

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

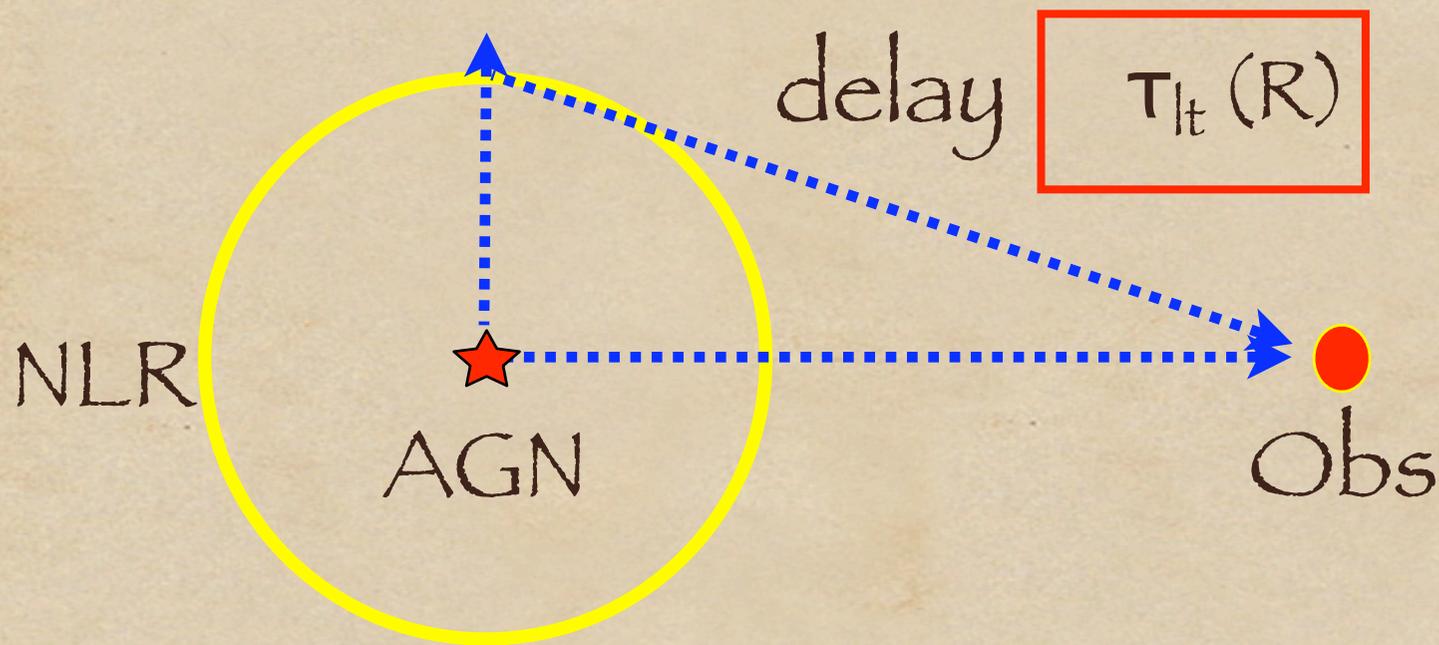
*The case of
NGC 5548*

