

The background of the slide is a Cosmic Microwave Background (CMB) fluctuation map, showing a complex pattern of temperature variations in shades of blue, orange, and yellow. A large black rounded rectangle is centered on the slide, containing the main title in white text. Below the title, a light blue rounded rectangle contains the names of the presenters and their affiliations.

Exploring reionization histories with radiative transfer simulation

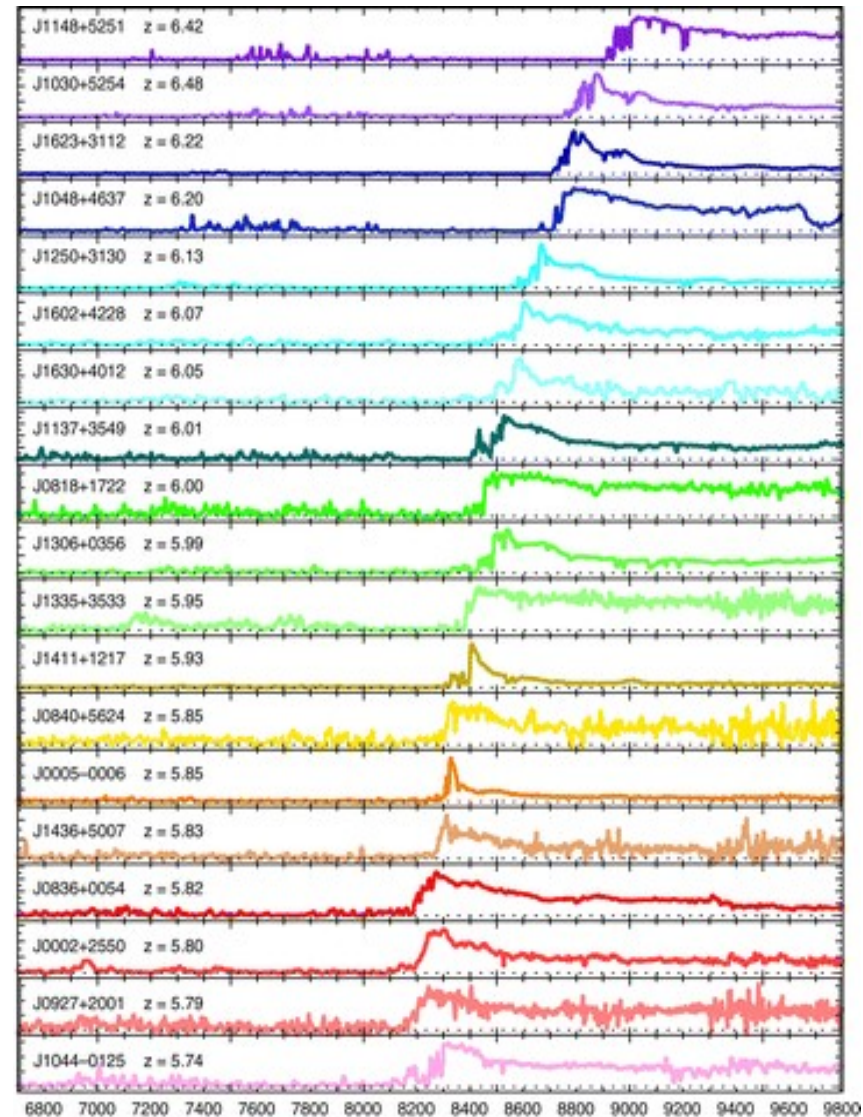
Shikhar Asthana
University of Cambridge
Martin Haehnelt

Girish Kulkarni, Vid Irsic, Laura Keating, Prakash Gaikwad
James Bolton, Ewald Puchwein, Margherita Molaro
Marseille: 3rd July, 2023

Lyman- α disappears at high Z

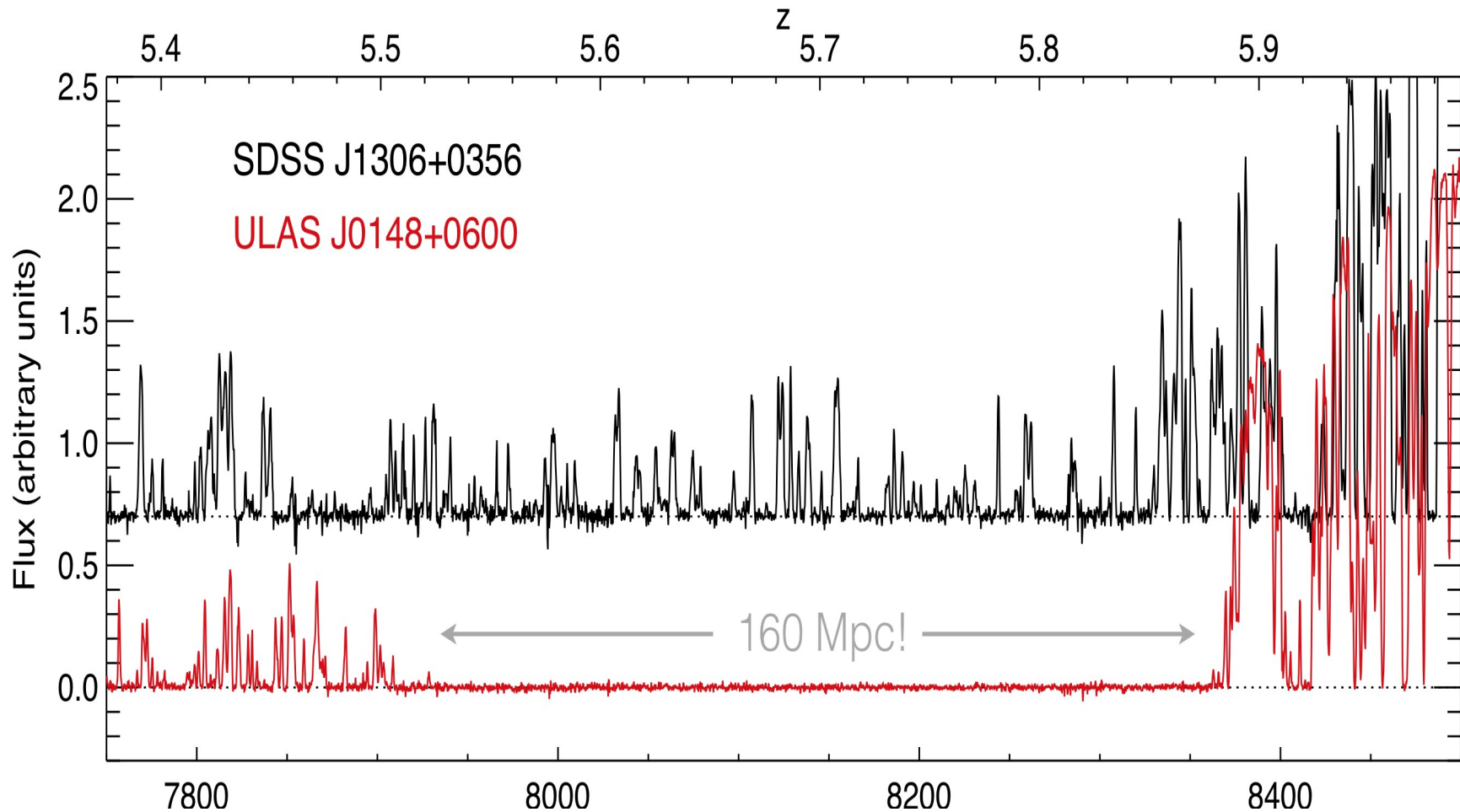
At $z \sim 6$, Ly α is almost completely absorbed.

Few quasars at $z > 7$.



