Welcome to the

9th CERN Patatrack Hackathon @TUE

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Leonardo Cristella, Loukas Gouskos, Benedikt Maier, Huilin Qu,

Felice Pantaleo, Wahid Redjeb, Marco Rovere for CERN

https://indico.cern.ch/e/tue-hackathon-9

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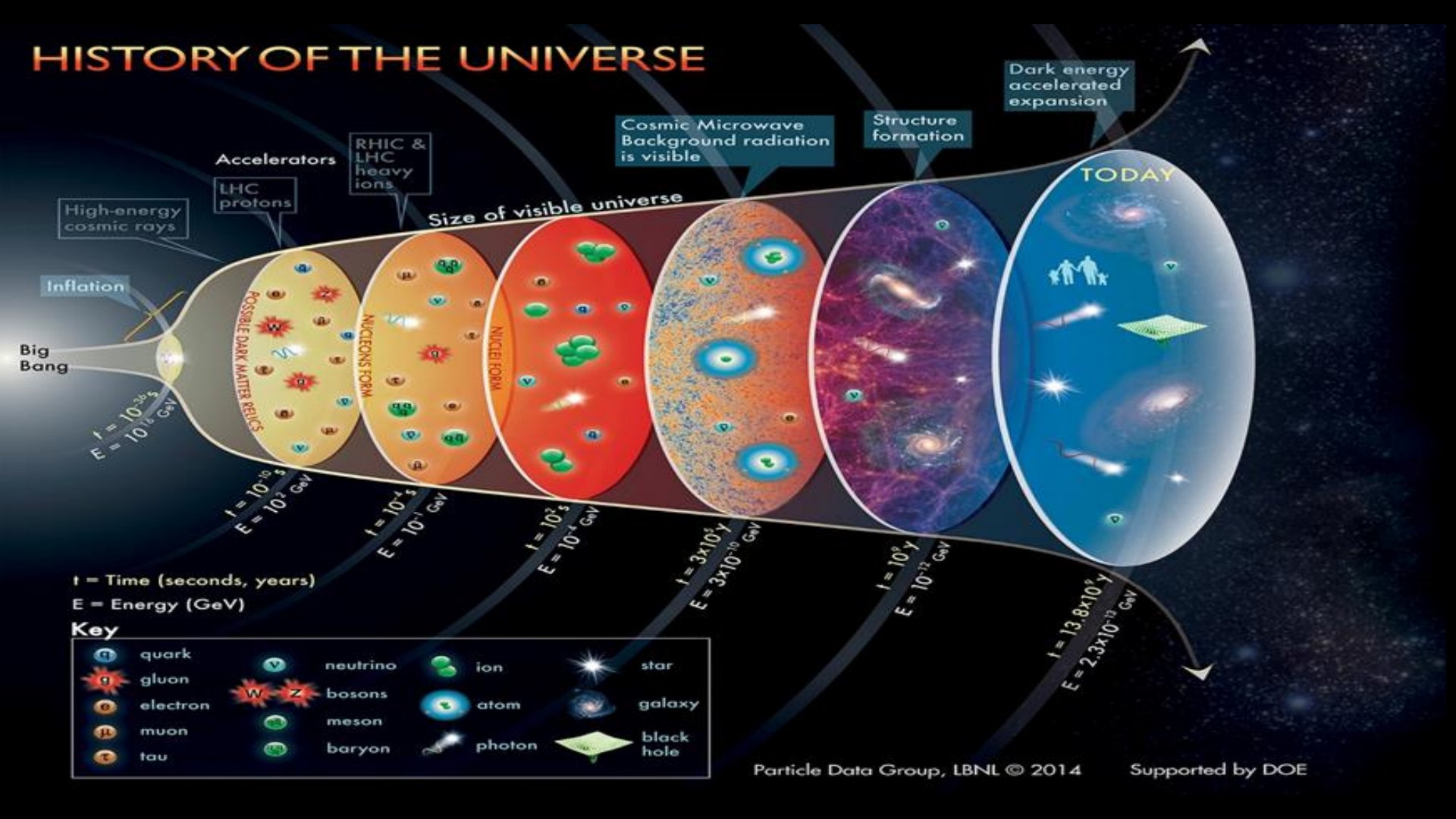
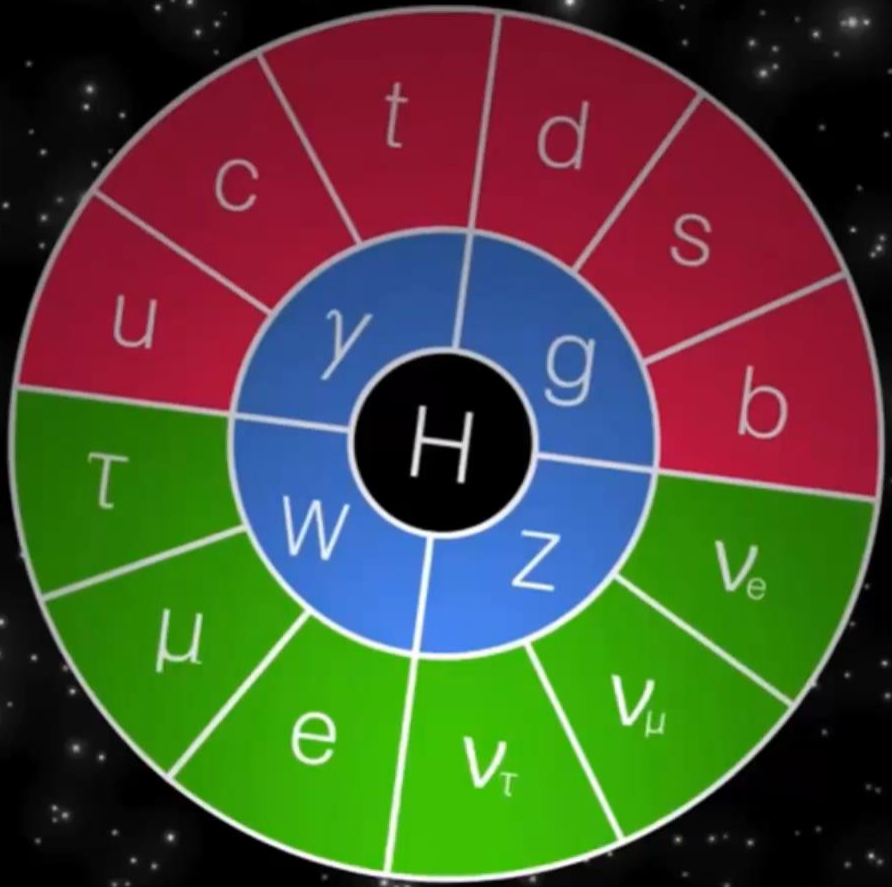
Patatrack

