Energy Resolution

Energy resolution

Spectroscopy with LXeGRIT is described in a detailed manner in Sec. 2.2.3; the energy is derived from the amplitude of the anode signal through the fitting procedure described in Sec. 2.1.8. To study the impact of the off-line analysis procedure on it, I break down the energy resolution in three pieces

$$\sigma_{tot} = \sigma_{LXe} \oplus \sigma_{el} \oplus \sigma_{other}$$

where $\oplus$ means sum in quadrature. σ_{LXe} is the intrinsic energy resolution in LXe for a drift field of 1 kV/cm; it is known to be $\sim 3.5/\sqrt{E}$ % (4). σ_{el} comes from electronic noise on the anodes, which is independently measured (Sec. 2.1.5) and does not depend on energy. σ_{other} accounts for everything else than σ_{LXe} and σ_{el}, therefore including inaccuracies introduced by the fitting procedure.

As shown in Sec. 2.2.3, the energy dependence of the energy resolution over the energy range 0.5-4.2 MeV is very well described by

$$\Delta E[\text{MeV}]\ (FWHM) = \sqrt{6.7 \cdot 10^{-3} \cdot E[MeV] + 3.6 \cdot 10^{-3}}$$

FWHM = 8.2%/√E ⊕ 6.0%(electronics noise)

where the term $6.7 \cdot 10^{-3} \cdot E$ accounts for $\sigma_{LXe} = 3.5\%$ and the energy independent term accounts for the electronic noise, $\sim$60 keV FWHM. Therefore, σ_{tot} is satisfactorily described setting $\sigma_{other} \equiv 0$ without too much room for any significant contribution. Moreover, the energy calibration over the same energy range is perfectly linear, ruling out any undesired dependence on amplitude. □

