



Computing Challenges in Unlocking the Secrets of the Universe

Marc Paterno

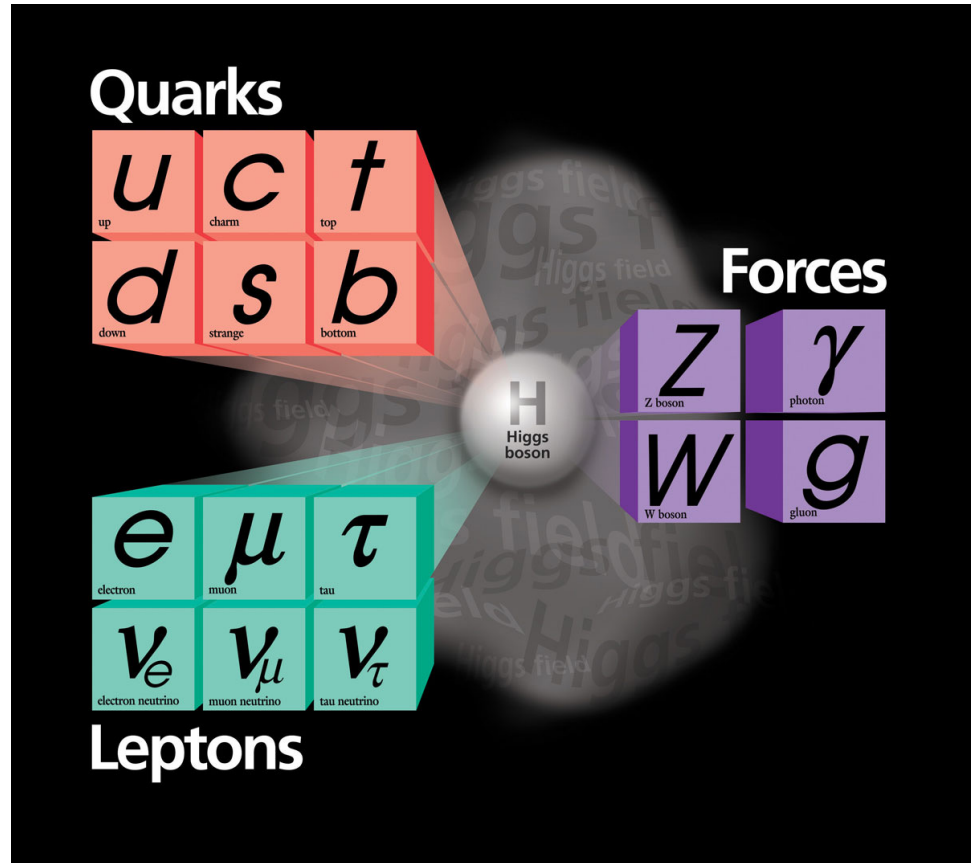
Fermi National Accelerator Laboratory

HDF Users Group Meeting

August 16, 2023

What is “fundamental physics”?

