

# AGN in massive galaxies identified via optical broadband variability

## Lessons from VST-COSMOS for future LSST science

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### Introduction

AGN feedback is key to galaxy evolution, especially in massive systems, but its triggers remain uncertain. X-ray and IR surveys offer important snapshots but can miss low-luminosity AGN due to host dilution and detection limits.

Optical variability traces stochastic accretion, revealing AGN in bright hosts. Using **VST-COSMOS** as an **LSST(Legacy Survey of Space and Time) precursor**, we test if morphology or environment regulates black hole growth at late epochs ( $z < 1$ ).

### Methodology

**AGN sample:** We used 11 years of r-band VST-COSMOS data (68 epochs,  $r \sim 24.6$  mag). Cross-matching these variable sources with the COSMOS2020 catalog ( $M_* > 10^{10} M_\odot$ ,  $z < 1$ ) yielded **56 AGN**

**Controls:** Each AGN is matched to 5 non-variable galaxies within  $\pm 0.05$  in  $z$  and  $\pm 0.05$  dex in  $M_*$ .

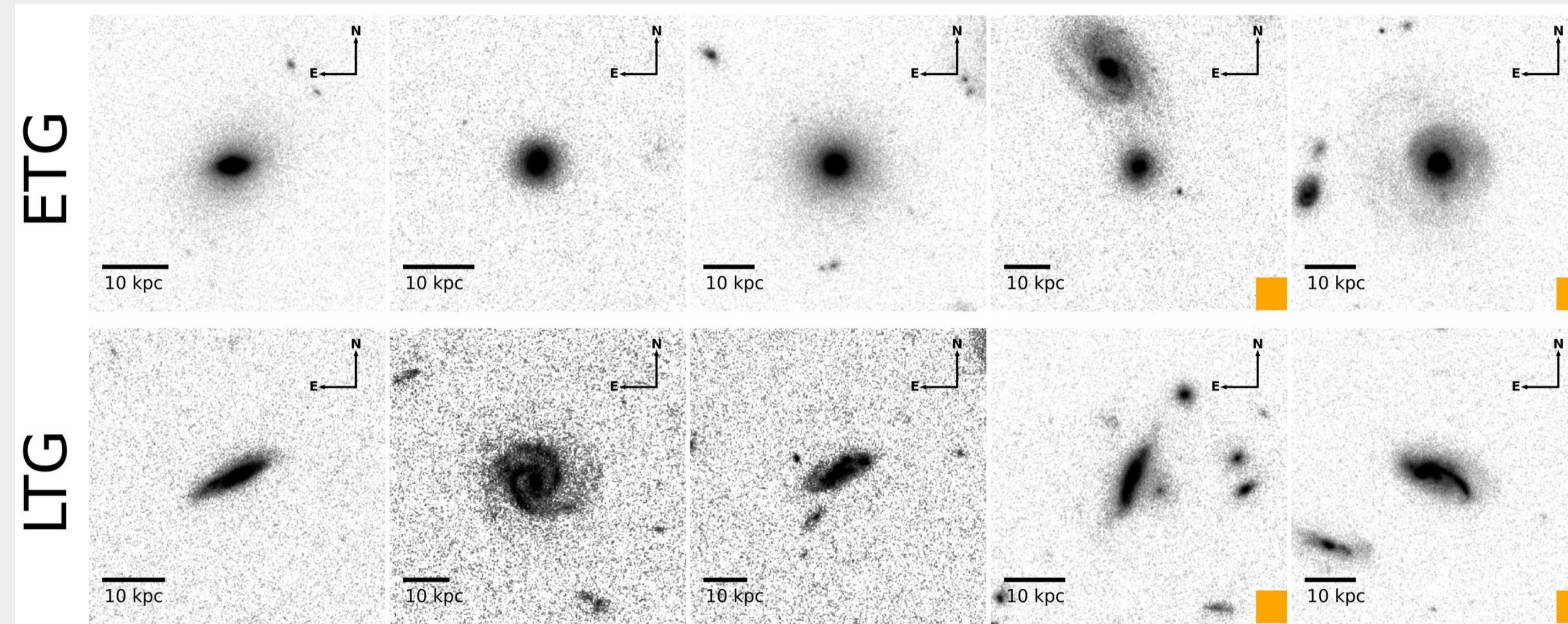
All controls were verified to lie outside the Donley et al. (2012) MIR AGN locus to ensure a "clean" non-active comparison sample.

### LSST Connection

Property	VST	LSST
Depth (r mag)	$\sim 24.6$	$\sim 24.7$
Baseline	11 yr	10 yr
Footprint	1 deg <sup>2</sup>	<b>18000 deg<sup>2</sup></b>

VST-COSMOS mirrors the LSST depth but in a footprint **10<sup>4</sup> times smaller**.

