


Sharpening the FCC Physics Case



A word cloud of descriptive terms for FCC Physics. The words are arranged in a cluster, with 'Versatile' and 'Unique' being the largest. Other words include 'Powerful', 'Flexible', 'Broad', 'Comprehensive', 'Complementary', 'Far-reaching', 'Staged', 'Effective', and 'Synnergetic'.

Powerful
Flexible
Effective
Synnergetic
Far-reaching
Versatile
Complementary
Broad
Unique
Staged
Comprehensive

Rebeca Gonzalez Suarez - Uppsala University

Since we are in Paris

We can bring up one of the best book openings in history

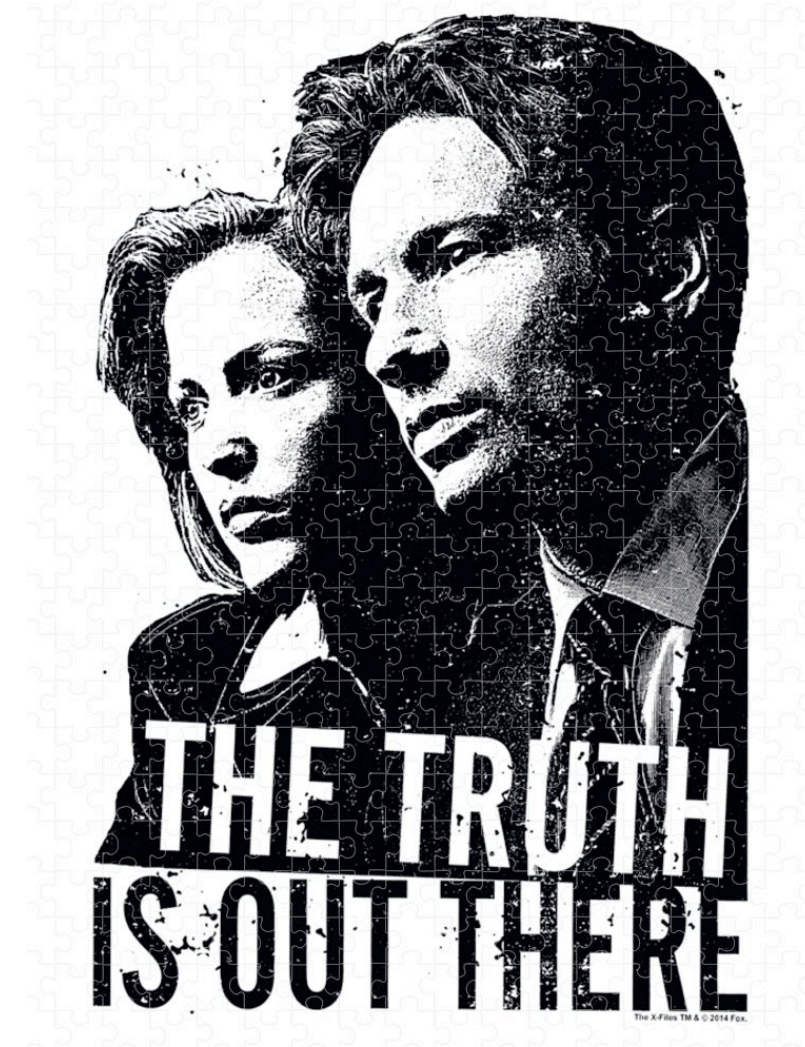


“It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us...”

A Tale of Two Cities
Charles Dickens

It is the best of times

- We have a model that works, is robust, thoroughly tested, and provides very precise predictions
- We have a relatively new particle that is quite special
 - And a lot to learn from it
 - New **exploration tool**
- We have decades of collider expertise to build on top (we are confident)
- We have the largest community we ever had
- **We know there is something out there**



- We have a **laundry list of questions to answer** that keeps growing (lots of fun problems to solve!)
 - What is up with gravitation at the fundamental level?
 - Why do neutrinos have mass?
 - What is dark matter? Is it even a particle?
 - What is behind dark energy?
 - Where did the antimatter go in the Big Bang?
 - What does the Higgs has the mass it has?
 -

