Size of absorber for MMC

- Thermodynamic energy fluctuation of sensor

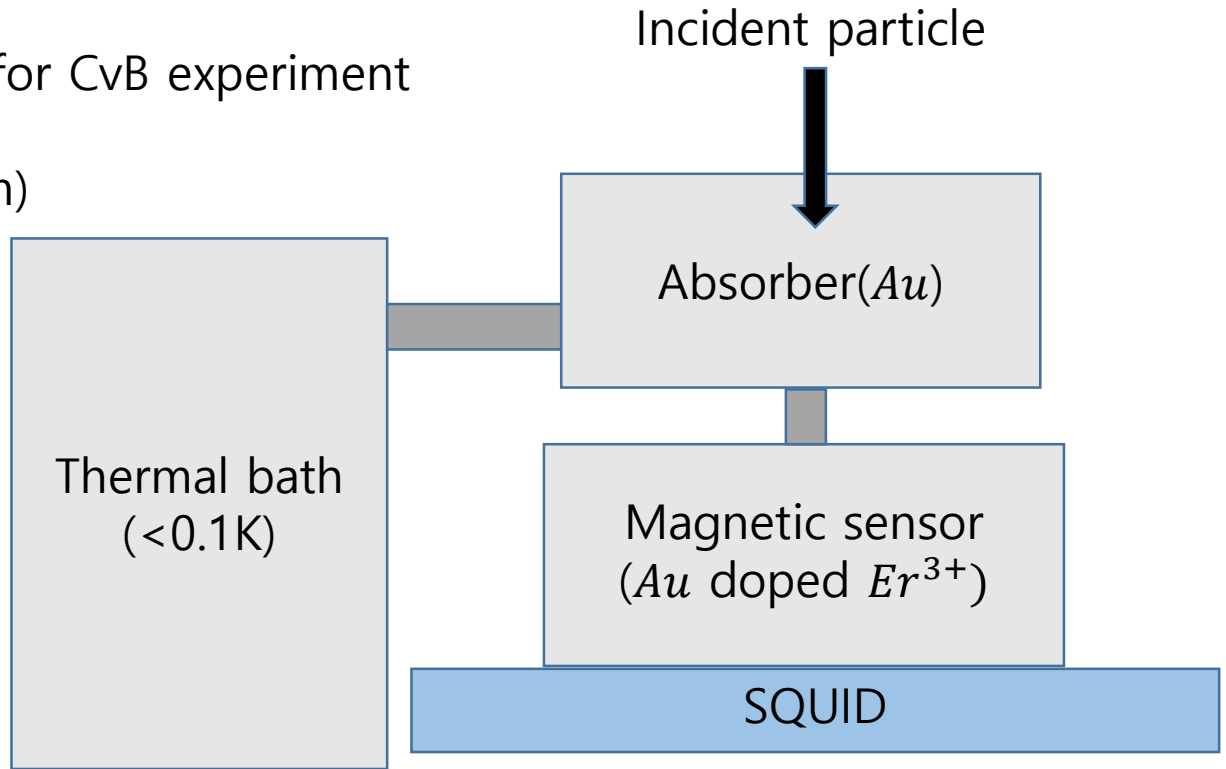
: accounts for dominant part on energy resolution in ideal situation

- $\Delta E_{rms} = \sqrt{4k_B C_e {T_0}^2}\left[\frac{G_{eb}}{G_{Ze}} + \left(\frac{G_{eb}}{G_{Ze}}\right)^2\right]^{1/4}$

- $\Delta E_{rms} \sim volume\ of\ absorber$, if neglect the volume dependence of $\frac{G_{eb}}{G_{Ze}}$ on absorber size
  ($G \sim$ contact area)

- Absorber : Maybe, no need to be flat cylindrical shape for CvB experiment
(x–ray exp. : external incident particle beam from source
-> needs sufficient absorber area projected from the beam)

