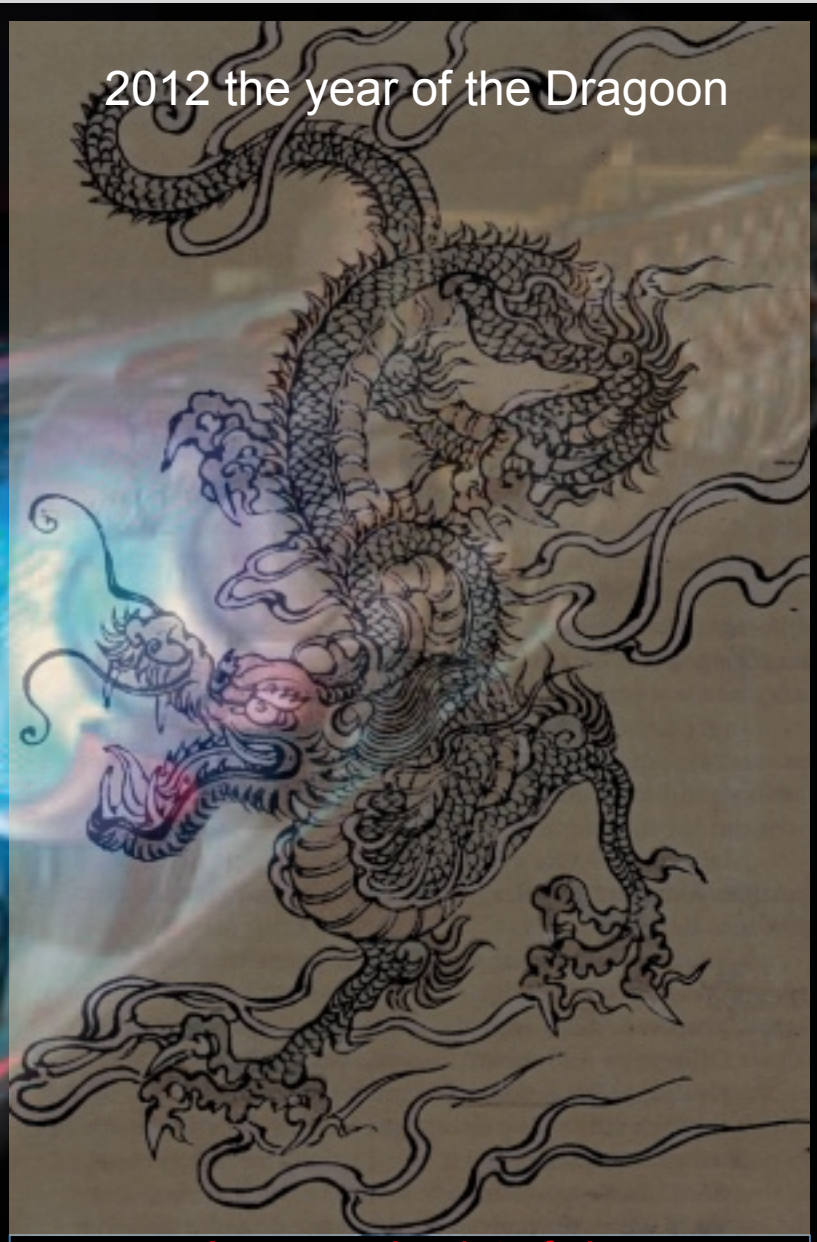
Francois Le Diberder

Quy Nhon, December 2012

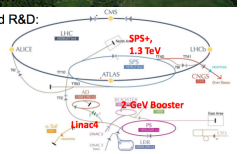


A personal point of view

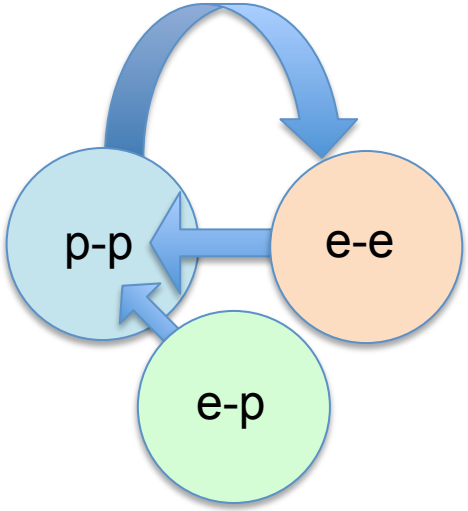
Lepton Collider next to LHC (?)

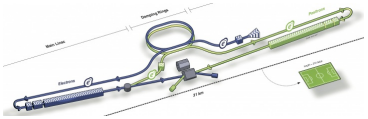
The future must be prepared well in advance

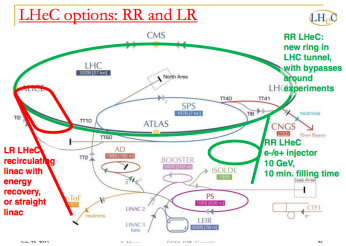
HE-LHC – main Issues and R&D:



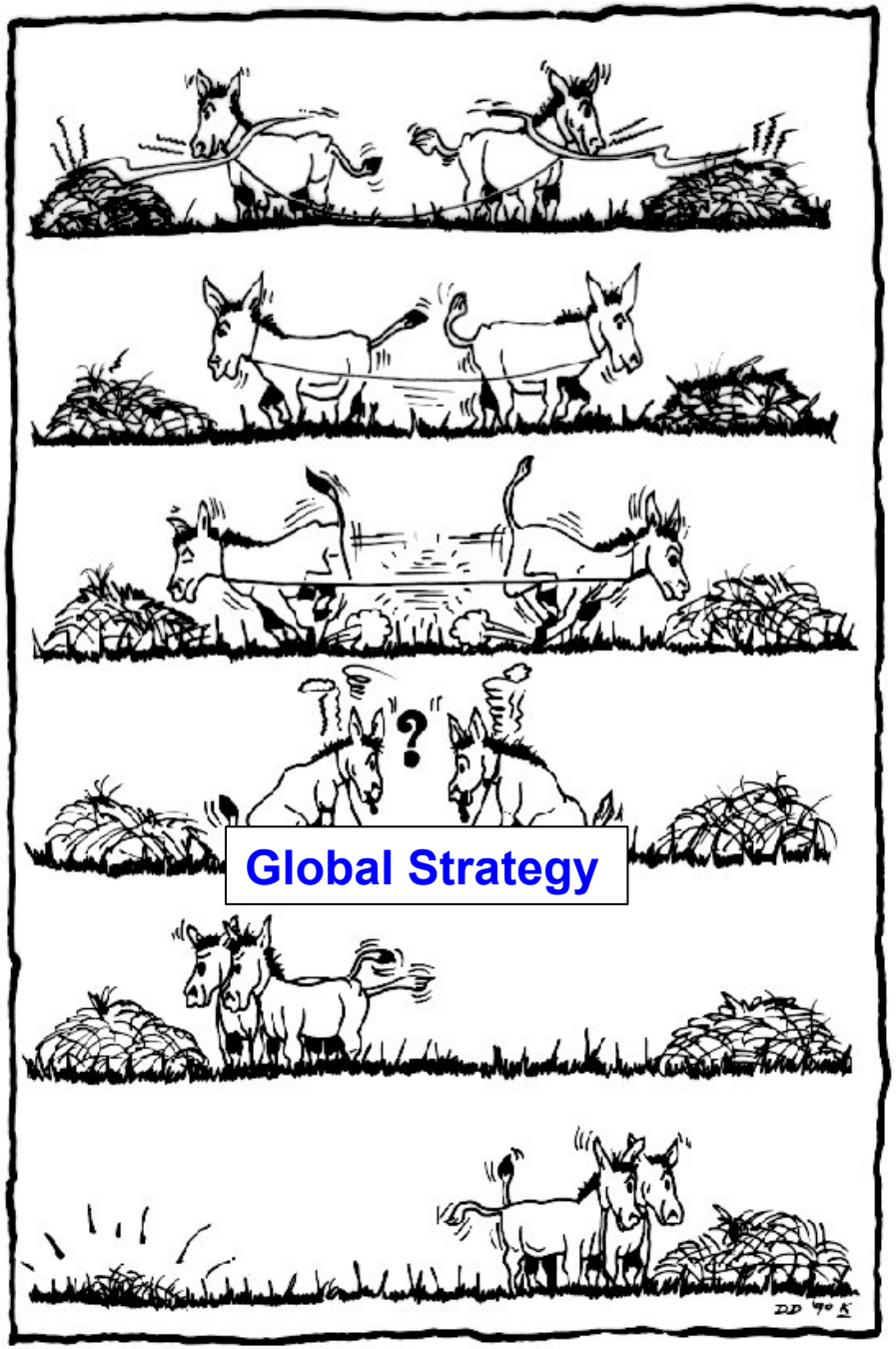
- High-field 20T dipole magnets based on Nb_3Sn, Nb_3Al, and HTS
- High-gradient quadrupole magnets for arc and IR
- Fast cycling SC magnets for ~1.3 TeV injector
- Emittance control in regime of strong SR damping and IBS
- Cryogenic handling of SR heat load (first analysis; looks manageable)
- Dynamic vacuum







History tought us that the interplay between
p-p & e-e & e-p colliders is intrumental
in allowing progresses
in our understanding of Physics

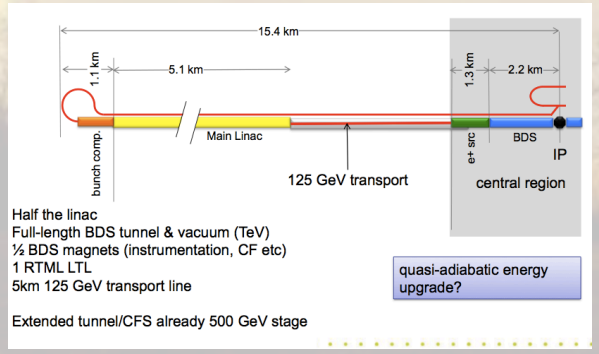

?
Global Strategy

The BIG question for High Energy Frontier

Remember:
DESY !
SLAC !
FNAL ?

European Strategy is likely to state that:
beyond HL-LHC next CERN based collider to be pondered in 2018.

Then came the long awaited miracle



Timeline for HEP Global roadmap: 24 busy months

Community Planning Meeting
Oct. 11-13 (FNAL)

ILC TDR and
DBD Reviews
start Dec. 15

eLCWS 2013
May 27-31 DESY

LP2013
June 24-29 (S.F.)

LCB takes charge
Feb. 21 (Vancouver)

Open Symposium
Sept. 10-12 (Krakow)

Community Summer Study
Early August "Snowmass"

HF 2012
Nov. 14-16 (FNAL)

Strategy Group drafting session
January 21-26 (Erice)

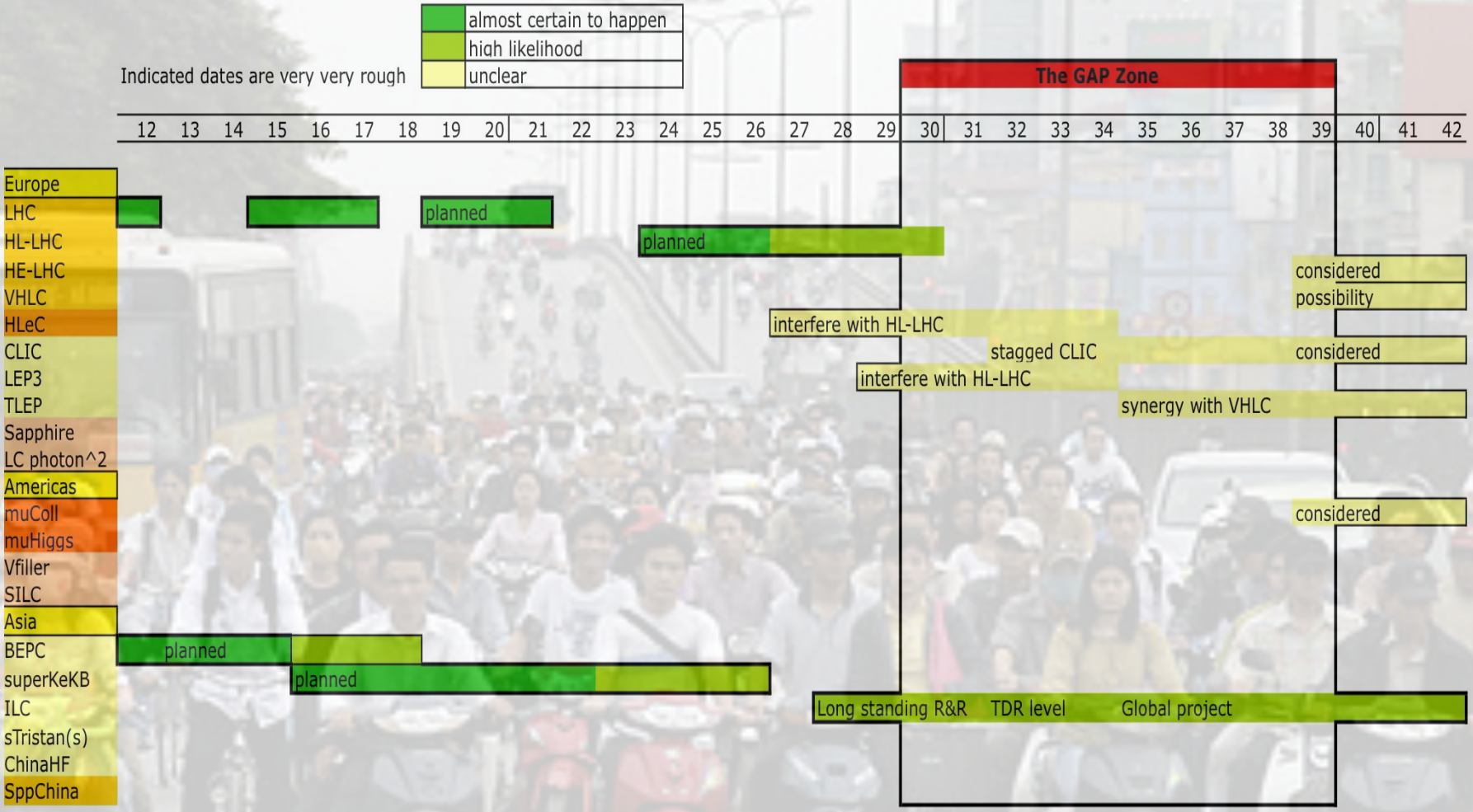
LCWS 2012
Oct. 22-26 (Arlington)

