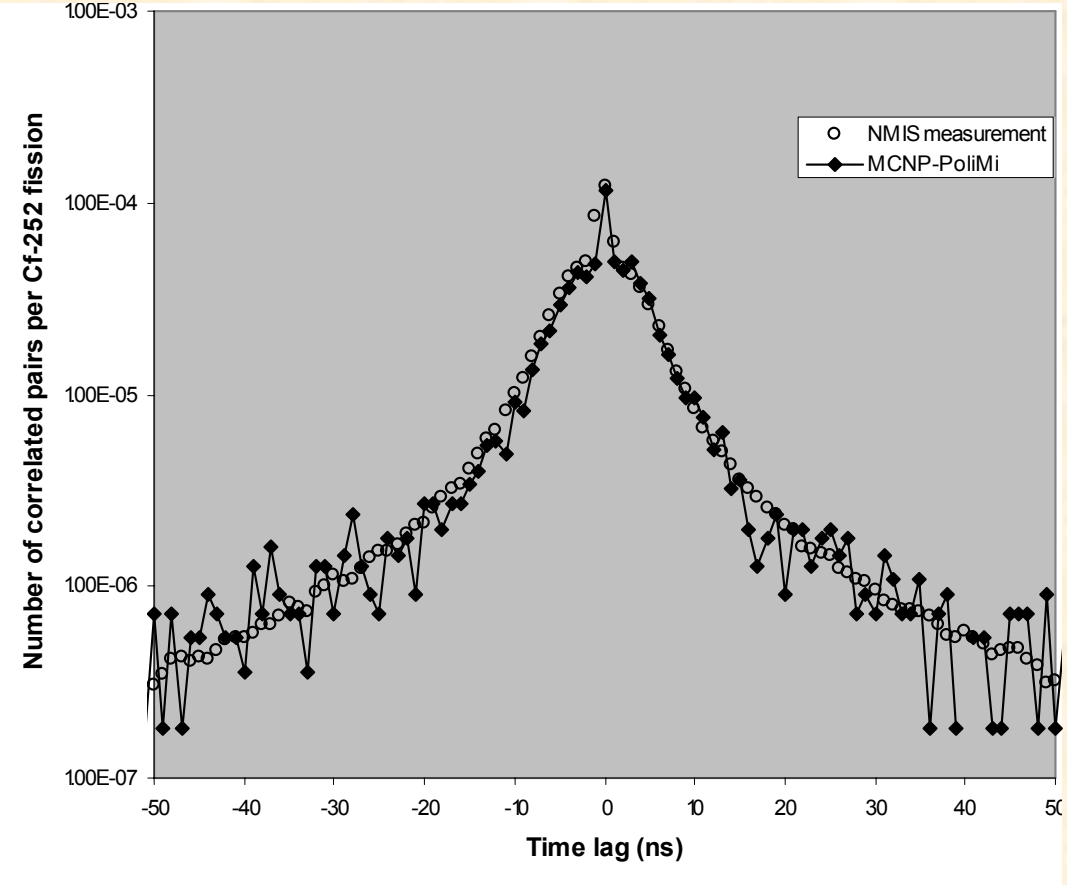
Source-casting-detector Configuration for Measurements for a 18.75 kg HEU (93.2 st of 235U) Metal



