Physics, Experiments, Detectors (PED) Overview: Physics

May 30th 2022

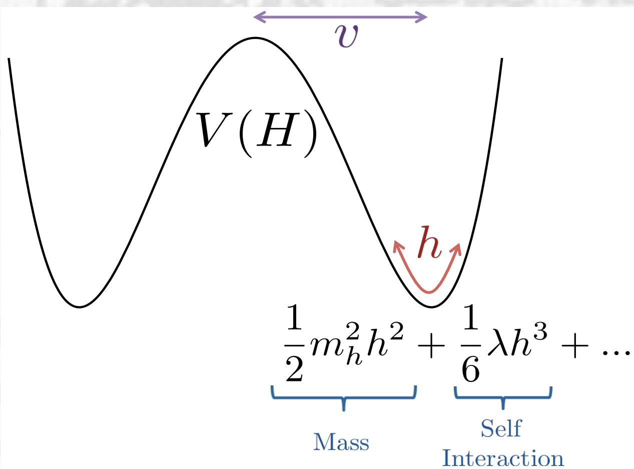
FCC Week

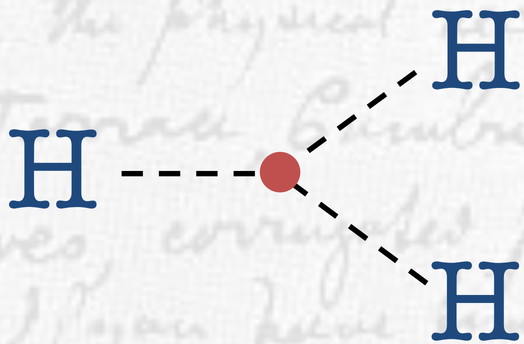
Matthew McCullough
(On behalf of colleagues Patrizia Azzi, Emmanuel Perez, Frank Simon)

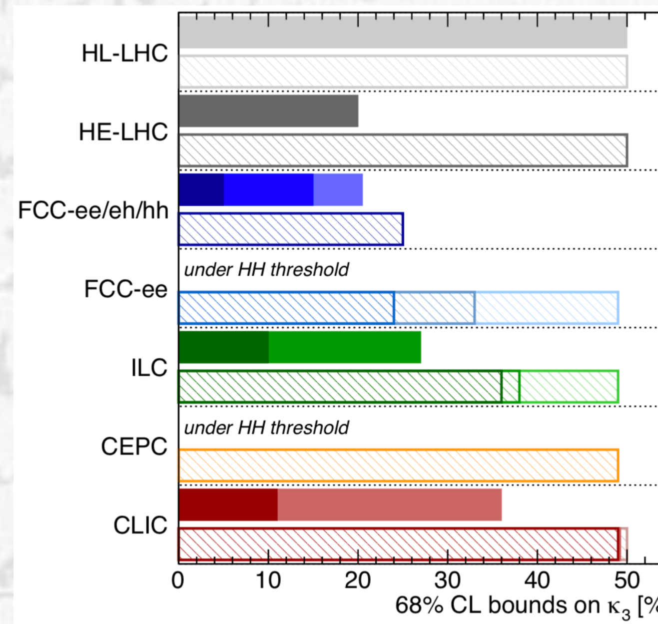
CERN

The FCC Physics Landscape

The physics landscape of FCC is vast. Personal highlights include:







True exploration of the Higgs self-coupling, one of the most profoundly important parameters in nature…

The FCC Physics Landscape

... and a quantum leap in our understanding of electroweak physics due to the Tera-Z programme!

