

The background of the slide is a deep space image of the galaxy NGC 5548, also known as the 'Eye' galaxy. It features a bright, glowing central region with a complex, multi-lobed structure, surrounded by a dense, swirling ring of gas and dust. The overall color palette is dominated by bright yellows and oranges in the center, transitioning to cooler blues and purples in the outer regions. The text is overlaid on this image.

# *X-ray narrow line region variability as a geometry probe*

*The case of  
NGC 5548*

**Rob Detmers (SRON), J. Kaastra (SRON),  
I.M.McHardy (Southampton)**

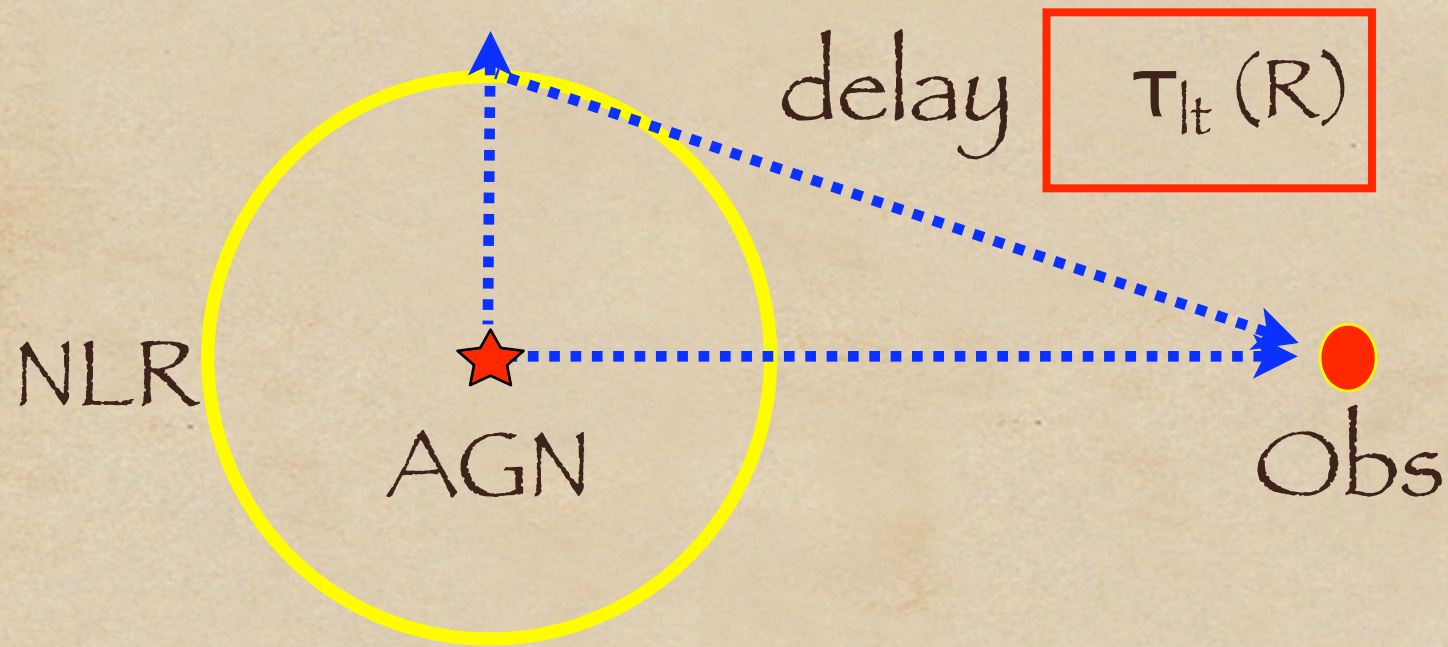


# Variability in AGN

- Variability is best way to learn geometry and physics of inner AGN region (absorption + emission)
- Can reveal location and physics of warm absorber (outflow) --> origin + feedback
- Can also be used to constrain geometry of X-ray NLR in Seyfert 1's

