

# Bootcamp de Procesamiento de Imágenes con Inteligencia Artificial

## Curso B

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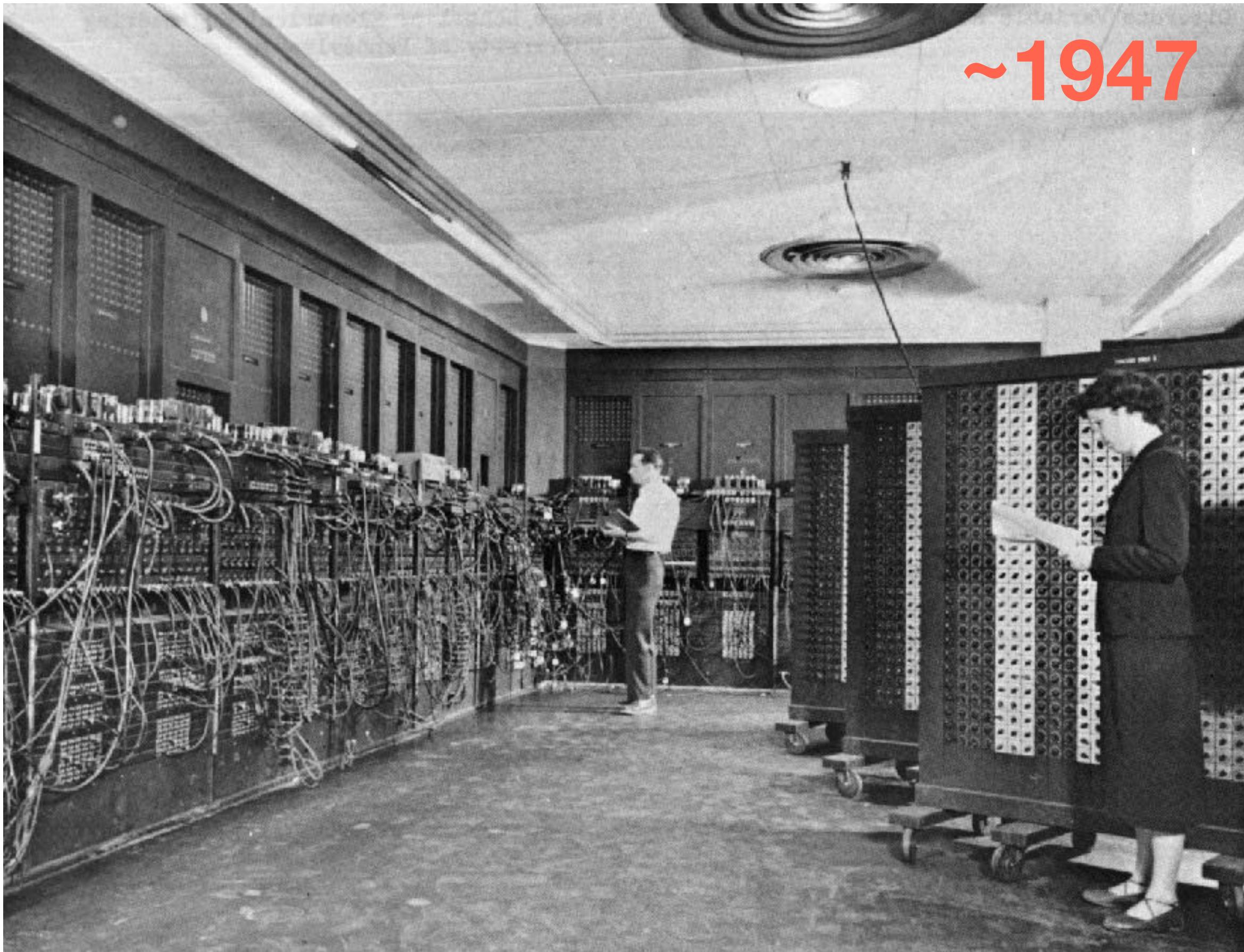
SCHOOL OF  
PHYSICAL SCIENCES  
AND NANOTECHNOLOGY

cedia



# Computing

From here



~1947

To here

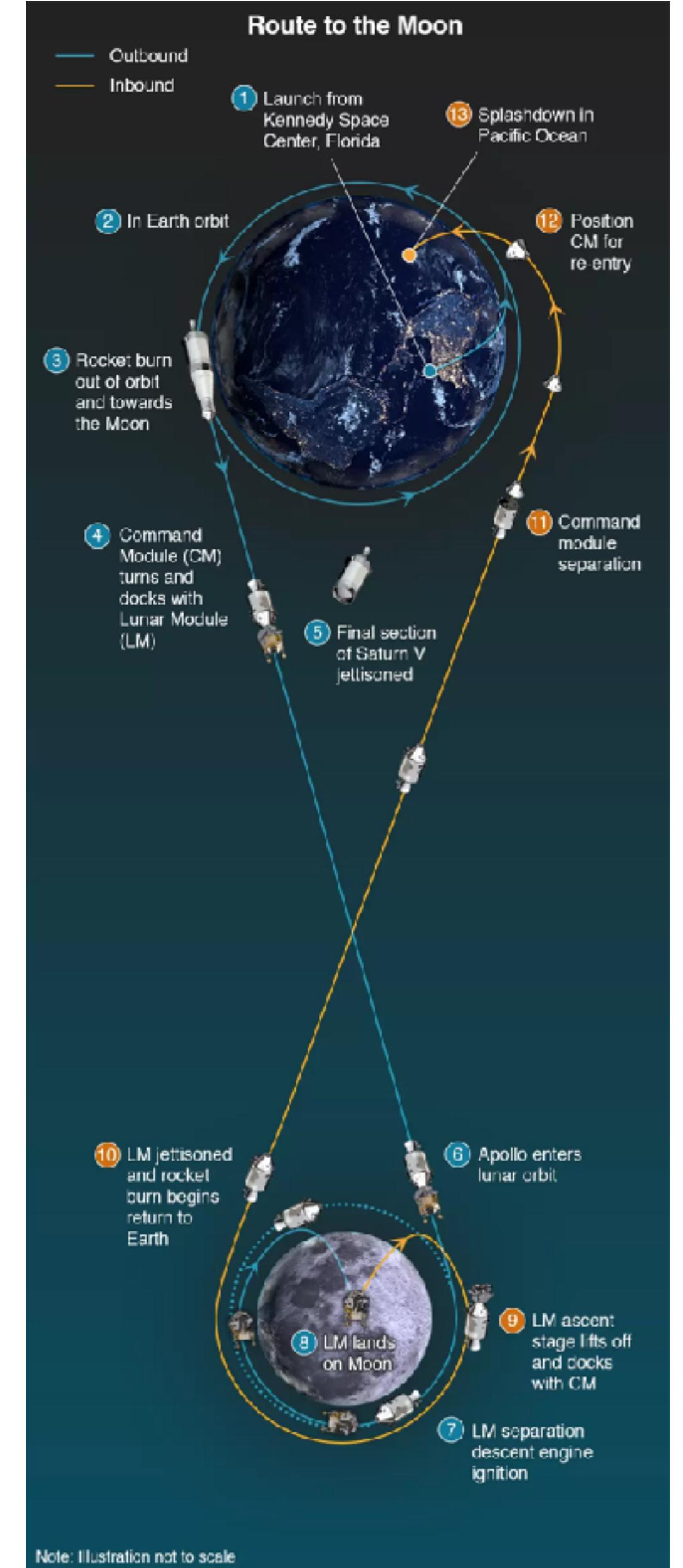


~2023



ENIAC (Electronic Numerical Integrator And Computer) in Philadelphia, Pennsylvania.

