

Title: LHC and Particle Physics

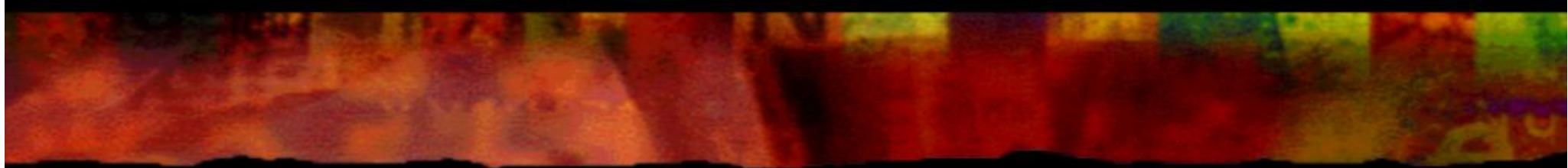
Date: Jul 29, 2010 01:00 AM

URL: <http://pirsa.org/10070032>

Abstract: Since the dawn of civilization, humans have attempted to dissect the world and uncover its fundamental constituents. Today, this quest continues in the field of particle physics, the study of the fundamental subatomic particle that make up everything in the universe.

The Large Hadron Collider (LHC) is a massive underground particle accelerator that physicists hope will reveal new secrets about the physical world. Located just outside Geneva, Switzerland at CERN, it has a circumference of 27 km and is the product of a collaboration that involves thousands of scientists worldwide.

This presentation will talk about the LHC and some of the exciting new ideas it may confirm.



The Large Hadron Collider

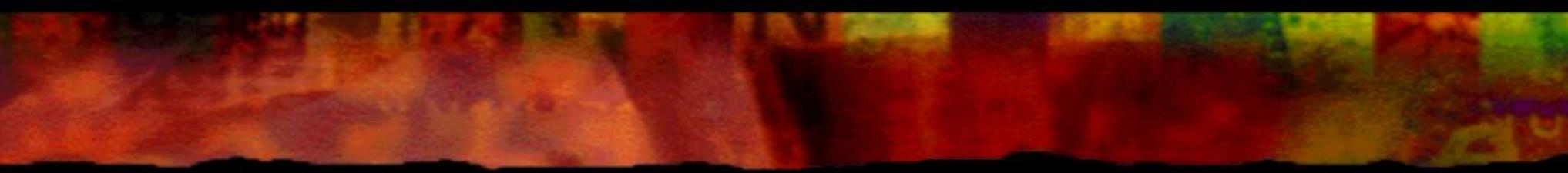
*Start of a New Era
or the End of the World?*



LARGE HADRON COLLIDER

C.P. Burgess





The Large Hadron Collider



*Start of a New Era
or the End of the World?*

C.P. Burgess



Outline

- What is it?
 - *The machine*
- Why was it built?
 - *The Standard Model and its limitations*
- What might it hope to see?
 - *Problems*
- Outlook

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The Machine

- The Accelerator
- The Detectors

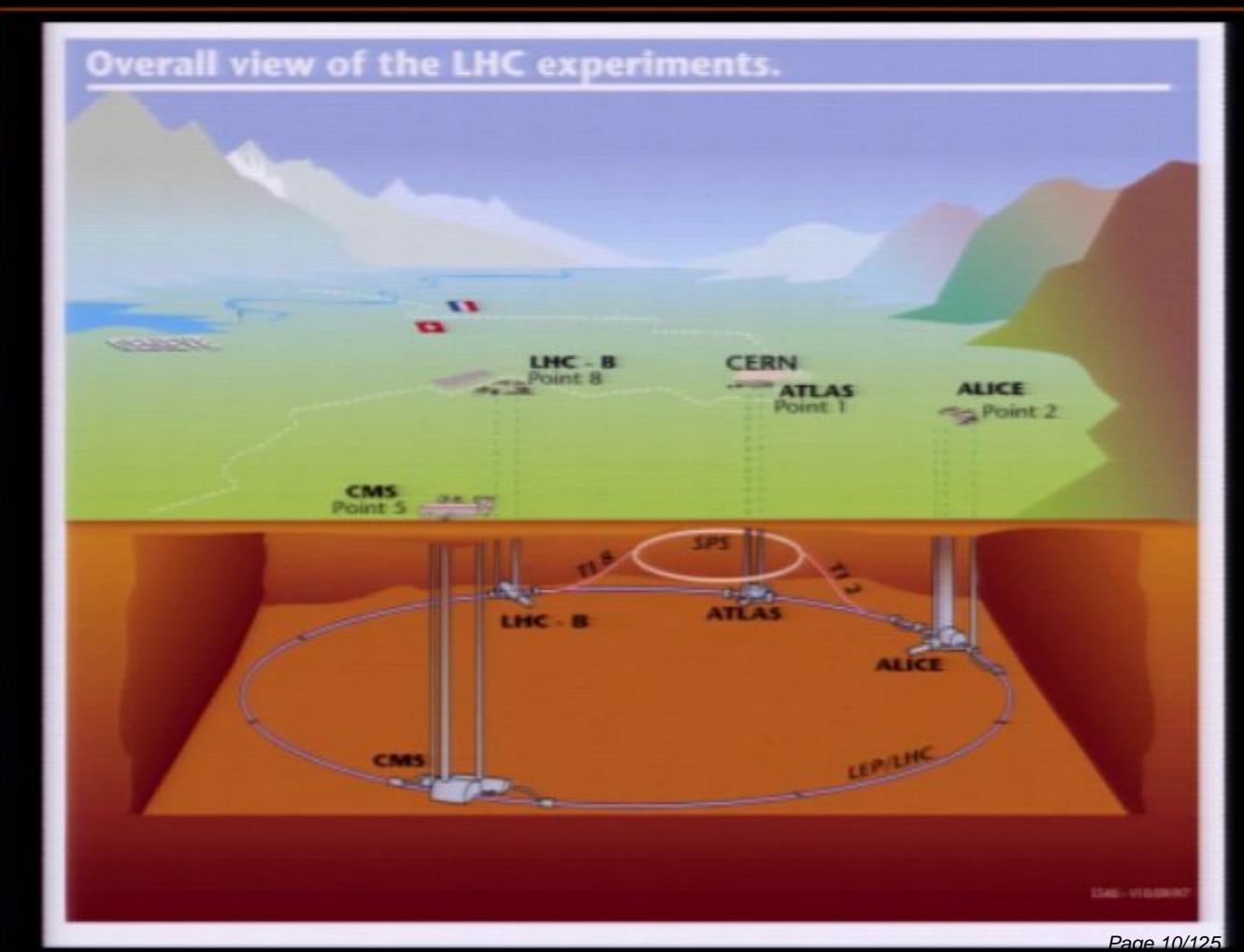
The Machine

- The Accelerator
- The Detector



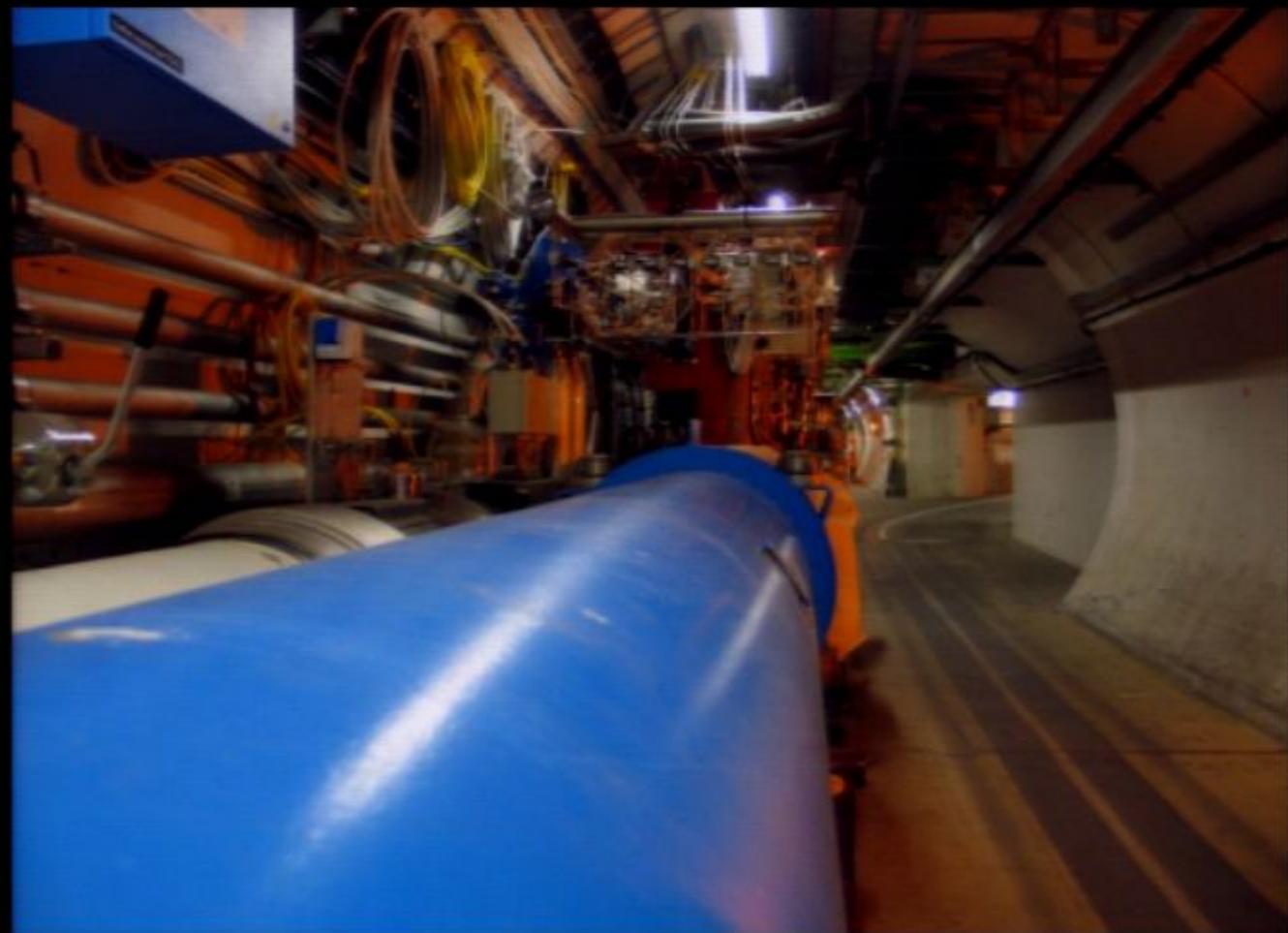
The Machine

- The Accelerator
- The Detector



The Machine

- The Accelerator
- The Detector



The Movie

- The Plot
- *Scenes at CERN*
- Scenes in Rome



The Movie

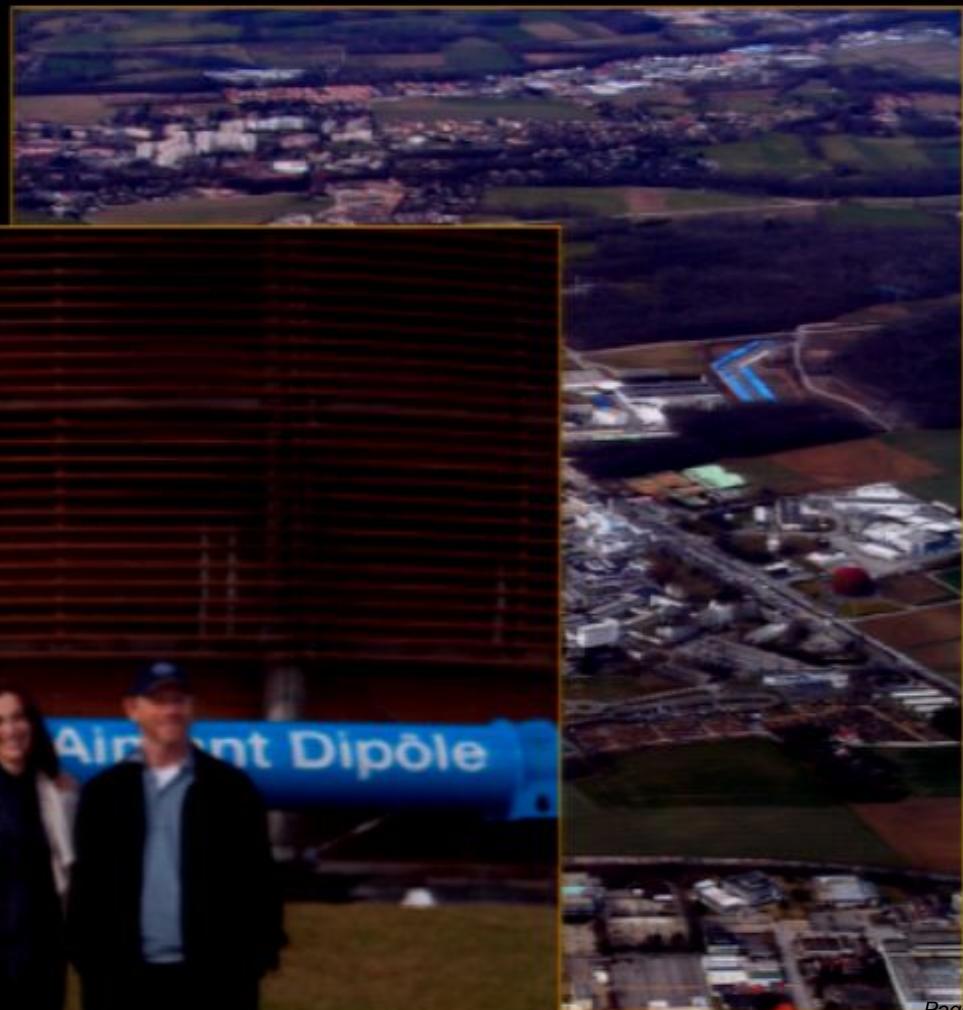
- The Plot

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Page

The Movie

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CERN

The Movie

- The



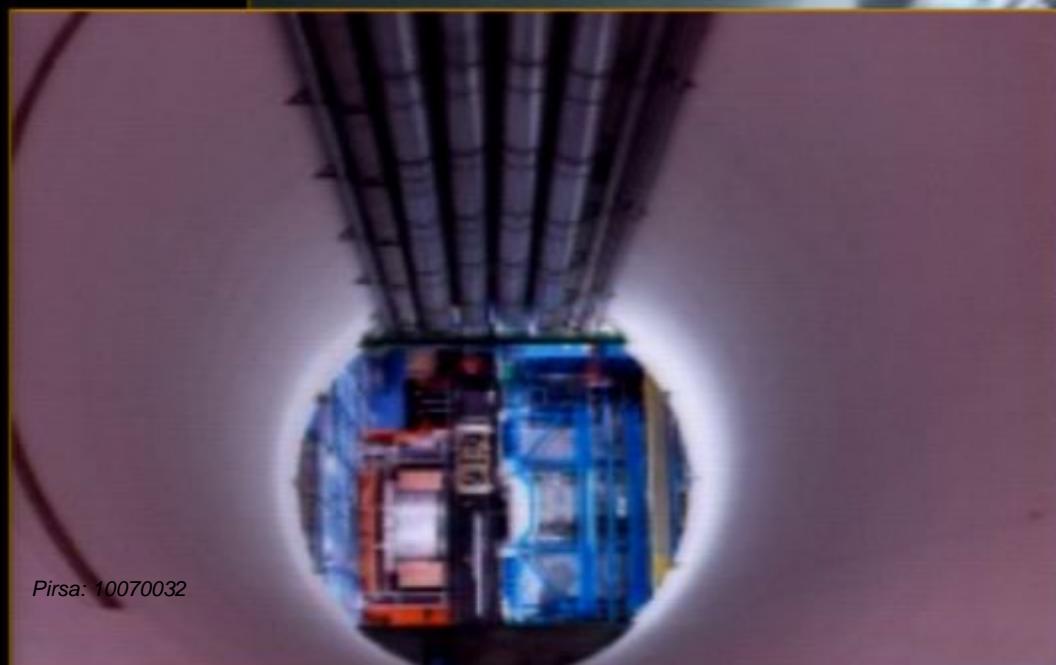
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The Movie

- Scenes in Rome

The Movie

- The



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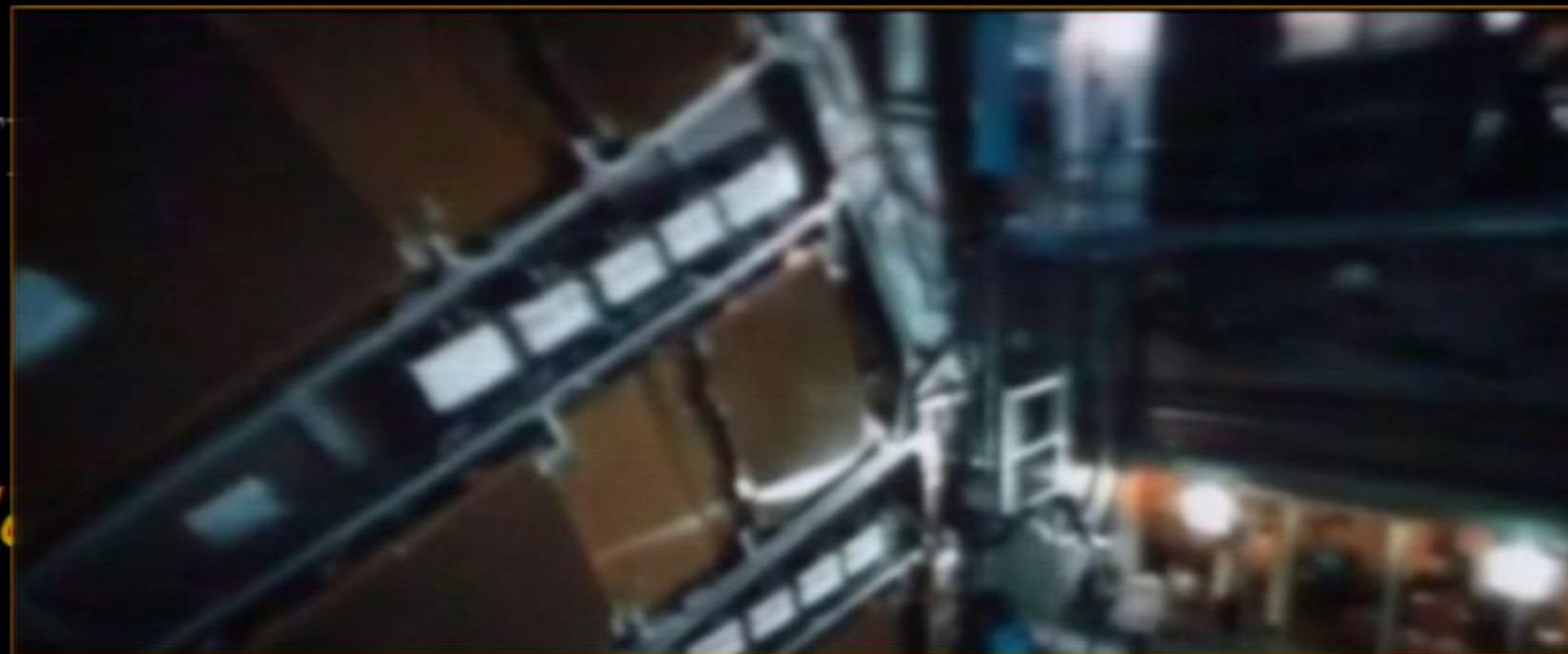


CERN

The Movie

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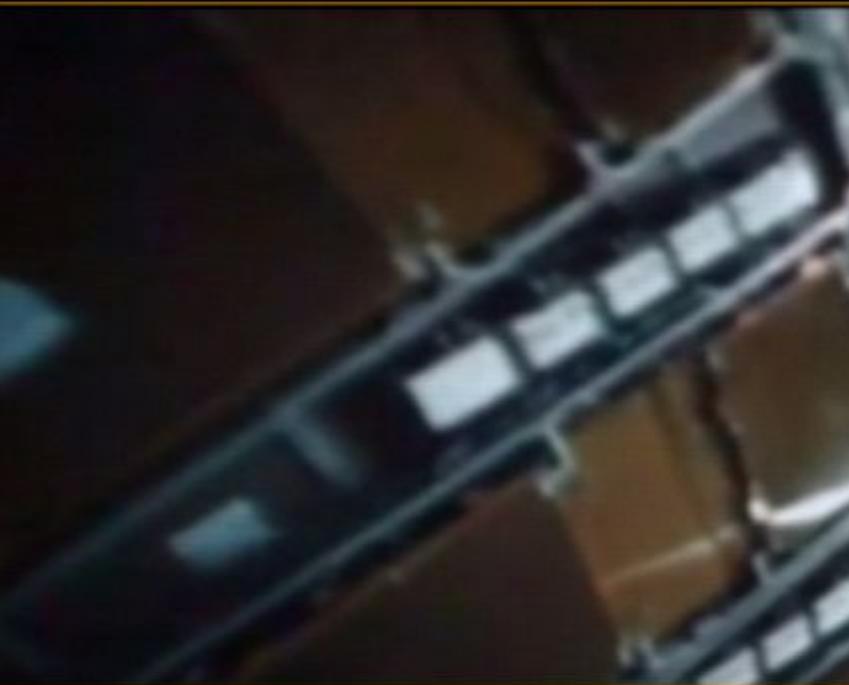
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The Movie

