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Lawrence Livermore National Laboratory's Book of Minimum Detectable Activity for Direct Measurement of Internally Deposited Radionuclides in Radiation Workers

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Lawrence Livermore National Laboratory maintains an in vivo measurement program designed to identify and evaluate the activity of radionuclides deposited in the body. Two types of systems are primarily used for the routine monitoring of radiation workers, the lung counting system and the scanning bed whole body counting system.

The lung counting system is comprised of two Canberra ACTII detector sets. Each ACTII set contains two planar germanium detectors with carbon composite end windows optimized to measure low energy photon emitting radionuclides. The ACTII detectors are placed on the upper torso over the lungs for the direct measurement of internally deposited radionuclides in the lungs that emit low energy photons. A correction for the thickness of the chest wall is applied to the efficiency. Because the thickness of the chest wall is a key factor in the measurement of low energy photon emitting radionuclides in the lung, the minimum detectable activity is a function of the chest wall thickness.

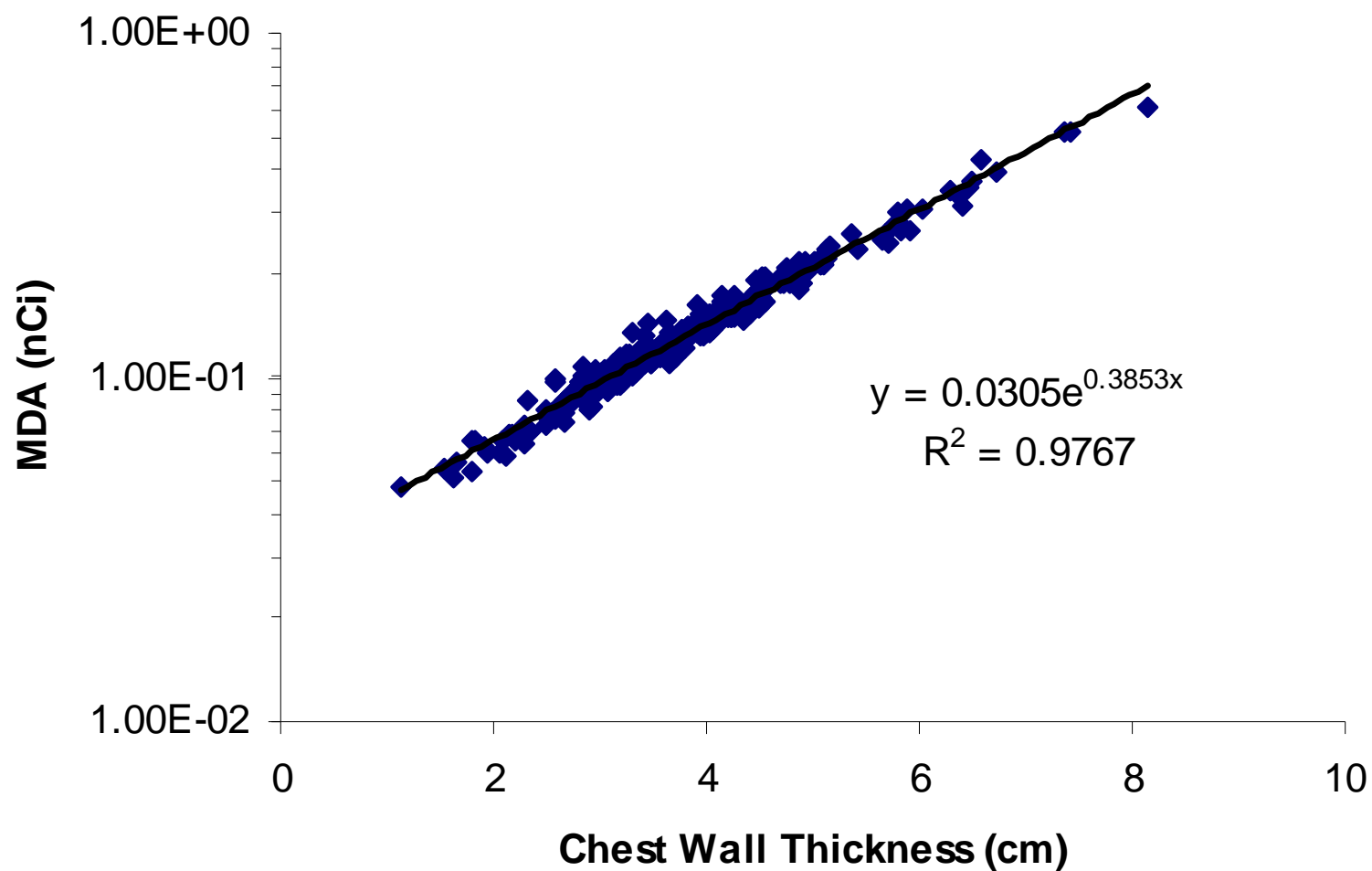
The scanning bed whole body counting system is comprised of a thin air mattress on top of a carbon fiber bed that slowly scans over four high purity germanium detectors. The scanning system is designed to minimize variations in detected activity due to radionuclide distribution in the body. The scanning bed detection system is typically used for the measurement of internally deposited radionuclides that emit photons above 100 to 200 keV. MDAs have been generated for radionuclides that provide energies above 80 keV since the lowest calibration energy for the system is approximately 86 keV.

The following charts and table provide best determination of minimum detectable activity using human subjects as controls for the background contributions. A wide variety of radionuclides are used throughout the laboratory and the following pages represent several of the radionuclides that have been encountered at the Whole Body and Spectroscopy Laboratories within Hazards Control.

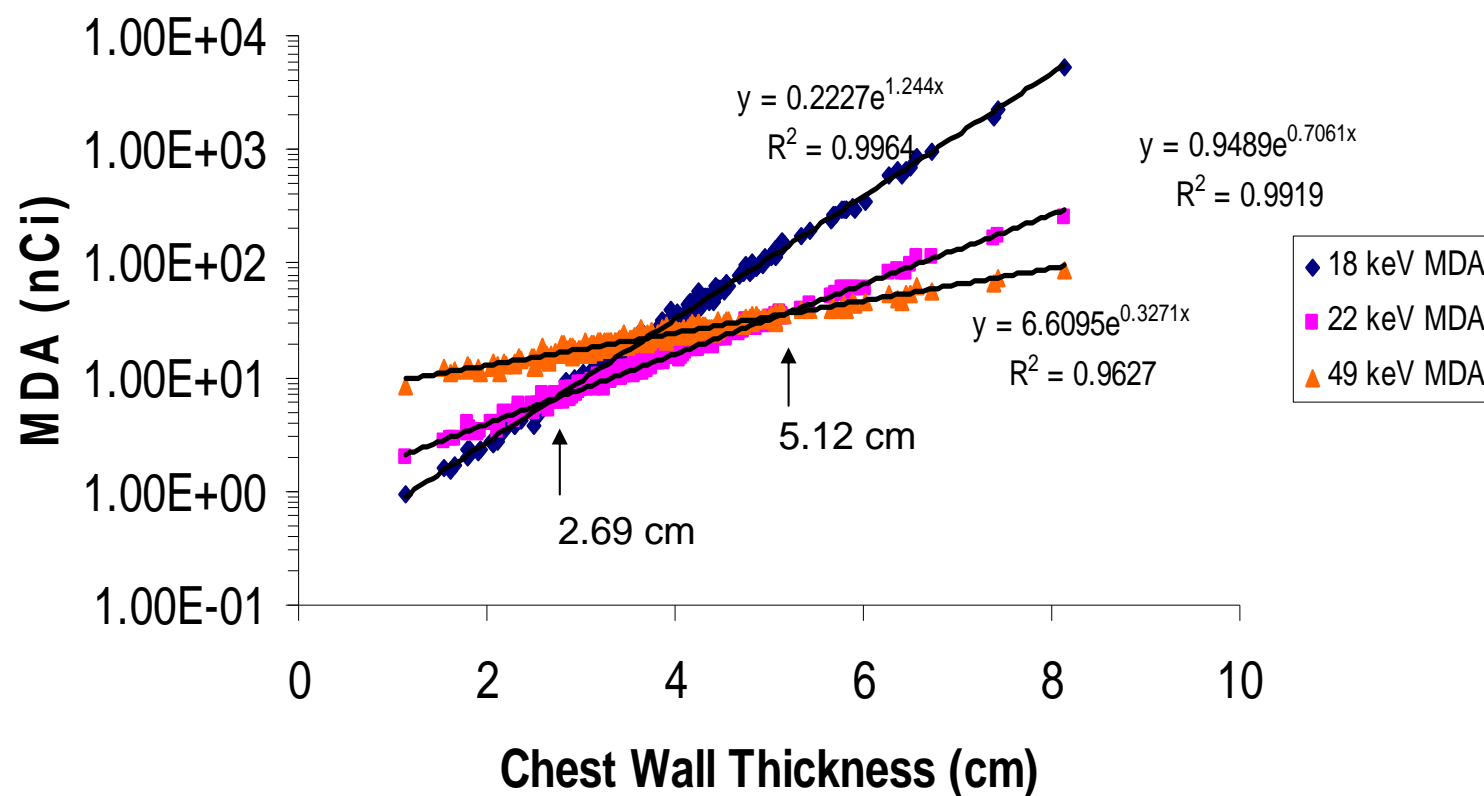
LUNG COUNTING MINIMUM DETECTABLE ACTIVITIES



