Amplitude Calibration

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$T_{\rm sys}$ Calculation

- Calibration provided via the tpi monitoring.
- Continuous $T_{\rm sys}$ is given by:

$$T_{\rm sys} = T_{\rm cal} \times \frac{\rm tpi - tpzero}{(\rm tpical - tpi')}$$

- For VLBA racks, AGC gain level (tpgain) used as proxy for tpi:

$$\rm tpi = tpi' \times 10^{\frac{tpgain - tpgain'}{10}}$$

  - Current ANTABFS seems to have a error in this...

- $T_{\rm cal}$ measured during CL*** experiments, as a function of frequency. RXG files used in calculating the $T_{\rm sys}$.

The Astronomer's Perspective

The final user is interested in the SEFD (in Jy) of each telescope as a function of time.

- $\mathrm{SEFD} = \frac{\mathrm{T_{sys}}}{\mathrm{DPFU} \times \mathrm{POLY(ELEV)}}$

  (K band is more complicated)

- Small amplitude errors are recovered using "Amplitude Closures"
- This only allows the relative amplitudes of the stations to be determined, not the absolute flux scale
- Subtle features may be irrecoverable if the errors are large
- Poorly calibrated stations are often disposed of during the calibration process – your efforts are wasted
- Accurate a priori calibration is a must!

Running Antabfs

Download from
`ftp://ftp.jive.nl/pub/reynolds/antabfs.tar.gz`

Requires RXG files:

- Produced with GNPLT
- Contains gain curves and $T_{\rm cal}$ as a function of frequency

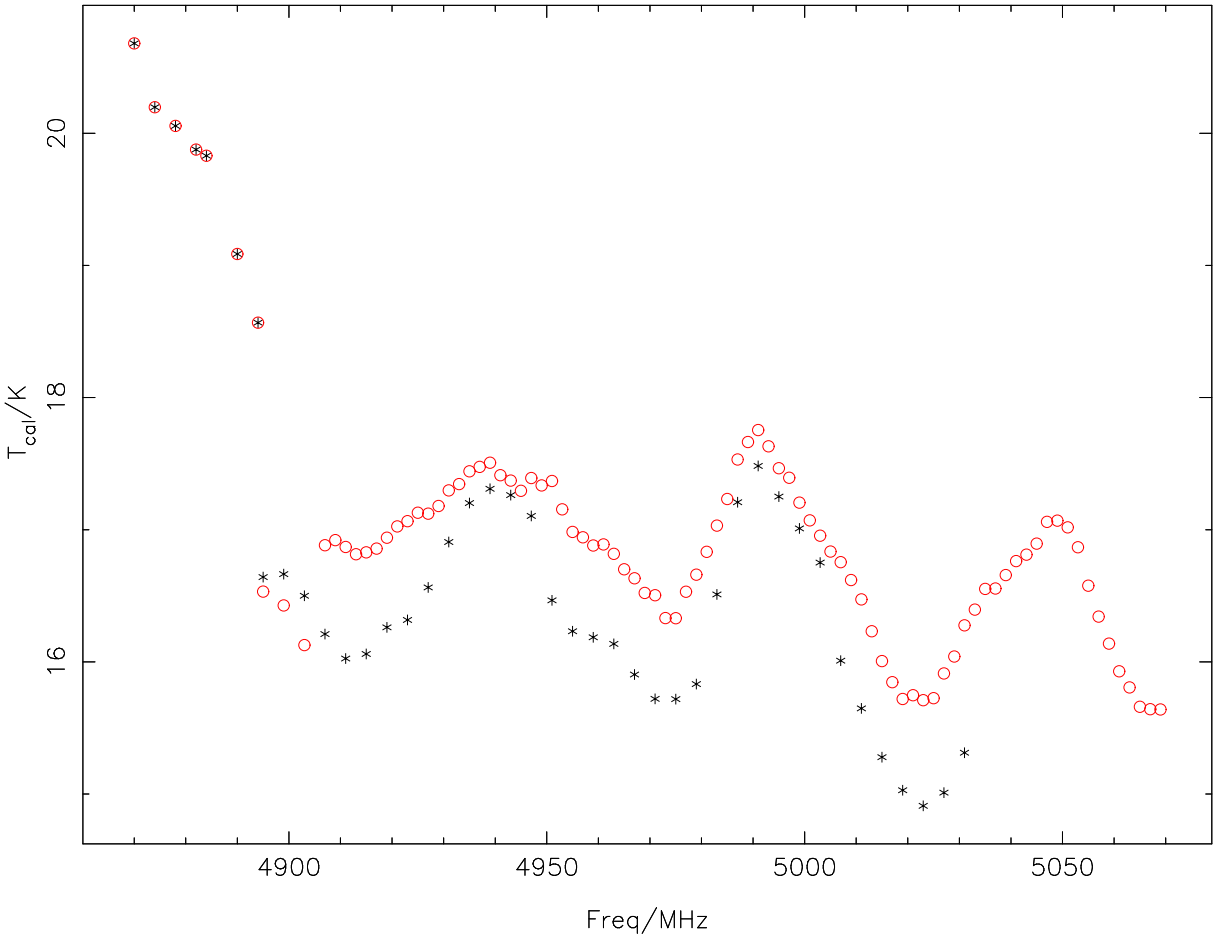
Demo to come. . .

