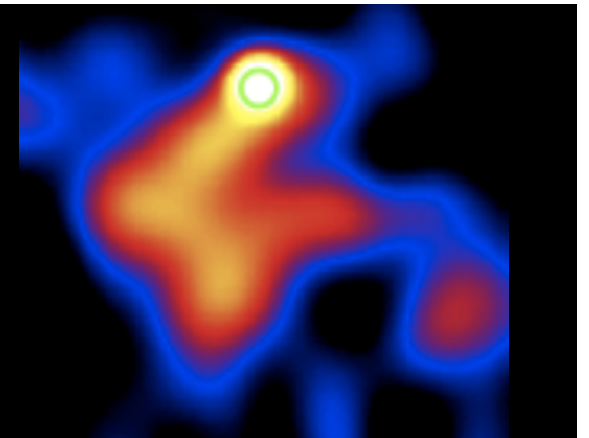
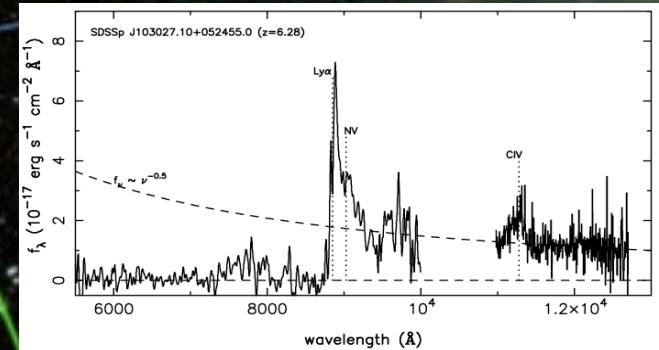


The J1030 deep field: an INAF legacy field

SDSSJ1030+0524 at $z=6.31$

Roberto Gilli (INAF – OAS Bologna)

M. Mignoli, R. Nanni, B. Balmaverde, M. Brusa, F. Calura,
G.B. Caminha, N. Cappelluti, M. Cappi, M. Chiaberge,
A. Comastri, T. Costa, Q. D'Amato, R. Decarli, K. Iwasawa,
G. Lanzuisi, E. Liuzzo, C. Norman, M. Paolillo, A. Peca,
I. Prandoni, G. Risaliti, P. Rosati, E. Sani, P. Tozzi,
E. Vanzella, C. Vignali, F. Vito, G. Zamorani

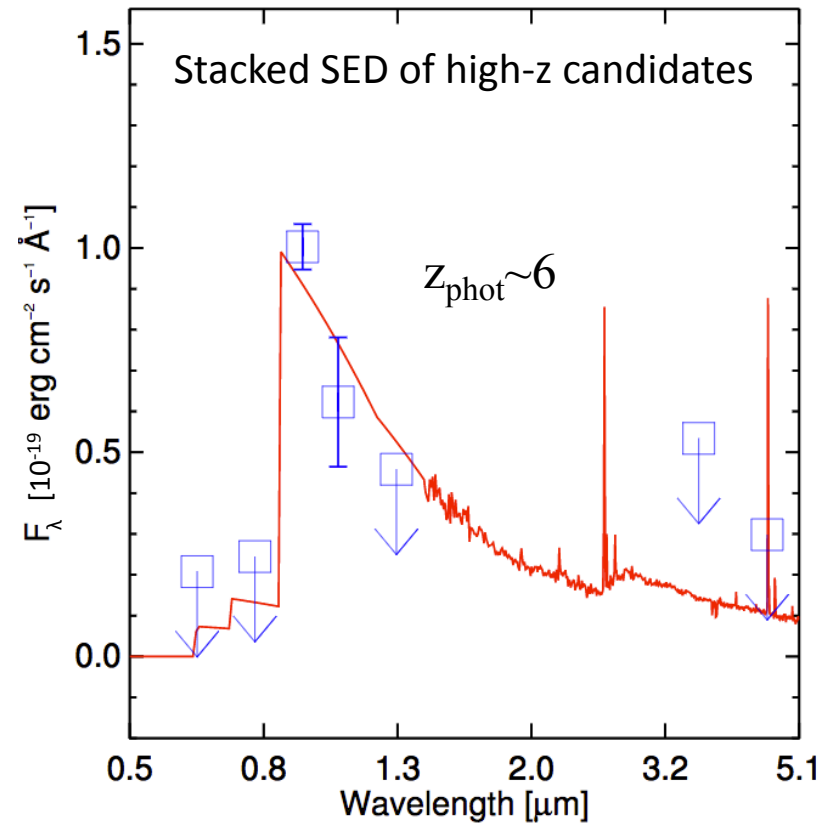
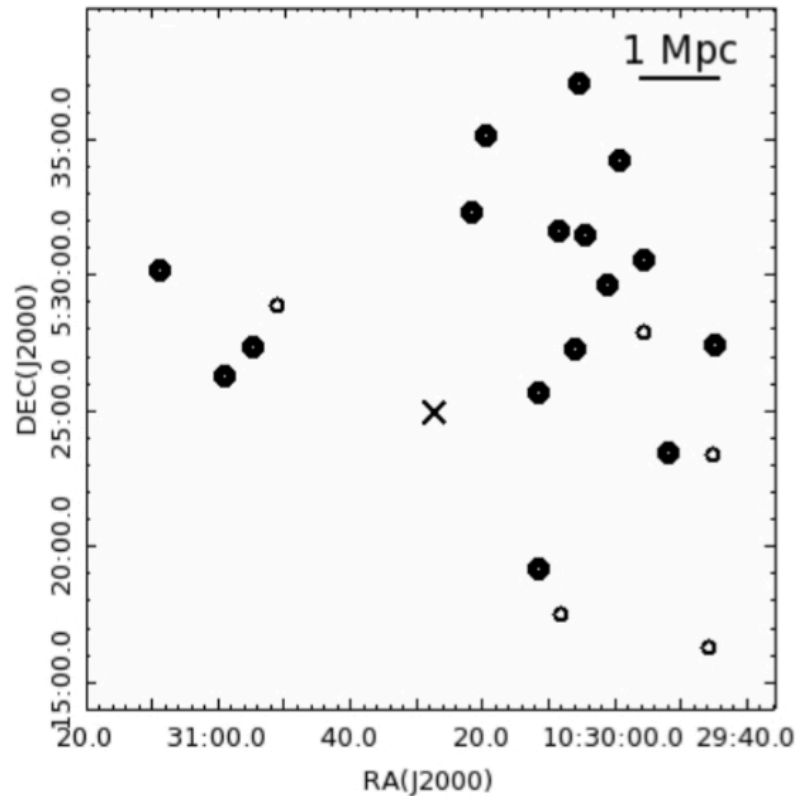


Peculiar field: candidate overdensity around a $z=6.3$ QSO

LBT/LBC + CFHT/WIRCAM [rizYJ](#): 20 LBG candidates, $z_{AB} < 25.5$

[Morselli+14](#)

[Balmaverde+17](#)

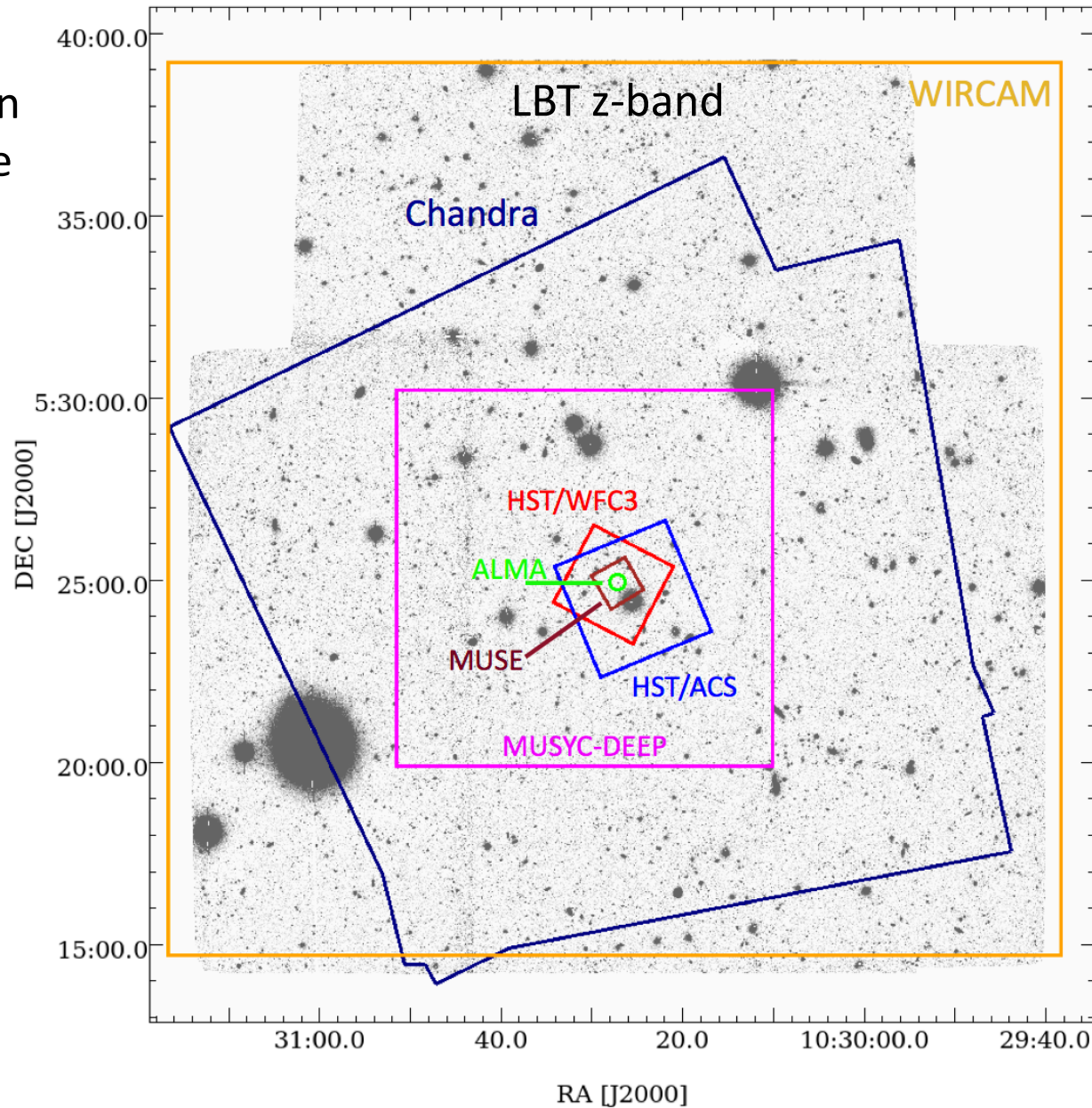


>4 σ overdensity: biased region of the early Universe

→ need confirmation: spectroscopy + multi- λ coverage

The multi- λ deep survey in the SDSS J1030 field

24 arcmin
on a side



Dense coverage

Opt/NIR

UBVRizJHK (MUSYC)

riz (LBT/LBC)

riz, NB_{CIV} (Subaru)