σ = 1 / (√816√E) ⊕ 1 / √1534 ➡ Q/Qo=1.4% ! for 60,000/MeV

E. Aprile et al.,
NIM A307 (1991)
119-125

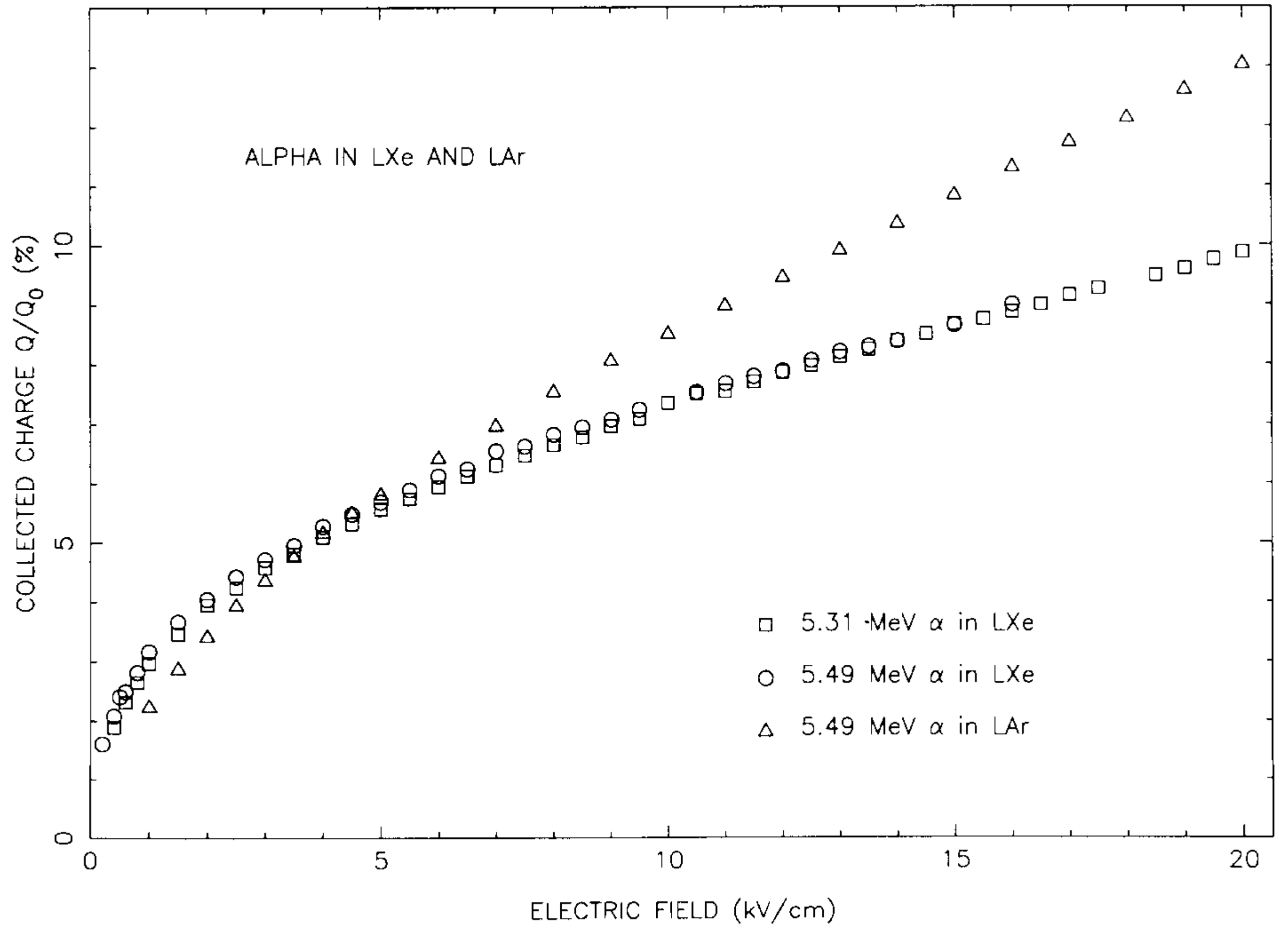


Fig. 5. Collected charge (Q/Q_0%) vs. electric field for ^{210}Po in liquid xenon (□) and ^{241}Am in liquid xenon (○) and liquid argon (△).

