2004年 11月 9日 VERA User Meeting [NAOJ/Mitaka]

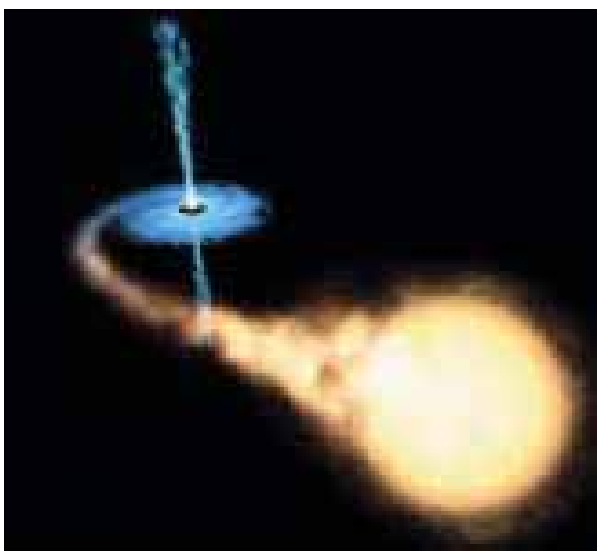
Rapid Variability in Microquasar Cyg X-3 with Water Maser W75N as a Calibrator [2]:

Search for Variabilities in BL Lac and Black Hole Microquasar Cyg X-3 (中間報告)

(2004年 5月 23日 15:15:00-24:50:00UT 観測)

Soon-Wook Kim [金 淳郁]

(Chungnam National Univ.)



