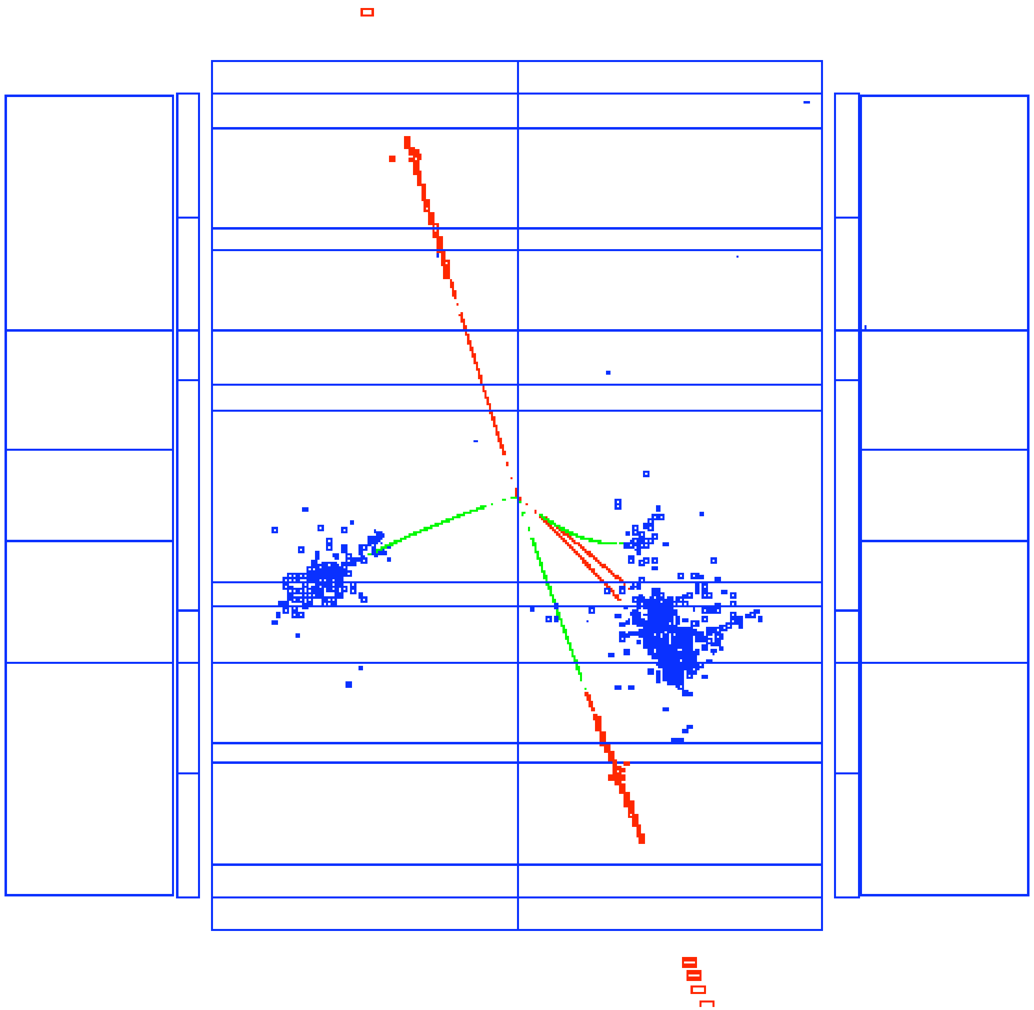
The Higgs Boson and the ILC



M. E. Peskin
KITP workshop
on the Higgs Boson
December 2012

Congratulations to Fabiola Gianotti, a Time Magazine person of the year, and to the Higgs Boson, named by Time the "Particle of the Year".

outline

1. What is an “ultimate” program of measurements on the Higgs boson ?

2. What does the ILC promise for Higgs measurements ?

3. What is the status of the ILC ?

4. Will Japan host the ILC ?

1. What is the ultimate Higgs program?

At the moment, we have only a limited data set for the Higgs boson.   Only three decay modes

$$h \to \gamma\gamma \ , \ ZZ^* \ , \ WW^*$$

have been observed unambiguously.   There may be some anomalies, and it is fun to devise theories to explain these.

However, I encourage you also to think about the situation of physics in the late 2020's.

LHC will have given us a more complete suite of measurements on the Higgs Boson. But, still, there will be much to learn about this particle.

What should our program be ?

In this talk, I will assume that the new particle at 125 GeV is a Higgs boson, that is, the particle of a scalar field whose expectation value breaks SU(2)xU(1).

We know that the "Higgs-like particle" couples to ZZ and WW with strength close to that of the Standard Model Higgs boson. So, it will still appear in e+e- experiments. If it is not the Higgs, the Higgs will also appear. This would be more interesting than the scenario I will discuss.

However, if the new boson is a Higgs boson with couplings close to the Standard Model values, we can make precise projections. I will take this more conservative point of view in this lecture.

This said, I must emphasize that measurement of the properties of the Higgs boson is conceptually completely different from "testing the Standard Model".

The Higgs boson is part of the "Standard Model", but it is too naive to say that we know all of its properties:

The gauge interactions of quarks, leptons, and gauge bosons follow from the SU(3)xSU(2)xU(1) symmetry of the Standard Model They depend only on the gauge group and quantum number assignments.

The quark and lepton masses and mixing come from their Higgs boson interactions. The Standard Model predictions for these is based only on the conjecture that a single Higgs field gives the full picture.

Lev Okun (1981) : "Problem number 1"

There are two ways that we can make progress in understanding the origin of quark and lepton masses:

1. Discover new particles that extend the Standard Model.

We hoped these would appear in the first stage of the LHC. Now, apparently, we must wait for 2016 or later.

2. Study the new particle at 125 GeV that we have discovered.

This particle is likely to be the origin of mass. In addition, it could well be a gateway to new physics.

The Standard Model predicts that the Higgs boson couplings to each species are exactly proportional to the mass of that species. We need to test this prediction until it breaks.

We theorists know that there is a model to tweak each individual Higgs coupling away from its Standard Model value.

Therefore, we need a program that can diagnose any pattern of deviations in Higgs boson couplings. This is the importance of "model-independent measurements".

The deviations may be large, but it is very possible that they are small. If there is a light Higgs boson is light but all other new particles are heavy, the Decoupling Theorem states that the light Higgs will resemble the Standard Model Higgs to an accuracy of order

$$(m_h^2 \text{ or } m_t^2)/M^2$$

where M is the new particle mass scale.

This sets a requirement for the precision of experiments in our future program.

There are many worked examples that point to the percent level of accuracy as the target.

Examples: (references in arXiv:1208.5152)

Supersymmetry:

$$g(\tau)/SM = 1 + 10\% \left(\frac{400\ \mathrm{GeV}}{m_A}\right)^2$$
$$g(b)/SM = g(\tau)/SM + (1-3)\%$$

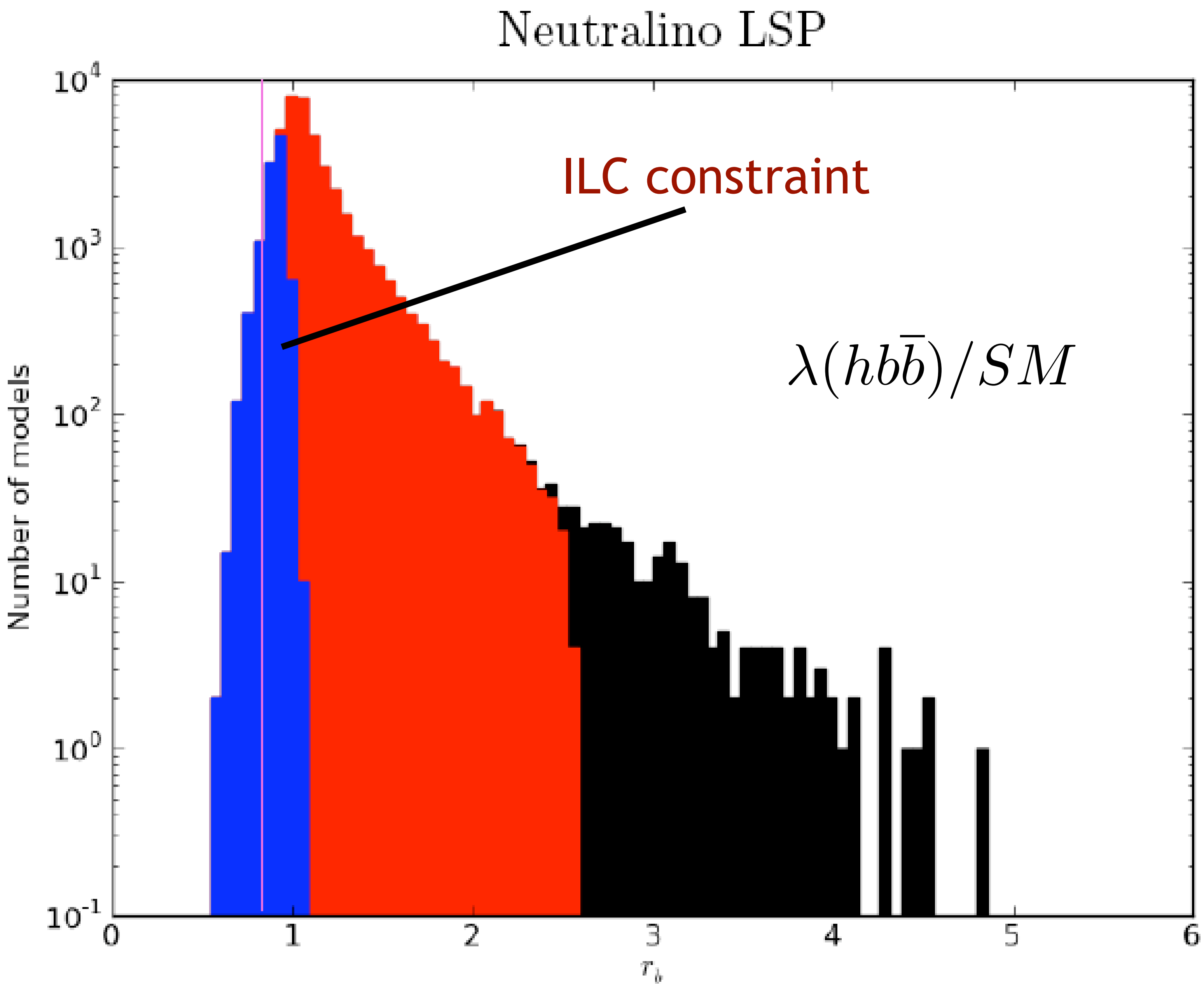
Little Higgs:

$$g(g)/SM = 1 + (5-9)\%$$
$$g(\gamma)/SM = 1 + (5-6)\%$$

Composite Higgs:

$$g(f)/SM = 1 + (3-9)\% \cdot \left(\frac{1\ \mathrm{TeV}}{f}\right)^2$$

reach: roughly 3 TeV in new particle masses for the most sensitive deviations.



Cahill-Rowley et al. pMSSM

To reach this level of accuray in model-independent coupling measurements, we need to think about the inputs:

We want to know: $\kappa_A = g(hA\overline{A})/SM$

The couplings to gg , $\gamma\gamma$, and γZ should be treated as distinct additional couplings. These could involve the tree-level $ht\bar{t}$ and hWW couplings and also contributions from new heavy species.

If we can measure a total cross section, we have

$$\sigma(A\overline{A} \to h)/SM = \kappa_A^2$$

A ratio of branching ratios gives

$$BR(h \to A\overline{A})/BR(h \to B\overline{B}) = \kappa_A^2/\kappa_B^2$$

The interpretation of these quantities is fairly unambiguous.

However, more typically, what we measure is

$$\mu_{AB} = \sigma(A\overline{A} \to h) BR(h \to B\overline{B})/SM$$

This is proportional to $\Gamma(h \to A\overline{A})\Gamma(h \to B\overline{B})/\Gamma_T$

or to
$$\frac{\kappa_A^2 \kappa_B^2}{\sum_C \kappa_C^2 \, BR(h \to C\overline{C})|_{SM}}$$

At the LHC, it is not possible to measure total cross sections for Higgs production. In additional to truly invisible decay modes, there are modes not visible in the hadron collider environment (e.g., gg). Also, it is not possible to measure the total Higgs width directly.

At the moment, there are no direct measurements of ratios of branching ratios. Different event selection strategies are used for each final state.

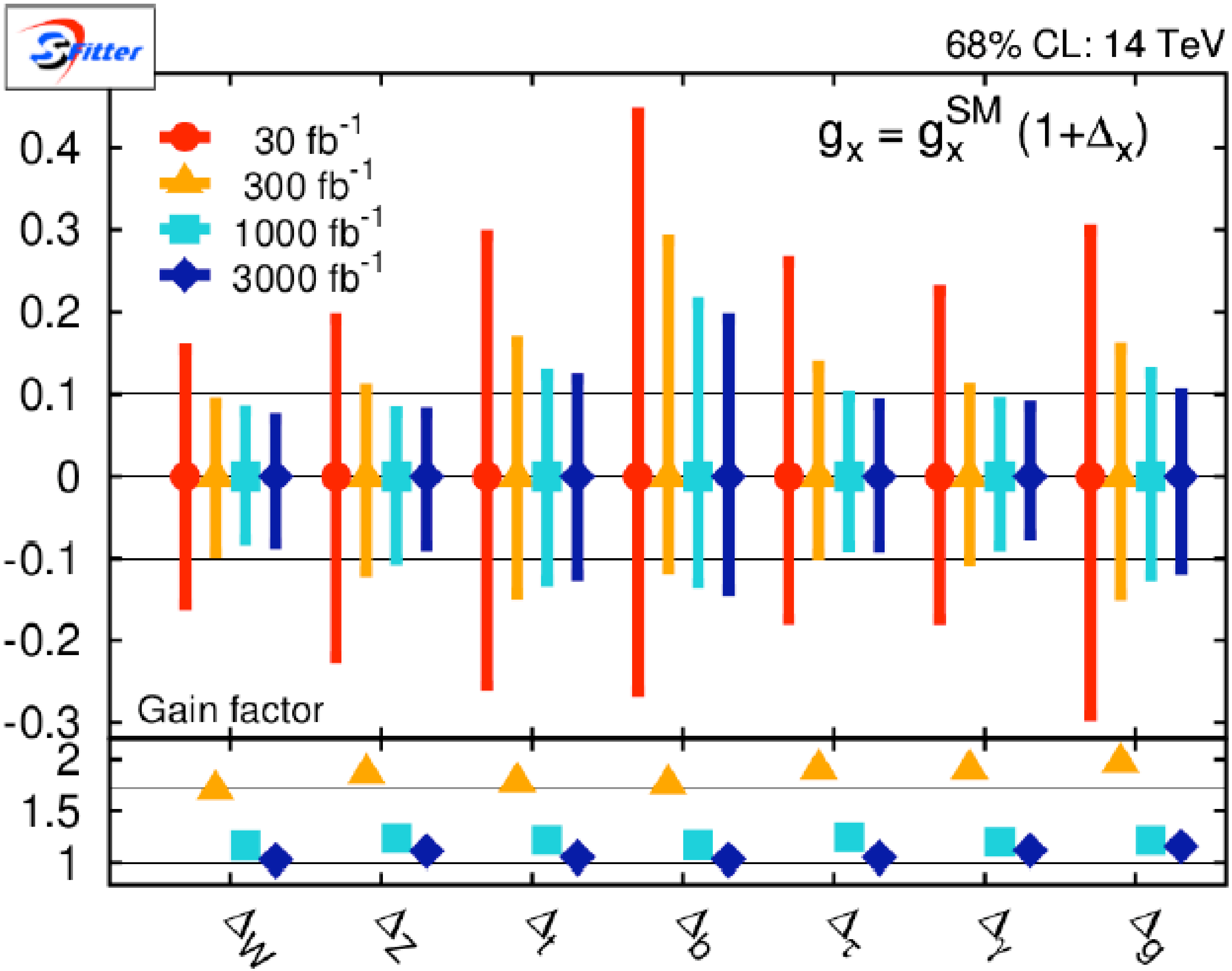
At the LHC, it is not possible to extract the κ_A in a model-independent way. It is possible that an unobserved decay model might increase the total width of the Higgs uncontrollably.

