# 86GHz VLBP of OVV 1633+382 after a major mm flare

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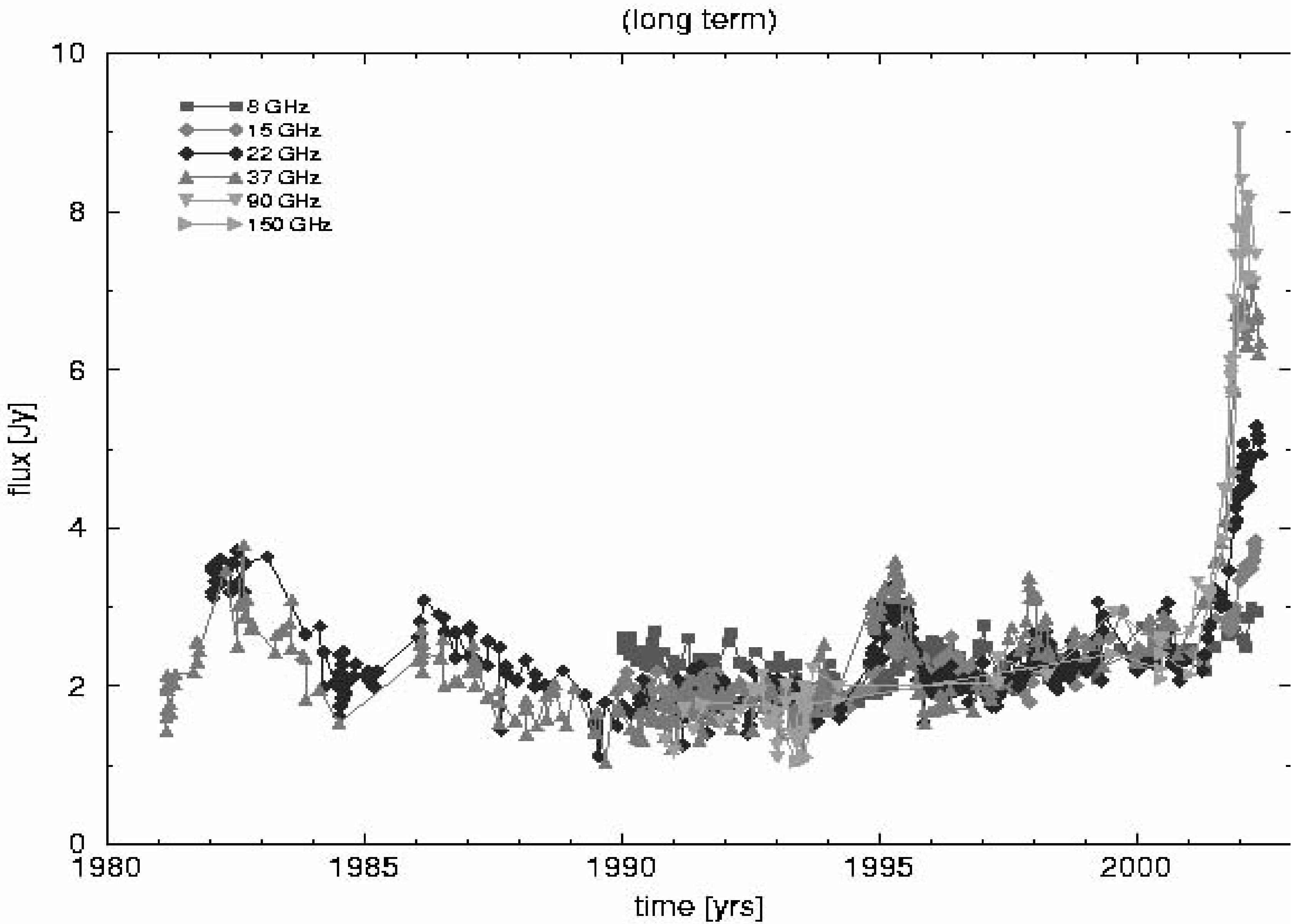
# Overview

- OVV 1633+382
- 3mm VLBP monitoring
- D-term correction
- EVPA check
- AGN at mm wavelength
- mm VLBP
- mm VLBI with KVN

# OVV 1633+382 (4C 38.41)

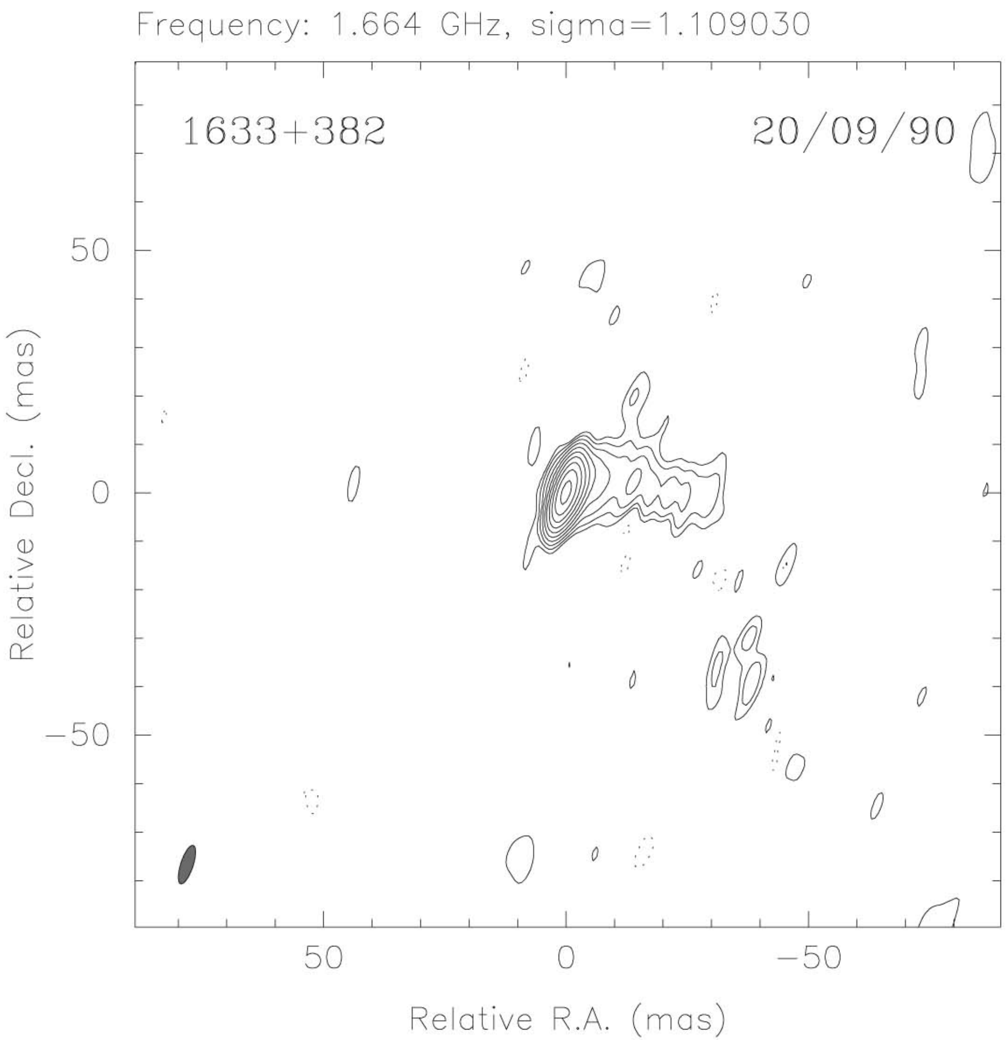
- z=1.814, QSO, Optically Violently Variable (OVV)
  ΔB ~ 3 mag (redshifted UV) (Barbieri et al. 1977)
- Gamma-lay bright AGN ~ 5 $10^{48}$ ergs $s^{-1}$ ( 0.1-100GeV EGRET, Mattox et al. 1993)
- Core-dominated radio feature (Murphy et al. 1993, Poladitis et al. 1995) at 1.6 GHz
- Superluminal jet components up to 10c (Barthel et al. 1995 & Xu et al.1998, Jorstad et al. 2001) ~ sub mas per year
- flat spectrum, cm & mm variable
- major mm flare 2001-2002, inversed spectrum

