In [99]:

```
import numpy as np
import matplotlib.pyplot as plt
```

In [100]:

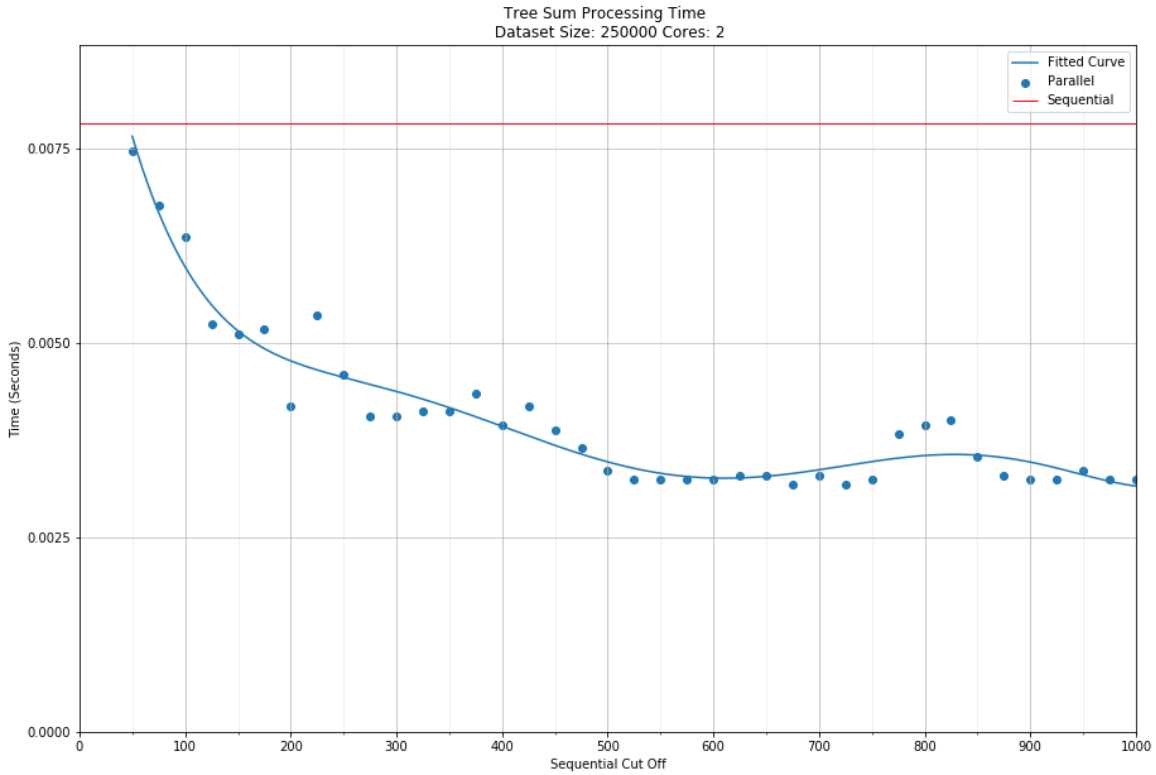
```
x= np.zeros(39)
count = 0
for i in range(50,1025,25):
    x[count] = i
    count += 1
```

In [101]:

```
def resPlot(x, y, seq, size, cores):
    ylimit = seq + 0.001
    fig,ax=plt.subplots(figsize=(15,10))
    major_ticks = np.arange(0, 1050, 100)
    minor_ticks = np.arange(0, 1050, 50)

    yticks = np.arange(0,0.04,0.0025)

    ax.set_xticks(major_ticks)
    ax.set_xticks(minor_ticks, minor=True)
    ax.set_yticks(yticks)

    # And a corresponding grid
    ax.grid(which='both')

    # Or if you want different settings for the grids:
    ax.grid(which='minor', alpha=0.2)
    ax.grid(which='major', alpha=0.8)

    plt.xlim(0,1000)  # adjust the max leaving min unchanged
    plt.ylim(0,ylimit)  # adjust the max leaving min unchanged
    plt.xlabel("Sequential Cut Off")
    plt.ylabel("Time (Seconds)")
    plt.title("Tree Sum Processing Time \n Dataset Size: "+size+" Cores: "+cores
)

    ax.scatter(x, y, label="Parallel")
    ax.hlines(y=sequential, xmin=0, xmax=1000, linewidth=1, color='r', label="Se
quential")

    xp = np.linspace(50, 1000, 9500)
    z = np.polyfit(x,y,6)
    p = np.poly1d(z)
    ax.plot(xp, p(xp), '-', label="Fitted Curve")

    plt.legend()
    plt.savefig(size+"_"+cores+".png")
```

