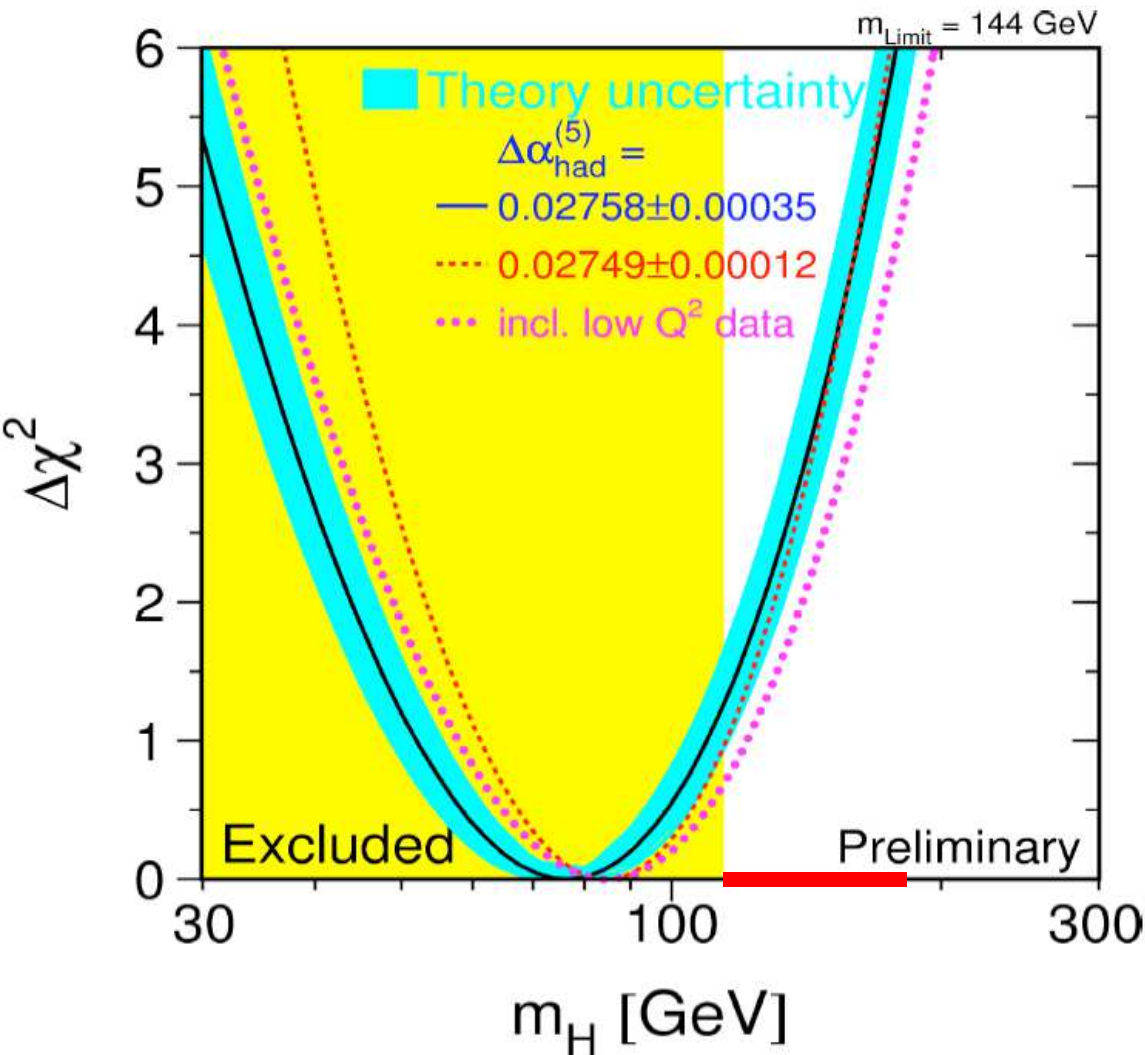


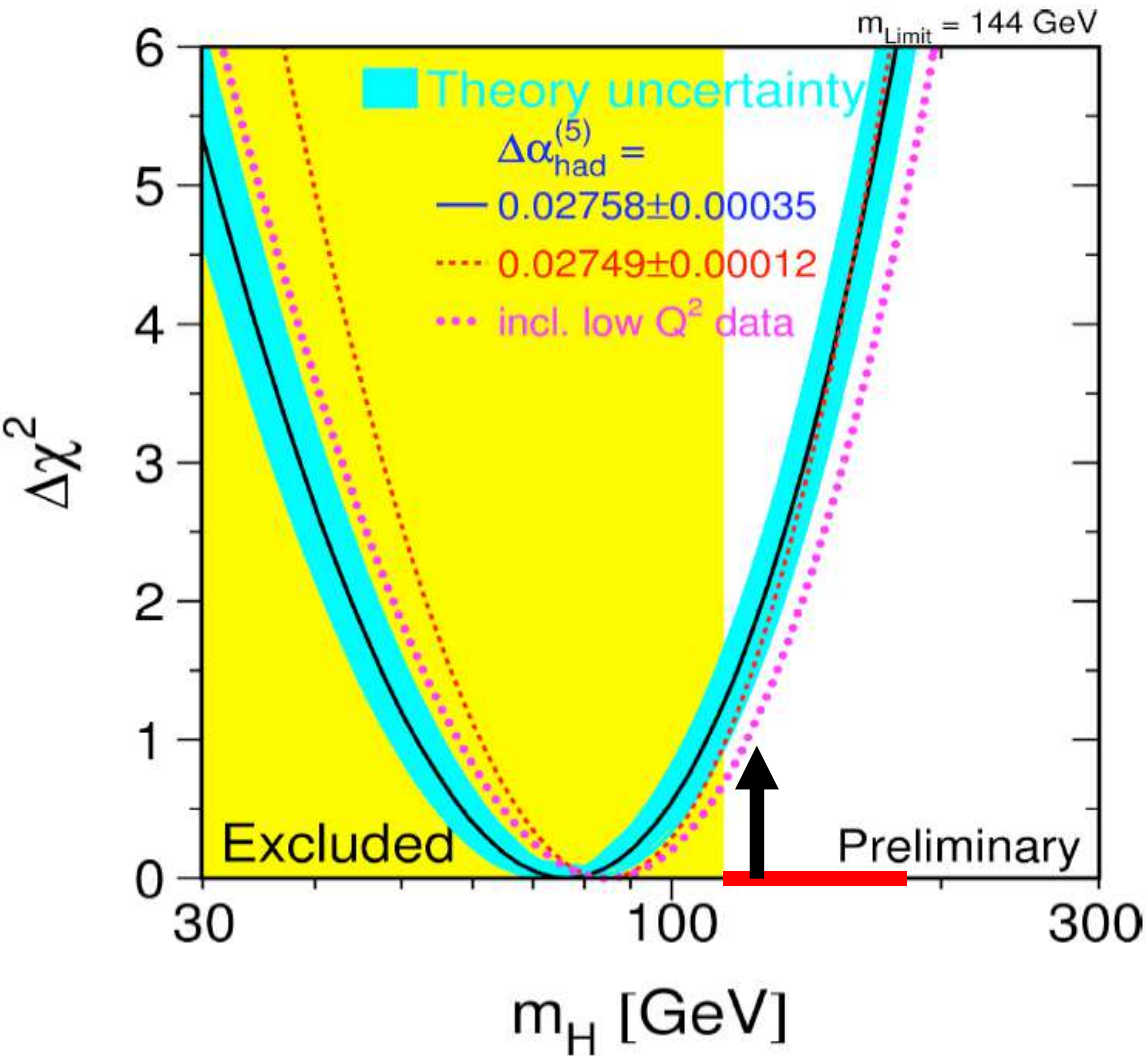
Precision @ LEP and Higgs



insert measured top mass into
precision measurements at LEP
→ now sensitive to Higgs mass
 $m_H < 182 \text{ GeV}$ at 95% CL

