

VLBI Observations of Cheng'E3

CORRELATION

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First international workshop on VLBI Observations of near-field targets

24 hr VLBI observations of QSRs of the ICRF3

SKED

guarantees appropriate
- sky coverage,
- SNR
for geodetic analysis



Only 1 vex file (geocentric ref. system):

- frequency set-up (\$FREQ section)
- cabling (\$BBC, \$IF, \$TRACKS sections)
- station (\$STATION, \$ANTENNA, \$SITE)
- target position (\$SOURCE)
- a-priori geometric model (\$EOP,\$CLOCK)
- scheduled observations (\$SCHED), e.g.

```
$SCHED;  
scan 229-1700a;  
start = 2016y229d17h00m00s;  
mode = GEOSX.SX;  
source = 0234+285;  
station = Ke : 0 sec : 157 sec : 0 ft : 1A : &n : 1;  
station = Kv : 0 sec : 157 sec : 0 ft : 1A : &ccw : 1;  
station = Ts : 0 sec : 43 sec : 0 ft : 1A : &ccw : 1;  
station = Ww : 0 sec : 157 sec : 0 ft : 1A : &n : 1;  
endscan;
```

Lunar lander observations added manually to vex file by scheduler:

```
$SCHED;  
  scan = <UT>           (e.g. <UT>=189-1804)  
  source = L - <hrs-min-sec @ start>   (e.g. L-180419)
```

Source ra,dec = lander station based ra,dec @ scan_start

```
$SOURCE;  
def L-133024;  
  source_name = L-133024;  
  ra = 16h26m35.947185s; dec = -17d31'05.159197"; ref_coord_frame = J2000;  
enddef;
```

One vex file for each station to run observations

Quite some editing needed to build a vex file for correlation
(geocentric ra,dec needed by DiFX--> change \$SOURCE section)

Bonn HPC : DiFX software correlator

vex_file + v2d_file :

```
vex = r1753.vex
antennas = FT, HH, KE
singleScan = True

SETUP geo {
  tInt = 1
  doPolar = False
  nChan = 32
}
ANTENNA FT {
  filelist = ft.filelist
}
```

vex2difx

Input files
for correlation:

- *.input,
- *.flag,
- *.calc

startdifx

(startdifx)

```
calcif2 --- > *.im (correlator model)
          *.flag,*.machines,*.threads
mpifxcorr ---> correlation
```

Fringe fitting with Fourfit software

difx2mark4

Visibilities (*.difx files)

1) calcif2 → CALC09 : does not

- include near-field model
- take parallax into account
- compute atmosphere contributions correctly
- correct delays for gravitational bending

switch to 

difxcalc (CALC11 version for DiFX) provides 3 near-field models:

- Duev,
- Sekido,
- LSR

2) Cheng'E3 orbit is not known to CALC → feed DiFX ephemeris (in *.calc) :