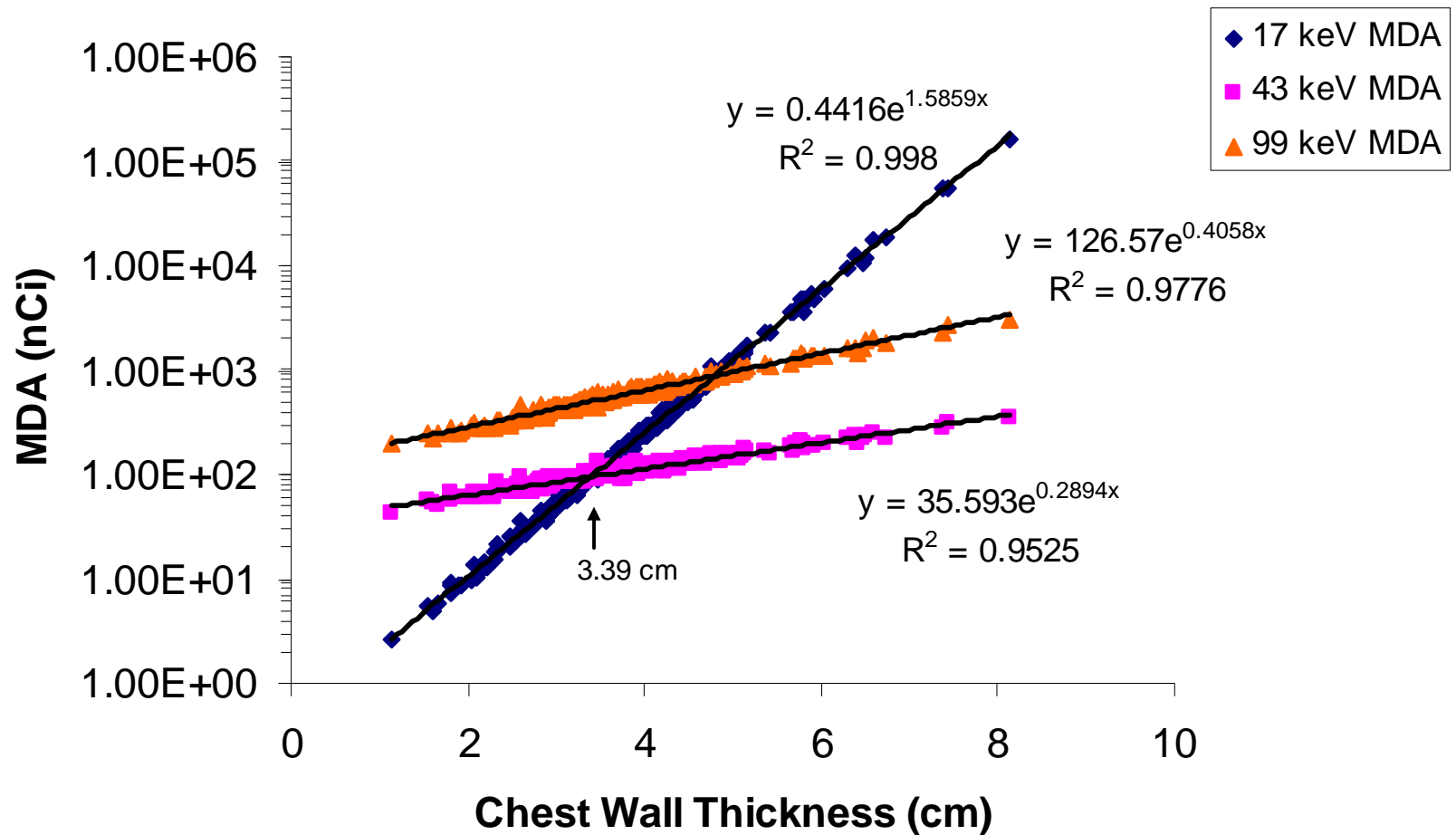
Am-241 (Pu Indirect) Lung Count Minimum Detectable Activity



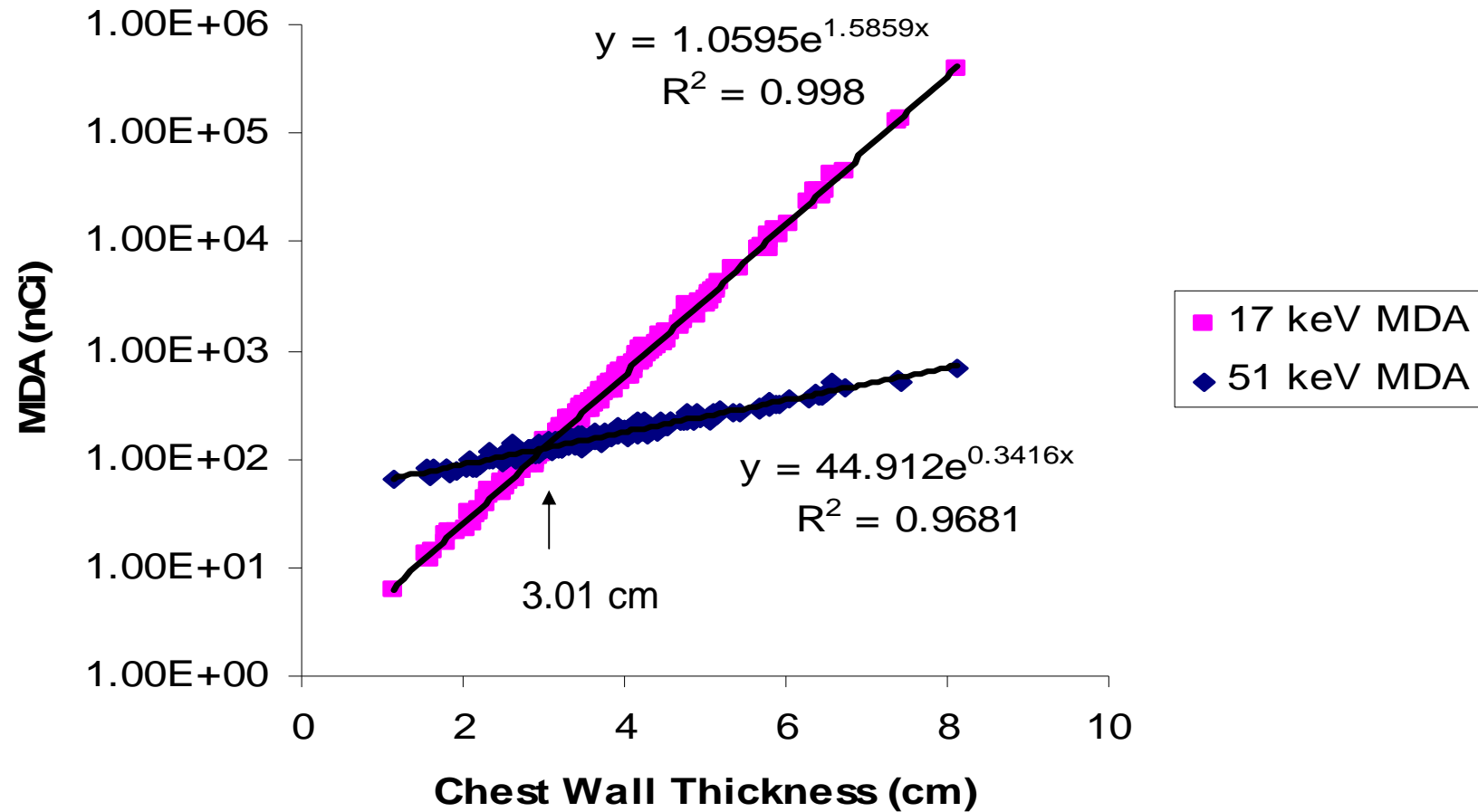
Am-242m Lung Count Minimum Detectable Activity



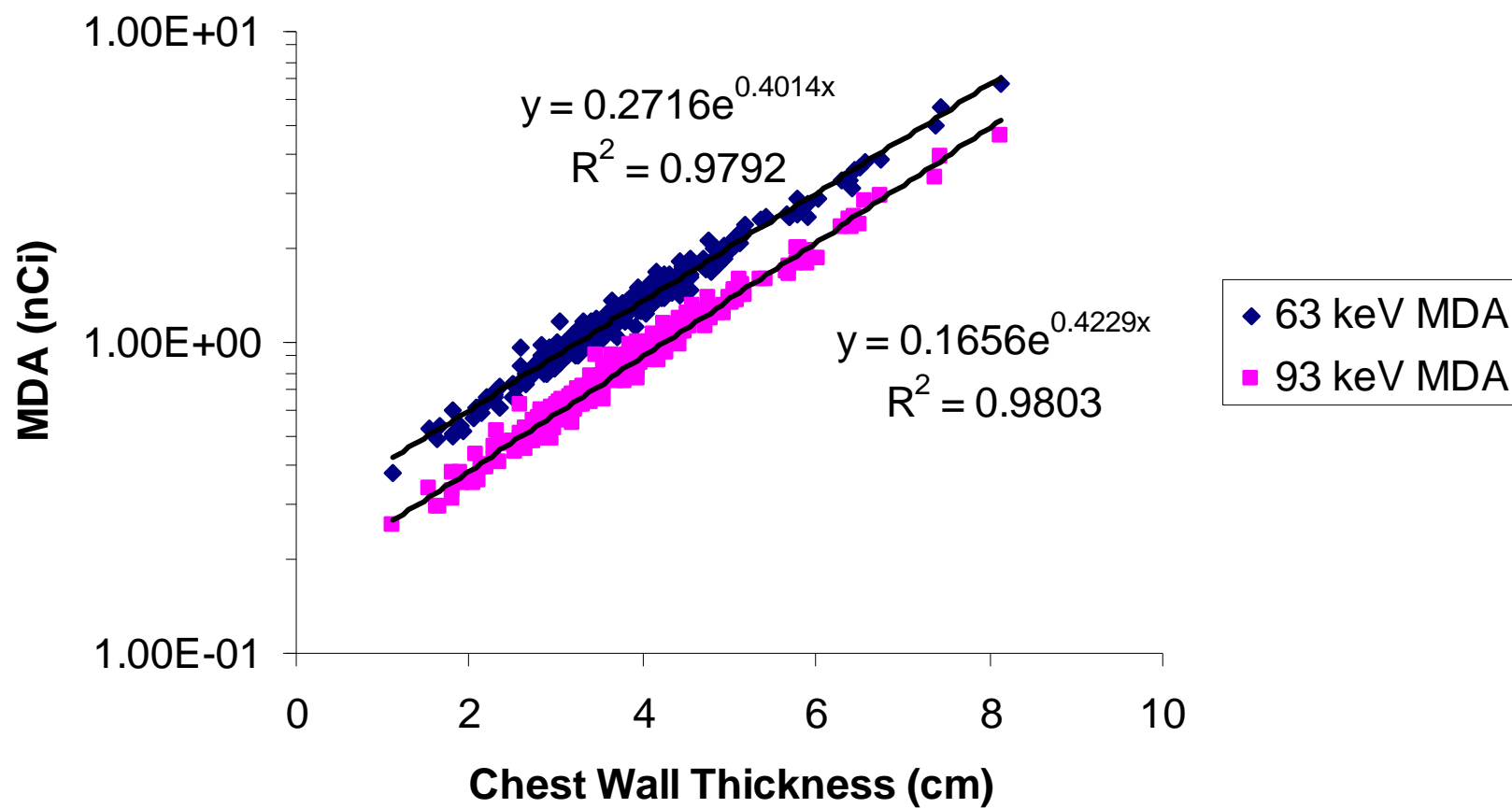
Pu-238 Lung Count Minimum Detectable Activity



