Angular dependence of Recombination ?

Reminder/Status

In Liqid Argon Ionization chambers the collected charge Q is different from the produced charge Q_0 due to Electron Recombination :

$$Q = \mathcal{R} Q_0 \; ; \; \mathcal{R} \leq 1$$

$\mathcal{R}$ is function of the electric field $\mathcal{E}$ and of the particle stopping power $\frac{dE}{dx}$. The Birks law (from columnar theory) usually reproduces data

$$Q(\mathcal{E}) = \frac{Q_0}{1 + k/\mathcal{E}} \qquad or \qquad Q(\frac{dE}{dx}) = A\frac{Q_0}{1 + k_Q \frac{dE}{dx}}$$

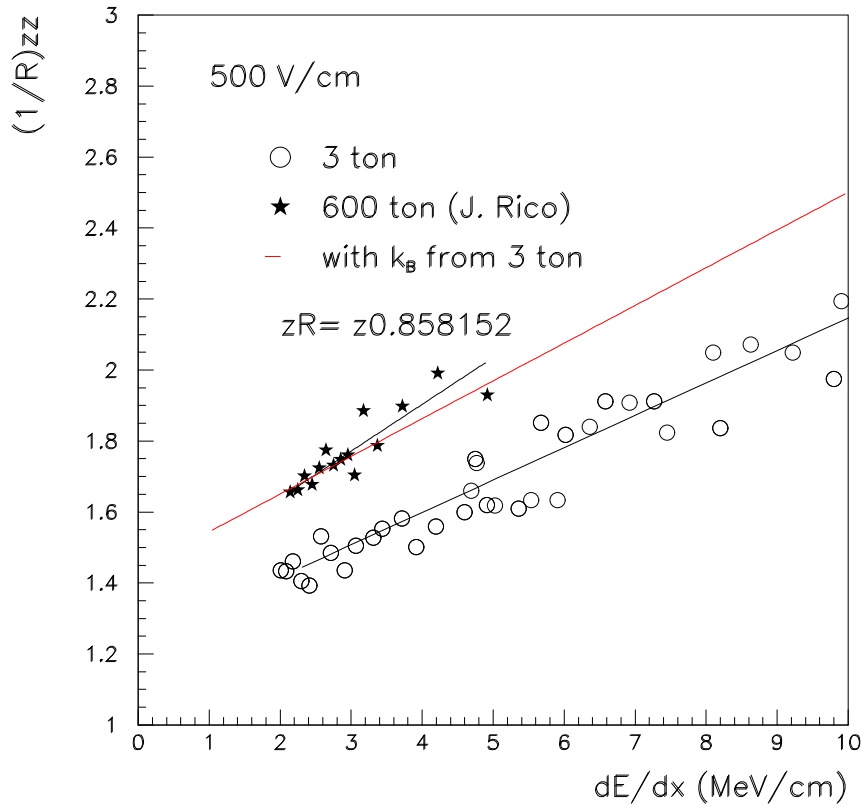
$$\searrow \qquad\qquad\qquad\qquad \swarrow$$

$$k_Q = \frac{k}{\mathcal{E}}$$

Other possibility: box model

$$Q(\mathcal{E}) = \frac{\log 1 + \xi}{\xi} \;\; ; \;\; \xi \propto \frac{1}{E} \qquad (1)$$

ICARUS DataSets



ICARUS $1/\mathcal{R}$ vs. $\frac{dE}{dx}$

3 ton data : μ, p

300 t data : μ (J. Rico)

