eBOSS/SPIDERS:AGN Target selection and first results
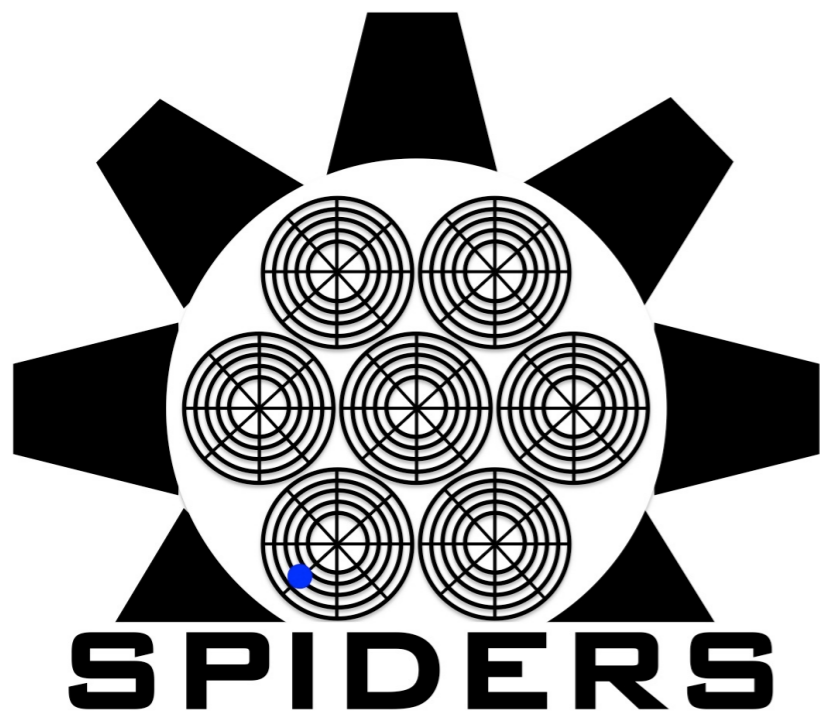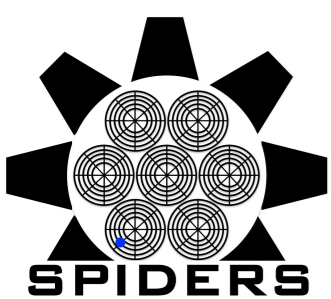
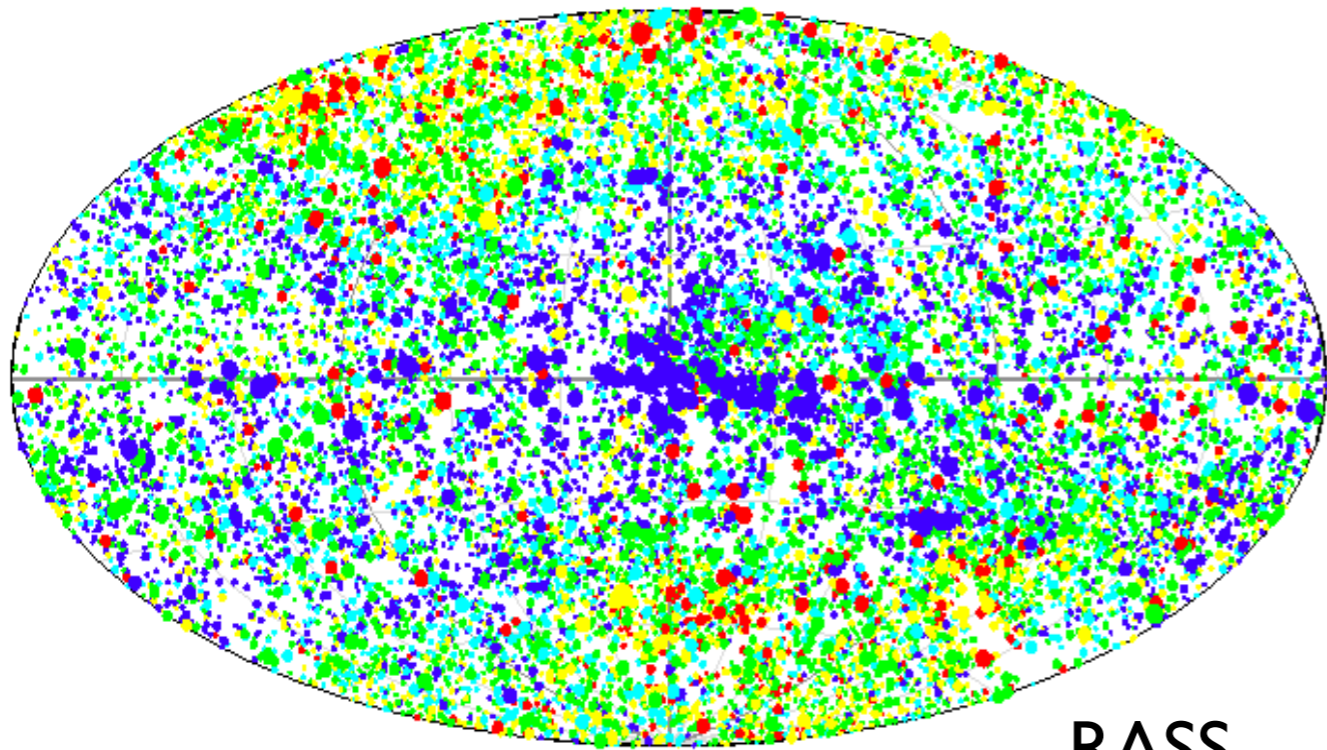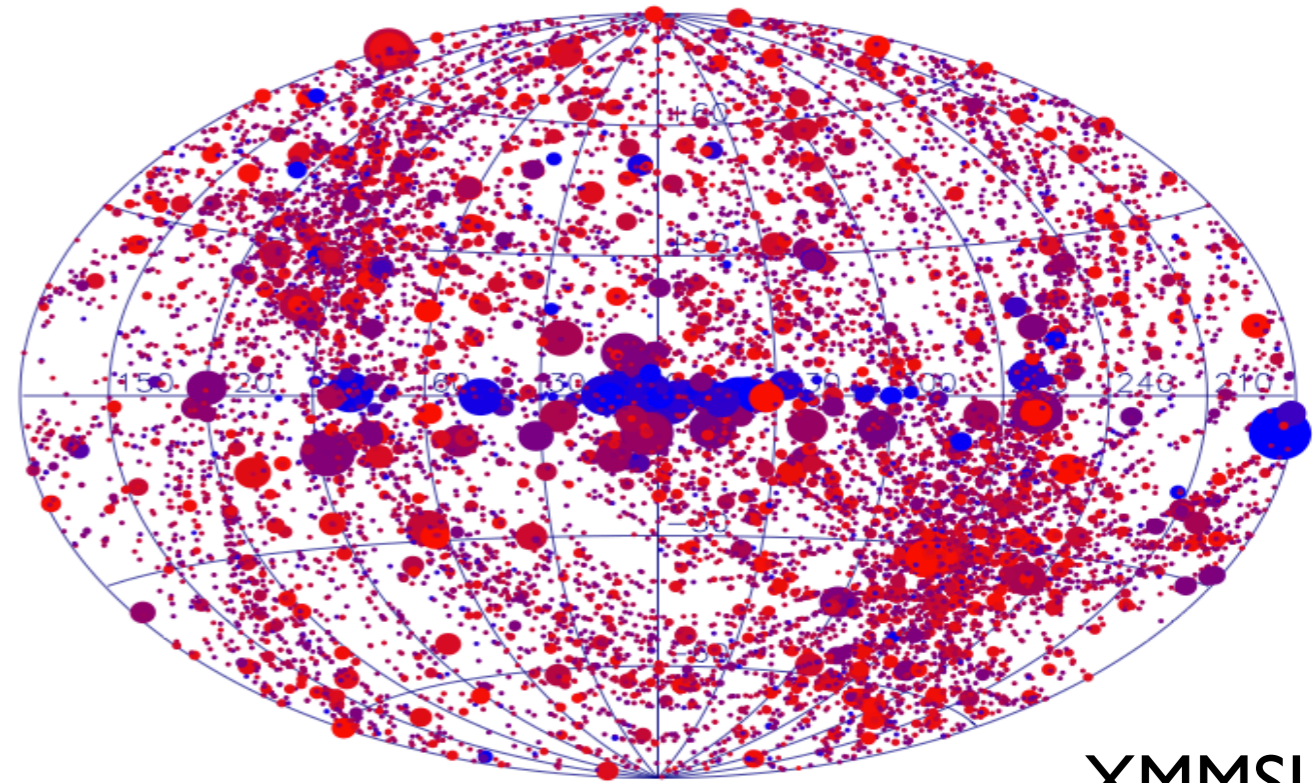Tom Dwelly (MPE)
for the SPIDERS team