YJ (CFHT/WIRCAM)

MIR

Spitzer/IRAC

FIR/mm

AzTEC

X-ray

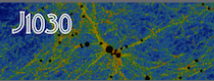
Chandra

XMM

Radio

VLA

Data collected and released at: <http://www.oabo.inaf.it/~LBTz6/1030/>

 <ul style="list-style-type: none">- Home- Team- Publications- Data- LBT z~6 QSOs- Internal	Multi-band data				
	Band	Survey/Instrument	Area	Depth(5 σ)	Status/Refs/Notes
	X-ray 0.5-7 keV	Chandra/ACIS-I	17' x 17'	1.7×10^{-16} erg/cm ² /s	Nanni+18
	X-ray 0.3-10 keV	XMM	30' diameter	1.0×10^{-15} erg/cm ² /s	Farrah+04 - reanalyzed data
	Opt - U B V R i z	MUSYC Wide	30' x 30'	m _{AB} = 25-26	Blanc+08
	Opt - r i z	LBT/LBC	23' x 25'	m _{AB} = 25, 26, 27.5	Morselli+14
	Opt - r i z	Subaru/Suprime-Cam	27' x 34'	m _{AB} = 26-28	Diaz+14
	Opt - F775W F850LP	HST/ACS	3.3' x 3.3'	m _{AB} = 27.5	Stiavelli+05, Kim+09
	NIR - Y J	WIRCAM/CFHT	24' x 24'	m _{AB} = 24	Balmaverde+17
	NIR - J H K	MUSYC Deep	10' x 10'	m _{AB} = 23	Quadri+07
	NIR - K	MUSYC Wide	30' x 30'	m _{AB} = 21	Blanc+08
	NIR - F160W	HST/WFC3	2' x 2'	m _{AB} = 27.5	HST archive
	MIR 3.4-8.0 μ m	Spitzer/IRAC	~35' x 35'	[3.4] = 22.7	IRSA archive
	MIR 24 μ m	Spitzer/MIPS	~10' x 16'	[24] = 19.5	IRSA archive
	FIR - 1.2 mm	ALMA	0.4' FWHM	250 μ Jy	Decarli+17
	FIR - 3.5 mm	ALMA	1.1' x 2.2'	33 μ Jy	Priority B, Cycle6 - PI Gilli
	Radio - 1.4 GHz	VLA	30' FWHM	75 μ Jy	Petric+03 - reanalyzed data
	Radio - 1.4 GHz	JVLA	30' FWHM	7.5 μ Jy	Observed June 2018, PI Prandoni

Many imaging and spectroscopy programs with INAF PI-ship (LBT, CFHT, ALMA, PdBI). The largest are:

- 500ks Chandra Large Program
- 52hrs LBT strategic program
- 36hrs JVLA program (PI Prandoni, INAF-IRA)
- 36hrs VLT/FORS2 (PI Mignoli, INAF-OAS)

Chandra large program

500ks with ACIS-I, obs. Jan-May 2017

FoV~17'x17'

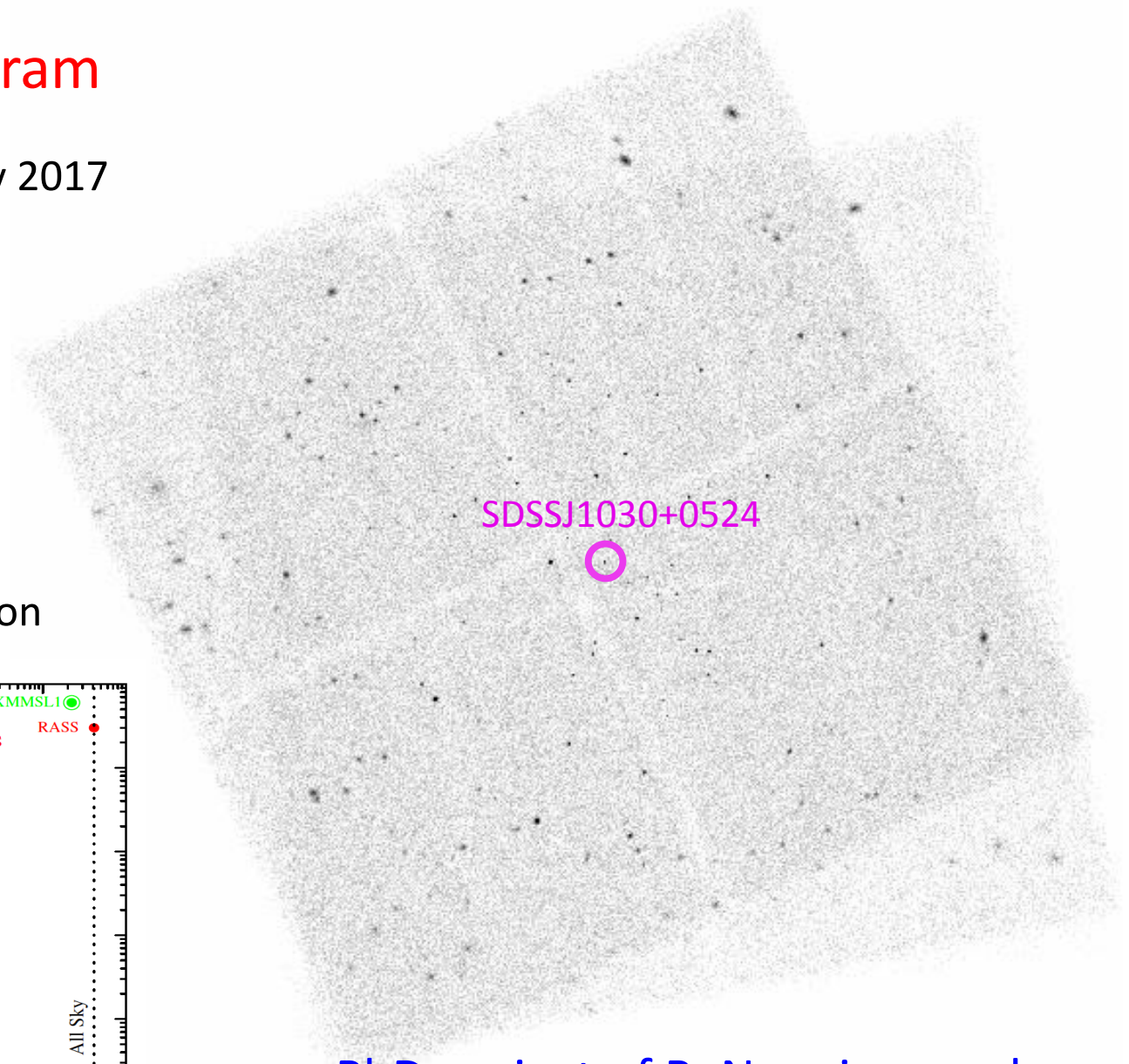
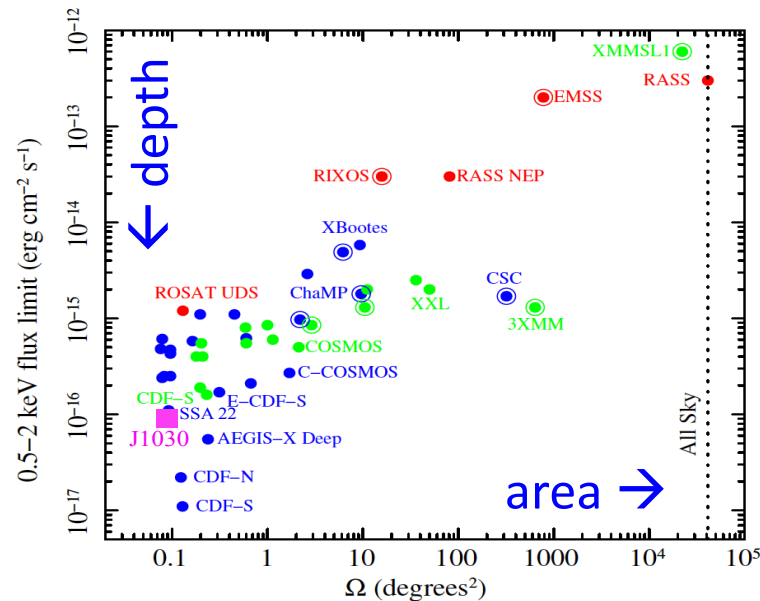
>250 X-ray sources

$F_{\text{soft}} > 9 \times 10^{-17} \text{ erg/cm}^2/\text{s}$

Nanni+ in prep.

