WORKING GROUP 4
USING CERN ANIMATIONS IN THE CLASSROOM
FINAL PRESENTATION
FOCUS AGE 13-16 YRS

OVERVIEW

Project 1:

- Writing a storyboard for a new animation to use with cloud chambers

Project 2:

- 4 short lesson plans which use at least 1 animation per lesson to explain the main physics of CERN – approx. total teaching time 2.5 hours.

Project 3:

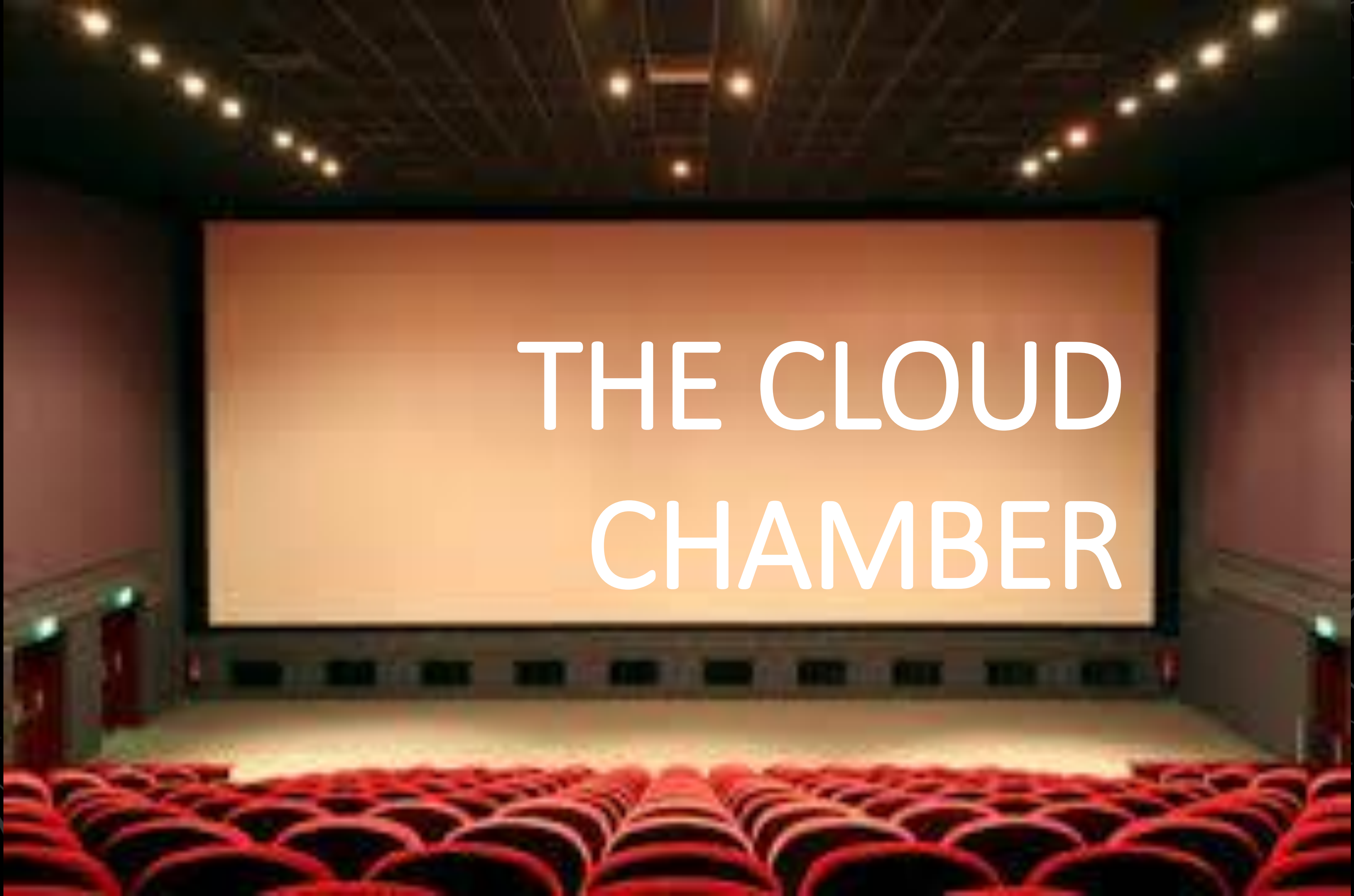
- Developing a teaching resource to assist teachers using animations who have little particle physics knowledge to communicate the physics of CERN.

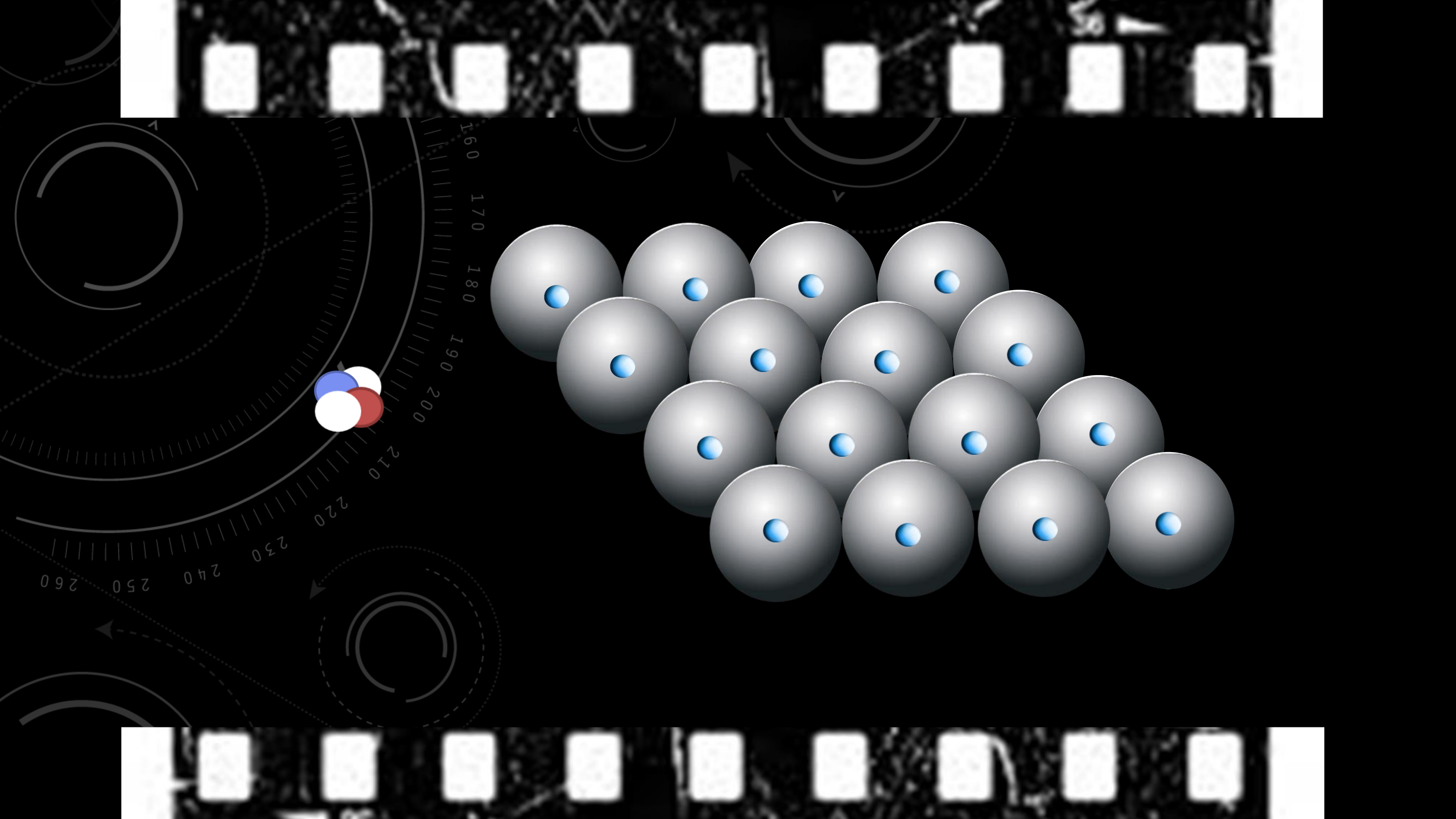
Project 4:

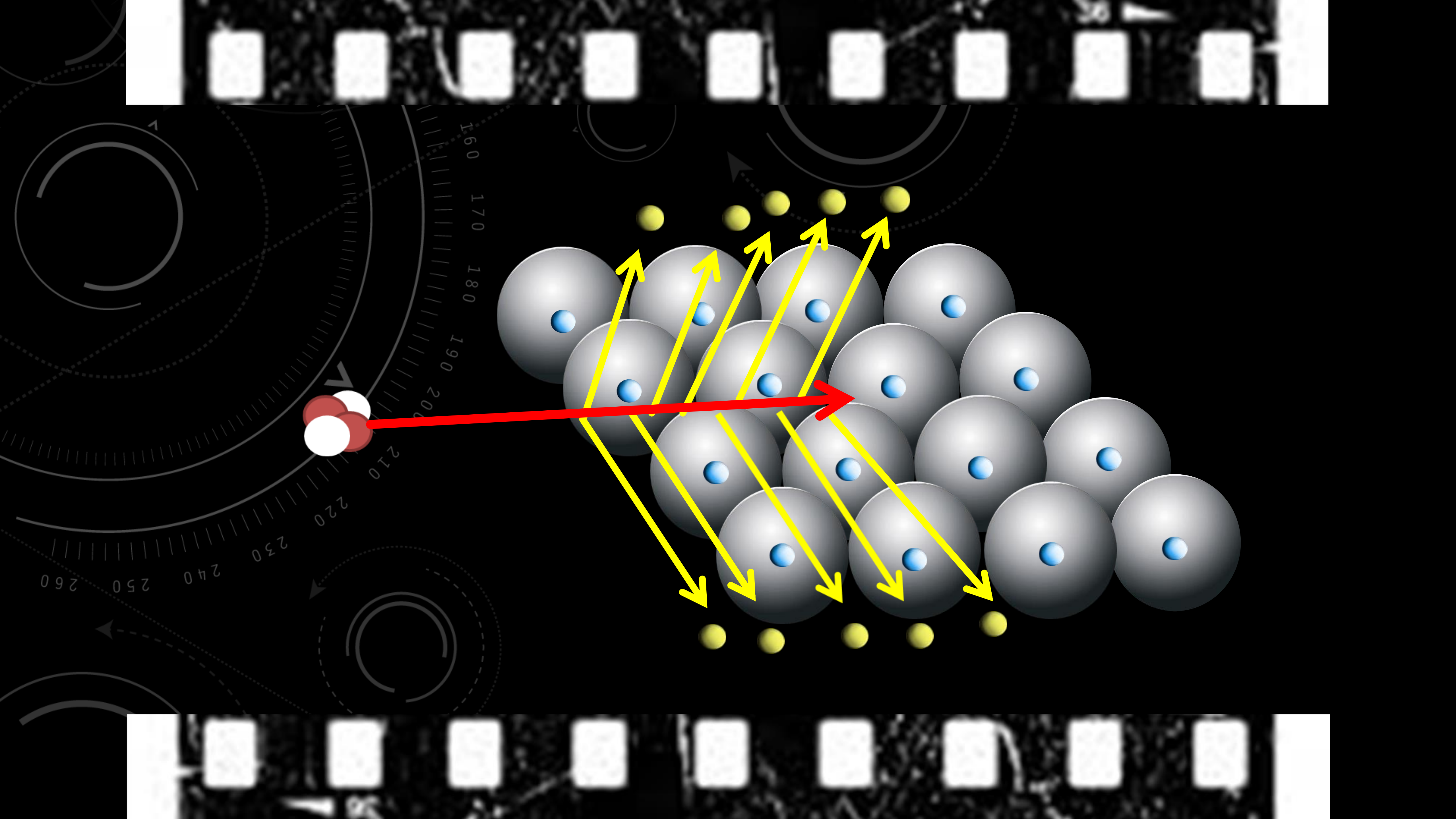
- Animation storyboard developed to link CERN physics with real world applications.

PROJECT 1 – STORYBOARD
PHIANKIT, SARAH, SARAH

THE CLOUD CHAMBER



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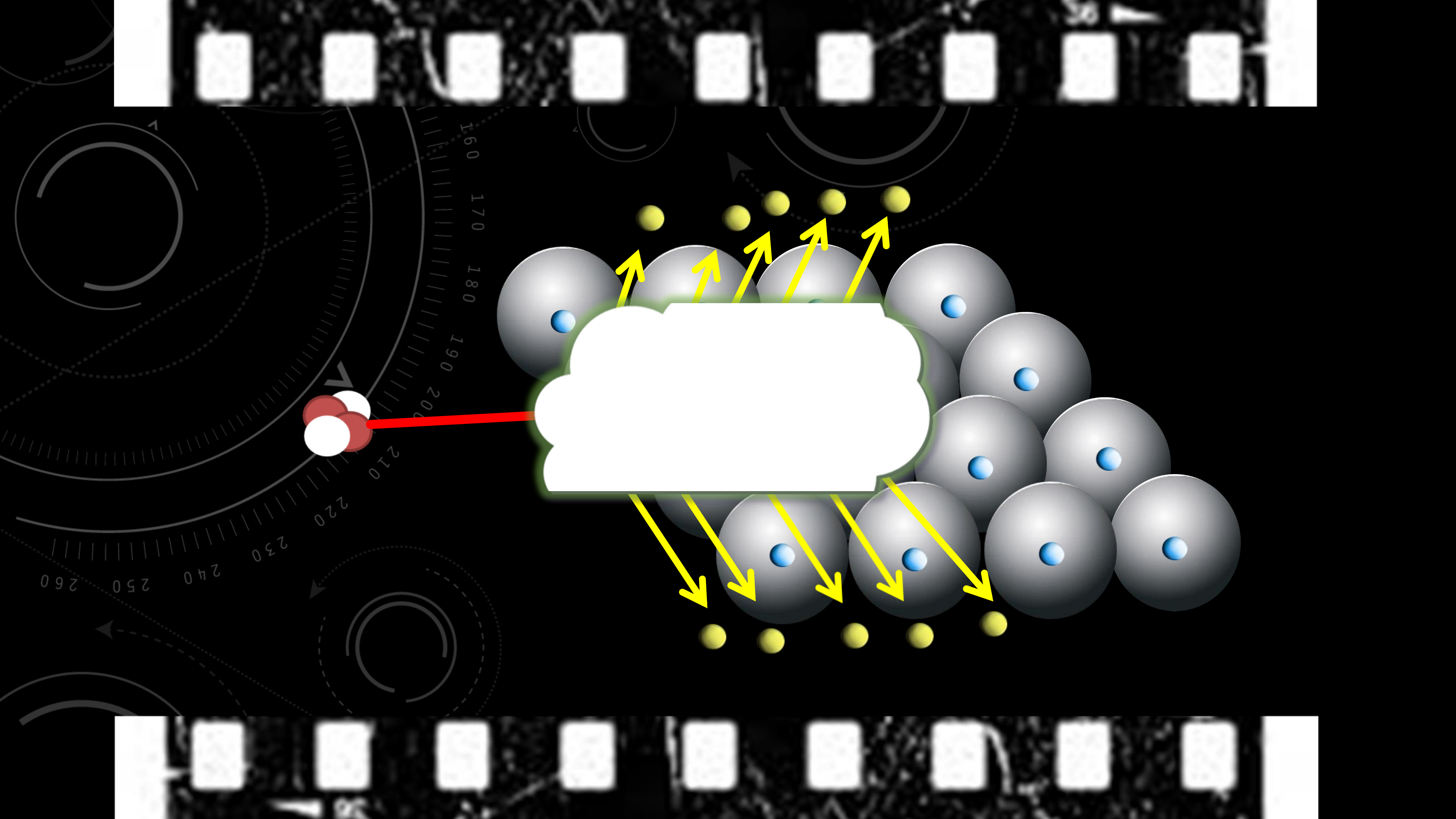

