Revealing the heaviest, highly-accreting SMBHs at the heart of hyper-luminous quasars

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The WISSH quasars project
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... and many others

At the brightest end of the AGN luminosity function

"Looking for AGN feedback in action: where to observe?"

Theory

e.g. Menci+08, Faucher-Giguère&Quataert 2012
Zubovas&King 2012

Observations

e.g. Cicone+14, Feruglio+15

The more luminous is the AGN the higher is the momentum rate $\dot{M}v \sim 20–50\ L_{Edd}/c$

The most luminous quasars are potentially the best targets to hunt for powerful AGN-driven outflows

- ***Theory predicts: "Blow-out phase during the transition from buried AGN to blue QSO"***

  —> Dust-reddened, red, IR-loud QSOs are primary targets

  —> Sampling LARGE areas at X-ray and Mid-IR to overcome obscuration biases
  (but most of X-ray and Spitzer/Herschel surveys are "small-area" surveys)

The WISSH Quasars survey

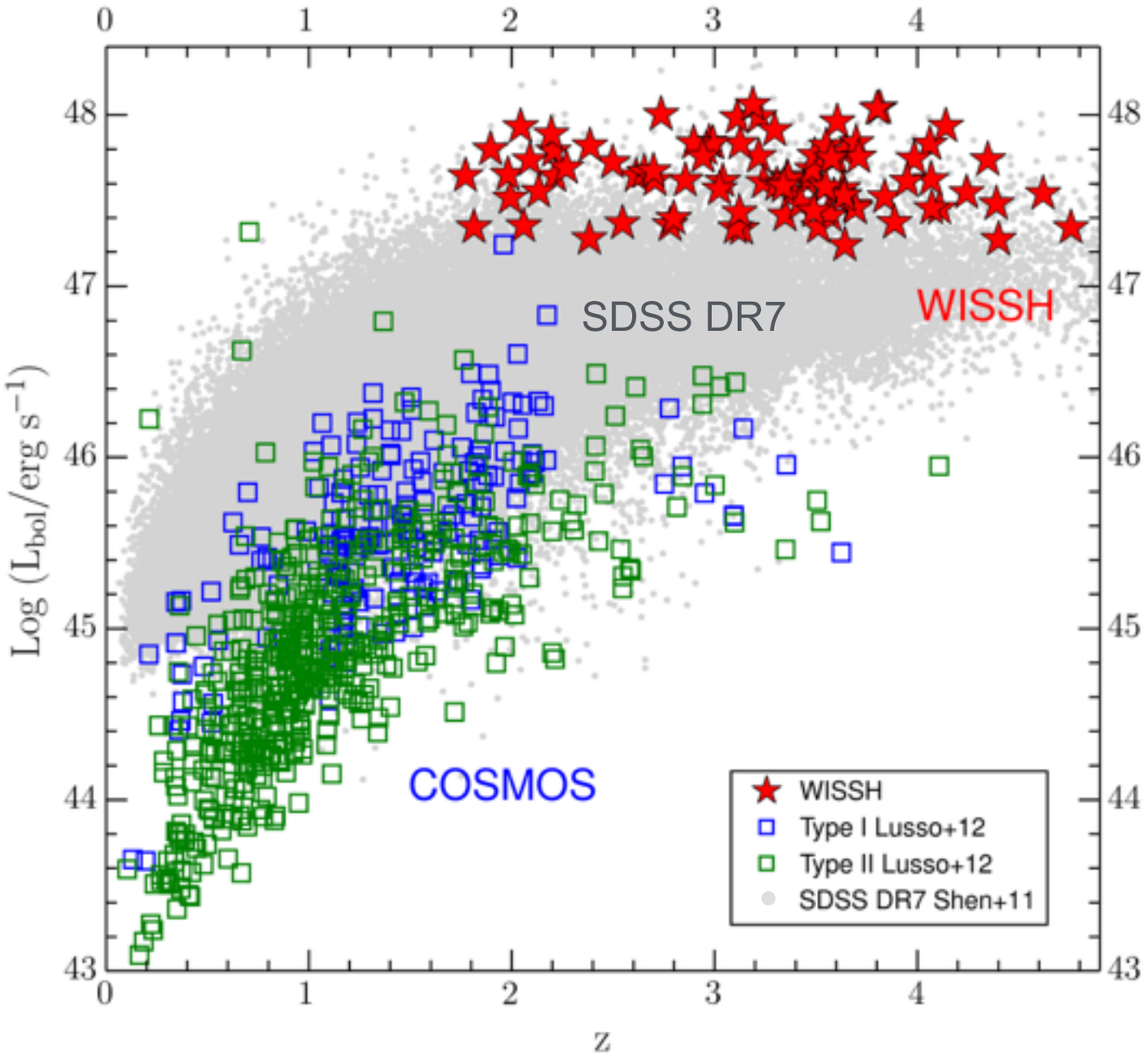
Cross-correlating WISE ALL-SKY Survey at 22 μm with SDSS broad line QSO at 1.5 < z < 4.5

Weedman+12

WISSH Quasars

WISE/SDSS Selected Hyper-luminous Quasars

86 broad-line Quasars with $L_{Bol} > 2 \times 10^{47}$ erg/s



The most luminous broad-line IR-loud AGN

Primary targets to search for AGN feedback at z ~ 2 - 4

Targeting WISSH Quasars

Extensive multi-λ observing program
Panchromatic view of Hyper-Lum QSOs
Nuclear, winds & host galaxy properties

- **XMM & Chandra** X-rays
- **LBT/LUCI - TNG** Hβ + [OIII]
- **SINFONI** IFU Spec Hβ + [OIII] + Hα
- **X-shooter** Hβ + CIV + MgII
- **ALMA** CII + FIR continuum
- **+ Herschel - WISE - 2MASS - SDSS** public