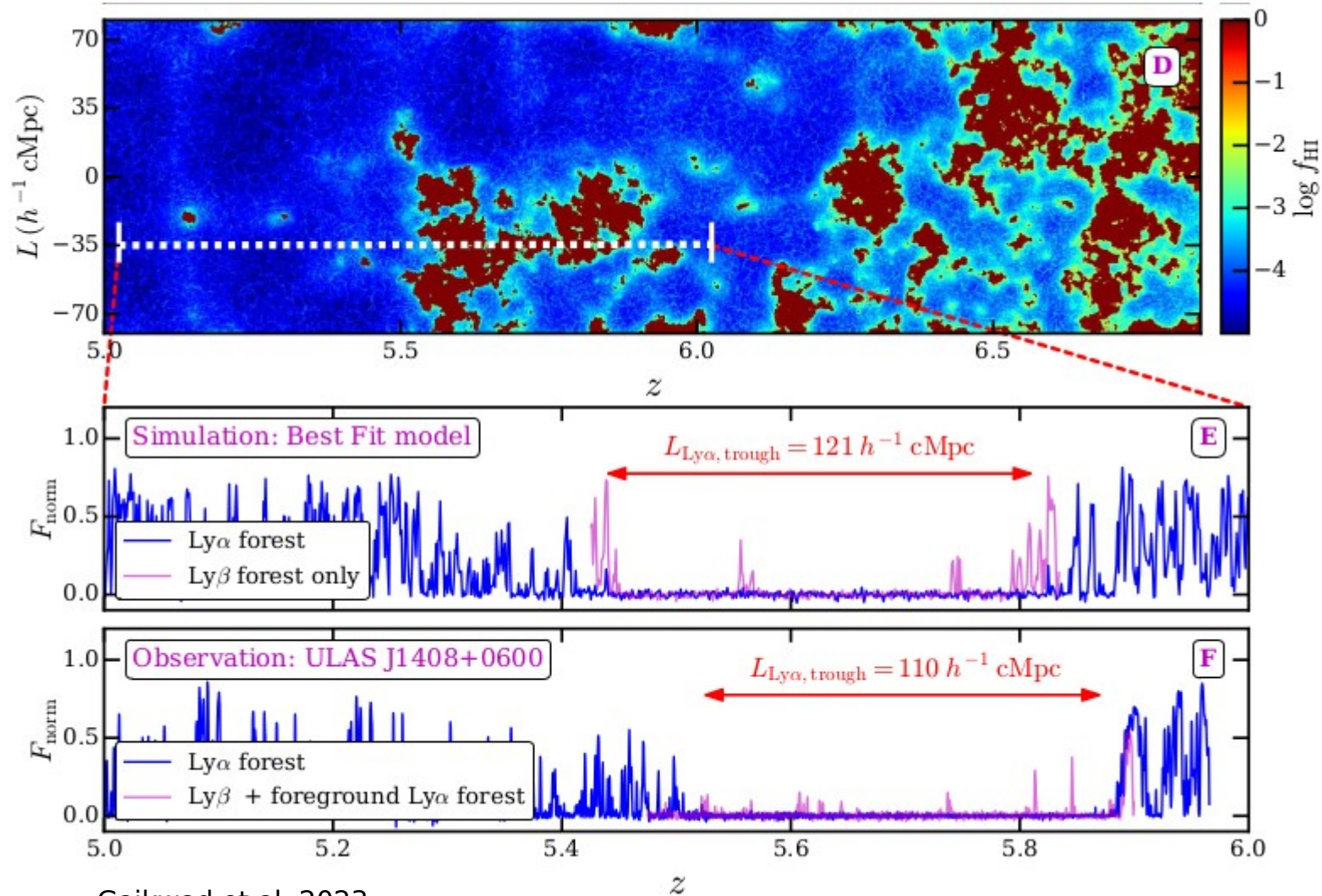
Fan et al. 2006

Large opacity fluctuations



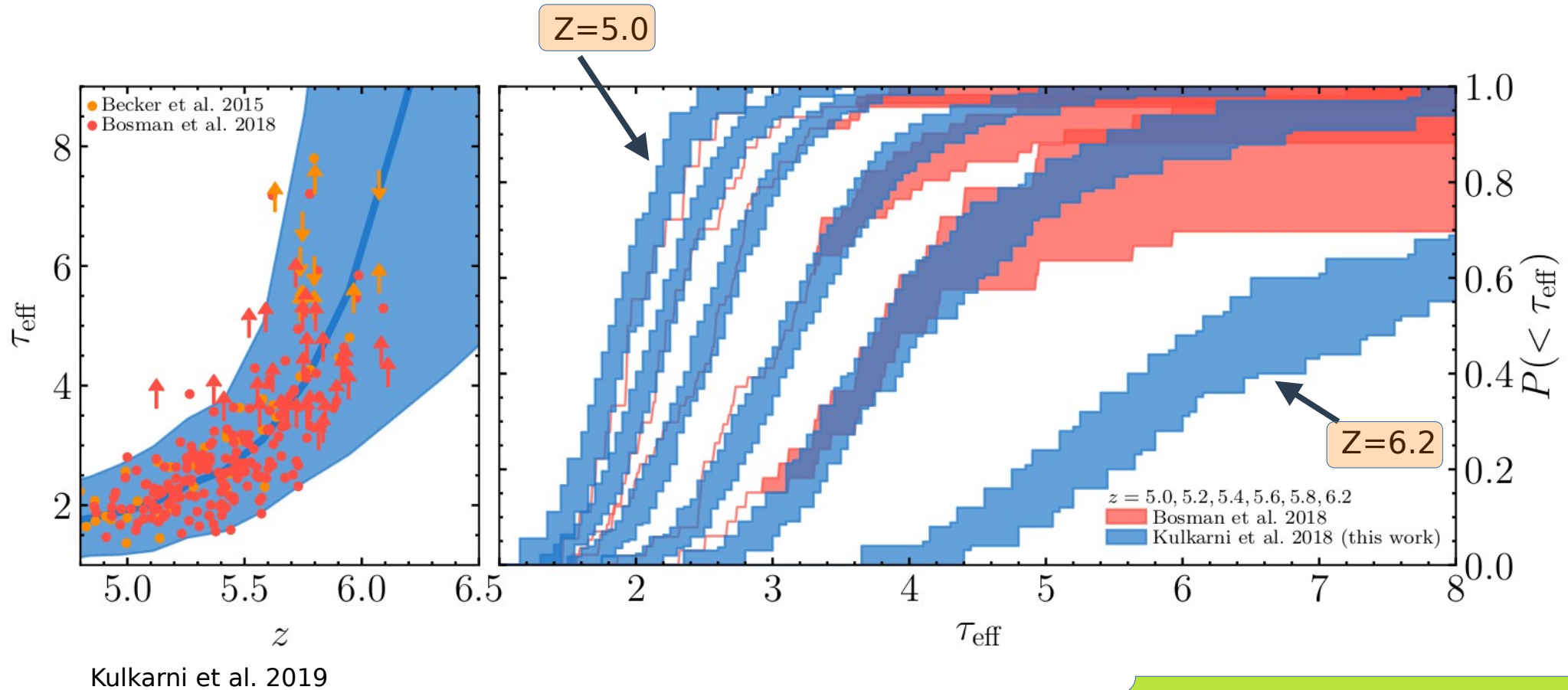
Becker et al. 2015

Large opacity fluctuations



