Locking vs Wind Speed @LHO

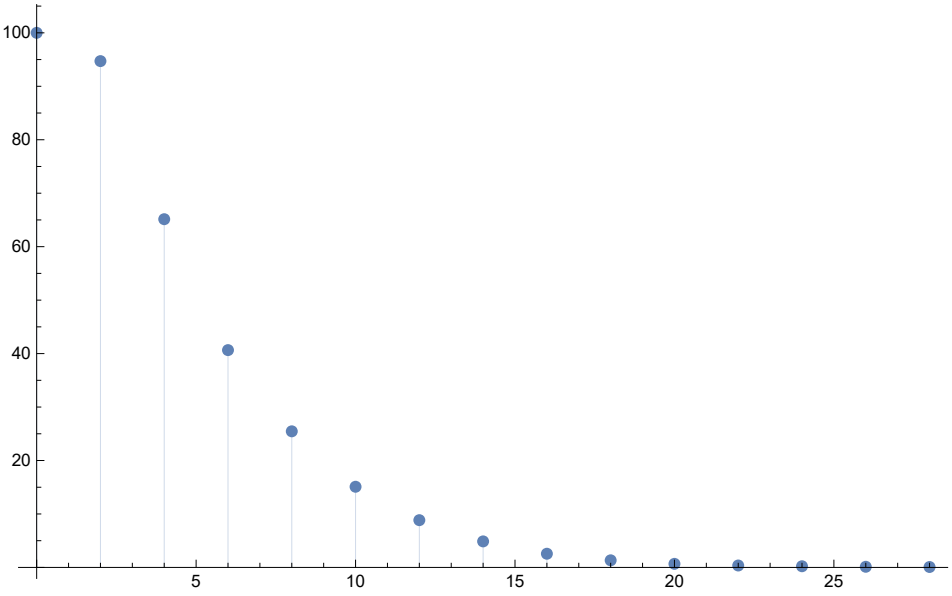
Wind Speed Histogram

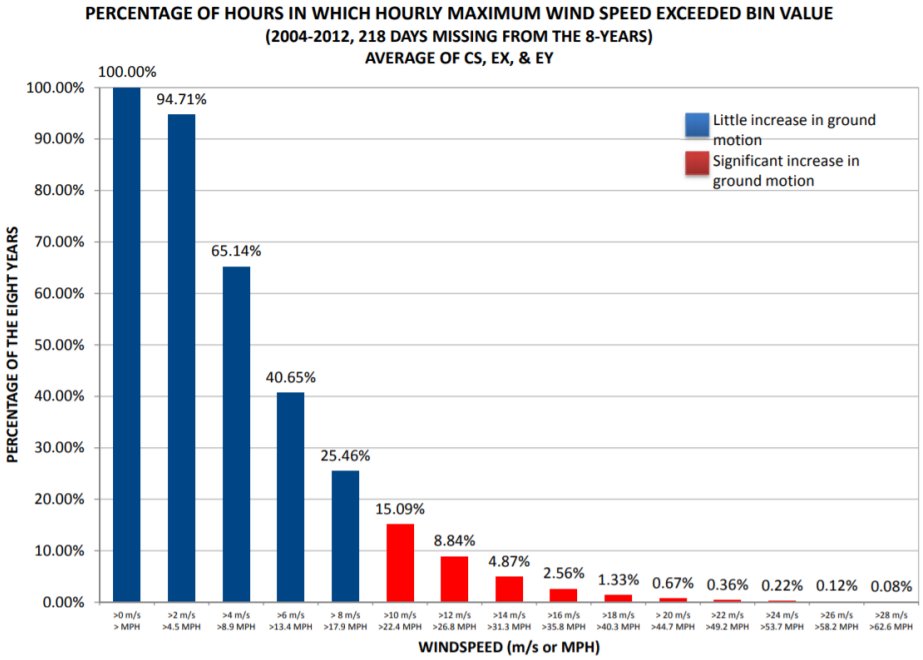
wind speed histogram from 8 years of data at LHO:
https://alog.ligo-wa.caltech.edu/aLOG/index.php?callRep=12996

