GLOW Interferometry Tutorial: Wednesday

We will reduce the 3C129 polarization continuum dataset from the 2008 NRAO summer school. (See http://casa.nrao.edu/Tutorial/SIworkshop2008/) The summer school used CASA for the data reduction. You are welcome to try to use CASA for the data reduction on your own (but see also the warnings about what to do what CASA crashes frequently), but we will do the basic reduction in AIPS.

2010 Nov 16: JMA updated for 31DEC10 AIPS

Web Image of 3C129

Wide-field 90 cm image of the large head-tail radio galaxy 3C129 (right). The bright source at the left is 3C129.1. From Lane et al., AJ, 123, 2985, 2002.

The 8.5 GHz observations being reduced here will only look at the central, brightest, portion of this source.

Data Reduction

Remember, the purpose f this exercise is not to teach you how to reduce radio interferometry data with AIPS. Consider all of the arcane incantations below as just that, magic incantations. You should instead try to figure out what each step is actually doing to the data. The AIPS Cookbook has quite a bit of information to help guide you. Check out chapters 4 and 5. (Note that you probably have a copy of the cookbook in your local AIPS installation if you don't have full web access.) However, at some of the most important points, the cookbook is relatively useless for **understanding what is going on**, as opposed to knowing which buttons to push, so ask your tutorial leader for help in this area.

Download the data from http://casa.nrao.edu/Data/VLA/3C129/3c129data.tgz and untar it in some directory. (If you are in Garching, there should be a local copy. Ask Sven.) Then, from that same directory, start aips. Login with a new user ID number.

Basic Environment

```
dowait 1
dohist=1
docrt=132
dotv=1
```

Load the raw data: FILLM

```
task 'fillm'
default
nfiles 0
prtlev 0
datain 'PWD:AT166_
doconcat true
clron
doweight 10
ncount 3
cparm(4)=28
cparm(8)=10./60
dparm 0
bparm 0
timer 0
vlamode = ' '
band = ' '
calcode ' '
clron
outdisk 1
go
```

Check where it went. You will need the X band version at 8.5 GHz

Note that there are multiple sequence numbers for the same bands, as the observation was done using different frequency settings. We want the initial 8.5 GHz observation.

```
indi 1
pcat
getn 3
imhe
```

```
AIPS 1: Got(1)   disk= 1  user= 100   type=UV   19940725.X BAND.2
AIPS 1: Image=MULTI     (UV)         Filename=19940725    .X BAND.   2
AIPS 1: Telescope=VLA                Receiver=VLA
AIPS 1: Observer=AT166               User #=  100
AIPS 1: Observ. date=25-JUL-1994     Map date=16-NOV-2010
AIPS 1: # visibilities    284570     Sort order  TB
AIPS 1: Rand axes: UU-L-SIN  VV-L-SIN  WW-L-SIN  BASELINE  TIME1
AIPS 1:            SOURCE  FREQSEL
AIPS 1: ------------------------------------------------------------------
AIPS 1: Type    Pixels   Coord value     at Pixel     Coord incr   Rotat
AIPS 1: COMPLEX      3   1.0000000E+00       1.00  1.0000000E+00    0.00
AIPS 1: STOKES       4  -1.0000000E+00       1.00 -1.0000000E+00    0.00
AIPS 1: FREQ         1   8.5149000E+09       1.00  5.0000000E+07    0.00
AIPS 1: IF           2   1.0000000E+00       1.00  1.0000000E+00    0.00
```

```
AIPS 1: RA           1    00 00 00.000       1.00       3600.000    0.00
AIPS 1: DEC          1    00 00 00.000       1.00       3600.000    0.00
AIPS 1: ------------------------------------------------------------------
AIPS 1: Coordinate equinox 1950.00
AIPS 1: Maximum version number of extension files of type HI is   1
AIPS 1: Maximum version number of extension files of type AN is   1
AIPS 1: Maximum version number of extension files of type NX is   1
AIPS 1: Maximum version number of extension files of type SU is   1
AIPS 1: Maximum version number of extension files of type FQ is   1
AIPS 1: Maximum version number of extension files of type CL is   1
AIPS 1: Maximum version number of extension files of type TY is   1
AIPS 1: Maximum version number of extension files of type OF is   1
AIPS 1: Keyword = 'CORRMODE'  value = '        '
AIPS 1: Keyword = 'VLAIFS  '  value = 'ABCD    '
AIPS 1: Keyword = 'CORRCOEF'  value =           -1
```

Print out some useful information

```
task 'listr'
default
getn 3
optype 'scan'
doweight 1
docrt=132
flagver 0
sources ' '
stokes ' '
docalib 0
gainuse 1
dopol -1
dparm 0
antenna 0
basel 0
stokes ' '
inext ' '
inver 0
bif 0
eif 0
uvrange 0
go
```

```
 vlb054    LISTR(31DEC10)    100     16-NOV-2010  17:47:48    Page    1
File = 19940725    .X BAND.   2 Vol = 1  Userid =  100
Freq =  8.514900000 GHz   Ncor =  4   No. vis =    284570
Scan summary listing

Scan      Source      Qual  Calcode Sub         Timerange          FrqID
START VIS  END VIS
   1 2345-167        : 0002  A        1  0/07:38:45 -   0/07:41:35     1
1       5236
```

```
   2 A2597           : 0002           1  0/07:53:05 -   0/08:00:15     1
5237      18977
   3 2345-167        : 0002  A        1  0/08:19:15 -   0/08:20:55     1
18978      22007
   4 A2597           : 0002           1  0/08:32:25 -   0/08:39:35     1
22008      35677
   5 2345-167        : 0002  A        1  0/08:58:25 -   0/09:00:15     1
35678      39018
   6 A2597           : 0002           1  0/09:11:35 -   0/09:18:55     1
39019      53084
   7 2345-167        : 0002  A        1  0/09:37:45 -   0/09:39:35     1
53085      56355
   8 A2597           : 0002           1  0/09:50:55 -   0/09:58:15     1
56356      70435
   9 2345-167        : 0002  A        1  0/10:17:05 -   0/10:18:55     1
70436      73790
  10 A2597           : 0002           1  0/10:30:15 -   0/10:37:35     1
73791      87870
  11 2345-167        : 0002  A        1  0/10:56:25 -   0/10:58:15     1
87871      91211
  12 A2597           : 0002           1  0/11:09:35 -   0/11:16:55     1
91212     105291
  13 2345-167        : 0002  A        1  0/11:35:45 -   0/11:37:35     1
105292     108646
  14 0420+417        : 0002  B        1  0/11:46:35 -   0/11:48:15     1
108647     111676
  15 3C129           : 0002           1  0/12:02:35 -   0/12:12:45     1
111677     131281
  16 0420+417        : 0002  B        1  0/12:25:25 -   0/12:27:15     1
131282     134636
  17 3C129           : 0002           1  0/12:39:45 -   0/12:49:55     1
134637     154172
  18 0420+417        : 0002  B        1  0/13:02:35 -   0/13:04:25     1
154173     157527
  19 3C129           : 0002           1  0/13:18:45 -   0/13:28:55     1
157528     175547
  20 0420+417        : 0002  B        1  0/13:41:35 -   0/13:43:25     1
175548     178625
  21 3C129           : 0002           1  0/13:55:55 -   0/14:06:05     1
178626     196645
  22 0420+417        : 0002  B        1  0/14:18:45 -   0/14:20:35     1
196646     199665
  23 3C129           : 0002           1  0/14:34:55 -   0/14:45:05     1
199666     216239
  24 0420+417        : 0002  B        1  0/14:57:45 -   0/14:59:35     1
216240     219330
  25 3C129           : 0002           1  0/15:10:55 -   0/15:18:15     1
219331     231264
  26 0420+417        : 0002  B        1  0/15:28:05 -   0/15:29:55     1
231265     234102
```

```
  27 3C129           : 0002           1  0/15:44:45 -   0/15:54:55     1
234103     250648
  28 0420+417        : 0002  B        1  0/16:08:05 -   0/16:09:55     1
250649     253428
  29 3C129           : 0002           1  0/16:24:35 -   0/16:34:45     1
253429     269933
  30 0420+417        : 0002  B        1  0/16:47:35 -   0/16:49:25     1
269934     273011
  31 0518+165        : 0002  C        1  0/17:03:05 -   0/17:06:25     1
273012     278789
  32 0134+329        : 0002  C        1  0/17:18:15 -   0/17:21:35     1
278790     284570
Type Q to stop, just hit RETURN to continue

 vlb054    LISTR(31DEC10)    100     16-NOV-2010  17:48:06    Page    2
File = 19940725    .X BAND.   2 Vol = 1  Userid =  100

Source summary
Velocity type = '        '    Definition = '        '

  ID Source           Qual  Calcode RA(1950.0)     Dec(1950.0)   IFlux
QFlux   UFlux   VFlux  No. vis
   1 2345-167        : 0002   A     23:45:27.6823 -16:47:52.600   0.000
0.000   0.000   0.000   24929
             IF( 2)                                               0.000
0.000   0.000   0.000
   2 A2597           : 0002         23:22:43.7000 -12:23:56.000   0.000
0.000   0.000   0.000   83717
             IF( 2)                                               0.000
0.000   0.000   0.000
   3 0420+417        : 0002   B     04:20:27.9370  41:43:08.045   0.000
0.000   0.000   0.000   27625
             IF( 2)                                               0.000
0.000   0.000   0.000
   4 3C129           : 0002         04:45:31.6950  44:55:19.950   0.000
0.000   0.000   0.000  136740
             IF( 2)                                               0.000
0.000   0.000   0.000
   5 0518+165        : 0002   C     05:18:16.5320  16:35:26.900   0.000
0.000   0.000   0.000    5778
             IF( 2)                                               0.000
0.000   0.000   0.000
   6 0134+329        : 0002   C     01:34:49.8320  32:54:20.520   0.000
0.000   0.000   0.000    5781
             IF( 2)                                               0.000
0.000   0.000   0.000

  ID Source           Freq(GHz) Velocity(Km/s) Rest freq (GHz)
   1 All Sources          8.5149         0.0000          0.0000
     IF(  2)              8.8851         0.0000          0.0000
```

```
Frequency Table summary
FQID IF#      Freq(GHz)      BW(kHz)   Ch.Sep(kHz)  Sideband
   1   1       8.51490000   50000.0039  50000.0039      1
       2       8.88510000   50000.0039  50000.0039      1
AIPS 1: Resumes
```

Where are the antennas located?

go prtan

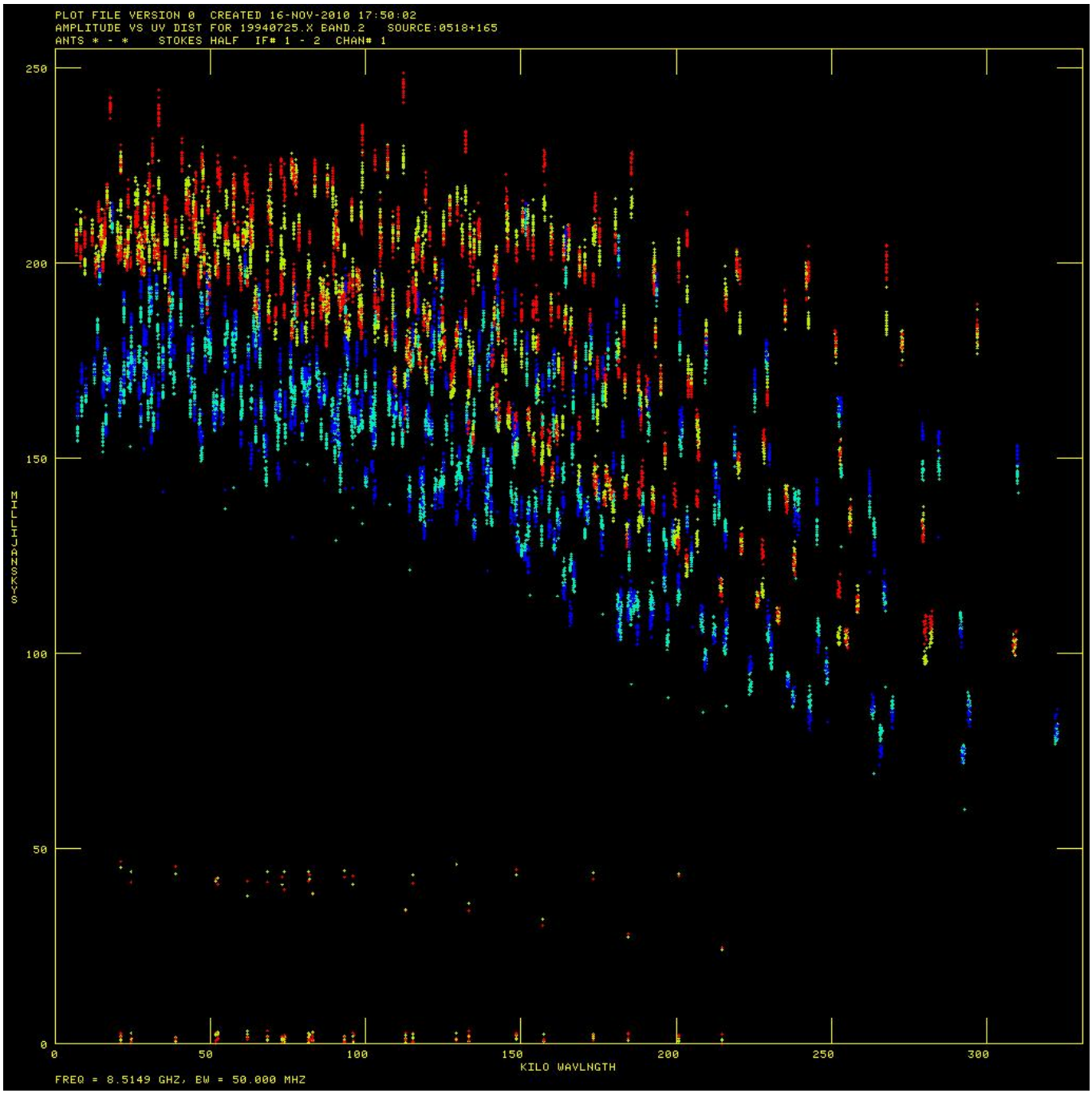
```
                     Location Of VLA Antennas

                              N36 (26)
                              N32 ( 1)
                              N28 (19)
                              N24 (11)
                              N20 (15)
                              N16 (25)
                              N12 (13)
                              N8  (27)
                              N4  (14)
                           (12) W4   E4  (22)
                         ( 8) W8       E8  ( 4)
                       ( 3) W12          E12 (16)
                     (28) W16              E16 ( 7)
                   ( 2) W20                  E20 (17)
                 (21) W24                      E24 (24)
               (10) W28                          E28 ( 5)
             (18) W32                              E32 (23)
           (20) W36                                  E36 ( 6)
                         VLA:_OUT ( 9)
                         VPT:_OUT (29)
```