$240 \times 240 \times 5\mu m^3$ -> $\Delta E_{rms} = 1.4\text{eV}$ in optimal case(50mK)



at low temperature. By the time the local electron temperature has reached about 1 K the absorbed energy is distributed within a volume of a few cubic micrometers. The further thermalization within the absorber can be described by thermal diffusion. The time scale for this process is mainly determined

Simulation with geant4 (need to be improved)

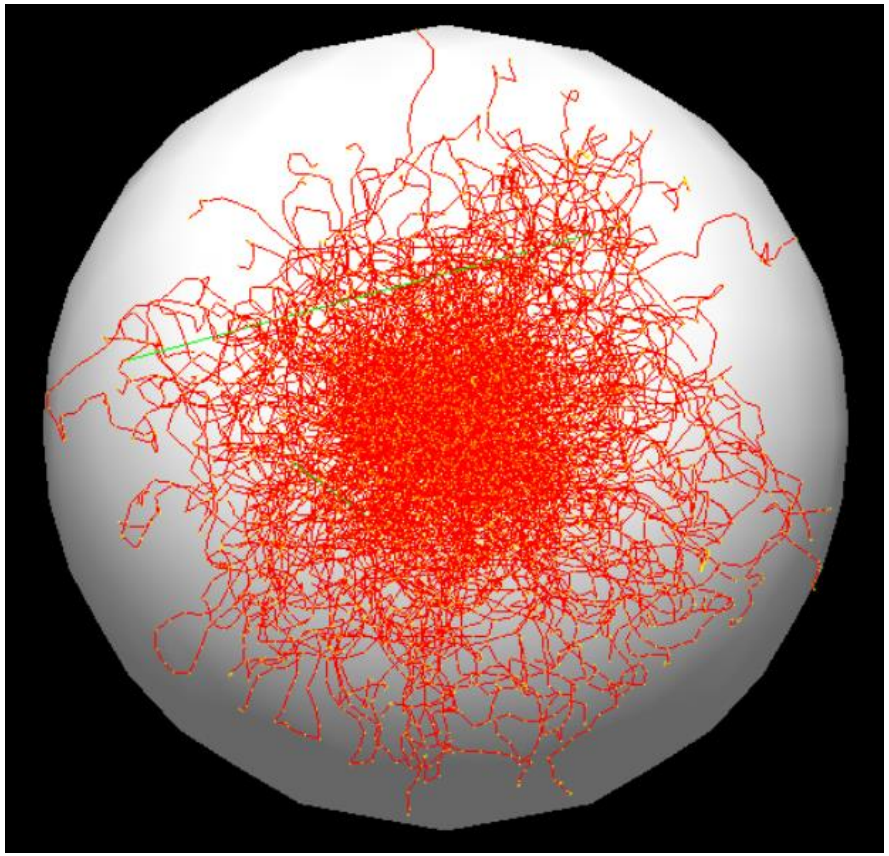
- A Electron from the beta decay of tritium source in gold absorber (18.6keV)

: loses its energy by interaction with the bound electron of gold (excitation or ionization)

- Find the maximally displaced step point from the center including secondary particles

- If possible, accurate simulation which could extract the electron temperature will give the more precise minimum absorber size