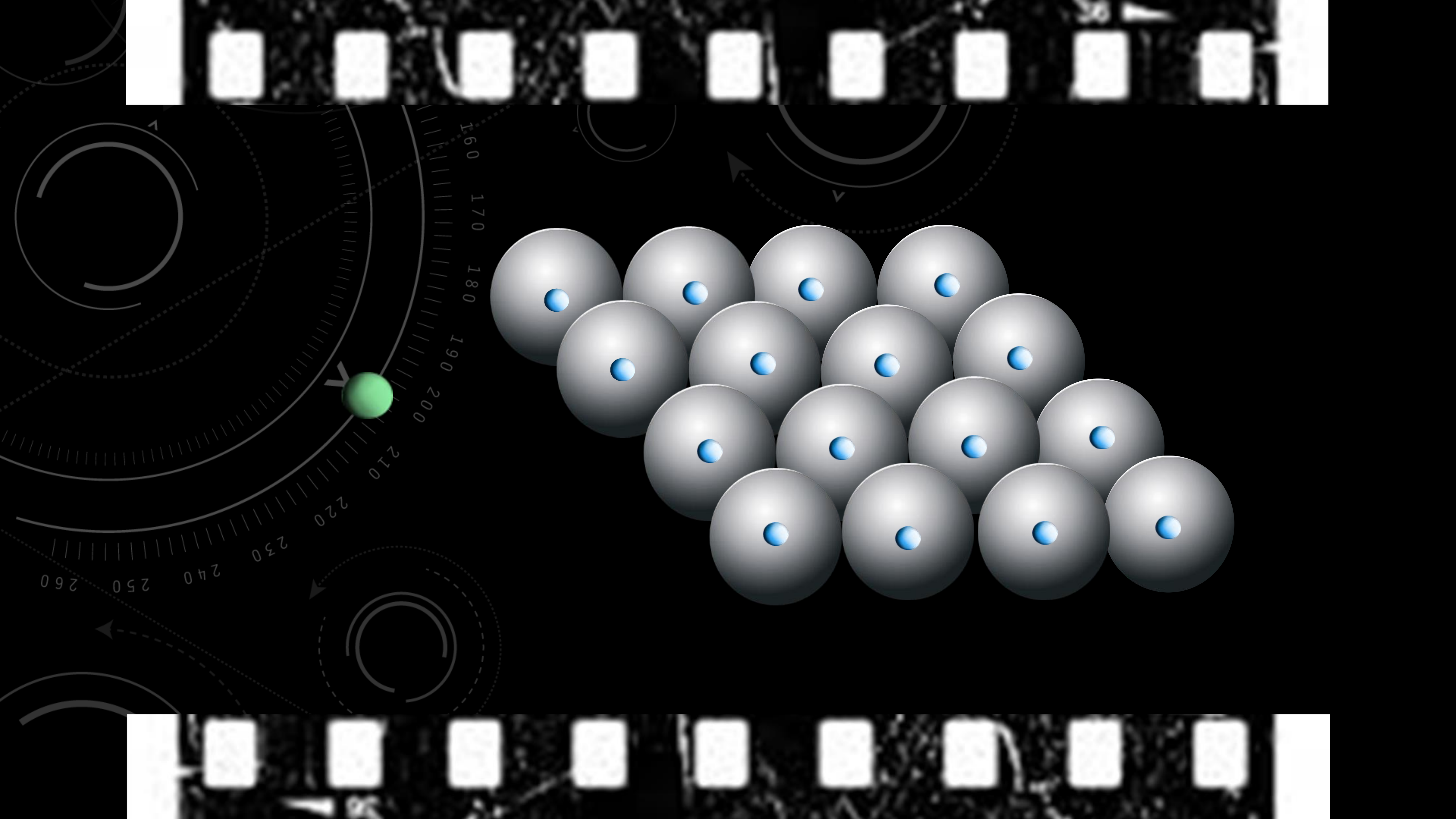

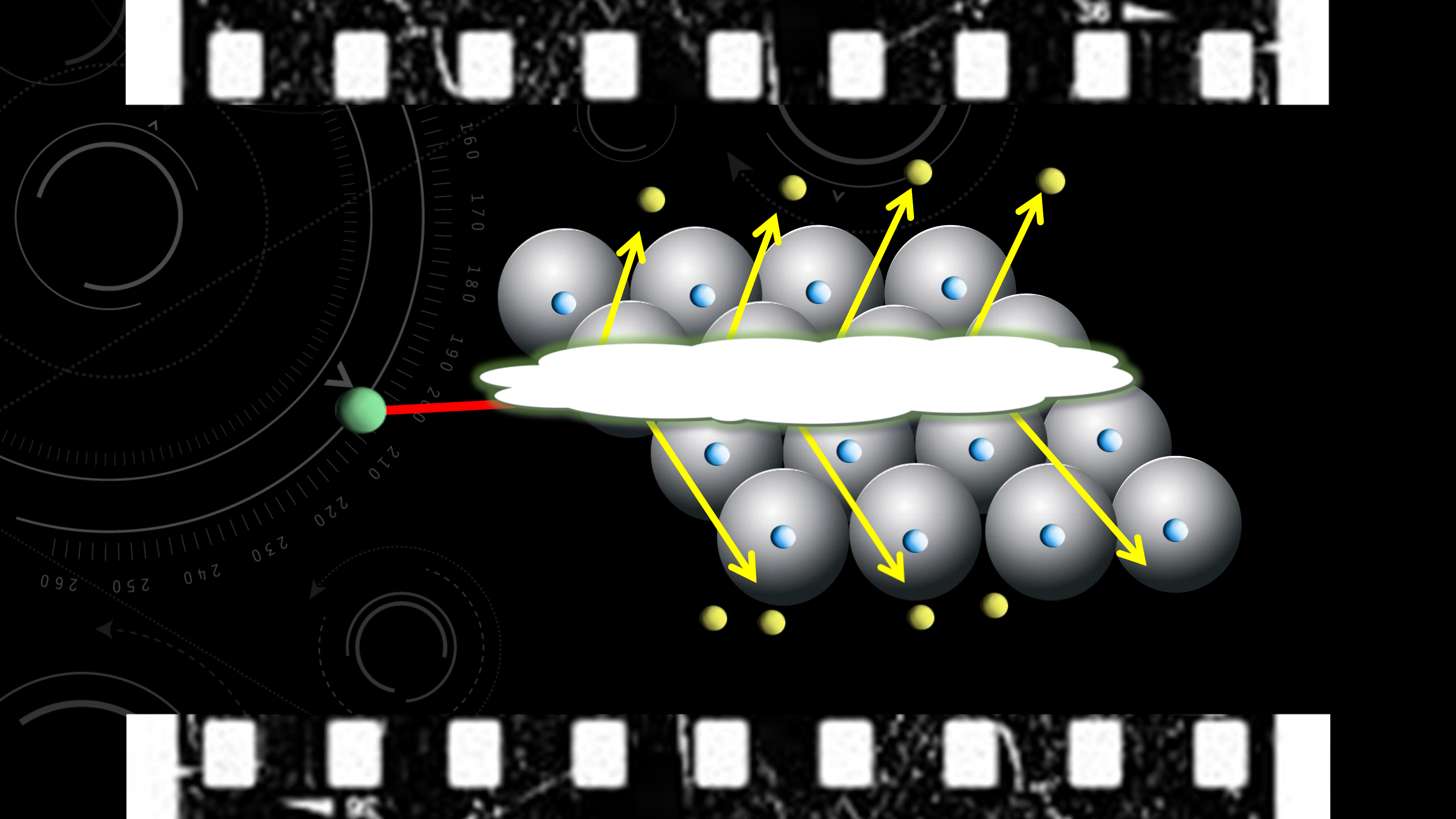

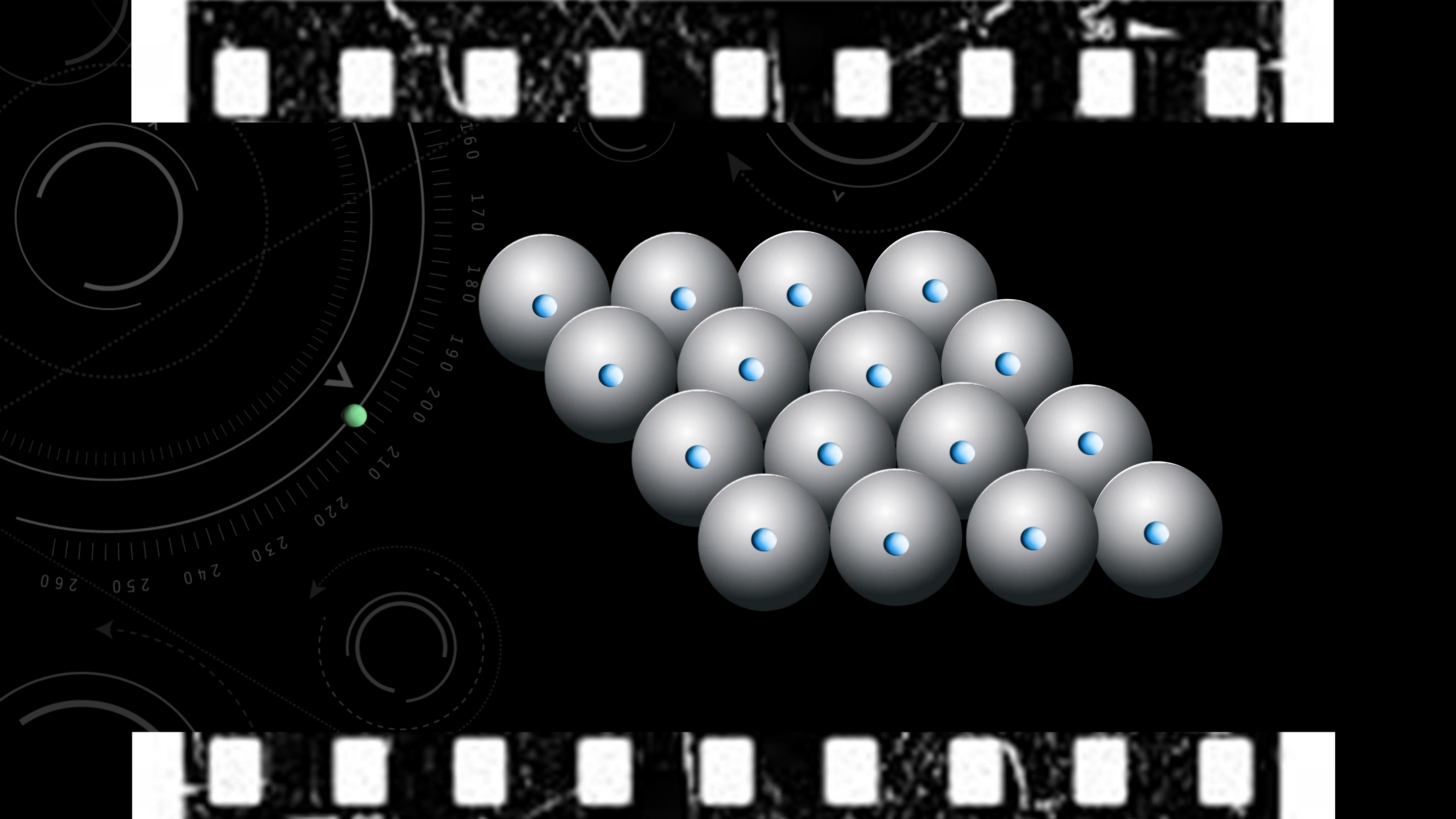

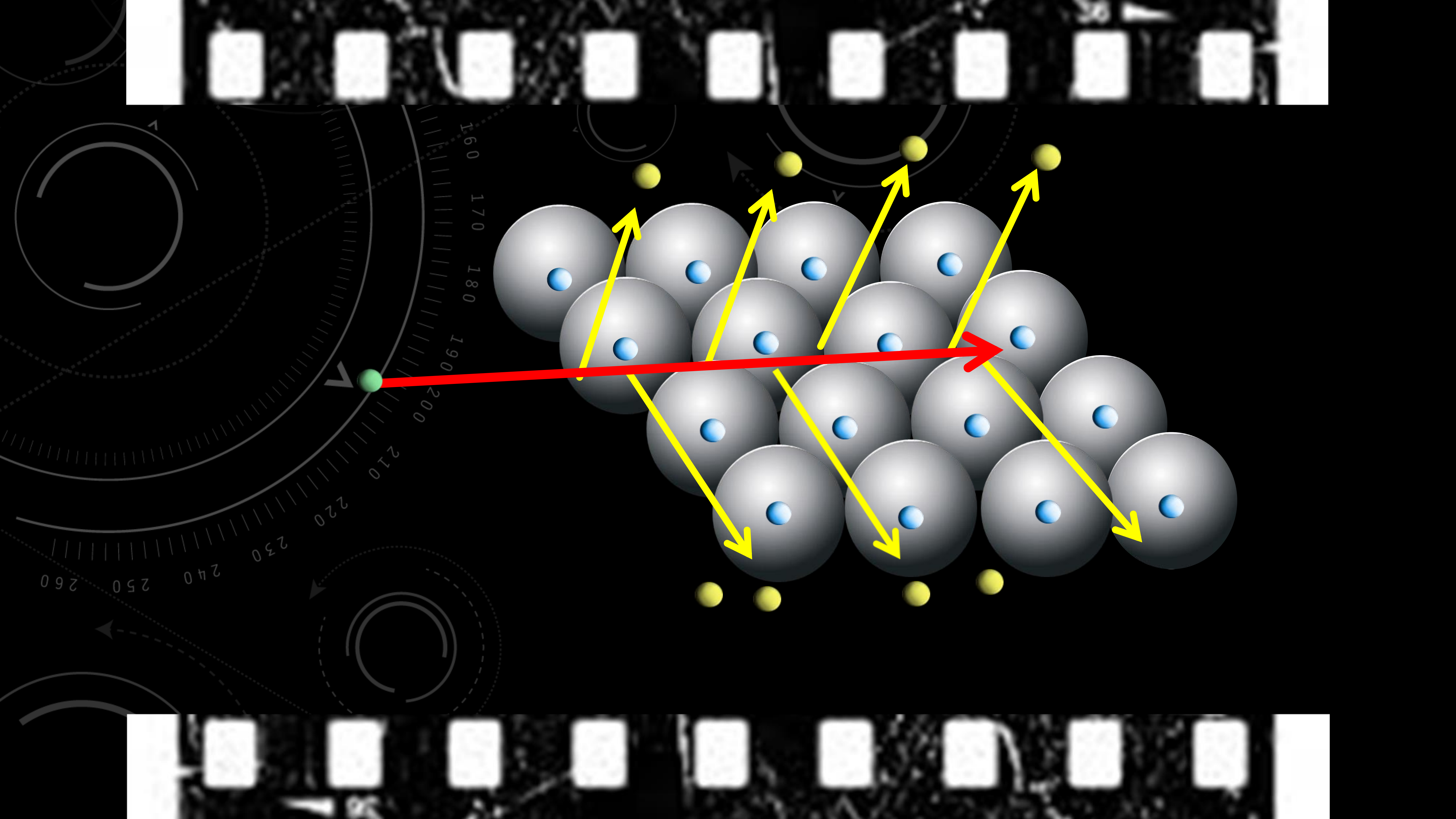

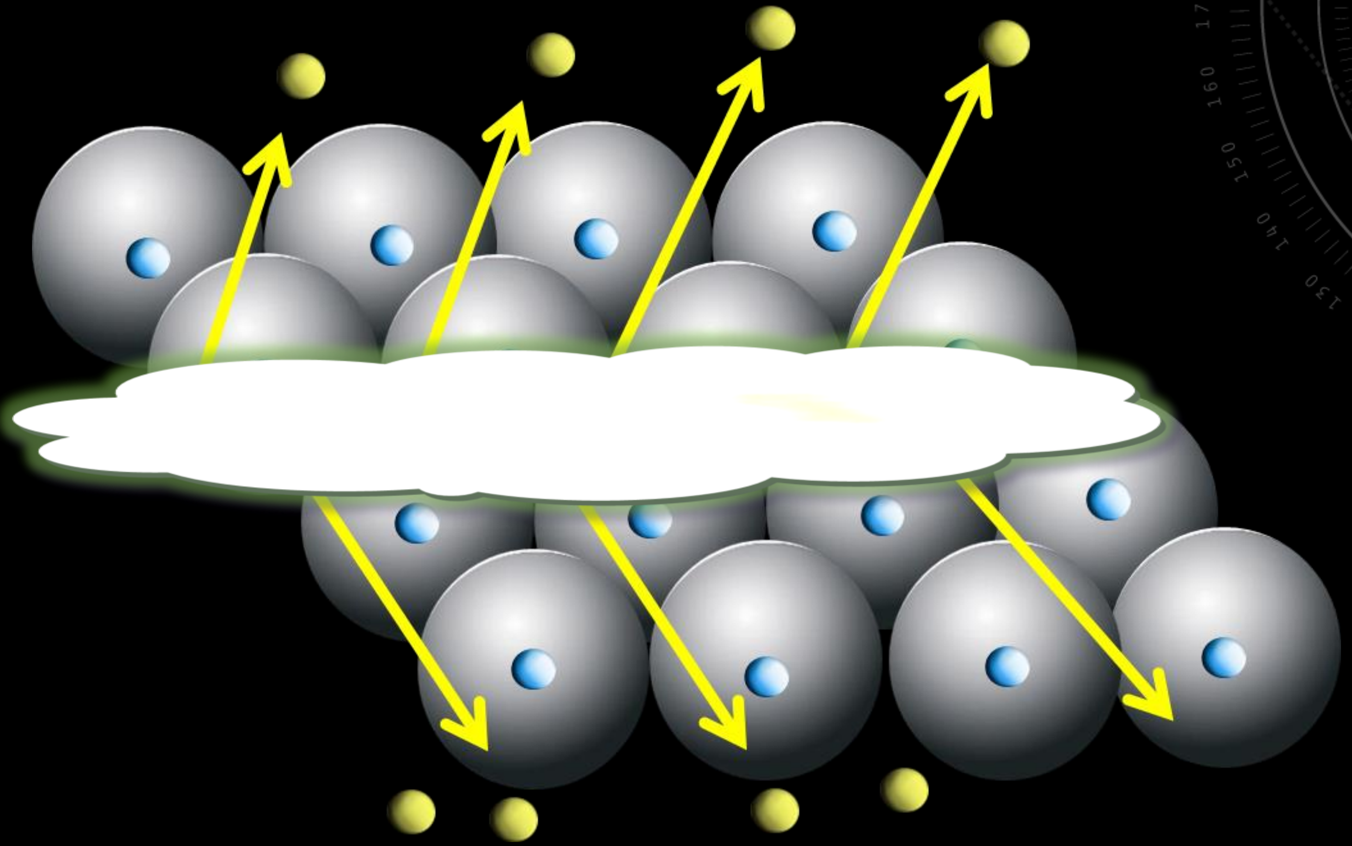

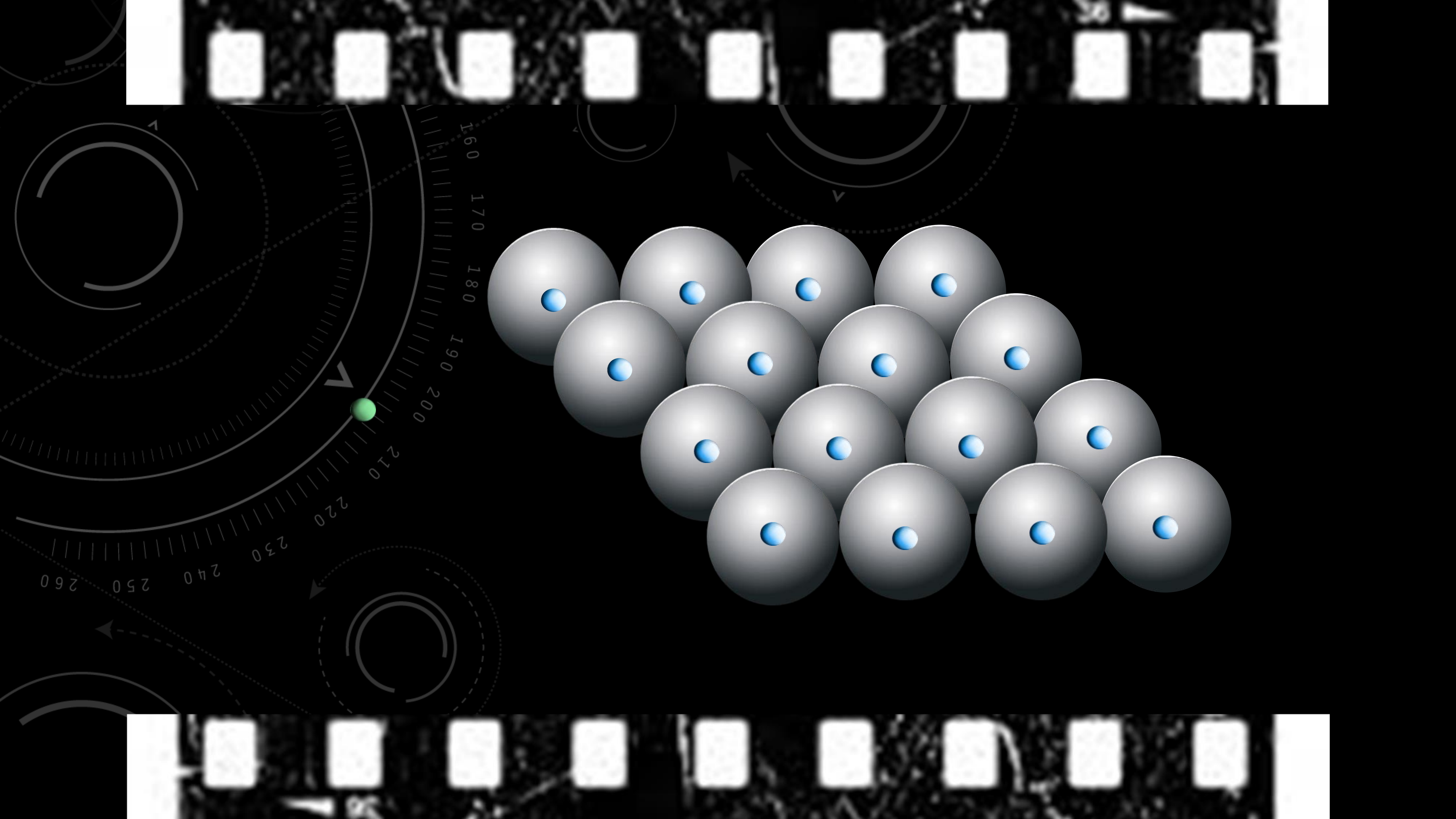
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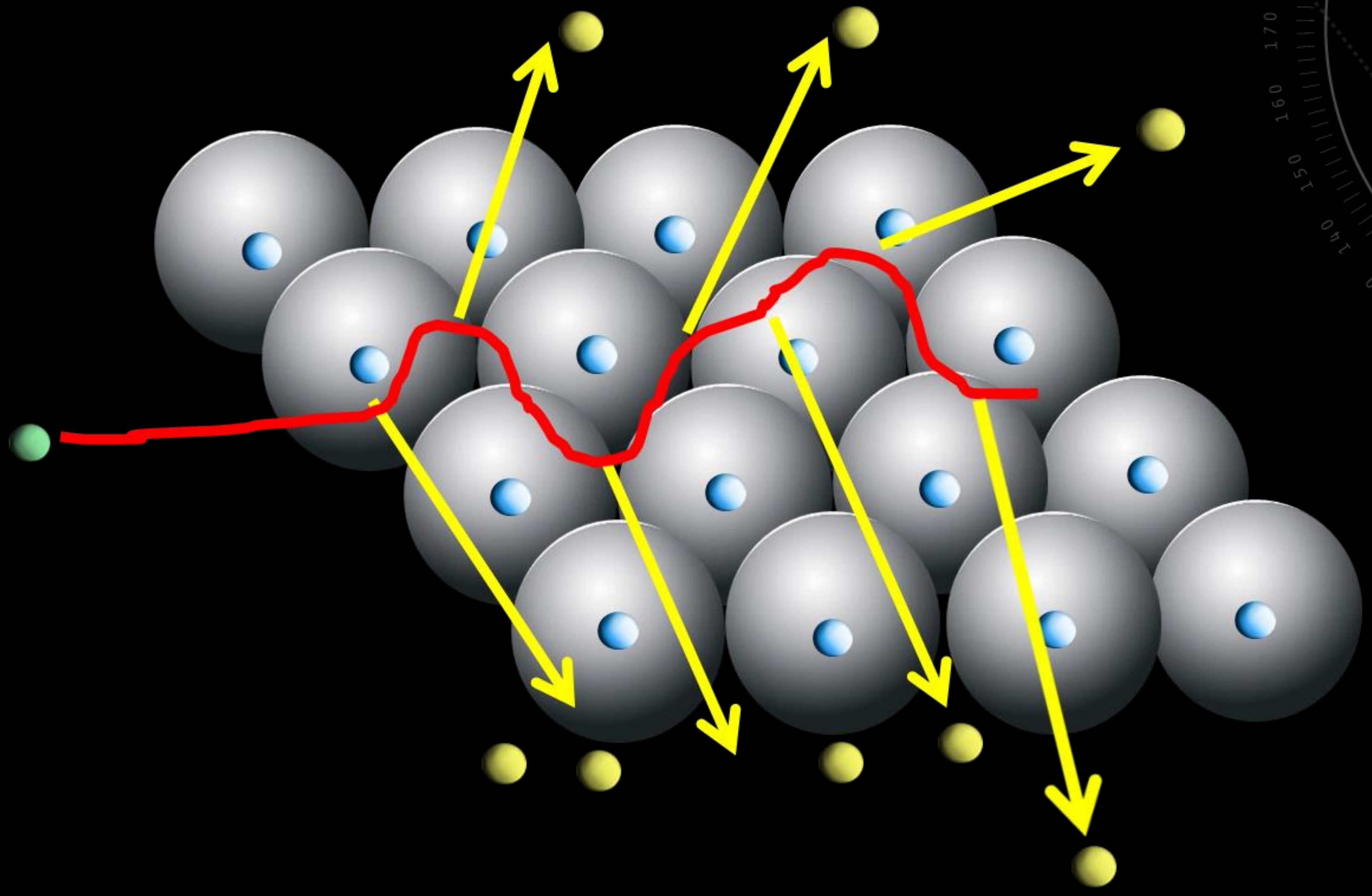
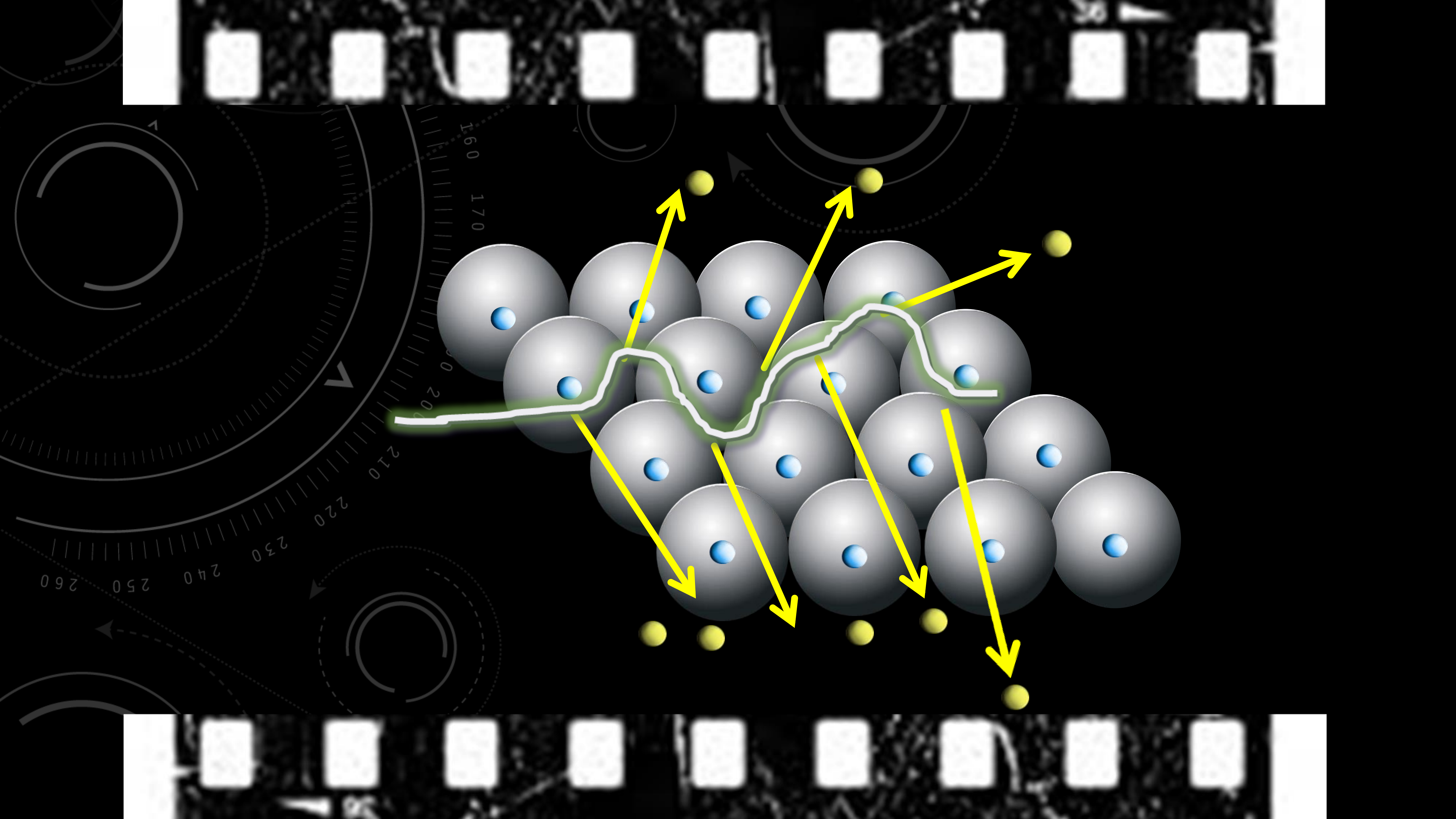




Alpha-Particle

Fast electron or muon

Slow electron


Thank you!!

PROJECT 2 LESSON PLANS
ANA, ANA, ELEANOR

SECTION 1: INTRODUCING CERN

AFTER COMPLETING THIS LESSON THE STUDENT WILL BE ABLE TO:

- EXPLAIN WHAT CERN IS WORKING TOWARDS AND WHY IT WAS CREATED
- IDENTIFY THE MEMBER STATES
- DESCRIBE THE COLLISION AND SOME OF THE DIFFICULTIES IN COLLIDING PROTONS