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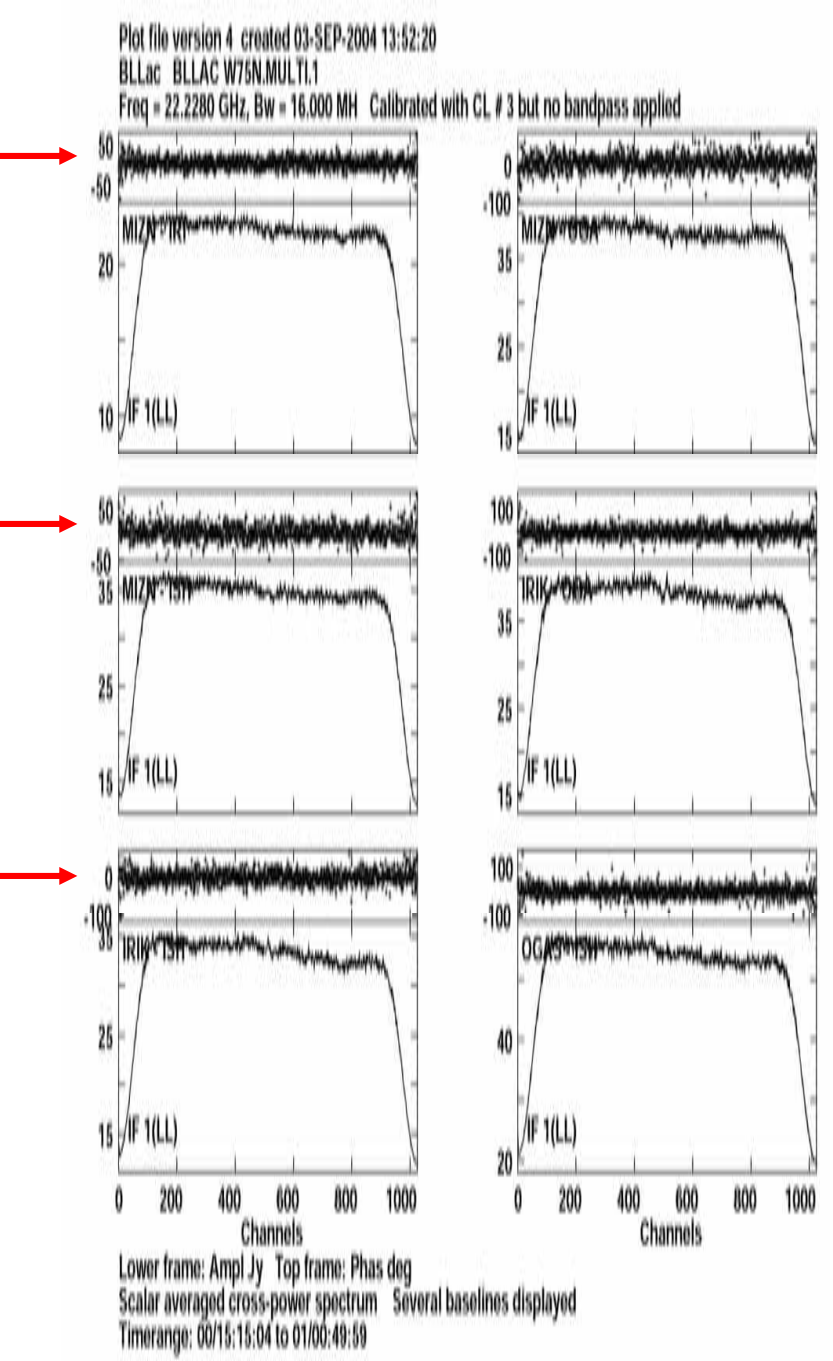
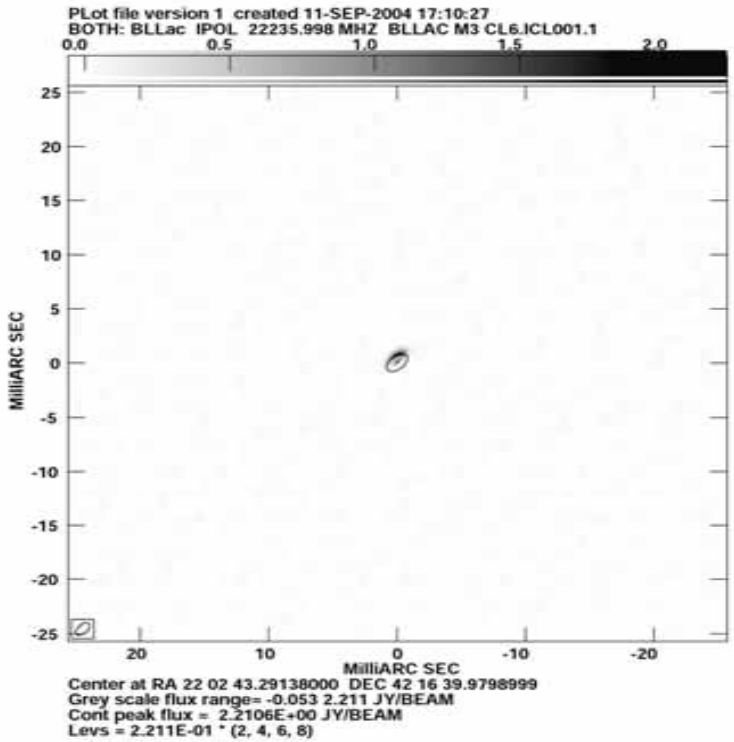
Honma Mareki (NAOJ),
Kurayama Tomoharu (NAOJ),

Sasao Tetsuo (Aju Univ. & KAO),
Jeong-Sook Kim [金 貞淑]
(Kyunghee Univ. & KAO)

