

# Power of UV+X-ray high-resolution spectroscopy for probing AGN outflows

→ *Need for Arcus Probe*

Missagh Mehdipour

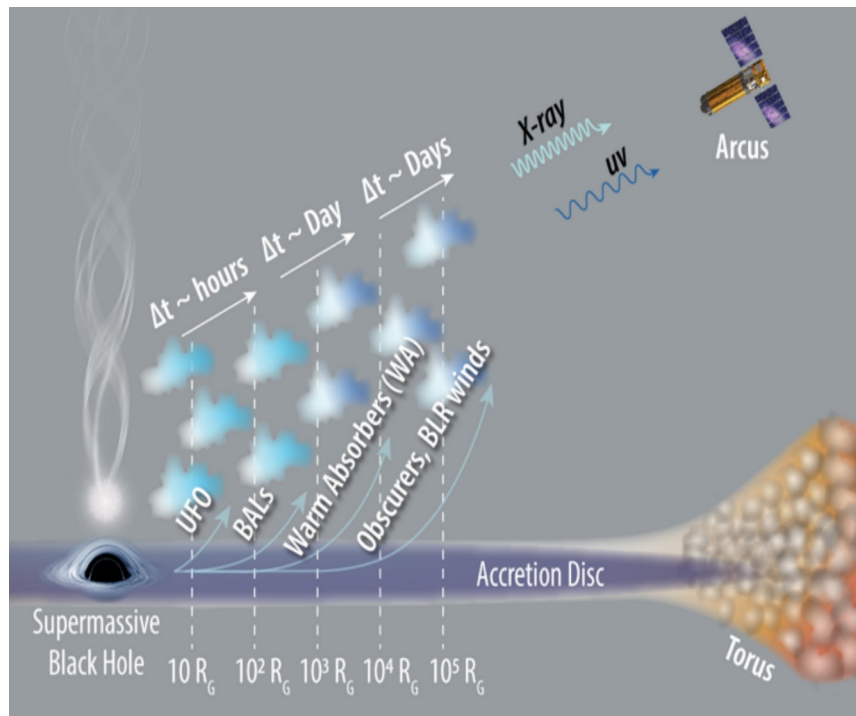
My Arcus AGN collaborators:

Laura Brenneman, Jon Miller, Elisa Costantini, Randall Smith,  
Sibasish Laha, Michael Nowak, Luigi Gallo, Jelle Kaastra, Ehud Behar





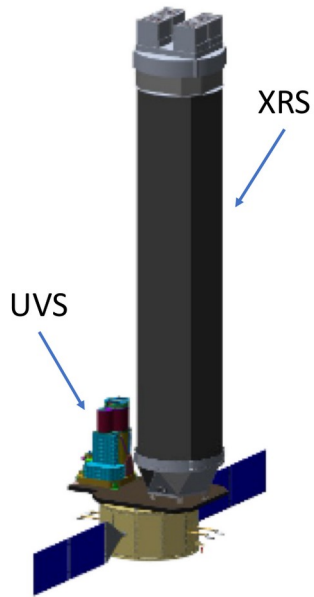
# Science goal: Reveal how black holes impact their surroundings



**Understanding different types and regions of AGN outflows  
with simultaneous UV+X-ray spectroscopy: Arcus Probe**

# Arcus

## A proposed NASA Probe mission concept



X-ray Spectrometer (XRS)	Ultraviolet Spectrometer (UVS)
Combines Silicon Pore Optics, Critical-Angle Transmission gratings, and X-ray sensitive CCDs	Off-axis Cassegrain spectrometer with eLiF coated optics and 0.6m primary
10–60 Å	970–1580 Å
R ~ 3500 (average)	R ~ 24000 (1050 Å)
~ 50x sensitivity of XMM/RGS	~ 5x sensitivity of HST/COS below 1100 Å



[www.arcusxray.org](http://www.arcusxray.org)

