

# 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 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 2
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 C band version at 5 GHz

```
indi 1
pcat
getn 4
imhe
```

```
<AIPS 1: Got(1)   disk= 1  user= 100   type=UV   19940725.C BAND.2
AIPS 1: Image=MULTI      (UV)           Filename=19940725   .C 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   216975      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    4.8851000E+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 4
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

```

```

AIPS 1: Got(1) disk= 1 user= 101 type=UV 19940725.C BAND.2
vlb054 LISTR(31DEC08) 101 13-NOV-2008 15:25:41 Page 1
File = 19940725 .C BAND. 2 Vol = 1 Userid = 101
Freq = 4.885100000 GHz Ncor = 4 No. vis = 216975
Scan summary listing

```

| Scan       | Source  | Qual   | Calcode | Sub | Timerange               | FrqID |
|------------|---------|--------|---------|-----|-------------------------|-------|
| START VIS  | END VIS |        |         |     |                         |       |
| 1 2345-167 |         | : 0003 | A       | 1   | 0/07:41:45 - 0/07:43:25 | 1     |
| 1 2917     |         |        |         |     |                         |       |
| 2 A2597    |         | : 0003 |         | 1   | 0/08:00:25 - 0/08:02:35 | 1     |
| 2918 6788  |         |        |         |     |                         |       |

|        |          |   |      |   |   |            |   |            |   |
|--------|----------|---|------|---|---|------------|---|------------|---|
| 3      | 2345-167 | : | 0003 | A | 1 | 0/08:21:05 | - | 0/08:22:45 | 1 |
| 6789   | 9709     |   |      |   |   |            |   |            |   |
| 4      | A2597    | : | 0003 |   | 1 | 0/08:39:45 | - | 0/08:41:55 | 1 |
| 9710   | 13605    |   |      |   |   |            |   |            |   |
| 5      | 2345-167 | : | 0003 | A | 1 | 0/09:00:25 | - | 0/09:02:05 | 1 |
| 13606  | 16505    |   |      |   |   |            |   |            |   |
| 6      | A2597    | : | 0003 |   | 1 | 0/09:19:05 | - | 0/09:21:15 | 1 |
| 16506  | 20401    |   |      |   |   |            |   |            |   |
| 7      | 2345-167 | : | 0003 | A | 1 | 0/09:39:45 | - | 0/09:41:25 | 1 |
| 20402  | 23322    |   |      |   |   |            |   |            |   |
| 8      | A2597    | : | 0003 |   | 1 | 0/09:58:25 | - | 0/10:00:35 | 1 |
| 23323  | 27218    |   |      |   |   |            |   |            |   |
| 9      | 2345-167 | : | 0003 | A | 1 | 0/10:19:05 | - | 0/10:20:45 | 1 |
| 27219  | 30140    |   |      |   |   |            |   |            |   |
| 10     | A2597    | : | 0003 |   | 1 | 0/10:37:45 | - | 0/10:39:55 | 1 |
| 30141  | 34036    |   |      |   |   |            |   |            |   |
| 11     | 2345-167 | : | 0003 | A | 1 | 0/10:58:25 | - | 0/11:00:05 | 1 |
| 34037  | 36957    |   |      |   |   |            |   |            |   |
| 12     | A2597    | : | 0003 |   | 1 | 0/11:17:05 | - | 0/11:19:15 | 1 |
| 36958  | 40832    |   |      |   |   |            |   |            |   |
| 13     | 2345-167 | : | 0003 | A | 1 | 0/11:37:45 | - | 0/11:39:25 | 1 |
| 40833  | 43702    |   |      |   |   |            |   |            |   |
| 14     | 0420+417 | : | 0003 | B | 1 | 0/11:48:25 | - | 0/11:50:05 | 1 |
| 43703  | 46624    |   |      |   |   |            |   |            |   |
| 15     | 3C129    | : | 0003 |   | 1 | 0/12:12:55 | - | 0/12:23:05 | 1 |
| 46625  | 66120    |   |      |   |   |            |   |            |   |
| 16     | 0420+417 | : | 0003 | B | 1 | 0/12:27:25 | - | 0/12:29:05 | 1 |
| 66121  | 69041    |   |      |   |   |            |   |            |   |
| 17     | 3C129    | : | 0003 |   | 1 | 0/12:50:05 | - | 0/12:56:05 | 1 |
| 69042  | 80412    |   |      |   |   |            |   |            |   |
| 18     | 3C129    | : | 0003 |   | 1 | 0/12:56:25 | - | 0/13:00:15 | 1 |
| 80413  | 88498    |   |      |   |   |            |   |            |   |
| 19     | 0420+417 | : | 0003 | B | 1 | 0/13:04:35 | - | 0/13:06:15 | 1 |
| 88499  | 91419    |   |      |   |   |            |   |            |   |
| 20     | 3C129    | : | 0003 |   | 1 | 0/13:29:05 | - | 0/13:39:15 | 1 |
| 91420  | 109415   |   |      |   |   |            |   |            |   |
| 21     | 0420+417 | : | 0003 | B | 1 | 0/13:43:35 | - | 0/13:45:15 | 1 |
| 109416 | 112112   |   |      |   |   |            |   |            |   |
| 22     | 3C129    | : | 0003 |   | 1 | 0/14:06:15 | - | 0/14:16:25 | 1 |
| 112113 | 130108   |   |      |   |   |            |   |            |   |
| 23     | 0420+417 | : | 0003 | B | 1 | 0/14:20:45 | - | 0/14:22:25 | 1 |
| 130109 | 132636   |   |      |   |   |            |   |            |   |
| 24     | 3C129    | : | 0003 |   | 1 | 0/14:45:15 | - | 0/14:55:25 | 1 |
| 132637 | 150081   |   |      |   |   |            |   |            |   |
| 25     | 0420+417 | : | 0003 | B | 1 | 0/14:59:45 | - | 0/15:01:25 | 1 |
| 150082 | 152778   |   |      |   |   |            |   |            |   |
| 26     | 3C129    | : | 0003 |   | 1 | 0/15:18:25 | - | 0/15:25:35 | 1 |
| 152779 | 164366   |   |      |   |   |            |   |            |   |
| 27     | 0420+417 | : | 0003 | B | 1 | 0/15:30:05 | - | 0/15:31:45 | 1 |
| 164367 | 166846   |   |      |   |   |            |   |            |   |

```

 28 3C129          : 0003          1 0/15:55:05 - 0/16:05:15 1
166847      183403
 29 0420+417      : 0003 B        1 0/16:10:05 - 0/16:11:45 1
183404      185861
 30 3C129          : 0003          1 0/16:34:55 - 0/16:45:05 1
185862      203522
 31 0420+417      : 0003 B        1 0/16:49:35 - 0/16:51:15 1
203523      206216
 32 0518+165      : 0003 C        1 0/17:06:35 - 0/17:09:45 1
206217      211608
 33 0134+329      : 0003 C        1 0/17:21:45 - 0/17:24:55 1
211609      216975

```

## Source summary

Velocity type = ' ' Definition = ' '

| ID    | Source   | Qual   | Calcode | RA(1950.0)    | Dec(1950.0)   | IFlux |
|-------|----------|--------|---------|---------------|---------------|-------|
| 1     | 2345-167 | : 0003 | A       | 23:45:27.6823 | -16:47:52.600 | 0.000 |
| 0.000 | 0.000    | 0.000  | 20372   |               |               |       |
|       | IF( 2)   |        |         |               |               | 0.000 |
| 0.000 | 0.000    | 0.000  |         |               |               |       |
| 2     | A2597    | : 0003 |         | 23:22:43.7000 | -12:23:56.000 | 0.000 |
| 0.000 | 0.000    | 0.000  | 23330   |               |               |       |
|       | IF( 2)   |        |         |               |               | 0.000 |
| 0.000 | 0.000    | 0.000  |         |               |               |       |
| 3     | 0420+417 | : 0003 | B       | 04:20:27.9370 | 41:43:08.045  | 0.000 |
| 0.000 | 0.000    | 0.000  | 24318   |               |               |       |
|       | IF( 2)   |        |         |               |               | 0.000 |
| 0.000 | 0.000    | 0.000  |         |               |               |       |
| 4     | 3C129    | : 0003 |         | 04:45:31.6950 | 44:55:19.950  | 0.000 |
| 0.000 | 0.000    | 0.000  | 138196  |               |               |       |
|       | IF( 2)   |        |         |               |               | 0.000 |
| 0.000 | 0.000    | 0.000  |         |               |               |       |
| 5     | 0518+165 | : 0003 | C       | 05:18:16.5320 | 16:35:26.900  | 0.000 |
| 0.000 | 0.000    | 0.000  | 5392    |               |               |       |
|       | IF( 2)   |        |         |               |               | 0.000 |
| 0.000 | 0.000    | 0.000  |         |               |               |       |
| 6     | 0134+329 | : 0003 | C       | 01:34:49.8320 | 32:54:20.520  | 0.000 |
| 0.000 | 0.000    | 0.000  | 5367    |               |               |       |
|       | IF( 2)   |        |         |               |               | 0.000 |
| 0.000 | 0.000    | 0.000  |         |               |               |       |

| ID | Source      | Freq(GHz) | Velocity(Km/s) | Rest freq (GHz) |
|----|-------------|-----------|----------------|-----------------|
| 1  | All Sources | 4.8851    | 0.0000         | 0.0000          |
|    | IF( 2)      | 4.5851    | 0.0000         | 0.0000          |

