

The Epoch of Reionisation

the formation of the primordial stars and galaxies
and their effect large scale structure of the Universe

ML4Science: Can ML replaces RT?

M. Bianco, M. Calafà, G. Mescolini, P. Motta

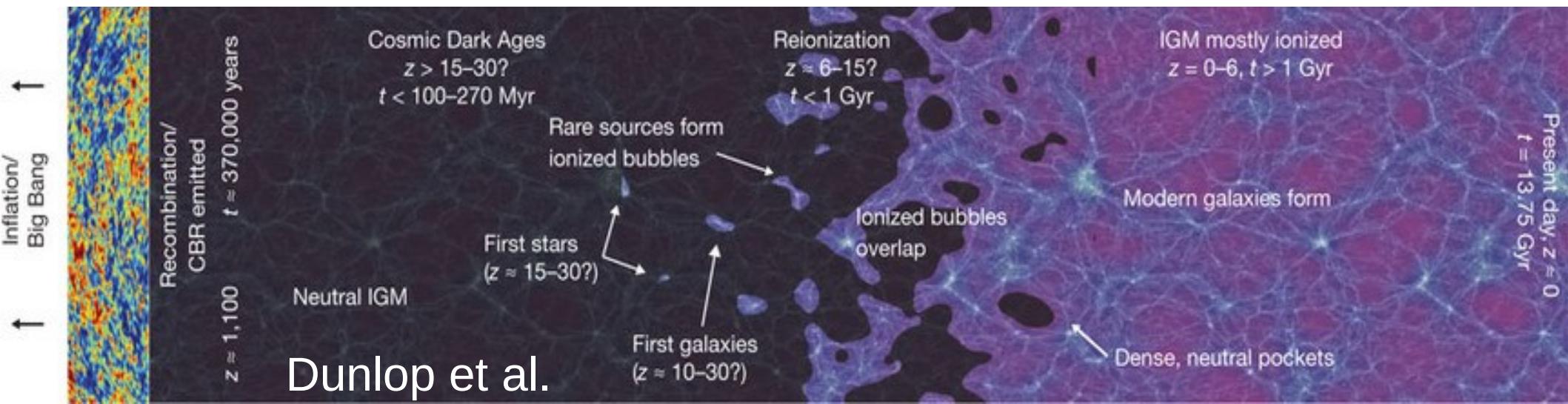
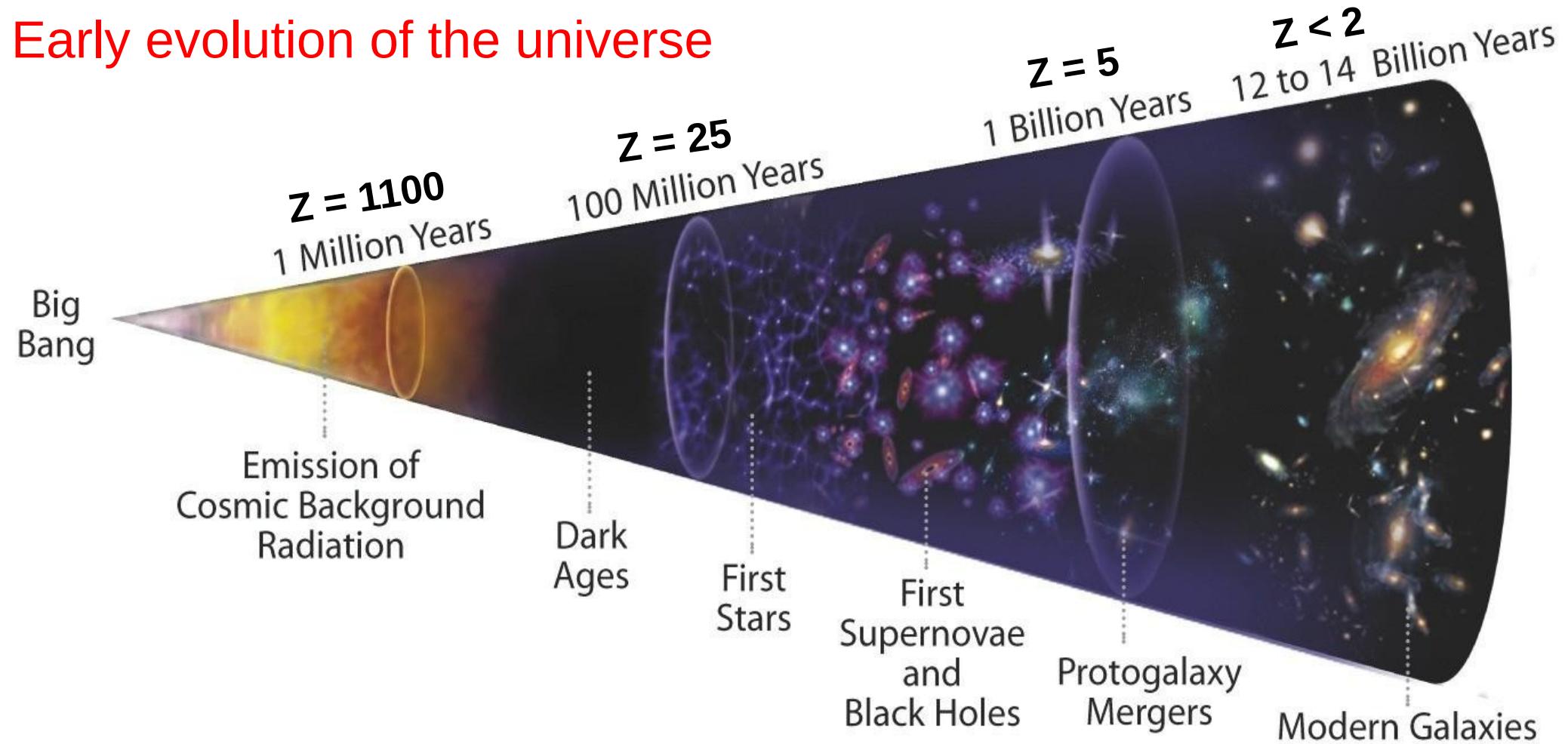
Project timeline