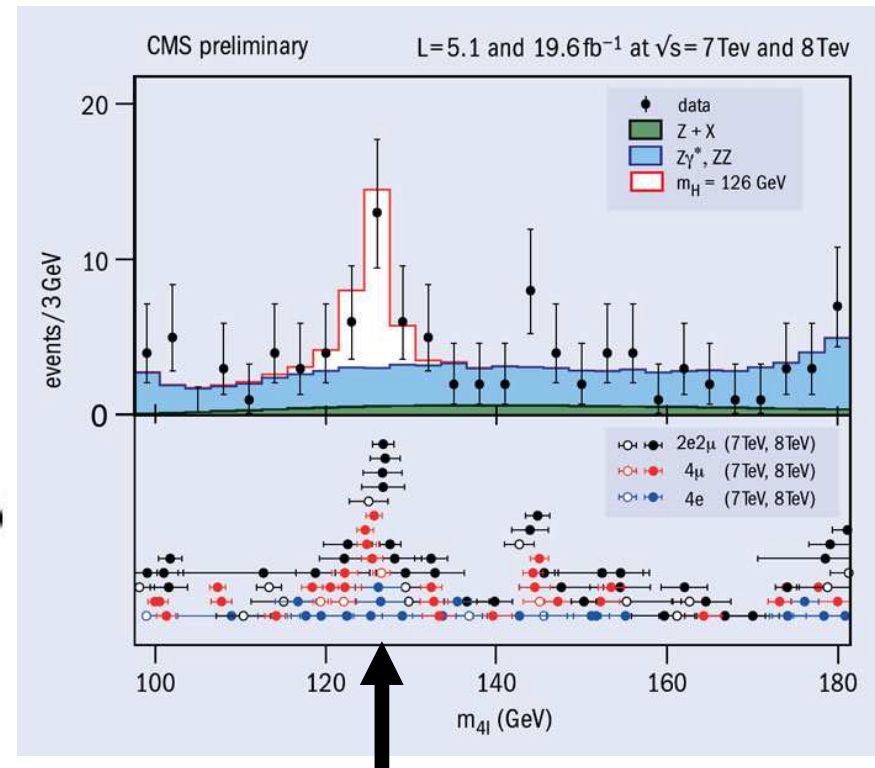
LEP direct lower limit:
 $m_H > 114 \text{ GeV}$ at 95% CL

Precision @ LEP and Higgs at LHC



and there it is!

$H \rightarrow ZZ^* \rightarrow 4 \text{ leptons}$



Special Fundamental Physics Prize 2013

for their leadership role in the scientific endeavour
that led to the discovery of the new Higgs-like particle
by the ATLAS and CMS collaborations at CERN's Large Hadron Collider.

by the Milner Foundation

Peter	Tejinder			
Jenni,	Singh	Lyn	Fabiola	Joe
ATLAS	Virdee,	Evans,	Gianotti,	Incandela,
	CMS	LHC	ATLAS	CMS

