# A maximum likelihood approach for e/p identification: application to the beam test data and simulation

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# Generalities (1)

- Input variables:
  - hits in TKR bilayers $h_i$ (i=0,17) evaluated from TkrNumStrips
  - energy deposits in CAL layers $E_j$ (j=0,7) evaluated from CalXtalEne
- From a reduced sample of electrons and protons at given momentum and angle of incidence we build the probability distributions:
  - $P_i(h_i|e)$ and $P_i(h_i|p)$ ≡ probability to detect $h_i$ hits in the i-th TKR bilayer for an electron (proton)
  - $P_j(E_j|e)$ and $P_j(E_j|p)$ ≡ probability to detect an energy release $E_j$ in the j-th CAL layer for an electron (proton)
- For each event we evaluate the electron and proton likelihoods:

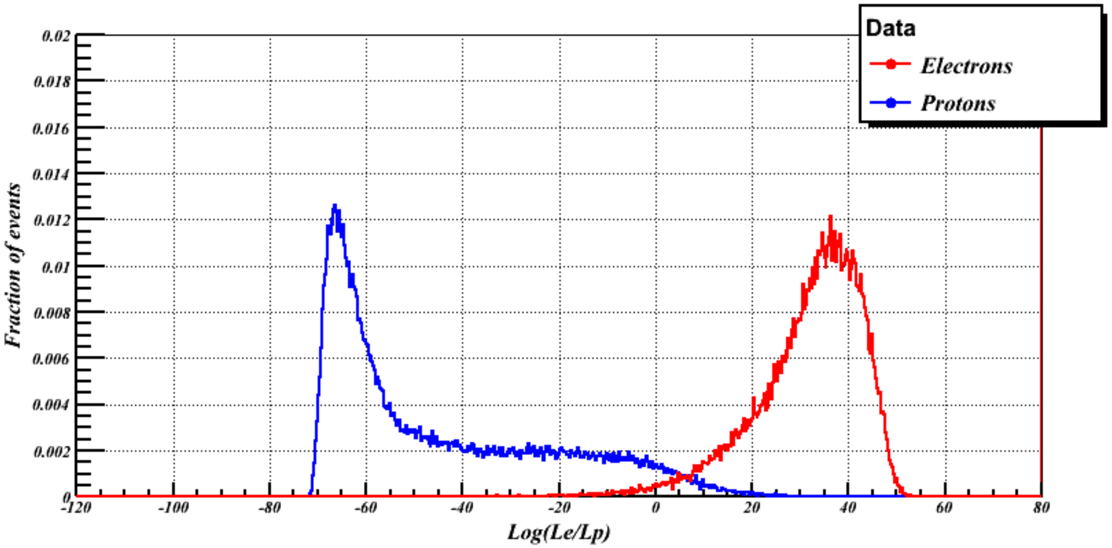
$$L_e = \prod_i P(h_i \mid e) \prod_j P(E_j \mid e)$$

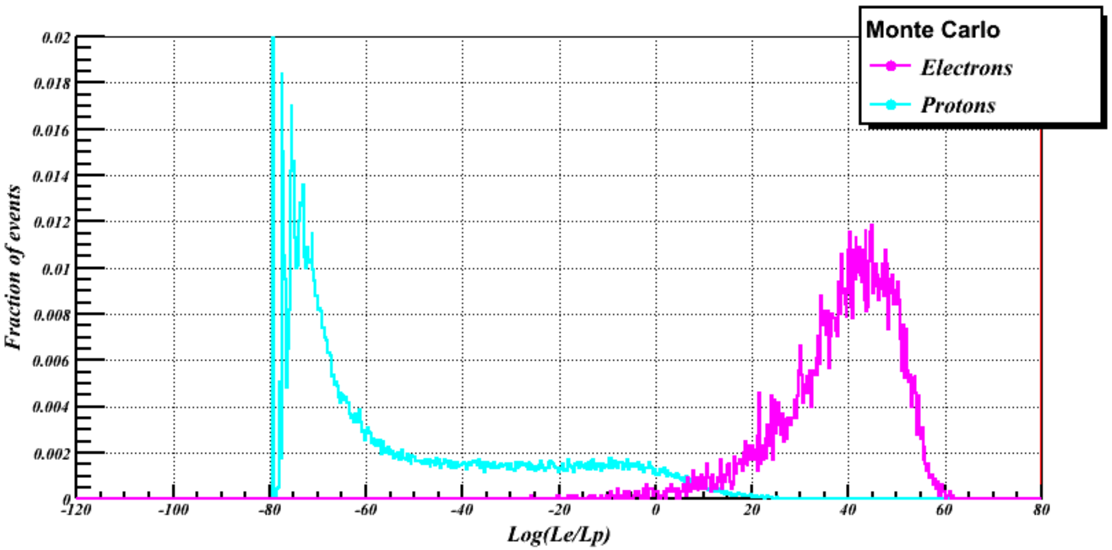
$$L_p = \prod_i P(h_i \mid p) \prod_j P(E_j \mid p)$$

