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Juan Antonio Fuster Verdú
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Chair of Linear Collider study of the European Committee for Future Accelerators

[redacted]

Date: 31 October 2018

Professor Yasuhiro Iye
Chair, the committee on the revised ILC
Science Council of Japan

Dear Professor Iye,

I am Juan Fuster present chair of the Linear Collider study for physics and detectors as designated by the European Committee for Future Colliders (ECFA). It is my highest pleasure the write this letter in support of the International Linear Collider (ILC) to be realized as an international project host by Japan.

As an introduction of this letter let me say that the central issue in particle physics today is the search for new phenomena needed to address shortcomings of the highly successful Standard Model. These new effects can manifest as new particles, new forces or deviations in the predictions of the Standard Model derived from high precision measurements. With the discovery of the Higgs boson in 2012 at the Large Hadron Collider (LHC), the building of Standard Model culminated one of its major steps. However, while theoretically self-consistent, with no evidence of physics beyond the Standard Model having appeared, a number of issues remain unaddressed, leaving the Standard Model as an incomplete theory of the fundamental interactions. New particles or forces could advance our understanding of how the physics of the Standard Model fits into a more complete picture of the nature of the universe.

The international Linear Collider (ILC) has the capabilities needed now to address the central physics issues continuing the gigantic scientific effort and exploration of LHC. First and most importantly, it provides unprecedented precision in the measurements and searches needed to pursue these questions. For example, ILC will have unique sensitivity to test the Higgs couplings, particularly critical should the deviations from the Standard Model be small. It offers a range of operating energies, both through beam energy variation and straight-forward accelerator energy upgrades. The energy upgrades will allow the ILC to remain a powerful discovery vehicle for decades. Beam polarizations provide unique access to important and powerful physics parameters. Finally, and critically, the technology is mature, ready for implementation today.

Among the outstanding questions that are the focus of energy frontier efforts are the explanation of the apparent mismatch of the scale of electroweak physics with the Planck scale, or the hierarchy problem. Why is the Higgs mass as light as it is? The Standard Model does not offer any explanation for the evidence for dark matter. Likewise, gravitation is not included. These and other issues motivate

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intense efforts to test the consistency of the Standard Model to high accuracy and look for small deviations that would provide clues toward answering such open questions.

For more than twenty years the worldwide community has been engaged in a research program developing the technology required to realize a high energy linear collider to precisely measure electron-positron collisions, contributing to answering the critical questions at the energy frontier, such as the hierarchy problem, the nature of dark matter and even the relationship to gravity. In the 1990's, as the technology options to realize the ILC were in early phases of maturing, the International Technology Review Panel (ITRP) was charged by
ICFA to review the options. Based on the review, superconducting radiofrequency (SCRF) was chosen, in a large part due to its energy efficiency and potential for broader applications. Many of those applications have been realized bringing the technology to a high level of
readiness for the ILC. The effort to design and establish the technology for the linear collider culminated in the publication of the Technical Design Report (TDR) for the International Linear Collider (ILC) in 2013. In its current form, the ILC250 is a 250 GeV (extendable in energy) linear e+e- collider, based on 1.3 GHz superconducting radio-frequency (SCRF) cavities. It is designed to achieve a luminosity of $1.5 \times 10^{34} cm^{-1} s^{-1}$ and provide an integrated luminosity of 350 fb^{-1} in the first four year of running. The electron beam will be polarised to 80 %, and positrons with 30 % polarization will be provided if the undulator based positron source concept is employed. The parameters were set by considerations of the physics goal, with an energy reach designed to likely provide access to the mechanism of electroweak symmetry breaking (Higgs or no-Higgs).

The collider design is thus the result of nearly twenty years of R&D. The heart of the ILC, the superconducting cavities, is based on over a decade of pioneering work by the TESLA collaboration in the 1990s. Some other aspects were based on the R&D carried out for the JLC/GLC and NLC projects, which were based on room-temperature accelerating structures. From 2005 to the publication of the TDR in 2013, the design of the ILC accelerator was conducted as a worldwide international collaboration, the Global Design Effort (GDE), under a mandate from the International Committee for Future Accelerators (ICFA). Since then, the Linear Collider Collaboration (LCC) has been coordinating the international activities for both the ILC and CLIC projects, again mandated by ICFA.