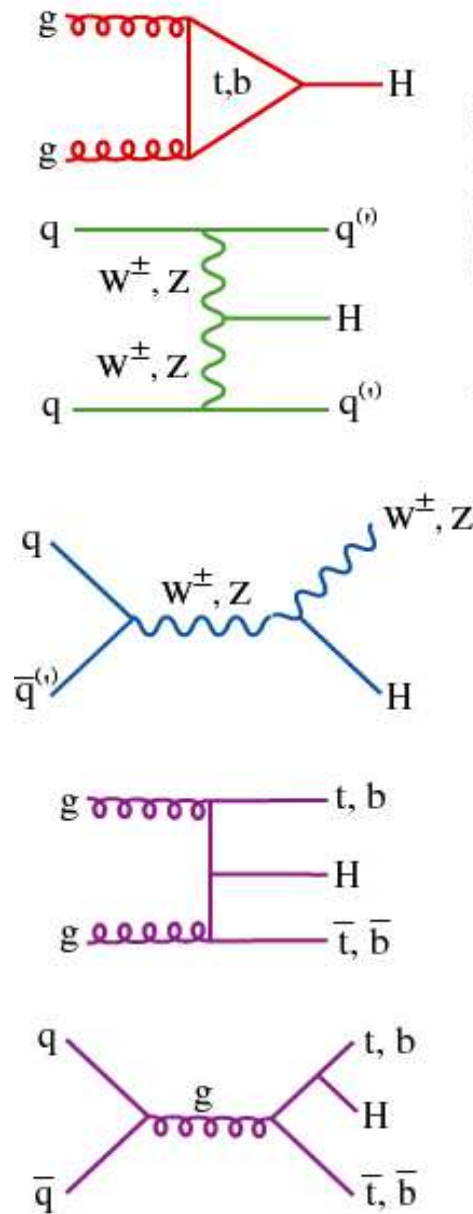


Michel	
Della	Guido
Negra	Tonelli,
CMS	CMS

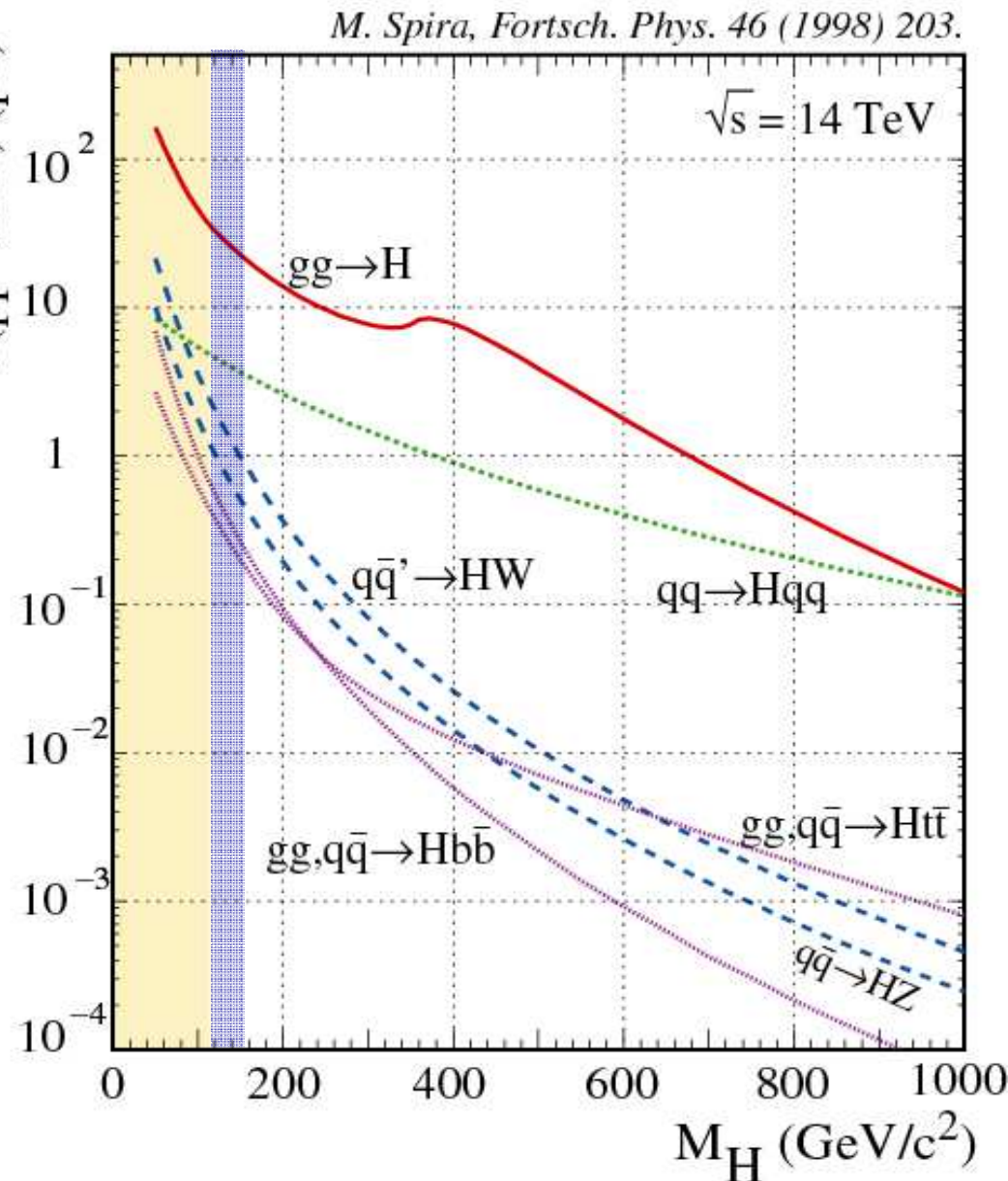


Higgs production at LHC

measure
as many as
possible
to
check
Higgs
properties

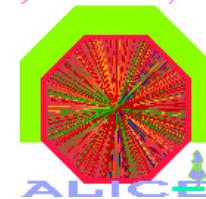
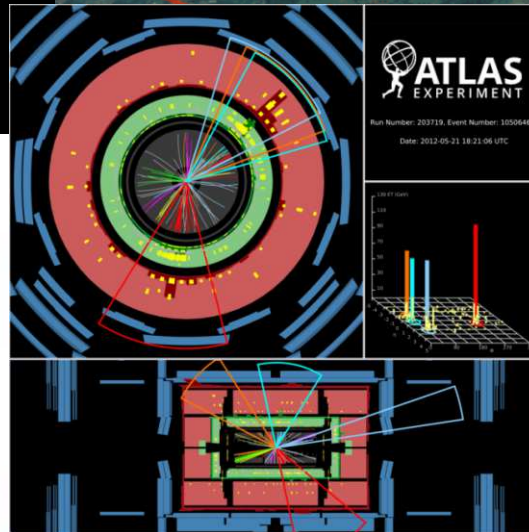
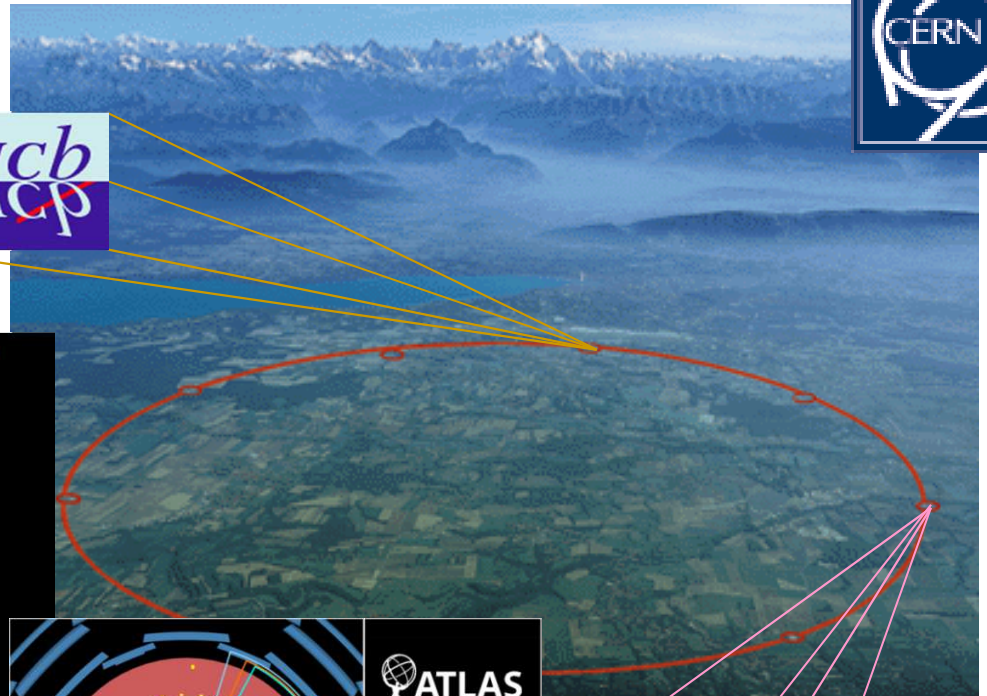
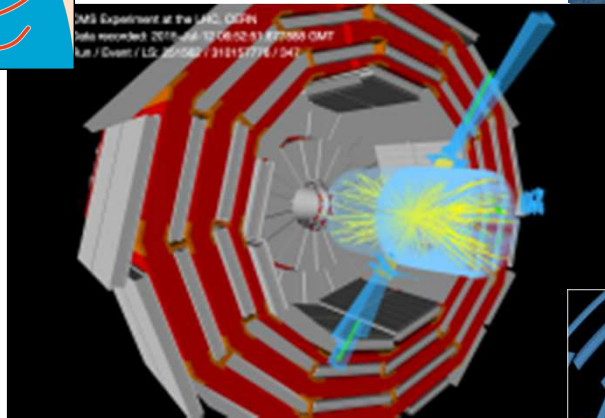
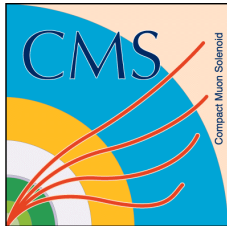


$\sigma(pp \rightarrow HX) \text{ (pb)}$



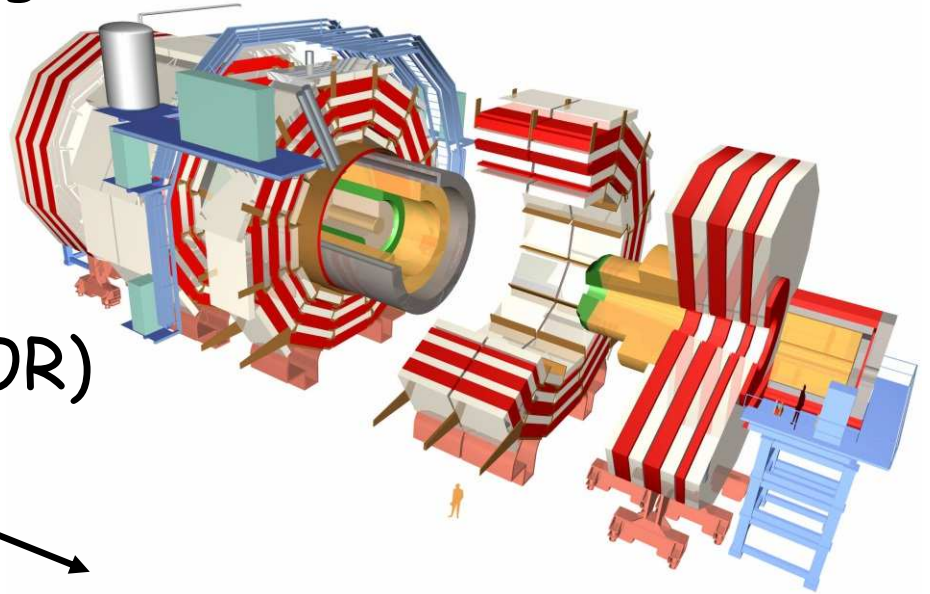
The LHC Project

currently running @ 13 TeV

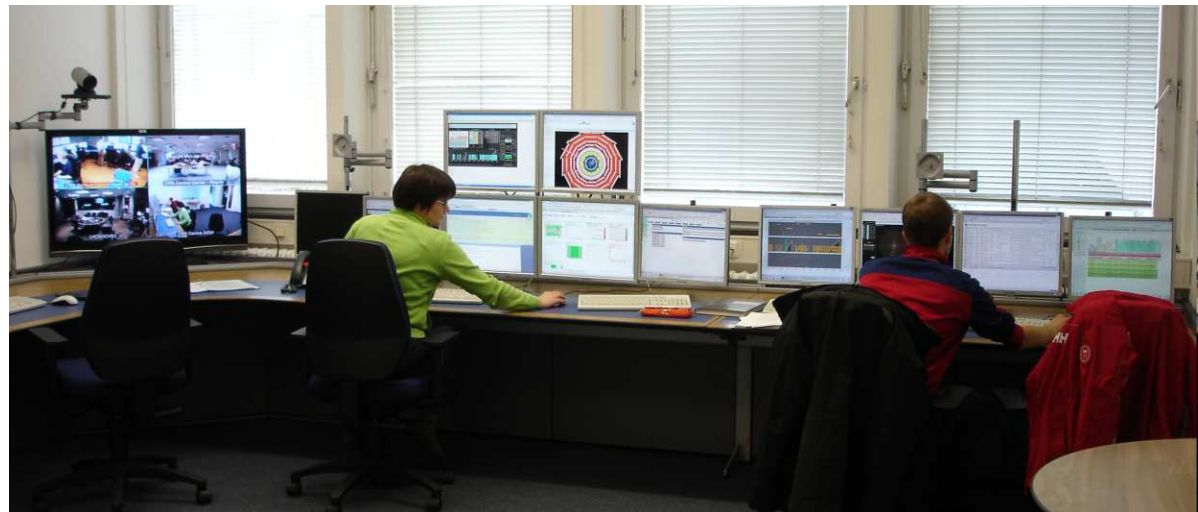


The DESY CMS group

- Installation & Commissioning
- Computing
- Tracking, Tracker upgrade
- Beam Condition Monitor
- Forward detectors (CASTOR)
- Data Quality Monitoring
building 1a, first floor

