Very preliminary study of brem gammas from simulated electrons in LArIAT

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Andrzej Szelc, Roberto Acciarri

Motivation

The idea is to revisit some questions related to the electron run we will have, like

- How many brem gammas (hence, gamma-induced showers) can we expect?
- What these gamma-induced showers will look like?
- Will a pre-shower disk (1 X0 or more) be useful?
- This leads to the physics question how well we can discrimate gamma-induced from electron-induced showers.

I have some preliminary answers for the first two/three points, nothing yet for the fourth one.

Done so far

- Andrzej simulated the interaction of beam electrons entering the TPC – both with and without the presence of a disk upstream the detector – at different energies ($0<E_{el}<2.5$ GeV).

- Andrzej realized a filter based on MC Truth information to select showers induced by brem gammas which:

  - ✔ Start inside the fiducial volume (2 cm around the TPC walls);
  - ✔ Have energy above a defined threshold;
  - ✔ Have no particle entering a cilinder of radius 2 cm and length 7 cm, centered around the shower start along the axis (in the 3D space) and starting 2 cm before the shower.

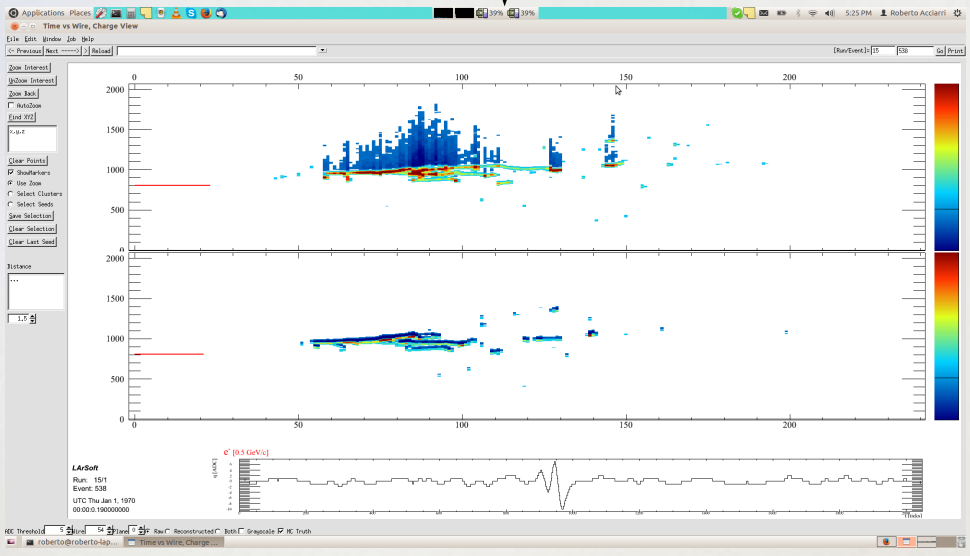
Done so far

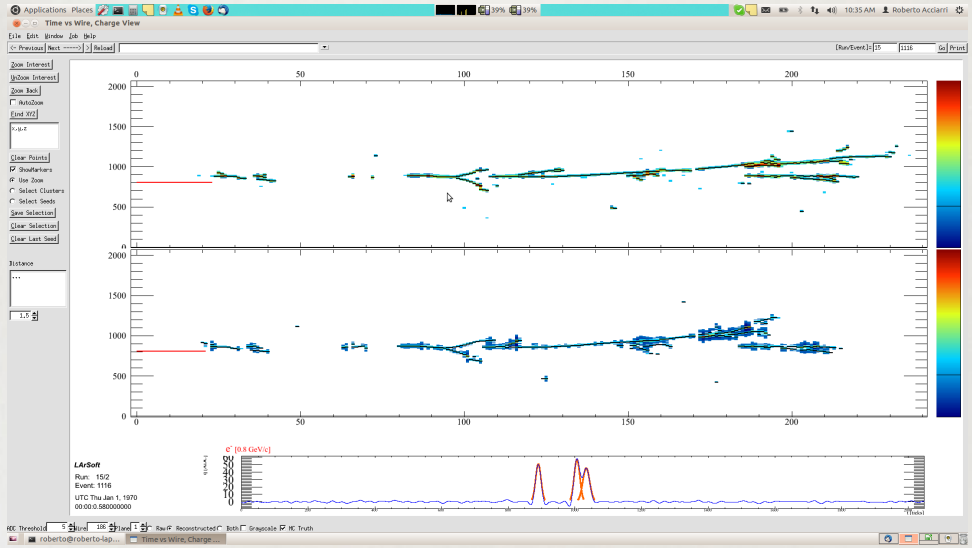
- Events from the first three sets of electrons (E_{el}= 0.25±0.15 GeV, 0.5±0.15 GeV, 0.75±0.15 GeV) selected by the filter have been hand scanned to remove showers "hard to reconstruct" (well isolated in the 3D space but overlapping with other tracks in one or both of the 2D views).

