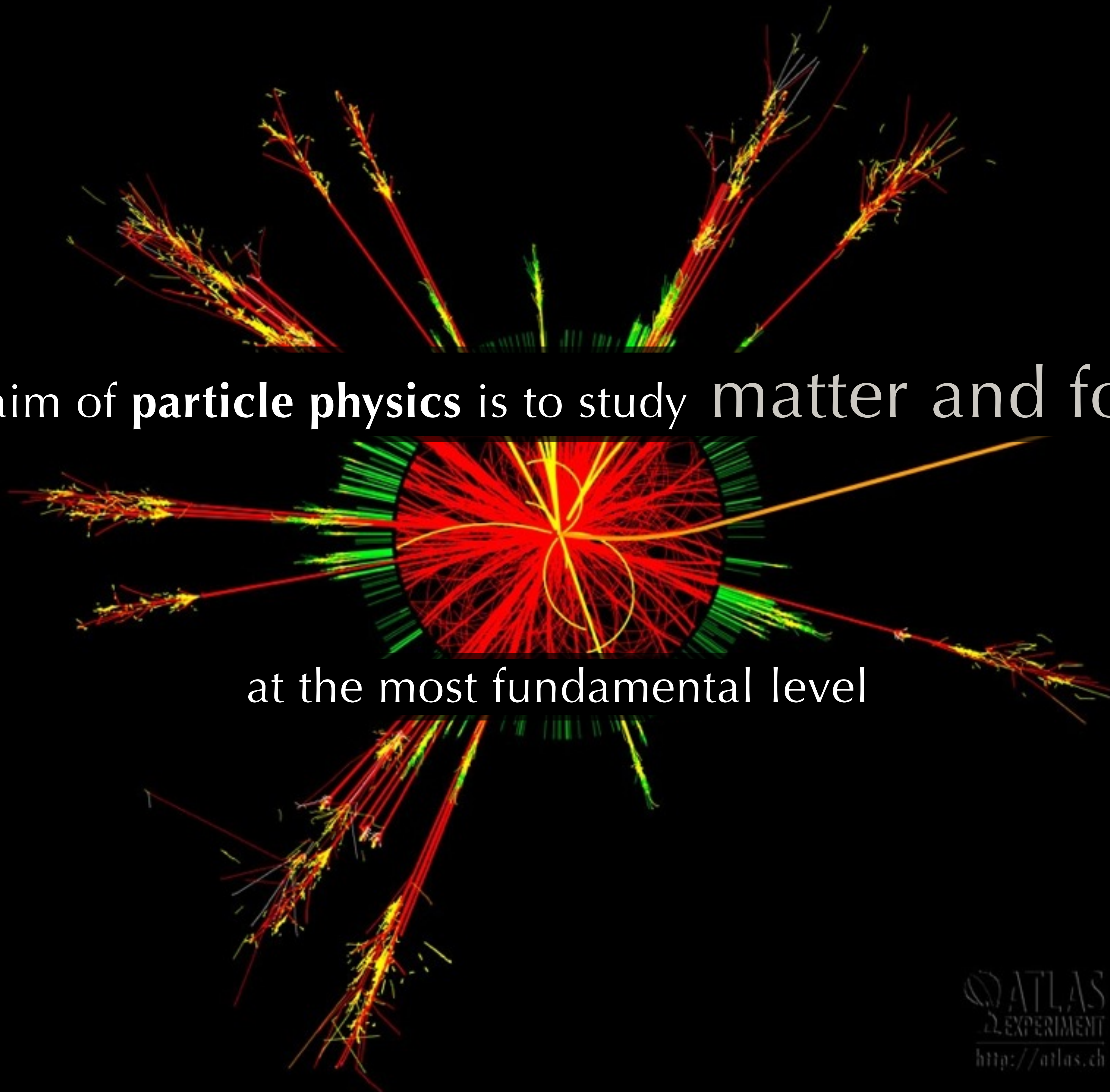
ARC Centre of Excellence for
Particle Physics at the Terascale