=> explore innermost region during/after a major flare : kinematics, spectral & polarization evolution



(long term)
8 GHz
15 GHz
22 GHz
37 GHz
90 GHz
150 GHz
flux [Jy]
time [yrs]
0
2
4
6
8
10
1980
1985
1990
1995
2000

Poladitis et al 1995




Maximum: 2.059 JY/BEAM

Contours (%): −0.15 0.15 0.30 0.60 1.20 2.40 4.80 9.60 19.20 38.40

Contours (%): 76.80

Beam: FWHM 8.33 × 2.56 mas, p.a. −18.3°

File: 1633+382.cmp_n (29−Sep−1994 19:43)

# Observations (still on-going)

**Table 1.** Observation Epochs

| Date | Stations[a] | Notes |
|---|---|---|
| 12 Jun 2002 | FD KP **LA** NL OV MK | b |
| 28 Aug 2002 | FD **KP** LA NL OV PT MK | c |
| 01 Nov 2002 | FD **KP** LA NL OV PT MK | b |
| 03 Jan 2003 | FD KP **LA** NL OV PT MK | |
| 20 Mar 2003 | FD KP **LA** NL OV PT MK | |
| 23 Jun 2003 | FD KP **LA** OV PT MK | |

[a] bold faced characters indicate the reference antenna
[b] no cross pol. detection
[c] offset in RCP/LCP IF4 in D-terms

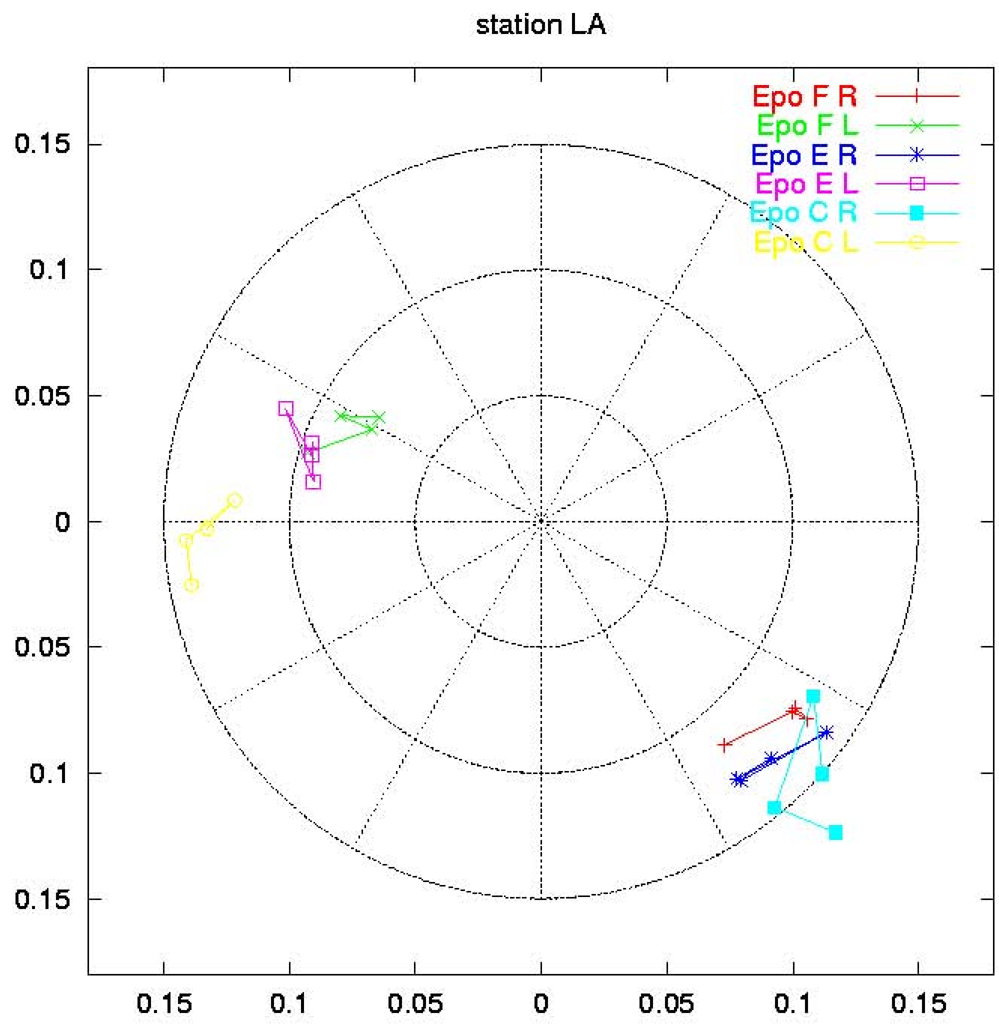
6 epochs at 86 GHz

VLBACPOL failed in the first 3 epochs.
*Source evolution or System evolution?*

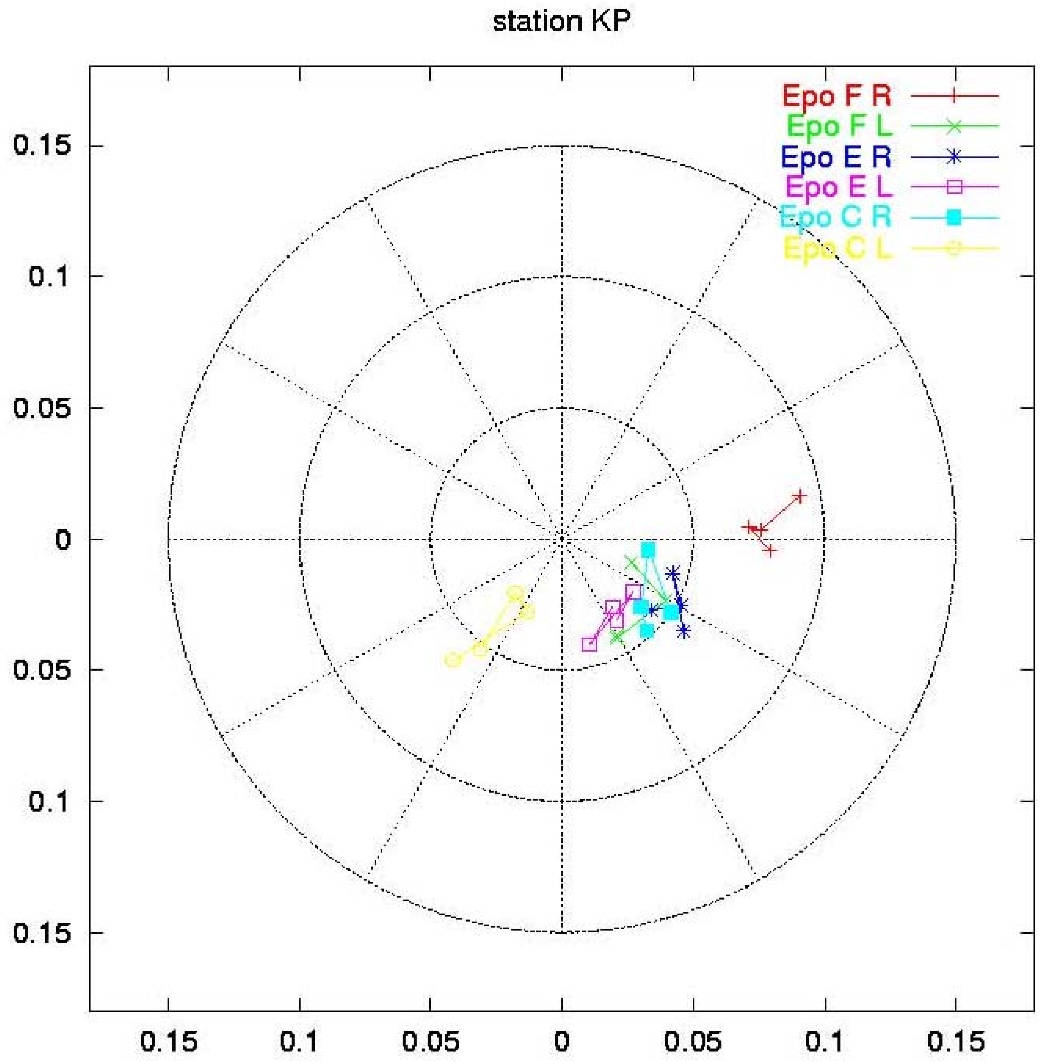
Conservative Band Cal.
*Flagging the first and the last channels of each IF*