LCWS 2013
fall (Japan)

1 2 3 4 5 6 7 8 9 10 11 12 1 2 7 8 9 10 11 12
2012 2013

European Strategy
Jan. 21-26 (Erice)

and then comes LHC: Large-Higgs-Chaos



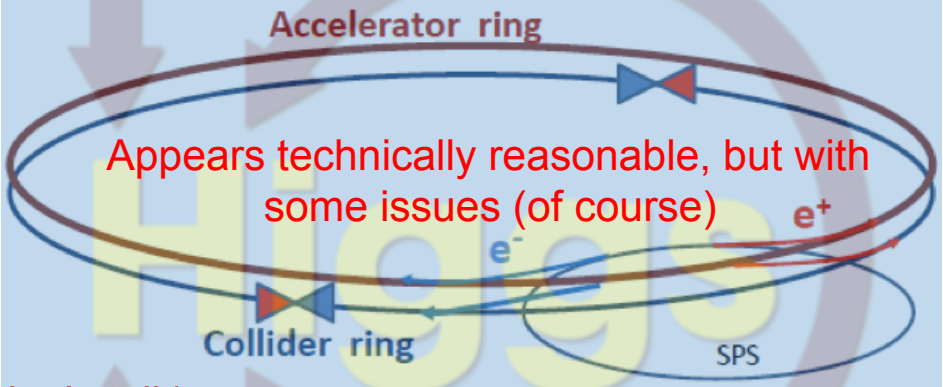
this is for High Energy Frontier only (and more are coming on the horizon)

- Linear e+e- collider:
  - ILC (discussed after)
  - CLIC
  - X-band klystron based
- Circular e+e- collider:
  - LEP3
  - TLEP
  - SuperTRISTAN
  - Fermilab site-filler
  - China Higgs Factory (CHF)
  - SLAC/LBNL big ring
- Muon collider (See Daniel Kaplan's talk)
  - Low luminosity
  - High luminosity
- γγ collider:
  - ILC-based
  - CLIC-based
  - Recirculating linac-based (SAPPHiRE)
  - SLC-type

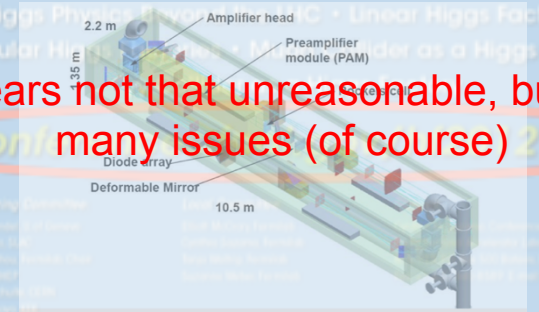
ICFA Beam Dynamics Workshop

Accelerators for a Higgs Factory: Linear vs. Circular

Facts Finding Workshop



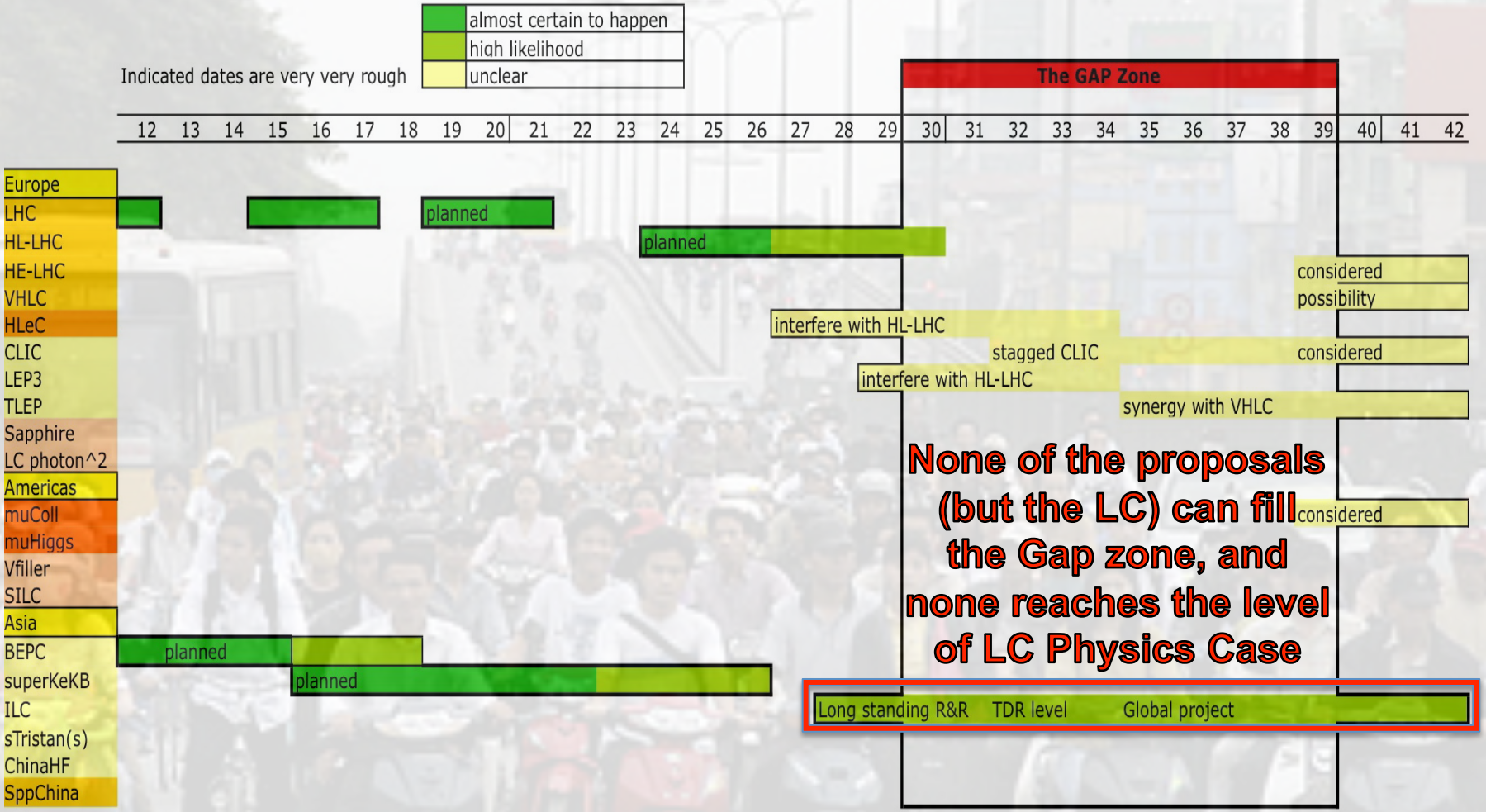
Appears technically reasonable, but with some issues (of course)



Appears not that unreasonable, but with many issues (of course)

Livermore fusion project LIFE will have 384 laser boxes
One would be enough for γγ collider

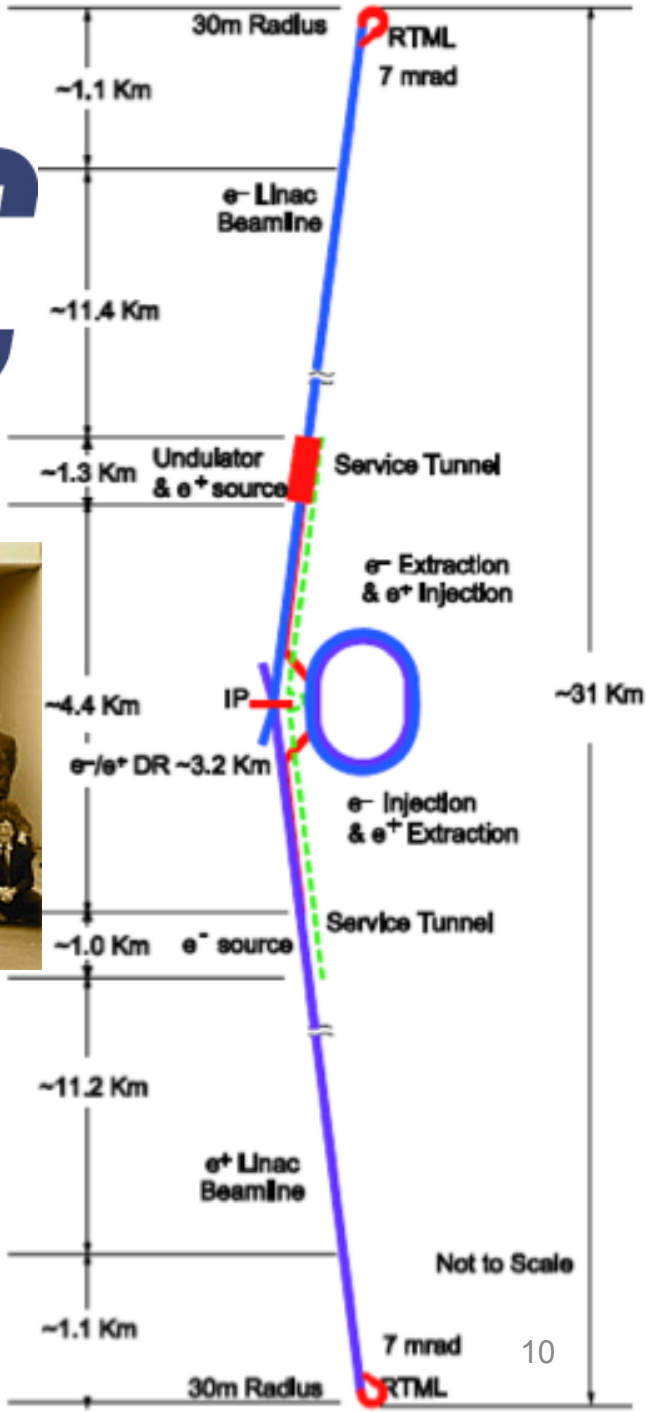
(Happy-Higgs) Chaos



To make a long history short: August 2004

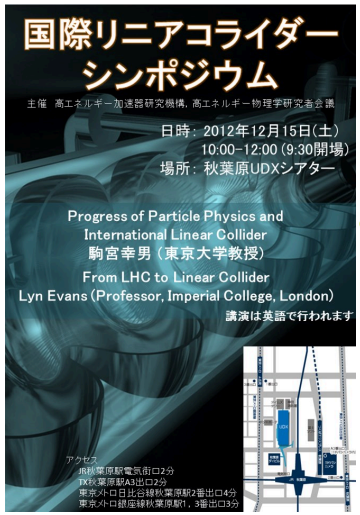
November 2004

March 2005



LC organisation

started in 2011

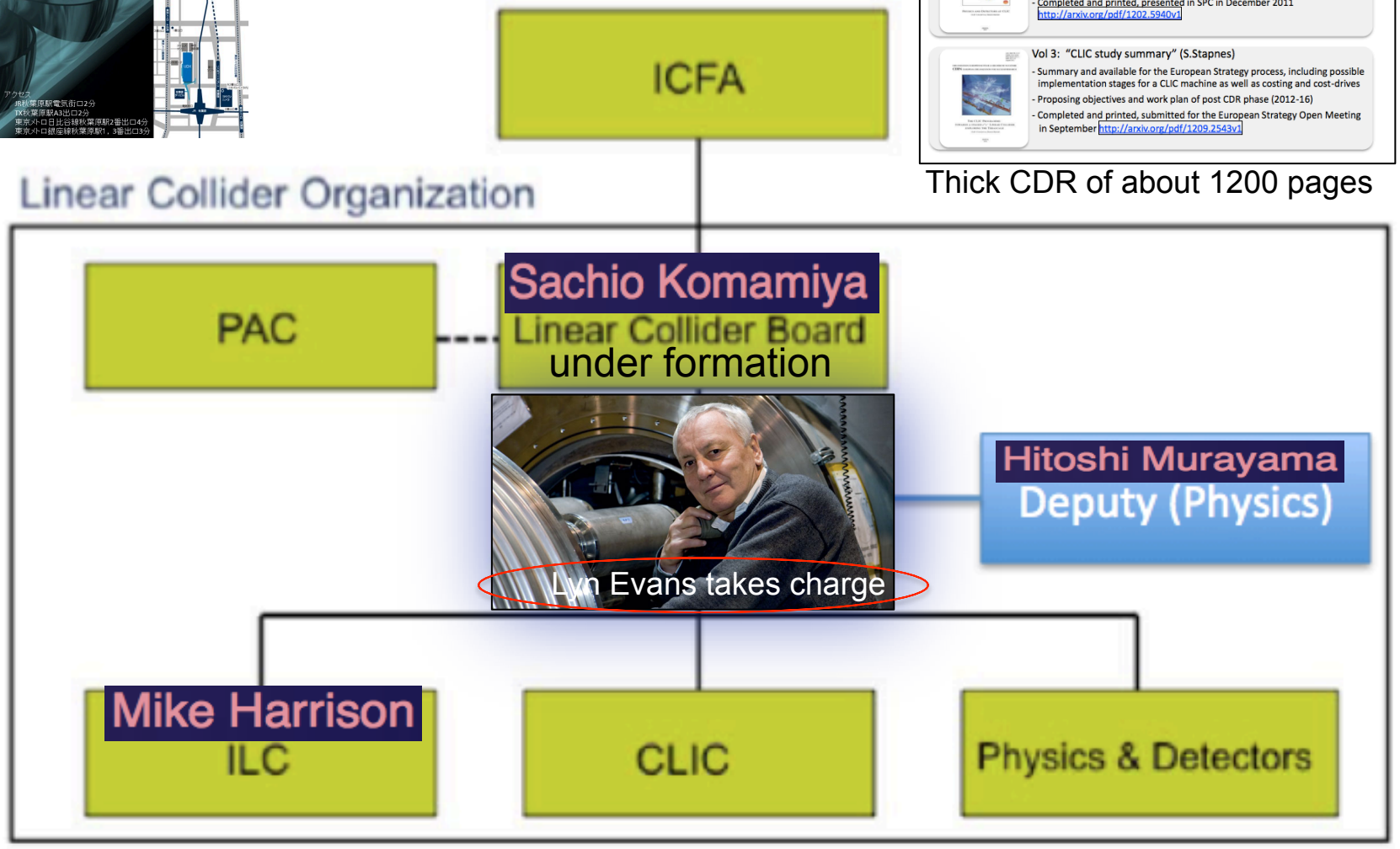


Vol 1: The CLIC accelerator and site facilities (H…
- CLIC concept with exploration over multi-TeV energy range
- Feasibility study of CLIC parameters optimized at 3 TeV (most demanding)
- Consider also 500 GeV, and intermediate energy range
- Complete, presented in SPC in March 2011, in print: https://edms.cern.ch/document/1234244/

