Electron recombination studies in LAr

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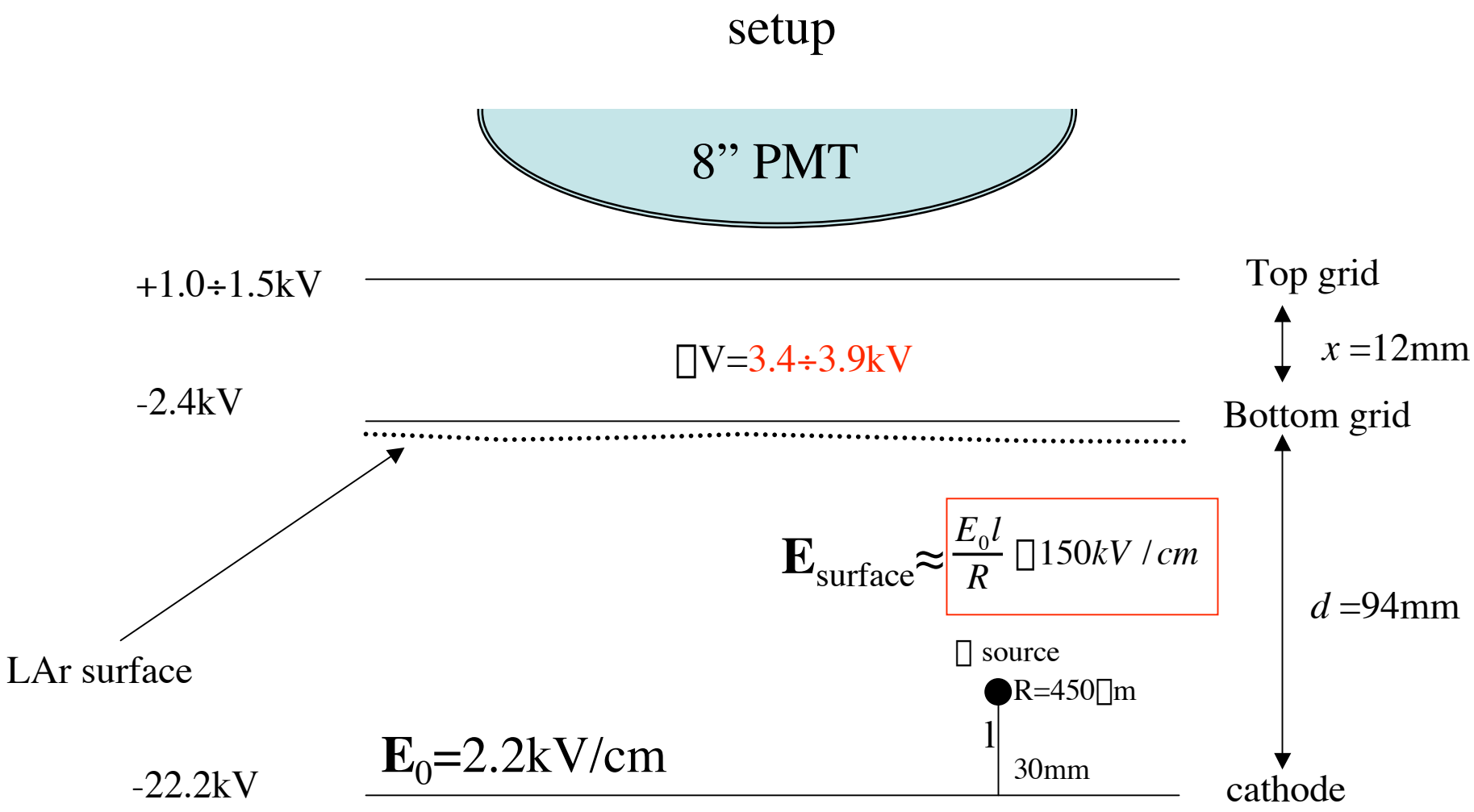
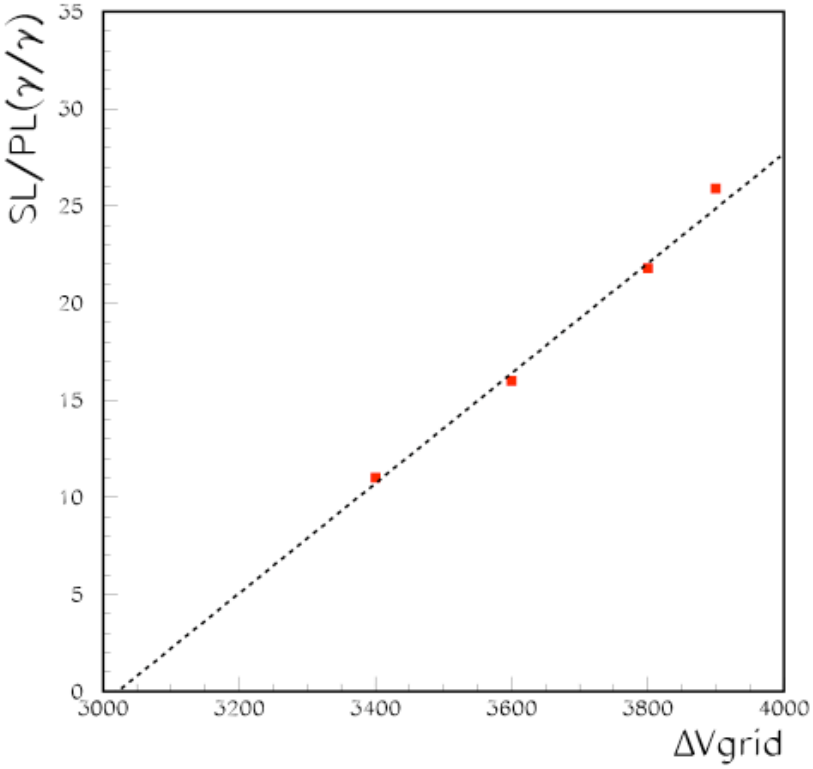
Highlight