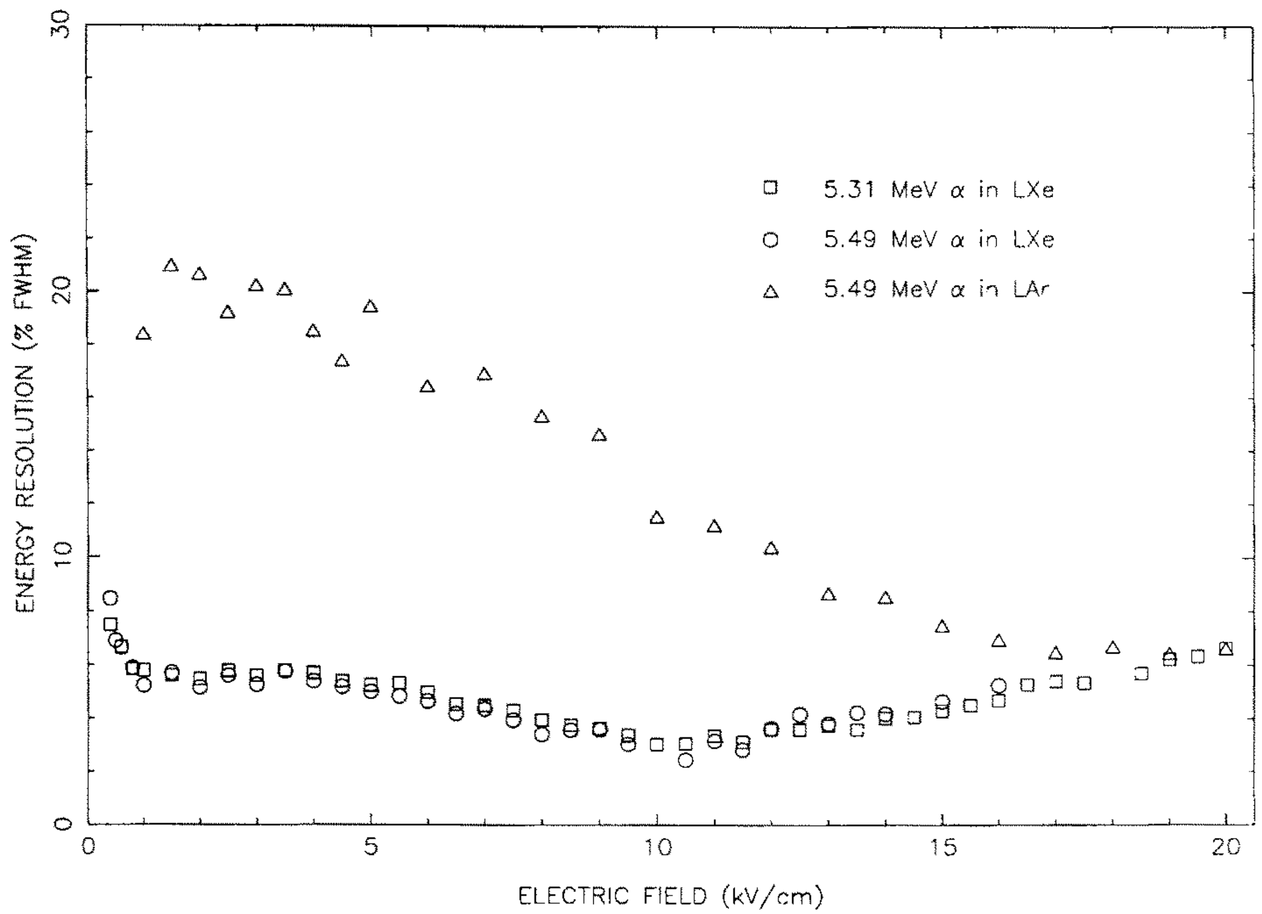


Fig. 6. Noise subtracted energy resolution vs. electric field for ^{210}Po in liquid xenon (□) and ^{241}Am in liquid xenon (○) and liquid argon (△).