## Frequency Table summary

| FQID | IF# | Freq(GHz)  | BW(kHz)    | Ch.Sep(kHz) | Sideband |
|------|-----|------------|------------|-------------|----------|
| 1    | 1   | 4.88510000 | 50000.0039 | 50000.0039  | 1        |
|      | 2   | 4.58510000 | 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)
```

### Flag some bad data. Just run the commands.

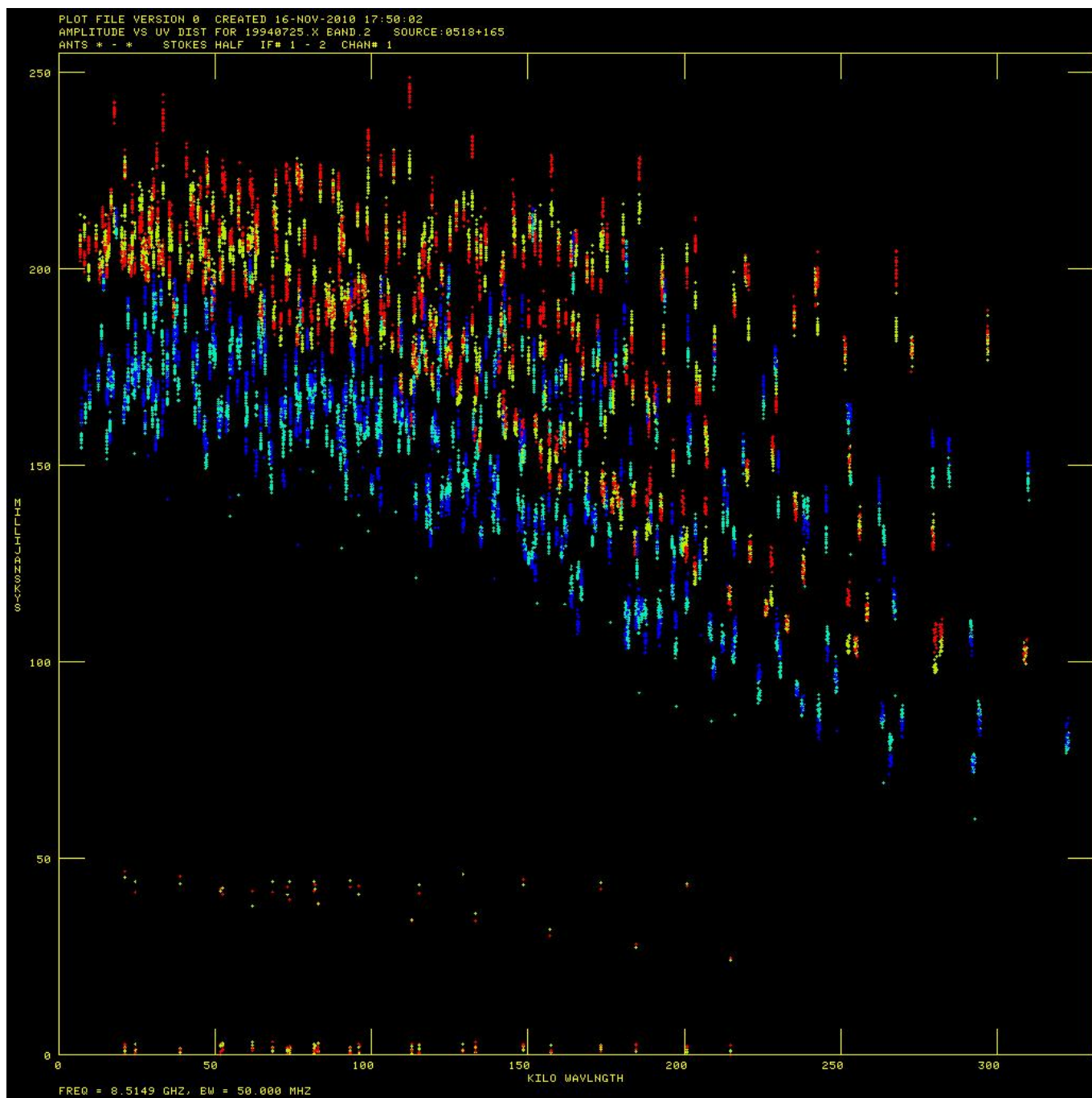