Investigate the data

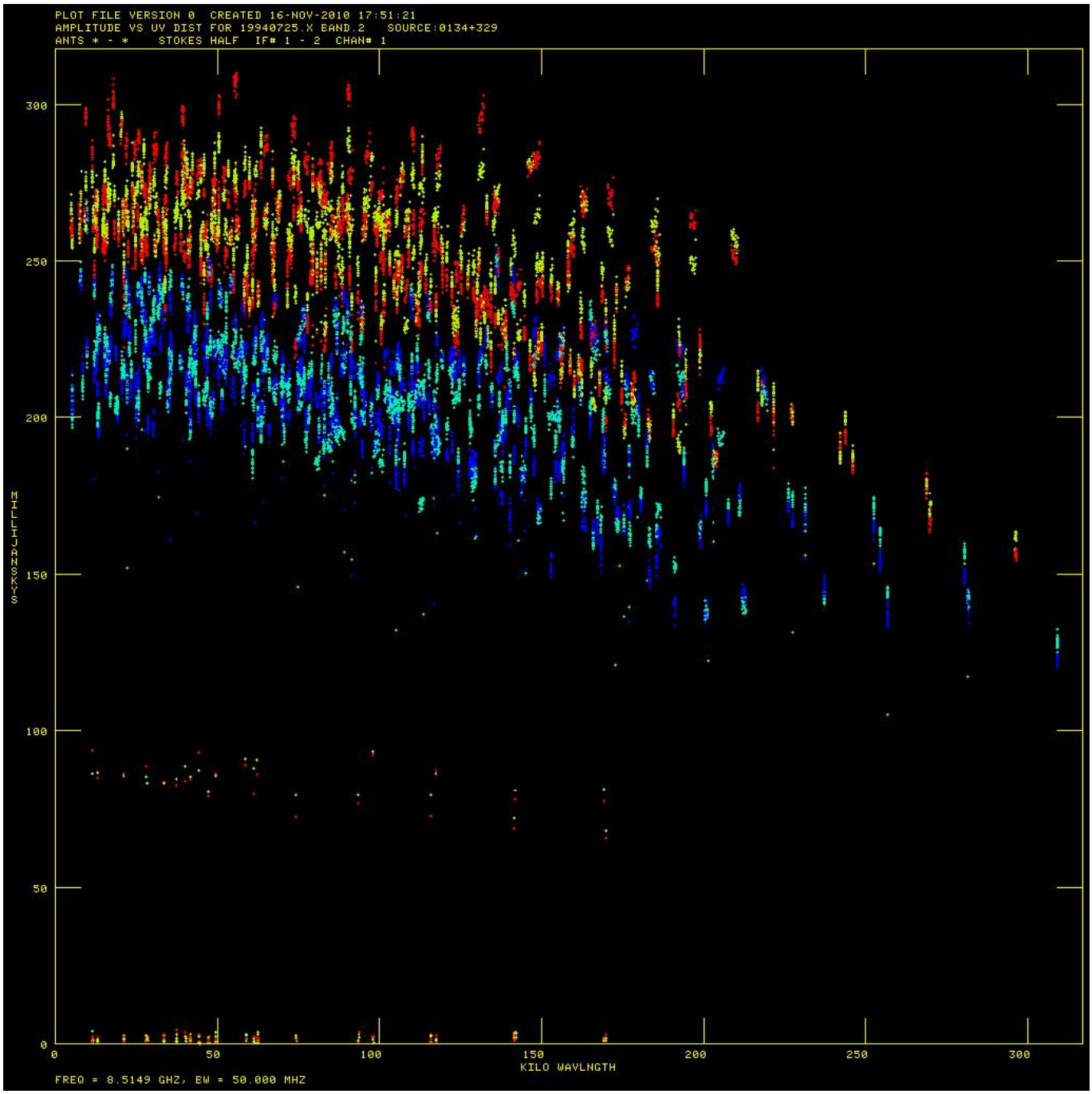
Plots

```
task 'uvplt'
source '0518+165',' '
calcode ' '
stokes 'half'
timer 0
uvrange 0
bif 0
eif 0
docalib 0
```

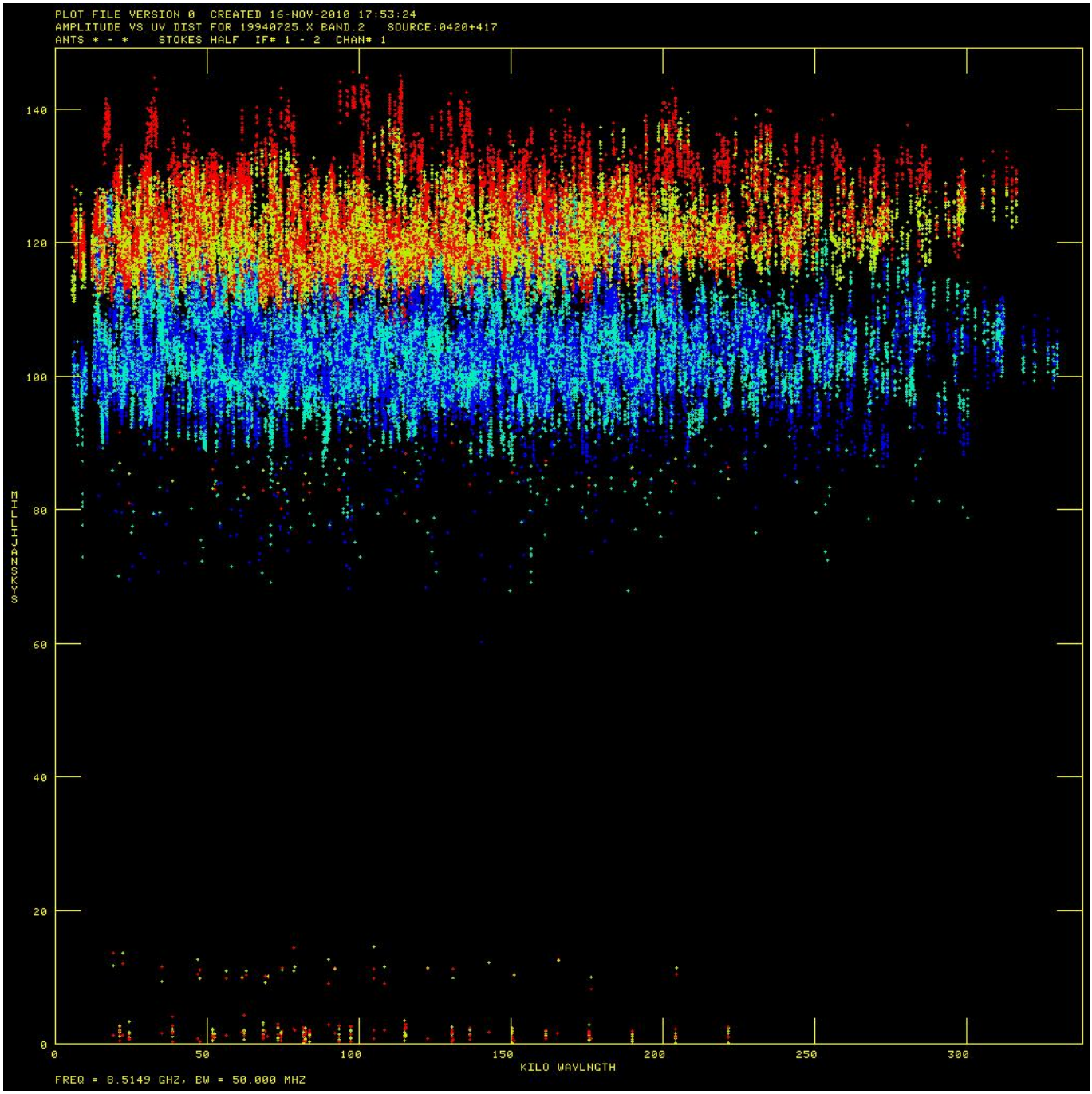
```
gainuse 1
bparm 0 1
aparm 0
refant 22
do3col 1
dotv 1
tvinit
go
```




```
source '0134+329',' '
tvinit
go
```




```
source '0420+417', ' '
tvinit
go
```

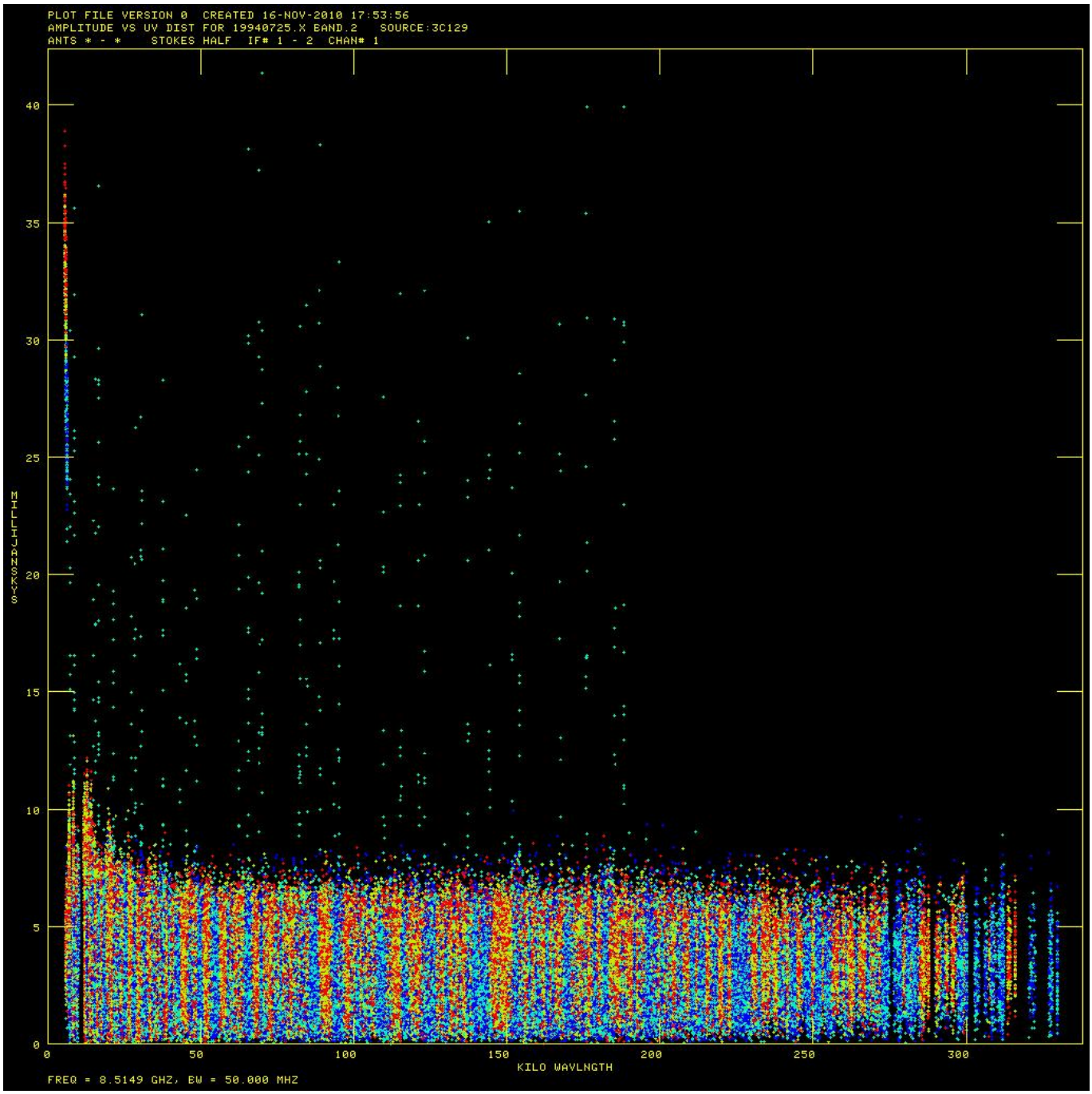


Note that the VLA Calibrator Manual says for this source:

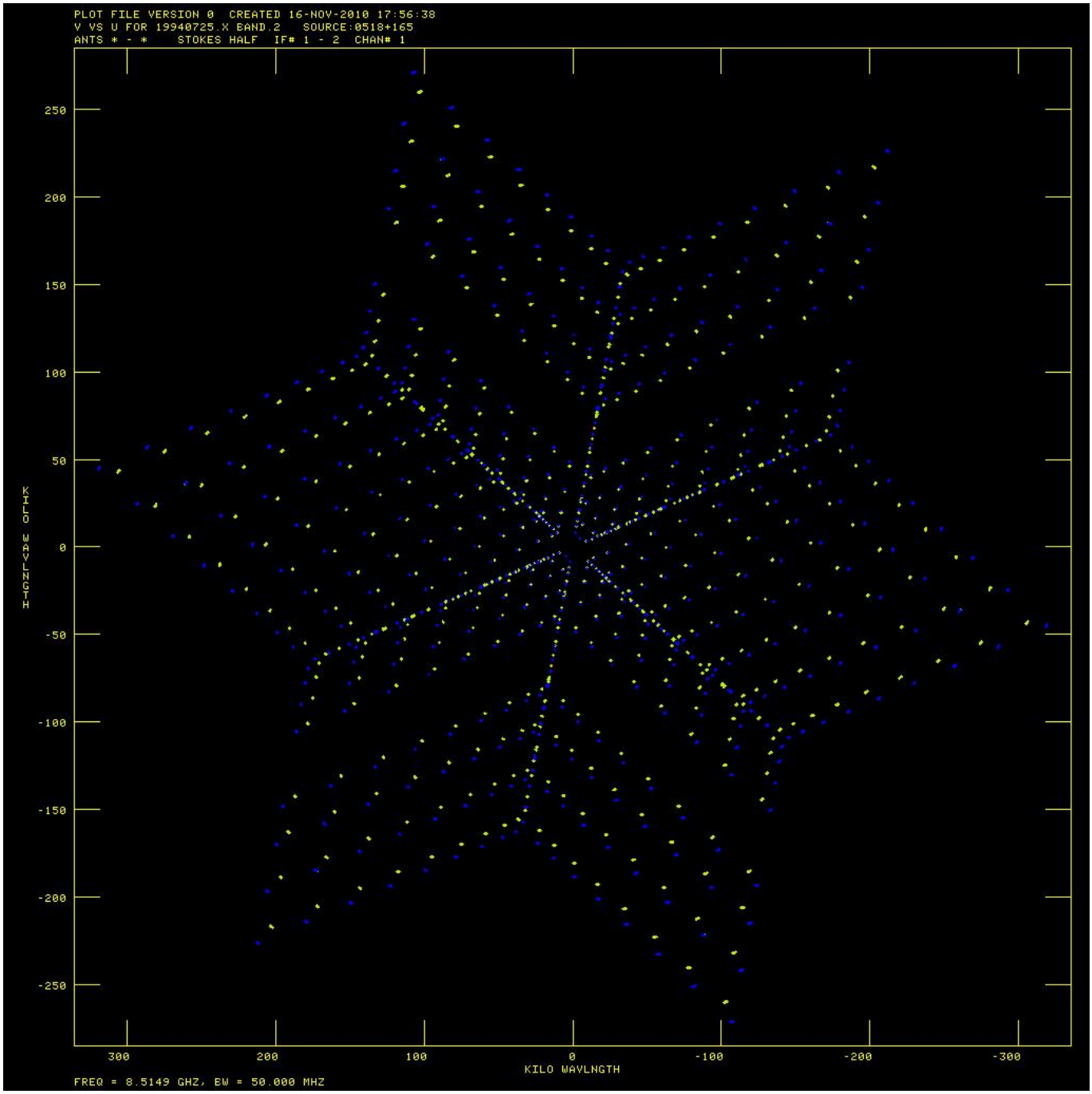
```
0423+418   J2000  A 04h23m56.009795s  41d50'02.712770"  Aug01
0420+417   B1950  A 04h20m27.936900s  41d43'08.039000"
-----------------------------------------------------
BAND        A B C D    FLUX(Jy)    UVMIN(kL)  UVMAX(kL)
=====================================================
 20cm    L  X X P P       2.00                      visplot
3.7cm    X  P P P P       1.12                      visplot
  2cm    U  P P P P       0.72                      visplot
0.7cm    Q  S S S S       1.00                      visplot
```

So we are not exactly sure at C band (5 GHz, 6 cm) what the source structure is like for the B configuration from the manual. Is it ok to use? For what (u,v) range?