- Scenes in Rome

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- Scenes in Rome



The Movie

- Scenes in Rome



CERN

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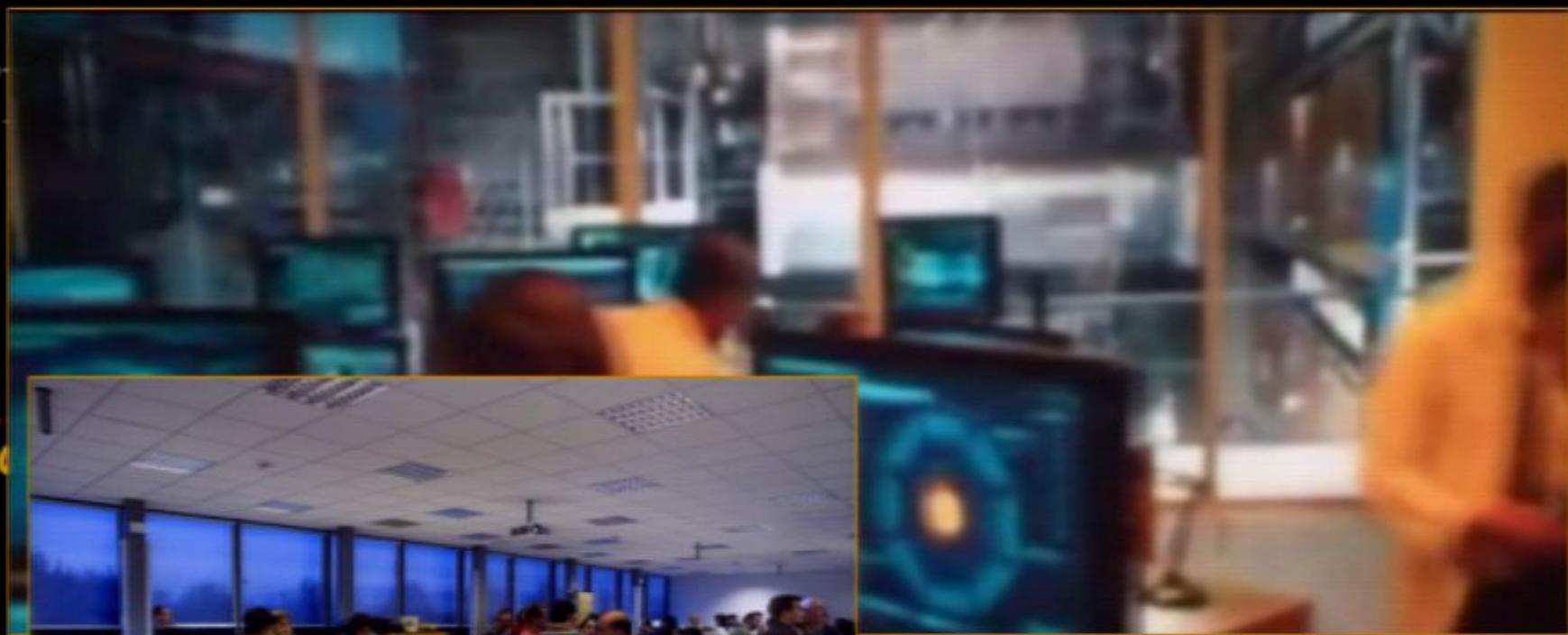
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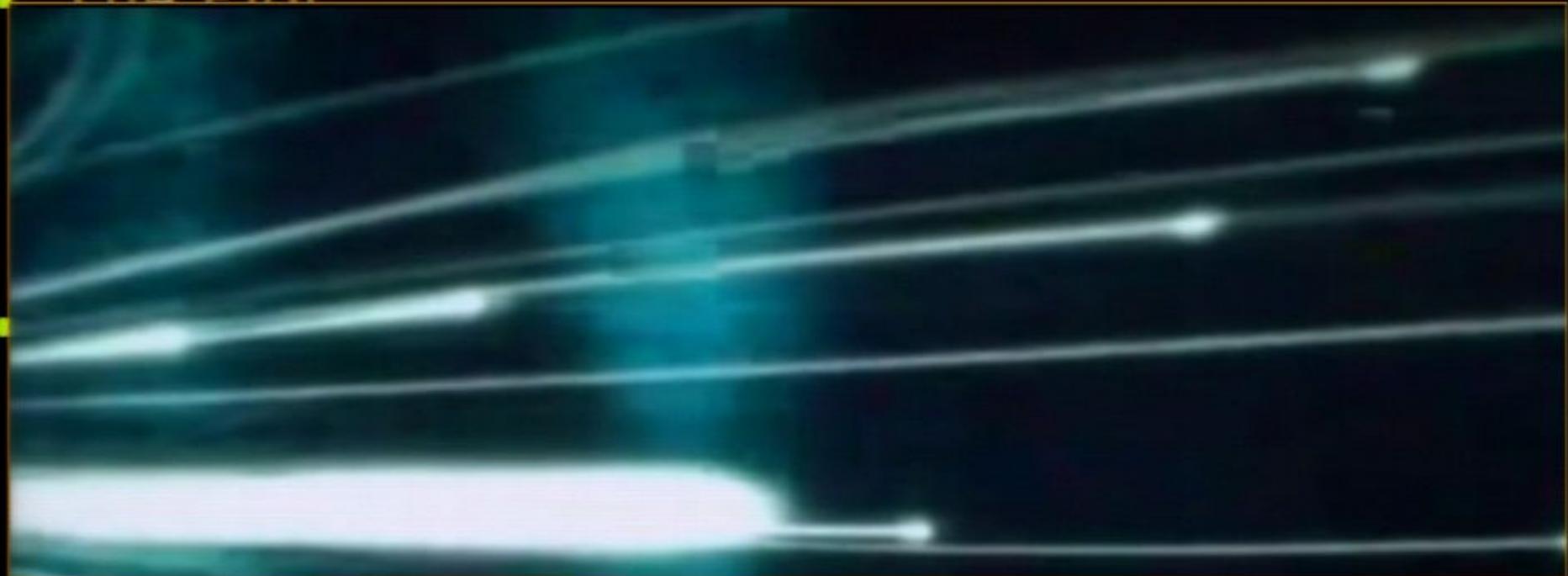
The Movie

CERN

The Movie



- The Plot



- Scenes in Rome

The Movie

The Movie

- The Plot



- Scenes in Rome

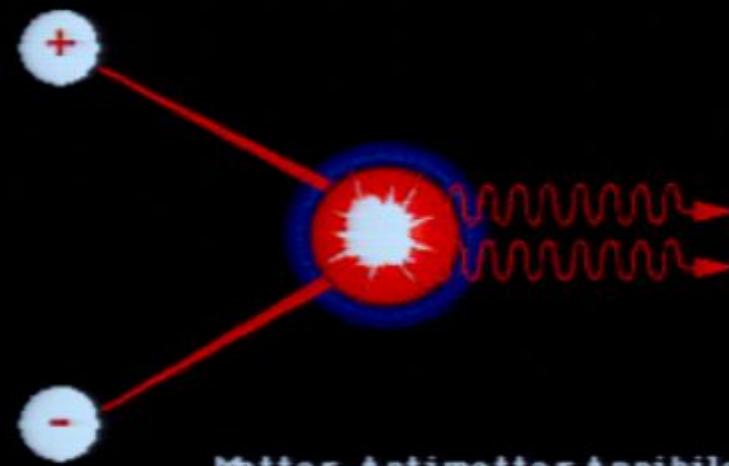
The Movie

The Movie

- The D1



- Scenes



Matter-Antimatter Annihilation

Antimatter: *for each elementary particle there is another having precisely the same mass and opposite charge.*

Movie

The Movie

- The Plot



- Scenes in Rome

The Movie

The Movie



- The Plot



Accelerators make as much antimatter as matter whenever particles collide.



- Scenes

Movie

The Movie



- The Plot



Accelerators make as much antimatter as matter whenever particles collide.

Left to itself antimatter annihilates with matter, so is very difficult to collect and contain (but would be a powerful bomb).

- Scenes



Movie

The Movie



- The Plot



Accelerators make as much antimatter as matter whenever particles collide.

Left to itself antimatter annihilates with matter, so is very difficult to collect and contain (but would be a powerful bomb).

Each collision produces only a handful of antiparticles; years of effort were required to accumulate enough to make a few atoms of anti-hydrogen (destroyed after use).

