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X-RAY SELECTED AGN: SELECTION AND CLASSIFICATION IN THE DARK ENERGY SURVEY

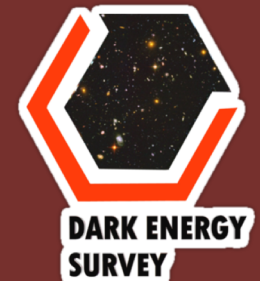
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Treasures Hidden in High Energy Catalogue – IRAP, May 2018



4MOST & DES: Overview

❖ DES (Dark Energy Survey)

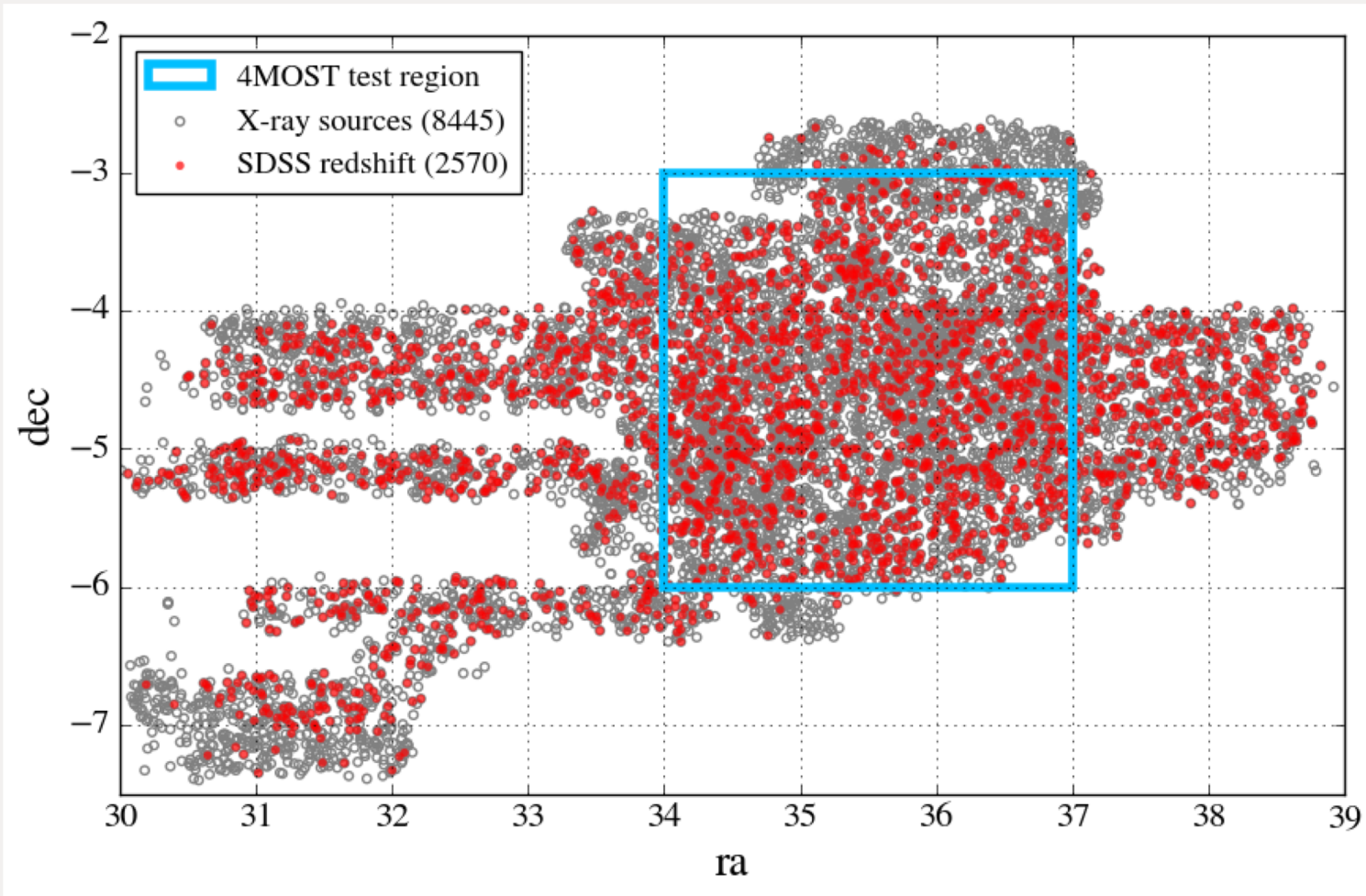
- 5 years observations (start Aug 2013)
- Wide area survey (5000deg²) in the southern sky
- Five optical filters, final depth in grizY[AB]: 25.5; 25.0;24.5; 23.5; 22.5 (**no u-band**)
- DR1 (Abbott+2018): 3-years of data