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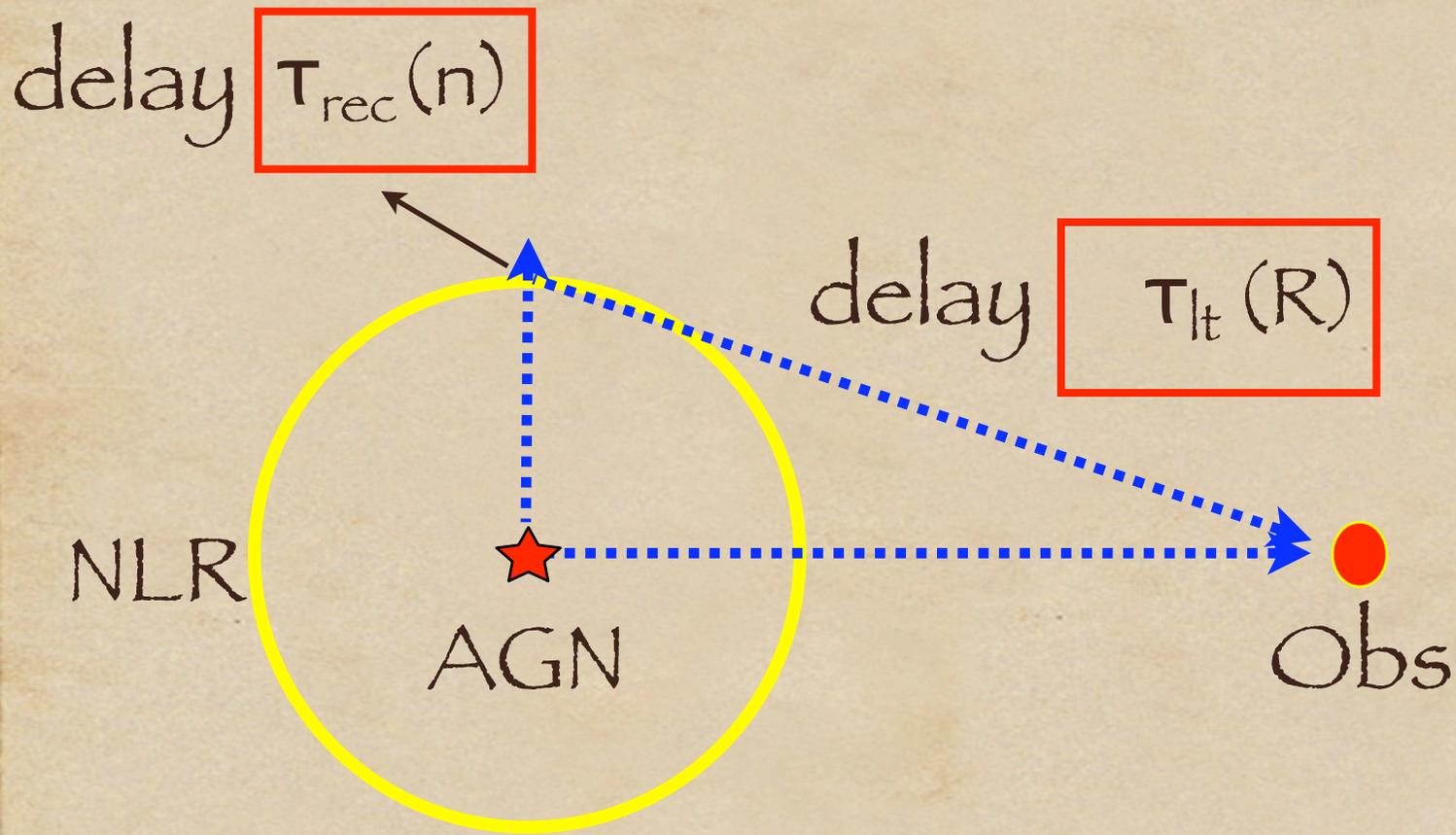
Variability in AGN

