KOOLS-IFU observations of hard X-ray selected nearby AGN

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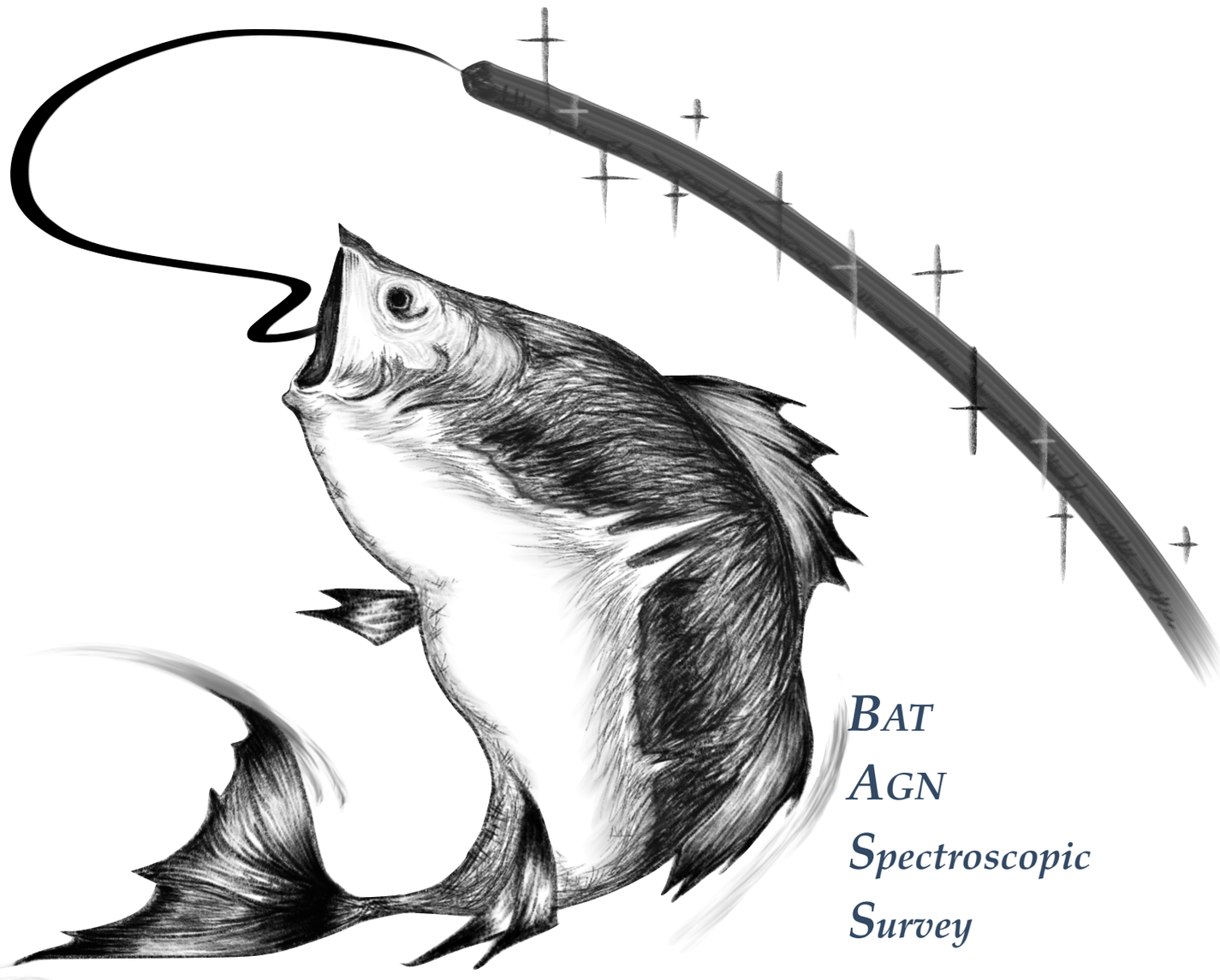
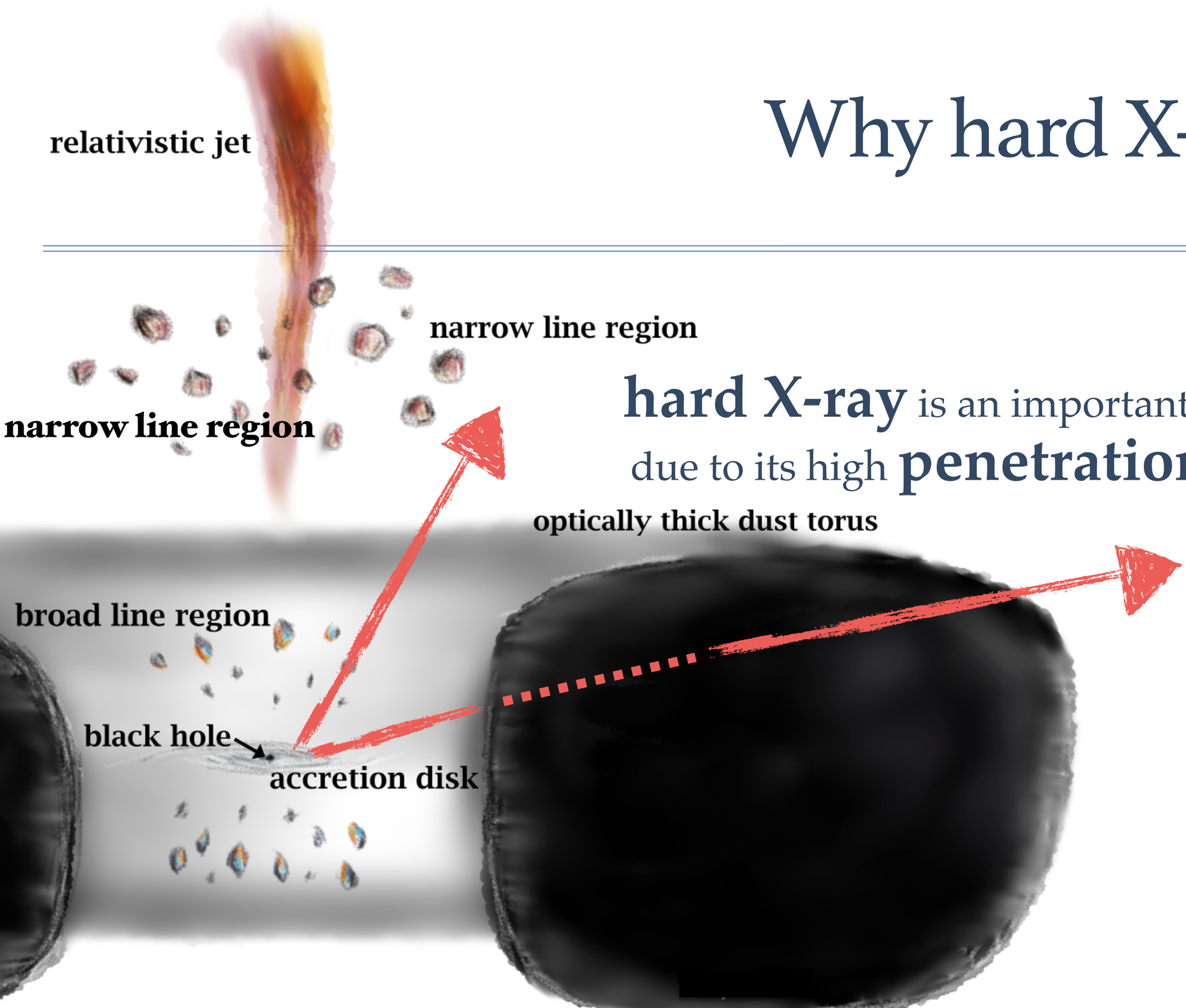
& Yoshihiro UEDA[1]
with BASS collaboration



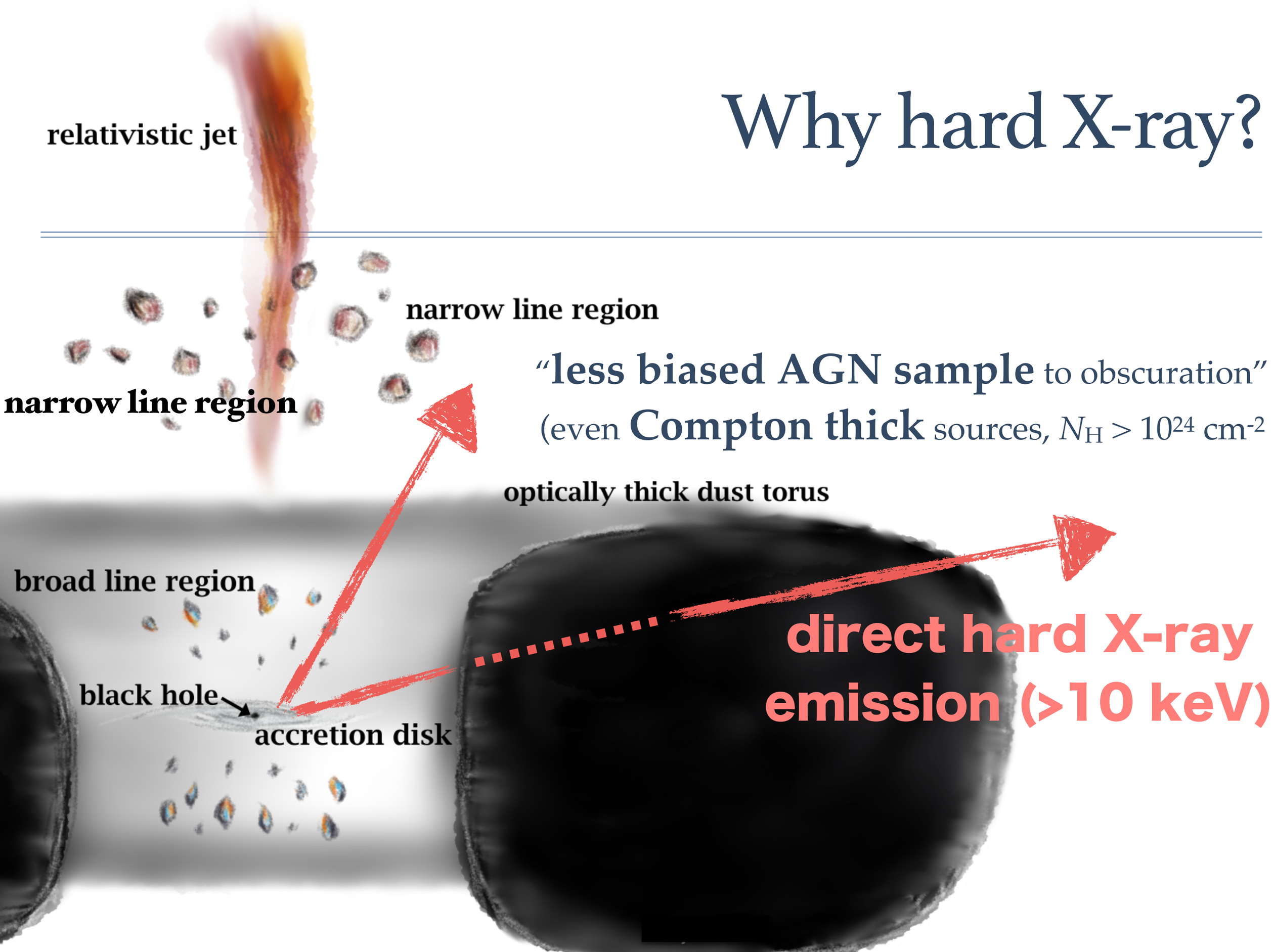
5-6 Feb 2018. KOOLS-IFU workshop

Why hard X-ray?



hard X-ray is an important window due to its high **penetration** ability

Why hard X-ray?



"**less biased AGN sample** to obscuration"

(even **Compton thick** sources, $N_H > 10^{24}$ cm^{-2}

Swift-BAT hard X-ray all-sky survey

PI: N. Gehrels (NASA GSFC)

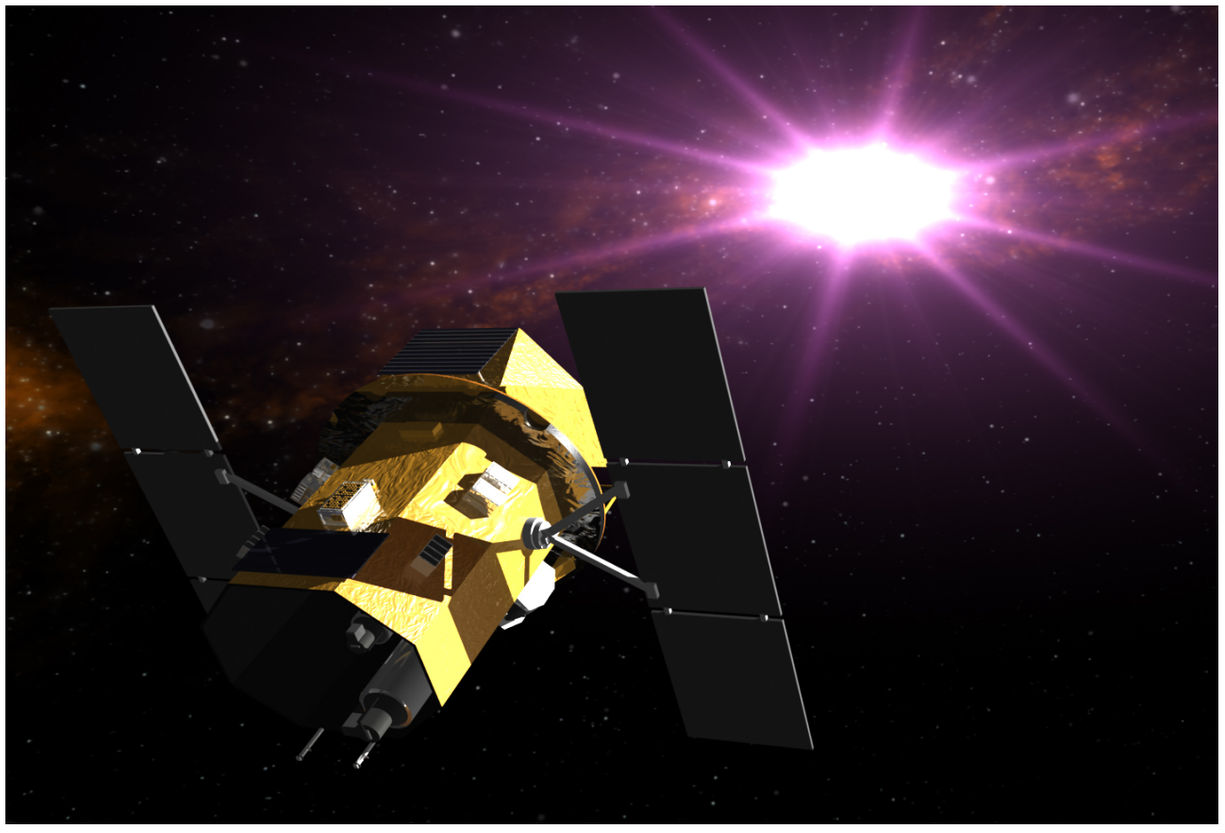


image credit: NASA

- Neil Gehrels ***Swift*** **observatory**
- Successfully surveying
  since **2004 - present**
- Energy range: **14-195 keV**
- **All sky survey**:
  20% of the sky at any one time
  50% of the sky each day
- wide FoV: 70° x 100°
- extensive **follow-up by UVOT and XRT**

