

Supercomputers in Science

from the big bang to
climate change

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what is EPCC?

- Edinburgh Parallel Computing Centre
 - founded in 1990
- The Supercomputing Centre at the University of Edinburgh



James Clerk Maxwell Building, The King's Buildings
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what are computers used for?



Unsaved spreadsheet - Google Docs & Spreadsheets - Windows Internet Explorer

Google Docs & Spreadsheets

Unsaved spreadsheet

	Number	Stuff
1		
2	A	3
3	B	4
4	C	5
5	D	6
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		

What type?

What data?

A2:B5

Group data by Rows Columns

Use row 2 as labels

Use column A as labels

Labels

Chart title: Stuff

Horizontal axis:

Vertical axis:

Legend: On right

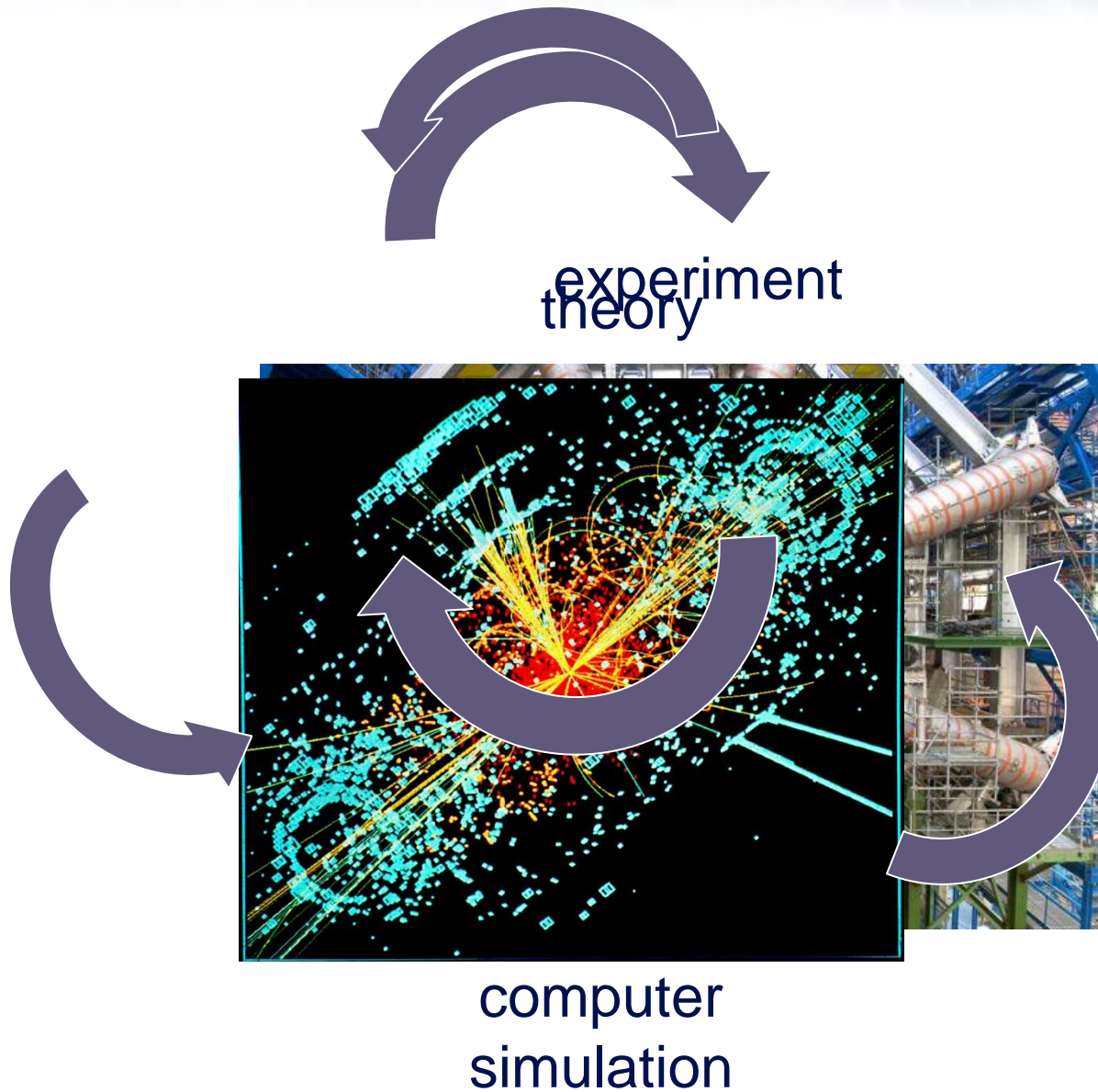
Preview

Unsaved spreadsheet

Careful. You're editing an unsaved spreadsheet.

[Start autosaving](#)

You



why?



what is the world's yearly income?


1	Aadel Abdali	Afghanistan	£873
2	Aamir Abdali	Afghanistan	£798
3	.....	.....	.....
4	.....	.....	.....
5	.....	.....	.....
6	.....	.....	.....
7	.....	.....	.....
8	.....	.....	.....
9	.....	.....	.....
10	.....	.....	.....

5,303,422,761	.....	.....	....	.....
5,303,422,762	.....	.....	....	.....
5,303,422,763	Mark Henson	UK	£28,176	
5,303,422,764	Mary Henson	UK	£37,866	
5,303,422,765	.....	.....	....	.....
5,303,422,766	.....	.....	....	.....
5,303,422,767	.....	.....	....	.....
5,303,422,768	David Henty	UK	£1,234	
5,303,422,769	.....	.....	....	.....
5,303,422,770	.....	.....	....	.....

5,342,564,831	.....	....	.....
5,342,564,832	.....	....	.....
5,342,564,833	.....	....	.....
5,342,564,834	<i>Elisa Windsor</i>	UK	£23,677
5,342,564,835	<i>Elizabeth Windsor*</i>	UK	£38,356,973
5,342,564,836	.....	....	.....
5,342,564,837	.....	....	.....
5,342,564,838	.....	....	.....
5,342,564,839	.....	....	.....
5,342,564,840	.....	....	.....

(* The Queen)

6,999,999,991	.....	.....	.....	.....
6,999,999,992	.....	.....	.....	.....
6,999,999,993	.....	.....	.....	.....
6,999,999,994	.....	.....	.....	.....
6,999,999,995	.....	.....	.....	.....
6,999,999,996	.....	.....	.....	.....
6,999,999,997	.....	.....	.....	.....
6,999,999,998	.....	.....	.....	.....
6,999,999,999	Zojj Zinyama	Zimbabwe	£3,564	
7,000,000,000	Zuka Zinyama	Zimbabwe	£1,236	




```
set running total to zero
start at top of list
add income to total
go to next item in list
repeat if not at end of list
print total
```


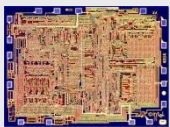
how long does it take?

Year	Intel CPU	Frequ-ency	Operations per second	Time per operation	Time per loop	Total time
1966						
1971						
1993						
2012						


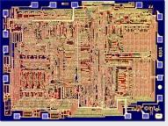

how long does it take?

Year	Intel CPU	Frequ-ency	Operations per second	Time per operation	Time per loop	Total time
1966	 Me	1 Hz	1	1 second	3 seconds	650 years
1971						
1993						
2012						


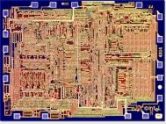


how long does it take?

Year	Intel CPU	Frequ-ency	Operations per second	Time per operation	Time per loop	Total time
1966	 Me	1 Hz	1	1 second	3 seconds	650 years
1971	 i4004	100 KHz	100 thousand	10 micro-seconds (millionths of a second)	30 micro-seconds	2½ days
1993						
2012						

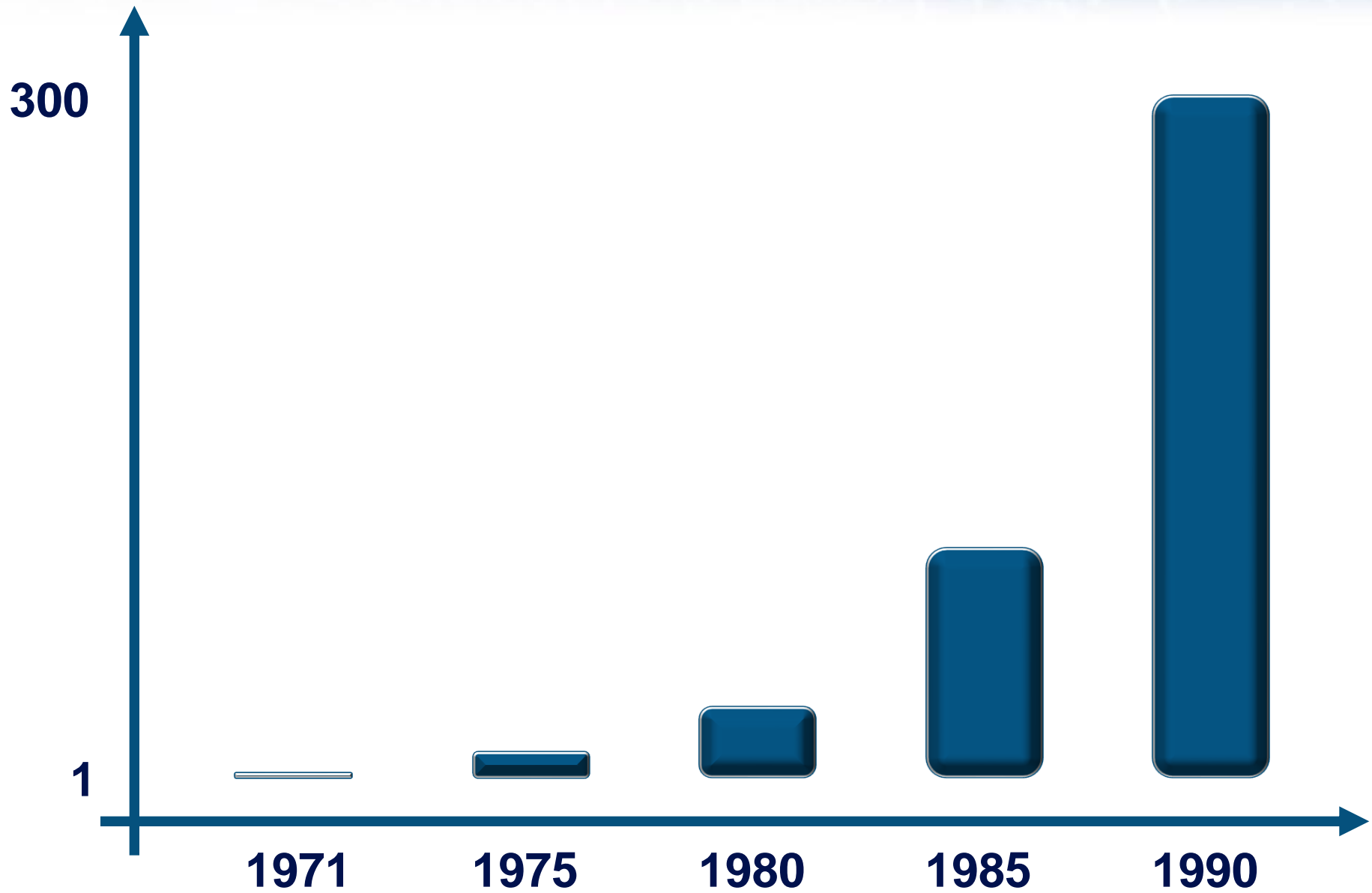
how long does it take?

Year	Intel CPU	Frequ-ency	Operations per second	Time per operation	Time per loop	Total time
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1993	 Pentium	60 MHz	60 million	17 nano-seconds	50 nano-seconds	6 minutes
2012						

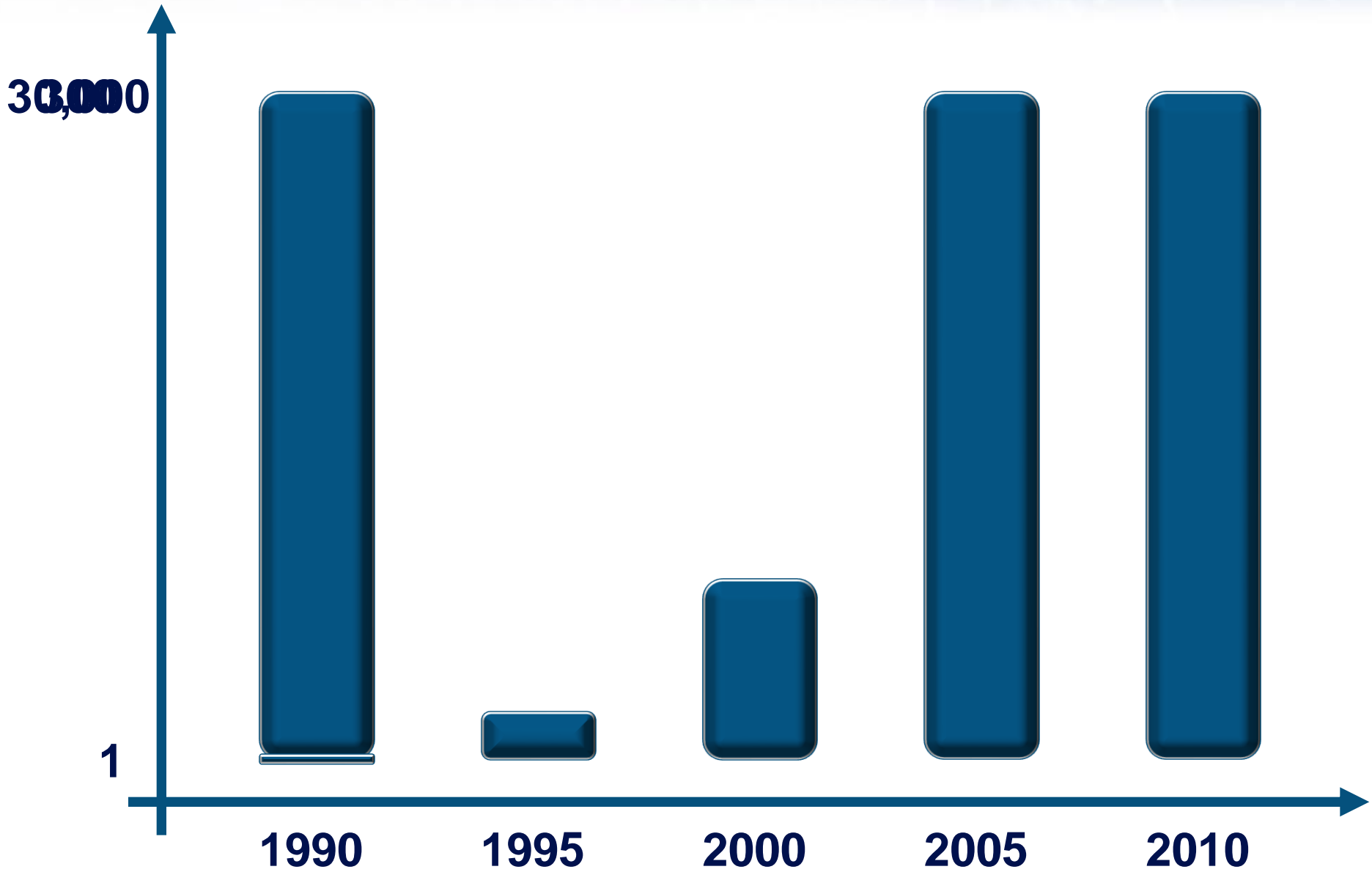
how long does it take?

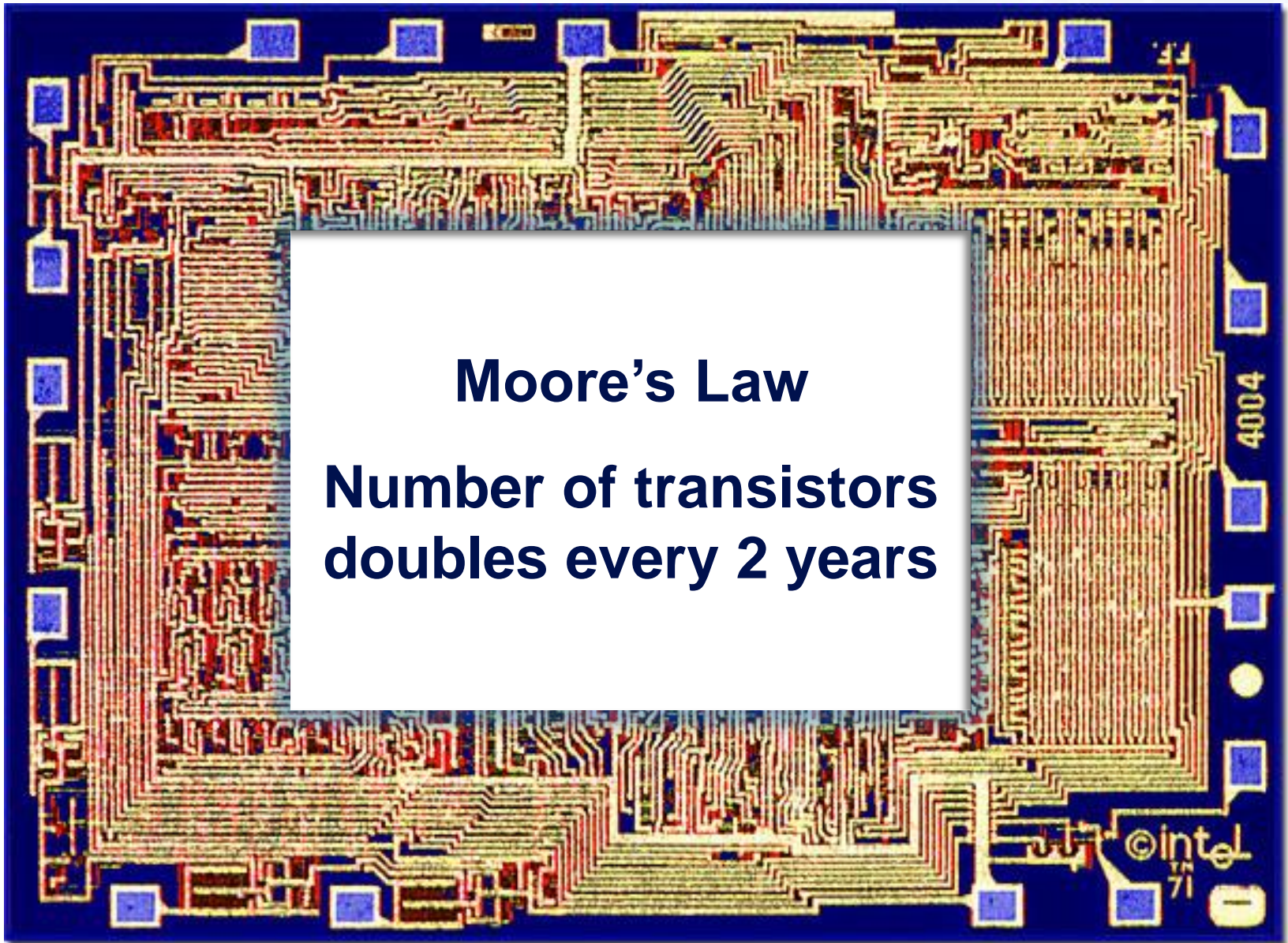
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1993	 Pentium	60 MHz	60 million	17 nano-seconds	50 nano-seconds	6 minutes
2012	 Core i7	3 GHz	3 billion	0.3 nano-seconds (billionths of a second)	1 nano-second	7 seconds

how much faster?