- Scenes



Movie

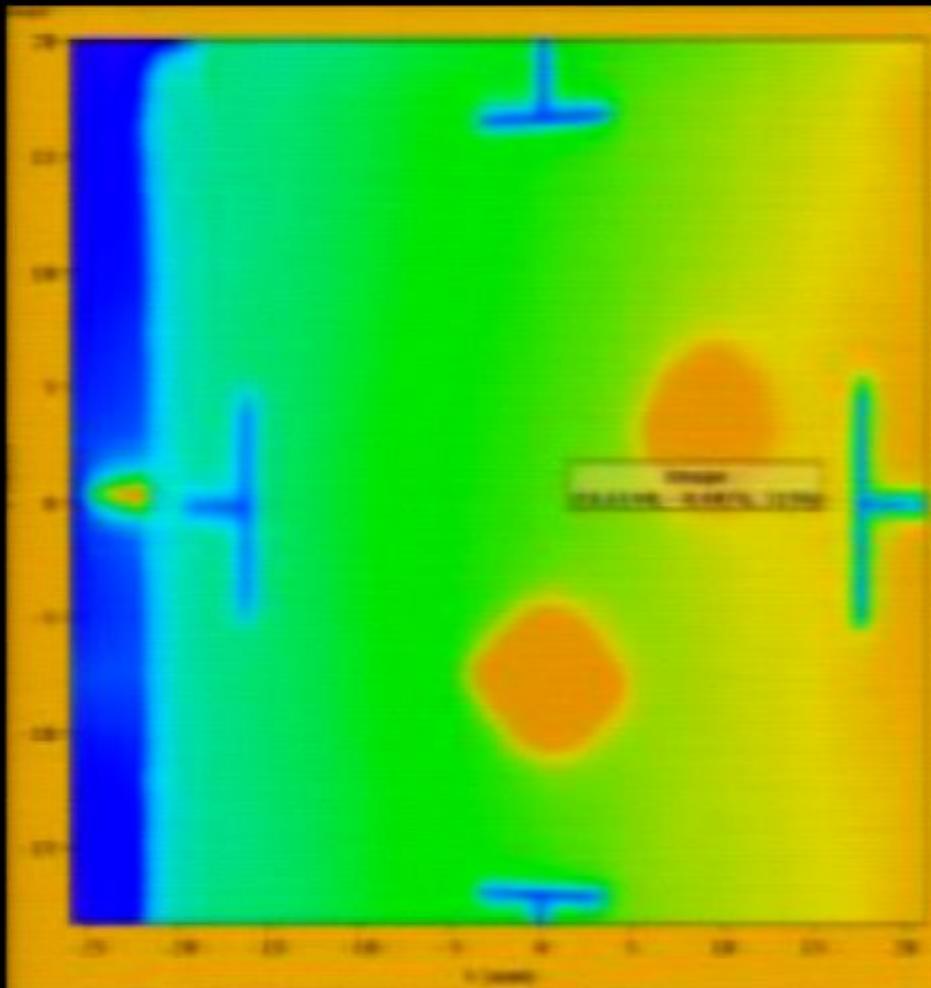
The Machine

- The Accelerator
- The Detector



The Machine

- The Accelerator
- The Detector



The Machine

W. Trischuk

- The Accelerator
- The Detector



The Incident

The Machine

W. Trischuk

- The Accelerator
- The Detector

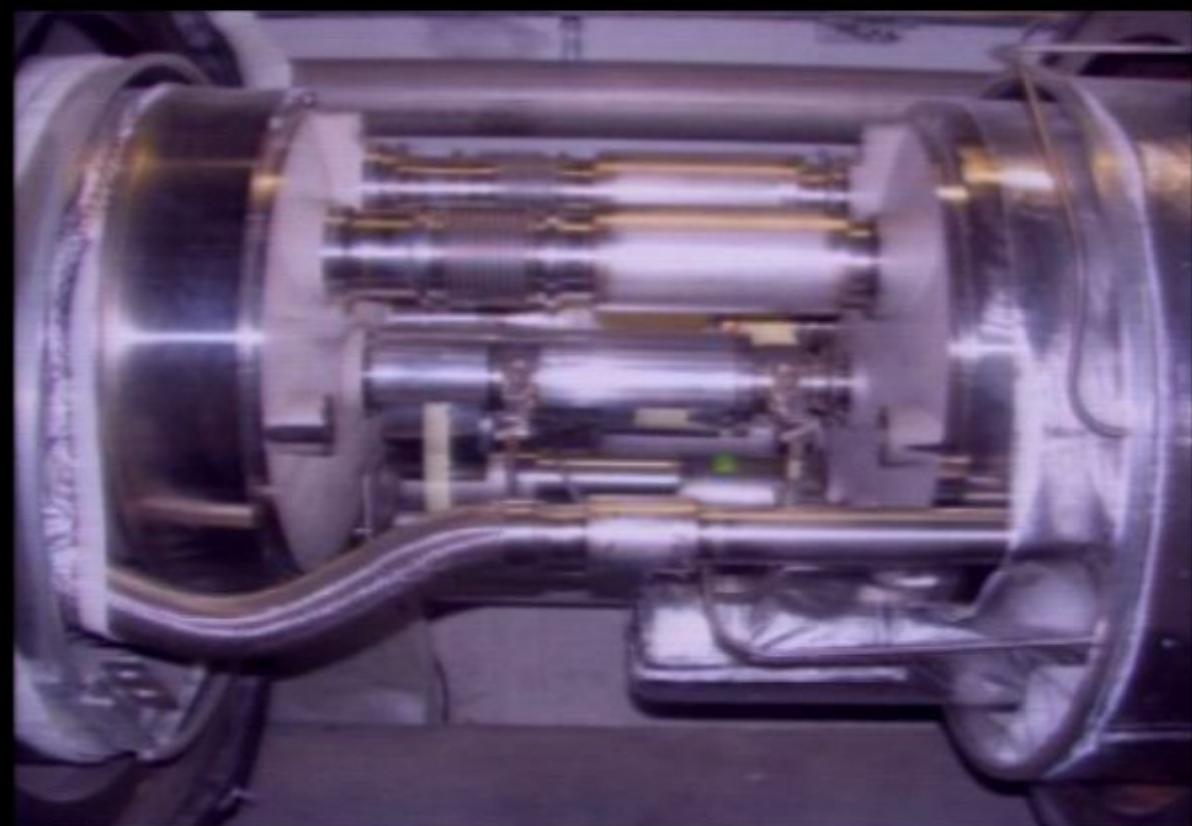


1200 superconducting magnets

The Machine

W. Trischuk

- The Accelerator
- The Detector

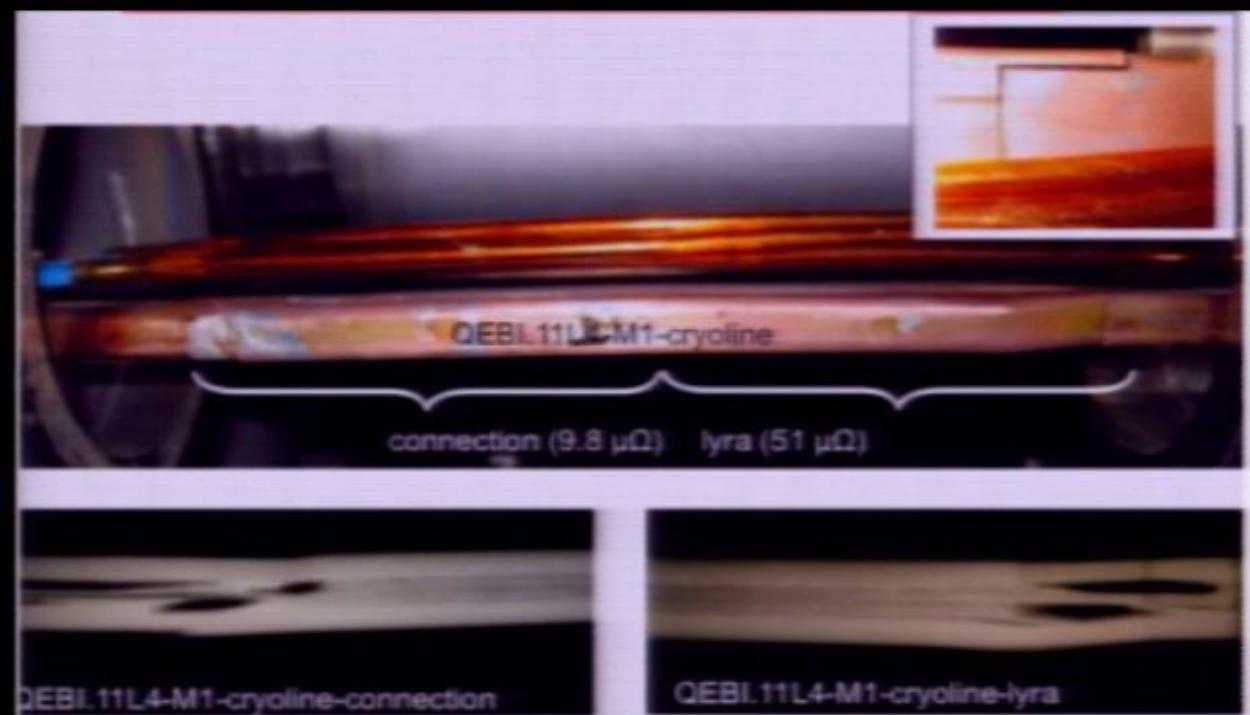


dipole interconnect

The Machine

W. Trischuk

- The Accelerator
- The Detector

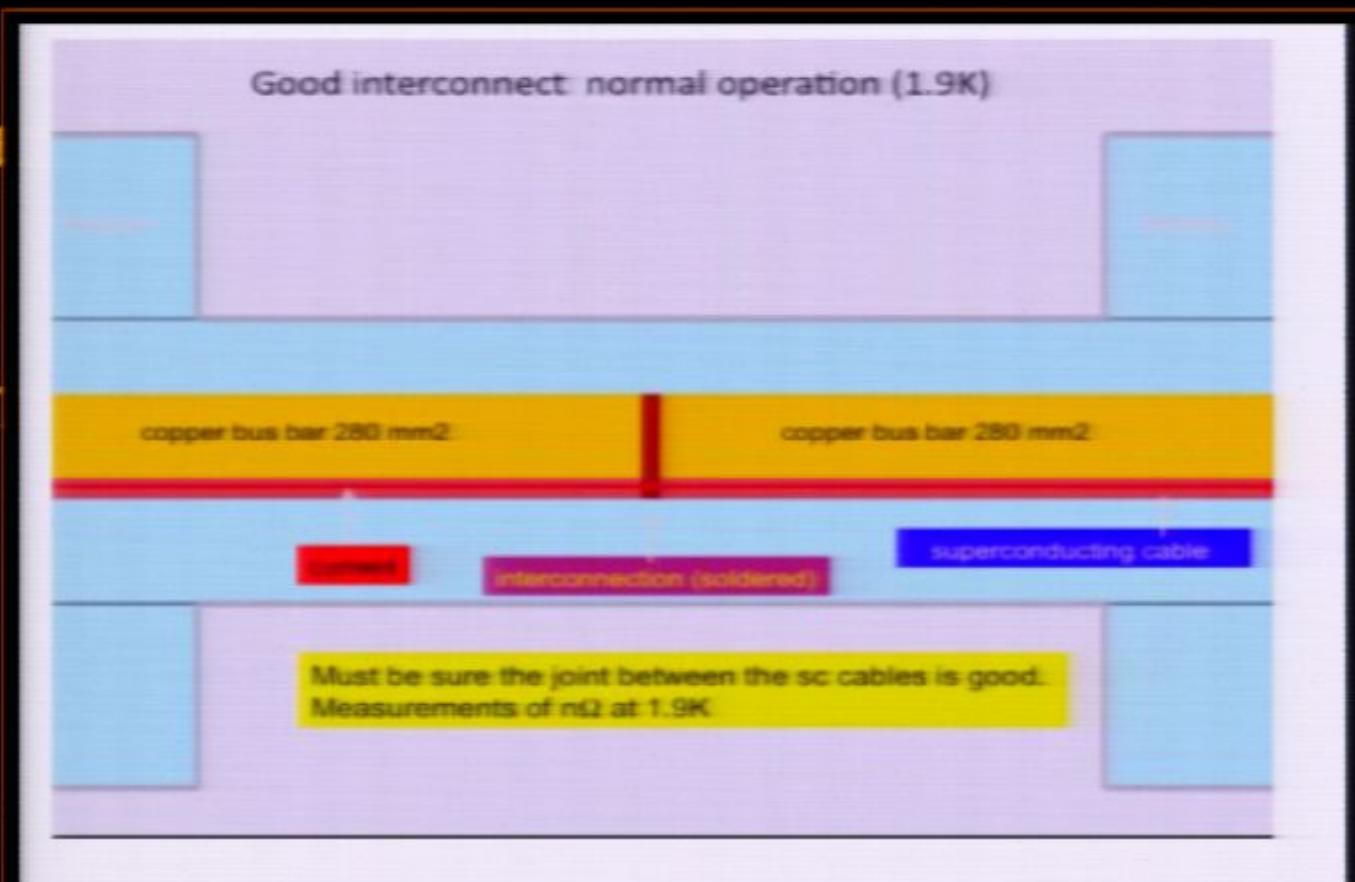


dipole interconnect

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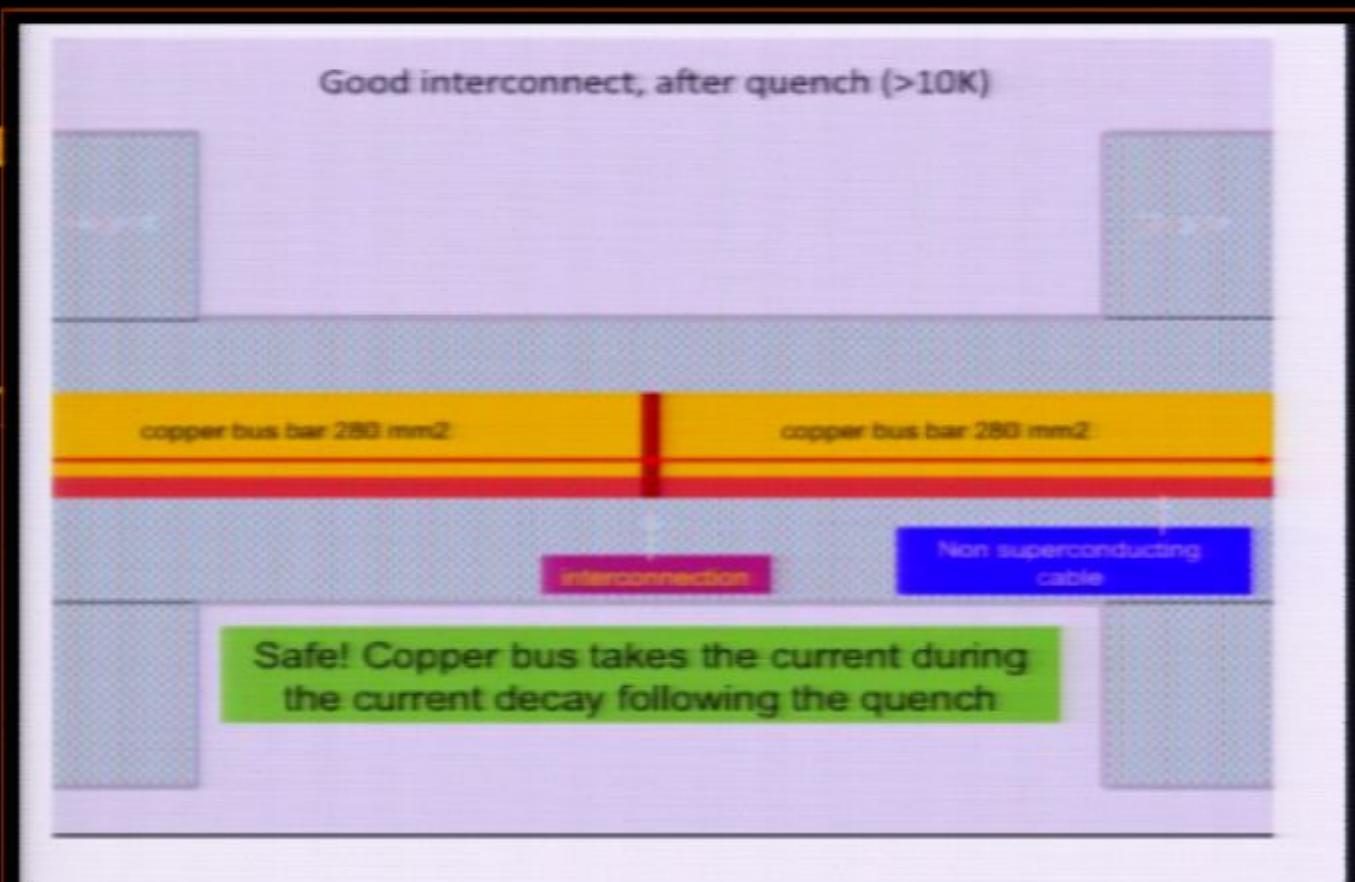


schematic connection

The Machine

W. Trischuk

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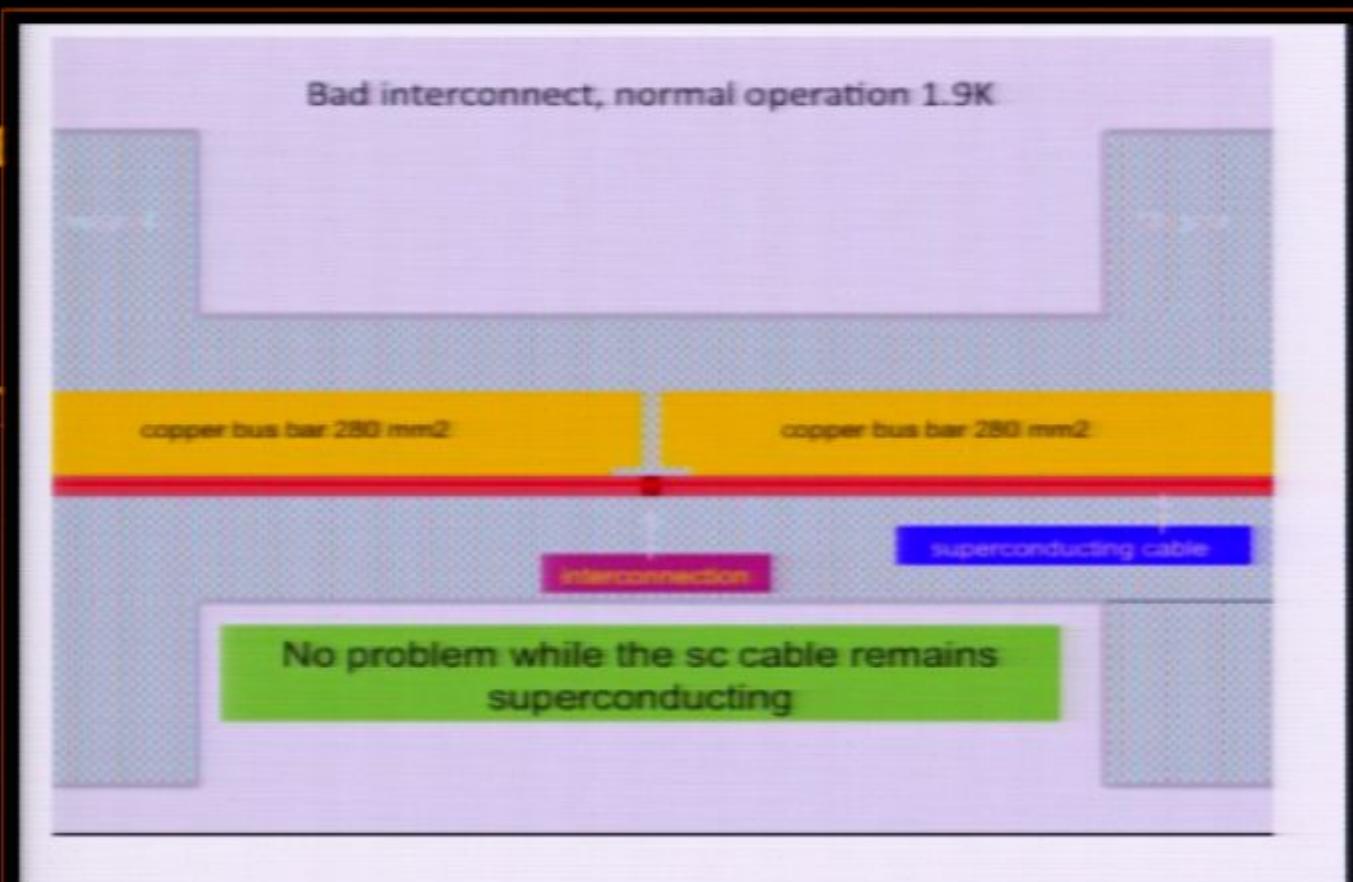


schematic connection

The Machine

W. Trischuk

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schematic connection

The Machine

W. Trischuk

- The Accelerator
- The Detector



mechanical damage

The Machine

W. Trischuk

- The Accelerator
- The Detector



soot in the beam pipe
(normal copper looks red)

The Machine

W. Trischuk

- The Accelerator
- The Detector



Replaced 14 quadrupoles and 29 dipoles,
34 interconnections fully repaired

The Machine

W. Trischuk

- The Accelerator
 - What if there are also problems with the other magnets that did not fail?
- The Detector
 - Can measure resistance of connections to infer which are bad
 - worst magnet (at 300K): $50 \mu\Omega$
 - At 7 TeV believed safe even with $120 \mu\Omega$
 - At 10 TeV believed safe even with $70 \mu\Omega$

The Machine

W. Trischuk

- The Accelerator

- The Detector

Circuit	Sector 12	Sector 23	Sector 34	Sector 45	Sector 56	Sector 67	Sector 78	Sector 81
R8	red		red, red	red, red	red	red, red		
R9		blue		blue			blue	blue
RQ	red		red	red	red	red, red		
RQ		blue		blue			blue	blue, blue

- Huge effort of dedicated measurement teams
 - About 35000 manual measurements
 - Over 400 kilometers walked in the tunnel

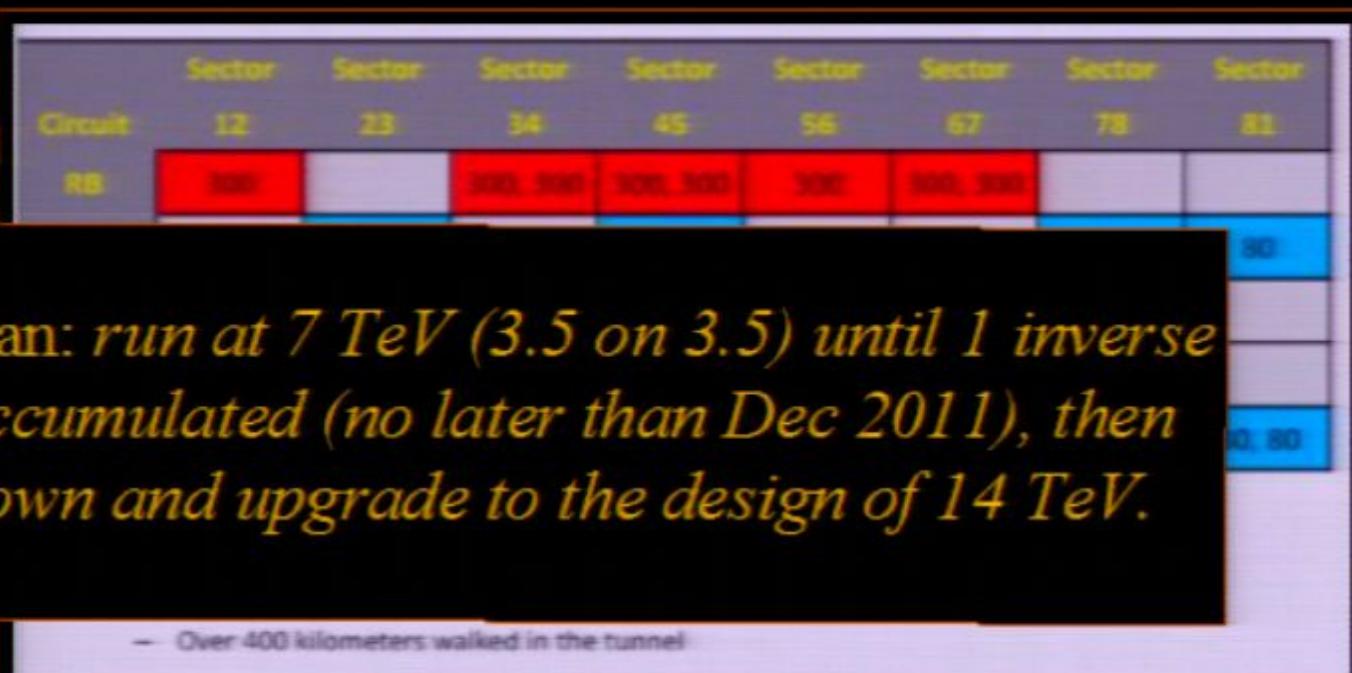
Some sectors remain cold

*Takes months to heat and recool and there is
not enough storage for the He*

The Machine

W. Trischuk

- The Accelerator



- The Detectors

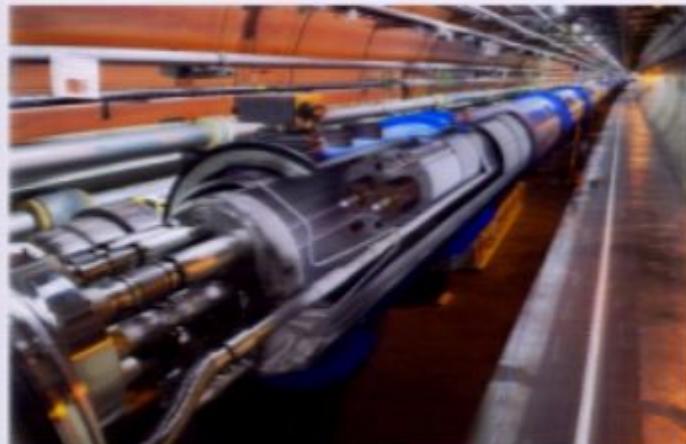
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The Machine

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20.11.2009: LHC about to restart



The LHC tunnel. Illustration shows the beampipes inside a dipole magnet. [M.Brioe, CERN]

On 18 November, the LHC was handed over for operation. Teams are now preparing for injecting and circulating the first beams of 2009.

For latest updates, follow us on Twitter: twitter.com/cern

The LHC is now back!

The Machine

- The Accelerator
- The Detector

23.11.2009: Two circulating beams bring first collisions in the LHC



Screens showing two beams in the LHC. [More photos >](#)

Geneva, 23 November 2009. Today the LHC circulated two beams simultaneously for the first time, allowing the operators to test the synchronization of the beams and giving the experiments their first chance to look for proton-proton collisions.

MORE INFORMATION:

- Press release: Two circulating beams bring first collisions in the LHC

The LHC is now back!

The Machine

- The Accelerator
- The Detector

LHC sets new world record 30 November 2009



Scenes of joy in the CERN Control Centre more photos >

Geneva, 30 November 2009. CERN's Large Hadron Collider has today become the world's highest energy particle accelerator, having accelerated its twin beams of protons to an energy of 1.18 TeV in the early hours of the morning. This exceeds the previous world record of 0.98 TeV, which had

The LHC is now back!

The Machine

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The Machine

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The most important machine at CERN

