PADME

Diamond Target Simulation

From preparatory work in Emanuela Cianci and Federica Oliva Theses

SIMULATION FRAMEWORK

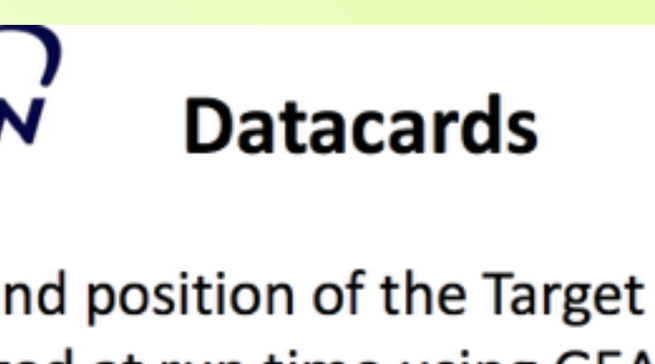
- GEANT4 simulation framework & general offline infrastructure by Emanuele Leonardi (links and general discussion in https://agenda.infn.it/conferenceDisplay.py?confId=10857, March 2 LNF, PADME Collaboration Meeting)
  - diamond target already in the GEANT4 PADME setup (Emanuele)
    - homogeneous Diamond as sensitive detector - logical volume “target”
    - 1 hit per track crossing the volume so far
    - missing:
      - implementation of the readout geometry (strips) - not a GEANT4 task
        - 18/side with:
          - 1.02mm dead, (0.82mm active +0.18mm dead)x17, 0.82mm active, 1.02mm dead
      - implementation of the signal on (each) strip when GEANT says a particle releases energy in the “target”
        - mainly e+ from the beam, loosing energy by ionization (thickness/X_0 negligeable)

From Emanuele - detector geometry done

Datacards

Size and position of the Target can be changed at run time using GEANT4 datacards.

N.B. position must be given in the PADME coordinate system, centered at the center of the magnet yoke.

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/Detector/Target/FrontFaceZ -70.
/Detector/Target/Size 2.
/Detector/Target/Thickness 100.
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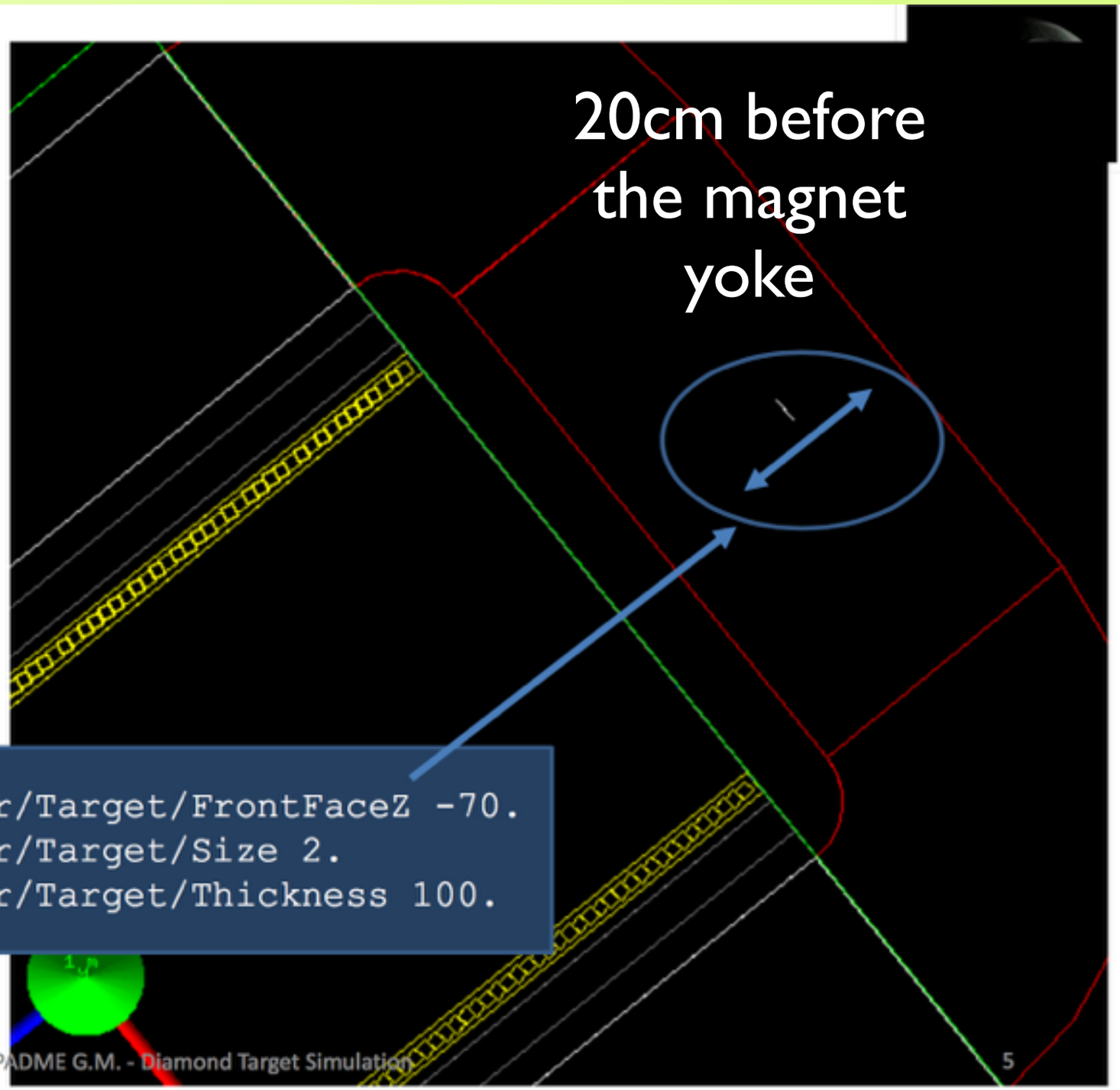

