E7.4-10.6.5.2
CR-138864



# S-193 IMPULSE RESPONSE CROSS CORRELATION

(Report Covering Sept. '73-March '74)

by

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WORK DONE UNDER

NASA Contract #NAS 9-13462

March 29, 1974

TR-74-11

(E74-10652) S-193 IMPULSE RESPONSE CROSS CORRELATION Progress Report, Sep. 1973 - Mar. 1974 (Houston Univ.) 19 p HC $4.00 CSCL 05B G3/13
N74-28885
Unclas 00652

TECHNICAL MONITOR
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Abstract / Summary

The impulse response of terrain to Altimeter (S 193) Model I, periodic pulse train signal and its verification consists of ground truth and terrain topographic data collection as well as sky lab data procurement and computer analysis, and finally the cross correlation between the sky lab data derived impulse response and that obtained from the corresponding topographic data. The ground truth and topographic (elevation) data were collected and reduced for Oregon Coast (SL #2) and Colorado overpass (SL #3). Seven track sky lab data was replaced by nine track data by December, 1973 in order to save excessive computer cost Retrieval of data usable in this study was initiated by late February 1974. Computer programs for calculationg the terrain impulse response from sky lab data were written, dry run, rewritten and modified. They are now considered operational. The matter of frequency and time resolution in computer calculations is still receiving more study.

A significant result for this period was the realization that the phase information, normally lost in envelope detection and sampling, could have been preserved if the samples were taken at the peaks of the carrier frequency at intervals equal to a twice or an integral multiple of the integral number of its period. Thus the Skylab S 193 Model I altimeter data does not contain phase information in accordance with the technical information obtained by us from NASA and Lockheed technical

personnel. Another significant discovery was to learn that the eight return pulse samples don't belong to the same pulse but represent an average over many pulses.

INTRODUCTION

The work for the period September, 1973 through March 31, 1974 is covered in this quarterly report, since the skylab data received until November 30, 1973 was not considered sufficient to yield any significant practical results. The reason was that skylab data received until November 30, 1973 was in seven track-magnetic tape format, and the reading of that data and reformating it to meet our Univac nine track requirement would have been excessively expensive and not possible within the budget provided. The request for nine track tape was processed by NASA-LBJ Space Center, and the first nine track data tape on S 193 Altimeter Mode 1 was received in late December, 1973. (Future reports shall be submitted quarterly.) Then it was possible to dry run our computer programs on that data to verify basic needs as to resolution in time and frequency domain for the terrain impulse response calculation from this data. Various aspects of our work under this contract with their present status are listed below under separate subtitles.

1. SKYLAB-ALTIMETER DATA

(A) S 193 Altimeter Mode 1: Since the start of and receipt of the nine track magnetic tape Altimeter (S 193) Mode 1 data in December, the following data tapes have been received:

1. SL-2 Project No. 8552C Nasa tape # 906153 (s19313-101-2-1-73-3)
   Covering Oregon Coast Time: 150-20-35-41
   Thru: 150-20-46-45

2. SL-3 Project No. 8550 Nasa tape # (s-93-100-01-12-72A) 907259
   Covering Colorado Time: 215-17-54-13
   Thru: 215-18-16-29

3. SL-2 Project No. Nasa tape # 906154/5
   Covering the Gulf Coast and Montana Time: 160-15-03-30
   160-15-07-14
   160-15-11-35
   160-15-18-4

4. SL-3 Project No. 8550 Nasa tape # S193-13-099-01-42-73-B
   Covering Mexico and western part of Texas
   Time: 258-16-23-06
   258-16-45-05
   258-16-23-9
   258-16-18-4

Since we are unable to associate tape numbers three and four above with preplanned flight and sites for Altimeter Mode 1 overflight, although efforts to salvage usable information from tapes is continuing to be made. Data from Tapes numbers one and two was taken over the sites assigned namely # 851167 and # 398295 respectively, and hence his data is being analyzed.