It is the worst of times too

LHC: driving cultural change forward

Theorists had a clear agenda for physics beyond the Standard Model

the once

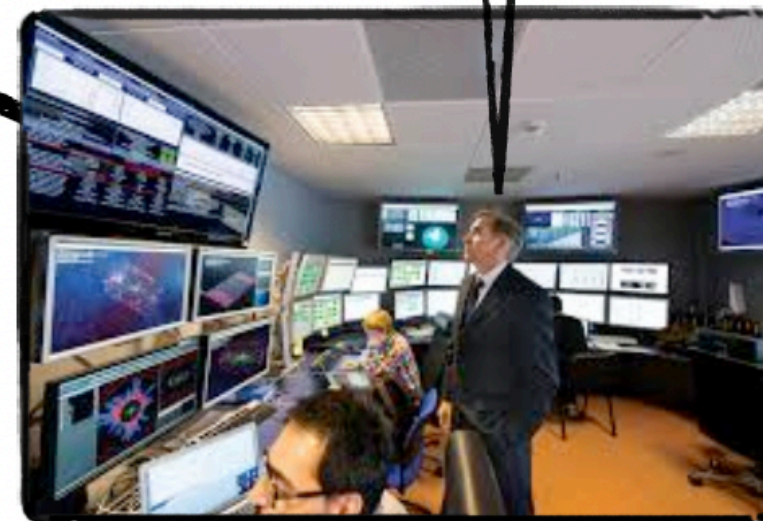


the guaranteed future



The LHC has revolutionised our views on the particle world. It didn't find (yet) any BSM physics. But its results have forced us to think differently about BSM physics.

G. Giudice@DESY'22



the now

shorter distances

FCC week, May 30, 2022

- The days of “guaranteed” discoveries are indeed over, we do not have an obvious energy target, we don't have a favourite BSM model to target, we don't have a strong signal to follow

