

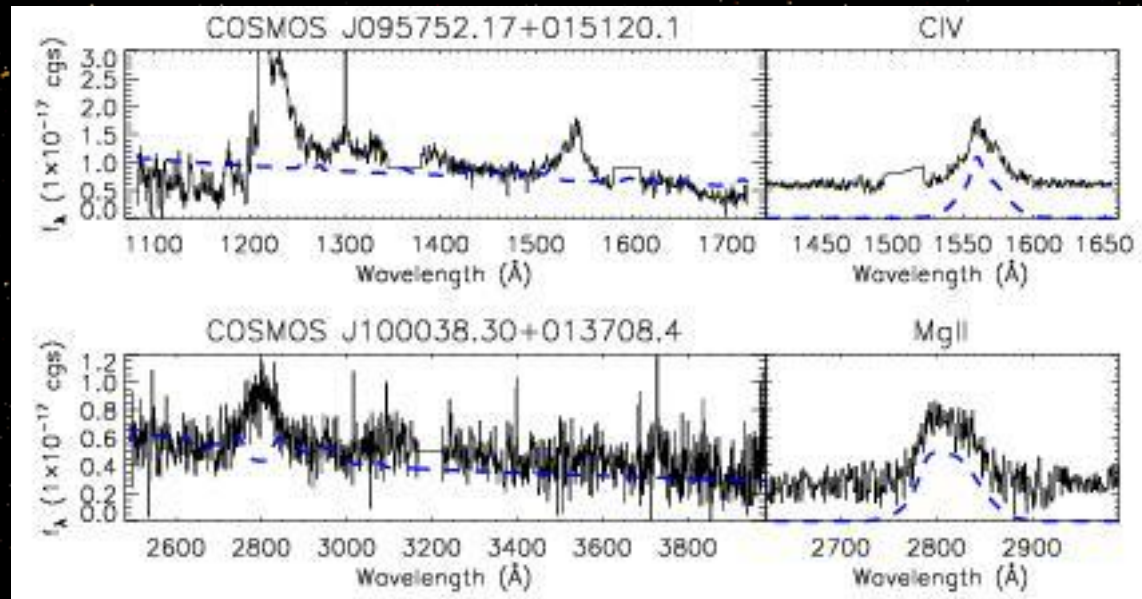
AGN Reverberation Mapping with MMT/Hectospec

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Reverberation Mapping

- Measure time delay between variability in the broad lines and the continuum
- Virial theorem: $M_{\text{BH}} \sim R_{\text{BLR}} v_{\text{BLR}}^2$
- $R_{\text{BLR}} = ct_{\text{lag}}$
- $v_{\text{BLR}} = v_{\text{FWHM}}$
- Requires a time series of spectra...

