Symmetry saga on LHC

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References and acknowledgements

The talk is based on materials of **ATLAS, CMS, ALICE** and **LHCb** collaborations to be found at CERN site

http://cern.ch

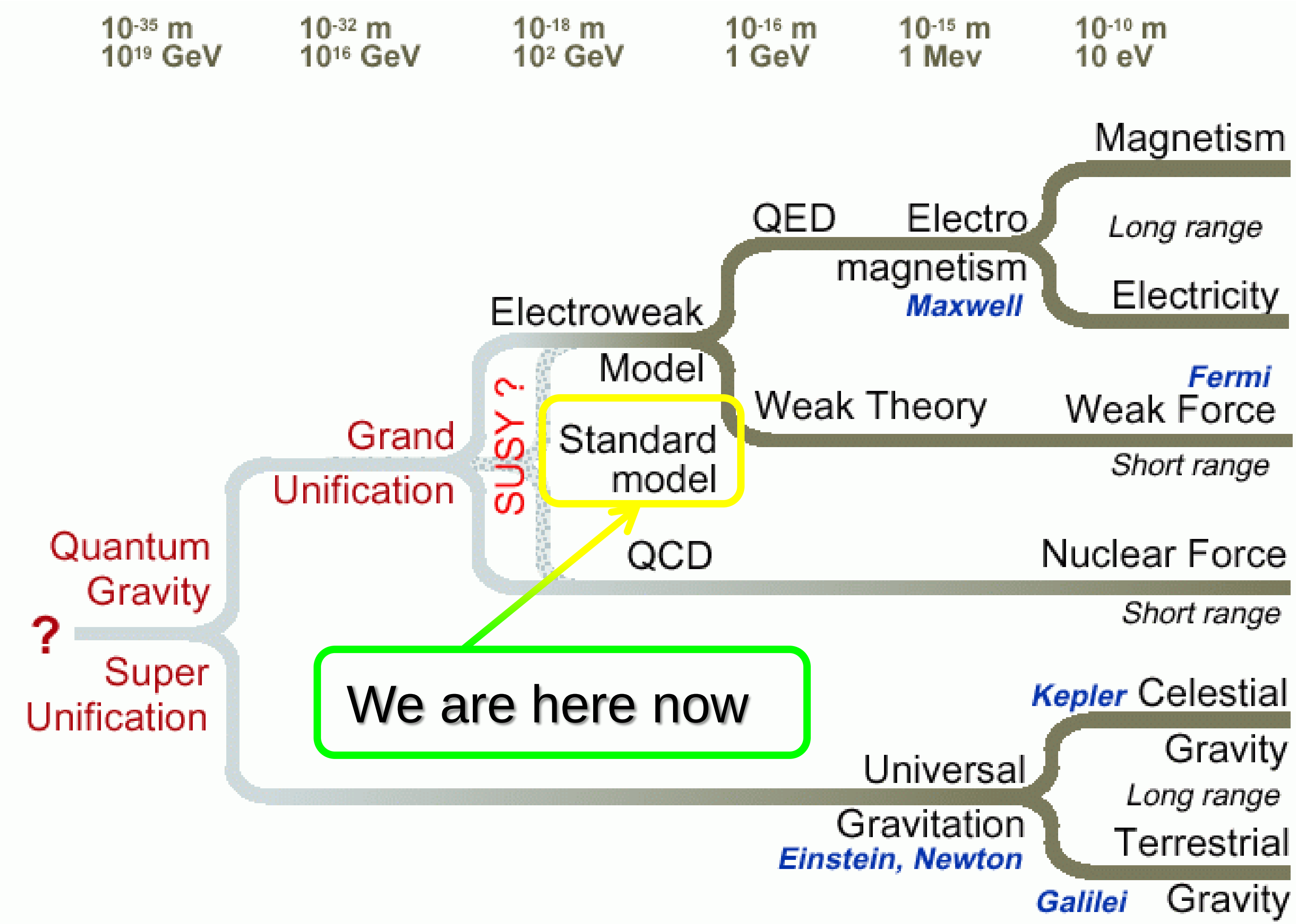
and sites of collaborations. The speaker is thankful to A.Golutvin, T.Nakada, A.Vorobyev, A.Bondar, V.Egorychev, V.Belyaev, D.Kharzeev, M.Polikarpov, V.Zakharov and many other colleagues for numerous discussions of LHC physics. Slides from conference talks and public lectures of A.Golutvin, R.Forty, D.Kharzeev, B.Schenke, S.Myers are borrowed.

PLAN:

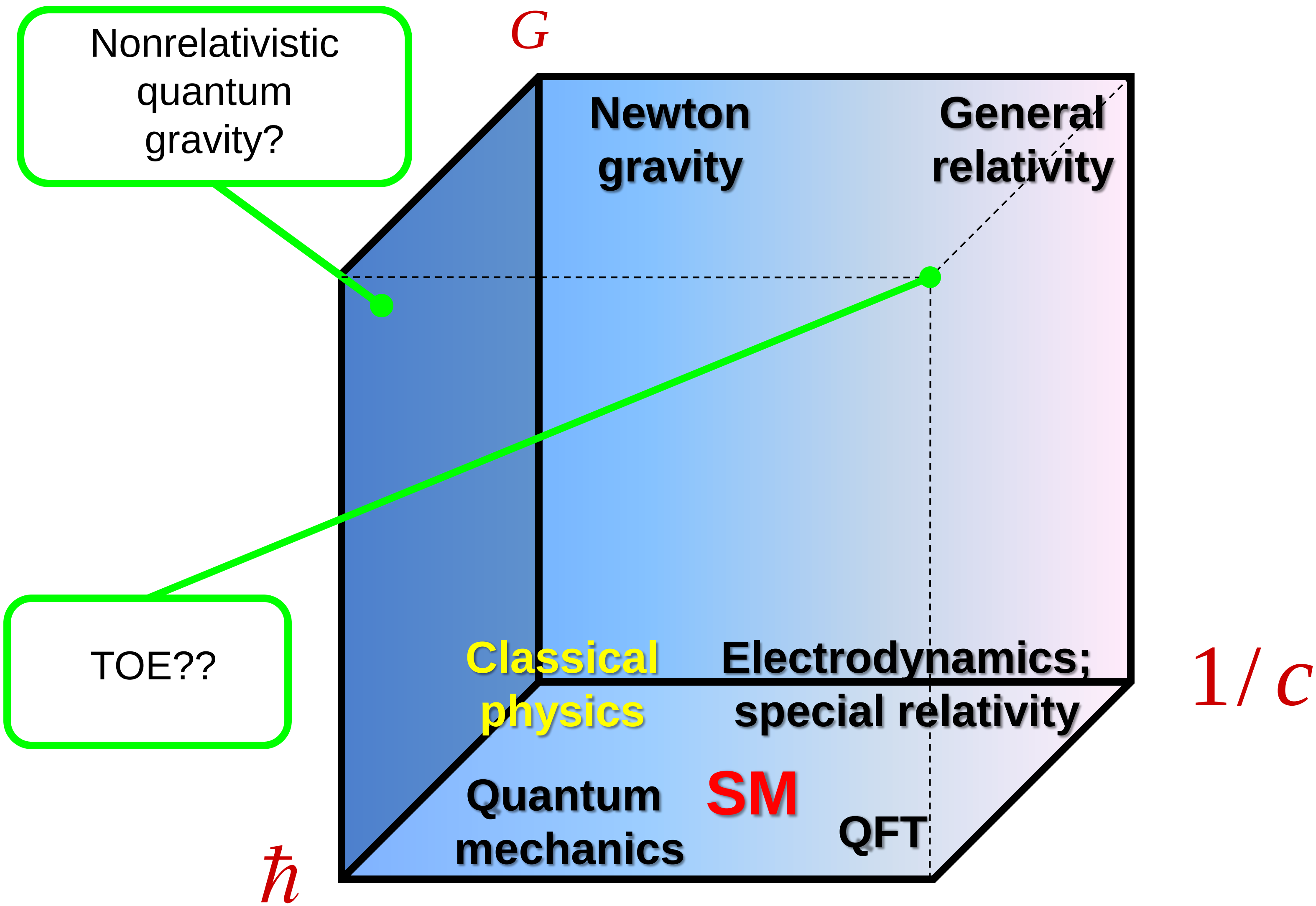
1. Theory
   - Scales, matter and dynamics – where we are
   - Main ideas of the Standard Model
   - Symmetries and their violation

2. Experiment
   - ABC of LHC
   - Four LHC experiments from symmetry point of view
   - Recent results and prospectives

Scales and processes



«Cube of theories» *(M.Bronshtein, A. Zelmanov)*



Discovery and formulation of the Standard Model is perhaps the most outstanding result of human intellect for all history of mankind

«From a long view of the history of mankind – seen from

event of the same decade.»

R.Feynman

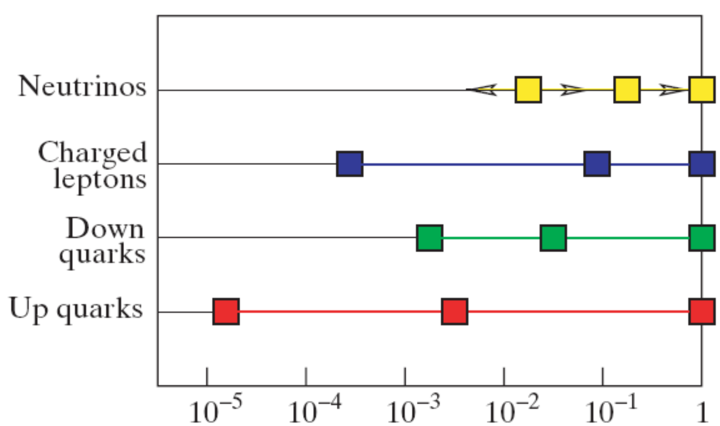
What are the key pillars of the Standard Model?

The Standard Model Zoo

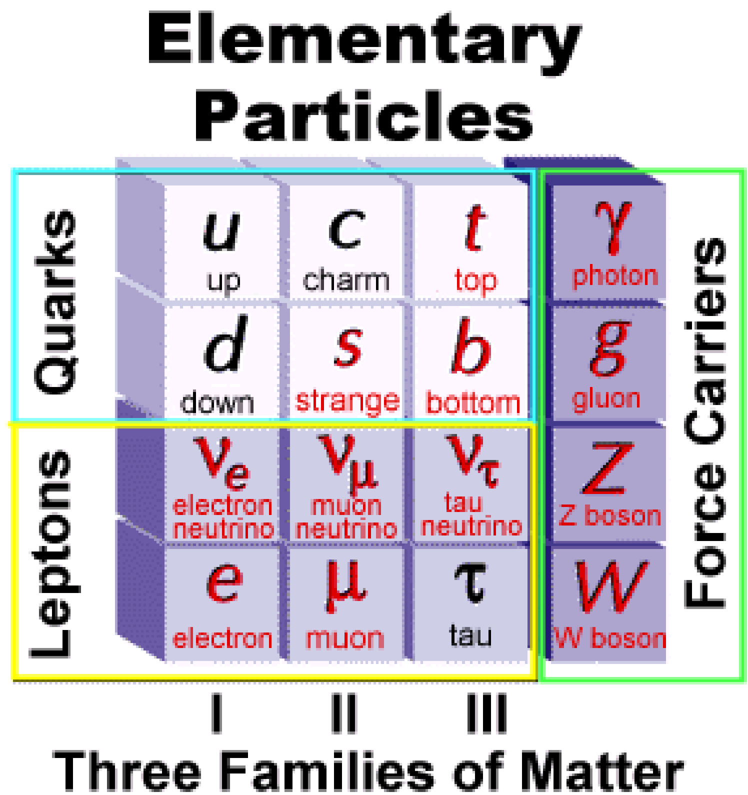
Gauge group $SU(3) \otimes SU(2)_L \otimes U(1)_Y$ [g; W, Z; γ]

is broken down to $SU(3) \otimes U(1)_Q$

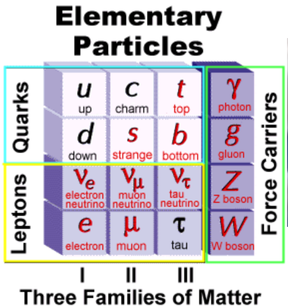
Quarks and leptons form *generations*. Masses come out of *interactions*

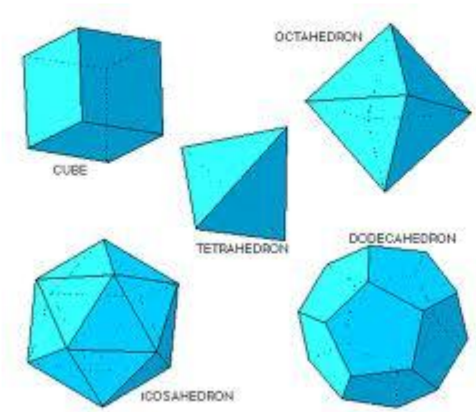


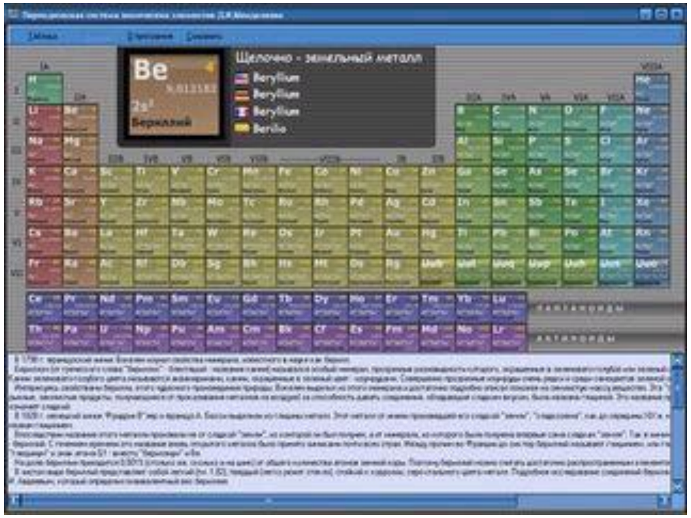
Mass hierarchy (from hep-ph/0603118)

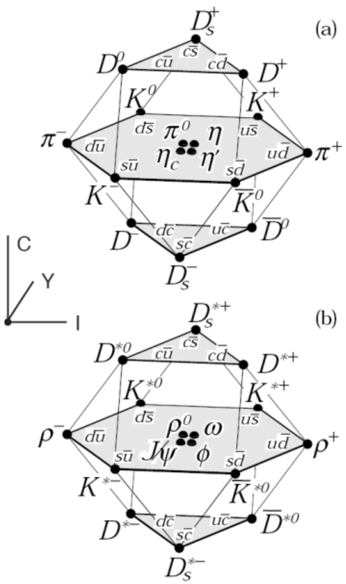


Matter: where from?









Dynamics: where from?

From symmetry and its breaking

Main ideas of the Standard Model

1. Gauge invariance

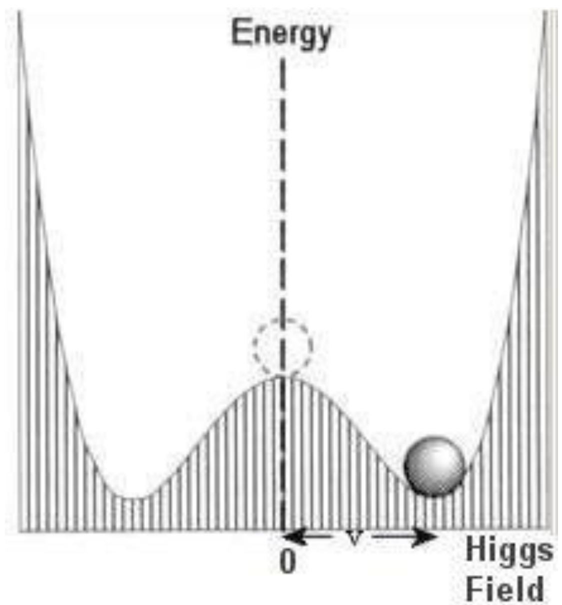
There is an internal symmetry in the theory with respect to some special field transformations. Different configurations of dynamical variables describe one and the same set of physical observables.

Theory is local (and hence elegant and economical) in terms of non-observable potentials, while non-local (and hence cumbersome) in terms of observable field strengths)

$A_\mu(x)$ local interaction with currents	$\Longleftrightarrow$	$F_{\mu\nu}(x)$ non-local interaction with currents

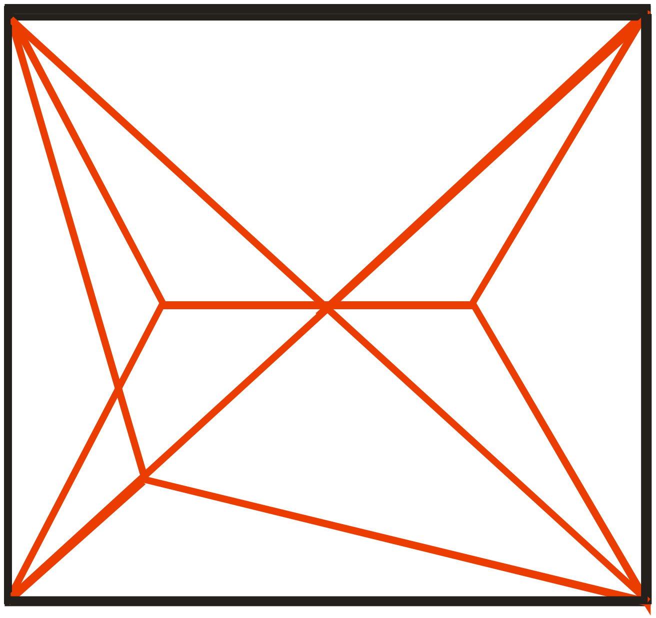
2. Spontaneous symmetry breaking

Symmetry of equation is not always a symmetry of its solution. If solution is to realize extremum of some quantity, it can be reached on less symmetric configuration.



Y.Nambu

Elementary example: opaque square



$$2\sqrt{2} \approx 2.82$$

$$1+\sqrt{3} \approx 2.73$$

$$\sqrt{2} + \sqrt{\frac{3}{2}} \approx 2.64$$

3. Masses come from broken symmetry

Ginzburg-Landau-Higgs mechanism

V.L.Ginzburg, L.D.Landau, 1950
P.W.Higgs, 1964; F.Englert, R.Brout, 1964
G.S.Guralnik, C.R.Hagen, T.W.Kibble, 1964

as if gauge symmetry is “broken”

$$SU(2)_L \otimes U(1)_Y \to U(1)_Q$$

$$L = |(i\partial + A)\Phi|^2 + V(\Phi)$$

- Electroweak sector of SM
- Superconductivity
- Meissner scenario for confinement

essentially classical

Dimensional transmutation

G. ‘t Hooft, 1972
D.Gross, F.Wilczek, 1973
H.Politzer, 1973

scale invariance is broken by anomaly

$SU(3)$

$$\Lambda = \mu \exp\left(-\frac{2\pi}{b\alpha_s(\mu)}\right)$$

$$T^\mu_\mu = \frac{\beta(g)}{2g^3} \mathrm{Tr}\, F_{\mu\nu}F^{\mu\nu}$$

principally quantum

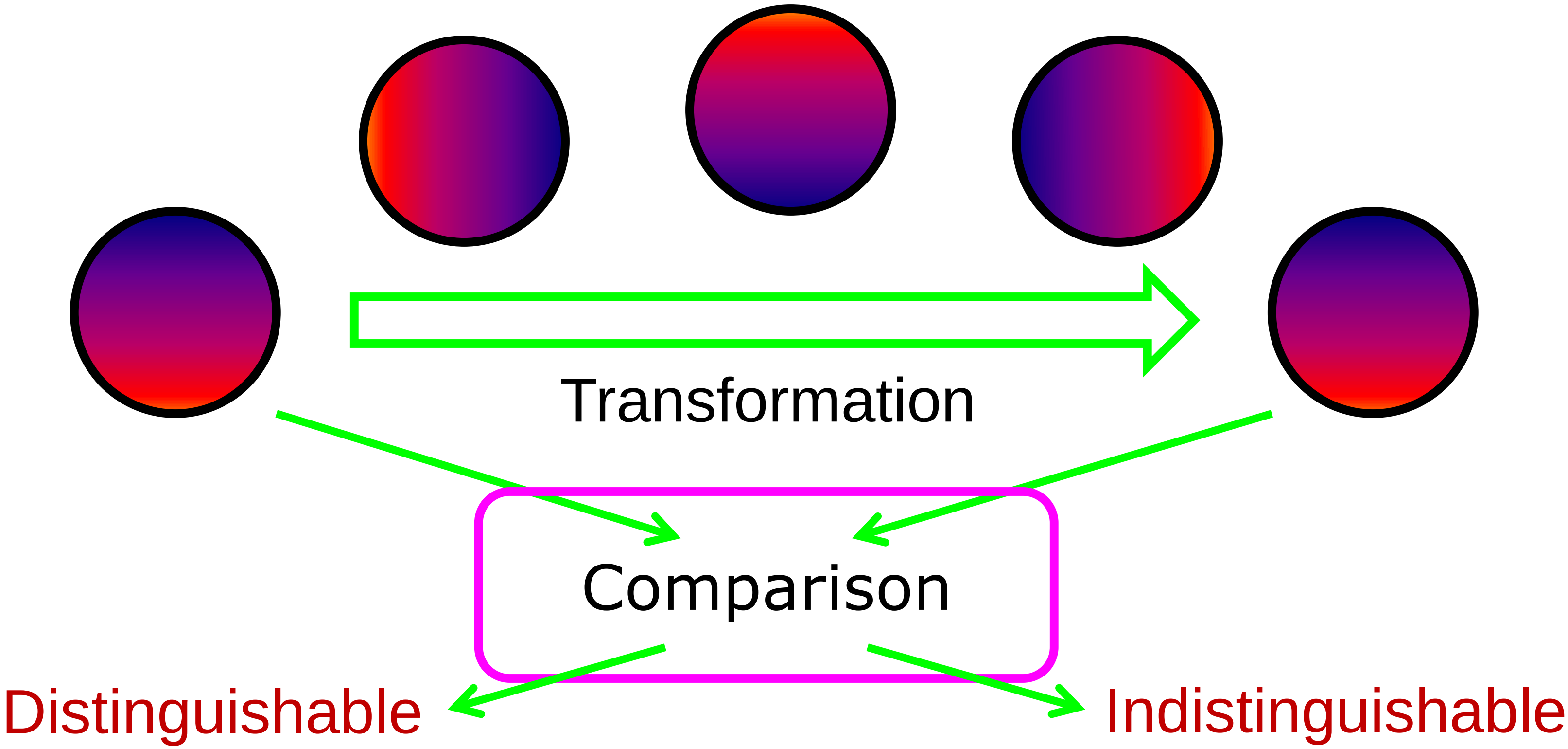
Standard Model has many built in small parameters.
Each one gives a chance to construct perturbation theory.
Some are related to symmetry breaking.