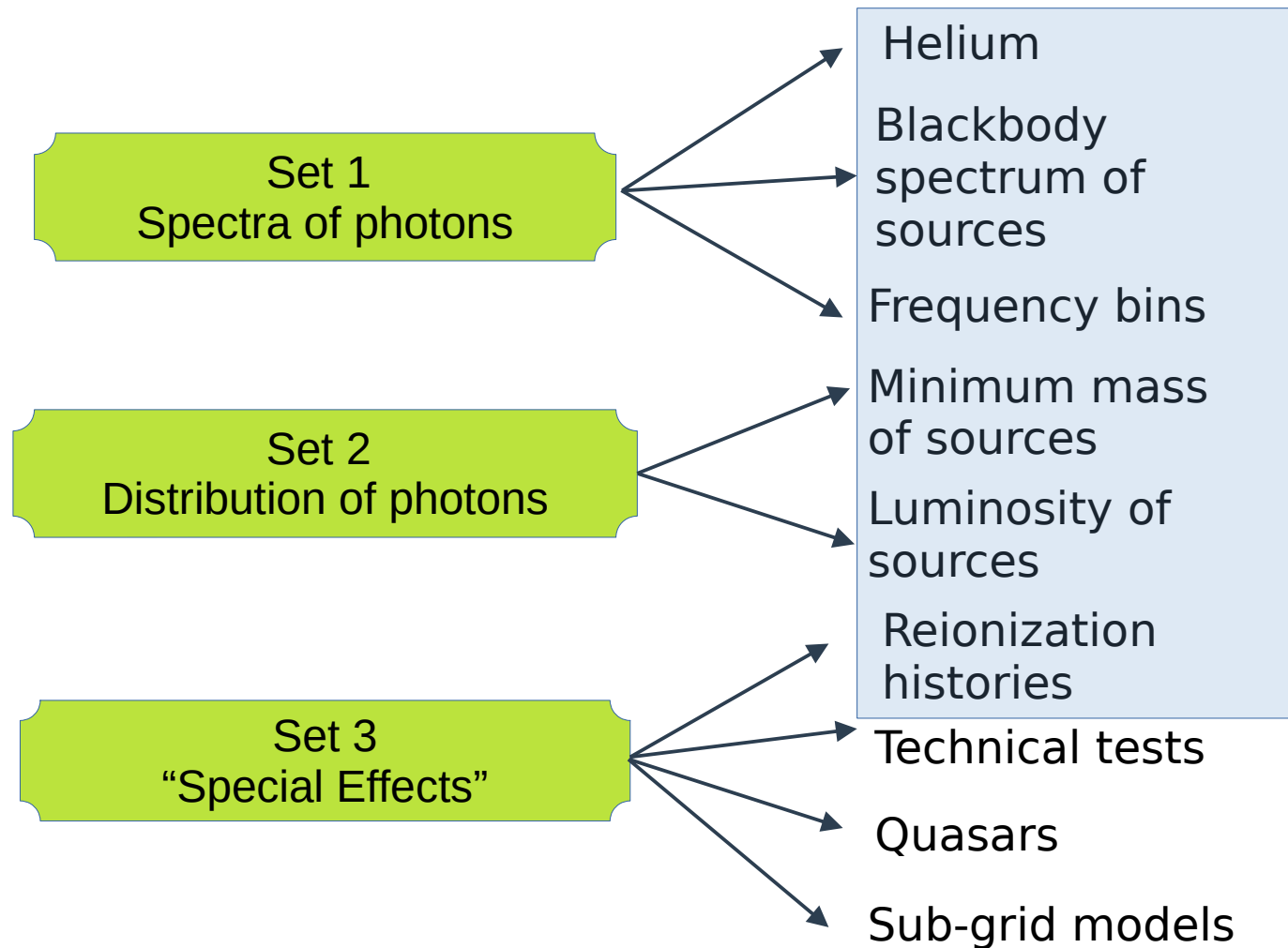
Gaikwad et al. 2023

Late end of reionization

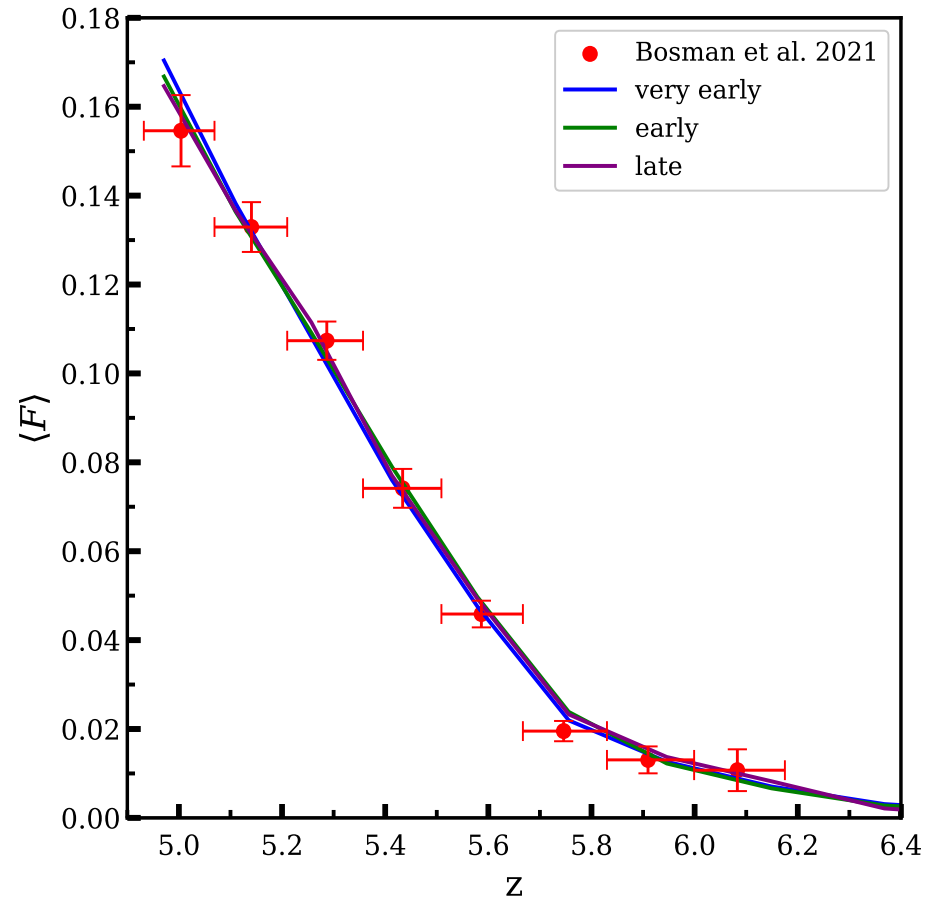
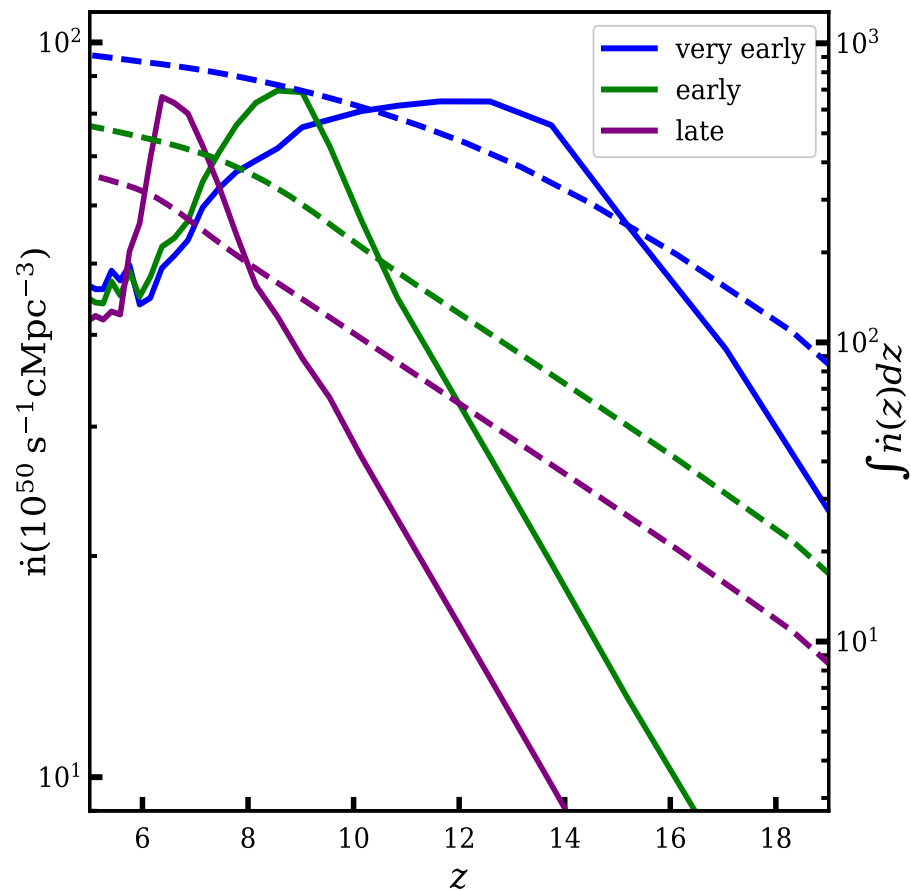