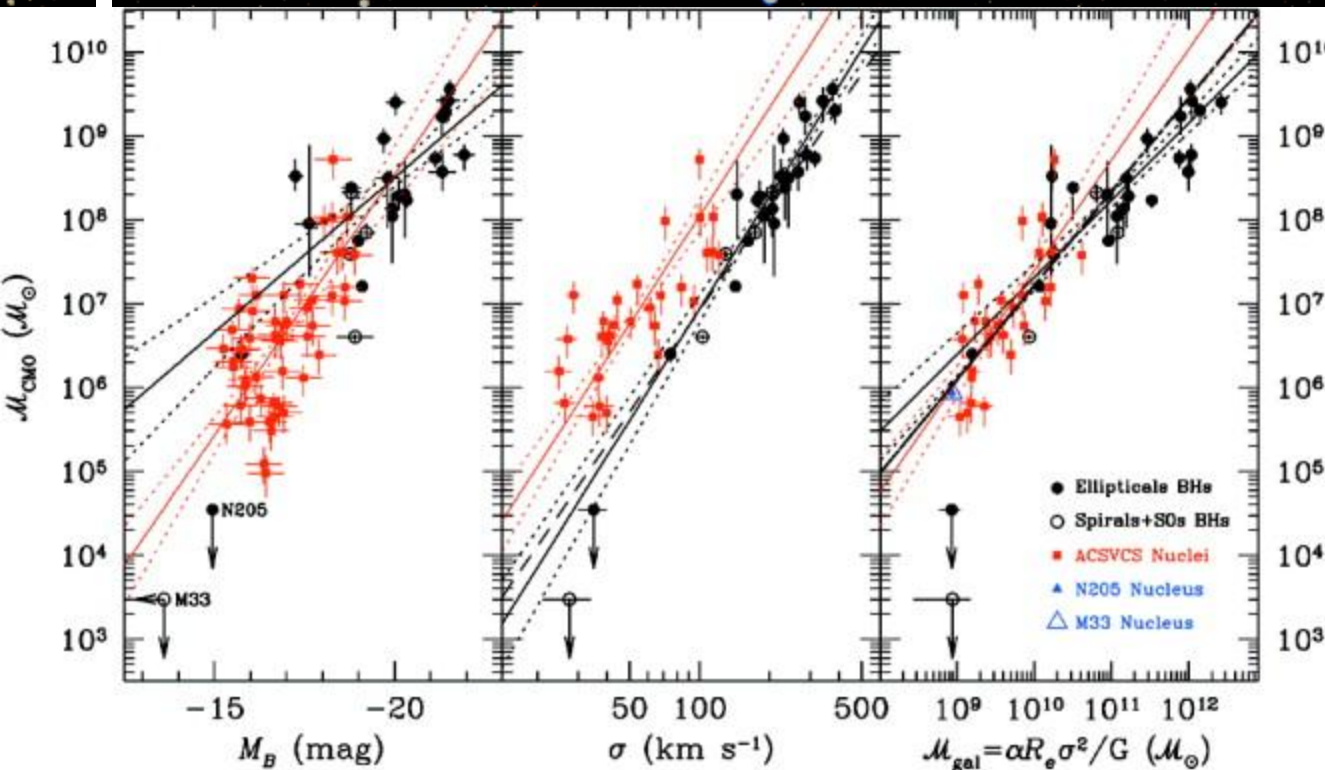


Previous AGN RM

- Typical $t_{\text{lag}} \sim 5\text{-}100$ days
- Previous work has been mostly single-target spectra on small telescopes
 - ~ 45 AGNs, all but 1 at $z < 0.4$
 - Almost all $H\beta$ (1 with MgII, 3 with CIV)
- This work: the first multi-object RM study
 - 37 AGNs, with 31 at $0.4 < z < 2.8$
 - 12 with $H\beta$, 26 with MgII, 13 with CIV
- Double total sample, 10x more at high- z !

Using M_{BH} : BH–Host relations

- Tight relation between M_{BH} and $M_{\text{bulge}} / L_{\text{bulge}}$
- Suggests that SMBH & host are connected