Antabfs – the Gory Details

- Uses `flagr` output to remove off-source tpi
- Uses *interpolated* values of $(\mathrm{tpical} - \mathrm{tpiprime})$ to calculate T_{sys} (see later...)
- $(\mathrm{tpical} - \mathrm{tpiprime})$ need to be edited – several options available
  - Automated editing a possibility for some experiments
- Always under development - suggestions welcome

Stability of $T_{\rm cal}$

Monitoring is necessary.



On L-band $T_{\rm cal}$ in Feb. 2005 and Feb. 2006.

Calibration Accuracy

Station	18cm	21 cm	C band	K band
Cm	0.22 (3)			
Ef	0.08 (10)	0.10 (2)	0.11 (7)	0.19 (3)
Hh	0.23 (2)		0.10 (3)	
Jb	0.20 (10)	0.29 (2)	0.42 (7)	0.67 (3)
Mc	0.22 (10)	0.26 (2)	0.05 (6)	0.15 (3)
Mh				0.27 (3)
Nt	0.21 (3)	0.27 (1)		0.21 (2)
On	0.10 (8)	0.09 (1)	0.09 (6)	0.90 (2)
Sh	0.18 (4)			0.22 (1)
Tr	0.33 (9)	0.51 (1)	0.13 (5)	
Ur	0.24 (5)	2.20 (1)	0.18 (4)	0.41 (1)
Wb	0.10 (10)	0.18 (2)	0.13 (6)	
VLBA		0.097 (1)		

Calibration Accuracy

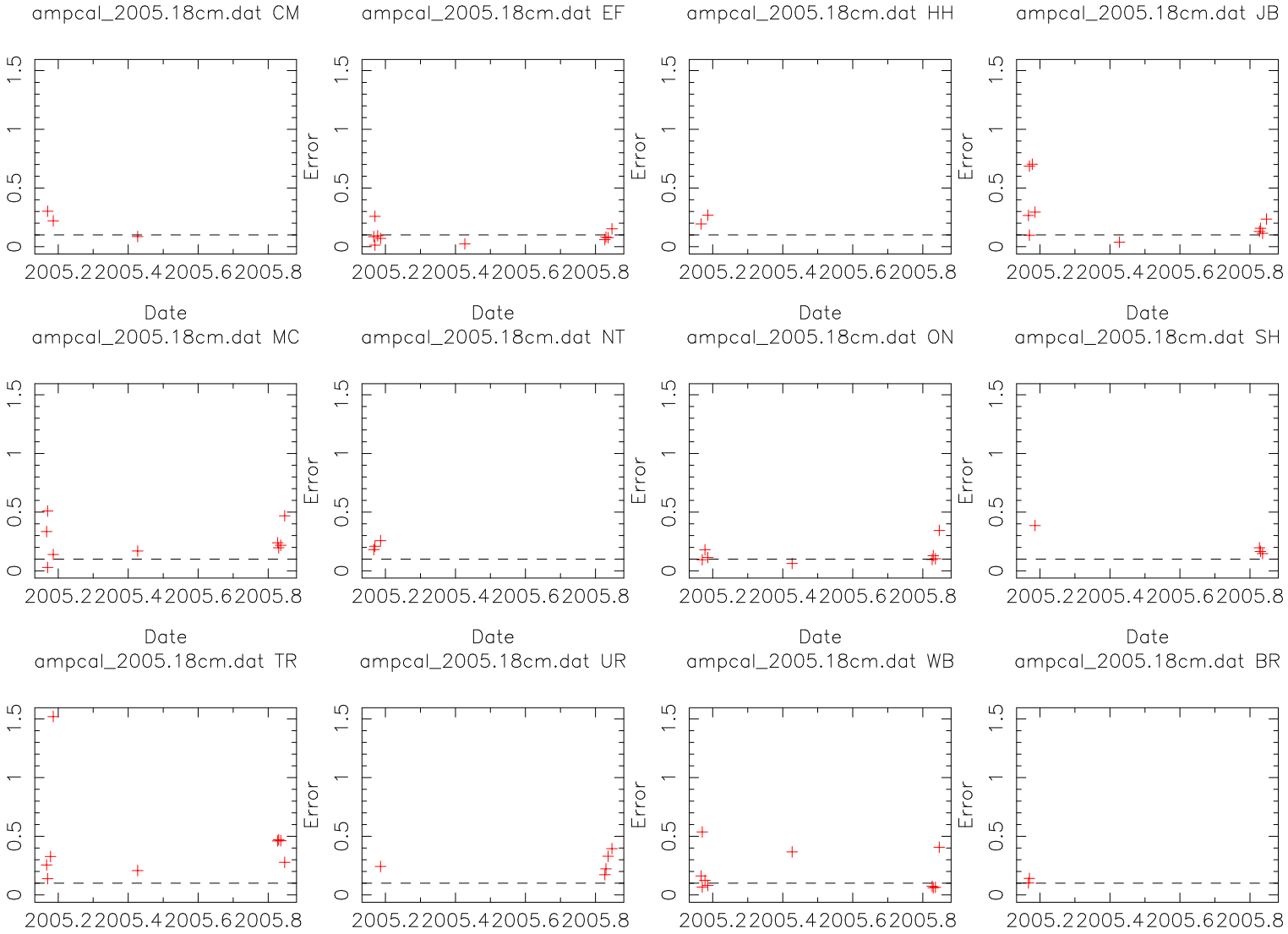
C-band reasonable – 2005 adversely affected by weather and a couple of “difficult” experiments (see note by Graham)

