WOLFRAM MATHEMATICA 13.0 aer

setup

overhead

tag

```
In[•]:= home = "topics/aer/truth/";
        Get["utility modules.m", Path → dirPack];
        stamp1;
```

CreateDirectory: /Users/dtopa/Mathematica_files/io/ already exists.

CreateDirectory: /Users/dtopa/Dropbox/_mm/io/topics/ already exists.

CreateDirectory: /Users/dtopa/Dropbox/_mm/io/topics/aer/ already exists.

General: Further output of CreateDirectory::eexist will be suppressed during this calculation.

```
maximum memory: 0.0868023 GB
seed file: /Users/dtopa/Mathematica_files/nb/seed 22_01.nb
user: dtopa, CPU: ehecoatl,  MM v. 13.0.0 for Mac OS X x86
date: Feb 9, 2022, time: 23:07:31
nb: /Users/dtopa/Mathematica_files/nb/topics/aer/truth/truth-datasets-02.nb
```

modules, functions, settings, ...

1 point

strings

```
In[•]:= dirHeatMaps = "/Volumes/Tlaloc/spacktivity/REPT Data/";
        fileNameLeft = "rbspa_rel03_ect-rept-sci-L3_";
        fileNameRight = ".cdf";
```

specific days

```
In[•]:= days = {"20170207_v5.1.0", "20170425_v5.5.0",
           "20170620_v5.3.0", "20170917_v5.3.0", "20171214_v5.3.0"};
```

2 pick one

In[•]:=
```
myFile = dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight
```

Out[•]=
```
/Volumes/Tlaloc/spacktivity/REPT
  Data/rbspa_rel03_ect-rept-sci-L3_20170207_v5.1.0.cdf
```

3 data sets

In[•]:=
```
dataSetNames = Import[dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight]
m = Length[%]
```

Out[•]=
```
{Epoch, Epoch_prot, FEDU_Alpha_DELTA, FEDU_Alpha, FEDU_0to180_Alpha,
 FEDU_180to360_Alpha, FPDU_Alpha, FPDU_0to180_Alpha, FPDU_180to360_Alpha,
 FEDU_Unbinned_Sector_Angle, FEDU_Unbinned_Alpha_DELTA, FEDU_Unbinned_Alpha,
 FEDU_Unbinned_Alpha360, FPDU_Unbinned_Sector_Angle, FPDU_Unbinned_Alpha_DELTA,
 FPDU_Unbinned_Alpha, FPDU_Unbinned_Alpha360, FEDU_Energy, FEDU_Energy_DELTA_minus,
 FEDU_Energy_DELTA_plus, FEDU_PA_LABL, FEDU_PA_0TO180_LABL, FEDU_PA_180TO360_LABL,
 FEDU_ENERGY_LABL, FEDU, FPDU_PA_LABL, FPDU_PA_0TO180_LABL, FPDU_PA_180TO360_LABL,
 FPDU_ENERGY_LABL, FPDU, FPDU_Energy, FEDU_0to180, FEDU_180to360,
 FPDU_0to180, FPDU_180to360, FEDU_Unbinned_0to180, FEDU_Unbinned_0to360,
 FPDU_Unbinned_0to180, FPDU_Unbinned_0to360, FPDU_Unbinned_LightMask_0to360,
 FPDU_Unbinned_Light_Flag, L_star, L, I, B_Calc, B_Eq, MLT, MLAT, Position}
```

Out[•]=
```
49
```

utilities

analysis sequences

```
In[ ]:= Clear[crunch]
        crunch[a_List] := Module[{μ, σ, mx, mn},
            μ = Mean[a];
            σ = StandardDeviation[a];
            mx = Max[a];
            mn = Min[a];
            Print[Mean[a] // N, " = mean"];
            Print[StandardDeviation[a] // N, " = standard deviation"];
            Print[Max[a], " = maximum"];
            Print[Min[a], " = minimum"];
            Print[mx - mn, " = variation"];
            Print["First 5 elements = ", Take[a, 5]];
            Print["Last 5 elements = ", Take[a, -5]];
          ];
```

```
In[ ]:= Clear[write]
        write[a_List, stem_String] := Module[{μ, σ, mx, mn, fstream},
            μ = Mean[a];
            σ = StandardDeviation[a];
            mx = Max[a];
            mn = Min[a];
            fname = dirData <> stem <> ".txt";
            fstream = OpenWrite[dirData <> stem <> ".txt", PageWidth → ∞];
            Write[fstream, "user: ", user, ", CPU: ", CPU, ",  MM v. ", mmv];
            Write[fstream, "date: ", date, ", time: ", time];
            Write[fstream, "nb: ", dirHome, nb];
            Write[fstream, ""];
            Write[fstream, Mean[a] // N, " = mean"];
            Write[fstream, StandardDeviation[a] // N, " = standard deviation"];
            Write[fstream, Max[a], " = maximum"];
            Write[fstream, Min[a], " = minimum"];
            Write[fstream, mx - mn, " = variation"];
            Write[fstream, ""];
            Write[fstream, "First 5 elements = ", Take[a, 5]];
            Write[fstream, "Last 5 elements = ", Take[a, -5]];
            Close[fstream];
            edit[fname];
          ];
```