The last three of the six
*usual calibration steps as at 22 & 43 GHz, multi IF mode LPCAL*

# D-terms, LA


station LA
Epo F R
Epo F L
Epo E R
Epo E L
Epo C R
Epo C L
0.15
0.1
0.05
0
0.05
0.1
0.15
0.15
0.1
0.05
0
0.05
0.1
0.15

# D-terms, KP


station KP
Epo F R
Epo F L
Epo E R
Epo E L
Epo C R
Epo C L
0.15
0.1
0.05
0
0.05
0.1
0.15
0.15
0.1
0.05
0
0.05
0.1
0.15

# Offset correction in EVPA
## (no p-cal…)

Lower freq. VLBI EVPA

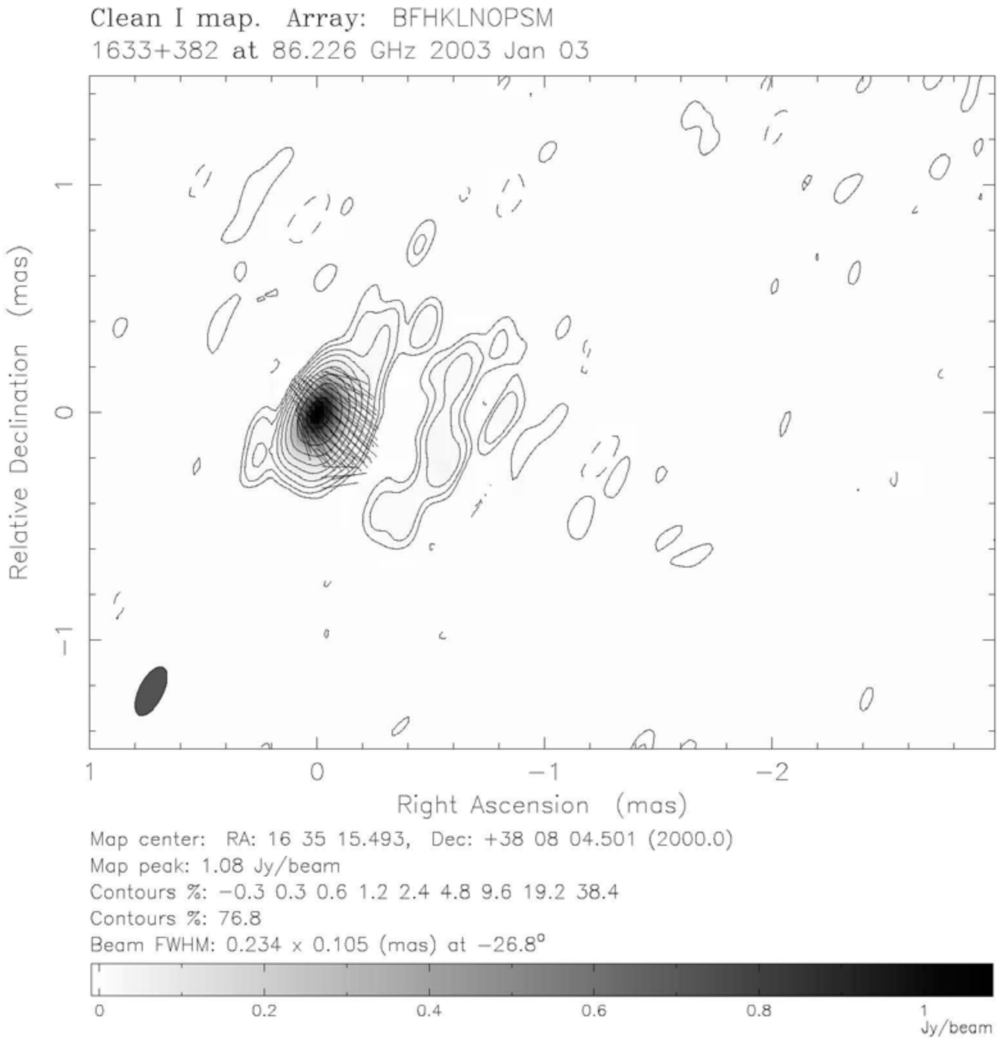
Sub mm EVPA

`[1633+382 EVPA at 3mm]`$_{\{\ldots,\mathbf{C},\mathbf{E},\mathbf{F},\ldots\}}$

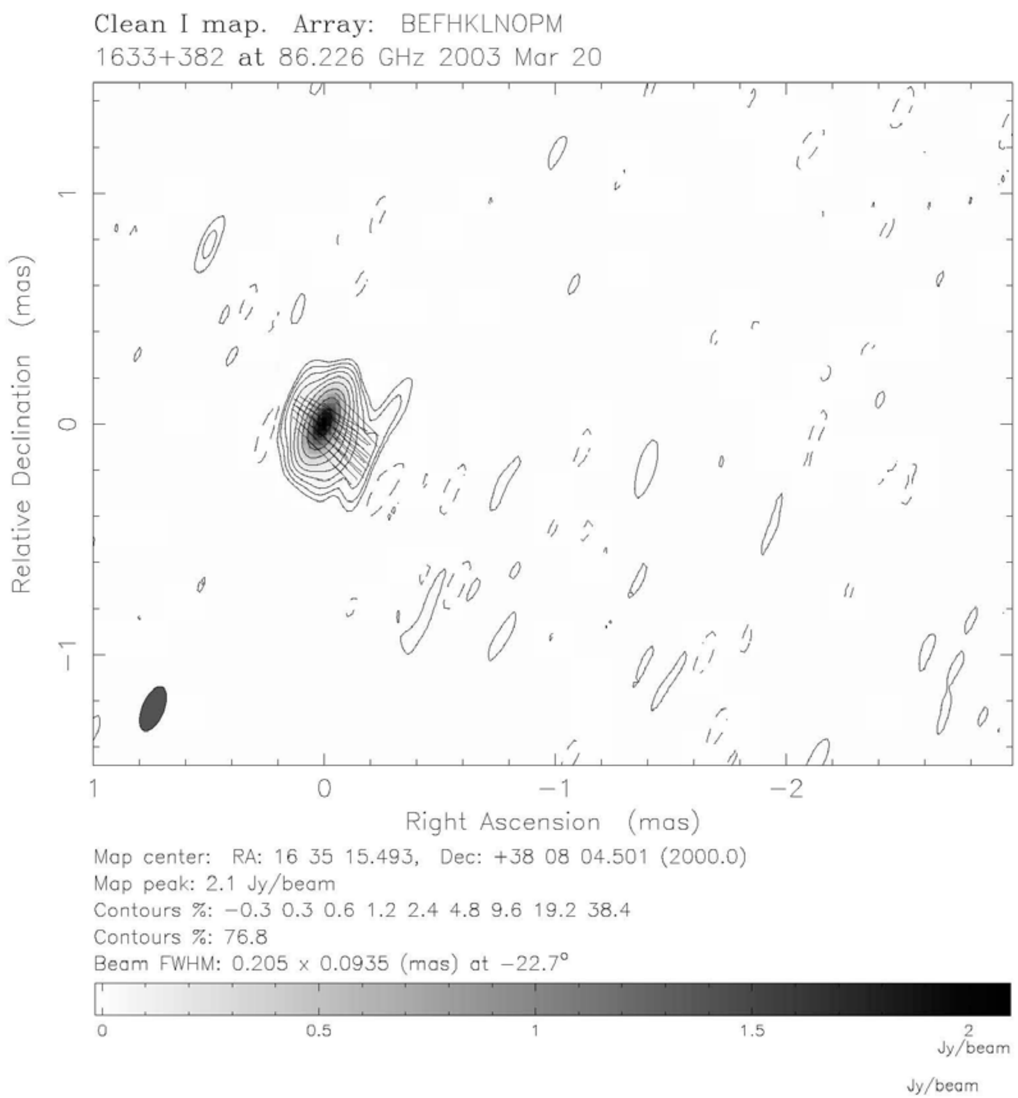
Calibrator EVPA at 3mm (3C345)