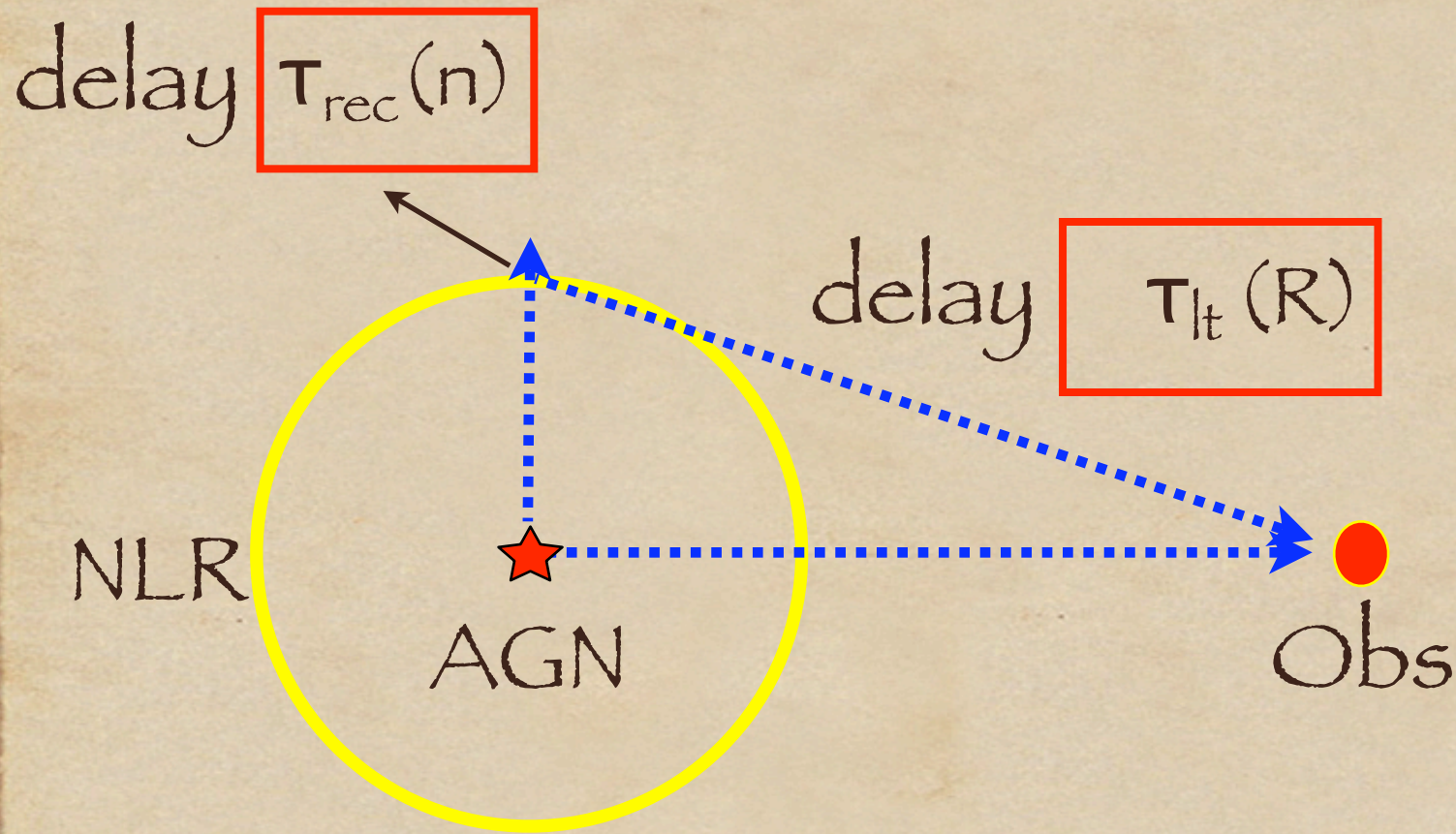


# Variability & Delays



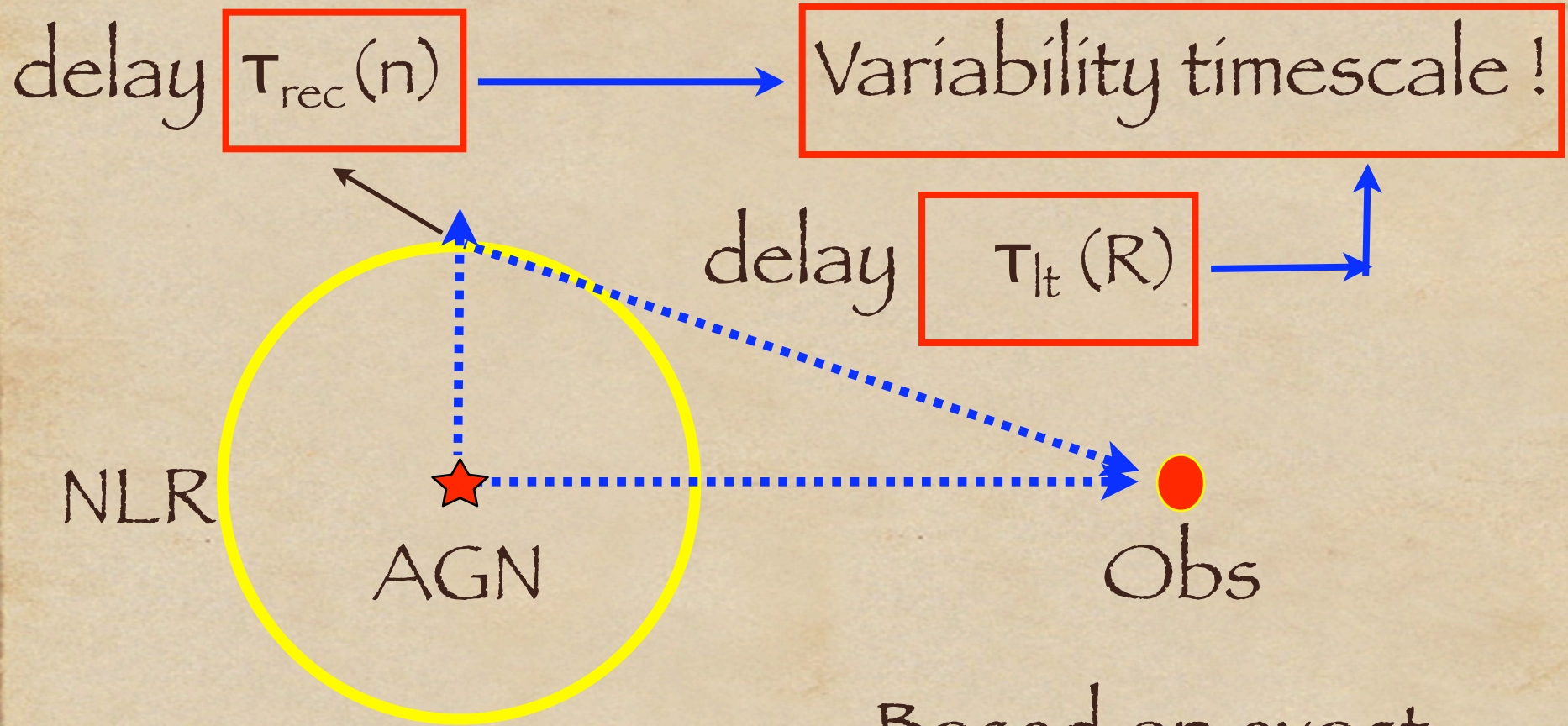


# Variability & Delays





# Variability & Delays



Based on exact  
