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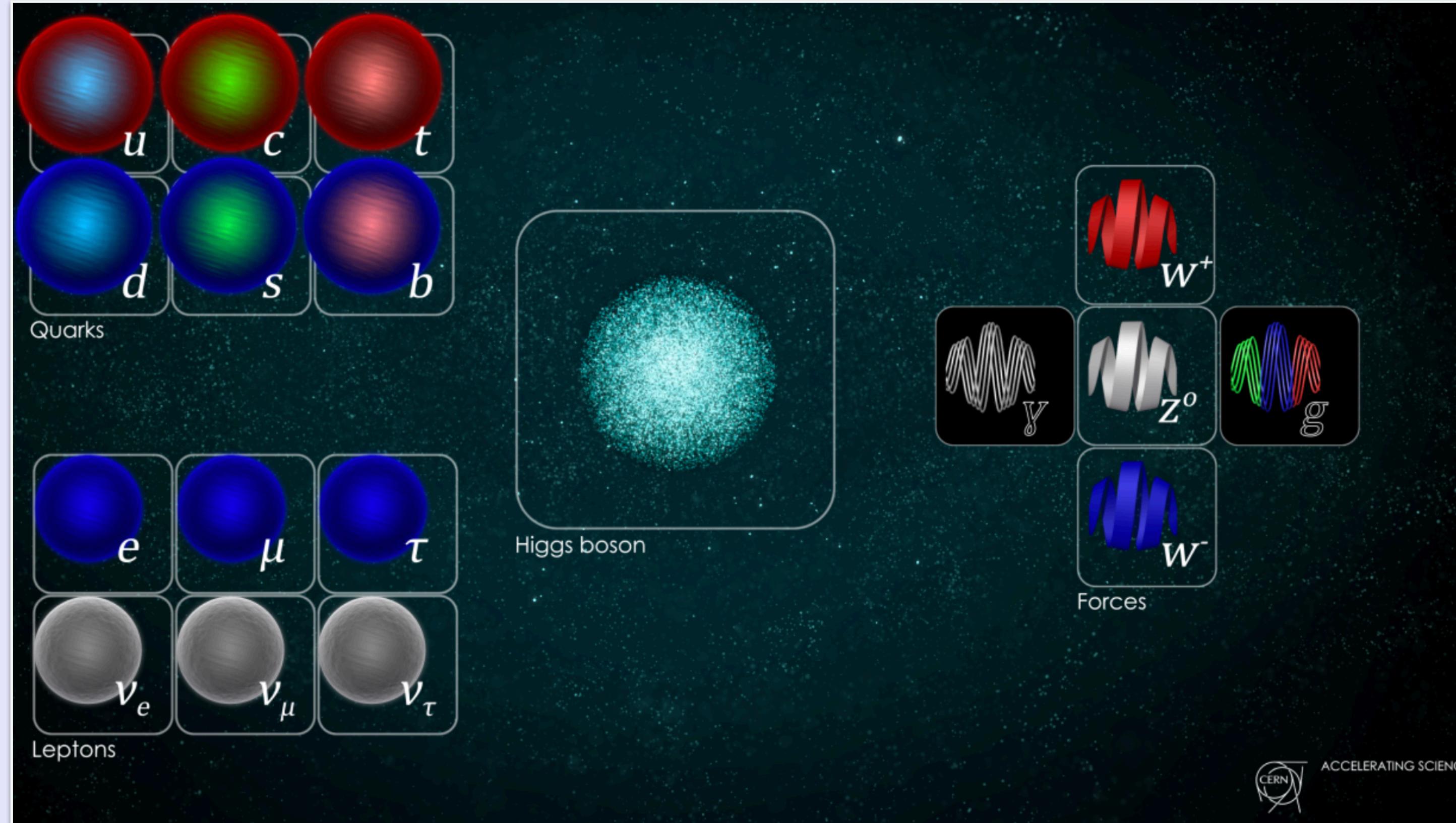
PÔLE DES HAUTES ÉNERGIES (PHE)

Felicia Volle,

Fresher's day 2021,

03/11/2021

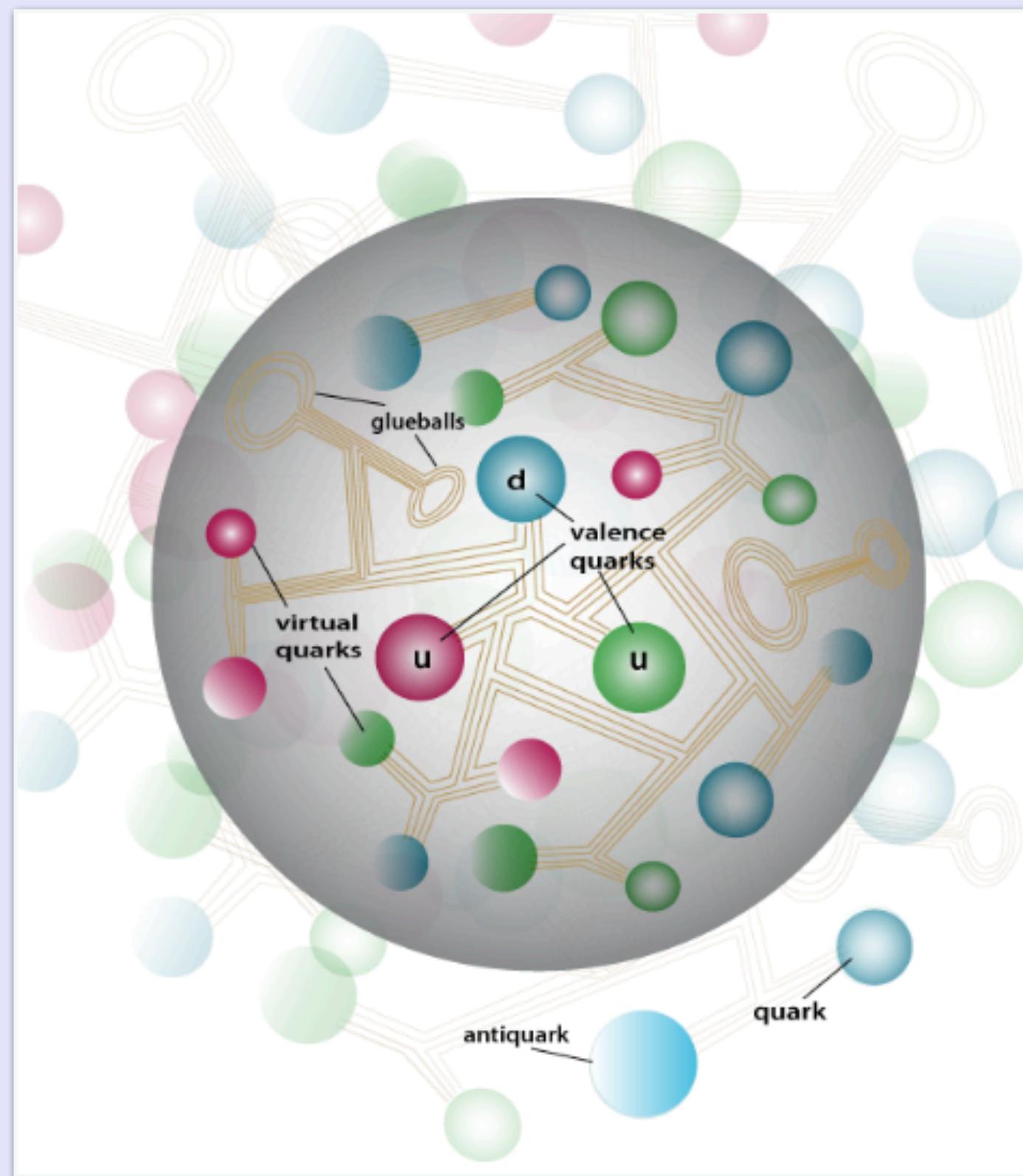
THE STANDARD MODEL OF PARTICLE PHYSICS (SM)



