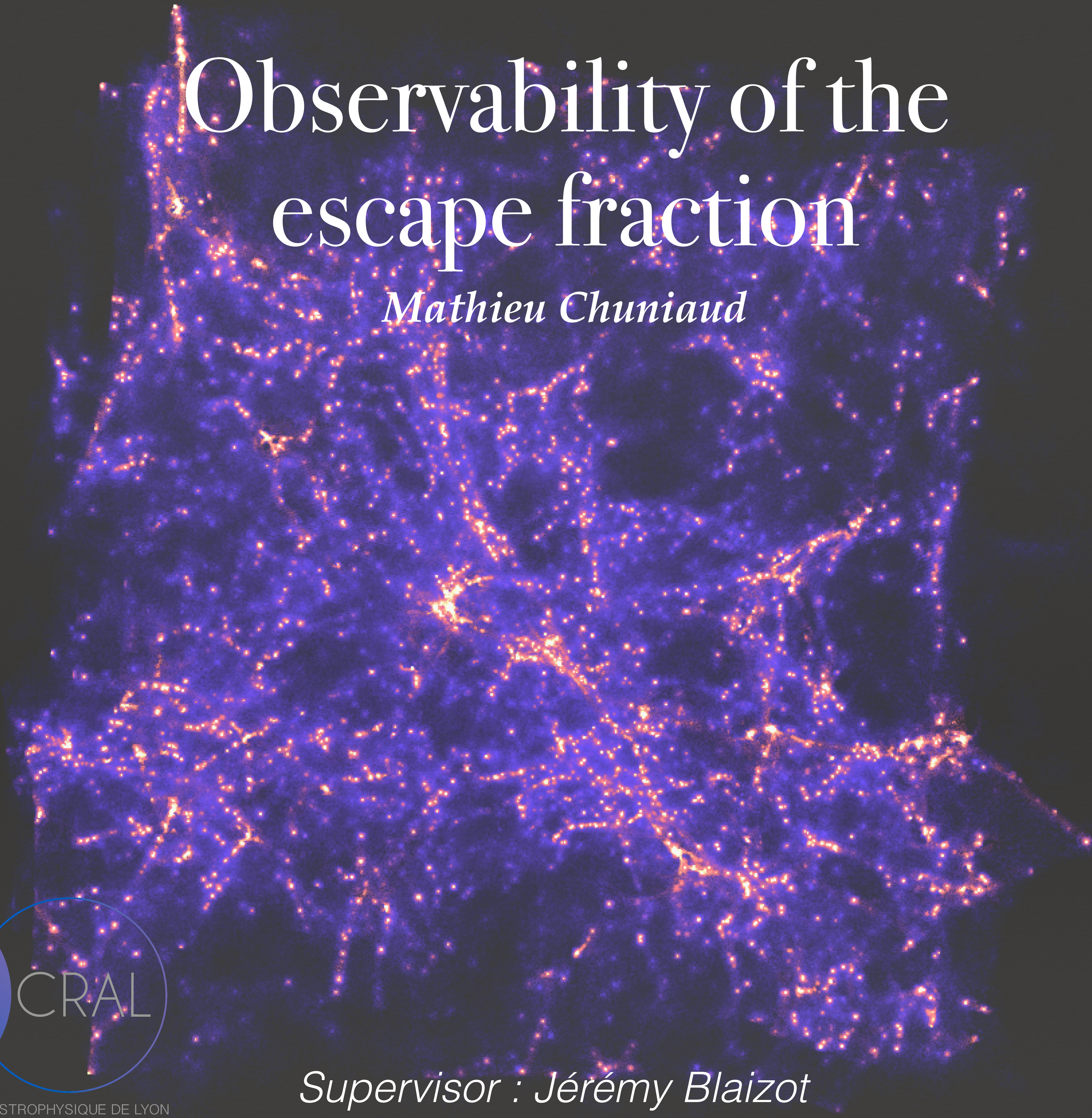

Observability of the escape fraction

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Characterizing the sources (galaxies) of reionization in SPHINX :

- Directionnality ?
- When is the source on ?

→ Intrinsic luminosity of the source

→ Escape fraction

→ Duty cycle

Ending with a **model** for the sources of reionization :

- for **bigger simulations** (where galaxies are not resolved)
- to understand the **process** of reionization

In this talk

Spatial evolution of the escape fraction

- **Directionnality ?**

- When is the source on ?

Intrinsic luminosity of the source

Escape fraction

Duty cycle

Time evolution of the escape fraction

In this talk

Spatial evolution of the escape fraction

- **Directionnality ?**
- When is the source on ?

