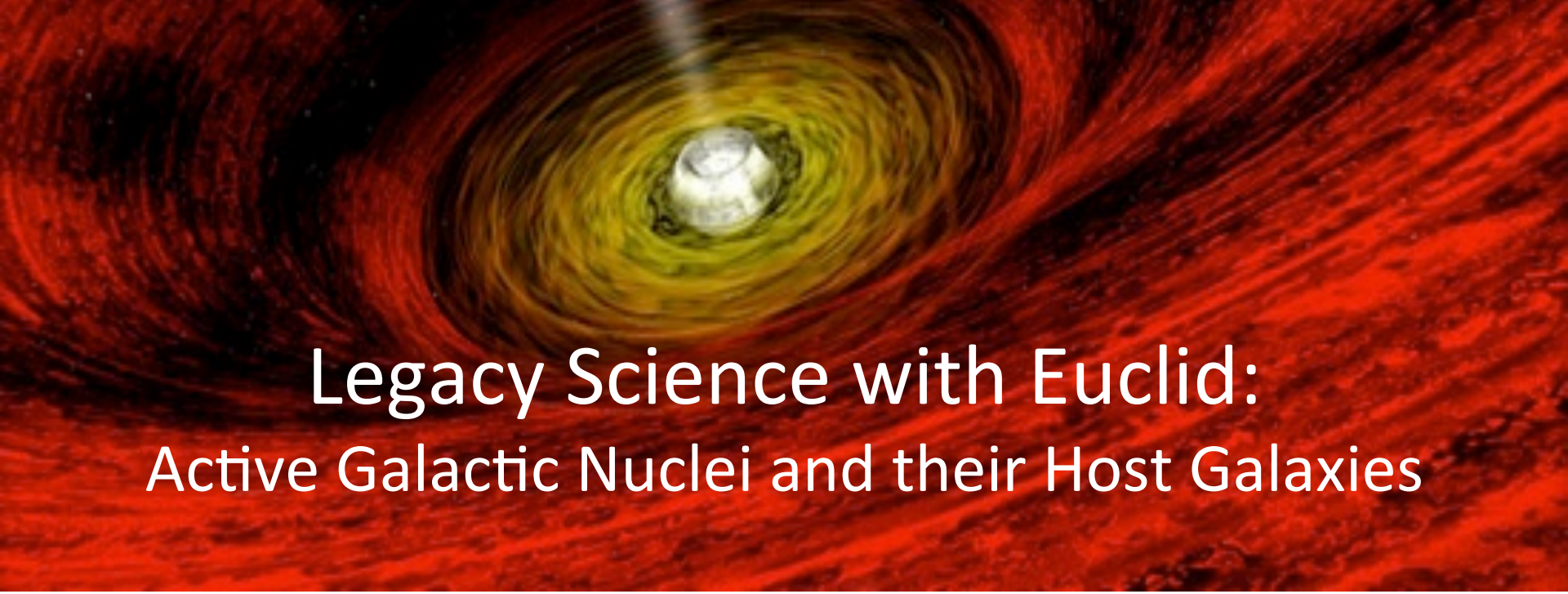

Legacy Science with Euclid:
Active Galactic Nuclei and their Host Galaxies

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Euclid France Meeting 2015 (January 2016)