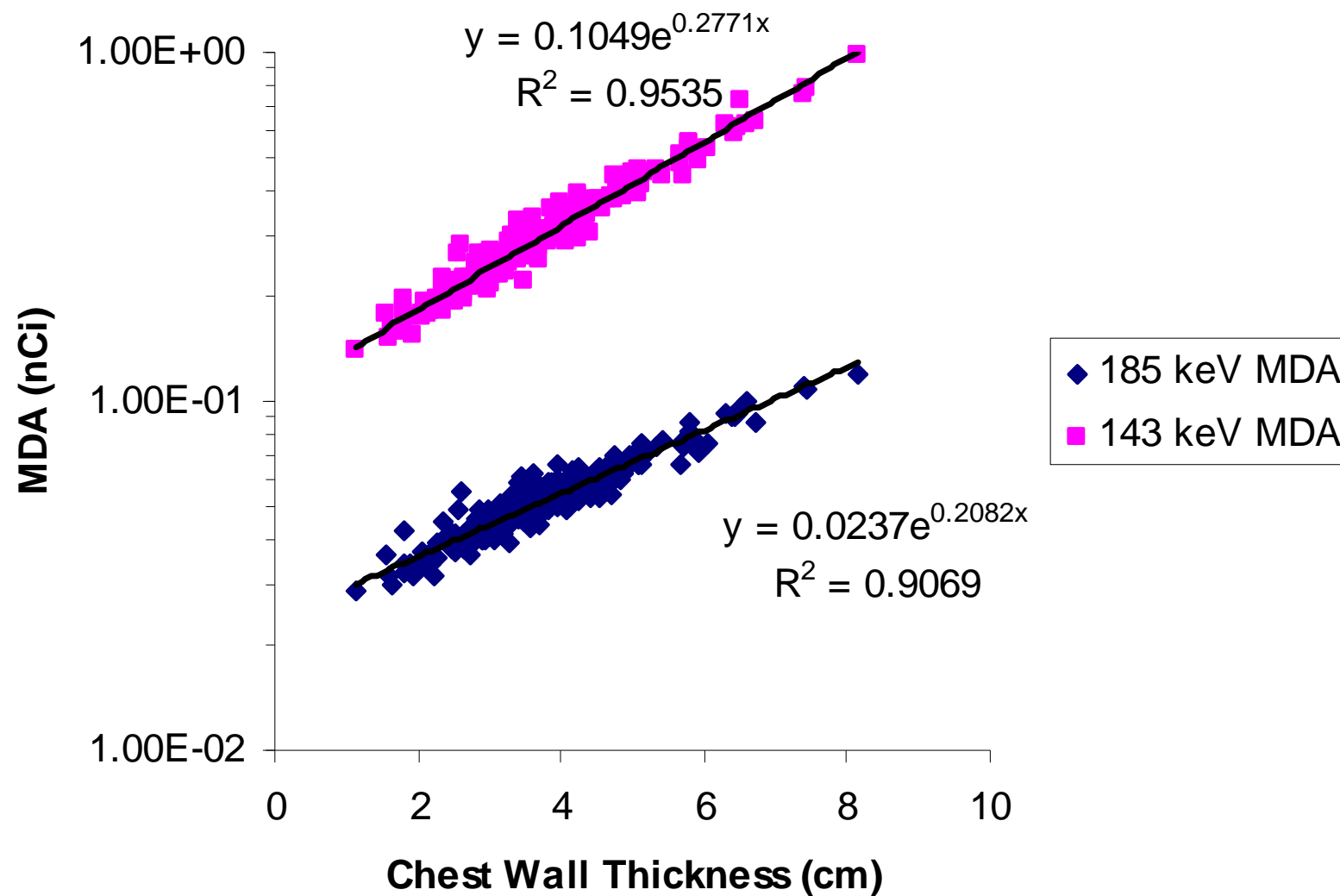
Pu-239 Lung Count Minimum Detectable Activity



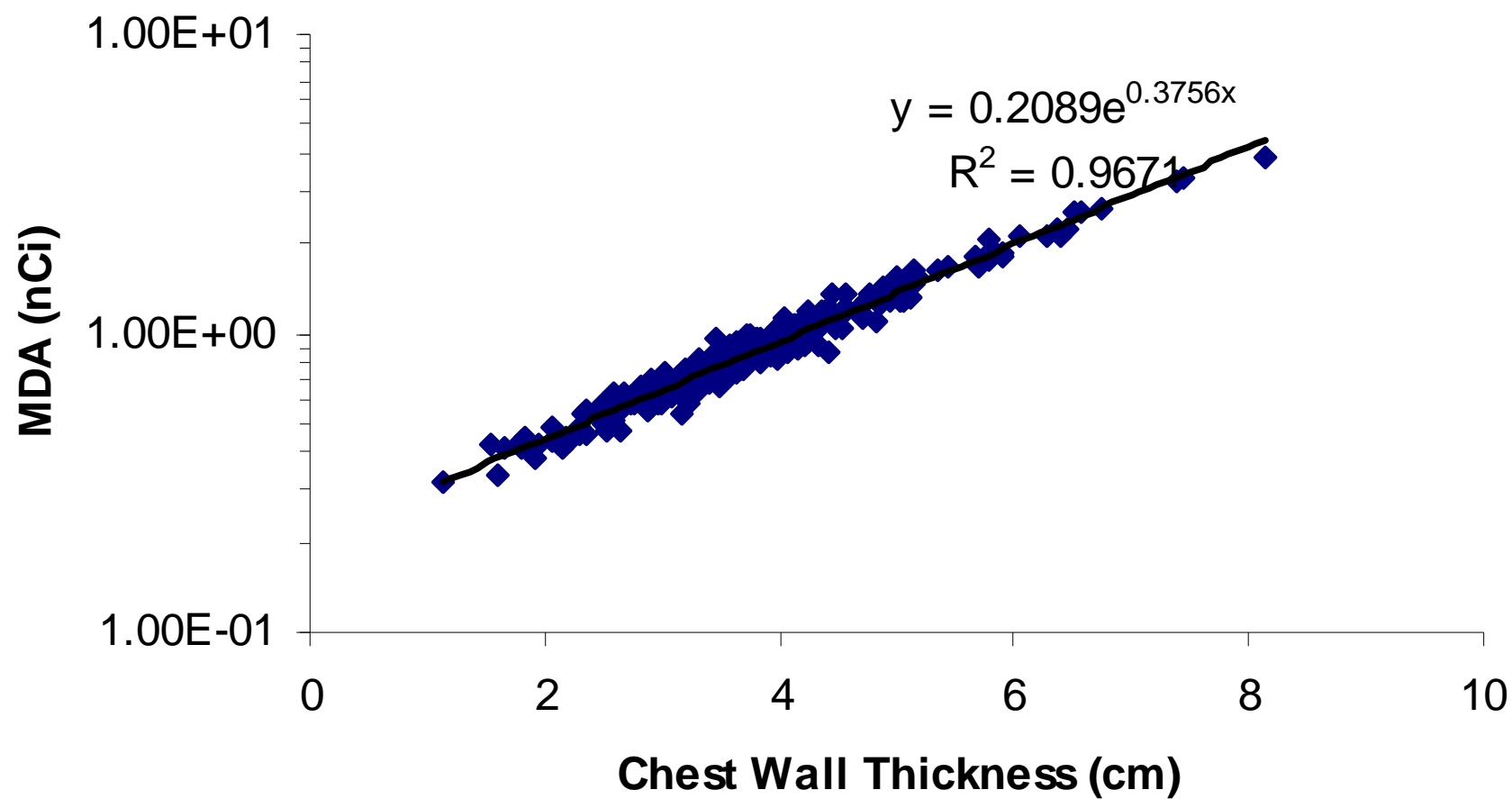
Th-234 (U-238) Lung Count Minimum Detectable Activity



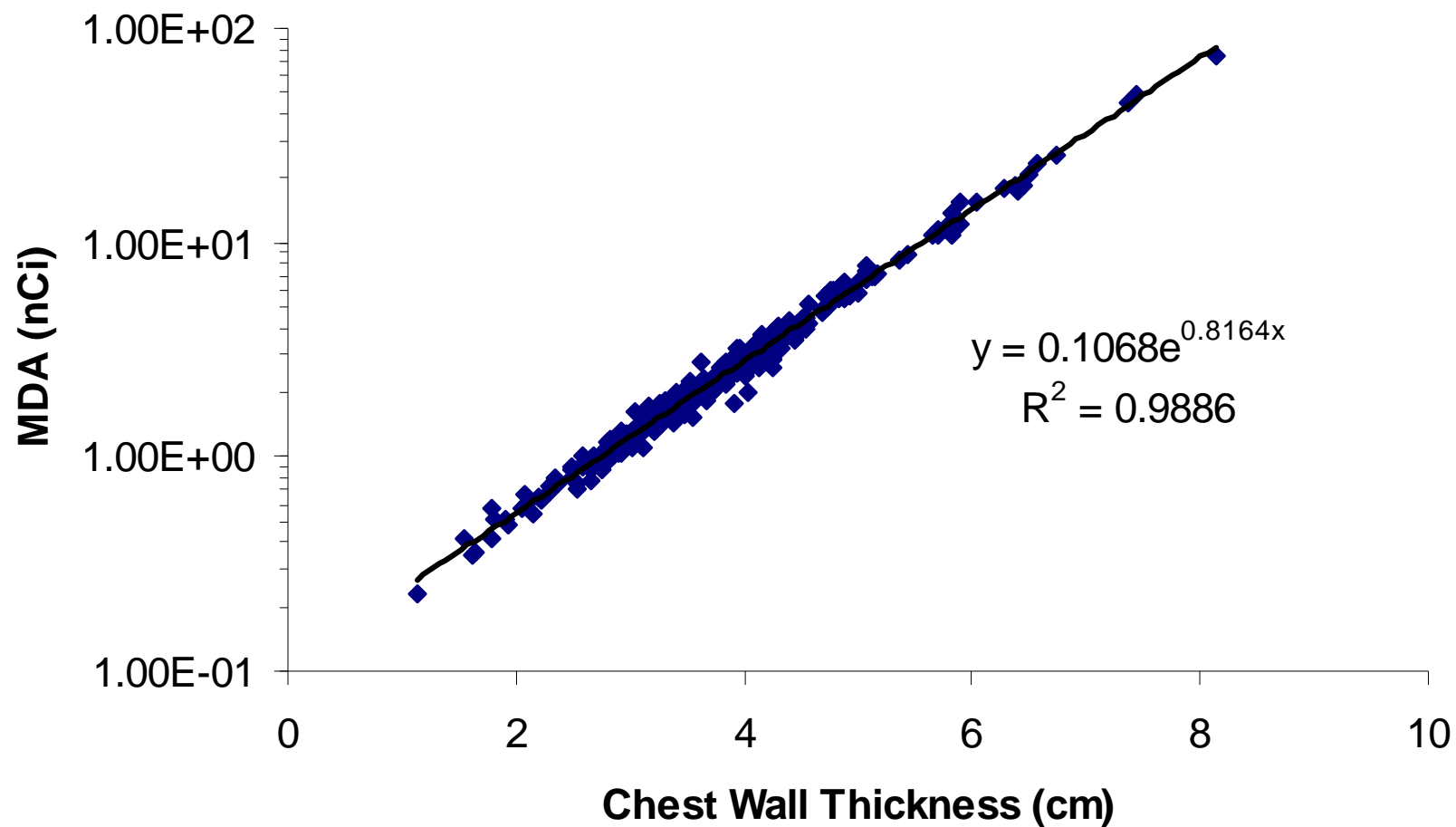
U-235 Lung Count Minimum Detectable Activity



