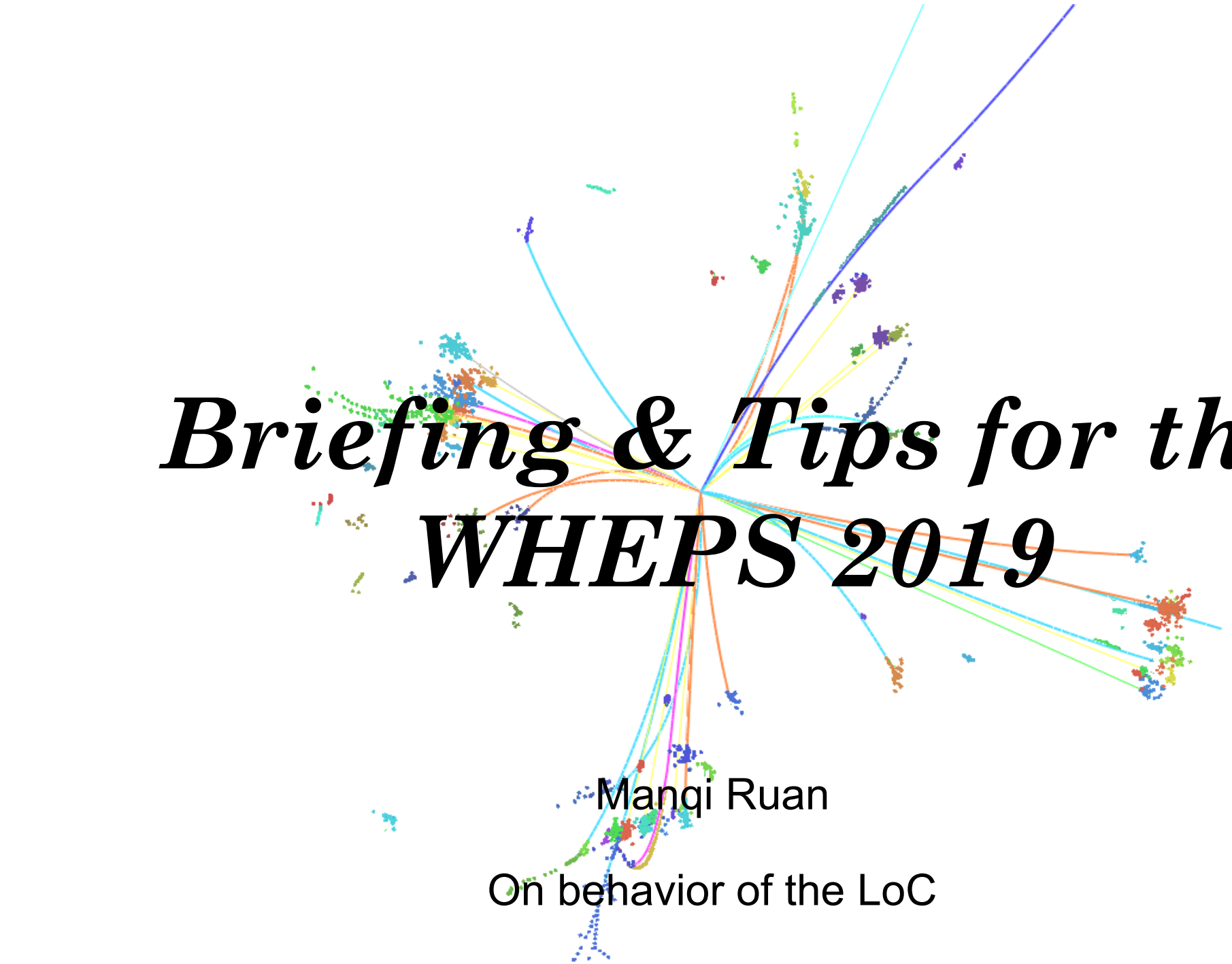
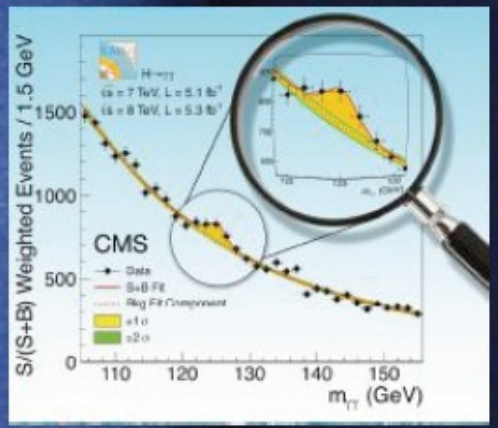
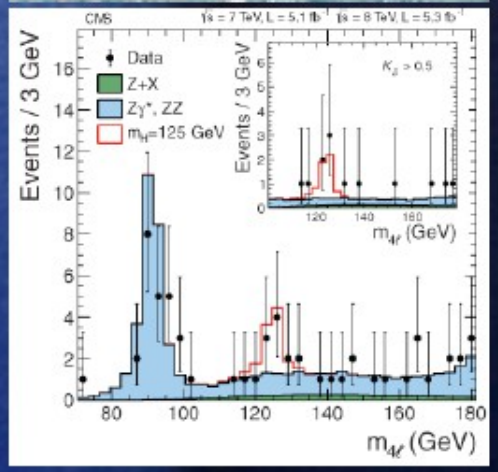


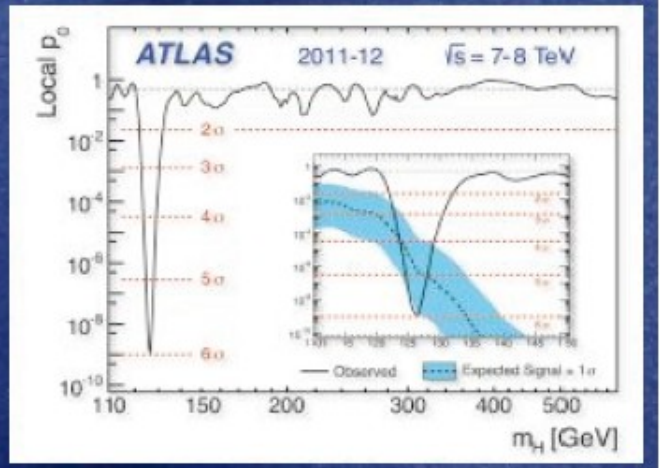
Briefing & Tips for the WHEPS 2019

Manqi Ruan

On behavior of the LoC


CMS
S/(S+B) Weighted Events / 1.5 GeV
$m_{\gamma\gamma}$ (GeV)