# Generalities (2)

- Data samples:
  - 0 degrees, 10 GeV
    - runs 2338 (e) and 1419 (p)
  - 0 degrees, 20 GeV
    - runs 2082 (e) and 2232 (p)
  - 0 degrees, 100 GeV
    - runs 1980, 1981 (e) and 2362 (p)
- BT release: v7r1117p1
- Helium is taken into account in electron SPS simulated runs, but not in proton runs (some are still not available!)
- e/p identification based on the logarithmic likelihood ratio $\ln(L_e/L_p)$
  - $\ln(L_e/L_p) >$ threshold value ➔ electron
  - $\ln(L_e/L_p) <$ threshold value ➔ proton
- electron identification efficiency and proton contamination change with the threshold value
- study of proton contamination vs electron efficiency

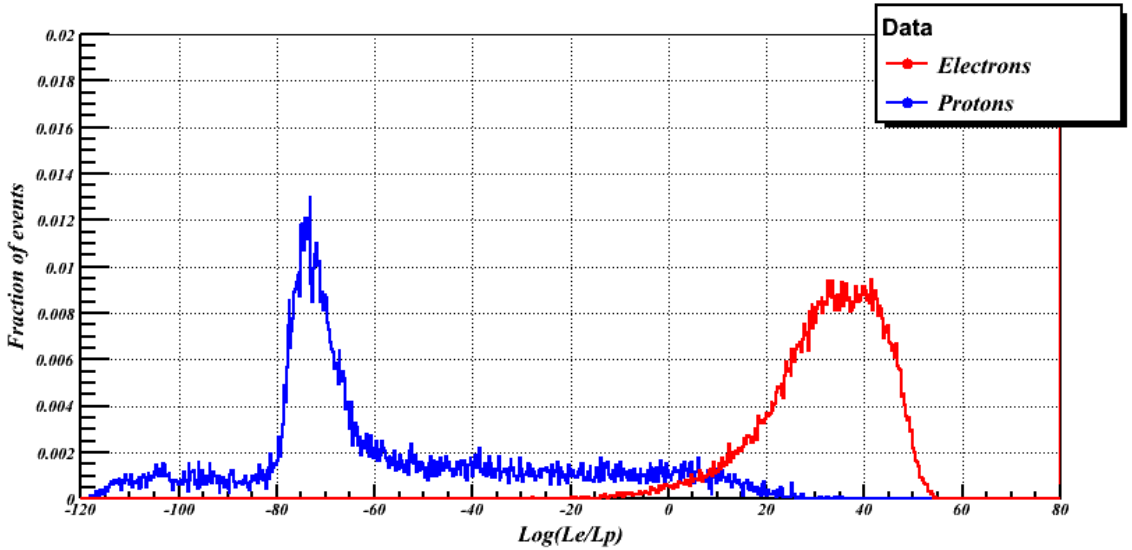
# Likelihood distributions at 10 GeV/c

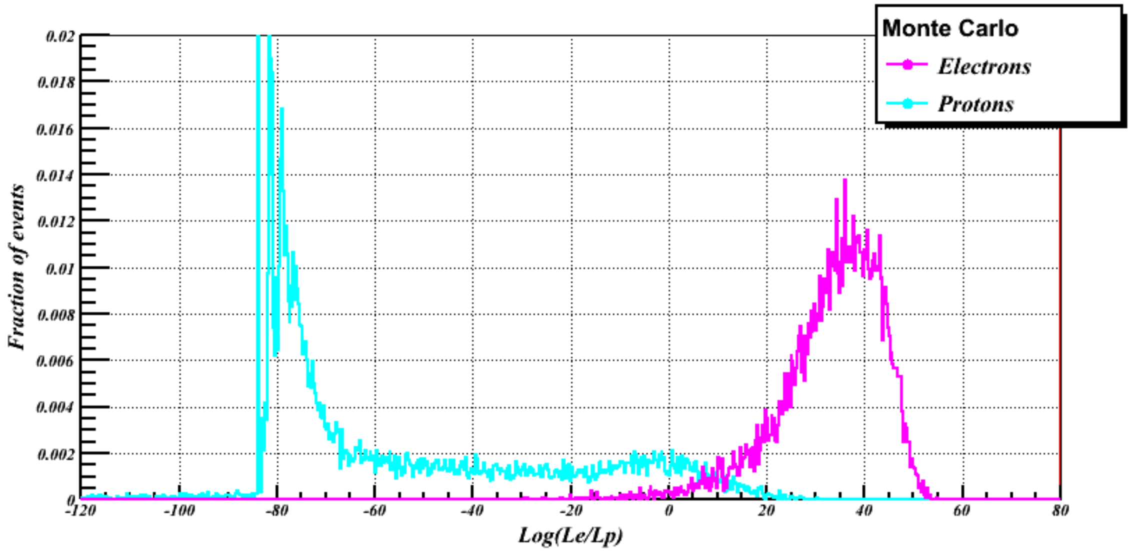



- The right tails of the proton distributions are originated by hadronic showers
- Data and MC exhibit a similar behaviour