❖ 4MOST (4m Multi-Object Spectroscopic Telescope)

- Initial 5 years survey in the southern sky
- Galactic & Extragalactic wide-field surveys (> 15,000 deg²)
 - **AGN Survey:** e-ROSITA X-ray selected AGN ($z < 6$) + optical and IR AGN selection criteria
- Spectrograph: simultaneously spectra of ~2400 objects over 4 deg²
- Start of operation: 2021

The XMM-XXL Catalogue

- ❖ XMM-XXL north field (*XXL*)
- ❖ X-ray point-sources catalogue (8445 sources; Liu+ 2016) with cross-matched counterparts in SDSS and WISE (Menzel+ 2016)
 - 4075 (48%) X-ray sources with a SDSS counterparts
 - 2570 (63%) have a reliable SDSS BOSS redshift
 - 4844 (57%) X-ray sources with a WISE counterparts



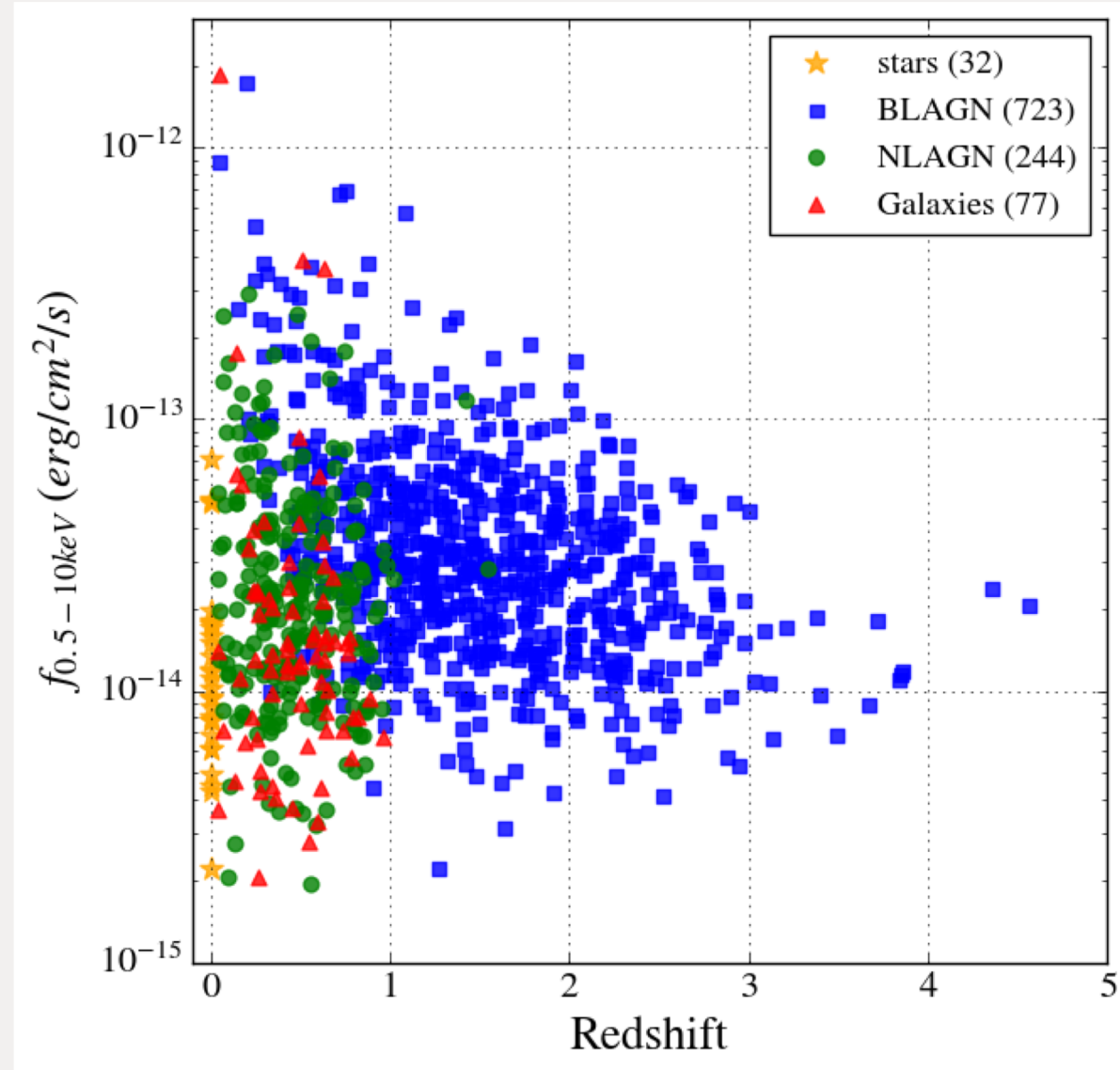
XXL-SDSS sources in DES

❖ XXL-SDSS \otimes DES ($r_{\text{SDSS-DES}} = 1''$) \rightarrow 1497 sources
 \rightarrow 1072 sources ($\sim 70\%$) have a SDSS spectroscopic redshift

❖ Spectroscopic classification

(Menzel+ 2016):

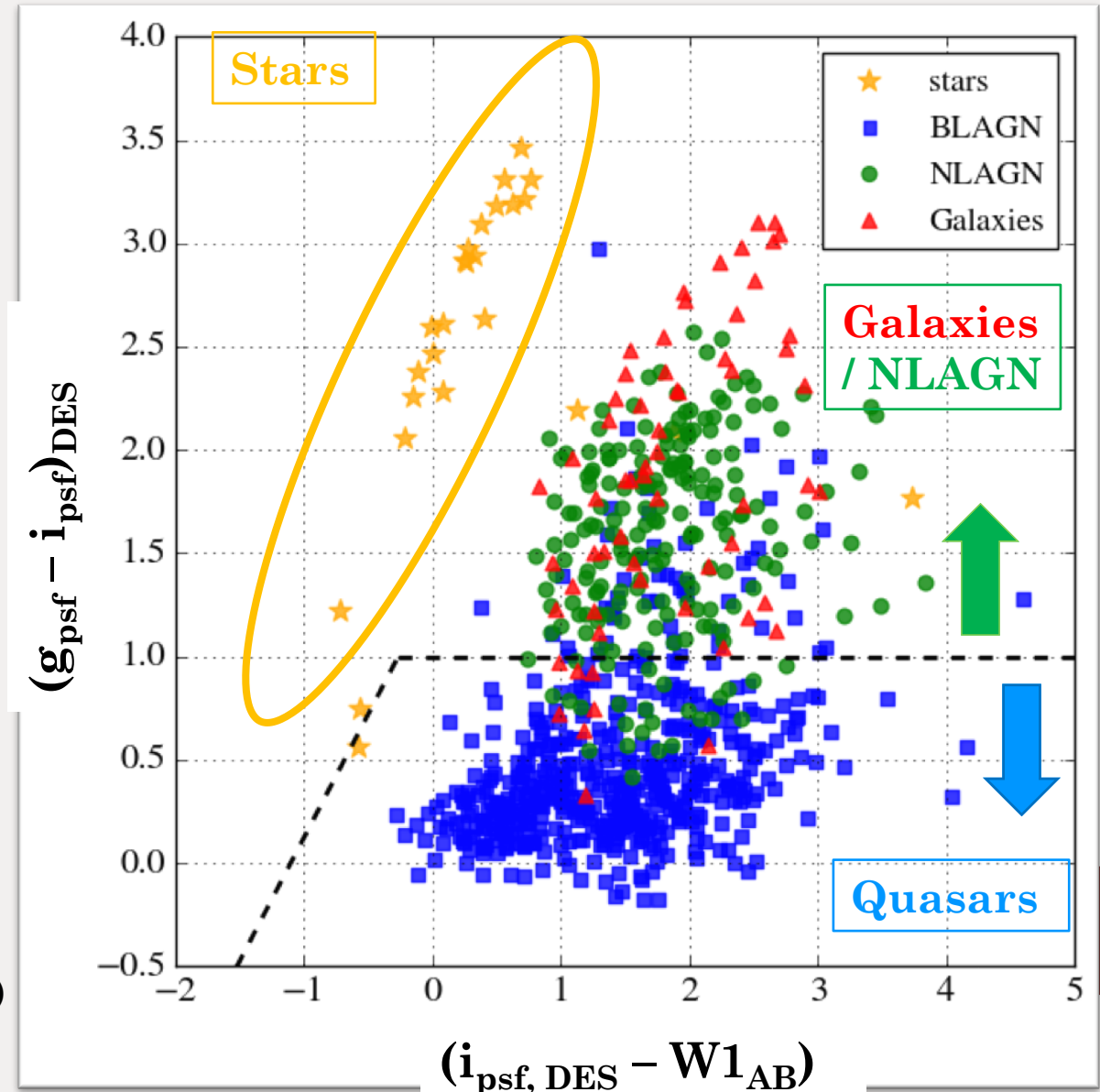
- 723 BL AGN
- 244 NL AGN
- 77 Galaxies
- 28 'not classifiable'
- 32 stars