A relatively mild theoretical assumption that resolves this issue is

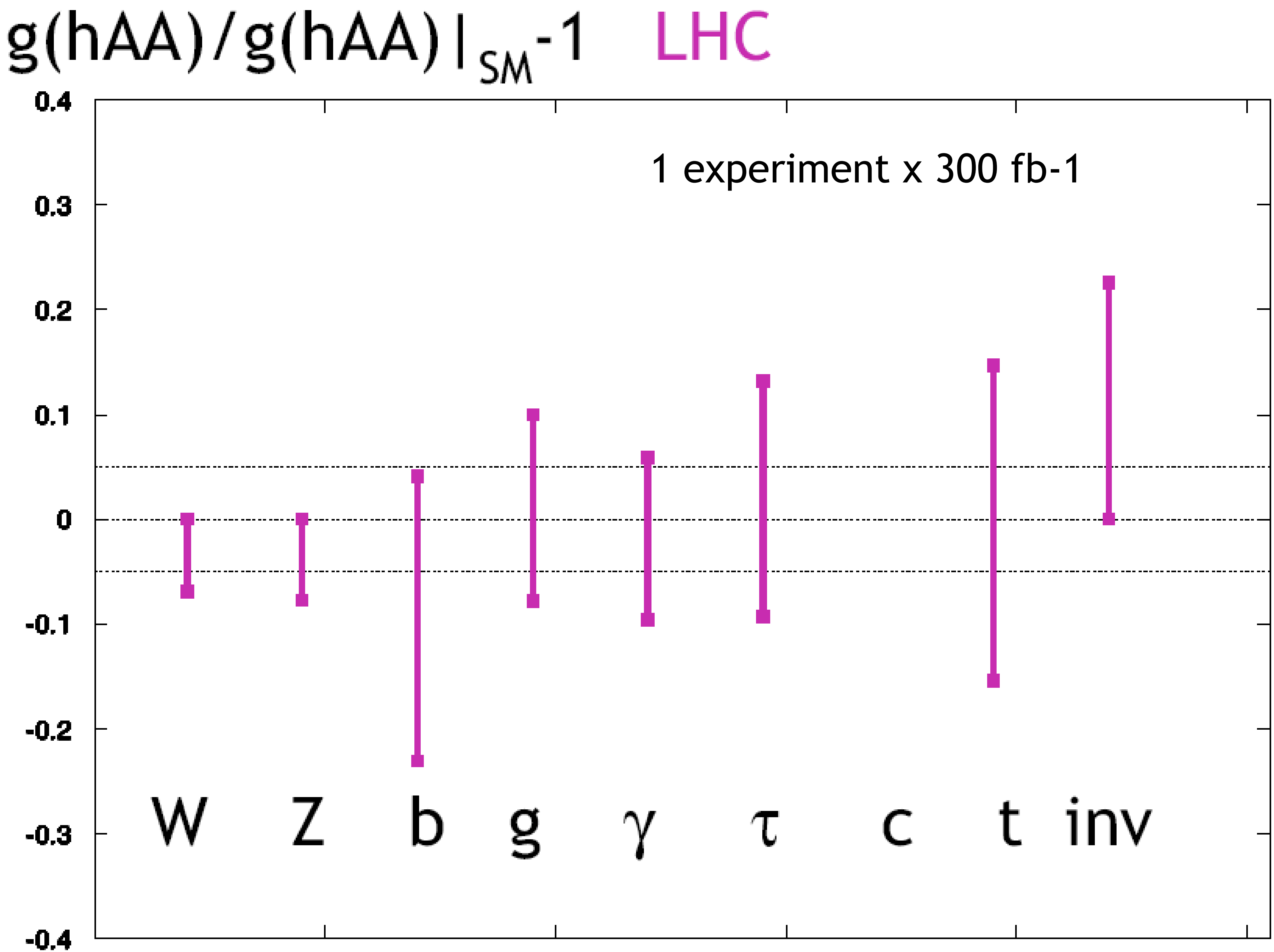
$$\kappa_W \leq 1 \quad \kappa_Z \leq 1$$

This is roughly equivalent to the statement that the various Higgs bosons in the theory contribute additively to the W and Z masses. It is correct in models with no doubly charged Higgs and no Higgs CP violation.

Using this assumption, several groups, starting with Duhrssen et al., have estimated the ultimate accuracy of the LHC measurements for "model-independent" Higgs couplings.



Sfitter, D. Zerwas at LCWS 2012



g(hAA) / g(hAA) | SM -1
LHC
1 experiment x 300 fb-1
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
W
Z
b
g
γ
τ
c
t
inv

The expectations for LHC are excellent, but, for an "ultimate" Higgs program, we need to do still better.

2. What does ILC promise for Higgs?

The International Linear Collider (ILC) is an e+e- collider with a design CM energy of 500 GeV.

The technology allows extension in energy to 1000 GeV.

The ILC is designed to run at any CM energy between about 200 GeV and the top energy, with instantaneous luminosity roughly proportional to the CM energy.

For definiteness, I will consider luminosity samples of

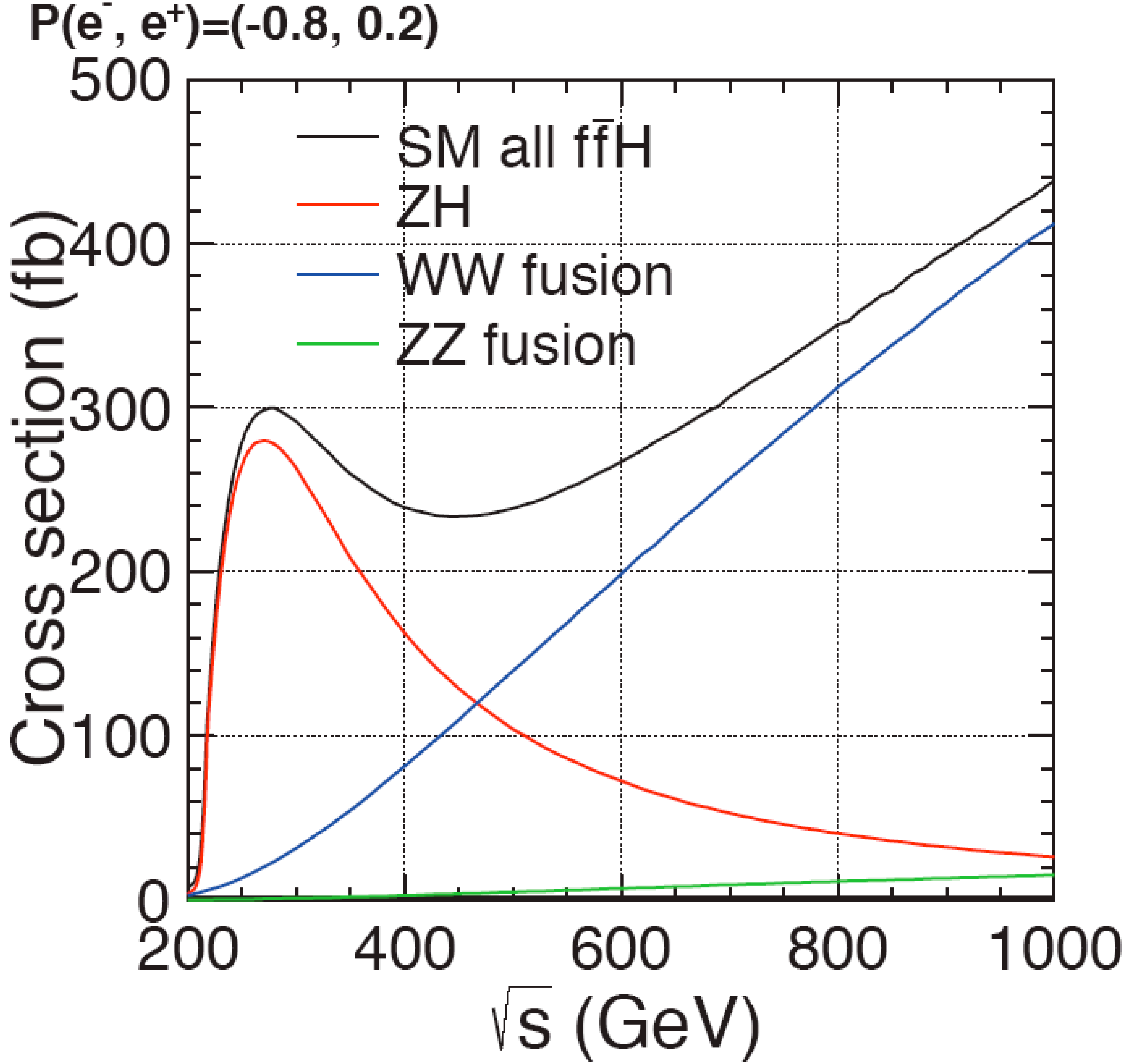
250 fb-1	at 250 GeV
500 fb-1	at 500 GeV
1000 fb-1	at 1000 GeV

corresponding approximately to a 3-year program at each energy.

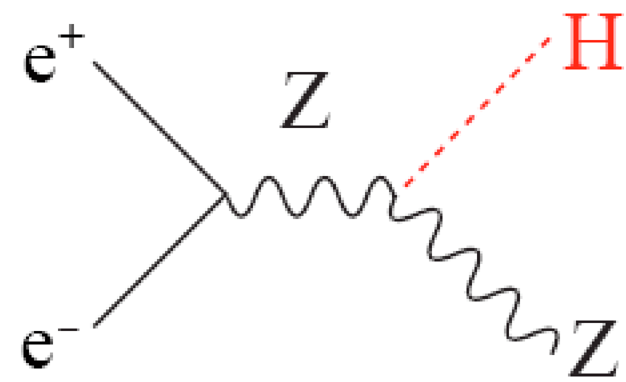
a concise overview of the ILC program:

Energy	Reaction	Physics Goal	Polarization
91 GeV	$e^+e^- \to Z$	ultra-precision electroweak	**A**
160 GeV	$e^+e^- \to WW$	ultra-precision W mass	**H**
250 GeV	$e^+e^- \to Zh$	precision Higgs couplings	**H**
350–400 GeV	$e^+e^- \to t\bar{t}$	top quark mass and couplings	**A**
	$e^+e^- \to WW$	precision W couplings	**H**
	$e^+e^- \to \nu\bar{\nu}h$	precision Higgs couplings	**L**
500 GeV	$e^+e^- \to f\bar{f}$	precision search for Z'	**A**
	$e^+e^- \to t\bar{t}h$	Higgs coupling to top	**H**
	$e^+e^- \to Zhh$	Higgs self-coupling	**H**
	$e^+e^- \to \tilde{\chi}\tilde{\chi}$	search for supersymmetry	**B**
	$e^+e^- \to AH, H^+H^-$	search for extended Higgs states	**B**
700–1000 GeV	$e^+e^- \to \nu\bar{\nu}hh$	Higgs self-coupling	**L**
	$e^+e^- \to \nu\bar{\nu}VV$	composite Higgs sector	**L**
	$e^+e^- \to \nu\bar{\nu}t\bar{t}$	composite Higgs and top	**L**
	$e^+e^- \to \tilde{t}\tilde{t}^*$	search for supersymmetry	**B**

in particular, the Higgs program has 3 stages: 250, 500, 1000.



P(e-, e+)=(-0.8, 0.2)
SM all ff̄H
ZH
WW fusion
ZZ fusion
Cross section (fb)
500
400
300
200
100
0
200
400
600
800
1000
√s (GeV)



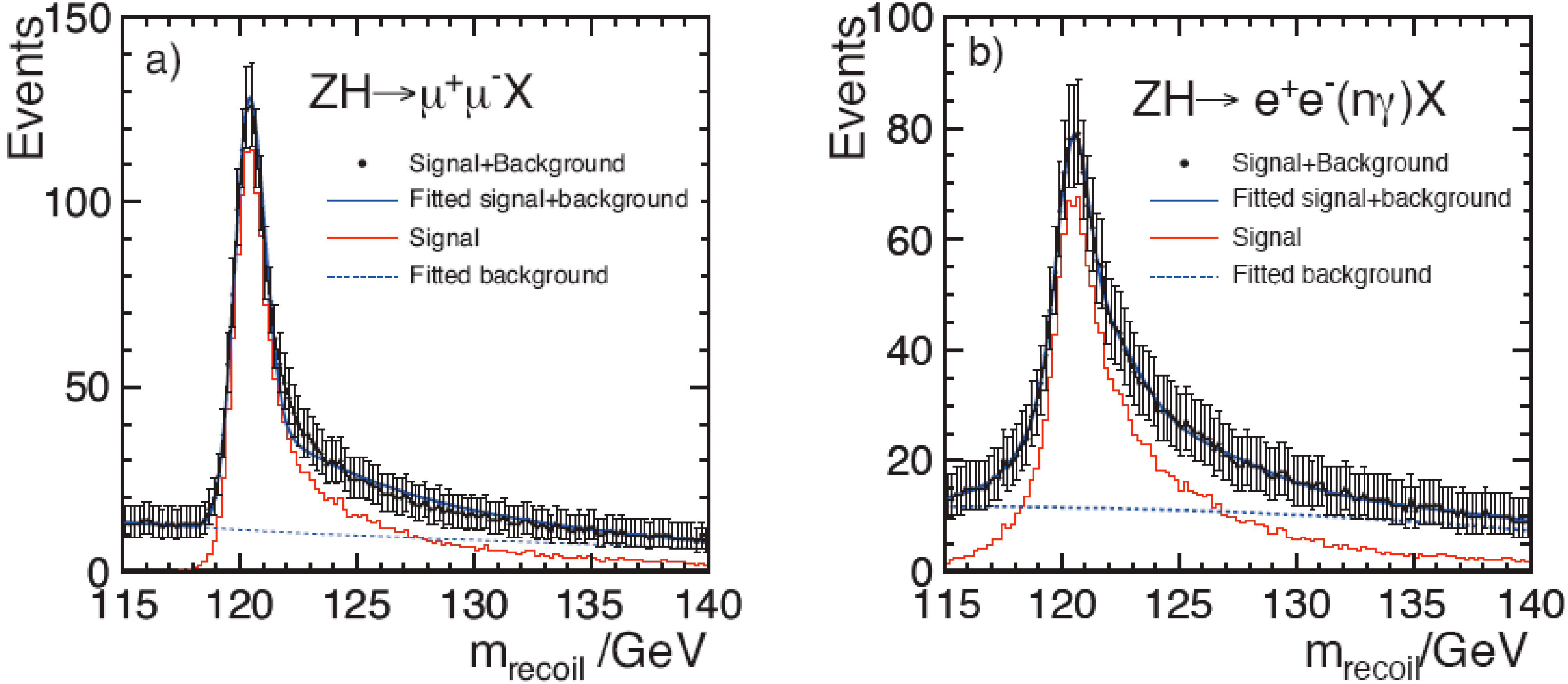
250 GeV:

This is mainly a program on $e^+e^- \to Zh$. About 90,000 Higgs bosons are produced.