Lander position in
ME or PA system



SPICE



position and velocities vectors in a geocentric
Cartesian coordinate system

(edited) vex_file + v2d_file

vex2difx

*.input
*.flag
*.calc

calc4ade (Z. Zhang): add ephemeris for lunar lander scans

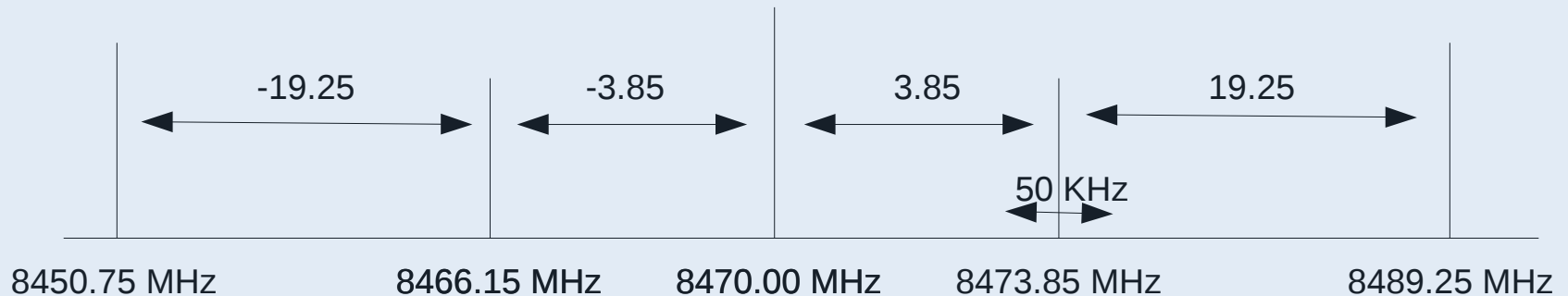
difxcalc

*.im files (correlator model)

mpifxcorr

Visibilities (*.difx)

Lander emits DOR signals (below) + data transmission channel (8496 MHz)



3 different kind of observation:

1) standard geodetic IVS-session
(S- and X-band, 4MHz-8MHz)

→ clock of the stations

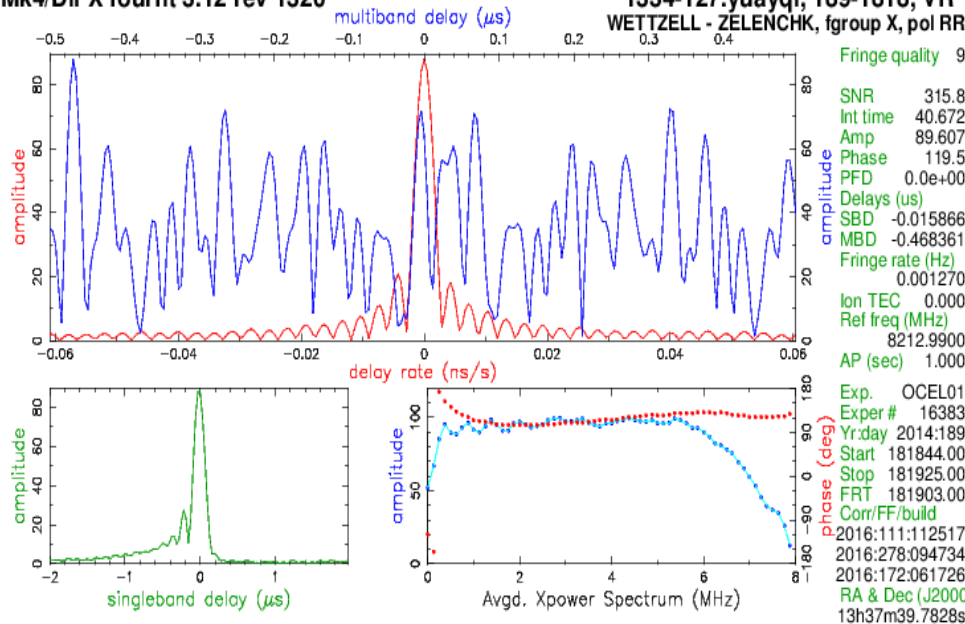
2) quasar observation with special frequency set-up
(sources at close angular distance from lander)

→ ionospheric correction
(no S-band data available)