Observable	Present value	±	error	FCC-ee (statistical)	FCC-ee (systematic)
m_Z (keV/c^2)	91 186 700	±	2200	5	100
Γ_Z (keV)	2 495 200	±	2300	8	100
R_ℓ^Z ($\times 10^3$)	20 767	±	25	0.06	1
$\alpha_s(m_Z)$ ($\times 10^4$)	1196	±	30	0.1	1.6
R_b ($\times 10^6$)	216 290	±	660	0.3	<60
σ^0_{had} ($\times 10^3$) (nb)	41 541	±	37	0.1	4
N_ν($\times 10^3$)	2991	±	7	0.005	1
$\sin^2\theta_W^{eff}$($\times 10^6$)	231 480	±	160	3	2–5
$1/\alpha_{QED}(m_Z)$($\times 10^3$)	128 952	±	14	4	Small
$A_{FB}^{b,0}$ ($\times 10^4$)	992	±	16	0.02	<1
$A_{FB}^{pol,\tau}$ ($\times 10^4$)	1498	±	49	0.15	<2
m_W (keV/c^2)	803 500	±	15 000	600	300

The FCC Physics Landscape

However, we are only at the beginning of the journey...

CHAPTER I

THE PHYSICS CASE

Physics with a Multi-TeV Hadron Collider

C.H. Llewellyn Smith

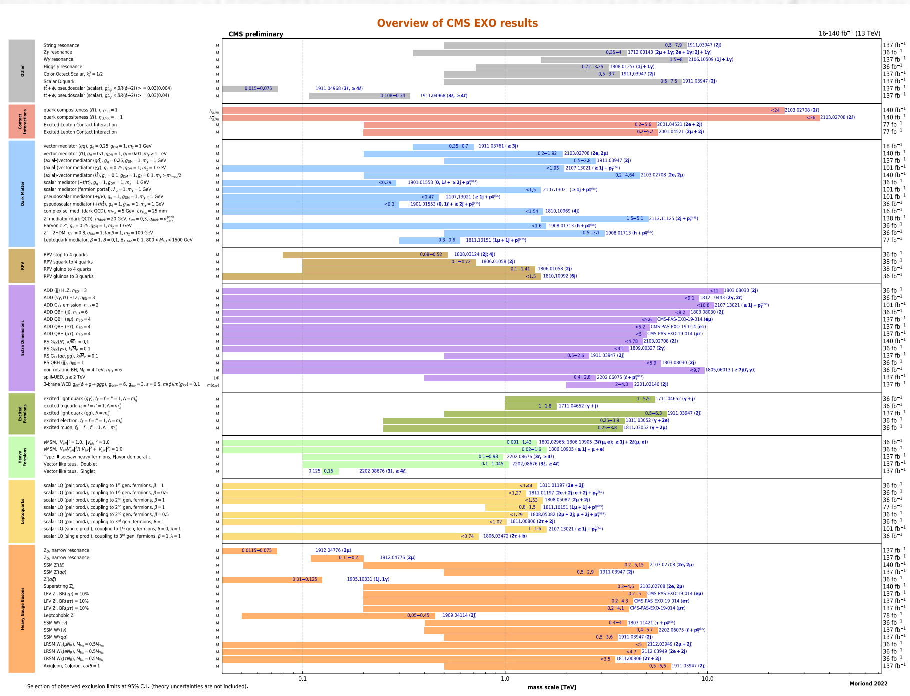
11. SUMMARY AND CONCLUSIONS

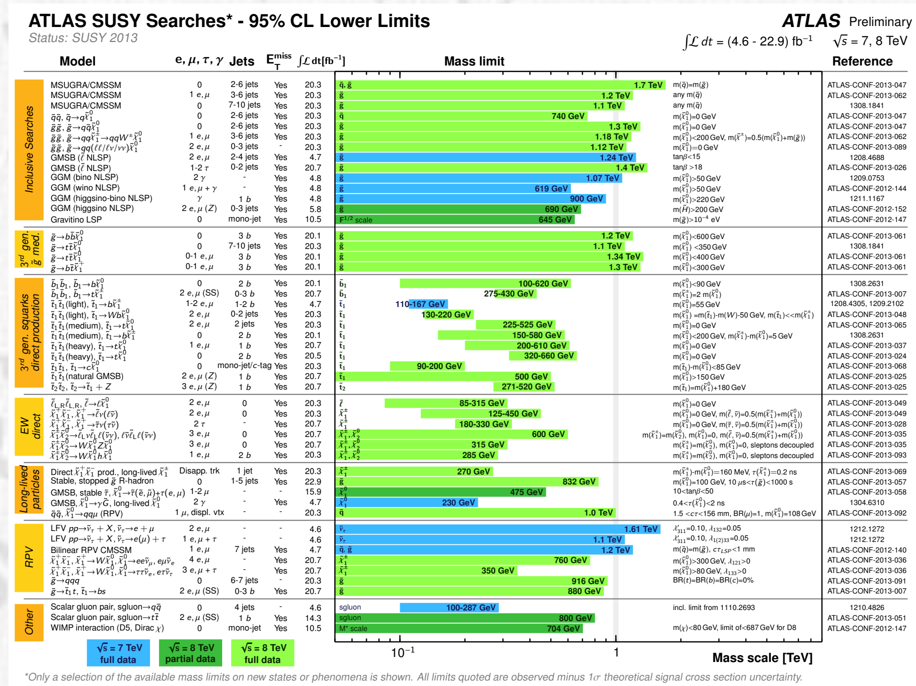
A theoretical consensus is emerging that new phenomena will be discovered at or below 1 TeV. There is no consensus about the nature of these phenomena but it is interesting that many of the ideas which have been suggested can be tested in experiments at an LHC. Although many, if not all, of these ideas will doubtless have been discarded, disproved or established by the time an LHC is built, this demonstrates the potential virtues of such a machine.

Consider the LHC Physics programme in 1984...

The FCC Physics Landscape

However, we are only at the beginning of the journey…





Consider the LHC Physics programme in 1984, versus now…

Some questions...

Have we discovered everything FCC can discover?

Can we do better than preliminary performance estimates?

What is required to realise systematic < statistics?