Higgs bosons are tagged by a Z at the recoil energy. This gives:

Higgs mass to:	32 MeV	
total cross section to:	2.5%	(model-independent)
invisible BR	< 0.8%	(95% conf)

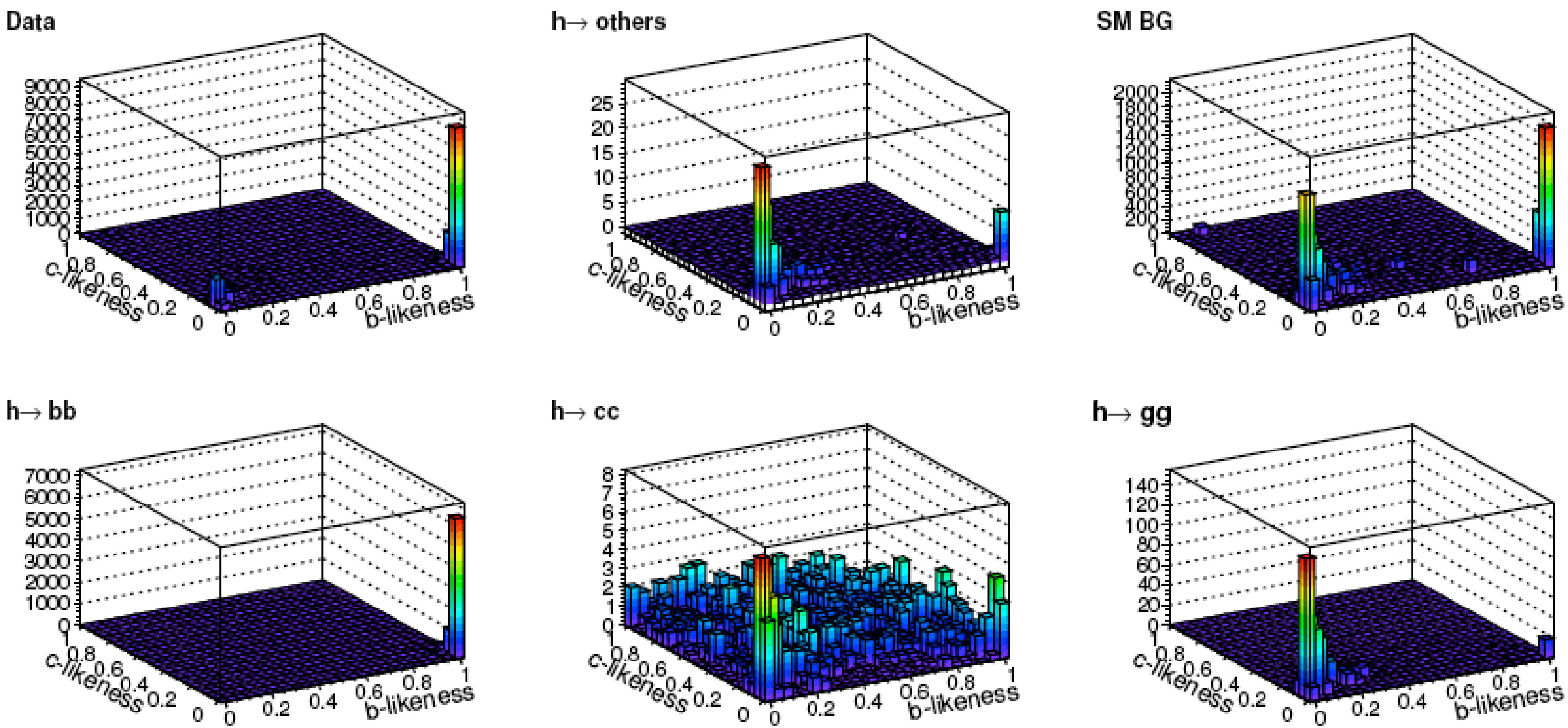
and sensitivity to all, even very unusual, decay modes.



Events
150
100
50
0
a)
ZH→μ+μ-X
Signal+Background
Fitted signal+background
Signal
Fitted background
115
120
125
130
135
140
mrecoil /GeV
Events
100
80
60
40
20
0
b)
ZH→ e+e-(nγ)X
Signal+Background
Fitted signal+background
Signal
Fitted background
115
120
125
130
135
140
mrecoil/GeV

Branching ratios are measured by counting.

A subtlety is the separation of the $c\bar{c}$ and gg decay modes. This requires a multivariate analysis.



Asian ILD group

ILC at 250 GeV with 250 fb^{-1}	expected relative error
$\sigma(Zh)$	0.025
$\sigma(Zh) \cdot BR(b\bar{b})$	0.010
$\sigma(Zh) \cdot BR(c\bar{c})$	0.069
$\sigma(Zh) \cdot BR(gg)$	0.085
$\sigma(Zh) \cdot BR(WW)$	0.08
$\sigma(Zh) \cdot BR(ZZ)$	0.28
$\sigma(Zh) \cdot BR(\tau^+\tau^-)$	0.05
$\sigma(Zh) \cdot BR(\gamma\gamma)$	0.27
$\sigma(Zh) \cdot BR(\mathrm{invisible})$	0.005

One problem should be noted:

It is still not possible to measure the Higgs boson width directly at an e+e- collider if it is as small as predicted in the Standard Model (4 MeV).

The Higgs width can be determined in a model-independent way using

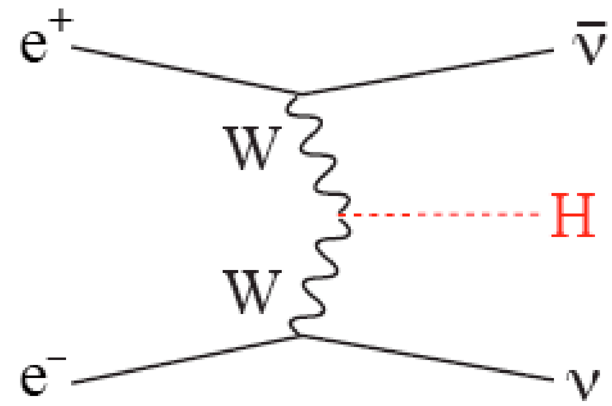
$$\Gamma_T = \Gamma(h \to ZZ)/BR(h \to ZZ)$$

Because the ZZ mode is relatively rare the BR is not well measured. This method is then statistics limited and leads to a 30% error in the total width.

This is lowered to about 7% in a global fit that uses LHC results, but still is significant.

The solution to this problem is running at higher energy.

500 GeV:



The main process studied at this energy is $e^+e^- \to \nu\overline{\nu}h$, that is, WW fusion to Higgs.

The measurement of the $\sigma(e^+e^- \to \nu\overline{\nu}h \to b\overline{b})$, combined with the very accurate measurement of $BR(h \to b\overline{b})$ at 250 GeV, gives directly 6% accuracy on the total width. This is again improved in a global fit.

The 500 GeV running gives another 600,000 Higgs bosons, allowing improvements in the BR measurements. b/c/g separation gets easier at higher energies.

First estimates can be made of the $ht\overline{t}$ coupling and the Higgs self-coupling.

ILC at 500 GeV with 500 fb^{-1}	expected relative error
$\sigma(Zh) \cdot BR(b\bar{b})$	0.016
$\sigma(Zh) \cdot BR(c\bar{c})$	0.11
$\sigma(Zh) \cdot BR(gg)$	0.13
$\sigma(Zh) \cdot BR(\tau^+\tau^-)$	0.07
$\sigma(Zh) \cdot BR(\gamma\gamma)$	0.36
$\sigma(WW) \cdot BR(b\bar{b})$	0.006
$\sigma(WW) \cdot BR(c\bar{c})$	0.04
$\sigma(WW) \cdot BR(gg)$	0.049
$\sigma(WW) \cdot BR(WW)$	0.03
$\sigma(WW) \cdot BR(\tau^+\tau^-)$	0.05
$\sigma(WW) \cdot BR(\gamma\gamma)$	0.28
$\sigma(t\bar{t}h) \cdot BR(b\bar{b})$	0.2

1000 GeV:

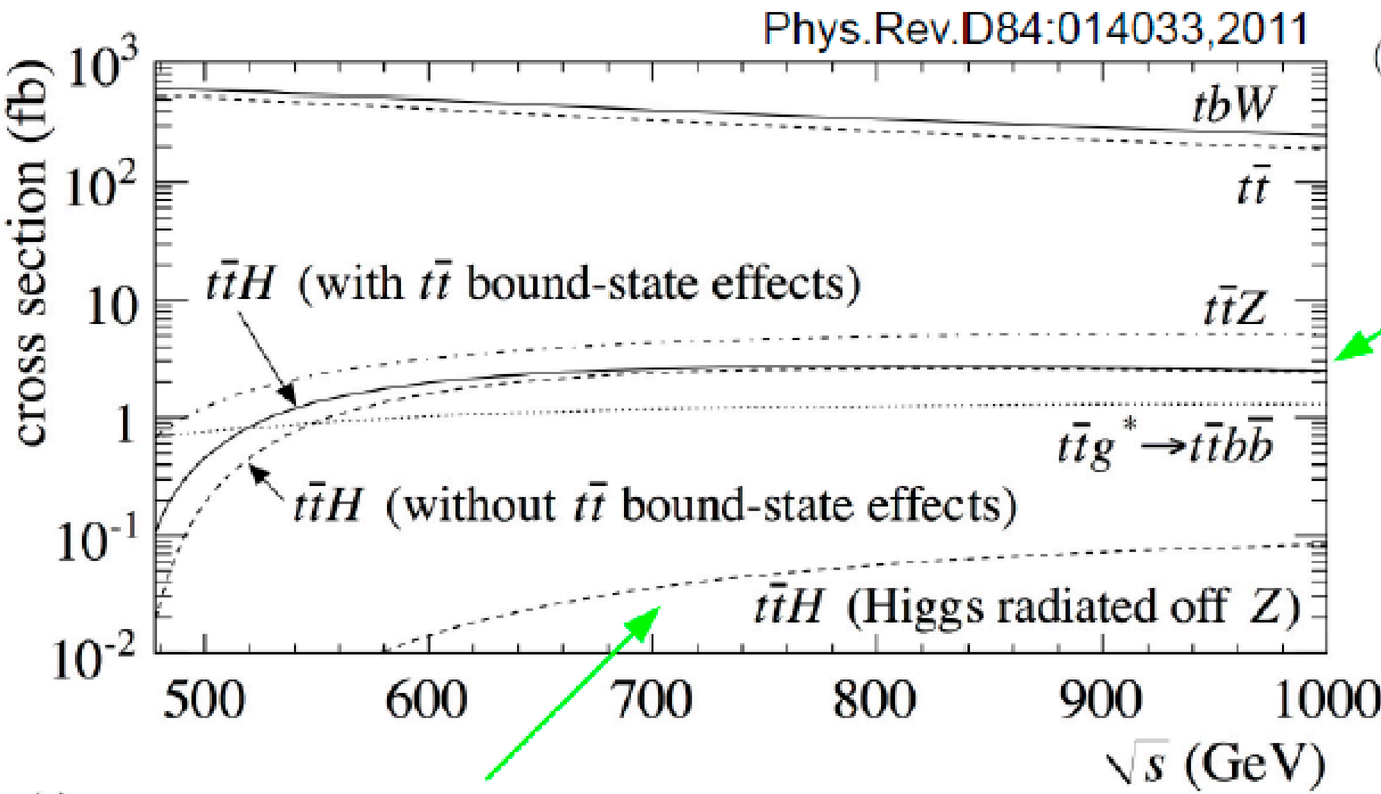
Running at still higher energies gives:

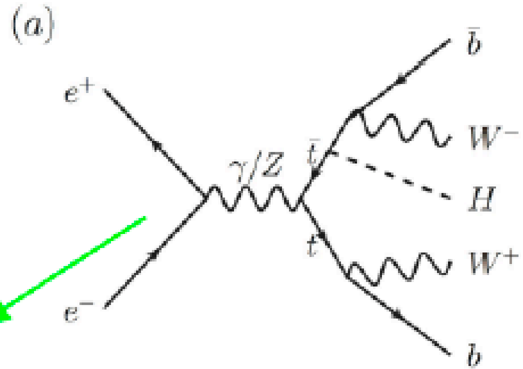
further improvement in Higgs statistics

opening up of $e^+e^- \to t\bar{t}h$: coupling measurement to 5%

study of Higgs self-coupling with $e^+e^- \to Zhh$ and
$e^+e^- \to \nu\overline{\nu}hh$: coupling meaurement to 24%

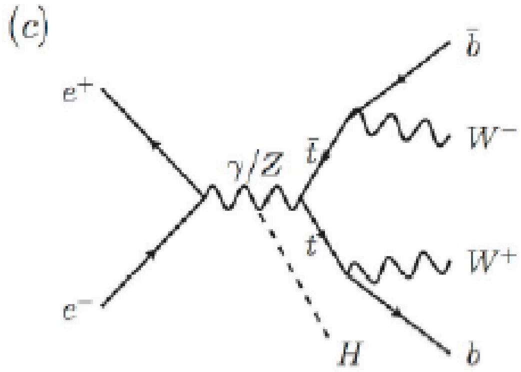
some statistics on $h \to \mu^+\mu^-$: coupling measurment to 20%





