Calorimetric reconstruction of ArgoNeuT cosmic muons: procedure and problems

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Data Sample

- ArgoNeuT summer 2008 test run data (cosmic muons – external trigger)
  - Runs with full electronics equipment (both Collection and Induction views) → for 3D geometric reconstruction
  - Runs with cathode HV=-4kV -> to avoid TPC current drawing

Data sample (few tracks) for present analysis includes runs with:
Cathod =-4kV Shield = -134V Induction Plane= -82V Collection Plane=+10V
Edrift = 82 V/cm Esi=130V/cm Eic=230V/cm

Run0342Event0005.root
Run0345Event0002.root
Run0345Event0007.root
Run0345Event0019.root
Run0378Event0008.root
Run0379Event0003.root
Run0382Event0004.root
Run0383Event0002.root
Run0383Event0009.root

Sept. 8^{th}-10^{th}

Procedure for the calorimetric reconstruction

- Visual Scanning of the event
- Selection of events corresponding to the external trigger geometry
- Hit reconstruction (Time and Amplitude)
- Muon track 3D geometrical reconstruction (see M.Antonello presentation at ArgoNeuT meeting 11-04-2008)
- Measurement of charge collected per unit track length → dQ/dx
- Correct for the charge loss due to attachment to electro-negative impurities (lifetime correction)
- Convert Charge into Energy correcting for the quenching effect in LAr (e- + ion recombination) → dE/dx

Quenching effect due to Recombination

- There is no theory yet that can successfully describe the e- -ion recombination processes in LAr as a function of the electric field (Efield) and of the stopping power (dE/dx).
- A semi-empirical model (Birks law) has been adopted to describe the recombination effect in the ICARUS 3t detector data at Efield= 200, 350,500 V/cm. P. Cennini et al. NIM A 345 (1994) 230.

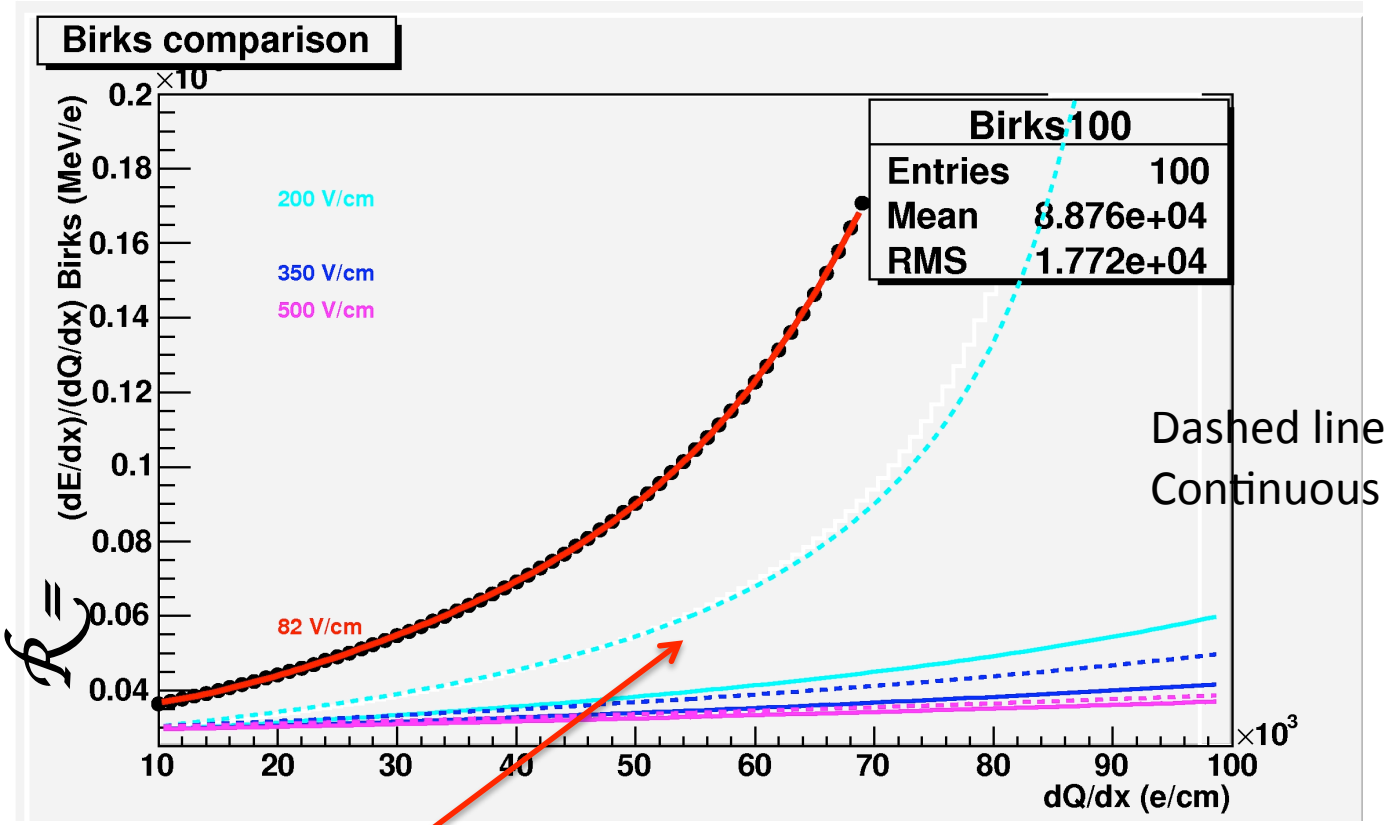
$$dQ/dx = A_{3t}\frac{dE/dx}{1 + k_{3t}dE/dx}$$