(simultaneous single dish observation at 3mm…, it can fool us too.)

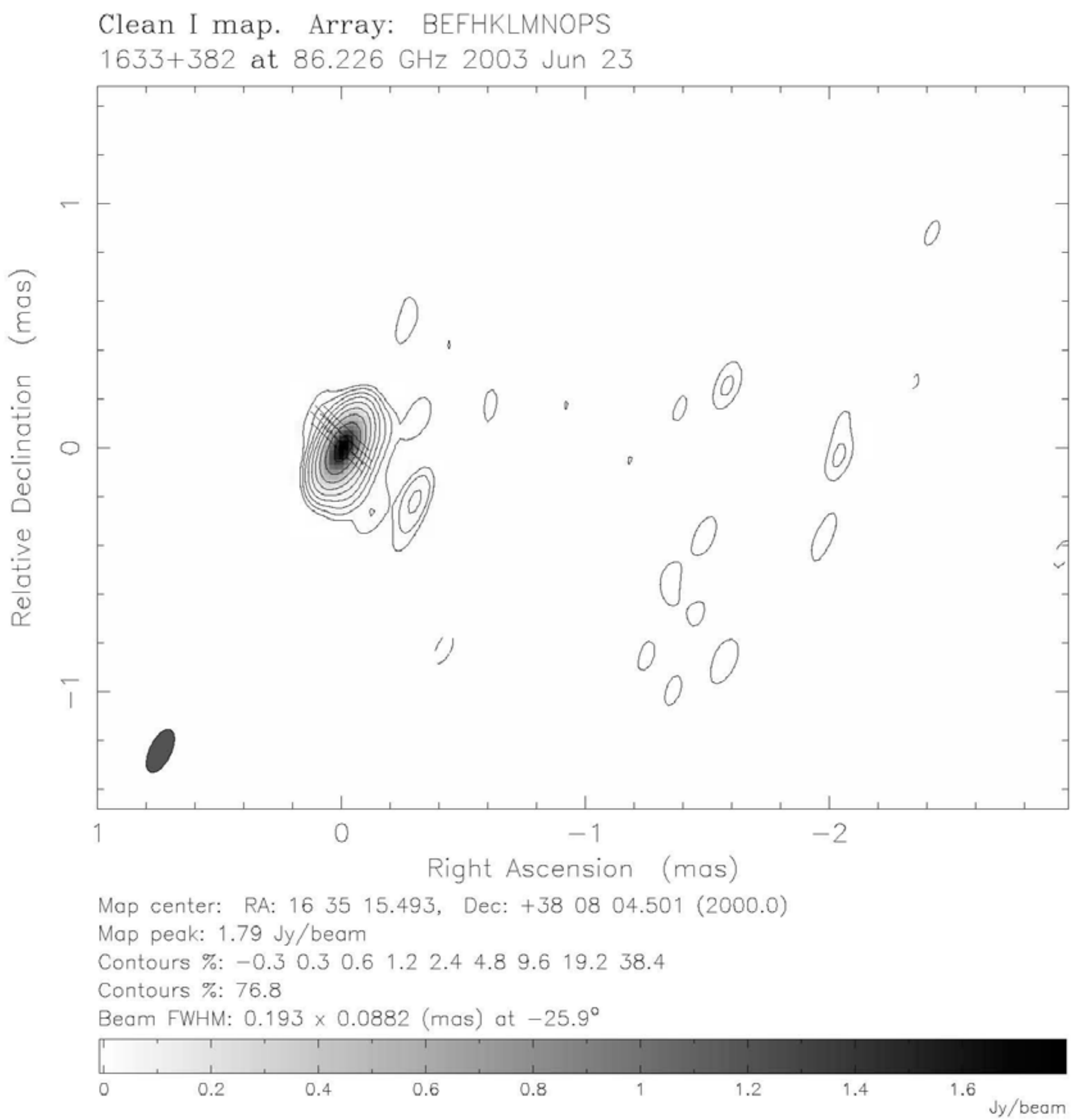
# 86GHz VLBP 1633+382



# 86GHz VLBP 1633+382



# 86GHz VLBP 1633+382



# single dish sub mm polarimetry



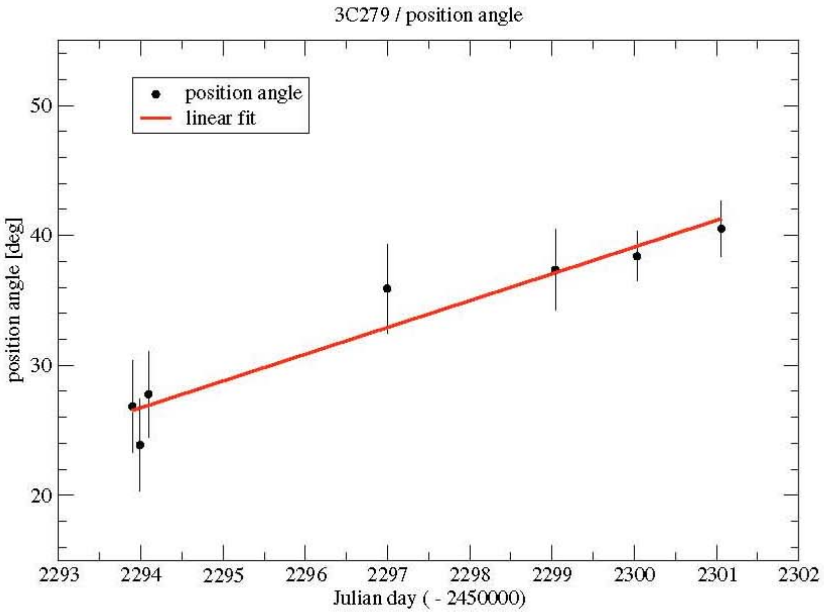



**Fig. 4.** Polarization position angle of 3C 279 in the 7 days of observations. The variation is ~14°. The linear fit gives a correlation coefficient of 0.97.