geometry  $\rightarrow \tau_{\text{var}}(R, n)$



# Why NLR ?

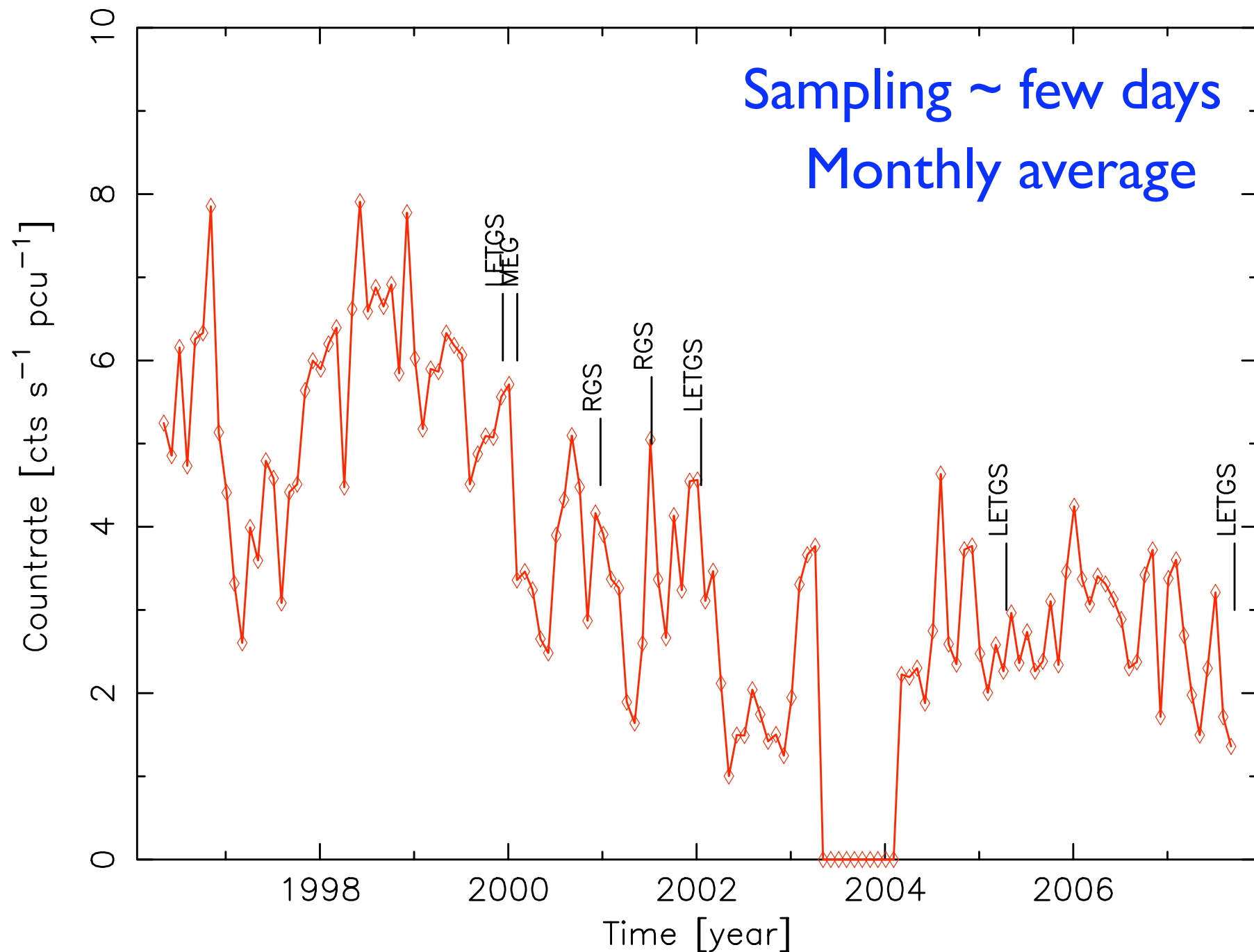
- Possible connection NLR and outflow --> geometry + location NLR can provide clues
- X-ray NLR in Seyfert 1's has not been studied before in systematic way
- Comparison to Seyfert 2 NLR --> same gas / geometry ?



