Radio-loud AGN: is there a link between luminosity and cluster environment?

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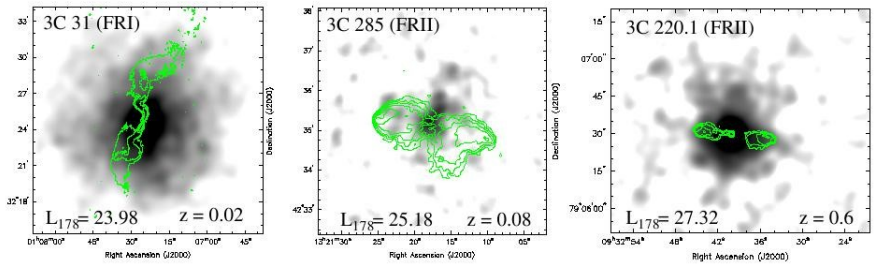
Background

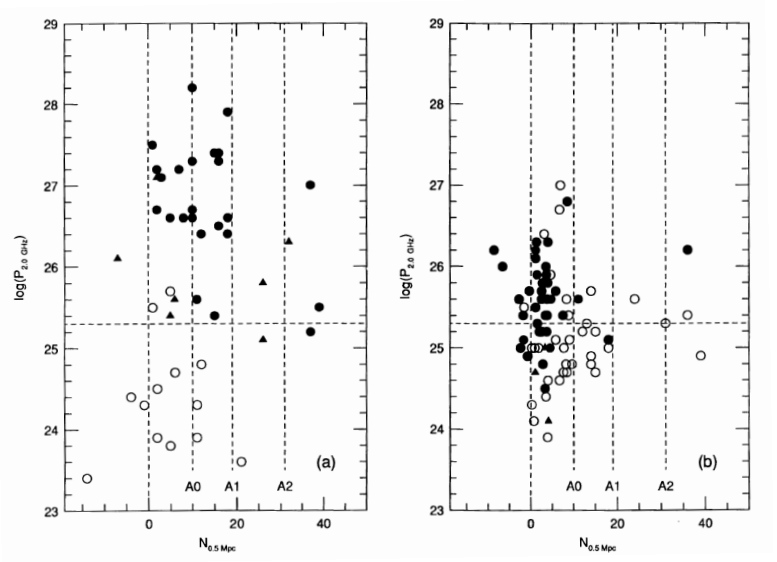
- The problem
  - AGN radio jets affect the galaxy cluster environment
  - AGN feeds on environment
  - What is the relationship between the radio properties and the environment?

Background

- Historical results
  - Comparing FRI and FRII RGs
  - Difference in environment at low redshift
    - Longair &Seldner (1979), Prestage &Peacock (1988)
  - Change of environment with redshift
    - Yee &Green (1987),
      Hill & Lilly (1991)



Hill and Lilly, 1991



0.34 < z < 0.7

z < 0.2

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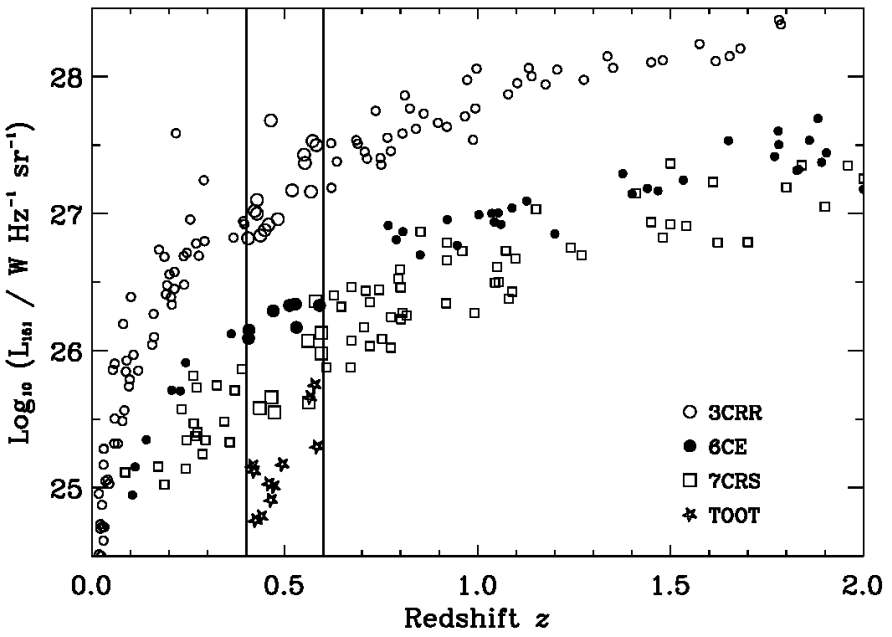
Background

