Debuncher Momentum Cooling Characterization
Pbar Note 673

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BD/Pbar Source

December 18, 2002

Abstract

The Debuncher Momentum cooling systems are designed to have fast ($\approx$ 1 sec) cooling times. As a result, measurement using spectrum analyzers is difficult. By using the Schottky signals of the Debuncher momentum cooling systems and the fast sampling of the HP89410A Vector Signal Analyzer, I am able to measure the cooling rates of the individual bands and of the entire system. In this note, I document the measurement method and present results. These are the first measurements of the cooling rate presented for these systems.

1 Measurement method

All measurements use the 8813th harmonic of the debuncher central revolution frequency, which is nominally 590035 Hz, corresponding to a frequency of 5.199976 GHz. This frequency is in the center of band 2. The HP 89410A Vector Signal Analyzer (VSA) operates in the range 0-200 MHz. I use the spectrum analyzer(SA) IF output signal, which down converts from the central value sampled to a central frequency of 21.4 MHz. The SA is centered at 5.199976 GHz, operated in 0 span mode, with a resolution bandwidth of 1 MHz. The input signal to the SA is the band 2 momentum Schottky signal. The full setup of the SA is included in Appendix 4.

The 21.4 MHz IF output signal is taken across the aisle in spigot FILLMEIN, where it is then connected to the input of the AD8116 Multiplexer at spigot 5. Channel 11 of the multiplexer output, which connects to the VSA RF input, is set to that input channel (currently known as Horizontal Damper Loop In on P189).

The VSA is centered at 21.4 MHz with a span of 350 kHz. I use rms averaging over 7 traces, with updates every 7 traces. In this way, each average trace is independent of the previous and following trace. The VSA is operated in armed trigger mode, with the arm on event (D:MOUNTT) at \$80 + 1.03 seconds (as bunch rotation concludes) and arm off (D:BEEPT) at \$80+8.03 seconds. A 10 second cycle time for \$29 events is used. Waterfall mode is turned on, with buffer depth of 100. The trace buffer is saved and then cleared before the next measurement. The full setup of the VSA is included in Appendix 5.

2 Data Analysis

The trace buffer is converted from SDF file format (native to the VSA) to ASCII using the DOS program SDFPRINT. The resulting file is read and analyzed, computing the mean of the