Intrinsic luminosity of the source

Escape fraction

Duty cycle

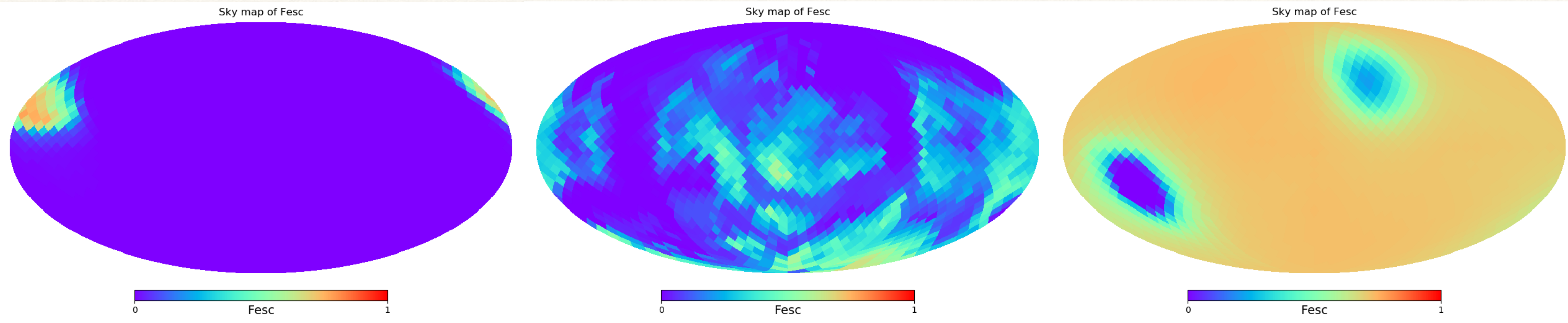
Time evolution of the escape fraction

$z = 6$

Anisotropy of the escape fraction :

Illustration of different F_{90} at z = 6

F_{90} : normalized solid angle through which 90% of the escaping photons escape

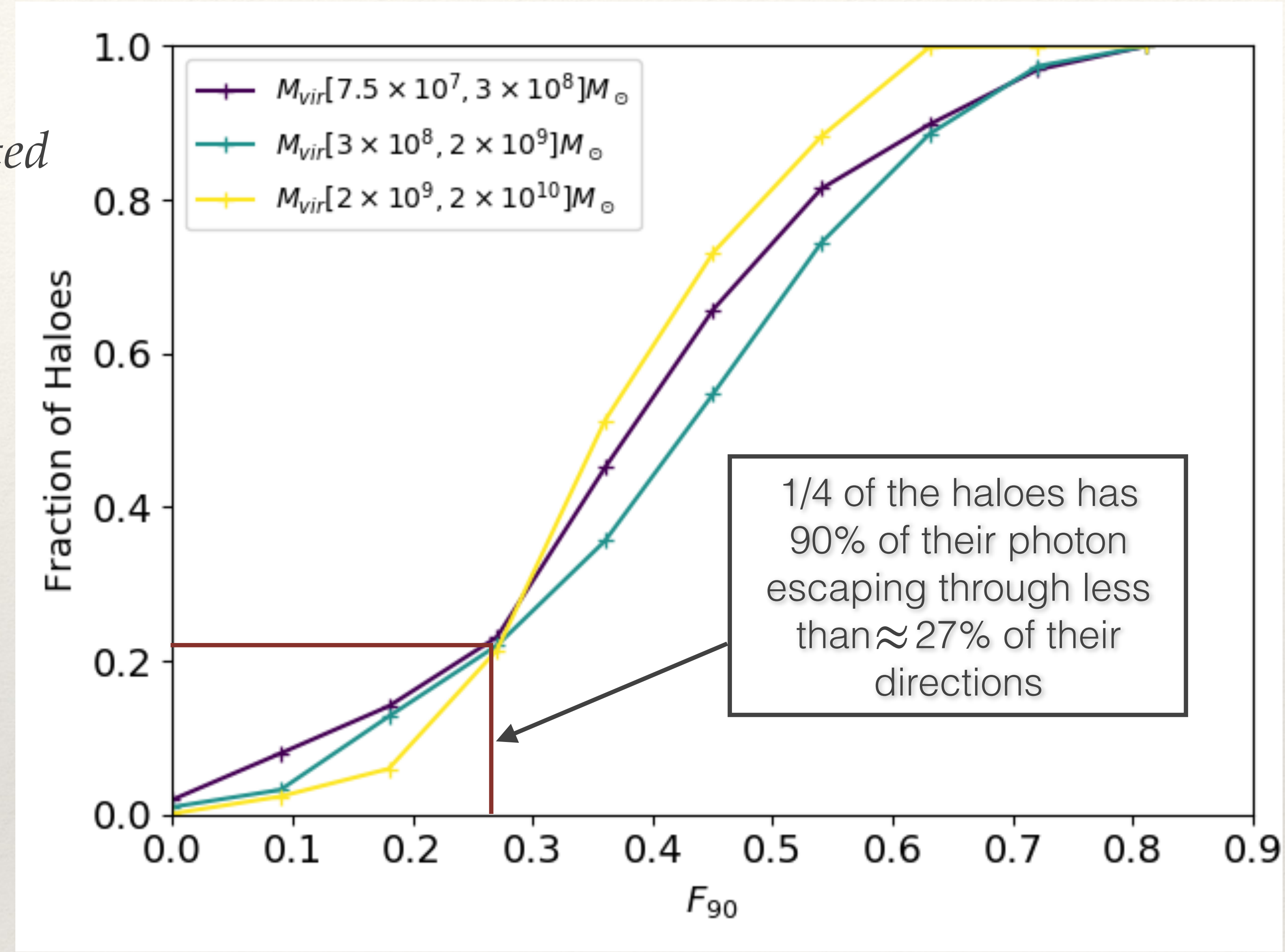


$F_{90} = 4.3\ \%$ $\quad$ $F_{90} = 52\ \%$ $\quad$ $F_{90} = 84\ \%$

- Illustration that the photons escape in an anisotropic way

Measure it as a function of the gas fraction

Luminosity weighted



- The photons escape in an anisotropic way
- The most massive haloes, more resistant to feedback, have a lower solid angle through which photons escape

