Diamond Target Simulation

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Materials

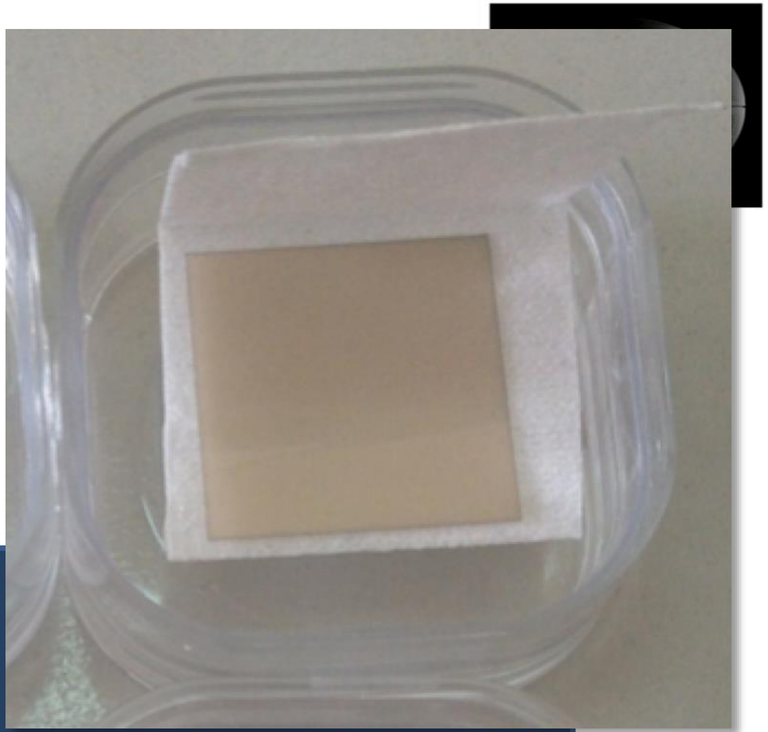
Diamond = Carbon at a density of 3.515 g/cm^3

```
// Create Diamond material to be used for Target
G4Material* Diamond = new G4Material("Diamond",3.515*g/cm3,1);
Diamond->AddElement(G4Element::GetElement("C"),100.*perCent);

Material:  Diamond    density:  3.515 g/cm3   RadL:  12.147 cm   Nucl.Int.Length:  22.817 cm
                                              Imean:  81.000 eV
   --->  Element: C (C)   Z =  6.0   N =  12.0   A =  12.01 g/mole
         --->  Isotope:   C12   Z =  6   N =  12   A =  12.00 g/mole   abundance:  98.93 %
         --->  Isotope:   C13   Z =  6   N =  13   A =  13.00 g/mole   abundance:   1.07 %
          ElmMassFraction: 100.00 %  ElmAbundance 100.00 %
```