- study of elementary particles
 - quarks & leptons
- study of fundamental forces :
 - strong
 - weak
 - electromagnetic
 - (gravitational)
- Higgs-boson

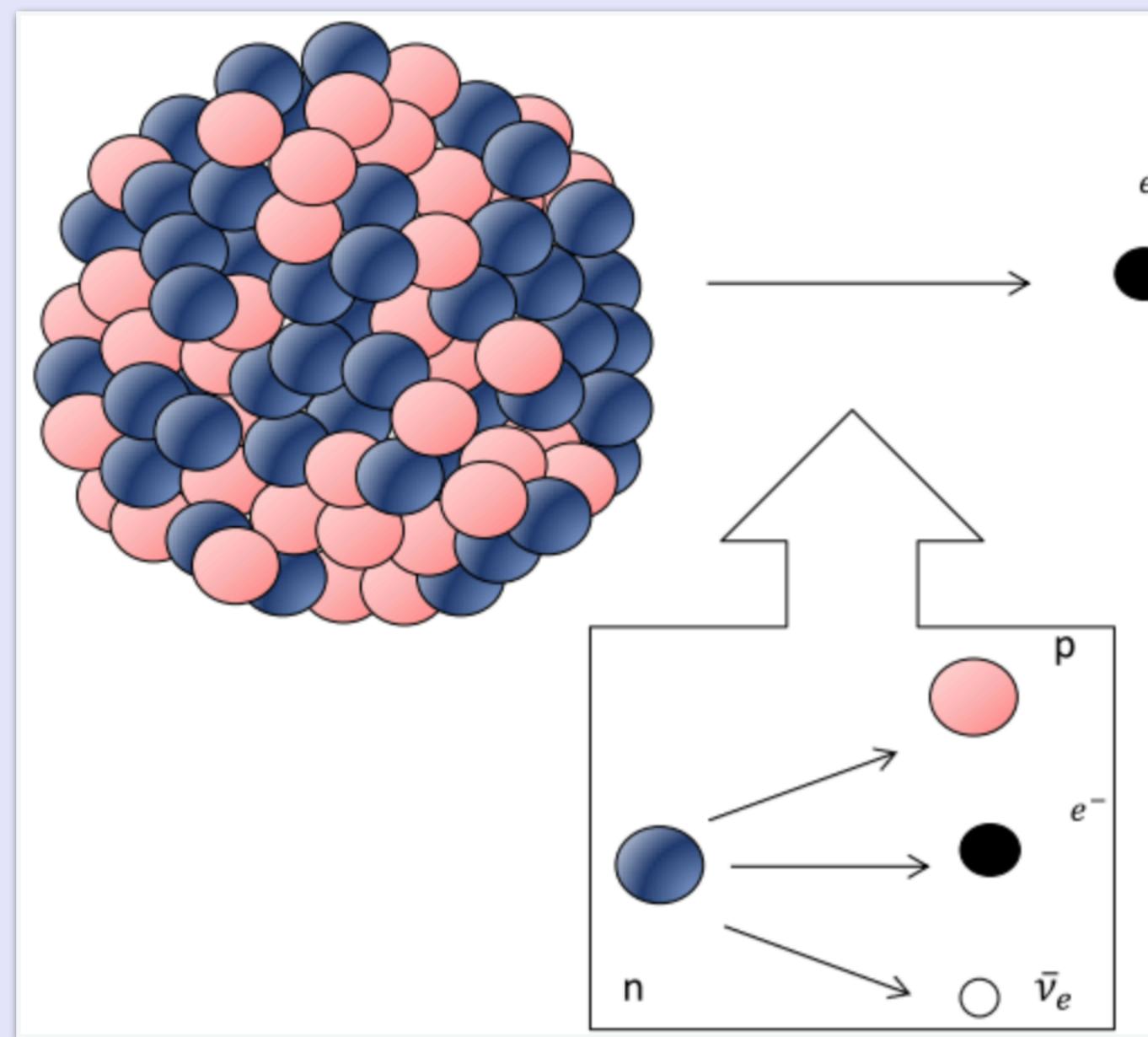
THE FORCES

strong force



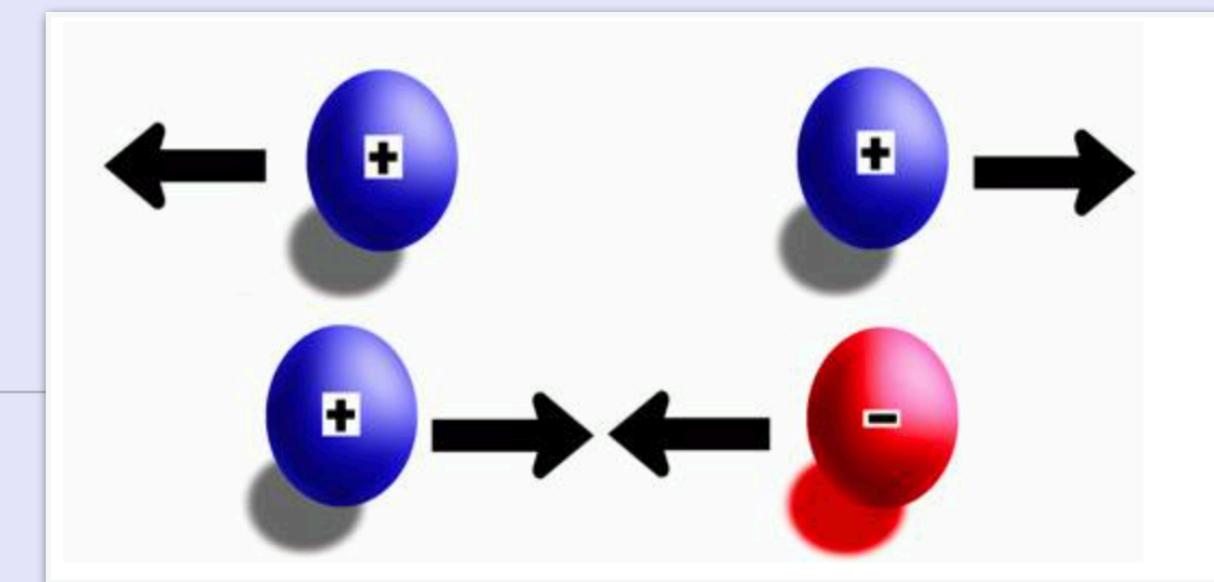
Credit: Alex Dzierba, Curtis Meyer and Eric Swanson