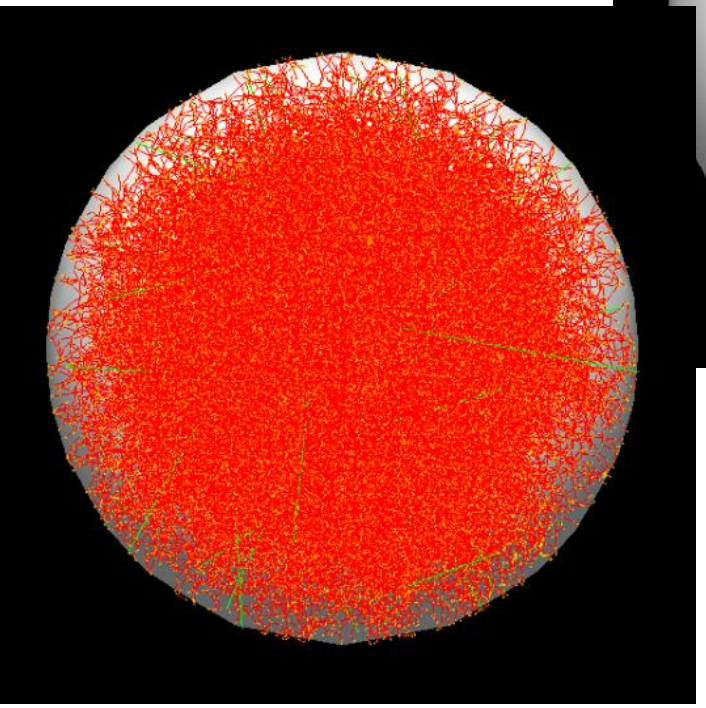
- At now, facing with incomprehensible results
  : simulation step dependence on absorber size