L-band very variable. On average not great, but occasionally very good. RFI?

E.g. GD018 from session 1 2005 had a median error of 0.25, while GB055B (session 3 2005) had a median error of 0.08.

K-band still bad.

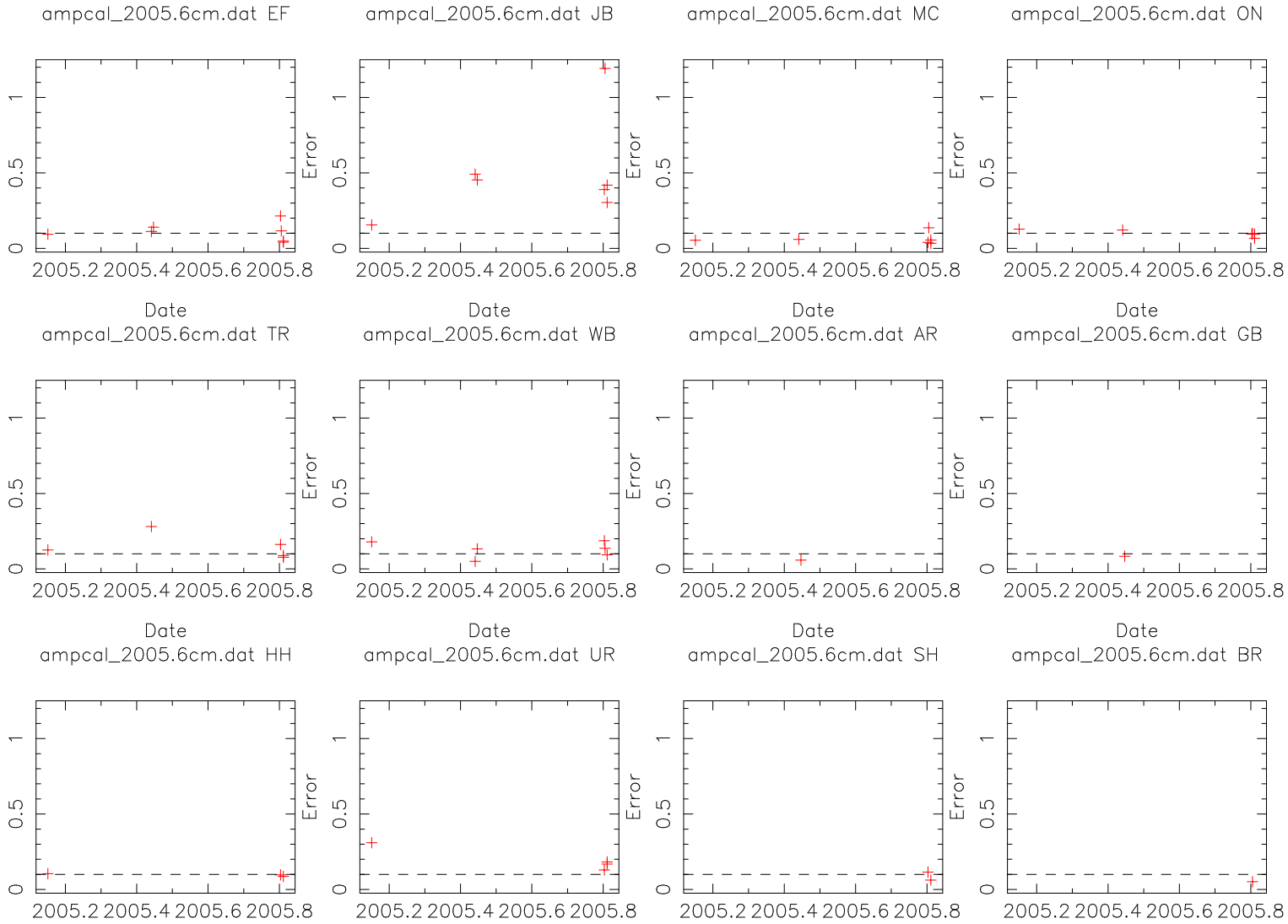
Calibration Accuracy is Variable
18 cm 2005