epochs ==> hours

```
In[•]:= ticks = Join[{0}, Table[
            {8034/24 k, k}
            , {k, 2, 24, 2}]];
```

time

```
In[•]:= a = Import[dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight,
            {"Datasets", {"Epoch"}}];
        Dimensions[%]
Out[•]=
        {8034, 6}

In[•]:= b = Import[dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight,
            {"Datasets", {"Epoch_prot"}}];
        Dimensions[%]
Out[•]=
        {8034, 6}

In[•]:= Norm[a - b, 2]
Out[•]=
        0.

In[•]:= Take[a, 2]
Out[•]=
        {{2017, 2, 7, 0, 0, 6.164}, {2017, 2, 7, 0, 0, 16.916}}

In[•]:= Take[a, -1]
Out[•]=
        {{2017, 2, 7, 23, 59, 38.576}}
```

experiment

```
In[•]:= asec = (#[[4]] 3600 + #[[5]] 60 + #[[6]]) & /@ a;
        ListPlot[asec];
```

MLT

MLT

```
In[•]:= set = "MLT";
```

```
In[ ]:= seq = Import[
          dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight, {"Datasets", {set}}];
        Print["size of ", set, " = ", Dimensions[%]]
        size of MLT = {8034}
```

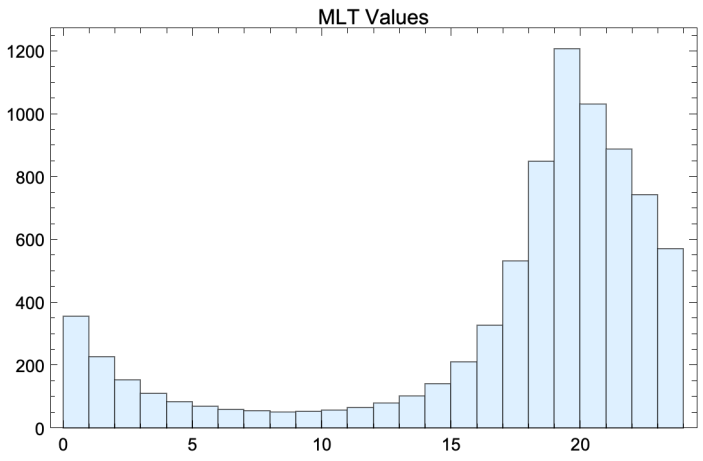
crunch

```
In[ ]:= crunch[seq]
        17.093 = mean
        6.51976 = standard deviation
        23.9988 = maximum
        0.000130694 = minimum
        23.9987 = variation
        First 5 elements = {22.5527, 22.557, 22.5613, 22.5656, 22.5699}
        Last 5 elements = {20.1263, 20.1284, 20.1306, 20.1328, 20.1349}
```

plot

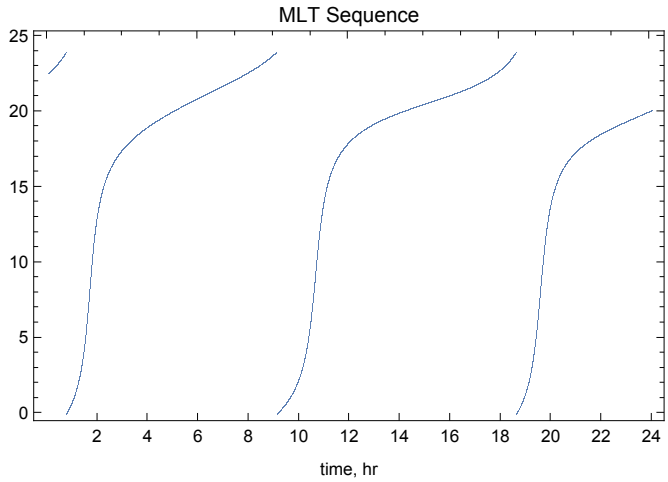
```
In[ ]:= ghistogram = Histogram[seq,
          PlotLabel → set <> " Values",
          ChartStyle → LightBlue,
          Frame → True]
```

Out[ ]=



```
In[•]:= glistplot = ListPlot[seq,
          PlotLabel → set <> " Sequence",
          FrameLabel → {"time, hr", ""},
          FrameTicks → {{Automatic, Automatic}, {ticks, Automatic}},
          Frame → True]
```

Out[•]=



export

```
In[•]:= write[seq, set];
```

```
In[•]:= multiExport["rept-histogram" <> set, ghistogram];
        multiExport["rept-listplot" <> set, glistplot]
```

```
In[•]:= edit[fname]
```

```
Removing quotes from /Users/dtopa/Mathematica_files/io/topics/aer/truth/data/MLT.txt
```

```
In[•]:= fname
```