Introduction by Peter Skands
School of Physics and Astronomy
Monash University

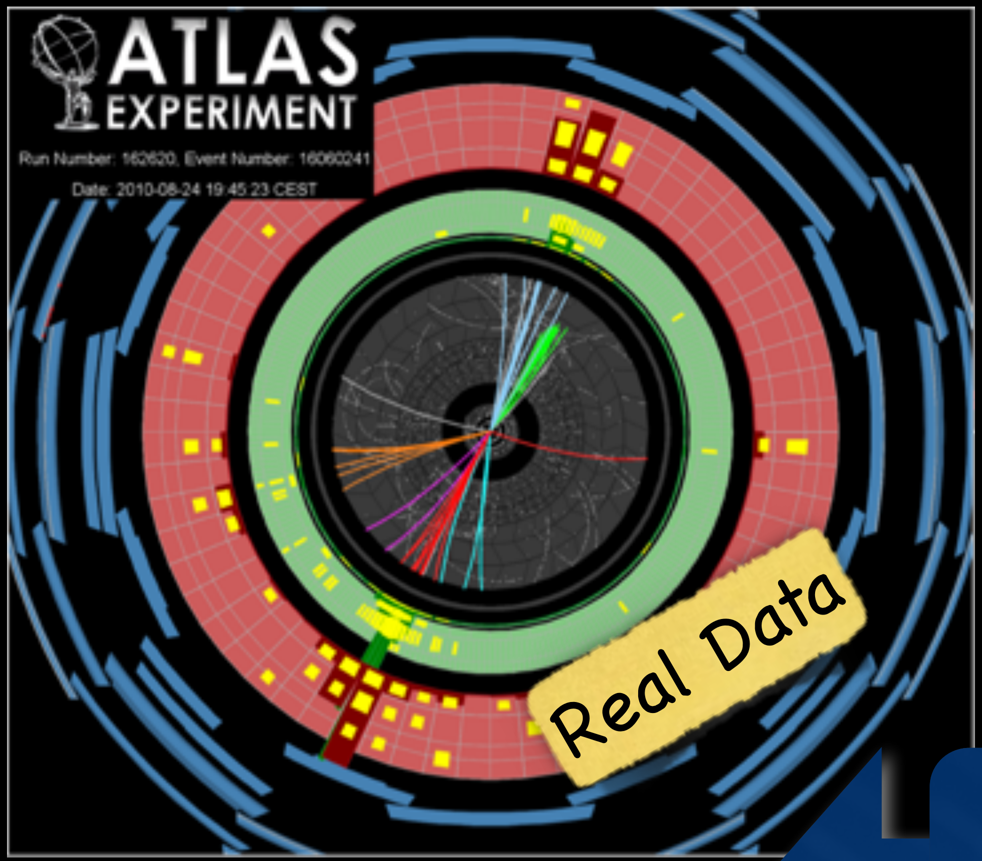
Particle Fever

The aim of **particle physics** is to study matter and force

