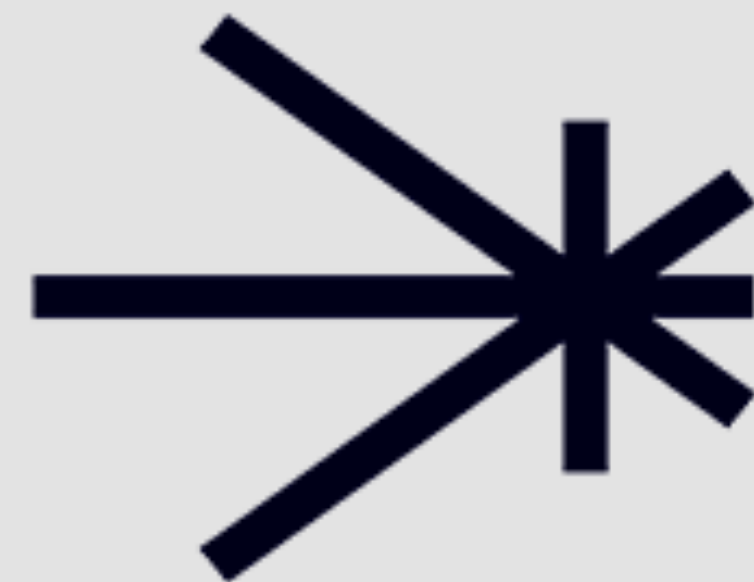


IGFAE

25



**1999
2024**



IGFAE aims to answer some of the most
fundamental questions in Nature

IGFAE aims to answer some of the most
fundamental questions in Nature

What is the Universe made of?

How it works

IGFAE aims to answer some of the most
fundamental questions in Nature

What is the Universe made of?

What are the fundamental building blocks

How it works

How they interact

Why the Universe is made of matter and not antimatter?

What is the nature of neutrinos?

What is the theory beyond the Standard Model?

How complexity is built from the fundamental building blocks of Nature?

What is the origin of the visible mass of the universe?

What is the structure of neutron stars?

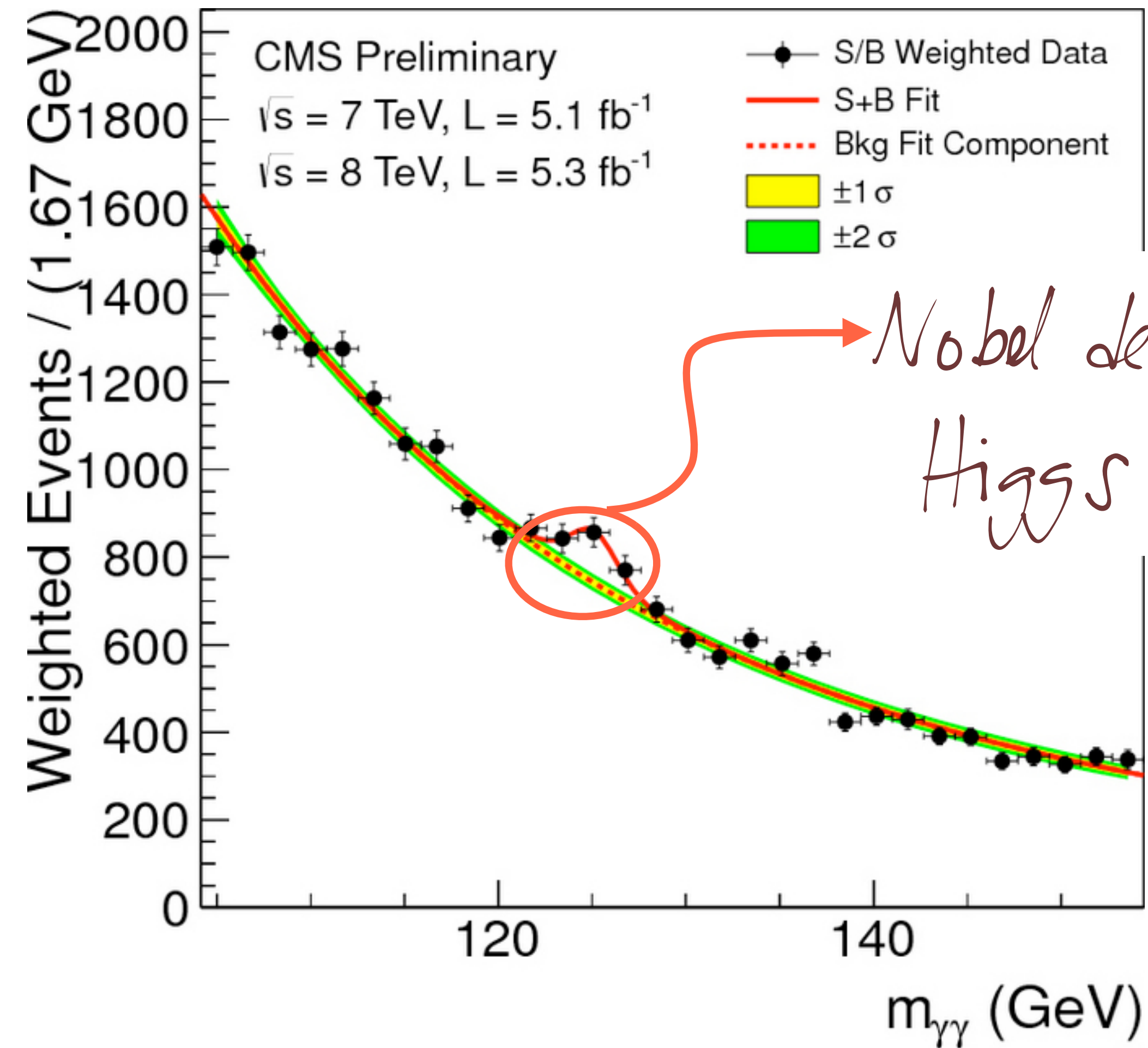
How were the first instants after the Big Bang?

Where is the limit of Einstein General Relativity?

How the most powerful particle accelerators in the universe work?

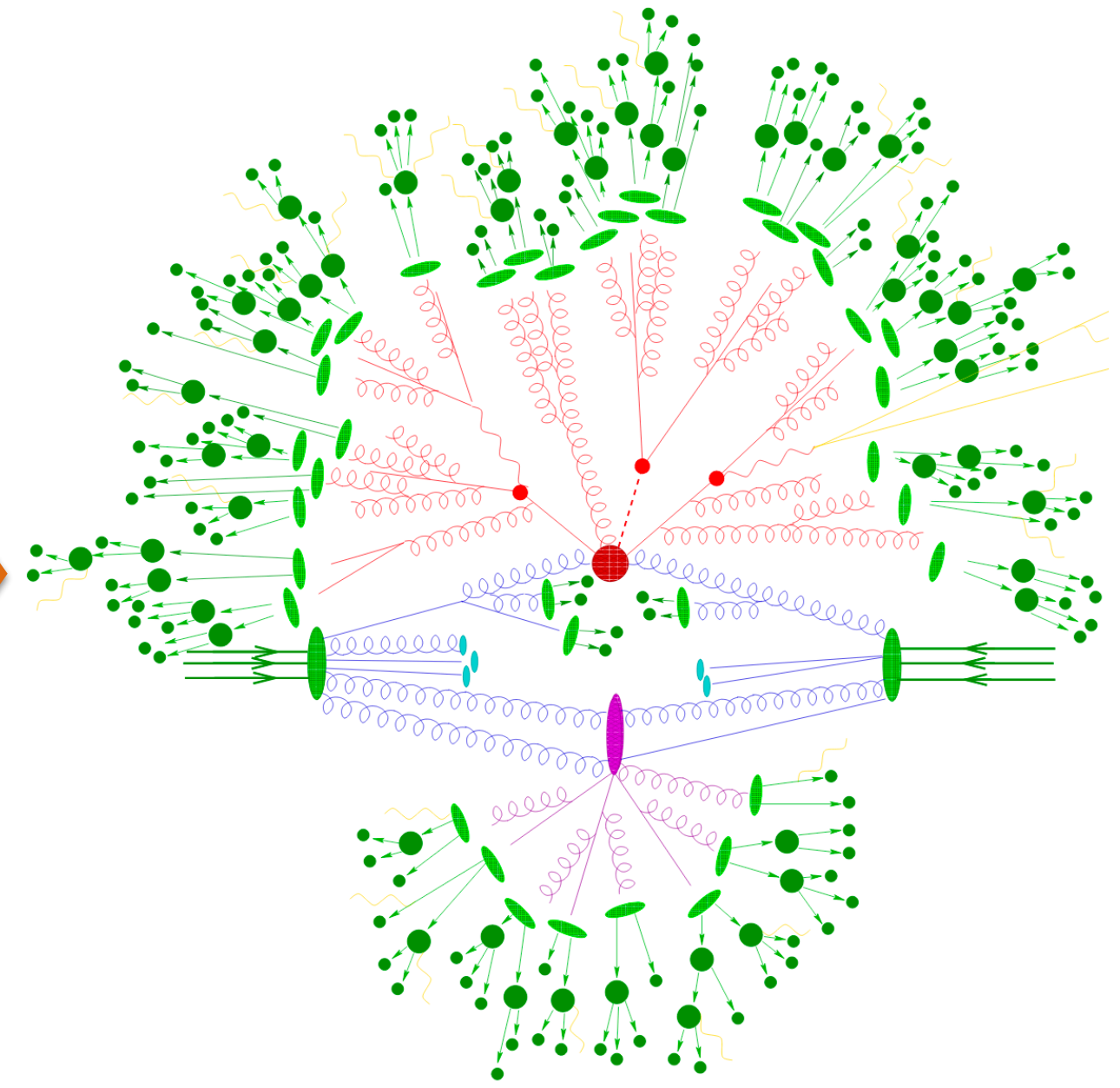
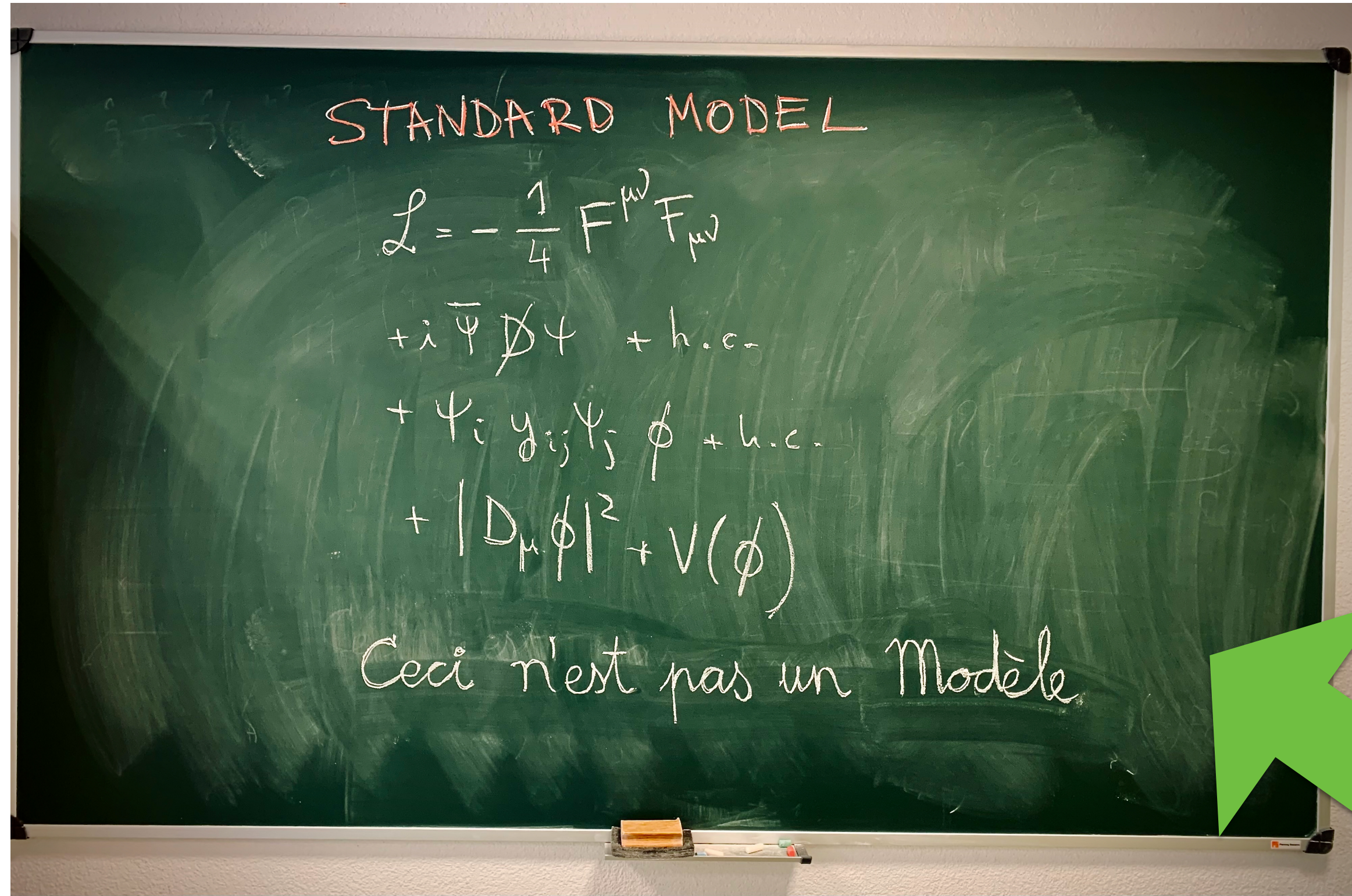
... are some of the specific questions
in which we actively work

The Higgs boson

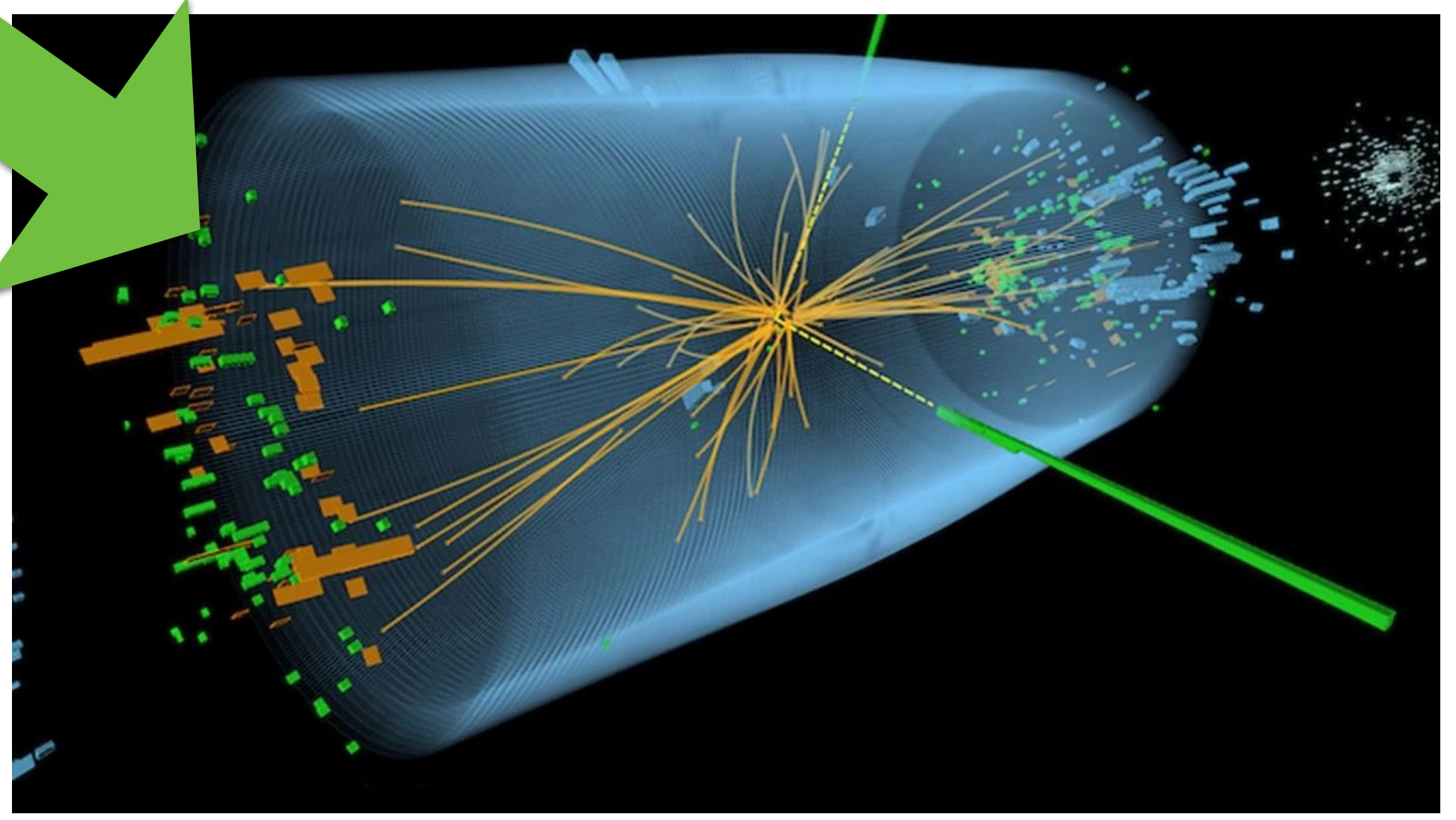


*Nobel de Física 2013
Higgs & Englert*

Physics ↔ data science

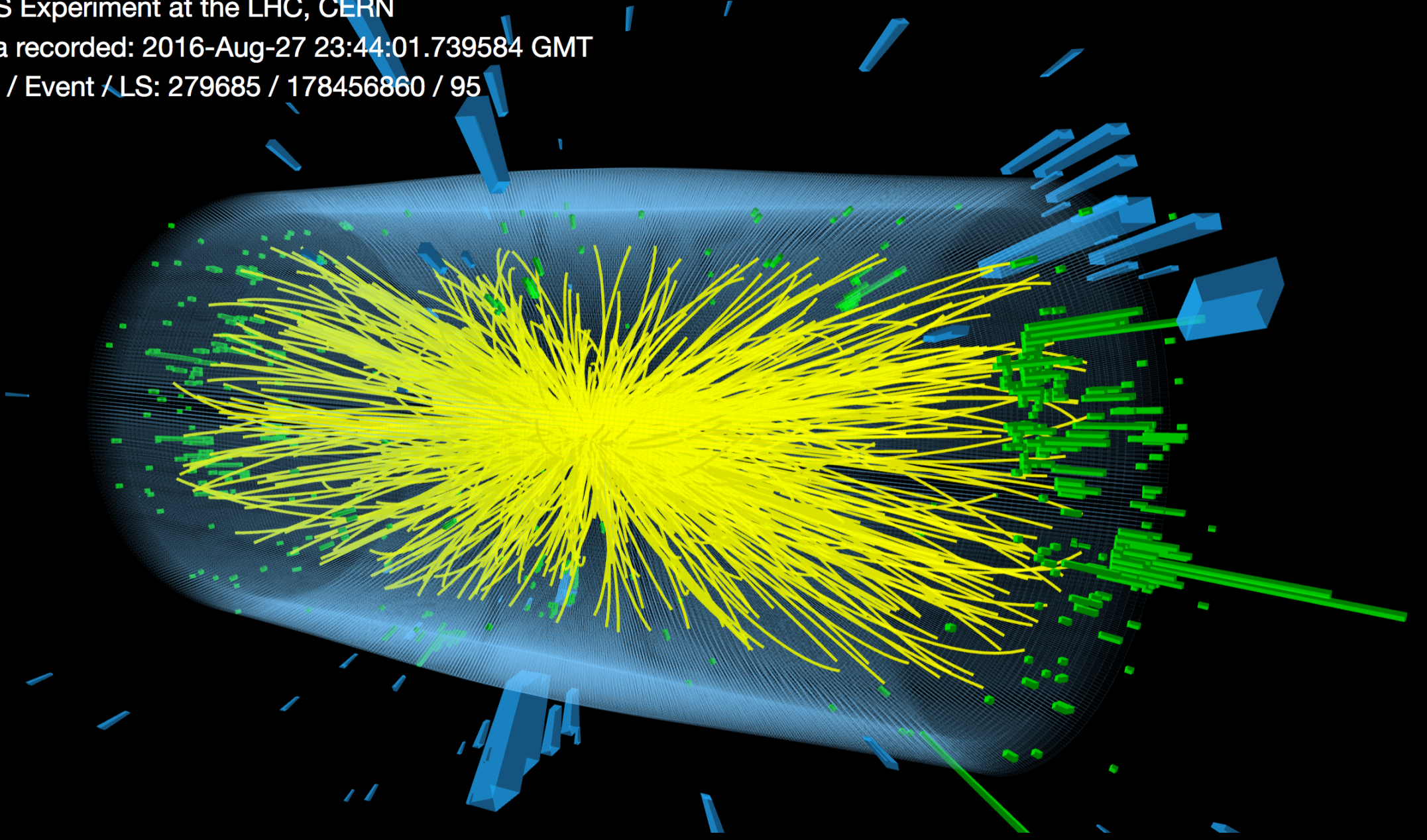


LHC crossing rate >30MHz
and 20 collisions per crossing
600 million collisions per second (1PB/s)!
[proton-proton collisions at 99.999999% of the speed of light]