Swift-BAT hard X-ray all-sky survey

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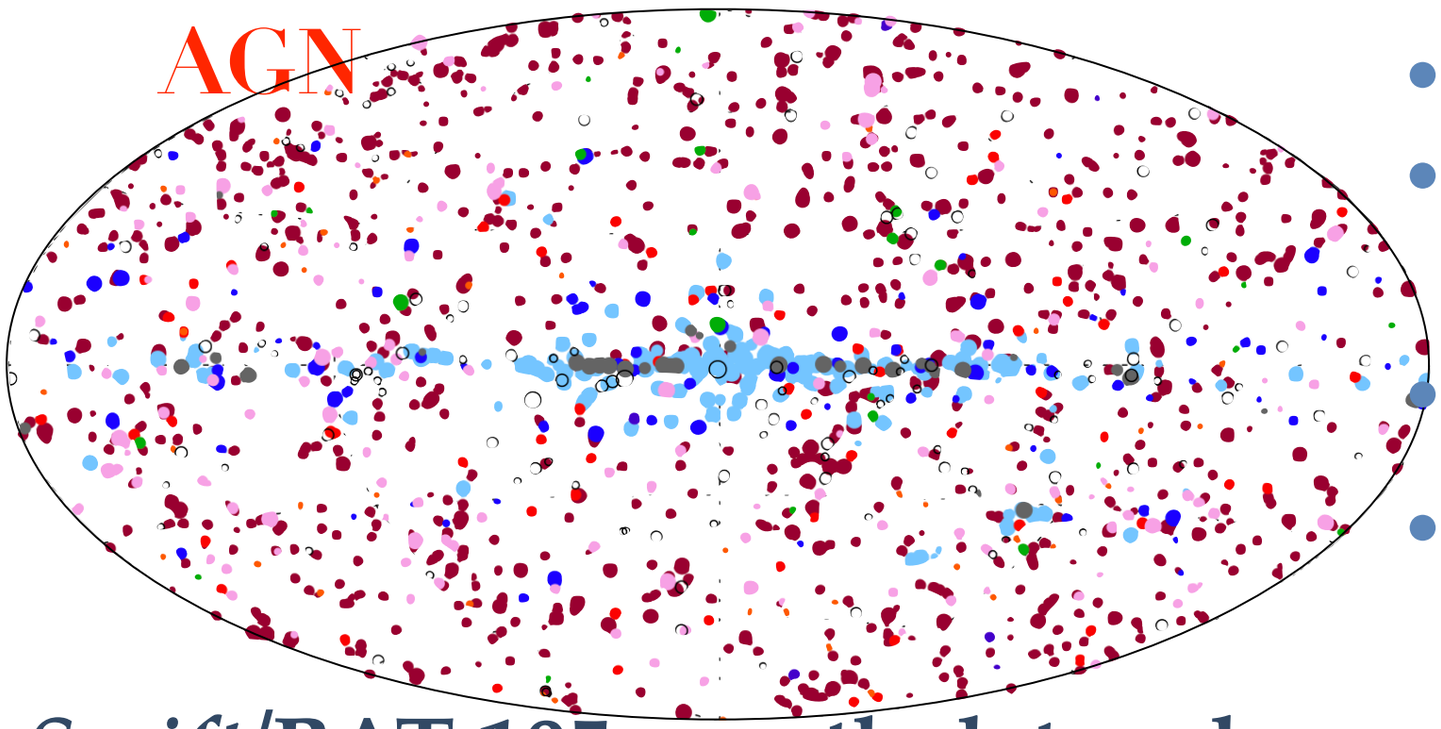


***Swift*/BAT 105 month data release**

Oh et al. 2018 (in press)

: 1100 hard X-ray AGN

"50 times increases"

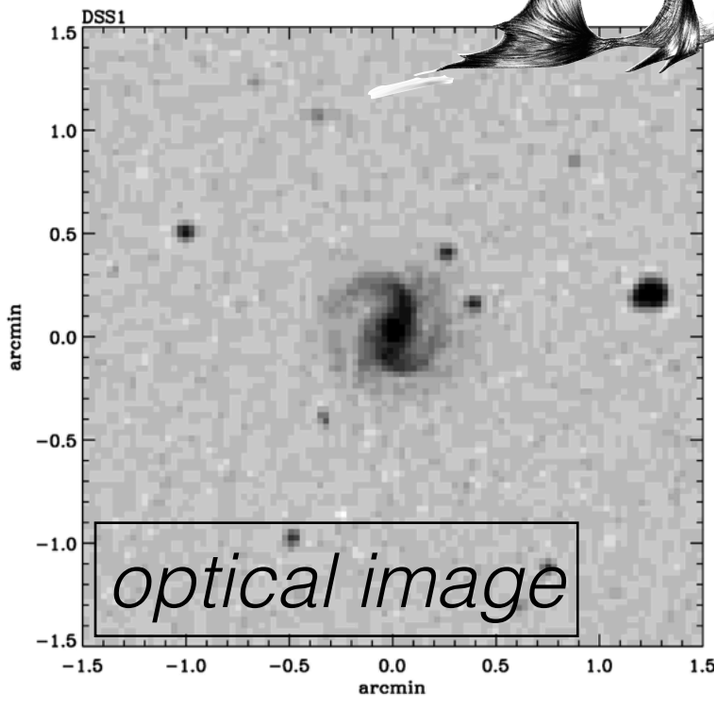
- Neil Gehrels ***Swift* observatory**
- Successfully surveying
  since **2004 - present**
- Energy range: **14-195 keV**
- **All sky survey**:
  20% of the sky at any one time
  50% of the sky each day
- wide FoV: 70° x 100°
- extensive **follow-up by UVOT and XRT**

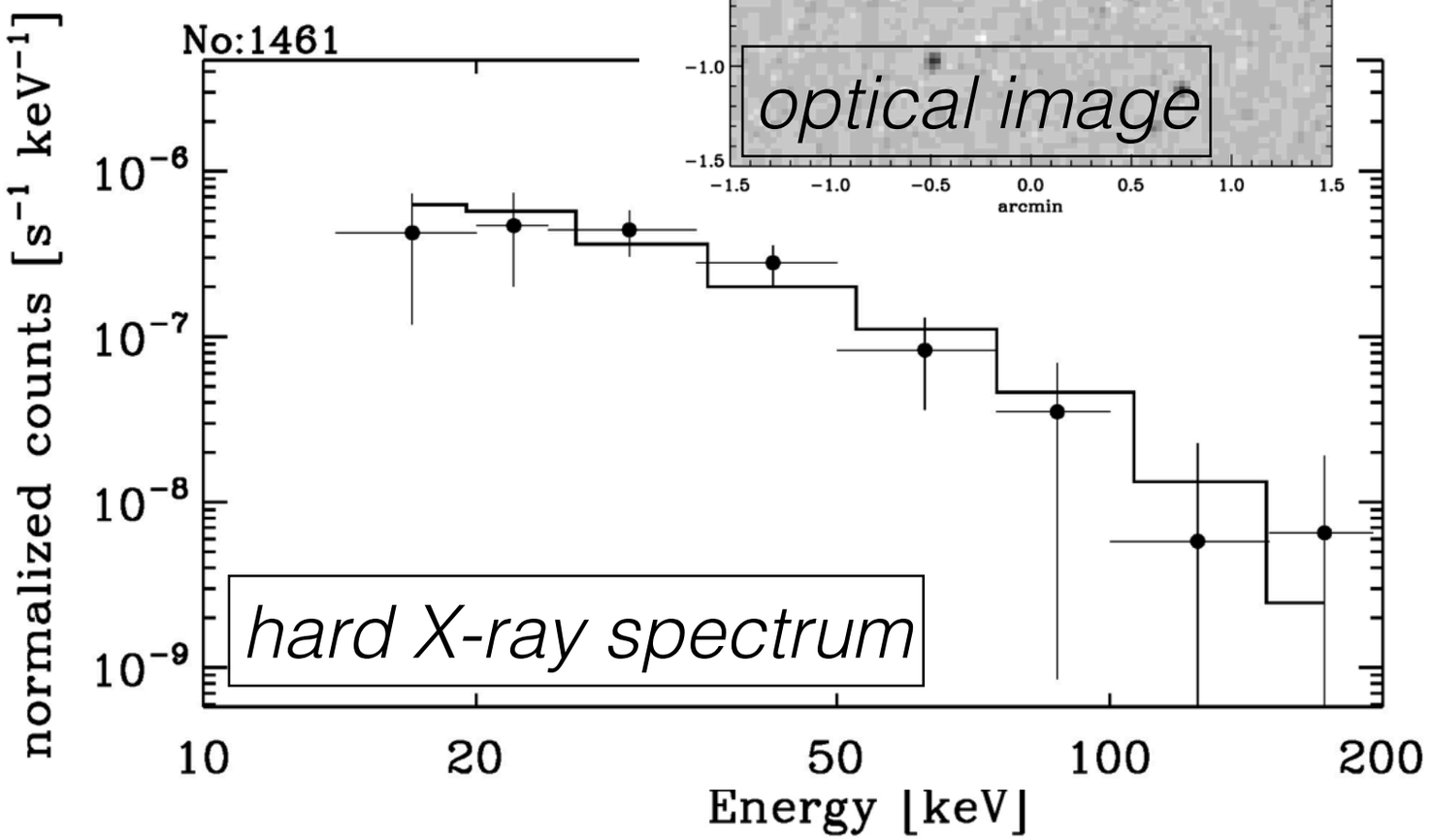
i.e., statistically significant demographic study is now available

"BASS"

BAT AGN Spectroscopic Survey

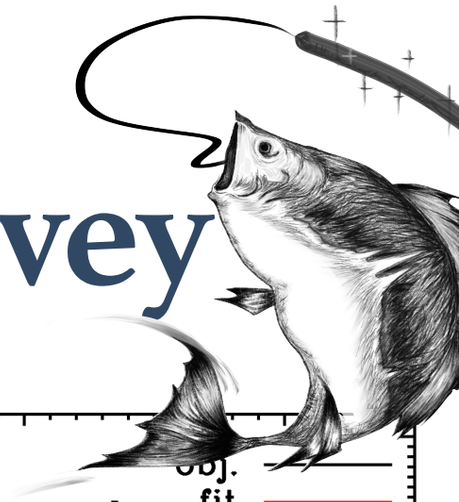
- All-sky study of the brightest and most powerful hard X-ray detected AGN





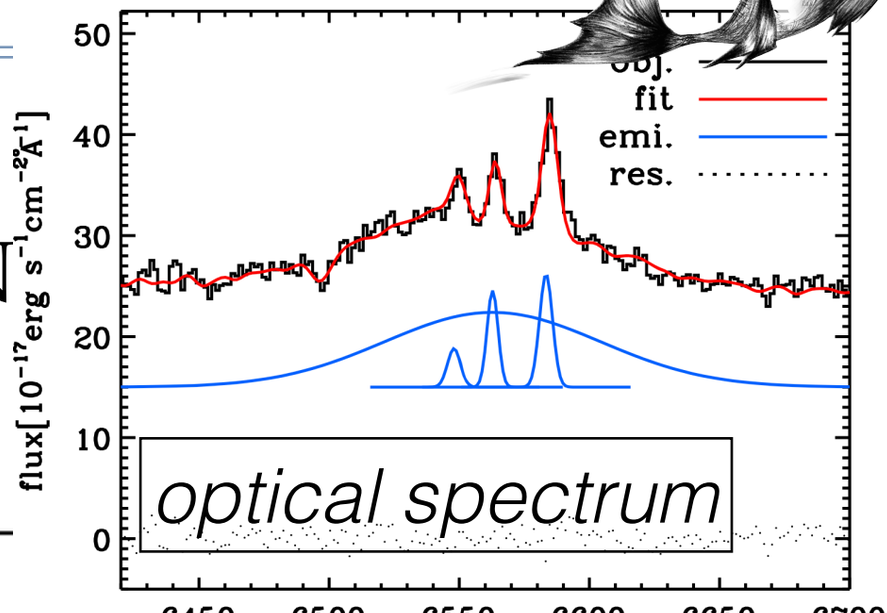
"BASS"

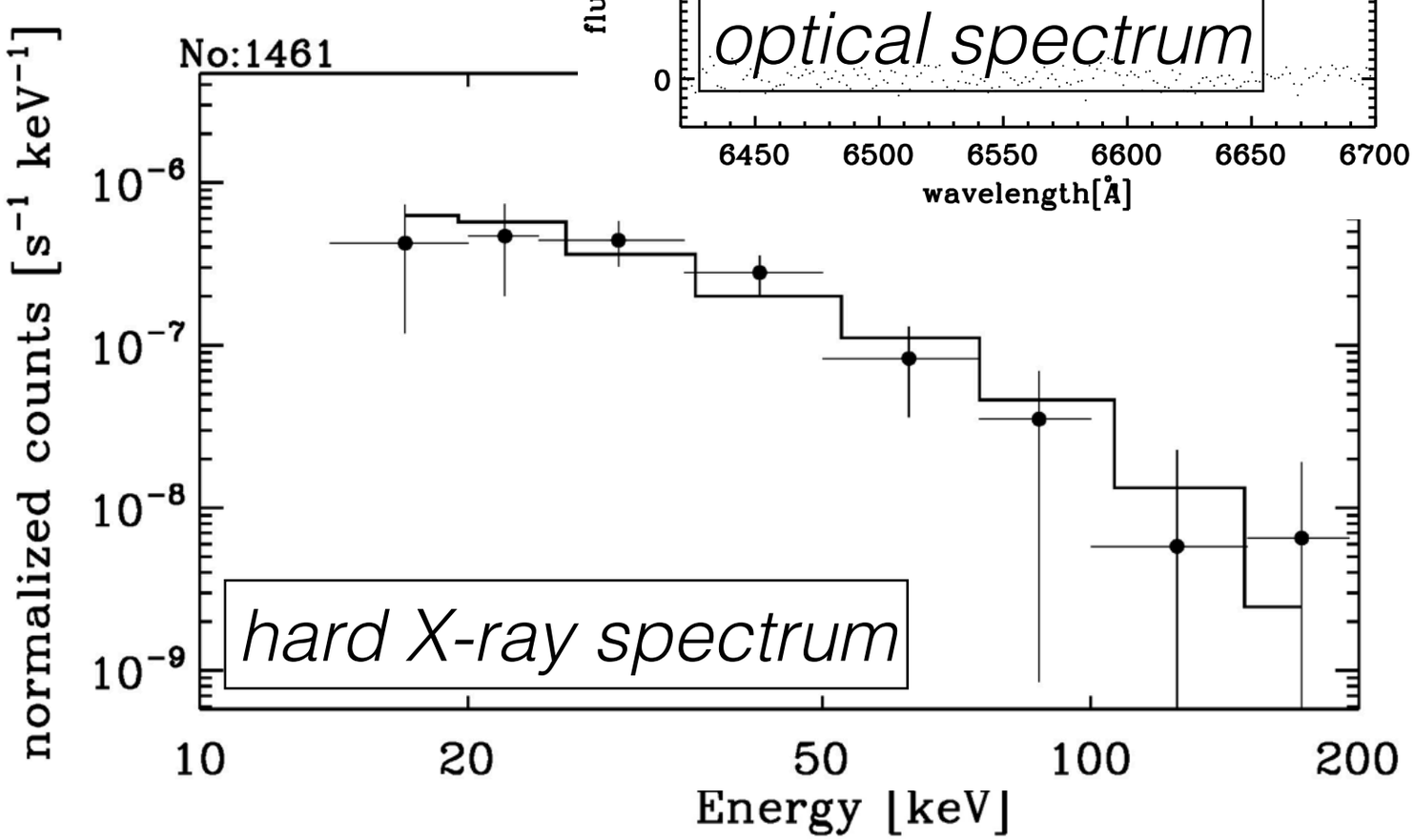
BAT AGN Spectroscopic Survey



- All-sky study of the brightest and most powerful hard X-ray detected AGN

- Goal: to complete the first large survey of hard X-ray selected AGN with optical spectroscopy