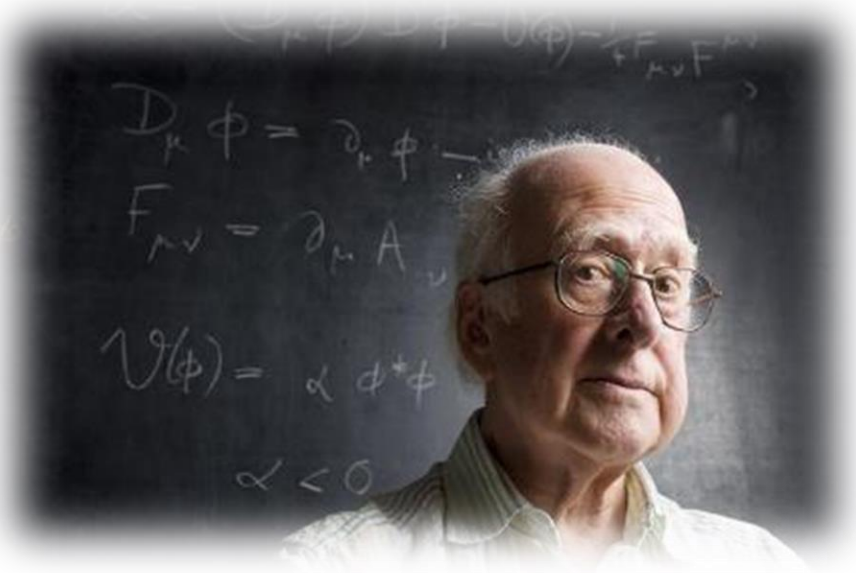
- Patatrack is a software R&D incubator
- Born in 2016 by a very small group of passionate people at CERN
- Interests: algorithms, HPC, heterogeneous computing, machine learning, software engineering


HISTORY OF THE UNIVERSE
Dark energy accelerated expansion
Structure formation
Cosmic Microwave Background radiation is visible
Accelerators
RHIC & LHC heavy ions
LHC protons
High-energy cosmic rays
Size of visible universe
TODAY
Inflation
Big Bang
t = 10^-36 s
E = 10^16 GeV
POSSIBLE DARK MATTER RELICS
NUCLEONS FORM
NUCLEI FORM
t = 10^-10 s
E = 10^2 GeV
t = 10^-4 s
E = 10^-1 GeV
t = 10^2 s
E = 10^-4 GeV
t = 3x10^5 y
E = 3x10^-10 GeV
t = 10^8 y
E = 10^-12 GeV
t = 13.8x10^9 y
E = 2.3x10^-13 GeV
t = Time (seconds, years)
E = Energy (GeV)
Key
quark
gluon
electron
muon
tau
neutrino
bosons
meson
baryon
ion
atom
photon
star
galaxy
black hole
Particle Data Group, LBNL © 2014
Supported by DOE


t
d
c
s
u
b
γ
g
H
τ
W
Z
ν_e
μ
e
ν_τ
ν_μ

0) Is the theory correct?

We discovered the Higgs boson
We don't know much about it



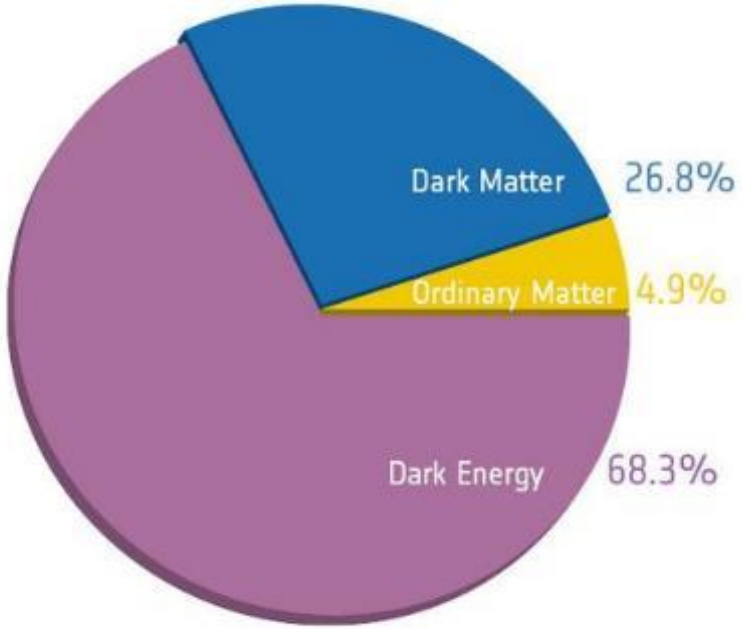
1) Antimatter

Big bang: equal amounts of matter
and antimatter

Today our universe exists…

Why?

2) What about the rest of our universe?