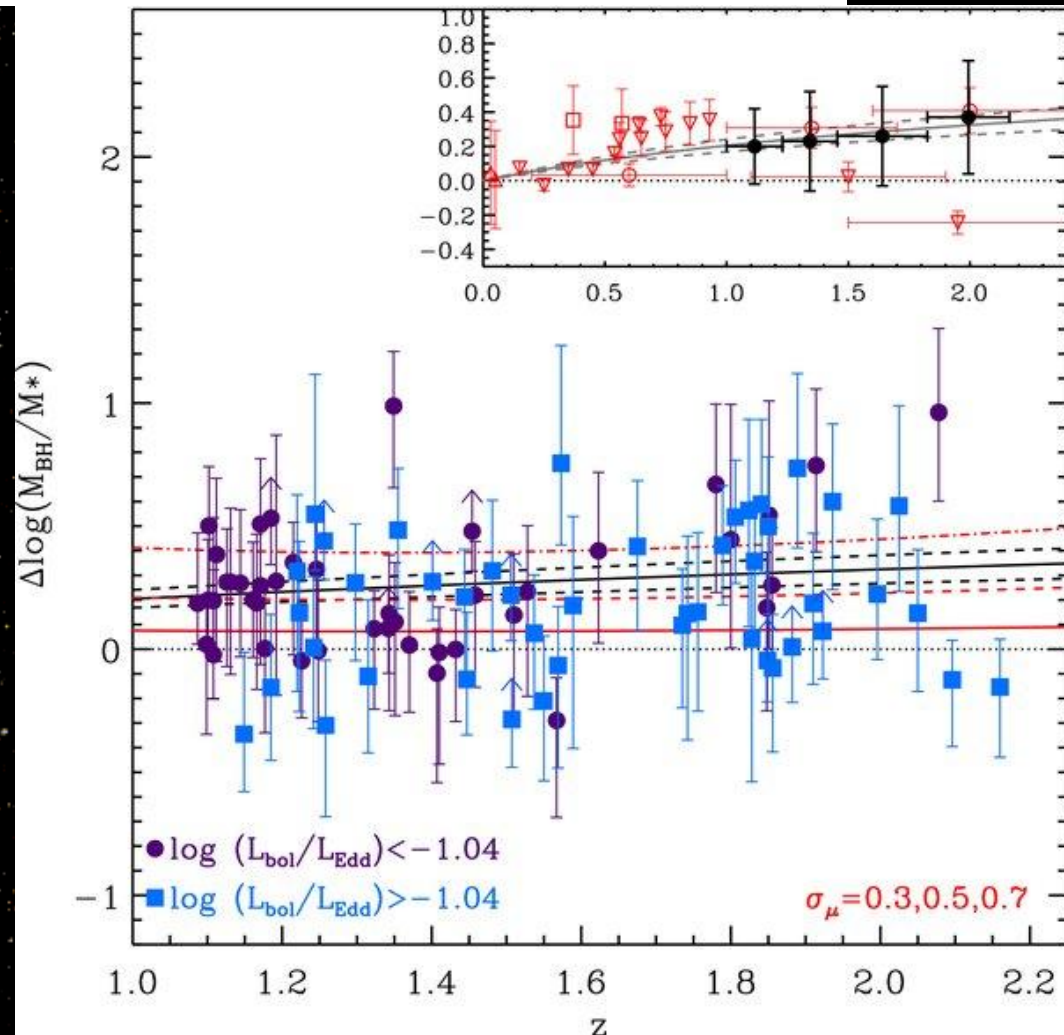


from Ferrarese et al. 2006

Host regulates
SMBH
accretion?
AGN phase
regulates star
formation in
host galaxy?

Evolution in $M_{\text{BH}}-M_{\text{Host}}$?

- Weak evidence for more massive BH compared to host with redshift
- Relies on M_{BH} uncertain to >0.4 dex from “scaling relations”
- RM at $z > 1$ could give M_{BH} to ~ 0.2 dex!