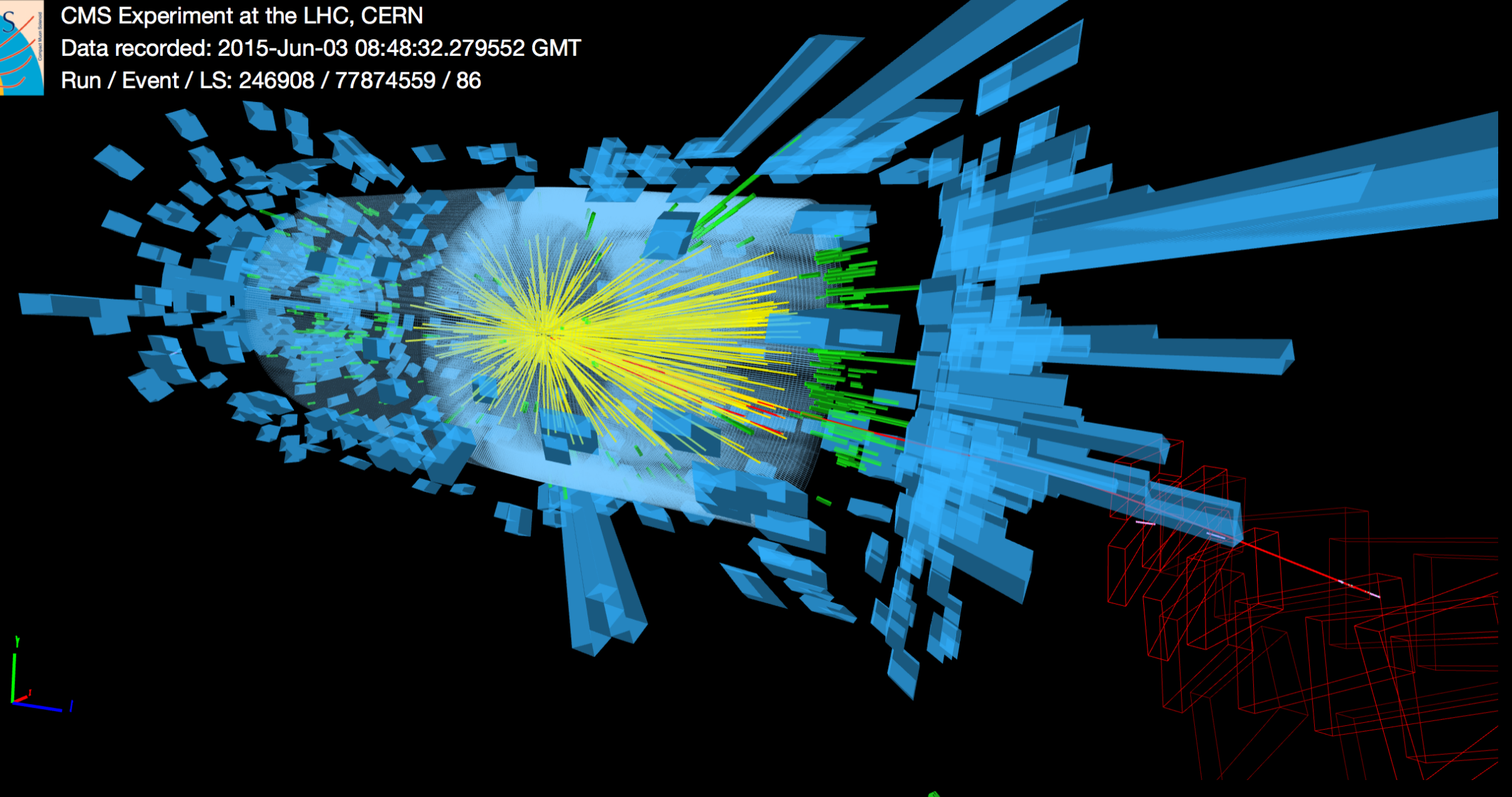




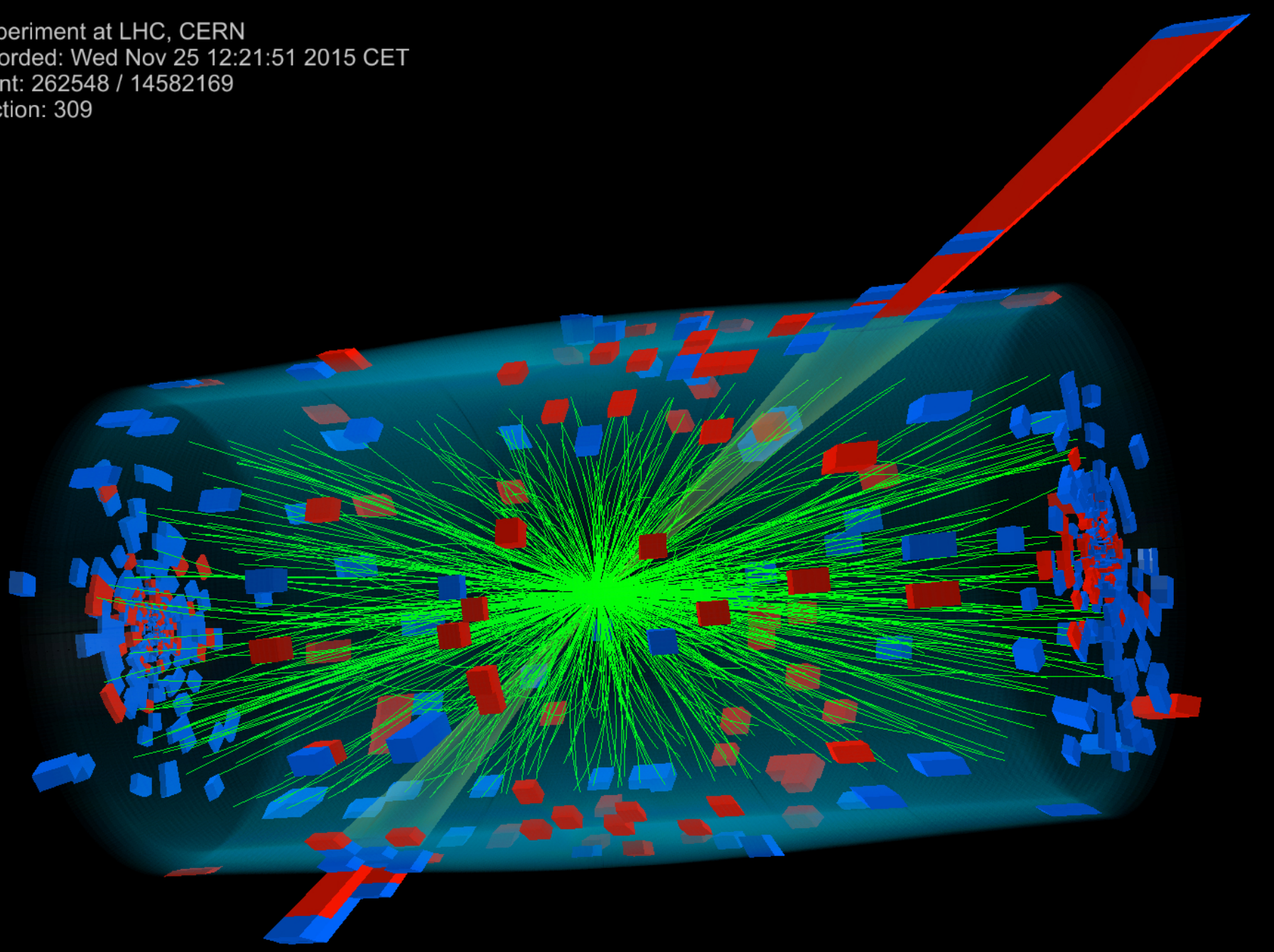
CMS Experiment at the LHC, CERN
 Data recorded: 2016-Aug-27 23:44:01.739584 GMT
 Run / Event / LS: 279685 / 178456860 / 95



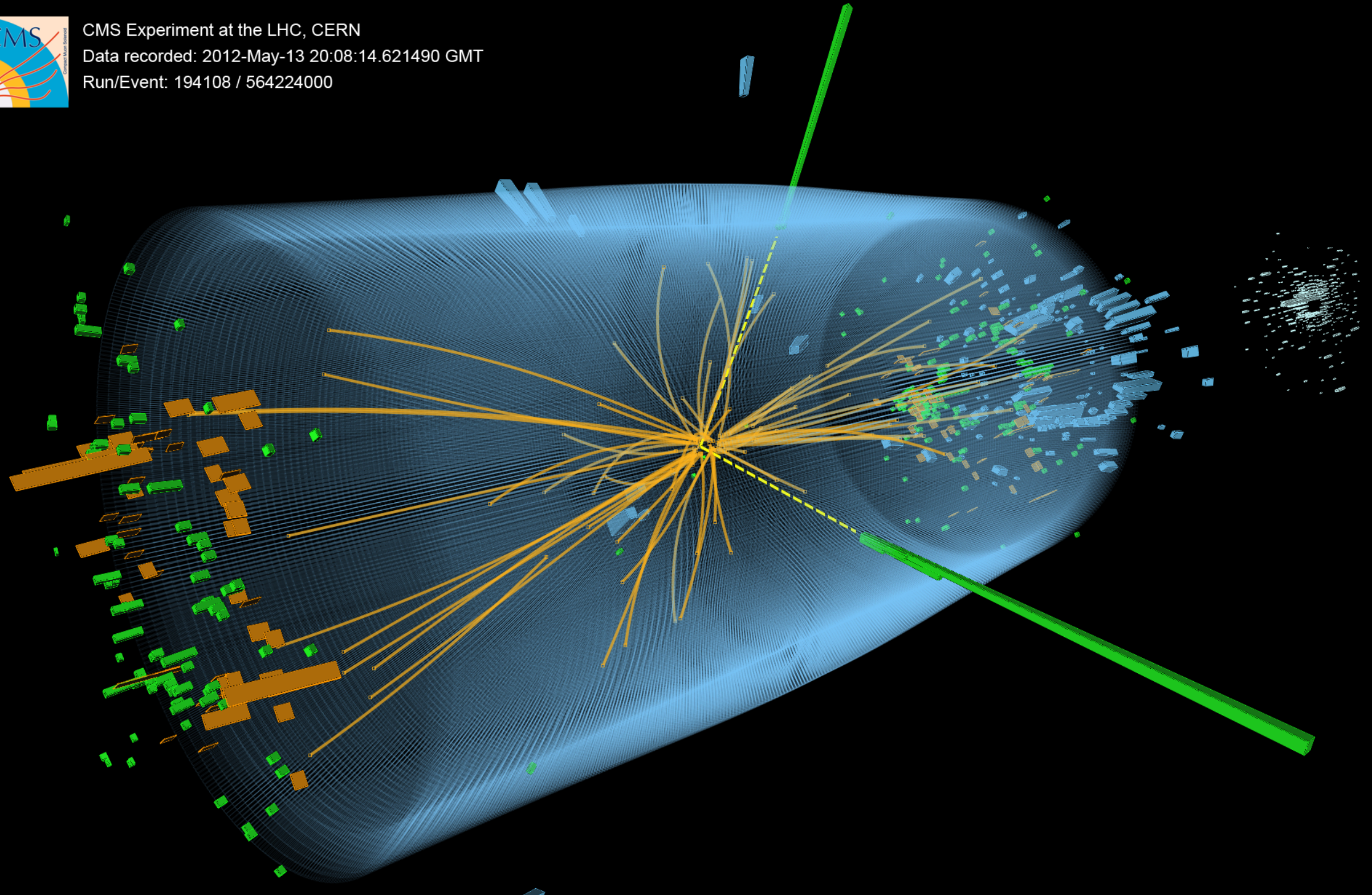
CMS Experiment at the LHC, CERN
 Data recorded: 2015-Jun-03 08:48:32.279552 GMT
 Run / Event / LS: 246908 / 77874559 / 86

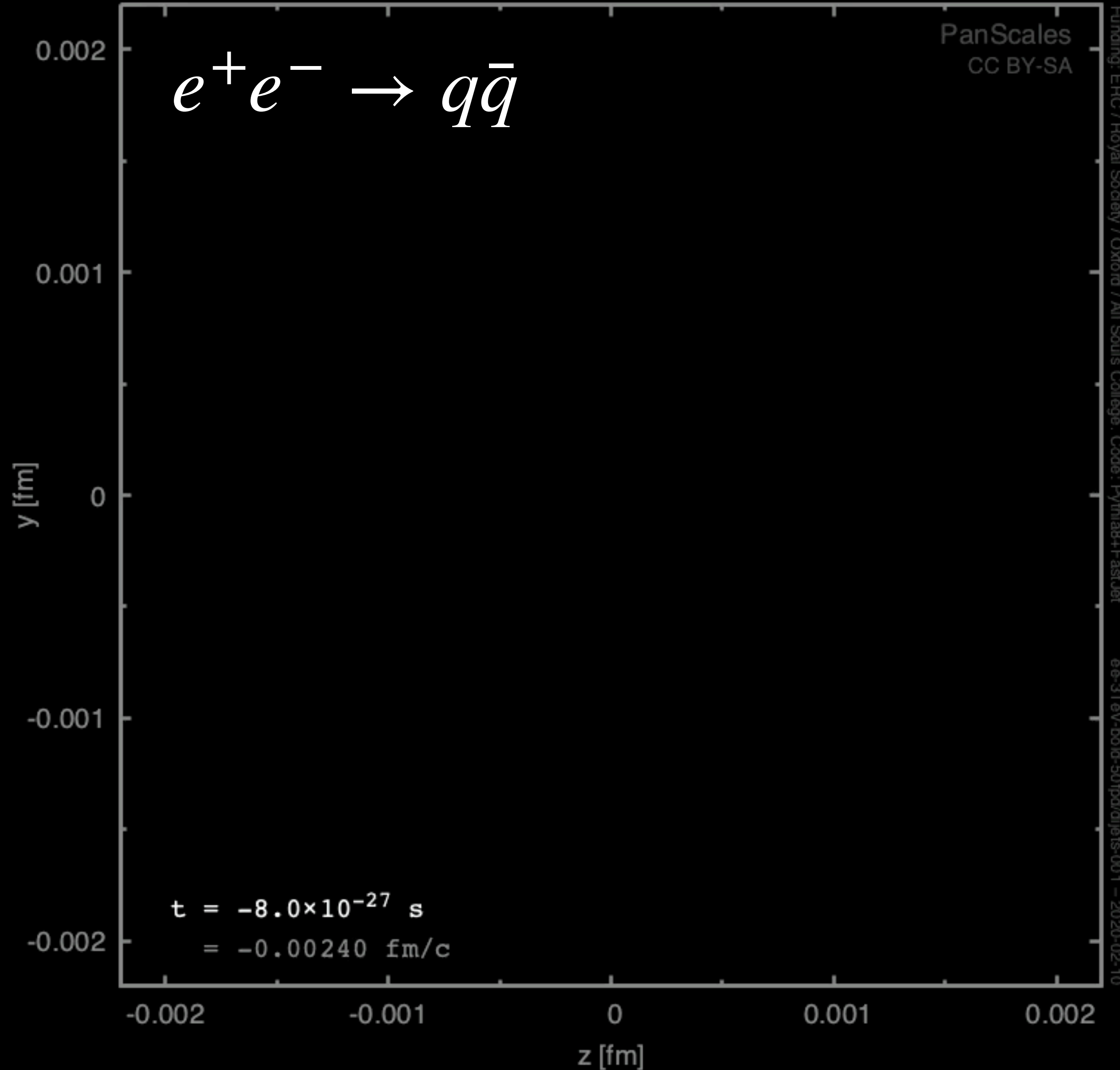


CMS Experiment at LHC, CERN
 Data recorded: Wed Nov 25 12:21:51 2015 CET
 Run/Event: 262548 / 14582169
 Lumi section: 309



CMS Experiment at the LHC, CERN
 Data recorded: 2012-May-13 20:08:14.621490 GMT
 Run/Event: 194108 / 564224000



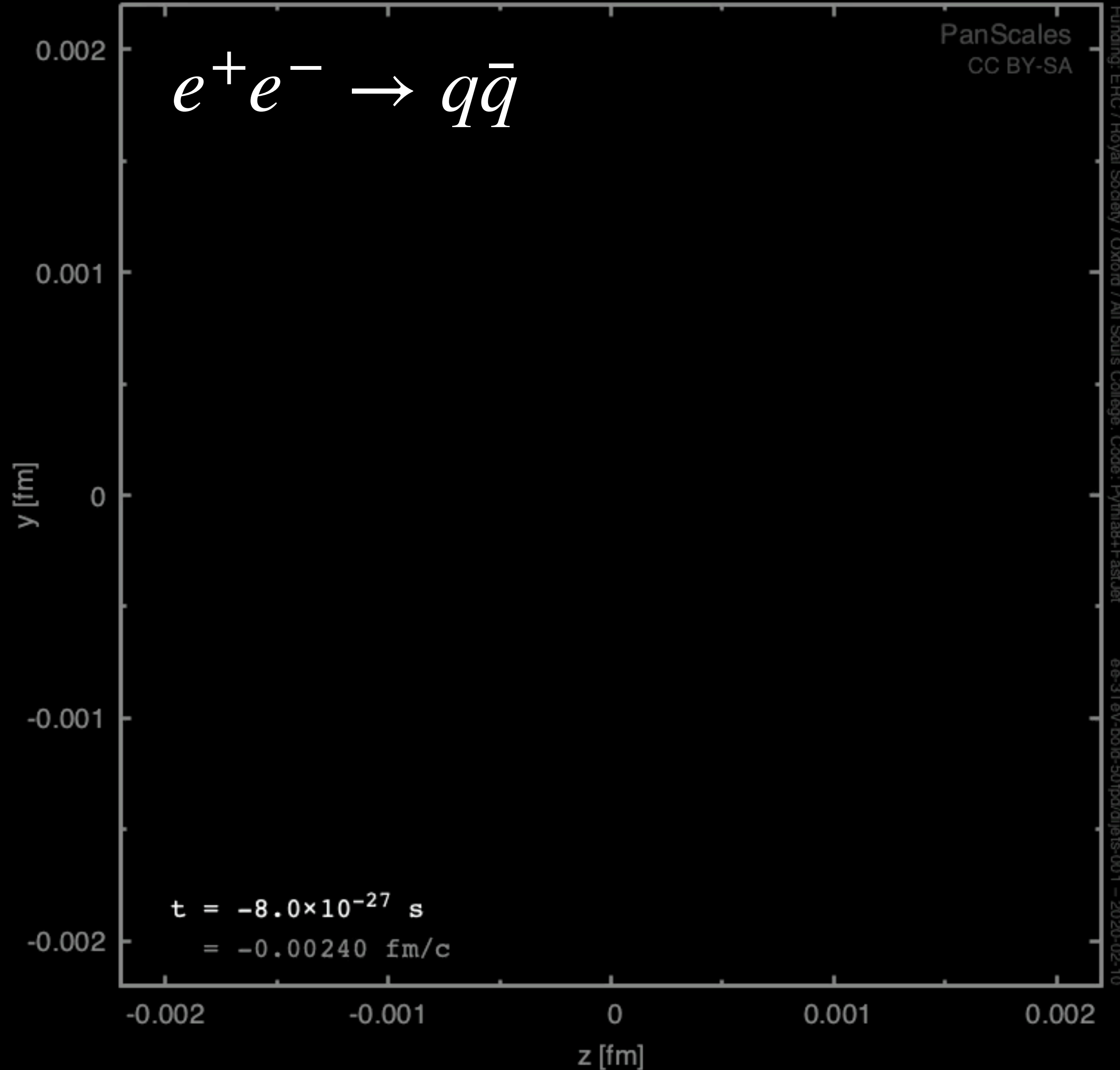


QCD JETS

3TeV e^+e^- events

Initial particles in yellow
Intermediate particles in blue
Final particles in red

[Simulation of the events are produced with Pythia 8 times estimated by clustering algorithm - see details in the web page]



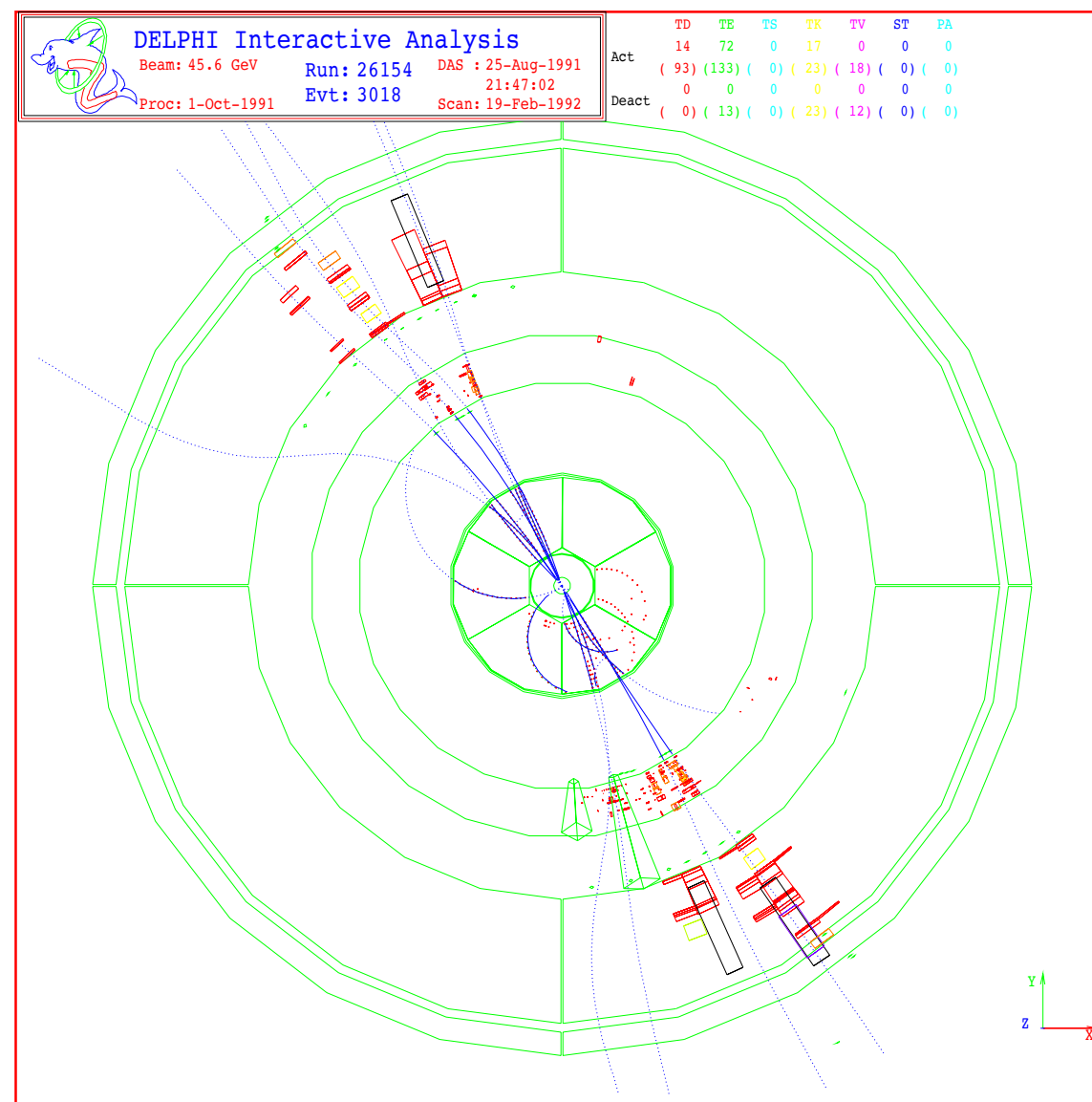
QCD JETS

3TeV e^+e^- events

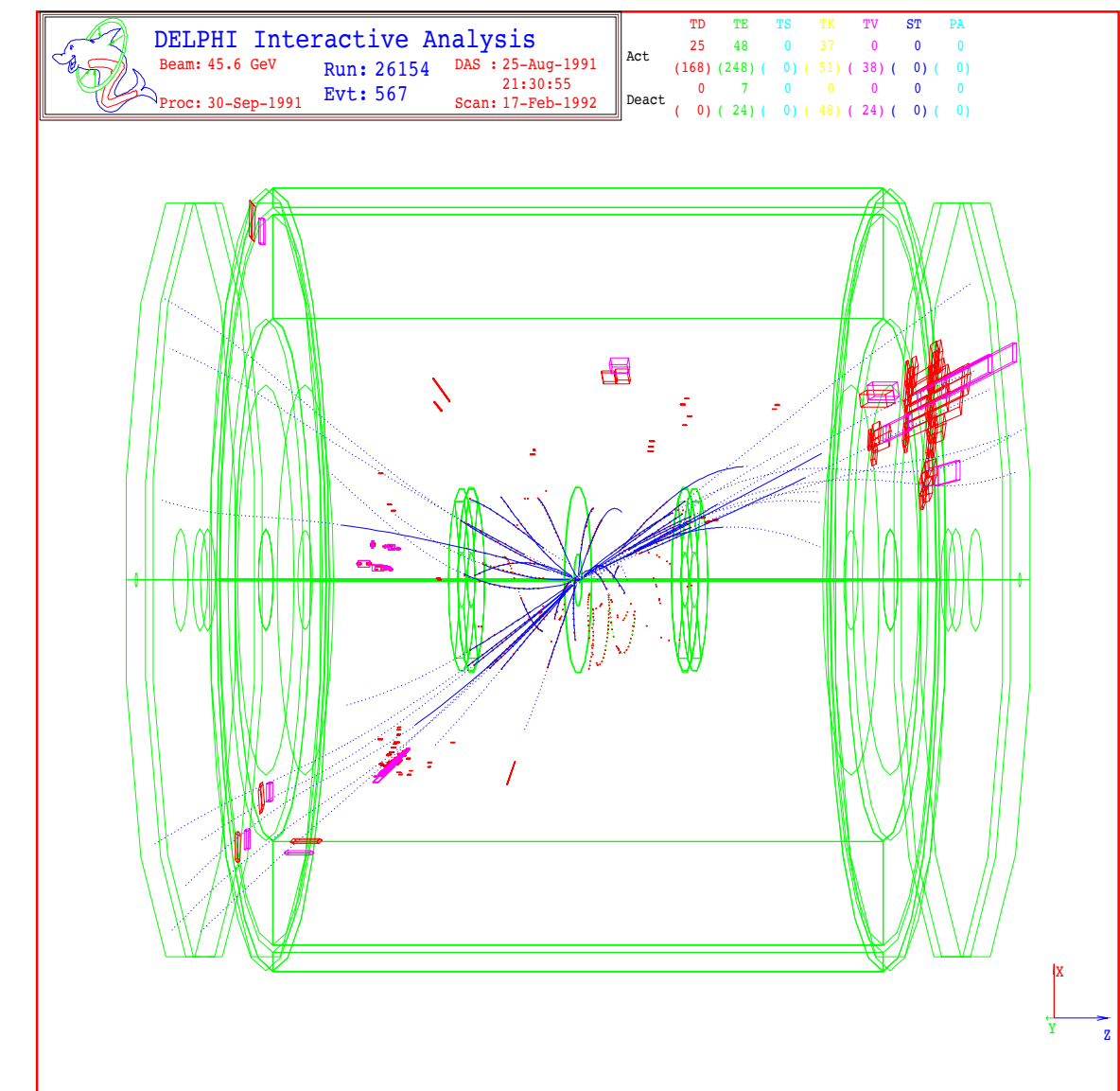
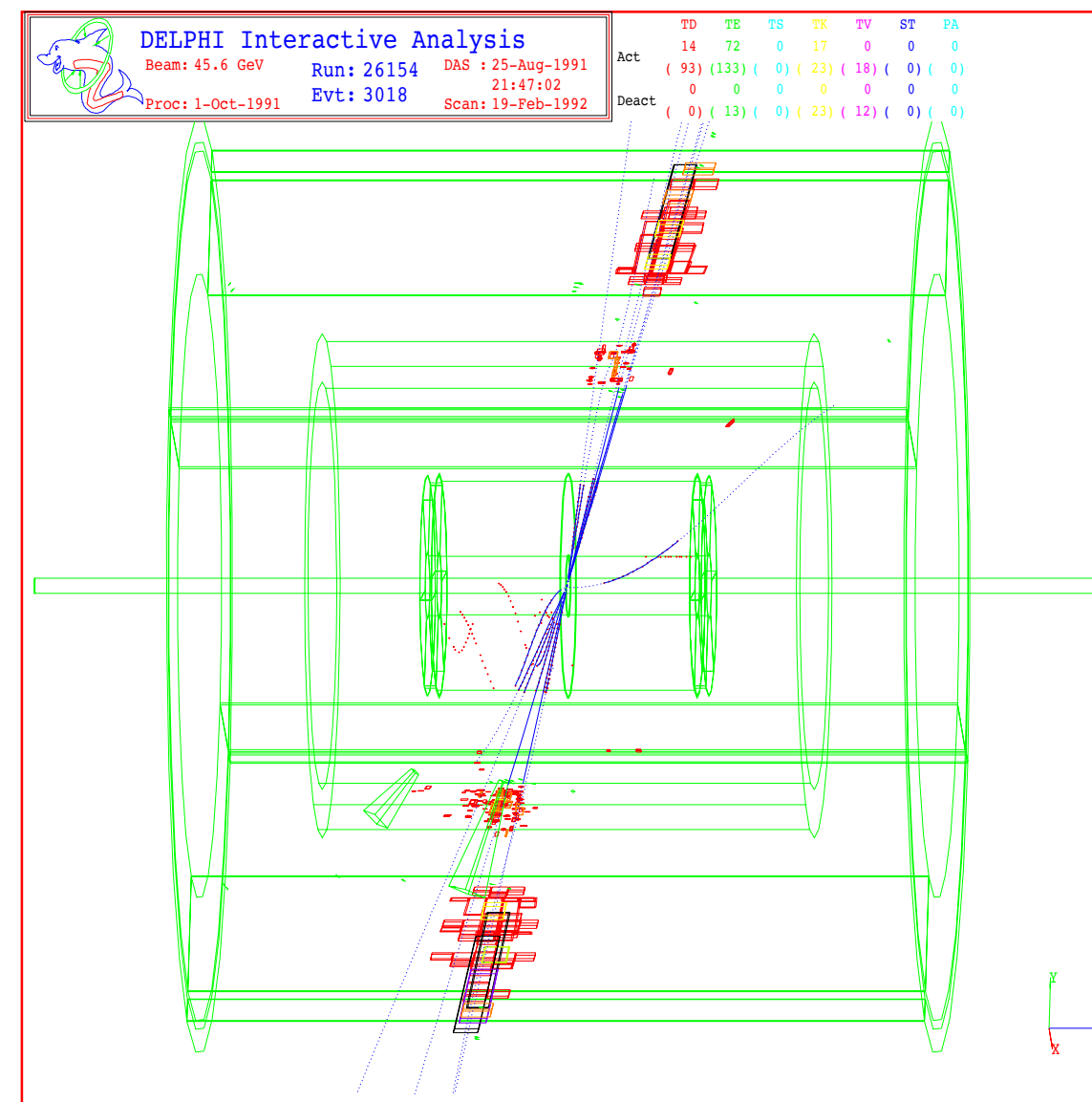
Initial particles in yellow
Intermediate particles in blue
Final particles in red