[1] BL Lac: Calibrator



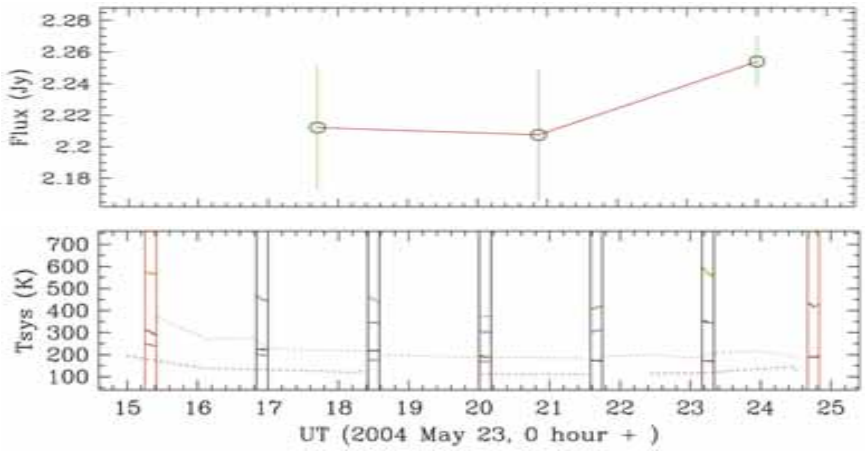


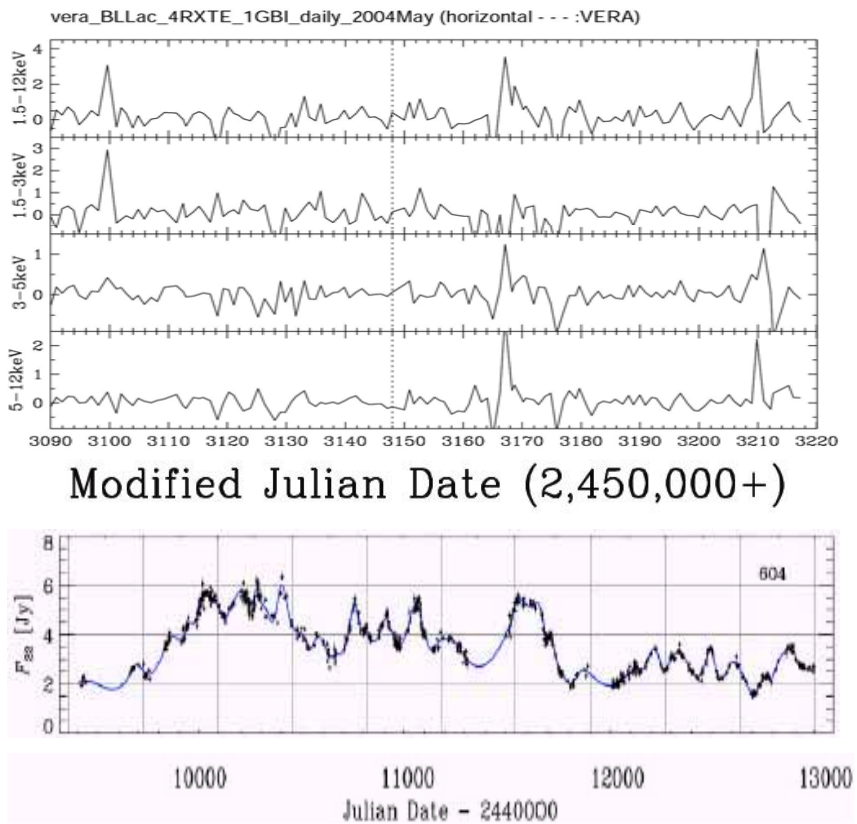
- **(LEFT) calibrated phase & amplitude:**

