

Analysis of Lu' s radioactive source data. Data set consists of 2001 time stamped waveforms recorded at 145 GSa/s.

```
In[581]:= SetDirectory["~white/Desktop/4mm^2"];
Clear [offfront]; Clear [offback];
Clear [time1]; Clear [back1]; Clear [front1];
Drop[FileNames[], 1] // Length;
ntrace = %

Out[585]= 1805

In[586]:= Namelist = Drop[FileNames[], 1];
Namelist[[1]]

Out[587]= T00001.csv

In[588]:= time = Transpose[Import[Namelist[[1]], "Data"]][[1]];
Dimensions[time];
half = % / 2

Out[590]= {7993}

In[591]:= front = Transpose[Import[Namelist[[1]], "Data"]][[2]];
offset = Mean[Take[front, 7693]]

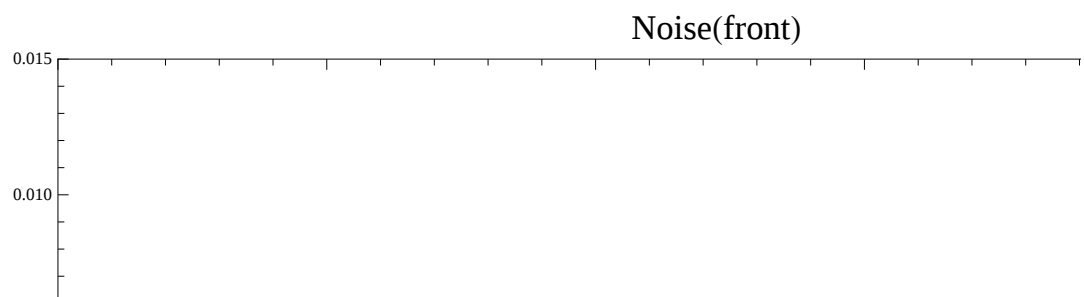
Out[592]= -0.000421501
```

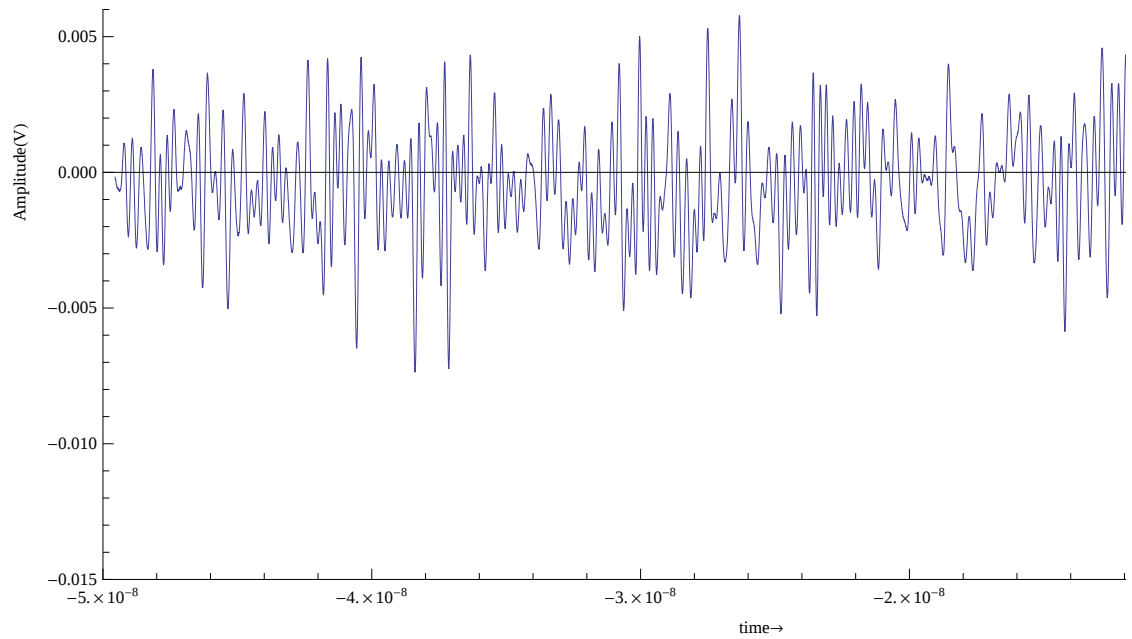
Front and Back are the 2 APDs which face each other. Front is closest to the CO⁶⁰ source.