Once the mass of the Higgs boson was known, it was established that the linear collider could begin to address these questions in unique fashion with an initial center- of-mass energy of 250 GeV at a cost reduced from the TDR. A revised design of the ILC (the ILC250) has been presented based on the ILC TDR. The cost estimate for ILC250 has been developed and presented as well. Additionally, advances in the theoretical understanding of the impact of precision measurements of the Higgs boson couplings by ILC250 have increased the understanding of their sensitivity to physics beyond the Standard Model. The experimental community has developed the designs for two complementary detectors, ILD and SiD. These detectors are designed to optimally address the ILC physics goals. They are based on a detector R&D program that has as well contributed a number of advances in detector capabilities and applications beyond the ILC.

The present LHC physics program being approved will maintain the machine operating until 2035 and ILC is the best machine humanity can offer today to continue exploring the High Energy Frontier. The LHC is at CERN, The European Laboratory for Particle Physics which is supported by its member states. The cost of LHC including its present upgrades is of similar size or even larger than that of the ILC. Japan participates as an Observer State and its contribution has been relevant for the success of

the LHC project. Furthermore, the participation of the Japanese scientists in the LHC experiments is essential. This mutual collaboration is thus highly successful for both Europe and Japan.

In what concerns Spanish matters recently, this week we have had a Spanish Community Meeting in Salamanca (Spain) (https://www.i-cpan.es/jornadas10/ubicacion.php) to discuss the Spanish input to the on-going European Strategy Process. The support of the Spanish Community to the completion of the LHC physics program and the ILC collider as its successor has been strong and unanimous.

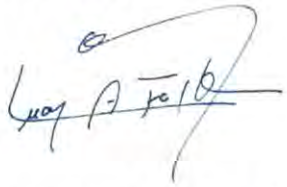
Following I reproduce the statements concerning the ILC which are not yet in their final version though are currently public in its present shape:

"***Beyond the LHC physics program:***

- The present ILC proposal, conceived as a Higgs factory at 250 GeV centre-of-mass energy with potential upgrades to higher energies, is positively seen by the community. The scientific program is sound and the project is realistic and feasible. In general, the community prioritize an e+e- collider extendable in energy. At this level both e+e- proposals, ILC and CLIC, are supported with a preference for the ILC as a more mature technology and for its faster implementation.

- If the Japanese government supports to construct and to host the ILC250, the Spanish community is eager to participate in this new endeavor. A possible future contribution from Spain to ILC250 should be negotiated in close collaboration with the rest of interested European countries. The participation of the CERN lab to this possible European contribution in technology and science as well as logistics is considered essential."

Yours sincerely,



Juan Fuster, Chair of the ECFA Linear Collider study for physics and detectors

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Professor Yasuhiro Iye
Chair of the ILC committee
Science Council of Japan

Valencia, 31st of October 2018

Dear professor Iye,

With the present document I would like to express my support for the project to host the International Linear Collider in Japan.

The physics case of the ILC is undeniable. Precise measurements of the interactions of the Higgs boson can bring fundamental physics a step closer to understanding what lies beyond the Standard Model. This potential is widely recognized in the global high-energy physics community and in many other areas of science. European countries have put this support in writing in their inputs to the next European strategy update. The document in preparation in Spain statest that "*If the Japanese government supports to construct and to host the ILC250, the Spanish community is eager to parlcipate in this new endeavour" [1].*

I understand that you consider the investment of the ILC as a "**sacrifice**"[2]. I think it is more accurately qualified as an **opportunity**. It is an opportunity for Japan to move to the first rank of international science. It is also an opportunity to internationalize Japanese science. It is an opportunity for Tohoku to attract highly-qualified personnel from the rest of Japan and the world. A concentration of talent in the region will seed new technology development and boost the economy. Finally, it is an opportunity for the planet to understand the universe. I note here that Europe did not consider the construction of the LHC a sacrifice. Nor did the US think in these terms when it built the LIGO installation.