  Phase is flat and near-zero

  → no structure
- **(ABOVE) BL Lac image appears with no structure (~ 2 mas)**

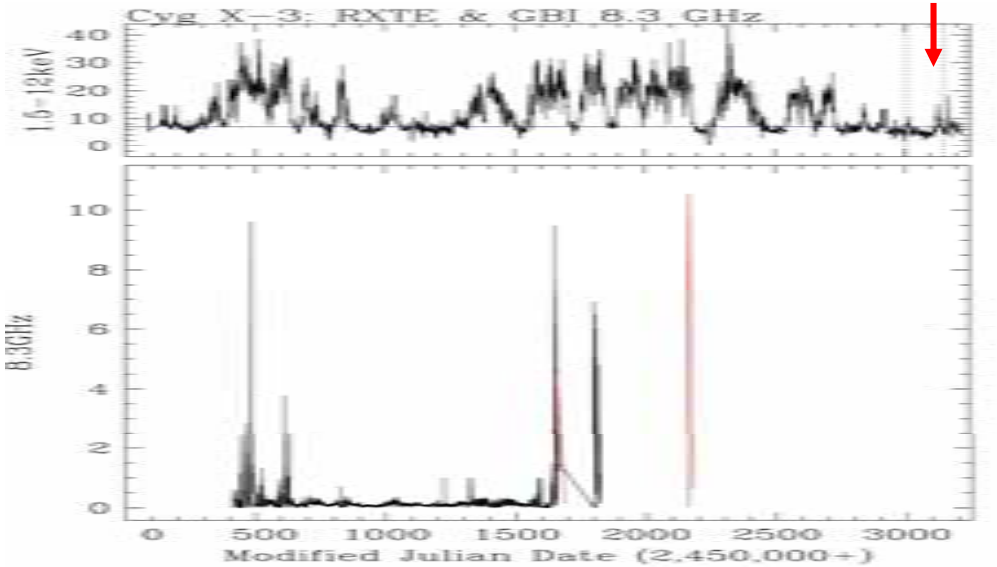
BL Lac





- We measured flux density at each snap-shot, every 10 minute or more, depending on on-/off-center for image to distinguish a real one from side lobes.
- Due to short UV coverage for only 10 min, we only were able to get a sure-level with 20 min or more (I.e., on-center image), which results in >2.2 Jy
- No appreciable variability over a few % detected for our 10 hour observation (so, no IDV), as expected from the flat, near-zero phase.
- At the time of our observation, X-ray in its near-minimum, while previous 22 GHz WEB campaign indicates, our 2.2 Jy is also close to its typical minimum in the radio.

Microquasar Cyg X-3



Long-term X-ray/radio monitorings & giant flares

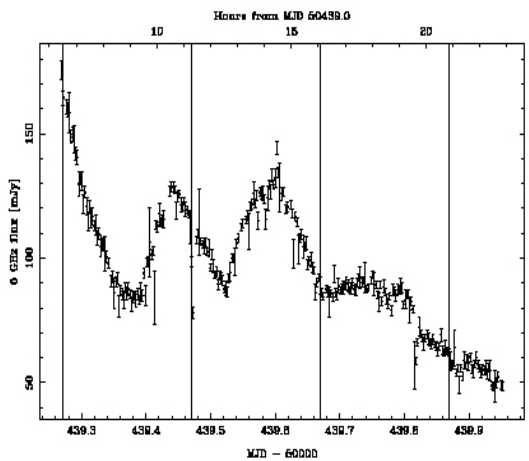


Figure 7. Cyg X-3 photometry on 1996 December 21. Time bins are 4.0 min.

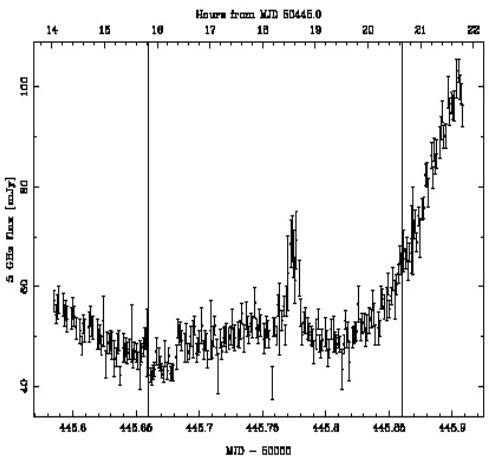
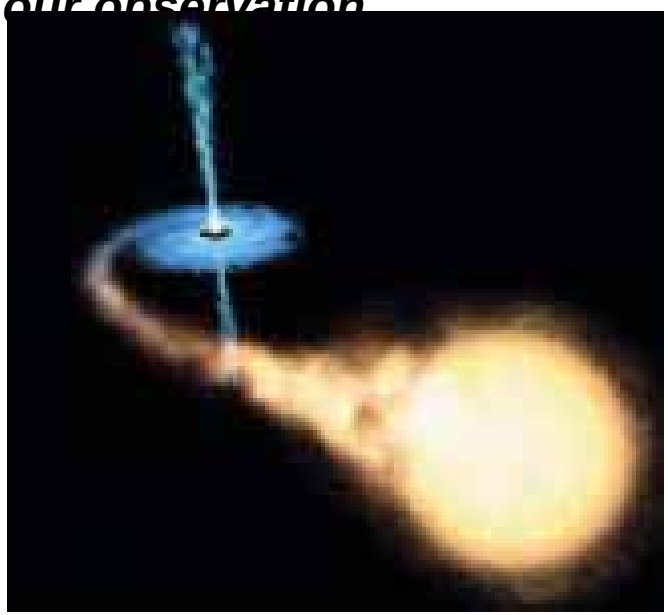