The first 49 nanoseconds are used to extract the baseline correction which is typically ~1 mV.

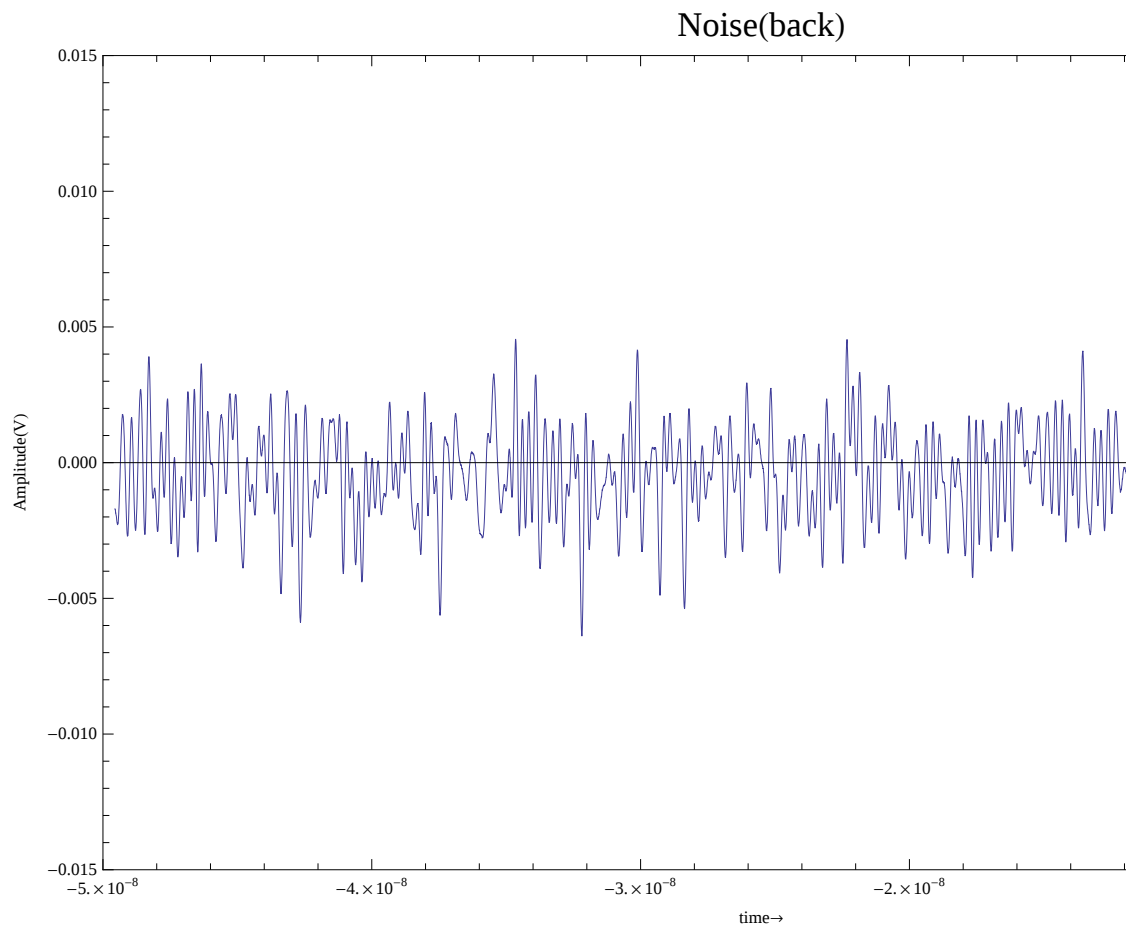
```
In[593]:= offfront = ConstantArray[offset, 15986];
front1 = Take[front - offfront, 7693];
time1 = Take[time, 7693];
back = Transpose[Import[Namelist[[1]], "Data"]][[3]];
offset = Mean[Take[back, 7693]]
offback = ConstantArray[offset, 15986];
back1 = Take[back - offback, 7693];
GraphicsColumn[{ListPlot[Transpose[{time, front}], Joined → True, Frame → True,
  FrameLabel → {"Amplitude(V)", {"time→", "Noise (front)"}},
  PlotRange → {{-0.00000005, -0.00000001}, {-0.015, 0.015}}],
  ListPlot[Transpose[{time, back}], Joined → True, Frame → True,
  FrameLabel → {"Amplitude(V)", {"time→", "Noise (back)"}},
  PlotRange → {{-0.00000005, -0.00000001}, {-0.015, 0.015}}]}}
```

```
Out[597]= -0.000401331
```