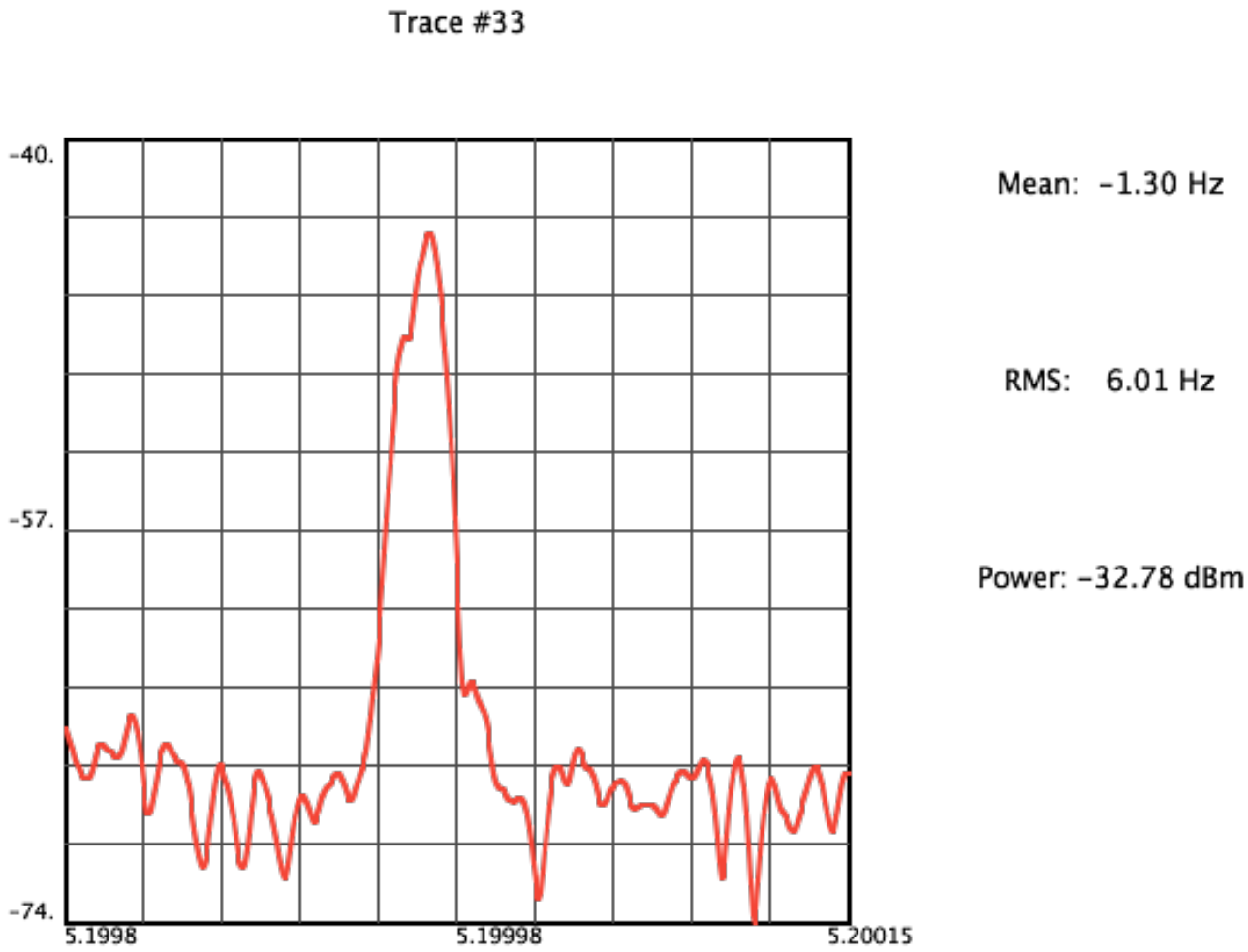


Figure 1: A sample trace near the end of the cooling cycle, with debuncher momentum cooling bands turned on. The horizontal axis is frequency in GHz, the vertical axis is power in dBm.

distribution, the RMS of the distribution, the power within $\pm 2\times$ the RMS, and the 95% width. All calculations subtract out a noise floor, measured to be -69 dBm by looking at cycles with no beam present. The 95% width is defined symmetrically, by looking for the points where the integral power (above the noise floor) goes past 2.5% and 97.5%. Figure 1 shows a sample trace near the end of the cycle. All frequencies are down converted to the fundamental (with nominal center of 590035 Hz).

A key element of this analysis is assigning times to traces. Data was taken with the standard setup, varying the amount of time the trigger was armed. I then counted traces in the trace buffer for each time period, which varied from 1 to 5 seconds. Based on the data in table 1, I used a $\delta t = 0.22$ seconds between traces.

In Figure 2, I show the data for a single 7 second time period. All 4 momentum bands are on. On the left are the individual traces in the buffer, with the horizontal axis the frequency in GHz and vertical power in dBm. The plots on the right show the mean (with respect to 590035 Hz), the power (within $\pm 2\times$ the RMS), the RMS of the distribution, and the 95% width. In these plots, the horizontal axis is time (in seconds). For the characterization measurements, I

t

Time period	Number of traces	δt (seconds)
1 second	5	0.2
2 seconds	9	0.22
2.4 seconds	11	0.23
2.6 seconds	12	0.23
2.8 seconds	12	0.22
3 seconds	13	0.22
5 seconds	22	0.23

Table 1: Defining timing for VSA setup. The trigger was armed for a defined time period and the trace buffer was saved. δt is defined as the time period / number of traces. Based on this data, I will use 0.22 seconds as the time between traces.

take 5 pulses for each setting and calculate the average and standard deviation for each statistic (mean, power, RMS, 95% width). The 95% width is converted from frequency to momentum with the following equation:

$$\delta \mathrm{p} = \frac{\delta \mathrm{f}}{f_0} \times \frac{\mathrm{p}}{\eta} \tag{1}$$

where f_0 is the measured 95% width, f_0 is the Debuncher central frequency (590035 Hz), p is the Debuncher central momentum (equal to Accumulator extraction orbit energy of 8886 MeV/c), and η is the Debuncher phase slip factor (0.006). For the Debuncher, a frequency width of 1 Hz corresponds to a momentum width of 2.51 MeV/c.

3 Results

The most recent data was taken on 12 Nov 02. In figure 3, I show the average 95% momentum width vs time for 5 different cases:

- Band 1 only
- Band 2 only
- Band 3 only
- Band 4 only
- All Bands

In all cases, all transverse cooling bands were on. Note that the asymptotic value of 7.7 ± 0.3 MeV/c is reached after ≈ 2 sec. The cooling time, found by fitting to an exponential over the first 1.5 seconds of data, is 1.7 pm0.3 seconds with a χ^2 of 1.4 for 6 degrees of freedom. Previous measurements (on Oct 7 and Nov 5) gave values of 1.4 ± 0.2 and 1.6 ± 0.2 seconds respectively.