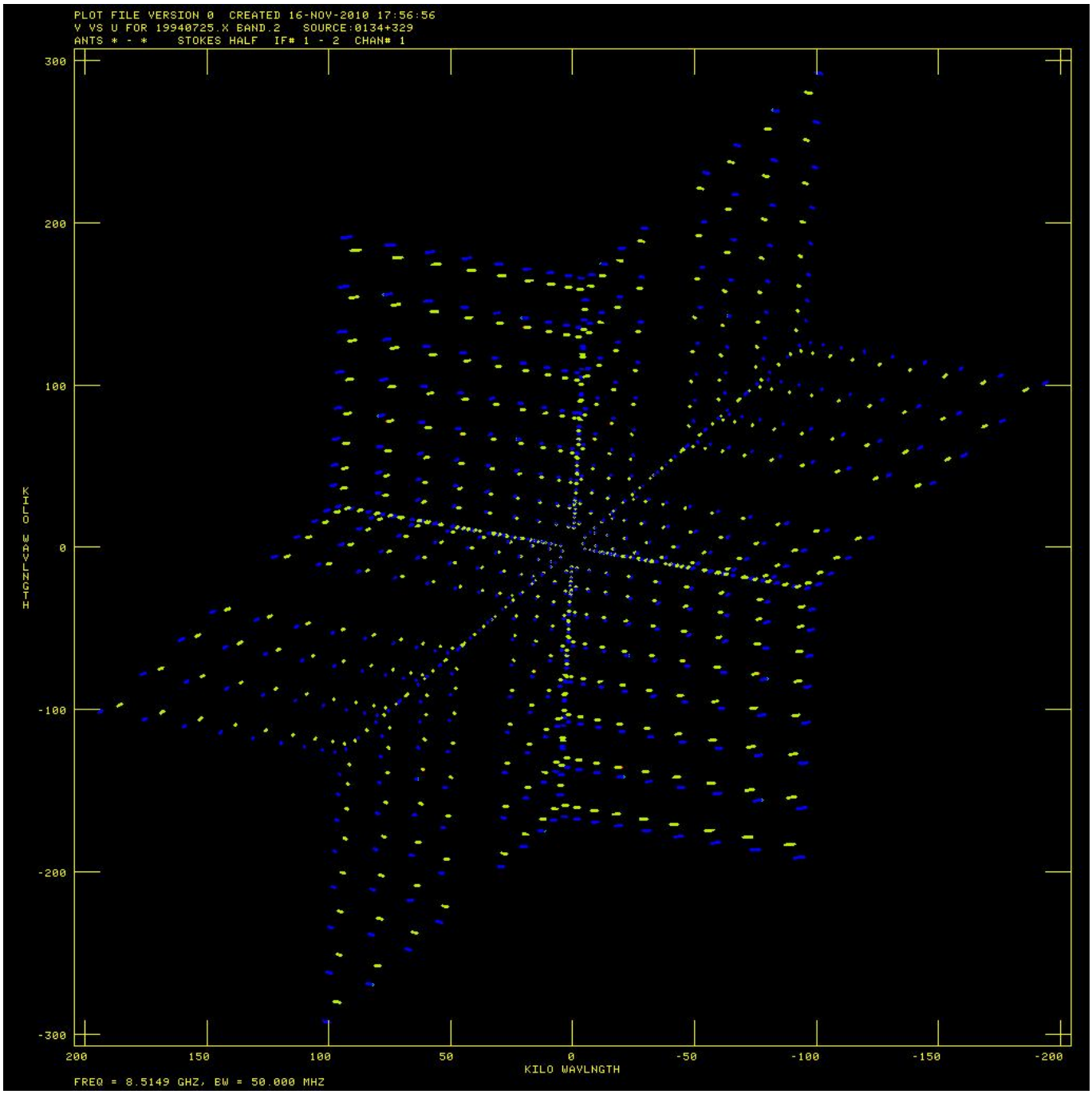
```
source '3C129', ' '
tvinit
go
```



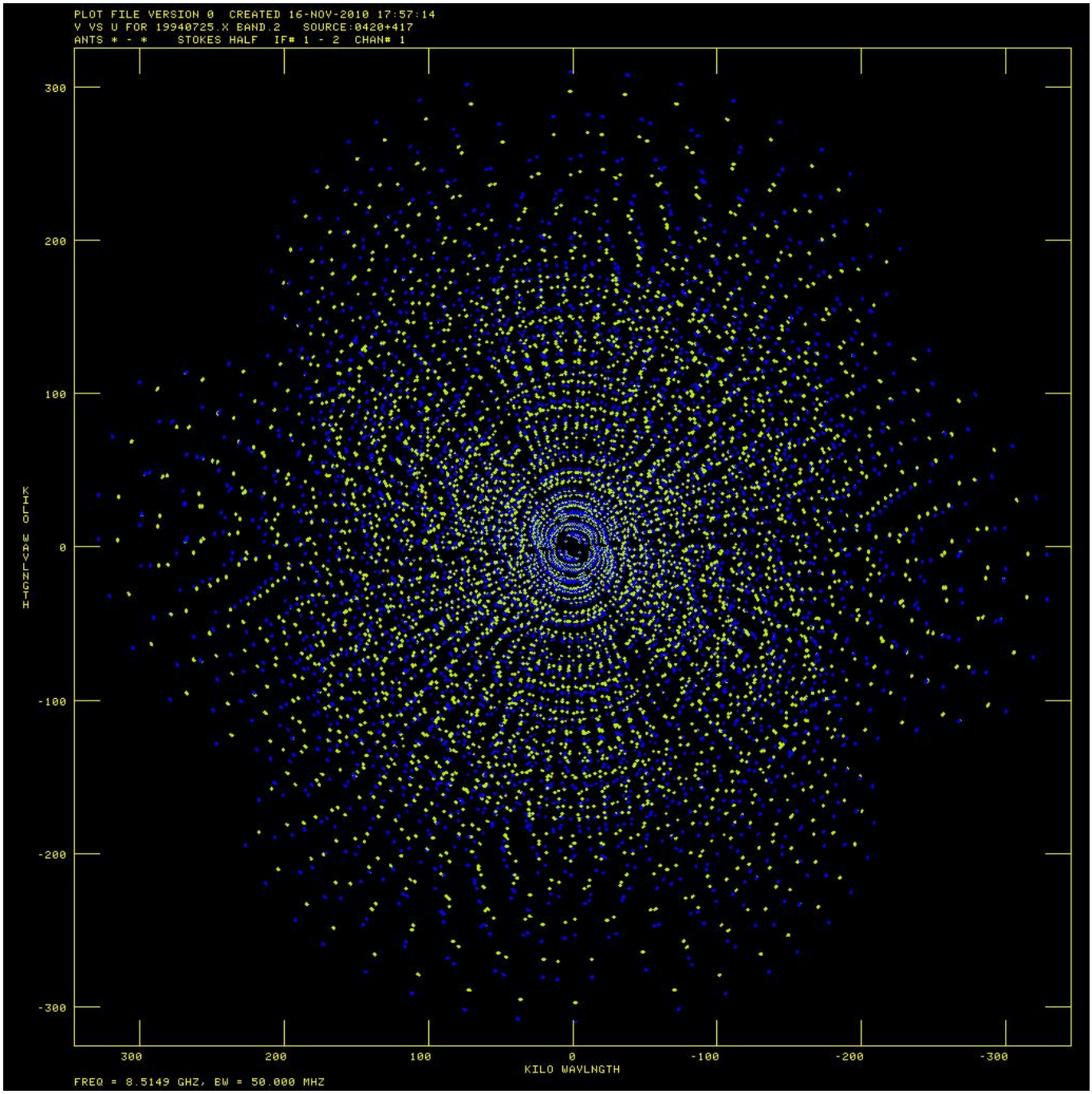

```
bparm 6 7
source '0518+165',' '
tvinit
go
```



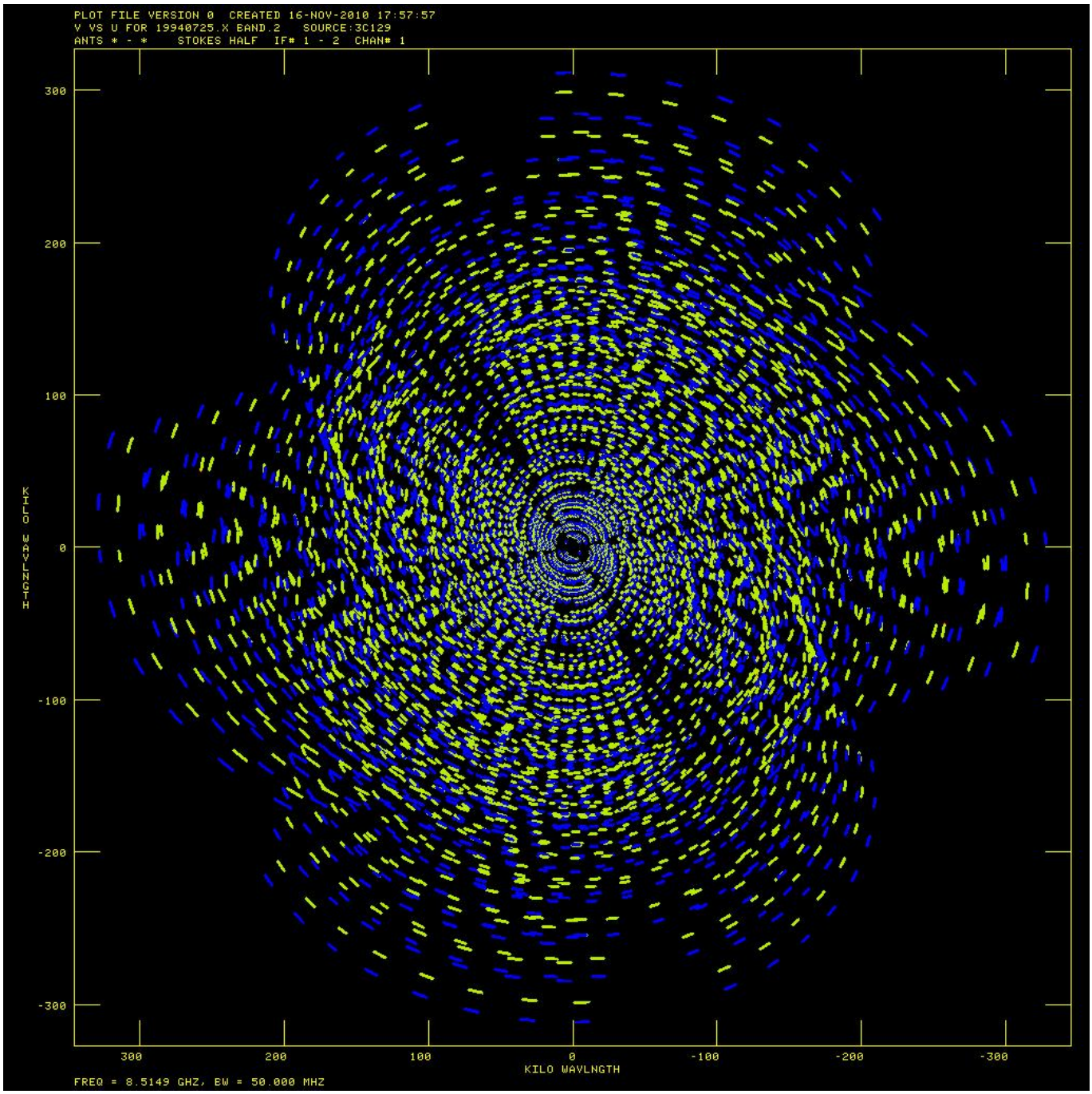

```
source '0134+329',' '
tvinit
go
```



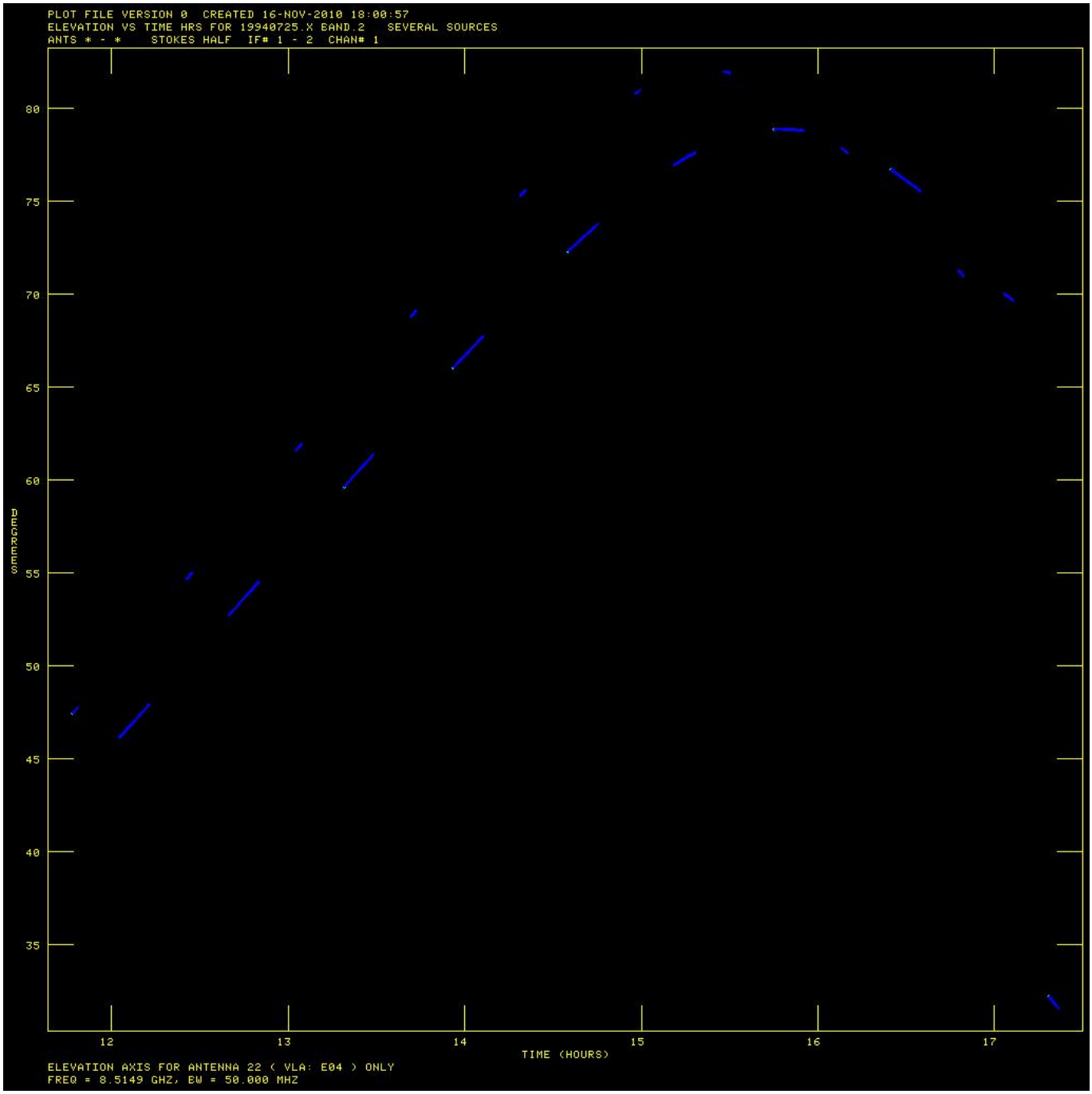

```
source '0420+417', ' '
tvinit
go
```