(B) S·191 and 190 and Associated Data

Other associated data including transparencies of color film shots covering two sites have been received for SL-3 corresponding to dat tape numbers two and four above since January 1974. An exact coordinate match is underway forvisual verification of data.

## (C) General and Specific Information

The product S073-5 for S193 Mode I has been requested for sites covered for this study, since only eight point pulse data is available, and the resolution enhancement is a major concern as discussed below.

### Ground Truth Data

The ground truth data consists of such factors as moisture, rain fall, foliage, season, man-nade effects such as timber cutting, mining or farming, forest fires etc., type of forestation, crops or grass etc., and topographical data. The status of this work to date of the Oregon and Colorado sites is as follows:

1. Site visit completed
2. Photographic and visual information on landscape, foliage, crops, or forestation, man-made effects collected
3. Topographic maps have been read, and data collected
4. Ground track of skylab has been delineated in order to pinpoint any special features along it

The S-193 Altimeter Mode I data over the Texas Hats Site apparently was not taken during all skylab passes, and therefore the ground truth along the overpass over the planned Hats site has not been compiled, although topographic maps for this planned overpass were procurred.

## Topographic Data and Analysis

The resolution of topographic data is 80 feet for all quadrangles in the Colorado overpass except for the quadrangles of Nucula, Silverton, Wolf Creek, Chama Peak, and Brazos Peak; for which the 208 feet resolution data will be interpolated to yield points 80 feet apart, resulting in expanding these sectional data points by a factor of approximately 2.5 . Similarly, the resolution for the topographical data for the Oregon overpass data is 208 feet.

This data is ready for correlation analysis using a moving window, which is equivalent to a period of the S-193 pulse, so that the pathlength on the ground illuminated by the altimeter pulse could be the same as the width of the window in our data processing. The only delay in initiating this processing is the receipt of detailed information on the S-193 transmitted pulse shape, since the point of return form the ground shall depend on cT/2 where c is the velocity of light or 3 x $10^8$ meters/sec and T is the effective pulse width, which is approximately 72 to 100 nanoseconds.

Furthermore, it has just come to our attention that in S-193 pulse shape experiment Mode I, the eight samples are so taken that these:

a. do not belong to one return pulse

b. are not consecutive in information sense, except in some "average" sense.

c. can not be said to represent a single foot print of S-193 beam on the ground

The Skylab Altimeter S-193 Mode I pulse data was taken using a pulse train with a nominal pulse width of 100 nanoseconds and a repetition rate of 250 pulses per second. Furthermore, the return pulse was sampled eight times during each pulse duration, and the sample spacing was 25 nanoseconds. This would yield a spatial sampling rate, for the terrain under the skylab, of a sample every 84,5 feet. since the skylab ground speed is approximately 4 miles per second or 21 feet per millisecond. Therefore the pulse period is the equivalent of 4 x 21 = 84 feet on the ground.

An exact detail of sampling method or routine has been requested from NASA for a clear understanding of which ground samples, the average received pulse represents.

Transmitted and Received Pulse

In Mode I pulse shape S-193 Altimeter experiment, due to no detailed information on the shape of the transmitted pulse x(t), it was assumed that it was an ideally square pulse of 13.98 ghz carrier. Later on inquiries on the rise and decay time of this pulse led us to find out that the pulse shape is indeed not spuare , but somewhat gaussian; but again the details of the clipped gaussian pulse are not, to this date, available from either NASA or NASA Contractors, such as Lockheed Electronics and Research Triangle Inc. in North Carolina; although these are expected to be received before the next quarterly report is issued.

The importance of the shape of this transmitted pulse is demonstrated by the Fourier Transforms given below:

Case I: Rectangular Pulse.