### Morphology & Interactions

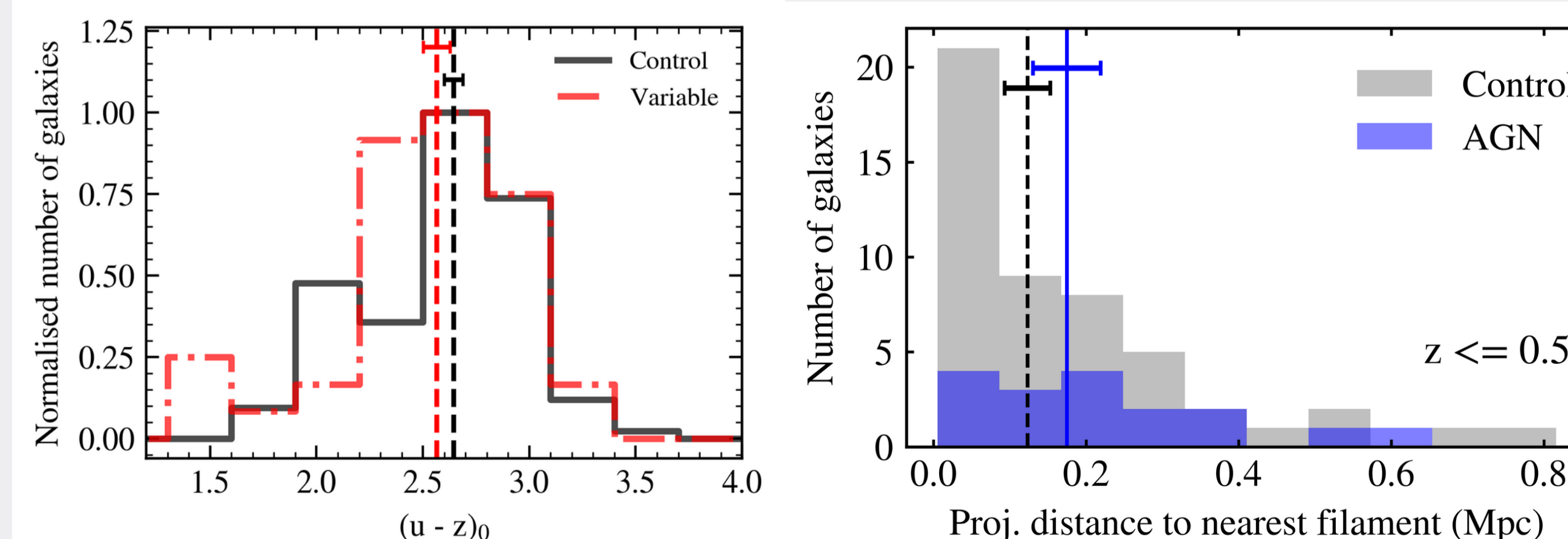


**Figure 1:** HST-ACS images: early-type galaxies (ETGs; top panels) and late-type galaxies (LTGs; bottom panels); orange marks interactions.

	AGN	Control
ETG frac	$0.55 \pm 0.08$	$0.48 \pm 0.04$
Int. frac	$0.23 \pm 0.06$	$0.16 \pm 0.03$

**Stats:**  $p = 0.43$  (Morph) and  $p = 0.16$  (Int). Differences are **statistically insignificant**. Triggering is largely **unrelated to interactions** and likely driven by secular processes.

### Environment and Colour Profiling



**Figure 2:** Distribution of  $(u - z)_0$  colours and filament distances. AGN (blue) and Controls (grey) are indistinguishable (KS tests  $p > 0.3$ ).

### Executive Summary

Similar early-type galaxy fractions ( $0.55 \pm 0.08$  vs  $0.48 \pm 0.04$ ) and comparable, relatively low interaction fractions ( $0.23 \pm 0.06$  vs  $0.16 \pm 0.03$ ), consistent within uncertainties, suggest that AGN activity is not primarily driven by mergers but is more likely associated with secular processes.

Comparable distances to cosmic filaments at both low ( $z < 0.5$ ) and high ( $z > 0.5$ ) redshifts suggest that the large-scale environment is unlikely to be a dominant driver of AGN activity.

The findings are consistent with studies of low-luminosity, variability-selected AGN. Observed differences compared to infrared (IR)- or X-ray-selected samples may reflect obscured or merger-driven phases.

Similar  $(u-z)$  colours indicate comparable recent star formation, suggesting SFR and galaxy growth may be weakly coupled or completely decoupled from AGN activity.

AGN triggering in optical variability-selected massive galaxies appears more consistent with secular processes than major mergers.

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