Out[600]=



```
In[601]:= dt = time[[2]] - time[[1]] // EngineeringForm
f = 1 / (time[[2]] - time[[1]]);
fftrange = f / 2
```

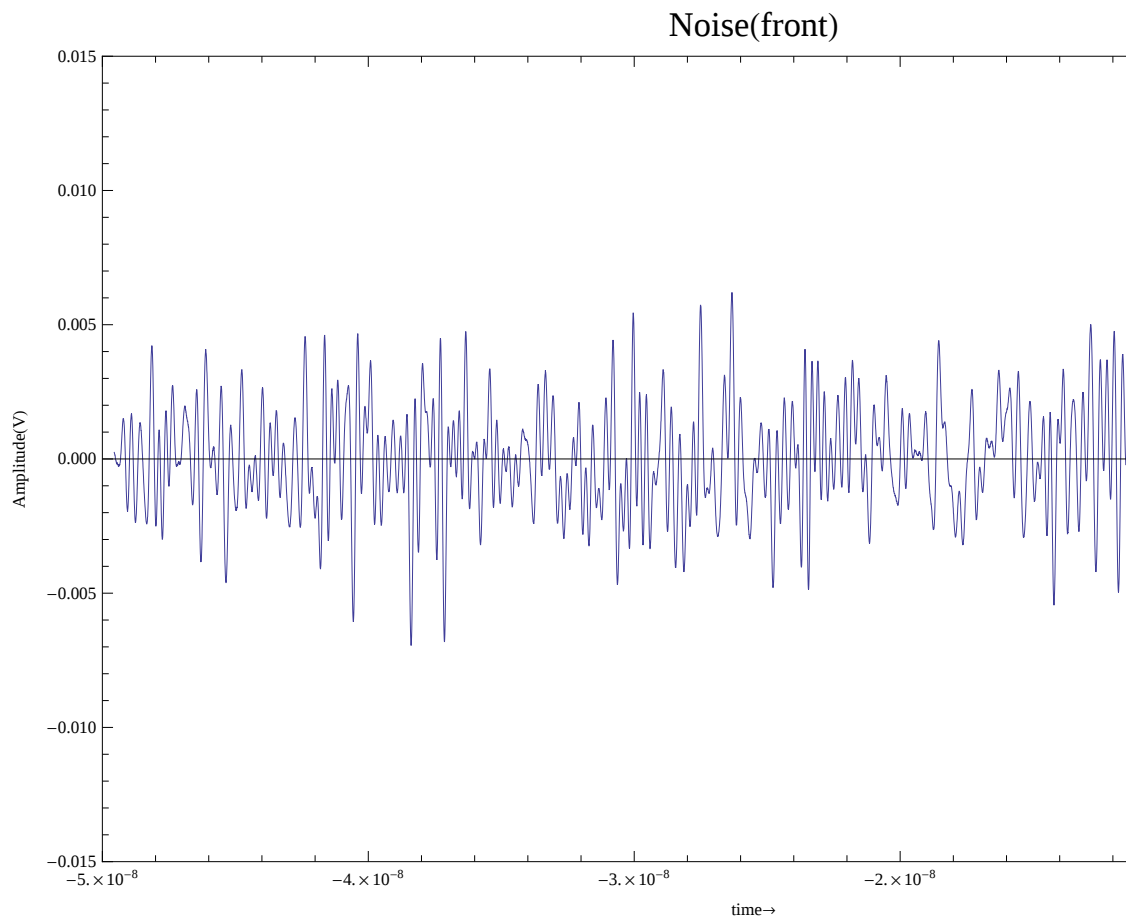
Out[601]//EngineeringForm=

$$6.2 \times 10^{-12}$$

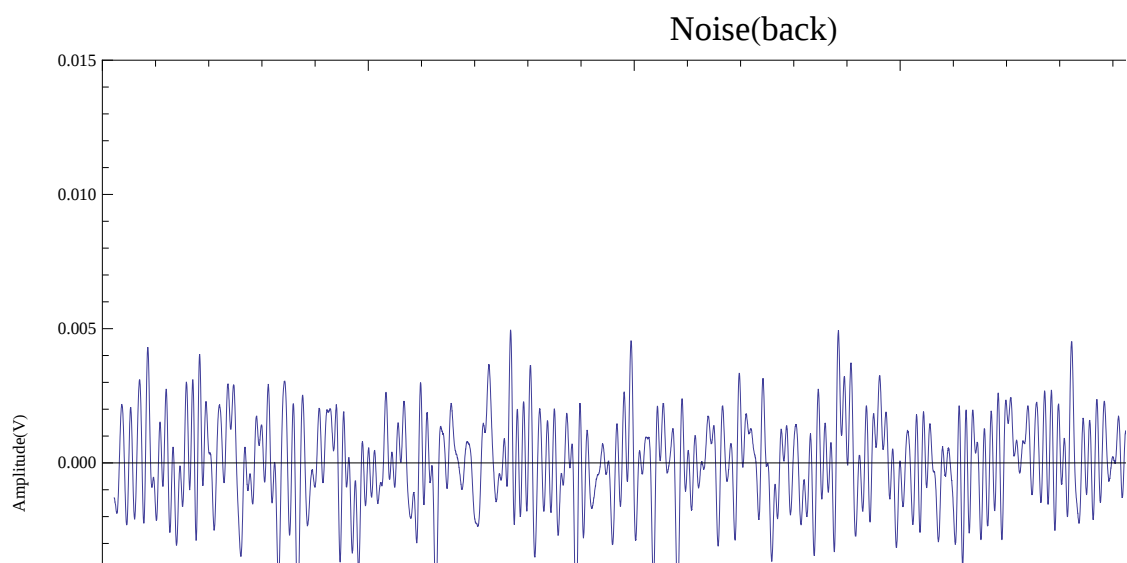
Out[603]= 8.06452×10^{10}

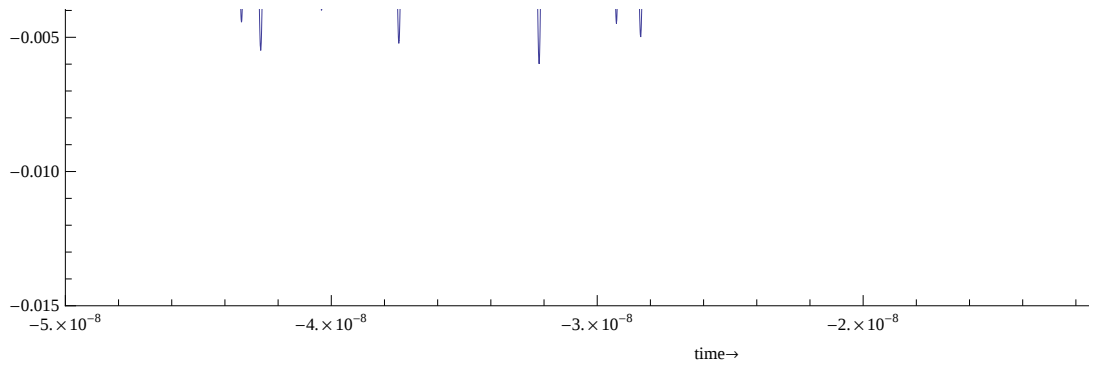
In[604]:=

```
GraphicsColumn[ {ListPlot[Transpose[{time1, front1}], Joined → True, Frame → True,
  FrameLabel → {"Amplitude(V)", {"time→", "Noise (front)"}},
  PlotRange → {{-0.00000005, -0.00000001}, {-0.015, 0.015}},
ListPlot[Transpose[{time1, back1}], Joined → True, Frame → True,
  FrameLabel → {"Amplitude(V)", {"time→", "Noise (back)"}},
  PlotRange → {{-0.00000005, -0.00000001}, {-0.015, 0.015}}]}
```



