LCWS 2008

University of Illinois at Chicago

Summary

Outlook

Physics
Accelerator and Detector
General Remarks

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R.-D. Heuer, Univ. Hamburg/DESY/CERN CERN, Nov 20, 2008

Past decades until today

“Discovery” of Standard Model

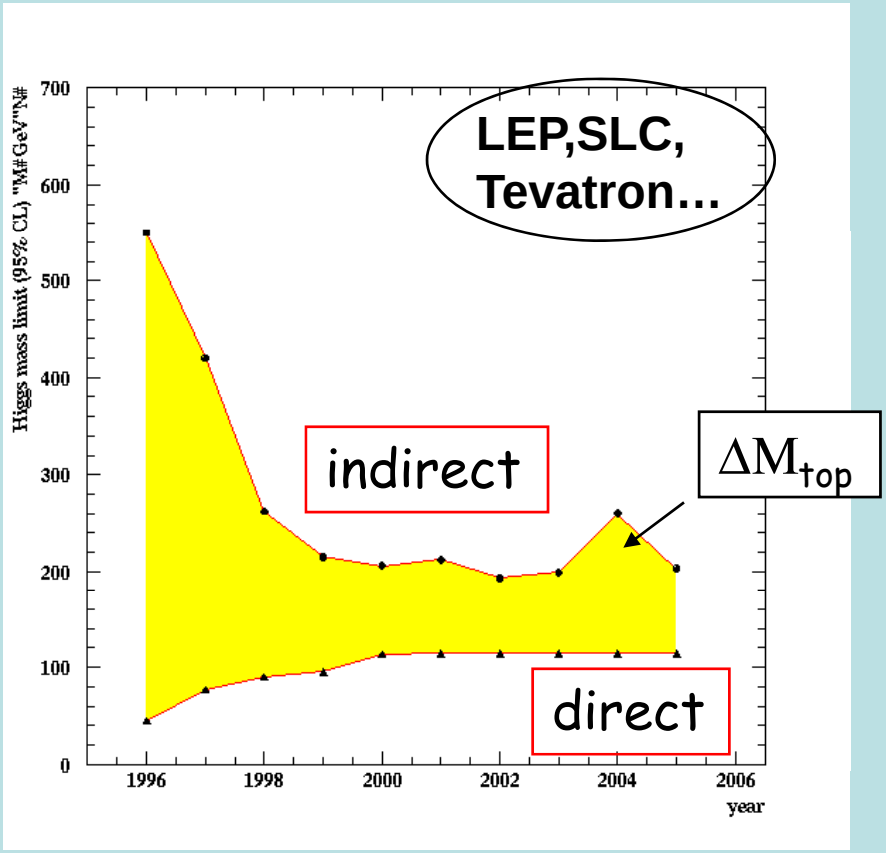
through synergy of

hadron - hadron colliders (e.g. Tevatron)

lepton - hadron colliders (HERA)

lepton - lepton colliders (e.g. LEP / SLC)

Time evolution of experimental limits on the Higgs boson mass



M_H between 114 and ~200 GeV

Synergy of colliders

knowledge obtained only through combination of results from different accelerator types

in particular:
Elektron-Positron Collider
and
Hadron Collider

together with highly developed theoretical calculations

With the turn on of LHC
entering an exciting phase of particle physics
at the highest collision energies ever
→ Many years of exciting physics ahead

1. **Is there a Higgs?**
2. **What is the Higgs mass?**
3. **Is the Higgs a SM-like we**
4. **Is the Higgs elem**
5. **Is the stabi ned by a symmetry or dyn**
6. **Is su effective at the weak scale?**
7. **Will w cover DM at the LHC?**
8. **Are there extra dimensions? Are there new strong forces?**
9. **Are there totally unexpected phenomena?**
10. **What is the mechanism of EW breaking?**

Initial phase of LHC will tell which way nature wants us to go

Standard

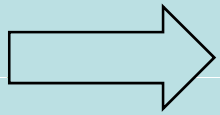
Nearly Standard

Not at all Standard

Jonathan Bagger

Physics case

- The physics case must be built on the LHC
  - The LHC will open the Terascale …
    - We need to celebrate its success!
- The case has not changed!
  - We have every expectation that the ILC will be the appropriate follow-on to the LHC …

Two striking examples of LHC-ILC synergy 

Dark Matter

Astronomers & astrophysicists over the next two decades using powerful new telescopes will tell us how dark matter has shaped the stars and galaxies we see in the night sky.

