Francois Le Diberder

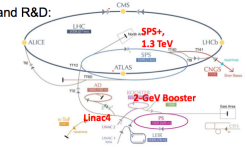
LPNHE, 21 novembre 2013

ILC the next generation Collider (?)

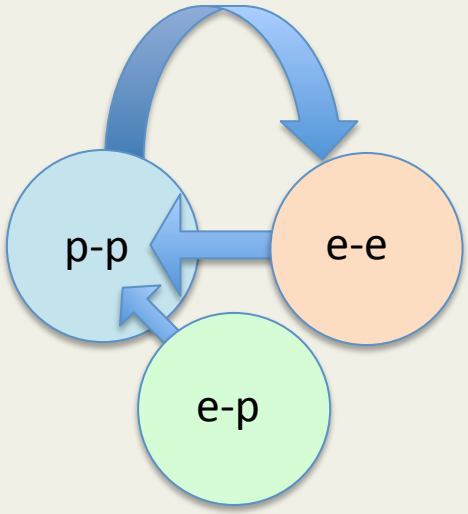
The driving force is the Physics case

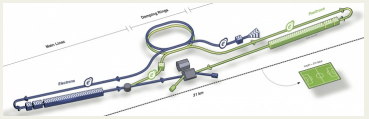
Physics Case for e+e- Collider

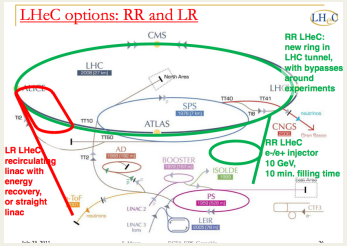
HE-LHC – main Issues and R&D:



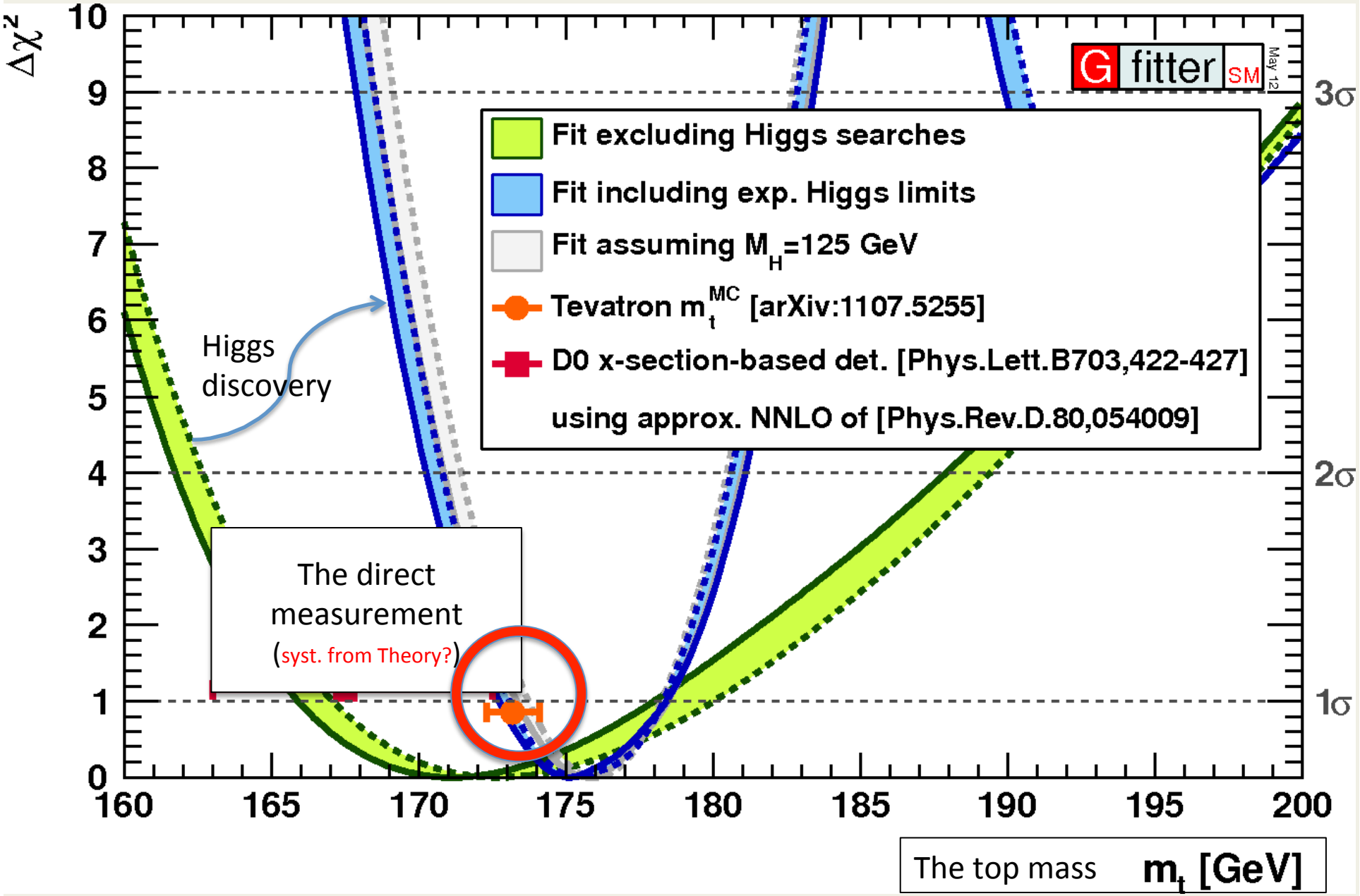
- High-field 20T dipole magnets based on Nb_3Sn, Nb_3Al, and HTS
- High-gradient quadrupole magnets for arc and IR
- Fast cycling SC magnets for ~1.3 TeV injector
- Emittance control in regime of strong SR damping and IBS
- Cryogenic handling of SR heat load (first analysis; looks manageable)
- Dynamic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

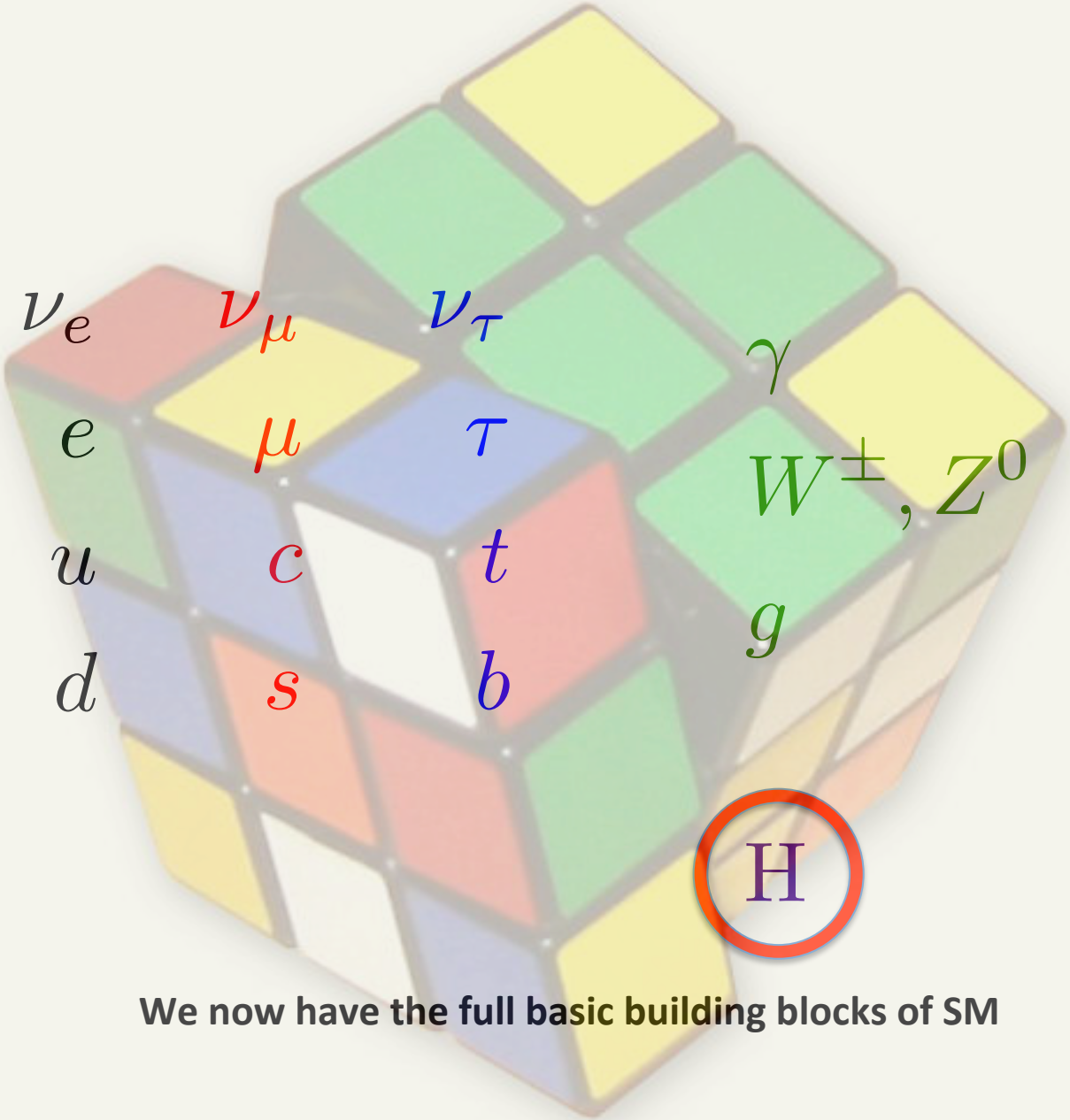






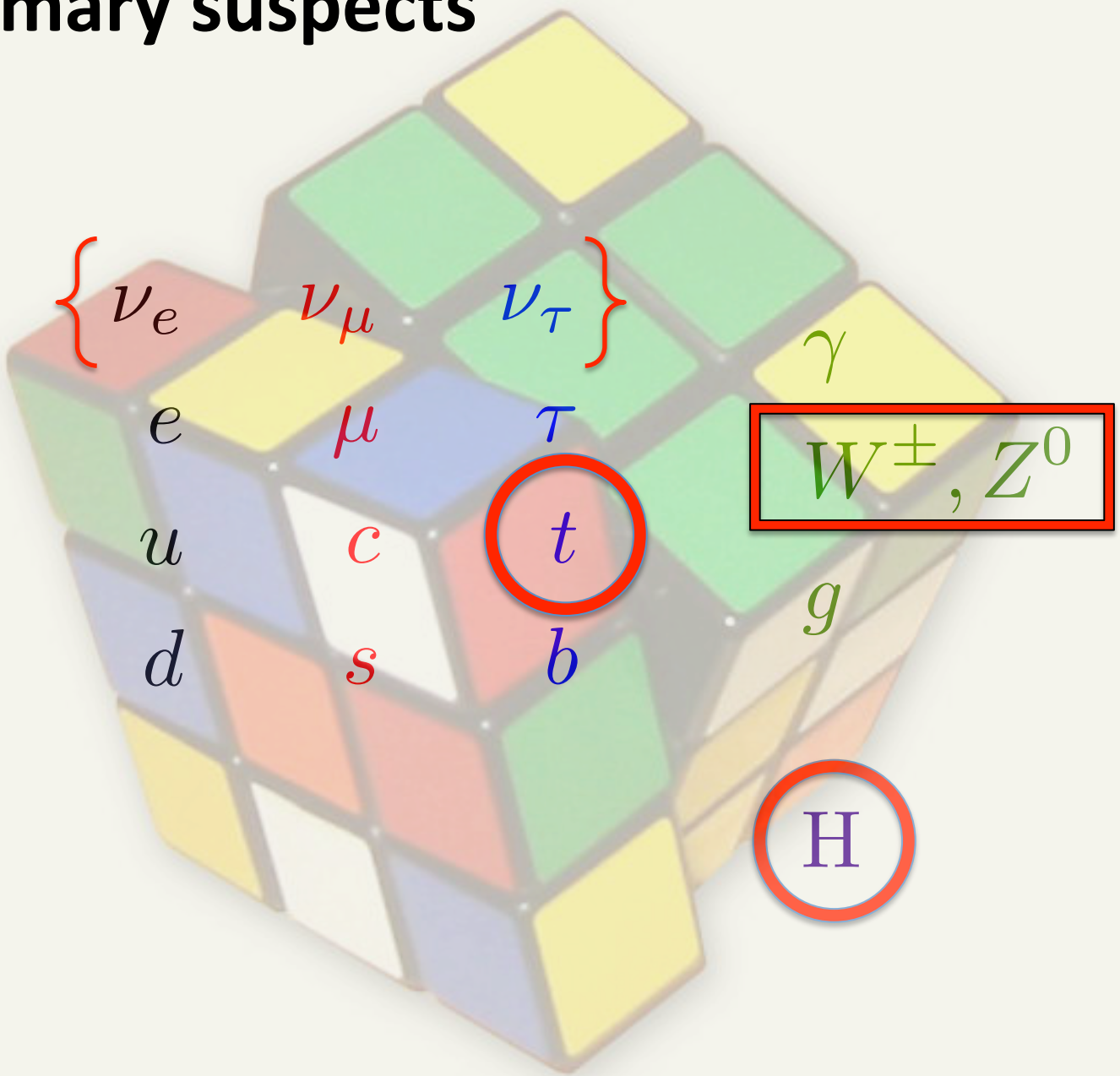
History tought us that the interplay between
p-p & e-e & e-p colliders is intrumental
in allowing progresses
in our understanding of Physics


$\Delta\chi^2$
10
9
8
7
6
5
4
3
2
1
0
160
165
170
175
180
185
190
195
200
3σ
2σ
1σ
G fitter SM
May 12
Fit excluding Higgs searches
Fit including exp. Higgs limits
Fit assuming M_H=125 GeV
Tevatron m_t^{MC} [arXiv:1107.5255]
D0 x-section-based det. [Phys.Lett.B703,422-427]
using approx. NNLO of [Phys.Rev.D.80,054009]
Higgs discovery
The direct measurement
(syst. from Theory?)
The top mass m_t [GeV]



We now have the full basic building blocks of SM

The primary suspects



Decoupling argument suggests that deviations of Higgs coupling are :

$$m_h^2/M^2$$

Model	κ_V	κ_b	κ_γ
Singlet Mixing	$\sim 6\%$	$\sim 6\%$	$\sim 6\%$
2HDM	$\sim 1\%$	$\sim 10\%$	$\sim 1\%$
Decoupling MSSM	$\sim -0.0013\%$	$\sim 1.6\%$	$< 1.5\%$
Composite	$\sim -3\%$	$\sim -(3-9)\%$	$\sim -9\%$
Top Partner	$\sim -2\%$	$\sim -2\%$	$\sim +1\%$

Must aim for High (experimental and theoretical) precisions

Discovery is 5σ , so the goal is sub-percent accuracy.

A 3-prong program is required:

- Study the Higgs boson in as much detail as possible.
- Search for the imprint of the Higgs on W, Z, and top.
- Search for new particles with TeV-scale masses.

The dream-machine

flexibility | Clean Luminosity | affordable

Mature technology | $SU(2)_L$ | Full SM reach

The dream-machine

LC collider

flexibility

e-e collider

Clean Luminosity

Mature technology

LC collider

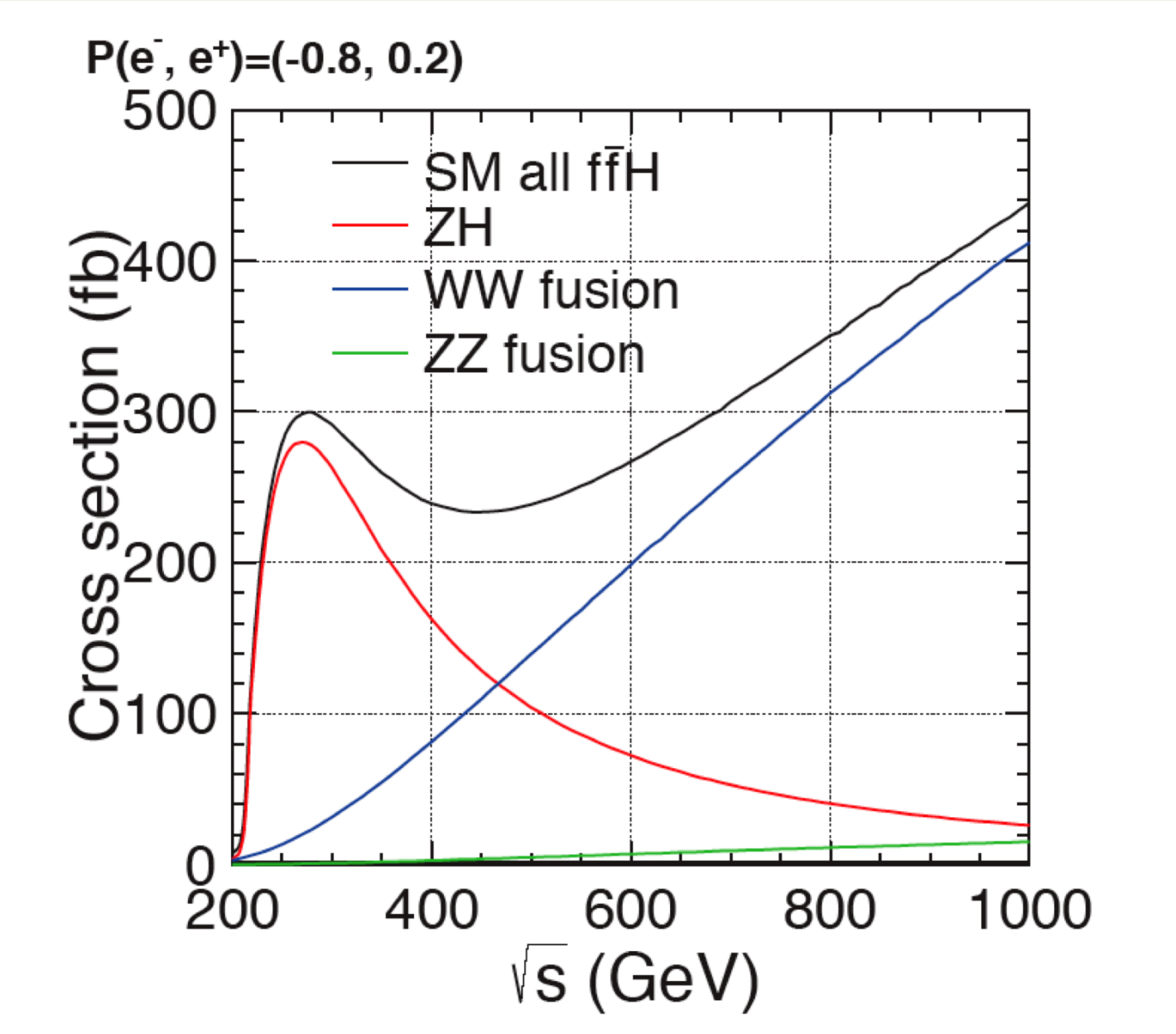
$SU(2)_L$

LC collider

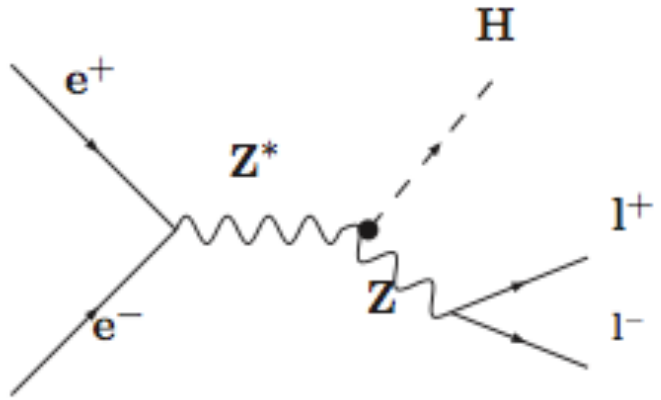
Full SM reach

LC collider

Total Higgs production cross section increases with energy



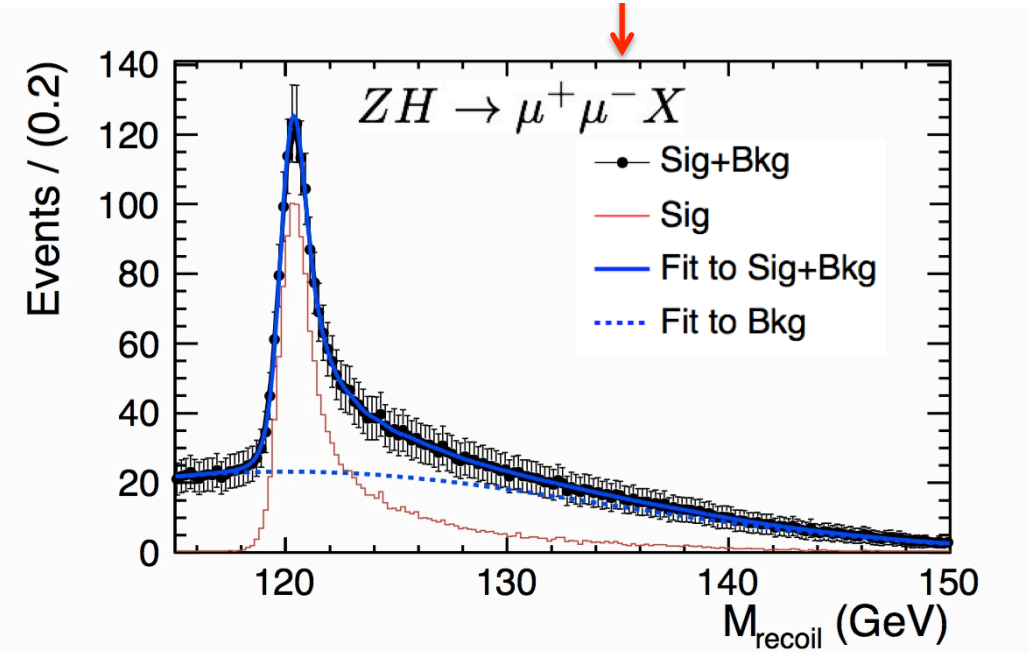
Higgs-strahlung Process:



