Growing black holes in (small) galaxies during the Epoch of Reionization

Maxime Trebitsch — Ramses User Meeting 2018

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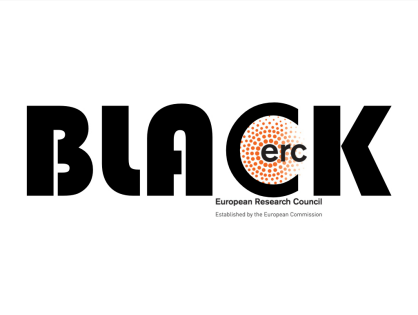
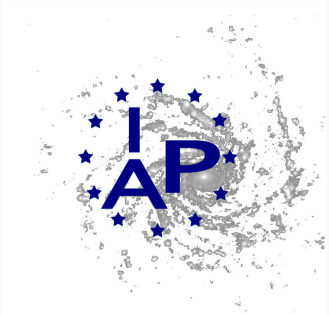
with Marta Volonteri, Yohan Dubois, Piero Madau

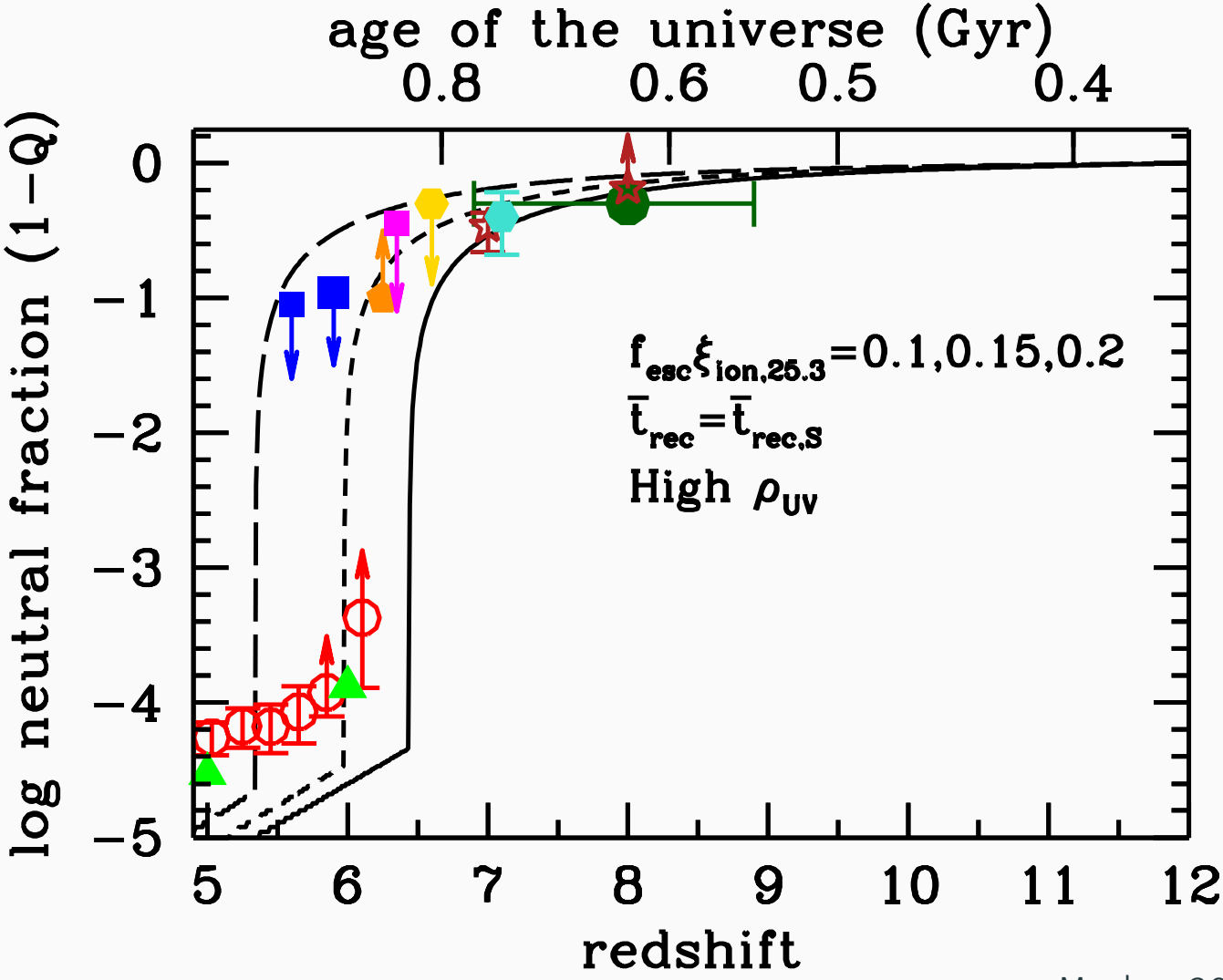
September 17, 2018





The Epoch of Reionisation

The reionisation history is sensitive to $f_{\rm esc}$



Madau 2017

Feedback regulated escape of photons

Photons can escape during SN feedback events

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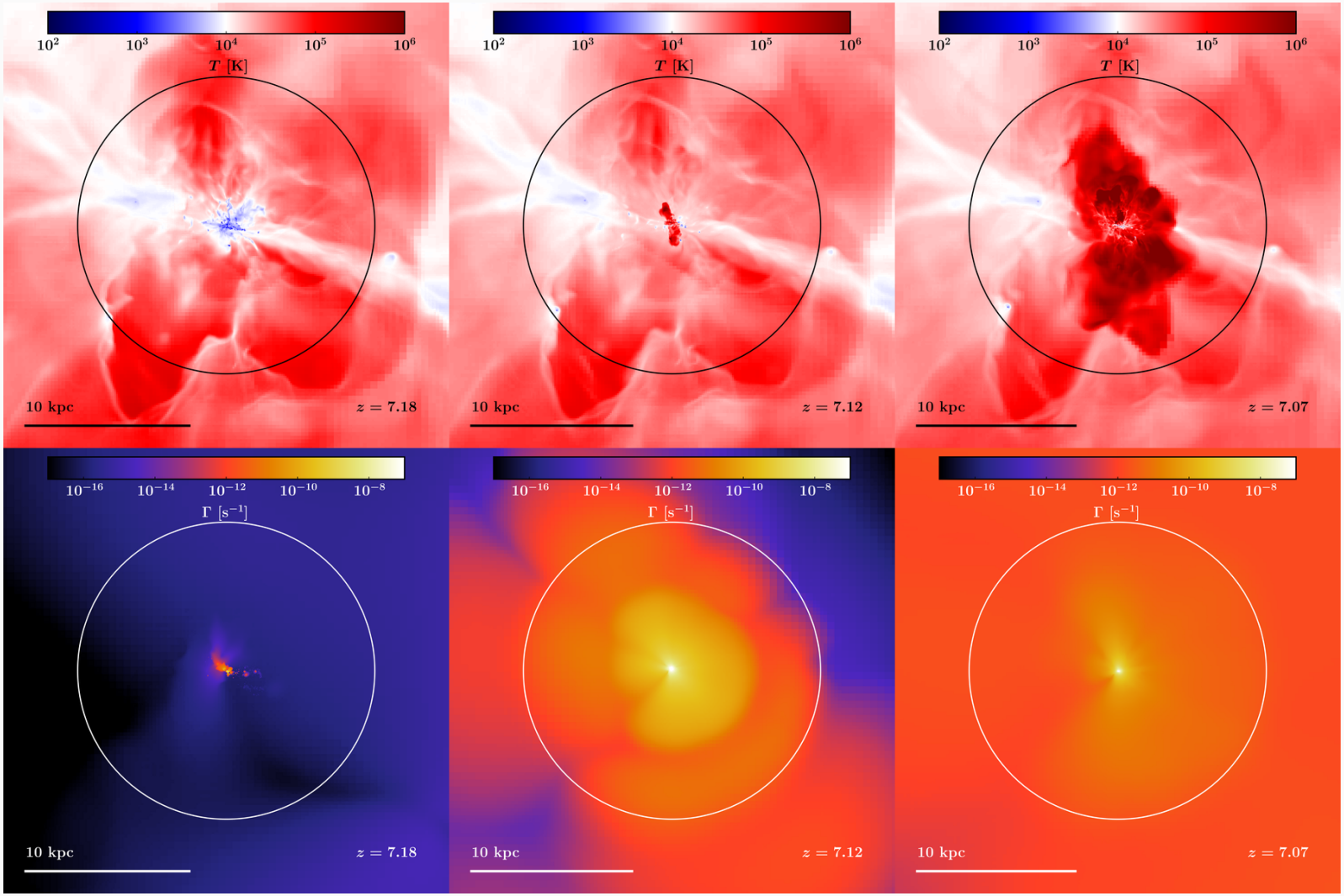
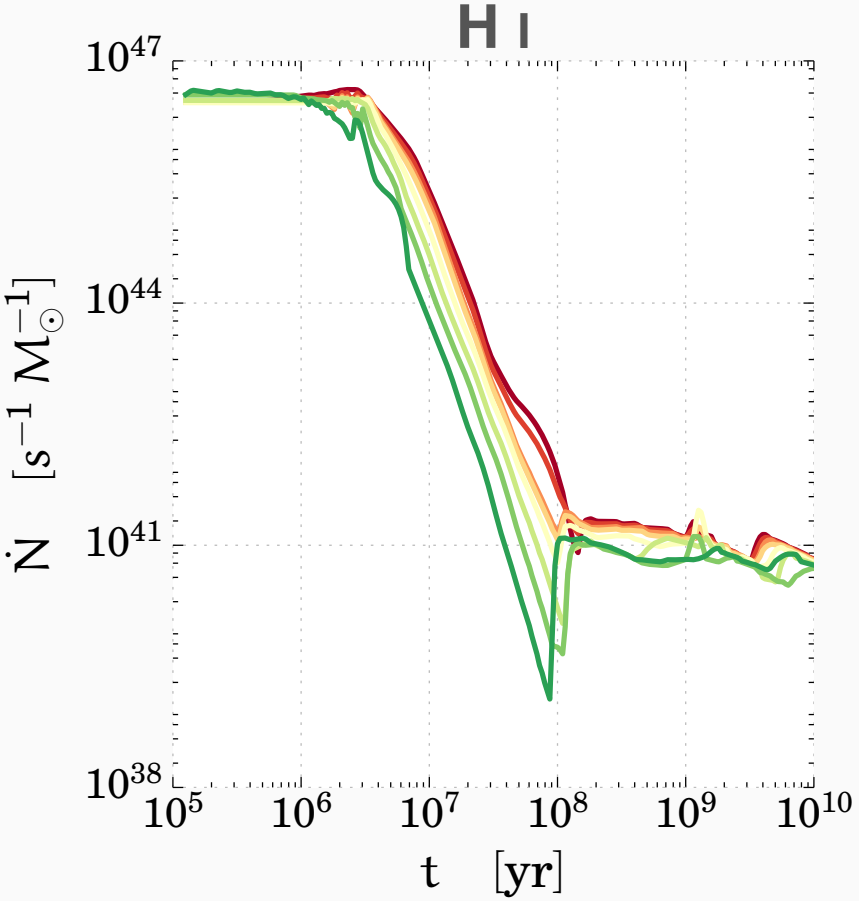