- Weekly meeting on Tuesday at 9 am? (eventually on Wed)
- Total of 5½ weeks: Each meeting hosted by one of the participants (1+3+1)
- Week 0: familiarise with the topic, define the network architecture and strategise the dataset preprocessing
- Week 1-2: setup and first draft of the network and estimation of its training time as well as accuracy estimation
- Week 3: finalise network architecture and start training
- Week 4: prediction analysis and finalise ML4Science report²

Today's Goal

- Quick overview of the Epoch of Reionisation
- Have a look at the dataset
- Strategise dataset preprocessing
- Define network architecture

Early evolution of the universe



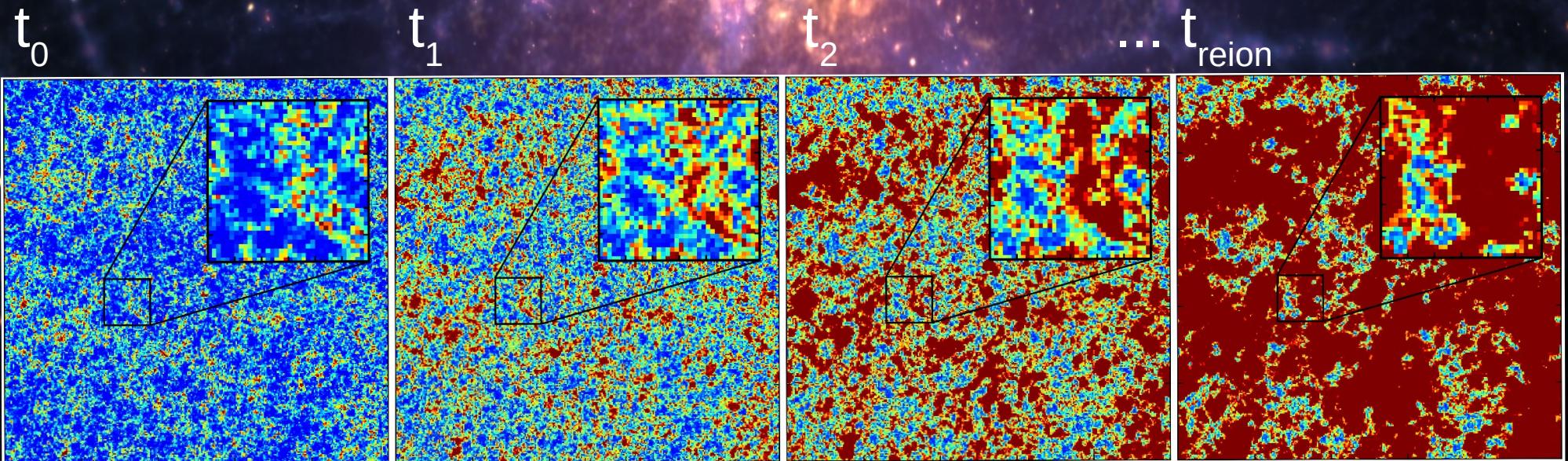
Time evolution of the ionisation fraction

Differential equation for the evolution of neutral gas density:

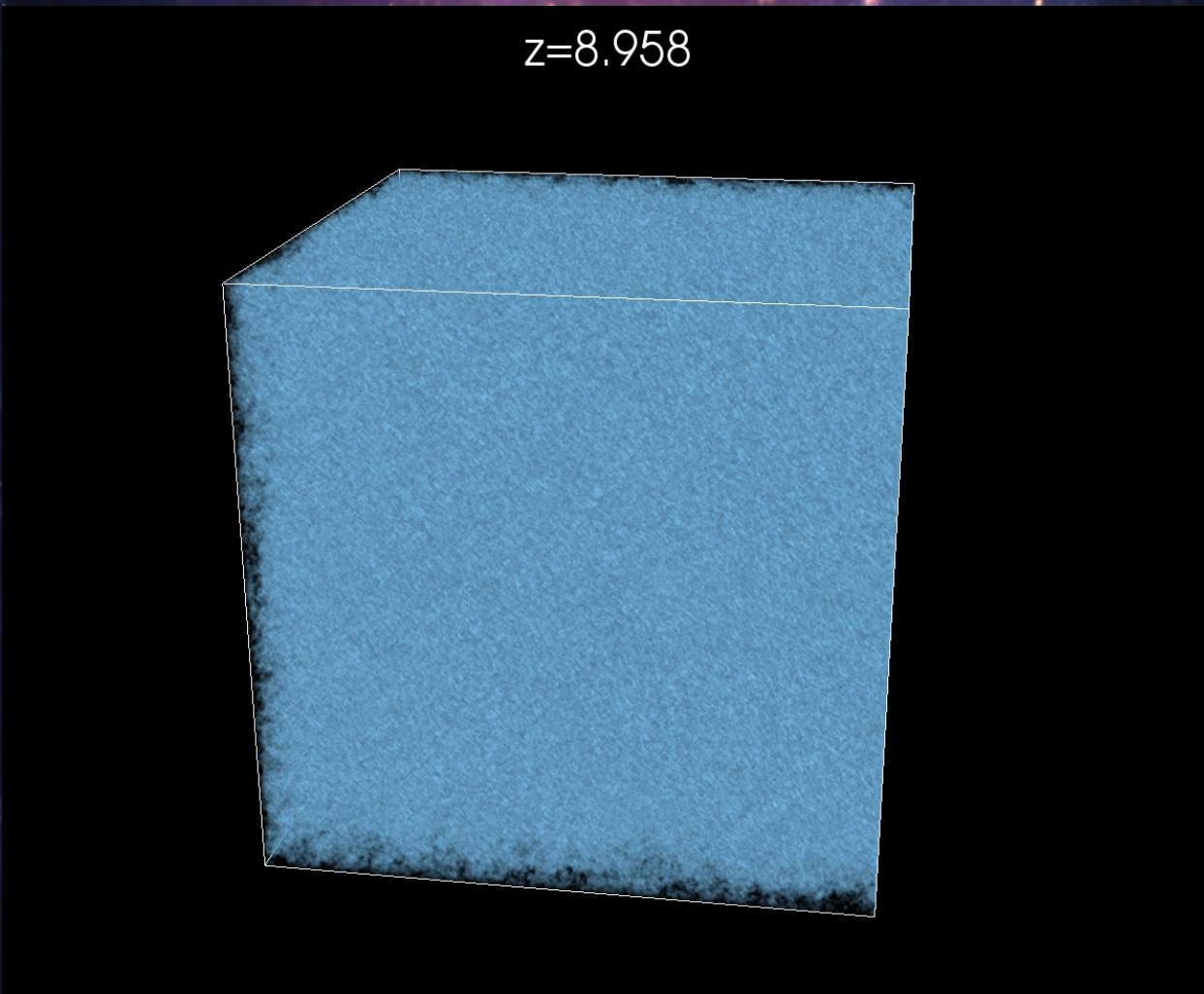
$$\frac{dx_{\text{HII}}}{dt} = -(1 - x_{\text{HII}}) \Gamma_{\text{ion}} + \frac{x_{\text{HII}}}{t_{\text{rec}}}$$