1. Dimensionless interaction constants $\alpha_{em}^{-1} = 137 \quad \alpha_s^{-1}(M_Z) = 8.5$
2. Rank of color gauge group **SU(3)** $1/9 = 1/3^2$
3. Quark masses in strong interaction scale units $\frac{m_{u,d}}{\Lambda} = (0.5 \div 2)\%$
4. Strong to weak scales ratio $G_F m_p^2 = 1 \cdot 10^{-5}$
5. Yukawa constants $\frac{m_e}{m_t} = 3 \cdot 10^{-6}$
6. Quark mixing parameters $\lambda = |V_{us}| = 0.22$
7. …

Many important small parameters are beyond the Standard Model:

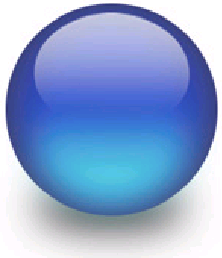
$m_\nu \qquad\qquad G_N m_p^2 = 6 \cdot 10^{-39}$

Symmetry is about invariants



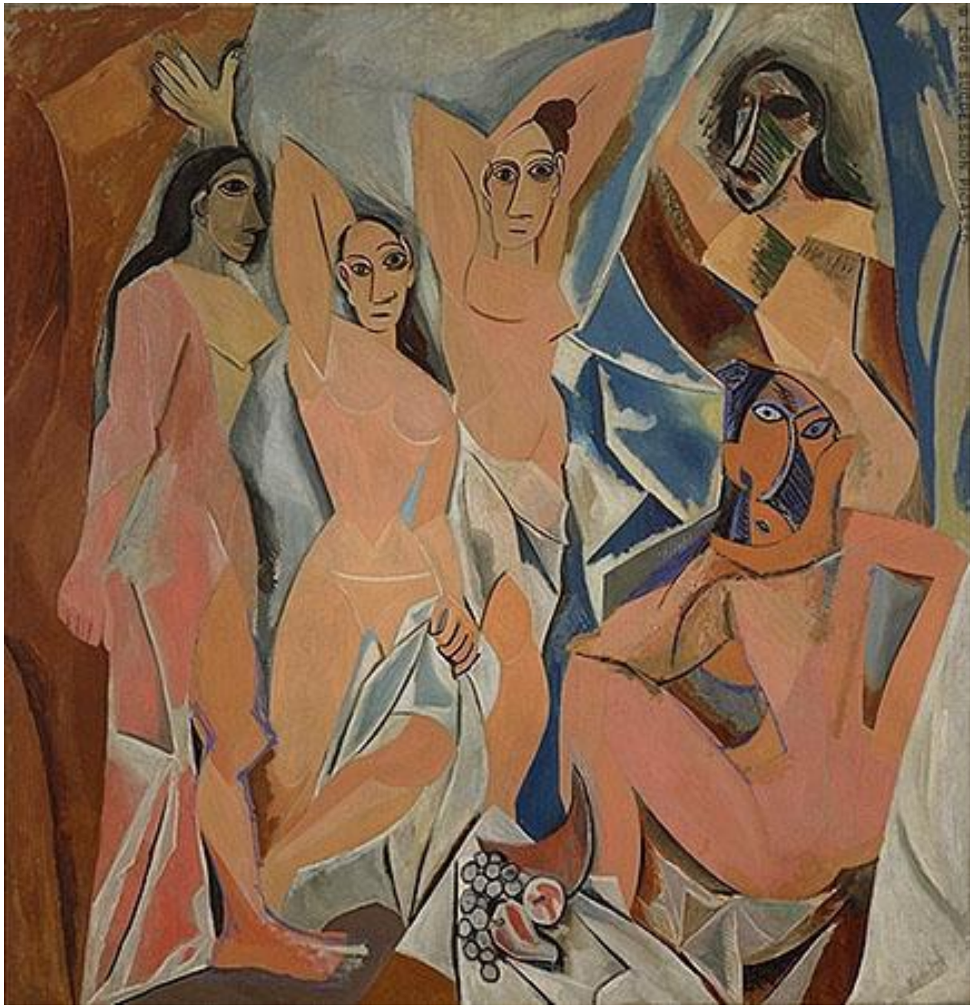
Basic classification of symmetries goes along these lines: type of transformation (e.g. discrete or continuous) and accuracy of comparison (built in or observer-dependent)

Maximal symmetry is not very interesting..



true harmony = beauty ⇔ slightly broken symmetry

But not *too much* broken...



Besides continuous symmetries (local and global) very important role is played by discrete ones. Among them the most important are:

P – parity transformation $\mathbf{x} \longrightarrow -\mathbf{x}$ **det P = -1 !**

T – time reversal $t \longrightarrow -t$

C – charge conjugation $e \longrightarrow -e$

In classical physics

P	$\mathbf{p} \rightarrow -\mathbf{p}$	$\mathbf{L} \rightarrow \mathbf{L}$	$\mathbf{j} \rightarrow -\mathbf{j}$	$\mathbf{E} \rightarrow -\mathbf{E}$	$\mathbf{B} \rightarrow \mathbf{B}$
C	$\mathbf{p} \rightarrow \mathbf{p}$	$\mathbf{L} \rightarrow \mathbf{L}$	$\mathbf{j} \rightarrow -\mathbf{j}$	$\mathbf{E} \rightarrow -\mathbf{E}$	$\mathbf{B} \rightarrow -\mathbf{B}$
T	$\mathbf{p} \rightarrow -\mathbf{p}$	$\mathbf{L} \rightarrow -\mathbf{L}$	$\mathbf{j} \rightarrow -\mathbf{j}$	$\mathbf{E} \rightarrow \mathbf{E}$	$\mathbf{B} \rightarrow -\mathbf{B}$

In quantum field theory the status of transformations C, P, T or their pairs CP, CT, TP is different from **CPT**.

Namely, for any local Lorentz-invariant quantum field theory one has

CPT theorem

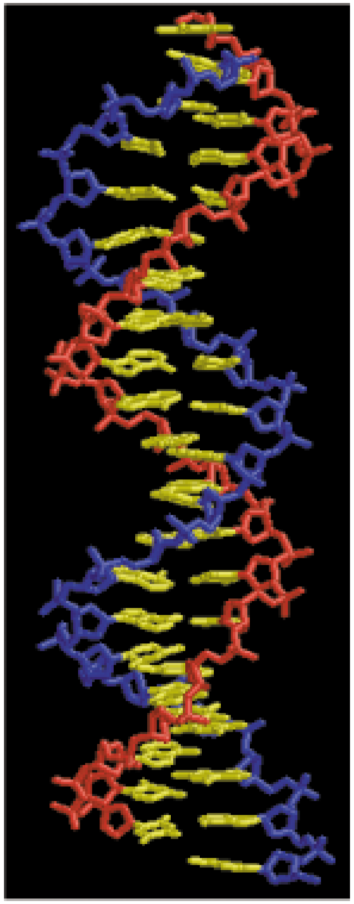
J.Schwinger, 1951
G.Lüders, W.Pauli, 1954

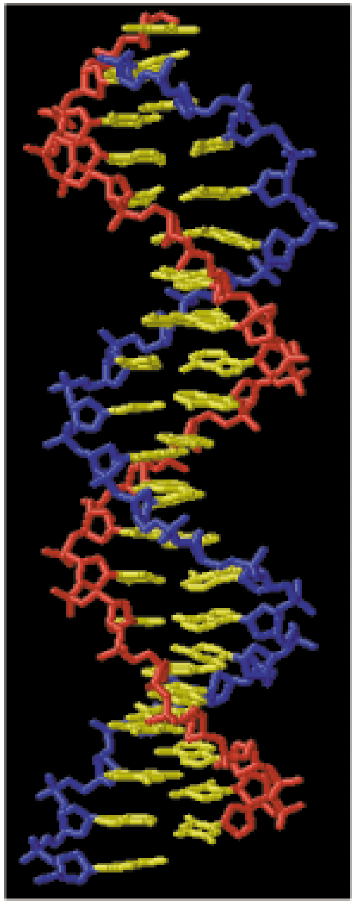
Physically, **CPT** theorem means that antiparticles and their interactions are indistinguishable from particles, going along the same world-lines in 3+1 space-time but in opposite directions.

In particular, mass of any particle regardless of its dynamics exactly equals to the mass of its antiparticle (experimentally checked for K-mesons at the level ***1*** *to* $\boldsymbol{10^{18}}$*).*

C, P, T have no such kinematical status

P-parity - broken is macroscopic world





Our world

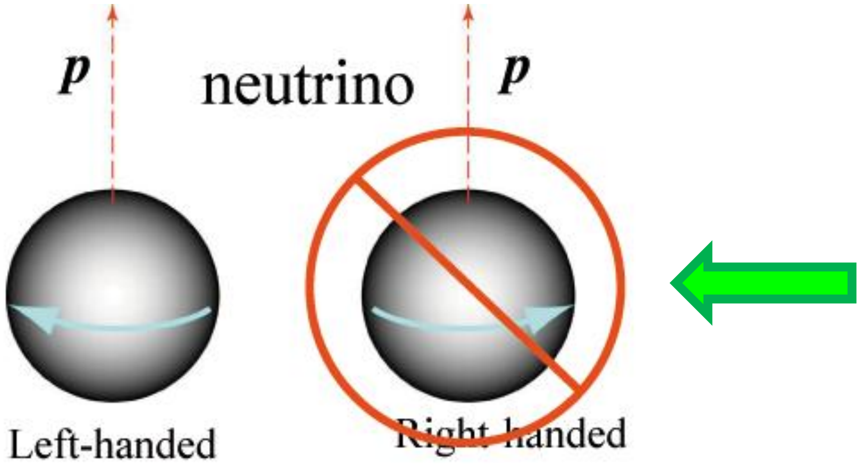
DNA

Wonderland

P-parity for elementary particles

T.D.Lee, C.N.Yang, 1956

C.S.Wu, 1957



not created

In Standard Model P-parity violation is built in at the level of Lagrangian

$$\Delta L = -\frac{g}{2\sqrt{2}} \sum_i \overline{\psi}_i \, \gamma^\mu \, (1-\gamma^5)(T^+ \, W_\mu^+ + T^- \, W_\mu^-) \, \psi_i$$

$$\psi_L = \frac{1-\gamma^5}{2}\psi \qquad (1-\gamma^5)\psi = (1-\gamma^5)(\psi_L + \psi_R) = 2\cdot\psi_L$$

$$\psi_R = \frac{1+\gamma^5}{2}\psi$$

therefore $\bar{\psi}\gamma^\mu(1-\gamma^5)\psi = 2\bar{\psi}_L\gamma^\mu\psi_L$

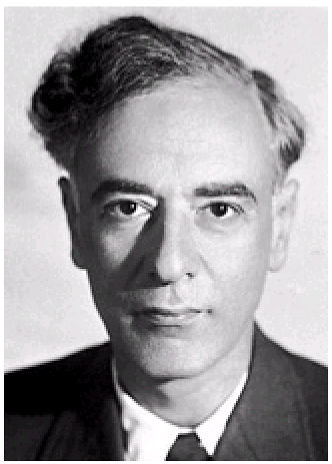
$$(V-A)(V-A)^\dagger = VV^\dagger + VA^\dagger + AV^\dagger + AA^\dagger$$

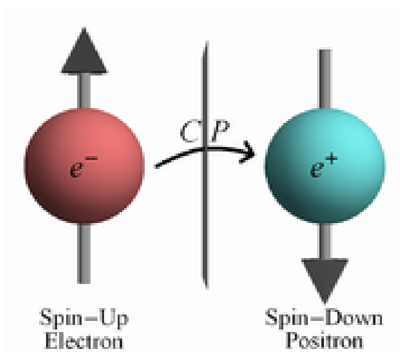
P C

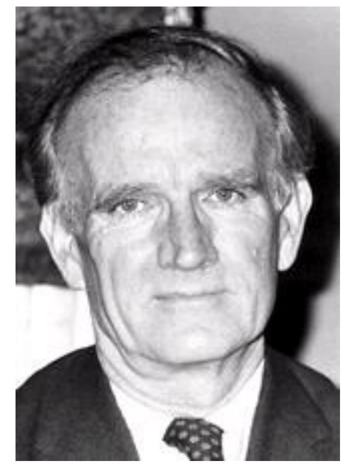
$$(V-A)(V-A)^\dagger = VV^\dagger - VA^\dagger - AV^\dagger + AA^\dagger$$

Thus V-A effective Lagrangian looks CP-invariant

$$
\begin{tikzcd}
\pi^+ \to \mu^+_R + \nu_L \arrow[r, "P"] \arrow[d, "C"] \arrow[dr, "CP"] & \pi^+ \to \mu^+_L + \cancel{\nu}_R \\
\pi^- \to \mu^-_R + \cancel{\bar{\nu}}_L & \pi^- \to \mu^-_L + \bar{\nu}_R
\end{tikzcd}
$$



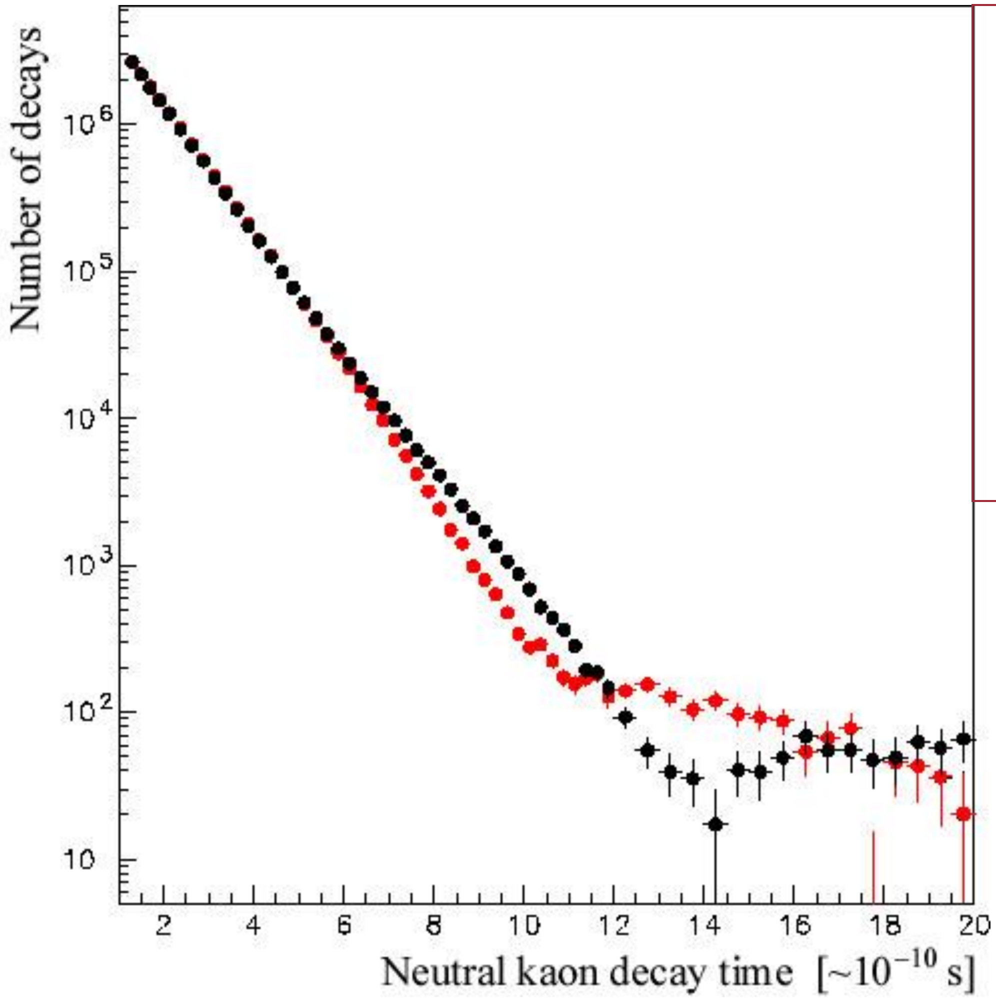




L.D.Landau, 1957:
CP-parity conservation hypothesis

J.Cronin, V.Fitch, 1964:
Discovery of CP-nonconservation in neutral kaons decays

CPLEAR 1999



distribution of number of decays for kaons

$\neq$

distribution of number of decays for anti-kaons

CP violation


M. Kobayashi, T.Maskawa, 1974:
theoretical mechanism of
CP-violation

based on ideas of
N.Cabibbo, 1963

Idea: flavor eigenstates are superposition of mass eigenstates (and vice versa)

In other way: it is impossible to diagonalize interaction term for charged currents and free kinetic term

$$L_{\text{int}} = \frac{g_2}{\sqrt{2}} \left(\bar{u}_L\,,\ \bar{c}_L\,,\ \bar{t}_L \right) \gamma^\mu \hat{V}_{CKM} \begin{pmatrix} d_L \\ s_L \\ b_L \end{pmatrix} W^+_\mu + h.c.$$

$$\begin{pmatrix} d' \\ s' \\ b' \end{pmatrix} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

It can be shown that arbitrary complex unitary N N matrix can be parameterized by N(N-1)/2 Euler angles and (N-1)(N-2)/2 complex phases.

For N<3 any matrix can be unitary rotated to equivalent real.

On the other hand, there are such 3 3 matrices that no choice of quark fields phases can make them real.

$$\eta = \arg\left(\frac{V_{ij}V_{ik}^{*}}{V_{lj}V_{lk}^{*}}\right) \qquad J = \left|\mathrm{Im}\ V_{i\alpha}V_{j\beta}V_{i\beta}^{*}V_{j\alpha}^{*}\right| \sim 3\times10^{-5}$$

Remark to remember:

is'n it strange that strong interactions do not violate **CP** at Lagrangian level?

$$\mathcal{L} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} - \frac{n_f g^2 \theta}{32\pi^2}F_{\mu\nu}\tilde{F}^{\mu\nu} + \bar{\psi}(i\gamma^\mu D_\mu - m e^{i\theta' \gamma_5})\psi$$

Current experimental constraint on θ is $|\theta| \leq 10^{-9}$

According to **CPT** theorem **CP**-violation means **T**-violation. The problem of time arrow *(A.Eddington, 1927)*

1. Thermodynamic arrow

   order → chaos

2. Cosmological arrow

   Big Bang → Armageddon

3. Causal arrow

   source / cause → detector / result

4. Psychological arrow

   memory → dreams

5. Quantum mechanical arrow

   $|\Psi>$ → $P|\Psi>$

6. Electroweak arrow – **CKM phase**

Important general conclusion

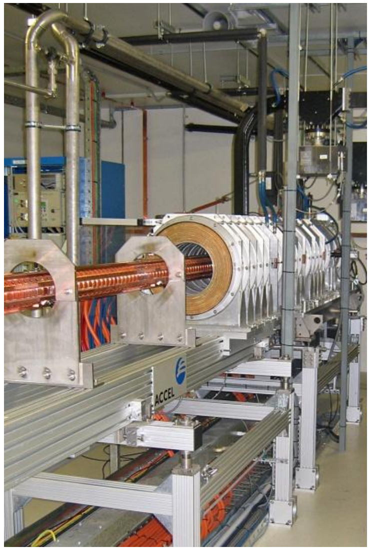
SYMMETRY

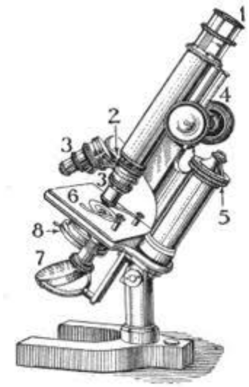
can be broken at the level of «laws»

DYNAMICS AS SYMMETRY BREAKING

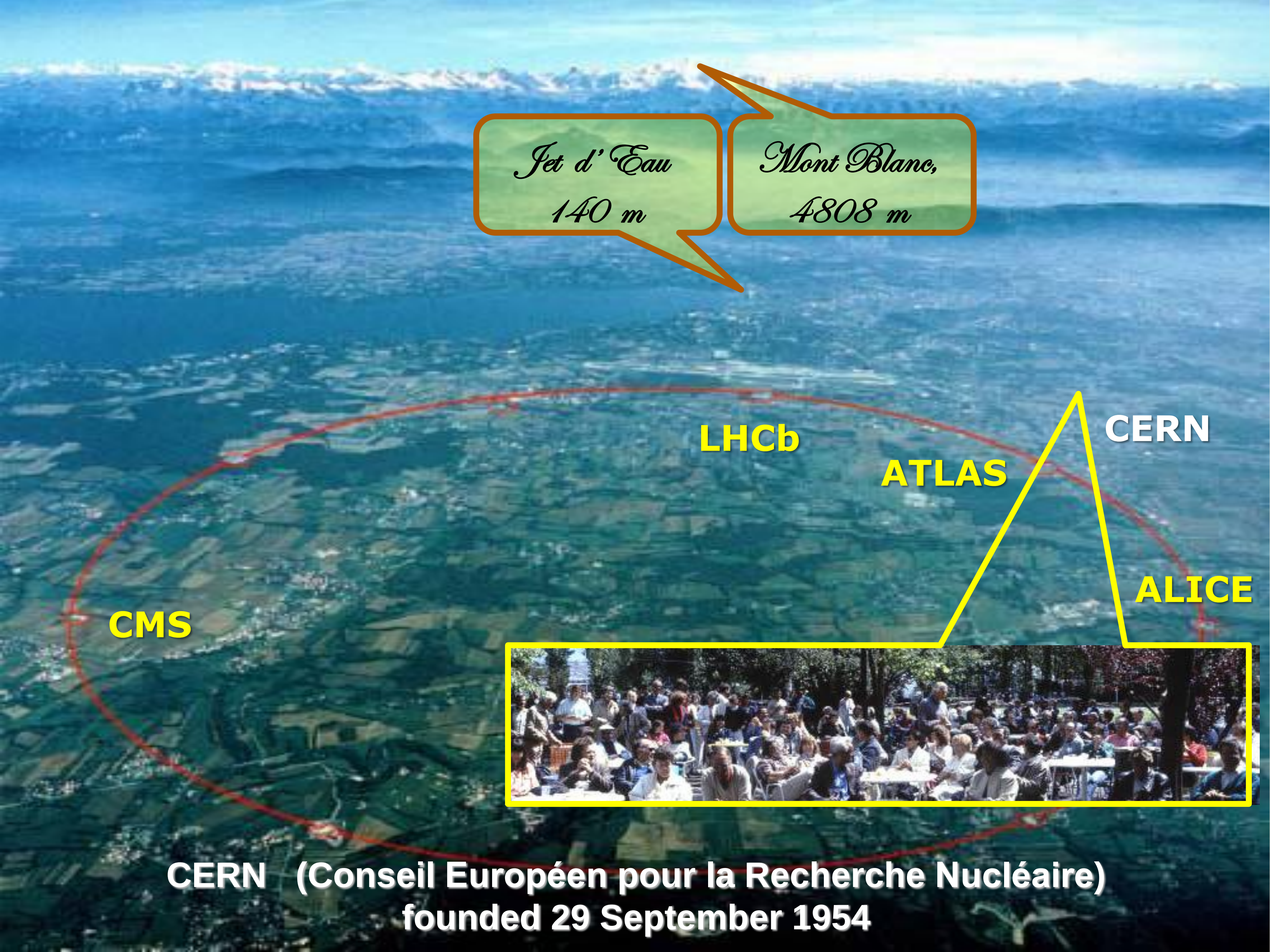
or can be broken spontaneously, at the level of «states»

Particle accelerators used in industry may be thought of as sophisticated hammers. But accelerators used in basic science (and Large Hadron Collider at CERN in particular) are better to think of as microscopes, not hammers.