Massive stars die young

The stars that produce ionizing photons are short-lived



Bruzual & Charlot (2003) model

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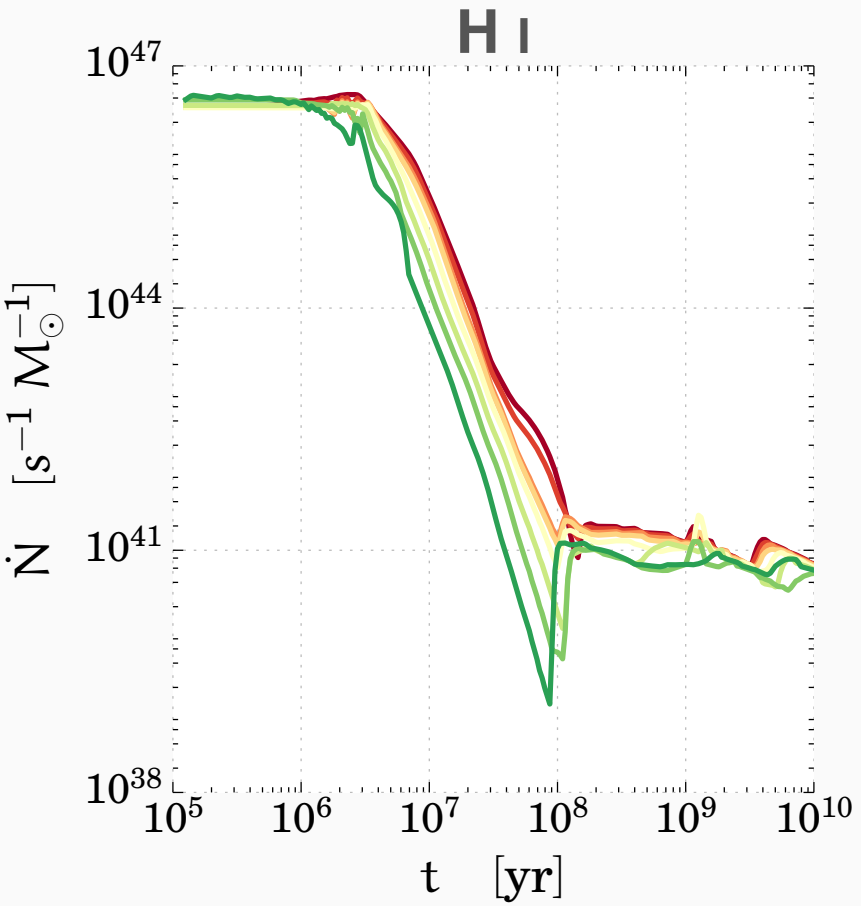
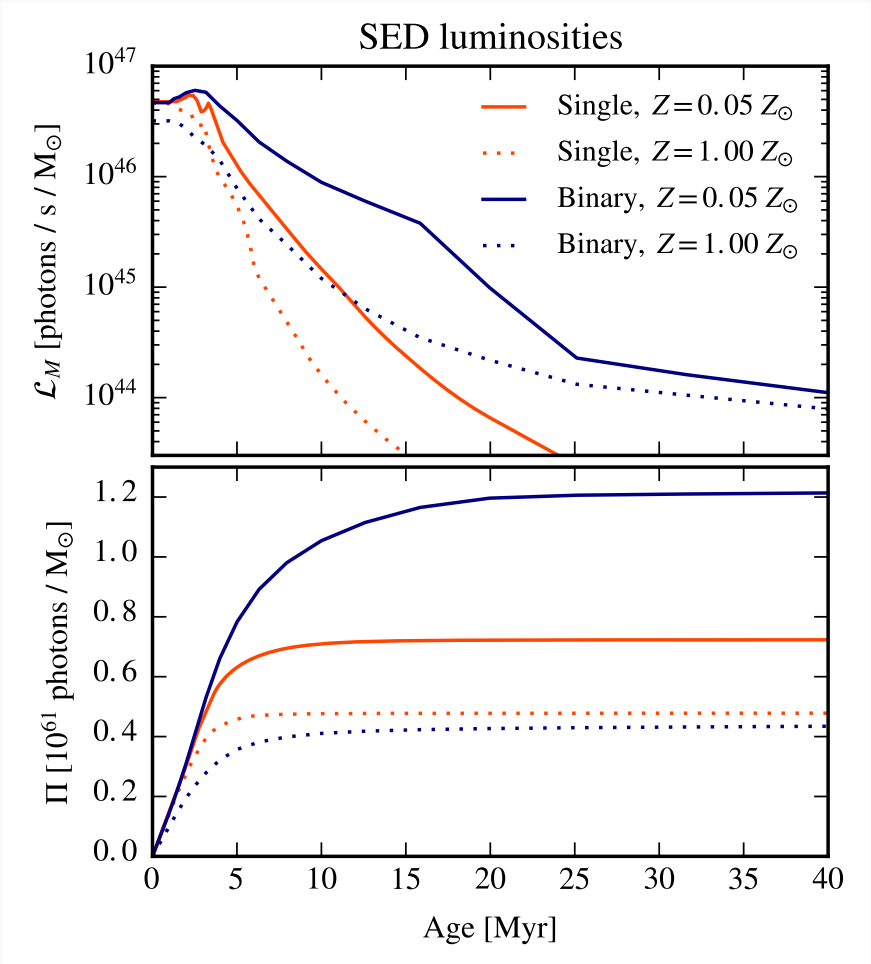


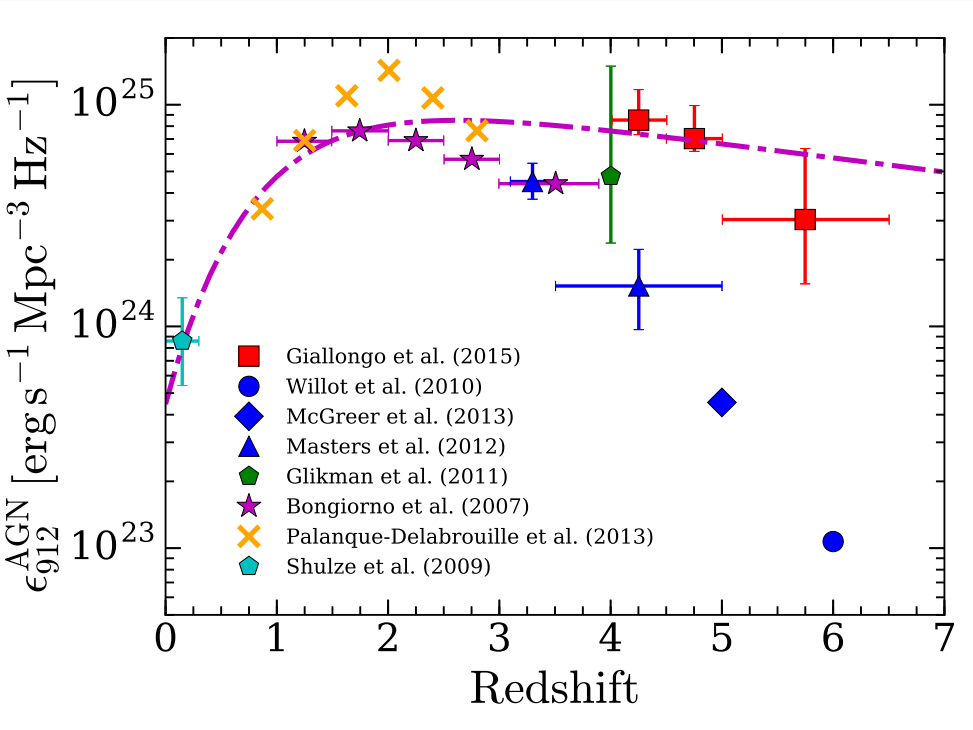


Bruzual & Charlot (2003) model

from Rosdahl+2018

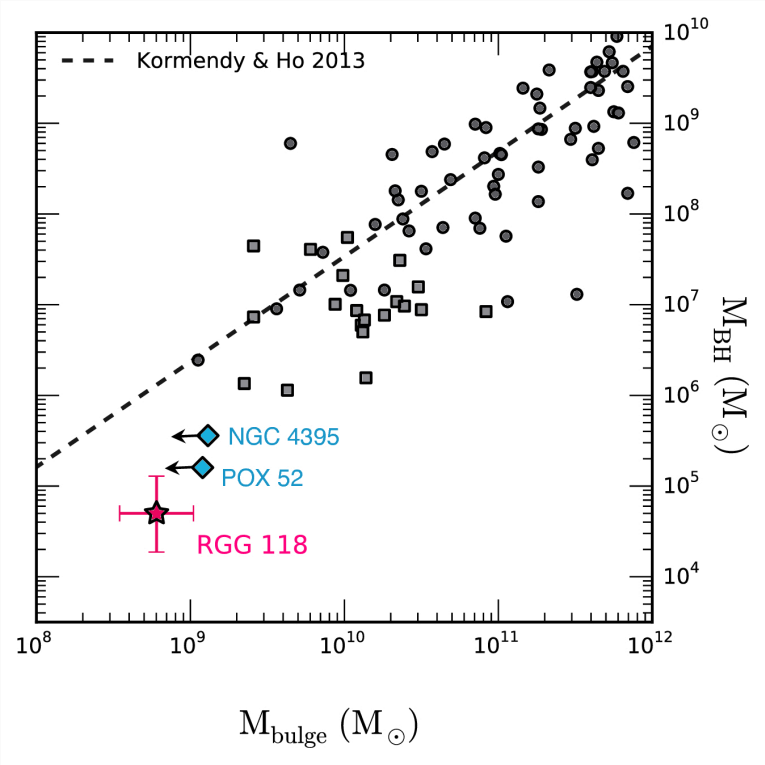
What about AGNs?