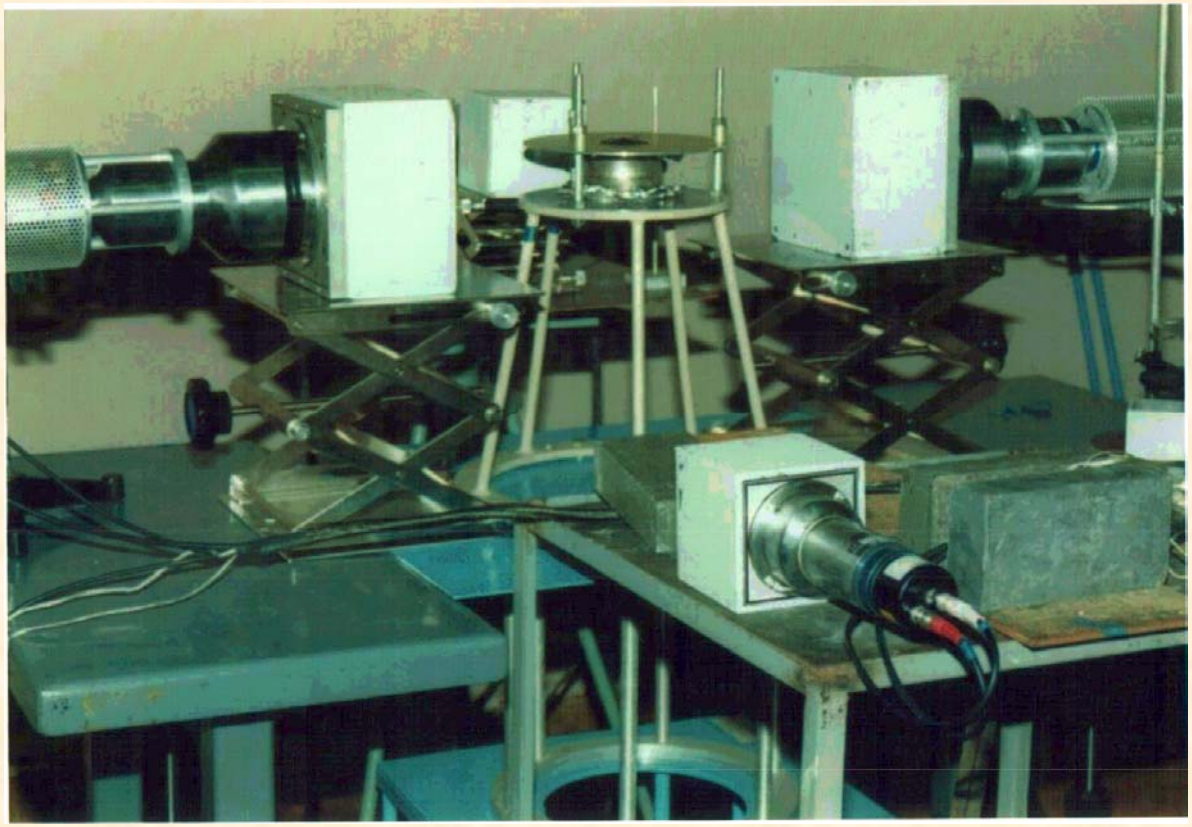
Number of Times n Pulses Occur in a 512 nsec Window from Plastic Scintillators (from NMIS ~8.5 Minute Measurement in 1997) for a HEU (93.2 235U) 18.75 kg Metal Casting



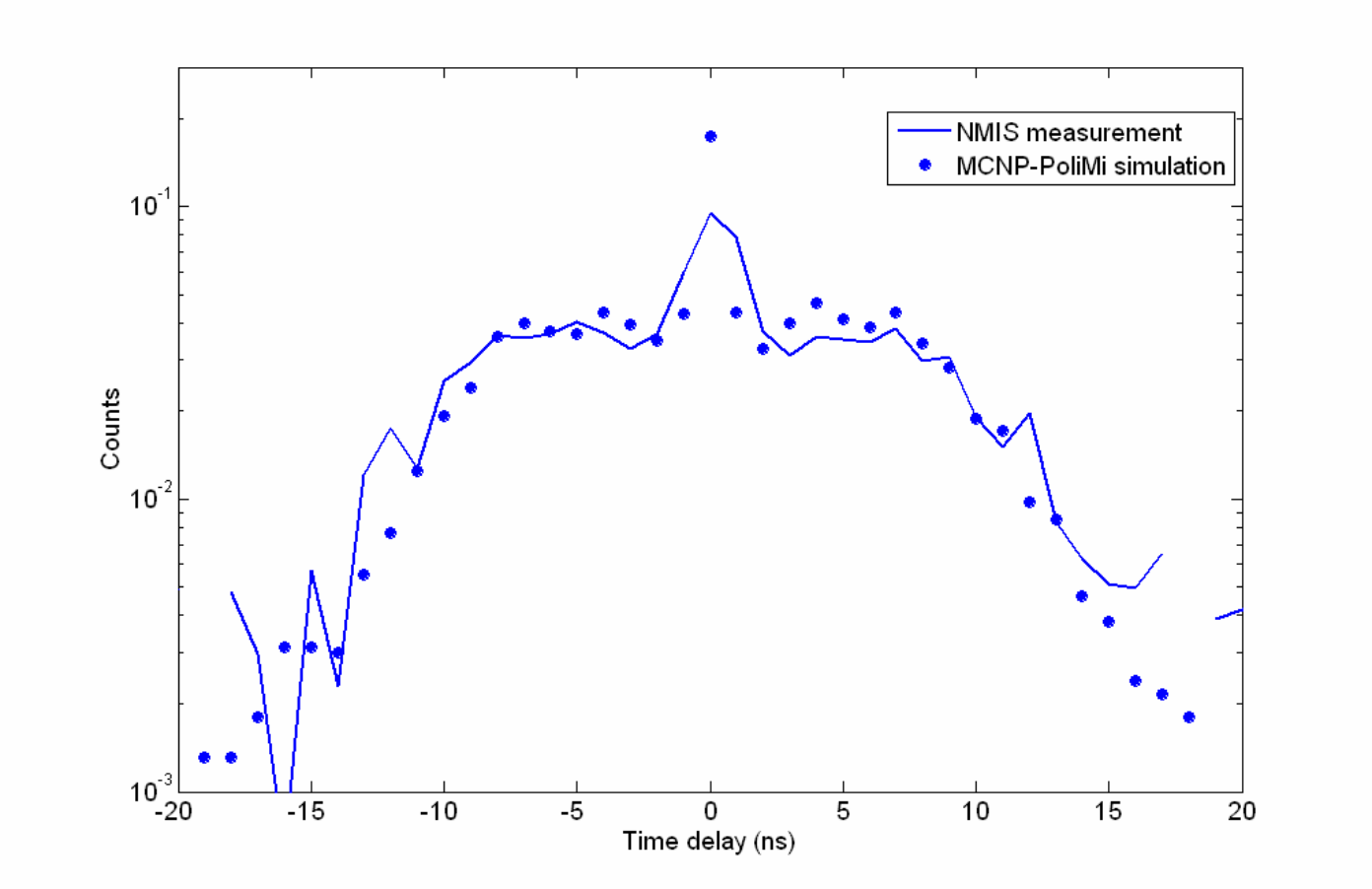
Time Distribution of Coincidences Between Two Plastic Scintillation Detectors for an Annular 18.75 kg HEU (93.2 235U) Metal Storage Casting



