

Amplitude Calibration

Cormac Reynolds, JIVE

March 23, 2006



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

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

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

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

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

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

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

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

(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_{cal} as a function of frequency

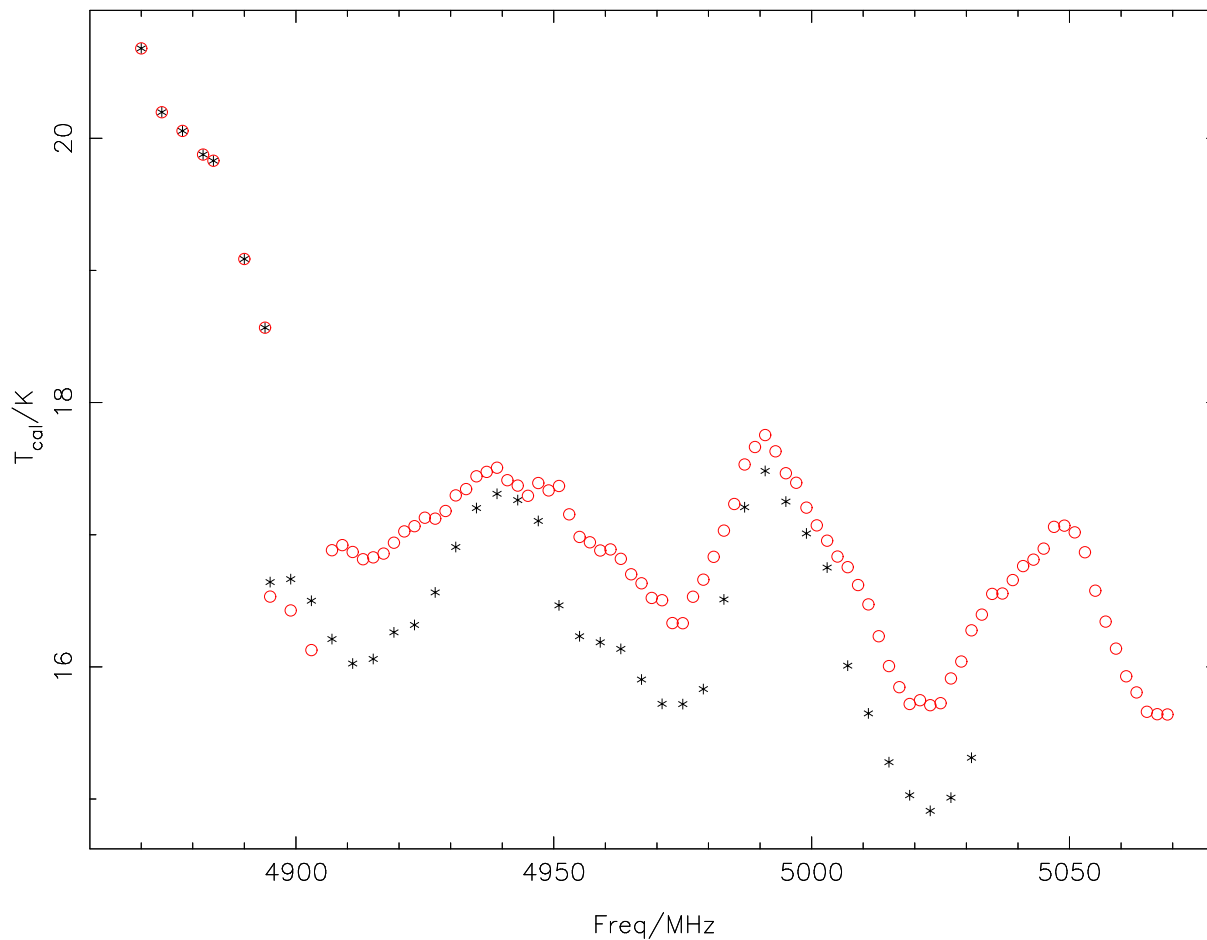
Demo to come...

Antabfs – the Gory Details

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

Stability of T_{cal}

Monitoring is necessary.



