Discovering Rare AGN with Stripe 82X

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Why X-ray Surveys?

- Study SMBH growth and evolution over cosmic time
- Representative sampling over various epochs
- X-rays
  - efficient in identifying AGN
  - finds obscured AGN at high *z*

X-ray Survey Wedding Cake Strategy

Area

Depth

0.1 – 0.3 deg^2

Chandra Deep Field N & S (Alexander+ 03, Xue et al.+ 11), E-CDFS (Lehmer+ 05, Ranalli+ 13)

0.9 – 3.2 deg^2

XMM & *Chandra* COSMOS (Cappelluti+ 09, Civano+ 12), XDEEP2(Goulding+ 12)

>15 deg^2

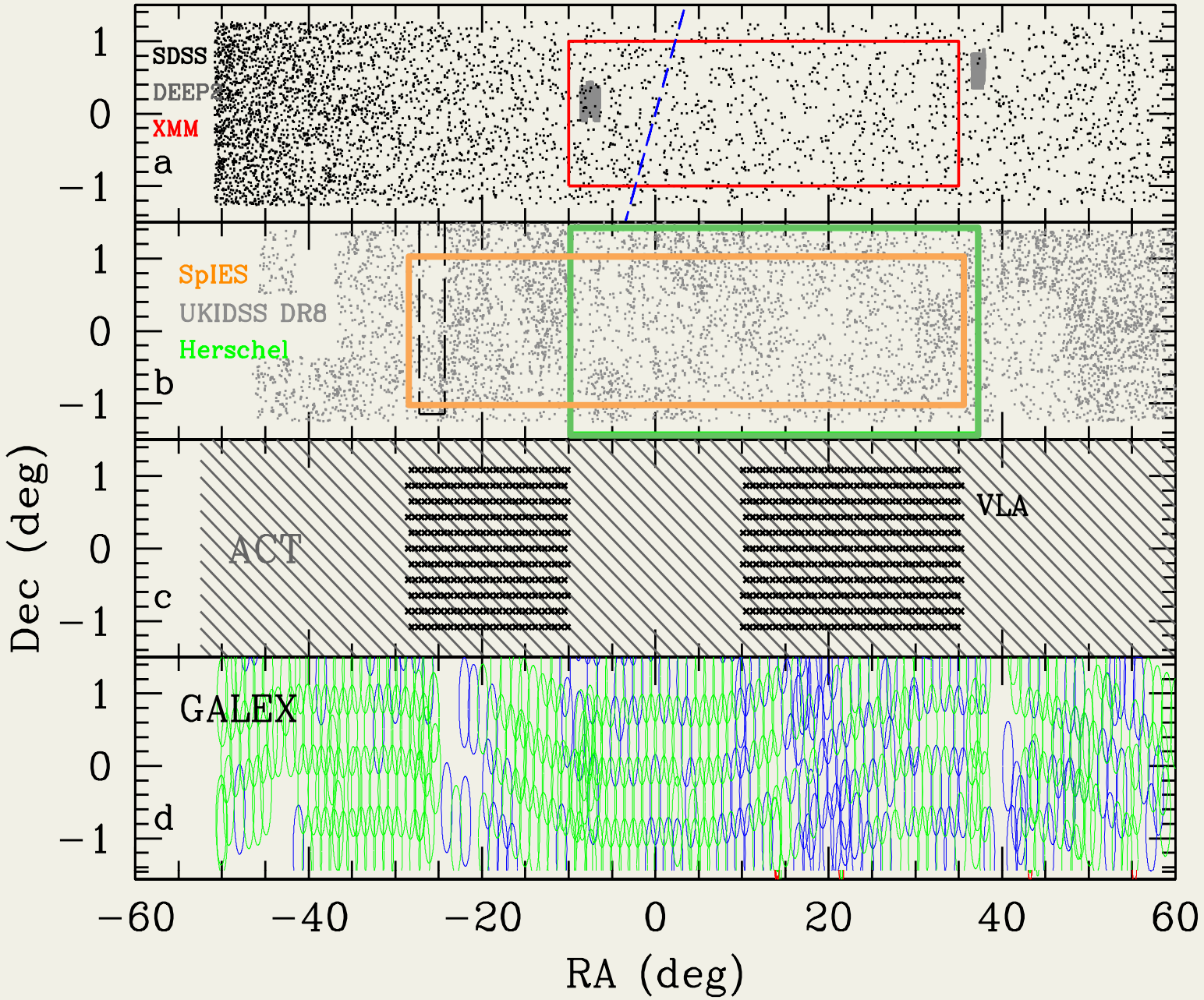
Stripe 82X (LaMassa+ 13a,b), *XMM*-LSS (Pierre+ 2004), XMM-XXL(Elyiv+ 12)

Importance of Wide Area Surveys

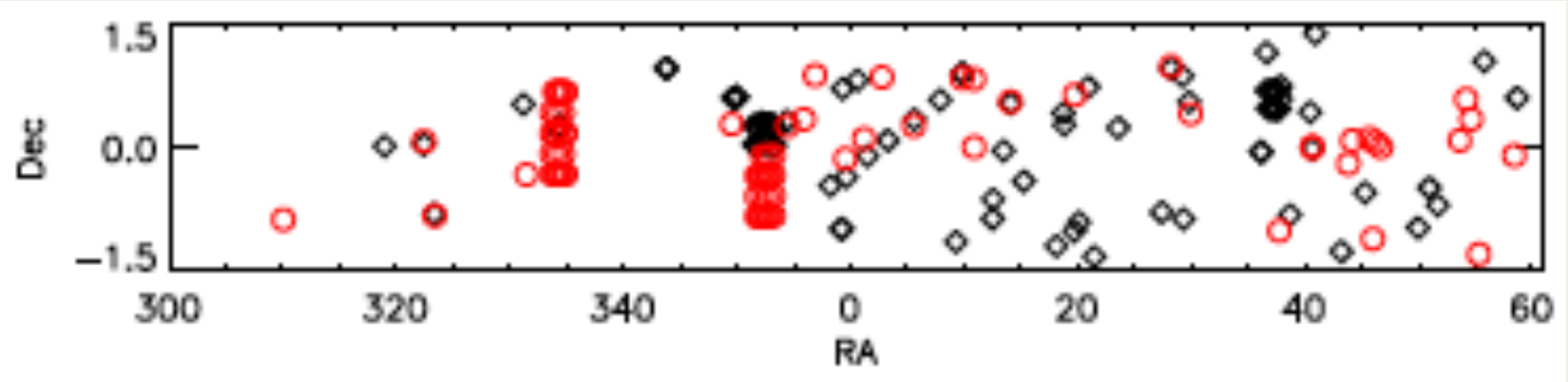
- Only way to discover rare objects, e.g. high-L & high-*z* AGN
- Rare but important
  - Signal where majority of mass accreting on SMBHs occurs

Stripe 82 Is a Legacy Field

- Deeper photometry than any other SDSS scan
- High level of spectroscopic completeness
  - SDSS, 2SLAQ, WiggleZ, DEEP2, PRIMUS, HETDEX (2015)
- Tons of λλλ coverage
- Equatorial field: accessible by both hemispheres


SDSS
DEEP2
XMM
a
SpIES
UKIDSS DR8
Herschel
b
ACT
VLA
c
GALEX
d
Dec (deg)
RA (deg)
1
0
−1
−60
−40
−20
0
20
40
60