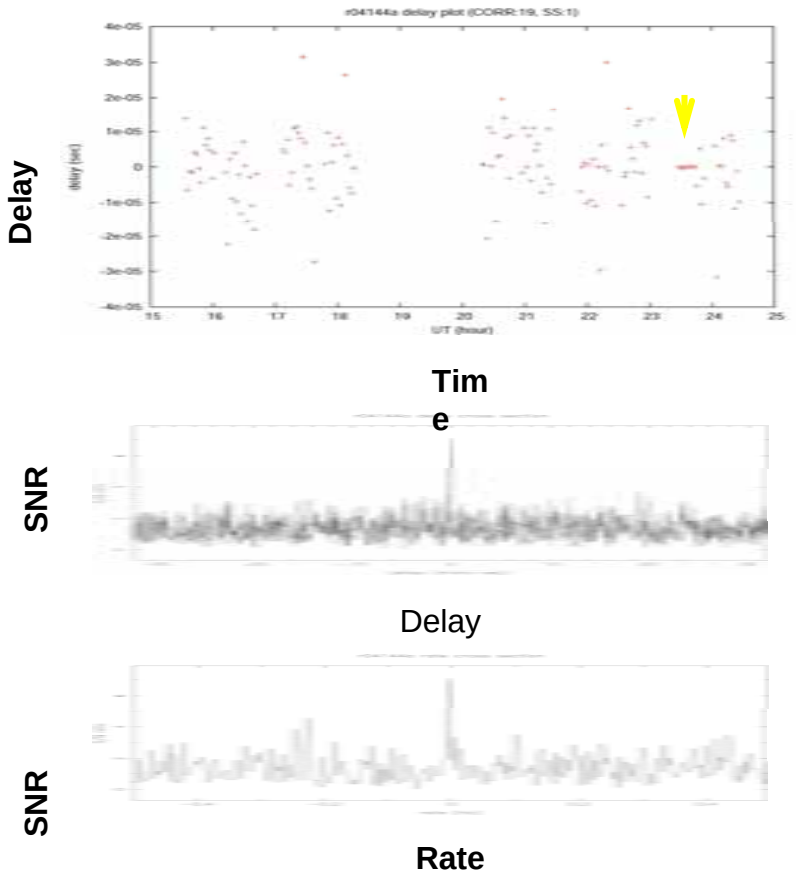
Figure 8. Cyg X-3 photometry on 1996 December 28. Time bins are 2.0 min.