- Problems
  - Sample bias
  - Sub-sample selection
    - FRI/FRII vs HERGs/LERGs
  - Disentangling evolution

McLure et al, 2004



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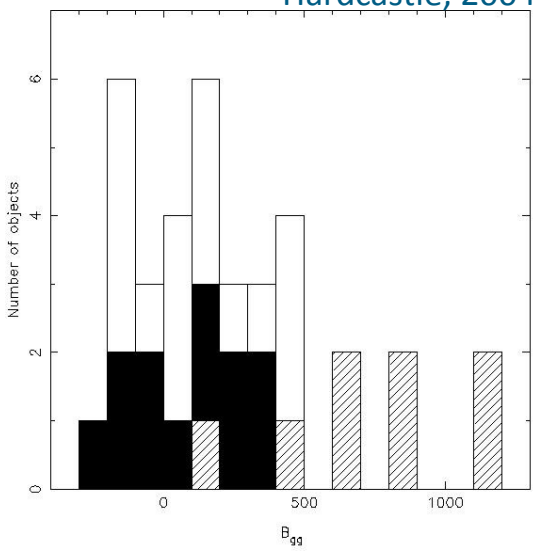
Background

- HERG/LERG results
- LERG luminosity correlates with environment richness
  - Best (2004), Hardcastle (2004), Croston et al (2008)
- HERG luminosity does not ...
  - Best (2004), Belsole et al (2007)
- ... or maybe it does
  - Wold et al (2000)
- Possible evolution of HERG environment
  - Belsole et al
- ... Or not
  - Wold et al

Hardcastle, 2004



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Background

- Outstanding questions
  - Is radio luminosity related to environment richness?
  - Does the environment evolve?
- ERA programme
  - Examine radio luminosity vs environment at one redshift
  - Compare this with results across different redshifts
  - Use properties of intra-cluster medium as measure of environment richness

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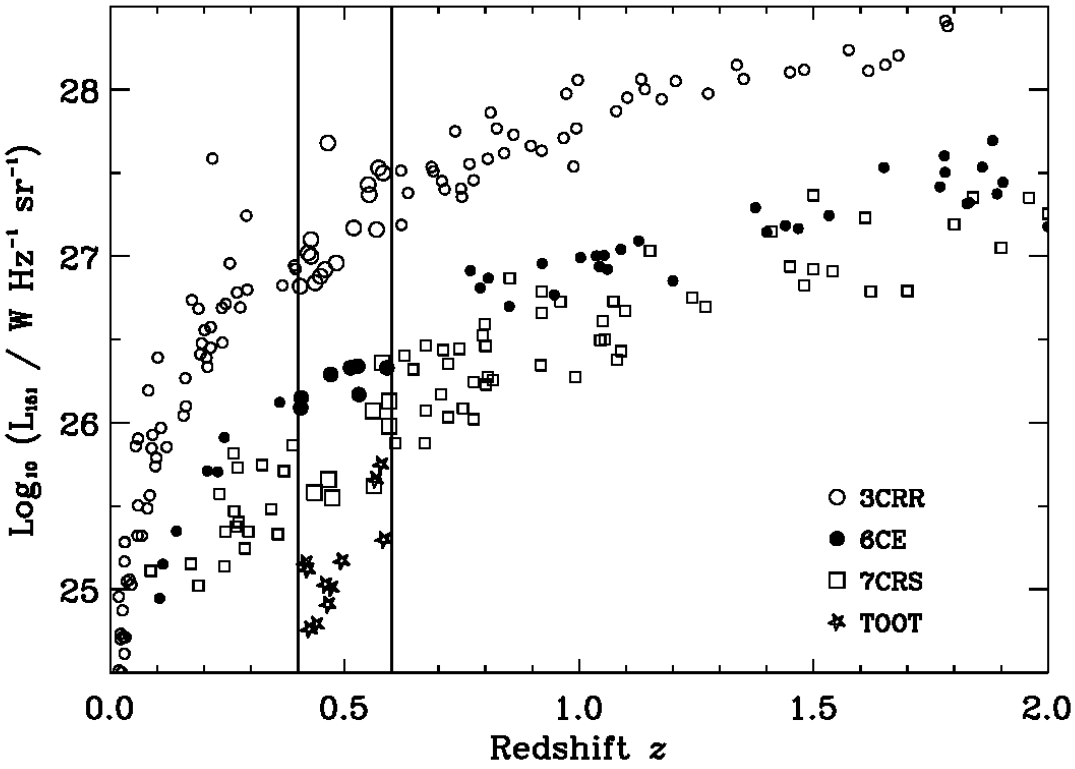
Samples