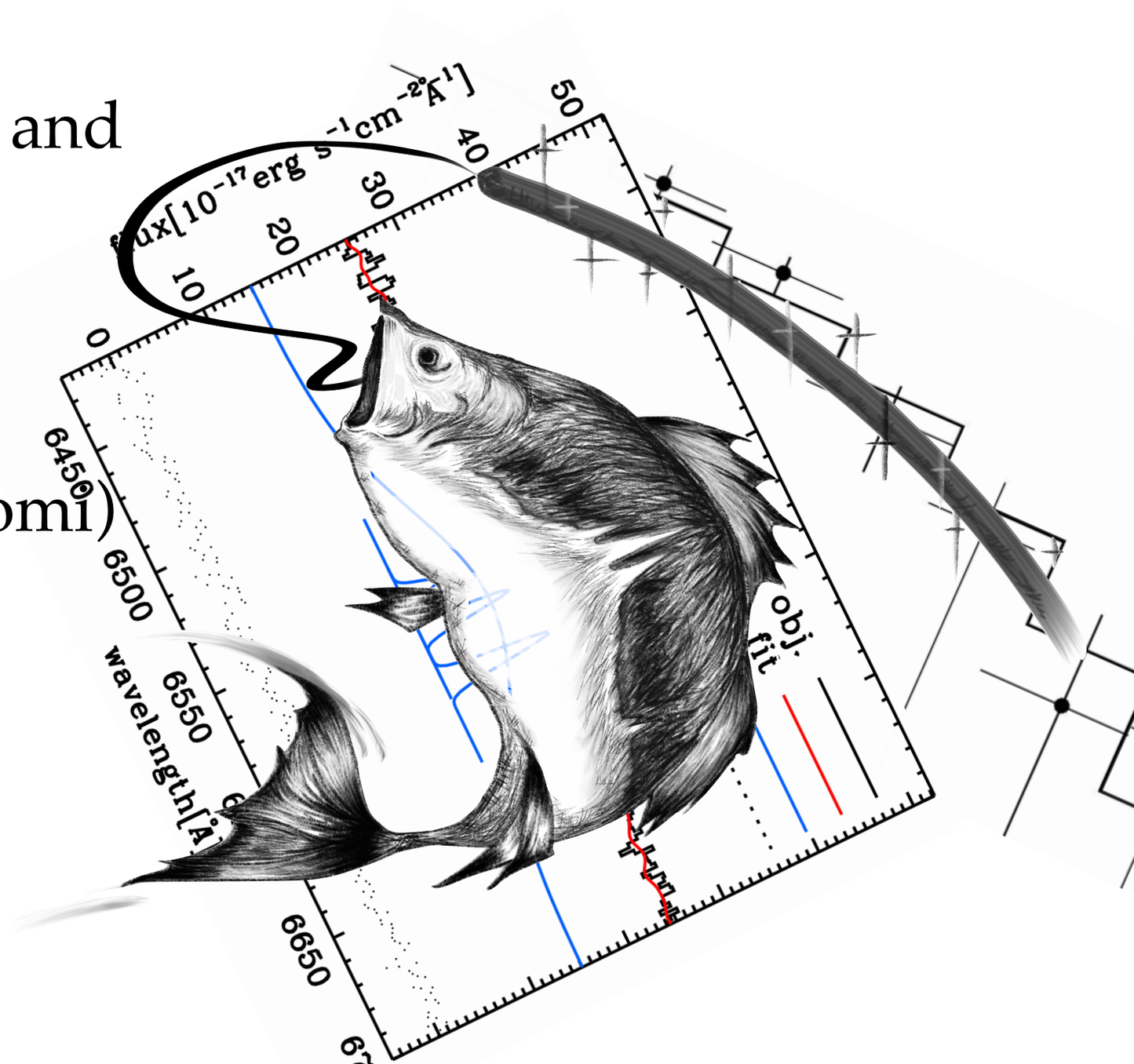




"BASS"

BAT AGN Spectroscopic Survey

- We'll be able to place constraints on the growth and structure around nearby blackholes and provide a baseline for future X-ray missions (ex. Athena, Hitomi)

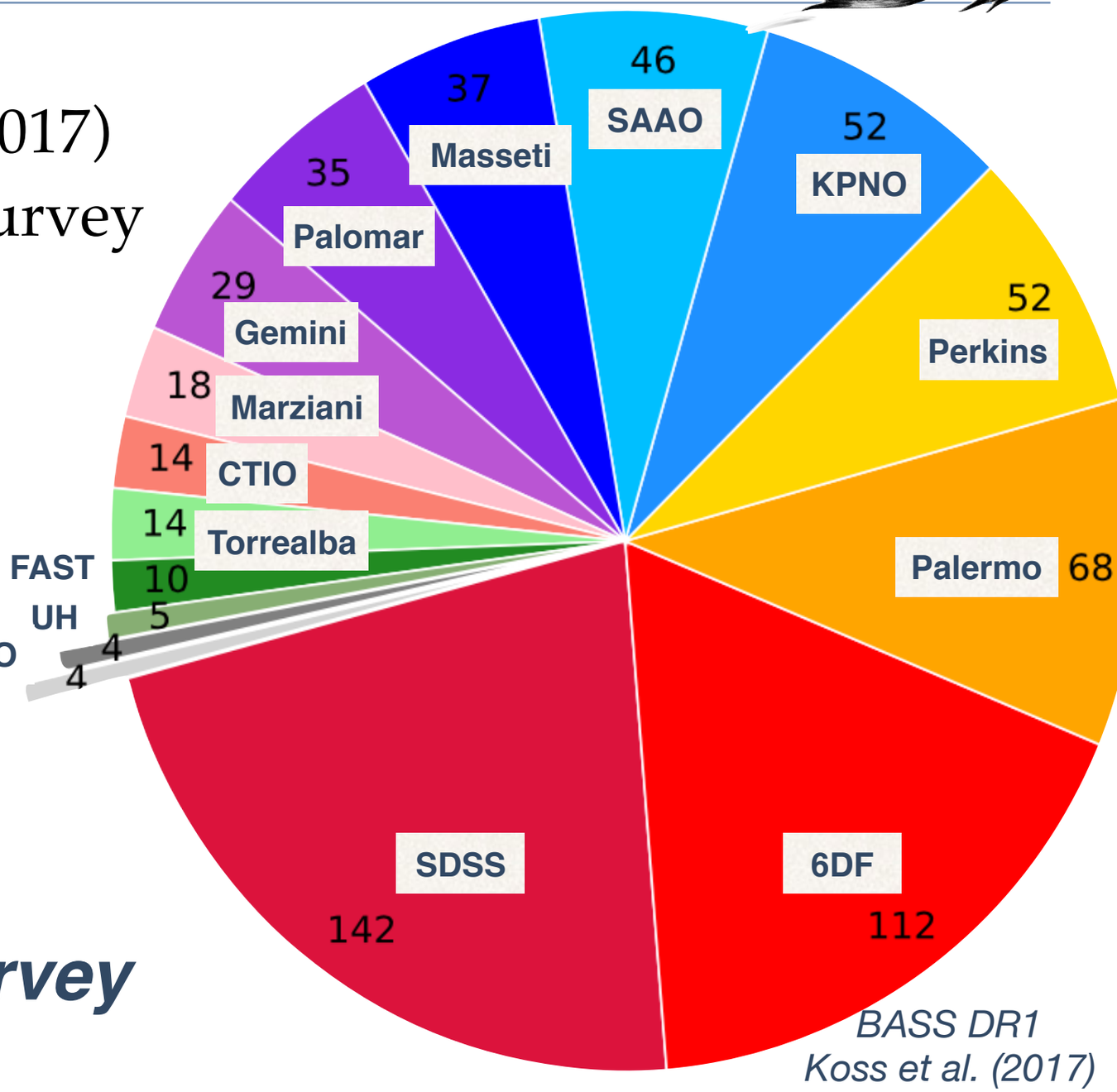


"BASS"

BAT AGN Spectroscopic Survey

- BASS Data Release 1 (Koss et al. 2017)
- Swift-BAT 70 month hard X-ray survey
- 642 optical spectra (77%)

  out of **836** AGN
- from 16 instruments/telescopes
- e.g.,
  large public catalogs (SDSS, 6DF)
  dedicated follow-up observations



****** Swift-BAT 105 month survey is available! ******

www.bass-survey.com

Core team

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Team members (alphabetical order)

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Baronchelli, Linda
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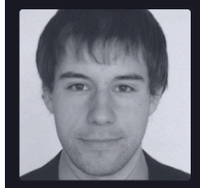

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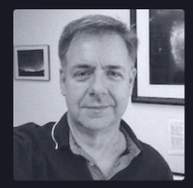

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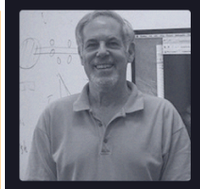

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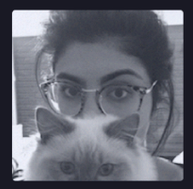

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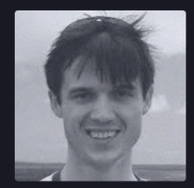

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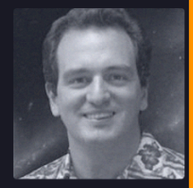
Strittmatter, Benjamin
(ETH Zurich)



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Veilleux, Sylvain
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Wong, Ivy
(International Centre for Radio Astronomy Research)

The BAT AGN Spectroscopic Survey

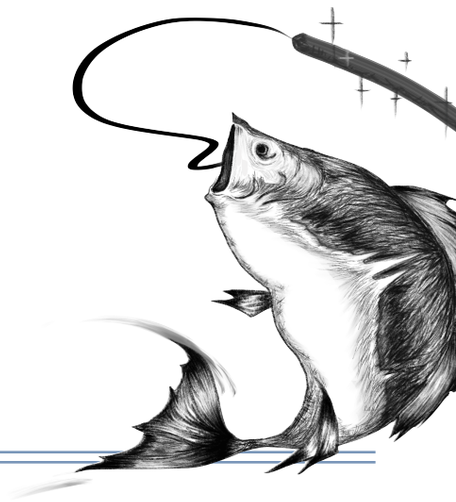
An all-sky study of the brightest and most powerful hard X-ray detected AGN

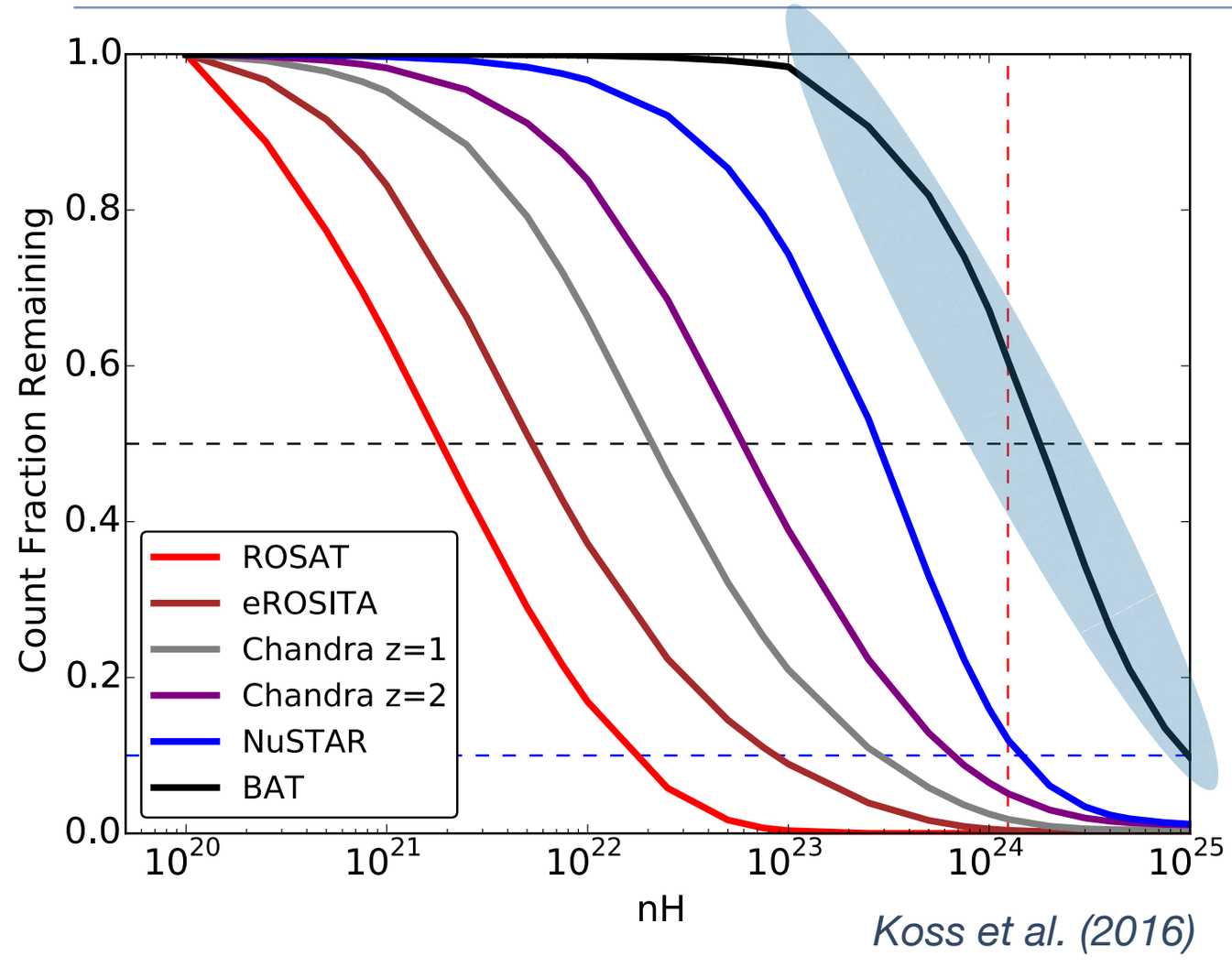
Publications

Refereed publications of BASS project

No.	Title	Author	ADS	arXiv
I	BAT AGN Spectroscopic Survey - I: Spectral measurements, derivied quantities, and AGN demographics	Koss et al. (2017)	ADS	arXiv
II	BAT AGN Spectroscopic Survey - II: X-ray emission and high-ionization optical emission lines	Berney et al. (2015)	ADS	arXiv
III	BAT AGN Spectroscopic Survey - III. An observed link between AGN Eddington ratio and narrow-emission-line ratios	Oh et al. (2017)	ADS	arXiv
IV	BAT AGN Spectroscopic Survey - IV: Near-Infrared Coronal Lines, Hidden Broad Lines, and Correlation with Hard X-ray Emission	Lamperti et al. (2017)	ADS	arXiv
V	BAT AGN Spectroscopic Survey - V: X-ray Properties of the Swift/BAT 70-month AGN Catalog	Ricci et al. (2017)	ADS	arXiv
VI	BAT AGN Spectroscopic Survey - VI. The Γ_X-L/L_{Edd} relation	Trakhtenbrot et al. (2017)	ADS	arXiv
VII	BAT AGN Spectroscopic Survey - VII. The close environments of accreting massive black holes are shaped by radiative feedback	Ricci et al. (2017)	Nature	
VIII	BAT AGN Spectroscopic Survey - VIII. Type 1 AGN with massive absorbing columns	Shimizu et al. (2017,*submitted*)		arXiv