3) lunar lander

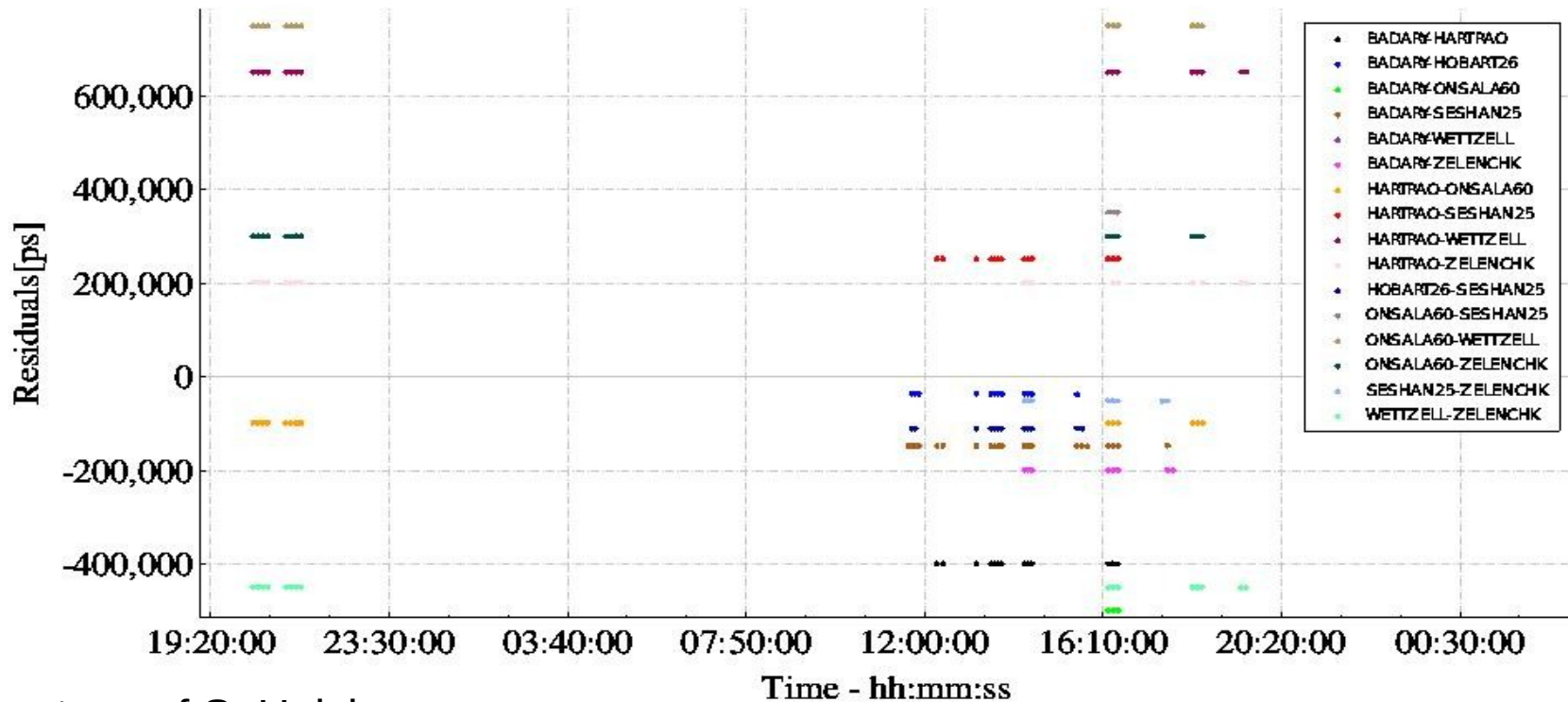
“Fourfit performs a 3-dimensional search over SBD, DR and MBD and reports the parameter values at the maximum correlation in this 3-dim space. “

Mk4/DiFX fourfit 3.12 rev 1320 1334-127.yuayql, 189-1818, VR
WETTZELL - ZELENCHK, fgroup X, pol RR