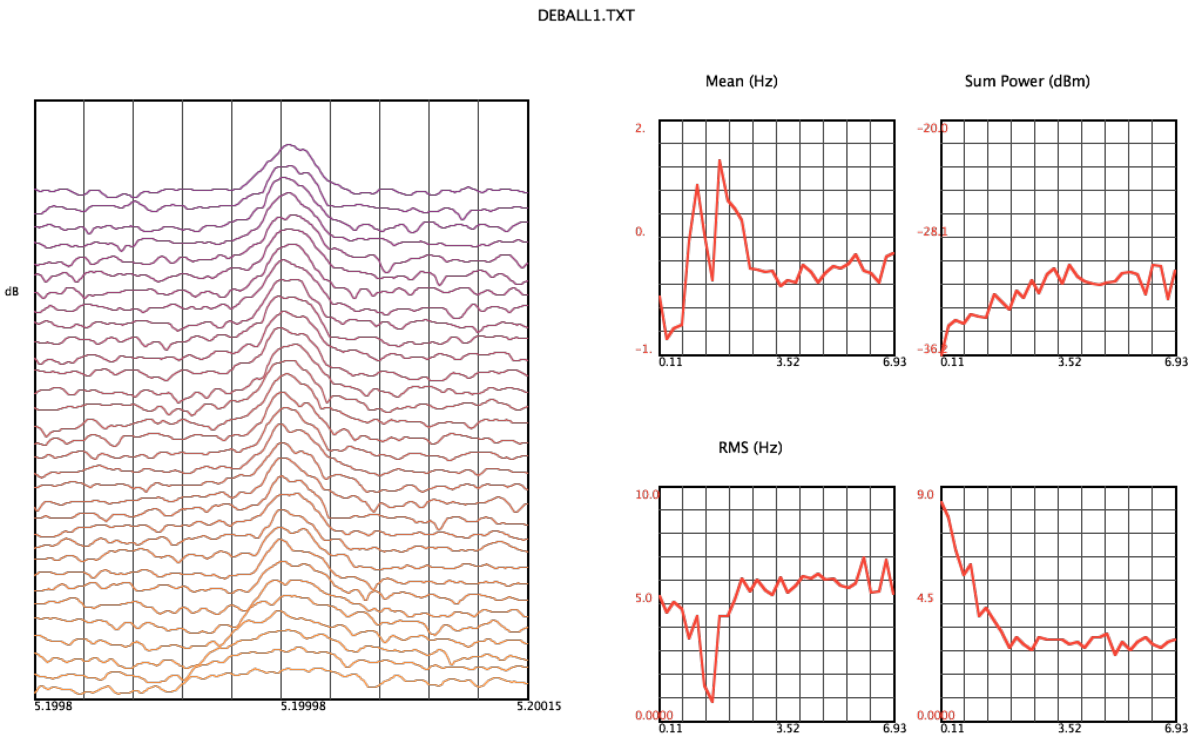
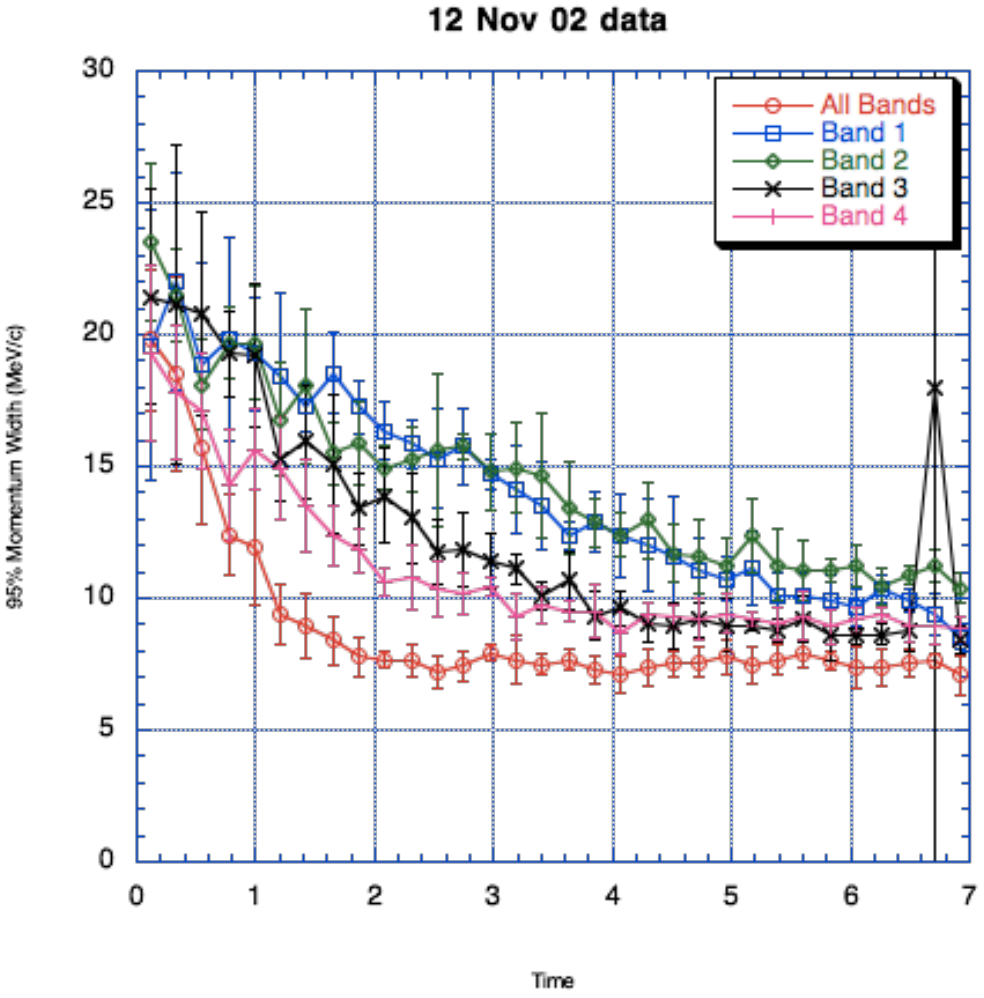


