

GLOW Interferometry Tutorial: Wednesday

We will reduce the 3C129 polarization continuum dataset from the 2008 NRAO summer school. (See <http://casa.nrao.edu/Tutorial/Slworkshop2008/>) 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 of 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 = 'VLAIIFS ' 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
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

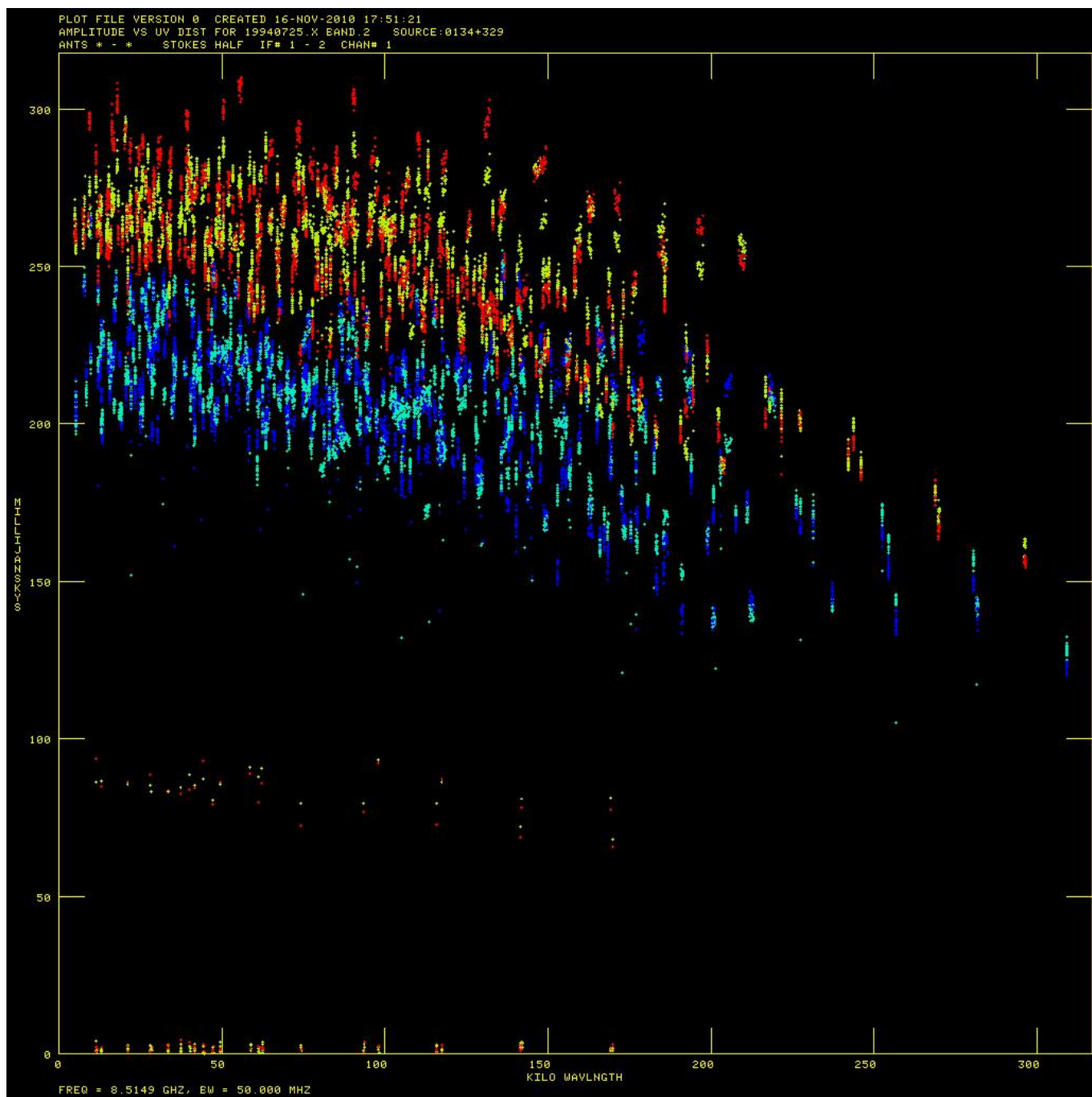
```

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

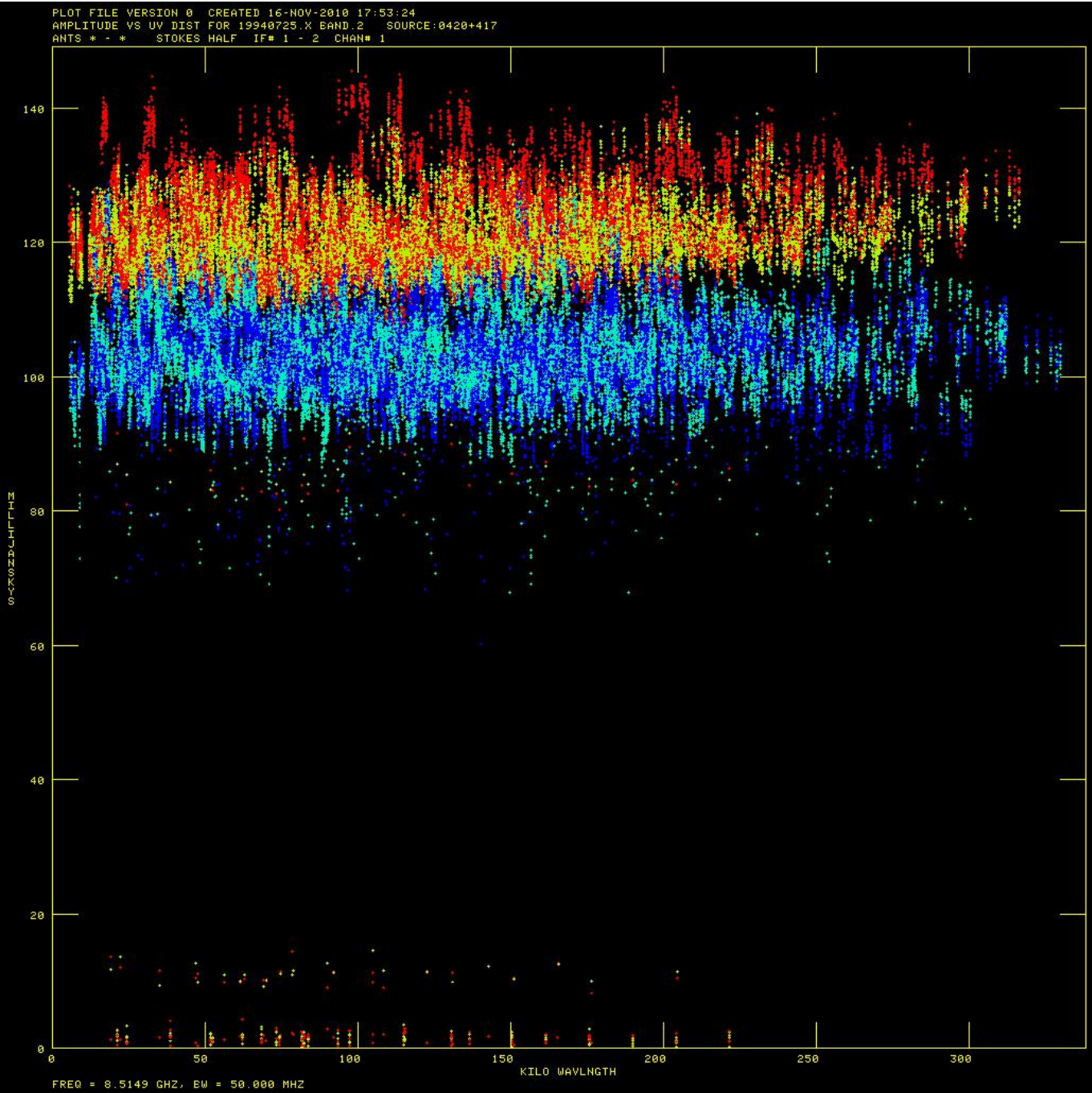
```

