PU1_dat := READPRN("coreband1_PU.dat") KR1_dat := READPRN("coreband1_KR.dat")

PU2_dat := READPRN("coreband2_PU.dat") KR2_dat := READPRN("coreband2_KR.dat")

PU3_dat := READPRN("coreband3_PU.dat") KR3_dat := READPRN("coreband3_KR.dat")

PUloop_dat := READPRN("planar.dat") KRloop_dat := READPRN("planar.dat")

$\beta pu := 6$ $\beta kr := 6$ $fo := 628887$ $\Delta fo := 15$ $pc := 8801$ $d := 31.598$

$q := 1.6 \cdot 10^{-19}$ $emit := 2$ $NF := 3.0$ $fc := 6$

$$gnorm(ge, Idc, rt_pu, rt_kr, f) := ge \cdot \frac{2}{2} \cdot \sqrt{2} \cdot rt_pu \cdot rt_kr \cdot Idc \cdot 10^{-3} \cdot \frac{fo^2}{\Delta fo \cdot f \cdot 10^9} \cdot \frac{1}{pc \cdot 10^6} \cdot \frac{\sqrt{\beta pu \cdot \beta kr}}{d \cdot 10^{-3}}$$

$$S(ge, Idc, rt_pu, rt_kr, f) := \frac{1}{1 + gnorm(ge, Idc, rt_pu, rt_kr, f)}$$

$k := 0 .. rows(KRloop_dat) - 1$

$$KRloop_dat_{k,3} := KRloop_dat_{k,3} \cdot \frac{300}{4 \cdot fc \cdot d} \cdot \sqrt{2} \cdot \frac{1}{\left(\frac{\pi}{2} \cdot \frac{KRloop_dat_{k,0}}{fc}\right)}$$

```
ge_opt(Idc, PU_data, KR_data) := | Zmax ← 0
                                 | imax ← 0
                                 | for i ∈ 0 .. rows(PU_data) − 1
                                 |   if PU_data[i,3]·KR_data[i,3] > Zmax
                                 |     | Zmax ← PU_data[i,3]·KR_data[i,3]
                                 |     | imax ← i
                                 | gopt ← gnorm(1, Idc, PU_data[imax,3], KR_data[imax,3], KR_data[imax,0])
                                 | gopt ← 1/gopt
```

```
data_range(pu_data) := | npt ← rows(pu_data)
                       | vmax ← 0
                       | icent ← 0
                       | for i ∈ 0 .. npt − 1
                       |   if vmax < pu_data[i, 3]
                       |     | vmax ← pu_data[i, 3]
                       |     | icent ← i
                       | imax ← icent
                       | i ← icent
                       | while i < npt − 1
                       |   | vratio ← pu_data[imax, 3] / pu_data[icent, 3]
                       |   | i ← npt − 1  if vratio < 0.1
                       |   | otherwise
                       |   |   | i ← i + 1
                       |   |   | imax ← imax + 1
                       | imin ← icent
                       | i ← icent
                       | while i > 0
                       |   | vratio ← pu_data[imin, 3] / pu_data[icent, 3]
                       |   | i ← 0  if vratio < 0.1
                       |   | otherwise
                       |   |   | i ← i − 1
                       |   |   | imin ← imin − 1
                       | irange[0] ← imin
                       | irange[1] ← imax
                       | irange
```

$$\text{Sbeam}(rt_pu, rt_kr, Idc, Iopt) := \left| \begin{array}{l} coeff \leftarrow 4 \cdot q \cdot Idc \cdot 10^{-3} \cdot \dfrac{\beta pu \cdot emit}{6 \cdot d^2} \cdot 10^9 \\ gopt \leftarrow ge_opt(Idc, rt_pu, rt_kr) \\ g \leftarrow gopt \cdot \left(1 - \sqrt{1 - \dfrac{Idc}{Iopt}}\right) \\ kT \leftarrow 10^{\frac{(-174+NF+90)}{10}} \cdot .001 \cdot g^2 \\ irange \leftarrow data_range(rt_pu) \\ \text{for } ii \in 0..irange_1 - irange_0 \\ \quad \left| \begin{array}{l} data_{ii,0} \leftarrow rt_pu_{ii+irange_0,0} \\ data_{ii,1} \leftarrow coeff \cdot \left(rt_pu_{ii+irange_0,3} \cdot g \cdot S\left(g, Idc, rt_pu_{ii+irange_0,3}, rt_kr_{ii+irange_0,3}, rt_pu_{ii+irange_0,0}\right)\right)^2 \\ data_{ii,2} \leftarrow kT \end{array} \right. \\ data \end{array} \right.$$