BAT AGN

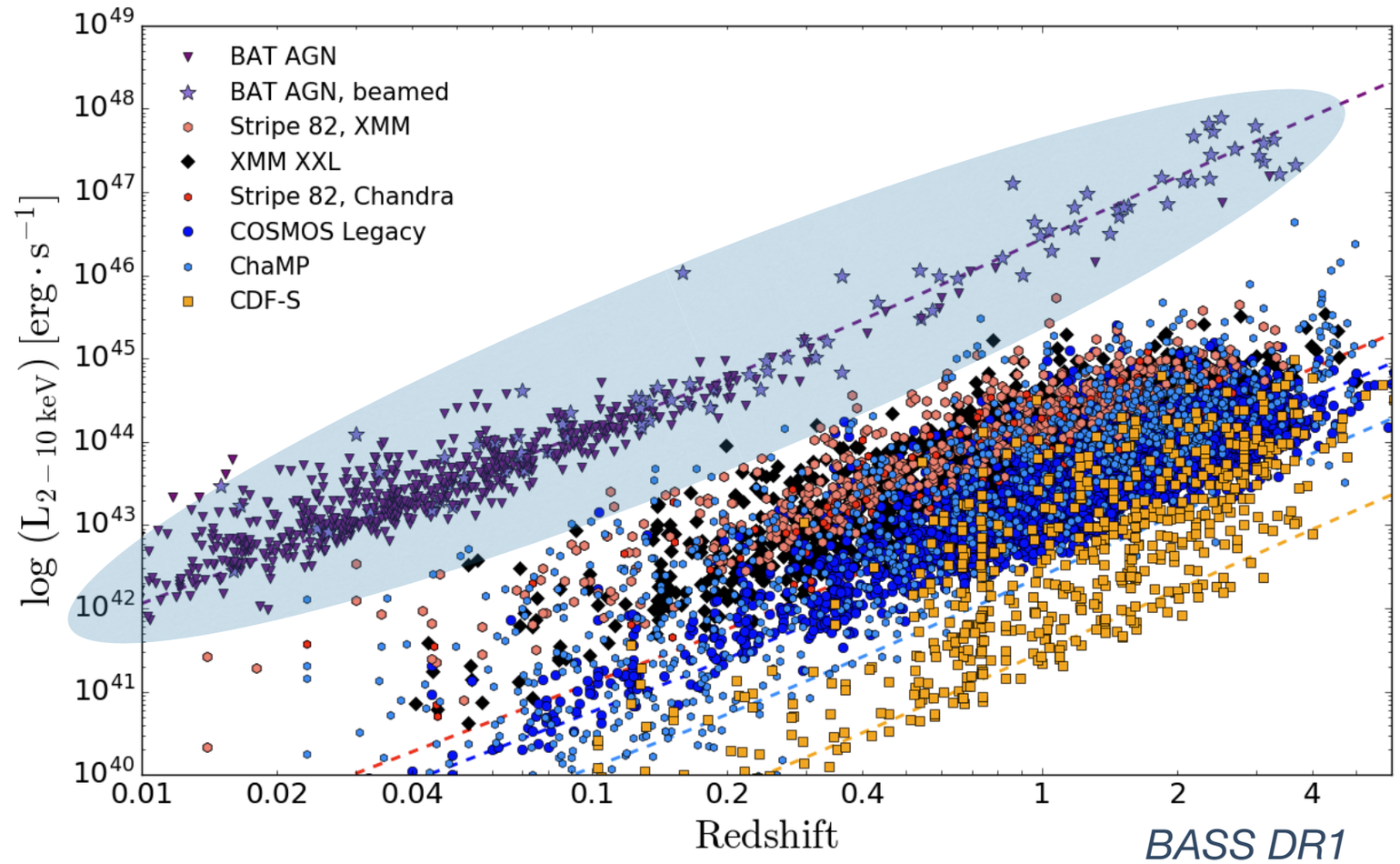




Koss et al. (2016)

- BAT AGN is the least biased all-sky surveyed nearby AGN sample (including even obscured AGN)

BAT AGN

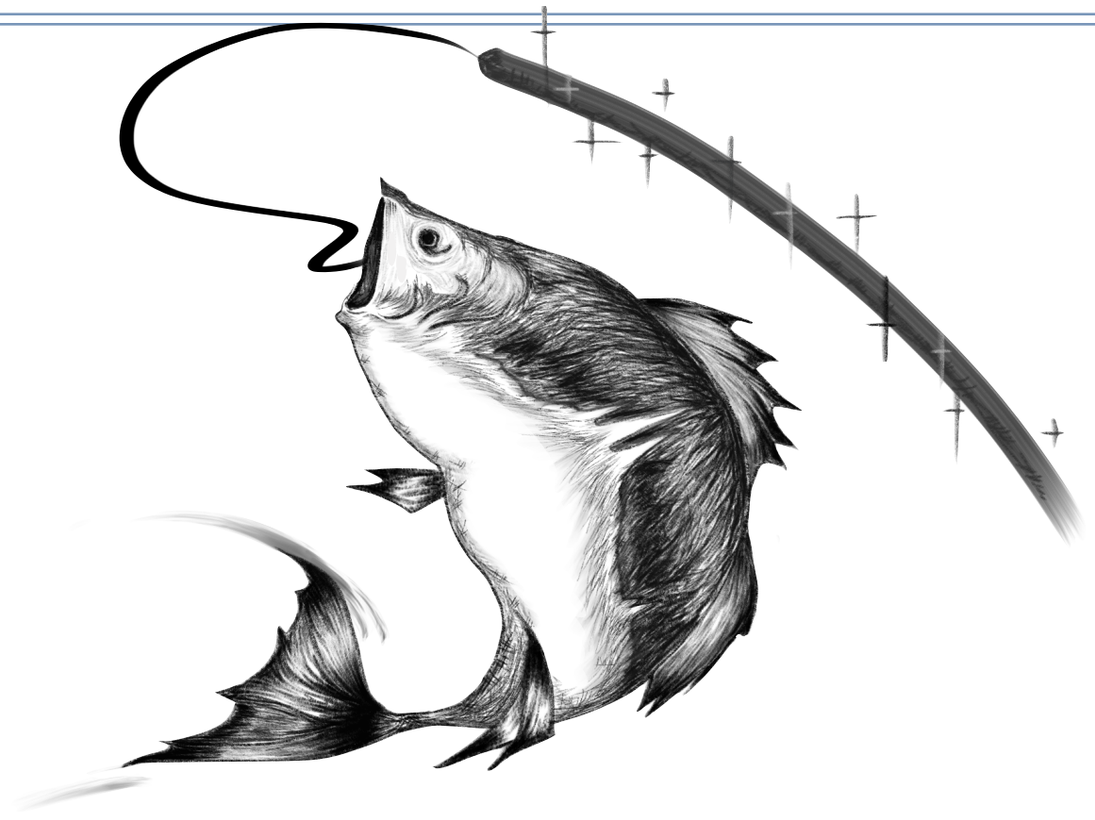


- nearby powerful AGN
- benchmark of high-z

BASS DR1
Koss et al. (2017)

"BASS"

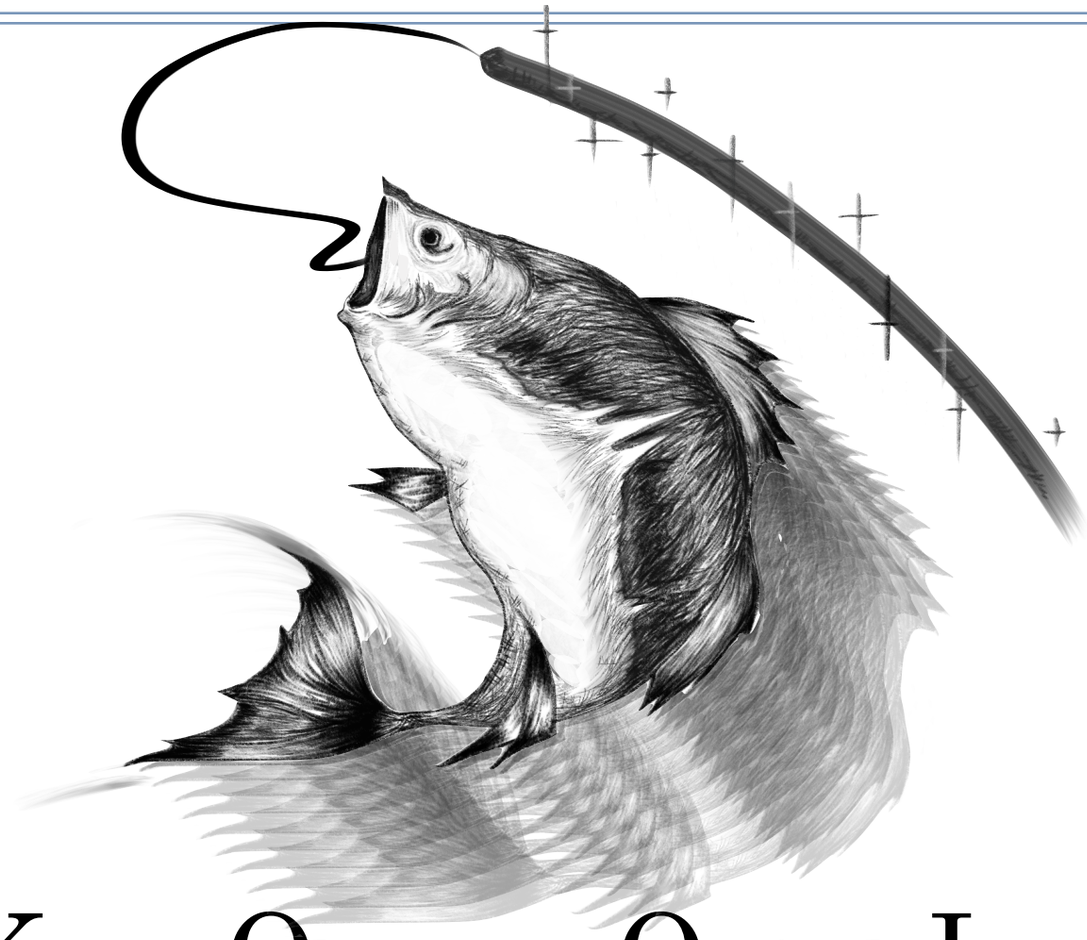
BAT AGN Spectroscopic Survey



KOOLS-IFU observations of hard X-ray selected nearby AGN

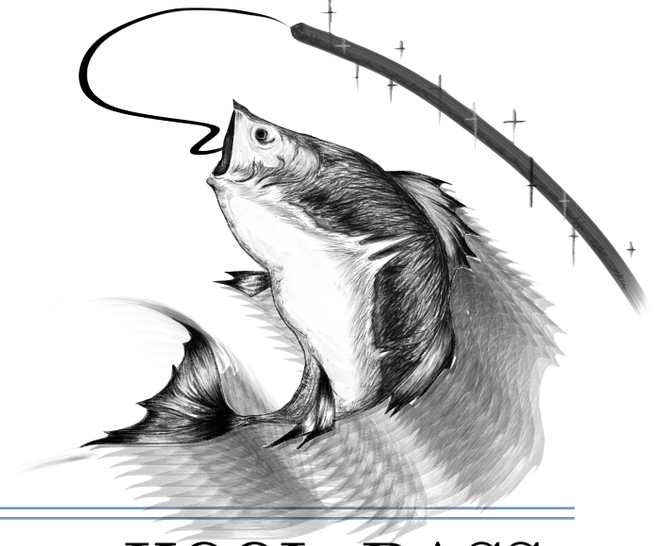
- **KOOL-BASS**

- IFU survey of hard X-ray selected nearby AGN



Kyoto Okayama Optical Low-dispersion spectrograph
-BAT AGN Spectroscopic Survey

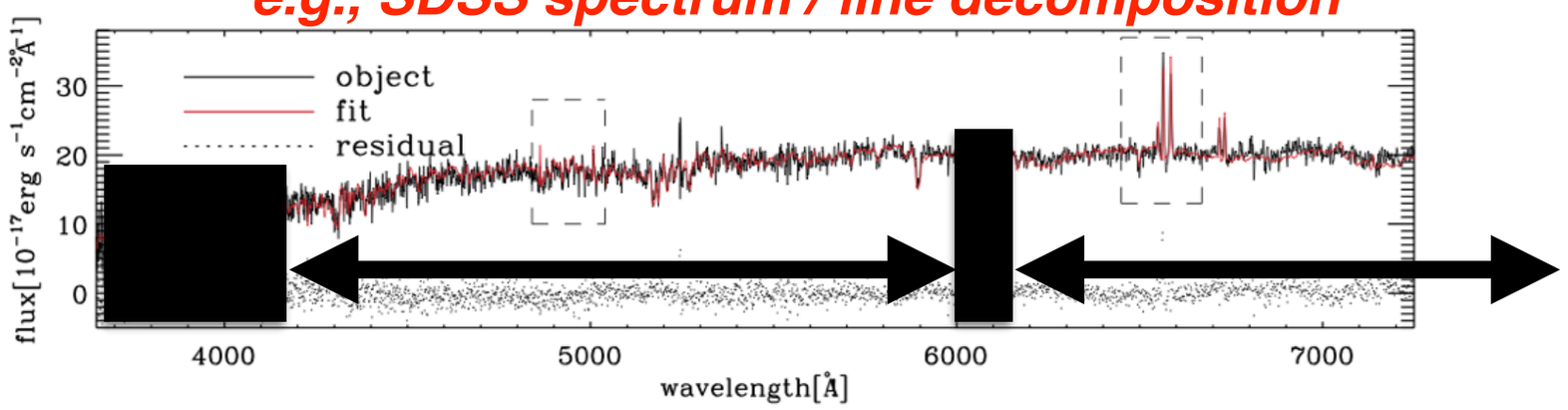
why KOOL-BASS?