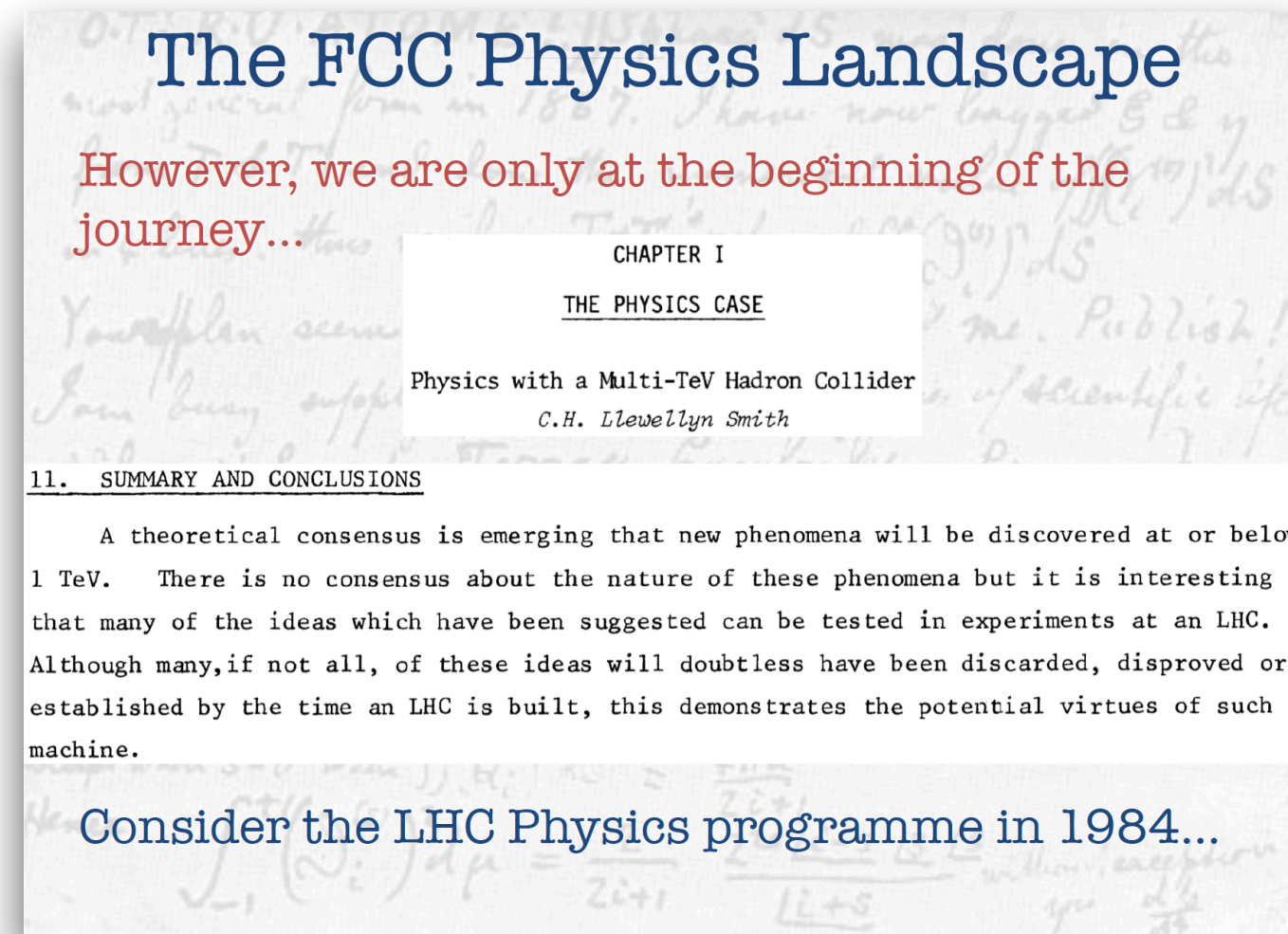
Christophe Grojean

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Christophe Grojean
Monday Plenary

