■ Processing APMP Round-Robin Data

Reprocessing of raw data from both trips of APMP GPS Intercomparison, following visit of a BIPM receiver with a calibrated internal delay to NML in September 2002.

```
Needs["Graphics`Graphics`"];
Needs["Statistics`LinearRegression`"];
Off[General::spell1];
SetOptions[ListPlot, Frame → True, Axes → False, PlotRange → Automatic];

rootPath = "c:\\documents and settings\\war354\\desktop\\gps_calibration\\";
outFile1 = "c:\\documents and settings\\war354\\desktop\\apmp_results.dat";
outFile2 = "c:\\documents and settings\\war354\\desktop\\apmp_delays.dat";
doSave = False;
```

■ Definitions

■ Read data file

```
ReadCCTF[name_] := Module[
   {filename, infile, str, flag = False, data = {}, format = Table[Number, {i, 18}]},
   filename = StringJoin[dataPath, name]; infile = OpenRead[filename];
   format[[2]] = format[[18]] = Word;
   While[True,
    If[(str = Read[infile, String]) == EndOfFile, Break[]];
    instr = StringToStream[str];
    AppendTo[data, Flatten[ReadList[instr, format]]];
    Close[instr];
   ];
   Close[infile];
   Print["> Read ", Length[data], " tracks from ", filename];
   Return[data];
  ];

ReadCCTFAustron[name_] := Module[
   {filename, infile, str, flag = False, data = {}, format = Table[Number, {i, 14}]},
   filename = StringJoin[dataPath, name]; infile = OpenRead[filename];
   format[[2]] = format[[6]] = Word;
   While[True,
    If[(str = Read[infile, String]) == EndOfFile, Break[]];
    instr = StringToStream[str];
    AppendTo[data, Flatten[ReadList[instr, format]]];
    Close[instr];
   ];
   Close[infile];
   Print["> Read ", Length[data], " tracks from ", filename];
   Return[data];
  ];
```

```
ReadCCTFBIPM[name_] := Module[
   {filename, infile, str, flag = False, data = {}, format = Table[Number, {i, 19}]},
   filename = StringJoin[dataPath, name]; infile = OpenRead[filename];
   format[[2]] = format[[18]] = Word;
   While[True,
    If[(str = Read[infile, String]) == EndOfFile, Break[]];
    instr = StringToStream[str];
    AppendTo[data, Flatten[ReadList[instr, format]]];
    Close[instr];
   ];
   Close[infile];
   Print["> Read ", Length[data], " tracks from ", filename];
   Return[data];
  ];
```

■ Select data columns

```
SV[list_] := list[[1]];
TrackMJD[list_] := list[[3]];
TrackTime[list_] := list[[4]];
TrackLength[list_] := list[[5]];
Elevation[list_] := list[[6]];
Azimuth[list_] := list[[7]];
RefSV[list_] := list[[8]] / 10;
SlopeSV[list_] := list[[9]];
RefGPS[list_] := list[[10]] / 10;
RefGPSAustron[list_] := list[[12]] / 10;
DSG[list_] := list[[12]] / 10;
SlopeGPS[list_] := list[[11]];
RefSV2[list_] := list[[26]] / 10;
RefGPS2[list_] := list[[28]] / 10;
DSG2[list_] := list[[30]] / 10;
TrackLength2[list_] := list[[23]];
```

■ Sort data (into time order then SV order)

```
OrderCCTF[a_, b_] :=
  If[a[[3]] == b[[3]], If[a[[4]] == b[[4]], First[a] < First[b], a[[4]] < b[[4]]], a[[3]] < b[[3]]];

SortCCTF[data_] := Sort[data, OrderCCTF[#1, #2] &];
```

■ Merge two CCTF data sets on matching tracks

```
MergeCCTF[data1_, data2_] := Module[{d1, d2, i, j, data = {}},
   d1 = SortCCTF[data1];
   d2 = SortCCTF[data2];
   j = 1;
   For[i = 1, i ≤ Length[d1], i++,
    While[(j <= Length[d2]) &&
      ((d2[[j, 3]] < d1[[i, 3]]) ||
        ((d2[[j, 3]] == d1[[i, 3]]) &&
          ((d2[[j, 4]] < d1[[i, 4]]) ||
            ((d2[[j, 4]] == d1[[i, 4]]) &&
              (d2[[j, 1]] < d1[[i, 1]])))))),
     j++];
    If[(j ≤ Length[d2]) &&
      (d2[[j, 3]] == d1[[i, 3]]) && (d2[[j, 4]] == d1[[i, 4]]) && (d2[[j, 1]] == d1[[i, 1]]),
     AppendTo[data, Flatten[{d1[[i]], d2[[j]]}]]];
   ];
   Print["> First ", Length[d1], " tracks, second ",
    Length[d2], " tracks, matching ", Length[data], " tracks"];
   Return[data];
  ];
```

■ Miscellaneous

```
TimeValue[list_] := Module[{val, h, m, s},
   val = TrackTime[list];
   h = Quotient[val, 10000];
   m = Quotient[Mod[val, 10000], 100];
   s = Mod[val, 100];
   Return[3600 h + 60 m + s];
  ];

MakeXY[list1_, list2_] := Module[{i, l1, l2},
   l1 = list1;
   l2 = list2;
   Return[Table[{l1[[i]], l2[[i]]}, {i, Length[l1]}]];
  ];

FilterTrackLength[list_, threshold_] := Module[{i, j = 0, outdata = {}},
   For[i = 1, i ≤ Length[list], i++,
    If[(list[[i, 3]] >= threshold) && (list[[i, 4]] ≥ threshold),
         j++; AppendTo[outdata, {list[[i, 1]], list[[i, 2]]}]]];
   Print[j, " common tracks out of ", Length[list],
    " were of length greater than or equal to ", threshold, " seconds."];
   Return[outdata];
  ];

DateValue[list_] := TrackMJD[list] + TimeValue[list] / 86400;
```

■ Compare (equal weighting)

```
Compare[dataHost_, dataTrav_] :=
  Module[{dMerge, diffdataGPS, regress, rtable, ptable},
   dMerge = MergeCCTF[dataHost, dataTrav]; diffdataGPS =
    Map[{DateValue[#1], RefSV[#1] - RefSV2[#1] - HostCorrection + TravCorrection,
       TrackLength[#1], TrackLength2[#1]} &, dMerge];
   diffdataGPS = FilterTrackLength[diffdataGPS, 780];
   regress = Regress[diffdataGPS, {1, x}, x];
   rtable = ANOVATable /. regress;
   ptable = ParameterTable /. regress;
   MJDFirst = DateValue[First[dMerge]];
   MJDLast = DateValue[Last[dMerge]];
   MJDMiddle = (MJDFirst + MJDLast) / 2;
   intercept = ptable[[1, 1, 1]];
   SEintercept = ptable[[1, 1, 2]];
   slope = ptable[[1, 2, 1]];
   SEslope = ptable[[1, 2, 2]];
   rms = Sqrt[rtable[[1, 2, 3]]];
   MeanOffset = intercept + slope * MJDMiddle;
   nTracks = Length[diffdataGPS];
   Print[nTracks, " of ", Length[dMerge],
    " common-view tracks were analysed between MJD ", NumberForm[
     MJDFirst // N, {6, 1}], " and MJD ", NumberForm[MJDLast // N, {6, 1}]]; Print[
    "The mean offset (Host Rx - Travelling Rx) between the two receivers was ",
    MeanOffset, " ns, with an RMS deviation of ", rms, "  ns."];
   Print["The slope of the line of best fit was ", slope * 1000,
    " ps/day, with a standard error of ", SEslope * 1000, " ps/day."];
   DisplayTogether[
    ListPlot[diffdataGPS, PlotRange → All],
    ListPlot[{{MJDFirst, MeanOffset}, {MJDLast, MeanOffset}}, PlotJoined → True],
    ListPlot[{{MJDMiddle, Min[#[[2]] & /@ diffdataGPS]},
      {MJDMiddle, Max[#[[2]] & /@ diffdataGPS]}}, PlotJoined → True],
    Plot[intercept + slope x, {x, MJDFirst, MJDLast}, PlotStyle → Hue[0]]
   ];
  ];
```