[Simulation of the events are produced with Pythia 8 times estimated by clustering algorithm - see details in the web page]

“Simple events” at LEP [1989-2000]



A 2-jet event at LEP



A 3-jet event at LEP

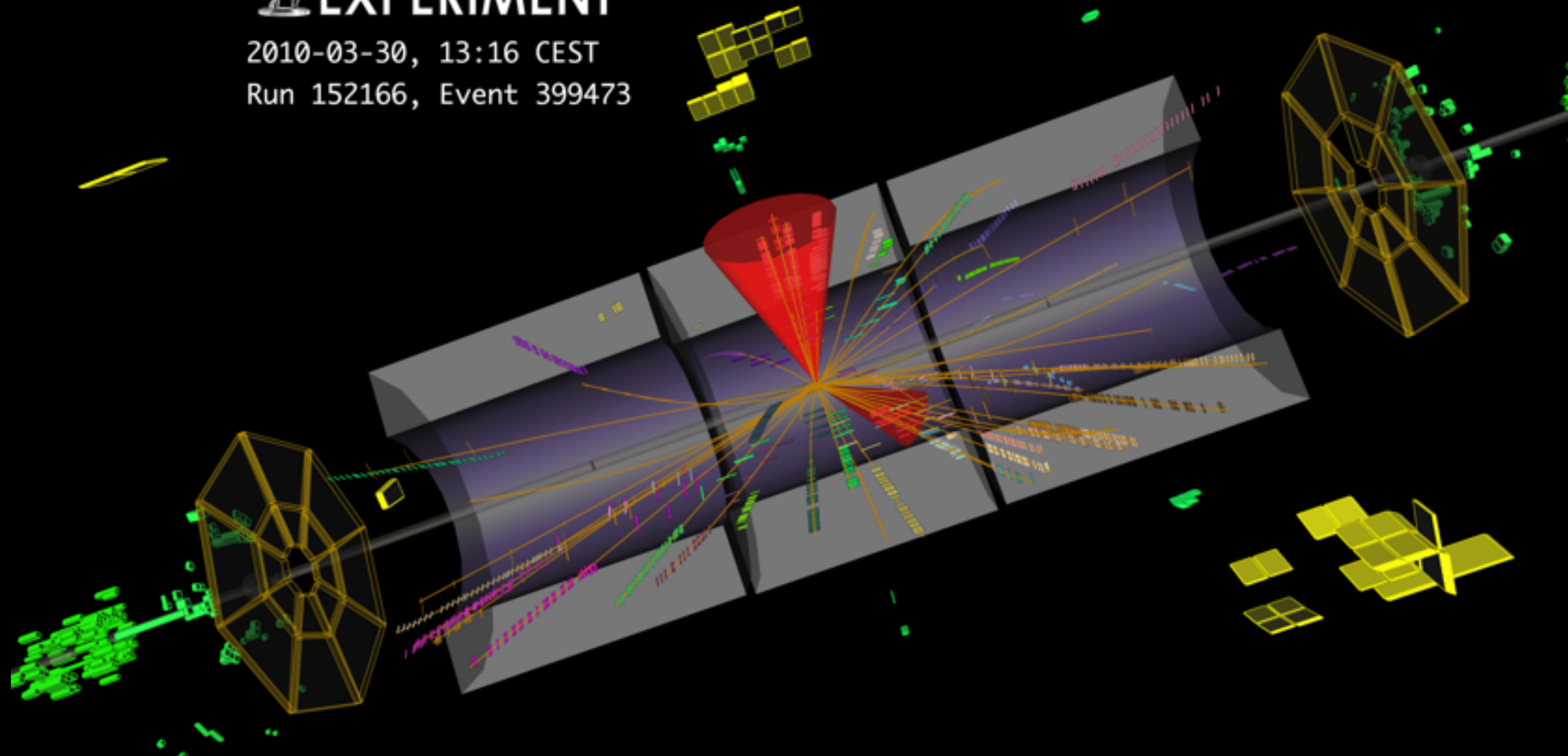
Jet clustering (identification) algorithms

Jets in hadronic colliders



2010-03-30, 13:16 CEST
Run 152166, Event 399473

2-Jet Collision Event at 7 TeV



Jet clustering (identification) algorithms

Jets in hadronic colliders



Run: 276731
Event: 876578955
2015-08-22 07:43:18 CEST

2 high p_T jets
(1.3 and 1.2 TeV)
with invariant mass 6.9 TeV

Jet clustering (identification) algorithms

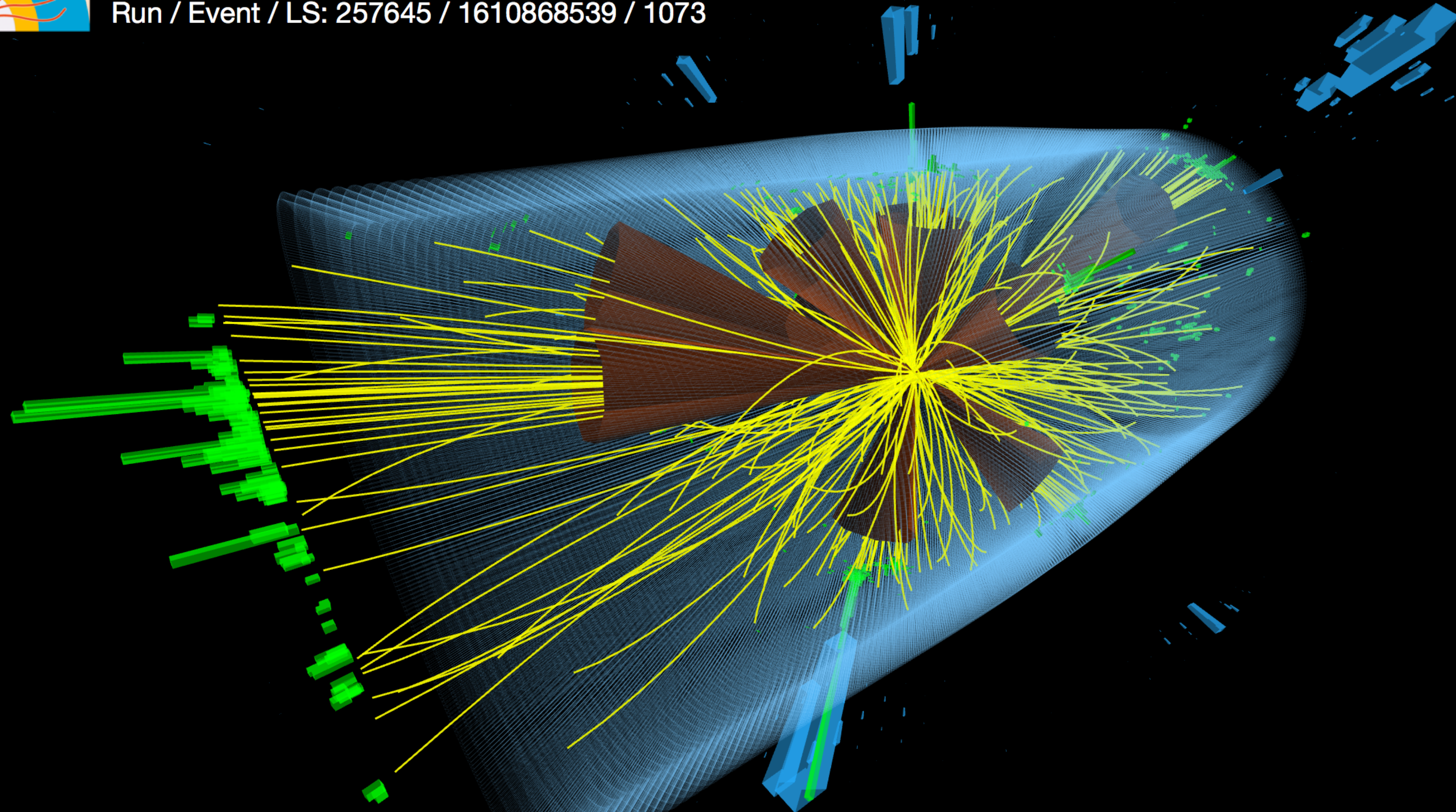
A multijet event at the LHC@13TeV



CMS Experiment at the LHC, CERN

Data recorded: 2015-Sep-28 06:09:43.129280 GMT

Run / Event / LS: 257645 / 1610868539 / 1073



Jet clustering (identification) algorithms

IGFAE



Fermilab
IIGO Livingston

Grand Accélérateur National d'Ions Lourds

CERN

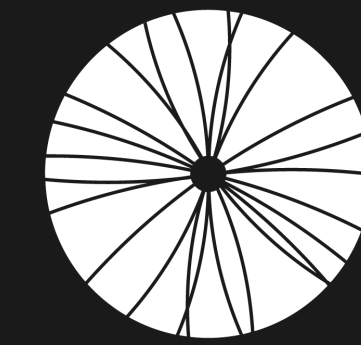
IGFAE
L2A2

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Image IBCAO
Image U.S. Geological Survey

INTERNATIONAL INFRASTRUCTURES WITH IGFAE PARTICIPATION



Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Image IBCAO
Image U.S. Geological Survey



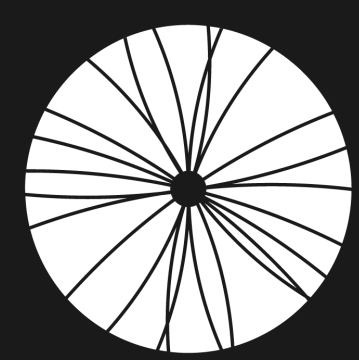
IGFAE

Instituto Galego de Física de Altas Enerxías

- ❑ IGFAE created in 1999
Joint research center Xunta-Universidade de Santiago de Compostela
- ❑ Reference in Galicia for relation with big
International infrastructures (CERN and more)
- ❑ New phase after excellence accreditation

María de Maeztu





IGFAE

Instituto Galego de Física de Altas Enerxías

Scientific Advisory Board



Sergio Bertolucci

Università Bologna
CERN Scientific
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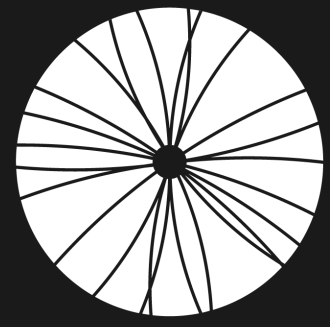
Director - Institute
for Nuclear Theory
Seattle



Giulia Zanderighi

CERN & Max
Planck München

Highest scientific level and research management experience



IGFAE

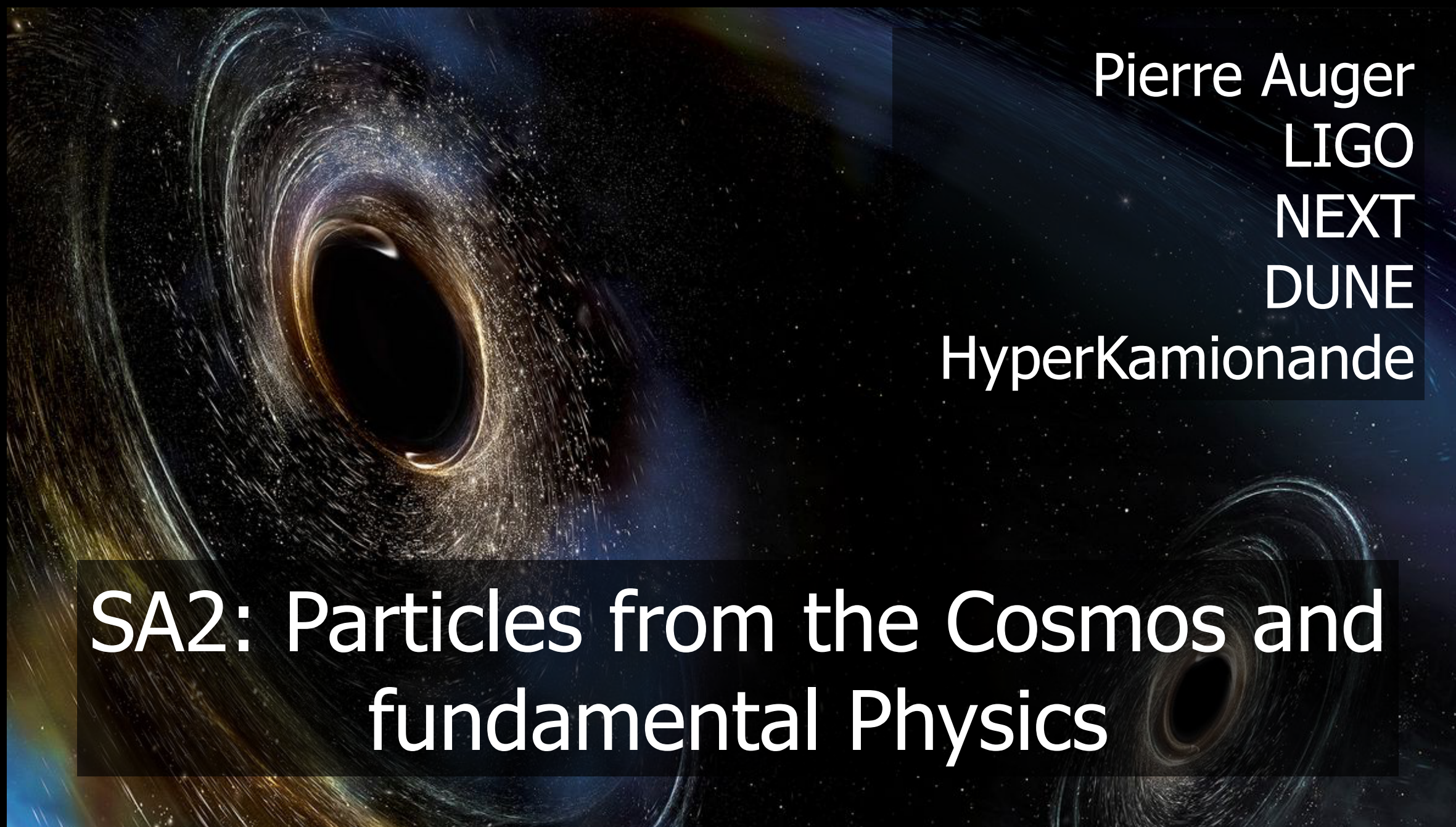
Instituto Galego de Física de Altas Enerxías