Colour Selection of QSO

- ❖ Different optical-IR SED between quasars and stars → different regions of the colour-colour diagram
- ❖ $(g - i)$ vs $(i - W1)$ (Tie+2017): designed to reduce contamination by stars ($z < 4$)
 - Quasar region = 501 sources (64%)
 - 467 (93%) are BL AGN (main contaminants are NLAGN)
 - Completeness: 90% of the BLAGN

Tot: 782 sources (522 BL AGN)

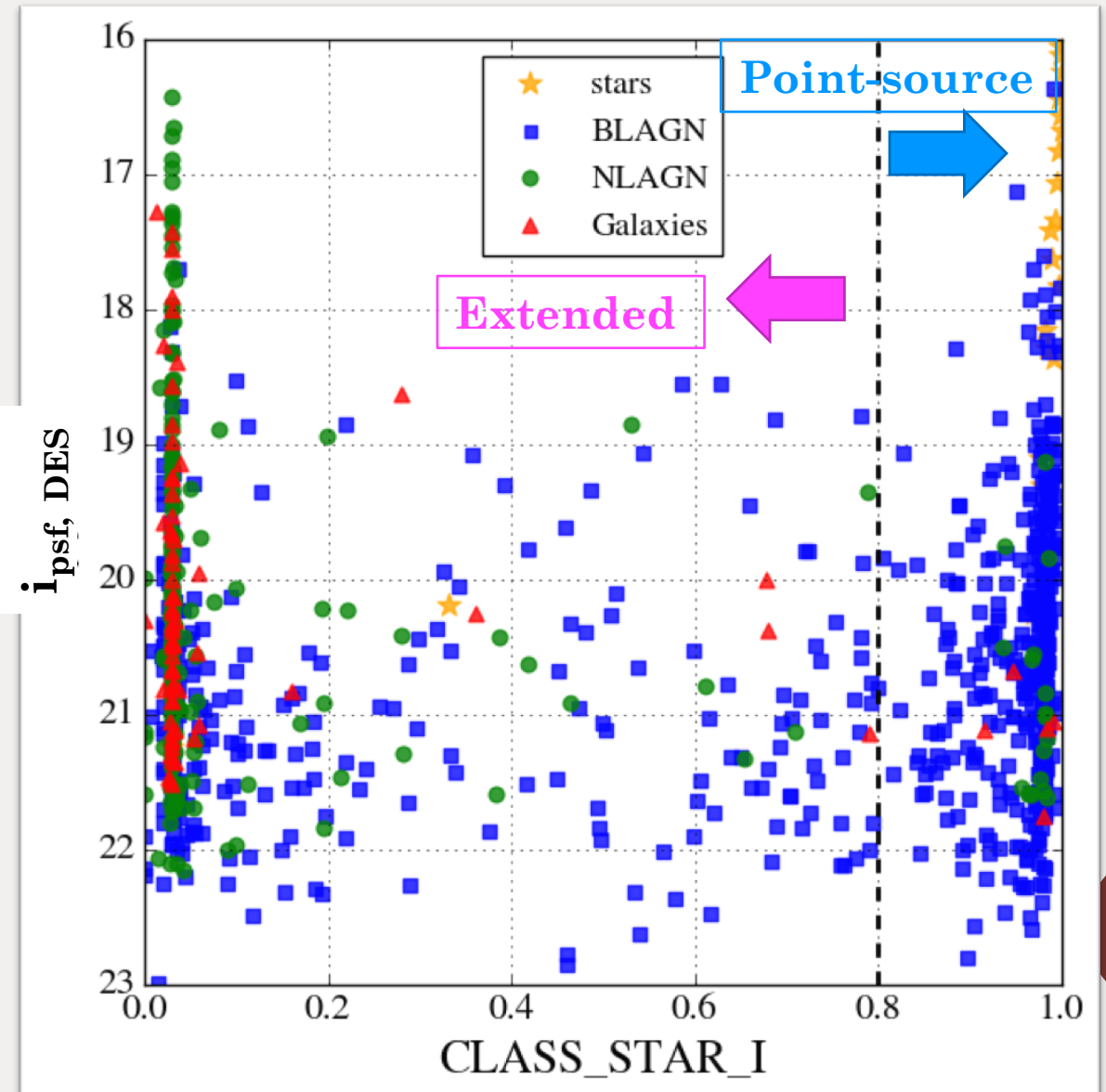


The star-galaxy separation in DES

1. CLASS_STAR

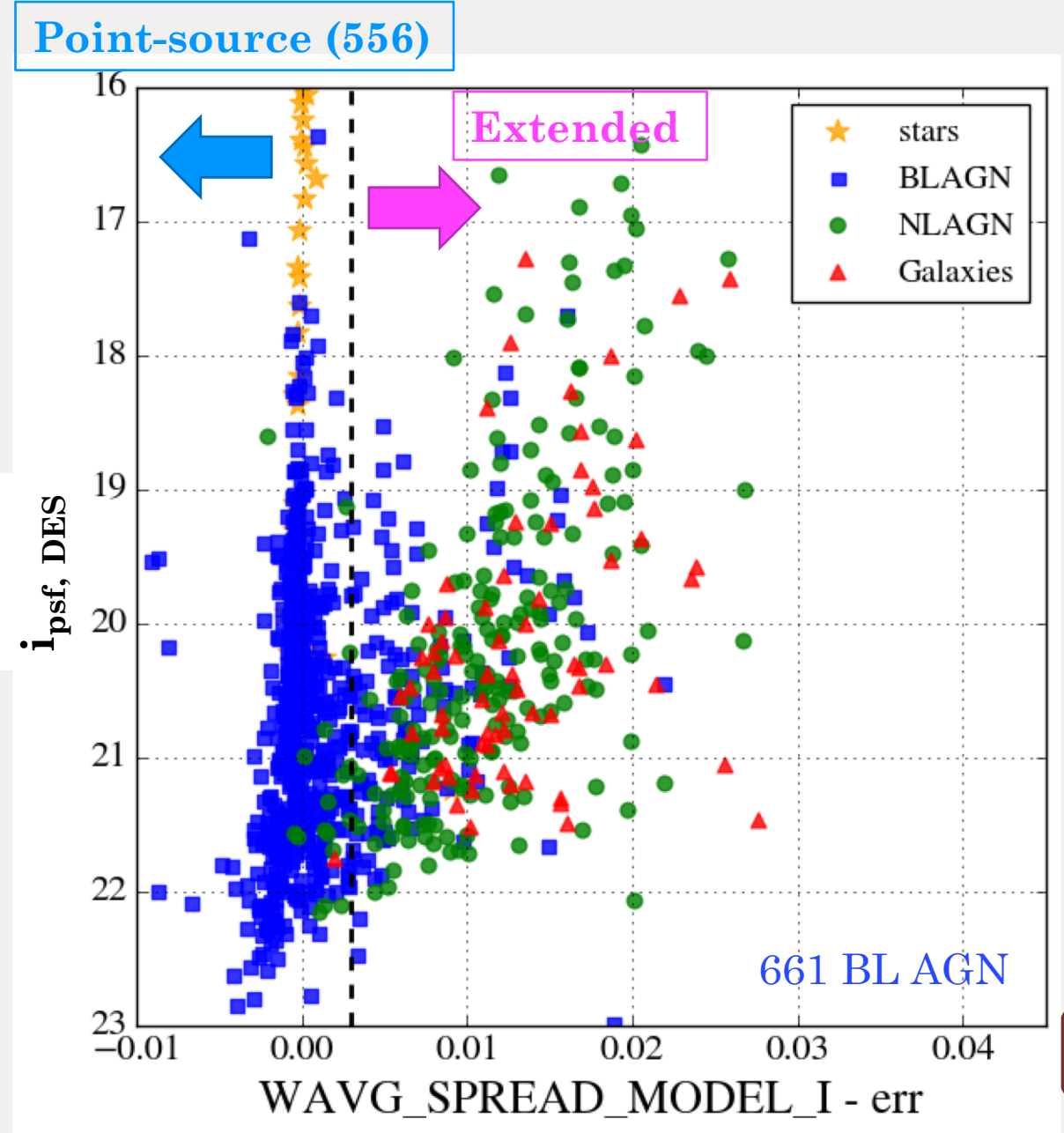
- ❖ standard SExtractor star-galaxy classifier
- ❖ works for intermediate magnitude
- ❖ point-source \rightarrow CLASS_STAR $>$ 0.8
 - Low completeness (60% of the BLAGN are classified as point-source)
 - Purity: 95% of the point-sources objects are BLAGN