On L-band T_{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)

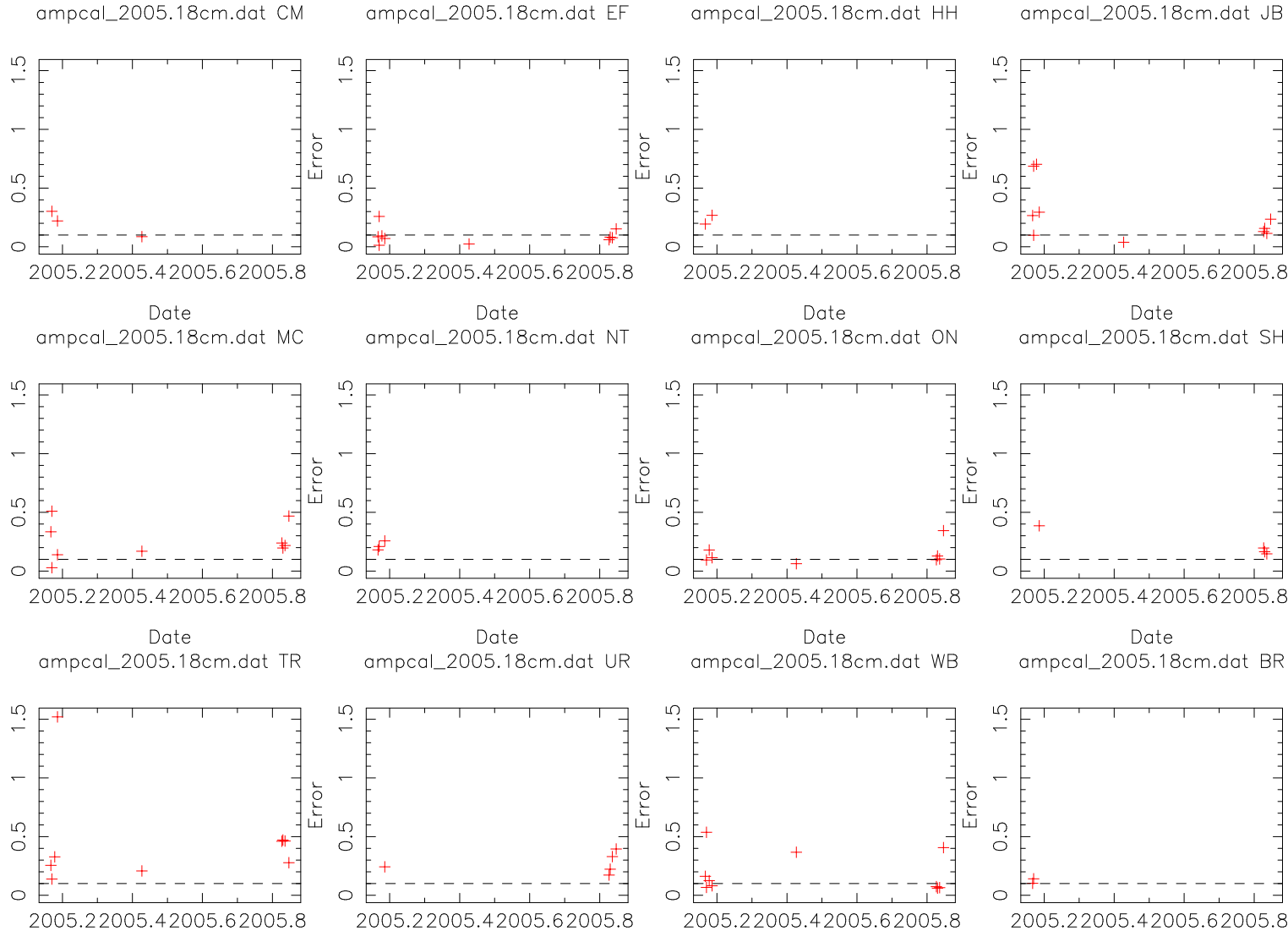
L-band very variable. On average not great, but occasionally very good. RFI?