Higher AGN contribution to the UVB?



D'Aloisio+2016

SMBHs in dwarf galaxies



Baldassare+2015

At the very least, we need to understand AGNs in dwarfs at high z.

Test this scenario with zoom simulations

Trebitsch+18

- Zoom-in on a $5 \times 10^9 M_\odot$ halo
- Physically motivated subgrid model:
  - Mechanical feedback
  - Virial-based star formation
  - Full RHD with 3 groups
- $\lesssim$ 10 pc resolution
- AGN + BH implementation similar to Dubois+2012
  - Bondi-Hoyle accretion
  - Dual mode (radio + quasar) feedback
- Switch on/off both SN and AGN feedback

Summary of the simulations

Simulation	SN	AGN	Accretion
———	✓	✓	Bondi
▪▪▪▪▪▪▪	✓	–	–
- - - - -	–	✓	Bondi
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———	✓	✓	Forced

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———	✓	✓	Forced

Dwarf galaxy at $z \sim 6$

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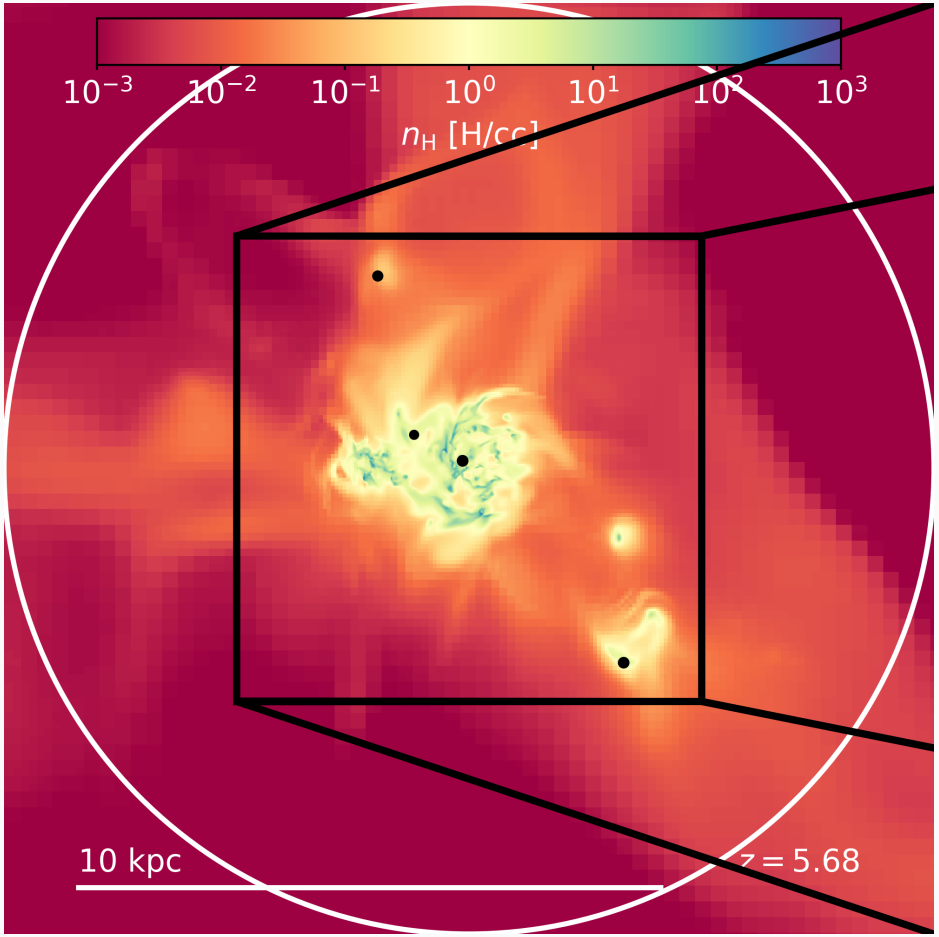
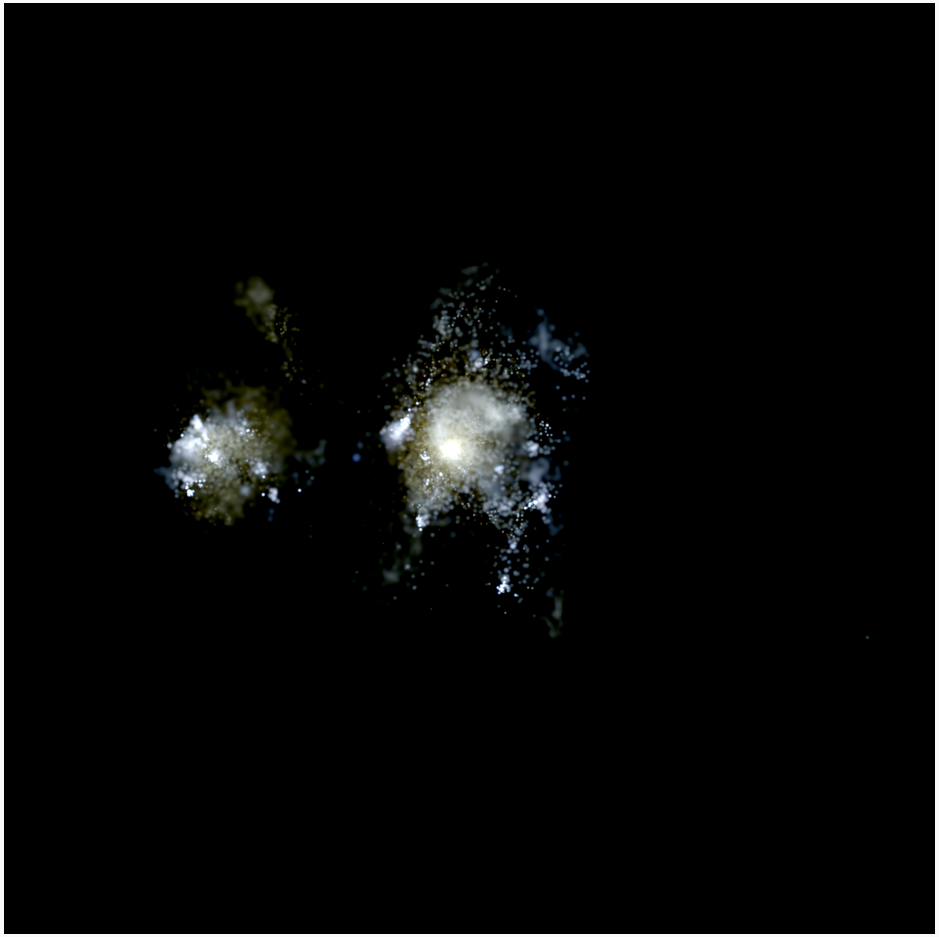
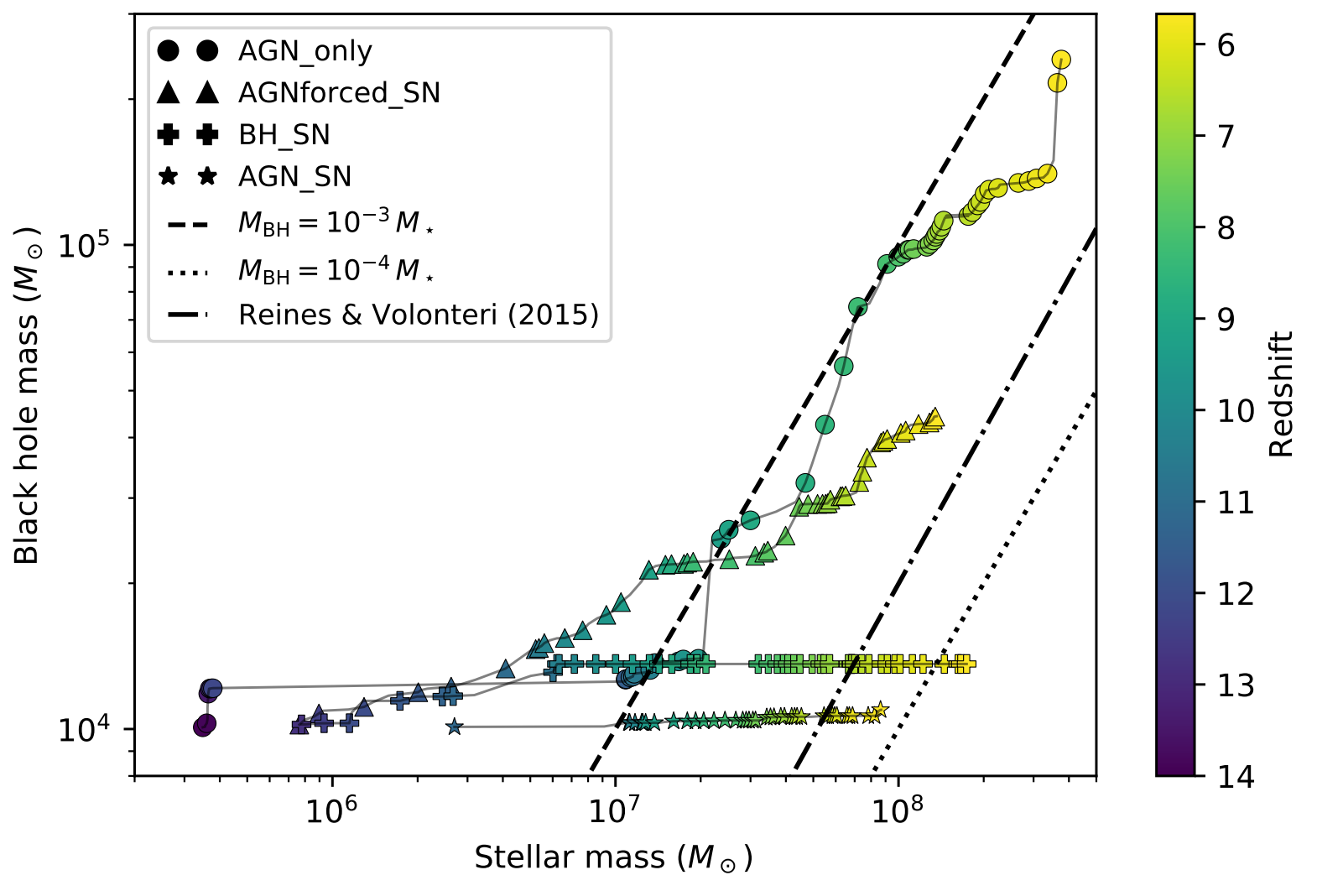
Gas distribution