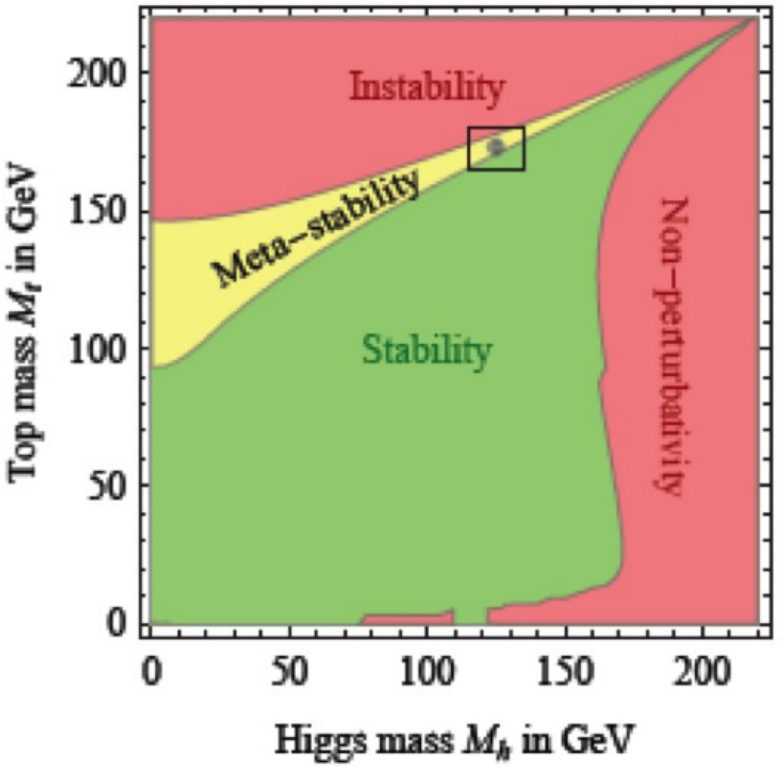

CMS
Data
Z+X
Zγ*, ZZ
m_H=125 GeV
Events / 3 GeV
$m_{4\ell}$ (GeV)


ATLAS
2011-12
$\sqrt{s}$ = 7-8 TeV
Local p_0
Observed
Expected Signal + 1σ
m_H [GeV]

SM is **NOT** the end after the Higgs

- Hierarchy: From neutrinos to the top mass, masses differs by 13 orders of magnitude
- Naturalness: Fine tuning of the Higgs mass
- Masses of Higgs and top quark: meta-stable of the vacuum
- Unification?
- Dark matter candidate?
- Not sufficient CP Violation for Matter & Antimatter asymmetry

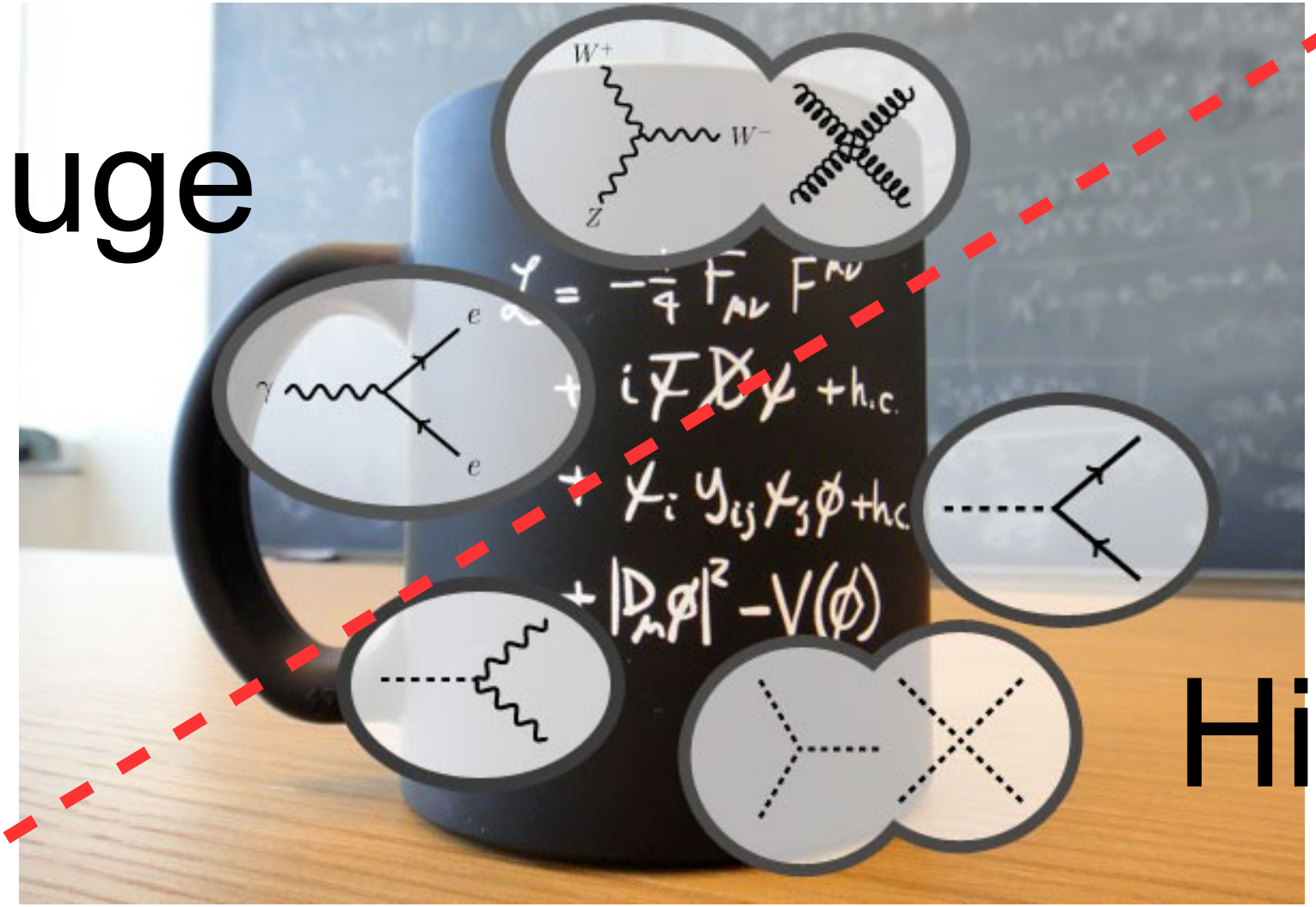
$$m_H^2 = 36,127,890,984,789,307,394,520,932,878,928,933,023$$
$$-36,127,890,984,789,307,394,520,932,878,928,917,398$$
$$= (125\ \text{GeV})^2\ !\ ?$$