# Early applications



# **Today ?**

# Today

## Science



## Every day life



STEAM®



# Where is computing in physics used?

# Computing in physics

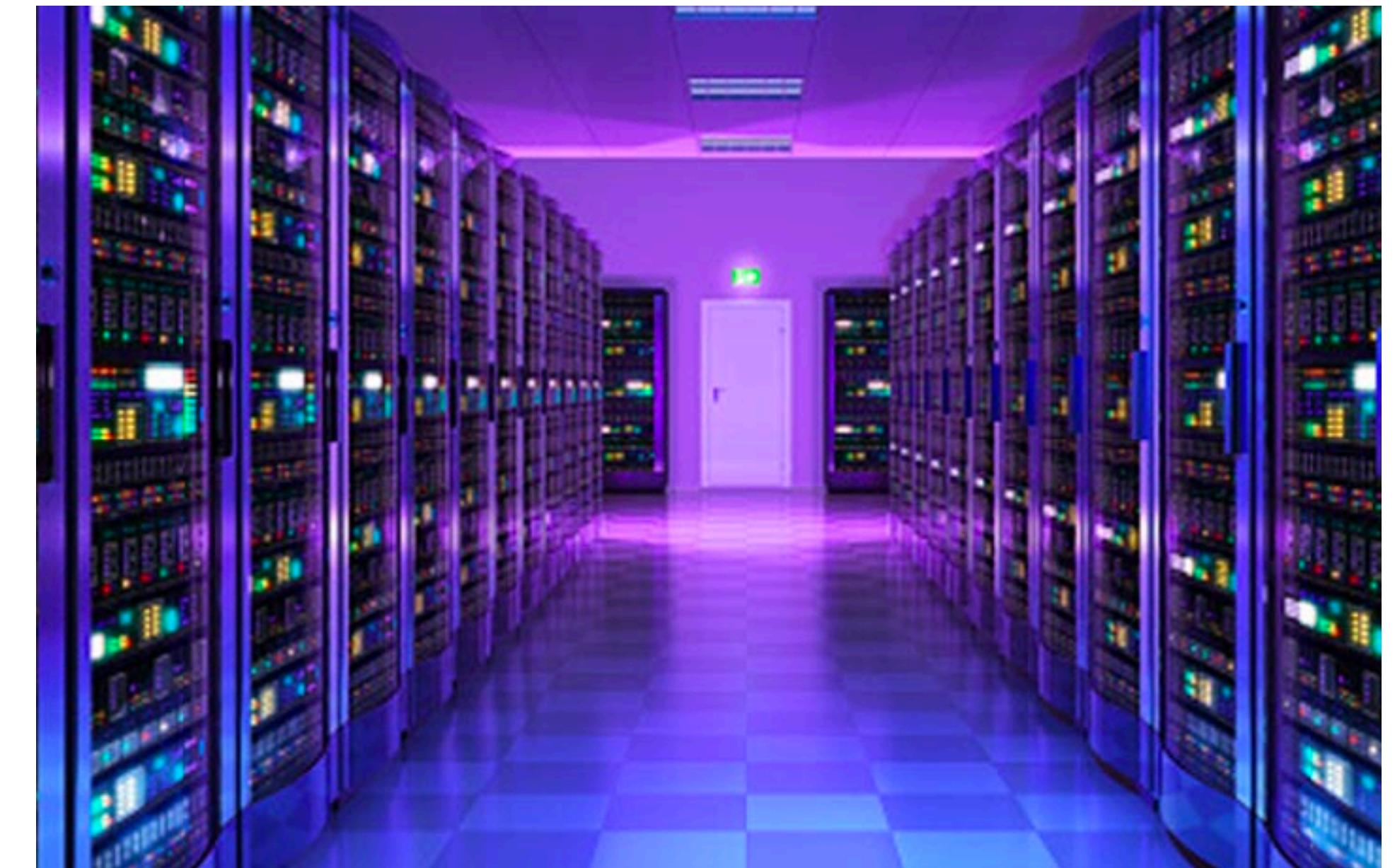
Instrumentation

Telescopes, detectors



Computation

(PCs, cluster computers, etc.)



Software tools

(Programming languages, computers)



Supercomputing

(Thousands of processors, parallel code, high performance)