- Starting point
  - McLure et al (2004) ZP5 sample



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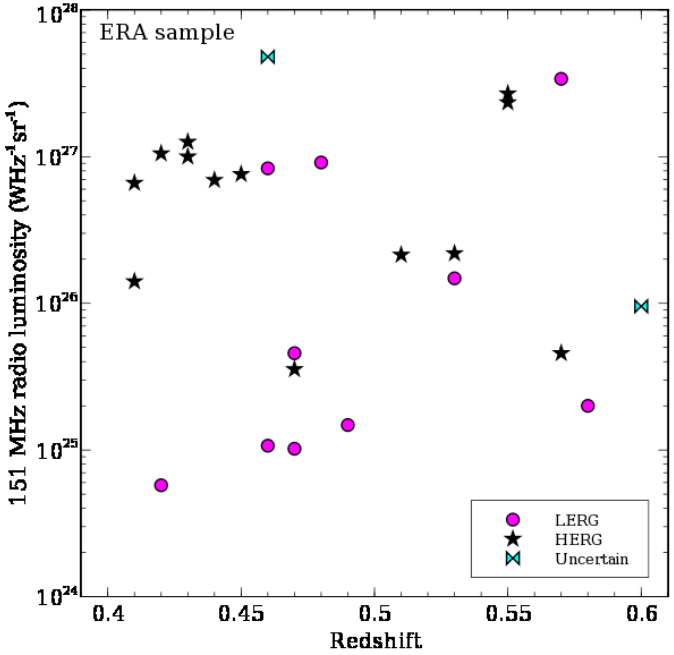
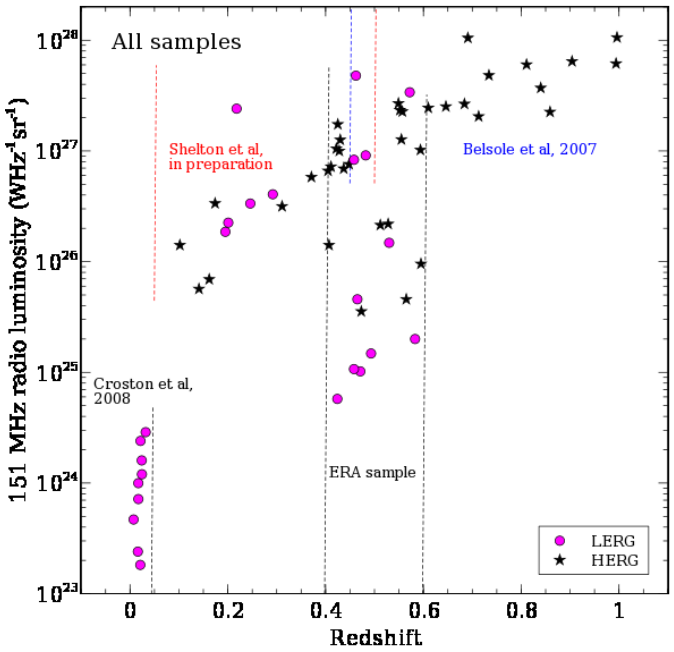
Samples