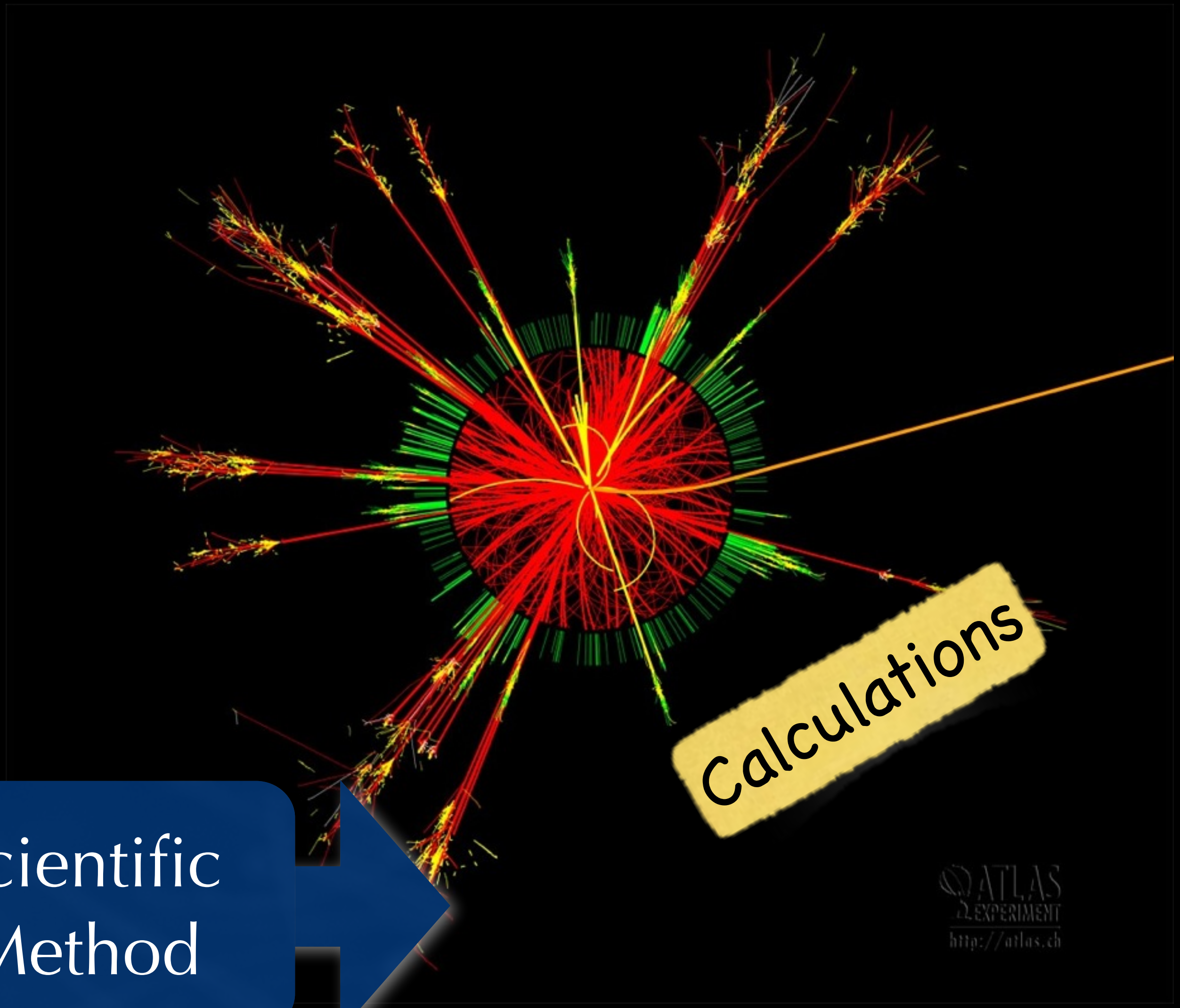
at the most fundamental level



Theory vs Experiment



Real Data



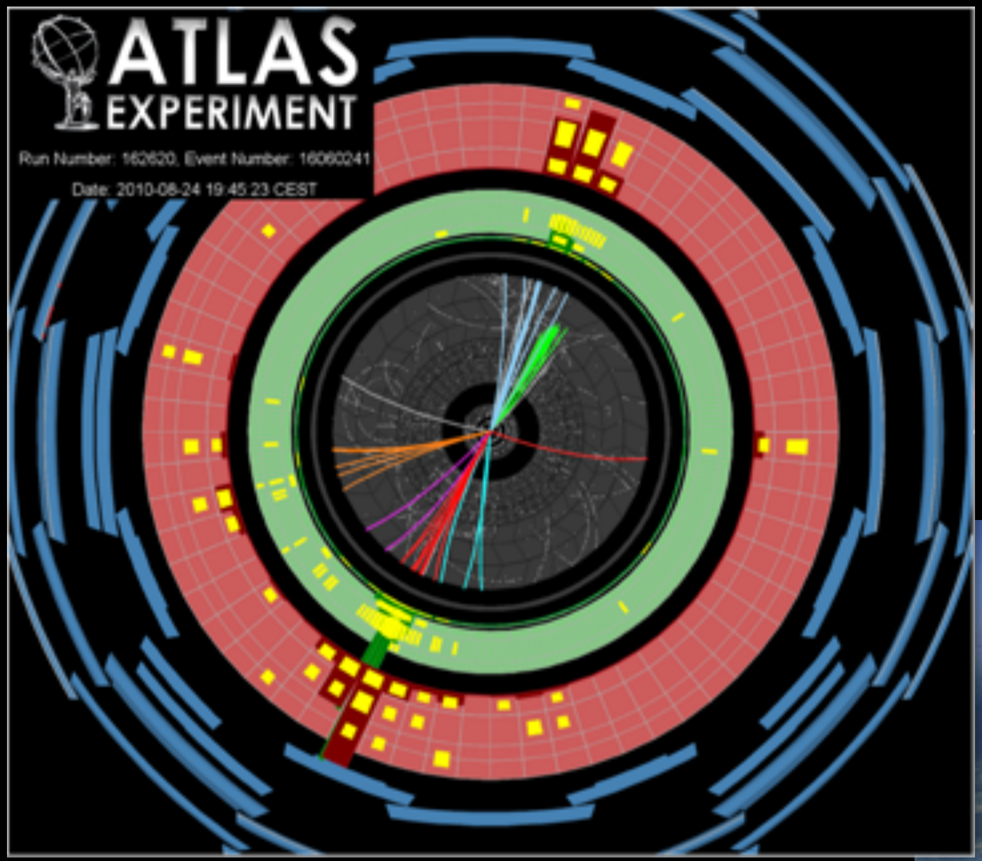
Calculations

Scientific Method

Real Universe

Theory Model