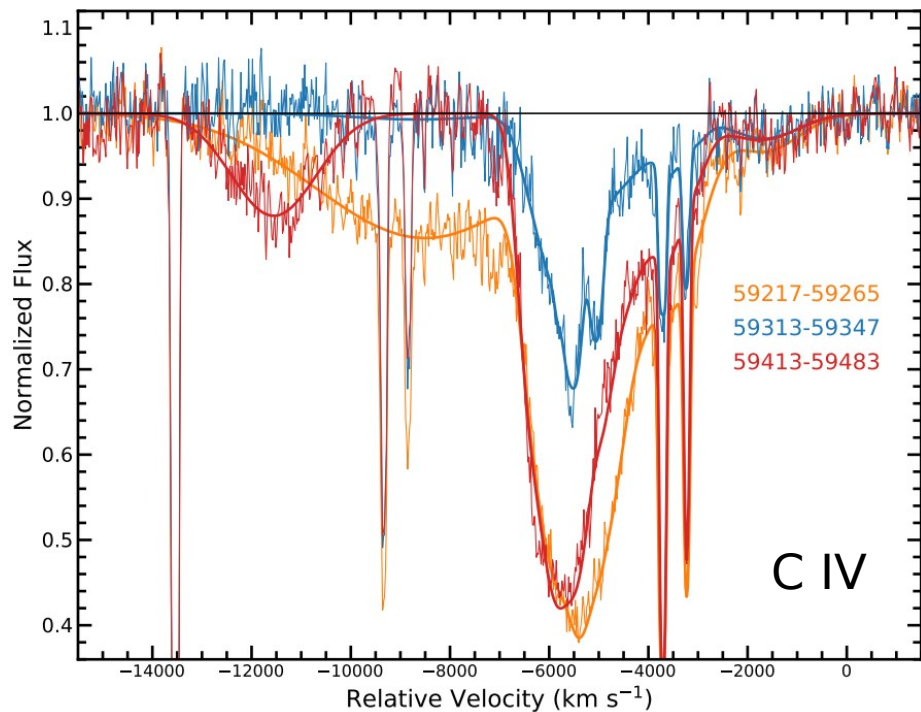
PI: Randall Smith (SAO)

# Open questions on AGN outflows

- **Kinematical & dynamical structure of outflows?  
How the multiple ionization & velocity components are formed?**
- **What is the connection between various outflows in the Broad and Narrow Line Regions?**
- **Do they have common or different origin & driving mechanism?**
- **Which wind parameters vary over time and produce the observed spectral variability?**
- **How wind parameters scale with redshift and the AGN properties such as accretion rate and luminosity?**
- **How the energy & momentum of outflows propagate into the host galaxy and what are their impact on their environment?**

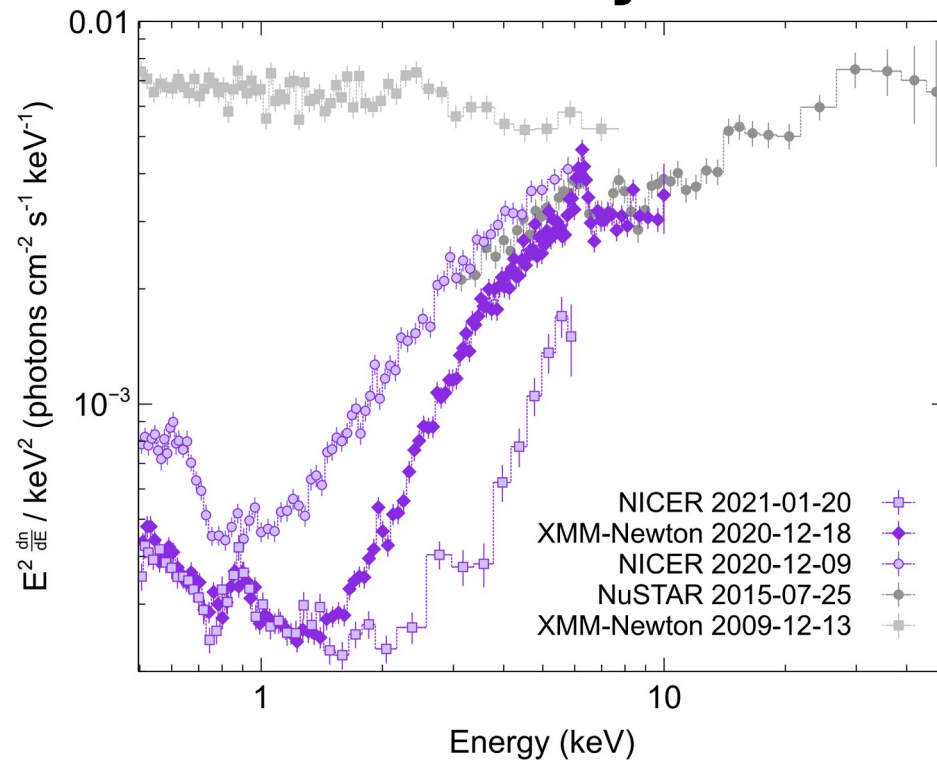
# Deciphering UV and X-ray spectral variability to probe key properties of AGN outflows