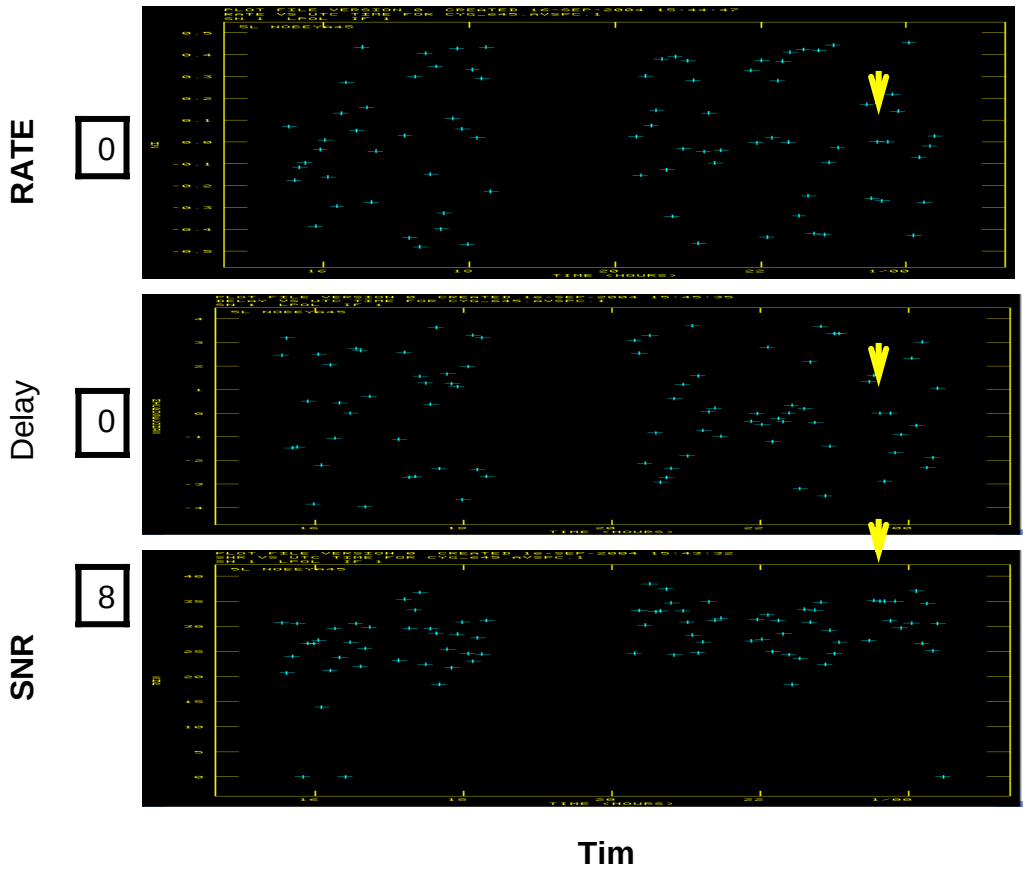
Rapid hour-scale small flares (2-3 hours)

- **Wolf-Rayet-BH Binary Candidate (~7$M_\odot$+~13$M_\odot$) with P_{orb}~4.8hr !**
- **Highly variable Mass Transfer !**
- **Giant flares (10-20 Jy) irregularly recur every ~ a half to a few years: ToO necessary ! [see the next talk]**
- **Numerous, chaotic, rapid small flares (from a few × 10mJy to a few hundred mJy) with hours: *the main goal of our observation***