SPIDERS

Outline

SPIDERS: Spectroscopic Identification of (pre-)eROSITA Sources

X-ray selected AGN component

- Pre-eROSITA targets (RASS, XMMSL)

- Counterpart selection method using WISE

- Sky coverage and target numbers

- First results from eBOSS

- SEQUELS results (if enough time)

RASS

XMMSL

SPIDERS AGN in 'Tier-0'

Targets Selected from RASS and XMMSL Available at start of eBOSS operations (July 2014)

3

X-ray catalogues
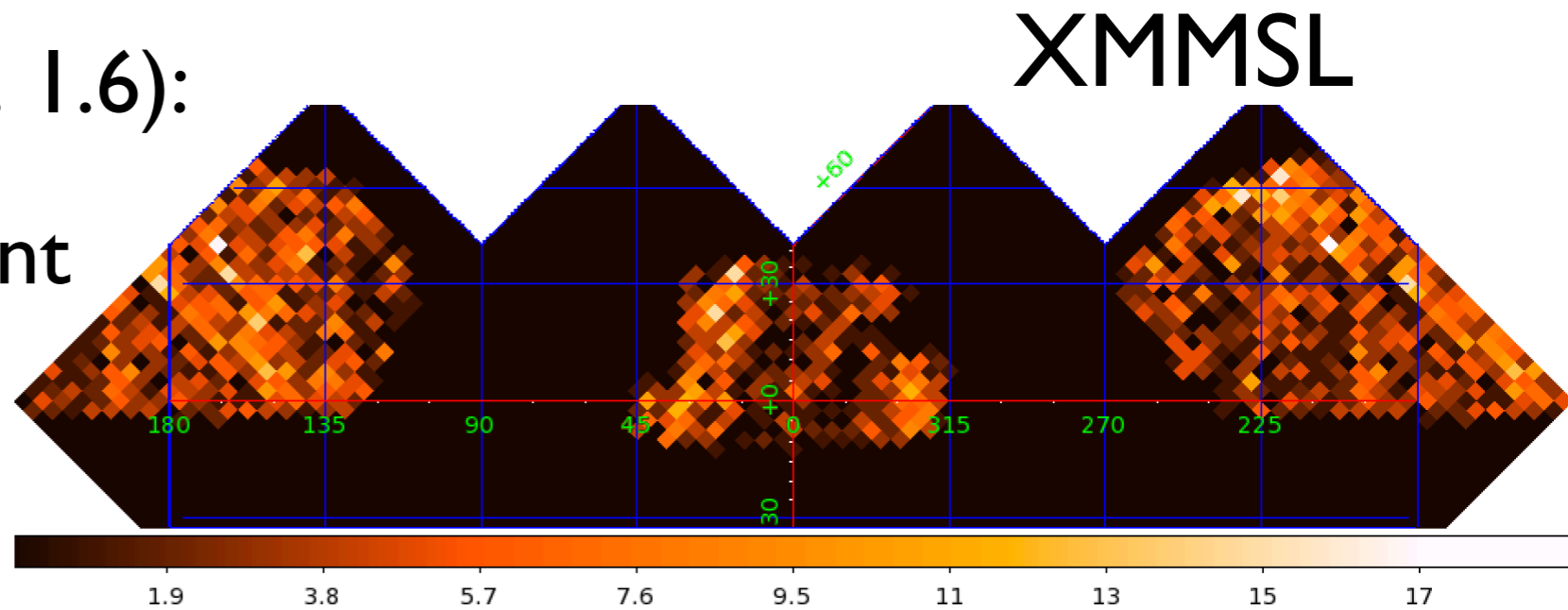
- Parent footprint:

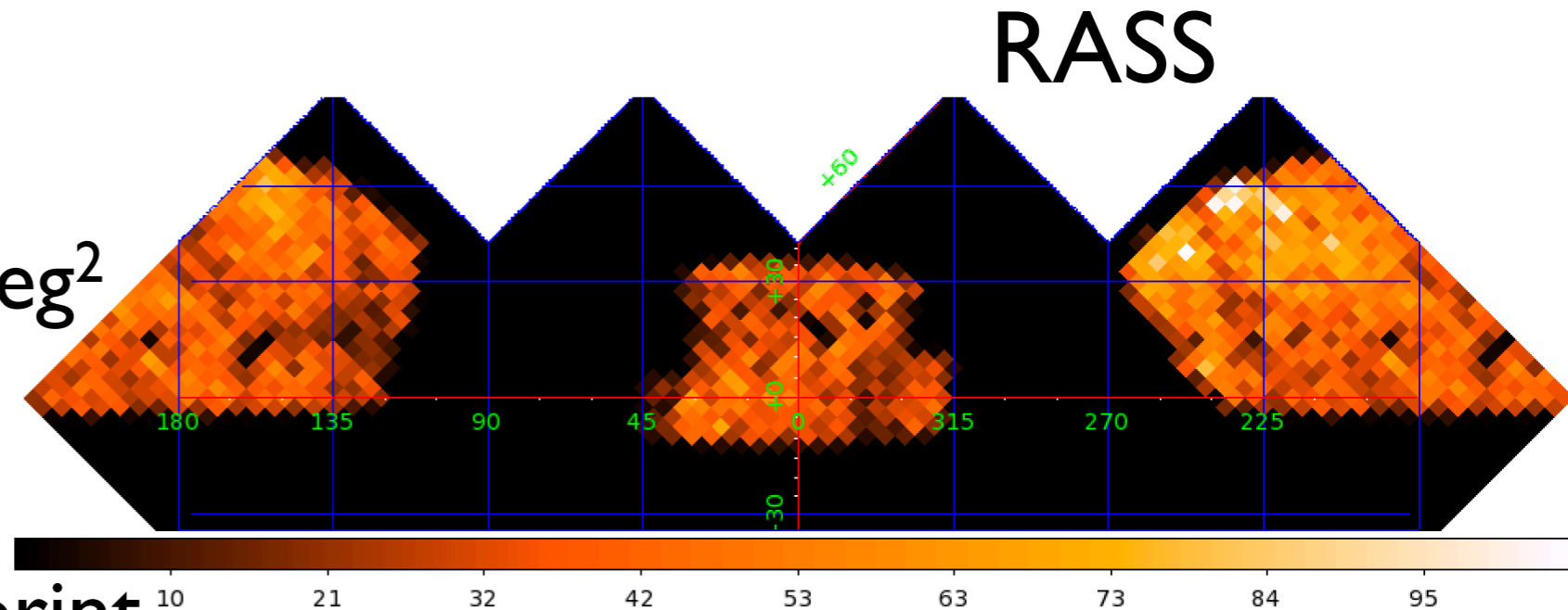 BOSS imaging=10800deg^2

- RASS (BSC+FSC):

  32400 sources in footprint

- XMM Slew Survey (rel. 1.6):