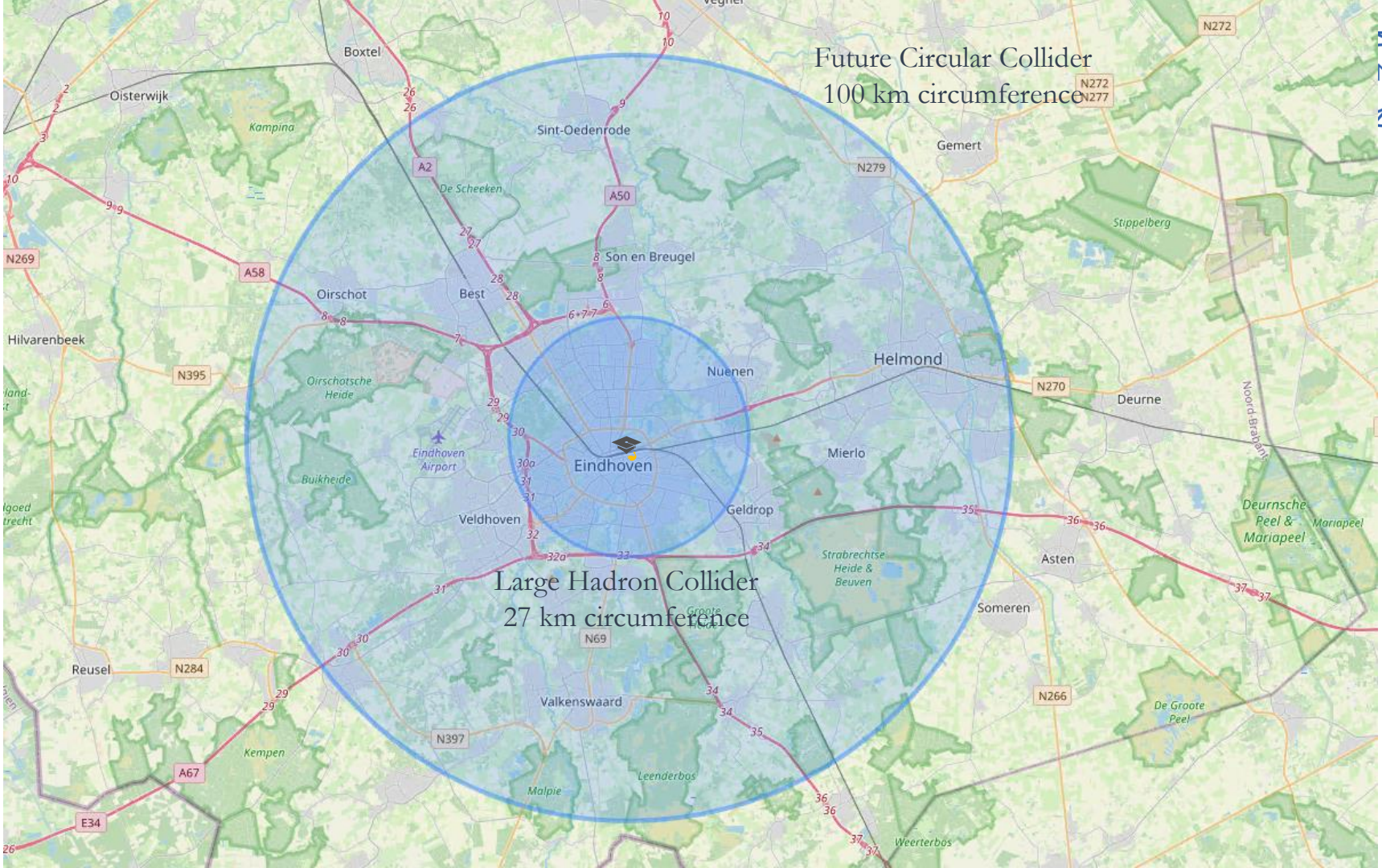
1949

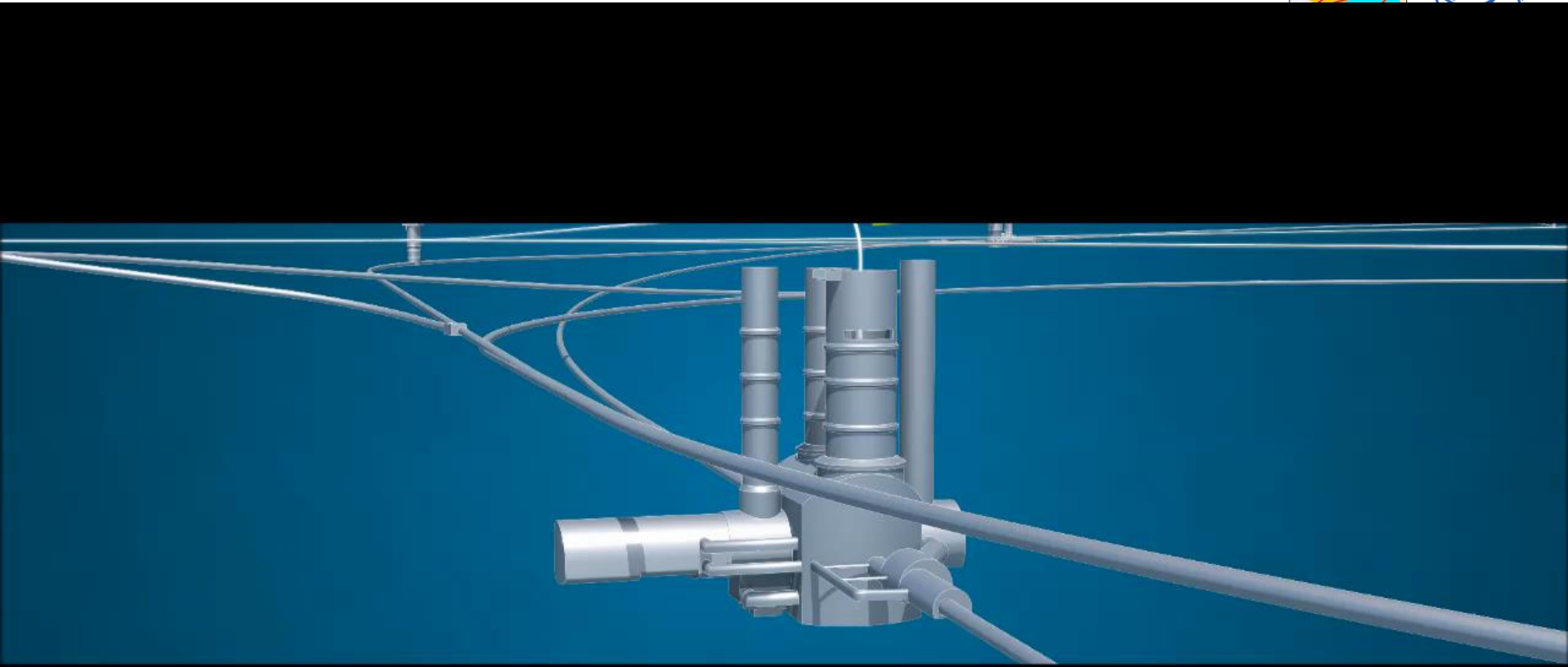
CERN today

Today CERN has 23 Member States: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovak Republic, Spain, Sweden, Switzerland and United Kingdom.