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

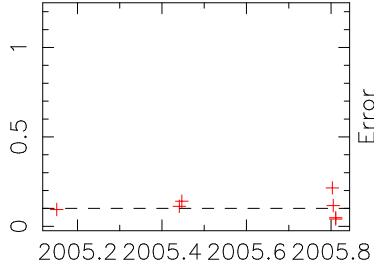


Jb session 1 –
no RXG update

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

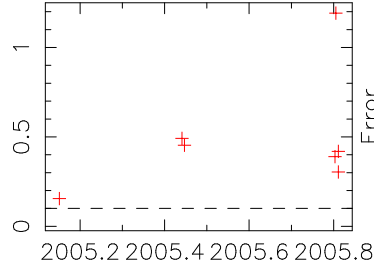
Calibration Accuracy is Variable 6 cm 2005

ampcal_2005.6cm.dat EF



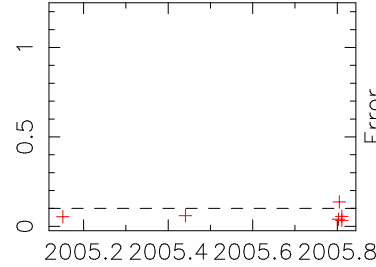
Date

ampcal_2005.6cm.dat JB



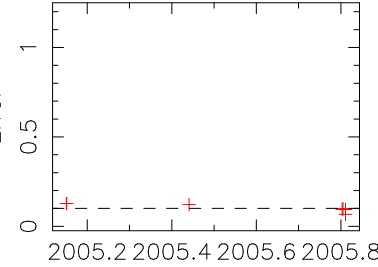
Date