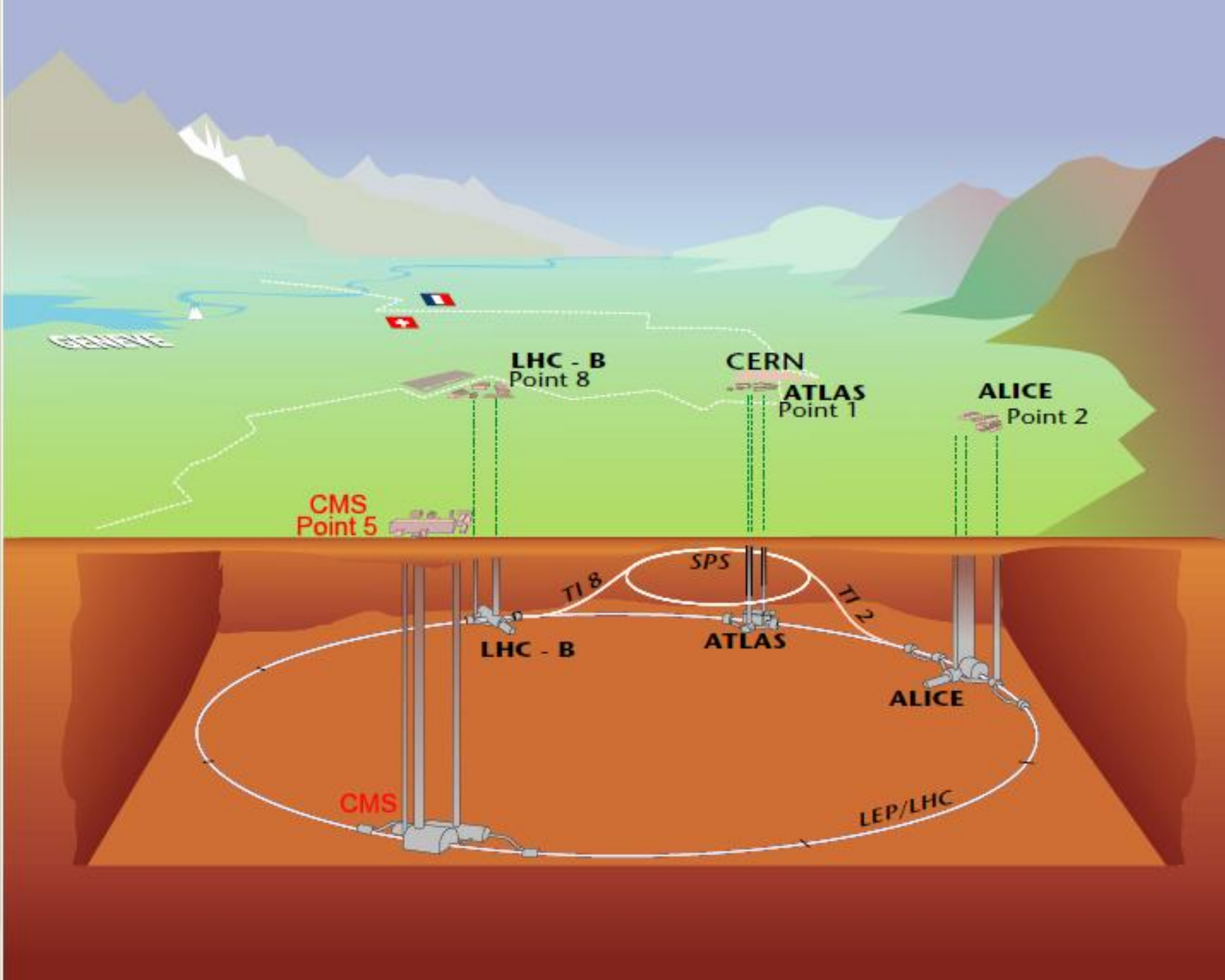




We need the highest possible resolution to test the fundamental symmetries of our Universe



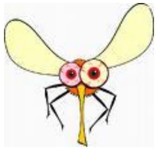
CERN (Conseil Européen pour la Recherche Nucléaire)
founded 29 September 1954


LHC - B
Point 8
CERN
ATLAS
Point 1
ALICE
Point 2
CMS
Point 5
SPS
TI 8
TI 2
LHC - B
ATLAS
ALICE
CMS
LEP/LHC

ABC of LHC

- Tonnel length – 27 kilometers
- Tonnel depth - between 50 and 175 meters
- Colliding p-p beams, 2808 bunches, 1.15 10^{11} p/bunch
- v = 0.99999998 c
- Energy = 7 TeV + 7 TeV, luminosity ~ 10^{34} cm^{-2} sec^{-1}
- About 600 millions collisions per second

Proton energy = 7 TeV = 10^{-6} joul.

This is about kinetic energy of a fly: 

Why not to use flies in particle physics?

Besause Avogadro number = 6.022×10^{23} $(\text{mol})^{-1}$

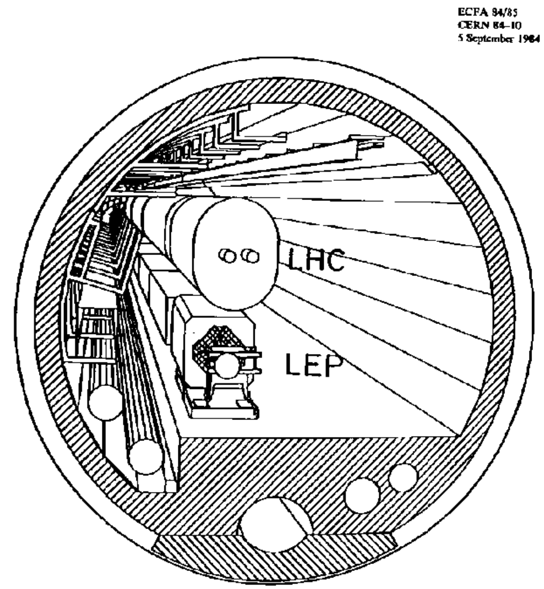
Fly's energy is distributed among ~ 10^{22} nucleons.

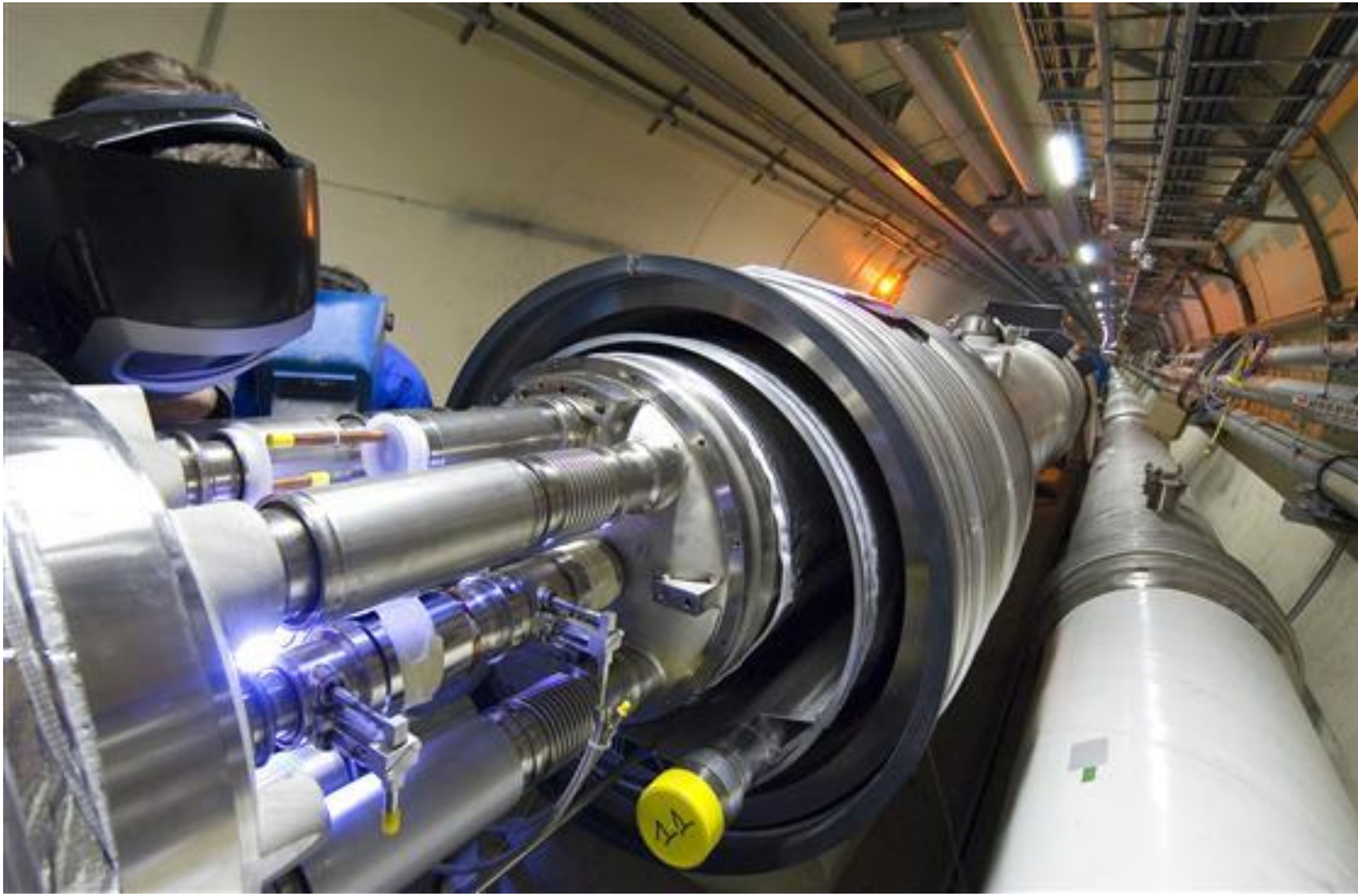
On the other hand, total beam energy is given by
2808 bunches $\times$ 10^{11} protons/bunch $\times$ 7 TeV/proton ~ 400 MJ
This is about 100 kg TNT-equivalent or kinetic energy of «Admiral Kuznetsov» cruising at 8 knots.

Modern HEP experiment has a long way to go ...

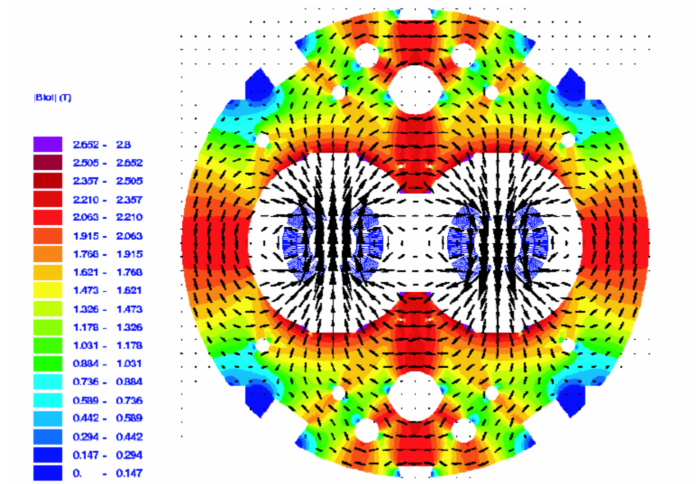
The life of an experiment

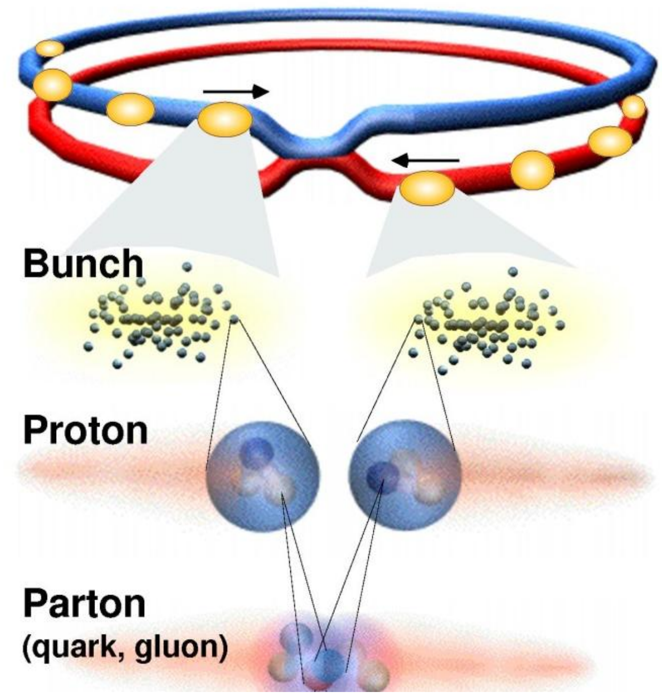
1984	Workshop in Lausanne on installing a Large Hadron Collider (LHC) in the LEP tunnel
1987	CERN's long-range planning committee chaired by Carlo Rubbia recommends LHC as the right choice for lab's future
1989	ECFA Study Week on instrumentation technology for a high-luminosity hadron collider; Barcelona; LEP collider starts operation
1990	ECFA LHC workshop, Aachen
1992	General meeting on LHC physics and detectors, Evian-les-Bains
1993	Letters of intent for LHC detectors submitted
1994	Technical proposals for ATLAS and CMS approved
1998	Construction begins
2000	CMS assembly begins above ground; LEP collider closes
2003	ATLAS underground cavern completed and assembly started
2004	CMS cavern completed
2007	Experiments ready for beam
2007	First proton–proton collisions
2008	First results
2010	Reach design luminosity
>2014	Upgrade LHC luminosity by factor of 10

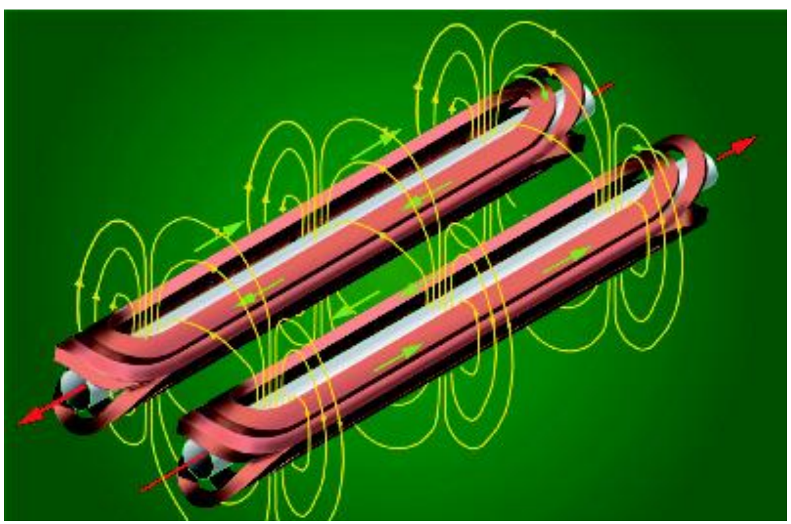




Bunches



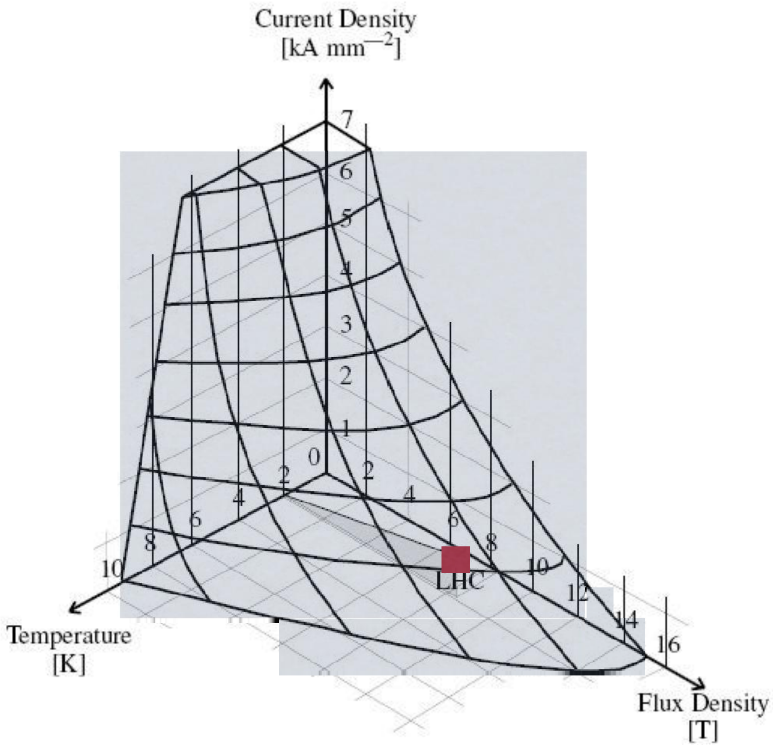


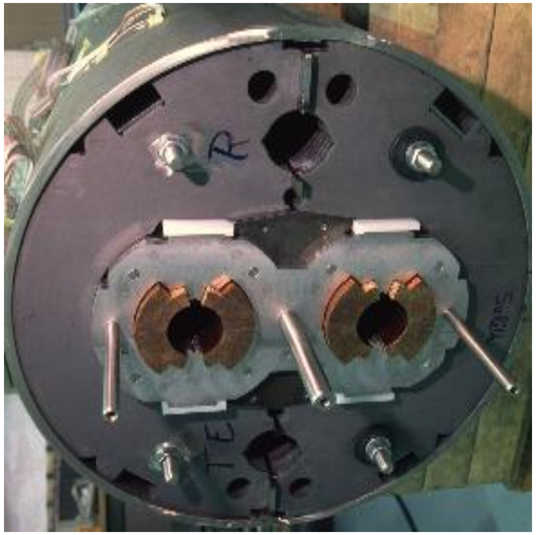


Two beam pipes with common magnetic system

Magnets

Dipole superconducting **Ti-Nb** magnets, magnetic field 8.3 T, current 11700 A, temperature 1.9 K (700000 litres of liquid **He**)





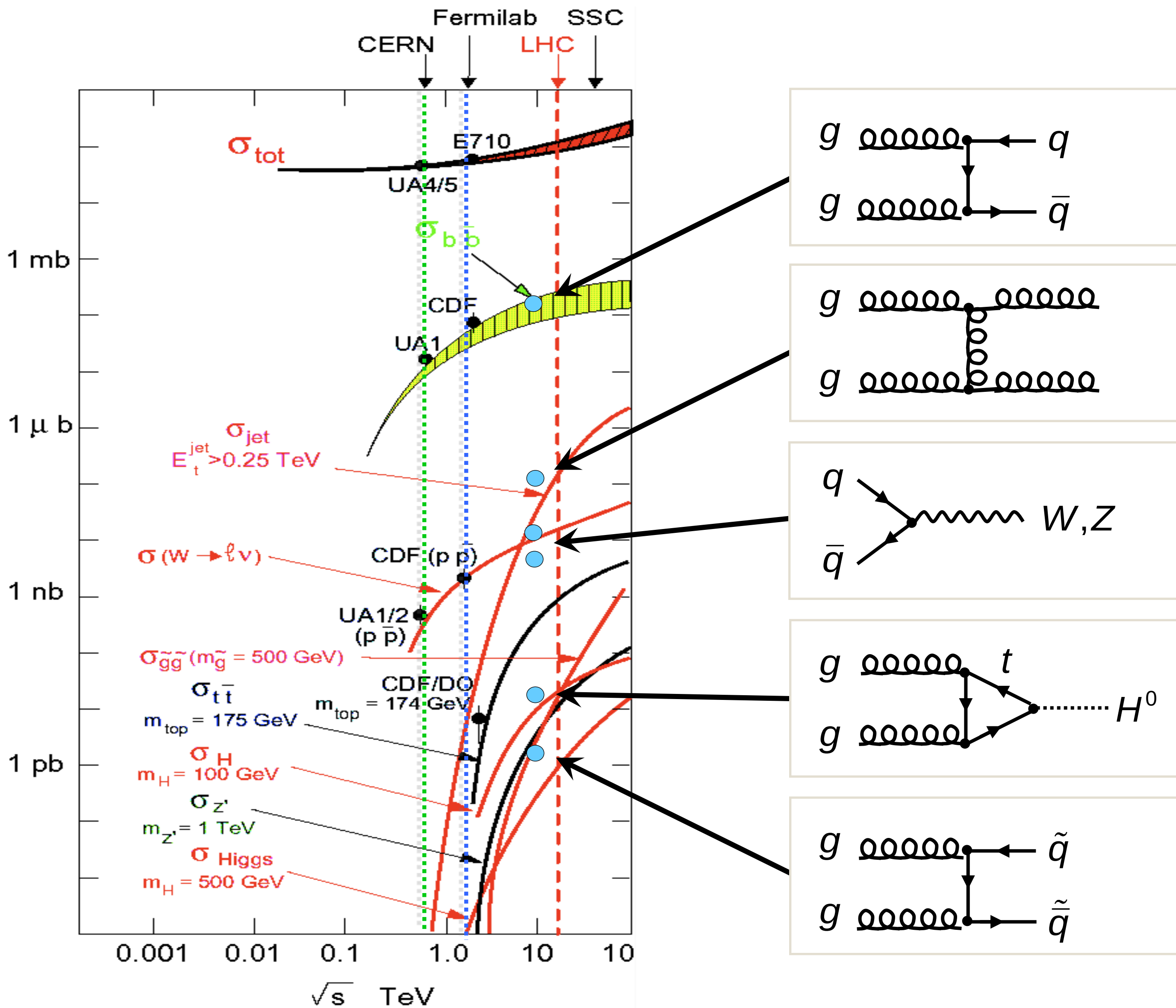
1232 items, 0.5M CHF each

r [m] B [T] = 3.33 p [GeV]

27 km, 2/3 is covered by dipole magnets field r ~ 2800 m

B = 8.3 T p = 7 TeV

Energy stored in magnets ~ 10.4 GJ = kinetic energy of Boeing at 700 km/h



Fermilab
SSC
CERN
LHC
σ tot
E710
UA4/5
1 mb
σ b b̄
CDF
UA1
1 μ b
σ jet
E t jet >0.25 TeV
σ (W → ℓν)
CDF (p p̄)
1 nb
UA1/2
(p p̄)
σ g̃g̃ (m g̃ = 500 GeV)
σ t t̄
m top = 175 GeV
CDF/D0
m top = 174 GeV
1 pb
σ H
m H = 100 GeV
σ Z'
m Z' = 1 TeV
σ Higgs
m H = 500 GeV
0.001
0.01
0.1
1.0
10
10
√s TeV
g
g
q
q̄
g
g
q
q̄
W,Z
g
g
t
H0
g
g
q̃
q̃̄

Testing symmetries in LHC experiments

General purpose - everything with high enough p_T

Electroweak gauge symmetry breaking pattern: Higgs boson or New Physics?