What are detector/technological performance requirements?

Are we presenting FCC capabilities optimally?

PED Physics Organisation

Coordination split into two branches of the same tree, with overlapping goals:

Physics Performance

P. Azzi & E. Perez

- Optimising case studies
- Specifying detector requirements
- Developing analysis and software tools
- …

Physics Programme

M. M. & F. Simon

- Developing discovery stories
- Roadmapping precision calculations
- Developing generators
- …

Further broken down into topics.

PED Physics Organisation

Coordination split into two branches of the same tree, with overlapping goals:

Ph... Performance

- Opti...
- Specifying detecto... requirements
- Developing analysis and software tools
- ...

Physics Programme

M. M. & F. Simon

- ... precision ... ns
- Developing generators
- ...

Synergy with many ECFA activities (e.g. ECFA WG1 and WG2 monthly seminars, etc)

Further broken down into topics.

Precision Electroweak

Conveners

Performance	**Programme**
C. Paus, G. Wilson	A. Freitas

Selected Goals

Developing roadmap for higher-order and generators

Understanding the control of systematic uncertainties to unprecedented level

Activities

Kickoff meeting in May 18

Precision calculations for future e+e− colliders: targets and tools (FC Unit Workshop June 7-17)

Higgs

Conveners

Performance	Programme
M. Selvaggi, J. Eysermans	C. Grojean, G. Durieux, J. de Blas

Selected Goals

Establishing precision (e.g. $h \to ss$, hZ at stat precision)

Connecting coupling reach with microscopic landscape

Activities

Meetings March 28 (flavour), May 23

Synergy with ECFA Higgs Factory activities

(e.g. ECFA Higgs & top Factory workshop October.)