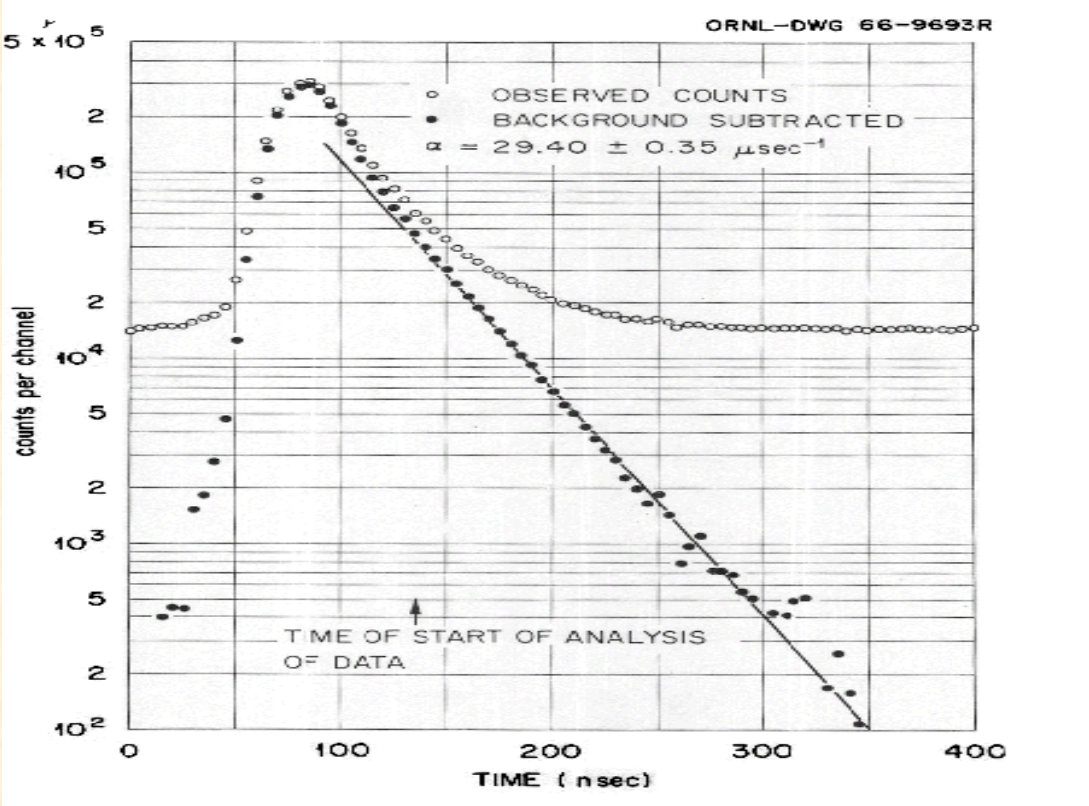
Photograph of the Plastic Scintillator Arrangement and a 4 kg Pu Metal (1.77% 240Pu) Spherical Shell With One Detector Removed