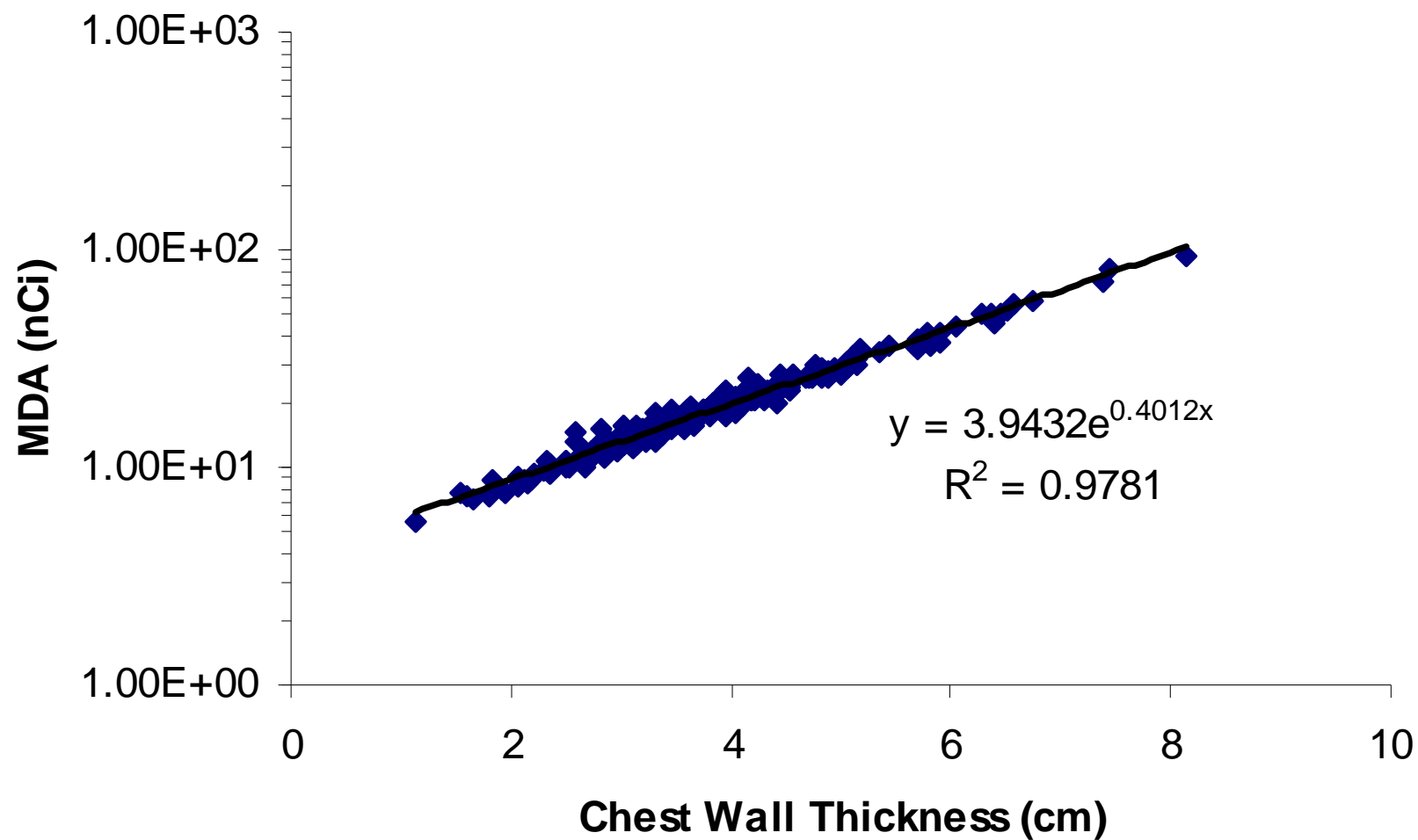
Pa-231 Lung Count Minimum Detectable Activity



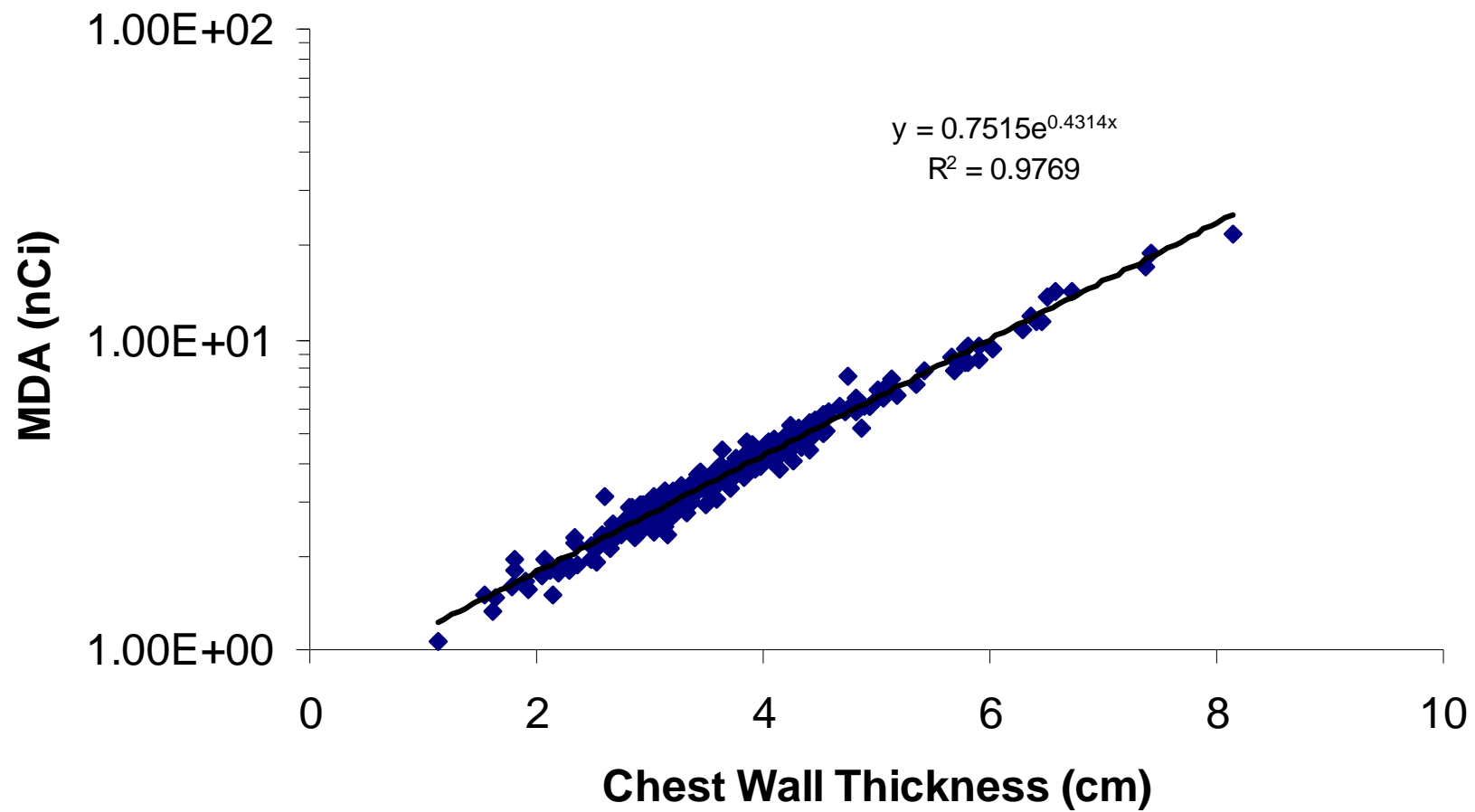
Ac-228 (Th-232 Indirect) Lung Count Minimum Detectable Activity



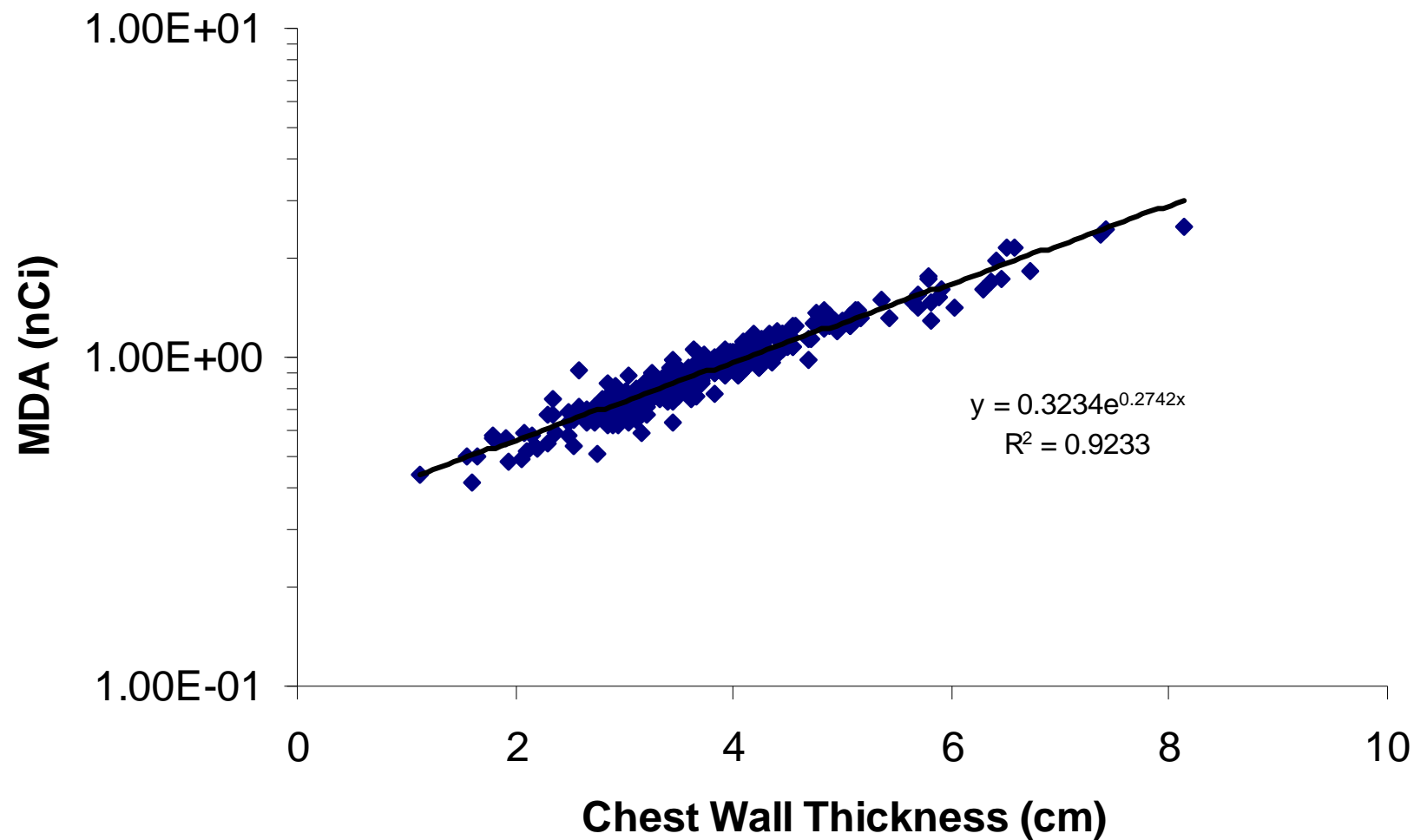
Th-232 (Direct) Lung Count Minimum Detectable Activity