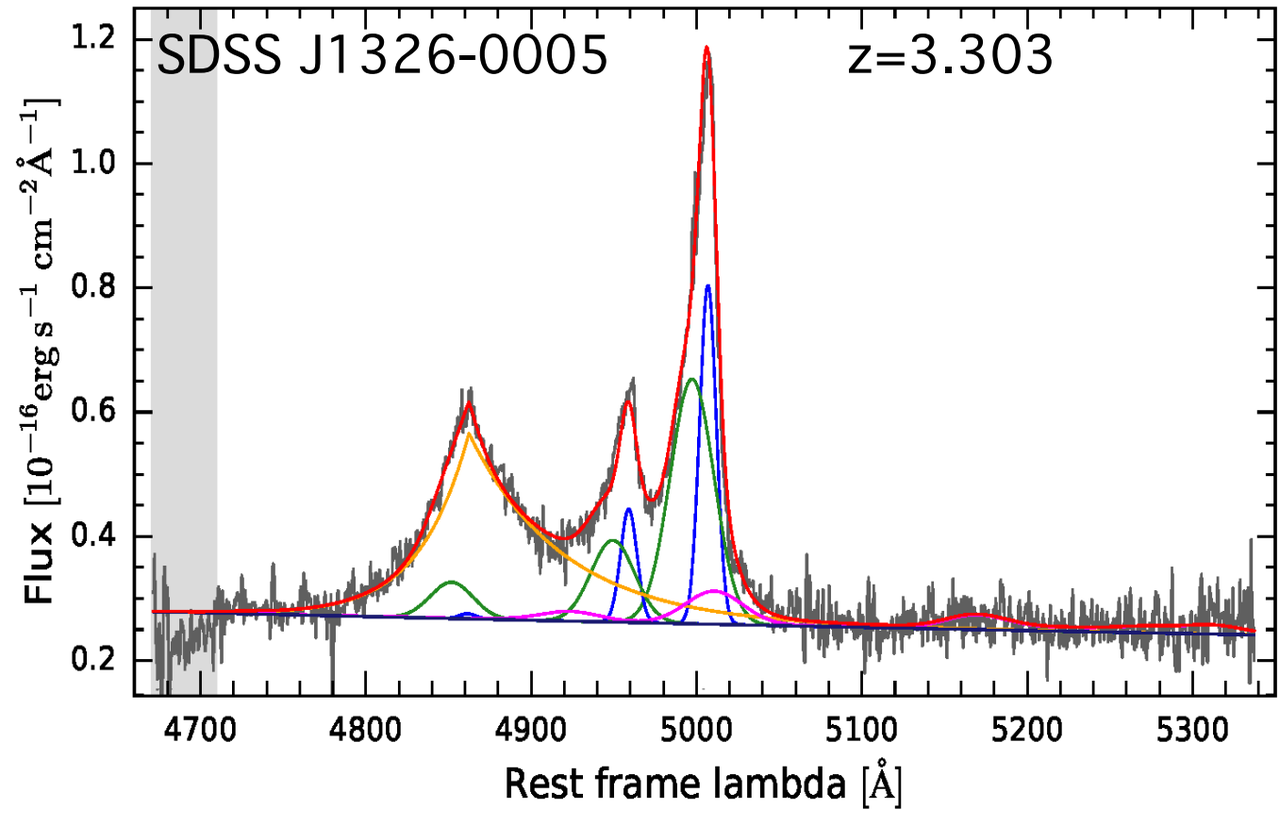
This talk:

LBT/LUCI Spectroscopy to investigate [OIII] and Hβ emission on 18 targets (21 more expected within 2017)

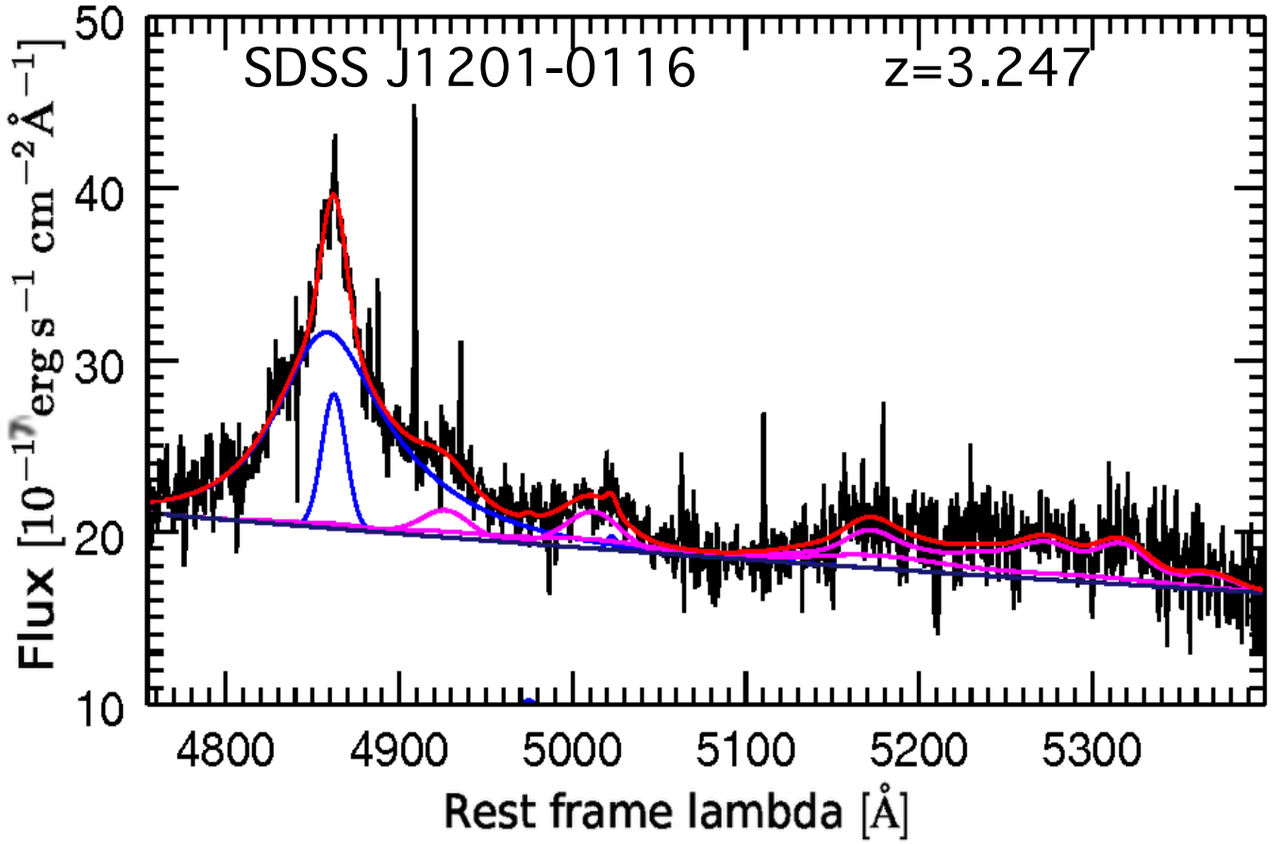
Goals: **revealing ionised outflows**
measuring SMBH mass and λ_{Edd}