The Machine

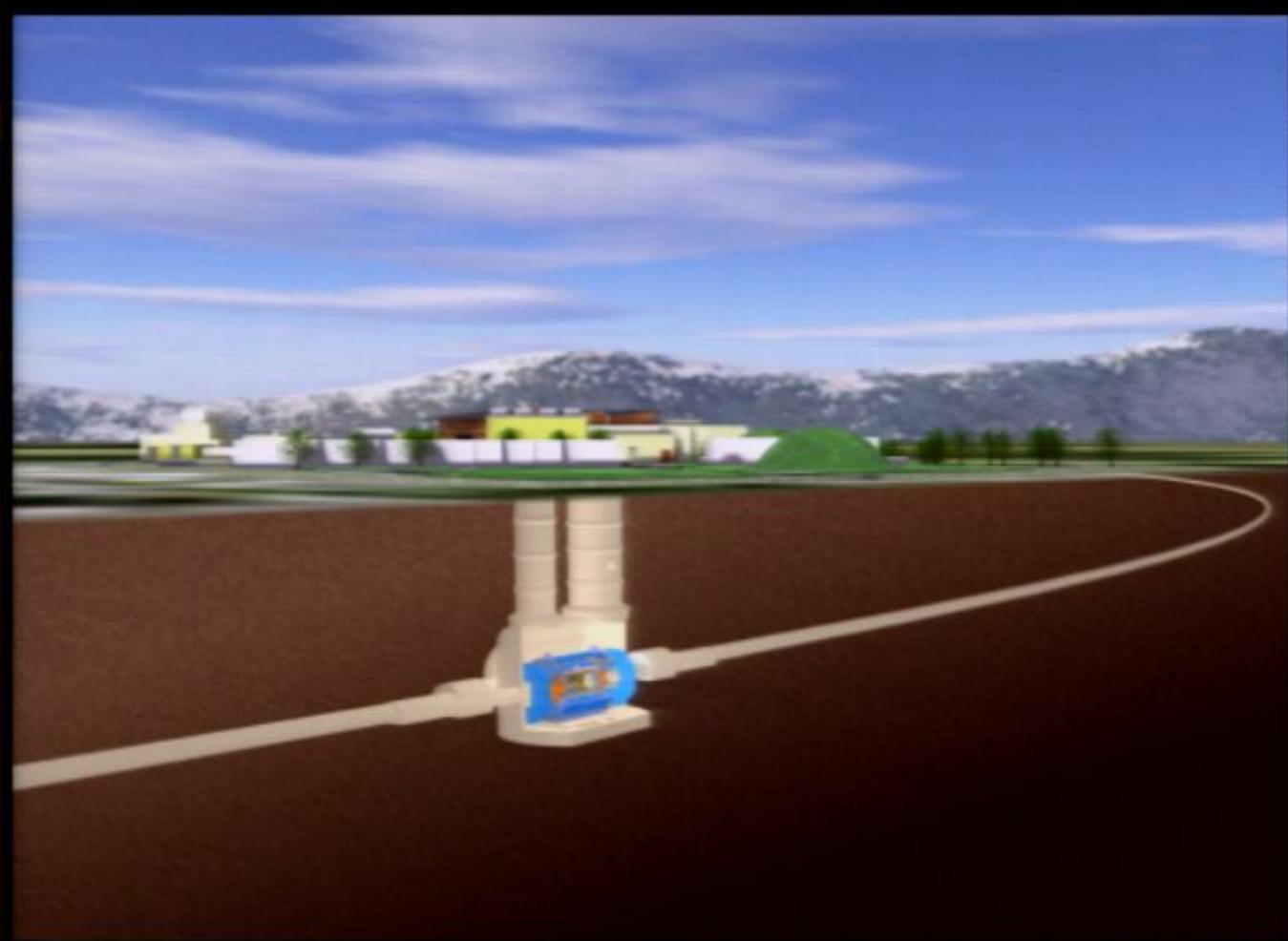
- The Accelerator
- The Detector



The ^{next} most important machine at CERN

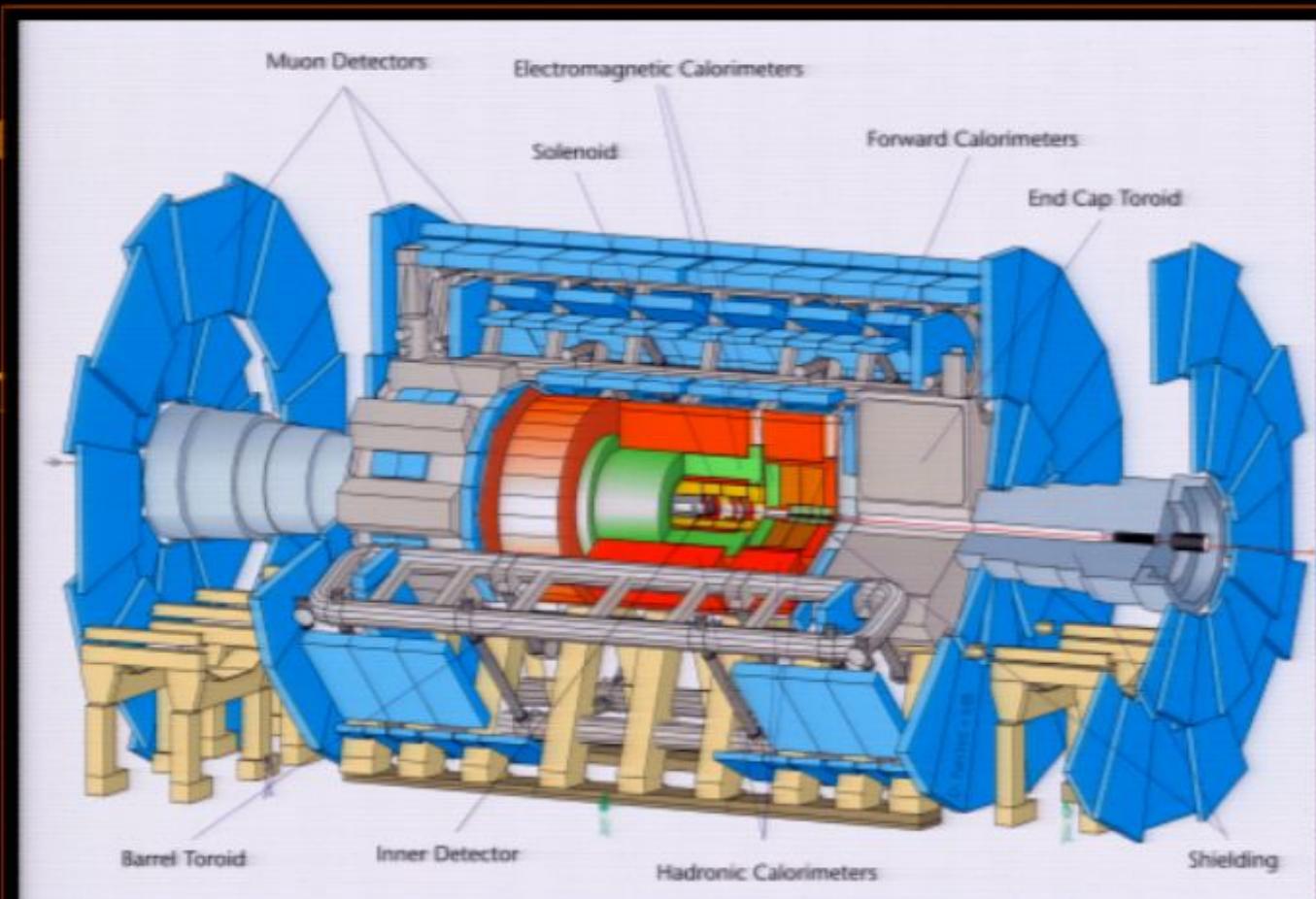
The Machine

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The Machine

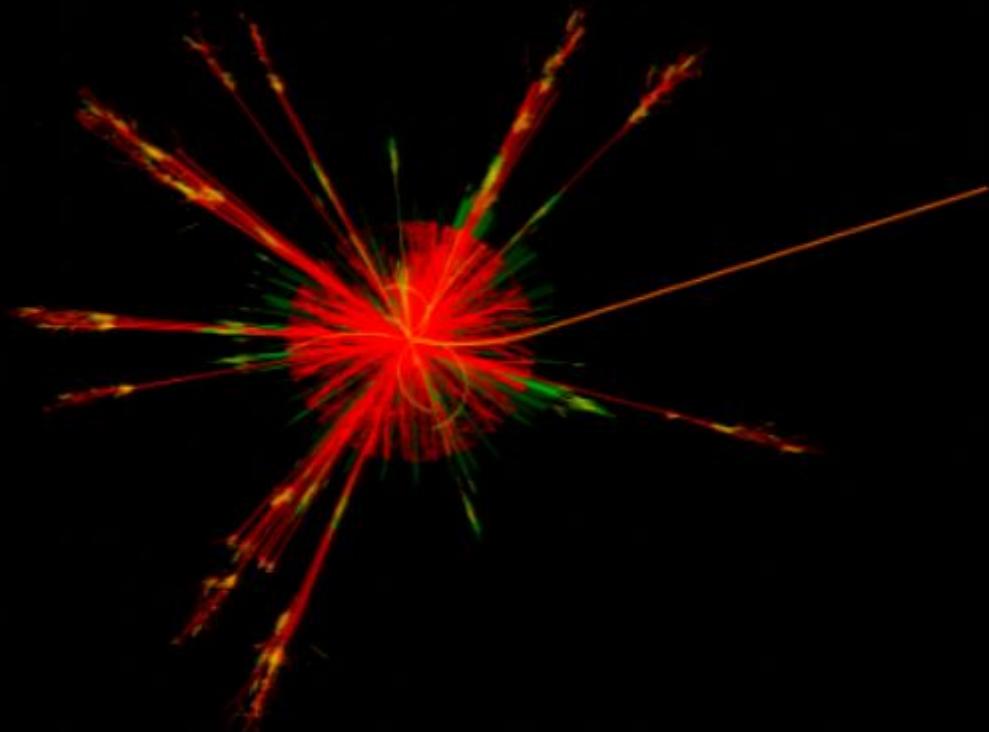
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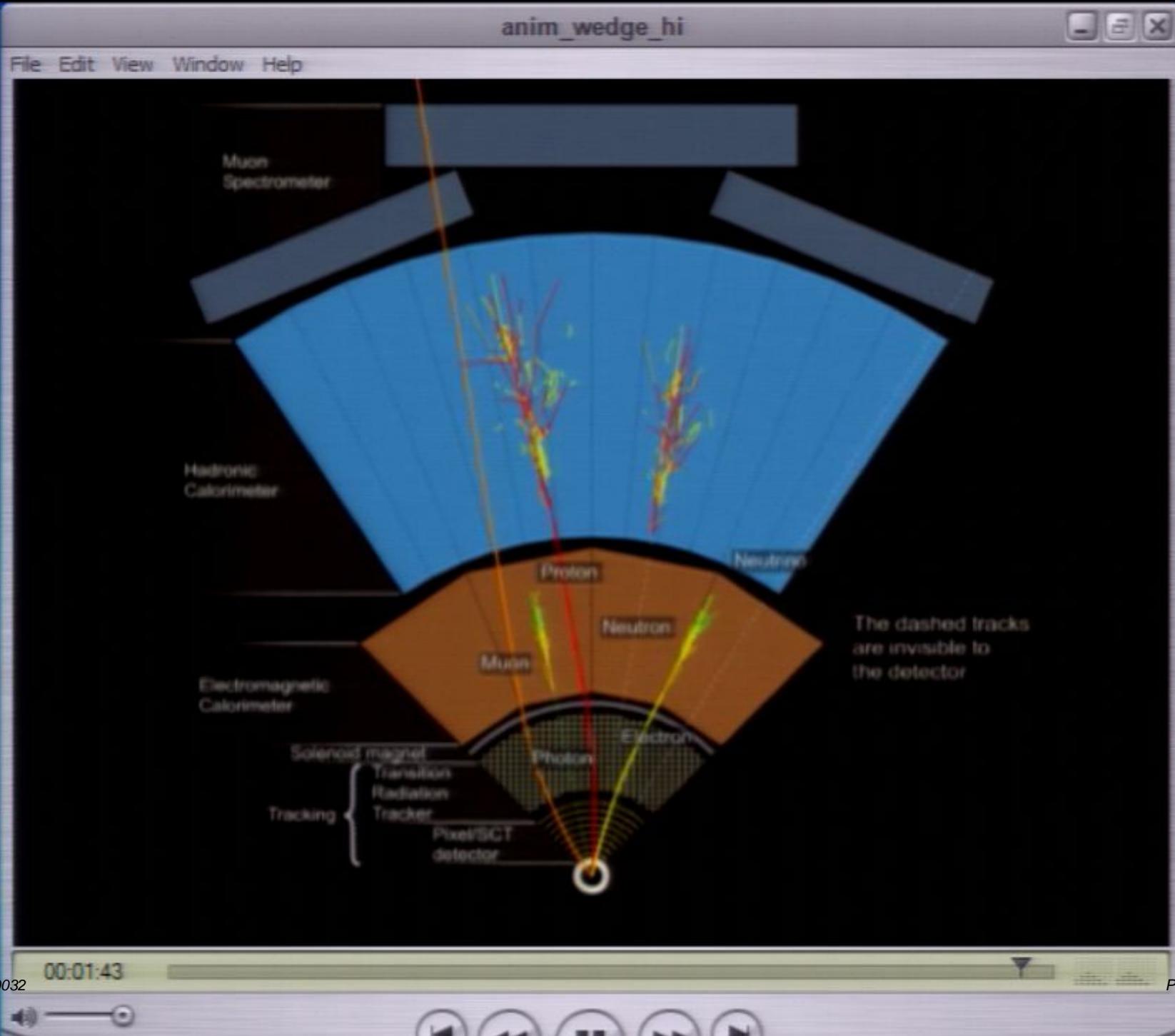
The ATLAS Detector

The Machine

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- The Detector

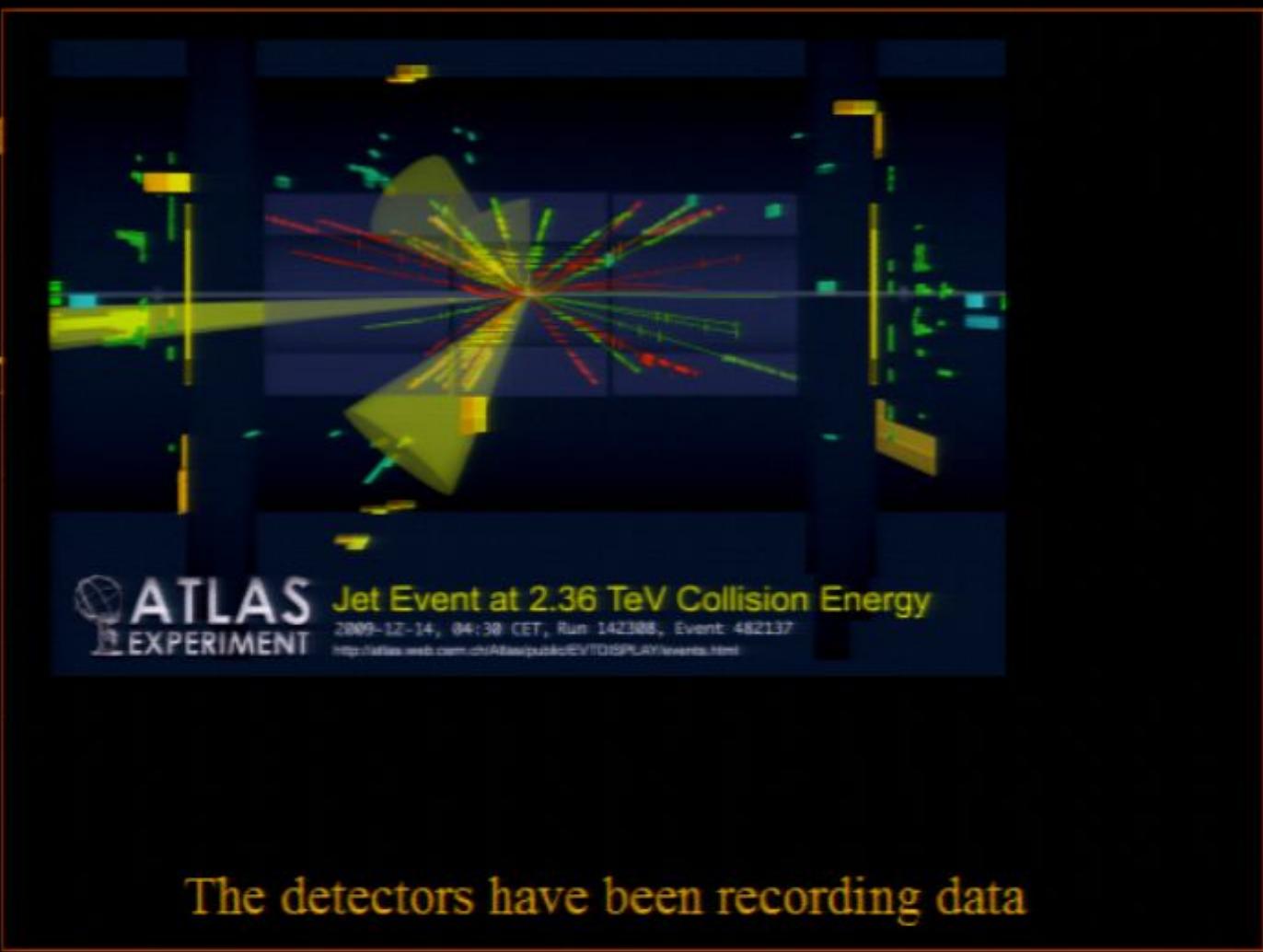


How the detectors work



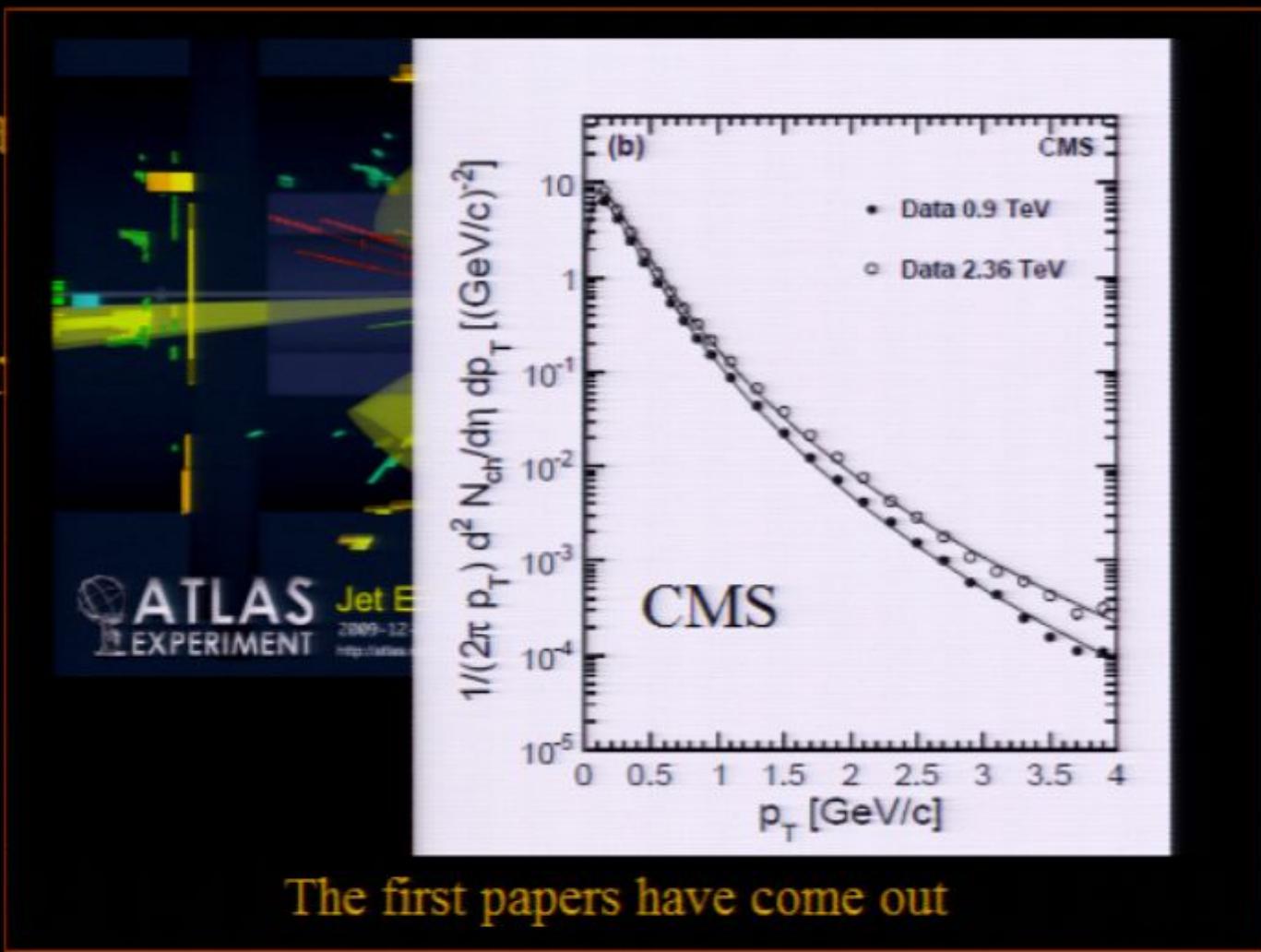
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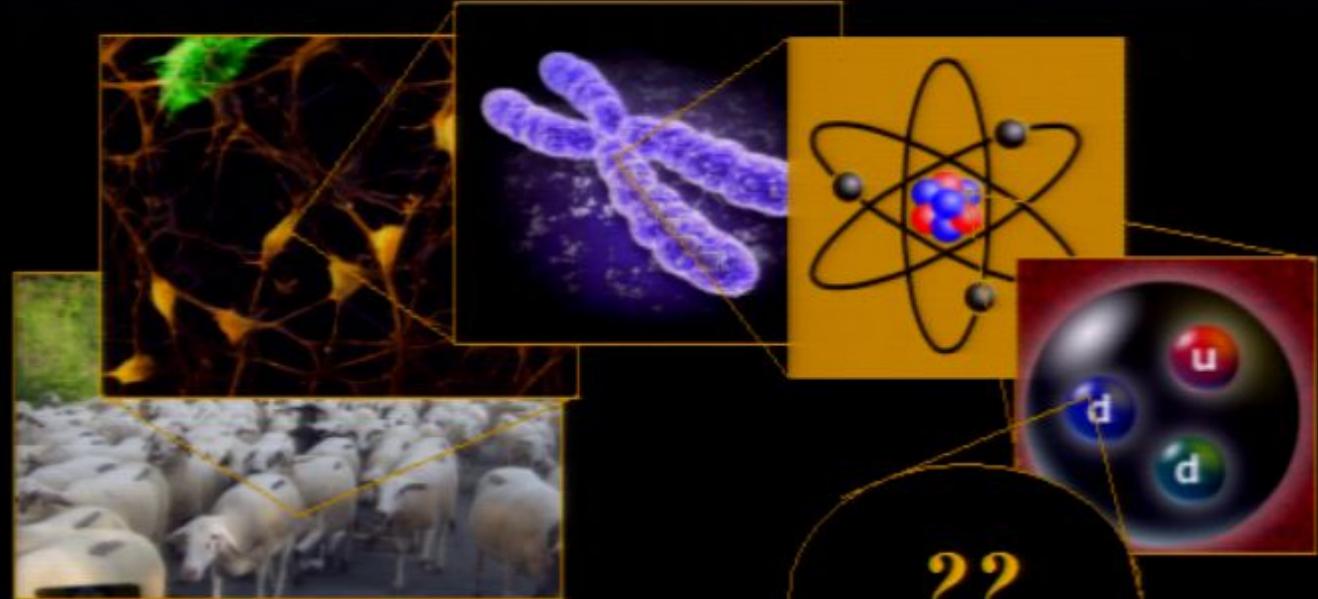


Outline

- What is it?
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 - *The Standard Model and its limitations*
- What might it hope to see?
 - *Problems*
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Outline

- What is it?
 - *The machine*
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 - *The Standard Model*
- What might it find?
 - *Problems*
- Outlook



Why was the LHC built?

Our presently successful understanding of elementary particles and the four forces through which they interact must break down at distances just out of reach.

The Standard Model

- The particles and interactions
- Successes
- Limitations

The Standard Model

- The particle interactions
- Successes
- Limitations



The Standard Model is the theory which describes the known elementary particles and their interactions. It describes well all experiments which have been performed to date, with a few recent exceptions.