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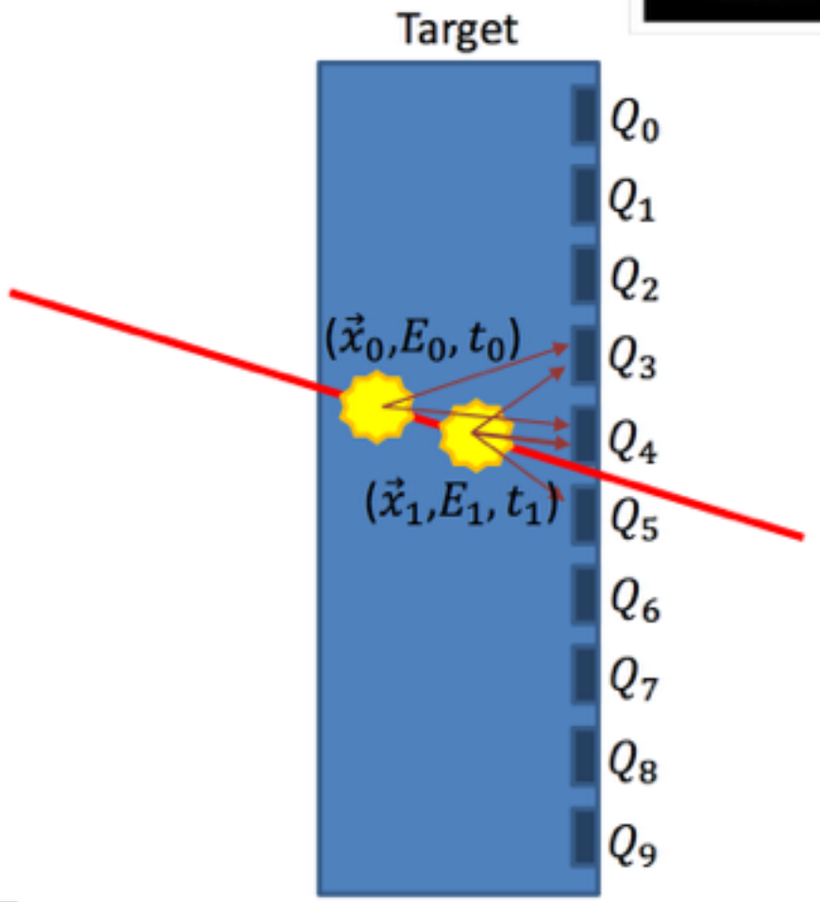
FROM EMANUELE - STRIP GEOMETRY & SIGNAL GENERATION TO DO

Signal generation

- Each energy deposit (hit) must be mapped to the charge collected by the nearest read-out strips with a transport function which depends on the energy, time, and position of the hit.
- All charges collected by a strip are accumulated together to generate the final signal.
- N.B. given the thickness of the Target and the width of the strips, we expect that most of the charge released by a single particle will be collected by a single strip.