  4300 sources in footprint
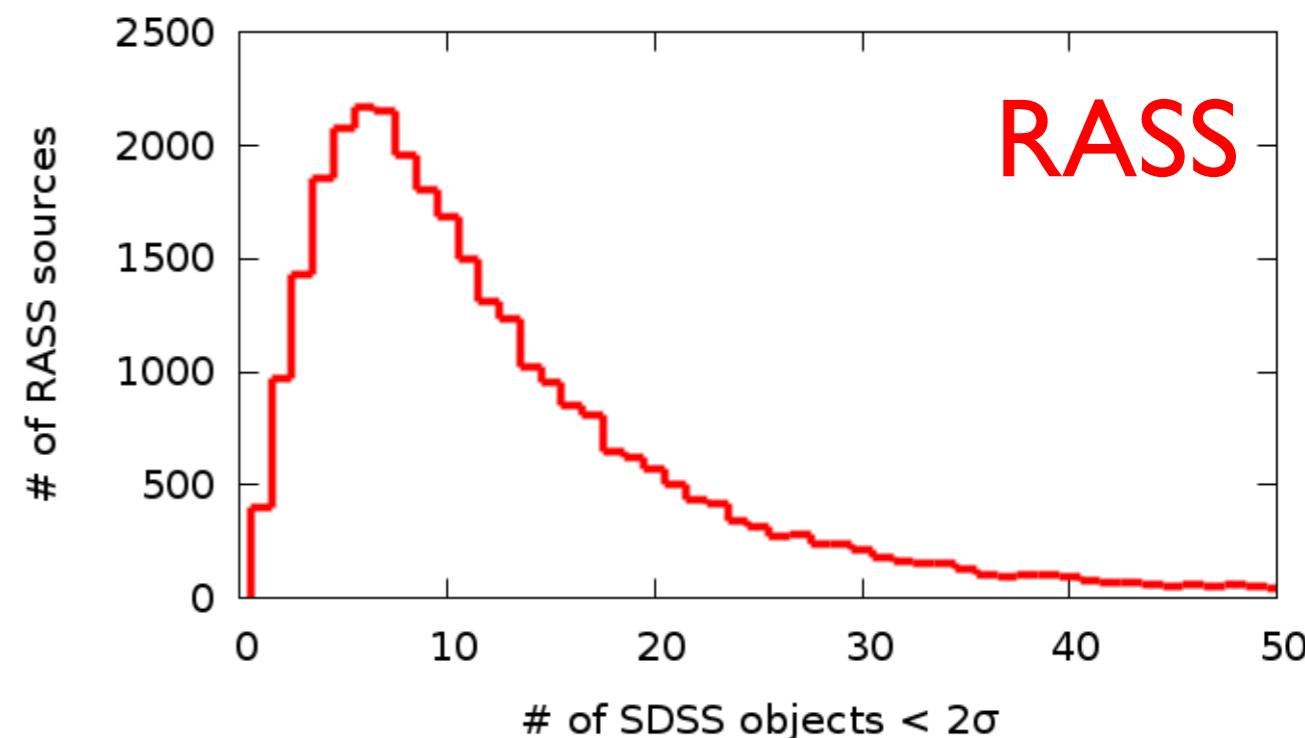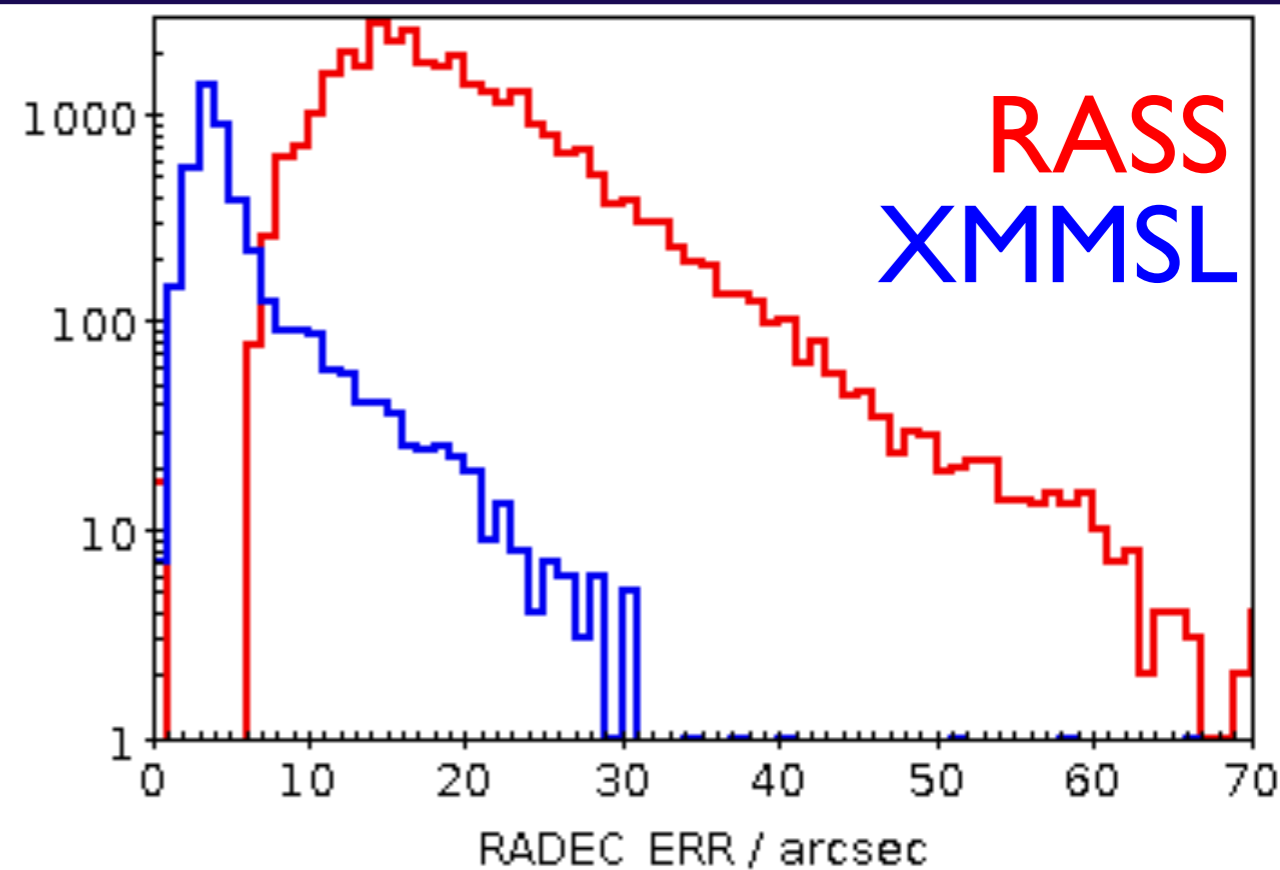
- Some sources appear in both RASS and XMMSL

RASS

XMMSL

Maps: HEALPIX nside=16 (13.4deg^2 pixel^{-1})

- X-ray position errors:

  RASS: $<1\sigma>$ =20'' (95%ile=35'')

  XMMSL: $<1\sigma>$ =6'' (95%ile=15'')

- Heterogeneous mix of
  AGN, Stars, Clusters etc

- ~8 objects arcmin^{-2} at SDSS
  imaging depths (g' ~ r' ~ 22 AB)

- How can we choose the
  correct counterpart?

RASS
XMMSL

RADEC ERR / arcsec

RASS

# of RASS sources

# of SDSS objects < 2σ
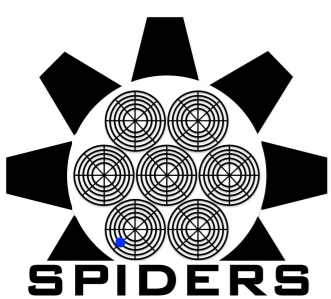
Target Selection

- Bayesian association method (Salvato, Buchner, et al.)

    - An extension of Budavari & Szalay (2008) method

    - Allows input priors based on any combination of counterpart characteristics

- But what are the best priors to use?

