Multifrequency Kinematic Study of the Blazar 0716+714 During the Active State in 2004:

The inner jet structure and kinematics

Elizaveta Rastorgueva[1]

Kaj Wiik[1], Tuomas Savolainen[2]

[1]Tuorla Observatory, Turku, Finland

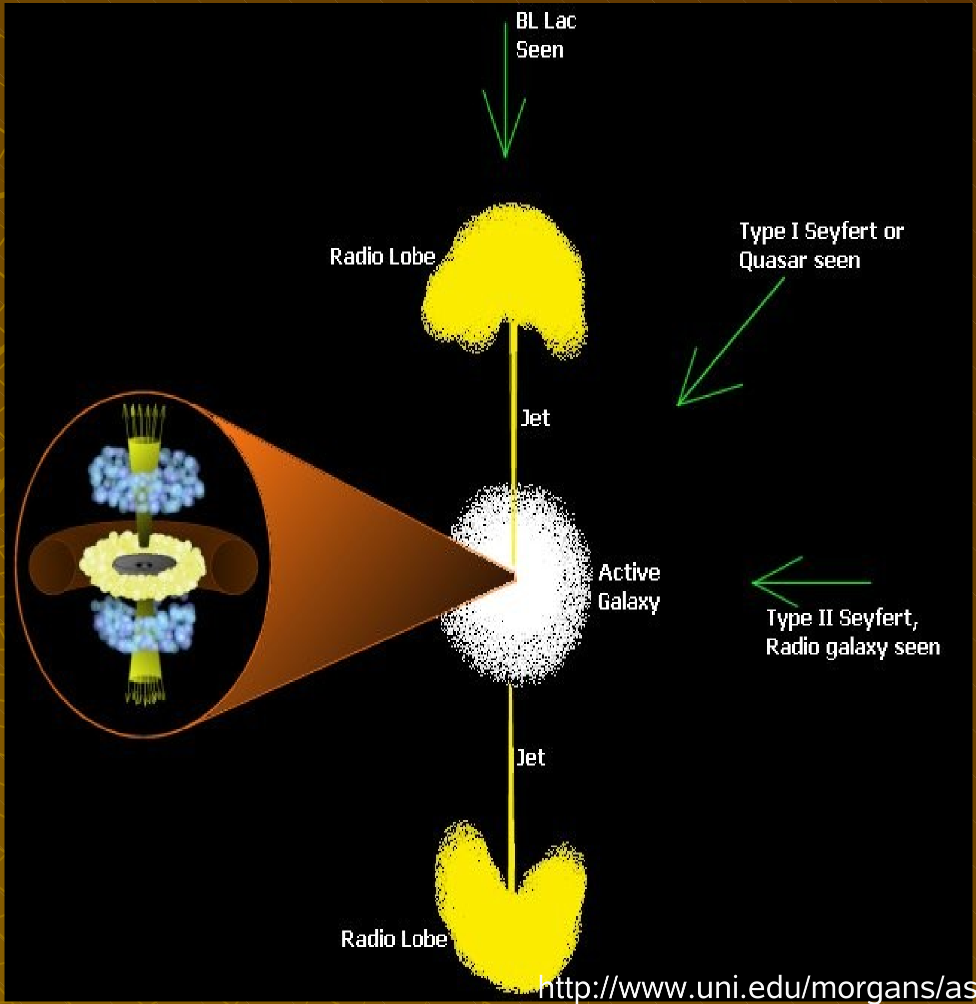
[2]MPIfR, Bonn, Germany

0716+714 in historical overview

Is a BLAZAR

(What does it mean?)

- AGN
- No spectral lines
- Strongly variable
- One-sided jet



http://www.uni.edu/morgans/astro

0716+714 in historical overview

- **Extremely variable** at different timescales
- **IDV**: correlated in optical and radio bands (Quirrenbach et al. 1991 and Wagner et al. 1996)
- **Redshift** is **unknown**: z>0.1; 0.3; 0.52
- **Radio** flare: **Nov 2003** and major **optical** outburst: **May 2004.** International observing campaign (Ostorero et al. 2006)
- **Controversial** description of VLBI kinematics in the literature

0716+714 in historical overview

Model#1: **fast superluminal** onward **motion** of components: $_{app}$~**5-21c**

(Jorstadt et al. 2001, Bach et al. 2005)

Model#2: **oscillation of components** around the mean position on the timescale of ~10 years with the projected velocities of $_{app}$~**5-10c** (Britzen et al. 2006)

0716+714 in historical overview

Model#1: **fast superluminal** onward **motion** of components: $_{app}$~**5-21c**

(Jorstadt et al. 2001, Bach et al. 2005)

Model#2: **oscillation of components** around the mean position on the timescale of ~10 years with the transverse velocities of $_{app}$~**5-10c** (Britzen et al. 2006)