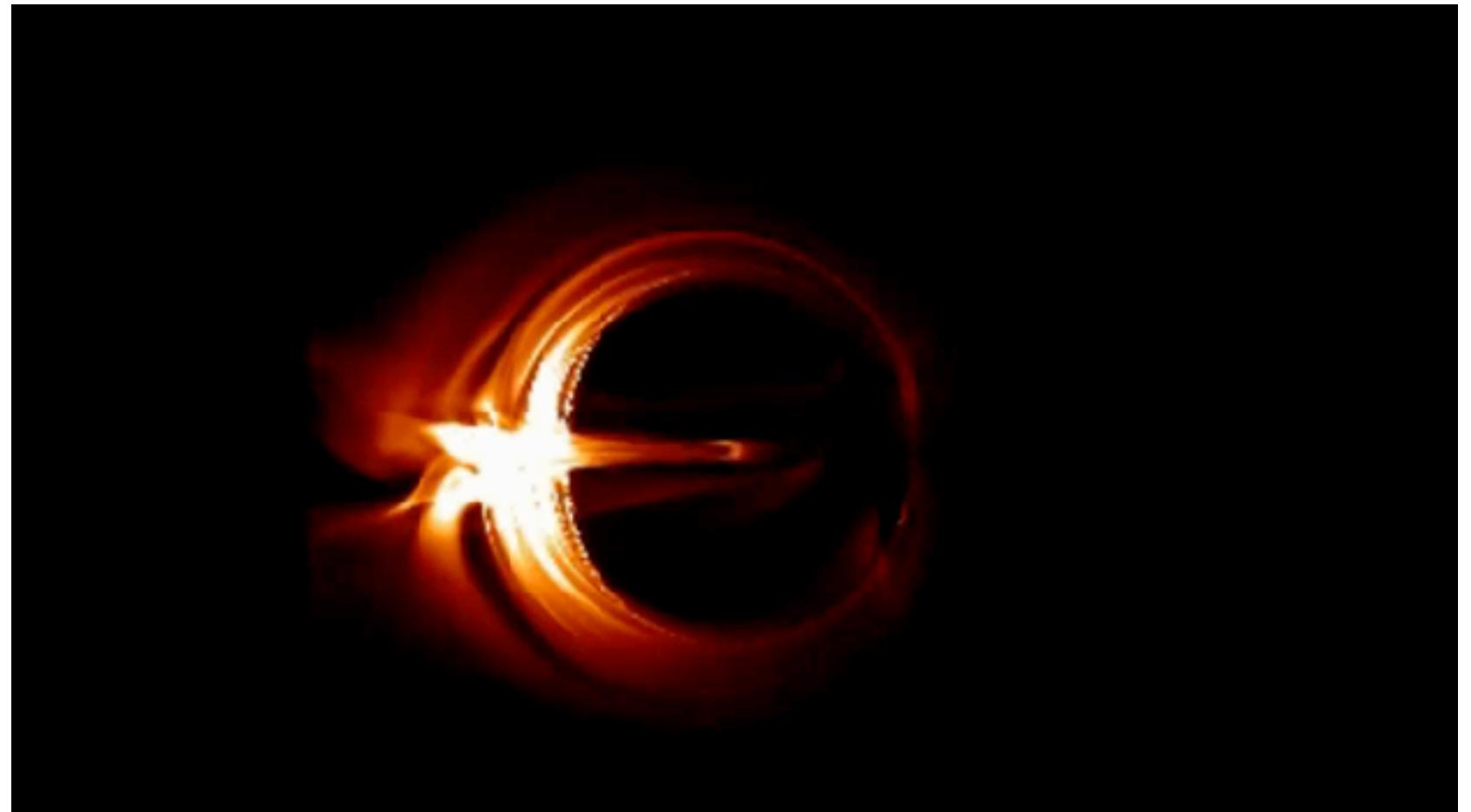


# Computing in physics

Observations motivating simulations

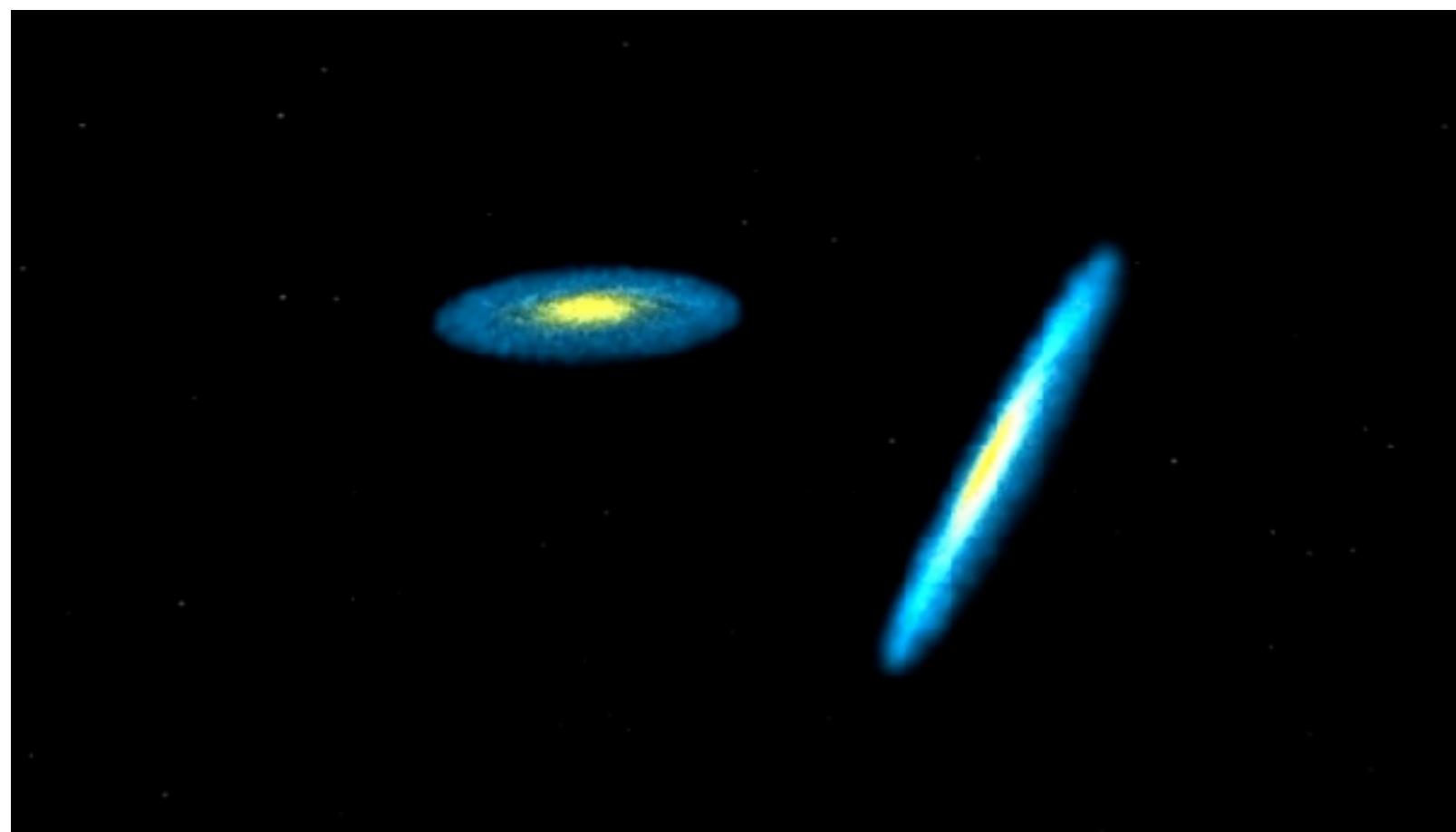


Simulations motivating observations

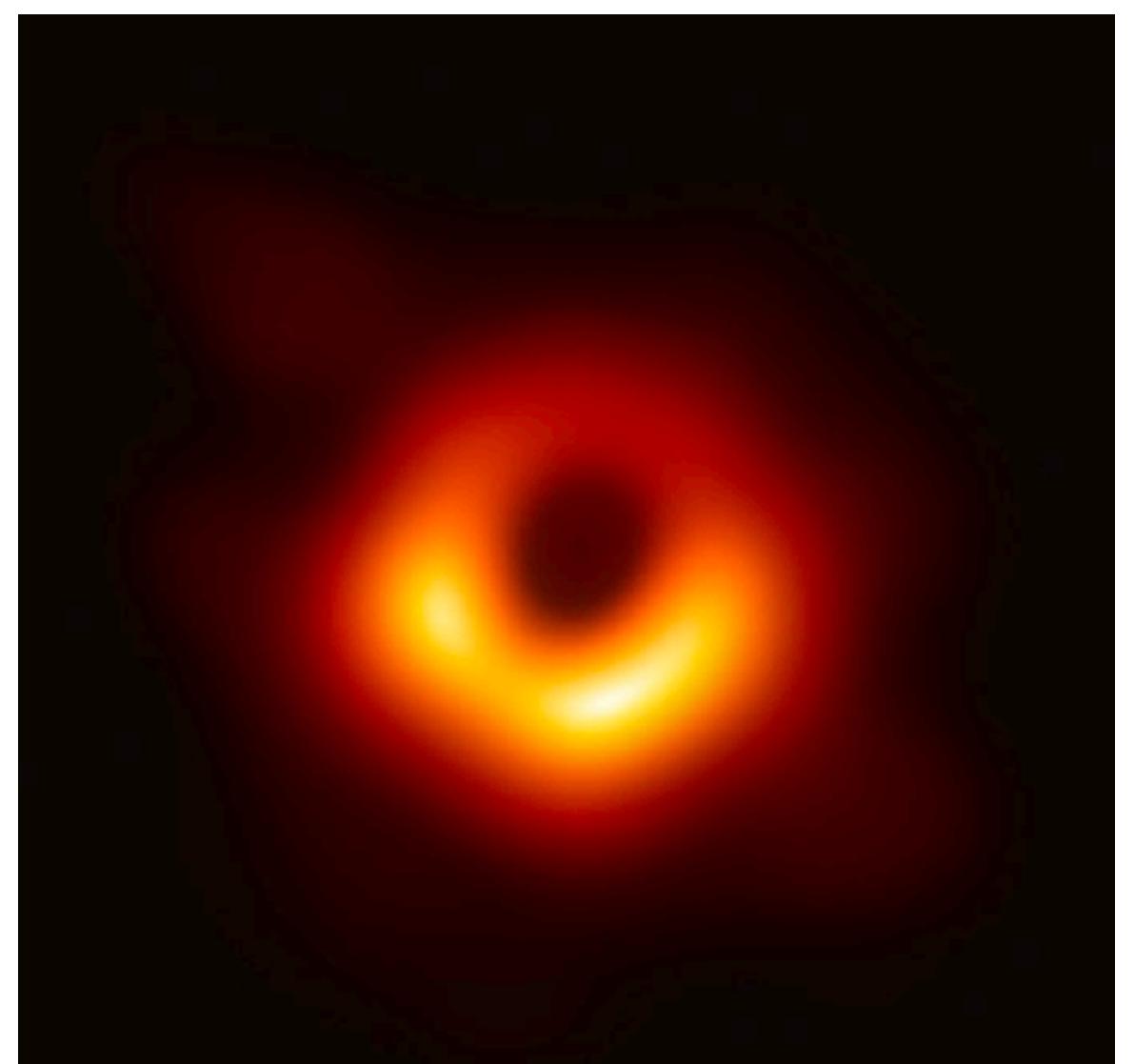
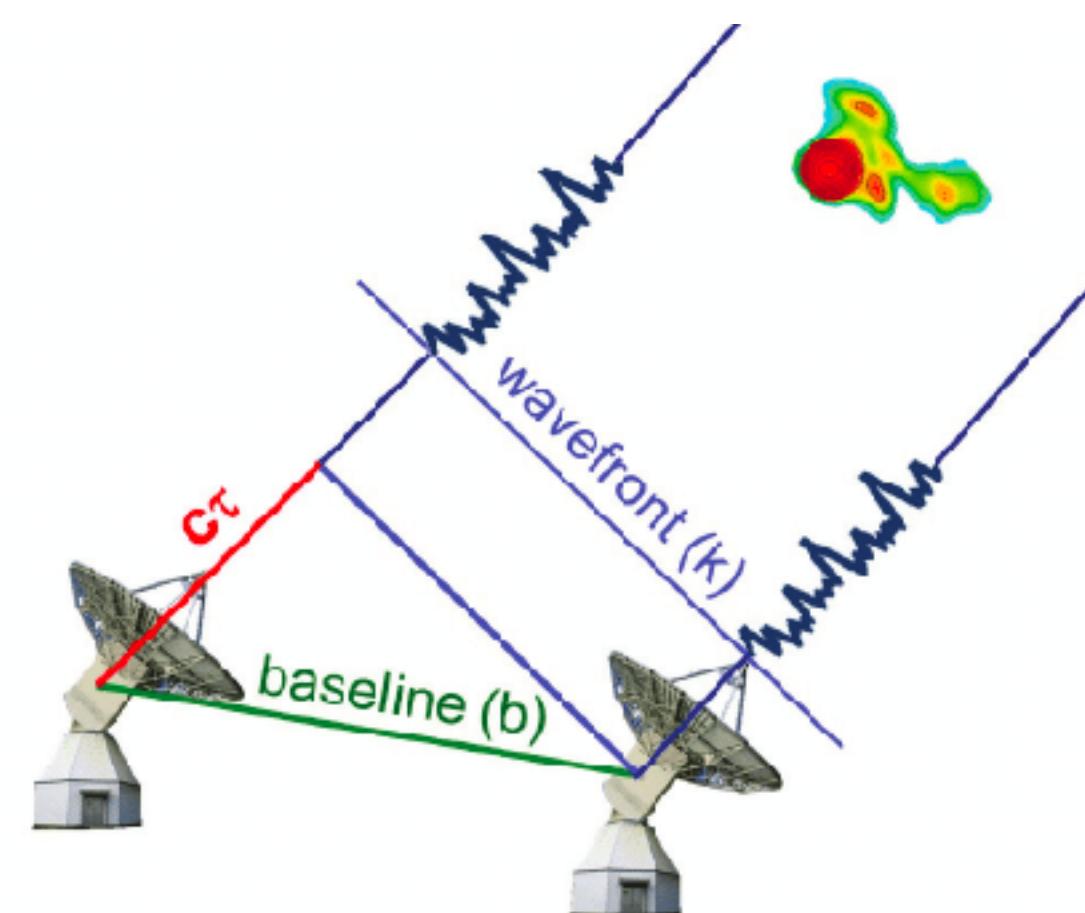