Out[•]=

```
/Users/dtopa/Mathematica_files/io/topics/aer/truth/data/MLT.txt
```

MLAT

MLAT

```
In[•]:= set = "MLAT";
```

```
In[•]:= seq = Import[
            dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight, {"Datasets", {set}}];
        Print["size of ", set, " = ", Dimensions[%]]
```

```
size of MLAT = {8034}
```

crunch

In[•]:=
```
crunch[seq]
```

-4.97884×10^{27} = mean

2.23091×10^{29} = standard deviation

17.5959 = maximum

$-1. \times 10^{31}$ = minimum

$1. \times 10^{31}$ = variation

First 5 elements = {-3.87152, -3.88083, -3.89017, -3.89953, -3.90891}

Last 5 elements = $\{5.33184, -1. \times 10^{31}, -1. \times 10^{31}, -1. \times 10^{31}, -1. \times 10^{31}\}$

In[•]:=
```
num = 0;
seq = If[Abs[#] > 1000, 0; num++, #] & /@ seq;
crunch[seq]
```

-2.37115 = mean

9.5003 = standard deviation

17.5959 = maximum

-20.6178 = minimum

38.2137 = variation

First 5 elements = {-3.87152, -3.88083, -3.89017, -3.89953, -3.90891}

Last 5 elements = {5.33184, 0, 1, 2, 3}

In[•]:=
```
num
```

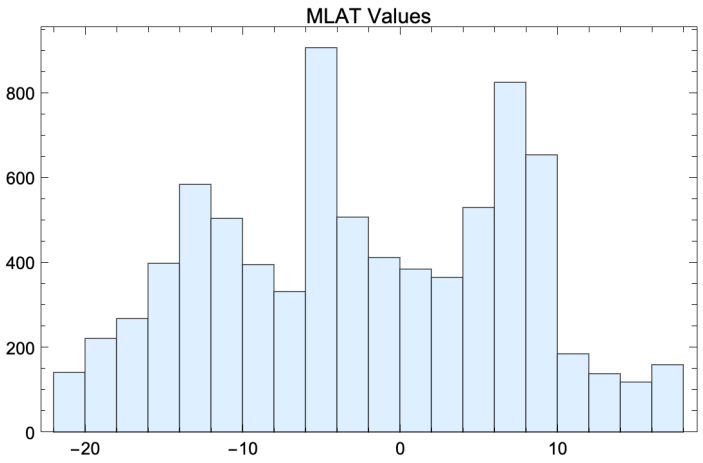
Out[•]=

4

plot

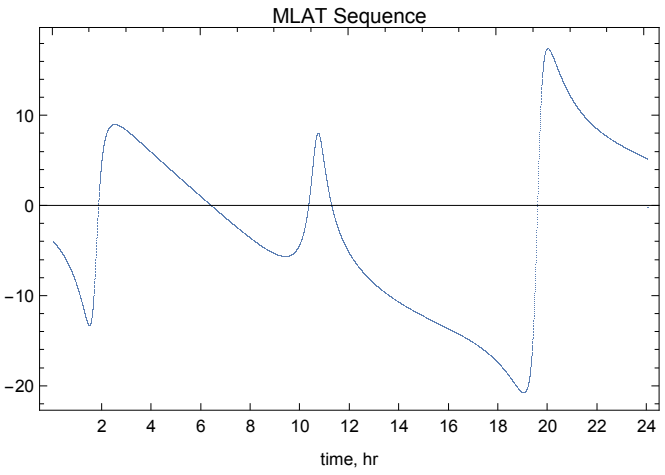
In[•]:=
```
ghistogram = Histogram[seq,
  PlotLabel → set <> " Values",
  ChartStyle → LightBlue,
  Frame → True]
```

Out[•]=



In[•]:=
```
glistplot = ListPlot[seq,
  PlotLabel → set <> " Sequence",
  FrameLabel → {"time, hr", ""},
  FrameTicks → {{Automatic, Automatic}, {ticks, Automatic}},
  Frame → True]
```

Out[•]=



export

In[•]:=
```
write[seq, set];
```

```
multiExport["rept-histogram" <> set, ghistogram];
multiExport["rept-listplot" <> set, glistplot]
```

position

position

```
set = "Position";
```

```
seq = Import[
    dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight, {"Datasets", {set}}];
Print["size of ", set, " = ", Dimensions[%]]
```

```
size of Position = {8034, 3}
```

```
{x, y, z} = seq^T;
```

crunch

```
crunch[x]
```

```
-2413.59 = mean
16 300.1 = standard deviation
25 907.8 = maximum
-28 432.6 = minimum
54 340.4 = variation
First 5 elements = {24 994.9, 24 970.5, 24 946.2, 24 921.9, 24 897.5}
Last 5 elements = {24 871.4, 24 864.8, 24 858.1, 24 851.5, 24 844.9}
```

```
crunch[y]
```

```
-65.0266 = mean
22 385.9 = standard deviation
36 718. = maximum
-27 098.9 = minimum
63 816.8 = variation
First 5 elements = {-4221.51, -4208.52, -4195.53, -4182.53, -4169.54}
Last 5 elements = {-27 073.6, -27 080., -27 086.3, -27 092.6, -27 098.9}
```

```
crunch[z]
```

```
-959.661 = mean

1956.22 = standard deviation

2062.14 = maximum

-3632.51 = minimum

5694.65 = variation

First 5 elements = {-3563.93, -3563.13, -3562.33, -3561.53, -3560.73}

Last 5 elements = {-1929.34, -1932.6, -1935.85, -1939.1, -1942.35}
```