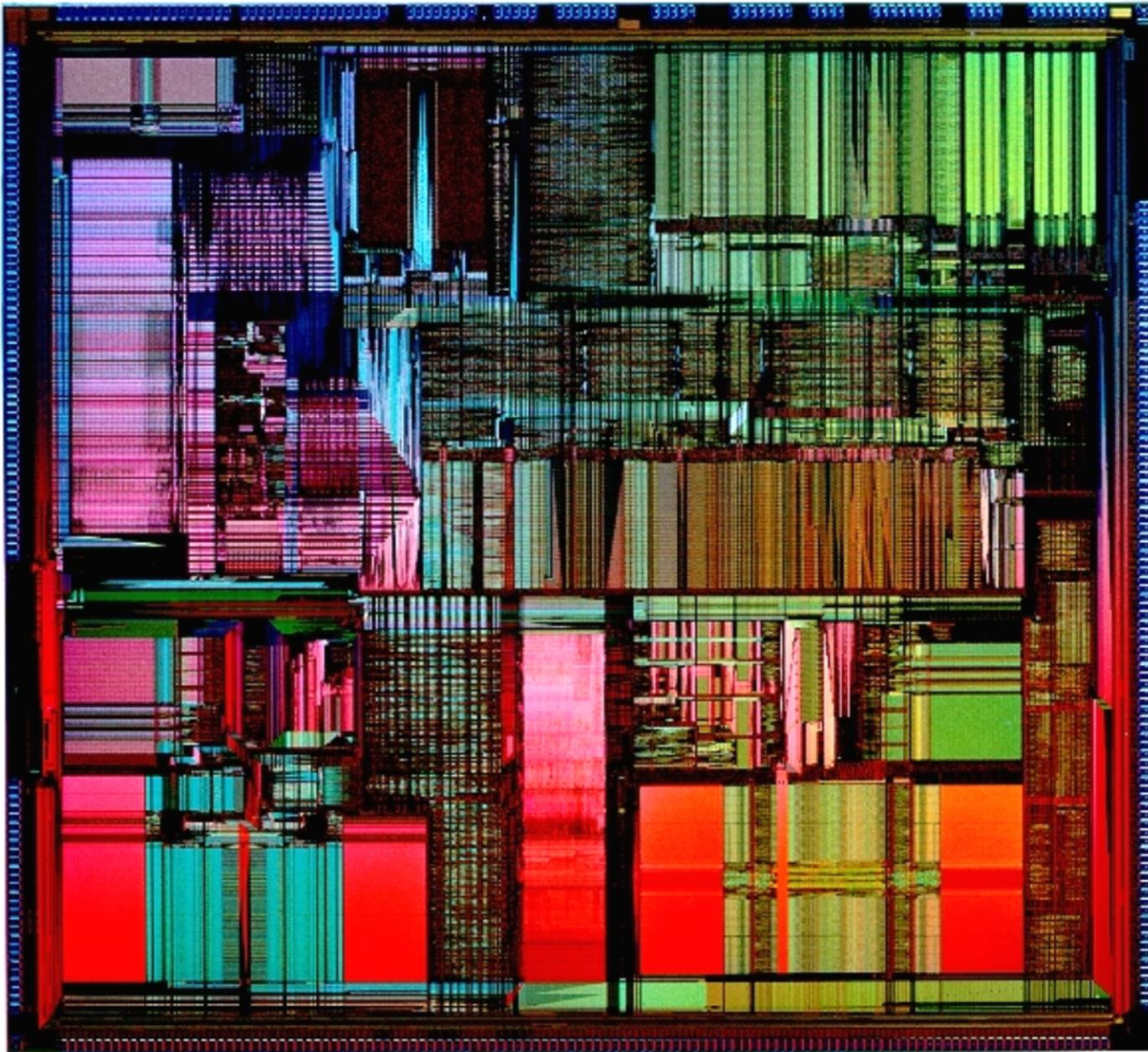
how much faster?



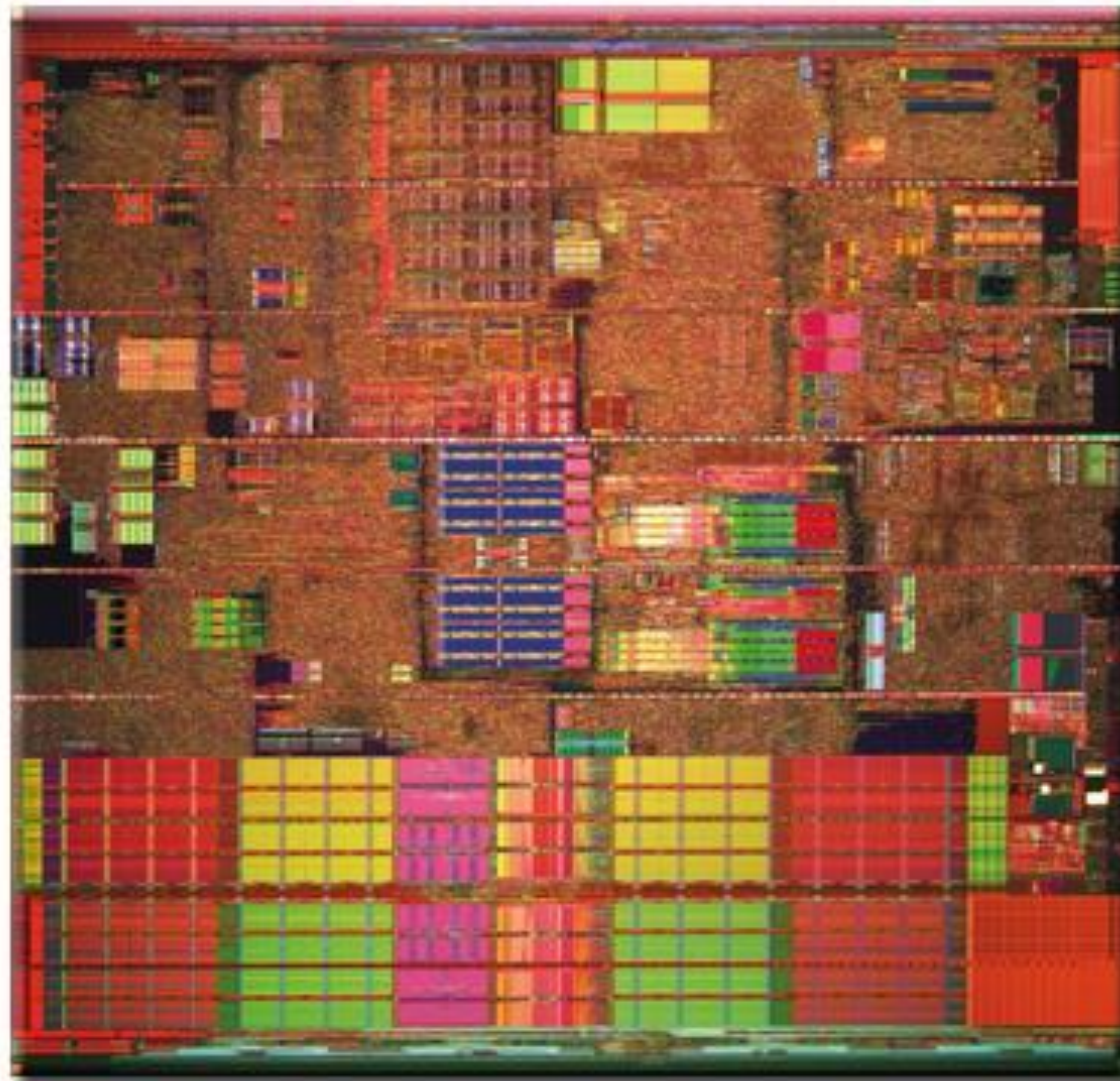


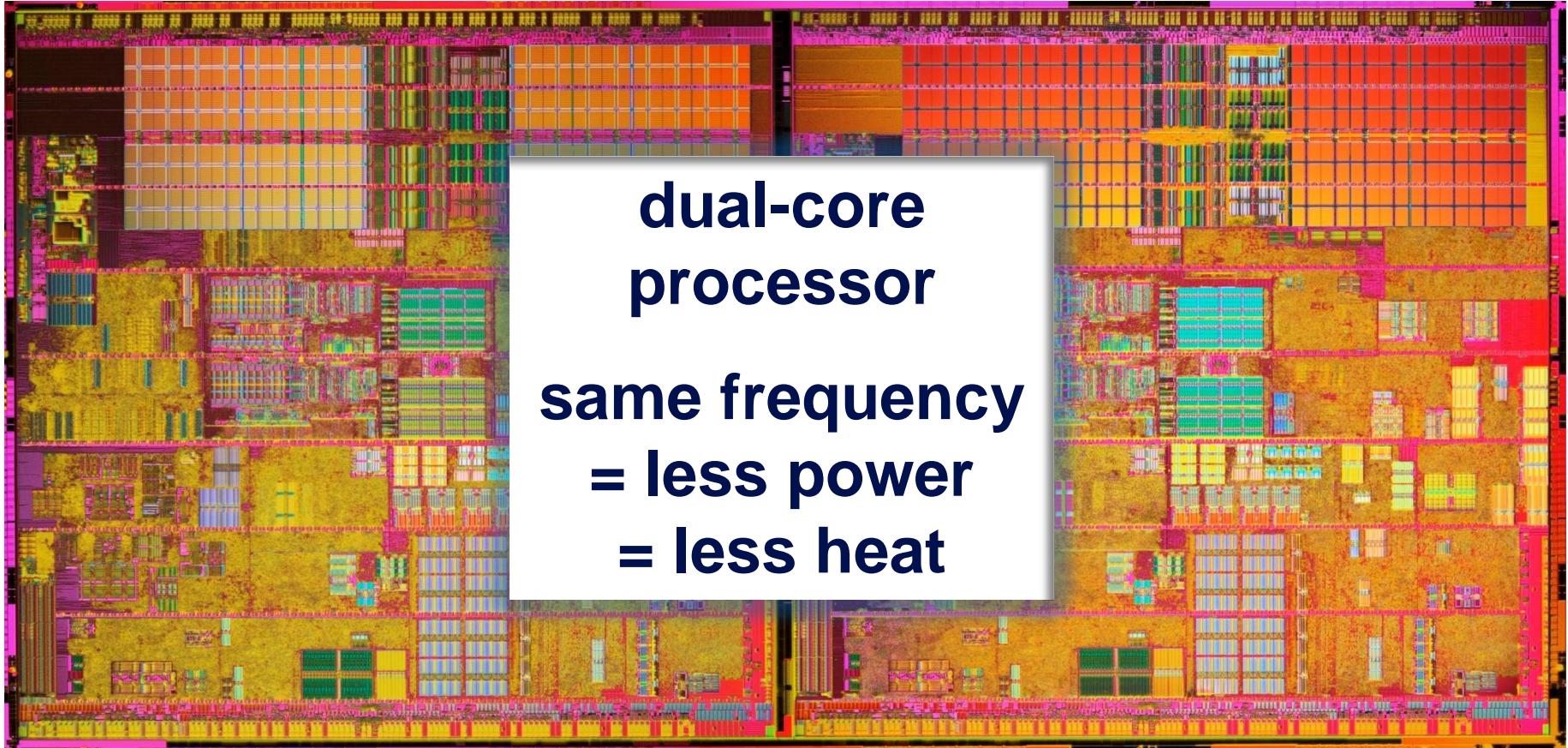
Moore's Law
**Number of transistors
doubles every 2 years**

three million transistors (1993)



100 million transistors (2004)



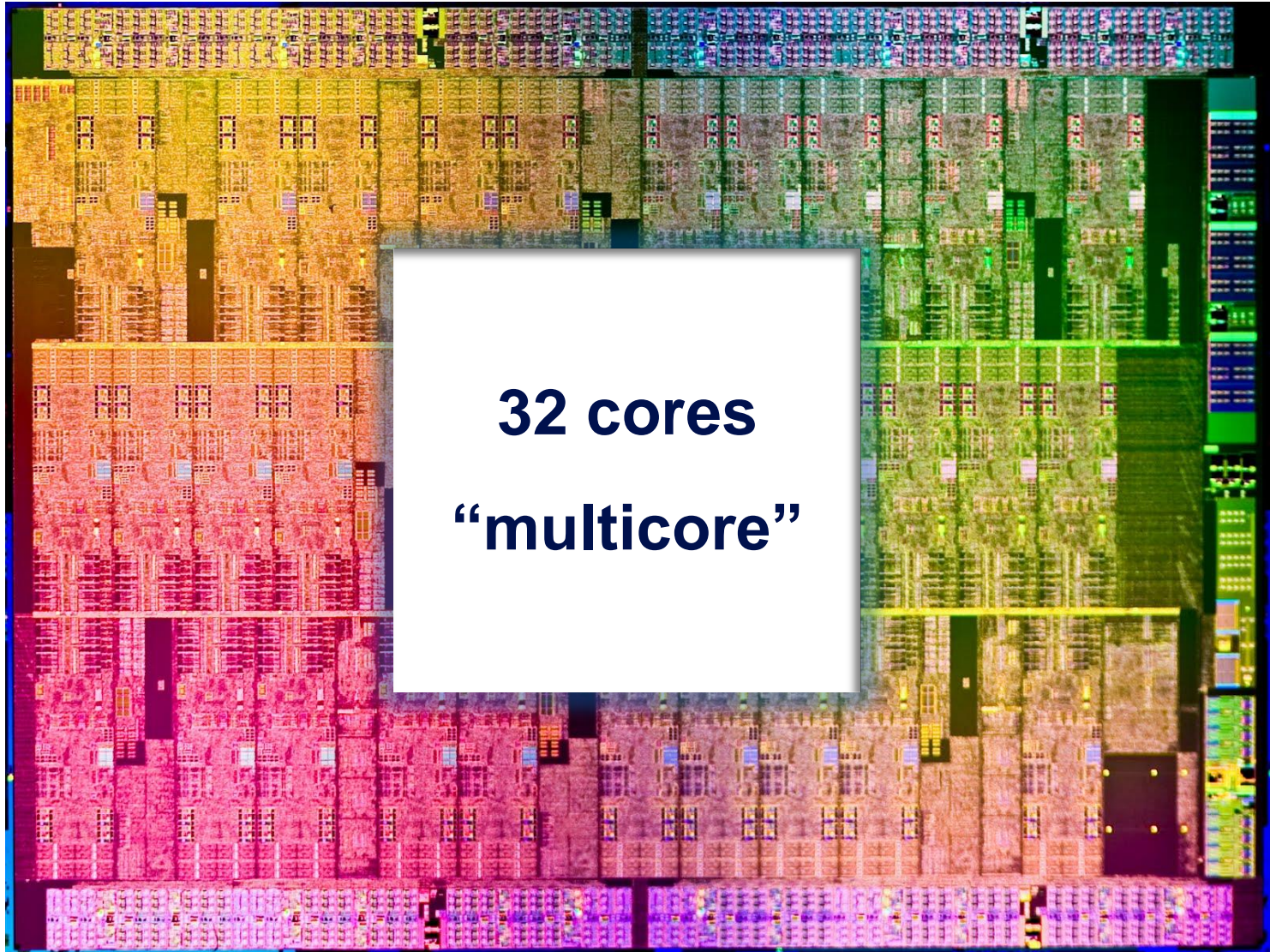


serial ► **adjective** [*attrib*] *Computing*

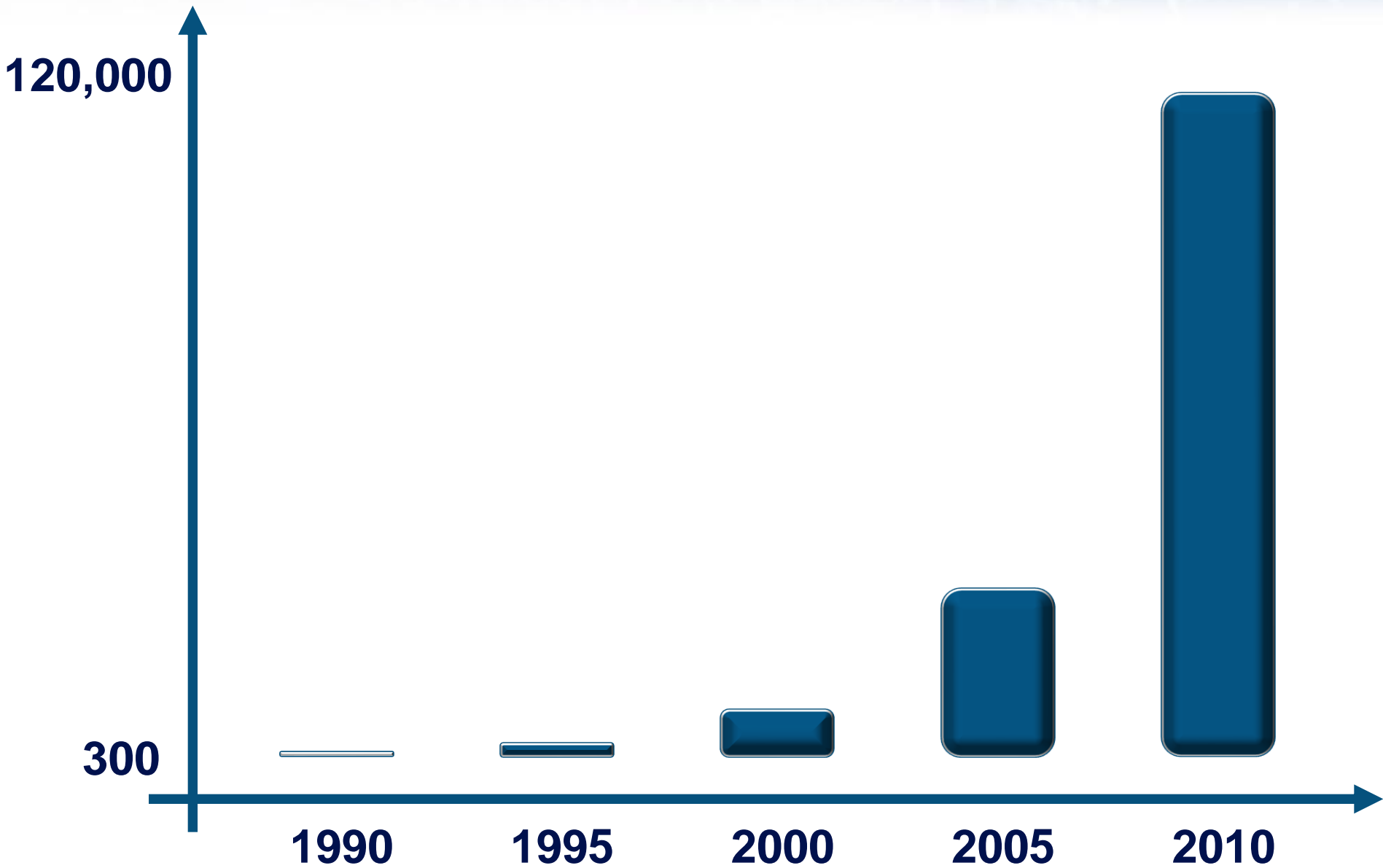
parallel processing ► **noun** [*mass noun*] *Computing*