```
task 'uvflg'
default
dohist 1
getn 4
antenna 1,0
basel 0
timer 0 13 45 20 0 15 0 0
stokes ' '
opcode 'flag'
reason 'bad ant'
outfgver 1
go
antenna 14,0
timer 0 16 50 50 0 16 51 0
go
```

timer 0

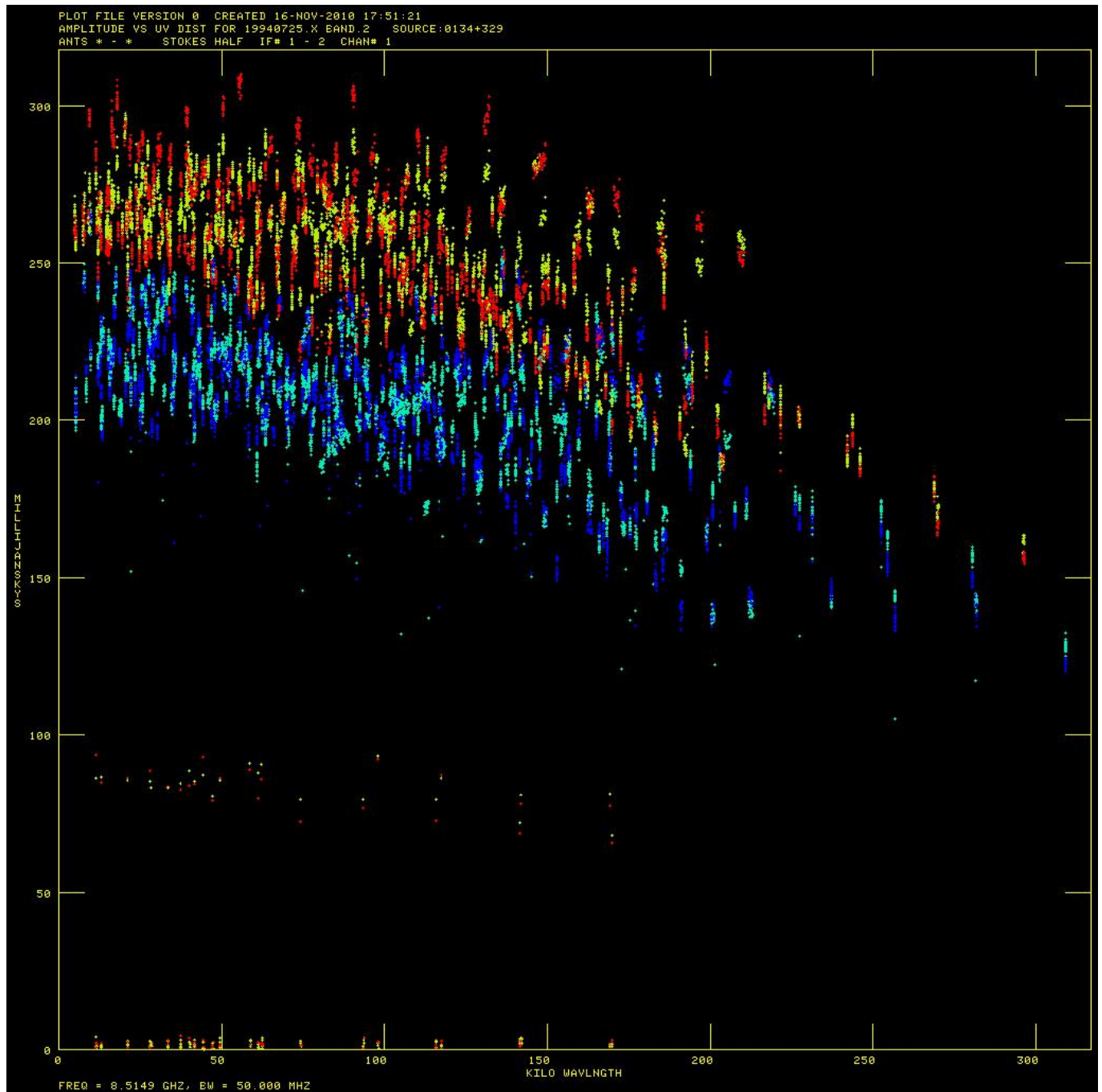
## Investigate the data

### Plots

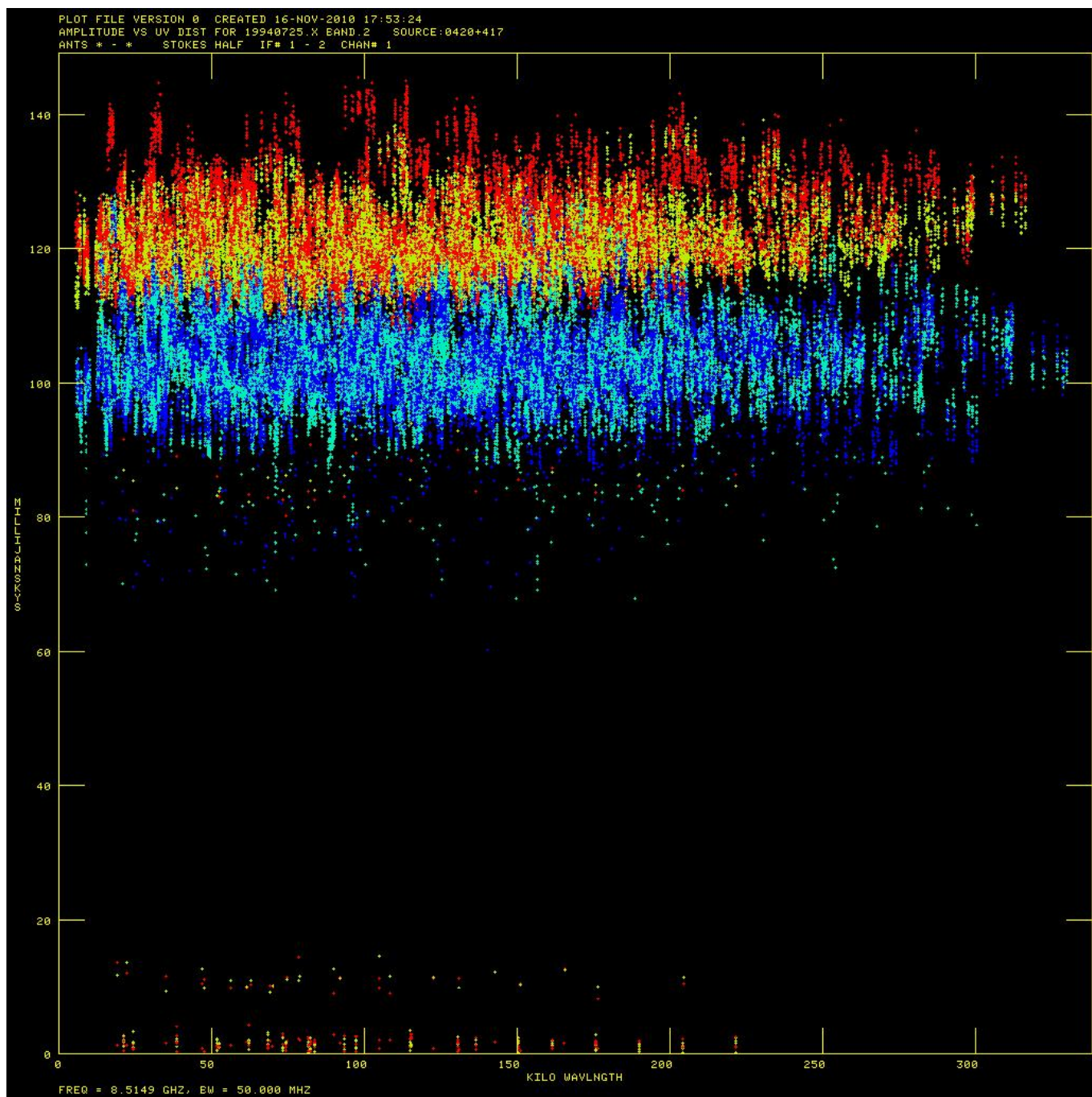
```
task 'uvplt'  
source '0518+165', ' '  
calcode ' '  
stokes 'half'  