Space-time symmetries: extra dimensions, black holes, KK-states?

Supersymmetry: particles – superpartners? Dark matter?

Enigma of flavor

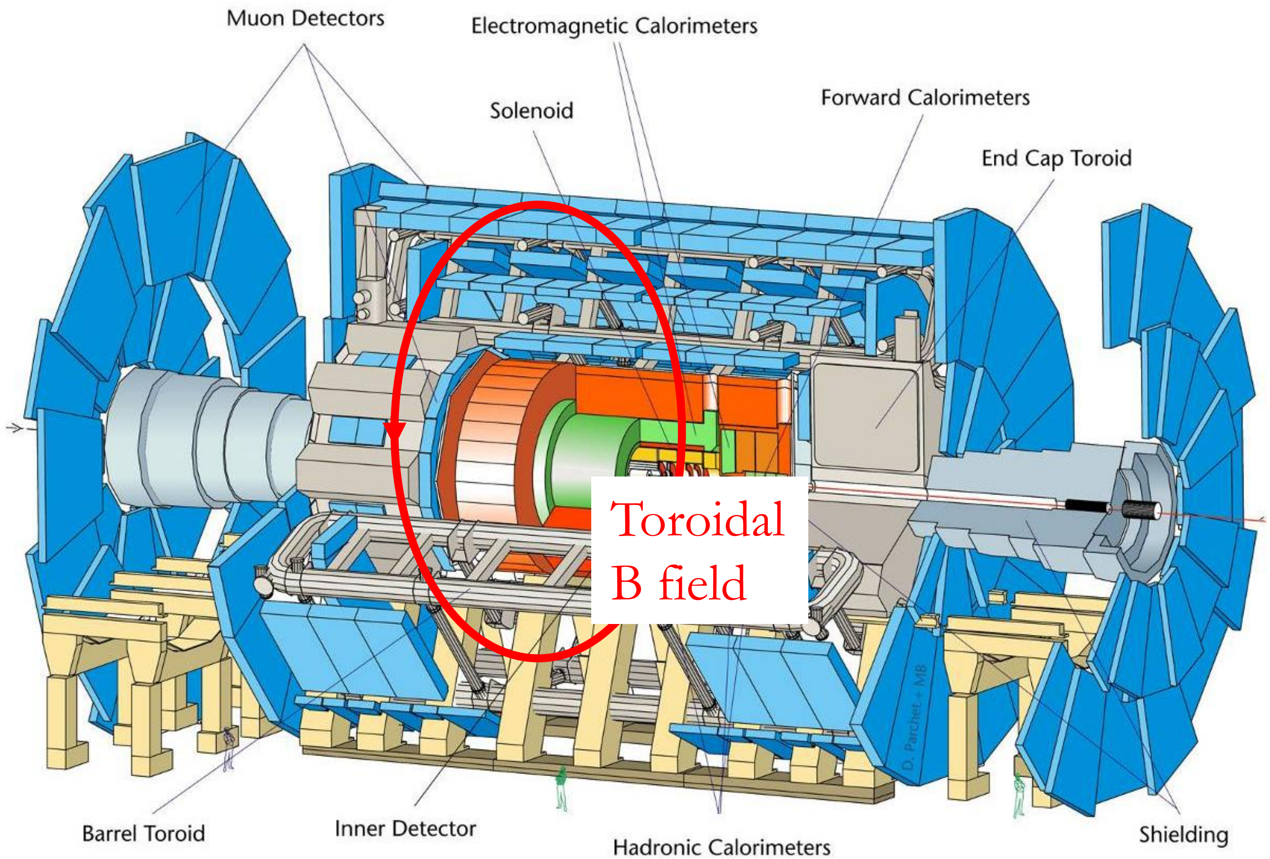
CP-symmetry violation: new sources?
Baryon asymmetry of the Universe.
Indirect search of superpartners.

New state of matter - new symmetries?

Chiral symmetry of strong interactions: pattern of restoration? Deconfinement.
P-parity violation as interplay of strong and electromagnetic interactions?

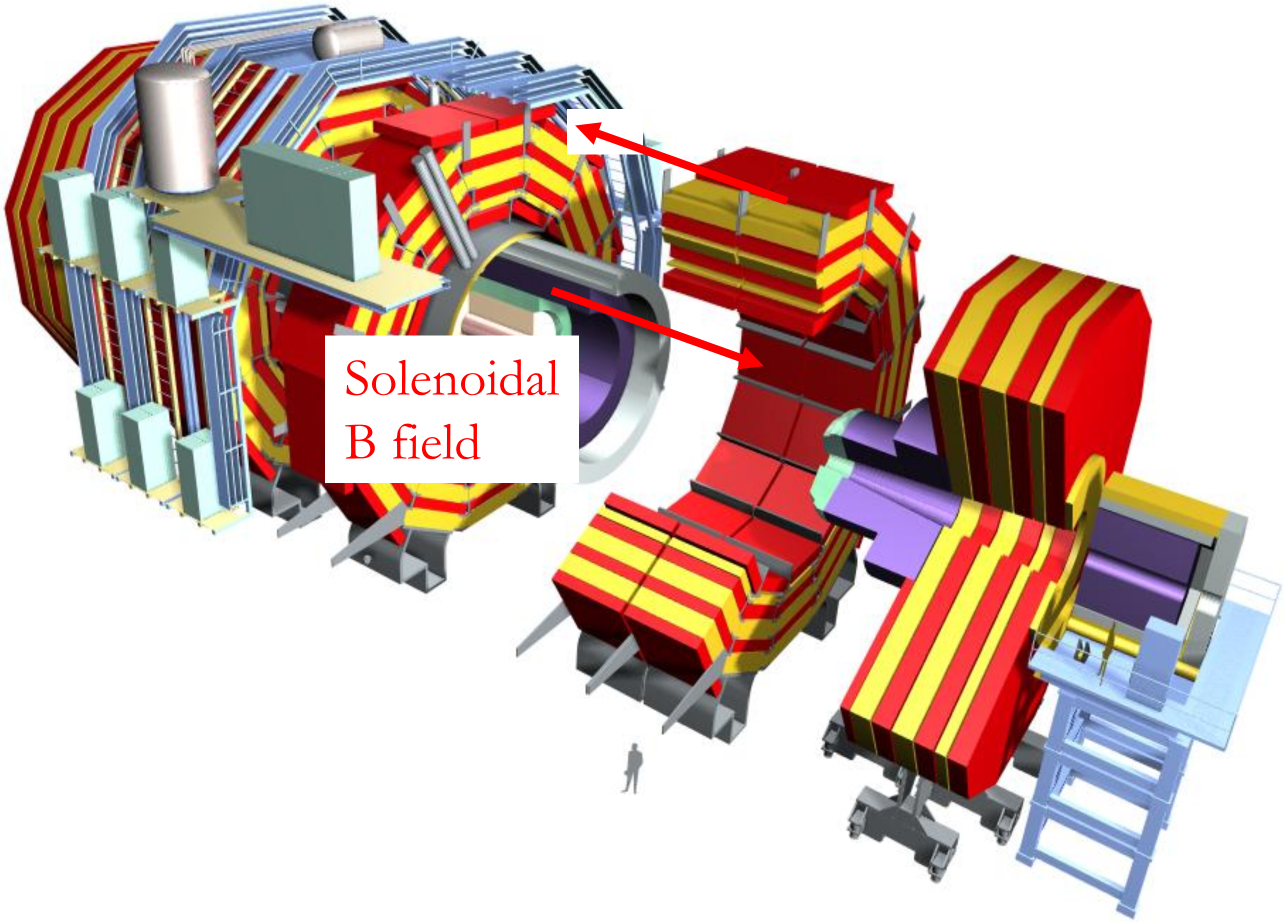
ATLAS – **A** **T**oroidal **L**hc **A**pparatu**S**

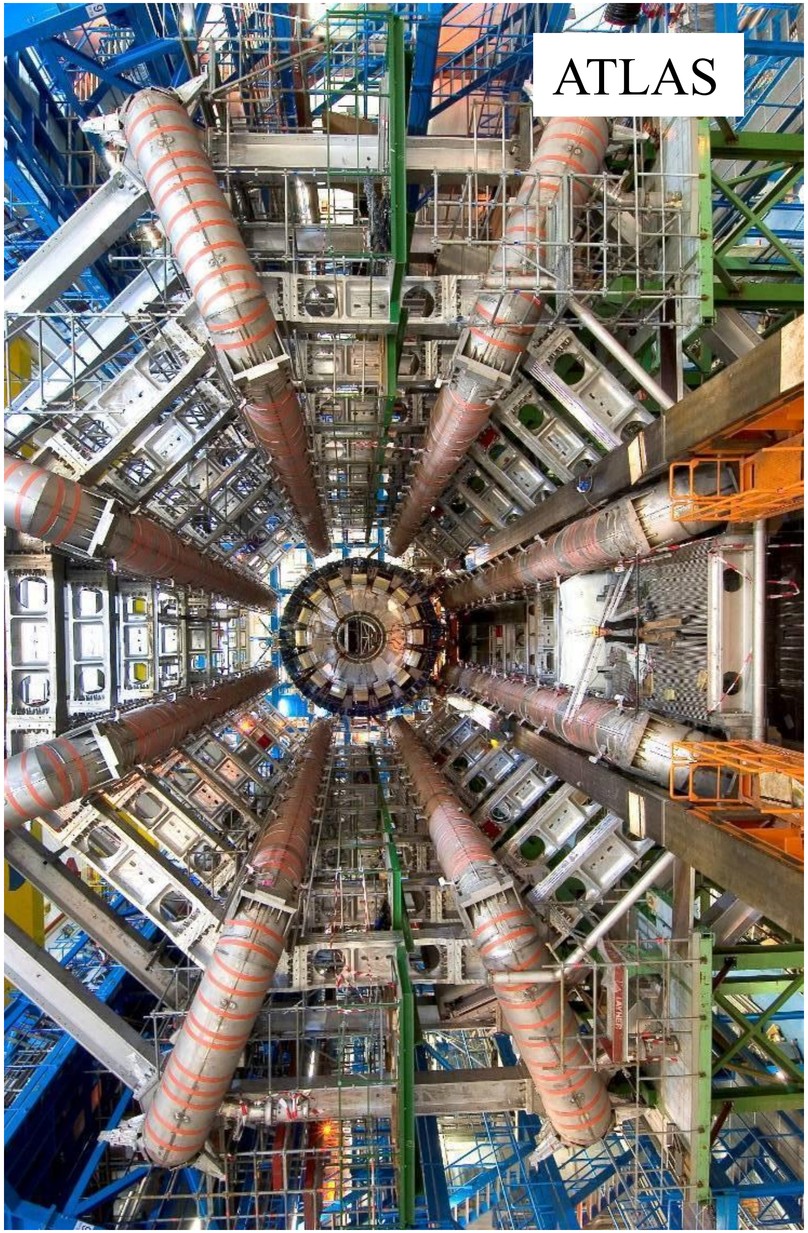
The largest detector in history of particle physics – 45 meters and 7000 tons