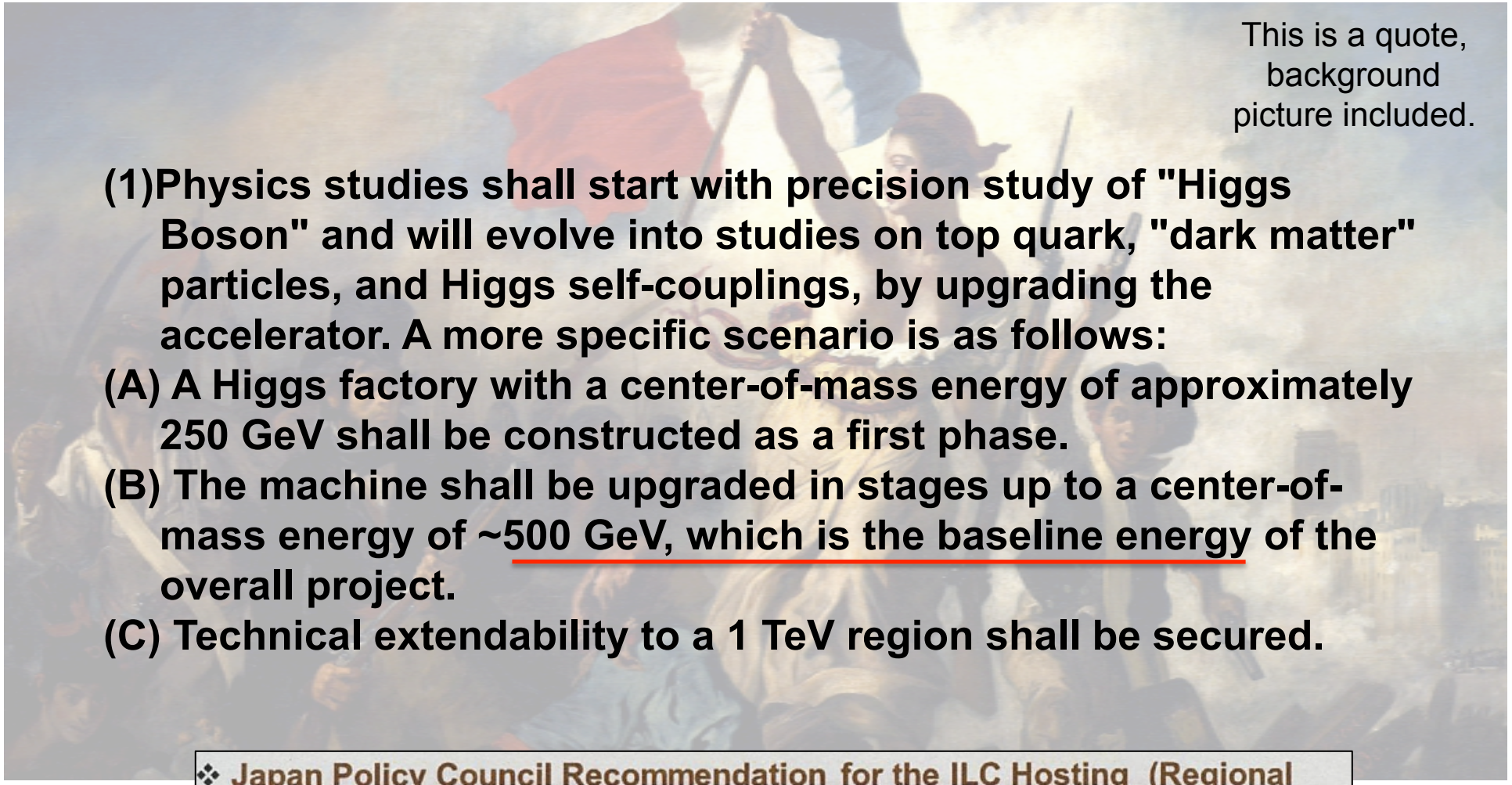
Vol 2: Physics and detectors at CLIC (L.Linssen)
- Physics at a multi-TeV CLIC machine can be measured with high precision, despite challenging background conditions
- External review procedure in October 2011
- Completed and printed, presented in SPC in December 2011 http://arxiv.org/pdf/1202.5940v1

Vol 3: "CLIC study summary" (S.Stapnes)
- Summary and available for the European Strategy process, including possible implementation stages for a CLIC machine as well as costing and cost-drives
- Proposing objectives and work plan of post CDR phase (2012-16)
- Completed and printed, submitted for the European Strategy Open Meeting in September http://arxiv.org/pdf/1209.2543v1

Thick CDR of about 1200 pages



Japan HEP community statement



This is a quote, background picture included.

(1)Physics studies shall start with precision study of "Higgs Boson" and will evolve into studies on top quark, "dark matter" particles, and Higgs self-couplings, by upgrading the accelerator. A more specific scenario is as follows:

(A) A Higgs factory with a center-of-mass energy of approximately 250 GeV shall be constructed as a first phase.

(B) The machine shall be upgraded in stages up to a center-of-mass energy of ~500 GeV, which is the baseline energy of the overall project.

(C) Technical extendability to a 1 TeV region shall be secured.

❖ Japan Policy Council Recommendation for the ILC Hosting (Regional Development through Creation of Global Country inside Japan)

is supported by industry and politicians

Dear Dr. Brinkman,

As members of the Diet and also leading figures of the supporting group for hosting the International Linear Collider (ILC) in Japan, we are writing this letter to express our deep desire to
accelerator-driven basic science, espe
Projects between Japan and the US.

The ILC, whose construction is strongly
discovery at the LHC, represents the fu
fundamental goal of making the next
Universe. The most delicate undertaki
national conditions to build the ILC
internationally structured. We consi
international enterprise would repres
projects in all fields of science, technolog

Sincerely yours,

Kaoru Yosano
A member of the House of Representatives
Previous Ministers of Finance, Education, International Trade and Industry

Takeo Kawamura
A member of the House of Representatives
Previous Chief Cabinet Secretary and Minister of Education, Culture, Sports, Science and Technology

Ryu Shionoya
A member of the House of Representatives
Previous Minister of Education, Culture, Sports, Science and Technology

Hiroya Masuda
Professor of University of Tokyo
Previous Minister of International Affairs and Communications

Japan: observer state of CERN

CC: Dr. Jim Siegrist Director, Office of High Energy Physics U.S. Department of Energy
Dr. Philip Rubin Principle Assistant Director for Science Office of Science and Technology Planning
Dr. Jerry Blazey Assistant Director for Physical Science Office of Science and Technology Planning

A bid-to host activity in Japan

Promoter's Meeting on Industry – KEK Collaboration Council

2008. 02.21

Industry – KEK Collaboration Council

(June 11, 2008)

Advanced Accelerator Association Promoting Science & Technology

Honorary Chairman :
Masatoshi Koshiba
Director General at Heisei Foundation for Basic Science

Advisory Meeting

Chairman:
Takashi Nishioka

Supreme Advisor :
Kaoru Yosano

General Meeting

Board of Directors

Secretariat

Technology Study Group

Outreach Group

Intellectual Property Study Group

Large Project Study Group

Rolf Heuer, global ILC cities and the role of Japan

Share |

Rika Takahashi | 1 November 2012

Rolf Heuer giving a talk at the ILC symposium held at University of Tokyo

On 24 October, a symposium to boost activities to invite the ILC to Japan was held at the University of Tokyo, Tokyo, Japan. This event was entitled "Forum on Advanced Accelerator Science & Industry – Creation of Global Project Cities." Because this event's date coincided with the height of the big ILC conference, LCWS12, held at University of Texas, Arlington, US, many Japanese scientists were unable to attend. Nonetheless, it attracted an audience of about 300 people – clearly not too many experts in th as they were all in Arlington. The talk that received greatest attention the one delivered by Rolf Heuer, Director-General of CERN.

The forum was jointly hosted by the Japan Policy Council (JPC) and Advanced Accelerator Association promoting science and Technolog (AAA). JPC was founded by business and labour leaders and scholar aims to create a grand design for Japan and to develop a strategy tov its realisation.

Statement on a Linear Collider Project in Japan as input to the European Strategy Process

The German Committee for Particle Physics (KET)

25.11.2012

The proposal of the Japanese community to host the ILC as an international project finds enthusiastic support in the German community. In view of the unique capabilities of such a facility for precision measurements of the newly discovered particle, the foreseen expandability to higher energies and the technical readiness of the project as documented in the Global Design Effort [4]) we strongly recommend to contribute actively to the realisation of this project.

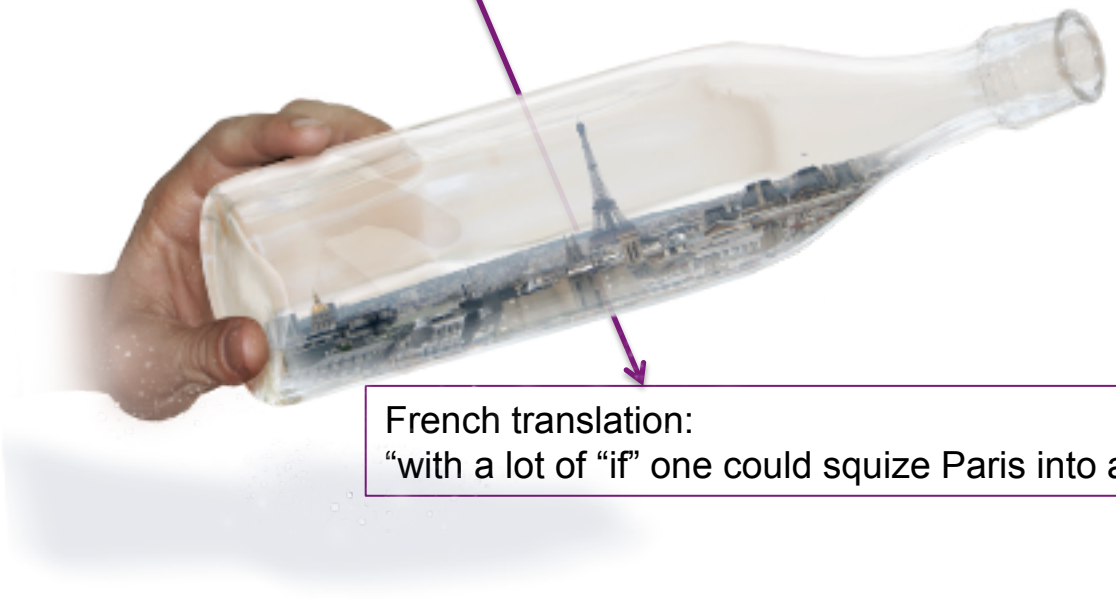
And a similar statement was provided by Spain

DOE wisdom

1) **Complete SM study to crack it down (Higgs, top, VV)**
2) Potential for New Physics Discoveries
   Both aiming for BSM

- **SCIENCE CASE FIRST!**
  - Then worry about experiments. Remember we need continuous science output
  - Snowmass is NOT a shootout. It is not a love fest either. We must be critical about science goals & think out of the box
  - Worthy science goals married to implausible assumptions do not advance the discussion

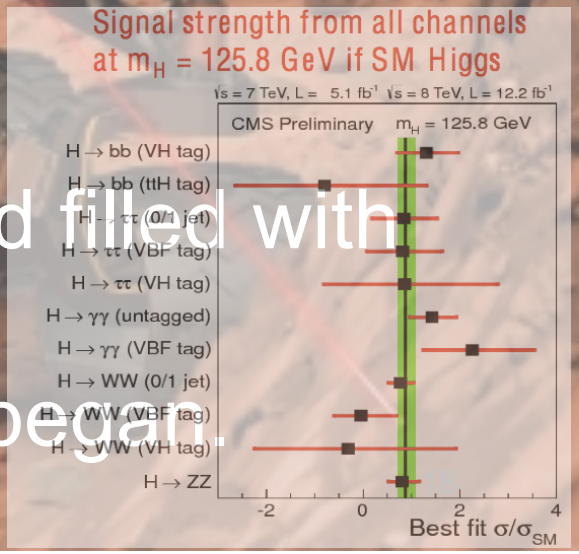
It is time for action



French translation:
“with a lot of “if” one could squize Paris into a bottle”

Just entering a new world with a potential for many big surprises

We need the right tool



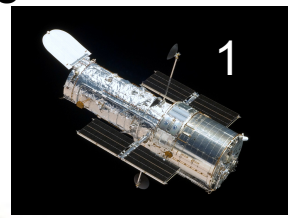
We should stay open-minded and filled with **intense** curiosity:

Exploration of Planet Higgs just began

Quy Nhon, December 2012

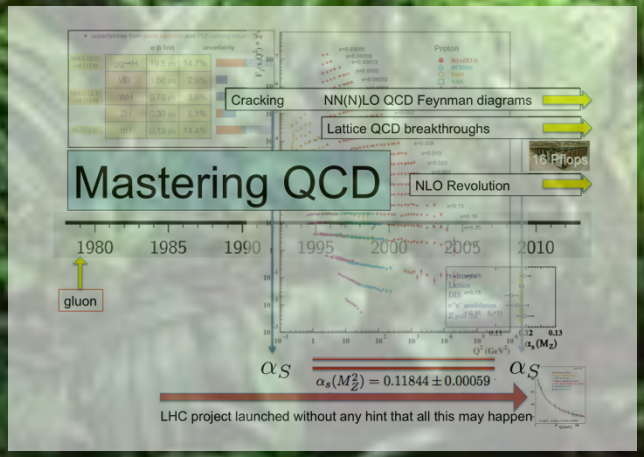
The 80 Million  question: **can't HL-LHC do the job?**

These are misleading units



(one billion)

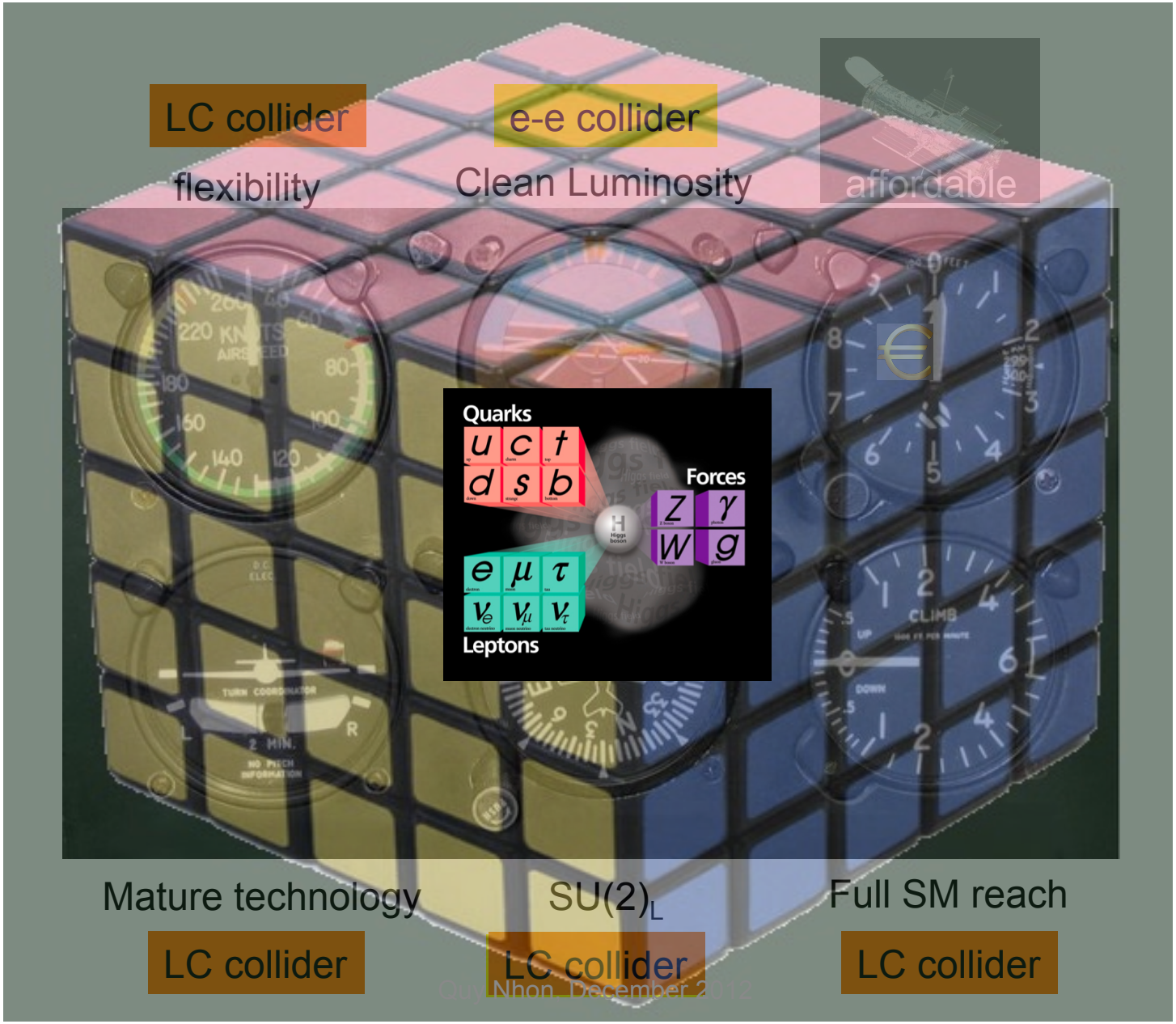
Physics at actual Collider



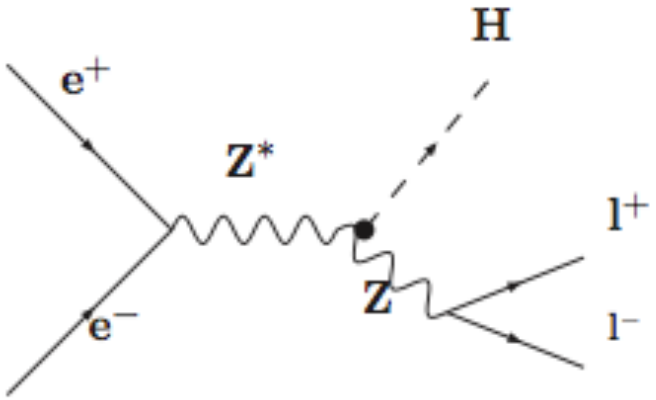
- Now 8 but 13 TeV soon
- Higher Luminosity
- Detectors upgrades
- Know-how improving

The dream-machine

http://ific.uv.es/~fuster/DBD-Chapters



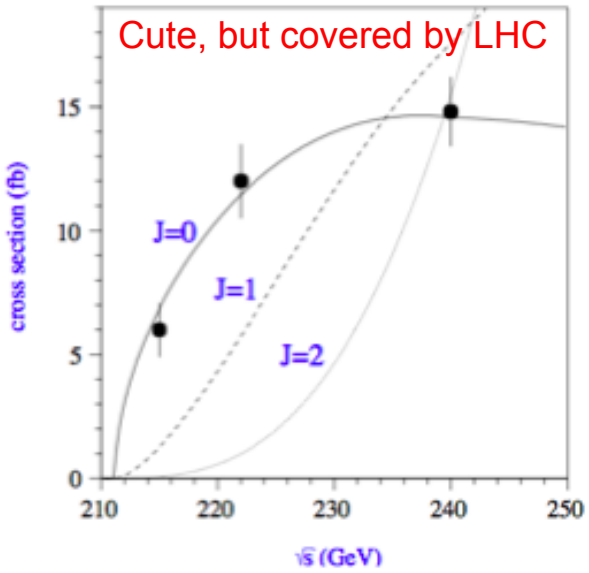
Higgs-strahlung Process:

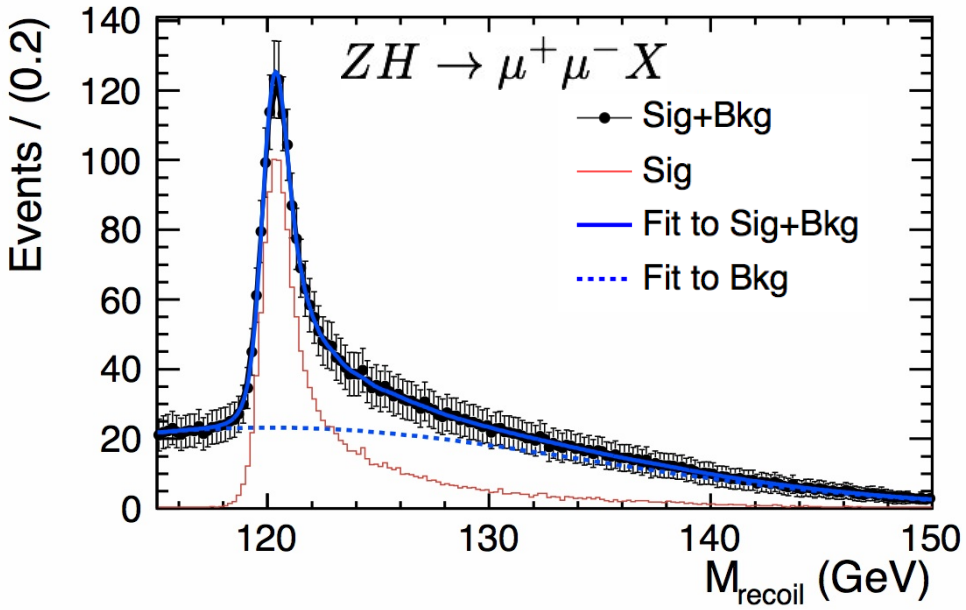


$$M_H^2 = (\sqrt{s} - E_Z)^2 - P_Z^2$$

$$g_{ZZH}^2 \propto \sigma = N/L\epsilon$$

Allows absolute measurements

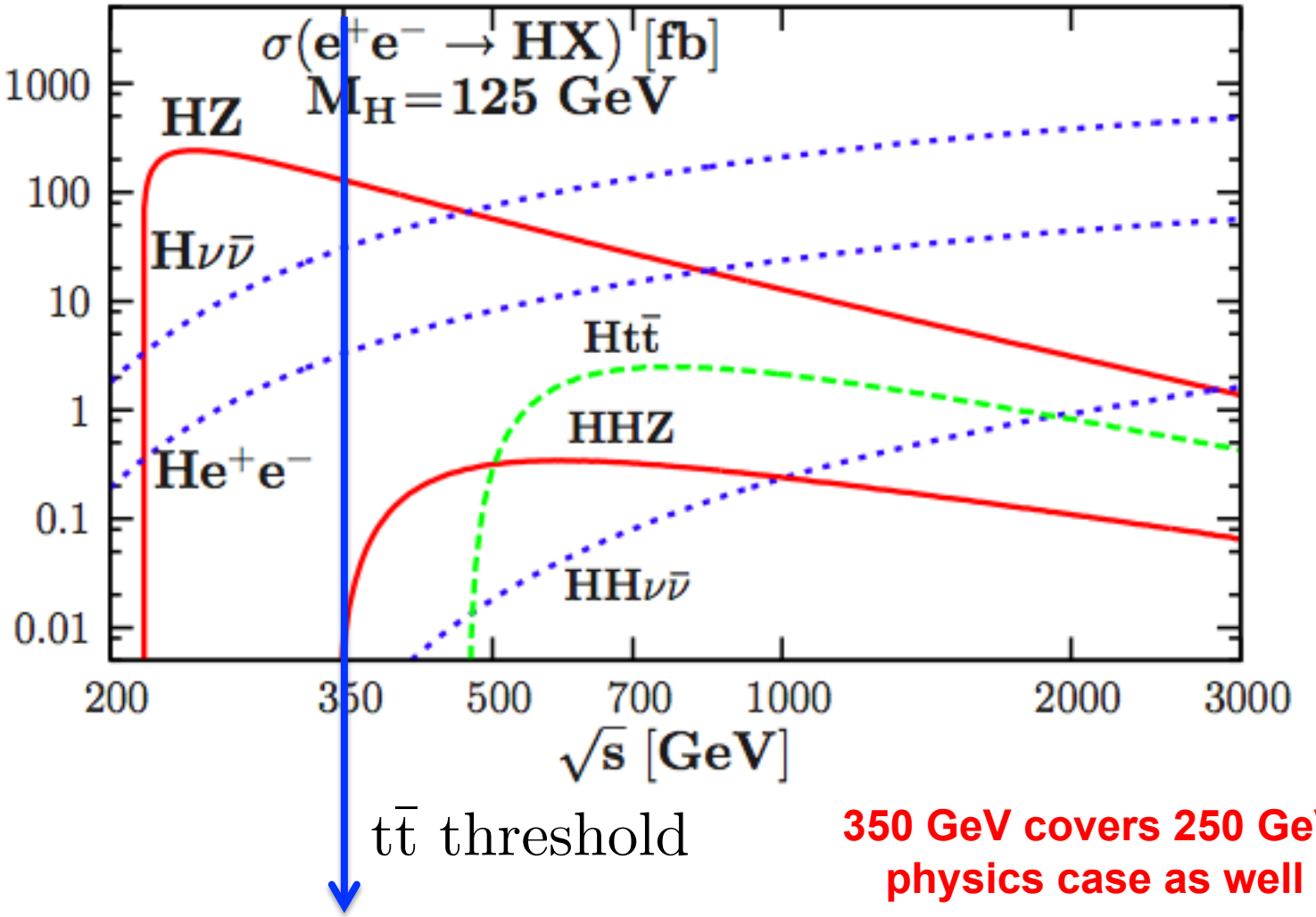




Invisible Higgs decays are made visible!