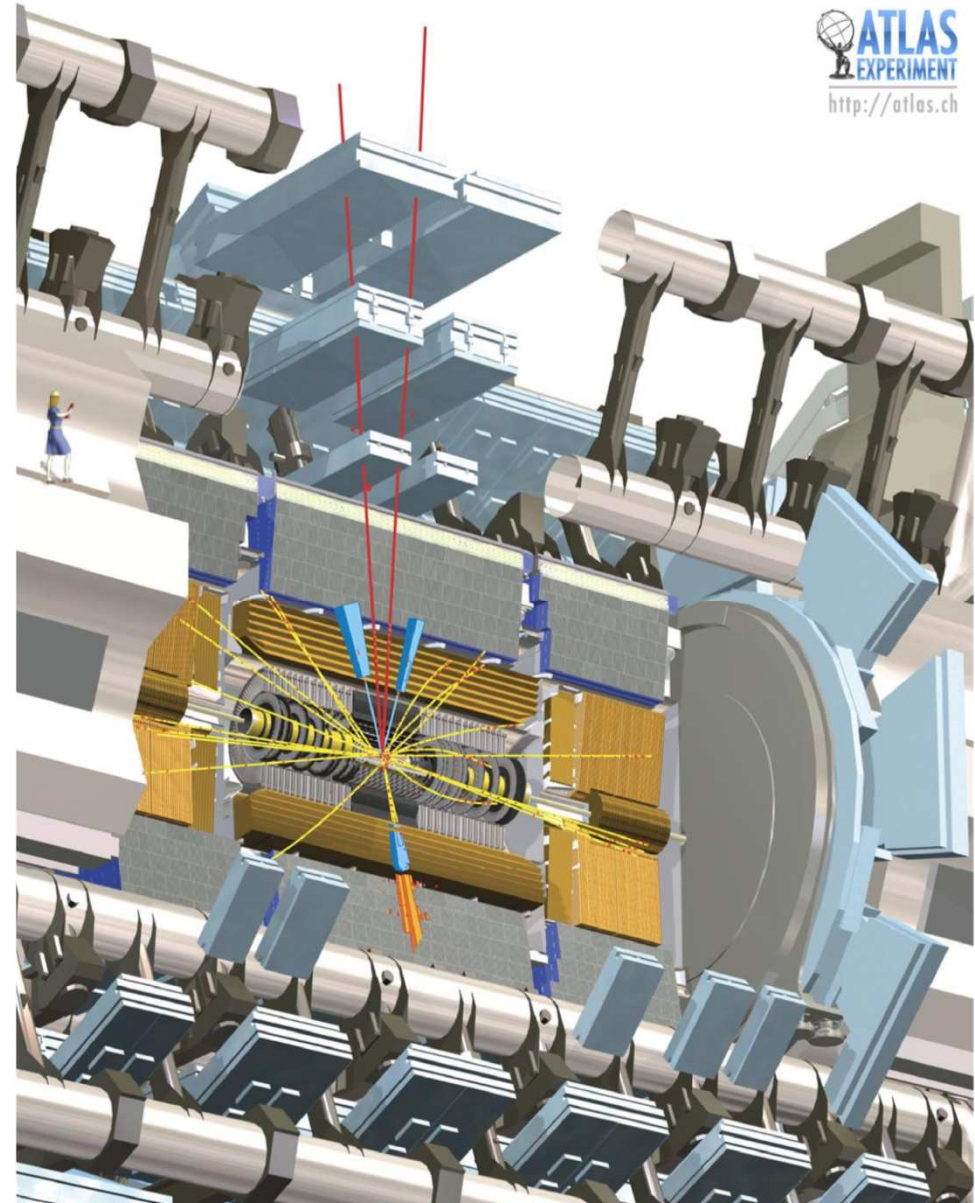


- **Physics**
 - Standard Model
 - Forward Physics
 - Top + Higgs
 - Supersymmetry



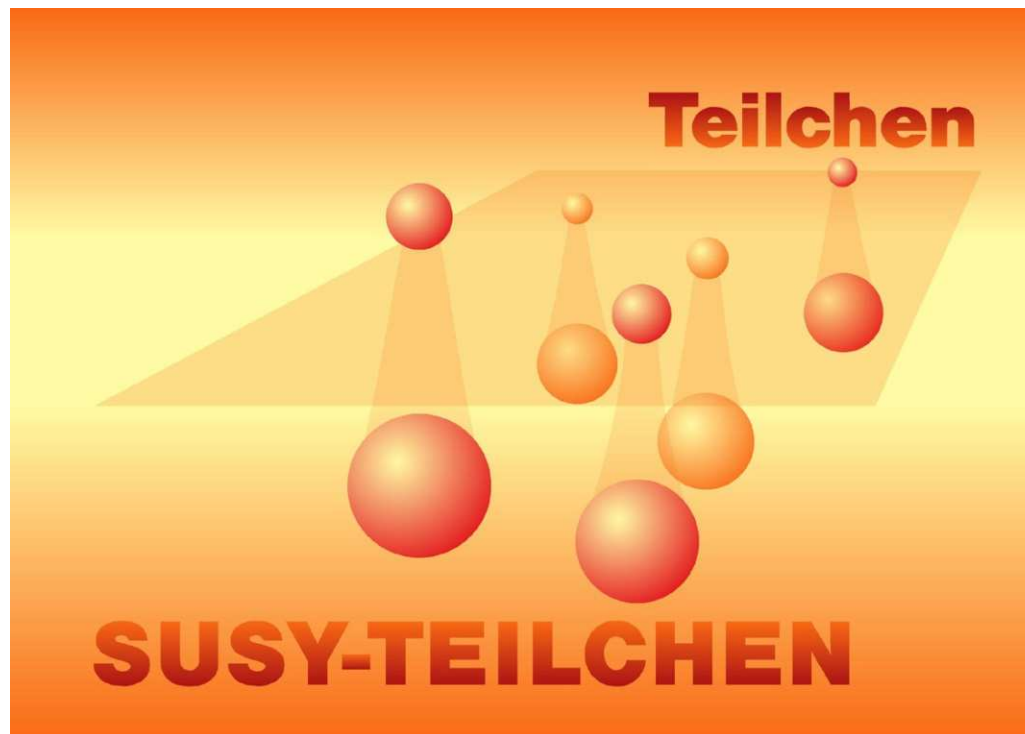
The DESY ATLAS group

- Trigger
- Computing
- Lumi monitor (ALFA)
- sLHC upgrade
- **Physics:**
 - Standard Model
 - Top quarks
 - Supersymmetry
 - Higgs



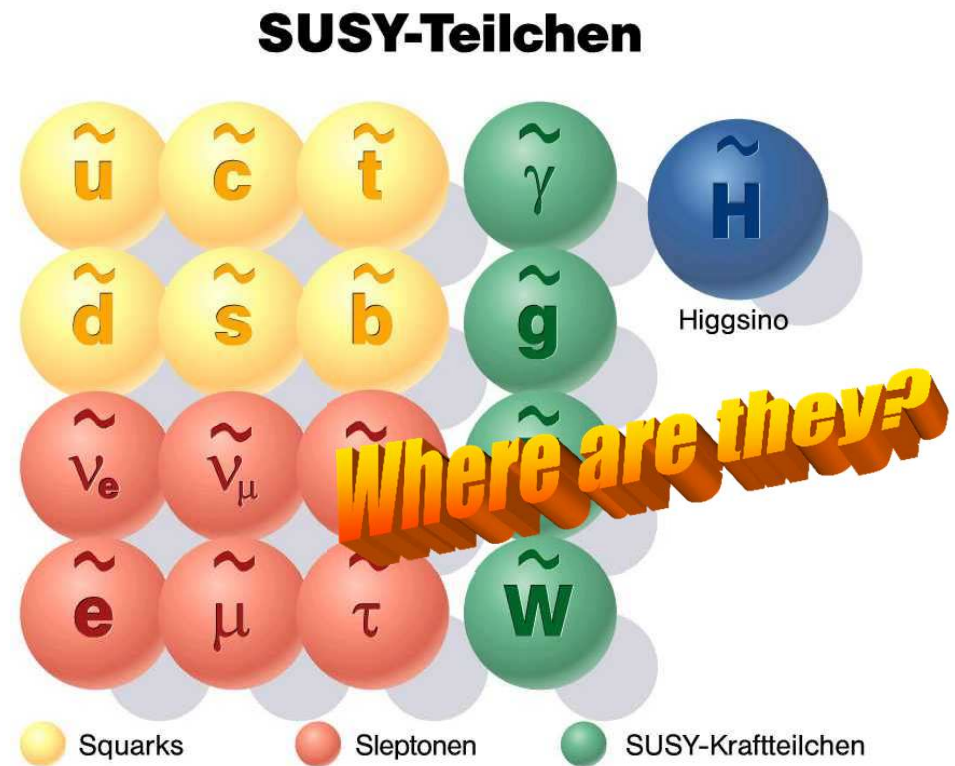
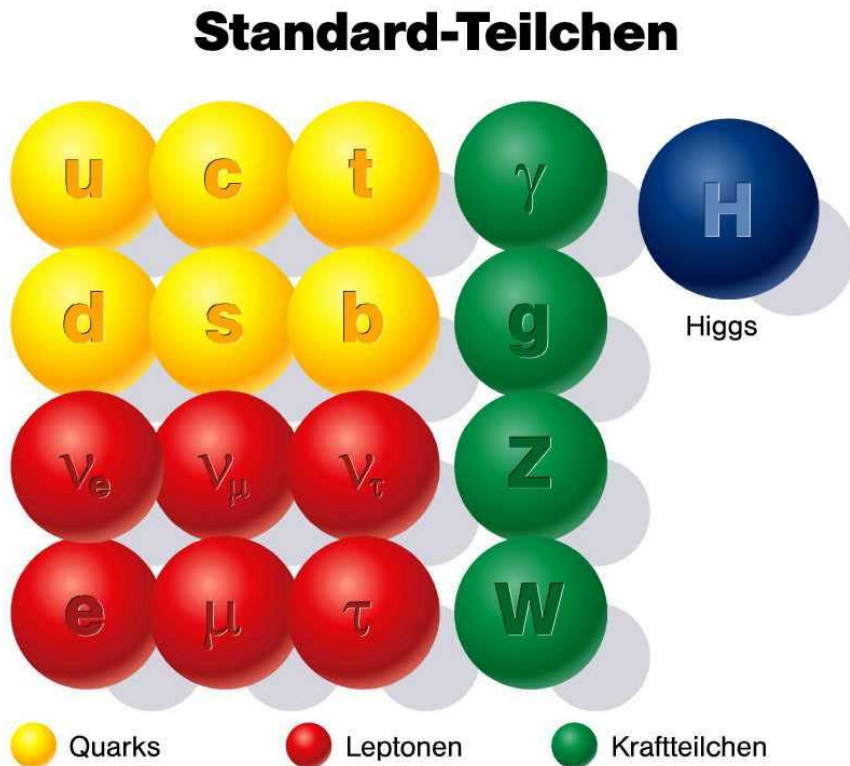
Supersymmetry