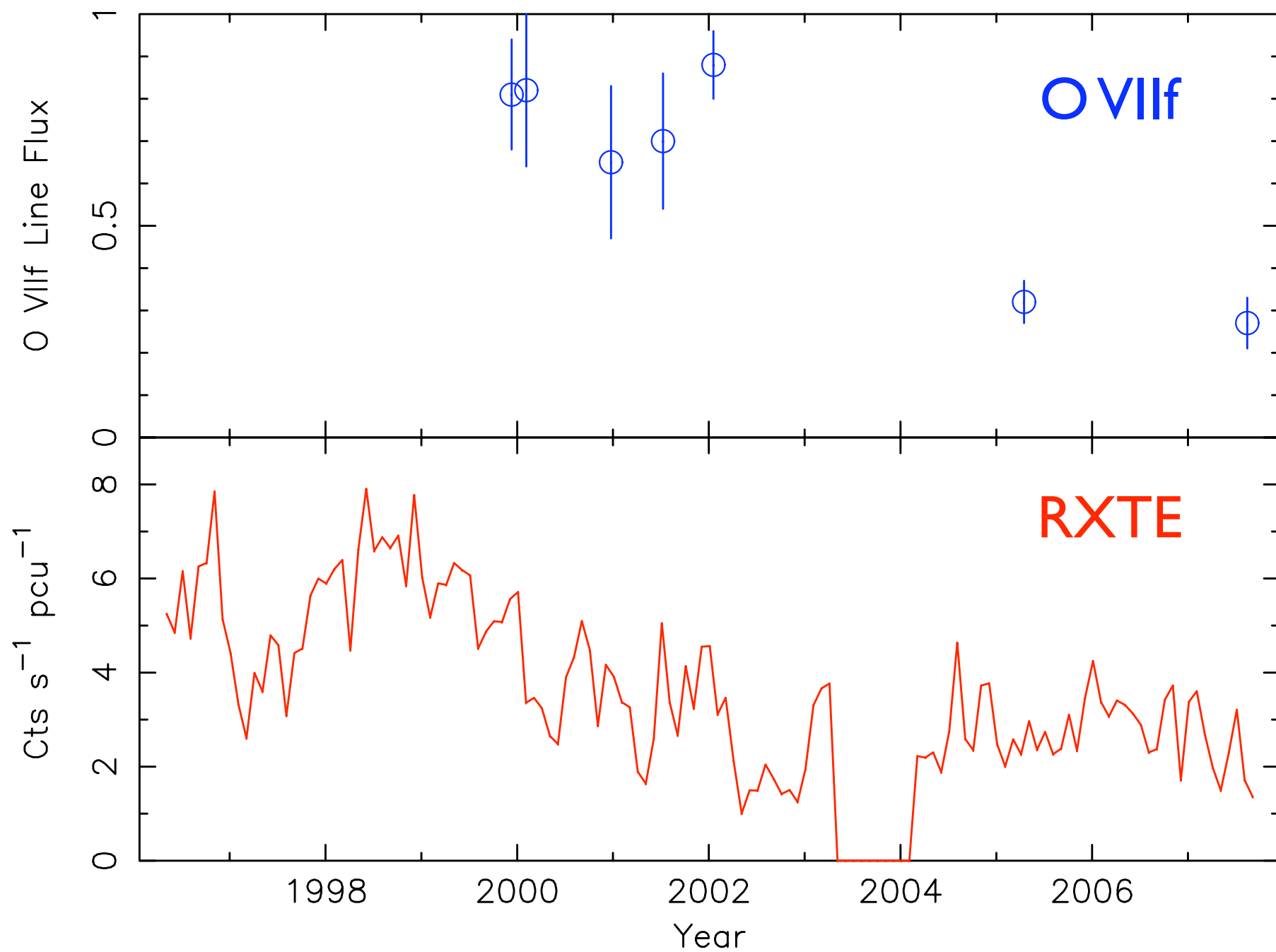
# Why NGC 5548 ?

- Best monitored AGN (Optical campaigns, RXTE)
- Seven high-res X-ray spectroscopic observations spanning 7 years !
- Unique opportunity to study long-term variability in detail and effects on NLR (O VII f emission line)