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

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

Allows absolute measurements

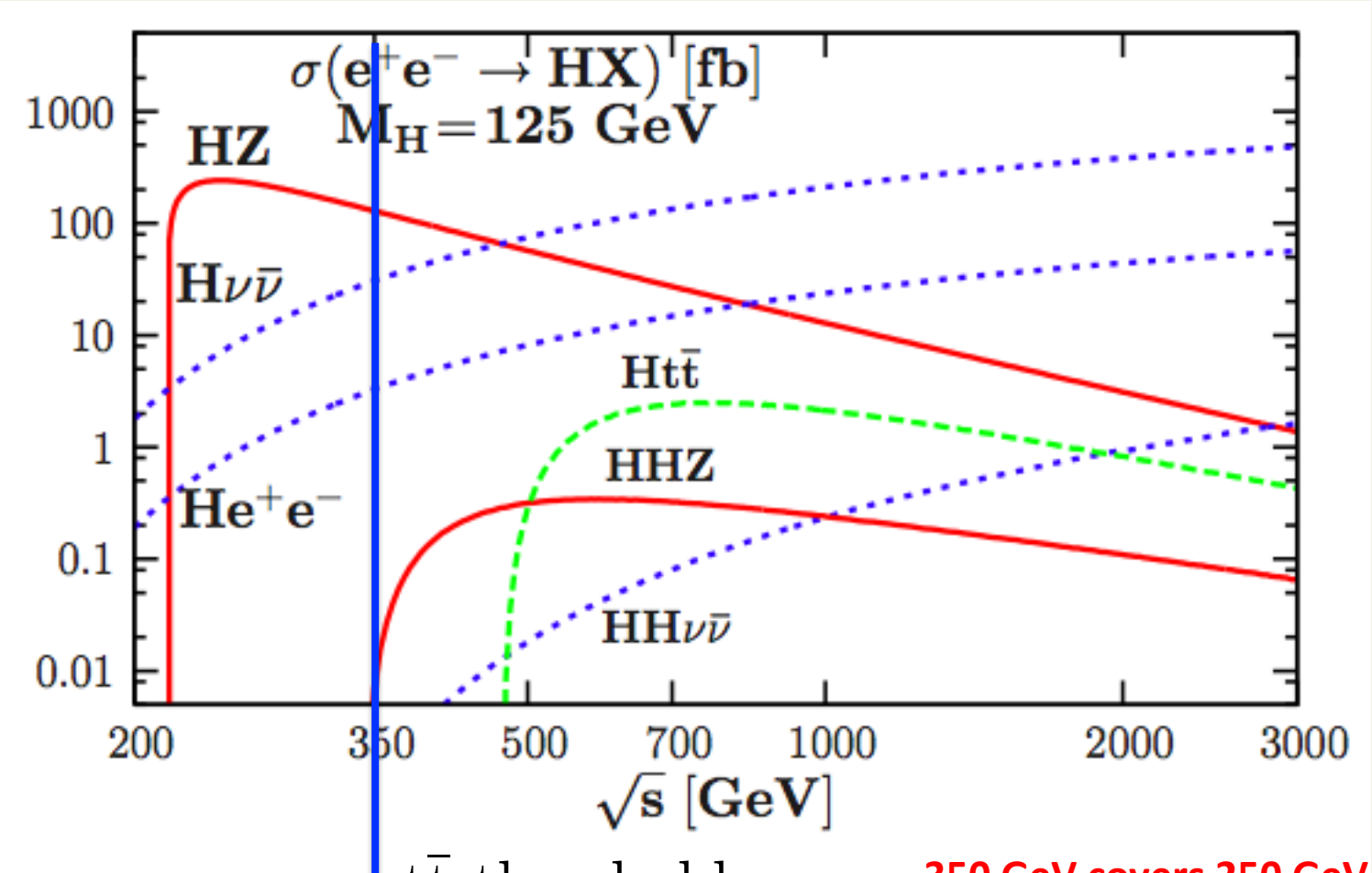


250 GeV is the entrance to Higgs world

Invisible Higgs decays are made visible!

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

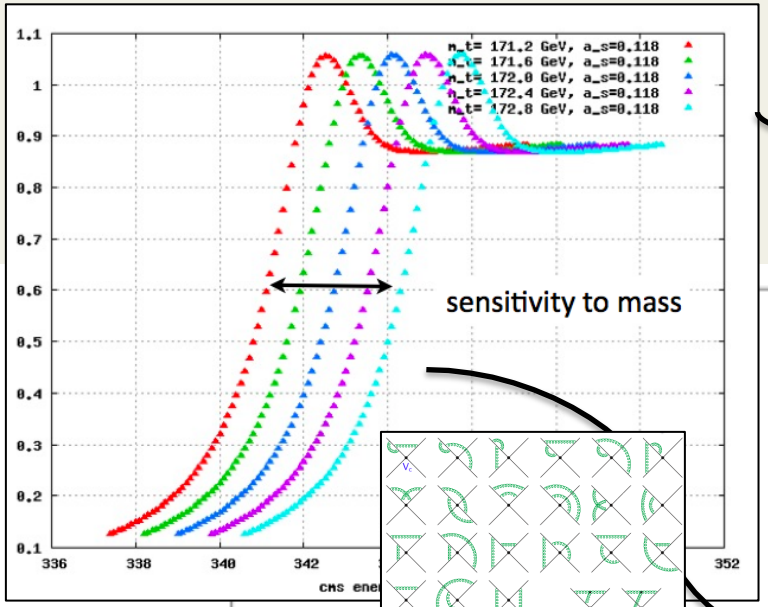
Two simultaneous thresholds : $t\bar{t}$ and HHZ

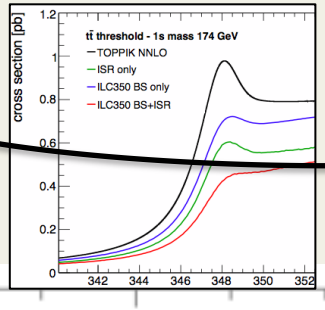


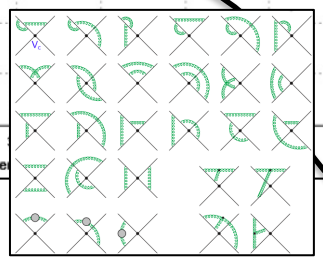
$t\bar{t}$ threshold

350 GeV is the entrance to top world

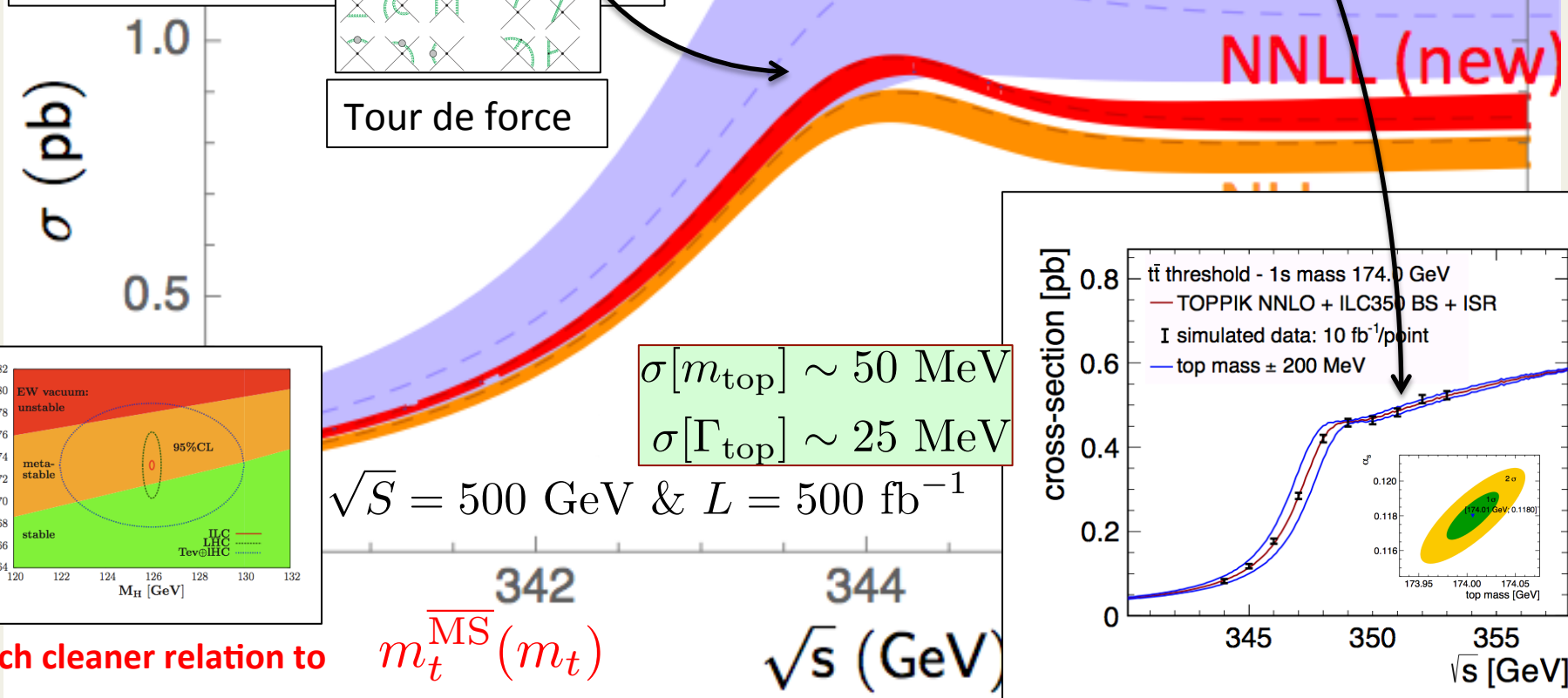
350 GeV covers 250 GeV physics case as well





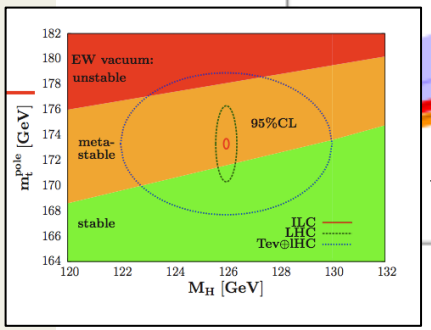


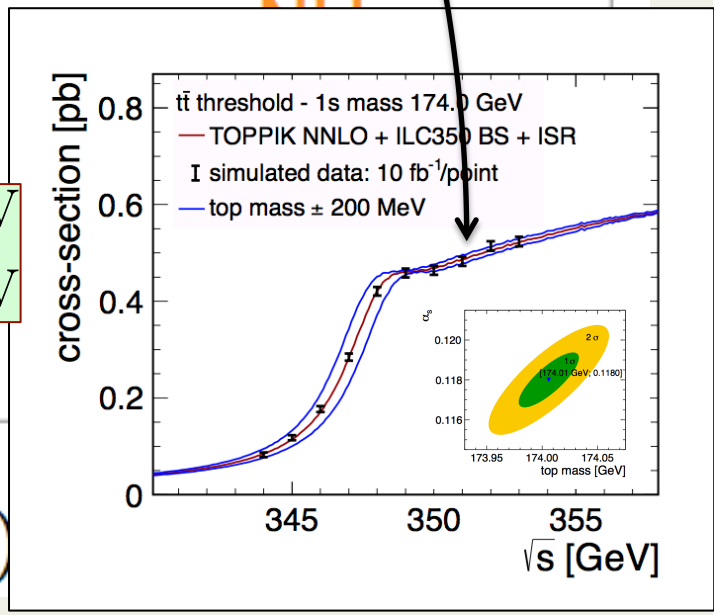
Tour de force



$$\sigma[m_{\rm top}] \sim 50 \text{ MeV}$$
$$\sigma[\Gamma_{\rm top}] \sim 25 \text{ MeV}$$

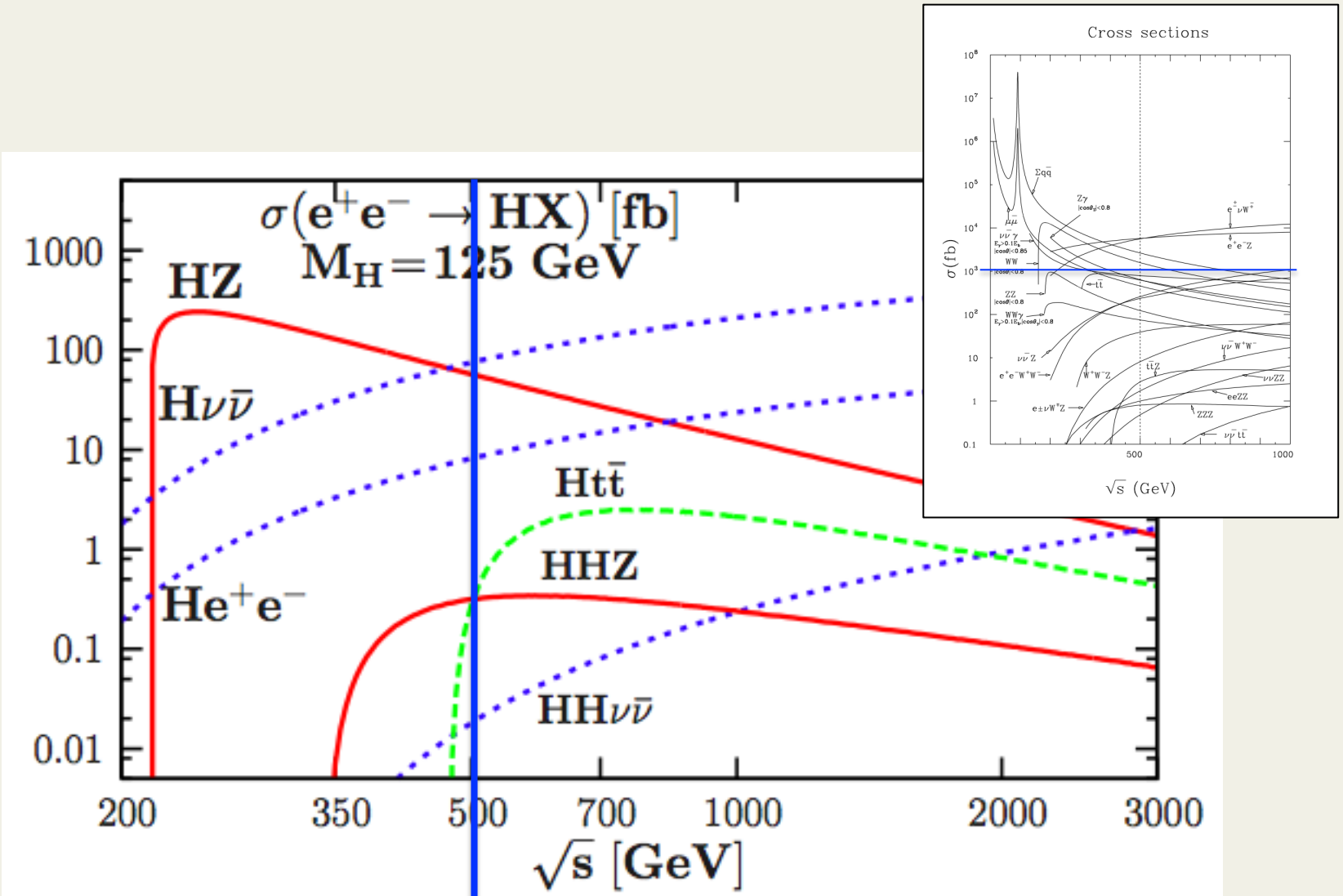
$$\sqrt{S} = 500 \text{ GeV } \& \ L = 500 \text{ fb}^{-1}$$





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

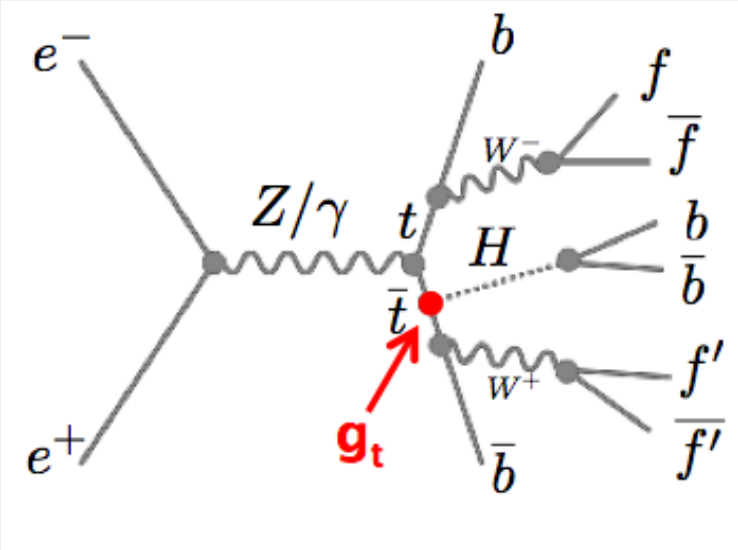
Circular machines are advocated as been able to reach up to 350 GeV. What follows goes beyond.

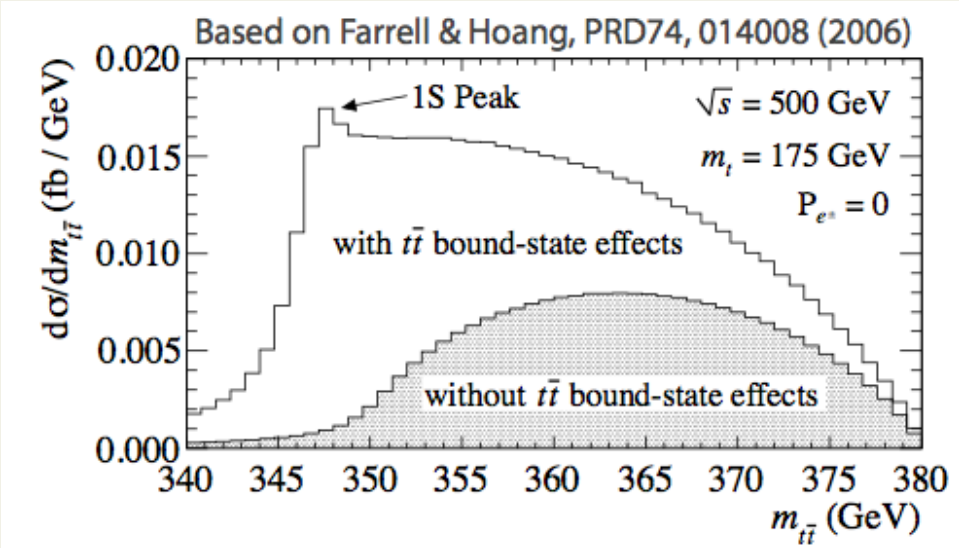


$e^+e^- \to \nu\bar{\nu}h$, $e^+e^- \to t\bar{t}h$, $e^+e^- \to Zhh$

500 GeV is the portal to the whole SM

base line energy

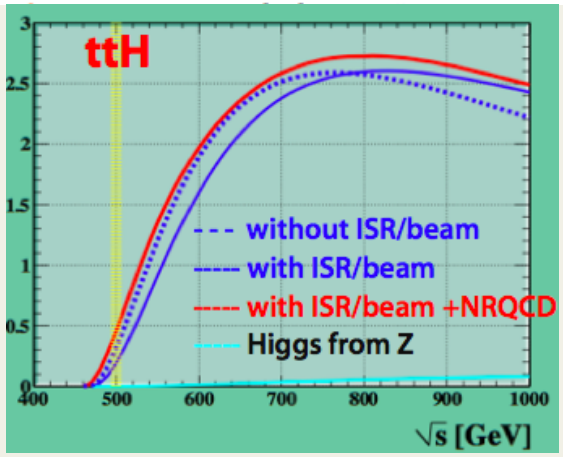




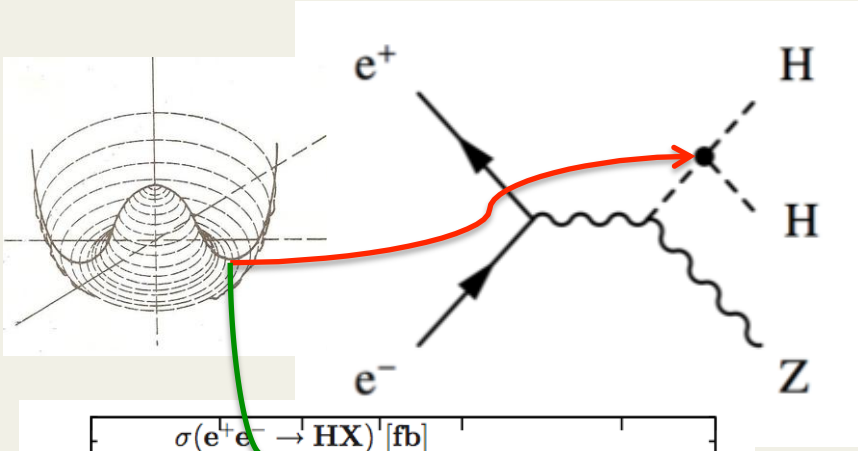
6-jet + lepton cut flow

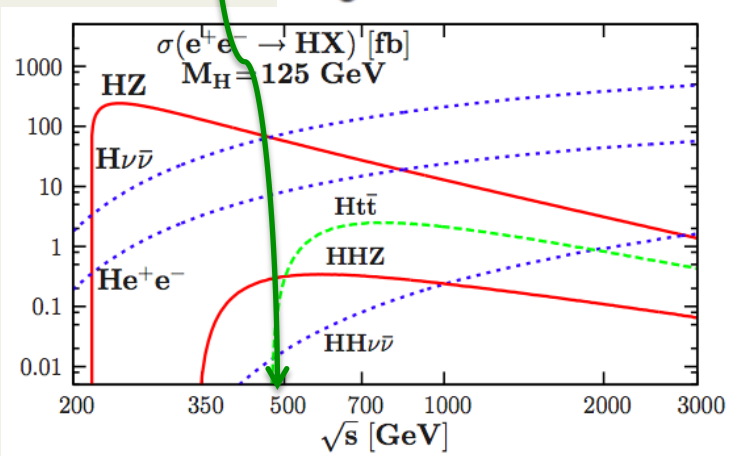
L = 1 ab^{-1}, polarized beams

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
$Y_{5\text{->}4}$ > 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