from Merloni et al. 2010

Spectral variability with Hecto

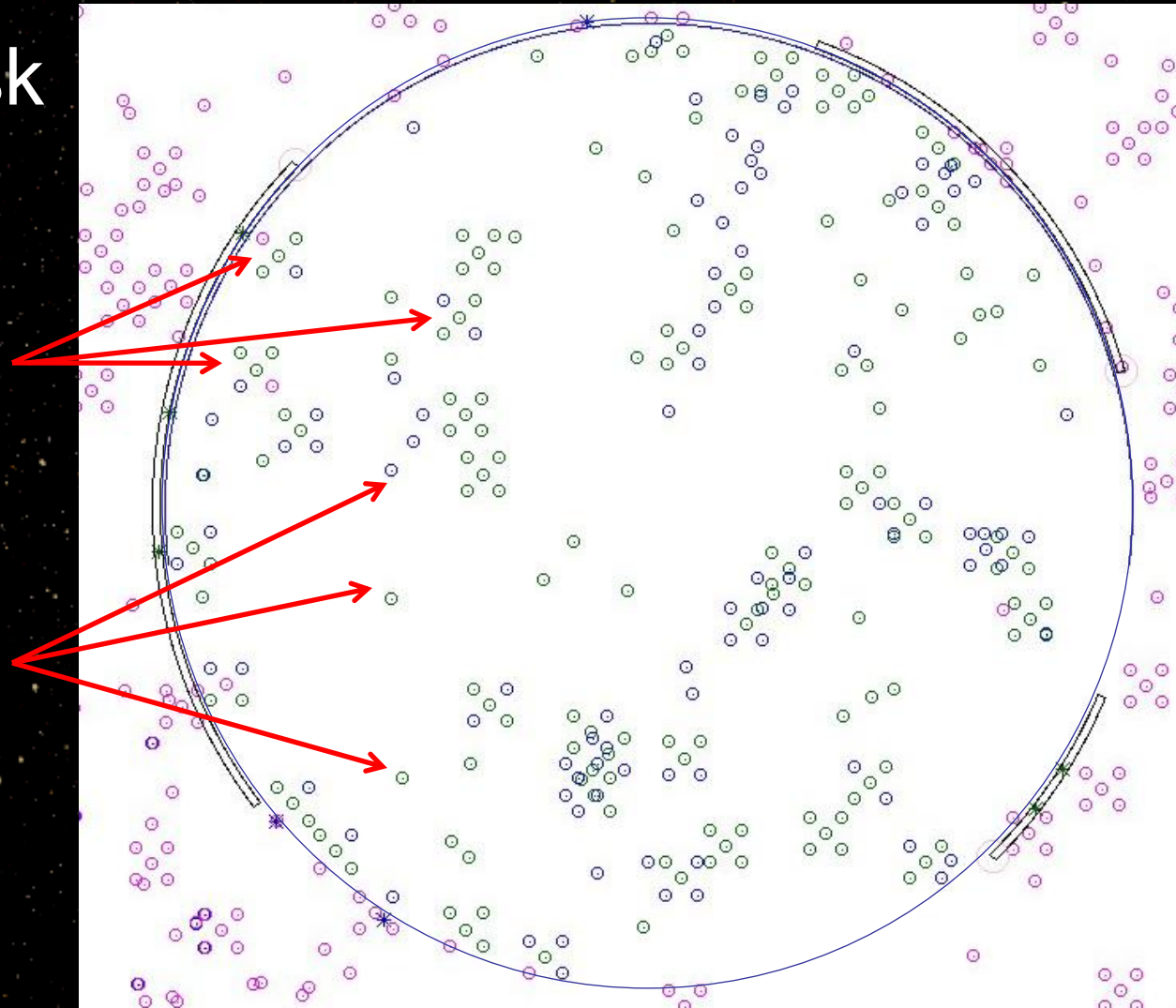
- Need accurate differential spectrophotometry
 - Fiber throughput differences: same rotator angle Feb–May, always same fiber–target
 - Weather variation: stars in target slits as standards
 - Fiber flexure: ancillary photometry (Bok/90')
 - Sky variations within the 1° field: 4+ sky fibers per target in same mask region
- Queue mode: 1 hr/night, total of 5 nights

Spectral variability with Hecto

1° Fiber Mask

AGNs with
sky fibers

Standard
stars



What we anticipated...