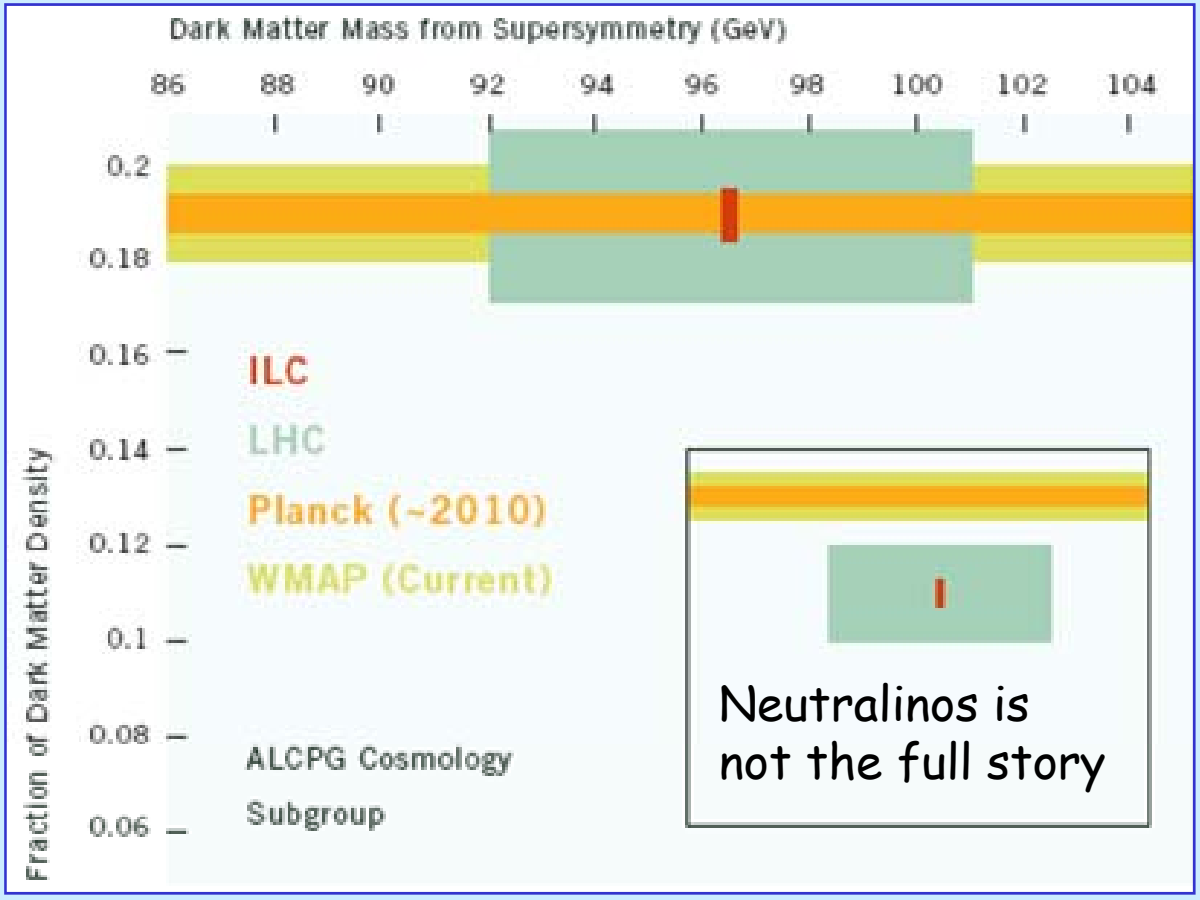
Only particle accelerators can produce dark matter in the laboratory and understand exactly what it is.

Composed of a single kind of particle
or
more rich and varied (as the visible world)?

LHC and LC may be perfect machines to study dark matter.

Dark Matter and SUSY

- Is dark matter linked to the Lightest Supersymmetric Particle?



LC and satellite data (WMAP and Planck):

complementary views of dark matter.

LC: identify DM particle, measures its mass;

WMAP/Planck: sensitive to total density of dark matter.

Together with LHC they establish the nature of dark matter.

LHC and LC results should allow,
together with dedicated dark matter searches,
first discoveries in the dark universe

- around 73% of the Universe is in some mysterious "dark energy". It is evenly spread, as if it were an intrinsic property of space. It exerts negative pressure.

Challenge:
get first hints about the world of dark energy in the laboratory

The Higgs is Different!

All the matter particles are spin-1/2 fermions.
All the force carriers are spin-1 bosons.