Flavour

Conveners

Performance

S. Monteil, A. Lusiani

Programme

G. Isidori, J. Kamenik

Selected Goals

Develop scope of flavour at FCC

Establishing experimental sensitivity

Activities

Kickoff programme meeting April 12

Mini-Workshop foreseen for Sept

Performance meeting March 28

QCD

Conveners

Performance	Programme
D. d'Enterria	P. Monni

Selected Goals

Roadmapping precision and observables

Understanding role of α_s uncertainties

Activities

Precision calculations for future e+e− colliders: targets and tools (FC Unit Workshop June 7-17)

Beyond the Standard Model

Conveners

Performance	Programme
R. Gonzalez-Suarez, G. Polesello	S. Heinemeyer, T. You

Selected Goals

Develop "Exploring Origins" physics of FCC

Investigating detector coverage of exotica

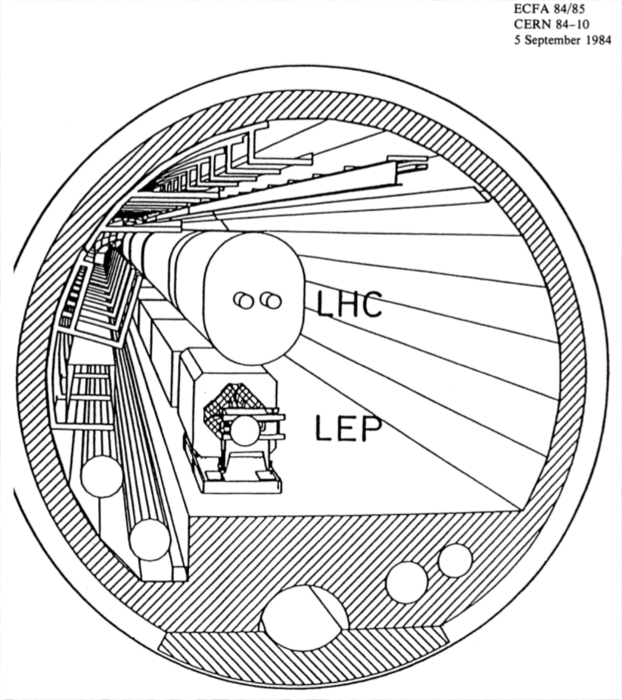
Activities

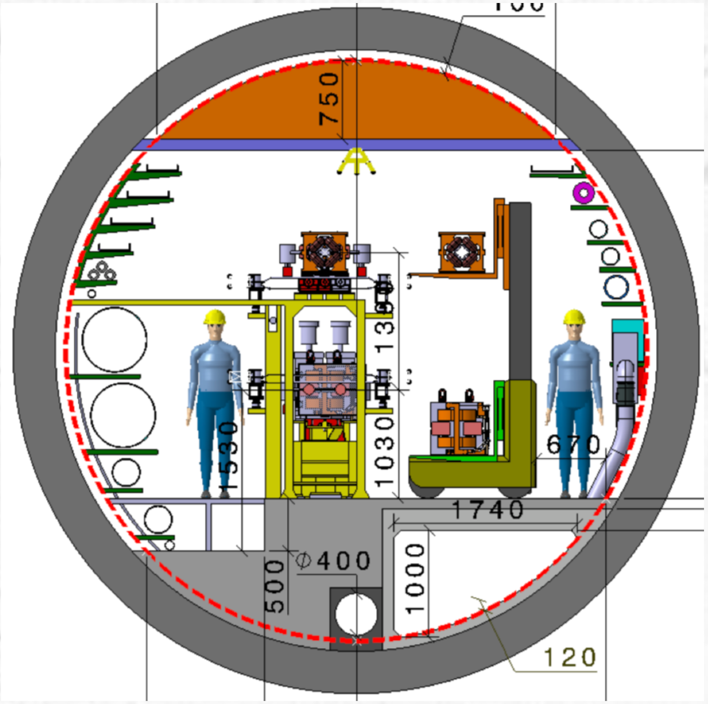
Kickoff meeting in May 10

Mini-Workshop foreseen for Sept

Summary

We know, from experience, the physics scope of a combined ee+hh facility is vast, requiring thousands of scientists to explore.

From 

to 

Physics PED is laying the foundation stones.

Join us!

https://fcc-ped.web.cern.ch

Thanks to everyone in PED physics!