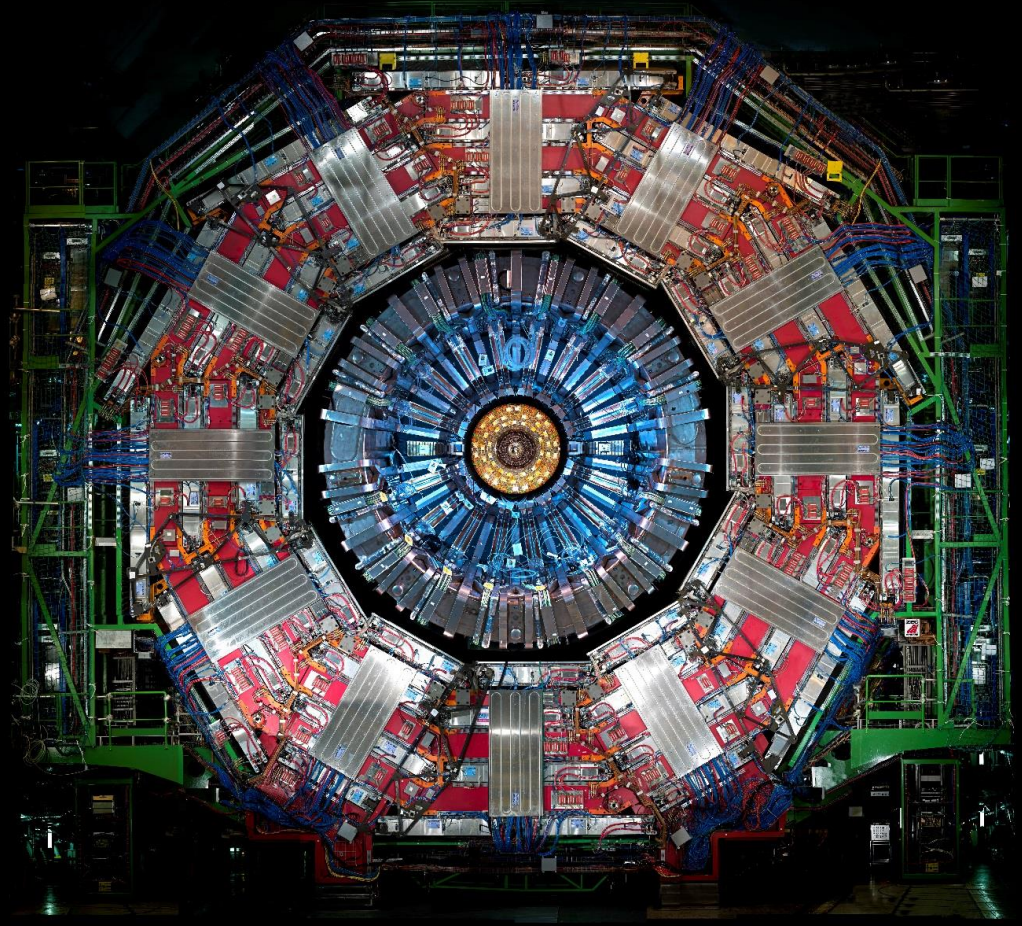
Cyprus, Estonia and Slovenia are Associate Member States in the pre-stage to Membership.

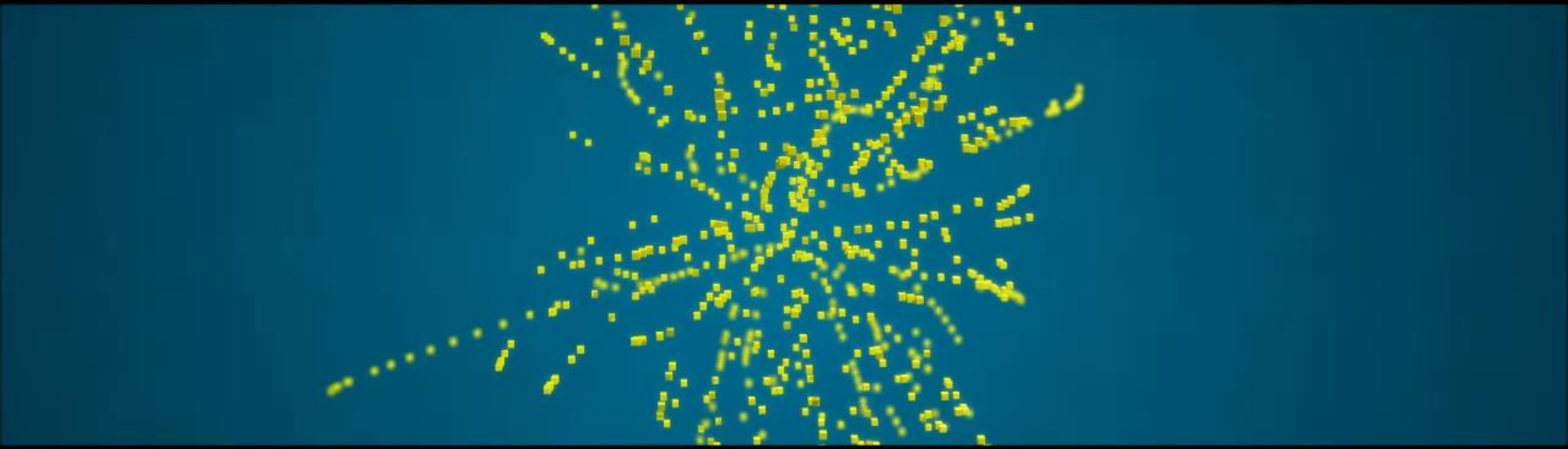
Croatia, India, Lithuania, Pakistan, Turkey and Ukraine are Associate Member States.