The Standard Model

- The particles interactions
- Successes
- Limitations

The Standard Model			
Fermions			
Quarks	u up	c charm	t top
	d down	s strange	b bottom
Leptons	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino
	e electron	μ muon	τ tau
Bosons			
		γ photon	Z Z boson
		W W boson	g gluon
Force carriers			

The 12 known constituents of matter and the 4 fundamental forces

The Standard Model

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- Limitations

Fermions				Bosons
Quarks	u up	c charm	t top	γ photon
Leptons	d down	s strange	b bottom	Z Z boson
	V_e electron neutrino	V_μ muon neutrino	V_τ tau neutrino	W W boson
	e electron	μ muon	τ tau	g gluon
	Higgs* boson			

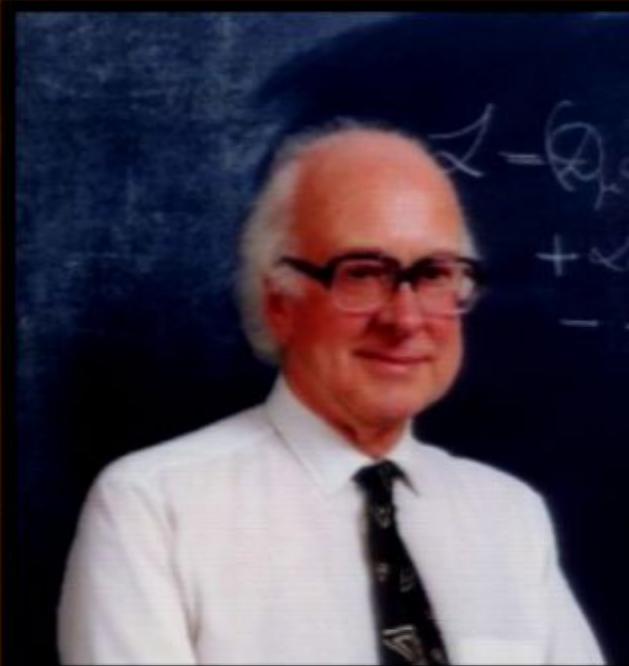
Sources: AAAS

*Yet to be confirmed

One SM particle remains AWOL: the Higgs boson

The Standard Model

- The particles interactions
- Successes
- Limitations



The Higgs boson is inferred theoretically, because it is associated with the *Higgs mechanism*: the reason why all of the SM particles have any mass at all.

The Standard Model

- The particles interactions
- Successes
- Limitations



The SM has a symmetry which requires all known particles to be massless. BUT, the vacuum has physical properties, which can break this symmetry.

The Standard Model

- The particles interactions
- Successes
- Limitations



Particle masses are due to the resistance of moving through the Higgs vacuum.

The Standard Model

- The particles interactions
- Successes
- Limitations



The Higgs *particle* is a wave moving through this Higgs vacuum.

The Standard Model

- The particles interactions
- Successes
- Limitations

$$\begin{aligned} L = & \bar{E}DE + \bar{L}DL + \bar{Q}DQ + \bar{U}DU + \bar{D}DD \\ & + B_{\mu\nu}B^{\mu\nu} + W_{\mu\nu}^\alpha W_a^{\mu\nu} + G_{\mu\nu}^\alpha G_\alpha^{\mu\nu} + G_{\mu\nu}^\alpha \tilde{G}_\alpha^{\mu\nu} \\ & + H(\bar{L}y_l E) + H(\bar{Q}y_d D) + H^*(\bar{Q}y_u U) \\ & + D_\mu H^* D^\mu H + \lambda(H^*H - v^2)^2 \end{aligned}$$

A model only a mother could love...

The Standard Model

- The particles interactions
- Successes
- Limitations

$$\begin{aligned} L = & \bar{E}DE + \bar{L}DL + \bar{Q}DQ + \bar{U}DU + \bar{D}DD \\ & + B_{\mu\nu}B^{\mu\nu} + W_{\mu\nu}^aW_a^{\mu\nu} + G_{\mu\nu}^\alpha G_\alpha^{\mu\nu} + G_{\mu\nu}^\alpha \tilde{G}_\alpha^{\mu\nu} \\ & + H(\bar{L}y_l E) + H(\bar{Q}y_d D) + H^*(\bar{Q}y_u U) \\ & + D_\mu H^* D^\mu H + \lambda(H^*H - v^2)^2 \end{aligned}$$

A model only a mother could love...

What is beautiful about the Standard Model is that it is the most general way that the given particles can interact at low energies (with the given gauge symmetries)

The Standard Model

- The particles interactions
- Successes
- Limitations

$$\begin{aligned} L = & \bar{E}DE + \bar{L}DL + \bar{Q}DQ + \bar{U}DU + \bar{D}DD \\ & + B_{\mu\nu}B^{\mu\nu} + W_{\mu\nu}^aW_a^{\mu\nu} + G_{\mu\nu}^\alpha G_\alpha^{\mu\nu} + G_{\mu\nu}^\alpha \tilde{G}_\alpha^{\mu\nu} \\ & + H(\bar{L}y_l E) + H(\bar{Q}y_d D) + H^*(\bar{Q}y_u U) \\ & + D_\mu H^* D^\mu H + \lambda(H^*H - v^2)^2 \end{aligned}$$

A model only a mother could love...

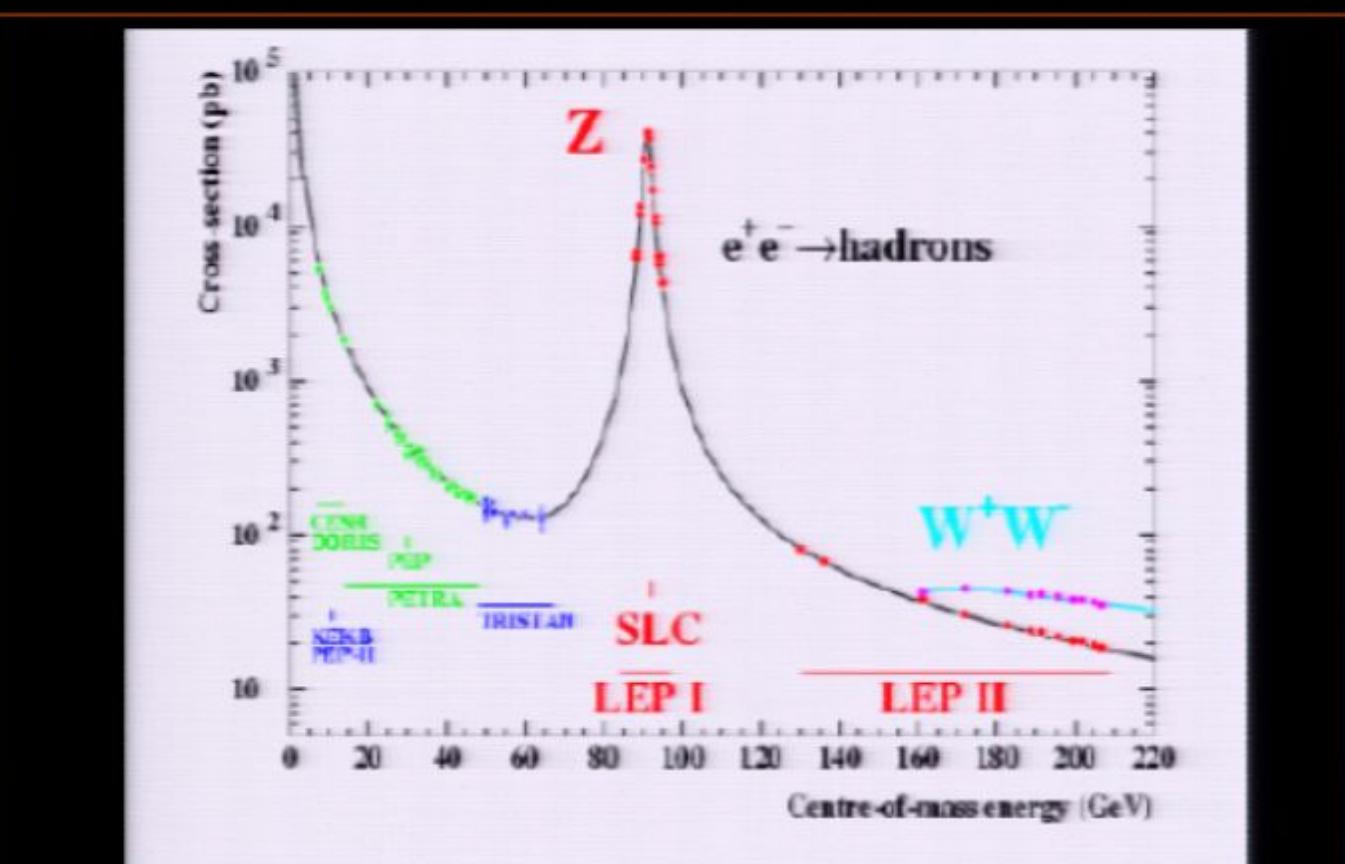
What is beautiful about the Standard Model is that it is the most general way that the given particles can interact at low energies (with the given gauge symmetries) Typical of a low-energy ‘effective theory’

The Standard Model

- The particles and interactions
- Successes
- Limitations

The Standard Model

- The particles interactions
- Successes
- Limitations

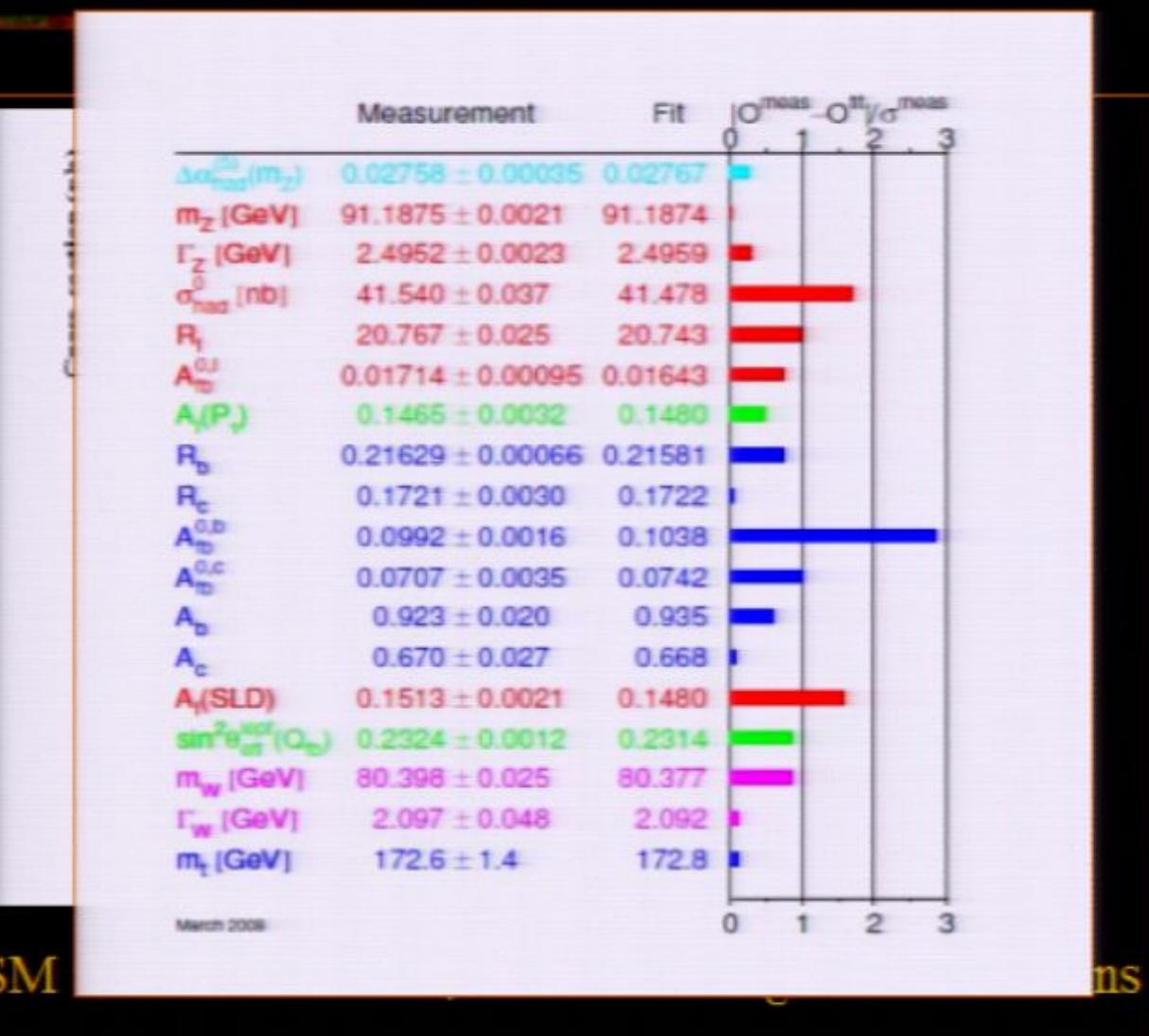


The SM is tested in detail, such as through e^+e^- collisions

The Standard Model

- The particles interactions
- Successes
- Limitations

The SM



The Standard Model

- The particles interactions
- Successes
- Limitations

The SM

	Measurement	Fit	$ O ^{\text{meas}} - O^{\text{fit}} /\sigma^{\text{meas}}$
$\Delta m_{\text{meas}}(m_Z)$	0.02758 ± 0.00035	0.02767	0
m_Z [GeV]	91.1875 ± 0.0021	91.1874	1
Γ_Z [GeV]	2.4952 ± 0.0023	2.4959	2
σ_{meas}^0 [nb]	41.540 ± 0.037	41.478	2
R_t	20.767 ± 0.025	20.743	1

LEP measurements were so accurate that they were sensitive to the passage of the TGV (due to electrical grounding currents), as well as to the position of the moon and the load of snow on the nearby Jura mountains (due to the flexing of the Earth's crust changing the length of the ring)!

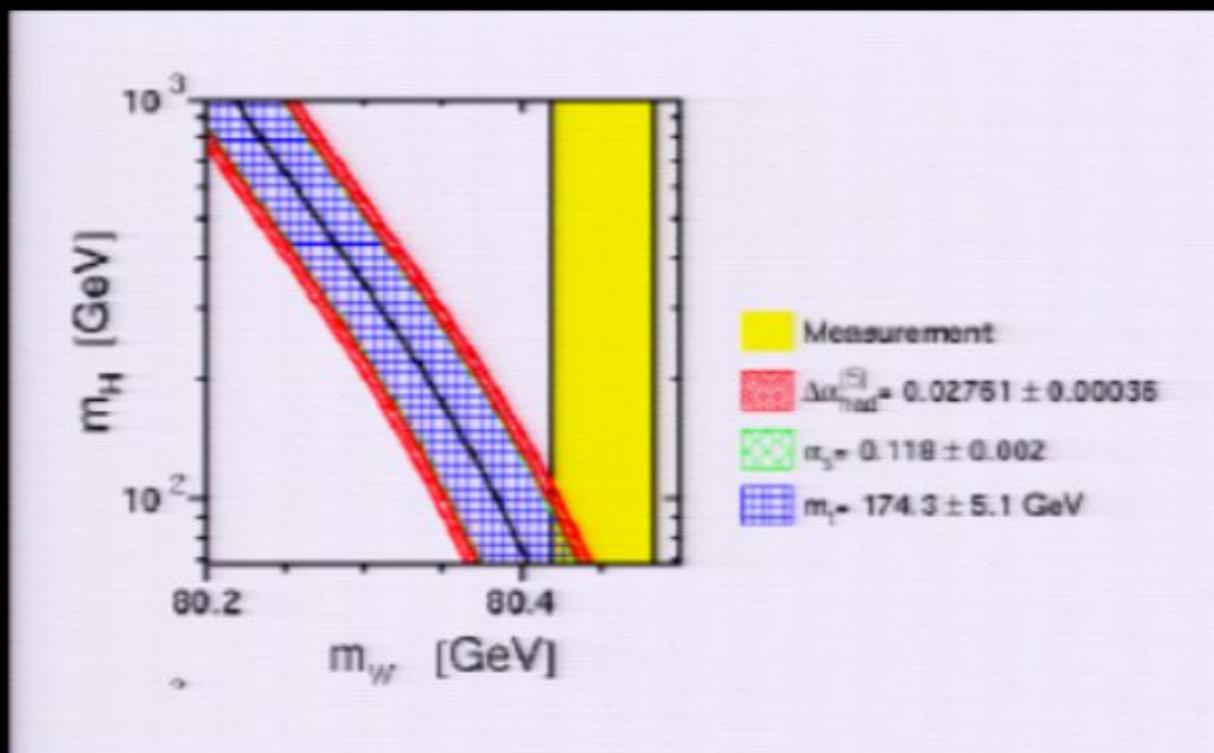
March 2008

0 1 2 3

ns

The Standard Model

- The particles interactions
- Successes
- Limitations



Unknown quantities, like the Higgs mass, are strongly constrained by the accuracy of these tests

The Standard Model

- The particles and interactions
- Successes
- Limitations

The Standard Model

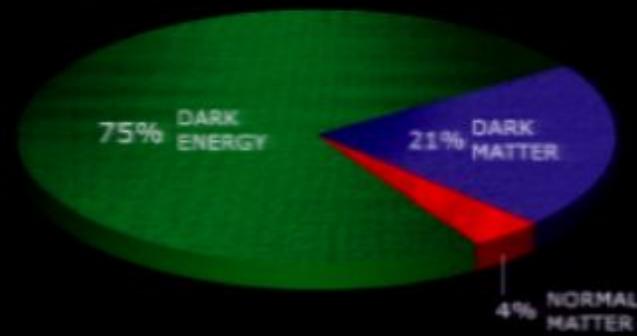
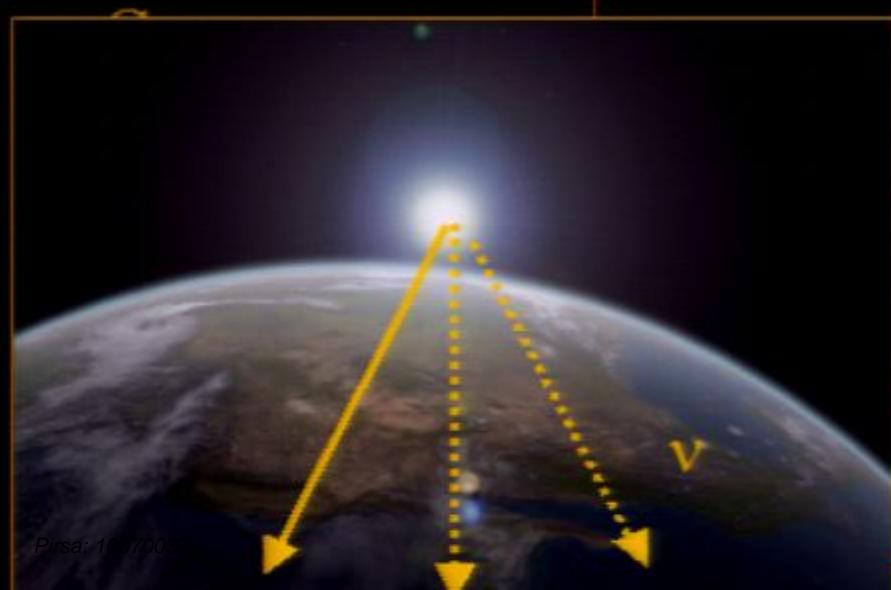
- The particles interactions

So what's wrong with the Standard Model?

Observational Problems:

Neutrinos appear to have masses...

Dark Matter and Dark Energy unexplained..



The Standard Model

- The particles interactions
- Successes
- Limitations

So what's wrong with the Standard Model?

Observational Problems:

Neutrinos appear to have masses...
Dark Matter and Dark Energy unexplained..

Theoretical Problems:

Hierarchy Problem
Cosmological Constant Problem
Who ordered all this?
What about Gravity?

The Standard Model

- The particles interactions
- Successes
- Limitations

$$M_{SUN} \approx M_p^3 / m_p^2$$

The Hierarchy Problem

Problem: Why is the *scale* of Higgs symmetry breaking (and so also all known masses) so much smaller than the only other fundamental scales about which we know?