weak force



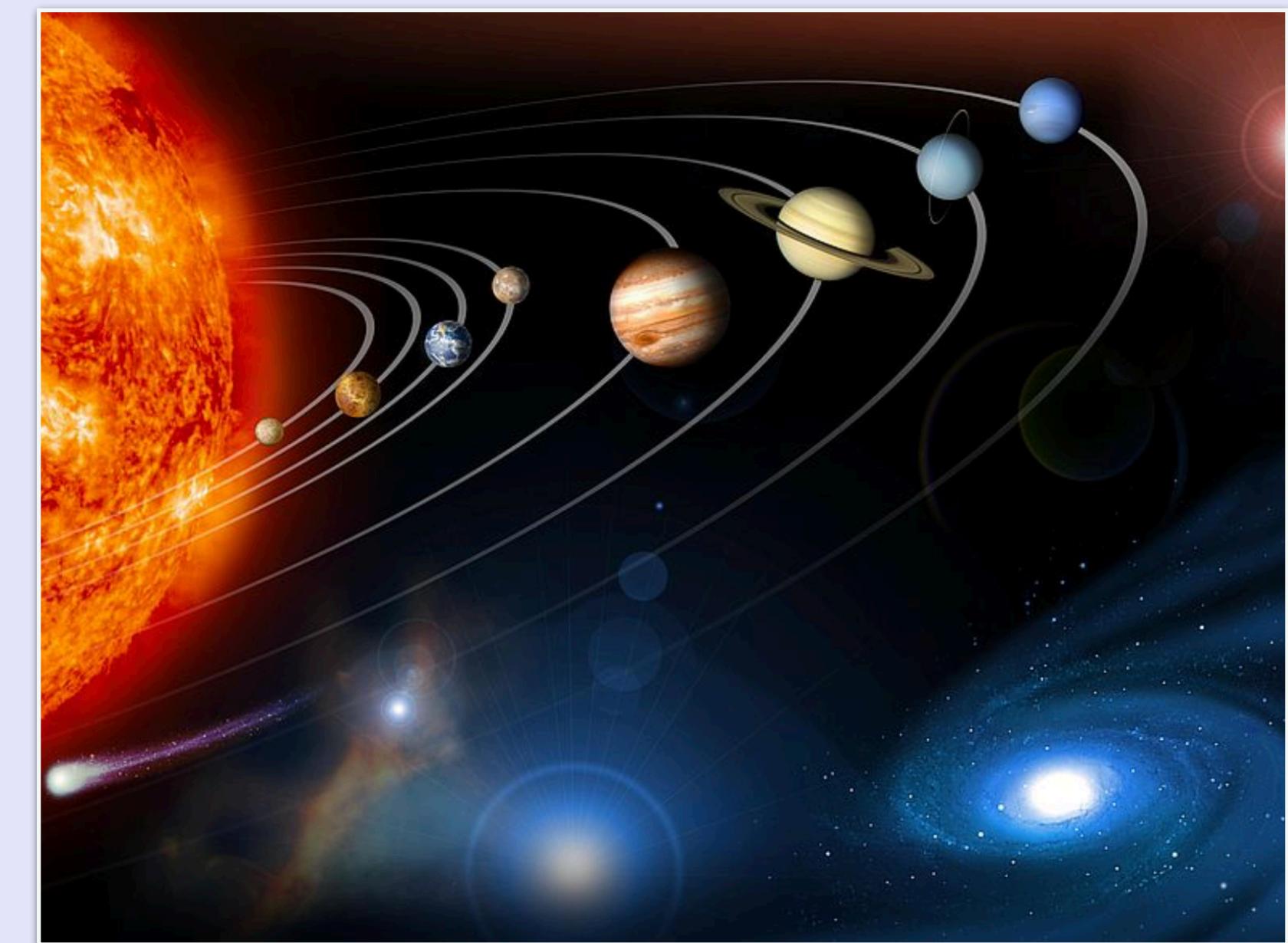
<https://www.abiweb.de/physik-atomphysik-kernphysik/kernphysik-1/radioaktivitaet/beta-zerfall.html>

electromagnetic force



<https://qsstudy.com/physics/electromagnetic-force>

gravitational force



NASA/JPL 2008

UNSOLVED PROBLEMS IN THE SM

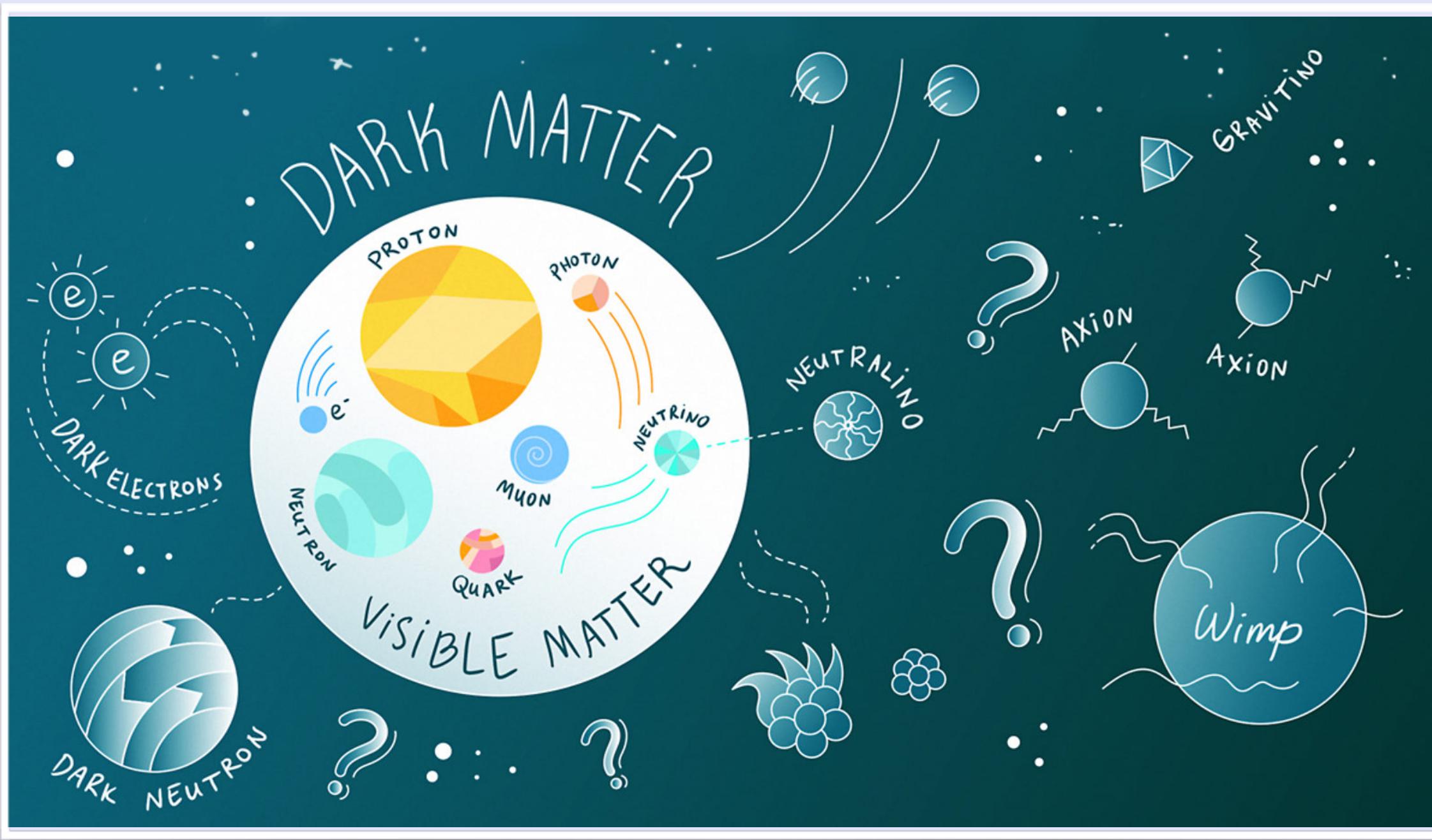


Illustration by Sandbox Studio, Chicago with Ana Kova

- Matter - antimatter asymmetry in our universe
not compatible with Big Bang and SM
- Λ CDM cosmology model : universe is composed
of 27% Dark matter & 68% Dark energy
- ν -oscillation
- Why ν mass so small ?
- Why 3 generations ?