Cyg X-3: Possible flare(s) at NRO 45m-Kashima 34m

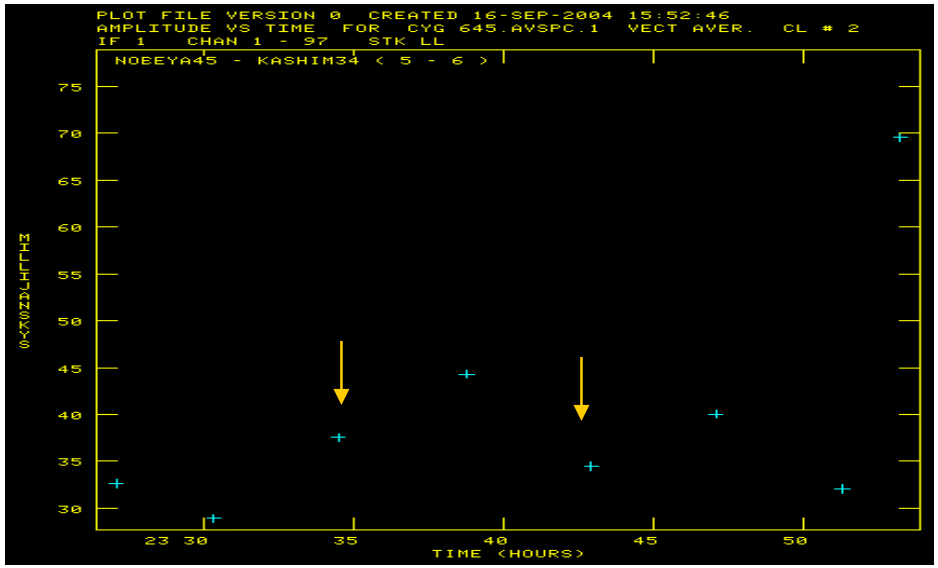




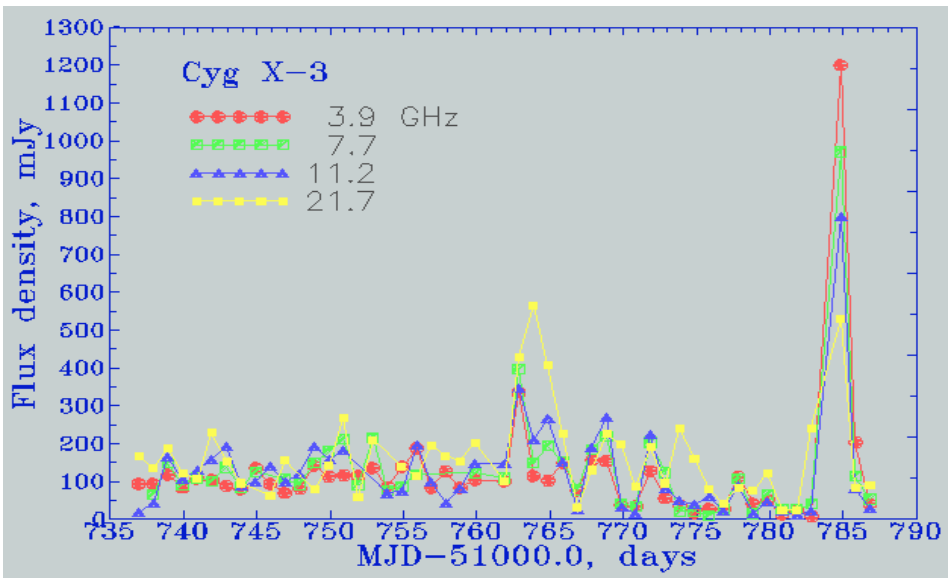
With DIR1000, the only NRO-Kashima baseline detected (a) possible small flare(s), though the Kashima was turned out to be something wrong at the time of our observation. No image for VERA with DIR1000 due to the low flux.

Now the AIPS analysis is on-going with DIR2000 (128 channels × 15 IFs for Cyg X-3) for VERA only.

Flares in Low Flux States of Cyg X-3



NRO 45m-CRL 34m (: zero phase)



RATAN Observations

<u>Brightness Temperature of Flares</u>:

$$T_b = 9.66\times10^{10}\,\frac{\Delta S_{mJy} D_{Kpc}^2}{\nu_{GHz}^2 \Delta t^2}\,K$$