- Fundamental particles
- Fundamental forces
- Evolution of the universe

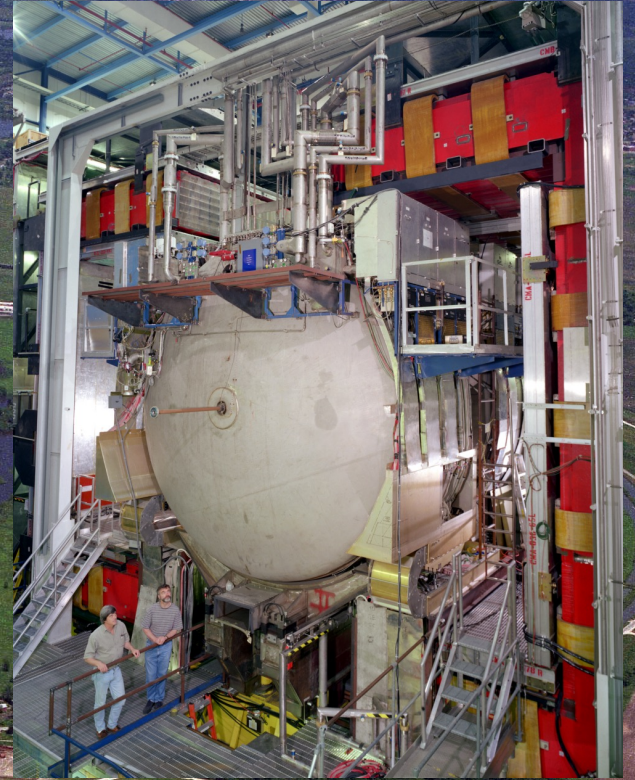
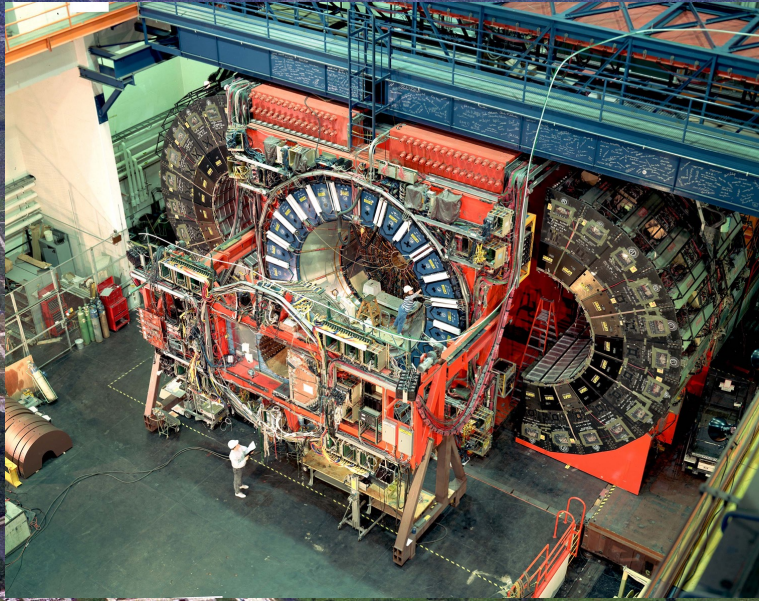












APRIL 16, 1990



A Hurry-Up Summit



\$2.50

TIME SMASH!

Colossal colliders are unlocking the secrets of the universe



Fermilab's Tevatron

Operational since 1983

Maximum collision energy:

2 trillion electron volts

Type: proton-antiproton collider

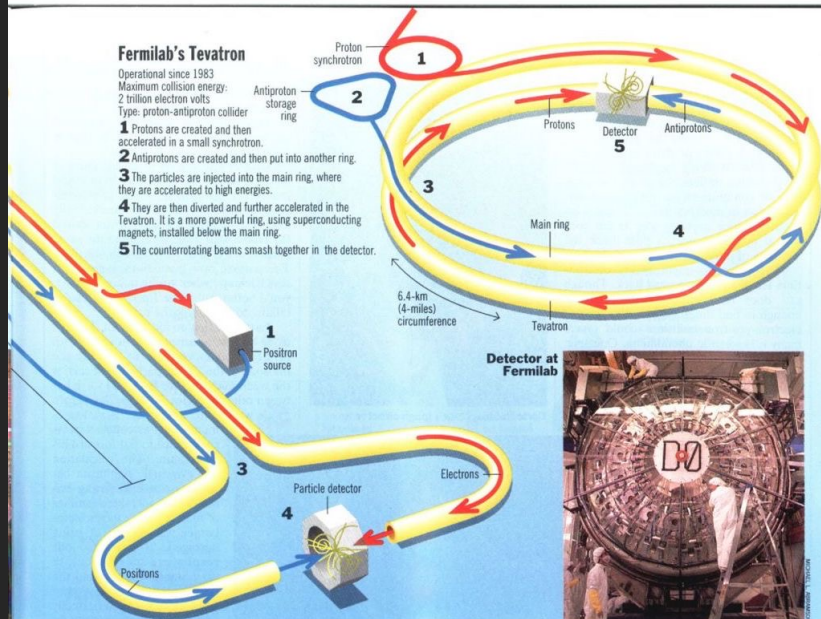
1 Protons are created and then accelerated in a small synchrotron.

2 Antiprotons are created and then put into another ring.

3 The particles are injected into the main ring, where they are accelerated to high energies.

4 They are then diverted and further accelerated in the Tevatron. It is a more powerful ring, using superconducting magnets, installed below the main ring.