WP9: Active Galactic Nuclei

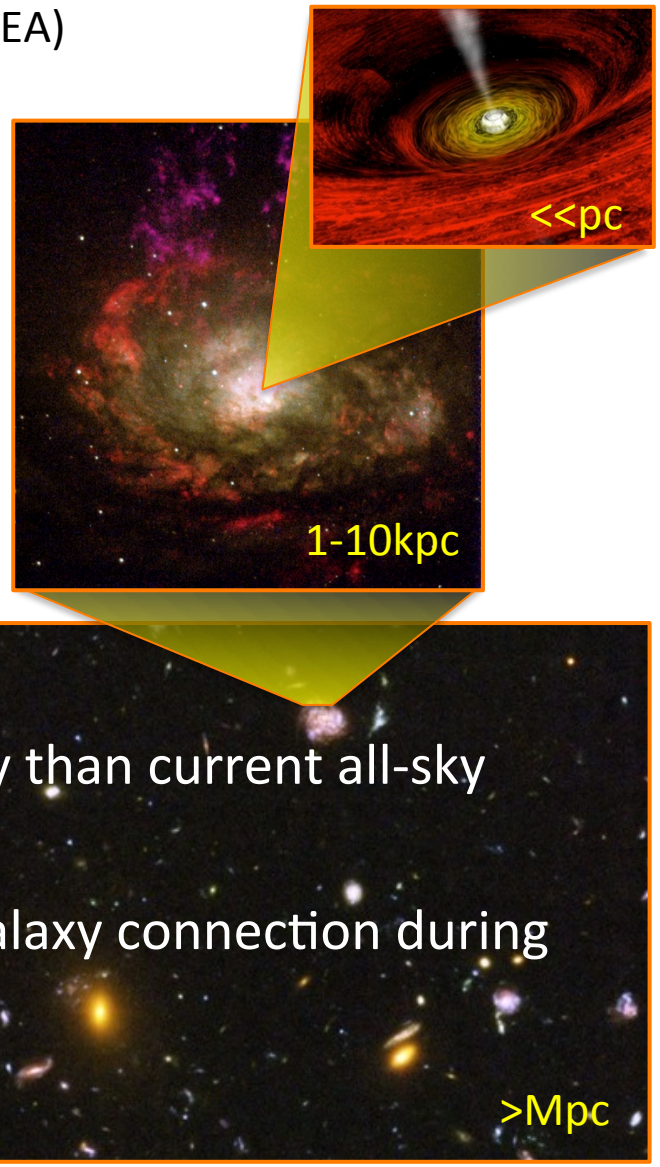
Coordinator: Stéphanie Juneau (CEA)

AGN identification

→ AGN Database useable by all other WPs

AGN studies:

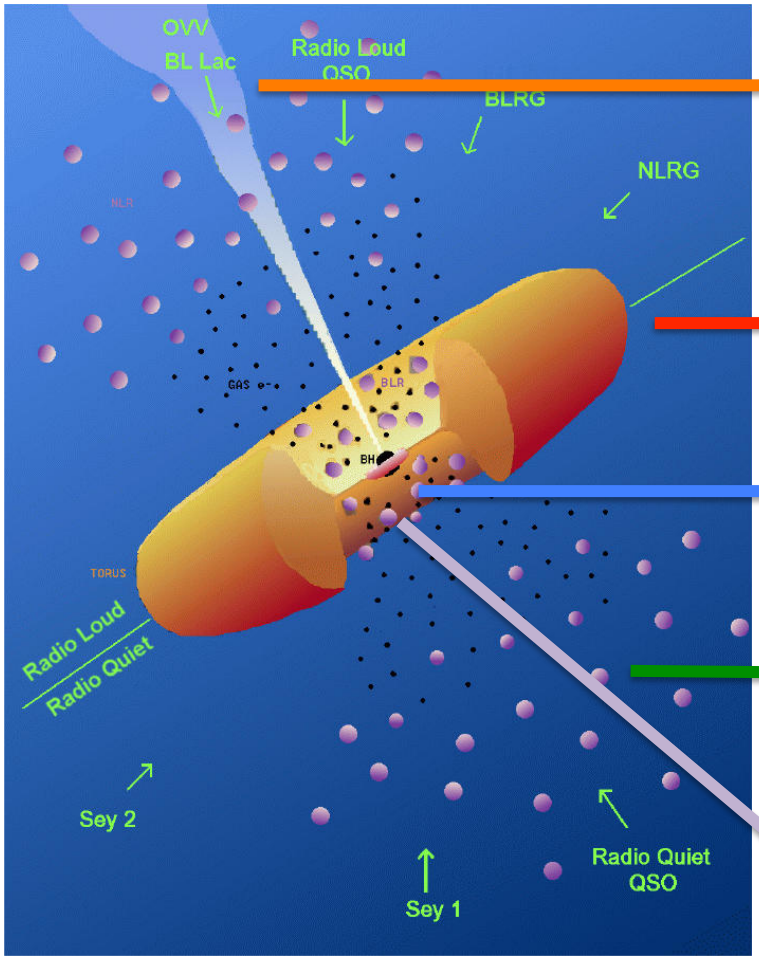
- AGN triggering/feedback
- AGN obscuration
- BH masses, BH growth budget
- Connection with host galaxies
- Connection with environment