Strategic Research Areas



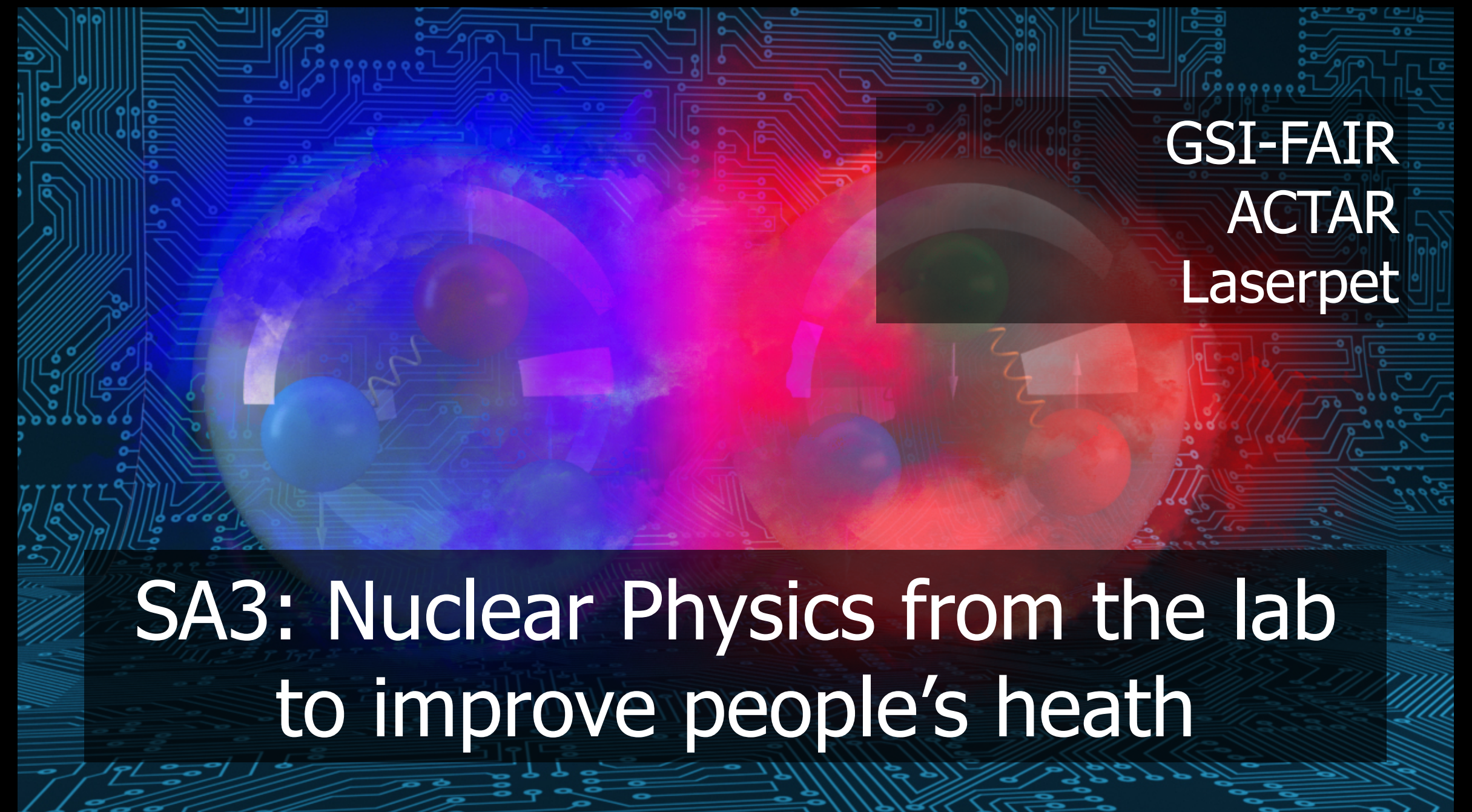
LHCb
QCD
String Theory
Phenomenology

SA1: The Standard Model to the limits



Pierre Auger
LIGO
NEXT
DUNE
HyperKamionande

SA2: Particles from the Cosmos and fundamental Physics



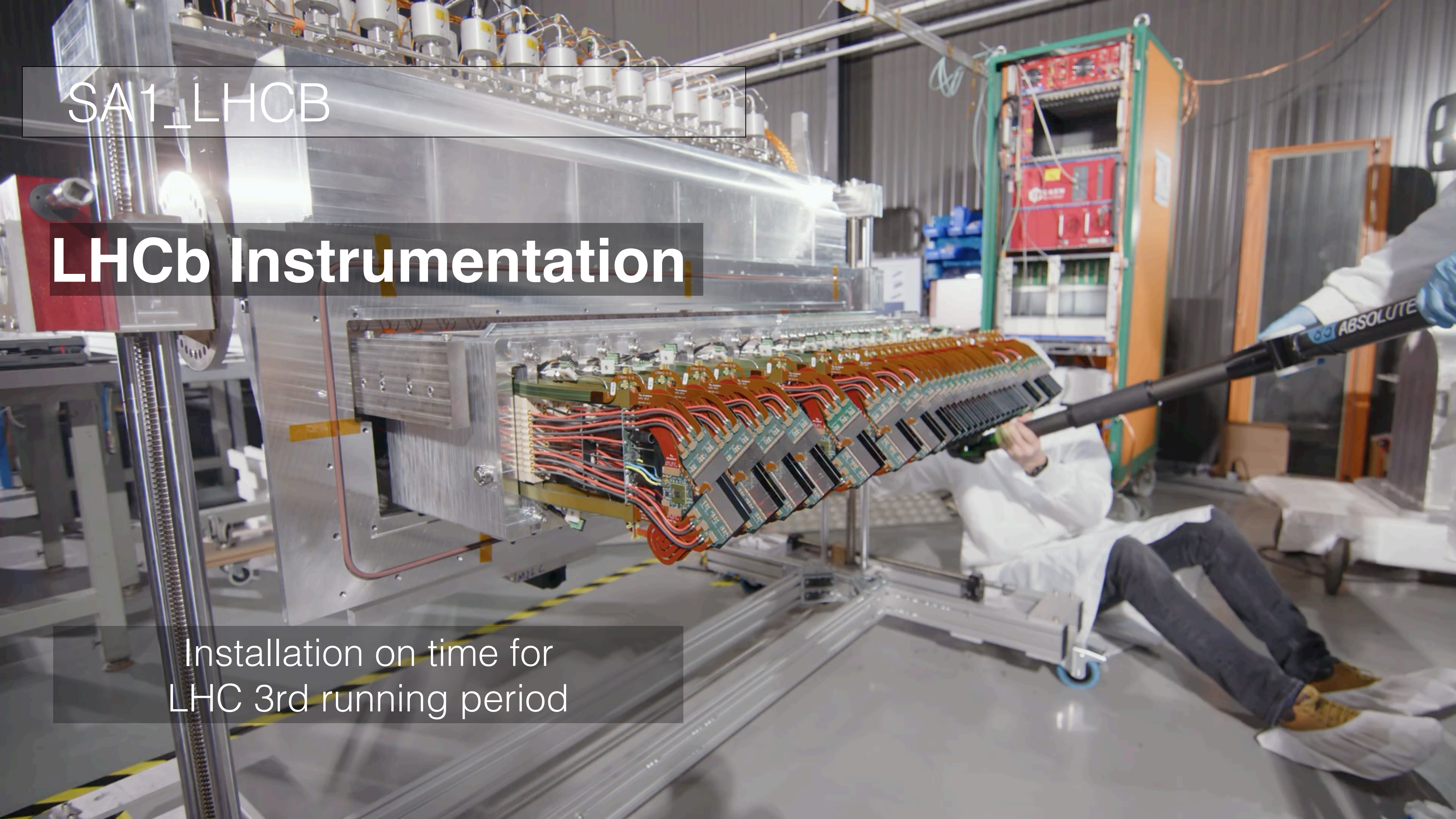
GSI-FAIR
ACTAR
Laserpet

SA3: Nuclear Physics from the lab to improve people's health

SA1_LHCB

LHCb Instrumentation

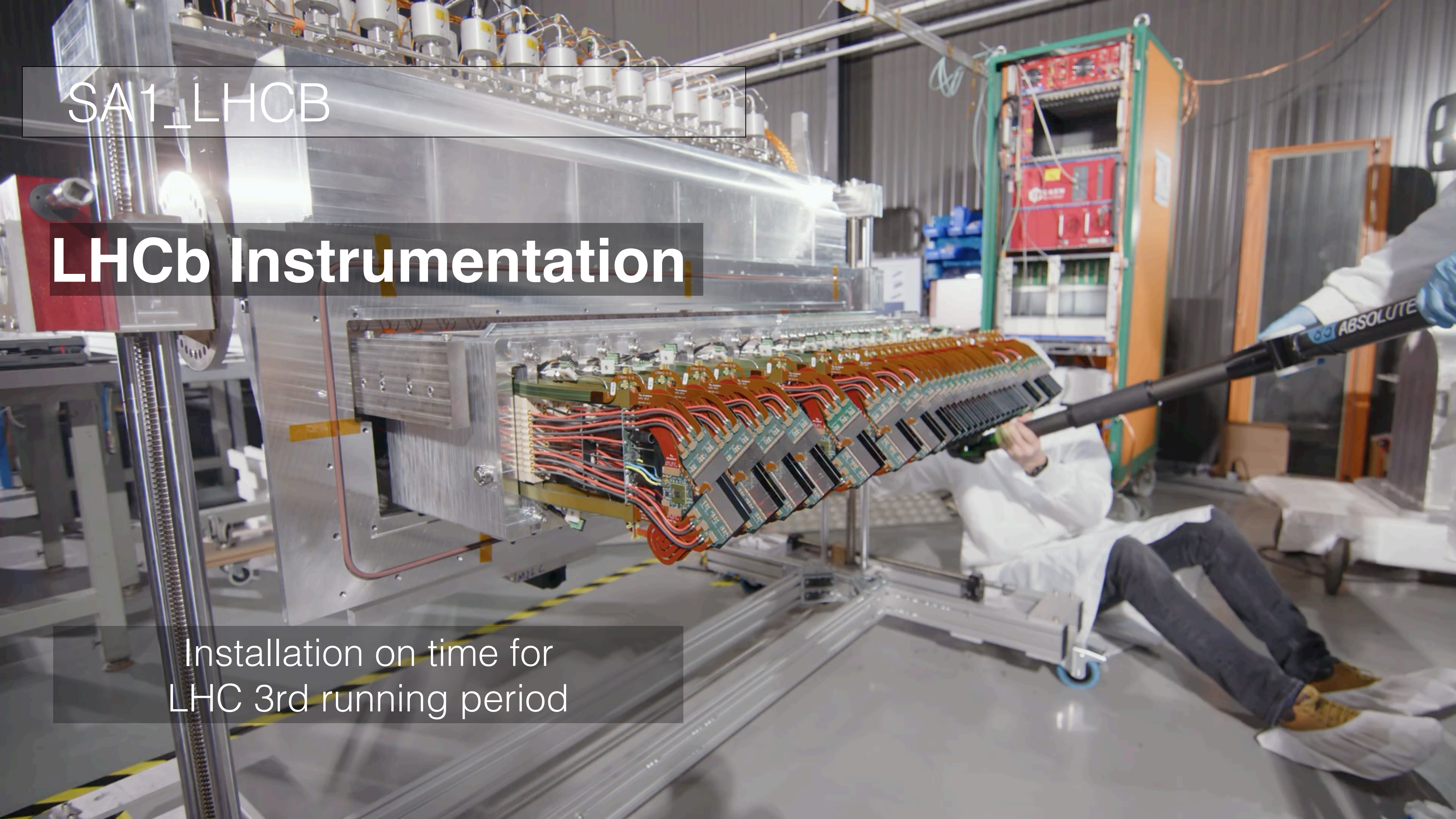
Installation on time for
LHC 3rd running period



SA1_LHCB

LHCb Instrumentation

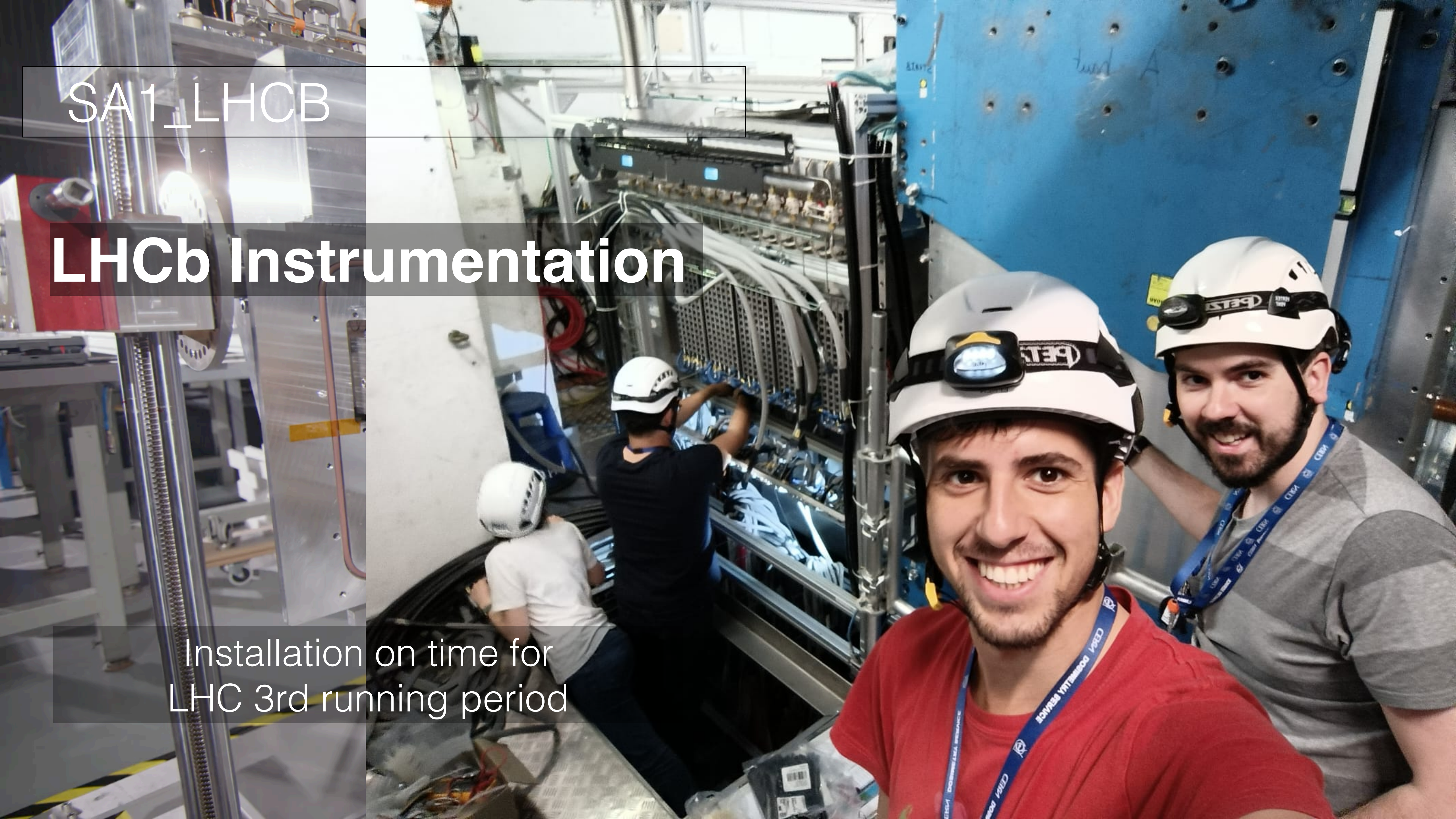
Installation on time for
LHC 3rd running period



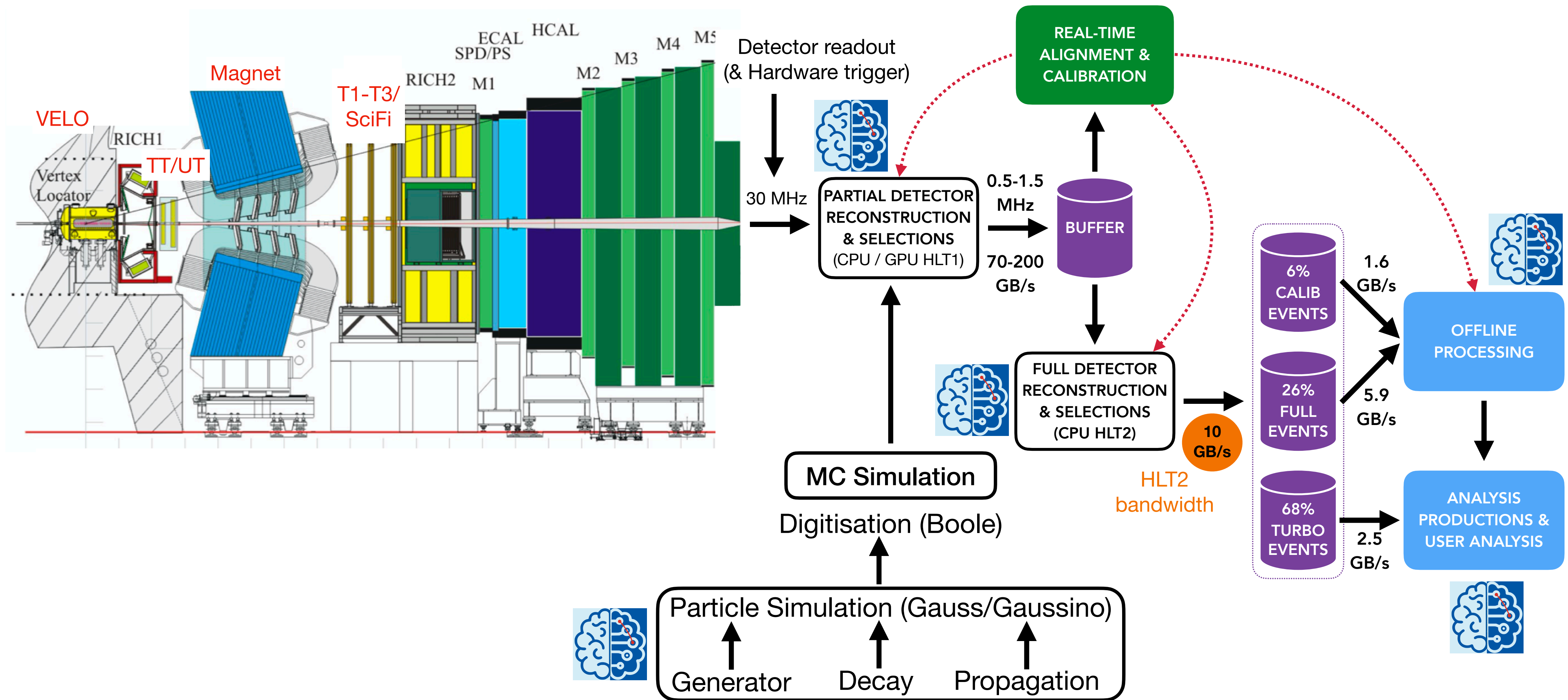
SA1_LHCB

LHCb Instrumentation

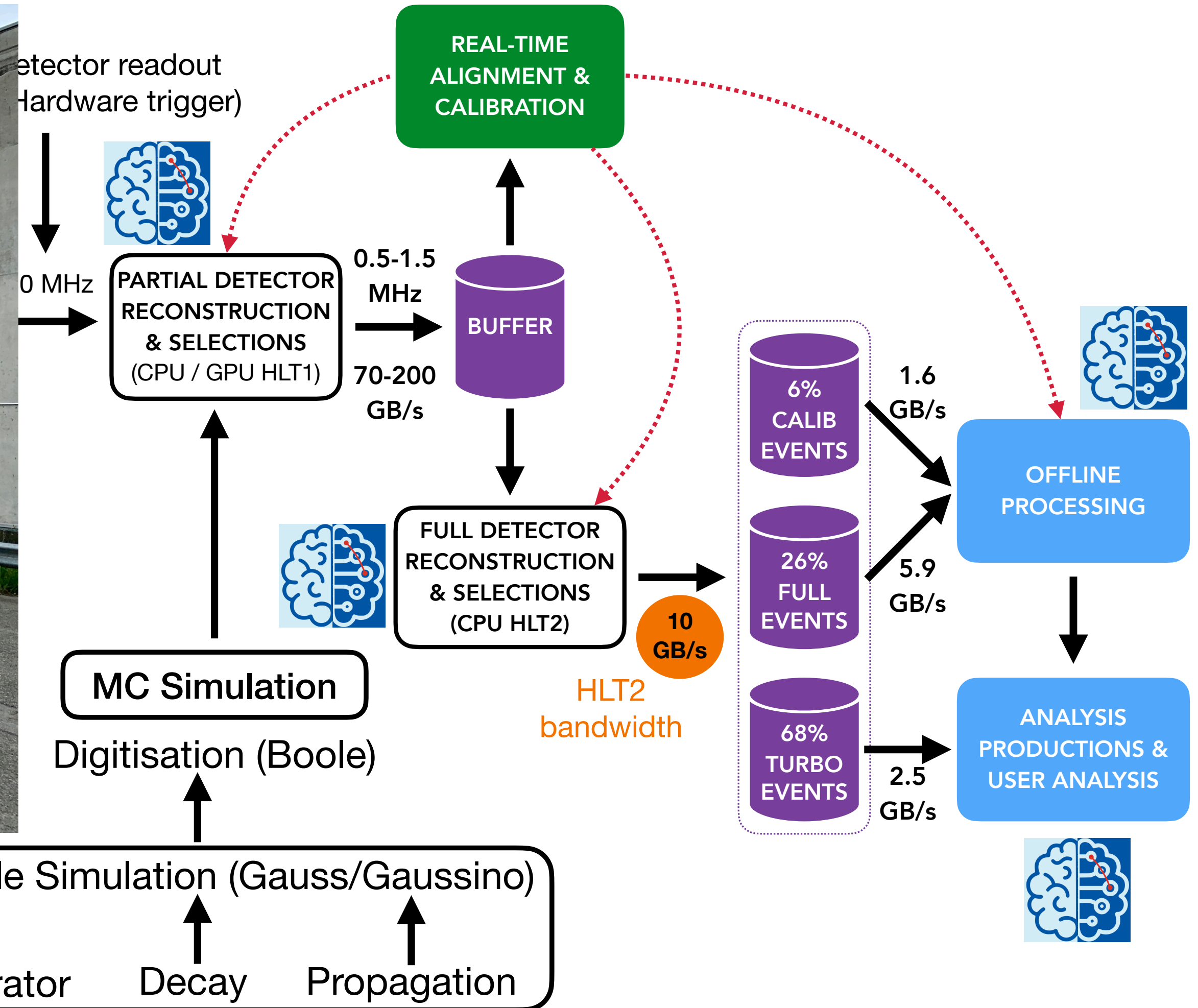
Installation on time for
LHC 3rd running period



LHCb - data processing chain



LHCb - data processing chain



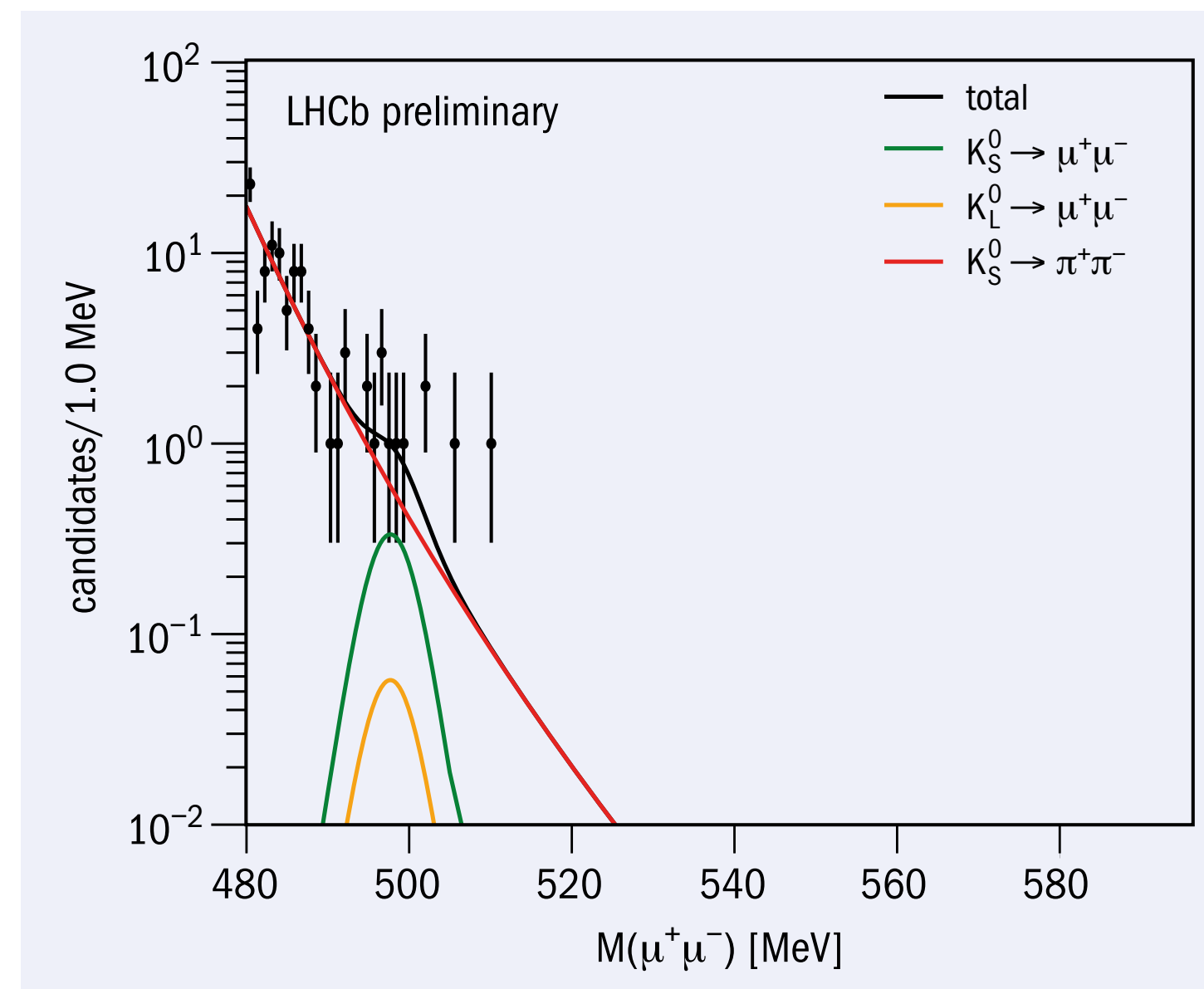


Fig. 1. The invariant mass of $K_S^0 \rightarrow \mu^+\mu^-$ candidates, and the fit to one of the most sensitive search regions. The $K_L^0 \rightarrow \mu^+\mu^-$ background (orange) is suppressed with respect to K_S^0 due to the longer distance of flight. The observed number of signal decays is consistent with zero.

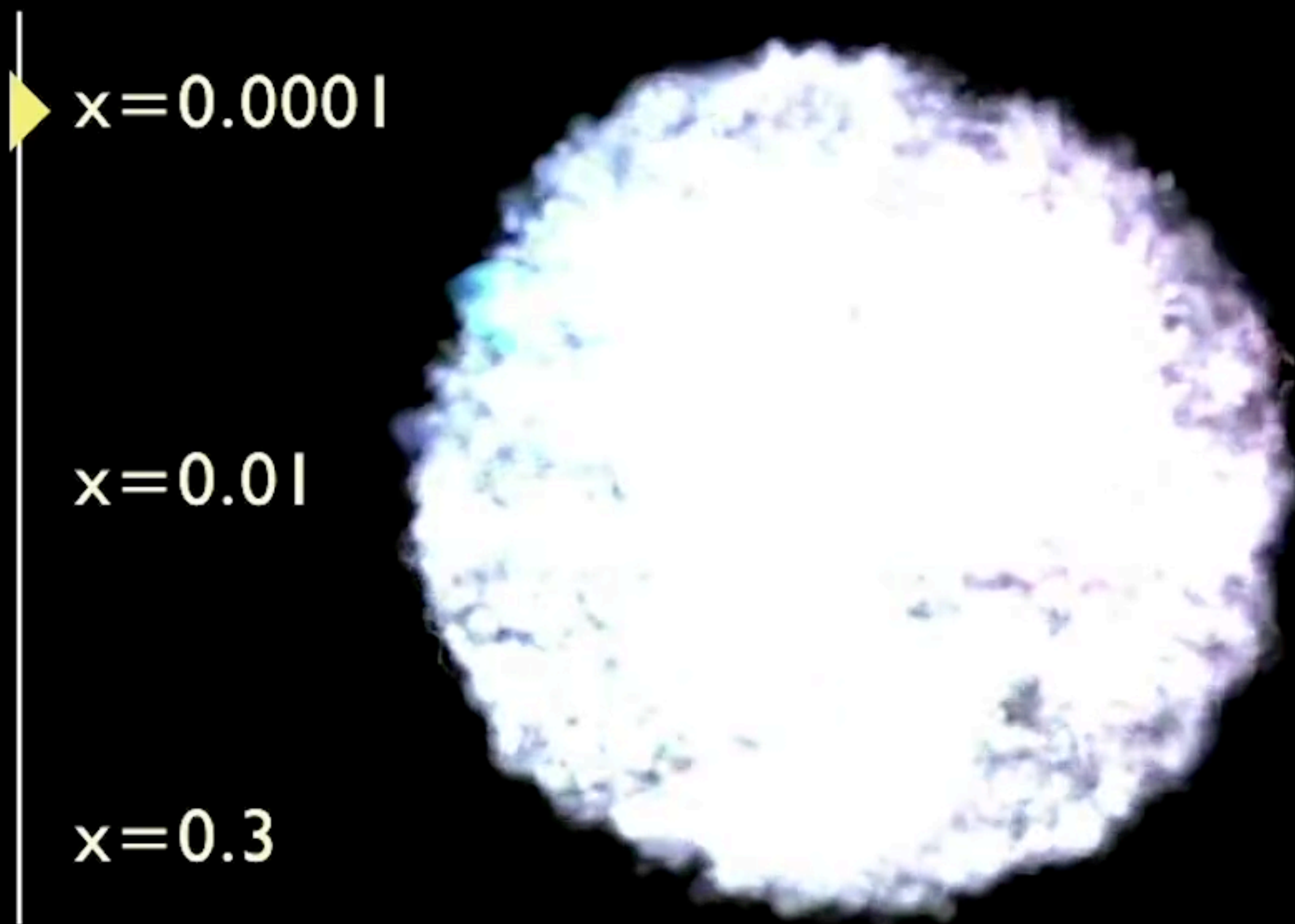
For every trillion K_S^0 only five
decay to two muons
[rarest decay event recorded]

This analysis uses two machine-learning
tools: one to discriminate muons from
pions and another to discriminate signal
from combinatorial background