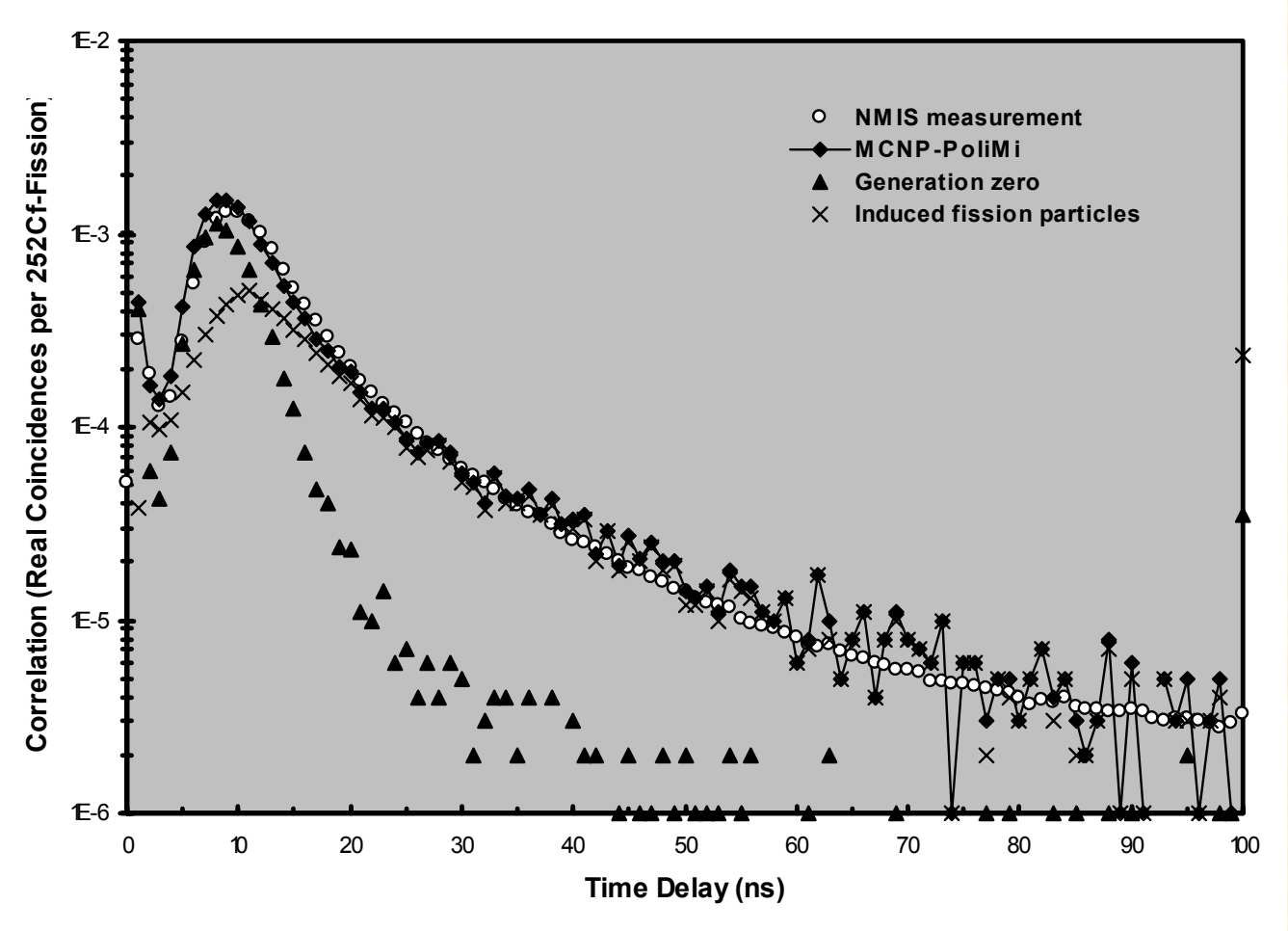
Time Distribution of Coincidences Between Two Plastic Scintillation Detectors for a 3.3 Kg Pu Metal (1.77 wt of 240Pu) Spherical Shell