4th deepest X-ray survey

only one in a high-z biased region



PhD project of R. Nanni + pre-doc fellow A. Peca (both INAF-OAS)

LBT strategic program, opt/NIR follow-up spectroscopy

52hrs approved in 2017:

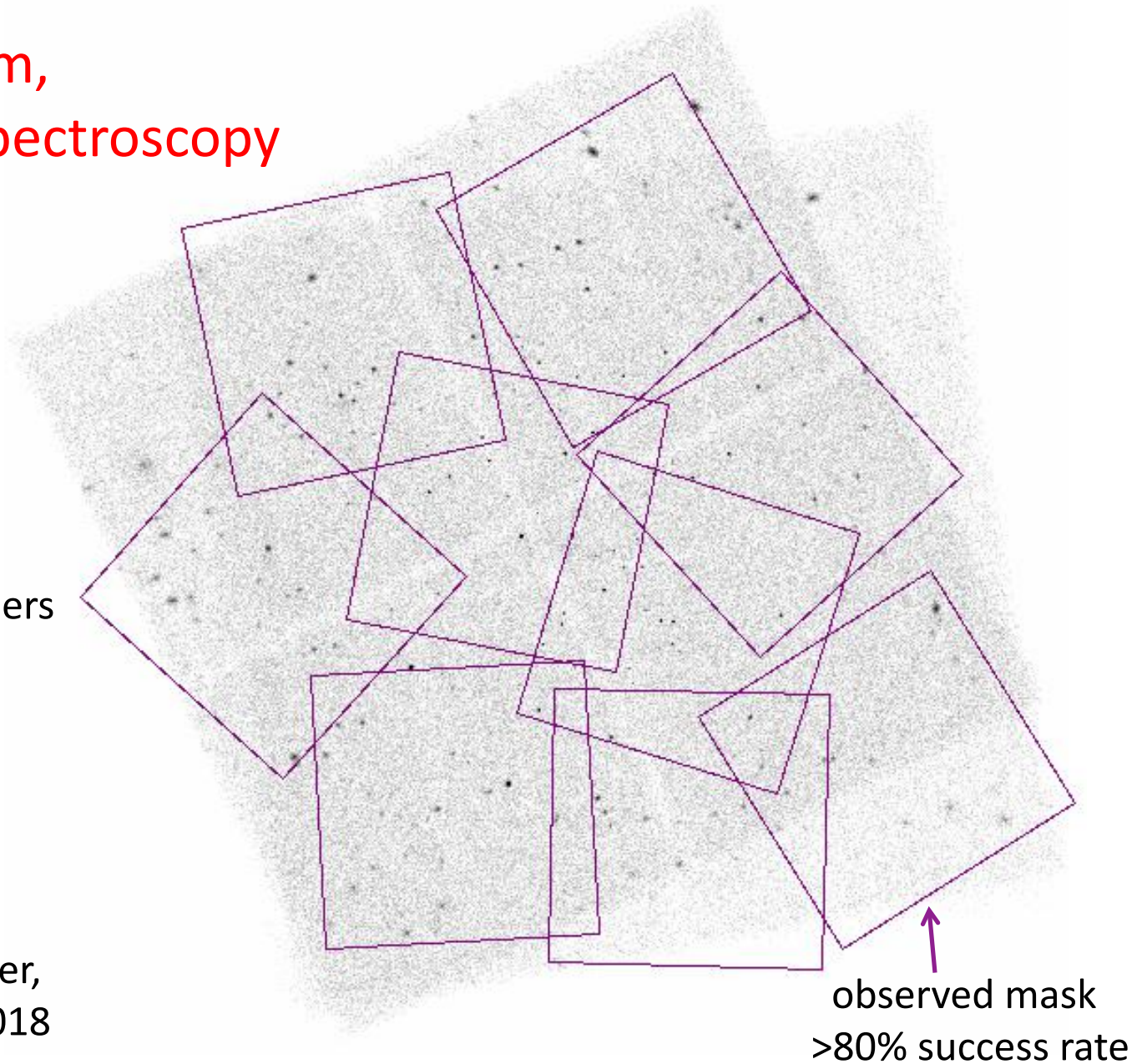
9 MODS masks, 4hr each
4 long slit LUCI, 4hr each

targets: ~200 X-ray sources
+ high-z and radio fillers

As of Dec 2018:

1/9 MODS masks observed
2/4 LUCI slits
(fully reduced and analyzed)

program has been carried over,
new obs. from now to Apr 2018



LBT strategic program, opt/NIR follow-up spectroscopy

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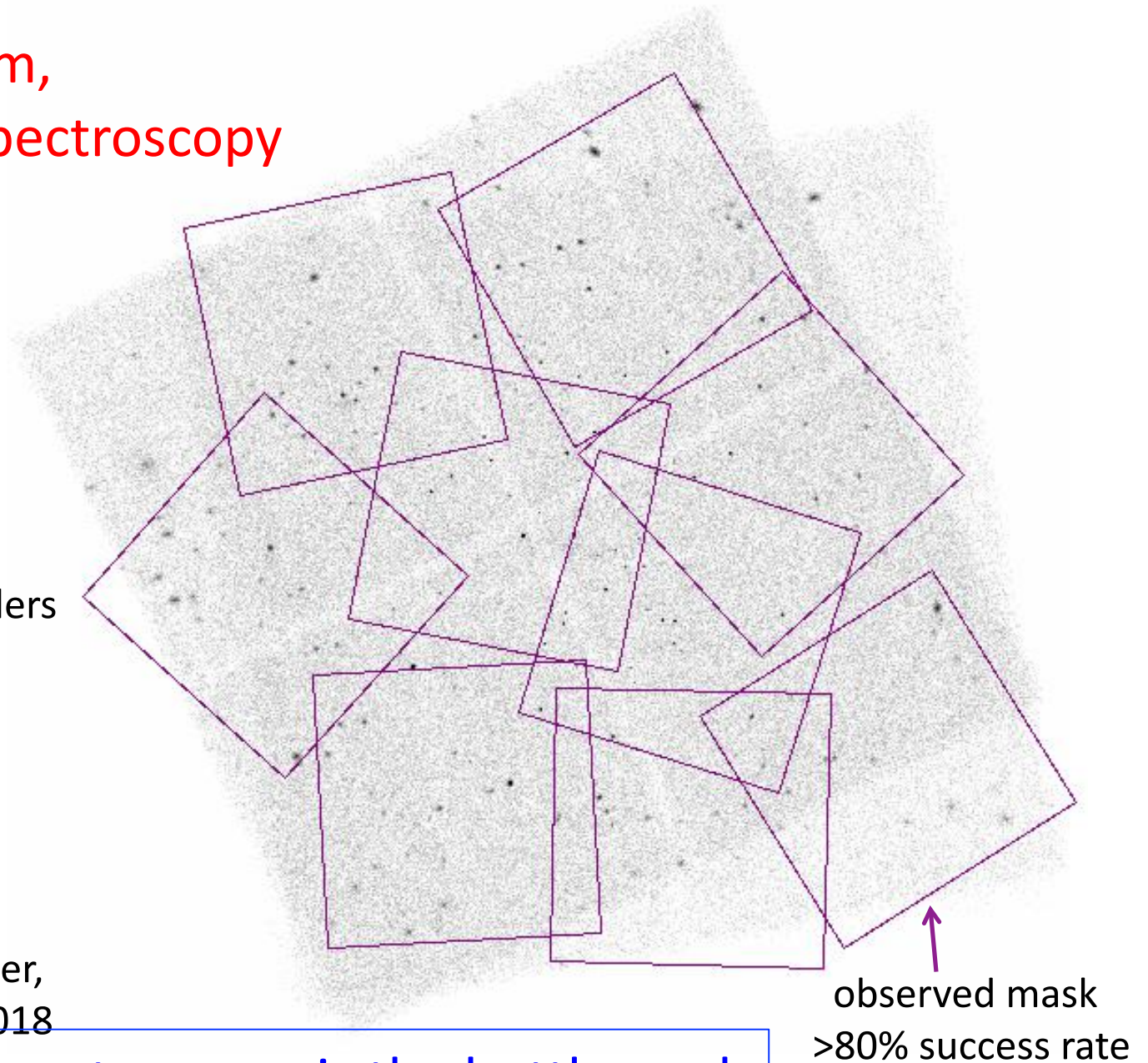
targets: ~200 X-ray sources
+ high-z and radio fillers

As of Dec 2018:

1/9 MODS masks observed
2/4 LUCI slits
(fully reduced and analyzed)

program has been carried over,
new obs. from now to Apr 2018

spectroscopy is the bottle-neck



JVLA deep μ Jy field

PI I. Prandoni

Obs. June 2018, [36hr](#), A-array

1.4GHz, 1.5'' res., 30' FWHM FoV

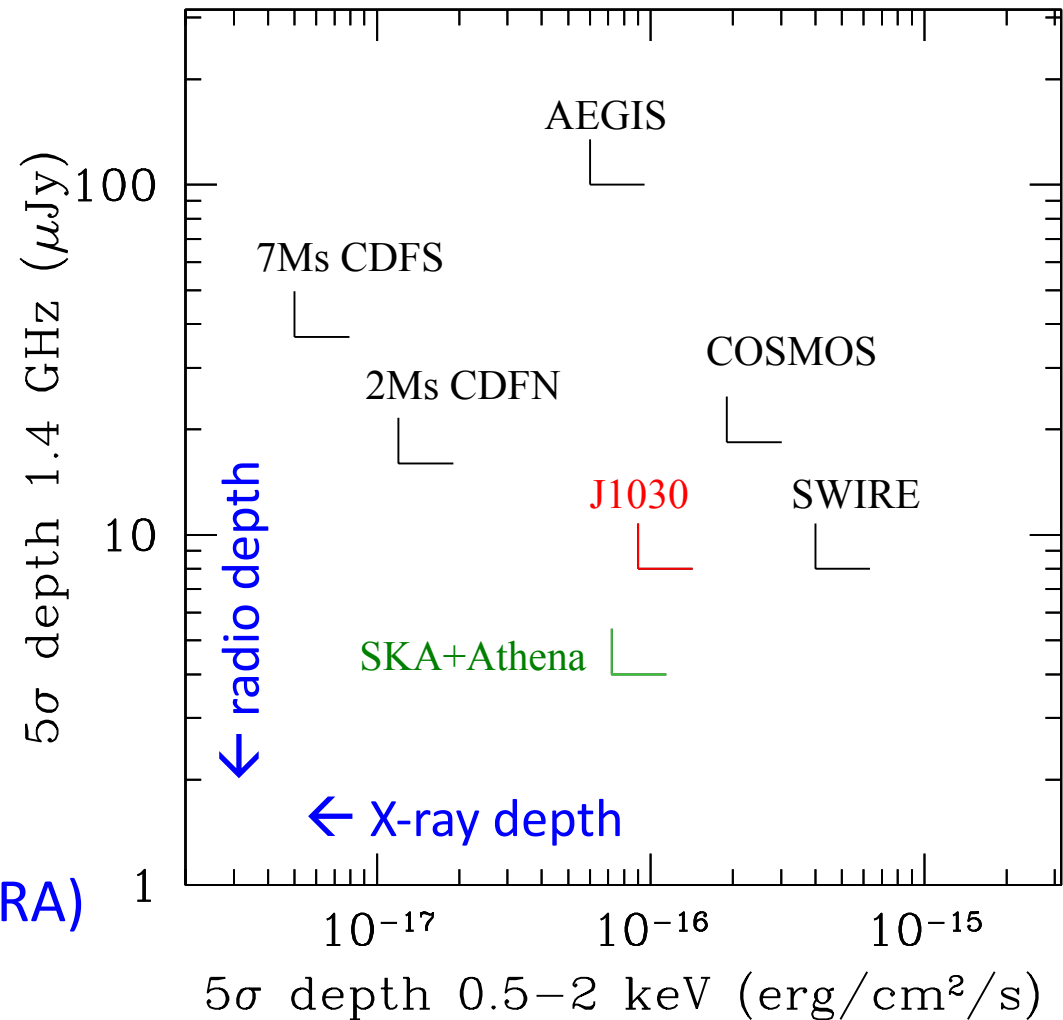
expected rms 1.7-1.8 μ Jy:

- i) 10x better rms than existing data
- ii) one of few μ Jy radio surveys
- iii) test field for SKA/Athena synergies

~4700 SFG expected

~1500 AGN

PhD project of Q. D'Amato (INAF-IRA)



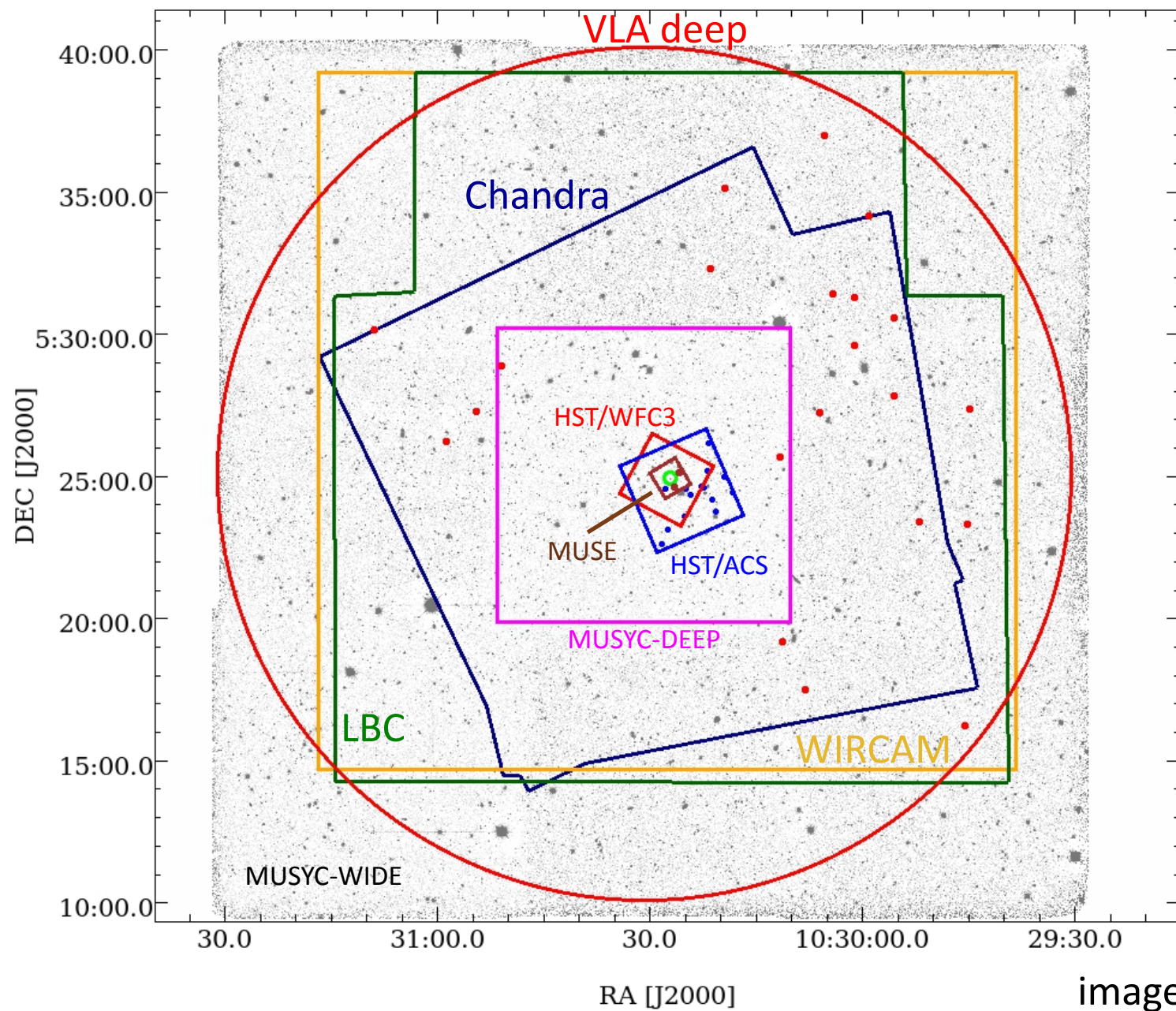


image 30' on a side