Current S82X Coverage

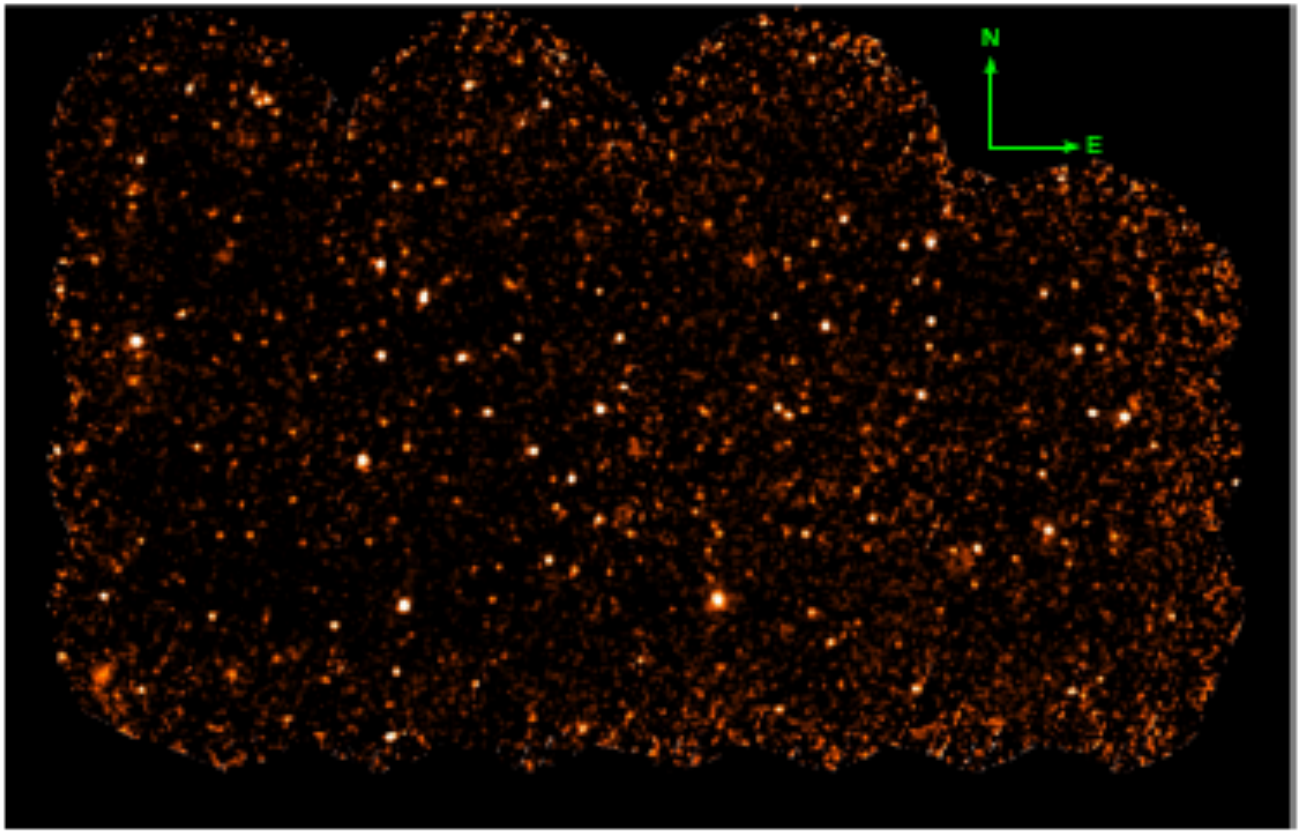


- Archival *Chandra*: 7.4 deg^2

- ***XMM-Newton*: 10.5 deg^2**
  - **4.6 deg^2 f/ AO 10**

16.5 deg^2 total + 20 deg^2 more to be added this year

Proprietary *XMM* Observation



~2.3 deg^2
364 sources

351°.47 < RA < 353°.45, −1°.10 < Dec. < 0°.15

(LaMassa+ 13b)

Stripe 82 X-ray sources

Band	Chandra	XMM	Total
Soft (0.5-2 keV)	785	2073	2743
Hard (2-10 keV)	248	607	823
Full (0.5-10 keV)	1137	2079	3074
Total	1146	2358	**3362**

LaMassa+ 2013a,b

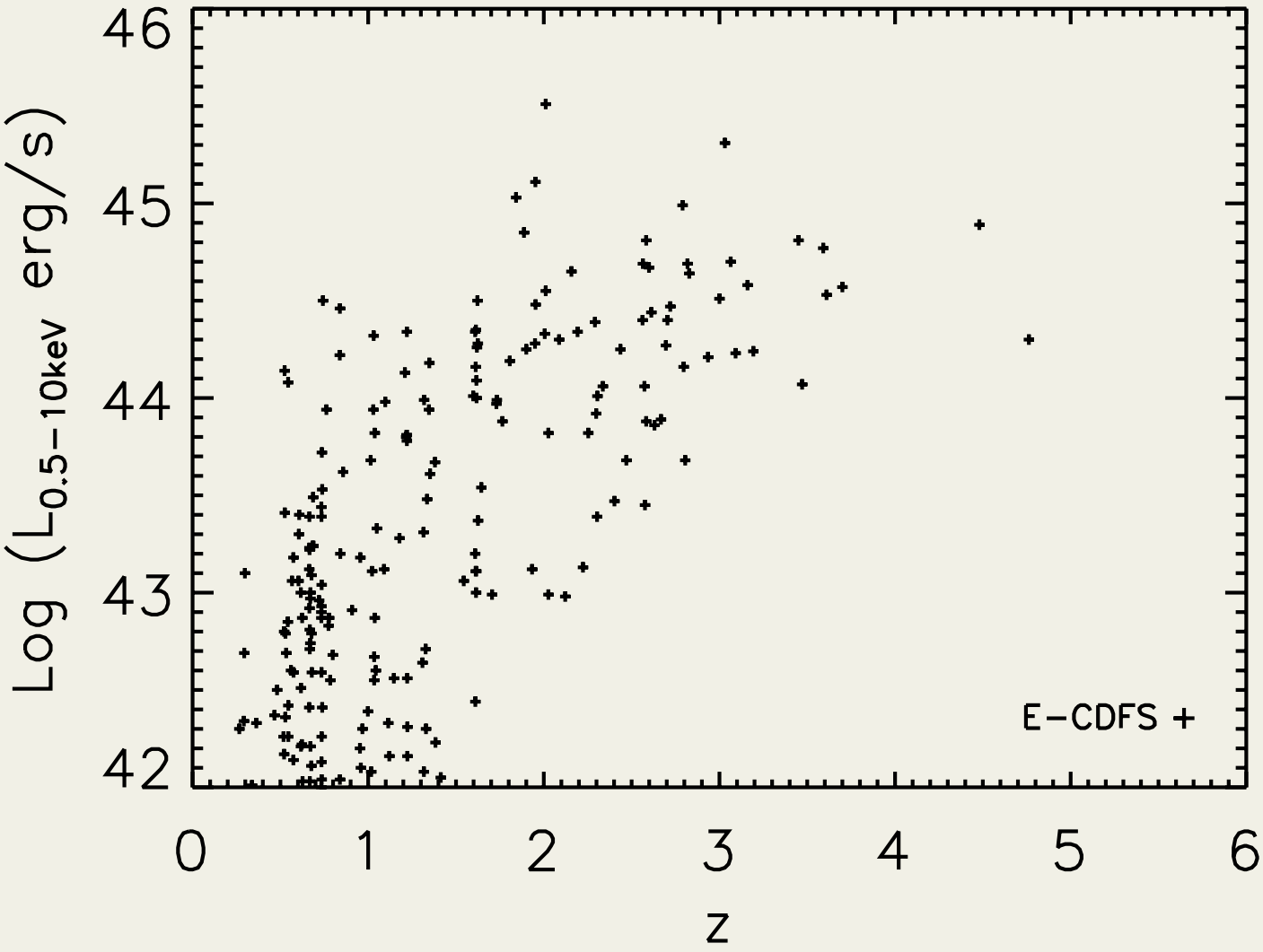
S82X Catalog Matching

- Maximum Likelihood Estimator (MLE)