Multi-frequency experiment

- **VLBA**
- **Aim:** to **resolve** the **inner jet** → observations on the **high frequencies**: **86, 43** and **22 GHz.**
- **Aim: monitor** jet **components**

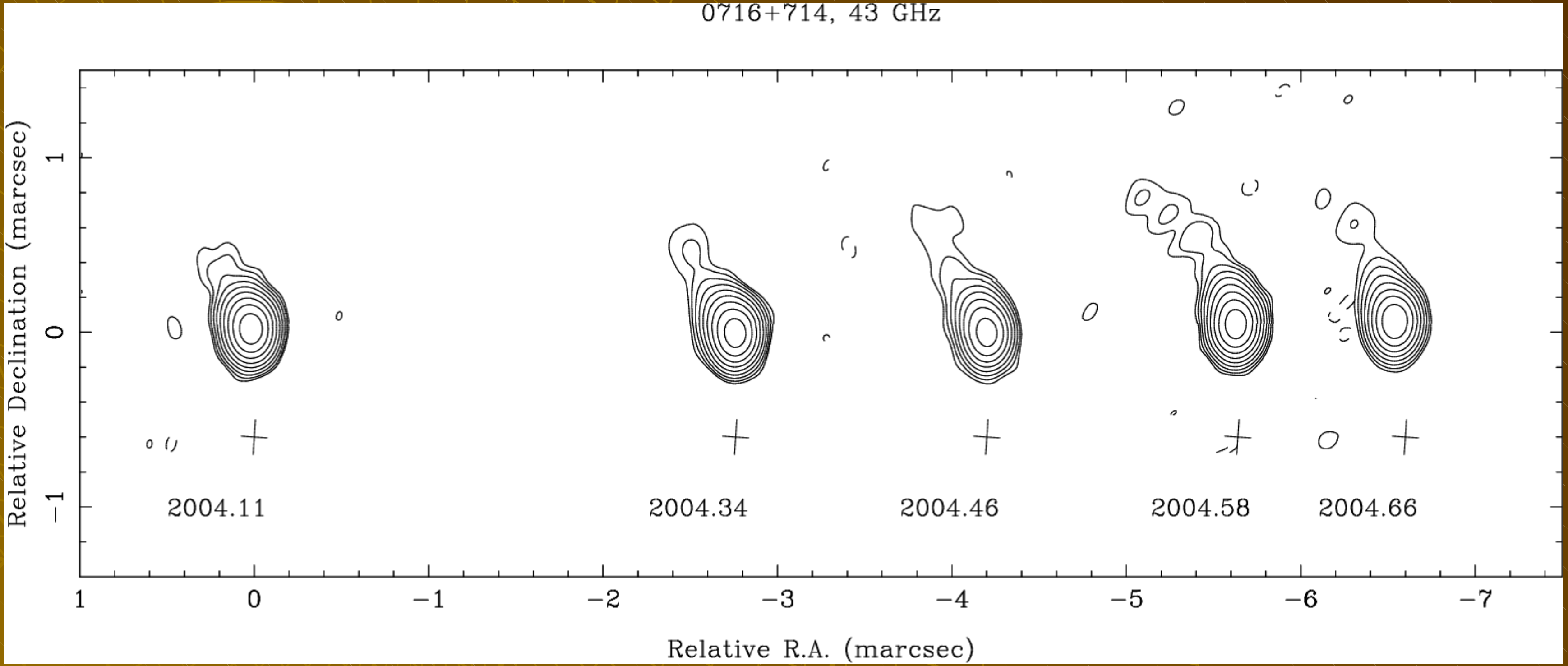
→**5 epochs** separated by ~**month: 10 Feb, 3 May, 18 Jun, 29 Jul** and **29 Aug 2004**

Multi-frequency experiment

- **VLBA**
- **Aim:** to **resolve** the **inner jet** → observations on the **high frequencies**: **86**, **43** and **22** **GHz.**
- **Aim: monitor jet components**