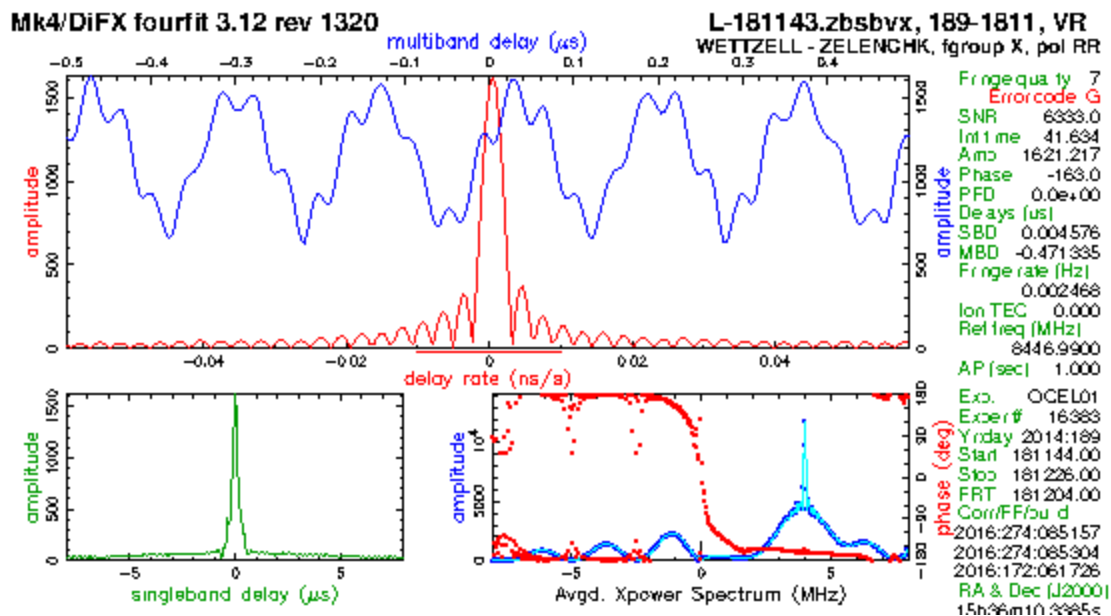
8446.99 MHz
8461.99 MHz
8465.99 MHz
8485.99 MHz
8491.99 MHz

Analysis of the QSR observations with special set-up: preliminary results



Courtesy of S. Halsig

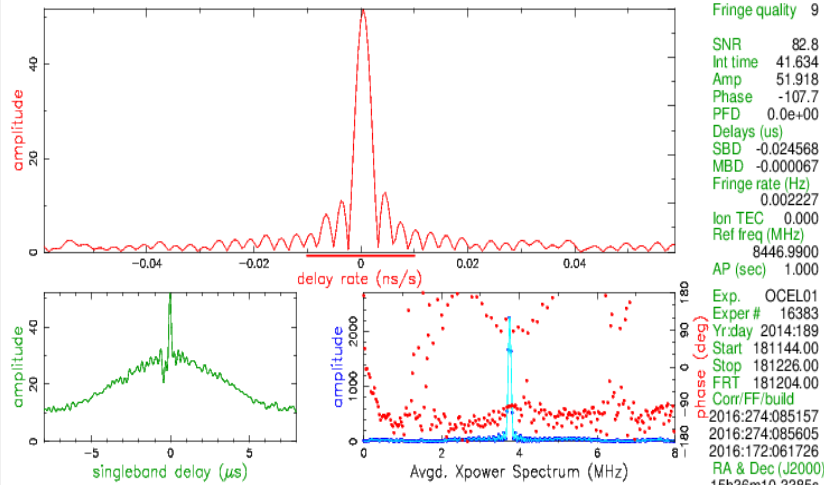
Ivg::ASCOT and CALC/SOLVE lead to the same results



8446.99 MHz -- > tone @ 8450 MHz
 8461.99 MHz -- > tone @ 8466 MHz
 8465.99 MHz -- > tones @ 8466 MHz, 8470 MHz and 8473 MHz
 8485.99 MHz -- > tone @ 8489 MHz
 8491.99 MHz -- > tone @ 8496 MHz