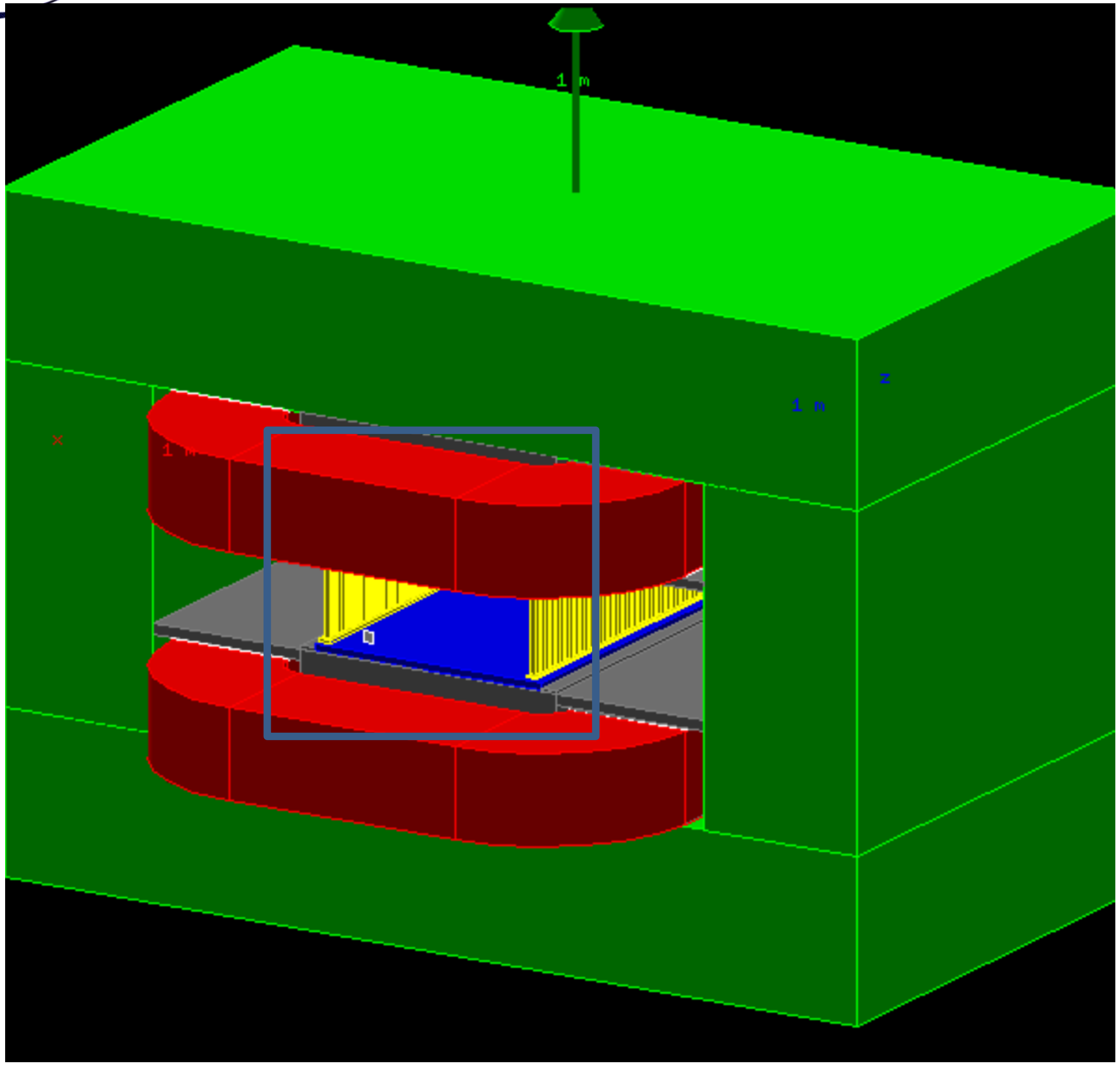
Diamond Target

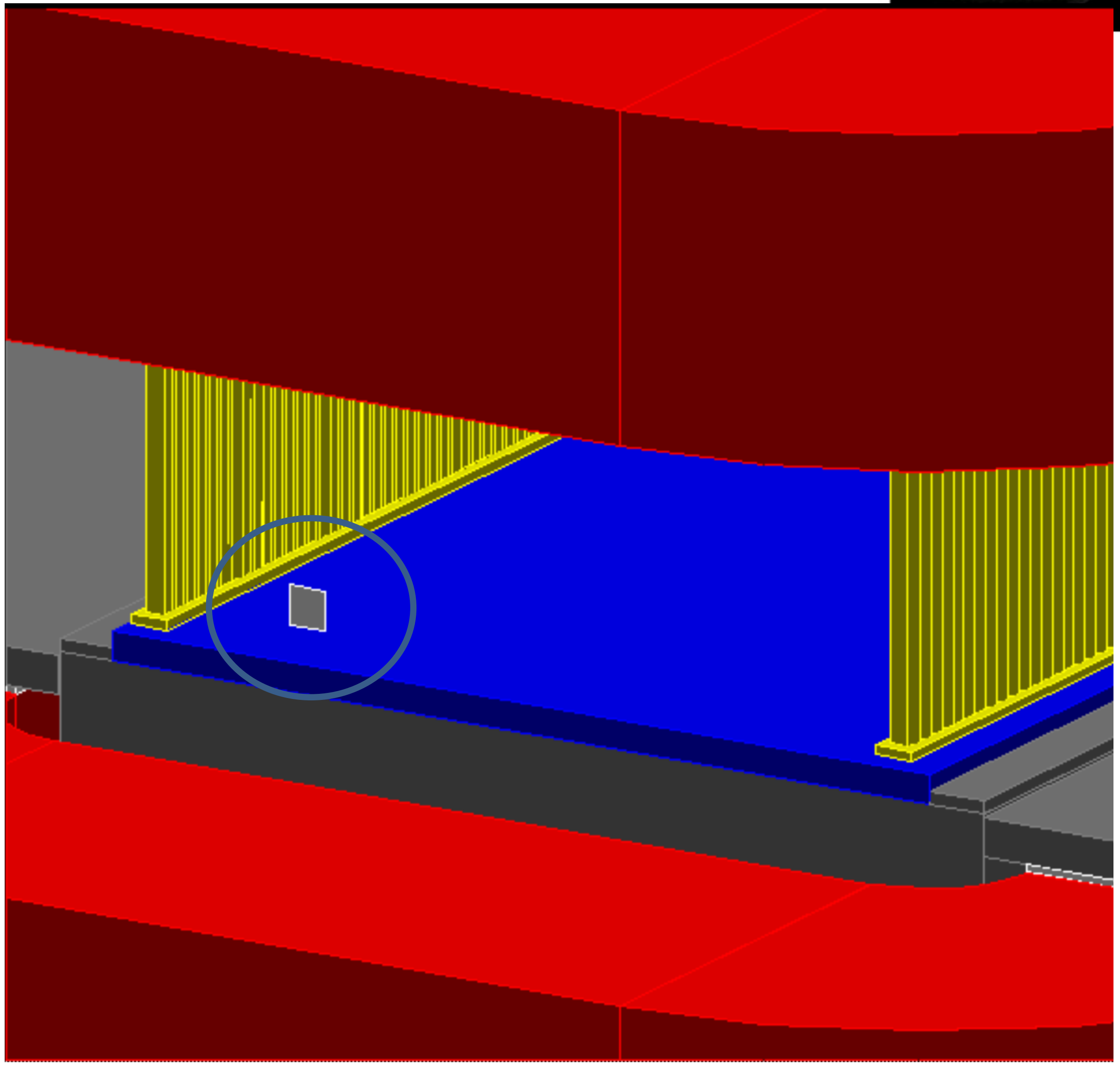
Size: 2 cm × 2 cm × 100 μm

Position: (0 cm, 0 cm, -20 cm) w.r.t. front face of magnet yoke



```
// Create Target plaque (a box)
G4double targetX = geo->GetTargetSizeX();
G4double targetY = geo->GetTargetSizeY();
G4double targetZ = geo->GetTargetSizeZ();
G4Box* solidTarget = new G4Box("Target",targetX*0.5,targetY*0.5,targetZ*0.5);

// Create Target logical volume using Diamond material
fTargetVolume = new G4LogicalVolume(solidTarget,
                G4Material::GetMaterial("Diamond"),"Target",0,0,0);

// Position Target logical volume inside World
G4ThreeVector positionTarget = G4ThreeVector(geo->GetTargetPosX(),
                                             geo->GetTargetPosY(),
                                             geo->GetTargetPosZ());
new G4PVPlacement(0,positionTarget,fTargetVolume,"Target",fMotherVolume,false,0,false);
```