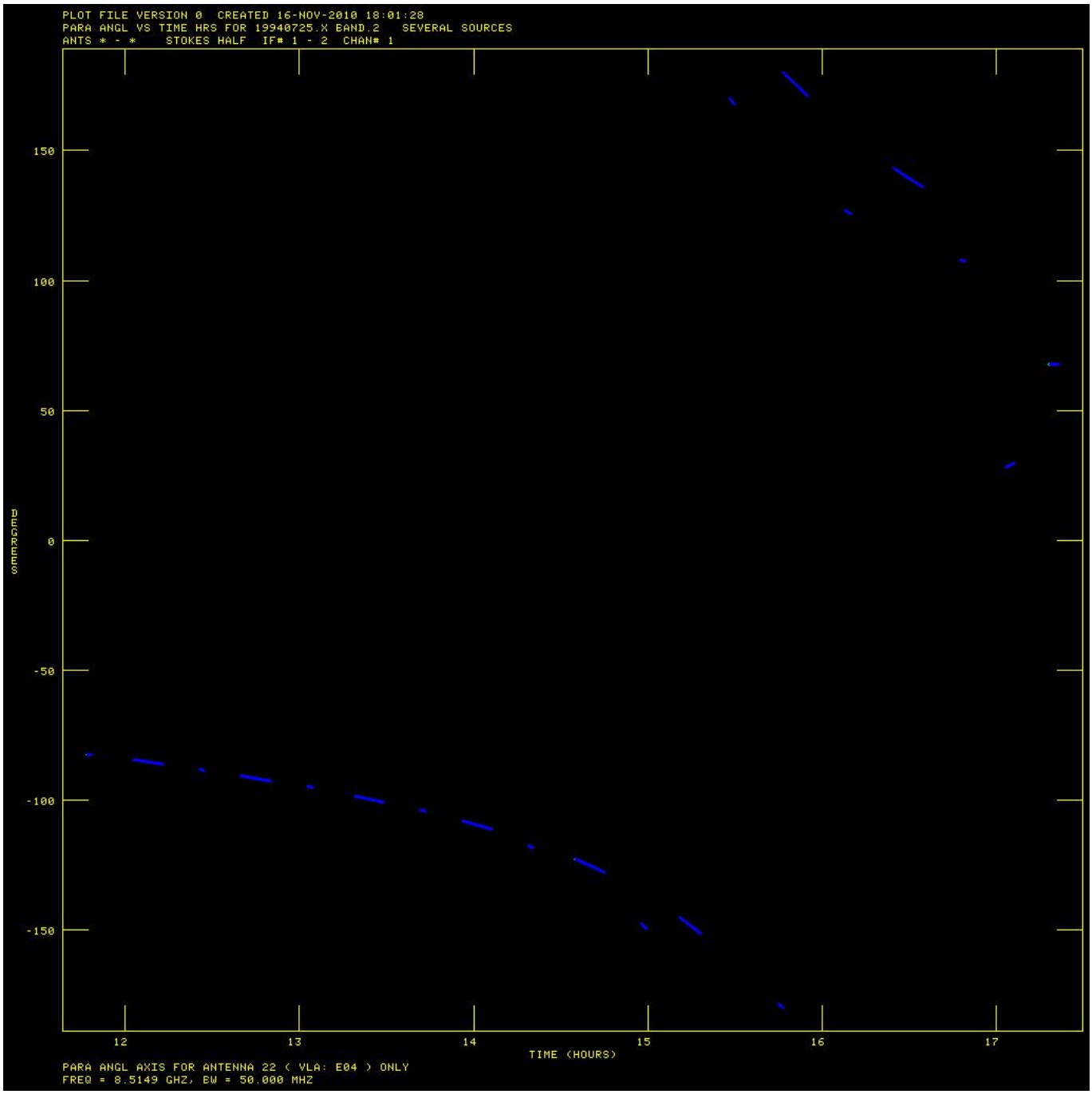

```
source '3C129', ' '
tvinit
go
```




```
bparm 11,15,0
sources '0518+165','0134+329','0420+417','3C129',' '
xinc=10
go
```




```
bparm 11,16,0
go
```




```
xinc=1
bparm 0
```

Raw visibilities

```
task 'listr'
optype 'list'
antenna 22,0
basel 0
sources '0518+165','0134+329','0420+417', '3C129', ' '
calcode '*'
bif 0
eif 0
```

```
docalib 0
dparm 0
go
```

```
Source=0420+417        : 0002, Stokes=RR  , IF=  1, Chans=   1-   1
Flux =  0.0000 Jy, Calcode = B   , Freq =  8.514900000 GHz
Amplitudes, 1000 =   1.000000 Jy, averging type = Vector

Baselines
0122022203220422052206220722082210221122122213221422152216221722182219222022
212222232224222522262227222 8
   0/16:47:55  120     117 124 124 129 135 121 122 131     122 123     126
120 125 124 122 124 135 122 119     124 128
   0/16:48:05  119 117 115 120 120 129 132 116 121 128     118 120     124
119 123 122 123 121 130 117 117 119 120 126
   0/16:48:15  116 113 116 121 121 127 130 115 121 128     119 120     124
116 122 122 120 120 128 116 114 119 121 123
   0/16:48:25  118 115 113 119 121 126 133 115 122 129     119 118     124
117 121 124 119 120 128 117 115 120 122 124
   0/16:48:35  117 114 116 119 121 127 136 117 123 127     118 120     122
117 122 121 121 120 127 117 115 116 121 126
   0/16:48:45  119 112 114 119 122 126 133 117 120 127     120 118     123
117 122 122 120 119 130 118 117 118 119 125
   0/16:48:55  117 114 118 120 121 124 133 118 120 130     119 121     124
115 121 122 119 119 128 117 114 119 120 125
   0/16:49:05  119 113 115 122 121 127 132 115 121 129     121 121     124
115 121 122 120 120 129 118 117 116 119 125
   0/16:49:15  119 116 116 121 120 127 133 117 121 128     117 121     123
117 122 120 119 121 128 120 116 119 120 125
   0/16:49:25  118 113 116 123 120 125 132 115 120 127     118 120     126
117 122 121 122 120 131 119 117 120 122 123

Source=0518+165        : 0002, Stokes=RR  , IF=  1, Chans=   1-   1
Flux =  0.0000 Jy, Calcode = C   , Freq =  8.514900000 GHz
Amplitudes, 1000 =   1.000000 Jy, averging type = Vector

   0/17:03:25  212 191 205 212 198 177 232 213 183 226     207 210     221
2 165 216 148 195 192 196 204     211 218
   0/17:03:35  205 187 199 205 193 171 227 209 179 224     205 206     216
2 161 212 145 188 189 191 201 203 208 212
   0/17:03:45  202 186 199 206 192 170 226 206 177 223     202 204     215
2 160 212 143 191 190 190 200 203 207 211
   0/17:03:55  205 184 198 205 190 169 228 207 174 224     202 203     216
1 160 210 142 188 187 191 199 202 205 209
   0/17:04:05  205 187 197 204 192 171 227 208 176 226     202 206     218
42 160 209 145 188 187 191 198 201 206 213
   0/17:04:15  205 185 197 208 190 169 224 207 176 222     202 205     216
197 163 208 145 189 188 190 198 202 205 210
   0/17:04:25  204 188 198 206 189 170 224 206 176 226     202 202     216
196 164 210 144 189 190 190 199 204 207 212
Type Q to stop, just hit RETURN to continue
```

```
 vlb054    LISTR(31DEC10)    100     16-NOV-2010  18:12:30    Page    3
Source=0518+165        : 0002, Stokes=RR  , IF=  1, Chans=   1-   1
Baselines
012202220322042205220622072208221022112212221322142215221622172218221922202
212222232224225222622272228
   0/17:04:35  204 187 197 206 190 170 227 208 175 225     203 208     217
194 161 210 144 189 190 193 198 206 205 209
   0/17:04:45  206 188 198 208 191 169 227 206 176 226     203 207     214
197 161 211 145 190 188 191 198 206 207 211
   0/17:04:55  207 188 199 207 190 170 227 207 177 224     204 206     216
196 161 210 144 191 188 191 199 205 205 209
   0/17:05:05  205 186 200 207 192 171 226 205 175 225     201 207     219
196 160 210 142 189 189 191 197 209 206 212
   0/17:05:15  206 190 198 208 189 171 227 208 175 224     204 205     217
197 161 207 141 189 190 191 197 208 205 211
   0/17:05:25  203 189 199 205 189 169 228 207 174 224     202 204     216
195 160 206 144 188 190 188 199 204 208 213
   0/17:05:35  203 189 200 206 193 170 226 208 176 226     202 205     215
196 162 207 145 188 187 191 198 206 206 207
   0/17:05:45  202 188 199 207 192 170 225 205 175 223     202 204     216
196 160 208 143 188 188 190 197 208 206 213
   0/17:05:55  202 189 200 207 190 170 228 206 175 223     203 205     219
195 158 208 143 190 190 191 201 207 208 210
   0/17:06:05  203 188 197 207 191 173 231 206 174 221     203 203     217
194 162 208 141 189 188 191 200 205 205 211
   0/17:06:15  204 187 200 206 190 170 227 206 177 222     206 205     217
196 162 206 145 189 189 191 197 202 207 209
   0/17:06:25  204 190 200 208 192 173 226 207 175 220     204 207     216
194 162 210 144 188 189 190 199 206 205 212

Source=0134+329        : 0002, Stokes=RR  , IF=  1, Chans=   1-   1
Flux =  0.0000 Jy, Calcode = C   , Freq =  8.514900000 GHz
Amplitudes, 1000 =   1.000000 Jy, averging type = Vector

Baselines
012202220322042205220622072208221022112212221322142215221622172218221922202
212222232224225222622272228
   0/17:18:35  247 246 256 263 275 264 291 261 253 281     270 266     271
2 236 267 219 251 287 265 261     271 285
   0/17:18:45  242 241 253 262 272 261 287 256 250 280     263 265     268
1 234 264 215 250 282 262 259 243 269 282
   0/17:18:55  246 241 252 265 273 263 289 257 252 280     265 265     267
2 238 264 217 248 283 262 257 243 266 282
   0/17:19:05  241 239 249 260 268 264 287 257 249 279     263 263     271
3 234 262 216 223 282 262 258 244 266 279
   0/17:19:15  240 239 248 257 264 257 288 255 248 277     263 259     269
84 234 262 214 245 280 262 255 240 264 280
   0/17:19:25  245 235 247 259 266 261 284 257 247 276     259 262     268
259 236 261 214 246 278 258 256 239 263 277
   0/17:19:35  244 238 249 259 269 263 283 258 248 277     263 261     269
```

```
259 236 260 215 243 279 259 254 238 262 276
   0/17:19:45  240 237 251 260 266 260 284 255 248 274     262 261     269
258 234 262 215 244 279 261 255 241 264 276
   0/17:19:55  245 240 250 258 267 259 287 258 247 276     259 259     267
257 236 261 217 249 281 259 255 237 265 275
   0/17:20:05  240 238 249 259 266 259 286 256 247 277     262 259     267
259 235 263 216 243 283 259 256 240 264 278
   0/17:20:15  242 234 251 257 264 259 284 254 247 274     260 257     272
258 233 263 215 245 278 258 253 241 261 276
   0/17:20:25  245 235 253 259 270 261 286 257 252 277     262 260     271
259 234 263 216 250 280 260 256 240 266 279
   0/17:20:35  240 239 253 261 269 263 289 260 249 276     264 261     272
261 235 262 220 250 280 261 258 240 268 279
   0/17:20:45  245 236 253 260 266 258 286 259 248 276     262 261     270
261 232 261 217 244 283 258 255 244 264 280
   0/17:20:55  245 238 254 257 267 260 284 260 248 277     265 261     272
261 237 263 217 249 282 260 254 242 265 280
   0/17:21:05  242 238 251 259 267 259 281 258 245 275     262 259     268
259 232 260 219 244 280 260 256 242 267 277
   0/17:21:15  242 238 254 260 268 261 288 262 247 274     262 260     269
263 233 260 217 246 285 260 257 238 267 279
   0/17:21:25  246 235 251 257 268 256 286 257 246 276     260 261     268
261 228 262 216 246 281 257 253 242 265 277
   0/17:21:35  247 238 254 260 271 267 287 261 249 276     264 265     269
260 237 262 218 251 282 256 256 242 266 281
```

```
dparm 1,0
go
```

```
Source=0420+417        : 0002, Stokes=RR  , IF=  1, Chans=   1-   1
Flux =  0.0000 Jy, Calcode = B   , Freq =  8.514900000 GHz
Phase, 1000 = 1000.00000 degrees, averging type = Vector

Baselines
012202220322042205220622072208221022112212221322142215221622172218221922202221222232224222522262227222 8
   0/16:47:55  -85     -95  90-159-108 170  91 167-133     -69 -83     142
-6-110-177 -27  62 -90 -40 -45     136  59
   0/16:48:05  -82  27 -93  92-155-106 171  92 168-131     -70 -84     145
-4-106-172 -25  67 -92 -40 -46-100 131  57
   0/16:48:15  -77  30 -89  96-155-104 175  95 172-128     -69 -83     146
-4-106-171 -23  72 -95 -45 -47-104 131  52
   0/16:48:25  -72  34 -81 101-147 -96 172 100 176-125     -64 -80     151
3 -98-167 -19  73 -99 -46 -50-109 128  47
   0/16:48:35  -74  34 -82  95-147 -97 166  98 176-126     -62 -80     146
2 -94-166 -19  71-100 -47 -45-106 126  45
   0/16:48:45  -73  36 -80  96-149 -95 169  98 175-122     -61 -80     142
2 -94-162 -18  71-101 -45 -48-110 127  48
   0/16:48:55  -73  34 -82  96-148 -96 175  99 176-121     -62 -82     143
3 -95-161 -17  70-101 -46 -47-108 129  49
   0/16:49:05  -72  34 -85  92-146 -94 172 100 176-121     -64 -84     141
```

```
-1 -98-160 -17  67-101 -44 -47-107 129  46
   0/16:49:15  -72  36 -85  92-148 -92 171  92 177-121     -60 -84     142
1 -97-159 -16  67-102 -45 -43-107 127  46
   0/16:49:25  -74  34 -87  92-148 -91 169  99 174-122     -60 -85     142
1 -96-159 -13  66-102 -45 -46-106 129  46

Source=0518+165        : 0002, Stokes=RR  , IF=  1, Chans=   1-   1
Flux =  0.0000 Jy, Calcode = C   , Freq =  8.514900000 GHz
Phase, 1000 = 1000.00000 degrees, averging type = Vector

   0/17:03:25  -99  26 -80 109-155-110 174 103 -82-130     -65 -79     135
70 -93 159 -37  24 -97 -37 -49     118  42
   0/17:03:35 -100  28 -80 110-151-110 173 103 -81-131     -65 -79     137
85 -91 160 -36  22 -96 -38 -49-104 119  42
   0/17:03:45 -103  24 -85 104-156-112 169 100 -86-136     -70 -81     133
19 -92 159 -40  22 -93 -32 -43-101 126  47
   0/17:03:55 -102  22 -88 102-157-113 169 100 -87-135     -72 -79     136
30 -90 158 -39  23 -90 -34 -44 -99 123  45
   0/17:04:05 -105  23 -92  99-160-116 167  98 -88-142     -76 -82     133
23 -91 154 -40  16 -88 -31 -43 -94 129  44
   0/17:04:15 -104  26 -88 101-156-114 169 103 -84-140     -73 -80     130
20 -89 156 -38  23 -89 -32 -48 -98 129  40
   0/17:04:25 -105  26 -89  99-157-113 169 103 -84-141     -76 -83     131
17 -90 157 -32  23 -89 -31 -45 -96 127  42
Type Q to stop, just hit RETURN to continue

 vlb054    LISTR(31DEC10)    100     16-NOV-2010  18:13:14    Page    3
Source=0518+165        : 0002, Stokes=RR  , IF=  1, Chans=   1-   1
Baselines
012202220322042205220622072208221022112212221322142215221622172218221922202221222223222422252226222722728
   0/17:04:35 -100  32 -80 108-147-103 175 109 -76-135     -69 -77     140
25 -81 165 -22  29 -98 -42 -49-100 120  33
   0/17:04:45 -101  31 -80 107-147-103 167 108 -76-142     -70 -78     142
23 -81 165 -22  28-100 -41 -45 -99 124  33
   0/17:04:55 -100  33 -80 109-145-102 173 109 -76-141     -68 -80     142
23 -82 164 -21  27-101 -40 -45 -98 124  31
   0/17:05:05 -102  30 -81 111-147-100 172 110 -74-141     -69 -81     141
22 -83 162 -21  28-103 -40 -45 -98 125  32
   0/17:05:15 -104  34 -81 112-142 -99 170 109 -71-142     -68 -80     145
23 -85 165 -16  30-103 -41 -45-100 124  26
   0/17:05:25 -105  32 -82 109-141 -96 176 109 -70-143     -68 -84     148
22 -86 168 -13  33-100 -40 -44-100 125  25
   0/17:05:35 -108  32 -83 111-141 -94 174 110 -71-142     -69 -78     151
20 -90 168 -11  34 -98 -41 -45 -98 125  25
   0/17:05:45 -111  33 -83 110-140 -94 172 108 -72-140     -69 -79     149
18 -94 166 -11  34 -97 -40 -44 -96 127  27
   0/17:05:55 -112  35 -81 110-140 -91 174 108 -68-142     -64 -76     151
18 -93 166  -9  39 -97 -40 -45 -95 127  24
   0/17:06:05 -111  34 -83 110-141 -94 174 108 -70-143     -66 -78     150
```

```
16 -95 163 -10  41 -96 -40 -43 -96 128  24
   0/17:06:15 -113  32 -85 108-143 -93 171 108 -72-145     -69 -79     151
15 -97 161 -12  41 -97 -41 -42 -92 131  27
   0/17:06:25 -112  32 -85 108-144 -95 171 109 -73-147     -69 -79     148
14 -98 161 -15  42 -97 -38 -42 -91 132  25

Source=0134+329        : 0002, Stokes=RR  , IF=  1, Chans=   1-   1
Flux =  0.0000 Jy, Calcode = C   , Freq =  8.514900000 GHz
Phase, 1000 = 1000.00000 degrees, averging type = Vector

Baselines
01220222032204220522062207220822102211221222132214221522162217221822192220222
21222223222422252226222722 28
   0/17:18:35 -138  62 -85 125-129 -67 172 106  28-170     -47 -92    -172
-15 -54 159  87 132-105 -17 -13     136  30
   0/17:18:45 -139  55 -87 121-130 -71 169 105  25-172     -49 -94
-172-162 -57 155  86 129-100 -15  -9 -42 137  30
   0/17:18:55 -139  54 -84 124-132 -70 163 104  22-174     -49 -92    -171
104 -56 149  82 127 -97 -12 -11 -45 135  28
   0/17:19:05 -144  48 -86 118-130 -74 153 100  13 175     -56 -99    -177
112 -64 139  79  93 -87  -1  -3 -39 138  31
   0/17:19:15 -147  46 -87 117-135 -81 152 100   7 172     -62-105     177
-19 -69 133  67  88 -80   2   6 -32 142  35
   0/17:19:25 -147  42 -91 114-131 -87 149  97  -2 164     -68-108     177
-21 -76 126  62  79 -74   7  10 -28 145  39
   0/17:19:35 -144  41 -86 119-130 -83 153  99  -6 165     -69-106     177
-16 -77 134  65 110 -75   2   9 -29 140  35
   0/17:19:45 -147  38 -89 115-134 -88 147  93  -9 163     -79-107     170
-21 -80 129  58 101 -67   0  13 -25 142  37
   0/17:19:55 -150  37 -90 115-139 -93 145  90 -15 165     -82-104     169
-21 -81 132  51  97 -64  -6  16 -24 141  39
   0/17:20:05 -150  40 -83 116-143 -91 144  89 -16 167     -82 -99     168
-17 -81 136  49  94 -67  -4  16 -27 138  40
   0/17:20:15 -149  41 -76 120-135 -89 148  94 -13 173     -83 -97     170
-16 -79 139  46 107 -70  -7  11 -30 132  40
   0/17:20:25 -146  43 -73 123-139 -87 150  94 -13 177     -85 -96     173
-17 -77 145  46 105 -72  -4   6 -34 131  40
   0/17:20:35 -147  46 -73 122-133 -91 151  94 -14 178     -85 -96     171
-21 -81 144  45 106 -68  -3  10 -36 128  44
   0/17:20:45 -146  45 -71 120-137 -88 154  97 -15-178     -84 -87     172
-18 -80 150  46  93 -67  -8  11 -40 123  49
   0/17:20:55 -143  49 -66 121-131 -81 160 103  -6-169     -78 -81     177
-13 -78 151  54 111 -72 -10   5 -47 117  44
   0/17:21:05 -149  40 -70 114-137 -82 159  99  -9-165     -86 -83     173
-15 -82 148  53  75 -69  -7   5 -45 120  47
   0/17:21:15 -153  38 -71 108-142 -82 160  98 -11-164     -92 -85     162
-16 -83 147  51  93 -70  -6  11 -40 122  50
   0/17:21:25 -156  37 -74 105-144 -84 157  92 -19-170    -101 -87     154
-14 -89 140  48  99 -66   0  13 -36 124  51
   0/17:21:35 -152  43 -76 104-142 -78 161  94 -13-164    -103 -84     155
-13 -85 145  52 102 -72   0  13 -39 121  47
```

```
dparm 0
```