LBT view of WISSH Quasars

30% presence [OIII] emission

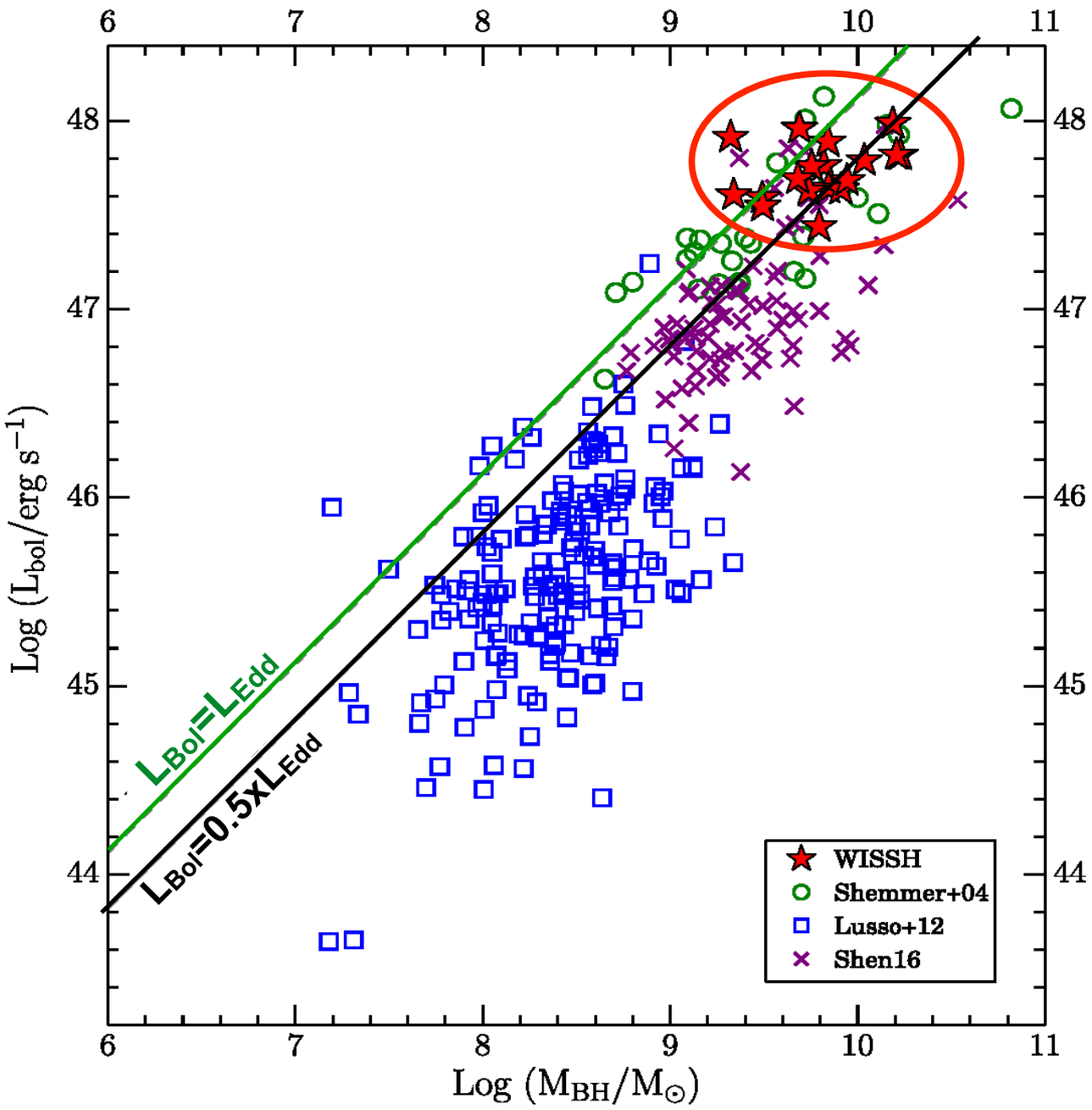


70% lack of [OIII] emission



- **Very complex spectra: skewed-asymmetric broad [OIII] and Hβ lines strong-complex FeII emissions**
- **Narrow [OIII] emission weak or absent in all of them**
- **If present, [OIII] shows broad blue-shifted profiles (in 5/18 quasars) indicative of outflows**

Revealing ultra-massive, highly accreting SMBH

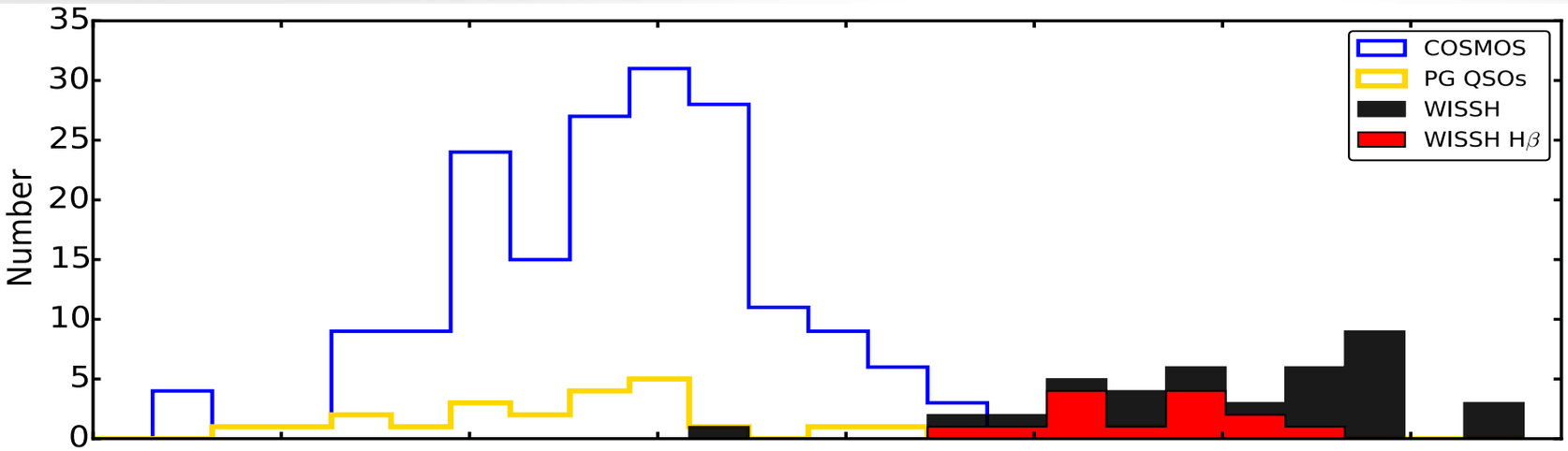


- **Hβ-based SMBH masses**
  from ~ 2 × 10^9 M⊙
  up to ~ 2 × 10^{10} M⊙

- **L_{Bol} from multi-component broad-band (far-IR to UV) SED fitting**
  (Duras et al. in prep)