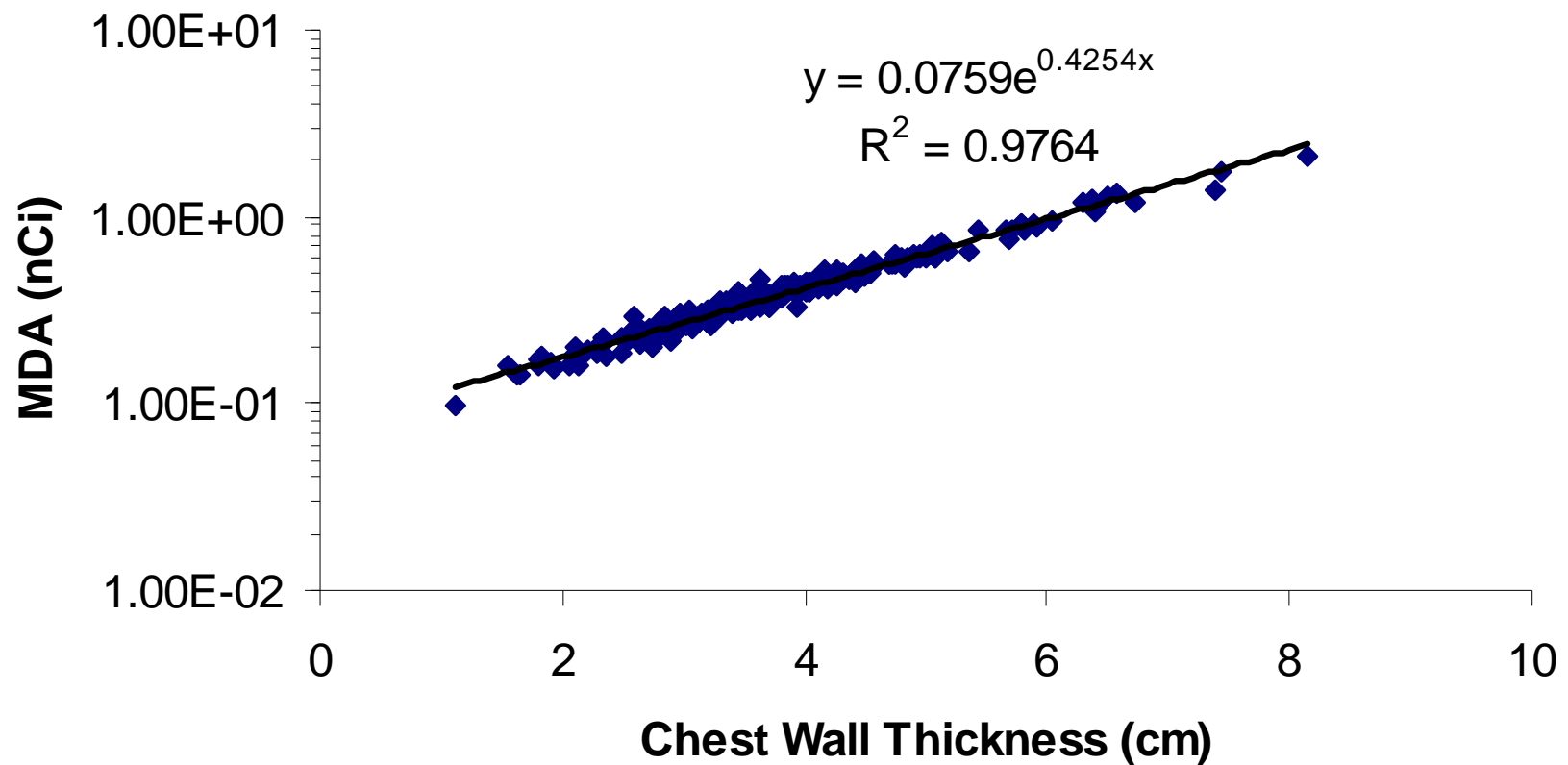
Th-228 (Indirect U-232 & Th-232) Lung Count Minimum Detectable Activity



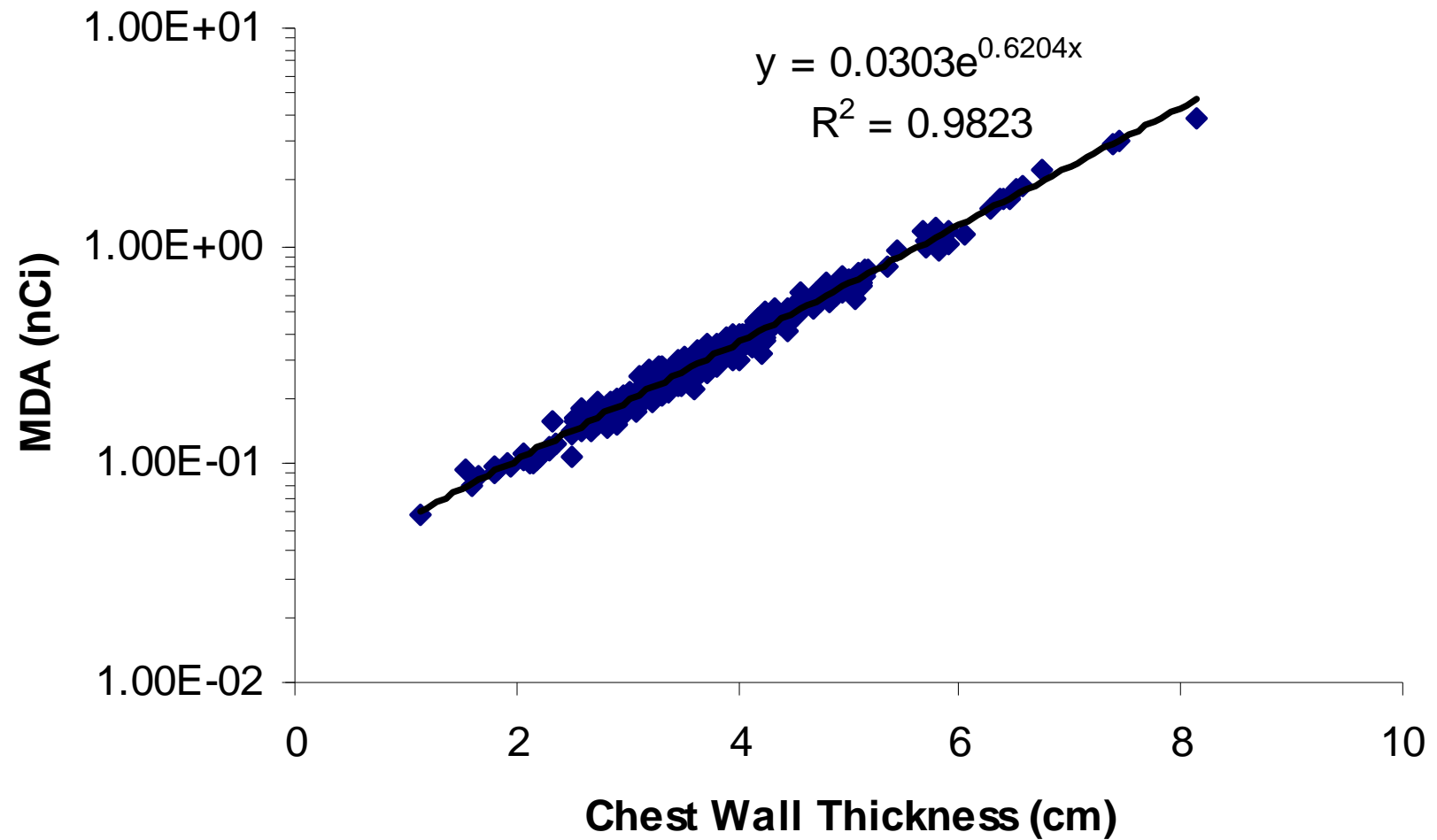
Ra-224 (Th-228) Lung Count Minimum Detectable Activity



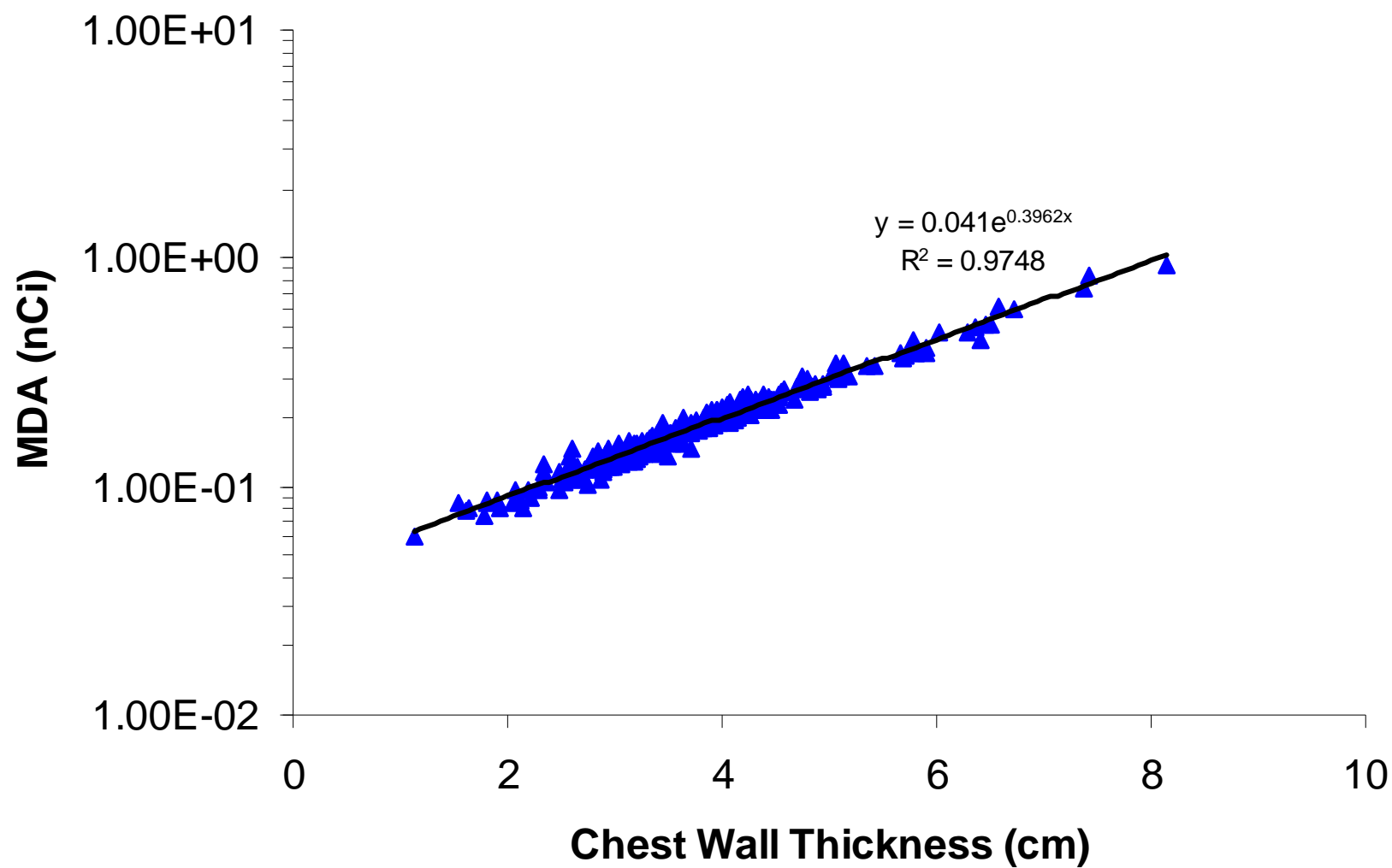
Np-237 Lung Count Minimum Detectable Activity