## UV



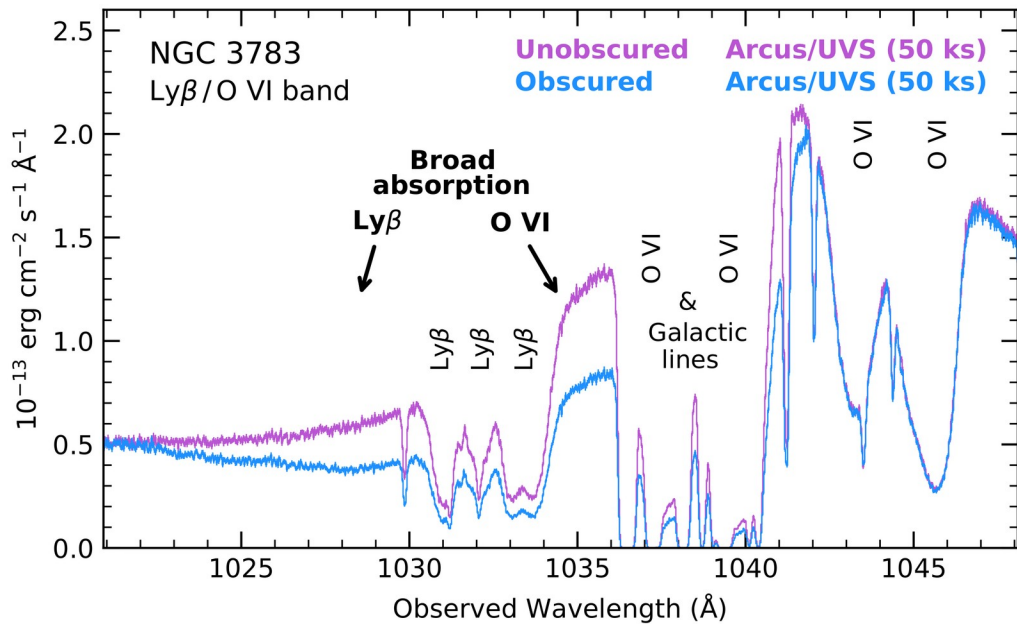
Mrk 817 HST/COS (STORM2 campaign)