$$\text{ge_const}(rt_pu, rt_kr, Idc, Iopt) := 20 \cdot \log\left[ge_opt(Idc, rt_pu, rt_kr) \cdot \left(1 - \sqrt{1 - \frac{Idc}{Iopt}}\right)\right]$$

$$\text{Power}(rt_pu, rt_kr, Idc, Iopt) := \left| \begin{array}{l} data \leftarrow \text{Sbeam}(rt_pu, rt_kr, Idc, Iopt) \\ beam_power \leftarrow \displaystyle\sum_{k=0}^{rows(data)-1} data_{k,1} \cdot \frac{\left(data_{rows(data)-1,0} - data_{0,0}\right)}{rows(data)} \\ noise_power \leftarrow \displaystyle\sum_{k=0}^{rows(data)-1} data_{k,2} \cdot \frac{\left(data_{rows(data)-1,0} - data_{0,0}\right)}{rows(data)} \\ power_0 \leftarrow beam_power \\ power_1 \leftarrow noise_power \\ power \end{array} \right.$$

$Imin := 20$ $\qquad$ $IOPT := 200$

$k := 0 .. 100$

$IDC_k := Imin + (IOPT - Imin) \cdot \frac{k}{100}$

$Pb_{k,0} := Power(PU1_dat, KR1_dat, IDC_k, IOPT)_0$