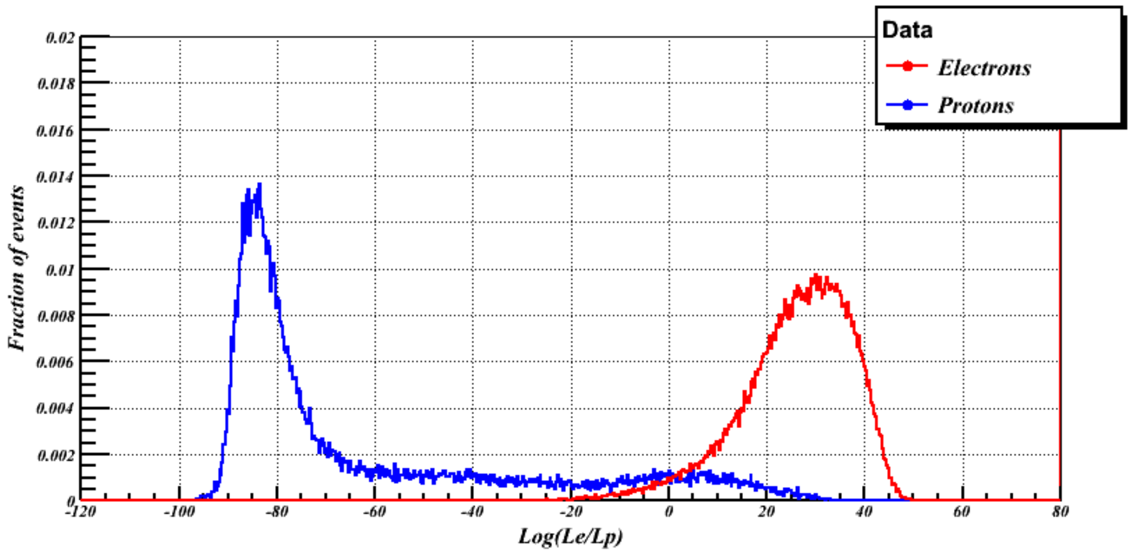
# Likelihood distributions at 20 GeV/c

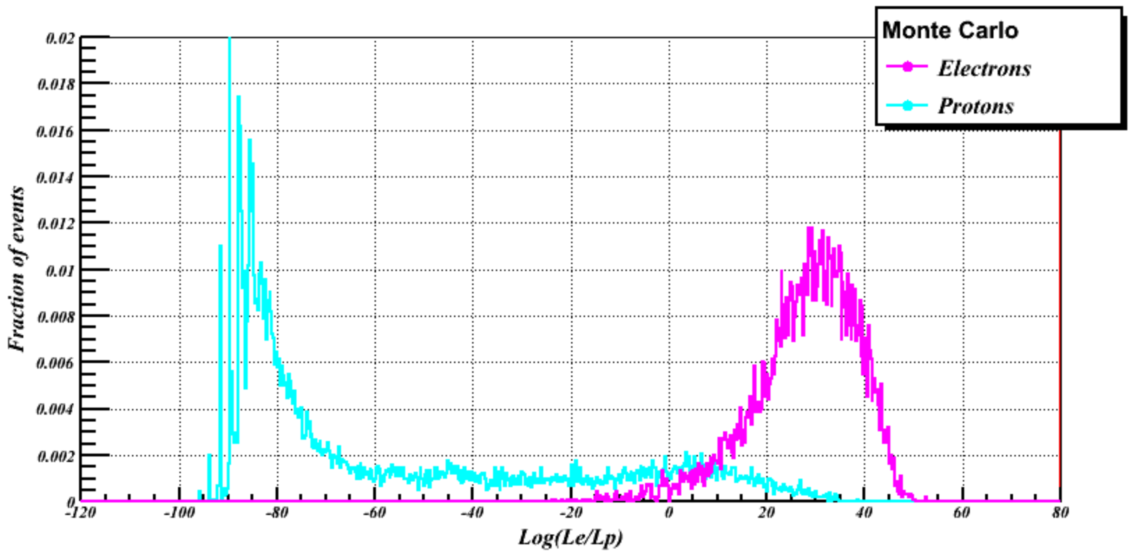



- Same results as at 10GeV/c