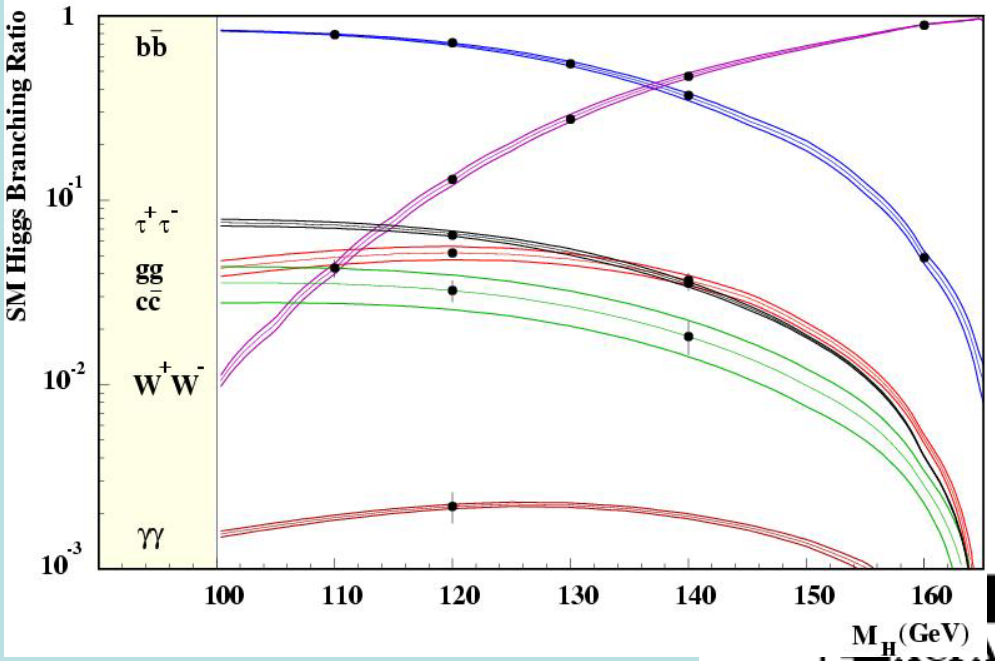
Higgs particles are spin-0 bosons.
The Higgs is neither matter nor force;
The Higgs is just different.
This would be the first fundamental scalar ever discovered.

The Higgs field is thought to fill the entire universe.
Could give some handle of dark energy (scalar field)?

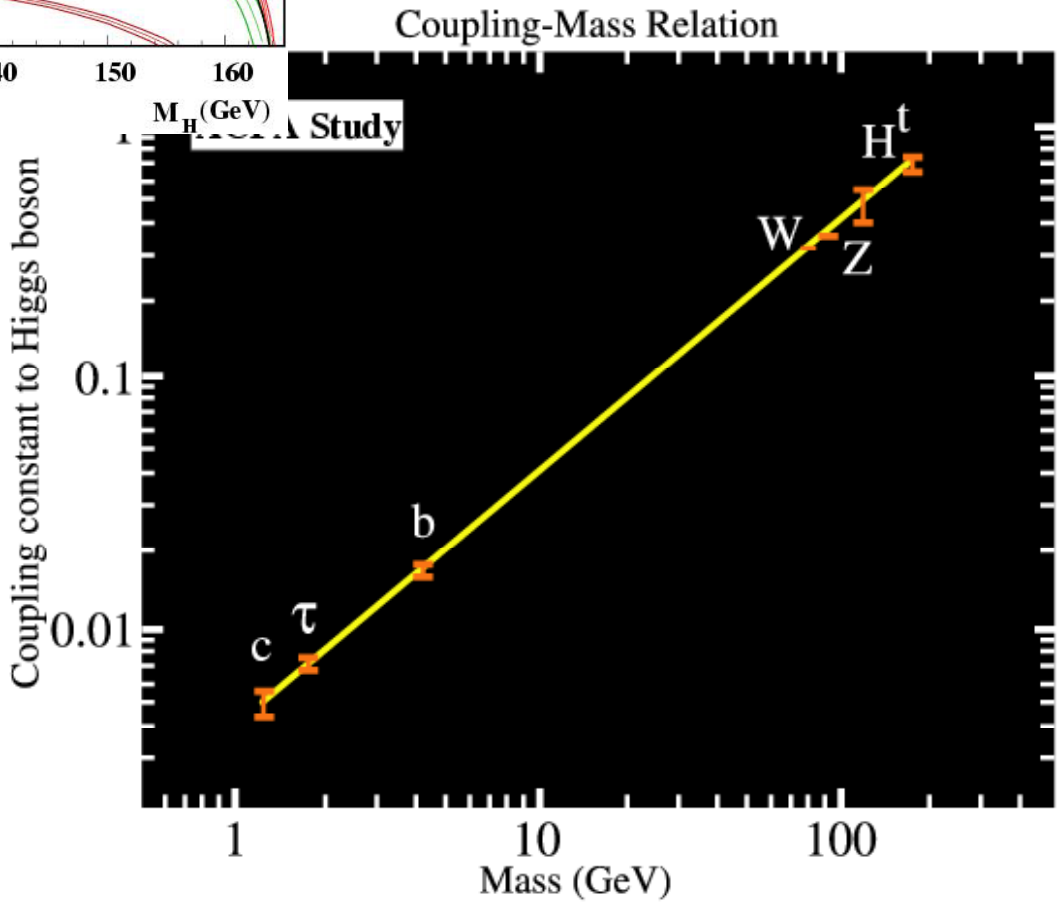
Many modern theories predict other scalar particles like the Higgs.
Why, after all, should the Higgs be the only one of its kind?