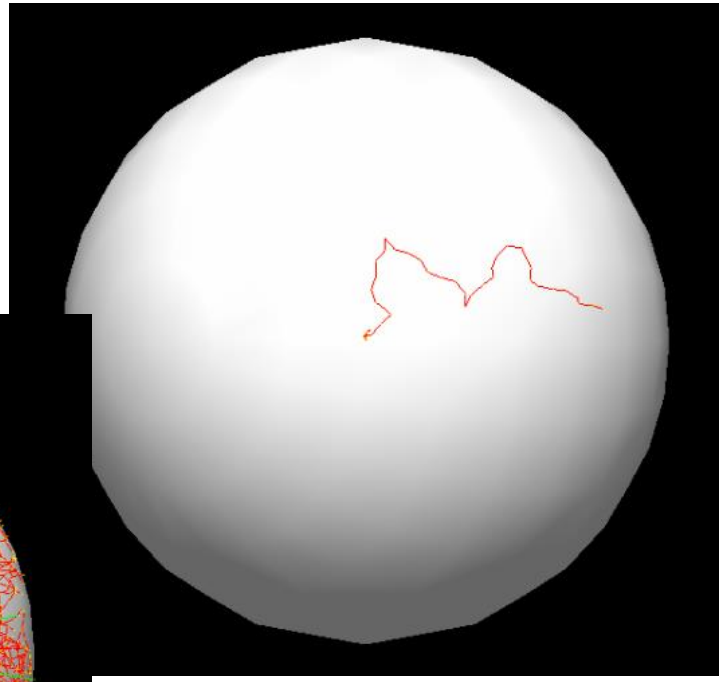


results

1. Detector radius : 1 μm

10000 source events





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*********************************************************************************************************
* 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      0 fm   18.6 keV     0 eV      0 fm      0 fm   Detector   initStep
    1   13.2 nm   14.8 nm     10 nm   18.6 keV  16.3 eV   24.1 nm   24.1 nm   Detector        msc
    2     36 nm   18.8 nm   23.5 nm   18.6 keV  28.8 eV   27.3 nm   51.4 nm   Detector        msc
    3   47.2 nm   13.5 nm   45.8 nm   18.6 keV     0 eV   26.3 nm   77.7 nm   Detector        msc
    4   62.1 nm    3.9 nm   63.7 nm   18.5 keV  68.8 eV   26.9 nm    105 nm   Detector        msc
    5     73 nm   4.15 nm     73 nm     17 keV   248 eV   14.7 nm    119 nm   Detector       eIoni
    6   88.8 nm   9.11 nm   94.3 nm   16.9 keV  45.2 eV   28.9 nm    148 nm   Detector        msc
    7    110 nm   9.23 nm   97.1 nm   16.9 keV  15.4 eV   22.9 nm    171 nm   Detector        msc
    8    122 nm   27.8 nm   86.5 nm   16.8 keV  77.4 eV   24.8 nm    196 nm   Detector        msc
    9    127 nm   42.4 nm   68.2 nm   15.8 keV  1.07 keV    25 nm    221 nm   Detector        msc
   10    105 nm   56.3 nm   67.2 nm   15.7 keV    95 eV   26.4 nm    247 nm   Detector        msc
   11   85.5 nm   63.6 nm   61.9 nm   15.5 keV   196 eV   25.9 nm    273 nm   Detector        msc
   12   72.6 nm   84.7 nm   59.2 nm   15.3 keV   168 eV   29.7 nm    303 nm   Detector        msc
   13   75.8 nm    109 nm   49.8 nm   15.2 keV   131 eV   27.4 nm    330 nm   Detector        msc
   14   68.9 nm    131 nm   45.5 nm   15.2 keV  16.3 eV   24.3 nm    355 nm   Detector        msc
   15   71.5 nm    148 nm   26.9 nm     15 keV   129 eV   26.3 nm    381 nm   Detector        msc
   16   59.6 nm    169 nm   13.2 nm   14.6 keV   414 eV   29.3 nm    410 nm   Detector        msc
   17   70.7 nm    151 nm    2.9 nm   14.6 keV  16.5 eV   25.1 nm    435 nm   Detector        msc
   18   86.8 nm    144 nm  -12.9 nm   14.5 keV  69.3 eV   24.6 nm    460 nm   Detector        msc
   19    109 nm    133 nm  -19.1 nm   14.5 keV    22 eV     27 nm    487 nm   Detector        msc
   20    116 nm    113 nm  -29.1 nm   14.4 keV  69.1 eV   24.3 nm    511 nm   Detector        msc
   21    127 nm    105 nm  -47.7 nm   14.4 keV     0 eV   24.6 nm    536 nm   Detector        msc
   22    145 nm   97.9 nm    -63 nm   14.4 keV  20.4 eV   25.8 nm    562 nm   Detector        msc
   23    157 nm   77.6 nm  -76.4 nm   13.4 keV  1.02 keV  29.5 nm    591 nm   Detector        msc
   24    163 nm   57.2 nm  -69.5 nm   13.4 keV     0 eV   23.7 nm    615 nm   Detector        msc
   25    179 nm   75.4 nm  -67.3 nm   13.2 keV   187 eV   25.5 nm    640 nm   Detector        msc
   26    188 nm   91.3 nm  -83.4 nm   12.9 keV   274 eV   25.6 nm    666 nm   Detector        msc
   27    206 nm    106 nm    -92 nm   12.2 keV   738 eV     27 nm    693 nm   Detector        msc
   28    215 nm    120 nm  -78.7 nm   11.9 keV   268 eV   22.4 nm    715 nm   Detector        msc
   29    228 nm    139 nm  -77.3 nm   11.9 keV     0 eV   27.2 nm    743 nm   Detector        msc
   30    240 nm    156 nm  -88.9 nm   11.9 keV  50.5 eV   25.2 nm    768 nm   Detector        msc
   31    259 nm    153 nm   -105 nm   11.8 keV  88.3 eV   25.9 nm    794 nm   Detector        msc
   32    269 nm    132 nm   -109 nm   11.7 keV   131 eV     25 nm    819 nm   Detector        msc
   33    258 nm    120 nm   -127 nm   11.6 keV  34.5 eV   24.2 nm    843 nm   Detector        msc
   34    250 nm    101 nm   -132 nm   10.7 keV   886 eV   23.1 nm    866 nm   Detector        msc
   35    249 nm   90.8 nm   -151 nm   10.6 keV  96.3 eV   26.4 nm    892 nm   Detector        msc
   36    266 nm   85.2 nm   -169 nm   10.6 keV  54.3 eV   27.1 nm    919 nm   Detector        msc
   37    274 nm   82.9 nm   -192 nm   10.3 keV   292 eV   28.1 nm    947 nm   Detector        msc
   38    296 nm     70 nm   -199 nm   8.75 keV  1.54 keV  28.2 nm    976 nm   Detector        msc
   39    311 nm   61.5 nm   -185 nm   7.59 keV  1.16 keV  28.6 nm     1 um   Detector        msc
   40    333 nm   57.7 nm   -188 nm   7.51 keV  75.2 eV   26.5 nm   1.03 um   Detector        msc
   41    337 nm   57.9 nm   -191 nm   6.01 keV  97.4 eV   5.48 nm   1.04 um   Detector       eIoni
   42    346 nm   52.9 nm   -206 nm      0 eV   6.01 keV   185 nm   1.22 um   Detector       eIoni