At 1 TeV:

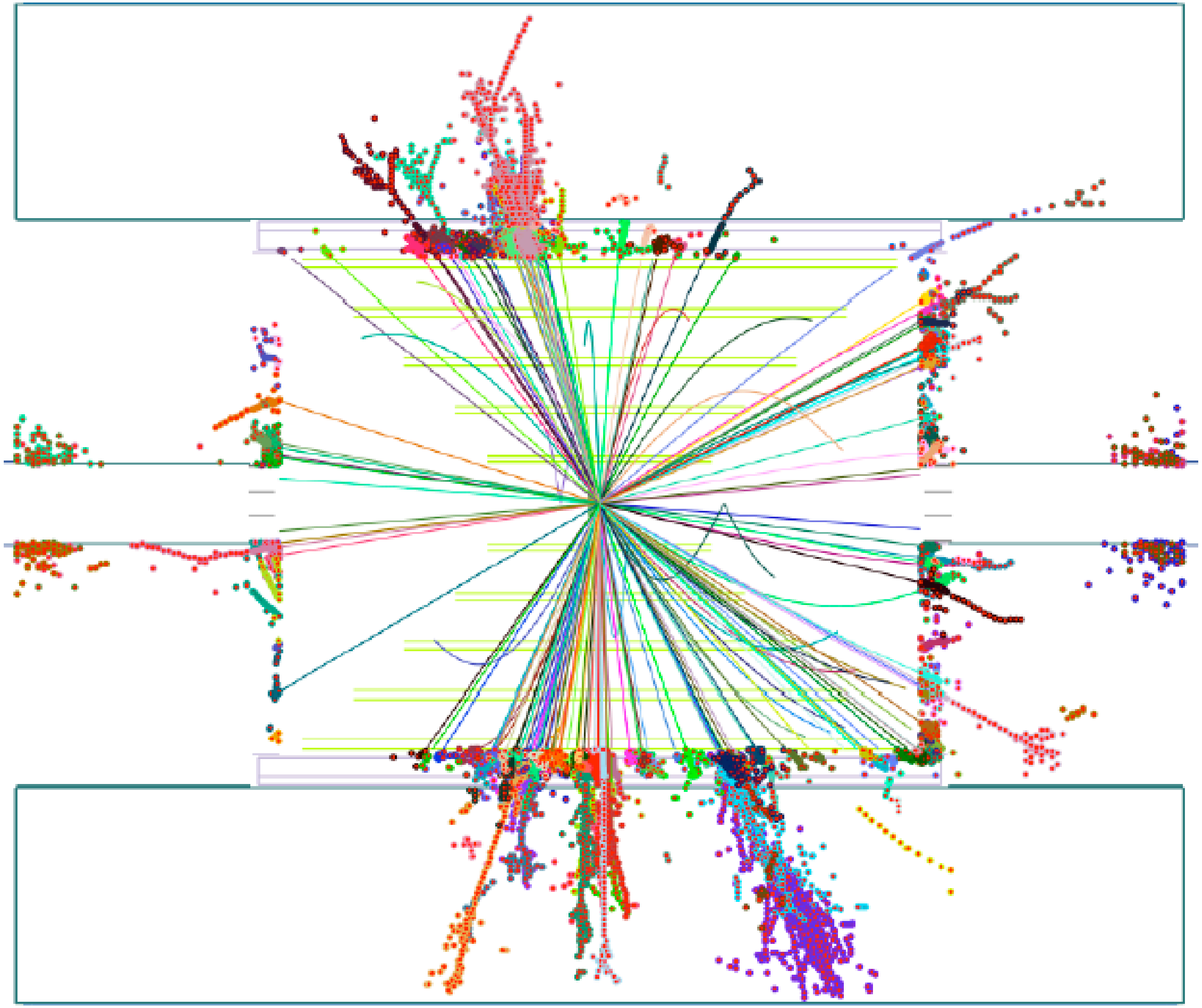
- $\sigma \approx 2.2$ fb
- $t\bar{t}$ bound-state effects can be neglected



Higgs radiated off Z:

- $\sigma \approx 0.08$ fb
- Not sensitive to y_t

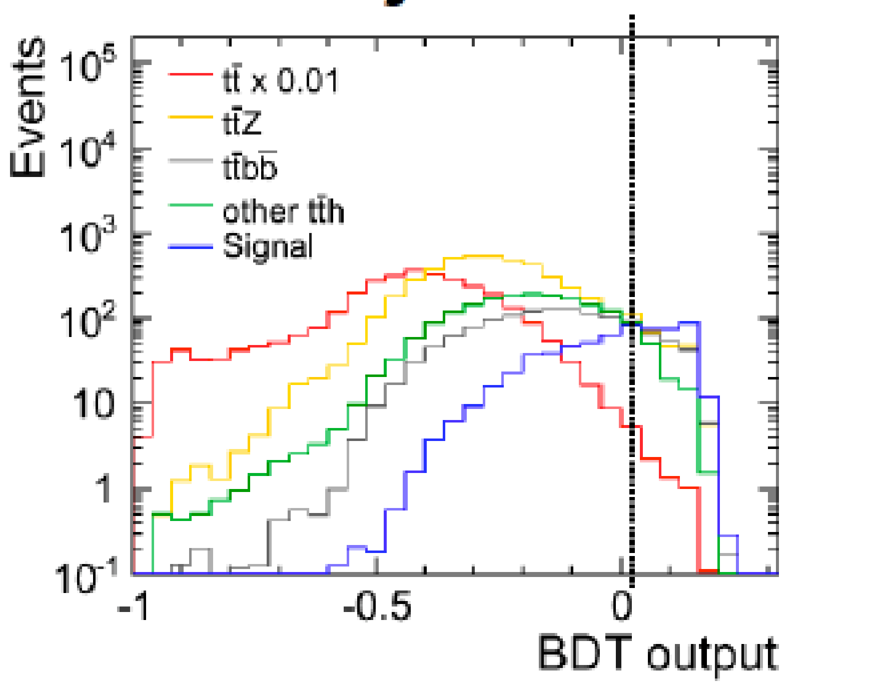
8-jet signal event in the SiD detector



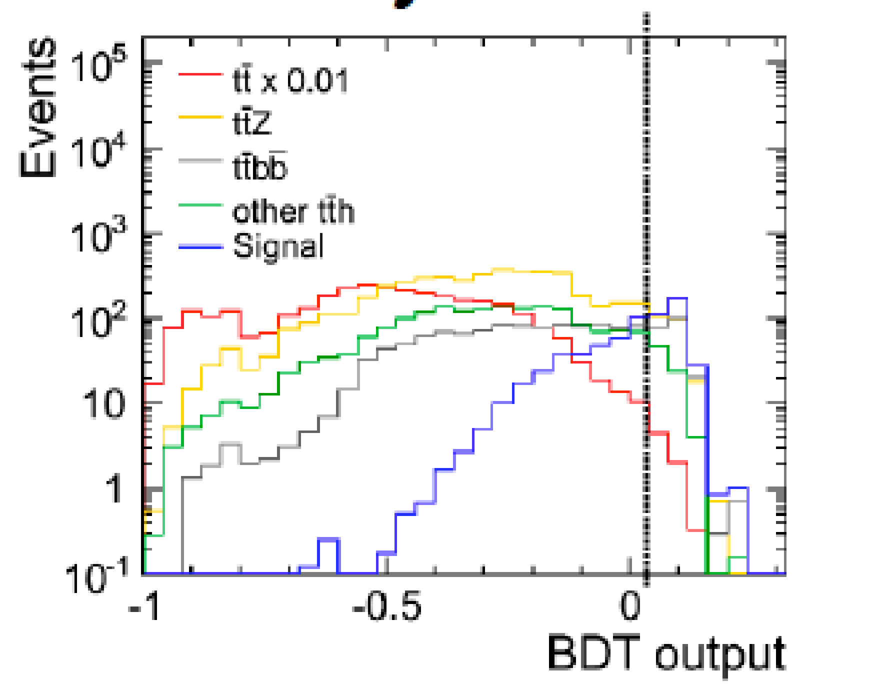
SiD analysis: Roloff/Strube

BDT outputs and results

6 jets: BDT > 0.0266



8 jets: BDT > 0.0363



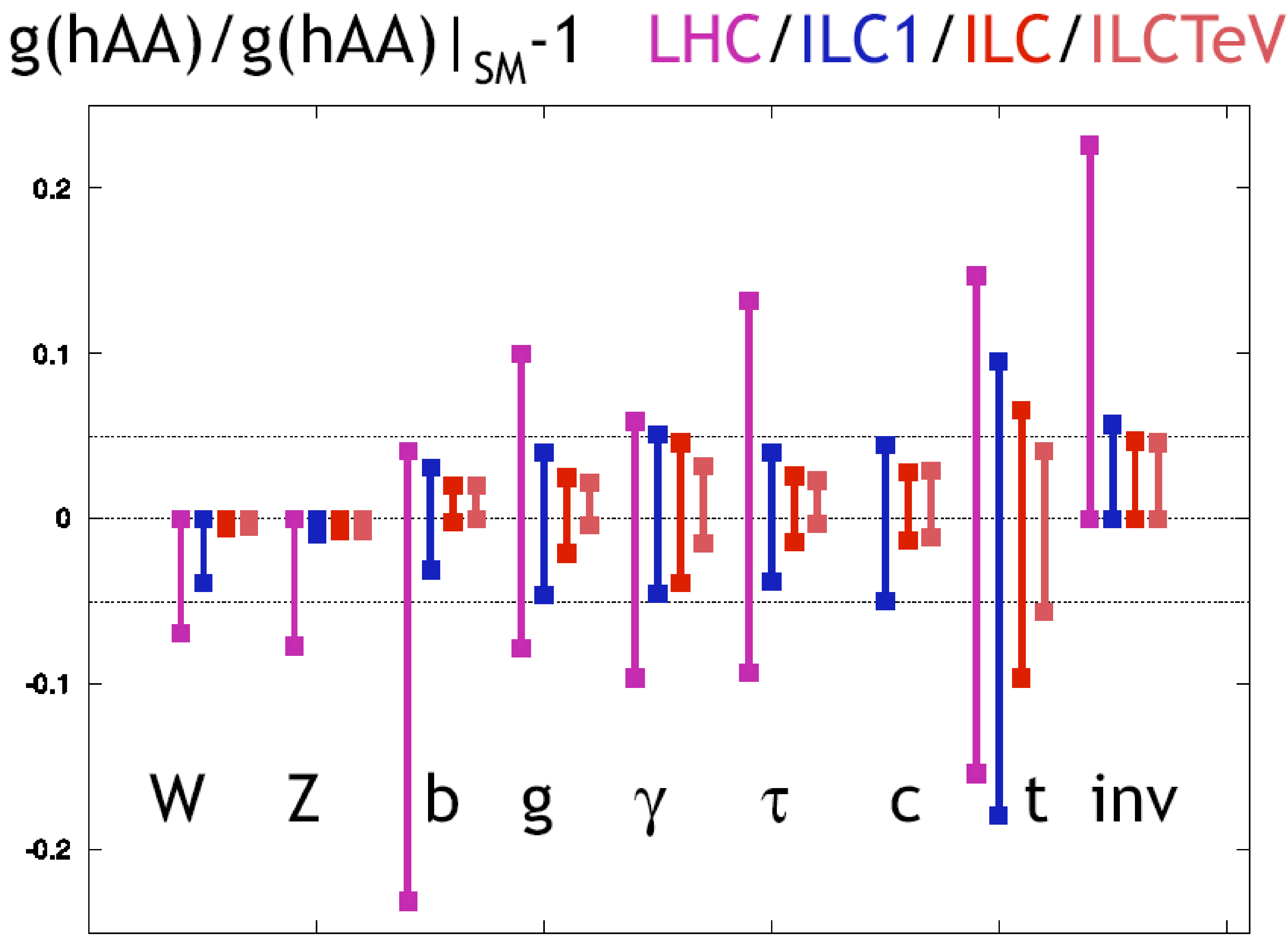
Using cut on BDT output with best $S / (S + B)^{1/2}$

$\Delta\sigma / \sigma = 13.6\% \rightarrow \Delta y_t / y \approx 6.8\%$	$\Delta\sigma / \sigma = 12.3\% \rightarrow \Delta y_t / y \approx 6.2\%$

Combined: $\Delta y_t / y \approx 4.6\%$ 500 fb^{-1} **each pol.** $L_{int} = 1\ \text{ab}^{-1}$

$\Delta y_t / y \approx 4.1\%$ **all 1 ab^{-1} at** $P(e^- / e^+) = -.8 / +.2$

ILC at 1 TeV with 1000 fb^{-1}	expected relative error
$\sigma(WW) \cdot BR(WW)$	0.01
$\sigma(WW) \cdot BR(gg)$	0.018
$\sigma(WW) \cdot BR(\tau + \tau -)$	0.02
$\sigma(WW) \cdot BR(\gamma\gamma)$	0.05
$\sigma(t\bar{t}h) \cdot BR(b\bar{b})$	0.12