■ CompareWeighted (weight by DSG^{-2})

```
CompareWeighted[dataHost_, dataTrav_] :=
  Module[{dMerge, diffdataGPS, regress, rtable, ptable, threshold = 780},
   dMerge = Select[MergeCCTF[dataHost, dataTrav], DSG[#] > 0 &];
   Print[Length[dMerge], " tracks after select non-zero DSG"];
   diffdataGPS =
    Select[dMerge, TrackLength[#] ≥ threshold && TrackLength2[#] ≥ threshold &];
   Print[Length[diffdataGPS], " common tracks out of ", Length[dMerge],
    " had a length greater than or equal to ", threshold, "s"];
   dsg = Sqrt[DSG[#]^2 + DSG2[#]^2] & /@ diffdataGPS;
   weights = #^-2 & /@ dsg;
   diffdataGPS = {DateValue[#],
       RefSV[#] - RefSV2[#] - HostCorrection + TravCorrection} & /@ diffdataGPS;
   MJDFirst = diffdataGPS[[1, 1]];
   MJDLast = diffdataGPS[[-1, 1]];
   MJDMiddle = (MJDFirst + MJDLast) / 2;
   (* Unweighted linear fit *)
   simple = Regress[diffdataGPS, {1, x}, x, Weights → Automatic];
   rtable = ANOVATable /. simple;
   srms = Sqrt[rtable[[1, 2, 3]]];
   ptable = ParameterTable /. simple;
   intercept = ptable[[1, 1, 1]];
   slope = ptable[[1, 2, 1]];
   simple = intercept + slope * MJDMiddle;
   (* Weighted linear fit *)
   regress = Regress[diffdataGPS, {1, x}, x, Weights → weights];
   ptable = ParameterTable /. regress;
   intercept = ptable[[1, 1, 1]];
   SEintercept = ptable[[1, 1, 2]];
   slope = ptable[[1, 2, 1]];
   SEslope = ptable[[1, 2, 2]];
   rtable = ANOVATable /. regress;
   rms = Sqrt[rtable[[1, 2, 3]]];
   MeanOffset = intercept + slope * MJDMiddle;
   nTracks = Length[diffdataGPS];
   Print[nTracks, " of ", Length[dMerge],
    " common-view tracks were analysed between MJD ",
    NumberForm[MJDFirst // N, {6, 1}], " and MJD ", NumberForm[MJDLast // N, {6, 1}]];
   Print["The mean offset (Host Rx - Travelling Rx) between the
      two receivers was ", MeanOffset, " ns (weighted) or ", simple,
    " ns (unweighted), with an unweighted RMS deviation of ", srms, "  ns."];
   Print["The slope of the line of best fit was ", slope * 1000,
    " ps/day, with a standard error of ", SEslope * 1000, " ps/day."];
   DisplayTogether[
    ListPlot[diffdataGPS, PlotRange → All],
    ListPlot[{{MJDFirst, MeanOffset}, {MJDLast, MeanOffset}}, PlotJoined → True],
    ListPlot[{{MJDMiddle, Min[#[[2]] & /@ diffdataGPS]},
      {MJDMiddle, Max[#[[2]] & /@ diffdataGPS]}}, PlotJoined → True],
    Plot[intercept + slope x, {x, MJDFirst, MJDLast}, PlotStyle → Hue[0]],
    FrameLabel → {"MJD", "Offset [ns]"}
   ];
   Show[GraphicsArray[{
```

```
      ListPlot[dsg, PlotRange → All,
       FrameLabel → {"", "", "DSG", ""}, DisplayFunction → Identity],
      ListPlot[weights, PlotRange → All, FrameLabel → {"", "", "Weight", ""},
       DisplayFunction → Identity]
     }, DisplayFunction → $DisplayFunction]];
  ];
```

■ Save output

```
SaveOutput[nmi_] := Module[{},
   If[! TrueQ[doSave], Return[]];
   PutAppend[{nmi, RepHostIntDly, RepHostIntDly + MeanOffset, RepTravIntDly,
     RepTravIntDly - MeanOffset, MeanOffset, simple, rms, srms, slope 10^3,
     SEslope 10^3, nTracks, N[MJDFirst], N[MJDLast], N[MJDMiddle]}, outFile1];
   PutAppend[{nmi, RepHostIntDly, RepHostRefDly, RepHostAntDly,
     RxHostIntDly, RxHostRefDly, RxHostAntDly, RepTravIntDly, RepTravRefDly,
     RepTravAntDly, RxTravIntDly, RxTravRefDly, RxTravAntDly}, outFile2];
  ];
```

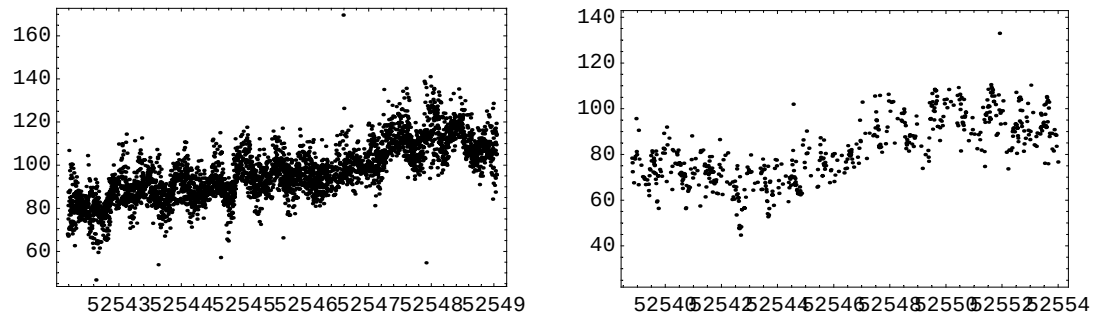
■ BIPM Calibration at NML (calibration of S/N 446)

```
dataPath = "c:\\documents and settings\\war354\\desktop\\bipm_calibration\\";
```

```
dataHost = ReadCCTF["ttr6.cctf"];
(*Host  reported values:*)
RepHostIntDly = 53.5;
  RepHostRefDly = 79.1;
 RepHostAntDly = 235;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 68;
  RxHostRefDly = 79;
 RxHostAntDly = 235;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTFBIPM["bipm.cctf"];
(*Host  reported values:*)
RepTravIntDly = -19.36;
  RepTravRefDly = 24.76;
 RepTravAntDly = 184.34;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = -19.36;
  RxTravRefDly = 24.76;
 RxTravAntDly = 184.34;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
```

```
> Read 584 tracks from c:\documents and settings\war354\desktop\bipm_calibration\ttr6.cctf

> Read 3736 tracks from c:\documents and settings\war354\desktop\bipm_calibration\bipm.cctf
```

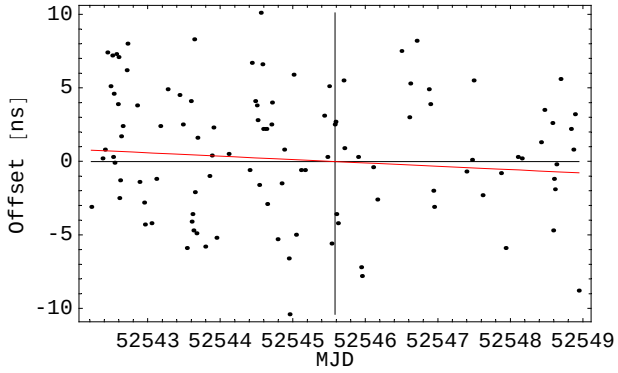
```
Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```

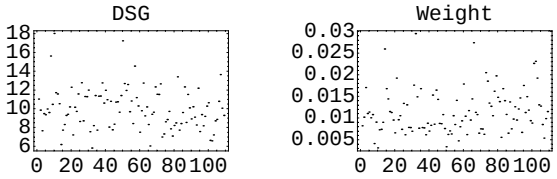



```
- GraphicsArray -
```

CompareWeighted[dataHost, dataTrav]

```
> First 584 tracks, second 3736 tracks, matching 116 tracks

115 tracks after select non-zero DSG

109 common tracks out of 115 had a length greater than or equal to 780s

109 of 115 common-view tracks were analysed between MJD 52542.2 and MJD 52548.9

The mean offset (Host Rx - Travelling Rx) between the two receivers was -0.00826043
  ns (weighted) or 0.549585 ns (unweighted), with an unweighted RMS deviation of 4.27866  ns.