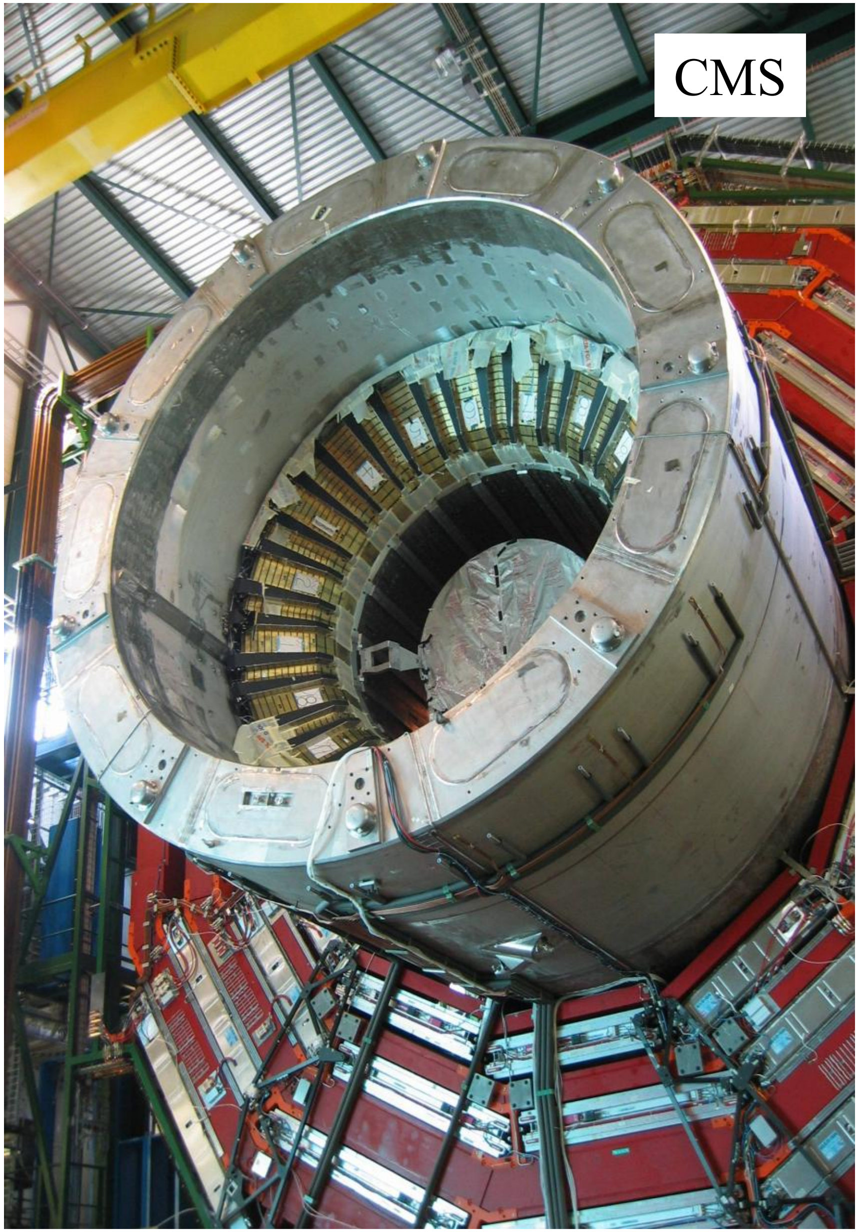


CMS – **C**ompact **M**uon **S**pectrometer

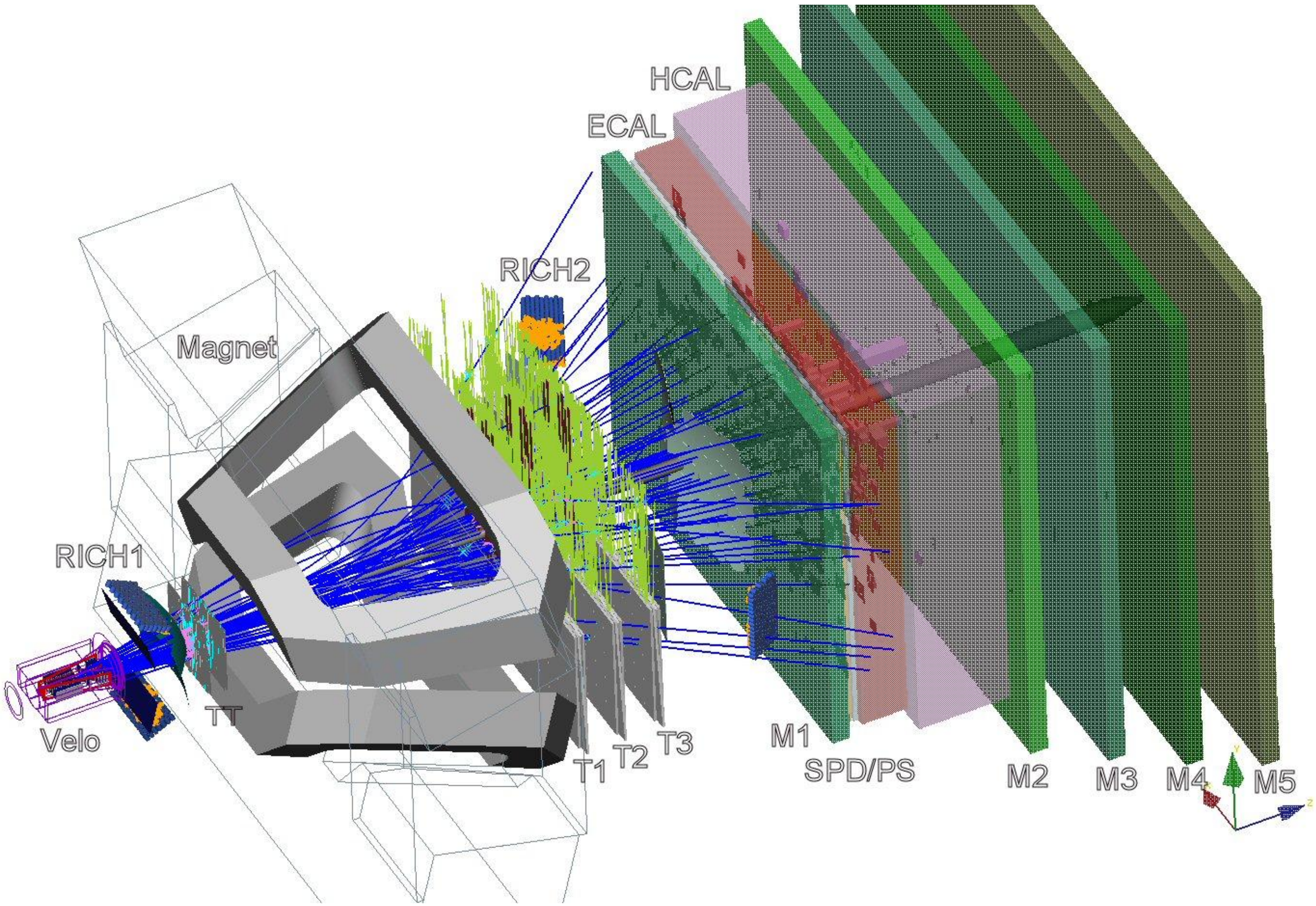
21 meters и 12500 tons

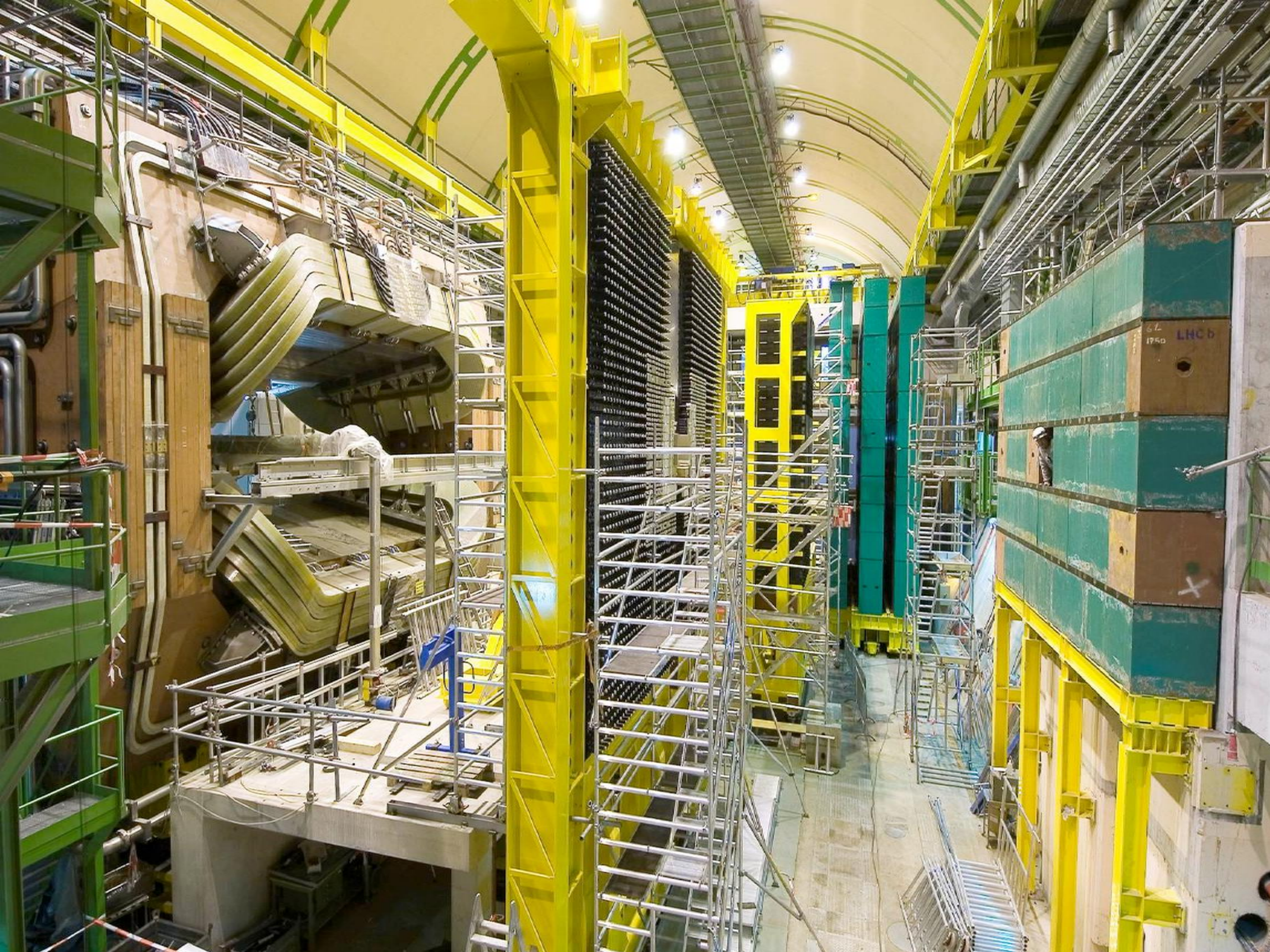



ATLAS

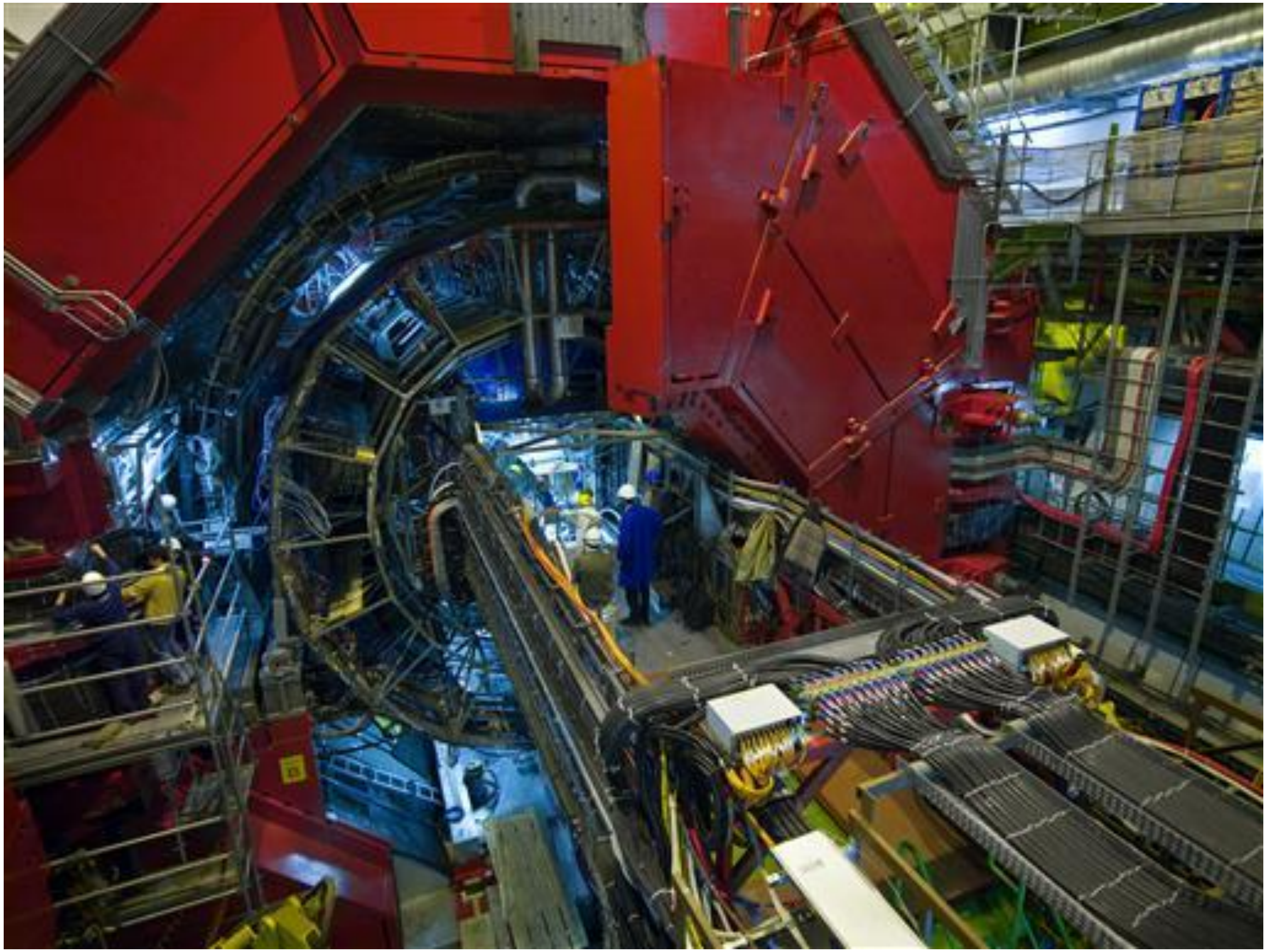

CMS

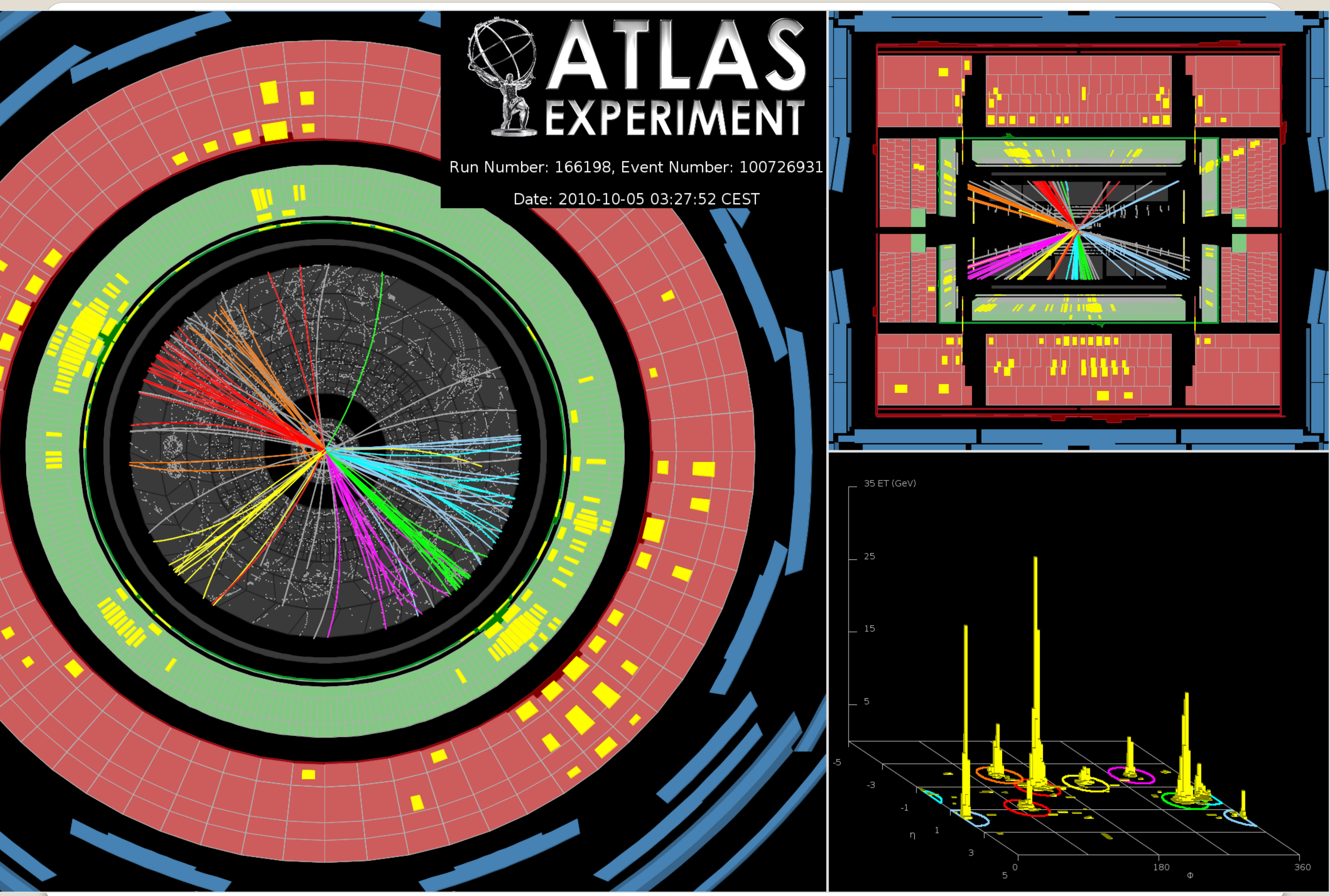
LHCb

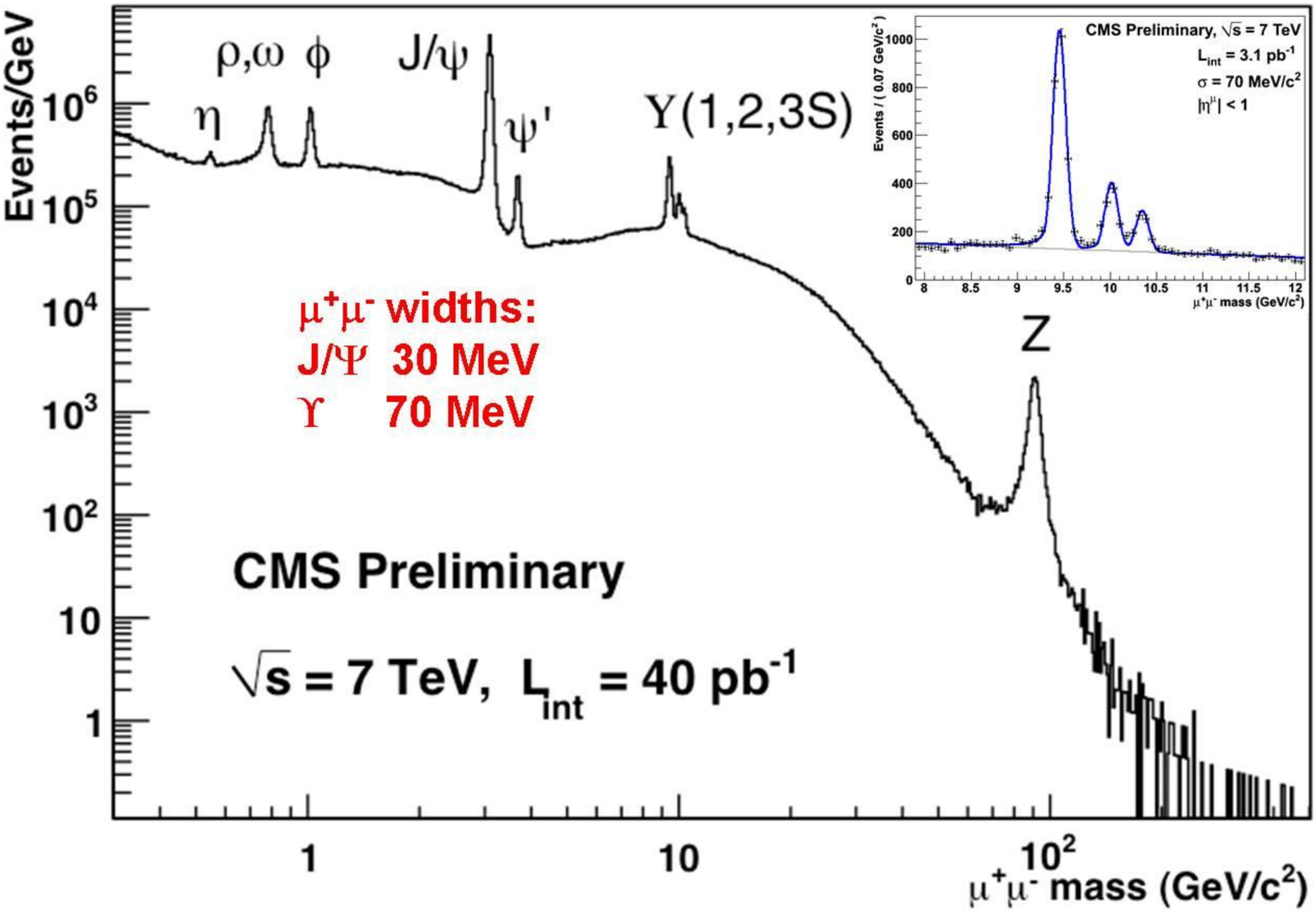

HCAL
ECAL
RICH2
Magnet
RICH1
Velo
TT
T1
T2
T3
M1
SPD/PS
M2
M3
M4
M5


LHCb

ALICE

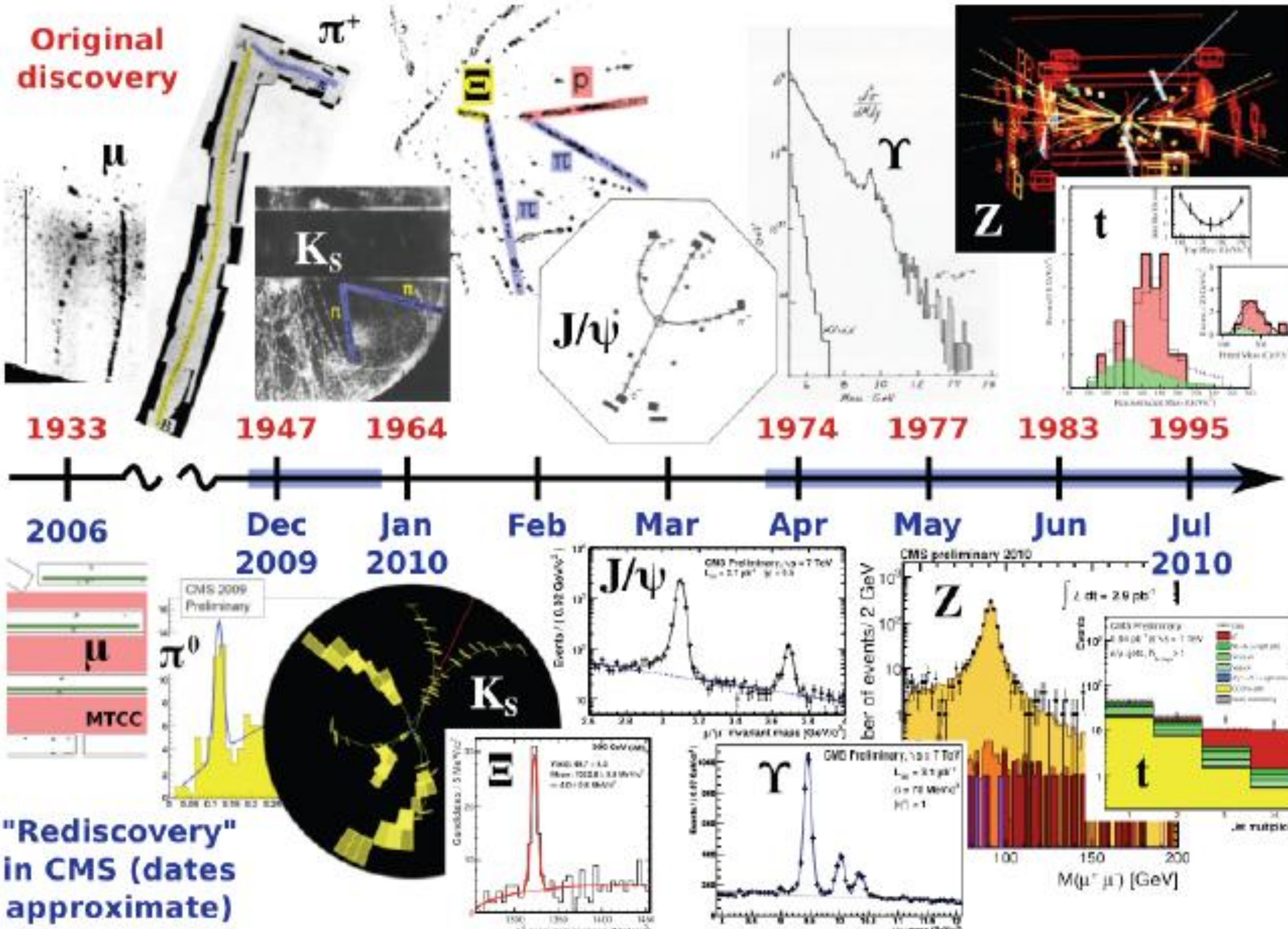



ATLAS
EXPERIMENT
Run Number: 166198, Event Number: 100726931
Date: 2010-10-05 03:27:52 CEST
35 ET (GeV)
25
15
5
-5
-3
-1
1
3
5
η
0
180
360
Φ

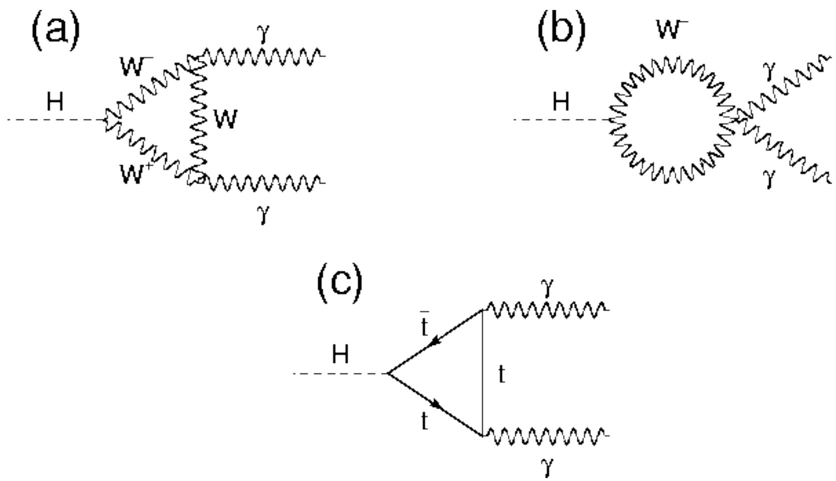


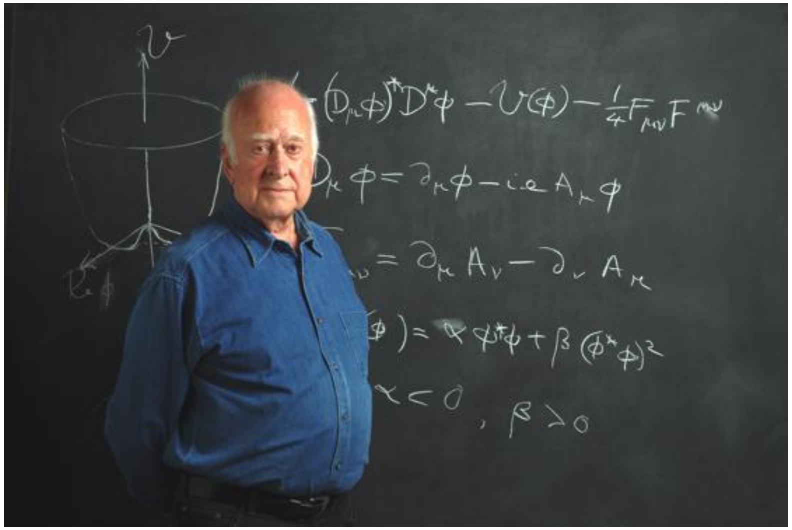
Events/GeV
ρ,ω
φ
J/ψ
η
ψ'
Υ(1,2,3S)
Z
μ⁺μ⁻ widths:
J/Ψ 30 MeV
Υ 70 MeV
CMS Preliminary
√s = 7 TeV, L_int = 40 pb⁻¹
μ⁺μ⁻ mass (GeV/c²)
CMS Preliminary, √s = 7 TeV
L_int = 3.1 pb⁻¹
σ = 70 MeV/c²
|η^μ| < 1
Events / (0.07 GeV/c²)