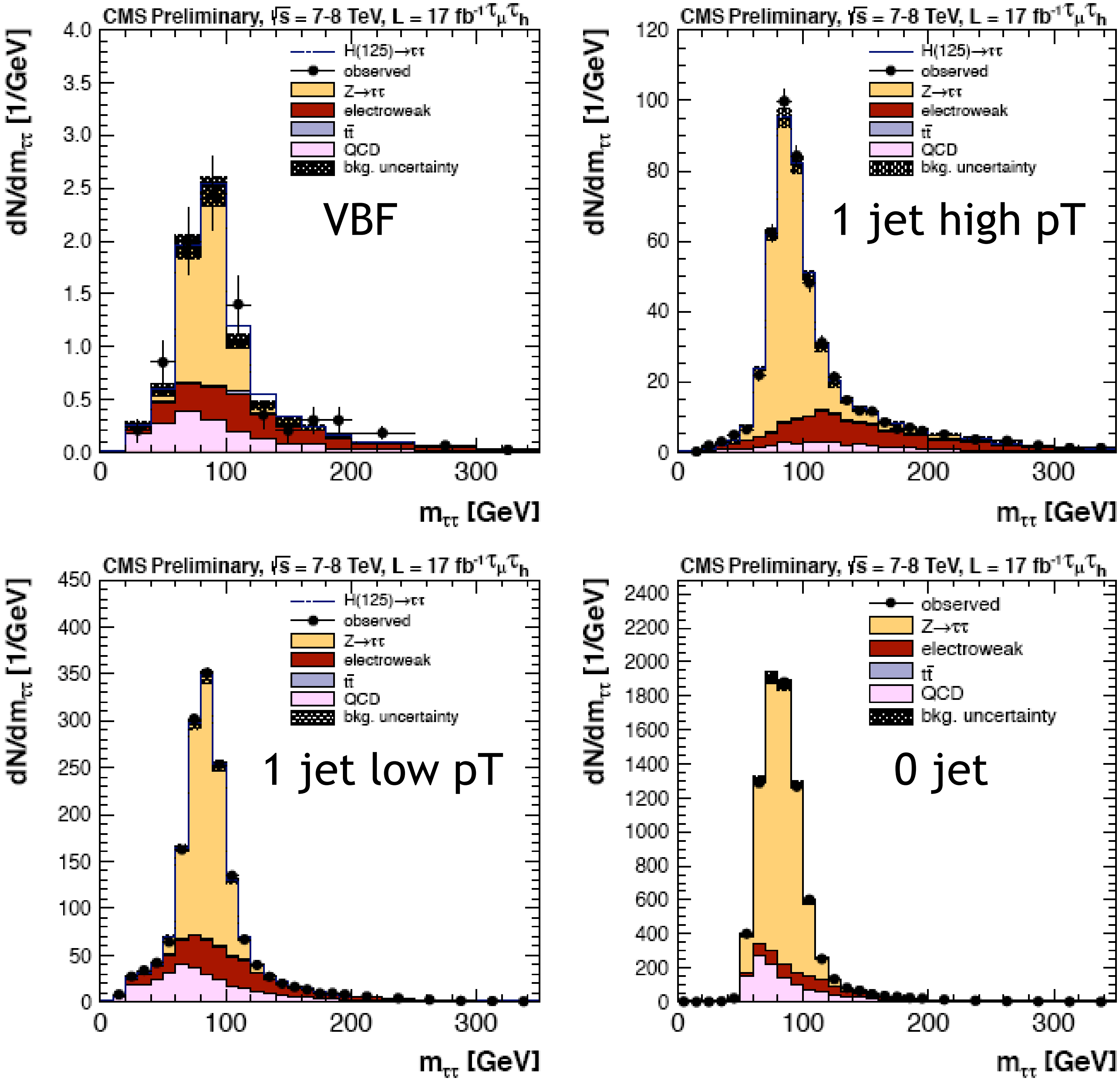


g(hAA)/g(hAA)|SM-1
LHC/ILC1/ILC/ILCTeV
0.2
0.1
0
-0.1
-0.2
W
Z
b
g
γ
τ
c
t
inv

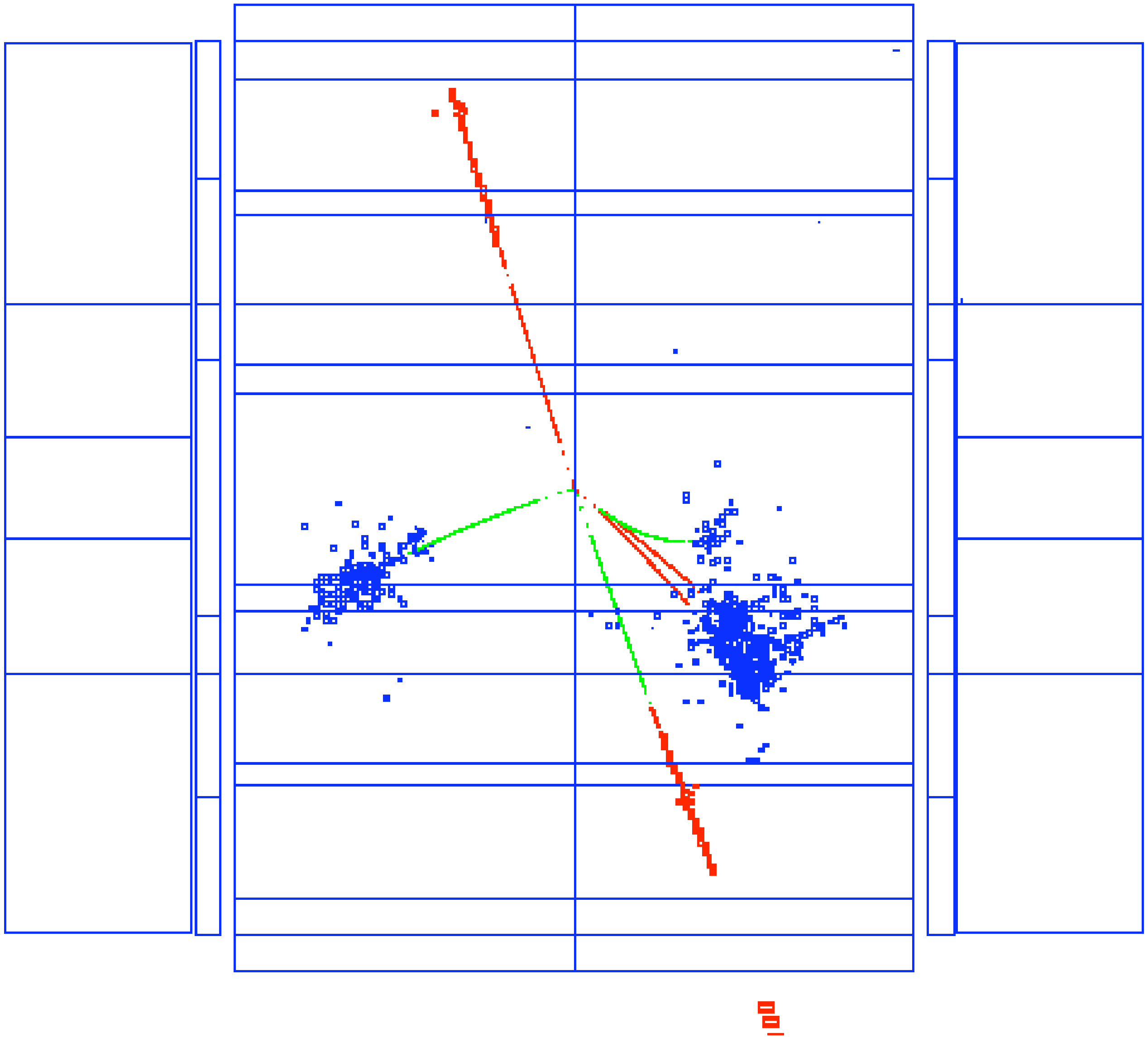
And, do not forget the qualitative differences between electron-positron and hadron collider experimentation.

In pp, Higgs production is 10^{-9} of the total cross section.

In e^+e^-, Higgs production is 1% of the total cross section.


CMS Preliminary, √s = 7-8 TeV, L = 17 fb⁻¹ τμτh
H(125)→ττ
observed
Z→ττ
electroweak
tt̄
QCD
bkg. uncertainty
VBF
1 jet high pT
1 jet low pT
0 jet
dN/dmττ [1/GeV]
mττ [GeV]

CMS



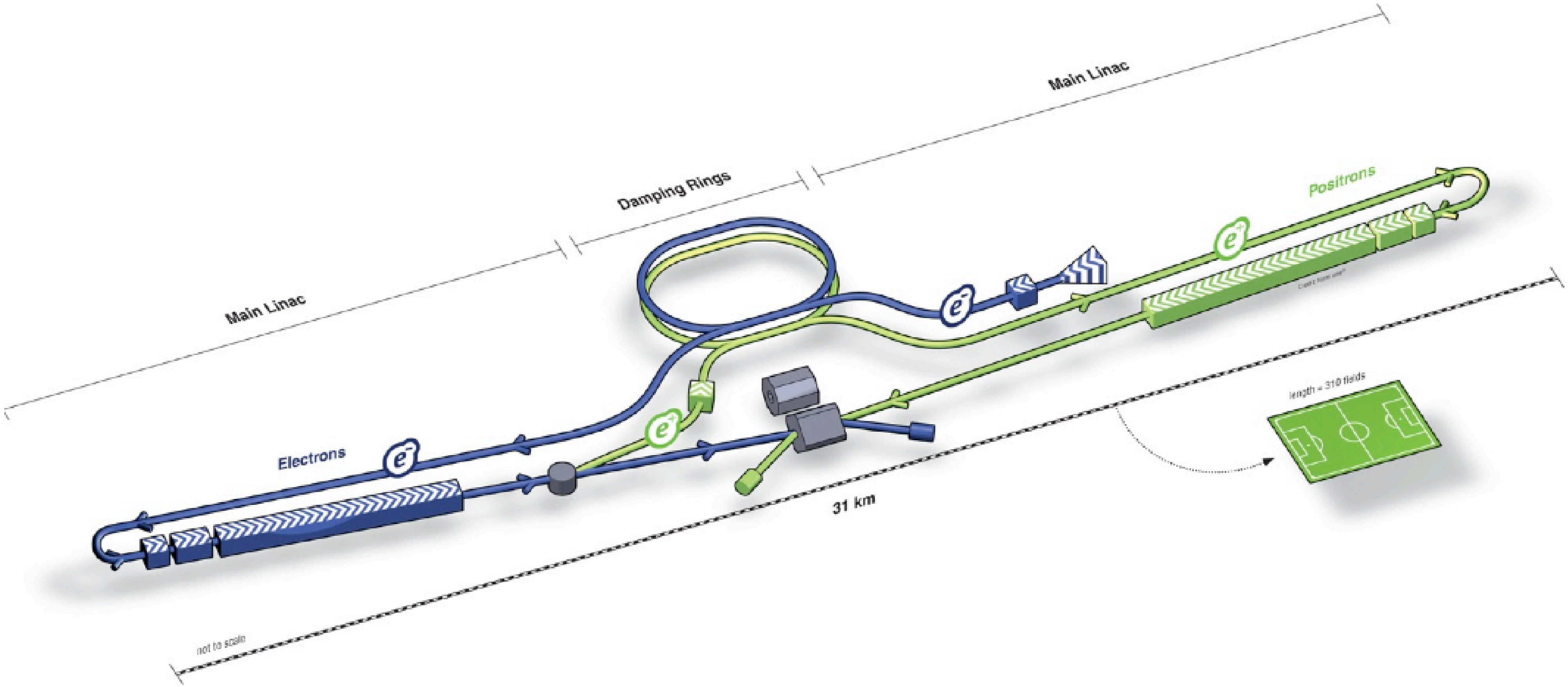
3. What is the status of ILC ?

The Technical Design Report for the ILC was reviewed last week by the Program Advisory Committee.

The design is not site-specific, but it does address the major technical issues of the design. All important components are prototyped.

I will present a few of the important results.

final machine layout:



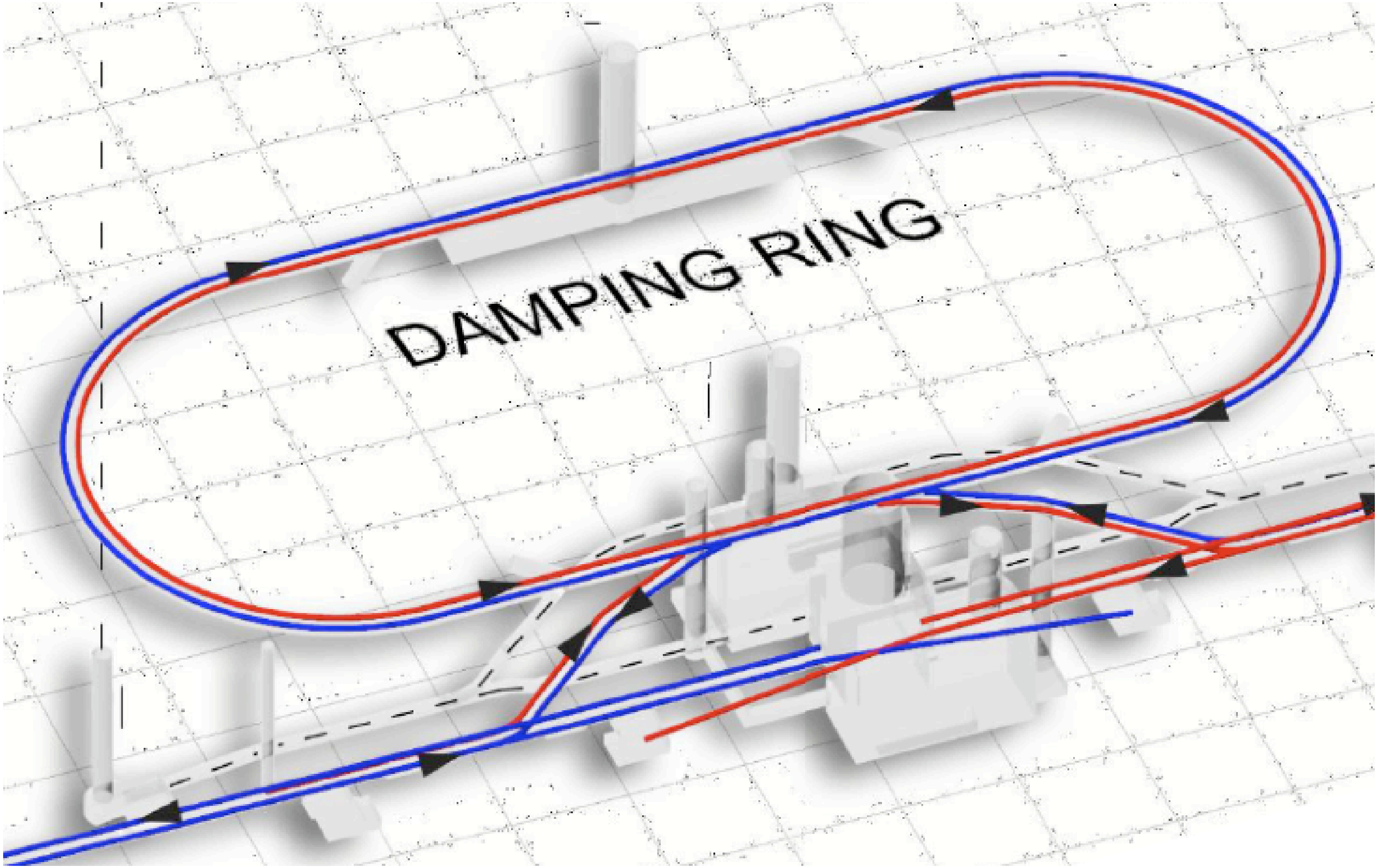
ILC Scheme | © www.form-one.de

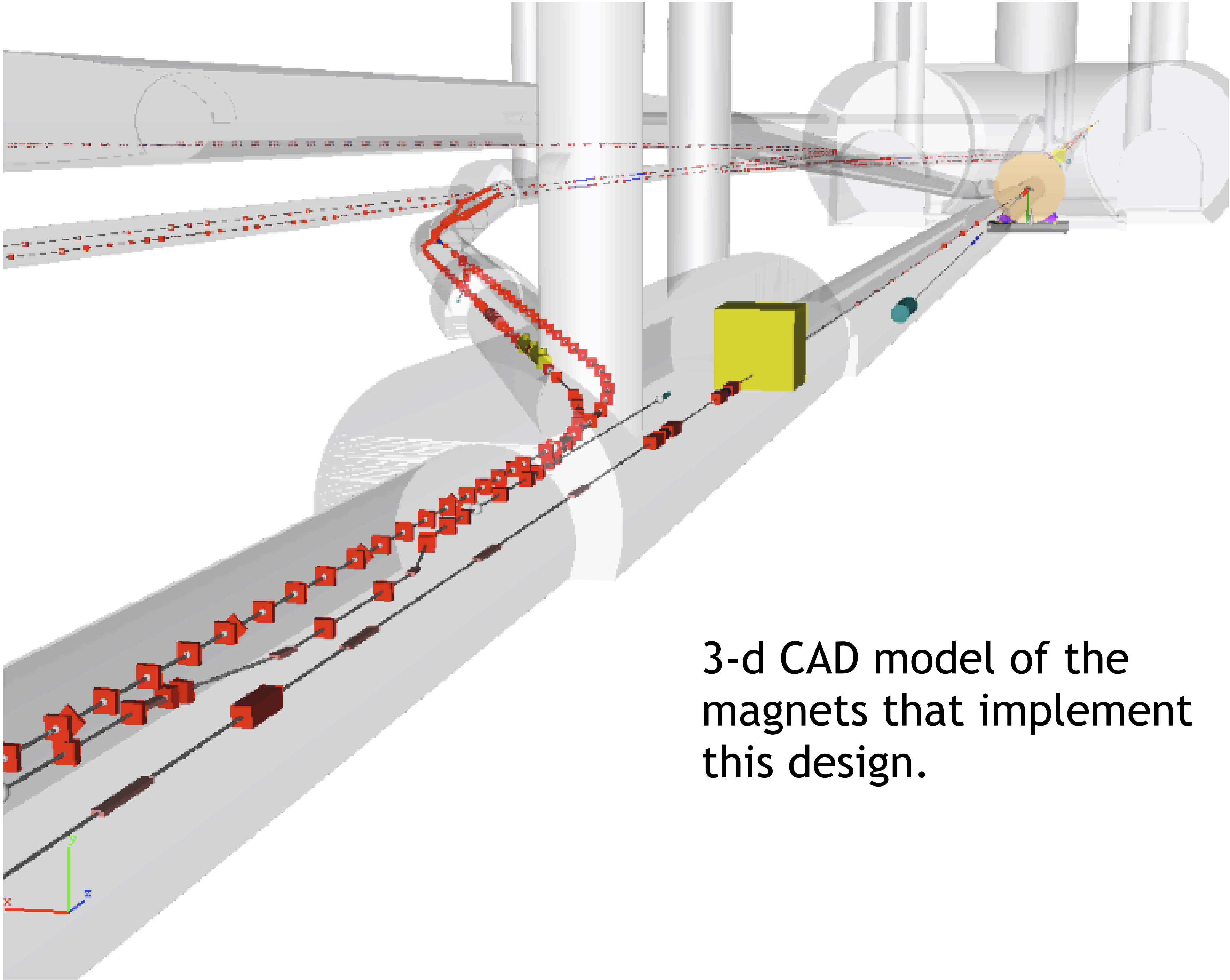
beam parameters, luminosity

Centre-of-mass energy	E_{CM}	GeV	200	230	250	350	500
Luminosity pulse repetition rate		Hz	5	5	5	5	5
Positron production mode			10 Hz	10 Hz	10 Hz	nom.	nom.
Bunch population	N	$\times 10^{10}$	2	2	2	2	2
Number of bunches	n_b		1312	1312	1312	1312	1312
Linac bunch interval	Δt_b	ns	554	554	554	554	554
RMS bunch length	σ_z	μm	300	300	300	300	300
Normalized horizontal emittance at IP	$\gamma\epsilon_x$	μm	10	10	10	10	10
Normalized vertical emittance at IP	$\gamma\epsilon_y$	nm	35	35	35	35	35
Horizontal beta function at IP	β_x^*	mm	16	14	13	16	11
Horizontal beta function at IP	β_y^*	mm	0.34	0.38	0.41	0.34	0.48
RMS horizontal beam size at IP	σ_x^*	nm	904	789	729	684	474
RMS horizontal beam size at IP	σ_y^*	nm	7.8	7.7	7.7	5.9	5.9
Vertical disruption parameter	D_y		24.3	24.5	24.5	24.3	24.6
Fractional RMS energy loss to beamstrahlung	δ_{BS}	%	0.65	0.83	0.97	1.9	4.5
Luminosity	L	$\times 10^{34}\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$	0.56	0.67	0.75	1.0	1.8
Fraction of L in top 1% E_{CM}	$L_{0.01}$	%	91	89	87	77	58
Electron polarisation	P_-	%	80	80	80	80	80
Positron polarisation	P_+	%	30	30	30	30	30
Electron relative energy spread at IP	$\Delta p/p$	%	0.20	0.19	0.19	0.16	0.13
Positron relative energy spread at IP	$\Delta p/p$	%	0.19	0.17	0.15	0.10	0.07

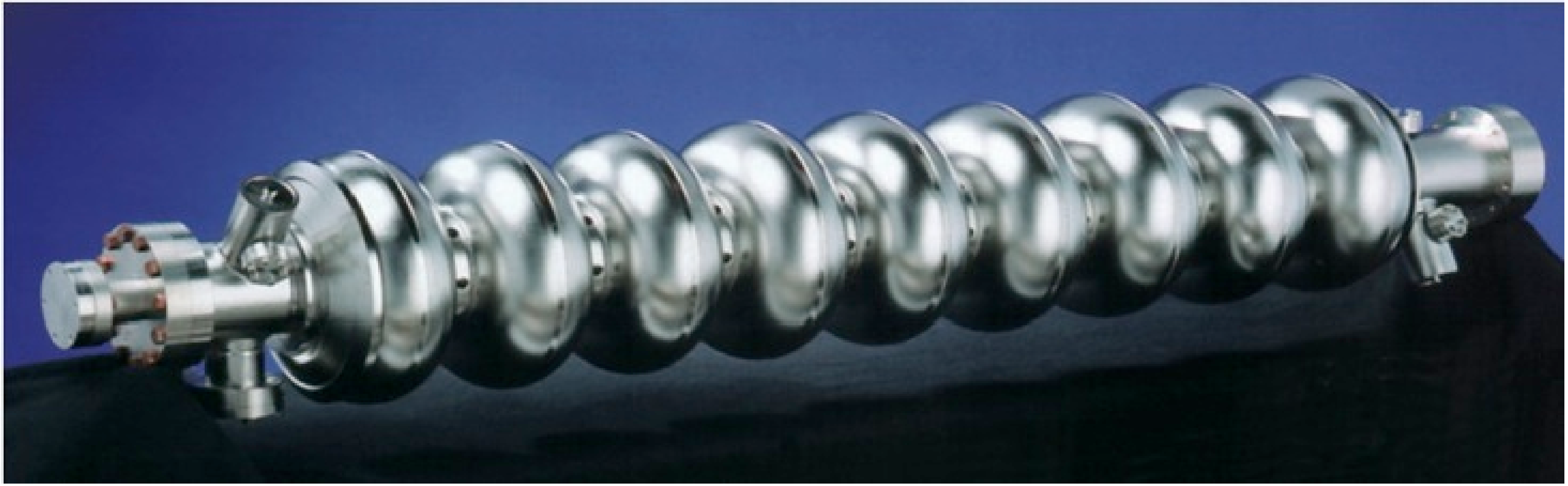
luminosity is not an extremum, it is a point in a tune space; strategies for another factor 2 are kept in reserve.

Note: both e- and e+ polarization.


DAMPING RING



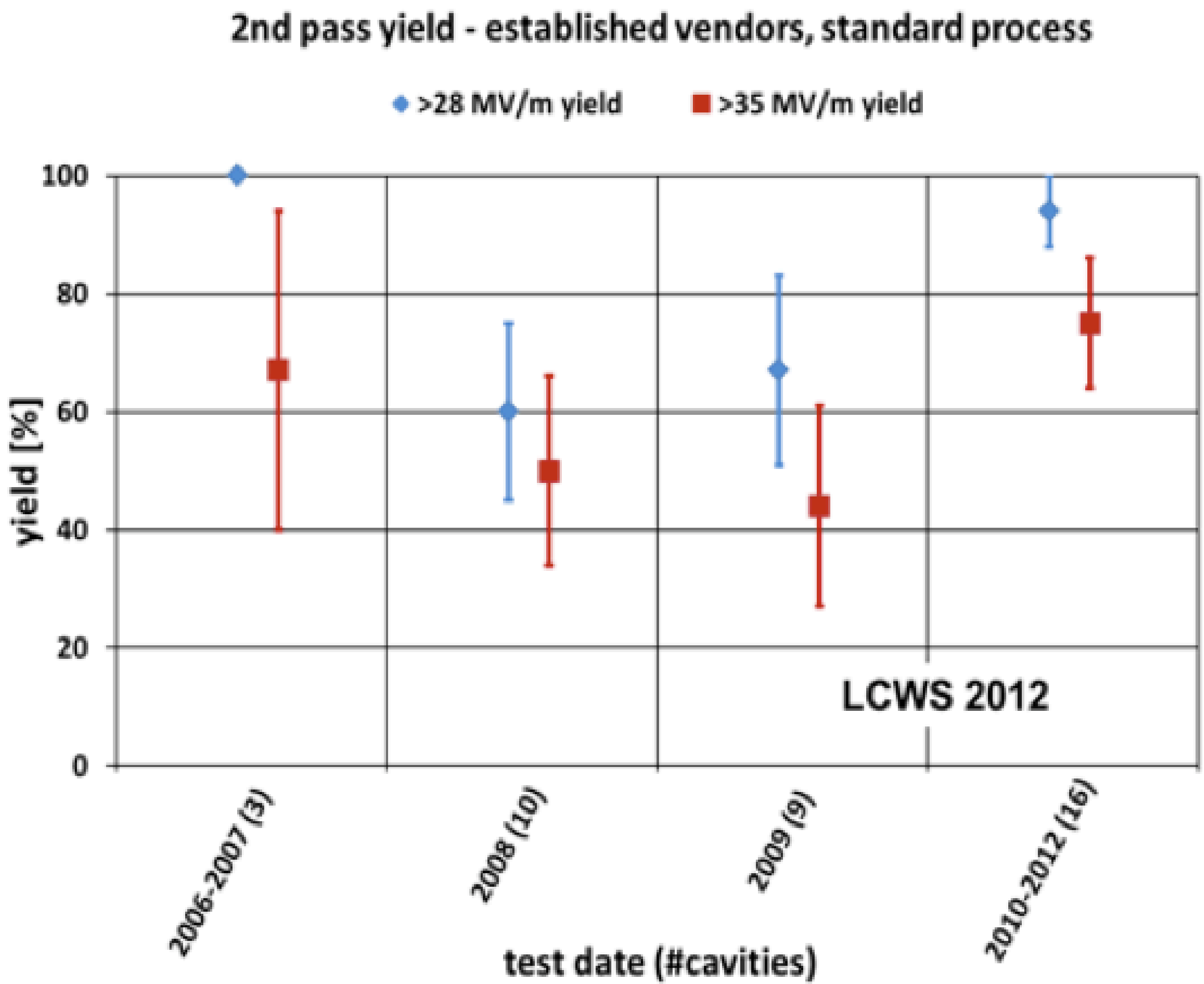
3-d CAD model of the magnets that implement this design.



Main Linac: Niobium 9-cell cavities

must achieve:

industrial vendors in 3 regions
high yield of cavities meeting ILC spec: 31.5 MeV/m