$$Q_j(t) = \sum_i q_j(t, \vec{x}_i, E_i, t_i)$$

Action item: define the transport functions

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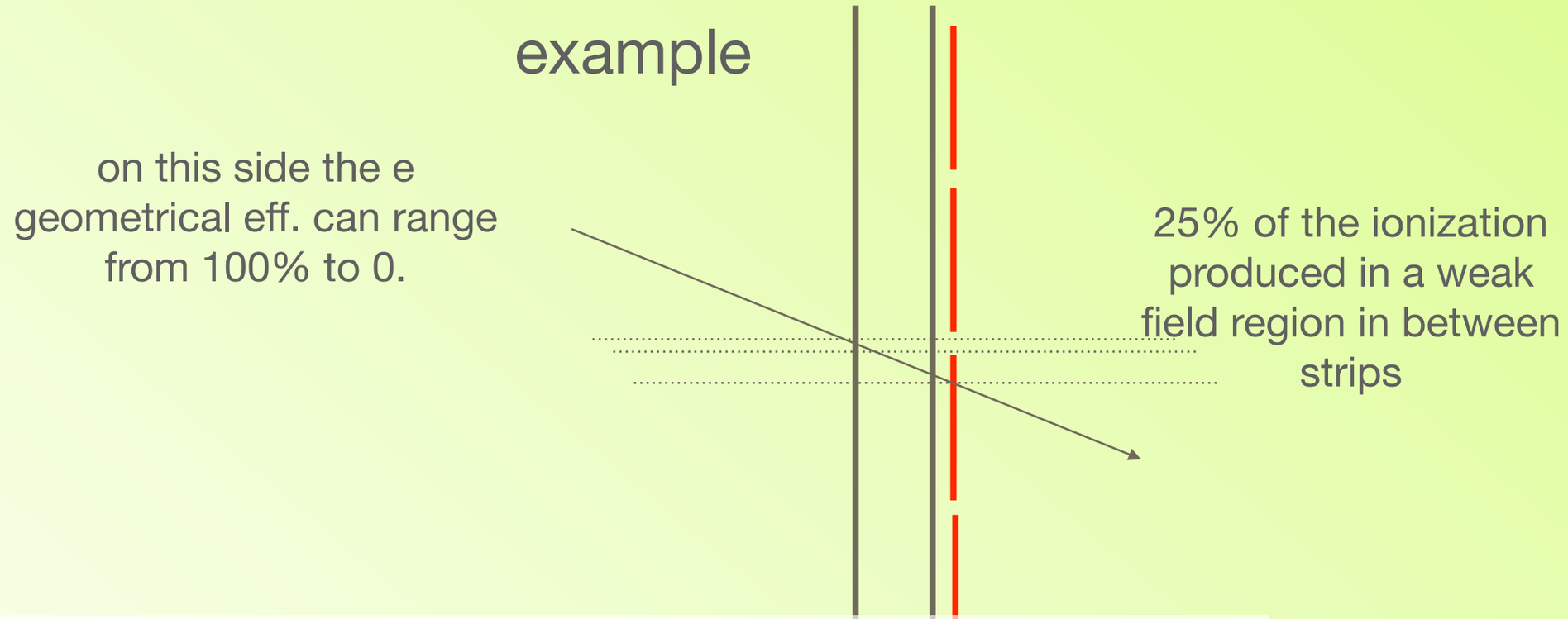
STRIP GEOMETRY & SIGNAL GENERATION: HOW TO

- 1) geometrical inefficiency emulation:
  - storing step-in-Diamond end point (along with entry point) to estimate *effective track length* in the field of a given strip (dead space)



More schematically,
beam divergenze ~0 for 100μm thickness
=> defining a x,y effective geometrical efficiency map should be realistic enough
Charge sharing ?
Transverse diffusion of 180μm for 100μm path should be negligible

STRIP GEOMETRY & SIGNAL GENERATION: HOW TO

exercised in Federica, Emanuela theses:

result is current vs time for a single track

- 2)
  - Define n. of e- /hole pairs (from Eloss, simulated by GEANT + typical E value for a single ionization [w=13.6 eV]); Large number, hence Gaussian fluctuations should be adequate
  - Distribute ionization along the track
  - generate a current induced on the strip lasting as much as the motion of the change through the diamond
  - emulate CCD; i.e. drift do not last up to the electrode but is dumped (with an exponential decay low by CCD).
  - add for each strip all signals from all e+ (or other particles/secondaries) in the BTF bunch, with the beam time spread (~flat current intensity in 10ns)

- input:
  - drift velocity of e- and holes vs E;
  - E map ? Edge effects ? or just geometrical effective efficiency map ?
  - CCD: In November TB ~12μm measured

SINGLE TRACK

- uniform (not random) ionisation production along the track
- a finite CCD reduces the duration of the current signal and the total charge seen at the electrodes