LHC and LC can search for new scalars with precision.

Precision Higgs physics



Determination of absolute coupling values with high precision



LHC and LC results will allow
to study the Higgs mechanism in detail and
to reveal the character of the Higgs boson

This would be the first investigation
of a scalar field

This could be the very first step to
understanding dark energy

Past decades saw precision studies of 5 % of our Universe → Discovery of the Standard Model

The LHC will soon deliver data

Preparations for the ILC as a global project are under way, R&D for CLIC well progressing

The next decades look very exciting:

We are just at the beginning of exploring 95 % of the Universe

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Marc Ross

Look back: 2004

- **International Technology Recommendation Panel (ITRP) Report:**
  - (released during LINAC 2004 Conference, Lubeck)

The superconducting technology has features, some of which follow from the low rf frequency, that the Panel considered attractive and that will facilitate the future design:

- The large cavity aperture and long bunch interval simplify operations, reduce the sensitivity to ground motion, permit inter-bunch feedback, and may enable increased beam current.
- The main linac and rf systems, the single largest technical cost elements, are of comparatively lower risk.
- The construction of the [illegible] electron laser will provide prototypes and test many [illegible].
- The industrialization of most major components of the linac is underway.
- The use of superconducting cavities significantly reduces power consumption.

great advantage not to be missed

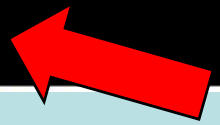
Basis of the ITRP decision; basis of our progress since then rests in large part on EU – XFEL project

Barry Barish

BLACK DECEMBER 2007

- Without warning, severe budget cuts in the USA and the UK
  - In UK, we preserved support for key scientists and their teams, but lost broader program (40 FTE to ~ 15 FTE)
  - In US, budget reduced FY98 to $15M, essentially already spent last December. The US program has effectively been on hold for 9 months.