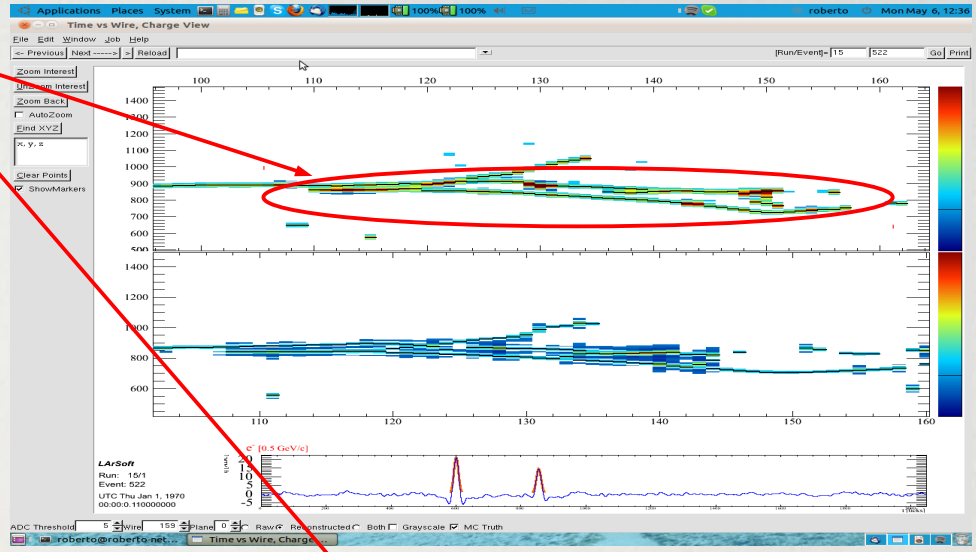
- For gammas above 200 MeV, a distinction between "well formed showers" and "tiny showers/pairs" has been done.