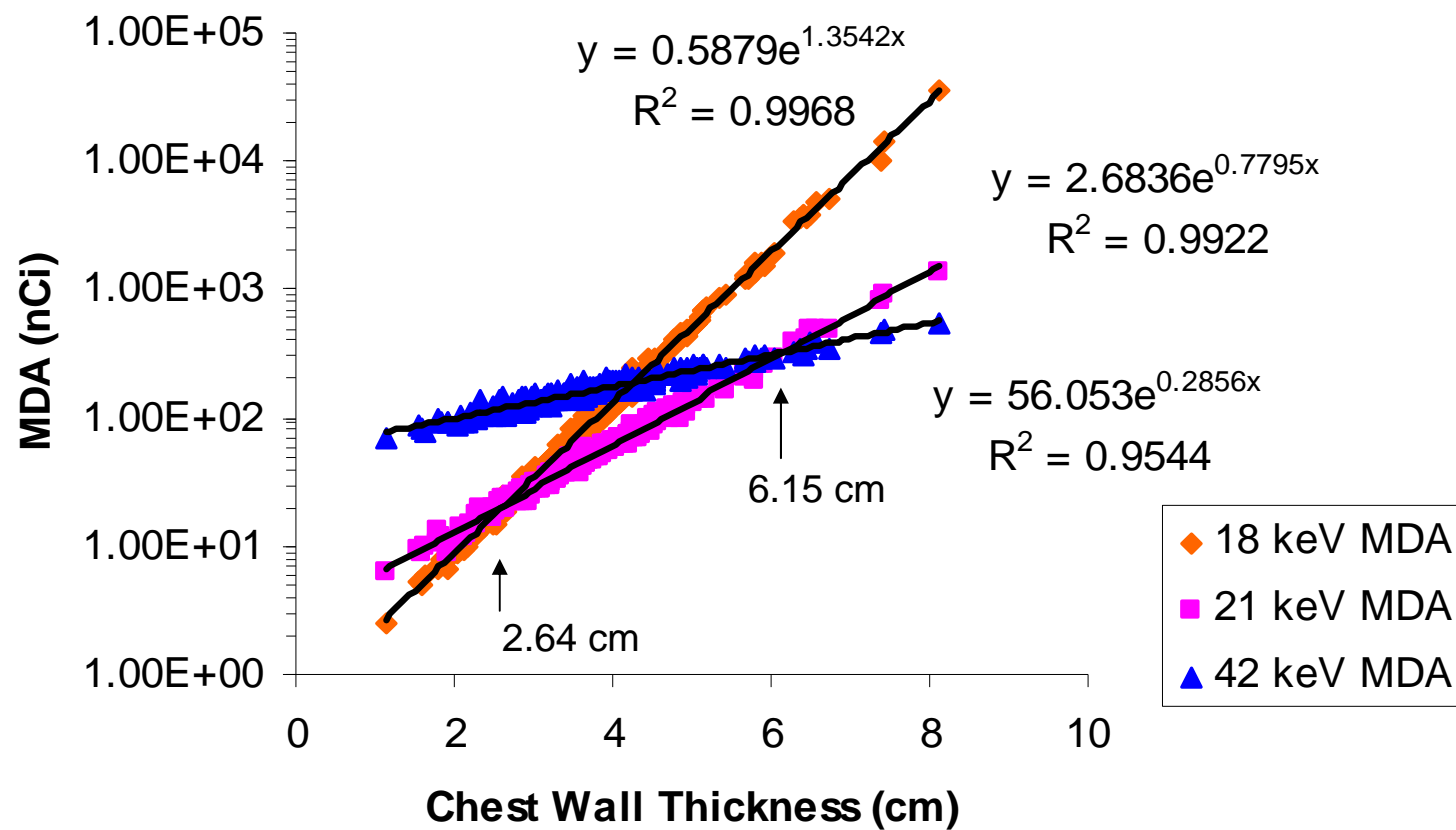
Pa-233 (Np-237) Lung Count Minimum Detectable Activity



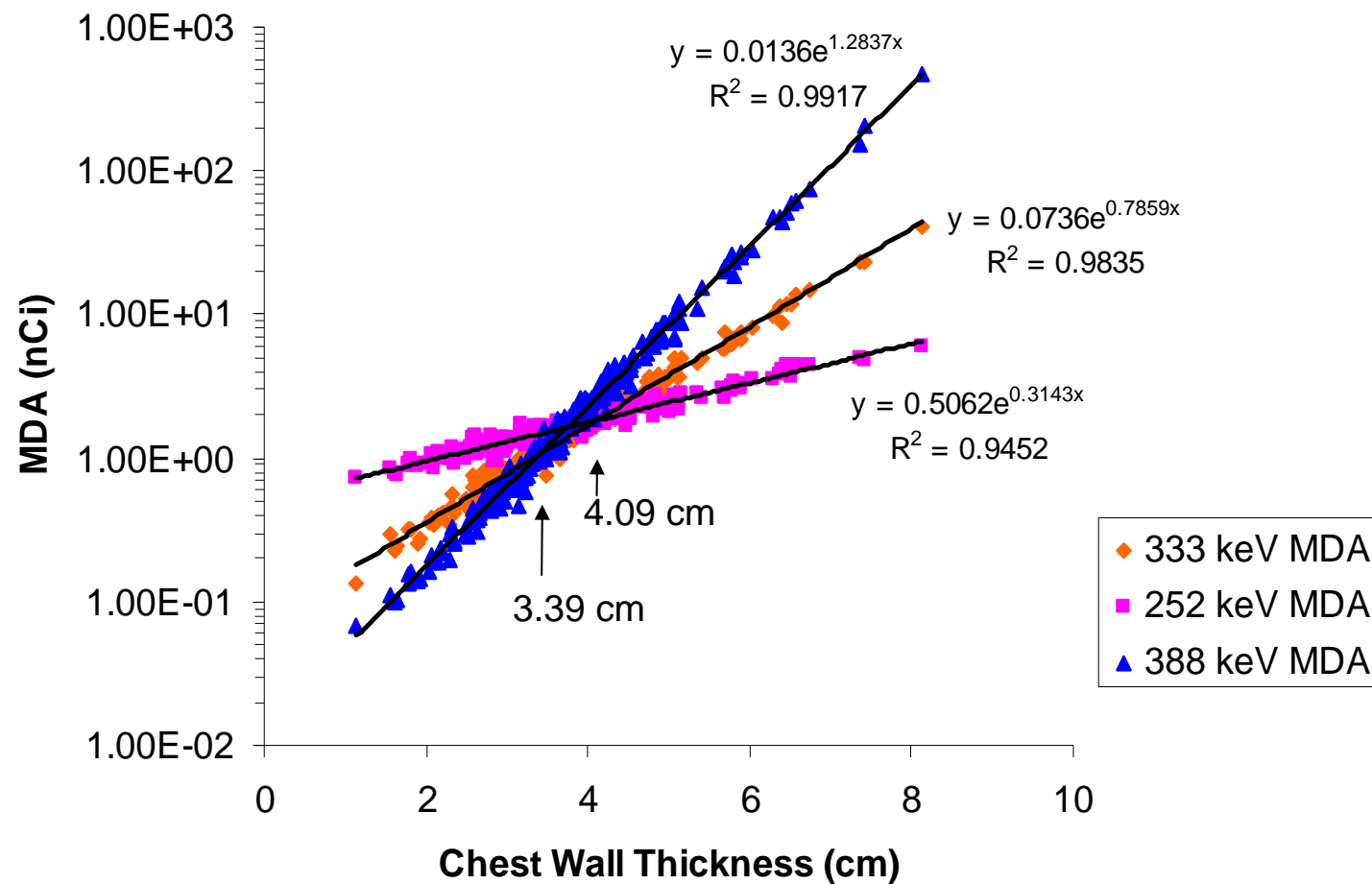
Cm-243 Lung Count Minimum Detectable Activity



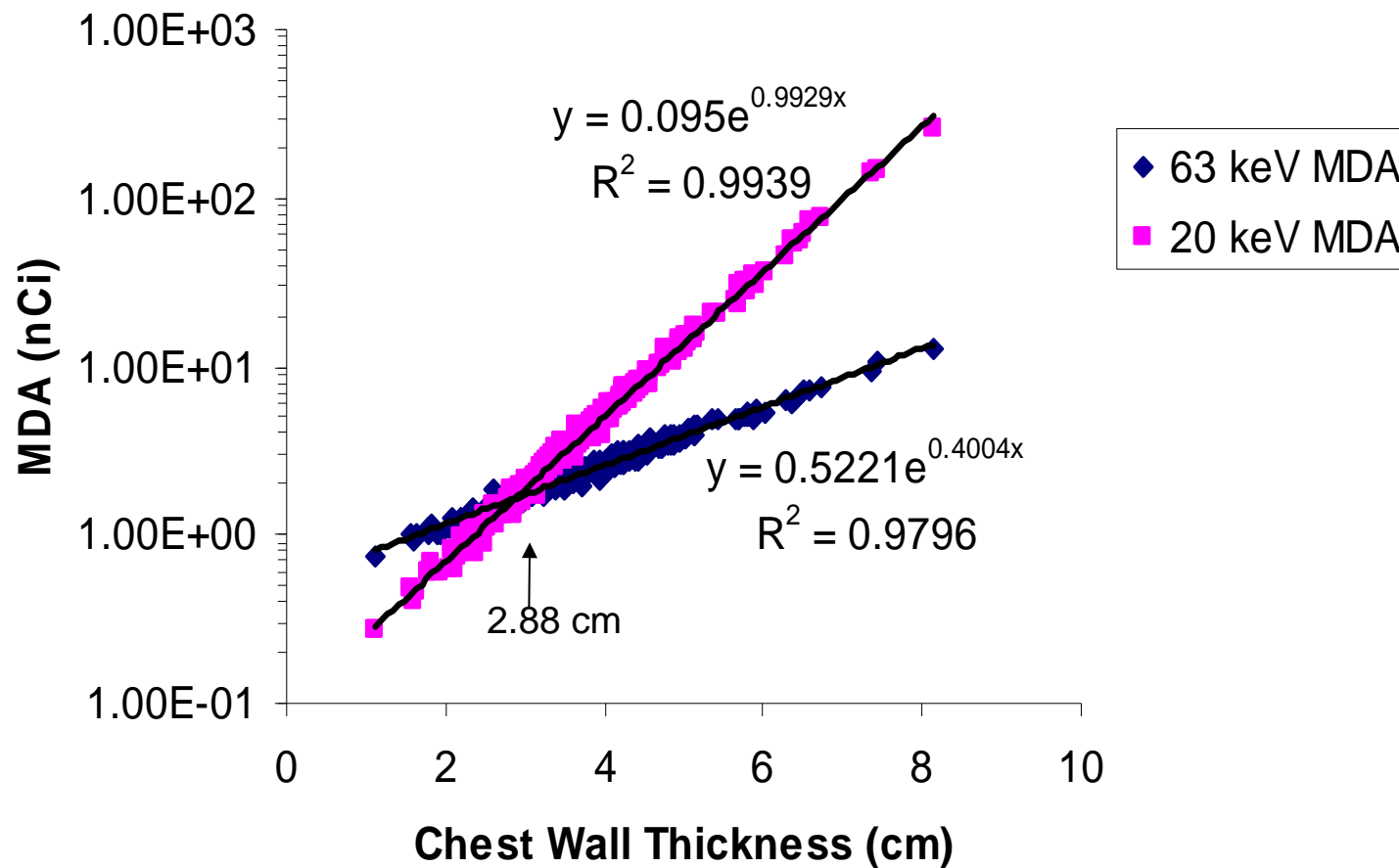
Cm-244 Lung Count Minimum Detectable Activity