The Large Hadron Collider



The LHC at CERN currently produces the highest energies we can create in lab conditions

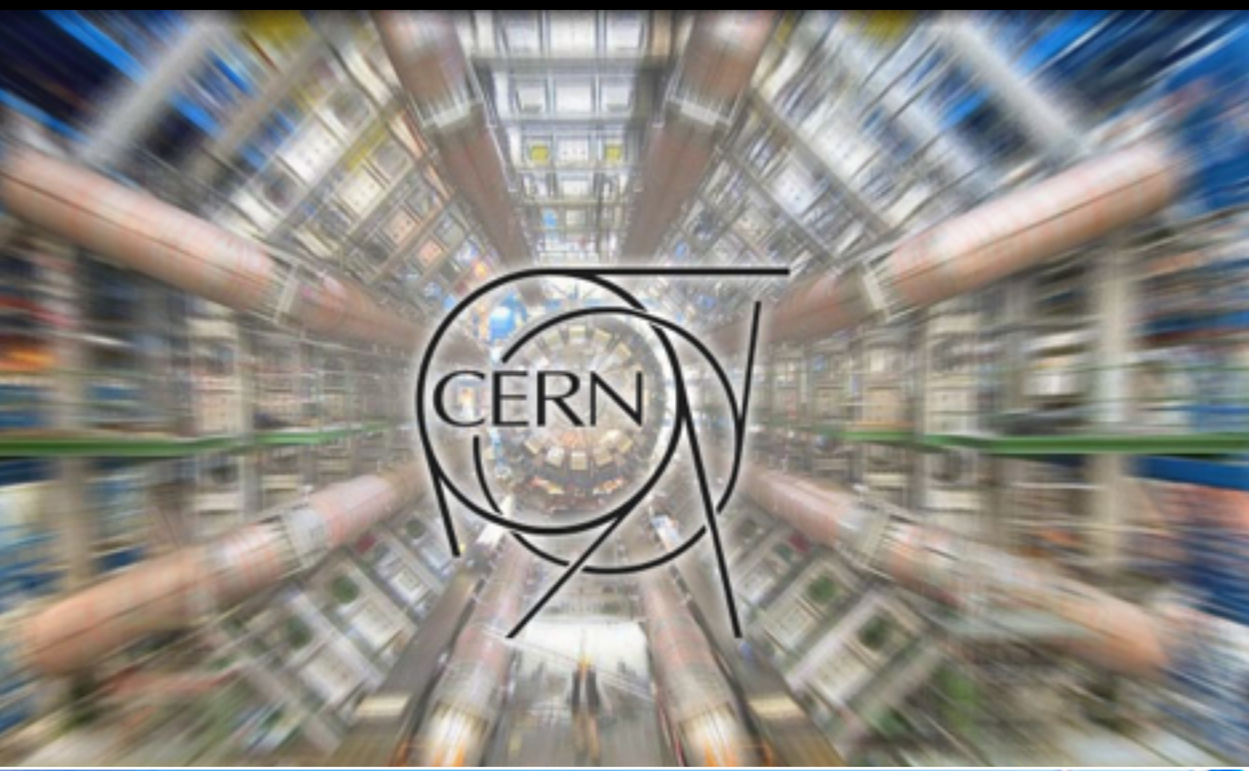
"Stable beams" for run 2: June 3rd, 2015