- **Most issues related to Higgs**

The SM

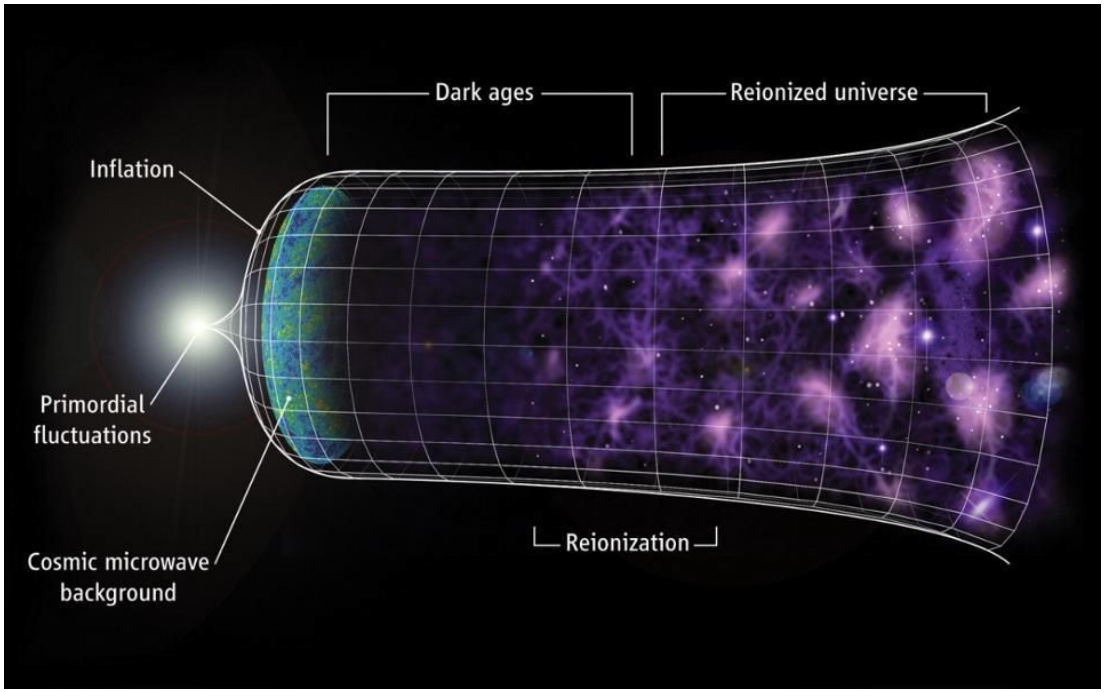
Gauge



Higgs

Higgs

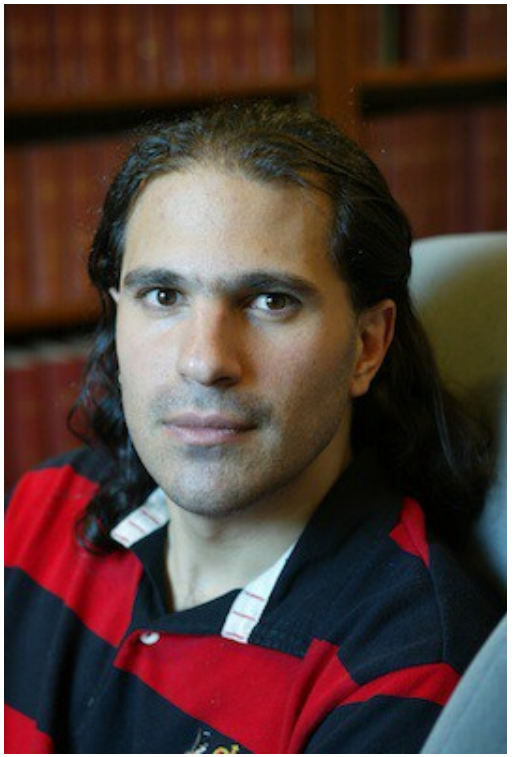
- Determines the configuration of our universe... and even its fate
  - Atom size
  - Weak interaction strength
  - Vacuum stability
  - ...
- Deeply related to almost all the mysteries of the SM
  - Mass hierarchy
  - Baryogenisis
  - Neutrino mass
  - Dark matter
  - Dark energy
  - Inflation



Higgs

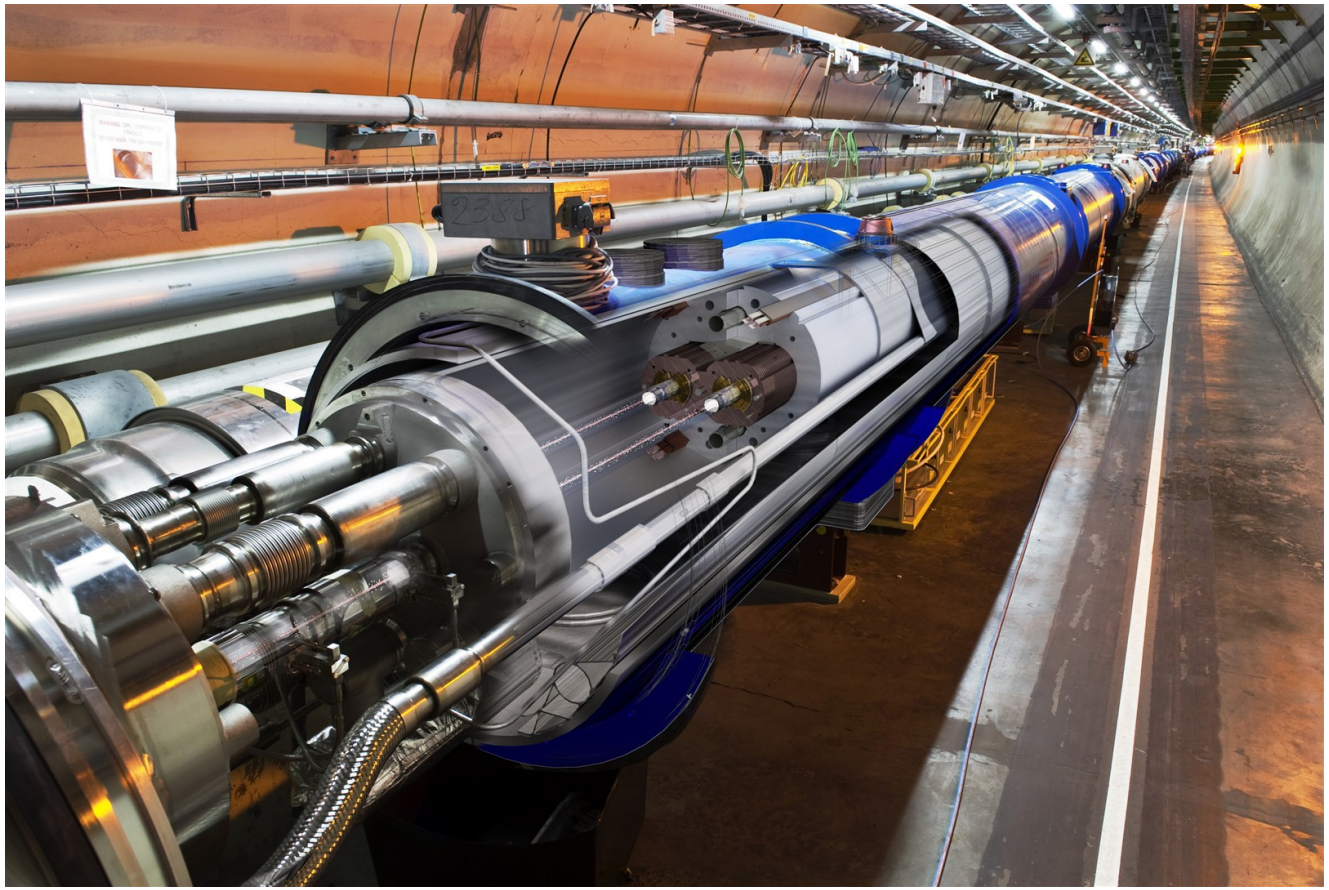
Higgs is Really New Physics!