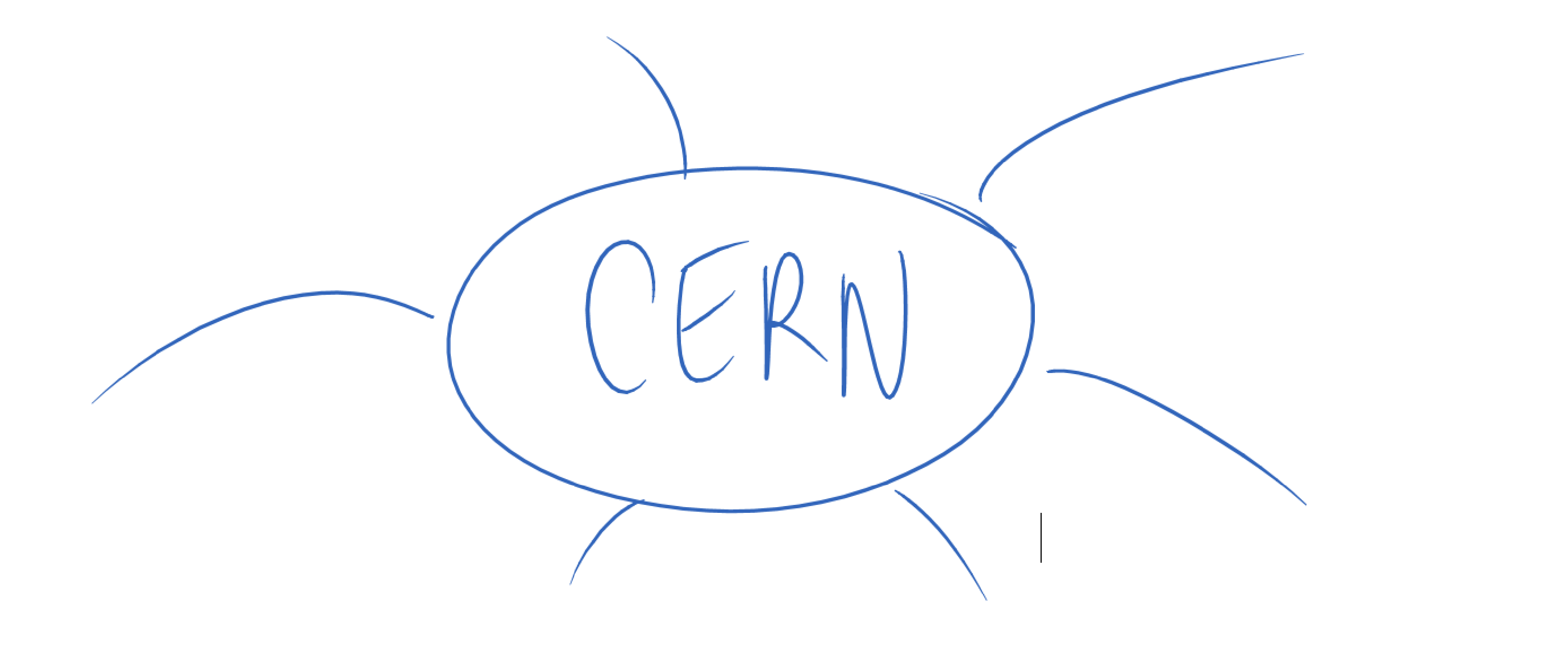
LEVEL

- ELEMENTARY

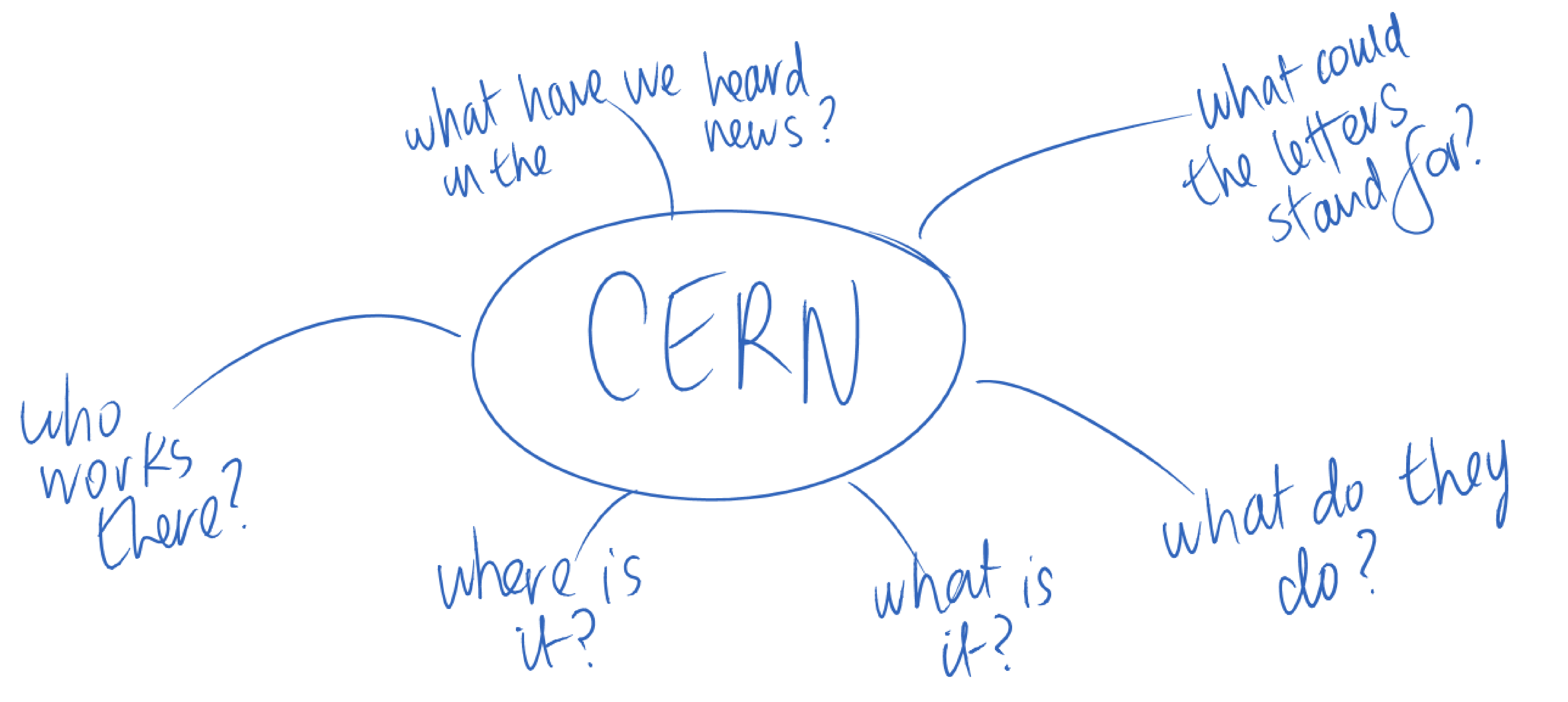
TIMING

- ONE CLASS SESSION
- ONE HOMEWORK ASSIGNMENT

FIRST IDEAS



SOME PROMPTS



MEMBER STATES

Member states have special duties and privileges.

They make a contribution to the capital and operating costs of CERN’s programmes, and are represented in the council, responsible for all important decisions about the organization and its activities.

WHO IS A MEMBER?

DISCUSSION POINT

Q1 What does CERN stand for?

CERN

Centre Européen pour la Recherche Nucléaire

European Centre for Nuclear Research

NEW KEYWORDS

Nucleus

Protons

Collision

Accelerator

Detector

European – Why Switzerland? How do the member states discuss ideas?

Is it useful to involve many countries? Advantages/Disadvantages?

Is there a similar organisation anywhere else?

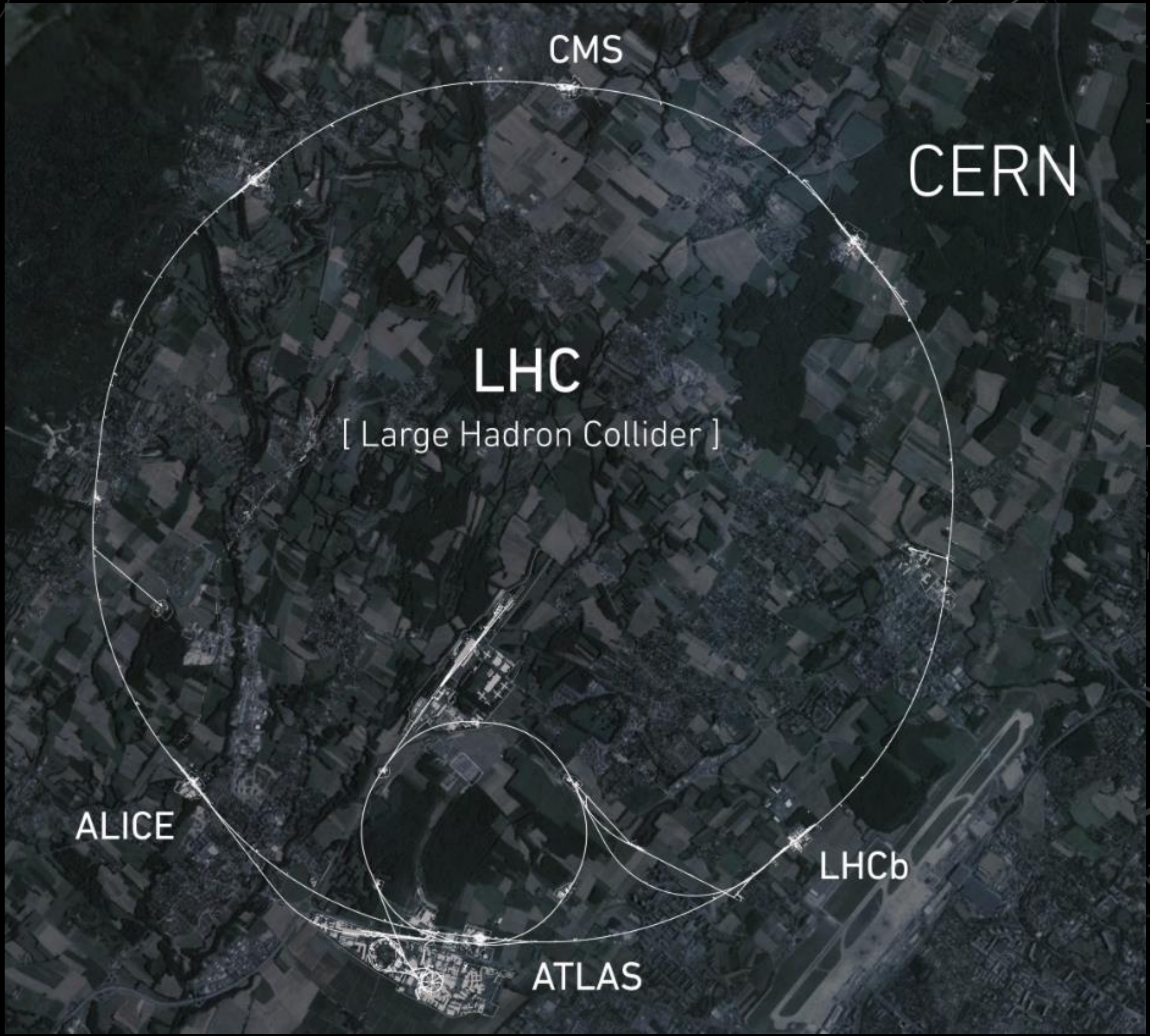
Nuclear – what does this mean? What is a nucleus?

Where is it? Can you see it? Is it related to you?

Should we know about it?

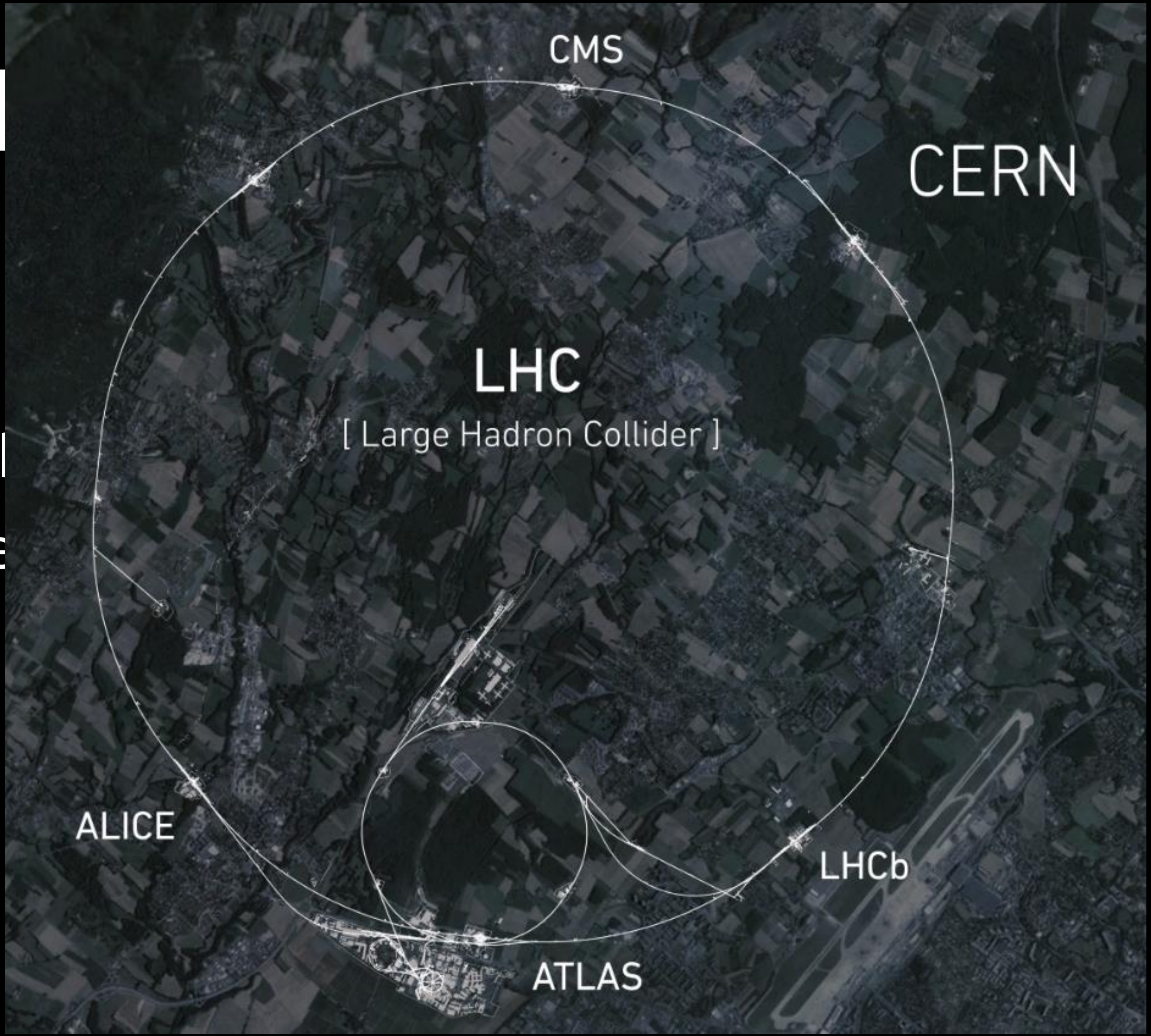
ANIMATION

- http://cern60.web.cern.ch/en/exhibitions/animations

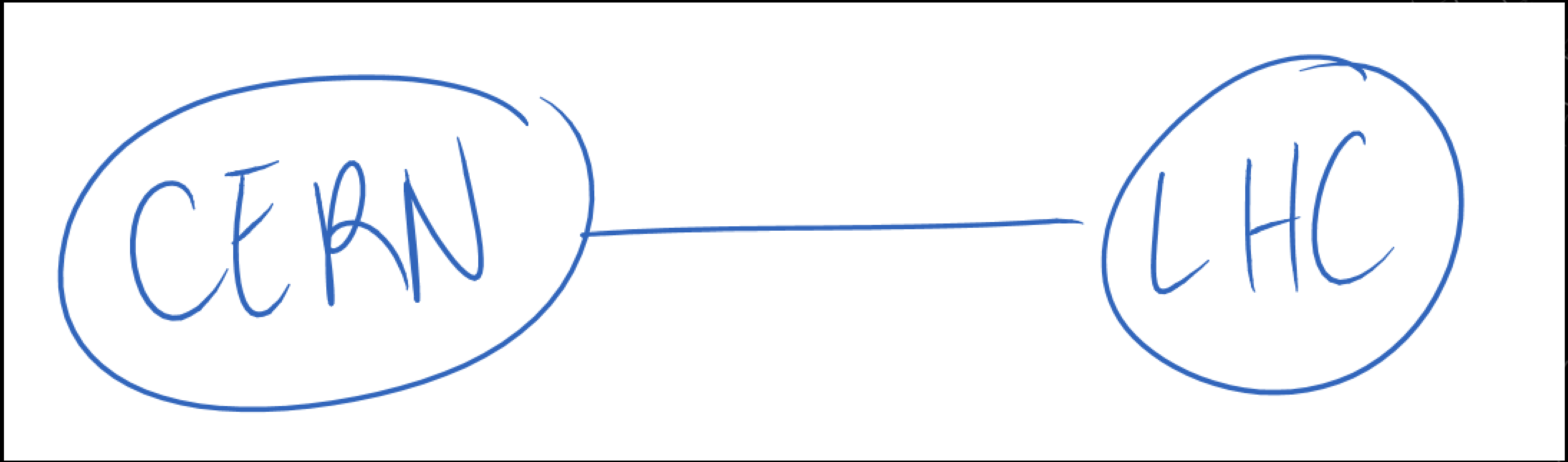


SOM

- What did we notice a
- What is the little brig
- Do they collide in one
- Why is this?
- What happens when



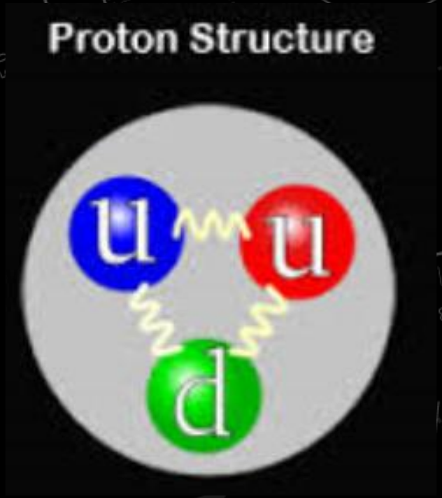
QUICK REVIEW – WHAT ARE THEY?