k values compatible

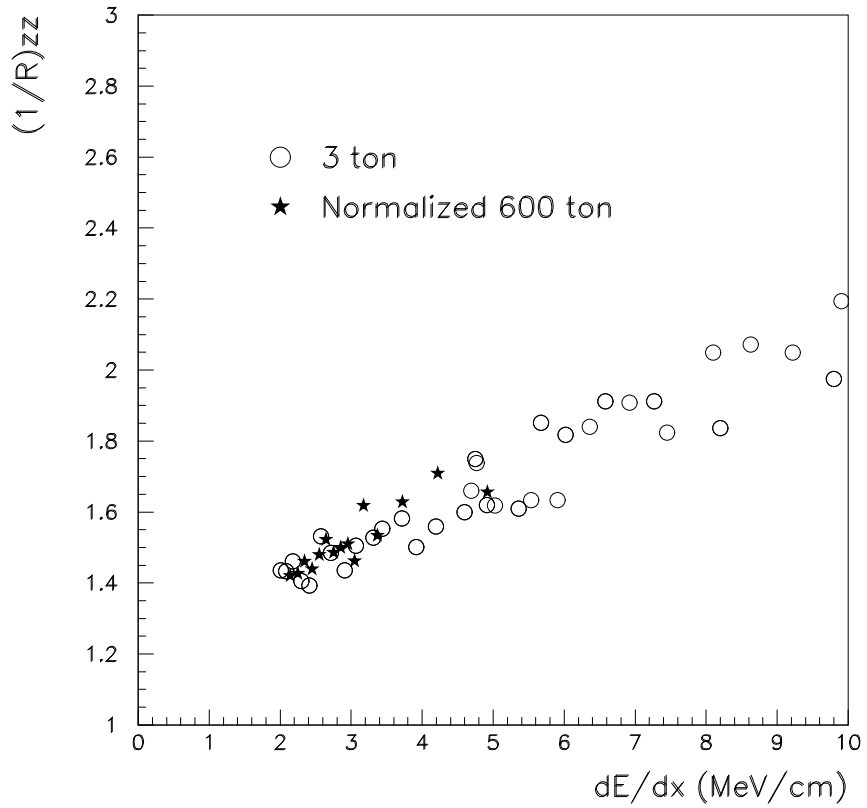
Different normalization

For simulations:

k from 3ton

A from 300 ton

ICARUS DataSets



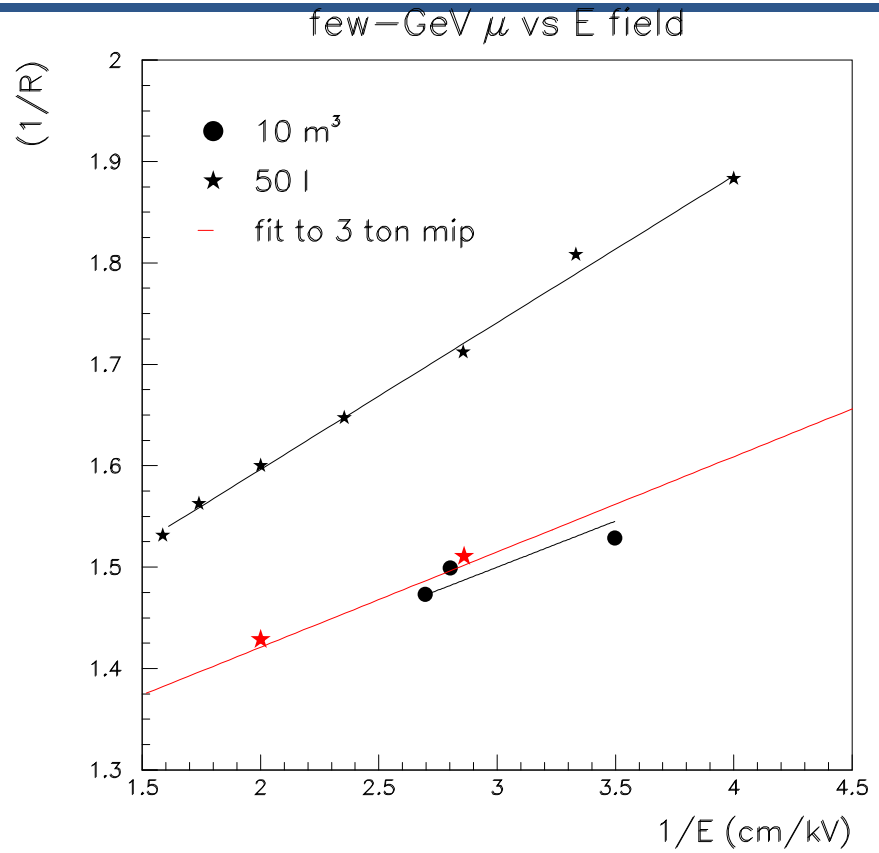
ICARUS $1/\mathcal{R}$ vs. $\frac{dE}{dx}$

3 ton data : μ, p

300 t data : μ (J. Rico)

Constant Renormalisation

ICARUS DataSets



ICARUS $1/\mathcal{R}$ vs. $\mathcal{E}$

muons

50 l (Silvia, Francesco)

10 m^3, (Ornella)

3 t from fitted k

Status

For 600t simulations

We have now experimental slope and normalization.