I understand that the approval of the ILC may cause some anxiety in other branches of science. I firmly believe, however, that new sources of funding can be found to build the ILC. The investment in the ILC can and should be covered without hurting the budgets of other fields. I hope that, rather than focussing on the competition for funding among scientific fields, scientists will stick together and maximize the overall investment in science. For a more authorative view on this subject, I highly recommend Steven Weinberg's article on big science[3]. Let me highlight this one sentence: *I took little pleasure from the observation that none of the funds saved by canceling the SSC went to other areas of science.*

Of course, I remain available to discuss any of these points.

Yours faithfully,

Dr. Marcel Vos
Staff researcher of CSIC at IFIC Valencia
Co-IP of the ATLAS/future colliders project

[1] https://indico.ific.uv.es/event/3366/contributions/9947/attachments/6559/7578/ExecutiveSummary-V0.pdf
[2] https://metropolisjapan.com/140152-2/
[3] https://www.nybooks.com/articles/2012/05/10/crisis-big-science/

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Dr. Ivanka Božović-Jelisavčić
Research Professor

Head of the Experimental HEP Group
Institute representative at ILD
and FCAL Collaborations at ILC

Professor Yasuhiro Iye
Chair, the Committee on the revised ILC
Science Council of Japan

Dear Proffessor Iye,

On behalf the Vinca Institute of Nuclear Sciences HEP group, I would like to express full support for the statement from LCWS2018 in Arlington, Texas, brought to your attention in the process of evaluation of the ILC project.

Leading the high energy physics group involved at ILC, CLIC and CEPC, I believe that I may say that the International Linear Collider Project is beyond any doubt the only future collider project that got unanimous support of majority of the European and international laboratories. And the only project maintaining such a large research community commitment over a very long process of its approval.

Being involved in the very forward instrumentation and MDI in the ILD and FCAL Collaborations at ILC, already for thirteen years, I would like to point out that **we have reached the level of technological feasibility proven in the test-beam campaigns.** This is documented in numerous publications. The advanced level of detail of physics related simulation studies in also impressive.

Certainly, being involved in this projects, I have sympathies for it. Nevertheless, for the very objective arguments like the above, I hope that SCJ and You personally will reach a decision that won't be disappointing for a large fraction of the international HEP community.

I stay at your disposal for any further information.

Sincerely,
Prof. Dr. Ivanka Božović-Jelisavčić

November 2018, Belgrade

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Professor Yasuhiro Iye
Chair, the committee on the revised ILC
Science Council of Japan

November 1, 2018

Subject: **Support Letter for the ILC**

Dear Professor Iye

The design of the International Linear Collider is based on the work of the late professor Bjrn Wiik, the former director of DESY, who originally had planned to build a linear collider in Germany. He was devoted to this project and would have succeeded. Unfortunately, he passed away in1999 due to a tragic accident. His successor did not have his skills to follow through with the full project. Instead, DESY built the XFEL, which is a modern light source. This project is the first successfully working prototype of the ILC. Professor Wiik got me interested in the ILC. I have been involved for over 15 years in this project. I think it is very important for particle physics in uncovering the origin of our universe. We see many phenomena that we do not understand, like dark matter and dark energy. History taught us that precision measurements are a key tool for finding discrepancies in our current understanding, which in several cases have lead to new discoveries (charm, bottom, top, neutral current and the Higgs to name a few). I have been involved in the BABAR experiment where we performed measurements of *CP* violation and rare decays. Both BABAR and the LHCb at CERN found significant discrepancies with the Standard Model that are presetly not understood. High precision measurements in the B-meson system will continue at Belle II and LHCb. The ILC planned in Japan provides the next step of performing precision measurements of the Higgs boson. Our theory colleagues tell us that New Physics may enter at a level of 1-10%. The ILC allows us to perform measurements at the 1% level or better in a model-independet way. The LHC will not reach this high-precision level. I am presently involved with Higgs studies in the ATLAS experiment and would like to continue these at the ILC. Besides precision measurements of the Higgs boson, the ILC also provides the opportunity to discover new phenomena directly. Please notice that there is a world-wide interest in the ILC. We just held a Linear Collider Workshop at The University at Arlington, Texas that was attended by nearly 200 physicists