- Data and MC still exhibit a similar behaviour

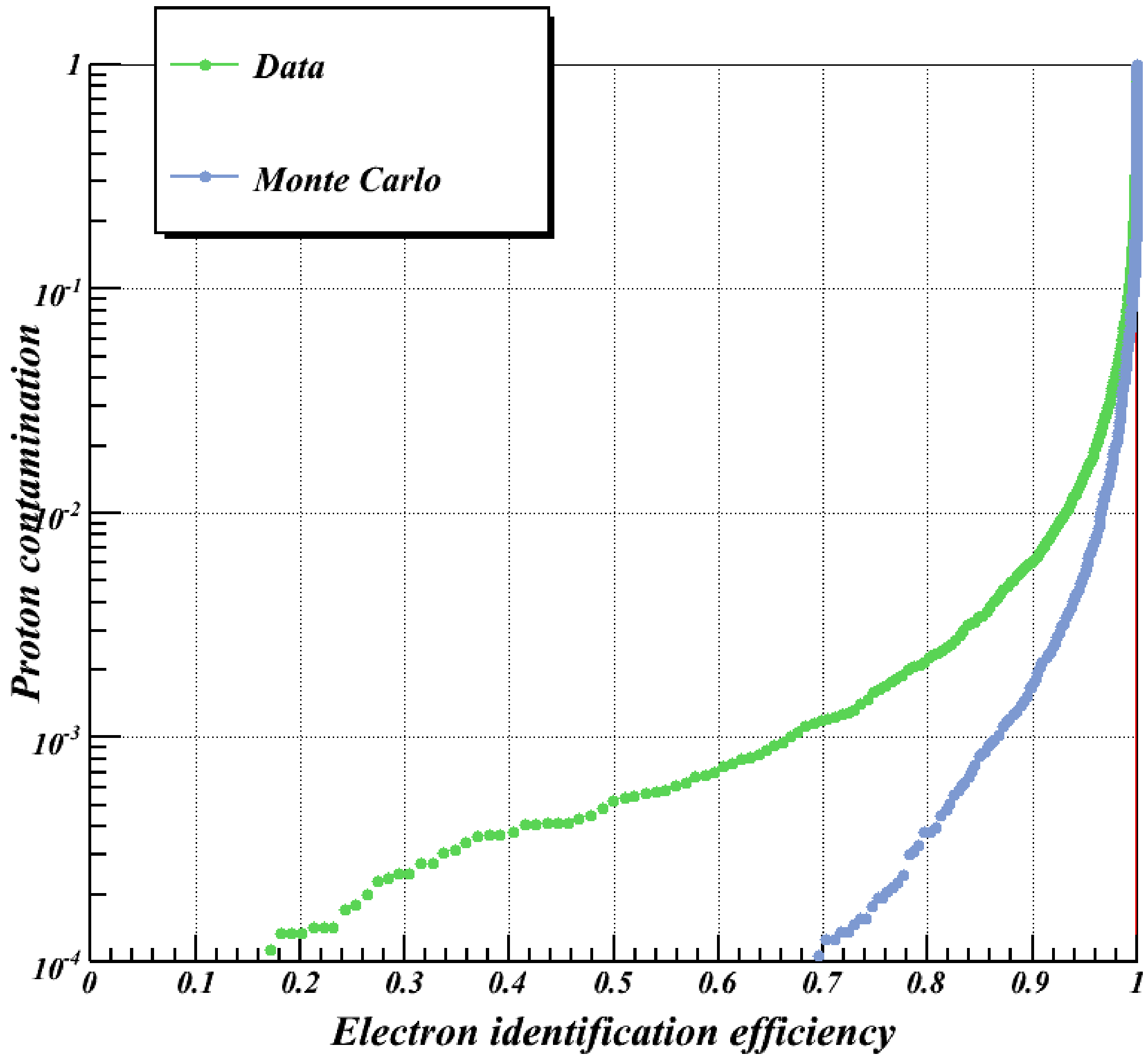
# Likelihood distributions at 100 GeV/c



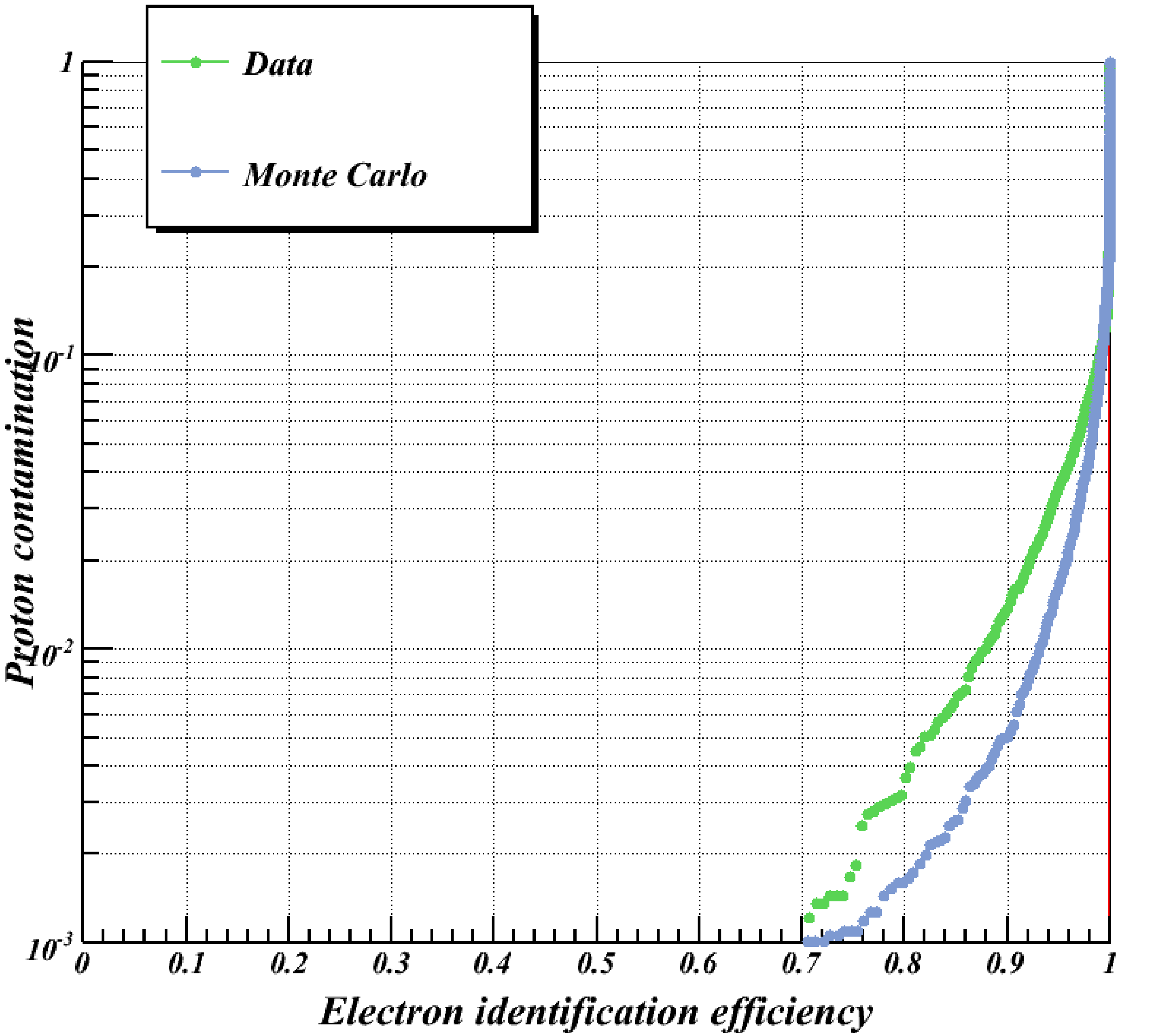




- The right tails of the proton distributions go deep inside the electron distributions
- Data and MC again exhibit a similar behaviour