If the envelope of the transmitted pulse x(t) has a period T and pulse width a, then its Fourier Transform pair would be given below:

$$x(t) = \begin{cases} 1 & -a/2 \leq t \leq a/2 \\ 0 & \text{OTHERWISE} \end{cases} \quad \text{OVER} \quad -T/2 < t < T/2$$

$$= \sum_{n=-\infty}^{\infty} C_n \exp . j\omega_n t$$

$$C_n = (1/T) \int_{-a/2}^{a/2} x(t) \exp(-j\omega_n t)\, dt = (a/T) \frac{\sin(\omega_n a/2)}{(\omega_n a/2)}$$

where $w_n = nw_0 = 2\pi n/T$

Futher more the power spectral density $P_x(f)$ would be given as:

$$P_x(f) = |X(f)|^2 = \sum_{n=\infty}^{\infty} |C_n|^2 \, \delta(\omega - \omega_n)$$

with phase angle spectrum

$$\phi_x(f) = \tan^{-1}(\text{Imaginary Part of } C_n / \text{Real part of } C_n) = 0$$

Case II: Gaussian [approximated by (sin x/x) form]

If the envelope of the transmitted pulse x(t) is approximated by an gaussian curve, as understood by telephonic inquiry as of April 1, 1974, then its Fourier transform pair shall be given as:

$$x(t) = A(\sin bt / bt) \qquad \text{for } -\infty < t < \infty$$

$$X(f) = \int_{-\infty}^{\infty} x(t)\, e^{-j\omega t}\, dt$$

$$= 2 \int_{0}^{\infty} A \frac{\sin bt}{bt} . \cos \omega t \, dt$$

$$= \begin{cases} \pi/b & |\omega_n| < b \\ \pi/2b & \omega_n = b \\ 0 & |\omega_n| > b \end{cases}$$

Since the following integral holds:

$$\int_{-\infty}^{\infty} (\sin at \;\; \cos xt)/t \;\; dt = \begin{cases} \pi & |x| < a \\ \pi/2 & x = a \\ 0 & |x| > a \end{cases}$$

Note again that the phase spectrum is zero here as well.

Case III: Truncated Gaussian Pulse

The real case of S-193 Mode I pulse is closest to a truncated gaussian pulse. For instance, let us say over, one period, one may write $x(t) = A \exp(-K^2t^2)$ $-T/2 < t < T/2$ and its generalized fourier coefficient $C_n$ shall be defined as:

$$X(t) = \sum_{n=-\infty}^{\infty} C_n \exp. j\omega_n t$$

and

$$C_n = (1/T) \int_{-T/2}^{T/2} \exp.(-k^2t^2 - j\omega_n t)\, dt$$

Let Kt = $t_1$ and therefore kdt = $dt_1$ and hence

$$C_n = (2/Tk) \int_0^{kT/2} \exp.(-t_1^2) \cos(\omega_n/k \, t_1)\, dt_1$$

$$= (2/Tk)\left(\sqrt{\pi}/4 \times e^{\omega_n^2/2k}\right)\Big[\operatorname{erf}(x - j\omega_n/2k) + \operatorname{erf}(x + j\omega_n/2k)\Big]_{x=0}^{x=kT/2}$$

Since $\int \exp(-x^2)\exp.ax\,dx =$

$$= \left[\sqrt{\pi}/4 \exp(a^2/4)\right]\left[\operatorname{erf}(x - ja/2) + \operatorname{erf}(x + ja/2)\right]$$

where $\operatorname{erf}(x) = (2/\sqrt{\pi}) \int_0^x \exp(-t^2)\, dt$

[Ref. 313.6 p.109 GROSSNER & Hofreiter]

Upon substitution of limits in the value of $C_n$, one obtains:

$$C_n = (2/Tk)(\Pi/16)^{1/2}\exp(\omega n/2k)^2[\text{erf}(kT/2-j\omega n/2k)+\text{erf}(kT/2+j\omega n/2k) -2\text{erf}(j\omega n/2k)]$$

since $\text{erf}(-x) = \text{erf}(+x)$

It is important to note that the power spectral density of $x(t)$ is $|C_n|^2$, and its phase spectrum is not the same as in cases I and II.