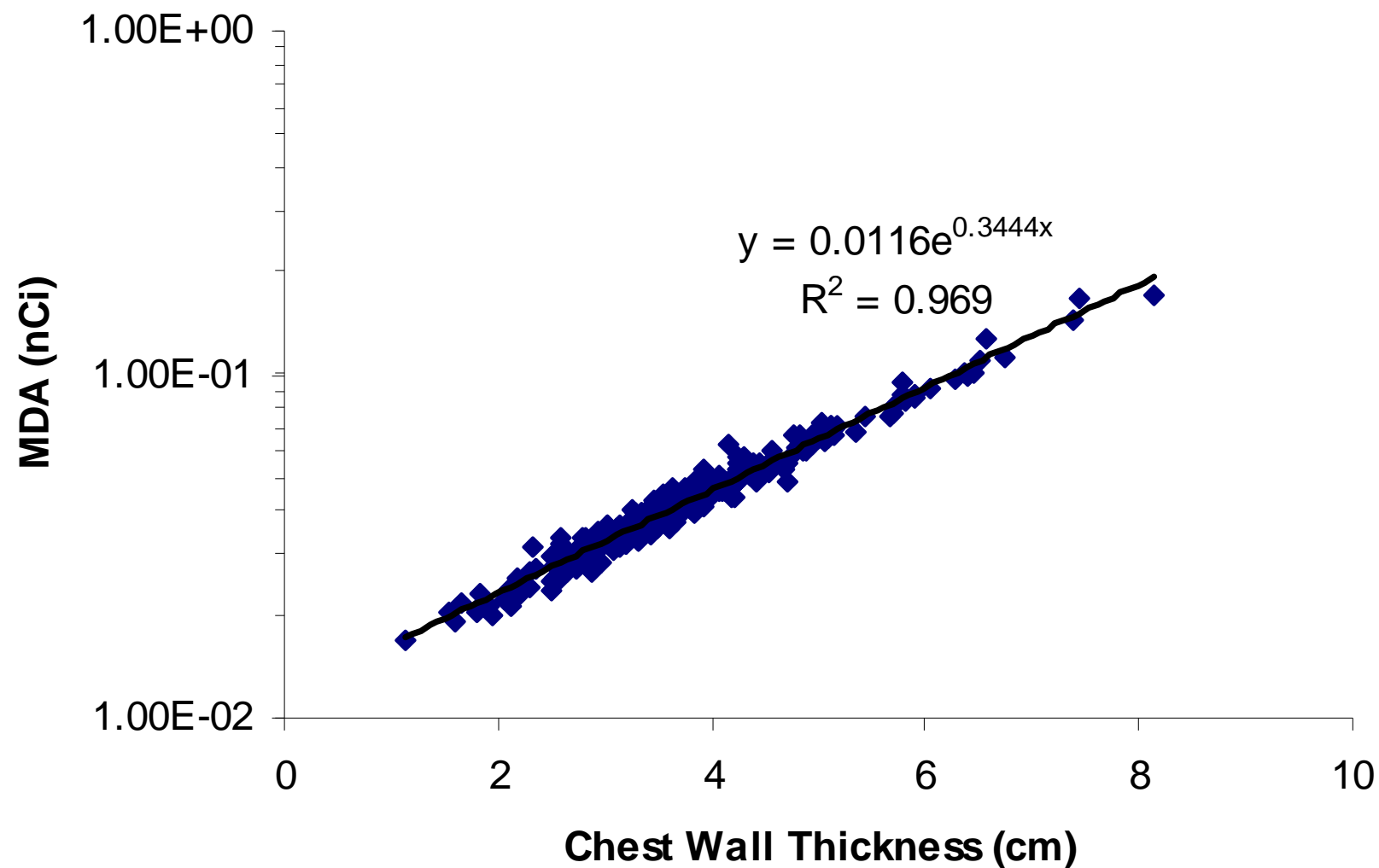
Cf-249 Lung Count Minimum Detectable Activity



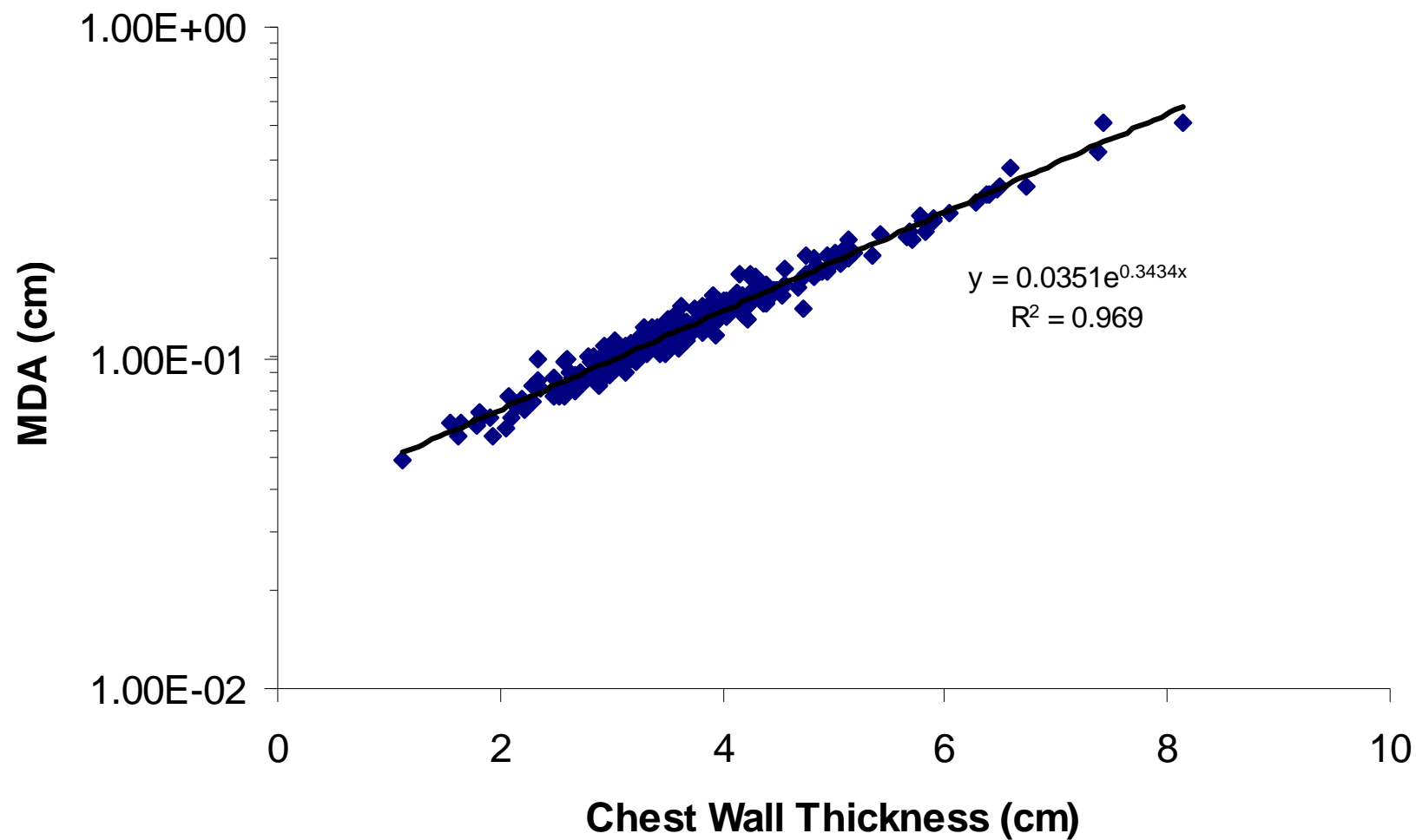
Es-254 Lung Count Minimum Detectable Activity



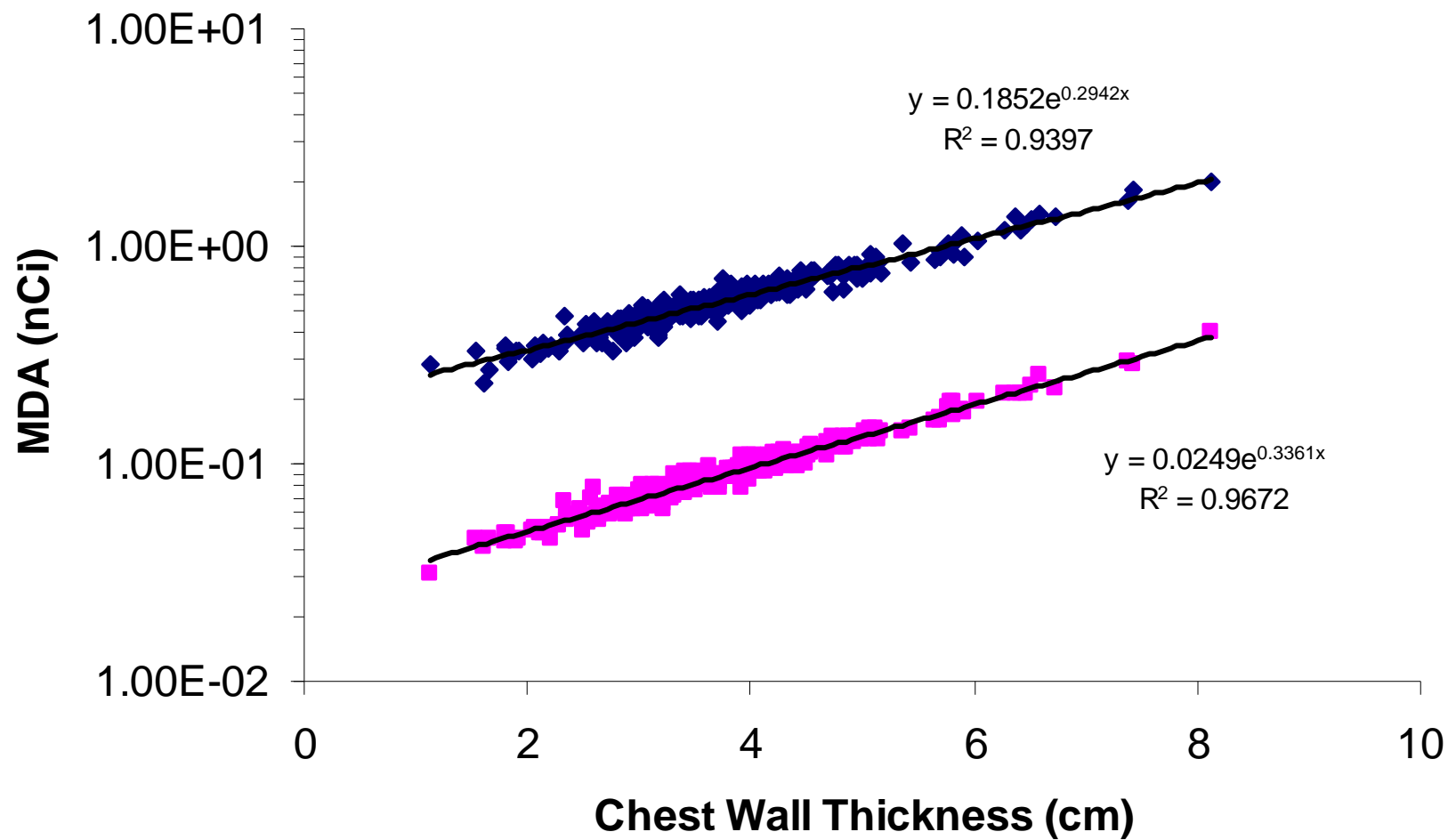
Co-57 Lung Count Minimum Detectable Activity