Catalog	Chandra	XMM	Total	
X-ray	1146	2358	**3362**	
SDSS	676	1328	**1938**	~60%
WISE	595	1341	**1870**	~50%
UKIDSS	543	1200	**1690**	
GALEX	164	249	**396**	
FIRST	42	82	**119**	
Spec-zs	301	485	~~747~~	823 as of 5/14

LaMassa+ 2013b

L – *z* Plane Probed by Surveys



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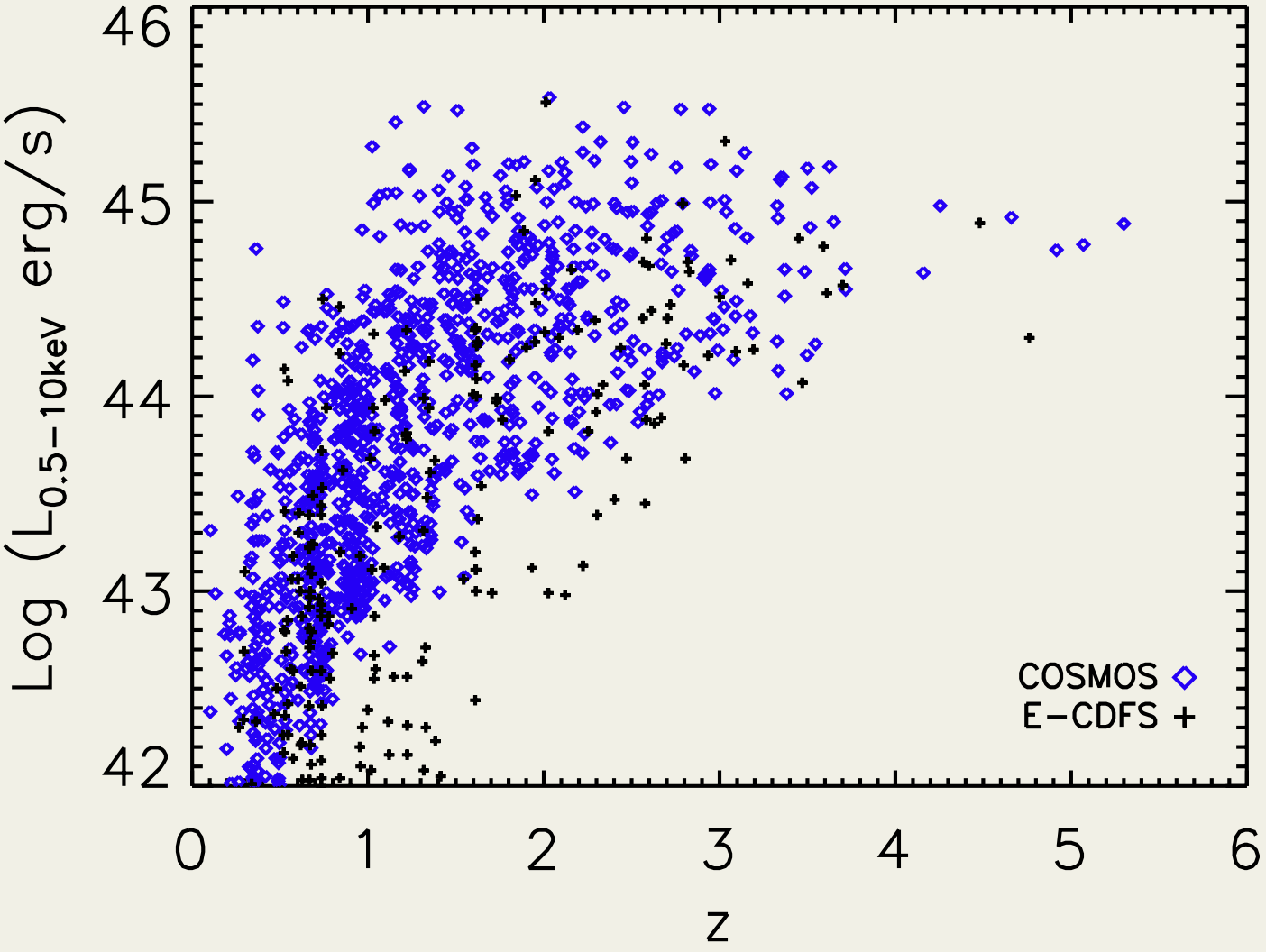
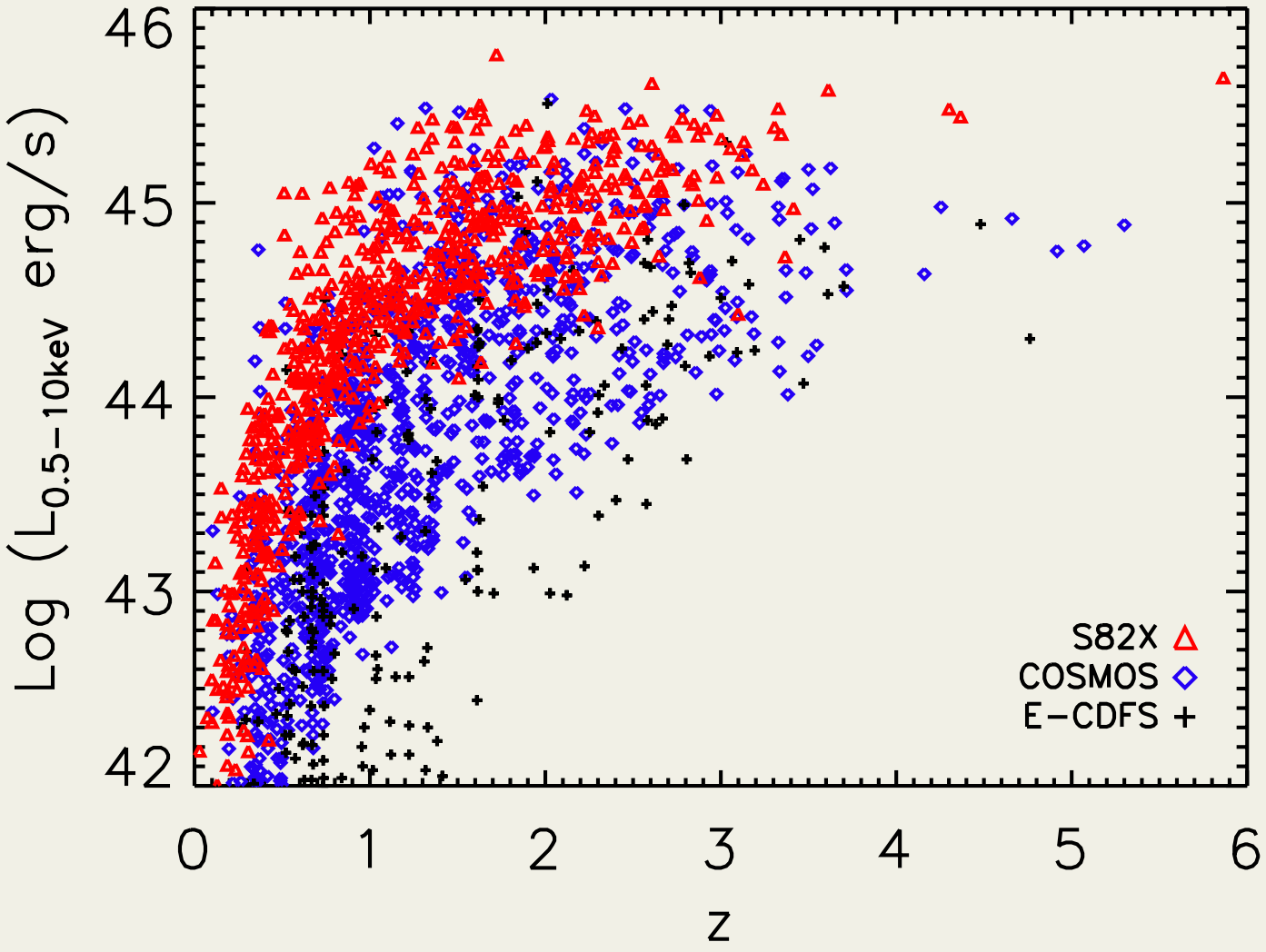
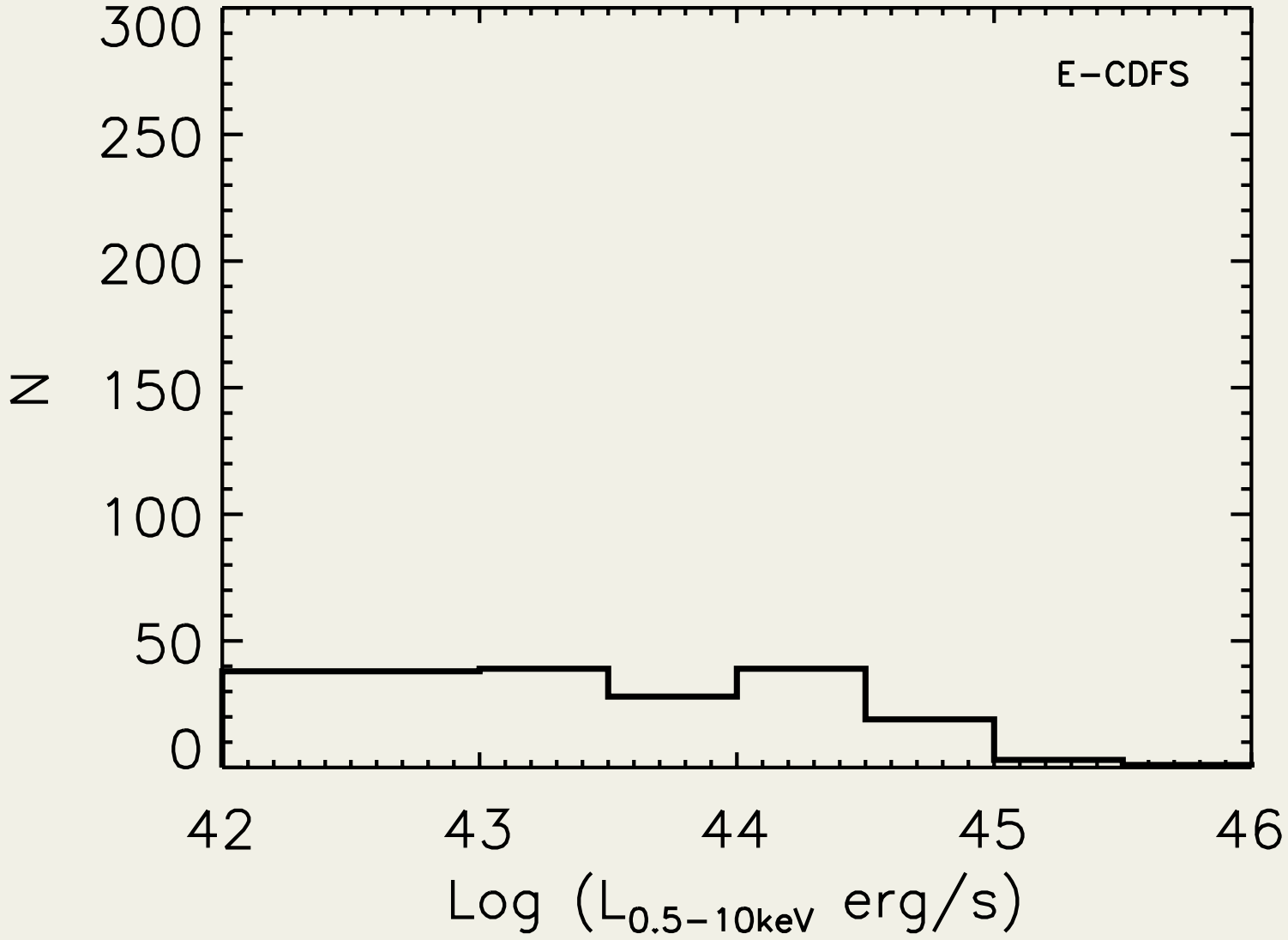