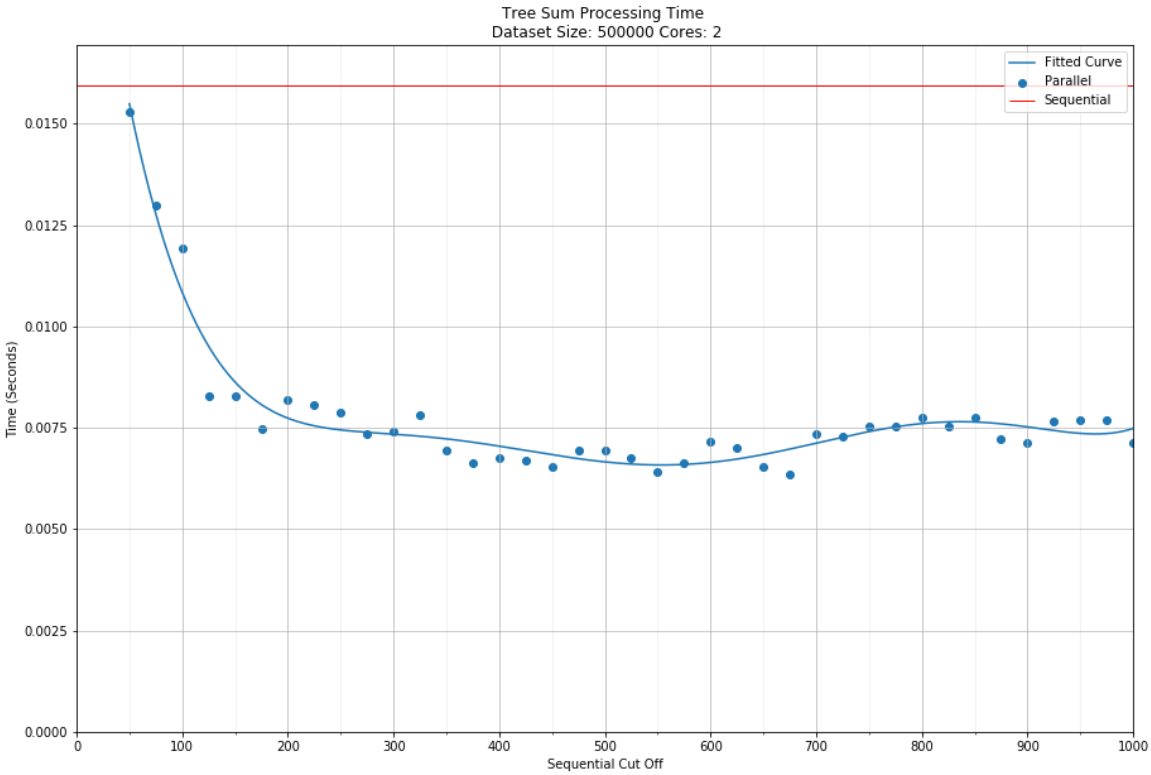
In [102]:

```
y = [0.0074705887,
0.006764706,
0.006352941,
0.005235294,
0.005117647,
0.005176471,
0.004176471,
0.005352941,
0.004588235,
0.004058824,
0.004058824,
0.004117647,
0.004117647,
0.0043529416,
0.0039411765,
0.004176471,
0.003882353,
0.0036470592,
0.003352941,
0.0032352938,
0.0032352938,
0.0032352938,
0.0032352938,
0.0032941175,
0.0032941175,
0.0031764703,
0.0032941175,
0.0031764703,
0.0032352938,
0.0038235297,
0.003941177,
0.004,
0.0035294115,
0.0032941173,
0.0032352938,
0.0032352938,
0.0033529412,
0.0032352938,
0.0032352938]
sequential = 0.007823531
resPlot(x,y,sequential,"250000","2")
```