Protons: the nuclear scale

$m_p = 1 \text{ GeV}$

Higgs: the weak scale

$M_W = G_F^{-1/2} \sim 10^2 \text{ GeV}$

Gravity: the Planck mass

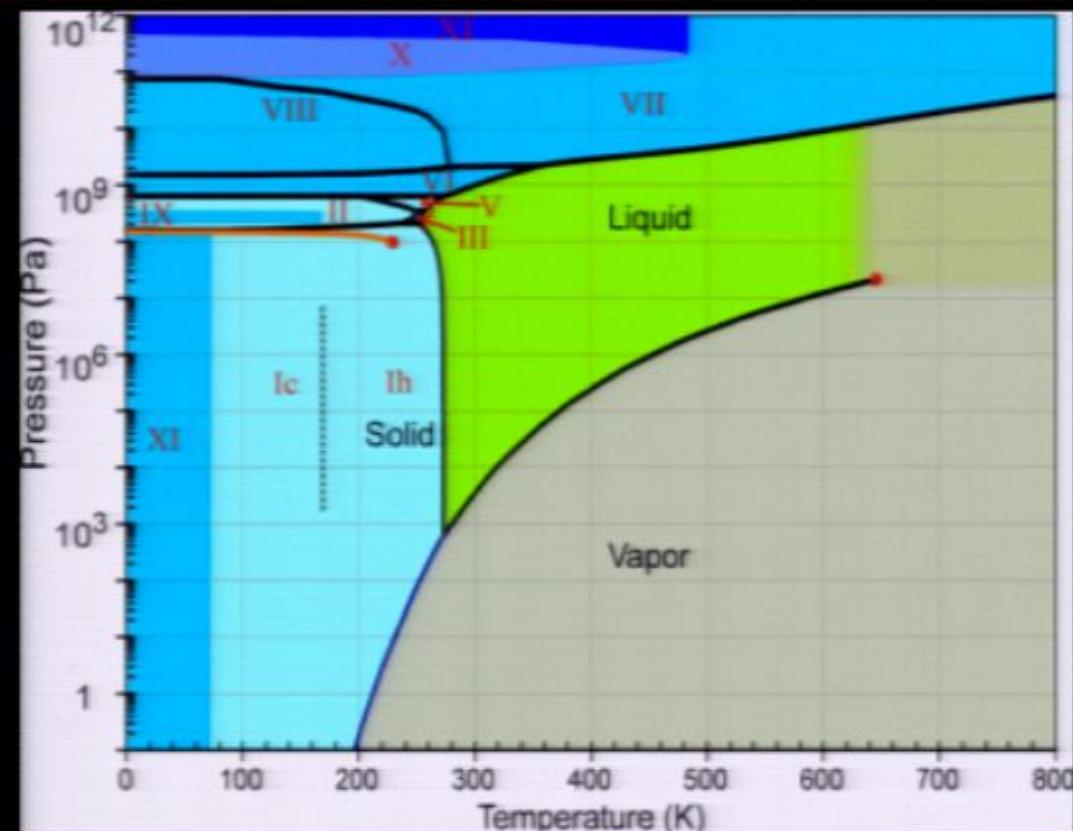
$M_p = G_N^{-1/2} \sim 10^{19} \text{ GeV}$

Neutrinos: L-violation scale $M_L = M_W^2 / m_\nu \sim 10^{11} \text{ GeV}$

The Standard Model

- The particles interact via
- Successive
- Limitations

$$M_{SUN} \approx M_p^3 / m_p^2$$



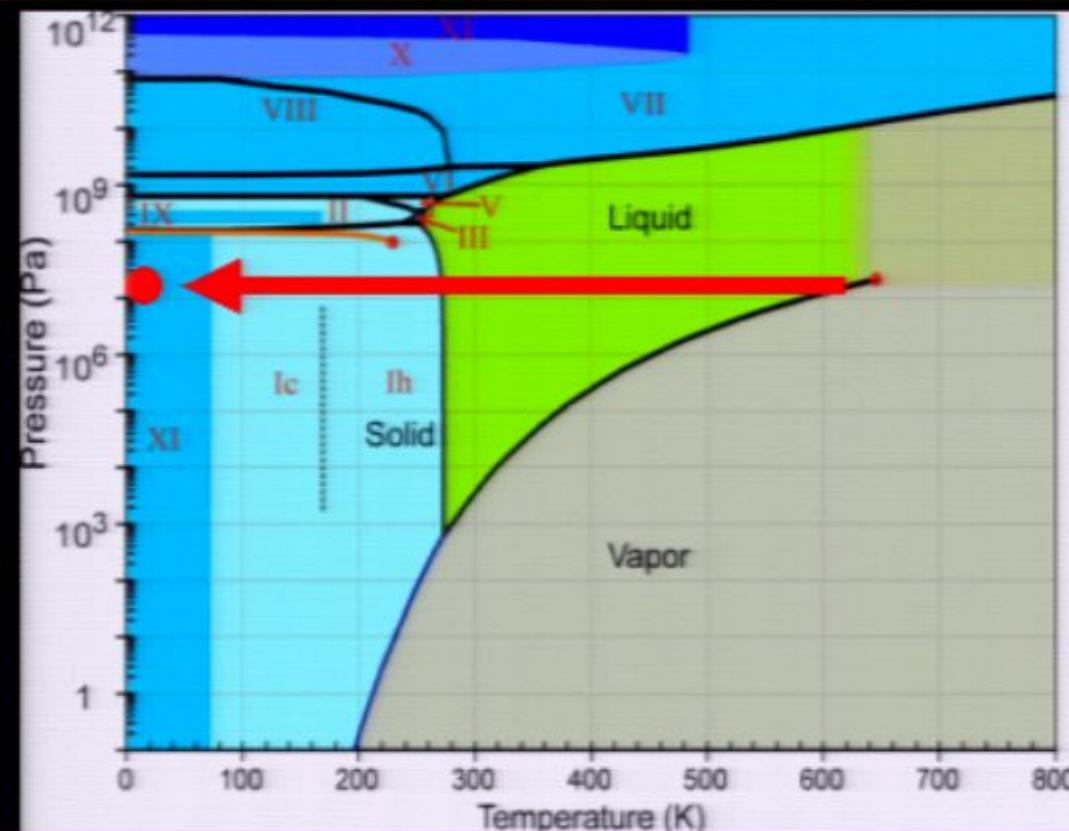
symmetry
s) so much
1 scales about

$t_p = 1 \text{ GeV}$
 $F^{-1/2} \sim 10^2 \text{ GeV}$
 $N^{-1/2} \sim 10^{19} \text{ GeV}$
 $/m_\nu \sim 10^{11} \text{ GeV}$

The Standard Model

- The particles interact via the gauge bosons.
- Successive generations of fermions.
- Limitations of the SM.

$$M_{SUN} \approx M_p^3 / m_p^2$$



symmetry
s) so much
1 scales about

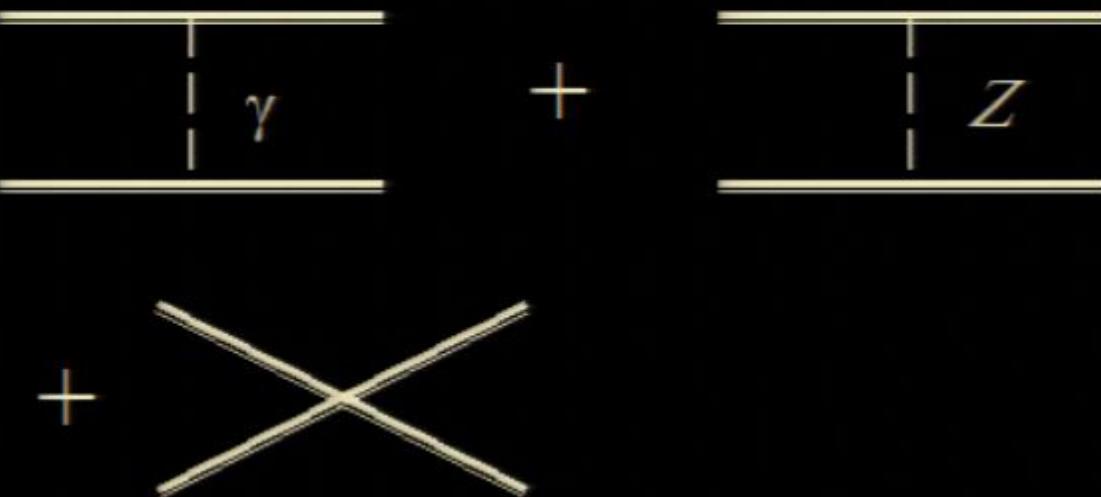
$t_p = 1 \text{ GeV}$
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 $N^{-1/2} \sim 10^{19} \text{ GeV}$
 $/m_\nu \sim 10^{11} \text{ GeV}$

What might be seen

- Nothing?

What might be seen

- Nothing?

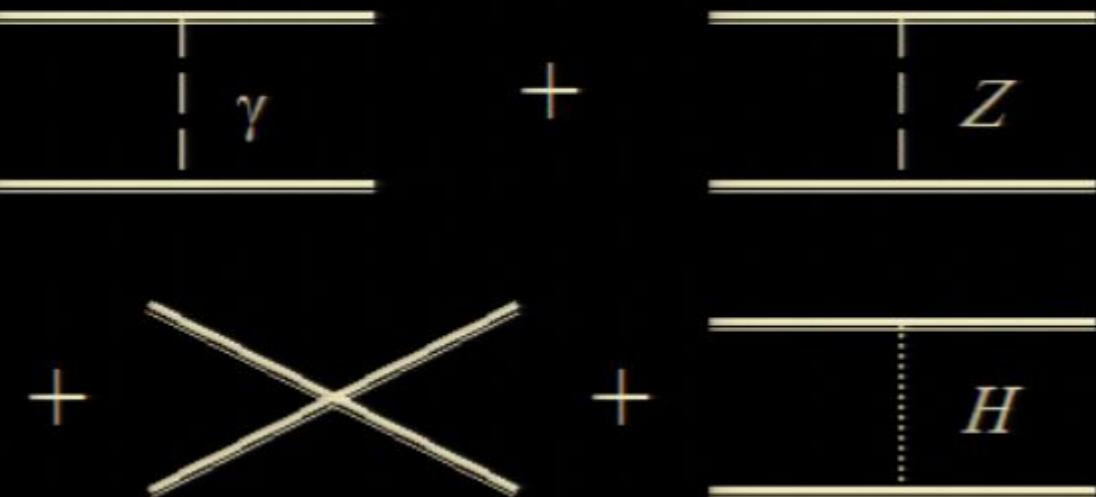


$$W\text{-}W \text{ scattering: } \sigma \sim (\alpha^2 \ln E) / M_W^2$$

The SM without the Higgs boson must break down at energies of order $M_W/\alpha \sim \text{few TeV}$ because $\sigma < 1/E^2$

What might be seen

- Nothing?



W - W scattering: $\sigma \sim \alpha^2/E^2$

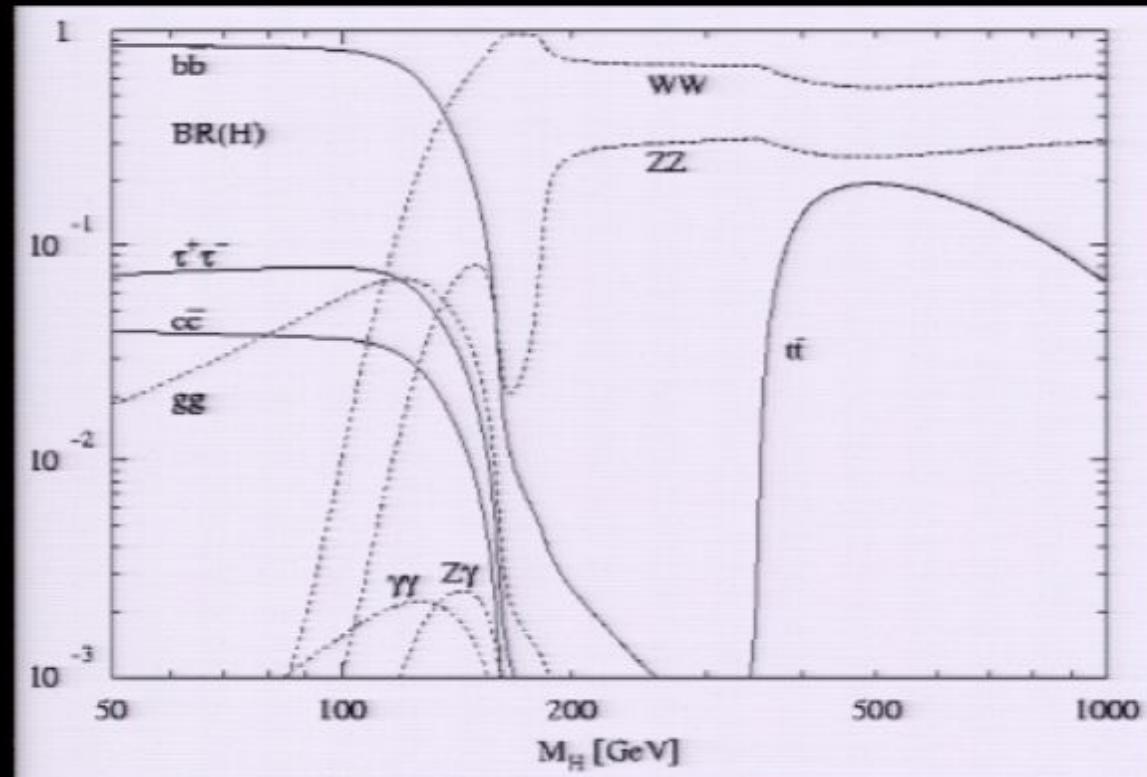
The SM with the Higgs boson *can make sense for energies much larger than $M_W/\alpha \sim$ few TeV*

What might be seen

- The Higgs Boson?

What might be seen

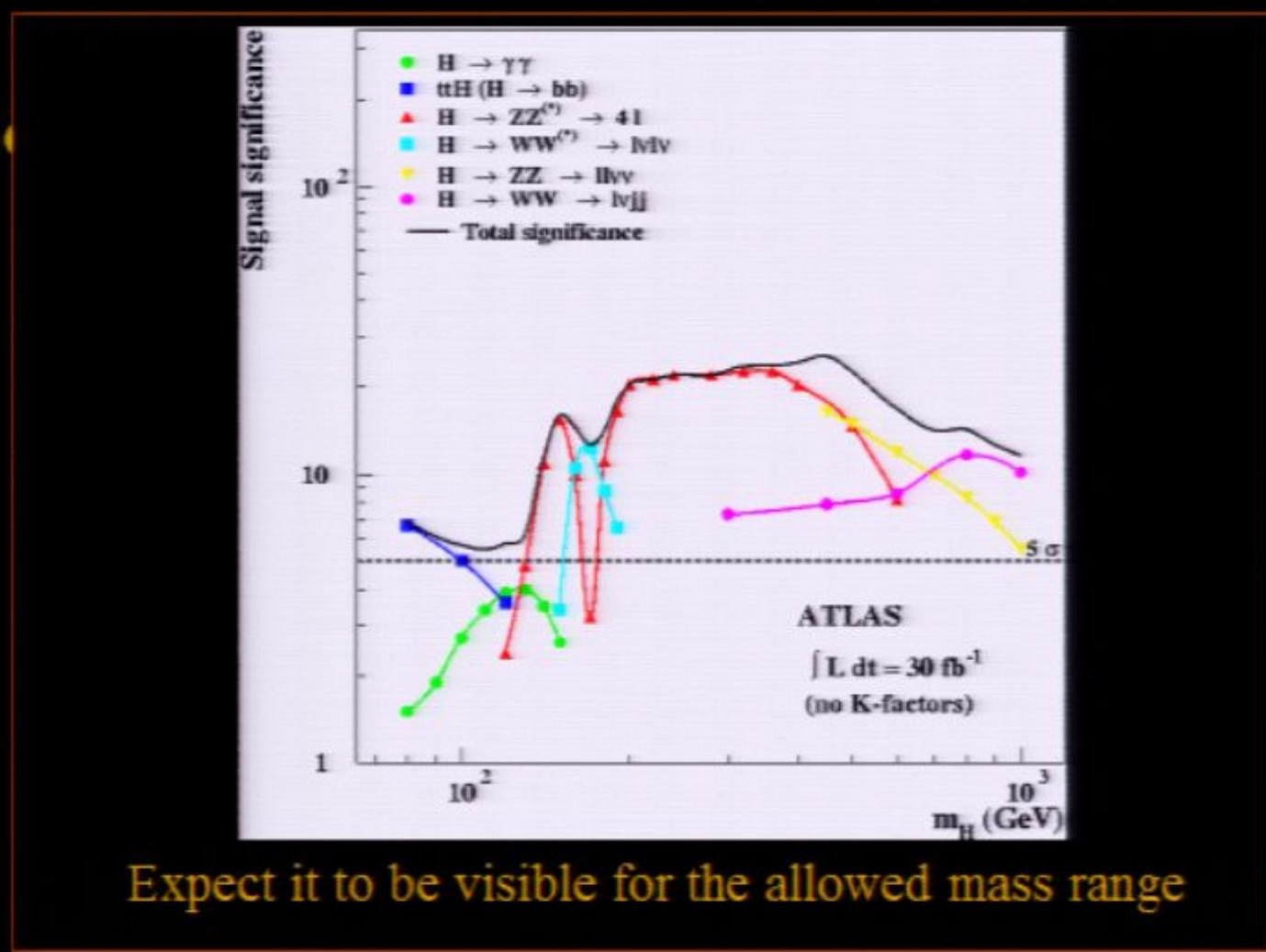
- The Higgs Be



Search strategies depend on what it decays into,
and this depends on its mass

What might be seen

- The Higgs Be

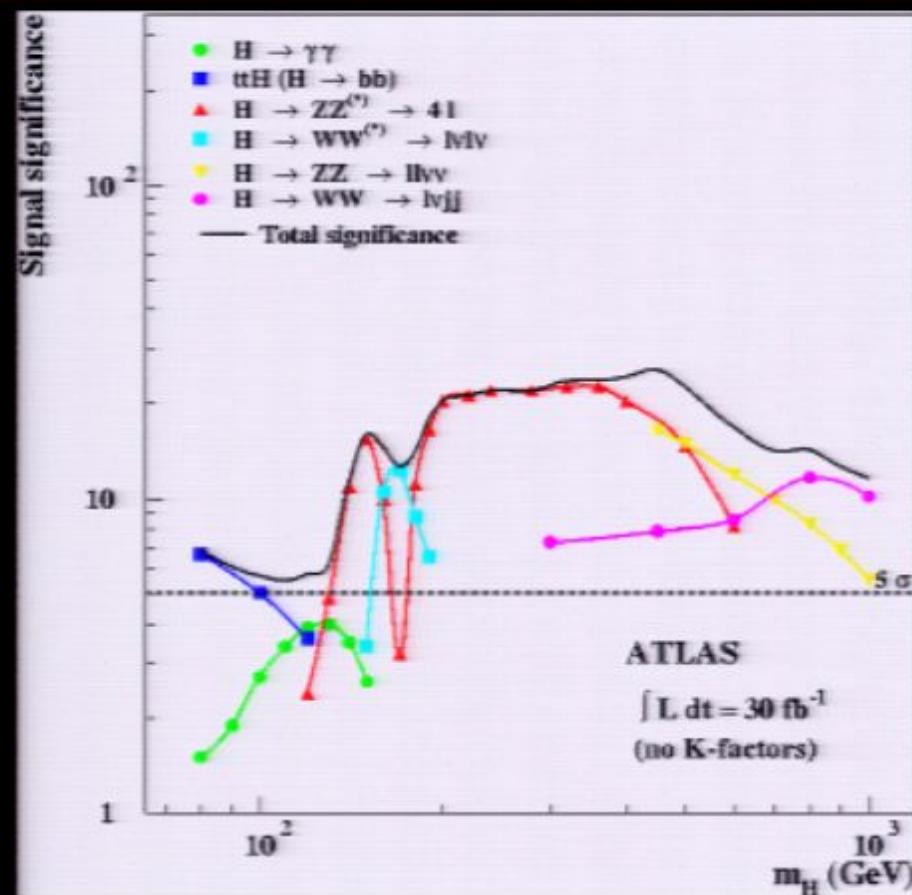


What might be seen

- Beyond the Standard Model?

What might be seen

- The Higgs Be



Expect it to be visible for the allowed mass range

What might be seen

- Beyond the Standard Model?