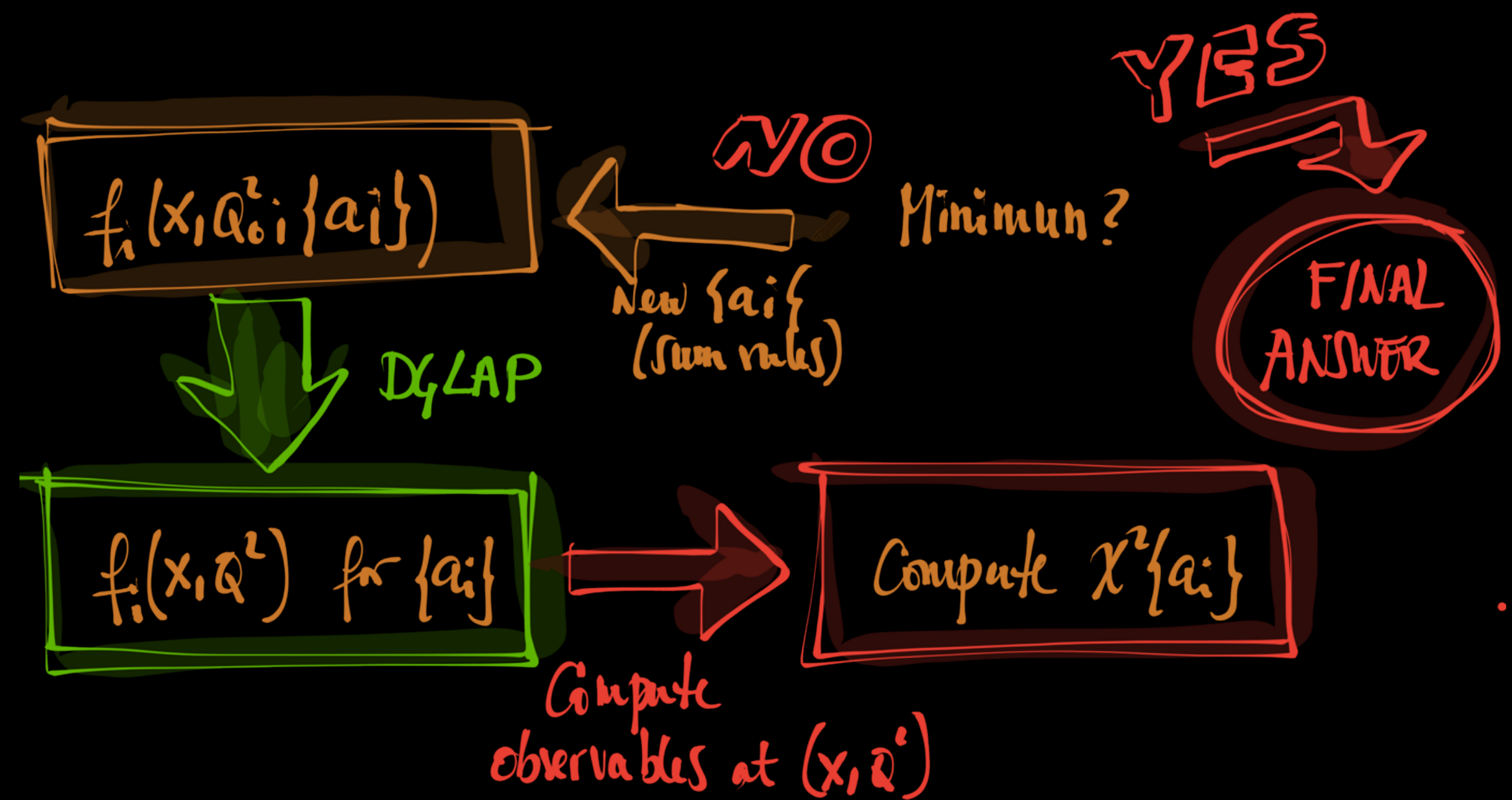
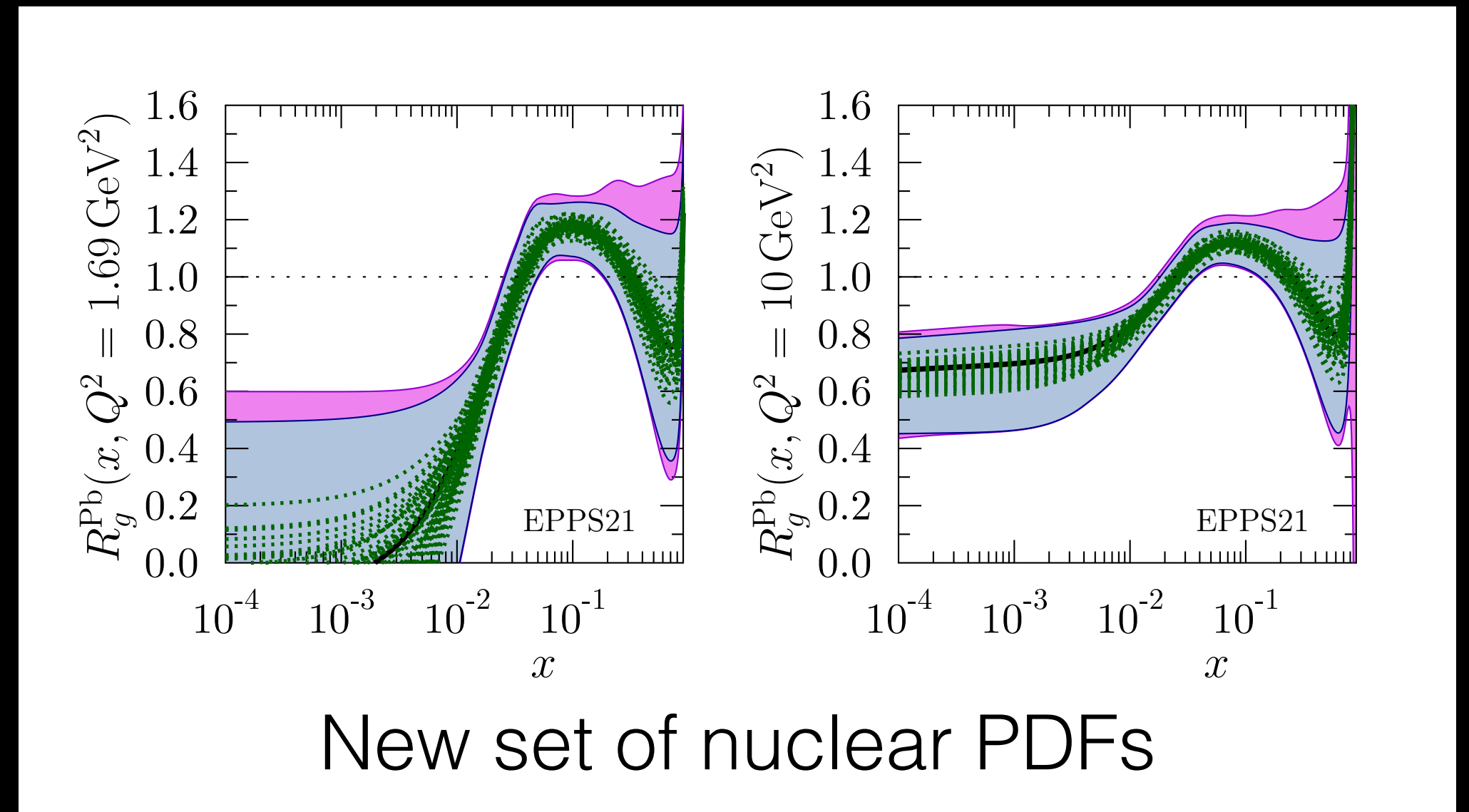
Challenging the Standard Model of Particle Physics
— still not clear signal of departure... but some of the most interesting results from LHC

SA1_HQCD

Unveil the structure of the proton

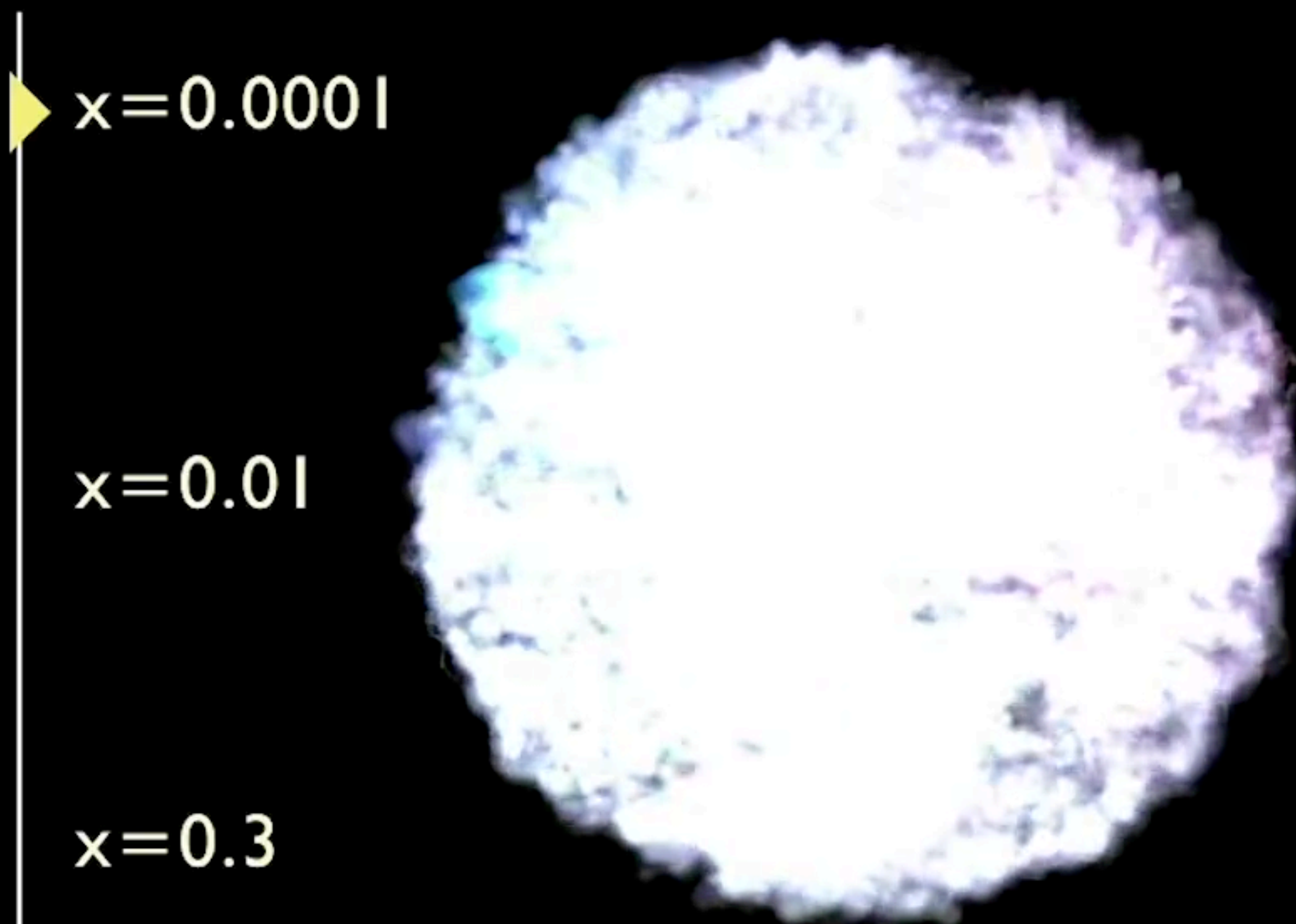


[Animation: Visualizing the proton - Arts at MIT]

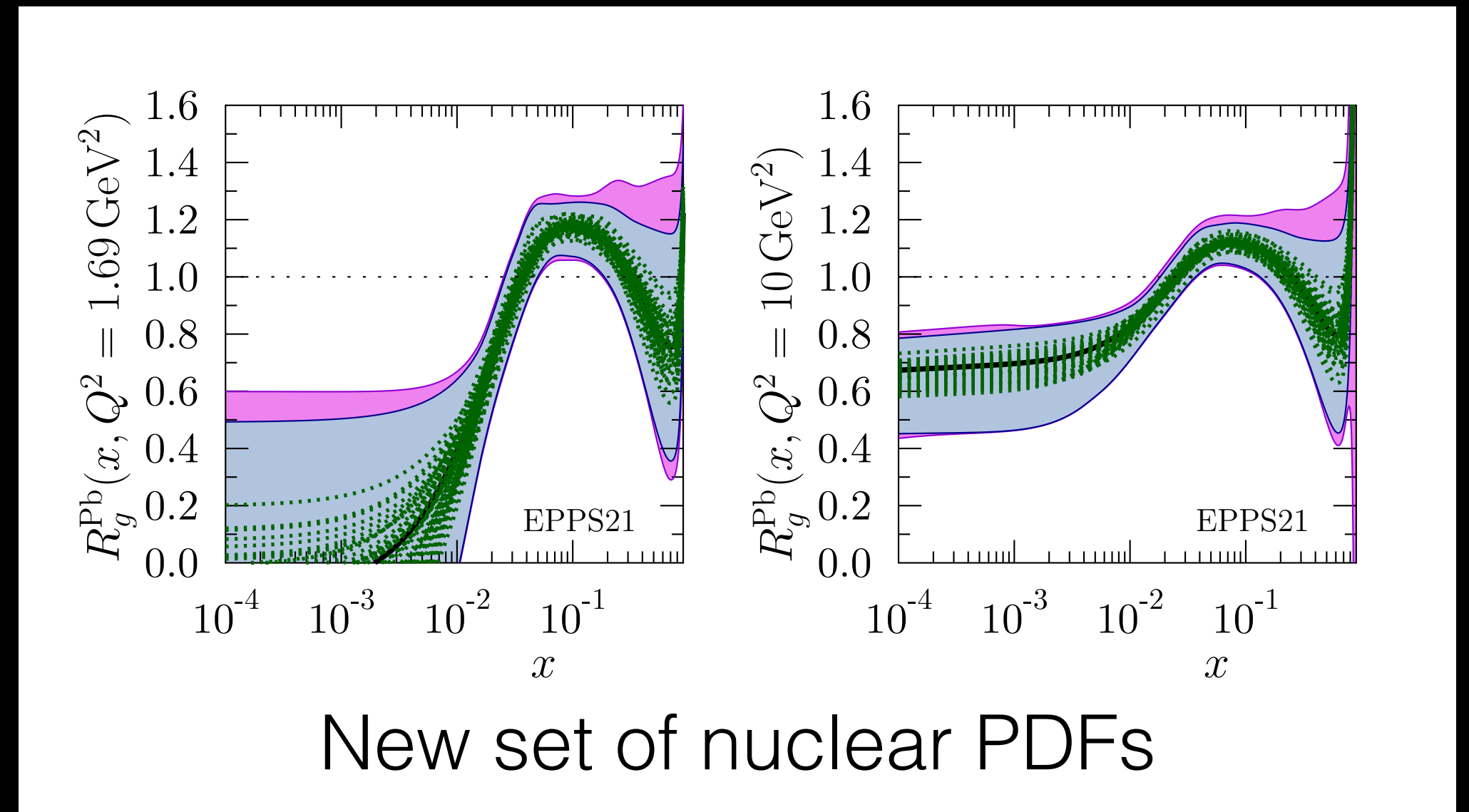


SA1_HQCD

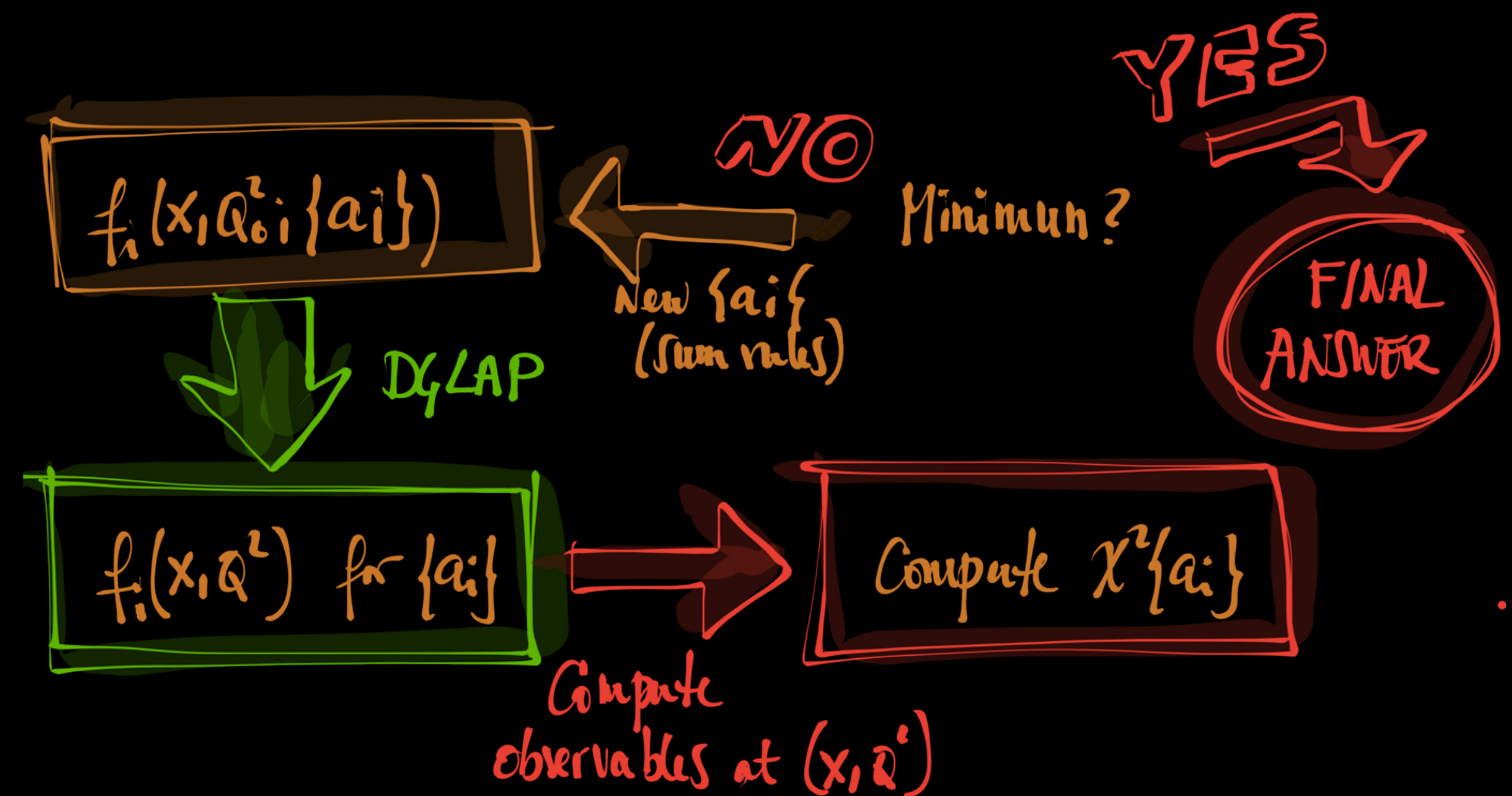
Unveil the structure of the proton



[Animation: Visualizing the proton - Arts at MIT]

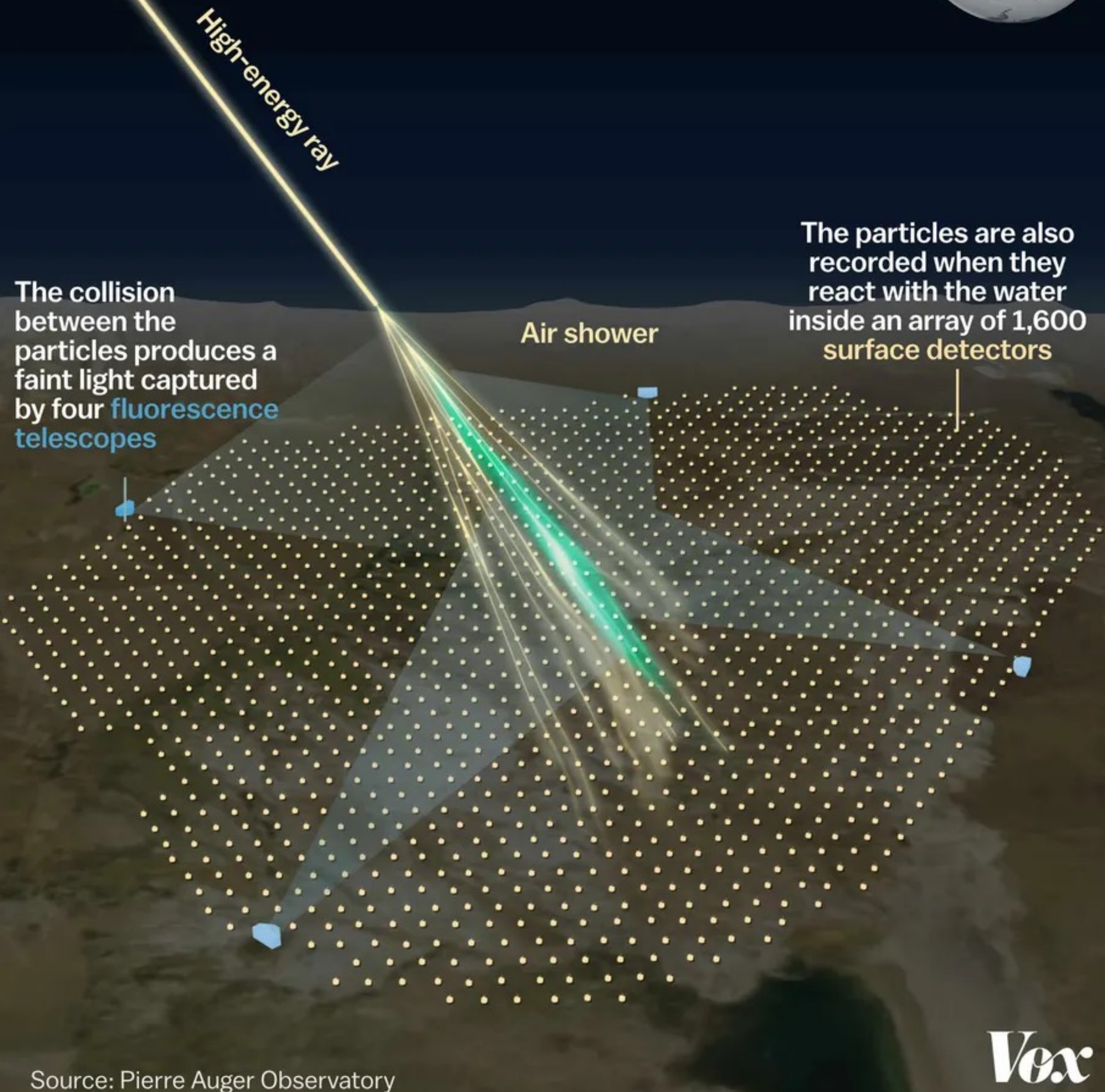


New set of nuclear PDFs



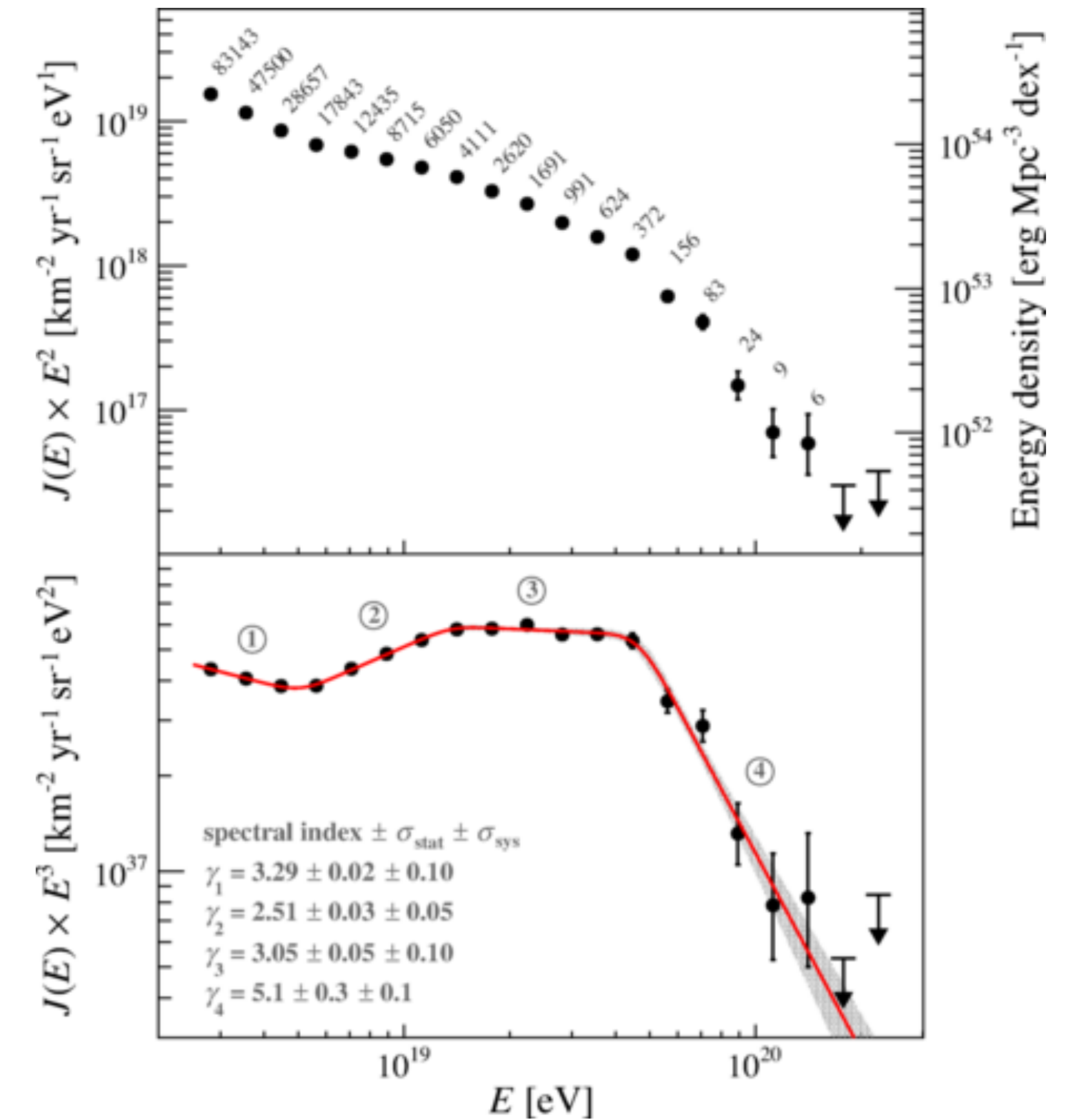
Pierre Auger Observatory

The observatory is a detector of high-energy cosmic rays that uses two different techniques