L – *z* Plane Probed by Surveys



AGN Luminosity by Survey



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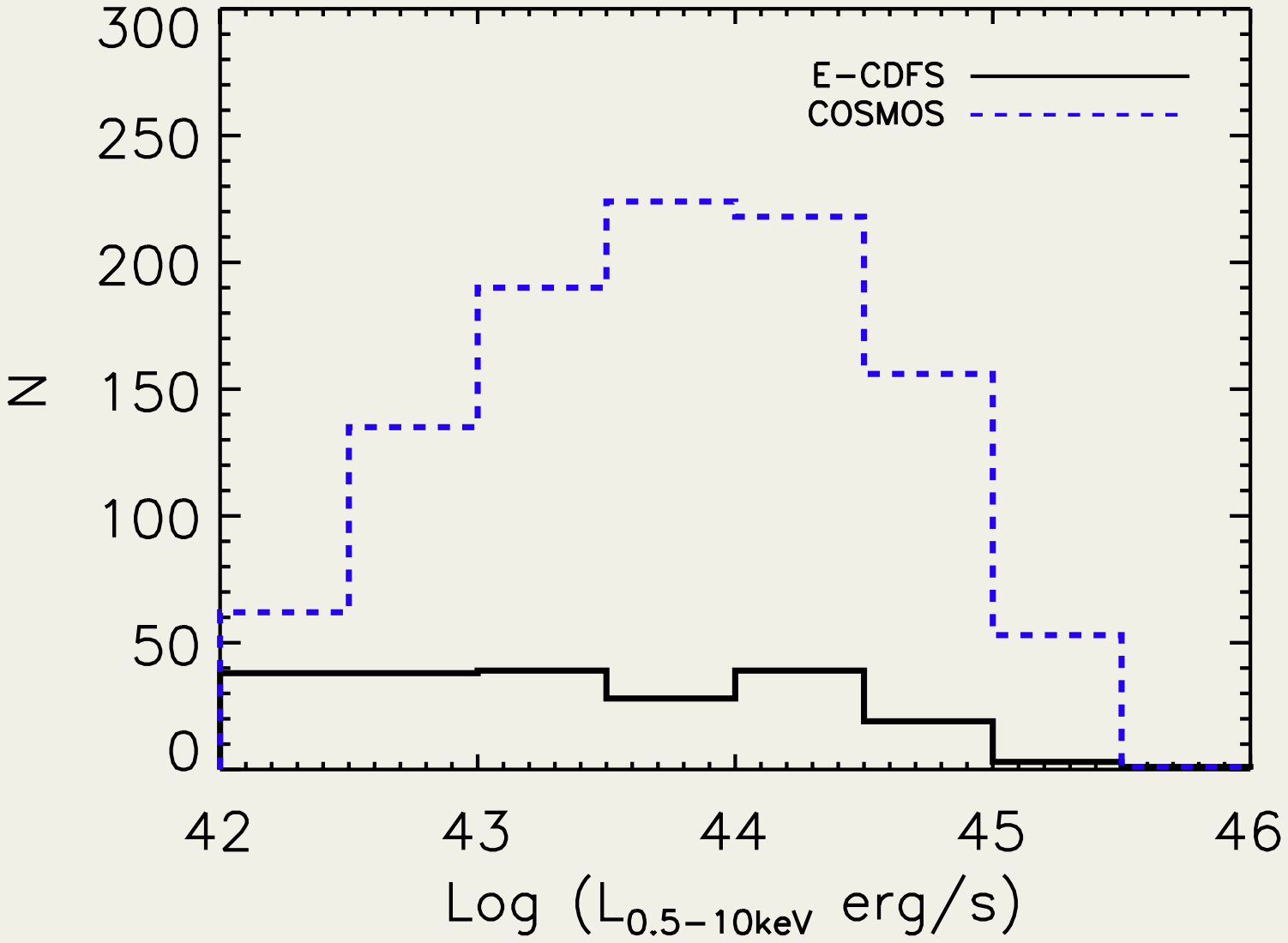