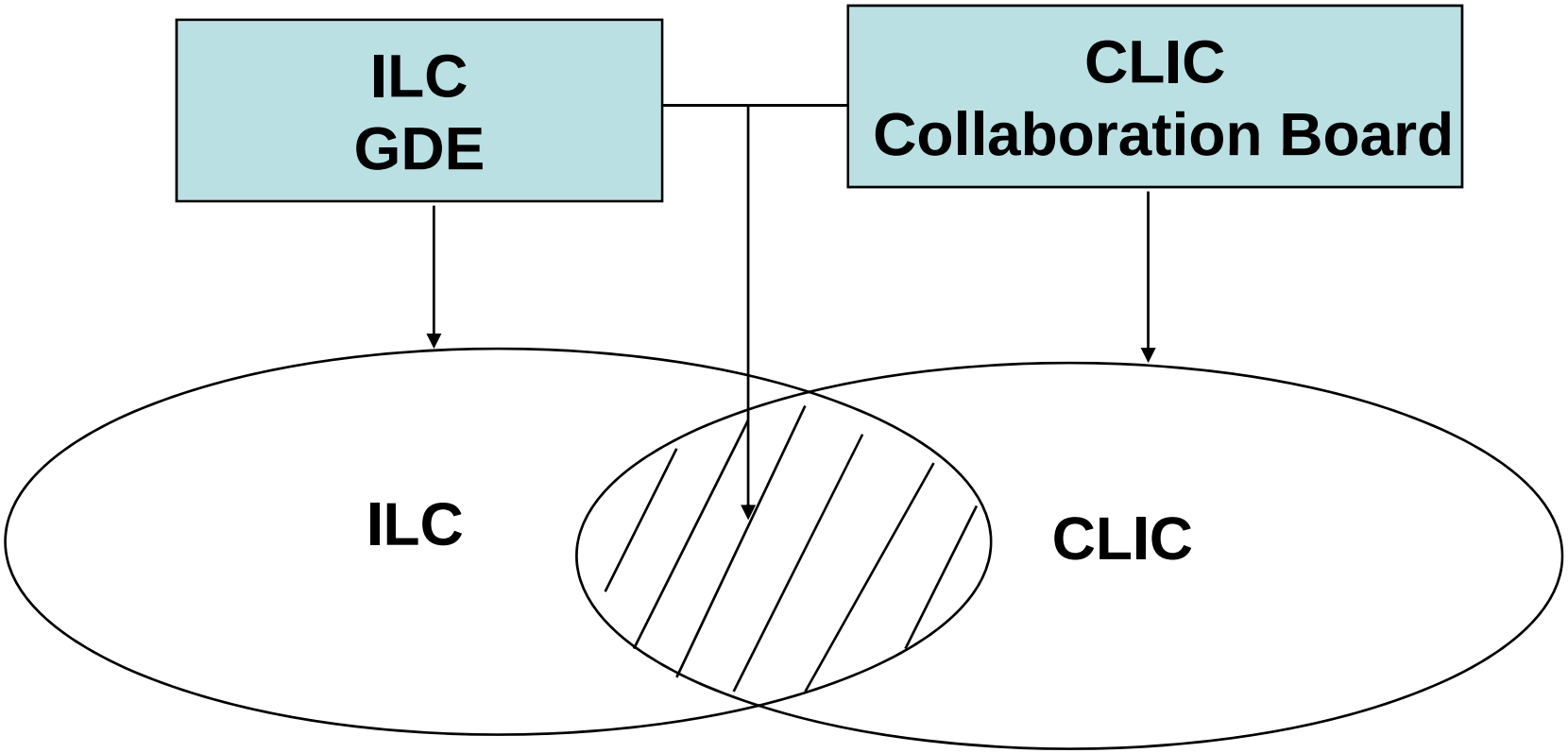
- Global Program has impressively moved on in the face of these devastating problems
  - The core of our program is focused on large R&D facilities; Global collaboration increased toward prioritized goals



CLIC-ILC Collaboration

started November 2007

Jean-Pierre Delahaye



No additional meetings but reinforced participation of CLIC experts to ILC meetings and ILC experts to CLIC workshop

CLIC – ILC Collaboration Strategy (M.Ross @ CLIC08)

What can ILC bring to CLIC?

- **Use the same cost basis.**
- **develop a credible comparison**
- **(ILC will help in the costing of CLIC)**

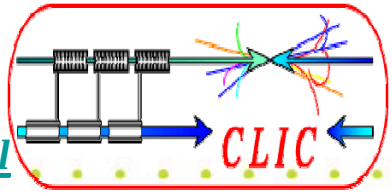
And CLIC to ILC:

- **CERN & CLIC-collaboration experts to work with ILC team on common design issues**

The credibility of each project within our community will be facilitated through communication

Conclusion of Barry

http://www.linearcollider.org/newsline/archive/2008/20081113.html



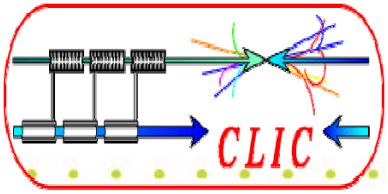
As we look to the future, we anticipate that LHC results will establish the scientific case for a linear collider.

If the science warrants a 0.5 to 1.0-TeV ILC, the agreement for joint ILC/CLIC work will be helpful towards our primary GDE goal of being ready to propose a solid project at that time.

If the LHC results indicate the need for a higher-energy lepton collider, we will be prepared as a community to aggressively continue to develop the CLIC concept on a longer timescale.

