

# News from Japan on ILC

Hitoshi Murayama (UC Berkeley, LBNL, Kavli IPMU Tokyo)  
HEPAP telecon Sep 26, 2017



BERKELEY CENTER FOR THEORETICAL PHYSICS



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LEP, Tevatron

$$\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} + i\bar{\psi} \not{D} \psi + \text{h.c.}$$

Babar  
Belle

$$+ \chi_i y_{ij} \chi_j \phi + \text{h.c.} + |D_\mu \phi|^2 - V(\phi)$$

LHC  
ILC

# Case for ILC

- Clear science target: Higgs boson @ 125GeV
- $e^+e^-$ 
  - clean, democratic, holistic
- Energy upgradability
  - ILC250 → ILC500 → ILC1000? → CLIC? → Plasma 30 TeV?
- Beam polarization
  - electroweak physics violates parity
- International project led by LCC → LCB → ICFA

# Issues with ILC

- **Expensive**
  - GDE: \$8B + labor (+ infrastructure) ~ \$10B
- **International**
  - many countries need to agree, negotiations take time
- **physics community not entirely unified**
  - $e^+e^-$ : FCCee, CEPC
  - neutrino: DUNE, HyperK
  - enthusiasm behind 100 TeV  $pp$  (FCC, SppC)

# LCWS 2016

- Morioka, Dec 5–9, 2016
- Kawamura, President of the Federation
- “*Science First*”
- Emphasized need for cost reduction
- Panel discussion on staging led by LCC
- broad understanding for the need of staging to reduce the sticker price shock within LC community



Starting with the US and Japan, we now have an entry point to the governments and parliaments in Europe and in Asia. But the main part of the battle is just ahead of us. **Cost reduction is an especially pressing and challenging issue**, which must be surmounted by worldwide efforts.

The ITER project, which I worked on as Minister of MEXT, was realized by significantly reducing the original cost. For Japan and other countries, the lower the costs are, the faster the negotiations would progress and hence the faster the realization. Thus **it is of utmost importance to reduce the cost**. However, we cannot afford to spend too much time on cost reduction. **What will happen next year will be critical**. Though many hard decisions will have to be made, it is our hope that prospects and direction will be shown in a timely manner.

Science is indeed the language to bring the world together. At CERN, many scientists come from all corners of the world with political and ideological differences. The fact that they can collaborate is proof that science can bring harmony.

President-Elect Mr. Trump has called for “America First” during his campaign. Now is the time for us in Japan to propose something different: “Science First” – The ILC will be its symbol!

It would be a marvelous thing if Japan could be the place to bring the world together by science. With “Science First” as our slogan, we hope to work with the world to provide a place for science and innovation. As Prof. Huntington said, Japan has its own distinct civilization. And I’m certain that we can play a leading role in this endeavor.

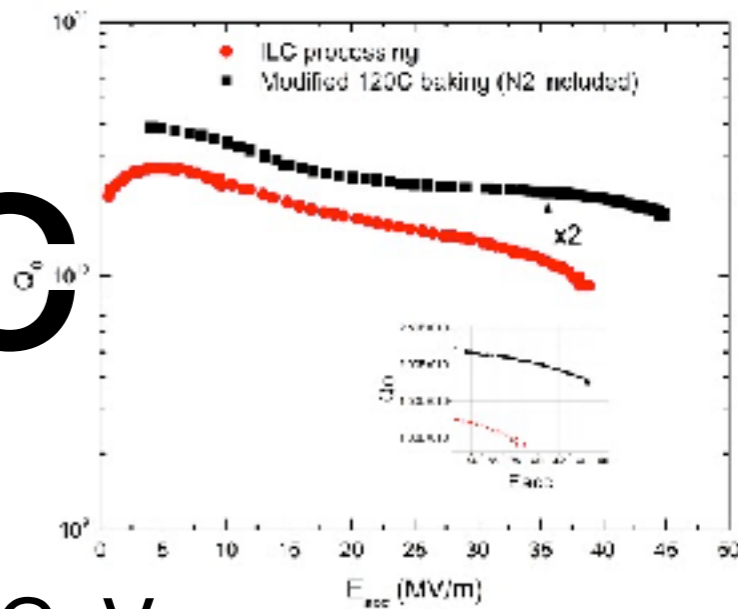
This the very reason why Japan wishes to bring the world together by “Science First”. I think the ILC will be at the core of the flow of science through the history of humankind.