Jb session 1 – no RXG update

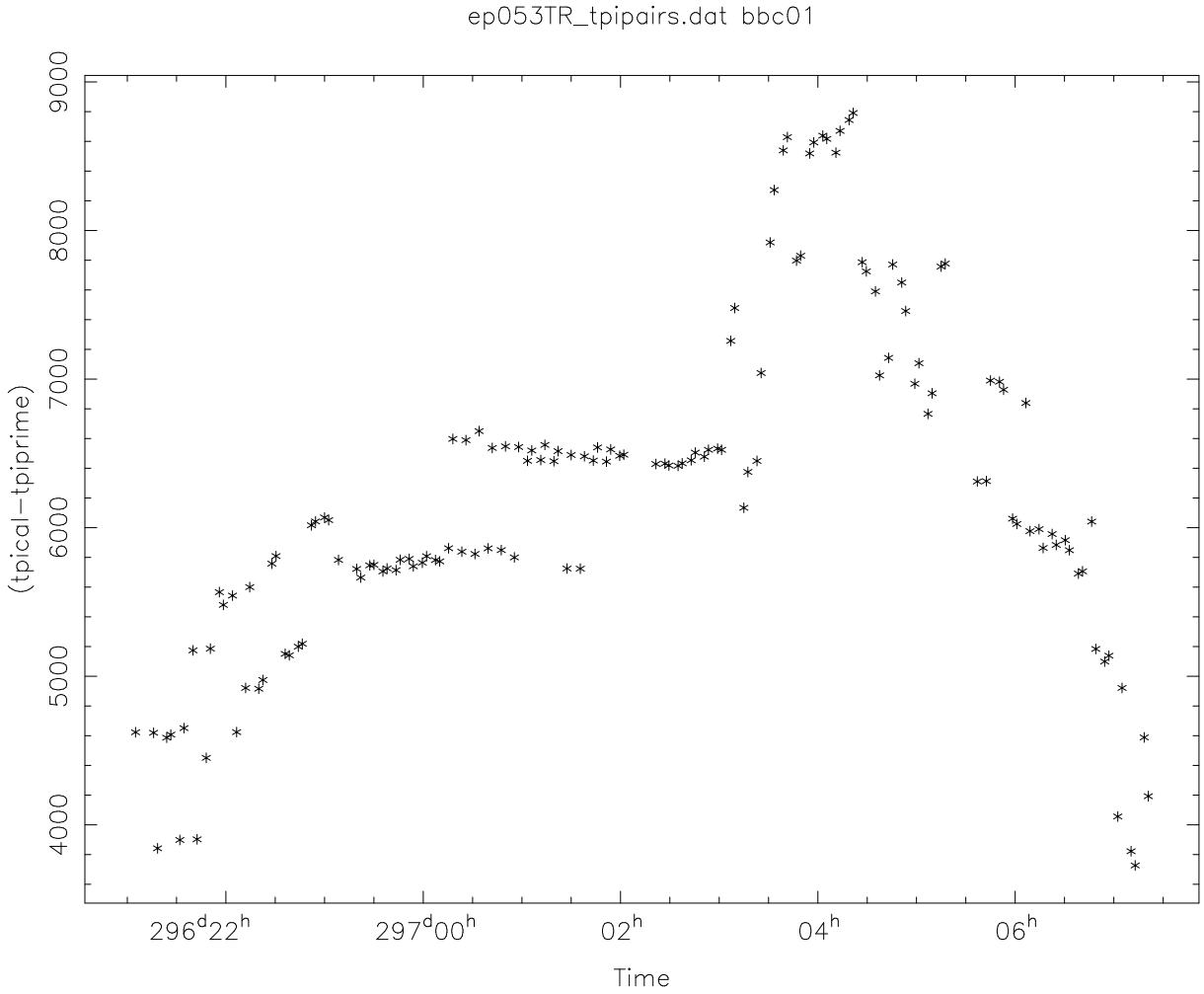
Perhaps should look at “best” channel instead of median (avoid RFI)