LHC - LARGE HADRON COLLIDER

- The LHC collides hadrons 40 million times a second!
- The hadrons used are protons which are made up of 3 quarks.
- Is it easy to collide a beam so small?

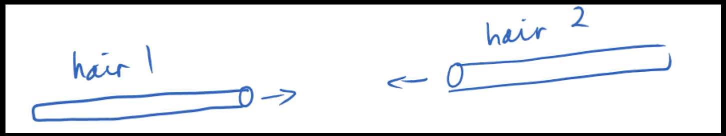
HADRON: An atomic particle made up of quarks.

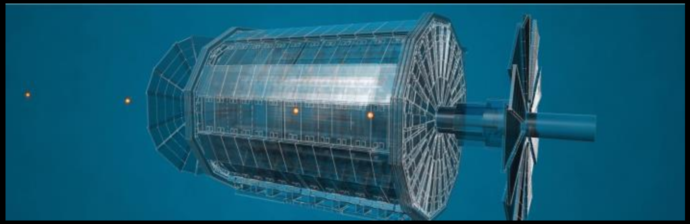


ACTIVITY: MAKE YOUR OWN COLLIDING BEAM!

INSTRUCTIONS:

- Carefully pull out 1 hair and cut the hair to 2cm long.
- Hold the hair between fingers and try to collide with hair of partner.





- Is it easy to collide them?
- What techniques help?

To Think About – Discussion Points

- If there is only half the particles in the same piece of hair what can we conclude about the space between them?
- Are the particles in the hair bigger/smaller than protons? Explain.
- Is it easy for the protons to collide?
- How many do you think collide each time?

Item	No. of particles (Average)
Hair (2cm)	18,000,000,000,000
Protons (Per Bunch)	40,000,000

FURTHER RESEARCH – HOMEWORK TASK

- Q: How long is the LHC?
- Q: What is the shape of the LHC?
- Q: When was it founded and who came up with the idea?
- Q: Can you find another organisation which is a similar international collaboration for Science?

SECTION 2: ACCELERATING PARTICLES.

AFTER COMPLETING THIS LESSON THE STUDENT WILL BE ABLE TO:

- KNOW THE EQUIVALENCE MASS-ENERGY.
- IDENTIFY CERN'S ACCELERATOR COMPLEX
- READ AND SUMMARIZE INFORMATION TO CREATE A TIME LINE.

LEVEL

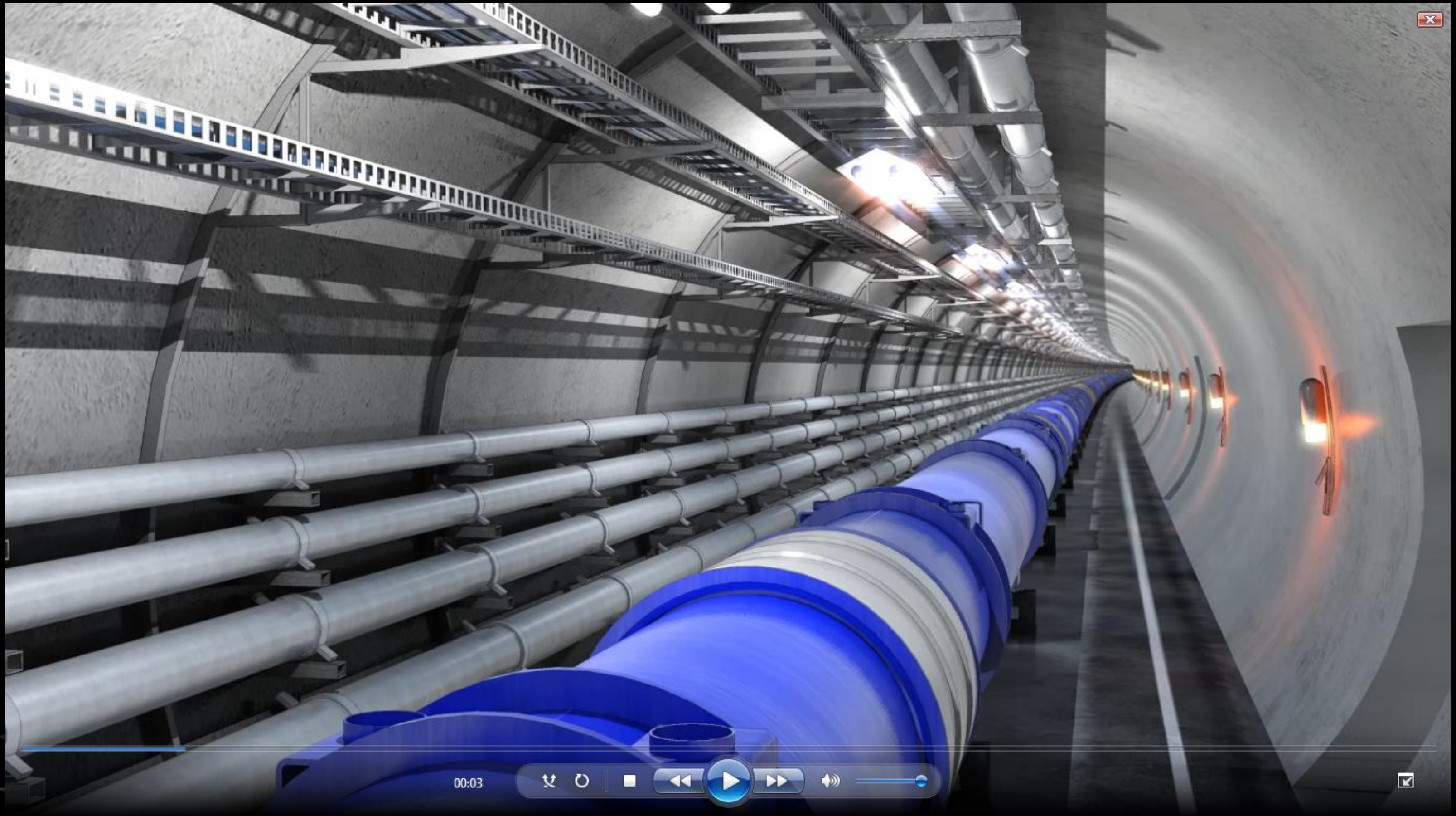
- ELEMENTARY

TIMING

- ONE CLASS SESSION
- ONE SELF-STUDY SESSION

LET'S START WITH AN EASY ANALOGY

PREVIOUS IDEAS



CMS collision.
From http://cern60.web.cern.ch/en/cern-exhibitions-content

Why do we need to accelerate particles?

Because…

LOOK AT THIS CLUE
THE MOST FAMOUS EQUATION IN THE WORLD IS …

$$E = mc^2$$

?

DISCUSSION

E means…

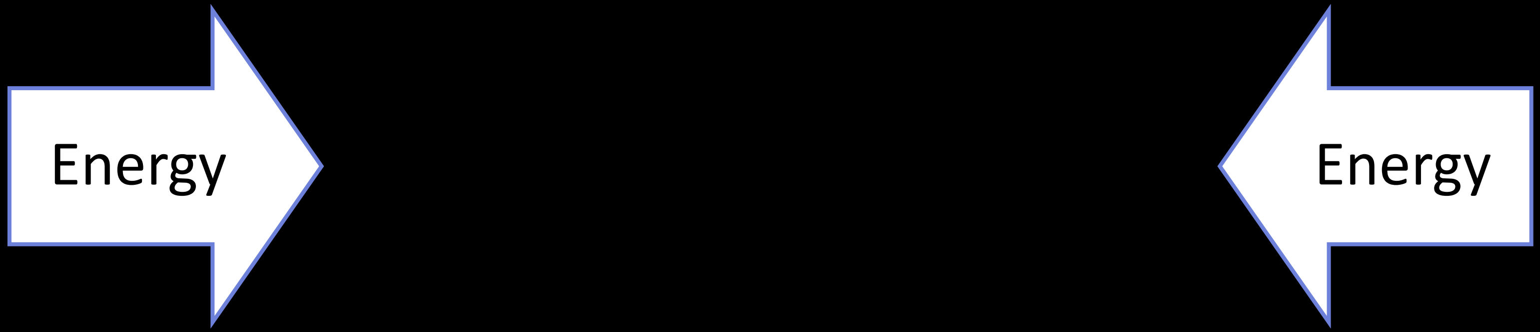
m means…

c means…

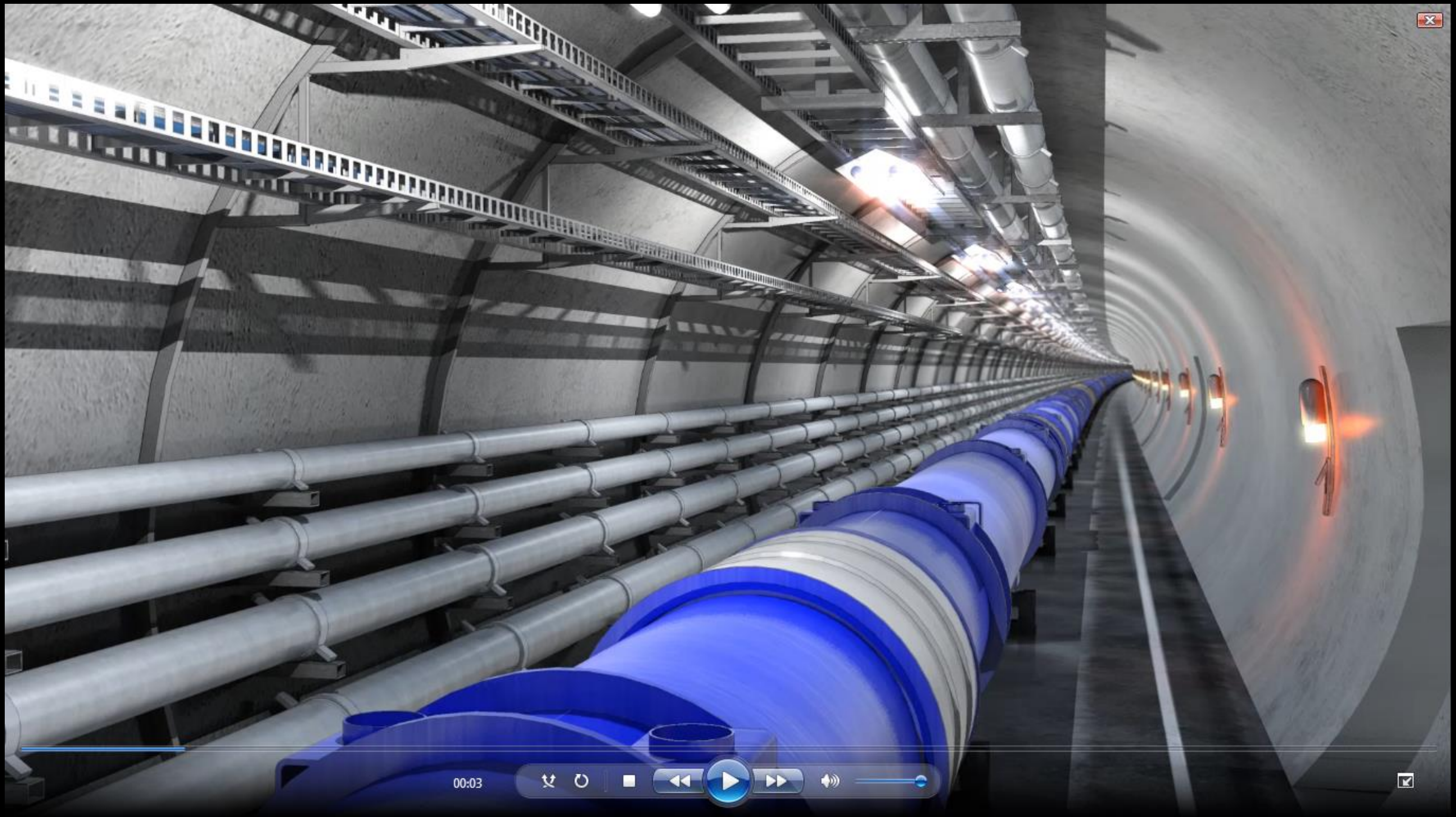
EXPLANATION

In order to get enough energy to produce new particles, we should accelerate protons. They travel almost at the speed of light in opposite directions when the collision happens.

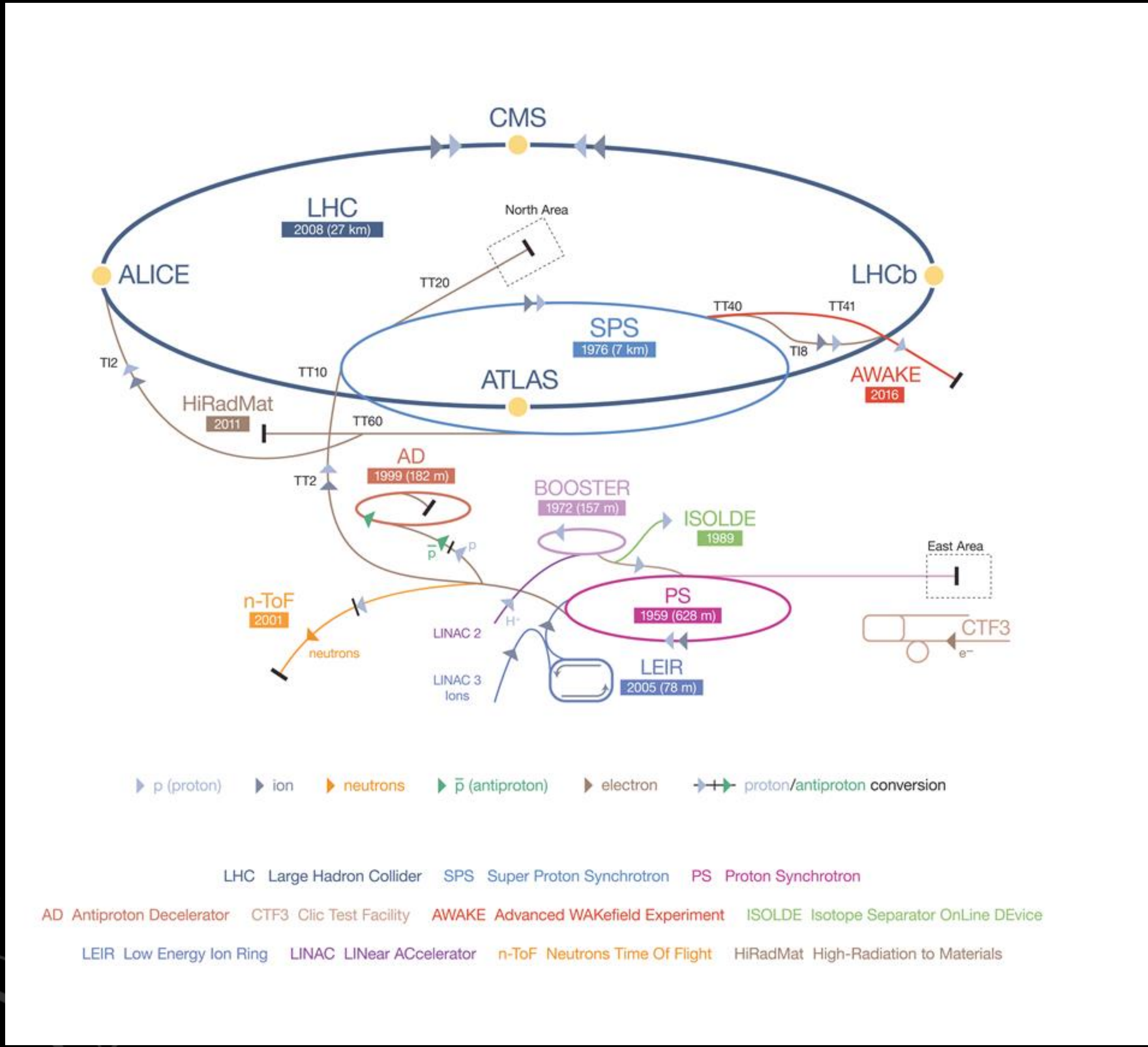
The more energy , the more mass and therefore the more particles we will produce.