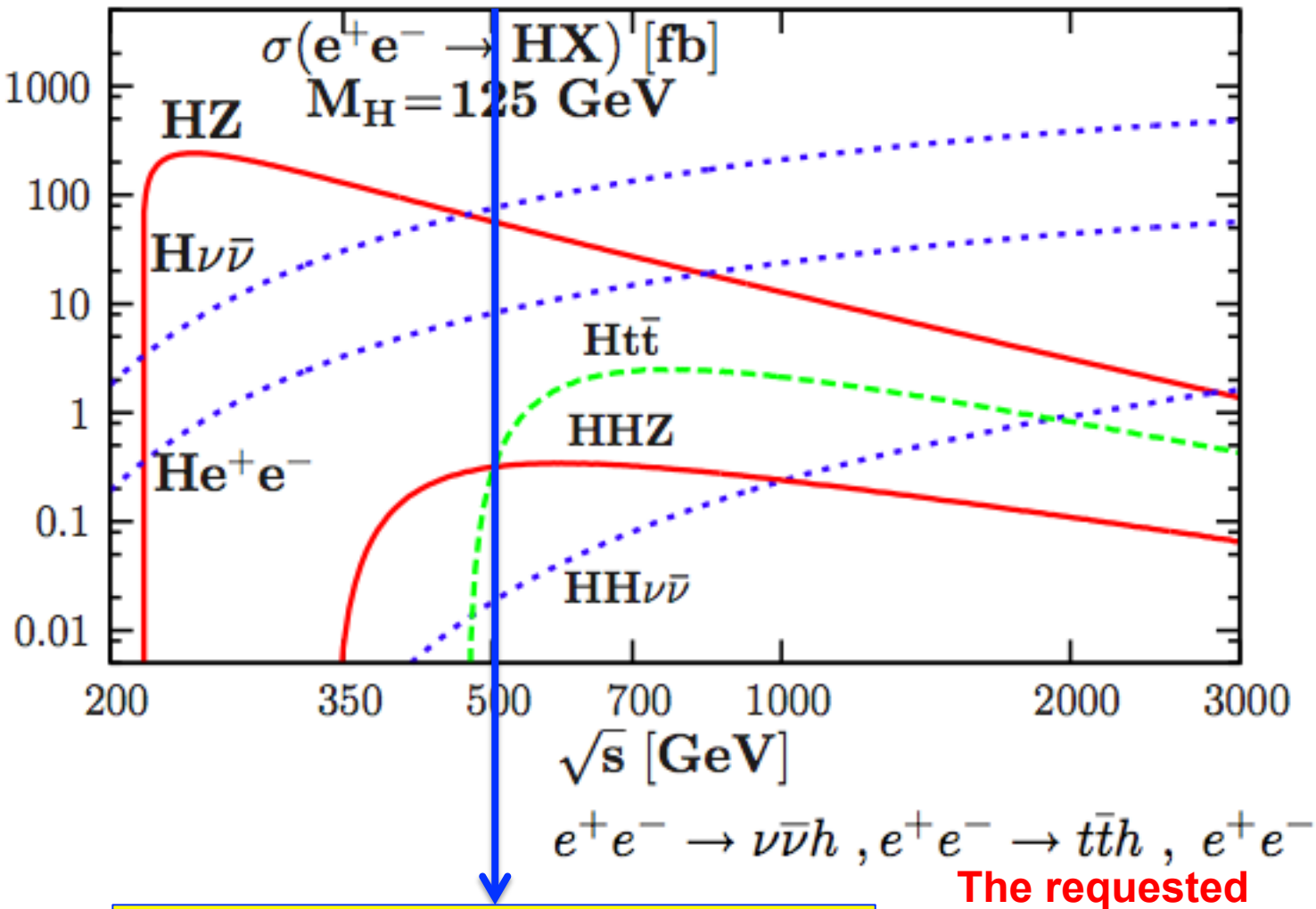
At 250 GeV, sensitivity to invisible and all unexpected decay modes of the Higgs to the 1% level.

Two simultaneous thresholds : $t\bar{t}$ and HHZ



350 GeV covers 250 GeV physics case as well

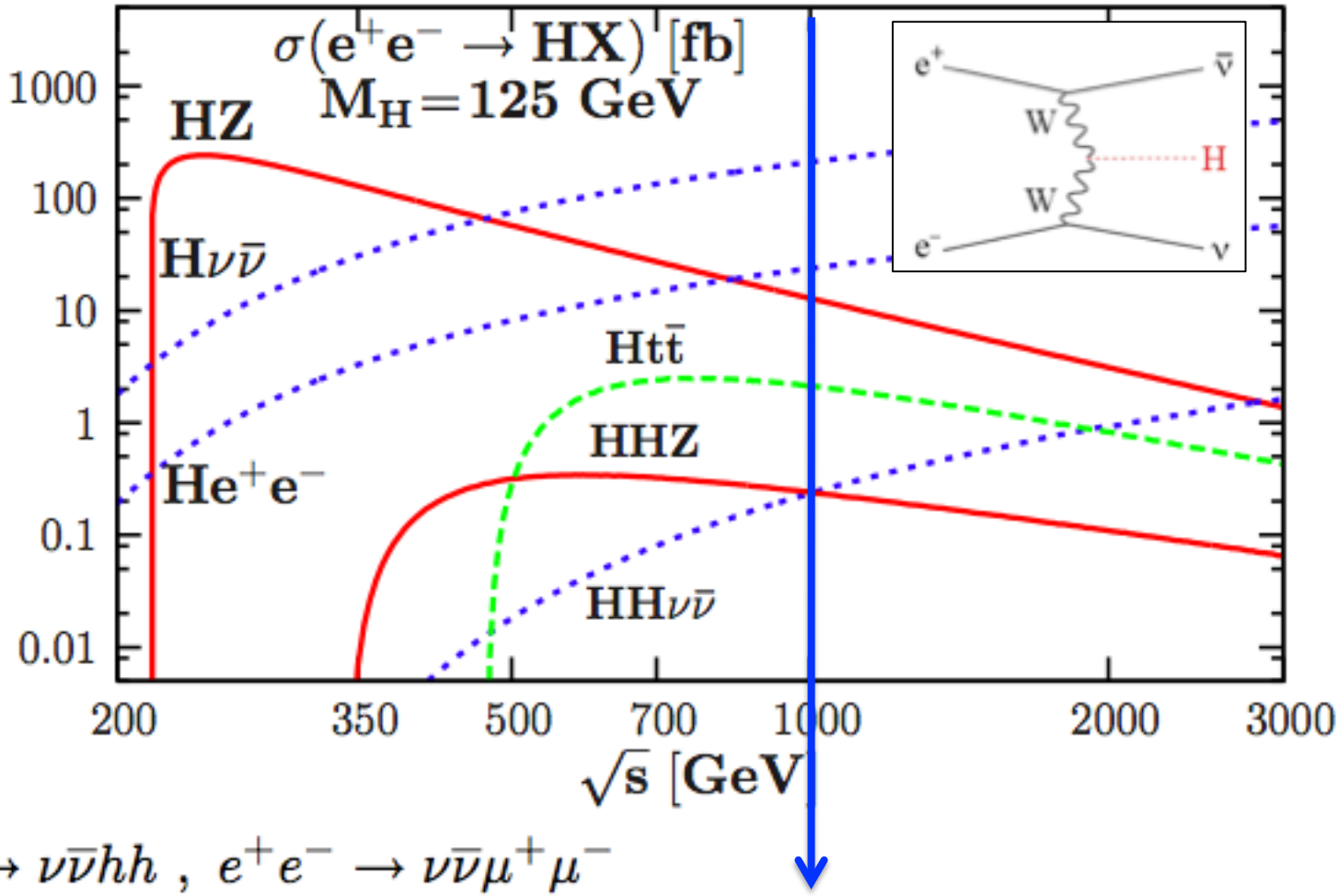
350 GeV is the entrance to top world



$e^+e^- \to \nu\bar{\nu}h\,, e^+e^- \to t\bar{t}h\,,\ e^+e^- \to Zhh$

The requested base line energy

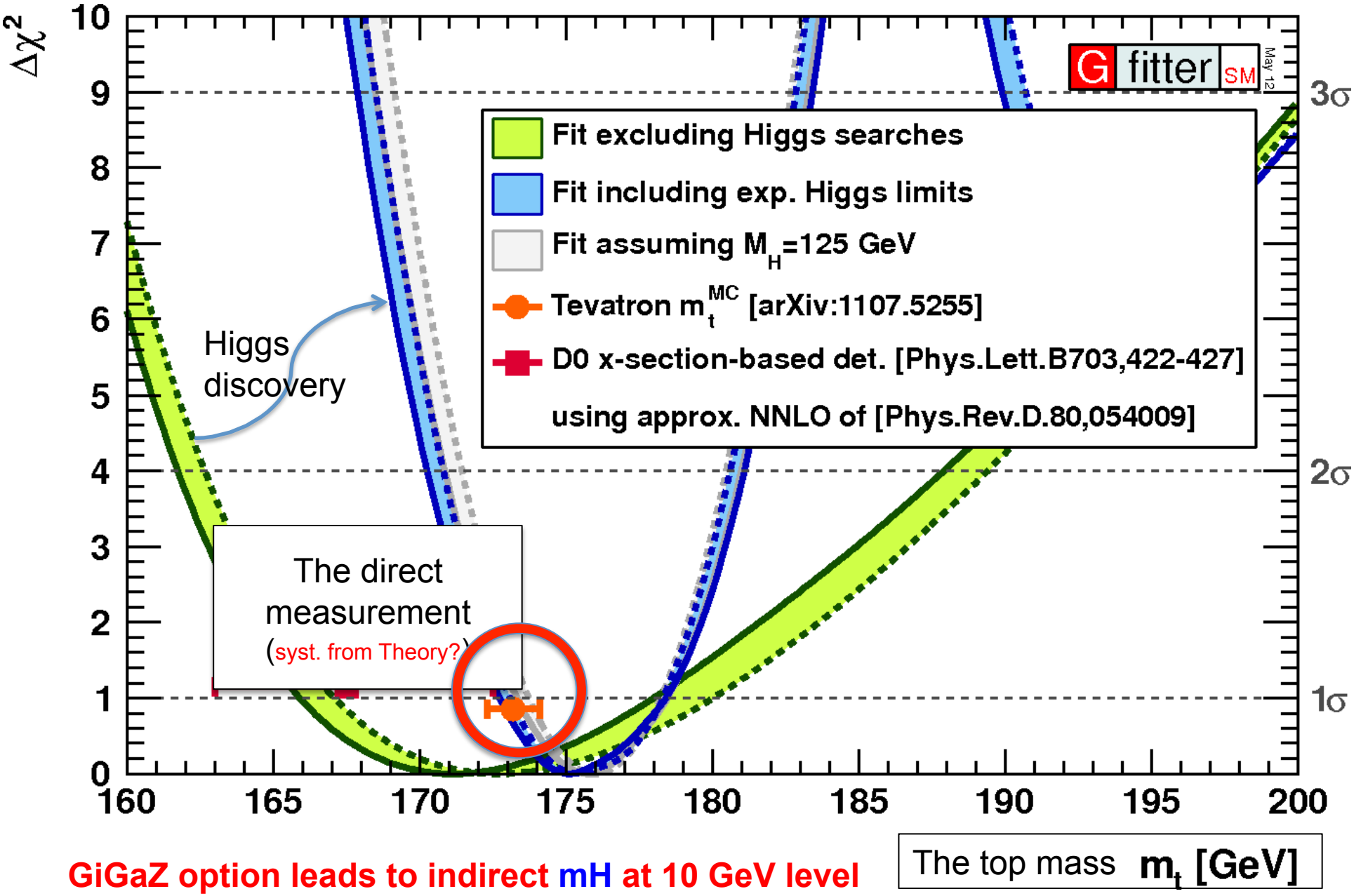
500 GeV is the portal to the whole SM



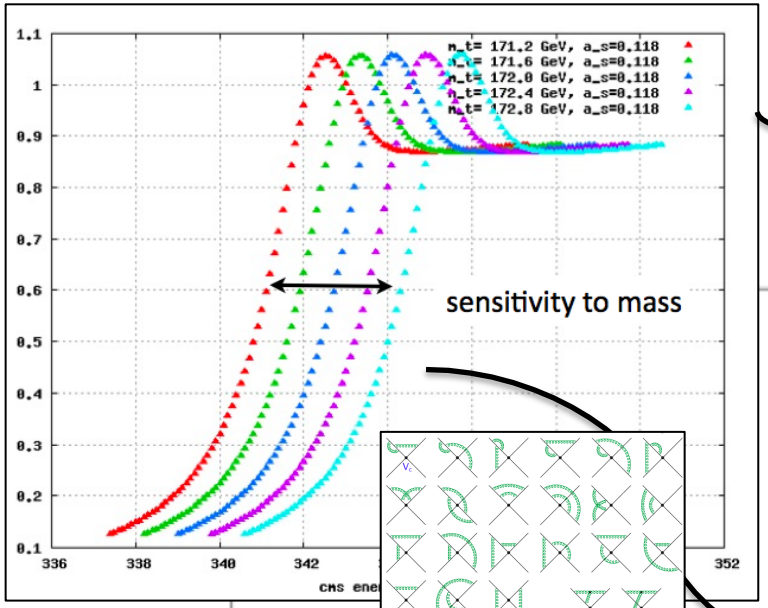
$e^+e^- \to \nu\bar{\nu}hh$, $e^+e^- \to \nu\bar{\nu}\mu^+\mu^-$

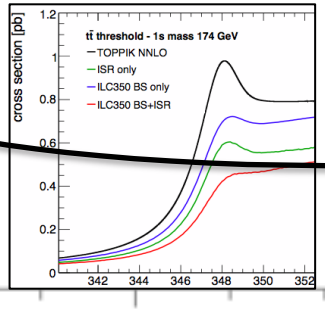
A new regime for Higgs studies

1000 GeV is the Vector-Vector world

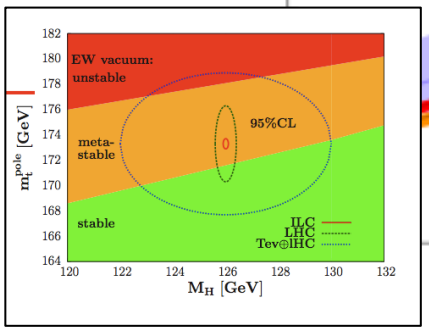


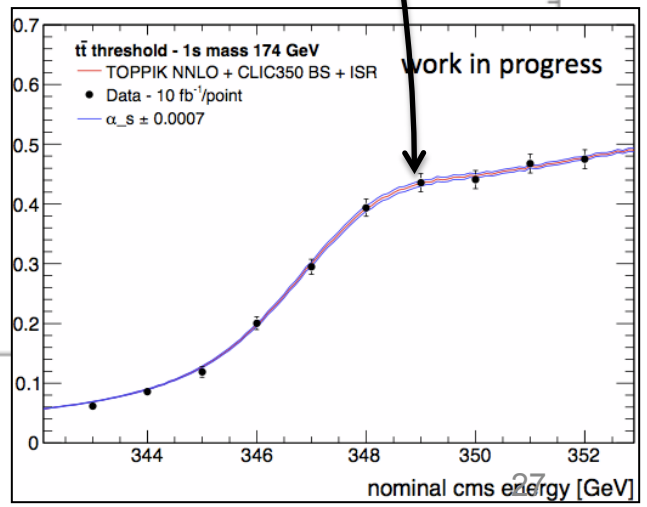
GiGaZ option leads to indirect mH at 10 GeV level