Conclusion

TILC08 March 2008

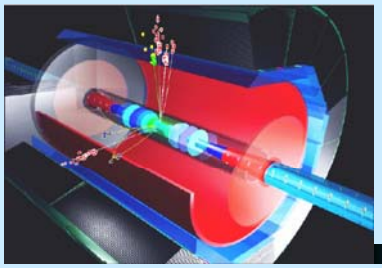


- **CLIC/ILC collaboration on subjects with strong synergy**

Win –Win for both studies and for HEP

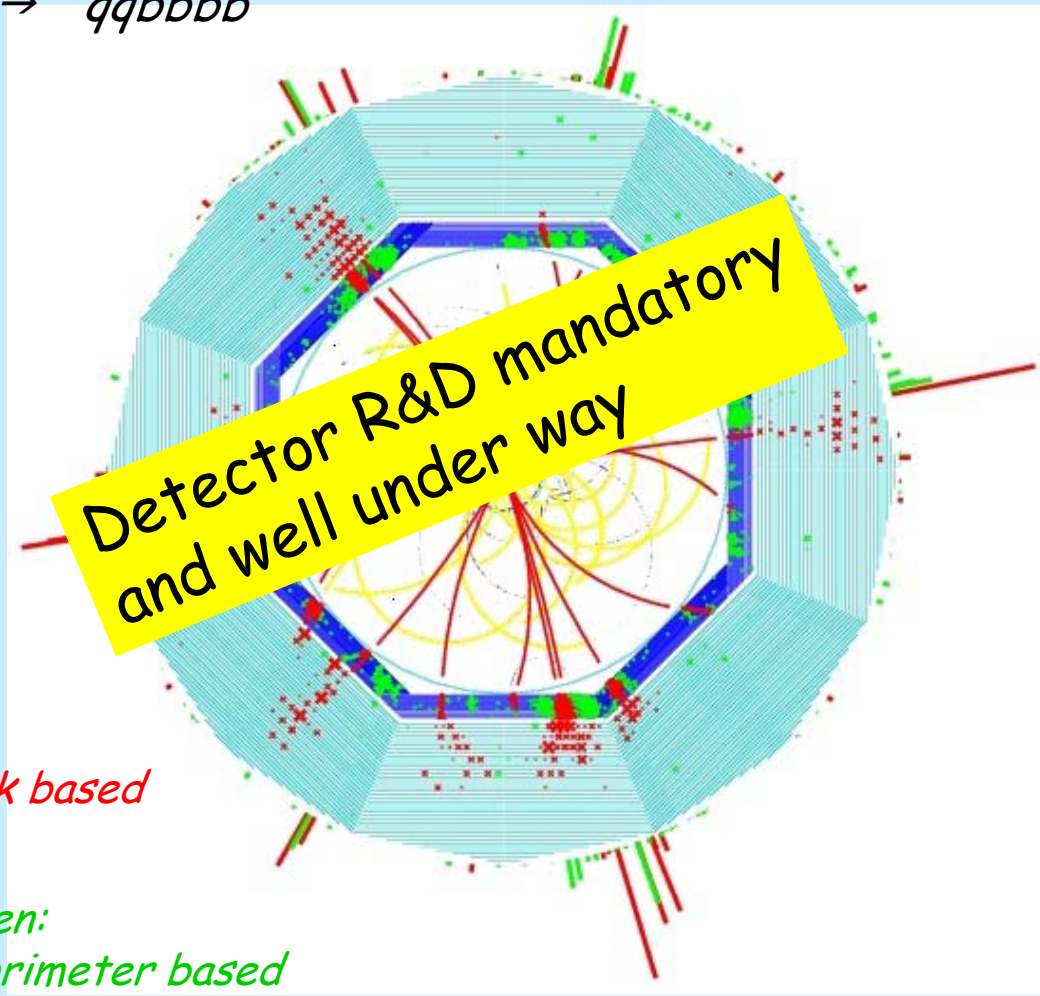
- **Ambitious but realistic and practical approach**
  - **starting on limited number of subjects**
  - **plan of actions defined by conveners**
  - **common work already started**
- **Most efficient use of limited resources**
- **Provide credibility to the whole Community by:**
  - **mutual unde** after all its physics which counts **f both tech.**
  - **responsible preparation of the future comparison of the possible options for HEP with agreed pro&cons and well defined criteria**

Collaborative Competition and / or Competitive Collaboration



ILC Detector challenges: calorimeter

ZHH → qqbbbb



red:
track based

green:
calorimeter based

High precision measurements demand new approach to the reconstruction:

- particle flow (i.e. reconstruction of ALL individual particles)