WATCH THE ANIMATION AGAIN



CERN'S ACCELERATOR COMPLEX POSTER



From http://cern60.web.cern.ch/en/exhibitions/posters-0

A succession of accelerators boost particles to increasingly higher energies, before injecting the beam into the next machine in the sequence

The path taken by the particles is also a journey through the **history of CERN.**

WEBQUEST ABOUT THE HISTORY OF CERN

- Using the information from the poster and from this website (http://home.web.cern.ch/about) discuss in class the following questions:
  1. When and why was CERN proposed?
  2. When CERN was founded and by whom?
  3. What is the name of the first accelerator? How long has it been running?
  4. When were antimatter particles detected for the first time?
  5. What was the detection method in the 1960's? Who proposed a new detection method? When?
  6. What happened in 1974-1976? What is the meaning of SPS?
  7. In 1988, a new accelerator was completed. What is it's name? Is it still running?
  8. When was the World Wide Web born?
  9. New experiments were approved between 1997-1998 at CERN. What are their names?
  10. The Globe of Science and Innovation was built in 2004 with what purpose?
  11. When did LHC start up? What are **the two** main results obtained recently?
  12. With this information you can create a time line of events in CERN from it's begining to the present day.

SECTION 3: DETECTION

AFTER COMPLETING THIS LESSON THE STUDENT WILL BE ABLE TO:

- KNOW THE NAMES AND LOCATION OF THE DETECTORS IN LHC.
- UNDERSTAND HOW SCIENTISTS IDENTIFY PARTICLES.
- BE AWARE OF THE HUGE AMOUNT OF DATA PRODUCED.

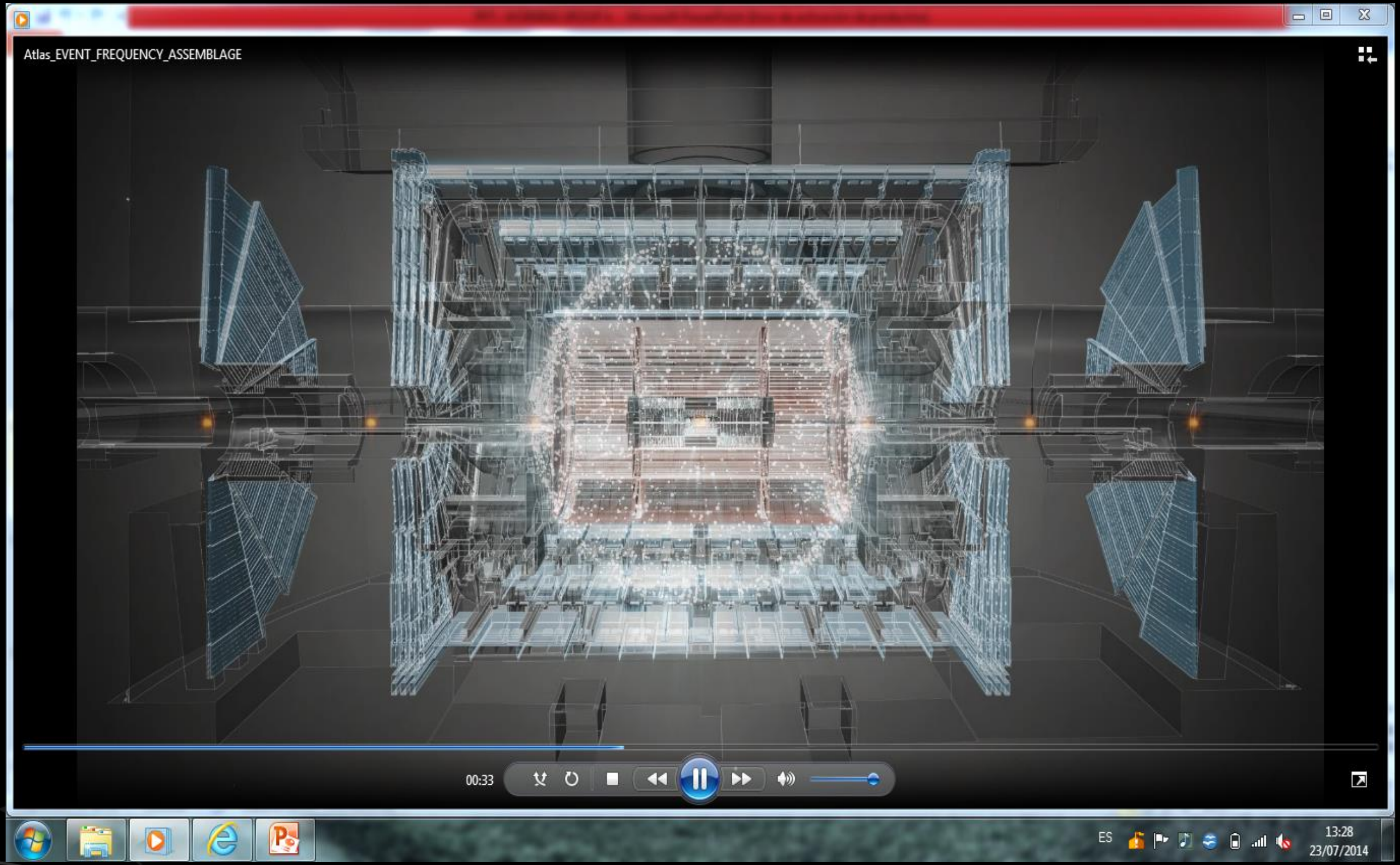
LEVEL

- ELEMENTARY

TIMING

- ONE CLASS SESSION

PREVIOUS IDEAS



Describe what you see in this animation.

KEY WORDS: Collision, Energy, Particles, Detector, Frequency

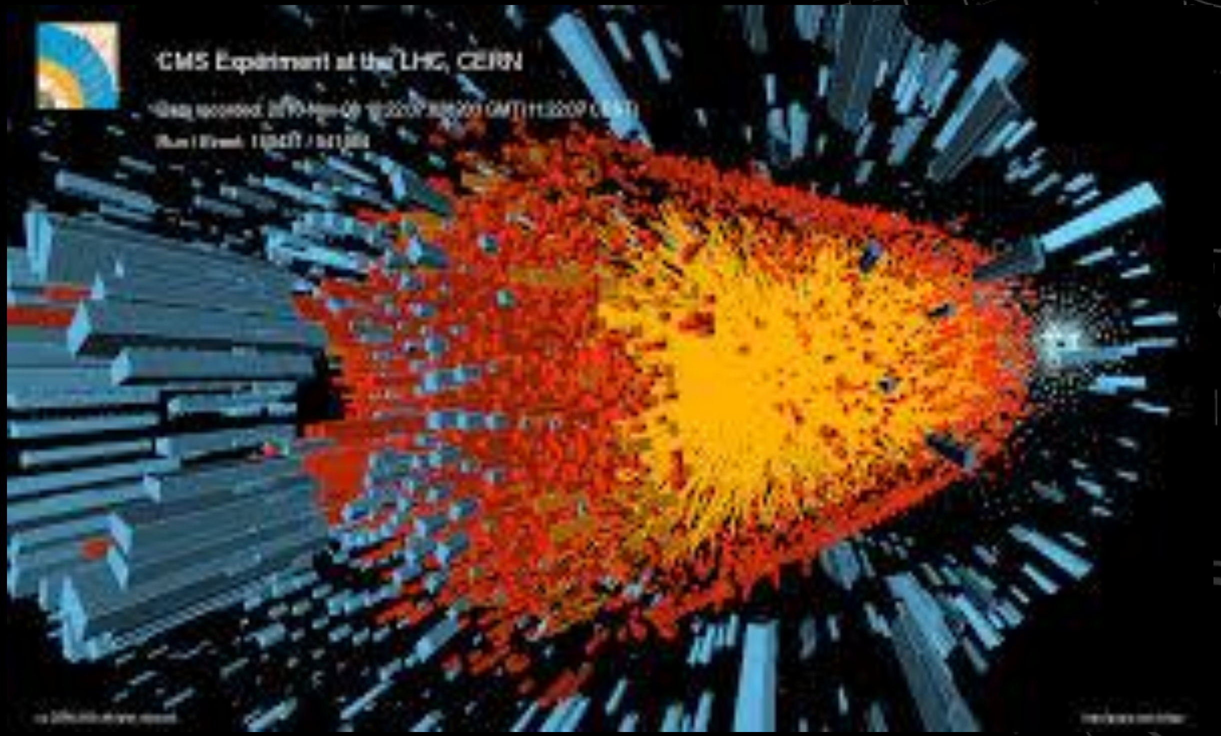
ATLAS event
http://cern60.web.cern.ch/en/exhibitions/atlas-event-frequency-assemblage

WHAT HAPPENS AFTER A COLLISION?

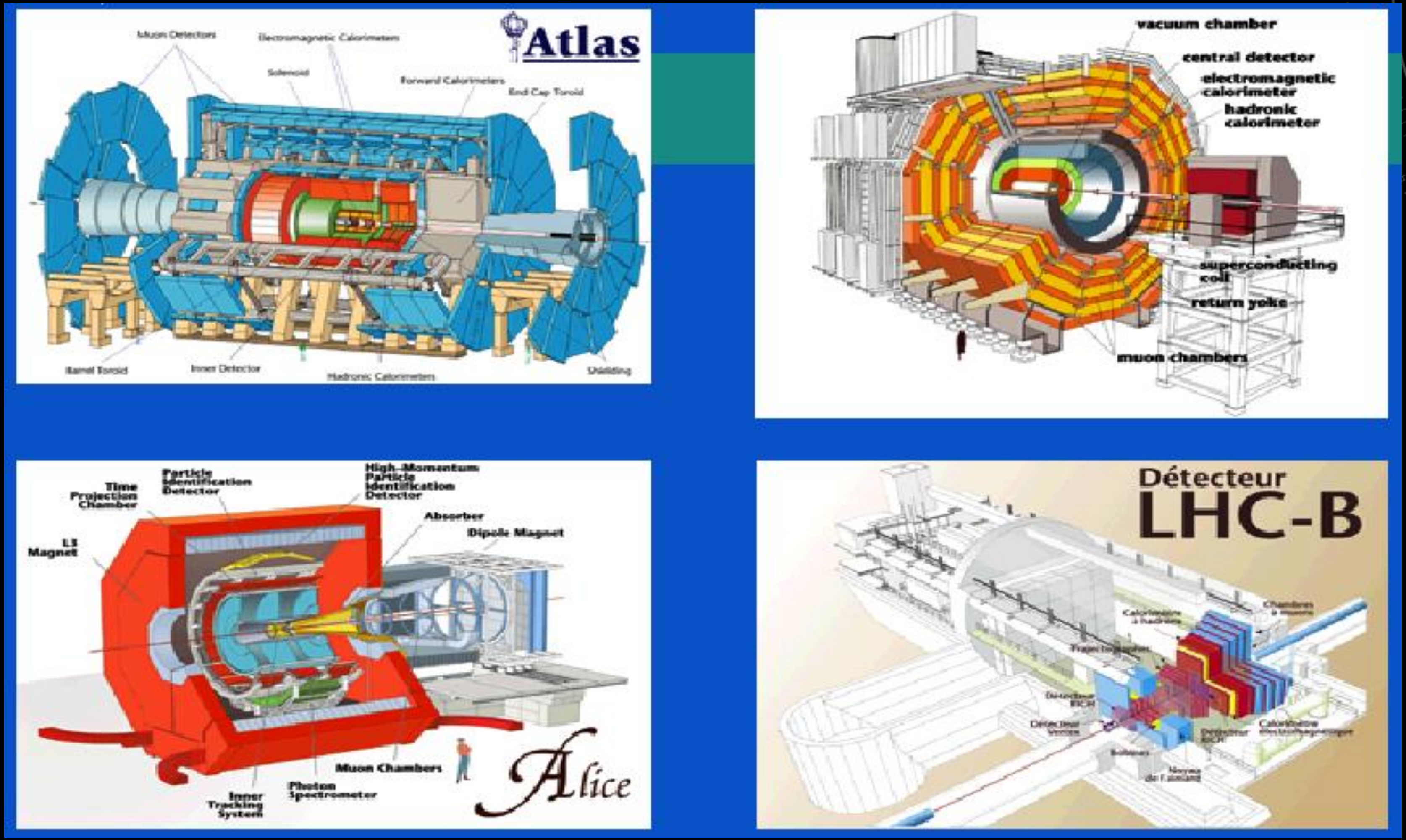
After each collision, many particles are created depending on the energy of the beam.

Detectors are used to trail, analyse and classify these particles.

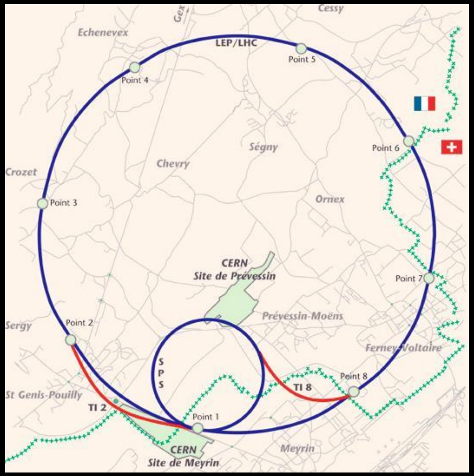
Let’s talk about detectors…

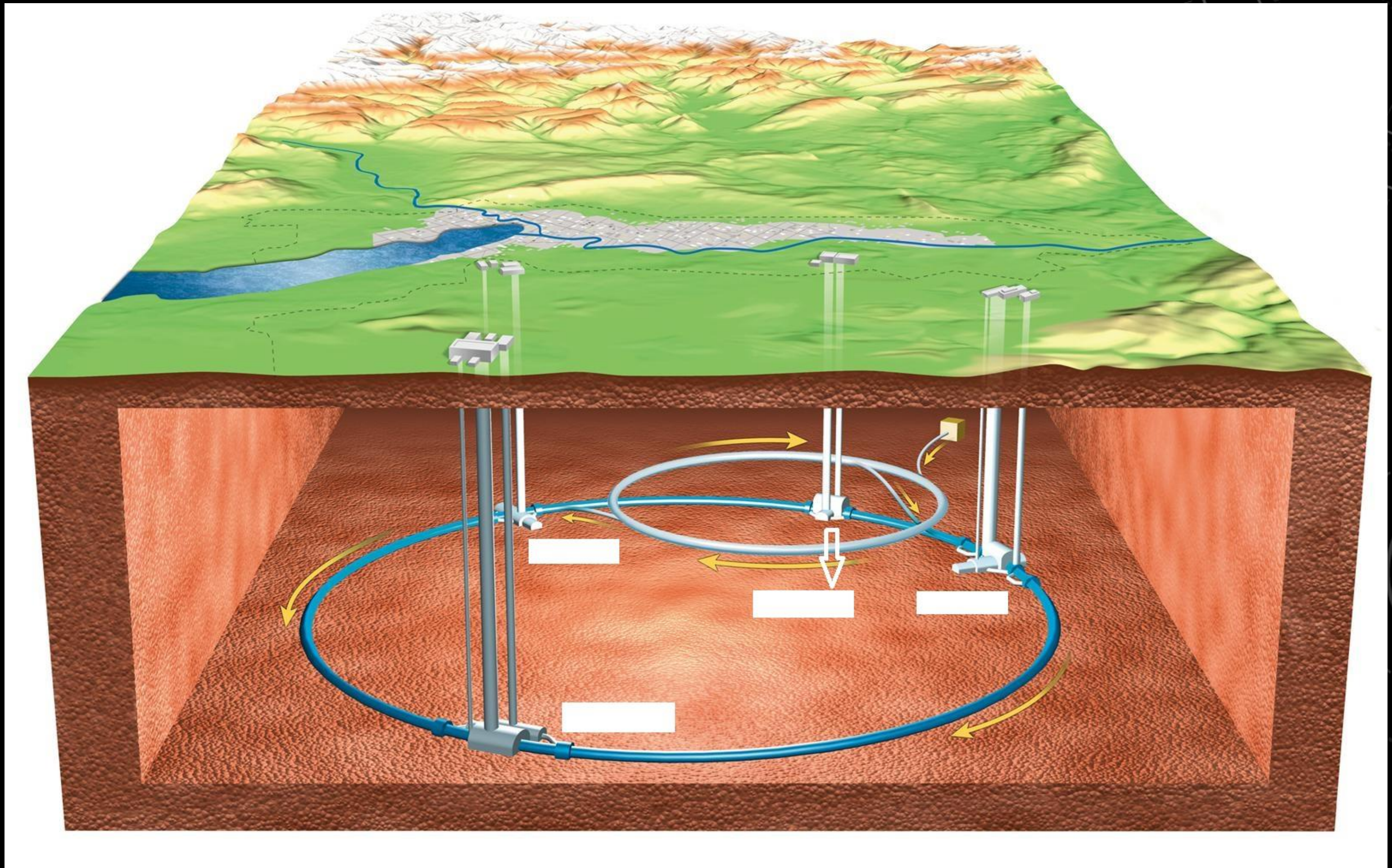


LHC Experiments



DO YOU KNOW WHERE THEY ARE SITUATED?