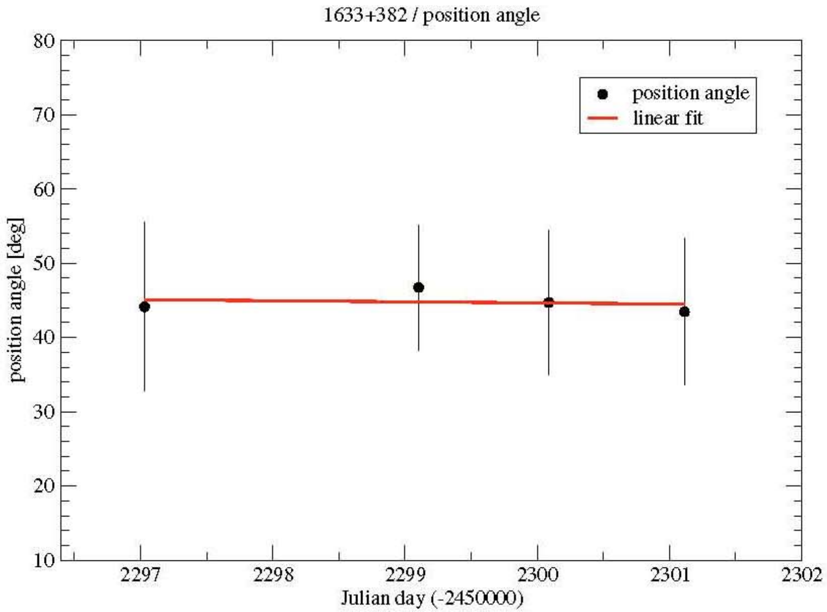
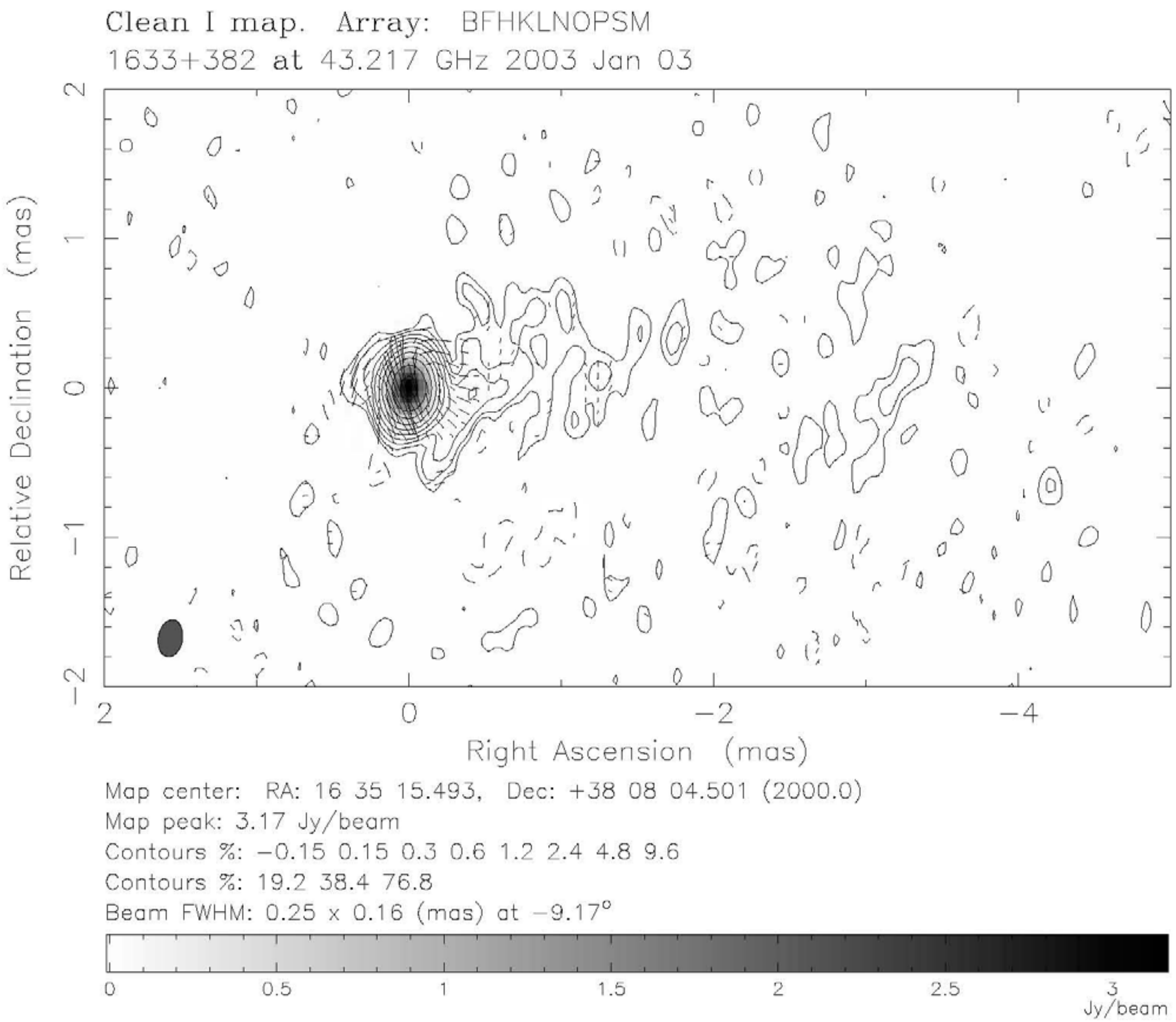
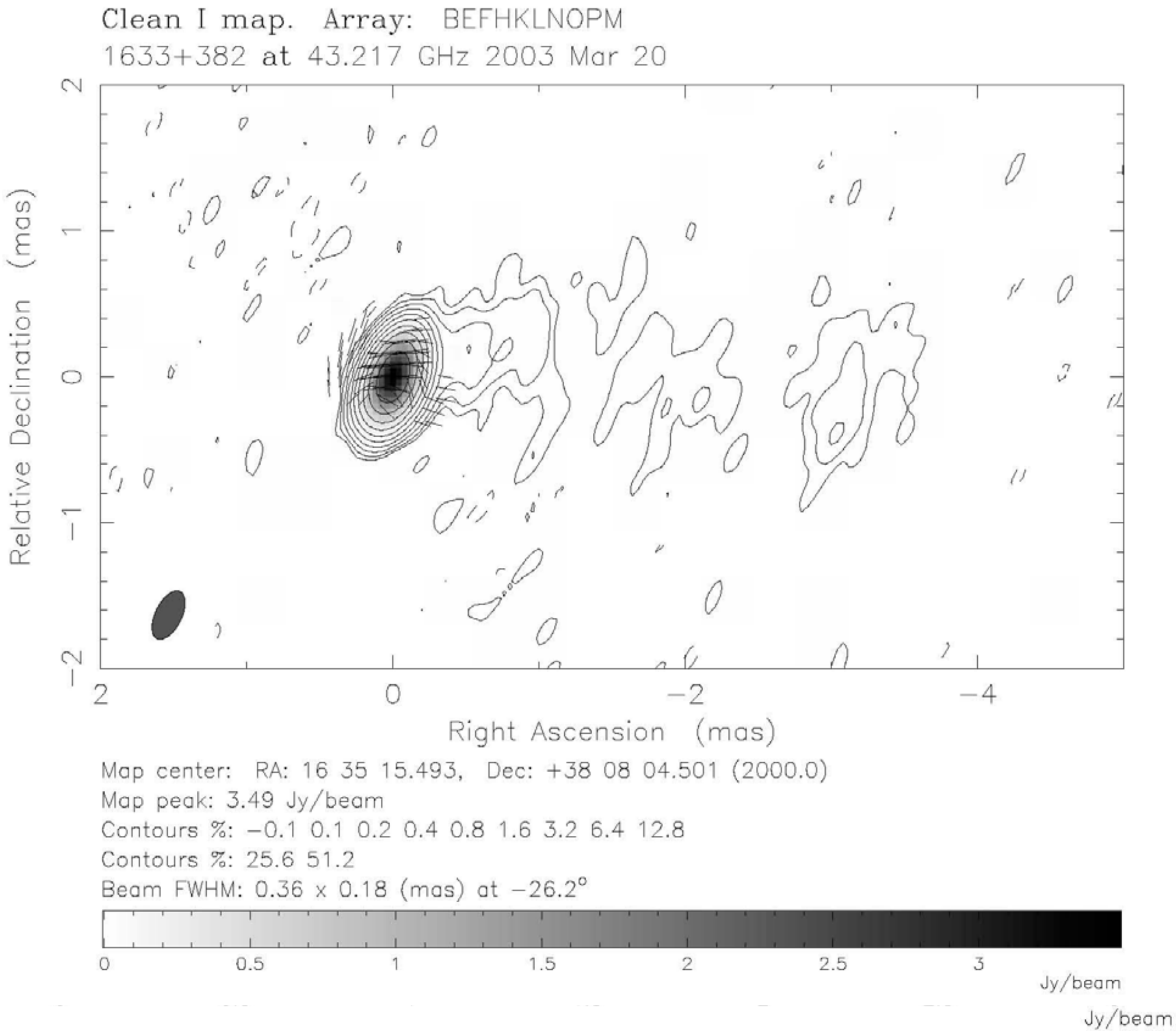



