CryoBLM: dose per MIP calculations

EDMS-1340708

three cases are considered: 500 um sCVD, 300 um Si and 100 um Si

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2013.12.26: added conversion dose-to-charge

(Debug) In[1]:= `Needs["PhysicalConstants`"] (* in principle obsolete *)`

```
General::obspkg :
  PhysicalConstants` is now obsolete. The legacy version being loaded may conflict with current Mathematica
      functionality. See the Compatibility Guide for updating information.
```

Detector properties

Material type

(Debug) In[2]:= `type = {"sCVD", "Si", "Si"}`

(Debug) Out[2]= `{sCVD, Si, Si}`

Thickness, density, surface, w-factor (energy to create electron-hole pair)

(Debug) In[3]:=
```
conv = Quantity[1.602*^-19 , "Electronvolts" / "Joules"]
thickness = {Quantity[0.500, "Millimeters"],
  Quantity[0.3, "Millimeters"], Quantity[0.100, "Millimeters"]}
density = {Quantity[3.515, "Grams" / ("Centimeters")^3],
  Quantity[2.329, "Grams" / ("Centimeters")^3],
  Quantity[2.329, "Grams" / ("Centimeters")^3]}
wfactor = {Quantity[13, "Electronvolts"],
  Quantity[3.6, "Electronvolts"], Quantity[3.6, "Electronvolts"]}
ssize = {Quantity[0.25, ("Centimeters")^2],
  Quantity[1, ("Centimeters")^2], Quantity[1, ("Centimeters")^2]}
```

(Debug) Out[3]= 1.602×10^{-19} eV/J

(Debug) Out[4]= {0.5 mm, 0.3 mm, 0.1 mm}

(Debug) Out[5]= $\{3.515\ \mathrm{g/cm^3},\ 2.329\ \mathrm{g/cm^3},\ 2.329\ \mathrm{g/cm^3}\}$

(Debug) Out[6]= {13 eV, 3.6 eV, 3.6 eV}

(Debug) Out[7]= $\{0.25\ \mathrm{cm^2},\ 1\ \mathrm{cm^2},\ 1\ \mathrm{cm^2}\}$

dE/dx

(Debug) In[8]:=
```
dEdx = {Quantity[1.76 * 10^6, "Electronvolts" * ("Centimeters")^2 * ("Grams")^-1],
  Quantity[1.67 * 10^6, "Electronvolts" * ("Centimeters")^2 / "Grams"],
  Quantity[1.67 * 10^6, "Electronvolts" * ("Centimeters")^2 / "Grams"] }
```

(Debug) Out[8]= $\{1.76 \times 10^6\ \mathrm{cm^2 eV/g},\ 1.67 \times 10^6\ \mathrm{cm^2 eV/g},\ 1.67 \times 10^6\ \mathrm{cm^2 eV/g}\}$

Calculations

Energy per MIP

(Debug) In[9]:=
```
Edep = dEdx * density * thickness
```

(Debug) Out[9]= {309 320. eV, 116 683. eV, 38 894.3 eV}

Mass of the detector

(Debug) In[10]:=
```
mass = density * thickness * ssize
```

(Debug) Out[10]= {0.0439375 g, 0.06987 g, 0.02329 g}

Dose per MIP

(Debug) In[11]:=
```
dose = UnitConvert[Edep, "Joules"] / UnitConvert[mass, "Kilograms"]
```
(Debug) Out[11]= $\{1.12793 \times 10^{-9}\ \text{J/kg},\ 2.67563 \times 10^{-10}\ \text{J/kg},\ 2.67563 \times 10^{-10}\ \text{J/kg}\}$

Charge per MIP

(Debug) In[12]:=
```
charge = Edep / wfactor (* in number of electrons *)
```
(Debug) Out[12]= {23 793.8, 32 411.9, 10 804.}

(Debug) In[13]:=
```
chargeC = charge * ElectronCharge (* Quantity[1.,"Coulombs"] in Coulombs *)
```
```
{3.81219408429877`*^-15 Coulomb,
 5.192961078193676`*^-15 Coulomb, 1.730987026064559`*^-15 Coulomb}
```

Charge per dose

(Debug) In[15]:=
```
ConvGy2C = chargeC / UnitConvert[dose, "Grays"]
```
(Debug) Out[15]= $\{\text{Coulomb}\ (3.37981 \times 10^{-6}/\text{Gy}),\ \text{Coulomb}\ (0.0000194083/\text{Gy}),\ \text{Coulomb}\ (6.46944 \times 10^{-6}/\text{Gy})\}$

Summary

In summary one can say:

*	sCVD 500 um	Si 300 um	Si 100 um
Conversion [C / Gy]	3.4 * 10^-6	1.9 * 10^-5	6.5 * 10^-6
Dose per MIP	1.1 nGy	0.27 nGy	0.27 nGy
Nelectrons per MIP	24 000	32 000	11 000