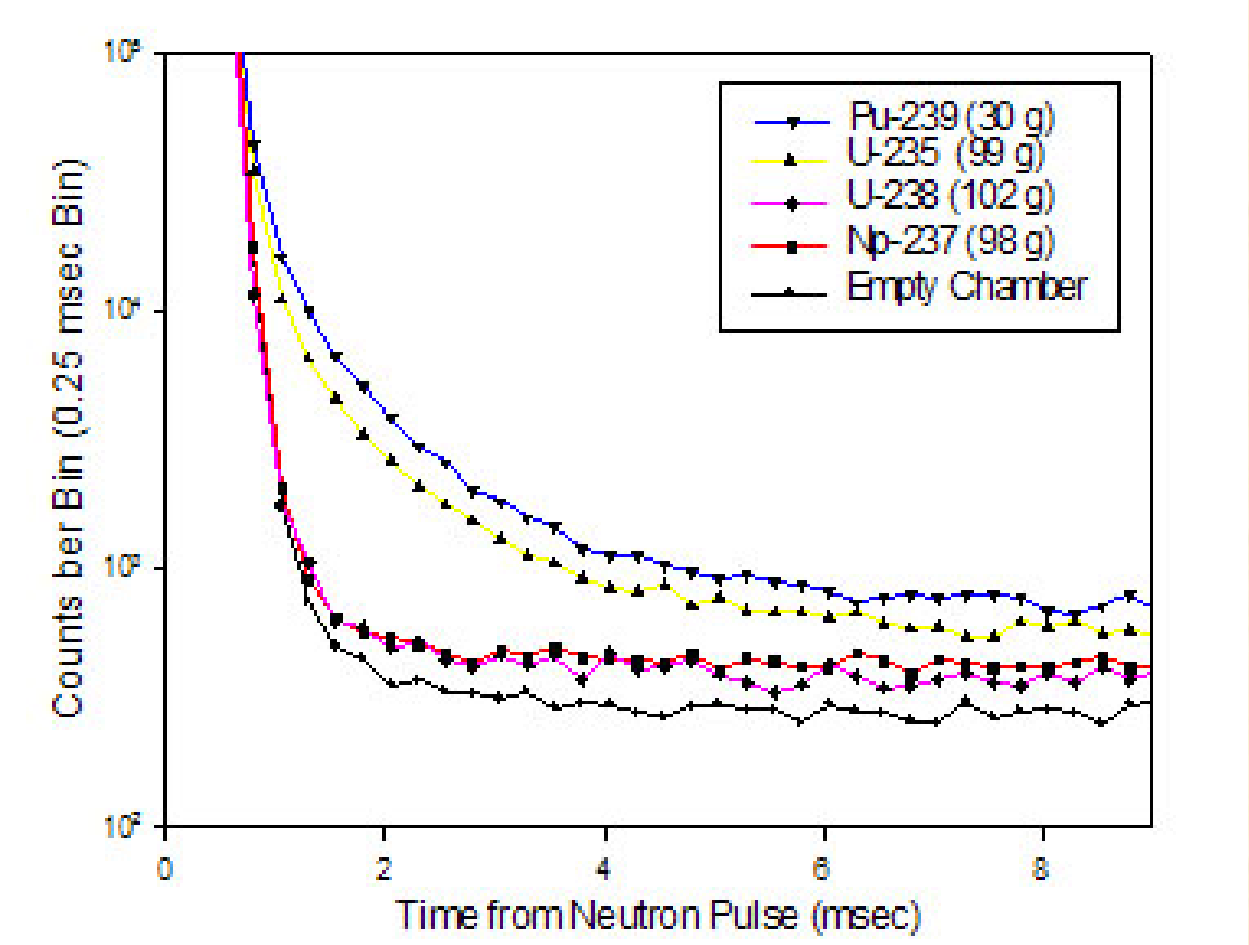
Time Distribution of Count After 30 nsec Accelerator Pulses for an 11-in.-diam, 2.5-in.-high HEU Cylinder