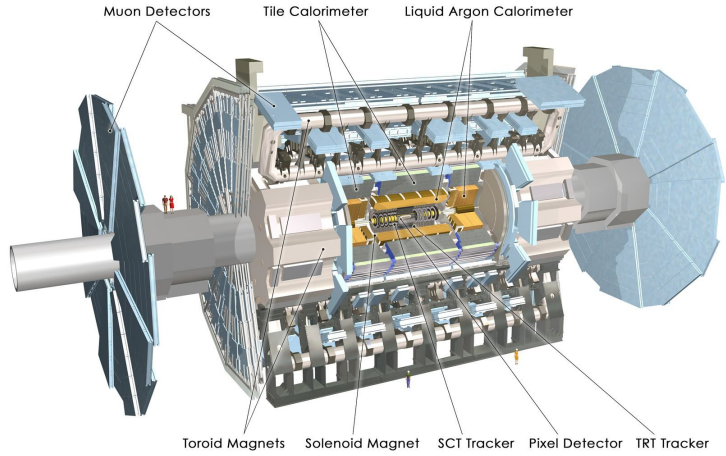
* We've never seen anything like it
* Harbinger of Profound New Principles at work in quantum vacuum
* MUST LOOK AT IT CLOSELY!

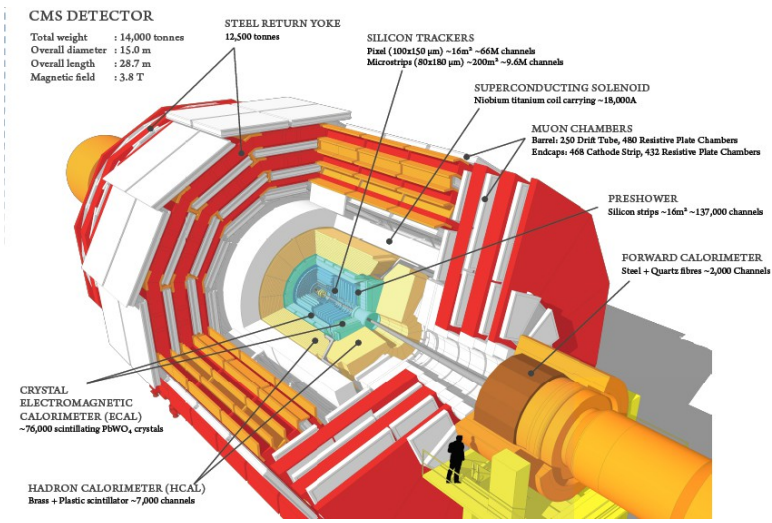


- The Higgs is core of mysterious of nowadays' Particle physics
- The Higgs boson is a sensitive probe, maybe the most sensitive one, to the physics principals underlying the SM