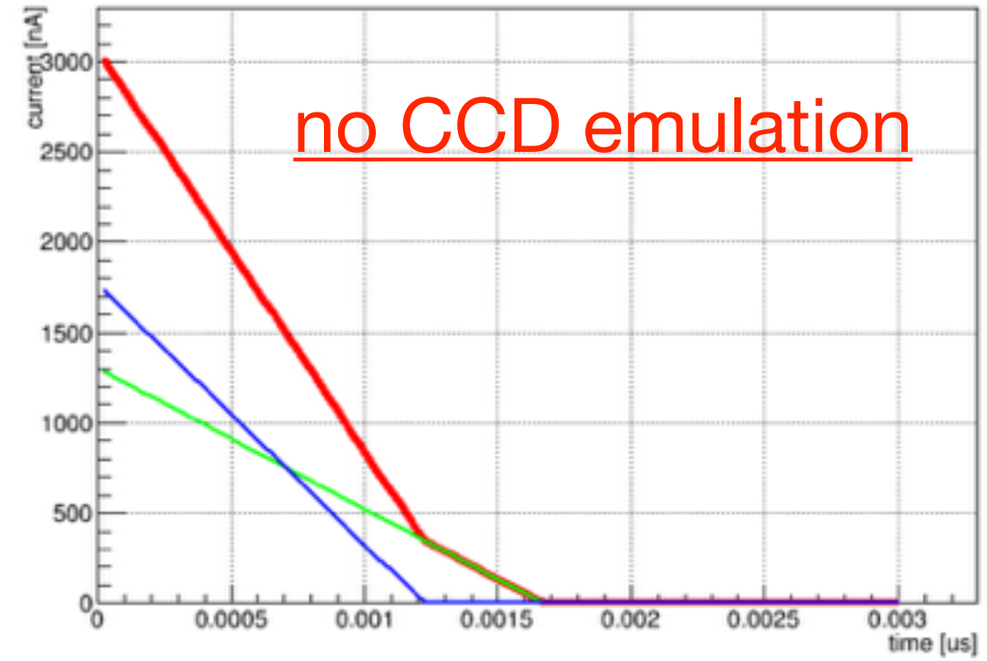


Figura 1.5 Corrente di elettroni (curva verde), lacune (curva blu) e la somma di entrambe (curva rossa), in funzione del tempo.

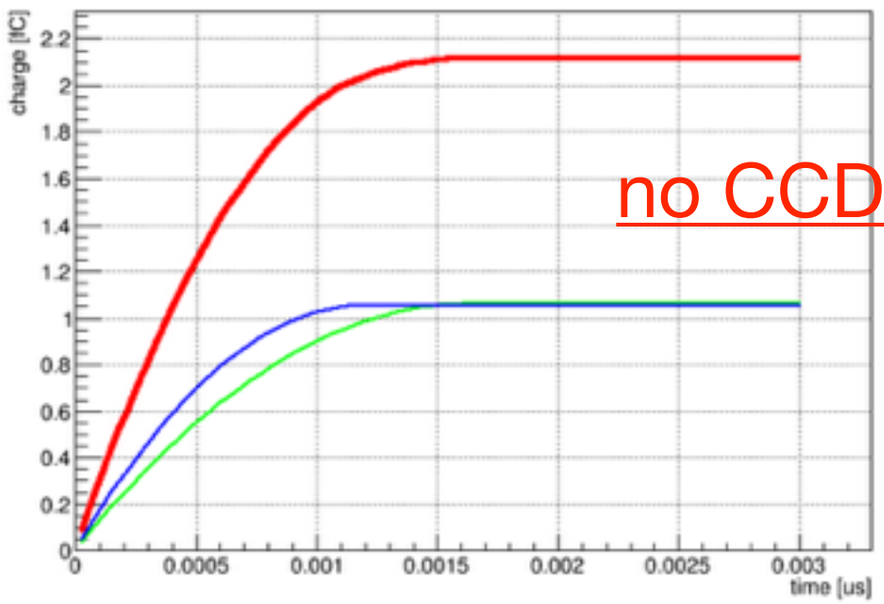


Figura 1.6 Carica raccolta nel rivelatore da elettroni (curva verde), lacune (curva blu) e la somma di entrambe (curva rossa), in funzione del tempo.

Thesis - Emanuela Cianci

STRIP GEOMETRY & SIGNAL GENERATION: HOW TO

- 3) exercised in Federica, Emanuela theses
  - front end electronics emulation -> amplified signal vs time ?
  - FEE gain and shaping properties to be emulated ?

Persistency

In principle, the result of the signal generation is a set of charge vs time histograms, one per read-out strip, which mimics the signal seen by the FADC.

Computing and storing these histograms is both:

- time consuming
- requires a huge amount of storage

Can we apply some approximated method to:

a) Define a higher (and more compact) level of output?
b) Avoid the creation of the histograms?

to be investigated

Action item: define the final output data

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