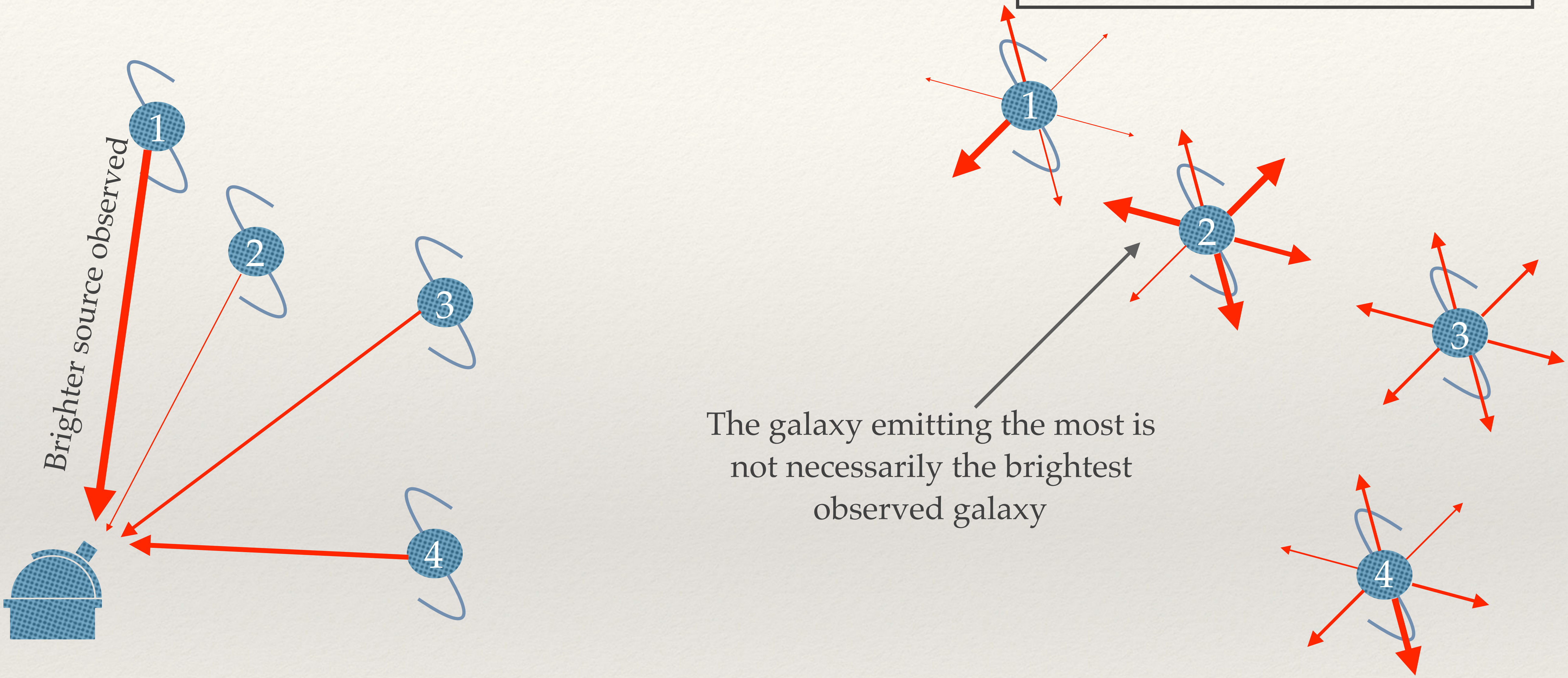
Observability of the escape fraction :

$F_{esc,obs} = F_{esc,1D}$

Galaxies are observed only through one direction

$F_{esc} = F_{esc,3D}$

Photons escape through many directions in a anisotropic way



There is a difference between the observed escape fraction and the actual 3D escape fraction of a galaxy taking into account all the directions.