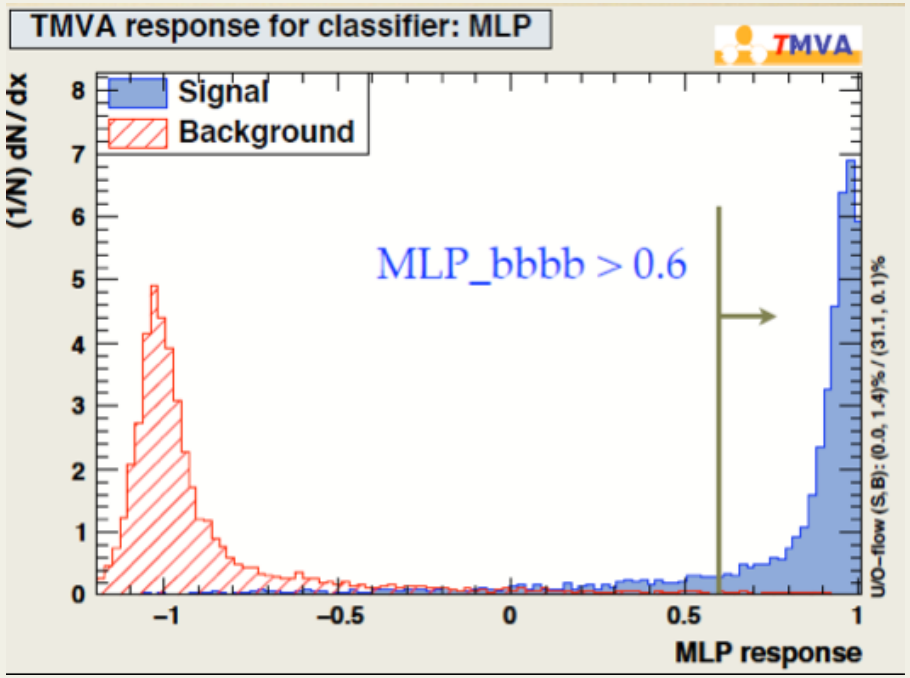


Coupling Htt at about 5%



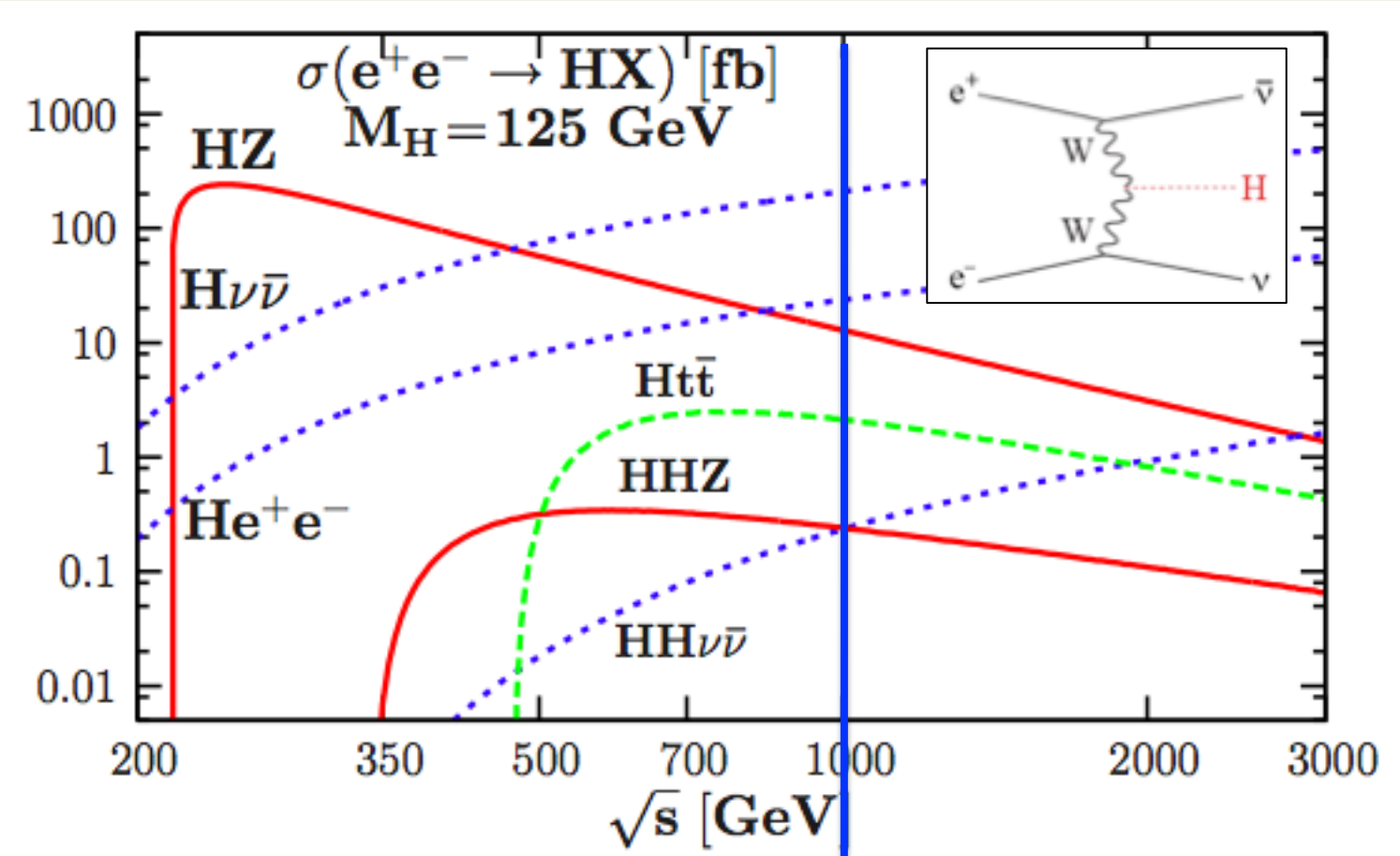


Decay mode	BR.	# events in 1 ab^{-1}
qqbbbb	32%	146
ννbbbb	9%	42
qqbbWW*->qqbbqqqq	6%	28
llbbbb	4%	19
qqbbWW*->qqbbqqlν	3%	14
qqbbWW*->qqbblνqq	3%	14
others	43%	194
tt -> bbqqqq		~800,000
ZZZ, ZZH -> qqbbbb		~600



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



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

A new regime for Higgs studies

1000 GeV is the Vector-Vector world

$$Y_1 = \sigma_{ZH} = F_1 \cdot g_{HZZ}^2$$

$$Y_2 = \sigma_{ZH} \times \mathrm{Br}(H \to b\bar{b}) = F_2 \cdot \frac{g_{HZZ}^2 g_{Hb\bar{b}}^2}{\Gamma_T}$$

$$Y_3 = \sigma_{\nu\bar{\nu}H} \times \mathrm{Br}(H \to b\bar{b}) = F_3 \cdot \frac{g_{HWW}^2 g_{Hb\bar{b}}^2}{\Gamma_T}$$

$$Y_4 = \sigma_{\nu\bar{\nu}H} \times \mathrm{Br}(H \to WW^*) = F_4 \cdot \frac{g_{HWW}^4}{\Gamma_T} \,,$$

where Γ_T is the Higgs total width, g_{HZZ}, g_{HWW}, and $g_{Hb\bar{b}}$ are the couplings of the Higgs to ZZ, WW, and $b\bar{b}$, respectively, and F_1, F_2, F_3, F_4 are calculable quantities. It is straightforward to get the couplings with the following steps:

i.) from measurement Y_1 we can get the coupling g_{HZZ}.

ii.) from the ratio Y_2/Y_3 we can get the coupling ratio g_{HZZ}/g_{HWW}.

iii.) with g_{HZZ} and g_{HZZ}/g_{HWW}, we can get g_{HWW}.

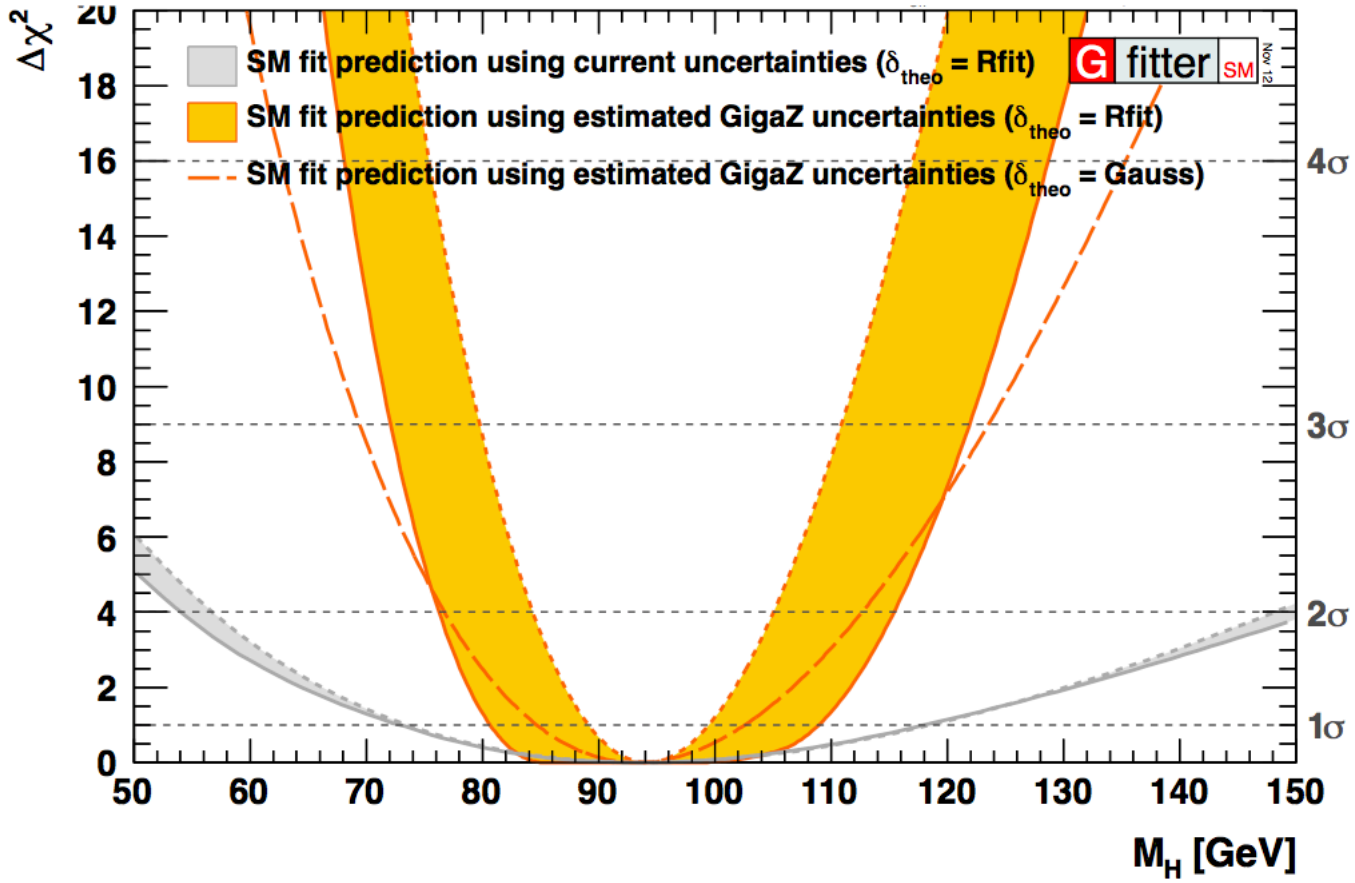
iv.) once we know g_{HWW}, from measurement Y_4 we can get the Higgs total width Γ_T.

M1 Magistère – Physique Subatomique

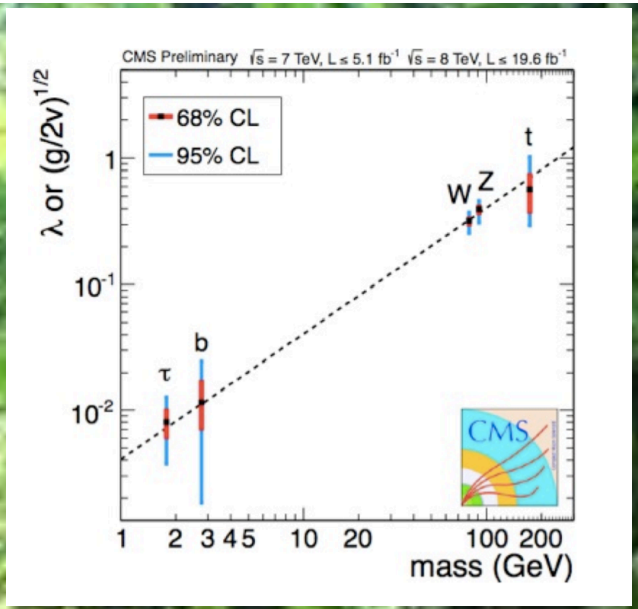
Année 2012-2013

Examen Partiel du 16 novembre 2013, 14:00-17:00

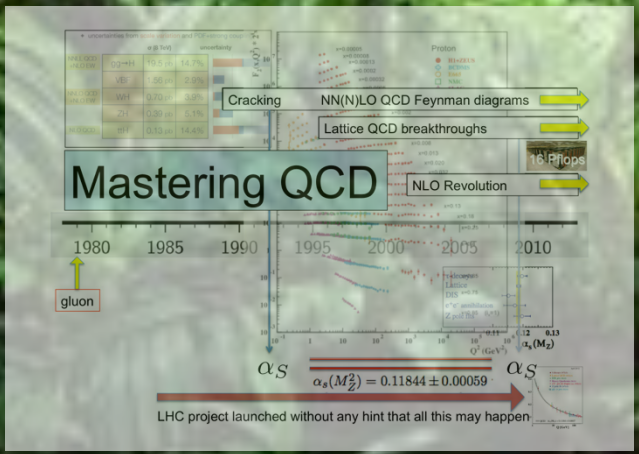
Figure 4.9
Contour of χ^2 in the precision electroweak fit as a function of the Higgs boson mass for the current values (grey band) and for improved uncertainties expected from the Giga-Z program (orange band) [51]. The figure assumes that the current central value remains unchanged.



GiGaZ option leads to indirect mH at 10 GeV level

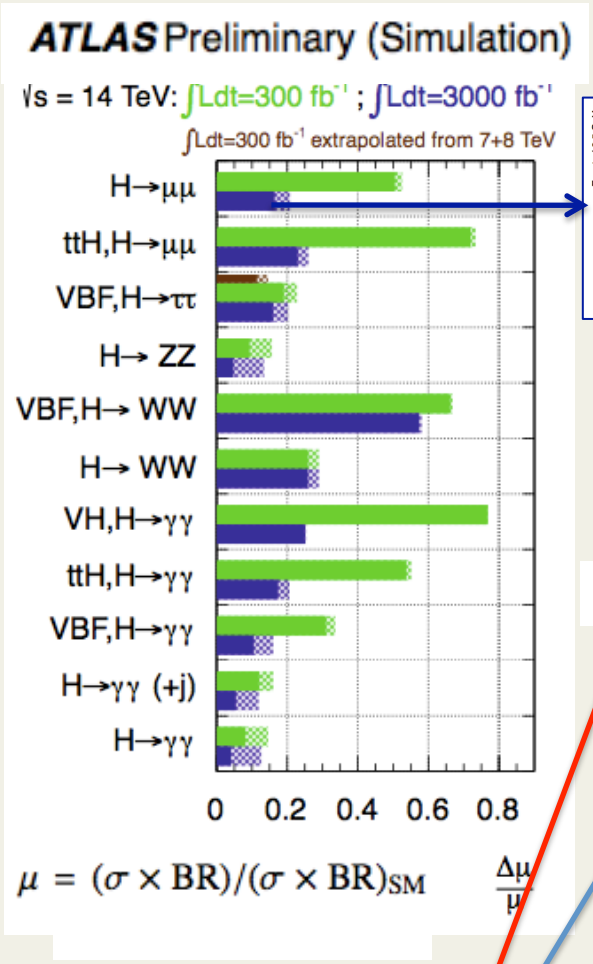


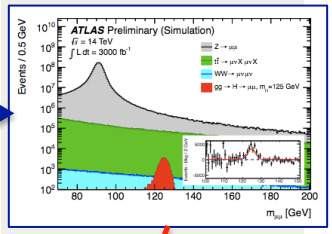
Physics at actual Collider

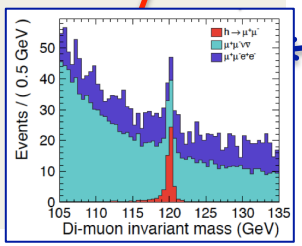


- Now 8 but 13 TeV soon
- Higher Luminosity
- Detectors upgrades
- Know-how improving

HL-LHC/LC comparison

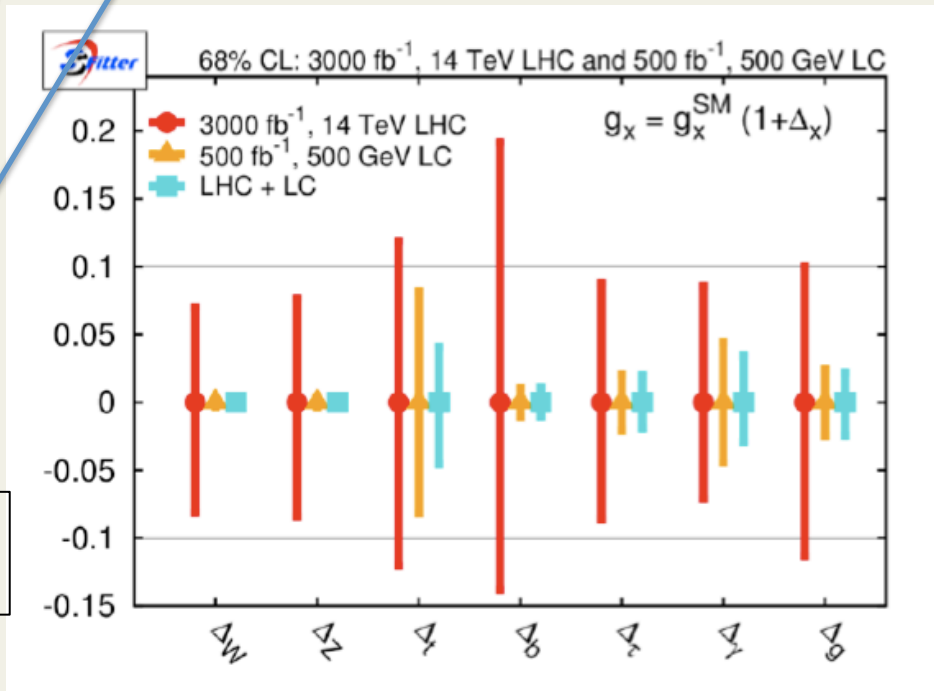






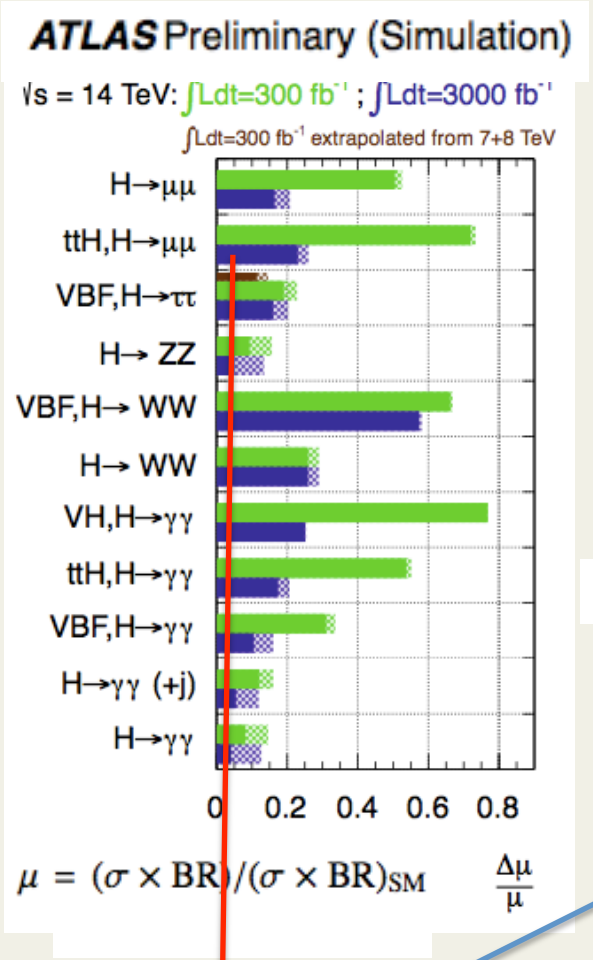
20% at 1000 GeV

	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%	



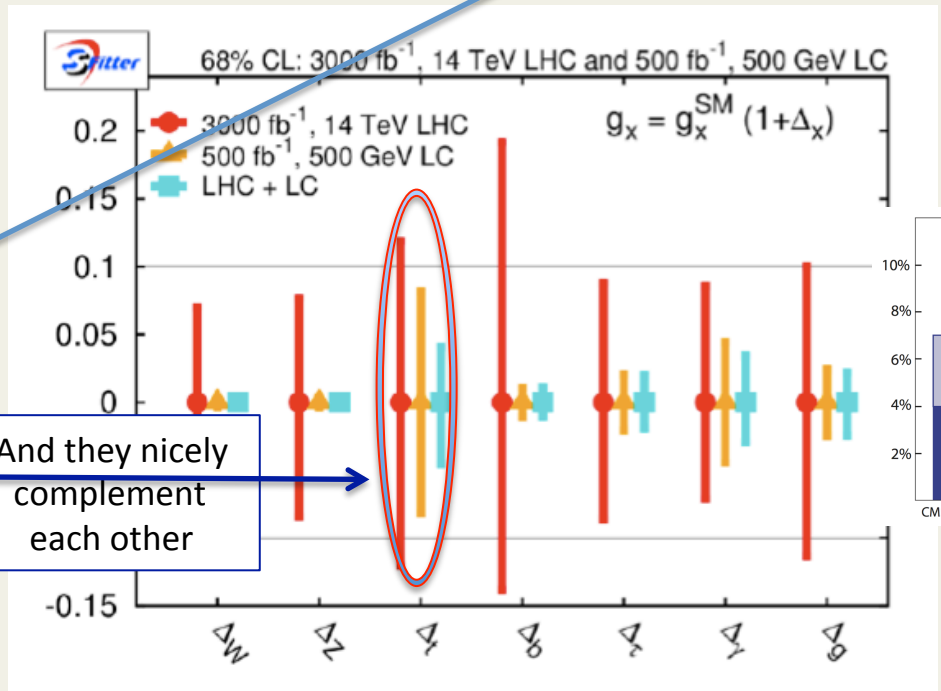
Similar, but LC gives an absolute measurement