Out[604]=



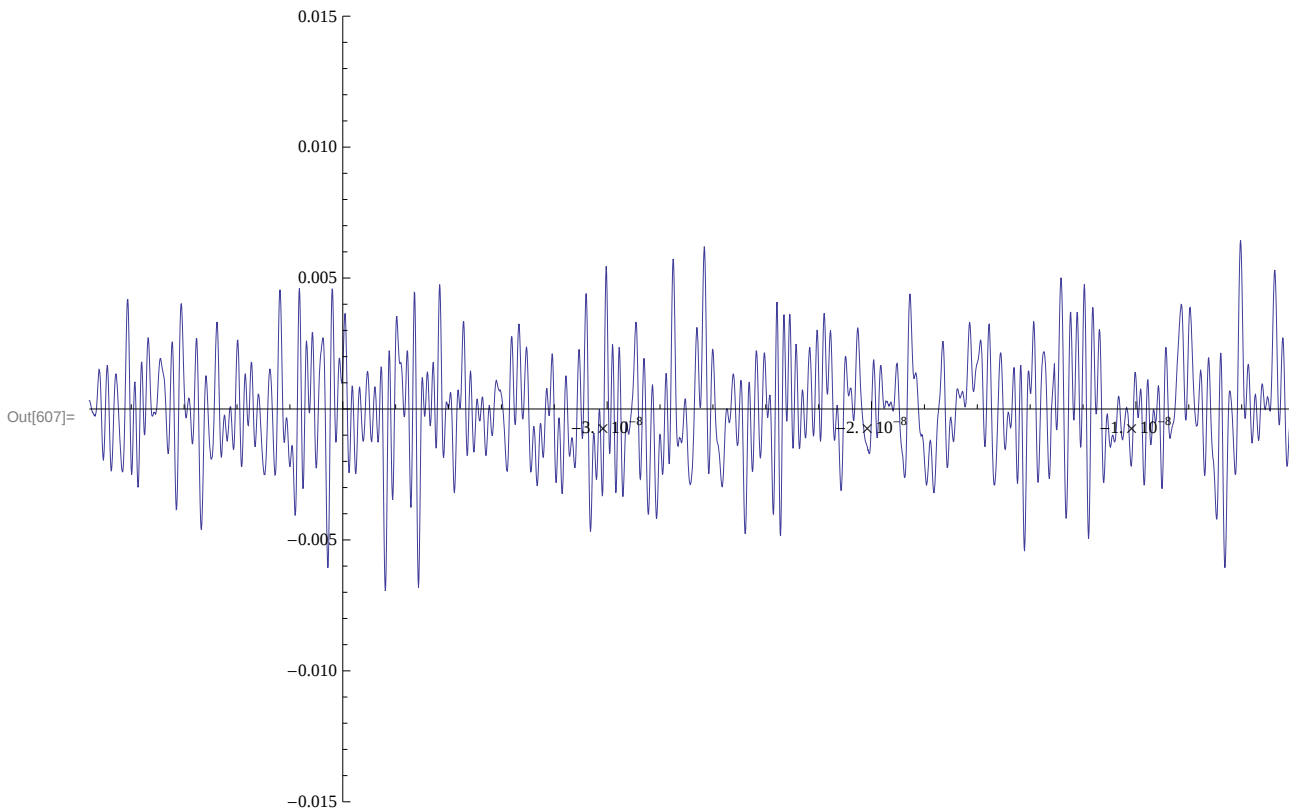


Noise Waveform as a function for later use

```
In[605]:= Ff = Interpolation[Transpose[{time1, front1}], Method -> "Spline"]
Fb = Interpolation[Transpose[{time1, back1}], Method -> "Spline"]
Plot[Ff[x], {x, -4.9586 x 10^-8, -1.5117 x 10^-9},
  PlotRange -> {{-4.9586 x 10^-8, -1.5117 x 10^-9}, {- .015, .015}}]
```

```
Out[605]= InterpolatingFunction[{{-4.95526 x 10^-8, -1.4776 x 10^-9}}, <>]
```

```
Out[606]= InterpolatingFunction[{{-4.95526 x 10^-8, -1.4776 x 10^-9}}, <>]
```