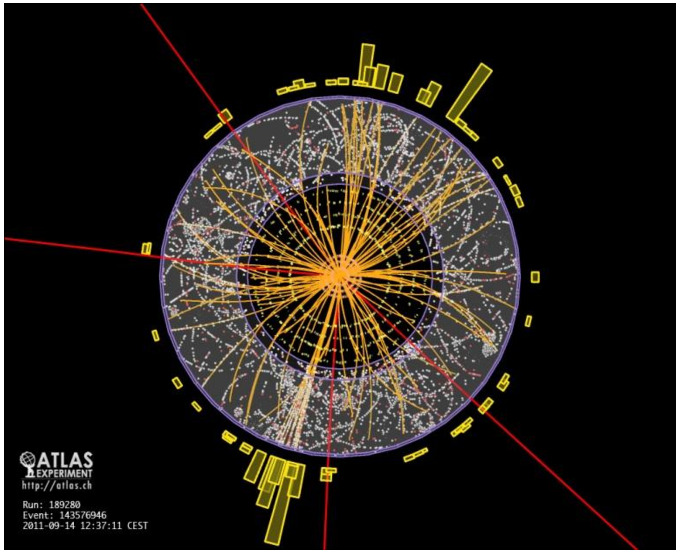
Brief History of the Standard Model

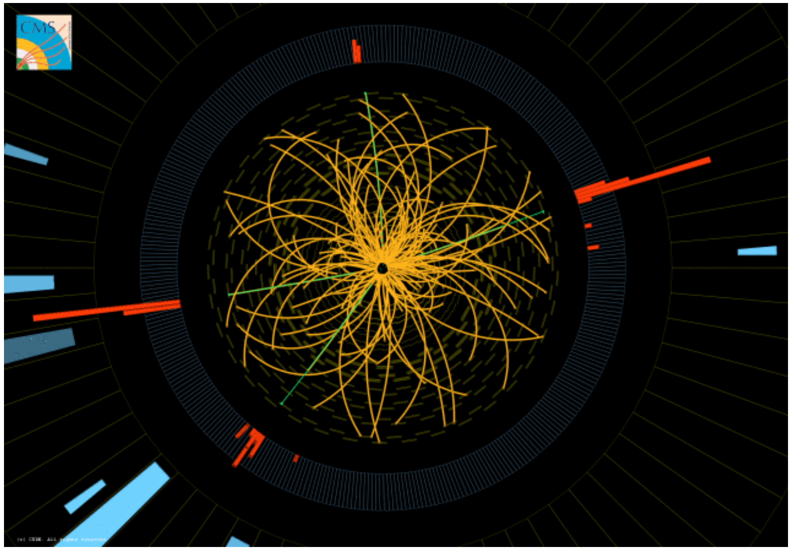


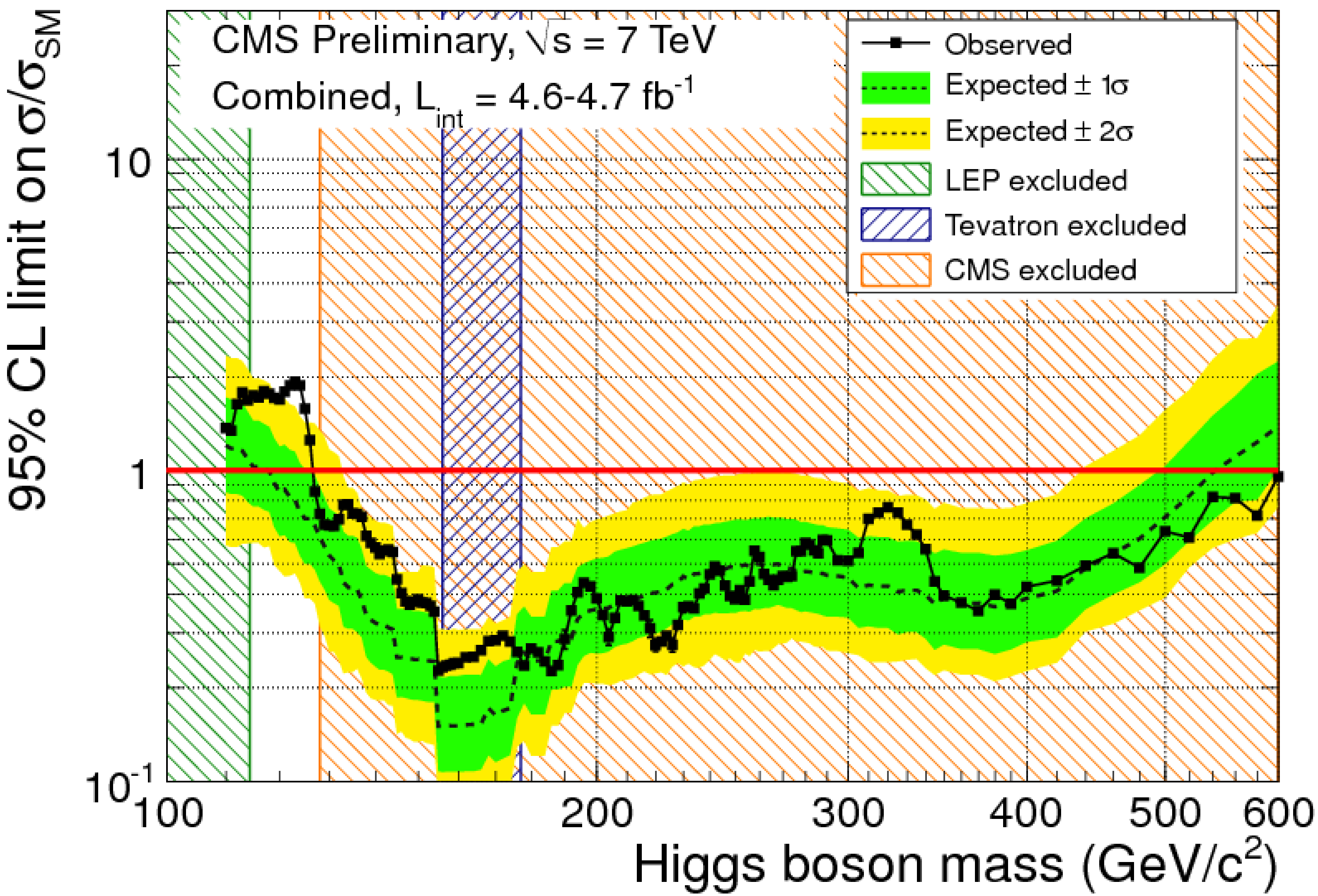
Hunting for Higgs…

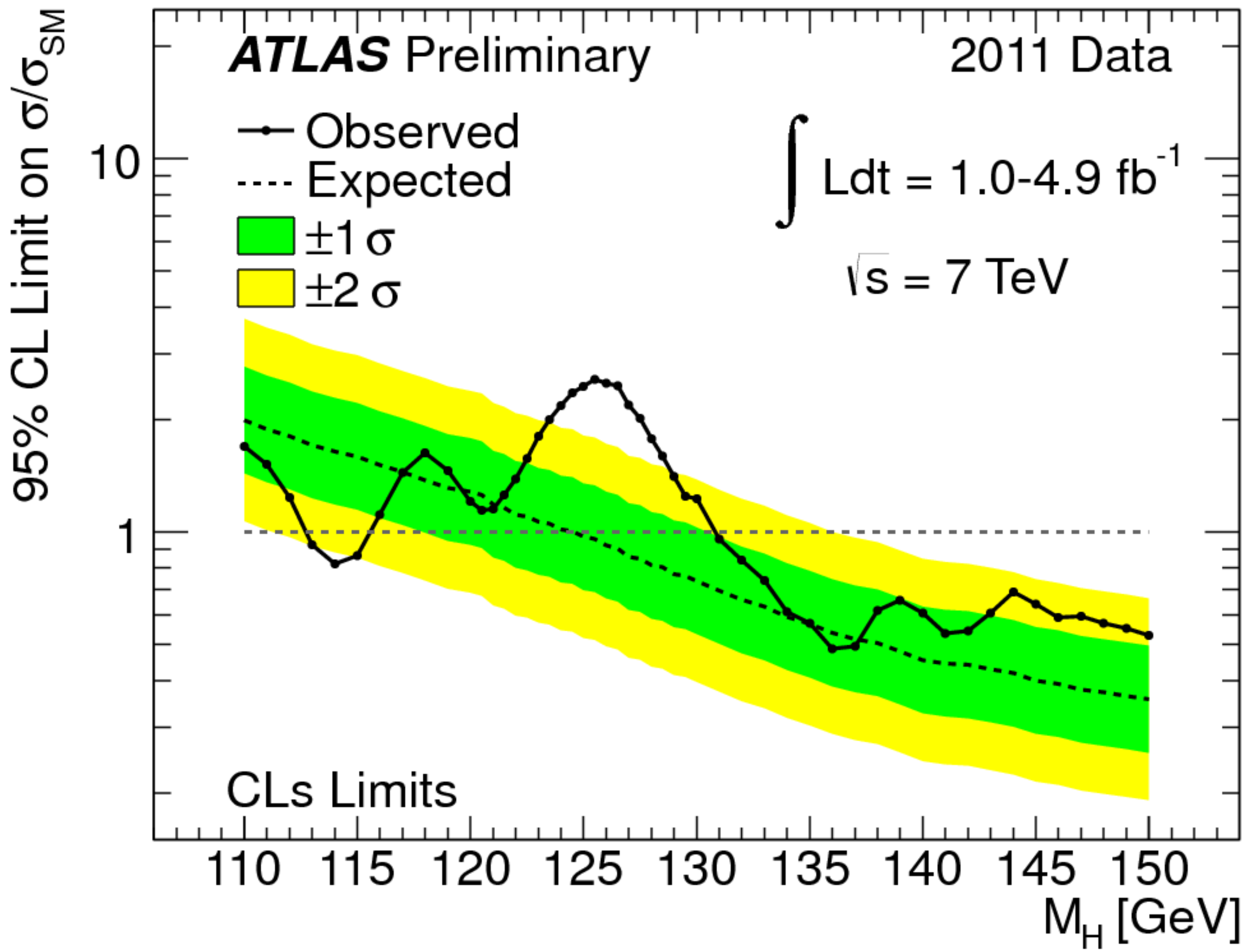




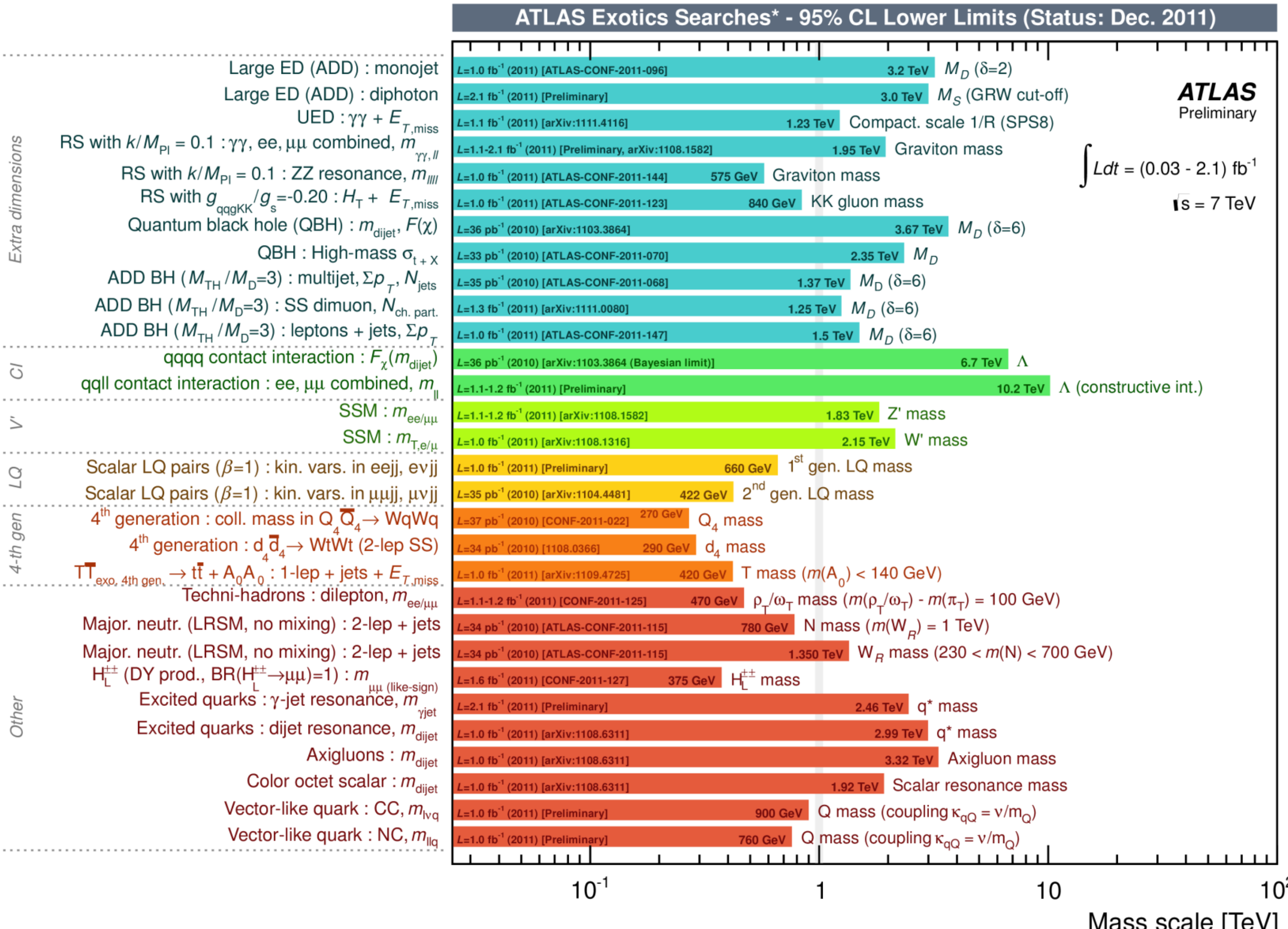




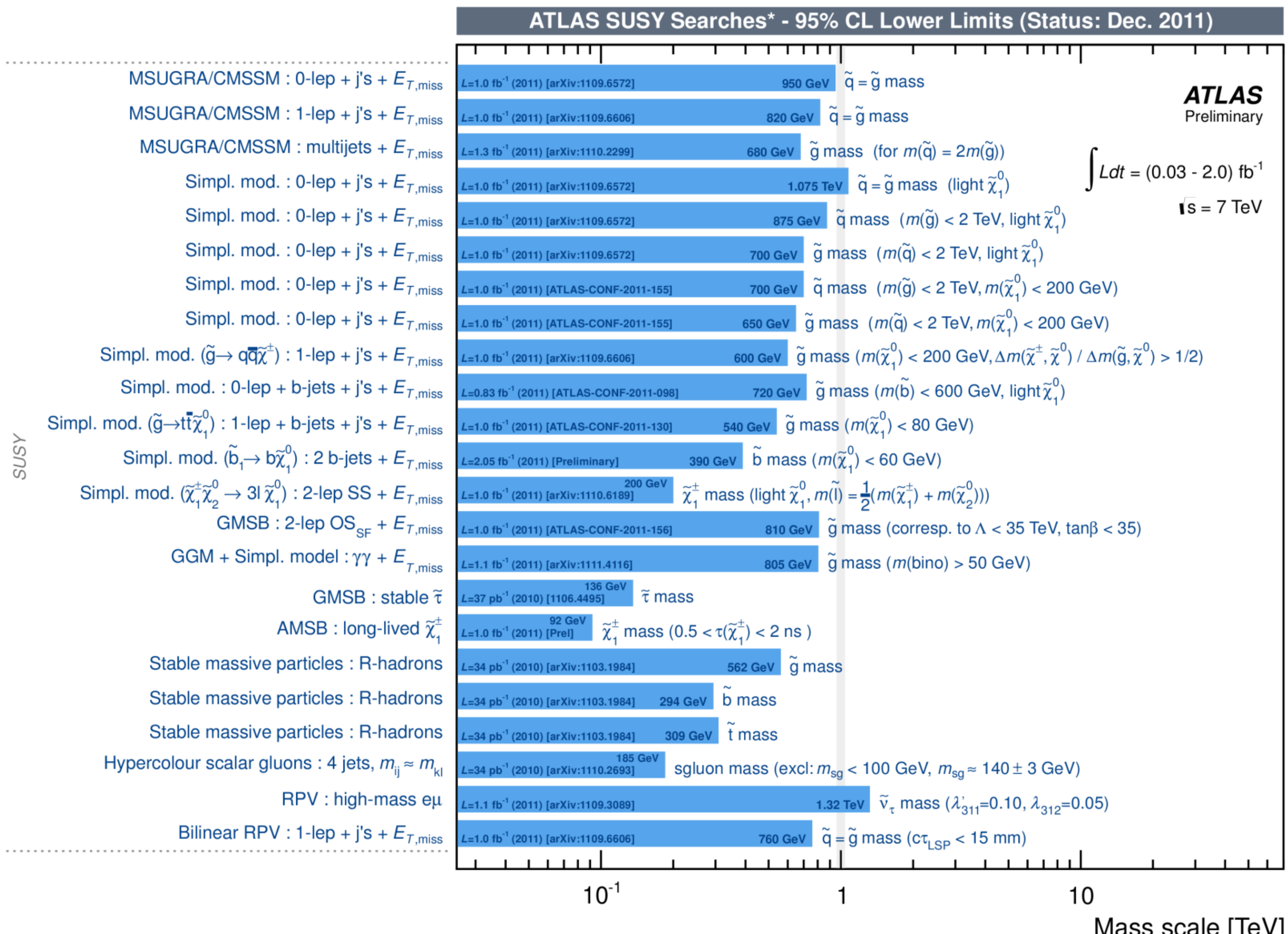

CMS Preliminary, √s = 7 TeV
Combined, L_int = 4.6-4.7 fb^-1
Observed
Expected ± 1σ
Expected ± 2σ
LEP excluded
Tevatron excluded
CMS excluded
95% CL limit on σ/σ_SM
10
1
10^-1
100
200
300
400
500
600
Higgs boson mass (GeV/c^2)



ATLAS Preliminary
2011 Data
Observed
Expected
±1 σ
±2 σ
$\int Ldt = 1.0\text{-}4.9\ fb^{-1}$
$\sqrt{s} = 7$ TeV
CLs Limits
95% CL Limit on σ/σ_{SM}
10
1
110
115
120
125
130
135
140
145
150
M_H [GeV]