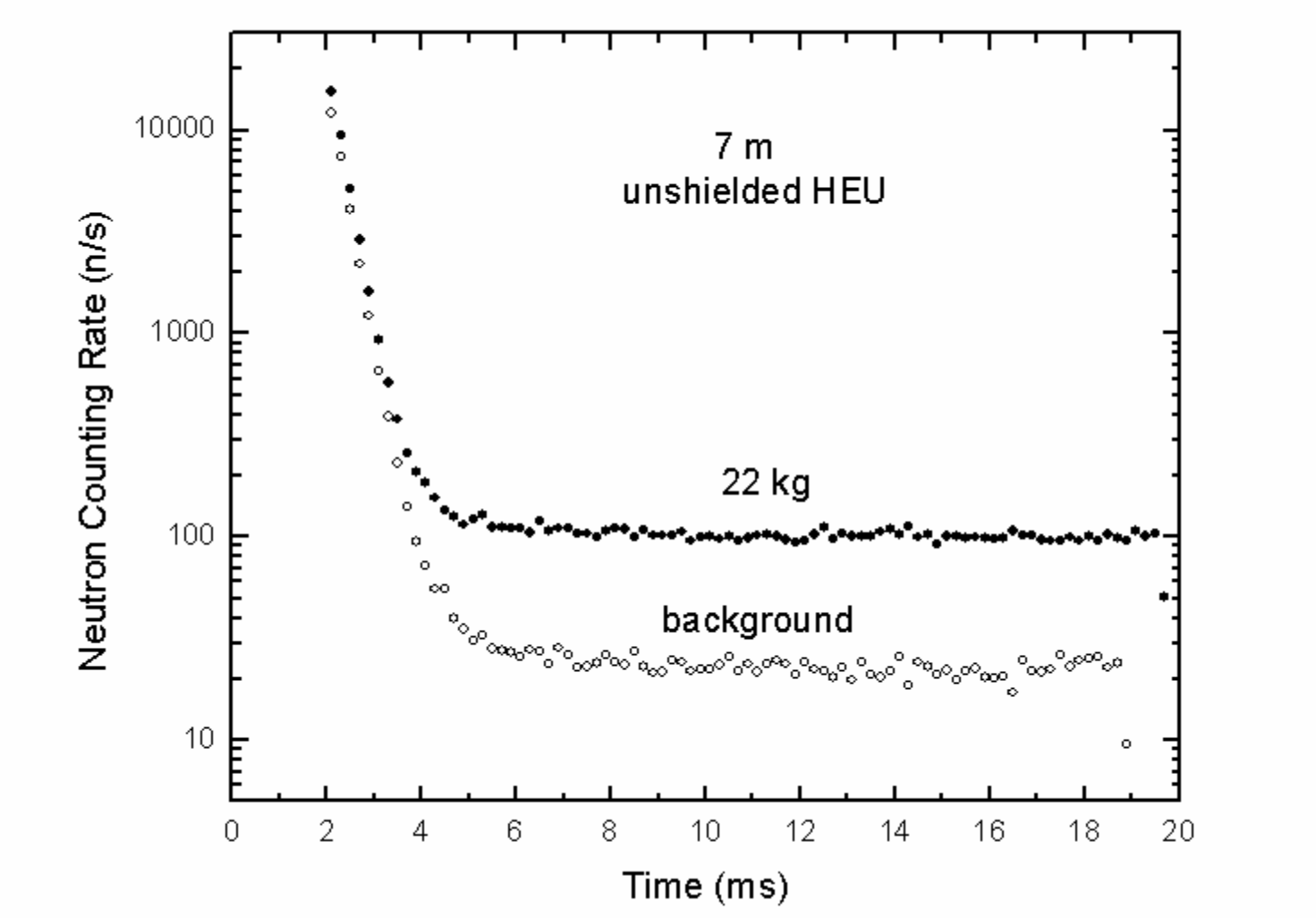
Time Distribution of Counts in a Plastic Scintillator after Cf Fission for an Annular 18.75 kg HEU Metal Storage



Typical Differential Dieaway Data from a Package Monitor at LANL (courtesy of C. Moss) Casting



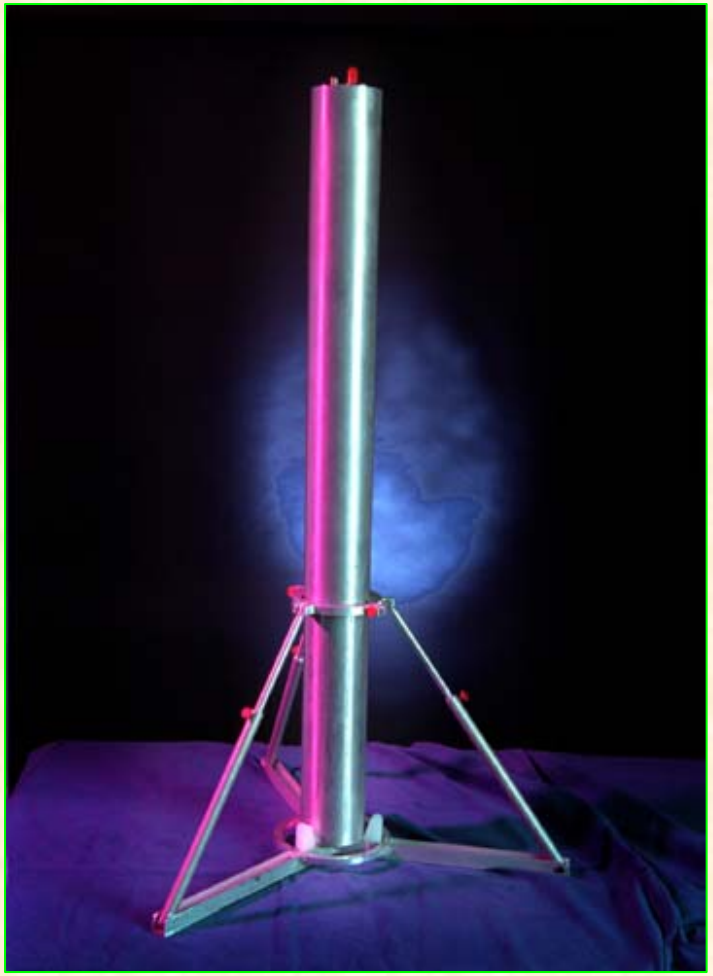
Response with Linac and Large-area Detector