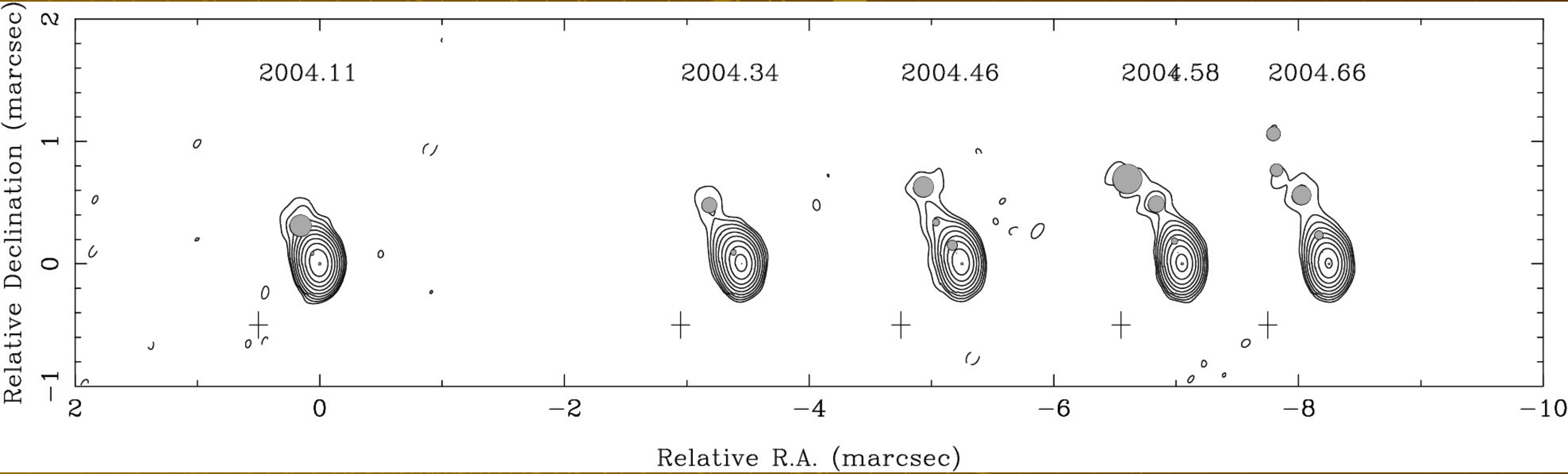
  →**5 epochs** separated by ~**month: 10 Feb, 3 May, 18 Jun, 29 Jul** and **29 Aug 2004**

Map of 0716+714 at 43GHz (7mm)

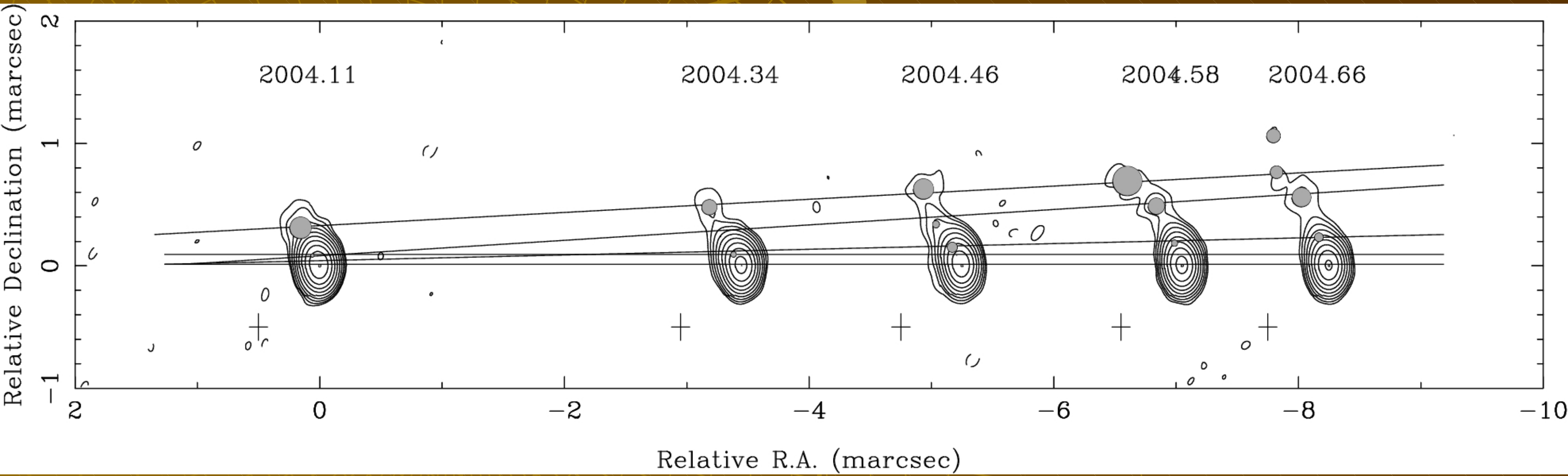


Smooth flux distribution along the jet.