Between my 47 meetings of the week I finally found time to make a plot

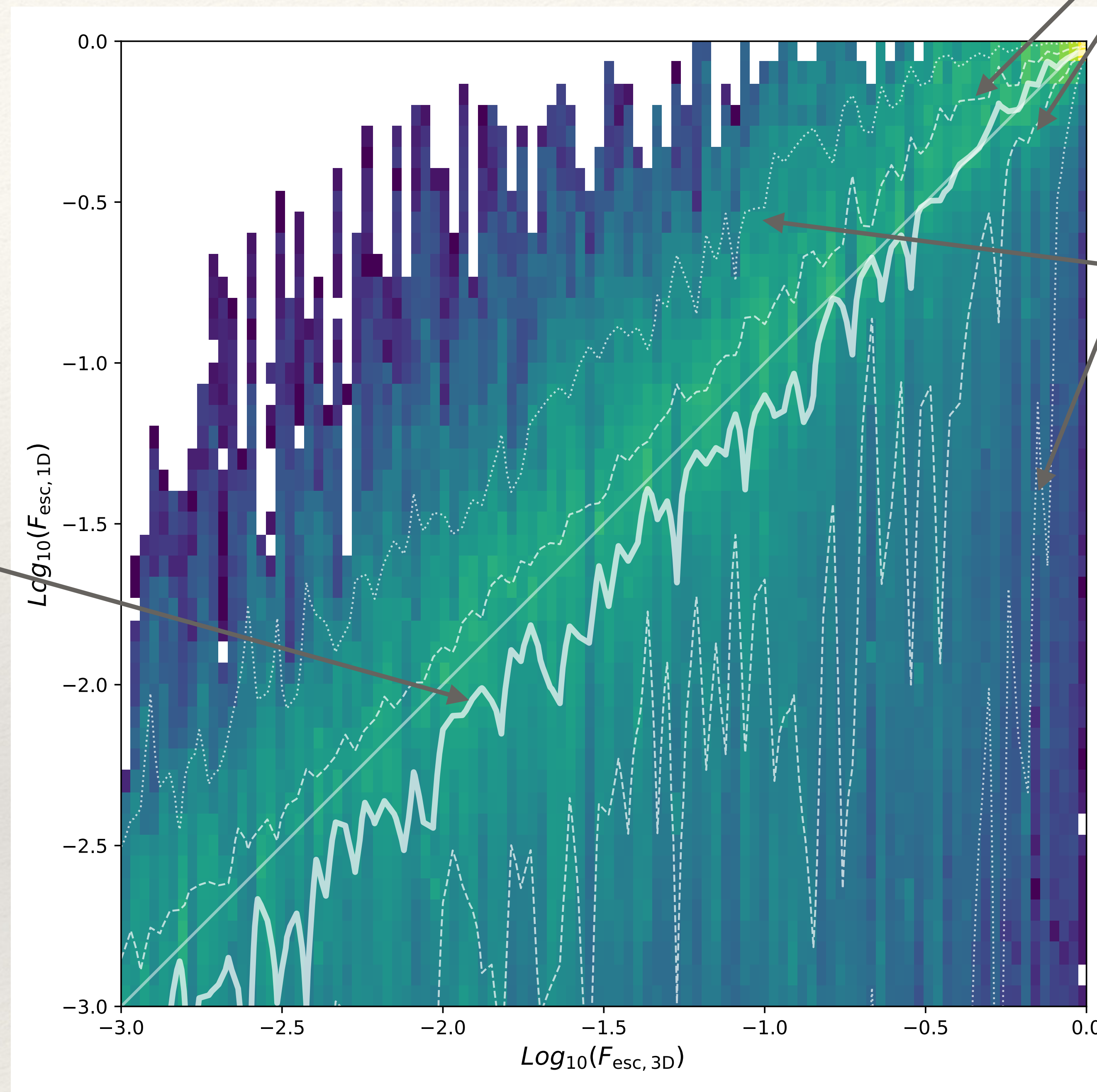
Credit to Jérémy

Variation of F_{esc} with the directions

25 and 75th percentiles

5 and 95th percentiles

The median

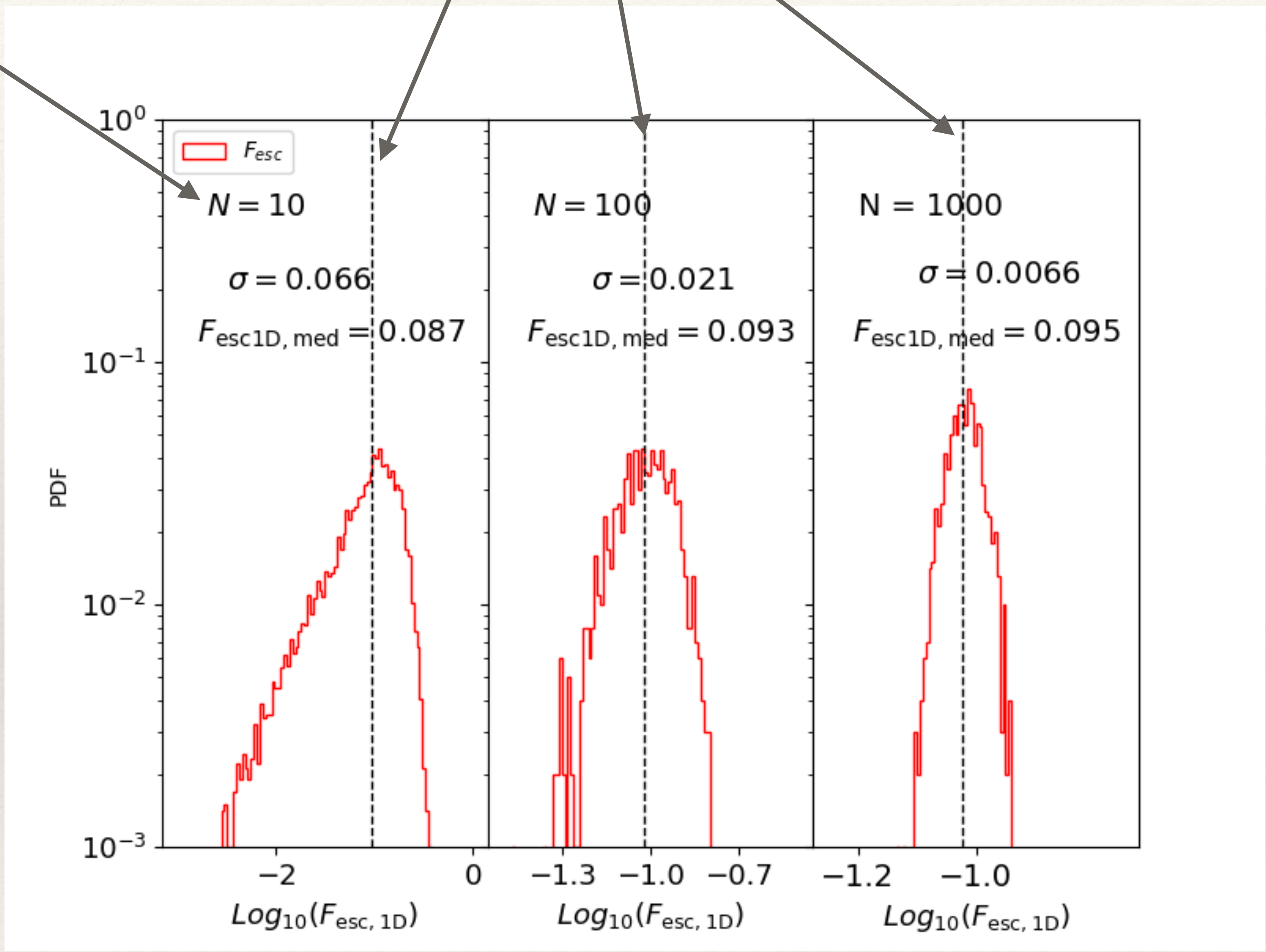


- The median escape fraction is close but under the average value within a halo