661 BL AGN



2. *spread_model*

- ❖ SExtractor parameter: best fit between a local PSF model and an extended exponential disk model (Desai+2012)
- ❖ $\text{wavg_spread_model_i - err} < 0.003$ (Tie+2016)
 - 538 spectroscopic BL AGN
 - ➔ *purity*: **97%** of the point-source objects are BL AGN
 - ➔ *completeness*: **81%** of the BL AGN are point-sources



3. *psf* and *model* magnitudes

❖ S/G classifier used by SDSS

❖ $i_{\text{psf}} - i_{\text{model}} < 0.1$:

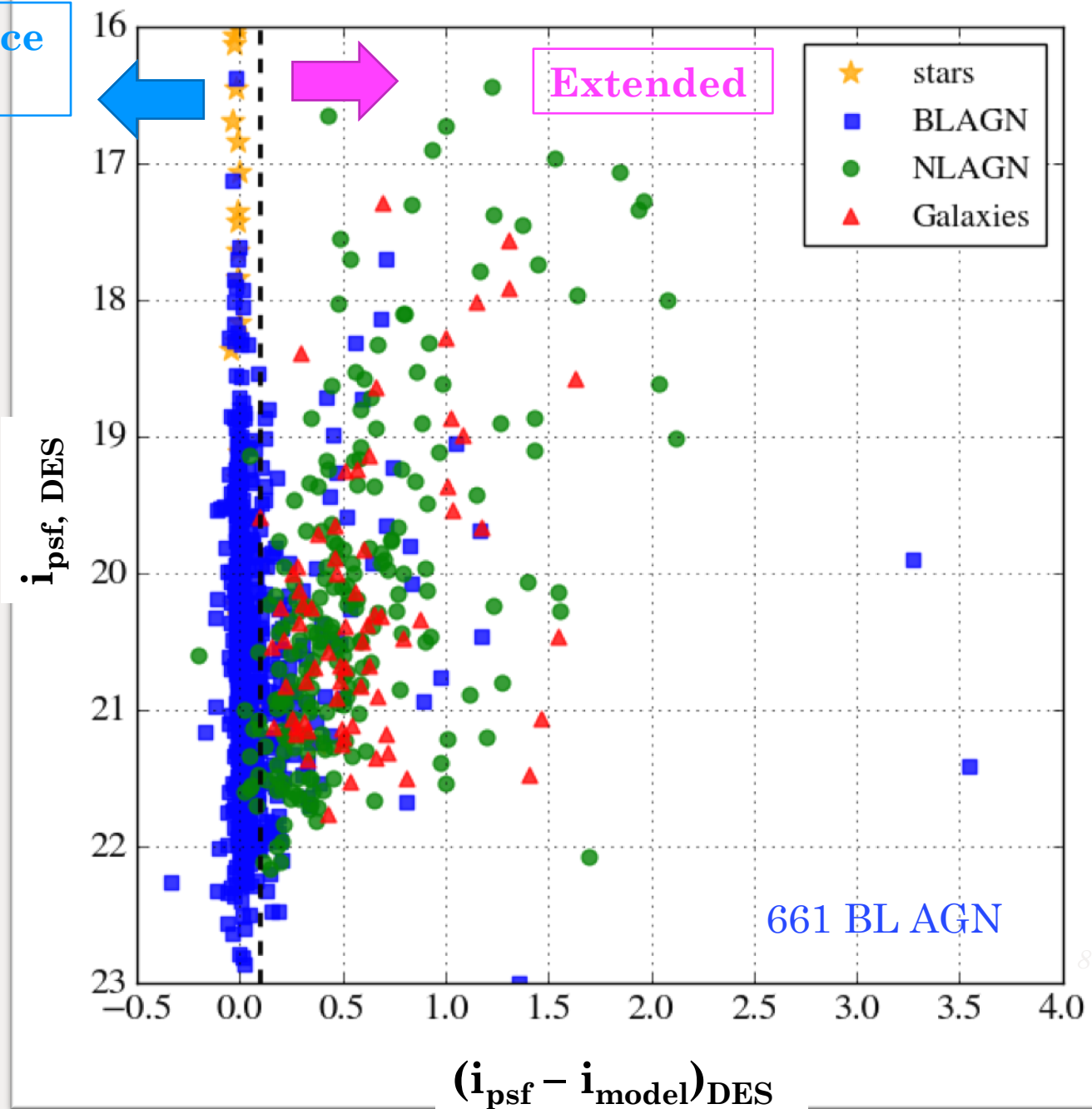
- 535 are spectroscopic BL AGN

➡ *purity*: **97%** of the point-source objects are BL AGN

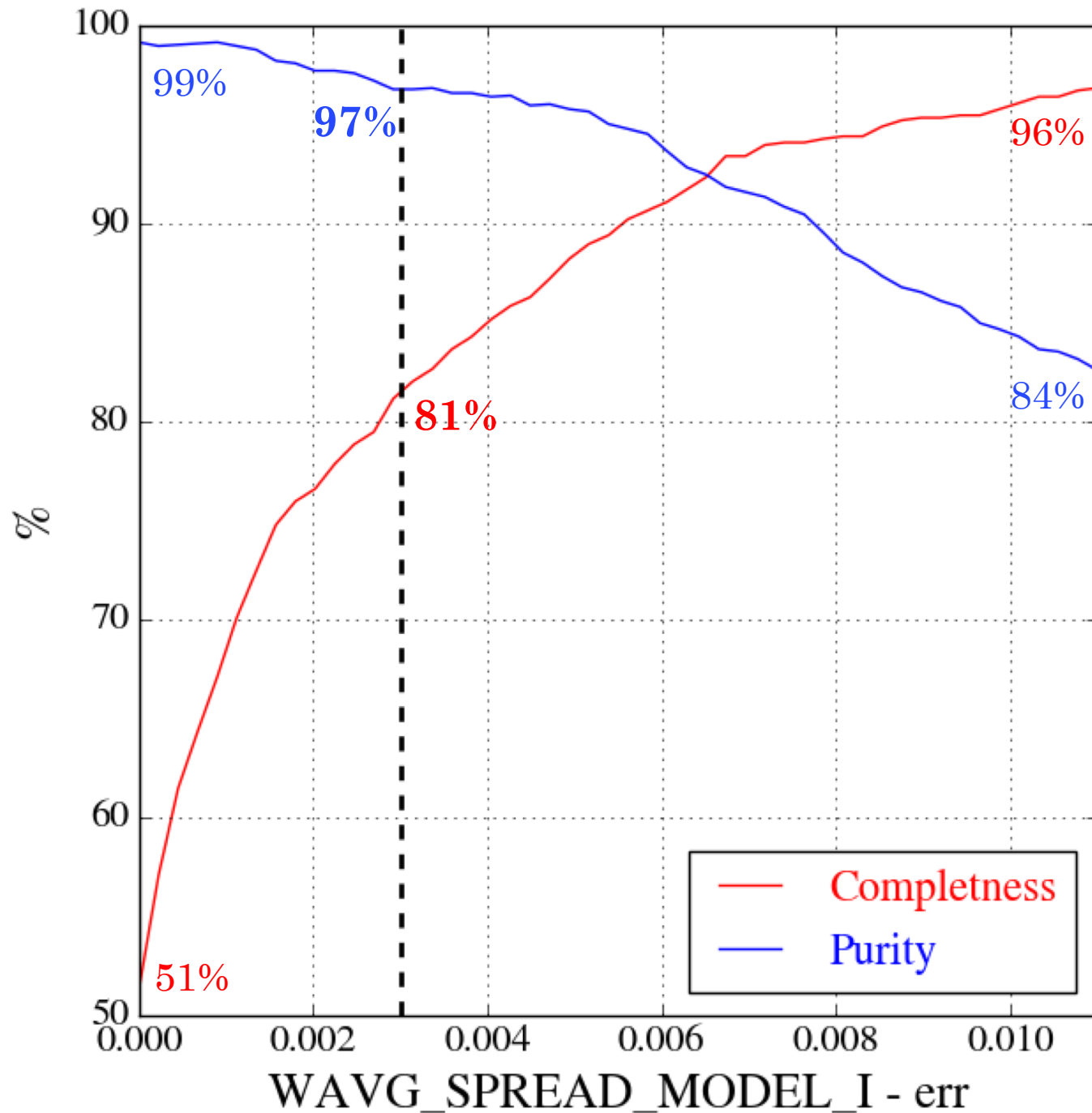
➡ *completeness*: **81%** of the BL AGN are point-sources

➡ Similar to *spread_model* classification

Point-source
(553)