$Pb_{k,1} := Power(PU2_dat, KR2_dat, IDC_k, IOPT)_0$

$Pb_{k,2} := Power(PU3_dat, KR3_dat, IDC_k, IOPT)_0$

$Pb_{k,3} := Power(PUloop_dat, KRloop_dat, IDC_k, IOPT)_0$

$Pn_{k,0} := Power(PU1_dat, KR1_dat, IDC_k, IOPT)_1$

$Pn_{k,1} := Power(PU2_dat, KR2_dat, IDC_k, IOPT)_1$

$Pn_{k,2} := Power(PU3_dat, KR3_dat, IDC_k, IOPT)_1$

$Pn_{k,3} := Power(PUloop_dat, KRloop_dat, IDC_k, IOPT)_1$

$Pt_{k,0} := Pb_{k,0} + Pn_{k,0}$

$Pt_{k,1} := Pb_{k,1} + Pn_{k,1}$

$Pt_{k,2} := Pb_{k,2} + Pn_{k,2}$

$Pt_{k,3} := Pb_{k,3} + Pn_{k,3}$

$GE_const_{k,0} := ge_const(PU1_dat, KR1_dat, IDC_k, IOPT)$

$GE_const_{k,1} := ge_const(PU2_dat, KR2_dat, IDC_k, IOPT)$

$GE_const_{k,2} := ge_const(PU3_dat, KR3_dat, IDC_k, IOPT)$

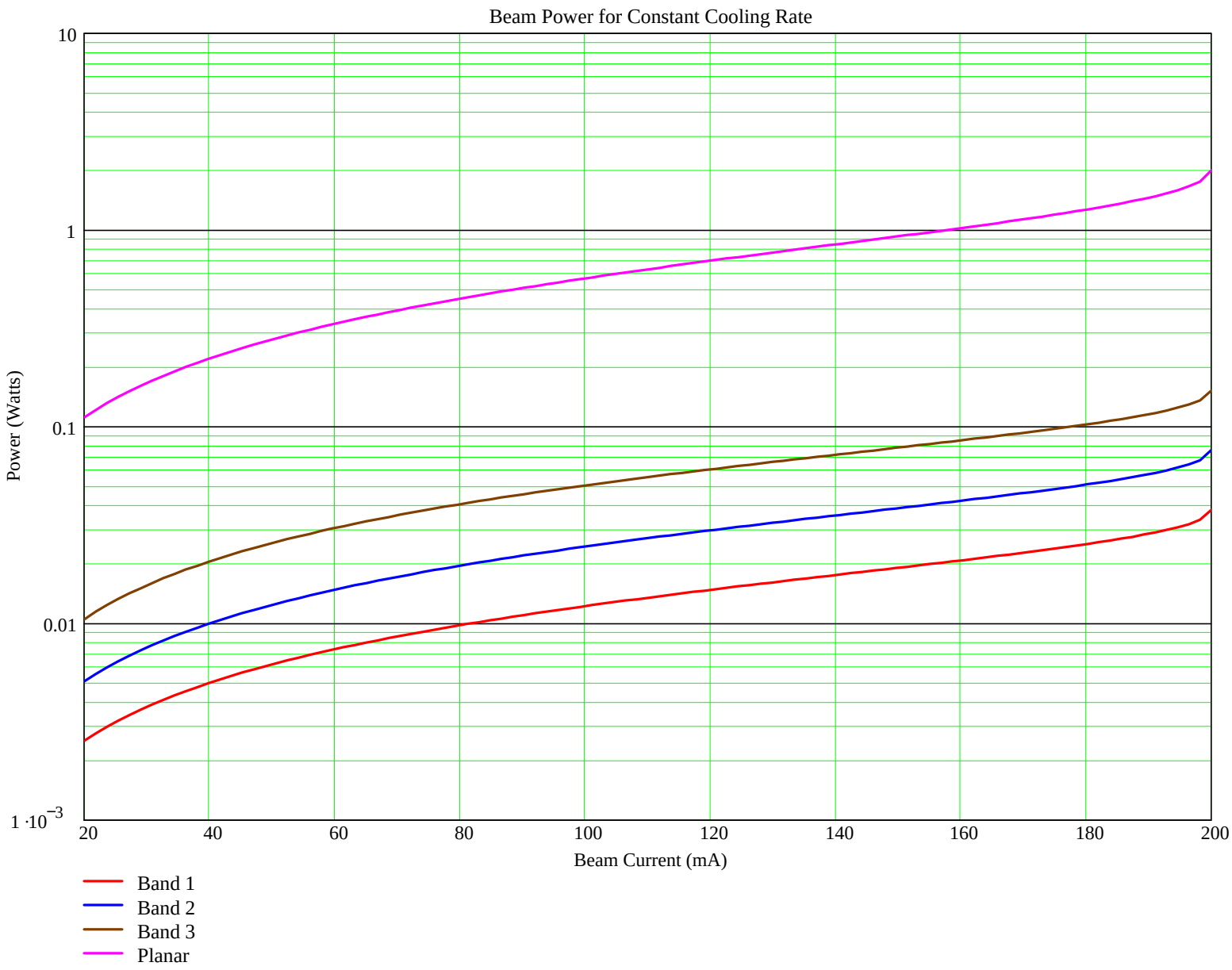
$GE_const_{k,3} := ge_const(PUloop_dat, KRloop_dat, IDC_k, IOPT)$