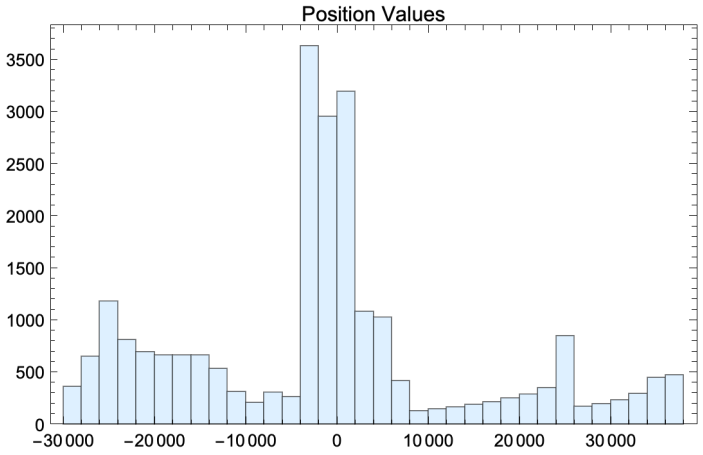
In[•]:=
```
crunch[Flatten[seq]]
```

```
-1146.09 = mean

16 056.1 = standard deviation

36 718. = maximum

-28 432.6 = minimum

65 150.6 = variation

First 5 elements = {24 994.9, -4221.51, -3563.93, 24 970.5, -4208.52}

Last 5 elements = {-27 092.6, -1939.1, 24 844.9, -27 098.9, -1942.35}
```

plot

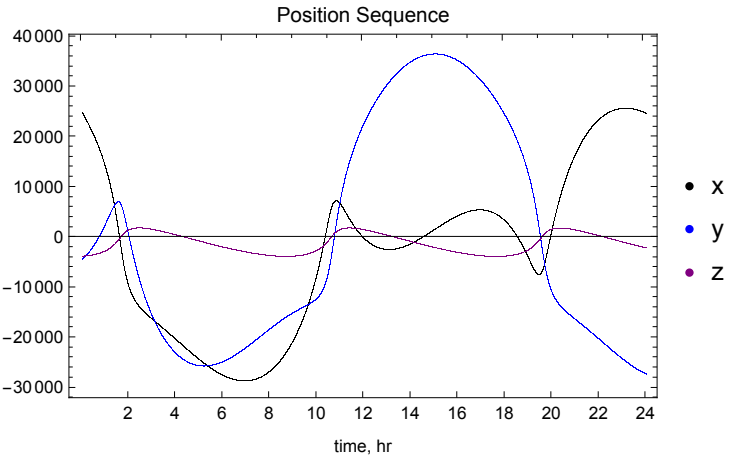
In[•]:=
```
ghistogram = Histogram[Flatten[seq],
  PlotLabel → set <> " Values",
  ChartStyle → LightBlue,
  Frame → True]
```

Out[•]=



```
In[•]:= glistplotcomponents = ListPlot[{x, y, z},
          PlotStyle → {Black, Blue, Purple},
          PlotLabel → set <> " Sequence",
          PlotLegends → {"x", "y", "z"},
          FrameLabel → {"time, hr", ""},
          FrameTicks → {{Automatic, Automatic}, {ticks, Automatic}},
          Frame → True]
```

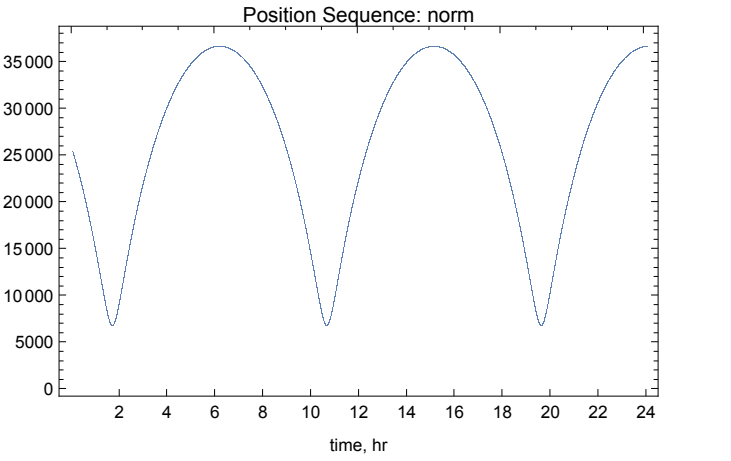
Out[•]=




```
In[•]:= nrms = Norm[#, 2] & /@ seq;
```

