Appendix G
Clausing Factor Monte Carlo Calculation

Visual Basic Monte-Carlo calculation of Clausing Factor for thruster grids.

Inputs:

Clausing Factor Calculator

Inputs	Radius (mm)	Diameter
thickScreen	0.381	
thickAccel	0.5	
rScreen	0.9525	1.905
rAccel	0.5715	1.143
gridSpace	0.5	
npart	10^6	

Code:

```
Sub Clausing()
    thickScreen = Range("C4")
    thickAccel = Range("C5")
    rScreen = Range("C6")
    rAccel = Range("C7")
    gridSpace = Range("C8")
    npart = Range("C9")
'  Monte Carlo Routine that calculates Clausing factor for
CEX
'    returns  Clausing  Factor  and  Downstream  Correction
factor
   Dim gone As Boolean
        Pi = 3.14159265358979
'assumes rTop = 1
```

```
    rBottom = rScreen / rAccel
    lenBottom = (thickScreen + gridSpace) / rAccel
    lenTop = thickAccel / rAccel
    Length = lenTop + lenBottom
        iescape = 0
        maxcount = 0
        icount = 0
        nlost = 0
            vztot = 0#
            vz0tot = 0#
   For ipart = 1 To npart
    ' launch from bottom
            notgone = True
            r0 = rBottom * Sqr(Rnd)
            z0 = 0#
            costheta = Sqr(1# - Rnd)
            If  (costheta  >  0.99999)  Then  costheta  =
0.99999
            phi = 2 * Pi * Rnd
            sintheta = Sqr(1# - costheta ^ 2)
            vx = Cos(phi) * sintheta
                vy = Sin(phi) * sintheta
                vz = costheta
                rf = rBottom
                t = (vx * r0 + Sqr((vx ^ 2 + vy ^ 2) * rf
^ 2 - (vy * r0) ^ 2)) / (vx ^ 2 + vy ^ 2)
                z = z0 + vz * t
                vz0tot = vz0tot + vz
                    icount = 0
            Do While notgone
                    icount = icount + 1
                If (z < lenBottom) Then
                ' hit wall of bottom cylinder and is re-
emitted
                        r0 = rBottom
                        z0 = z
                        costheta = Sqr(1# - Rnd)
                        If   (costheta   >   0.99999)   Then
costheta = 0.99999
                        phi = 2 * Pi * Rnd
                        sintheta = Sqr(1# - costheta ^ 2)
                        vz = Cos(phi) * sintheta
                        vy = Sin(phi) * sintheta
                        vx = costheta
                        rf = rBottom
                        t = (vx * r0 + Sqr((vx ^ 2 + vy ^
2) * rf ^ 2 - (vy * r0) ^ 2)) / (vx ^ 2 + vy ^ 2)
                        z = z0 + t * vz
                End If ' bottom cylinder re-emission
```

```
                If ((z >= lenBottom) And (z0 < lenBottom))
Then
                ' emitted below but going up
                    ' find radius at lenBottom
                        t = (lenBottom - z0) / vz
                        r = Sqr((r0 - vx * t) ^ 2 + (vy *
t) ^ 2)
                    If (r <= 1) Then
                    '  continuing upward
                        rf = 1#
                        t = (vx * r0 + Sqr((vx ^ 2 + vy ^
2) * rf ^ 2 - (vy * r0) ^ 2)) / (vx ^ 2 + vy ^ 2)
                        z = z0 + vz * t
                    Else
                    '  hit the upstream side of the accel
grid and is re-emitted downward
                        r0 = r
                        z0 = lenBottom
                        costheta = Sqr(1# - Rnd)
                        If  (costheta  >  0.99999)  Then
costheta = 0.99999
                        phi = 2 * Pi * Rnd
                        sintheta = Sqr(1# - costheta ^ 2)
                            vx = Cos(phi) * sintheta
                            vy = Sin(phi) * sintheta
                            vz = -costheta
                        rf = rBottom
                        t = (vx * r0 + Sqr((vx ^ 2 + vy ^
2) * rf ^ 2 - (vy * r0) ^ 2)) / (vx ^ 2 + vy ^ 2)
                        z = z0 + vz * t
                    End If
                End If ' end upward
                If ((z >= lenBottom) And (z <= Length))
Then
                    '  hit the upper cylinder wall and is
re-emitted
                        r0 = 1#
                        z0 = z
                        costheta = Sqr(1# - Rnd)
                        If  (costheta  >  0.99999)  Then
costheta = 0.99999
                        phi = 2 * Pi * Rnd
                        sintheta = Sqr(1# - costheta ^ 2)
                        vz = Cos(phi) * sintheta
                        vy = Sin(phi) * sintheta
                        vx = costheta
                        rf = 1#
                        t = (vx * r0 + Sqr((vx ^ 2 + vy ^
2) * rf ^ 2 - (vy * r0) ^ 2)) / (vx ^ 2 + vy ^ 2)
```

```
                        z = z0 + t * vz
                        If (z < lenBottom) Then
                        ' find z when particle hits the
bottom cylinder
                            rf = rBottom
                            If ((vx ^ 2 + vy ^ 2) * rf ^ 2
- (vy * r0) ^ 2 < 0#) Then
                               t = (vx * r0) / (vx ^ 2 +
vy ^ 2) 'if sqr arguement is less than 0 then set sqr term
to 0 12 May 2004
                            Else
                                t = (vx * r0 + Sqr((vx ^ 2
+ vy ^ 2) * rf ^ 2 - (vy * r0) ^ 2)) / (vx ^ 2 + vy ^ 2)
                            End If
                            z = z0 + vz * t
                        End If
                End If ' end upper cylinder emission
                If (z < 0#) Then
                    notgone = False
                End If
                If (z > Length) Then
                    iescape = iescape + 1
                    vztot = vztot + vz
                    notgone = False
                End If
                If (icount > 1000) Then
                    notgone = False
                    icount = 0
                    nlost = nlost + 1
                End If
            Loop  ' while
            If (maxcount < icount) Then maxcount = icount
        Next ipart ' particles
         Range("C11") = (rBottom ^ 2) * iescape / npart
         Range("C12") = maxcount
         Range("C13") = nlost
            vz0av = vz0tot / npart
            vzav = vztot / iescape
        DenCor = vz0av / vzav ' Downstream correction
factor
    End Sub ' Clausing
```