Mono-frequency
Hydrogen

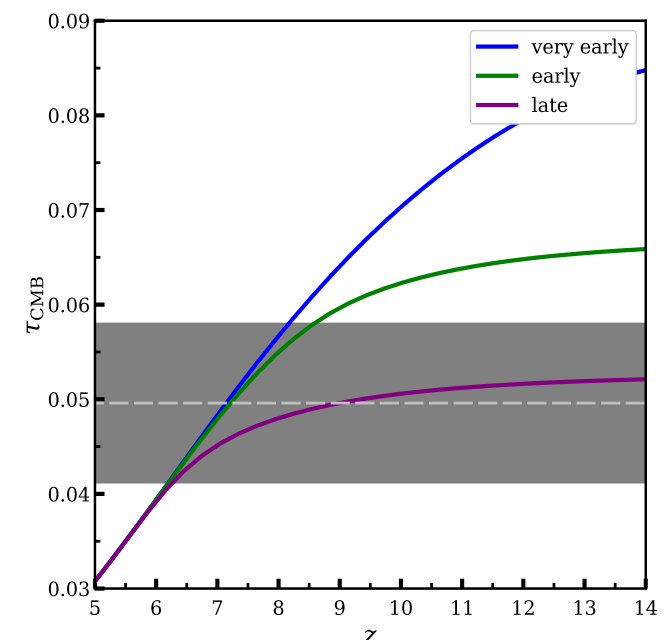
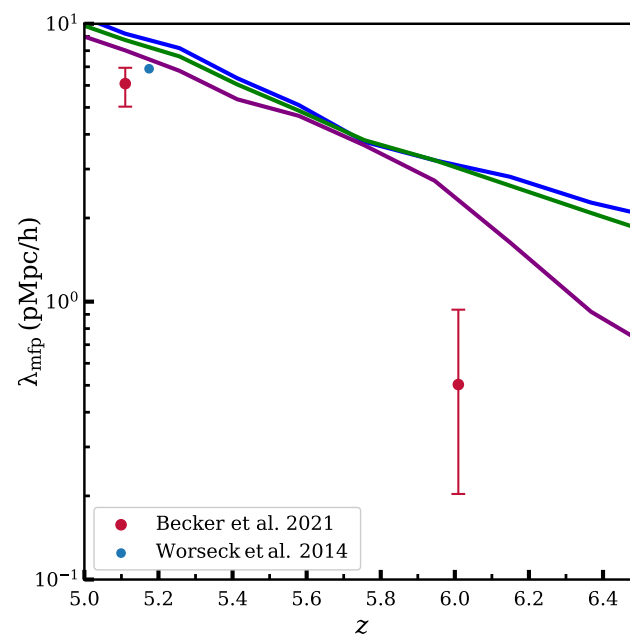
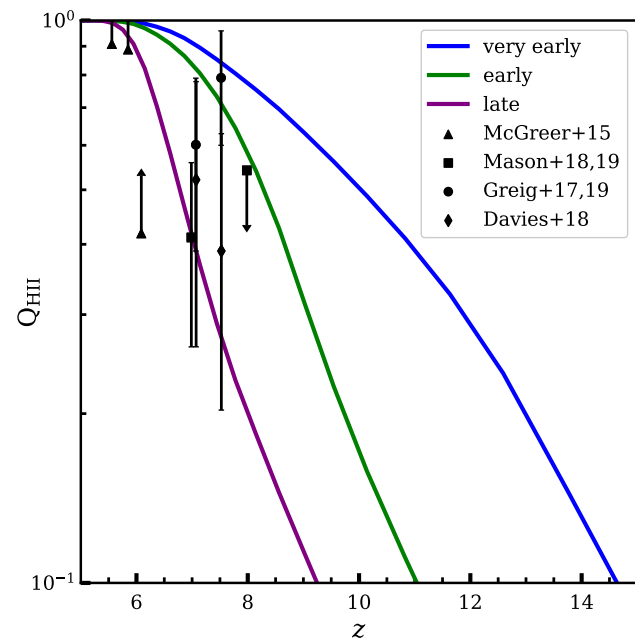
Table of Cosmological simulations



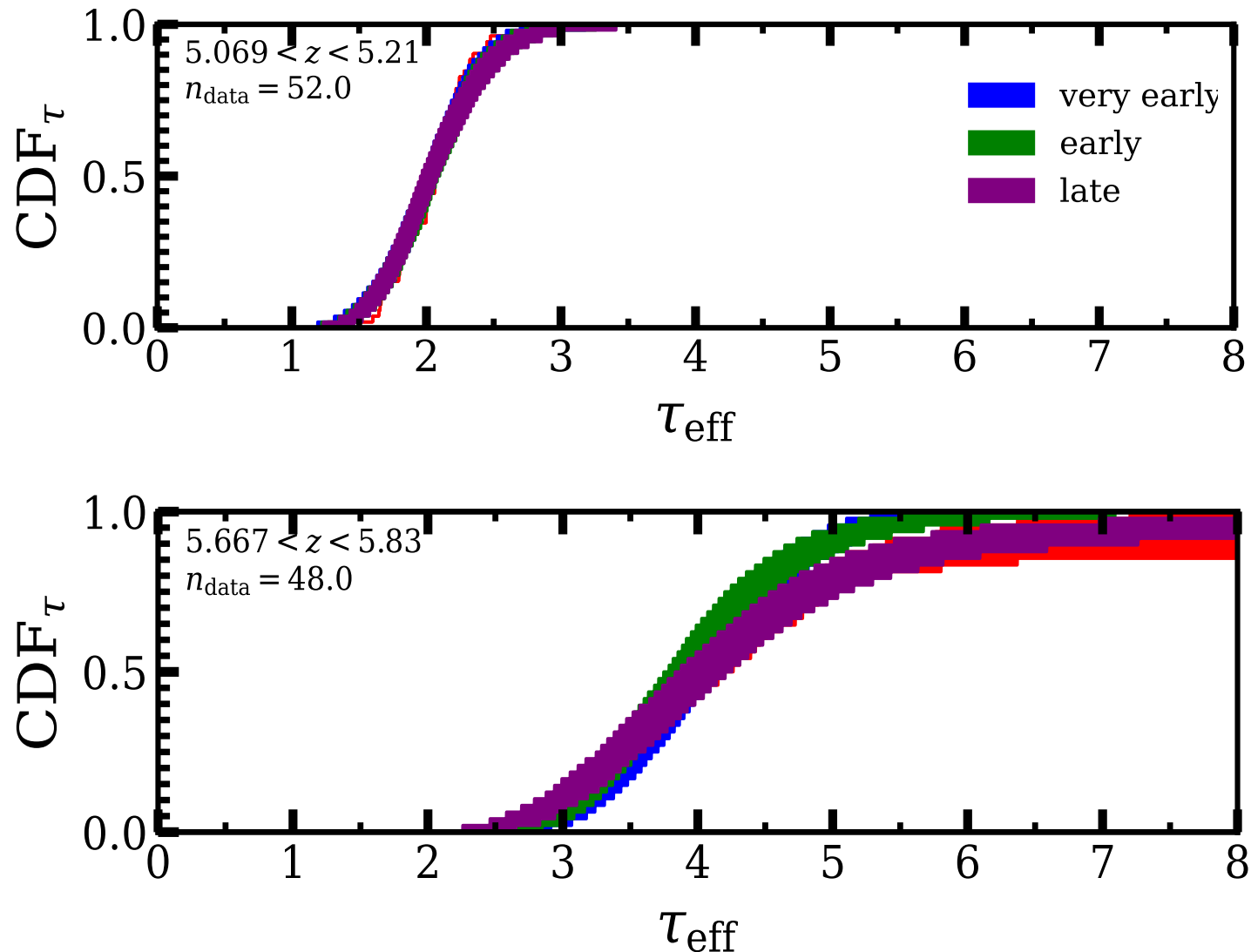
Early start to late reionization - Higher emissivity