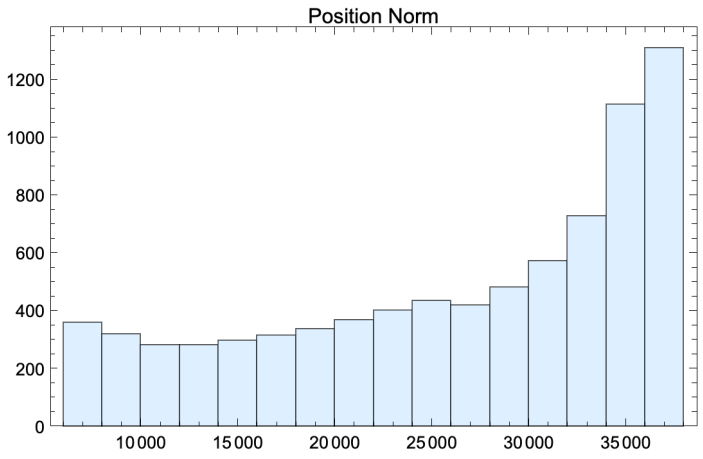
```
In[•]:= glistplotnorm = ListPlot[nrms,
          PlotLabel → set <> " Sequence: norm",
          FrameLabel → {"time, hr", ""},
          FrameTicks → {{Automatic, Automatic}, {ticks, Automatic}},
          Frame → True]
```

Out[•]=



```
In[•]:= ghistogramnorm = Histogram[nrms,
          PlotLabel → set <> " Norm",
          ChartStyle → LightBlue,
          Frame → True]
```

Out[•]=



export

```
In[•]:= write[x, set <> "- x"];
        write[y, set <> "- y"];
        write[z, set <> "- z"];

In[•]:= write[nrms, set <> "- norms"];

In[•]:= multiExport["rept-histogram" <> set, ghistogram];
        multiExport["rept-listplot" <> set <> "-components", glistplotcomponents];
        multiExport["rept-listplot" <> set <> "-norm", glistplotnorm];

In[•]:= multiExport["rept-histogram-norm" <> set, ghistogramnorm];
```

---

electromagnetics: L, L*

L*

```
In[•]:= set = "L_star";

In[•]:= seq = Import[dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight,
            {"Datasets", {"L_star"}}];
        Print["size of ", set, " = ", Dimensions[%]]
        size of L_star = {8034}
```

L

```
In[•]:= set = "L";

In[•]:= seq = Import[dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight,
            {"Datasets", {"L_star"}}];
        Print["size of ", set, " = ", Dimensions[%]];
        num = 0;
        seq = If[Abs[#] > 1000, 0; num++, #] & /@ seq;
        Print["kickouts: ", num];
        crunch[seq]
        size of L = {8034}
        kickouts: 235
        7.47971 = mean
        22.3112 = standard deviation
        234 = maximum
        0 = minimum
        234 = variation
        First 5 elements = {4.07835, 4.07466, 4.07098, 4.0673, 4.06361}
        Last 5 elements = {5.63695, 5.63709, 5.63722, 5.63735, 5.63748}
```

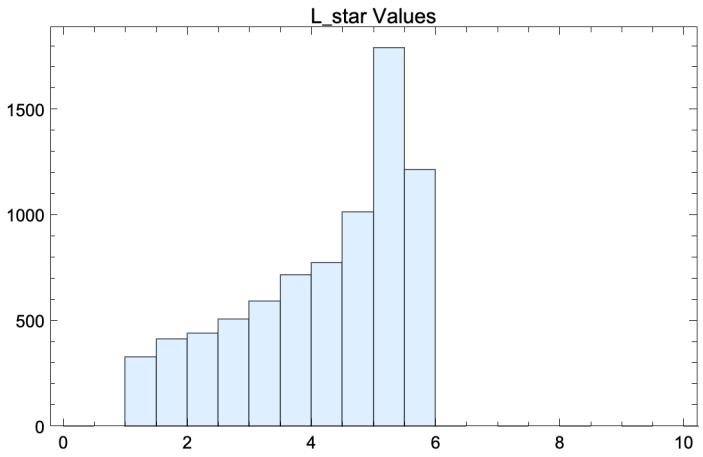
crunch

```
In[•]:= num = 0;
        seq = If[Abs[#] > 1000, 0; num++, #] & /@ seq;
        num
Out[•]=
        235

In[•]:= crunch[seq]
        7.47971 = mean
        22.3112 = standard deviation
        234 = maximum
        0 = minimum
        234 = variation
        First 5 elements = {4.07835, 4.07466, 4.07098, 4.0673, 4.06361}
        Last 5 elements = {5.63695, 5.63709, 5.63722, 5.63735, 5.63748}
```

plot

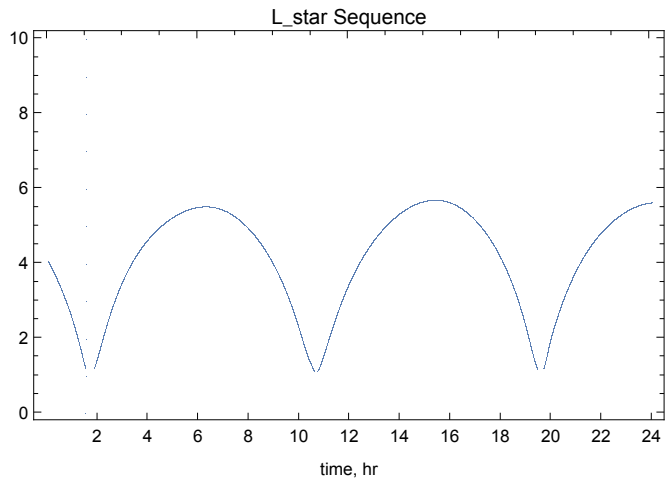
In[ ]:=
```
ghistogram = Histogram[seq,
  PlotLabel → set <> " Values",
  ChartStyle → LightBlue,
  Frame → True]
```