Tree Sum Processing Time
Dataset Size: 250000 Cores: 2
Fitted Curve
Parallel
Sequential
Time (Seconds)
0.0000
0.0025
0.0050
0.0075
0
100
200
300
400
500
600
700
800
900
1000
Sequential Cut Off

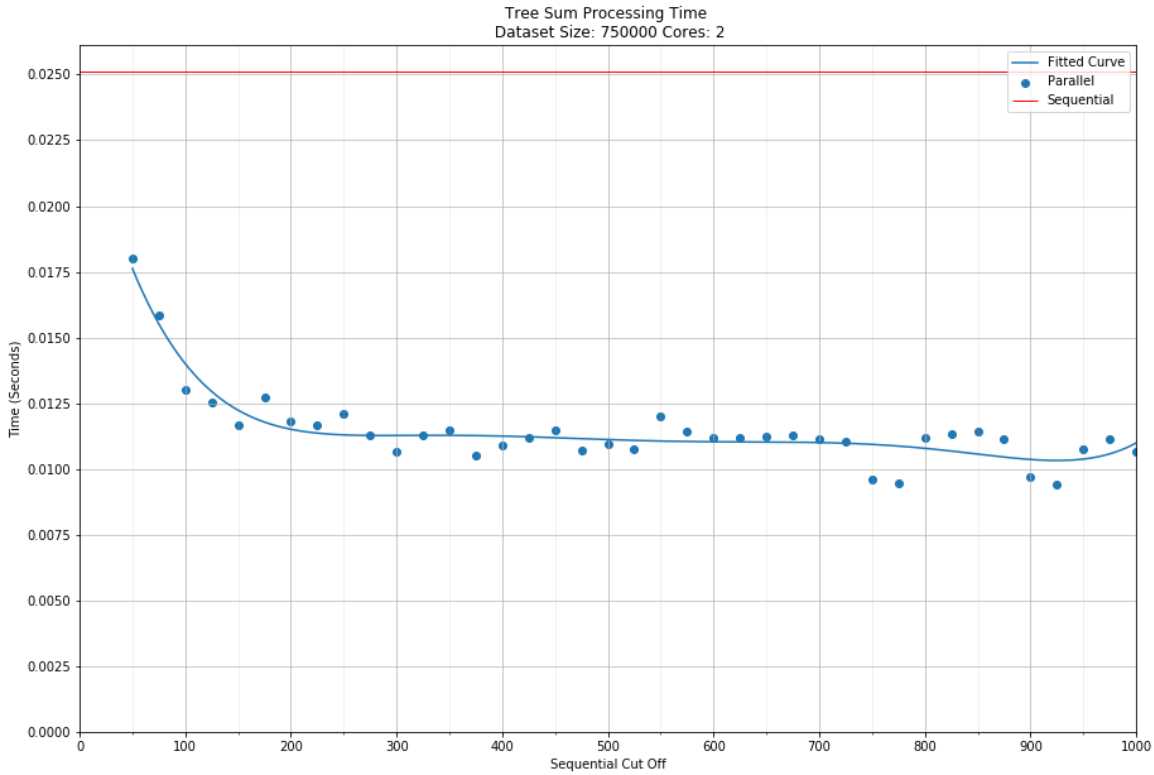
In [103]:

```
y = [0.015294119,
0.013000001,
0.011941177,
0.008294118,
0.008294118,
0.0074705887,
0.00817647,
0.008058824,
0.007882353,
0.007352941,
0.007411765,
0.007823531,
0.006941176,
0.0066470583,
0.0067647058,
0.006705882,
0.006529411,
0.0069411756,
0.0069411765,
0.0067647058,
0.006411765,
0.0066470588,
0.0071764705,
0.0069999993,
0.006529411,
0.0063529406,
0.007352941,
0.007294117,
0.007529412,
0.0075294115,
0.007764707,
0.007529412,
0.007764706,
0.0072352937,
0.0071176467,
0.0076470585,
0.007705882,
0.007705882,
0.007117647]
sequential = 0.015941177
resPlot(x,y,sequential,"500000","2")
```


Tree Sum Processing Time
Dataset Size: 500000 Cores: 2
Fitted Curve
Parallel
Sequential
Time (Seconds)
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
0
100
200
300
400
500
600
700
800
900
1000
Sequential Cut Off