$$\sim 9.9\times10^{9}(\Delta S_{mJy})$$

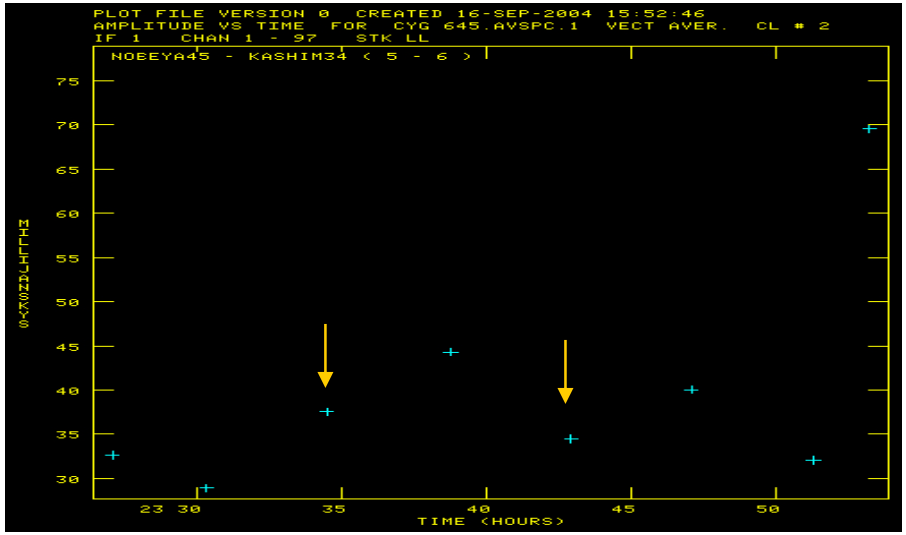
$$\sim (2-3)\times10^{10}\,K$$

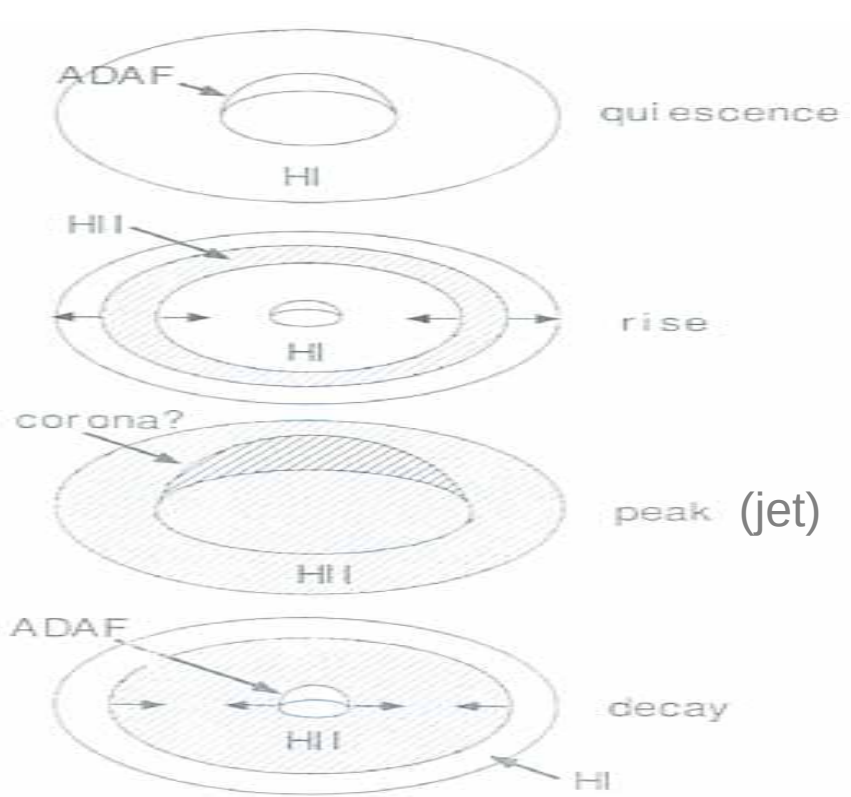
D = 9 kpc, ν ~ 22.228 GHz, $\Delta t \le$ 4min.,

ΔS ~ 20 – 30 mJy (S_{min} = 10 mJy)

[e.g., Radio Astrophysics, 1970, Pacholczyk; Tools of Radio Astronomy, 2000, Rohlfs & Wilson]

This is non-thermal. If Δt goes a few times faster, the flare can exceed the inverse Compton limit (» 10^{11}K) !





Rapid Flares in Microquasars: Optically Thick to Thin Transition, Disk Oscillation & Evaporation

<Inner accretion rate>

$$\left(M_{dot}\right)_{tr} = \left(1.4\times10^{17}\right)\left(\frac{\xi}{\eta}\right)\alpha^2 M_{BH}$$

<transition radius>

$$R_{tr} \sim \left(3\times10^{2}\right)\alpha^4\left(\frac{1.4\times10^{18}}{M_{dot}}\right)^2\left(\frac{M_{BH}}{M_{Sun}}\right)^2$$

i.e.,

10^3 $R_g \le R_{out}$ in quiescence, and a few $R_g \ge 3R_g$ at outburst max.

<viscosity parameter>

$$\alpha \sim \alpha_0\left(\frac{H}{R}\right)^n \propto \left(T_c\right)_{DI}^{n/2}$$

$R_{tr} \rightarrow$ 100 times as $M_{dot} \rightarrow$ 10 times !

END

THANK YOU !