ERA sample



Comparison samples



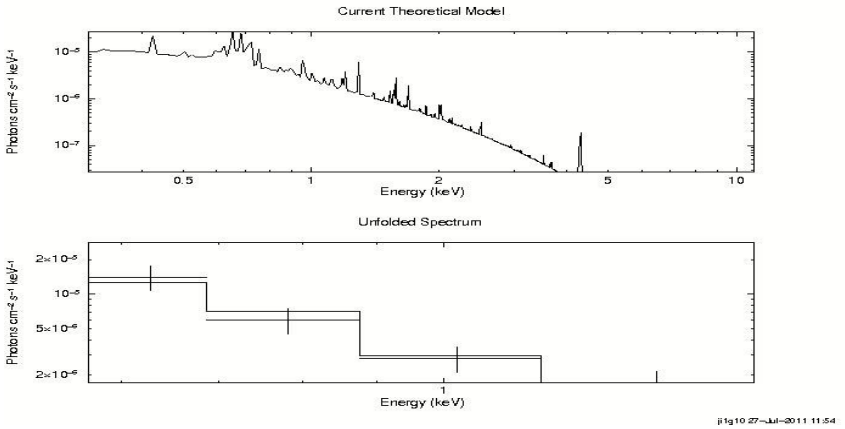
z<0.03: Croston et al, 2008

0.1<z<0.5: Shelton et al (in preparation)

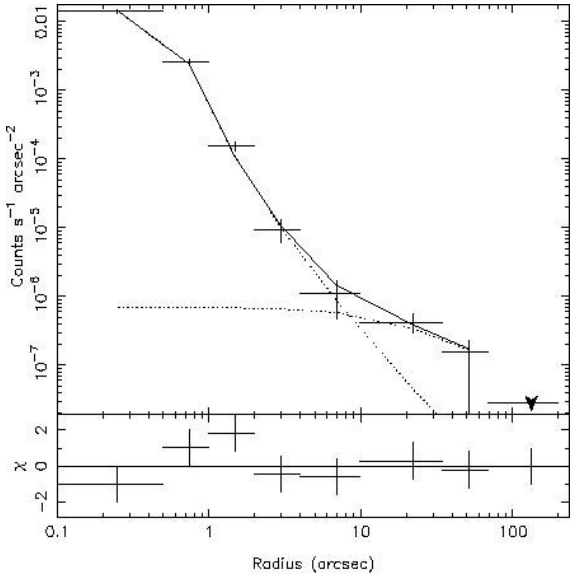
0.45<z<1.0: Belsole et al, 2007

ICM properties

- Temperature
  - R_{500} radius
    (Arnaud et al, 2005)



- Luminosity
  - Surface brightness profiles
  - Beta model



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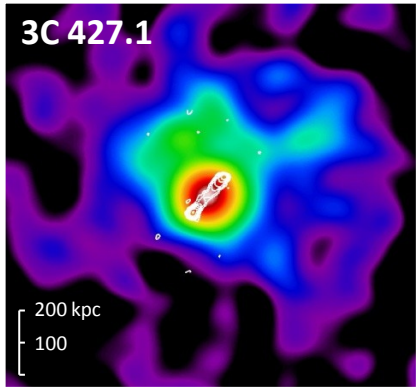
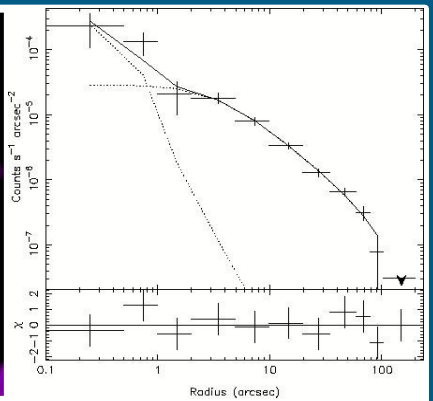
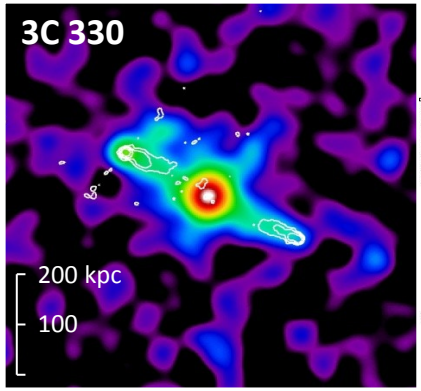
Examples