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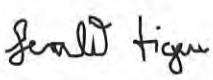
from all over the world. Over 20 years of work has been devoted to the ILC machine and we have come up with a design that is ready to go. Similarly, more than 20 years of work have gone into detector R&D resulting in two competing experiments (ILD and SiD). We have built and tested prototypes and have come up with two detector designs that can be built now. So I hope you acknowledge our efforts and support us to obtain green light from the Japanese government to build the ILC.

Sincerely,



Gerald Eigen

Jefferson Lab
Thomas Jefferson National Accelerator Facility
Exploring the Nature of Matter

Hugh E. Montgomery
Director Emeritus

Date: November 1, 2018

[redacted]

Professor Yasuhiro Iye,
Chair, Committee on the revised ILC
Science Council of Japan

Dear Professor Iye,

I understand that you and your colleagues on the *Committee on the revised ILC*, a sub-committee of the Science Council of Japan, are completing your work and will submit your report soon. This work is of extreme importance to world physics and I, along with many colleagues across the world, appreciate very much the efforts you have put into this work. I should point out that the views in this letter are my own, and should not be construed as representing either Jefferson Lab or the US Department of Energy. The intent of my letter is to urge you strongly to support the initiative to construct the ILC in Japan with global support from the other particle physics communities.

It has been my privilege to have worked at Daresbury Nuclear Physics Laboratory in the UK, at CERN, in Switzerland, at Fermilab in the USA, and most recently at Jefferson Lab in the USA. At CERN, I was spokesman of the European Muon Collaboration, at Fermilab, Spokesman of the E665 Muon scattering experiment, and during the time of the discovery of the top quark, a co-leader of the DZero experiment. Subsequently, I served as Associate Director for Research at Fermilab before becoming Laboratory Director at Jefferson Lab. I served for 5 years on the International Advisory Committee for the J-PARC laboratory in Tokai. I have been honored by the United Kingdom Institute of Physics with their Glazebrook Prize, and by the Department of Energy with a Secretarial Distinguished Service award from Secretary Moniz in 2017. I am currently Director Emeritus at Jefferson Lab and am enjoying a number of advisory roles across the field of particle and nuclear physics, from Germany to Canada.

The case for a high energy electron positron machine has been consistently strong. The discovery of the Higgs particle with a mass accessible to a 250 GeV electron-positron collider, and with it the need for high precision elaboration of its properties, makes the construction of such a machine mandatory. Current wisdom indicates that the ILC would be the appropriate choice for such a machine. The superconducting radio frequency technology, chosen by wise men in 2003 is now the technology of choice for numerous knowledge-frontier accelerators in both nuclear and particle physics. The technology is mature and the European XFEL machine in DESY, and the LCLSII FEL in the United States represent large scale superconducting radiofrequency technology prototypes.

The XFEL machine has recently achieved its design energy. Of course, a linear collider is intrinsically extensible so could provide the basis for higher energy collisions should the physics we will learn demand it.

During the past two years, I have served as the Chairman of the Americas Linear Collider Committee, which tries to foster support for the International Linear Collider, within the US community and with our funding agencies, in particular the Department of Energy. In a recent visit to Japan by DOE Undersecretary for Science, Paul Dabbar, his remarks indicated a readiness by the Department of Energy to enter in discussions about the ILC with the Japanese government. A similar message was delivered by Dr Chris Fall, the nominee for the position of Director of the Office of Science in the DOE, to the recent international Linear Collider Workshop (LCWS2018) at the University of Texas, Arlington, on October 26, 2018

The economic benefits for the host nation of such a large international science project are well documented. My personal view is that the advancement of science is an important human endeavor and should be the privilege of all peoples on the globe. The construction of the International Linear Collider in Japan would be an important step toward ensuring worldwide participation in frontier science and the continued physics leadership by Japan, which has been demonstrated by the awards of Nobel Prizes to Kajita; Akasaki, Amano, and Nakamura; Nambu, Kobayashi and Maskawa; and Koshiba during this 21st century.