- There is more directions with very low escape fraction than with very high escape fraction

Among the most massive haloes $M_{vir} > 10^9 M_\odot$:
If I do N mock observations how precisely can I estimate the 3D escape fraction ?

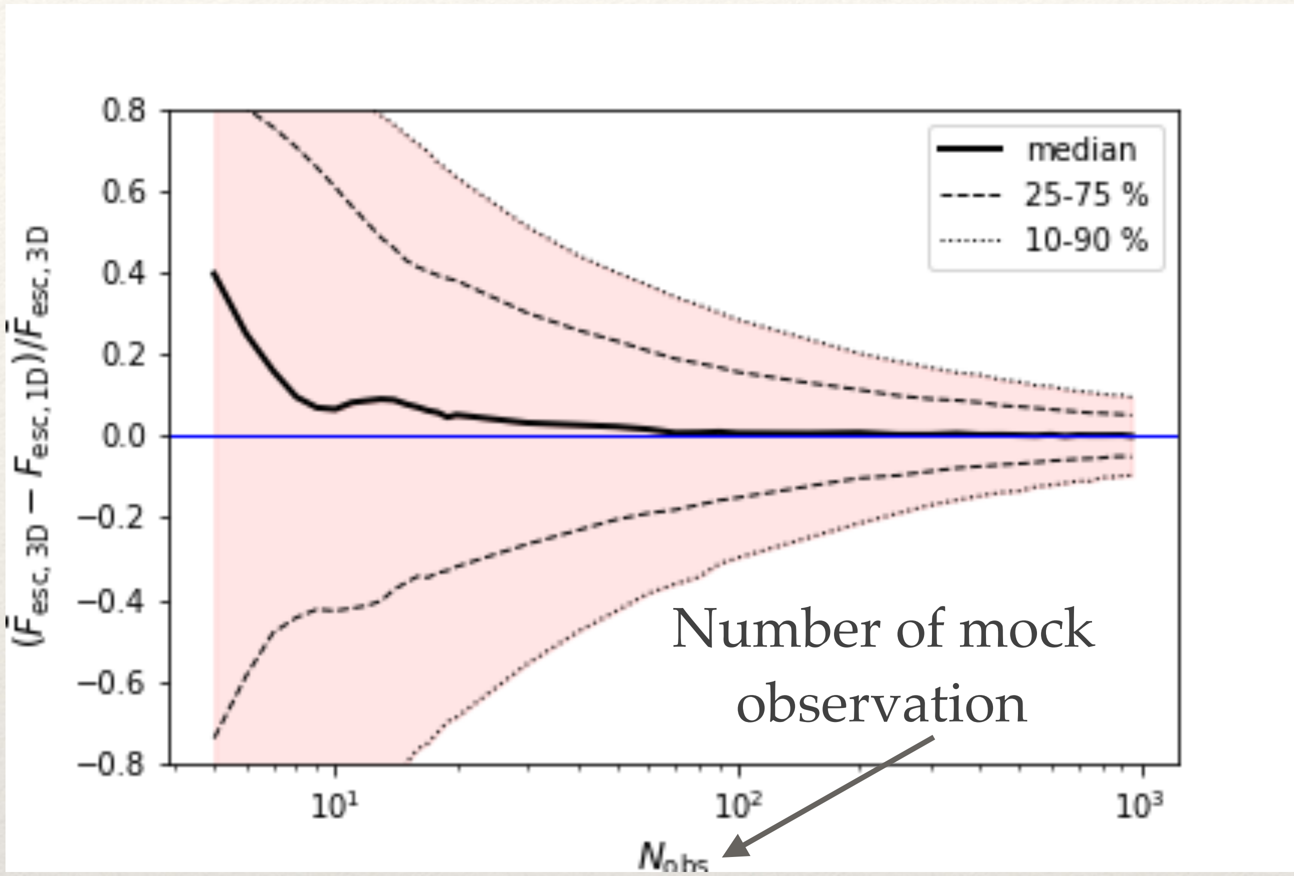
$< F_{esc,3D} > = 0.095$ (averaged haloes with $M_{vir} > 10^9 M_\odot$)