Motivations

LHC

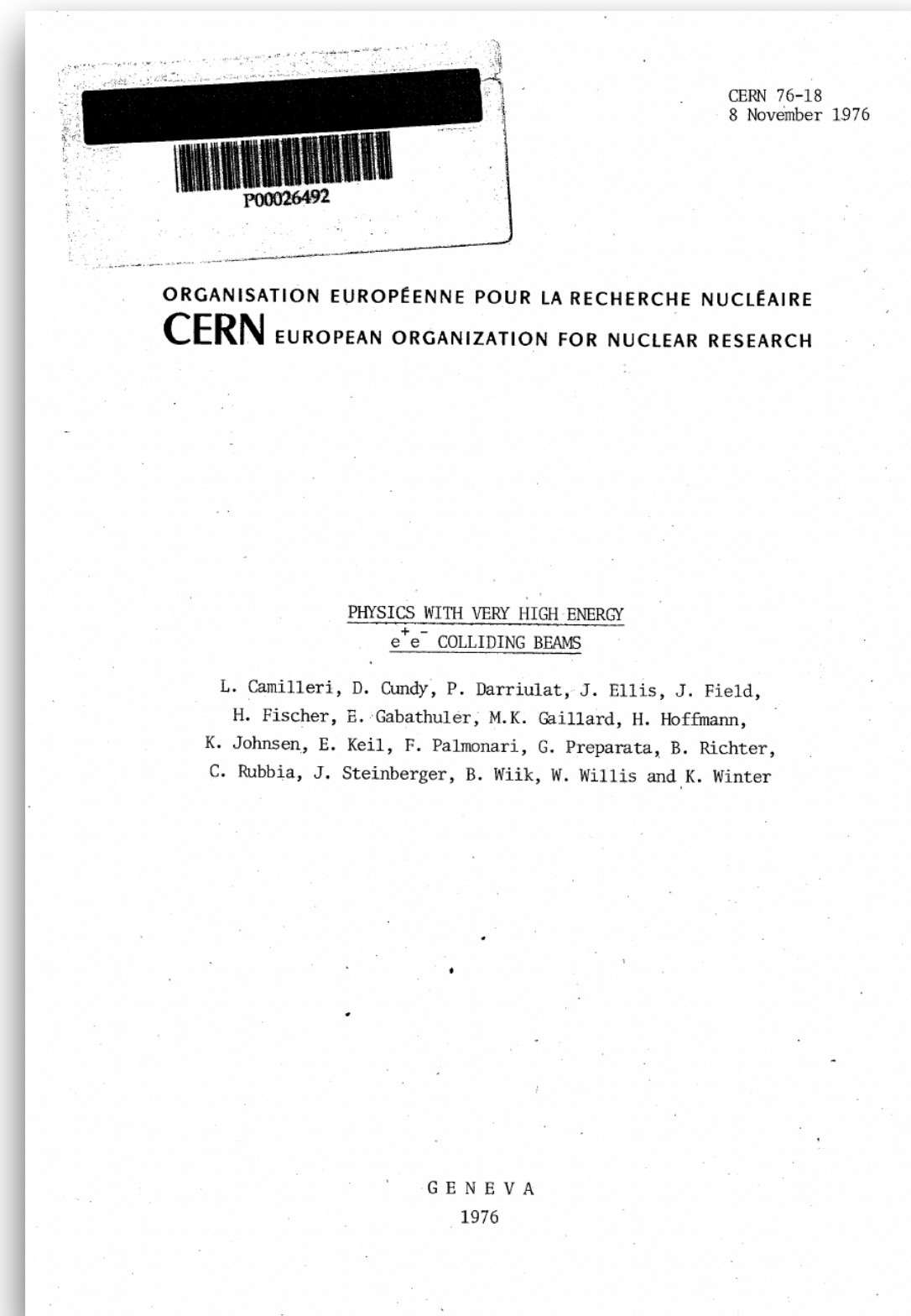


1984: Consensus, new physics at or below 1TeV

Matthew McCullough
Monday Plenary

Started operation 2008
Observed: the Higgs boson

LEP