- A way to solve theoretical problems with Unification of Forces: **Supersymmetry**
- For each existing particle, introduce similar particle, with spin different by $1/2$ unit



Supersymmetry

- double number of particles:



- not seen at LEP, HERA, Tevatron ... -> must be heavy!
- (still) hope to see them at LHC !

We can hear the universe!

INSPIRAL

RINGDOWN

MERGER

LIGO 2016

Challenge:

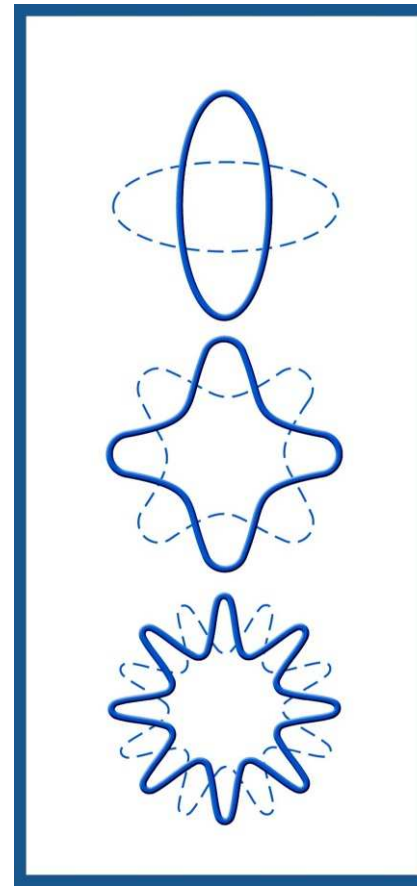
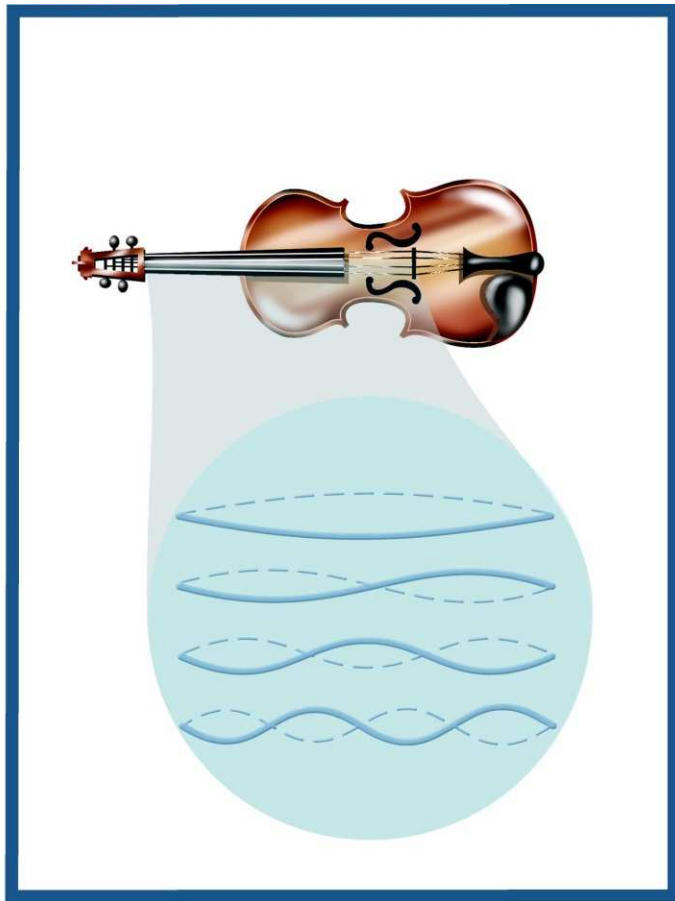
How to merge this with the Standard Model of particle physics?

HANFORD, WASHINGTON
LIVINGSTON, LOUISIANA

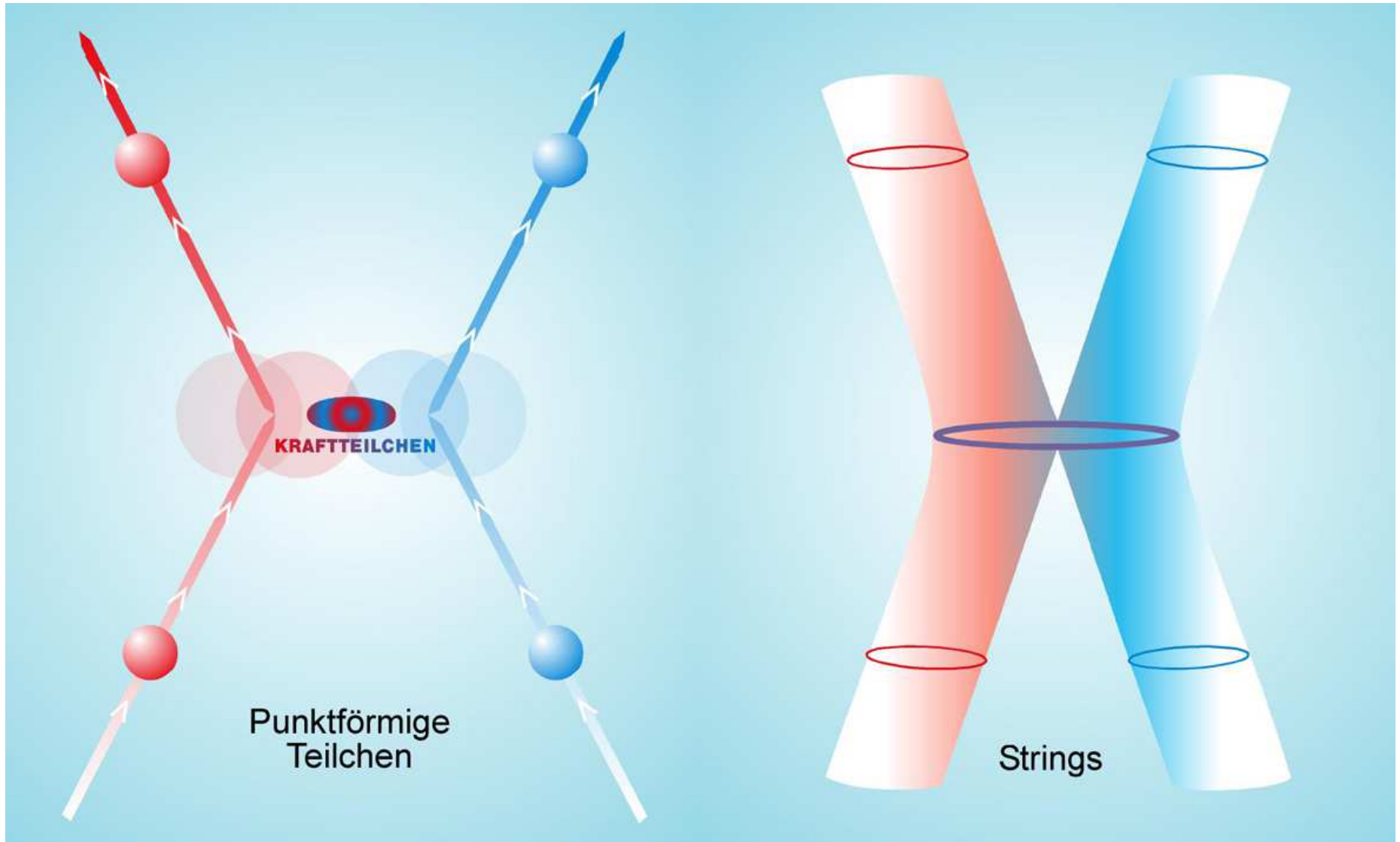
A. Geiser, Particle Physics

Unification and Superstrings

To include gravity in unification of forces,
need Superstrings (Supersymmetric strings)

