

A highly efficient 2"x2" inch cylindrical NaI(Tl) gamma ray detector

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Abstract:Scintillation detectors based on inorganic crystals of NaI(Tl) and fotomultipliers(PMT) are used in gamma-ray spectrometry due to their advantages. For this was selected a 2"x2" inch NaI(Tl) scintillator probe with a radioactive source of 241Am placed on the front face of the crystal, inside the detector Aluminium housing. The activity of the radioactive source was 0.1μCi. The photomultiplier type was AVP56 made in France and the high bias voltage had a value of +900V. The signal from this detector was sent to a spectroscopy amplifier N968 CAEN made in Italy. For a fixed fine gain, the coarse gain of the amplifier was set for the four values: 100, 200, 500 and 1k. At the 1k coarse gain, the energy spectra have a small noise and the energy resolution a value of 10.2% at peak energy of 59.54keV. For the smaller coarse gain, the energy resolution increases to bigger values. The full energy peak efficiency was calculated for each energy peak of the used radionuclides (241Am,60Co,133Ba, 137Cs) which were situated at 2cm from detector, on the symmetry axis. All radioactive sources were point radioactive sources. The calibration efficiency curve was obtained. This scintillation detector allows to perform very good gamma energy spectra with a multichannel analyzer type MCA 8k N957 from CAEN. The software of acquisition, display and analysis was InterWinner 6.0, which is dedicated for NaI(Tl) detectors.

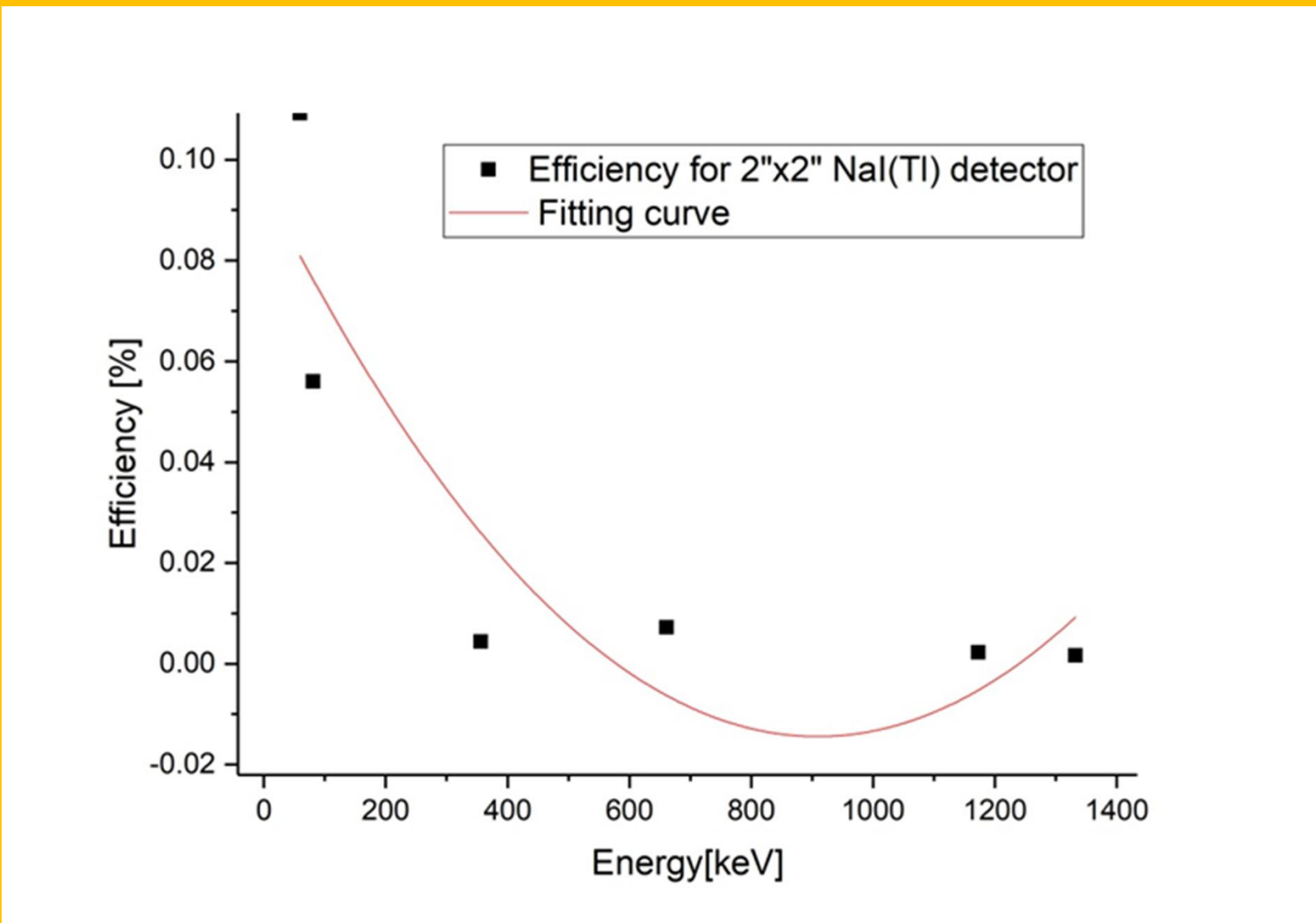
I. **METHODOLOGY:** Gamma spectroscopy with NaI(Tl) detector with Am-241 embedded in the crystal