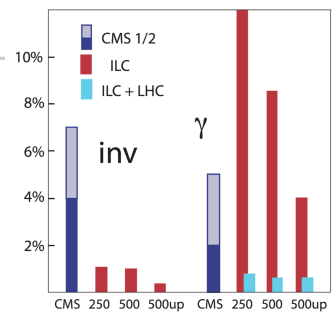
HL-LHC/LC comparison



	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%	

20% at 1000 GeV



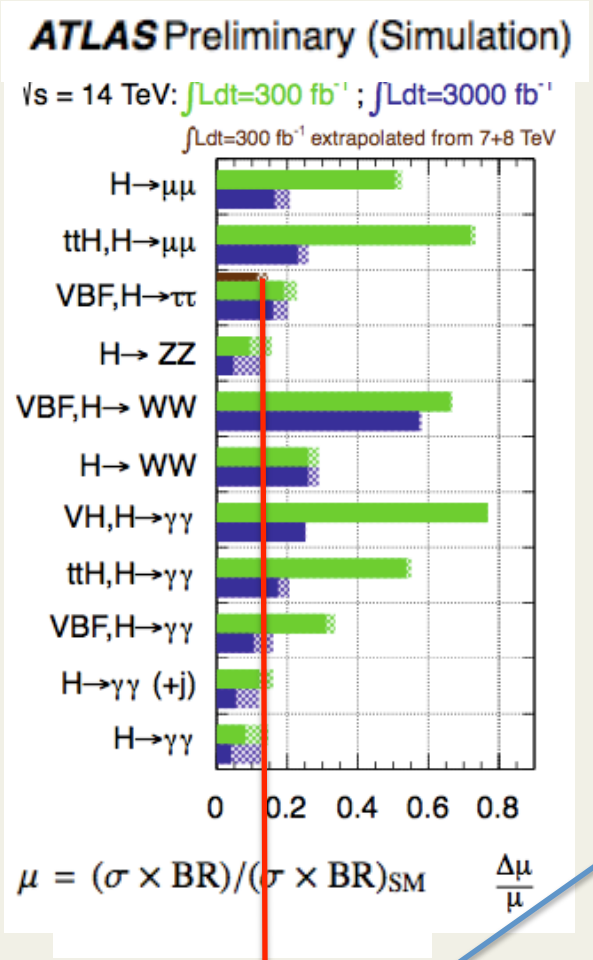


Similar, but LC gives an absolute measurement

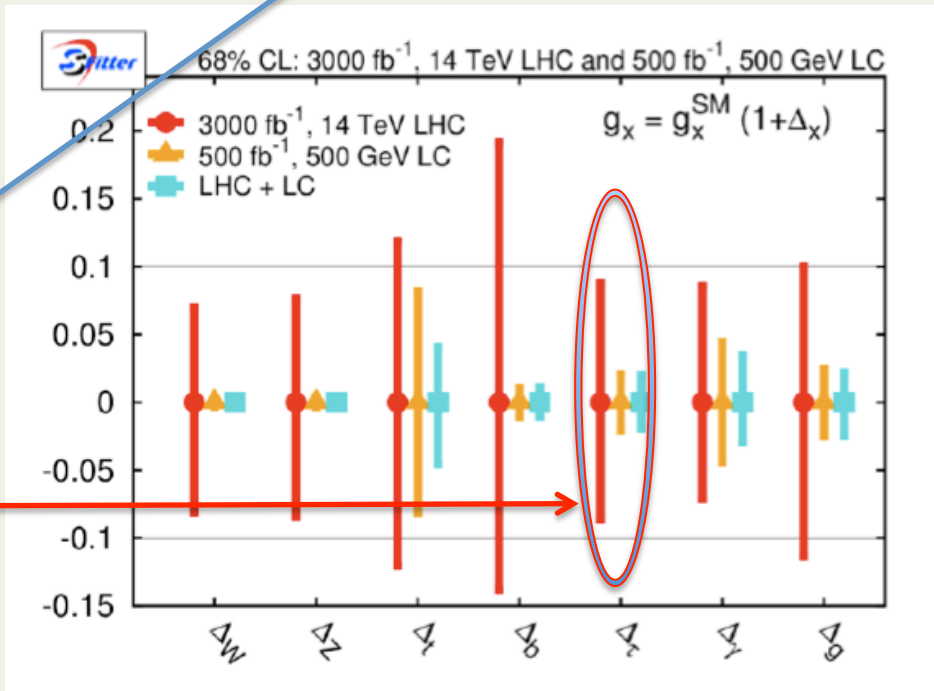
Above 500 GeV LC much better

And they nicely complement each other

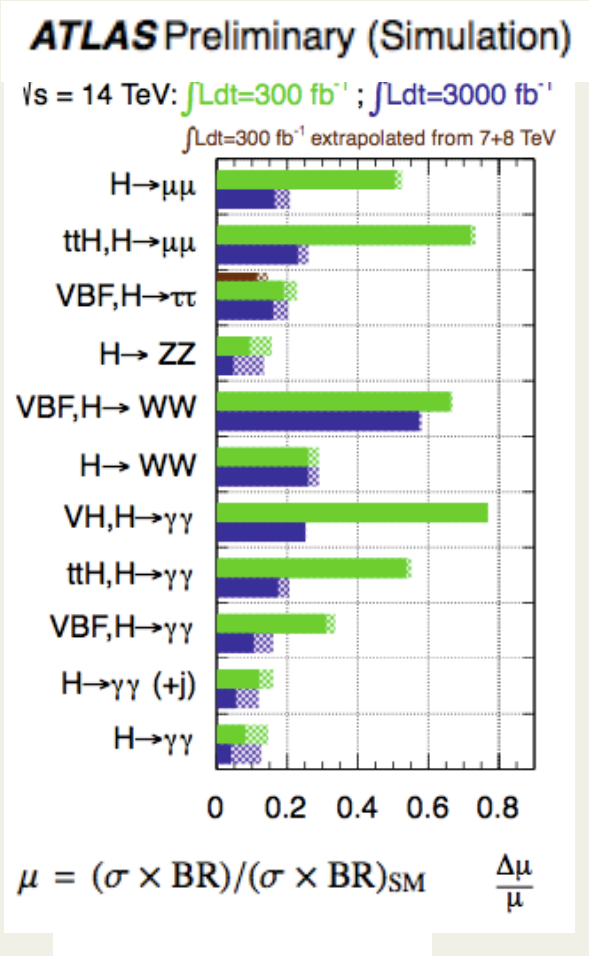
HL-LHC/LC comparison



	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%	

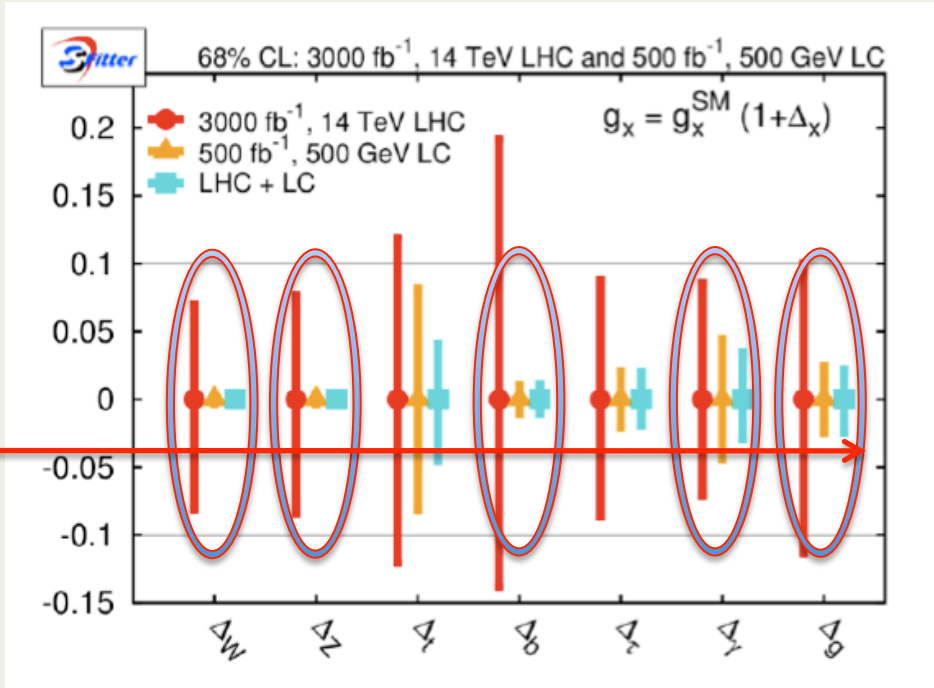


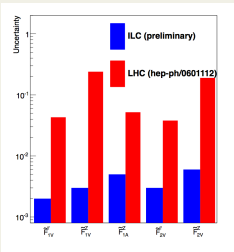
LC much better and gives an absolute measurement



HL-LHC/LC comparison

	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 statement for these 5

LC much better and gives an absolute measurement

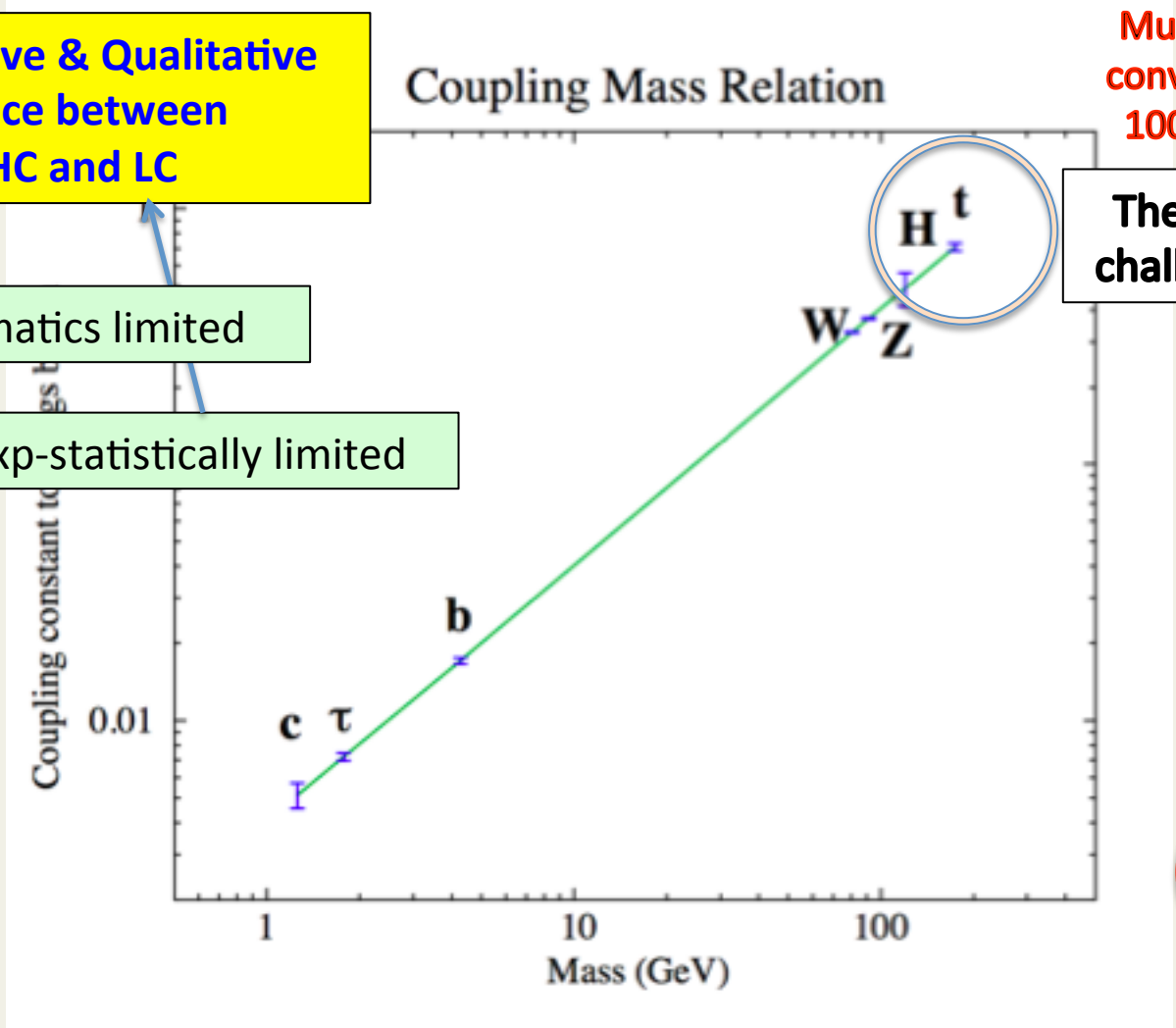
The dream-machine

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

A Quantitative & Qualitative difference between HL-LHC and LC

exp&the systematics limited

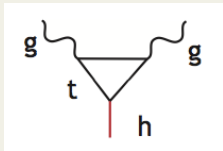
exp-statistically limited



Much more convincing at 1000 GeV !

The most challenging

Γ_{gg}



$\Gamma_{\gamma\gamma}$

Γ_{tot}

$\Gamma_{invisible}$

A brief history (25 years old project)

To make a long history short: August 2004

November 2004

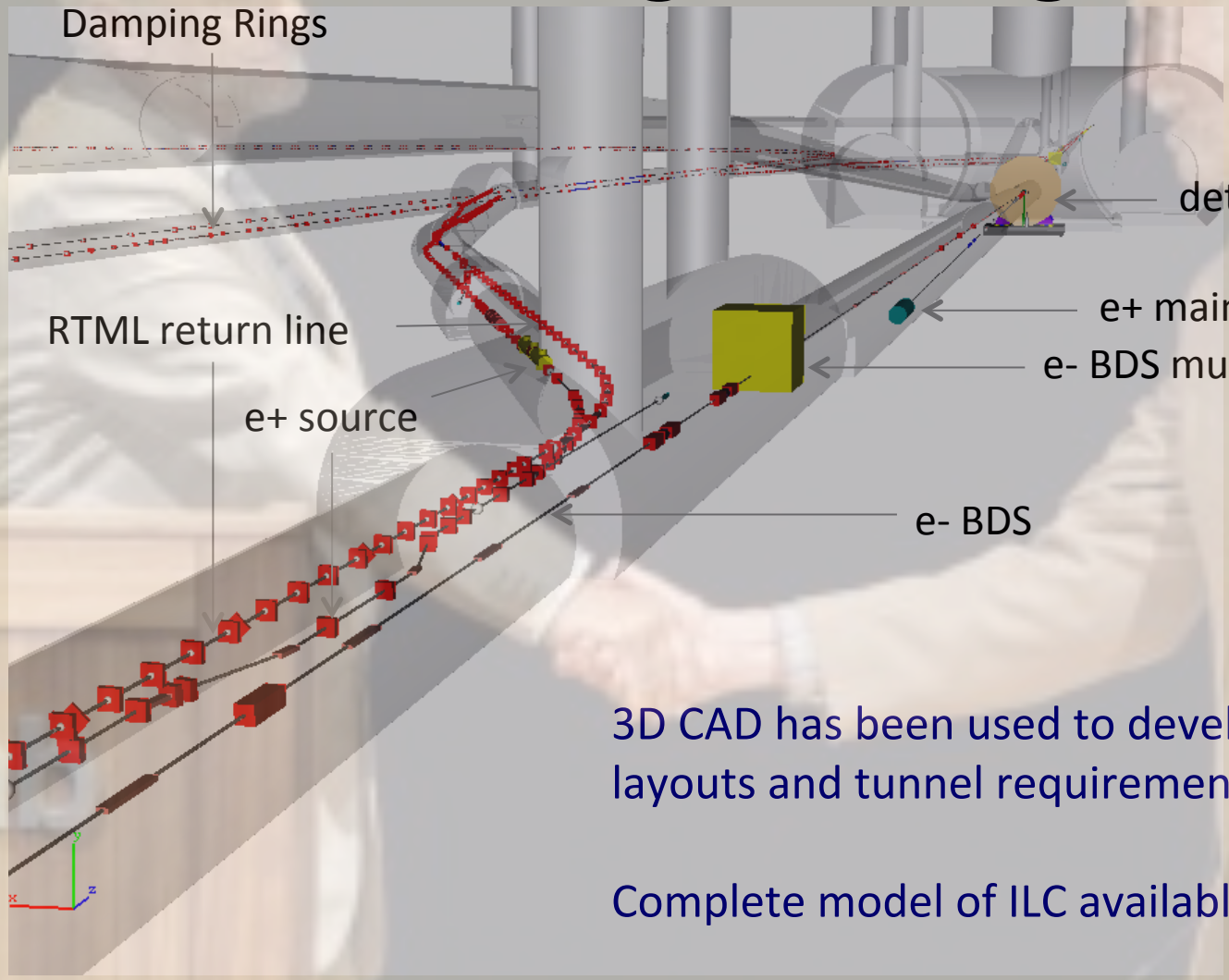
March 2005

A greatman agreement

March 2005

June 2013

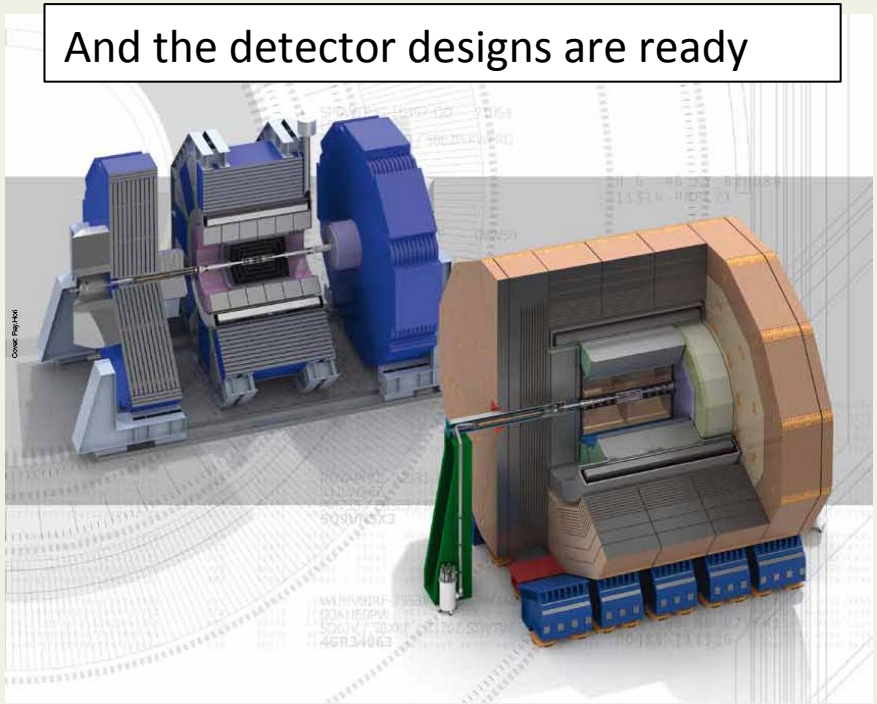
Central Region Integration

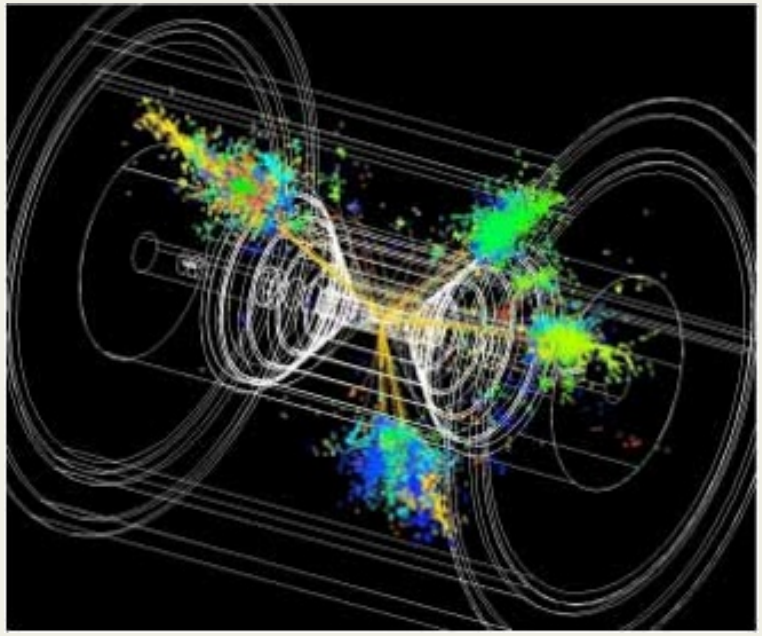


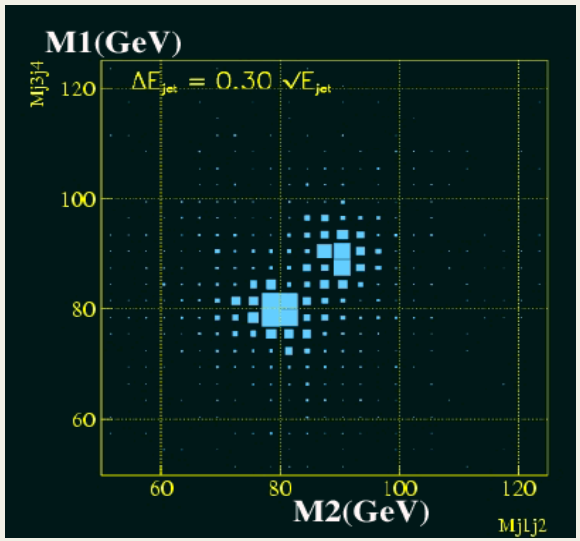
3D CAD has been used to developed beamline layouts and tunnel requirements.

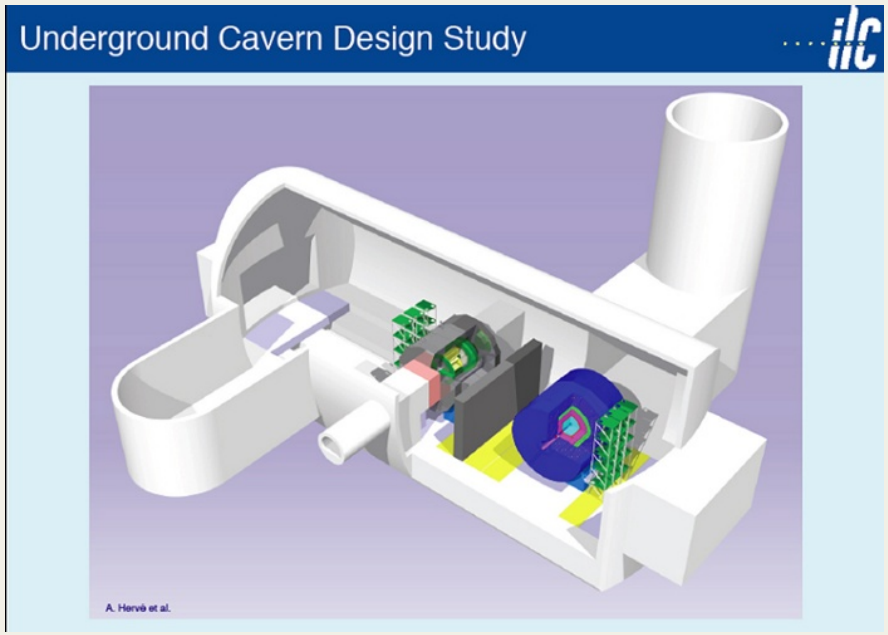
Complete model of ILC available.