*********************************************************************************************************
* G4Track Information:   Particle = e-,   Track ID = 3,   Parent ID = 1
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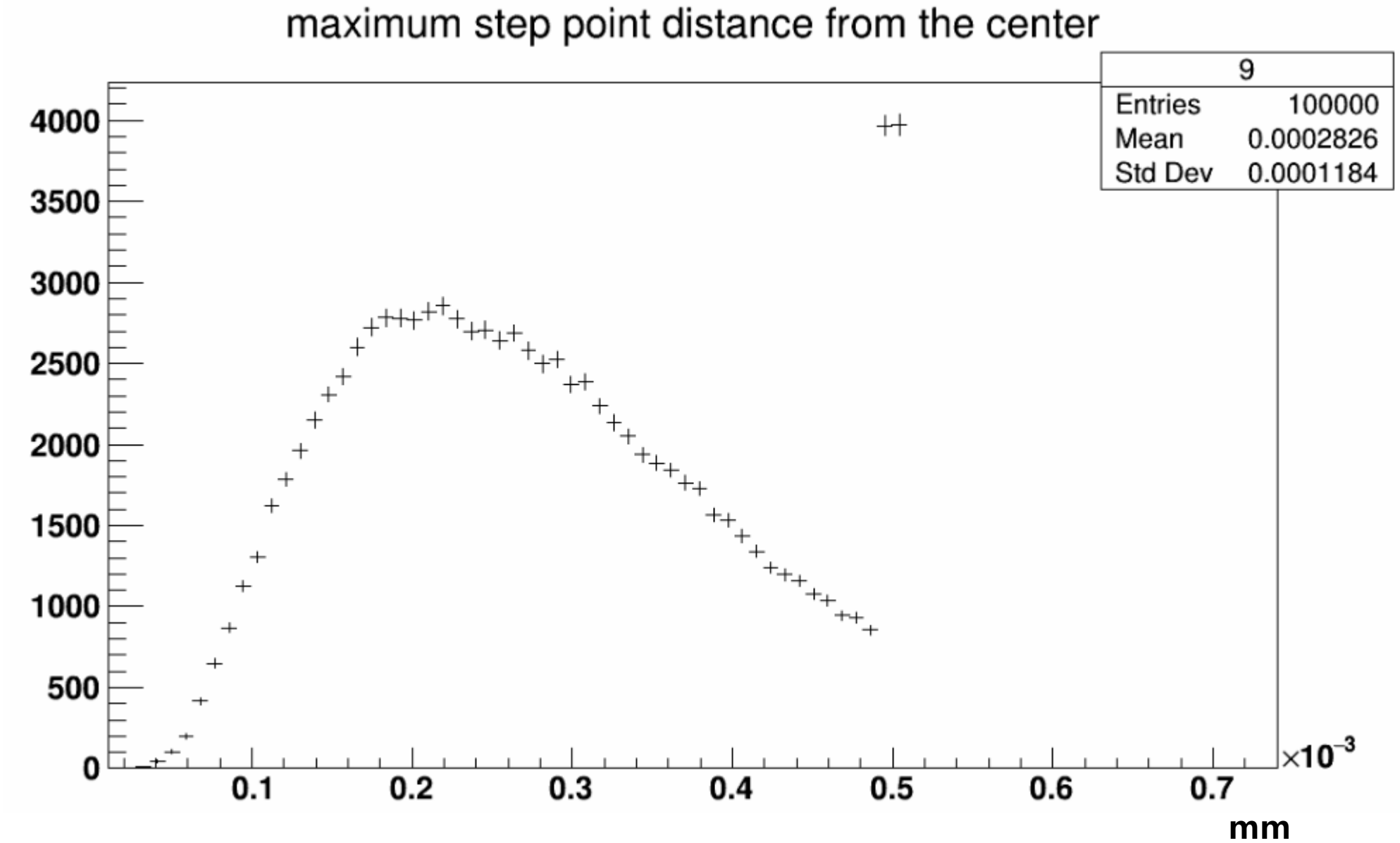
Step#      X         Y         Z        KineE    dEStep   StepLeng  TrakLeng    Volume     Process
    0    337 nm   57.9 nm   -191 nm    1.4 keV     0 eV      0 fm      0 fm   Detector   initStep
    1    339 nm   60.5 nm   -191 nm      0 eV    1.4 keV  22.5 nm   22.5 nm   Detector       eIoni