What might be seen

- Beyond the SM
- *Beyond the SM:* the Hierarchy problem provides clues as to what else might be found, since any explanation of what allows $M_w \ll M_p$ must change physics at energies *just above* M_w

What might be seen

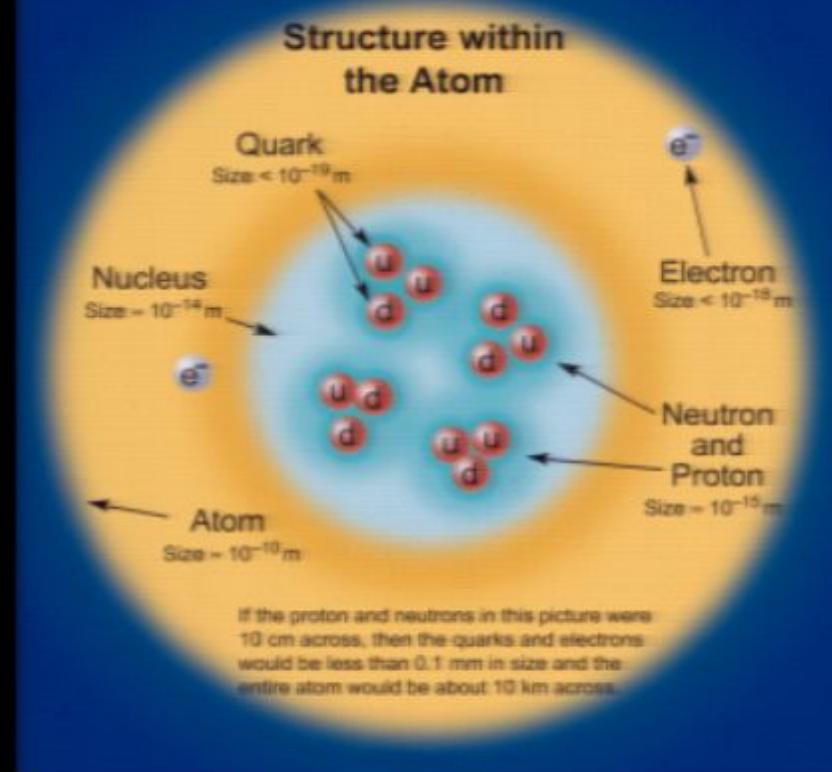
- Beyond the SM: basically three options:

What might be seen

- Beyond the SM
- *Beyond the SM:* basically three options:
 - No elementary Higgs:
 - *Composite models*

What might be seen

- Beyond the S



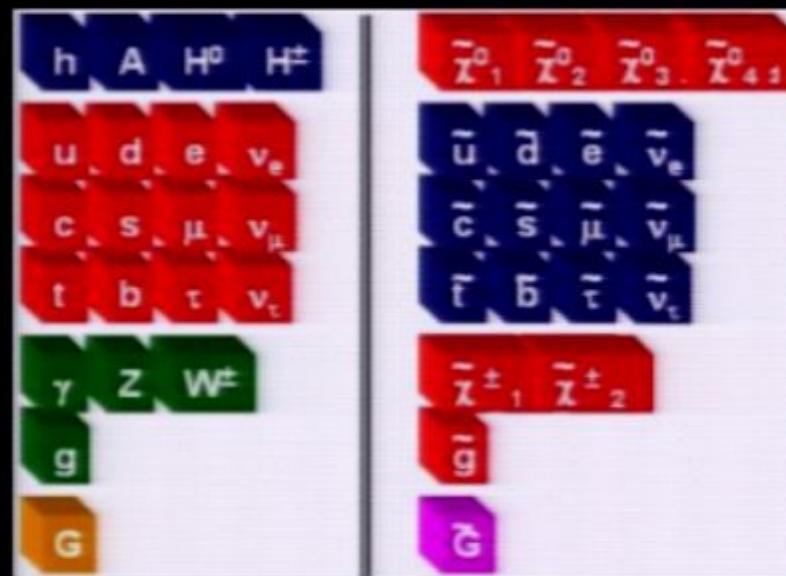
- Another level of substructure is historically the most conservative guess

What might be seen

- Beyond the SM:
 - *Beyond the SM:* basically three options:
 - No elementary Higgs:
 - *Composite models*
 - New symmetry alleviating fine tuning:
 - *Supersymmetry*

What might be seen

- The Higgs Boson
- Usually implies ‘superpartners’ for each kind of known particle
- lightest superpartner is usually a good dark matter candidate
- Beyond the Standard Model

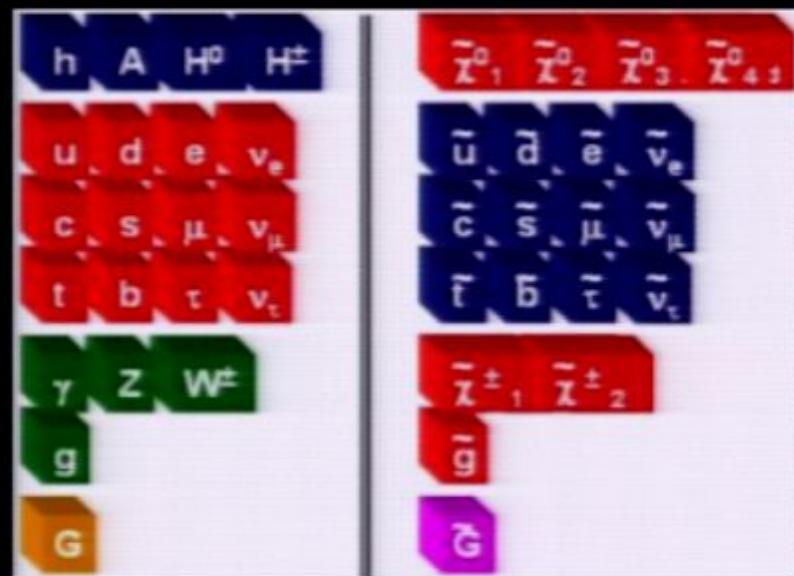


What might be seen

- Beyond the SM:
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 - No elementary Higgs:
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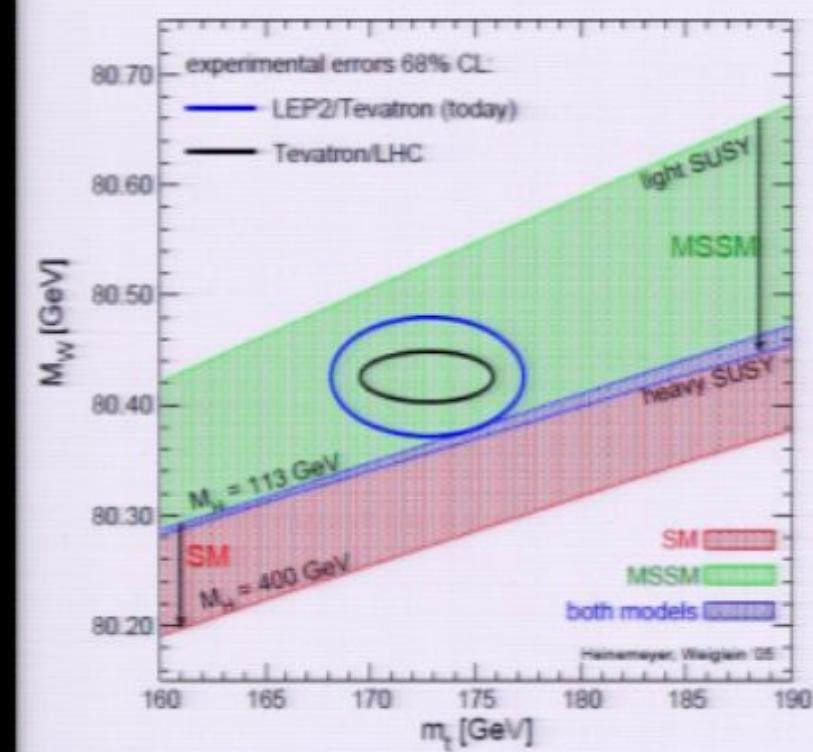
What might be seen

- The Higgs Boson
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- lightest superpartner is usually a good dark matter candidate
- Beyond the Standard Model



What might be seen

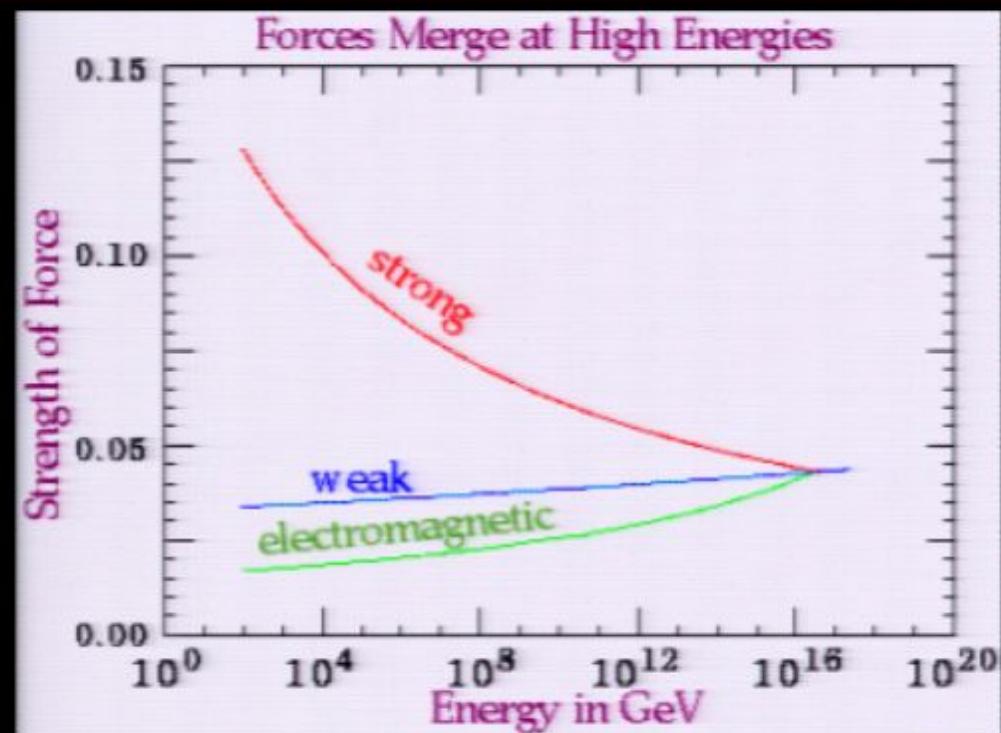
- The Higgs Boson
- Beyond the Standard Model



- Hint for supersymmetry: in the preference for light Higgs in precision measurements

What might be seen

- Beyond the S



- Hints for supersymmetry: apparent unification of SM couplings

What might be seen

- Beyond the SM:
 - *Beyond the SM:* basically three options:
 - No elementary Higgs:
 - *Composite models*
 - New symmetry alleviating fine tuning:
 - *Supersymmetry*
 - Gravity scale is not really M_p
 - *Extra dimensions*

What might be seen

- The Higgs Boson
- If there are extra dimensions and they are large, then the gravity scale could be much lower than we think....
- Beyond the Standard Model



What might be seen

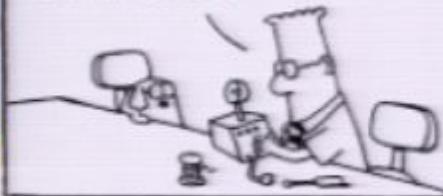
- Beyond the S

This is the scenario that potentially leads to black hole production...



Wh

I'VE INVENTED A QUANTUM COMPUTER, CAPABLE OF INTERACTING WITH MATTER FROM OTHER UNIVERSES TO SOLVE COMPLEX EQUATIONS.



www.unitedmedia.com
S. Adams

ACCORDING TO CHAOS THEORY, YOUR TINY CHANGE TO ANOTHER UNIVERSE WILL SHIFT ITS DESTINY, POSSIBLY KILLING EVERY INHABITANT.



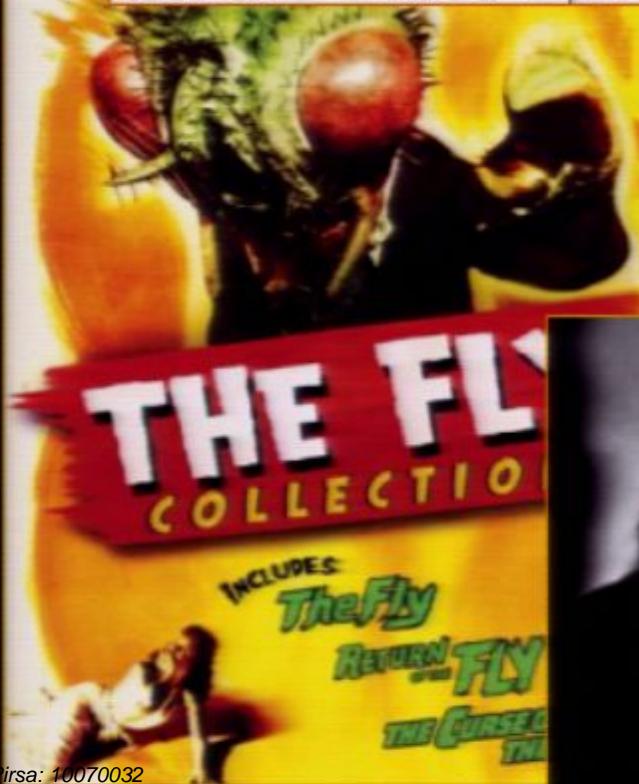
SHIFT HAPPENS.

FIRE IT UP.



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What might be seen

- Beyond the S

This is the scenario that potentially leads to black hole production...



What might be seen

- Beyond the S

This is the scenario that potentially leads to black hole production...



What might be seen

- Beyond the S

This is the scenario that potentially leads to black hole production...



What might be seen

- Bey

The screenshot shows a Mozilla Firefox browser window with the title bar "has the lhc destroyed the world yet - Google Search - Mozilla Firefox". The address bar contains the URL "http://www.google.ca/#hl=en&source=hp&q=has+the+lhc+destroyed+the+world+yet". The search query "has the lhc destroyed the ..." is visible in the search bar. Below the search bar, there are links for "Web", "Images", "Videos", "Maps", "News", "Books", "Gmail", and "more". On the right side of the header, there are links for "Web History", "Search settings", and "Sign in".

The main content area displays Google search results for the query. A red oval highlights the first result, which is a link to a blog post titled "Has the Large Hadron Collider destroyed the world yet?". Below this, another red oval highlights a link to a page titled "Has the Large Hadron Collider destroyed the world yet? NO ?". Further down, another red oval highlights a link to a page titled "Has the Large Hadron Collider destroyed the world yet? | Ed ...".

The search results also include links to "Has the Large Hadron Collider Destroyed the World Yet?" by Scott Gilbertson, a page from webmonkey.com, and a forum post from donationcoder.com. At the bottom of the search results, there is a "Done" button.

What might be seen

- Beyond the S

This is the scenario that potentially leads to black hole production...



What might be seen

- Bey

The screenshot shows a Mozilla Firefox browser window with the title bar "has the lhc destroyed the world yet - Google Search - Mozilla Firefox". The address bar contains the URL "http://www.google.ca/#hl=en&source=hp&q=has+the+lhc+destroyed+the+world+yet". The search query "has the lhc destroyed the ..." is visible in the search bar. The search results page from Google is displayed, with the first result highlighted by a red oval. The result is titled "Has the Large Hadron Collider destroyed the world yet?" and includes a snippet from a blog post about the LHC's successful startup tests.

has the lhc destroyed the world yet

Search Advanced Search

Web Options... Results 1 - 10 of about 12,100 for has the lhc destroyed the world yet (0.28 seconds)

[Has the Large Hadron Collider destroyed the world yet?](#)

has the large hadron collider destroyed the world yet - Cached - Similar

Has the Large Hadron Collider destroyed the earth yet?
NO ?
[www.hasthelhcdestroyedtheearth.com/](#) - Cached - Similar

Has the Large Hadron Collider destroyed the world yet? | Ed ...
11 Sep 2008 ... Nope. That's the answer you'll get from
has the large hadron collider destroyed the world yet.com today, despite the LHC's successful
startup tests ...
[blogs.zdnet.com/Burnette/?p=663](#) - Cached - Similar

Has the Large Hadron Collider Destroyed the World Yet - Webmonkey
Has the Large Hadron Collider Destroyed the World Yet? By Scott Gilbertson
September 10, 2008 Categories: Humor, hope Where would science be without the ...
[www.webmonkey.com/.../Has_the_Large_Hadron_Collider_Destroyed_the_World_Yet...](#)
- Cached - Similar

Has the LHC destroyed the world yet? - DonationCoder.com
Have a look at the page source, how neatly they check if the **world has** ended or not. Only I
think it's a bug that they don't detect the actual reason of the ...
[www.donationcoder.com/Forums/bb/index.php?topic=14859.../japan](#)

