e-VLBI monitoring of the ULX X-8 in the Triangulum Galaxy

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ULXs

- Some decades ago:
  ULX = Ultraluminous X-ray sources
- Lx~10^{39} – 10^{41} erg/s => 100 – 10000 Msol for isotropic radiation !
- IMBH or high mass X-ray binaries?
- Many ULXs sources were found in the centers of galaxies => AGNs?
  CHANDRA => off-center ULXs !
- Do they radiate at the Eddington Limit?

Introduction to M33 X-8

- M33 is at 795 kpc (van den Bergh 1991)
- Lx ~ 1.2^{39} erg/s
- With 0.6” resolution M33 X-8 coincides with the M33 center (Dubus & Rutledge 2002) and unresolved at 0.4” resolution (Dubus et al 2004)
- There are also VLA and 2MASS observations but not sure it is the same source.
- X-8 is very close to the center of M33.
- If M33 X-8 is a single object then it could be an ULX (Dubus et al 2004)
- X-rays suggest M33 X-8 acreting at super-Eddington rates

Detect radio emission of M33 X-8

- We are interested in milliarcsec scales emission => VLA no EVN ok
- We expect a faint target => Very good sensitivity is needed => we need many hours on source and also the Arecibo telescope.
- Several epochs => look for variability

How?

- 5 epochs (including Arecibo) requested
- Arecibo's visibility implies short times => use several observing blocks
- Combine all data and get the lowest rms possible
- Goal sensitivity to achieve = 5 μJy/beam

We want Non-long term scheduled observations => Use e-VLBI

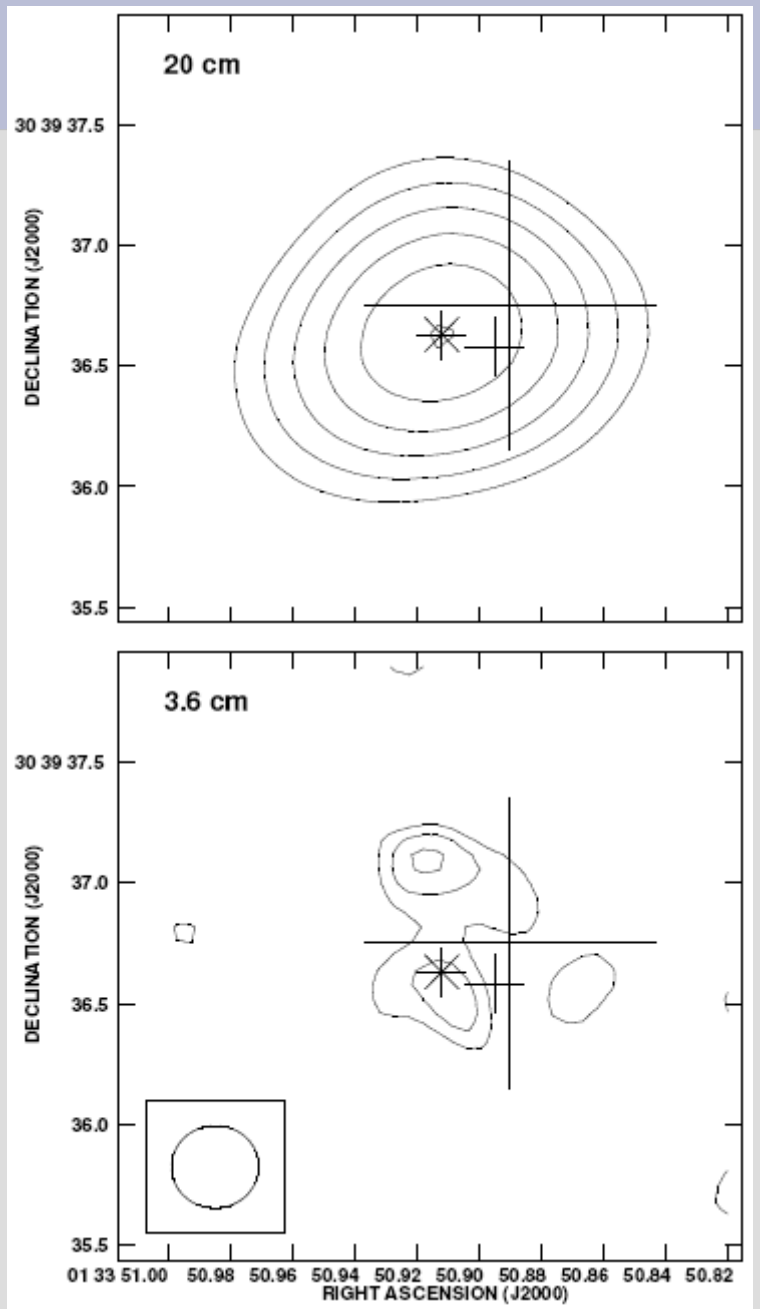
What for?