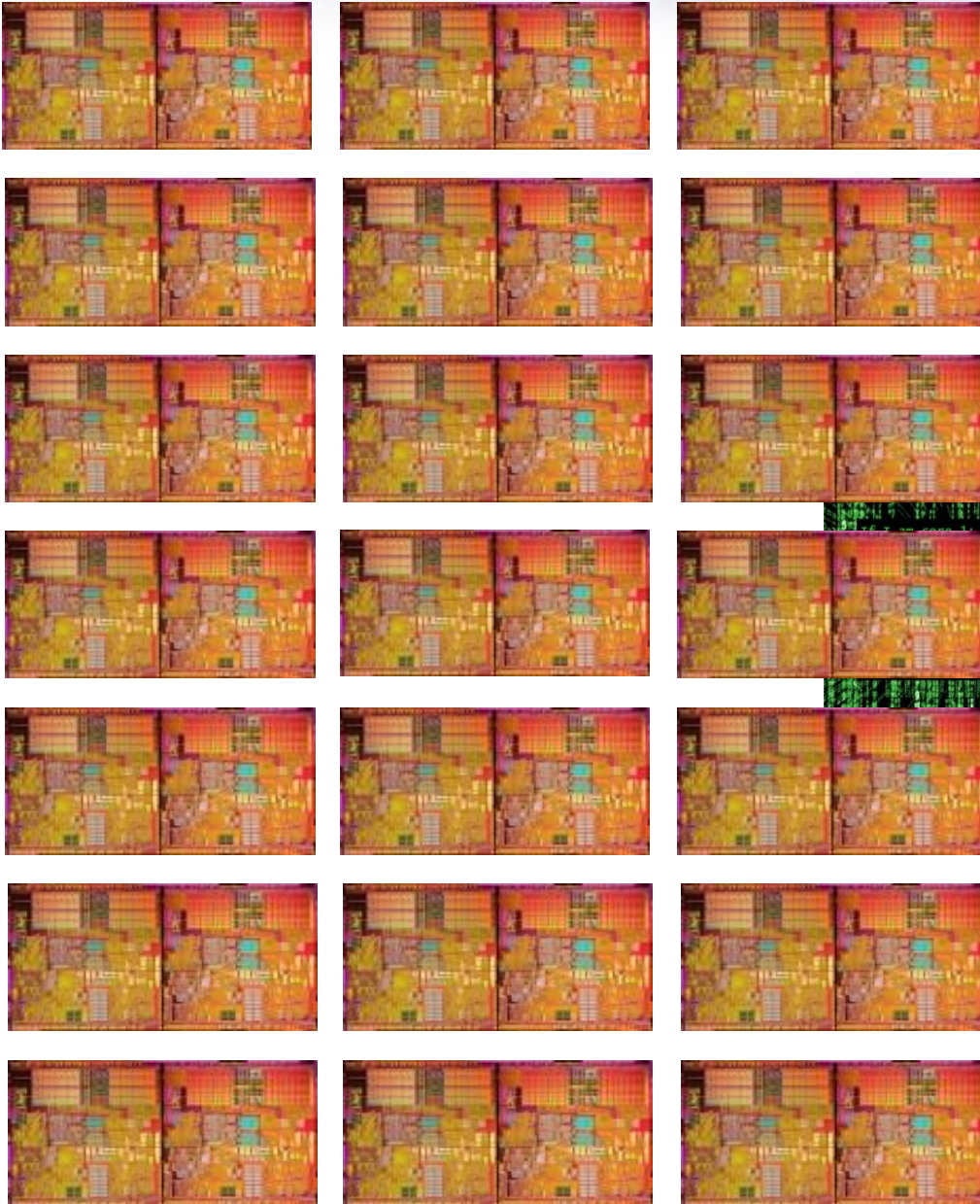
a mode of operation in which a process is split into many parts, which are executed simultaneously on different processors attached to the same computer.

```
if I am core 1:  
    total1 = sum top half list  
if I am core 2:  
    total2 = sum bottom half list  
wait for both cores to finish  
total = total1 + total2  
print total
```



how much faster in parallel?





```
top half list
bottom half list
wait for both cores to finish
total2
```

+ =

```
If I am core 1:
    total1 = sum top half list
If I am core 2:
    total2 = sum bottom half list
wait for both cores to finish
total = total1 + total2
Print total
```

= *super fast*



5632 CPUs
90,112 cores
90,112 GB
1 Megawatt

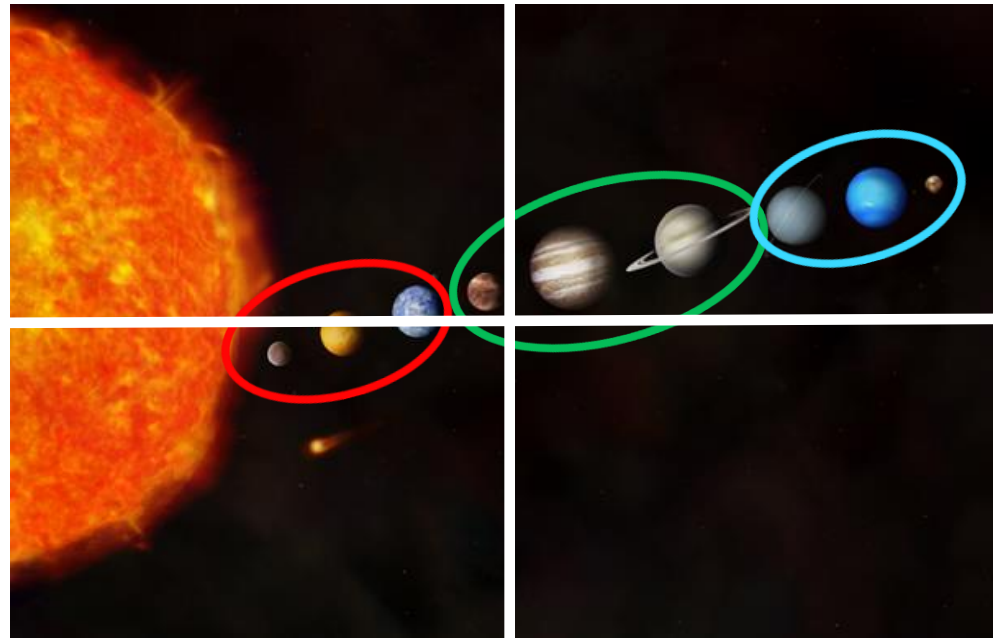
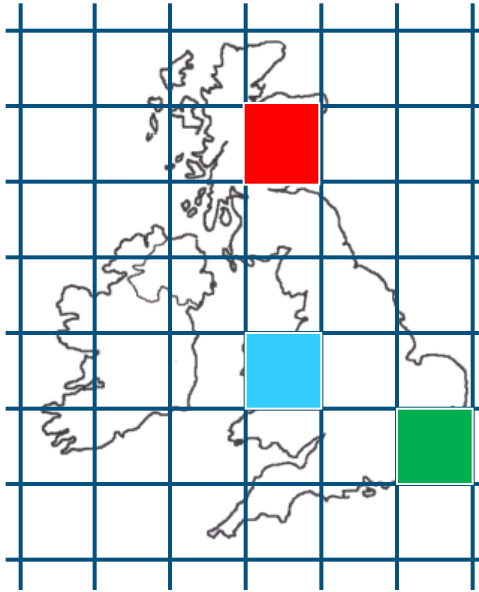
very fast network



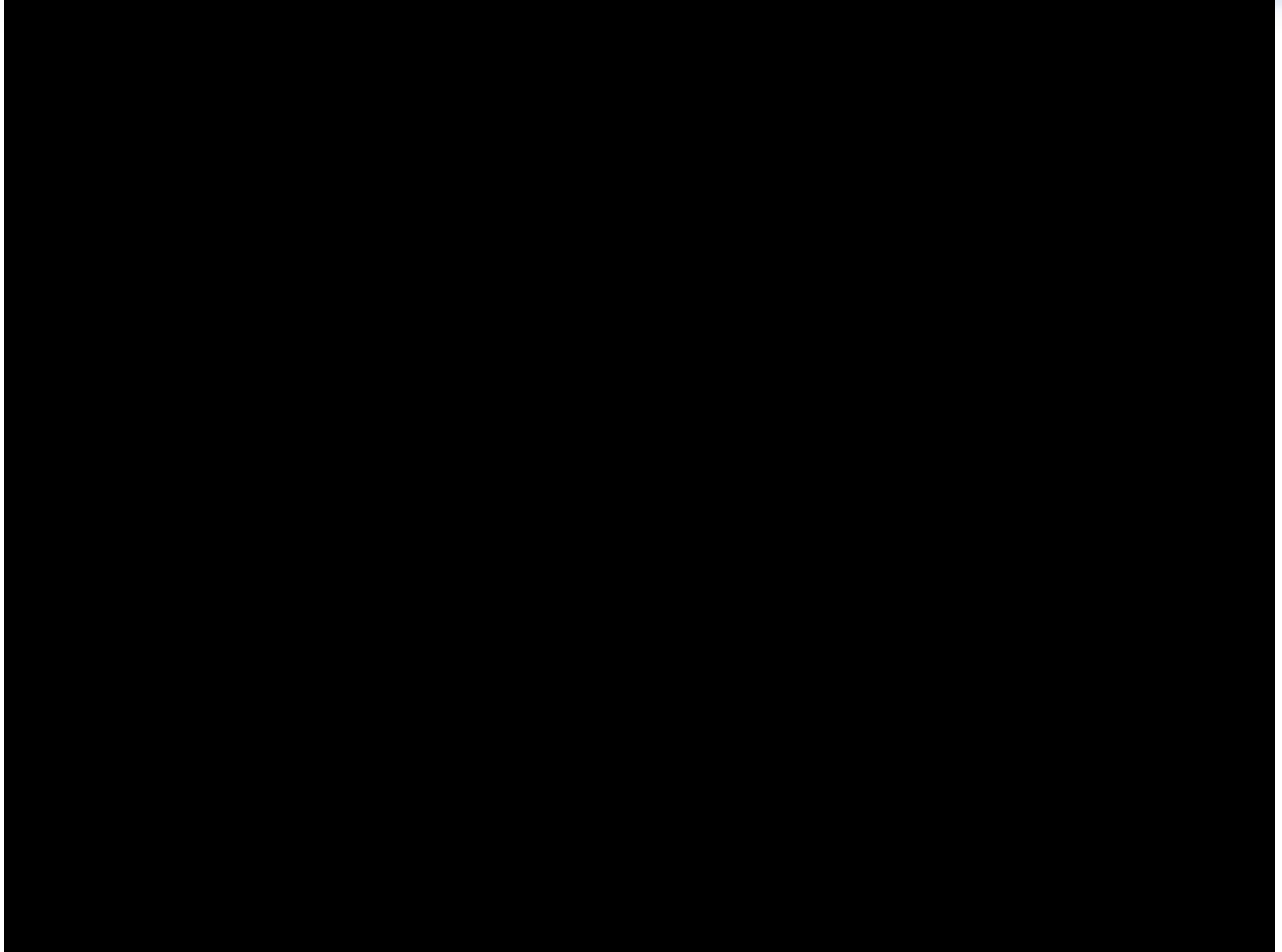
9840 CPUs
118,080 cores
338,944 GB
1 Megawatt

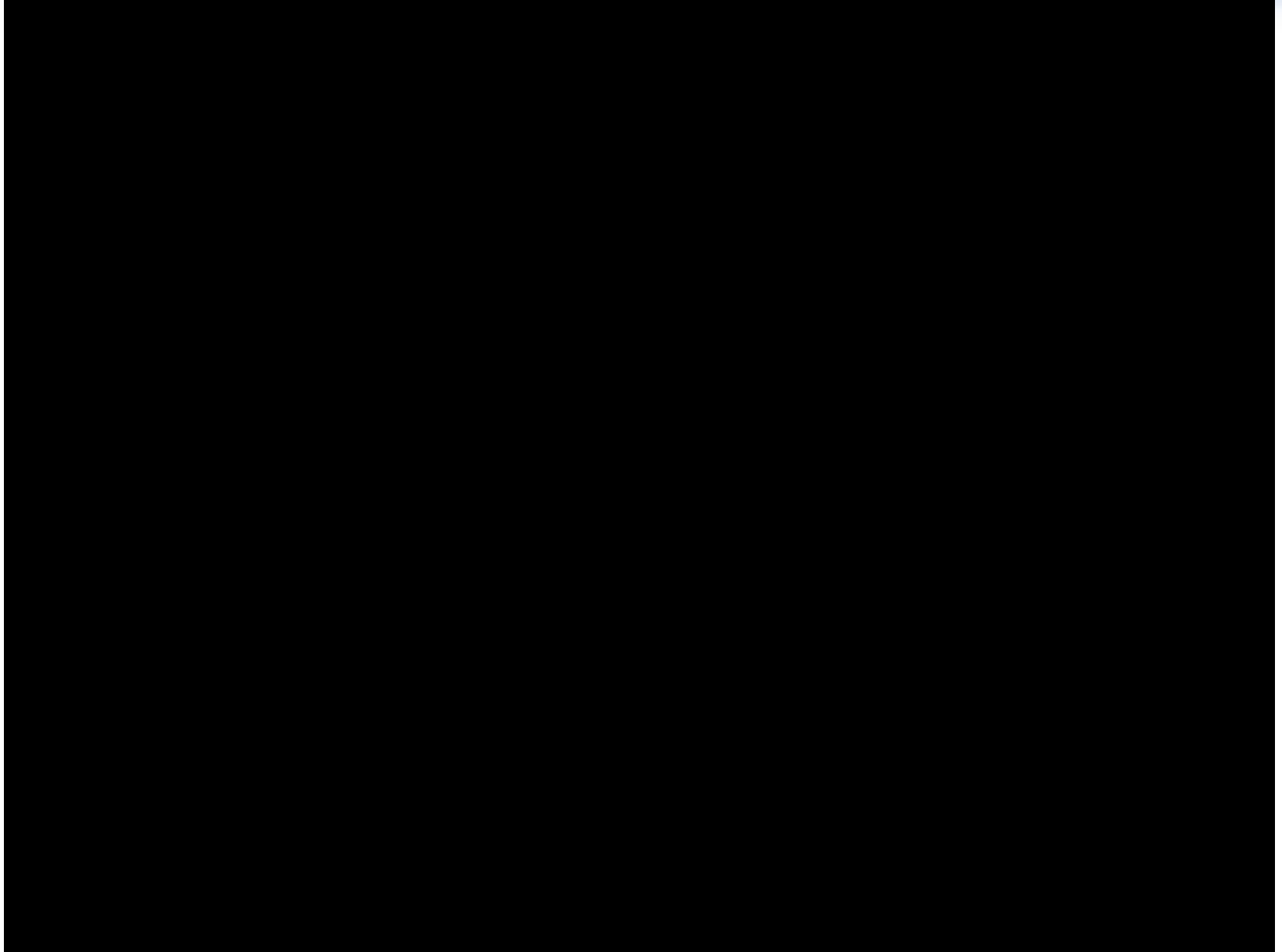
even faster network and CPUs





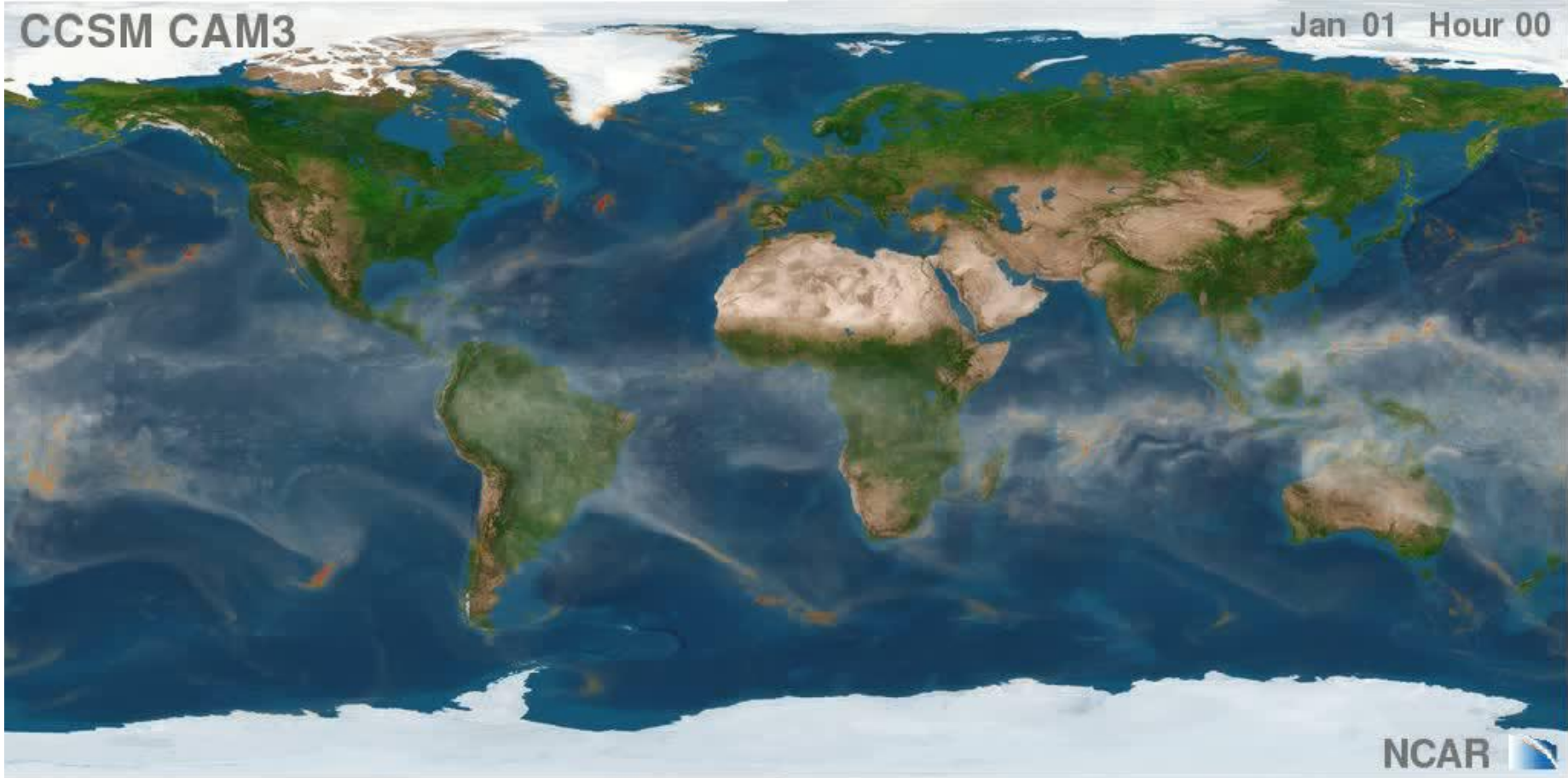
```
using System; // C# does not import a .h file, uses metadata
namespace FirstApplication // scope for classes. No Obj-c counterpart
{
    class Person // only uses class implementation
    {
        private DateTime birthDate; // a private field accessible to this class
        private int ageOn(DateTime date) // a private method
        {
            TimeSpan span = date.Subtract(birthDate); //uses a .notation to invoke
            return span.Days;
        }
        public int age // this is a property.
        {
            Get // just a getter; it's a read-only property
            {
                return this.ageOn(DateTime.Now);
            }
        }
        public Person( DateTime dob) // instance constructor. Unlike Objective-C
        { // it combines allocation and initialization
            birthDate = dob;
        }
    }
    class Program //Unlike Obj-C, another class in the same file.
    {
        static void Main(string[] args) // main entry point into the program
        {
            Person p = new Person(new DateTime(1973,11,12)); //construct an instance
            System.Console.WriteLine("The age is is" + p.age.ToString());
            DateTime dt = p.birthDate; //error in compilation birthDate is private
        }
    }
}
```