HOW DETECTORS WORK?

Detectors are designed to find the identification mark of the particles i.e. the Particle ID!

Each particle has its own identity properties; just like animals or humans.

How do we identify them?

ANIMAL TRACKS

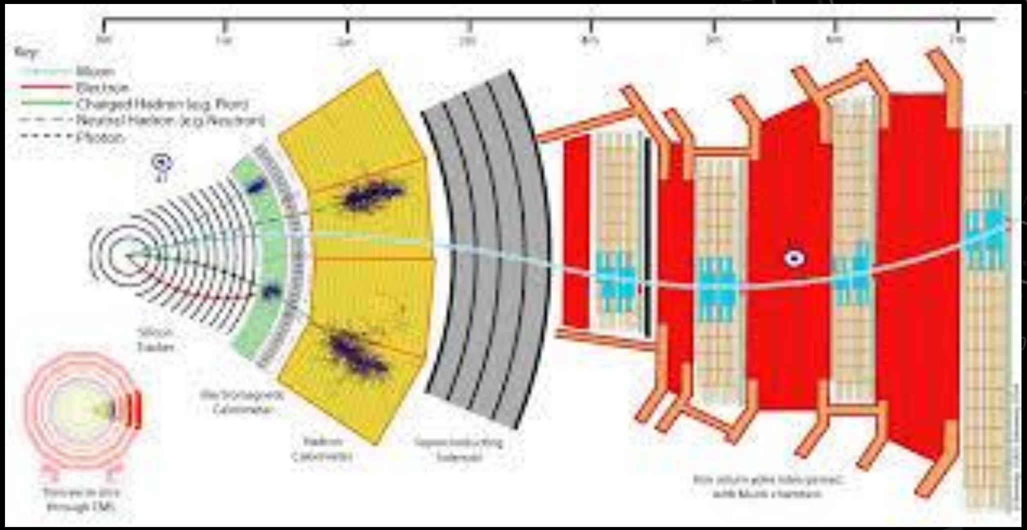
HUMAN FINGERPRINTS

HOW ARE THEY DESIGNED?

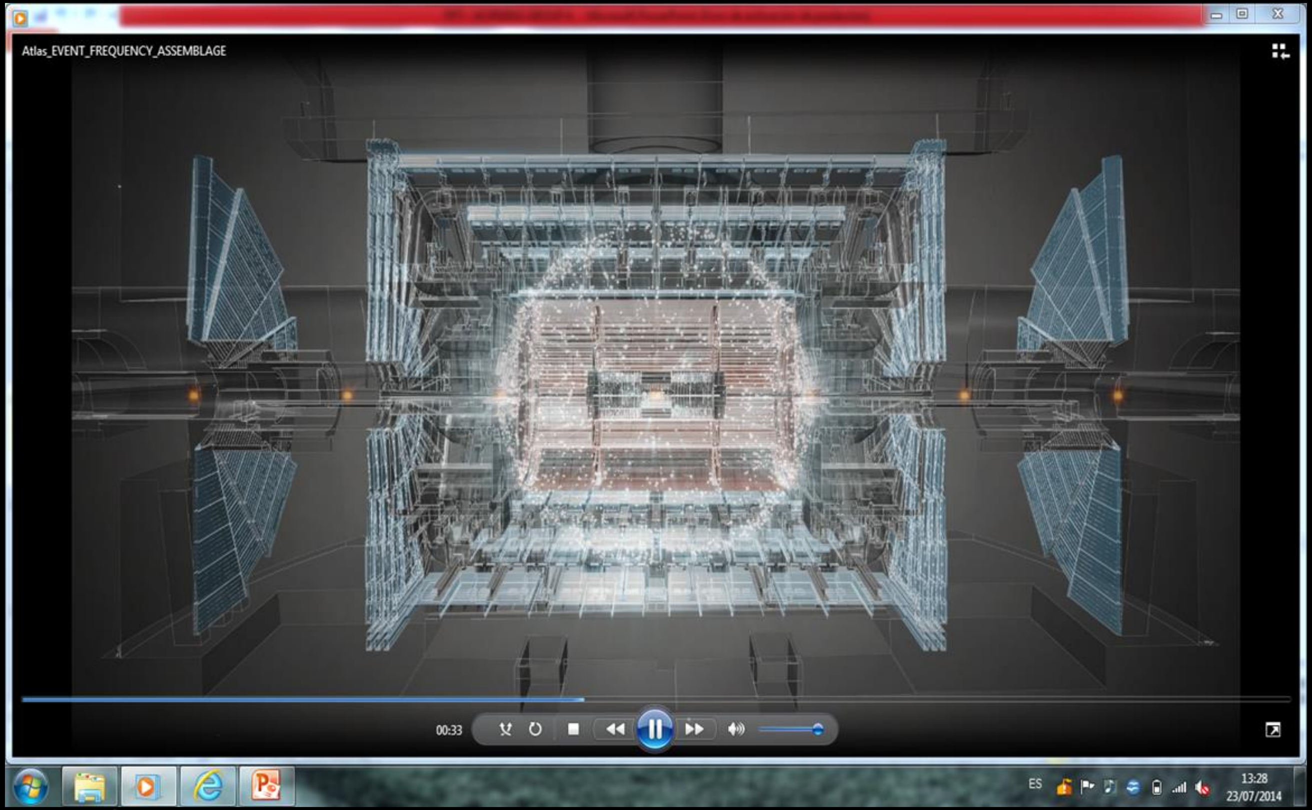
Detectors are made of several layers.

In some of the layers, the particles don’t leave any tracks whereas in other regions they do.

Combining all the information from all the detectors involved, we may identify the particles.



WATCH THE ANIMATION AGAIN AND ANSWER THE QUESTIONS



- What is a bunch?
- Which is the collision frequency?
- How many collisions will happen in one minute? And in one second?
- Discuss in class how you could analyse this data.

SECTION 4: BEYOND COLLISION!

AFTER COMPLETING THIS LESSON THE STUDENT WILL BE ABLE TO:

- VISUALISE HOW THE PARTICLE TRACKS ARE CREATED FROM THE DETECTOR SIGNALS
- RECOGNISE THAT THE VOLUME OF DATA PRODUCED IN THE COLLISIONS REQUIRES NEW COMPUTING TECHNIQUES
- EXPLAIN HOW INTERNATIONAL COLLABORATION AND TECHNOLOGY IS CONTRIBUTING TO DATA ANALYSIS OF THE COLLISION OUTPUT.

LEVEL

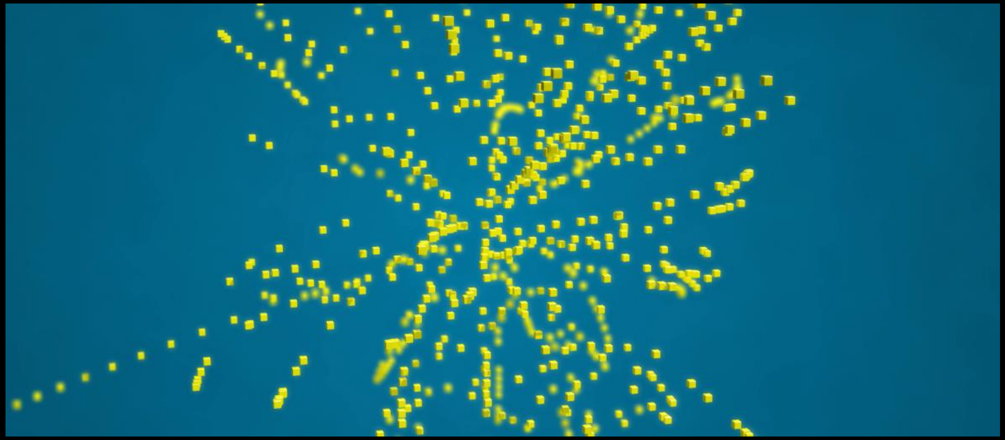
- INTERMEDIATE

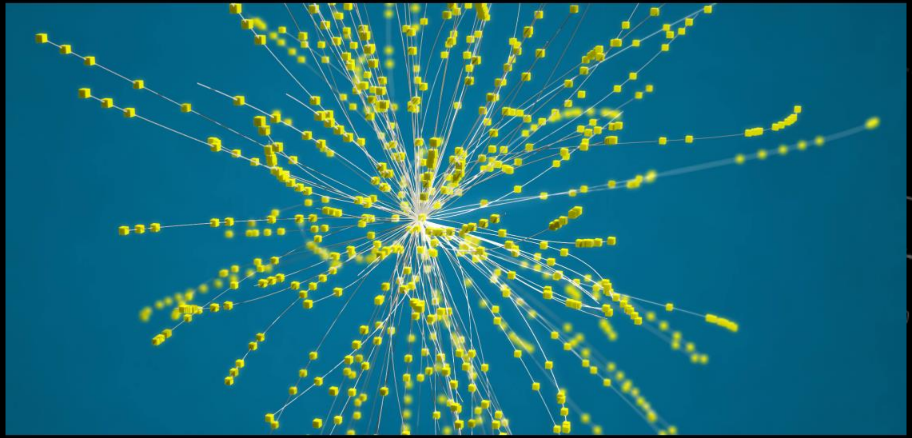
TIMING

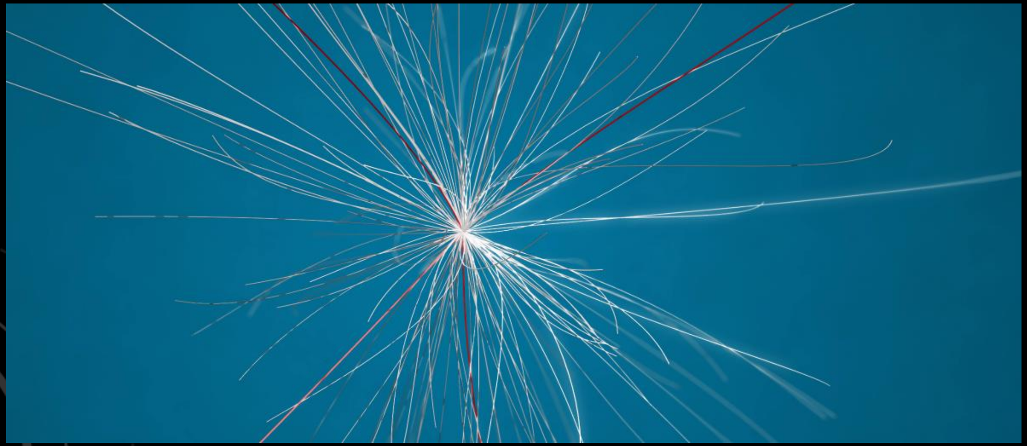
- HALF CLASS SESSION

- http://cern60.web.cern.ch/en/exhibitions/animations-2

RECALL HOW THE DETECTOR CAPTURES THE INFORMATION







NOT ALL PARTICLE TRACKS CAN BE SAVED!

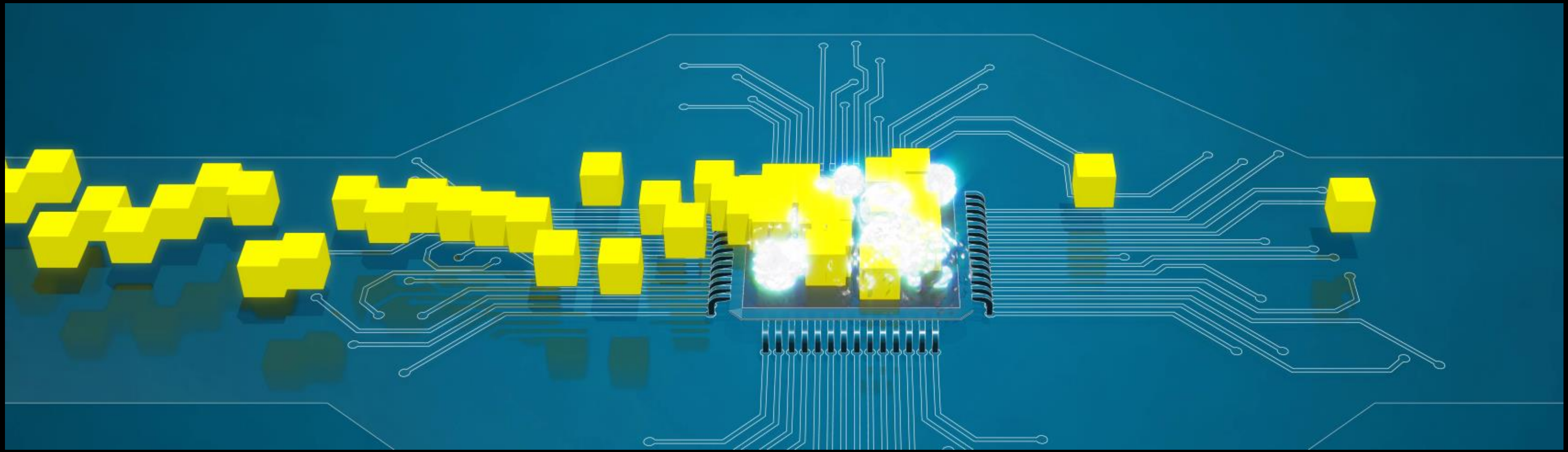
150 million sensors - Generating data 40 million times per second!

This is too much information coming too quickly!!!

Trigger Selects 100,000 per second which look 'interesting'.

Filter Selects 100 per second which contain the physics we want to study

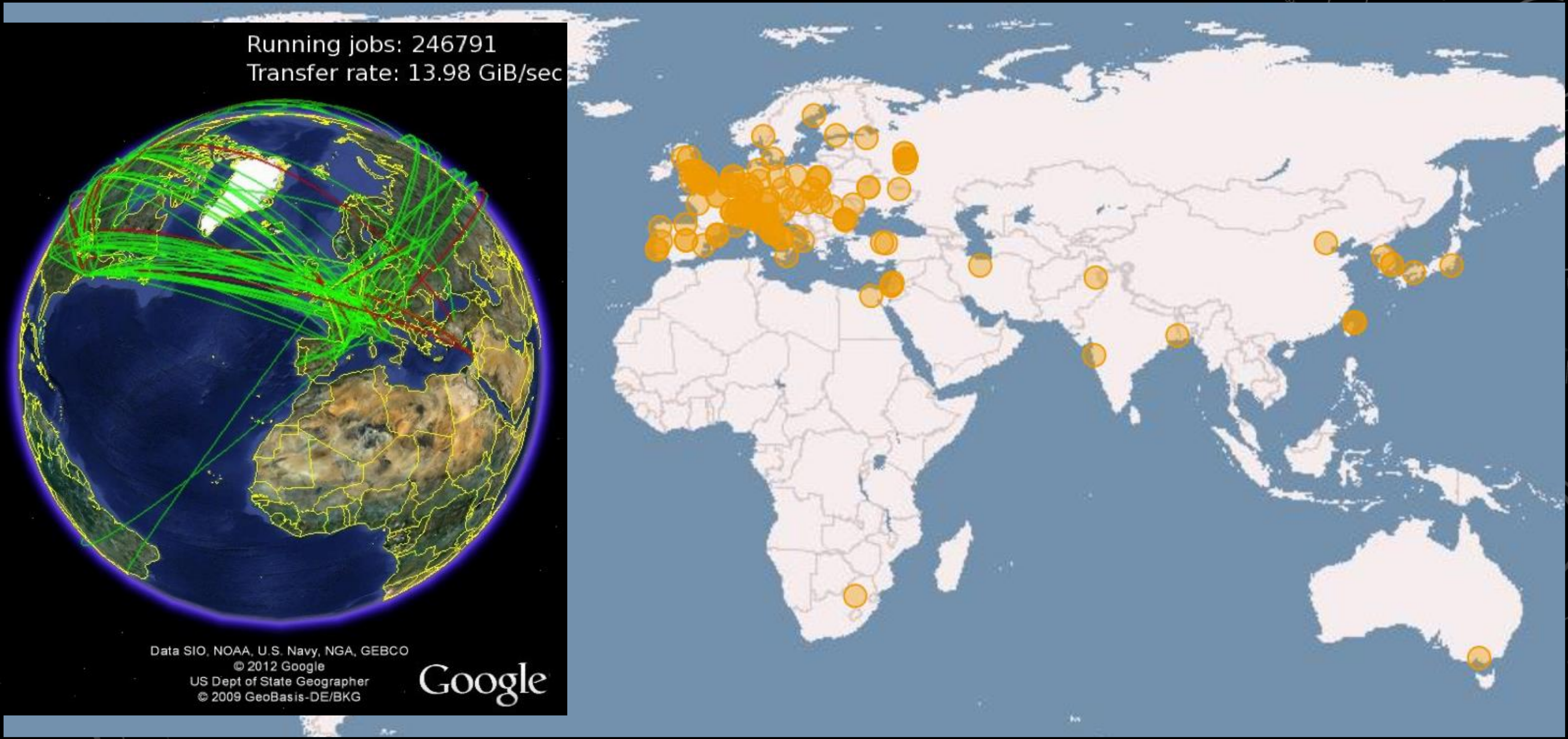
Trigger animation



CERN still cannot manage all that data on it's own!