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





```
source '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	2.00 visplot
3.7cm	X	P	P	P	1.12 visplot
2cm	U	P	P	P	0.72 visplot
0.7cm	Q	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
2122222322242225222622272228
```

```
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						
0122022203220422052206220722082210221122122213221422152216221722182219222022						
2122222322242225222622272228						
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						
0122022203220422052206220722082210221122122213221422152216221722182219222022						
2122222322242225222622272228						
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

0122022203220422052206220722082210221122122213221422152216221722182219222022		
2122222322242225222622272228		
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

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Source=0518+165 : 0002, Stokes=RR , IF= 1, Chans= 1- 1

Baselines

0122022203220422052206220722082210221122122213221422152216221722182219222022
 2122222322242225222622272228

```
    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

```

0122022203220422052206220722082210221122122213221422152216221722182219222022
2122222322242225222622272228
    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'
clon
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
```

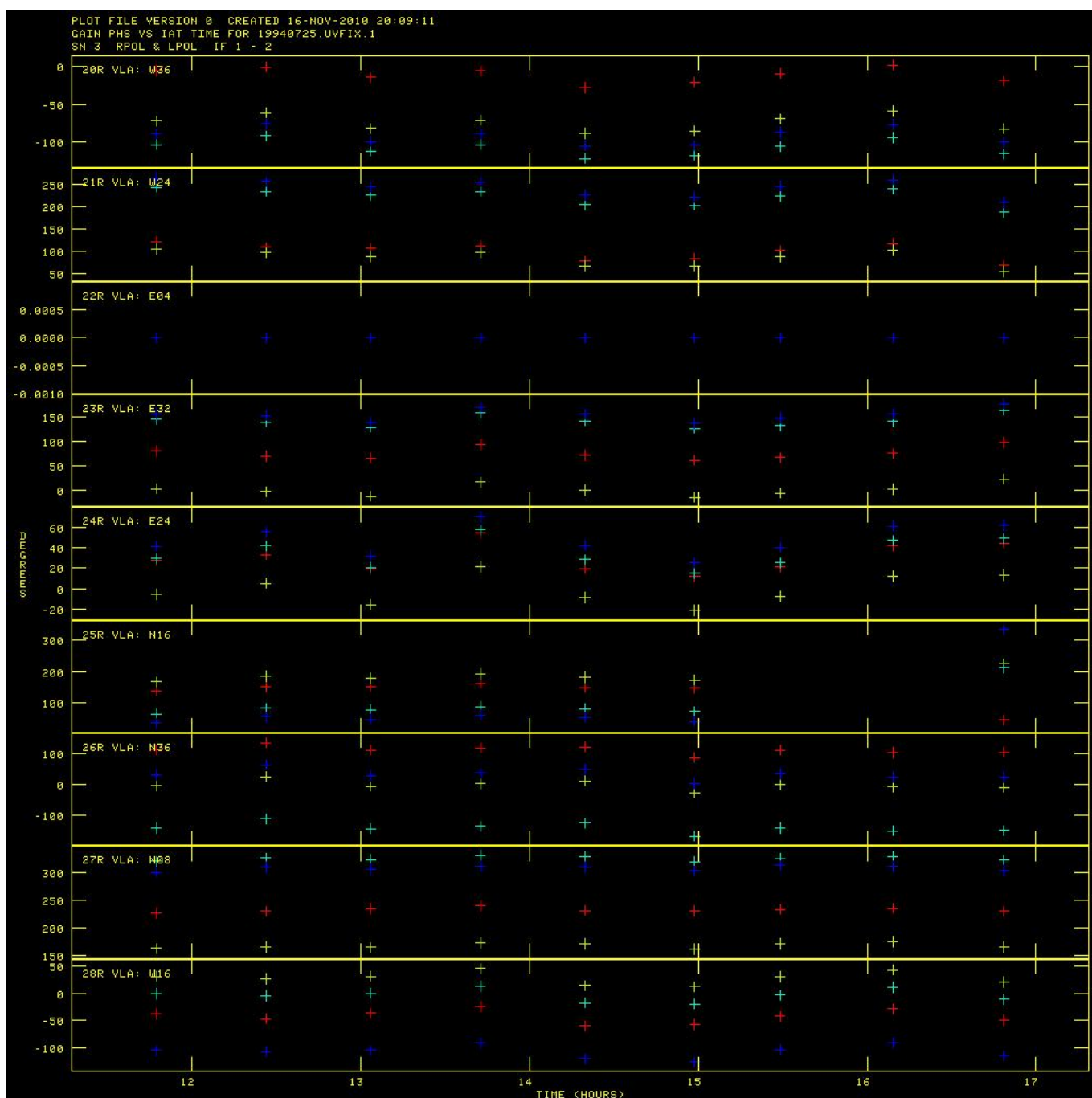
Check the results

```
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.

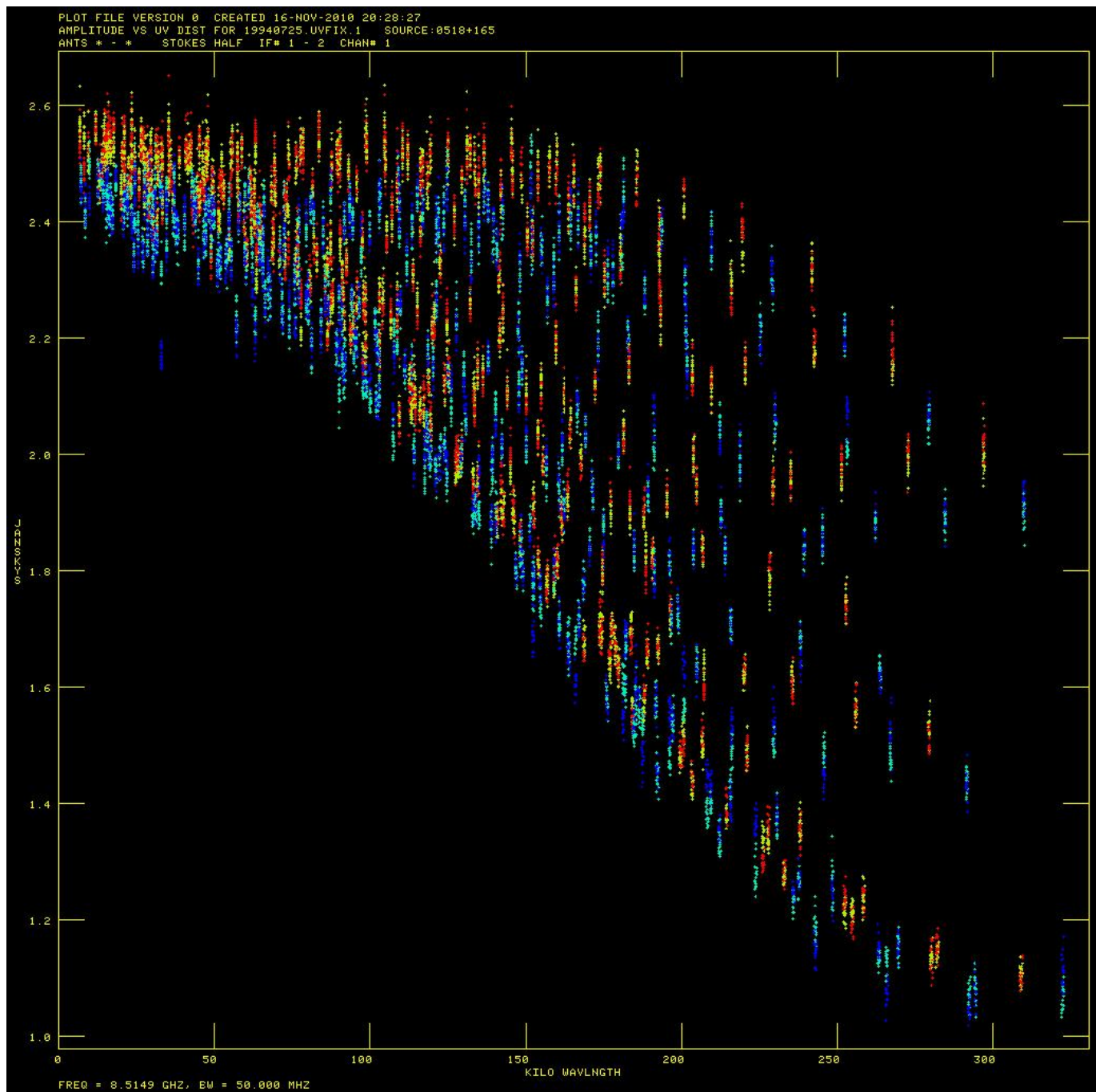
```
task 'clcal'
sources '0518+165','0134+329','0420+417', '3C129', ' '
calsour '0518+165','0134+329','0420+417', ' '
opcode 'cali'
gainver 1
gainuse 2
```