In[2]:=
```
windHistogram = {{0, 100.00}, {2, 94.71}, {4, 65.14},
    {6, 40.65}, {8, 25.46}, {10, 15.09}, {12, 8.84}, {14, 4.87}, {16, 2.56},
    {18, 1.33}, {20, 0.67}, {22, .36}, {24, .22}, {26, .12}, {28, .08}};
```

In[43]:=
```
plt1 = ListPlot[windHistogram, Filling → Axis]
```

Out[43]=





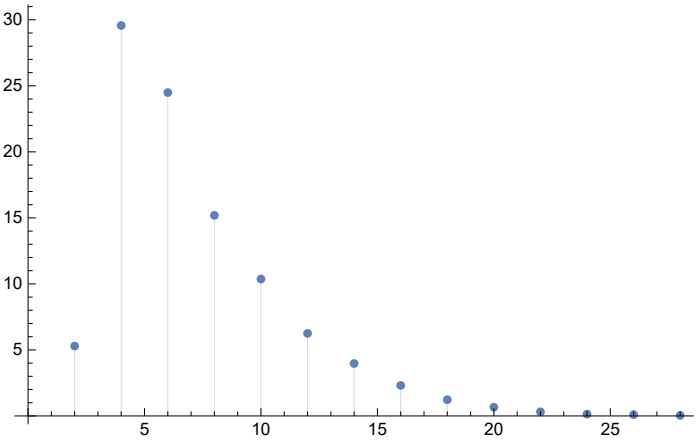
Wind Speed Probability Density Function

In[141]:=
```
npts = Dimensions[windHistogram][[1]] - 1;
windPDF = Transpose[Partition[Join[Drop[Transpose[windHistogram][[1]], 1],
    Drop[RotateRight[Transpose[windHistogram][[2]]] -
      Transpose[windHistogram][[2]], 1] / 100], npts]]
```

Out[142]=
```
{{2, 0.0529}, {4, 0.2957}, {6, 0.2449}, {8, 0.1519},
 {10, 0.1037}, {12, 0.0625}, {14, 0.0397}, {16, 0.0231}, {18, 0.0123},
 {20, 0.0066}, {22, 0.0031}, {24, 0.0014}, {26, 0.001}, {28, 0.0004}}
```

In[84]:=
```
ListPlot[windPDF, Filling → Axis]
```

Out[84]=



In[143]:=
```
windSpeeds = Transpose[windPDF][[1]];
```

In[150]:=
```
PDFvalues = Transpose[windPDF][[2]];
Total[PDFvalues]
```

Out[151]= 0.9992

Duty cycle vs wind speed

Plot of duty cycle vs wind speed in O2 in figure 16 here:
https://dcc.ligo.org/DocDB/0150/P1800038/001/BRSLIGOCQG.pdf
Histogram of fraction of the time the interferometer was locked as a function of wind speed for the O1 and O2 configuration