**Fig. 5.** Position angle of QSO B1633+382 in the 7 days of observations. There is no evidence of variability.

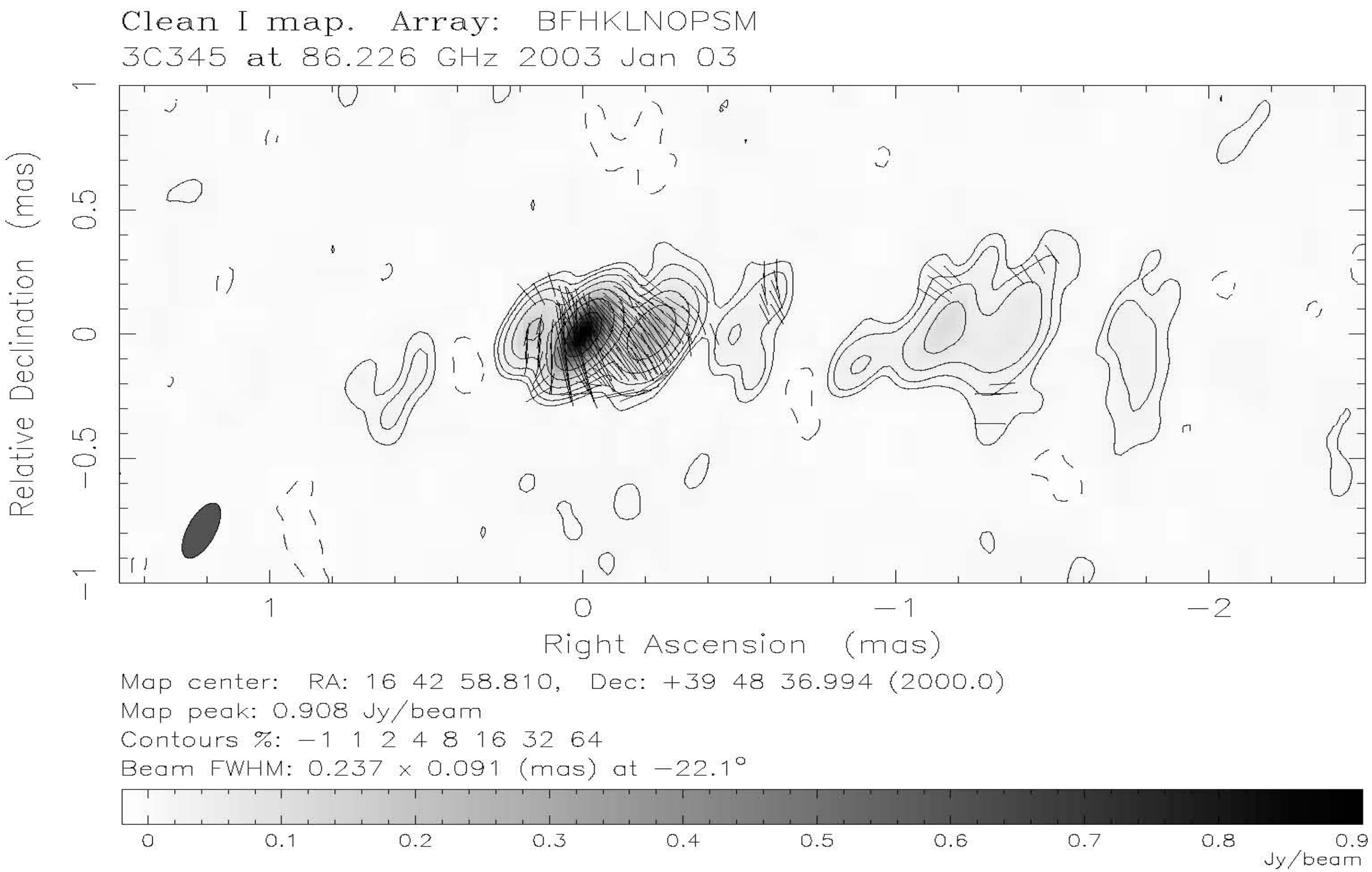