Butterfly galaxy, Gemini Observatory

Merging galaxies



Space Telescope Science Institute



Event Horizon Telescope

# **What can we do with computing in physics ?**

# What can we do with computing in physics ?

A good understanding of physics + mathematics + computing -> critical thinking, problem solving, good communication skills -> open many doors in:

Working in academia:

- Universities
- Research institutes

Working in industry:

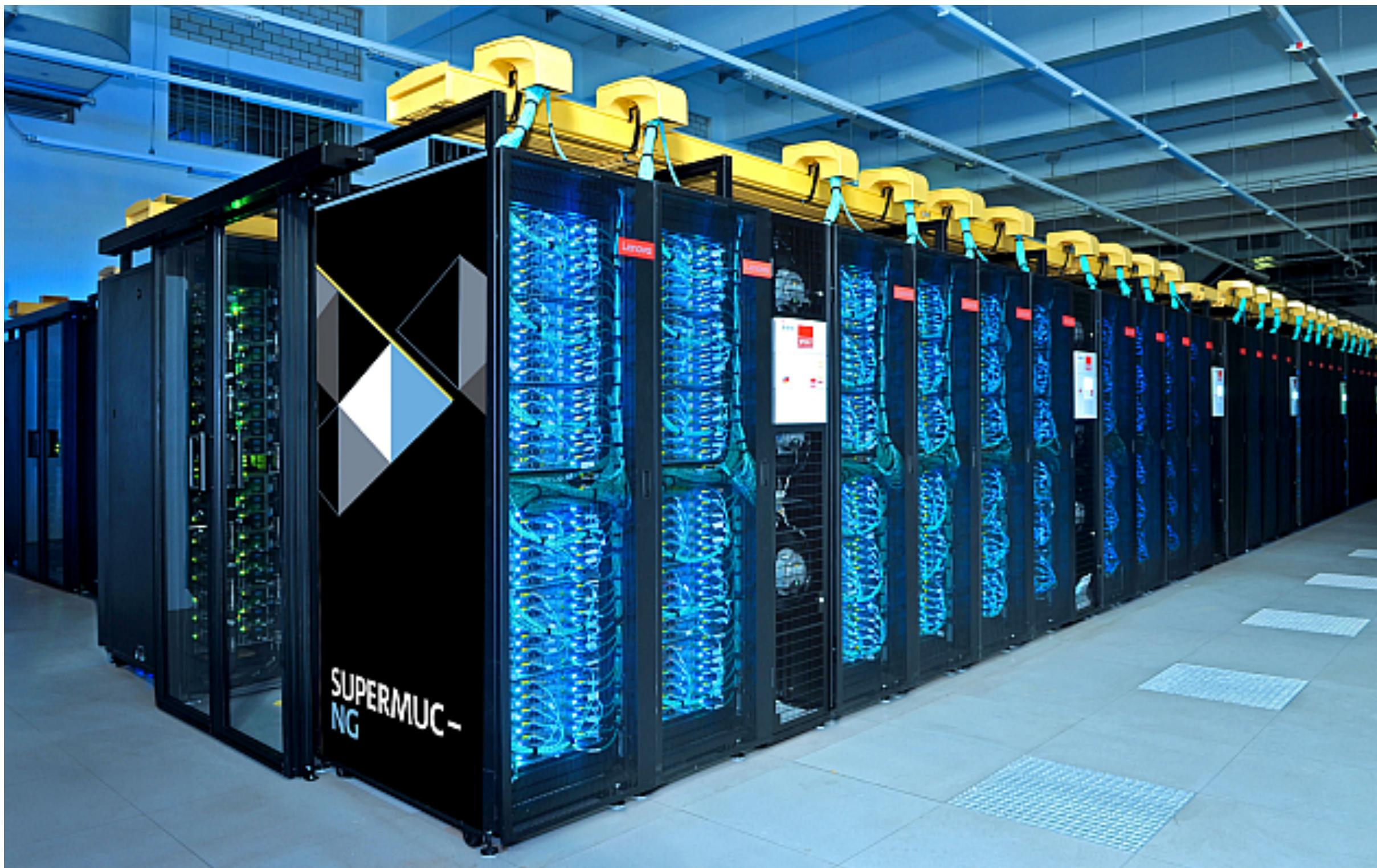
- Data science
- Government
- Industry development