You are probably used to thinking that the ILC is where collisions take place. Don’t forget that it will also bring harmony to the world. Harmony is at the heart of the country of the rising sun. Let the ILC be the ray of hope to shine the world.

Thank you, and again, “Science First” with ILC!



# Strategies with ILC



- **Expensive**  $\Rightarrow$  Reasonable? Staging from 250 GeV
  - ~60% of ILC500? (cost review today at KEK)
  - N<sub>2</sub>-doped cavity, smaller cross section of tunnel
  - being designed to be extendable at least to 500 GeV
  - site allows for 50km, 1TeV with current technology
- **International**
  - HERA or X-FEL model: Japan announces intent to host with certain contribution committed, other interested countries join in
- **physics community not entirely unified**
  - Need political progress before European Strategy Update

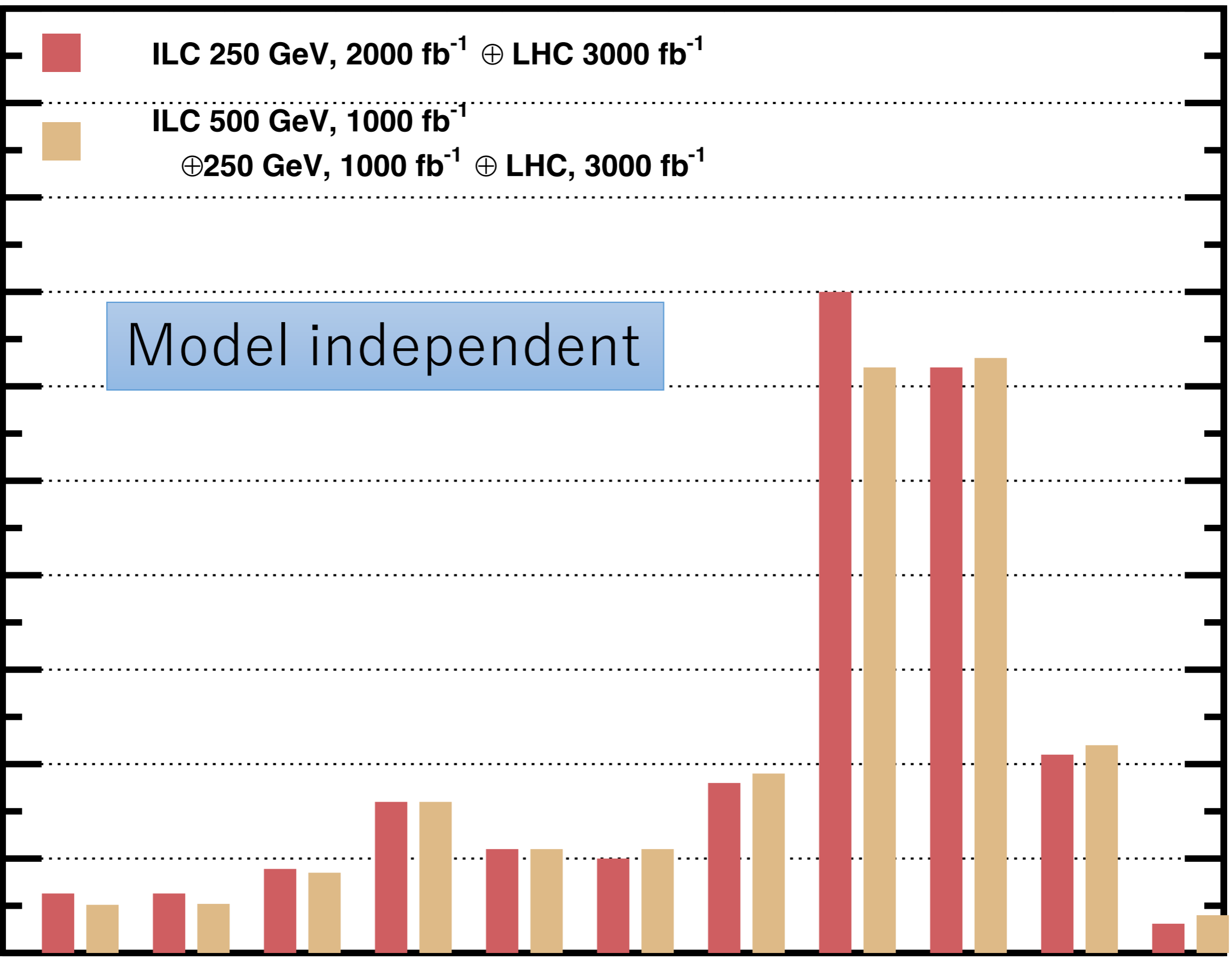
# Asai Committee

- Working group exclusively by non-ILC physicists led by Shoji Asai (ATLAS)
  - ATLAS, Belle II, theory
- Concluded that **ILC250+HL-LHC** is comparable to **ILC500** for precision Higgs physics
- *“ILC250 should run concurrently with HL-LHC to enhance physics outcomes from LHC. Given that a new physics scale is yet to be found, ILC250 is expected to deliver physics outcomes that are nearly comparable to those previously estimated for ILC500 in precise examinations of the Higgs boson and the Standard Model.*
- *“The ILC250 Higgs factory, together with HL-LHC and SuperKEKB, will play an indispensable role in the discovery of new phenomena originating from new physics with the energy scale up to 2–3 TeV and the elucidation of the origin of matter-antimatter asymmetry.*
- *“A linear collider has a definite advantage for energy-upgrade capability. ILC250 possesses a good potential for its upgrades to reach the higher energy of new physics that the findings of ILC250 might indicate.”*

(EFT fit)

Precision of Higgs coupling and width [%]

10  
9  
8  
7  
6  
5  
4  
3  
2  
1  
0



Model independent

$g(HZZ)$   $g(HWW)$   $g(Hbb)$   $g(Hgg)$   $g(H\gamma\gamma)$   $g(H\tau\tau)$   $g(Hcc)$   $g(Htt)$   $g(H\mu\mu)$   $\Gamma_{\text{tot}}$   $\Gamma_{\text{invis}}^{(CL95\%)}$