# 1633+382 at 43GHz varying pol. angle…



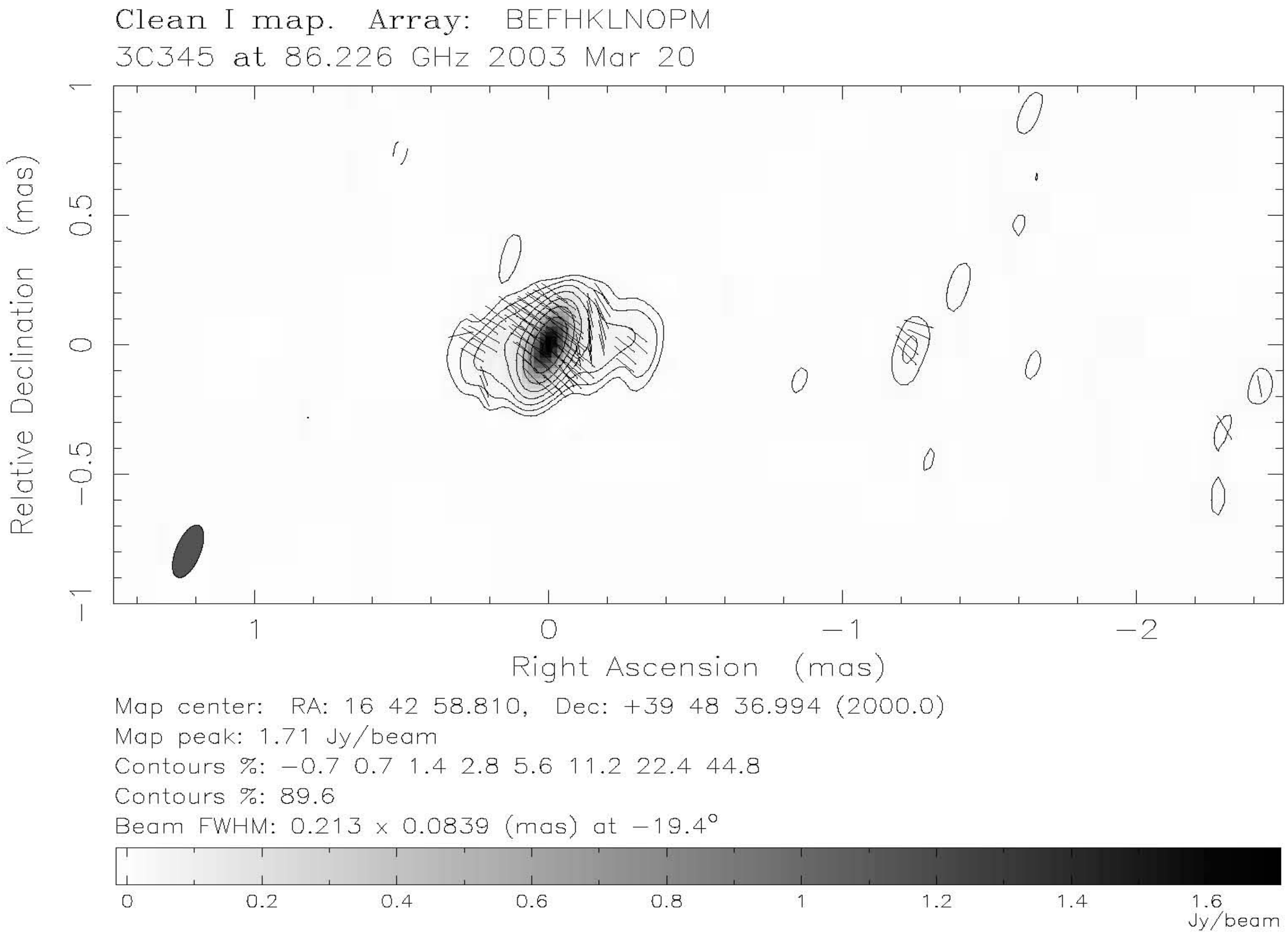
# 1633+382 at 43GHz varying pol. angle…



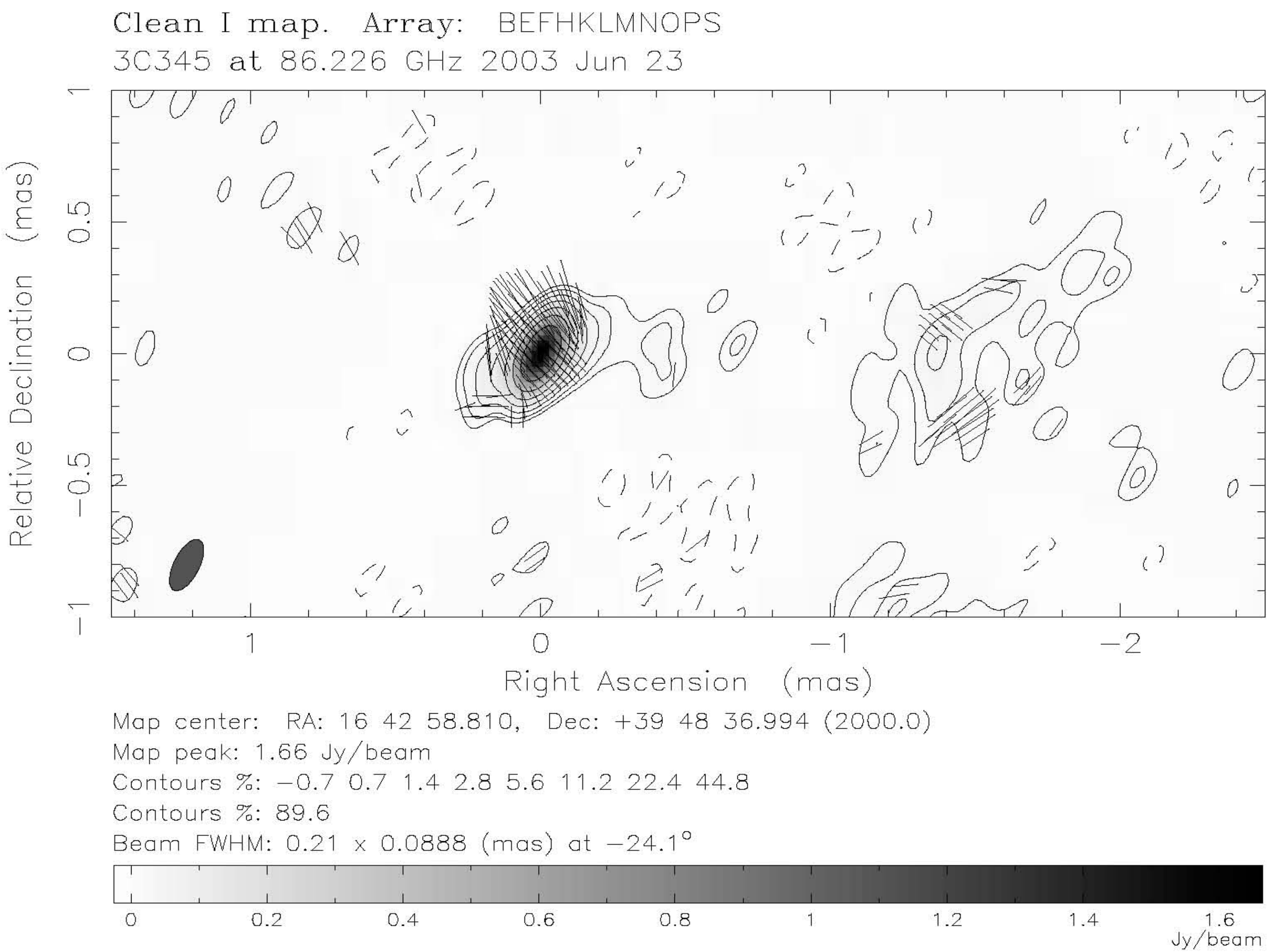
# 3C345 at 86GHz (Calibrator…)