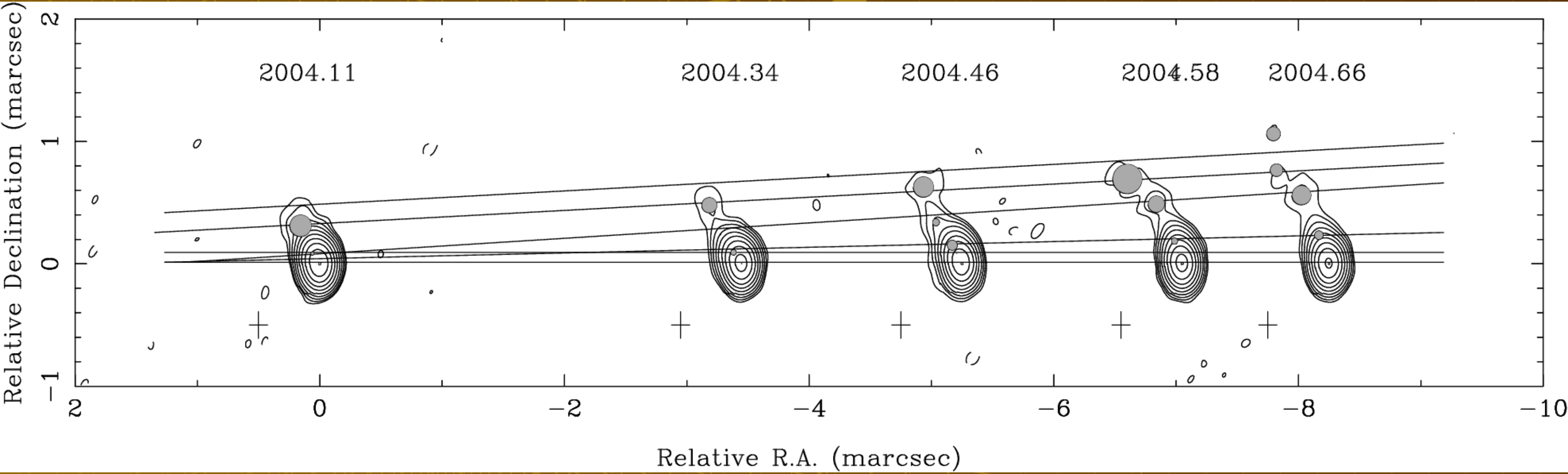
Map of 0716+714 at 43GHz (7mm)



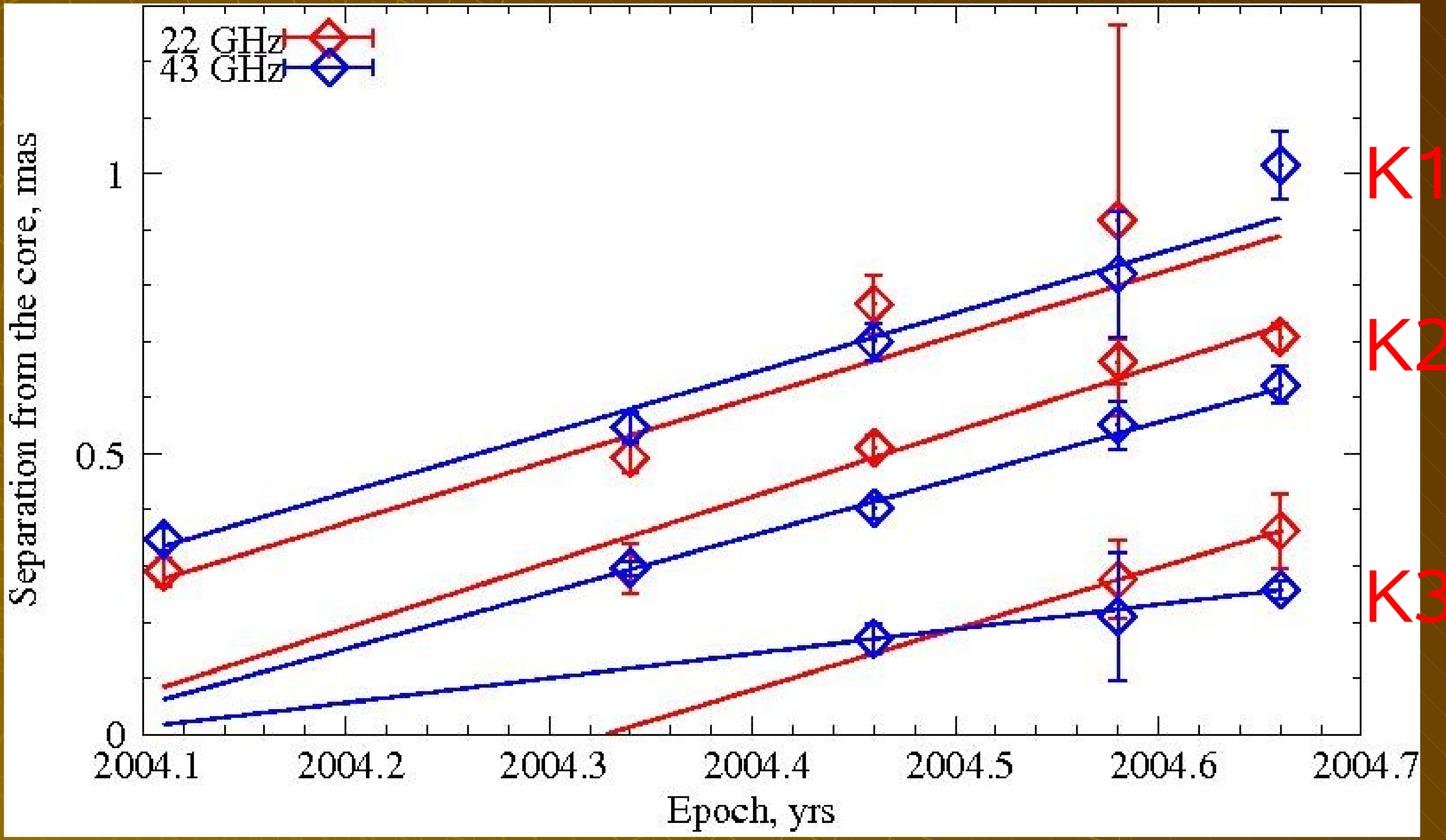
Map of 0716+714 at 43GHz (7mm)