Sources
ionisation radiation

Gas Recombination

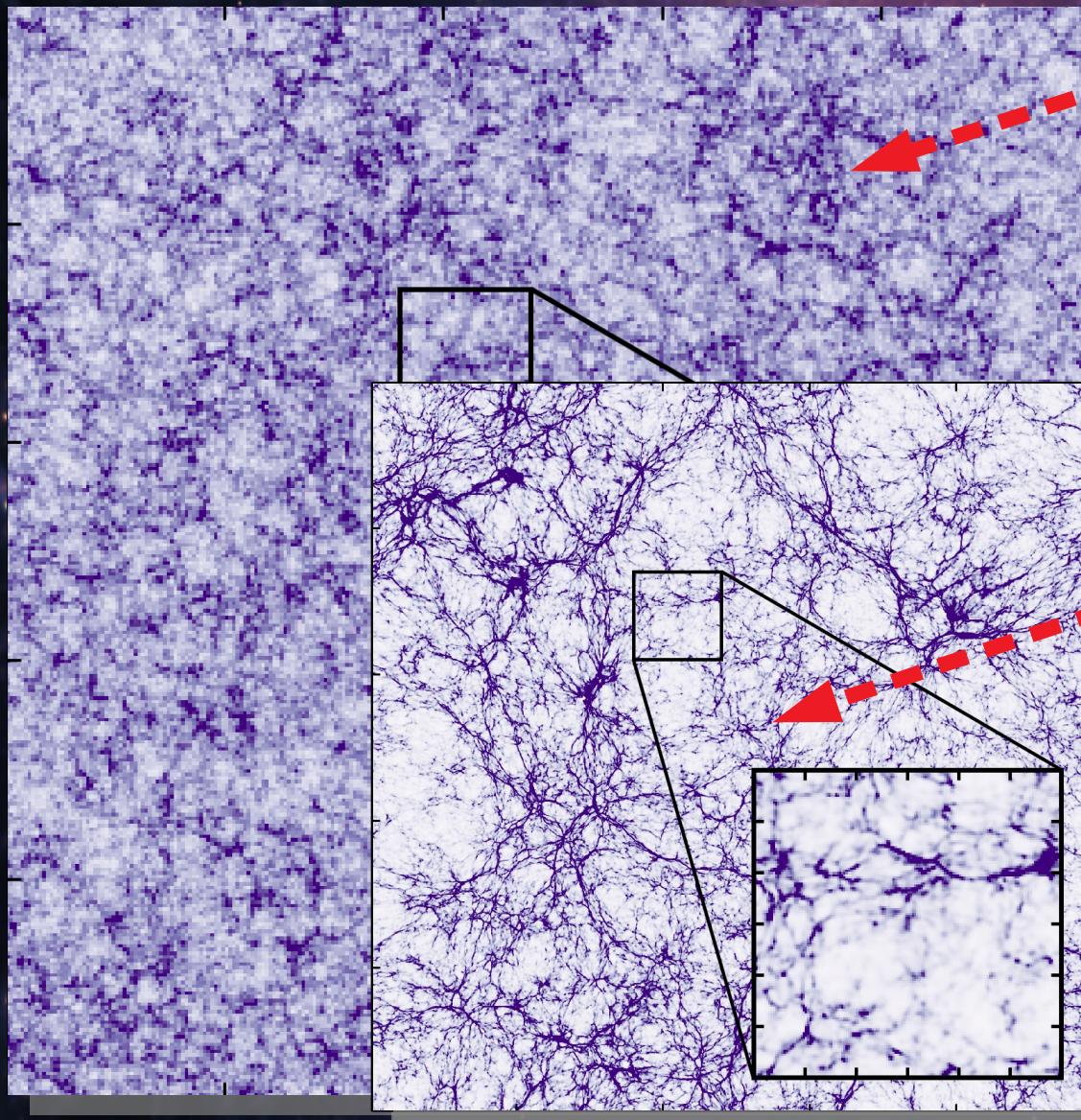


Reionization in Action: Flying Through RT Simulations



Scale Comparison in Cosmic Reionisation

(Bianco et al., 2021)

