# Gravitational lensing of AGN with WSO-UV/ISSIS (latest design)


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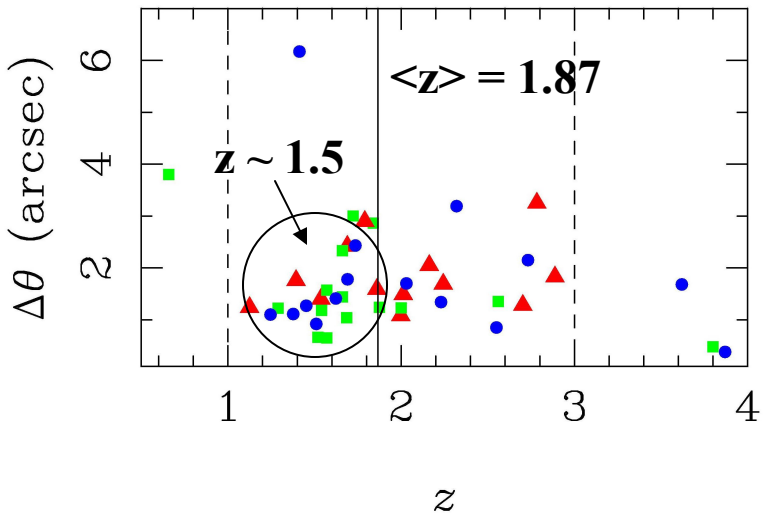
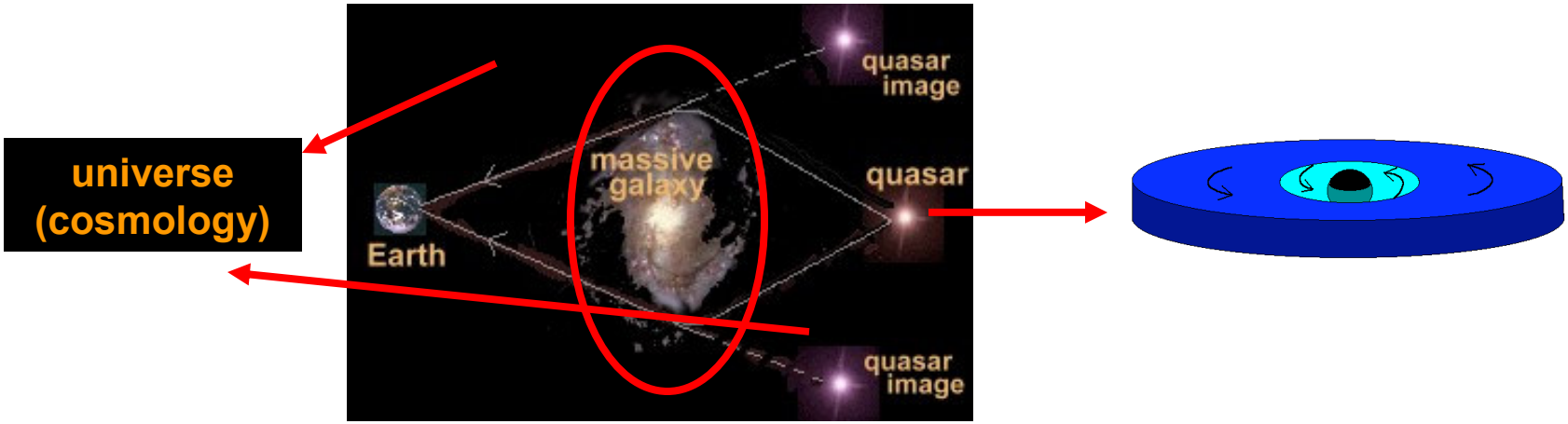
# GRAVITATIONALLY LENSED QSOs (GLQs): THE SAMPLE & SOME KEY GOALS

From the CfA-Arizona Space Telescope LEns Survey (CASTLES: http://www.cfa.harvard.edu/castles/) and SDSS Quasar Lens Search (SQLS: http://www-utap.phys.s.u-tokyo.ac.jp/~sdss/sqls/) databases in 2010, we select 41 optically bright GLQs at $1 < z < 3$. These GLQs have at least two images with $V < 20$ mag, and they represent ~ 90% of the bright objects in the CASTLES+SQLS archive