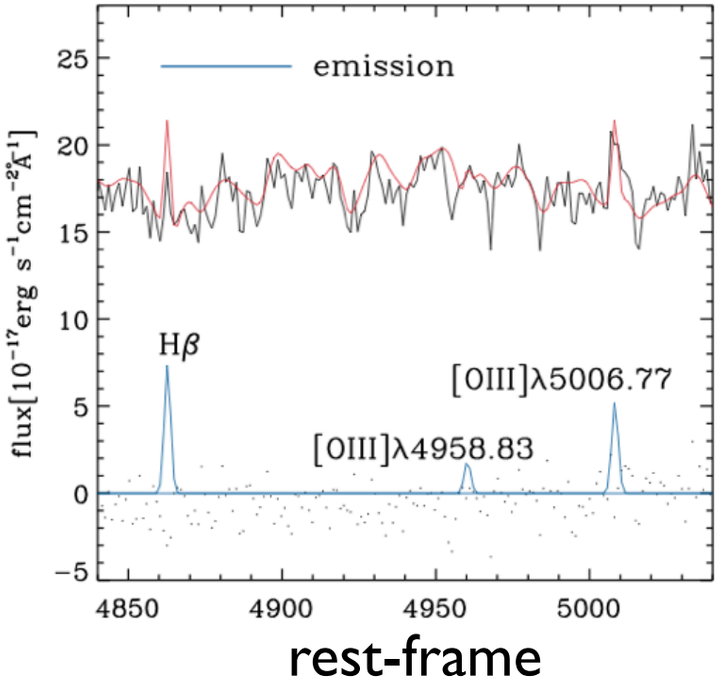


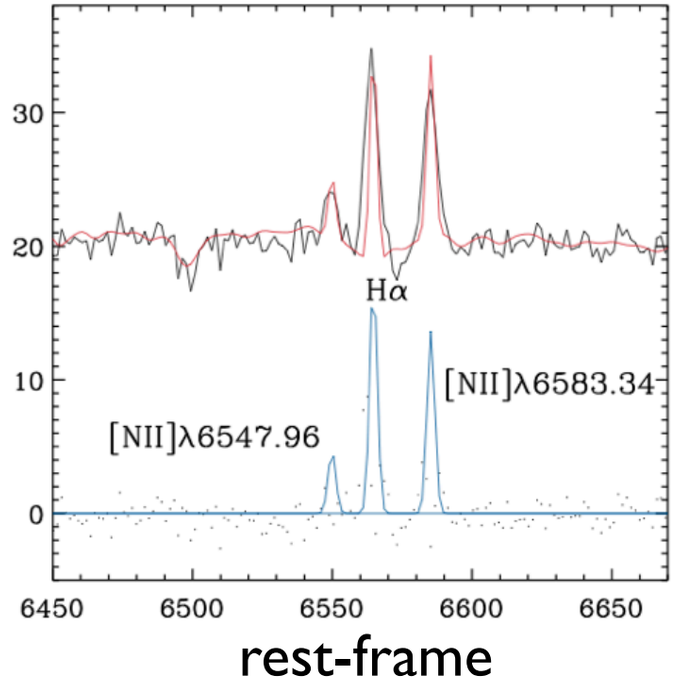
- Other 3d-spectroscopy
  - Atlas-3D, MASSIVE, SAMI, MaNGA…
    - optical selected samples with follow-up IFU survey
    - host morphology limited / missing obscured AGN / biased toward luminous samples
- KOOL-BASS: **hard X-ray selected**, including **wide range of different host galaxy types**, from low to high luminosity, the least biased sample of nearby AGN, with statistically significant number of samples

Specification & expectation

- VPH495: 4160 - 6000 Å (R>1300)
- VPH683: 6150 - 7930 Å (R:1900-2300)







- e.g., at 19.1 limiting mag
  - 2100 sec X 3 frames, $\Delta\lambda$=10 Å, seeing~1.5”
  - **SN>20 in continuum** based on **KOOLS-IFU Exposure Time Calculator**

Specification & expectation

- VPH495: 4160 - 6000 Å (R>1300)
- VPH683: 6150 - 7930 Å (R:1900-2300)

KOOLS-IFU covers major optical emission lines & stellar continuum with enough spectral resolution

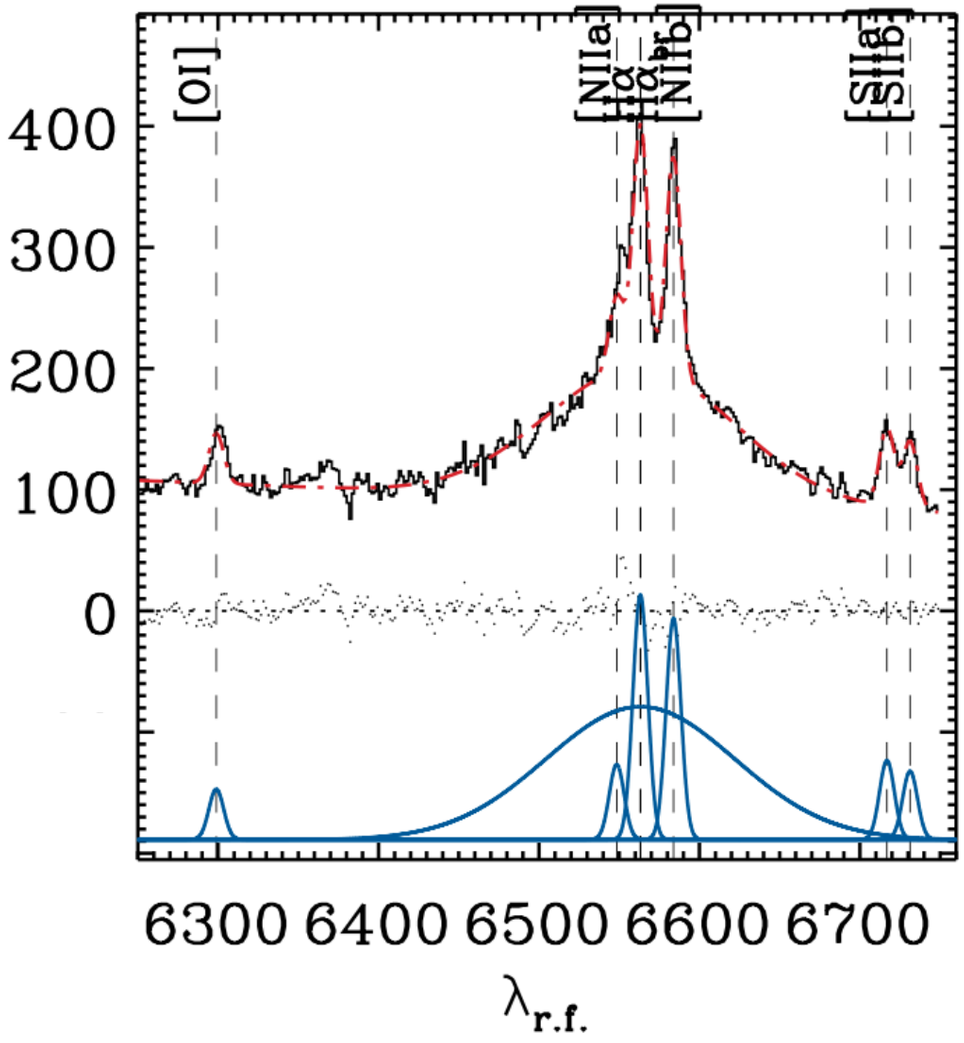
- ***stellar velocity dispersion (σ)***
- ***nebular emission lines***
- ***black hole mass (M_{BH})***
- ***black hole growth rate (λ_{Edd})***

- e.g., at 19.1 limiting mag
  - 2100 sec X 3 frames, $\Delta\lambda$=10 Å, seeing~1.5”
  - **SN>20 in continuum**

M_{BH} (i.e., λ_{Edd}) measurements

"template fitting and Spectral line decomposition"

- type 1 AGN: broad-line profile
- type 2 AGN: stellar velocity dispersion



M_{BH} measurements

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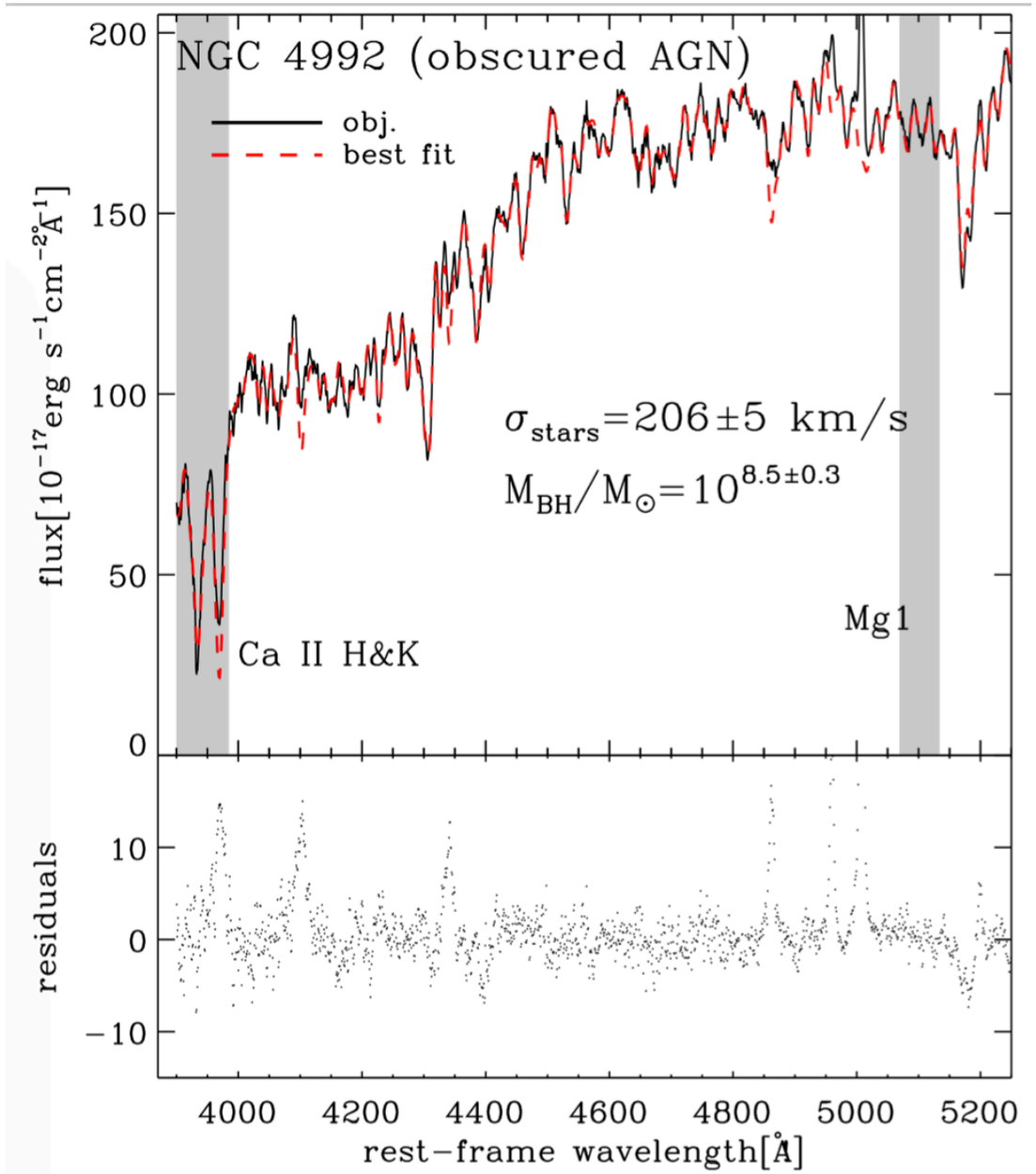
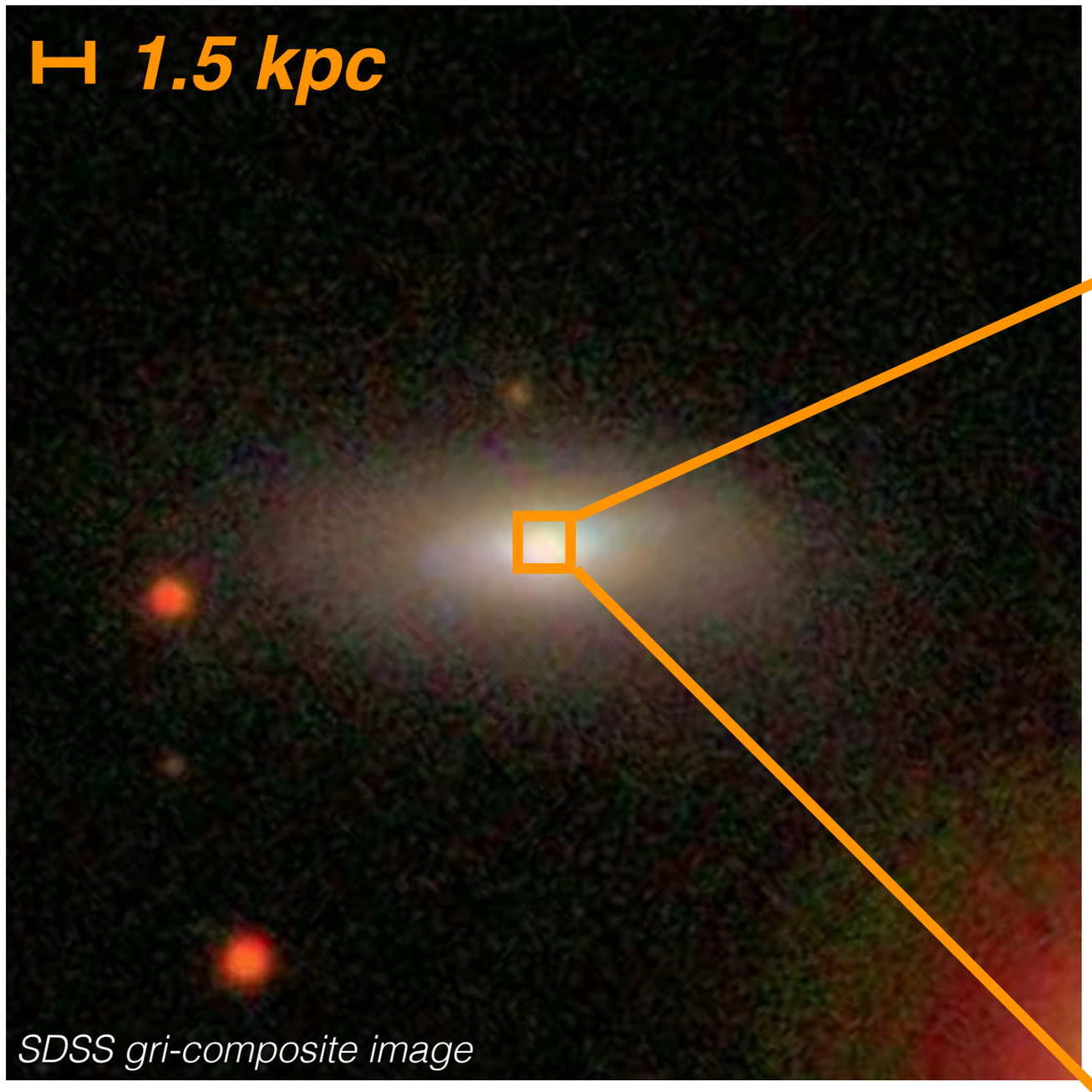
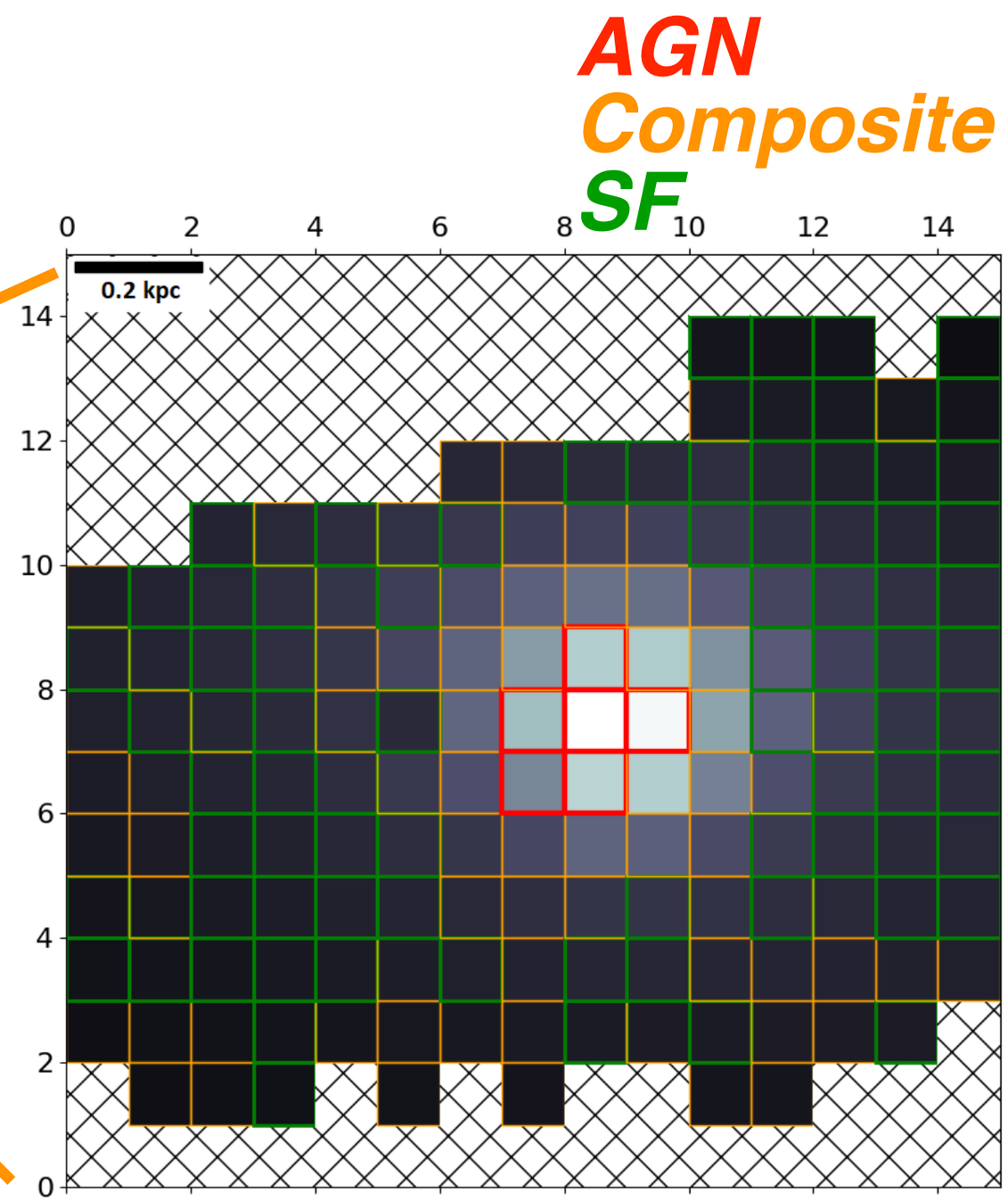