    - Must be available over full BOSS footprint

    - Must cope with heterogeneous counterpart types

- Many RASS sources already have SDSS spectrum (Anderson+,2003,2007)

AGN in the mid-IR

- X-ray bright AGN are **red** in the MIR

- X-ray bright sources are **bright** in the MIR

- Field stars+galaxies are **faint** and/or **blue** in the MIR
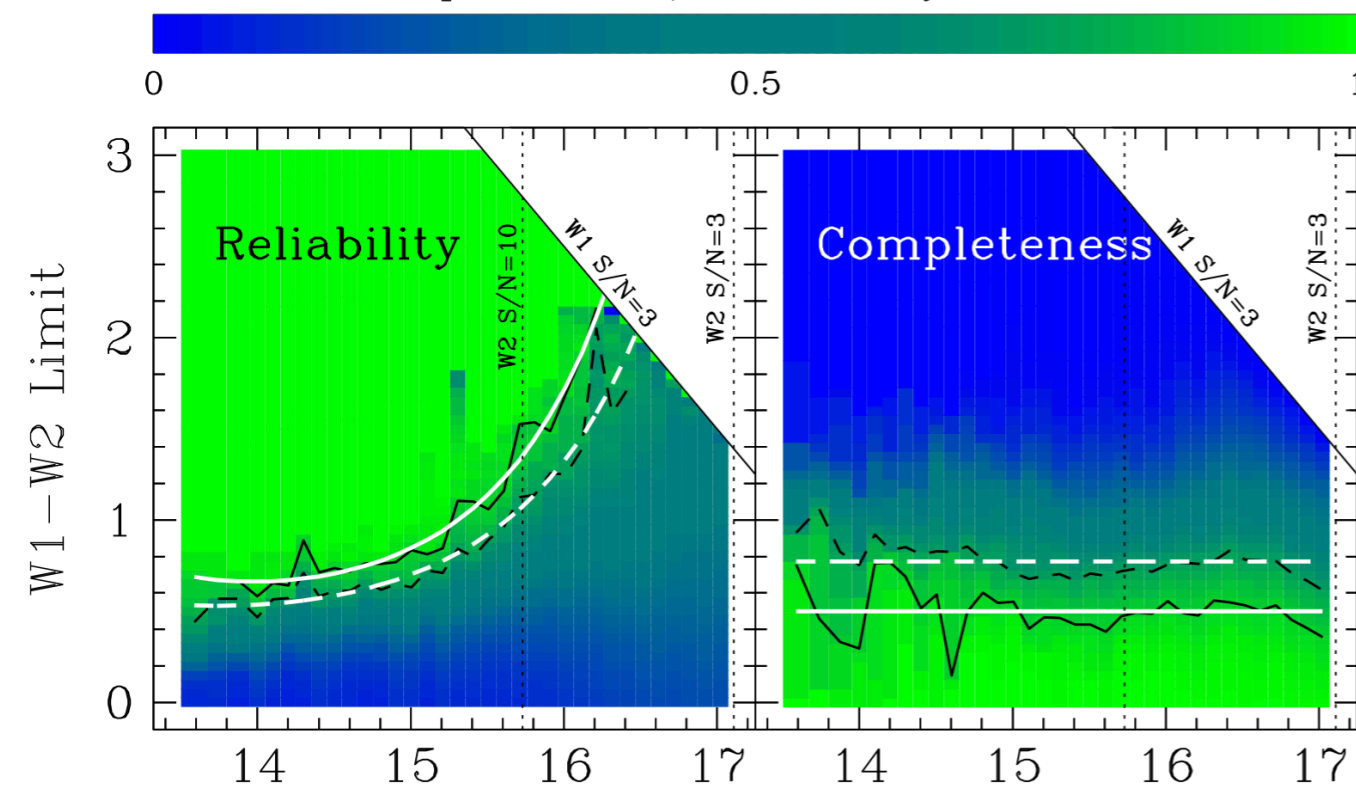
Assef+ (2013)