# **Exo-scale computing**

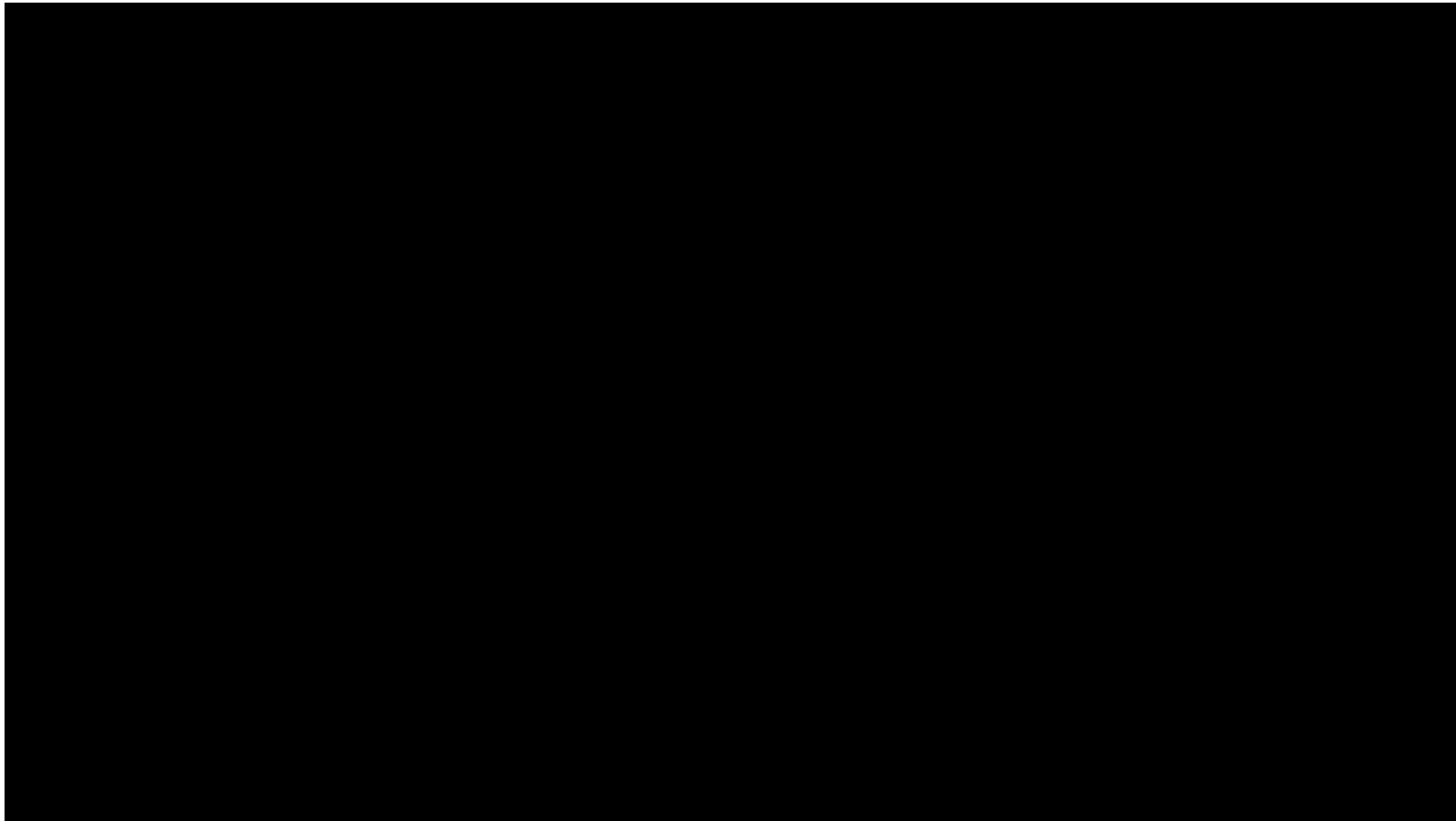
# Supercomputers - Theoretical physics

SuperMUC in Germany  
Powering computer simulations of scientists  
and industry

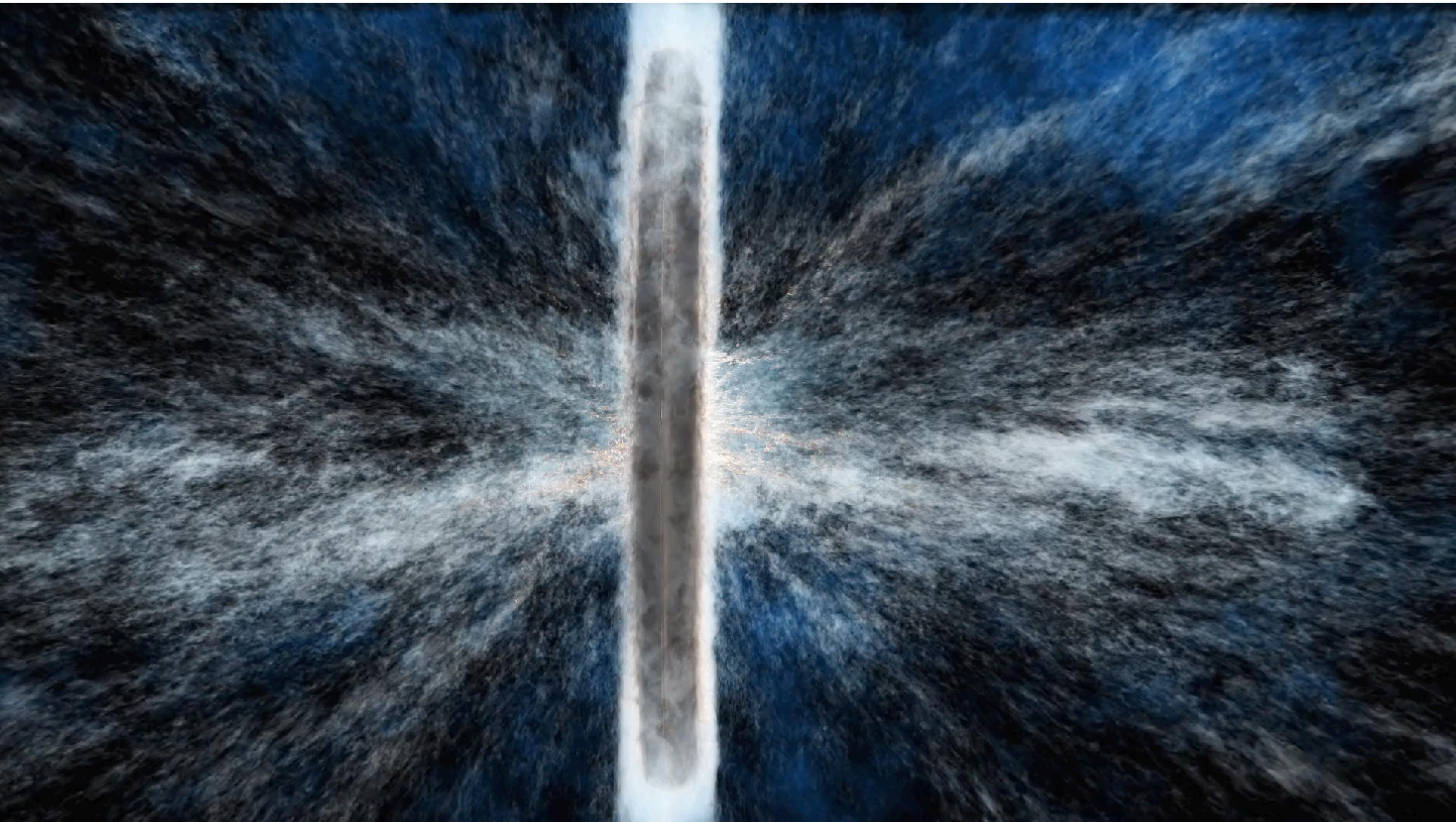


Pawsey Centre in Australia  
Powering some of the largest radio  
telescopes in the world

# Large scale structure

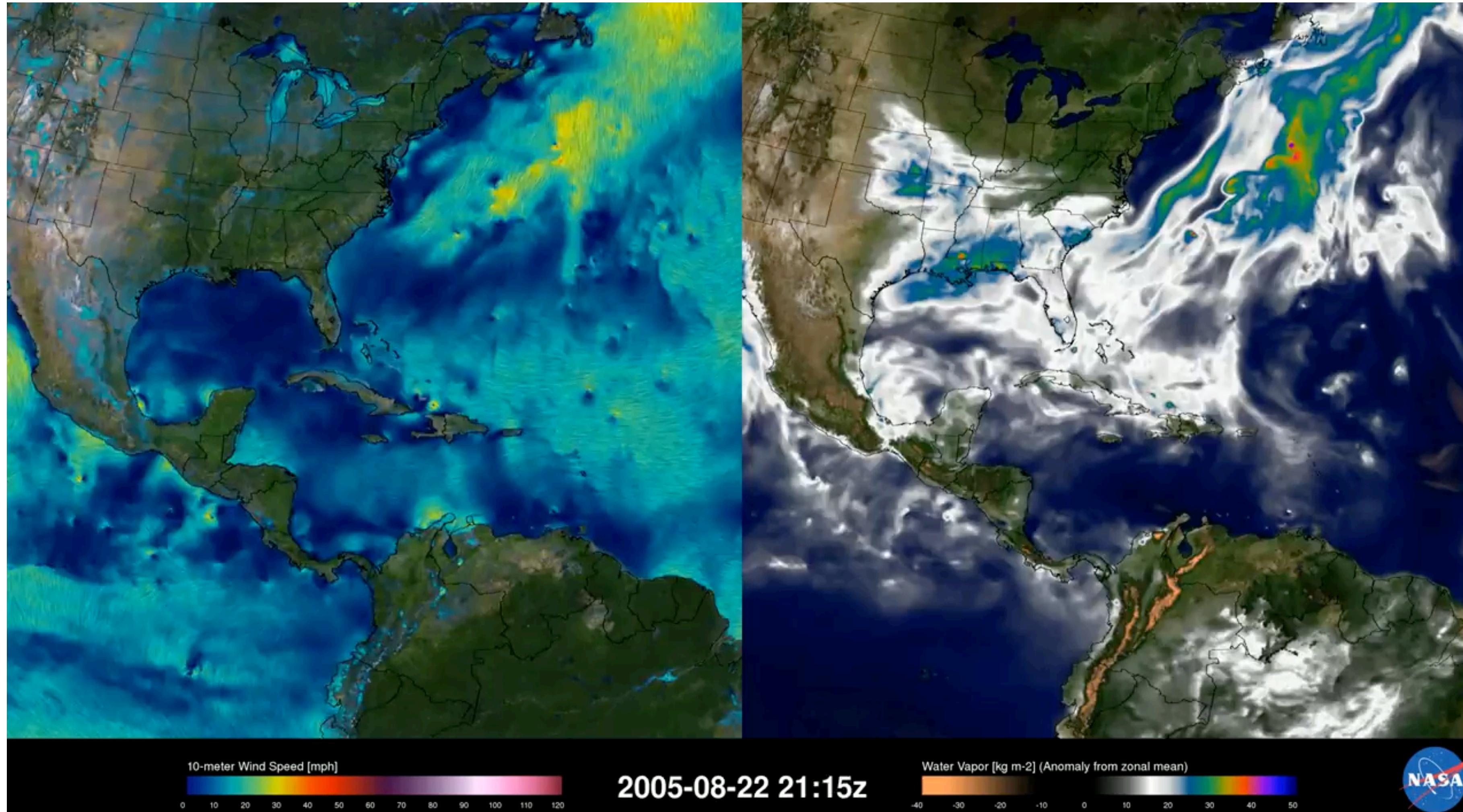


# Outflows In galaxies



# GEOS-5 Simulation of Hurricane Katrina

## Weather modelling



High resolution weather and climate simulations generate peta-byte scale data.