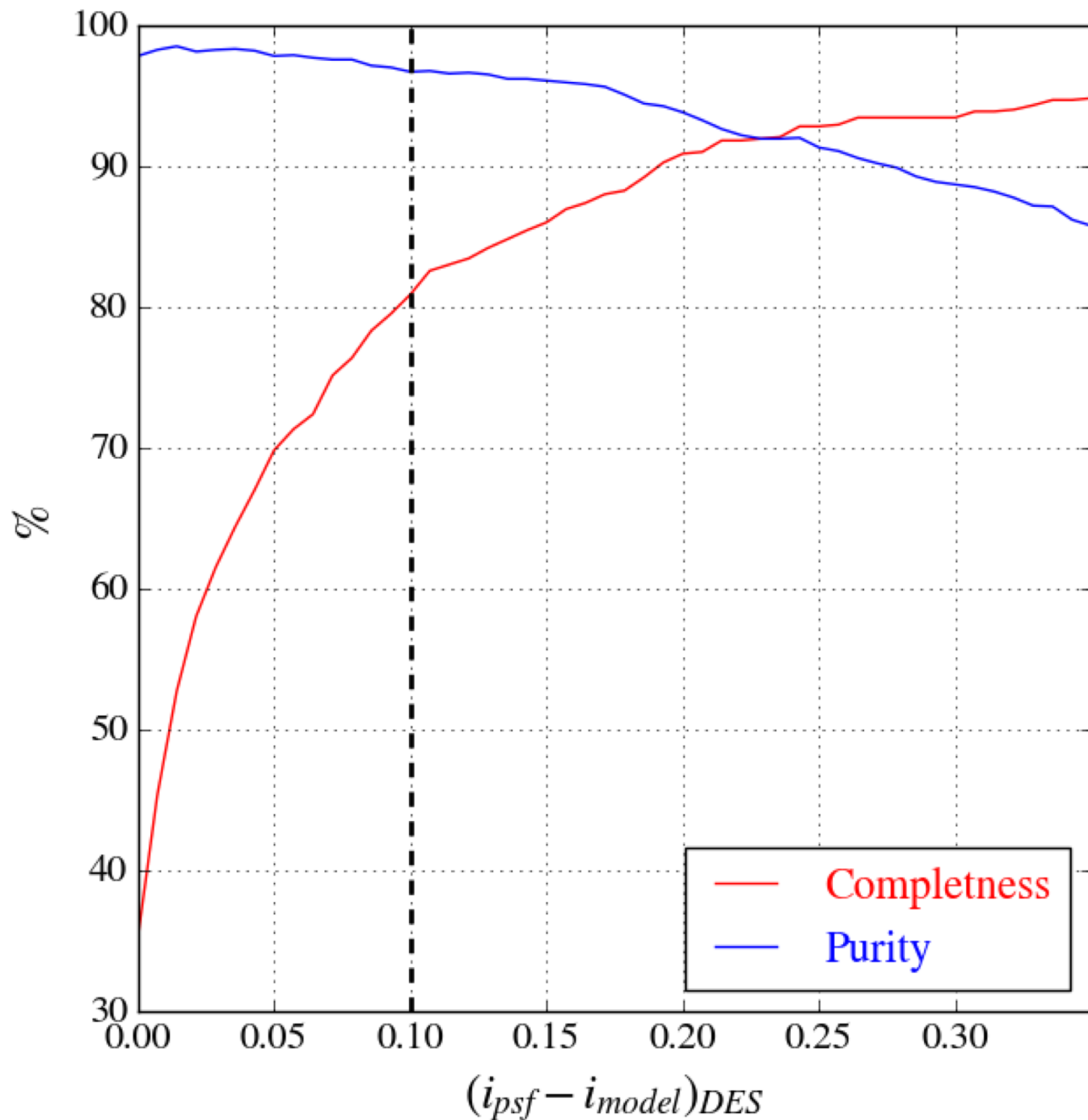
Completeness vs purity



❖ colour + morphological selection:

- 76% of the spectroscopic BL AGN are point-source and have QSO colours
- Very low contamination (1.5%)

❖ spectroscopic target strategy → relax / restrict the point-source selection



❖ Completeness vs purity for $i_{psf} - i_{model}$

- Cleaner sample at high completeness (95%) compared to *spread_model*

Conclusion

- ❖ Quasars colours selection: giW1
 - purity = 93%, completeness = 90%
- ❖ Star vs galaxy morphology:
 - CLASS_STAR: purity = 95%, completeness = 60%
 - $Spread_model / i_{psf} - i_{model}$: purity = 97%, completeness = 81%
- ❖ Morphology and colours selection
 - **Completeness**: reselect **76%** of the spectroscopic BL AGN
 - **Purity**: **only 1.5%** of the point-source objects with quasars colours are **not BL AGN**
- ❖ *On-going work*: Predicted number of DES QSO ($z < 4$). To be compared with XMM/eROSITA observations/predictions