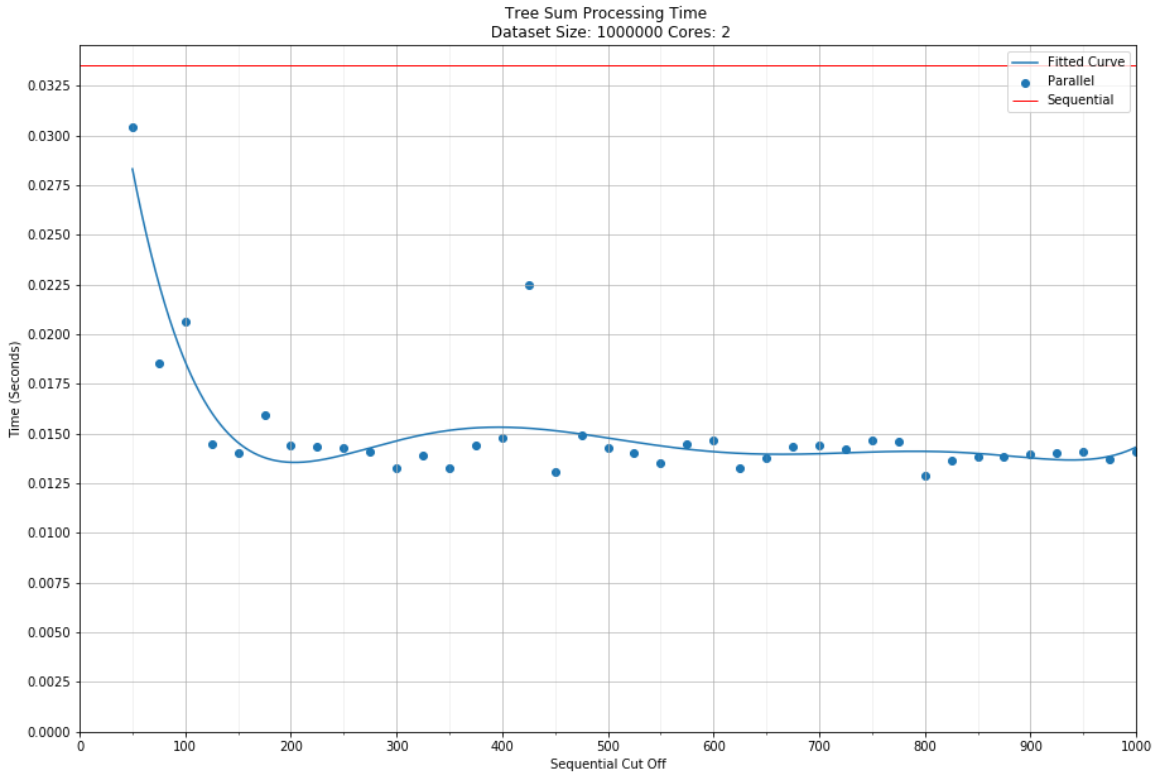
In [104]:

```
y = [0.018,
0.015823528,
0.013000001,
0.01252941,
0.01164706,
0.012705882,
0.0118235275,
0.011647059,
0.012117646,
0.011294119,
0.0106470585,
0.011294118,
0.011470588,
0.010529412,
0.010882353,
0.01117647,
0.011470587,
0.010705883,
0.010941176,
0.010764707,
0.012,
0.011411765,
0.01117647,
0.011176472,
0.011235293,
0.011294119,
0.0111176465,
0.011058823,
0.009588234,
0.009470589,
0.011176471,
0.011352941,
0.011411764,
0.011117648,
0.0097058825,
0.009411765,
0.010764707,
0.011117646,
0.010647058]
sequential = 0.025117647
resPlot(x,y,sequential,"750000","2")
```


Tree Sum Processing Time
Dataset Size: 750000 Cores: 2
Fitted Curve
Parallel
Sequential
Time (Seconds)
Sequential Cut Off
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
0
100
200
300
400
500
600
700
800
900
1000