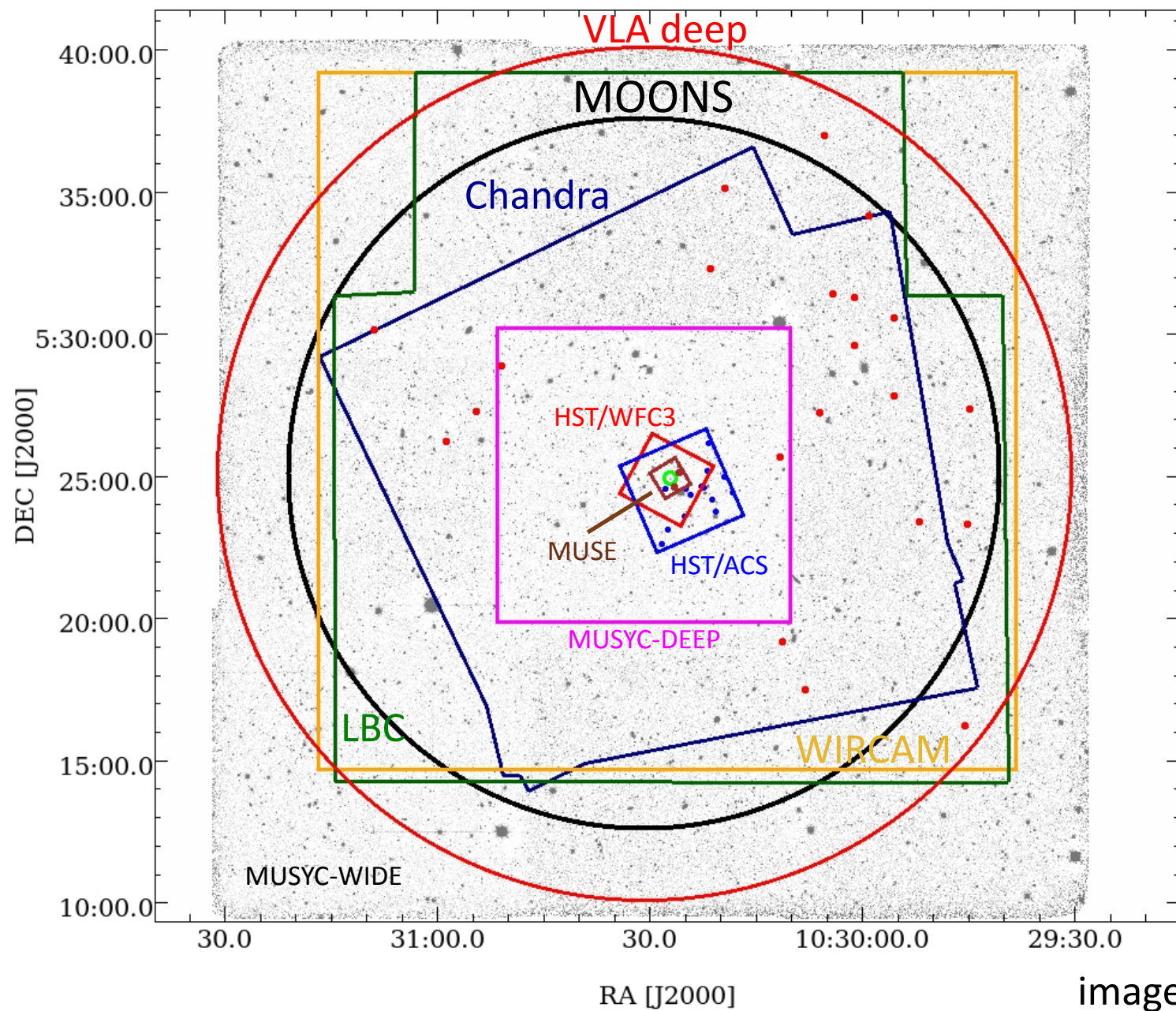
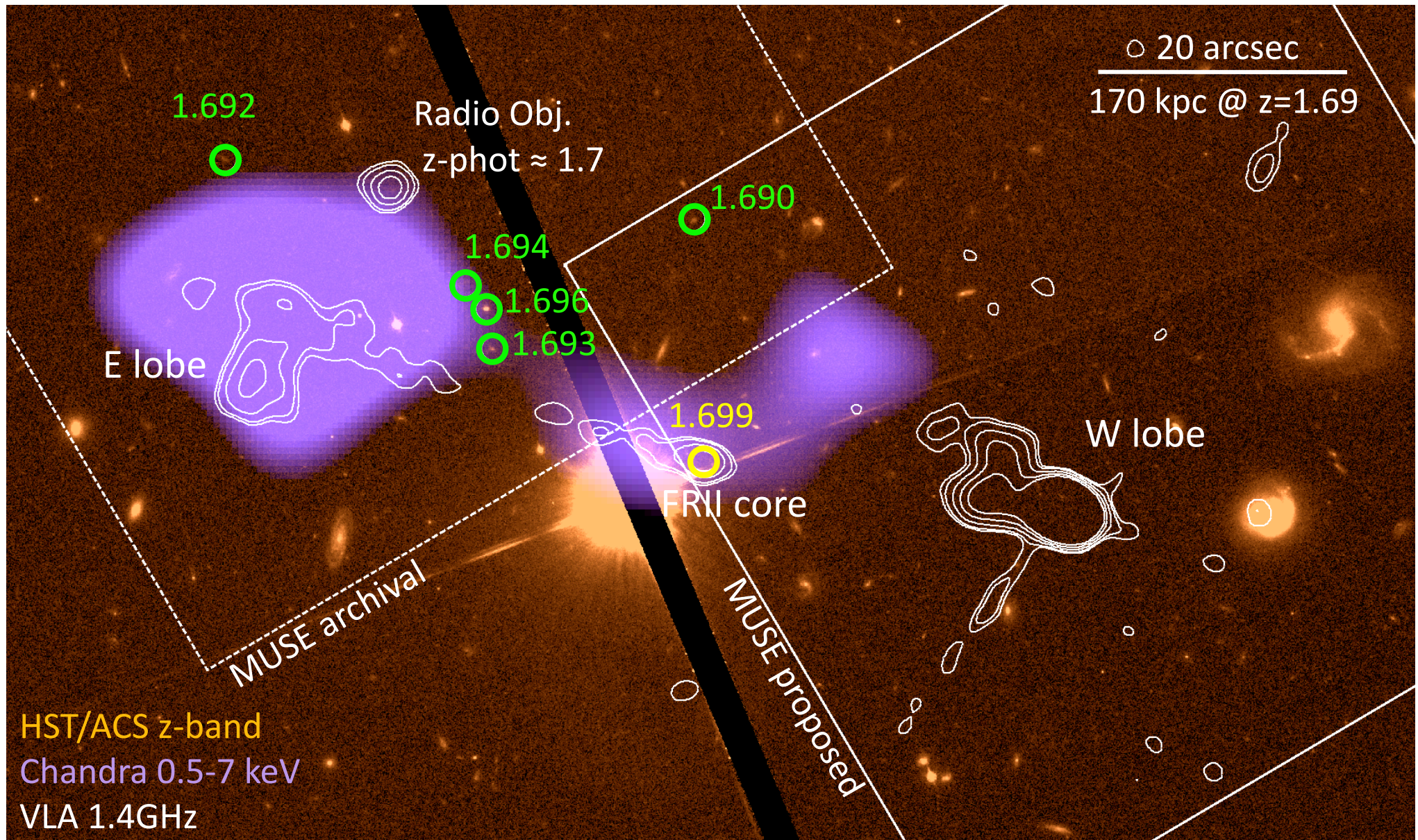
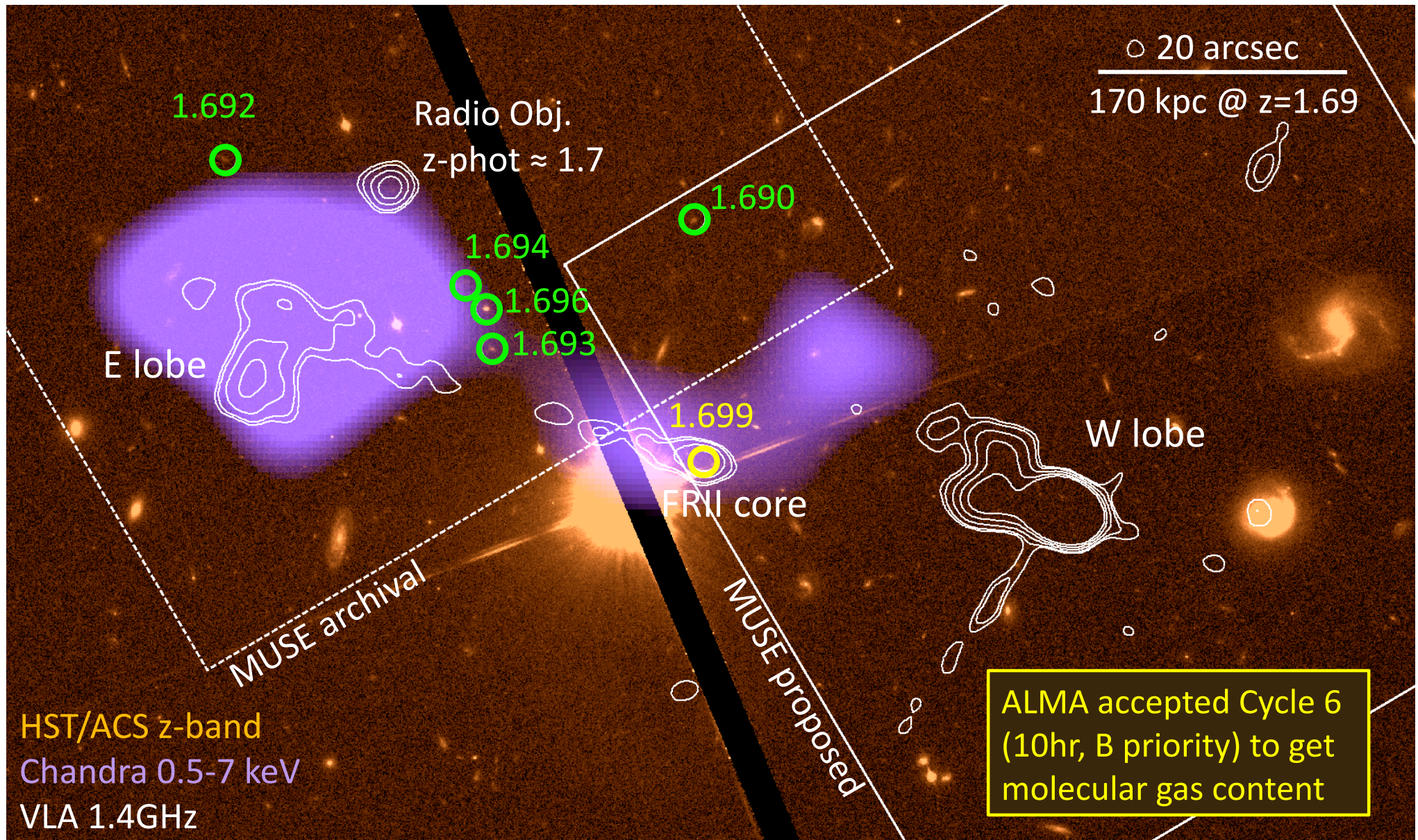


image 30' on a side

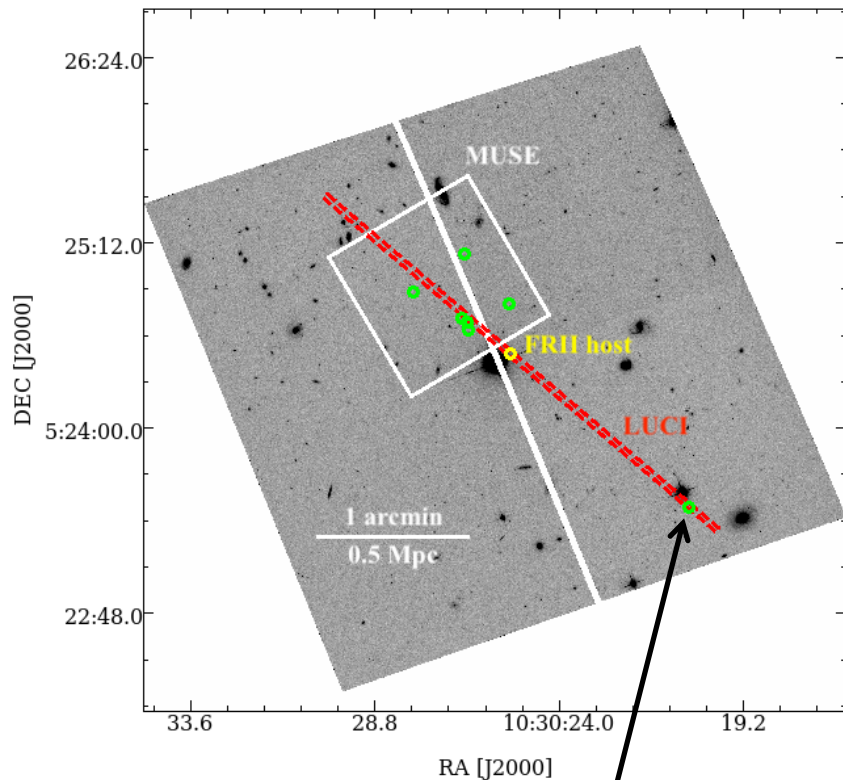
Proto-cluster around a Compton-thick FRII at $z=1.7$