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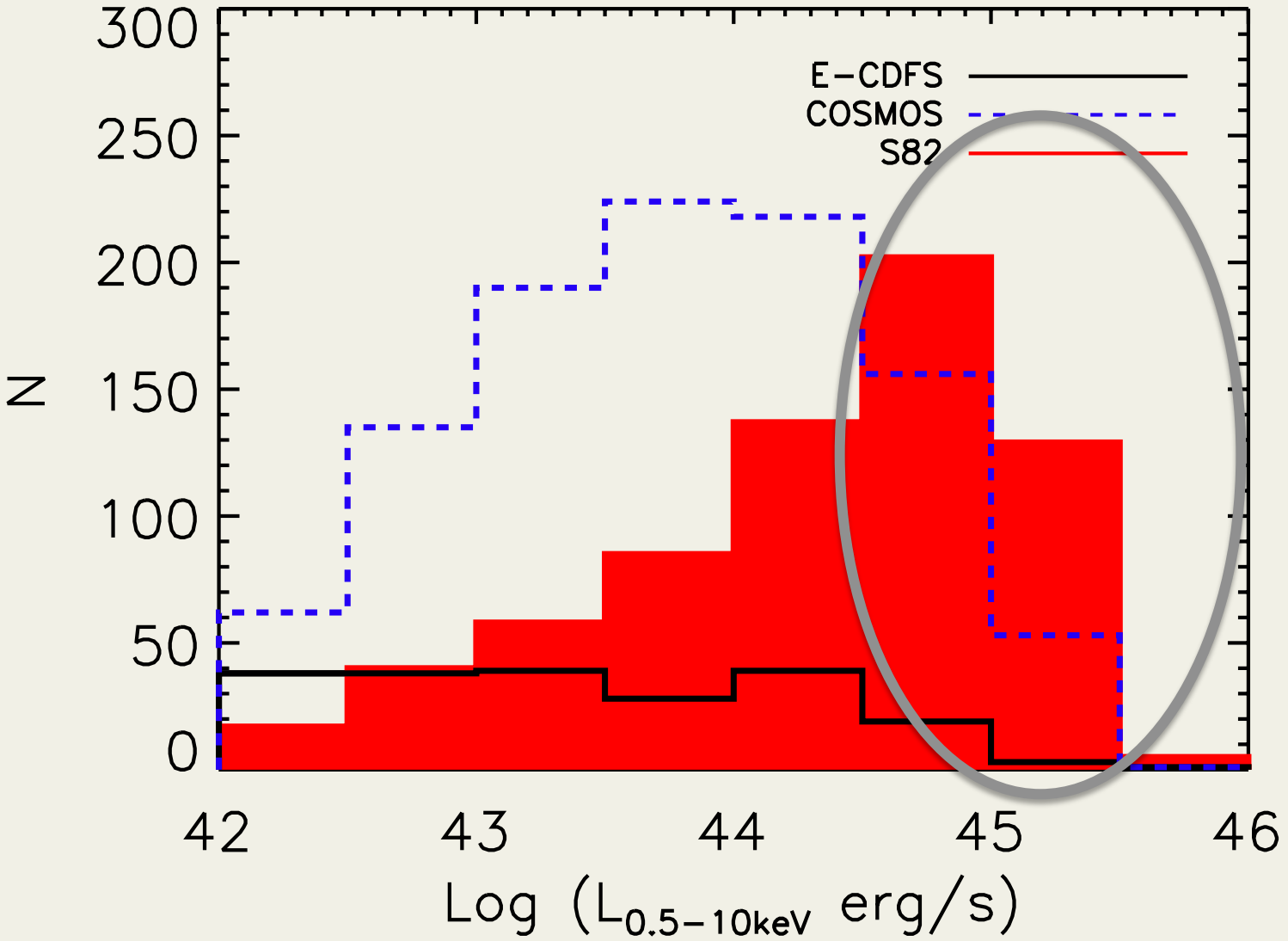
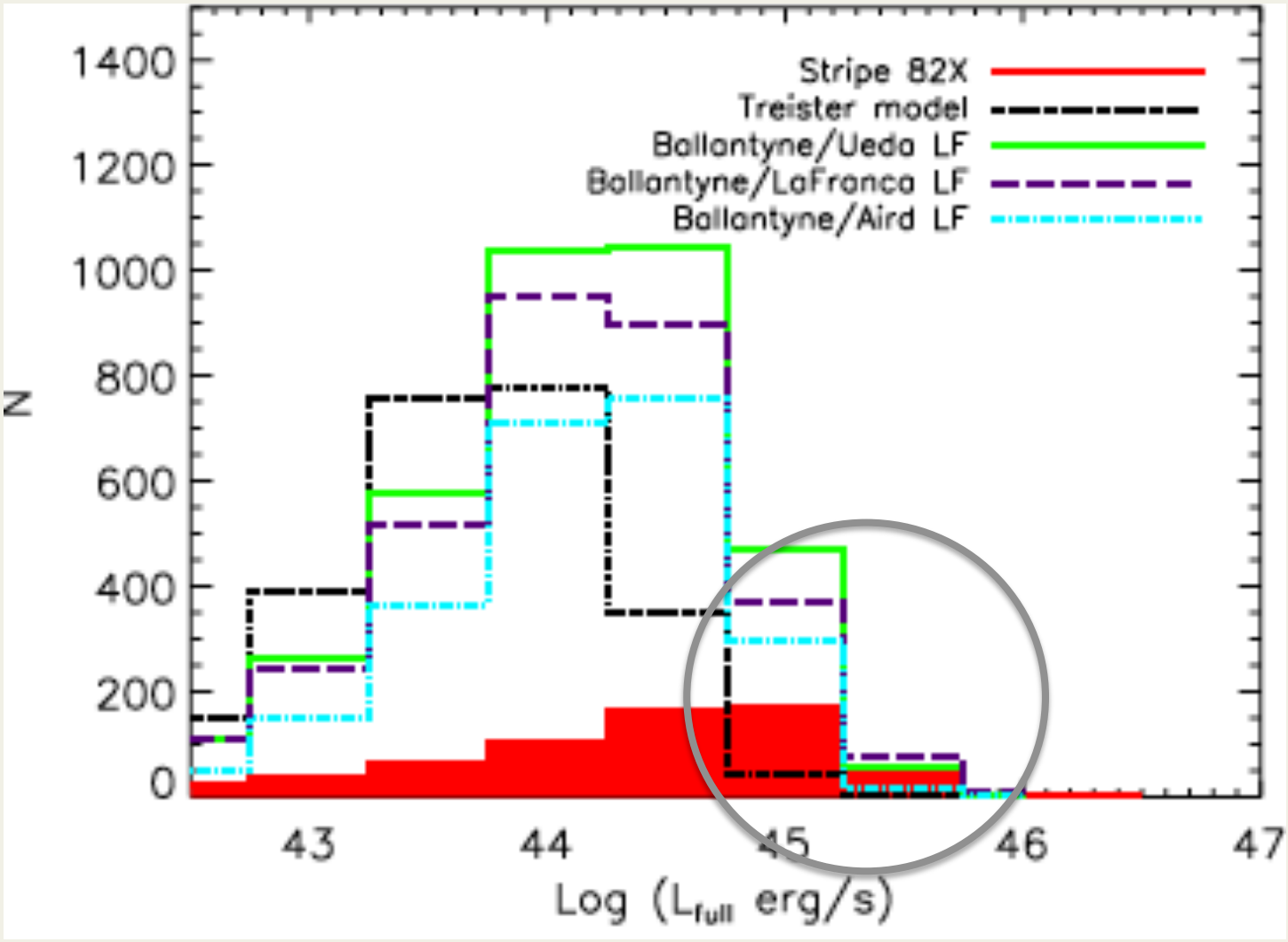