5 The counterrotating beams smash together in the detector.



Fermilab is led by director John Peoples, who is widely respected for being a hands-on physicist. But experiments at the lab are not dominated by superstars, such as CERN's Rubbia and Ting. Instead, the atmosphere is one of relative consensus and collegiality. Explains researcher Melynn Shochet, who commutes to Fermilab from the University of Chicago: "We have pushed to set up a more democratic system, rather than an autocratic system where one person heads up the project." When one team of scientists goes off duty and another comes on, they often share an informal dinner right in the control room. "There's Chinese food with chopsticks, dripping all over

It's time they recognized that we also can do good work."

CERN. "Many people doubted that Europe could pull off this venture," said French President François Mitterrand in a speech at the gala official opening of CERN's new accelerator last November, "but the achievement of LEP shows that Europe can harness its cultural diversity." In fact, LEP, which took more than four years and nearly \$1 billion to build, is much more than a European showcase; it is a laboratory for the entire world. It has attracted scientists from 29 countries in both the West and the East. More

The tone and pace for the whole CERN operation is set by Rubbia, a pushy director with a thirst for glory and little patience for laggardly performances. Says one senior CERN researcher: "Rubbia is insensitive, abusive, intolerant and high-handed." Yet no one denies his brilliance, energy and vision. "He works incredibly hard," observes a staffer, "and every waking minute is dedicated to physics." Concedes a critic: "If he was not respected intellectually, he would not be able to get away with the way he behaves. The other mitigating factor is that he is rude to everybody, high and low; he doesn't discriminate." Says Rubbia: "This



Fermilab

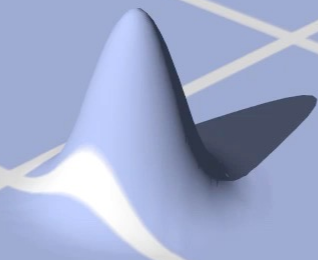
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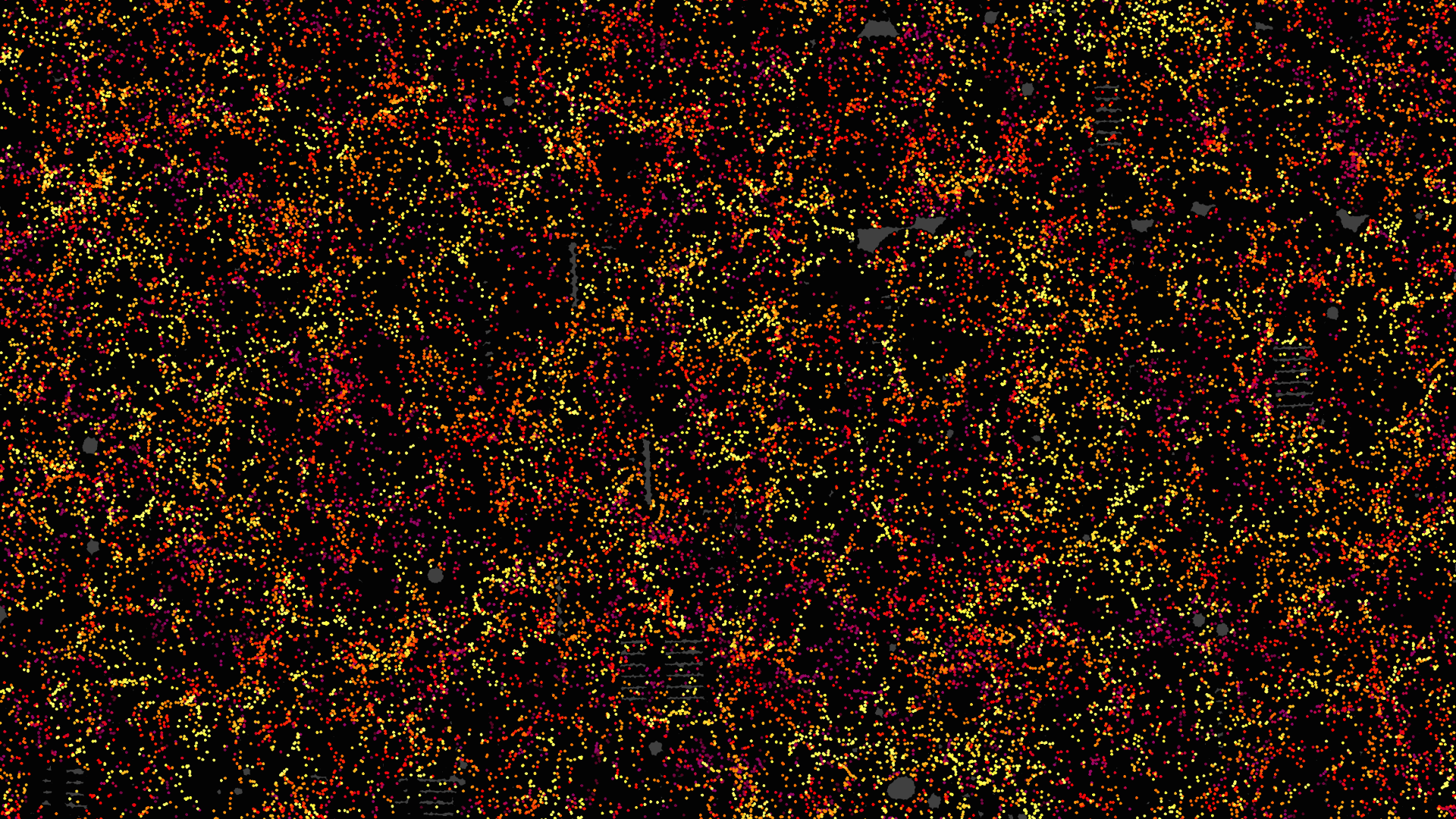