Case IV: Truncated Gaussian Pulse with Fast Drop Off.

In this case the Fourier Transform integral for $C_n$ in the previous case may be modified to extend its upper and lower limits to infinity since the pulse is already assumed to have dropped to negligible and essentially zero amplitude before reaching the limits of its period. Thus we would obtain:

$$C_n \approx x(f)_n = (2/T)\int_0^\infty \exp(-k^2t^2)\cos w\,t\,dt$$

$$= (2/T)\ (\Pi/4k^2)^{1/2}\ \exp(-w^2/4k^2)$$

Note that in this approximation the power spectral density of $x(t)$ in a given period is essentially the same as that obtained in Case III but its phase spectrum is zero as was the case in Case I and Case II.

Importance of Power Spectrum and Phase Angle Spectrum in Impulse Response Calculations.

The results obtained above will now be shown to have significance in this study, where the power and phase spectrum of $x(t)$ is needed to calculate the impulse response of the terrain radiated by S-193 pulse. Let the received pulse be $y(t)$, and its power spectral density $P_y(w)$, the phase angle spectrum $P_y(w)$, and the corresponding values for $x(t)$ as $P_x(w)$ and $\phi_x(w)$. Then the Fourier Transform of $h(t)$, the terrain impulse response is given by the following relationships:

$$Y(j\omega) = X(j\omega)\, H(j\omega)$$
$$P_y(\omega) = P_x(\omega)\, P_h(\omega)$$
$$\phi_y(\omega) = \phi_x(\omega) + \phi_h(\omega)$$

and therefore

$$h(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} P_h^{1/2}(\omega)\, exp.\, j\,\phi_h(\omega)\, d\omega = \text{INV. F.F.T}\left[(P_y/P_x)^{1/2} exp.\, j\,(\phi_y - \phi_x)\right]$$

In this connection the Fast Fourier Transform technique was used to solve for h(t) given the eight sampled values of $x(t)$. A typical program for this effort is attached and it is the result of extensive computer analysis of data samples of the type available from S-193, with basic intent to enhance resolution of the $h(t)$.

Most early programs yielded a quick drop-off of the values of $h(t)$ for t greater than zero. In fact the first value, for the data shown on attached pages A1-A6, would be 176.51 and the next would be 0.539. A special technique of padding data with optimum number of zeros has now yielded at least 4 to 8 point resolution. In this effort eight S-193 return pulse sample values are extended to 256 points by adding 248 zeros at the end, and assuming that the phase angle information for the eight points is unknown and assumed zero as is the case of envelope detection.

Other programs with phase angle imput, with eight points of $x(t)$ were also tried and the results were significantly interesting. A close analysis of this part of the work reveals that this system would have been much more effective for such work and all other surface effects if the pulse samples were taken at the peaks of the carrier signal and synchronized to the starting of the pulse at its positive zero crossing, and thus preserving its phase information.

Conclusion:

Recommendation for a new simple technique has been advanced to enhance the capability of S-193 Mode I altimeter pulse shape experiment. Futher work on the transmitted pulse shape specification and its effect on the impulse response of terrain shall be reported in the next quarterly. Futhermore cross correlation between different skylab data and the impulse response calculated shall be reported in the next report.

```
@FOR,US      SKYLAB.MAIN,.MAIN
FOR S011-04/04/74-13:47:34 (2,3)

   MAIN PROGRAM

   STORAGE USED: CODE(1) 000277; DATA(0) 010103; BLANK COMMON(2) 000000

   EXTERNAL REFERENCES (BLOCK, NAME)

    0003   FOUR1
    0004   NINTR$
    0005   NRDU$
    0006   NIO1$
    0007   NIO2$
    0010   NWDU$
    0011   SQRT
    0012   ATAN2
    0013   SIN
    0014   COS
    0015   NSTOP$

   STORAGE ASSIGNMENT  (BLOCK, TYPE, RELATIVE LOCATION, NAME)

    0000    010020 100F       0000    010022 101F       0000    010032 102F       000
    0000    010037 107F       0001    000024 111G       0001    000033 120G       000
    0001    000114 155G       0001    000147 170G       0001    000162 177G       000
    0000 R  010016 AMEAN      0000 R  007000 ASPECH     0000 R  003000 ASPECY     000
    0000 R  000000 DATAY      0000 R  010017 FM         0000 I  010014 I          000
    0000 I  010012 NSIG       0000 R  006000 PSPECH     0000 R  002000 PSPECY     000

00100        C*************************************************************
00100        C      DIMENSION VARIABLES.
00100        C*************************************************************
00101               DIMENSION DATAY(2,512),PSPECY(512),ASPECY(512),
00101              1          DATAH(2,512),PSPECH(512),ASPECH(512),
00101              2          PTS(8)
00101        C*************************************************************
00101        C      ASSIGN FOLLOWING --
00101        C*************************************************************
00103               NPTS = 8
00104               NPWR = 512
00105               NSIG = 256
00106               CONST = 5.8468
00106        C*************************************************************
00106        C      READ IN POINTS.
00106        C*************************************************************
00107               READ (5,100) (PTS(I),I=1,NPTS)
00115        100    FORMAT(4F16.3)
00116               SUM = 0.0
00117               DO 1 I = 1,NPTS
00122               SUM = SUM + PTS(I)
00123        1      CONTINUE
00125               AMEAN = SUM / FLOAT(NPTS)
00126               WRITE(6,101)
00130        101    FORMAT (' THE FOLLOWING POINTS - MEAN WERE READ: ')
00131               DO 2 I = 1,NPTS
00134               PTS(I) = PTS(I) - AMEAN
```

```
00135              WRITE (6.102) I.PTS(I)