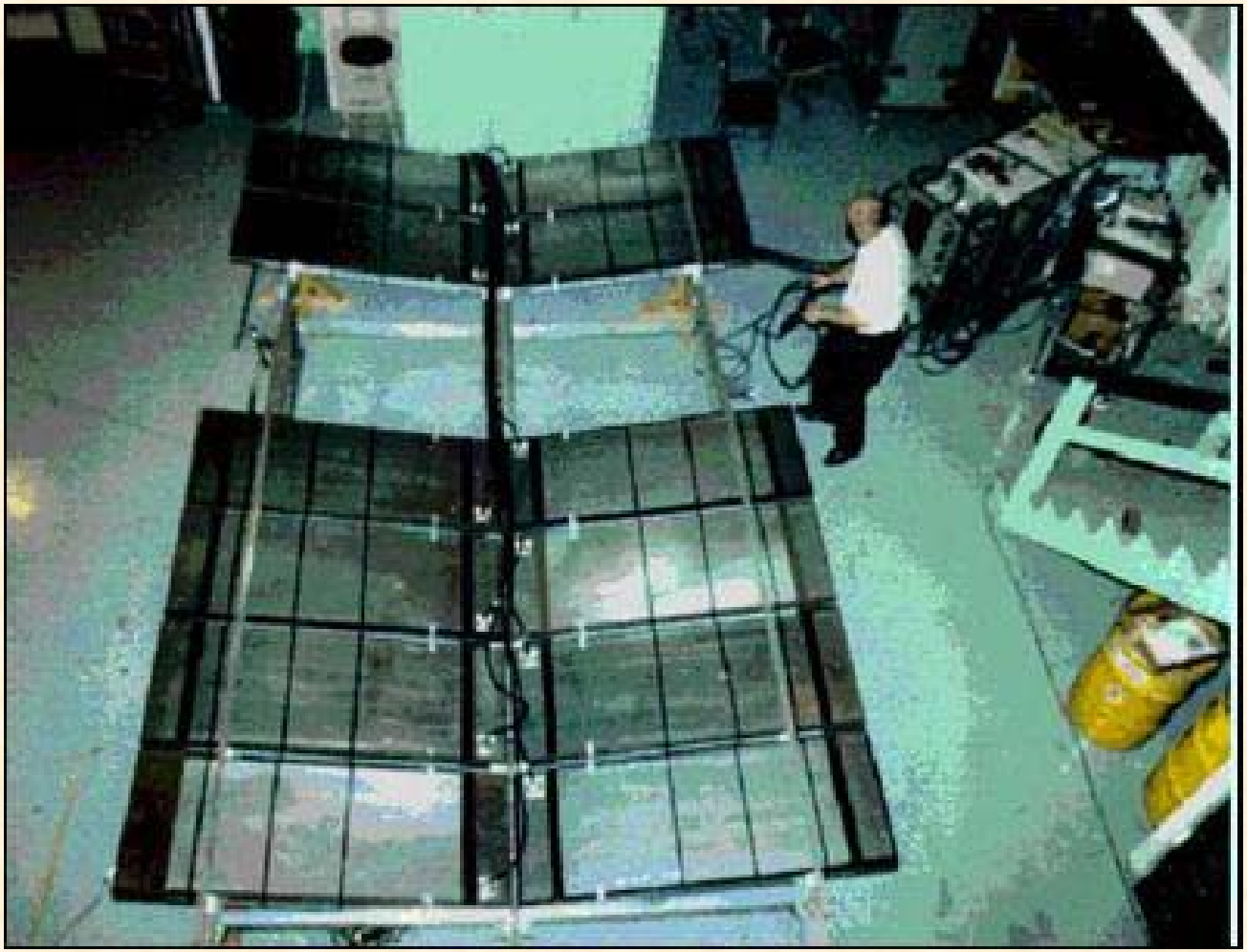
Large-area (4 × 8 ft), 3He Neutron Detector Panel

Portable 3He Detector in Moderator (51 × 43 × 10 cm Dimensions)