Flag some bad data. Just run the commands.

```
task 'quack'
reason 'slow start'
sources ' '
calcode ' '
stokes ' '
timer 0
antenna 17 0
flagver 1
opcode 'beg'
basel 0
bif 1
eif 1
aparm 0
aparm(2) 72.5/60
go


reason 'quack'
sources ' '
calcode ' '
stokes ' '
timer 0
antenna 0
flagver 1
opcode 'beg'
basel 0
bif 2
eif 2
aparm 0
aparm(2) 22.5/60
go

task 'uvflg'
default
dohist 1
getn 3
antenna 14,0
basel 0
timer 0 15 10 50 0 15 55 0
stokes ' '
bif 2
eif 2
opcode 'flag'
reason 'bad ant'
```

```
outfgver 1
go
timer 0 13 25 30 0 13 27 40
go
timer 0 13 59 0 0 14 2 20
go
timer 0
bif 0
eif 0
antenna 0
```

Start the calibration

Set the flux values of the known calibrators

```
task 'setjy'
default
getn 3
source '0518+165',' '
bif 0
eif 0
optype 'calc'
aparm(2) 3
go
```

```
vlb054> SETJY1: Task SETJY  (release of 31DEC10) begins
vlb054> SETJY1: **WARNING: OPCODE=CALC AND FREQID =   -1
vlb054> SETJY1:      FREQID WILL BE RESET TO 1, CHECK YOUR RESULTS CAREFULLY
vlb054> SETJY1: A source model for this calibrator is available
vlb054> SETJY1: Consult the help file for CALRD for assistance
vlb054> SETJY1: / Flux calculated using known spectrum
vlb054> SETJY1: BIF =  1 EIF =  2 /Range of IFs
vlb054> SETJY1: '0518+165        ' IF =  1 FLUX = 2.4983 (Jy calcd)
vlb054> SETJY1: '0518+165        ' IF =  2 FLUX = 2.4166 (Jy calcd)
vlb054> SETJY1: / Using (1995.2) VLA or Reynolds (1934-638) coefficients
vlb054> SETJY1: Appears to have ended successfully
vlb054> SETJY1: vlb054       31DEC10 TST: Cpu=       0.0  Real=       0
```

```
bif 1
eif 1
optype ' '
zerosp 2.4983, 0.3092, -0.0628, 0.0
go
bif 2
eif 2
zerosp 2.4166, 0.2990, -0.0607, 0.0
go
```

```
bif 0
eif 0
zerosp 0
optype 'calc'
source = '0134+329',' '
go
```

```
vlb054> SETJY1: Task SETJY  (release of 31DEC10) begins
vlb054> SETJY1: **WARNING: OPCODE=CALC AND FREQID =   -1
vlb054> SETJY1:      FREQID WILL BE RESET TO 1, CHECK YOUR RESULTS CAREFULLY
vlb054> SETJY1: A source model for this calibrator is available
vlb054> SETJY1: Consult the help file for CALRD for assistance
vlb054> SETJY1: / Flux calculated using known spectrum
vlb054> SETJY1: BIF =  1 EIF =  2 /Range of IFs
vlb054> SETJY1: '0134+329        ' IF =  1 FLUX = 3.2045 (Jy calcd)
vlb054> SETJY1: '0134+329        ' IF =  2 FLUX = 3.0714 (Jy calcd)
vlb054> SETJY1: / Using (1995.2) VLA or Reynolds (1934-638) coefficients
vlb054> SETJY1: Appears to have ended successfully
vlb054> SETJY1: vlb054       31DEC10 TST: Cpu=       0.0  Real=       0
```

```
bif 1
eif 1
optype ' '
zerosp 3.2045, 0.0772, -0.1722, 0.0
go
bif 2
eif 2
zerosp 3.0714, 0.0740, -0.1650, 0.0
go

bif 0
eif 0
```

Get images (and thus clean components) for the calibrators

```
task 'calrd'
object '3c138'
band 'c'
go

object '3c48'
band 'c'
go

pcat
```

```
AIPS 1: Catalog on disk  1
AIPS 1:  Cat Usid Mapname      Class   Seq  Pt     Last access      Stat
```

```
AIPS 1:    1  100 19940725    .C BAND.    1 UV 16-NOV-2010 13:15:34
AIPS 1:    2  100 19940725    .X BAND.    1 UV 16-NOV-2010 13:15:34
AIPS 1:    3  100 19940725    .X BAND.    2 UV 16-NOV-2010 13:15:34
AIPS 1:    4  100 19940725    .C BAND.    2 UV 16-NOV-2010 15:02:52
AIPS 1:    5  100 19940725    .U BAND.    1 UV 16-NOV-2010 13:15:34
AIPS 1:    6  100 19940725    .C BAND.    3 UV 16-NOV-2010 13:15:45
AIPS 1:    7  100 19940725    .C BAND.    4 UV 16-NOV-2010 13:15:44
AIPS 1:    8  100 19940725    .X BAND.    3 UV 16-NOV-2010 13:15:44
AIPS 1:    9  100 19940725    .X BAND.    4 UV 16-NOV-2010 13:15:45
AIPS 1:   10  100 3C138_C     .MODEL .    1 MA 16-NOV-2010 15:03:51
AIPS 1:   11  100 3C48_C      .MODEL .    1 MA 16-NOV-2010 15:03:55
```

Convert the (u,v) data to the epoch of the calibration images

Note: it is possible to change the epoch of the calibration image headers to B1950, but there would remain a small error in the rotation of the coordinate system. The proper fix is to convert the (u,v) coordinates or to rotate the images.

```
task 'uvfix'
clron
outdisk 1
shift 0
uvfixprm 0
go
```

Now fix the index table.

```
pcat
```

```
task 'indxr'
getn 12
cparm 0
cparm(3)= -1
bparm 0
go
cparm 0
```

Do the actual calibration. Start with 3C138

```
task 'calib'
default
getn 12
calsour '0518+165',' '
uvrange 0
antenna 0
refant 22
minamper 10
minphser 10
weightit 1
```

```
get2n 10
ncomp 0
solmode 'A&P'
aparm(6) 2
solint 2
solsub 2
cparm(3) 10
cparm(4) 10
go
clrmsg
```

Calibrate 3C48

```
calsour '0134+329',' '
get2n 11
go
clrmsg
```

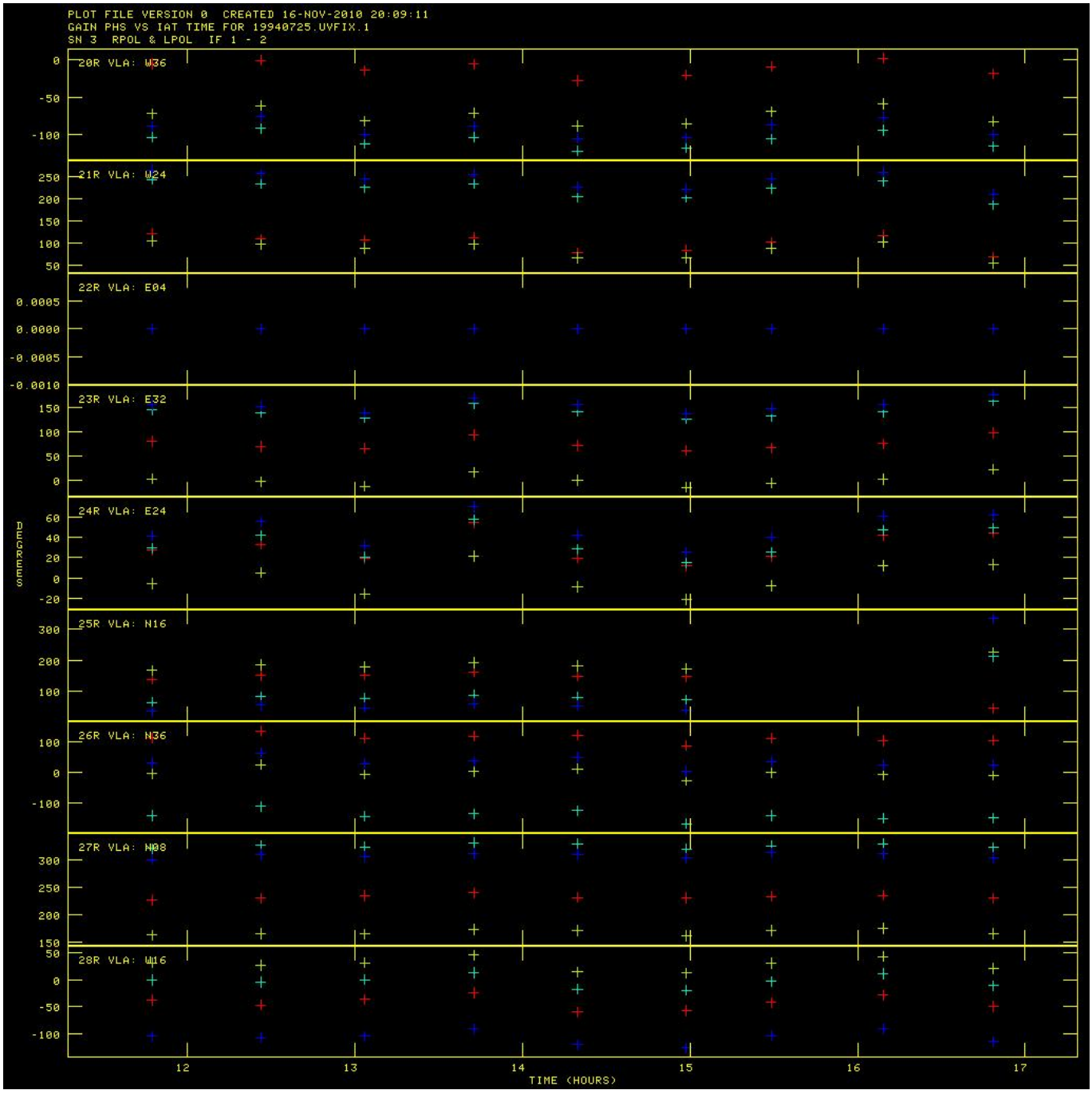
Calibrate the phase calibrator

```
clr2n
calsour '0420+417', ' '
solint 0
uvrange 20 0
go
clrmsg
```