The slope of the line of best fit was
 -229.541 ps/day, with a standard error of 198.658 ps/day.
```





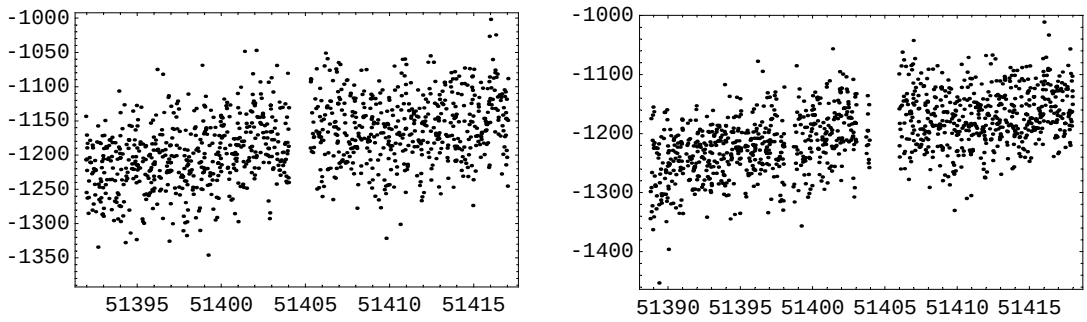
■ NML Australia (September 1999)

dataPath = StringJoin[rootPath, "nml sept 99\\"];

```
dataHost = ReadCCTF["Host.NML"];
(*Host  reported values:*)
RepHostIntDly = 53.5;
  RepHostRefDly = 102.4;
 RepHostAntDly = 235;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 68;
  RxHostRefDly = 102;
 RxHostAntDly = 235;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTF["Trav.NML"];
(*Host  reported values:*)
RepTravIntDly = 68;
  RepTravRefDly = 102.4;
 RepTravAntDly = 235;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = 68;
  RxTravRefDly = 103;
 RxTravAntDly = 230;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
```

```
> Read 1163 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\nml sept 99\Host.NML

> Read 1073 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\nml sept 99\Trav.NML
```

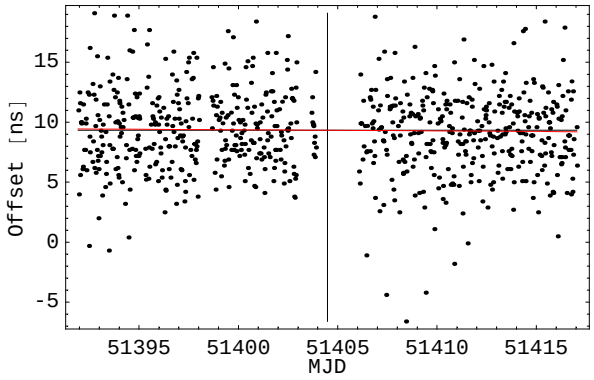
```
Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```

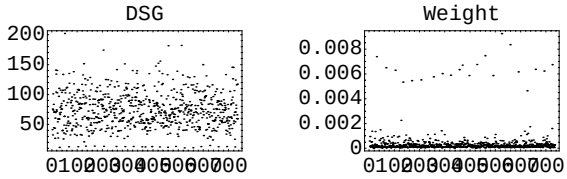



```
- GraphicsArray -
```

```
CompareWeighted[dataHost, dataTrav]
```

```
> First 1163 tracks, second 1073 tracks, matching 768 tracks

768 tracks after select non-zero DSG

734 common tracks out of 768 had a length greater than or equal to 780s

734 of 768 common-view tracks were analysed between MJD 51391.9 and MJD 51417.

The mean offset (Host Rx - Travelling Rx) between the two receivers was 9.32864
  ns (weighted) or 9.23191 ns (unweighted), with an unweighted RMS deviation of 3.43929  ns.

The slope of the line of best fit was
 -9.21569 ps/day, with a standard error of 13.3563 ps/day.
```






```
SaveOutput["NMLSep99"];
delay1 = {RepTravIntDly - MeanOffset, rms};
```

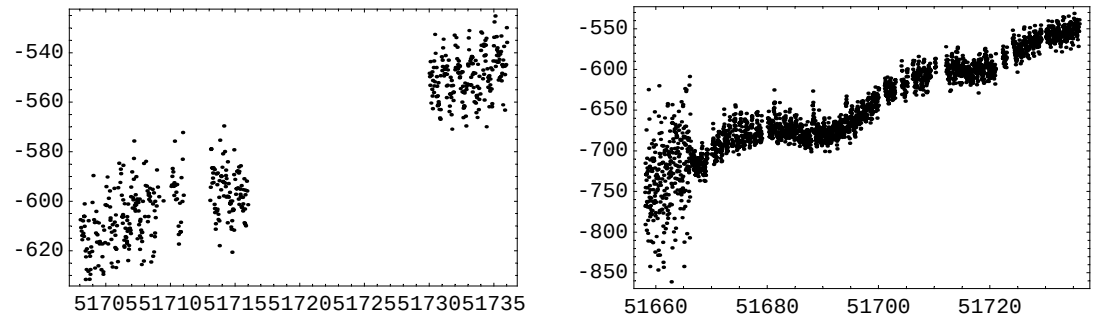
■ NML Australia (May 2000)

```
dataPath = StringJoin[rootPath, "nml may 2000\\"];
```

```
dataHost = ReadCCTF["Host.NML"];
(*Host  reported values:*)
RepHostIntDly = 53.5;
  RepHostRefDly = 79.1;
 RepHostAntDly = 235;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 68;
  RxHostRefDly = 79;
 RxHostAntDly = 235;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTF["Trav.NML"];
(*Host  reported values:*)
RepTravIntDly = 68;
  RepTravRefDly = 79.9;
 RepTravAntDly = 235;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = 68;
  RxTravRefDly = 79.6;
 RxTravAntDly = 235;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
```

```
> Read 2493 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\nml may 2000\Host.NML

> Read 511 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\nml may 2000\Trav.NML
```

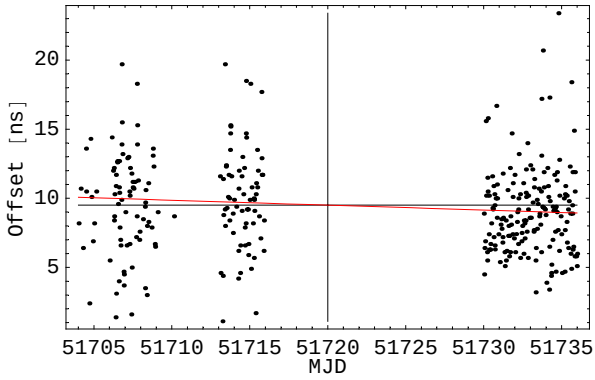
```
Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```

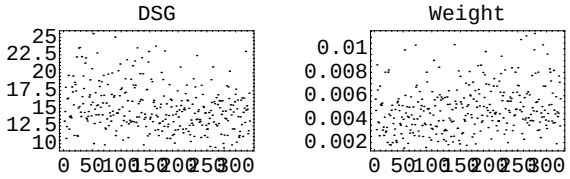


- GraphicsArray -

```
CompareWeighted[dataHost, dataTrav]
```

```
> First 2493 tracks, second 511 tracks, matching 346 tracks

346 tracks after select non-zero DSG

324 common tracks out of 346 had a length greater than or equal to 780s

324 of 346 common-view tracks were analysed between MJD 51704. and MJD 51736.

The mean offset (Host Rx - Travelling Rx) between the two receivers was 9.50723
  ns (weighted) or 9.41286 ns (unweighted), with an unweighted RMS deviation of 3.39233  ns.