ampcal_2005.6cm.dat MC



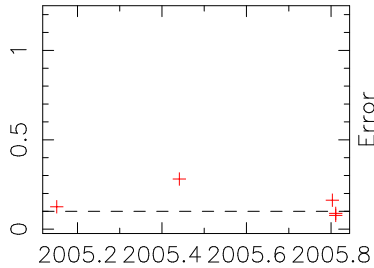
Date

ampcal_2005.6cm.dat ON



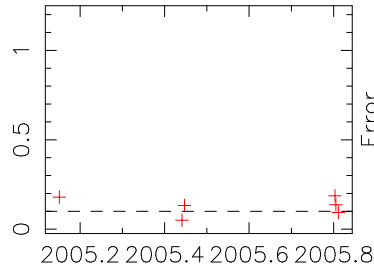
Date

ampcal_2005.6cm.dat TR



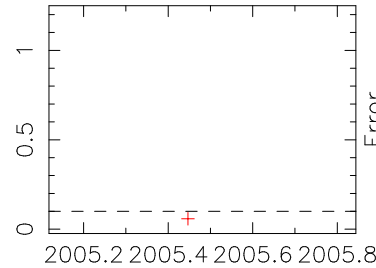
Date

ampcal_2005.6cm.dat WB



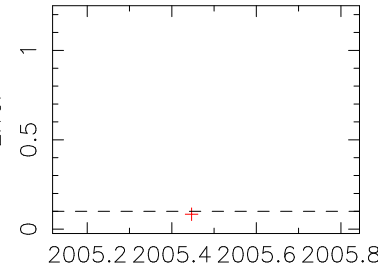
Date

ampcal_2005.6cm.dat AR



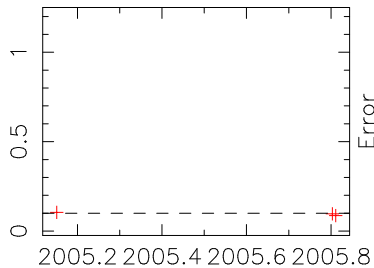
Date

ampcal_2005.6cm.dat GB



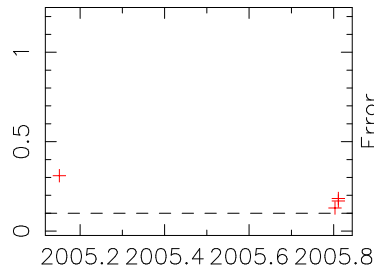