Tour de force



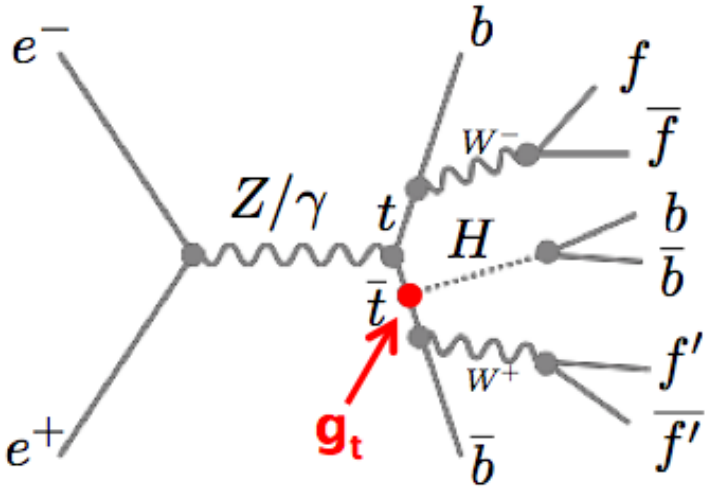


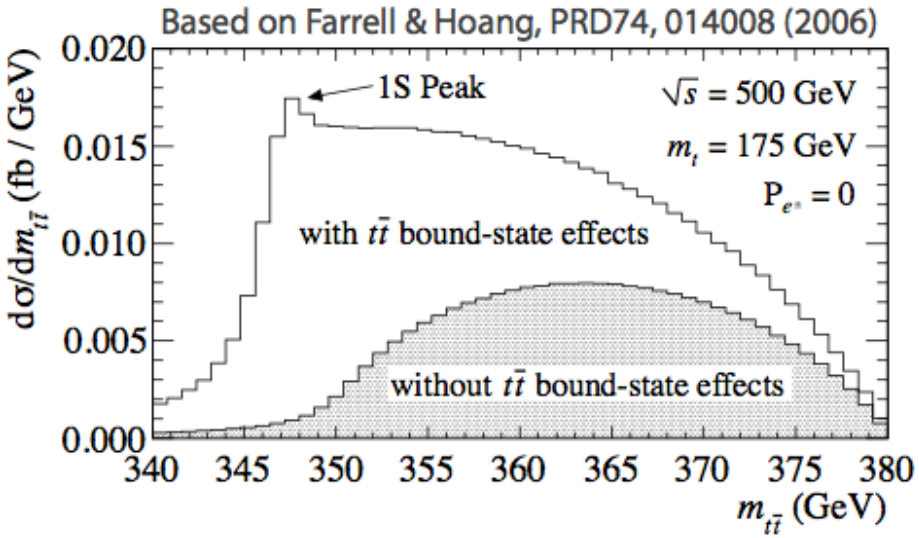
$\sigma[m_{\rm top}] \sim 50$ MeV

$\sigma[\Gamma_{\rm top}] \sim 25$ MeV

$\sqrt{S} = 500$ GeV & $L = 500$ fb^{-1}

Much cleaner relation to $m_t^{\overline{\rm MS}}(m_t)$

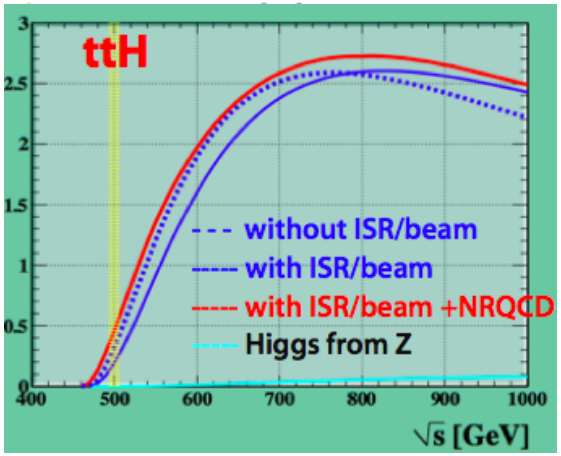




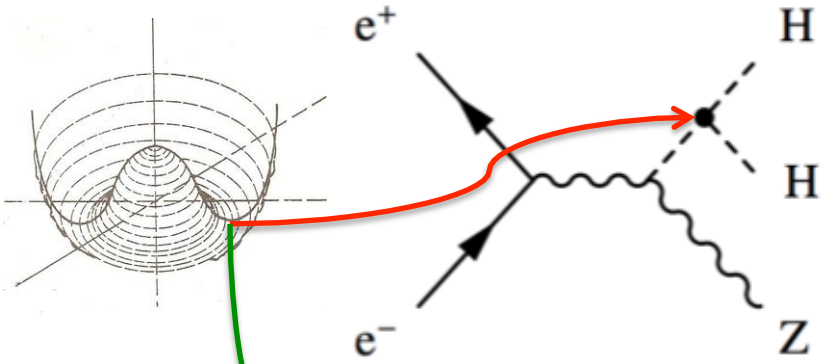
6-jet + lepton cut flow

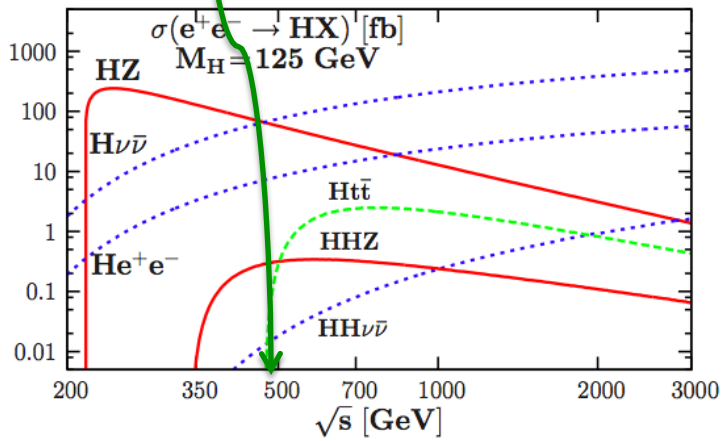
L = 1 ab^{-1}, polarized beams

cut \ sample	ttH (6J)	ttH (8J/4J)	tt	ttZ	ttg*-> ttbb	significance
no cuts	282.	358.	980739.	2407.	1160.	0.3
# isolated lepton = 1	180.	49.0	340069.	791.	398	0.3
thrust < 0.77	146.	37.7	144999.	617.	266.	0.4
$Y_{5->4}$ > 0.005	126.	25.8	12298.	416.	114.	1.1
4x btag	49.0	4.2	173.	53.3	37.8	2.8
mass cuts	39.5	1.6	23.0	33.9	13.2	3.7

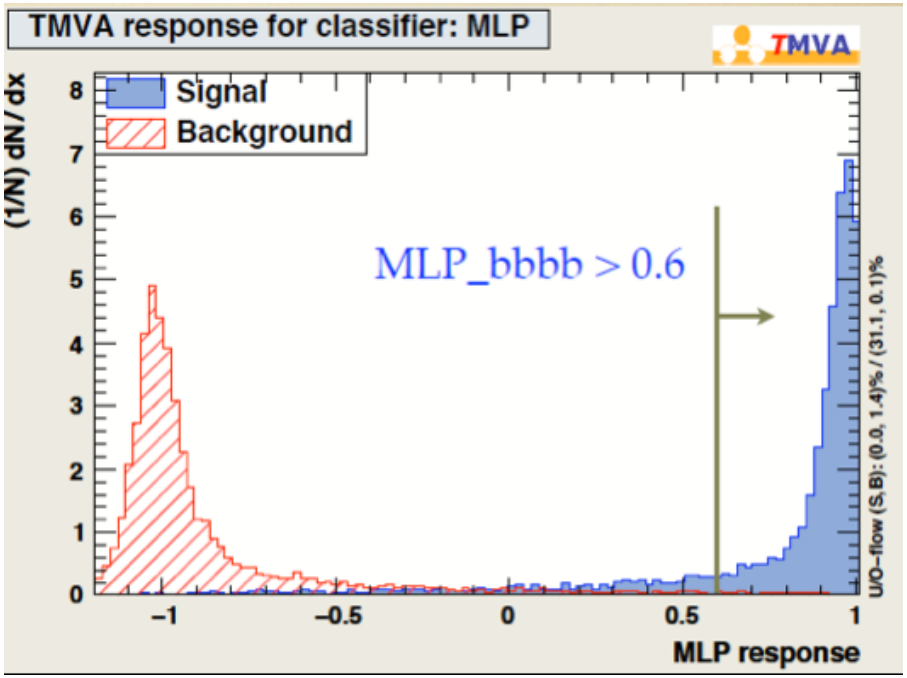


Coupling Htt at about 5%





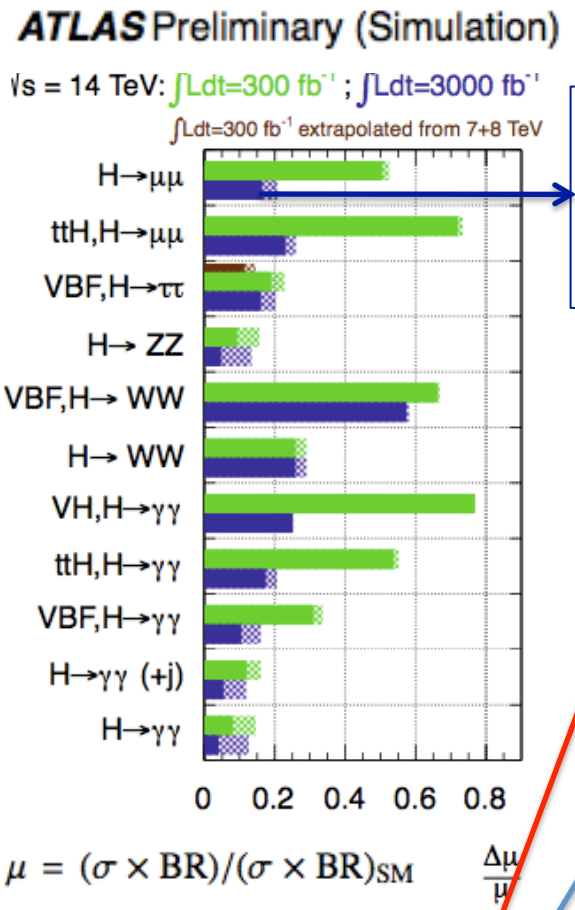
Decay mode	BR.	# events in 1 ab^{-1}
qqbbbb	32%	146
vvbbbb	9%	42
qqbbWW*->qqbbqqqq	6%	28
llbbbb	4%	19
qqbbWW*->qqbbqqlv	3%	14
qqbbWW*->qqbblvqq	3%	14
others	43%	194
tt -> bbqqqq		~800,000
ZZZ, ZZH -> qqbbbb		~600

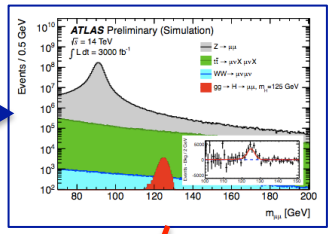


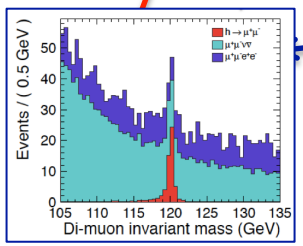
Energy (GeV)	Modes	signal	background	significance	
				excess (I)	measurement (II)
500	$ZHH \to (l\bar{l})(b\bar{b})(b\bar{b})$	6.4	6.7	2.1σ	1.7σ
500	$ZHH \to (\nu\bar{\nu})(b\bar{b})(b\bar{b})$	5.2	7.0	1.7σ	1.4σ
500	$ZHH \to (q\bar{q})(b\bar{b})(b\bar{b})$	8.5	11.7	2.2σ	1.9σ
		16.6	129	1.4σ	1.3σ