Calibration Accuracy is Variable
6 cm 2005



Jb sensitivity problems in session 3

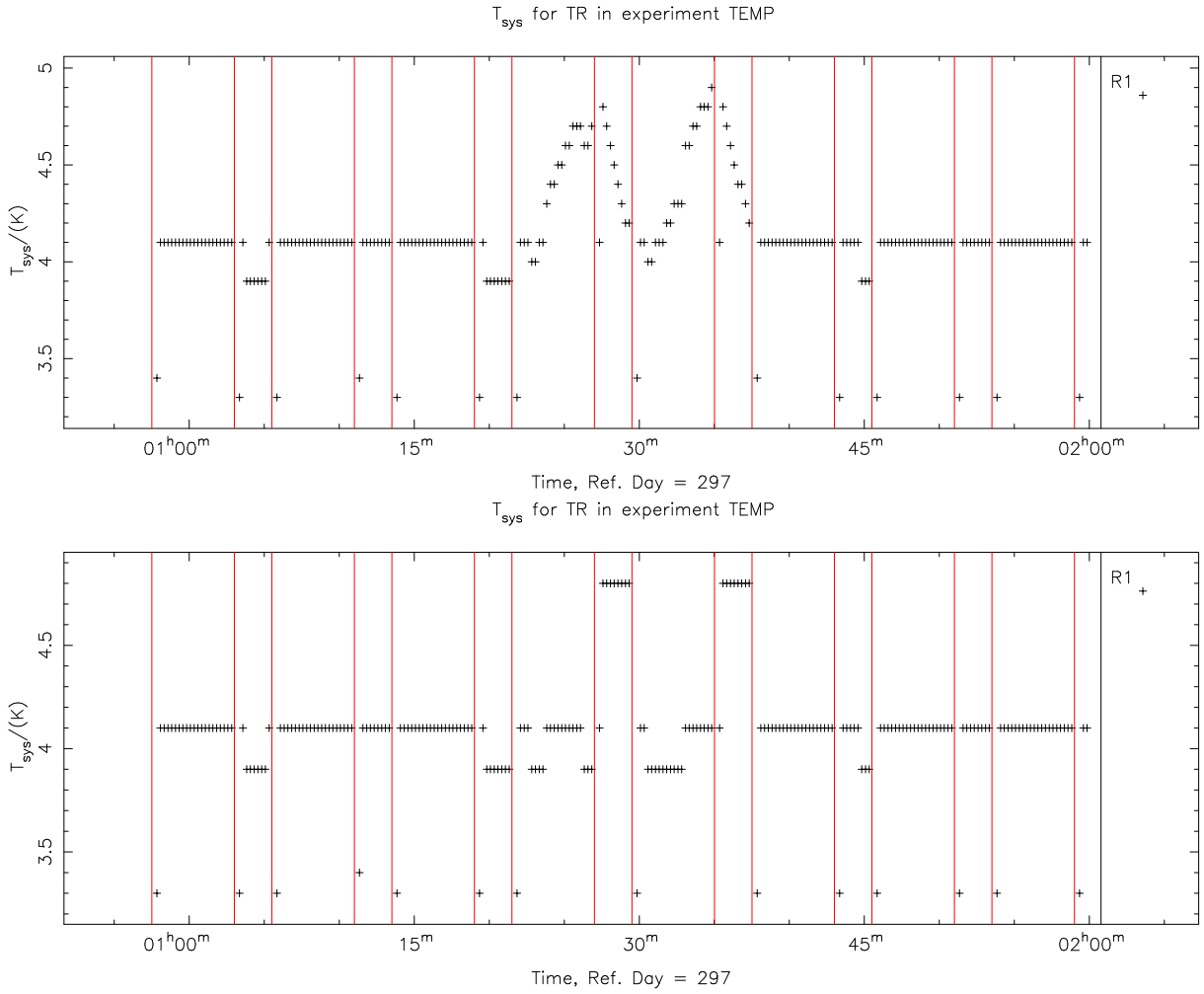
ANTABFS Problems – VLBA Racks



tpdiff has two preferred levels

No apparent relation to source or elevation

ANTABFS Problems – VLBA Racks



Comparing $T_{\rm sys}$ calculated with and without interpolation

- Interpolation not good
- How to cope with real schedules?

