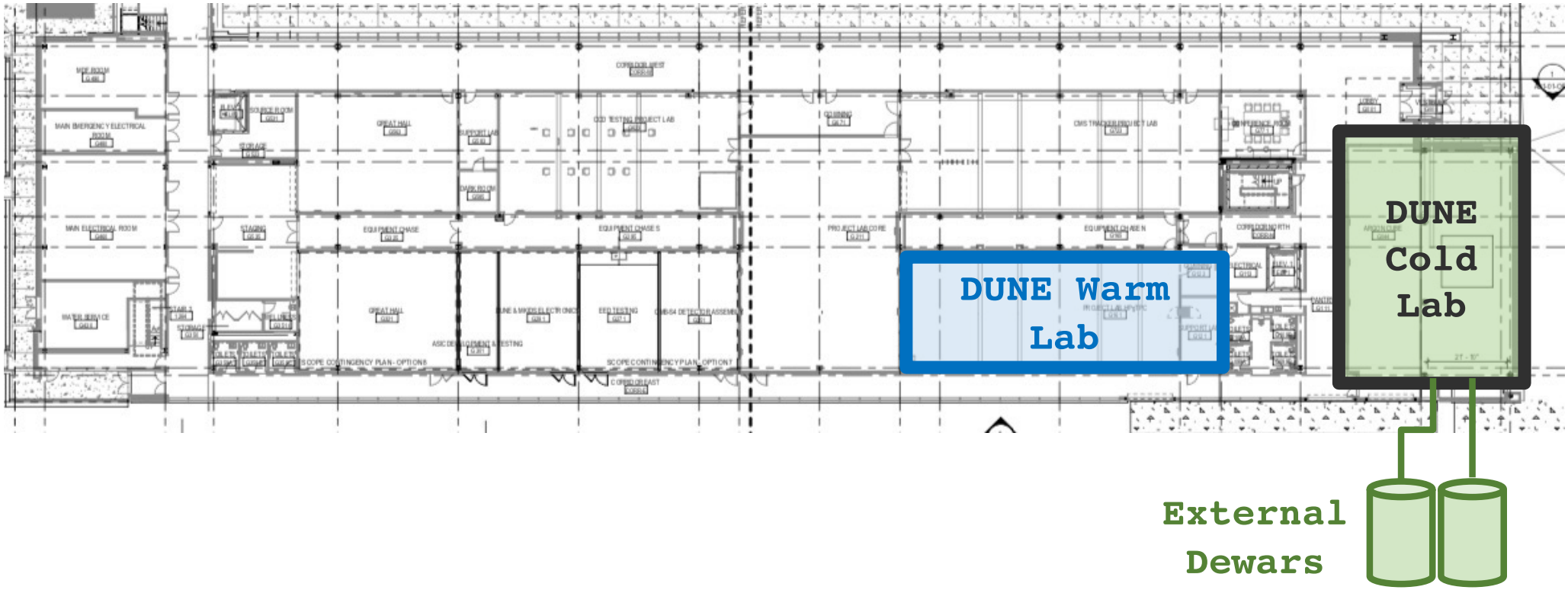
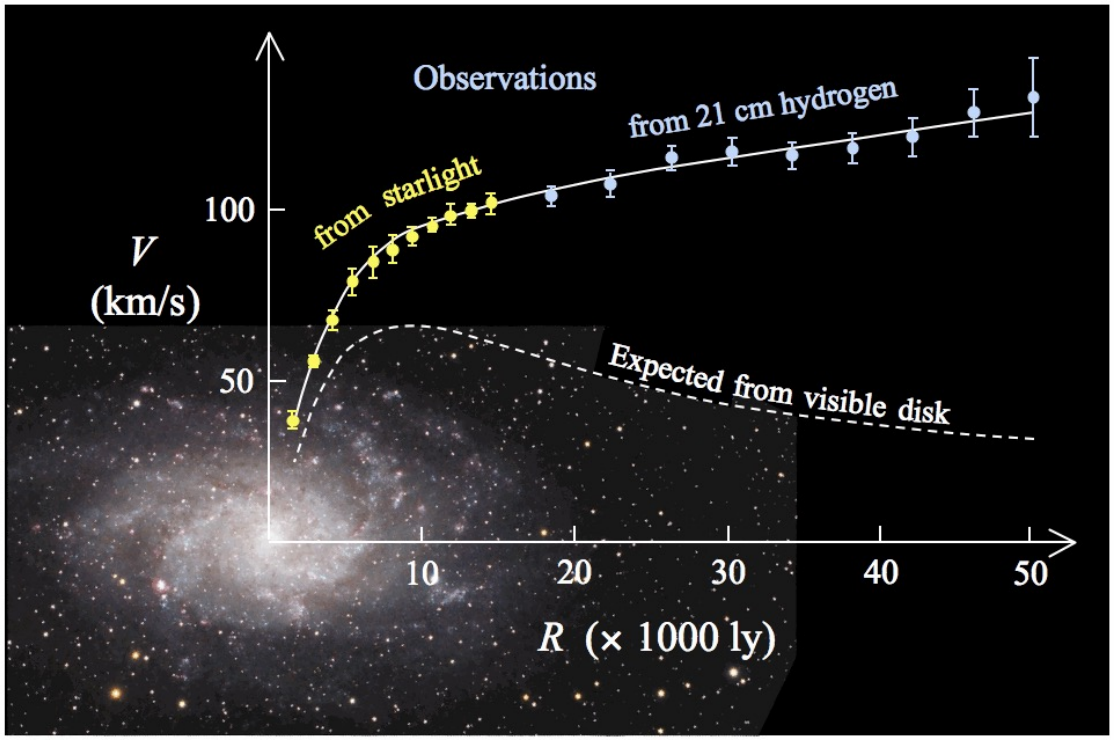
Ground Floor