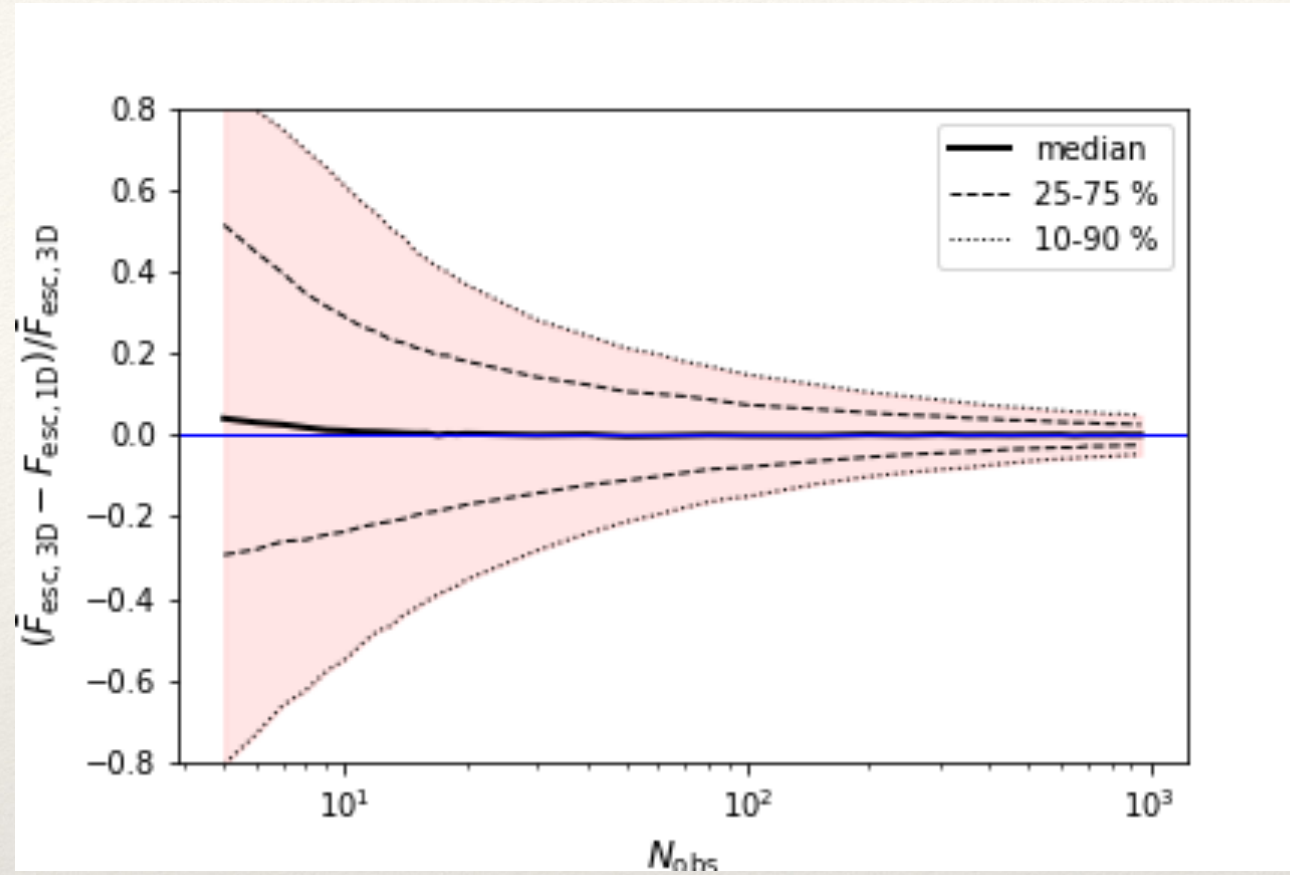
Number of mock observation



The PDF always peaks close to the expected value $< F_{esc,3D} > = 0.095$:
there is no bias the 3D escape fraction can be deduced from observations

Estimation of the measure precision : relative error in the estimation of $F_{esc,3D}$





$F_{esc,3D}$ is averaged over **all haloes** with $M_{vir} > 10^9 M_{\odot}$

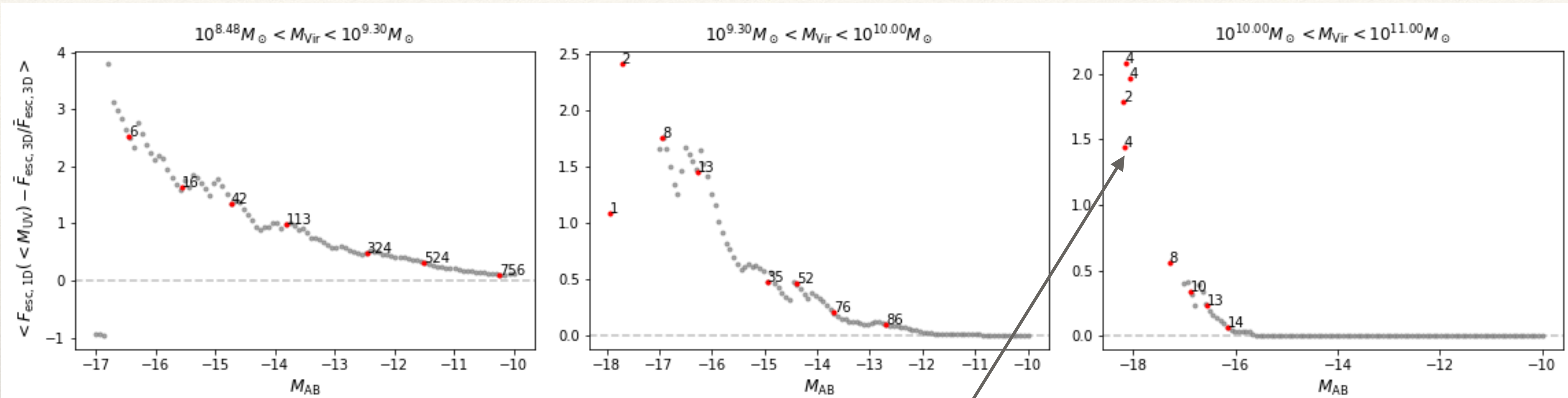
$F_{esc,3D}$ is averaged only over the **targeted haloes**

- What dominates the imprecision is the important dispersion for a low number of observations
- Similar to Cen & Kimm 2015 we find that at least tens of observations are required for a precise estimation

Observability of the escape fraction : U.V. selection of the haloes

If haloes are U.V. selected does it change the precision in the estimation of $F_{esc,3D}$ by $F_{esc,1D}$?