ANTABFS – K-band

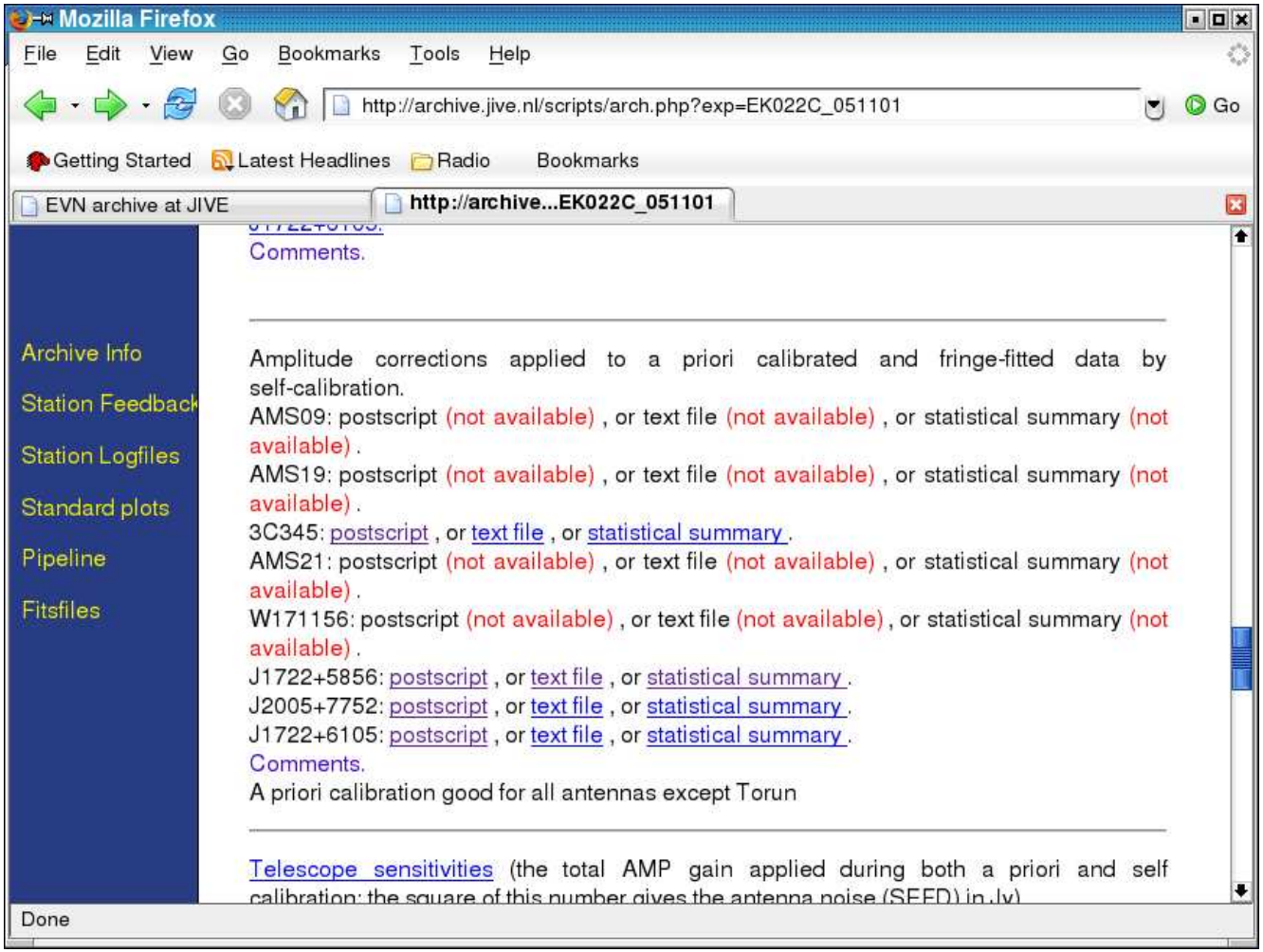
New 'Chopper Wheel' method implemented for Onsala

- Uses ambient load in front of receiver
- Ambient temperature is logged as caltemp
- 'Load' and 'Sky' powers are logged as tpical and tpiprime
- caltemp from log is used instead of caltemp from RXG file

Initial result (one experiment) indicates this works better than traditional scheme