Collision Energy now: 13 Tera-eV
(~ 1 million times higher than nuclear fusion)

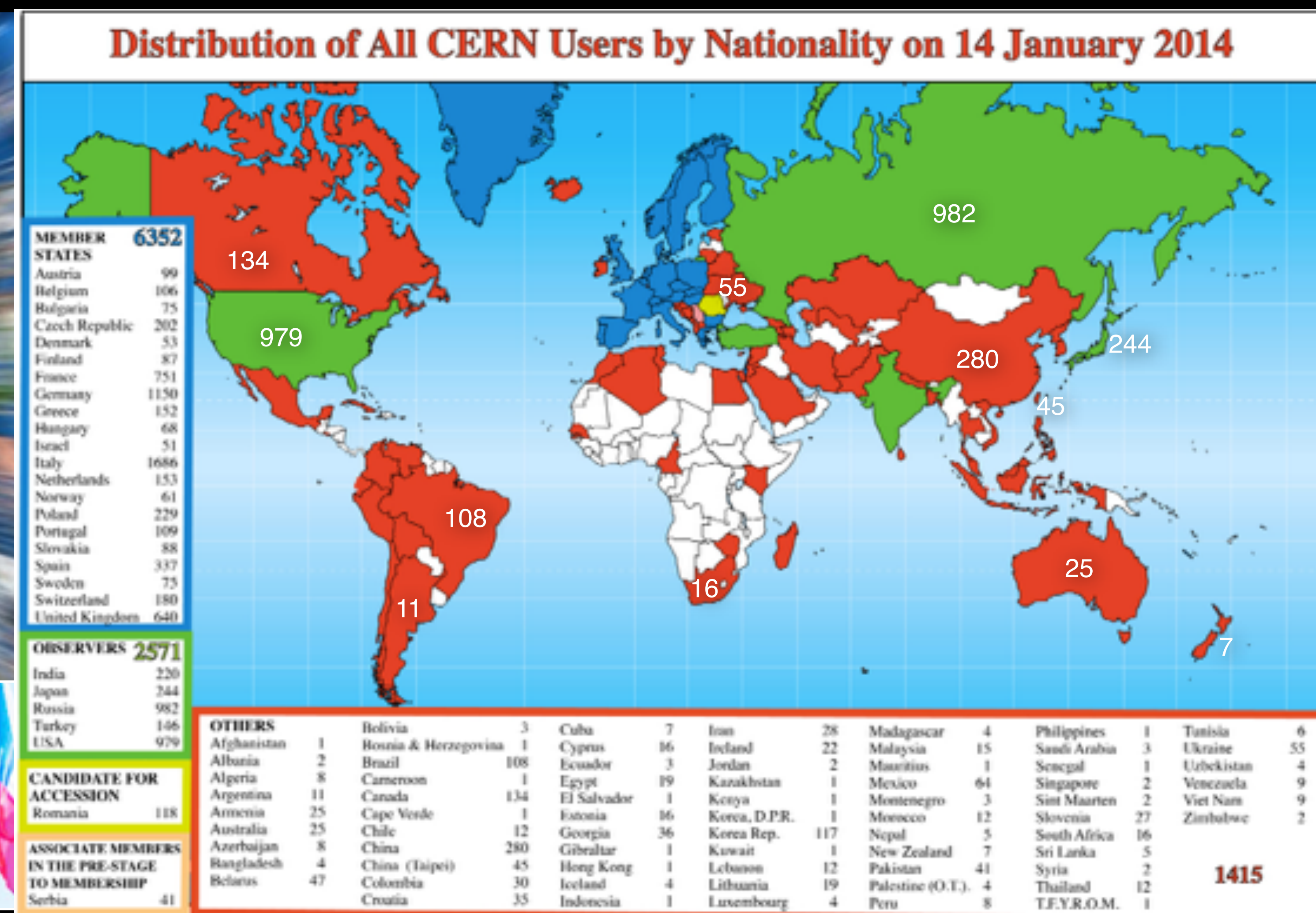
CERN: European Organization for Nuclear Research

20 European Member States and around 60 other countries

~ 10 000 scientists work at CERN.