Early reionization is mildly in tension with planck

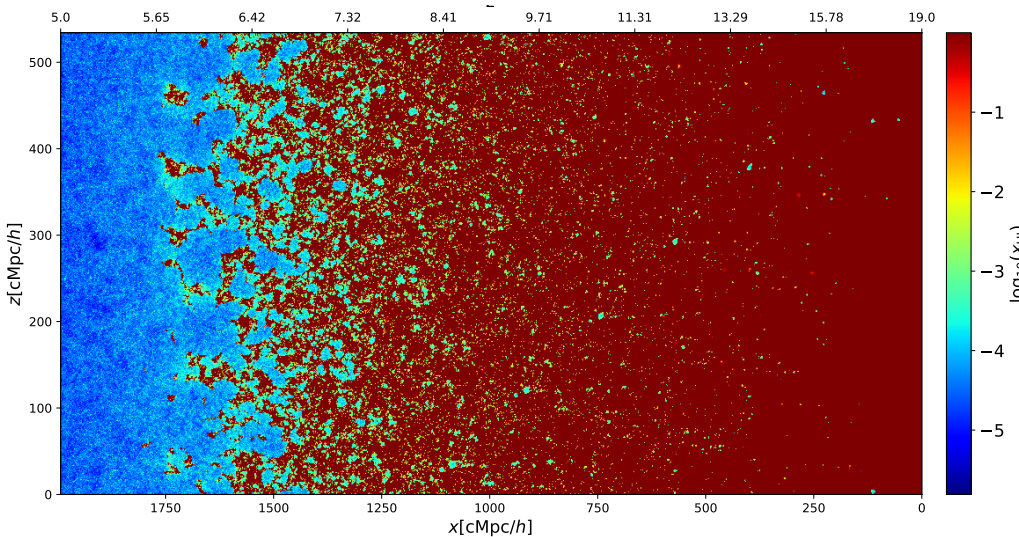


Calibration to mean flux does not reproduce optical depth distribution at high z



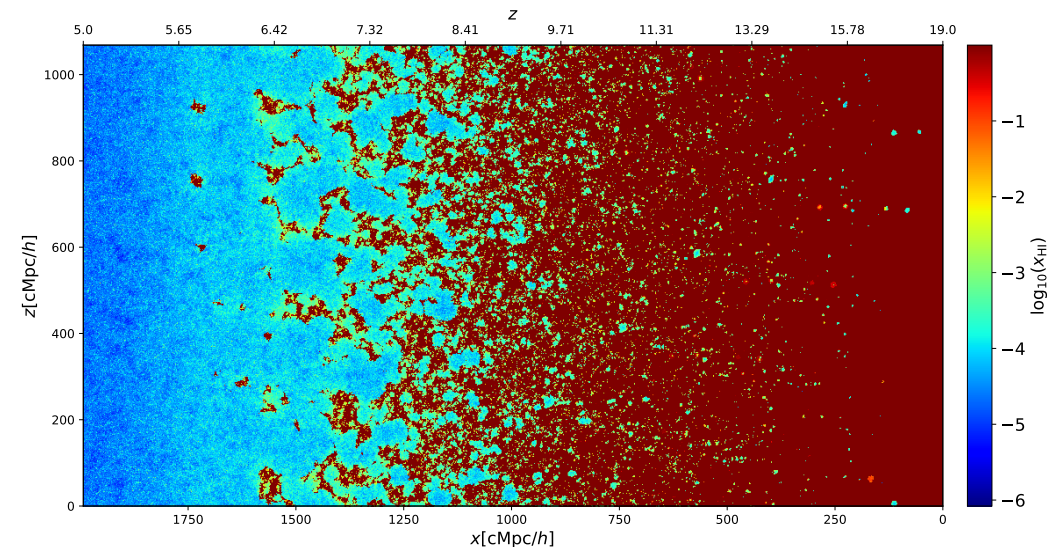
Lightcones show differences in bubble growth

Late start of Reionization



Rapid growth of bubbles
Start forming much later

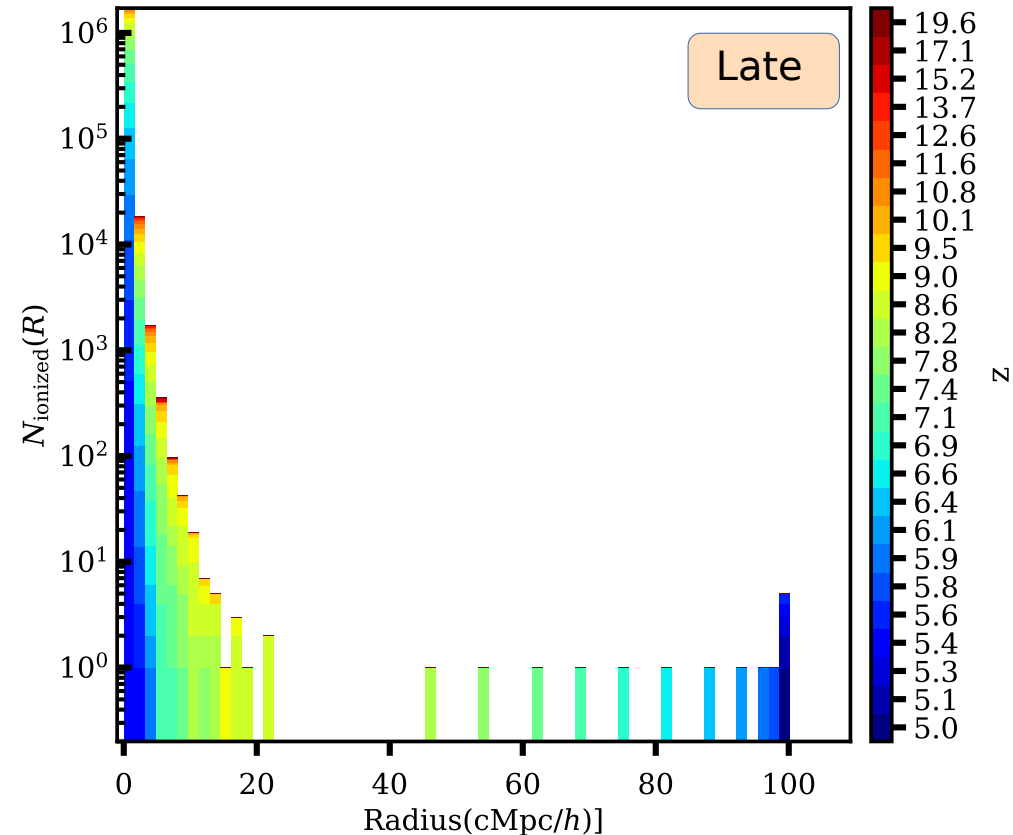
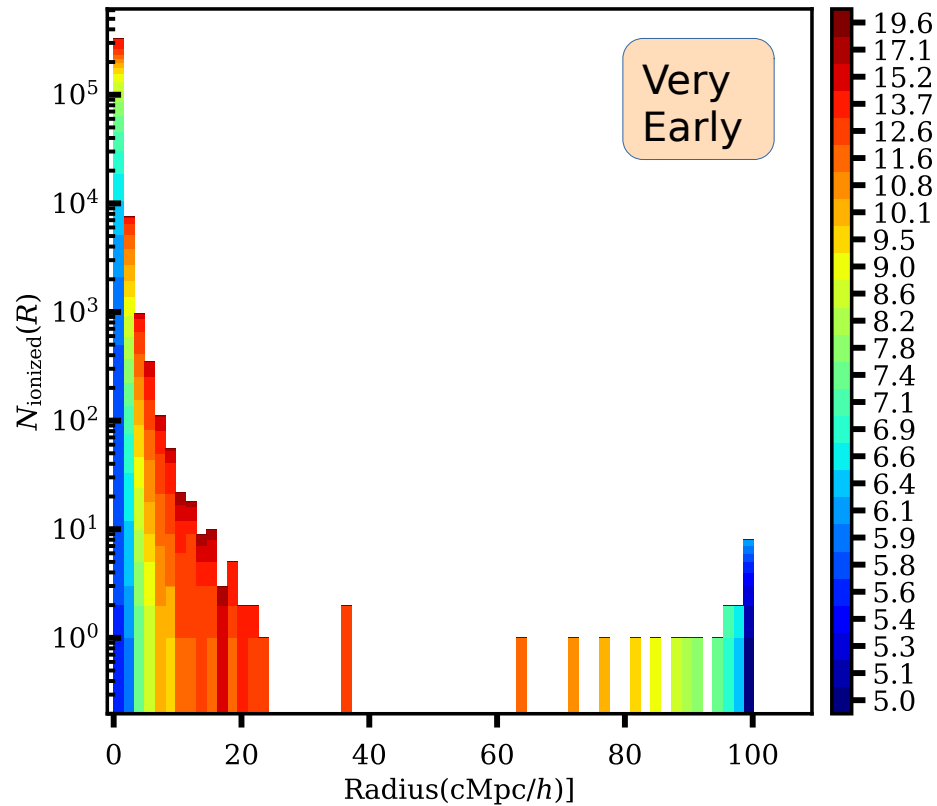
Early start of Reionization