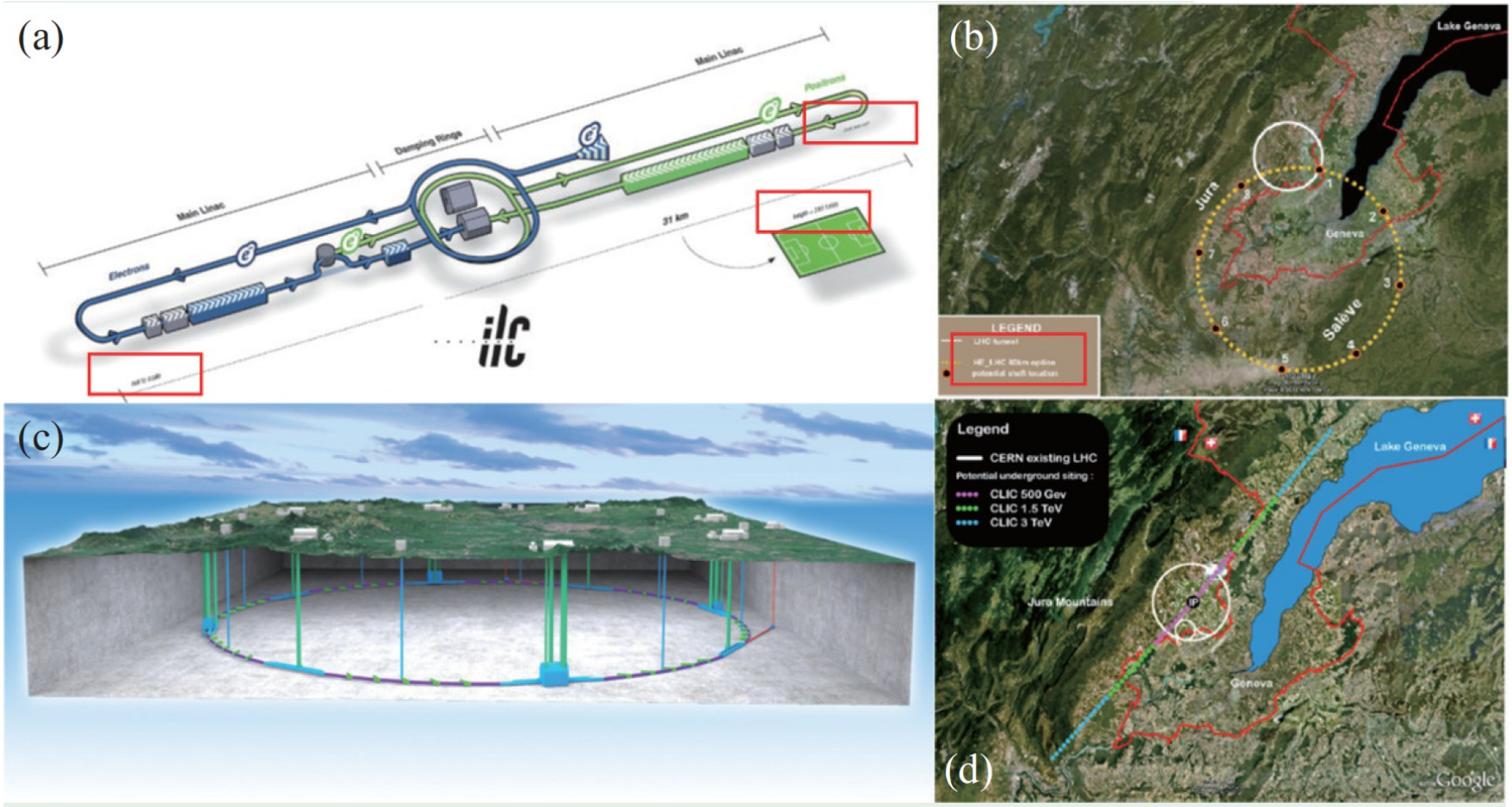
The running Higgs factory: LHC



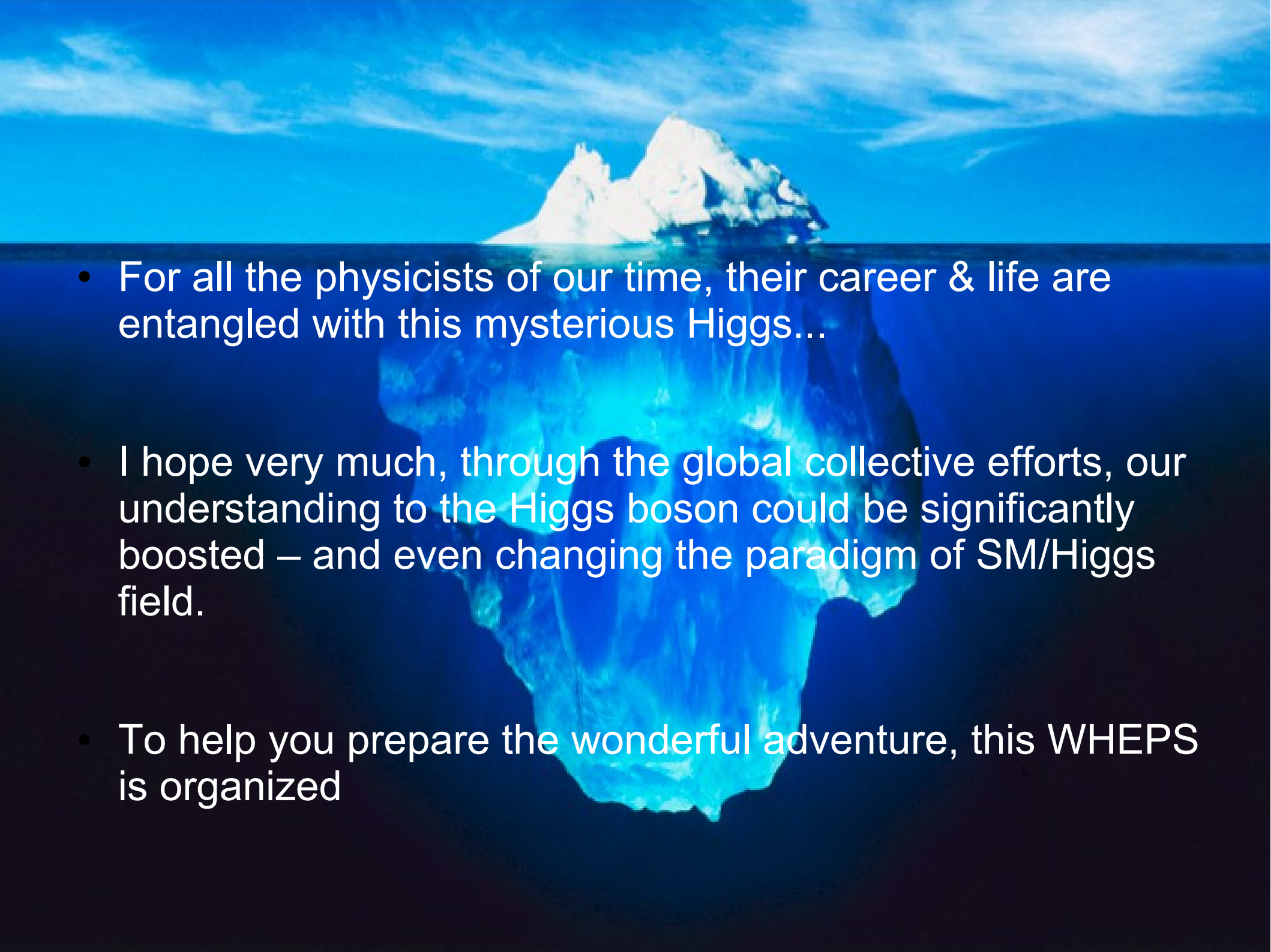




Multiple future proposals



ILC (a): TDR released in 2013
FCC (b): CDR released in 2019
CEPC (c): CDR released in 2018
CLIC (d): CDR released in 2013



- For all the physicists of our time, their career & life are entangled with this mysterious Higgs…
- I hope very much, through the global collective efforts, our understanding to the Higgs boson could be significantly boosted – and even changing the paradigm of SM/Higgs field.
- To help you prepare the wonderful adventure, this WHEPS is organized