- Summary of the previous test
- Description of new test
- Study of electron recombination
- Comparison with published data
- Effective energy evaluation
- Proportionality factors between luminescence light and electron
- Conclusion and Outlook

Summary of the past measurements



Summary of the past measurements



- We got the electrons extractions
- The luminescence light is proportional to the field between the grids

$$\frac{SL}{PL} = (28.6 \pm 0.6) \cdot (V - V_0)$$

$$V_0 = 3020 \pm 100$$

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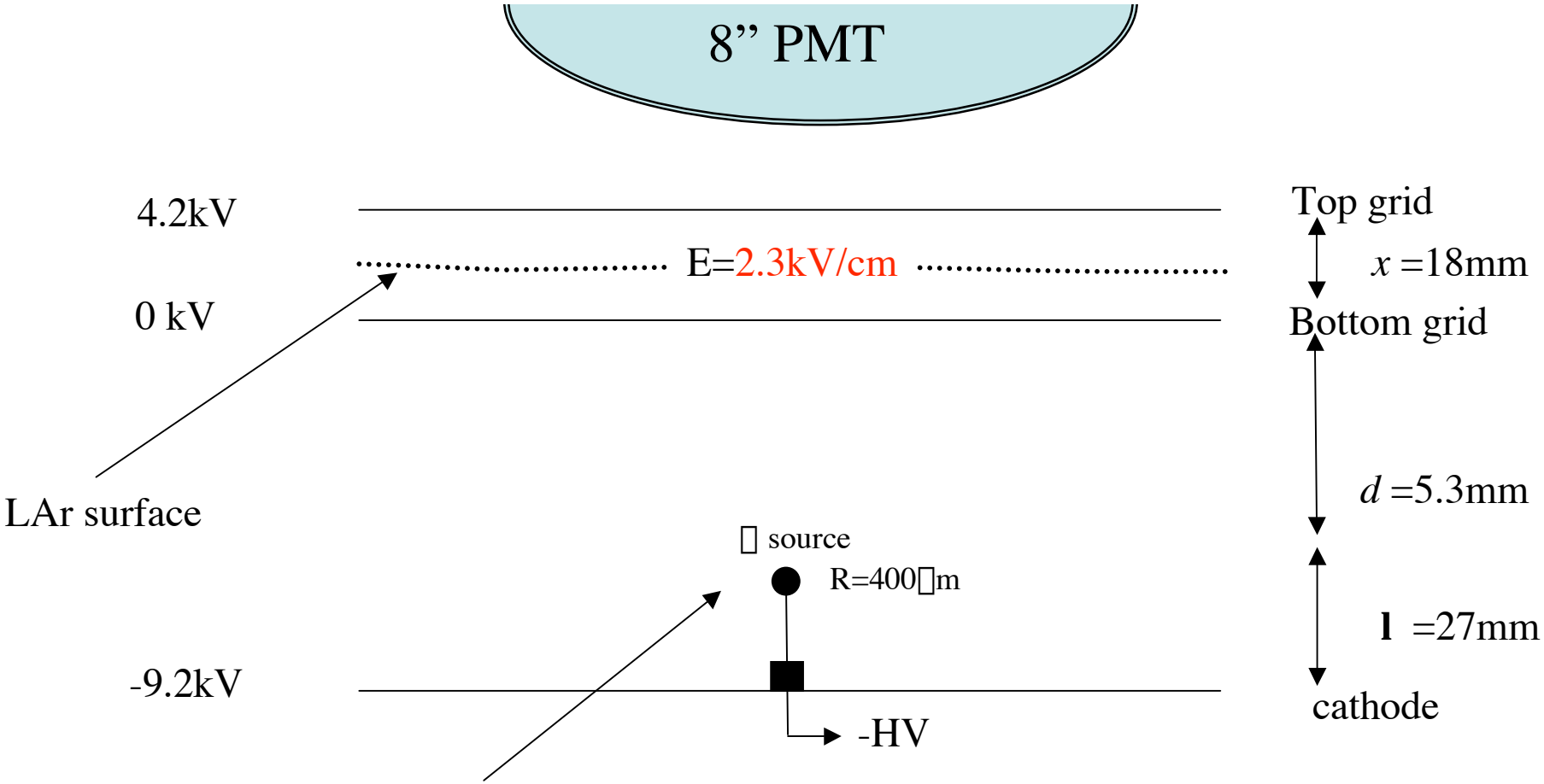
Schematic Setup recombination studies



High E.F. prevent electron recombination

Aim of the test

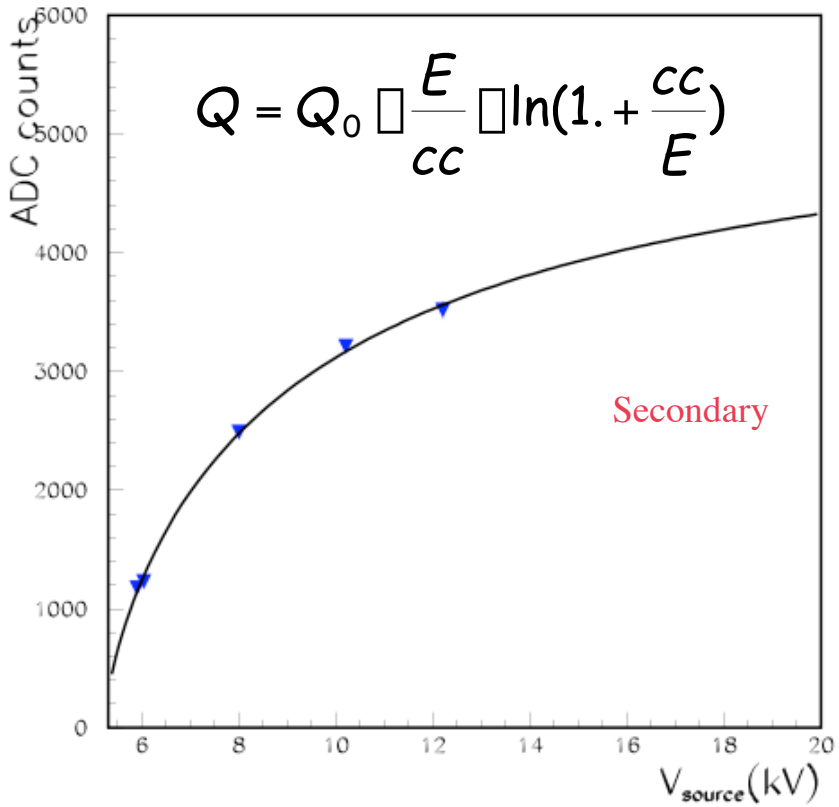
- The measurement of primary scintillation light vs. E_{source}
- The measurement of luminescence light due to electrons drift in GAr vs. E_{source}
- The measurement of proportionality factors between luminescence light and electrons