1976: Unique opportunity to study the weak interaction

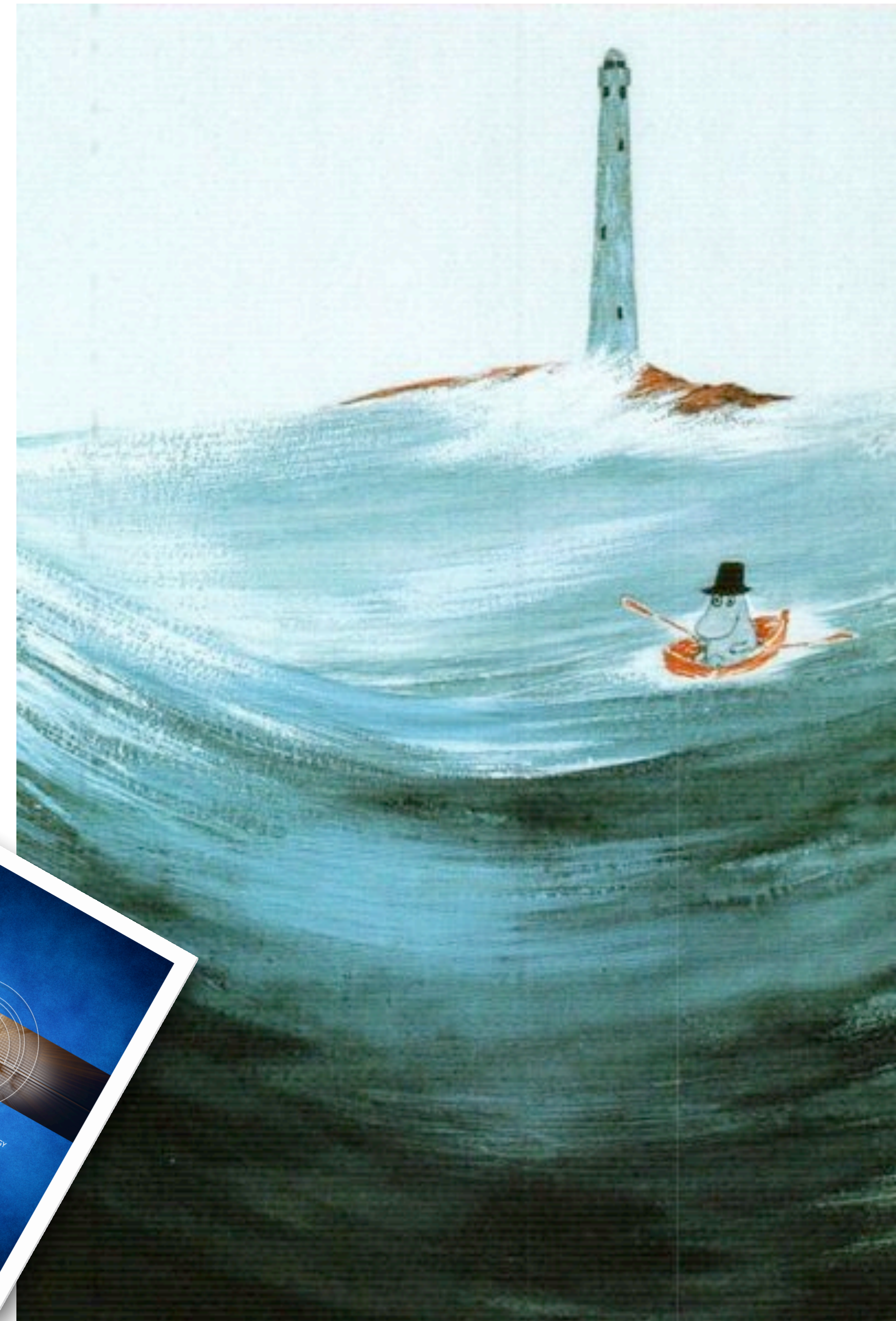
“the situation might well be compared with making a spaceship journey to some other galaxy from which one has received already some faint signals”