# JAHEP Statement

2017/08/16

As discussed above, the scientific significance and importance of ILC has been further clarified considering the current LHC outcomes. **ILC250 should play an essential role in precision measurement of the Higgs boson and, with HL-LHC and SuperKEKB, in determining the future path of new physics.** Based on ILC250's outcomes, a future plan of energy upgrade will be determined so that the facility can provide the optimum experimental environment by considering requirements in particle physics and by taking advantage of the advancement of accelerator technologies. It is expected that ILC will lead particle physics well into the 21st century.

To conclude, in light of the recent outcomes of LHC Run 2, **JAHEP proposes to promptly construct ILC as a Higgs factory with the center-of-mass energy of 250 GeV in Japan.**

## Statement by the Japanese HEP Community

- A subcommittee<sup>(\*)</sup> was formed under the Japanese HEP committee to deliberate the scientific significance of the 250GeV ILC, and the report from the subcommittee was approved recently at the community meeting. JAHEP then issued a statement based on the report .

<http://www.jahep.org/files/JAHEP-ILCstatement-170722-EN.pdf>

“As discussed above, the scientific significance and importance of ILC has been further clarified considering the current LHC outcomes. ILC250 should play an essential role in precision measurement of the Higgs boson and, with HL-LHC and SuperKEKB, in determining the future path of new physics. Based on ILC250’s outcomes, a future plan of energy upgrade will be determined so that the facility can provide the optimum experimental environment by considering requirements in particle physics and by taking advantage of the advancement of accelerator technologies. It is expected that ILC will lead particle physics well into the 21st century.

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\* The subcommittee consists of 10 physicists: two from ATLAS, two from Belle II, one from ILC physics group and five theorists.