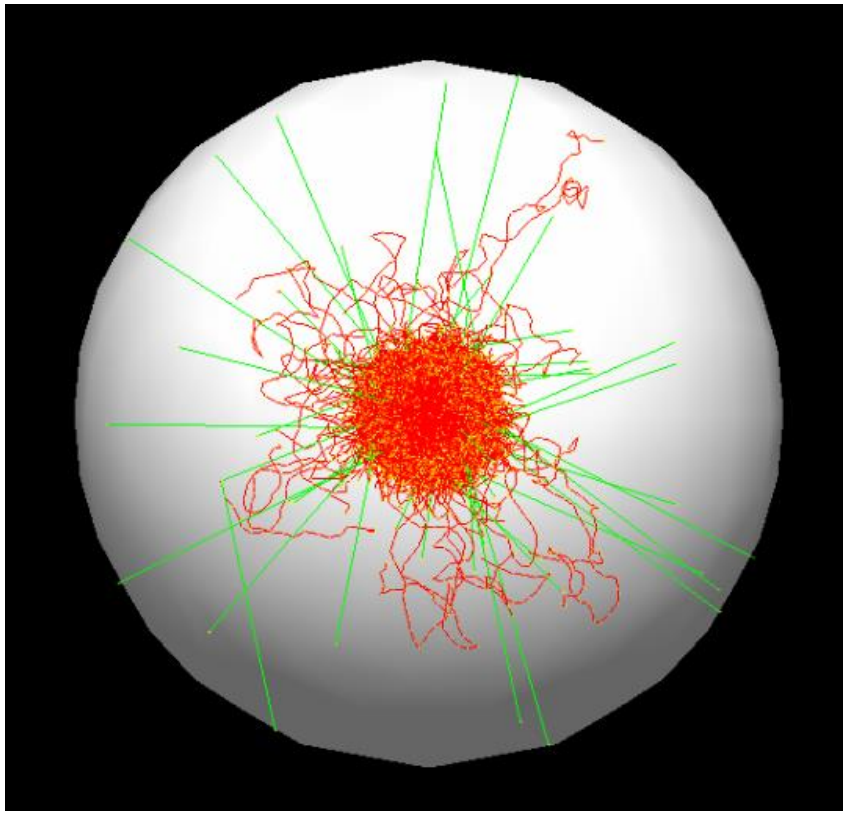
*********************************************************************************************************
* G4Track Information:   Particle = e-,   Track ID = 2,   Parent ID = 1
*********************************************************************************************************