<https://www.youtube.com/watch?v=p-3aB9hJ8Hc>

# Supercomputers - Experimental Physics

The brain of these telescopes is a supercomputer

- + another supercomputer to process all the data from them
- + One to analyse the data that they produce

[FAST: The Five Hundred Meter Aperture Telescope  
\(China\)](#)

[The ASKP Telescope in Australia](#)



# Experimental Physics: Telescopes

The brain of these telescopes is a supercomputer  
+ another supercomputer to process all the data from them  
+ One to analyse the data that they produce

**The ASKP Telescope in Australia**  
**The antennas**

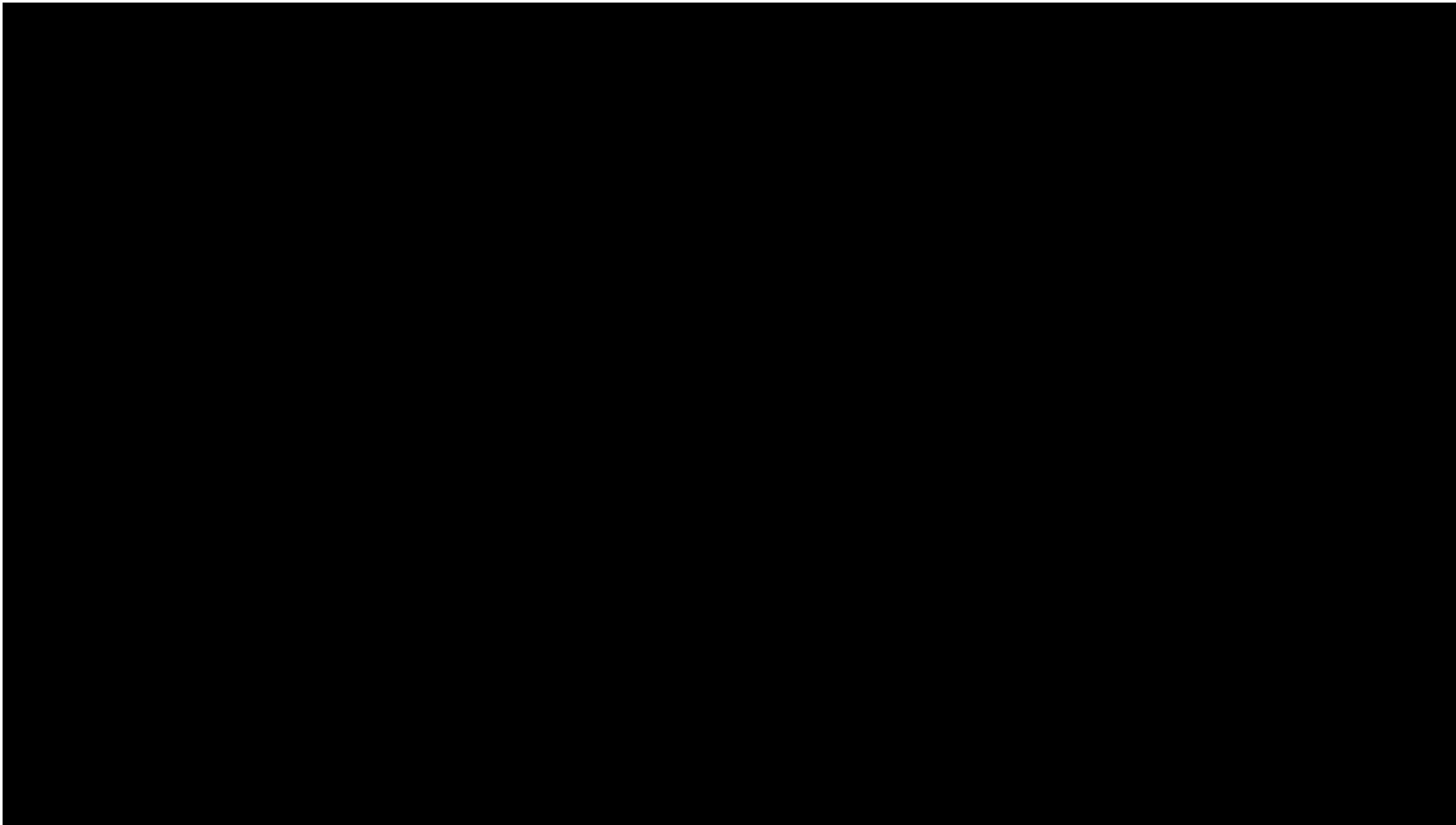


Approximately 5 PB of raw data per year.  
1 finished spectral line data cube ~30GB.