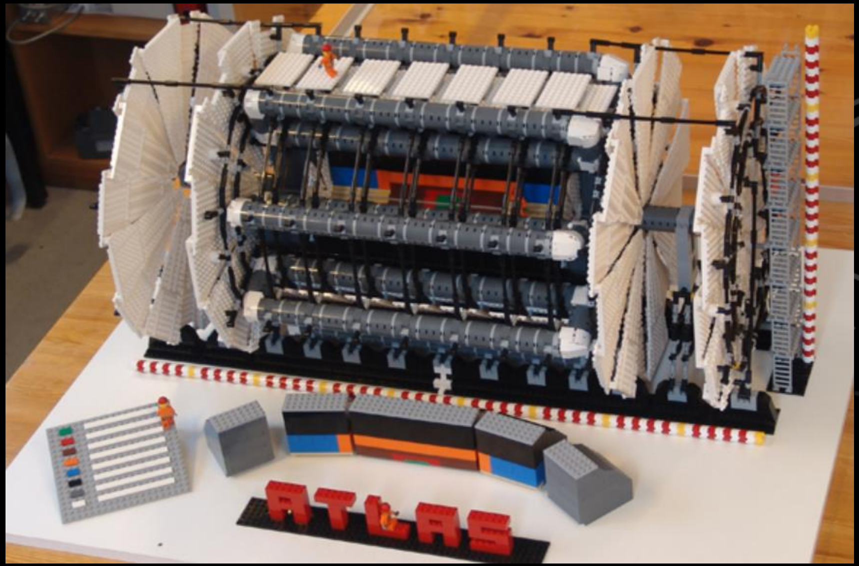
What solutions can you think of to help process as much data as possible???

THE WORLDWIDE LHC COMPUTING GRID

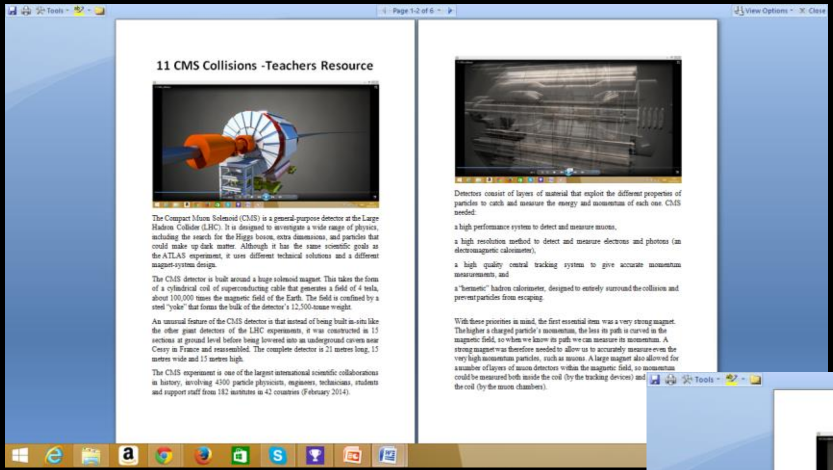


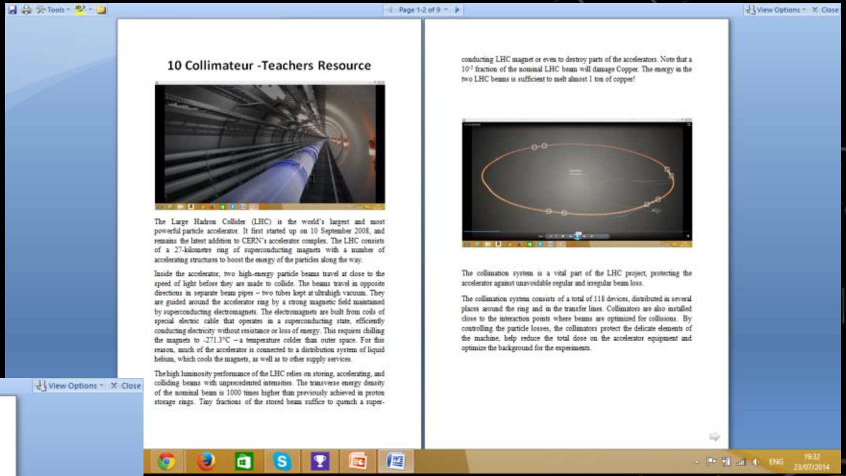
FINAL ACTIVITY – LEGO SEARCH!

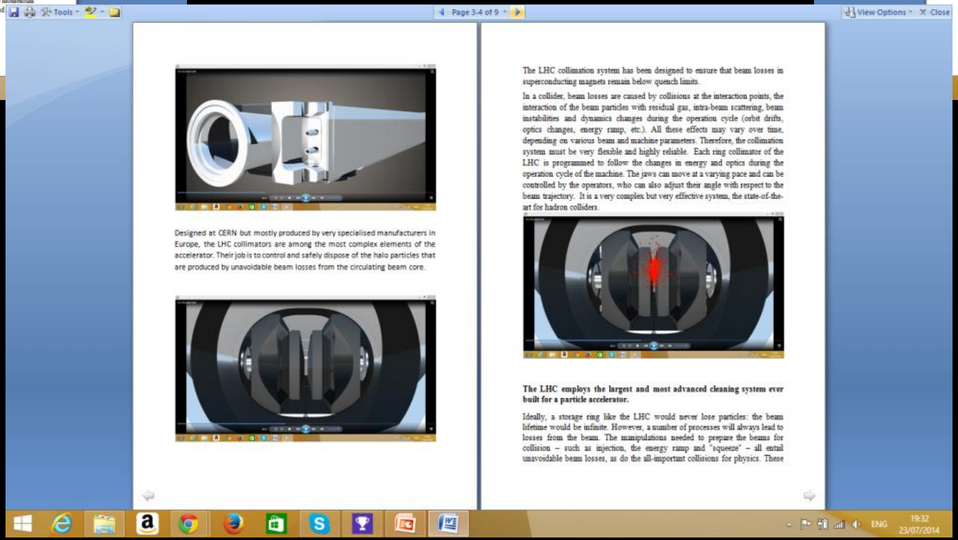
- Use google street view to find the 3 of the many hidden Lego men in the LHC Computing Centre.
- Try looking on top of racks and servers – they won't be hanging in mid air!
- Take a screen shot once yu have found them and save it as your homework assignment. Bonus points if yu can name where you found it.
- Click here for a map to help you…



PROJECT 3 – TEACHING NOTES NEASA,CHRISTOPHE,ROBERT





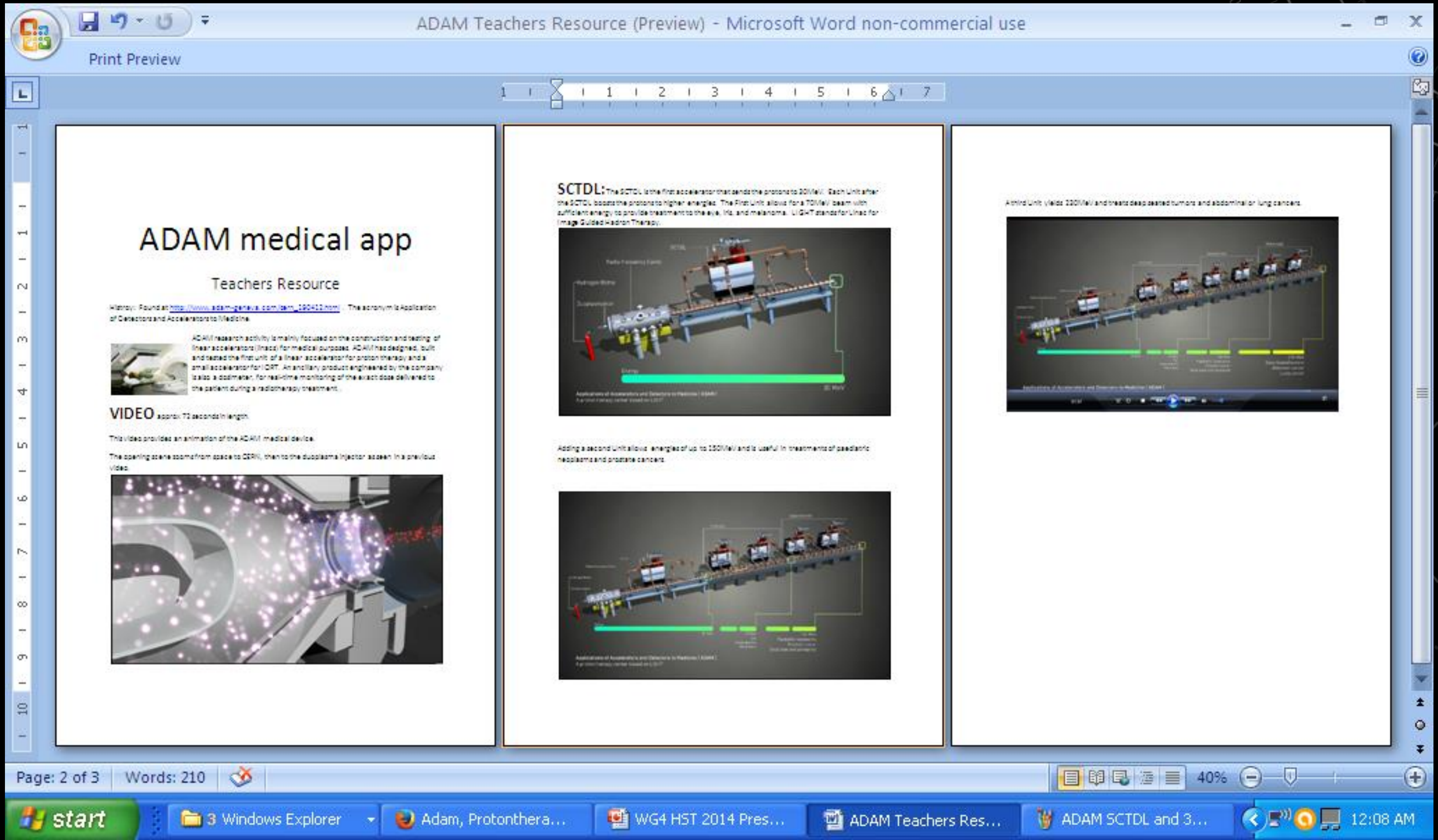


PROJECT 4 – REAL WORLD APPLICATIONS
ROBERT

MEDICAL RESEARCH

Click here

MEDICAL RESEARCH



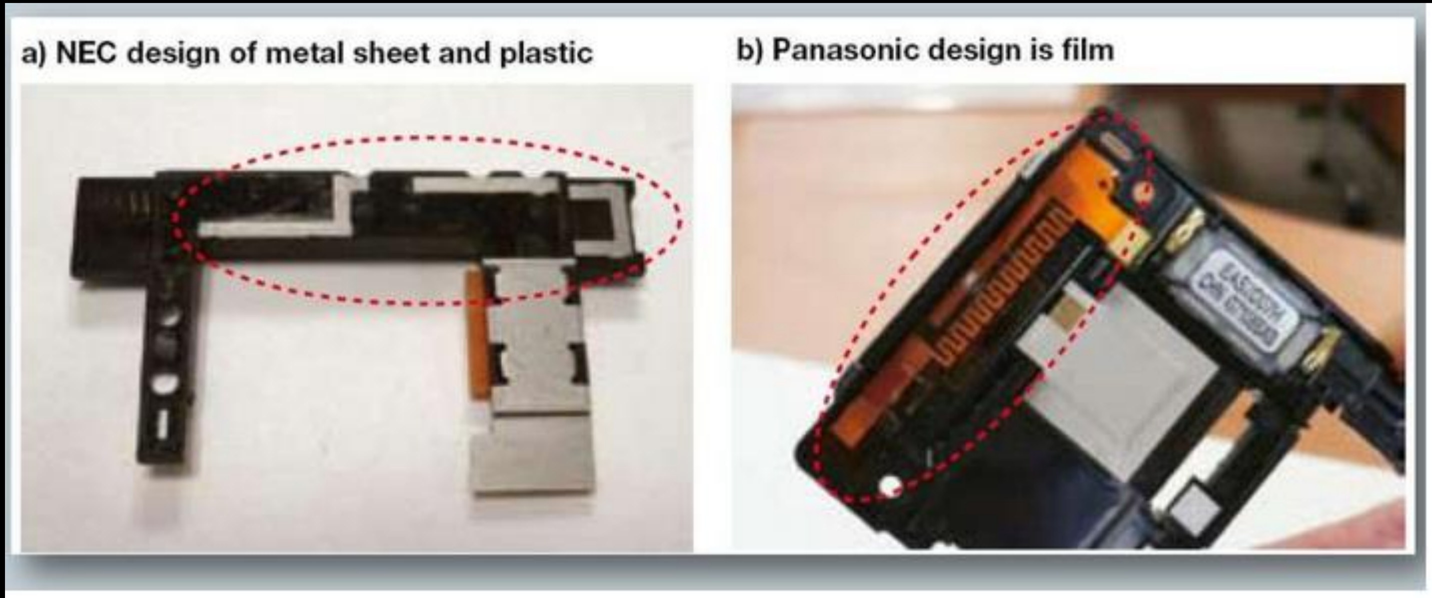
STORY BOARD OF REAL WORLD APPLICATIONS - SYNCHOTRON

OPEN SCENE WITH A SMARTPHONE OR IPHONE FLOATING. THE PHONE IS TURNED ON OR IS ALREADY ON AND ICONS APPEAR ON THE SCREEN. THE PHONE SPINS SLOWLY ONCE OR TWICE AND GOES TO A VIEW OF THE BACK BATTERY PANEL.

THE BATTERY PANEL OPENS REVEALING THE BATTERY WITH POSITIVE AND NEGATIVE SIGNS ILLUMINATED. ZOOM IN ON THE BATTERY CONNECTIONS AND SHOW ELECTRONS LEAVING THE NEGATIVE TERMINAL AND ARRIVING AT THE POSITIVE. HERE WE WILL WAIT FOR A FEW SECONDS FOR A DRAMATIC PAUSE. BEGIN MOVING AGAIN WITH A SLIGHT DRAW BACK, THEN FOLLOW THE ELECTRONS THROUGH THE CIRCUITRY.

(I IMAGINE HERE TRAVELLING AROUND HE CIRCUITS FOR 8-10 SECONDS, AND THE SCENE WOULD RESEMBLE SOMETHING LIKE THE MOVIE TRON.) THE FLOW OF ELECTRONS MOVE UNDER AND AROUND OUR VIEW IN HE CIRCUITS, AND VIEWPOINT ARRIVES AT THE ANTENNA PORTION OF THE CIRCUIT.

METAL STRIP ANTENNA (NAVEEN KUMAR, SLIDESHARE)



TRON

http://www.youtube.com/watch?v=oufRW8qDiTw

ONCE HERE WE SEE ELECTRONS OSCILLATING IN THE ANTENNA. WHEN THE PACKET OF ELECTRONS REACH THE END OF THE ANTENNA AND TURN AROUND TO MOVE AGAIN, A SPLASH OF PHOTONS ARE EMITTED SPHERICALLY AROUND THE TURNAROUND POINT OF THE PACKET.

ZOOM OUT FROM THE INTERIOR AND CONTINUE TO OBSERVE THE PHOTONS RADIATING SPHERICALLY.

THANK YOU!
QUESTIONS?