```
refant 22  
interp '2pt'  
doblack 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

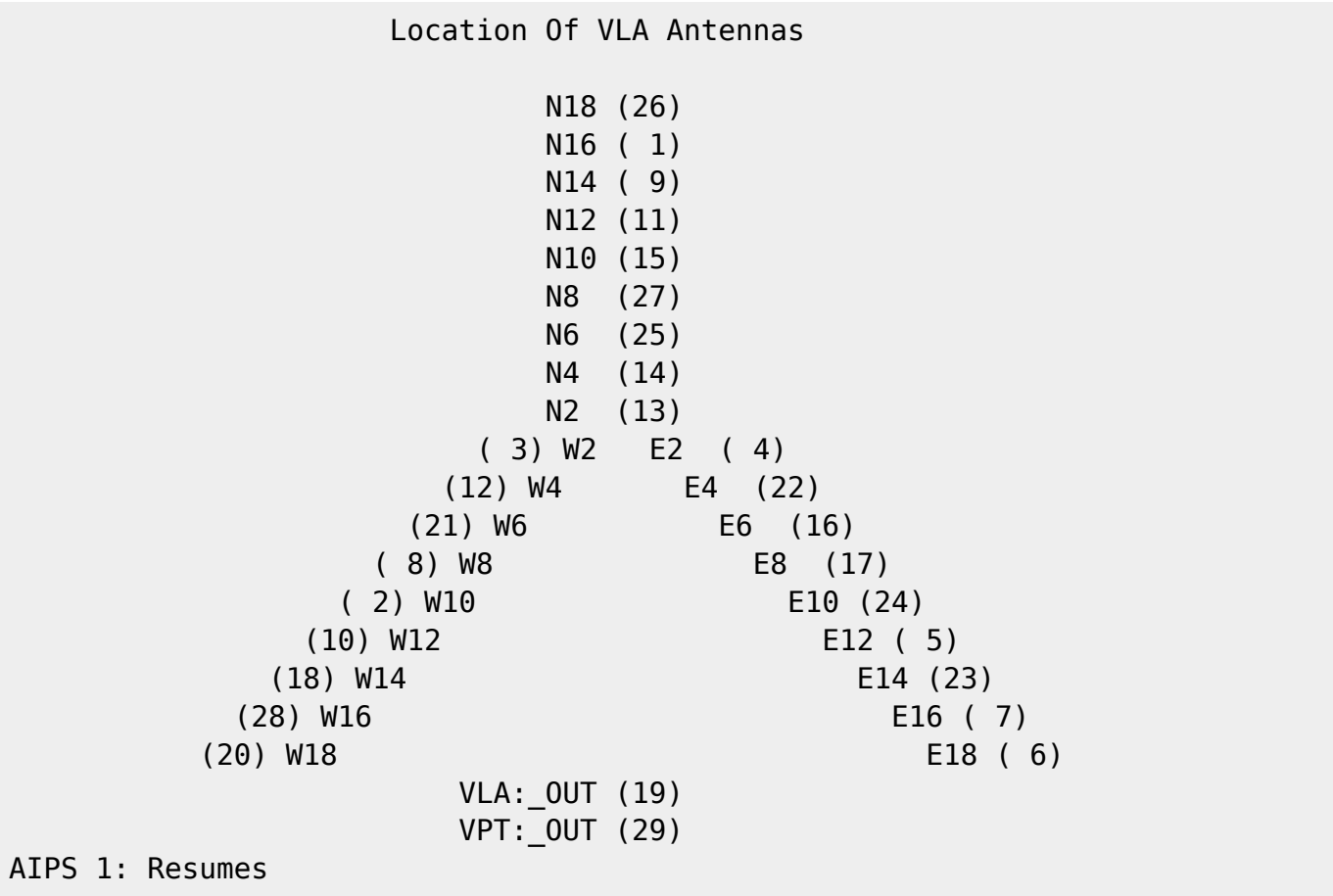
```
Velocity type = '      '      Definition = '      '
```

ID	Source	Qual	Calcode	RA(1950.0)	Dec(1950.0)	IFlux
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



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 3
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 'quack'  
reason 'quack'  
sources ' '  
calcode ' '  
stokes ' '  
timer 0  
antenna 0  
flagver 1  
opcode 'beg'  
basel 0  
bif 0  
eif 0  
aparm 0  
aparm(2) 22.5/60  
go
```