Coupling HHH: LC similar to LHC

HL-LHC/LC comparison

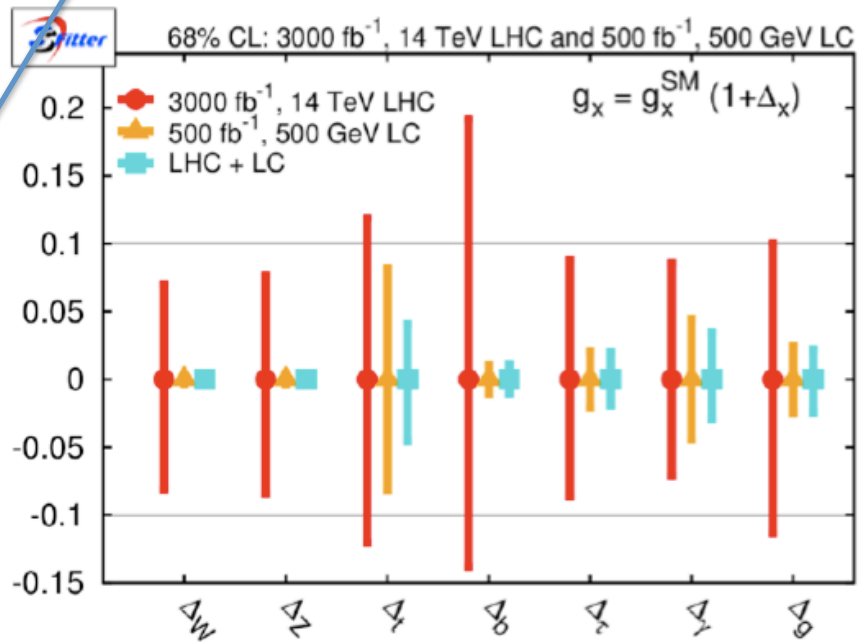




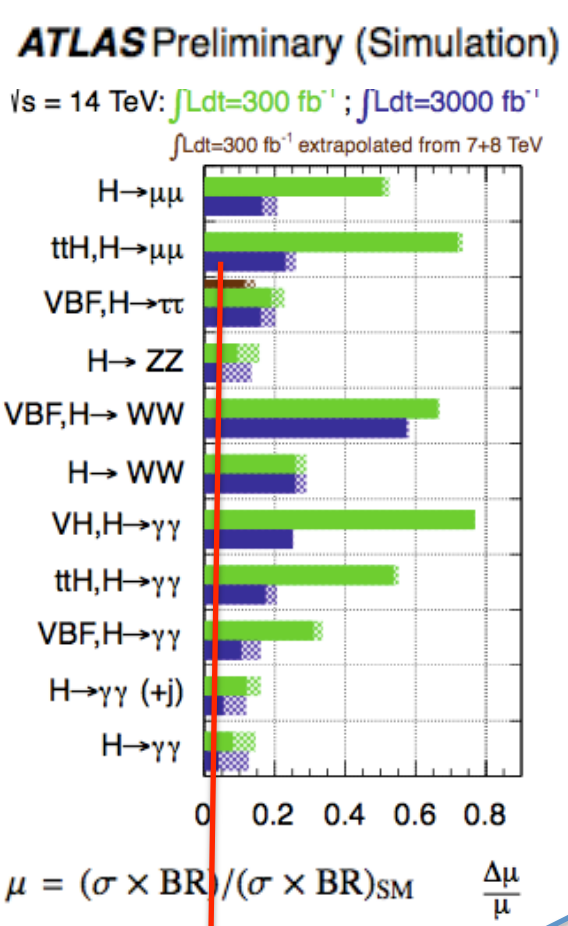


20% at 1000 GeV

	250/350 GeV	500 GeV	3 TeV
g_{Hbb}	1.6/1.4%		2%
g_{Hcc}	4/3%	2%	2%
$g_{H\tau\tau}$	3/3 %	2.5 %	
g_{HWW}	4/3%	1.4%	<2%
$g_{H\mu\mu}$	–	–	7.5%
g_{HZZ}	1.5–2%		
g_{HWW}/g_{HZZ}			<1%
g_{ttH}	–	15%	
g_{HHH}	–	30–40%	20%
Γ_H	11/7%	5%	



Similar, but LC gives an absolute measurement



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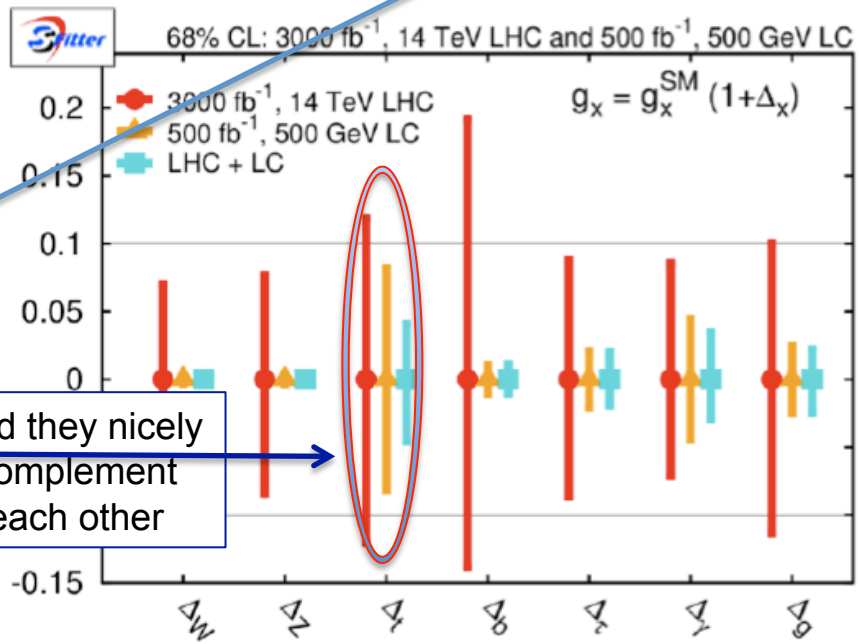
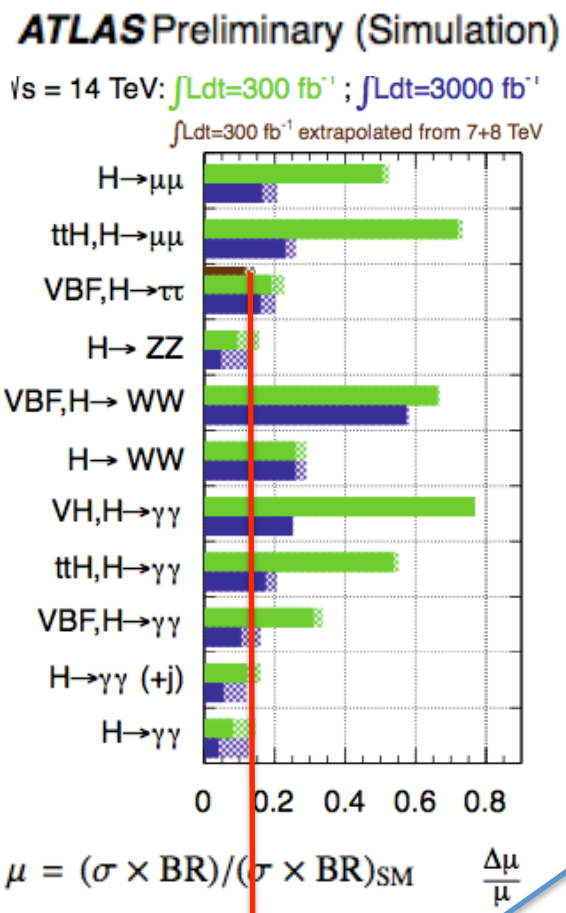


Similar, but LC gives an absolute measurement

Above 500 GeV LC much better

And they nicely complement each other



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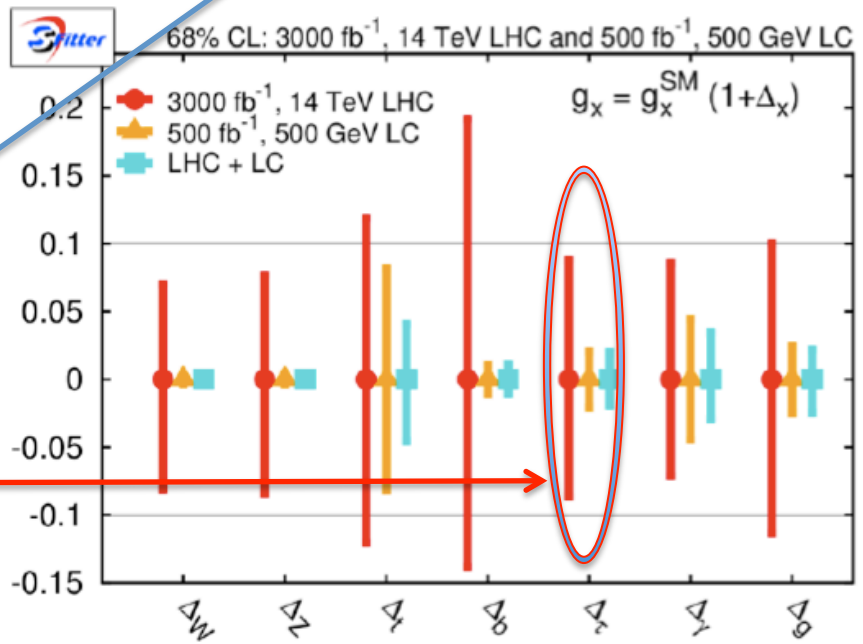
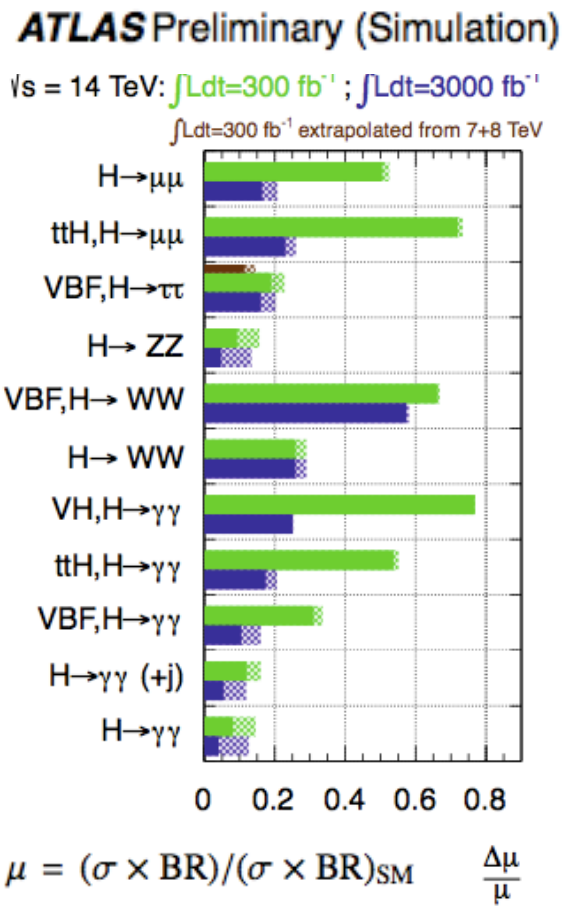


LC much better and gives an absolute measurement



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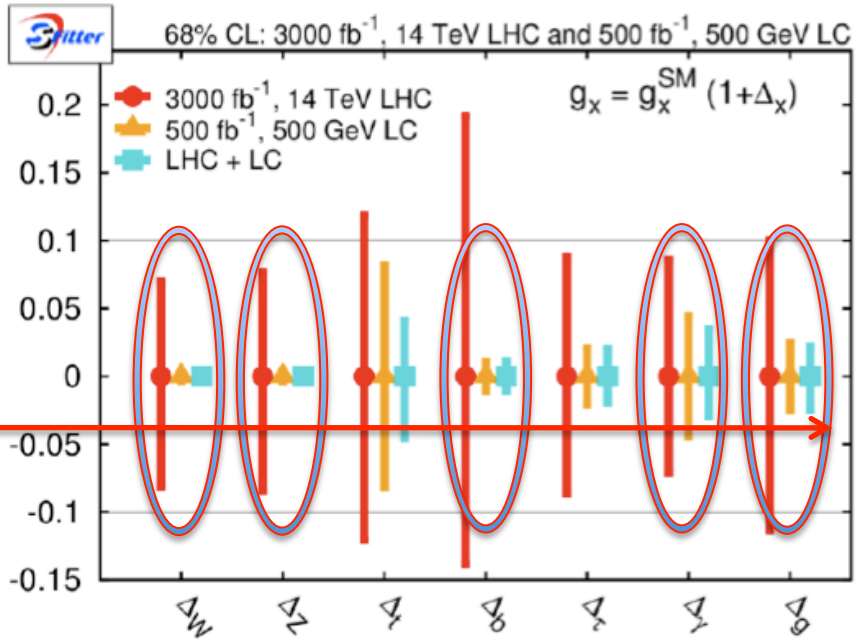


Similar statement for these 5

LC much better and gives an absolute measurement

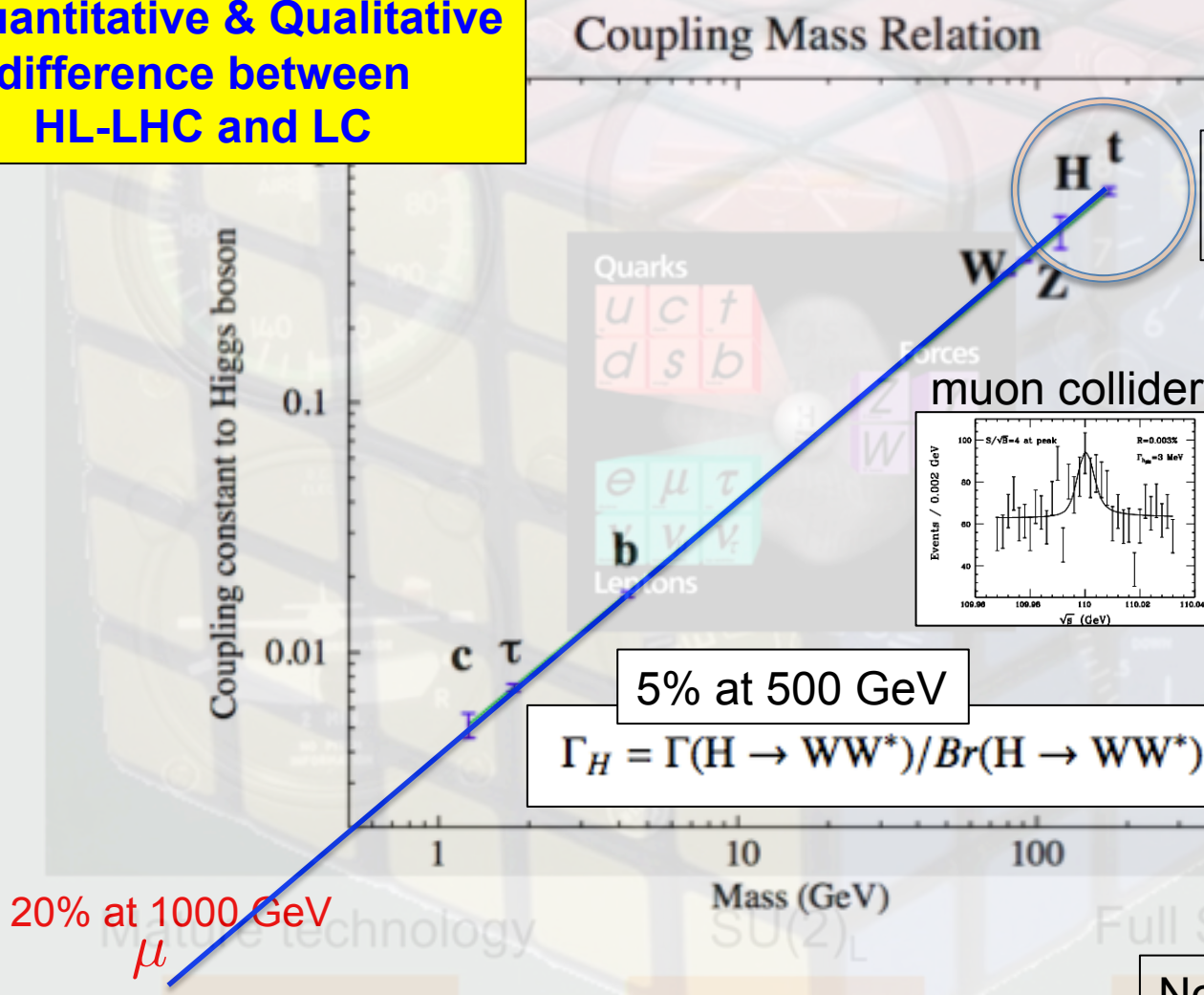
The dream-machine

A 500+ GeV Linear Collider can cover
most accessible Higgs couplings

A Quantitative & Qualitative difference between HL-LHC and LC

Much more convincing at 1000 GeV !