Better understanding of the SM and search for New Physics (NP) is essential

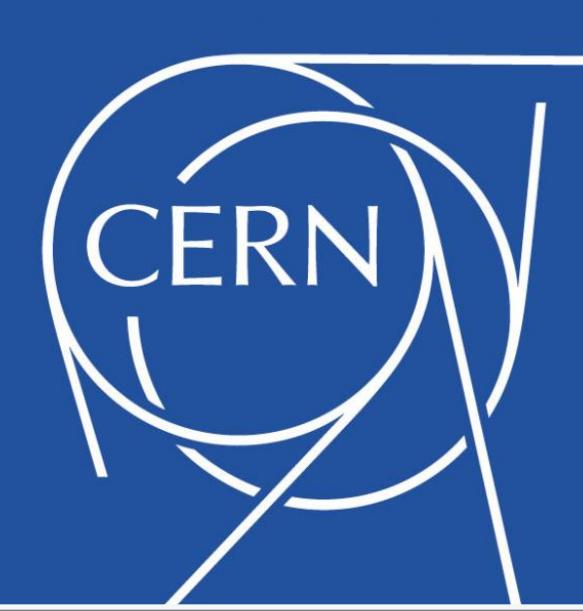


PHE PÔLE AT IJCLAB

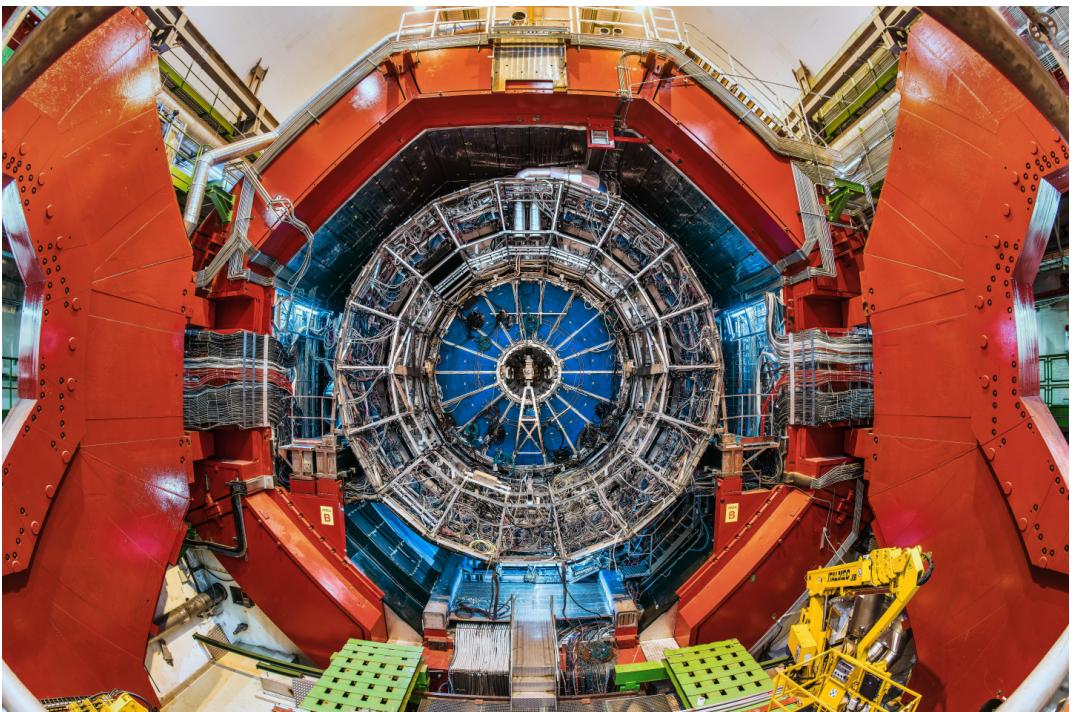


DISCLAIMER : This presentation aims to give a short overview about the research activities at the IJCLab, but it should not be taken as a complete list !

LARGE HADRON COLLIDER AT CERN

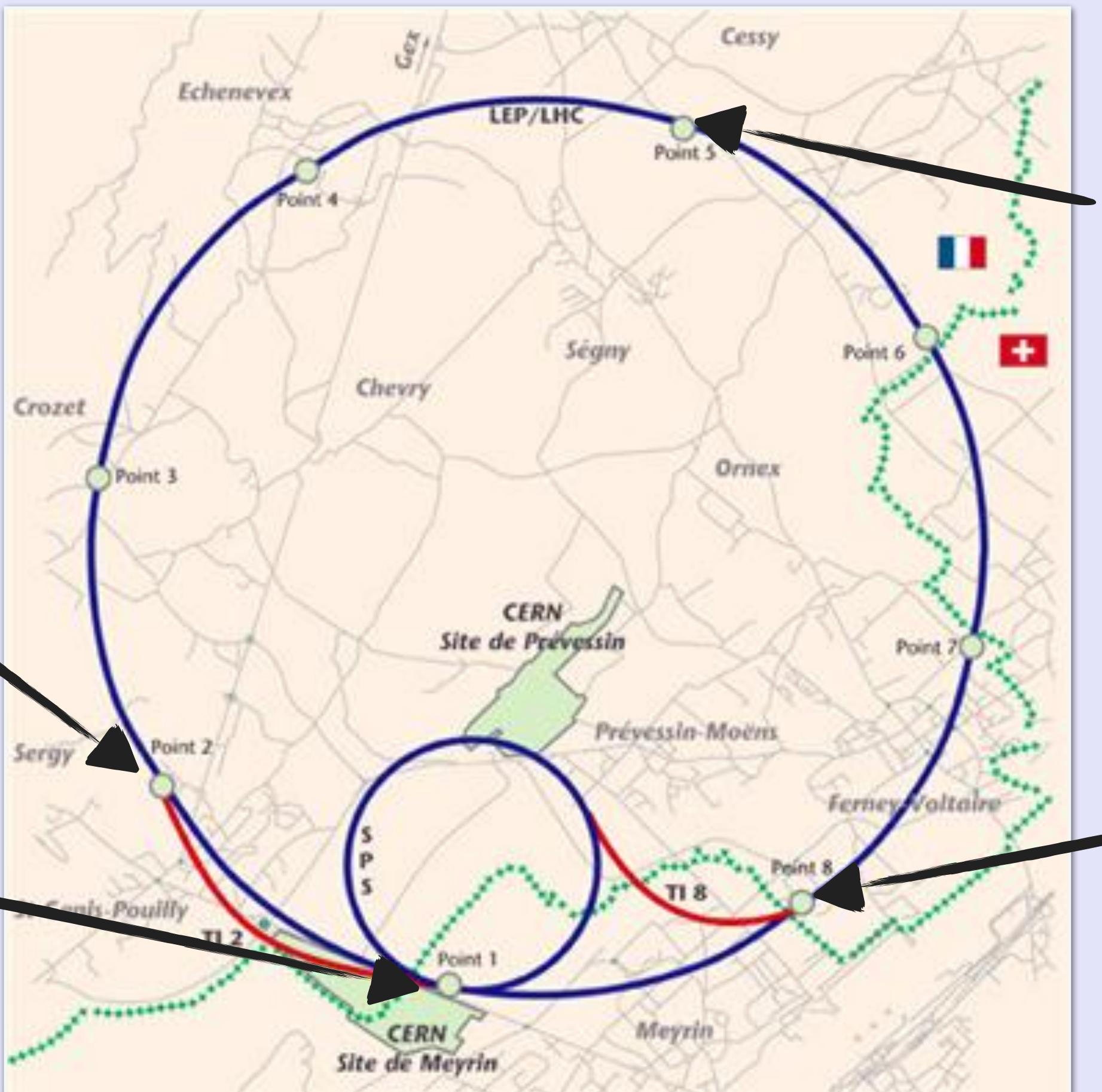
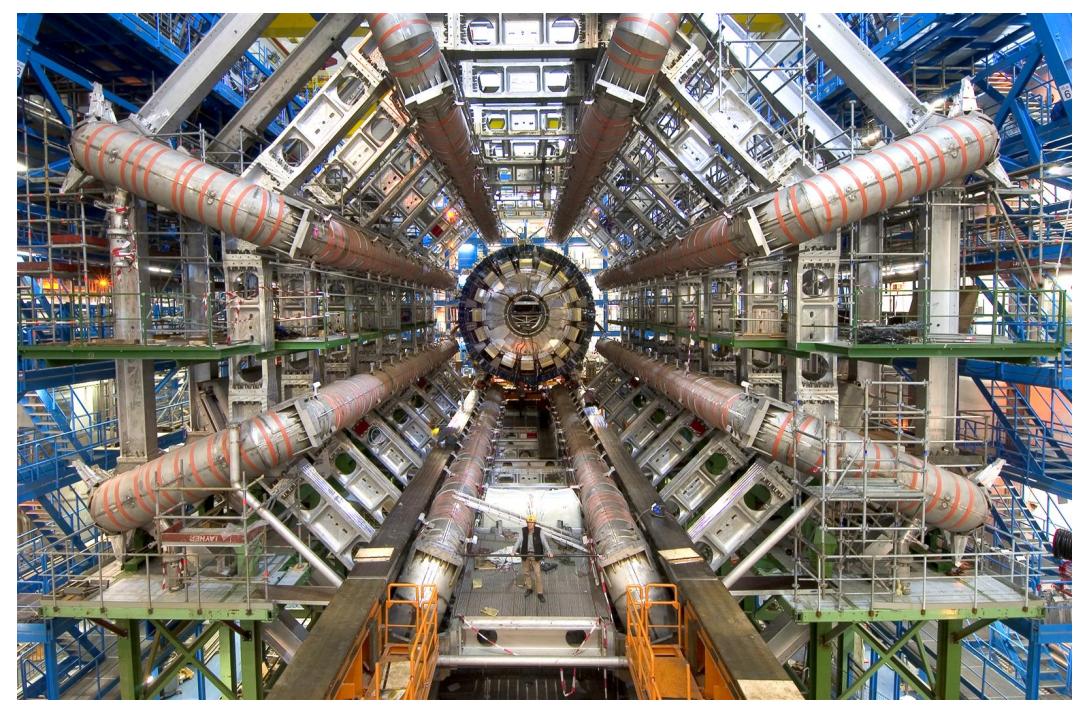