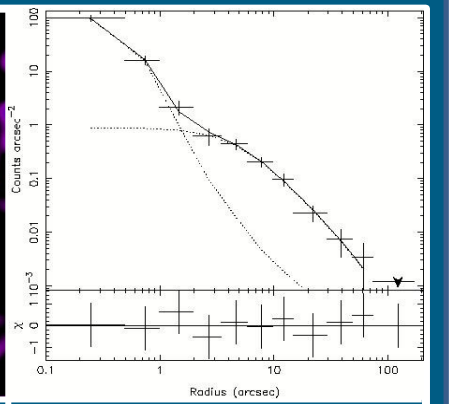




FRII, classical double, LERG
L_{151} = 339x10^{25} WHz^{-1}sr^{-1}
Redshift = 0.572

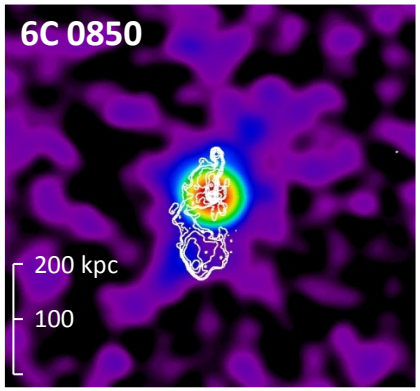
R_{500} = 620 kpc
L_x = 26.2x10^{43} erg.s^{-1}
Temperature = 3.1 keV

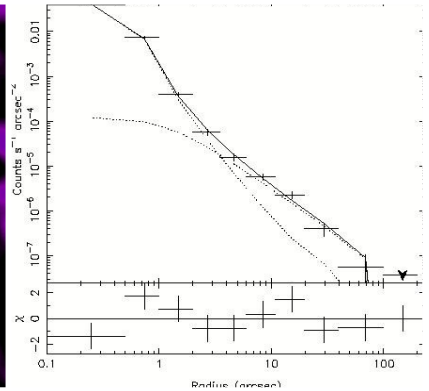




FRII, classical double, HERG
L_{151} = 269x10^{25} WHz^{-1}sr^{-1}
Redshift = 0.549

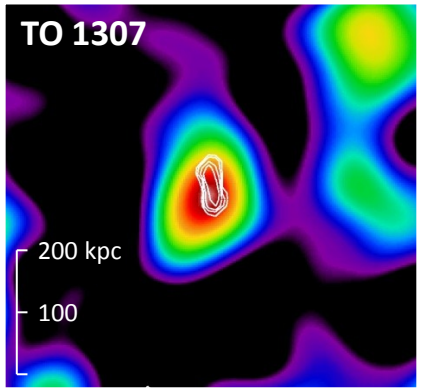
R_{500} = 430 kpc
L_x = 4.66x10^{43} erg.s^{-1}
Temperature = 2.0 keV