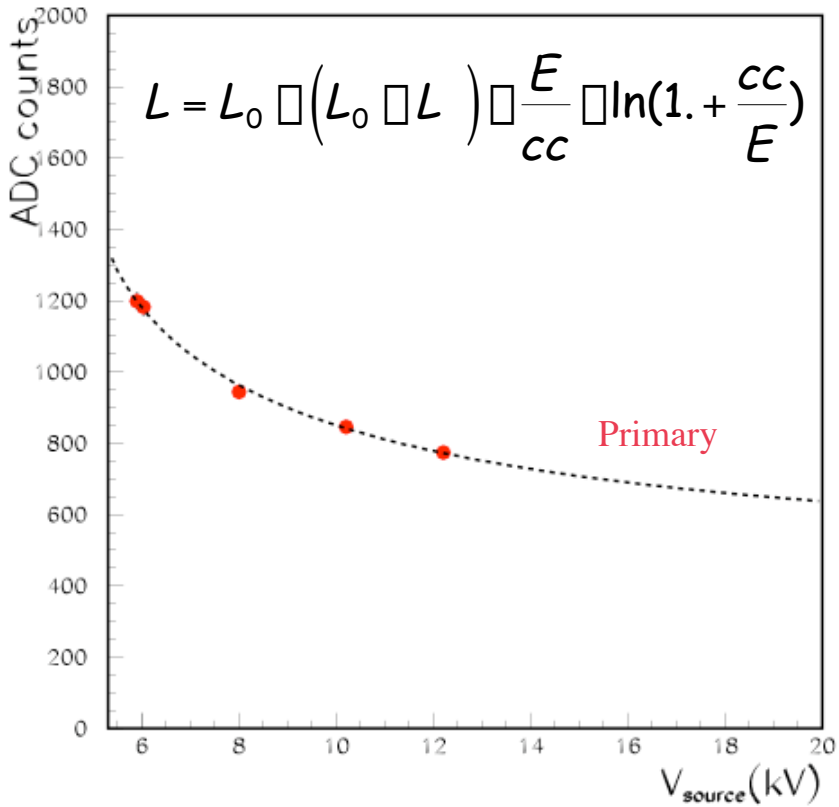
Data taken

- Source: activity ≈ 100 Bq,
  5.3 MeV (monoenergetic)
- Readout ≈ 1 Hz
- High voltages:
  - Upper Grid : +4200V
  - Lower grid: 0 V
  - Cathode: –9.2 kV ($E_{drift} \approx 1.15$ kV/cm)
  - Source potential -12.1 ÷ -5.9 V ($E_{source} = (V-V_0)/R \approx 0. \div 170.$ kV/cm)
  - PMT +1250V
- ≈6000 events per run