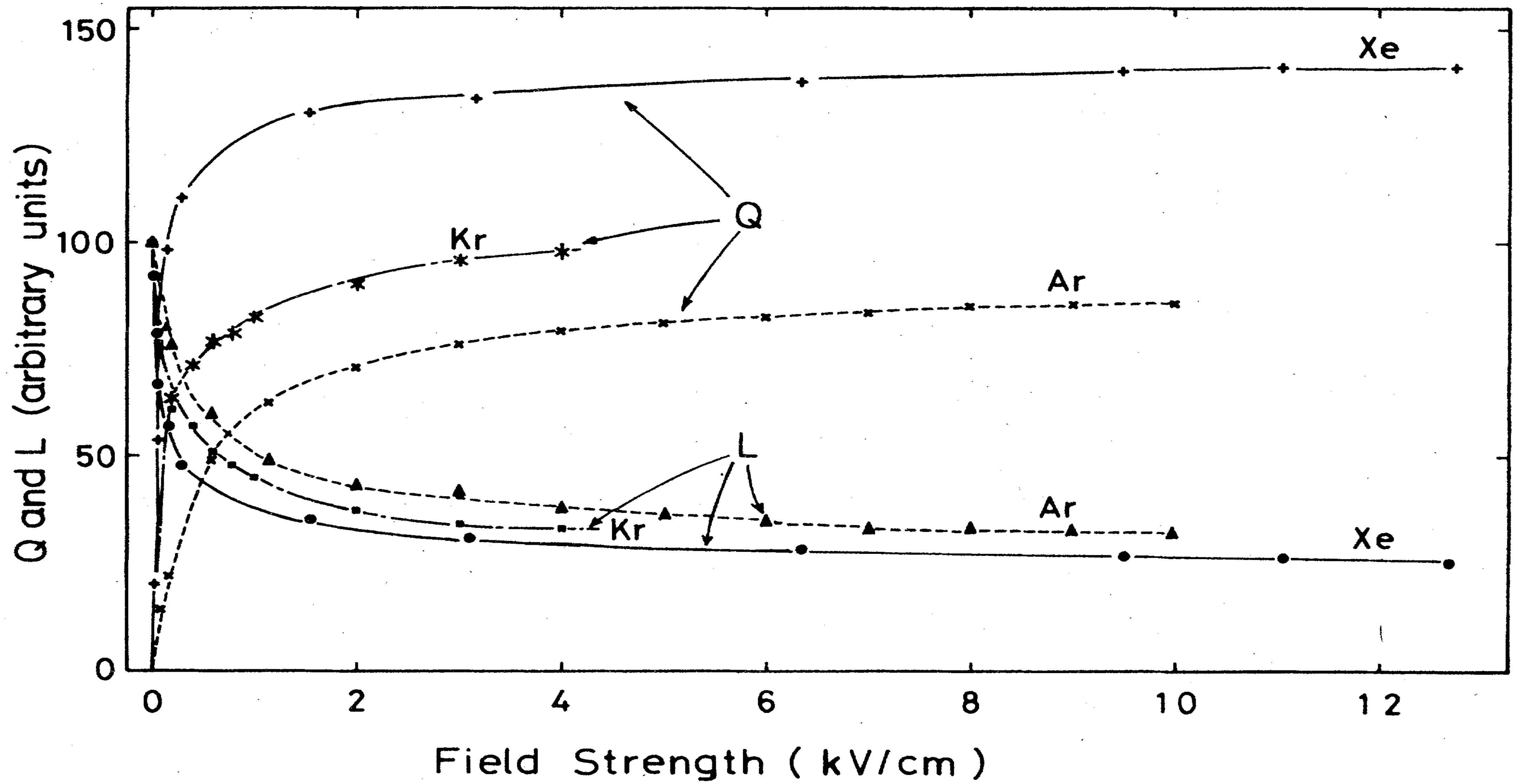
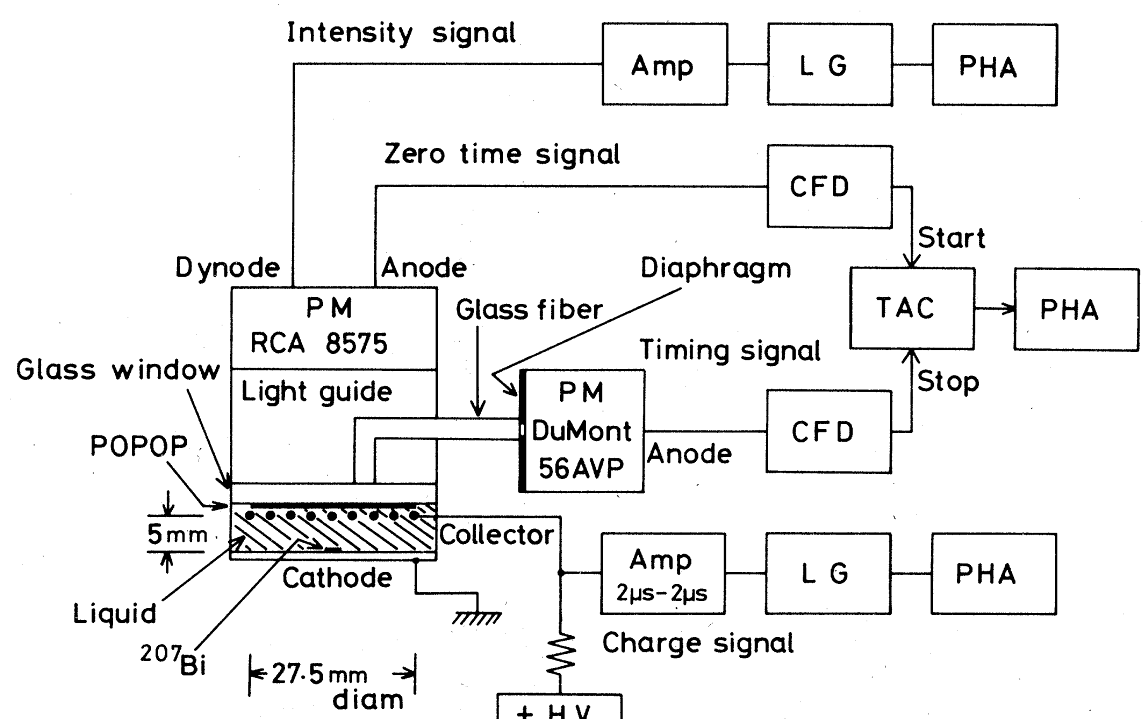


FIG. 2. Variation of relative luminescence intensity L and collected charge Q in liquid argon, krypton, and xenon vs applied-electric-field strength for 0.976- and 1.05-MeV electrons.