# ISSIS: FUV OR NUV CHANNEL?

The possible presence of high column densities of neutral hydrogen in intervening objects at $z \leq 1$ could greatly hinder or make impossible the detection of photons at $\lambda \leq 1824$ Å. For some GLQ, intervening systems at higher z may not even allow us to observe a part of its spectrum at $\lambda > 1824$ Å. Hence, our GLQ programme focuses on the NUV Channel: 1850-3200 Å

$z = 1.5 \rightarrow$ 740-1280 Å

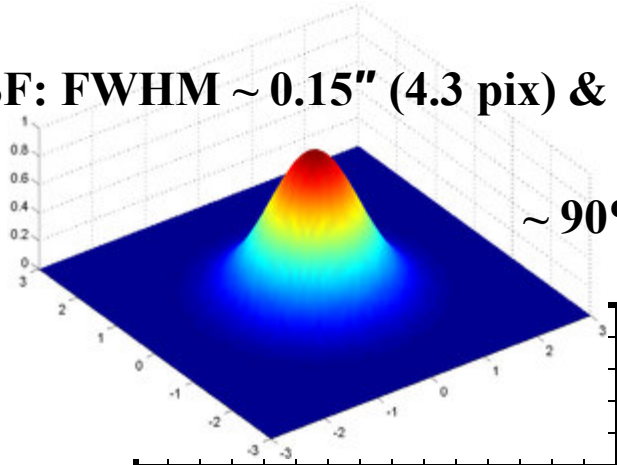
$z = 2 \rightarrow$ 617-1067 Å

**emission at ~ 10-20 eV**

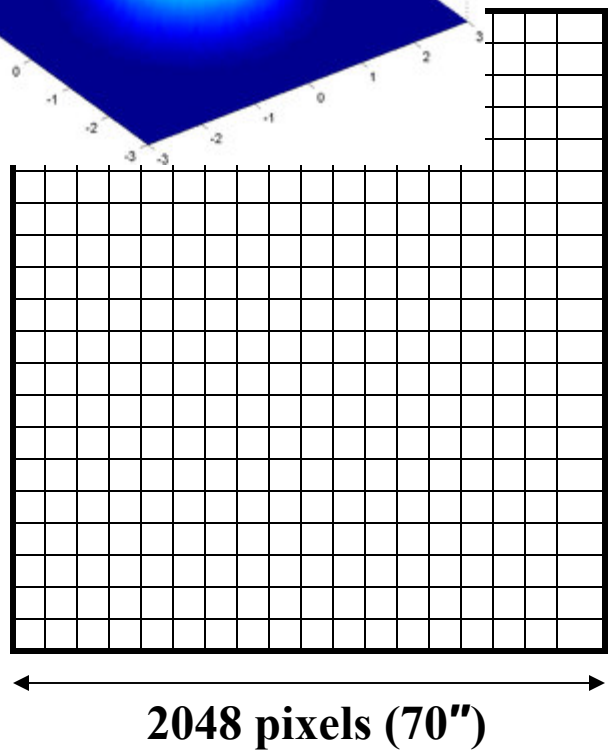
These observations would provide information to build an ***UV data base of the CASTLES-SQLS sample***. For each GLQ, the scientific goals are to disentangle the nuclear and circumnuclear 10-eV emissions, i.e., to resolve the emissions at ~ 10-20 eV within a 0.3″ radius, to compare with other observations (e.g., VLBI radio jets), to reconstruct the UV morphology of the central region in the active galaxy and to constraint the gravitational lens scenario

# NUV CHANNEL: SPATIAL RESOLUTION

**PSF: FWHM ~ 0.15″ (4.3 pix) & ASYMMETRY (*b*/*a*) ~ 8%**



**~ 90% SIGNAL WITHIN R ~ 0.2″ (5.7 pix)**



**2048 pixels (75″)**

**0.035″**

**2048 pixels (70″)**

**IDEAL PSF (FIRST SIMULATIONS): 2D Gauss**

- **No asymmetry**
- **90% signal in 0.9 × FWHM (4 pix)**

# SPATIAL RESOLUTION: FIRST SIMULATIONS

Source at z ~ 1.5 with flat continuum and $F = 2 \times 10^{-15}$ erg cm$^{-2}$ s$^{-1}$ Å$^{-1}$ (V = 17 mag)

**ETC**

# Channel: NUV
# Mode: Image
# Filters: NFN_01, Open
# Input data: Flat continuum (2e-15)
# Background: none
# SNR: 100 → (user's manual) $10^4$ c
#
# Exposure time: 434.4 sec