Out[ ]=



In[ ]:=
```
glistplot = ListPlot[seq,
  PlotLabel → set <> " Sequence",
  FrameLabel → {"time, hr", ""},
  FrameTicks → {{Automatic, Automatic}, {ticks, Automatic}},
  Frame → True]
```

Out[ ]=



combine

```
In[•]:= Lstar = Import[dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight,
            {"Datasets", {"L_star"}}];
        L = Import[
            dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight, {"Datasets", {"L"}}];
```

```
In[•]:= crunch[L]
```

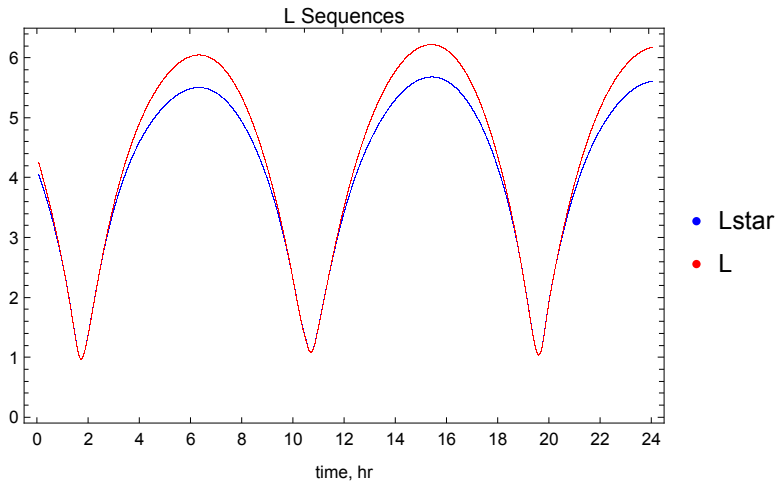
```
4.35728 = mean

1.60025 = standard deviation

6.24782 = maximum

0.998371 = minimum

5.24945 = variation

First 5 elements = {4.27847, 4.27401, 4.26954, 4.26508, 4.26062}

Last 5 elements = {6.20179, 6.202, 6.2022, 6.2024, 6.2026}
```

```
In[•]:= num = 0;
        Lstar = If[Abs[#] > 1000, 0; num++, #] & /@ Lstar;
        Print["kickouts: ", num];
        crunch[Lstar]
```

```
kickouts: 235

7.47971 = mean

22.3112 = standard deviation

234 = maximum

0 = minimum

234 = variation

First 5 elements = {4.07835, 4.07466, 4.07098, 4.0673, 4.06361}

Last 5 elements = {5.63695, 5.63709, 5.63722, 5.63735, 5.63748}
```

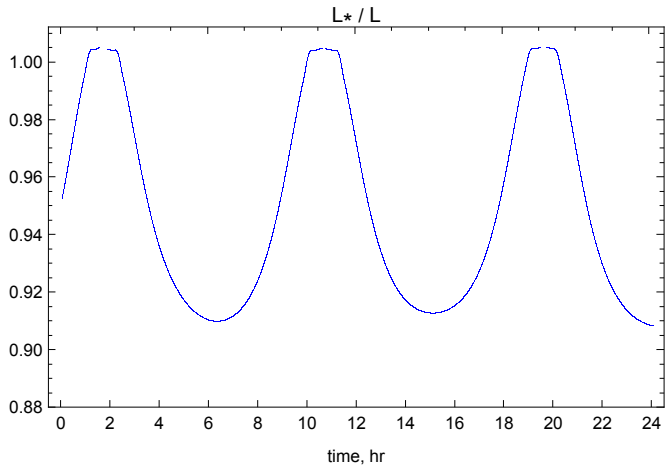
In[ ]:=
```
glistplotLsL = ListPlot[{Lstar, L},
  PlotStyle → {Blue, Red},
  PlotLabel → set <> " Sequences",
  PlotLegends → {"Lstar", "L"},
  PlotRange → {Automatic, {-0.1, 6.5}},
  FrameLabel → {"time, hr", ""},
  FrameTicks → {{Automatic, Automatic}, {ticks, Automatic}},
  Frame → True]
```

Out[ ]=



In[ ]:=
```
glistplotLratio = ListPlot[Lstar / L,
  PlotLabel → "L* / L",
  PlotStyle → Blue,
  PlotRange → {Automatic, {0.88, Automatic}},
  FrameLabel → {"time, hr", ""},
  FrameTicks → {{Automatic, Automatic}, {ticks, Automatic}},
  Frame → True]
```