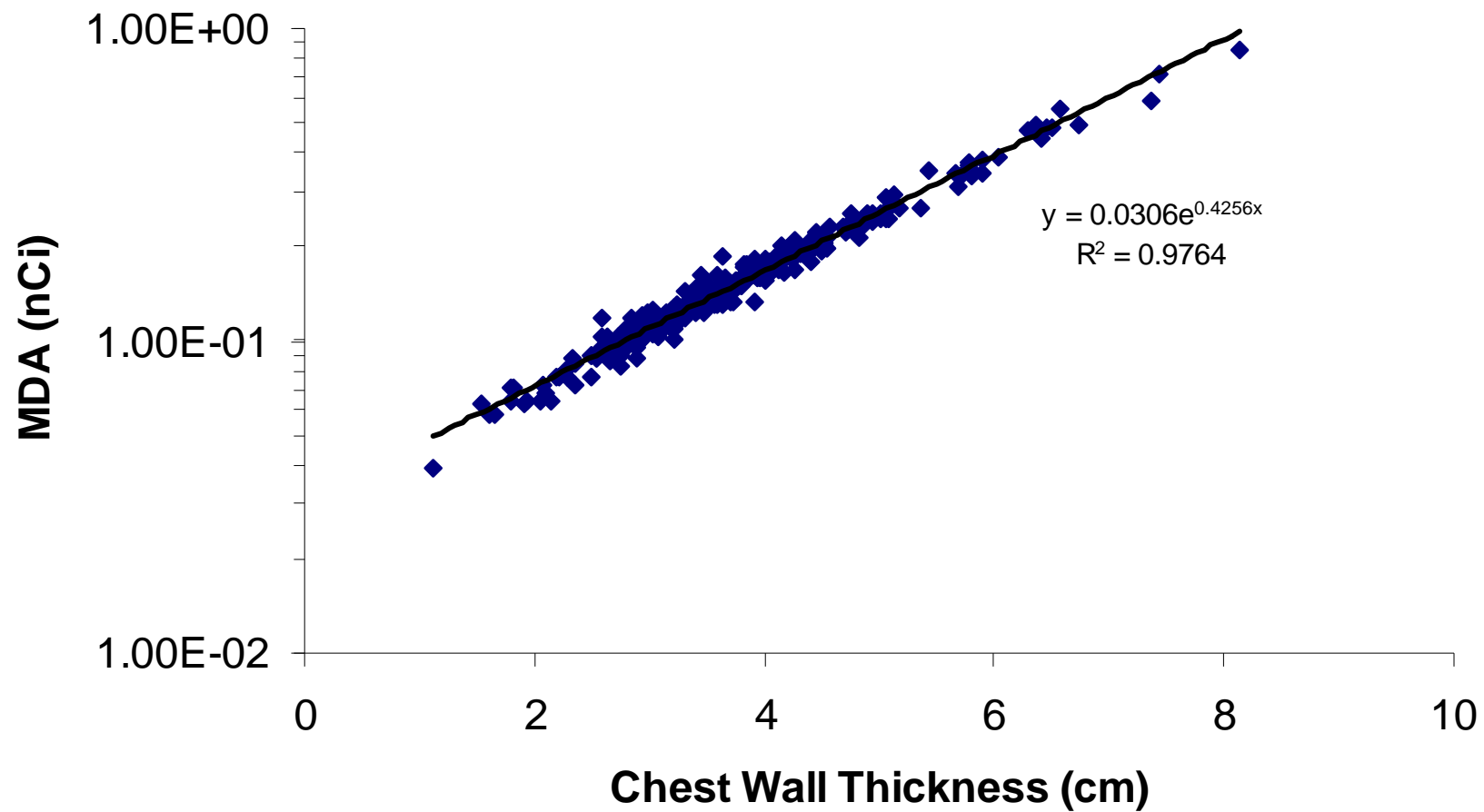
Eu-152 Lung Count Minimum Detectable Activity



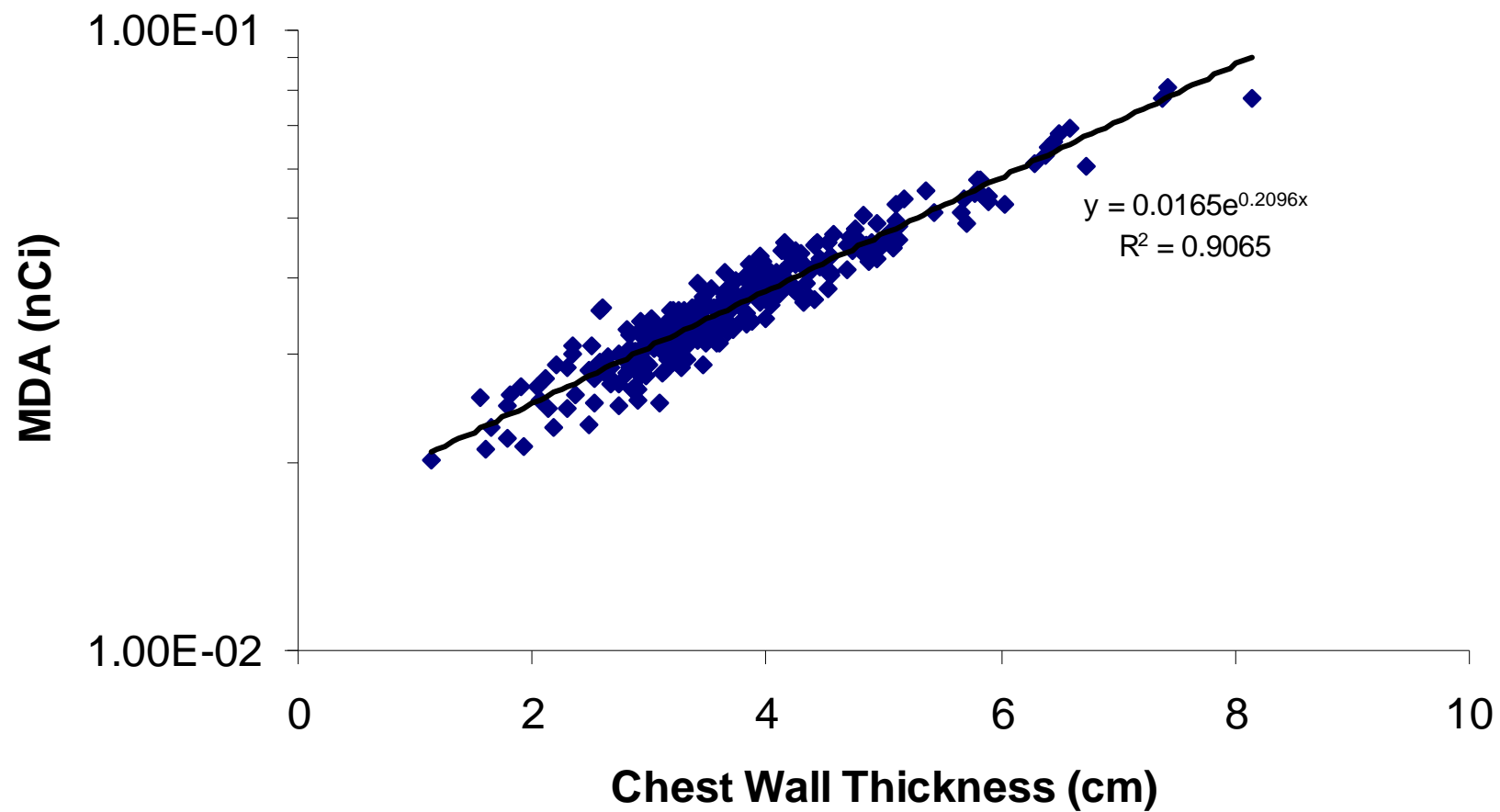
Eu-154 Lung Count Minimum Detectable Activity



Eu-155 Lung Count Mimimum Detectable Activity



Ho-166m Lung Count Minimum Detectable Activity



SCANNING BED WHOLE BODY COUNT MINIMUM DETECTABLE ACTIVITIES



Scanning Bed Whole Body Counter Average Minimum Detectable Activity.

Radionuclide	MDA (nCi)	+/-1s
Ac-228	2.74	0.30
Ba-133	0.85	0.09
Bi-207	0.47	0.05
Bi-212	7.71	1.10
Bi-214	1.82	0.43
Cf-249	0.83	0.09
Cm-243	3.59	0.29
Co-57	0.97	0.08
Co-60	0.37	0.08
Cs-134	0.56	0.07
Cs-137	0.70	0.10
Eu-152	1.75	0.44
Eu-154	1.25	0.89
Eu-155	2.58	0.23
I-131	0.68	0.07
K-40	2.52	1.06
Na-22	0.40	0.08
Np-237	6.38	0.57
Np-239	4.73	0.46
Pa-231	21.83	2.27
Pa-233	1.60	0.16
Pa-234	3.93	0.62
Pb-212	2.23	0.23
Pb-214	2.36	0.34
Po-210	3.40E+04	5.72E+03
Ra-224	20.6	2.0
Ra-226	23.9	2.4
Th-231	11.6	1.6
Th-234	15.8	1.0
U-235	1.61	0.16