WISSH QSOs populate the massive end of the BH mass function at z ~ 2.5 - 3.5

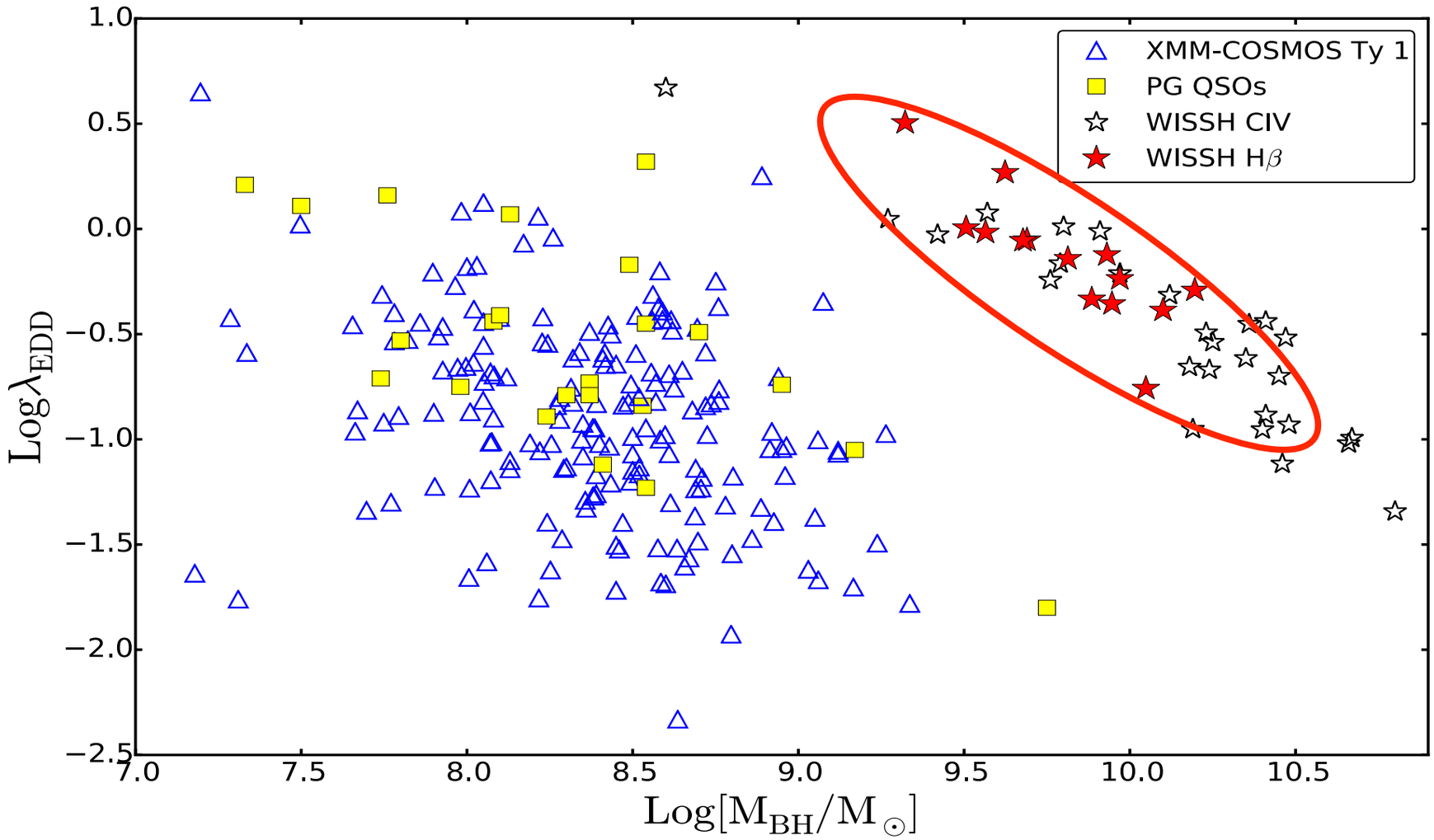
WISSH vs "typical" AGN SMBHs

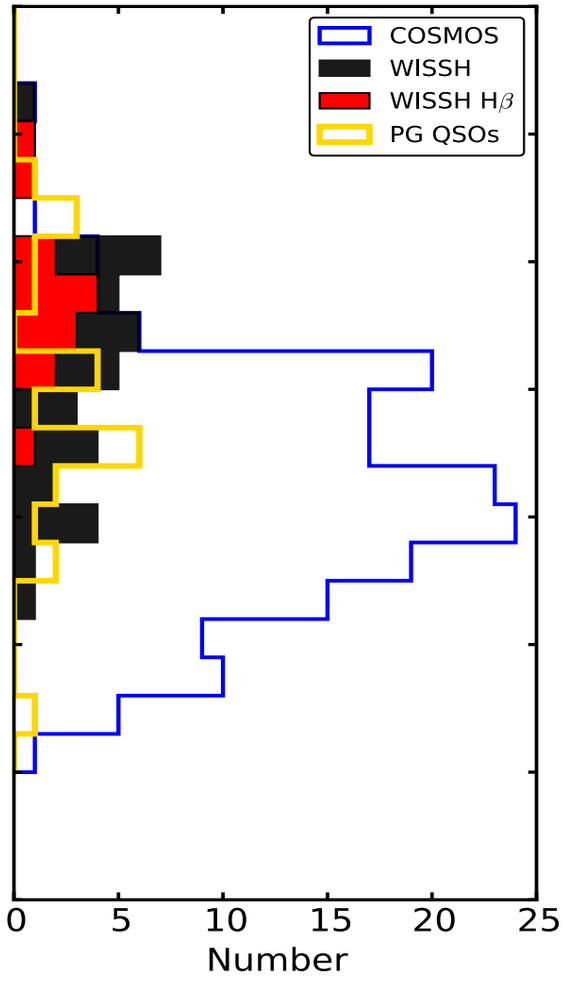


- **high accretion rates**

$$0.4 < \lambda_{Edd} < 3$$

(Martocchia et al. in prep)