Figure 2: Summary data for an example trace. All four cooling bands are on for this data. The left plot shows the individual traces in the buffer, the right plots the statistics calculated for each trace.



t

Figure 3: 95% momentum width measurements for data taken on 12 Nov 02. I show the measurements from individual cooling bands 1-4 and for all bands. The asymptotic value for all bands is 7.7 ± 0.3 MeV/c with a fitted cooling time (over the first 1.5 seconds) of 1.7 ± 0.3 seconds.

4 Appendix SA Setup

```
IP                      ! Preset SA
RL -55 DB               ! Reference Level
AT 0 DB                 ! Attenuation Level
CF 5199.976 MZ          ! Center Frequency
SP 0 HZ                 ! Frequency Span
RB 1 MZ                 ! Resolution Bandwidth
```

5 Appendix VSA Setup

```
1 ! Instrument State File. Date: 11-12-02  01:17:59 PM
2 ! Checksum =  5031.
3 !*IDN HEWLETT-PACKARD,89410A/89430A,3346A00474/3517A00655,A.04.20/A.00.01
4 !SYST:PRES
5 !PAUS
6 !INST DEM
7 !FREQ:EXT:BAND +3E+006HZ
8 !FREQ:EXT:CENT +5.6E+006HZ
9 !FREQ:EXT:COMM +1
10 !FREQ:EXT:COMM:ADDR +18
11 !FREQ:EXT:MAX +2.2E+010HZ
12 !FREQ:EXT:MIN +0E+000HZ
13 !FREQ:EXT:MIRR OFF
14 !ROUT:REC RF2
15 !SWE1:POIN +401
16 !SWE2:POIN +401
17 !DEM1 OFF
18 !DEM2 OFF
19 !DEM1:CARR:AUTO +1
20 !DEM2:CARR:AUTO +1
21 !DEM1:CARR:AUTO:PM PAFR
22 !DEM2:CARR:AUTO:PM PAFR
23 !FREQ:STAR +2.1225E+007HZ
24 !FREQ:STOP +2.1575E+007HZ
25 !FREQ:BAS +1
26 !WIND FLAT
27 !WIND:GATE FLAT
28 !WIND:GATE:COUP ON
29 !SWE1:TIME +3.83928571428571E-004S
30 !SWE2:TIME +3.83928571428571E-004S
31 !SWE1:TIME:DEL +0E+000S
32 !SWE2:TIME:DEL +0E+000S
33 !SWE1:TIME:GATE +3.79464285714286E-005S
34 !SWE2:TIME:GATE +3.79464285714286E-005S
35 !SWE1:TIME:GATE:DEL +0E+000S
36 !SWE2:TIME:GATE:DEL +0E+000S
37 !SWE1:TIME:GATE:DEL:STEP +0E+000S
38 !SWE2:TIME:GATE:DEL:STEP +0E+000S
39 !SWE1:TIME:GATE:STAT +0
40 !SWE2:TIME:GATE:STAT +0
41 !BAND:MODE:ARB +0
42 !BAND +1E+004HZ
```

```
43 !BAND:AUTO:OFFS +0
44 !SWE1:TIME:RES:AUTO +0
45 !SWE2:TIME:RES:AUTO +0
46 !BAND:AUTO ON
47 !ARM:DEL +0E+000S
48 !ARM:LEV +9.9E-001V
49 !CORR1:LOSS:MAGN +1E+000
50 !CORR2:LOSS:MAGN +1E+000
51 !CORR1:IMP +5E+001OHM
52 !CORR2:IMP +5E+001OHM
53 !INP1 +1
54 !INP2 +1
55 !INP1:IMP +5E+001OHM
56 !INP2:IMP +5E+001OHM
57 !INP1:FILT +1
58 !INP2:FILT +1
59 !INP1:COUP AC
60 !INP2:COUP AC
61 !VOLT1:RANG -5.82692988212741E-016DBM
62 !VOLT2:RANG -5.82692988212741E-016DBM
63 !VOLT1:RANG:UNIT:VOLT DBM
64 !VOLT2:RANG:UNIT:VOLT DBM
65 !ARM:REG ABOV
66 !ARM:SOUR EXT
67 !CALC1:MATH:SEL F1
68 !CALC2:MATH:SEL F2
69 !CALC3:MATH:SEL F3
70 !CALC4:MATH:SEL F4
71 !CALC1:MATH:STAT +0
72 !CALC2:MATH:STAT +0
73 !CALC3:MATH:STAT +0
74 !CALC4:MATH:STAT +0
75 !CALC1:FEED "XFR:POW 1"
76 !CALC2:FEED "XFR:POW 2"