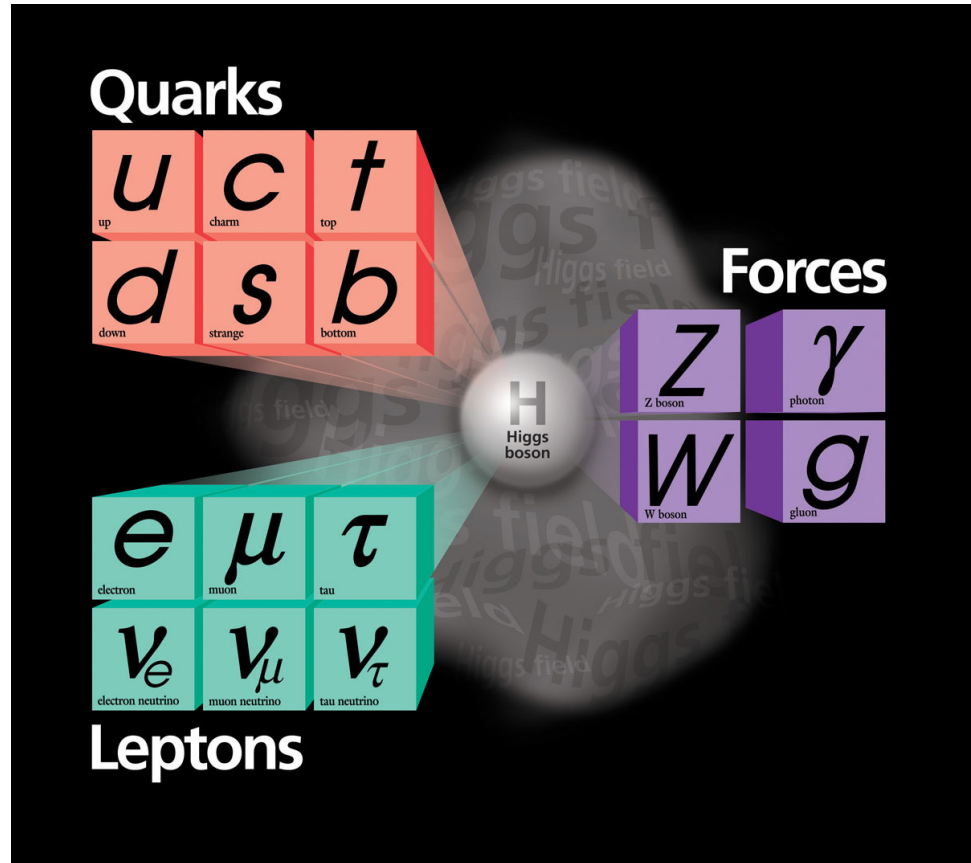






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LHCb

ATLAS

CERN Meyrin

CERN Prévessin

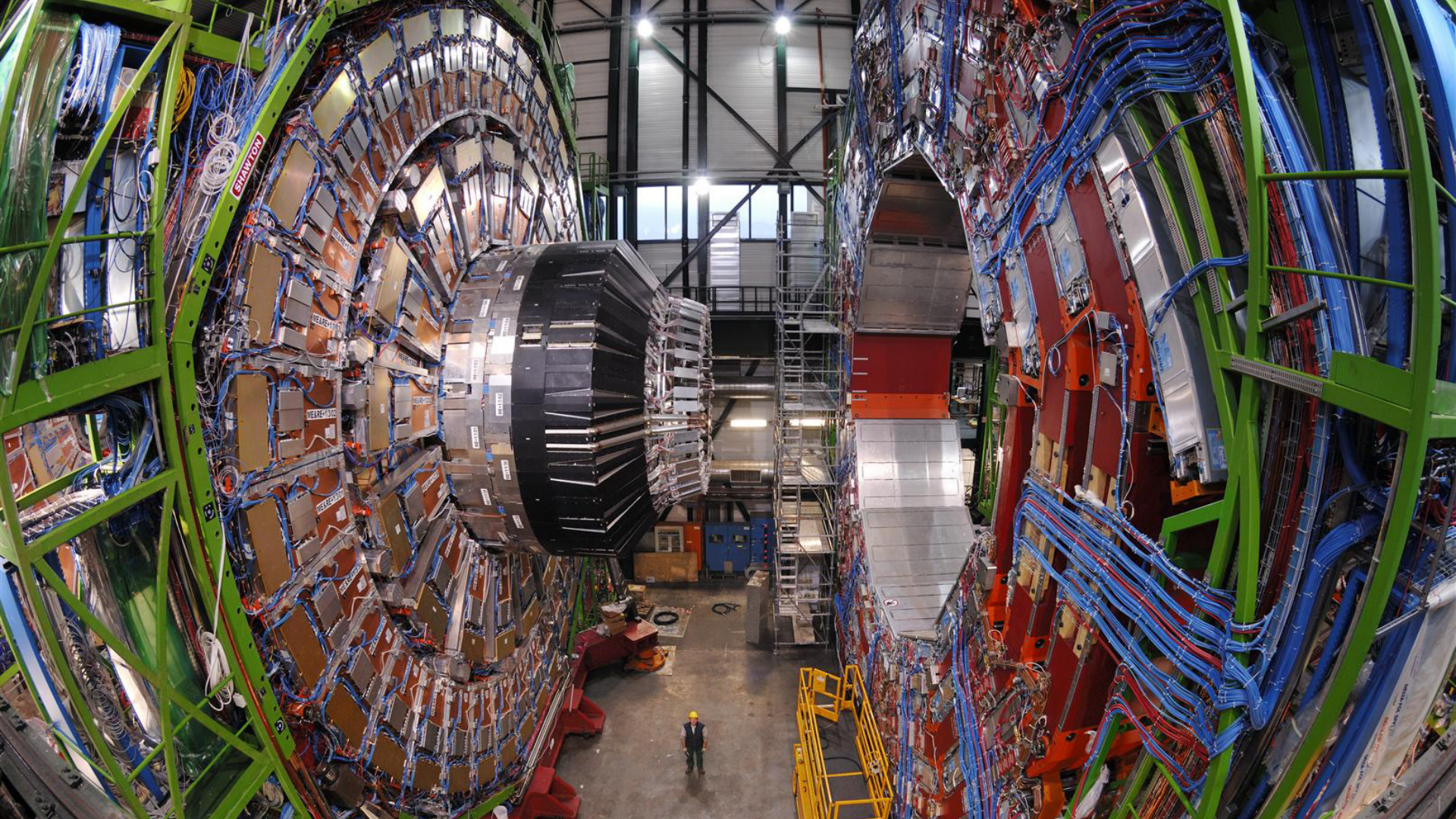
SPS 7 km

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LHC 27 km



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DIE WELT

SONNENTAG, 5. JULI 2012



Geldhedra bei Zwangsleistung - Golf-Tour

Union will Überschüsse in Sozialkassen horten

Teile der Sozialversicherer in London, um Rückstellungen für den Notfall zu sichern. Sozialversicherer fordern...