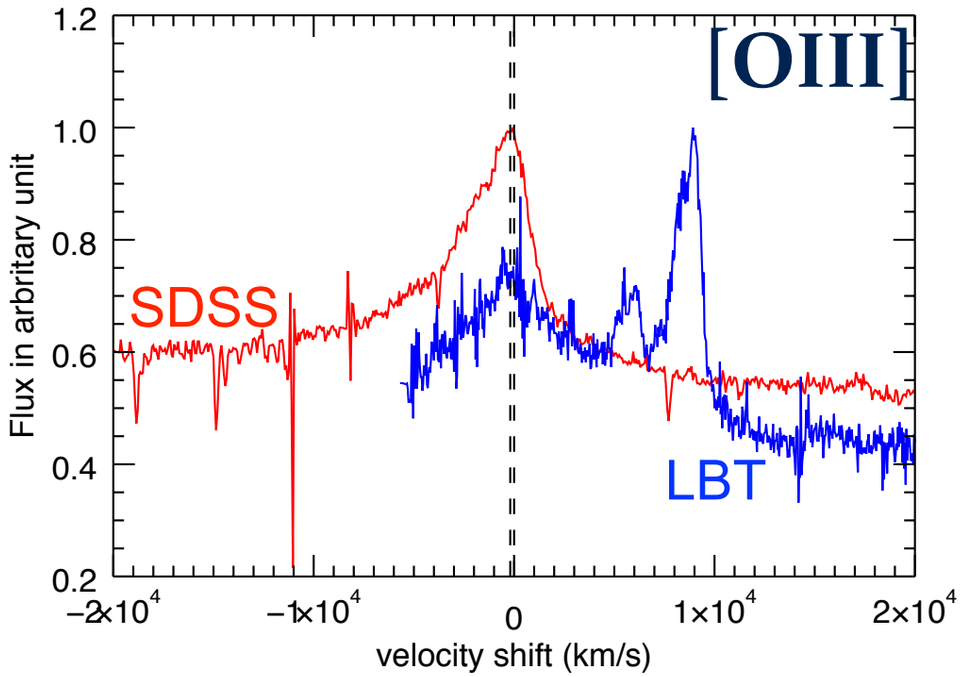


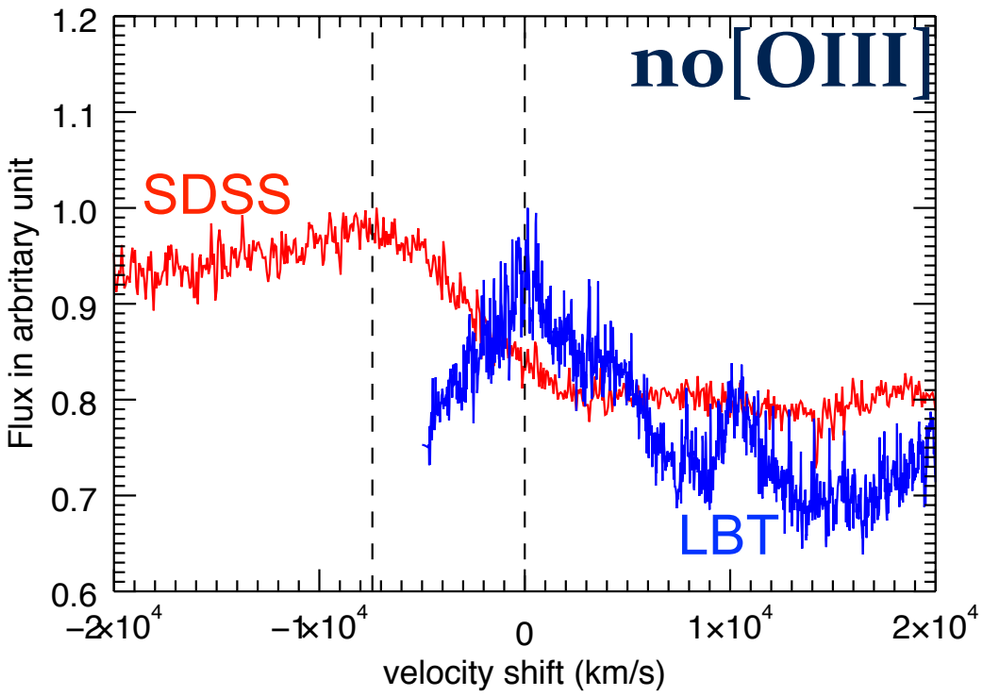


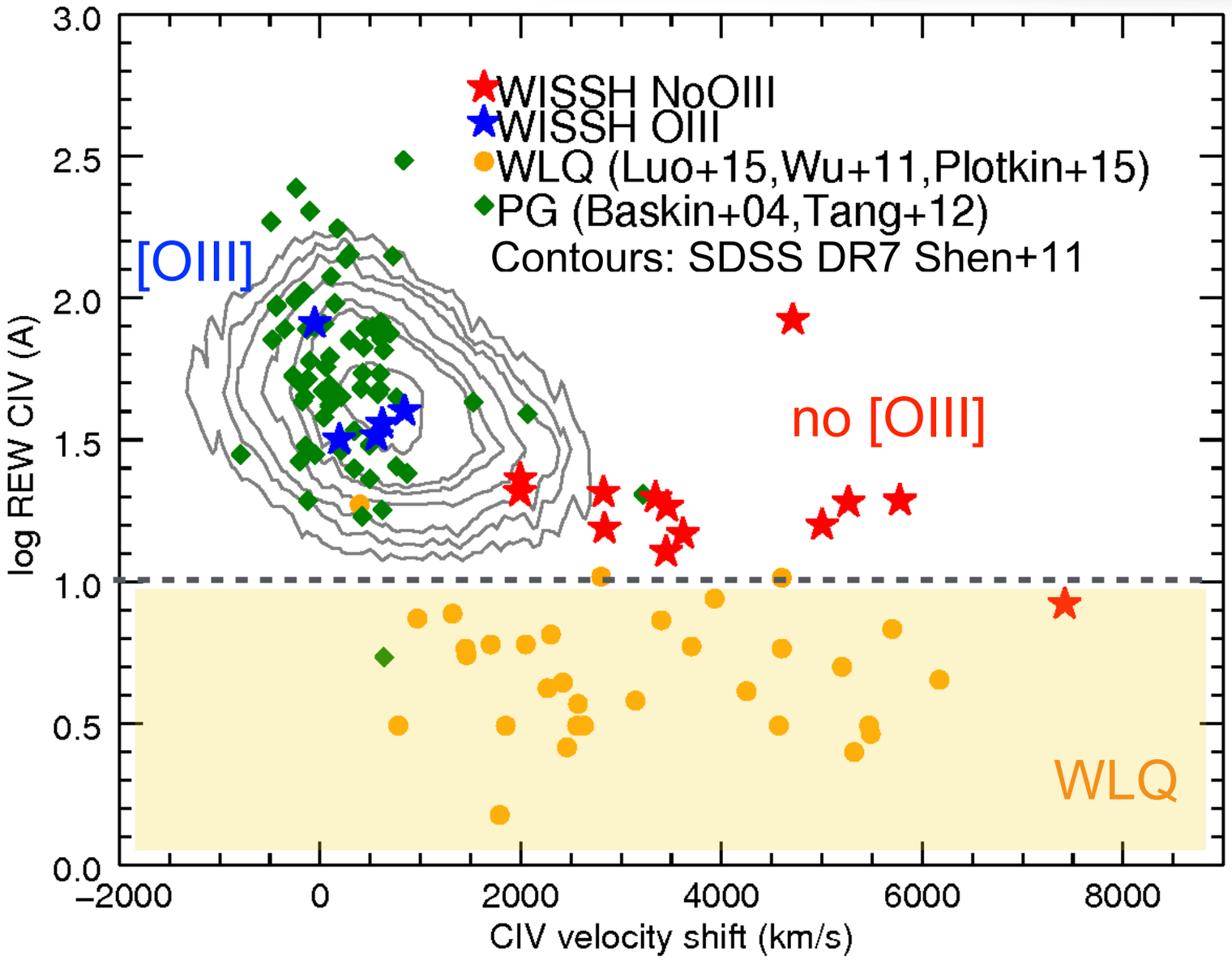
Opportunity of collecting high-mass, highly accreting SMBHs at the peak of the quasars number density

BLR winds vs [OIII] winds: a dichotomy

CIV-Hβ velocity shift







If [OIII] -> small shift (< 1000 km/s)

If no [OIII] -> large shift (> 2000 km/s)