- Model for ULX: IMBH, X-ray binary, above Eddington?, beamed radiation?
- Getting flux or upper limit => Constraint the mass of the source

- Black hole mass – X-ray and radio luminosities: empirical formula of the fundamental black hole plane activity.

M33: VLA detection

(Trejo & Rodriguez 2004)



Radio counterpart with VLA: 1.4 and 4.8 GHz

rms = 21, 8 μJy

θ ~ 1.5" and 0.4"

flux ~ 0.2 and 0.1 mJy

Is X-8 the AGN in M33?

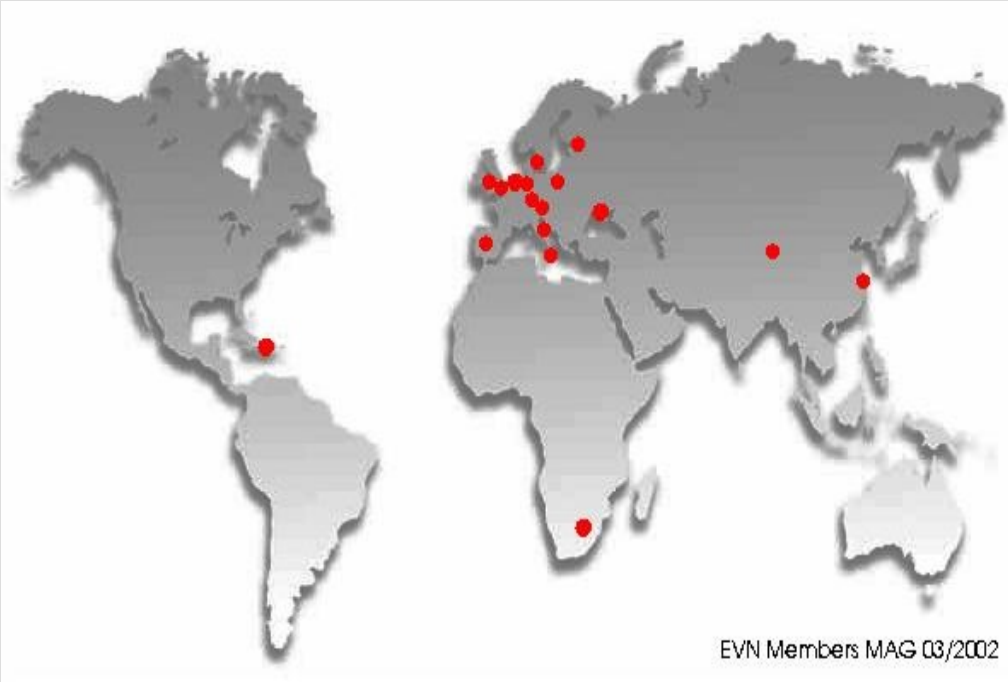
We should detect either of the two sources with the EVN+Arecibo

What we got

- 2 epochs granted
- Get an upper limit for the flux => set an upper limit for the mass

- 1st epoch is bad: Effelsberg and Lovell telescope missing!!
- 2nd epoch is good :)

e-EVN 1st epoch



- 10 Feb 2009
- Ar Mc On Tr Wb Cm Jb Ef
- 512 Mbps
- 8 IFs, 16 channels
- ~ 5.7 hours total ~ 2.8 on target