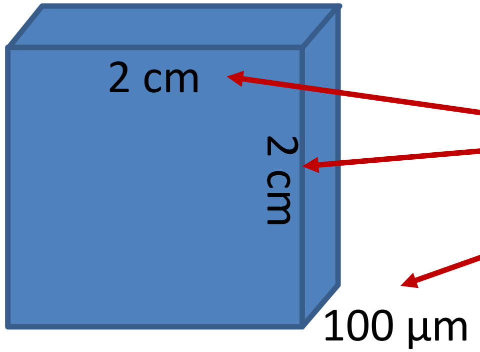

1 m
1 m
Z
X



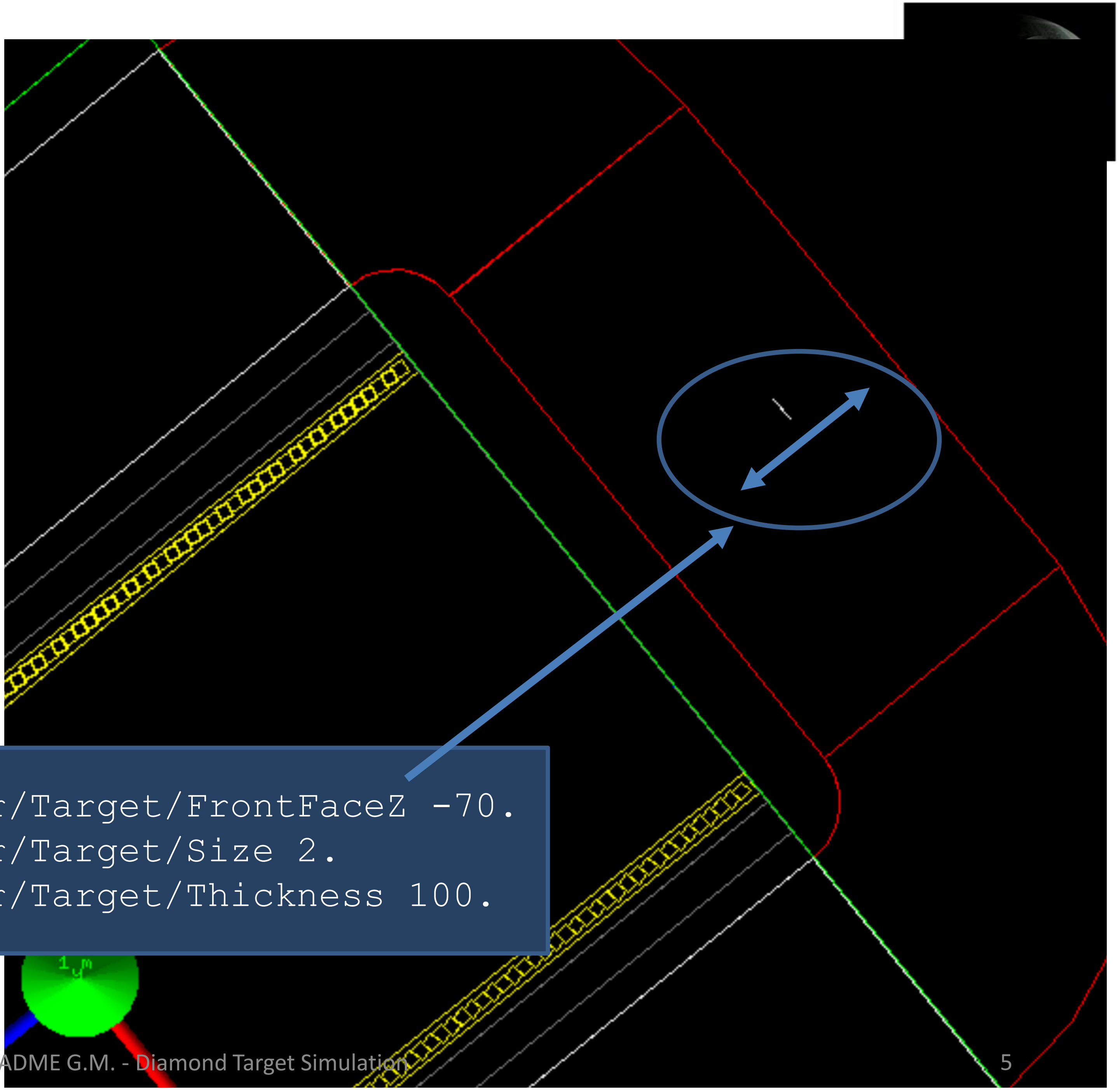
Datacards

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.




