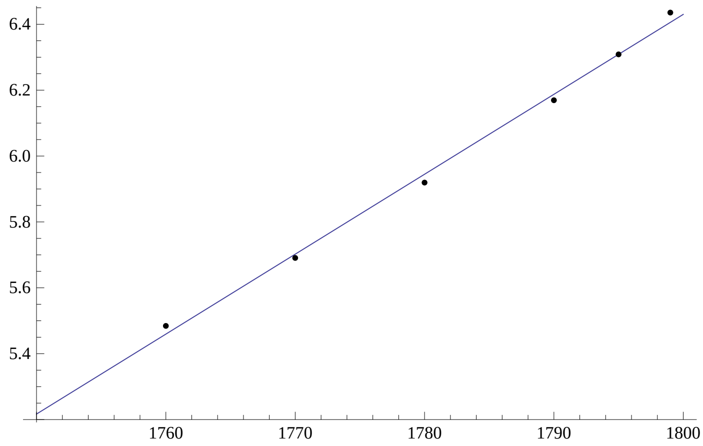
```
In[161]:= SetDirectory["~white/Desktop"];
```

- **Input Iouri' s APD gain measurements at 20 deg. C for a 64 mm^2 detector. Approximate with an exponential dependence on bias voltage.**

```
In[162]:= gaindat = Import["iouri_gain.csv", "CSV"];
          HV = Transpose[gaindat][[1]]
          Gain = Transpose[gaindat][[3]]

Out[163]= {100, 400, 800, 1200, 1500, 1600, 1700,
           1720, 1740, 1750, 1760, 1770, 1780, 1790, 1795, 1799}

Out[164]= {0.99, 1, 1.08, 1.99, 9.98, 25.5, 88.4, 120,
           166.4, 199.4, 241.9, 297.1, 373.2, 478.9, 550.3, 624.6}

In[165]:= Gainl = Log[Gain - 1]
          fulldata = Transpose[{HV, Gain}]
          data = Drop[Transpose[{HV, Gainl}], 10]

Out[165]= {-4.60517 + 3.14159 i, -∞, -2.52573, -0.0100503, 2.195, 3.19867, 4.4705,
           Log[119], 5.10837, 5.29029, 5.48438, 5.6907, 5.91943, 6.1694, 6.30864, 6.43551}

Out[166]= {{100, 0.99}, {400, 1}, {800, 1.08}, {1200, 1.99}, {1500, 9.98}, {1600, 25.5},
           {1700, 88.4}, {1720, 120}, {1740, 166.4}, {1750, 199.4}, {1760, 241.9},
           {1770, 297.1}, {1780, 373.2}, {1790, 478.9}, {1795, 550.3}, {1799, 624.6}}

Out[167]= {{1760, 5.48438}, {1770, 5.6907}, {1780, 5.91943},
           {1790, 6.1694}, {1795, 6.30864}, {1799, 6.43551}}

In[168]:=
          model = k * (t - a);
          fit = FindFit[data, model, {a, k}, t]

Out[169]= {a → 1535., k → 0.0242644}

In[170]:= modelf = Function[{t}, Evaluate[model /. fit]]
          Plot[modelf[t], {t, 1750, 1800}, Epilog → Map[Point, data]]
          Expfit[t_] := 1 + Exp[.024264 * (t - 1535)]

Out[170]= Function[{t}, 0.0242644 (-1535. + t)]
```

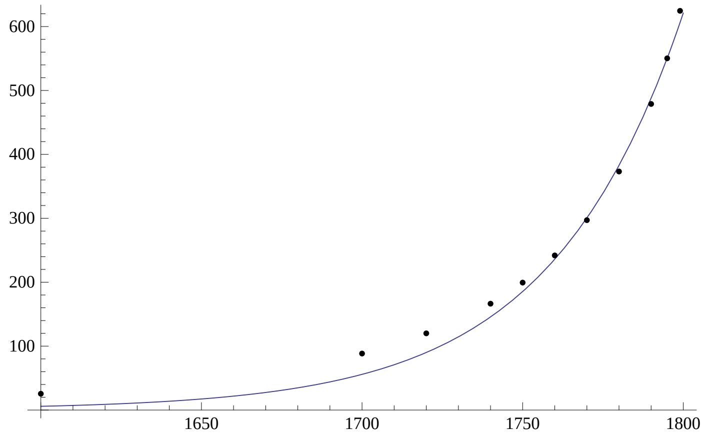
Out[171]=



In[173]:=

```
Plot[Expfit[v], {v, 1600, 1800}, Epilog → Map[Point, fulldata]]
```