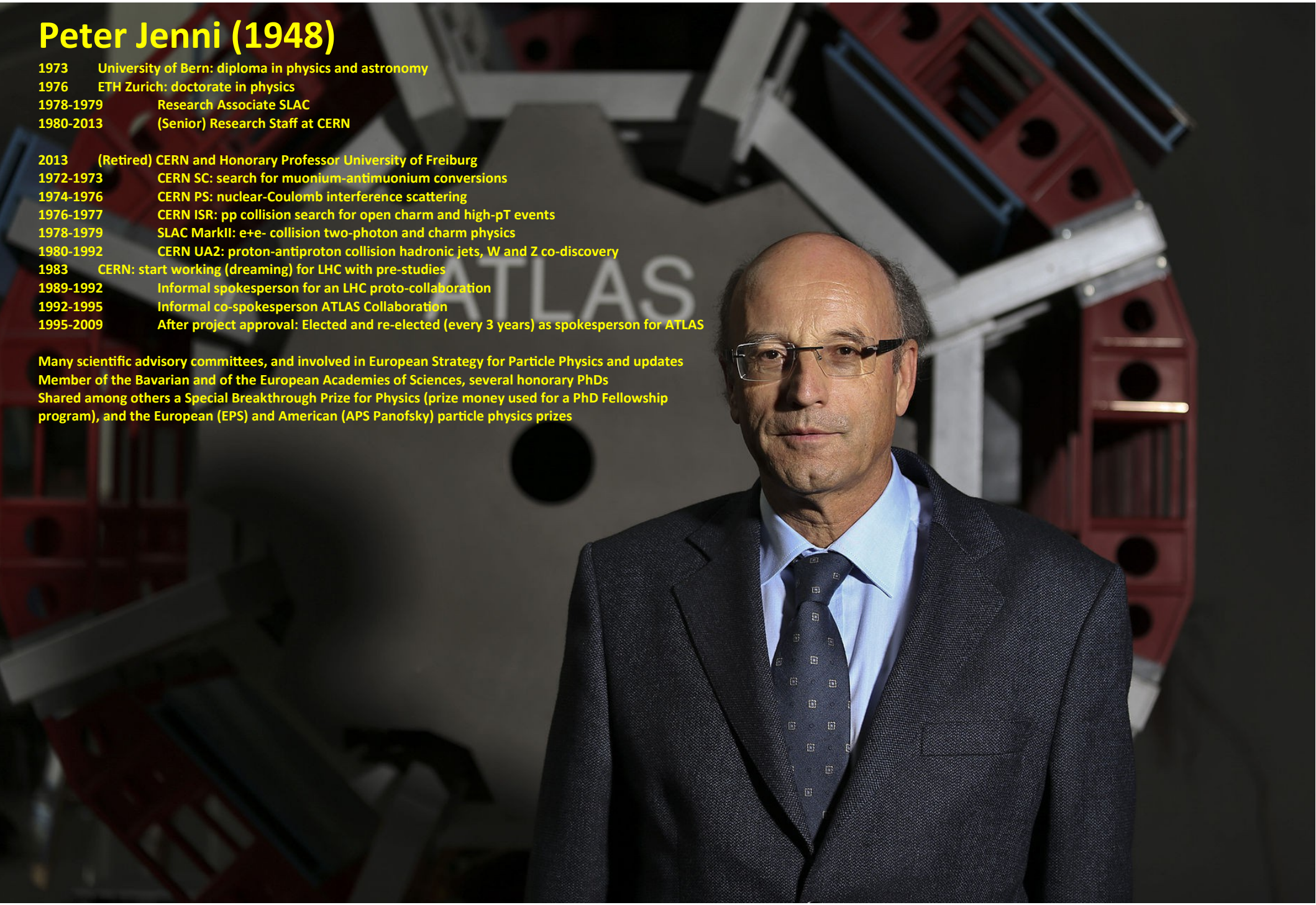
Our honorable lecturers

Peter Jenni (1948)

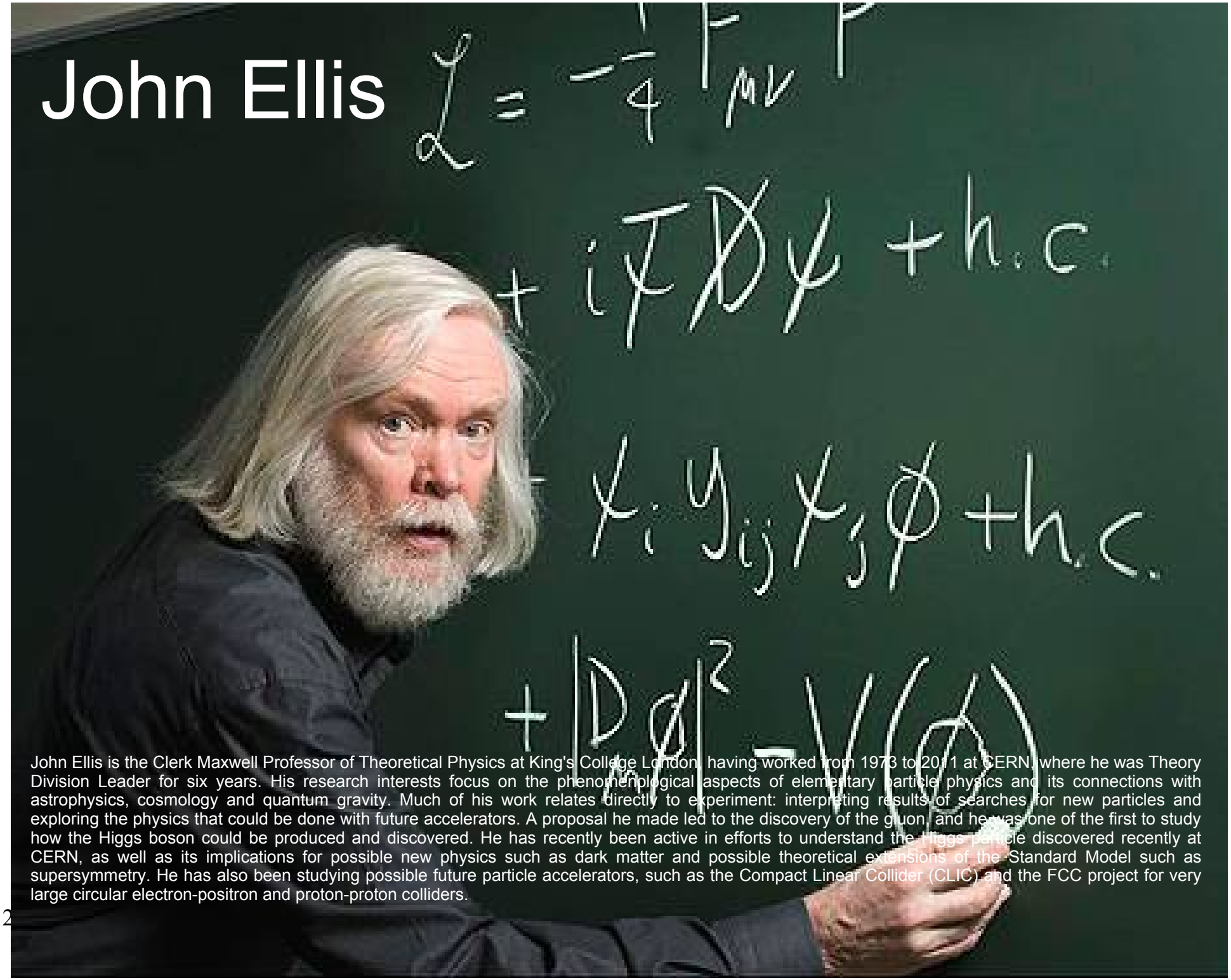
1973 University of Bern: diploma in physics and astronomy
1976 ETH Zurich: doctorate in physics
1978-1979 Research Associate SLAC
1980-2013 (Senior) Research Staff at CERN