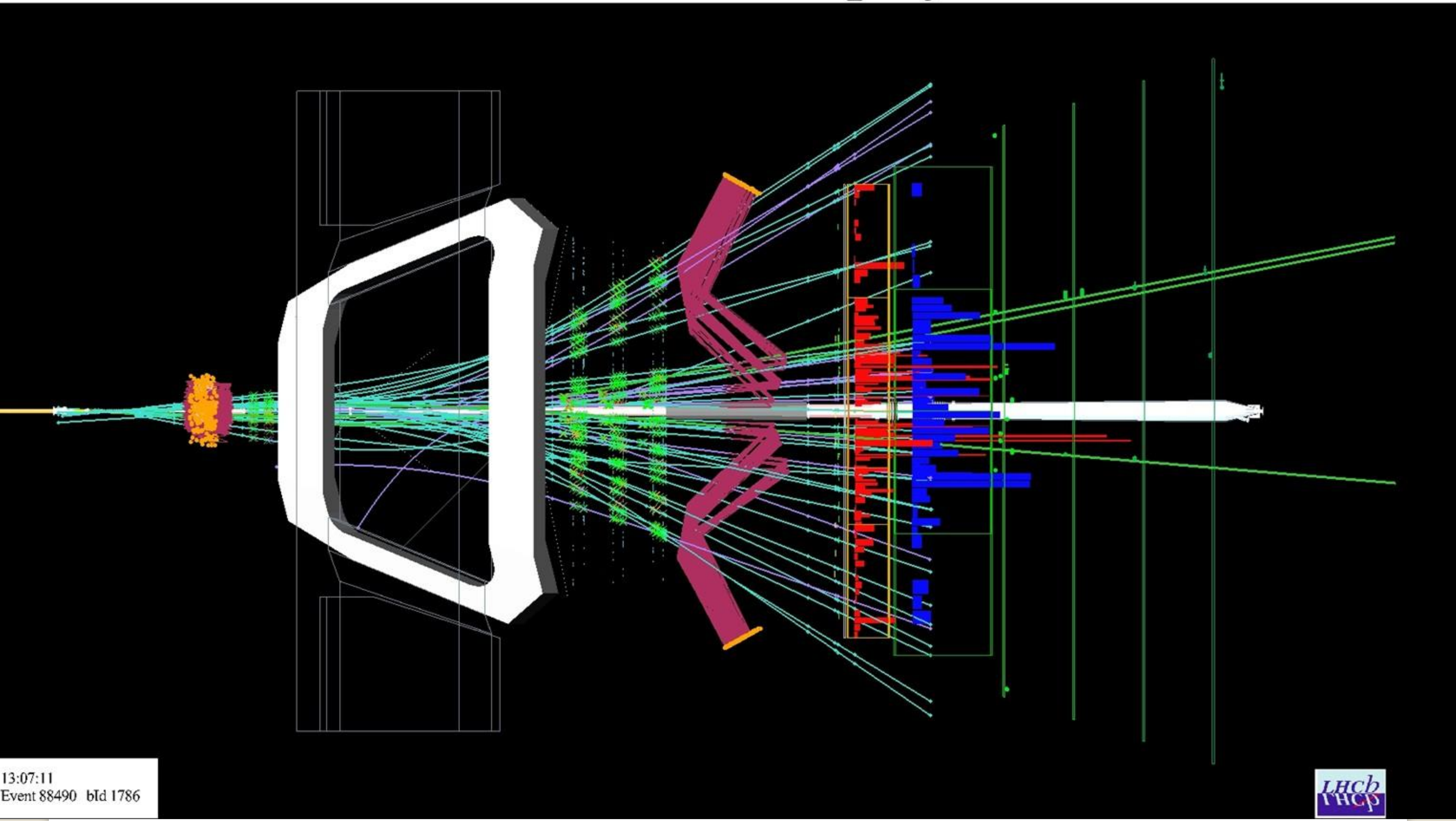


*Only a selection of the available results leading to mass limits shown

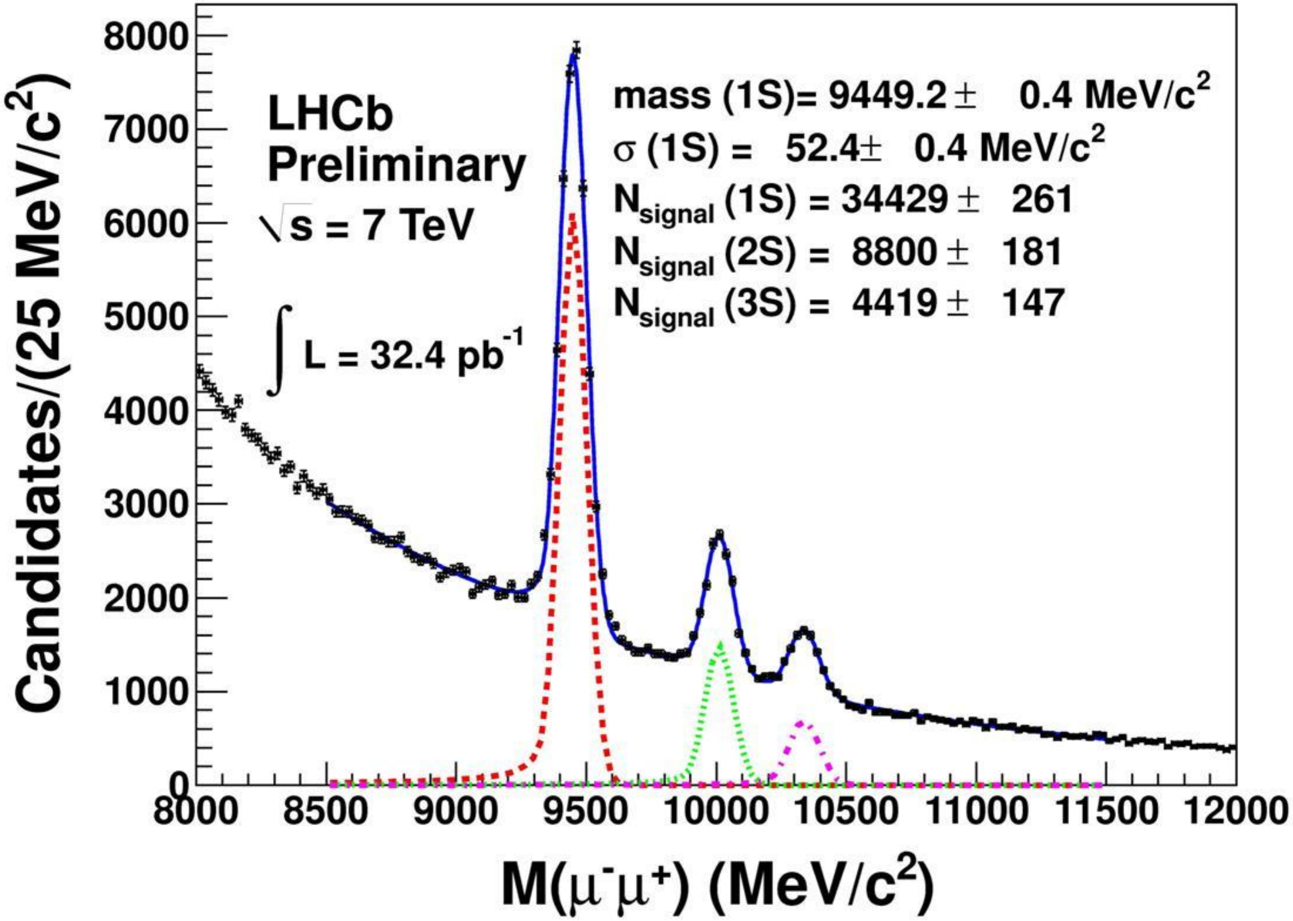


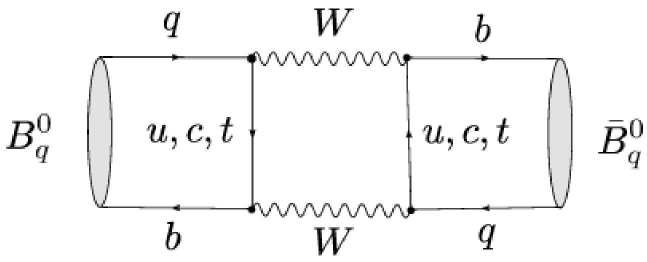
*Only a selection of the available results leading to mass limits shown

LHCb Event Display

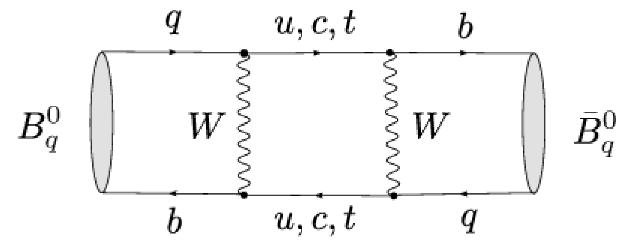


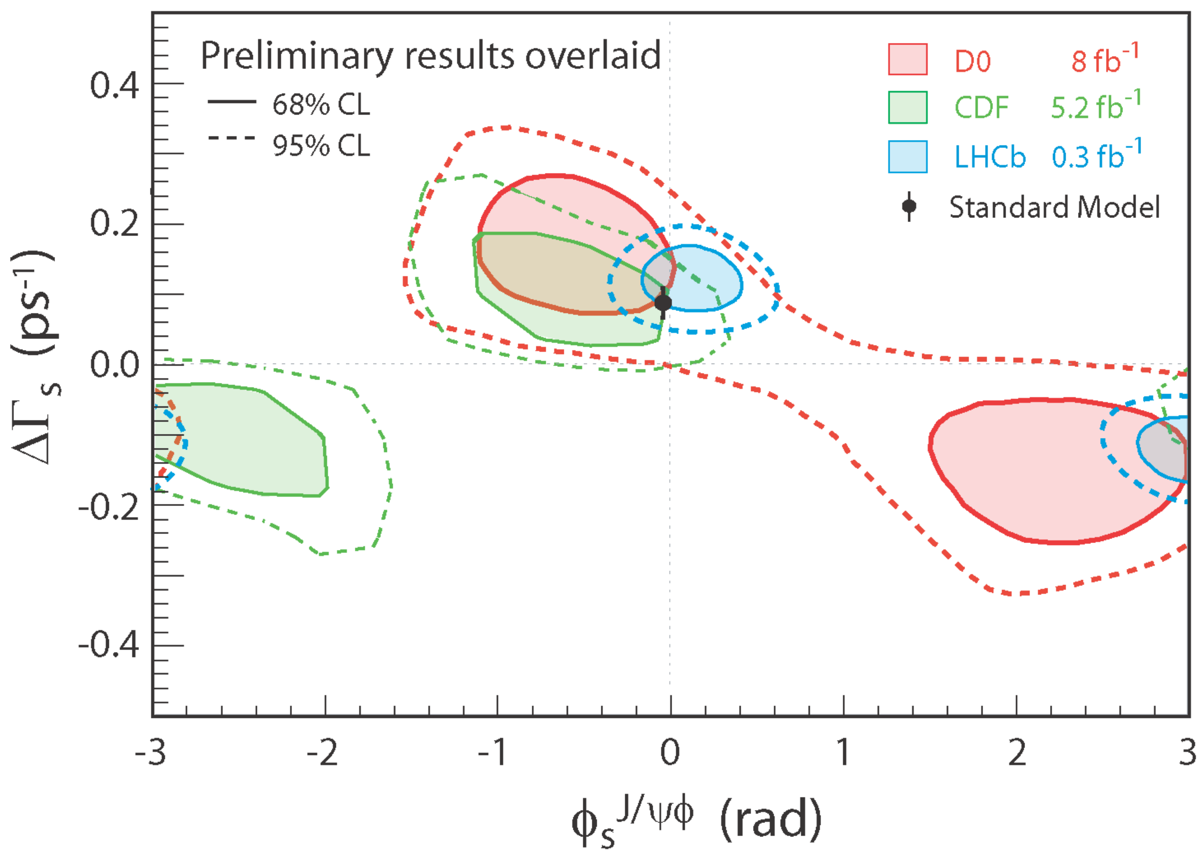
Bound states of b and anti-b quarks





CP-violating phase of B_s oscillations



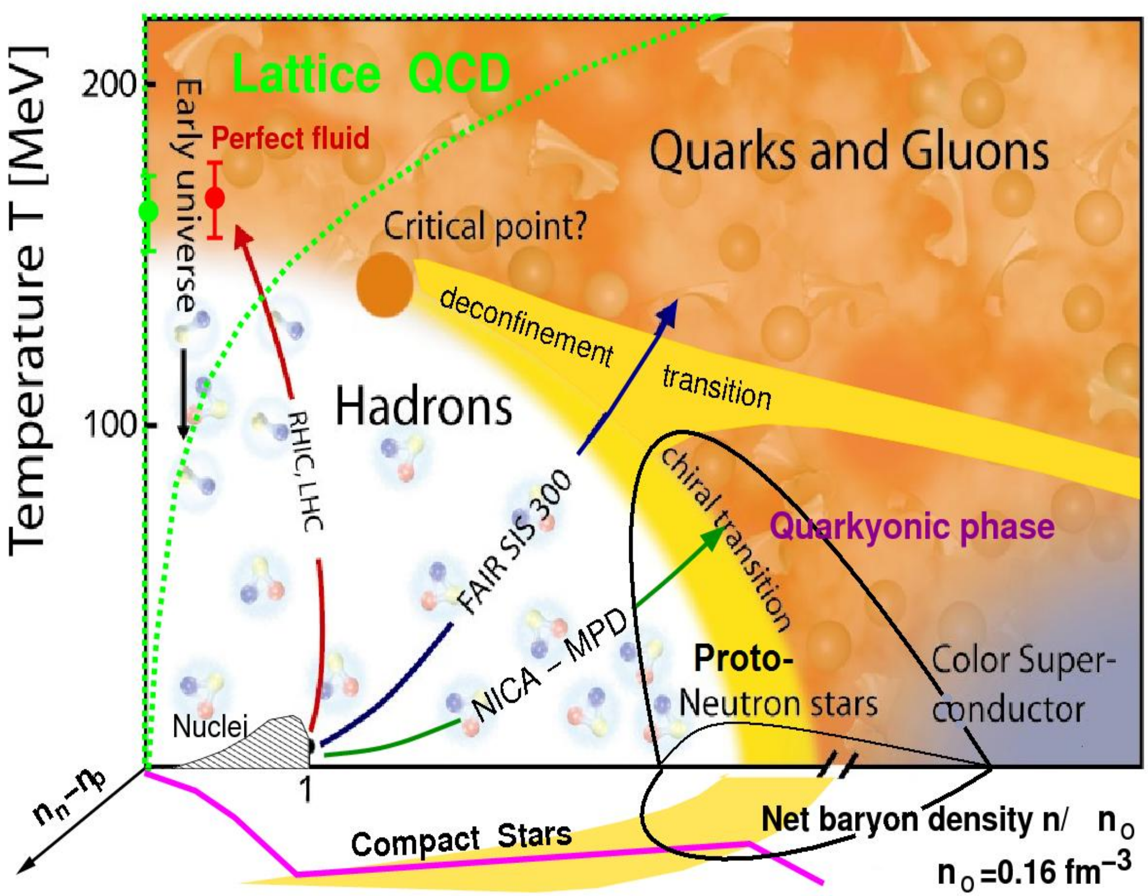


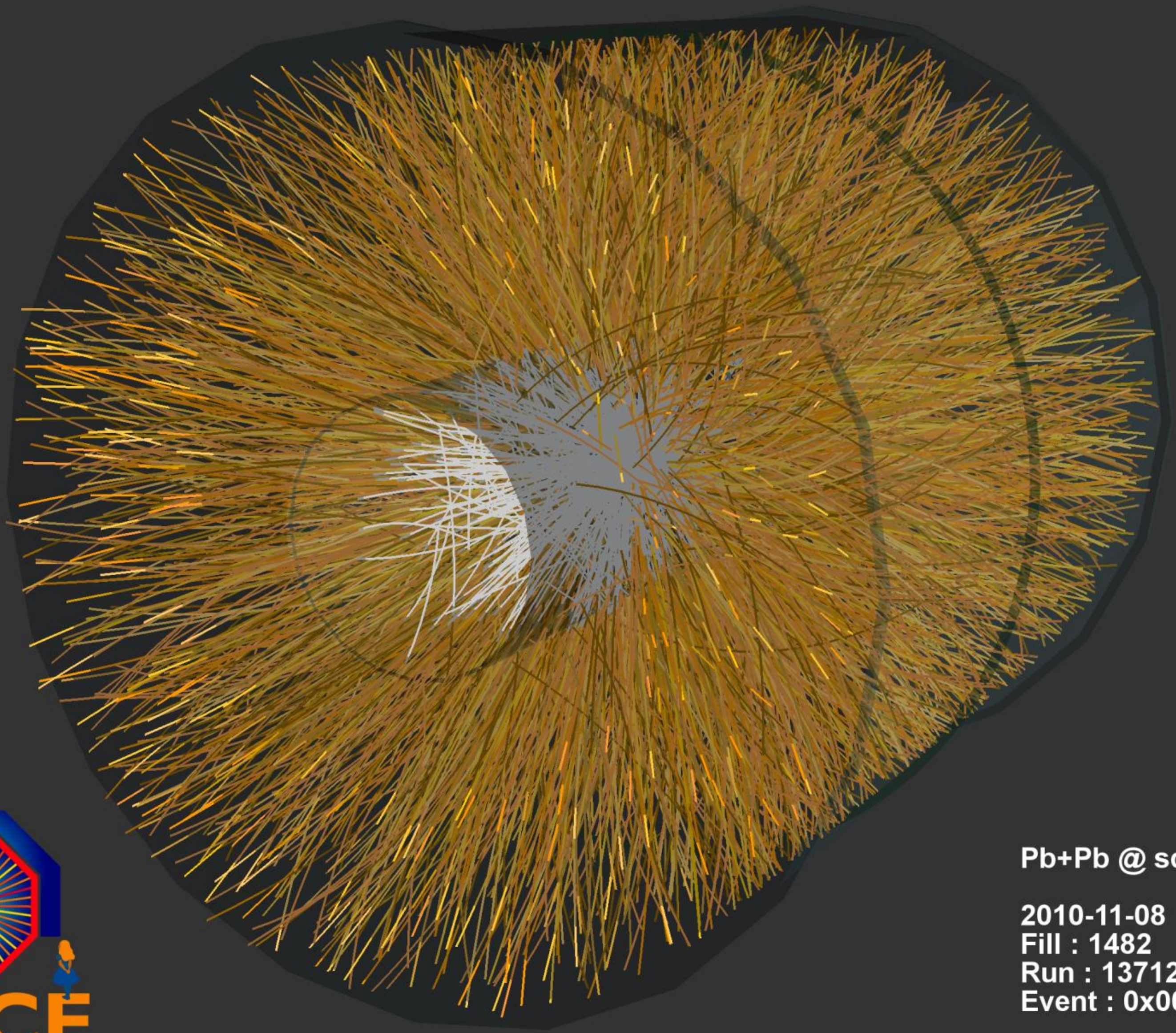
The primary goal of ALICE experiment is to study new state of matter, sometimes referred to as quark-gluon plasma

It is not plasma

RHIC

strongly coupled
(no obvious quasiparticles)
nearly ideal
(small viscosity)
liquid
(well described by hydrodynamics)

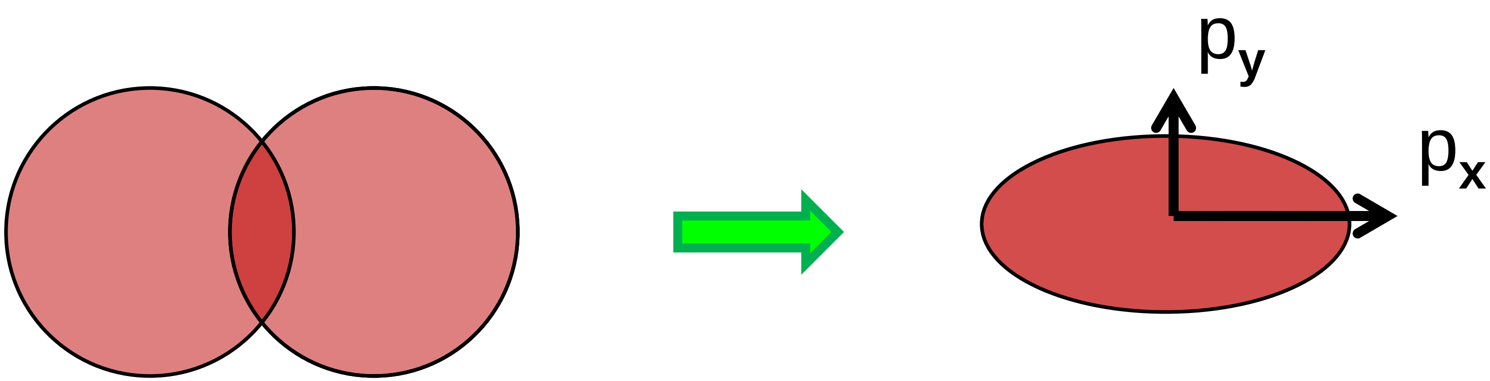




ALICE

Pb+Pb @ sqrt(s) = 2.76 ATeV

2010-11-08 11:30:46
Fill : 1482
Run : 137124
Event : 0x00000000D3BBE693

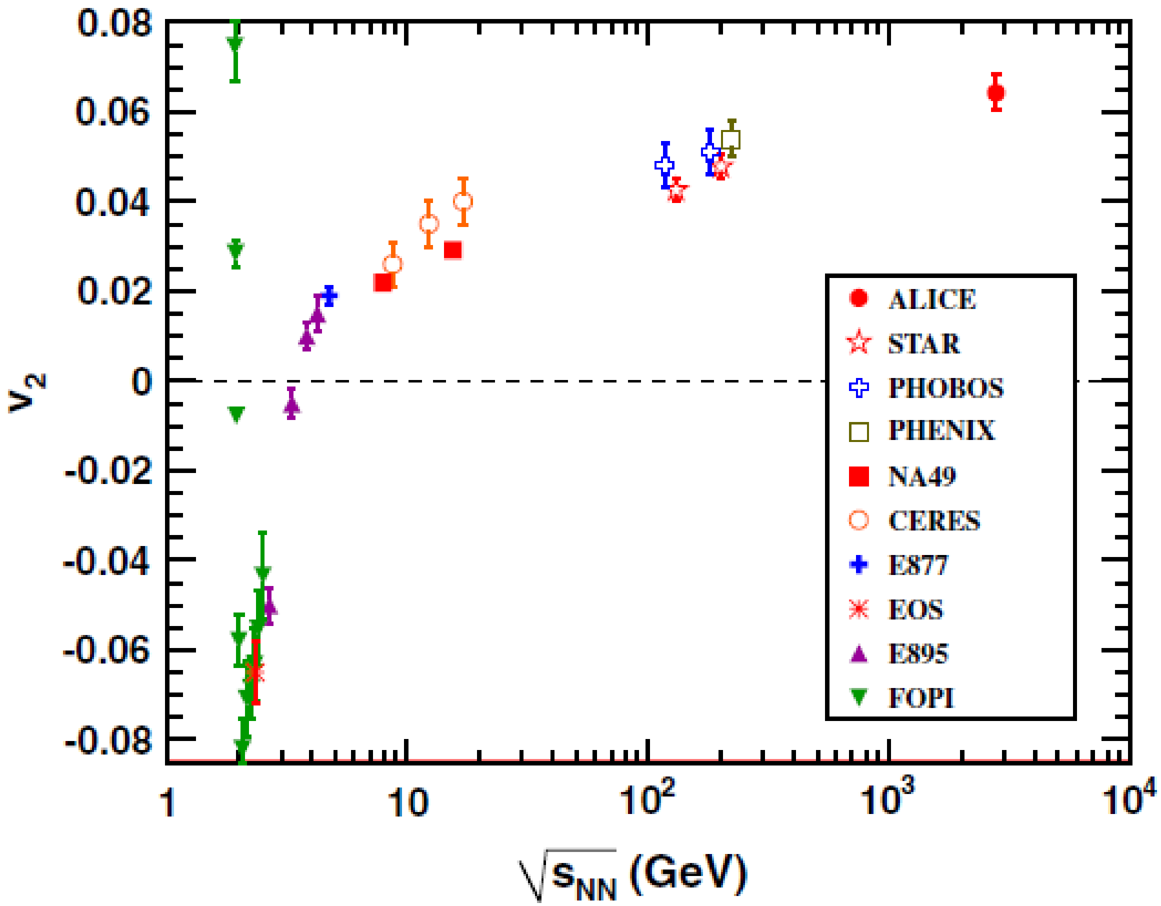


Coordinate space asymmetry is transformed into momentum space asymmetry

$$E\frac{d^3N}{d^3p} = \frac{1}{2\pi}\frac{d^2N}{p_t dp_t dy}\left(1 + \sum_{n=1}^{\infty} 2v_n \cos[n(\phi - \Psi_R)]\right)$$

Single event – no special symmetry

$$1+2v_1\cos(\phi-\Psi_1)+2v_2\cos(2(\phi-\Psi_2))+2v_3\cos(3(\phi-\Psi_3))+$$
$$+2v_4\cos(4(\phi-\Psi_4))+2v_5\cos(5(\phi-\Psi_5))+\ldots$$



The matter produced at LHC still behaves as very low viscosity fluid

(from PRL, 105 (2010) 252302)