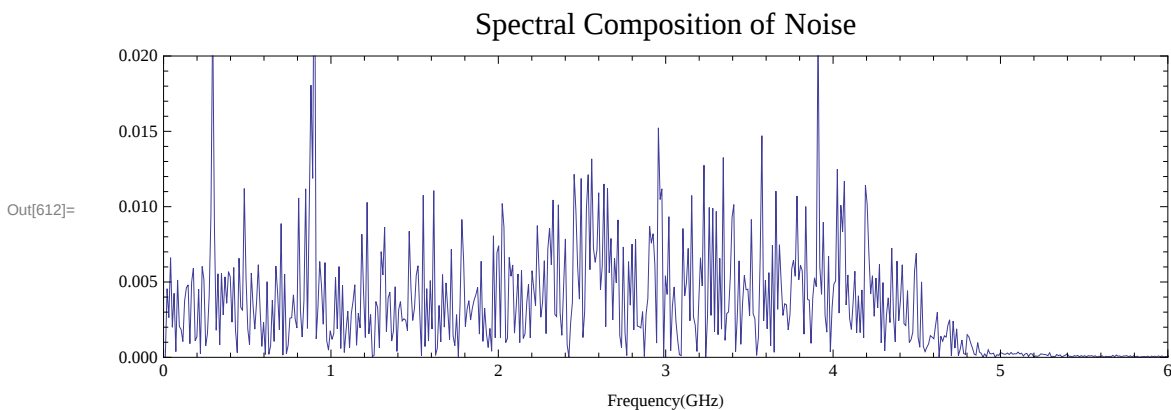


```
In[608]:= fftout1 = Abs[FourierDCT[front1]];
df = fftrange / 7693;
In[610]:= freq = Range[df, fftrange, df] / 1 000 000 000.;
In[611]:= fftnew = Transpose[{freq, fftout1}];
```

For this scope the Sampling frequency is much higher than the actual bandwidth. Therefore in the plots below there is a

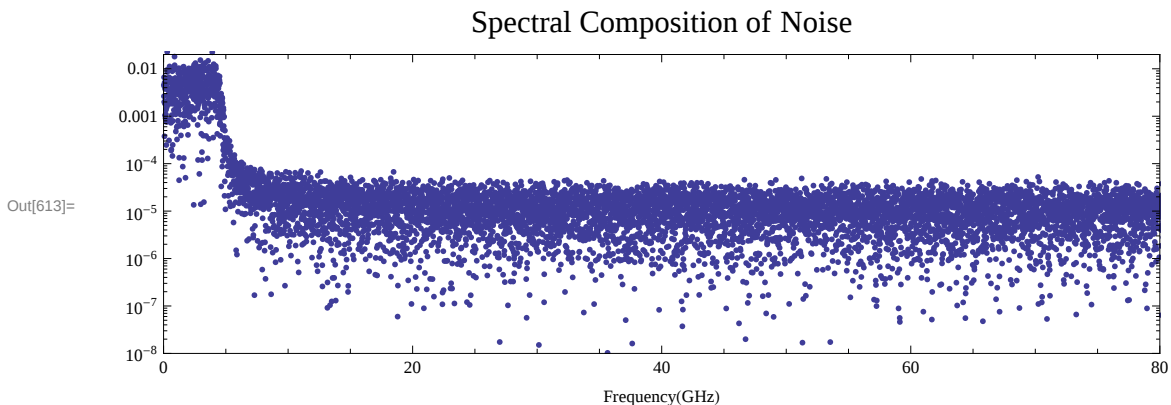
white noise distribution out to a few GHz. Above this (the scope bandwidth) there is an apparent reduction in noise. But in this region data are really reflecting the fact that high sampling frequency is really a figment of 'on - chip ' interpolation.

```
ListPlot[fftnew, Joined → True, AspectRatio → 0.3, ImageSize → Large, Frame → True,
FrameLabel → {{}, {"Frequency(GHz)", "Spectral Composition of Noise"}},
PlotRange → {{0, 6}, {0, .02}}]
```



This has zero frequency in element 1. The 7693- th element corresponds to 1/2 the sampling frequency. After that aliasing takes over and the frequency heads back to zero.

```
In[613]:= ListLogPlot[fftnew, AspectRatio → 0.3, Frame → True,
FrameLabel → {{}, {"Frequency(GHz)", "Spectral Composition of Noise"}},
ImageSize → Large, PlotRange → {{0, 80}, {10-8, .02}}]
```



```
In[614]:= ListPlot[{Transpose[{time, front - offfront}], Transpose[{time, back - offback}]],  
  Joined → True, PlotStyle → Thick, PlotRange → {{-10-9, .3 × 10-8}, {- .25, .25}}]
```