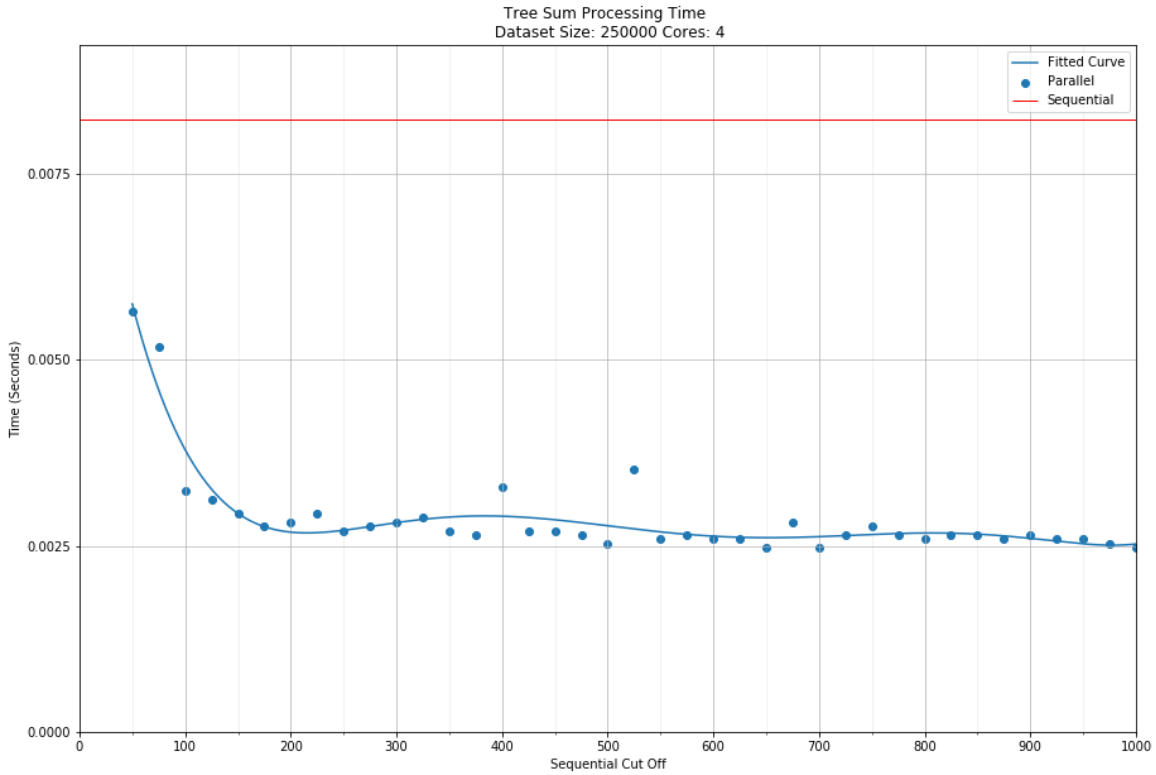
In [105]:

```
y = [0.030411763,
0.018529411,
0.020647056,
0.0144705875,
0.013999999,
0.015941178,
0.014411764,
0.014352941,
0.014294118,
0.014058823,
0.013294117,
0.013882352,
0.0132941175,
0.014411764,
0.014764705,
0.022470586,
0.013058821,
0.0149411755,
0.014294117,
0.0139999995,
0.013529411,
0.014470588,
0.014647059,
0.013235293,
0.013764704,
0.014352941,
0.014411765,
0.014235294,
0.014647058,
0.014588235,
0.012882351,
0.013647057,
0.013823529,
0.01382353,
0.013941176,
0.0139999995,
0.014117647,
0.013705881,
0.014117647]
sequential = 0.033529416
resPlot(x,y,sequential,"1000000","2")
```


Tree Sum Processing Time
Dataset Size: 1000000 Cores: 2
Fitted Curve
Parallel
Sequential
Time (Seconds)
Sequential Cut Off
0.0000
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200
0.0225
0.0250
0.0275
0.0300
0.0325
0
100
200
300
400
500
600
700
800
900
1000