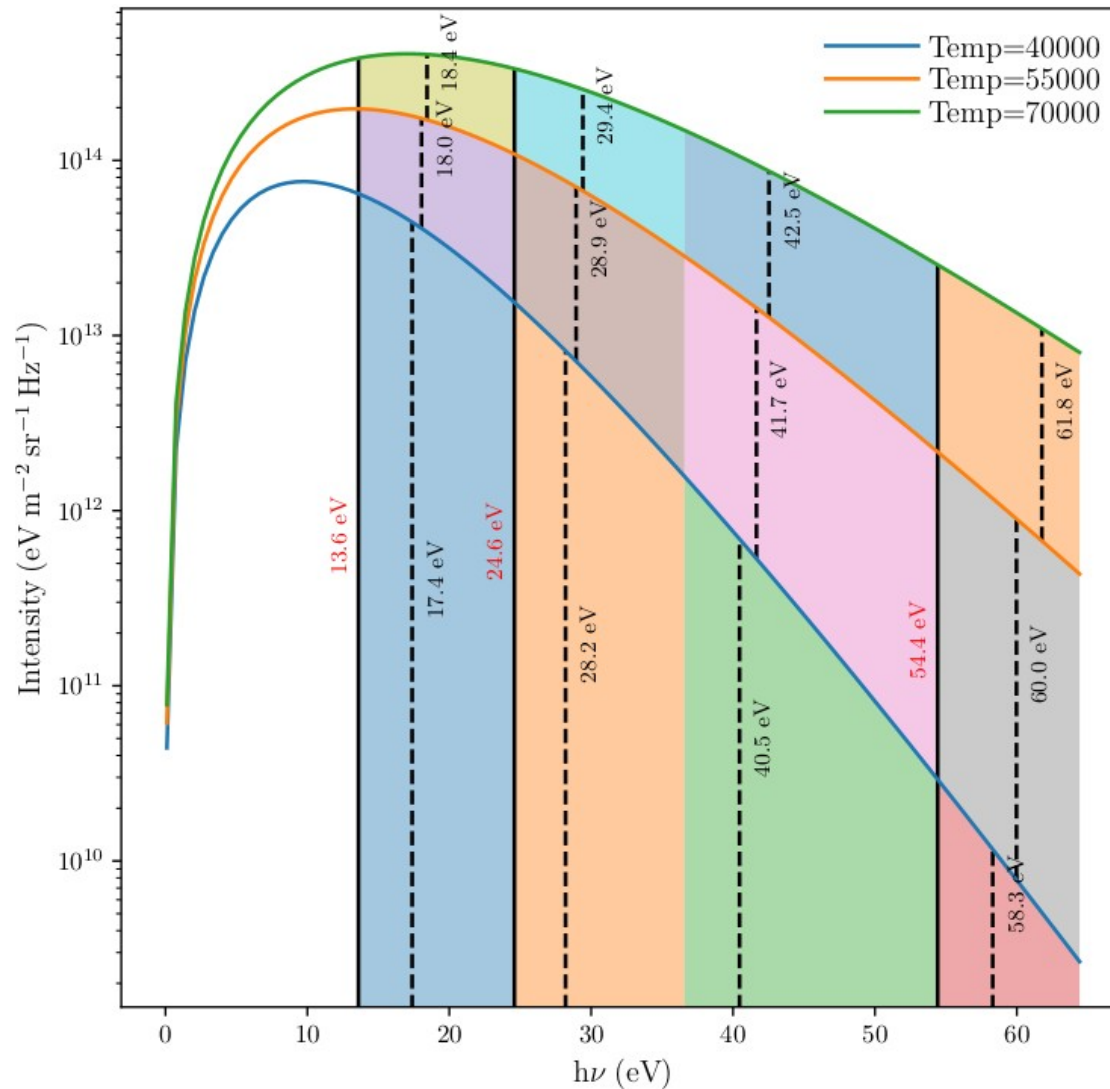
Large bubbles at high redshift
Smaller growth rate

Larger bubbles at high redshift

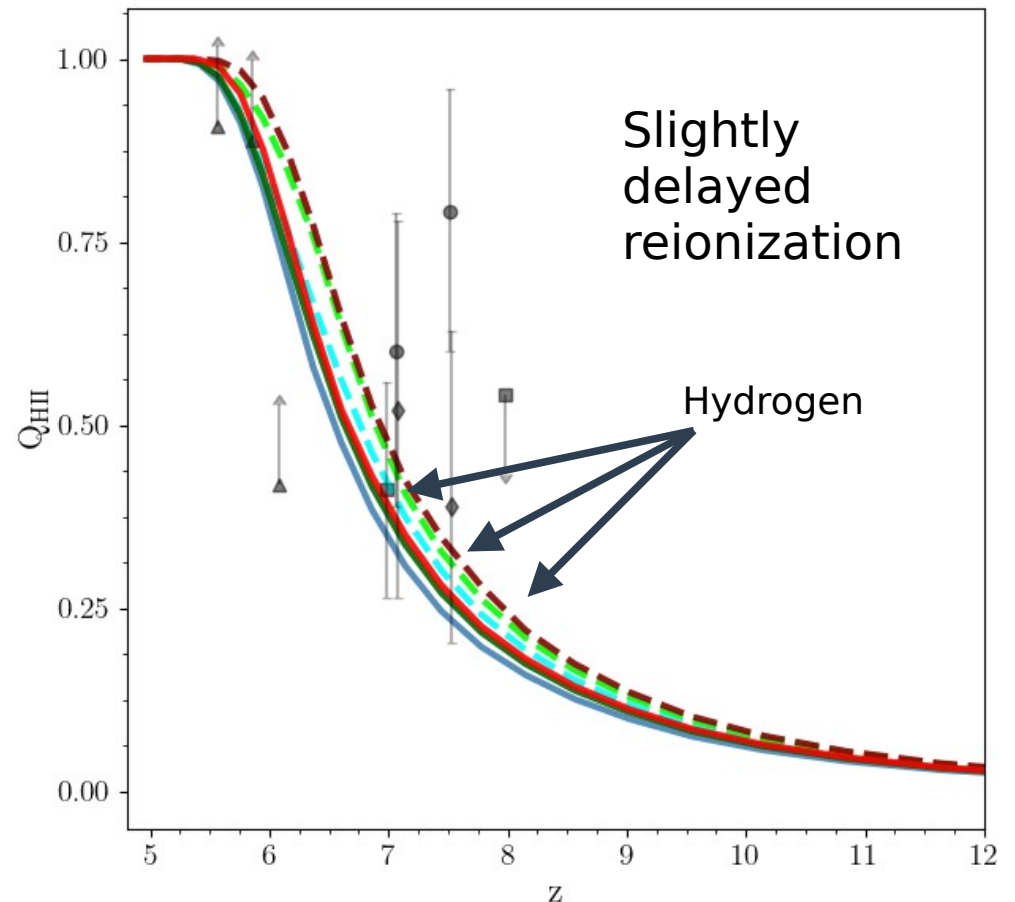
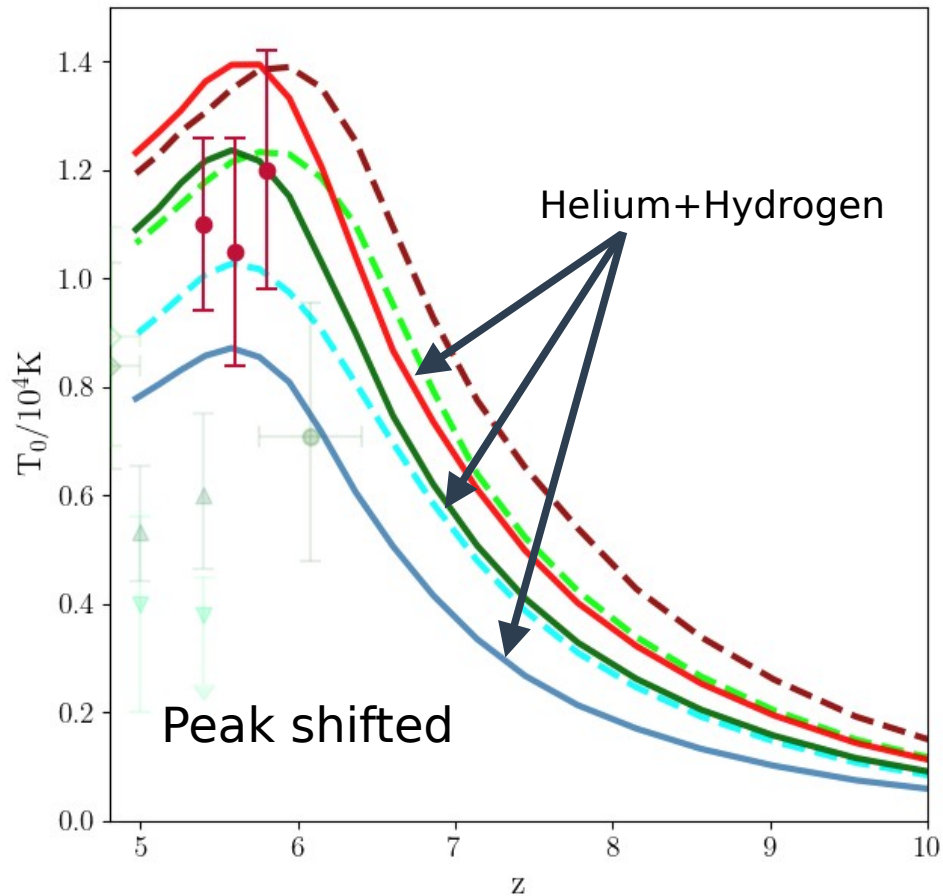
Preliminary!