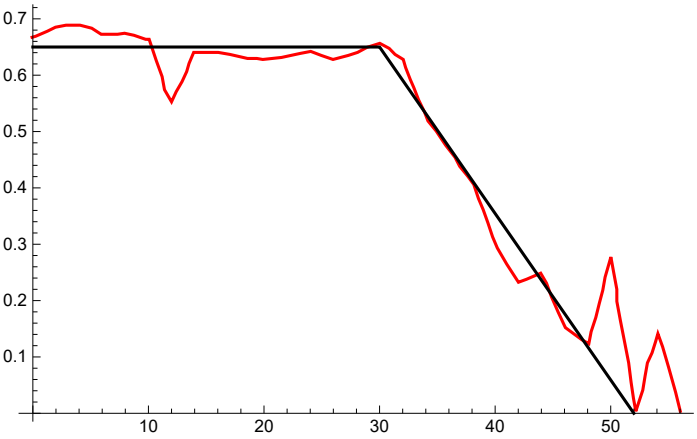
locking vs wind speed data

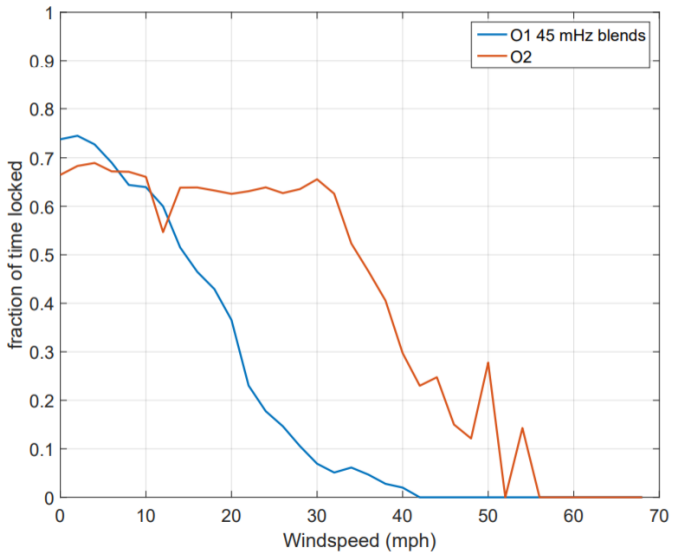
locking vs wind speed approximation

In[8]:=
```
generalizedLocking = {{0, .65}, {30, .65}, {52, 0}};
```

In[10]:=
```
ListPlot[{locking, generalizedLocking}, PlotJoined → True, PlotStyle → {Red, Black}]
```

Out[10]=





c = conversion from mph to m/s

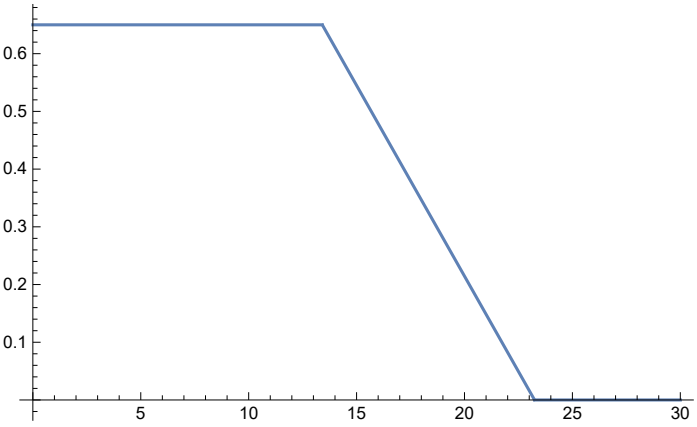
In[92]:=
```
c = 0.44704;
```

In[93]:=
```
L = Piecewise[{{0.65, x < 30 c}, {0.65 (52 c - x) / (22 c), x < 52 c}}]
```

Out[93]=
$$\begin{cases} 0.65 & x < 13.4112 \\ 0.0660913\ (23.2461 - x) & x < 23.2461 \\ 0 & \text{True} \end{cases}$$

In[94]:=
```
Plot[L, {x, 0, 30}]
```

Out[94]=



Convolution of duty cycle and wind speed frequency

In[152]:=
```
z = Table[0, {npts}];
For[i = 1, i < npts, i++, z[[i]] = PDFvalues[[i]] L /. x → windSpeeds[[i]]];
```

In[155]:=
```
Total[z]
```

Out[155]=
```
0.633799
```

In[156]:=
```
maxLocking = L /. x → 0
```

Out[156]=
```
0.65
```

In[157]:=
```
maxLocking - Total[z]
```

Out[157]=
```
0.0162013
```

If we were to make the interferometer locking completely independent of wind speed, then duty cycle increase would only be ~1.6%

N.B.: BNS, BBH range dependence on wind speed is another matter.