Observations vs. Predictions



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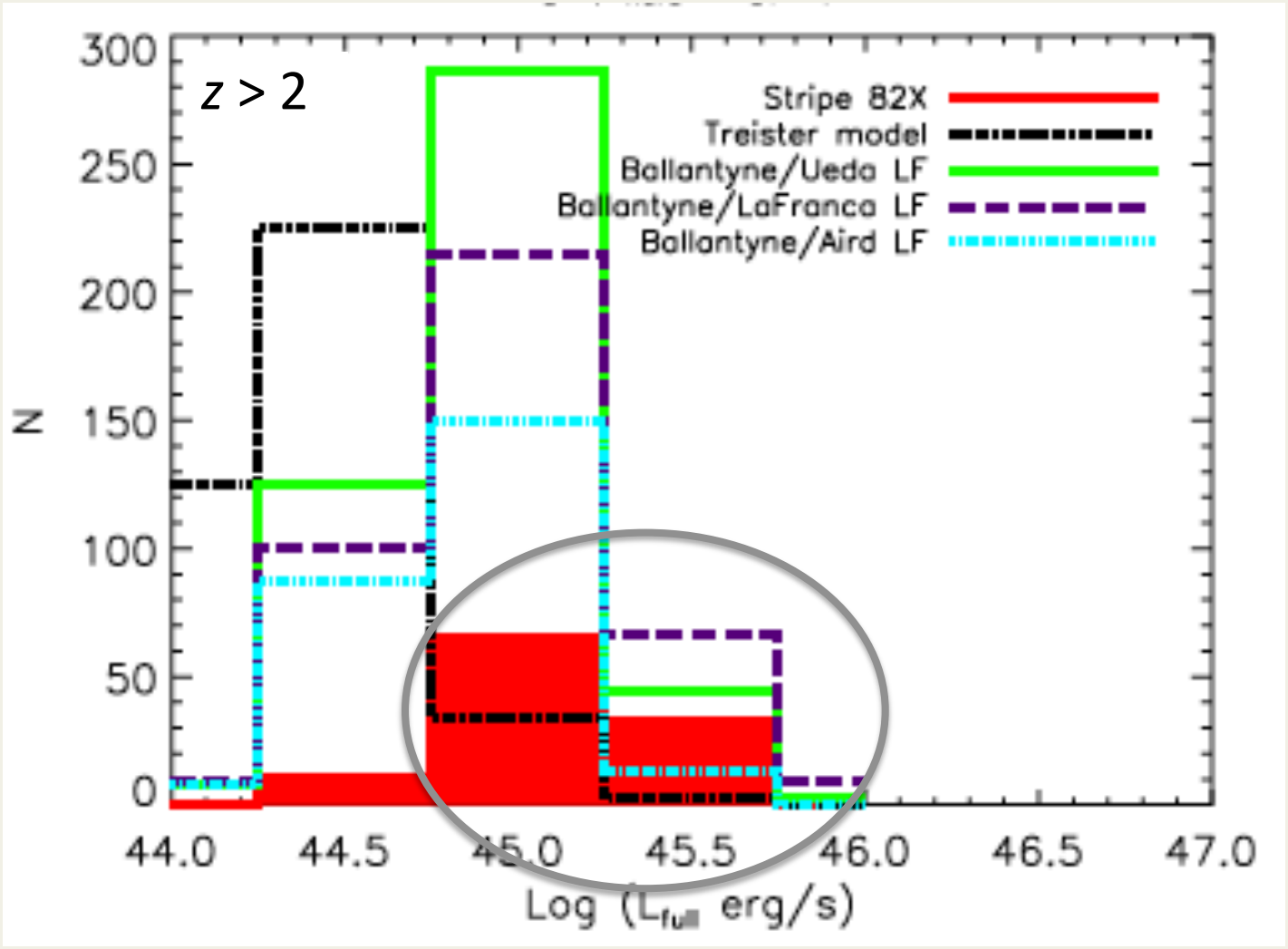
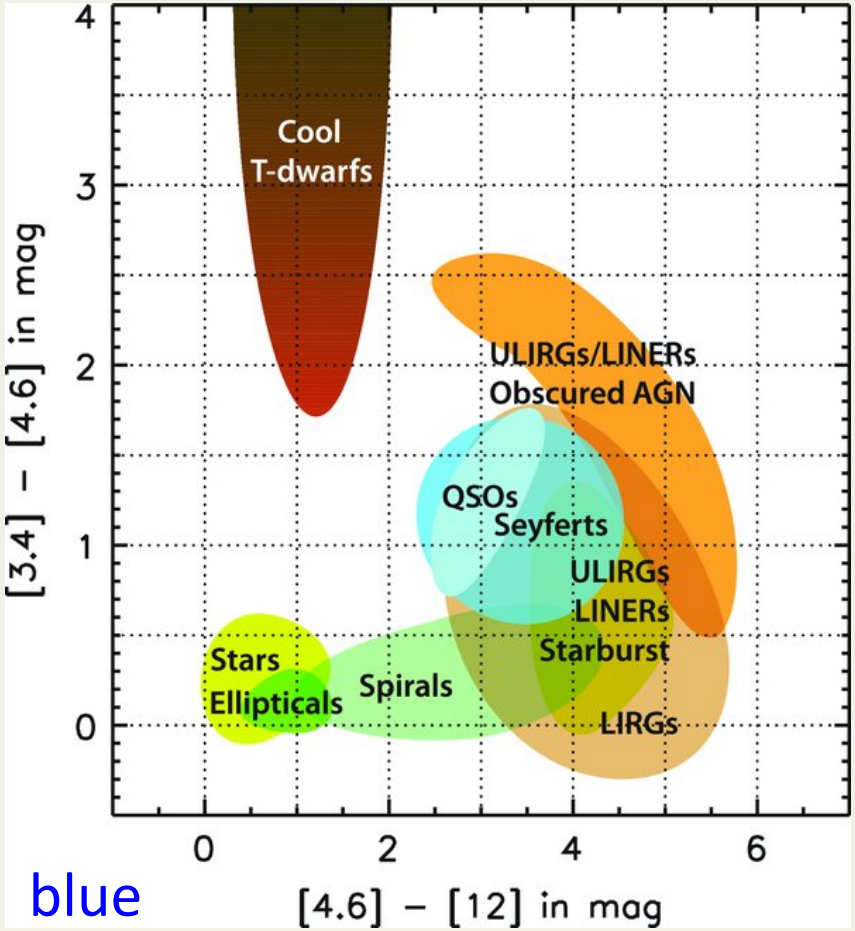