The Universe We Can't See

- It is relatively easy to tell if a star is moving towards or away from us (Doppler shift)
- You can calculate how fast the motion should be for different parts of a galaxy because from the brightness of the stars in the middle tells you how big & many stars there are and that tells you how much gravity they should have

The Universe we Can't See

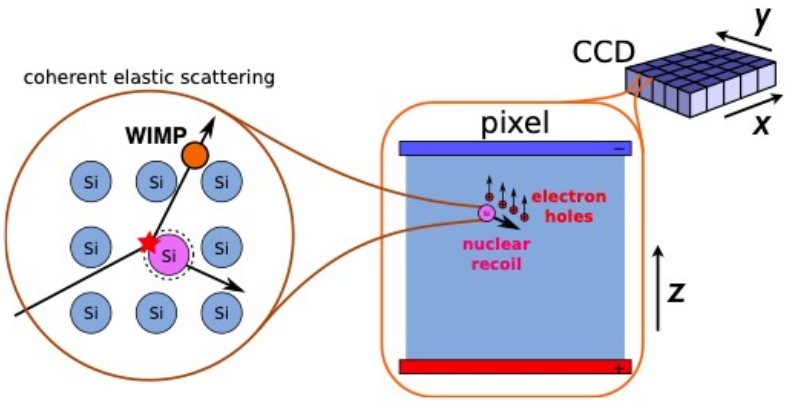


Vera Rubin, 1978

Most of the mass in galaxies isn't in stars - it is some kind of dark matter.

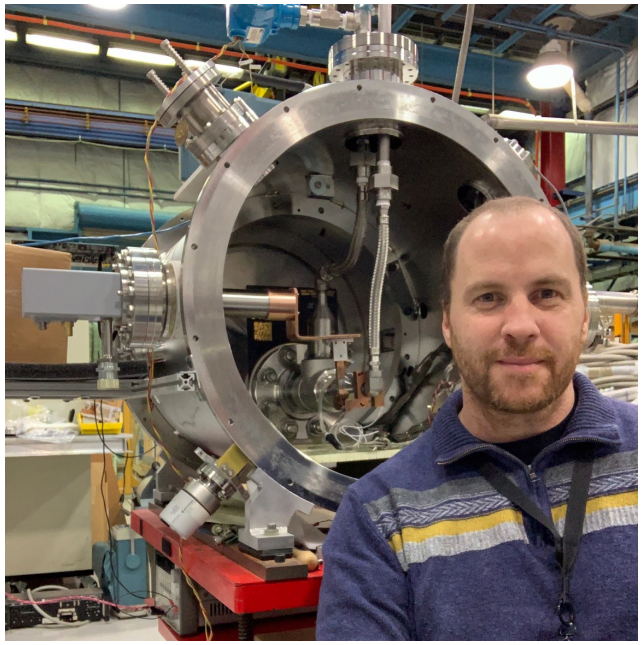
Which we ought to have right here on earth