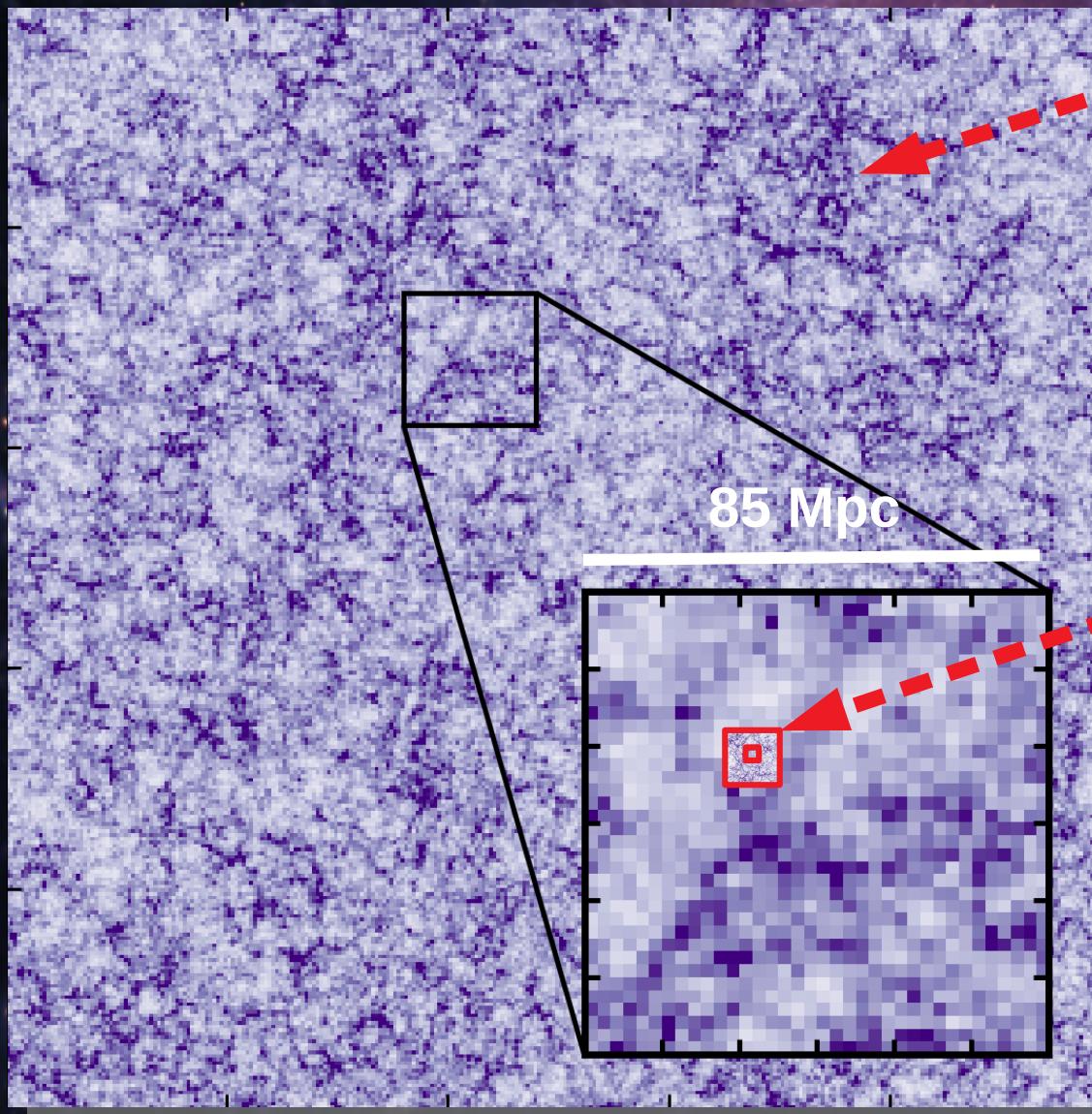


714 Mpc
6,912³ particles
Mesh_{LB}: 300³
Res_{LB}: 2.4 Mpc

9 Mpc
1,728³ particles
Mesh_{SB}: 1,200³
Res_{SB}: 7.5 kpc

Scale Comparison in Cosmic Reionisation

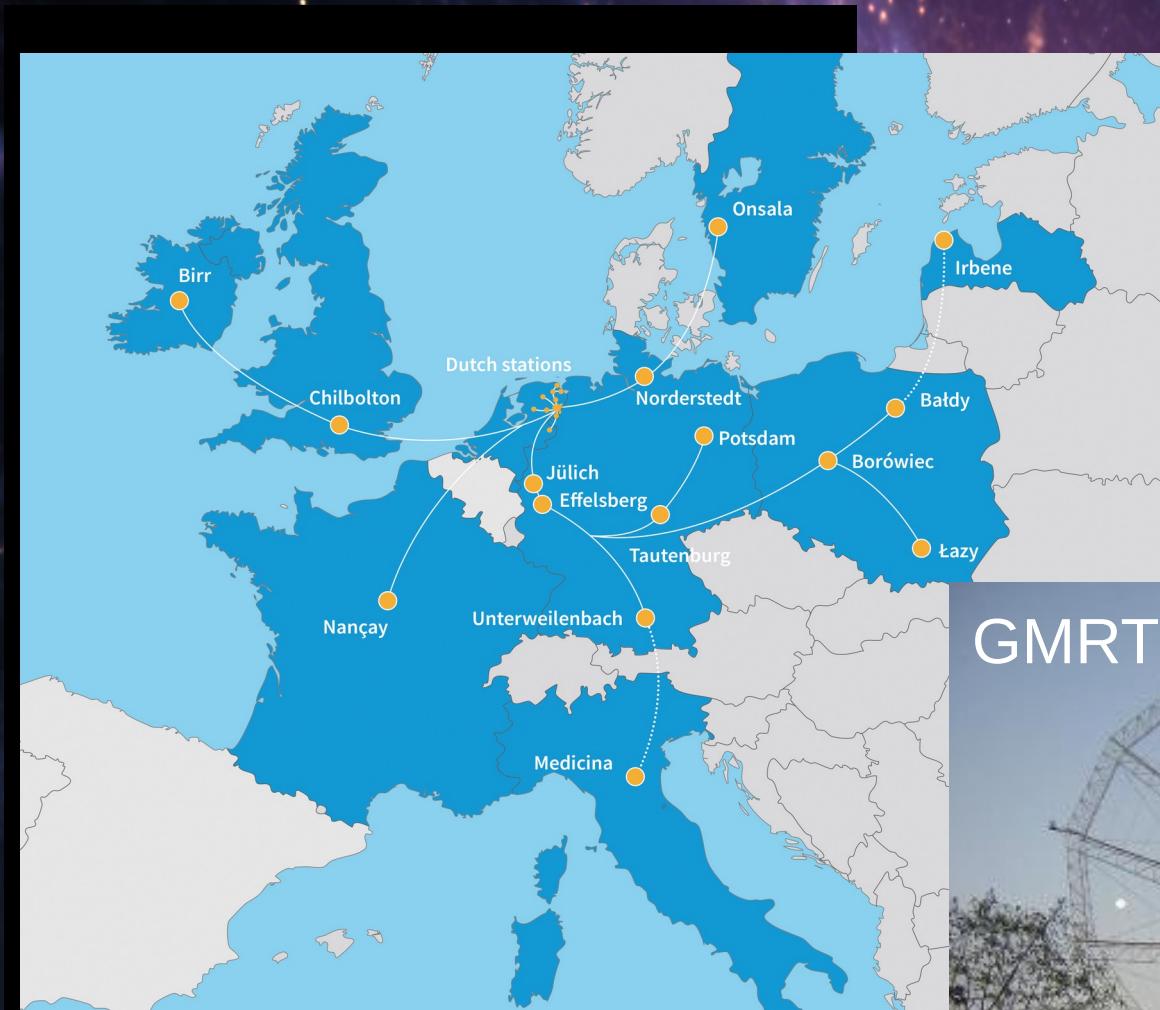
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