# 3C345 at 86GHz (Calibrator…)



# 3C345 at 86GHz (Calibrator…)



# 3C345 at lower freq.



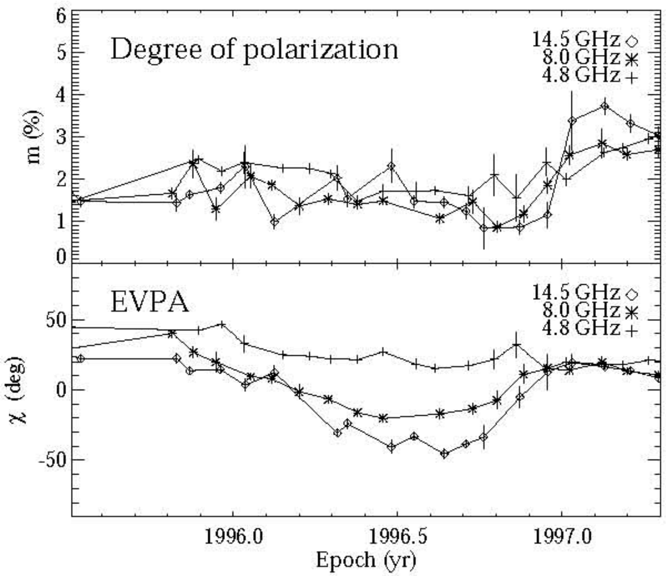



**Fig. 8.** Single dish $m$ and $\chi$ of 3C 345 (UMRAO).



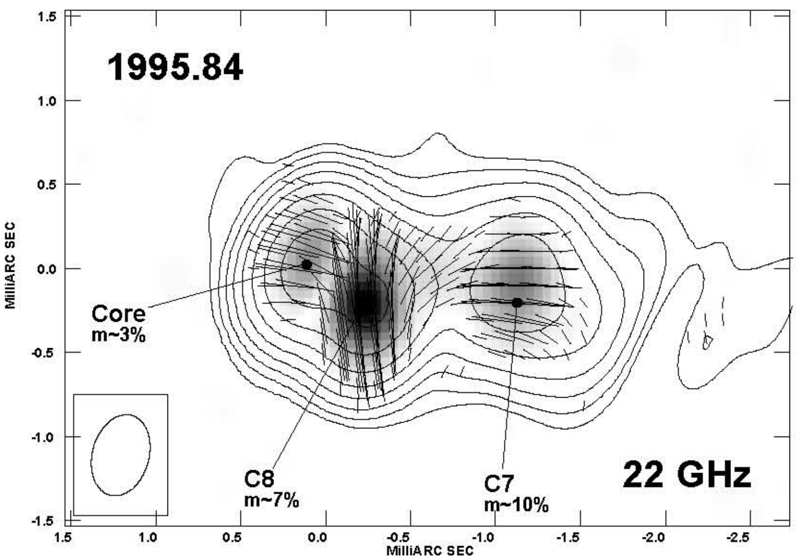



**Fig. 9.** VLBA $I$, $p$ and $\chi$ images of 3C 345 at 22 GHz, epoch 1995.84. The total intensity $I$ is represented with contours (value of 6 mJy/beam$\times$ $-1, 1, 2.24, 5, 11.18, 25, \ldots$), superimposed over a grey scale polarized intensity map (peak of brightness of 112.4 mJy) and the superimposed electric vectors ($\chi$, length proportional to $p$, 1 mas in the map is equivalent to 100 mJy/beam).

# VLBP at 86 GHz

- is possible, *but be patient*.
- 1633+382 varying too fast. (>100c?)
  - or opacity?
    - high [B * $n_e$] media with low filling factor ?
  - very low linear pol. after mm flare
    - source evolution or system evolution ?
- Calibrators are varying too…

  Sources are different at mm wavelength

  (resolution + opacity ) ?

Better baseline & image sensitivity are needed.

(***<u>at mm wavelength</u>***)

# mm VLBP study of AGNs is interesting…, and probably very important

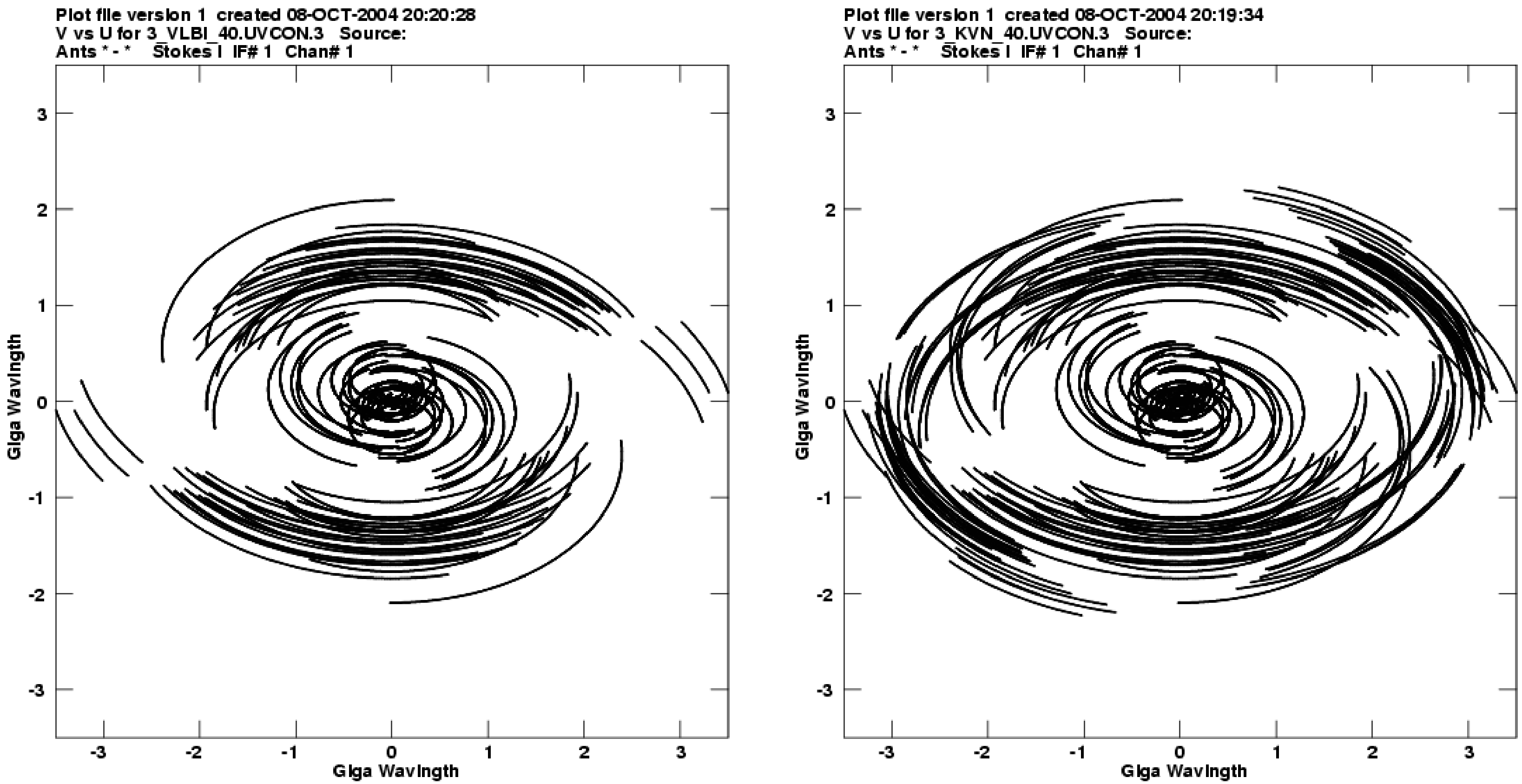
- SKA – will be great, but cm facility (Opacity problem (dust torus, SSA), resolution …).
- ALMA – will be great, but on the southern hemisphere (RM from G-Plane, GC plus Maggellanic stream,  e.g. Kronberg et al).
  - be aware that $RM_{o.f.}$ prop. to $(1+Z)^{-2}$

Sensitive mm VLBI on the northern hemisphere will be a great asset for AGN study…

sub-mas structure beyond opaque media…

# KVN included mm VLBI …

- At the expense of FoV…, sensitive imaging is possible (long $t_{int}$ at 3mm will be possible) .
  - For wide FoV, you could use local (e)VLBI facilities (e.g. EVN, VLBA, VERA + KVN, …)




Jung (2004)

# Summary and Outlook

- 3mm VLBP is possible (without magic).
  - (mm)VLBI(P) could survive quite long.
    - since there are resolution, sensitivity, *opacity*-frequency, and space (n. h.) gaps.
  - Study of inner most AGN structure will benefit from filling the gaps.

  mm VLBI could be more than a niche product…
- 8$^{th}$ EVN, more physics of 1633+382
- 10 (+ - 1) $^{th}$ EVN, KVN included 2 & 3mm VLBP