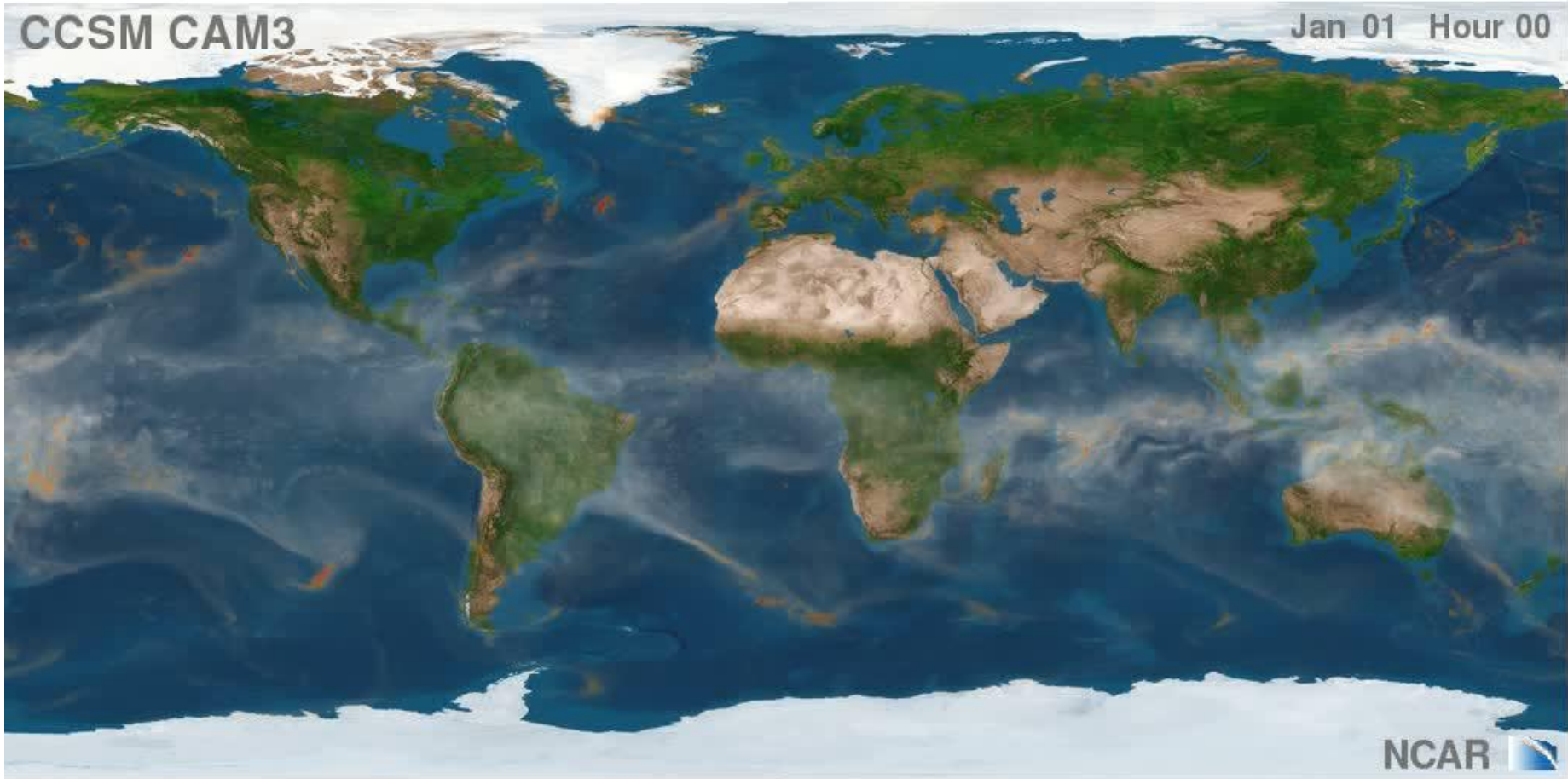


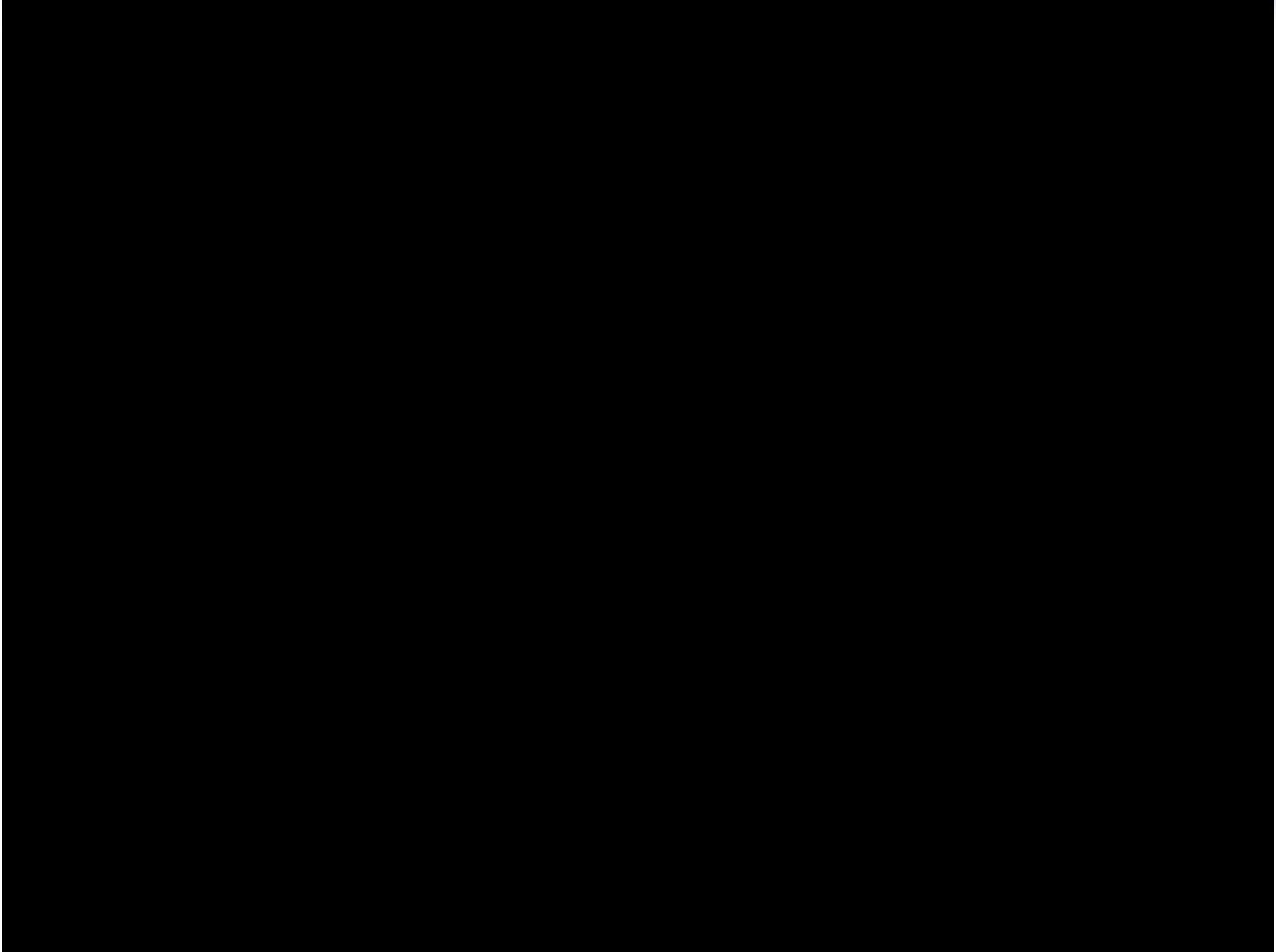


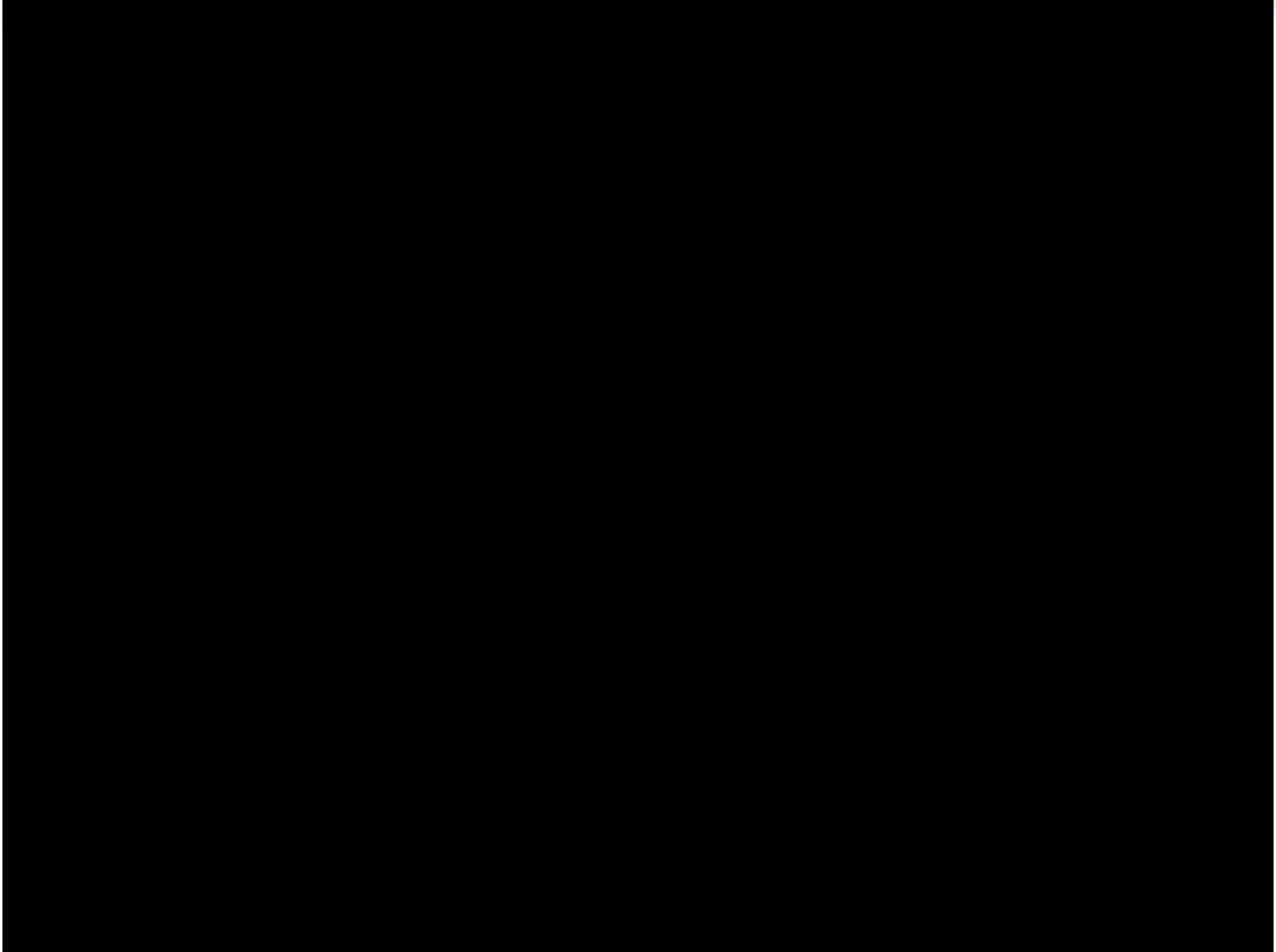
Searching for Baryon
Acoustic Oscillations in
Intergalactic Absorption
Project StarGate Application Driver

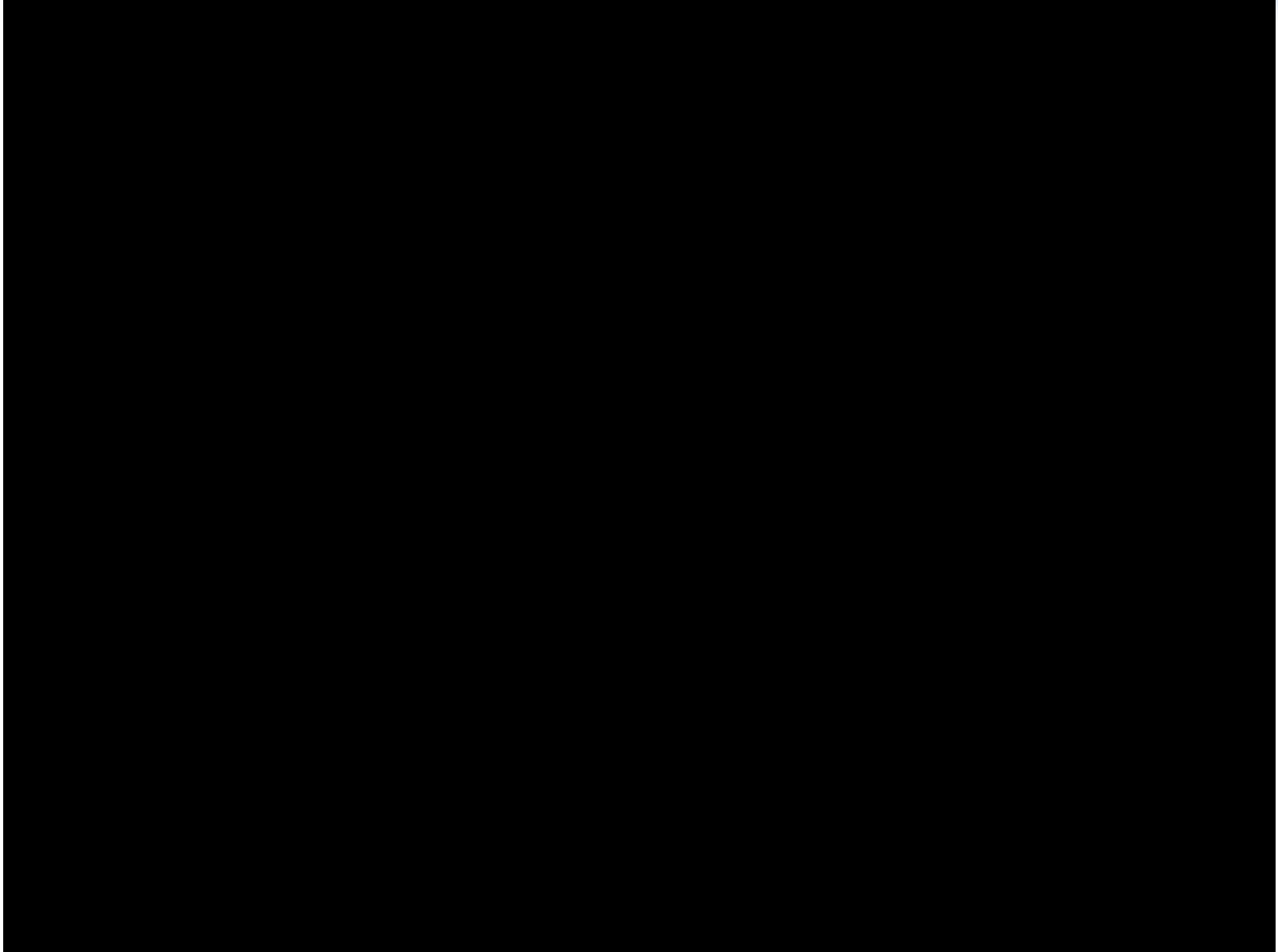
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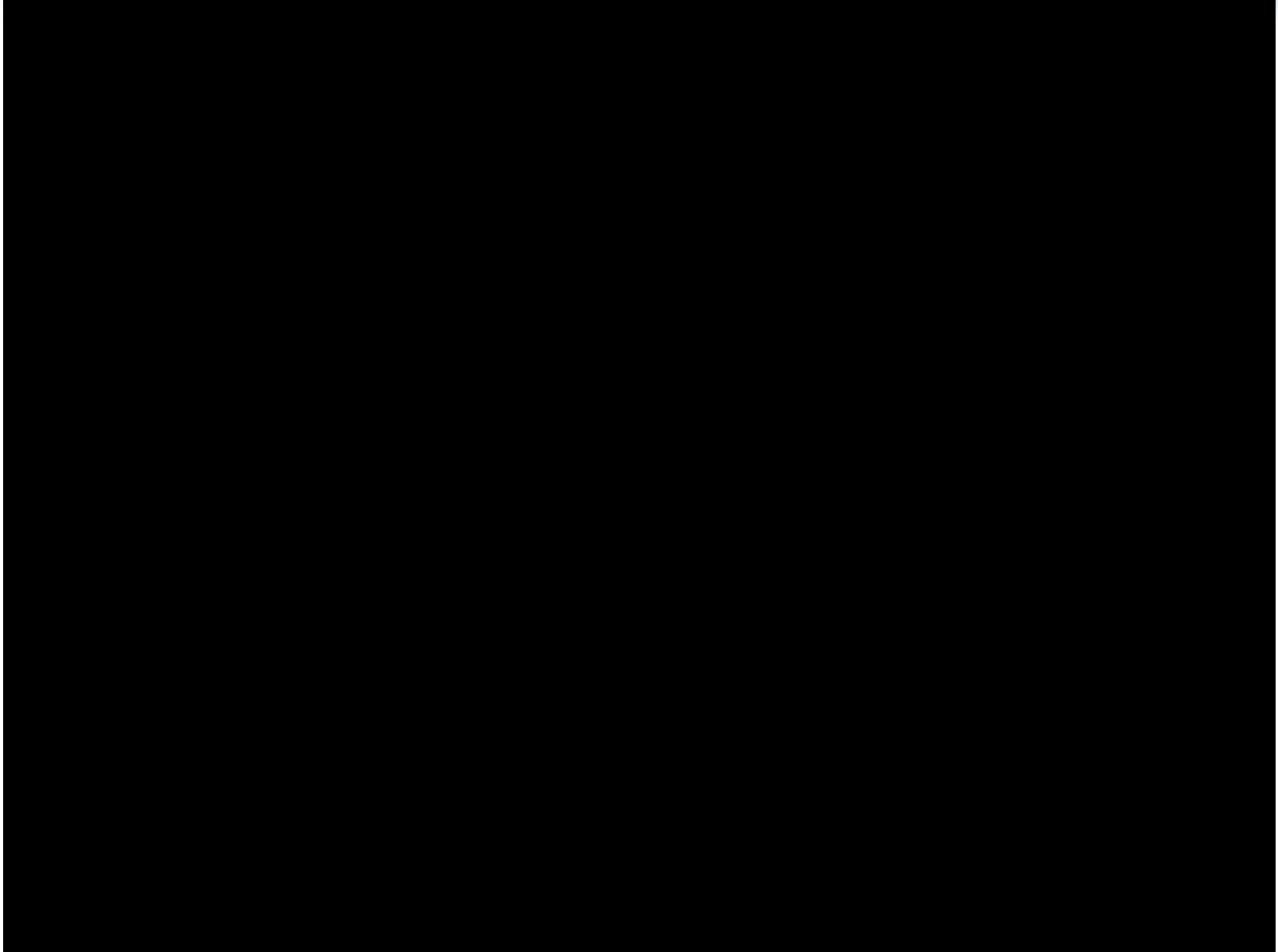