Step#      X         Y         Z        KineE    dEStep   StepLeng  TrakLeng    Volume     Process
    0     73 nm   4.15 nm     73 nm   1.27 keV     0 eV      0 fm      0 fm   Detector   initStep
    1   71.2 nm   6.19 nm   73.6 nm      0 eV    1.27 keV    20 nm     20 nm   Detector       eIoni
 Run terminated.
```


maximum step point distance from the center
9
Entries 100000
Mean 0.0002826
Std Dev 0.0001184
4000
3500
3000
2500
2000
1500
1000
500
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
×10⁻³
mm

2. Detector radius : 1.3 μm

10000 source events



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**********************************************************************************************************
* 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      0 fm   18.6 keV     0 eV      0 fm      0 fm   Detector   initStep
    1   46.7 nm   46.8 nm   12.5 nm   16.9 keV   339 eV    119 nm    119 nm   Detector       eIoni
    2   62.6 nm     42 nm  -63.9 nm   10.2 keV  5.08 keV   467 nm    586 nm   Detector       eIoni
    3     76 nm   8.25 nm  -59.7 nm      0 eV   10.2 keV   454 nm   1.04 um   Detector       eIoni

**********************************************************************************************************
* G4Track Information:   Particle = e-,   Track ID = 3,   Parent ID = 1