SA2_AUGE

Energy spectrum of UHECR



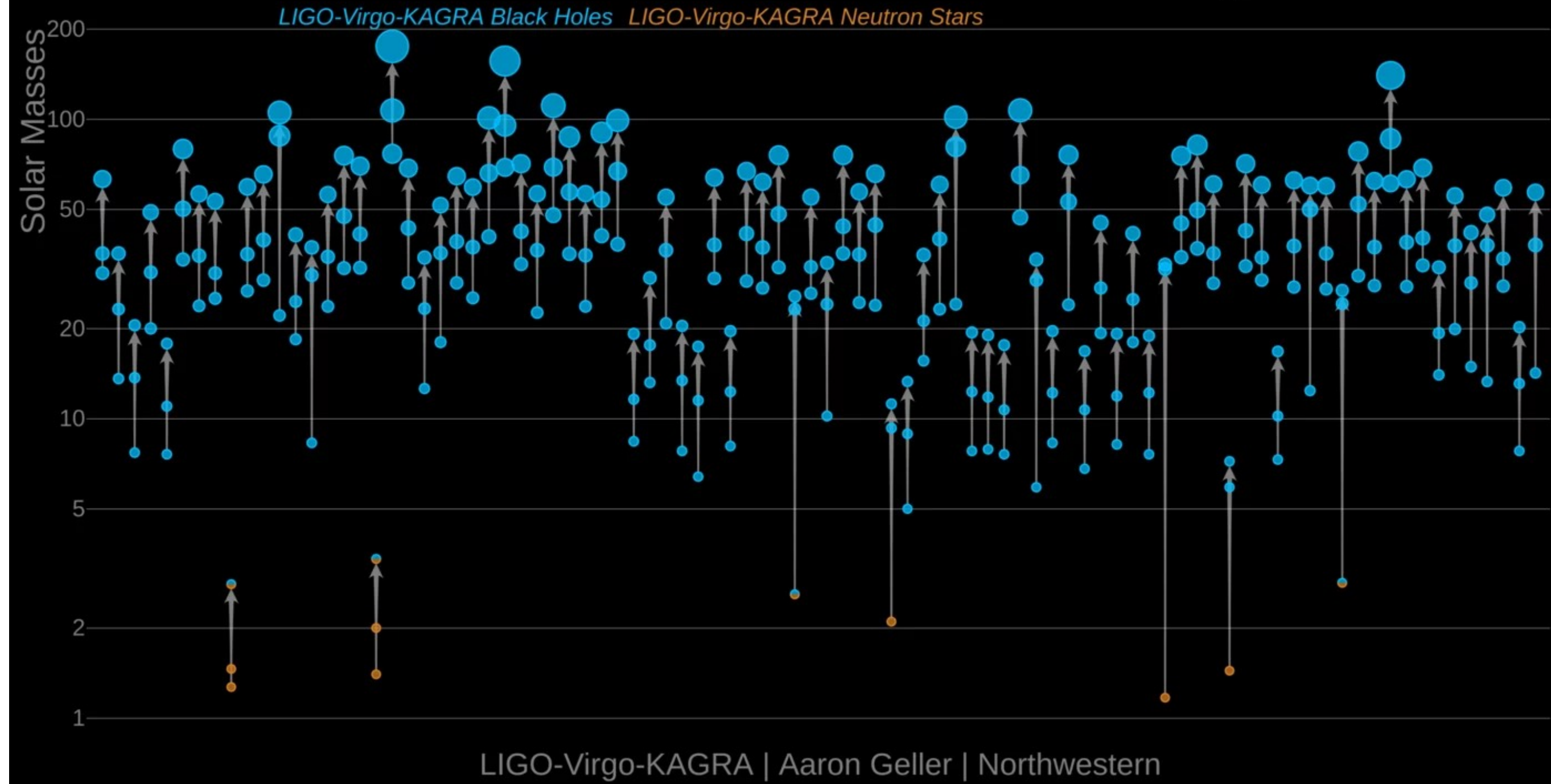
Change of slope at 13×10^{18} eV

Excludes UHECR from small number of nearby sources

Multimessenger Astronomy - with SA2_GRWA

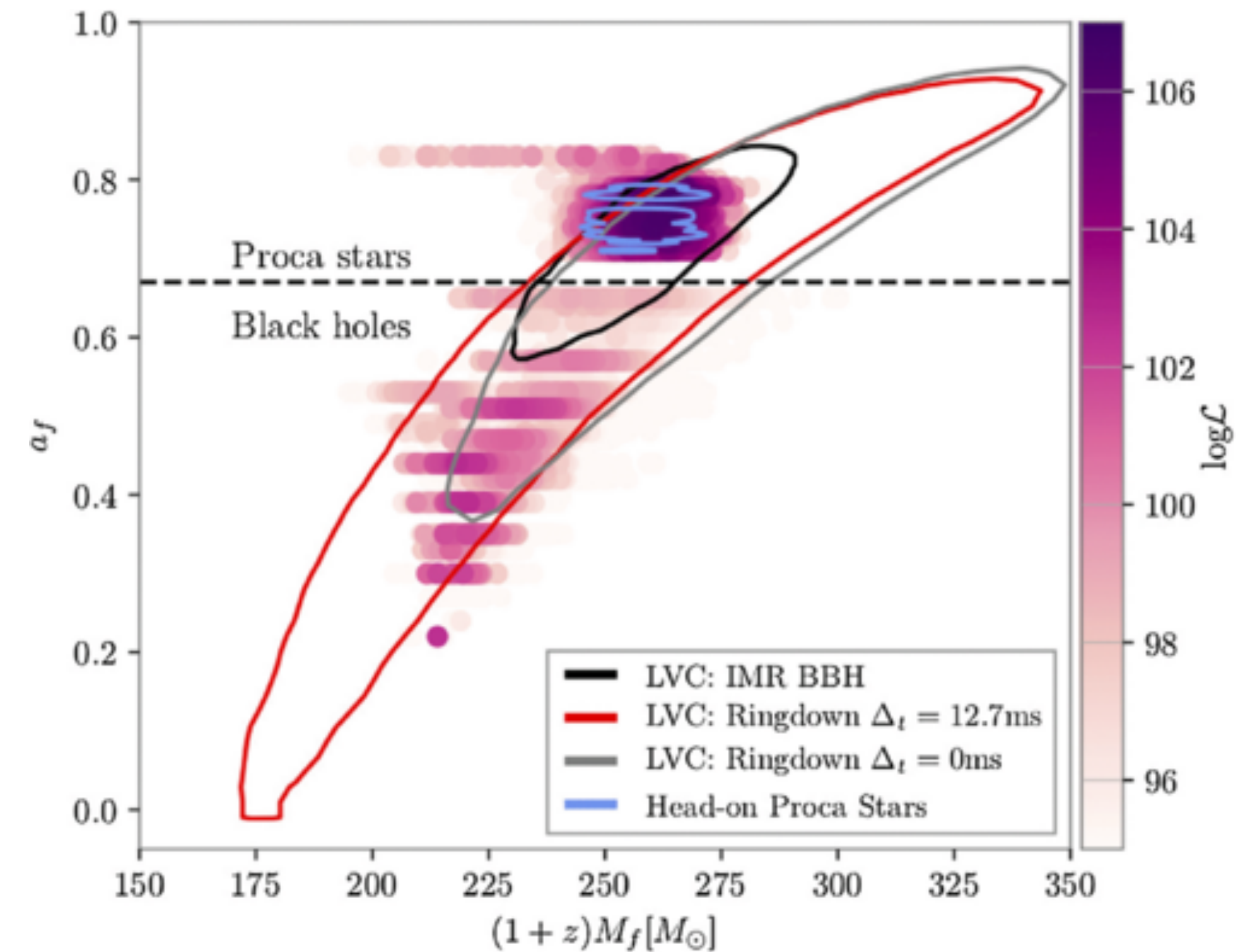
SA2_GRWA

Masses in the Stellar Graveyard



Leading role in PyCBC pipeline

GW190521 as a Merger of new boson stars?



SA2

BBC WHAT YOUR BRAIN DOES TO CREATE REALITY

Science Focus

Why people think
THEY CAN HEAR THE DEAD

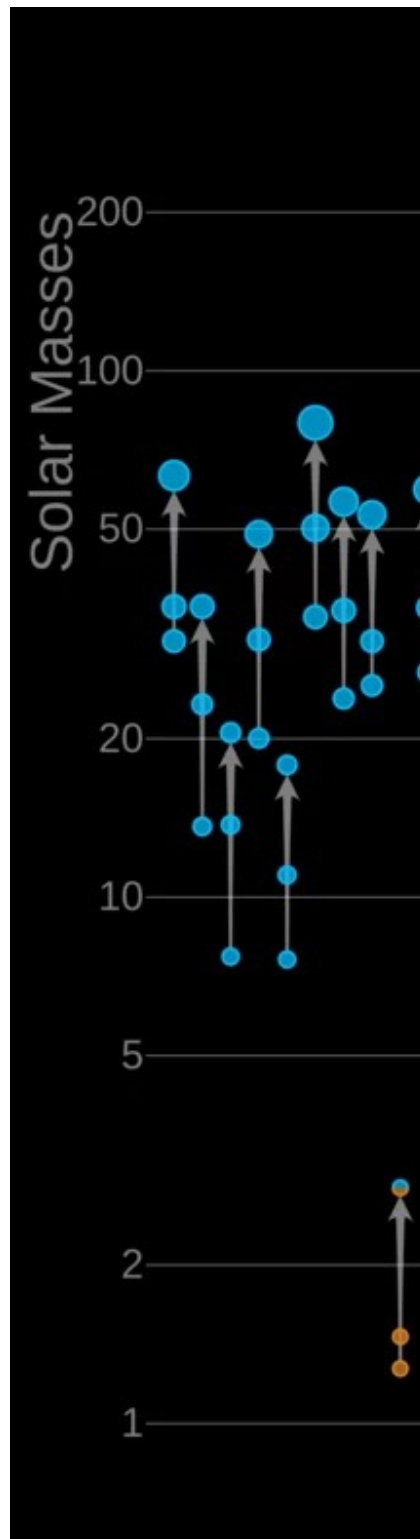
How to beat
COVID-19 BY 2022

How to teach
A MACHINE TO TELL A STORY

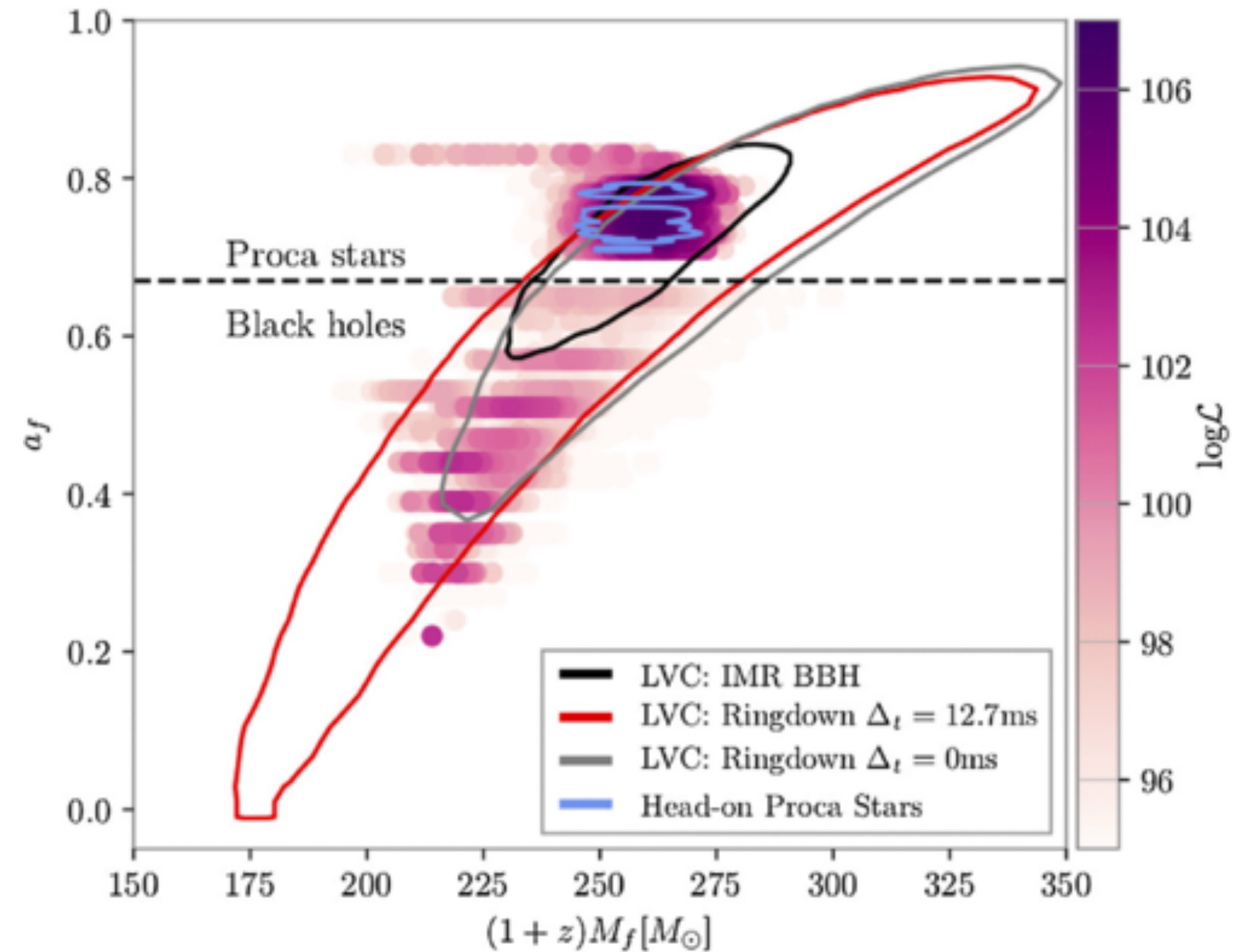
DARK

STARS

How a string of strange discoveries
could reveal a cosmos hidden just out of view

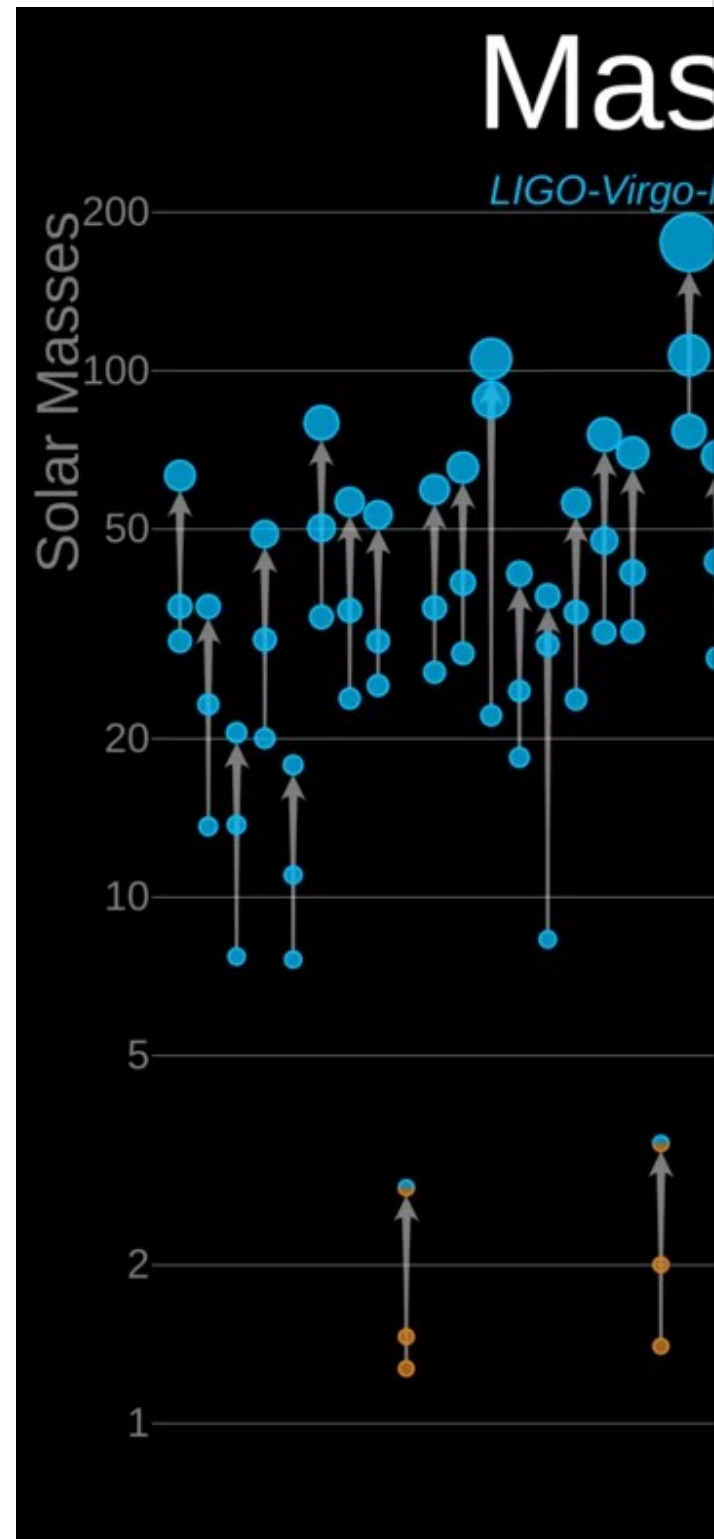


GW190521 as a Merger of new boson stars?



IN THIS ISSUE — **Health** — **Nature** — **Environment**
The truth about gene-edited food | Are climbing plants conscious? | Genius zero-waste inventions

SA2_G



Lead

marca.com

M Tiramillas / Actualidad Cine Series Televisión Música Lujo Videojuegos Tecnología Gastronomía

PUBLICIDAD

Actualidad • Confirmaría la existencia de estos objetos y, con ellos, la de la materia oscura

El misterioso motivo que explicaría la mayor onda gravitacional: la fusión de dos estrellas bosones

Ilustración de la fusión de dos estrellas de bosones EFE

EFE Actualizado 25/02/2021 - 09:39

La **mayor onda gravitacional** captada hasta el momento puede no ser fruto de la colisión de dos agujeros negros, sino tener un motivo más misterioso, la fusión de dos estrellas de bosones, lo que confirmaría la

Relacionados

- Luna de nieve: qué significa y cómo ver la luna llena con la que se despide febrero
- Descubren indicios de un mundo habitable en la vecina estrella de Alpha Centauri A

Este

PUBLICIDAD

MARCA Plus PARTIDO A PARTID MAD CUP

PUBLICIDAD

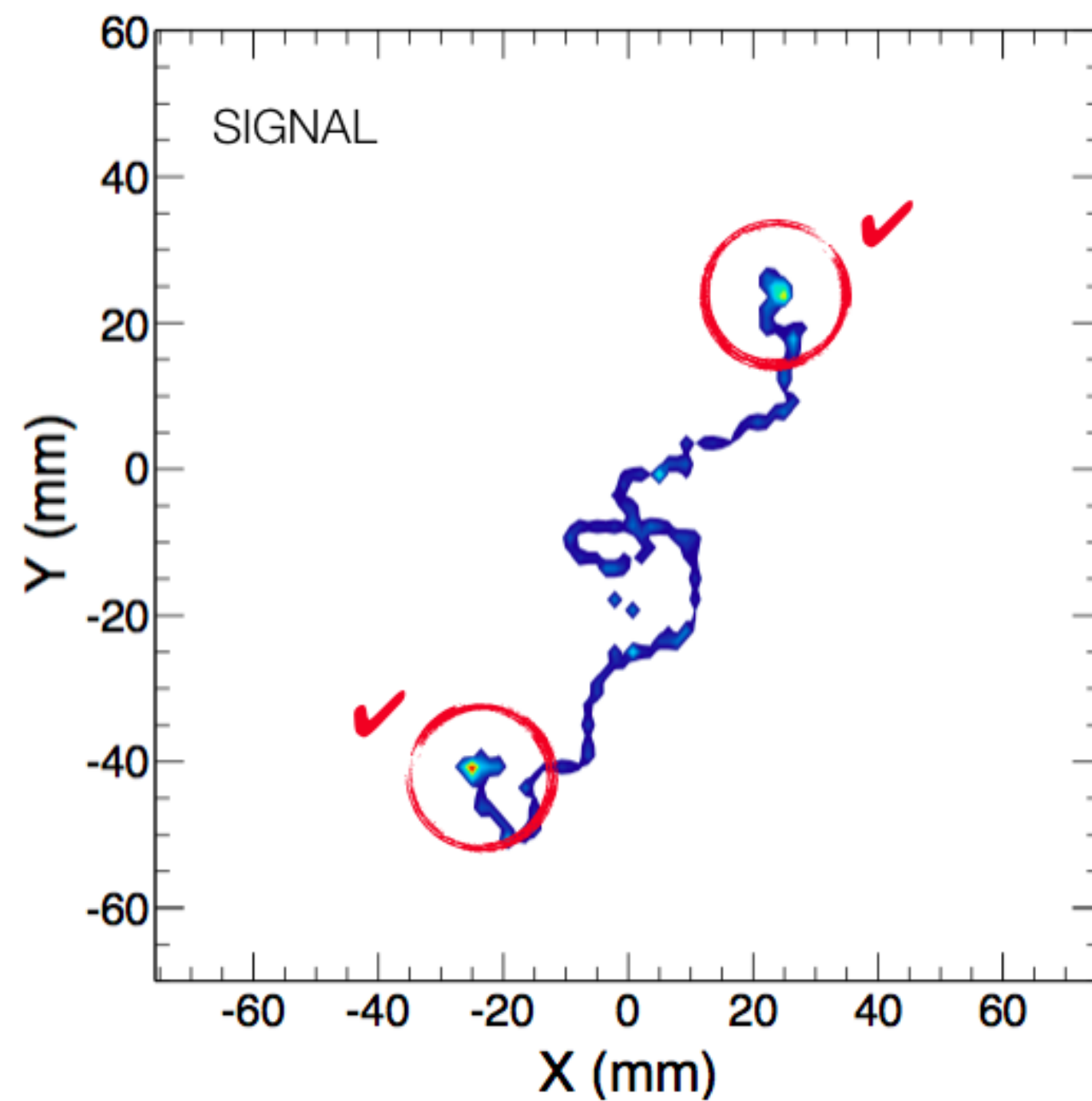
Rebajas en Camper Camper

ars?

Este

SA2_NEXT

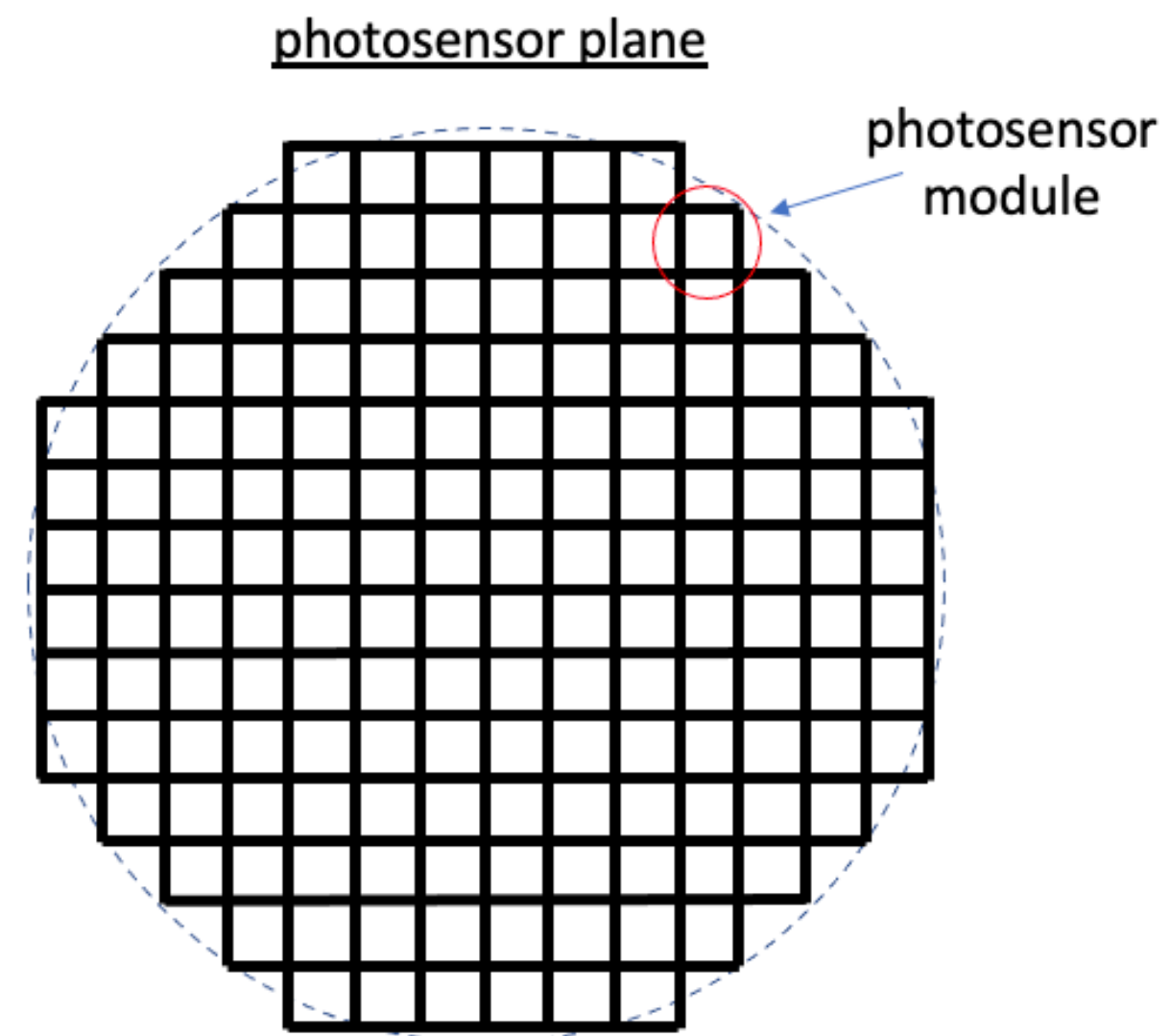
Neutrinos de Majorana?