Flags of CERN's Member States



Yearly budget ~ 1 billion CHF ~ 1.4 billion AUD

Colliding Protons

Many from One (well … from Two, really)

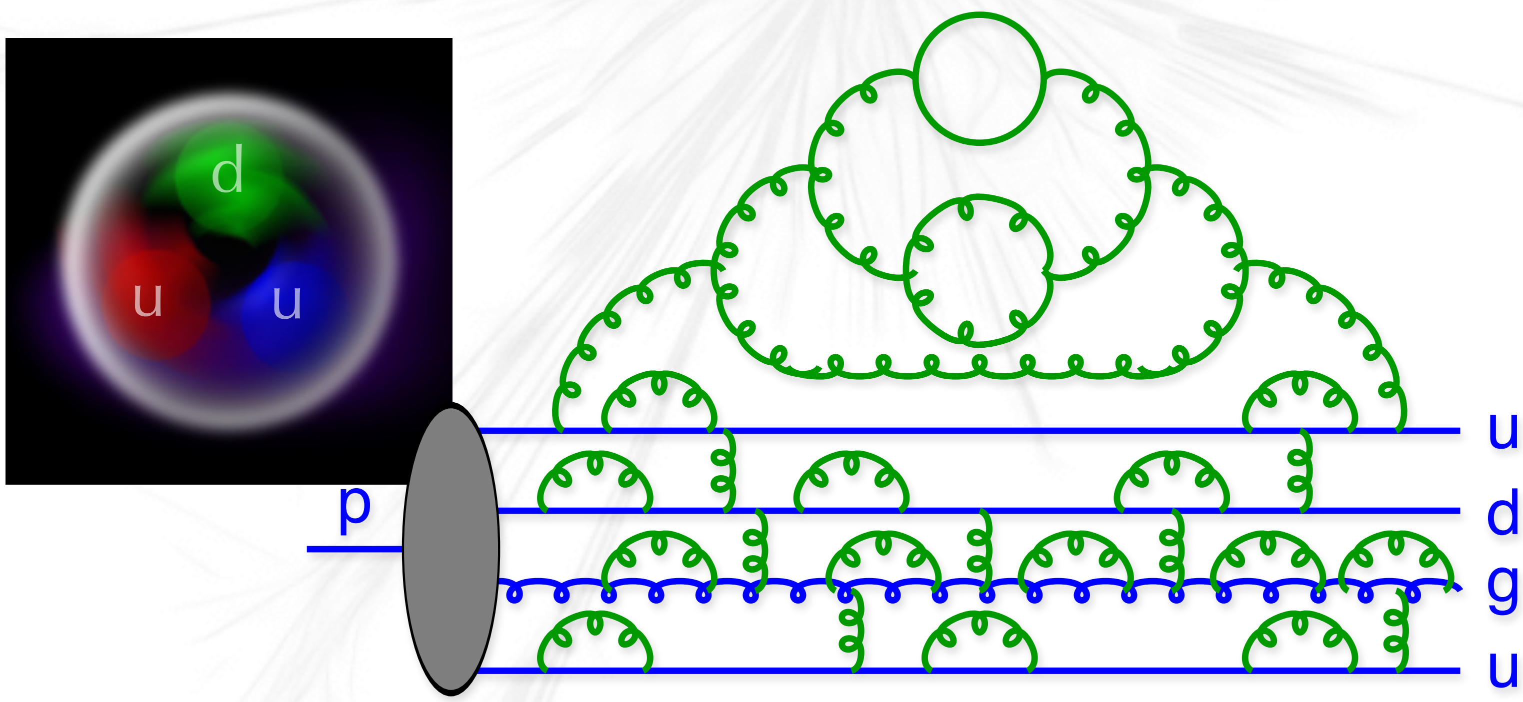
Quantum processes can convert the kinetic energy of the beam particles into rest energy (mass) + momentum of outgoing particles

$$E = mc^2\sqrt{1 + p^2/(m^2c^2)}$$

E = energy
m = mass
p = momentum
c = speed of light

What are we really colliding?