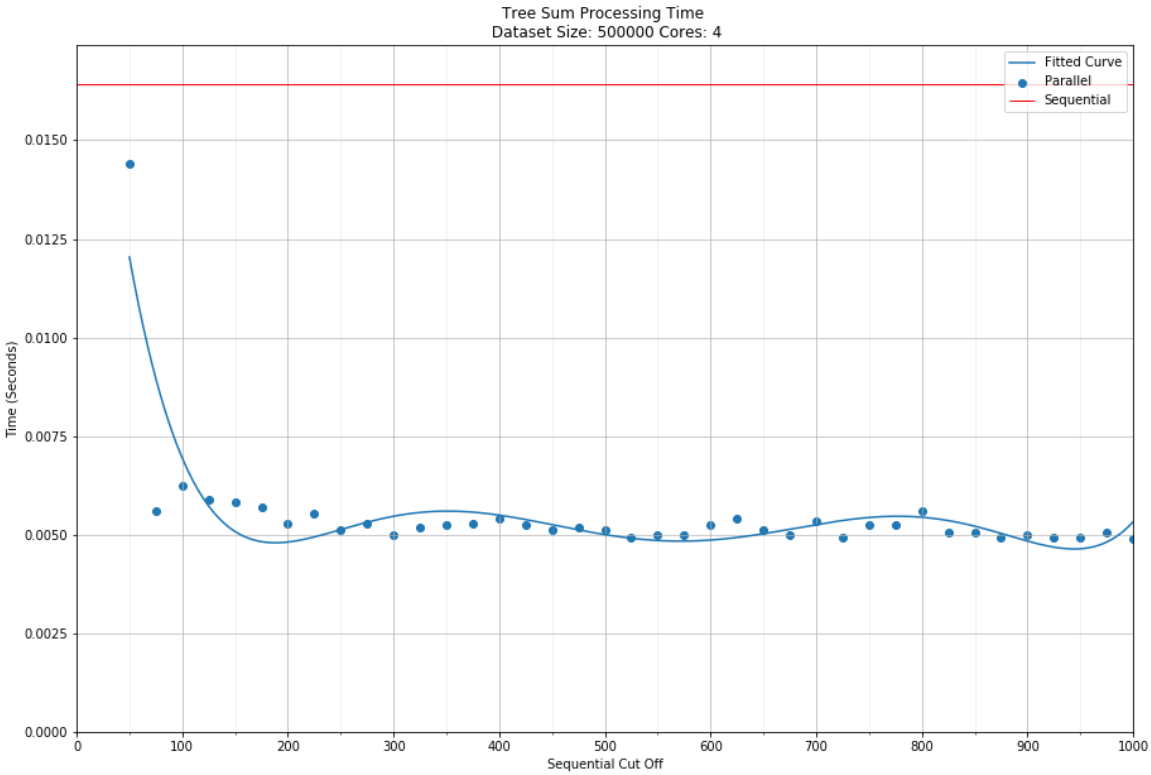
In [106]:

```
y = [0.005647059,
0.0051764706,
0.003235294,
0.003117647,
0.0029411763,
0.0027647058,
0.0028235293,
0.002941176,
0.0027058823,
0.0027647058,
0.0028235293,
0.0028823526,
0.0027058823,
0.0026470588,
0.0032941173,
0.002705882,
0.0027058823,
0.0026470588,
0.0025294118,
0.0035294117,
0.0025882353,
0.0026470588,
0.0025882353,
0.0025882353,
0.0024705883,
0.0028235293,
0.0024705883,
0.0026470588,
0.0027647058,
0.0026470588,
0.0025882353,
0.0026470588,
0.0026470588,
0.0025882353,
0.0026470588,
0.0025882353,
0.0025882353,
0.0025294118,
0.0024705883]
sequential = 0.008235295
resPlot(x,y,sequential,"250000","4")
```


Tree Sum Processing Time
Dataset Size: 250000 Cores: 4
Fitted Curve
Parallel
Sequential
Time (Seconds)
0.0000
0.0025
0.0050
0.0075
0
100
200
300
400
500
600
700
800
900
1000
Sequential Cut Off