00141        102   FORMAT(' POINT(',I3,')= ',F16.3)
00142        2     CONTINUE
00142        C***************************************************************
00142        C     GENERATE Y POINT ARRAY.
00142        C***************************************************************
00144              DO 3 I = 1,8
00147              DATAY(1,I) = PTS(I)
00150              DATAY(2,I) = 0.00000
00151        3     CONTINUE
00151        C***************************************************************
00151        C     COMPUTE FFT. POWER SPECTRA AND ANGLE SPECTRA OF Y.
00151        C***************************************************************
00153              CALL FOUR1(DATAY,NPWR,+1)
00154              DO 5 I = 1,NPWR
00157              PSPECY(I) = DATAY(1,I)**2 + DATAY(2,I)**2
00160              PSPECY(I) = SQRT(PSPECY(I))
00161              PSPECH(I) = PSPECY(I)
00162              ASPECY(I) = ATAN2(DATAY(2,I),DATAY(1,I))
00163        5     CONTINUE
00163        C***************************************************************
00163        C     SET POINTS FOR X.
00163        C***************************************************************
00165              ASPECH(1) = 0.00000
00166              FM = 0.00000
00167              DO 6 I = 2,NPWR
00172              FM = FM + CONST
00173              ASPECH(I) = SIN(FM)
00174        6     CONTINUE
00174        C***************************************************************
00174        C     COMPUTE POINTS FOR H.
00174        C***************************************************************
00176              DO 8 I = 1,NPWR
00201              ASPECH(I) = ASPECY(I) - ASPECH(I)
00202              DATAH(1,I) = PSPECH(I) * COS(ASPECH(I))
00203              DATAH(2,I) = PSPECH(I) * SIN(ASPECH(I))
00204        8     CONTINUE
00204        C***************************************************************
00204        C     COMPUTE INVERSE FFT OF H.
00204        C***************************************************************
00206              CALL FOUR1(DATAH,NPWR,-1)
00207              DO 10 I = 1,NPWR
00212              PSPECH(I) = DATAH(1,I)**2 + DATAH(2,I)**2
00213              PSPECH(I) = SQRT(PSPECH(I))
00214              ASPECH(I) = ATAN2(DATAH(2,I),DATAH(1,I))
00215        10    CONTINUE
00217              WRITE(6,107)
00221        107   FORMAT(28X,'SPECTRA OF INVERSE DATA H.')
00222              WRITE (6,105)
00224        105   FORMAT (1H1,1X,' FREQUENCY',2X,' POWER SPECTRA',2X,
00224             1' ANGLE SPECTRA')
00225              DO 11 I = 1,NSIG
00230              WRITE(6,106) I,PSPECH(I),ASPECH(I)
00235        106   FORMAT (1X,I12,2X,F14.3,2X,F14.3)
00236        11    CONTINUE
00240              STOP
00241              END
```