- 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

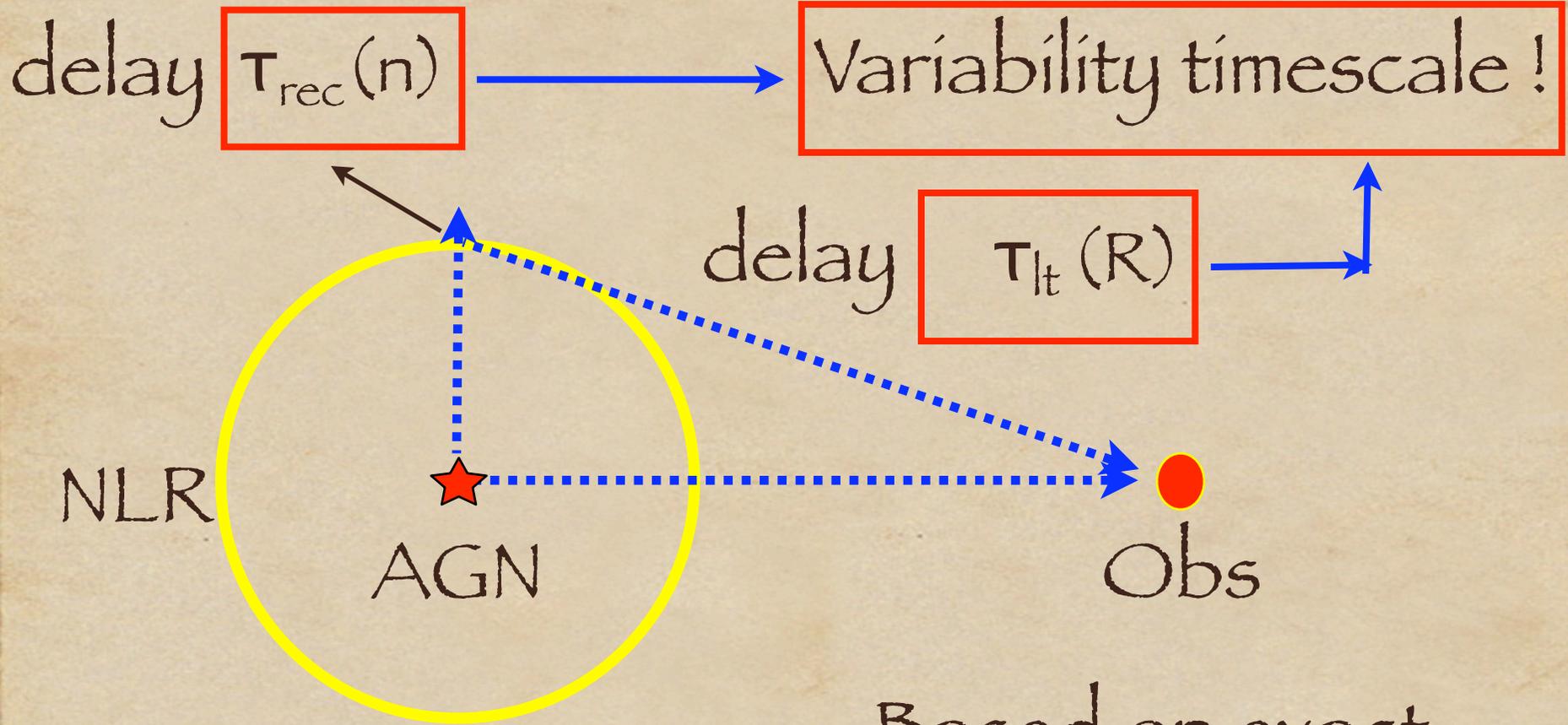
Variability & Delays