"pixel resolved origin of photo-ionisation"

Specification & expectation (example)

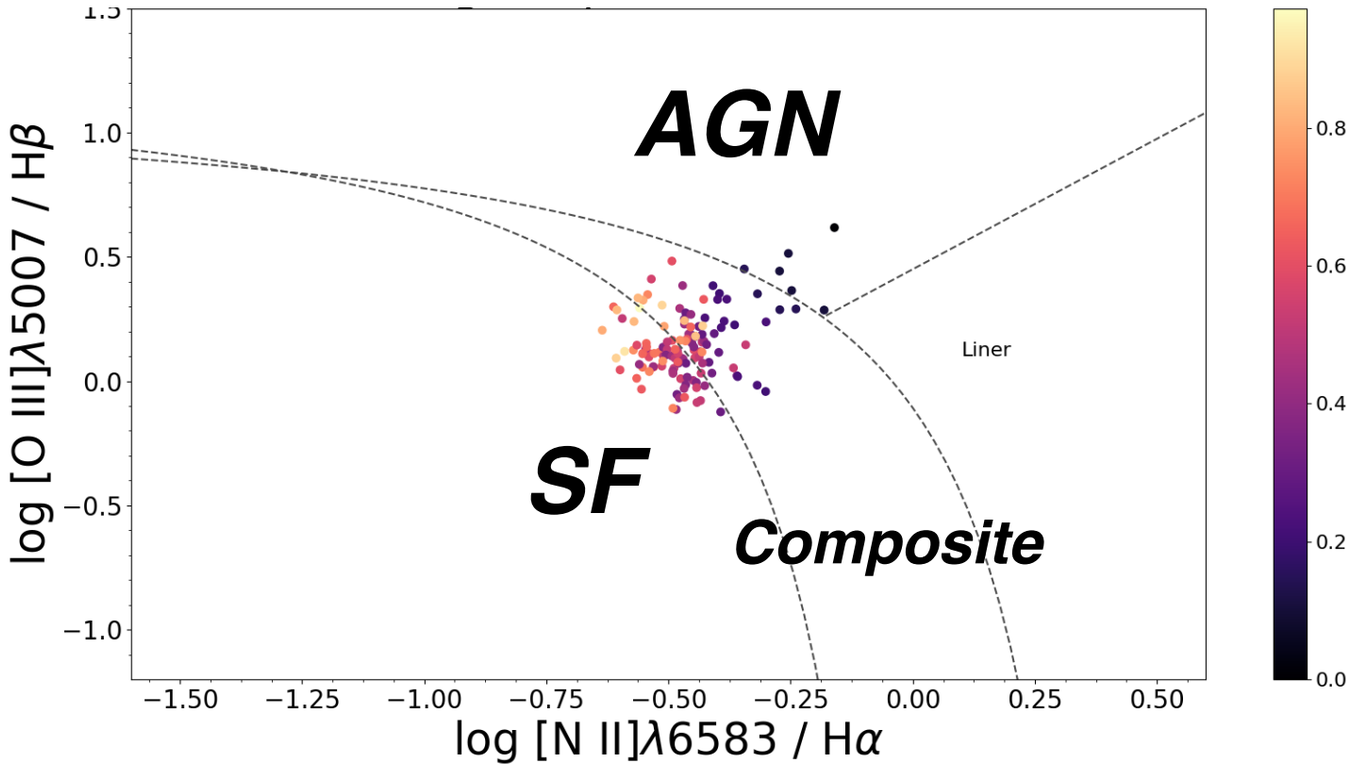


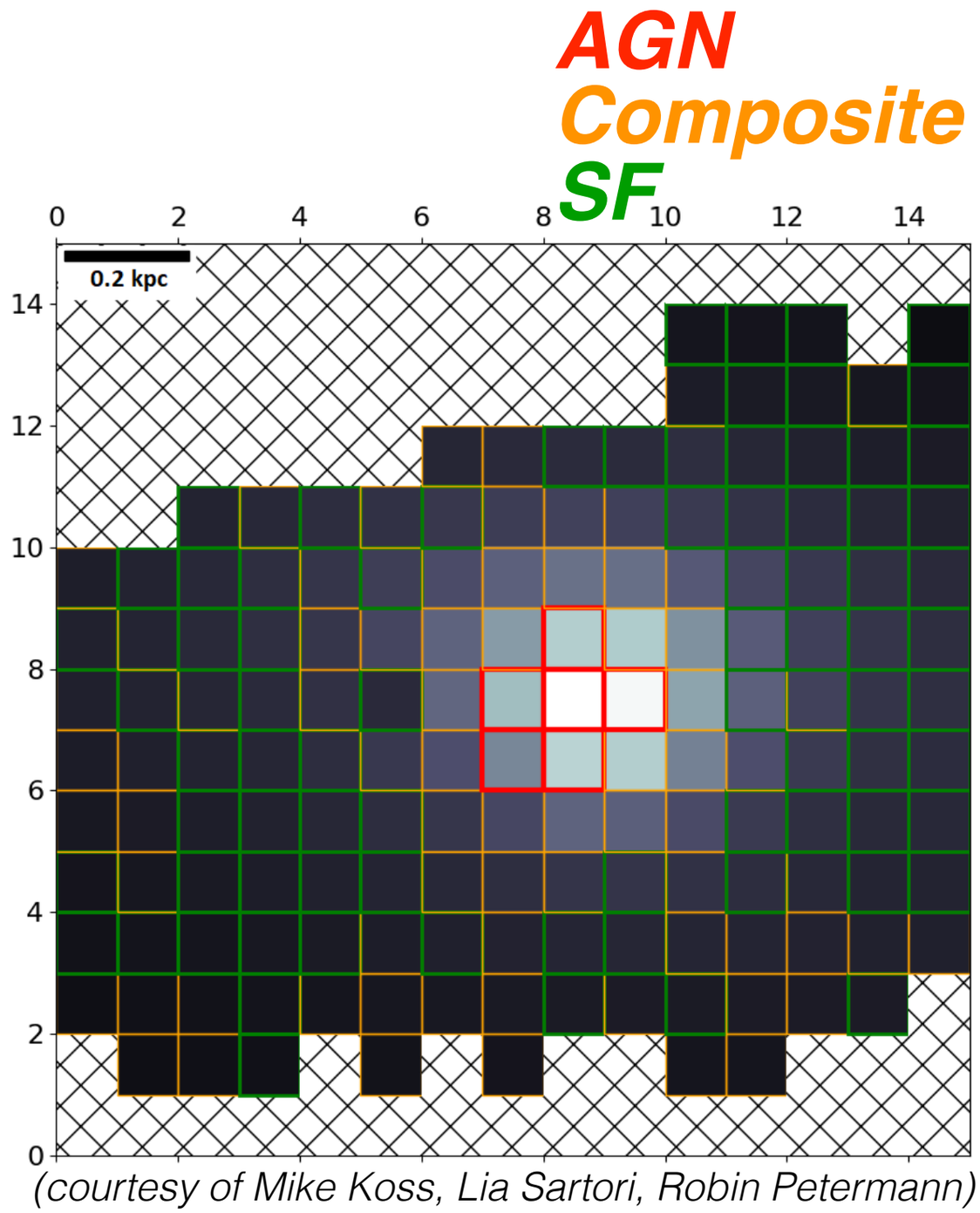


(courtesy of Mike Koss, Lia Sartori, Robin Petermann)

“pixel resolved origin of photo-ionisation”

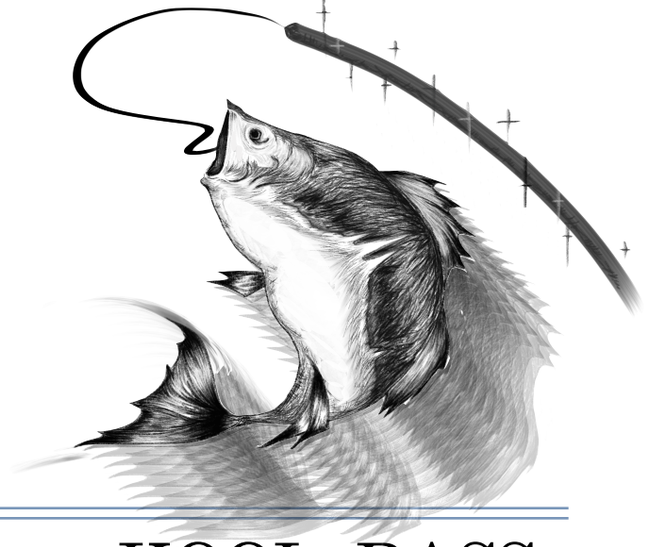
Specification & expectation (example)