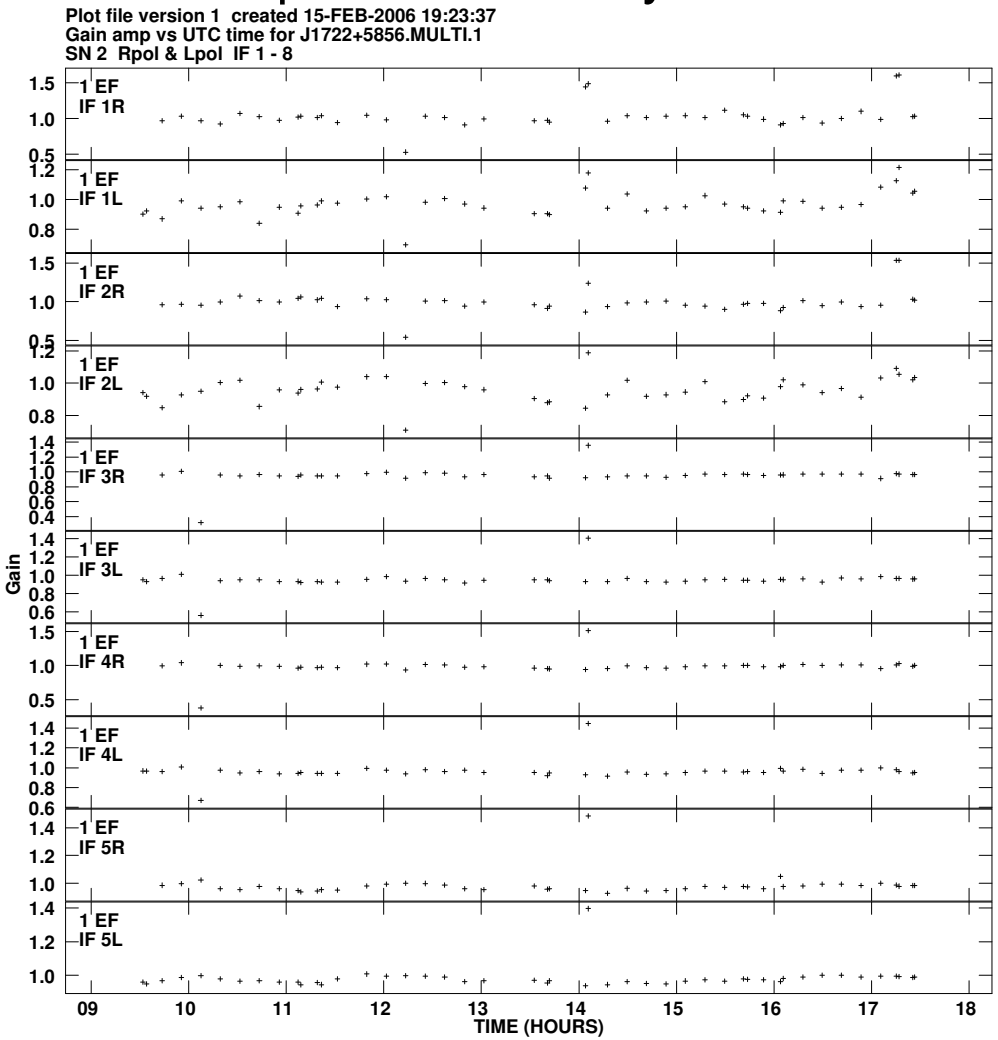
Pipeline Results

http://www.jive.nl/archive



Pipeline Results

Results are plotted for every calibrator scan



Note the peculiar `AIPS` use of 'IF' to mean subband

Pipeline Results

The results are also available in text form:

```
      jop15      LISTR(31DEC02)    1029               02-MAR-2004   12:36:48               Page    1
File = J1651+0129  .MULTI .   1 Vol = 1  Userid = 1029    IF =  1
Freq=  1.637990000 GHz   Ncor=  4   No. vis=     76335
Polarization = R    Subarray =   1
Listing SN table, version   2
SN table has not been applied to a CL table

Gain amplitudes, 1000 =    0.1000
Stokes = R    IF =  1 Freq =  1.637990000 GHz

  Time   Source  -- 1---- 2---- 3---- 4---- 5---- 6---- 7---- 8---- 9--

Day #   0
08:30:51 J1651+01 10977        9816 10420  8210  9104              7740
08:35:54 J1651+01 10738        9690 10351  8302  9060
08:36:23 J1651+01 10800        9584  9909  8286  9097
08:41:23 J1651+01 10651 10624 10560 10217  8751  9111
08:45:58 J1651+01       10522  9648  8382 11490
08:46:27 J1651+01 10610  9756  9907 10304  7551  9282
08:51:30 J1651+01 10278  9743  9996 11362  9693  9124              7419
08:53:49 J1651+01  9810 10201 10124 11279  8783 11667              7565
08:58:50 J1651+01 10139  9752  9381  9872  8449  9197
08:59:20 J1651+01 10258  9593  9645 10519  7423  9181
09:04:10 J1651+01 10212  9706  9676 10313  8142  9308
09:08:56 J1651+01
09:09:26 J1651+01 10156  9652  9796 10005  7592  9450
```

Pipeline Results

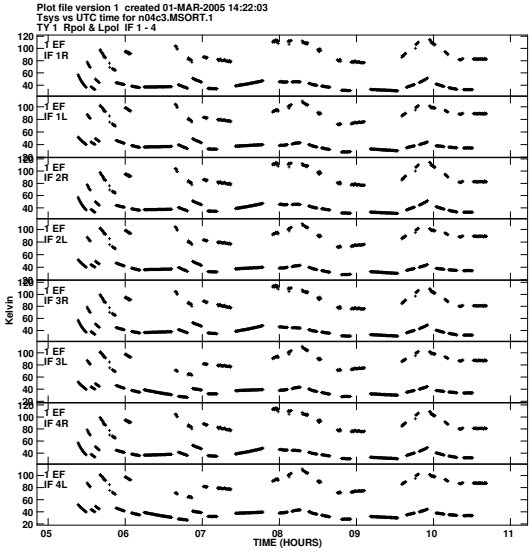
And as a statistical summary:

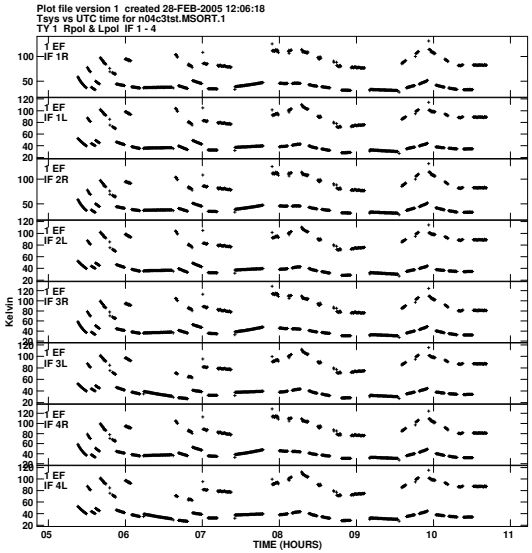
```
      File = J1722+5856  .MULTI .   1 Vol = 1  Userid = 3606    IF =  8
FQID IF#      Freq(GHz)       BW(kHz)   Ch.Sep(kHz)  Sideband
   1   1       1.59499000   16000.0010    500.0000      1
       2       1.61049000   16000.0010    500.0000      1
       3       1.62699000   16000.0010    500.0000      1
       4       1.64249000   16000.0010    500.0000      1

station=1(EF)
IF  median  med.err  stderr  med.err-(med-1)  ndata
L1  0.9535  0.0555  0.01211  0.0090            47
L2  0.9571  0.0525  0.01097  0.0096            47
L3  0.9423  0.0578  0.01300  0.0001            47
L4  0.9539  0.0484  0.01248  0.0023            47
R1  1.0085  0.0347  0.02638  0.0262            45
R2  0.9797  0.0432  0.02167  0.0229            45
R3  0.9497  0.0511  0.01699  0.0008            45
R4  0.9827  0.0201  0.01820  0.0028            45
All:  0.9765  0.03785  0.00726  0.0144         8
```