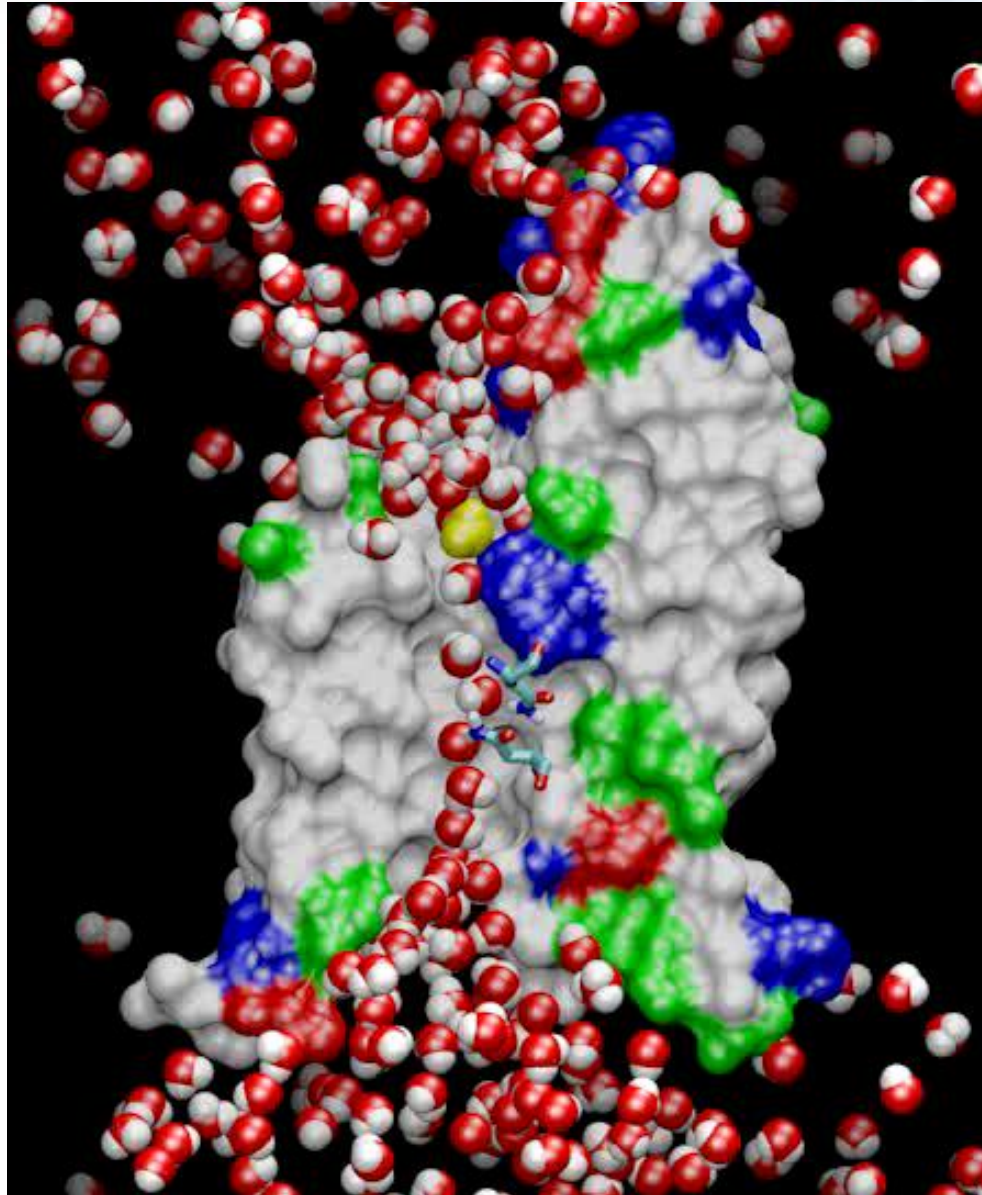


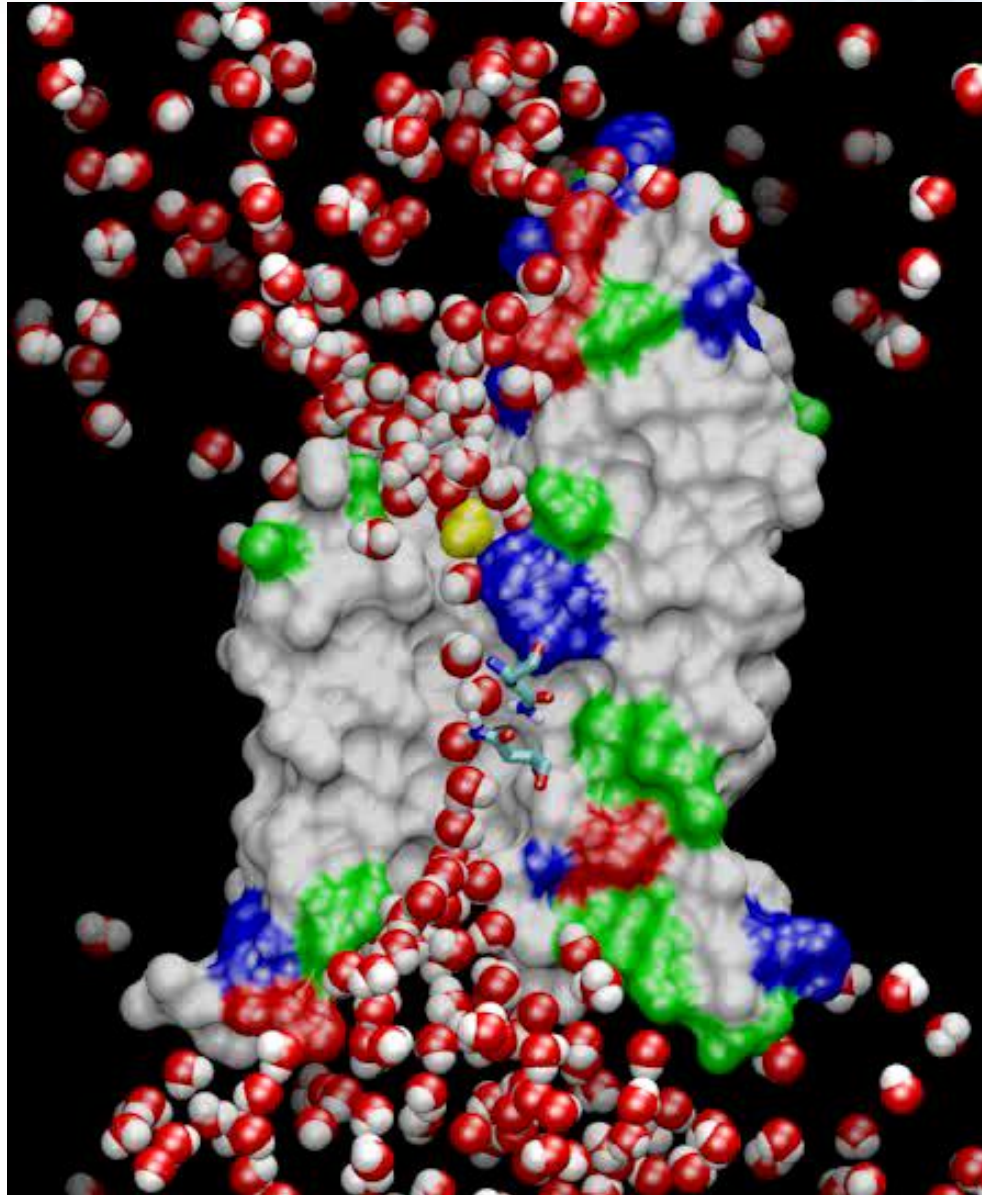


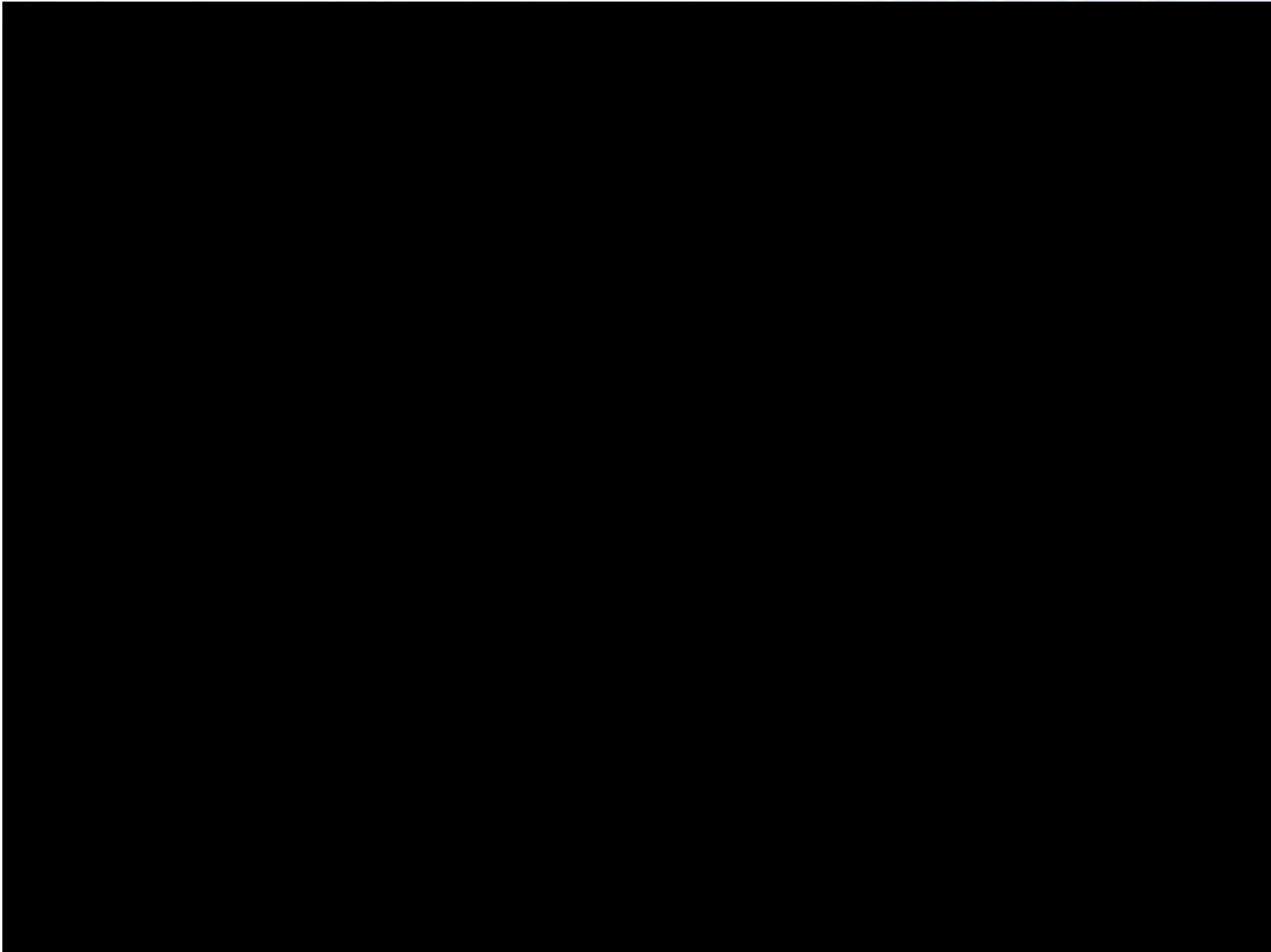


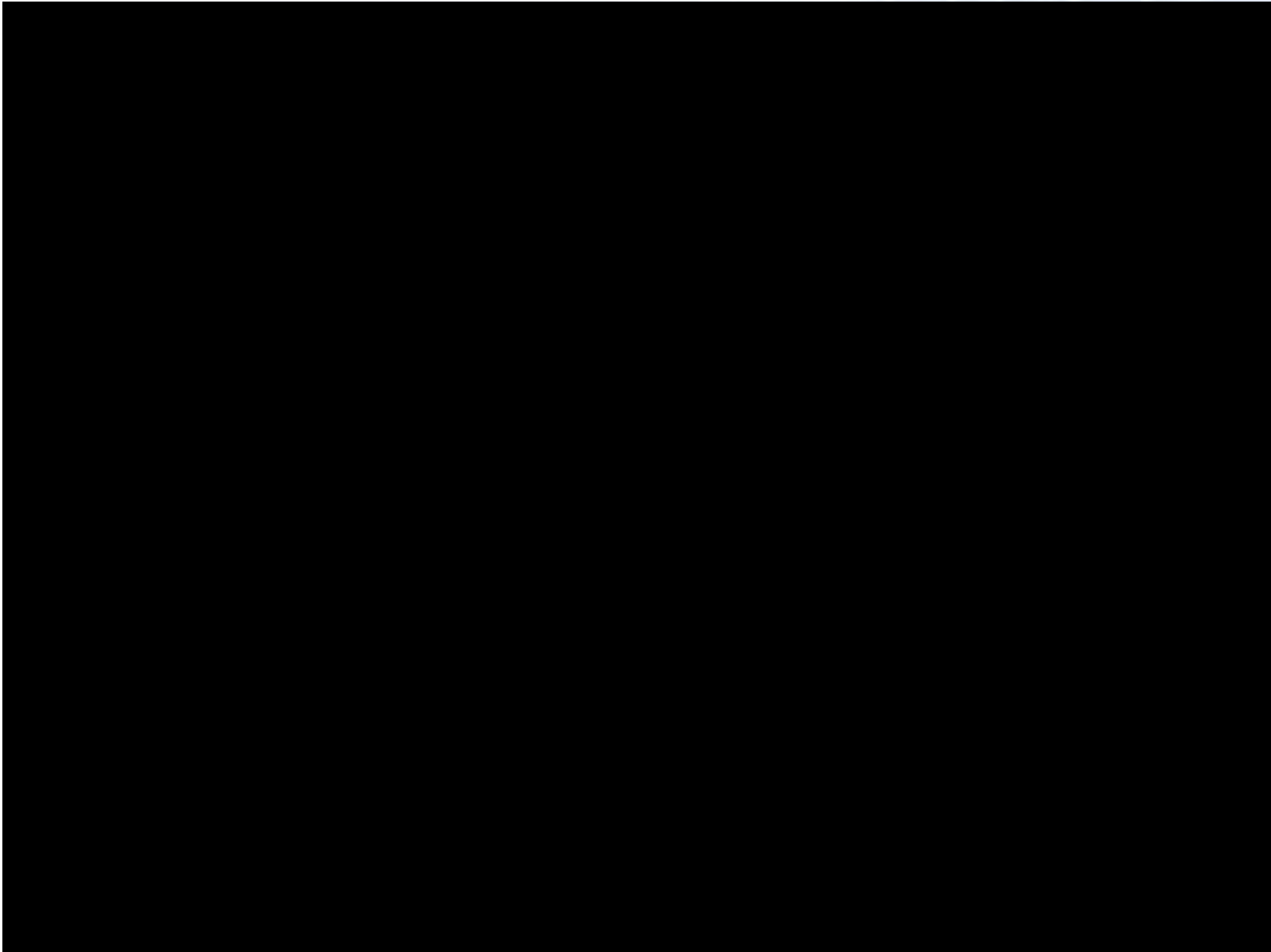


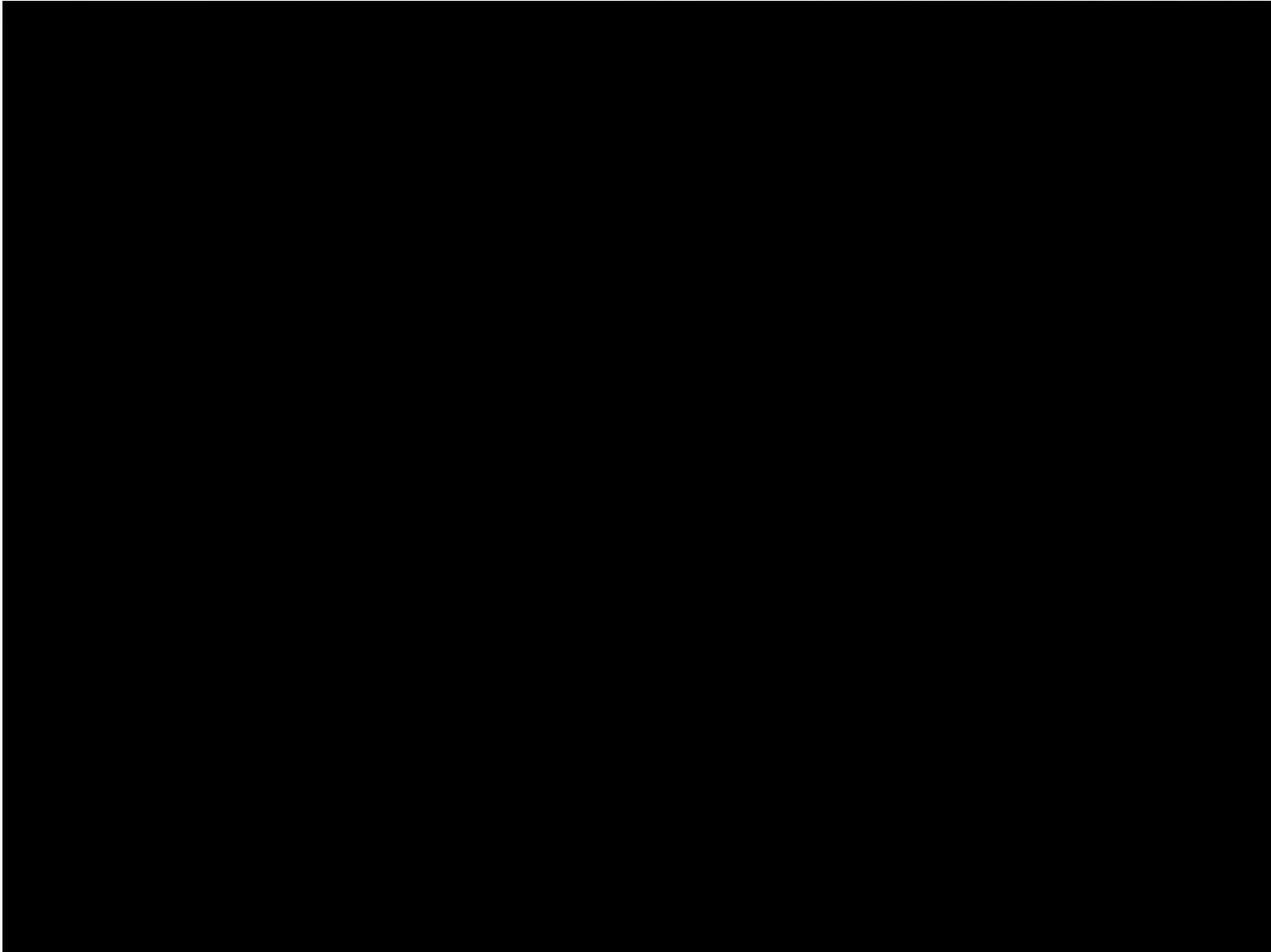


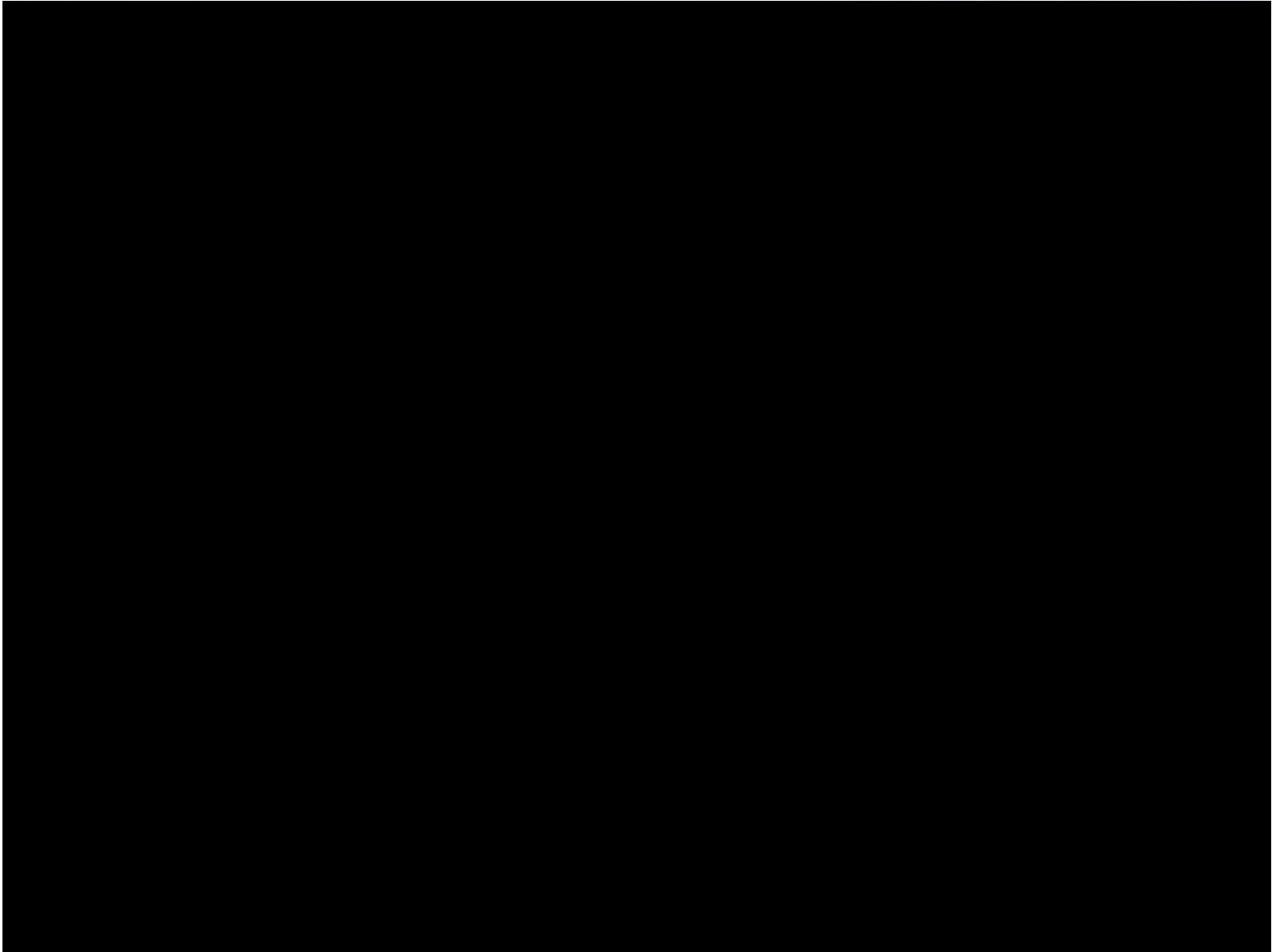