Mateos+ (2012)
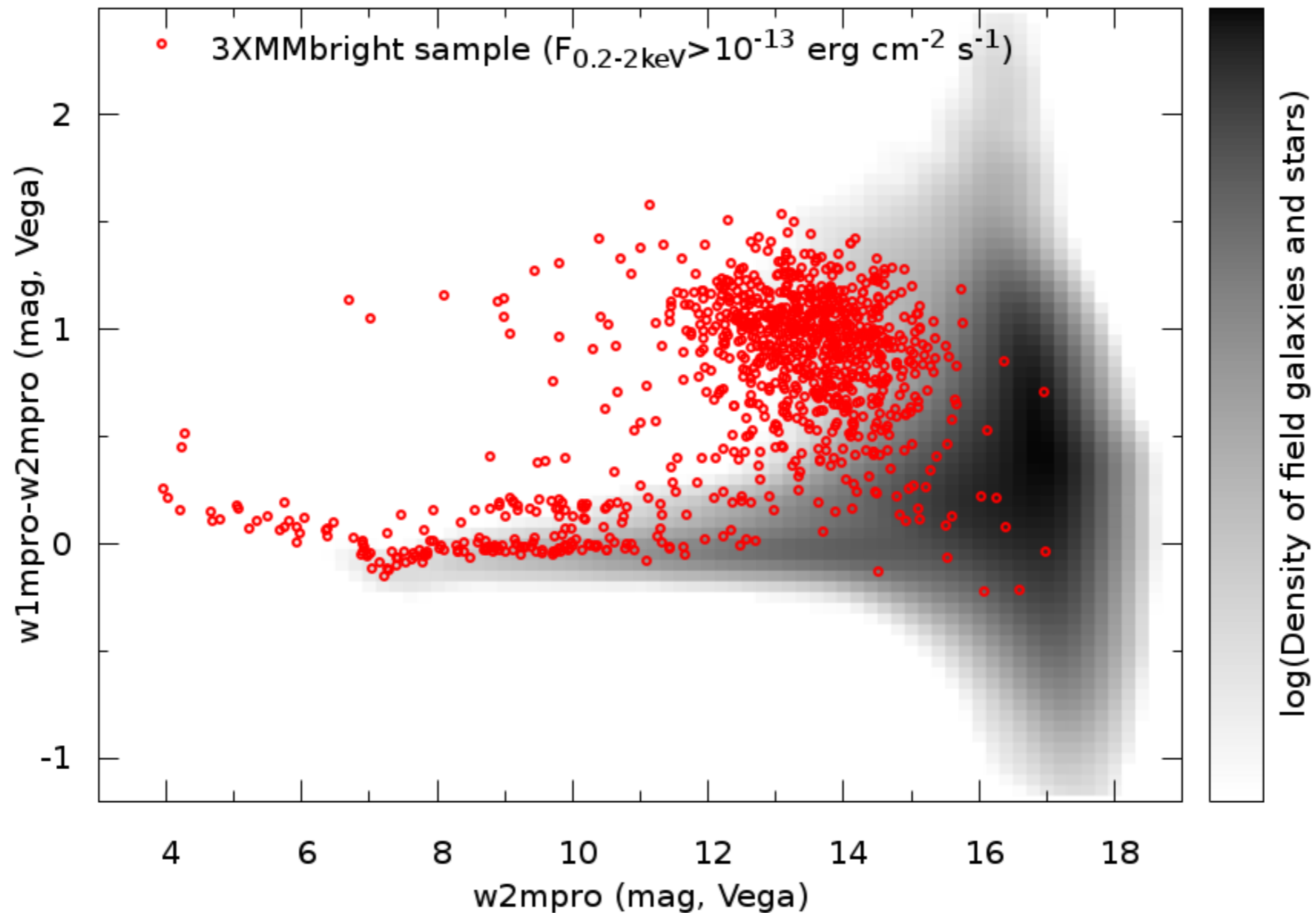
SPIDERS

eBOSS
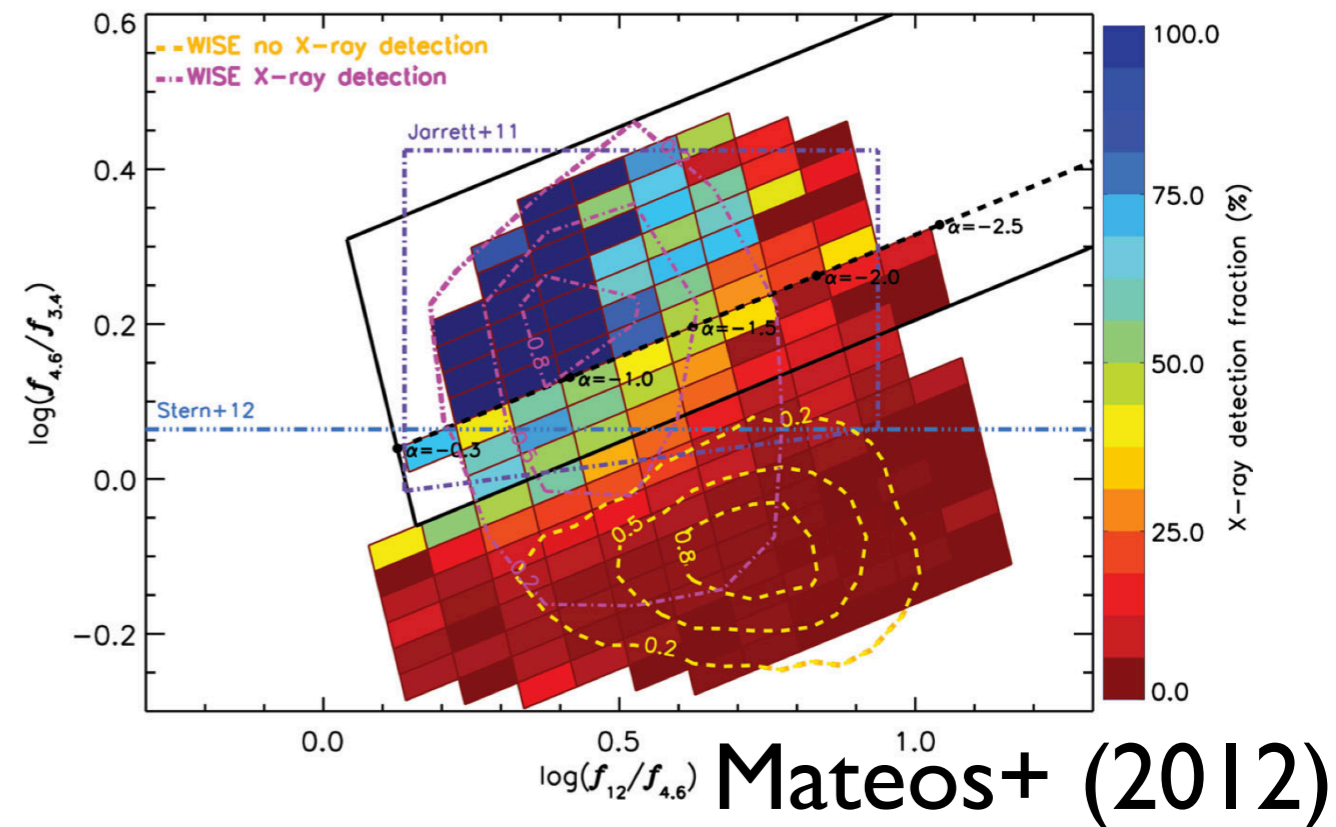
- Uses all of the WISE data from the primary mission

- 4 mid-IR bands (λ_{eff}=**3.4, 4.6**, 12 and 22um)

- 95% of sky covered to 5σ limits of at least:

  - **3.4um (W1) ➔ 17.6 Vega = 20.3 AB**

  - **4.6um (W2) ➔ 16.1 Vega = 19.5 AB**

  - 12um (W3) ➔ 11.5 Vega = 16.7 AB

- Unobscured QSOs typically have colours:
  r' – W2 ~ 5   (Vega, see e.g. DiPompeo+14)

  - Obscured QSOs much redder

Training sample

- Train on a sample of ~1000 bright point-like 3XMM sources ($F_{0.2-2keV} > 10^{-13}$ erg cm^{-2} s^{-1})

- Train on a sample of ~1000 bright point-like 3XMM sources ($F_{0.2-2keV} > 10^{-13}$ erg cm^{-2} s^{-1})
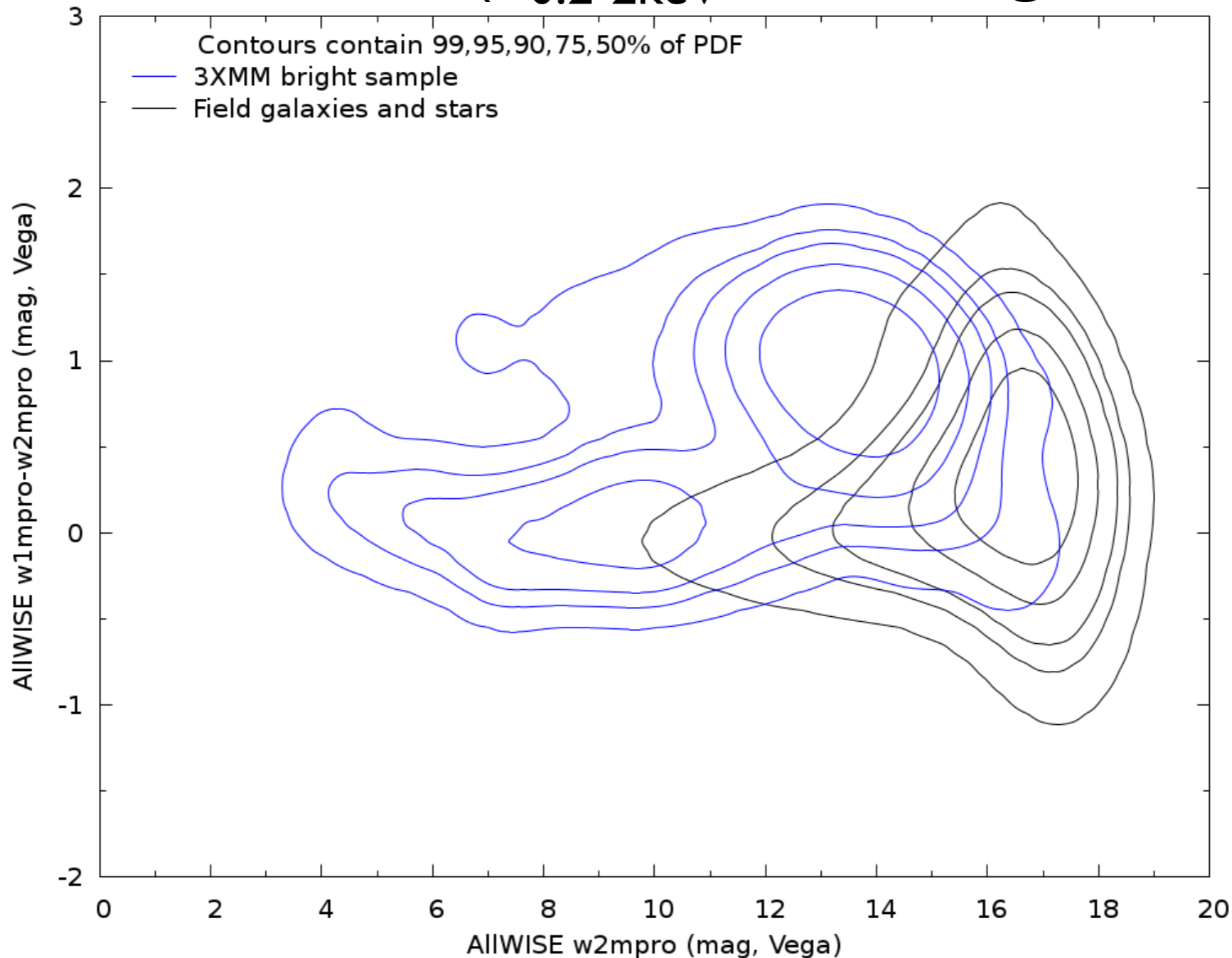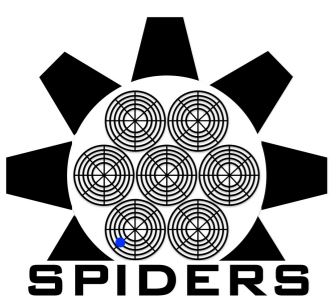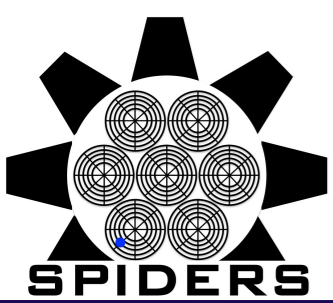
- 30855/32408 RASS sources have an AllWISE counterpart with $P \geq 0.01$ ➜ choose maximum P