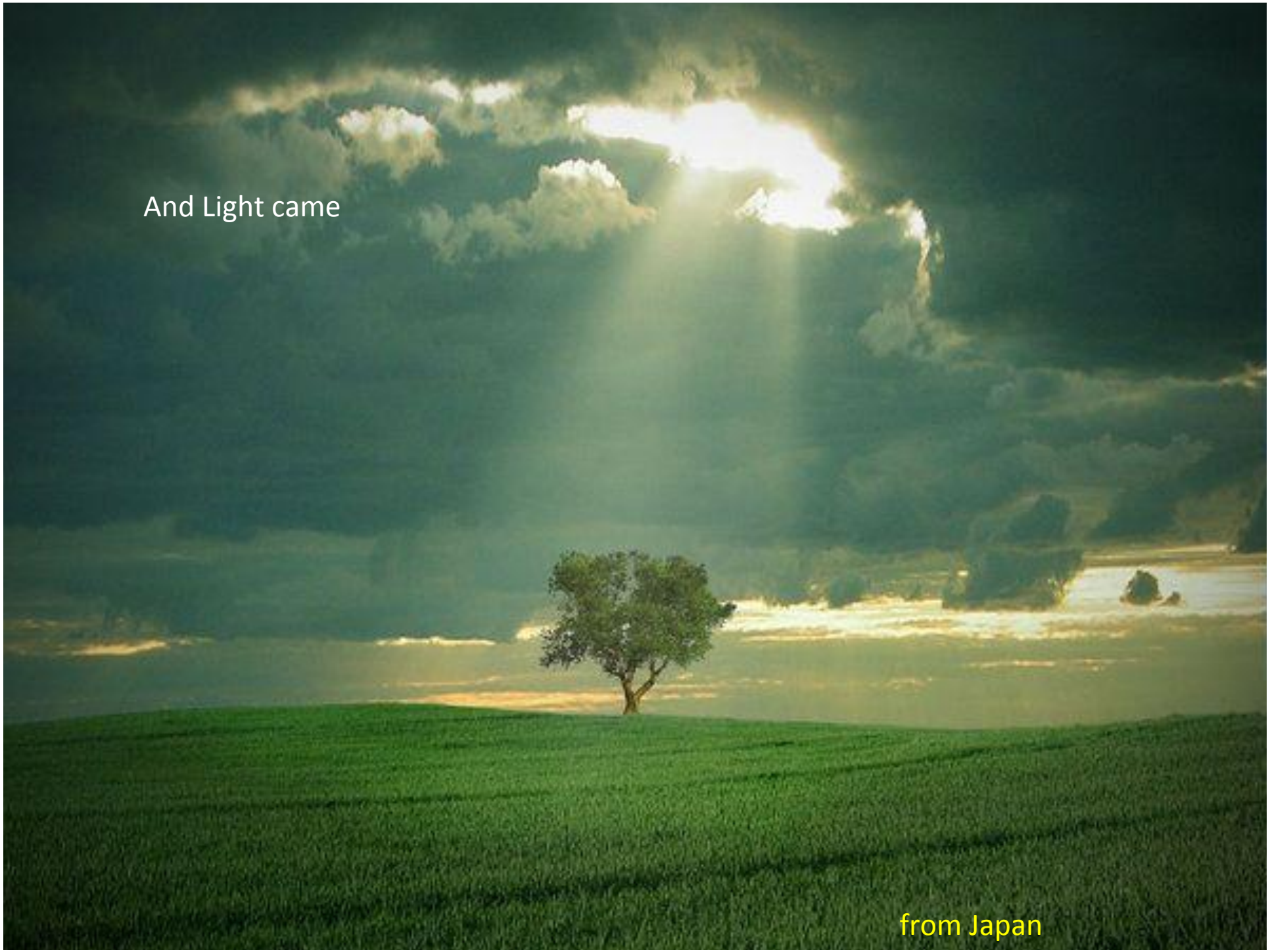
And the detector designs are ready







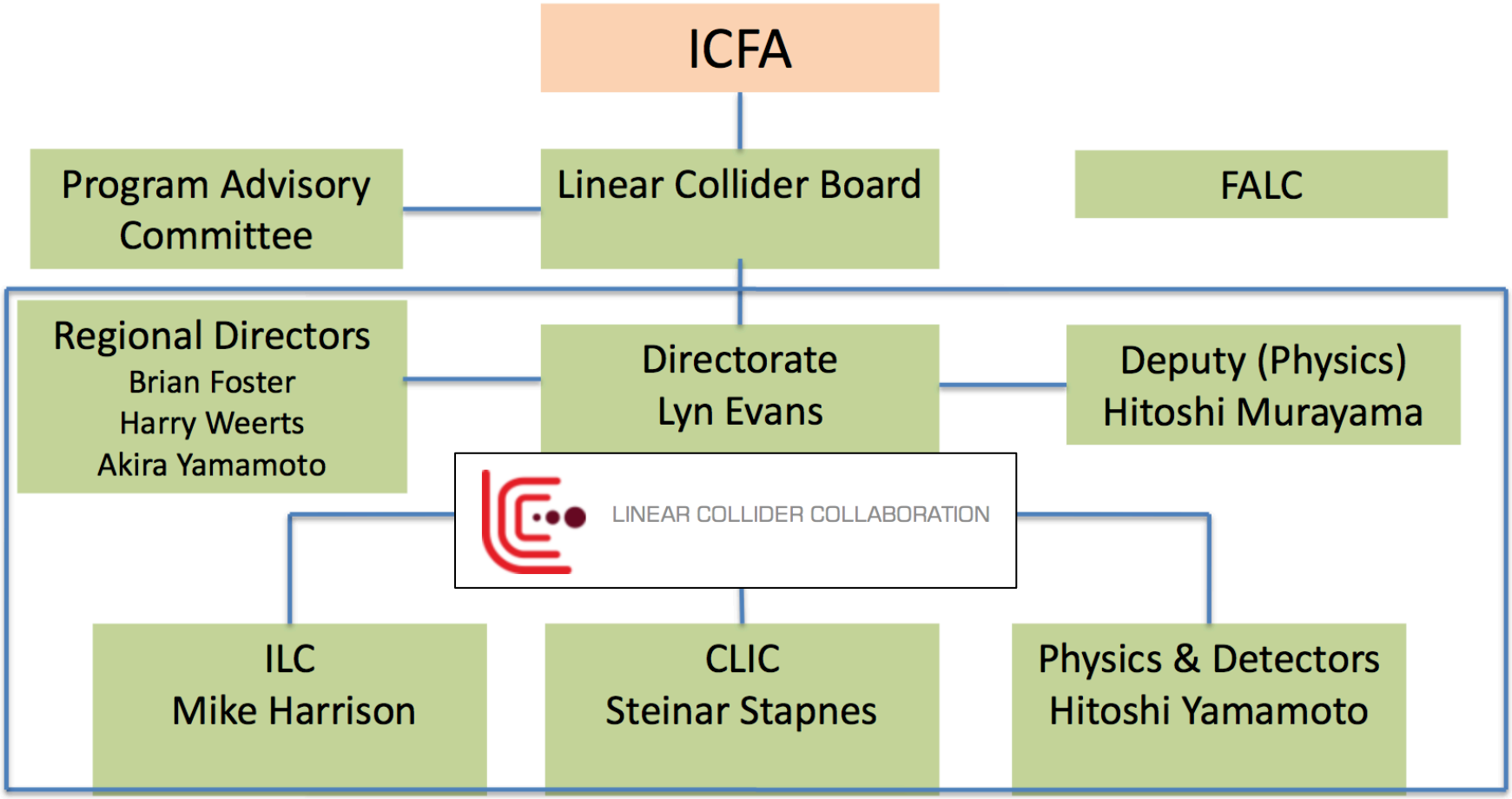



And Light came
from Japan

LINEAR COLLIDER COLLABORATION

Designing the world's next great particle accelerator

Organization



One needs consensus in critical countries

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

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.

IHEP Director, Prof. Yi Fang Wang's speech for ILC Event on June 12, 2013

(During Fragrant Hill Scientific Meeting on future e+e- colliders, June 12-14, 2013, Beijing)

(China's stand point on ILC)

Today is a very important day for our high energy physics community and for the global Science community. After almost 10 years efforts, we completed the technical design report of the International Linear Collider(ILC). This is truly an international event, to be celebrated by all the scientists and engineers involved in the last twenty years, by everybody in the community and by the whole world.

Since August of 2004, when ICFA having chosen the cold technology for ILC at IHEP in Beijing, thousands of scientists and engineers around world from different institutions and universities have been working as an integrated team on this unique project, a truly global efforts, a great worldwide endeavor of human being, and a big dream for all of us. The way we are organized is very successful, of course, with a very strong leadership and inspiration of Prof. Barry Barish and Prof. Sakue Yamada. The completion of TDR shows that we can organize ourselves successfully and efficiently. This is also a demonstration that we can organize ourselves to construct the ILC, and our dream can become a truth.

The discovery of Higgs comes really on time, thanks to our colleagues at the Large Hadron Collider. ILC cannot be better justified at this moment. We can now study in detail the properties of Higgs, and search for signs of new physics beyond the Standard Model. Both are extremely important towards the understanding of the world we are living in, which is a dream by billions of people over thousands of years.

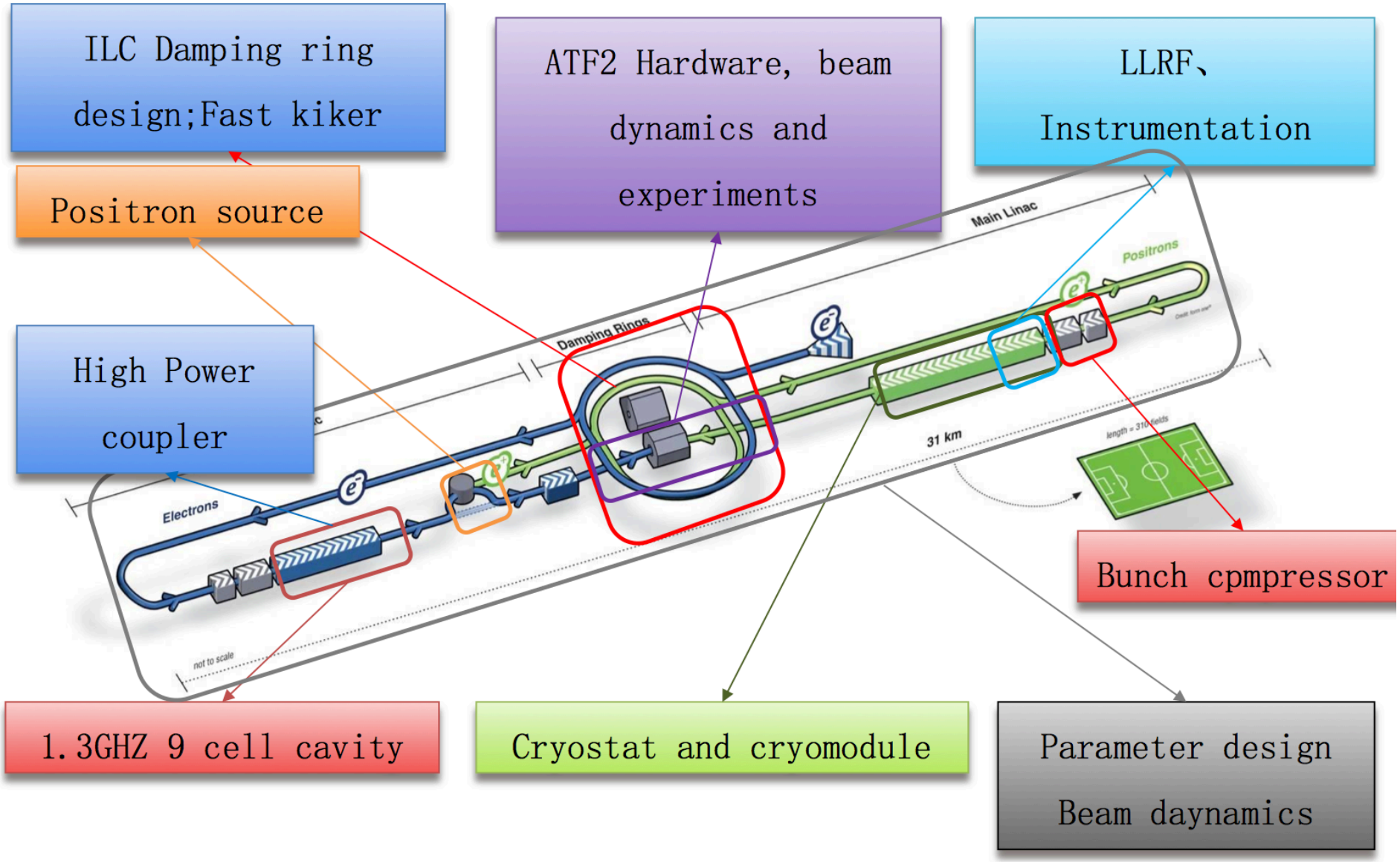
On behalf of the Chinese High Energy Physics Community, I am honored to share with you our strong emotion and full support for ILC. We will certainly be part of it. This is a new way of life for us to explore, a new wonderful culture for us to enrich, a common endeavor for us to find our own roles to participate, to contribute, to support each other, and to share its coming fruits, both for the progress of science and to the progress of our society, all in general.

With the success of this worldwide observed ILC Event, we reset the needles of our clock and make the new counting for the next milestone, the final approval of all the participating governments for the construction.

2013-6-12 Beijing

Activities in China

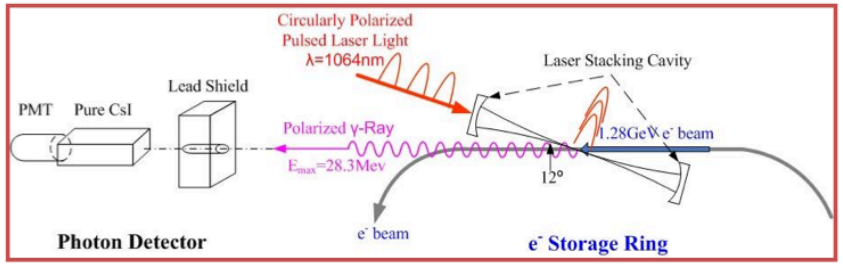
ILC R&D Activities (fields) in China

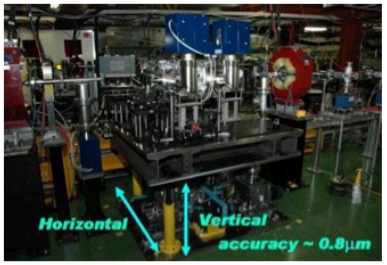


IHEP in collaborations on ILC positron source

IHEP in Collaboration With KEK

Polarized Gamma-rays generation experiment at KEK-ATF





- From September of 2005, IHEP started collaboration on ILC positron source with Omori's group from KEK.
- From September of 2006 to July of 2008, IHEP Ph. D student, Xiaoping Li, visited at KEK working on the experiment studies on the polarized Gamma-rays generation at KEK-ATF.

Setup of the experiment at KEK-ATF

IHEP in Collaboration With LAL (FCPPL)

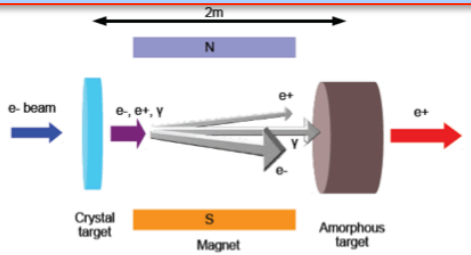
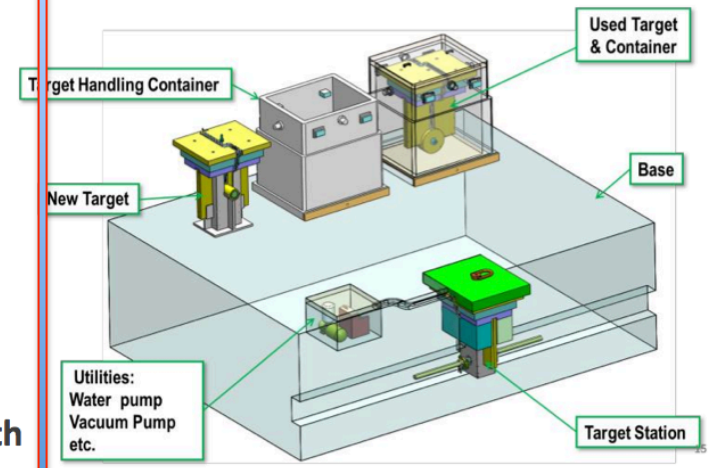


Figure 5.1: Hybrid scheme using crystal and granular target for ILC.(TODO not correct, take the figure of the bending magnet)

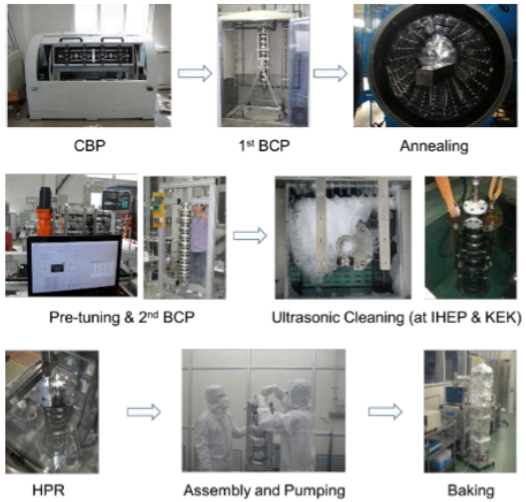
A Ph.D student of IHEP, Mr. Chenghai Xu, has been co-directed by supervisors LAL (R. Chehab) and IHEP under FCPPL (2008-2012). Now Dr. Jin Song works with LAL (2013-) .

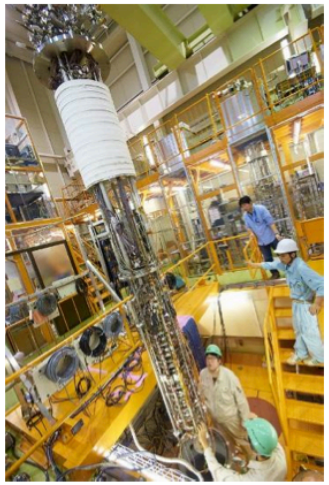
New General Layout for Remote Target Replacement of positron source , Dr.Jia of IHEP



IHEP in Collaboration With ANL

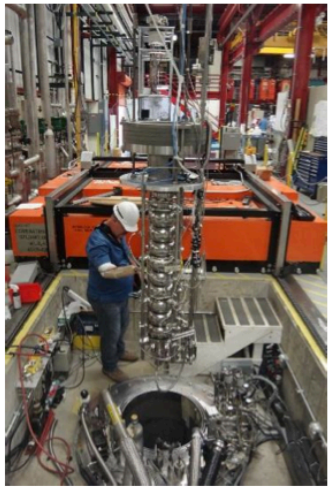
IHEP 1.3GHz 9-cell LL-LG Cavity Process, Test and Dressing (Collaboration with KEK, Jlab and Fermi)





IHEP-01 1st pass at IHEP and KEK (2010)

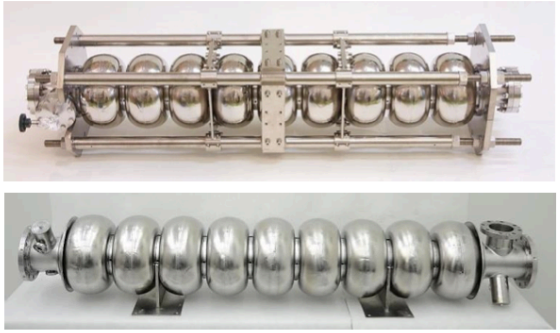
IHEP-01 2nd pass at IHEP and JLAB (2011)



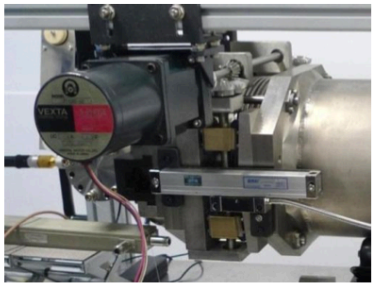
IHEP-02 at IHEP and FNAL （2013）

Helium vessel and magnetic shield （2013）

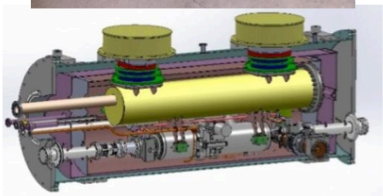
Key SC Accelerator Technologies for ILC at IHEP
（Summary)



1.3GHz 9-cell cavity (IHEP-01,IHEP-02)
IHEP first Large-grain low-loss shape, 20MV/m



Tuner



Input coupler (tested)

LLRF (tested)

IHEP ILC Test Unit

12 m Cryomodule for Euro-XFEL
PXFEL1 in FLASH; 58 ordered for XFEL

First Visit from Japanese Government on ILC

-Visit of Japanese Embassy Officer to IHEP

（日本驻华使馆经济部一等秘书来访）

Vietnam is coming…

"Windows on the Universe" held at ICISE, Quy Nhon, August 11-17, 2013, Vietnam

"Physics at LHC and beyond" to be held at ICISE, Quy Nhon, August 11-17, 2014, Vietnam

Statement from the Asian High Energy Physics Community on the International Linear Collider

（http://www.interactions.org/cms/?pid=1033193）

Date Issued: 3 September 2013

……

(Asia's stand point on ILC)