Accu

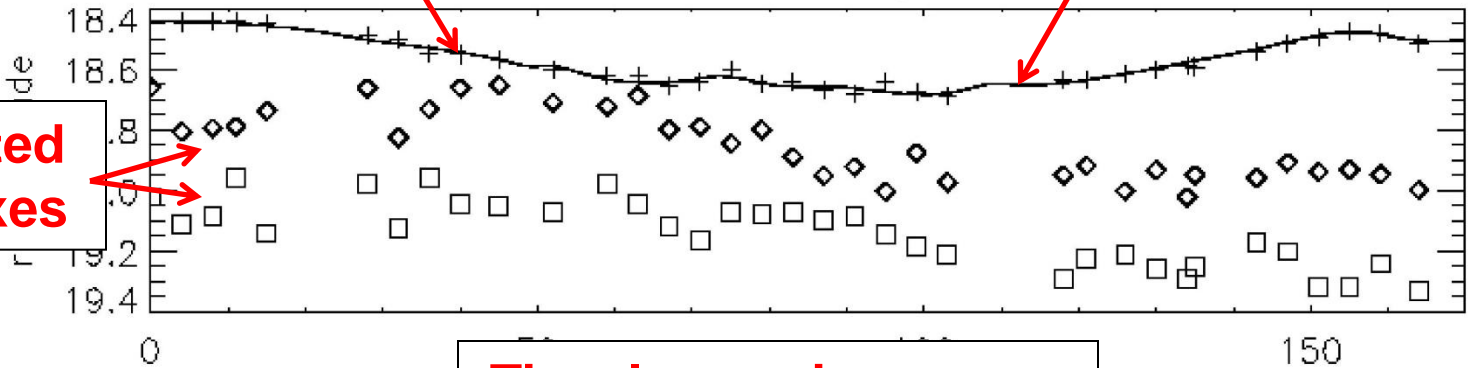
**Simulated
continuum flux (+)**

ex!

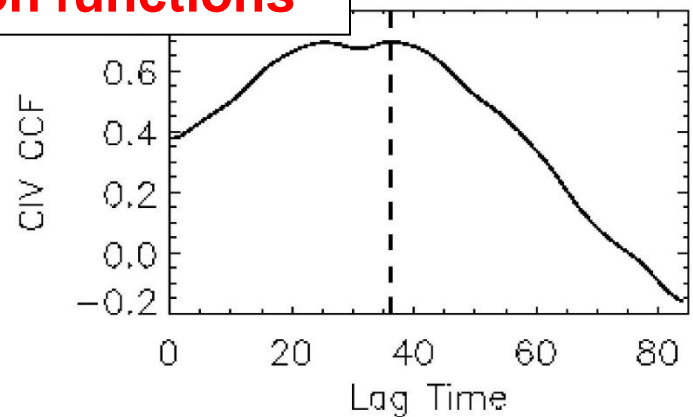
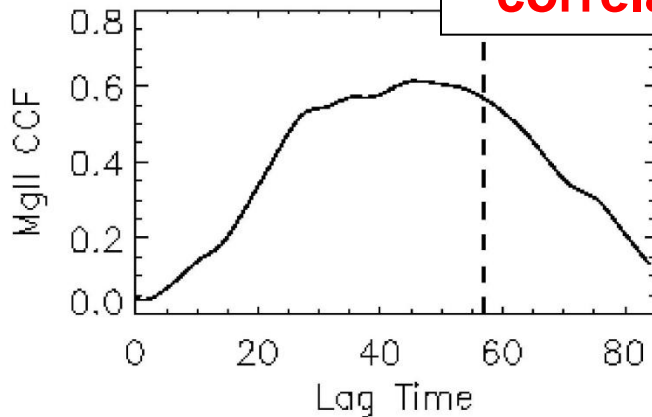
Actual variability