77 !CALC3:FEED "XTIM:VOLT 1"
78 !CALC4:FEED "XTIM:VOLT 2"
79 !CALC1:FORM MLOG
80 !CALC2:FORM MLOG
81 !CALC3:FORM REAL
82 !CALC4:FORM REAL
83 !CALC1:GDAP:APER +5E-001PCT
84 !CALC2:GDAP:APER +5E-001PCT
85 !CALC3:GDAP:APER +5E-001PCT
86 !CALC4:GDAP:APER +5E-001PCT
87 !CALC1:MARK:BAND:STAR +4.5E+006HZ
88 !CALC2:MARK:BAND:STAR +4.5E+006HZ
89 !CALC3:MARK:BAND:STAR -8.76816254171301E-007S
90 !CALC4:MARK:BAND:STAR -8.76816254171301E-007S
91 !CALC1:MARK:BAND:STOP +5.5E+006HZ
92 !CALC2:MARK:BAND:STOP +5.5E+006HZ
93 !CALC3:MARK:BAND:STOP +1.1231837458287E-006S
94 !CALC4:MARK:BAND:STOP +1.1231837458287E-006S
95 !CALC1:MARK:COUP +0
96 !CALC2:MARK:COUP +0
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97 !CALC3:MARK:COUP +0
98 !CALC4:MARK:COUP +0
99 !CALC1:MARK:FCO +0
100 !CALC2:MARK:FCO +0
101 !CALC3:MARK:FCO +0
102 !CALC4:MARK:FCO +0
103 !CALC1:MARK:FUNC OFF
104 !CALC2:MARK:FUNC OFF
105 !CALC3:MARK:FUNC OFF
106 !CALC4:MARK:FUNC OFF
107 !CALC1:MARK:OFFS +0
108 !CALC2:MARK:OFFS +0
109 !CALC3:MARK:OFFS +0
110 !CALC4:MARK:OFFS +0
111 !CALC1:MARK:OFFS:X +0E+000HZ
112 !CALC2:MARK:OFFS:X +0E+000HZ
113 !CALC3:MARK:OFFS:X +0E+000S
114 !CALC4:MARK:OFFS:X +0E+000S
115 !CALC1:MARK:OFFS:Y -2.35431510388986E-019DBM
116 !CALC2:MARK:OFFS:Y -2.35431510388986E-019DBM
117 !CALC3:MARK:OFFS:Y +0E+000V
118 !CALC4:MARK:OFFS:Y +0E+000V
119 !CALC1:MARK:OFFS:Z +0E+000S
120 !CALC2:MARK:OFFS:Z +0E+000S
121 !CALC3:MARK:OFFS:Z +0E+000S
122 !CALC4:MARK:OFFS:Z +0E+000S
123 !CALC1:MARK:SEAR:BUFF OFF
124 !CALC2:MARK:SEAR:BUFF OFF
125 !CALC3:MARK:SEAR:BUFF OFF
126 !CALC4:MARK:SEAR:BUFF OFF
127 !CALC1:MARK:SEAR:TARG -3E+000DBM
128 !CALC2:MARK:SEAR:TARG -3E+000DBM
129 !CALC3:MARK:SEAR:TARG +0E+000V
130 !CALC4:MARK:SEAR:TARG +0E+000V
131 !CALC1:MARK +1
132 !CALC2:MARK +1
133 !CALC3:MARK +1
134 !CALC4:MARK +1
135 !CALC1:MARK:TRAC +0
136 !CALC2:MARK:TRAC +0
137 !CALC3:MARK:TRAC +0
138 !CALC4:MARK:TRAC +0
139 !CALC1:MARK:X +2.14E+007HZ
140 !CALC2:MARK:X +3.5E+005HZ
141 !CALC3:MARK:X +0E+000S
142 !CALC4:MARK:X +0E+000S
143 !CALC1:MARK:MAX:TRAC +0
144 !CALC2:MARK:MAX:TRAC +0
145 !CALC3:MARK:MAX:TRAC +0
146 !CALC4:MARK:MAX:TRAC +0
147 !CALC1:MARK:Z +1E+002
148 !CALC2:MARK:Z +6E+001
149 !CALC3:MARK:Z +1E+000
150 !CALC4:MARK:Z +1E+000
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151 !CALC1:MARK:Z:UNIT UNITLESS
152 !CALC2:MARK:Z:UNIT UNITLESS
153 !CALC3:MARK:Z:UNIT UNITLESS
154 !CALC4:MARK:Z:UNIT UNITLESS
155 !CALC1:STAT +1
156 !CALC2:STAT +1
157 !CALC3:STAT +1
158 !CALC4:STAT +1
159 !CALC1:UNIT:POW DBM
160 !CALC2:UNIT:POW DBM
161 !CALC3:UNIT:POW V
162 !CALC4:UNIT:POW V
163 !CALC1:UPH:CREF +0E+000HZ
164 !CALC2:UPH:CREF +0E+000HZ
165 !CALC3:UPH:CREF +0E+000S
166 !CALC4:UPH:CREF +0E+000S
167 !CALC1:UPH:OFFS +0E+000DEG