Stellar distribution



SN feedback prevents BH growth



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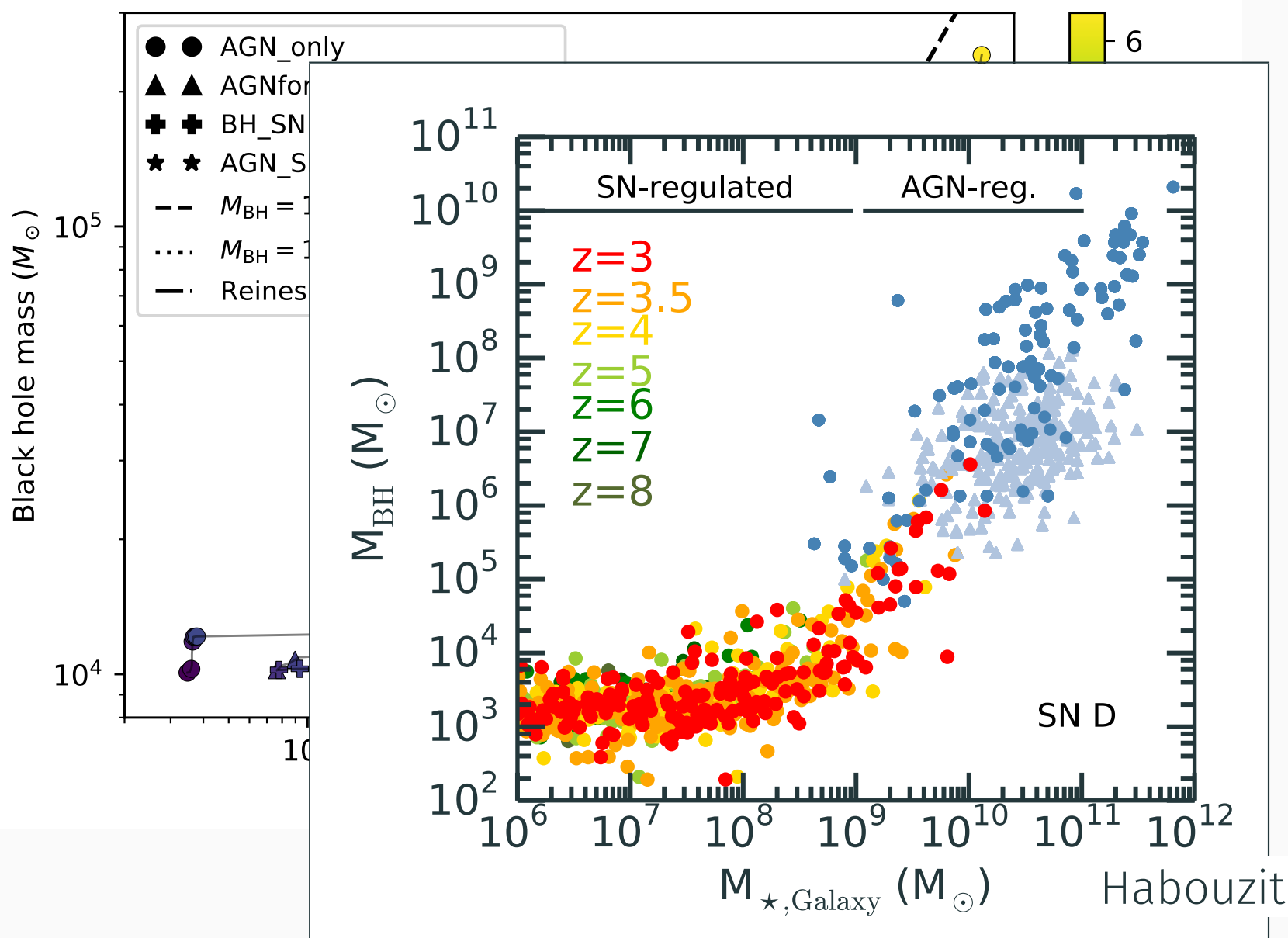