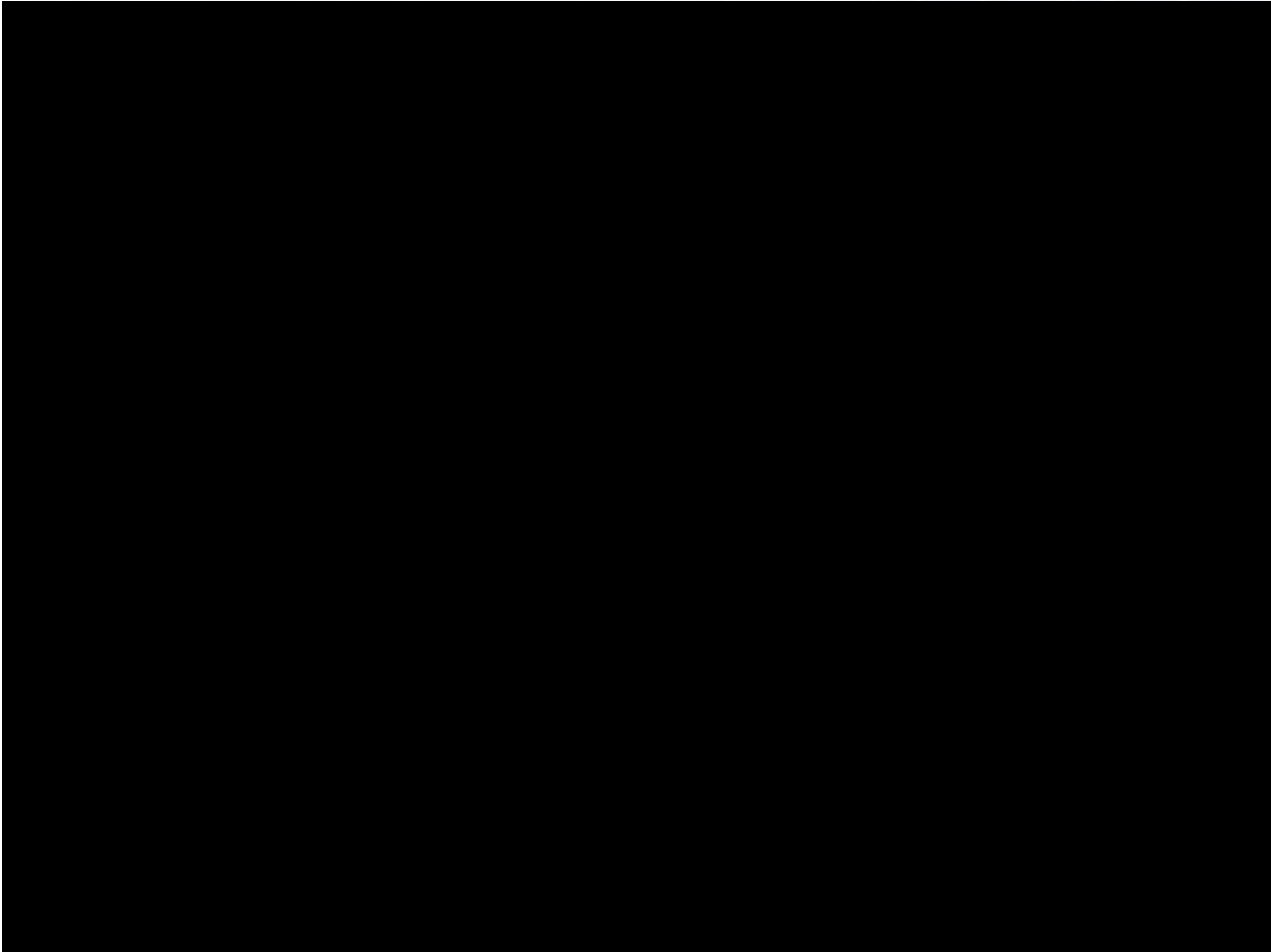


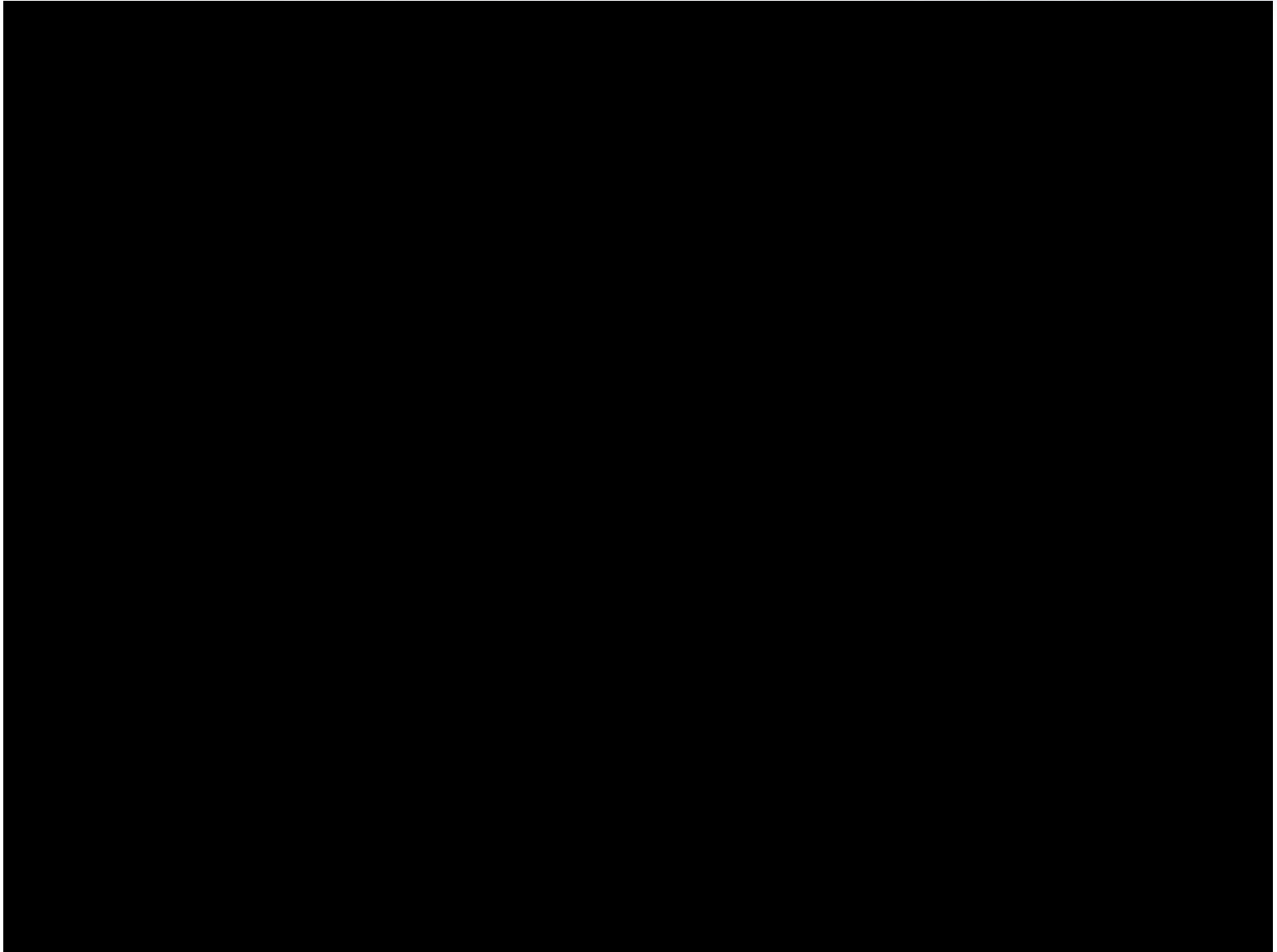


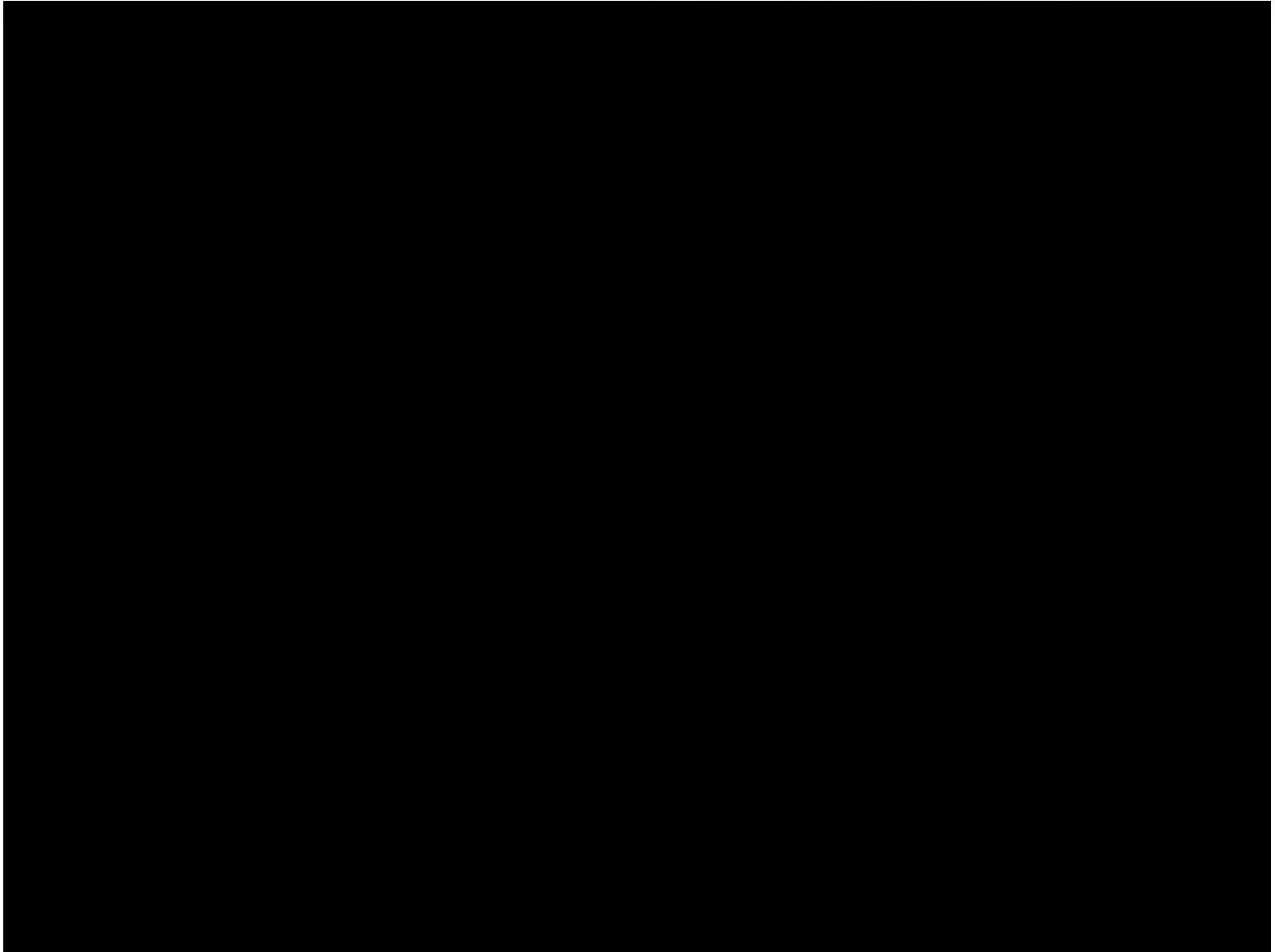


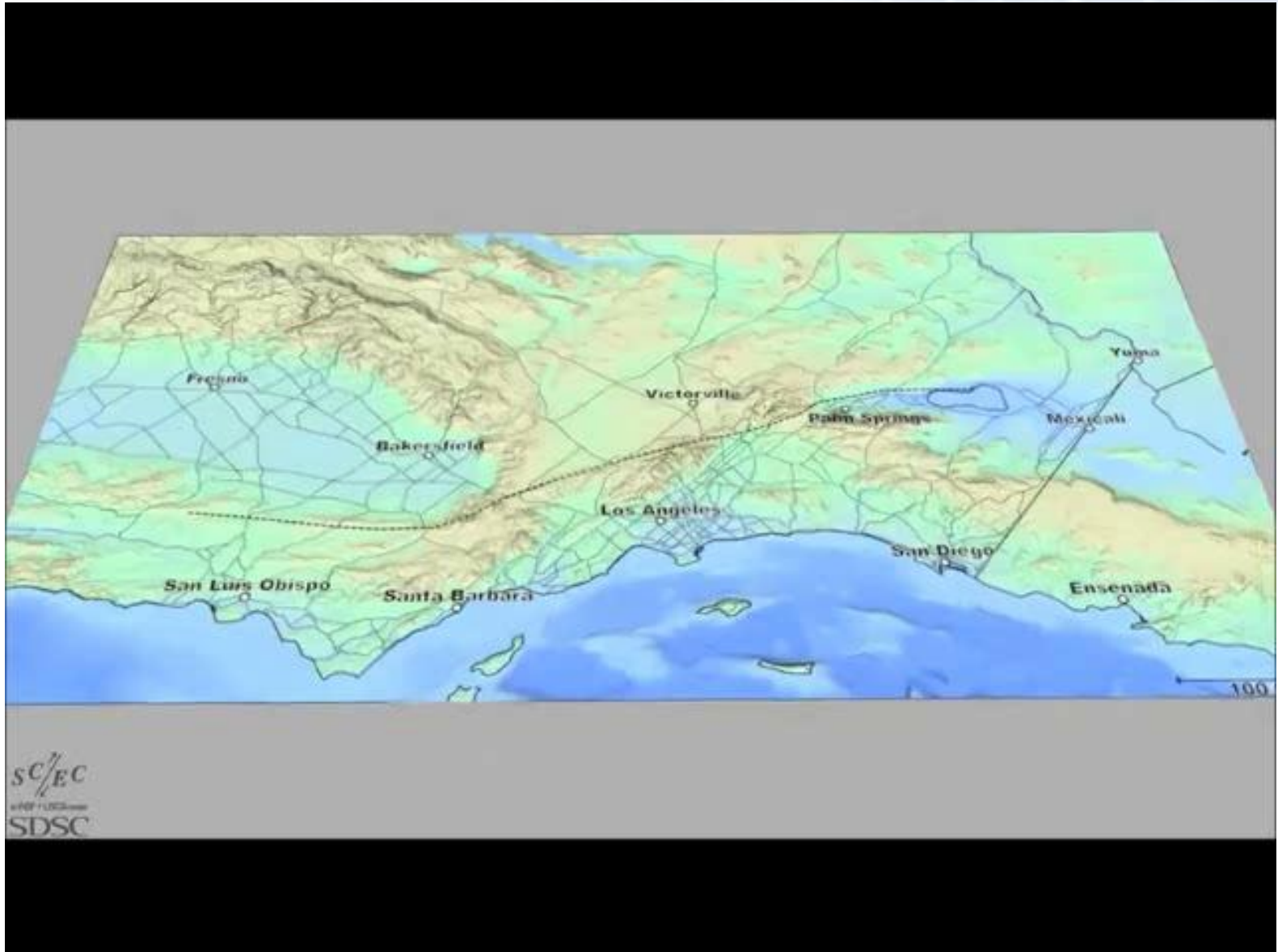


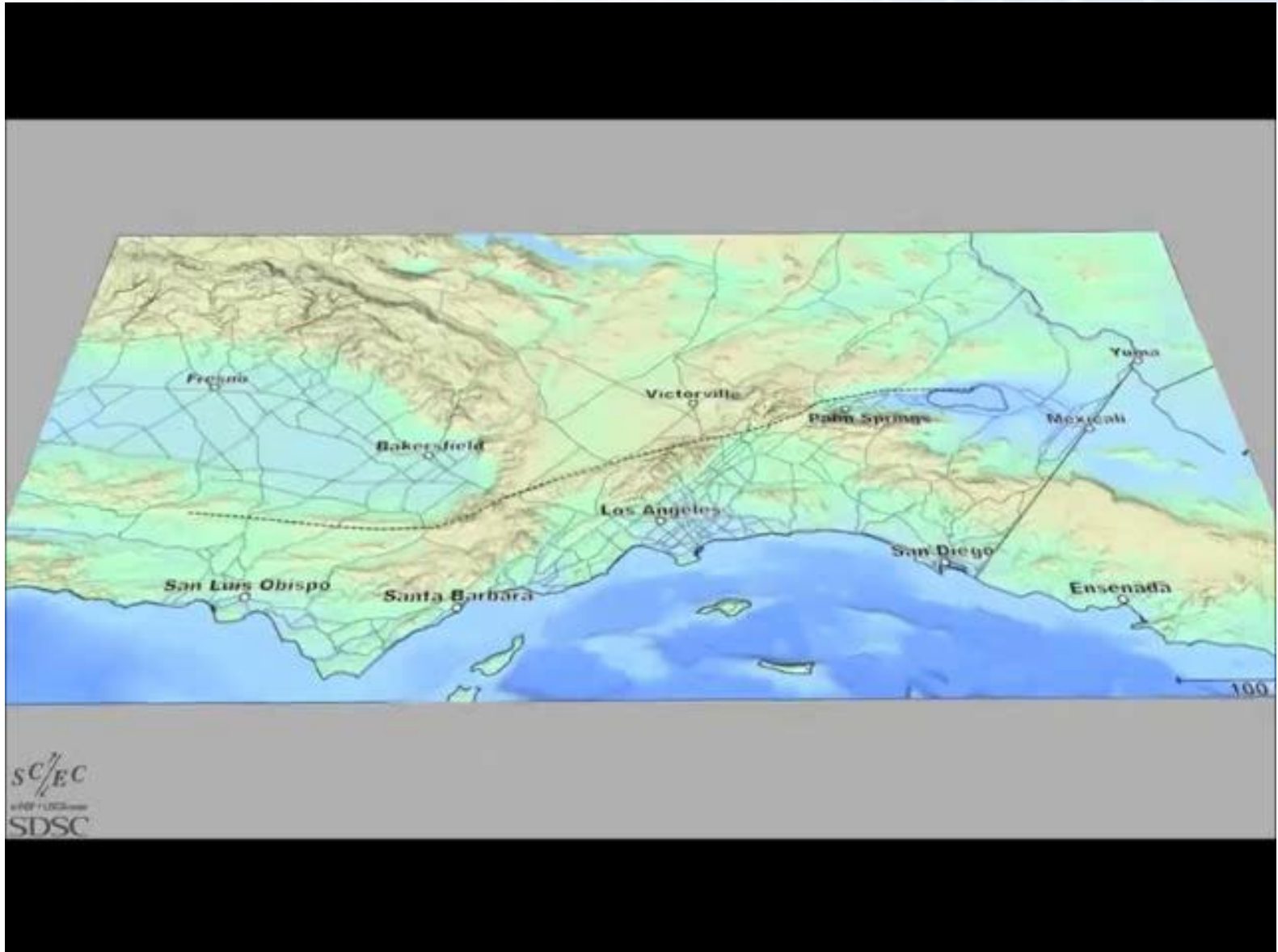