THE HINDU



Particle found, looks like Higgs boson

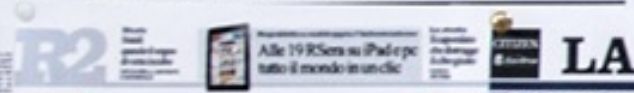
US physicists had evidence of a new elementary particle...

ALGEMEEN DAGBLAD

Daten hat er über...
Zweiter Teil von...
Kommen in der...

El juez imputa a Rato y 32 consejeros de Bankia

La Audiencia Nacional admite una querrela contra los exgobernadores del grupo
El magistrado ve indicios de cuatro posibles delitos en la crisis del banco



la Repubblica

“Perché l’Italia deve farcela”

Colloquio con Napolitano: buona idea la Costituzione, ma nel 2013 la riforma



The Telegraph

It walks, it quacks but best to...

Bose behind the boson

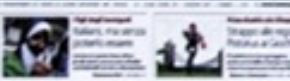
আনন্দবাজার পত্রিকা

বিজ্ঞানের ‘ঈশ্বর’ দর্শন



La anterior crinida de

LA STAMPA



Nomine Rai Schifani-Fini ai ferri corti

Supremazia del Tesoro e del Parlamento. La replica finale



l'Unità

Lo Strega secondo Trevis e Carofoglio

Rai, colpo di mano di Schifani

Monti a Merkel non ci serve alcun aiuto

Osperali da tagliare scontro nel governo



МК



ПОСЛЕДНИЙ КИРПИЧ В СТЕНУ МИРОЗДАНИЯ



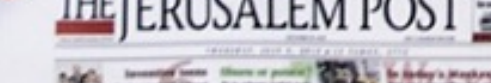
The Gazette

Monday, 2nd July 2012, 17:00



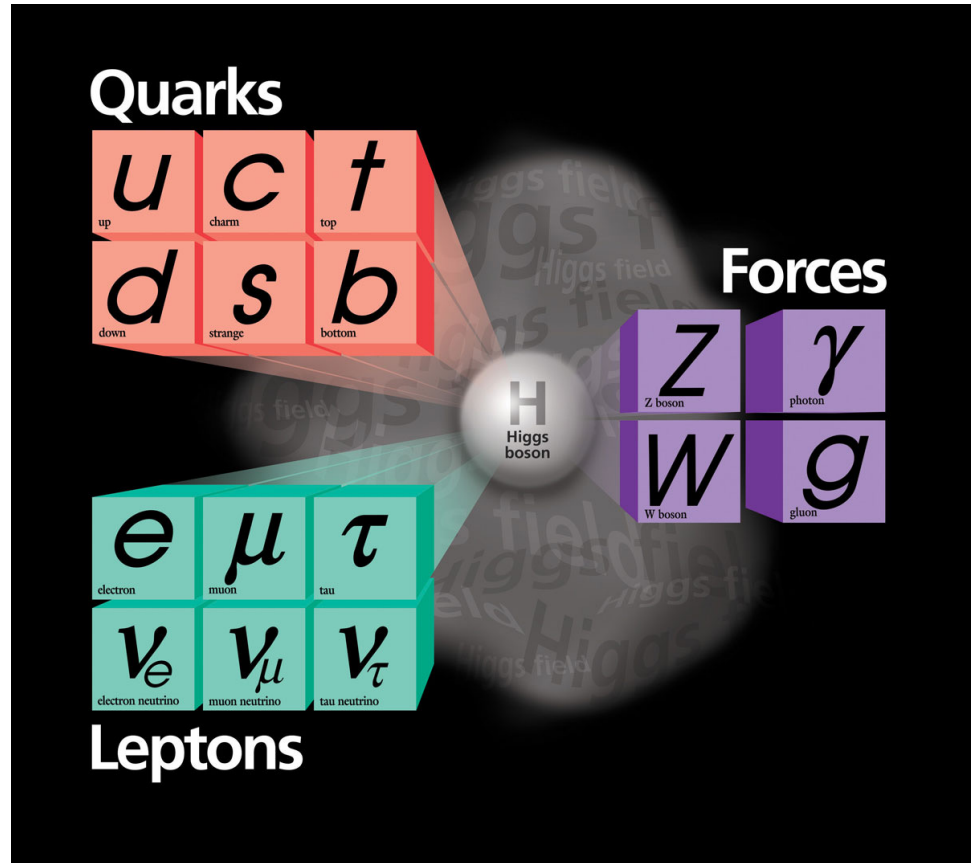
The Jerusalem Post

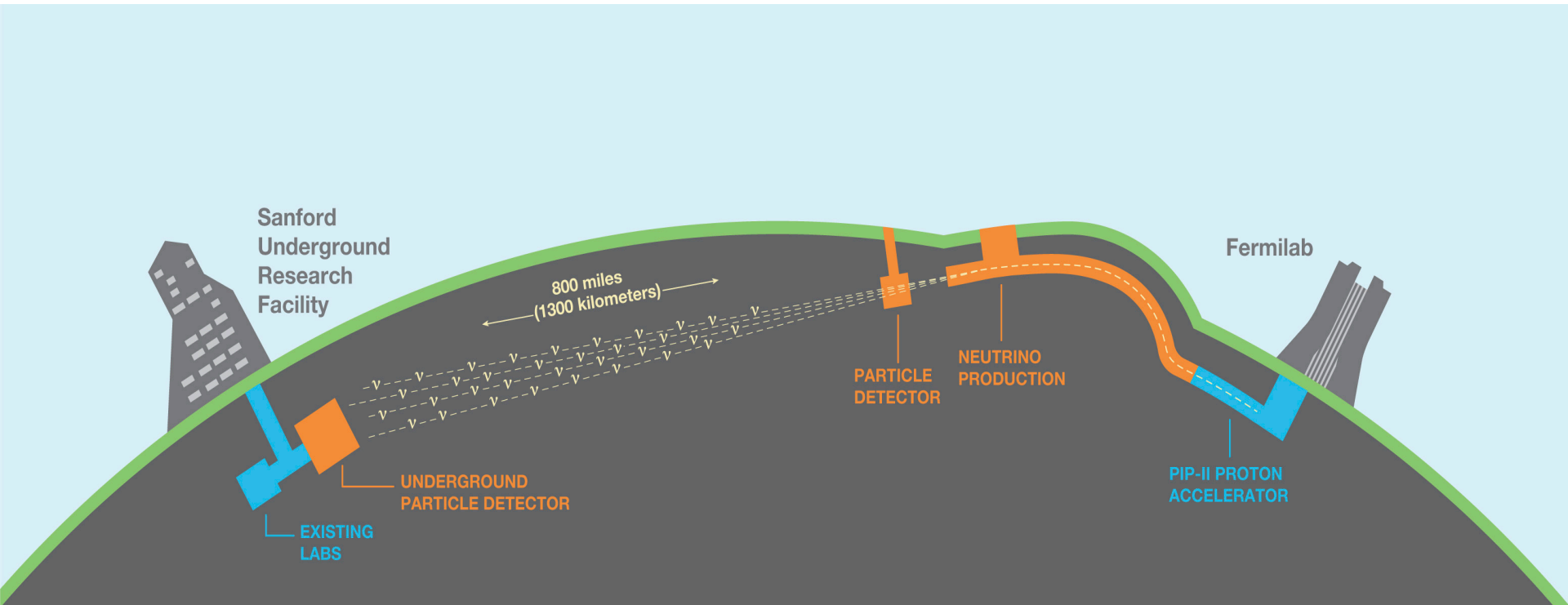
July 5, 2012



What is “fundamental physics”?