Large shifts —> Radiatively driven winds dominating the BLR kinematics

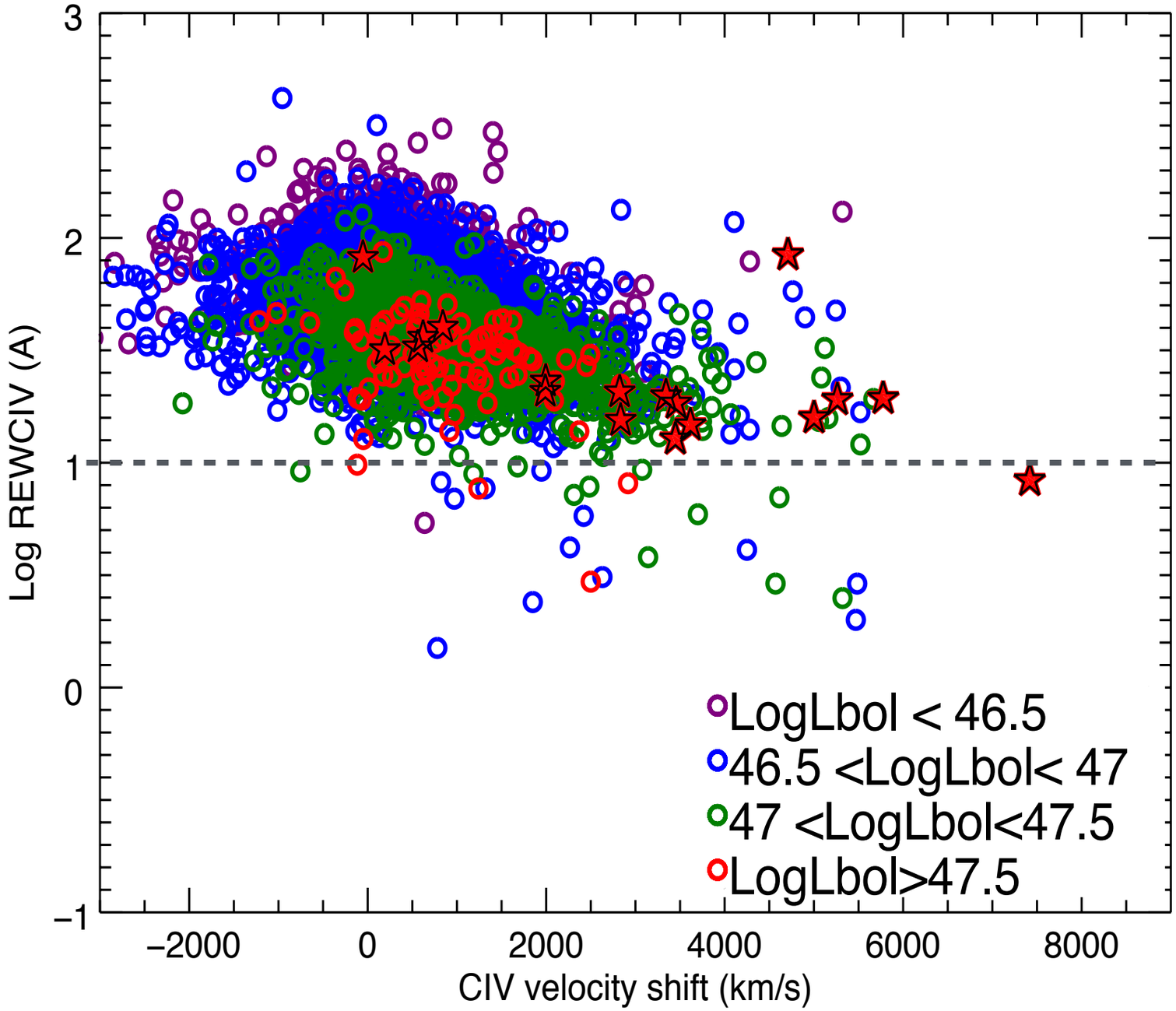
(Vietri et al. in prep)

BLR winds vs Bolometric Luminosity

Larger shifts with increasing L_{Bol}

Lower EW with increasing L_{Bol}

Baldwin effect

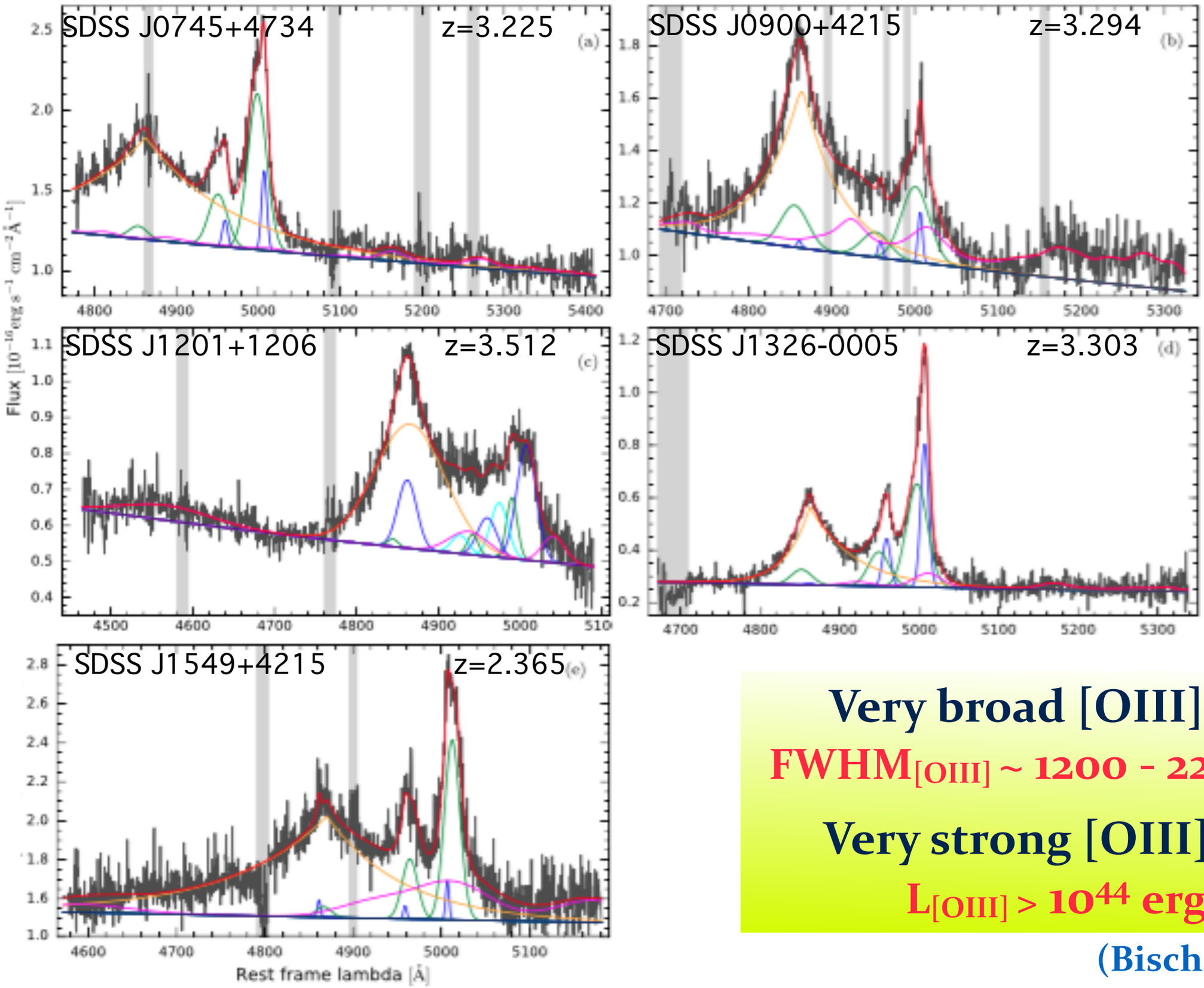


SDSS DR7
1.5 < z < 2.2
(Shen+2011)
+
★WISSH

...Work in progress

(Vietri et al. in prep)