Map of 0716+714 at 43GHz (7mm)

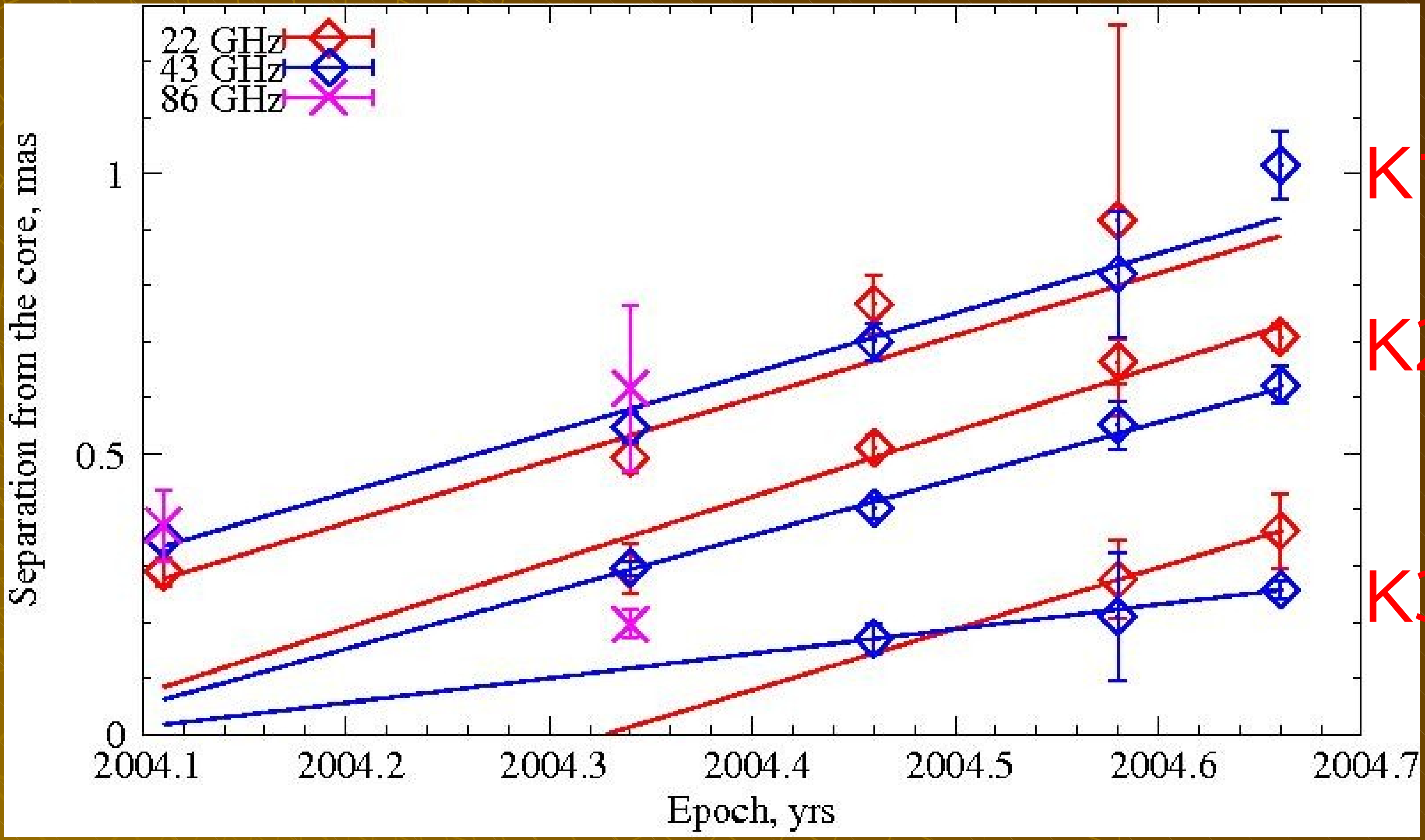


Fit to the 43 and 22 GHz data