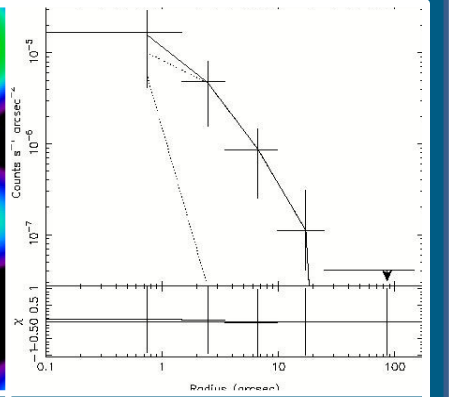




FRII, fat double, HERG
L_{151} = 14.1x10^{25} WHz^{-1}sr^{-1}
Redshift = 0.407

R_{500} = 648 kpc
L_x = 4.85x10^{43} erg.s^{-1}
Temperature = 2.9 keV



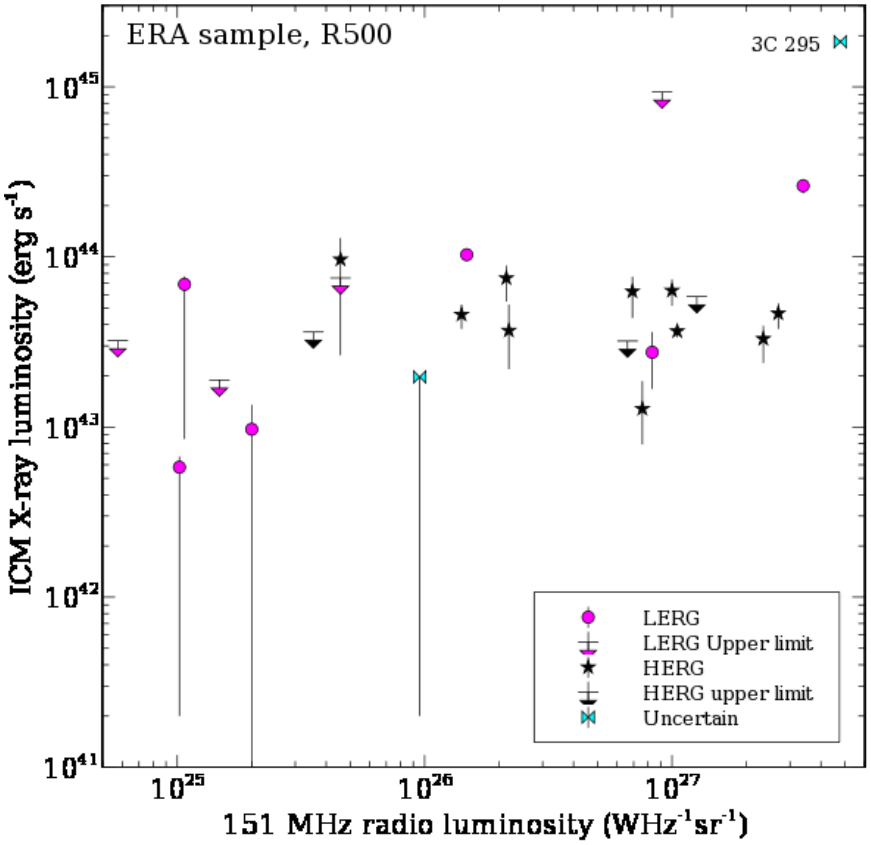


FRI, jet, LERG
L_{151} = 2.00x10^{25} WHz^{-1}sr^{-1}
Redshift = 0.583

R_{500} = 347 kpc
L_x = 0.97x10^{43} erg.s^{-1}
Temperature = 2.0 keV

Results – ERA sample

Radio luminosity vs Environment richness



ERA sample	
All data	$p < 0.05$
HERG	N/S
LERG	$p < 0.005$
LERG, no 3C 295	$p < 0.02$

Weak correlation between radio luminosity and environment richness

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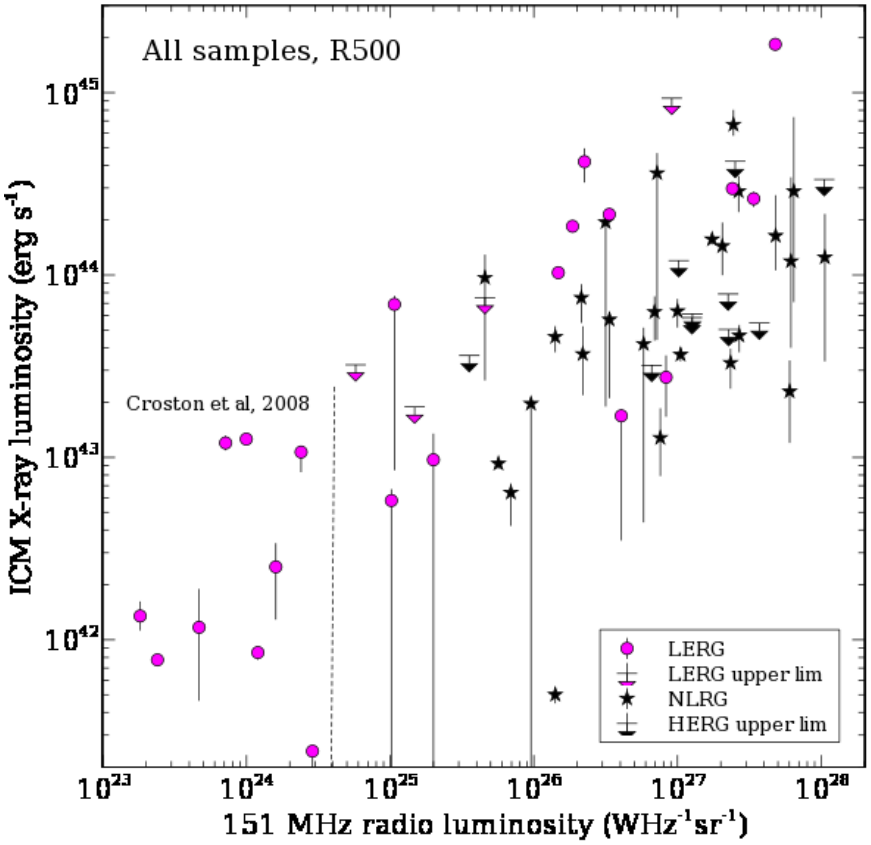
Results – comparison samples