Luminous Obscured AGN

- >30% of optical dropouts found in IR



red

blue

red

(Wright+ 2010)

Luminous Obscured AGN

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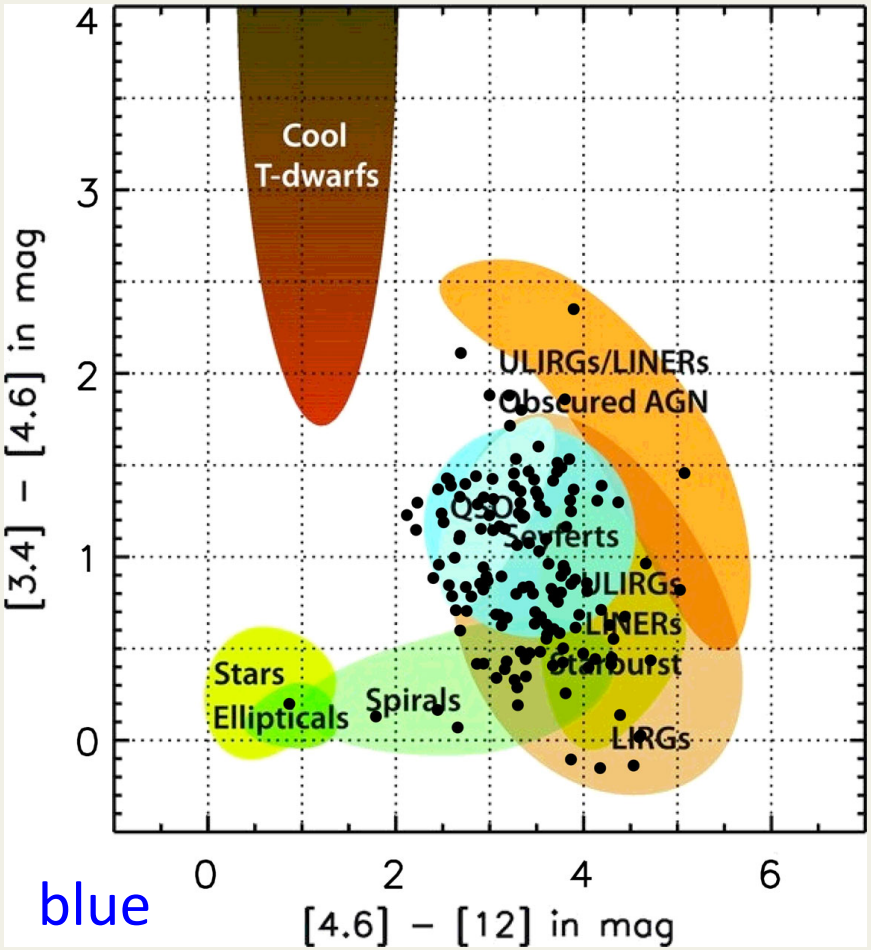


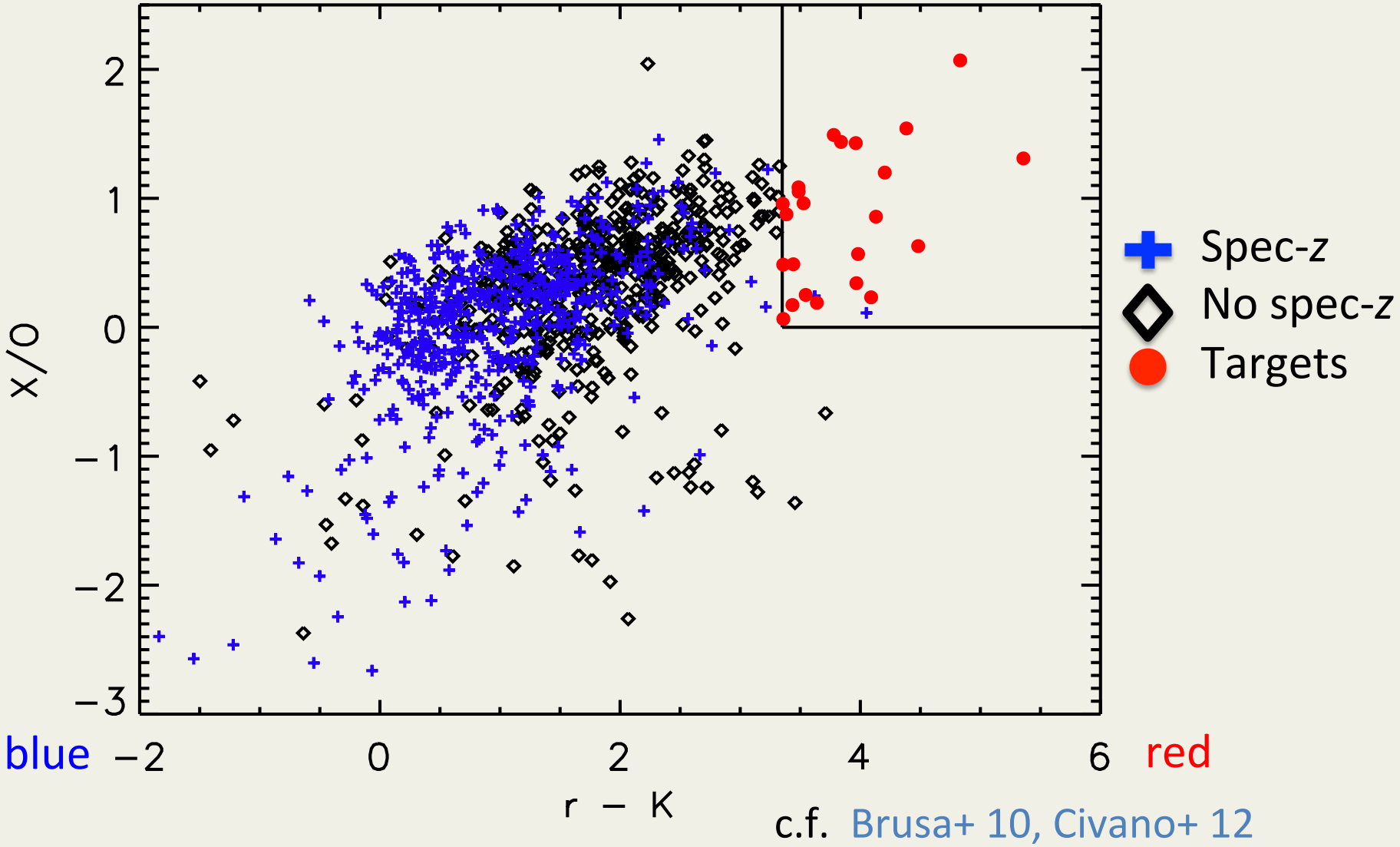
red

blue

red

(Wright+ 2010)