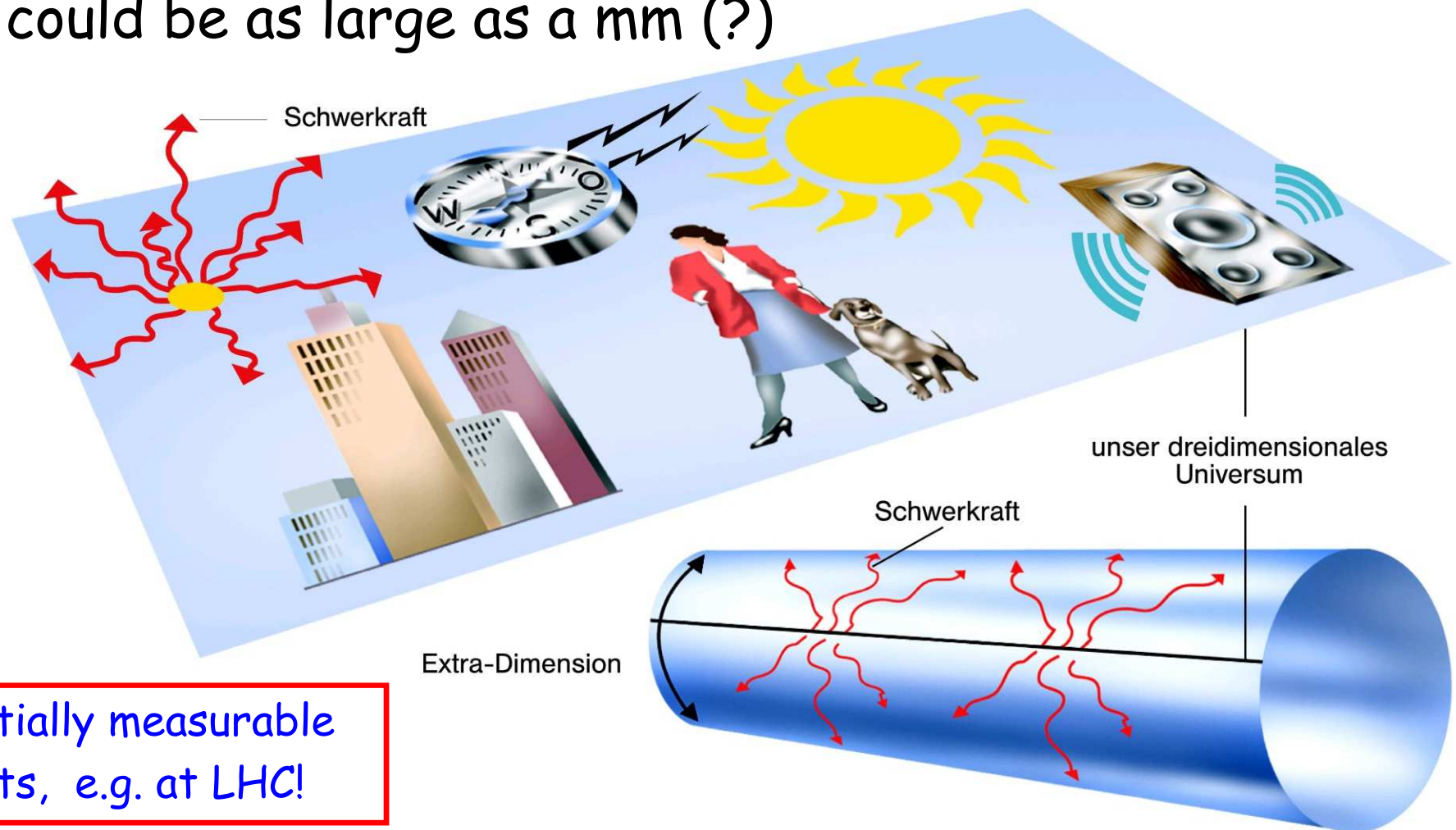


Superstring interaction



Extra Dimensions?

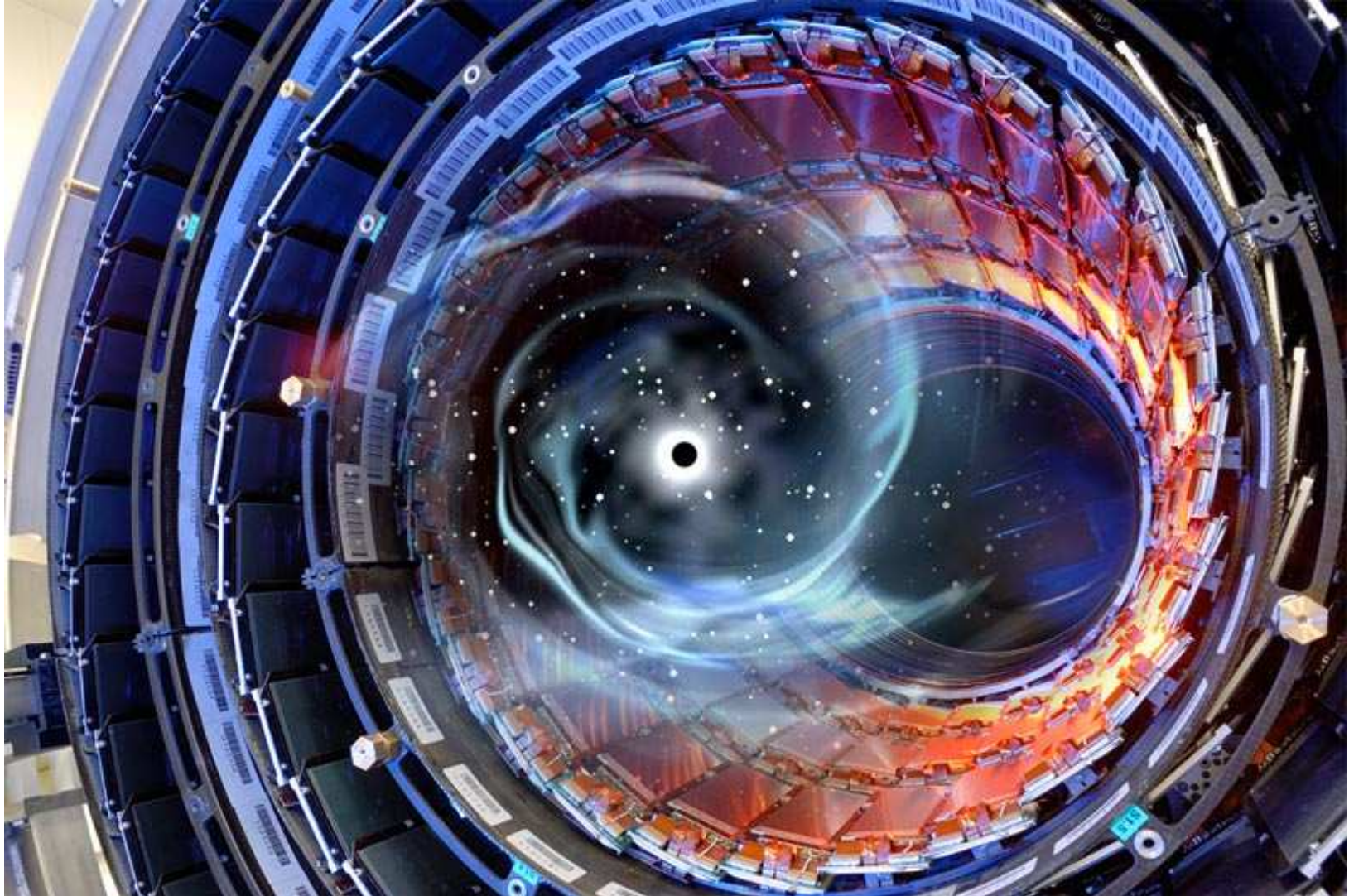
- Superstrings require more than 3+1 dimensions
- additional "extra" dimensions -> "curled up"
 - could be as large as a mm (?)



potentially measurable
effects, e.g. at LHC!

extra dimensions -> micro black holes?