The Universe we Can't See

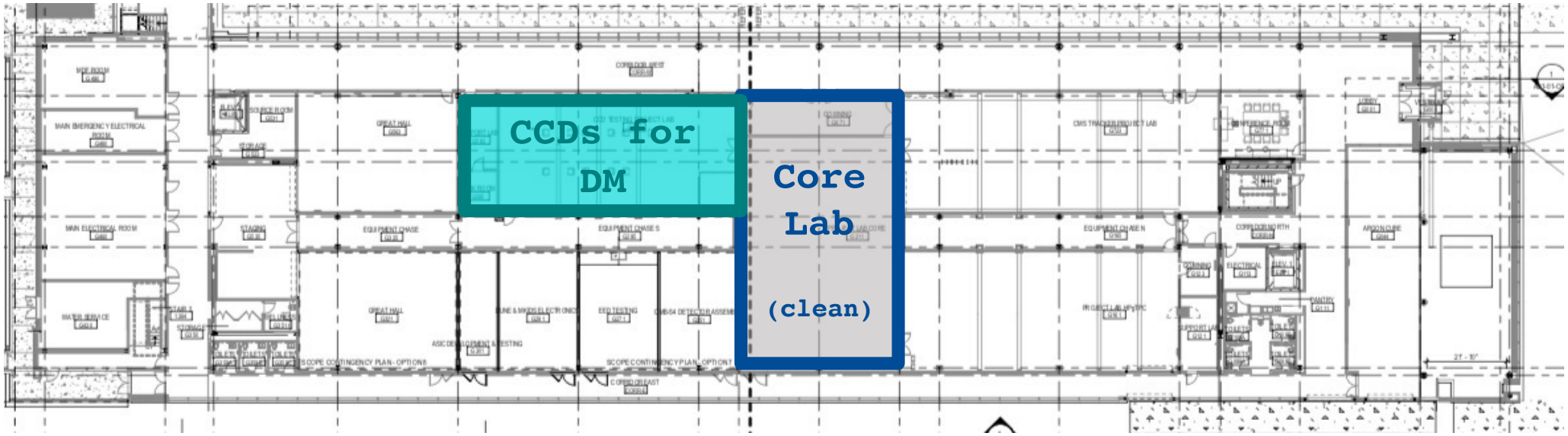


Which we ought to have right here on earth

And maybe some of it goes through sensors like we have in our cameras

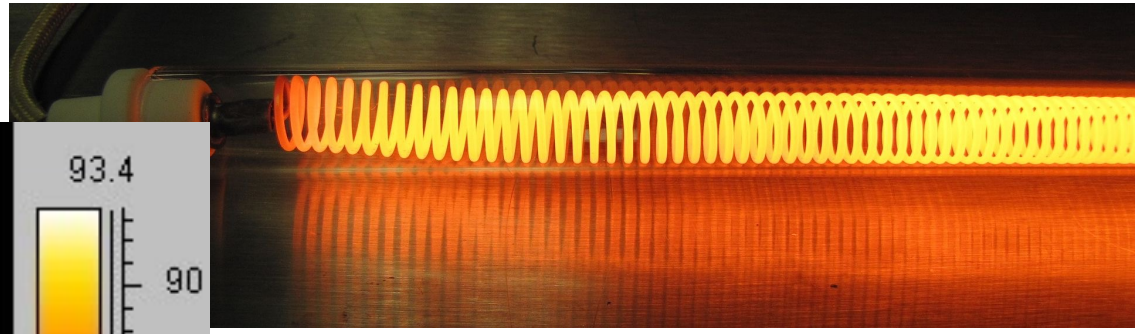


Ground Floor



The Temperature of the Universe

Warm bodies give off a certain kind of light just because they are warm