Date

ampcal_2005.6cm.dat HH



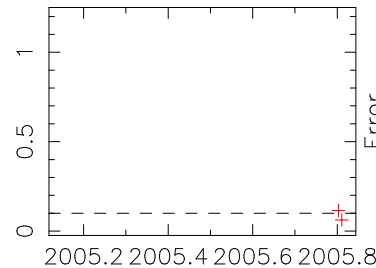
Date

ampcal_2005.6cm.dat UR



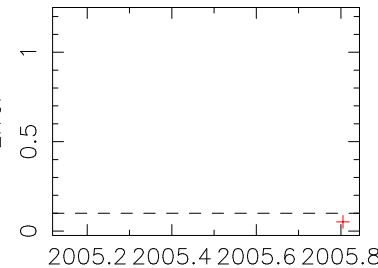
Date

ampcal_2005.6cm.dat SH



Date

ampcal_2005.6cm.dat BR

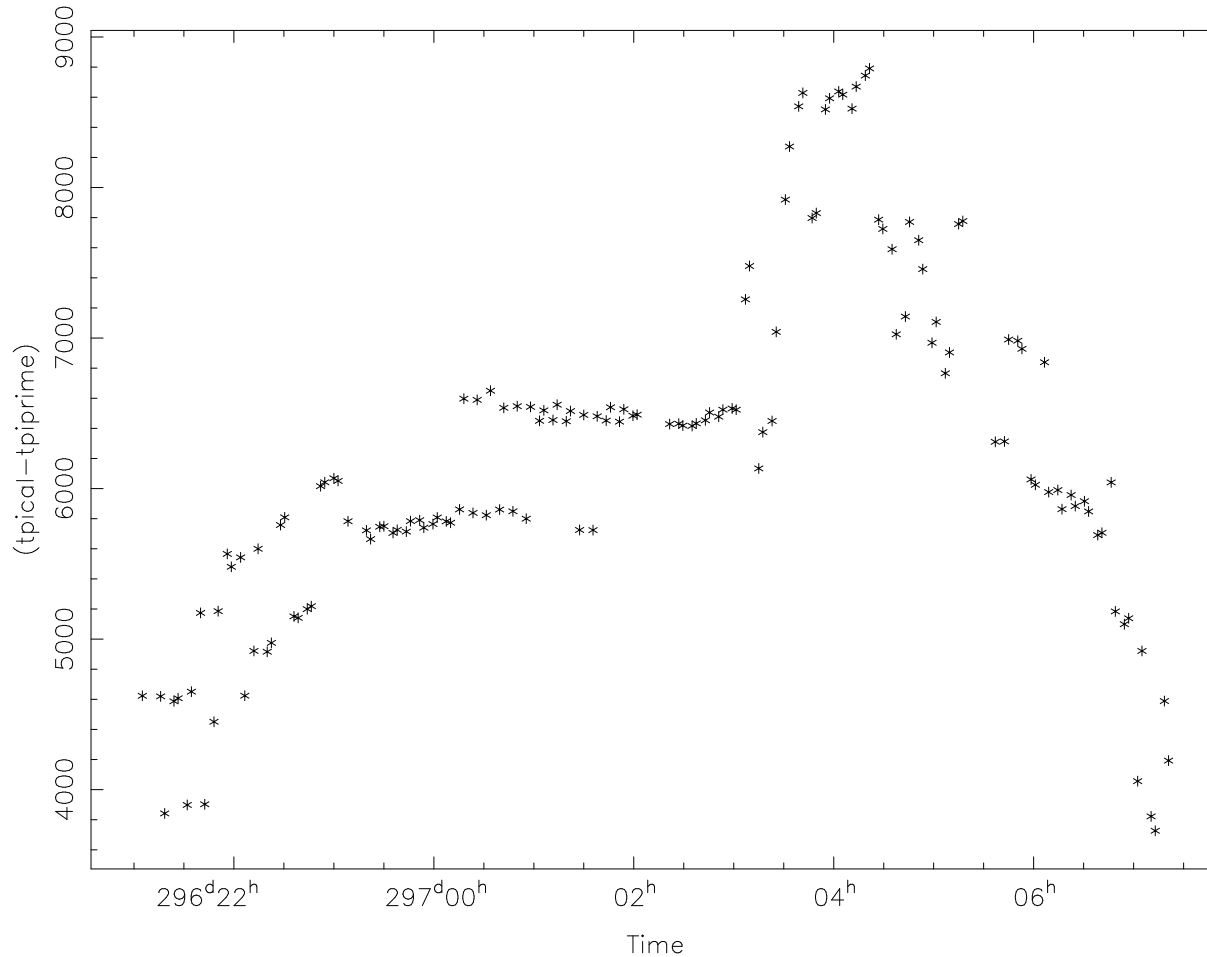


Date

Jb sensitivity
 problems in
 session 3

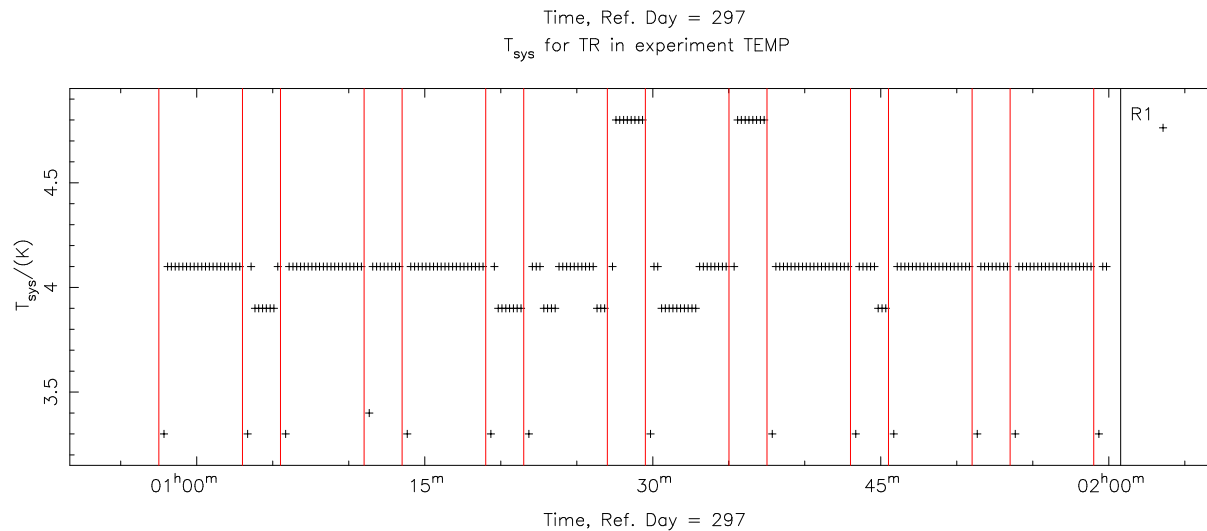
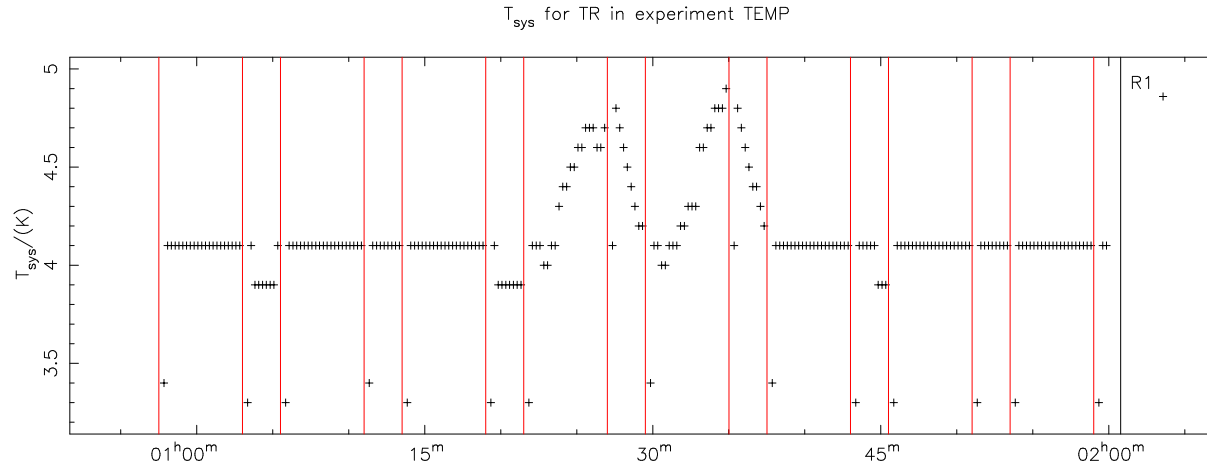
ANTABFS Problems – VLBA Racks