S. Kubota et al., PR B20 (1979) 3486



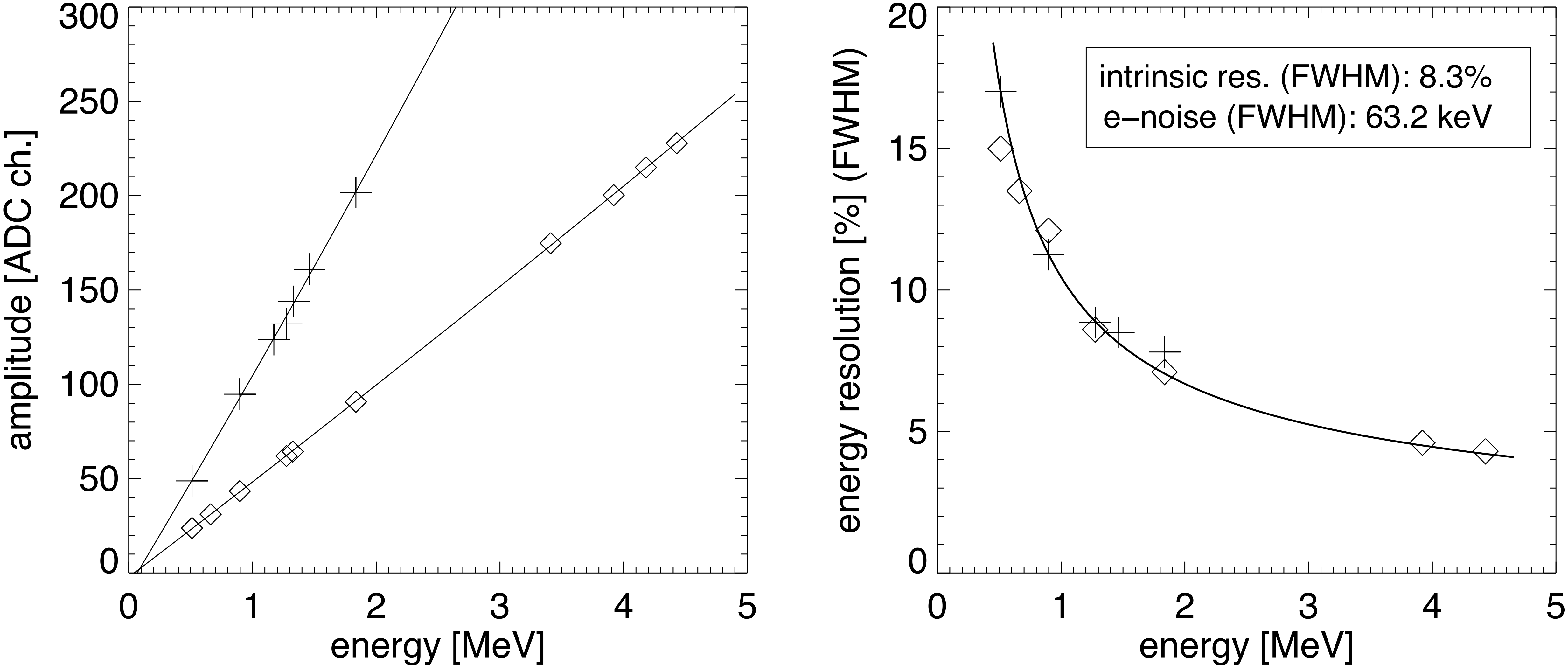


Figure 2.30: *Left:* the linearity plot for ADC ch. vs. MeV for both the 1999 (*open diamonds*) and the 2000 (*crosses*) setting. The gain in year 2000 was about twice the gain in 1999. *Right:* energy resolution versus energy, showing the $1/\sqrt{E}$ dependence expected from Poisson statistic corrected by a constant term.