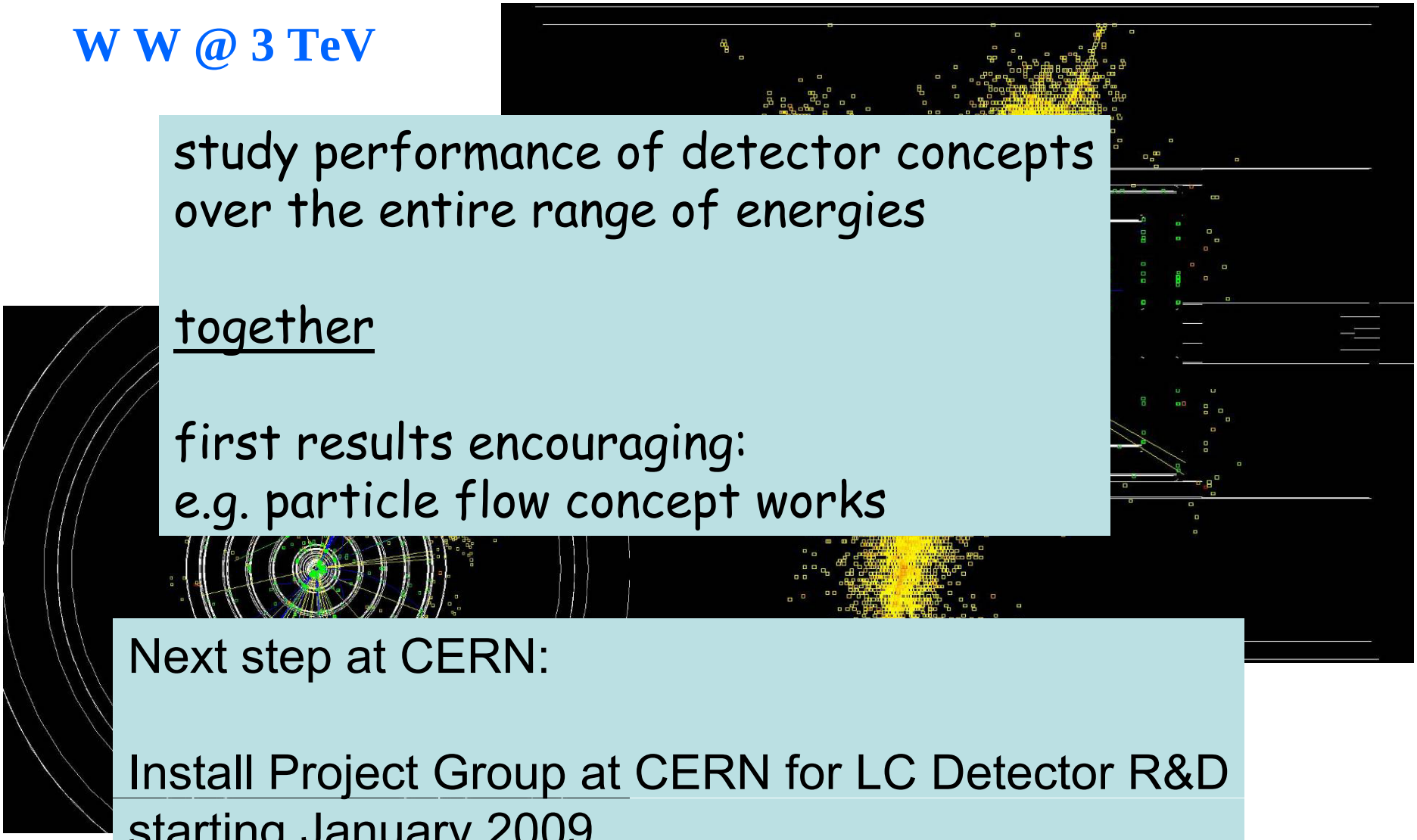
this requires

- unprecedented granularity

in three dimensions

R&D needed now for key components

W W @ 3 TeV



study performance of detector concepts over the entire range of energies

<u>together</u>

first results encouraging:
e.g. particle flow concept works

Next step at CERN:

<u>Install Project Group at CERN</u> for LC Detector R&D starting January 2009

There was a proposal at this workshop about an

ECFA LC Workshop in April 2010 at CERN

Please approach us……

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We are NOW entering a new exciting era of particle physics