Variability & Delays



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

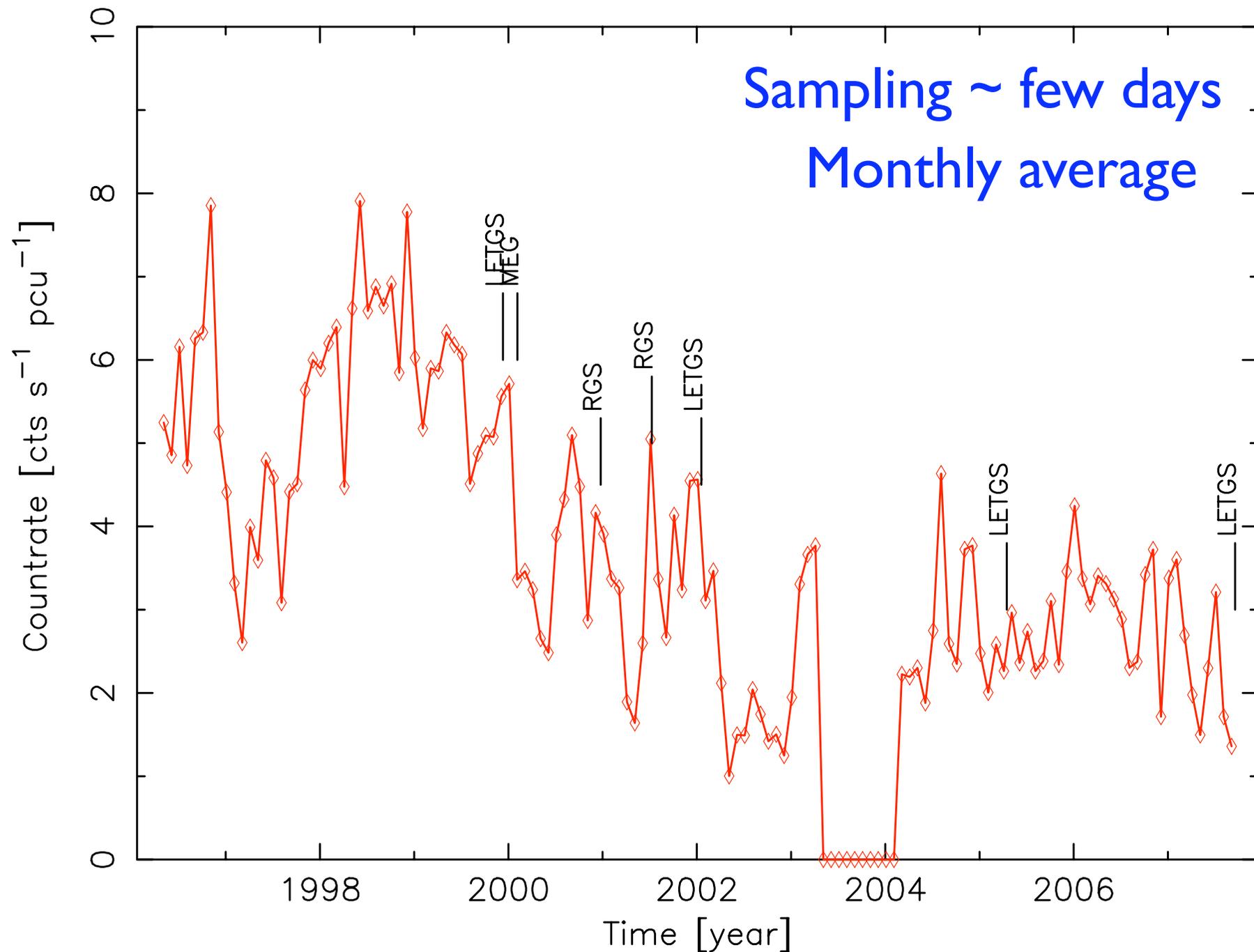
Why NLR ?