Hydrodynamic description:

$$T^{\mu\nu} = (\epsilon + P)u^\mu u^\nu - P g^{\mu\nu} + \pi^{\mu\nu}$$

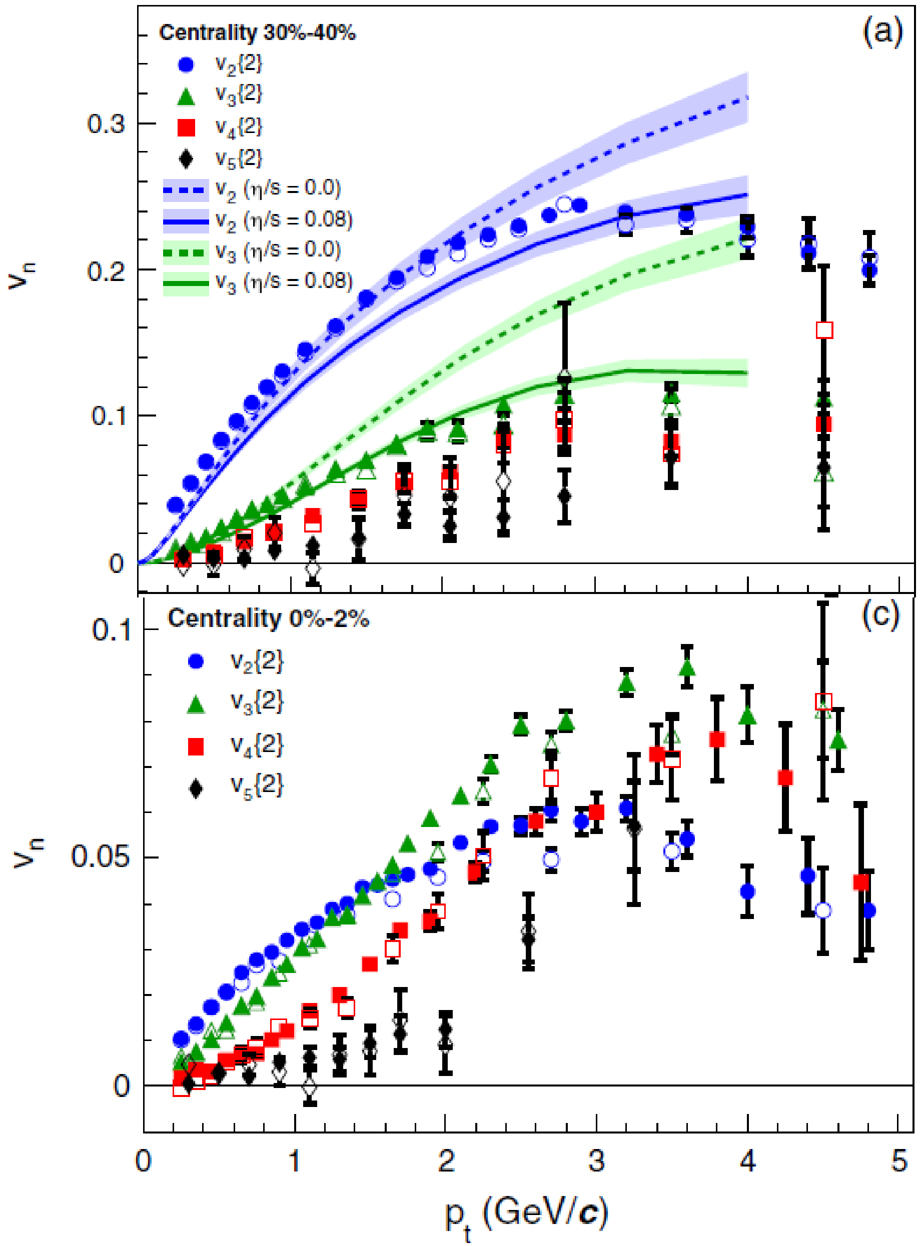
$$\pi^{\mu\nu} = \pi^{\mu\nu}_{(1)} = \eta(\nabla^\mu u^\nu + \nabla^\nu u^\mu - \tfrac{2}{3}\Delta^{\mu\nu}\nabla_\alpha u^\alpha)$$

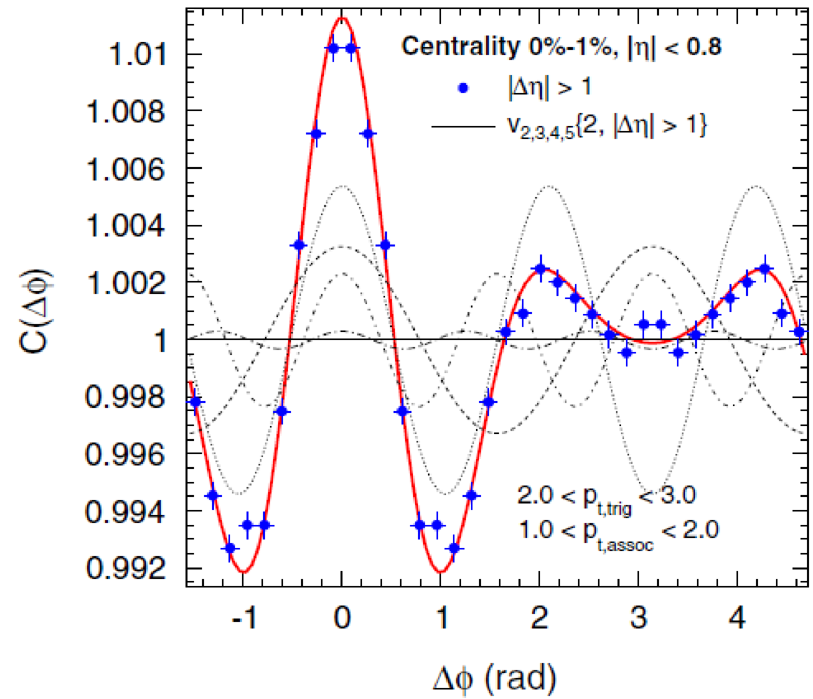
Equation of motion: $\partial_\mu T^{\mu\nu} = 0$

Equation of state: $\epsilon = \epsilon(P)$

Emergent conformal symmetry for effective theory:

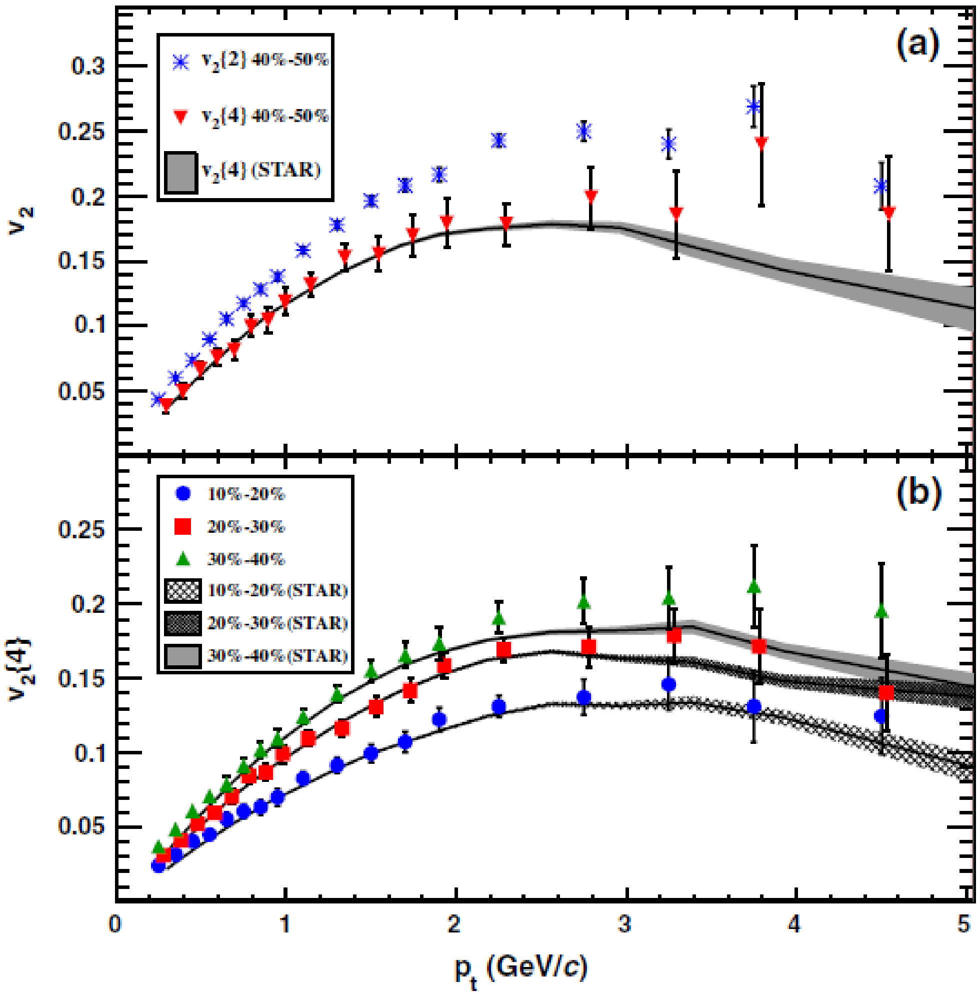
$$T^\mu_\mu = 0$$

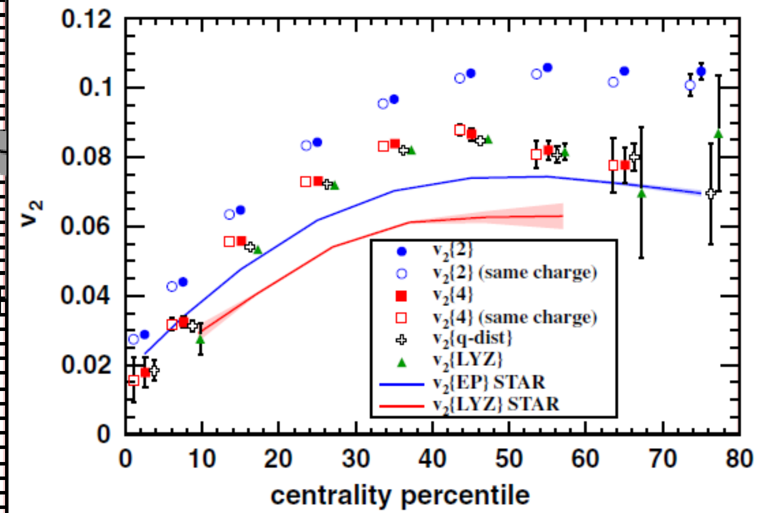




Higher harmonic anisotropic flow

(from PRL, 107 (2011) 032301)

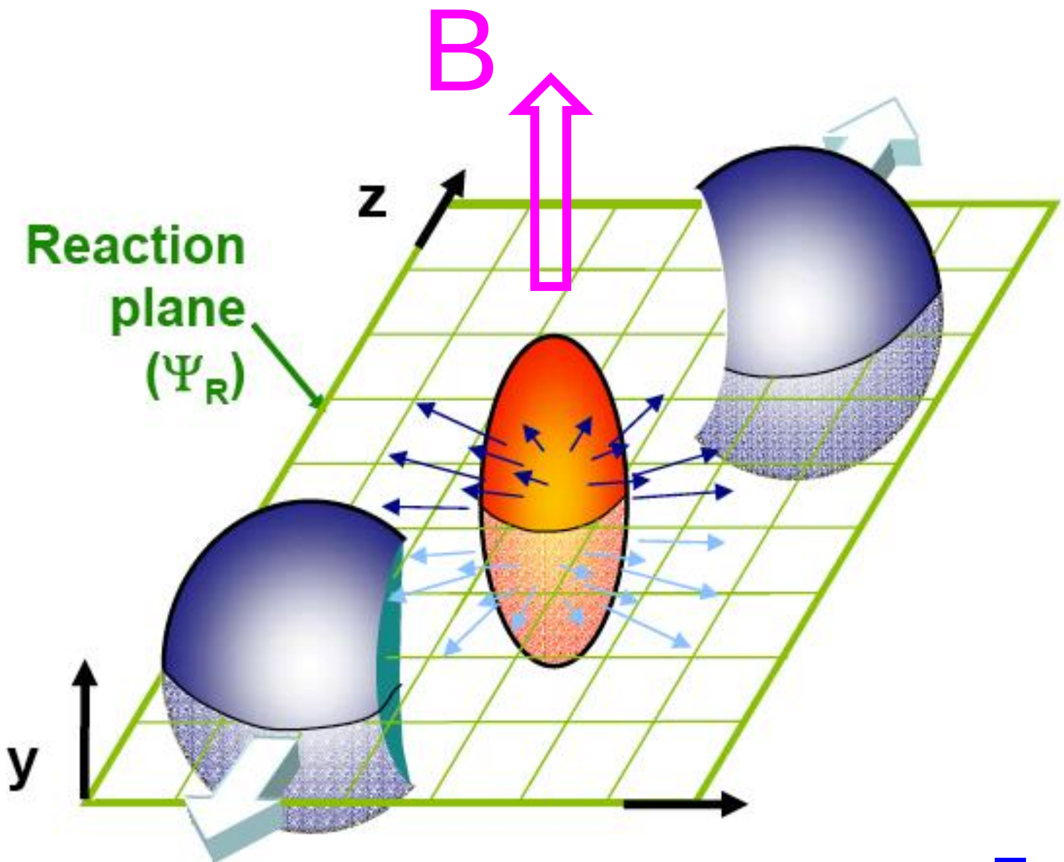


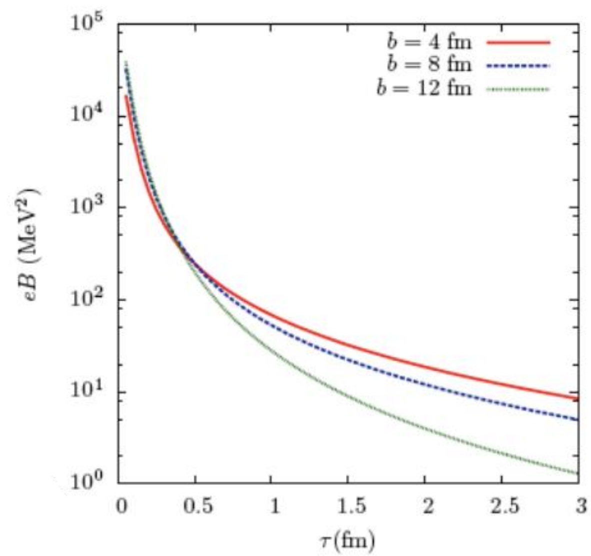


Elliptic flow does not change much
from RHIC to LHC

(from PRL, 105 (2010) 252302)

P-violation in heavy ions collisions?





(Kharzeev, McLerran, Warringa, '08)

Fate of chiral symmetry?

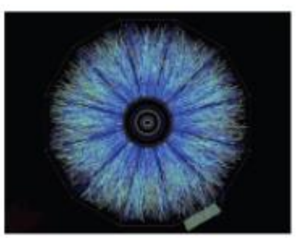
$$\sqrt{B} = 10 \div 100 \text{ MeV}$$

$$\langle 0|\bar{\psi}\psi|0\rangle \neq 0$$

Comparison of magnetic fields

The Earths magnetic field	0.6 Gauss
A common, hand-held magnet	100 Gauss
The strongest steady magnetic fields achieved so far in the laboratory	4.5×10^5 Gauss
The strongest man-made fields ever achieved, if only briefly	10^7 Gauss
Typical surface, polar magnetic fields of radio pulsars	10^{13} Gauss
Surface field of Magnetars	10^{15} Gauss

http://solomon.as.utexas.edu/~duncan/magnetar.html



Heavy ion collisions: the strongest magnetic field ever achieved in the laboratory

Off central Gold-Gold Collisions at 100 GeV per nucleon

$$e\,B(\tau = 0.2\,\mathrm{fm}) \;=\; 10^3 \sim 10^4\ \mathrm{MeV}^2 \sim 10^{17}\,\mathrm{Gauss}$$

(slide from D.Kharzeev)

A seminal suggestion:

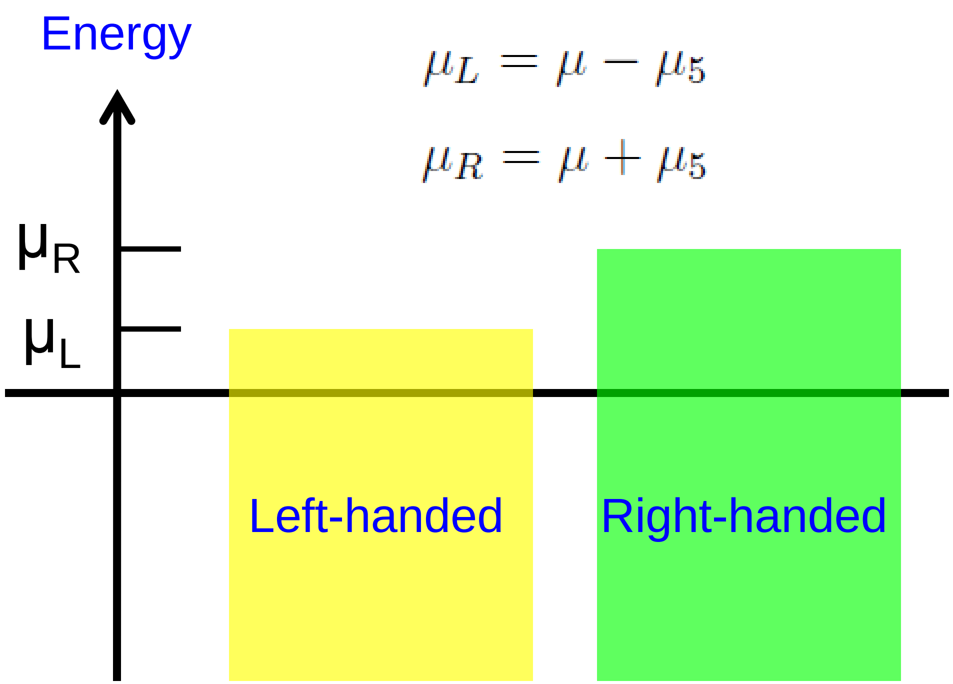
Kharzeev, Pisarski, Tytgat, ’98; Halperin, Zhitnitsky, ‘98; Kharzeev, ’04; Kharzeev, McLerran, Warringa ’07; Kharzeev, Fukushima, Warringa ’08

Possible experimental manifestations of **chiral magnetic effect** in heavy ion collisions ?

$$\boxed{\mathbf{j} = \frac{e^2}{2\pi^2}\mu_5 \mathbf{B}}$$

$$\mu_L = \mu - \mu_5$$

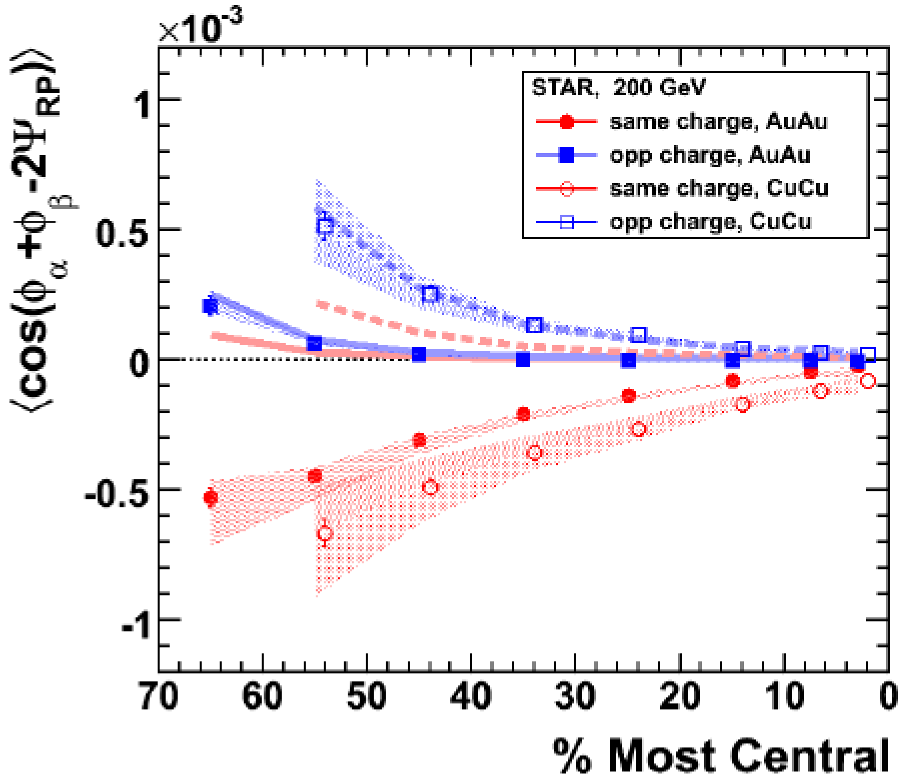
$$\mu_R = \mu + \mu_5$$



Many complementary ways to derive (Chern-Simons, linear response, triangle loop etc). At effective Lagrangian level

$$\mu_5 \sim \dot{\theta}$$

Robust theoretical effect



P-parity forbidden correlators may be nonzero in external fields. Manifestation of chiral magnetic effect?

$$i \int dx\, e^{iq(x-y)} \langle \Omega | j_\mu(x) \cdot \partial j^{5,a}(y) | \Omega \rangle = \mathrm{Tr}\,[Q^2 t^a] \cdot \left(-\frac{N_c}{4\pi^2} \right) \cdot q_\nu \tilde{F}_{\mu\nu}$$

Subtle interplay of strong and electromagnetic anomalies

Conclusion

1). By the end of 2012 Higgs boson of the Standard Model will be either found (with the mass about 128 GeV) or ruled out in ATLAS and CMS experiments

2). In the latter case new effects in interactions of W and Z bosons are to be seen

3). By the end of 2012 a few minimal New Physics scenarios will be closed (or their effects seen)

4). Only SM Higgs in ATLAS and CMS and nothing in LHCb – Nightmare Scenario

THERE ARE MORE THINGS IN HEAVEN AND EARTH, HORATIO, THAN ARE DREAMT OF IN YOUR PHILOSOPHY.

W.SHAKESPEARE, HAMLET
ACT 1, SCENE 5

Все, что на волю Высшую согласно,
Своею волей чуждую творит,
И под личиной вещества бесстрастной
Везде огонь Божественный горит.

В.С.Соловьев