Check the results

```
task 'snplt'
antenna 0
stokes ' '
inext 'sn'
inver 1
sources ' '
timer 0
optype 'amp'
opcode 'alsi'
do3col 1
dotv 1
xinc 1
nplots 9
tvinit
go
optype 'phas'
go
```

```
inver 2
optype 'amp'
go
optype 'phas'
go
inver 3
optype 'amp'
go
optype 'phas'
go
```



Apply the calibration to the phase calibrator

```
task 'getjy'
```

```
sources '0420+417', ' '
calsour '0518+165','0134+329',' '
calcode ' '
bif 0
eif 0
antenna 0
timer 0
snver 0
go
```

```
vlb054> GETJY1: Task GETJY  (release of 31DEC10) begins
vlb054> GETJY1: Calibrator robust averaging used    800 of    800 gain
samples
vlb054> GETJY1:    Source:Qual      CALCODE IF  Flux (Jy)
vlb054> GETJY1: 0420+417        :  2   B     1    1.41467 +/-   0.00432
0.00431
vlb054> GETJY1:                               2    1.40641 +/-   0.00455
0.00455
vlb054> GETJY1:    Source:Qual    CALCODE    used   total     bad used  tot
bad
vlb054> GETJY1: 0420+417        :  2 B        904     904       0  100  100
0
vlb054> GETJY1: Appears to have ended successfully
vlb054> GETJY1: vlb054 31DEC10 TST: Cpu=      0.0  Real=      0  IO=
1
```

Redo the phase calibrator calibration

Now that the flux density of the phase calibrator has been found, redo its calibration (just to make sure there are no remnants of some subtle assumptions about its flux density left in AIPS).

```
inext 'sn'
inver 3
extdest
inver 0
tget calib
go
clrmsg
```

Apply the calibration to all sources of interest.

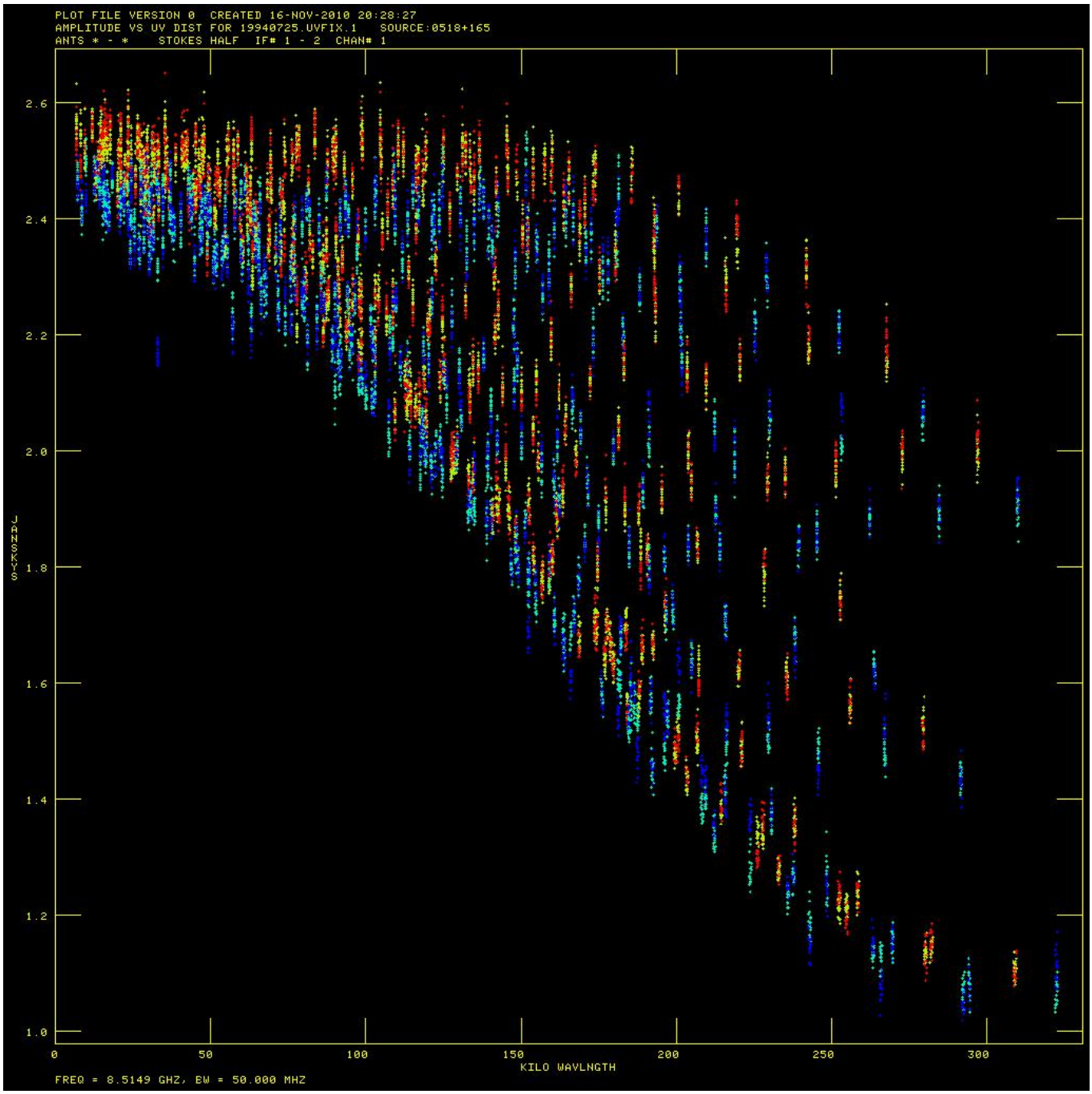
```
task 'clcal'
sources '0518+165','0134+329','0420+417', '3C129', ' '
calsour '0518+165','0134+329','0420+417', ' '
opcode 'cali'
gainver 1
gainuse 2
```

```
refant 22
interp '2pt'
doblank 1
go
```

Have a look at the calibration

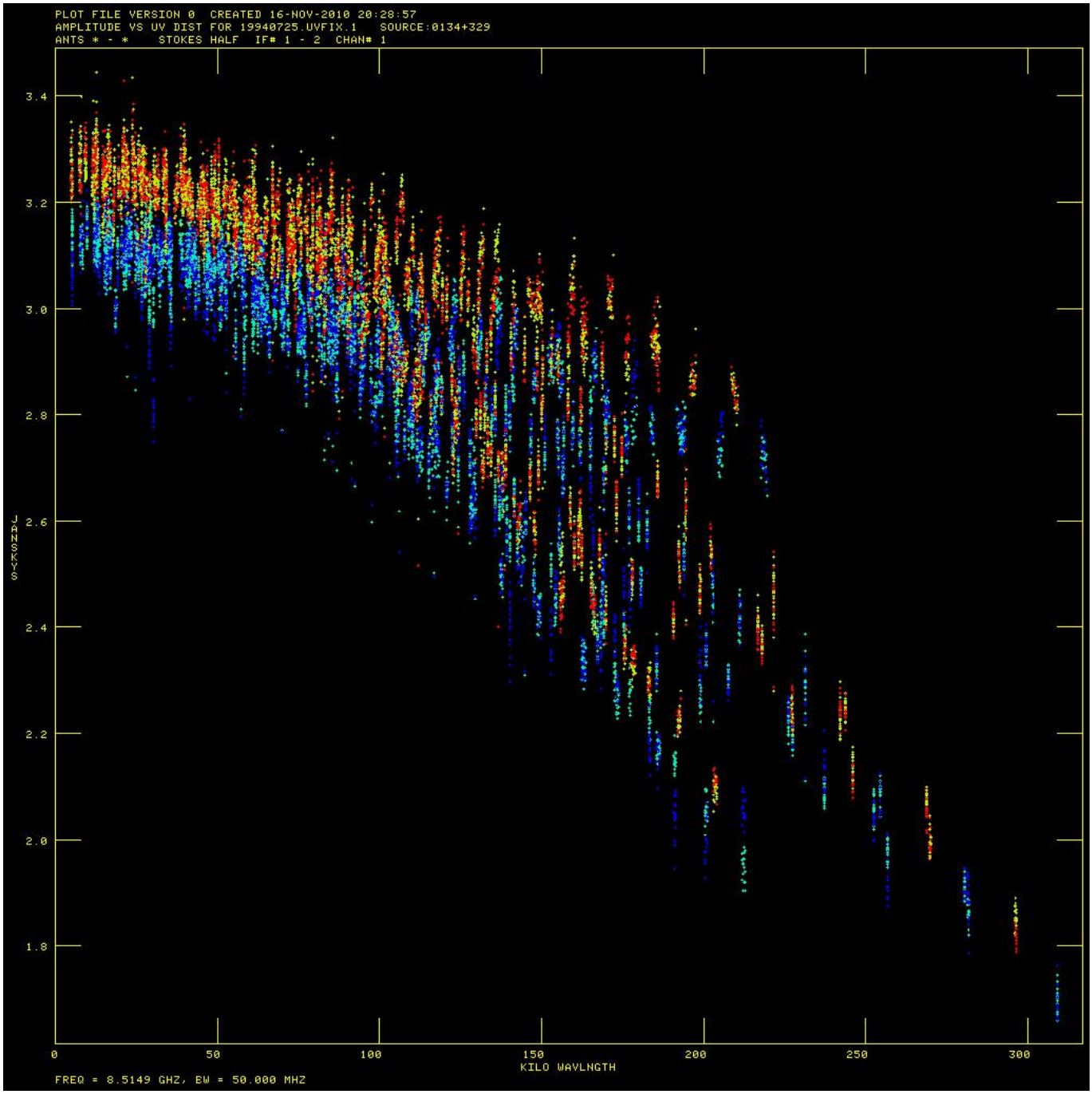
Plots

```
task 'uvplt'
source '0518+165',' '
calcode ' '
stokes 'half'
timer 0
uvrange 0
bif 0
eif 0
docalib 1
gainuse 2
bparm 0 1
aparm 0
refant 22
do3col 1
dotv 1
tvinit
go
```



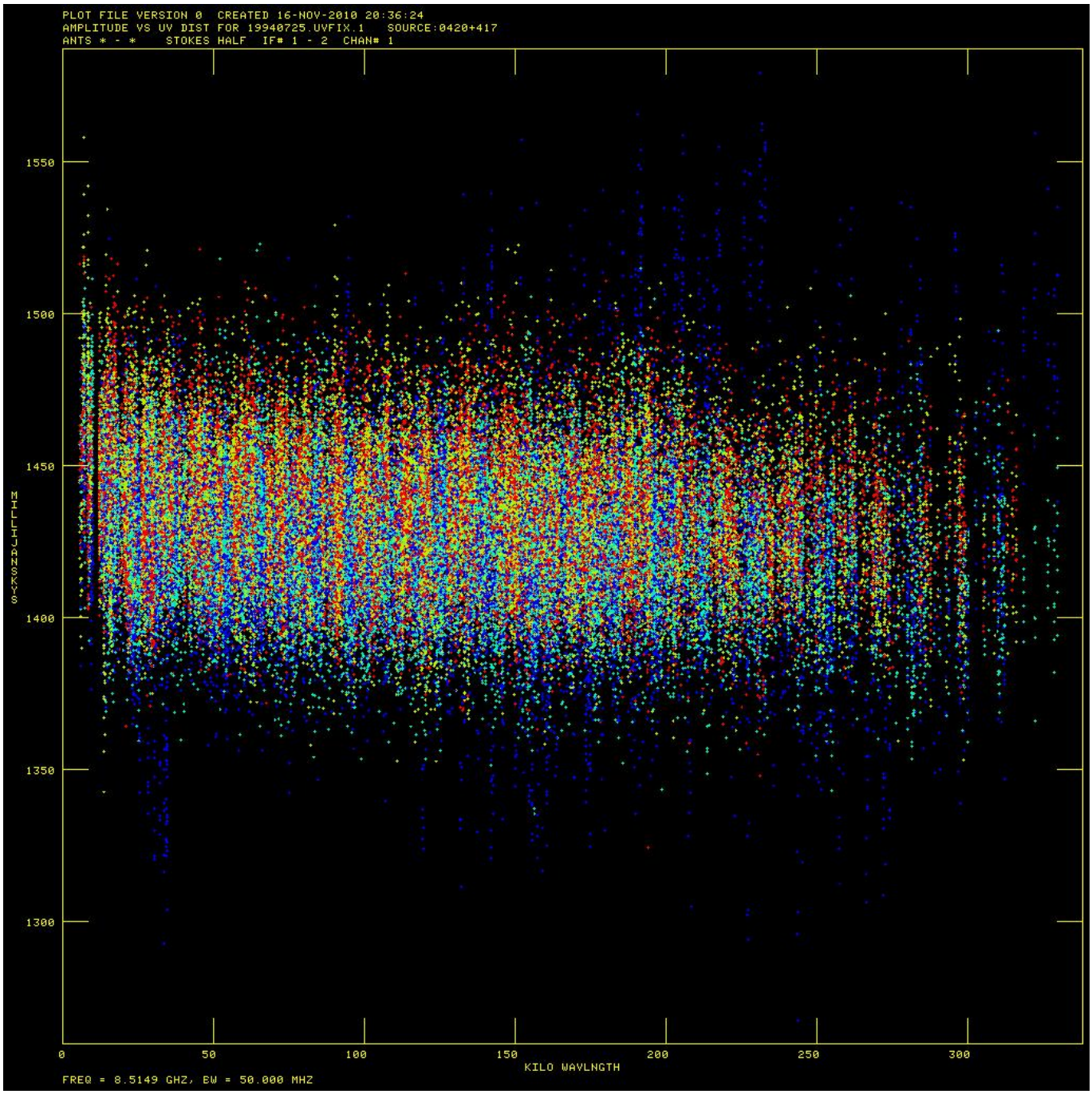
Why are the different colored points for the different subbands and polarizations not overlapping?

```
source '0134+329',' '
tvinit
go
```