**********************************************************************************************************

Step#      X         Y         Z        KineE    dEStep   StepLeng  TrakLeng    Volume     Process
    0   62.6 nm     42 nm  -63.9 nm   1.63 keV     0 eV      0 fm      0 fm   Detector   initStep
    1   65.7 nm   43.2 nm  -65.3 nm      0 eV   1.63 keV  27.2 nm   27.2 nm   Detector       eIoni

**********************************************************************************************************
* G4Track Information:   Particle = e-,   Track ID = 2,   Parent ID = 1
**********************************************************************************************************

Step#      X         Y         Z        KineE    dEStep   StepLeng  TrakLeng    Volume     Process
    0   46.7 nm   46.8 nm   12.5 nm   1.35 keV     0 eV      0 fm      0 fm   Detector   initStep
    1   46.7 nm   49.7 nm   12.4 nm      0 eV   1.35 keV  21.4 nm   21.4 nm   Detector       eIoni
 Run terminated.
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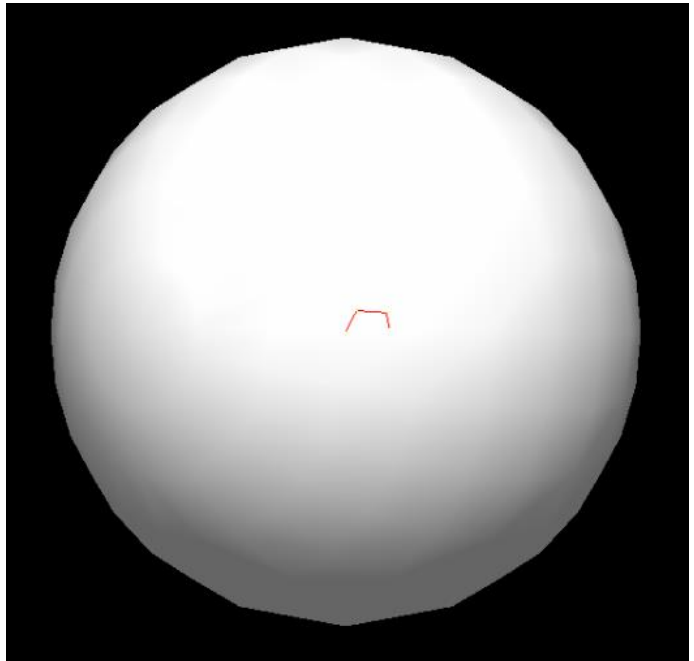

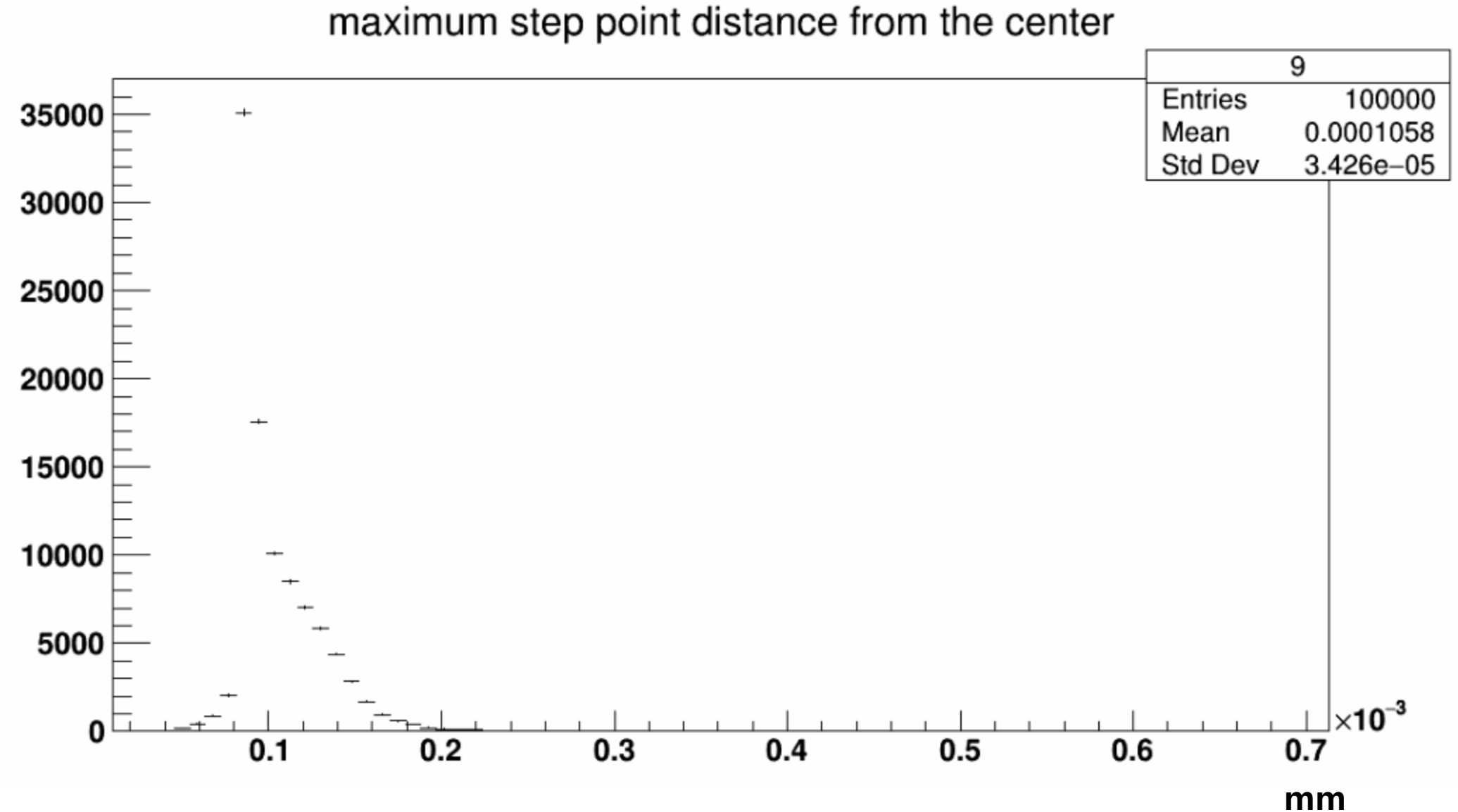
maximum step point distance from the center
9
Entries 100000
Mean 0.0001058
Std Dev 3.426e−05
35000
30000
25000
20000
15000
10000
5000
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
×10⁻³
mm