NaI(Tl) scintillation crystal sealed in dural with Am-241 embedded in crystal

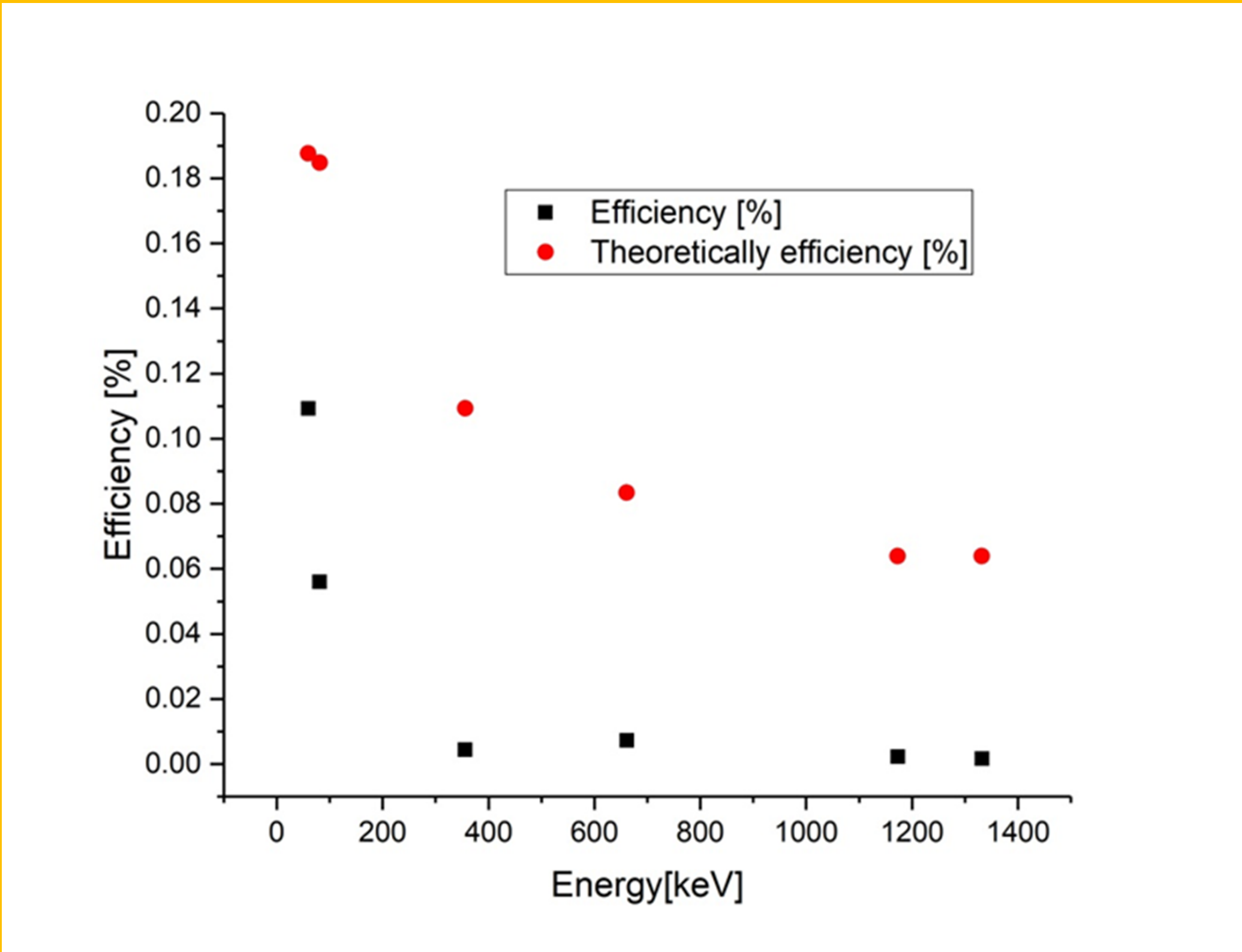
NaI(Tl)	Value
Density[g/cm3]	3.67
Melting Point [°C]	924
Decay time[ns]	230
Peak emission[nm]	415
Light yield[Photons/MeV]	38000
Index of Refraction	1.85
Conversion efficiency(%)	100
Higroscopicity	yes