Prominent [OIII] emission in WISSH quasars



Very broad [OIII] lines

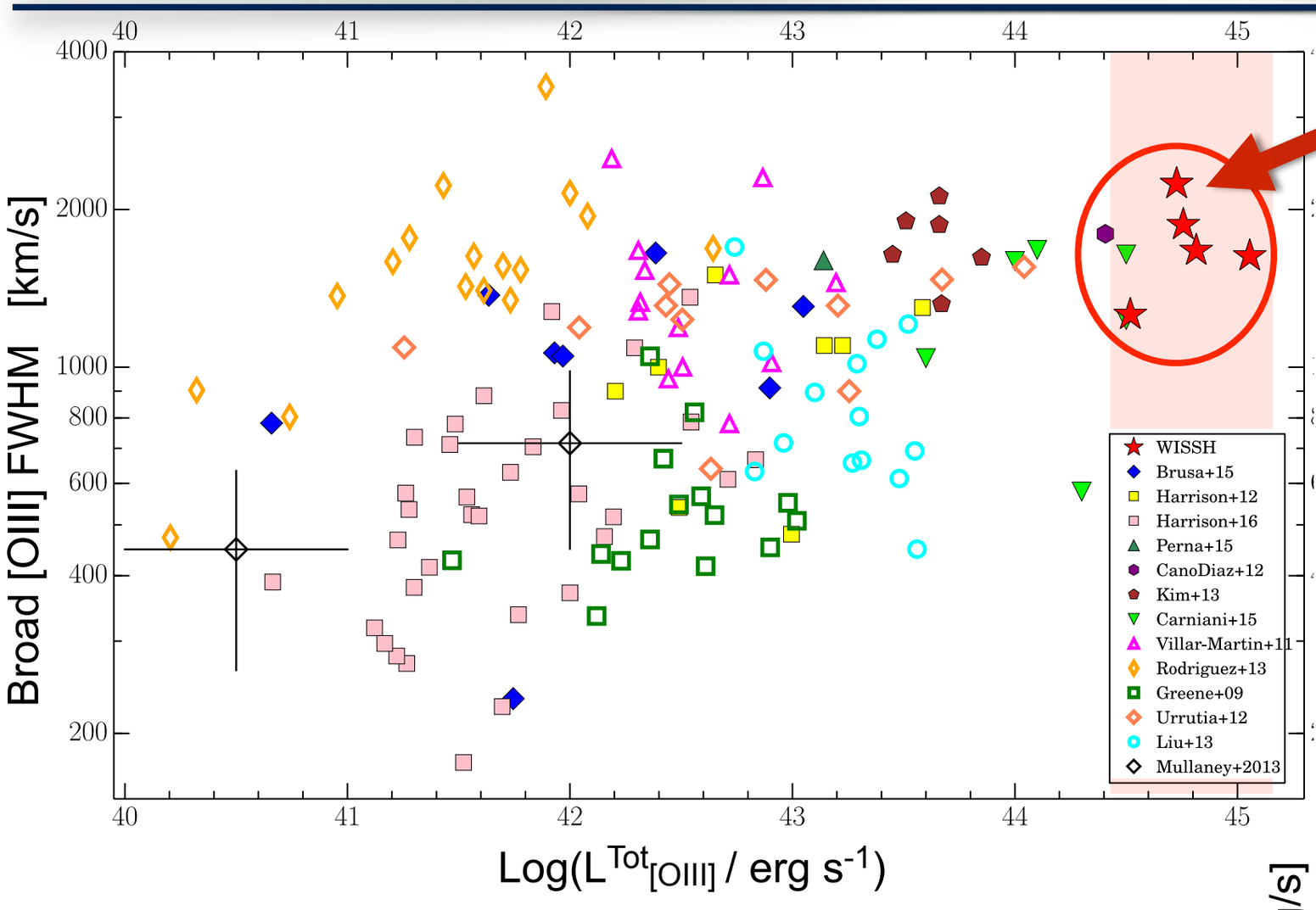
$FWHM_{[OIII]}$ ~ 1200 - 2200 km/s

Very strong [OIII] lines

$L_{[OIII]} > 10^{44}$ erg/s

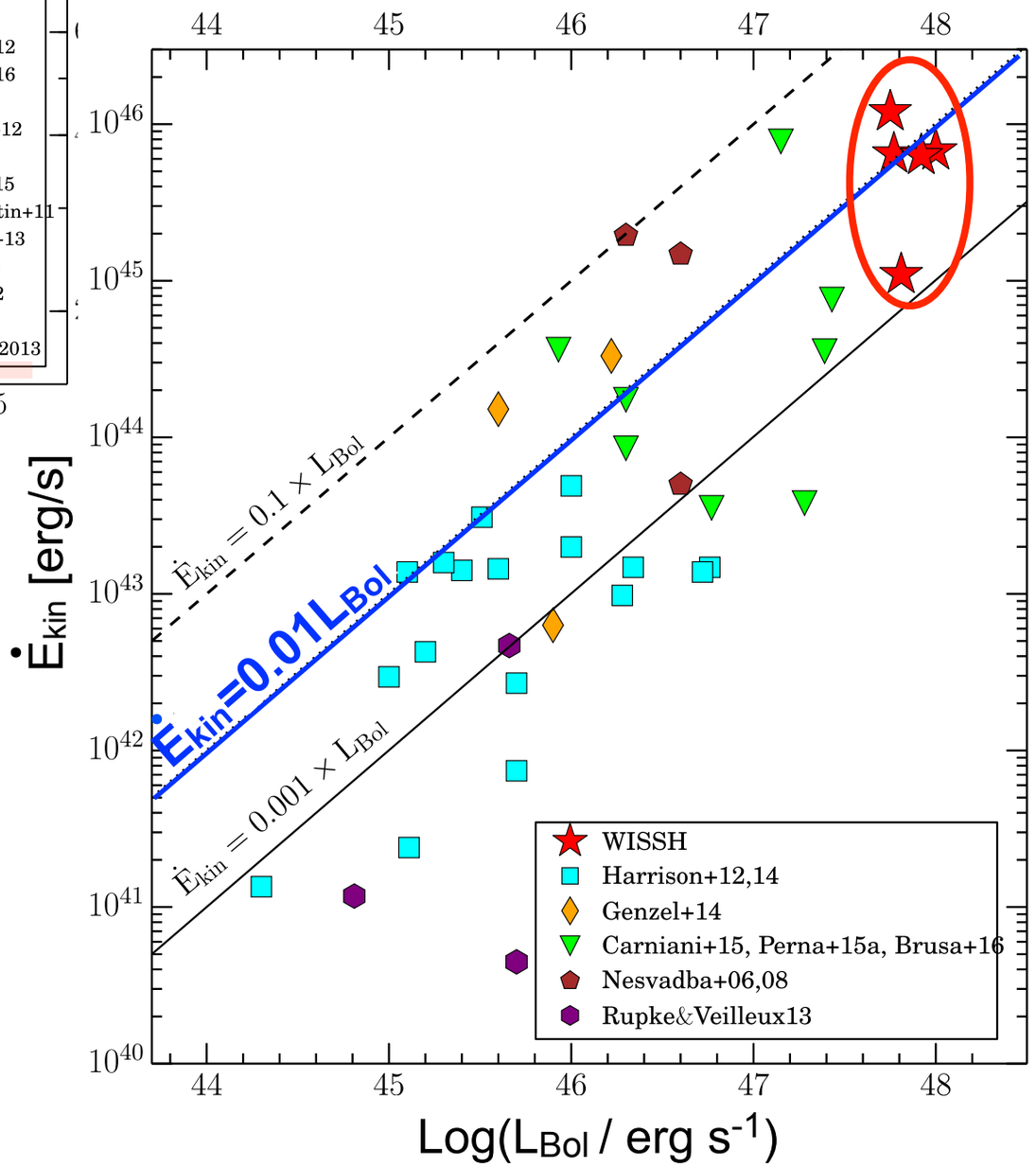
(Bischetti+2016 sub)