- 28515/30855 have ≥ 1 match in SDSS imaging (<1.5")

- Filter out all objects which:

  - already have SDSS spectra (11643 sources)

  - have $i'_{fiber} < 17$ or $i'_{fiber} > 22.5$ (7411+283 sources)

  - lie near very bright stars (150 sources)

- Leaves 9028 RASS AGN targets for eBOSS

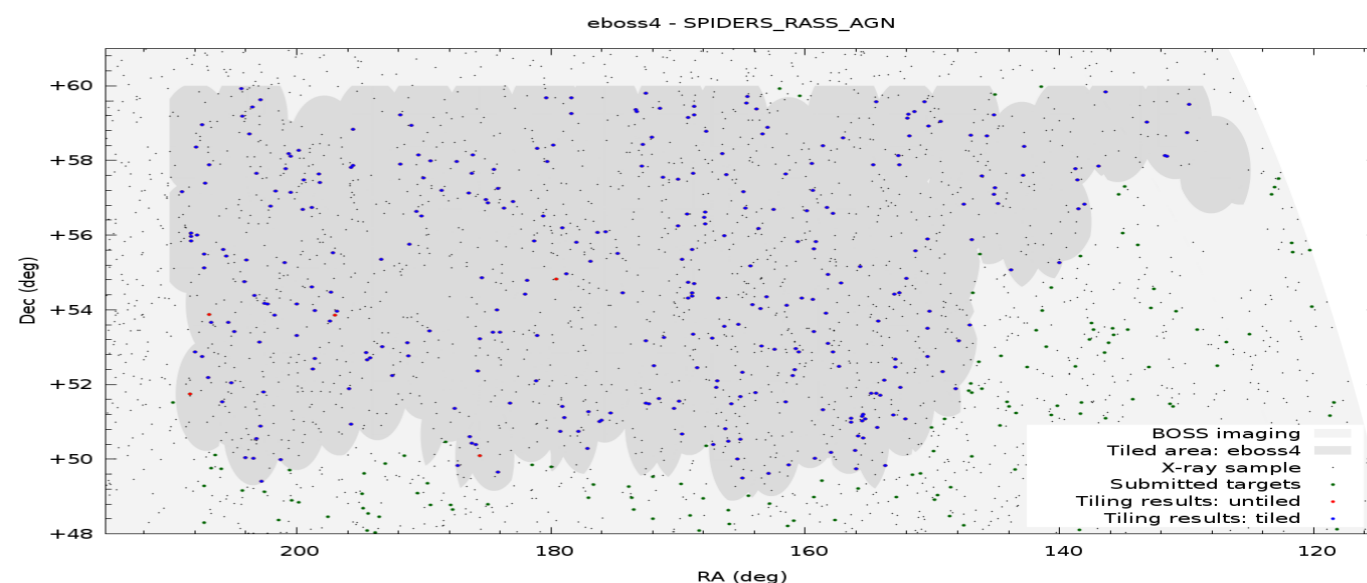- Similarly, 819 XMMSL AGN targets in eBOSS

X-match validataion

- How well do we recover correct counterparts when starting with RASS positions+errors?

  - Use 3XMMBright$\rightarrow$AllWISE matches as 'truth'

    - 295/1000 of 3XMMBright+AllWISE sample are matched to RASS sources

    - For 279/295 we choose exactly the same WISE counterpart that was chosen using XMM position

    - = 94.6±1.3 % success rate!

  - Similar test against bright 1SPXS (Swift-XRT) sources gives 940/1006 = 93.4±0.8% success rate
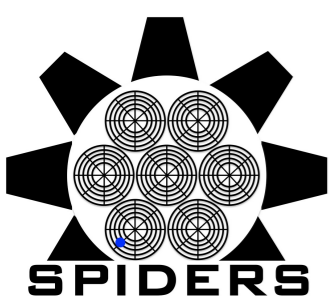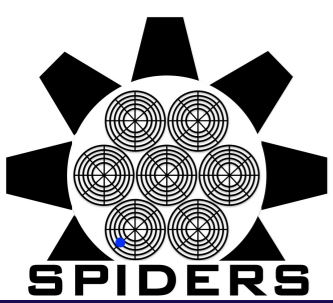
eBOSS tiling results

- Tiling results for first 4 chunks of eBOSS (2840deg^2)

- SPIDERS targets tiled with high priority

- RASS AGN: 3084 targets

- XMMSL AGN:
  - 288 targets

- Over 98% of submitted targets will get spectra

- Tiling results for first 4 chunks of eBOSS ($2840\deg^2$)