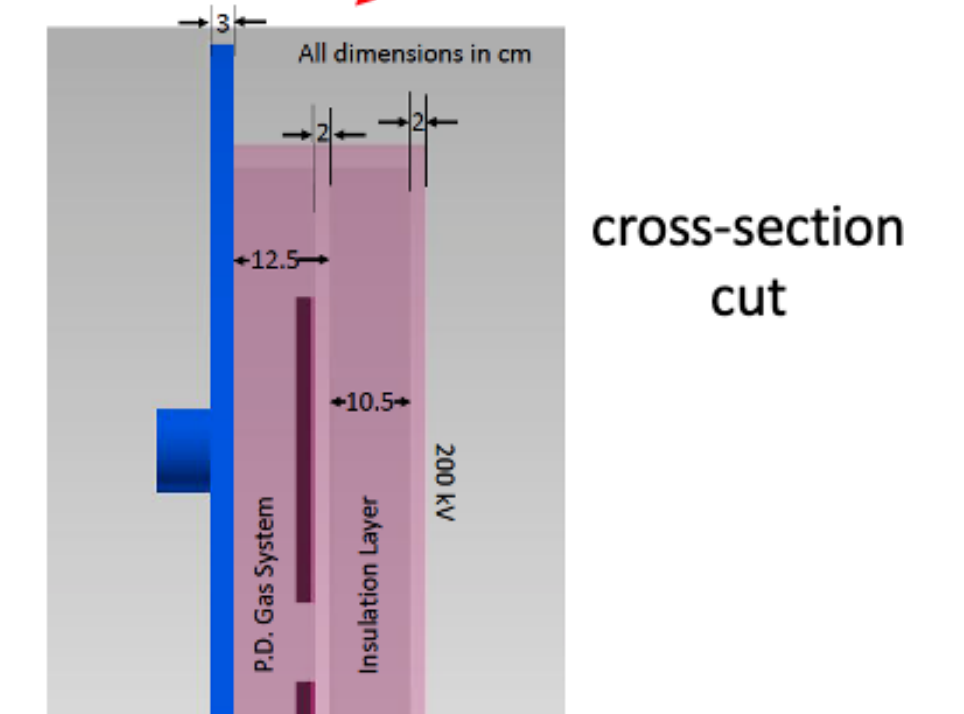
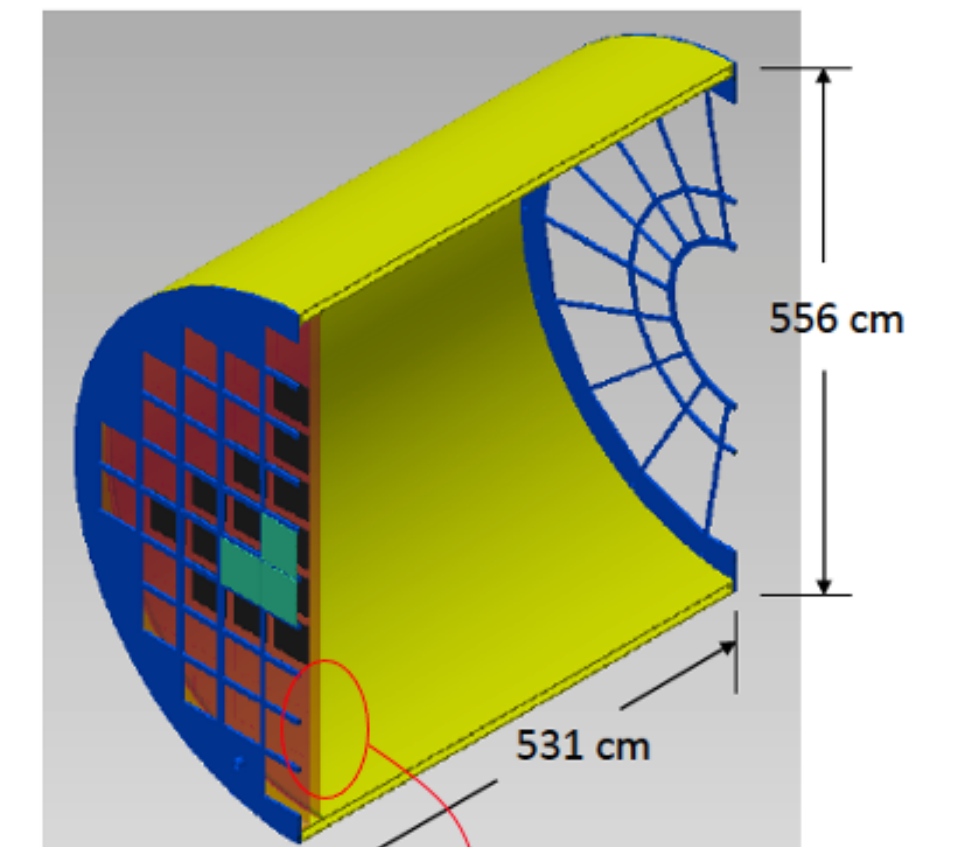
NEXT

Software development, e.g. convolutional neural networks for background rejection

approximate layout (ball-park numbers)



125-150 modules in cathode plane
256 tiles per module
16 SiPMs (6mm x 6mm) per tile (ganged)
32000 readout channels



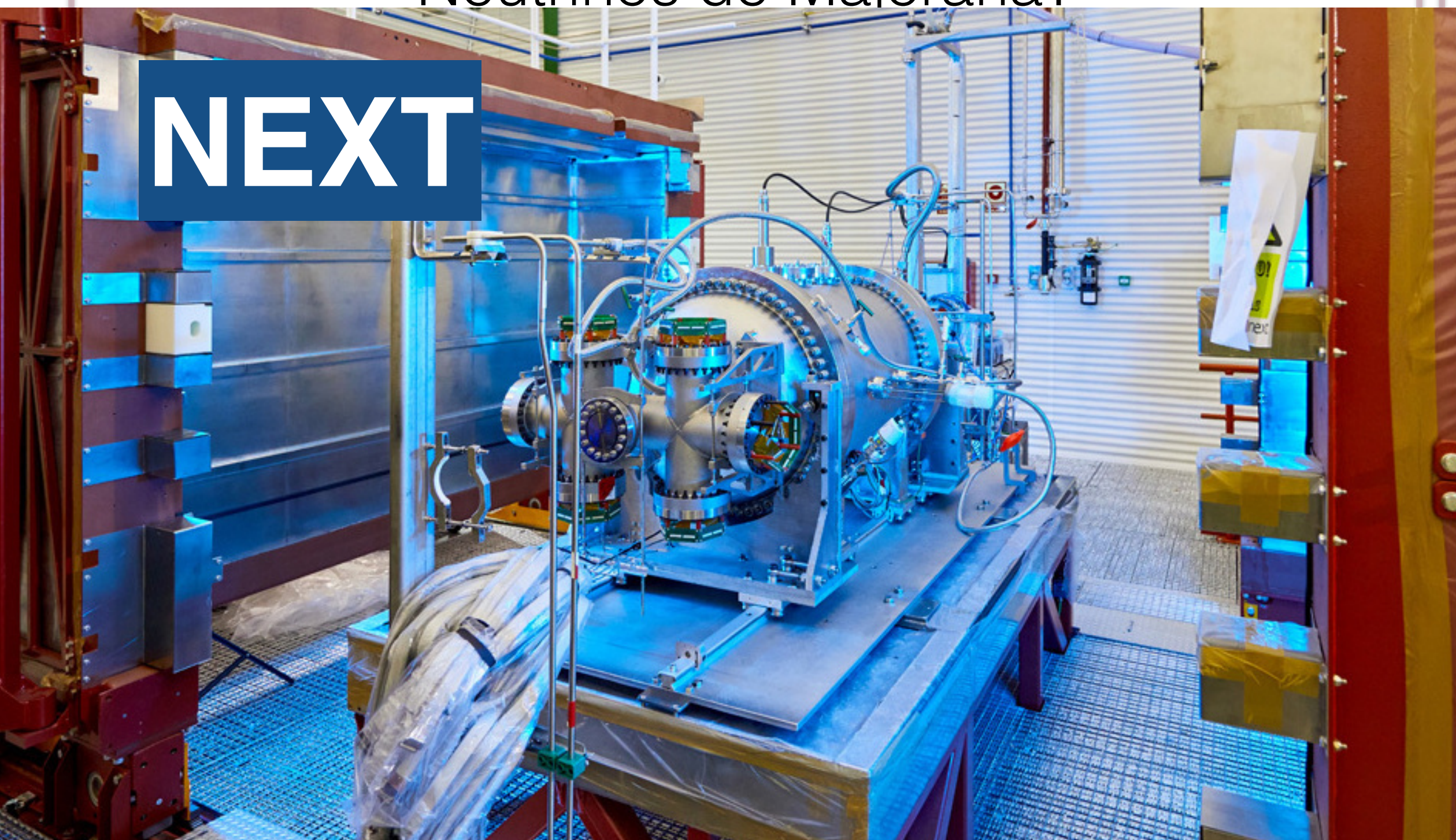
IGNITE

Contribution to DUNE near-side detector

SA2_NEXT

Neutrinos de Majorana?

NEXT



λ (mm)

NEXT

Software development, e.g. convolutional neural networks for background rejection

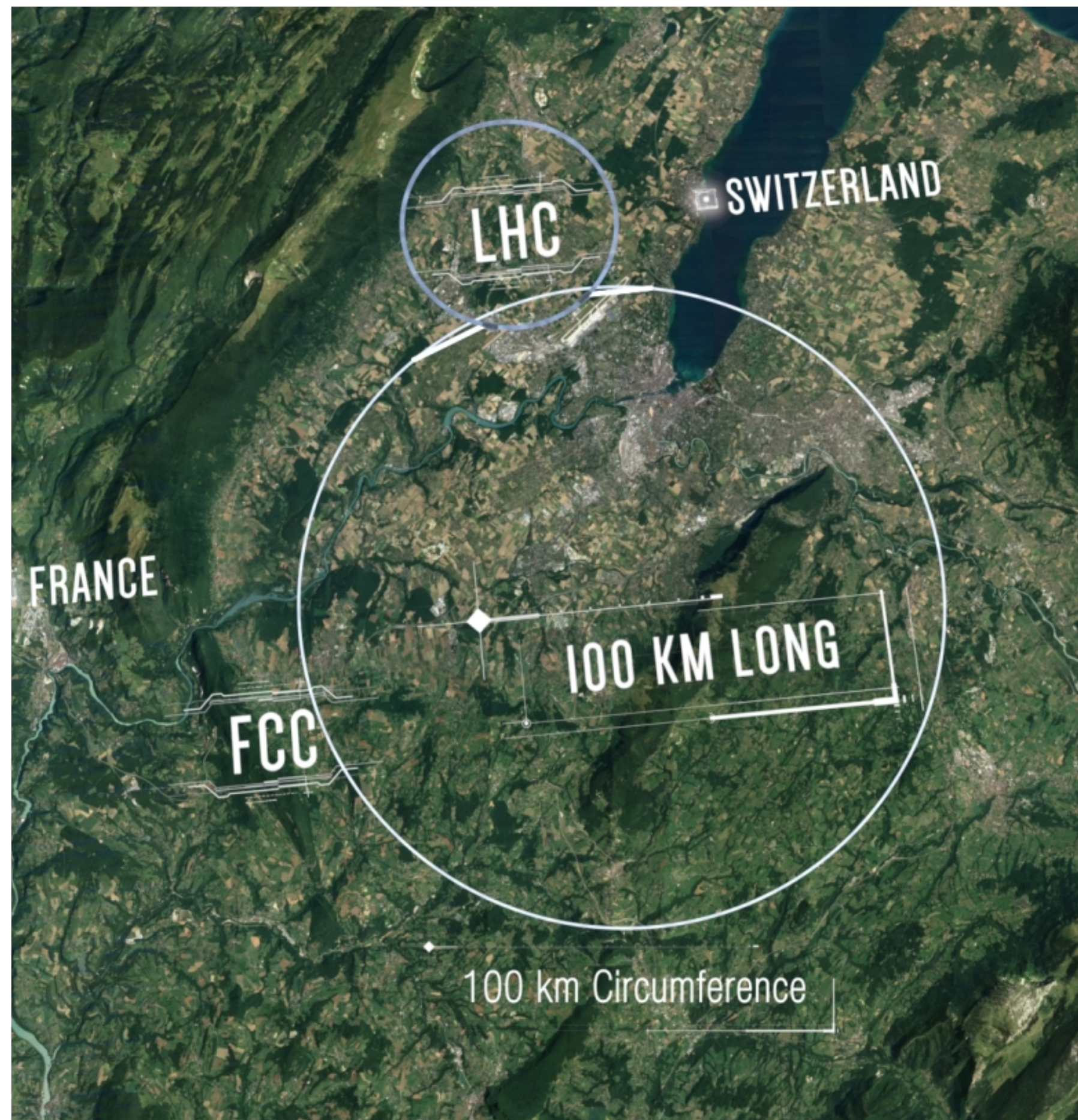


IGFAE laboratory

IGNITE

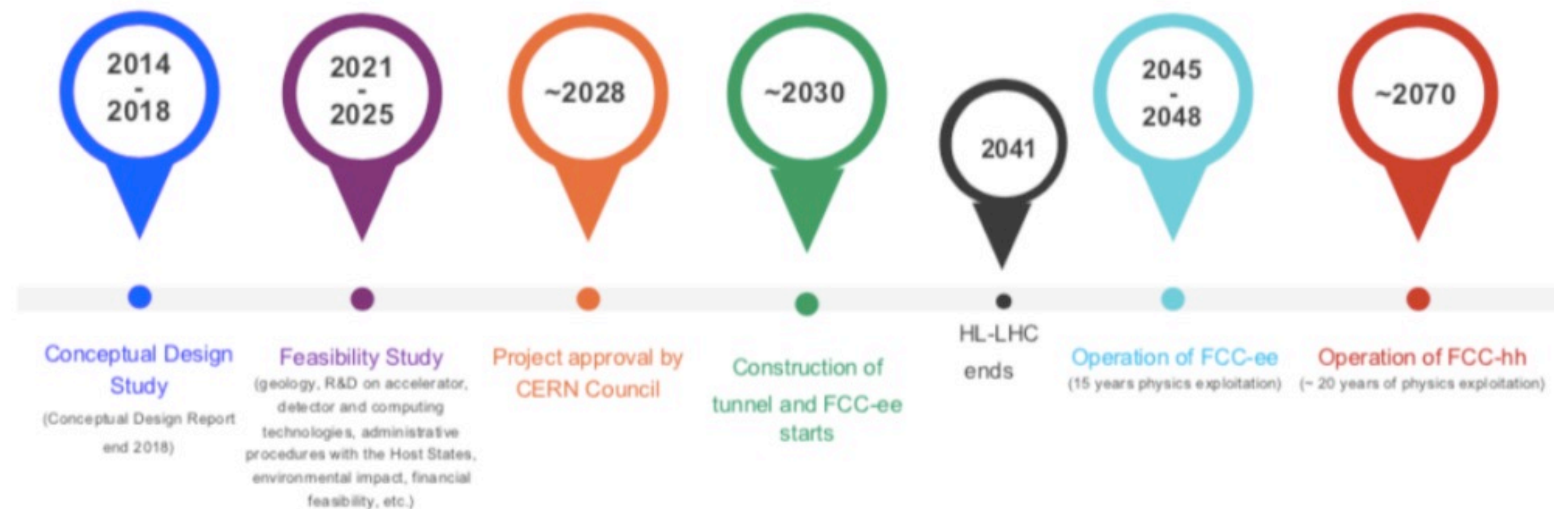
Contribution to DUNE near-side detector

Long planning times...



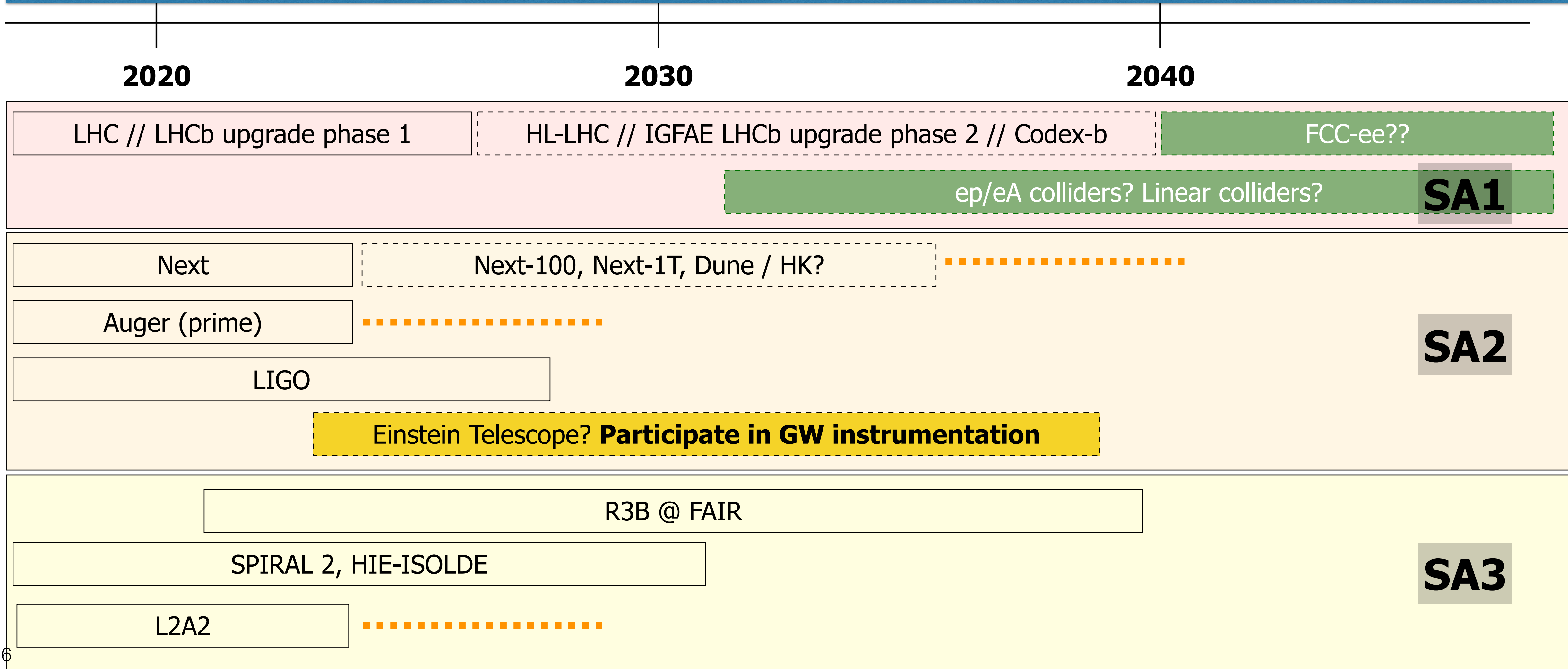
The Future Circular Collider (FCC) is a proposal under study to build an accelerator in a new 100km long circumference tunnel.

This is a good example to understand the extremely long timescales in Particle Physics projects



HL: Strategy for new facilities

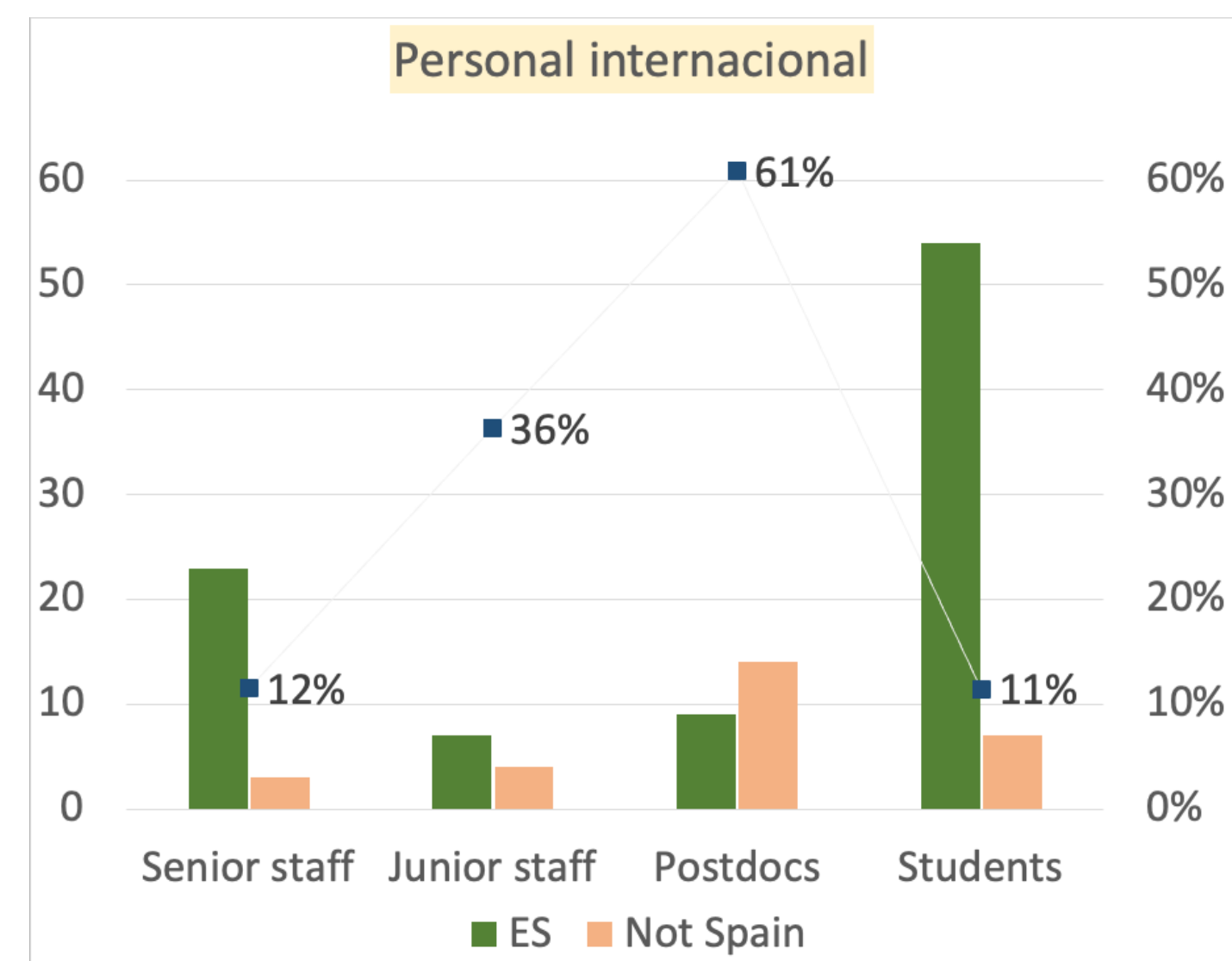
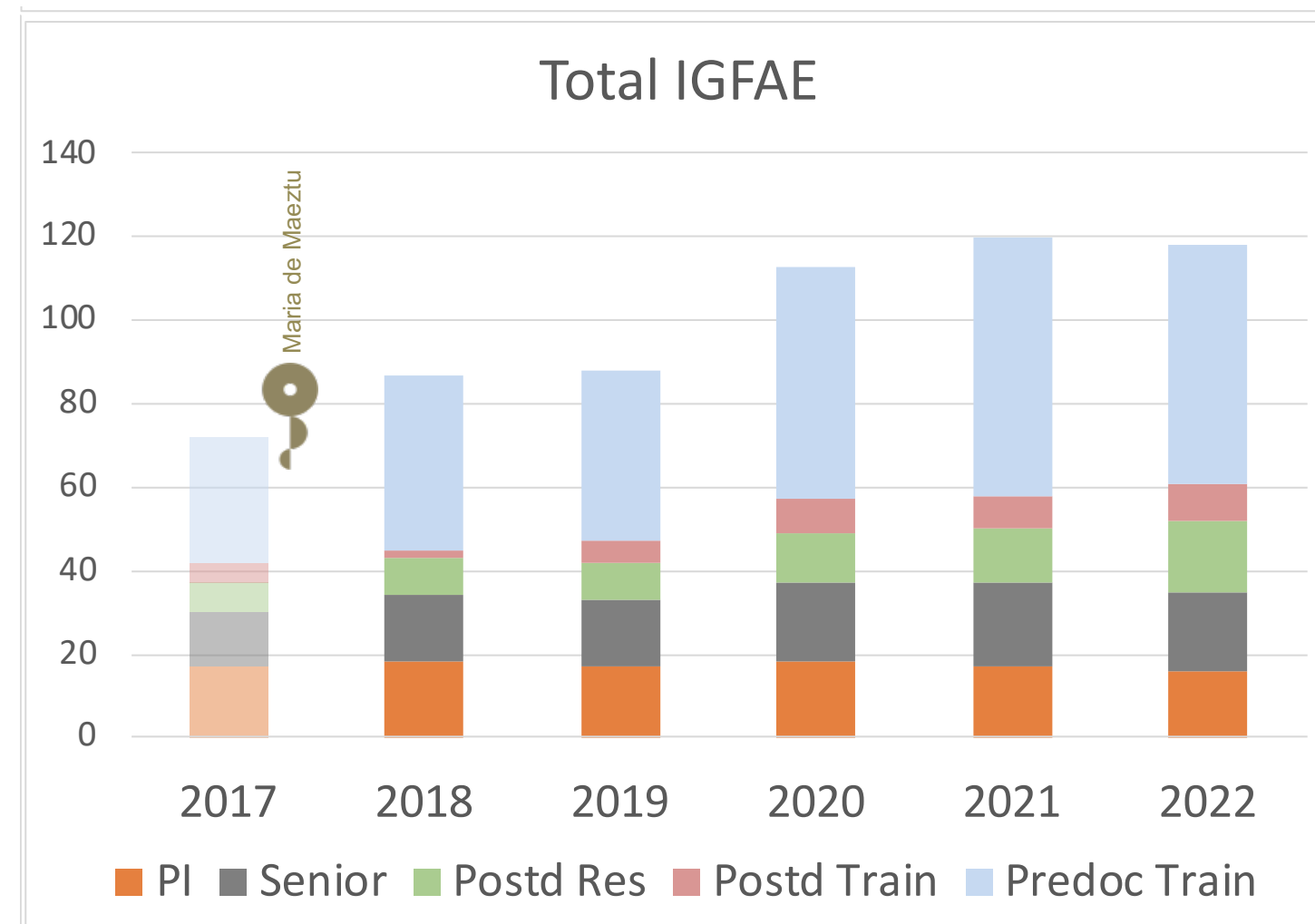
Perspectiva de estabilidade a longo prazo e cumprimento de compromisos esencial