timer 0  
uvrange 0  
bif 0  
eif 0  
docalib 0  
gainuse 1  
bparm 0 1  
aparm 0  
refant 22  
do3col 1  
dotv 1  
tvinit  
go
```



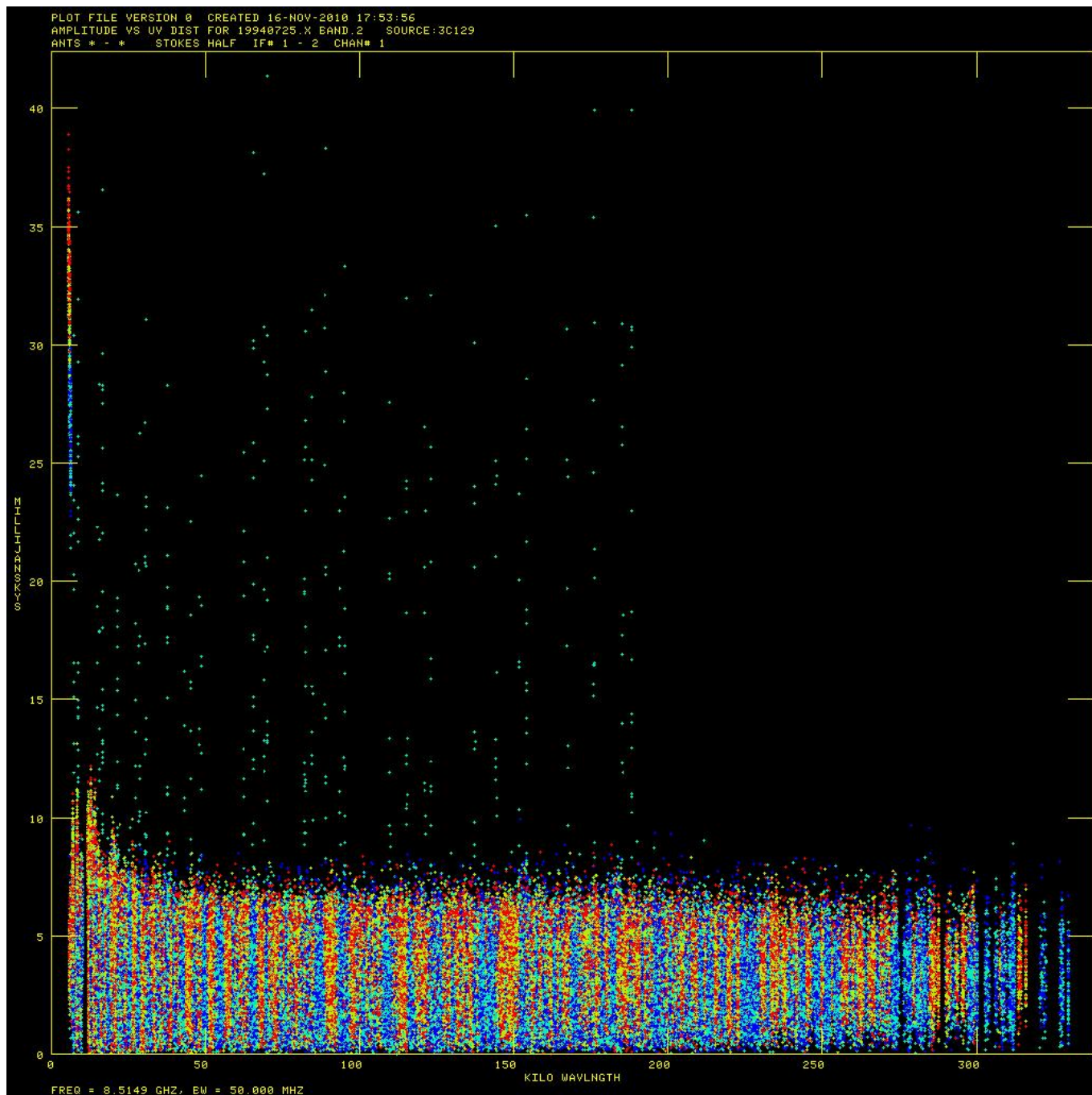
```
source '0134+329', ' '  
tvinit  
go
```



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



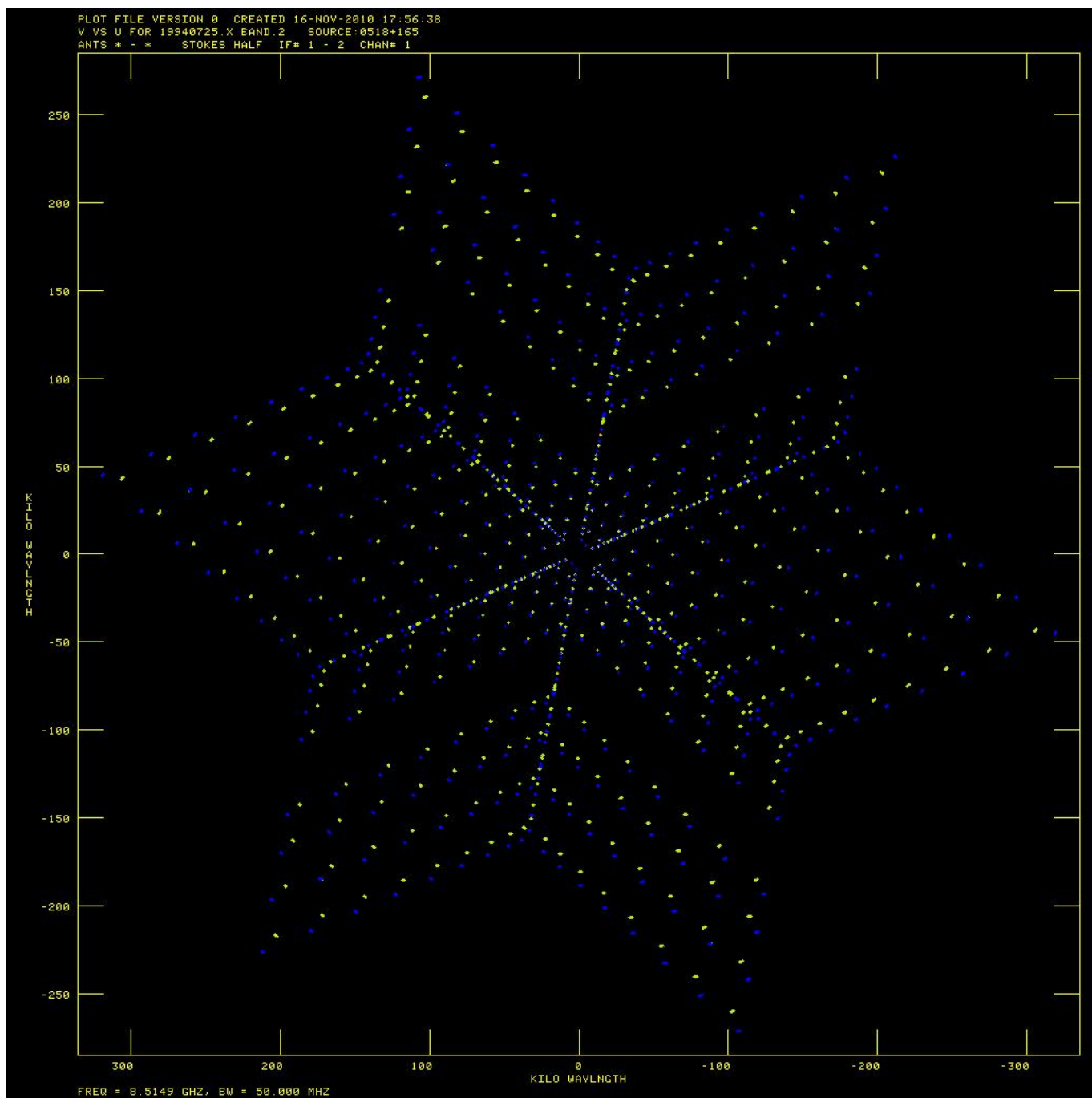
source '3C129', ' '  
tvinit  
go



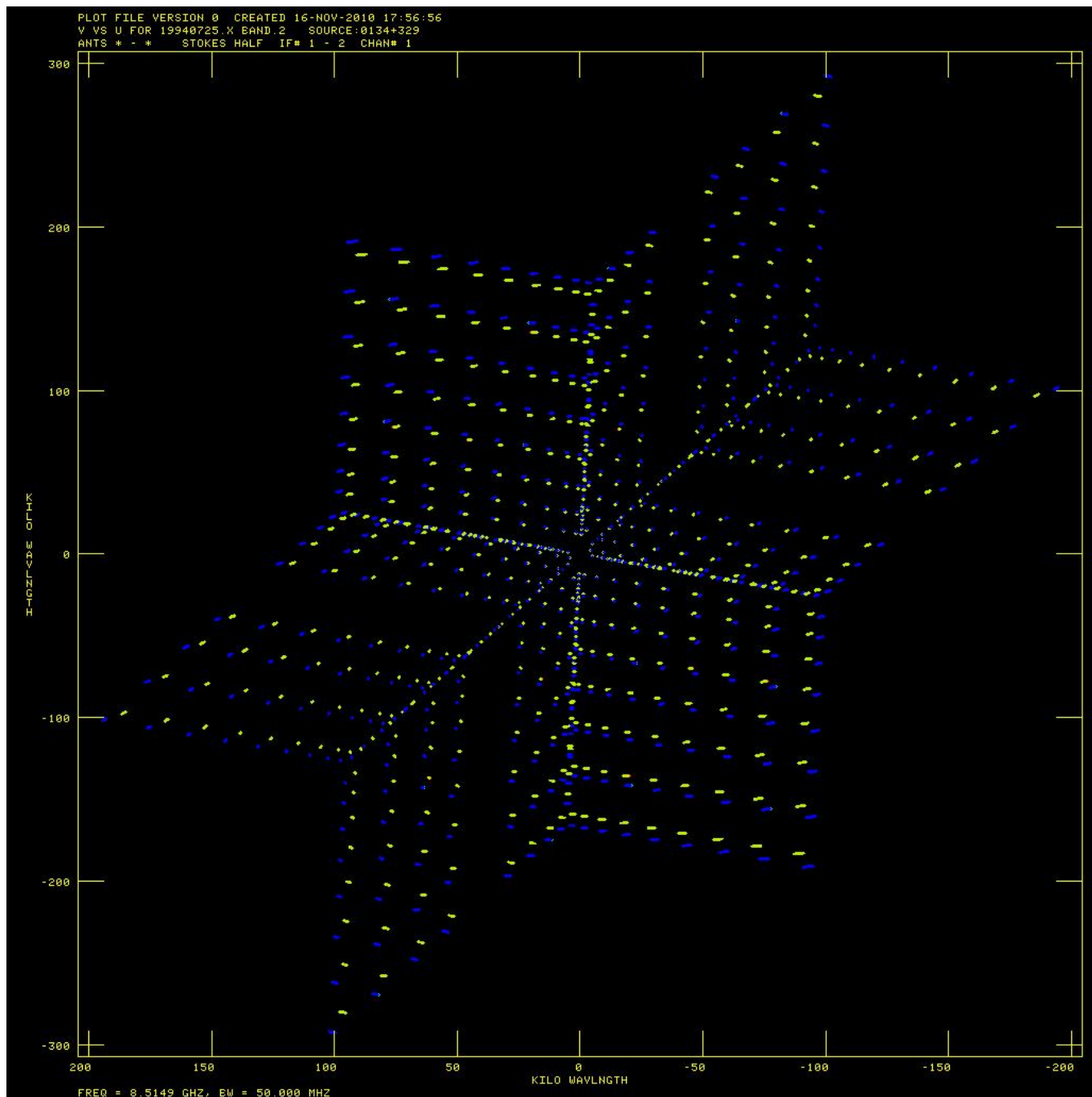
```