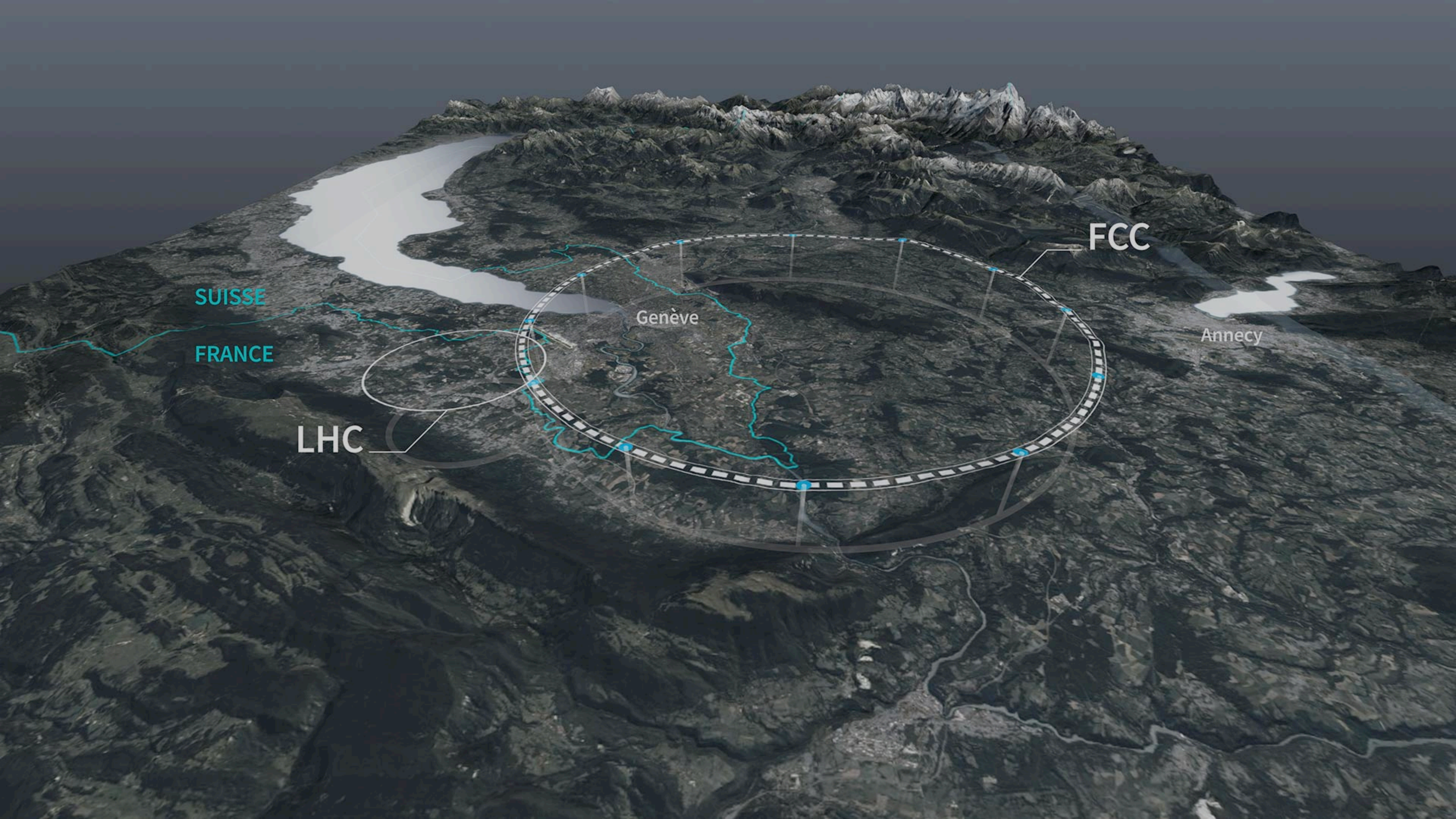
Started operation 1989

We have to keep exploring

Even without a clear sign of safe land

- **We have no choice but to be systematic**
 - We cannot afford not making the right choices
- **Progress will be driven by experimental exploration**
- ESPP 2020 Update
 - An **electron-positron Higgs factory** is the highest-priority next collider. For the longer term, the European particle physics community has the ambition to operate a **proton-proton collider at the highest achievable energy.**





SUISSE

FRANCE

Genève

Annecy

LHC

FCC

The FCC integrated programme

FCC-ee/FCC-hh/FCC-eh (+ HI)

- Brings a broad, powerful scope, that combines
 - **Precision (electron-positron) INTENSITY FRONTIER**
 - Unique opportunity to scrutinize the “known” SM to its limits
 - Versatile: Sequential Z, W, H, t factory
 - Indirect / low mass BSM sensitivity
 - **Discovery (hadron) ENERGY FRONTIER**
 - Maximizing potential for BSM discovery
 - 100 TeV
 - Direct / high mass sensitivity for new particles

For the ultimate
physics potential



**No matter what is
out there, we are
ready**

Physics complementarity

In shared infrastructure

- A natural continuation of LEP - LHC benefiting from that experience
 - Strategic, long-term physics vision
- **FCC-ee:**
 - Builds on top of 50 years of experience (technology available, **doable now**)
- **FCC-hh:**
 - 6x HL-LHC mass reach
 - Guided by FCC-ee findings, enabled by FCC-ee
 - Same tunnel, same caverns
 - **FCC-eh** : complementary, bridging the gap between both
- Complementary and synergetic → effective, no safe place for new physics to hide

*“FCC-ee fills need for a precision EW/
Higgs factory while setting stage for a
100 TeV pp collider in the future
FCC infrastructure will support a
century of physics”*

Frank Zimmermann (Monday plenary)

*“About one LEP per minute”
Christoph Paus (Tuesday PE&D
session)*

One more motivation

Started operation 1983
Observed: the top quark

Tevatron

1976: “the physics frontier is justification enough for such a venture.”

**the physics frontier is
justification enough**

**the physics frontier is
justification enough**

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Proposal 492

Proposal to Construct an Antiproton Source
for the Fermilab Accelerators

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Abstract

We propose to build a small storage ring for the accumulation of antiprotons produced in an external target. Stochastic and electron cooling will be used to reduce the transverse and longitudinal phase space of the antiprotons. The dynamics of stochastic and electron cooling will also be studied in this storage ring using circulating protons. The cooled antiprotons can be reinjected into the main ring or energy doubler ring; after simultaneous acceleration along with a proton bunch the accelerator will become a colliding $\bar{p}p$ machine with a center of mass energy range of 300-2600 GeV. Luminosities in the range $10^{29} - 10^{32} \text{ cm}^{-2} \text{ sec}^{-1}$ are expected.

“Ce qui embellit le désert, dit le petit prince, c’est qu’il cache un puits quelque part...”

Le petit prince - Antoine de Saint-Exupéry

"What makes the desert beautiful," said the little prince, "is that somewhere it hides a well . . ."

Let's go find it!



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