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- RASS AGN: 3084 targets

- XMMSL AGN:
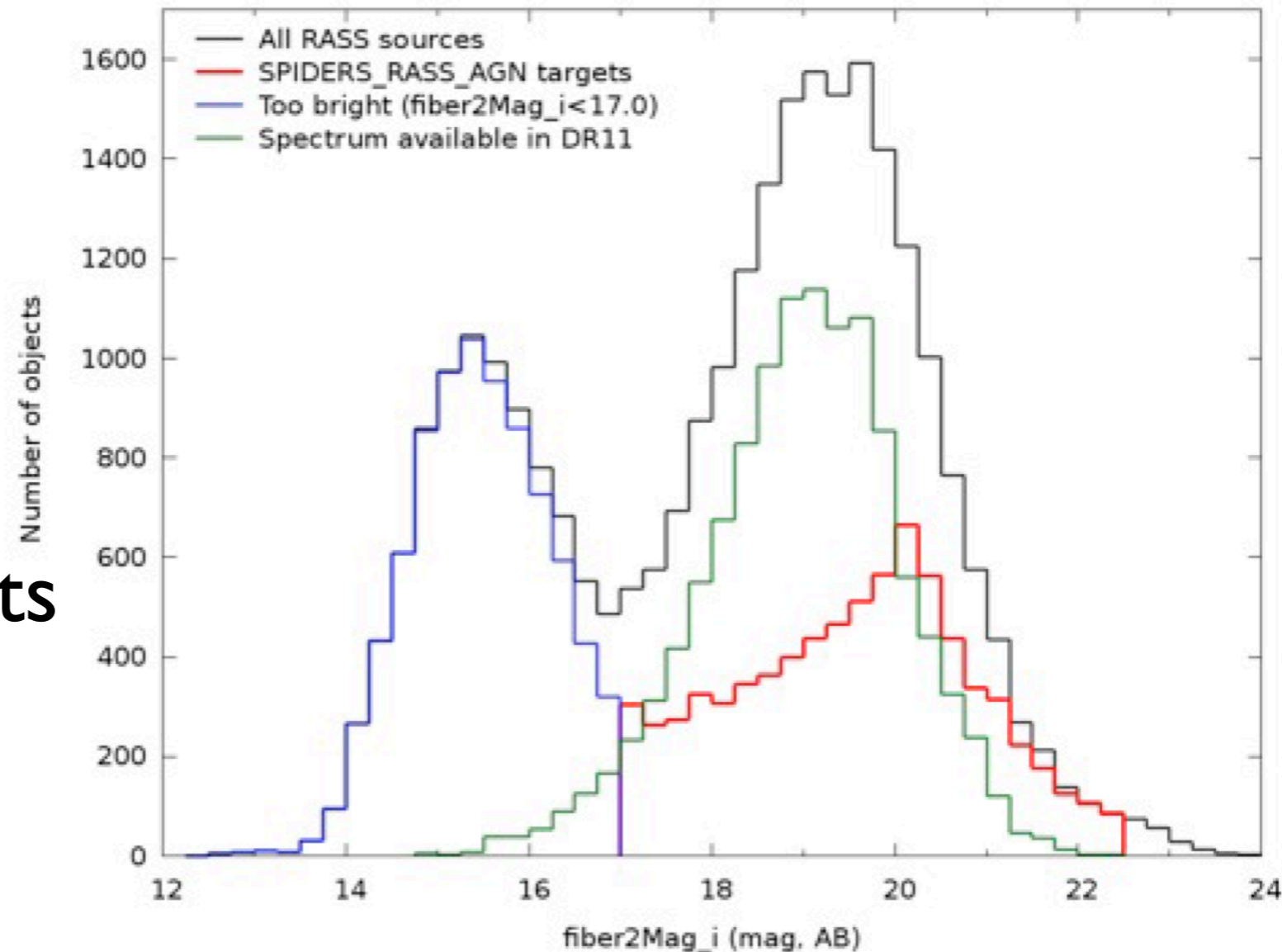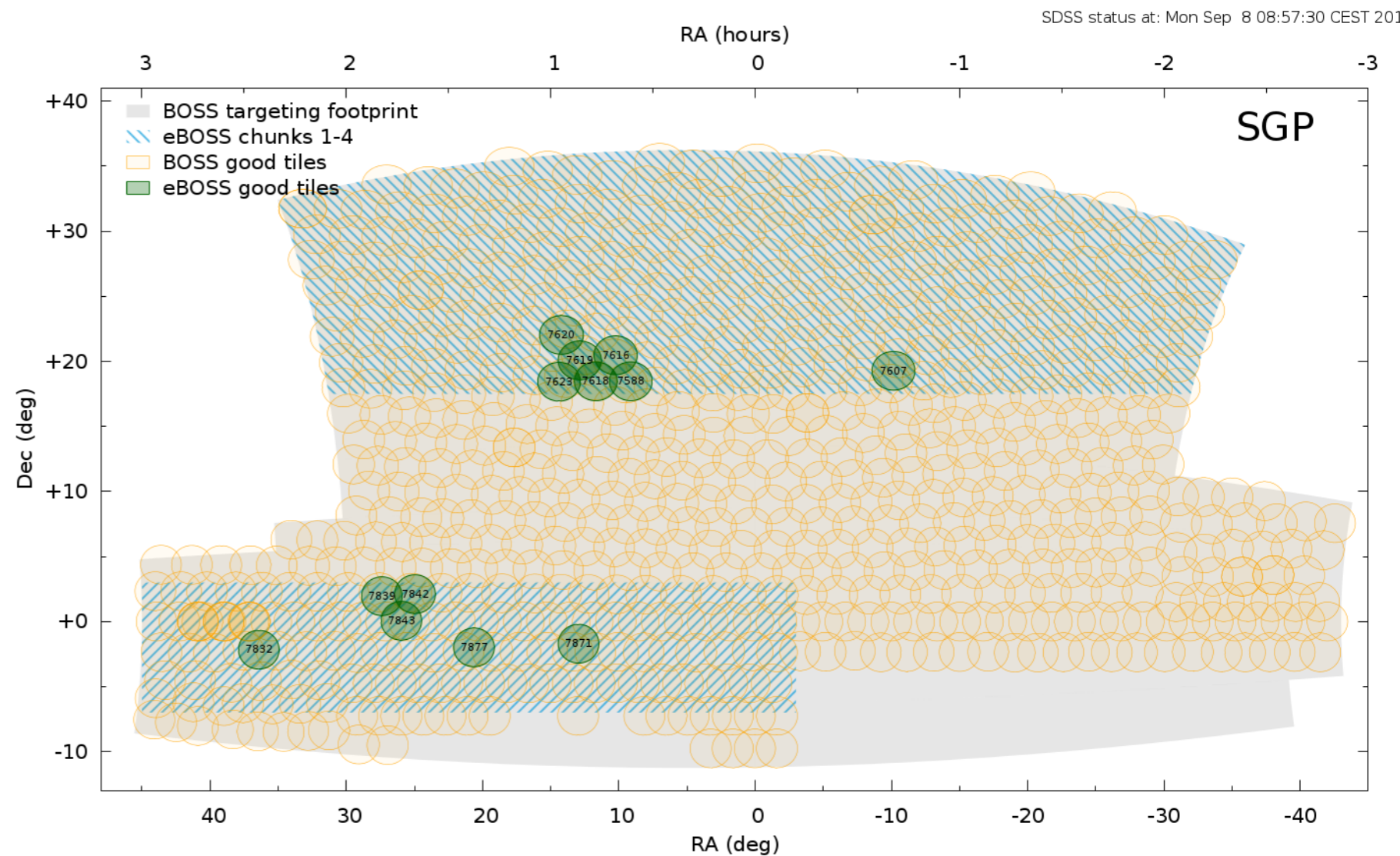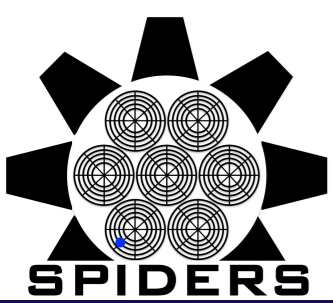 - 288 targets

- Over 98% of submitted targets will get spectra

Legend:
- All RASS sources
- SPIDERS_RASS_AGN targets
- Too bright (fiber2Mag_i<17.0)
- Spectrum available in DR11

Y-axis: Number of objects
X-axis: fiber2Mag_i (mag, AB)

eBOSS first results

- First 13 eBOSS plates have already been observed

PIPE-LINE CLASS	RASS AGN	XMMSL AGN
QSO	44	6
GALAXY	15	1
STAR	6	-
WARN-ING	1	-

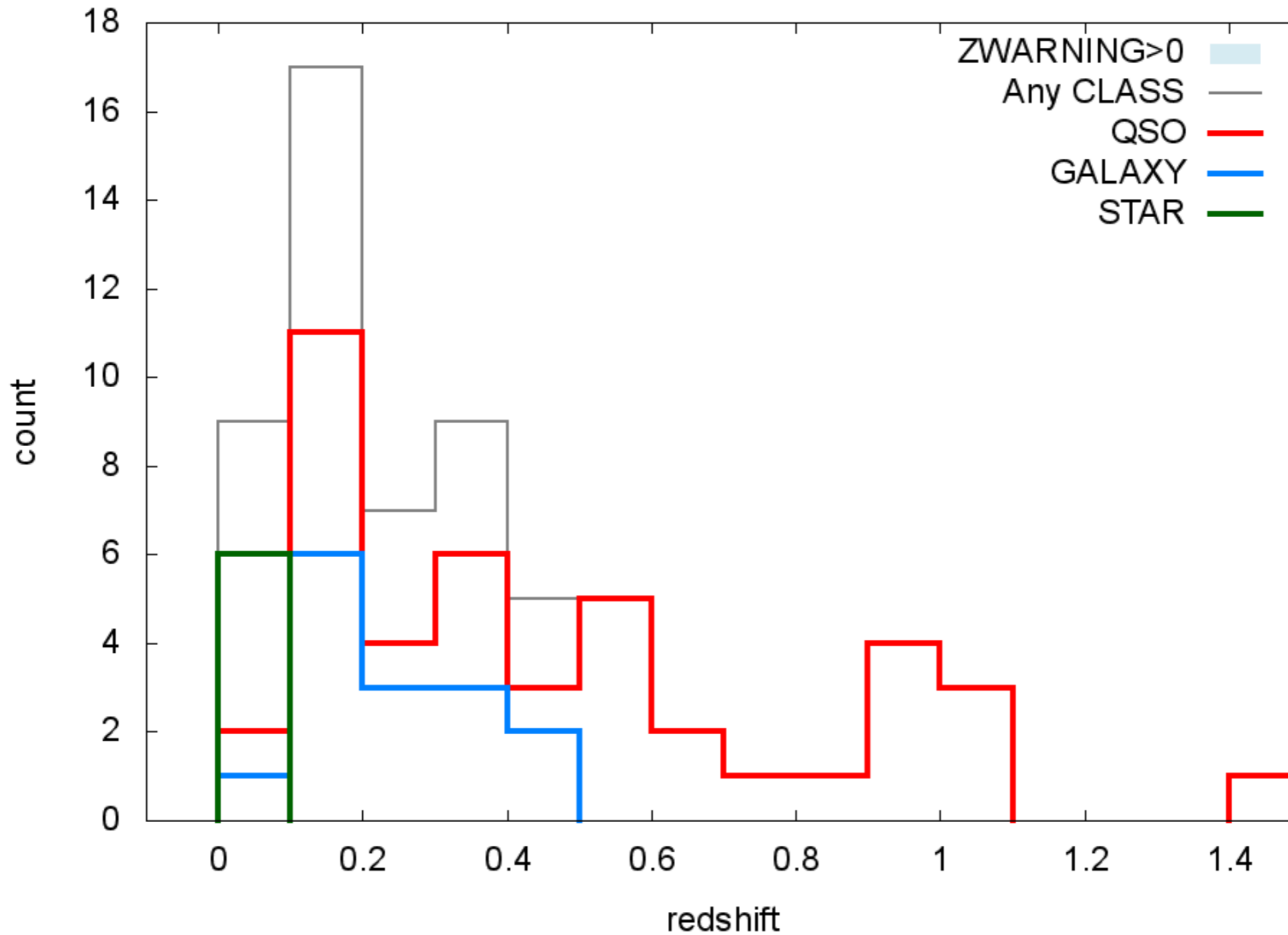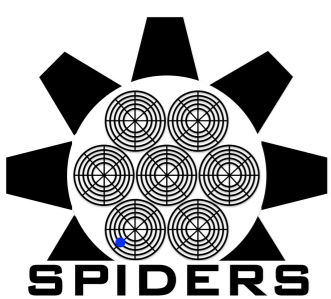# eBOSS first results