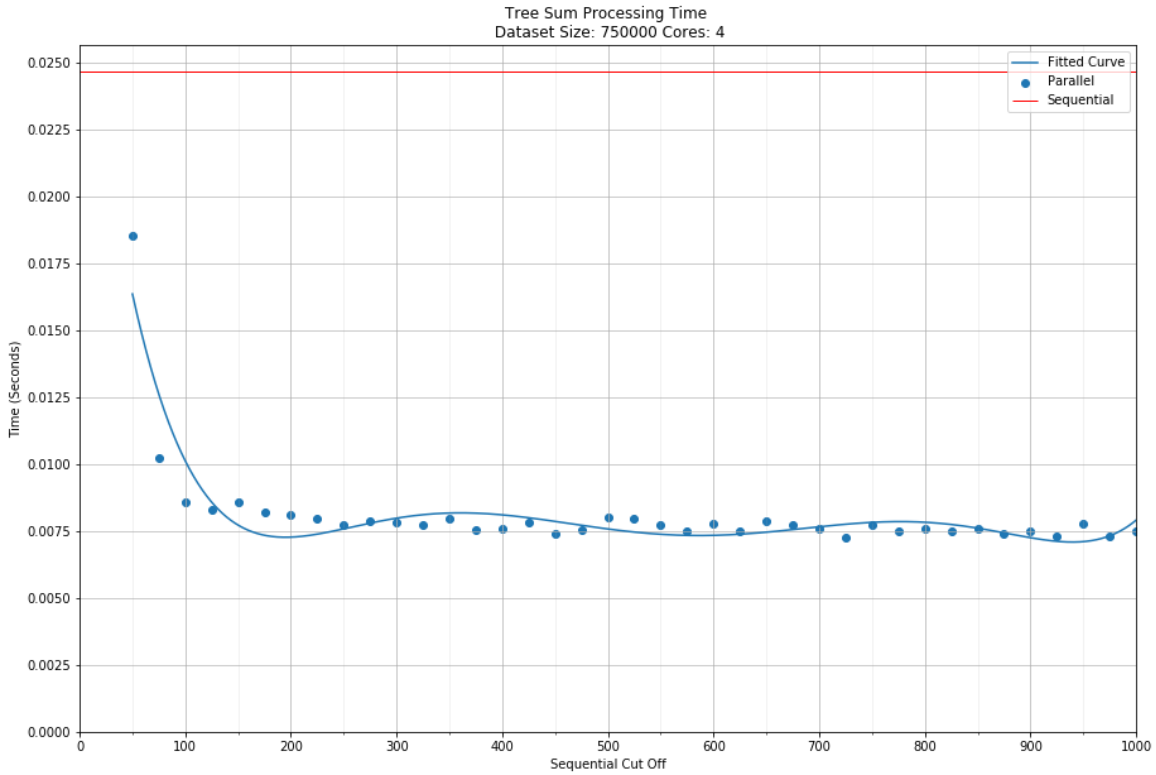
In [107]:

```
y = [0.014411765,
0.005588236,
0.006235294,
0.0058823526,
0.00582353,
0.0057058823,
0.005294118,
0.005529412,
0.0051176473,
0.005294118,
0.0050000004,
0.0051764697,
0.005235294,
0.005294118,
0.0054117646,
0.0052352943,
0.0051176473,
0.0051764706,
0.005117648,
0.0049411766,
0.0049999994,
0.0049999994,
0.005235294,
0.0054117646,
0.0051176473,
0.005,
0.005352941,
0.0049411766,
0.005235295,
0.005235294,
0.005588236,
0.0050588236,
0.005058824,
0.0049411766,
0.005,
0.0049411766,
0.0049411766,
0.0050588236,
0.004882354]
sequential = 0.016411766
resPlot(x,y,sequential,"500000","4")
```


Tree Sum Processing Time
Dataset Size: 500000 Cores: 4
Fitted Curve
Parallel
Sequential
Time (Seconds)
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
0
100
200
300
400
500
600
700
800
900
1000
Sequential Cut Off