Probe of luminous objects with more sensitivity than current all-sky AGN surveys (+ get host galaxy properties!)

Improved understanding of the Black-Hole – Galaxy connection during the peak epoch of activity (z~2)

AGN Unification Model



(Antonucci 1984; Urry & Padovani 1995)

1.4 GHz / FIR
(radio-excess; Del Moro+12)

IRAC colors
(Stern+05; Donley+07; Lacy+04)

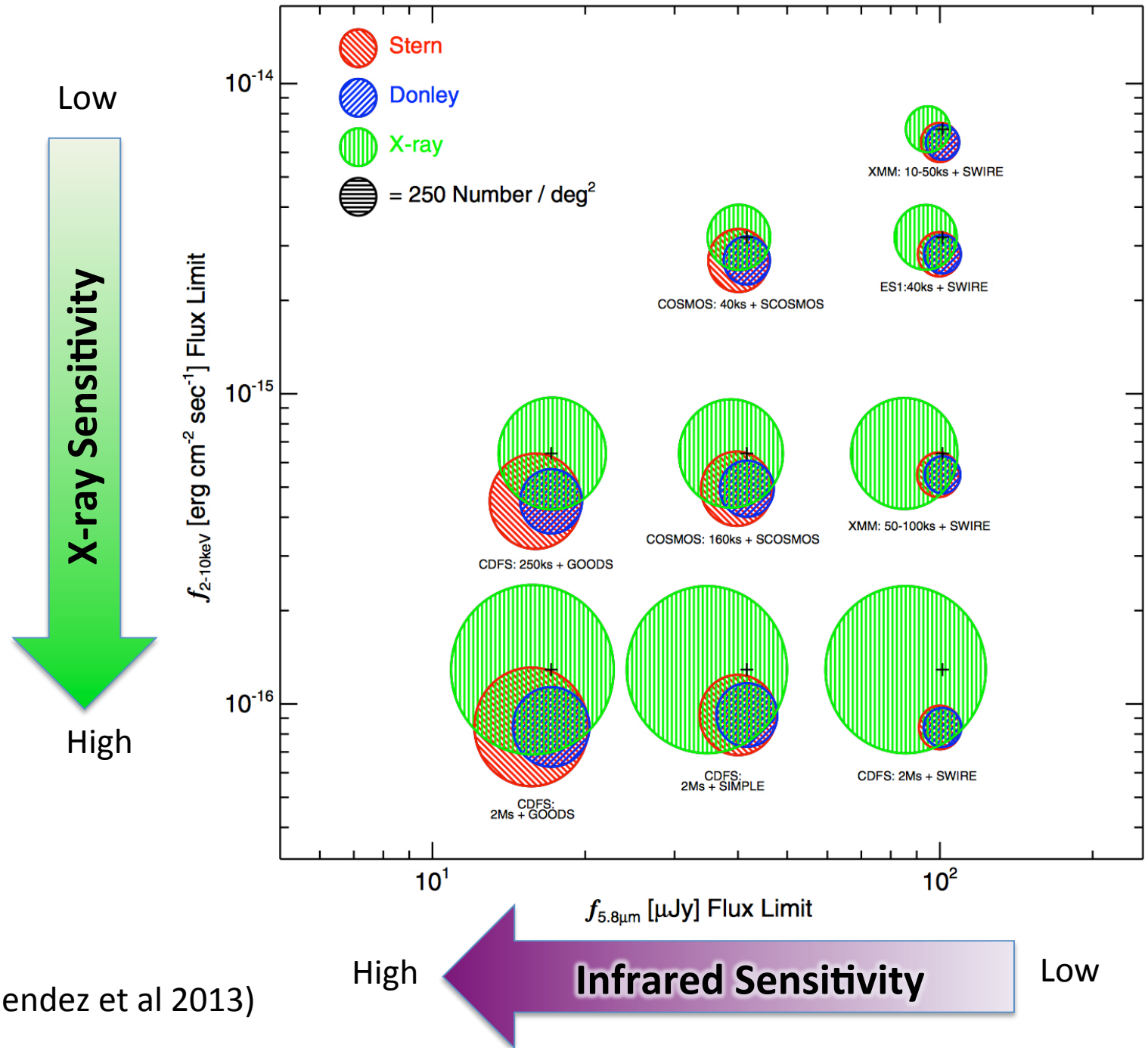
L_X(2-10keV) > 10^{42} erg/s
(Bauer+04)