## The Reality of ILC

- Despite our continued efforts over the last five years since we proposed ILC to the Japanese government in 2012, we realized that the cost for the ILC described in the TDR is beyond financial capabilities for the Japanese government to initiate international negotiation in a reasonable timeframe.
- We need substantial cost reductions.
  - ▶ Improvement of the SCRF performance and reduction of the manufacturing cost of the cavities
  - ▶ Reduction of the energy of the collider down to 250GeV
  - ▶ Note that ILC250 possesses the potential for its upgrades to reach the higher energy of new physics that the findings of ILC250 may indicate.
- We hope to propose a less costly ILC to the Japanese government together with ICFA as an international project to be hosted in Japan, and request MEXT to come to a conclusion in a short time based on the findings they have made.
- Strong support is expected from the Federation of the Diet Members and AAA.

## Our Next Steps

- We request ICFA to endorse the 250GeV ILC as an international project.
  - ▶ Definition: ILC is a linear collider to be constructed by collecting intellectual contributions, financial and/or in-kind contributions, and labor from the international partners.
  
- If so, please be prepared for the next step.
  - ▶ We will make all the possible efforts to have MEXT initiate negotiation with the other governments to give a joint approval to the international project.
  - ▶ It is extremely important that the physics communities of each country work concurrently with us to request their governments to consider participation in ILC, and to be positively involved in the negotiation with MEXT.

# LCB Tentative Statement

20 August 2017

Physics studies by the LCC Physics and Detector Group and the JAHEP make it clear that there is a compelling physics case for the ILC built at 250 GeV. And the cost of such machine is at a level of some of the existing large international scientific facilities. For these reasons, the **LCB strongly supports the JAHEP conclusion to promptly construct the ILC at 250 GeV in Japan and encourages the Japanese government to give their proposal very serious consideration with a favourable conclusion.** Expression of Japanese government's interest to host the machine should enable to start negotiations for realising the project with international participation and pave a way for the interested partners to initiate a meaningful discussion with their own governments for possible contributions.

One of the unique qualities of a linear collider is the capability of increasing its operating energy by improving the acceleration technology and/or extending the tunnel length, with much of the infrastructure such as the electron and positron sources already in place. Therefore, the design and implementation of a 250 GeV machine should not have any constraining elements for such energy upgrade, so that after its successful construction and exploitation, an increase of machine energy could be discussed with well-justified physics goals. Such machine will also serve as an important stepping stone for the future development of this promising technology.

To be updated at ICFA Seminar on Nov 7 in Ottawa



# Politics in Japan

- ILC enjoys broad political support
- *“Federation of Diet Members promoting ILC in Japan”*
  - includes >1/3 of the Diet
  - multi-party organization
  - many Ministers, powerful politicians
  - political discussion picked up momentum with staging
- Strong local support
  - Iwate prefecture promotes ILC heavily
  - So far no local opposition
- Strong support from Industry
  - Advanced Accelerators Association Promoting S&T (AAA)
  - active under Nishioka (former chairman of Mitsubishi Heavy Industry)

# Politics in Japan

- Deputy Minister of Education chairs ILC task force
  - ILC Advisory Panel since 2014
- many committees under him
  - science, human resource, cost, technological feasibility, management model
  - to be concluded sometime next year (expected)
- probably requires vetting by Science Council
- (snap election on October 22, 2017)

# Picking up momentum

- Sep 1st Meeting with Prime Minister
  - Honorables Kawamura, Shinoya
  - briefed PM on cost reduction, international situation, urgency, etc
  - PM told them to discuss detail with MEXT Minister
- Sep 7th Meeting with Minister of MEXT
  - 3 Diet members (Hon. Shinoya & Ito, Minister of Olympic Suzuki) + Industry AAA chair Nishioka (MHI former chairman) + Yamashita + MEXT officers Itakura etc
  - Good discussion thanks to Minister's S&T understanding, additional budget etc..
- Sep 25 Federation meeting (open to media)
  - report on the meetings above to Diet members, MEXT, METI, MOFA
  - Lyn Evans, Jim Brau, Tatsuya Nakada
  - MEXT announced additional few \$M to cost reduction R&D

# Timetable

- ongoing Japan-US work on cost reduction
- 2018–19 Commitment from Japanese government
- 2019–20 European Strategy Update
- 2020 US P5?
- ~2020 cost reduction by N<sub>2</sub>-doping becomes clear
- a few years of negotiation
- 8 years of construction
- aim for concurrent run of ILC250 with HL-LHC