The slope of the line of best fit was
 -35.4839 ps/day, with a standard error of 15.323 ps/day.
```






```
SaveOutput["NMLMay00"];
delay2 = {RepTravIntDly - MeanOffset, rms};
```

■ NML Australia (January 2001)

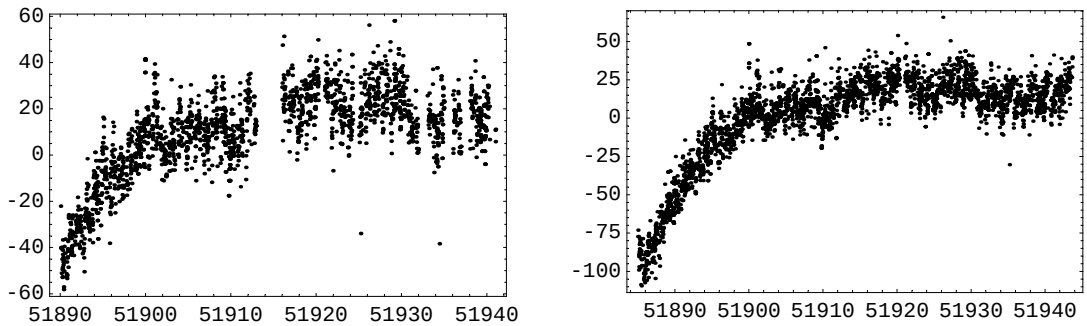
```
dataPath = StringJoin[rootPath, "nml jan 2001\\"];
```

```
dataHost = ReadCCTF["host.cctf"];
(*Host  reported values:*)
RepHostIntDly = 53.5;
  RepHostRefDly = 79.1;
 RepHostAntDly = 235;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 68;
  RxHostRefDly = 79;
 RxHostAntDly = 235;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTF["trav.cctf"];
(*Host  reported values:*)
RepTravIntDly = 68;
  RepTravRefDly = 77.8;
 RepTravAntDly = 235;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = 68;
  RxTravRefDly = 77.8;
 RxTravAntDly = 235;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
```

```
> Read 3322 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\nml jan 2001\host.cctf
```

```
> Read 2279 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\nml jan 2001\trav.cctf
```

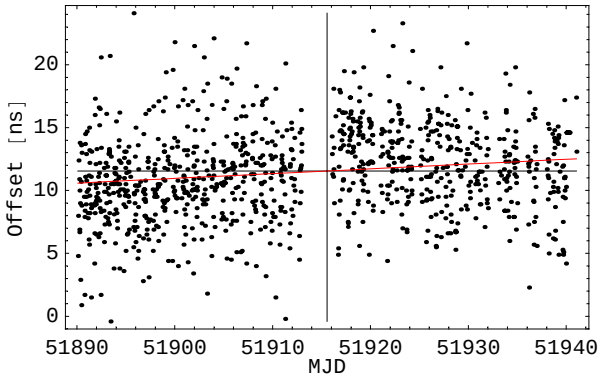
```
Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```

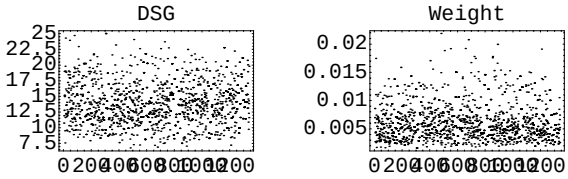



```
- GraphicsArray -
```

```
CompareWeighted[dataHost, dataTrav]
```

```
> First 3322 tracks, second 2279 tracks, matching 1538 tracks

1538 tracks after select non-zero DSG

1338 common tracks out of 1538 had a length greater than or equal to 780s

1338 of 1538 common-view tracks were analysed between MJD 51890.1 and MJD 51941.

The mean offset (Host Rx - Travelling Rx) between the two receivers was 11.5538
  ns (weighted) or 11.4681 ns (unweighted), with an unweighted RMS deviation of 3.52207  ns.

The slope of the line of best fit was
 37.9411 ps/day, with a standard error of 5.82532 ps/day.
```






```
SaveOutput["NMLJan01"];
delay3 = {RepTravIntDly - MeanOffset, rms};
```

■ Transfer of calibration from S/N 446 to S/N 267

```
{delay1, delay2, delay3} // TableForm
```

```
58.6714      0.0602945
58.4928      0.221475
56.4462      0.250262
```

```
IntDly267Trip1 = 58.6;
IntDly267Trip2 = 56.4;
```

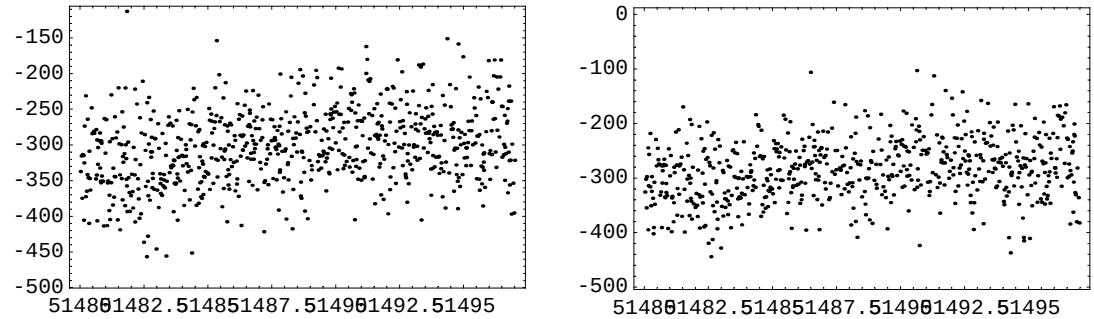
■ TL Taiwan

```
dataPath = StringJoin[rootPath, "tl taiwan\\"];

dataHost = ReadCCTF["TL.TL"];
(*Host  reported values:*)
RepHostIntDly = 50;
  RepHostRefDly = 51;
 RepHostAntDly = 229;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 50;
  RxHostRefDly = 51;
 RxHostAntDly = 229;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTF["TL.Trx"];
(*Host  reported values:*)
RepTravIntDly = IntDly267Trip1;
  RepTravRefDly = 51;
 RepTravAntDly = 235;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = 68;
  RxTravRefDly = 51;
 RxTravAntDly = 235;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
```

```
> Read 657 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\tl taiwan\TL.TL
```

```
> Read 745 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\tl taiwan\TL.Trx
```

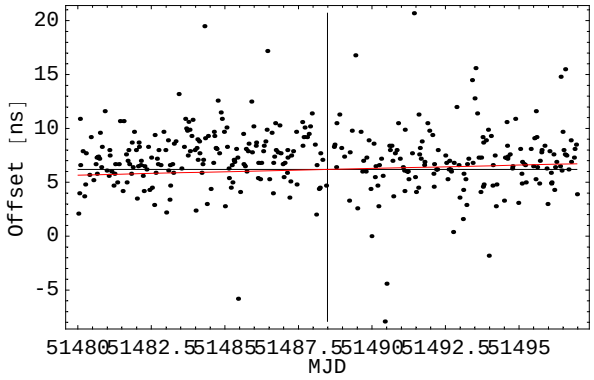
```
Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```

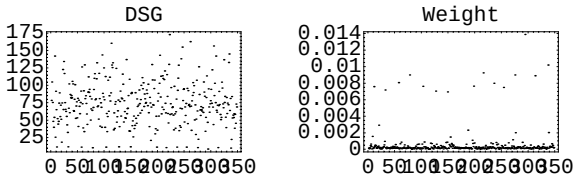



```
- GraphicsArray -
```

```
CompareWeighted[dataHost, dataTrav]
```

```
> First 657 tracks, second 745 tracks, matching 376 tracks

376 tracks after select non-zero DSG

348 common tracks out of 376 had a length greater than or equal to 780s

348 of 376 common-view tracks were analysed between MJD 51480. and MJD 51497.

The mean offset (Host Rx - Travelling Rx) between the two receivers was 6.19493
  ns (weighted) or 7.19025 ns (unweighted), with an unweighted RMS deviation of 2.96283  ns.