To reiterate, I urge your support of the ILC as an international project to be led by Japan.

Sincerely,

Hugh E. Montgomery

Dr. Karsten Buesser
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Germany

Prof. Yasuhiro Iye
Chair, the Committee on the Revised ILC
Science Council of Japan

Hamburg, November 2nd 2018

Dear Professor Iye,

I am a senior research scientist at the German national laboratory for accelerator and particle physics, DESY, and I chair the working group on Machine-Detector Interfaces in the Linear Collider Collaboration. In addition, I am the deputy technical coordinator of ILD, one of the proposed detector concepts for the International Linear Collider.

I have started working on the scientific and technical aspects of linear colliders more than 18 years ago being motivated by the excellent scientific opportunities. The detailed studies of the symmetries that drive the dynamics of the micro- and macroscopic structures of our Universe will bring the knowledge of mankind to insights that are – in my true persuasion – not possible with other research instruments. I share this opinion with many colleagues in the international community as has been documented in the Fukuoka and Texas Statements as well as in the recent statement of ICFA, the International Committee on Future Accelerators.

The emphasis of my work for the ILC project lies on the technical aspects towards a possible realization in Japan. Those have been thoroughly studied by international teams of accelerator, detector, and civil engineering experts. In doing so, we rely on the expertise that has been gained over decades at existing accelerator facilities, e.g. at CERN (CH), DESY (D), KEK (J), and SLAC (USA). The most recent example is the realization of the European XFEL at DESY, that is based on the ILC technology and shows that large linear accelerator facilities of this type can be built and operated within time and budget constraints.

Japan is in a unique position of making the next step in this truly international endeavor. The ILC will be a research facility where the world comes together to work on the fundamental questions of the Universe. This will have invaluable influence on many aspects of societies – not only in science and technology – in Japan and worldwide.

I want to thank you for your efforts in reviewing the scientific scope of the ILC. I sincerely hope that as a result of the work of your committee Japan will be able to move forward and make the ILC a reality.

Yours sincerely,

Dr. Karsten Büsser

Dr. Frank Gaede
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Germany

Prof. Yasuhiro Iye
Chair of the Committee on the Revised ILC
Science Council of Japan

Hamburg, November 2nd 2018

Dear Professor Iye,

I am working as a senior scientist at DESY, Germany's national laboratory for accelerator and particle physics. I am currently the chair of the Software Working Group of the Linear Collider Collaboration (LCC) as well as Software Coordinator of ILD, one of the two detector concepts proposed for the ILC. For more than 16 years I have worked on virtually all aspects of computing, simulation, reconstruction and analysis software for the preparation of a detector concept at ILC that meets the design and performance goals to address the fundamental open questions of particle physics today.

Of prime importance for particle physics are the measurements of all properties of the Higgs boson with the highest precision possible. This view is widely shared in the field and has for example recently been expressed in a dedicated statement by the German particle physics community as well as in the Fukuoka and Texas Statements of the international community.

Such precise measurements will only be possible at an electron-positron collider, where the ILC is by far the most advanced of the proposed projects. This is well documented in the TDR and also demonstrated with the recent realization of the European XFEL at DESY, which could be considered a 'prototype' for the ILC, as it is entirely based on the same accelerator technology.

I truly believe that realizing the ILC in Japan offers the unique possibility to host one of the most outstanding international research facilities in your country. It will attract generations of physics researches in the coming decades to come to work and live in Japan. The ILC in Japan will be a place where the whole world comes together to answer the some of the most fundamental questions of the universe.

I would like to thank you for your efforts in reviewing the scientific potential of the ILC and hope that the final report of your committee will mark the first step toward realizing the ILC in Japan.

Yours sincerely,

F. Gaede