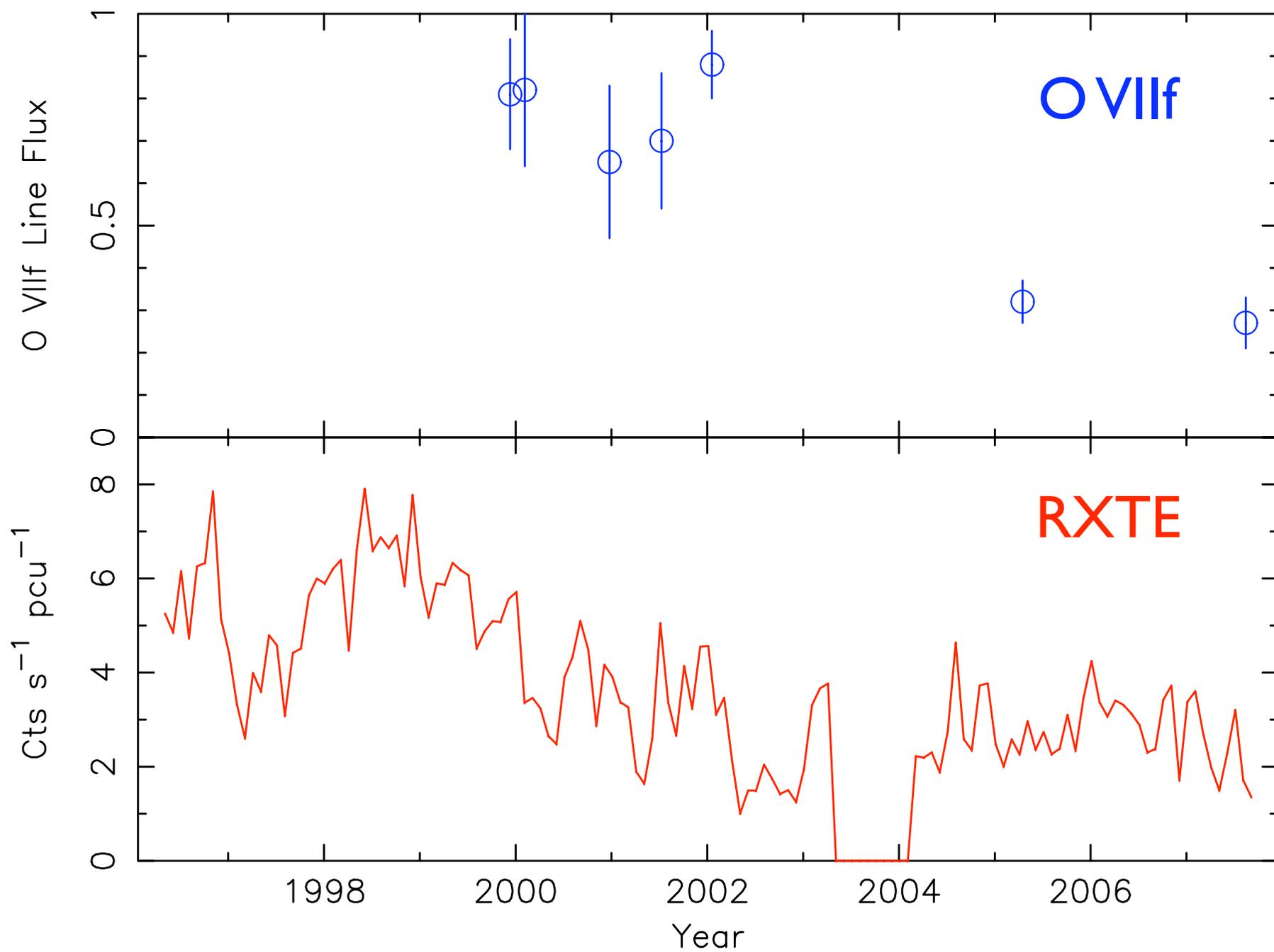
- Possible connection NLR and outflow --> geometry + location NLR can provide clues
- X-ray NLR in Seyfert 1's has not been studied before in systematic way
- Comparison to Seyfert 2 NLR --> same gas / geometry ?