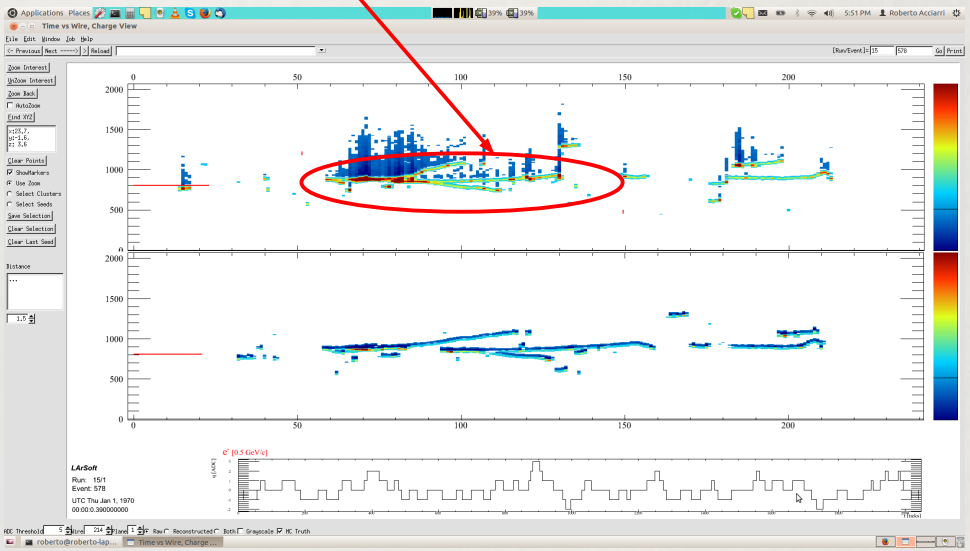
Hard to reconstruct

Good showers



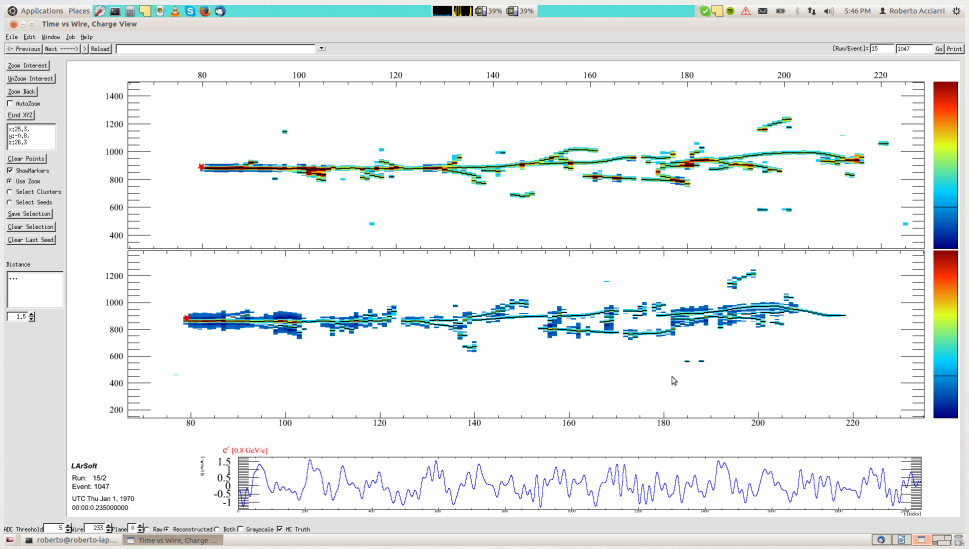




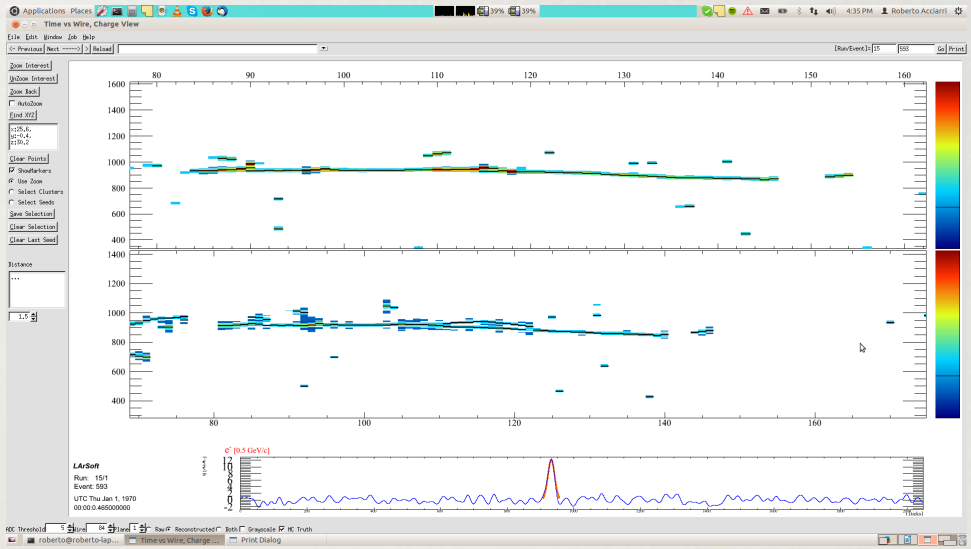


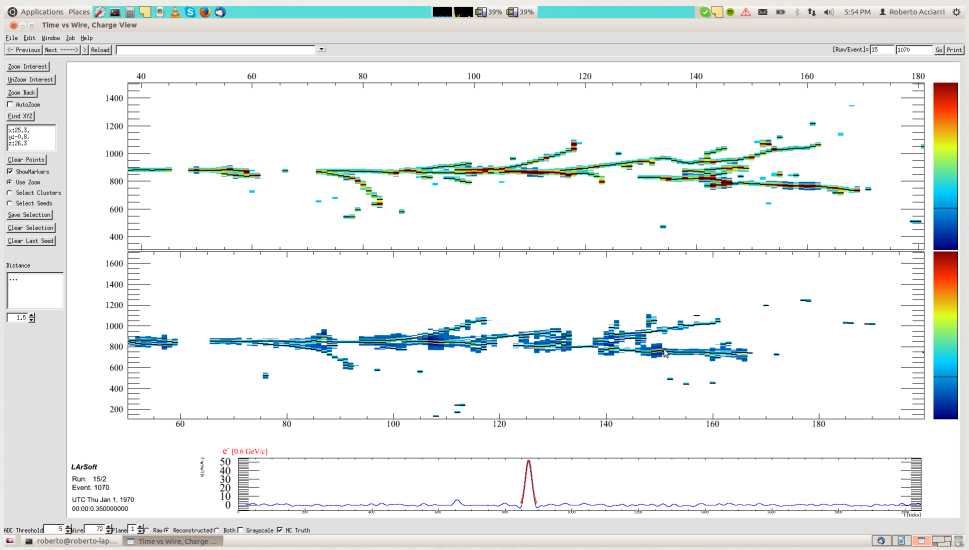
Brem Gamma with E_γ > 200 MeV

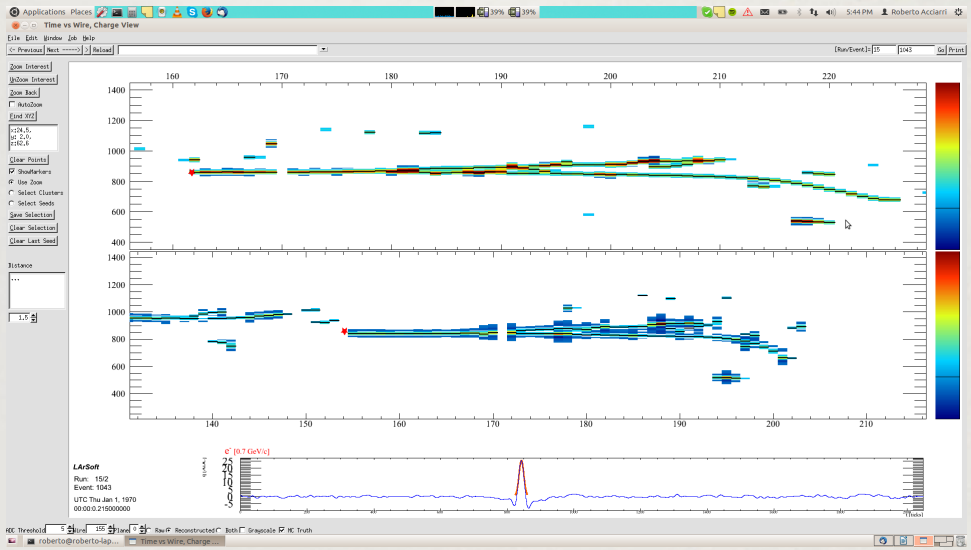
"well formed showers"



"tiny showers/pair"







Hand Scan results

Simulation without thin disk

Simulation With thin disk

	E_{el} = 0.25±0.15 GeV – NO Thin Disk	E_{el} = 0.25±0.15 GeV – Thin Disk
Simulated electron events seen	300	290
γ-induced showers per incident electron expected with 70 MeV<Eγ<100 MeV	0.05	0.09
γ-induced showers per incident electron expected with Eγ>100 MeV	0.23	0.16
	E_{el} = 0.5±0.15 GeV – NO Thin Disk	E_{el} = 0.5±0.15 GeV – Thin Disk
Simulated electron events seen	150	150
γ-induced showers per incident electron expected with 70 MeV<Eγ<100 MeV	0.10	0.05
γ-induced showers per incident electron expected with Eγ>100 MeV	0.39	0.38
γ-induced showers per incident electron expected with Eγ>200 MeV	0.15	0.16
% of γ with Eγ>200 MeV which are actual showers	35%	29%
	E_{el} = 0.75±0.15 GeV – NO Thin Disk	E_{el} = 0.75±0.15 GeV – Thin Disk
Simulated electron events seen	150	150
γ-induced showers per incident electron expected with 70 MeV<Eγ<100 MeV	0.06	0.11
γ-induced showers per incident electron expected with Eγ>100 MeV	0.41	0.45
γ-induced showers per incident electron expected with Eγ>200 MeV	0.21	0.24
% of γ with Eγ>200 MeV which are actual showers	45%	47%

- ✔ Results are conservative (as first step, events that may be reconstructed have been rejected by the hand scan).
- ✔ Few showers expected with E_γ<100 MeV.
- ✔ Quite good situation for showers with E_γ>100 MeV: a shower every 2–3 electrons entering the TPC with E_{el}>0.4 GeV.
- ✔ Not many "good looking" showers for E_γ>200 MeV, but clearly identifiable through dE/dx of the first part of the shower.

Possible next steps

- Use information from beam simulation about electron rate and energies to make a better estimate of the expected gammas;

- Start looking at cluster reconstruction;

- See how often in a low energy (E_γ<100 MeV) gamma-induced shower an immediate positron decay occurs, leading to a mis-identification of the event based on a dE/dx discrimination.

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