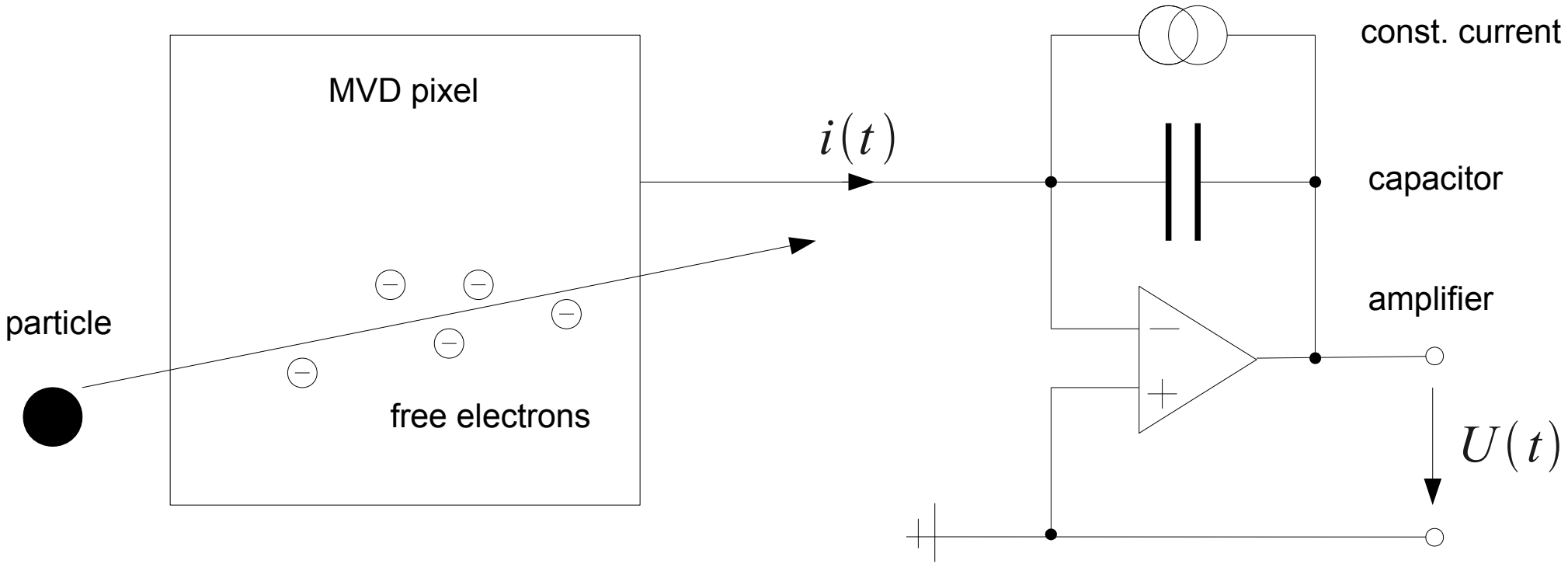
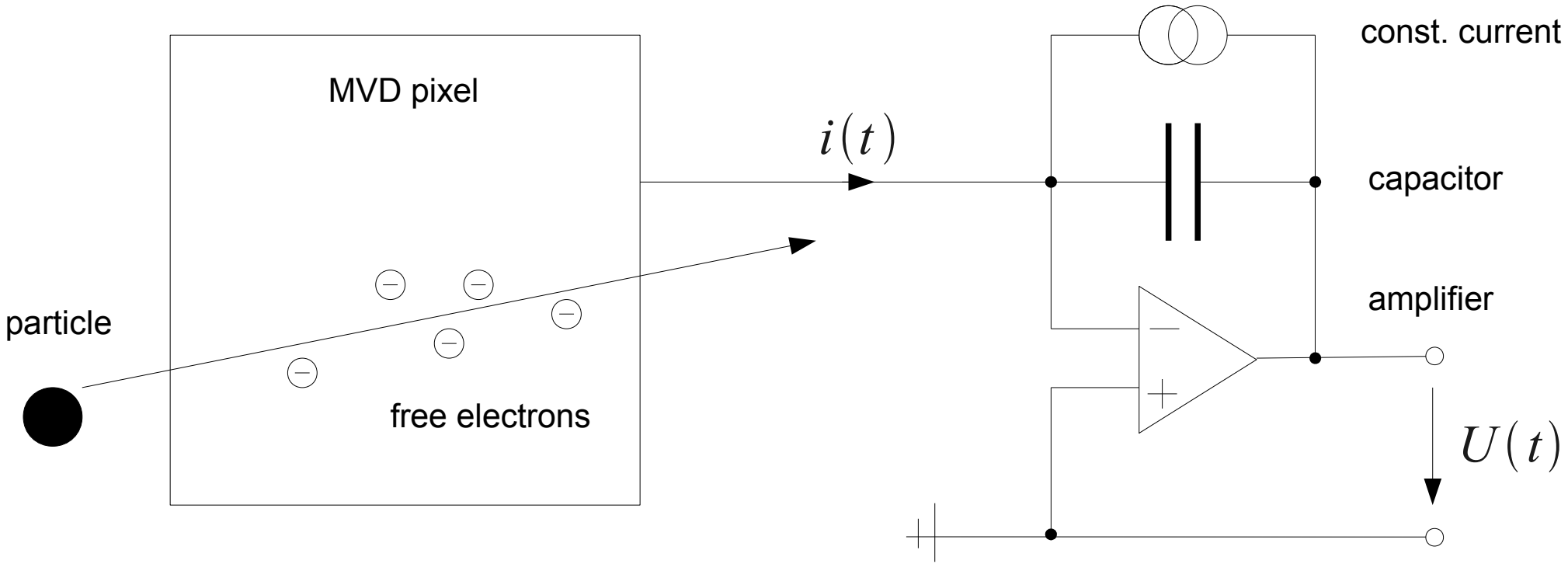
PandaROOT
MVD

digitization and reconstruction of the energyloss

David-Leon Pohl



$$\Delta E_{particle} \propto Q \propto N \cdot e \xrightarrow{i(t)} \propto \frac{1}{C} \int_0^{t_c} i(t)\,dt \propto \frac{N \cdot e}{C} \propto U(t_c)$$