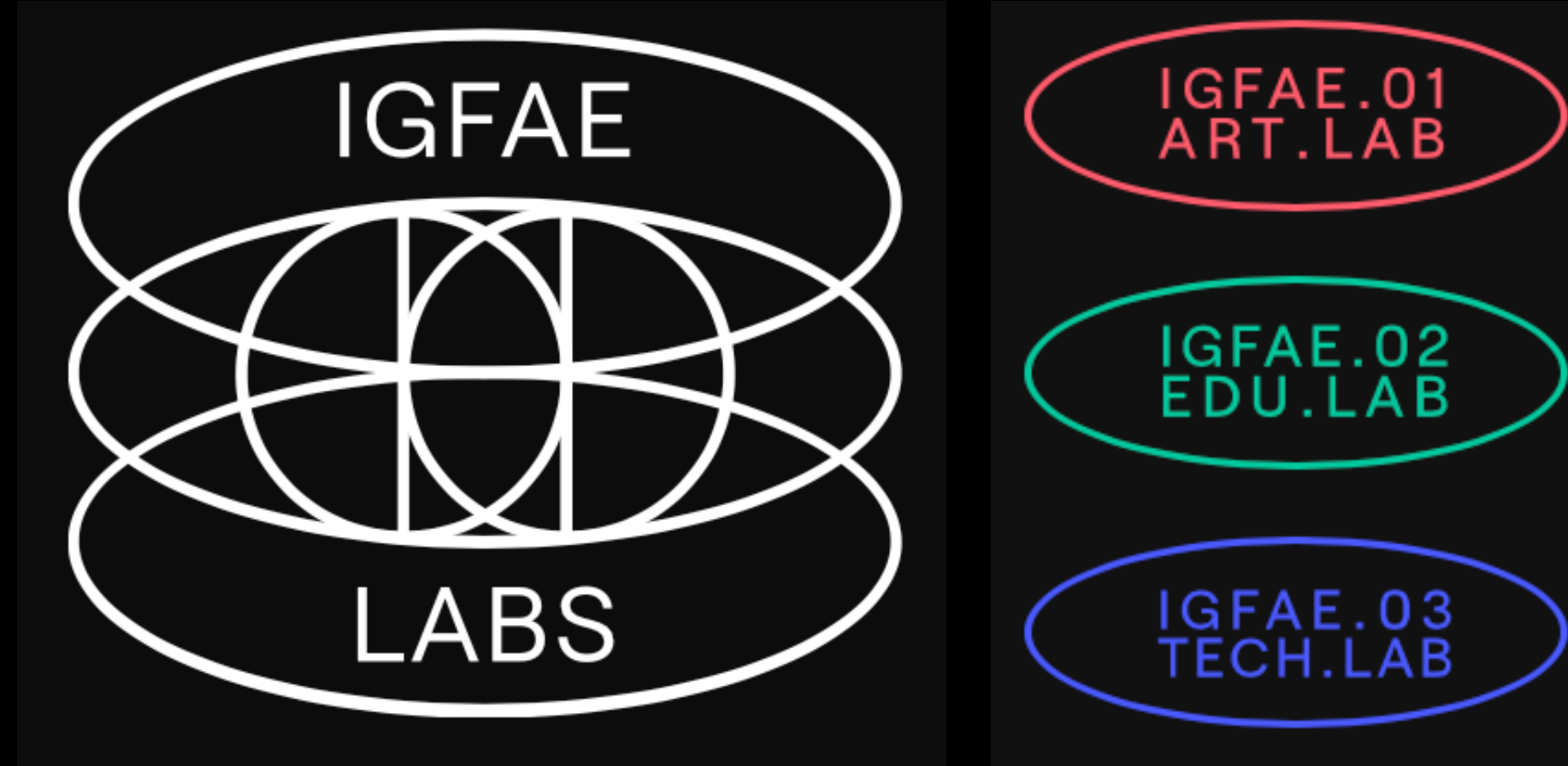
Talent



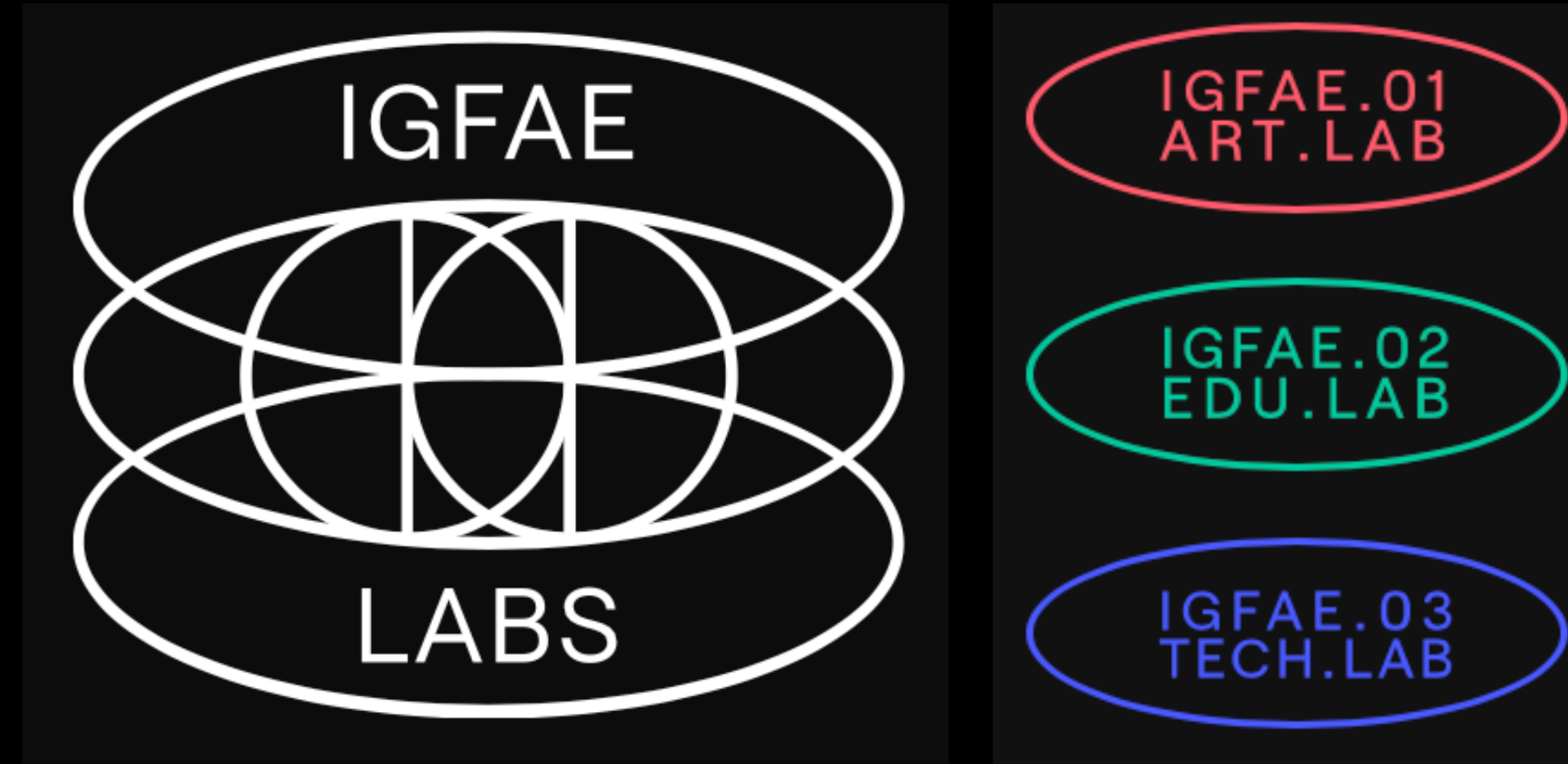
Personnel



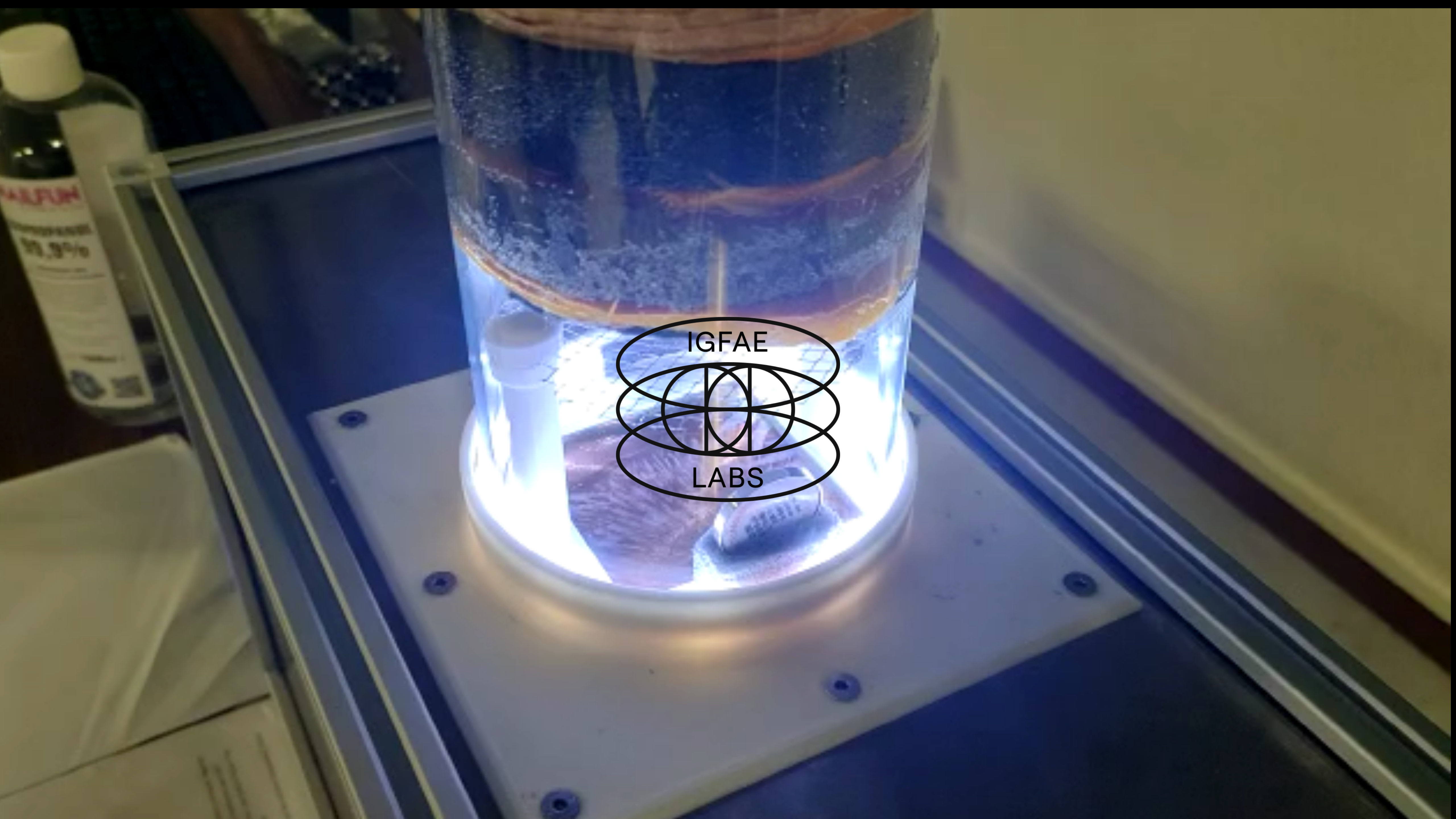
Responsible Research and Innovation



Responsible Research and Innovation

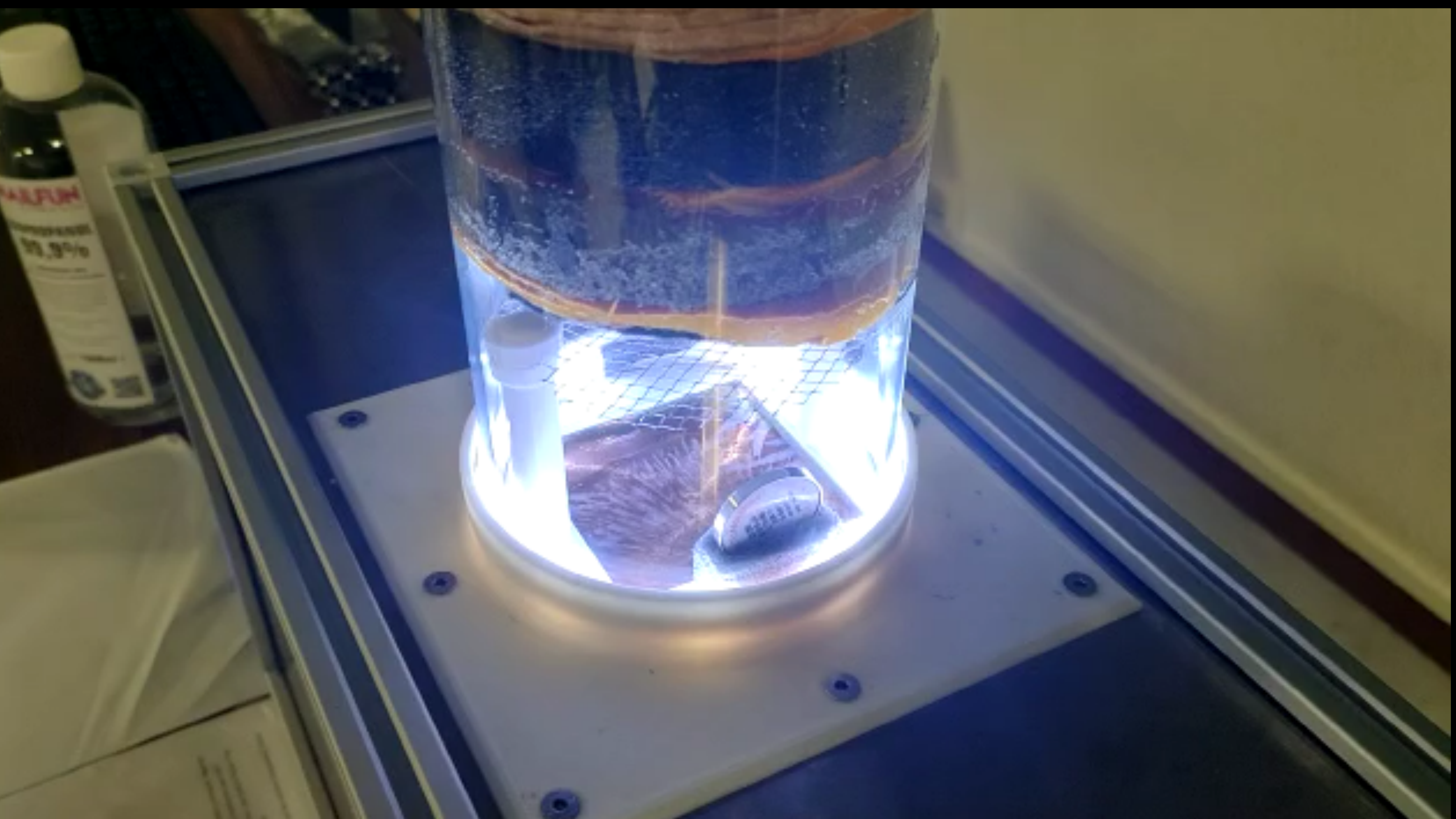


Societal and Industrial Engagement Strategy



IGFAE

LABS



ALFUM
10.9%

10.9%

IGFAE.LABS

Obradoiro

Cámara de Néboa

Sab. 09.10.2021
9:00h - 13:00 h.
Aula C / IGFAE

IGFAE.02
EDU.LAB

Inscripcións

<https://igfae.usc.es/igfae/gl/obradoiro-camara-neboa/>

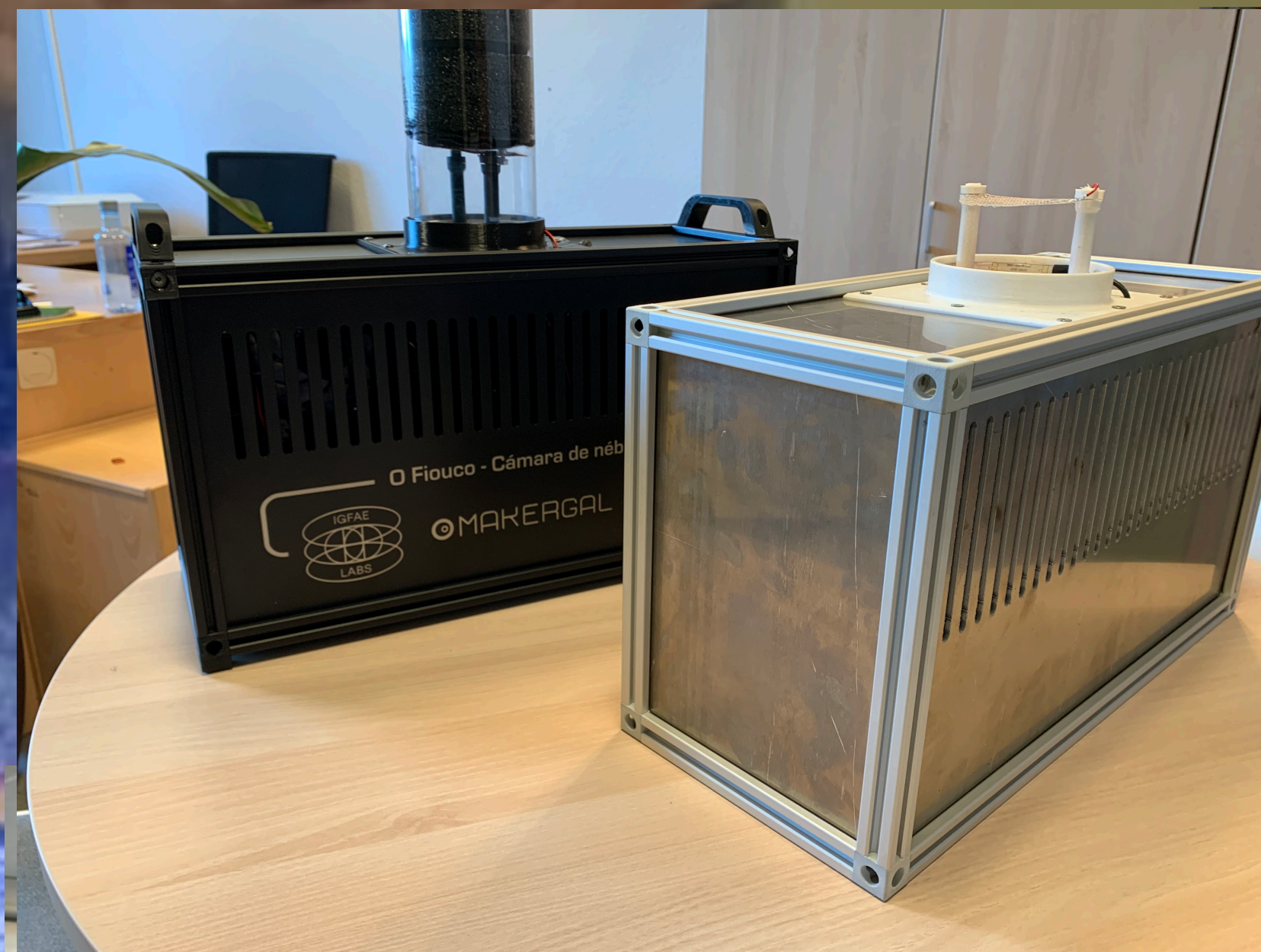


001/2021

Instituto Galego
de Física de
Altas Enerxías

USC

Inventada a principios do século XX, a cámara de néboa é un dos primeiros e máis sinxelos detectores de partículas subatómicas que se poden construír. Coa colaboración de MakerGal, o programa EduLab do IGFAE deseñou un prototipo a partir do cal construír estes detectores por un orzamento reducido e con materiais que non requiren dun mantemento nin manexo complexos. Nesta actividade, impartiremos un obradoiro para profesorado de secundaria no que se ensinará o funcionamento básico destes dispositivos e o procedemento para montalos a partir dun kit de montaxe e de materiais proporcionado polo IGFAE. Unha vez finalizado o obradoiro, o detector entregarase aos centros educativos dos docentes con obxecto de que poida ser utilizado como recurso educativo.



IGFAE. I
Obrado
Cámara
Sab. 09
9:00h
Aula C

Inscripcións



Inventada a principios
máis sinxelos detector
colaboración de Make
partir do cal construír
materiais que non req
actividade, impartire
ensinará o funcioname
montalos a partir dun
Unha vez finalizado o
dos docentes con obxe



ArtLab | Instituto Galego de Física de Altas Enerxías (IGFAE) presenta



ArtLab | Instituto Galego de Física de Altas Enerxías (IGFAE) presenta



Technology Transfer

TechLab - Pablo Cabanelas / head of the unit

A lot of activity

- * Industrial PhD
- * Protontherapy
- * Natural radioactivity
- * Proof-of-concept projects
- * WG KTI in SOMMa
- * Homeland security - Portos de Galician
- * **Quantum technologies**

DATA SCIENCE

Grazas

21.06.2024

EXPOSICIÓN ORGANIZADA
IGFAE ↔ CERN

28.08.2024

IGREXA DA UNIVERSIDADE
SANTIAGO DE COMPOSTELA



ARMIN LINKE INSTRUMENTOS DE VISIÓN

● Esta exposición reúne fotografías do artista Armin Linke realizadas, nas últimas décadas, durante as súas visitas a grandes instalacións experimentais, como a Organización Europea de Investigación Nuclear (CERN). Co gallo do 25º aniversario do IGFAE (Instituto Galego de Física de Altas Enerxías) e os 70 anos da fundación do CERN, ambas as dúas institucións únense para fomentar novos modos de encontro entre arte e ciencia baixo o apreixo da Igrexa da Universidade.