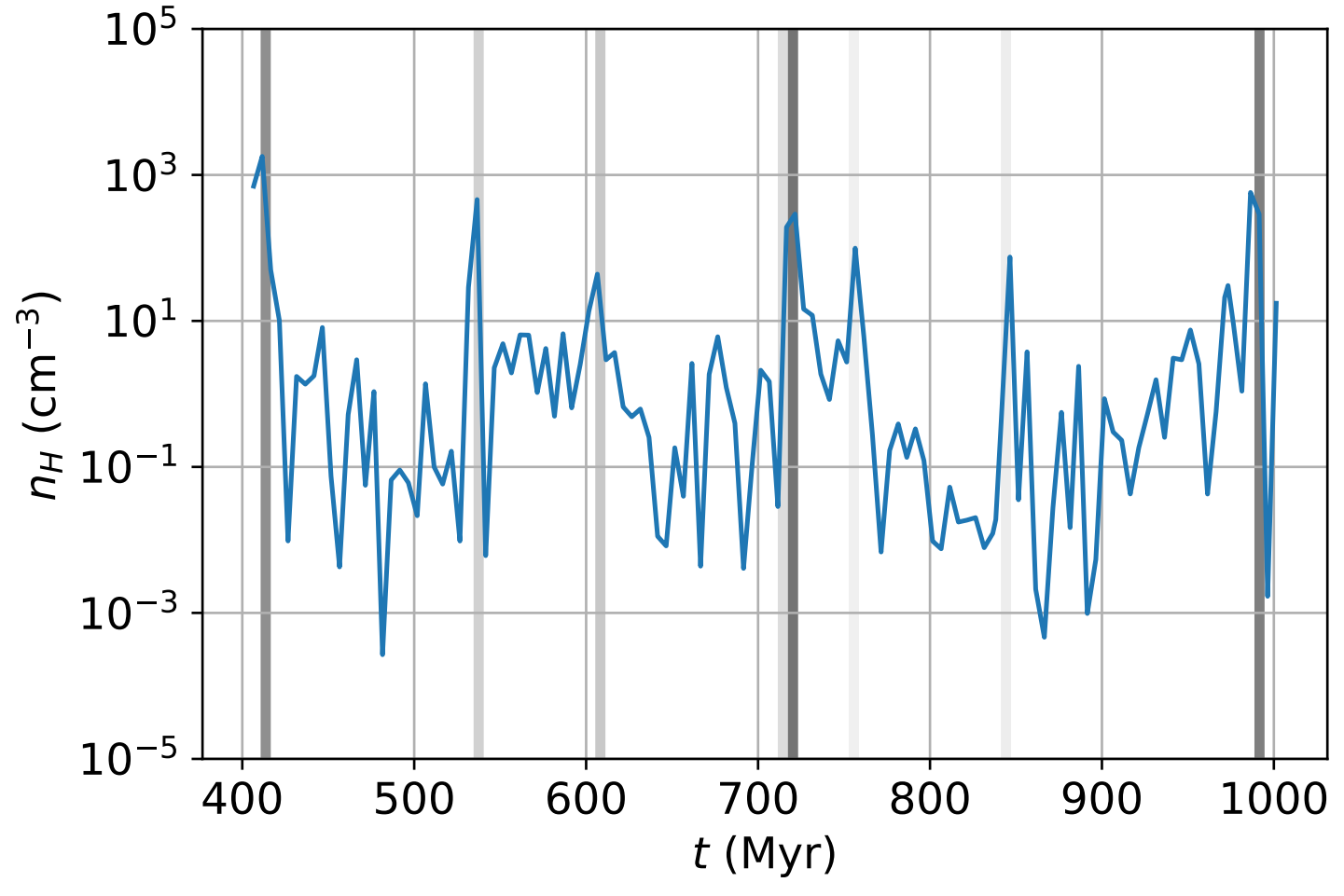
Habouzit+17

SN decreases the central density

Trebitsch+18

With all feedback mechanisms

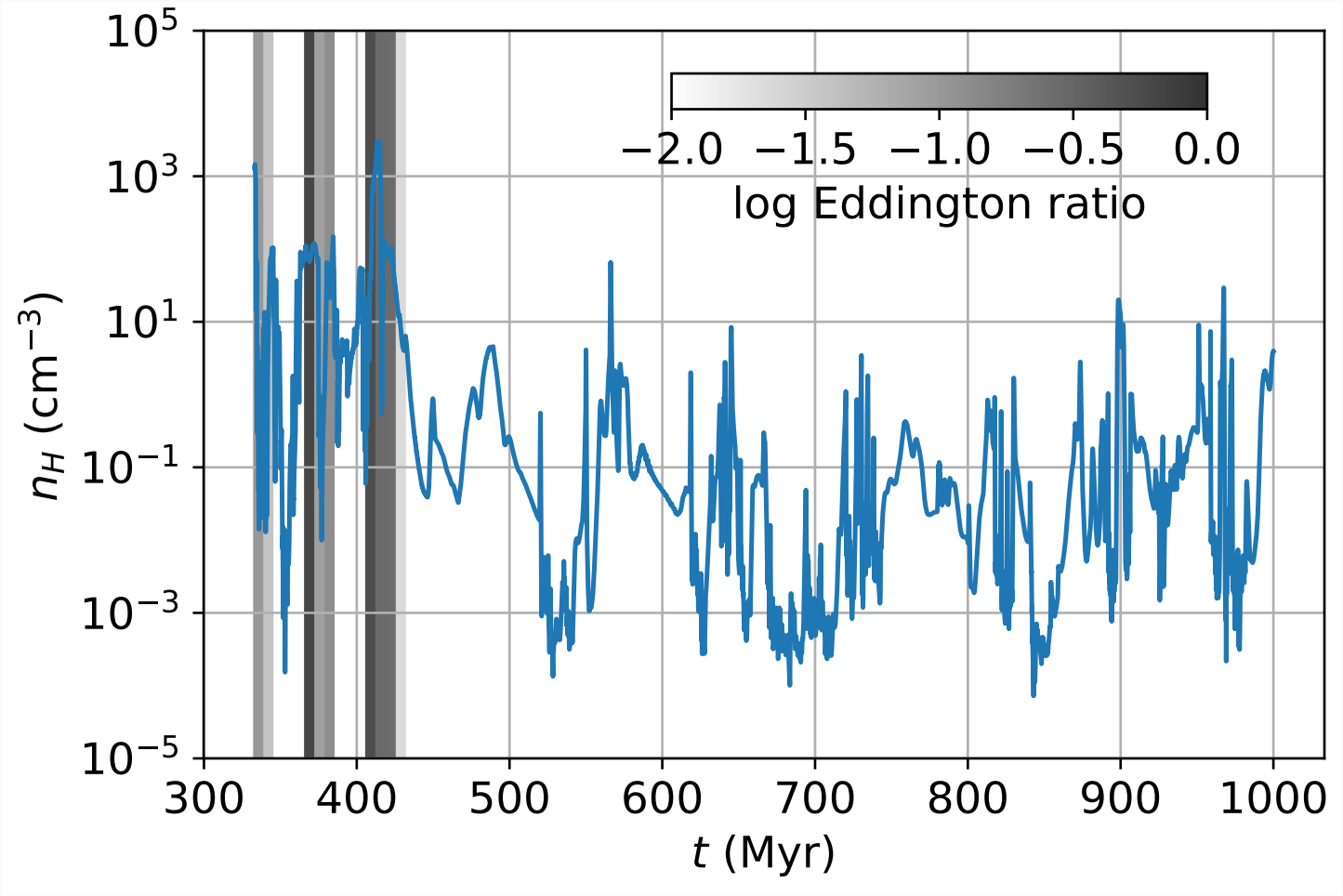
Grey background $\propto$ BH accretion rate



- Low density (1 cm^{-3}) on average
- Very few high accretion episodes

Turning off AGN feedback

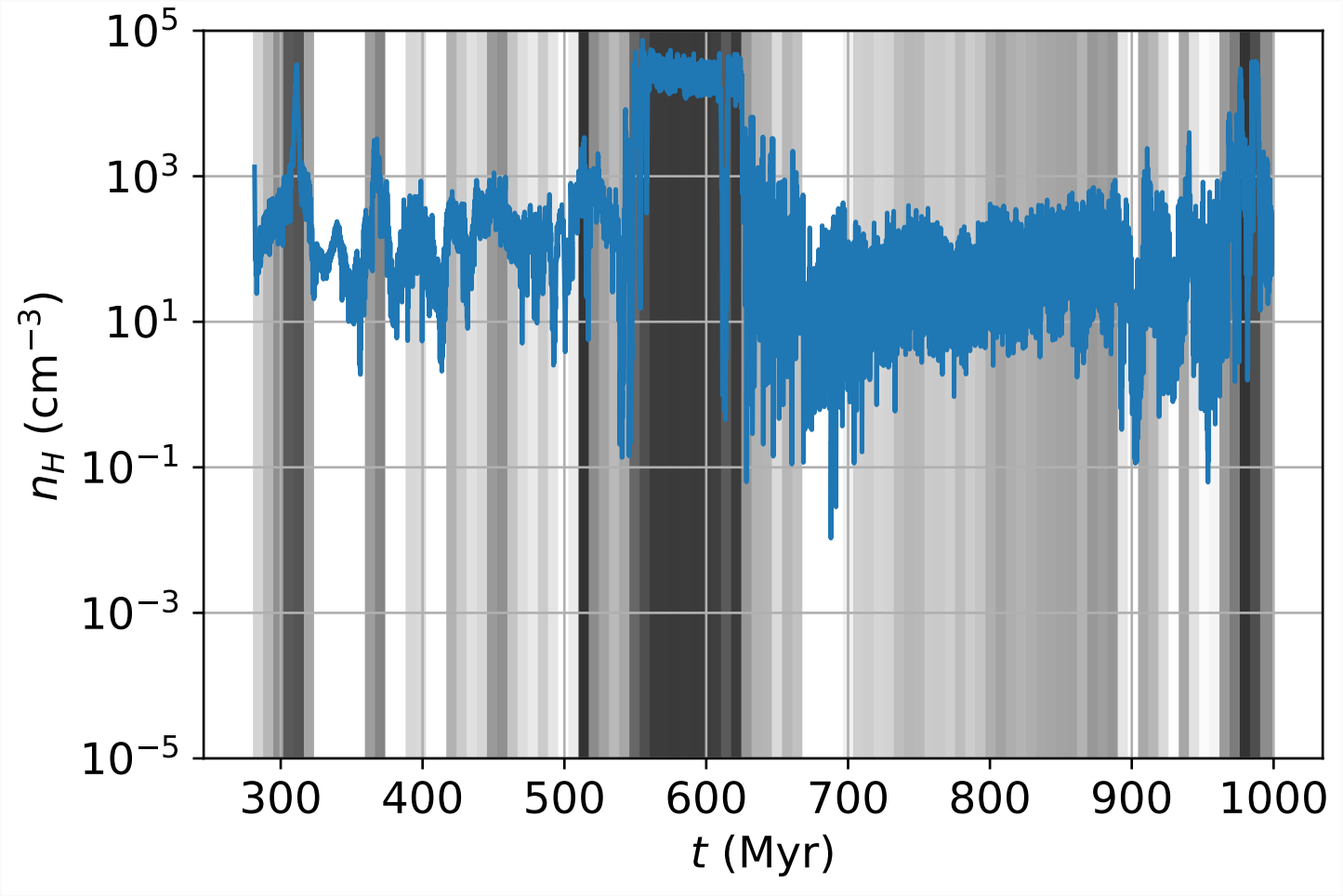
Grey background $\propto$ BH accretion rate



- Low density (1 cm^{-3}) on average
- Few high accretion episodes, for $\sim$ 5 – 10 Myr