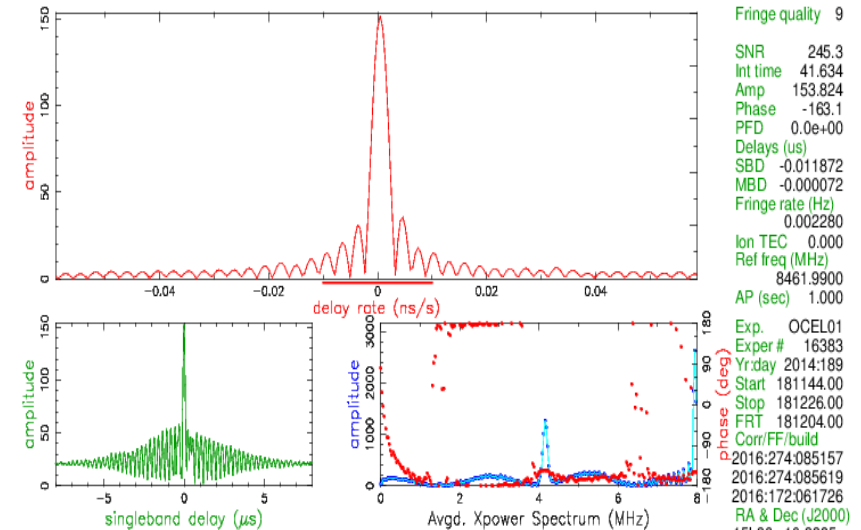
Mk4/DiFX fourfit 3.12 rev 1320

L-181143.zbsbvX, 189-1811, VR
WETTZELL - ZELENCHK, fgroup X, pol RR



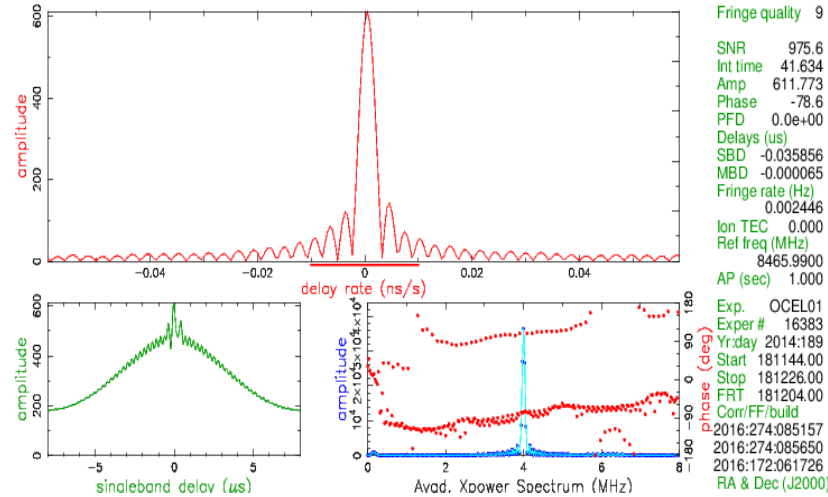
Mk4/DiFX fourfit 3.12 rev 1320

L-181143.zbsbvX, 189-1811, VR
WETTZELL - ZELENCHK, fgroup X, pol RR



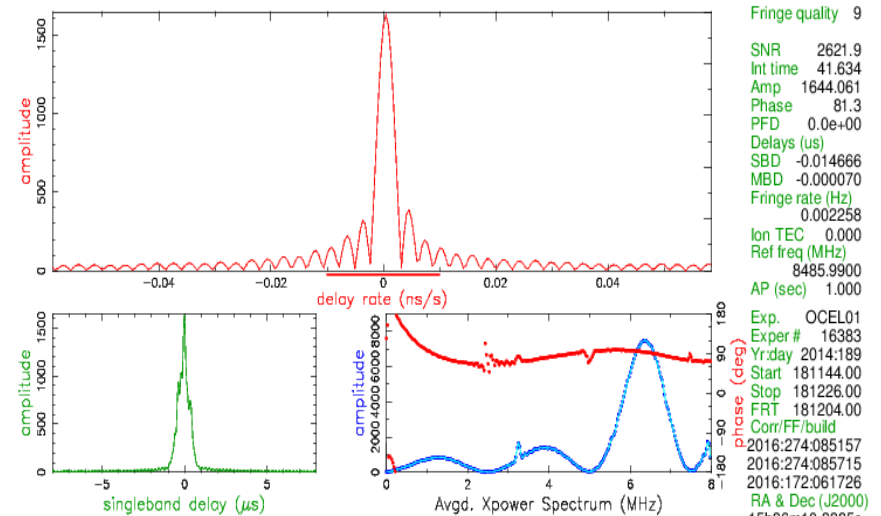
Mk4/DiFX fourfit 3.12 rev 1320

L-181143.zbsbvX, 189-1811, VR
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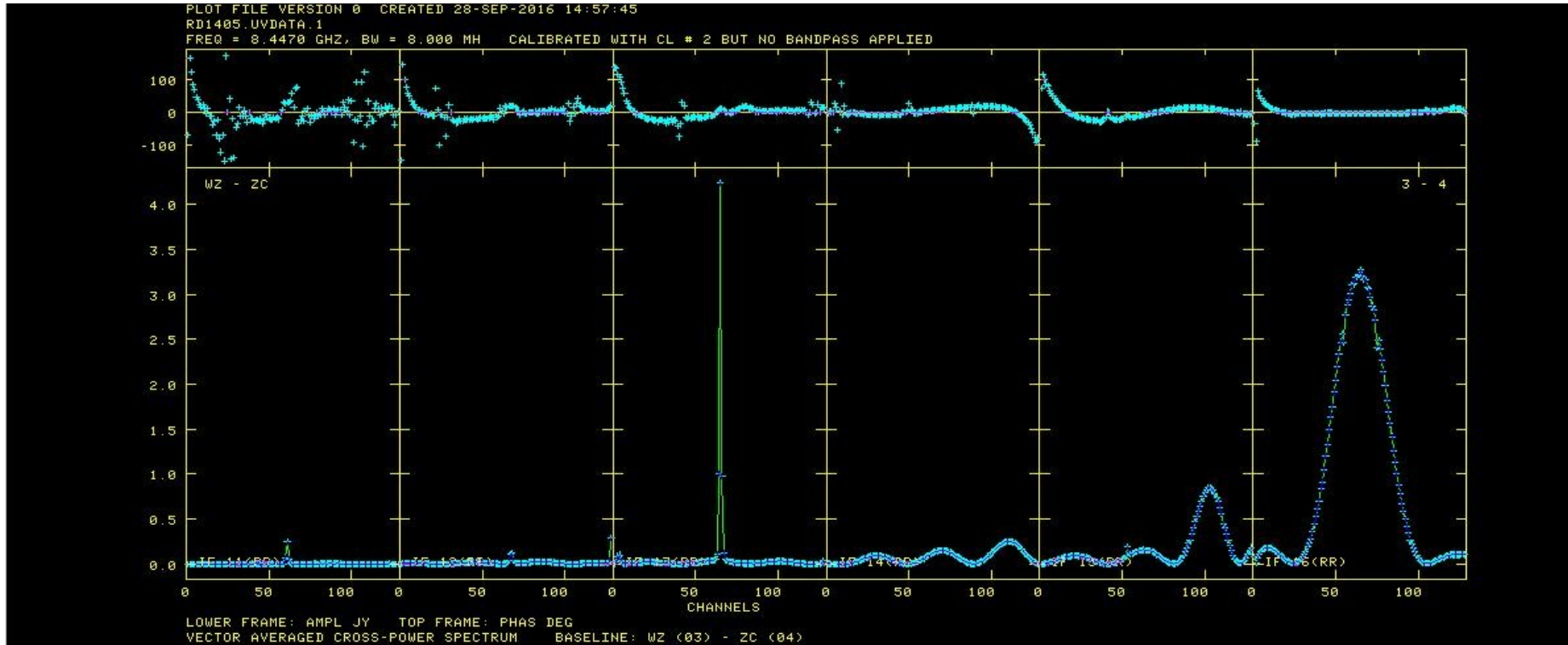


Mk4/DiFX fourfit 3.12 rev 1320

L-181143.zbsbvX, 189-1811, VR
WETTZELL - ZELENCHK, fgroup X, pol RR



OCEL01, Baseline Wz/V-Zc/R, Scan 189-1811 – Fringe fitting in AIPS



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Processing of lunar lander observations → lots of editing → prone to errors



Automatic processing procedure needed !

- | | |
|--|-------------------------------|
| • Scheduling program | SCHED, SKED, VieVS ? |
| • Program for ephemeris computation | include calc4ade in DiFX ? |
| • Fringe fitting program | modify Fourfit, update AIPS ? |
| • Software for quality-control of data processing (data editing, problem diagnosis) | aedit ? |