Z = 6



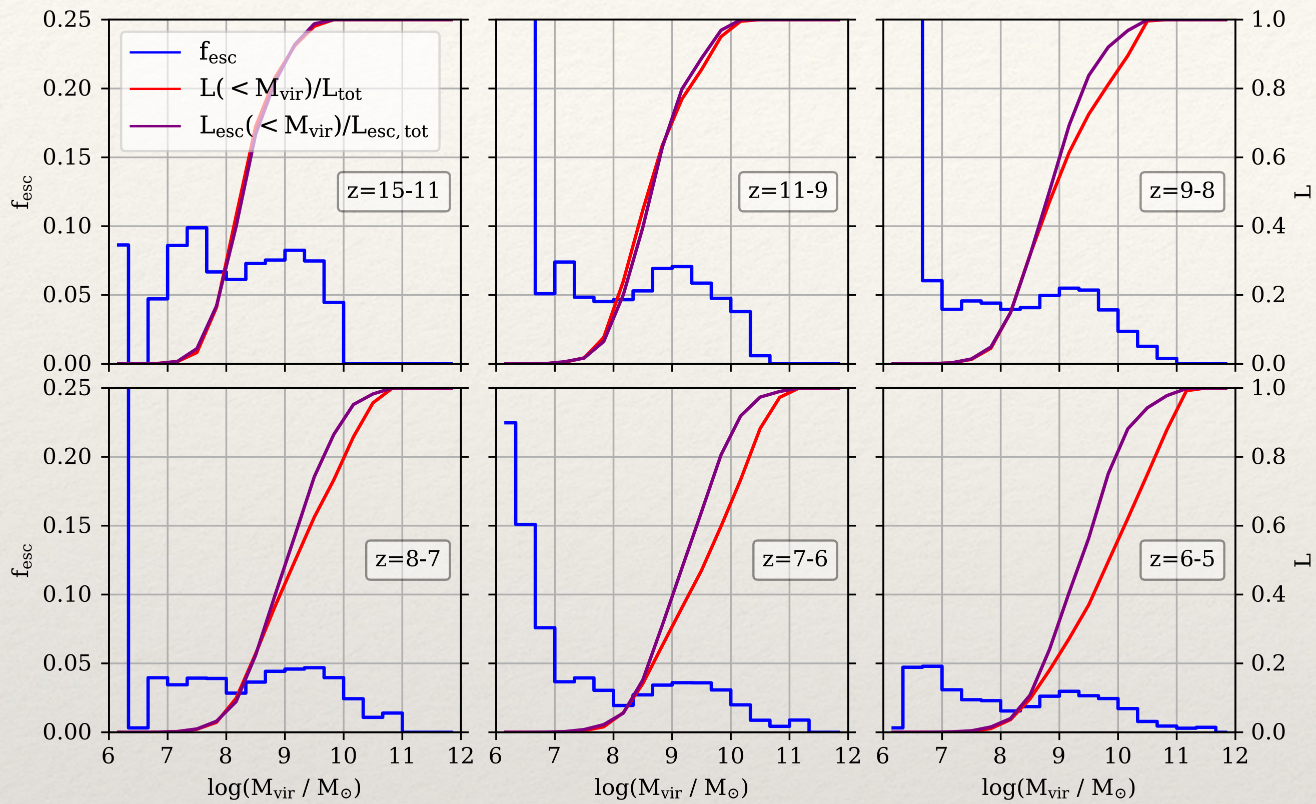
Number of observations brighter than the magnitude threshold

When haloes are U.V. selected there is a tendency to overestimate the escape fraction of about a factor 2, no matter the mass range