Future Circular Collider
100 km circumference
Large Hadron Collider
27 km circumference
Eindhoven
Helmond
Boxtel
Oisterwijk
Sint-Oedenrode
Son en Breugel
Oirschot
Best
Hilvarenbeek
Nuenen
Mierlo
Geldrop
Veldhoven
Asten
Someren
Deurne
Gemert
Reusel
Valkenswaard
Eindhoven Airport
Kampina
De Scheeken
Stippelberg
Oirschotsche Heide
Buikheide
Strabrechtse Heide & Beuven
Deurnsche Peel & Mariapeel
De Groote Peel
Kempen
Malpie
Leenderbos
Weerterbos
A2
A50
A58
A67
E34
N269
N272
N277
N279
N395
N270
N69
N284
N397
N266



Tier 0

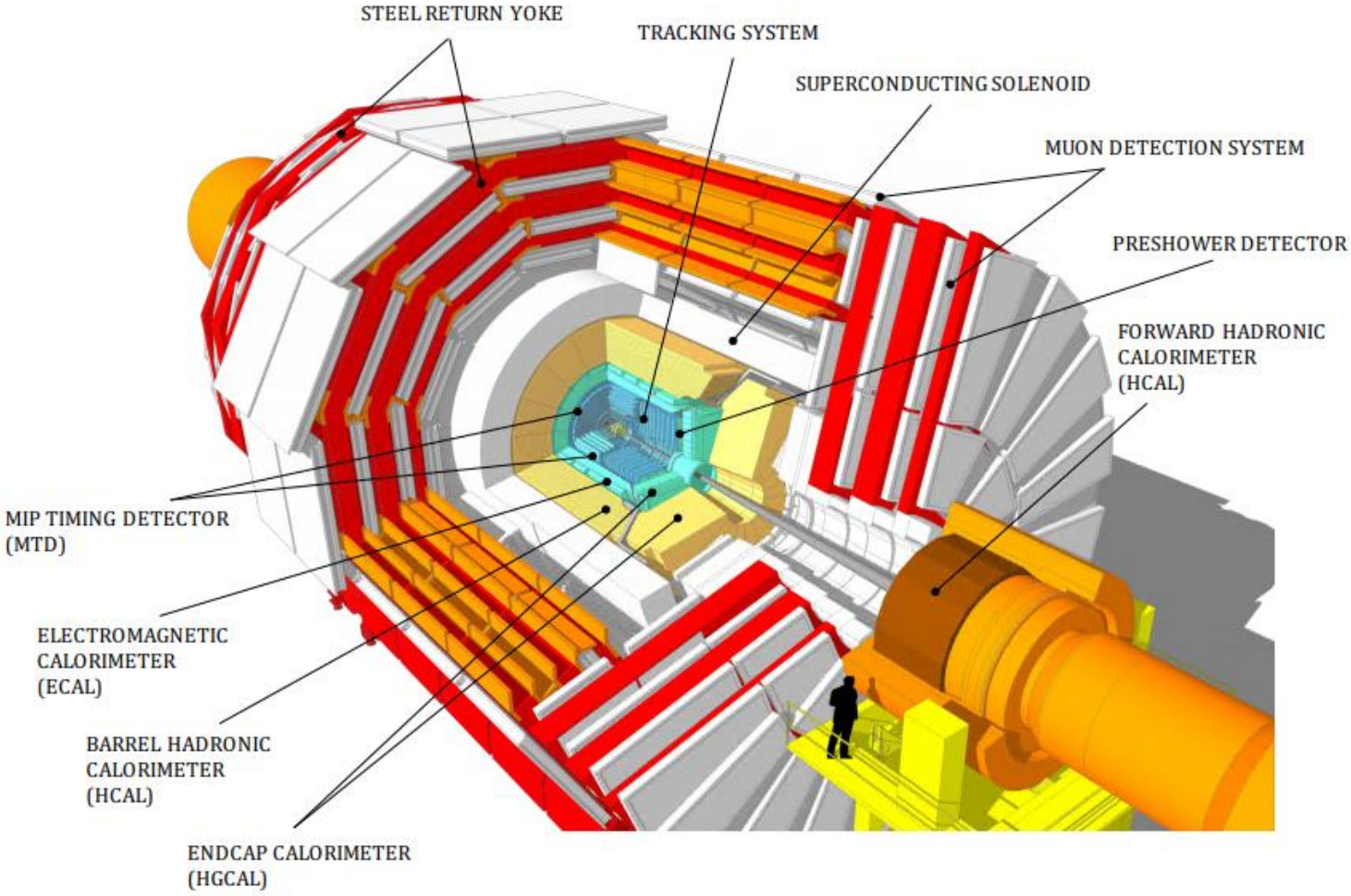


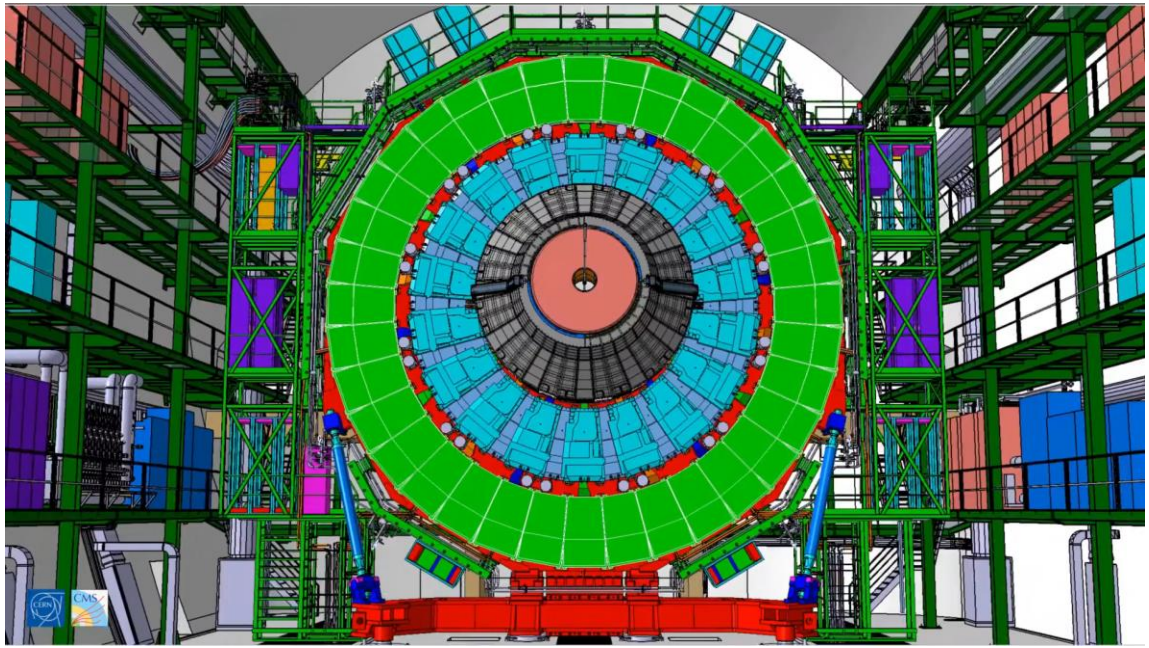


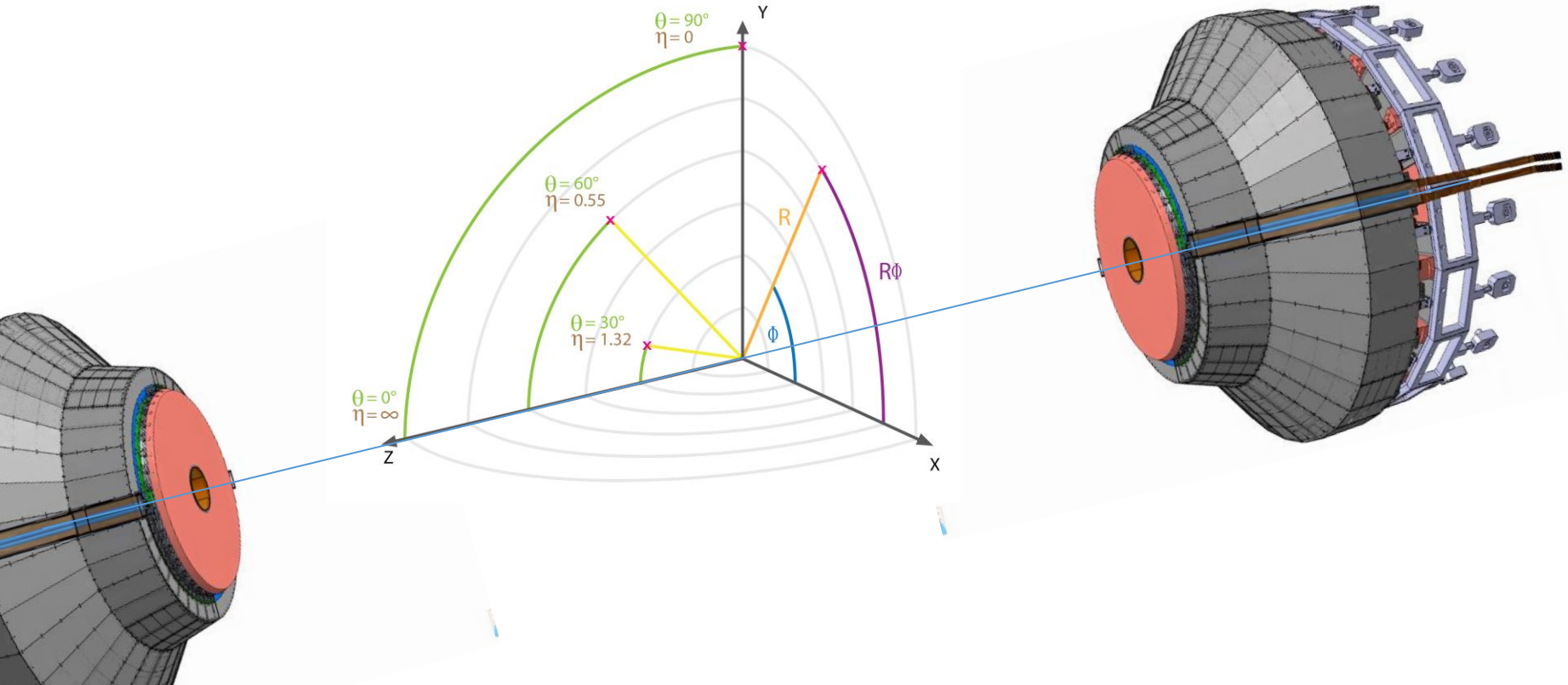
Events / GeV
4500
4000
3500
3000
2500
2000
1500
1000
500
Data
Backgrou
Data - Fit
200
0
-200
100
110
120
130
800
GeV]