END OF COMPILATION:    NO DIAGNOSTICS.

```
@MAP,IN    .MAP,.ABS
MAP 0023-04/04-13:47 -(,0)

@XQT .ABS
 THE FOLLOWING POINTS - MEAN WERE READ:
 POINT(  1)=          .450
 POINT(  2)=          .268
 POINT(  3)=          .120
 POINT(  4)=         -.001
 POINT(  5)=         -.101
 POINT(  6)=         -.182
 POINT(  7)=         -.249
 POINT(  8)=         -.304
                 SPECTRA OF INVERSE DATA H,
```

| FREQUENCY | POWER SPECTRA | ANGLE SPECTRA | | | |
|---|---|---|---|---|---|
| 1 | 176.151 | -.001 | 62 | .676 | 1.525 |
| 2 | 104.849 | -.001 | 63 | .637 | 1.458 |
| 3 | 46.866 | -.001 | 64 | .614 | 1.374 |
| 4 | .539 | -3.135 | 65 | .609 | 1.270 |
| 5 | 39.716 | 3.141 | 66 | .631 | 1.145 |
| 6 | 71.451 | 3.141 | 67 | .692 | 1.006 |
| 7 | 97.701 | 3.141 | 68 | .821 | .858 |
| 8 | 119.250 | 3.141 | 69 | 1.078 | .713 |
| 9 | .173 | 2.198 | 70 | 1.627 | .588 |
| 10 | .200 | 2.114 | 71 | 3.165 | .486 |
| 11 | .231 | 2.050 | 72 | 26.921 | .392 |
| 12 | .264 | 2.000 | 73 | 11.340 | .407 |
| 13 | .301 | 1.960 | 74 | 1.523 | .553 |
| 14 | .341 | 1.927 | 75 | 5.407 | -2.803 |
| 15 | .386 | 1.901 | 76 | 10.330 | -2.781 |
| 16 | .435 | 1.879 | 77 | 13.604 | -2.774 |
| 17 | .491 | 1.860 | 78 | 15.481 | -2.772 |
| 18 | .553 | 1.845 | 79 | 15.470 | -2.772 |
| 19 | .624 | 1.832 | 80 | 3.193 | .433 |
| 20 | .706 | 1.821 | 81 | 1.530 | .495 |
| 21 | .801 | 1.811 | 82 | .967 | .558 |
| 22 | .911 | 1.803 | 83 | .687 | .620 |
| 23 | 1.042 | 1.796 | 84 | .523 | .685 |
| 24 | 1.198 | 1.790 | 85 | .418 | .752 |
| 25 | 1.388 | 1.785 | 86 | .346 | .818 |
| 26 | 1.623 | 1.781 | 87 | .294 | .886 |
| 27 | 1.917 | 1.777 | 88 | .257 | .953 |
| 28 | 2.295 | 1.774 | 89 | .228 | 1.019 |
| 29 | 2.793 | 1.771 | 90 | .206 | 1.085 |
| 30 | 3.470 | 1.769 | 91 | .189 | 1.150 |
| 31 | 4.428 | 1.767 | 92 | .177 | 1.215 |
| 32 | 5.860 | 1.766 | 93 | .167 | 1.280 |
| 33 | 8.171 | 1.764 | 94 | .160 | 1.345 |
| 34 | 12.369 | 1.764 | 95 | .156 | 1.411 |
| 35 | 21.887 | 1.763 | 96 | .154 | 1.478 |
| 36 | 62.372 | 1.761 | 97 | .155 | 1.545 |
| 37 | 44.452 | -1.380 | 98 | .159 | 1.614 |
| 38 | 64.118 | -1.380 | 99 | .166 | 1.683 |
| 39 | 64.698 | -1.379 | 100 | .179 | 1.750 |
| 40 | 56.437 | -1.379 | 101 | .199 | 1.817 |
| 41 | 42.295 | -1.379 | 102 | .229 | 1.882 |
| 42 | 23.350 | -1.379 | 103 | .277 | 1.942 |
| 43 | 3.321 | 1.764 | 104 | .356 | 1.997 |
| 44 | 59.536 | 1.761 | 105 | .500 | 2.047 |
| 45 | 19.782 | 1.762 | 106 | .818 | 2.088 |
| 46 | 11.325 | 1.762 | 107 | 2.005 | 2.118 |
| 47 | 7.582 | 1.761 | 108 | 2.930 | -.985 |
| 48 | 5.503 | 1.760 | 109 | 3.181 | -.985 |
| 49 | 4.201 | 1.758 | 110 | 2.732 | -.983 |
| 50 | 3.323 | 1.755 | 111 | 2.017 | -.979 |
| 51 | 2.700 | 1.752 | 112 | 1.147 | -.967 |
| 52 | 2.241 | 1.747 | 113 | .165 | -.805 |
| 53 | 1.891 | 1.741 | 114 | 1.041 | 2.116 |
| 54 | 1.619 | 1.734 | 115 | 3.067 | 2.134 |
| 55 | 1.403 | 1.724 | 116 | .861 | 2.116 |
| 56 | 1.229 | 1.712 | 117 | .494 | 2.095 |
| 57 | 1.087 | 1.696 | 118 | .339 | 2.072 |
| 58 | .970 | 1.676 | 119 | .254 | 2.052 |
| 59 | .873 | 1.651 | 120 | .201 | 2.031 |
| 60 | .793 | 1.618 | 121 | .166 | 2.011 |
| 61 | .728 | 1.577 | 122 | .140 | 1.992 |
| | | | 123 | .122 | 1.973 |