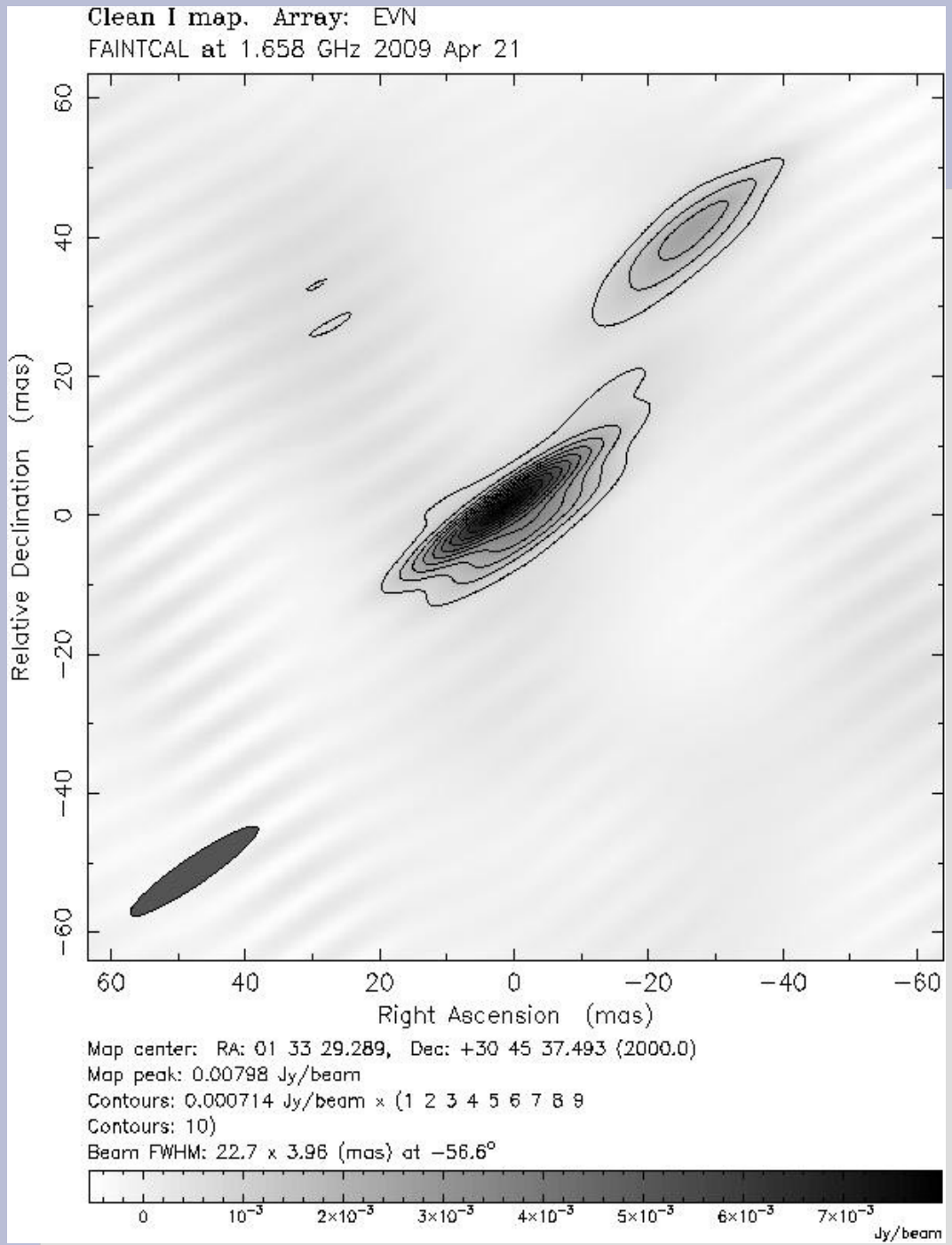
e-EVN 2nd epoch

- 21-22 April 2009
- Ar Mc On Tr Wb Cm Jb Ef Da
- 512 Mbps
- 8 IFs, 16 channels
- ~ 8 hours total ~ 3.5 on target

Steps in aips and difmap

- FITLD loading...
- ANTAB amplitud calibration
- FRING rates and delays corrections (J0137+3122 and 3C84)
- SPLIT calibrated files
- DIFMAP Imaging and self-calibration of secondary phase cal.
- CALIB Apply self-calibration if possible
- DIFMAP re-imaging => detection or upper limit

Secondary phase calibrator



J0137+3122
main phase calibrator

Secuence of observations:

J0137+3122	~ 1 min
Secondary cal.	~ 1 min
M33 X-8	~ 3 min
J0137+3122	
...	

<- secondary calibrator

Resolved with natural weighting

Upper limits

1st epoch

- 2.8 hr on source => rms ~ 24 μJy

2nd epoch

- 3.5 hr on source => rms ~ 13 μJy

Both of them with natural weighting

Final remarks

- Measured velocity dispersion (Gebhardt et al 1991) => 1500 Msun upper limit.
- Fundamental plane relation:
  logLr = 0.6 logLx + 0.78 logM + 7.33
  this relation was obtained for 5GHz obsevations
- This is an ongoing project.
- We still have to observe again the target.

Thank You !