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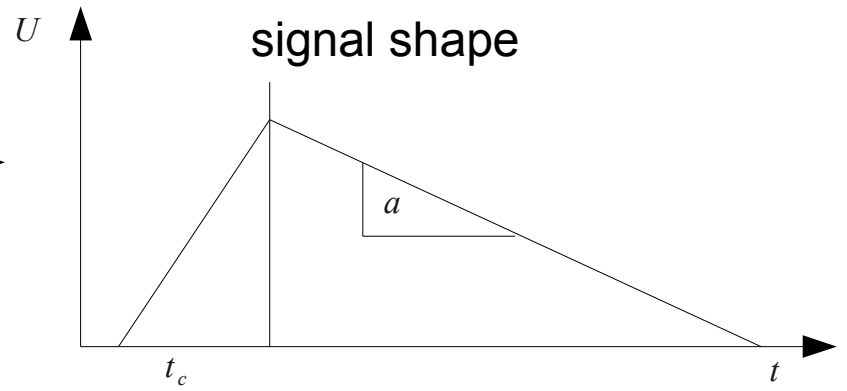
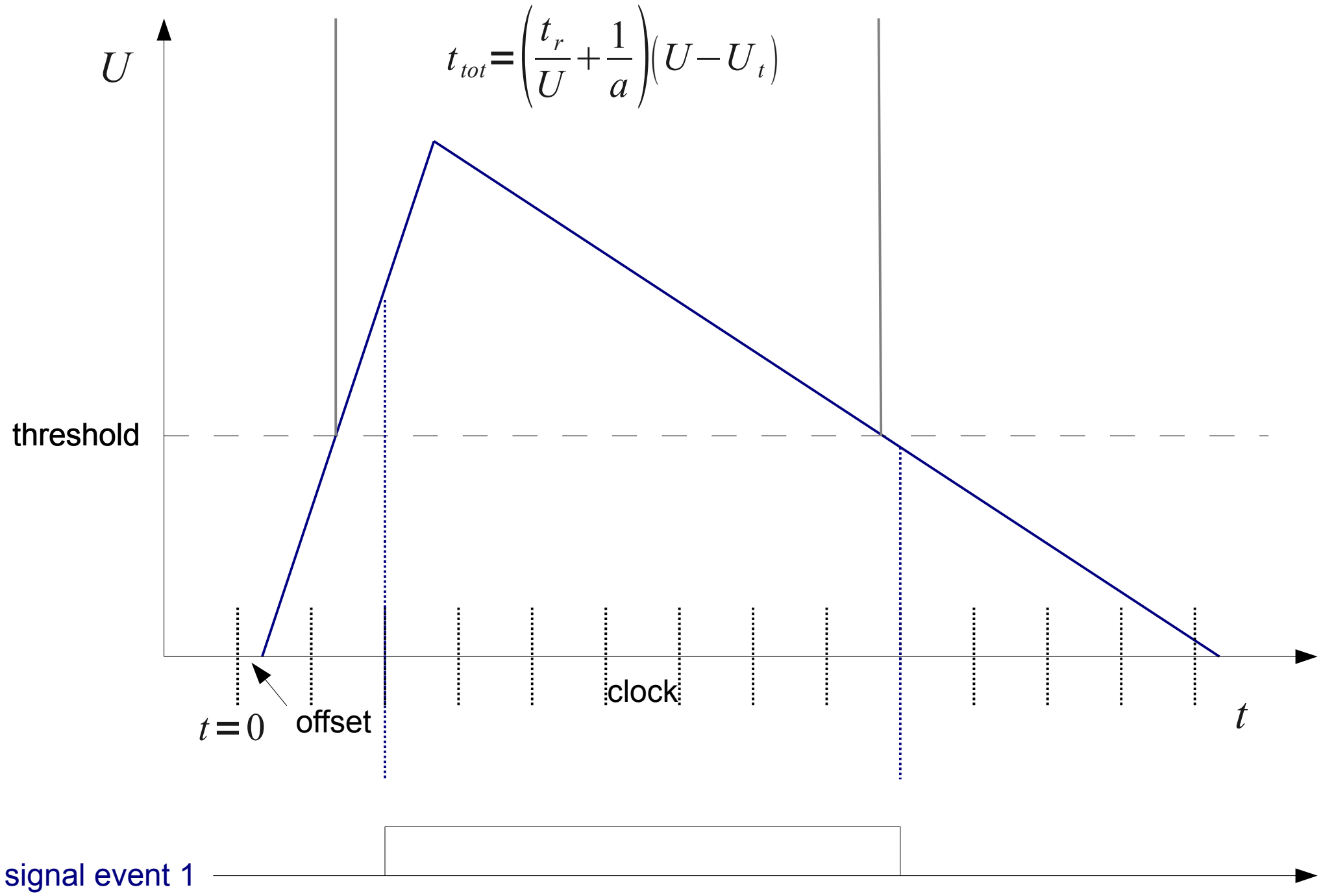
assumptions:

t_c = const. ~ 100 ns

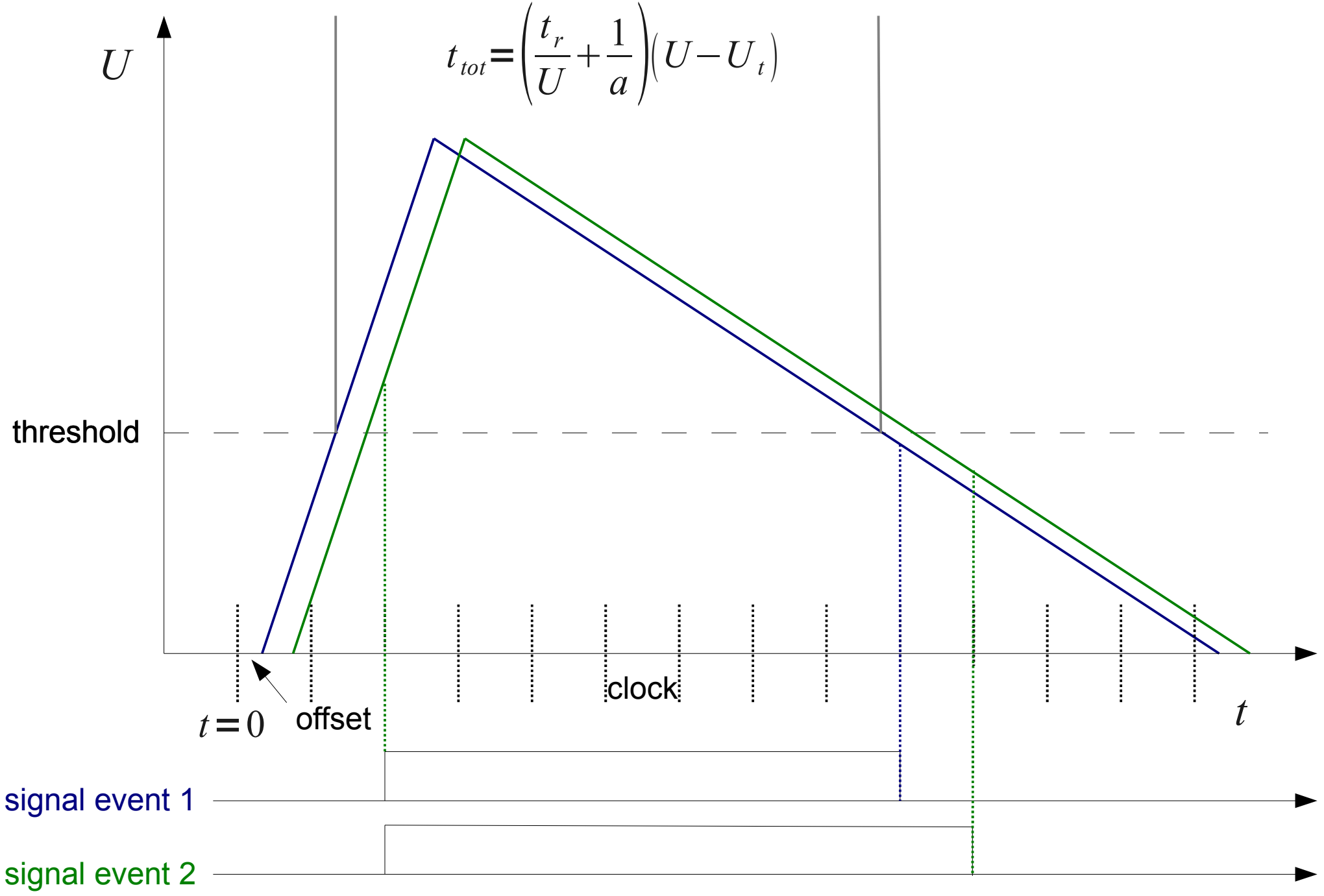
const. current = a ~ 60 e/ns

$i(t)$ = const.