ep053TR_tpipairs.dat bbc01



tpdiff has two preferred levels

No apparent relation to source
or elevation



Comparing T_{sys} calculated with and without interpolation

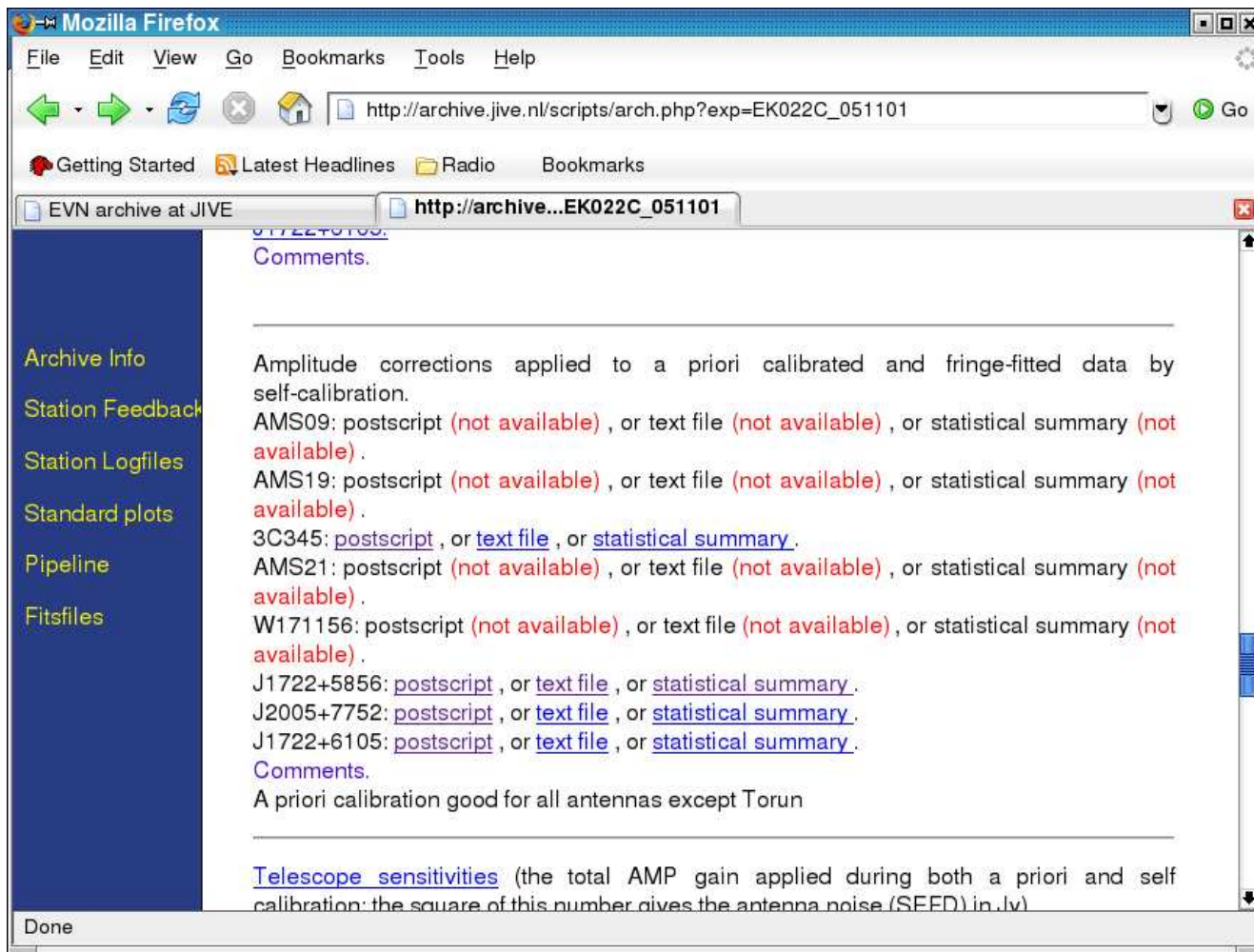
- Interpolation not good
- How to cope with real schedules?

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

<http://www.jive.nl/archive>



The screenshot shows a Mozilla Firefox browser window with the address bar containing http://archive.jive.nl/scripts/arch.php?exp=EK022C_051101. The page content includes a sidebar with navigation links: Archive Info, Station Feedback, Station Logfiles, Standard plots, Pipeline, and Fitsfiles. The main content area displays the following text:

Comments.

Amplitude corrections applied to a priori calibrated and fringe-fitted data by self-calibration.

AMS09: [postscript](#) (not available), or [text file](#) (not available), or [statistical summary](#) (not available).

AMS19: [postscript](#) (not available), or [text file](#) (not available), or [statistical summary](#) (not available).

3C345: [postscript](#), or [text file](#), or [statistical summary](#).

AMS21: [postscript](#) (not available), or [text file](#) (not available), or [statistical summary](#) (not available).