168 !CALC2:UPH:OFFS +0E+000DEG
169 !CALC3:UPH:OFFS +0E+000DEG
170 !CALC4:UPH:OFFS +0E+000DEG
171 !CALC1:X:UNIT:FREQ HZ
172 !CALC2:X:UNIT:FREQ HZ
173 !CALC3:X:UNIT:TIME S
174 !CALC4:X:UNIT:TIME S
175 !DISP:ANN +1
176 !DISP:ENAB +1
177 !DISP:FORM SING
178 !DISP:MFUN +0
179 !DISP:PROG OFF
180 !DISP:TCAP:ENV +1
181 !DISP:WIND1:ACT +1
182 !DISP:WIND2:ACT +0
183 !DISP:WIND3:ACT +0
184 !DISP:WIND4:ACT +0
185 !DISP:WIND1:ACT +1
186 !DISP:WIND2:ACT +0
187 !DISP:WIND3:ACT +0
188 !DISP:WIND4:ACT +0
189 !DISP:WIND1:SPEC:COL +64
190 !DISP:WIND2:SPEC:COL +64
191 !DISP:WIND3:SPEC:COL +64
192 !DISP:WIND4:SPEC:COL +64
193 !DISP:WIND1:SPEC:ENH +50PCT
194 !DISP:WIND2:SPEC:ENH +50PCT
195 !DISP:WIND3:SPEC:ENH +50PCT
196 !DISP:WIND4:SPEC:ENH +50PCT
197 !DISP:WIND1:SPEC:MAP COL
198 !DISP:WIND2:SPEC:MAP COL
199 !DISP:WIND3:SPEC:MAP COL
200 !DISP:WIND4:SPEC:MAP COL
201 !DISP:WIND1:SPEC +0
202 !DISP:WIND2:SPEC +0
203 !DISP:WIND3:SPEC +0
204 !DISP:WIND4:SPEC +0
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205 !DISP:WIND1:SPEC:THR +0PCT
206 !DISP:WIND2:SPEC:THR +0PCT
207 !DISP:WIND3:SPEC:THR +0PCT
208 !DISP:WIND4:SPEC:THR +0PCT
209 !DISP:WIND1:TRAC:BUFF +100
210 !DISP:WIND2:TRAC:BUFF +60
211 !DISP:WIND3:TRAC:BUFF +1
212 !DISP:WIND4:TRAC:BUFF +1
213 !DISP:WIND1:TRAC:DCAR +0
214 !DISP:WIND2:TRAC:DCAR +0
215 !DISP:WIND3:TRAC:DCAR +0
216 !DISP:WIND4:TRAC:DCAR +0
217 !DISP:WIND1:TRAC:EYE:COUN +2
218 !DISP:WIND2:TRAC:EYE:COUN +2
219 !DISP:WIND3:TRAC:EYE:COUN +2
220 !DISP:WIND4:TRAC:EYE:COUN +2
221 !DISP:WIND1:TRAC:GRAT:GRID +1
222 !DISP:WIND2:TRAC:GRAT:GRID +1
223 !DISP:WIND3:TRAC:GRAT:GRID +1
224 !DISP:WIND4:TRAC:GRAT:GRID +1
225 !DISP:WIND1:TRAC:IND CROS
226 !DISP:WIND2:TRAC:IND CROS
227 !DISP:WIND3:TRAC:IND CROS
228 !DISP:WIND4:TRAC:IND CROS
229 !DISP:WIND1:TRAC:IND:SIZE +15
230 !DISP:WIND2:TRAC:IND:SIZE +15
231 !DISP:WIND3:TRAC:IND:SIZE +15
232 !DISP:WIND4:TRAC:IND:SIZE +15
233 !DISP:WIND1:TRAC:INFO ""
234 !DISP:WIND2:TRAC:INFO ""
235 !DISP:WIND3:TRAC:INFO ""
236 !DISP:WIND4:TRAC:INFO ""
237 !DISP:WIND1:TRAC:LAB:USER ""
238 !DISP:WIND2:TRAC:LAB:USER ""
239 !DISP:WIND3:TRAC:LAB:USER ""
240 !DISP:WIND4:TRAC:LAB:USER ""
241 !DISP:WIND1:TRAC:LAB:AUTO +1
242 !DISP:WIND2:TRAC:LAB:AUTO +1
243 !DISP:WIND3:TRAC:LAB:AUTO +1
244 !DISP:WIND4:TRAC:LAB:AUTO +1
245 !DISP:WIND1:TRAC +1
246 !DISP:WIND2:TRAC +0
247 !DISP:WIND3:TRAC +0
248 !DISP:WIND4:TRAC +0
249 !DISP:WIND1:TRAC:SYMB DOTS
250 !DISP:WIND2:TRAC:SYMB BARS
251 !DISP:WIND3:TRAC:SYMB OFF
252 !DISP:WIND4:TRAC:SYMB OFF
253 !DISP:WIND1:TRAC:SYMB:FORM BIN
254 !DISP:WIND2:TRAC:SYMB:FORM BIN
255 !DISP:WIND3:TRAC:SYMB:FORM BIN
256 !DISP:WIND4:TRAC:SYMB:FORM BIN
257 !DISP:WIND1:TRAC:X:LEFT +2.5E+006HZ
258 !DISP:WIND2:TRAC:X:LEFT +2.5E+006HZ
```