Take a look at the quantum level



Such Stuff as Beams are Made Of

Lifetime of typical fluctuation ~ r_p/c (=time it takes light to cross a proton)

~ 10^{-23} s; Corresponds to a frequency of ~ 500 billion THz

To the LHC, that's slow! (reaches "shutter speeds" thousands of times faster)

Planck-Einstein: $E=h\nu$ ➜ ν_{LHC} = 13 TeV/h = 3.14 million billion THz

➜ Protons look "frozen" at moment of collision

But they have a lot more than just two "u" quarks and a "d" inside

Hard to calculate, so use statistics to parametrise the structure

Every so often I will pick a gluon, every so often a quark (or antiquark)

Measured at previous colliders, as function of energy fraction

Then compute the probability for all possible quark and gluon reactions and compare with experiments …

OK… there's a bit more to it, but you get the idea


LHC@home 2.0
Test4Theory - A Virtual Atom Smasher
p
p
citizen cyberLab
citizen cyberscience centre
LHC@home
CERN
SEVENTH FRAMEWORK PROGRAMME
MCnet
LPCC
LHC Physics Center at CERN
Over 2000 billion simulated collision events

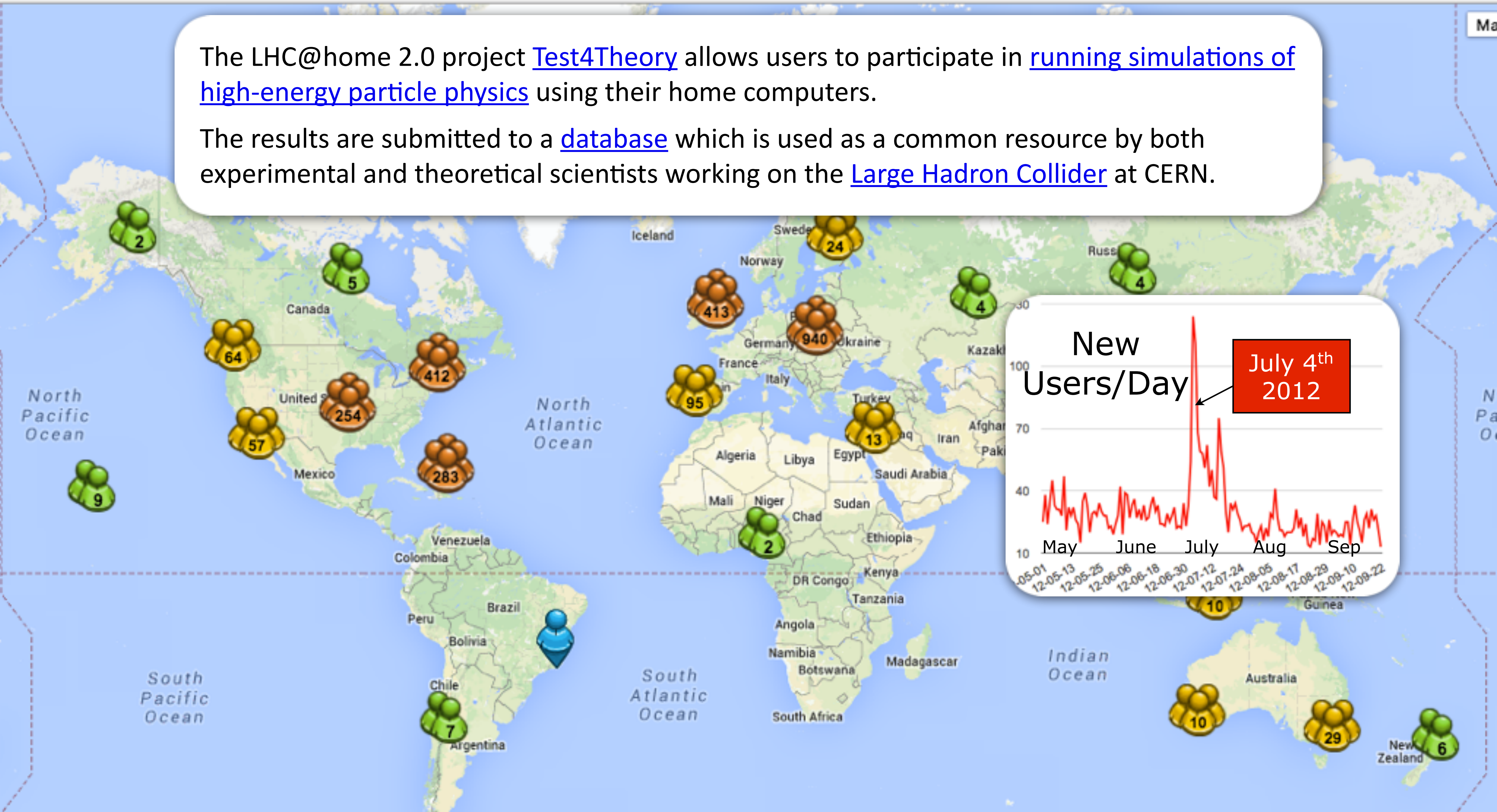
Test4Theory - LHC@home

http://lhcathome.web.cern.ch/projects/test4theory