Calibration Transfer – Motivation

Currently `ANTAB` files applied in “Classic” `AIPS`

- Archiving and data retrieval are complicated (many different files and formats)
- Details of applying the text files are partly responsible for the VLBI “black-belt” perception
- Reduces compatibility with data from VLBA
- Software is in user domain – less easy to update/control
- Correlation details are not known at time of production
- Calibration information not available during initial data assessment in `aips++`





Cal Transfer – Results

Calibration transfer has been implemented for

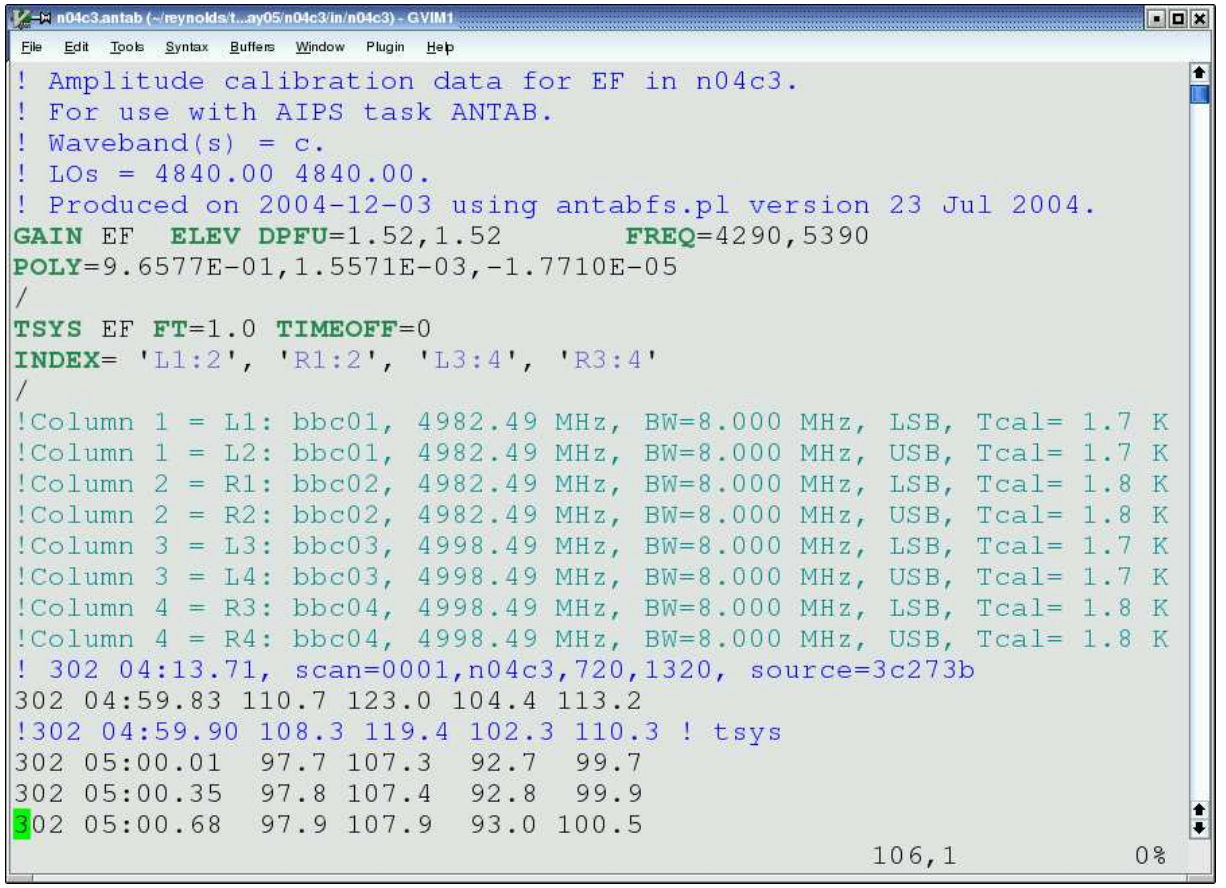
- System temperatures
- Gain curves
- Off-source flagging files

Intended expansion to

- Phase-cal tones
- Correlator model, etc.

"Extended ANTAB" format defined

Requires implementation in `antabfs` and relatives



Demos

Over to...