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259 !DISP:WIND3:TRAC:X:LEFT +6.15918729143493E-008S
260 !DISP:WIND4:TRAC:X:LEFT +6.15918729143493E-008S
261 !DISP:WIND1:TRAC:X:RIGH +7.5E+006HZ
262 !DISP:WIND2:TRAC:X:RIGH +7.5E+006HZ
263 !DISP:WIND3:TRAC:X:RIGH +1.84775618743048E-007S
264 !DISP:WIND4:TRAC:X:RIGH +1.84775618743048E-007S
265 !DISP:WIND1:TRAC:X:RLEV -3.5E+001DBM
266 !DISP:WIND2:TRAC:X:RLEV +0E+000DBM
267 !DISP:WIND3:TRAC:X:RLEV +0E+000V
268 !DISP:WIND4:TRAC:X:RLEV +0E+000V
269 !DISP:WIND1:TRAC:X:SPAC LIN
270 !DISP:WIND2:TRAC:X:SPAC LIN
271 !DISP:WIND3:TRAC:X:SPAC LIN
272 !DISP:WIND4:TRAC:X:SPAC LIN
273 !DISP:WIND1:TRAC:Y:RLIN +0
274 !DISP:WIND2:TRAC:Y:RLIN +0
275 !DISP:WIND3:TRAC:Y:RLIN +0
276 !DISP:WIND4:TRAC:Y:RLIN +0
277 !DISP:WIND1:TRAC:X:AUTO +1
278 !DISP:WIND2:TRAC:X:AUTO +1
279 !DISP:WIND3:TRAC:X:AUTO +1
280 !DISP:WIND4:TRAC:X:AUTO +1
281 !DISP:WIND1:TRAC:Y:AUTO +0
282 !DISP:WIND2:TRAC:Y:AUTO +0
283 !DISP:WIND3:TRAC:Y:AUTO +0
284 !DISP:WIND4:TRAC:Y:AUTO +0
285 !DISP:WIND1:TRAC:Y:PDIV +5E+000DB
286 !DISP:WIND2:TRAC:Y:PDIV +1E+001DB
287 !DISP:WIND3:TRAC:Y:PDIV +1E-001V
288 !DISP:WIND4:TRAC:Y:PDIV +1E-001V
289 !DISP:WIND1:TRAC:Y:RLEV -3.5E+001DBM
290 !DISP:WIND2:TRAC:Y:RLEV +0E+000DBM
291 !DISP:WIND3:TRAC:Y:RLEV +0E+000V
292 !DISP:WIND4:TRAC:Y:RLEV +0E+000V
293 !DISP:WIND1:TRAC:Y:RLEV:AUTO +0
294 !DISP:WIND2:TRAC:Y:RLEV:AUTO +1
295 !DISP:WIND3:TRAC:Y:RLEV:AUTO +1
296 !DISP:WIND4:TRAC:Y:RLEV:AUTO +1
297 !DISP:WIND1:TRAC:Y:RPOS +1E+002PCT
298 !DISP:WIND2:TRAC:Y:RPOS +1E+002PCT
299 !DISP:WIND3:TRAC:Y:RPOS +5E+001PCT
300 !DISP:WIND4:TRAC:Y:RPOS +5E+001PCT
301 !DISP:WIND1:WAT:AZIM +0PIXELS
302 !DISP:WIND2:WAT:AZIM +0PIXELS
303 !DISP:WIND3:WAT:AZIM +0PIXELS
304 !DISP:WIND4:WAT:AZIM +0PIXELS
305 !DISP:WIND1:WAT:BLIN +0
306 !DISP:WIND2:WAT:BLIN +0
307 !DISP:WIND3:WAT:BLIN +0
308 !DISP:WIND4:WAT:BLIN +0
309 !DISP:WIND1:WAT:ELEV +15PIXELS
310 !DISP:WIND2:WAT:ELEV +5PIXELS
311 !DISP:WIND3:WAT:ELEV +10PIXELS
312 !DISP:WIND4:WAT:ELEV +10PIXELS
```