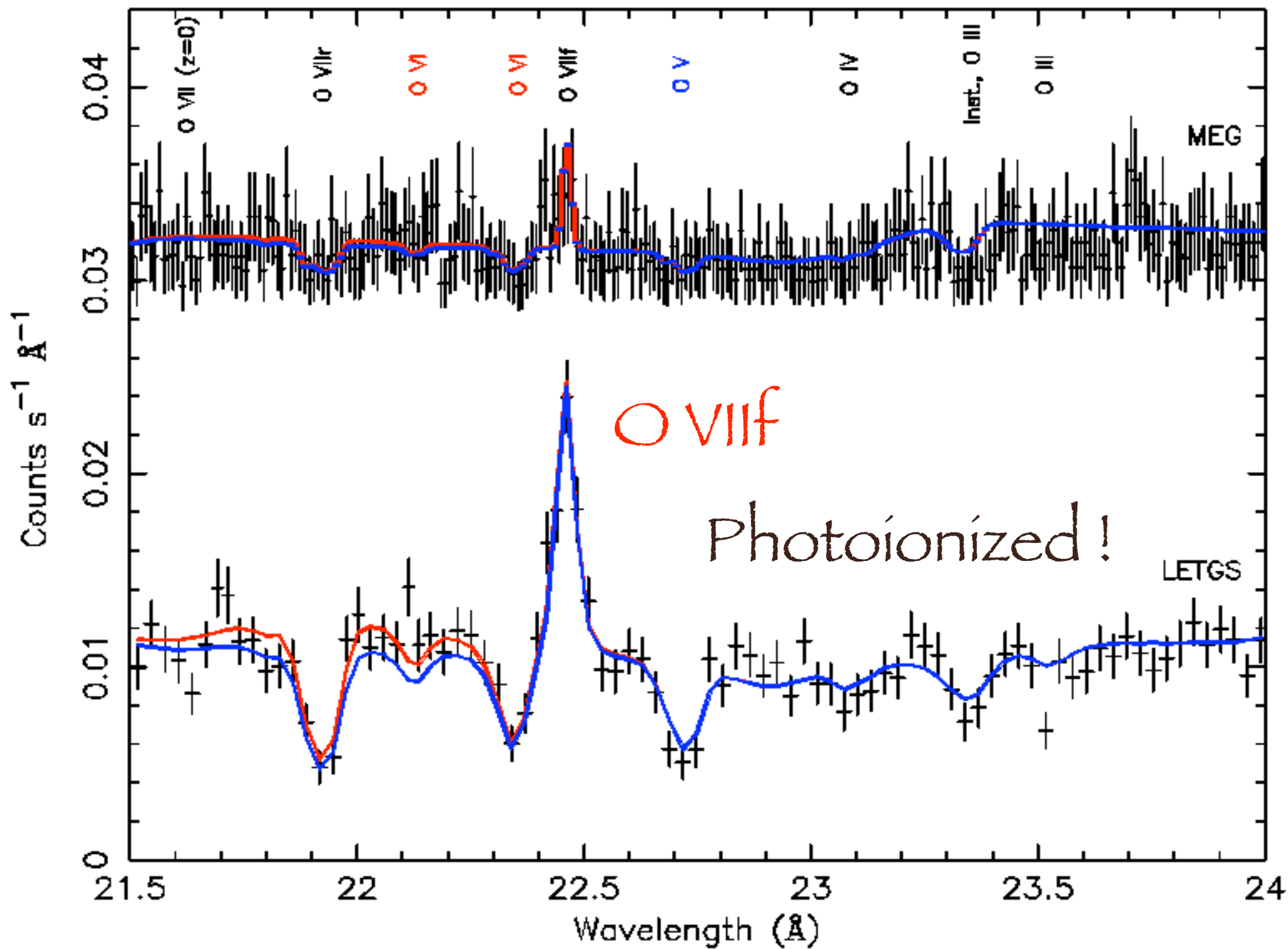
# RXTE Lightcurve 1996 - 2007









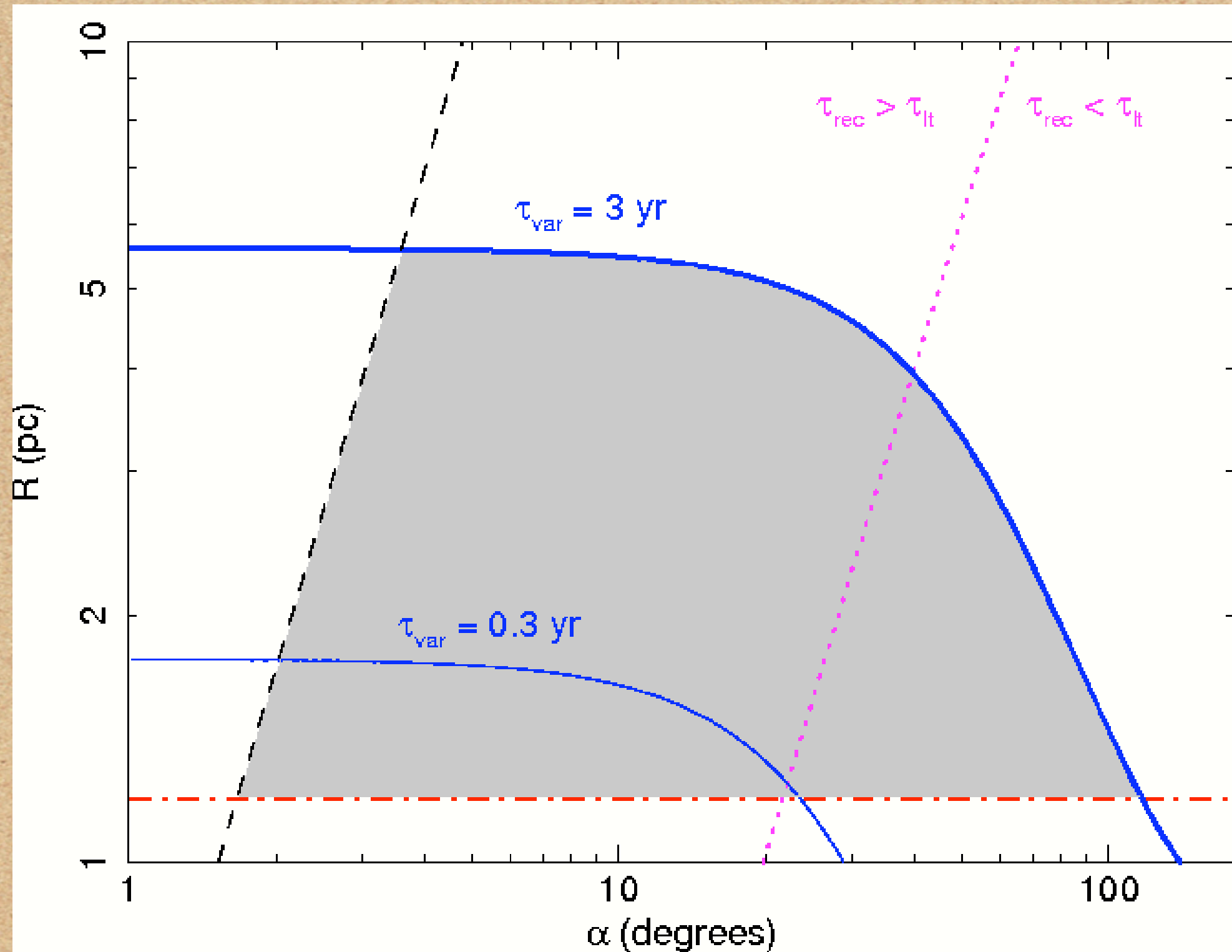




# Geometry I

- Assume ionization cone with opening angle  $\alpha$ .
- $\xi \approx L / n R^2 \rightarrow n$  from  $\tau_{\text{rec}}$
- Upper limit to distance from  $\tau_{\text{var}} \approx \tau_{\text{rec}} + \tau_{\text{lt}}$
- Lower limit from  $V_{\text{fwhm}}$  of line
- Limit on  $\alpha$  from EM of gas ( $\epsilon < 1$ )







# Remaining questions

- Seyfert 1 just high density part of the base of the Sey 2 ionization cone ?
- Are we seeing the inner wall of the torus ?
- Connection to high  $\xi$  optical forbidden lines ?
- Can detailed photoionization models put the pieces together ?



# Conclusions

- Variability --> constrains X-ray NLR geometry
- Continuous monitoring + regular high-res spectroscopy observations crucial, need to know history of source !
- Extend to other sources as well (NGC 3516, NGC 4151, Mrk 509 ) + photoionization modeling