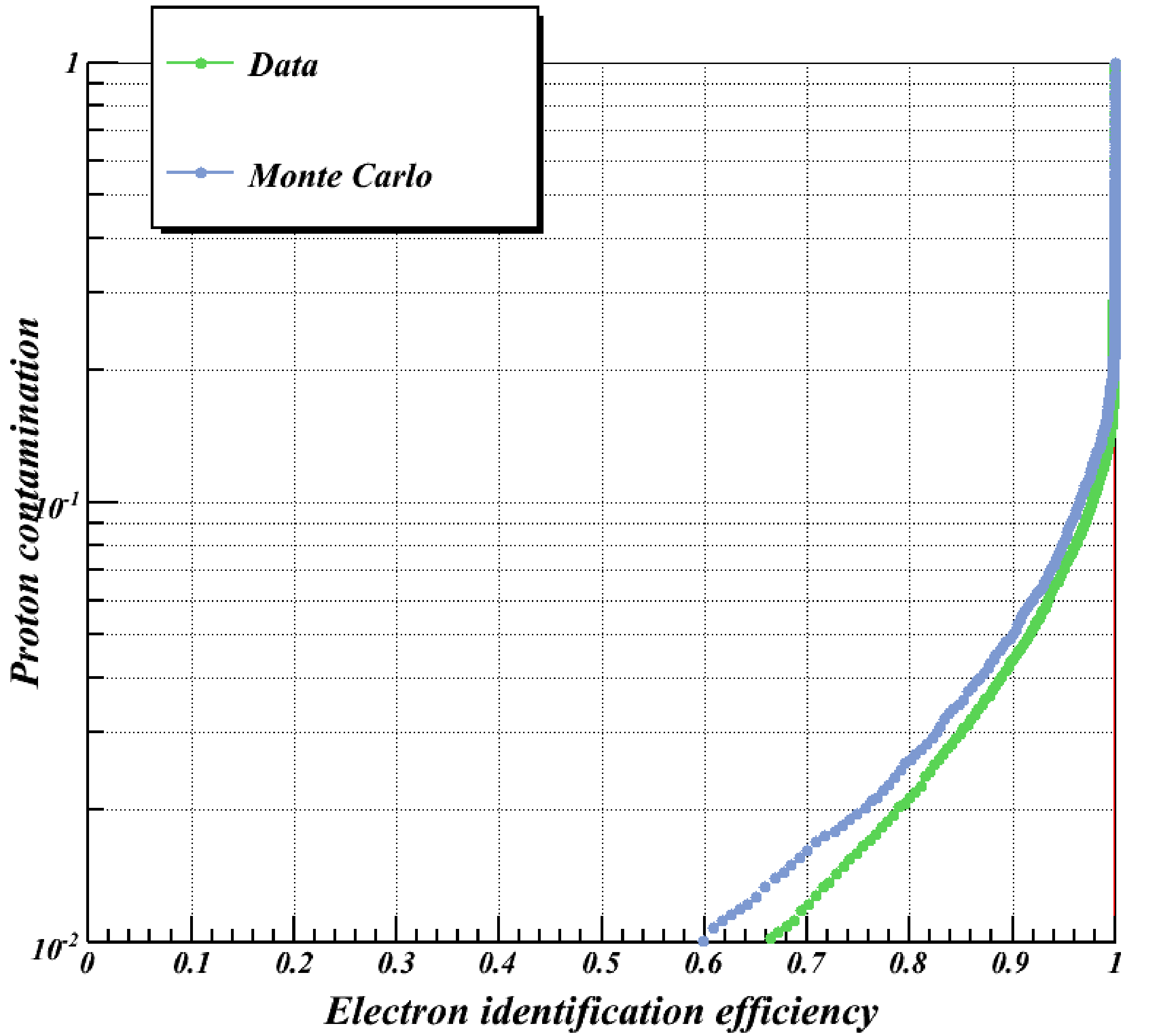
# Contamination vs efficiency at 10 GeV/c



# Contamination vs efficiency at 20 GeV/c



# Contamination vs efficiency at 100 GeV/c



# Conclusions

- The maximum likelihood approach is a possible way to separate electrons from protons
  - 10 GeV/c BT data: 0.6% proton contamination at 90% electron identification efficiency
  - 20 GeV/c BT data: 2% proton contamination at 90% electron identification efficiency
  - 100 GeV/c BT data: 5% proton contamination at 90% electron identification efficiency
- A lower proton contamination can be achieved requiring a lower electron identification efficiency
- Further variables can be introduced in the likelihood to improve the particle identification performance