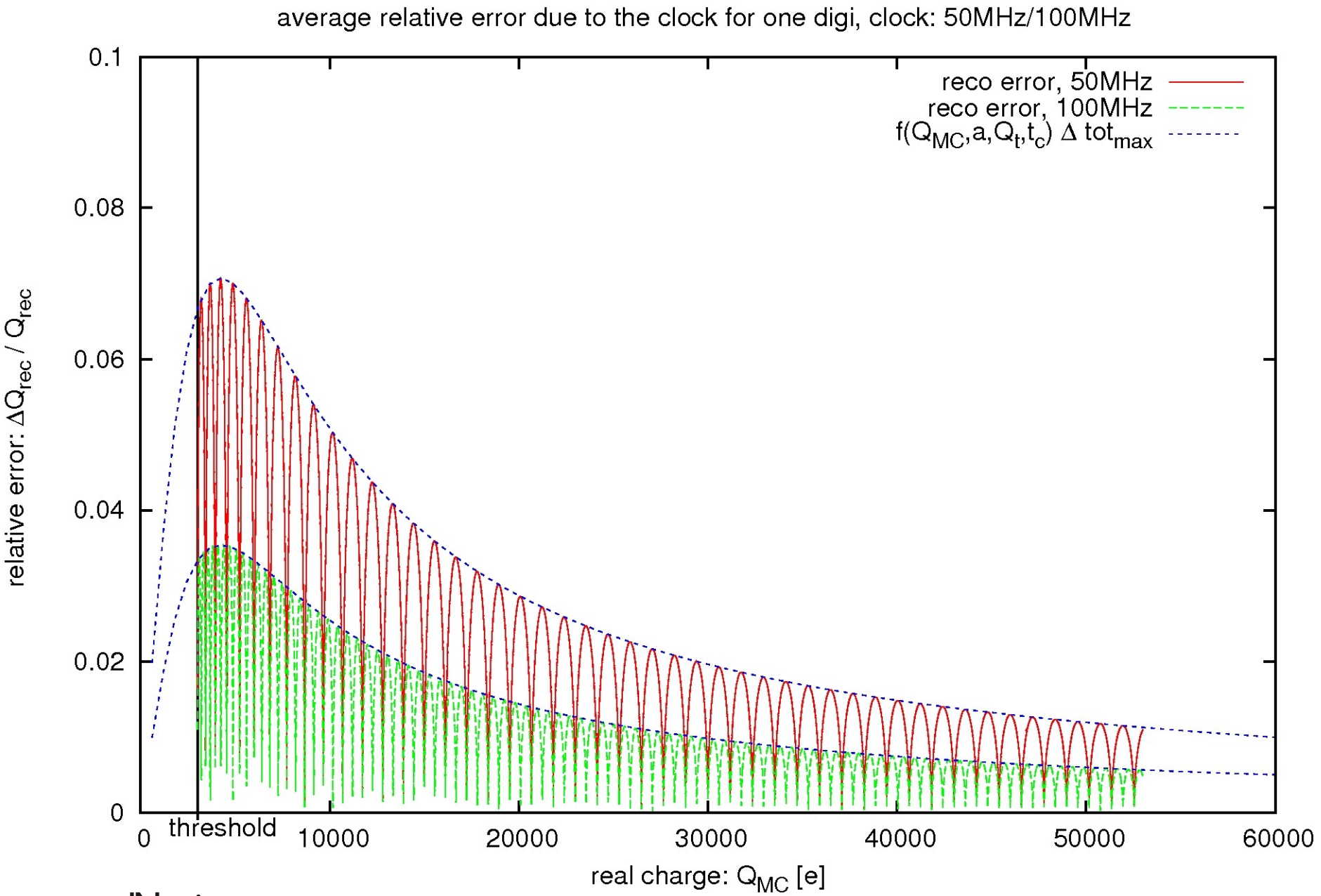



$t_{tot} = \left(\frac{t_r}{U} + \frac{1}{a}\right)(U - U_t)$
U
threshold
clock
t
t = 0
offset
signal event 1

$$t_{tot} = \left(\frac{t_r}{U} + \frac{1}{a}\right)\left(U - U_t\right)$$

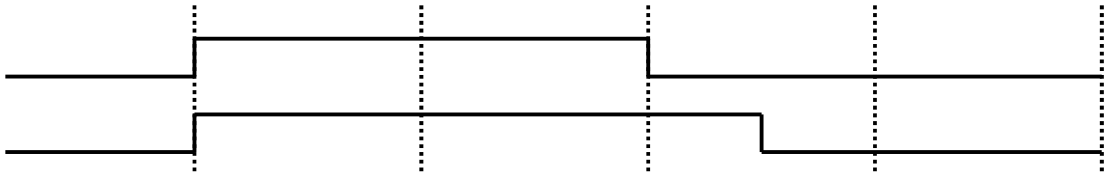


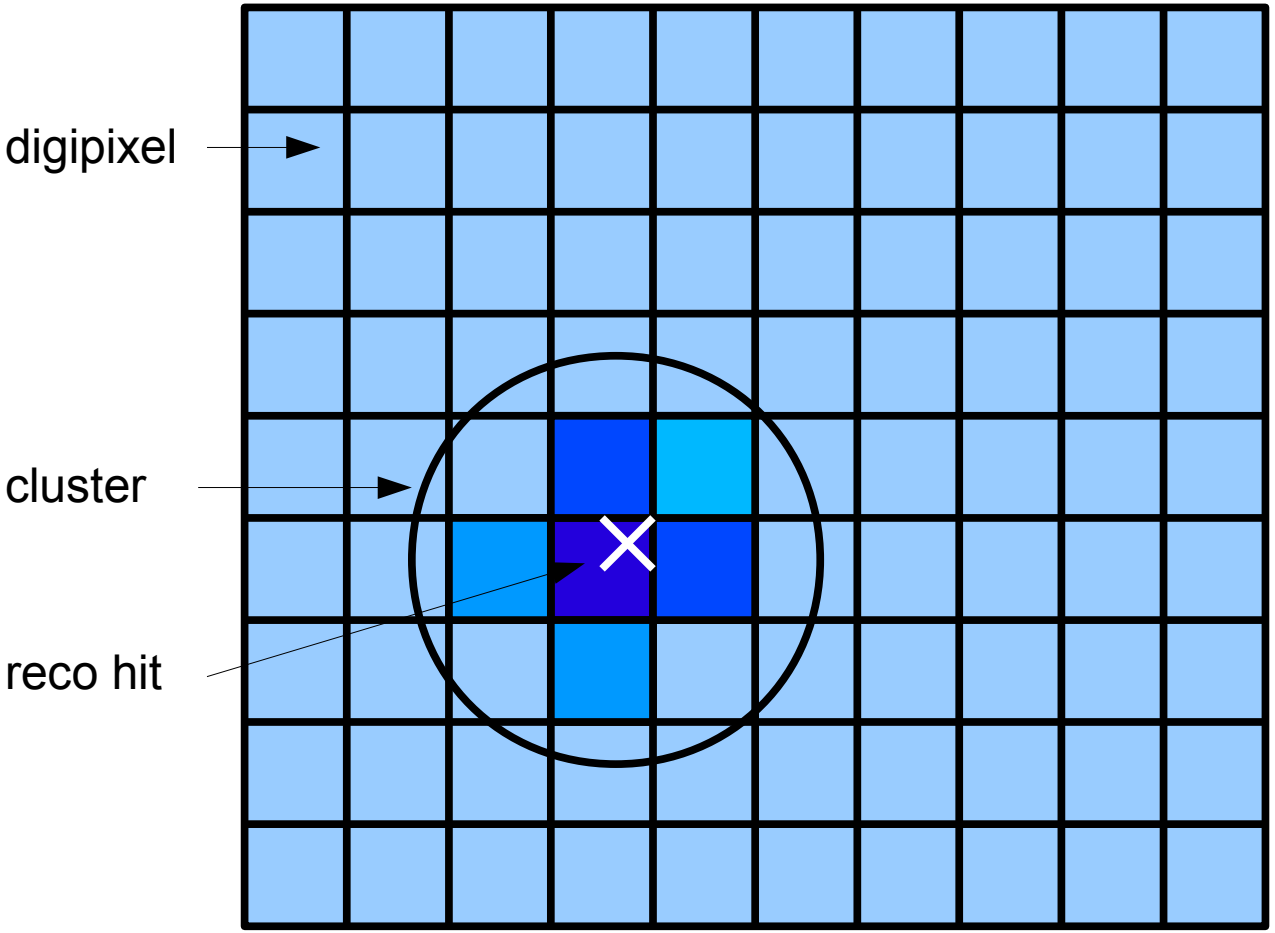
event 1,2: same energy but different TOT!