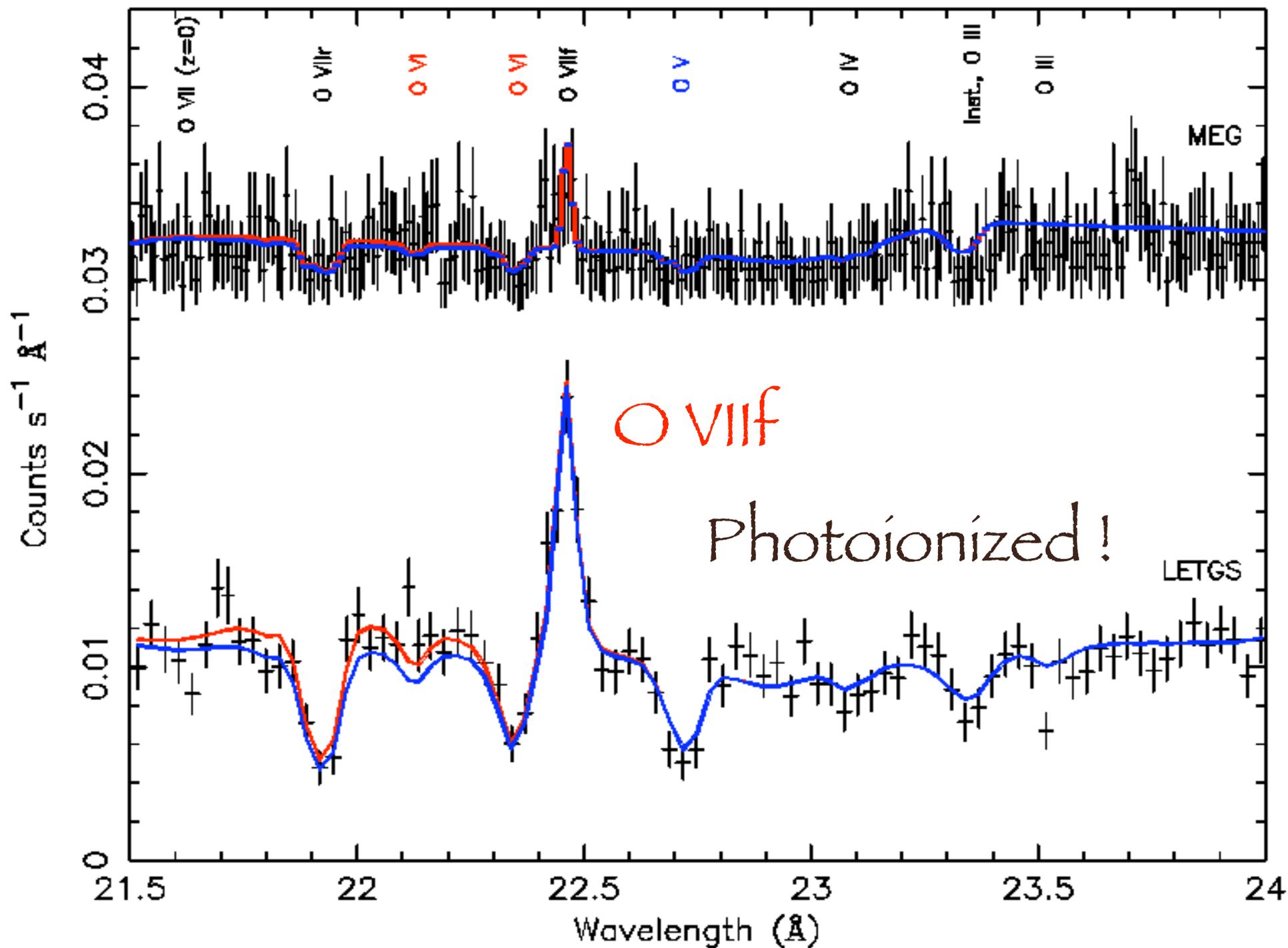
Why NGC 5548 ?