ALICE experiment



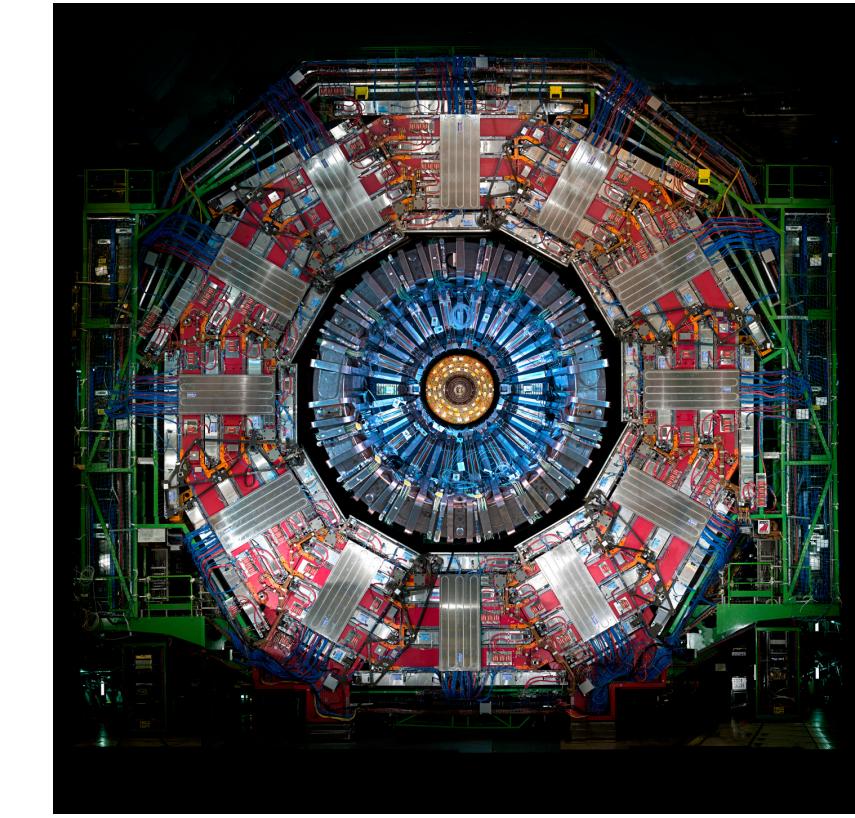
<https://cds.cern.ch/images/CERN-PHOTO-201901-004-4>

ATLAS experiment



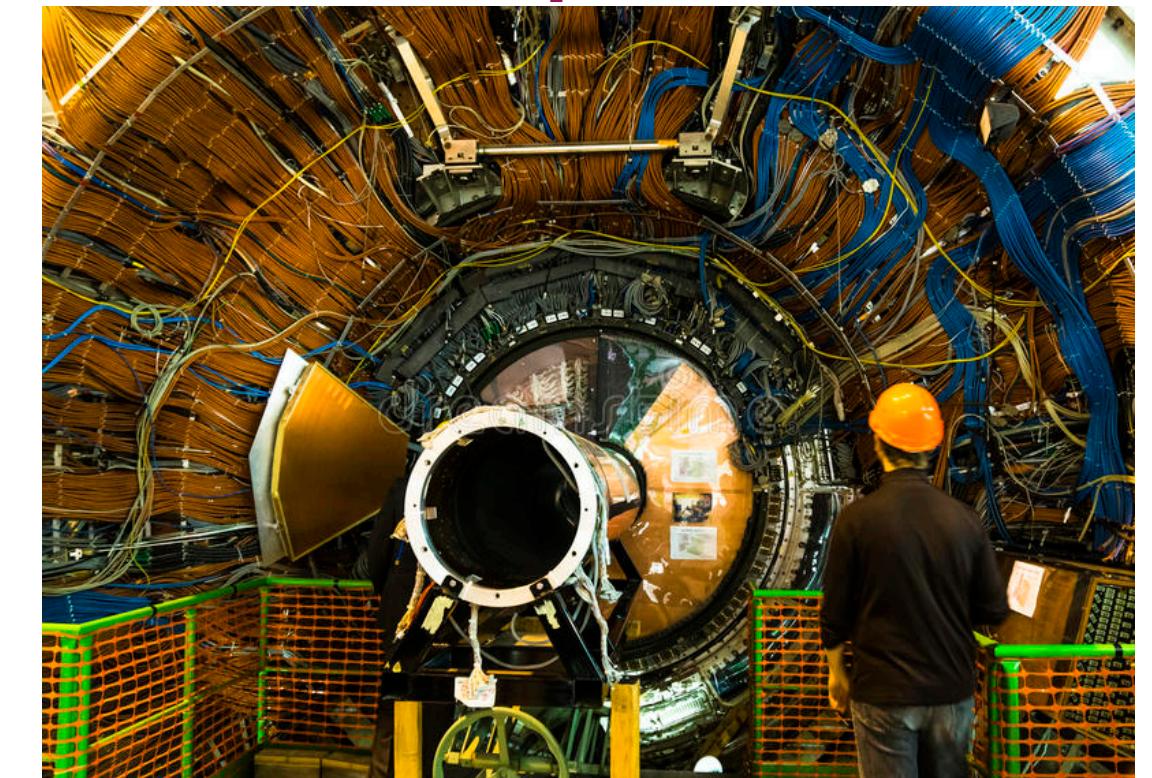
<https://peda.net/hankkeet/c/esittely2/kuvia-genevestä/transfer-tunnels>