MC can reproduce 600t data

For recombination paper

Normalization to be understood

No hint from calibration tests

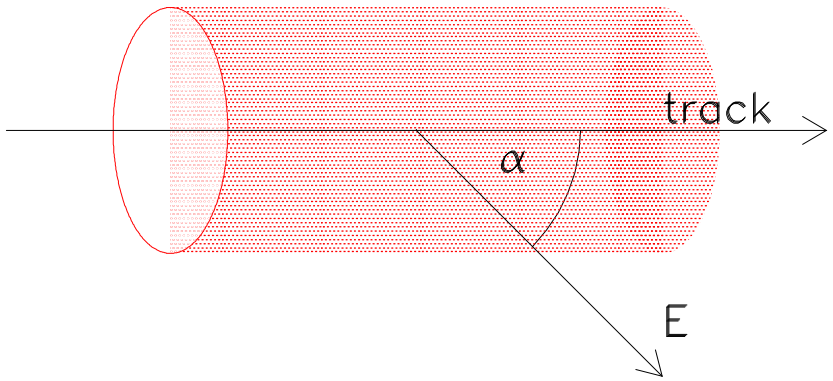
Test with μ in 50l in program (soon)

Analisys of angular dependence- this meeting

Angular dependence?

A dependence of recombination on the angle α between $\mathcal{E}$ and the track direction is foreseen in the columnar theory (Jaffè, Kramer):

$\mathcal{E} \rightarrow \mathcal{E} \cdot \sin\alpha$ " for not too small α "



What matters is the time spent inside the column

Angular dependence in FLUKA

Given a track at an angle α with the drift field

For each substep in each subtrack

find β angle between subtrack and $\mathcal{E}$

redefine the Birks k as $k/\sin\beta$

Small angle limit::?

First guess: limit from longitudinal path S needed to have

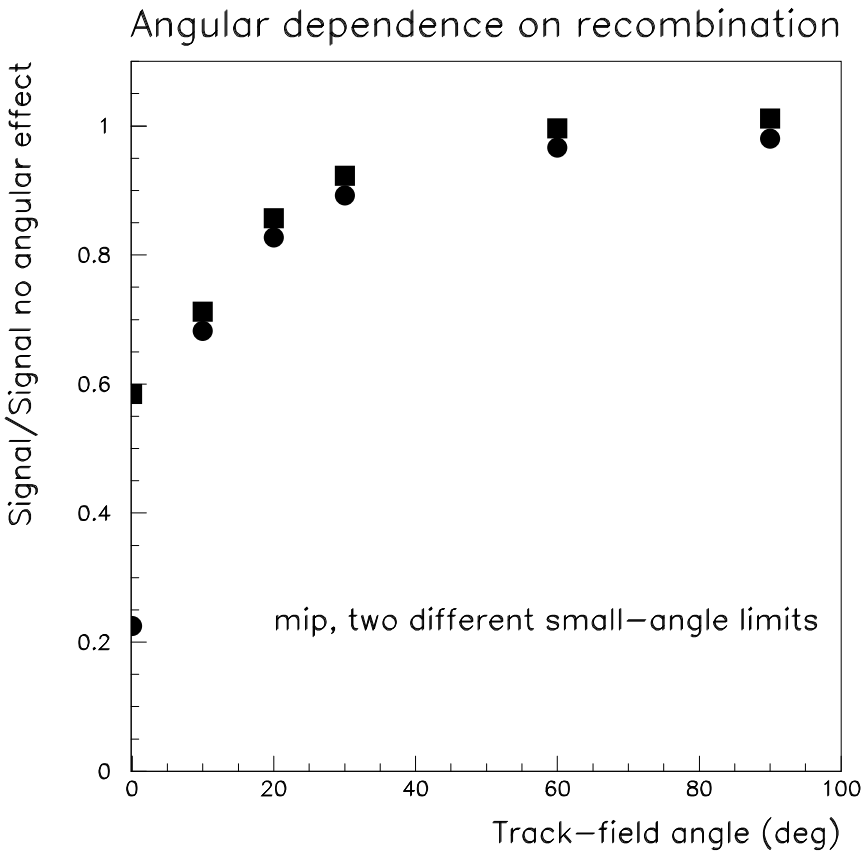
diffusion radius $>$ radius of ionization column

If D $= 5$ cm^2/s, (3ton paper), v=1.5 mm/μs, $r^2 = 4DS/v_{drift}$

r/S $= 0.1$ for r=100nm , r/S $= 0.01$ for r=10nm

Ask also $S <$ track length

Angular dependence?



FLUKA recombination

mip muon

vs α : muon track-$\mathcal{E}$ angle

normalized to no angular dependence

Birks k from ICARUS data

$\rightarrow$ 10 % at 30°

$\rightarrow$ Uncertain at low α