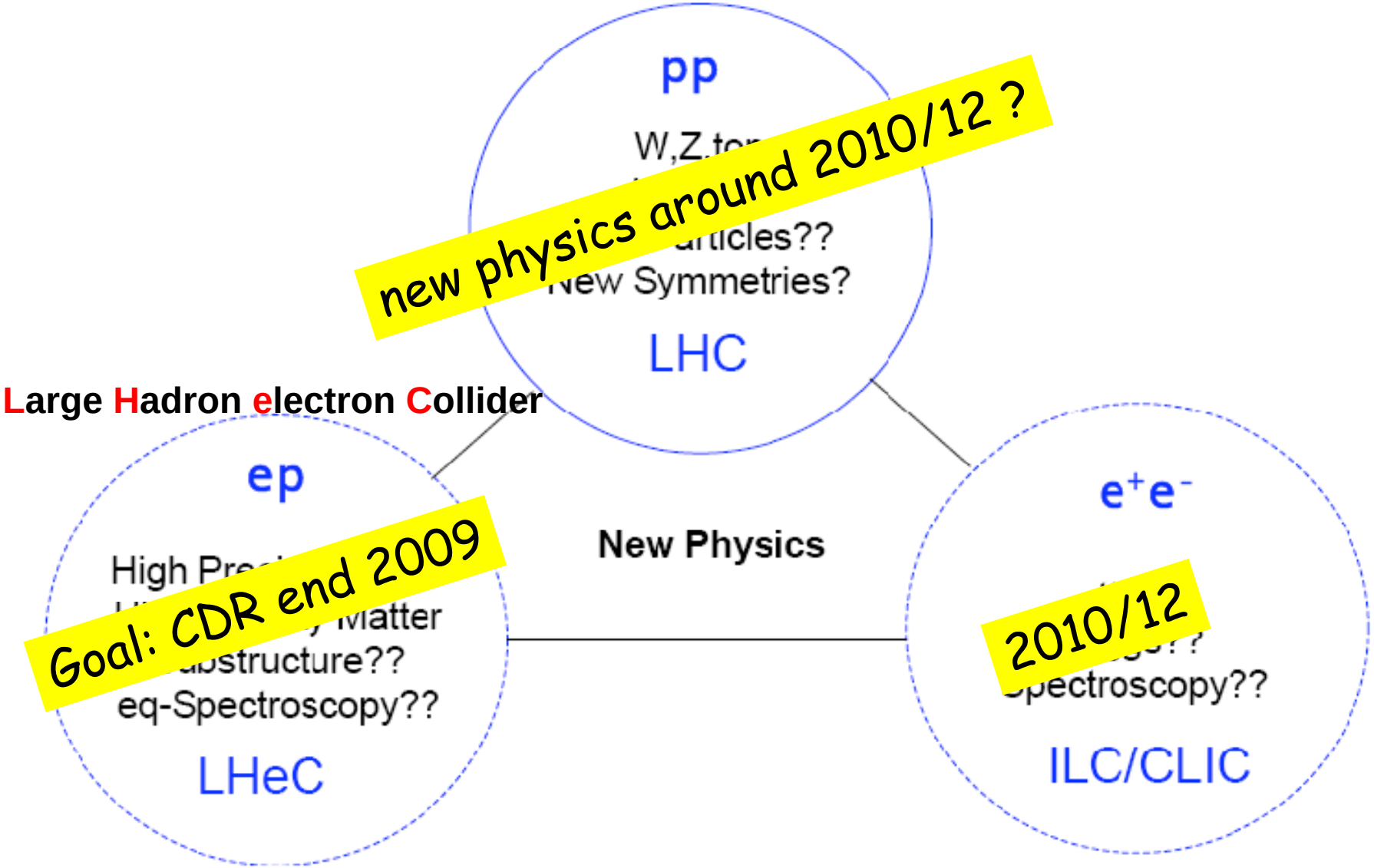
Turn on of LHC
allows particle physics experiments
at the highest collision energies ever

Expect
- revolutionary advances in understanding the microcosm
- changes to our view of the early Universe

Results from LHC will guide the way

Expect
- period for decision taking on next steps in 2010 to 2012
  (at least) concerning energy frontier
-(similar situation concerning neutrino sector Θ_{13})

The TeV Scale [2008-2033..]



We are NOW in a new exciting era of accelerator planning-design-construction-running
and need
- intensified efforts on R&D and technical design work to enable these decisions
- global collaboration and stability on long time scales (reminder: first workshop on LHC was 1984. . .)

First steps concerning CERN in 2009:

Meeting of CERN-DG
ILC GDE Executive Committee
CLIC Steering Committe

Meeting of directorates of FNAL-KEK-CERN

We need to define the most appropriate organisational form
NOW and need to be open and inventive
(scientists, funding agencies, politicians. . .)

Mandatory to have accelerator laboratories in all regions
as partners in accelerator development / construction /
commissiong / exploitation

Planning and execution of HEP projects today need
global partnership for *global, regional and national* projects
in other words: for the whole program

Use the exciting times ahead to establish such a partnership