$$\Delta tot_{min} = \mathbb{N} \cdot timestep$$

$$\Delta tot_{max} = (\mathbb{N} + \frac{1}{2}) timestep$$



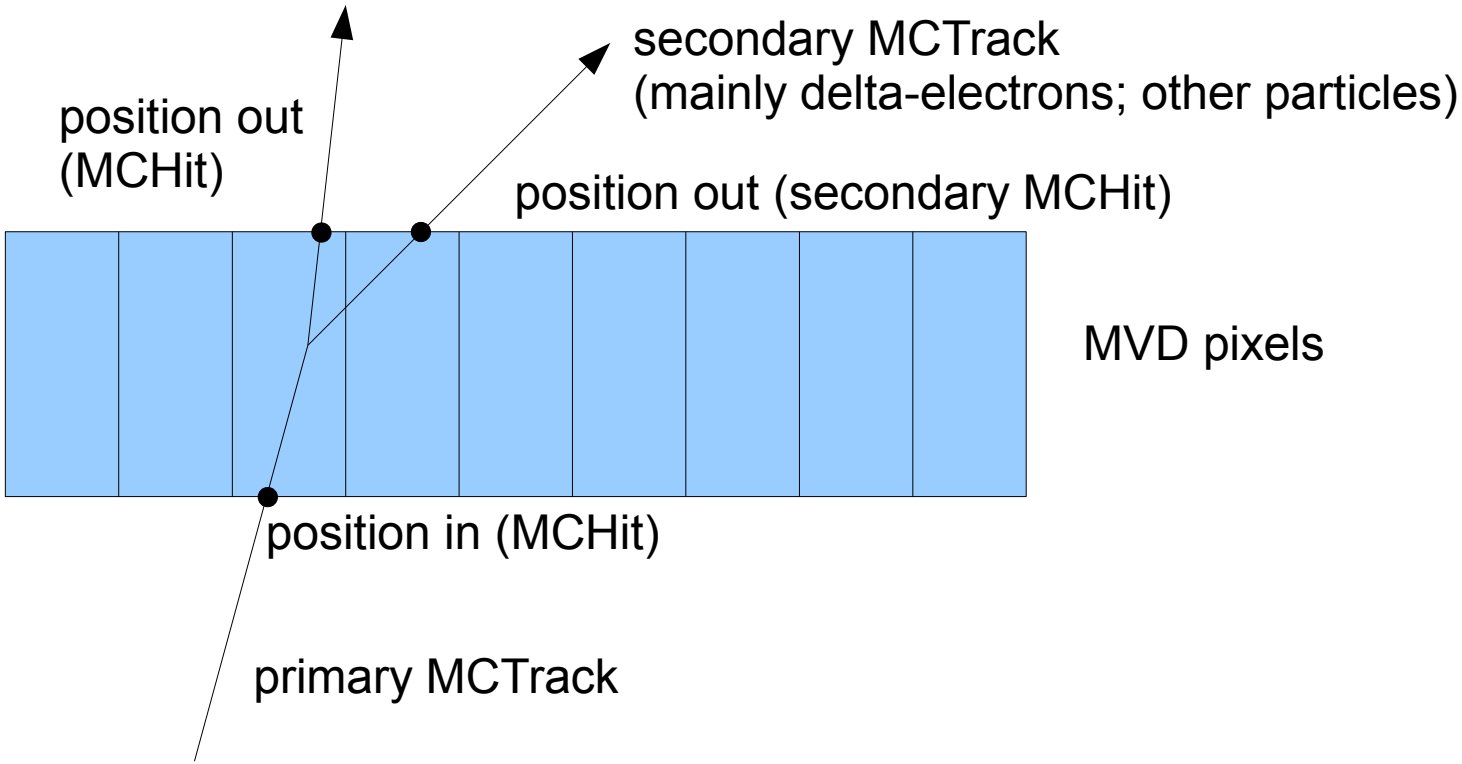


every digipixel of a MC Hit:
- different charge
- same timeoffset
- different TOT
- different charge error

reco hit:
- has a cluster of digis
- reconstructed energy resolution depends on digi number