2013 (Retired) CERN and Honorary Professor University of Freiburg
1972-1973 CERN SC: search for muonium-antimuonium conversions
1974-1976 CERN PS: nuclear-Coulomb interference scattering
1976-1977 CERN ISR: pp collision search for open charm and high-pT events
1978-1979 SLAC MarkII: e+e- collision two-photon and charm physics
1980-1992 CERN UA2: proton-antiproton collision hadronic jets, W and Z co-discovery
1983 CERN: start working (dreaming) for LHC with pre-studies
1989-1992 Informal spokesperson for an LHC proto-collaboration
1992-1995 Informal co-spokesperson ATLAS Collaboration
1995-2009 After project approval: Elected and re-elected (every 3 years) as spokesperson for ATLAS

Many scientific advisory committees, and involved in European Strategy for Particle Physics and updates
Member of the Bavarian and of the European Academies of Sciences, several honorary PhDs
Shared among others a Special Breakthrough Prize for Physics (prize money used for a PhD Fellowship program), and the European (EPS) and American (APS Panofsky) particle physics prizes



John Ellis



John Ellis is the Clerk Maxwell Professor of Theoretical Physics at King's College London, having worked from 1973 to 2011 at CERN, where he was Theory Division Leader for six years. His research interests focus on the phenomenological aspects of elementary particle physics and its connections with astrophysics, cosmology and quantum gravity. Much of his work relates directly to experiment: interpreting results of searches for new particles and exploring the physics that could be done with future accelerators. A proposal he made led to the discovery of the gluon, and he was one of the first to study how the Higgs boson could be produced and discovered. He has recently been active in efforts to understand the Higgs particle discovered recently at CERN, as well as its implications for possible new physics such as dark matter and possible theoretical extensions of the Standard Model such as supersymmetry. He has also been studying possible future particle accelerators, such as the Compact Linear Collider (CLIC) and the FCC project for very large circular electron-positron and proton-proton colliders.

Andrey Korytov

- Professor, University of Florida
- Research Interests: Higgs boson physics, Searches for BSM, CMS Experiment muon system and reconstruction of muons
- 1994-2009: Led the CMS Endcap muon detector project from the early R&D stages through the end of construction, and was Deputy Project manager for the CMS Endcap Muon System maintenance and operations
- 2009-2010: Convener of the CMS Higgs Physics Group,
- 2011-2012: Led combination of all CMS Higgs boson searches
- American Physical Society Fellow (2012)
  - For major contributions to the Higgs searches at LHC, and to the design and construction of high rate high precision muon detectors for the CMS experiment

Iacopo Vivarelli

- **Professor, University of Sussex, UK**
- **Research Interests and Contributions**: Searches for BSM, ATLAS hadronic calorimeter system and jet reconstruction and calibration, a dual readout calorimeter development for future e+ e- colliders (FCC_ee/CEPC)
- **2008-2009:** ATLAS Physics Validation coordinator.
- **2009:** CERN fellowship (funded by INFN – Italy).
- **2011-2012:** ATLAS SUSY background forum subgroup convener.
- **2012-2013:** ATLAS SUSY 3rd generation subgroup convener.
- **2013-2014:** Member (and leader in some case) of task forces for the proposal and implementation of the ATLAS Run 2 analysis model.
- **2015-2017:** Convener of the ATLAS SUSY Physics Group
- **2016:** CERN Scientific Associateship.

Professor Glen Cowan

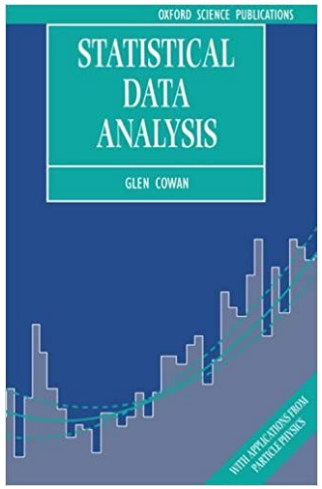
Royal Holloway, University of London

glen.cowan@cern.ch

g.cowan@rhul.ac.uk

- 1981 -- B.S. in Physics from University of California, Los Angeles
- 1988 -- Ph.D in Physics from University of California, Berkeley
- 1988–1998 -- Research on electron-positron annihilation with the ALEPH Collaboration (properties of hadronic Z decays, QCD) with MPI Munich and University of Siegen.
- 1998-present -- Senior Lecturer in Particle Physics at Royal Holloway, University of London. Research with the BaBar and ATLAS experiments.

Statistics expert with lots of lectures for many summer schools around the world
http://www.pp.rhul.ac.uk/~cowan/stat/



Statistical Data Analysis

2018/2019 University of London Postgraduate Lectures for Particle Physicists

University of London MSci PH4515

Christophe Grojean

Academic career

2012-2014	ICREA Research Professor, IFAE, Universitat Autònoma de Barcelona
2006-2012	Staff scientist, CERN Physics Department, theory unit, Geneva
2006	CERN fellow, CERN Physics Department, theory unit, Geneva
2003-2004	Visiting professor, Michigan Center for Theoretical Physical, University of Michigan, Ann Arbor
2001-2011	Staff member at Service de Physique Théorique, CEA Saclay. On leave at CERN from January 2006 to October 2011.
1999-2001	Postdoctoral fellow, University of California, Berkeley
1995-1999	Ph.D. thesis, University Paris XI Orsay. Supervisor: Carlos A. Savoy
1997-1998	French National Service, CEA, Bruyères–le–Châtel
1992-1995	Ecole Normale Supérieure de Lyon. Bachelor in Physics (June 93), Bachelor in Mathematics (June 94), Master Degree in Physics (June 94), DEA in theoretical physics (June 95), Magistère in Physics (July 95).