The slope of the line of best fit was
 61.7706 ps/day, with a standard error of 37.7024 ps/day.
```






```
SaveOutput["TL"];
```

■ NAO Japan

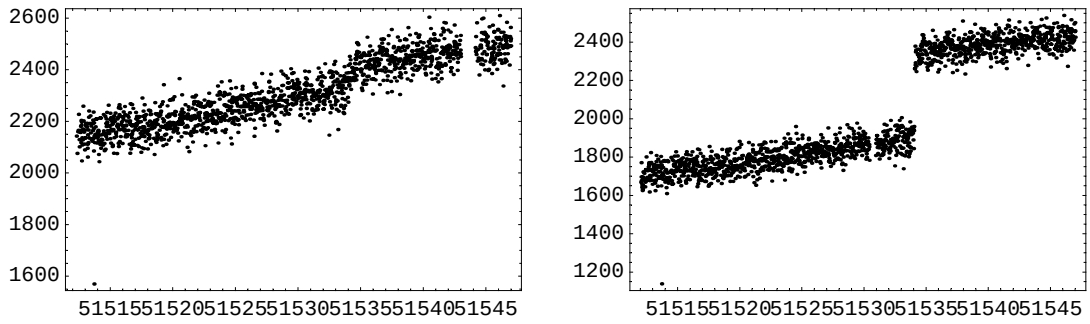
```
dataPath = StringJoin[rootPath, "nao japan\\"];

(* Host Comments:
   **On Dec .22,1999,the T-junction connector was replaced by a distribution
  amplifier to supply reference 1 sec signal to a GPS receiver from the
  master clock.This has given rise to a step of 437 ns in UTC (NAO)-GPS
  and 70 ns in UTC (NAO)-GPS (portable TTR6) from MJD51534 01 h14mUTC.It is
  considered that a difference in the sharpness between pulses of the
  reference signal amplified by the distributor and those by the T-junction
  connector caused different time delay counts in a GPS receiver.
*)
```

```
dataHost = ReadCCTF["host.nao"];
(*Host  reported values:*)
RepHostIntDly = 50.0;
  RepHostRefDly = 108;
 RepHostAntDly = 250;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 50;
  RxHostRefDly = 0;
 RxHostAntDly = 250;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTF["trav.nao"];
(*Host  reported values:*)
RepTravIntDly = IntDly267Trip1;
  RepTravRefDly = 108;
 RepTravAntDly = 235;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = 68;
  RxTravRefDly = 51;
 RxTravAntDly = 235;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
```

```
> Read 1582 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\nao japan\host.nao
```

```
> Read 1496 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\nao japan\trav.nao
```

```
Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```

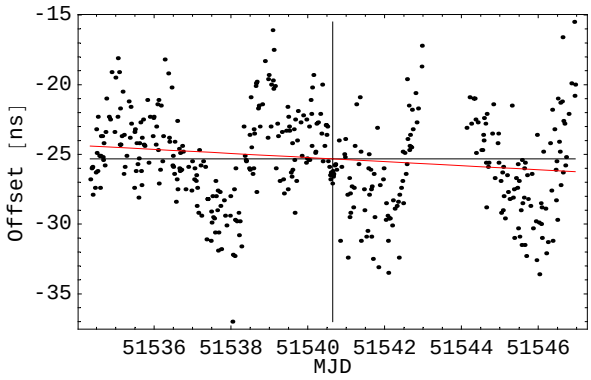


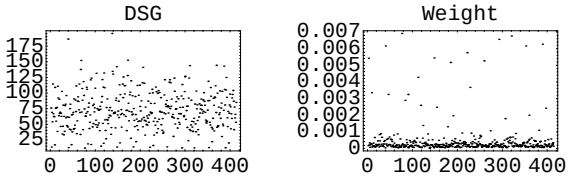

```
- GraphicsArray -
```

```
(*Select only the last 10 days of data for further processing*)
dataHost = Drop[Select[dataHost, RefGPS[#] > 2100 &], 10];
```

```
CompareWeighted[dataHost, dataTrav]
```

```
> First 586 tracks, second 1496 tracks, matching 431 tracks

431 tracks after select non-zero DSG

413 common tracks out of 431 had a length greater than or equal to 780s

413 of 431 common-view tracks were analysed between MJD 51534.3 and MJD 51547.

The mean offset (Host Rx - Travelling Rx) between the two receivers was -25.3186
  ns (weighted) or -25.5388 ns (unweighted), with an unweighted RMS deviation of 3.3639  ns.

The slope of the line of best fit was
 -145.951 ps/day, with a standard error of 42.4717 ps/day.
```






```
SaveOutput["NAO"];
```

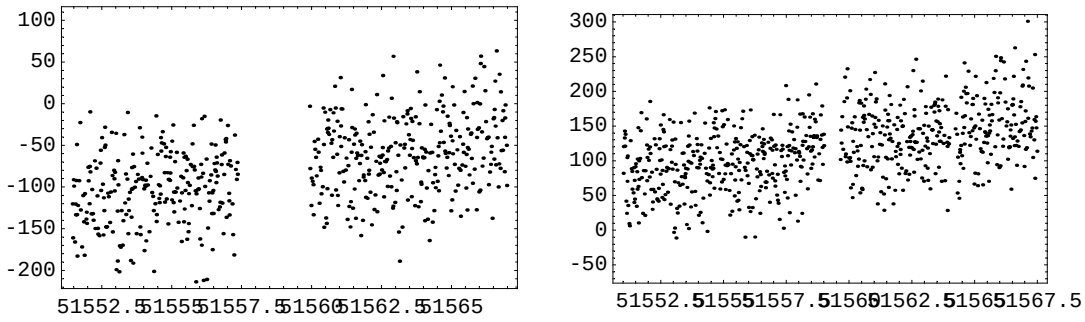
■ CRL Japan

```
dataPath = StringJoin[rootPath, "crl tokyo\\"];
```

```
dataHost = ReadCCTF["host.crl.dat"];
(*Host  reported values:*)
RepHostIntDly = 49.7;
  RepHostRefDly = 515.9;
 RepHostAntDly = 219.6;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 49.7;
  RxHostRefDly = 515.9;
 RxHostAntDly = 250;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTF["trav.crl.dat"];
(*Host  reported values:*)
RepTravIntDly = IntDly267Trip1;
  RepTravRefDly = 527.42 + 207.56;
 RepTravAntDly = 235;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = 68;
  RxTravRefDly = 527.4;
 RxTravAntDly = 235;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
```

```
> Read 723 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\crl tokyo\host.crl.dat

> Read 556 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\crl tokyo\trav.crl.dat
```

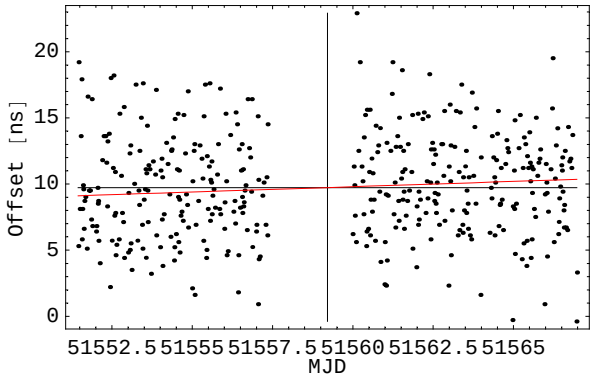
```
Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```

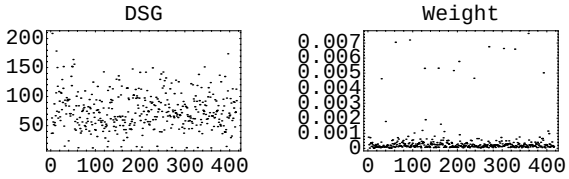



```
- GraphicsArray -
```

```
CompareWeighted[dataHost, dataTrav]
```

```
> First 723 tracks, second 556 tracks, matching 435 tracks

435 tracks after select non-zero DSG

415 common tracks out of 435 had a length greater than or equal to 780s

415 of 435 common-view tracks were analysed between MJD 51551.4 and MJD 51567.