```
task 'uvflg'  
default  
dohist 1  
getn 9  
antenna 0  
basel 0  
timer 101 4 3 50 101 4 4 20  
stokes ' '  
bif 0  
eif 0  
opcode 'flag'  
reason 'dropout'  
outfgver 1  
go  
timer 0  
bif 0  
eif 0  
antenna 0
```

Begin the calibration

Apply the flux densities for the known calibrators

```
task 'setjy'
default
getn 9
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
```

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 16
cparm 0
cparm(3)= -1
bparm 0
go
cparm 0
```

Run the calibration for 3C138

```
task 'calib'
default
```

```
getn 16
calsour '0518+165', ' '
uvrange 0
antenna 0
refant 3
minamper 10
minphser 10
weightit 1
get2n 10
ncomp 0
solmode 'A&P'
aparm(6) 2
solint 1
solsub 2
cparm(3) 10
cparm(4) 10
go
clrmsg
```

Calibrate 3C48

```
get2n 11
calsour '0134+329', ' '
solint 1
uvrange 0
go
clrmsg
```

Calibrate the phase calibrator

In this step we will try to get an amplitude calibration of the phase calibrator. Only the first scan seems to be good in amplitude, so set the time range for just it.

```
clr2n
calsour '0420+417', ' '
solint 40./60
uvrange 0
timer 101 0 0 0 101 8 0 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
inver 3
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','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      818 of      818 gain
samples
vlb054> GETJY1:      Source:Qual      CALCODE IF  Flux (Jy)
vlb054> GETJY1: 0420+417      : 2  B      1      1.50919 +/-      0.00369
0.00369
vlb054> GETJY1:      2      1.50224 +/-      0.00401
0.00401
vlb054> GETJY1:      Source:Qual      CALCODE      used      total      bad used      tot
bad
vlb054> GETJY1: 0420+417      : 2  B      416      416      0      104      104
0
```

```
vlb054> GETJY1: Appears to have ended successfully
vlb054> GETJY1: vlb054          31DEC10 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. This time, run through the entire time range.

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

Apply the calibration to all sources

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

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

Make a backup of calibration information

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

Run the polarization calibration on 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 3  
bparm 0  
cparm 0  
go  
clrmsg
```

```
vlb054> PCAL 1: Calibration source    1    0420+417
```

```

vlb054> PCAL 1: Q+iU=( -0.01935, 0.08692) +/- ( 0.000536, 0.000536)
Jy
vlb054> PCAL 1: Pol. inten. = 0.08905 +/- 0.000758 Jy
vlb054> PCAL 1: Pol. angle = 51.28 +/- 0.172 deg
vlb054> PCAL 1: 0420+417 I,Q,U,V= 1.5092 -0.01935 0.08692
0.00000 Jy
vlb054> PCAL 1: Calibration source 1 0420+417
vlb054> PCAL 1: Q+iU=( 0.08929, -0.01579) +/- ( 0.000699, 0.000699)
Jy
vlb054> PCAL 1: Pol. inten. = 0.09068 +/- 0.000988 Jy
vlb054> PCAL 1: Pol. angle = -5.02 +/- 0.221 deg
vlb054> PCAL 1: 0420+417 I,Q,U,V= 1.5022 0.08929 -0.01579
0.00000 Jy

```

Check the phase difference between polarizations on a polarization calibrator

```

task 'rldif'
source '0518+165', ' '
timer 0
antenna 0
uvrange 0
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    -55.2632  -171.0893  R-L phase difference returned
AIPS 1:              *rest 0

```

Make backups again

```

task 'tasav'
clro
outdi 1
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 -22.98

Correct the measured values

```
for i=1 to 2;clcorp(i) = -22.98 - 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  
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 12
source '0518+165','0134+329','0420+417','3C129', ' '
timer 0
bif 0
eif 0
docalib 1
gainuse 3
dopol true
stokes ' '
douvcomp false
aparm 0
go
getn 16
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 20
```