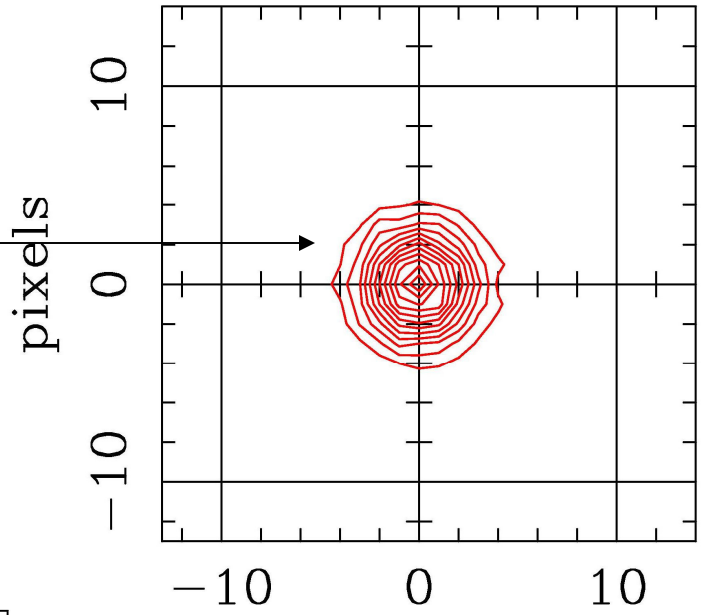
**DYNAMIC RANGE** (design & performance)

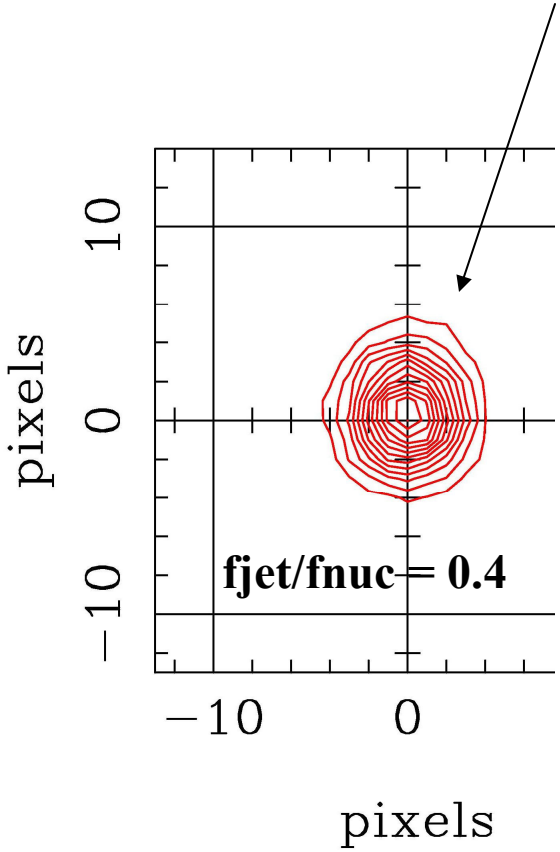
peak throughput at λ = 2500 Å:
$F = 8.76 \times 10^{-16}$ erg cm$^{-2}$ s$^{-1}$ Å$^{-1}$ → N = 200 cps
↓
using NFN_01 (× 0.1):
$F = 8.76 \times 10^{-16}$ erg cm$^{-2}$ s$^{-1}$ Å$^{-1}$ → N = 20 cps
$F = 2 \times 10^{-15}$ erg cm$^{-2}$ s$^{-1}$ Å$^{-1}$ → N = 46 cps
↓
NUV Channel throughput ~ peak throughput/2:
~ $10^4$ c in 434.4 sec