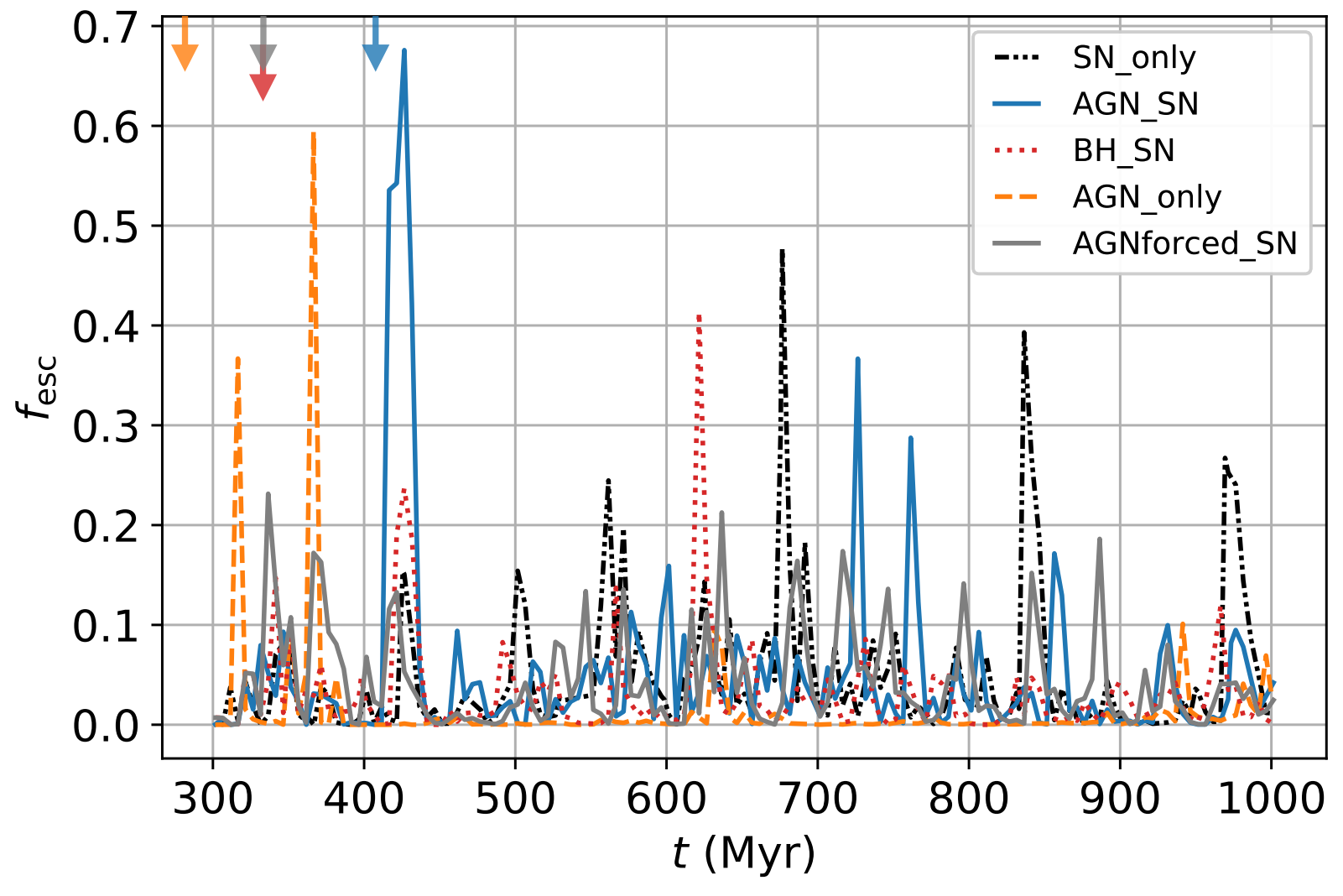
Turning off SN feedback

Grey background $\propto$ BH accretion rate



- Higher density (100 cm^{-3}) on average
- Much higher accretion rate

Not really: bursty behaviour dominated by SN feedback



Enhancement in f_{esc}?

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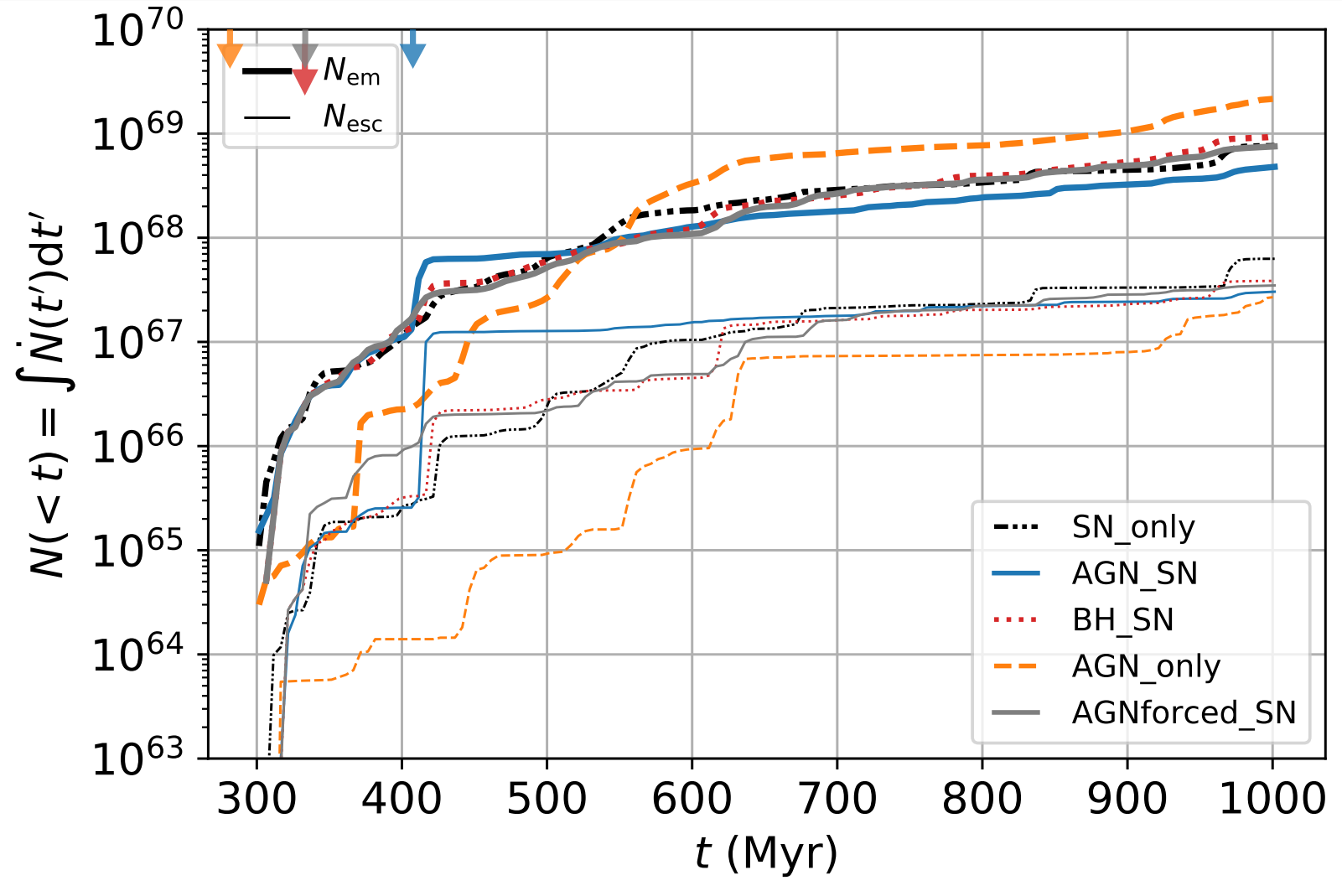
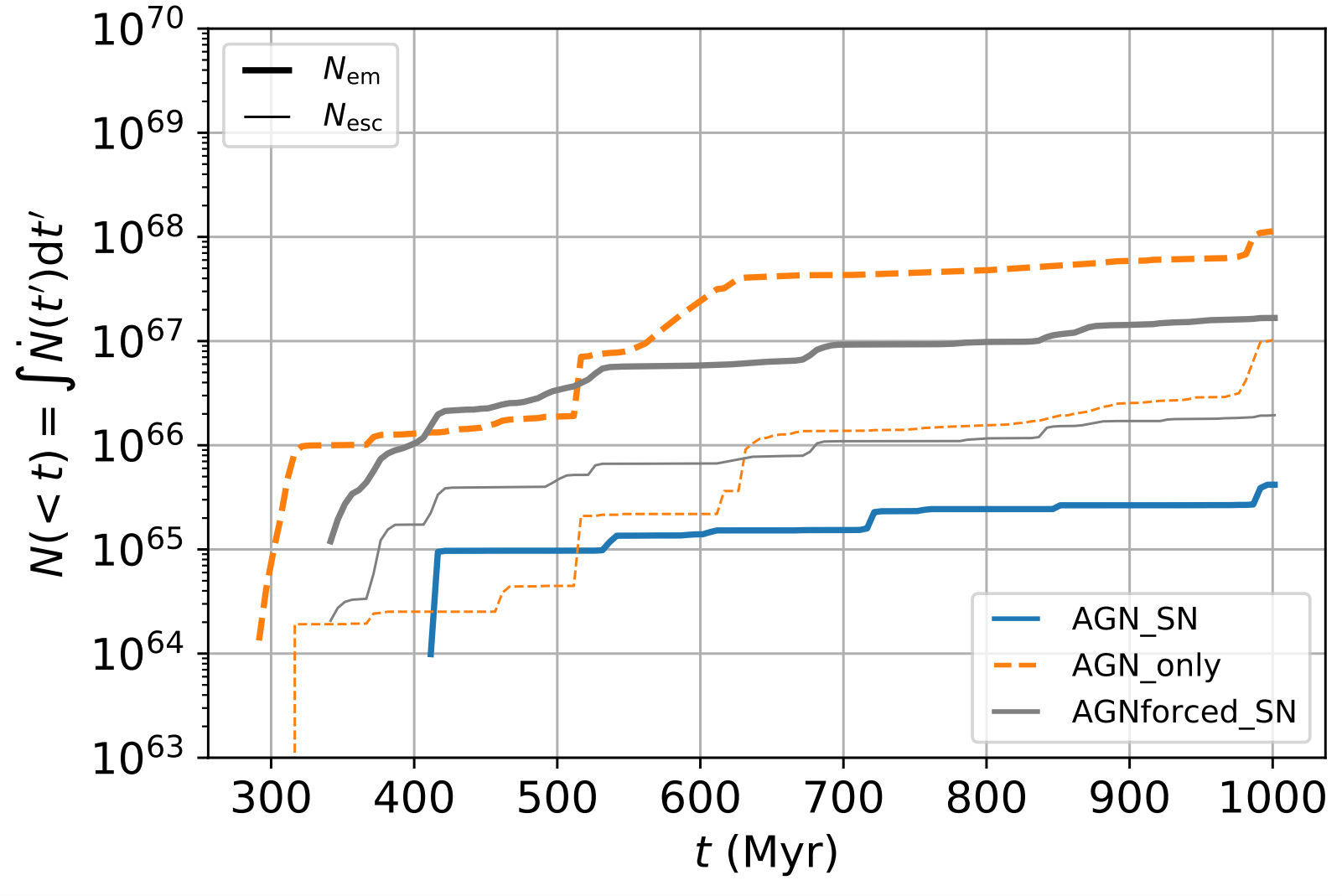
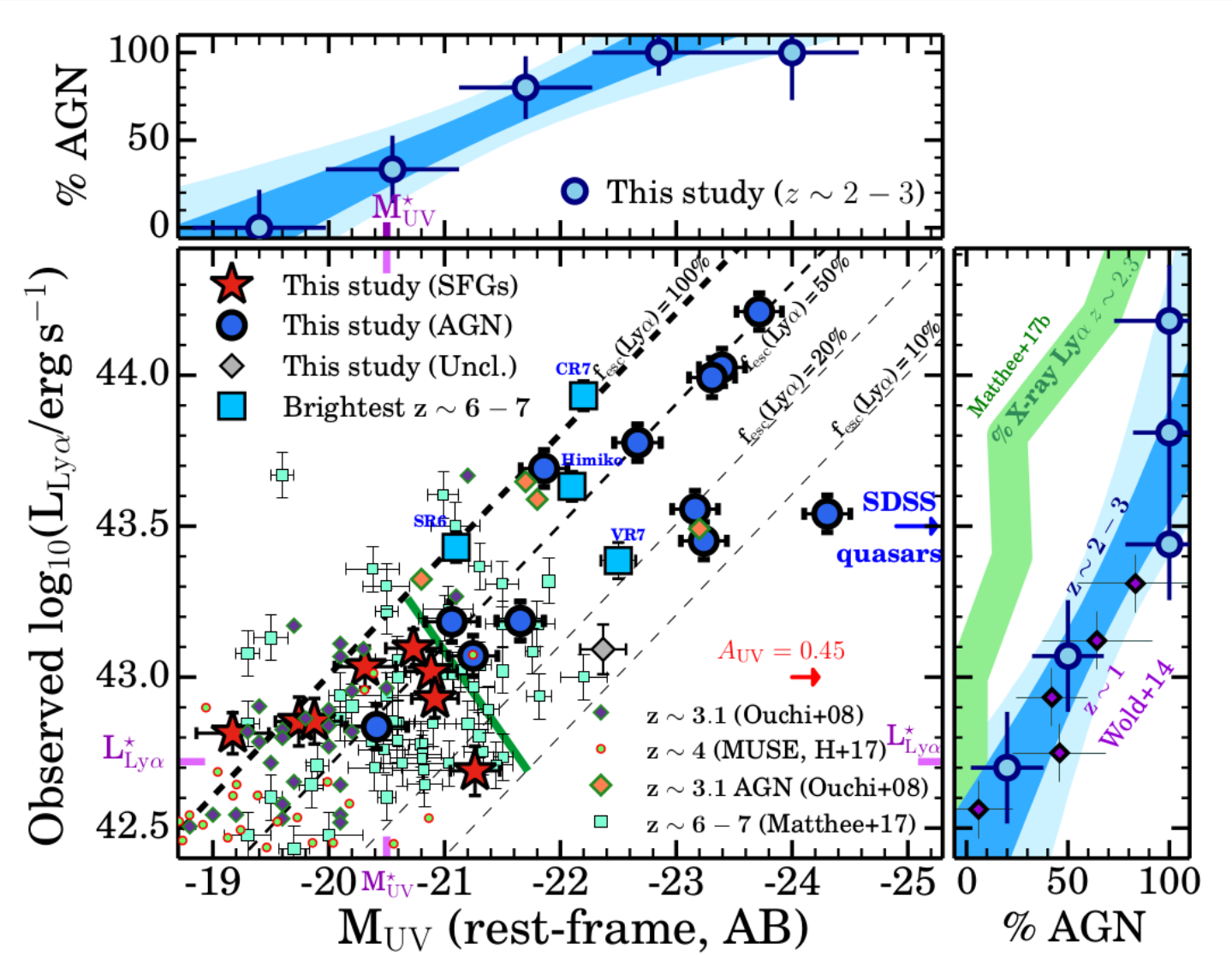