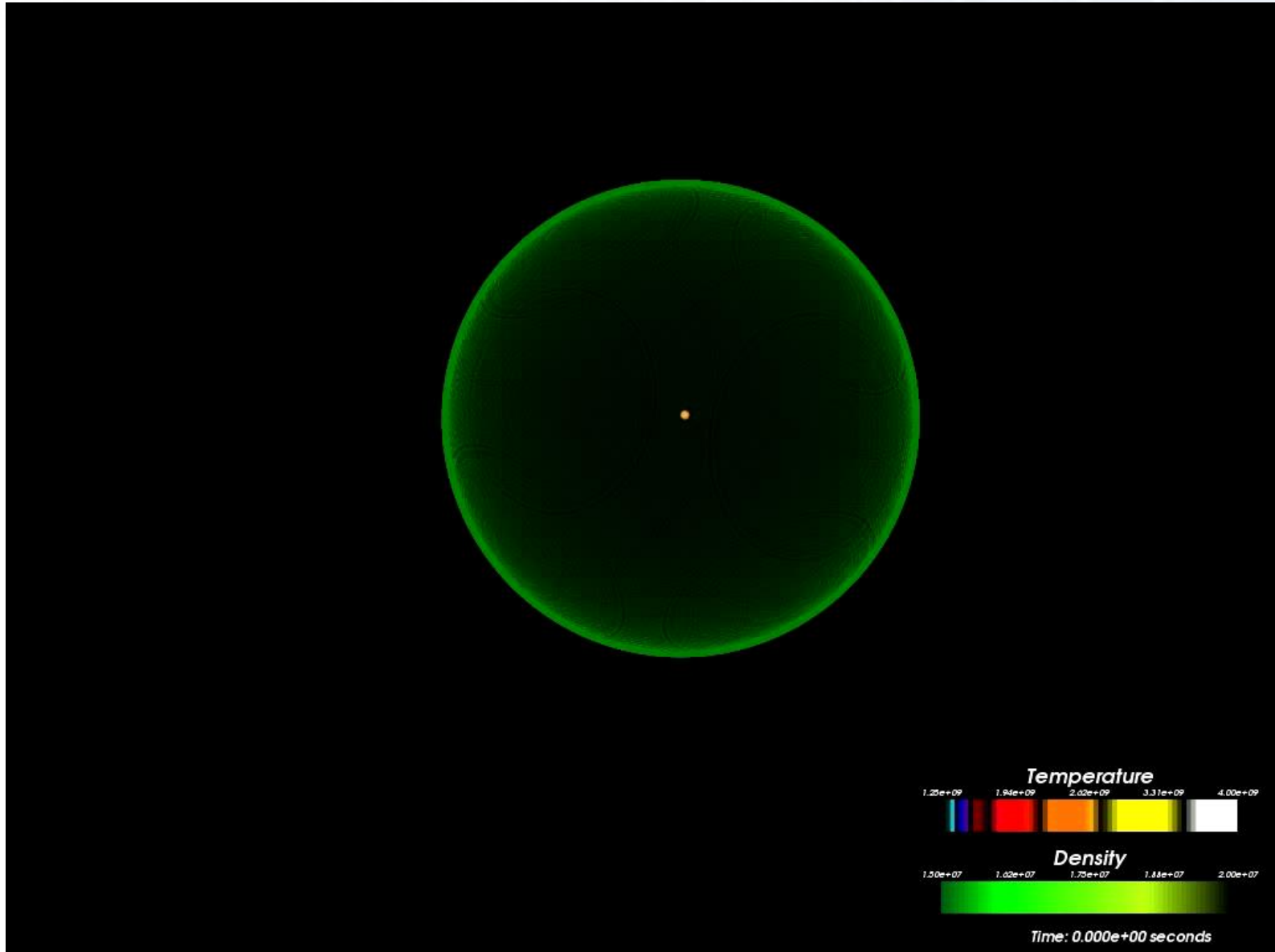


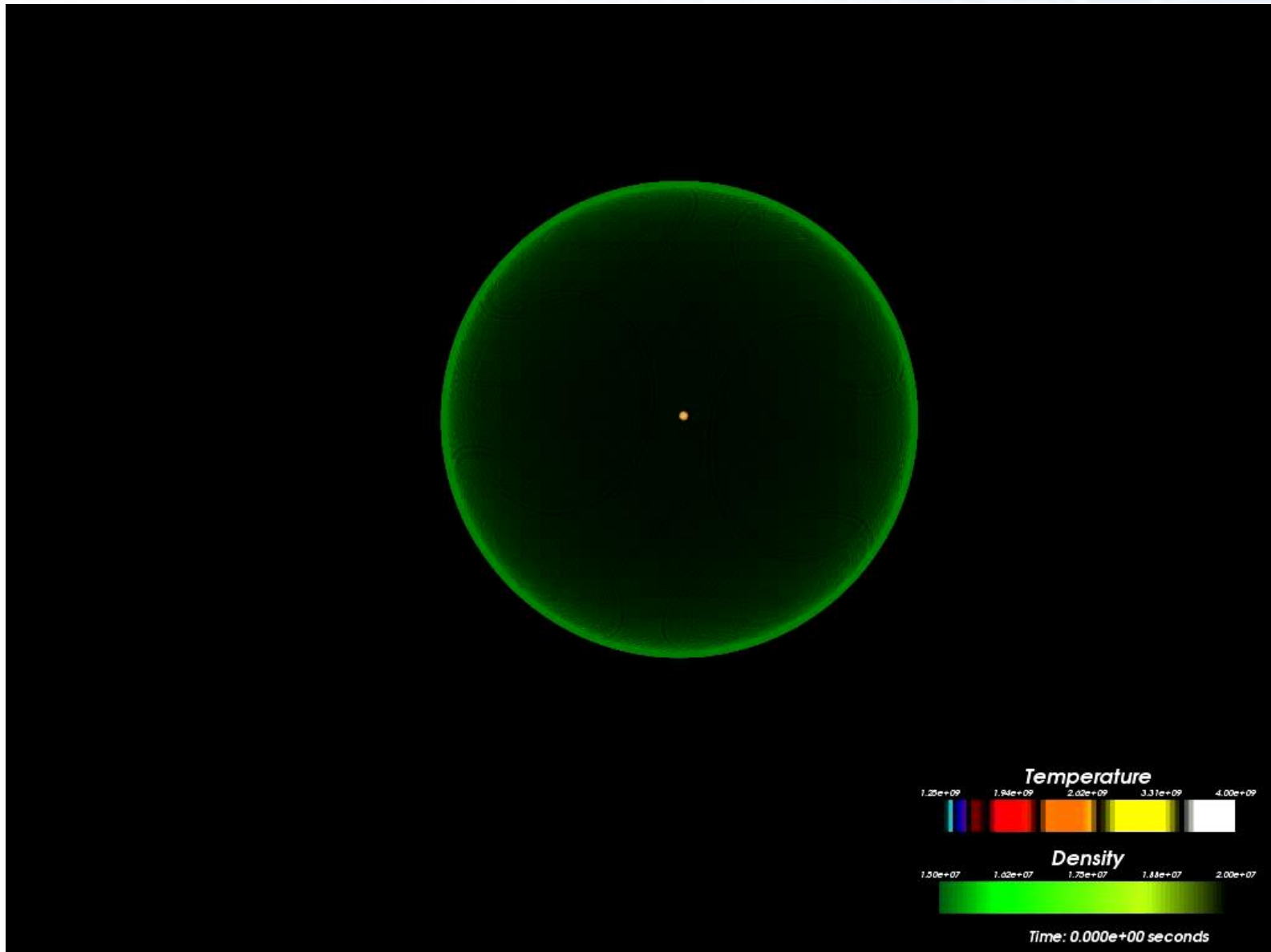


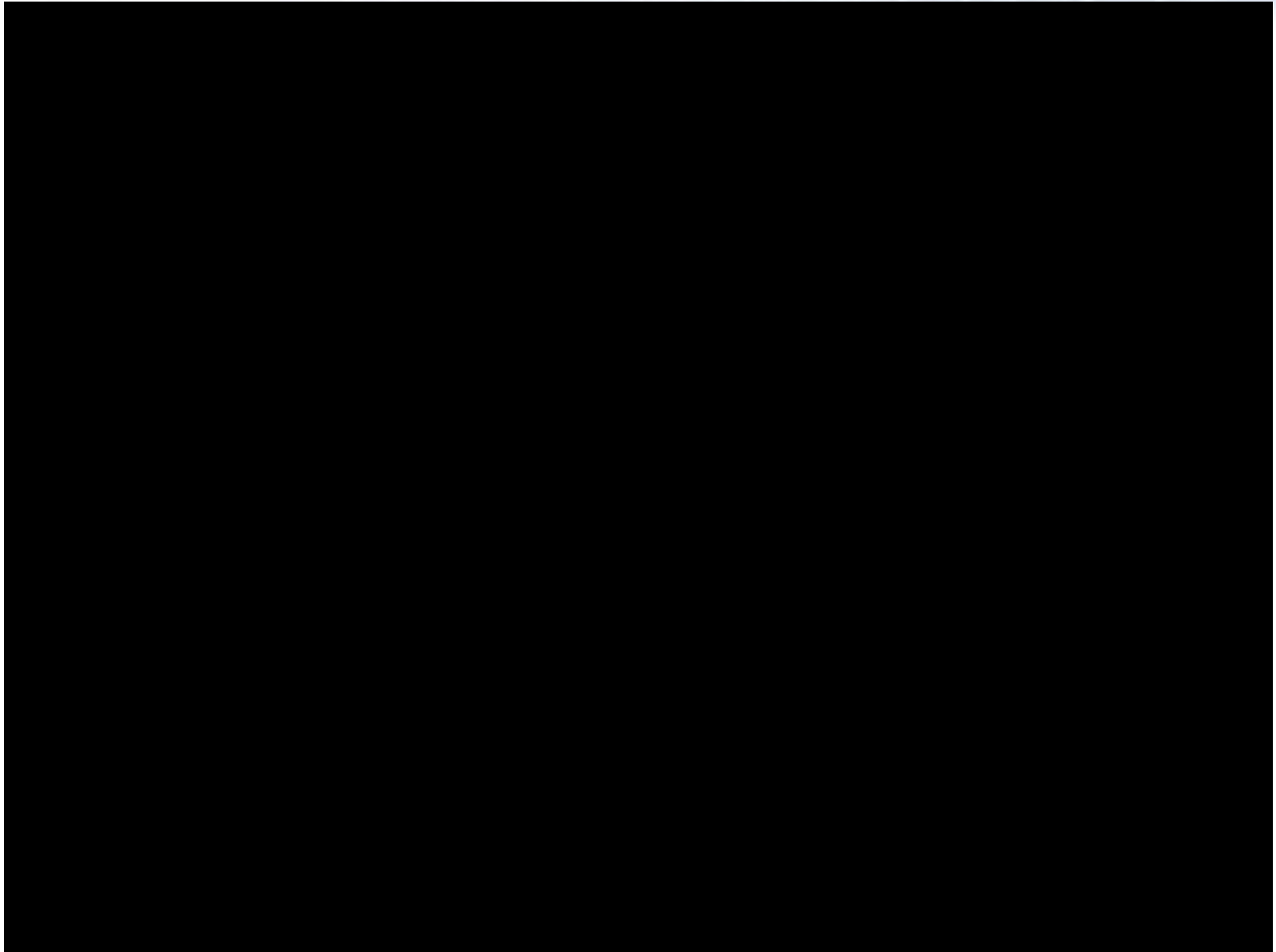


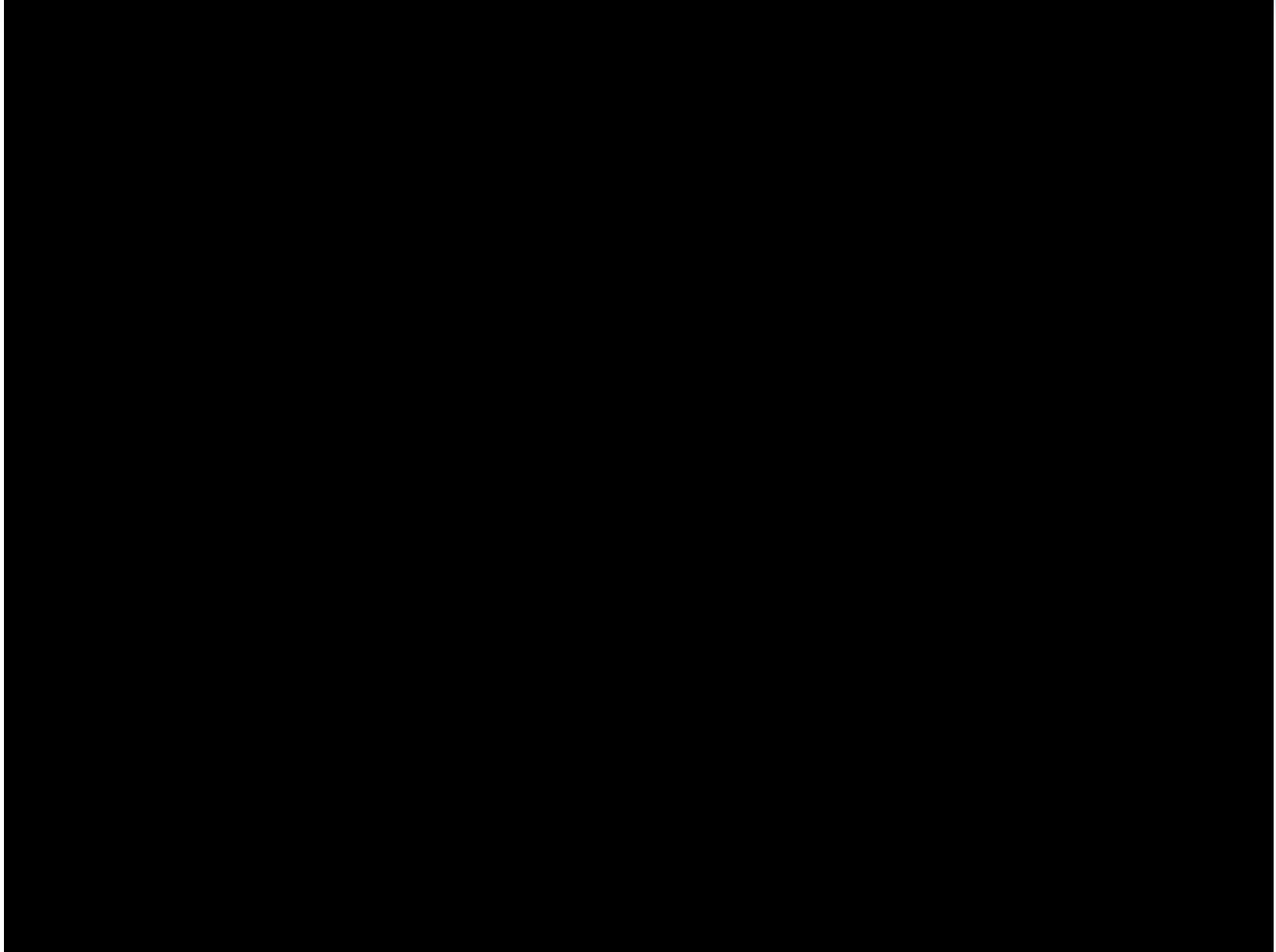


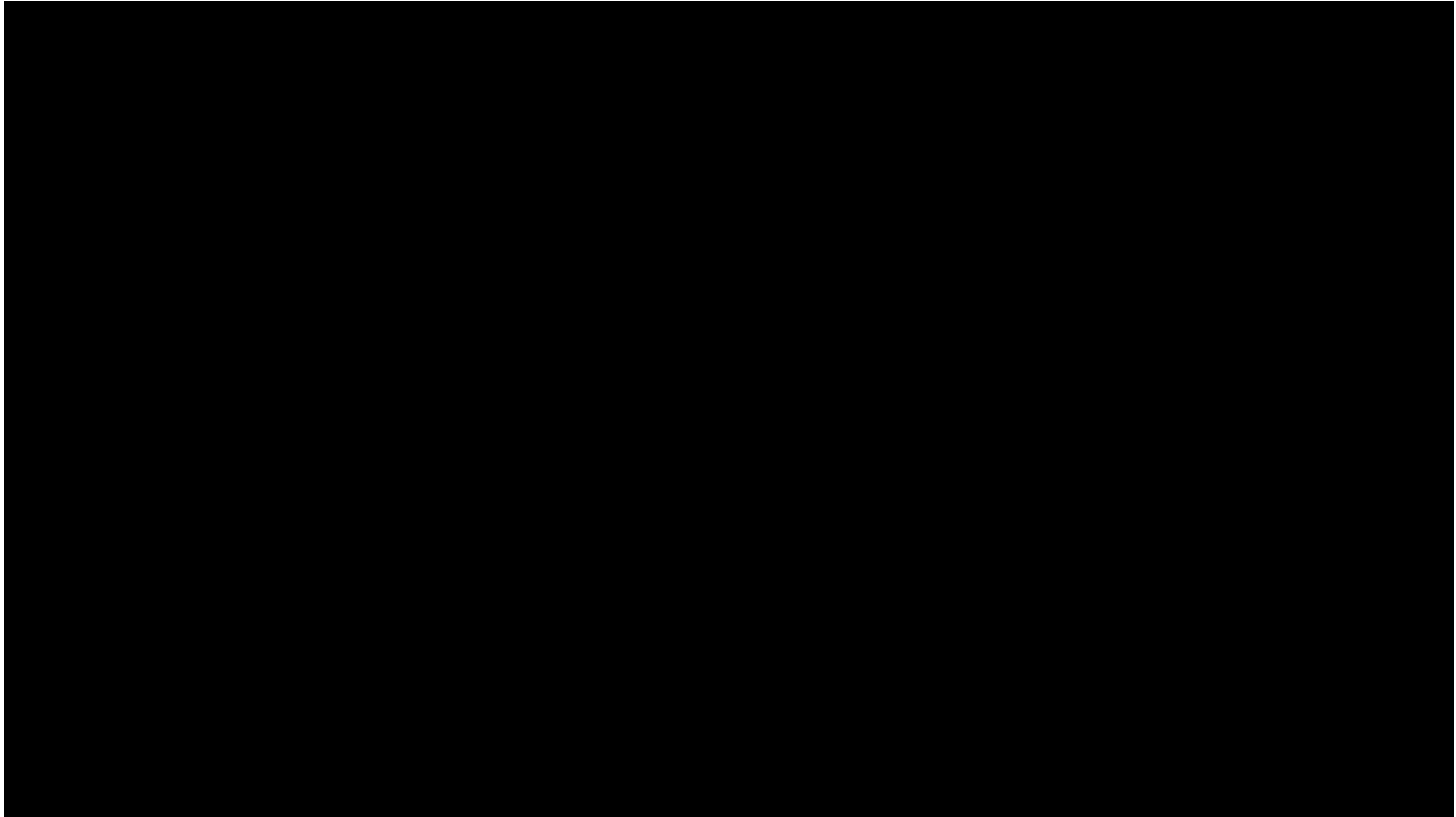


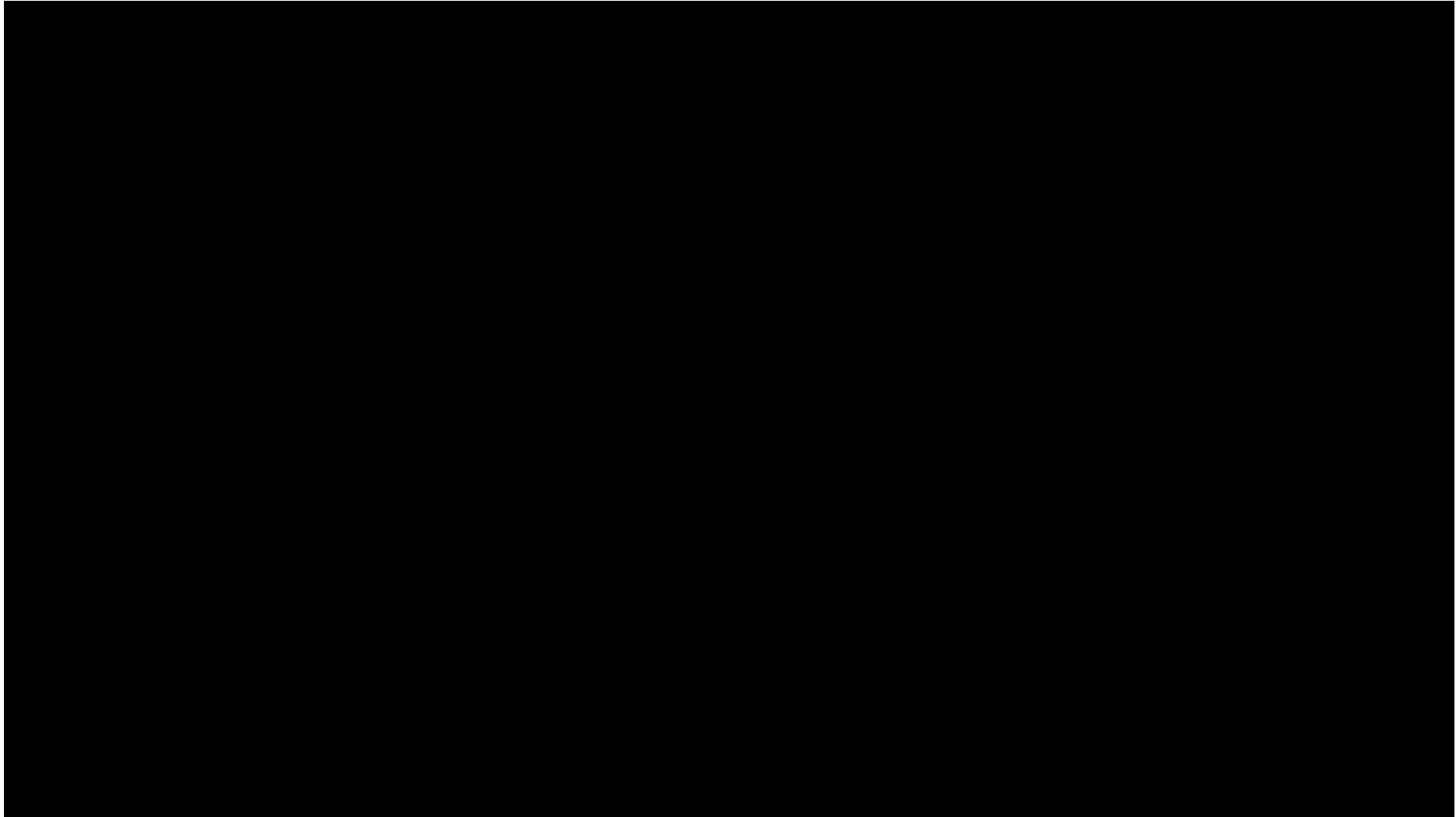