- 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

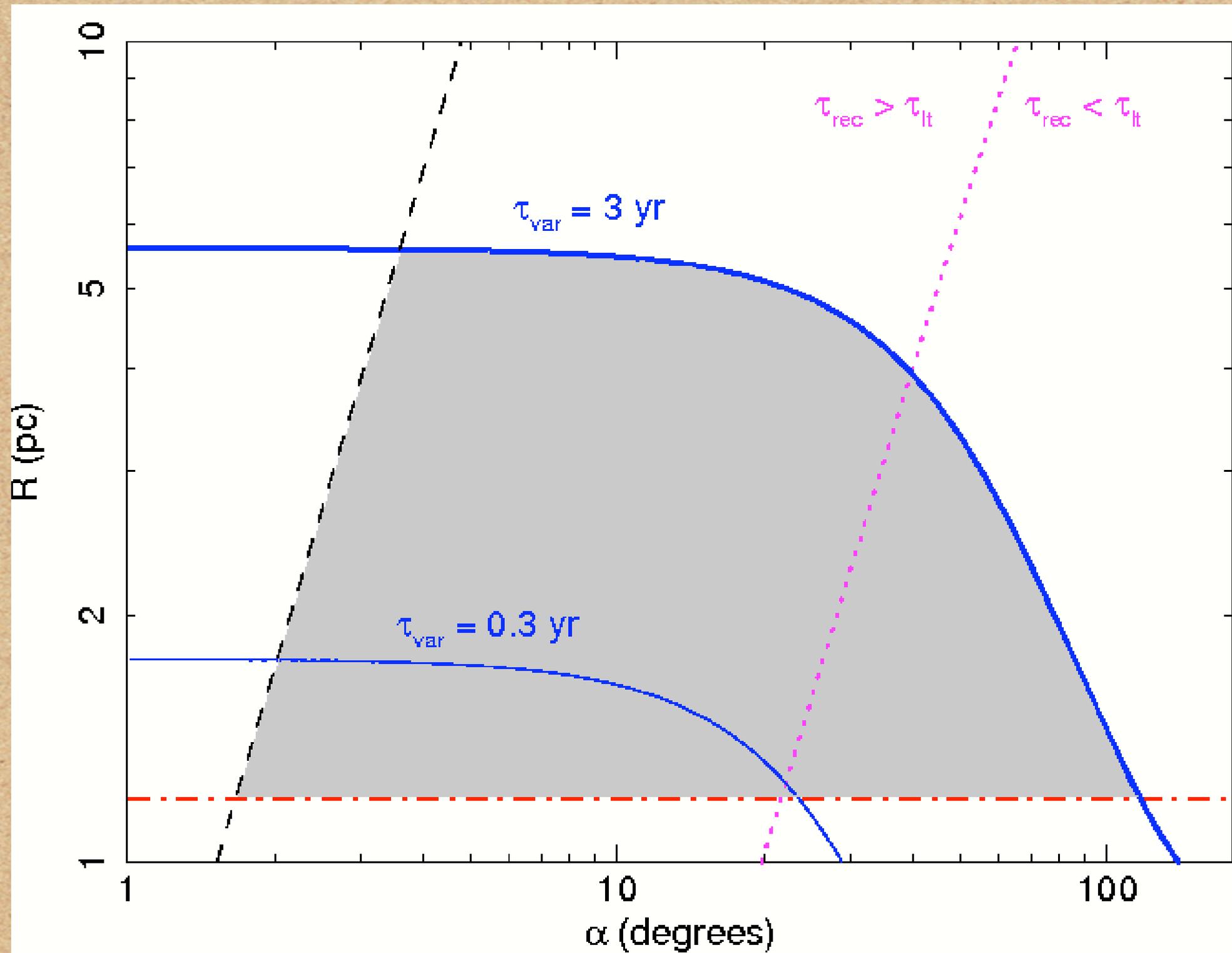






Geometry I

- Assume ionization cone with opening angle α .
- $\xi = L / n R^2 \rightarrow n$ from τ_{rec}
- Upper limit to distance from $\tau_{\text{var}} \approx \tau_{\text{rec}} + \tau_{\text{lt}}$
- Lower limit from V_{fwhm} of line
- Limit on α 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 ξ 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