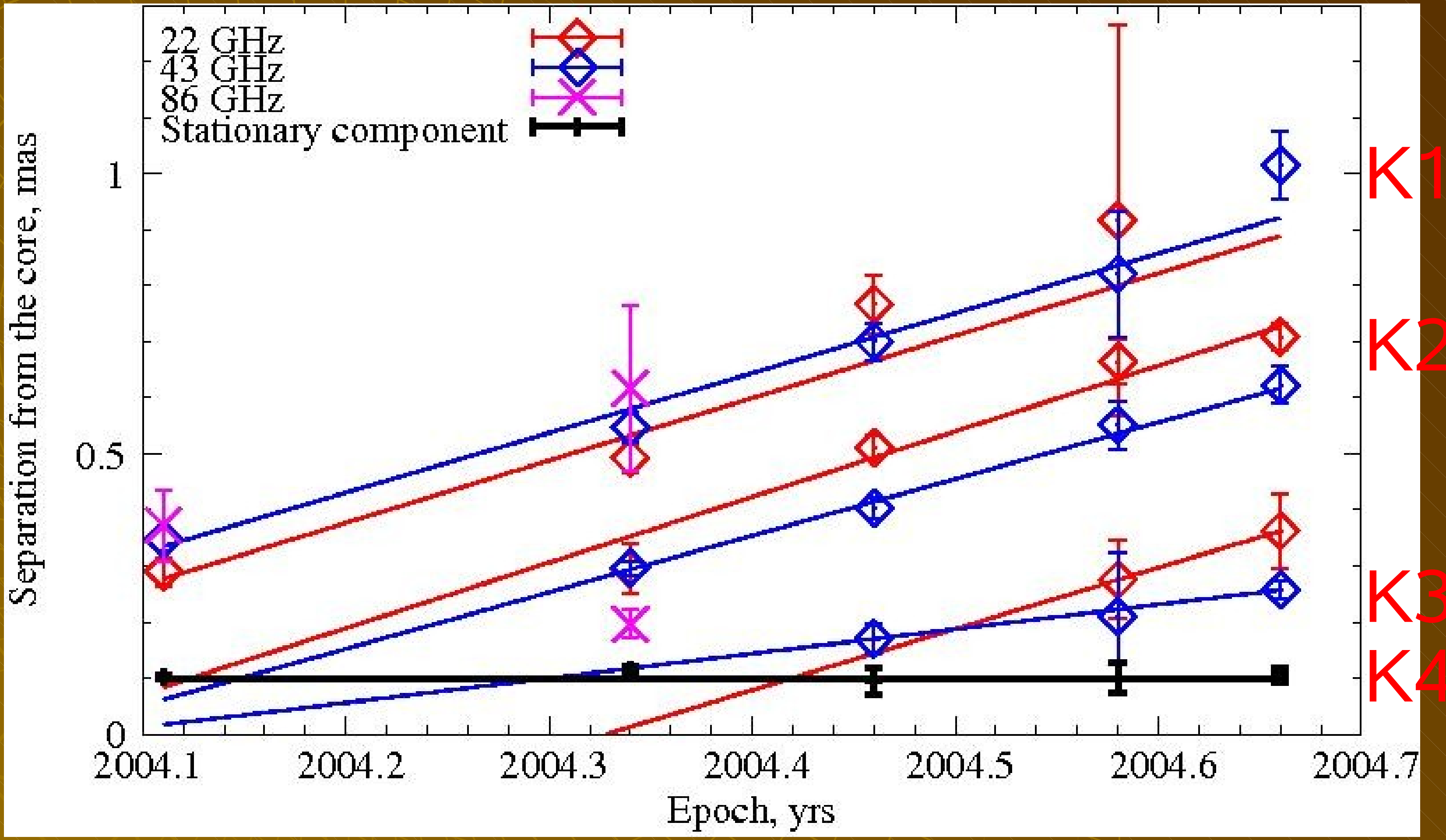
Fit performed using travelled distance!