Out[ ]=



```
In[•]:= crunch[Lstar/L]
```

-2.6879×10^{29} = mean

1.55039×10^{30} = standard deviation

1.00566 = maximum

-1.00163×10^{31} = minimum

1.00163×10^{31} = variation

First 5 elements = {0.953226, 0.953359, 0.953493, 0.953627, 0.953761}

Last 5 elements = {0.908923, 0.908916, 0.908907, 0.908898, 0.908889}

export

```
In[•]:= multiExport["rept-compare-L", glistplotLsL];
```

```
In[•]:= multiExport["rept-ratio-L", glistplotLratio];
```

B

```
In[•]:= Bcalc = Import[dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight,
          {"Datasets", {"B_Calc"}}];
        Beq = Import[
          dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight, {"Datasets", {"B_Eq"}}];
```

```
In[•]:= crunch[Bcalc]
```

2274.07 = mean

5174.43 = standard deviation

31 104.5 = maximum

130.577 = minimum

30 973.9 = variation

First 5 elements = {401.268, 402.607, 403.945, 405.284, 406.622}

Last 5 elements = {130.66, 130.639, 130.618, 130.598, 130.577}

```
In[•]:= crunch[Beq]
```

2003.42 = mean

4787.46 = standard deviation

30 086.9 = maximum

111.625 = minimum

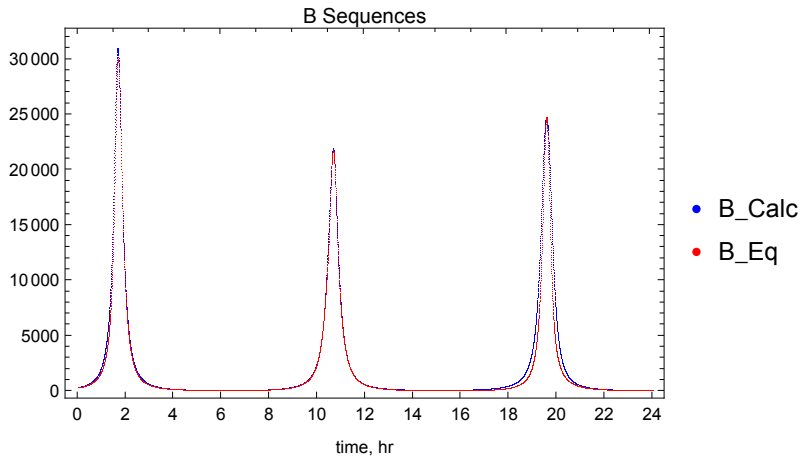
29 975.3 = variation

First 5 elements = {378.508, 379.701, 380.893, 382.086, 383.279}

Last 5 elements = {123.655, 123.644, 123.633, 123.623, 123.612}

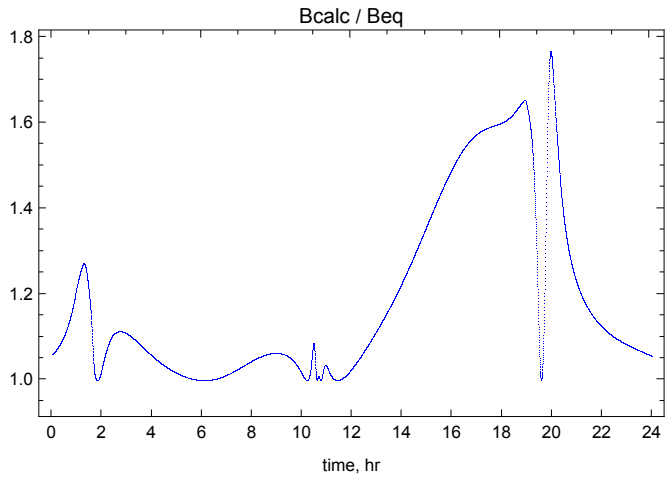
In[•]:=
```
glistplotBB = ListPlot[{Bcalc, Beq},
  PlotStyle → {Blue, Red},
  PlotLabel → "B Sequences",
  PlotLegends → {"B_Calc", "B_Eq"},
  PlotRange → {Automatic, Full},
  FrameLabel → {"time, hr", ""},
  FrameTicks → {{Automatic, Automatic}, {ticks, Automatic}},
  Frame → True]
```

Out[•]=



In[•]:=
```
glistplotBratio = ListPlot[Bcalc / Beq,
  PlotStyle → {Blue},
  PlotLabel → "Bcalc / Beq",
  PlotRange → {Automatic, Full},
  FrameLabel → {"time, hr", ""},
  FrameTicks → {{Automatic, Automatic}, {ticks, Automatic}},
  Frame → True]
```

Out[•]=



export

```
In[•]:= multiExport["rept-compare-B", glistplotBB];
```

```
In[•]:= multiExport["rept-ratio-B", glistplotBratio];
```