**The correlator**  
**Processes and combines all the signal from the antennas**



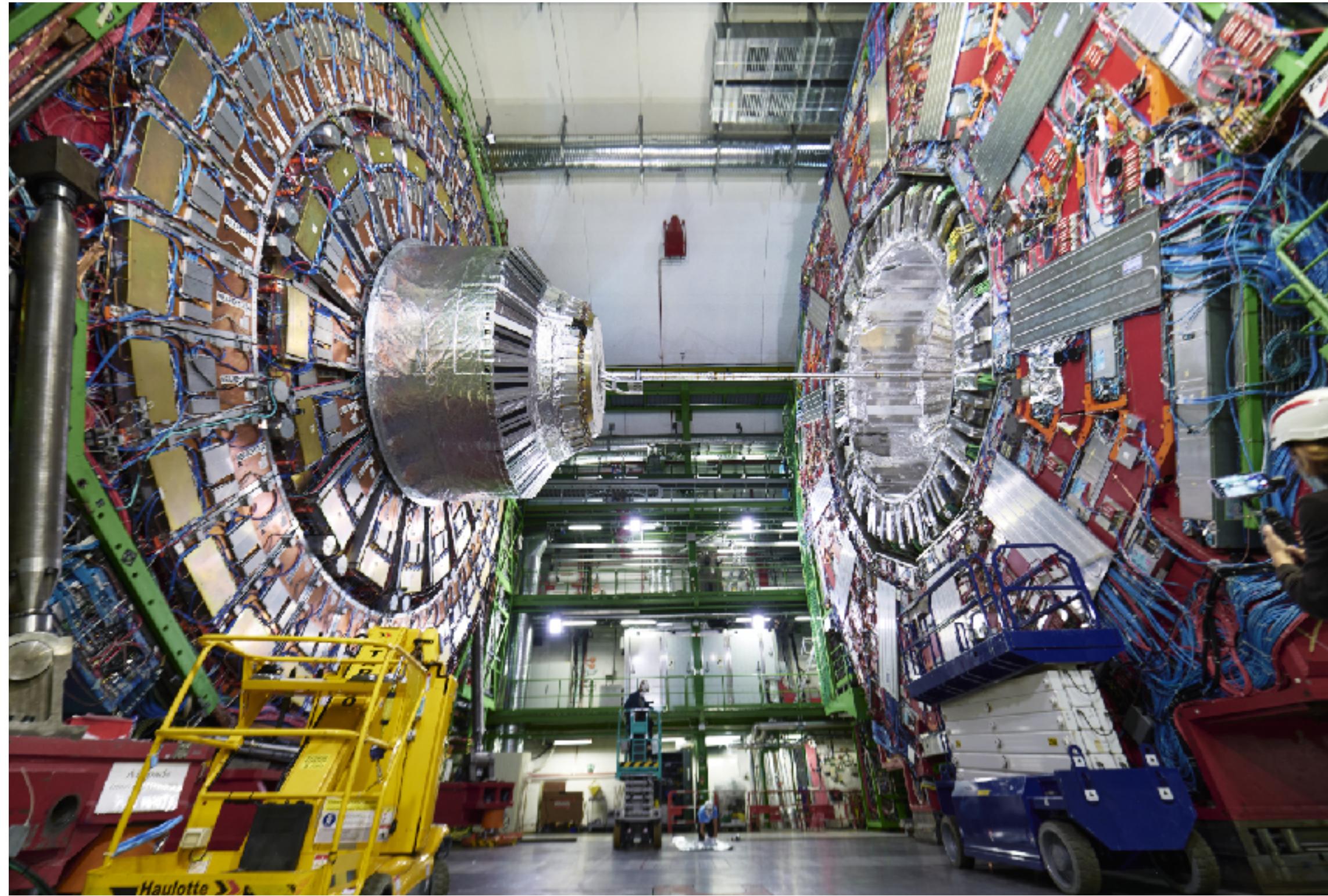
# Experimental Physics: Telescopes



The HI4PI survey of Hydrogen in the Milky Way

# Experimental Physics: Particle physics

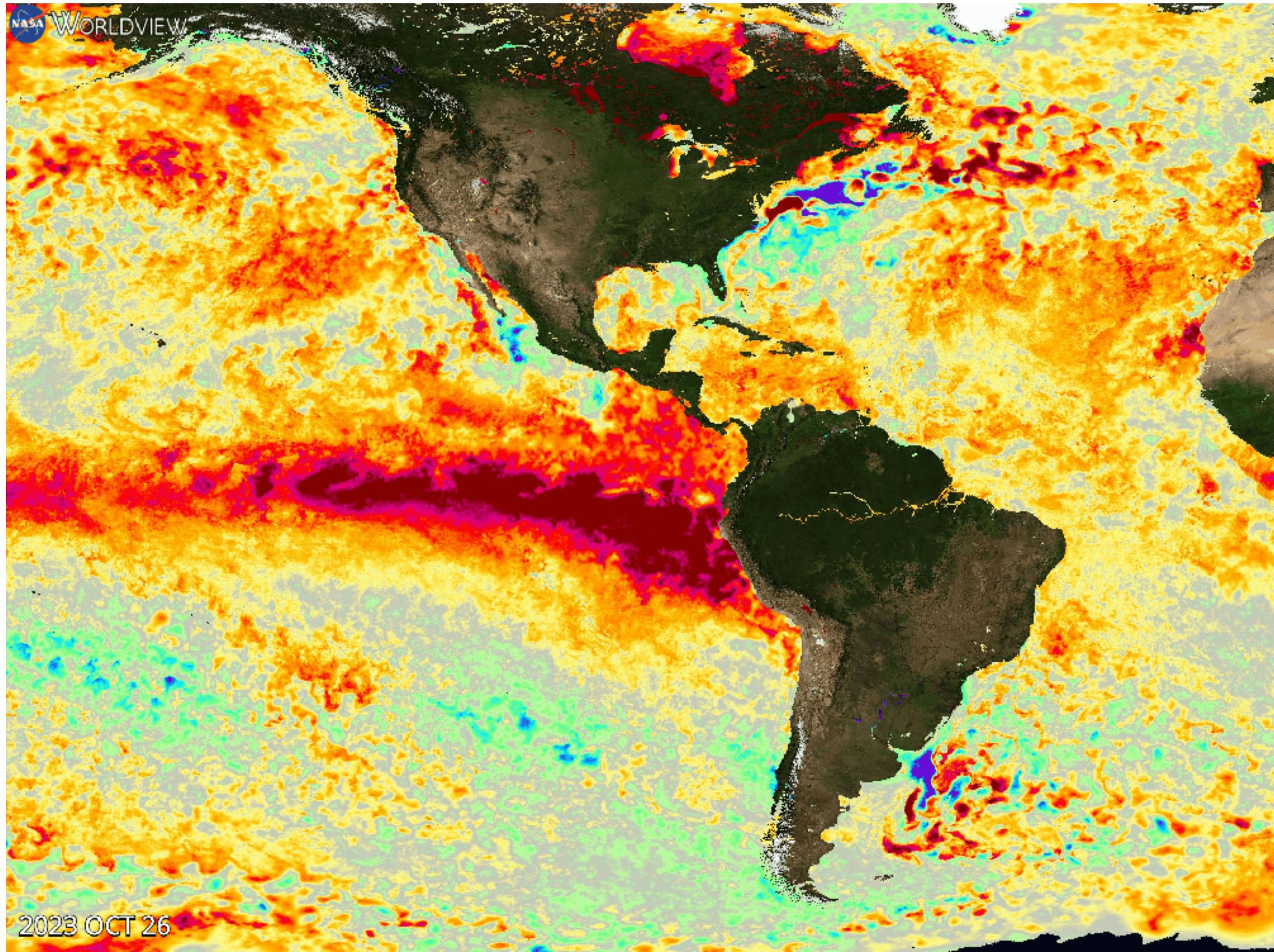
Particle physics experiments generate petabytes of data from measurements while searching for new particles.



**More than 5 petabytes** of open data are currently available from CERN's experiments, primarily from the Large Hadron Collider (LHC).

# Experimental Physics: Climate science

The current total volume of Earth observation satellite data collected annually is estimated to be over **100 petabytes (PB)** per year.

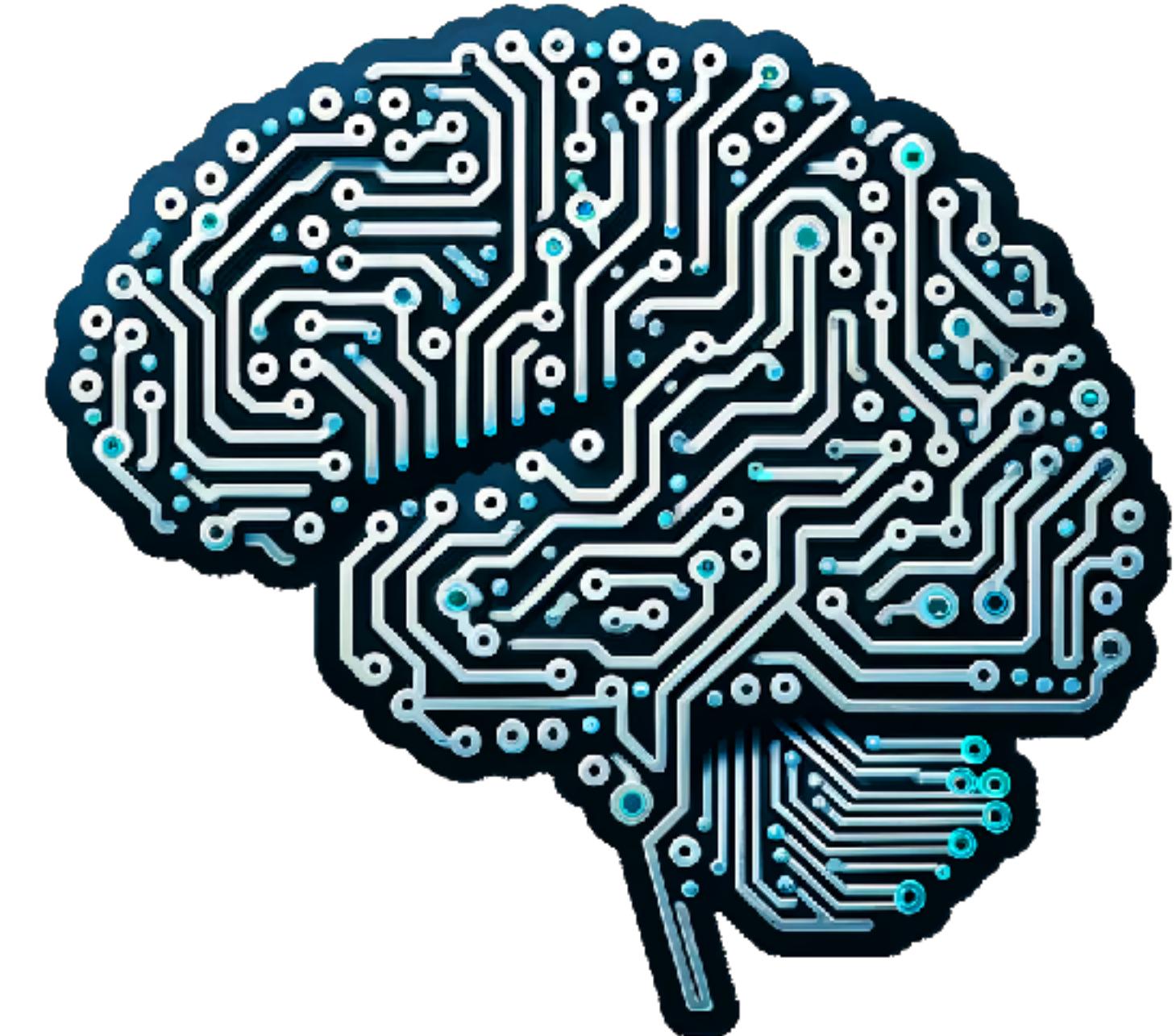


# **What is machine learning and AI?**

# Machine Learning

Classical ML relies on **statistical methods** like regression and decision trees, often requiring human expertise to select features.