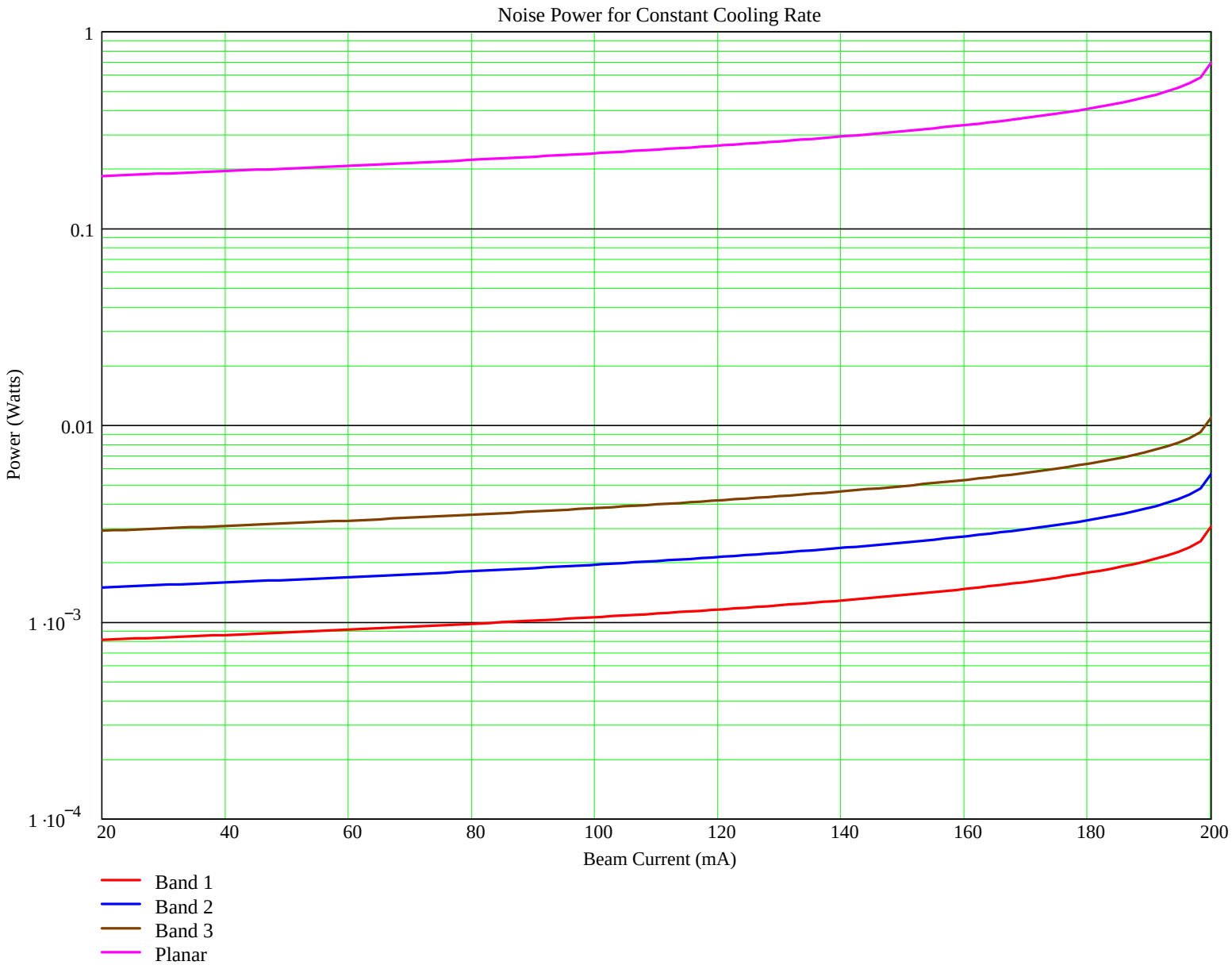
$Ptotal := \frac{Pt_{100,0} + Pt_{100,1} + Pt_{100,2}}{3}$