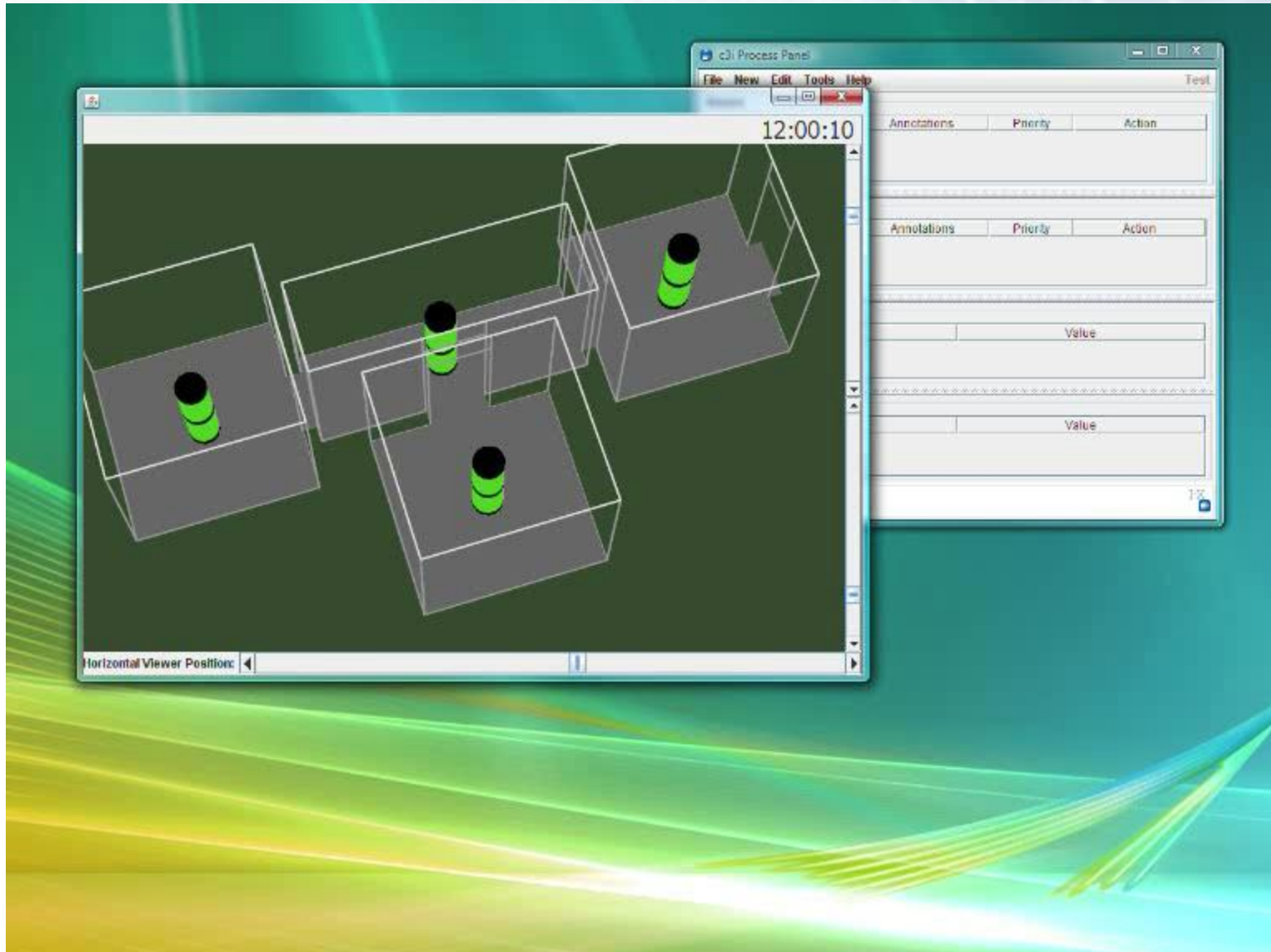


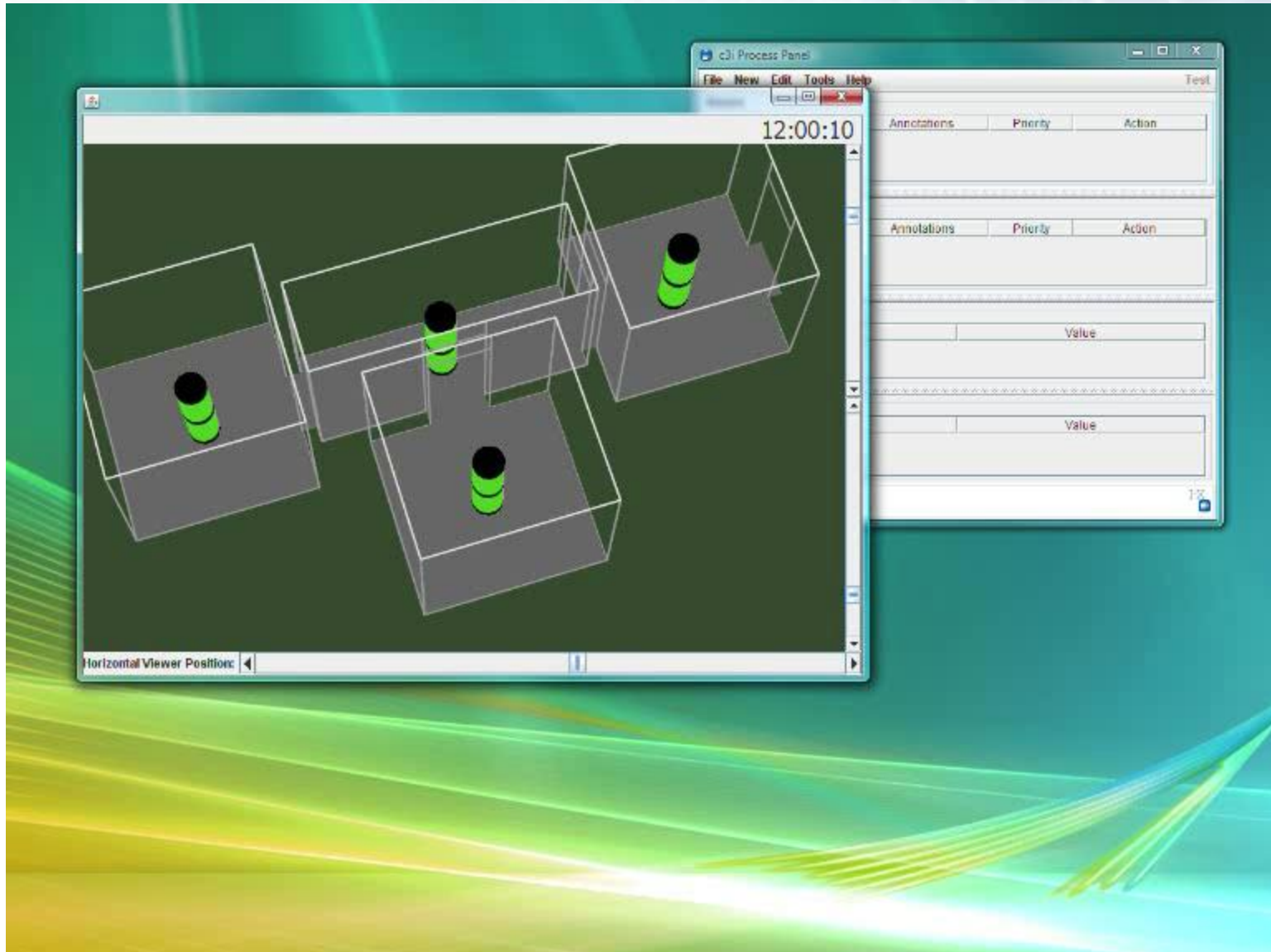












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 - d.henty@epcc.ed.ac.uk



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- Iakovos Panourgias of EPCC