CG 5756+024840, $z=1.6$

**Simulated
line fluxes**

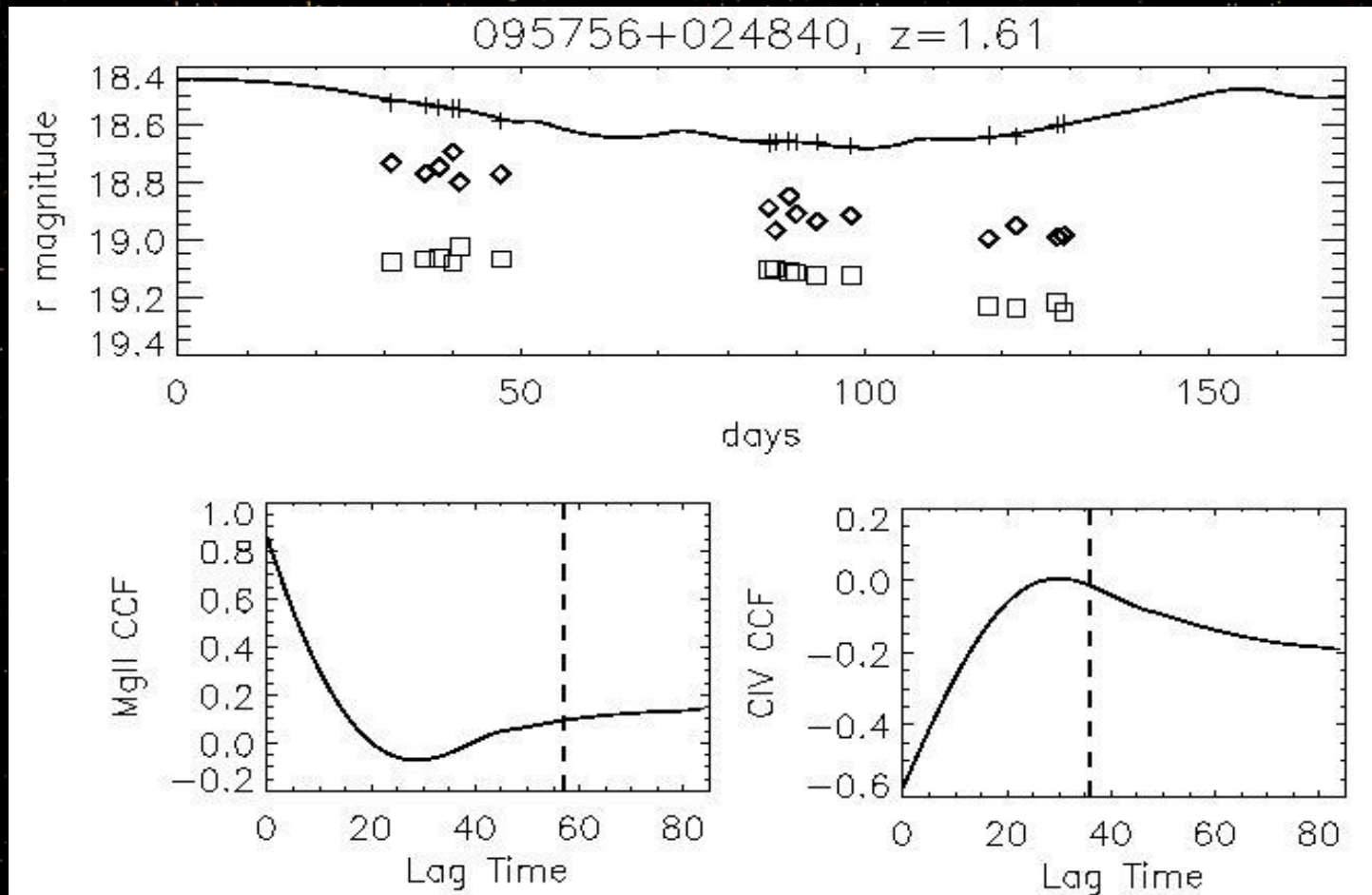


**Time lags using cross-
correlation functions**



What we got...

Weather & scheduling: gaps in Jan/Mar/Jun



Summary (so far...)

- Accurate variability with MMT/Hecto is ambitious, but possible with the right mask design
- Weather and scheduling weren't favorable for a solid time series...
 - Another year or two of data would help
 - There are better stat. techniques than CCF
- Stay tuned!