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

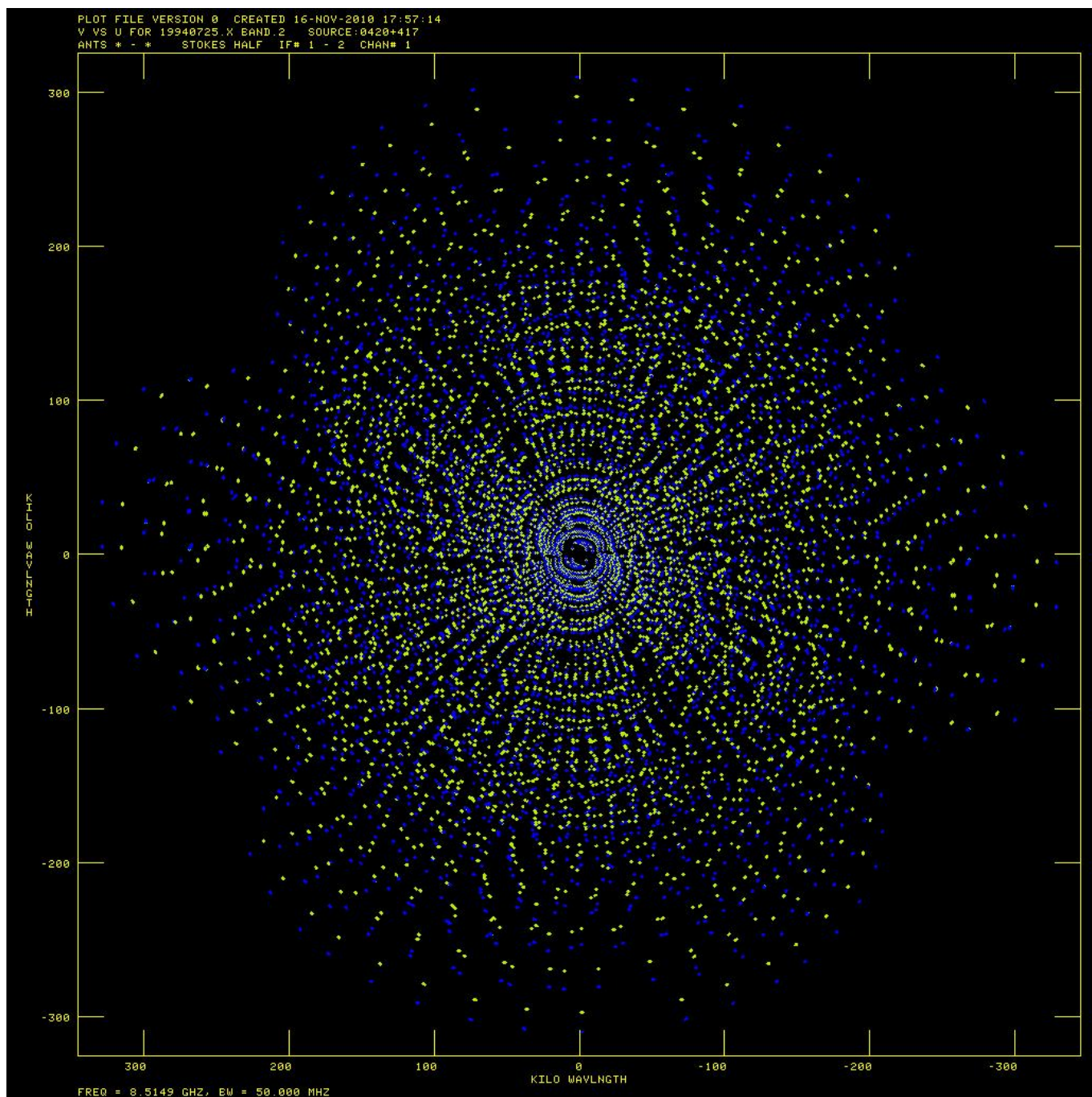
```



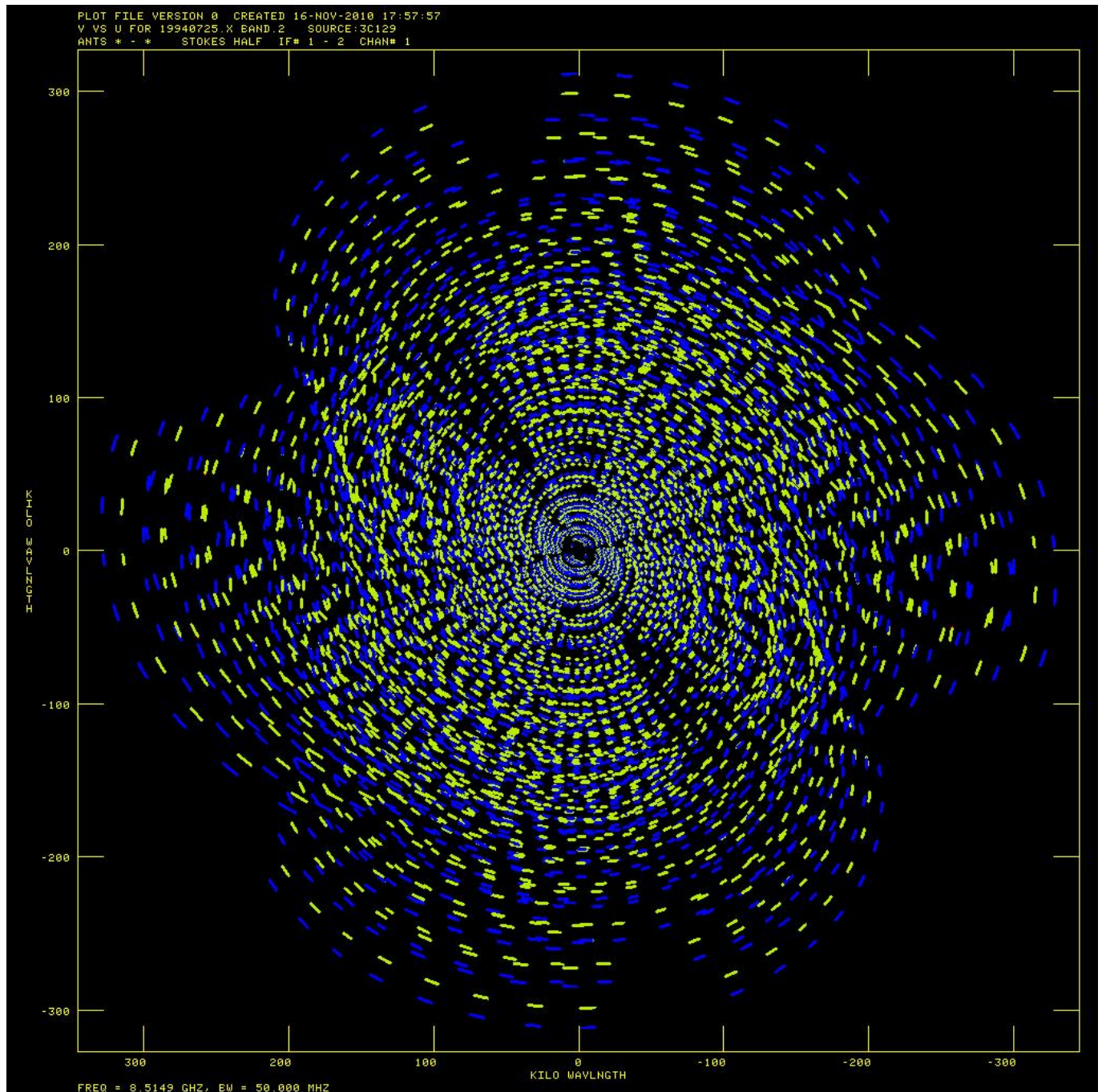
source '0134+329', ' '  
tvinit  
go



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



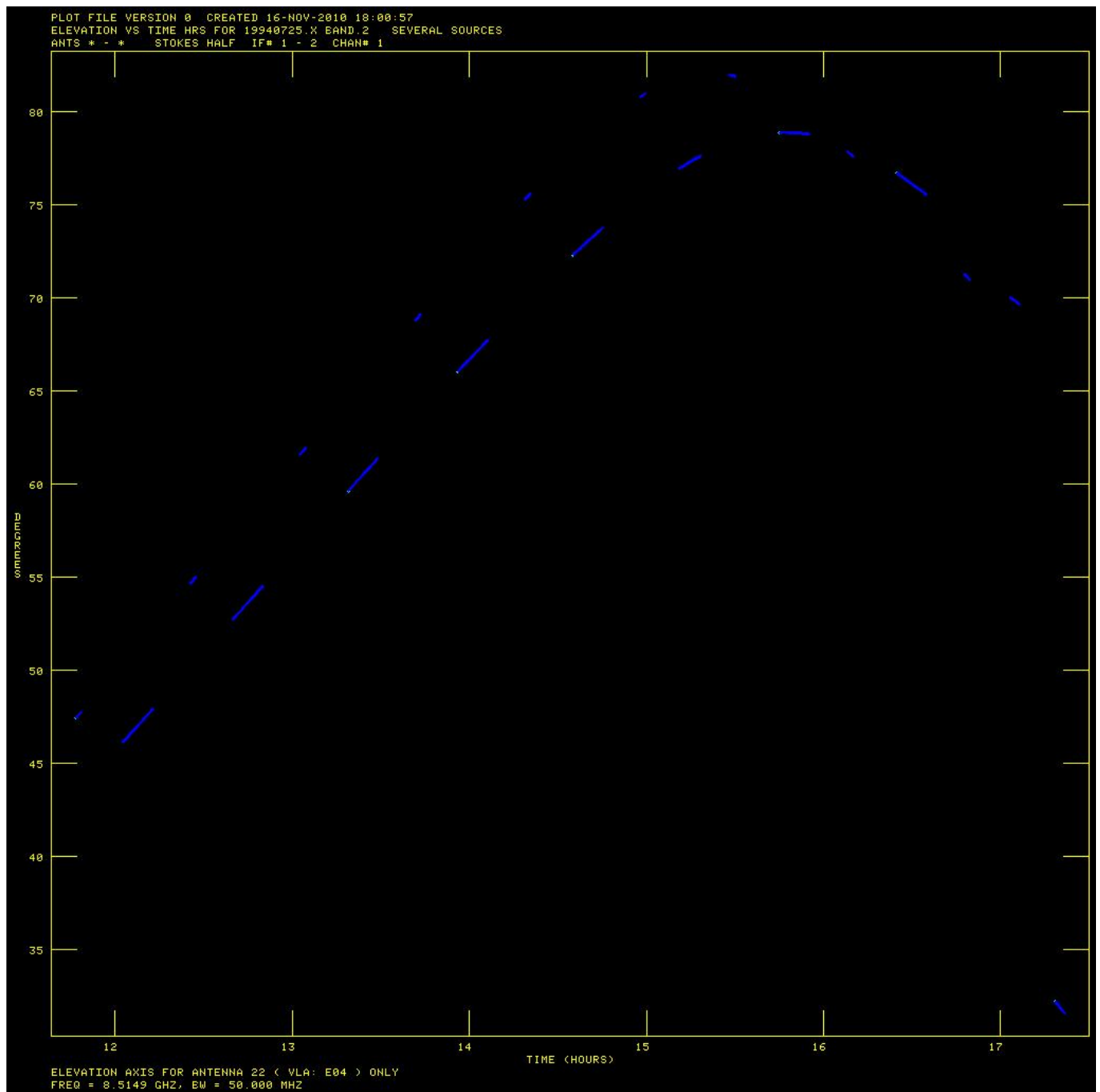
source '3C129', ' '  
tvinit  
go