Fit to the 43 and 22 GHz data



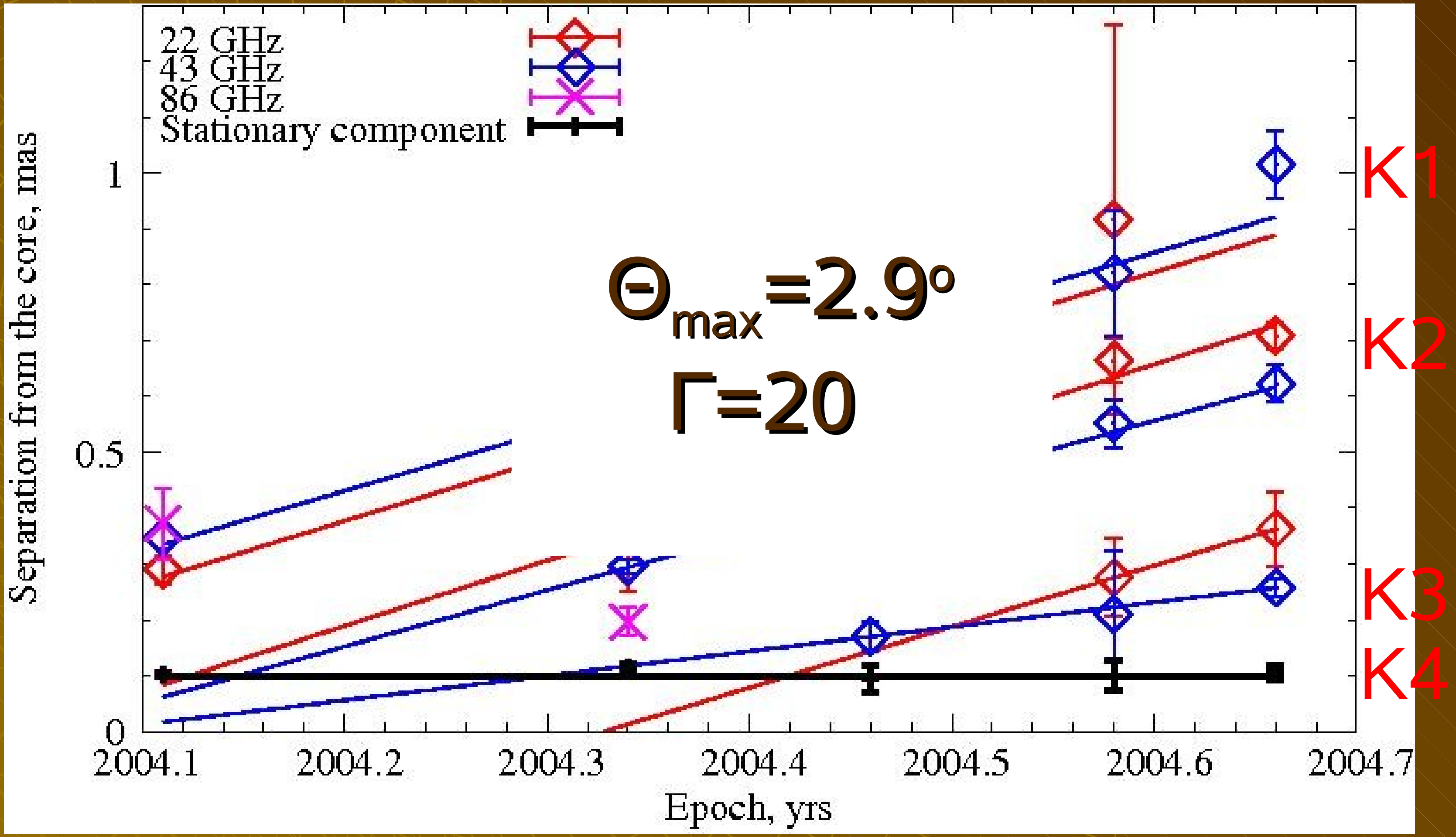
Fit performed using travelled distance!

Fit to the 43 and 22 GHz data



Fit performed using travelled distance!

Fit to the 43 and 22 GHz data



Fit performed using travelled distance!

Fit to the 43 and 22 GHz data

Comp. name	, mas/yr	app		
		Z=0.1	Z=0.3	Z=0.52
K1	1.07±0.10	7.0±0.6	20.0±1.9	32.7±3.0
K2	1.01± 0.05	6.6±0.3	18.9±0.9	30.8±1.5
K3	0.43± 0.03	2.8±0.2	9.1±0.6	13.2±0.9

Fit to the 43 and 22 GHz data: **superluminal speeds**

Comp. name	, mas/yr	app		
		Z=0.1	Z=0.3	Z=0.52
K1	1.1	7.0	20	33
K2	1.0	6.6	19	31
K3	0.4	2.8	9	13

Fit to the 43 and 22 GHz data: **superluminal speeds**

		app		
				0.52
K2	1.0			
K3	0.4	2.8	9	

The source has fast superluminal motions and need to be observed more frequently with VLBI!

Trajectories of the individual components in the inner jet: **helical motion**.