```
313 !DISP:WIND1:WAT:HEIG +80PIXELS
314 !DISP:WIND2:WAT:HEIG +50PIXELS
315 !DISP:WIND3:WAT:HEIG +40PIXELS
316 !DISP:WIND4:WAT:HEIG +40PIXELS
317 !DISP:WIND1:WAT:HLIN +0
318 !DISP:WIND2:WAT:HLIN +0
319 !DISP:WIND3:WAT:HLIN +0
320 !DISP:WIND4:WAT:HLIN +0
321 !DISP:WIND1:WAT +1
322 !DISP:WIND2:WAT +0
323 !DISP:WIND3:WAT +0
324 !DISP:WIND4:WAT +0
325 !DISP:WIND1:WAT:THR +0PCT
326 !DISP:WIND2:WAT:THR +0PCT
327 !DISP:WIND3:WAT:THR +0PCT
328 !DISP:WIND4:WAT:THR +0PCT
329 !OUTP:FILT +1
330 !OUTP:IMP +5E+001
331 !OUTP +0
332 !AVER:COUN +7
333 !AVER:IRES:RATE +7
334 !AVER:IRES +1
335 !AVER +1
336 !AVER:TCON REP
337 !AVER:TYPE RMS
338 !CORR1:EDEL +0E+000S
339 !CORR2:EDEL +0E+000S
340 !CORR1:EXT +0
341 !CORR2:EXT +0
342 !CORR1:FILT:XTIM:STAT +1
343 !CORR2:FILT:XTIM:STAT +1
344 !DET POS
345 !FEED "INP"
346 !FREQ:CENT:TRAC OFF
347 !FREQ:MAN +9.01E+008HZ
348 !FREQ:SPAN:PCH EXAC
349 !FREQ:STEP:AUTO +1,
350 !FREQ:STEP +4.495E+006HZ
351 !SWE1:MODE AUTO
352 !SWE2:MODE AUTO
353 !SWE1:OVER +0E+000PCT
354 !SWE2:OVER +0E+000PCT
355 !SWE1:TIME:OVER +9.8E+001PCT
356 !SWE2:TIME:OVER +9.8E+001PCT
357 !TCAP1:DIR FORW
358 !TCAP2:DIR FORW
359 !TCAP1:LENG +2.9314656E+005POINTS
360 !TCAP2:LENG +2.9314656E+005POINTS
361 !TCAP1:STAR +0E+000S
362 !TCAP2:STAR +0E+000S
363 !TCAP1:STOP +0E+000S
364 !TCAP2:STOP +0E+000S
365 !SOUR:RF +1
366 !SOUR:AM:STAT +0
```

```
367 !SOUR:FREQ +1E+006HZ
368 !SOUR:FREQ:OFFS +0E+000HZ
369 !SOUR:FUNC SIN
370 !SOUR:FUNC:USER:FEED "D1"
371 !SOUR:IFIN:STAT +0
372 !SOUR:USER:REP +1
373 !SOUR:VOLT -1E+001DBM
374 !SOUR:VOLT:OFFS +0E+000V
375 !SOUR:VOLT:UNIT:VOLT DBM
376 !TRIG:HOLD:DEL +0E+000S
377 !TRIG:HOLD:STAT +0
378 !TRIG:SOUR IMM
379 !TRIG:LEV +0E+000V
380 !TRIG:SLOP POS
381 !INIT:CONT +1
382 !CAL:ZERO:AUTO +1
383 !VOLT1:RANG:AUTO:DIR EITH
384 !VOLT2:RANG:AUTO:DIR EITH
385 !VOLT1:RANG:AUTO +0
386 !VOLT2:RANG:AUTO +0
387 !CAL:AUTO +0
388 !SYST:GPIB:ECHO +0
389 !CONT
```