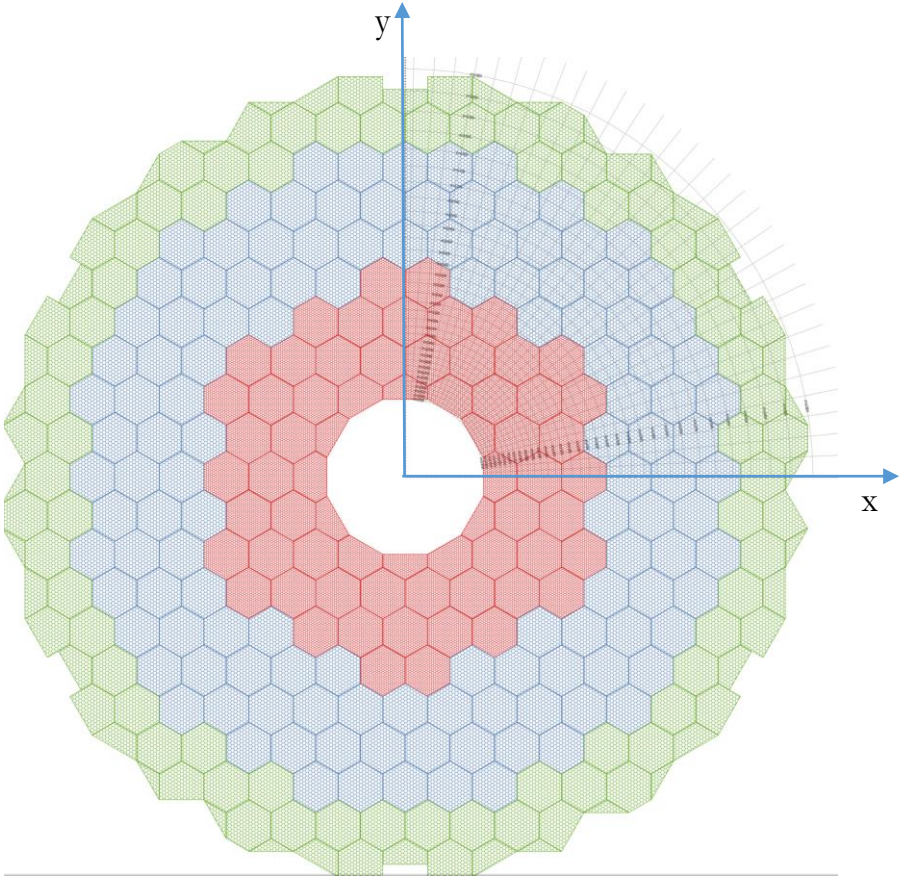
The Hackathon

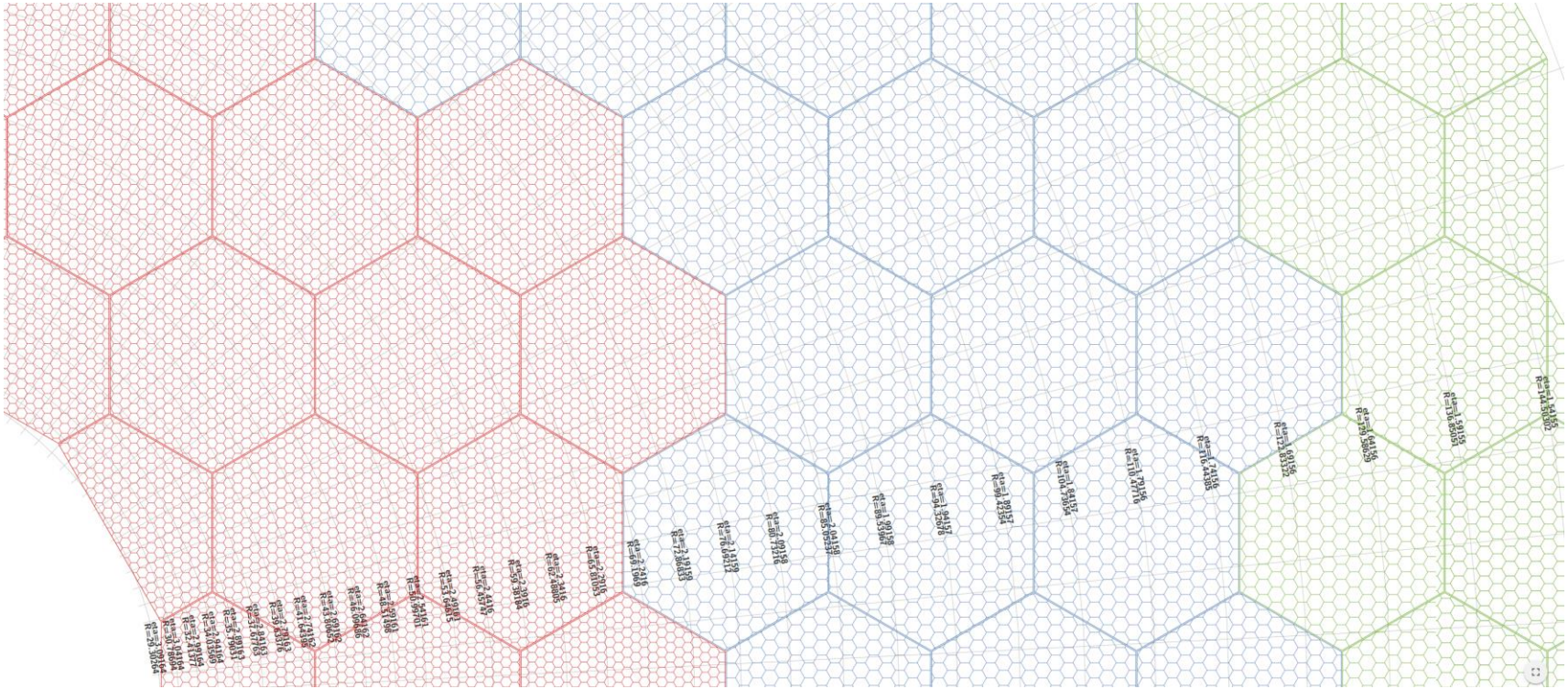
The Phase-2 CMS detector



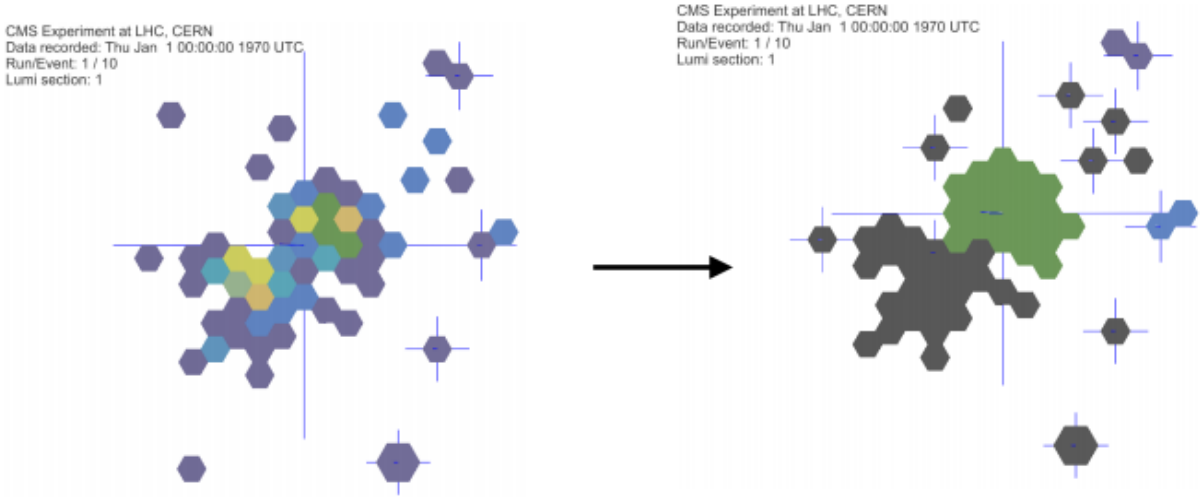



θ = 90°
η = 0
θ = 60°
η = 0.55
θ = 30°
η = 1.32
θ = 0°
η = ∞
Y
Z
X
R
Rϕ
ϕ

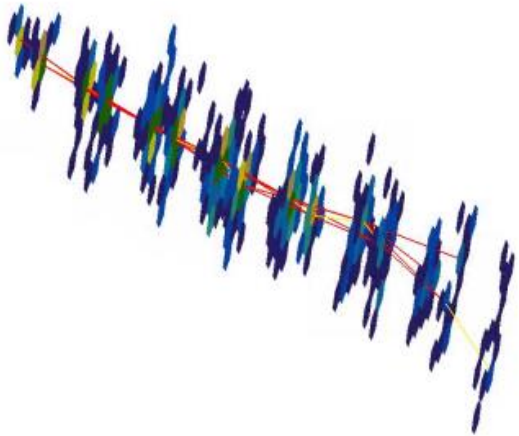

y
x



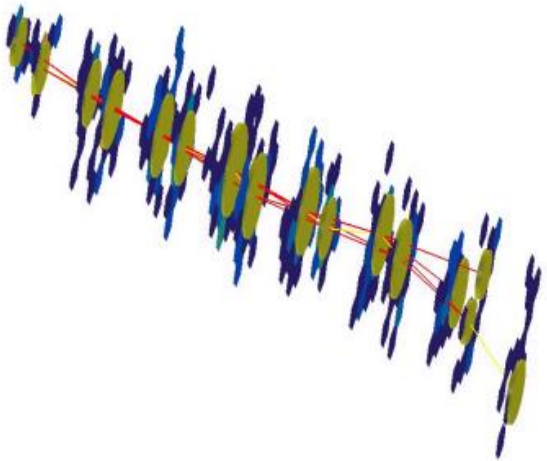
Layer Clusters



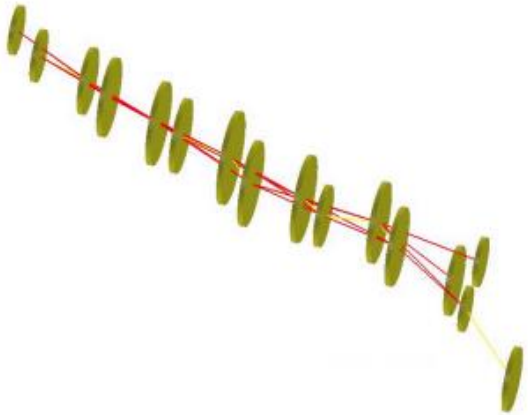
A pattern recognition to rule them all



A pattern recognition to rule them all



A pattern recognition to rule them all



Input dataset

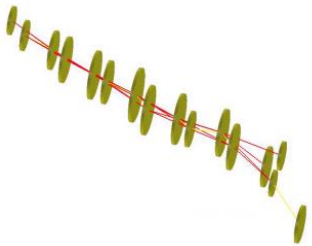
Layerclusters (lc) to be linked together in a 3d trackster

Input dataset would look like:

lc_id	pos_x	pos_y	pos_z	layerId	Energy	time	eta	phi	truth_TracksterIDs	fractions
5	11.4	88.3	327.1	18	20	5	1.8	2.7	<2,17,19>	<0.3,0.4,0.3>

The truth is out there!

You will have the truth information as SimTracksters together with the true fractions



Expected output

Assign each layercluster in input to at most 3 tracksters with a fraction of the energy

lc_id	Reconstructed trackster ids	Reconstructed fractions
5	<2,17,19>	<0.3,0.4,0.3>

You can start with a one-to-one association between layerclusters and tracksters

The challenge

- You have until Wednesday 14/07 at 8am to submit a solution
- We will execute your solution on Wednesday morning over an evaluation dataset and produce a score for each of the proposed solutions
- On Wednesday afternoon you will be asked to present your solution with what you think are its pros and cons, together with some “future possible improvements”
- Winners will be announced on Wednesday at 4pm

The CERN team

Leonardo Cristella

Senior Applied Fellow at CERN

Physics analyses: B Physics

Machine learning techniques for event reconstruction