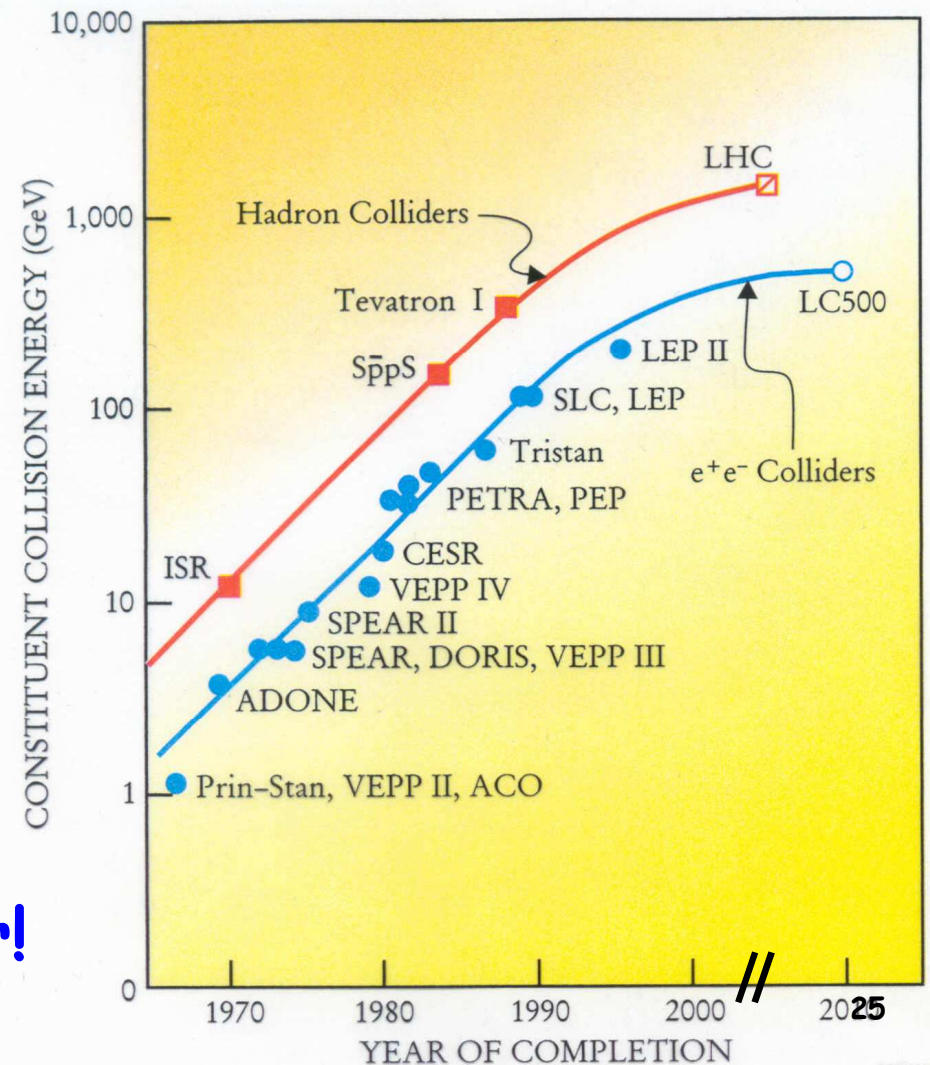
extremely short-lived - no indications so far



The case for an e^+e^- Linear Collider

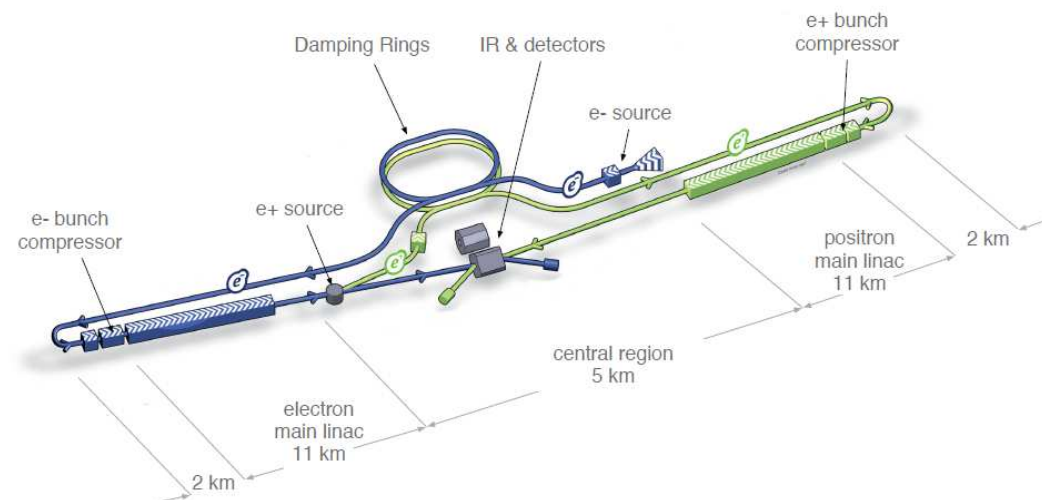
for more see lectures K. Büsser

- Historically, hadron (proton) and electron colliders have yielded great symbiosis:
- hadron colliders: discoveries at highest energies
- electron colliders: discoveries and precision measurements
- latest example: Tevatron/LEP (top), now Higgs at LHC
=> **International Linear Collider!**



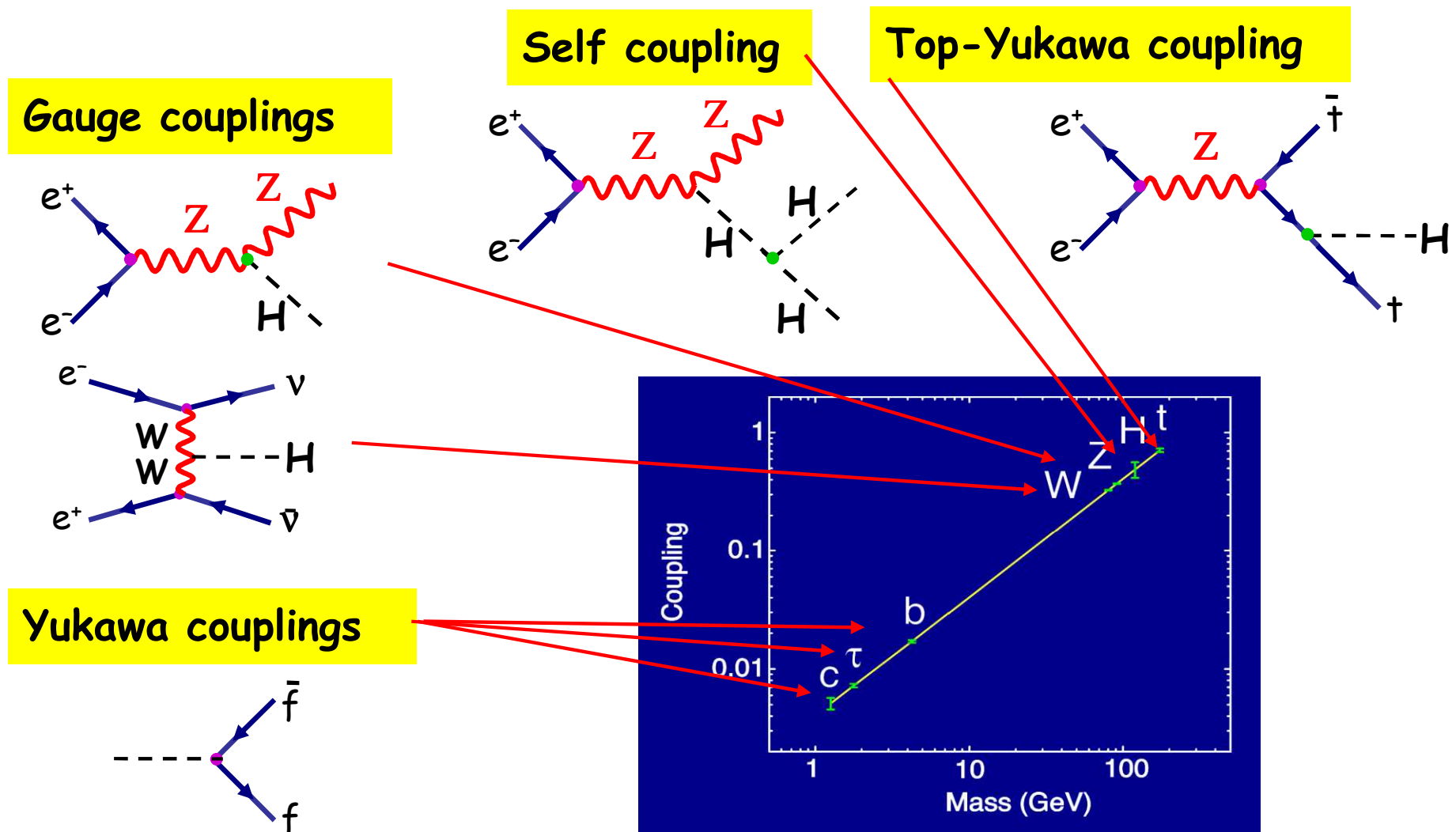
"NEW DIRECTIONS IN SCIENCE ARE LAUNCHED BY NEW TOOLS MUCH MORE OFTEN THAN BY NEW CONCEPTS. THE EFFECT OF A CONCEPT-DRIVEN REVOLUTION IS TO EXPLAIN OLD THINGS IN NEW WAYS. THE EFFECT OF A TOOL-DRIVEN REVOLUTION IS TO DISCOVER NEW THINGS THAT HAVE TO BE EXPLAINED." FREEMAN DYSON, Imagined Worlds