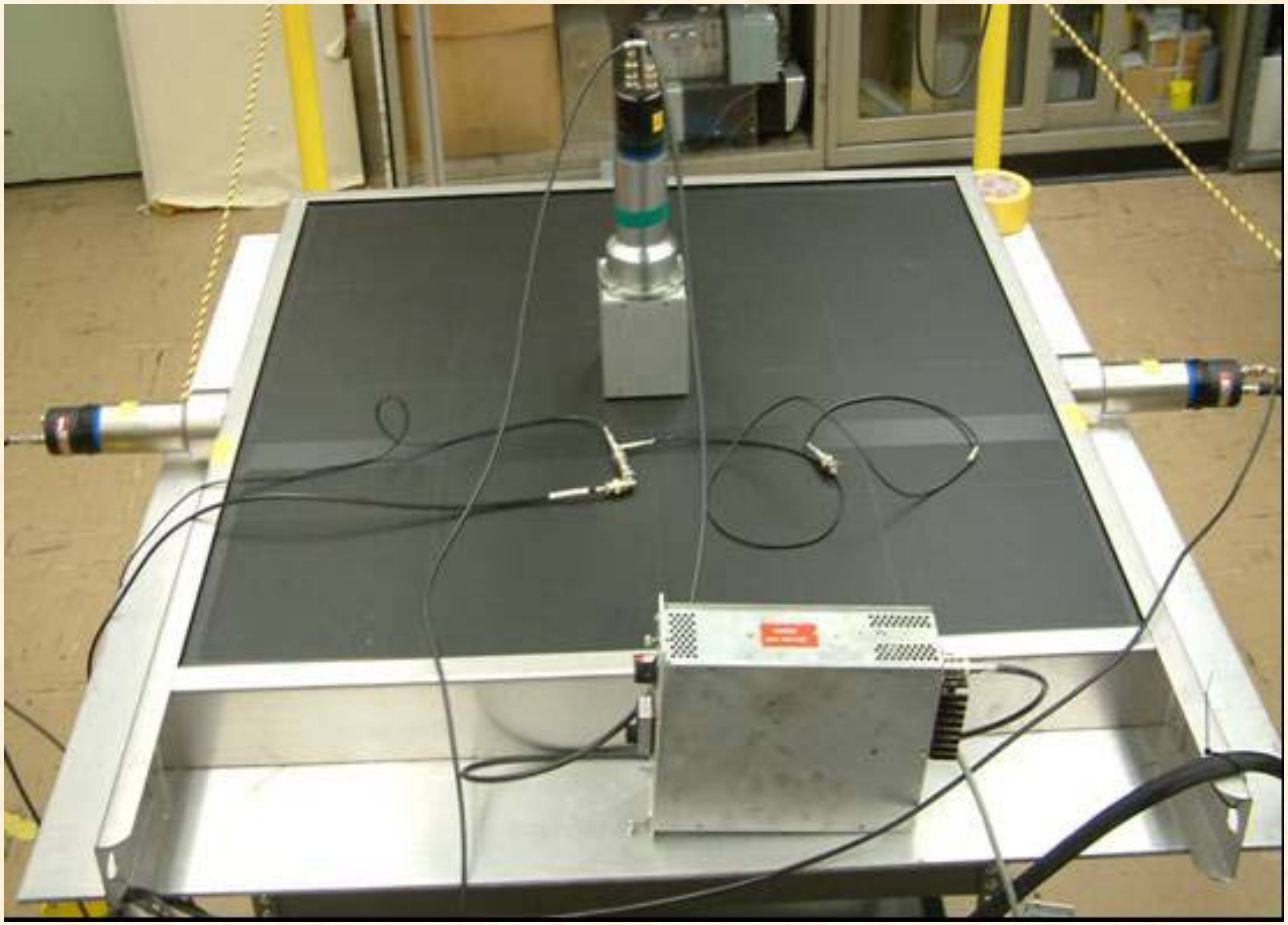
INEL's 3He Proportional Counter for Pulsed LINAC Photo Fission Measurements



Large Panels of 6Li Glass Fiber Thermal Neutron Detectors



Photograph of a 1x1 meter Plastic Scintillator in Testing at ORNL



Matrix of Interrogating Sources and Potenial Measurements

INTERROGATION SOURCE	Prompt time Correlations			Delayed time correlations			Count Rate	Gamma Ray Spectrometry
	Multiplets	With Source	Detector Detector	Multiplets	With Source	Detector Detector		
1.1 Low energy stimulated multiplication (60KeVn)	DP*	BP	DP	BP	BP	BP	BP	
1.2 High energy stimulated multiplication (14.1 MeVn)	SS**	SS**	SS**	BP	BP	BP	BP	
1.3 PFNA (14.1MeVn)				BP	AP***	BP	BP	
1.4 High energy monoenergetic photofission (4-14MeVp)				BP	BP	BP	BP	HPGe
1.5 Neutron induced fission from thermalized 2.5MeVn	DP		DP	BP	AP	BP	BP	
1.7 Monoenergetic Photon induced fission (6-7MeVp)	SS		SS	BP	AP	BP	BP	HPGe
2.1 Thermal neutron induced fission (14.1 MeVn)			-	BP		BP	BP	
2.2 Thermal neutron induced fission (5-8MeVn)	-		-					>3MeV
2.4 Photon (bremstralung) induced fission, delayed neutron detection (7-9MeVp)	-	AP	-	BP	AP	BP	BP	
2.6 Pulsed photonuclear assessment (PPA) bremstrahlung (10-20MeVp)		AP		BP	AP	BP	BP	HPGe

* BP means between pulses, DP means during source interrogation, and AP means immediately after pulsing.
** DT generator operated steady state with alpha detector to define a cone of neutrons.
*** Differential dieaway.