Kelvin–Helmholtz instability

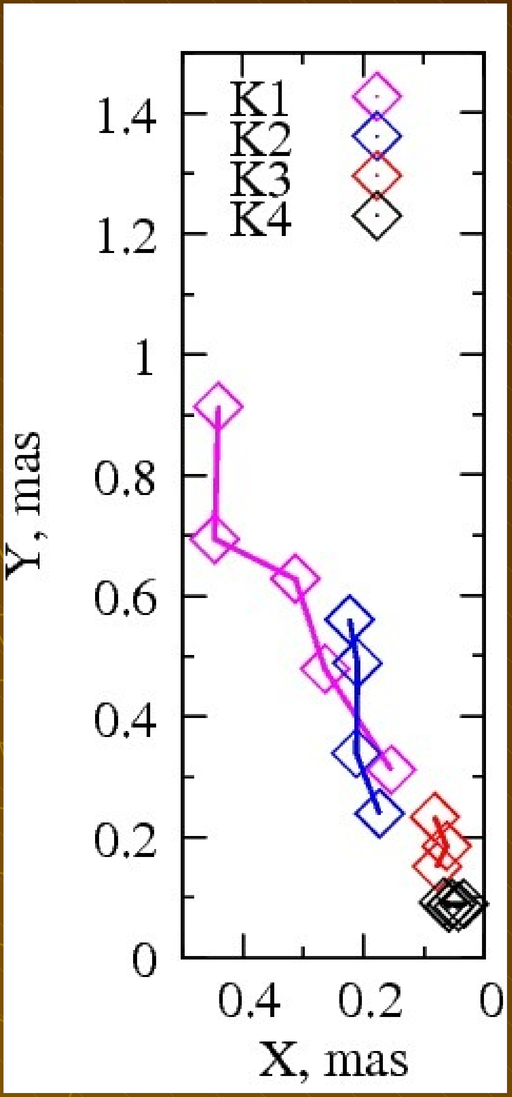
(Lobanov, Hardee & Eilek 2005; M87)

Two-fluid jet model

(Fraix-Burnet & Despringre 1996)

Helical jet model

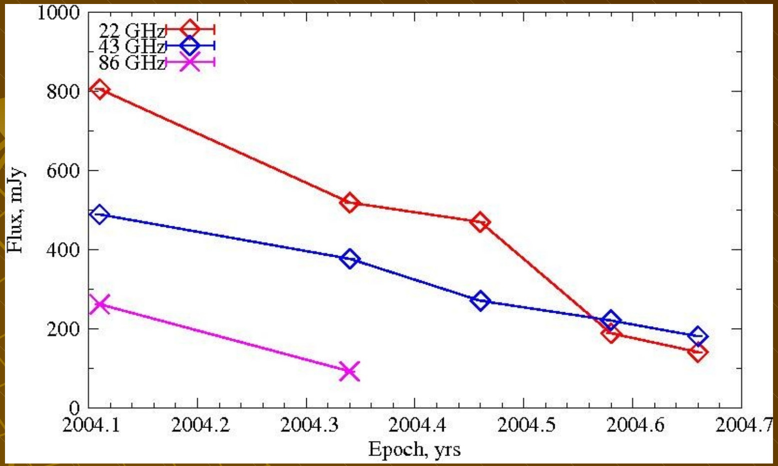
(Villata & Raiteri 1999)

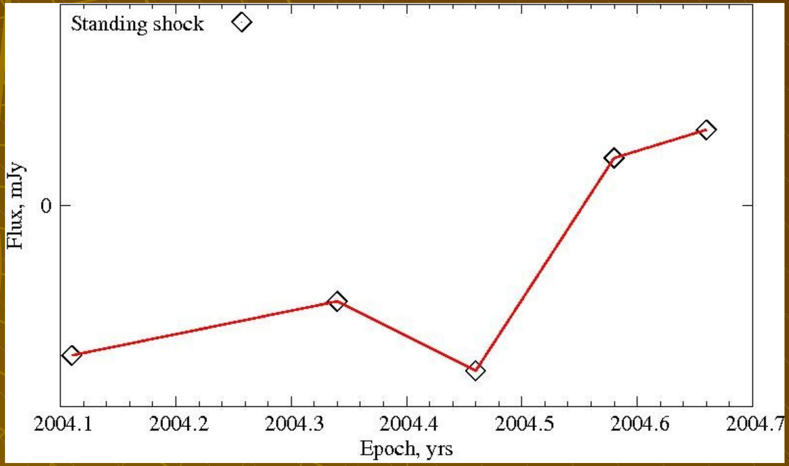


Changes of the of the **standing shock spectral index** with time: optically thin → optically thick.

At 3 first epochs standing shock as optically thin, on the last two – optically thick

Domination of the core emission over emission from component





Plans for the near future

- Lower frequencies (5 and 1.6 GHz)
- Component spectra
- Polarization

Plans for the near future

- Lower frequencies (5 and 1.6 GHz)
- Component spectra
- Polarization

Thank you for your attention!