```

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 ' '
calcode '*'
bif 0
eif 0
docalib 0
```

dparm 0  
go

Source=0518+165 : 0003, Stokes=RR , IF= 2, Chans= 1- 1  
Flux = 0.0000 Jy, Calcode = C , Freq = 4.585100000 GHz  
Amplitudes, 1000 = 1.000000 Jy, averging type = Vector

|                                             |                                         |                         |     |         |     |
|---------------------------------------------|-----------------------------------------|-------------------------|-----|---------|-----|
| 0/17:06:55                                  | 442 464 454                             | 442 462                 | 497 | 432 454 | 471 |
| 460 430                                     | 418                                     | 436 456 456 471 443 453 |     |         |     |
| 0/17:07:05                                  | 442 463 448 460 456 438 460 441 421 503 |                         |     | 435 443 | 466 |
| 452 427 487 415                             | 440 453 455 471 443 452                 |                         |     |         |     |
| 0/17:07:15                                  | 442 459 446 466 454 437 458 439 421 504 |                         |     | 440 445 | 466 |
| 451 423 481 415                             | 442 450 459 476 442 458                 |                         |     |         |     |
| 0/17:07:25                                  | 443 462 450 464 455 433 460 445 419 502 |                         |     | 435 441 | 465 |
| 452 428 483 417                             | 443 453 456 472 441 453                 |                         |     |         |     |
| 0/17:07:35                                  | 443 464 449 463 455 433 460 442 420 499 |                         |     | 435 444 | 466 |
| 451 429 481 420                             | 440 450 457 483 438 456                 |                         |     |         |     |
| 0/17:07:45                                  | 438 459 451 467 453 433 458 440 420 500 |                         |     | 432 443 | 462 |
| 453 426 480 415                             | 441 449 456 478 439 454                 |                         |     |         |     |
| 0/17:07:55                                  | 441 461 452 467 453 438 460 438 418 504 |                         |     | 438 446 | 468 |
| 456 431 480 415                             | 442 451 458 480 443 453                 |                         |     |         |     |
| 0/17:08:05                                  | 437 460 447 460 454 434 459 445 413 500 |                         |     | 439 445 | 464 |
| 454 430 478 419                             | 441 450 458 480 443 453                 |                         |     |         |     |
| 0/17:08:15                                  | 436 459 447 465 459 434 456 443 419 501 |                         |     | 440 445 | 466 |
| 452 429 478 416 451 440 450 459 481 440 456 |                                         |                         |     |         |     |
| 0/17:08:25                                  | 438 461 448 464 456 437 460 440 415 504 |                         |     | 436 444 | 465 |
| 454 429 475 416 452 442 452 459 476 442 451 |                                         |                         |     |         |     |

Type Q to stop, just hit RETURN to continue

v1b054 LISTR(31DEC10) 100 16-NOV-2010 14:51:57 Page 6  
Source=0518+165 : 0003, Stokes=RR , IF= 2, Chans= 1- 1  
Baselines  
0122022203220422052206220722082210221122122213221422152216221722182219222022  
2122222322242225222622272228

|                                             |                                         |         |     |
|---------------------------------------------|-----------------------------------------|---------|-----|
| 0/17:08:35                                  | 436 459 445 462 456 434 459 440 418 500 | 438 438 | 467 |
| 452 431 476 418 455 442 449 462 474 442 455 |                                         |         |     |
| 0/17:08:45                                  | 433 455 449 465 455 440 459 439 414 499 | 435 444 | 465 |
| 453 430 474 414 454 439 447 456 473 441 451 |                                         |         |     |
| 0/17:08:55                                  | 437 460 447 462 454 436 458 439 418 499 | 437 442 | 466 |
| 454 428 480 415 454 441 448 460 472 443 452 |                                         |         |     |
| 0/17:09:05                                  | 433 457 448 465 456 436 457 441 416 498 | 436 445 | 465 |
| 454 433 477 415 451 439 450 459 473 441 456 |                                         |         |     |
| 0/17:09:15                                  | 432 464 447 469 454 436 462 441 419 498 | 438 445 | 465 |
| 453 431 476 417 455 441 452 464 473 444 456 |                                         |         |     |
| 0/17:09:25                                  | 428 457 449 468 457 436 459 440 418 493 | 438 438 | 462 |
| 455 428 470 420 455 441 445 462 469 442 453 |                                         |         |     |
| 0/17:09:35                                  | 431 456 446 464 455 434 459 442 414 498 | 435 441 | 460 |
| 449 426 473 414 449 437 450 458 474 442 454 |                                         |         |     |
| 0/17:09:45                                  | 429 458 445 463 451 434 456 442 415 492 | 437 445 | 465 |
| 450 429 471 419 452 437 449 459 466 439 457 |                                         |         |     |

Source=0134+329 : 0003, Stokes=RR , IF= 2, Chans= 1- 1  
 Flux = 0.0000 Jy, Calcode = C , Freq = 4.585100000 GHz  
 Amplitudes, 1000 = 1.000000 Jy, averging type = Vector

#### Baselines

0122022203220422052206220722082210221122122213221422152216221722182219222022  
 2122222322242225222622272228

|                                             |                                         |         |         |     |     |
|---------------------------------------------|-----------------------------------------|---------|---------|-----|-----|
| 0/17:22:05                                  | 629 683 677                             | 671 687 | 719     | 653 | 704 |
| 677 647 685                                 | 695 663 676 661 672 643 658             |         |         |     |     |
| 0/17:22:15                                  | 630 683 673 666 690 669 685 655 630 723 |         | 662 653 | 692 |     |
| 670 646 694 643 689 666 672 664 681 643 659 |                                         |         |         |     |     |
| 0/17:22:25                                  | 635 687 671 677 690 671 685 652 631 732 |         | 662 651 | 693 |     |
| 670 646 697 641 694 671 674 664 674 643 660 |                                         |         |         |     |     |
| 0/17:22:35                                  | 632 683 669 671 692 669 687 651 632 727 |         | 663 651 | 689 |     |
| 667 642 694 639 692 669 667 662 678 640 657 |                                         |         |         |     |     |
| 0/17:22:45                                  | 629 680 675 668 689 672 687 657 639 730 |         | 662 653 | 691 |     |
| 670 645 694 643 693 671 670 664 679 639 657 |                                         |         |         |     |     |
| 0/17:22:55                                  | 627 684 670 672 695 669 684 652 629 729 |         | 658 651 | 690 |     |
| 669 644 692 638 684 669 672 664 679 640 656 |                                         |         |         |     |     |
| 0/17:23:05                                  | 632 685 673 680 695 669 686 649 640 728 |         | 658 653 | 694 |     |
| 676 646 698 643 689 671 672 668 681 635 659 |                                         |         |         |     |     |
| 0/17:23:15                                  | 635 683 670 673 694 675 689 651 637 728 |         | 662 652 | 695 |     |
| 675 643 696 642 695 667 675 663 682 640 656 |                                         |         |         |     |     |
| 0/17:23:25                                  | 635 679 672 676 696 667 687 657 631 724 |         | 658 648 | 693 |     |
| 670 649 699 641 694 671 674 662 677 637 664 |                                         |         |         |     |     |
| 0/17:23:35                                  | 634 684 668 673 690 662 682 653 634 726 |         | 659 648 | 691 |     |
| 670 640 692 639 692 668 669 662 677 639 656 |                                         |         |         |     |     |
| 0/17:23:45                                  | 628 685 668 678 684 666 684 651 638 732 |         | 660 650 | 690 |     |
| 672 643 695 647 693 676 671 664 678 640 660 |                                         |         |         |     |     |
| 0/17:23:55                                  | 629 680 672 674 690 671 682 650 637 729 |         | 664 655 | 692 |     |
| 674 643 696 646 692 670 676 666 676 646 659 |                                         |         |         |     |     |
| 0/17:24:05                                  | 632 686 672 679 695 672 680 654 639 727 |         | 663 656 | 689 |     |
| 675 647 694 647 692 669 670 665 678 641 658 |                                         |         |         |     |     |
| 0/17:24:15                                  | 630 686 672 674 693 671 689 658 636 728 |         | 659 653 | 691 |     |
| 676 649 698 643 690 669 674 661 684 643 656 |                                         |         |         |     |     |
| 0/17:24:25                                  | 630 685 674 680 690 676 683 657 637 729 |         | 658 652 | 688 |     |
| 679 645 699 642 697 674 675 666 682 641 659 |                                         |         |         |     |     |
| 0/17:24:35                                  | 637 681 673 678 693 670 687 658 634 732 |         | 659 655 | 689 |     |
| 678 644 696 644 691 672 675 668 680 642 658 |                                         |         |         |     |     |
| 0/17:24:45                                  | 632 686 670 677 692 670 685 655 634 722 |         | 661 653 | 689 |     |
| 671 646 698 645 691 669 671 662 677 642 660 |                                         |         |         |     |     |
| 0/17:24:55                                  | 634 685 675 678 697 675 682 657 632 727 |         | 658 654 | 691 |     |
| 671 643 699 643 693 669 673 666 677 641 658 |                                         |         |         |     |     |

AIPS 1: Resumes

dparm 1,0  
 go

Source=0518+165 : 0003, Stokes=RR , IF= 2, Chans= 1- 1  
 Flux = 0.0000 Jy, Calcode = C , Freq = 4.585100000 GHz  
 Phase, 1000 = 1000.00000 degrees, averging type = Vector