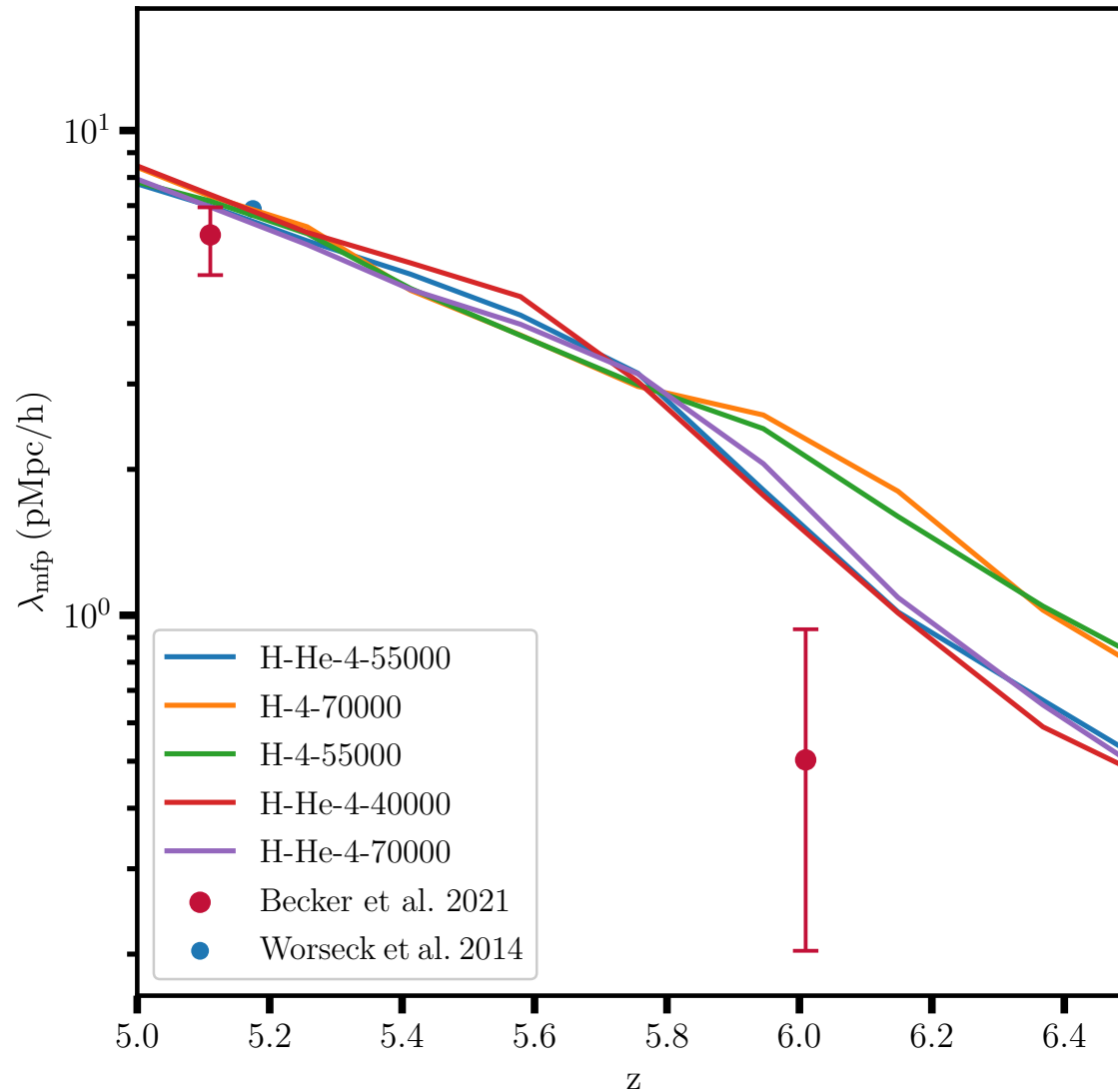
Multi-frequency capabilities with helium