CMS experiment



CERN

LHCb experiment

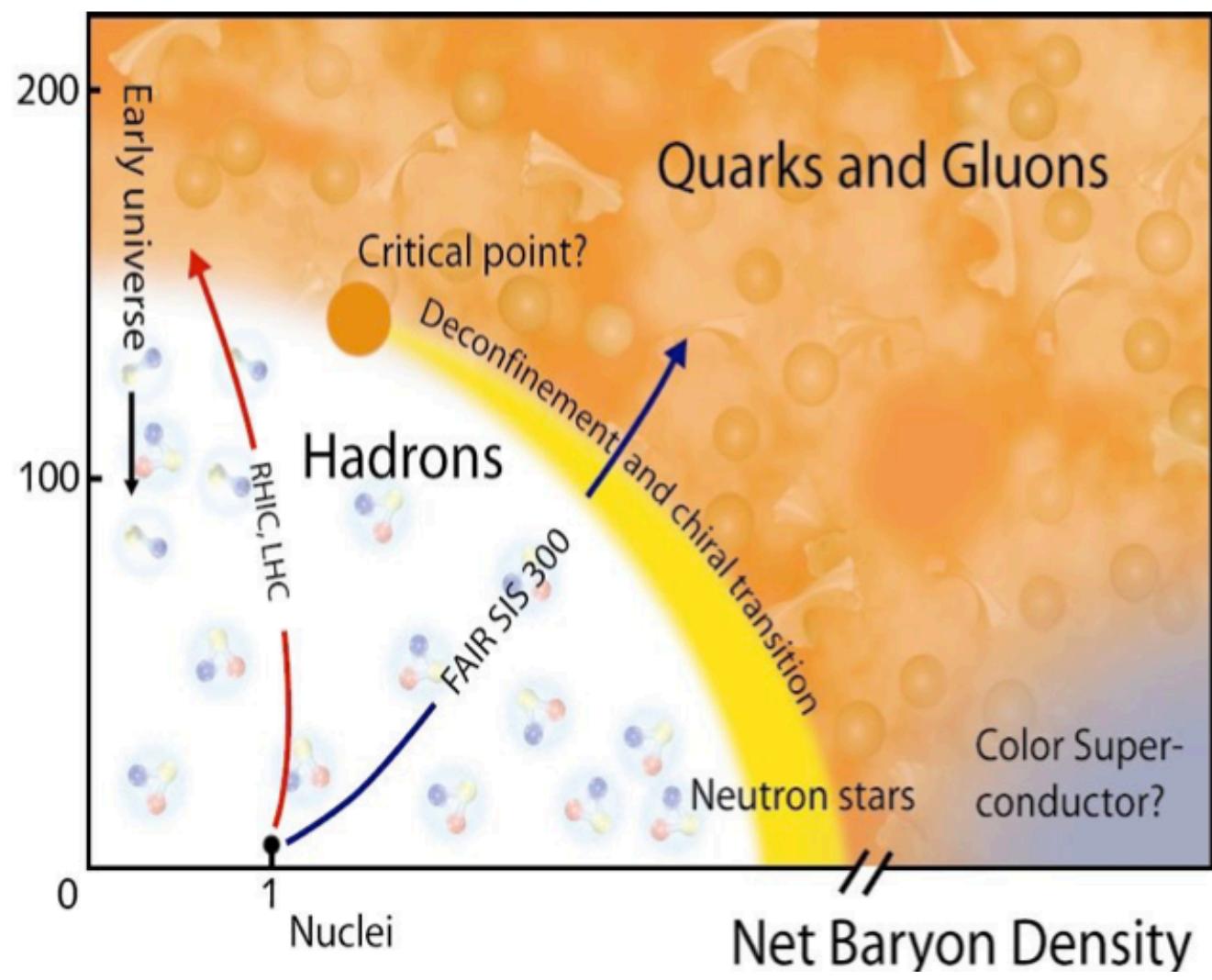


<https://de.dreamstime.com/lizenzfreie-stockfotografie-lhc-detektor-cern-gen-image33990607>

ALICE experiment



Quark-gluon plasma, Detector Upgrade



ATLAS experiment



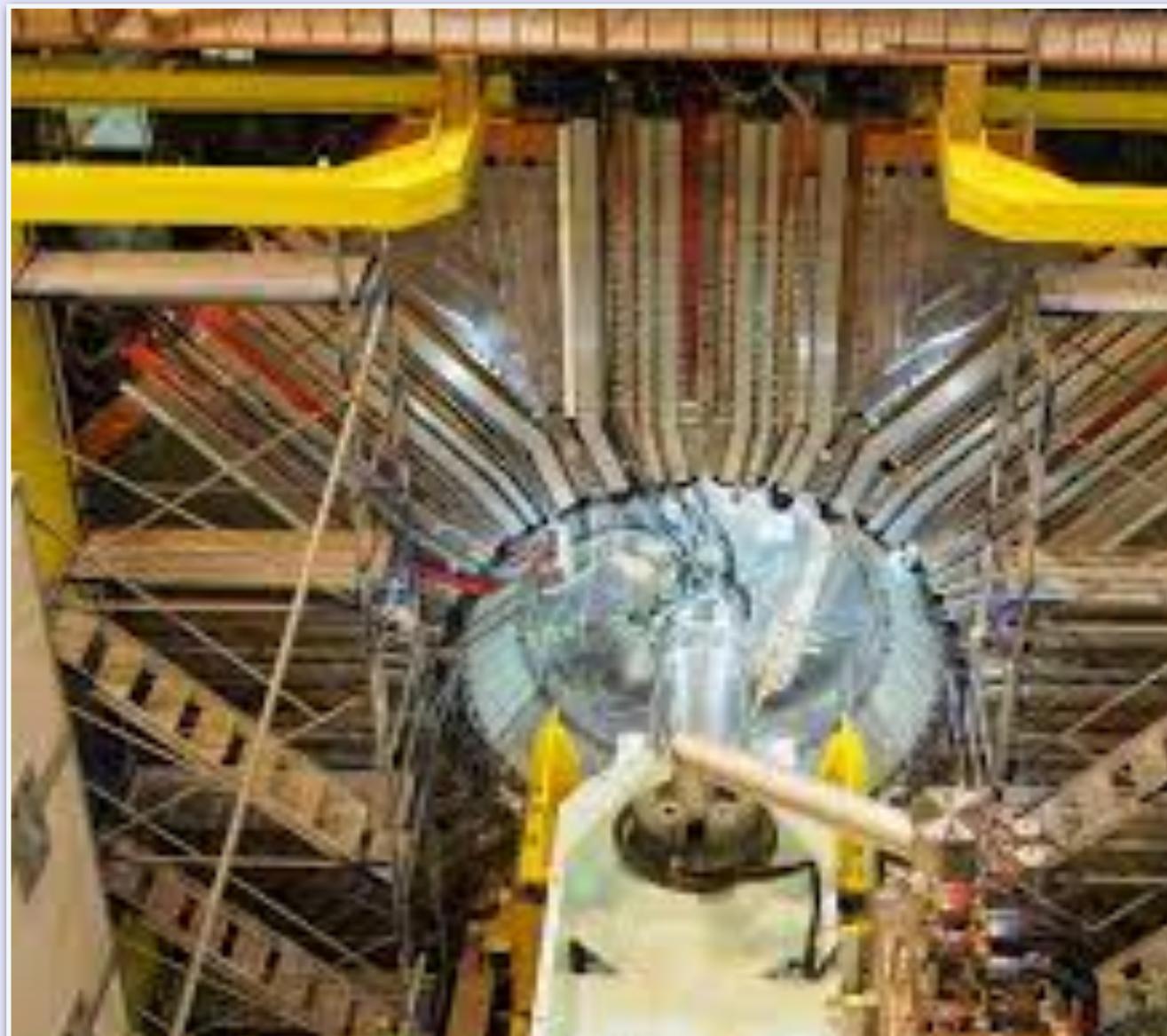
- LAr Calorimeter
- Detector performance
- Higgs-boson and its properties
- SM precision measurements (f.ex. W -mass)
- Search for NP

LHCb experiment



- Calorimeter electronics + L0 hardware trigger
- Online coordination
- Luminometer Plume
- Indirect searches of NP
- Precise measurement of CKM angle γ
- Measurement of heavy flavor productions

BELLE 2 AT SUPERKEKB



[https://commons.wikimedia.org/wiki/File:KEK_Belle_II_Detector_\(2\).jpg](https://commons.wikimedia.org/wiki/File:KEK_Belle_II_Detector_(2).jpg)