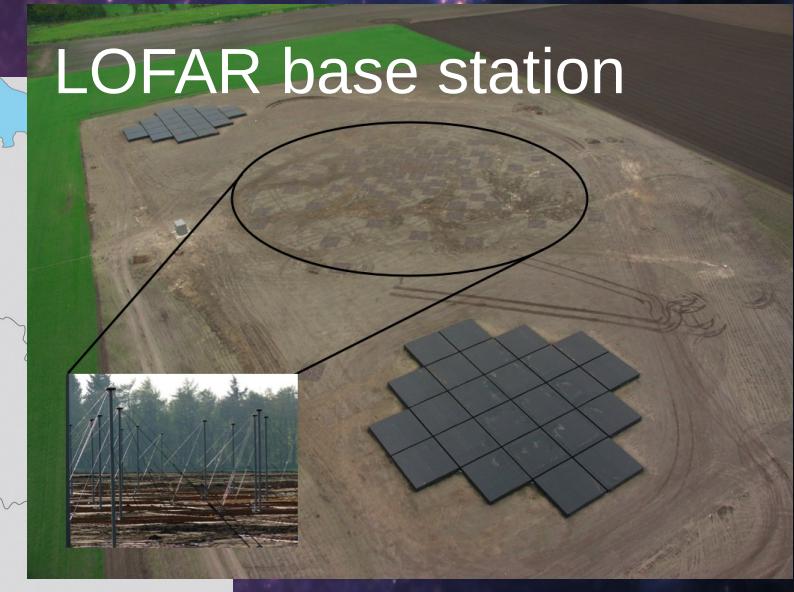
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How are we going to observe that epoch?

Giant Radio Arrays



LOFAR



GMRT



The Future: Square Kilometer Array

SKA1 LOW



- 200 dishes of 15m diameter
- 350 MHz - 14 GHz
- Total raw data: ~2 TiB
- **4x resolution, 5x more sensitive and 60x faster than JVLA**

SKA1 MID



- 130,000 antennas in 500 stations
- 50 MHz - 350 MHz
- Total raw data: ~157 TiB
- **8x more sensitive, 135x faster and 25% better resolution than LOFAR**

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