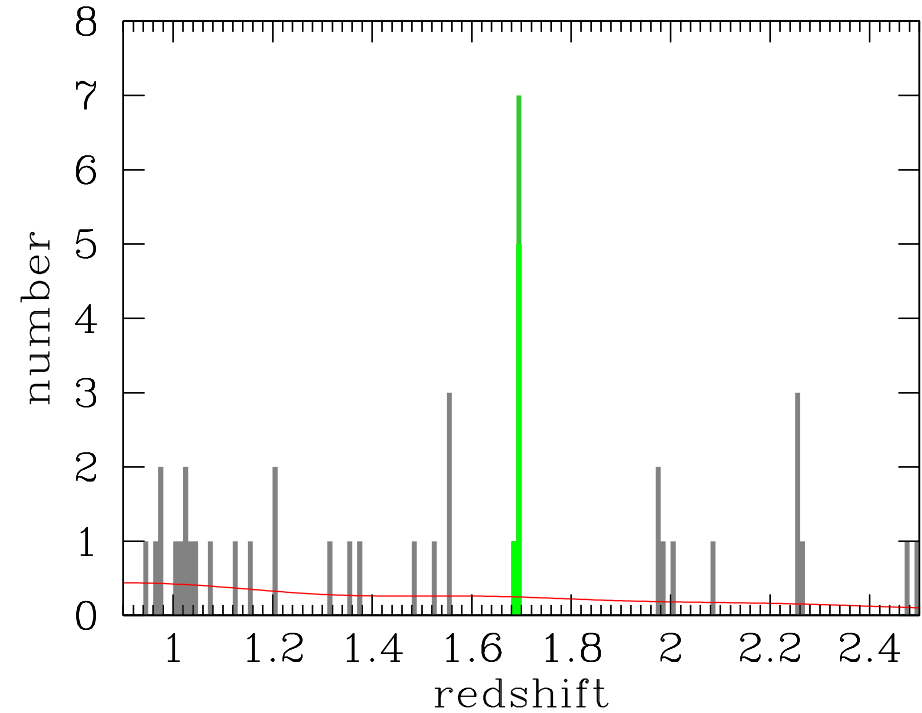
Proto-cluster around a Compton-thick FRII at $z=1.7$



Proto-cluster around a FRII radio-galaxy at $z=1.7$

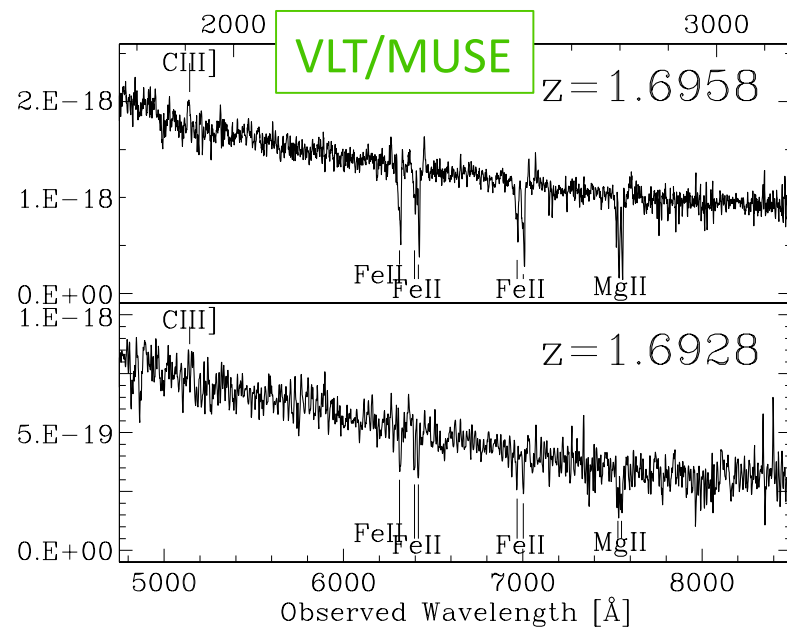
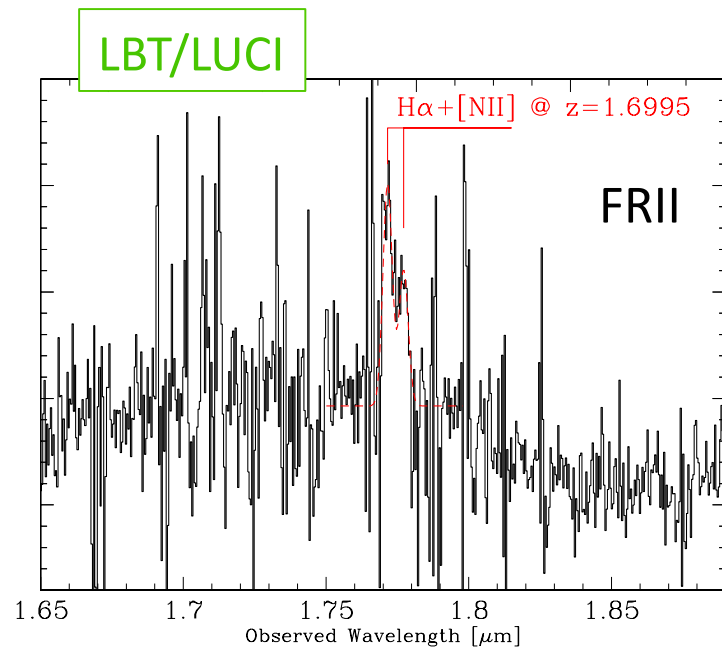


serendipitous galaxy at $z=1.696$
 $f_{\text{H}\alpha} = 2.4 \times 10^{-17} \text{ erg/cm}^2/\text{s}$
 $\text{SFR} = 5 M_{\text{sun}}/\text{yr}$



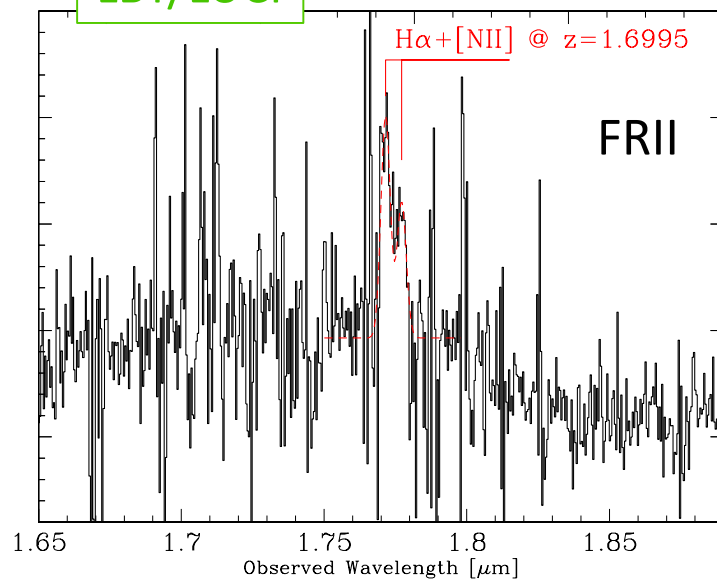
$\sigma_v \sim 500 \text{ km/s}$: likely progenitor
of a $>10^{14} M_{\text{sun}}$ local galaxy cluster
(but structure likely not virialized)

likely extended for several arcmin

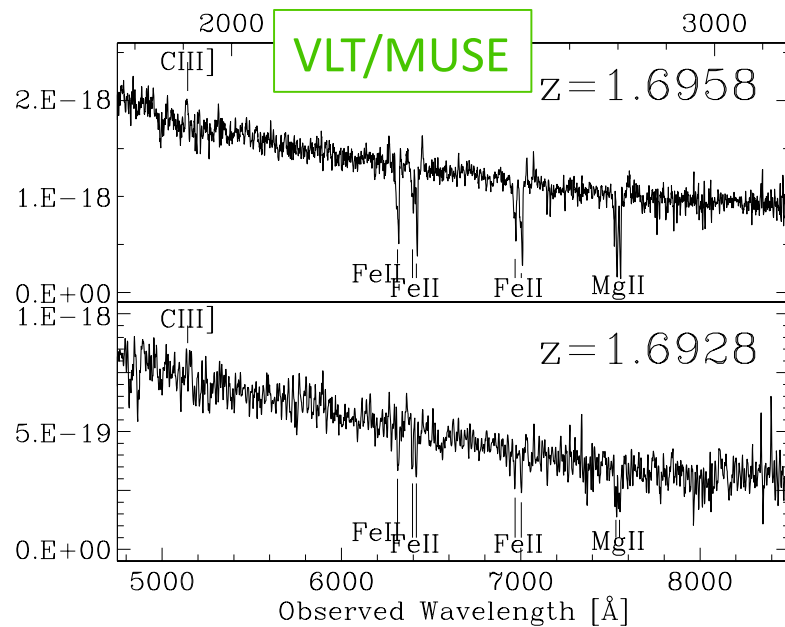


blue galaxies, $\text{SFR} \sim 8\text{-}70 M_{\text{sun}}/\text{yr}$

LBT/LUCI

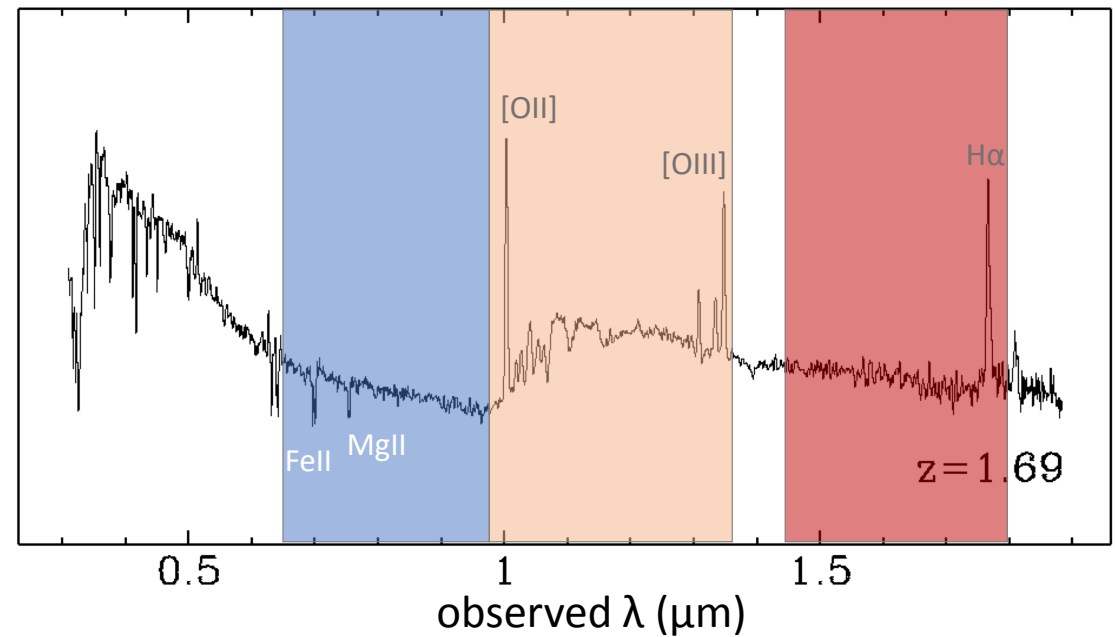


VLT/MUSE



blue galaxies, $\text{SFR} \sim 8\text{--}70 M_{\text{sun}}/\text{yr}$

VLT/MOONS



$\text{H}\alpha$, $[\text{OIII}]$, $[\text{OII}]$, MgII , FeI at $z=1.69$

e.g. down to $10^{-17} \text{ erg/cm}^2/\text{s}$ in 4 hrs ($\text{S/N}=3$)

Conclusions

J1030 competitive with other major multi- λ deep surveys:

- 4th deepest in the X-rays, ~2nd in the radio
- equatorial field

INAF-led survey (<http://www.oabo.inaf.it/~LBTz6/1030/>): INAF legacy field?