The mean offset (Host Rx - Travelling Rx) between the two receivers was 9.73367
  ns (weighted) or 9.89838 ns (unweighted), with an unweighted RMS deviation of 3.87542  ns.

The slope of the line of best fit was
 80.0535 ps/day, with a standard error of 31.6377 ps/day.
```






```
SaveOutput["CRL"];
```

■ NRLM Japan

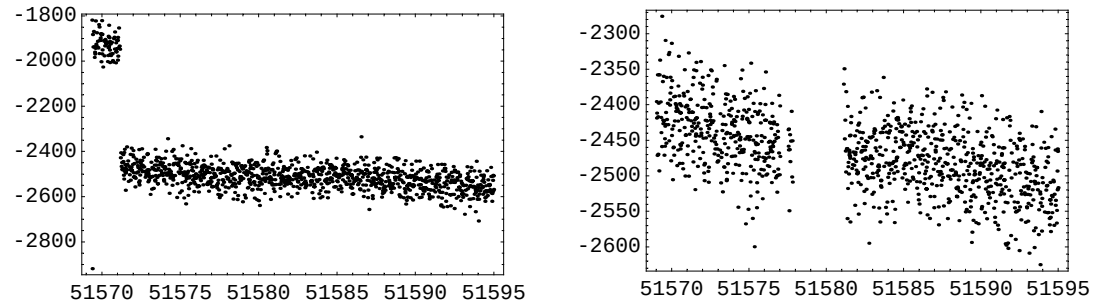
```
dataPath = StringJoin[rootPath, "nrlm japan\\"];
```

```
dataHost = ReadCCTF["Host.NRLM"];
(*Host  reported values:*)
RepHostIntDly = 64;
  RepHostRefDly = 89;
 RepHostAntDly = 250;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 64;
  RxHostRefDly = 89;
 RxHostAntDly = 250;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTF["Trav.NRLM"];
(*Host  reported values:*)
RepTravIntDly = IntDly267Trip1;
  RepTravRefDly = 0;
 RepTravAntDly = 235;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = 68;
  RxTravRefDly = 0;
 RxTravAntDly = 235;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
```

```
> Read 1004 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\nrlm japan\Host.NRLM
```

```
> Read 1101 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\nrlm japan\Trav.NRLM
```

```
Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav,
    PlotRange → All, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```

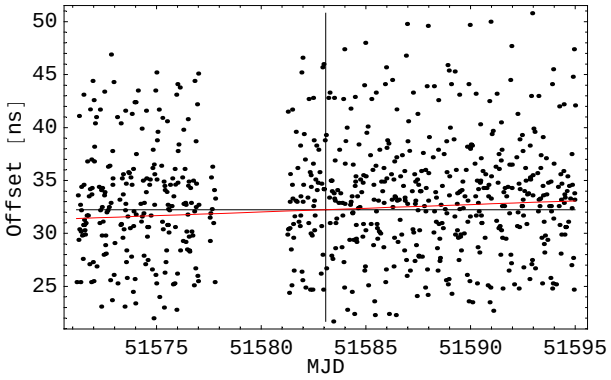


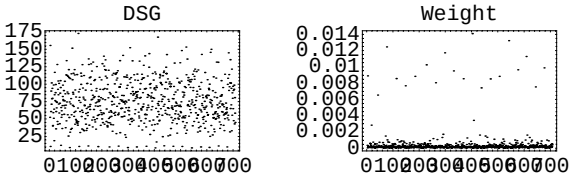

```
- GraphicsArray -
```

```
(*Select for further processing*)
dataTrav = Drop[dataTrav, 75];
```

```
CompareWeighted[dataHost, dataTrav]
```

```
> First 1004 tracks, second 1026 tracks, matching 727 tracks

727 tracks after select non-zero DSG

707 common tracks out of 727 had a length greater than or equal to 780s

707 of 727 common-view tracks were analysed between MJD 51571.2 and MJD 51595.

The mean offset (Host Rx - Travelling Rx) between the two receivers was 32.2397
  ns (weighted) or 33.4375 ns (unweighted), with an unweighted RMS deviation of 5.49522  ns.

The slope of the line of best fit was
 69.9539 ps/day, with a standard error of 20.6451 ps/day.
```






```
SaveOutput["NRLM"];
```

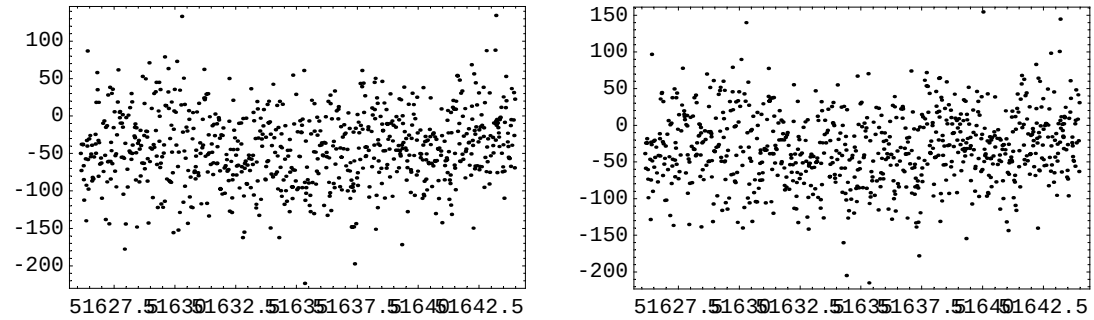
■ KRISS Korea

```
dataPath = StringJoin[rootPath, "kriss korea\\"];
```

```
dataHost = ReadCCTF["host.kriss.dat"];
(*Host  reported values:*)
RepHostIntDly = 50;
  RepHostRefDly = 576;
 RepHostAntDly = 250;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 50;
  RxHostRefDly = 576;
 RxHostAntDly = 250;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTF["trav.kriss.dat"];
(*Host  reported values:*)
RepTravIntDly = IntDly267Trip1;
  RepTravRefDly = 582;
 RepTravAntDly = 235;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = 68;
  RxTravRefDly = 582;
 RxTravAntDly = 235;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
Null
```

```
> Read 819 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\kriss korea\host.kriss.dat

> Read 802 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\kriss korea\trav.kriss.dat
```

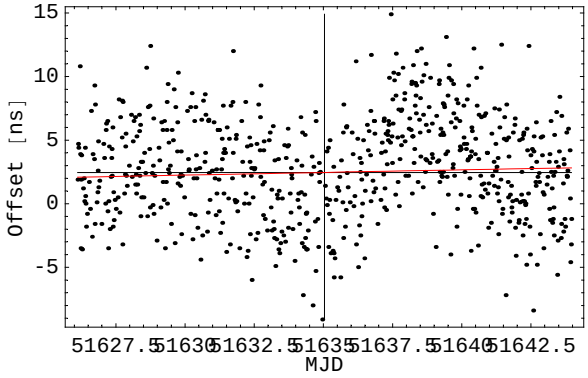
```
Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```

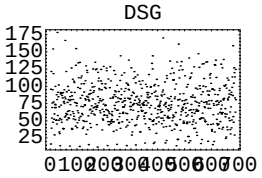


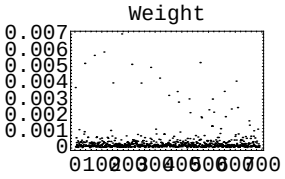

```
- GraphicsArray -
```

CompareWeighted[dataHost, dataTrav]

```
> First 819 tracks, second 802 tracks, matching 707 tracks

704 tracks after select non-zero DSG

689 common tracks out of 704 had a length greater than or equal to 780s

689 of 704 common-view tracks were analysed between MJD 51626.1 and MJD 51644.

The mean offset (Host Rx - Travelling Rx) between the two receivers was 2.4605
  ns (weighted) or 2.80093 ns (unweighted), with an unweighted RMS deviation of 3.92408  ns.