NaI(Tl) scintillator characteristics



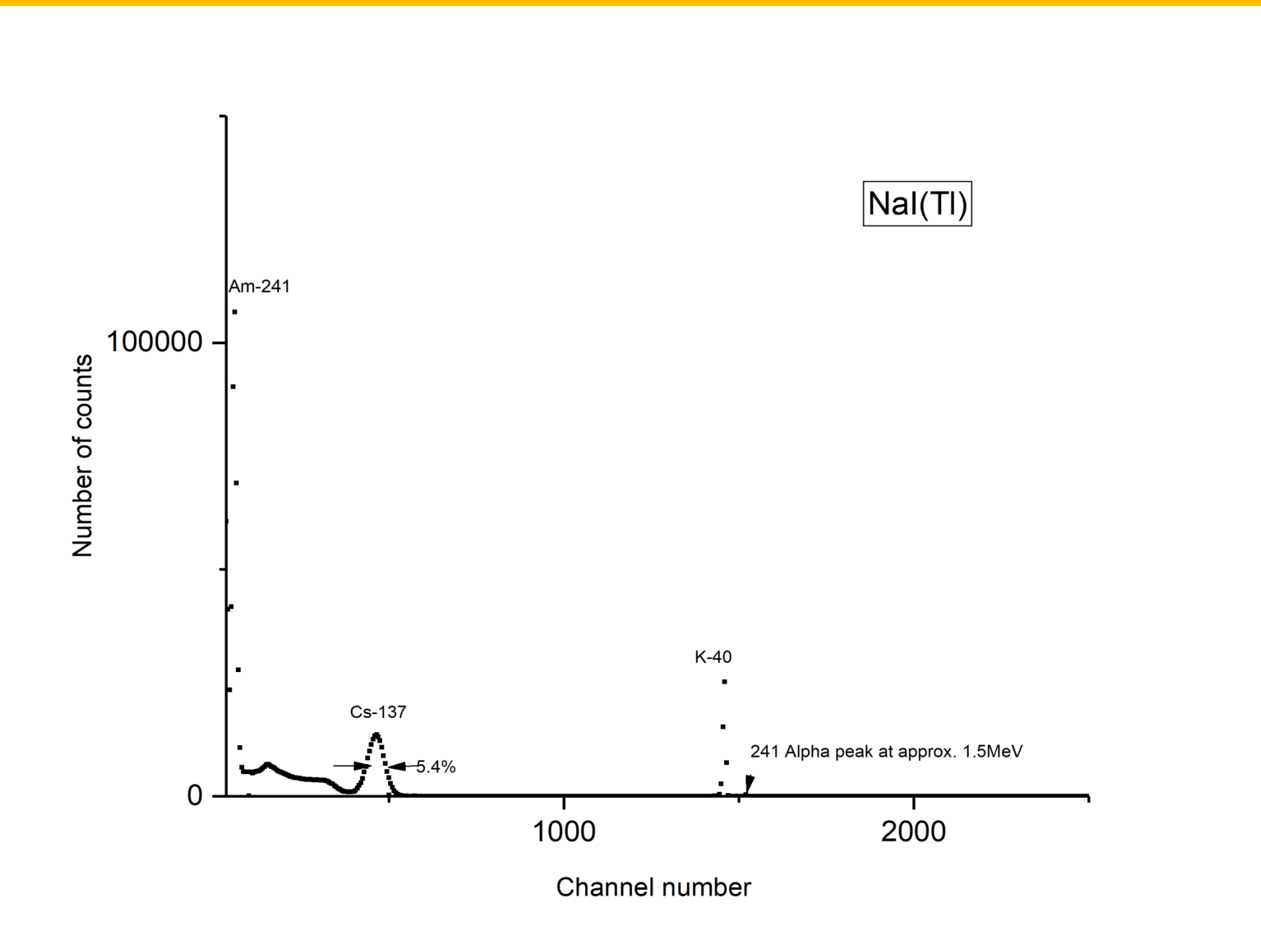
Efficiency vs. energy; fitting curve(with red) for NaI(Tl) with four calibration sources

Scintillation probe of NaI(Tl) with photomultiplier readout



Standard	Energy(keV)	Activity(kBq) 01.02.2025	Half-life(years)	Probability (%)
Ba- 133 SEG7-864	81 356.02	5.81	10.551	34 62
Cs-137 SEG7-815	661.66	9.28	30.05	84.99
Co-60 SEG7-833	1173.2 1332.5	1.42	5.271	99.85 99.9826
Am-241	59.54	1	432.2	35.92

Characteristics for radioactive sources used for calibration



II. **RESULTS:** Gamma spectrum obtained for Cs-137, americium 241 peak at 59.54keV, 1460keV peak for K-40 661keV peak for Cs-137 and 241 Alpha peak at approx. 1.5MeV.

Conclusions: with Am-241 pulser the gamma spectrum is stabilized. This is useful in the case of photomultiplier readout when are registered high count rates. The experimentally efficiency has smaller value then the theoretically efficiency

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