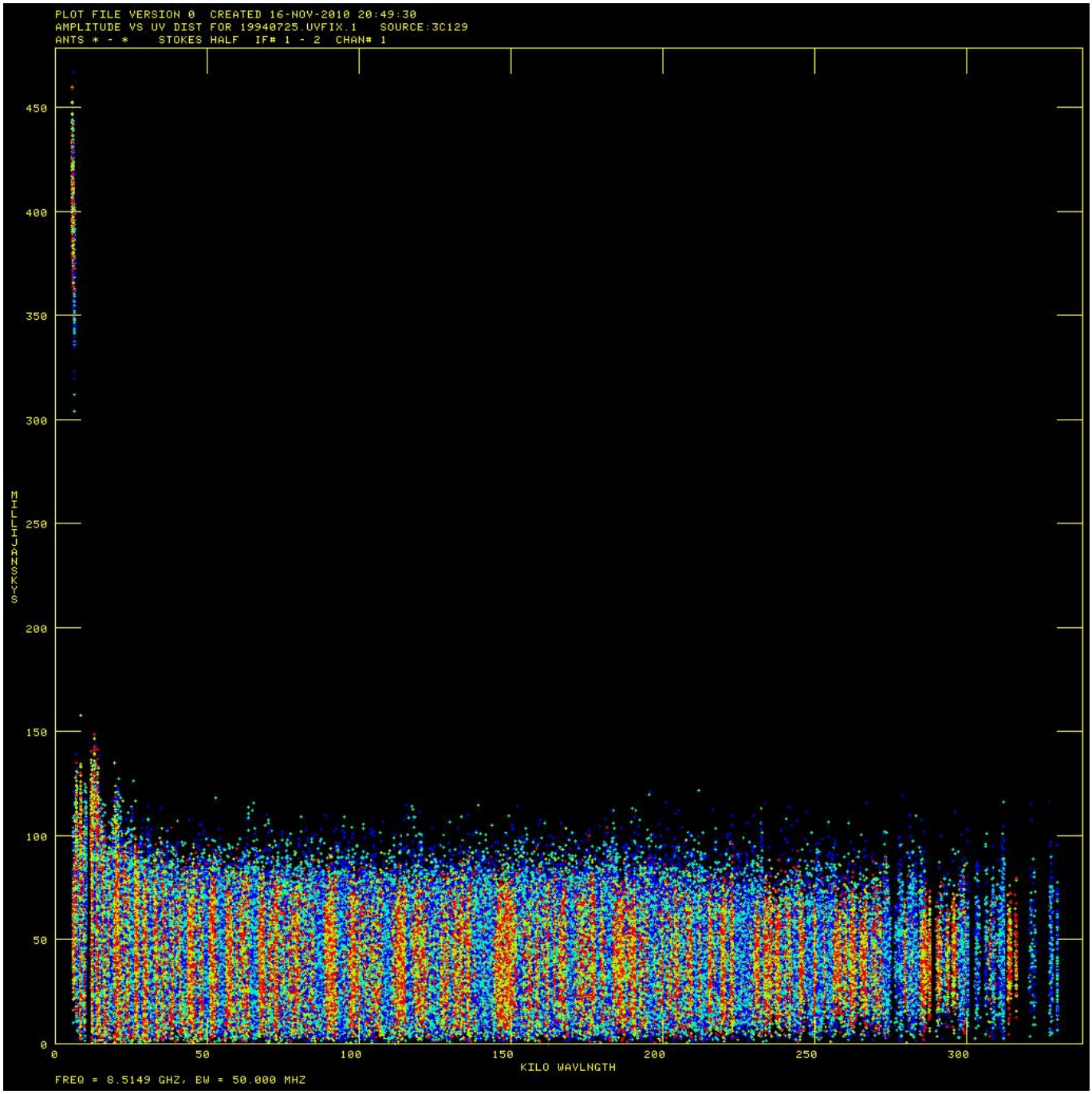
Again the different colors do not overlap. Why not?

```
source '0420+417', ' '
tvinit
go
```



But here they do overlap. Why? How has this changed from before?

```
source '3C129', ' '
tvinit
go
```



Start the polarization calibration

Check the parallactic angle change

```
task 'listr'
sources '0518+165','0134+329','0420+417', ' '
inext 'cl'
inver 2
optype 'gain'
dparm 9,0
stokes ' '
go
```

Or just look at the PA plot above in the initial UVPLT section.

Make a backup of calibration values, in case we mess up

```
task 'tasav'
clro
outdi 1
go
```

Now do the polarization calibration using the phase calibrator

```
task 'pcal'
calsour '0420+417', ' '
timer 0
antenna 0
uvrange 20,0
bif 0
eif 0
docalib 1
gainuse 2
clr2n
pmodel 0
solint 3
soltype 'appr'
prtlev 1
refant 22
bparm 0
cparm 0
go
clrmsg
```

```
vlb054> PCAL 1: Calibration source   1   0420+417
vlb054> PCAL 1:   Q+iU=(  -0.02115,  -0.06575) +/- (  0.000088,  0.000088)
Jy
vlb054> PCAL 1:   Pol. inten. =   0.06906 +/-  0.000124 Jy
vlb054> PCAL 1:   Pol. angle  = -53.92 +/-  0.036 deg
vlb054> PCAL 1: 0420+417         I,Q,U,V=   1.4147 -0.02115 -0.06575
0.00000 Jy
vlb054> PCAL 1: Calibration source   1   0420+417
vlb054> PCAL 1:   Q+iU=(   0.03641,   0.05888) +/- (  0.000116,  0.000116)
Jy
vlb054> PCAL 1:   Pol. inten. =   0.06922 +/-  0.000163 Jy
vlb054> PCAL 1:   Pol. angle  =  29.14 +/-  0.048 deg
vlb054> PCAL 1: 0420+417         I,Q,U,V=   1.4064  0.03641  0.05888
0.00000 Jy
```

Using the calibration, check the difference between polarizations on a polarized calibrator

```
task 'rldif'
source '0518+165', ' '
timer 0
antenna 0
uvrange 0
docalib 1
gainuse 2
dopol true
go
```

```
Ampscalar average of matrix  =    90.43(  0.020) sigma =  0.496
Ampscalar average of matrix  =  -102.71(  0.065) sigma =  1.583
```

```
outputs
```

```
AIPS 1: RLDIF:  Task to return/apply Right - Left phase difference
AIPS 1: Adverbs     Values                 Comments
AIPS 1: ------------------------------------------------------------------
AIPS 1: CLCORPRM     90.4283   -102.7064   R-L phase difference returned
AIPS 1:            *rest 0
```

Another save, just in case

```
task 'tasav'
clro
outdi 1
go
```

What is the angle supposed to be for this calibrator?

Polarization data for C band from http://www.vla.nrao.edu/astro/calib/polar/1999/

Correct number is -22.98

Correct the measured values

```
for i=1 to 2;clcorp(i) = -22.98 - clcorp(i);end
```

Apply them

```
task 'clcor'
source ' '
```

```
antenna 0
timer 0
bif 0
eif 0
gainver 2
gainuse 0
opcode 'polr'
stokes 'l'
go
```

Check that the angles match what we expect

```
task 'rldif'
source '0518+165', ' '
timer 0
antenna 0
uvrange 0
docalib 1
gainuse 3
dopol true
go
```

Look at what AIPS gave back

```
outputs
```

```
AIPS 1: RLDIF:  Task to return Right - Left phase difference
AIPS 1: Adverbs     Values                Comments
AIPS 1: ------------------------------------------------------------
AIPS 1: CLCORPRM    -22.98      -22.98     R-L phase difference returned
AIPS 1:            *rest 0
```

Save the tables again

```
task 'tasav'
clro
outdi 1
go
```

Now start with the smaller array data. Load it in

(Actually, in the 2010 Nov 16 version of these instructions, it is already loaded in slot 9. You can skip this step if you want.)

FILLM

```
task 'fillm'
default
nfiles 2
prtlev 0
datain 'PWD:AT166_
doconcat true
clron
doweight 10
ncount 1
cparm(4)=28
cparm(8)=10./60
go
```

Check where it went

```
pcat
```

```
AIPS 1: Catalog on disk  1
AIPS 1:  Cat Usid Mapname      Class   Seq  Pt     Last access      Stat
AIPS 1:    1  100 19940725    .C BAND.    1 UV 16-NOV-2010 13:15:34
AIPS 1:    2  100 19940725    .X BAND.    1 UV 16-NOV-2010 13:15:34
AIPS 1:    3  100 19940725    .X BAND.    2 UV 16-NOV-2010 13:15:34
AIPS 1:    4  100 19940725    .C BAND.    2 UV 16-NOV-2010 15:08:27
AIPS 1:    5  100 19940725    .U BAND.    1 UV 16-NOV-2010 13:15:34
AIPS 1:    6  100 19940725    .C BAND.    3 UV 16-NOV-2010 13:15:45
AIPS 1:    7  100 19940725    .C BAND.    4 UV 16-NOV-2010 16:08:46
AIPS 1:    8  100 19940725    .X BAND.    3 UV 16-NOV-2010 13:15:44
AIPS 1:    9  100 19940725    .X BAND.    4 UV 16-NOV-2010 13:15:45
AIPS 1:   10  100 3C138_C     .MODEL .    1 MA 16-NOV-2010 15:17:52
AIPS 1:   11  100 3C48_C      .MODEL .    1 MA 16-NOV-2010 15:24:38
AIPS 1:   12  100 19940725    .UVFIX .    1 UV 16-NOV-2010 16:03:44
AIPS 1:   13  100 19940725    .TASAV .    1 UV 16-NOV-2010 15:49:48
```

Make sure we have the right one

```
getn 9
imhe
```

Get the scan information

```
task 'listr'
default
getn 9
optype 'scan'
```

doweight 1
go

```
 vlb054    LISTR(31DEC10)    100     16-NOV-2010  21:19:54    Page    1
File = 19940725    .X BAND.   4 Vol = 1  Userid =  100
Freq =  8.514900000 GHz   Ncor =  4   No. vis =    287494
Scan summary listing

Scan      Source      Qual  Calcode Sub         Timerange          FrqID
START VIS  END VIS
   1 0134+329        : 0002  C        1101/04:01:46 - 101/04:03:55     1
1       3635
   2 0134+329        : 0002  C        1101/04:04:15 - 101/04:05:05     1
3636       5560
   3 0056-001        : 0002  C        1101/04:11:25 - 101/04:13:45     1
5561       7731
   4 0053-016        : 0002           1101/04:22:15 - 101/04:30:35     1
7732      23734
   5 0053-015        : 0002           1101/04:39:04 - 101/04:47:15     1
23735      39425
   6 0056-001        : 0002  C        1101/04:49:45 - 101/04:52:05     1
39426      43741
   7 0053-016        : 0002           1101/05:00:35 - 101/05:08:55     1
43742      59757
   8 0053-015        : 0002           1101/05:17:25 - 101/05:25:35     1
59758      74973
   9 0056-001        : 0002  C        1101/05:28:05 - 101/05:30:25     1
74974      79289
  10 0053-016        : 0002           1101/05:38:55 - 101/05:47:15     1
79290      95250
  11 0053-015        : 0002           1101/05:55:45 - 101/06:03:45     1
95251     110616
  12 0056-001        : 0002  C        1101/06:06:25 - 101/06:08:45     1
110617     114932
  13 0053-016        : 0002           1101/06:17:15 - 101/06:25:36     1
114933     130948
  14 0053-015        : 0002           1101/06:34:05 - 101/06:42:15     1
130949     146625
  15 0056-001        : 0002  C        1101/06:44:45 - 101/06:47:05     1
146626     150928
  16 0053-016        : 0002           1101/06:55:34 - 101/07:03:55     1
150929     166906
  17 0053-015        : 0002           1101/07:12:25 - 101/07:20:36     1
166907     182583
  18 0056-001        : 0002  C        1101/07:23:05 - 101/07:25:24     1
182584     186886
  19 0420+417        : 0002  B        1101/07:31:35 - 101/07:33:26     1
186887     190226
  20 0518+165        : 0002  C        1101/07:39:04 - 101/07:42:25     1
190227     196417
```

```
  21 3C129           : 0002           1101/08:02:45 - 101/08:17:55     1
196418     225758
  22 0420+417        : 0002  B        1101/08:25:34 - 101/08:27:25     1
225759     228387
  23 0420+417        : 0002  B        1101/08:47:25 - 101/08:49:15     1
228388     231675
  24 3C129           : 0002           1101/08:51:55 - 101/09:06:55     1
231676     260851
  25 0420+417        : 0002  B        1101/09:15:04 - 101/09:16:55     1
260852     264196
  26 3C129           : 0002           1101/09:29:56 - 101/09:40:15     1
264197     284173
  27 0420+417        : 0002  B        1101/09:47:34 - 101/09:49:25     1
284174     287494
Type Q to stop, just hit RETURN to continue

 vlb054    LISTR(31DEC10)    100     16-NOV-2010  21:19:56    Page    2
File = 19940725    .X BAND.   4 Vol = 1  Userid =  100

Source summary
Velocity type = '        '    Definition = '        '

  ID Source           Qual  Calcode RA(1950.0)     Dec(1950.0)   IFlux
QFlux   UFlux   VFlux  No. vis
   1 0134+329        : 0002   C     01:34:49.8320  32:54:20.520   0.000
0.000   0.000   0.000    5560
             IF( 2)                                               0.000
0.000   0.000   0.000
   2 0056-001        : 0002   C     00:56:31.7550 -00:09:18.750   0.000
0.000   0.000   0.000   23725
             IF( 2)                                               0.000
0.000   0.000   0.000
   3 0053-016        : 0002         00:53:28.0000 -01:36:45.000   0.000
0.000   0.000   0.000   79974
             IF( 2)                                               0.000
0.000   0.000   0.000
   4 0053-015        : 0002         00:53:52.2350 -01:31:57.790   0.000
0.000   0.000   0.000   77627
             IF( 2)                                               0.000
0.000   0.000   0.000
   5 0420+417        : 0002   B     04:20:27.9370  41:43:08.045   0.000
0.000   0.000   0.000   15923
             IF( 2)                                               0.000
0.000   0.000   0.000
   6 0518+165        : 0002   C     05:18:16.5320  16:35:26.900   0.000
0.000   0.000   0.000    6191
             IF( 2)                                               0.000
0.000   0.000   0.000
   7 3C129           : 0002         04:45:31.6950  44:55:19.950   0.000
0.000   0.000   0.000   78494
             IF( 2)                                               0.000
```

```
0.000   0.000   0.000

  ID Source            Freq(GHz) Velocity(Km/s) Rest freq (GHz)
   1 All Sources          8.5149         0.0000          0.0000
     IF(  2)              8.8851         0.0000          0.0000

Frequency Table summary
FQID IF#      Freq(GHz)      BW(kHz)   Ch.Sep(kHz)  Sideband
   1   1       8.51490000   50000.0039  50000.0039      1
       2       8.88510000   50000.0039  50000.0039      1
```

Get antenna positions

```
go prtan
```

```
                      Location Of VLA Antennas

                               N18 (26)
                               N16 ( 1)
                               N14 ( 9)
                               N12 (11)
                               N10 (15)
                               N8  (27)
                               N6  (25)
                               N4  (14)
                               N2  (13)
                            ( 3) W2   E2  ( 4)
                          (12) W4       E4  (22)
                        (21) W6           E6  (16)
                      ( 8) W8               E8  (17)
                    ( 2) W10                  E10 (24)
                  (10) W12                      E12 ( 5)
                (18) W14                          E14 (23)
              (28) W16                              E16 ( 7)
            (20) W18                                  E18 ( 6)
                            VLA:_OUT (19)
                            VPT:_OUT (29)
AIPS 1: Resumes
```

Check out some properties of the raw data

Plots

```
task 'uvplt'
source '0518+165',' '
calcode ' '
```

```
stokes 'half'
timer 0
uvrange 0
bif 0
eif 0
docalib 0
gainuse 1
bparm 0 1
aparm 0
refant 4
antennas 0
do3col 1
dotv 1
tvinit
go
source '0134+329',' '
tvinit
go
source '0420+417', ' '
tvinit
go
source '3C129', ' '
tvinit
go
bparm 6 7
source '0518+165',' '
tvinit
go
source '0134+329',' '
tvinit
go
source '0420+417', ' '
tvinit
go
source '3C129', ' '
tvinit
go
bparm 0
```