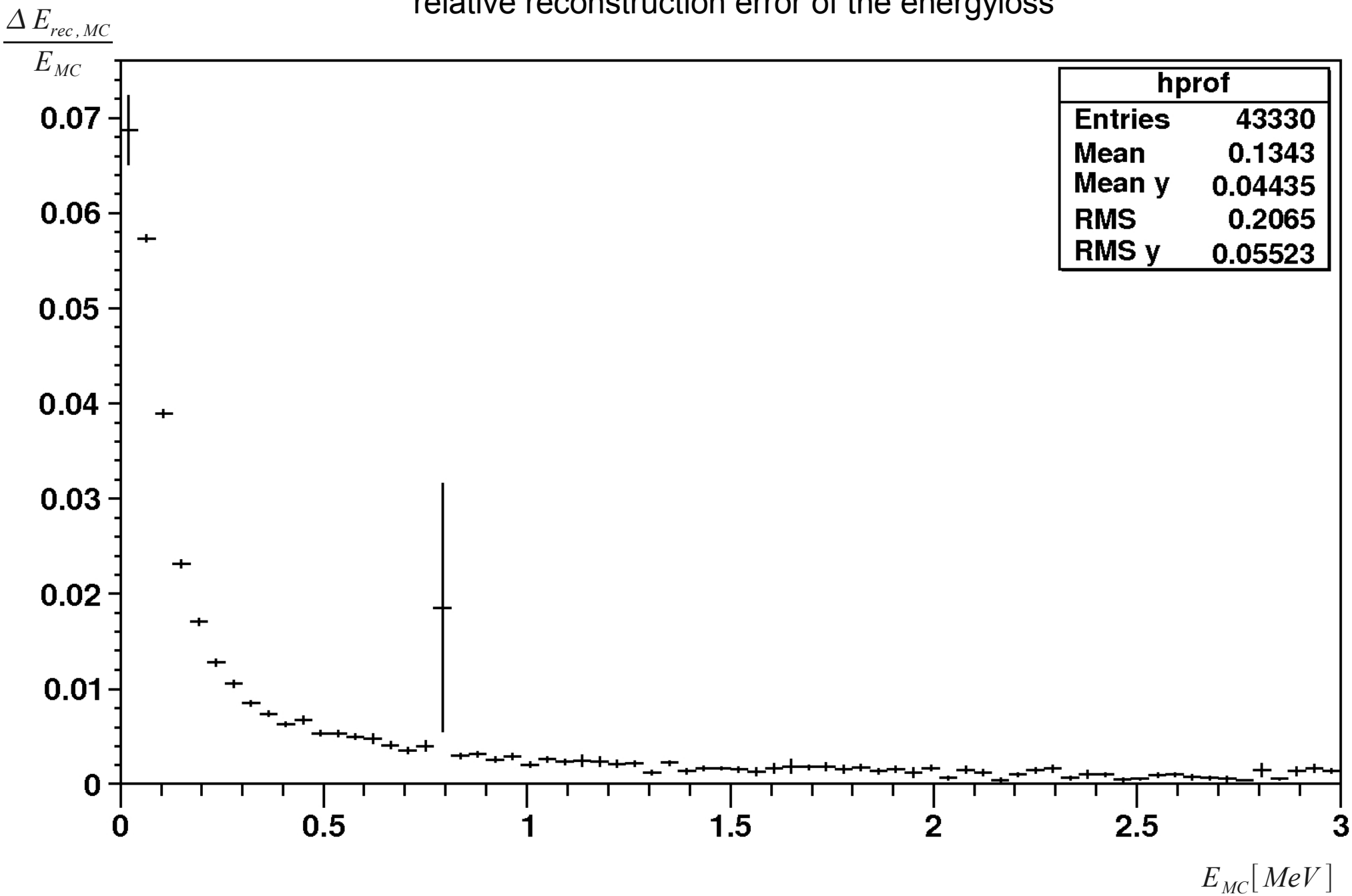
observation:
- digipixel has a higher energy than the MCHit belonging to it

Explanation:



consequence:
- the charge of the digipixel cannot be used for dE/dx
- recoHit with charged weighted cluster has a wrong position
- GEANT 4, boxgenerator, Protons [0..5GeV/c]: **0,3%** of the digis show that

relative reconstruction error of the energyloss



- compare the simulated results with the experimental data of the FE-I3/ToPiX chip
- investigate the impact on the PID

- clockfrequency: 50/100 MHz
- threshold: 3000e
- noise: 200e
- simulation engine: GEANT 4
- eventgenerator:
    - boxgenerator
    - protons
    - momentum [0..5] GeV/c
    - PhiRange [0..360]
    - ThetaRange[0..90]
    - vertex [0,0,0]

$$\frac{\Delta Q_{rec}}{Q_{rec}} = \frac{\frac{a}{2}\left(1+\frac{\frac{Q_t - a\,t_c}{2}+\frac{a}{2}\left(\frac{t_c}{Q}+\frac{1}{a}\right)(Q-Q_t)}{\sqrt{\left(\frac{Q_t - a\,t_c}{2}+\frac{a}{2}\left(\frac{t_c}{Q}+\frac{1}{a}\right)(Q-Q_t)\right)^2 + a\cdot Q_t \cdot t_c}}\right)\Delta tot_{max}}{\frac{Q_t - a\,t_c}{2}+\frac{a}{2}\left(\frac{t_c}{Q}+\frac{1}{a}\right)(Q-Q_t)+\sqrt{\left(\frac{Q_t - a\,t_c}{2}+\frac{a}{2}\left(\frac{t_c}{Q}+\frac{1}{a}\right)(Q-Q_t)\right)^2 + a\cdot Q_t \cdot t_c}}$$