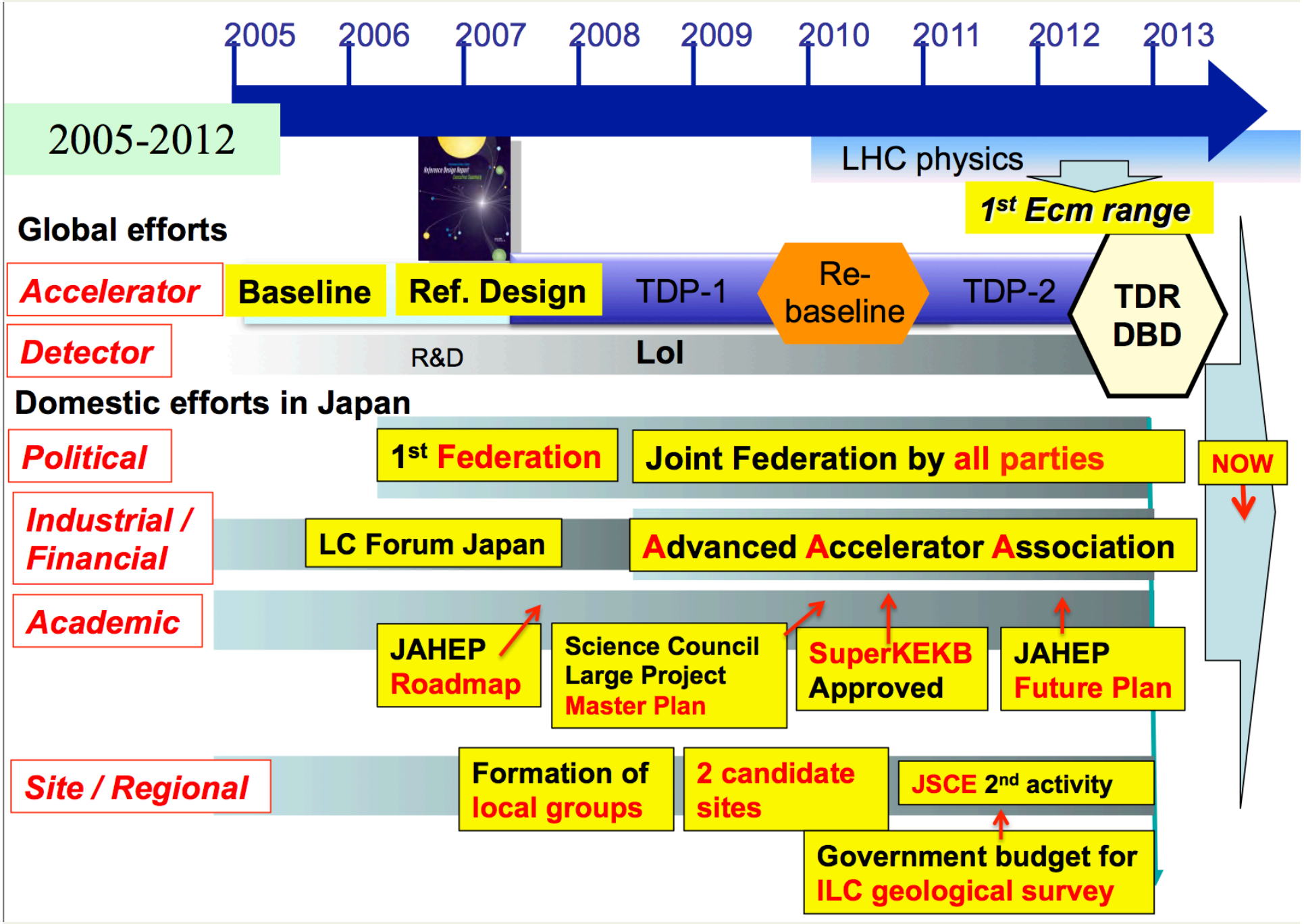
AsiaHEP/ACFA believes that the ILC is the most promising electron positron collider to achieve next generation physics objectives.

……

AsiaHEP/ACFA welcomes the proposal by the Japanese HEP community for the ILC to be hosted in Japan. AsiaHEP/ACFA looks forward to a proposal from the Japanese Government to initiate the ILC project.
Considering the situation in which accelerator science is rapidly growing and related technologies are building in Asia-Oceania region, the participation in a cutting-edge accelerator project, such as the ILC, will accelerate the benefits to the whole accelerator science as well as to high energy physics in this region.

AsiaHEP/ACFA will make every effort to promote the ILC, especially in Asia-Oceania region.

An essential element is political


2005
2006
2007
2008
2009
2010
2011
2012
2013
2005-2012
LHC physics
1st Ecm range
Global efforts
Accelerator
Baseline
Ref. Design
TDP-1
Re-baseline
TDP-2
TDR
DBD
Detector
R&D
LoI
Domestic efforts in Japan
Political
1st Federation
Joint Federation by all parties
NOW
Industrial / Financial
LC Forum Japan
Advanced Accelerator Association
Academic
JAHEP Roadmap
Science Council Large Project Master Plan
SuperKEKB Approved
JAHEP Future Plan
Site / Regional
Formation of local groups
2 candidate sites
JSCE 2nd activity
Government budget for ILC geological survey

Federation of Diet Members for promoting ILC

In 2006, Ruling Party members (LDP at that time) established the Federation of Diet members for ILC

1st step:
Efforts to help politicians understand the importance of the basic research and global projects

→ In 2008, expanded to "Joint federation" among the Ruling and Opposition parties (Democratic Party, LDP, New Komeito, and so on)

→ In **2013 Feb**. new headquarter was established and expanded

→ more than **150 Diet members** participate (out of ~700 Diet members)

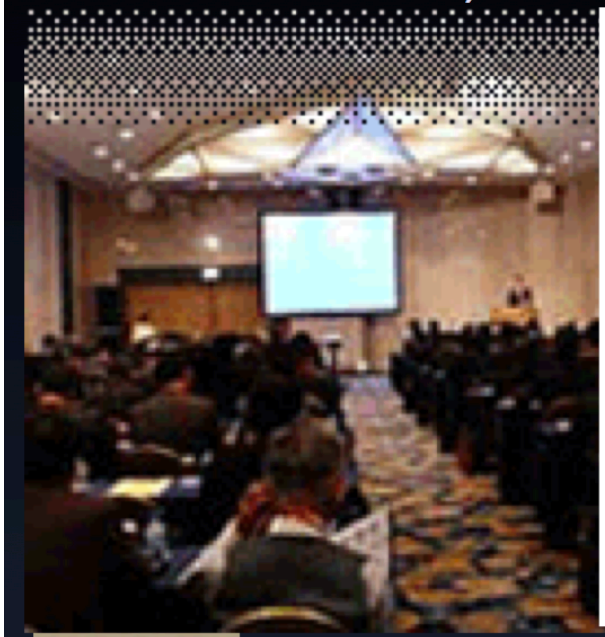
Chair:
Takeo Kawamura

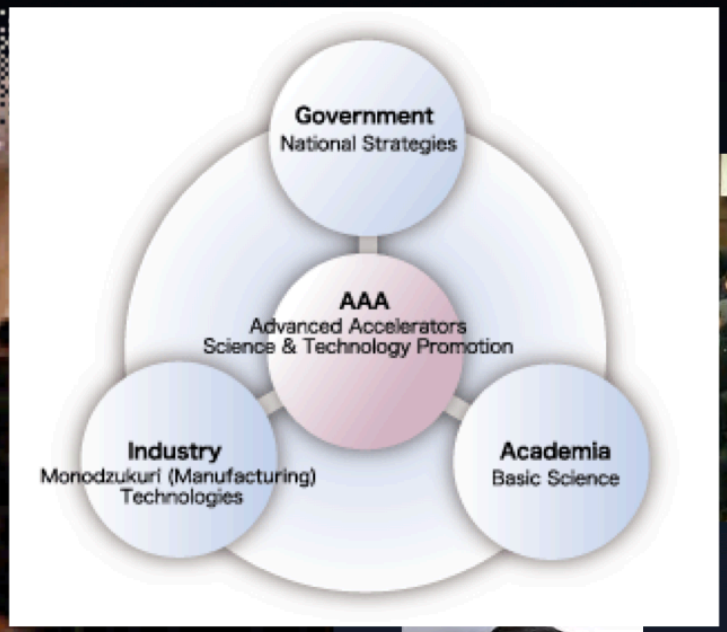
The most important target of the Federation is to realize **ILC as the GLOBAL PROJECT, and strongly support the global R&D efforts.**

The Federation supports domestic preparation processes and investigations to prepare the case for **Japan as the host if global society wishes**.

Advanced Accelerator Association
Promoting Science & Technology

Established in 2008 to promote accelerator research and ILC. Members include 95 corporations (e.g. Kyocera, Hitachi, Mitsubishi Electric, Mitsubishi Heavy Industries, Toshiba) and about 40 universities and institutions.





http://www.aaa-sentan.org/

Takashi Nishioka, Chairman
Former Chairman of the Board, MHI

Kaoru Yosano, Supreme Advisor
Former Minister of Finance, MEXT,
Former Chief Cabinet Secretary

Satoru Yamashita

Masatoshi Koshiba, Honorary Chairman
Professor Emer., The University of Tokyo

Atsuto Suzuki, Trustee
Director General, KEK

March 27th 2013

2013 Mar 27

Lyn Evans, as Linear Collider Collaboration director, meets Prime Minister Abe

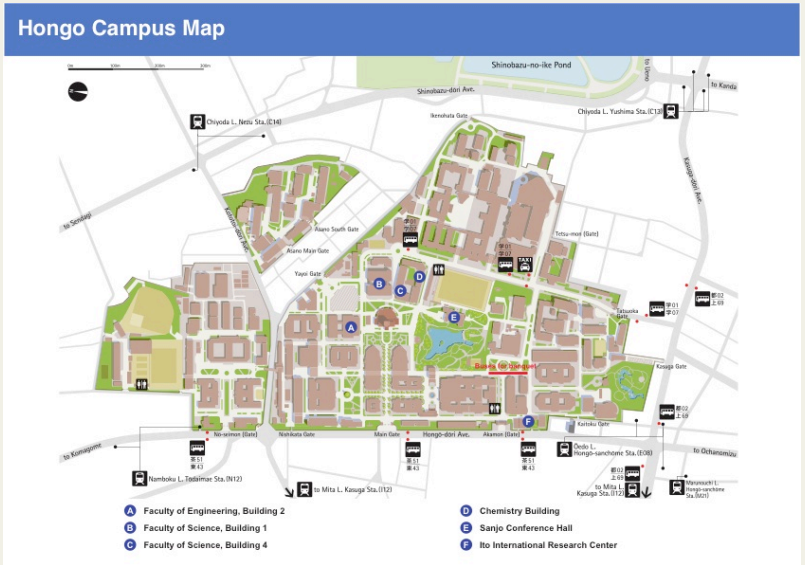
Bring message from Europe (white paper), thanks for the supports by Japan, world-wide expectation to Japan for ILC.

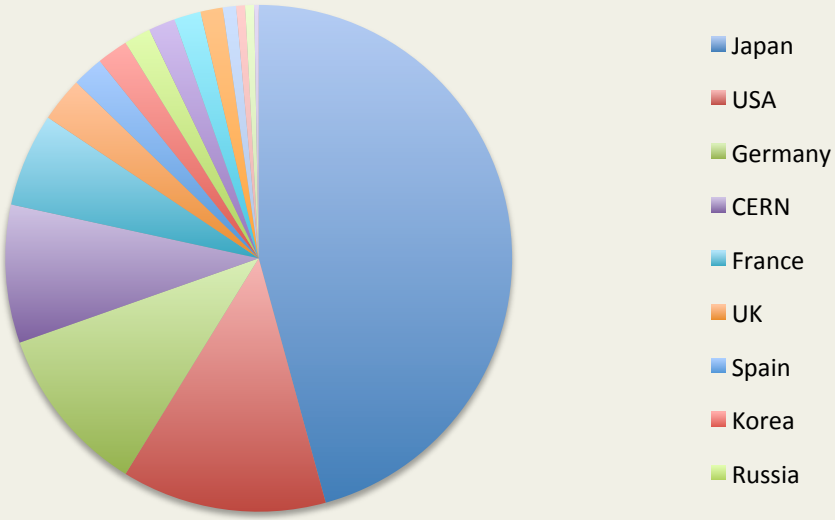
Prime Minister Abe, Mr Kawamura, Mr Shionoya, Lyn Evans, Prof. Koshiba, A. Suzuki, H. Murayama, S. Yamashita

Minister of MEXT

Minister of S&T of CAO

Mr. Okamura of Japan Chamber of Commerce and Industry (business sector)


Hongo Campus Map
Shinobazu-no-ike Pond
Shinobazu-dori Ave.
Chiyoda L. Nezu Sta.(C14)
Chiyoda L. Yushima Sta.(C15)
Ikenohata Gate
Asano South Gate
Asano Main Gate
Yayoi Gate
Tetsu-mon (Gate)
Tatsuoka Gate
Kasuga Gate
Kariyoku Gate
Bunkyo-do-dori Ave.
No-seimon (Gate)
Nishikata Gate
Main Gate
Hongo-dori Ave.
Akamon (Gate)
Dedo L. Hongo-sanchome Sta.(E08)
Namboku L. Todaimae Sta.(N12)
to Mita L. Kasuga Sta.(I12)
A Faculty of Engineering, Building 2
B Faculty of Science, Building 1
C Faculty of Science, Building 4
D Chemistry Building
E Sanjo Conference Hall
F Ito International Research Center


Japan
USA
Germany
CERN
France
UK
Spain
Korea
Russia

Federation of Diet Members meeting

16th October 2013

MEXT

Mr Yoshida DG Research promotion bureau
Mr Ikukawa Director of Promotion policy division
Mr Ando Director basic research division
Mr Odoi Director of particle and nuclear physics
Mr Narai Accelerator expert in Particle and nuclear division

Cabinet Office

Mr Morimoto Deputy DG for science and technology
Mr Matsui Council for Science and Technol

LINEAR COLLIDER COLLABORATION

Federation (continued)

Ministry of Foreign Affairs

Mr Takahashi Director, International Science Cooperation
Mr Ikeda International Science cooperation division

METI

Dr Tokumasu Director International affairs office

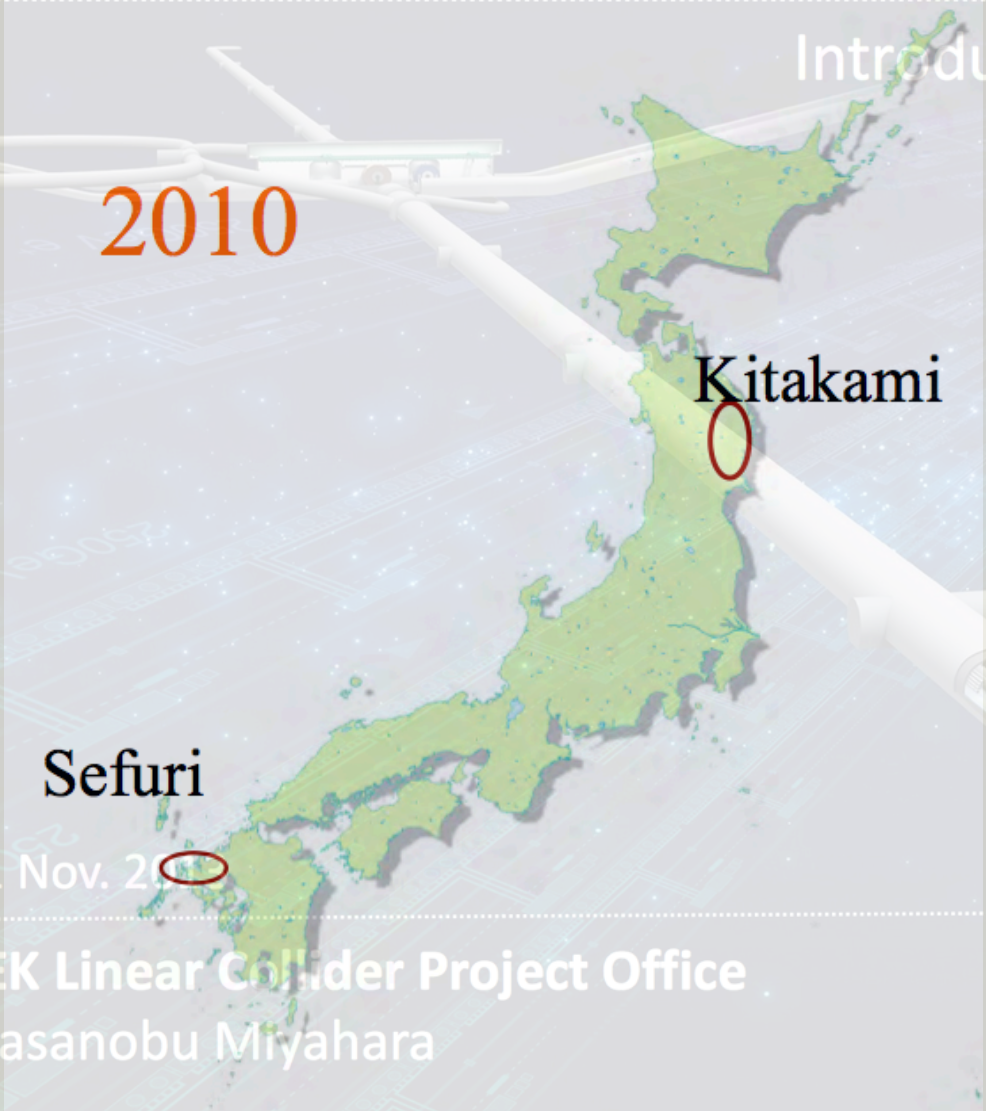
MLIT (ministry of construction and transport)

Mr Yamamoto Director for environment and engineering

Plus many senior Diet members.

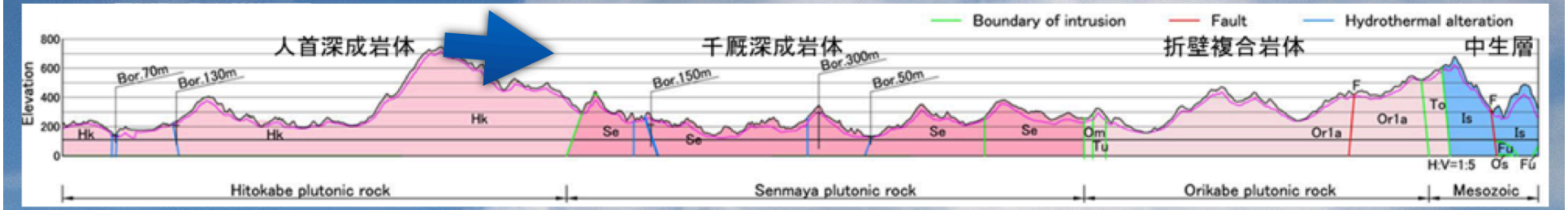
ILC Candidate Site Studies

Introduction of Kitakami Site

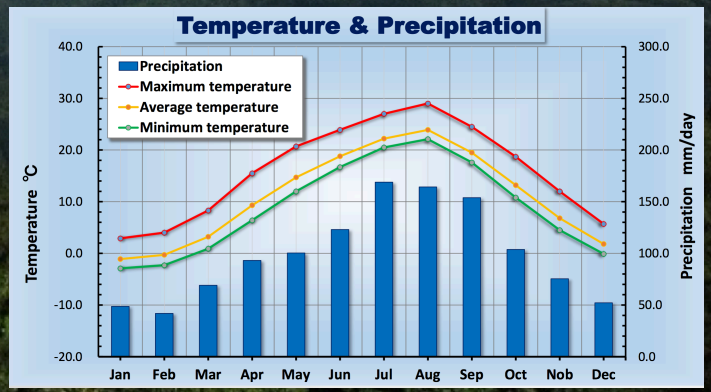


11 Nov. 2013

KEK Linear Collider Project Office
Masanobu Miyahara


Boundary of intrusion
Fault
Hydrothermal alteration
Elevation
800
600
400
200
0
人首深成岩体
千厩深成岩体
折壁複合岩体
中生層
Bor.70m
Bor.130m
Bor.150m
Bor.300m
Bor.50m
Hk
Se
Om
Tu
Or1a
F
To
Is
Fu
Os
H:V=1:5
Hitokabe plutonic rock
Senmaya plutonic rock
Orikabe plutonic rock
Mesozoic

IP (~12km away)