Largely subdominant, even in extreme cases



In progress: galaxy-AGN connection in the LAE/LBG regime

Fraction of AGN in the LAE population



Sobral+2018

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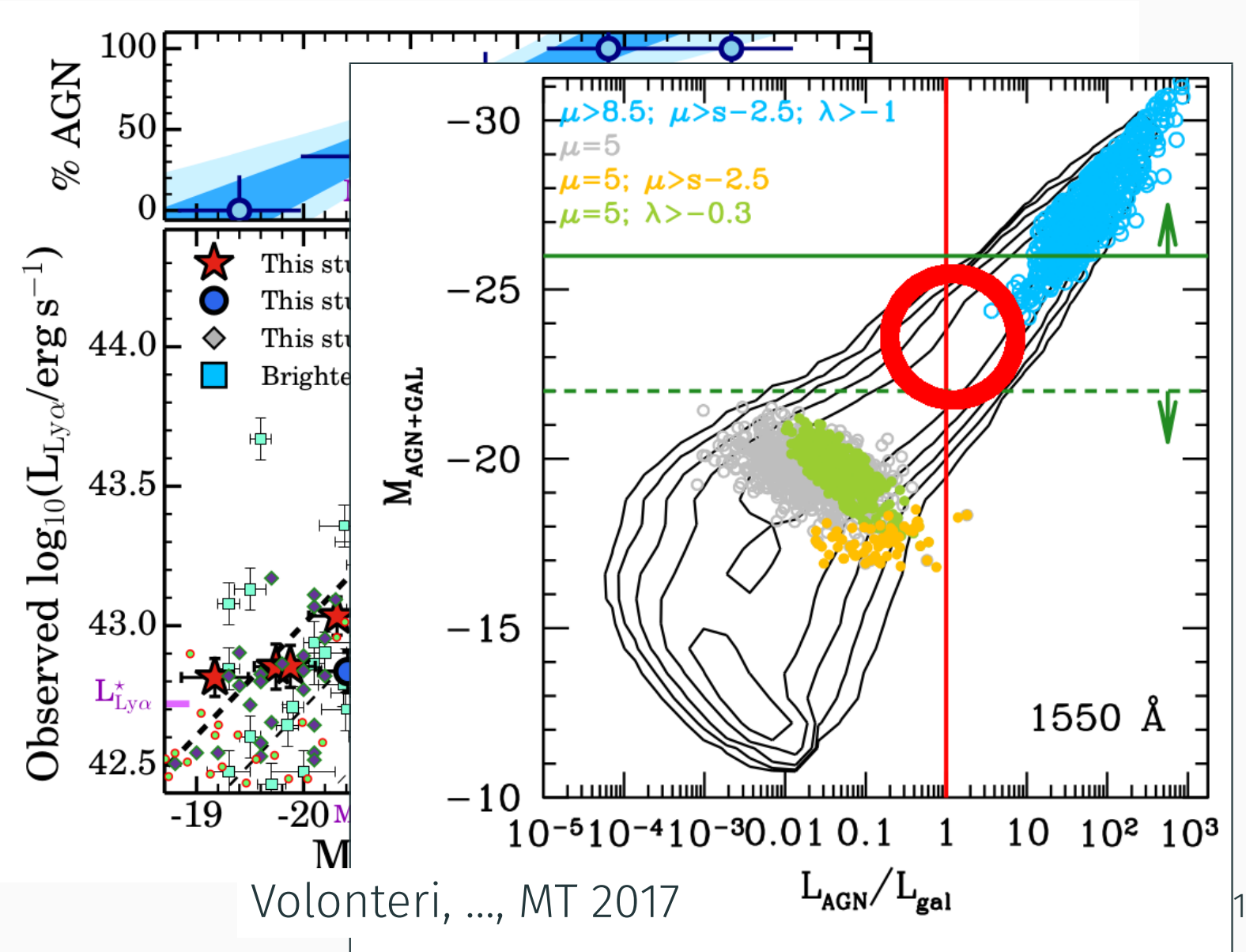
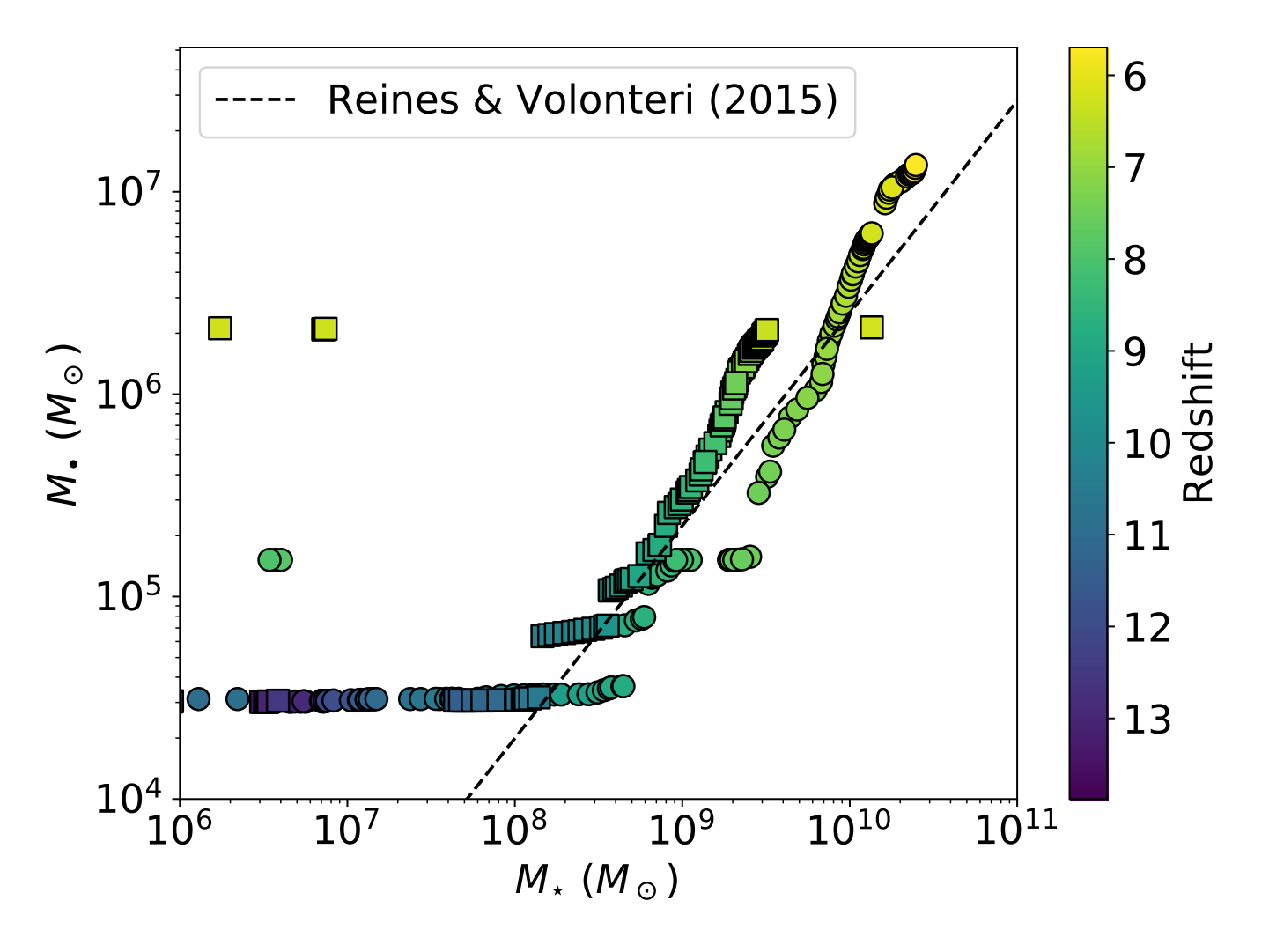