```
get2n 26
go
pcat
```

```
AIPS 1: 27 100 3C129 .DBCON . 1 UV 16-NOV-2010 22:13:56
```

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'
default
getn 27
stokes 'i'
dopol 0
cellsize 0.15,0.15
imsize 2048,2048
clr2n
do3dimag 1
docalib 0
uvrange 0
niter 20000
overlap 1
dotv 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

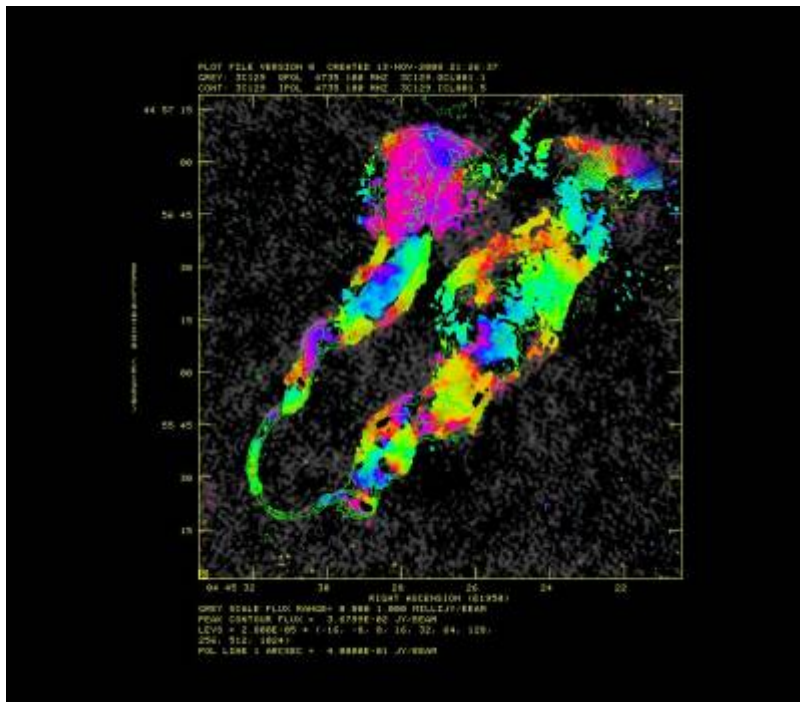
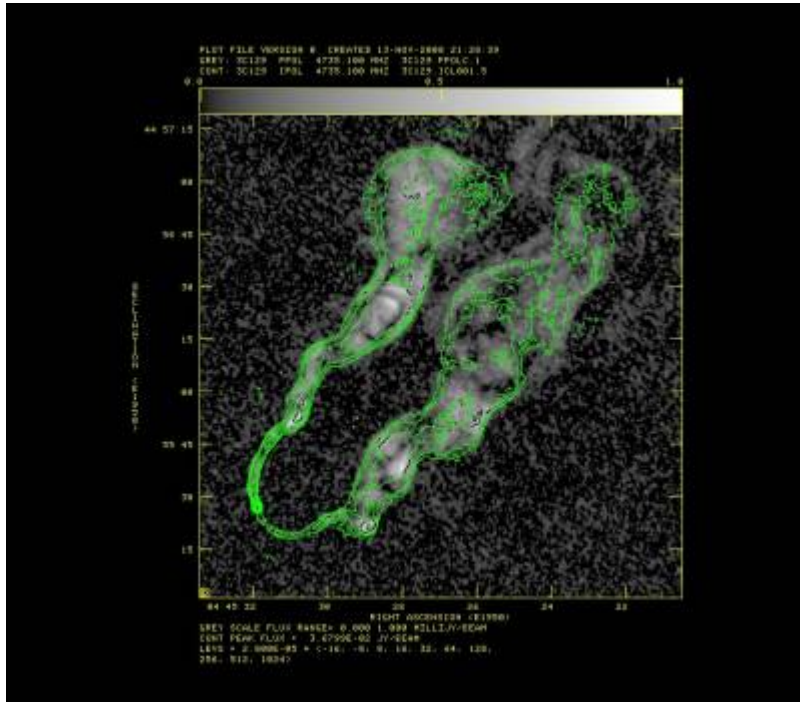
```
task 'kntr'  
getn 30  
get2n 28  
docont 1  
dogrey 2  
dovect 0  
pixrange 0 1E-3  
clev 28E-6  
levs=-16,-8,8,16,32,64,128,256,512,1024  
dowedge true  
cbplot 1  
dotv 1  
blc 950 950  
trc 1500 1500  
go
```

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



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