Out[173]=

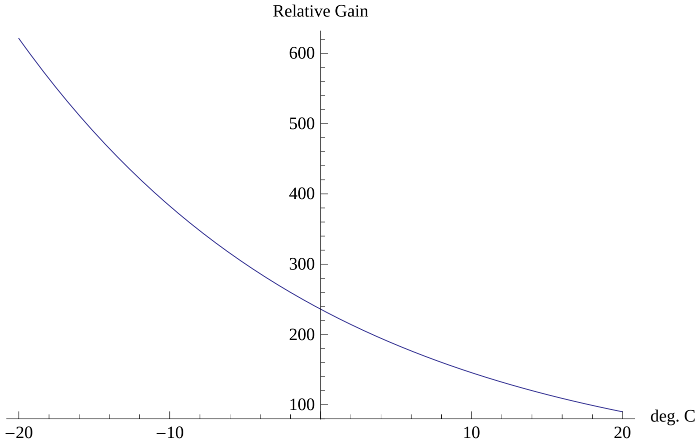


We have rule of thumb from Dick that 1 deg. C drop in temperature is equivalent to a 2 V increase in bias. What is Gain vs. temp. at a constant bias of 1720 v. Start at + 20 deg. C and go down to - 20 deg. C.
This calculation could be improved with a piecewise fit to the gain vs. bias below 1760 V.

In[174]:=

```
Plot[Expfit[1720 + 2 * (20 - t)], {t, -20, 20}, AxesLabel → {"deg. C", "Relative Gain"}]
```

Out[174]=

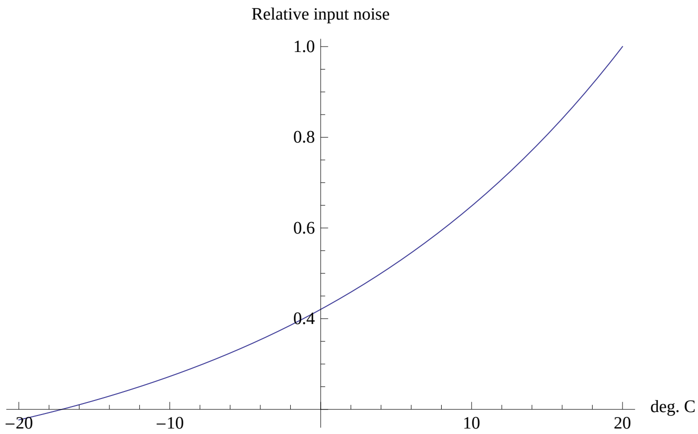


- **We also have the rule of thumb that the bulk leakage current decreases a factor of 2 for every 8 deg. C drop in temperature and the detector noise goes as the square root of the bulk leakage current.What is the input noise as a function of temperature?**

In[175]:=

```
Plot[Sqrt[2^((t - 20) / 8)], {t, -20, 20}, AxesLabel → {"deg. C", "Relative input noise"}]
```

Out[175]=



- **We know from the manufacturer that the electronic gain of the Minicircuits amplifiers does not vary much with temperature so we can predict that even if our apparent noise measurements are dominated by detector noise the decrease in leakage current with temperature should roughly compensate the increase in APD gain as we lower temperature at fixed voltage.**

  Note that we would also have the same result if apparent noise on the scope is dominated by external factors, such as the scope noise floor and external pickup. I think that this has almost always been the case in the measurements we have made up to now.

  The next step would be to calculate the expected detector noise with our signal processing and compare it with what we observe.