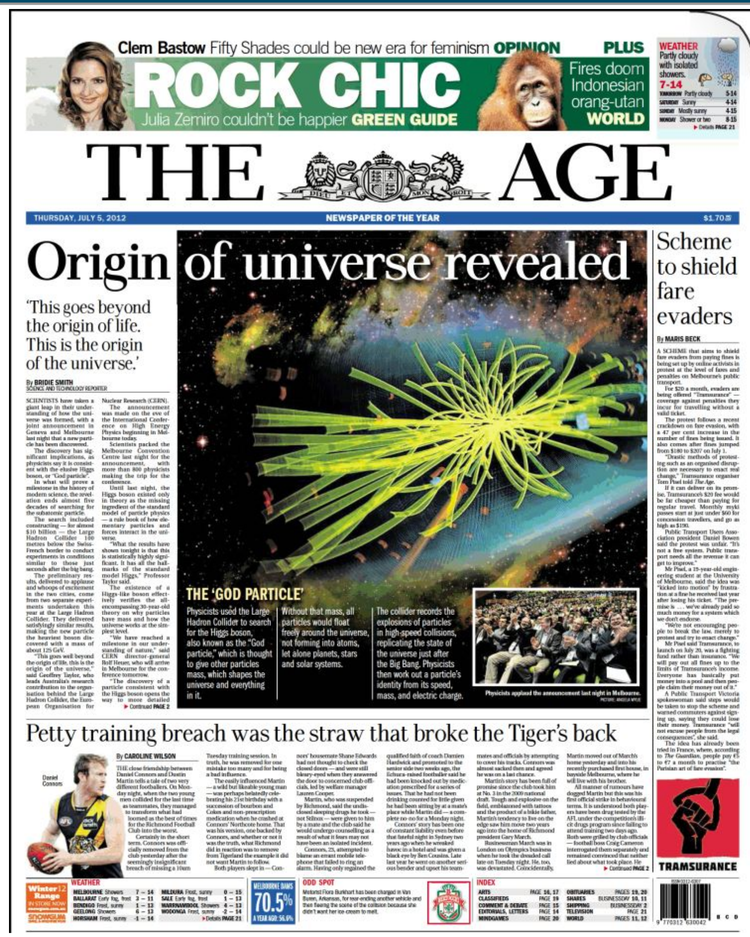
LHC@home 2.0 Test4Theory volunteers' machines seen since Sat Sep 27 2014 09:00:00 GMT-0500 (CDT) (2737 machines overall)

The LHC@home 2.0 project Test4Theory allows users to participate in running simulations of high-energy particle physics using their home computers.

The results are submitted to a database which is used as a common resource by both experimental and theoretical scientists working on the Large Hadron Collider at CERN.



Higgs Discovery



Clem Bastow Fifty Shades could be new era for feminism OPINION

ROCK CHIC

Julia Zemiro couldn't be happier GREEN GUIDE

PLUS Fires doom Indonesian orang-utan WORLD

THE AGE

THURSDAY, JULY 5, 2012 NEWSPAPER OF THE YEAR

Origin of universe revealed

'This goes beyond the origin of life. This is the origin of the universe.'

THE 'GOD PARTICLE'

Scheme to shield fare evaders

Petty training breach was the straw that broke the Tiger's back

News Science

Key discoveries that changed the world

Higgs boson discovery shines light on secrets of the Universe

Tears for the British hero of particle physics

Q&A

Remember when fun was affordable!?