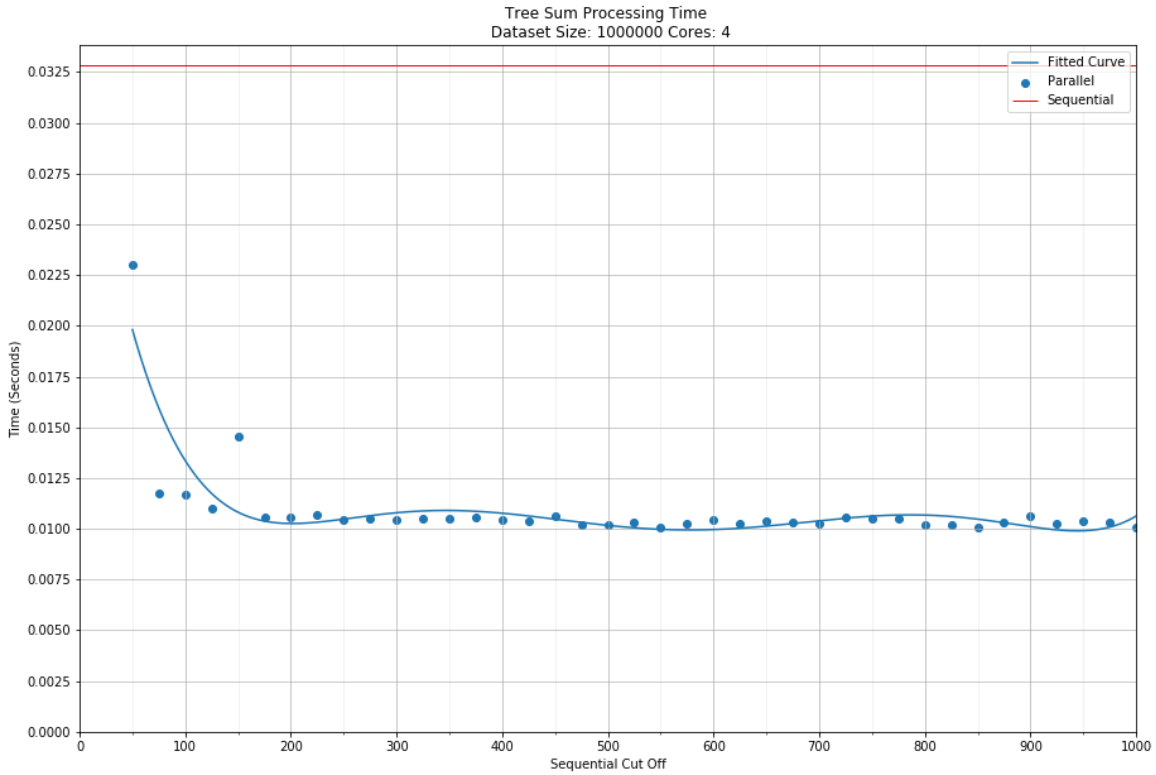
In [108]:

```
y = [0.018529415,
0.010235295,
0.008588236,
0.008294118,
0.008588235,
0.008176471,
0.008117648,
0.007941177,
0.007705882,
0.007882353,
0.00782353,
0.007705883,
0.007941177,
0.007529412,
0.0075882357,
0.00782353,
0.007411765,
0.007529412,
0.008,
0.007941177,
0.007705882,
0.0074705887,
0.007764706,
0.0074705887,
0.007882354,
0.007705882,
0.0075882347,
0.0072352937,
0.007705883,
0.0074705887,
0.0075882357,
0.0074705887,
0.0075882357,
0.007411765,
0.0074705887,
0.0072941175,
0.007764707,
0.0072941175,
0.0074705877]
sequential = 0.024647059
resPlot(x,y,sequential,"750000","4")
```


Tree Sum Processing Time
Dataset Size: 750000 Cores: 4
Fitted Curve
Parallel
Sequential
Time (Seconds)
Sequential Cut Off
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
0
100
200
300
400
500
600
700
800
900
1000

In [109]:

```
y = [0.023000002,
0.011764707,
0.011705883,
0.011,
0.014529411,
0.010588235,
0.010588237,
0.010705883,
0.010470589,
0.010529411,
0.010411765,
0.010529411,
0.010529412,
0.010588236,
0.0104117645,
0.010352941,
0.010647059,
0.010176471,
0.0101764705,
0.010294118,
0.010058825,
0.010235296,
0.010470589,
0.010235295,
0.010352941,
0.010294117,
0.010235294,
0.010588236,
0.010529412,
0.010529411,
0.010176471,
0.0101764705,
0.010058825,
0.010294117,
0.010647059,
0.010235295,
0.010352943,
0.010294118,
0.010058824]
sequential = 0.03282353
resPlot(x,y,sequential,"1000000","4")
```


Tree Sum Processing Time
Dataset Size: 1000000 Cores: 4
Fitted Curve
Parallel
Sequential
Time (Seconds)
Sequential Cut Off
0.0000
0.0025
0.0050
0.0075
0.0100
0.0125
0.0150
0.0175
0.0200
0.0225
0.0250
0.0275
0.0300
0.0325
0
100
200
300
400
500
600
700
800
900
1000