```

0/17:06:55 105 80-114 -18-170 123 -164 -93 79
57 45 107 -113-174-124 29 -85 -25
0/17:07:05 106 81-112 -76 142 -16-169 98 12 124 -162 -93 80
57 46 -84 109 -113-175-125 28 -87 -25
0/17:07:15 103 78-112 -79 140 -18-169 97 10 121 -164 -95 78
55 43 -86 108 -110-175-124 30 -87 -24
0/17:07:25 104 78-111 -78 141 -17-168 99 9 120 -164 -95 78
55 43 -85 107 -112-176-124 30 -90 -23
0/17:07:35 102 77-112 -78 139 -19-169 98 9 121 -164-100 76
54 42 -88 106 -109-174-122 31 -86 -21
0/17:07:45 102 77-113 -79 138 -19-169 98 9 120 -163-100 75
54 42 -89 106 -109-174-121 31 -86 -21
0/17:07:55 100 74-116 -77 137 -21-171 97 8 118 -165-100 73
53 41 -89 106 -109-173-119 31 -86 -19
0/17:08:05 101 76-114 -77 138 -19-171 99 9 122 -163 -98 74
54 43 -88 108 -110-173-120 29 -86 -20
0/17:08:15 100 78-115 -76 139 -18-171 99 10 121 -163 -98 76
55 44 -89 110 -85-110-174-119 28 -86 -20
0/17:08:25 101 79-115 -75 139 -19-167 101 10 120 -163 -98 75
55 45 -88 109 -83-111-175-121 28 -88 -21

```

Type Q to stop, just hit RETURN to continue

```

v1b054 LISTR(31DEC10) 100 16-NOV-2010 14:54:07 Page 6
Source=0518+165 : 0003, Stokes=RR , IF= 2, Chans= 1- 1
Baselines
0122022203220422052206220722082210221122122213221422152216221722182219222022
2122222322242225222622272228
0/17:08:35 103 80-113 -76 141 -17-167 102 13 120 -160 -95 75
55 47 -87 110 -81-113-177-121 27 -87 -22
0/17:08:45 106 80-112 -75 140 -16-168 102 15 122 -159 -94 78
55 50 -87 111 -81-114 176-122 26 -88 -23
0/17:08:55 108 80-110 -76 141 -15-168 106 17 122 -157 -92 79
55 51 -85 111 -79-115 175-123 26 -92 -26
0/17:09:05 105 77-110 -76 140 -17-169 105 16 121 -158 -94 78
53 49 -87 109 -81-113 176-123 28 -90 -23
0/17:09:15 105 78-109 -78 139 -18-168 105 17 123 -159 -98 80
53 48 -88 108 -82-113 177-123 29 -92 -24
0/17:09:25 108 77-108 -77 140 -18-166 107 20 124 -159 -97 81
56 47 -86 109 -81-113 176-123 28 -95 -27
0/17:09:35 112 80-106 -74 141 -16-165 107 23 126 -156 -94 84
57 48 -84 107 -78-114 180-126 24 -96 -31
0/17:09:45 108 81-102 -75 140 -15-165 105 22 125 -156 -93 83
57 46 -85 107 -78-114-179-125 25 -96 -28

```

Source=0134+329 : 0003, Stokes=RR , IF= 2, Chans= 1- 1  
Flux = 0.0000 Jy, Calcode = C , Freq = 4.585100000 GHz  
Phase, 1000 = 1000.00000 degrees, averging type = Vector

Baselines  
0122022203220422052206220722082210221122122213221422152216221722182219222022

```

2122222322242225222622272228
  0/17:22:05   84  88-111          -5-173          107      171      71
41  51 -98      -66-102-153 -91  54 -86 -12
  0/17:22:15   85  88-109 -80 148 -2-172  89  42 110      172-102      76
43  55 -96 145 -70-104-154 -93  51 -88 -12
  0/17:22:25   84  91-108 -84 146 -7-176  86  41 105      172-102      73
40  53-100 142 -76-103-152 -93  52 -85 -10
  0/17:22:35   82  91-110 -85 148 -5-176  85  42 102      175-100      76
41  50-100 143 -80-106-153 -96  50 -84 -10
  0/17:22:45   81  90-113 -83 150 -4-176  84  43 103      176 -99      79
42  53-100 144 -81-108-155 -96  50 -82 -13
  0/17:22:55   81  90-114 -84 152 -2-177  83  43  98      175-106      75
41  53-101 144 -72-111-155 -95  48 -79 -20
  0/17:23:05   79  86-119 -88 151 -3-179  79  39  96      173-109      71
36  50-102 143 -72-110-153 -94  48 -73 -19
  0/17:23:15   82  85-116 -88 154  1-177  84  43  99      175-105      73
36  54 -98 145 -77-116-157 -96  46 -74 -26
  0/17:23:25   87  90-113 -86 159  4-173  88  45  99      179-101      76
38  60 -94 150 -75-118-161 -99  42 -76 -25
  0/17:23:35   90  90-108 -82 161  9-170  89  48 101      -179 -98      78
41  64 -91 152 -73-120-164-101 41 -76 -29
  0/17:23:45   86  82-114 -87 154  6-175  84  42  97      175-103      71
37  60 -93 146 -76-114-161 -99  45 -71 -26
  0/17:23:55   92  81-115 -86 152  5-174  85  40  98      175-102      71
39  62 -92 148 -77-116-162-102 43 -72 -27
  0/17:24:05   99  82-114 -85 152  5-173  87  42  99      177 -98      71
39  66 -90 150 -76-118-164-102 41 -74 -26
  0/17:24:15   96  80-114 -81 155  7-172  88  44 103      -179 -98      72
41  69 -89 154 -73-121-167-107 37 -75 -27
  0/17:24:25   95  78-119 -79 153  4-175  84  39  97      180 -99      69
40  67 -91 153 -76-119-165-105 37 -69 -25
  0/17:24:35   96  79-120 -79 153  5-177  85  41  96      -180 -98      68
42  68 -91 152 -75-118-165-104 35 -68 -20
  0/17:24:45   98  75-117 -80 152  5 179  86  38 100      178 -97      68
43  68 -90 149 -74-118-163-105 34 -68 -15
  0/17:24:55   99  74-117 -81 151  7 178  88  37 100      176-101      67
45  67 -88 150 -74-117-162-104 33 -69 -12
AIPS 1: Resumes

```

dparm 0

## Start the calibration

### Set the flux values of the known calibrators

```

task 'setjy'
default
getn 4

```

```
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
```

```
v1b054> SETJY1: v1b054      31DEC08 TST: Cpu=      0.0  Real=      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 7  
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
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
```

```
v1b054> GETJY1: Task GETJY (release of 31DEC08) begins
v1b054> GETJY1: Source:Qual      CALCODE IF Flux (Jy)
v1b054> GETJY1: 0420+417      : 3   B      1    1.46472 +/-    0.00304
v1b054> GETJY1:                      2    1.46512 +/-    0.00341
v1b054> GETJY1: Appears to have ended successfully
v1b054> GETJY1: v1b054      31DEC08 TST: Cpu=      0.0  Real=      0
```

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

## Start the polarization calibration

### Check the parallactic angle change

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

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

```
task 'tasav'  
clro  
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  
vlb054> PCAL 1:  Q+iU=(  -0.01035,   0.03766) +/- (  0.000106,   0.000106)  
Jy  
vlb054> PCAL 1:  Pol. inten. =   0.03905 +/-   0.000150 Jy, angle =   52.68  
+/-  
vlb054>           0.078 deg
```

```
vlb054> PCAL 1: 0420+417          I,Q,U,V =  1.4647 -0.01035  0.03766
0.00000 J
vlb054>          y
vlb054> PCAL 1: Calibration source  1
vlb054> PCAL 1:  Q+iU=( -0.03423,  0.00815) +/- ( 0.000114,  0.000114)
Jy
vlb054> PCAL 1:  Pol. inten. =  0.03519 +/-  0.000161 Jy, angle =  83.31
+/-
vlb054>          0.093 deg
vlb054> PCAL 1: 0420+417          I,Q,U,V =  1.4651 -0.03423  0.00815
0.00000 J
vlb054>          y
```

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

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

```
Ampscalar average of matrix = -30.19( 0.081) sigma = 1.160
Ampscalar average of matrix = 33.93( 0.097) sigma = 1.389
```

### outputs

```
AIPS 1: RLDIF: Task to return Right - Left phase difference
AIPS 1: Adverbs      Values                      Comments
AIPS 1: -----
AIPS 1: CLCORPRM    -30.1863      33.9257    R-L phase difference returned
AIPS 1:              *rest 0
```

## Another save, just in case

```
task 'tasav'
clro
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 -21.71

## Correct the measured values

```
for i=1 to 2;clcorp(i) = -21.71 - 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 0,45
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                                            | -21.71  | -21.71 | R-L phase difference returned |
| AIPS 1:                                                     | *rest 0 |        |                               |

#####

## Now start with the smaller array data. Load it in

### 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  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 17:24:13
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 16:16:53
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 17:24:36
```