W171156: [postscript](#) (not available), or [text file](#) (not available), or [statistical summary](#) (not available).

J1722+5856: [postscript](#), or [text file](#), or [statistical summary](#).

J2005+7752: [postscript](#), or [text file](#), or [statistical summary](#).

J1722+6105: [postscript](#), or [text file](#), or [statistical summary](#).

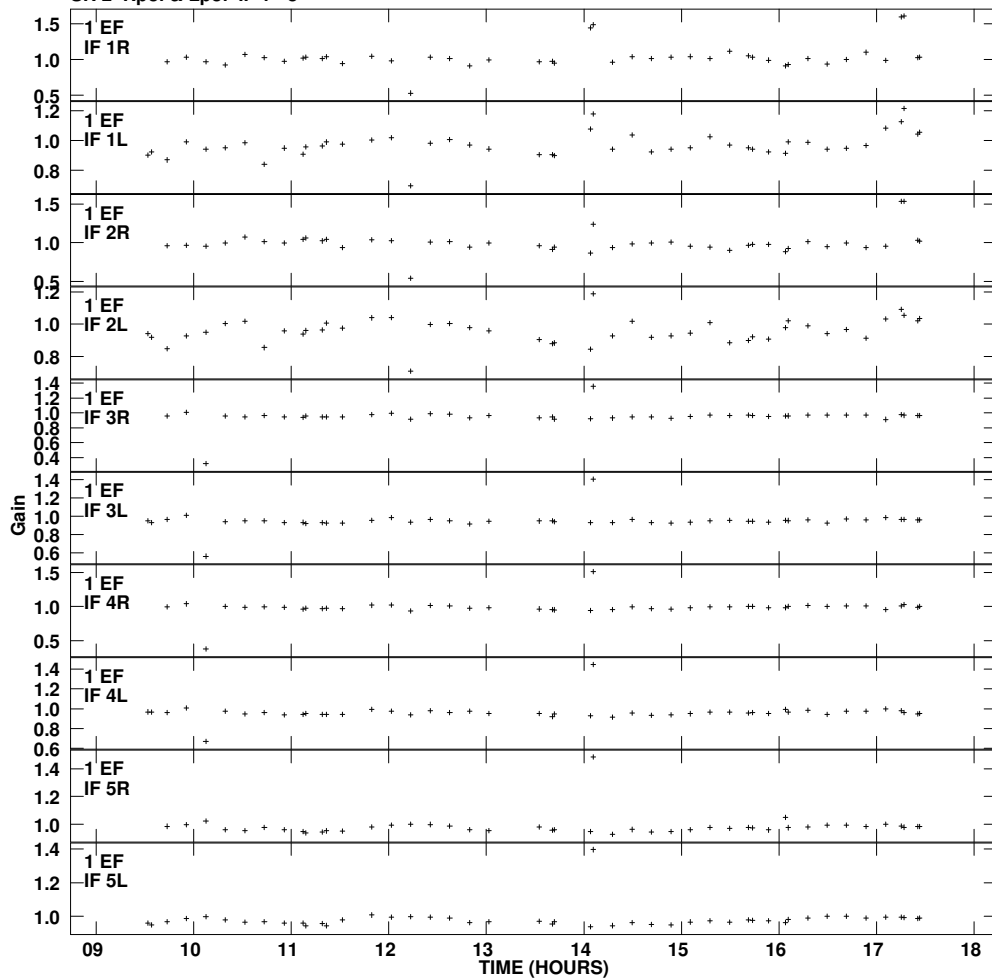
Comments.

A priori calibration good for all antennas except Torun

[Telescope sensitivities](#) (the total AMP gain applied during both a priori and self calibration: the square of this number gives the antenna noise (SEFD) in Jy)

Results are plotted for every calibrator scan

Plot file version 1 created 15-FEB-2006 19:23:37
 Gain amp vs UTC time for J1722+5856.MULTI.1
 SN 2 Rpol & Lpol IF 1 - 8



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

The results are also available in text form:

```
jop15      LISTR(31DEC02)      1029      02-MAR-2004      12:36:48
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
```

Page 1

```
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
```

And as a statistical summary:

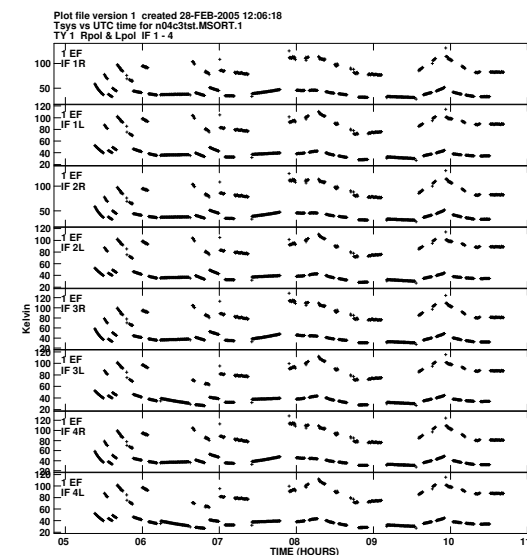
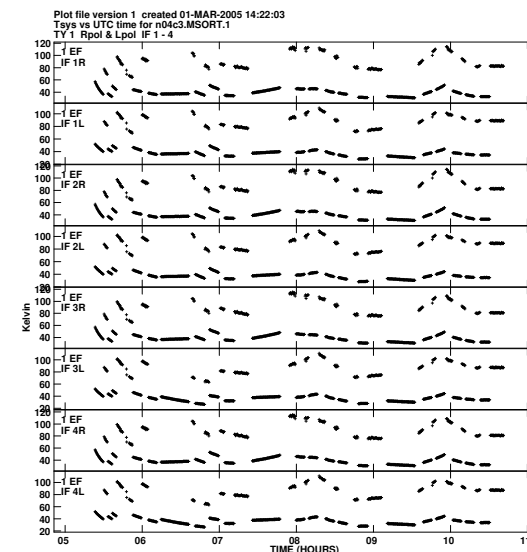
```
File = J1722+5856 .MULTI . 1 Vol = 1 Userid = 3606 IF = 8
FQID IF# Freq(GHz) BW(kHz) Ch.Sep(kHz) Sideband
  1 1 1.59499000 16000.0010 500.0000 1
  2 1.61049000 16000.0010 500.0000 1
  3 1.62699000 16000.0010 500.0000 1
  4 1.64249000 16000.0010 500.0000 1
```

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

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`

```

n04c3.antab (-/reynolds/t...ay05/n04c3/in/n04c3) - GVIM1
File Edit Tools Syntax Buffers Window Plugin Help
! Amplitude calibration data for EF in n04c3.
! For use with AIPS task ANTAB.
! Waveband(s) = c.
! LOs = 4840.00 4840.00.
! Produced on 2004-12-03 using antabfs.pl version 23 Jul 2004.
GAIN EF  ELEV DPFU=1.52,1.52          FREQ=4290,5390
POLY=9.6577E-01,1.5571E-03,-1.7710E-05
/
TSYS EF  FT=1.0  TIMEOFF=0
INDEX= 'L1:2', 'R1:2', 'L3:4', 'R3:4'
/
!Column 1 = L1: bbc01, 4982.49 MHz, BW=8.000 MHz, LSB, Tcal= 1.7 K
!Column 1 = L2: bbc01, 4982.49 MHz, BW=8.000 MHz, USB, Tcal= 1.7 K
!Column 2 = R1: bbc02, 4982.49 MHz, BW=8.000 MHz, LSB, Tcal= 1.8 K
!Column 2 = R2: bbc02, 4982.49 MHz, BW=8.000 MHz, USB, Tcal= 1.8 K
!Column 3 = L3: bbc03, 4998.49 MHz, BW=8.000 MHz, LSB, Tcal= 1.7 K
!Column 3 = L4: bbc03, 4998.49 MHz, BW=8.000 MHz, USB, Tcal= 1.7 K
!Column 4 = R3: bbc04, 4998.49 MHz, BW=8.000 MHz, LSB, Tcal= 1.8 K
!Column 4 = R4: bbc04, 4998.49 MHz, BW=8.000 MHz, USB, Tcal= 1.8 K
! 302 04:13.71, scan=0001,n04c3,720,1320, source=3c273b
302 04:59.83 110.7 123.0 104.4 113.2
!302 04:59.90 108.3 119.4 102.3 110.3 ! tsys
302 05:00.01 97.7 107.3 92.7 99.7
302 05:00.35 97.8 107.4 92.8 99.9
302 05:00.68 97.9 107.9 93.0 100.5
106,1 0%
  
```



Over to...

Demos