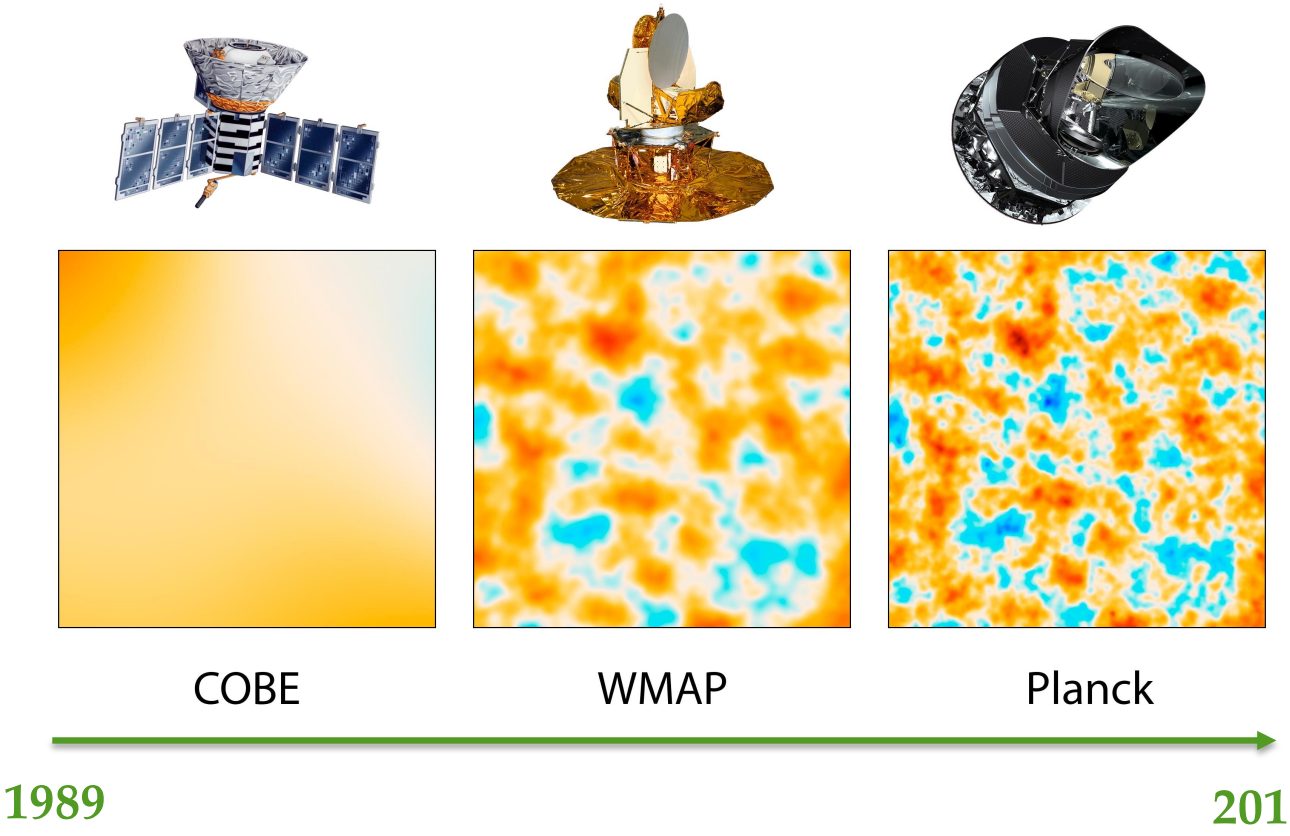


~370,000 years after the big bang, the universe became transparent, and this thermal radiation could travel across it

As the universe stretched out (expands) the thermal radiation was stretched out, corresponding to cooler temperatures. Now the universe is about –455°F