Temperature & Precipitation
Precipitation
Maximum temperature
Average temperature
Minimum temperature
Temperature °C
Precipitation mm/day
40.0
30.0
20.0
10.0
0.0
-10.0
-20.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
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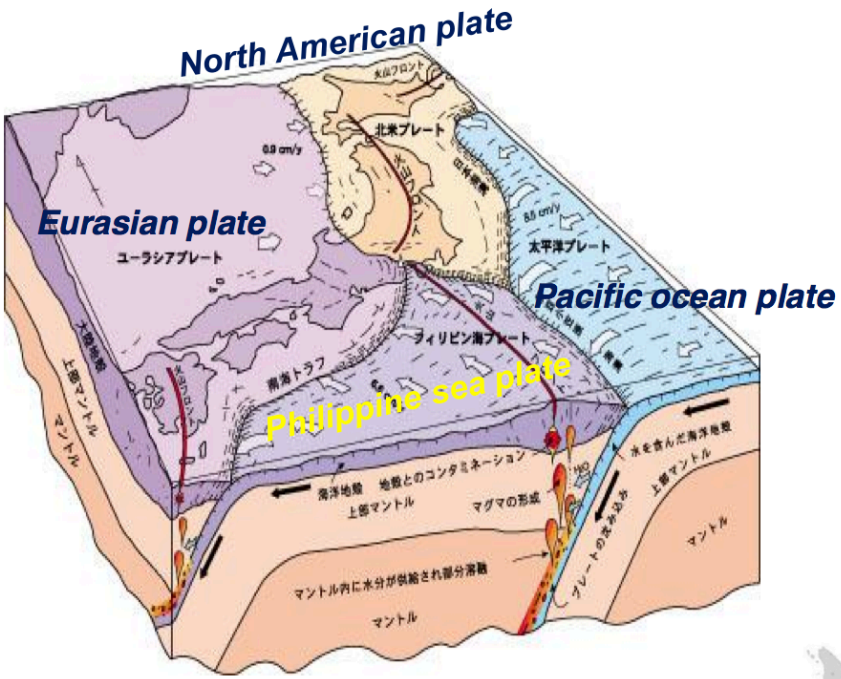
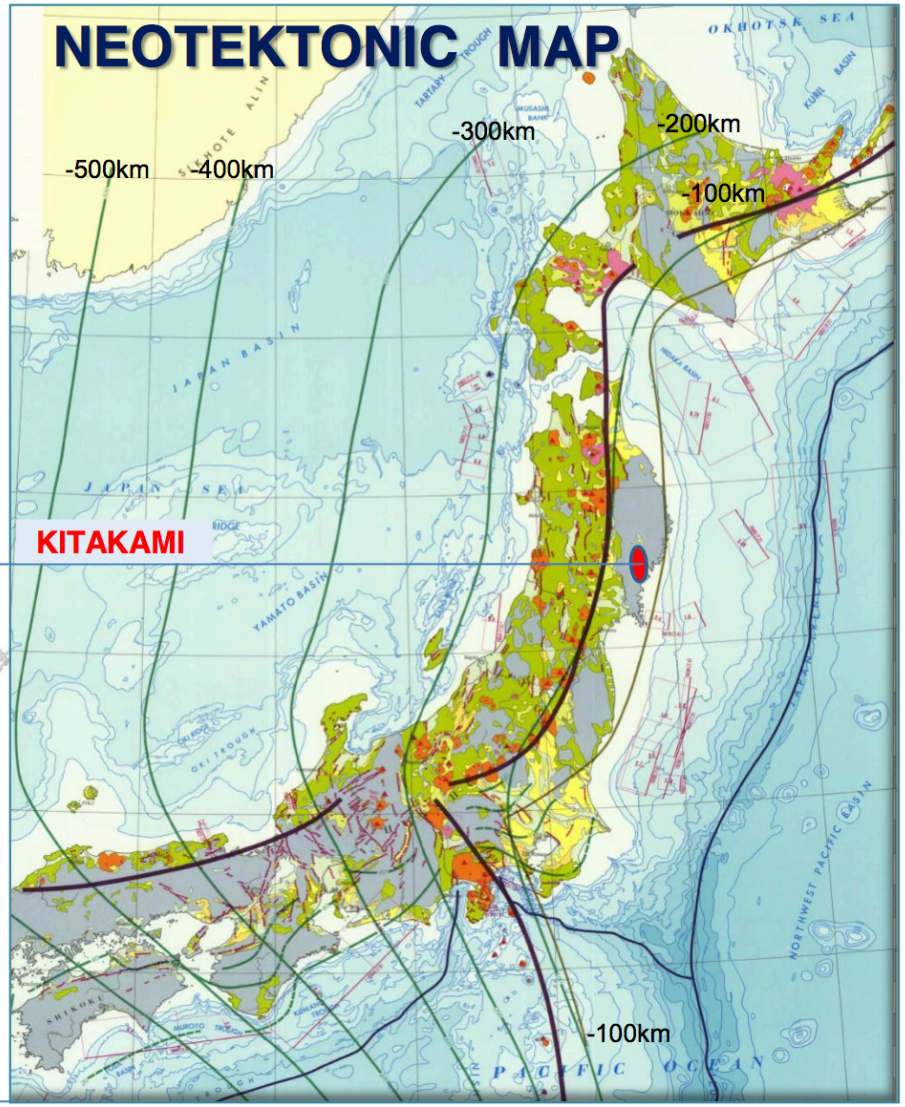
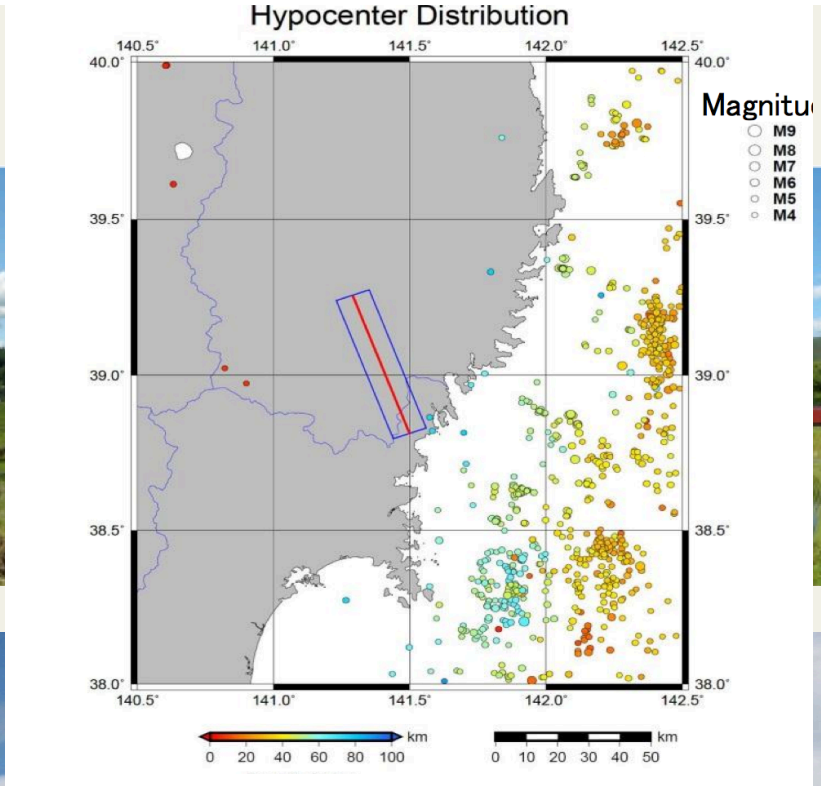
Oct
Nob
Dec

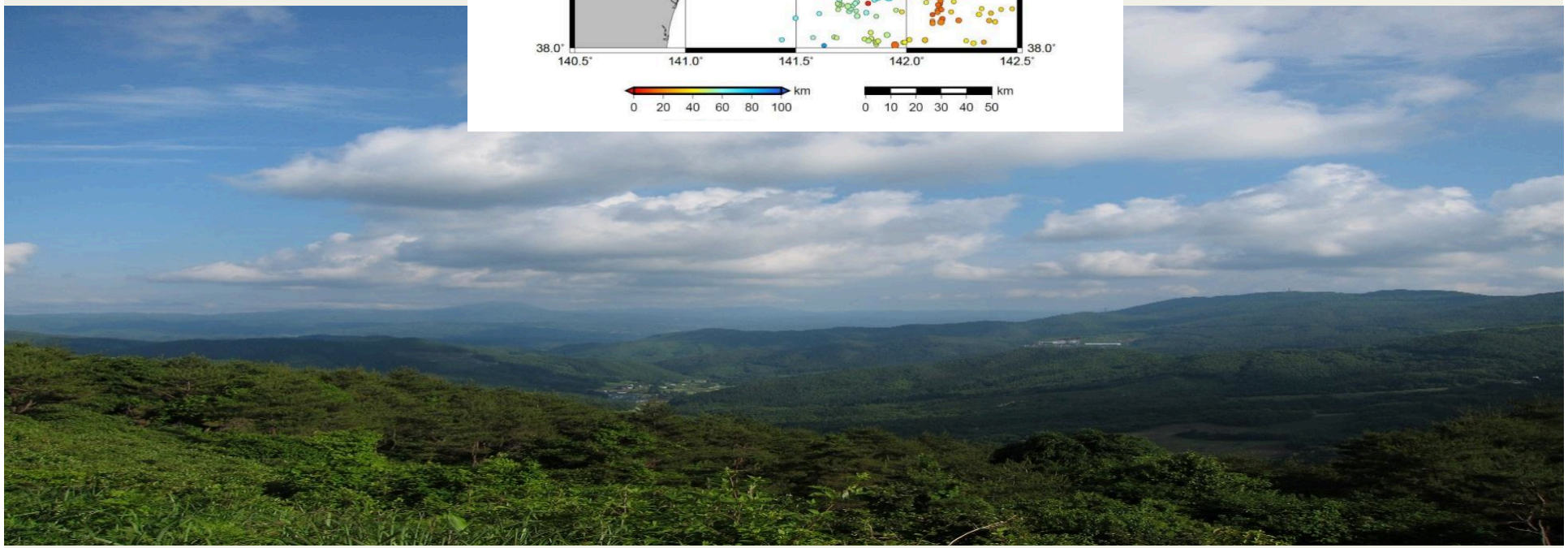


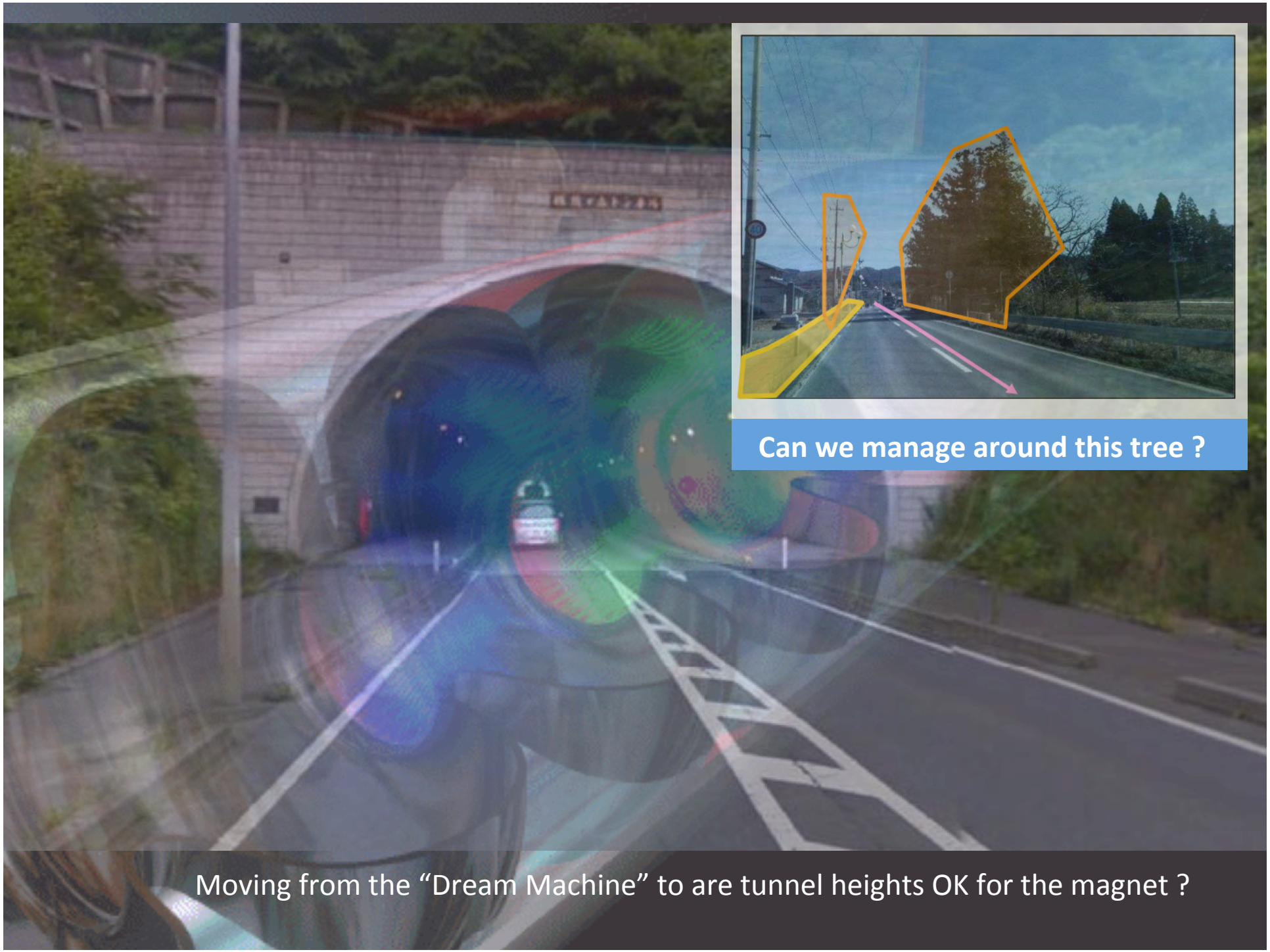


Legend

- Sea Trench
- Volcanic front
- Upper surface of subducting plate


Hypocenter Distribution
140.5°
141.0°
141.5°
142.0°
142.5°
40.0°
39.5°
39.0°
38.5°
38.0°
Magnitu
M9
M8
M7
M6
M5
M4
km
0 20 40 60 80 100
km
0 10 20 30 40 50




Can we manage around this tree ?
Moving from the “Dream Machine” to are tunnel heights OK for the magnet ?

Government and Science Council of Japan

CAO（内閣府）
(Cabinet Office)

CSTP

MEXT（文部科学省）

In Feb 2013, MEXT formed a "task force" headed by vice Minister of MEXT for the ILC. (current head: Mr. Sakurada)

Science Council of Japan （日本学術会議）

Advisory body (only academy side)

In May 2013, MEXT asked Science Council of Japan to assess the ILC → SCJ (report back on Sep 30th)

MEXT

Ministry for Education, Culture, Sports, Science and Technology

- Establish **official** body: **ILC-Taskforce** in **MEXT**
  headed by vice-Minister (Feb. 2013)
- **Official** request to **SCJ** (Science Council of Japan) to assess the academic significance of ILC and issues to solve (May, 2013)
- Division in MEXT for all accelerator-rerated infrastructure: Quantum radiation research division → Additional **new division** is established in MEXT (June, 2013) : **Particle and Nuclear Research Promotion Division**; Director: S. Odoi
- **Official** hand-in process to MEXT has been done for **TDR** (Oct, 2013)
- **Official** hand-in process to MEXT has been done for Site Assessment (Oct, 2013)
- Direct communications started between MEXT and LCC management team
- **Governmental Budget Request** by MEXT for ILC **Project investigation** for FY2014 (conclusion for request to come early in Jan. 2014)
- **Renewal** of **ILC-Taskforce** in MEXT headed by vice-Minister (Nov. 2013)
- Committees/working groups to be established under the ILC-Taskforce (to come)

Science Council of Japan

Remarks on the ILC, September 30, 2013

Excerpt (tentative/private translation)

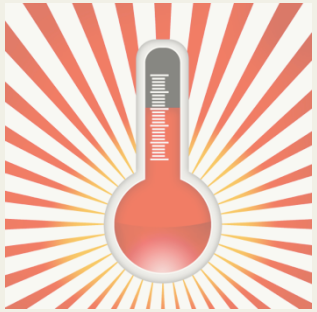
- **Based on the viewpoints above, the Science Council of Japan proposes that the Japanese Government funds budget for the necessary investigations on various issues in order to judge as Japan for the realization of the ILC project, and for 2 to 3 years intensively conduct investigations involving experts from outside the field and corresponding Government bodies.**

- **In deciding to host the ILC in Japan, it is indispensable that the issues and concerns raised by this report are fully investigated and reviewed, and clear prospects are obtained for questions such as the whole pictures of project cost for the construction, operation, upgrades, up to the final disposition and the prospects of international cost sharing thereof, as well as issues of sharing of human resources, and international governance structure.**

- **In parallel with the above investigations, negotiations should be conducted with research laboratories and responsible funding authorities of primary countries and regions to clarify the prospects for the international cost sharing.**

- **Upon fully examining the various conditions for the ILC project to be implemented in Japan and to be highly successful, it is important to form a consensus within the Japanese academic community and to seek understanding of the Japanese public.**

Media thermometer



TRANSCRIPT (English translation)
Speaker: **Mr. Takeo KAWAMURA**
Date: November 11, 2013
Venue: International Workshop on Future Linear Colliders (LCWS13) at The University of Tokyo

As you already know, there were two candidate locations for the construction of the ILC, in the north and south of Japan. After a series of both scientific and sociological evaluations by experts, in August of this year the northern site in the Kitakami Mountains was chosen as the site for the ILC. We politicians agree that the site for the ILC should be chosen based on scientific and technological arguments.

I think that most Diet members' knowledge of physics is at high school students' level. If you allow me, let me take the liberty of pointing out that the understanding of political dynamics by most particle physicists is also at high school students' level. If physicists and politicians collaborate by using each other's area of expertise, it is certain that we can accelerate the realization of the ILC project.

TRANSCRIPT (English translation)
Speaker: **Mr. Takeo KAWAMURA**
Date: November 11, 2013
Venue: International Workshop on Future Linear Colliders (LCWS13) at The University of Tokyo

After a request from the Department of Education and Science, the Science Council of Japan announced its "opinions on the ILC project", from an academic point of view. We would like to clear up some misunderstandings which may have arisen from the way in which this opinion was reported in the media. The conclusion of the final report proposes to appropriate fund to both evaluate the academic motivation for the ILC, and to investigate aspects which may need more work, in order to appropriately allocate government funds.

Particular emphasis was put on the need for a more precise cost estimate, the need to discuss the required budget and international partnerships, and the necessary distribution of manpower over the next 2-3 years. To achieve these goals, the Department of Education has requested the Department of Finance to provide an ILC investigation fund of 50 million yen in next year's budget, in addition to R&D funds for research laboratories.

Although this amount is not large compared to the R&D funds, it will be the first official governmental "investigative budget" aimed at realizing the ILC. This still needs to be approved by the Department of Finance, however once it has been approved, we members of the house will have achieved one of the most important milestones of recent years. We are aware that people are usually worried that an increase of academic budget in one field may mean a decrease in other fields. ILC is not simply an academic project within science. We shall arrange a dedicated budget to accommodate its much wider implications. It is the responsibility of the government to carry this out.

MEXT

- October 1st, 2013

Minister of MEXT, H. Shimomura, in a general press conference:

Japanese government will create a working group of advisors with specialists from various fields as soon as possible. A task force exclusively set up to study the ILC at MEXT has been working since February, deepening the understanding of the project in the ministry. A new working group will be set up under the task force, which will review the possible issues on the realization of the ILC in Japan.

The official process has been started !

Genuine OFFICIALIZATION to come when MEXT budget is approved

Government has provided **R&D** budgets for a long time (more than 10M$/year excluding salary, more than 100M$ M&S budget in total → all have been allocated to KEK/Universities)

- **One of the most important milestones reached! Governmental PROJECT investigation budget** (NOT KEK R&D Budget) to **officially** start project process.
- **It means** the project plan is in **official line** and **officially** within the insight of Government (not only for MEXT, but also for the whole Japanese government). Then, government officials are required to **act on** the plan.
- Requested amount is 0.5 M$ (FY2014): One of the main usages shall be travel expenses of officers for international partnership discussions.

Soon, the ILC Taskforce in MEXT will start the investigation of

1. Construction cost and total Project cost (the earliest start to come)
2. Project plan from construction, operation, upgrade to possible dismantling
3. Feasibility of world-wide Sharing of human resources (accelerator experts)
4. Possible Schemes of the International organization

Urgent request by MEXT to the HEP Community

MEXT (the head of the task-force and officers) is now requesting us to **urgently prepare materials** to start with. Otherwise, no efficient progress.

It is urgent and vital for the successful investigation to have ***MODELS, GUIDES and HYPOTHESIS*** **by international researchers** (**lead by LCB/LCC** with world-wide LC-HEP Community) and *prepare* *simple and easy-to-understand materials* on;

- List of relevant contact divisions/branches/bureaus/authorities in each government, to whom to first contact for ILC from Japanese Government
- Explanations of Official situations (honest one) of ILC in each country/region
- Project Plans (models of schedule), International Governance Models,
- Total Project Cost and Models of necessary world-wide budget profile for ILC
- Feasibility Demonstration of international sharing models of experts world-wide

+ Later if possible, Hypothetical models of international sharing of the project Costs

Ministry of Foreign Affairs (MOFA)

In Japan, when government authorities interact with foreign countries, consultation or cooperation by Ministry of Foreign Affairs (MOFA) is essential. MOFA is also watching the world situation of ILC project.

- MOFA actually once surveyed in Jul.-Sep. 2013 about the government-level situation of ILC in various countries by hearing from corresponding officials in each country/region.
- The result of the survey was *disappointing…* (told by a former vice-Minister of MOFA, who is one of the strongest supporters of ILC)
- Currently, no country **officially** supports the realization of ILC project, most are "neutral", some are negative.. It causes additional fear and hesitation against jumping for Japan to raise the hand→ **Need our best effort for "official" recognition in government branches, and to urgently prepare a list of best corresponding officers for ILC for mutually contacting among nations.** (FALC would be one of the best sets, but not all countries are involved)
- But it's a good starting point, because **we can only go in the positive direction!**

- **France**

Discussion with J. Martino (IN2P3) in January 2012. Expected ~ constant effort over next few years on SCRF-related topics, e.g. HOM coupler etc. New meeting with JM, and leaders of CEA, planned this month in conjunction with IRFU LC meeting (see later). Substantial XFEL work, mostly at Saclay & Orsay, relevant for ILC. Production line for XFEL cryomodules now operating smoothly at Saclay.

- **Italy**

Discussion with N. Perroni & U. Dosselli in June. ~All ILC dedicated activity stopped after "approval" of SuperB. After cancellation, INFN examining several ideas for future facilities. Several of them would use SCRF technology. INFN would like strong involvement in ILC once there is a clear signal from Japanese government.

- BF & E. Elsen visited Brussels on 13.9 to brief them on ILC status and enquire about possible H2020 funding. Very useful meeting.

IRFU Linear Collider Days

The 2013 Irfu Linear Collider Days organized jointly with CNRS will take place in CEA Saclay on-site in Building 526 Amphitheater Joliot Curie on November 27-29.
This will be the second "Journées Collisionneur Linéaire" of the French community, following the first event organized in Lyon on May 13-14, 2013*

The goal of the meeting is to discuss and to review linear collider activities in France in the areas of physics/phenomenology, detector and accelerators technologies:

http://irfu.cea.fr/Meetings/jcl02

Program Layout (Wednesday, Nov. 27 – Friday, Nov. 29, 2013):

Wed., Nov. 27	14:00-18:00	- Physics/Phenomenology Activities in France
Thu., Nov. 28	09:00-12:30	- Accelerator Activities in France
	14:00-18:00	- Detector Activities in France
		Visit XFELCEA cryomodule production facility
Fri., Nov. 29	09:00 – 12:00	- ILC Country presentations from Europe, Asia and North America (areas of cooperation with France)

(* https://indico.in2p3.fr/conferenceDisplay.py?confId=8347)

European ILC Meeting

Organised by the Linear Collider Collaboration
Friday, November 29, 2013
(Paris, 14:00 – 18:00):

Informal Discussion about the current status of EU projects, future EU H2020 call and its implication for the ILC community

Outline programme

14:00 - 14:20 -- H2020 general description and opportunities for a possible ILC application.
14:25 - 14:45 -- Present situation of the Japanese initiative.
14:50 - 15:10 -- Plans of the machine community for a H2020 application.
15:15 - 15:35 -- What ILD needs in view of H2020.
15:40 - 16:00 -- What SiD needs in view of H2020.
- break –
16:30 – 16:45 -- CALICE view.
16:45 – 17:00 -- Silicon detector views (pixels+strip).
17:00 - 17:15 -- LCTPC views.
17:15 – 17:30 -- FCAL views.
17:30 - 18:00 -- Discussion to set the main goals of the EU application.