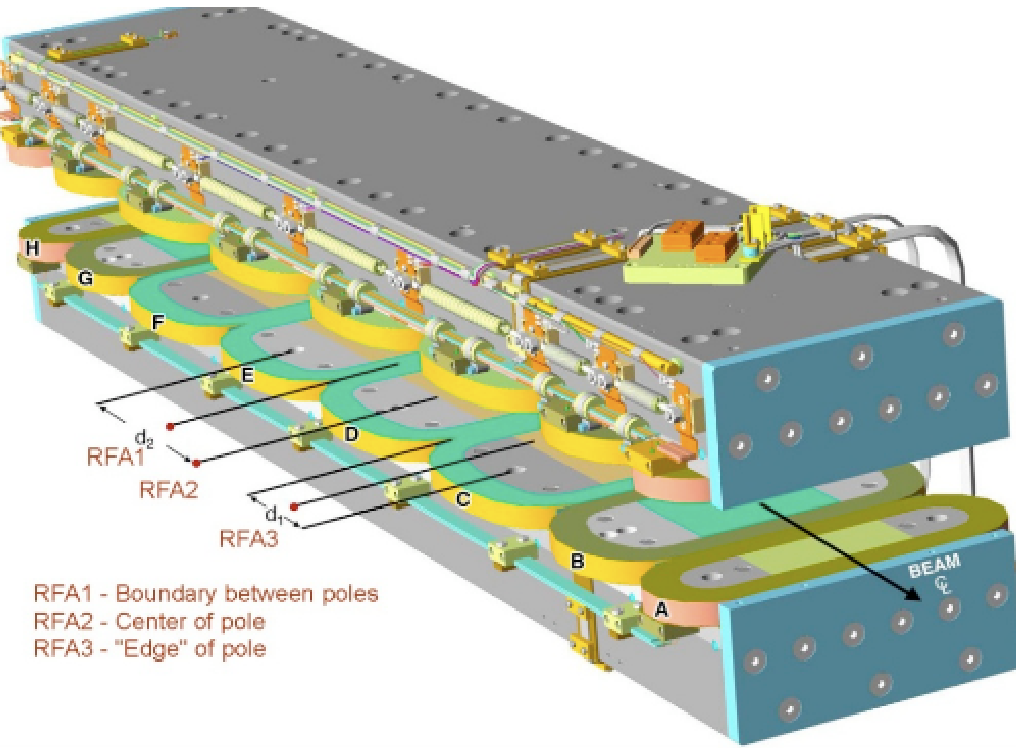


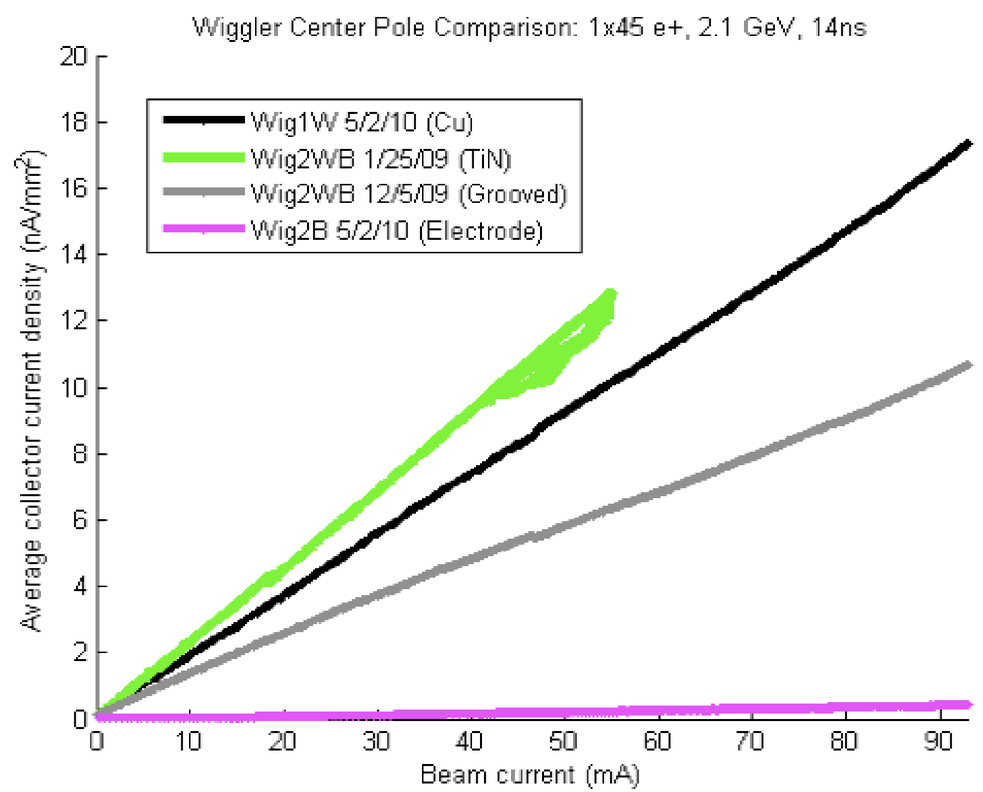
2010-2012: production yield 94% > 28 MeV/m
average gradient 37.1 MeV/m

S1-Global test:

assembly and operation of a cryomodule with plug-compatible cavities from 3 regions.

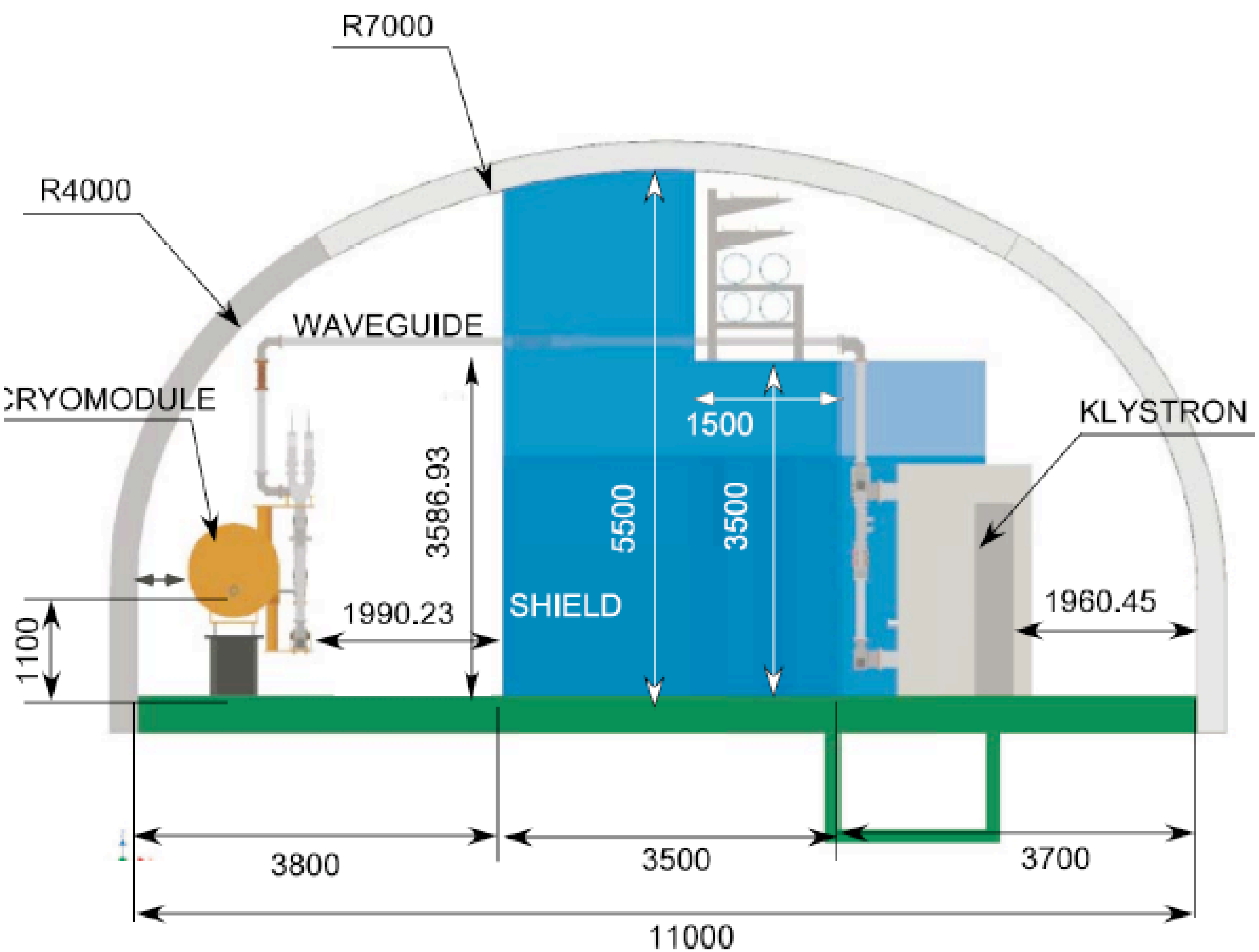
Maintenance of ultra-low emittance in the damping ring -- study of electron cloud mitigation at CESR-TA.



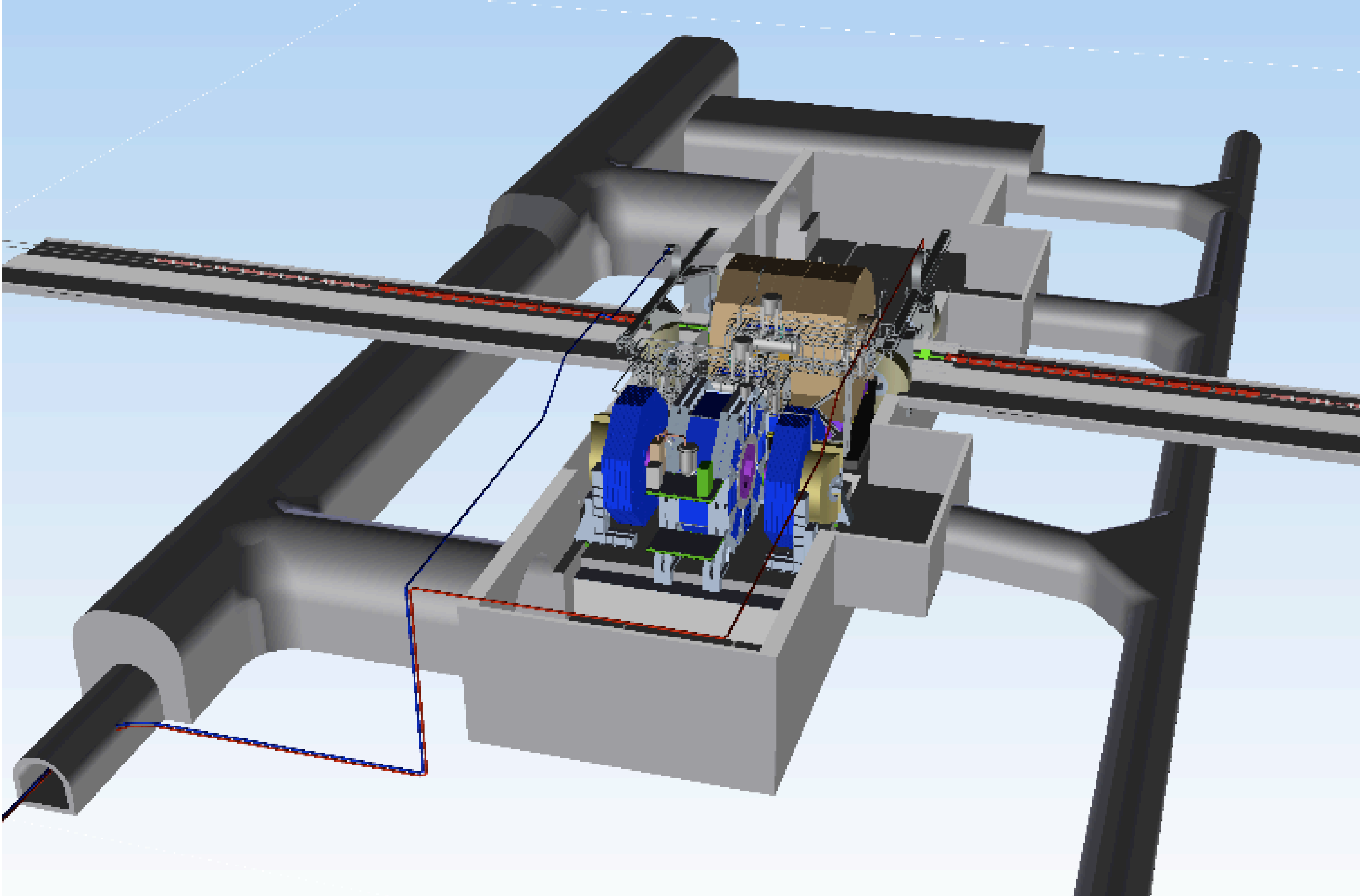


- Japanese Mountainous Sites -
Site-A
KITAKAMI
IWATE
TOHOKU district
SEFURI
Site-B
FUKUOKA
SAGA
KYUSHU district
Tokyo

tunnel design for mountainous site:



- **Personnel can occupy klystron area during operation**
  - Radiation analysis later in presentation
- **Cross-over paths for egress (500 m)**
- **11 m wide x 5.5 m high**
  - dimensions in mm



interaction region design for mountainous site

4. Will Japan host the ILC ?

First, what is the attitude of the Japanese HEP community ?

Here is the complete excutive summary of the Final Report of the Subcommittee on Future Projects in High Energy Physics, T. Mori (Chair) February 11, 2012

The KEK super-B-factory is approved and under construction.

A future neutrino program can be envisioned within the Japanese HEP budget.

ILC would require new funding outside the expected HEP budget.

Recommendations

The committee makes the following recommendations concerning large-scale projects, which comprise the core of future high energy physics research in Japan.

- **Should a new particle such as a Higgs boson with a mass below approximately 1 TeV be confirmed at LHC, Japan should take the leadership role in an early realization of an e^+e^- linear collider.** In particular, if the particle is light, experiments at low collision energy should be started at the earliest possible time. In parallel, continuous studies on new physics should be pursued for both LHC and the upgraded LHC version. Should the energy scale of new particles/physics be higher, accelerator R&D should be strengthened in order to realize the necessary collision energy.

- **Should the neutrino mixing angle θ_{13} be confirmed as large, Japan should aim to realize a large-scale neutrino detector through international cooperation, accompanied by the necessary reinforcement of accelerator intensity, so allowing studies on CP symmetry through neutrino oscillations.** This new large-scale neutrino detector should have sufficient sensitivity to allow the search for proton decays, which would be direct evidence of Grand Unified Theories.

It is expected that the Committee on Future Projects, which includes the High Energy Physics Committee members as its core, should be able to swiftly and flexibly update the strategies for these key, large-scale projects according to newly obtained knowledge from LHC and other sources.

It is important to complete and start the SuperKEKB including the detector, as scheduled. Some of the medium/small scale projects currently under consideration have the implicit potential to develop into important research fields in the future, such as neutrino physics and as such, should be promoted in parallel to pursue new physics in various directions. Flavour physics experiments such as muon experiments at J-PARC, searches for dark matter and neutrinoless double beta decays or observations of CMB B-mode polarization and dark energy are considered as projects that have such potential.

It is difficult to understand the attitude of the Japanese government. No politician will promise sums of $ 10 B in advance of negotiations. In Japan especially, broad consensus is needed before any public pronouncement is made.

Nevertheless, there are positive signs.

Road Map to realize ILC

- **Assume to complete ILC construction by 2025 (~2030)**
  - Assume the construction time to be 10 years (2+7+1)
  - Need to start construction in 2016 (~2021)
  - Need to have the project budget approval (to prepare for "real starting = bidding") in 2014 (~2019)
- **Keep the full-energy (500 GeV) construction, however,**
- **The project starting with staging shall be a possibility**
  - Stage 1: Higgs Factory (> 250 GeV : center-of-mass energy)
  - Stage 2: Full-energy (500 GeV)
  - Stage 3: Future extension : up to 1 TeV
- **The budget sharing**
  - Basic assumption: 50 % by host country for the full-energy construction
  - It corresponds to ~70 % by host country for the stage 1 construction

Advanced Accelerator Association Promoting Science and Technology (aaa-sentan.org)

Honorary Chairman: Masatoshi Koshiba

91 corporate, 38 university members

these include Canon, Hitachi, IBM Japan, Mitsubishi, NEC, ...

"Japan has accomplished and contributed to important scientific and technological result in the past; yet, we have not recognized enough to truly call ourselves leaders in science and technology in the world."

"The AAA has designated the ILC as its core project."