I

I

```
In[•]:= set = "I";
```

```
In[•]:= seq = Import[
            dirHeatMaps <> fileNameLeft <> days[[1]] <> fileNameRight, {"Datasets", {set}}];
        Print["size of ", set, " = ", Dimensions[%]]
```

```
size of I = {8034}
```

crunch

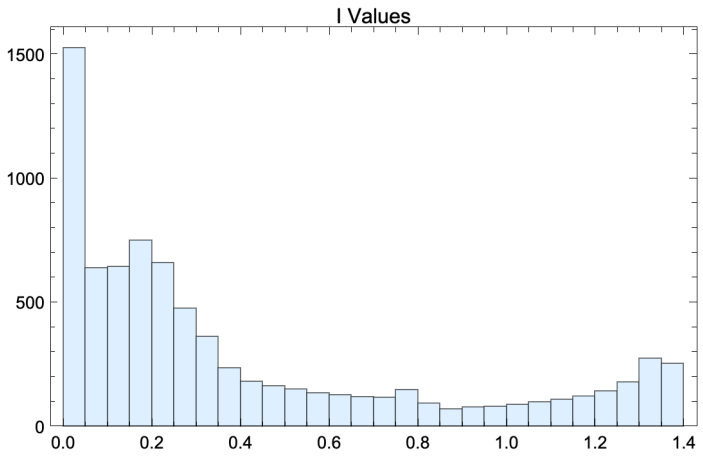
```
In[•]:= crunch[seq]
```

```
0.411424 = mean

0.427008 = standard deviation

1.36534 = maximum

1.45262 × 10^-6 = minimum

1.36534 = variation

First 5 elements = {0.151743, 0.152131, 0.152518, 0.152905, 0.153293}

Last 5 elements = {0.1822, 0.181935, 0.181671, 0.181406, 0.181141}
```

plot

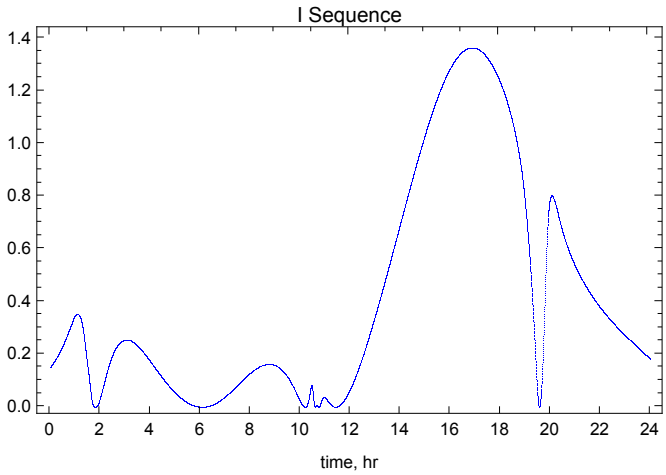
In[ ]:=
```
ghistogram = Histogram[seq,
  PlotLabel → set <> " Values",
  ChartStyle → LightBlue,
  Frame → True]
```

Out[ ]=



In[ ]:=
```
glistplot = ListPlot[seq,
  PlotLabel → set <> " Sequence",
  PlotStyle → Blue,
  FrameLabel → {"time, hr", ""},
  FrameTicks → {{Automatic, Automatic}, {ticks, Automatic}},
  Frame → True]
```

Out[ ]=



export

In[ ]:=
```
write[seq, set];
```

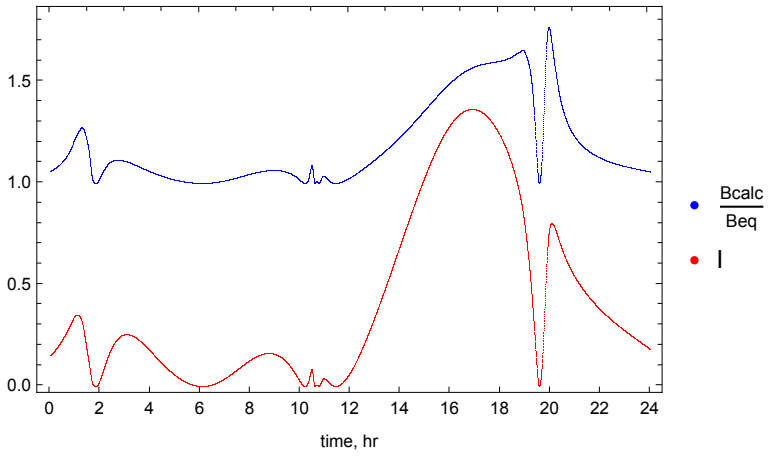
```
Removing quotes from /Users/dtopa/Mathematica_files/io/topics/aer/truth/data/I.txt
```

```
In[•]:= multiExport["rept-histogram-" <> set, ghistogram];
        multiExport["rept-listplot-" <> set, glistplot]
```

compare I, B

```
In[•]:= glistplotIB = ListPlot[{Bcalc/Beq, seq},
          PlotStyle → {Blue, Red},
          PlotLegends → {"Bcalc/Beq", "I"},
          PlotRange → {Automatic, Full},
          FrameLabel → {"time, hr", ""},
          FrameTicks → {{Automatic, Automatic}, {ticks, Automatic}},
          Frame → True]
```

Out[•]=



export

```
In[•]:= multiExport["rept-I-B", glistplotIB]
```

end