- An effort to define a model including the dependence from the Efield has been done in S.Amoruso et al. NIM A 523 (2004) 275.

$$Q = A\frac{Q_0}{1 + \frac{k}{\varepsilon}dE/dx}$$

Nevertheless this model seems not to be able to reproduce data below 200V/cm

Birks correction extrapolation at low fields

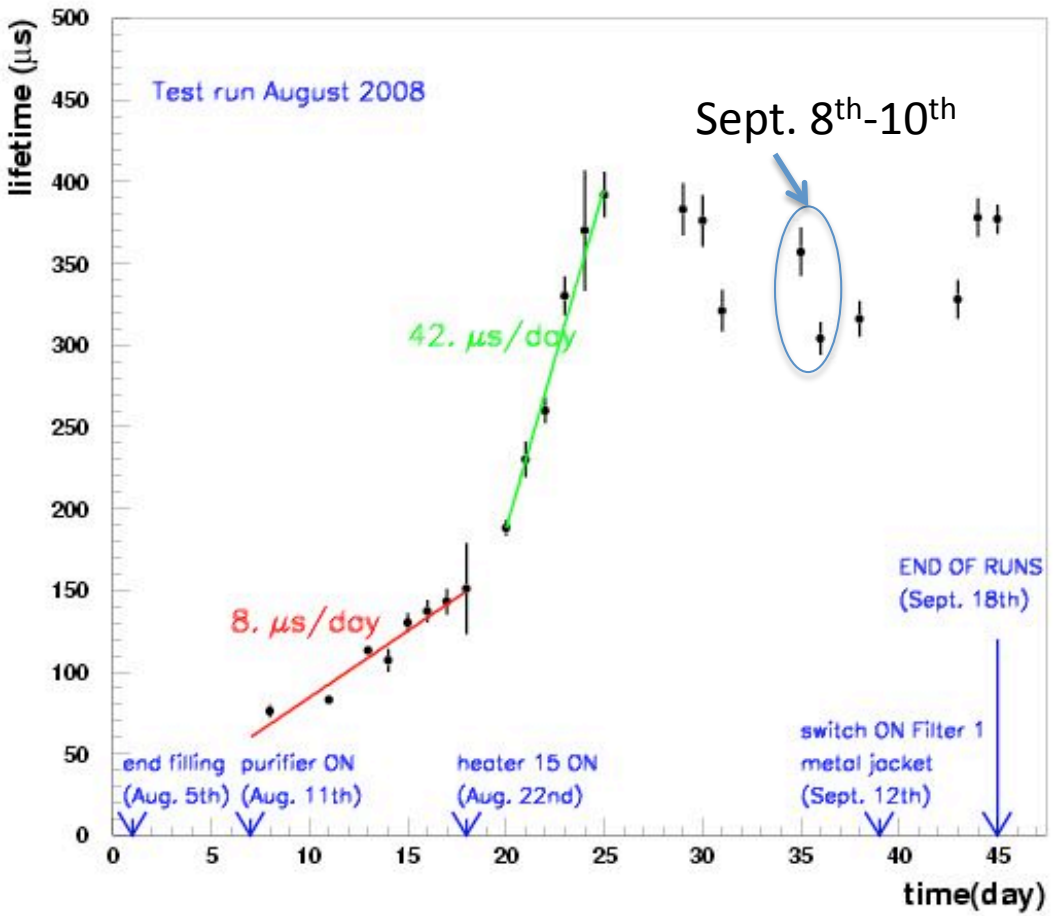


Dashed line = P.Cennini et al
Continuous line = S.Amoruso et al.

- ArgoNeuT data has been acquired at 82 V/cm
- Using the ICARUS 3t parameterization of the Birks law at 200,350 and 500V/cm (dashed lines), we have extrapolated the quenching effect correction at 82 V/cm (black dots) and fitted with a polynomial law (red line)
- **At the typical TPC electric fields the recombination effect $\mathcal{R}$ is almost independent from the stopping power, while at low fields the dependence is strong.**

Lifetime correction

- Lifetime measurements done last summer during the test run do not take into account the recombination effect (as usually done for the typical TPC electric fields).