Raw numbers

```
task 'listr'
optype 'list'
antenna 4,0
basel 0
sources '0518+165','0134+329','0420+417', '3C129', ' '
calcode '*'
bif 0
eif 0
docalib 0
```

```
stokes ' '
dparm 0
go

dparm 1 0
go
dparm 0
```

Flag some bad data. Just run the commands and think about this later.

```
task 'uvflg'
default
dohist 1
getn 7
antenna 4 0
basel 0
timer 101 4 0 50 101 4 5 0
stokes ' '
opcode 'flag'
reason 'bad ant
outfgver 1
go
```

Begin the calibration

Apply the flux densities for the known calibrators

```
task 'setjy'
default
getn 6
source '0518+165',' '
bif 0
eif 0
optype 'calc'
aparm(2) 3
go
```

```
vlb054> SETJY1: Task SETJY  (release of 31DEC10) begins
vlb054> SETJY1: **WARNING: OPCODE=CALC AND FREQID =   -1
vlb054> SETJY1:      FREQID WILL BE RESET TO 1, CHECK YOUR RESULTS CAREFULLY
vlb054> SETJY1: A source model for this calibrator is available
vlb054> SETJY1: Consult the help file for CALRD for assistance
vlb054> SETJY1: / Flux calculated using known spectrum
vlb054> SETJY1: BIF =  1 EIF =  2 /Range of IFs
```

```
vlb054> SETJY1: '0518+165        ' IF =  1 FLUX = 3.7742 (Jy calcd)
vlb054> SETJY1: '0518+165        ' IF =  2 FLUX = 3.9464 (Jy calcd)
vlb054> SETJY1: / Using (1995.2) VLA or Reynolds (1934-638) coefficients
vlb054> SETJY1: Appears to have ended successfully
vlb054> SETJY1: vlb054       31DEC10 TST: Cpu=       0.0  Real=       0
```

```
bif 1
eif 1
optype ' '
zerosp 3.7742, 0.380, -0.153, 0.0
go
bif 2
eif 2
zerosp 3.9464, 0.397, -0.161, 0.0
go
```

```
bif 0
eif 0
zerosp 0
optype 'calc'
source = '0134+329',' '
go
```

```
vlb054> SETJY1: Task SETJY  (release of 31DEC08) begins
vlb054> SETJY1: **WARNING: OPCODE=CALC AND FREQID =   -1
vlb054> SETJY1:      FREQID WILL BE RESET TO 1, CHECK YOUR RESULTS CAREFULLY
vlb054> SETJY1: A source model for this calibrator may be available
vlb054> SETJY1: Use the verb CALDIR to see if there is one
vlb054> SETJY1: A source model for this calibrator may be available
vlb054> SETJY1: Use the verb CALDIR to see if there is one
vlb054> SETJY1: / Flux calculated using known spectrum
vlb054> SETJY1: BIF =  1 EIF =  2 /Range of IFs
vlb054> SETJY1: '0134+329        ' IF =  1 FLUX = 5.4891 (Jy calcd)
vlb054> SETJY1: '0134+329        ' IF =  2 FLUX = 5.8249 (Jy calcd)
vlb054> SETJY1: / Using (1995.2) VLA or Reynolds (1934-638) coefficients
vlb054> SETJY1: Appears to have ended successfully
vlb054> SETJY1: vlb054       31DEC08 TST: Cpu=       0.0  Real=       0
```

Run the calibration for 3C138

```
task 'calib'
default
getn 13
calsour '0518+165',' '
uvrange 0
antenna 0
refant 4
minamper 10
minphser 10
weightit 1
```

```
get2n 6
ncomp 0
solmode 'A&P'
aparm(6) 2
solint 2
solsub 2
cparm(3) 10
cparm(4) 10
go
clrmsg
```

Calibrate the phase calibrator

```
clr2n
calsour '0420+417', ' '
solint 0
uvrange 0
go
clrmsg
```

Check the results

```
task 'snplt'
antenna 0
stokes ' '
inext 'sn'
inver 1
sources ' '
timer 0
optype 'amp'
opcode 'alsi'
do3col 1
dotv 1
nplots 9
tvinit
go
optype 'phas'
go
inver 2
optype 'amp'
go
optype 'phas'
go
```

Use the amplitude calibrator to get the phase calibrator flux density

```
task 'getjy'
sources '0420+417', ' '
calsour '0518+165',' '
calcode ' '
bif 0
eif 0
antenna 0
timer 0
snver 0
go
```

```
vlb054> GETJY1: Task GETJY  (release of 31DEC08) begins\\
vlb054> GETJY1:    Source:Qual      CALCODE IF  Flux (Jy)
vlb054> GETJY1: 0420+417        :  3   B     1    1.33893 +/-   0.00641
vlb054> GETJY1:                               2    1.34714 +/-   0.00525
vlb054> GETJY1: Appears to have ended successfully
vlb054> GETJY1: vlb054       31DEC08 TST: Cpu=       0.0  Real=       0
```

Redo the phase calibrator calibration

Now that we know the flux density of the phase calibrator, run through its calibration again, just to be sure AIPS doesn't have some information left around from calibrating before with an unknown flux density.

```
inext 'sn'
inver 2
extdest
inver 0
tget calib
go
clrmsg
```

Apply the calibration to all sources

```
task 'clcal'
sources '0518+165','0420+417', '3C129', ' '
calsour '0518+165','0420+417', ' '
opcode 'cali'
gainver 1
gainuse 2
refant 4
interp '2pt'
doblank 1
go
```

Check the results

Plots

```
task 'uvplt'
docalib 1
gainuse 2
source '0420+417', ' '
stokes 'half'
aparm 0
bparm 0 1
doweight 1
uvrange 0
tvinit
go
```

Now start the polarization calibration

Check the paralactic angles

```
task 'listr'
sources '0518+165','0420+417', ' '
inext 'cl'
inver 2
optype 'gain'
dparm 9,0
go
```

Make a backup of calibration information

```
task 'tasav'
clro
go
```

Run the polarization calibration on the phase calibrator

```
task 'pcal'
calsour '0420+417', ' '
timer 0
antenna 0
uvrange 0
bif 0
eif 0
```

```
docalib 1
gainuse 2
clr2n
pmodel 0
solint 3
soltype 'appr'
prtlev 1
refant 4
bparm 0
cparm 0
go
clrmsg
```

```
vlb054> PCAL 1: Calibration source   1
vlb054> PCAL 1:   Q+iU=(   0.00444,  -0.04706) +/- (  0.000273,  0.000273)
Jy
vlb054> PCAL 1:   Pol. inten. =   0.04727 +/-  0.000386 Jy, angle = -42.30
+/-
vlb054>         0.165 deg
vlb054> PCAL 1: 0420+417         I,Q,U,V =   1.3389  0.00444 -0.04706
0.00000 J
vlb054>         y
vlb054> PCAL 1: Calibration source   1
vlb054> PCAL 1:   Q+iU=(   0.02002,   0.03901) +/- (  0.000277,  0.000277)
Jy
vlb054> PCAL 1:   Pol. inten. =   0.04385 +/-  0.000392 Jy, angle =  31.42
+/-
vlb054>         0.181 deg
vlb054> PCAL 1: 0420+417         I,Q,U,V =   1.3471  0.02002  0.03901
0.00000 J
vlb054>         y
```

Check the phase difference between polarizations on a polarization calibrator

```
task 'rldif'
source '0518+165', ' '
timer 0
antenna 0
uvrange 0,45
docalib 1
gainuse 2
dopol true
go

outputs
```

```
AIPS 1: RLDIF:  Task to return Right - Left phase difference
AIPS 1: Adverbs     Values                Comments
AIPS 1: ------------------------------------------------------------------
AIPS 1: CLCORPRM    132.6554    -74.984    R-L phase difference returned
```

```
AIPS 1:              *rest 0
```

Make backups again

```
task 'tasav'
clro
go
```

Find out what the polarization angle on the sky is supposed to be

Polarization data for C band from http://www.vla.nrao.edu/astro/calib/polar/1999/

Correct number is -21.71

Correct the measured values

```
for i=1 to 2;clcorp(i) = -21.71 - clcorp(i);end
```

Apply the corrections

```
task 'clcor'
source ' '
antenna 0
timer 0
bif 0
eif 0
gainver 2
gainuse 0
opcode 'polr'
stokes 'l'
go
```

Check that the angles are now correct

```
task 'rldif'
source '0518+165', ' '
timer 0
antenna 0
uvrange 0,45
docalib 1
gainuse 3
dopol true
go
```

outputs

```
AIPS 1: RLDIF:  Task to return Right - Left phase difference
AIPS 1: Adverbs     Values                 Comments
AIPS 1: ------------------------------------------------------------------
AIPS 1: CLCORPRM    -21.71      -21.71     R-L phase difference returned
AIPS 1:            *rest 0
```

############################

Work on just the target data now

Run SPLIT on the two datasets

```
task 'split'
getn 4
source '3C129', ' '
timer 0
bif 0
eif 0
docalib 1
gainuse 3
dopol true
stokes ' '
douvcomp false
aparm 0
go
getn 13
go
clrmsg
```

Check for where the new datafiles are stored

```
pcat
```

```
AIPS 1: Catalog on disk  1
AIPS 1:  Cat Usid Mapname      Class   Seq  Pt     Last access      Stat
AIPS 1:    1  101 19940725    .C BAND.    1 UV 13-NOV-2008 17:24:12
AIPS 1:    2  101 19940725    .X BAND.    1 UV 13-NOV-2008 17:24:13
AIPS 1:    3  101 19940725    .X BAND.    2 UV 13-NOV-2008 17:24:13
AIPS 1:    4  101 19940725    .C BAND.    2 UV 13-NOV-2008 18:24:07
AIPS 1:    5  101 19940725    .U BAND.    1 UV 13-NOV-2008 17:24:13
AIPS 1:    6  101 3C138_C     .MODEL .    1 MA 13-NOV-2008 17:51:33
AIPS 1:    7  101 3C48_C      .MODEL .    1 MA 13-NOV-2008 16:19:09
AIPS 1:    8  101 19940725    .TASAV .    1 UV 13-NOV-2008 17:24:13
AIPS 1:    9  101 19940725    .TASAV .    2 UV 13-NOV-2008 17:24:13
AIPS 1:   10  101 19941103    .C BAND.    1 UV 13-NOV-2008 17:24:36
```

```
AIPS 1:   11  101 19941103    .X BAND.    1 UV 13-NOV-2008 17:24:36
AIPS 1:   12  101 19941103    .X BAND.    2 UV 13-NOV-2008 17:24:36
AIPS 1:   13  101 19941103    .C BAND.    2 UV 13-NOV-2008 18:24:18
AIPS 1:   14  101 19941103    .TASAV .    1 UV 13-NOV-2008 17:54:20
AIPS 1:   15  101 19941103    .TASAV .    2 UV 13-NOV-2008 17:56:30
AIPS 1:   16  101 3C129       .SPLIT .    1 UV 13-NOV-2008 18:24:07
AIPS 1:   17  101 3C129       .SPLIT .    2 UV 13-NOV-2008 18:24:18
```

Combine the two different observations into one big one

```
task 'dbcon'
getn 16
get2n 17
go
pcat
```

```
AIPS 1:   18  101 3C129       .DBCON .    1 UV 13-NOV-2008 18:28:31
```

Imaging

IMAGR is the standard imaging tool for AIPS

This will start up an imaging/cleaning session. Draw boxes and clean the source structure. Do this for all 4 Stokes parameters. (Unfortunately, IMAGR requires separate runs for the different Stokes parameters.)

```
task 'imagr'
getn 18
stokes 'i'
dopol 0
cellsize 0.25,0.25
imsize 2048,2048
clr2n
do3dimag 1
docalib 0
uvrange 0
niter 20000
overlap 1
go
clrmsg
stokes 'q'
go
clrmsg
stokes 'u'
go
clrmsg
```

```
stokes 'v'
go
clrmsg
```

Check where the files went

```
pcat
```

```
AIPS 1:   29  101 3C129       .IBM001.    3 MA 13-NOV-2008 19:46:00
AIPS 1:   30  101 3C129       .ICL001.    5 MA 13-NOV-2008 19:46:00
AIPS 1:   31  101 3C129       .QBM001.    1 MA 13-NOV-2008 19:47:30
AIPS 1:   32  101 3C129       .QCL001.    1 MA 13-NOV-2008 19:47:30
AIPS 1:   33  101 3C129       .UBM001.    1 MA 13-NOV-2008 19:49:06
AIPS 1:   34  101 3C129       .UCL001.    1 MA 13-NOV-2008 19:49:06
AIPS 1:   35  101 3C129       .VBM001.    1 MA 13-NOV-2008 19:49:39
AIPS 1:   36  101 3C129       .VCL001.    1 MA 13-NOV-2008 19:49:39
```

Polarization images

Combine Q and U to get linear polarization

```
task 'comb'
opcode 'polc'
getn 32
get2n 34
aparm 0
bparm(1) 28E-6
bparm(2) 28E-6
go
```

Get the linear polarization angle

```
opcode 'pola'
go
```

Check where file went

```
pcat
```

```
AIPS 1:   28  101 3C129       .PPOLC .    1 MA 13-NOV-2008 19:59:45
AIPS 1:   37  101 3C129       .PANG  .    1 MA 13-NOV-2008 20:00:28
```

Look at the images

Linear Polarization

```
getn 28
tvinit
tvlod
tvfiddle
tvstat
```

```
AIPS 1: Mean= 1.3417E-05 rms= 2.8180E-05 JY/BEAM   over  178694. pixels
```

Polarization Angle

```
getn 37
tvinit
tvlod
tvfiddle
```

I

```
getn 30
tvinit
tvlod
tvfiddle
tvstat
```

Clip the data so we only see information where there is good S/N

```
task 'comb'
getn 37
get2n 28
opcode 'clip'
aparm(1) 100E-6
aparm(10) 100E-6
bparm 0
outclass 'PANGC'
go
task 'comb'
getn 28
get2n 28
opcode 'clip'
aparm(1) 100E-6
aparm(10) 100E-6
```

```
bparm 0
outclass 'POLCC'
go
```

Check where these files went

```
pcat
```

```
AIPS 1:   38  101 3C129       .PANGC .    1 MA 13-NOV-2008 20:31:21
AIPS 1:   39  101 3C129       .POLCC .    1 MA 13-NOV-2008 20:31:21
```

Look at the polarization angle

```
getn 38
tvinit
tvlod
tvfiddle
```

Plotting your data

Plot I contours and P greyscale

```
task 'kntr'
getn 30
get2n 28
docont 1
dogrey 2
dovect 0
pixrange 0 1E-3
clev 28E-6
levs=-16,-8,8,16,32,64,128,256,512,1024
dowedge true
cbplot 1
dotv 1
blc 950 950
trc 1500 1500
go
```

Plot I contours and colors for polarization angle

```
task 'pcntr'
getn 30
get2n 32
get3n 34
```

```
docont 1
dogrey 2
dovect 1
pixrange 0 1E-3
clev 28E-6
levs=-16,-8,8,16,32,64,128,256,512,1024
factor 5
pol3col 1
pcut 80E-6
icut 0
dowedge 0
cbplot 1
dotv 1
blc 950 950
trc 1500 1500
go
```

Final Images