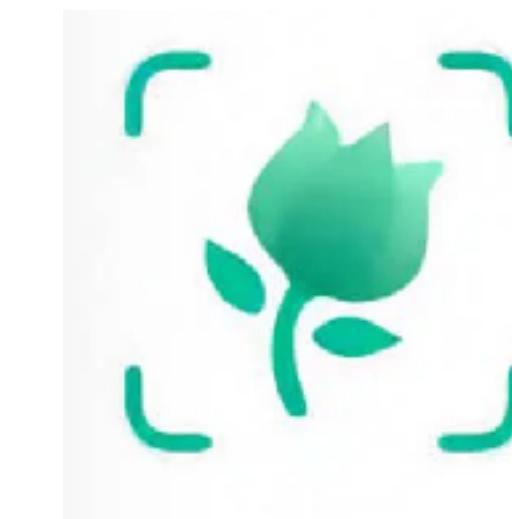
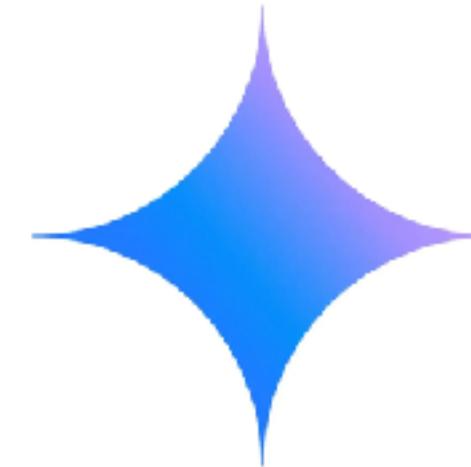
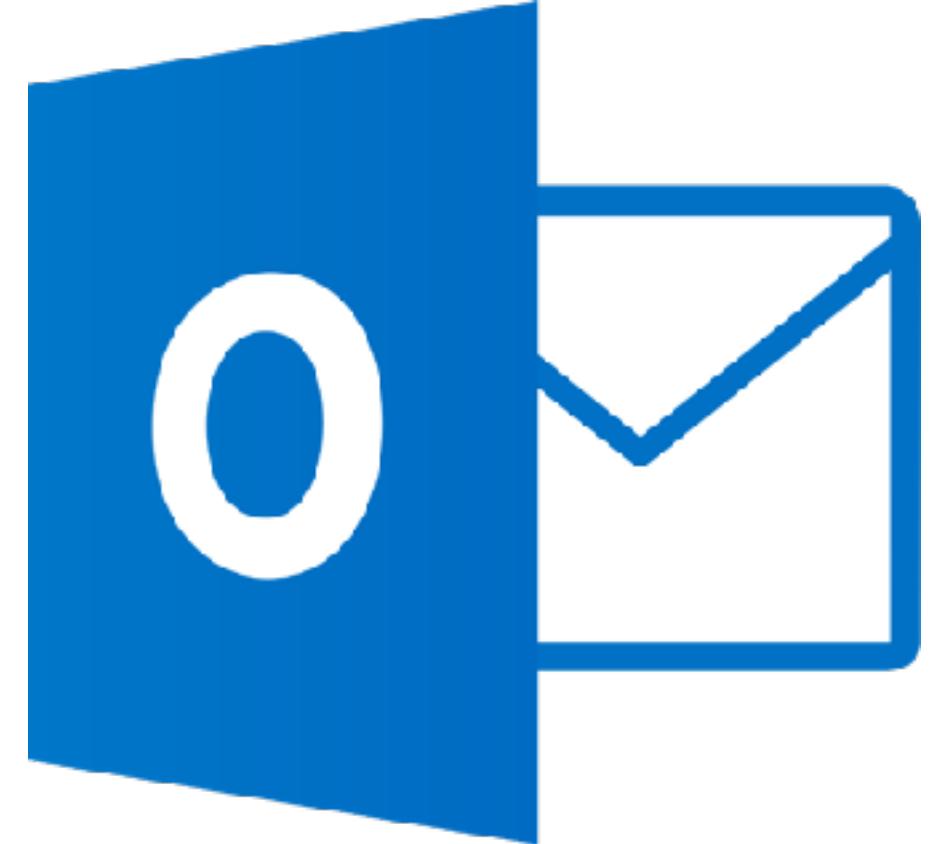
More advanced approaches include deep learning, which uses **neural networks (several layers of algorithms)** capable of learning from unstructured data with less human intervention.



# Machine Learning

## Machine Learning:

- natural language processing: LLMs (e.g. Chat GTP, Gemini)
- computer vision (google image finder, face recognition)
- speech recognition (Siri, Alexa, virtual assistants)
- email filtering (e.g. spam filters, priority filters)
- agriculture (e.g. monitoring crops and animals, predicting crop yield, plant classification)
- Medicine (e.g. analysing medical images, robotic surgery )



PictureThis

# AI applications



Large Language Models - the new fashionable thing, but not the start  
The google search engine has been around for years

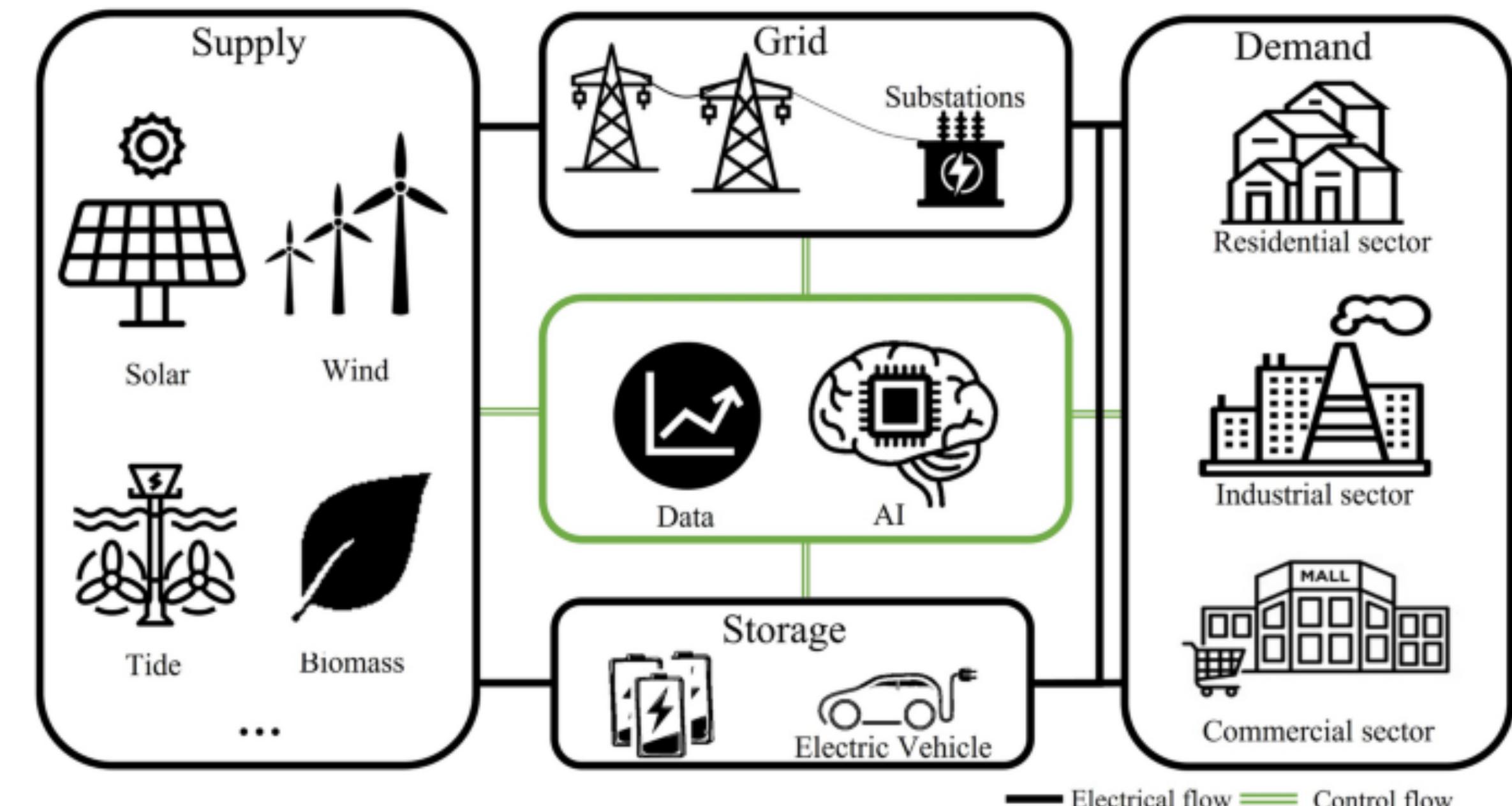
Zooniverse

## Science:

- Optimisation
- Galaxy classification
- Particle physics, searching for new particles
- Classification of biological systems
- Weather prediction
- Understanding genetics

## Industry:

- power grid optimisation
- self driving cars
- Robotics for production





Thank you!

# Interacting galaxies



Four galaxies interacting and merging together (N-body simulation)

Pavel Ševeček

[https://www.youtube.com/watch?  
v=YCbIjZEtmcY&ab\\_channel=Pavel%C5%A0eve%C4%8Dek](https://www.youtube.com/watch?v=YCbIjZEtmcY&ab_channel=Pavel%C5%A0eve%C4%8Dek)