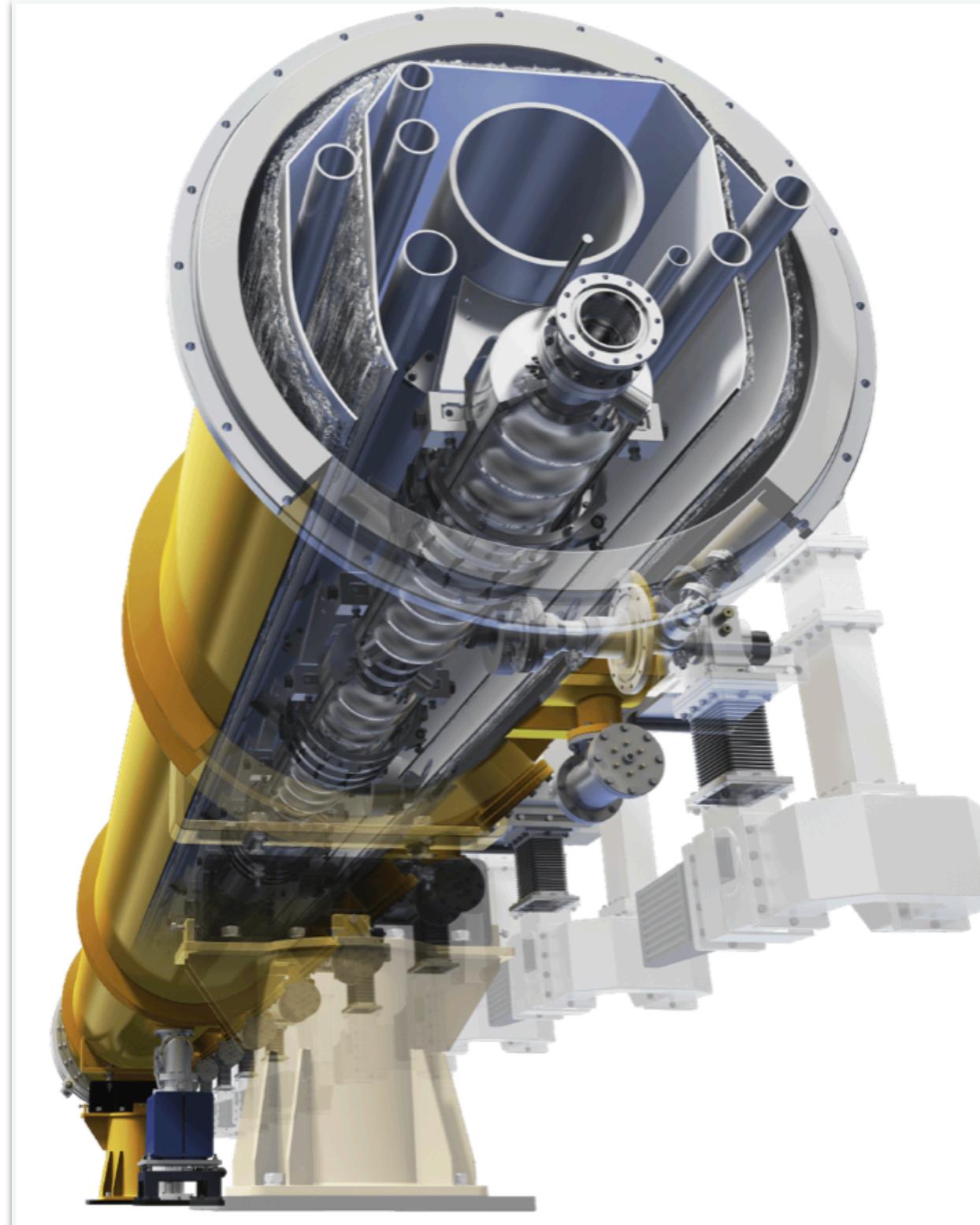


https://www.researchgate.net/figure/Layout-of-SuperKEKB-at-the-KEK-Tsukuba-campus_fig1_311780507

- DAQ upgrade + Belle 2 fast luminometer
- rare/forbidden decays of B-mesons
- rare/forbidden decays of τ -leptons
- Quality assurance monitoring
- Optimizing code reconstruction

Future collider experiments

ILC - INTERNATIONAL LINEAR COLLIDER



<https://linearcollider.org>



- Future e^+e^- - collider
- Development studies to optimise ILC
- Goal is test of Higgs-boson with a linear collider

FCC - FUTURE CIRCULAR COLLIDER



- ~100km circular collider at CERN



- Sensitivity studies for b-, τ -, Higgs-physics
- Calorimeter design
- FCC-ee runs at Z-peak, ZZ-, WW-, $t\bar{t}$ -threshold

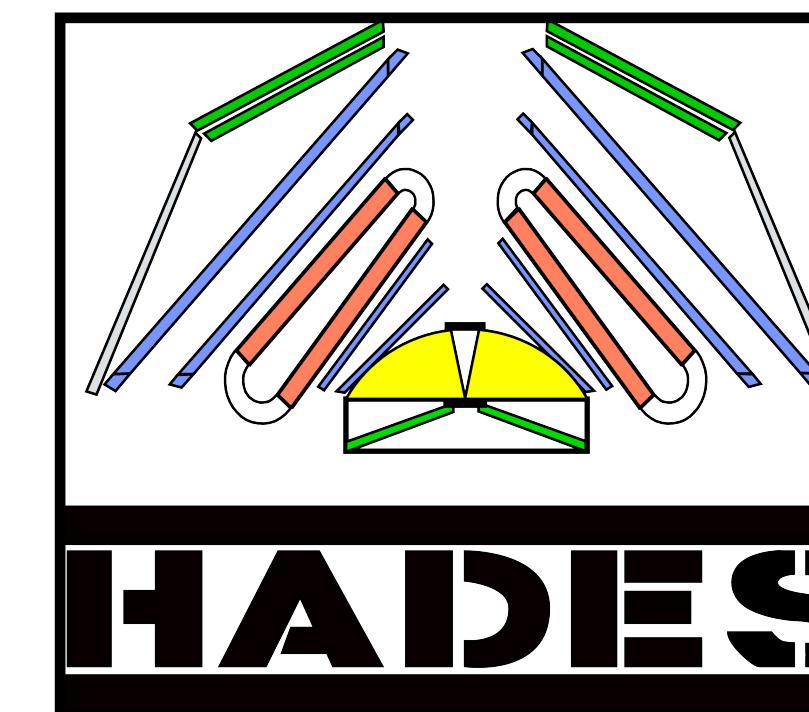
Experiments to study the nucleons and hadrons