16%(FWHM) at E_γ=0.5MeV

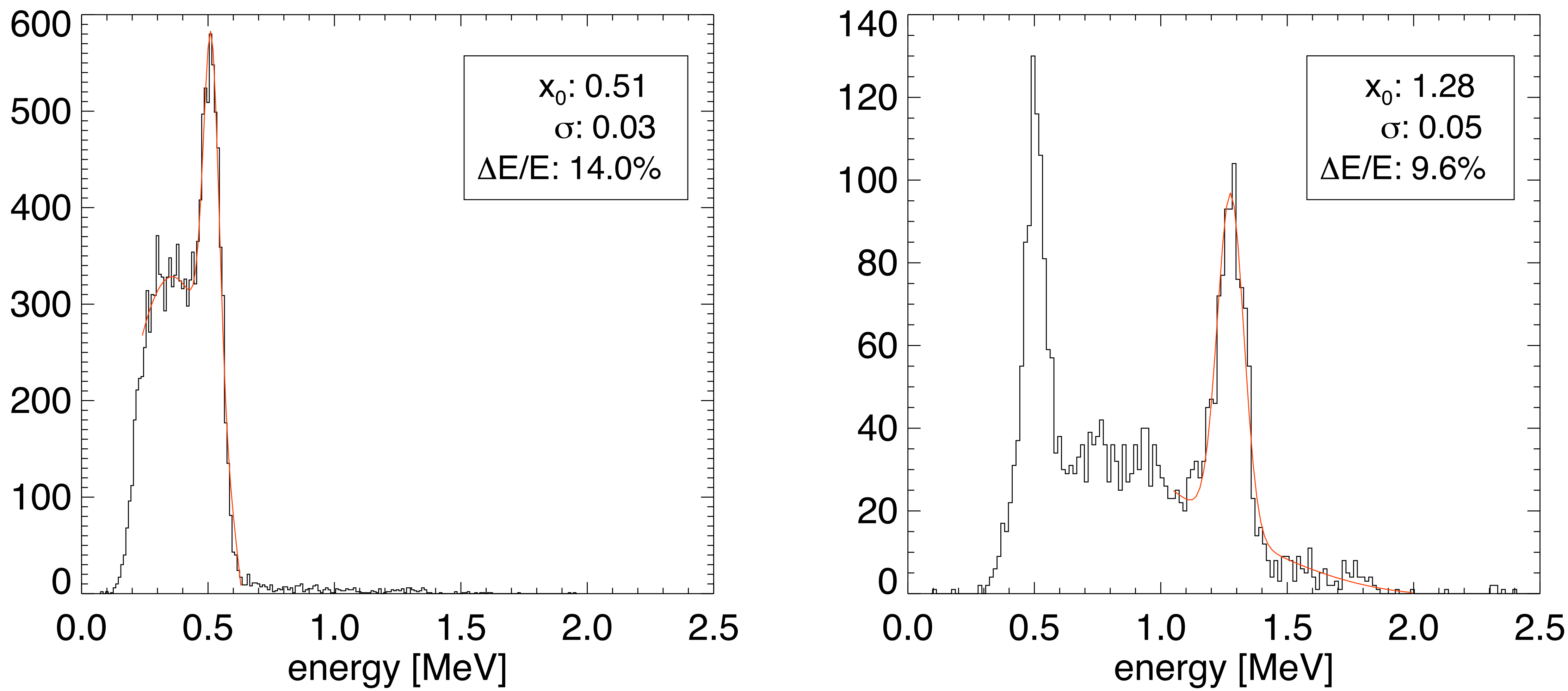


Figure 2.26: *Left:* 0.511 MeV line from a ^{22}Na source tagged source, 1-site events. The spectrum has been fitted fitted with a gaussian plus a second order polynomial to account for the underlying background; the mean and r.m.s. of the gaussian are shown in the inlet, together with the $\Delta E/E$ (FWHM). *Right:* 0.511 MeV and 1.275 MeV lines from a ^{22}Na source source, 2-site events.

energy [MeV]	source	1999	2000
0.511	^{22}Na	yes	yes
0.662	^{137}Cs	yes	no
0.898	^{88}Y	yes	yes
1.173^{*}	^{60}Co	no	yes
1.275	^{22}Na	yes	yes
$1.325^{a,*}$	^{88}Y	yes	no
1.332^{*}	^{60}Co	no	yes
1.465	^{40}K	no	yes
1.836	^{88}Y	yes	yes
$3.41^{a,*}$	Am-Be	yes	no
3.92^{b}	Am-Be	yes	no
$4.18^{c,*}$	Am-Be	yes	no
4.43	Am-Be	yes	no

Table 2.1: Energy lines used for calibration of the LXeTPC in 1999 and 2000. All the lines are measured as FEP with the exception of: (^{a}) single escape peak; (^{b}) double escape peak; (^{c}) Compton edge. Lines marked as (*) have not been used to determine the energy resolution because of limited statistics (^{60}Co doublet) or because the line profile was not well reproduced by a gaussian (^{88}Y and Am-Be single escape peaks, Am-Be Compton edge).