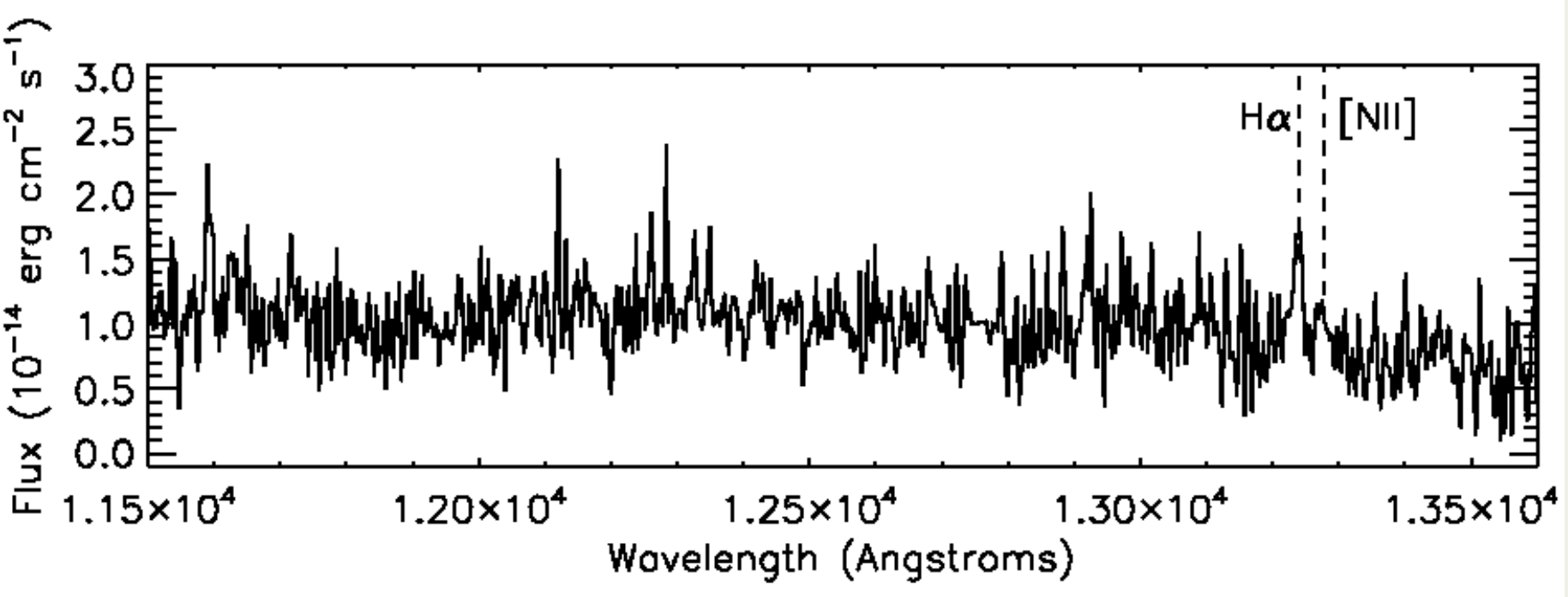
Luminous Obscured AGN



c.f. Brusa+ 10, Civano+ 12

Luminous Obscured AGN

Keck spectrum f/ Sep 2013

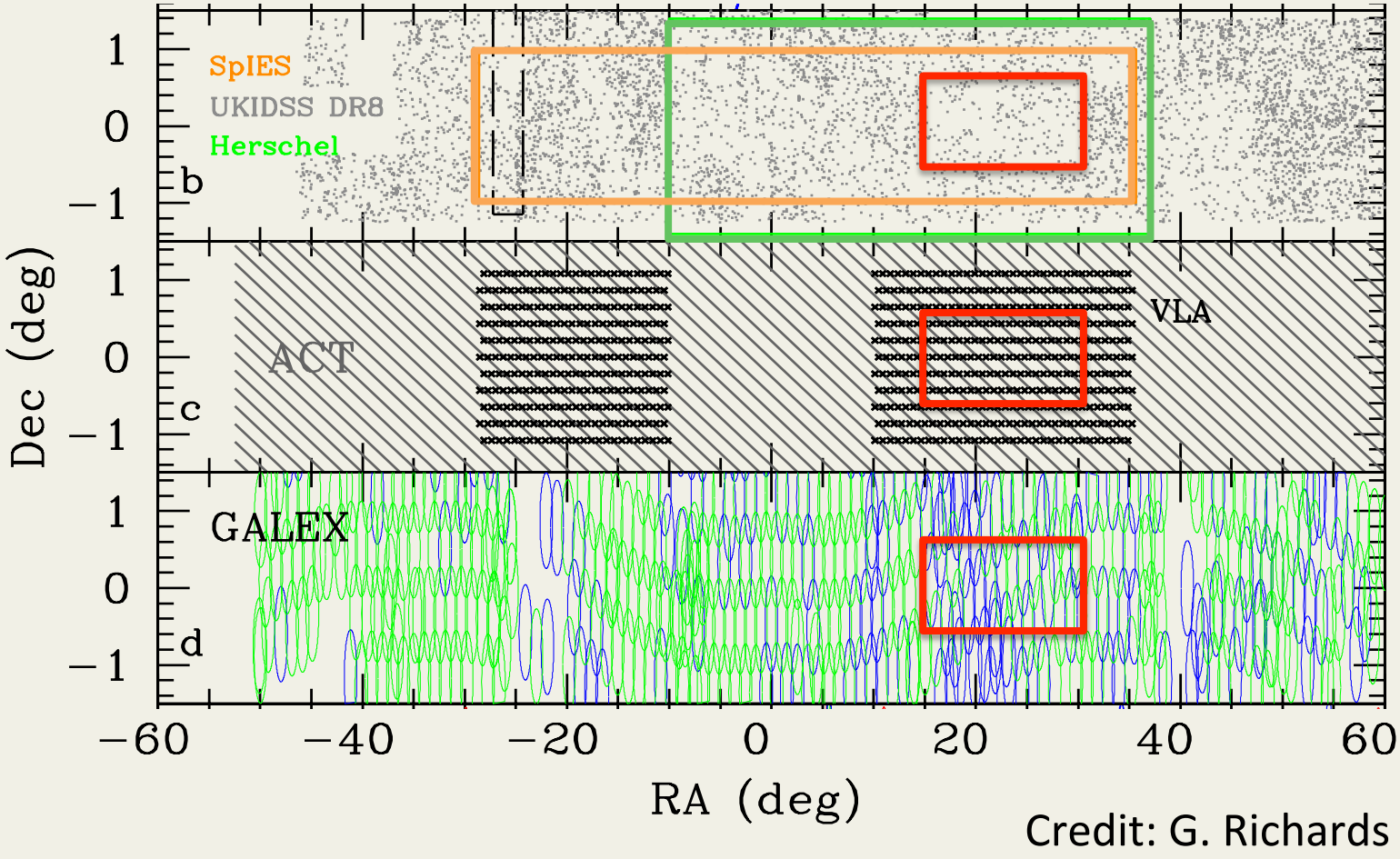


z = 1.02

L_x = 7.4 x 10^{44} erg/s

Coming Up: More X-ray Data!

- 20 deg^2 w/ *XMM* AO13 (2014-2015)



Credit: G. Richards

Summary

- Stripe 82X so far:
  - 16.5 deg^2: 3362 X-ray sources (LaMassa+ 13a,b)
  - λλλ catalogs: www.astro.yale.edu/lamassa/s82x.html (and CDS)
- Short term:
  - SEDs, photo-*z*s
  - X-ray modeling of bright sources
- + 20 deg^2 *XMM* coverage coming soon

  ➔ goal: 100 deg^2