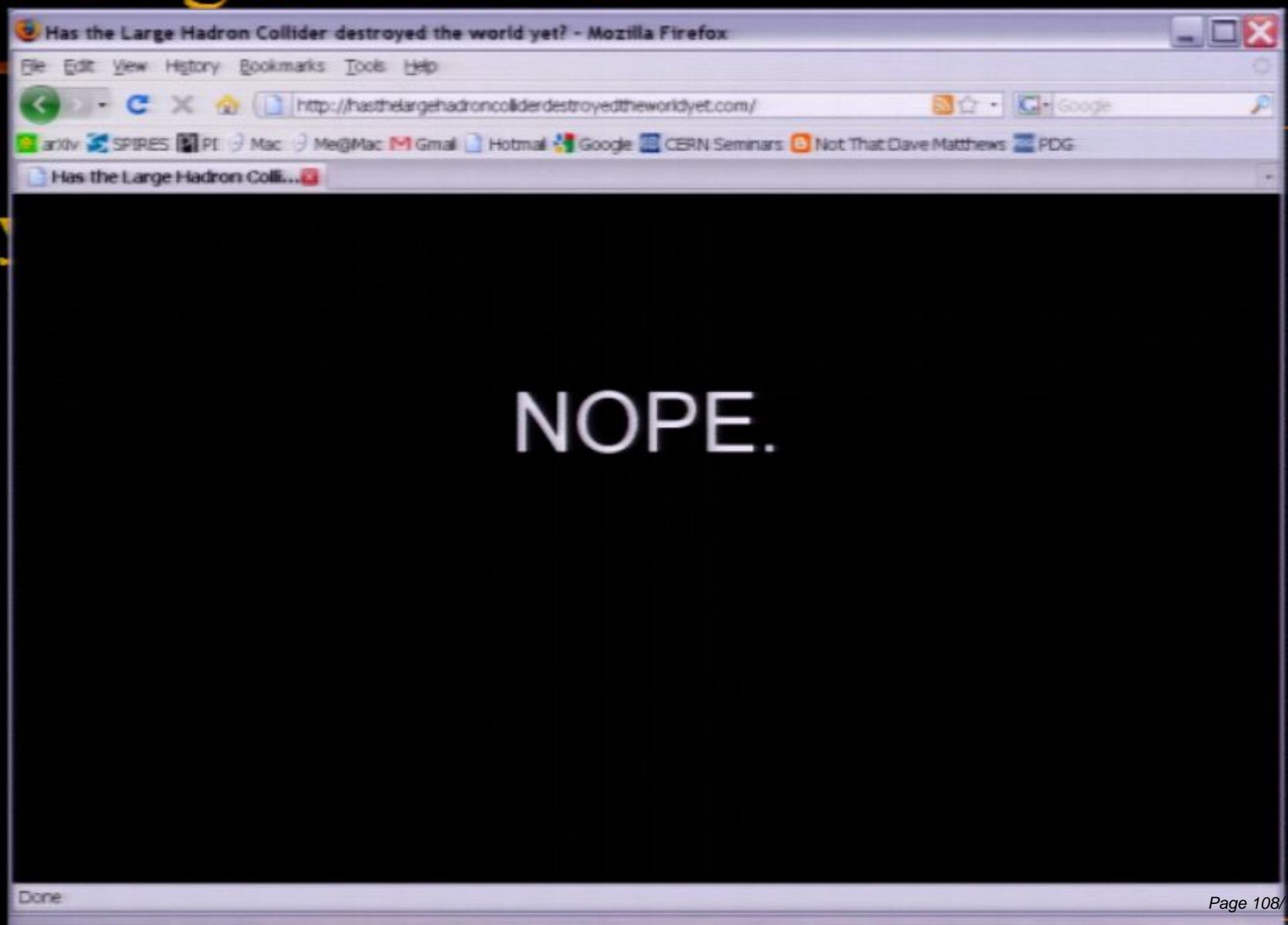
Done

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What might be seen

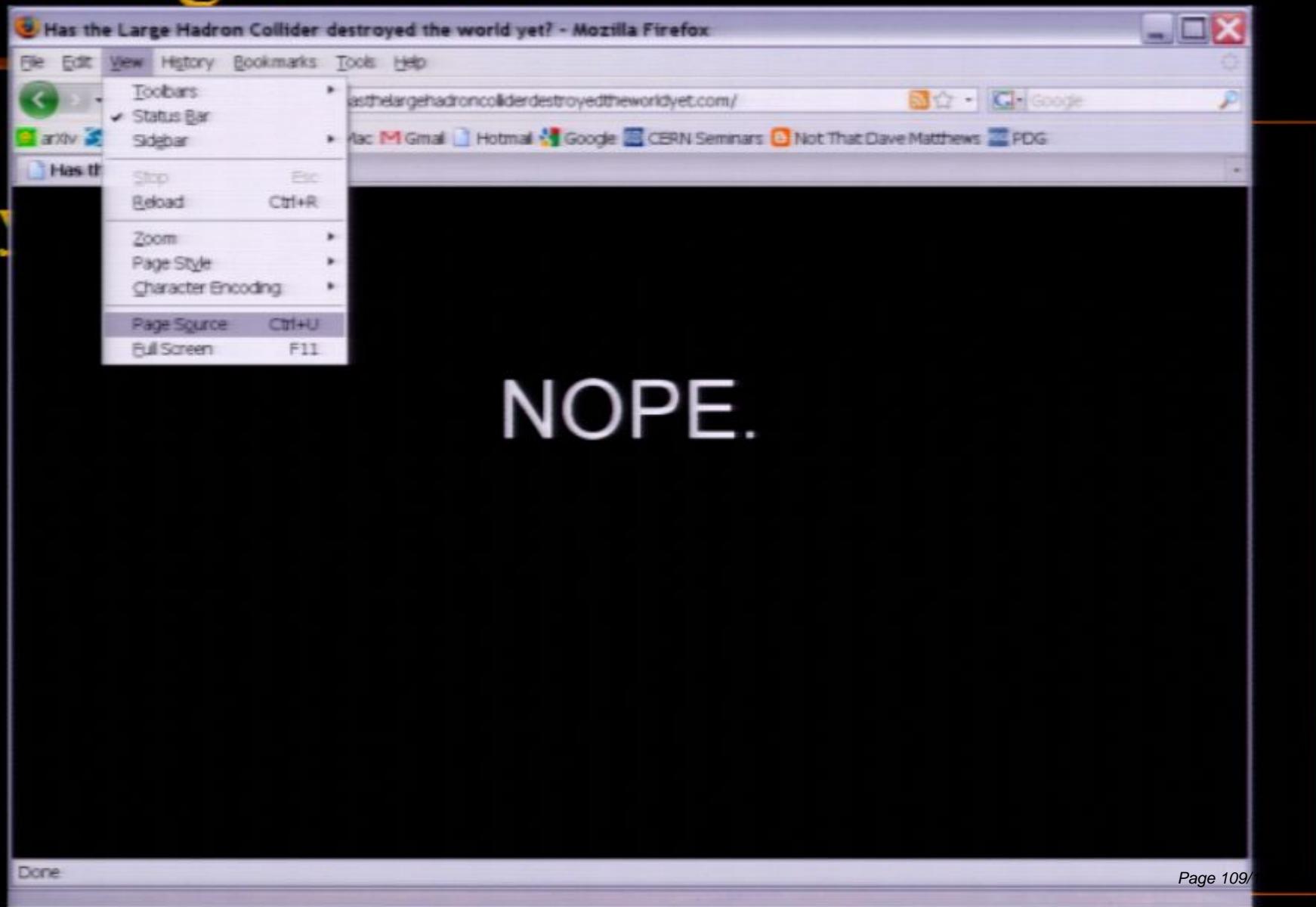
- Bey

NOPE.



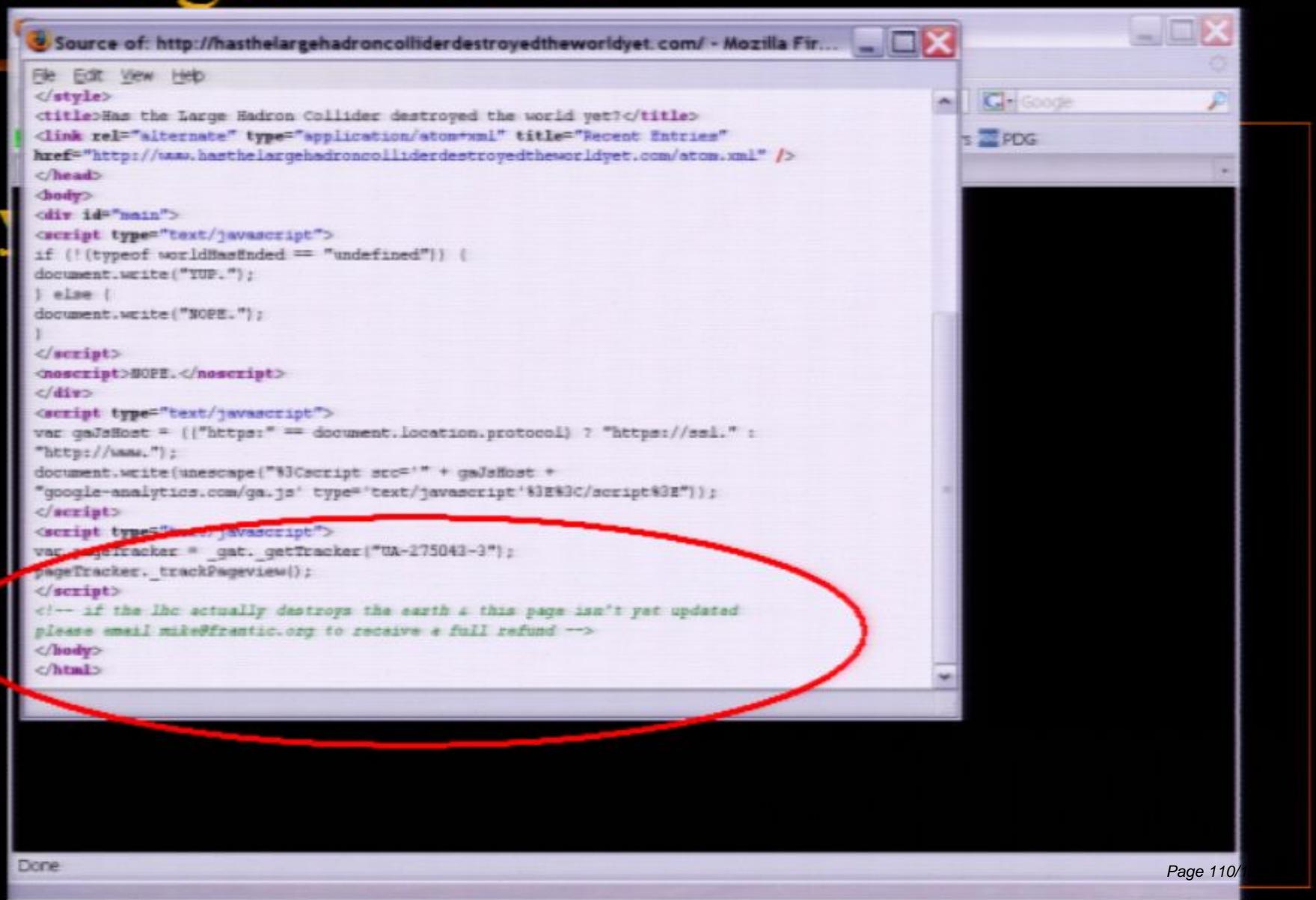
What might be seen

- Bey



What might be seen

- Bey...



The screenshot shows the Mozilla Firefox browser window displaying the source code of a webpage. The title bar reads "Source of: http://hasthelargehadroncolliderdestroyedtheworldyet.com/ - Mozilla Fir...". The code is as follows:

```
<style>
<title>Has the Large Hadron Collider destroyed the world yet?</title>
<link rel="alternate" type="application/atom+xml" title="Recent Entries"
      href="http://www.hasthelargehadroncolliderdestroyedtheworldyet.com/atom.xml" />
</head>
<body>
<div id="main">
<script type="text/javascript">
if (! (typeof worldHasEnded == "undefined")) {
    document.write("YUP.");
} else {
    document.write("NOPE.");
}
</script>
<noscript>NOPE.</noscript>
</div>
<script type="text/javascript">
var gaJsHost = (("https:" == document.location.protocol) ? "https://ssl." :
"http://www.");
document.write(unescape("%3Cscript src='"+gaJsHost+
"google-analytics.com/ga.js' type='text/javascript'%3E%3C/script%3E"));
</script>
<script type="text/javascript">
var _gat = _gat || _getTracker("UA-275043-3");
_gat._trackPageview();
</script>
<!-- if the lhc actually destroys the earth & this page isn't yet updated
please email mike@frantic.org to receive a full refund -->
</body>
</html>
```

A large red oval highlights the following comment in the script block:

```
<!-- if the lhc actually destroys the earth & this page isn't yet updated
please email mike@frantic.org to receive a full refund -->
```

At the bottom left of the browser window, there is a "Done" button.

What might be seen

- Beyond the S

This is the scenario that potentially leads to black hole production...



Outline

- What is it?
 - *The machine*
- Why was it built?
 - *The Standard Model and its limitations*
- What might it hope to see?
 - *Problems*
- Outlook

Outlook

- The LHC started a long physics run a few months ago!
 - Runs at full beam energy could begin late next year.

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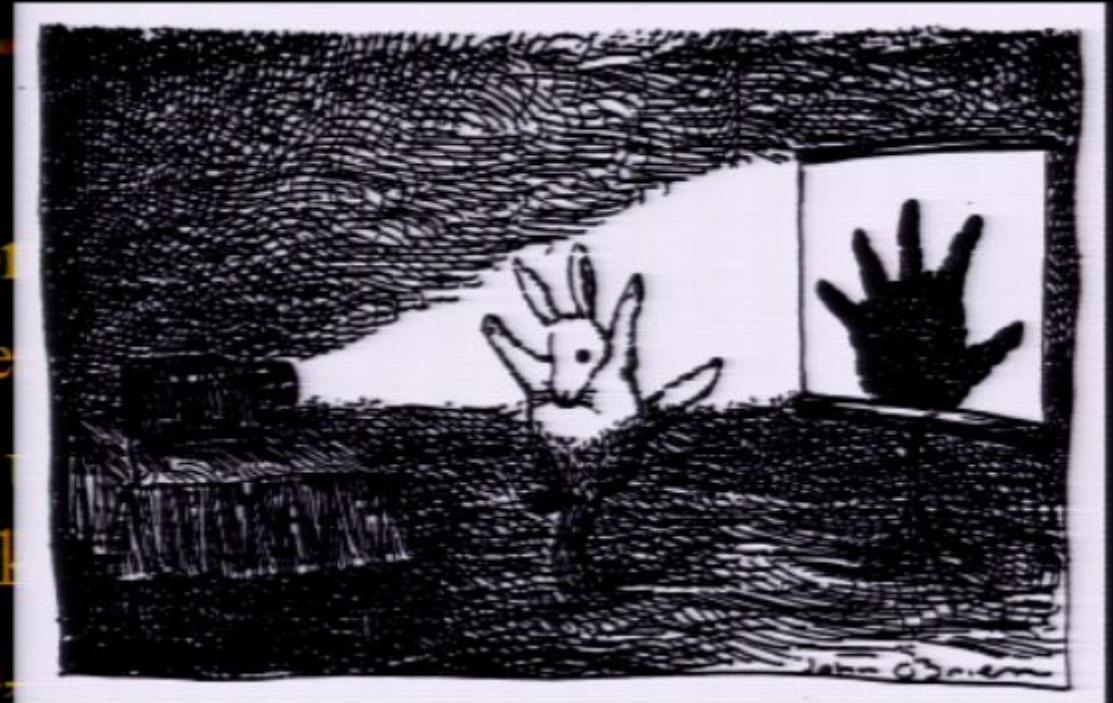
HOLY SHIT!!

Outlook

- The LHC started a long physics run a few months ago!
 - Runs at full beam energy could begin late next year.
- The LHC should tell us if the Higgs mechanism is right, and how it works.
 - The SM Higgs boson, or its alternative, should be found.

Outlook

- The LHC started a long time ago
 - Runs at full beam energy
- The LHC should tell us what is right, and how it works
 - The SM Higgs boson,
- Surprises are inevitable!
 - The LHC is likely to represent a major change to our understanding of Nature at its most elementary level.



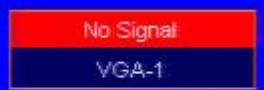
Outlook

- The LHC started
 • Runs at full beam energy
- The LHC should find the Higgs right, and how
 • The SM Higgs
- Surprises are inevitable
 • The LHC is likely to change our understanding

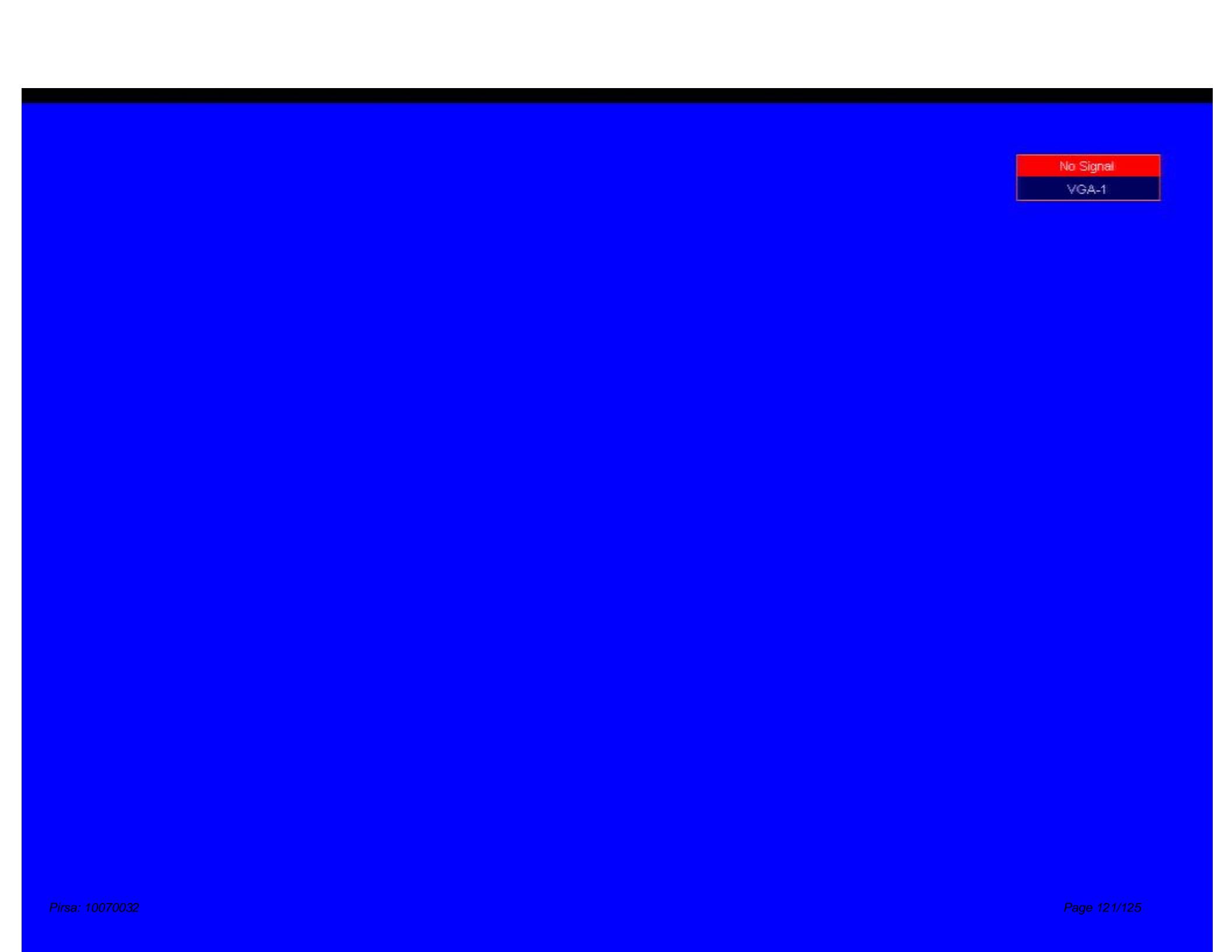
My personal pick: *large extra dimensions and string theory in your face!*

Websites with more information

- The ATLAS and CMS detectors:
 - <http://atlas.ch>, <http://cms.cern.ch>
- LHC outreach:
 - <http://lhc-machine-outreach.web.cern.ch/lhc-machine-outreach/>
- Particle Data Group outreach:
 - <http://pdg.lbl.gov/2006/html/outreach.html>
- LHC Rap: <http://www.youtube.com/watch?v=j50ZssEojtM>



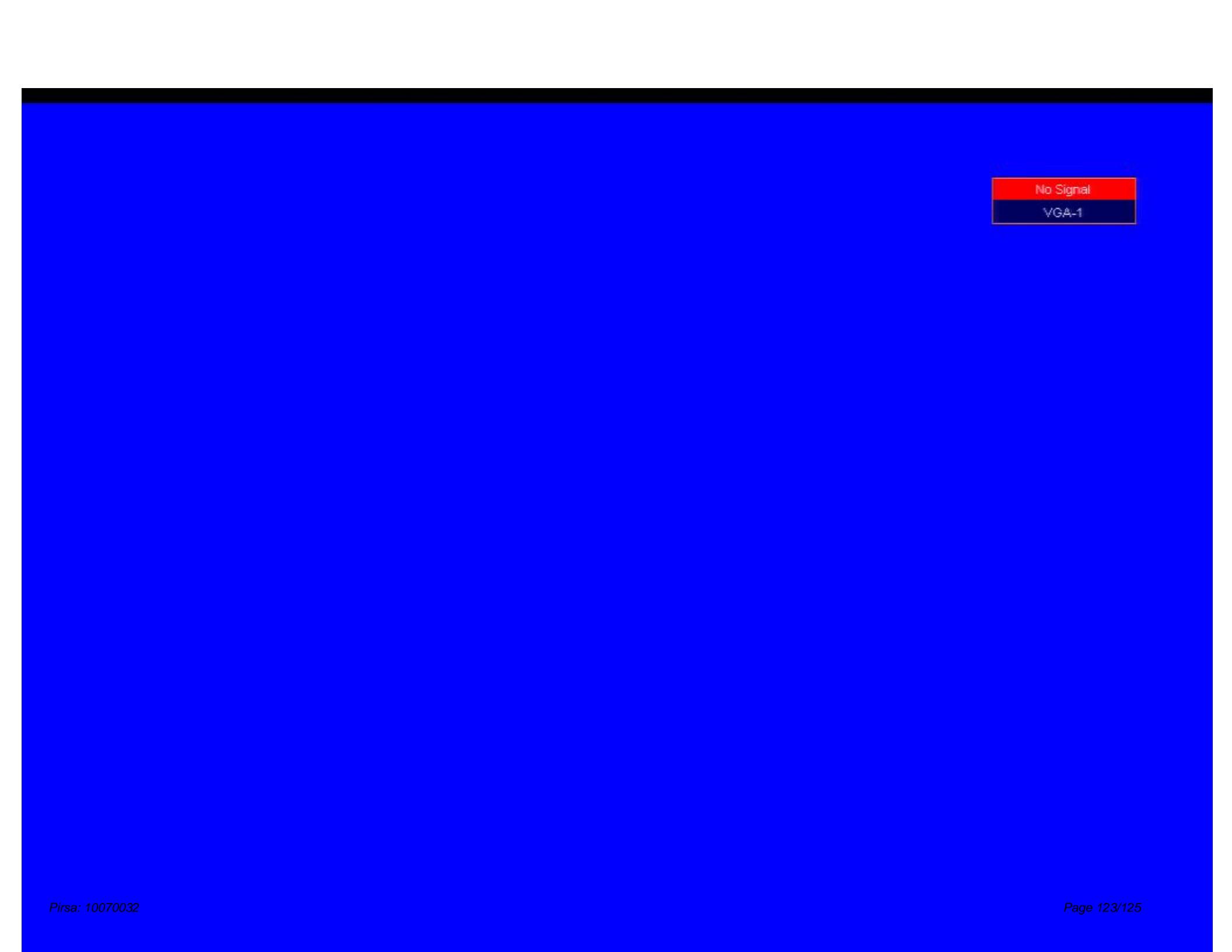
No Signal
VGA-1



No Signal

VGA-1





No Signal

VGA-1