## X-ray

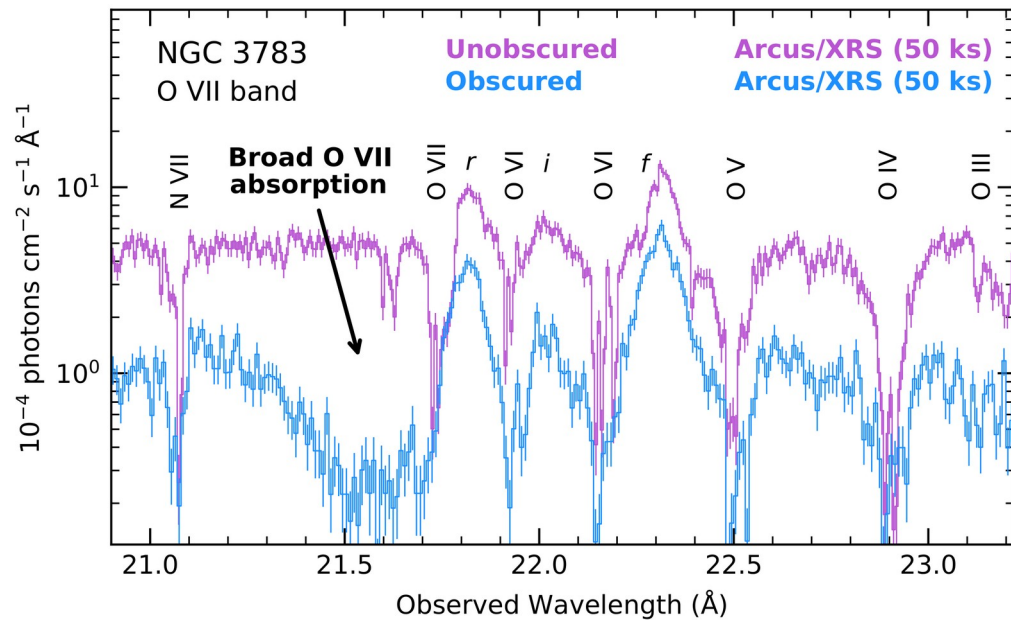


Mrk 817 (Kara+21)