Particle shower reconstruction in HGCal, Computing+Data Management

Loukas Gouskos

Staff Physicist at CERN

Physics analyses: Higgs measurements and searches for new physics

Jet physics particularly with the deployment of Machine learning techniques

CMS Upgrades towards High-Luminosity LHC: High Granularity Calorimeter (HGCal) focusing on the particle shower reconstruction

Future experiments: FCC-hh/ee

Benedikt Maier

Senior Research Fellow at CERN

Physics analyses: searches for dark matter and dark interactions

Machine learning techniques for event reconstruction

Particle shower reconstruction in HGCal, Computing+Data Management

Felice Pantaleo

Staff Physicist at CERN

Pattern Recognition and Algorithms

Heterogeneous computing and Performance Portability

Quantum Computing

Huilin Qu

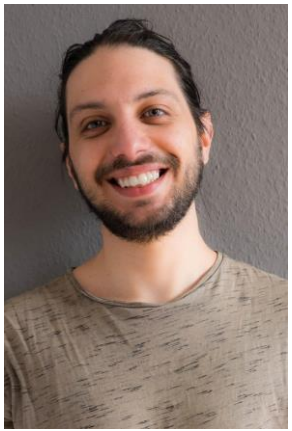
Senior Research Fellow at CERN

Physics analyses: Higgs measurements and searches for new physics

Jet physics particularly with the deployment of Machine learning techniques

CMS Upgrades towards High-Luminosity LHC: High Granularity Calorimeter (HGCal) focusing on the particle shower reconstruction

Wahid Redjeb



- PhD at RWTH in collaboration with CERN
- Software development for High Energy Physics
- CMS High Granularity Calorimeter (HGCal) particle shower reconstruction
- Heterogeneous Computing

Marco Rovere

Staff Physicist at CERN

Pattern Recognition and Algorithms

Heterogeneous computing and Performance Portability

Support during hackathon

Some of us will be always connected during the hackathon to provide support

A mattermost team was created
https://mattermost.web.cern.ch/signup_user_complete/?id=by1b4s3ap3fobbbcekyyymobse

Enjoy the hacking!