Tip 1: organization

- A group presentation is planned at the afternoon of Aug. 28th. The presentation can be any topic related to the Higgs & BSM.
- Attendees are divided randomly into 10 groups. For each group, please elect your leader & let me know the name by tomorrow afternoon.
- The responsibility of group leader:
  - Make sure your group members are safe – especially during the breaks
  - Coordinate your efforts-study
  - Appoint the speaker for the group presentation
  - Peer review: score the performance of all the other groups

Tip2: seafood

- Weihai has wonderful sight, food, beer...
- But be aware that local food might challenge your digestive system...

Tip3: be careful about the sea/swim, especially the jellyfish

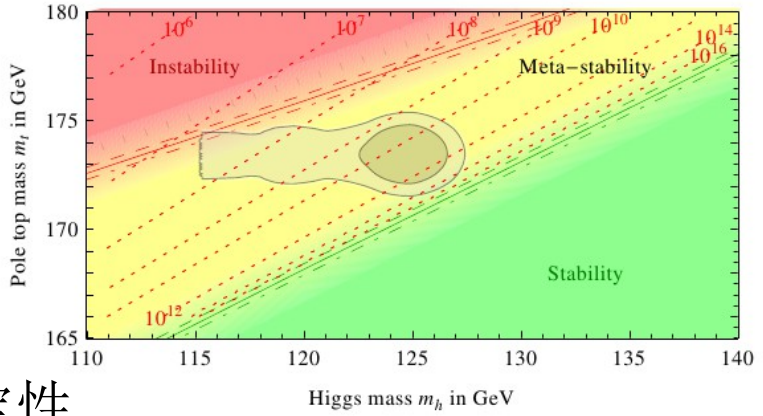
Not everyone can do this!

- Be safe, be happy, be creative
- Enjoy WHEPS & Weihai!

Backup

分饰多角的 Higgs

- *Higgs 场所参与的，是不同于四大相互作用的新相互作用。。。*
- 决定了电子的质量和原子的大小
- 决定了真空是否稳定！
  - 决定了顶夸克的质量
  - 决定了 Higgs 粒子本身的质量

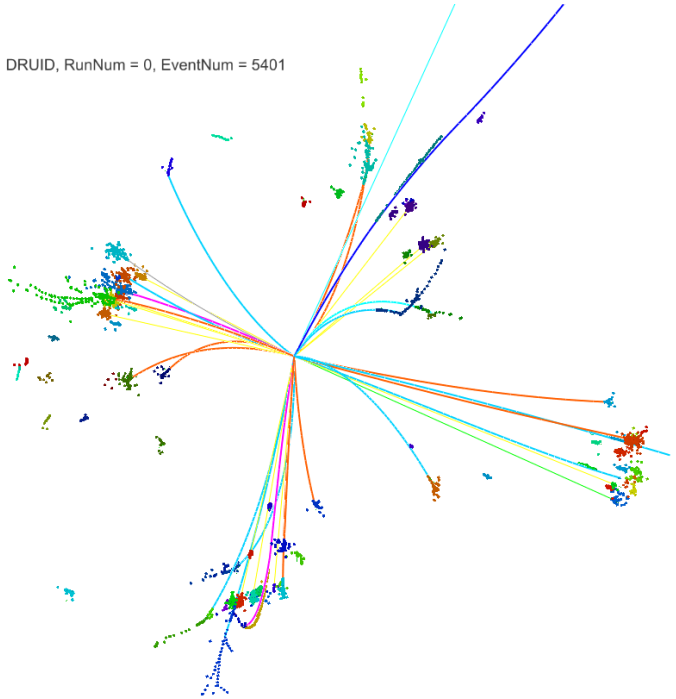


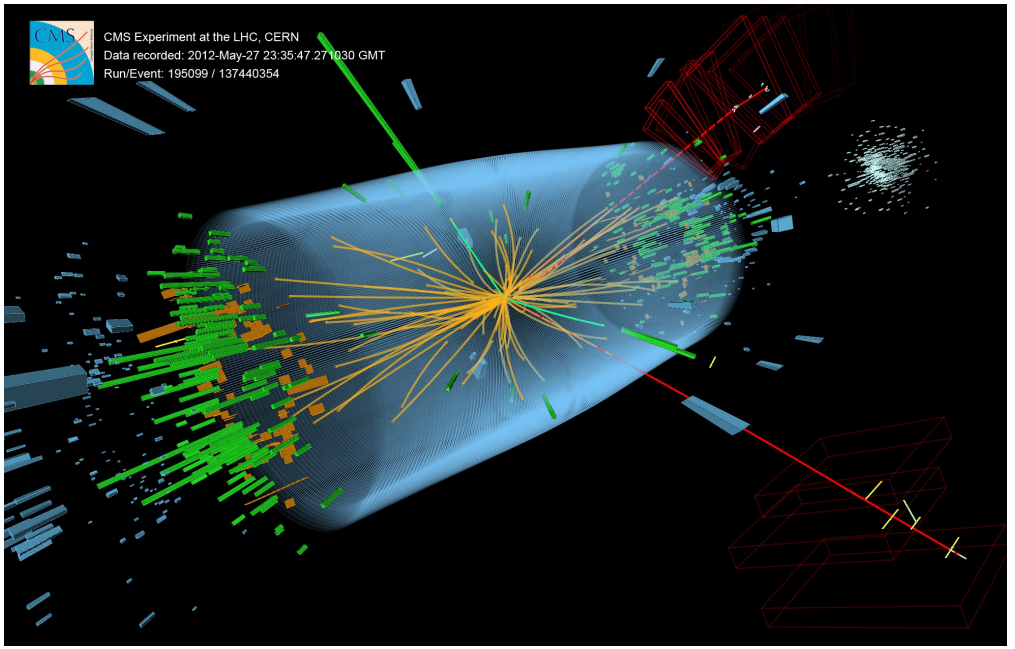
- 参决定了质子和中子的质量差，保证质子稳定性
- 决定了 W, Z 粒子的质量，决定了弱相互作用的力程并影响了其强度
- 通过和物质 / 反物质的不同耦合：物质产生的前提条件

...

- *是否是暗物质的质量之源？*
- *是否和暗能量、暴涨有深刻的关联？*

Higgs measurement at e+e- & pp





	Yield	efficiency	Comments
LHC	Run 1: 10^6 Run 2/HL: $10^{7\text{-}8}$	~o(10^{-3})	High Productivity & High background, Relative Measurements, Limited access to width, exotic ratio, etc, Direct access to g(ttH), and even g(HHH)
CEPC	10^6	~o(1)	Clean environment & Absolute measurement, Percentage level accuracy of Higgs width & Couplings

Complementary