The ILC



**Technical Design Report
released (June 2013)
Hosting in Japan being
discussed**

Example: Higgs Physics at the ILC



all measurable with high precision!

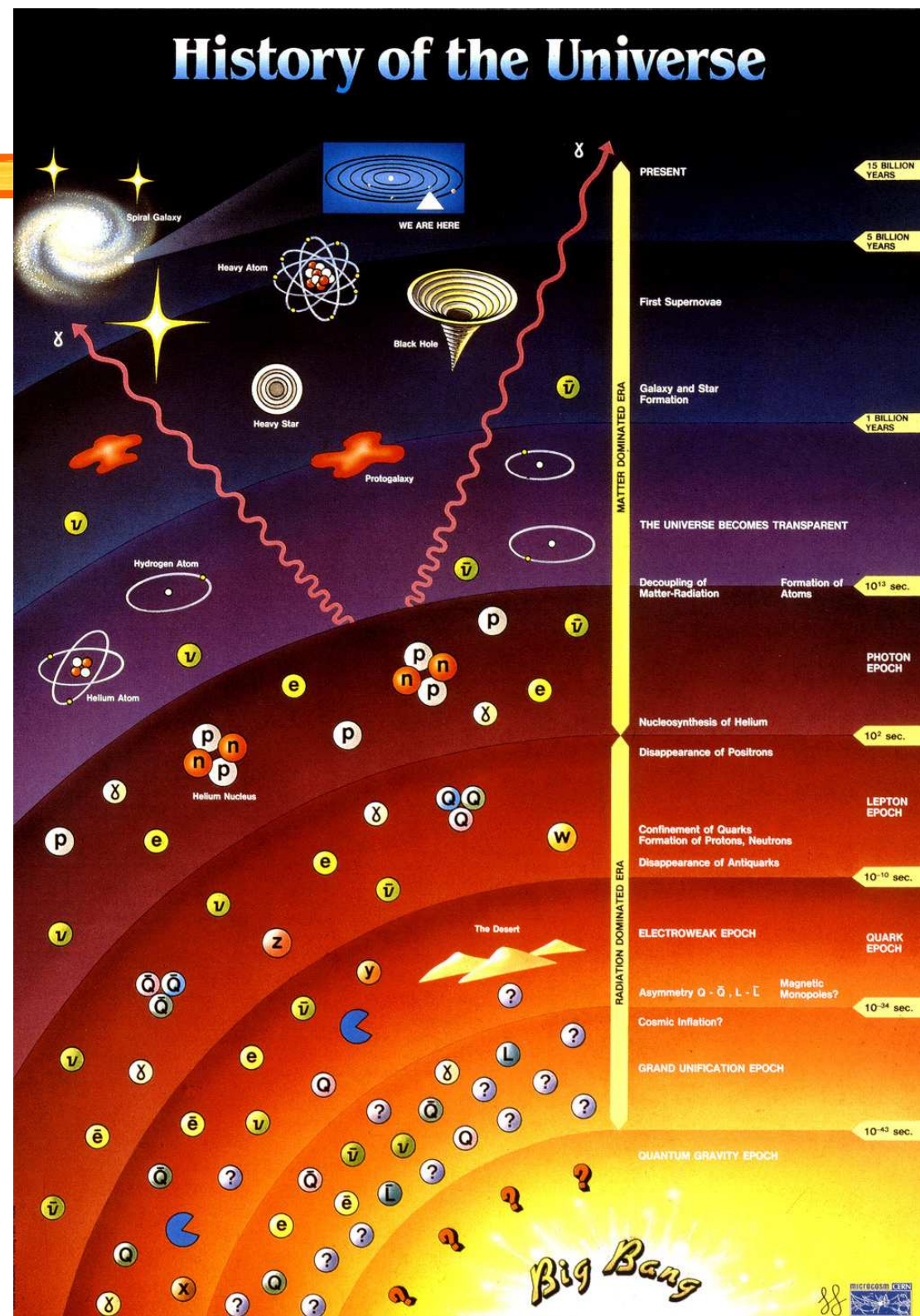
Cosmology

Direct link between Particle Physics and Cosmology

increasing energy
-> going further
backwards in time
in the universe
-> getting closer to
the **Big Bang**

19.-21.7.17

A. Geiser,



The Big Bang

Galaxy
formation

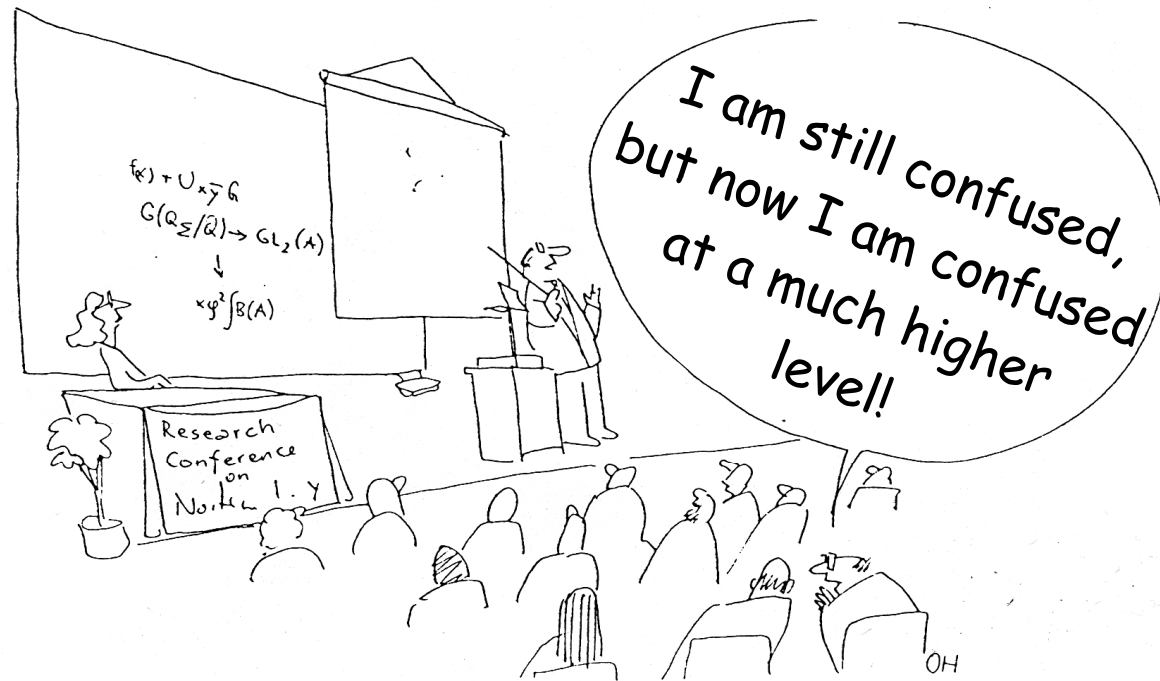
1000 M years

Galaxies begin to form

You!

Elementary Particle Physics is exciting!

- We already know a lot, but many open issues



- Exciting new insights expected for the coming decade!

Join the Fun!