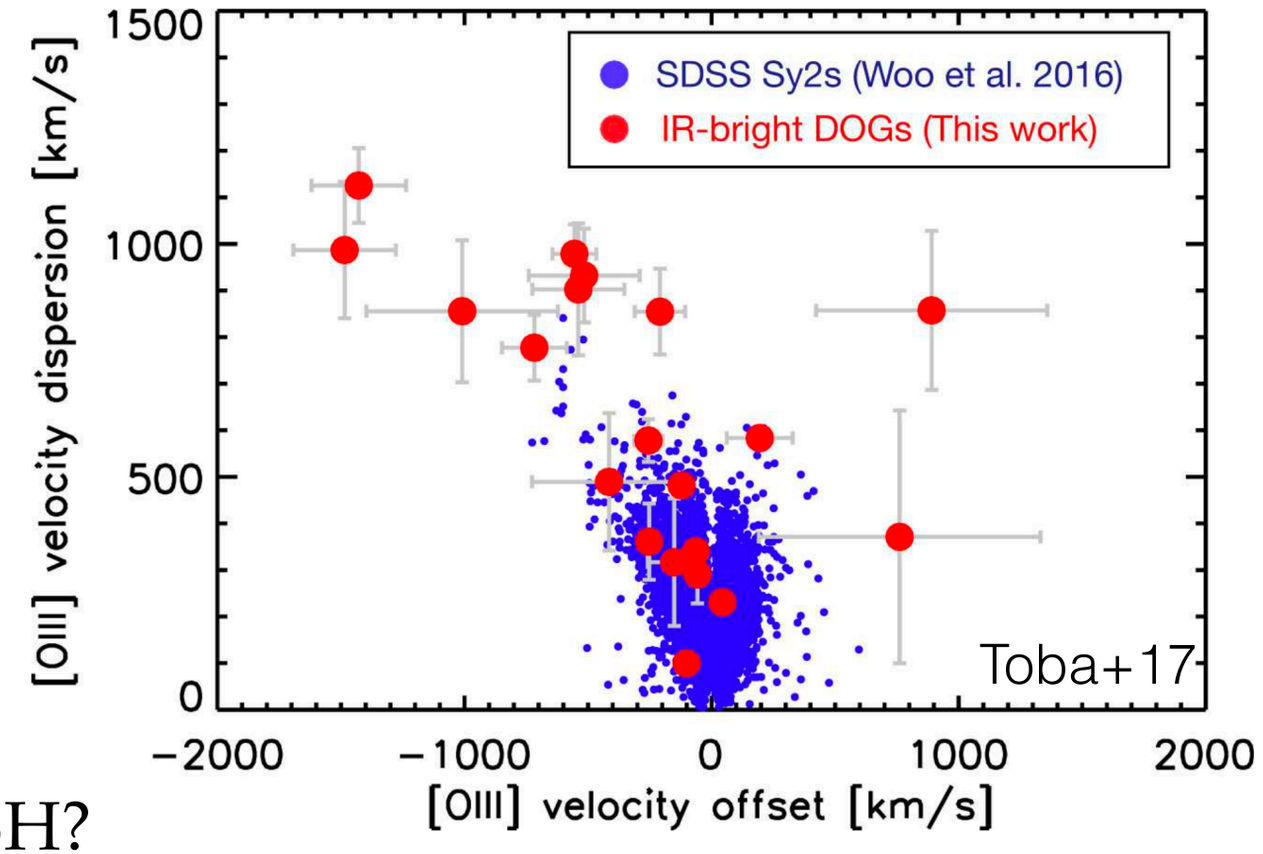


(courtesy of Mike Koss, Lia Sartori, Robin Petermann)

KOOL-BASS: studies

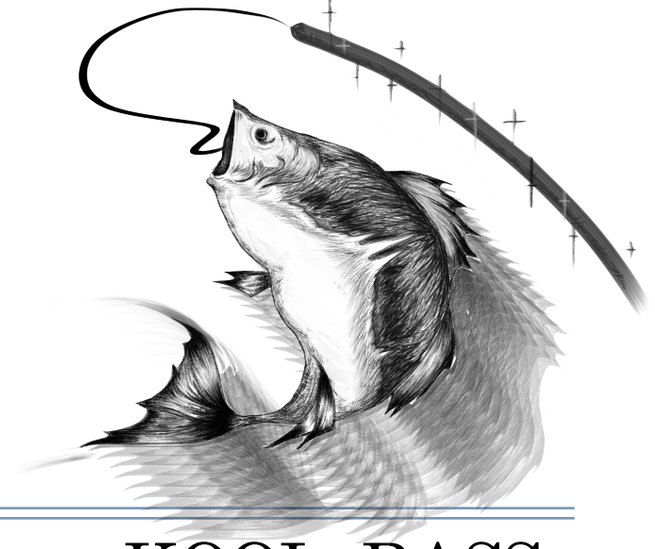


- study of extended ionised gas
  - powered by ongoing SF?
  - large scale AGN-driven outflow?
    - kinematic impact on radio jet?
- radial metallicity gradient
- how host galaxy can feed central SMBH?



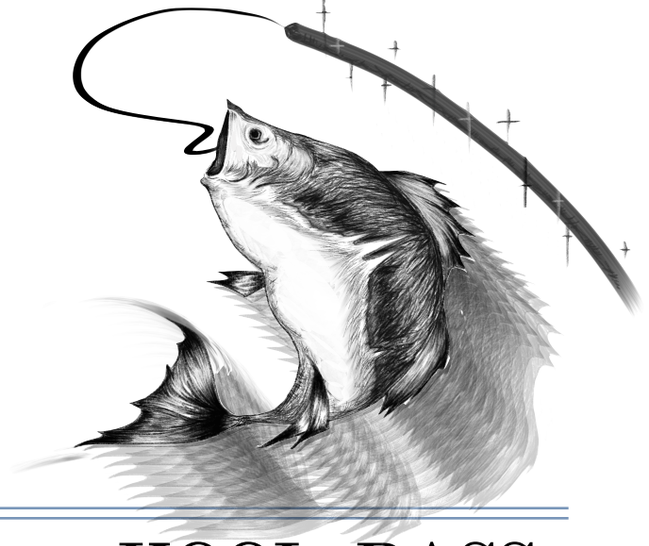
- `rare objects' that haven't studied using IFU with X-ray detection:
  - XBONG / HII / dusty galaxies / dual AGN

KOOL-BASS: targets

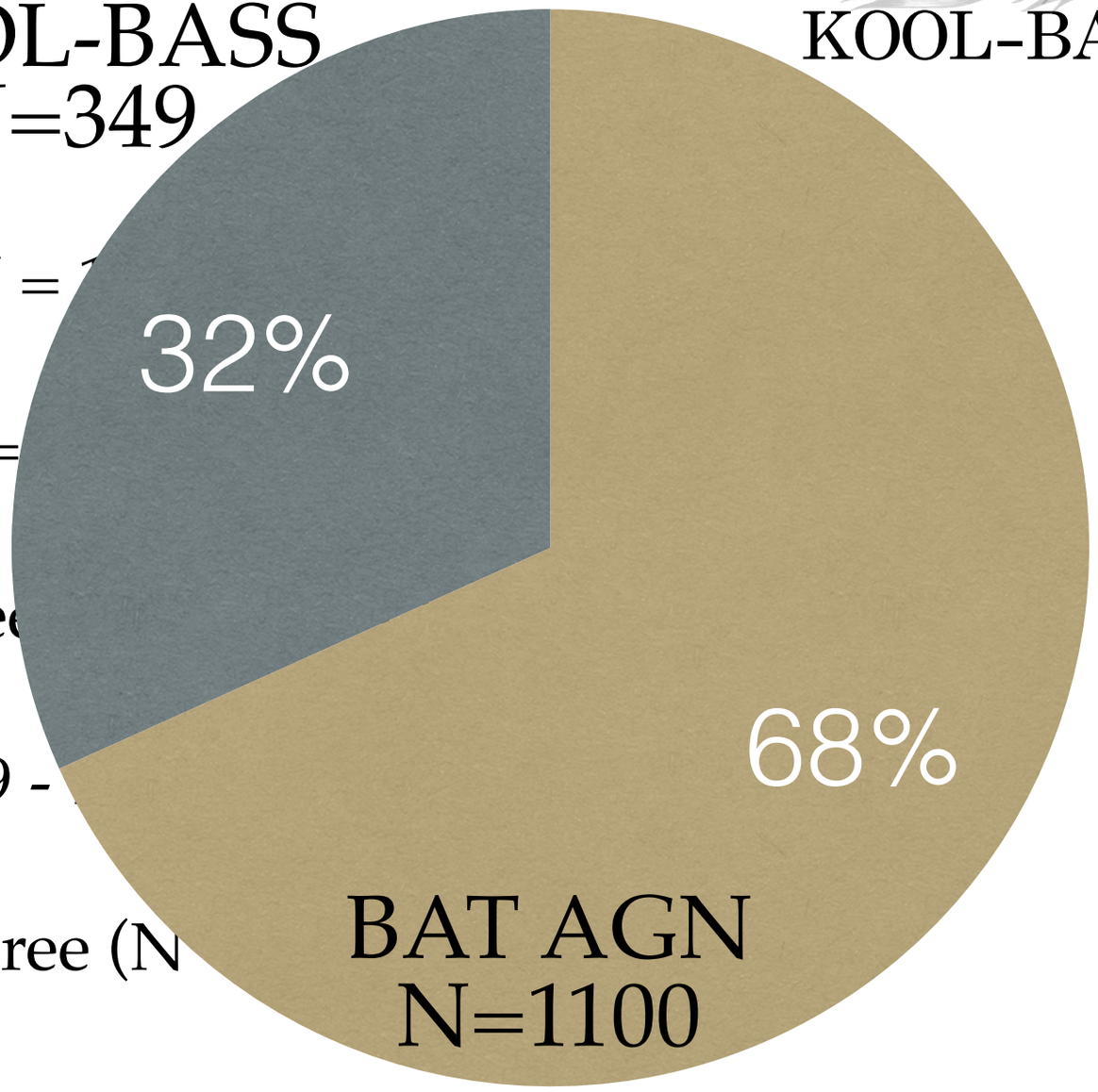


- Target selection
  - Swift-BAT 105 month AGN: N = 1100
  - non-blazar (N = 1100 - 158 = 942)
  - galactic latitude > |10degree| (N = 942 - 103 = 839)
  - optical mag. < 19.0 (N = 839 - 15 = 824)
  - observability: dec.> -10 degree (N = 824 - 321 = 503)
  - redshift cut: z < 0.06 + Unknown-z (N = 503 - 154 = **349**)

KOOL-BASS: targets

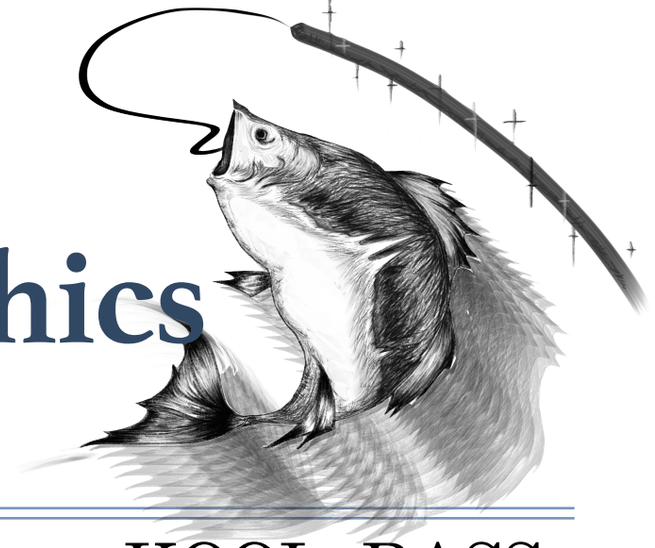


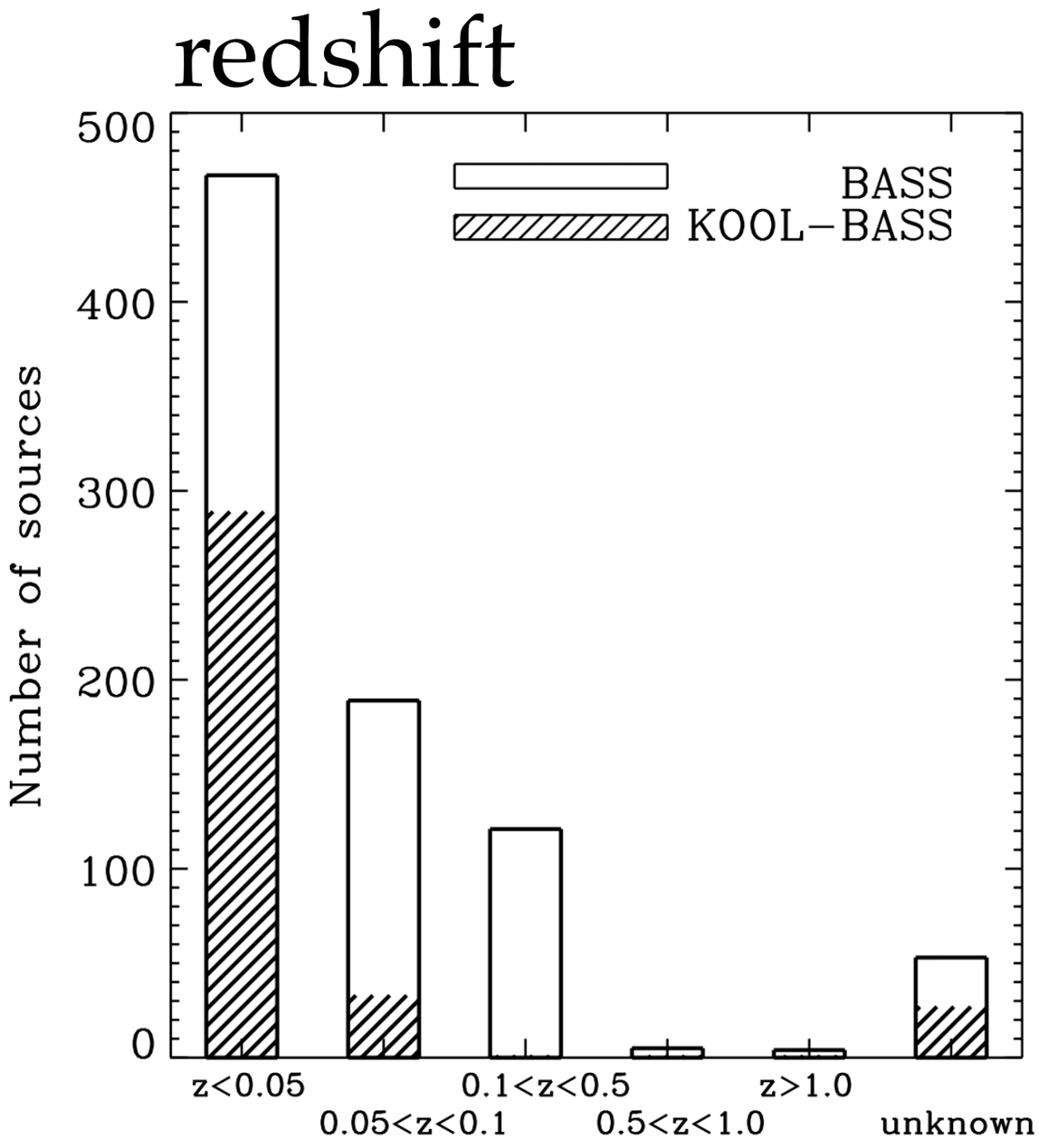
- Target selection
  - Swift-BAT 105 month AGN: N = 1
    - non-blazar (N = 1100 - 158 =
    - galactic latitude > |10degree
    - optical mag. < 19.0 (N = 839 -
    - observability: dec.> -10 degree (N
    - redshift cut: z < 0.06 + Unknown-z (N = 503 - 154 = **349**)