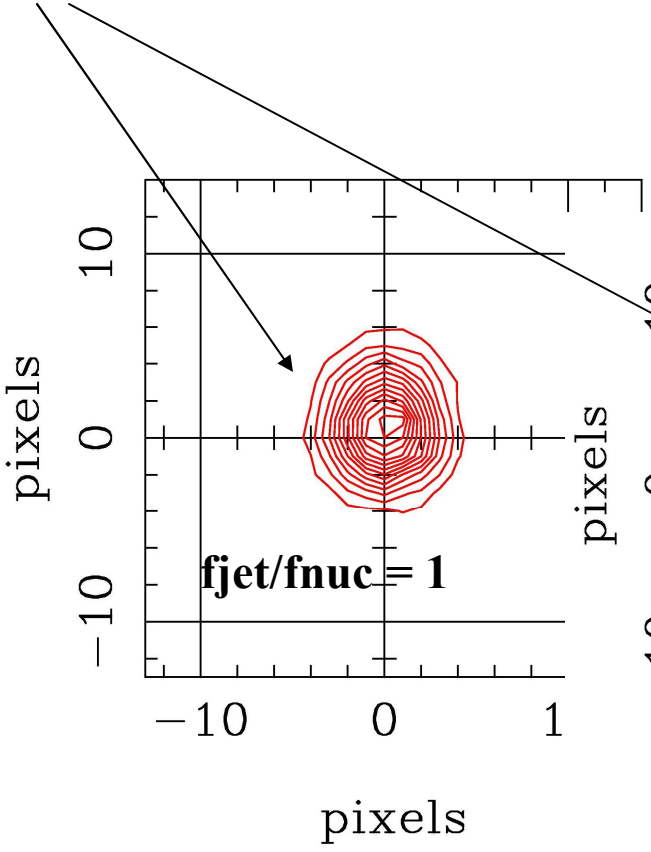
**good agreement !**

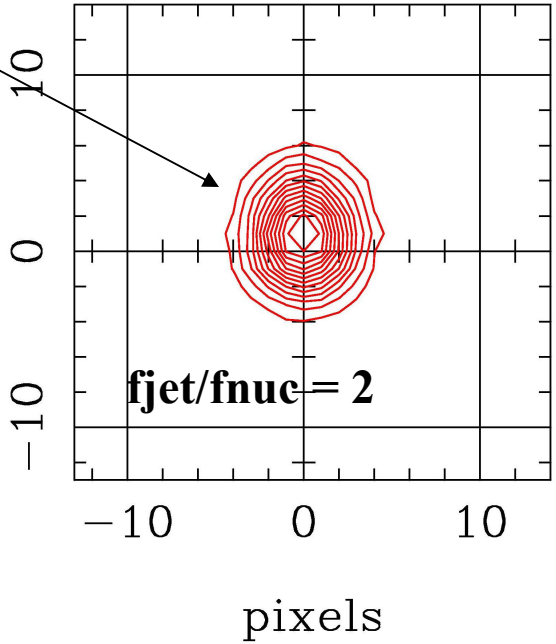
**Frames of 28 pix × 28 pix (~ 1″ × 1″)**
**● Nuclear source (no background) with integrated instrumental flux of $10^4$ counts**
**● Poisson noise**

**+ 0.1″ (3 pix) internal jet ∥ Y-axis (Y > 0)**



# TIME-DOMAIN STUDIES

Another main aim is the ***UV monitoring of optically bright GLQs belonging to the CASTLES-SQLS sample***. For each selected GLQ, we want to study the intrinsic variability of the nuclear continuum (time delays between the lensed images, structure function analysis, etc), as well as the extrinsic effects caused by the main lensing galaxy (dust extinction, microlensing magnification, etc)

**Table 1** Exposure times required to obtain SNR = 100 ($V = 18$ mag)

| Filter | | Emission | Time (s) | |
|---|---|---|---|---|
| F170W | **NFN_01** | EUV | **270** | ~430 |
| F255W | **F232N** | EUV | **265** | ~190 |
| F336W | **F280N** | FUV | **90** | ~25 |
| | **F308N** | | **485** | |

**50 (NF/open)-10 (other)**

**UPDATE of Goicoechea et al. (2011, Ap&SS 335, 237)**

**Table 2** Exposure times required to obtain SNR = 100 ($V$ = 17–20 mag)

| Filter | | Time/$V = 17$ (ks) | | Time/$V = 20$ (ks | |
|---|---|---|---|---|---|
| | **NFN_01/open** | | | | |
| F170W | | ~0.17 | **0.11** | ~2.63 | **0.17** |
| F255W | **F232N** | ~0.08 | **0.11** | ~1.19 | **1.63** |
| F280N | **F280N** | ~0.40 | **0.04** | ~6.14 | **0.57** |
| | **F308N** | | **0.19** | | **2.98** |

**Apart from open and neutral filters (NF), we need additional medium-band (~ 400 Å) filters to get at least SNR = 50 over reasonable exposure times !**