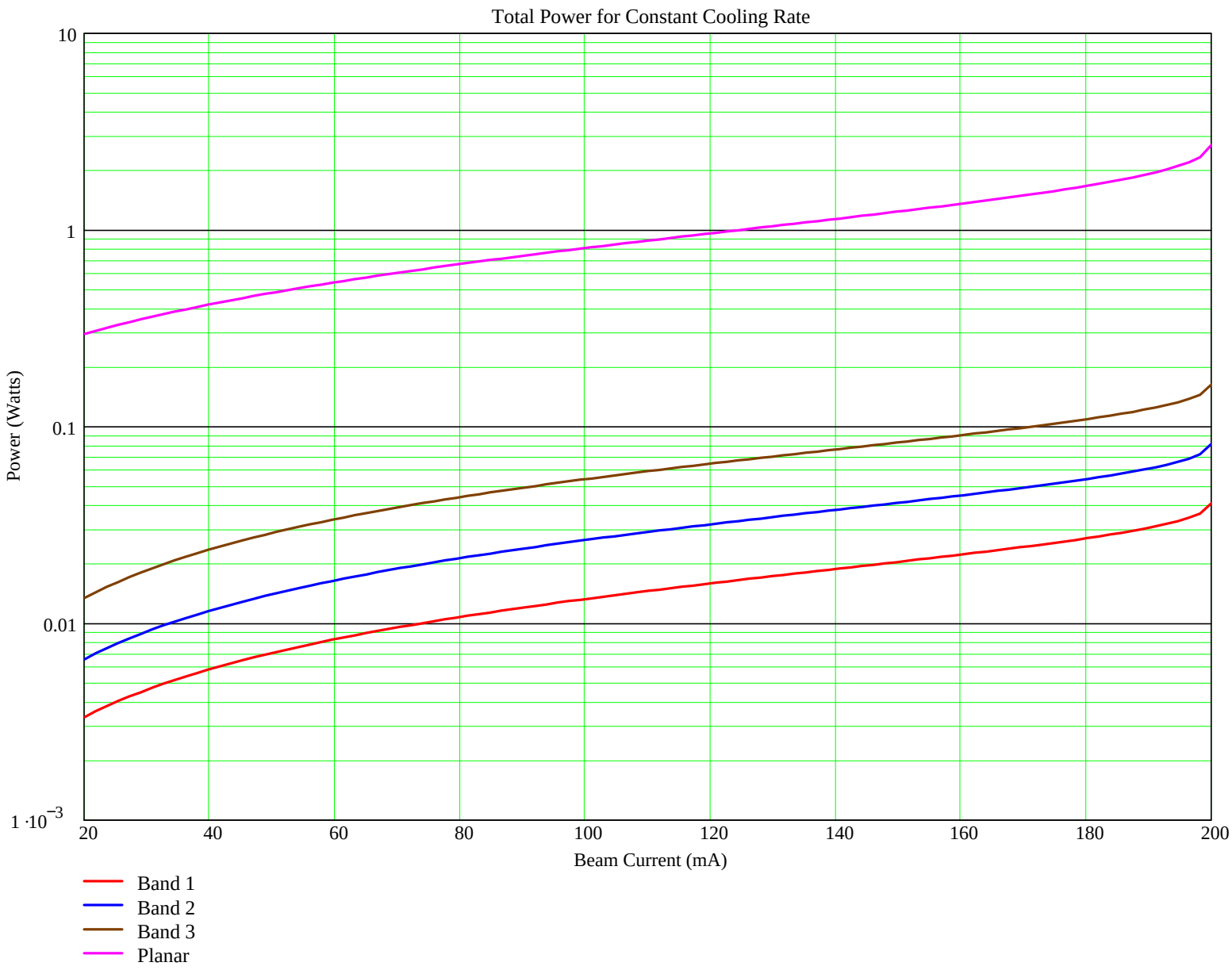
$Ploop := Pt_{100,3}$

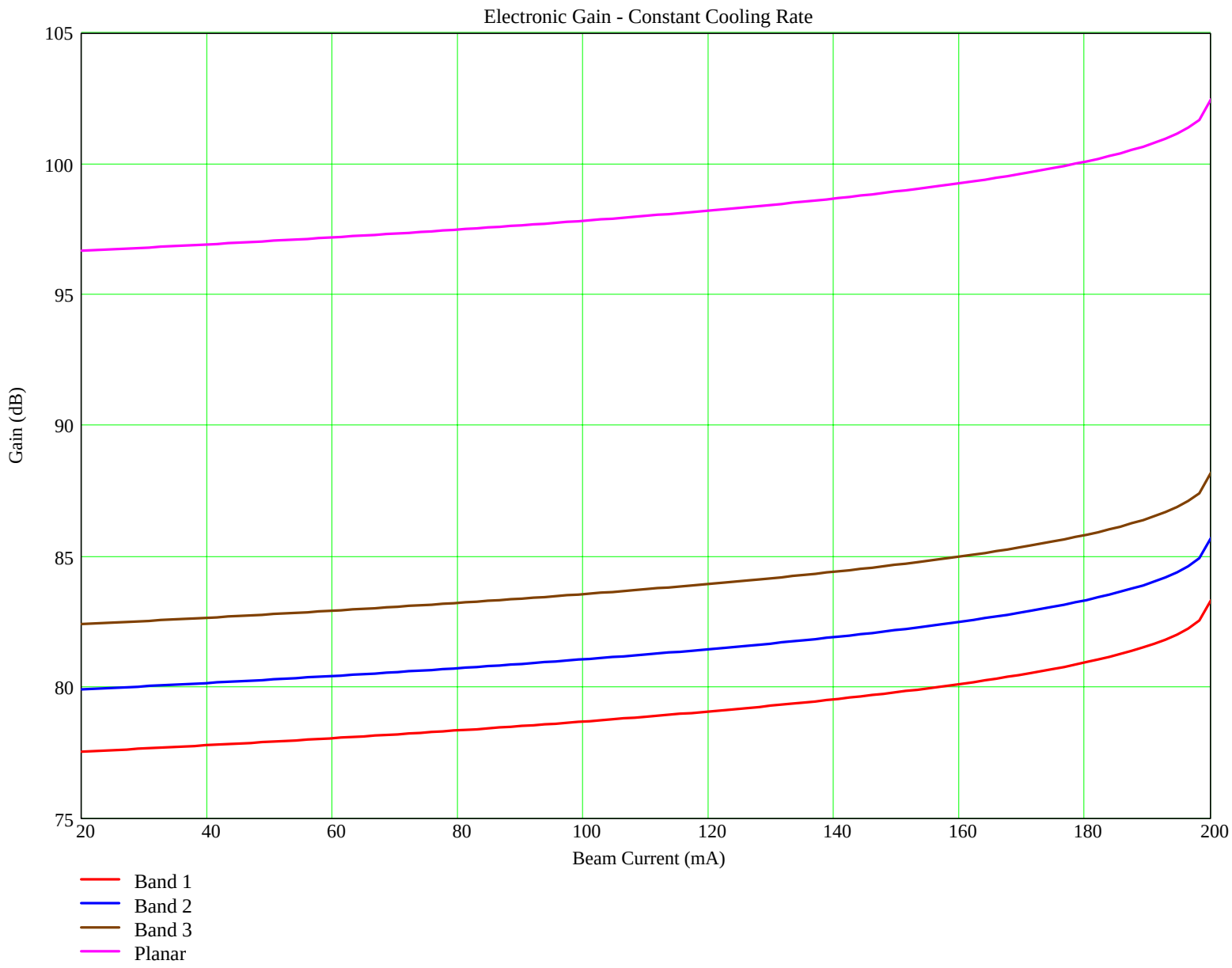
$Ploop = 2.721$

$Ptotal = 0.096$


Beam Power for Constant Cooling Rate
10
1
0.1
0.01
1 ·10^−3
Power (Watts)
20
40
60
80
100
120
140
160
180
200
Beam Current (mA)
Band 1
Band 2
Band 3
Planar


Noise Power for Constant Cooling Rate
1
0.1
0.01
1 ·10^−3
1 ·10^−4
Power (Watts)
20
40
60
80
100
120
140
160
180
200
Beam Current (mA)
Band 1
Band 2
Band 3
Planar


Total Power for Constant Cooling Rate
10
1
0.1
0.01
1 ·10^−3
Power (Watts)
20
40
60
80
100
120
140
160
180
200
Beam Current (mA)
Band 1
Band 2
Band 3
Planar


Electronic Gain - Constant Cooling Rate
Gain (dB)
105
100
95
90
85
80
75
20
40
60
80
100
120
140
160
180
200
Beam Current (mA)
Band 1
Band 2
Band 3
Planar