Radio luminosity vs Environment richness



All samples	
All data	$p < 0.0001$
HERG	$p < 0.04$
LERG	$p < 0.0001$
Without Croston sample	
All data	$p < 0.004$
HERG	$p < 0.04$
LERG	$p < 0.003$

Supports result from ERA sample

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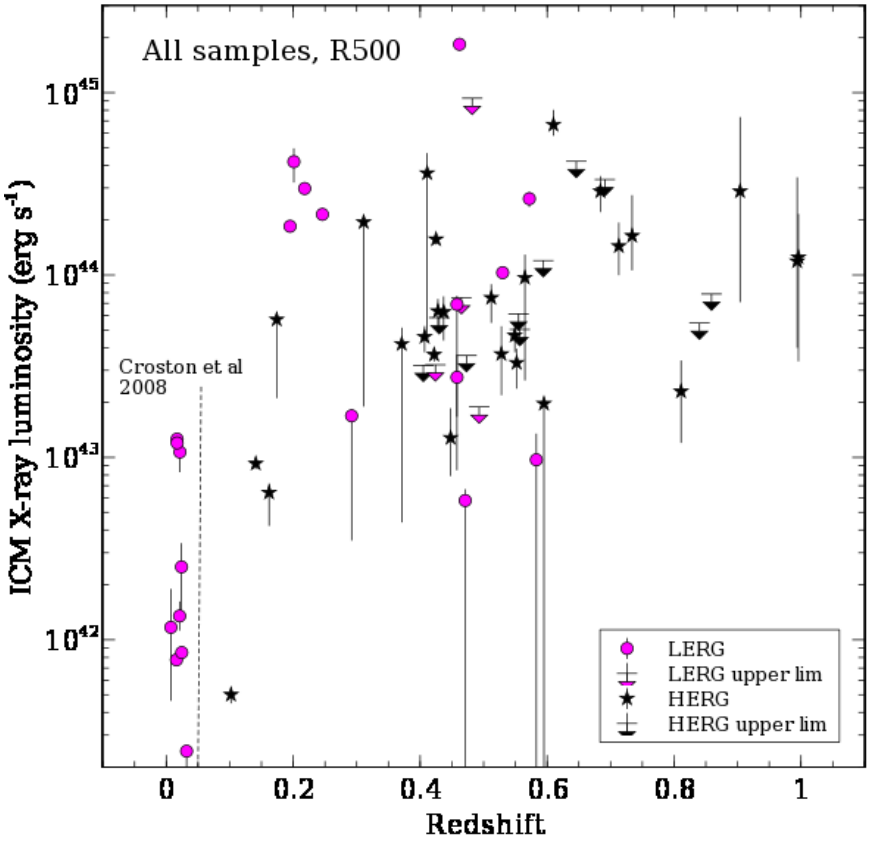
Results – comparison samples

Redshift vs Environment richness



All samples	
All data	p < 0.01
HERG	N/S
LERG	N/S
Without Croston sample	
All data	N/S
HERG	N/S
LERG	N/S

No evidence of environment evolution

Summary

- Indications of correlation between large-scale environment and radio luminosity
  - Potential scaling relation for AGN feedback models
- No evidence of environment evolution
  - But samples need improving
- Improve comparison data
  - Complete search of archives
  - Convert optical measures?
- Comparisons with host galaxy properties
  - Black hole mass (HST data and spectroscopy, McLure et al, 2004)
- Comparisons with optical environment measures
  - B_{gg} (WHT wide-field imaging, Herbert, PhD thesis)