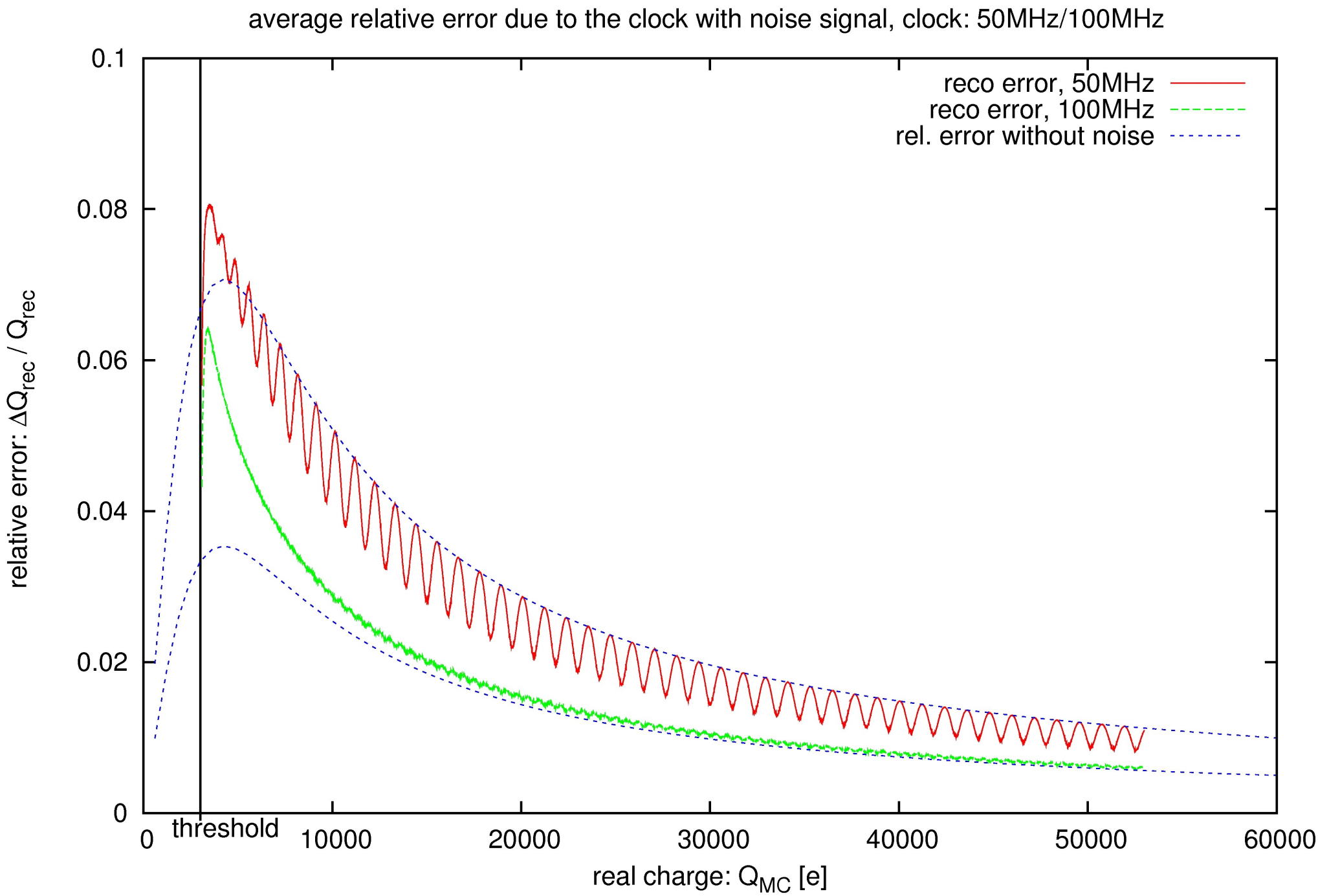
Q: real charge of the MVD pixel

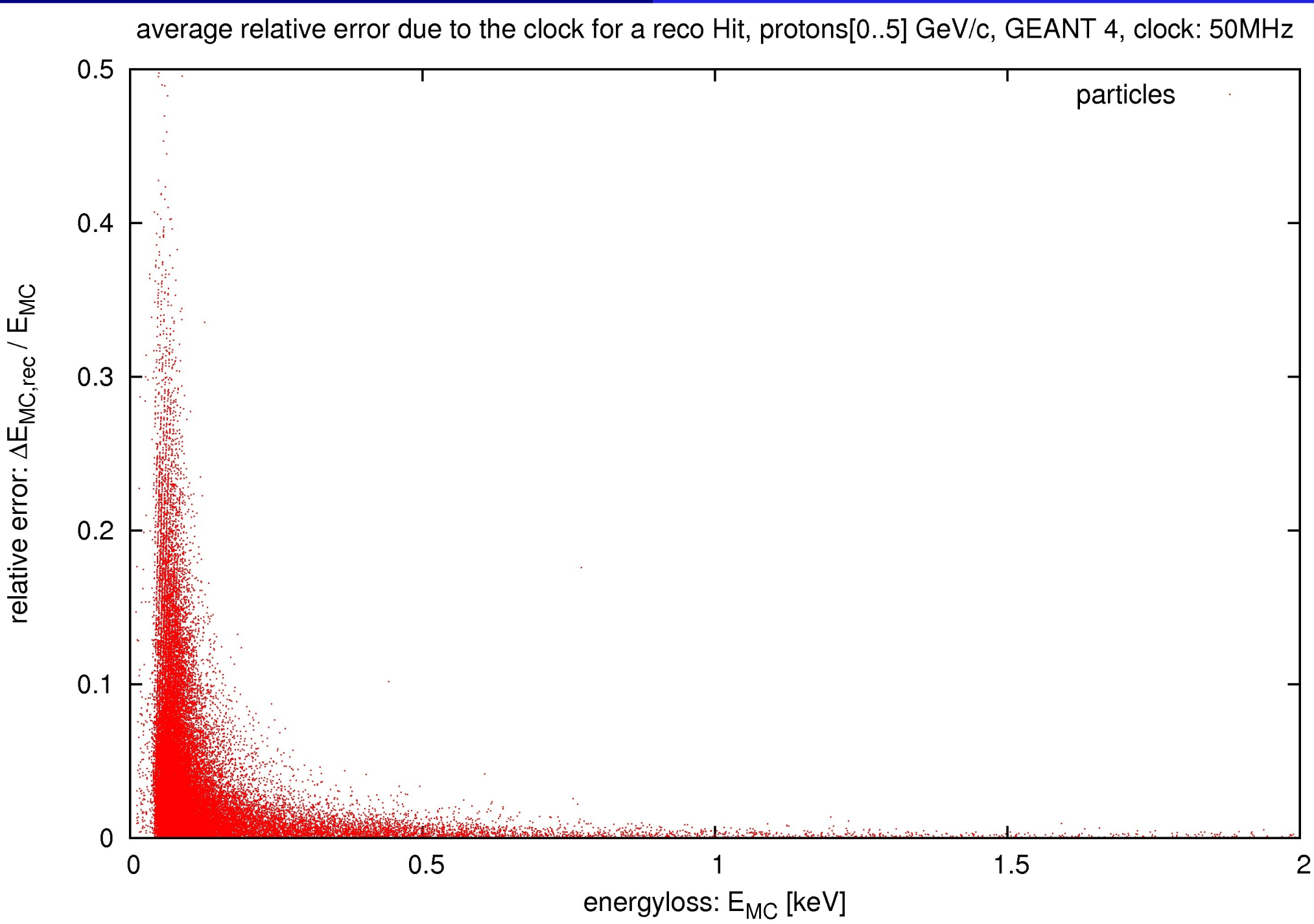
Q_t: threshold

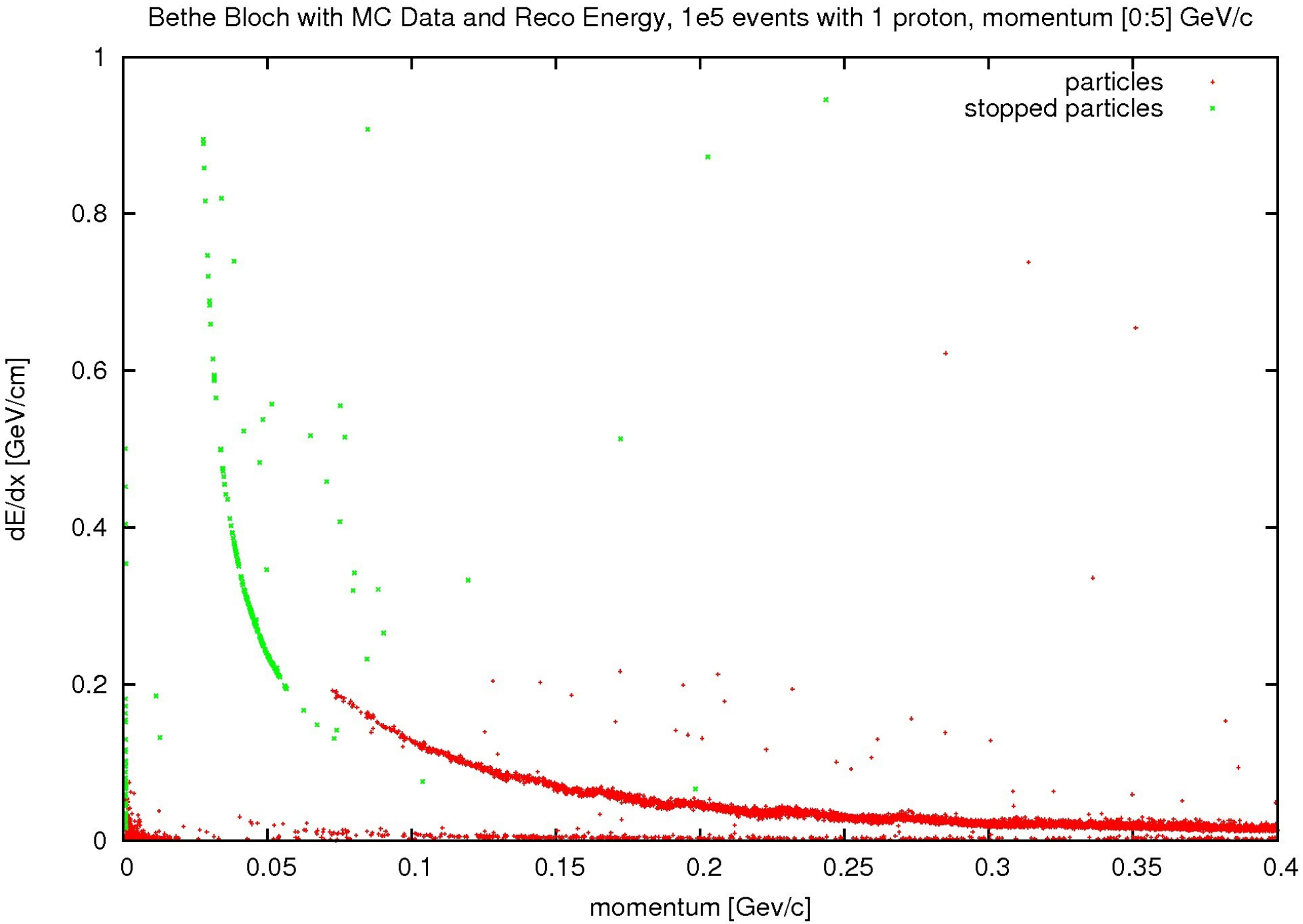
a: current that unloads the capacitor

t_c: capacitor charging time

$$\Delta tot_{max} = \frac{1}{2\,clockfrequency}$$


average relative error due to the clock with noise signal, clock: 50MHz/100MHz
reco error, 50MHz
reco error, 100MHz
rel. error without noise
relative error: ΔQrec / Qrec
real charge: QMC [e]
threshold
0
0.02
0.04
0.06
0.08
0.1
0
10000
20000
30000
40000
50000
60000


average relative error due to the clock for a reco Hit, protons[0..5] GeV/c, GEANT 4, clock: 50MHz
particles
relative error: ΔE_MC,rec / E_MC
energyloss: E_MC [keV]
0
0.1
0.2
0.3
0.4
0.5
0
0.5
1
1.5
2


Bethe Bloch with MC Data and Reco Energy, 1e5 events with 1 proton, momentum [0:5] GeV/c
particles
stopped particles
dE/dx [GeV/cm]
momentum [Gev/c]
0
0.2
0.4
0.6
0.8
1
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4