### Makre sure we have the right one

```
getn 13
imhe
```

## Get the scan information

```
task 'listr'
default
getn 13
optype 'scan'
doweight 1
go
```

```
vlb054    LISTR(31DEC08)    101    13-NOV-2008 17:25:15    Page    1
File = 19941103    .C BAND.    2 Vol = 1    Userid =    101
Freq = 4.885100000 GHz    Ncor = 4    No. vis =    52167
Scan summary listing
```

| Scan        | Source  | Qual   | Calcode | Sub | Timerange               | FrqID |
|-------------|---------|--------|---------|-----|-------------------------|-------|
| START VIS   | END VIS |        |         |     |                         |       |
| 1 0134+329  |         | : 0003 | C       | 1   | 0/04:05:15 - 0/04:07:25 | 1     |
| 1           | 36      |        |         |     |                         |       |
| 2 0420+417  |         | : 0003 | B       | 1   | 0/07:33:35 - 0/07:35:15 | 1     |
| 37          | 3169    |        |         |     |                         |       |
| 3 0518+165  |         | : 0003 | C       | 1   | 0/07:42:35 - 0/07:45:45 | 1     |
| 3170        | 9457    |        |         |     |                         |       |
| 4 3C129     |         | : 0003 |         | 1   | 0/08:18:05 - 0/08:23:25 | 1     |
| 9458        | 20308   |        |         |     |                         |       |
| 5 0420+417  |         | : 0003 | B       | 1   | 0/08:27:35 - 0/08:29:15 | 1     |
| 20309       | 22845   |        |         |     |                         |       |
| 6 0420+417  |         | : 0003 | B       | 1   | 0/08:49:25 - 0/08:51:05 | 1     |
| 22846       | 25972   |        |         |     |                         |       |
| 7 3C129     |         | : 0003 |         | 1   | 0/09:07:05 - 0/09:12:25 | 1     |
| 25973       | 35132   |        |         |     |                         |       |
| 8 0420+417  |         | : 0003 | B       | 1   | 0/09:17:05 - 0/09:18:45 | 1     |
| 35133       | 38213   |        |         |     |                         |       |
| 9 3C129     |         | : 0003 |         | 1   | 0/09:40:25 - 0/09:45:05 | 1     |
| 38214       | 47664   |        |         |     |                         |       |
| 10 0420+417 |         | : 0003 | B       | 1   | 0/09:49:35 - 0/09:51:55 | 1     |
| 47665       | 52167   |        |         |     |                         |       |

Source summary

Velocity type = ' ' Definition = ' '

| ID         | Source | Qual   | Calcode | RA(1950.0)    | Dec(1950.0)  | IFlux |
|------------|--------|--------|---------|---------------|--------------|-------|
| QFlux      | UFlux  | VFlux  | No. vis |               |              |       |
| 1 0134+329 |        | : 0003 | C       | 01:34:49.8320 | 32:54:20.520 | 0.000 |
| 0.000      | 0.000  | 0.000  | 36      |               |              |       |
|            | IF( 2) |        |         |               |              | 0.000 |
| 0.000      | 0.000  | 0.000  |         |               |              |       |
| 2 0420+417 |        | : 0003 | B       | 04:20:27.9370 | 41:43:08.045 | 0.000 |
| 0.000      | 0.000  | 0.000  | 16381   |               |              |       |
|            | IF( 2) |        |         |               |              | 0.000 |
| 0.000      | 0.000  | 0.000  |         |               |              |       |

|                         |             |       |            |                |                 |              |       |
|-------------------------|-------------|-------|------------|----------------|-----------------|--------------|-------|
| 3                       | 0518+165    | :     | 0003       | C              | 05:18:16.5320   | 16:35:26.900 | 0.000 |
| 0.000                   | 0.000       | 0.000 | 6288       |                |                 |              |       |
|                         | IF( 2)      |       |            |                |                 |              | 0.000 |
| 0.000                   | 0.000       | 0.000 |            |                |                 |              |       |
| 4                       | 3C129       | :     | 0003       |                | 04:45:31.6950   | 44:55:19.950 | 0.000 |
| 0.000                   | 0.000       | 0.000 | 29462      |                |                 |              |       |
|                         | IF( 2)      |       |            |                |                 |              | 0.000 |
| 0.000                   | 0.000       | 0.000 |            |                |                 |              |       |
|                         |             |       |            |                |                 |              |       |
| ID                      | Source      |       | Freq(GHz)  | Velocity(Km/s) | Rest freq (GHz) |              |       |
| 1                       | All Sources |       | 4.8851     | 0.0000         | 0.0000          |              |       |
|                         | IF( 2)      |       | 4.5851     | 0.0000         | 0.0000          |              |       |
| Frequency Table summary |             |       |            |                |                 |              |       |
| FQID                    | IF#         |       | Freq(GHz)  | BW(kHz)        | Ch.Sep(kHz)     | Sideband     |       |
| 1                       | 1           |       | 4.88510000 | 50000.0039     | 50000.0039      | 1            |       |
|                         | 2           |       | 4.58510000 | 50000.0039     | 50000.0039      | 1            |       |
| AIPS 1: Resumes         |             |       |            |                |                 |              |       |

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          |          |         |     |               |  |  |  |

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

```
task 'uvflg'
default
dohist 1
getn 13
antenna 0
basel 0
timer 0 0 0 0 0 4 8 0
stokes ' '
opcode 'flag'
reason 'bad scan'
outfgver 1
go
timer 0 8 18 0 0 8 30 0
go
antenna 0
timer 0 9 10 0 0 9 15 0
go
reason 'bad ant'
antenna 4,0
timer 0
```

## 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
do3col 1
dotv 1
tvinit
go
source '0420+417',' '
tvinit
go
source '3C129',' '

```

```
tvinit
go
bparm 6 7
source '0518+165', ' '
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 ' '
calcode '*'
bif 0
eif 0
docalib 0
stokes ' '
dparm 0
go
```

## Begin the calibration

### Apply the flux densities for the known calibrators

```
task 'setjy'
default
getn 13
source '0518+165', ' '
bif 0
eif 0
optype 'calc'
aparm(2) 2
go
```

```
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
```

```
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'
```

## 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 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  
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

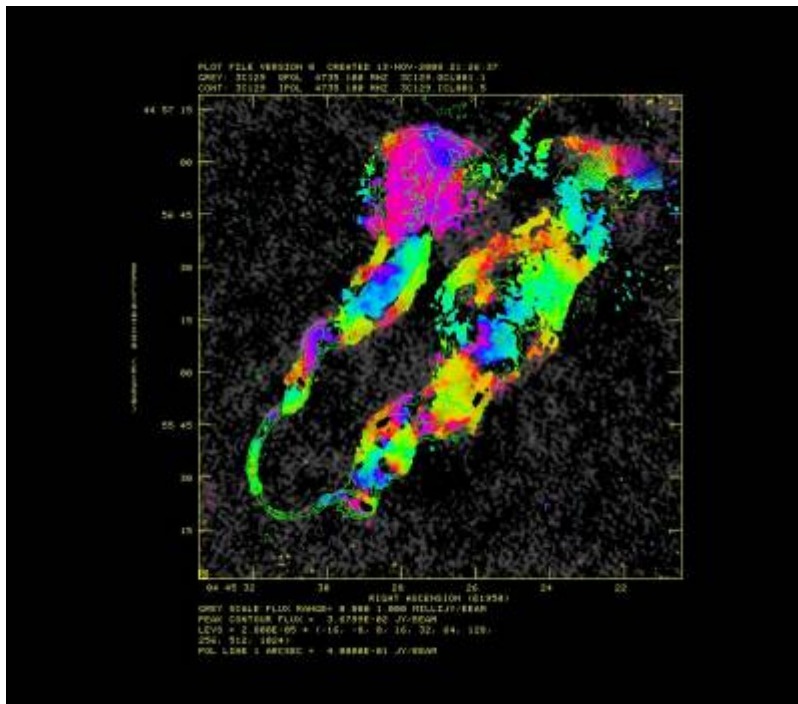
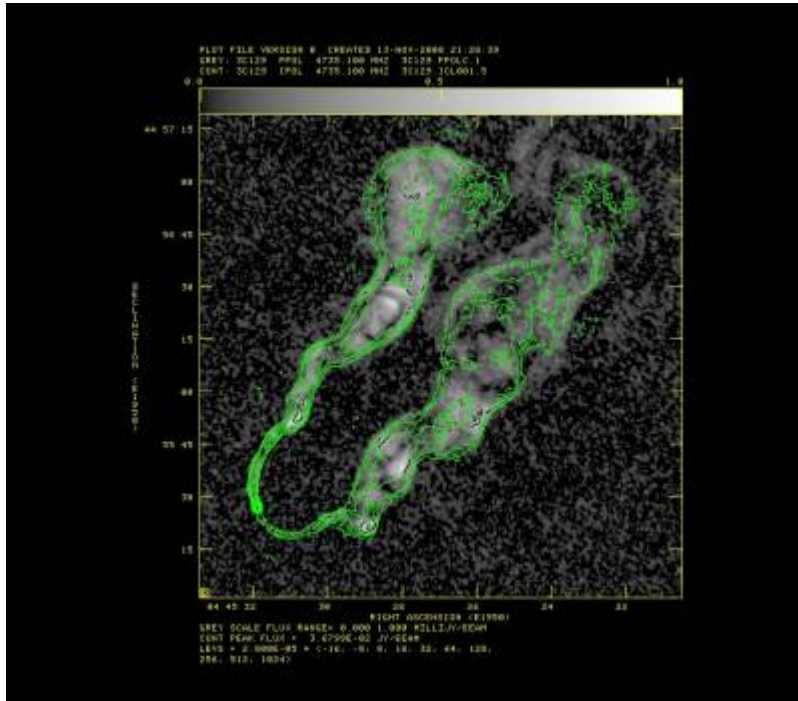
## Plot I contours and P greyscale

```
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



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