Narrow Line Regions
(BPT 81, MEx diagram Juneau+11)

Broad Lines (Hα, Hβ, MgII, [CVI], etc.)
and/or Bright Point Source (right colors)

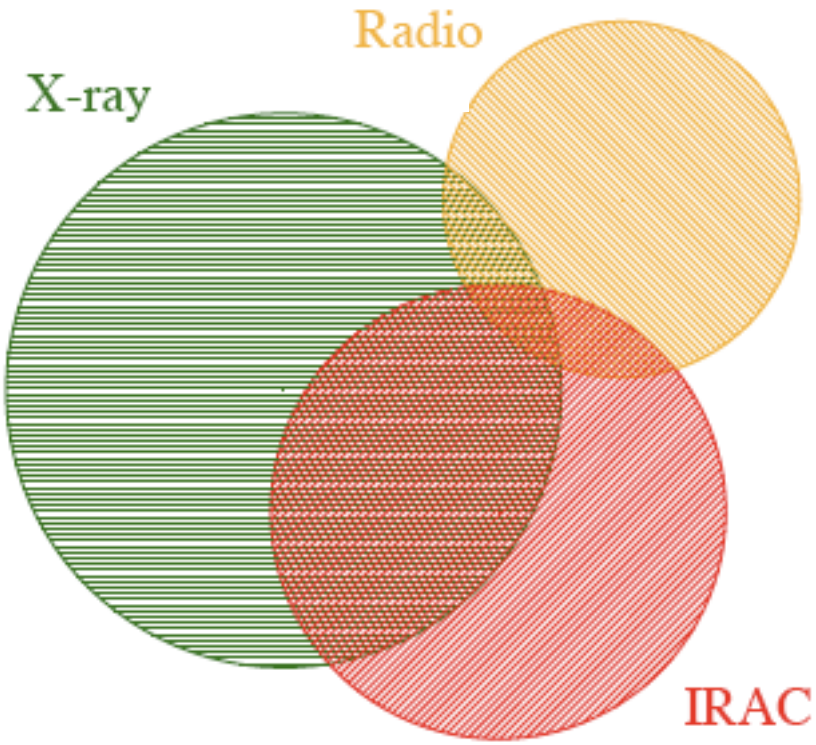
AGN Identification: Pros & Cons

Regime	Advantages	Limitations
Radio (e.g., 1.4 GHz / FIR)	• Dust insensitive • Can get high resolution in some systems (VLBI)	• Radio loudness is rare (and not fully understood?) • Limited sensitivity
Mid-IR (IRAC or WISE colors)	• Both obscured and unobscured AGNs • All sky with WISE (rare populations)	• Limited sensitivity (L_X>10^{43} erg/s) • Need contrast with SF in host
Optical (Colors or emission lines [BPT, MEx, etc.])	• Most sensitive (L_X<10^{41}erg/s) • Can detect Compton-thick AGNs (geometry)	• Dust obscuration from host/ Optical elusive cases • Spectroscopy is expensive
X-rays (luminosity or excess)	• Reliable tracer (>2keV) • Intermediate sensitivity (better than mid-IR colors)	• Compton-thick AGNs (even hard w/ NuSTAR) • Ambiguous at low luminosities (<10^{42})