"The ILC will bring a great expectation to the future of Japan and Asia ... "

Japan Policy Council (www.policycouncil.jp)

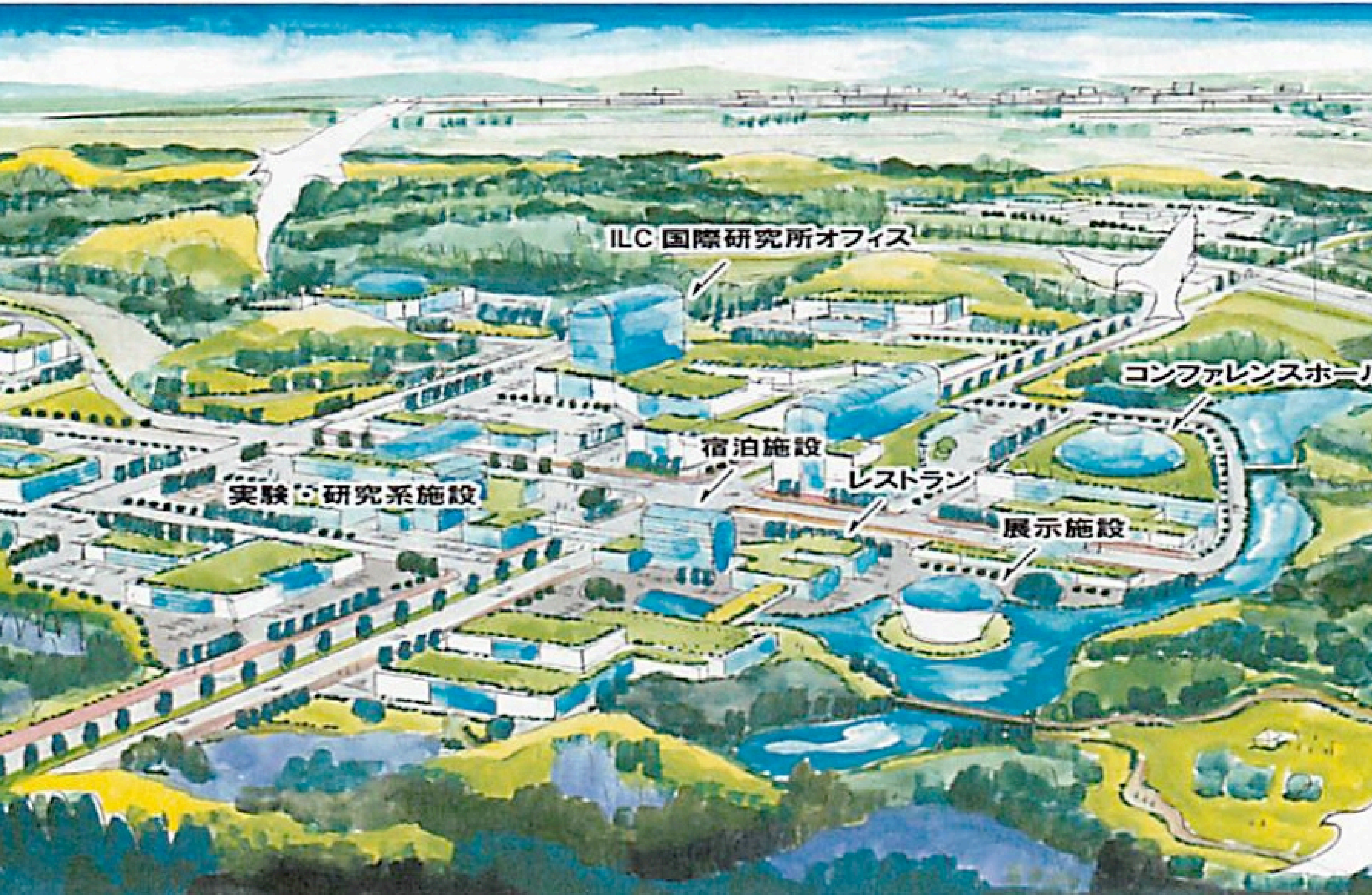
Chair: Hiroya Masuda
(U Tokyo professor involved in the creation of Tsukuba)

Second recommendation document:

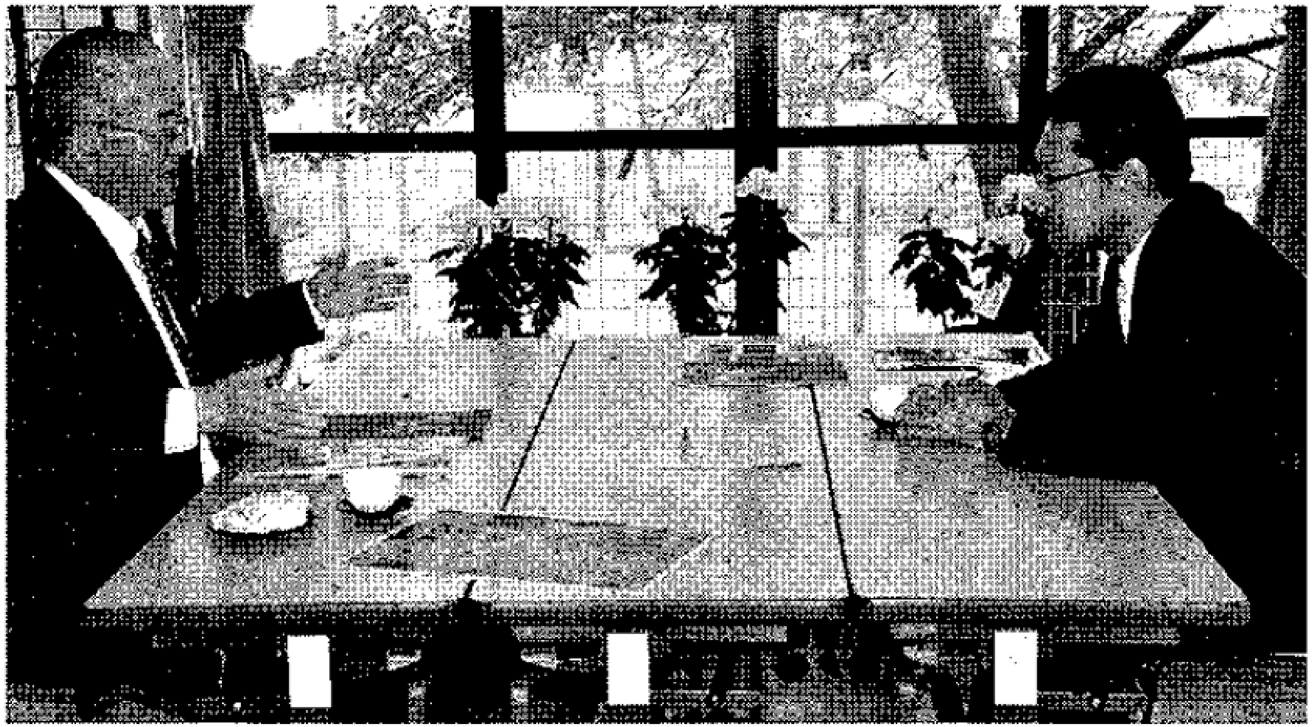
Creation of Global Cities by hosting the International Linear Collider

"Japan should revitalize its provincial cities to revitalize Japan itself ..."

"... explore "Domestic Globalization" taking advantage of the opportunity of Japan's possible bid to host the International Linear Collider (ILC) project ... "


ILC 国際研究所オフィス
コンファレンスホール
宿泊施設
実験・研究系施設
レストラン
展示施設

Expressions of interest from local politicians, governors of Iwate and Saga provinces.   ILC appears in the press and before the public.



「中東北」の拠点都市形成を目指す勝部市長が提案。ＩＬＣについて両市長は「誘致されれば研究施設が建設される地域以外への波及効果も大きく、東北一円に及ぶ」と展望しながら「誘致以外の部分でも周辺自治体が協力していくべき」とする考えで一致し

一関市は餅、

「はっと」が食

てあり、「イベ

の機会で互いに

たい」と〝切磋

ることを誓った

両市長はコミ

ＦＭの利用や市

を訪れる「移動

"Shuichi Katsube, mayor of Ichinoseki City (Iwate province) and Takahisa Fuse, mayor of Tome City (Miyagi province) discuss their cooperative partnership concerning a wide range of issues including the ILC..."

Somewhere on the road to Morioka:

Federation of Diet Members for promoting ILC

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

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

The most important target of the Federation is
to realize **ILC as the GLOBAL PROJECT,**
and strongly supporting the global R&D efforts.
The Federation is **seeking ways to promote ILC to be located somewhere in Asia,**
and supporting domestic preparation processes and investigations
to prepare the case for **Japan as the host if global society wishes.**

S. Yamashita, talk at KILC12

December 2011:

AAA symposium; Prime Minister Yoshihiko Noda was a speaker.

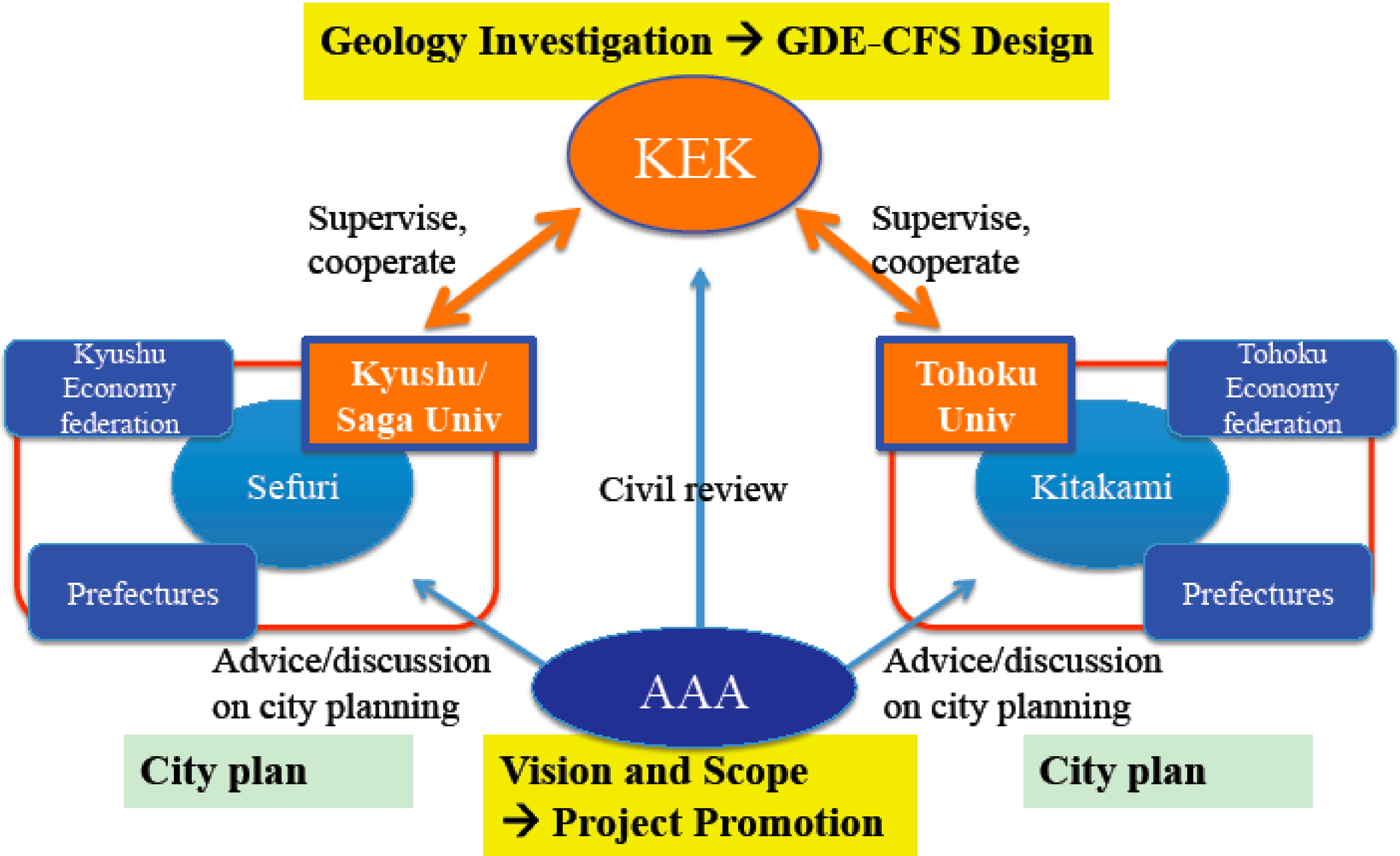
After 2011.3.11 Tsunami

- Iwate Prefecture officially proposed the ILC project at Kitakami area as the statue of recovery from the disaster (May 2011).
- Recommendation by "Science-technology-innovation division" of Democratic Party to boost efforts to realize ILC in Tohoku (June 2011).
- Resolution to promote ILC realization by "Science and technology division" and "Special committee for space and marine" of Liberty and Democratic Party (Aug 2011).
- Official brief document on the ILC project given to CSTP (Council of Science and Technology Policy) documented by MEXT *et al.* (Sep. 2011)
- At several occasions, discussions at Diet on the issues of ILC.

Budget is given by Japanese government for ILC to investigate geology at the candidate sites (Dec. 2011)

Kitakami and Sefuri area: Each local team has been working on

1. **Geological surveys** including boring investigation
2. **City-planning** with the ILC as the core.



ILC appears in the LDP Election Manifesto

32　科学技術政策の強力な推進力となる真の「司令塔」機能の再構築

資源の少ないわが国にとって、今後の社会・経済をさらに発展させるため、企業の研究開発投資が激減する中、新たな成長に向けて国主導で科学技術イノベーションをリードするのが喫緊の課題です。

しかし、年間約 3.6 兆円にも及ぶ科学技術関係予算については、文部科学省を中心に、経済産業省や厚生労働省等、関係省庁に予算が配分され、各省内で同様な研究が行われている事例も見受けられ、縦割りの弊害が顕著です。また、限られた予算にも関わらず、効果的な配分が行われていないのが現状です。

そこで、産業の生命線である科学技術を国家戦略として推進し、「価値の創造拠点」とするべく、総合科学技術会議の「権限」「体制」「予算システム」を抜本的に強化し、真の「司令塔」機能へと再構築します。

具体的には、各省庁の縦割りを排し、強力な予算配分権限を集中させ、適正な評価を行うことができる人材育成とシステムの構築を行います。例えば、素粒子物理分野の大規模プロジェクトである ILC（国際リニアコライダー※研究所建設）計画等を含む国際科学イノベーション拠点作りに日本が主導的な役割を果たせるなど、再生医療※や創エネ・省エネ・蓄エネ等の重点分野を産学の知を結集した国家戦略として強力に推進します。

A very urgent issue for the leaders of the country is to take the lead in science and technology innovation and aim for new growth in order to develop the future society and economy.

... and make Japan play a leading role in the formation of an international scientific innovation base that includes, for example, the plan for the ILC ...

Yamashita concludes the talk quoted above:

"Clear and timely voice of the world HEP community and the global proposal as solid as possible are the most essential to realize ILC in the near future."

Conclusions:

We need to envision an "ultimate" program of Higgs measurements that will supply all sizeable Higgs couplings in a model-independent way to percent accuracy.

The ILC will supply that program. No other proposed facility fills this requirement.

The ILC Technical Design is well advanced. The ILC is ready for a construction proposal.

There are many positive signs that Japan will bid to host the ILC.

The ultimate Higgs program can become a reality. Will the world HEP community support it ?