A delayed reionization because of helium

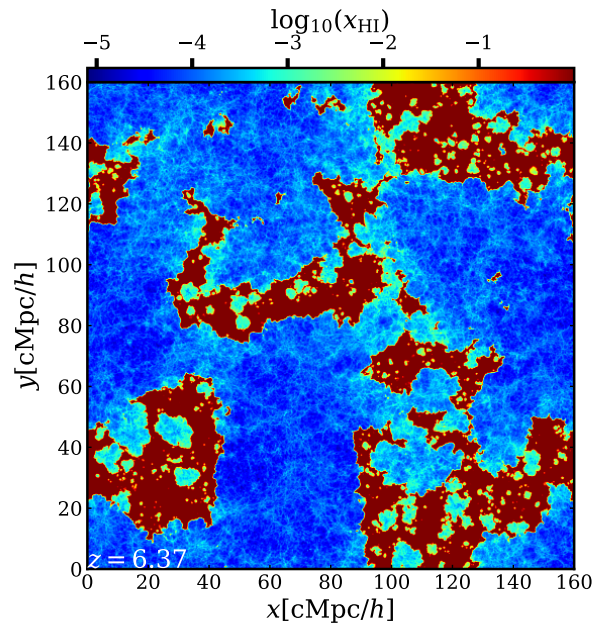


Shorter mean free path at high redshift

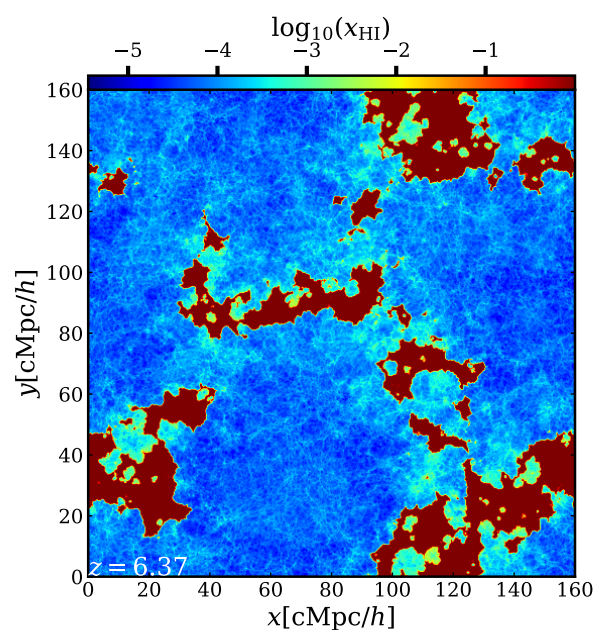


Same calibration but different source distribution

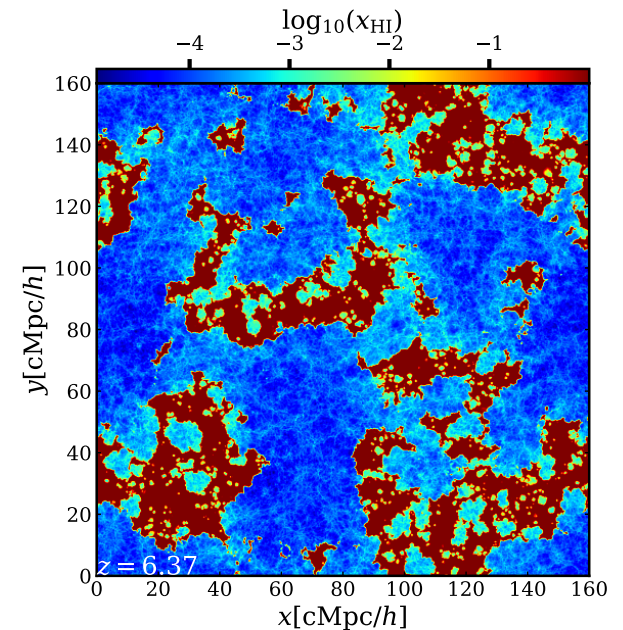
Z=6.37



Fiducial: Mass cut-off
 $1e9 M_{\odot}$ with luminosity
proportional to mass

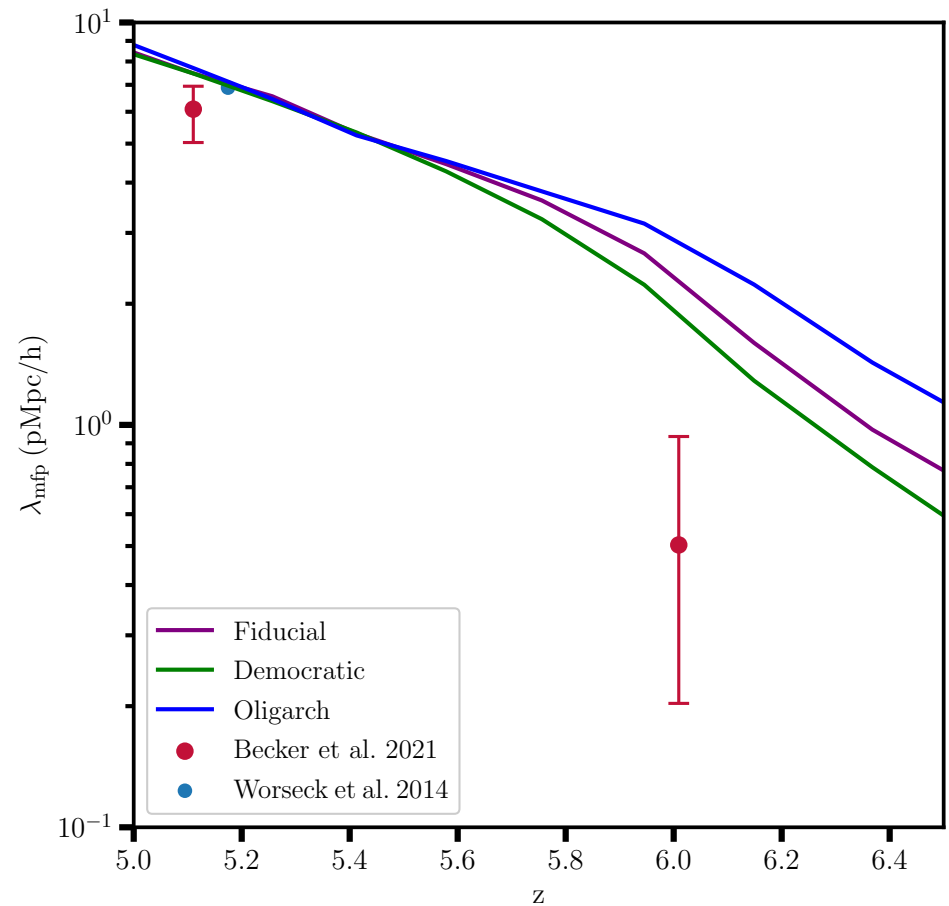
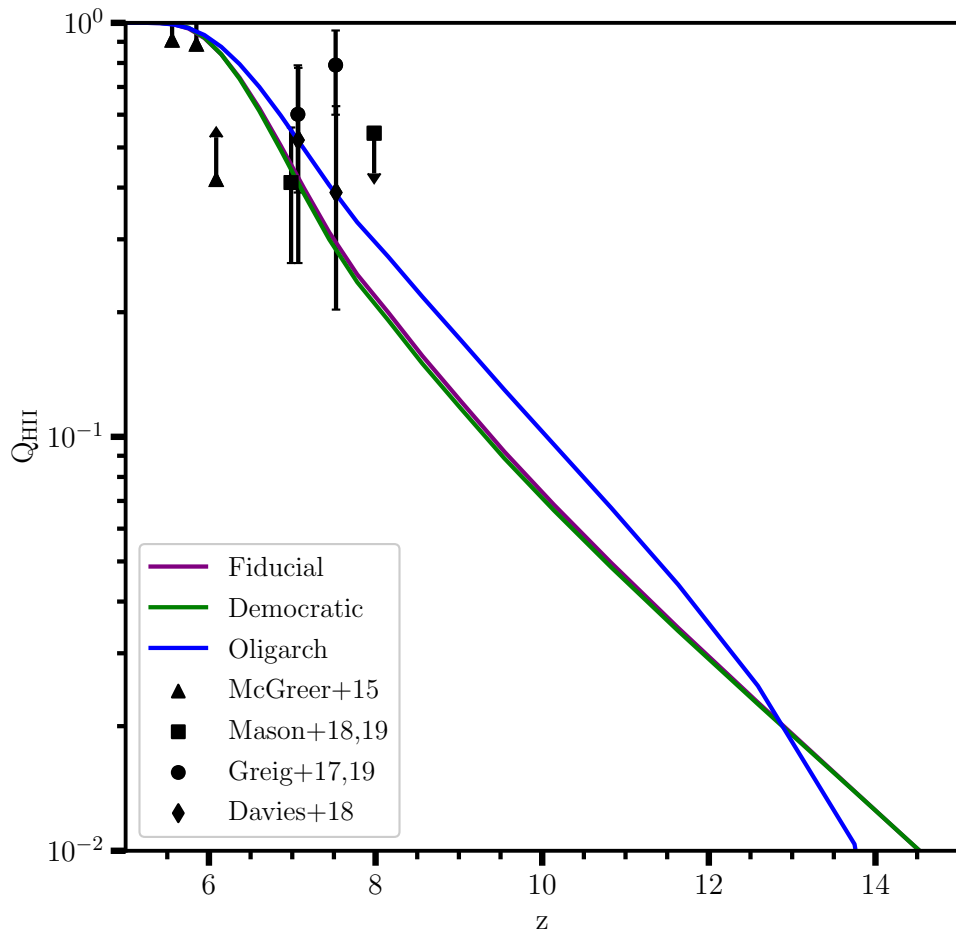


Oligarch : Mass cut-off
 $8.5e9 M_{\odot}$ with
luminosity proportional
to mass



Democratic: Mass cut-off
 $1e9 M_{\odot}$ with constant
luminosity

Dense neutral regions determine the mean free path



Summary

- Calibrated cosmological simulations with varying physical parameters using ATON.
- Inclusion of helium delays reionization and decreases the mean free path.
- Different bubble morphology can be seen with changing start of reionization or source models.
- Distribution of LAEs, and model with QSOs and galaxies.