Volonteri, ..., MT 2017

In progress: galaxy-AGN connection in the LAE/LBG regime

BH only grow when the host galaxy is massive enough



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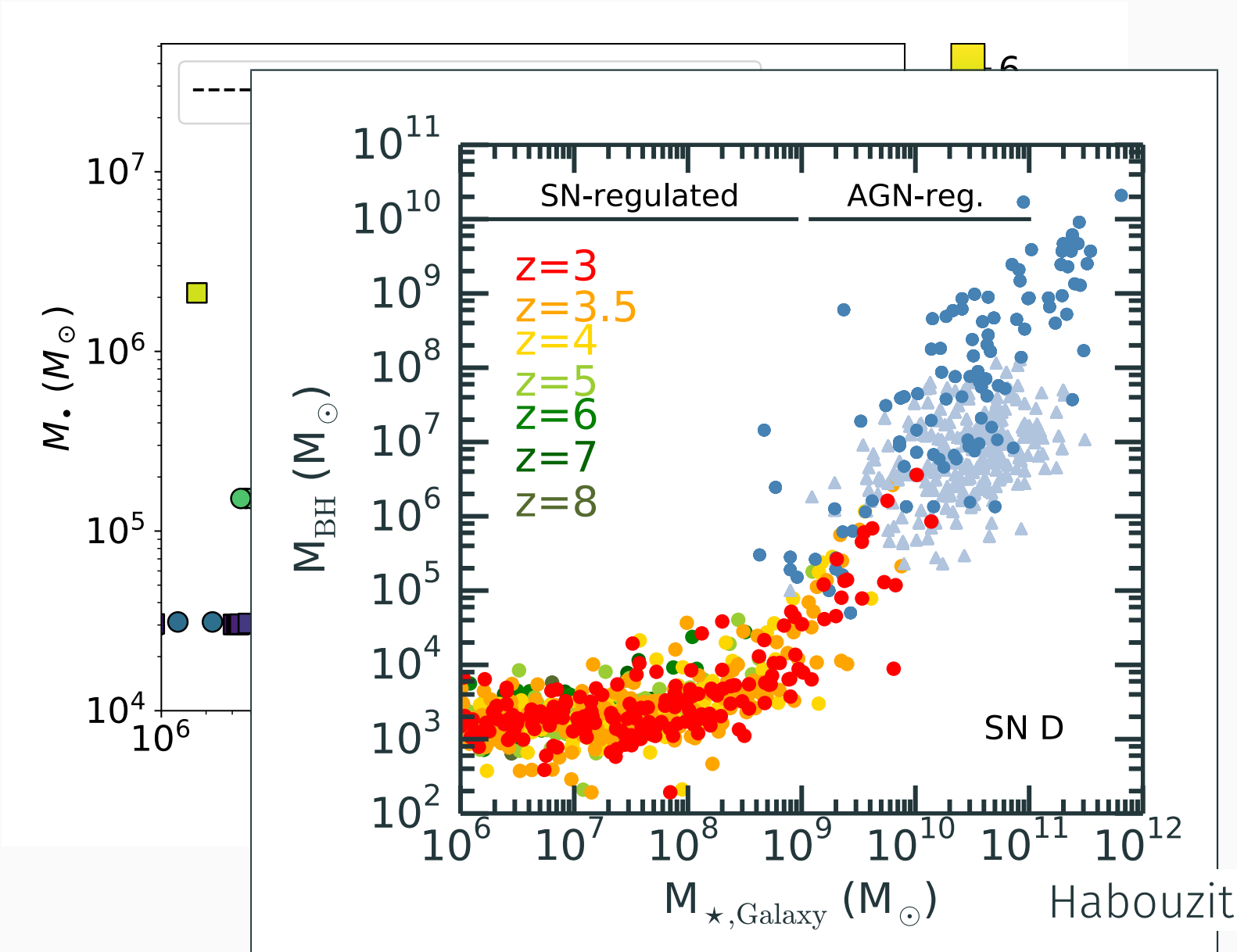

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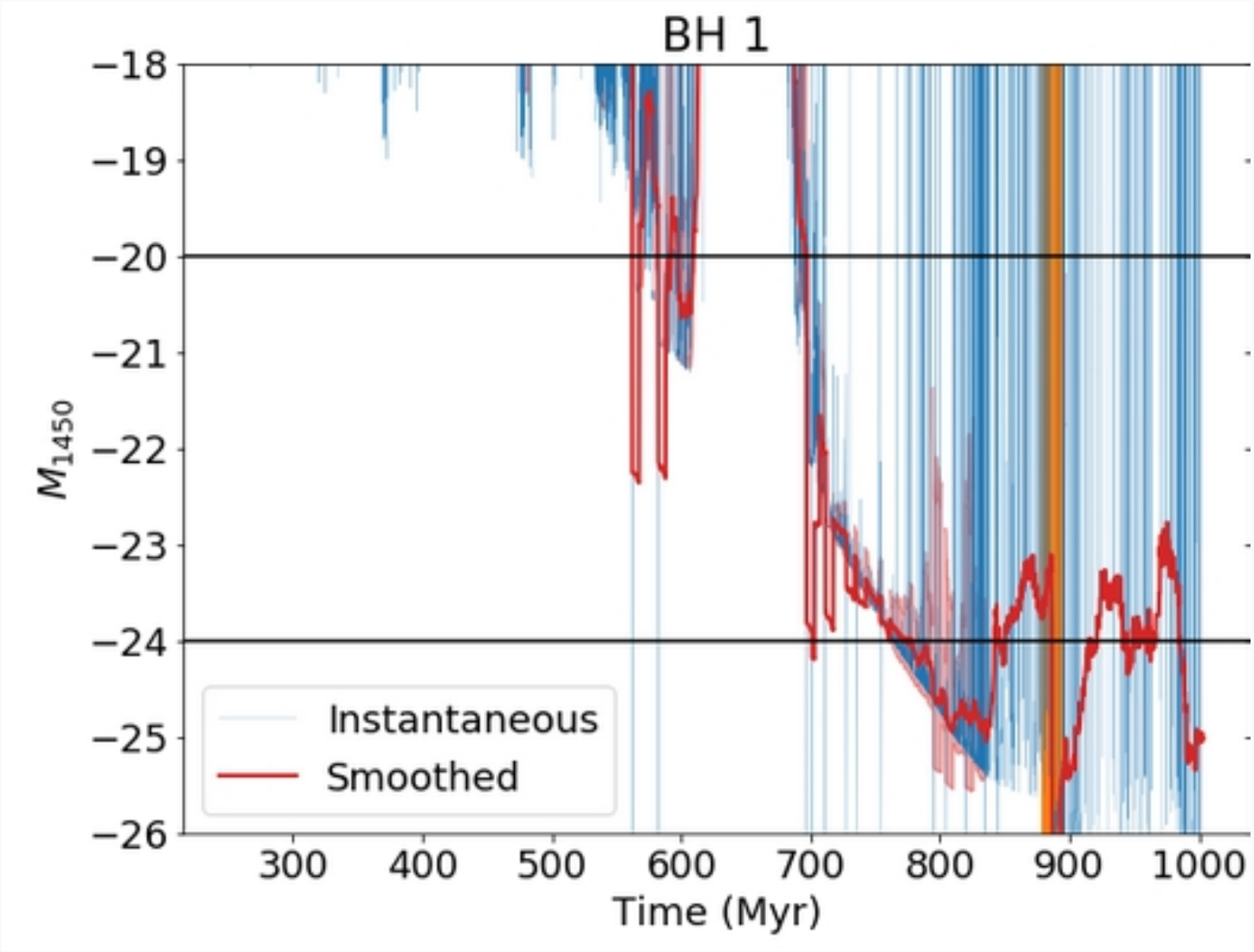

Conclusions

BH in small galaxies

- They don't grow: SN feedback prevents gas feeding
- AGN feedback has a low effect on f_{esc}
- The AGN itself does not contribute much to the reionisation
- ...but stay tuned for exciting new results on (more) massive galaxies

Extra slides

AGN SED

Based on Shakura-Sunyaev disc solution + power-law