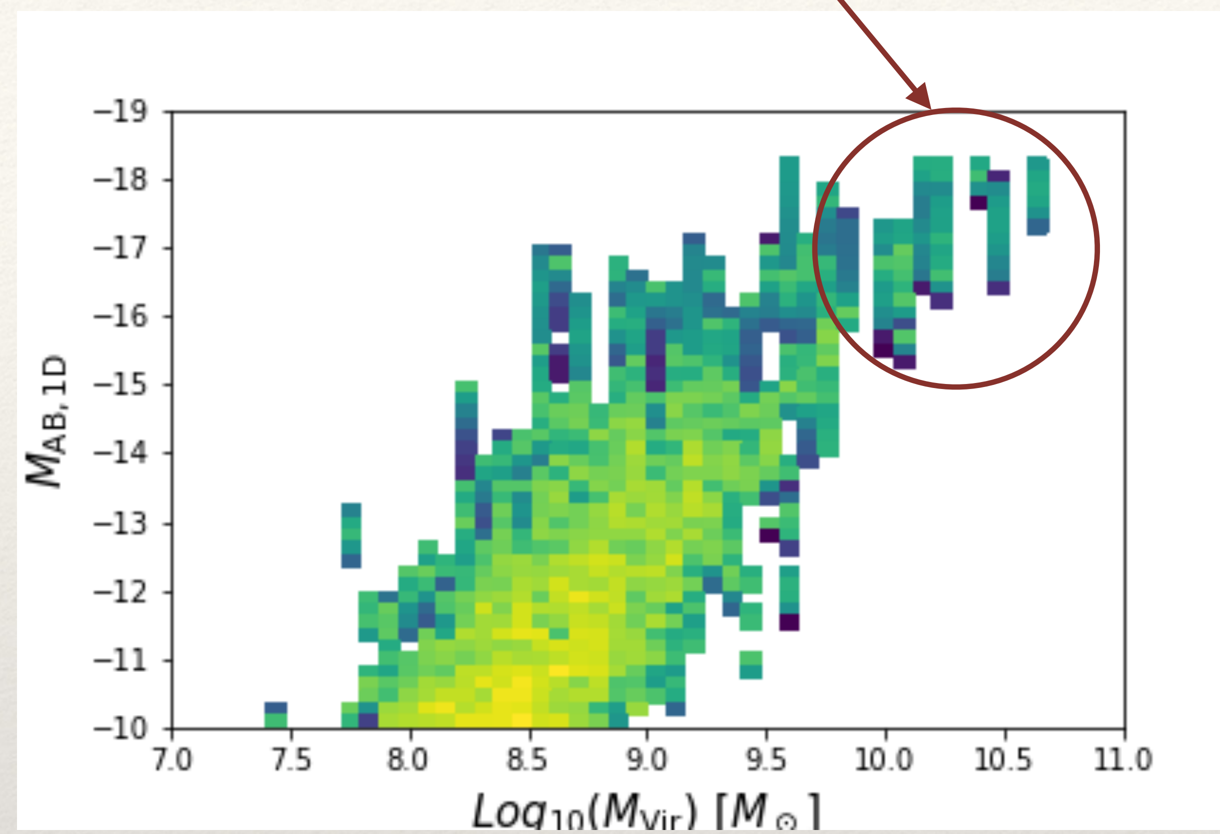
I can reionize the
Universe on demand.
Ask me at
joki@sphinx.com

Credit to Joki

Consequences :



Bright haloes : the most massive ones



Mass range that produces 90% of the escaping photons at z = 6 in SPHINX20

Observing haloes responsible for reionization without bias is for now completely impossible

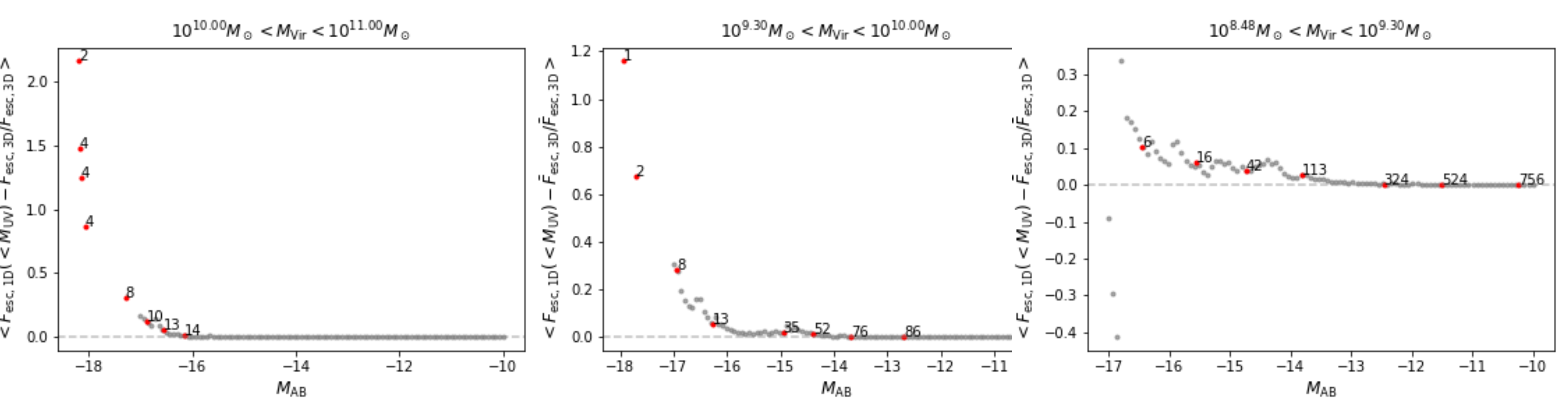
Conclusion

- Anistropy of the escape fraction
- Estimation of $F_{esc,3D}$ possible but at least tens of observation are required for a precise estimation
- When haloes are U.V. selected tendency to overestimate the escape fraction : may this explain discrepancy between simulations and observations about F_{esc} ? (*Faucher-Giguère (2020)*)
- Need to improve our dataset at high mass (above $10^{10}M_{\odot}$)

Prospects :

- Using Sphinx 20 (20cMpc a side) to increase the mass range of study.

Bonus :



$10^{10.00}M_\odot < M_{\rm Vir} < 10^{11.00}M_\odot$
$10^{9.30}M_\odot < M_{\rm Vir} < 10^{10.00}M_\odot$
$10^{8.48}M_\odot < M_{\rm Vir} < 10^{9.30}M_\odot$
$< F_{\rm esc,\,1D}(< M_{\rm UV}) - \bar{F}_{\rm esc,\,3D}/\bar{F}_{\rm esc,\,3D} >$
$M_{\rm AB}$
2
4
4
4
8
10
13
14
1
2
8
13
35
52
76
86
6
16
42
113
324
524
756