# Simultaneous UV+X-ray high-resolution spectroscopy with Arcus

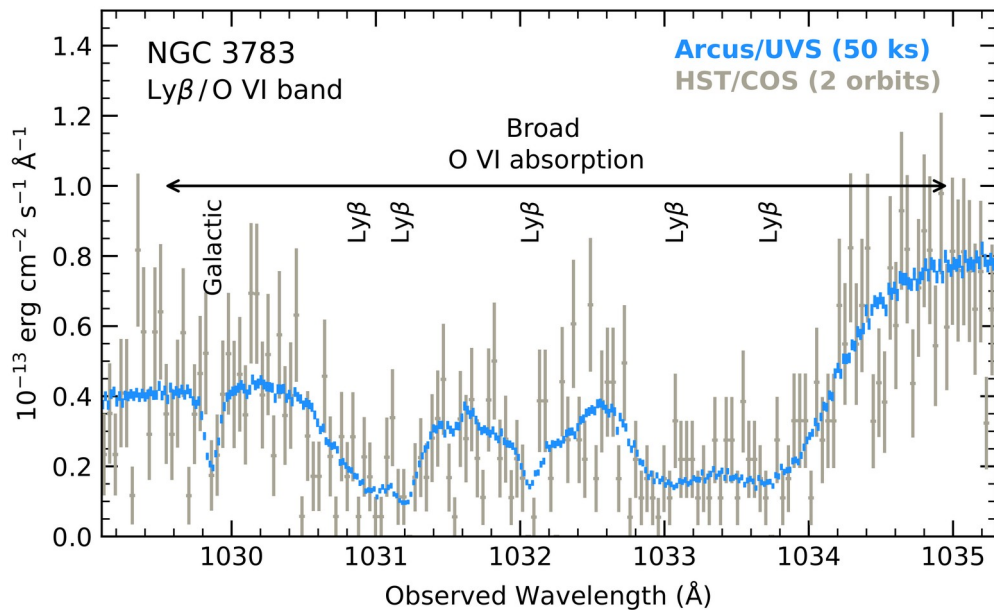


UV

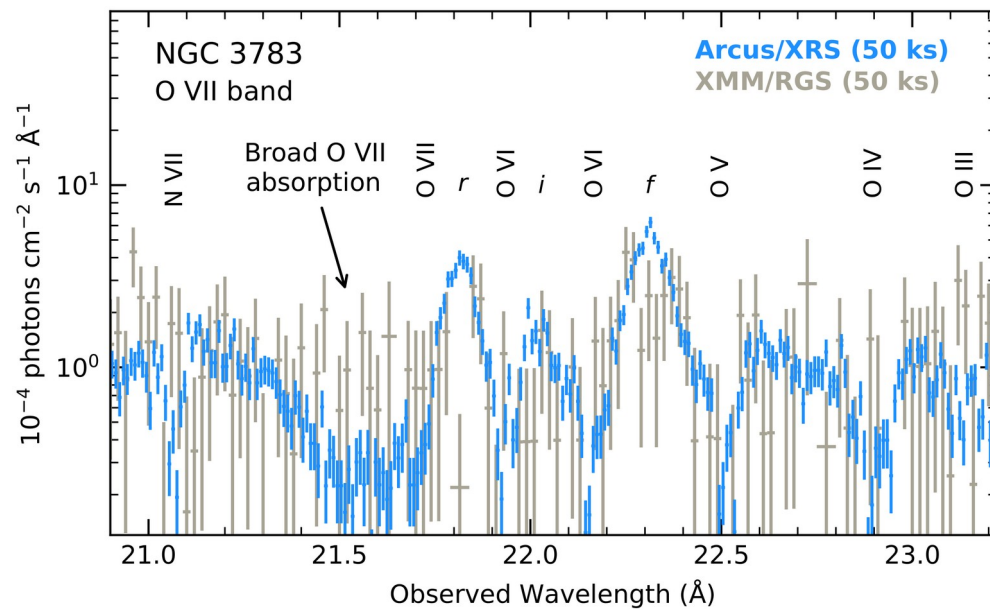


X-ray

# Simultaneous UV+X-ray high-resolution spectroscopy