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



Particle tracking

When a particle crosses the Target, GEANT4:

- simulates all physical interactions with the material
  - ionization, bremsstrahlung, annihilation, …
- computes the energy released.

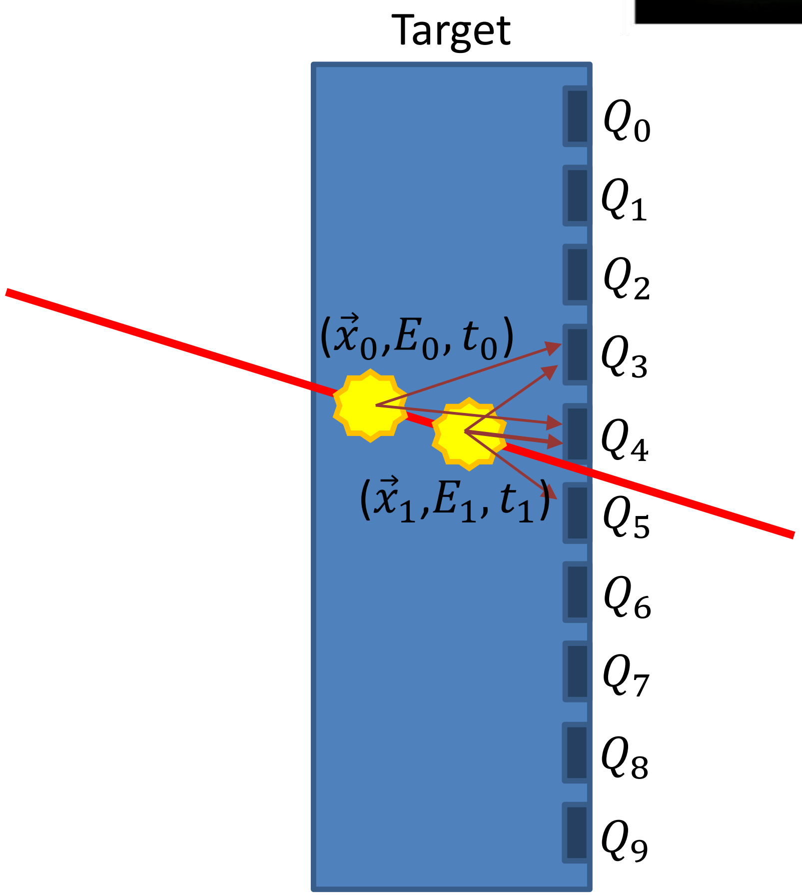
```
*******************************************************************************************
* G4Track Information:   Particle = e+,   Track ID = 1,   Parent ID = 0
*******************************************************************************************

Step#      X          Y          Z        KineE    dEStep     StepLeng  TrakLeng    Volume     Process
    0      0 fm       0 fm     -70 cm    549 MeV      0 eV       0 fm      0 fm      World    initStep
    1      0 fm       0 fm     -70 cm    549 MeV 4.22e-23 eV 1e+03 nm  1e+03 nm      World    Transportation
    2      0 fm       0 fm     -70 cm    549 MeV   35.3 keV    100 um    101 um     Target    Transportation
    3   3.03 mm    7.89 mm       6 m     549 MeV 2.83e-16 eV    6.7 m     6.7 m      World    OutOfWorld
```

Translation: a 549 MeV almost horizontal primary e^+ crossed the Target at its center releasing a total energy of 35.3 keV via the ionization process.

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.

Action item: define the transport functions



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

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?

Action item: define the final output data

ToDo List

- Finalize Target geometry adding the support structure and the readout hardware
  - ➢ Will be done as soon as the technical design is available
- Define the transport functions to generate the signal on the read-out strips
- Define the final data to be stored in the MC output files
  - ➢ A PADME common persistency framework, based on ROOT, is under development