The slope of the line of best fit was
 41.5026 ps/day, with a standard error of 27.0846 ps/day.
```







SaveOutput["KRISS"];

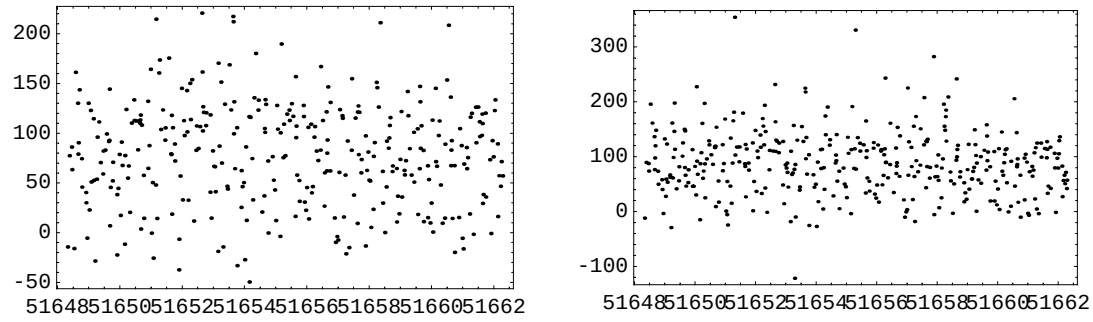
■ SCL Hong Kong

dataPath = StringJoin[rootPath, "scl hong kong\\"];

```
dataHost = ReadCCTF["host.scl.dat"];
(*Host  reported values:*)
RepHostIntDly = 55;
  RepHostRefDly = 10;
 RepHostAntDly = 728;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 55;
  RxHostRefDly = 10;
 RxHostAntDly = 728;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTF["trav.scl.dat"];
(*Host  reported values:*)
RepTravIntDly = IntDly267Trip1;
  RepTravRefDly = 10;
 RepTravAntDly = 720;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = 68;
  RxTravRefDly = 10;
 RxTravAntDly = 720;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
```

```
> Read 382 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\scl hong kong\host.scl.dat

> Read 346 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\scl hong kong\trav.scl.dat
```

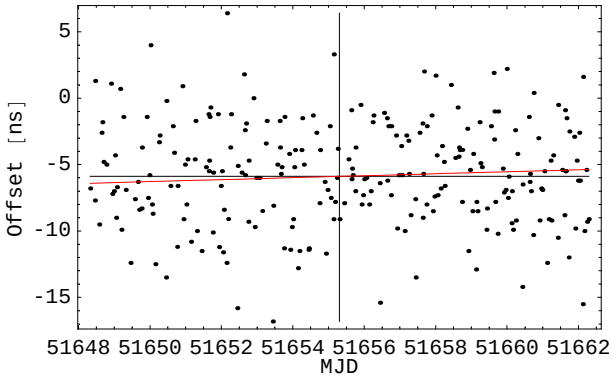
```
Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```

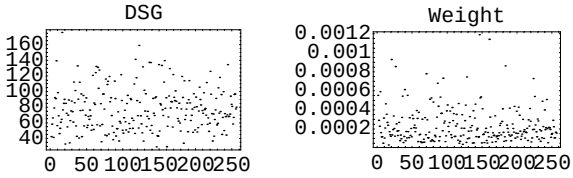



```
- GraphicsArray -
```

```
CompareWeighted[dataHost, dataTrav]
```

```
> First 382 tracks, second 346 tracks, matching 289 tracks

289 tracks after select non-zero DSG

256 common tracks out of 289 had a length greater than or equal to 780s

256 of 289 common-view tracks were analysed between MJD 51648.3 and MJD 51662.3

The mean offset (Host Rx - Travelling Rx) between the two receivers was -5.88996
  ns (weighted) or -5.7339 ns (unweighted), with an unweighted RMS deviation of 3.90487  ns.

The slope of the line of best fit was
 74.0424 ps/day, with a standard error of 61.4126 ps/day.
```






```
SaveOutput["SCL"];
```

■ PSB Singapore

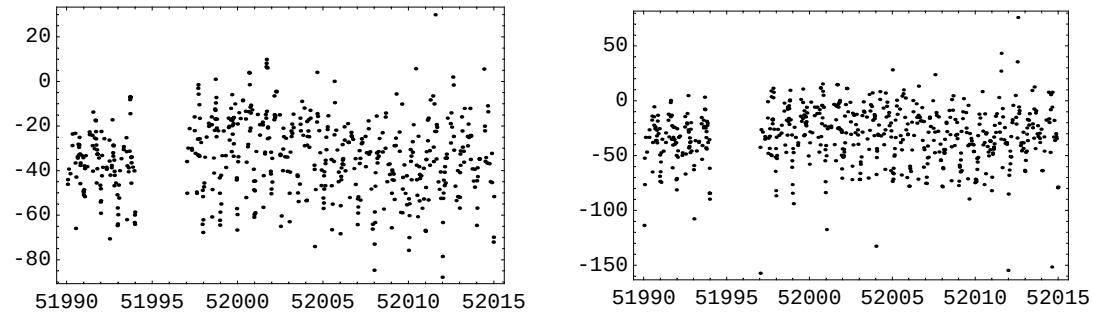
```
dataPath = StringJoin[rootPath, "psb singapore\\"];
```

```
dataHost = ReadCCTFAustron["host.txt"];
(*Host  reported values:*)
RepHostIntDly = 142;
  RepHostRefDly = 16;
 RepHostAntDly = 403;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 142;
  RxHostRefDly = 16;
 RxHostAntDly = 403;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTF["trav.txt"];
(*Host  reported values:*)
RepTravIntDly = IntDly267Trip2;
  RepTravRefDly = 16;
 RepTravAntDly = 392;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = 68;
  RxTravRefDly = 16;
 RxTravAntDly = 392;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
```

```
> Read 605 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\psb singapore\host.txt
```

```
> Read 563 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\psb singapore\trav.txt
```

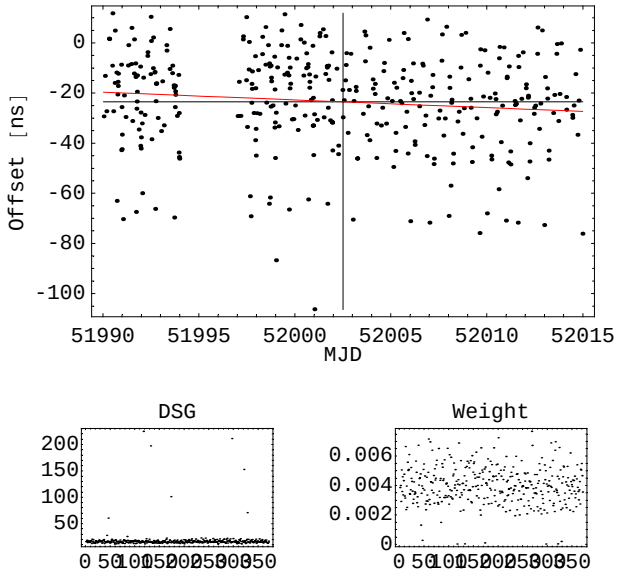
```
dataHost = {#[[1]], #[[2]], #[[3]] + 50000, #[[4]], #[[5]], 10 #[[7]], 10 #[[8]], #[[10]],
     10 #[[11]], #[[12]], 10 #[[13]], 10 #[[14]], 0, 0, 0, #[[9]], 0, 0} & /@ dataHost;

Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```



- GraphicsArray -

```
CompareWeighted[dataHost, dataTrav]
```

```
> First 605 tracks, second 563 tracks, matching 385 tracks

385 tracks after select non-zero DSG

371 common tracks out of 385 had a length greater than or equal to 780s

371 of 385 common-view tracks were analysed between MJD 51990. and MJD 52015.

The mean offset (Host Rx - Travelling Rx) between the two receivers was -23.5006
  ns (weighted) or -23.3155 ns (unweighted), with an unweighted RMS deviation of 19.1724  ns.