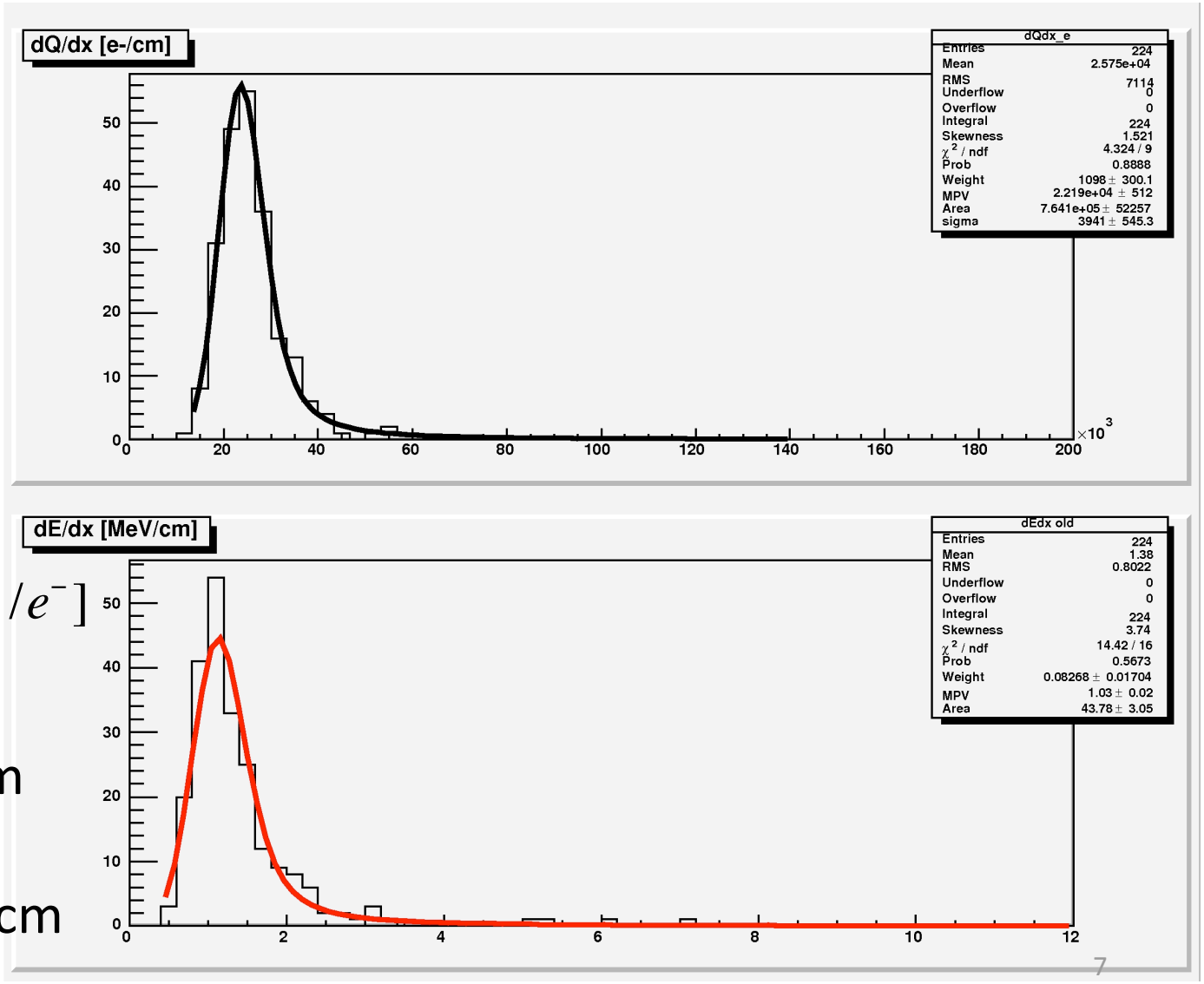
- Lifetime has been re-evaluated for the present data sample taking into account the Birks correction at 82 V/cm

Procedure:

- dQ/dx distributions computed by grouping the hits according to their drift coordinate in ~5 cm wide slices.
- Value of the most probable dQ/dx extracted by fitting each histogram with the a landau-gauss convolution.
- Exponential fit of the most probable dQ/dx as a function of the drift coordinate gives the measurement of the lifetime: <tau>=186 us

$$dQ/dx[e^-/cm] = dQ/dx[ADC/cm] \cdot \frac{F_{cal}[fC/ADC]}{e[fC/e^-]} \cdot e^{\frac{t}{\tau}}$$

Calibration factor F_{cal} = 7.54 ADC/fC (from D.Edmunds)



$$dE/dx[MeV/cm] = dQ/dx[e^-/cm] \cdot R[MeV/e^-]$$

<dE/dx>=1.38MeV/cm

Lower than 2.1 MeV/cm of a m.i.p. !

Conclusions

- The calorimetric reconstruction procedure has been set up
- dE/dx lower than expected

  Possible explanations:
  - Birks law extrapolation at 82 V/cm
  - Effective Electric field inside the TPC could have been different from the nominal value due to the well known current drawing problem (i.e. data taken at 5 kV show inconsistency with 4kV data).

  Any ideas?
- To be done: dE/dx measurement with muon tracks from NuMI beam data also to check the reliability of the calorimetric reconstruction