(Mendez et al 2013)

AGN Selection Comparison / Overlap



- These AGNs live in different host galaxies!
- →*not* multiple views of the same system
- →different evolutionary paths and/or different points along an evolutionary path? (e.g., Hopkins+2008; Hickox+2009; Alexander & Hickox 2012)

Hickox+ 2009 (also Juneau+ 2013, Menzel+ 2015)

AGN Identification: Methods

- Euclid "internal" identification of AGNs:
  - NIR spectroscopy
    - Broad lines (type 1): a few 10^5 at $0.9<z<9$
    - Narrow lines (type 2): ~8000 from [NII]/Hα; 2.7×10^4 from [OIII]/Hβ
  - Imaging
    - Point-sources (w/ OU-PHZ)
    - SED fitting (w/ GAWG-WP1; OU-PHZ)
    - Variability

- Euclid "external" identification of AGNs:
  - Ancillary data (OU-MER?)
    - X-ray (e.g., eROSITA)
    - MIR/FIR? (e.g., WISE)
    - Radio
  - Follow-up surveys

AGN Identification: Challenges

- Limited spectral resolution R~250
  - Blending of key emission lines (Hα+[NII]) (w/ WP2)
- Limited availability of given sets of diagnostic emission lines (for Type 2 AGN)
  - "BPT" lines only at 1.5<z<1.8 (red) or 1<z<1.8 (red+blue)
  - [NII]/Hα at 0.9<z<1.8 (red) or 0.4<z<1.8 (red+blue)
  - [OIII]/Hβ at 1.5<z<2.7 (red) or 1.0<z<2.7 (red+blue)
  - Behavior of emission line diagnostics at high redshift? (e.g., Kewley+2013a,b; Juneau+2014, Steidel+2014)
- Heterogeneous selection/detection limits from multi-wavelength AGN studies (X-ray, Infrared, etc.)

AGN Identification: Challenges

- Close collaboration w/ OU-PHZ (AGN WP coord. Salvato):

Q1:Are we using an homogenised classification, or, when possible we go deeper and use more data?

or Q2: How do we take into account the different data depth? How we document that?

TODO:
1)see a which depth you can extend the various methods
2)Check AllWISE vs. UNWISE
3)Check ability in computing photo for non X-ray AGN.

AGN Identification: Progress

- Close collaboration w/ OU-PHZ (AGN WP coord. Salvato):
  - Already testing/comparing AGN **identification** methods with existing datasets (SDSS, Stripe82-X, XMM-XXL, WISE, AllWISE, …)
  - Already testing/comparing AGN **photo-z** methods (e.g., SED fitting vs. Machine Learning)
  - Ongoing work on testing emission-line diagnostics at redshift>1

- At OU-PHZ level (required for main mission; coord. Paltani):
  - For proper object classification, we need a spectroscopic training set (ongoing effort in North by Capak+)
  - + need another spec-z sample to verify the accuracy (independent from training set)

Expected Scientific Outcome

- Key insights into Galaxy Evolution:
  → Black-Hole – Galaxy connection during the peak epoch of activity (z~2)
  → First Black Holes (seeds) and their growth across Cosmic time

- Key Euclid advantage: Host galaxy properties such as morphologies (talks by Tasca, Huertas-Company, Duc), and galaxy stellar masses
  → How are BH fueled: galaxy collisions vs. isolated galaxies?

- Large-scale environment/clustering of AGN hosts
  → How are BH fueled: in dense or field environment?

- The most luminous AGNs back to young universe (redshift > 7)
  → The most active growth episodes + earliest supermassive black holes

- **NEEDED:** Multi-wl surveys (eROSITA, WISE, etc.); Close ties with other GAWG WPs and OUs (PHZ and SPE)