with Arcus

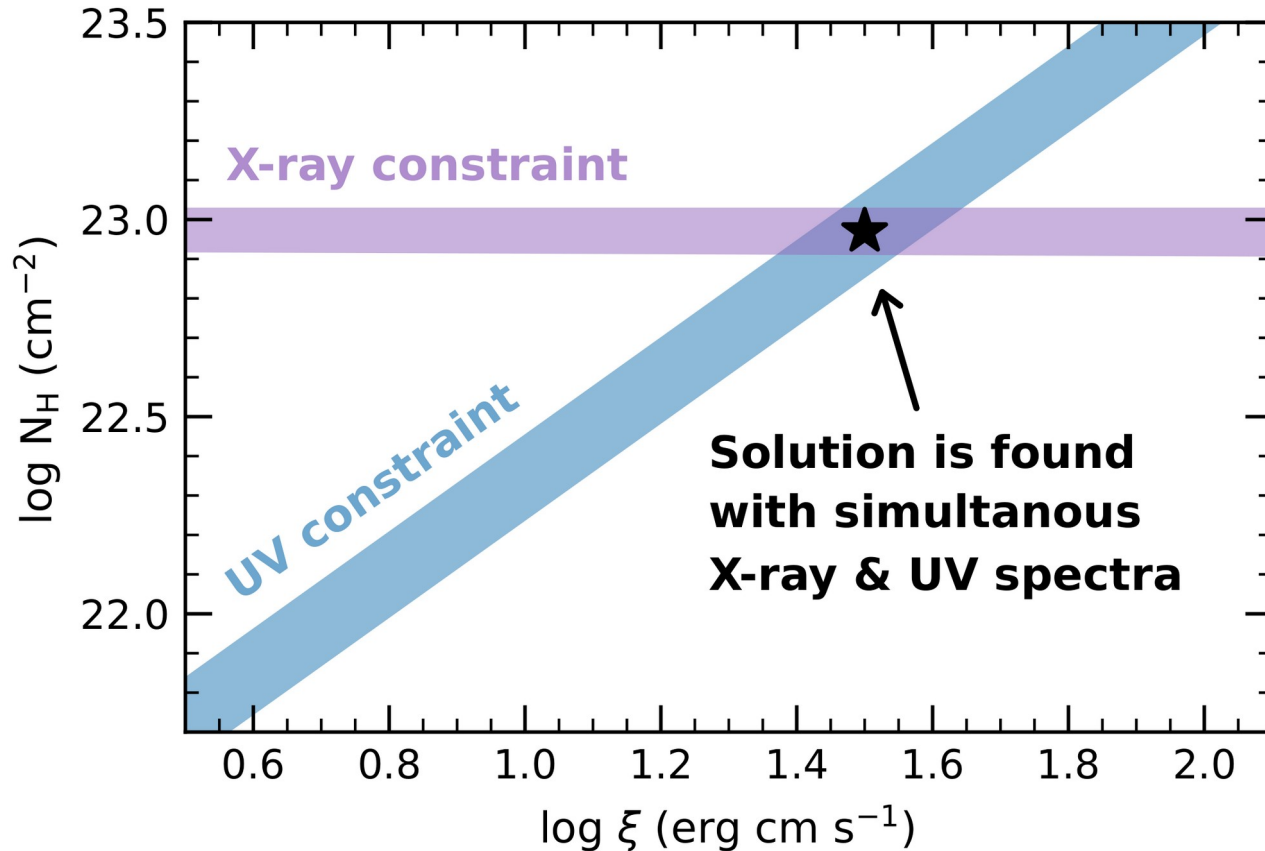


**UV**



**X-ray**

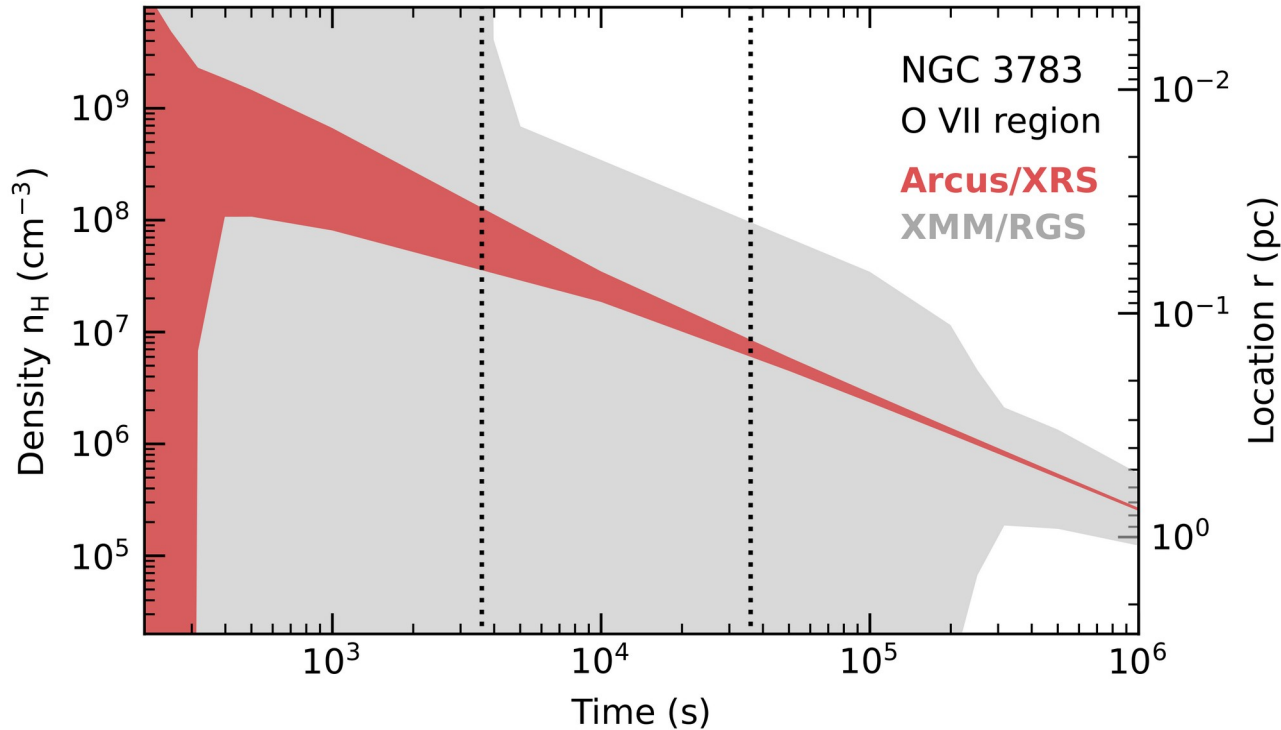
# Constraints on parameters of Broad Line Region winds using simultaneous UV+X-ray spectroscopy