The slope of the line of best fit was
 -307.009 ps/day, with a standard error of 131.848 ps/day.
```




```
SaveOutput["PSB"];
```

■ NPL India

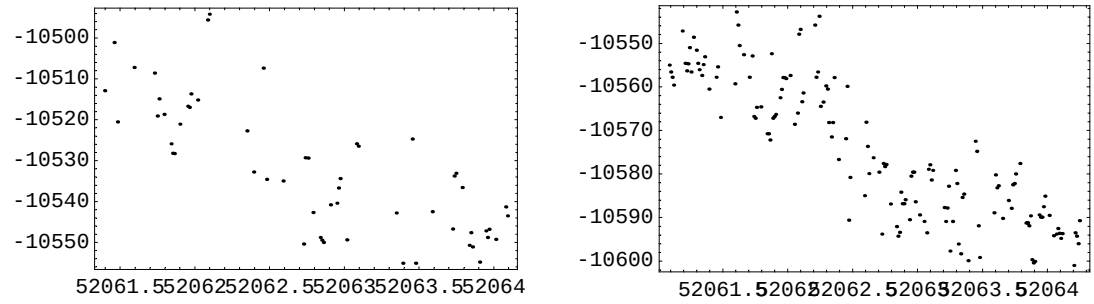
```
dataPath = StringJoin[rootPath, "npl india\\"];
```

```
dataHost = ReadCCTF["host2.cctf"];
(*Host  reported values:*)
RepHostIntDly = 64;
  RepHostRefDly = 53.8;
 RepHostAntDly = 250;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 64;
  RxHostRefDly = 0;
 RxHostAntDly = 250;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTF["trav2.cctf"];
(*Host  reported values:*)
RepTravIntDly = IntDly267Trip2;
  RepTravRefDly = 20.8;
 RepTravAntDly = 235;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = 68;
  RxTravRefDly = 16;
 RxTravAntDly = 235;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
```

```
> Read 150 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\npl india\host2.cctf
```

```
> Read 56 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\npl india\trav2.cctf
```

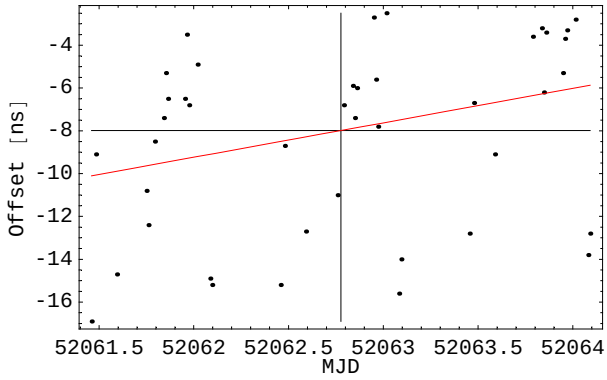
```
Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```

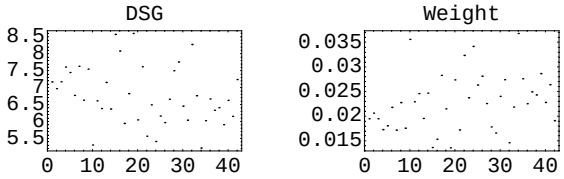


- GraphicsArray -

```
CompareWeighted[dataHost, dataTrav]
```

```
> First 150 tracks, second 56 tracks, matching 42 tracks

42 tracks after select non-zero DSG

42 common tracks out of 42 had a length greater than or equal to 780s

42 of 42 common-view tracks were analysed between MJD 52061.5 and MJD 52064.1

The mean offset (Host Rx - Travelling Rx) between the two receivers was -7.98426
  ns (weighted) or -8.4006 ns (unweighted), with an unweighted RMS deviation of 4.14716  ns.

The slope of the line of best fit was
 1609.34 ps/day, with a standard error of 740.429 ps/day.
```






```
SaveOutput["NPL"];
```

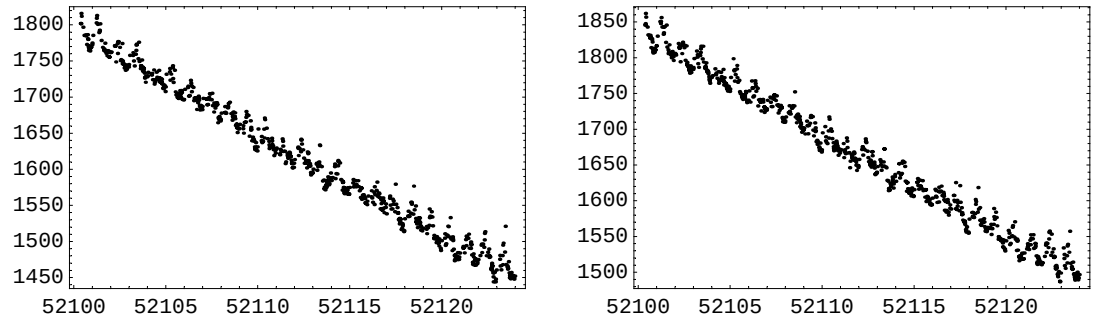
■ VMI Vietnam

```
dataPath = StringJoin[rootPath, "vmi vietnam\\"];
```

```
dataHost = ReadCCTF["host.txt"];
(*Host  reported values:*)
RepHostIntDly = 50;
  RepHostRefDly = 38;
 RepHostAntDly = 250;
RepHostDly = RepHostIntDly + RepHostAntDly - RepHostRefDly;

(*Host Receiver internal settings:*)
RxHostIntDly = 50;
  RxHostRefDly = 23;
 RxHostAntDly = 250;
RxHostDly = RxHostIntDly + RxHostAntDly - RxHostRefDly;
HostCorrection = RepHostDly - RxHostDly;

dataTrav = ReadCCTF["trav.txt"];
(*Host  reported values:*)
RepTravIntDly = IntDly267Trip2;
  RepTravRefDly = 68;
 RepTravAntDly = 235;
RepTravDly = RepTravIntDly + RepTravAntDly - RepTravRefDly;

(*Travelling receiver internal settings:*)
RxTravIntDly = 68;
  RxTravRefDly = 68;
 RxTravAntDly = 235;
RxTravDly = RxTravIntDly + RxTravAntDly - RxTravRefDly;
TravCorrection = RepTravDly - RxTravDly;
```

```
> Read 742 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\vmi vietnam\host.txt

> Read 709 tracks from
 c:\documents and settings\war354\desktop\gps_calibration\vmi vietnam\trav.txt
```

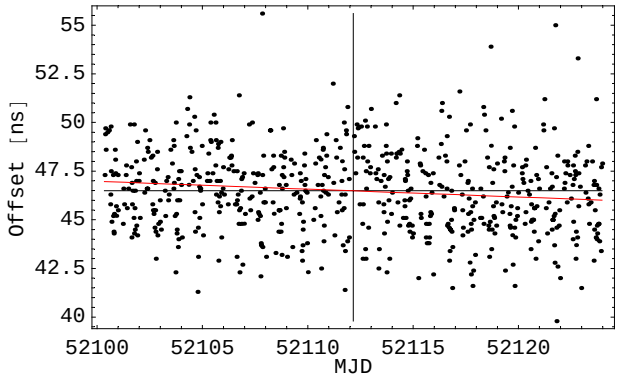
```
Show[GraphicsArray[{
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataTrav, DisplayFunction → Identity],
   ListPlot[{DateValue[#], RefGPS[#]} & /@ dataHost, DisplayFunction → Identity]
  }]]
```

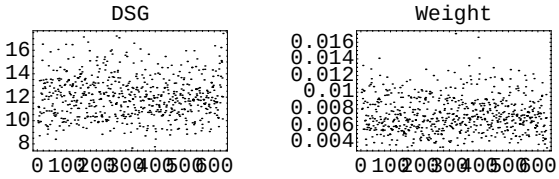


- GraphicsArray -

CompareWeighted[dataHost, dataTrav]

```
> First 742 tracks, second 709 tracks, matching 657 tracks

657 tracks after select non-zero DSG

629 common tracks out of 657 had a length greater than or equal to 780s

629 of 657 common-view tracks were analysed between MJD 52100.4 and MJD 52124.

The mean offset (Host Rx - Travelling Rx) between the two receivers was 46.4863
  ns (weighted) or 46.4634 ns (unweighted), with an unweighted RMS deviation of 2.14309  ns.

The slope of the line of best fit was
 -40.1837 ps/day, with a standard error of 12.0789 ps/day.
```





SaveOutput["VMI"];