USA

2012: US starts new strategic planning process

Step 1: Document science opportunities (done in Energy, Intensity & Cosmic frontiers) and what "tools" are needed (Instrumentation, Computing & Capabilities) plus Theory & Education/Outreach

Start in October 2012 → Community Summer Study (CSS2013) aka "Snowmass" July-August 2013

Nov 2013 Reports are complete from ~30 working groups; plus numerous white papers and summaries. Very comprehensive summary of opportunities in field and what is needed to execute them

P5 membership & activities

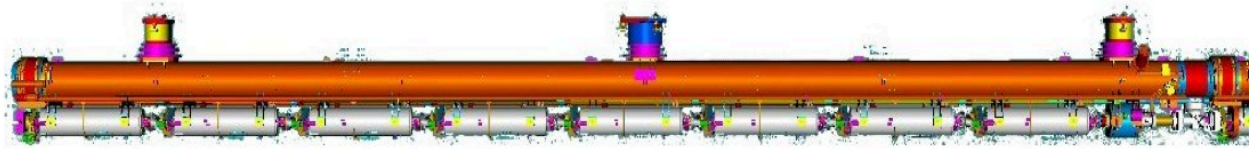
Membership
Steve Ritz (UCSC) - chair
Hiroaki Aihara (Tokyo)
Marty Breidenbach (SLAC)
Bob Cousins (UCLA)
André de Gouvea (Northwestern)
Marcel Demarteau (ANL)
Scott Dodelson (FNAL/Chicago)
Jonathan Feng (UCI)
Bonnie Fleming (Yale)
Fabiola Gianotti (CERN)
Francis Halzen (Wisconsin)
JoAnne Hewett (SLAC)
Wim Leemans (LBNL)
Joe Lykken (FNAL)
Dan McKinsey (Yale)
Lia Merminga (TRIUMF)
Toshinori Mori (Tokyo)
Tatsuya Nakada (Lausanne)
Steve Peggs (BNL)
Saul Perlmutter (Berkeley)
Kevin Pitts (Illinois)
Kate Scholberg (Duke)
Rick van Kooten (Indiana)
Mark Wise (Caltech)
Andy Lankford (UCI) – *ex officio*

Members are/were associated with ILC; some are even here

ILC cavities are at the core of various projects

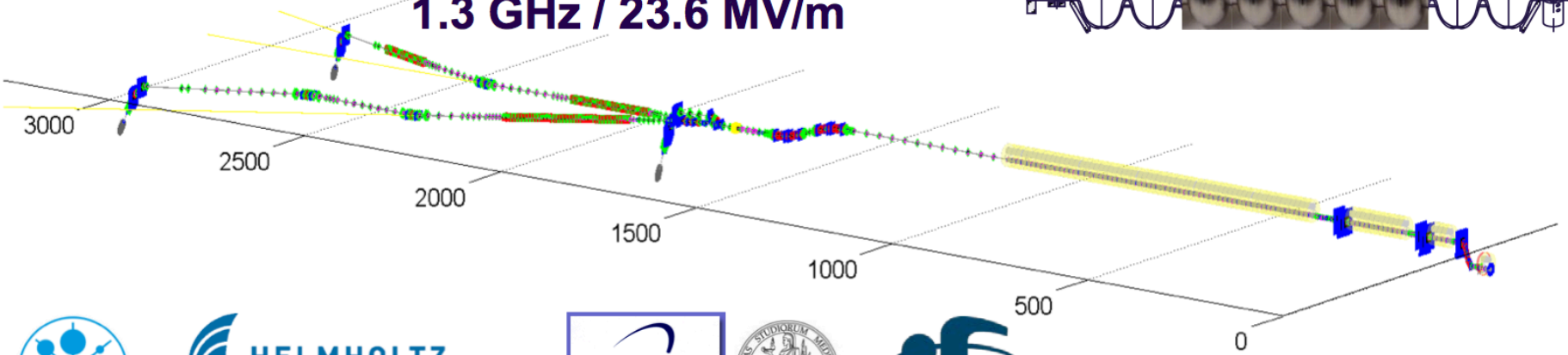
Contributors to the XFEL Accelerator

100 accelerator modules



800 accelerating cavities

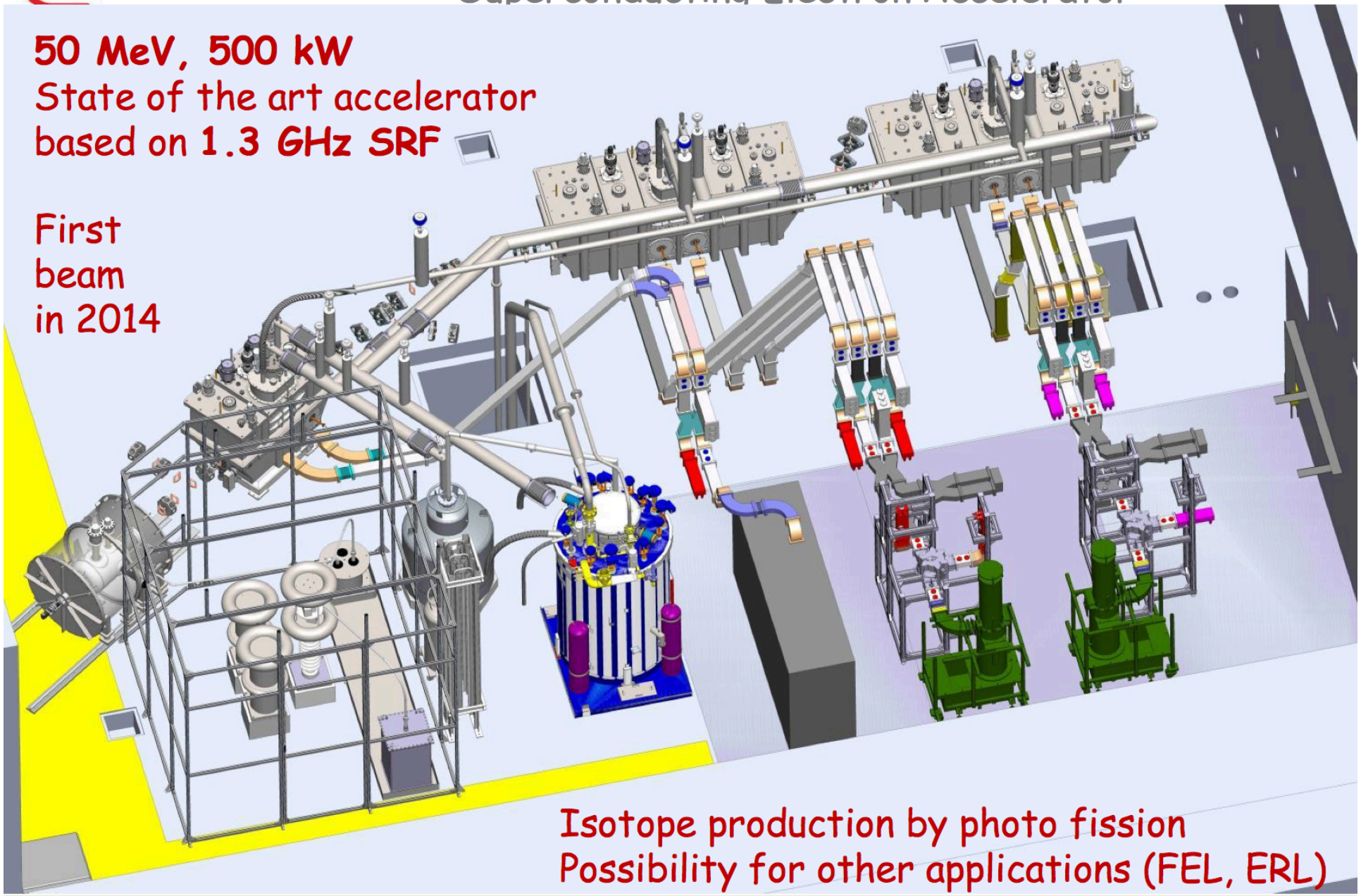
1.3 GHz / 23.6 MV/m



DESY
HELMHOLTZ ASSOCIATION
INFN Istituto Nazionale di Fisica Nucleare
irfu cea saclay
cnrs In2p3
MINISTERIO DE EDUCACIÓN Y CIENCIA
Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
Wrocław University of Technology
IHEP ИФВЭ
UPPSALA UNIVERSITET
Stockholm University
PAUL SCHERRER INSTITUT PSI

Canada: ARIEL e-Linac : MW-class Superconducting Electron Accelerator

TRIUMF

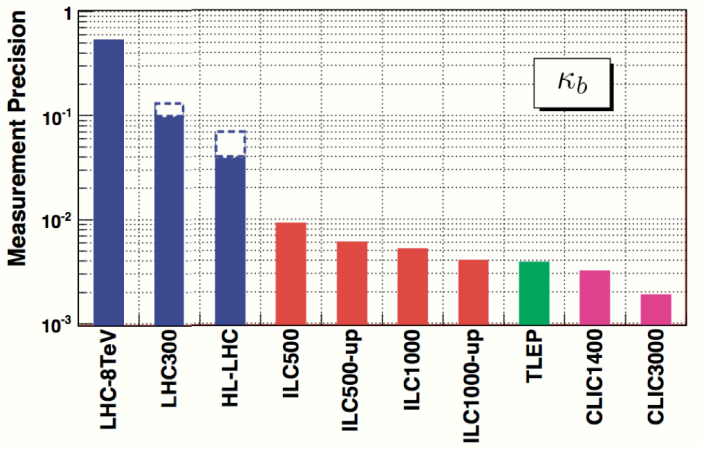


SLAC's proposed new FEL:LCLS-II

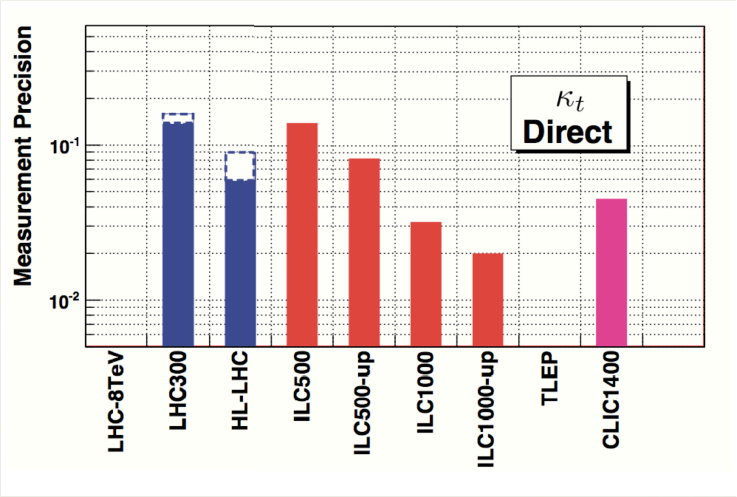
For BES
not HEP

- (under development)
- 4 GeV CW Superconducting RF Linac
  - based on DESY XFEL / ILC 1.3 GHz cavities
  - 35 cryomodules / 280 cavities
  - Gradient 16 MV/m; Q_0 2e10 at 1.8 deg K
- 0.1 micro-amp typical / 1 MHz bunch rate
- 25 micron bunch length
- Average beam power 1.2 MW max
- Cryogenics power 5.5 MW

Build on SRF expertise developed through ILC R&D: 2005-2012



?



Circular Collider ?

(so far just a set of unchecked but nice ideas)

-- ILC is linear and «ready»

-- TLEP is circular and <u>begins design study</u>

A nice wagon

But, it remains a very interesting set of ideas !
Circular machine might be technically feasible
and it would provide a link towards
a possible ultra-high energy hadron machine.
This link might prove very useful, in case:

VHE-LHC

New Physics is discovered at LHC
and
ILC nor CLIC do not materialize

LEP3 should not be dismissed… for the worst case scenario

International Workshop on Future High Energy Circular Colliders

December 16-17, 2013, Institute of High Energy Physics (IHEP), Beijing

To bring together people interested in high energy circular e^+e^- colliders as a Higgs factory as well as future high energy circular pp colliders beyond the LHC, and to discuss critical issues in accelerator development, detector design, theoretical aspects of Higgs precision measurements, and the physics potential of pp colliders of 50-100 TeV in center of mass energy.

Local organizing committee:

Gang Chen (IHEP)
Yaquan Fang (IHEP)
Liang Han (USTC)
Shan Jin (IHEP) Co-chair
Yajun Mao (Peking University)
Meng Wang (Shandong Univ.)
Haijun Yang (SJTU)
Zhengguo Zhao (USTC)
Shouhua Zhu (Peking Univ.)

Guoming Chen (IHEP)
Jie Gao (IHEP)
Tao Han (Univ. of Pittsburgh/Tsinghua Univ.)
XinChou Lou (IHEP) Co-chair
Qing Qin (IHEP)
Yifang Wang (IHEP) Chair
Chunxu Yu (Nankai Univ.)
Yangheng Zheng (UCAS)

Shenjian Chen (Nanjing University)
Yuanning Gao (Tsinghua Univ.) Co-chair
Hongjian He (Tsinghua Univ.)
Caidian Lu (IHEP)
Manqi Ruan (IHEP)
Zhizhong Xing (IHEP)
Huaqiao Zhang (IHEP)
Hongbo Zhu (IHEP)

But a possibility for China

http://indico.ihep.ac.cn/conferenceDisplay.py?confId=3813

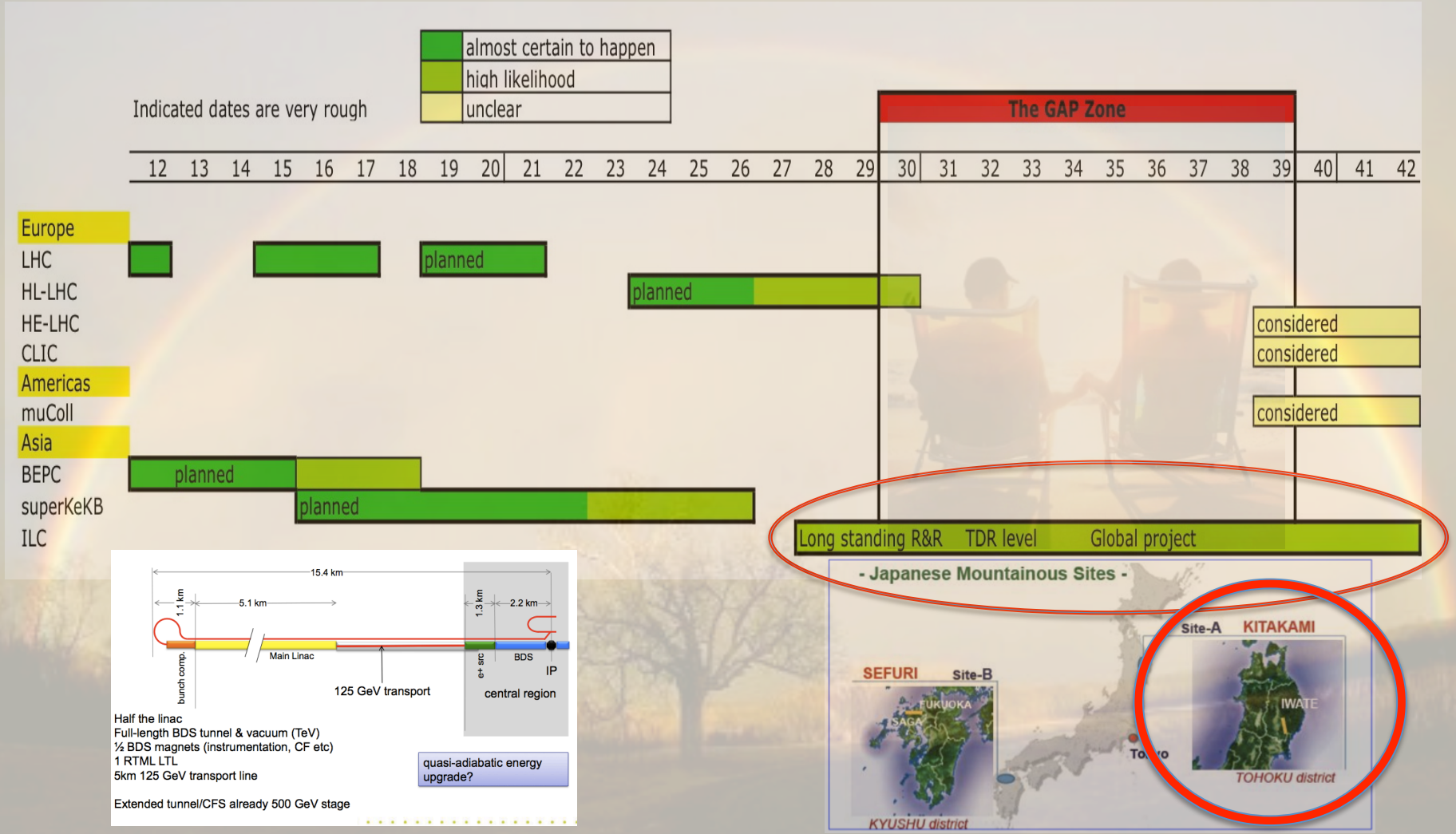
IHEP

ILC Timeline

Proposed by LCC

- 2013 - 2016
  - Negotiations among governments
  - Accelerator detailed design, R&Ds for cost-effective production, site study, CFS designs etc.
  - Prepare for the international lab.
- 2016 – 2018
  - 'Green-sign' for the ILC construction to be given (in early 2016)
  - International agreement reached to go ahead with the ILC
  - Formation of the ILC lab.
  - Preparation for biddings etc.
- 2018
  - Construction start (9 yrs)
- 2027
  - Construction (500 GeV) complete, (and commissioning start)
    (250 GeV is slightly shorter)

Serious hope for the long awaited miracle to come



Faire prendre la mayonnaise

The Way Forward

Francois R. Le Diberder
LCB European member

Linear motor train is ~ 10 ILC

Cost

These are misleading units

Hubble telescope is ~ ILC

(one billion

ILC TDR Value estimate

- The Value estimate for the cost of the ILC design as presented in the Technical Design Report, averaged over the three regional sites, is 7,780 MILCU.
- This may be compared with the escalated RDR estimate: 7,266 MILCU.
- The overall cost growth between the TDR and the RDR, not attributable to inflation, is thus 514 MILCU, i.e, an increase of approximately 7%.
- The net cost growth is the sum of
  - A cost **decrease** of approximately 9% in the total project cost, due to value engineering and cost optimization of the machine design, which was carried out after the RDR; and
  - A cost **increase** of approximately 16% of the total project cost, due to a re-estimate of the fabrication cost of cavities and cryomodules, which is based on extensive experience and studies not available at the time of the RDR.

Regional dependence

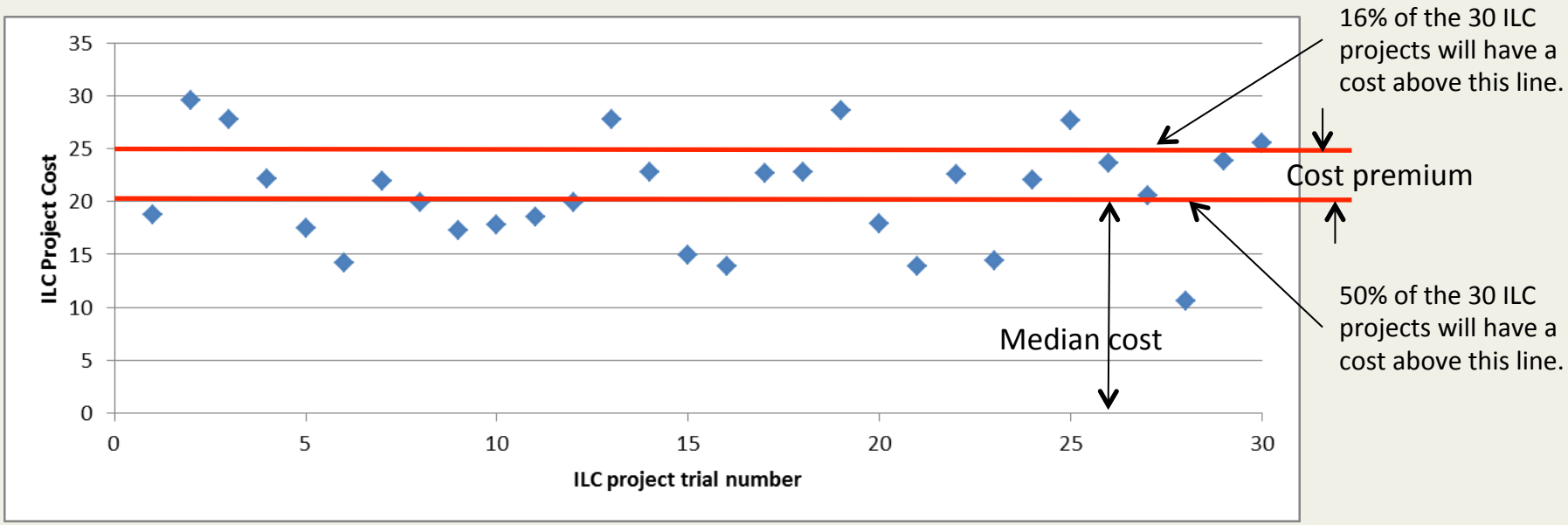
Region	Value (MILCU)
Americas	7,723
Asia	7,982
Europe	7,634

ILC TDR Labor estimate

- The explicit Labor estimate for the ILC design as presented in the Technical Design Report, averaged over the three regional sites, is 22,613 thousand person-hours.
- This may be compared with the RDR estimate: 24,427 thousand person-hours.
- The overall reduction of about 7% from the RDR to the TDR is due to
  - cost-optimization of the machine design (reduction);
  - re-estimate of the cavity and cryomodule labor (increase); and
  - re-estimate of installation, management, administration, and system integration manpower (reduction).

Regional dependence

Region	Labor (M person-hours)
Americas	22.37
Asia	22.89
Europe	22.58

Value estimate confidence level

- The Value estimate is a median estimate. In other words, we estimate that the probability that the cost of the ILC construction project will be equal to or less than the Value estimate is 50%.
- Because some regional funding agencies may require an estimate with a higher confidence level, we also provide a "cost premium".
- The cost premium is our estimate of the additional Value or Labor required to achieve an 84% confidence level.
- Thus, the probability that the cost of the ILC construction project will be equal to or less than the sum of the Value estimate and the cost premium is 16%.