Powerful [OIII] outflows in WISSH Quasars



WISSH: max Lum[OIII]

$\dot{E}_{kin}$ ~ 1-3 % L_{Bol}



The [OIII] outflows are strong

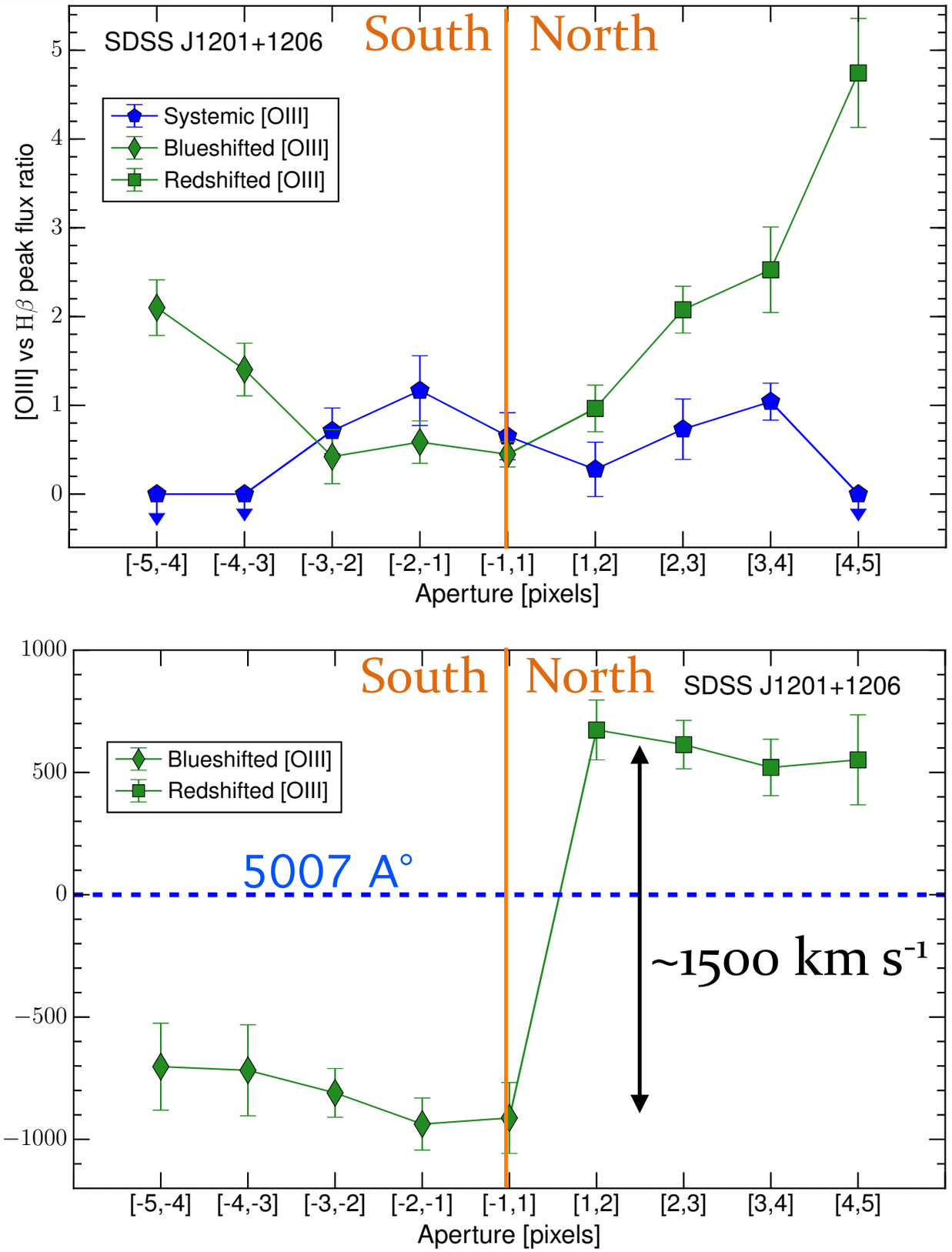
$\dot{M}$ up to ~ 8000 M⊙/yr

$\dot{E}_{kin}$ up to ~ 10^{46} erg/s

larger fraction of L_{Bol} than lower luminosity AGN

(Bischetti+2016 sub)

Extended fast [OIII] in SDSSJ1201+1206



(Bischetti+2016 sub)

An increased [OIII]/Hβ(BLR) flux ratio indicating

truly extended outflowing gas

Extended (up to ~7 kpc) fast [OIII] emission

blue- red-shifted components tracing a

Bipolar outflow

IFU/SINFONI data incoming...

Conclusions

- The WISSH sample consists of 86 hyper-luminous, IR-loud, broad-band AGN at $2 < z < 5$ with $L_{Bol} > 2 \times 10^{47}$ erg/s
- Ongoing multi-lambda observing programs (LBT, SINFONI, CHANDRA, ALMA) investigating nuclear, outflows, host galaxy properties

Results from LBT observations (18 targets):

- SMBH (2×10^9 M⊙ up to 2×10^{10} M⊙) at the massive end of the BH mass function
- High accretions rates $(0.4 < \lambda_{Edd} < 3)$
- BLR winds with CIV shifts 2000 - 7000 km/s (70 %)
- Narrow [OIII] emissions weak/absent
- If present (30%), broad [OIII] (FWHM ~ 2000 km/s) indicative of outflows
  highest broad [OIII] luminosities observed so far (up to 10^{45} erg/s)
  the associated kinetic power is ~ 1–3 % L_{Bol}
- BLR winds - [OIII] dichotomy

Incoming SINFONI and ALMA data will give an insight about the spatial extent of outflows and their impact on the host galaxies