Jefferson Lab

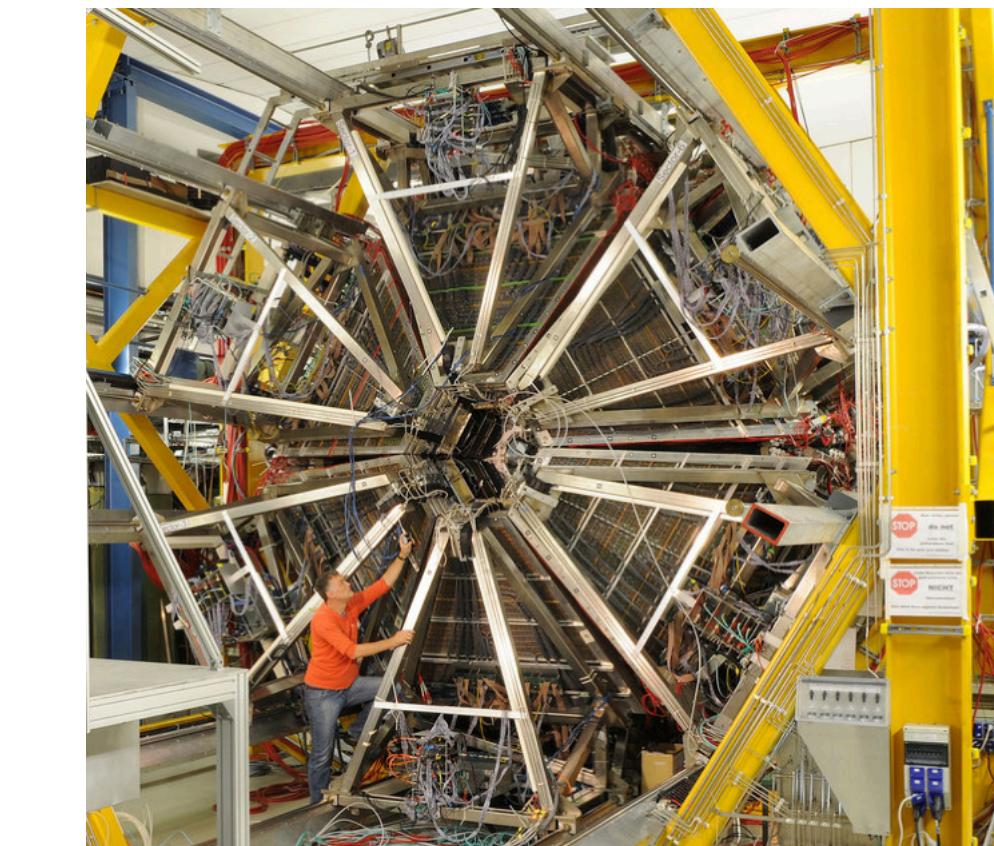


University of Richmond

- Study of nucleon structure
 - nucleon tomography
 - quarks angular momentum



HADES at GSI



HADES at GSI

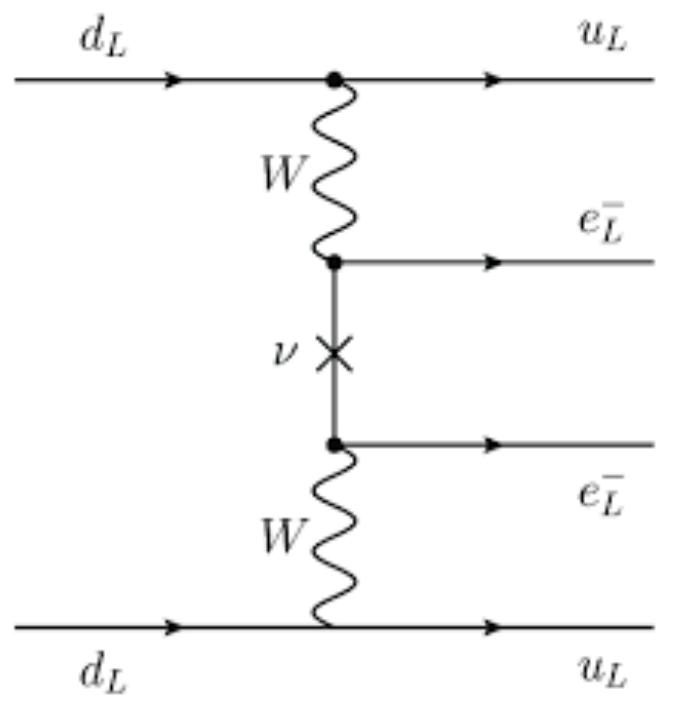
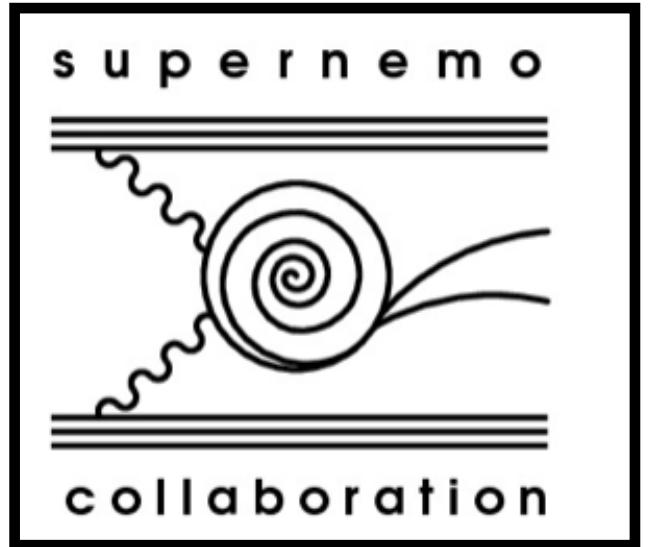


GSI Helmholtzzentrum für Schwerionenforschung GmbH

- Medium effects on the hadronic properties
- HADES detector upgrade

Neutrino experiments

SuperNemo

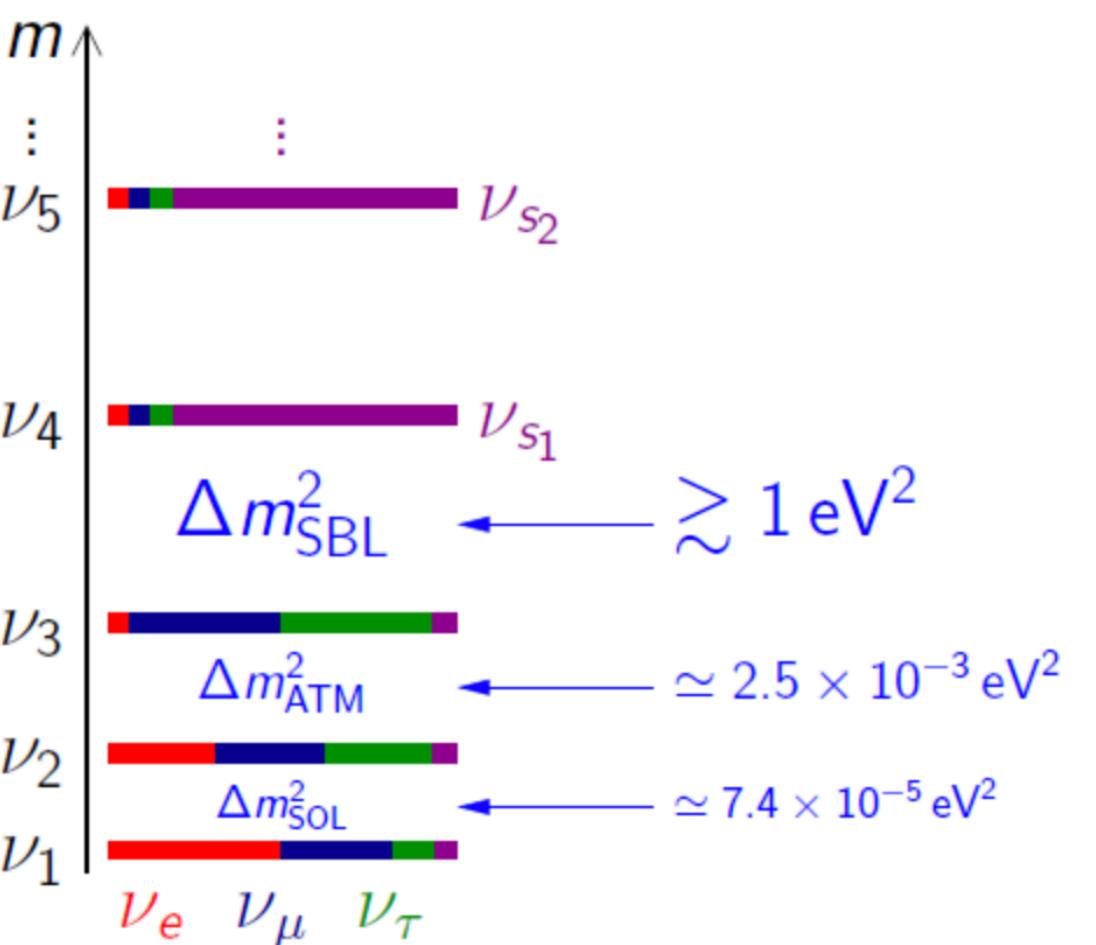


Search for
neutrinoless
double beta decay

Solid



Sterile ν 's with
nuclear reactor



<https://www.nevis.columbia.edu/daedalus/motiv/sterile.html>

JUNO



- ν -Oscillation with nuclear reactor
 - Mass hierarchy
 - $\Delta m_{21}^2, \Delta m_{32}^2$
 - Mixing angle θ_{12}
 - Dual calorimetry

DUNE



- ν -Oscillation with accelerator beam
 - Mass hierarchy
 - CP-phase δ_{CP}
 - Mixing angle θ_{23}
 - Cathode

DeLLIGHT



News IJCLab / The DeLLight experiment gives its first results

- Test of quantum theory of electromagnetism (QED) in the high field intensity region
- Measure decrease of the speed of light in vacuum by applying an intense external electromagnetic field

WIDE SPECTRUM OF RESEARCH ACTIVITIES IN HIGH ENERGY PHYSICS

« It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong. »

- *Richard P. Feynman*