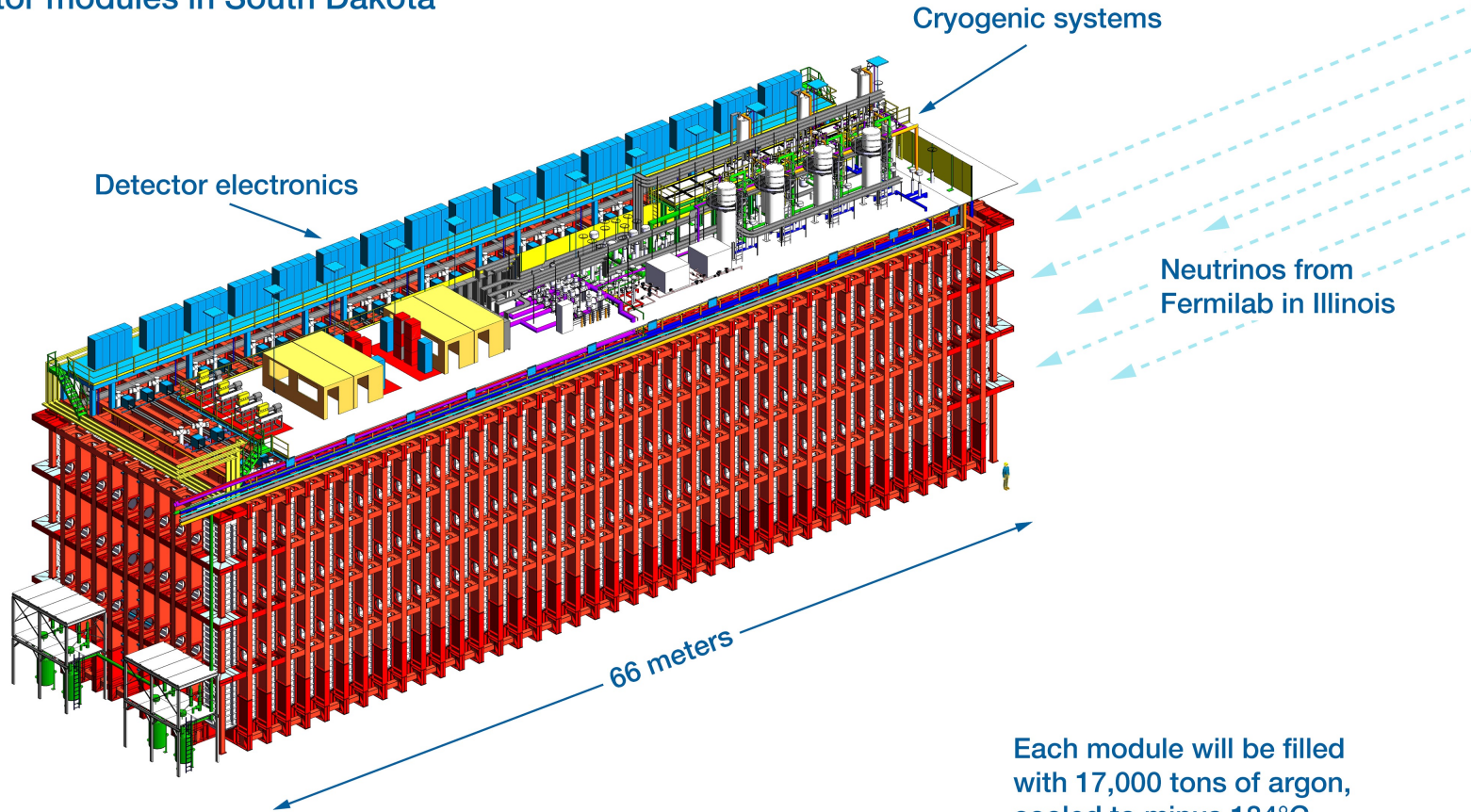
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Deep Underground Neutrino Experiment

One of four detector modules in South Dakota



Detector located
1.5 kilometers
underground at
Sanford Lab

Each module will be filled
with 17,000 tons of argon,
cooled to minus 184°C

Thanks

- All images and videos are credited to Fermilab unless otherwise noted.
- SDSS galaxy cluster image courtesy of *classics.sdss.org*.
- BAO video courtesy of the ARC Centre of Excellence for All-sky Astrophysics (CAASTRO).
- LHC aerial photograph courtesy of CERN.
- Higgs discovery newspaper montage courtesy of the American Physical Society.