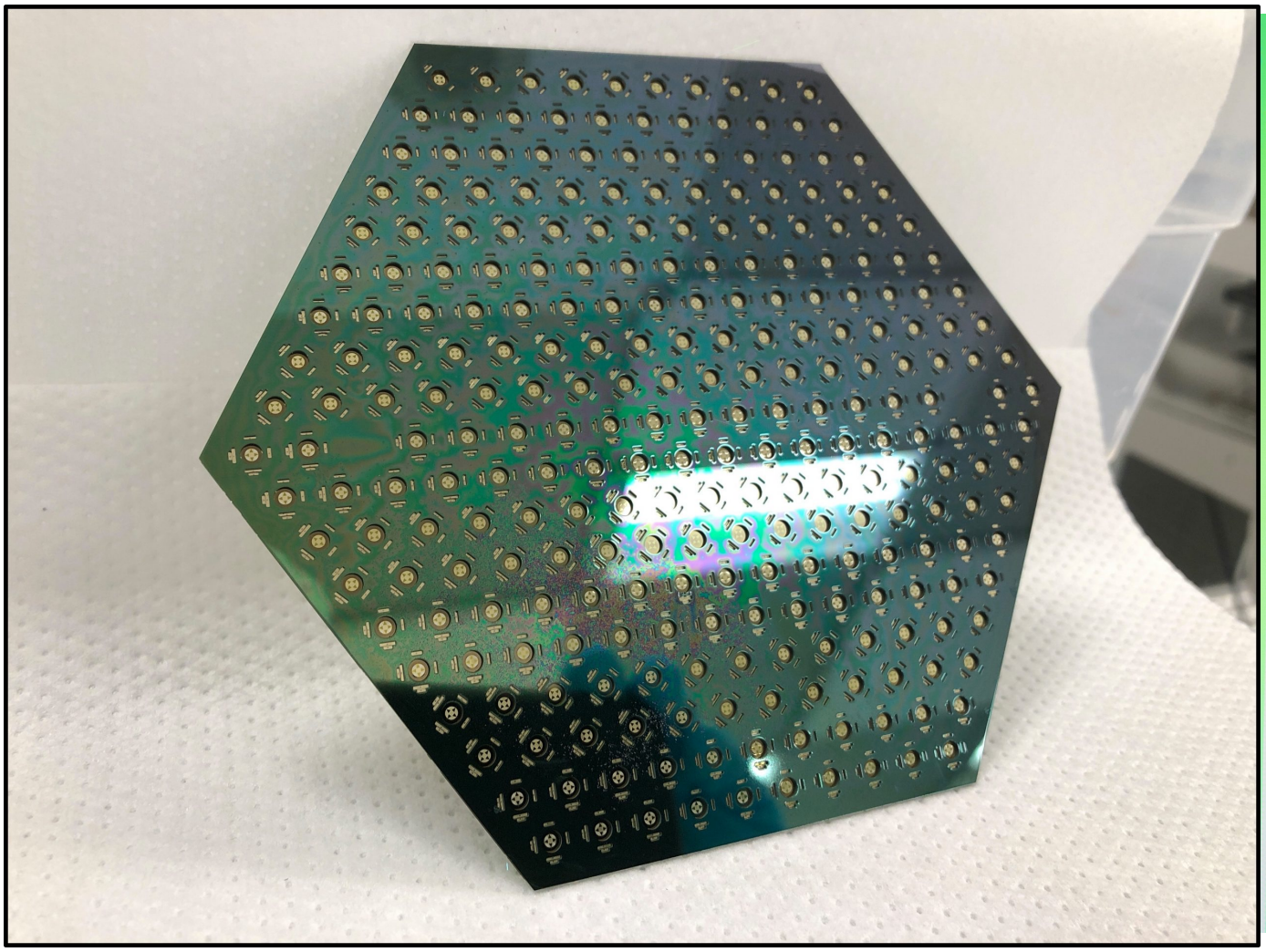
The Temperature of the Universe

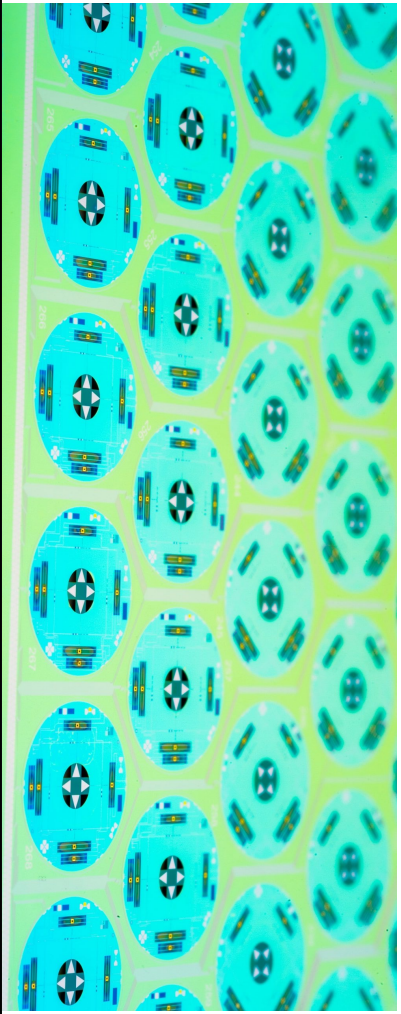
Small variations in the universe's thermal radiation are a picture of the universe when it was 370,000 years old – these pictures are steadily getting clearer



The Temperature of the Universe

The Temperature of the Universe





HEERC GF Final configuration