The most challenging



muon collider

5% at 500 GeV

$\Gamma_H = \Gamma(H \to WW^*)/Br(H \to WW^*)$

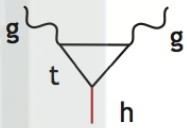
20% at 1000 GeV

Γ_{gg}

$\Gamma_{\gamma\gamma}$

Γ_{tot}

$\Gamma_{invisible}$



No projection from LHC

LHC projections are realistic, but are:
1) dealing only with subset of channels, yet,
2) preliminary (more important things to do :-),
3) cannot really assess experimental limitations to come,
4) cannot foresee theoretical progresses (20 years from now!)

LC projections realistic but are:
1) dealing with (full) Monte Carlo only,
2) often preliminary (lack of manpower),
3) not boosted by real data in hand

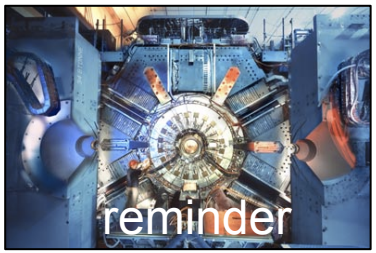
But, undoubtly

A Quantitative & Qualitative difference between HL-LHC and LC

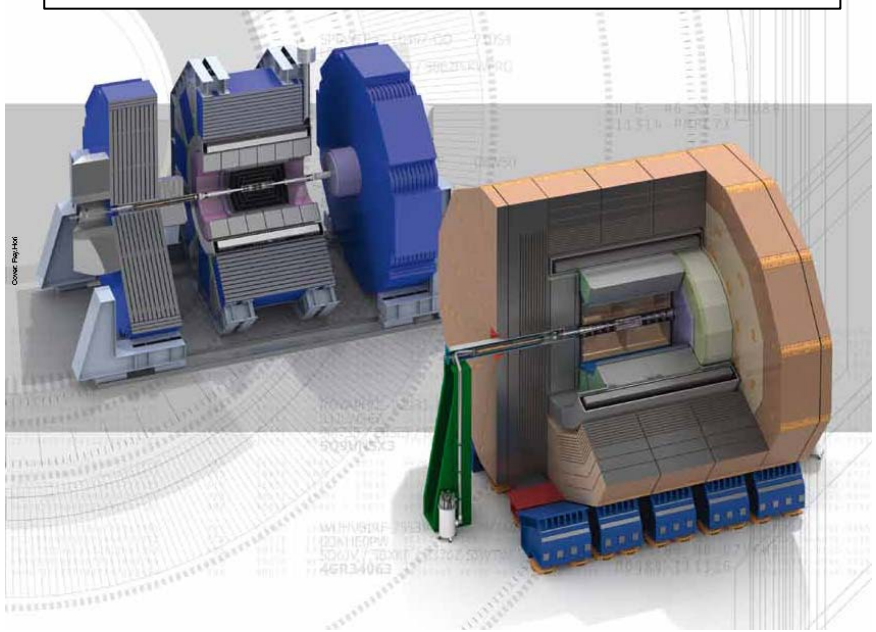
exp&the systematics limited

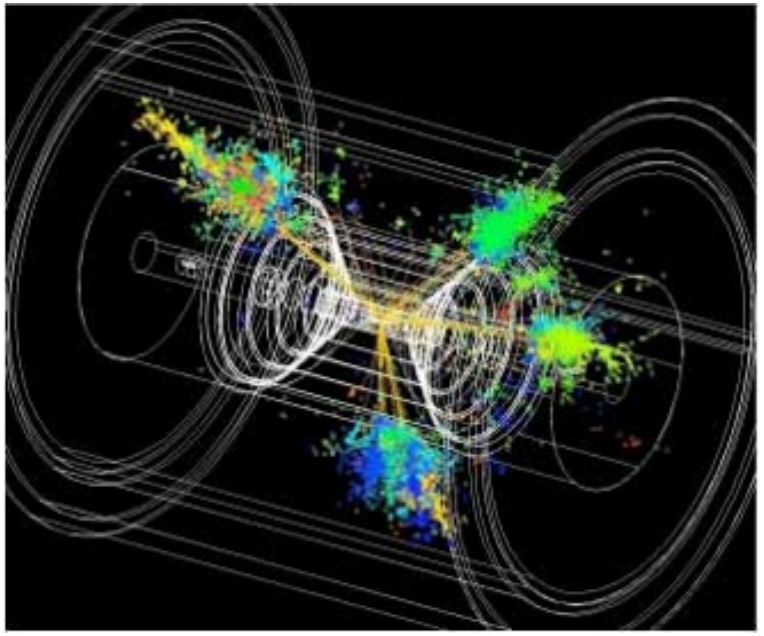
exp-statistically limited

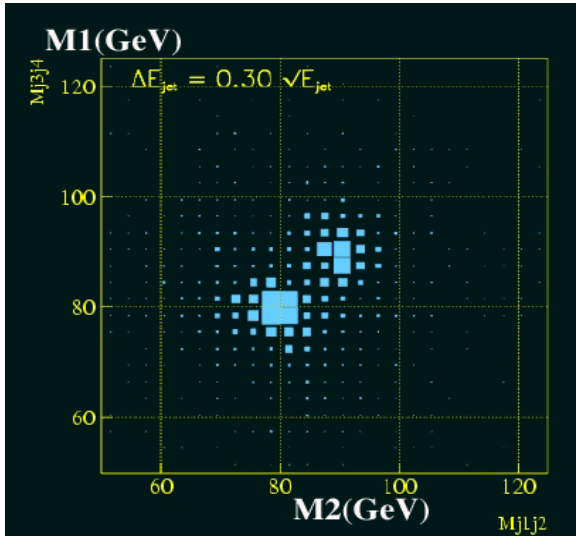
BaBar observes T-violation

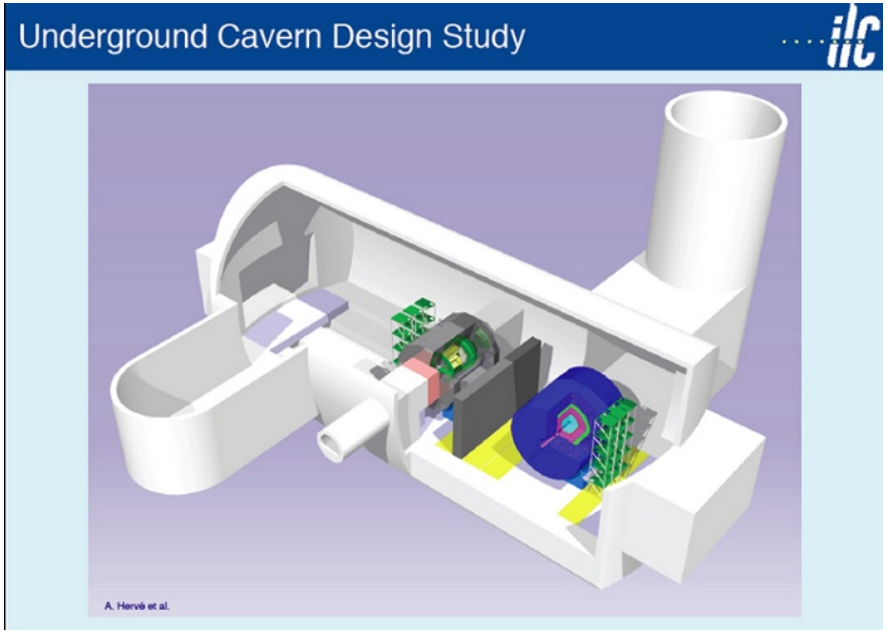


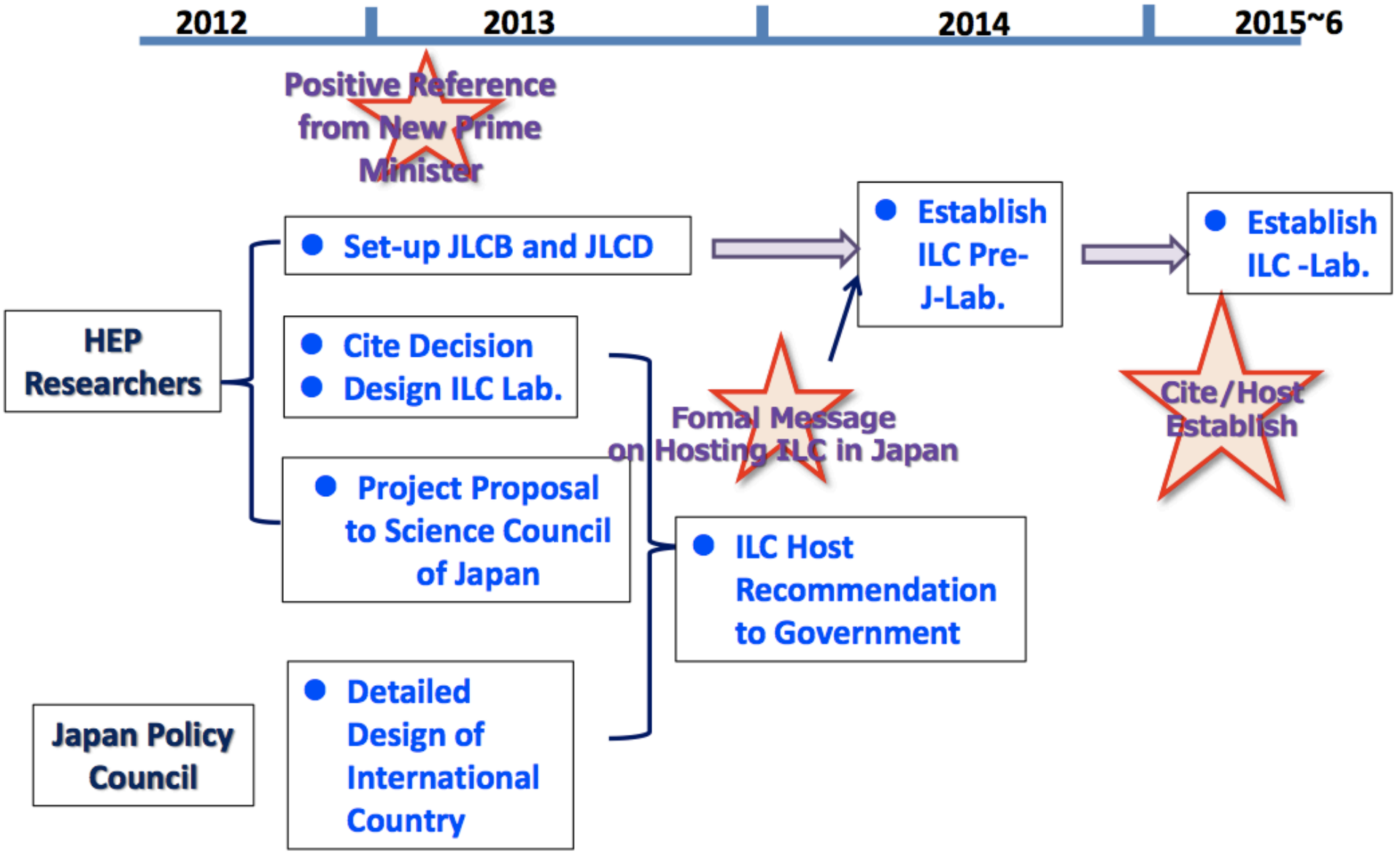
And the detector designs are ready










2012
2013
2014
2015~6
Positive Reference from New Prime Minister
HEP Researchers
Set-up JLCB and JLCD
Cite Decision
Design ILC Lab.
Project Proposal to Science Council of Japan
Japan Policy Council
Detailed Design of International Country
ILC Host Recommendation to Government
Fomal Message on Hosting ILC in Japan
Establish ILC Pre-J-Lab.
Establish ILC -Lab.
Cite/Host Establish

We must dare
to make up
our mind:
time is ripe!