Added value

- only deep survey in a highly biased region of the early Universe
- deepest field on a protocluster

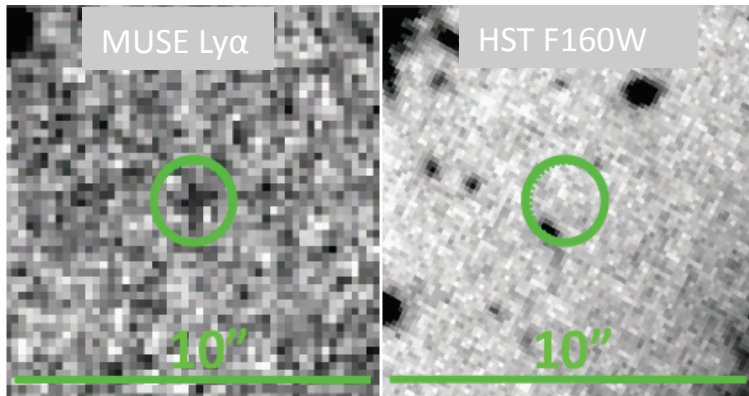
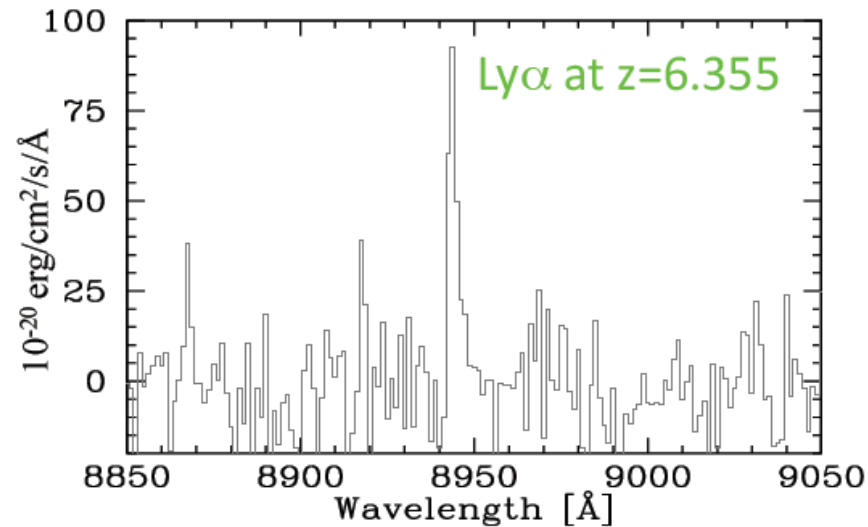
Ideal target for MOONS

Science

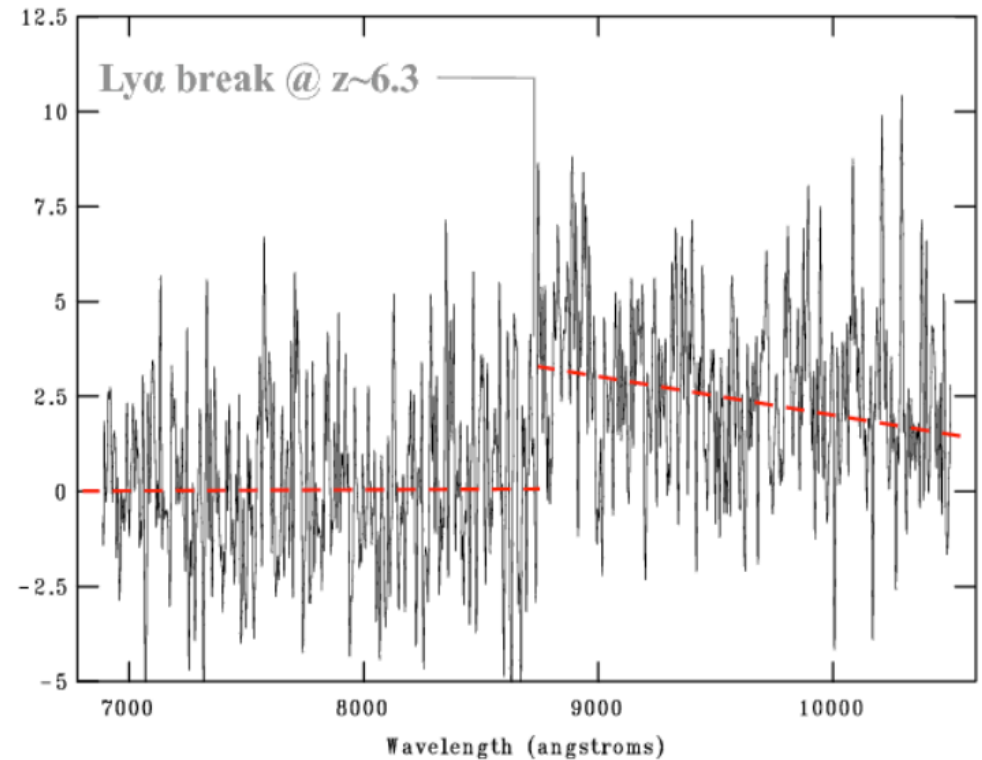
- survey legacy: identification and physics of faint X-ray and radio sources (e.g. obscured, high- z AGN) - pathfinder field for SKA/Athena synergies
- identification and physical characterization of a new protocluster at $z=1.69$
- spectroscopic confirmation of a LSS around a $z=6.3$ QSO