**Need  
Arcus**



# Arcus enables constraining the density, location, and energetics of the AGN outflow components



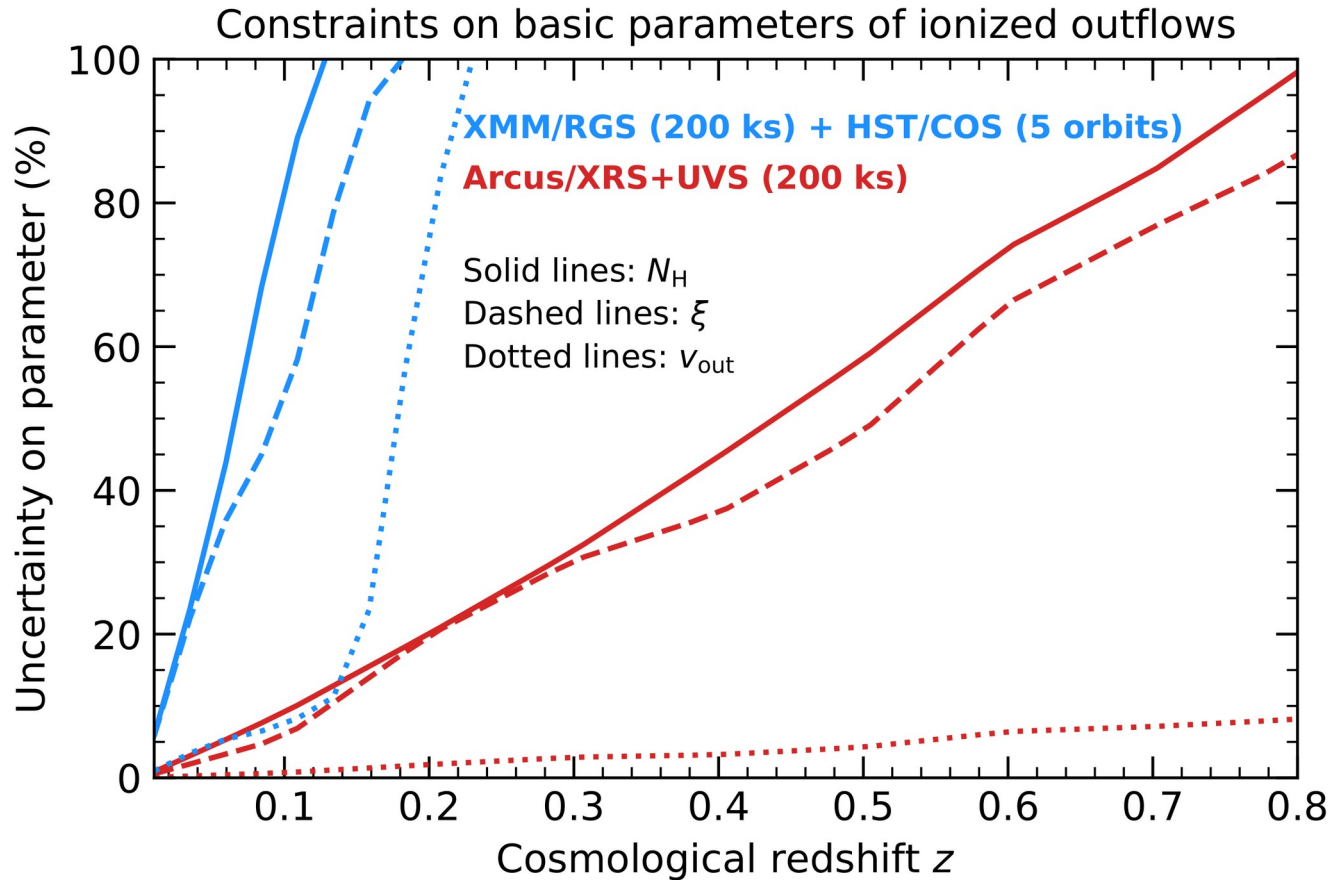
Ionization  
parameter:

$$\xi = \frac{L}{n_{\text{H}} r^2}$$

Kinetic power:

$$P_{\text{kin}} \propto N_{\text{H}} v_{\text{out}}^3 r$$

# Pushing the frontiers of high-resolution UV+X-ray spectroscopy to higher redshift AGN



# Conclusions

- **AGN outflows are multi-component with complex ionization and velocity structure**
- **Simultaneous UV+X-ray spectroscopy and timing are key for probing the poorly-understood properties of AGN outflows**
- **Arcus high-resolution spectroscopy is needed to overcome current limitations in measuring parameters of AGN outflows**
- **Arcus would enable us to establish the ionization structure, kinematics, and energetics of the various outflows in AGN**
- **Arcus diagnosis of the origin and driving mechanism of the outflows would provide useful benchmarks for testing different theoretical models**