| | | | | | |
|---|---|---|---|---|---|
| 124 | .107 | 1.955 | 186 | .052 | 2.420 |
| 125 | .096 | 1.938 | 187 | .019 | 2.251 |
| 126 | .087 | 1.922 | 188 | .015 | 2.191 |
| 127 | .079 | 1.905 | 189 | .014 | 2.163 |
| 128 | .073 | 1.889 | 190 | .013 | 2.150 |
| 129 | .068 | 1.872 | 191 | .012 | 2.144 |
| 130 | .064 | 1.855 | 192 | .012 | 2.142 |
| 131 | .060 | 1.835 | 193 | .011 | 2.143 |
| 132 | .057 | 1.814 | 194 | .011 | 2.147 |
| 133 | .054 | 1.789 | 195 | .011 | 2.152 |
| 134 | .052 | 1.760 | 196 | .010 | 2.158 |
| 135 | .051 | 1.724 | 197 | .010 | 2.164 |
| 136 | .050 | 1.679 | 198 | .010 | 2.171 |
| 137 | .050 | 1.622 | 199 | .010 | 2.178 |
| 138 | .051 | 1.548 | 200 | .010 | 2.186 |
| 139 | .055 | 1.453 | 201 | .009 | 2.194 |
| 140 | .062 | 1.330 | 202 | .009 | 2.202 |
| 141 | .080 | 1.181 | 203 | .009 | 2.210 |
| 142 | .130 | 1.010 | 204 | .009 | 2.217 |
| 143 | .566 | .815 | 205 | .009 | 2.225 |
| 144 | .136 | .979 | 206 | .009 | 2.233 |
| 145 | .087 | -2.702 | 207 | .009 | 2.240 |
| 146 | .211 | -2.503 | 208 | .008 | 2.246 |
| 147 | .283 | -2.467 | 209 | .008 | 2.251 |
| 148 | .314 | -2.456 | 210 | .008 | 2.253 |
| 149 | .307 | -2.455 | 211 | .008 | 2.250 |
| 150 | .247 | -2.474 | 212 | .008 | 2.237 |
| 151 | .157 | .905 | 213 | .008 | 2.191 |
| 152 | .077 | 1.057 | 214 | .010 | 1.931 |
| 153 | .053 | 1.186 | 215 | .008 | 2.359 |
| 154 | .042 | 1.295 | 216 | .007 | 2.589 |
| 155 | .036 | 1.387 | 217 | .007 | 2.710 |
| 156 | .031 | 1.465 | 218 | .007 | 2.762 |
| 157 | .028 | 1.530 | 219 | .007 | 2.761 |
| 158 | .026 | 1.584 | 220 | .007 | 2.712 |
| 159 | .025 | 1.630 | 221 | .007 | 2.592 |
| 160 | .023 | 1.670 | 222 | .008 | 2.178 |
| 161 | .022 | 1.704 | 223 | .007 | 2.322 |
| 162 | .021 | 1.734 | 224 | .007 | 2.373 |
| 163 | .021 | 1.761 | 225 | .007 | 2.404 |
| 164 | .020 | 1.785 | 226 | .007 | 2.427 |
| 165 | .019 | 1.807 | 227 | .007 | 2.447 |
| 166 | .019 | 1.828 | 228 | .007 | 2.463 |
| 167 | .018 | 1.847 | 229 | .007 | 2.483 |
| 168 | .018 | 1.866 | 230 | .006 | 2.498 |
| 169 | .017 | 1.884 | 231 | .006 | 2.513 |
| 170 | .017 | 1.902 | 232 | .006 | 2.527 |
| 171 | .017 | 1.920 | 233 | .006 | 2.541 |
| 172 | .017 | 1.940 | 234 | .006 | 2.554 |
| 173 | .016 | 1.962 | 235 | .006 | 2.567 |
| 174 | .016 | 1.987 | 236 | .006 | 2.579 |
| 175 | .017 | 2.019 | 237 | .006 | 2.594 |
| 176 | .017 | 2.063 | 238 | .006 | 2.608 |
| 177 | .019 | 2.128 | 239 | .006 | 2.622 |
| 178 | .027 | 2.249 | 240 | .006 | 2.635 |
| 179 | .037 | -.430 | 241 | .006 | 2.649 |
| 180 | .031 | -.398 | 242 | .006 | 2.663 |
| 181 | .020 | -.287 | 243 | .006 | 2.677 |
| 182 | .009 | .142 | 244 | .006 | 2.691 |
| 183 | .009 | 1.750 | 245 | .006 | 2.705 |
| 184 | .020 | 2.229 | 246 | .006 | 2.719 |
| 185 | .033 | 2.357 | 247 | .006 | 2.733 |

| | | |
|---|---|---|
| 248 | .006 | 2.747 |
| 249 | .006 | 2.761 |
| 250 | .005 | 2.767 |
| 251 | .005 | 2.784 |
| 252 | .006 | 2.800 |
| 253 | .006 | 2.816 |
| 254 | .006 | 2.832 |
| 255 | .006 | 2.846 |
| 256 | .006 | 2.861 |