eBOSS data at: Mon Sep 8 08:57:30 CEST 2014

eBOSS first results

eBOSS data at: Mon Sep 8 08:57:30 CEST 2014

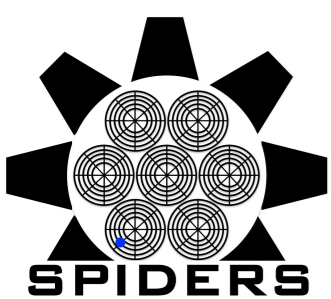eBOSS redshifts for SPIDERS_RASS_AGN

- Field galaxies and stars
- 3XMM bright sample
- SPIDERS_RASS_AGN
- eBOSS QSO
- eBOSS GALAXY
- eBOSS STAR

AllWISE w1mpro–w2mpro (mag,Vega)

AllWISE w2mpro (mag,Vega)

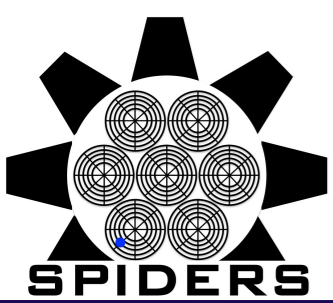redshift
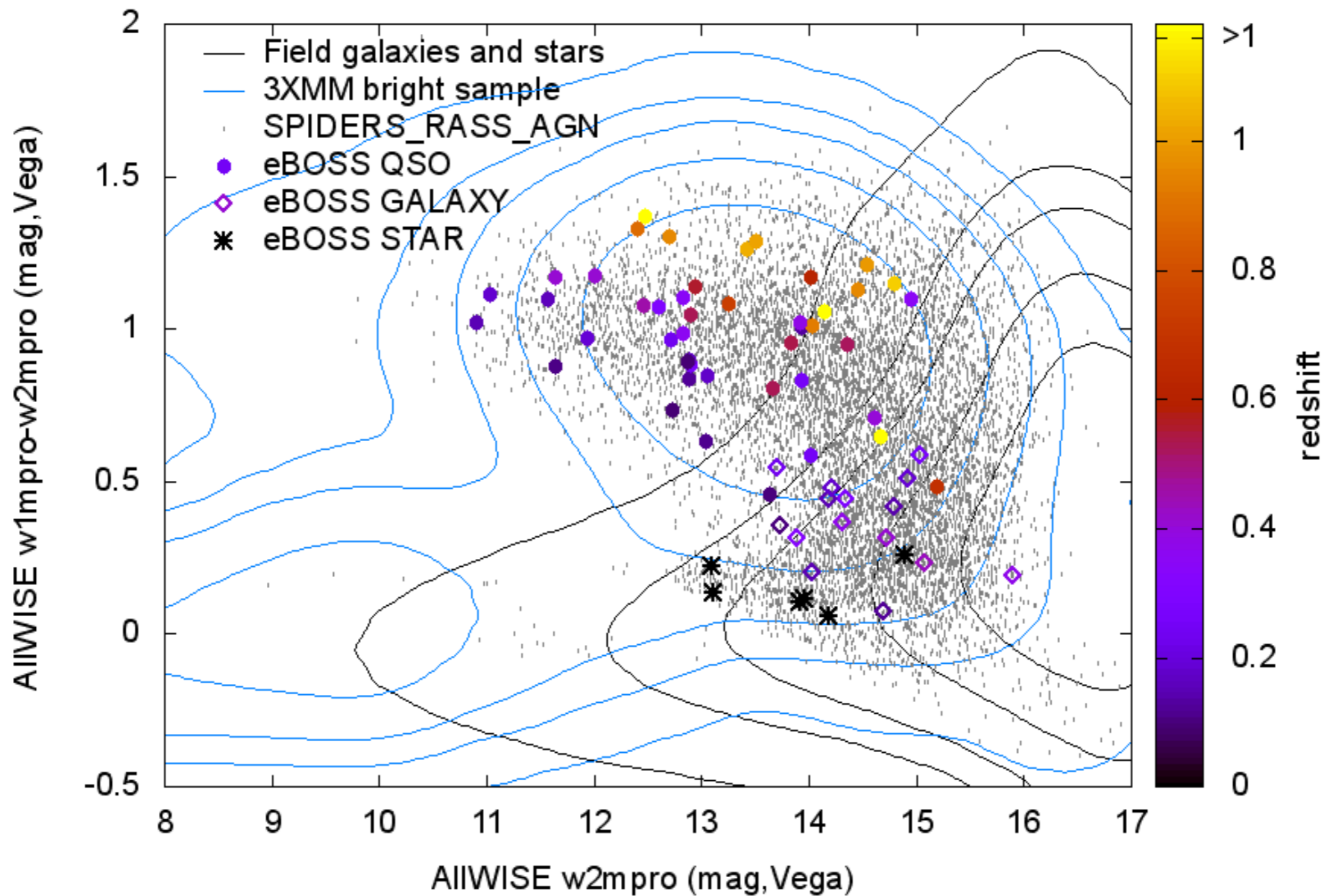
eBOSS forecast

- Expected completeness for RASS AGN after combining eBOSS + SDSS-I+II+III

- Fraction of RASS with ≥ 1 P>0.01 WISE (0.952)
    - × Fraction with correct WISE counterpart (0.94)
    - × Fraction with SDSS counterpart (0.924⭐)
    - × Fraction with SDSS i'<22.5 (0.983)
    - × Fraction outside bright star mask (0.991)
        - × Tiling completeness (0.981)
        - × Redshift success rate (~0.98)

  = 77% completeness, 94% reliability over 7500deg^2 inc. >15000 X-ray selected AGN with redshifts

⭐ Lost fraction includes some saturated stars, and extended galaxies

Thanks

More details on the SDSS IV wiki:

https://trac.sdss.org/wiki/eBOSS/Targets/SPIDERS/AllWISETargetSelection

- 66 SEQUELS plates observed

- RASS AGN targets selected using u'+r' priors (no WISE)

PIPE-LINE CLASS	RASS AGN
QSO	51
GALAXY	51
STAR	51
WARN-ING	10

SDSS status at: Mon Sep 8 08:57:30 CEST 2014

RA (hours)

BOSS targeting footprint
eBOSS chunks 1-4
BOSS good tiles
SEQUELS good tiles
eBOSS good tiles

NGP

Dec (deg)

RA (deg)