Delayed and Prompt light w.r.t. E_{source}

The phenomenological Box model well reproduce the data





$$E_{source} = \frac{V_{source} - E_{drift} \cdot d}{R}$$

Results of the fit

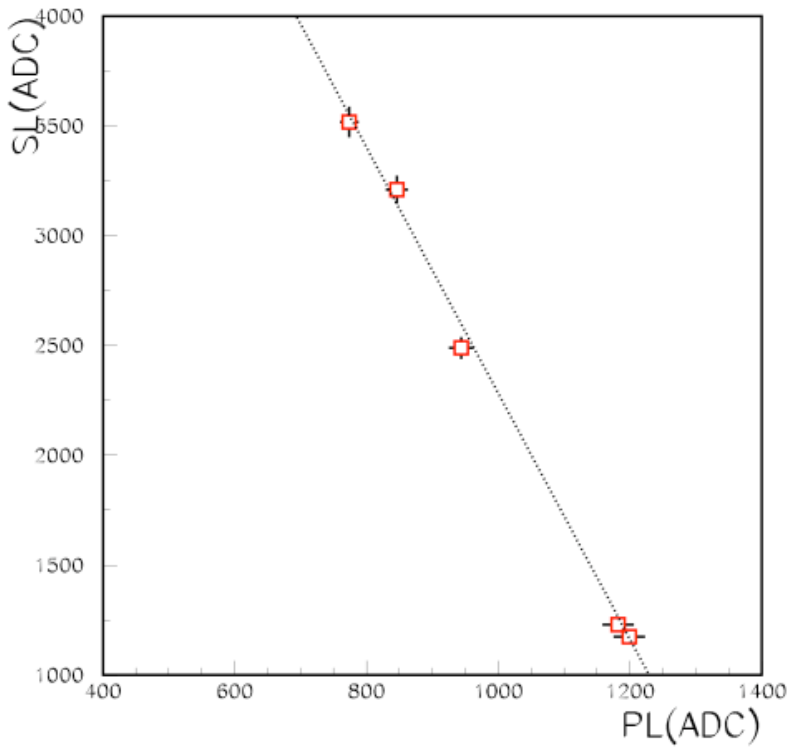
V_0	5.19	±	0.08	V
cc	221	±	50	kV/cm
L_∞	430	±	72	ADC_c
L_0	1396	±	107	ADC_c
Q_0	5497	±	456	ADC_c

$$\frac{L}{L_0} \square 30\%$$

In agreement with published data

Results

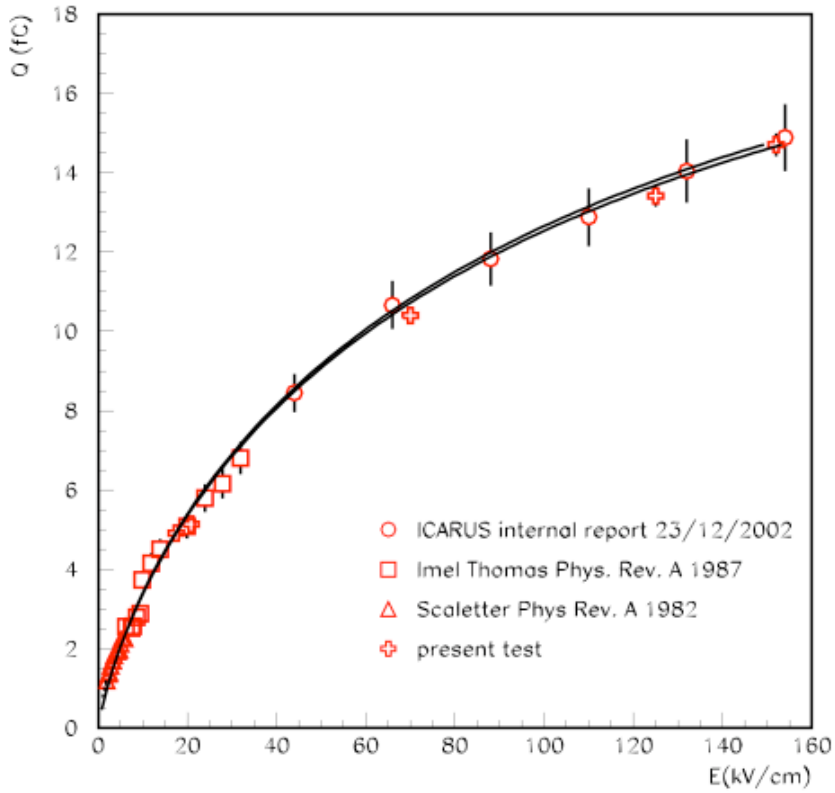
Secondary vs primary light



$$L_S = -5.6 \cdot L_P + 7915$$

A linear correlation between the SL & PL is observed

Checks with existing data



Published data have been fit and the result is:

24±3 fC

223±53 kV/cm

Calibration of the present test:

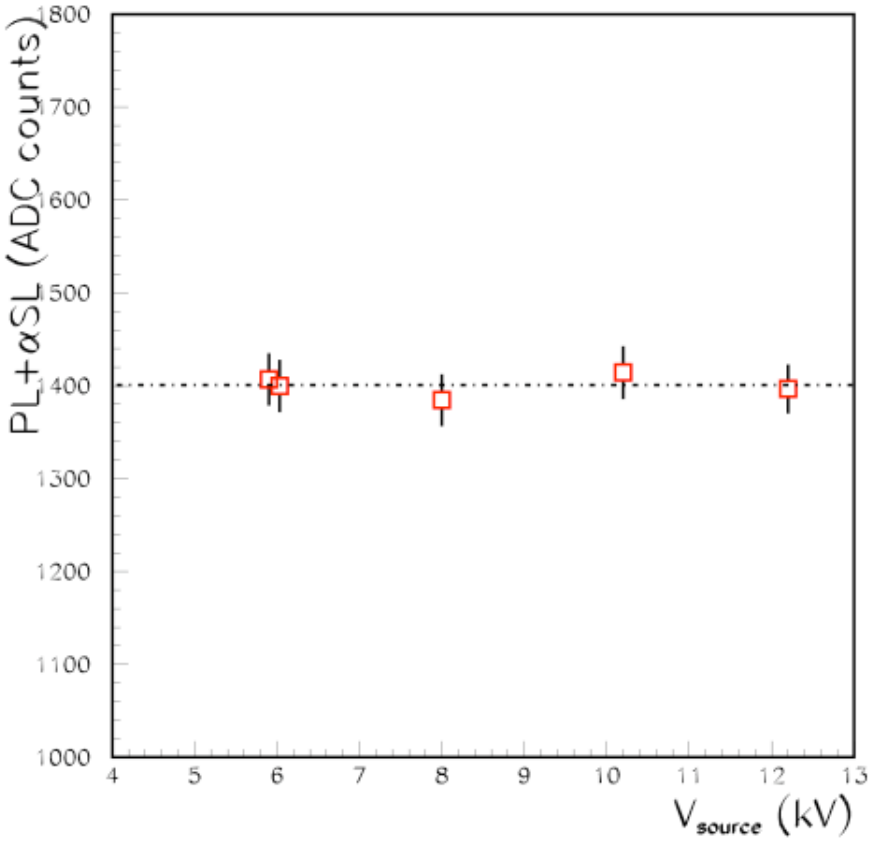
23fC 143750 *e*

143750 x 23.6 eV=3.4MeV

Some energy does not contribute to the ionization.
Other degrees of freedom could be involved

Results

We want to test if the sum of the energy spent for the PL and SL(electron) production is constant vs. V_{source}



	e	□
$W_{□}$	19eV	27.5eV
W_e	23.6eV	?

5.3MeV/143750=37eV

A different W_e is found for the alpha w.r.t. the m.i.p.

$$N_{□}(E=0) = E_{source}/W_{□}$$

$$N_e(E\ □\ ) = E_{source}/W_e$$

Results

The gain factor G defined as the number of secondary photon vs. ionization electrons has been measured. It is given by the ratio of the measured SL(E->infinity) and the PL(E=0)

$$G = \frac{\varepsilon_P}{\varepsilon_S} \cdot \frac{W\gamma}{W_e} \cdot \frac{5497(A.D.C._{counts})}{1396(A.D.C._{counts})}$$

$$\frac{\varepsilon_P}{\varepsilon_D} \cdot \gamma_1 = 0.31$$

$$G \pm \Delta G_W \pm \Delta G_{measure} = 0.98 \pm 0.07 \pm 0.11$$

Results

Comparison of the results of the first and second test

$$G = \alpha \cdot (E - E_{TH}) \cdot \Delta x$$

$$E_0 = 2516\,kV/cm$$

$$\alpha\left(N_\alpha/electron/kV\right) = \frac{SL}{PL} \cdot \frac{N_{\alpha_P}}{N_{e_P}} \frac{\beta_P}{\beta_e} = 32$$

First test

litterature-> W_α/W_e

Second test

The alpha rate has been measured for the LAr.
The value found has to be compared to
77photon/electron/kV for LXe

Conclusion and Outlook

- A study has been performed about electron recombination
- The scintillation and luminescence light well agree with phenomenological model(Box)
- A good agreement with existing data has been found
- Clear hints have been found showing that for the alpha particle not only the effective energy to crate a photon is different w.r.t. m.i.p. but also the effective energy to get free an electron is different
- A further investigation could be useful to understand the reason of particle dependency of the effective energies