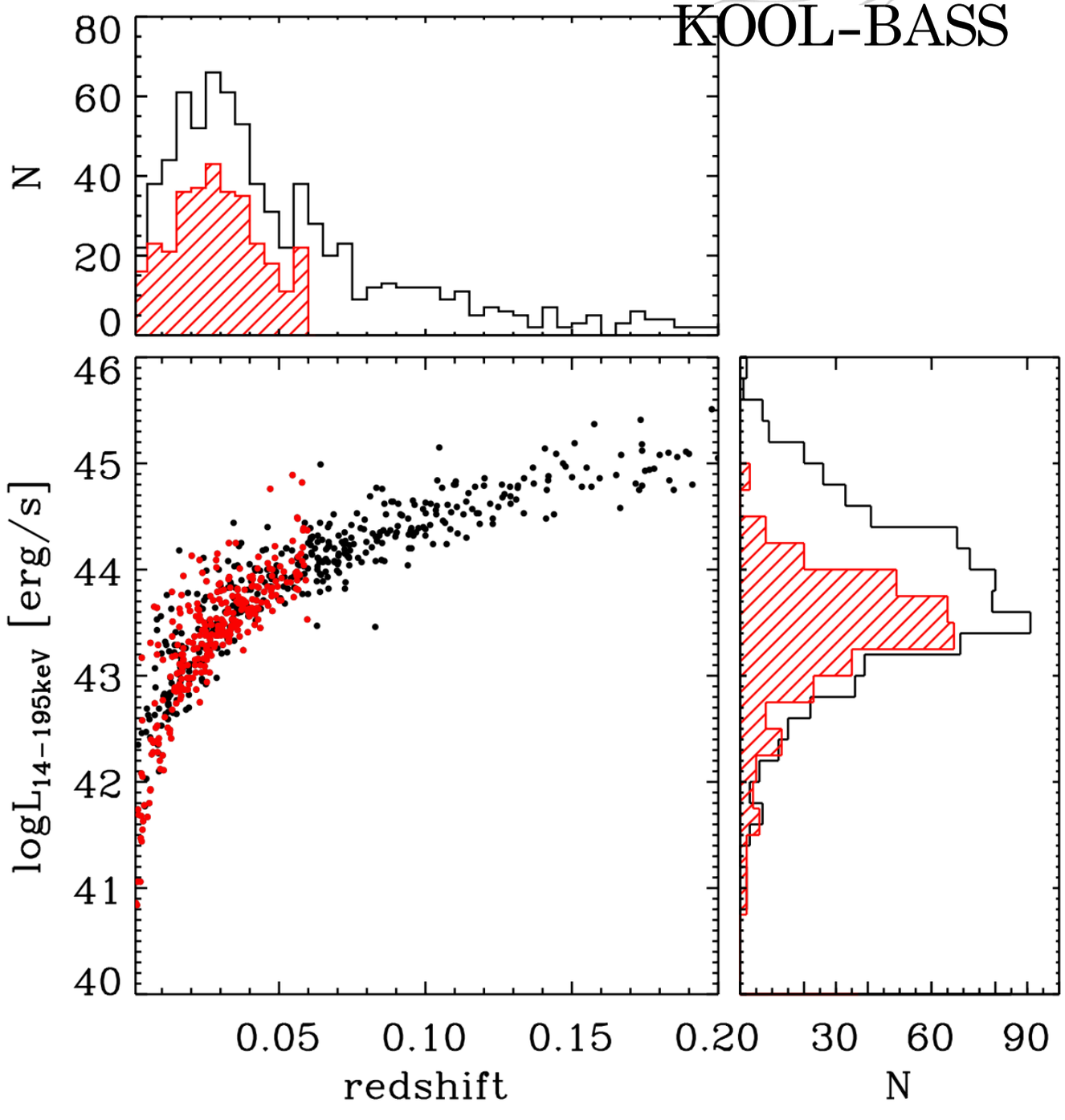


KOOL-BASS

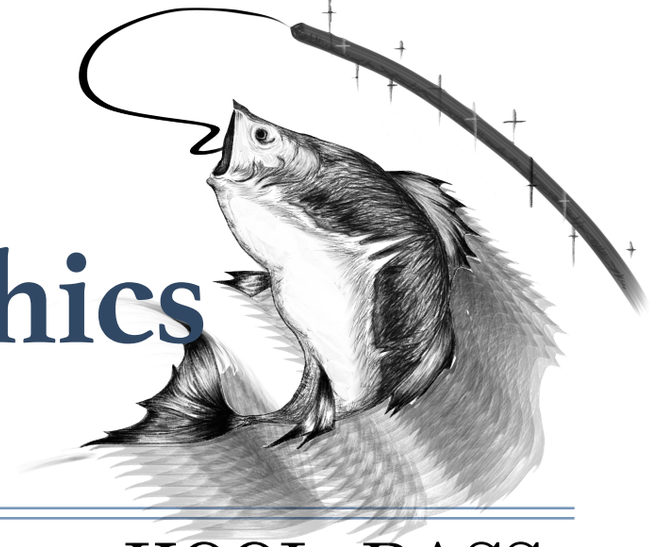
KOOL-BASS: target demographics





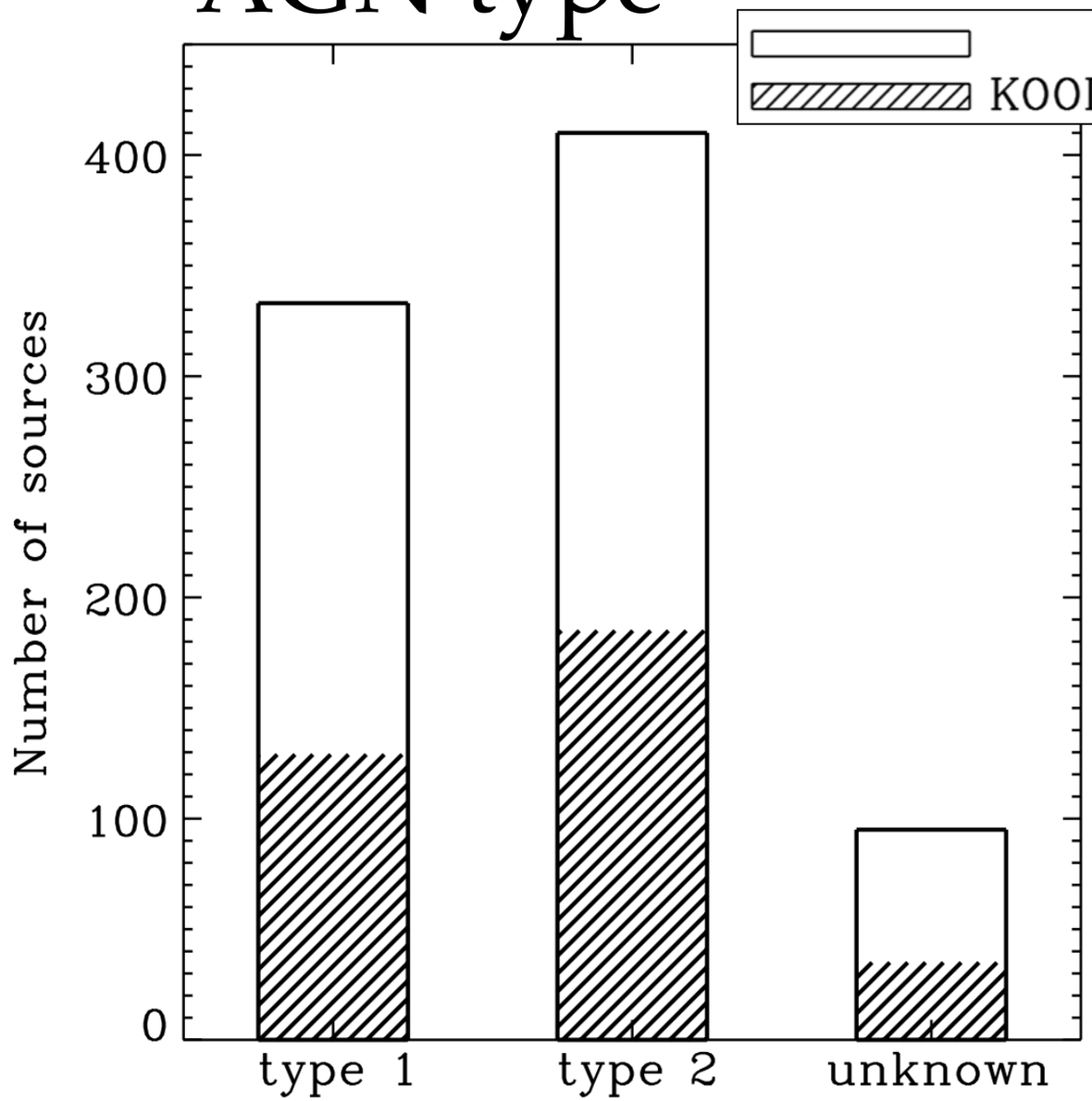


KOOL-BASS: target demographics

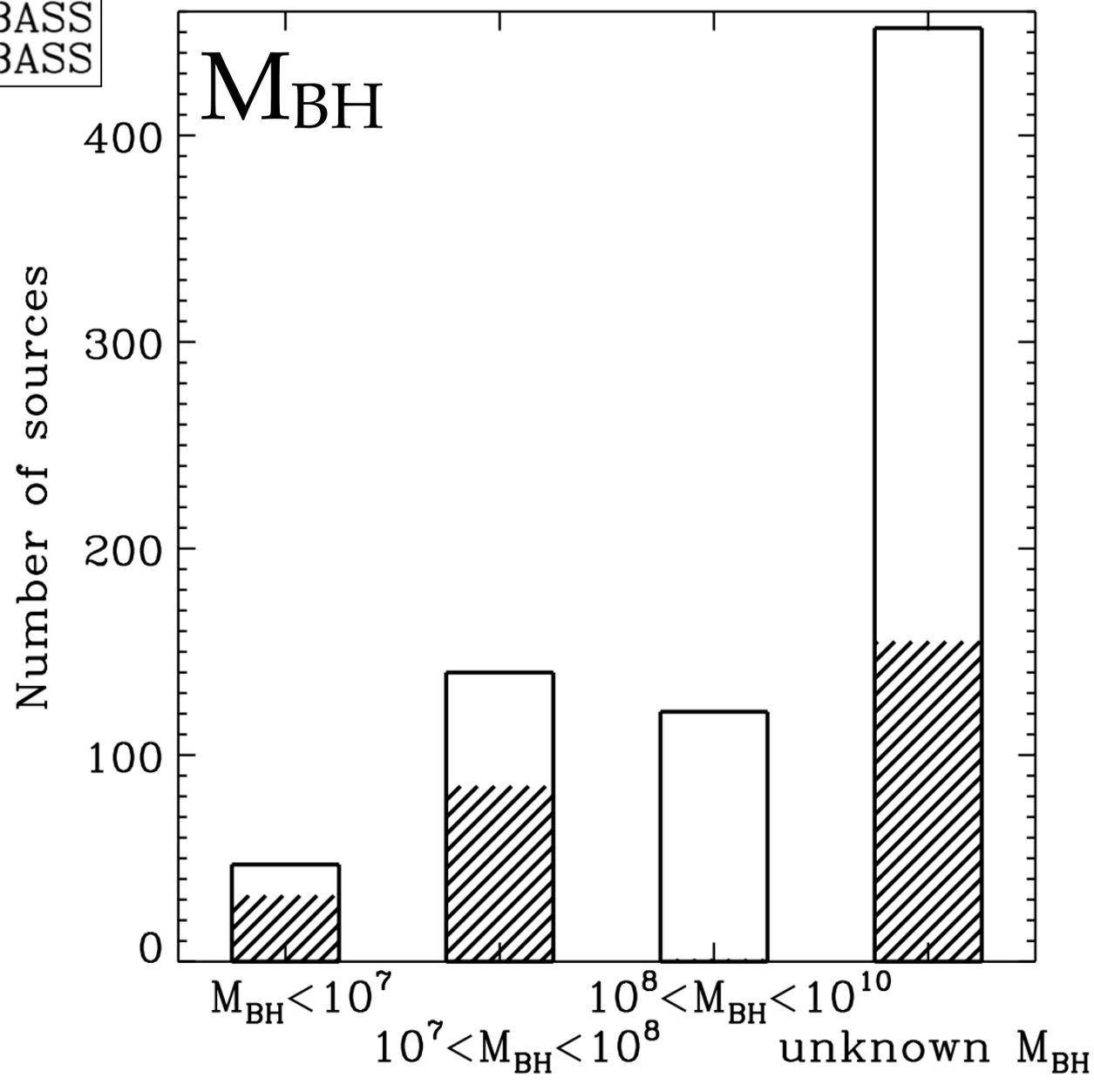


KOOL-BASS

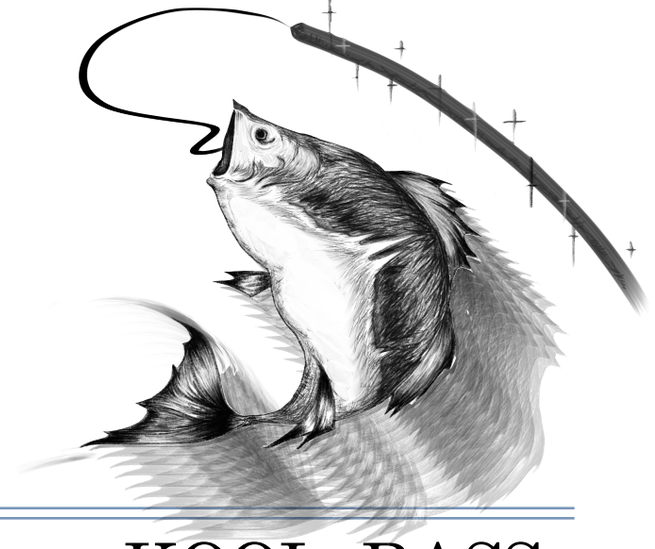
AGN type



M_{BH}



KOOL-BASS: target priority



- N = **349**

- M_{BH} not known + redshift not known: N = **27**

- M_{BH} not known + redshift known: N = **128**

- M_{BH} known + redshift known: N = **194**

Summary

- KOOL-BASS: IFU survey of hard X-ray selected nearby AGN
  - least biased sample of AGN including obscured AGN
- 349 targets: $z<0.06$ with z-unknown sources (N=27)
  - type 1: 129, type 2: 185, unknown type: 35
  - unknown M_{BH}: 155
- studies of extended ionised gas, feeding, outflow, jet, radial metallicity gradient, rare objects (XBONG, HII etc)