back up slides

MUSE Lyman Alpha Emitter



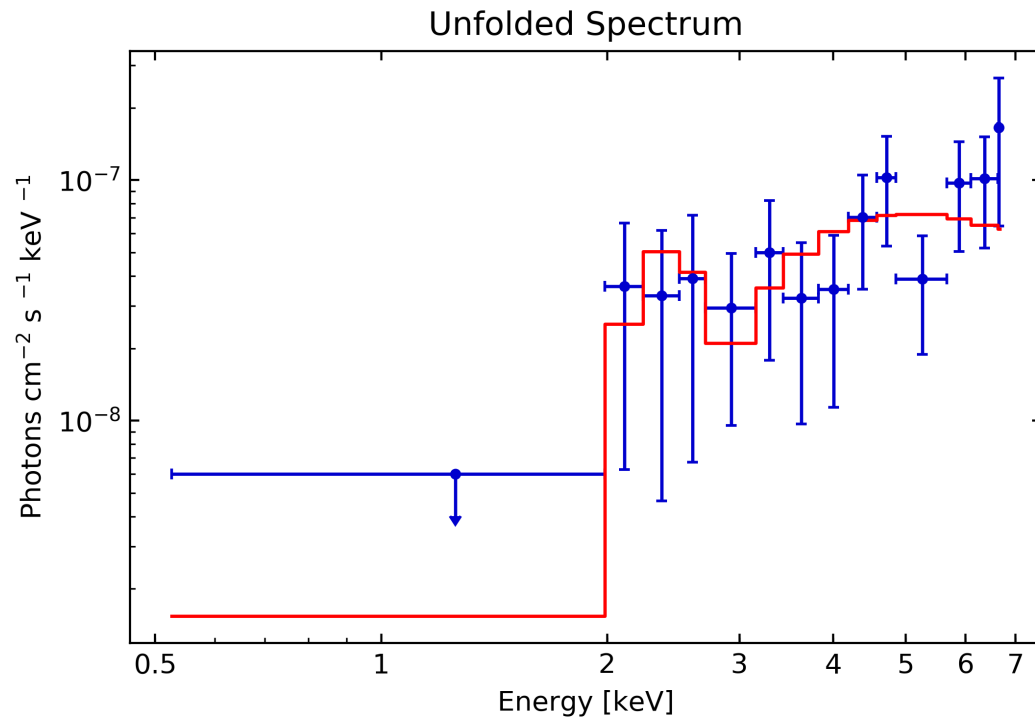
Keck Lyman Break Galaxy



separation from QSO $\sim 3\text{-}4 \text{ pMpc} \dots$

ok, but need more spectra to confirm overdensity with high significance

XID189: a Compton-thick FR II at $z=1.699$



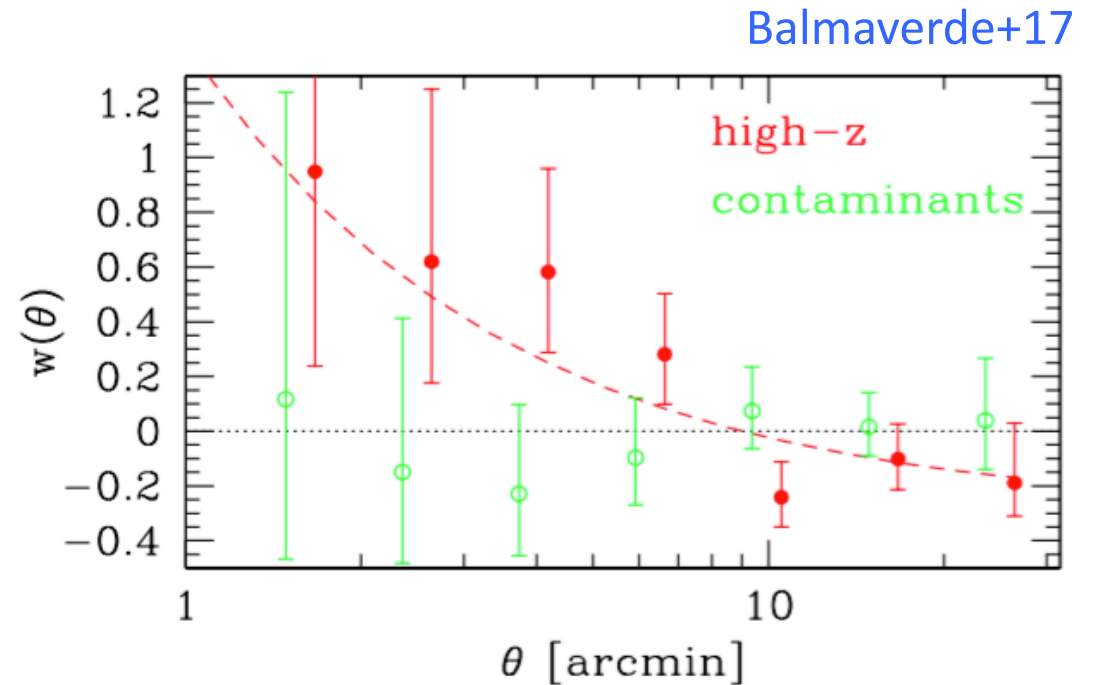
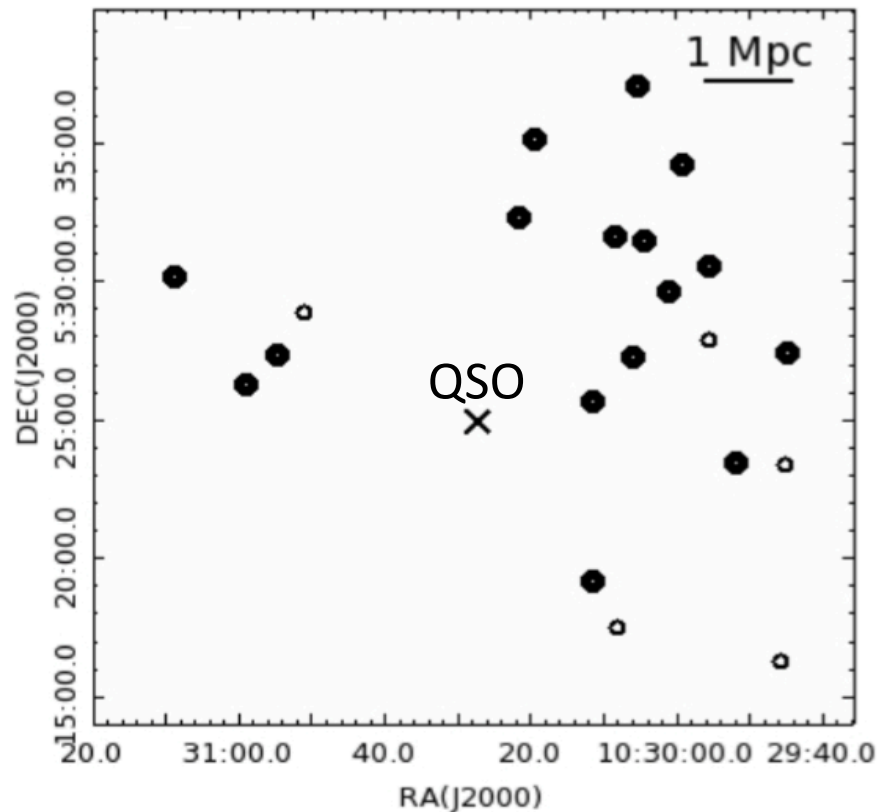
30 counts , hard band only

$$N_{\text{H}} = 1.5 (\pm 0.5) \times 10^{24} \text{ cm}^{-2}$$

$$L_{\text{x}} = 1.8 \times 10^{44} \text{ erg/s}$$

→ Compton-thick QSO

LBG candidates are clustered

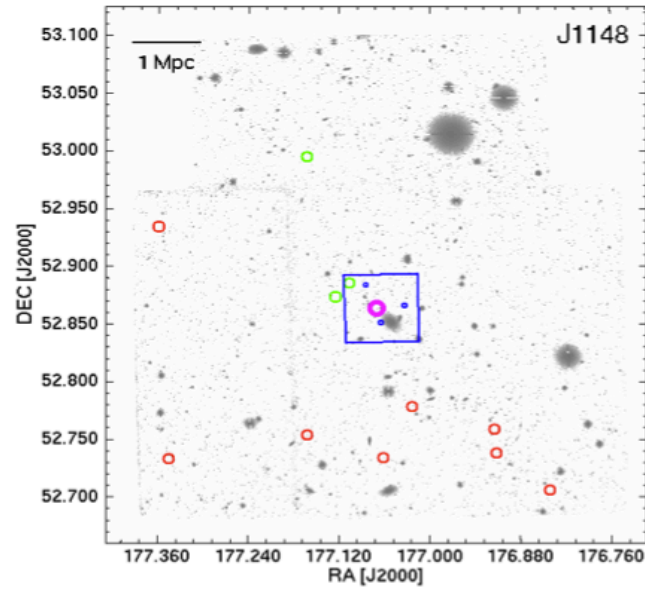
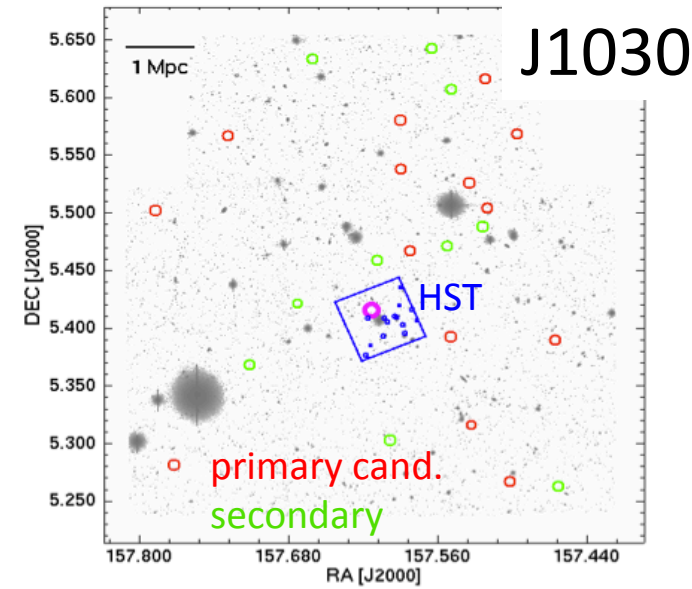


high- z candidates highly clustered as opposed to contaminants

overdensity reinforced ($>4\sigma$, $\delta=2.4$) – best evidence so far around a $z\sim 6$ QSO

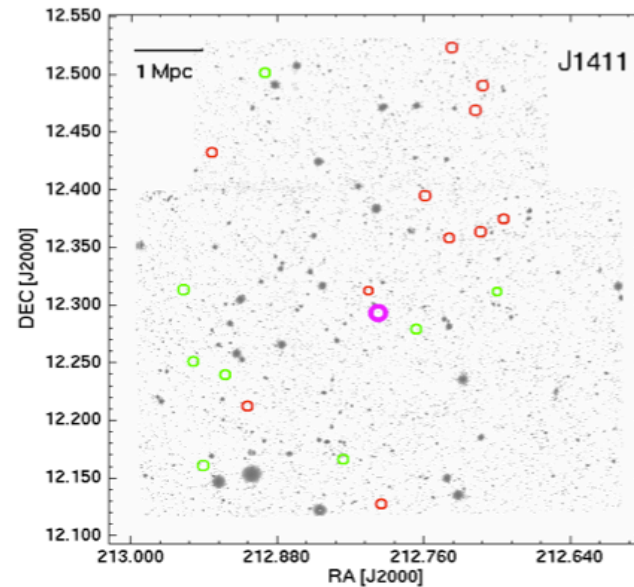
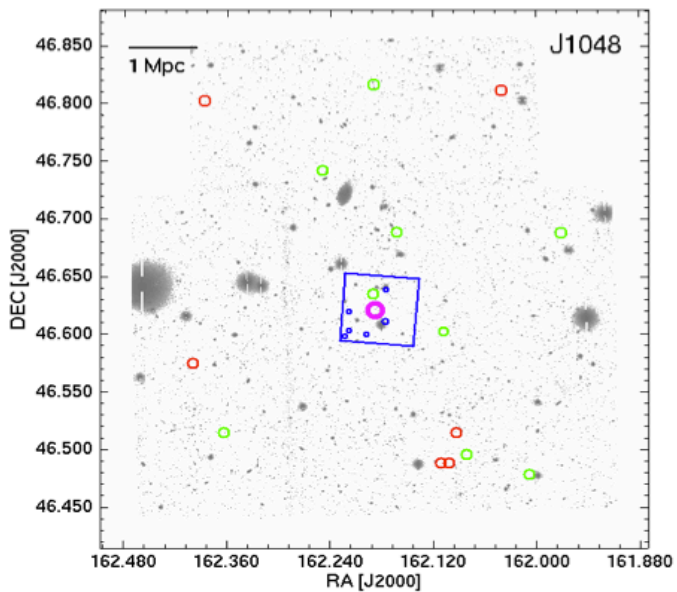
➔ intensive effort to get confirmation: spectroscopy + multi-band coverage

LBT/LBC *riz* imaging around four $z \sim 6$ QSOs with $M_{\text{BH}} > 10^9 M_{\text{sun}}$



Morselli+14

24 arcmin
8 pMpc



i-band dropouts
selected down to $z_{\text{AB}} \sim 25$

J1030 most overdense