



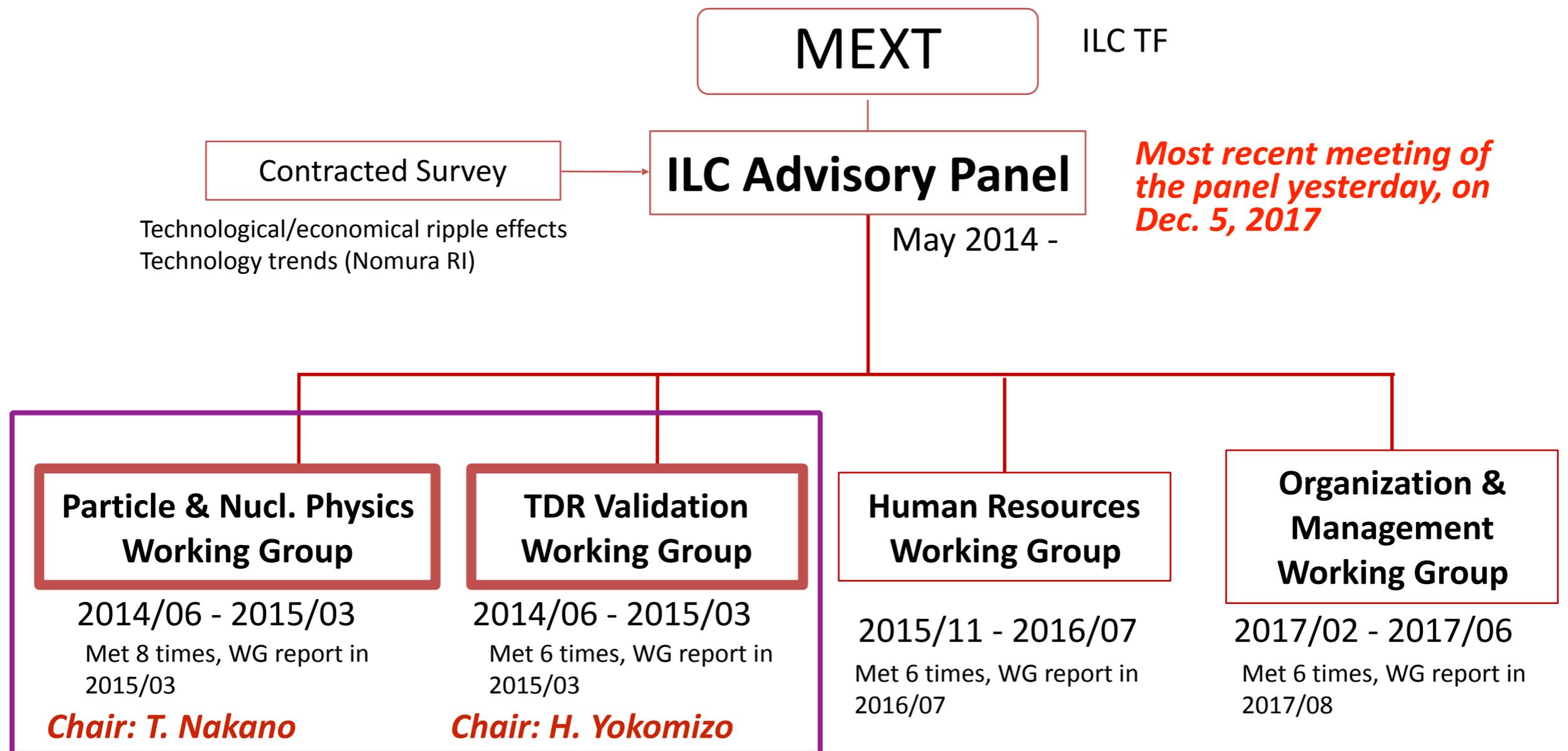
# Report from Physics WG

Keisuke Fujii  
on behalf of the Physics WG  
February 7, 2018

# ***MEXT Review***

# ILC Advisory Panel

Set up in May 2014 under MEXT ILC Task Force to investigate various issues concerning the possibility of hosting the ILC in Japan



*New round started from January 2018.*

# *The 2nd Meeting of the Particle & Nuclear Physics WG happened on*

*February 5, 2018*

## ***Agenda:***

- ***Physics Case of the 250 GeV ILC***
  1. ***Discussions in JHEP: Shoji Asai (Tokyo)  
arXiv: 1710.08639 (Asai Committee)***
  2. ***Physics potential of the ILC at 250 GeV:  
Georg Weiglein (DESY)***
- ***AOB***

# *Main points made in Asai's talk*

- *In order to maximally exploit the potential of the HL-LHC measurements, **concurrent running of the ILC250 is crucial.***
- *LHC has not yet discovered new phenomena beyond the Standard Model. **The ILC250 operating as a Higgs Factory will play an indispensable role to fully cover new phenomena up to  $\Lambda \sim 2-3$  TeV and uncover the origin of matter-antimatter asymmetry, combining all the results of ILC250, HL-LHC, the SuperKEKB, and other experiments. Synergy is a key.***
- *Given that a new physics scale is yet to be found, **ILC250 is expected to deliver physics outcomes, combined with those at HL-LHC, SuperKEKB and other experiments, that are nearly comparable to those previously estimated for ILC500 in precise examinations of the Higgs boson and the Standard Model.***
- *The inherent advantage of a linear collider is its energy upgradability. **The ILC250 has the potential, through an energy upgrade, to reach the energy scale of the new physics discovered by its own physics program.***

*These are the same 4 points made in the Asai Committee's report  
(arXiv: 1710.08639)*

# Comments on E-upgrade in Asai's talk

- *In the case where ILC250 and/or HL-LHC reveals the energy scale for new phenomenon and/or principle, use the best technology that will be available by that time.*
- *If no deviations from SM found, it will become important to study EWSB in detail, necessitating **cubic Higgs self-coupling measurements at 500 (positive interference) and 1000 GeV (negative interference).***
- *For precision tests of SM and its vacuum stability, LHC's precision of  $\Delta m_t = 200\text{-}300$  MeV is enough. In case results from HL-LHC and ILC250 would have suggested direct connection of SM to ultra-high energy physics such as that at GUT scale, precision  $m_t$  measurement at ILC350 would be important.*

# *Main points made in Georg's talk*

- *The physics case of the ILC at 250 GeV is extremely strong.*
- *The physics program at 250 GeV with polarized beams will tremendously advance our understanding of the fundamental laws of nature and complement the measurements at the LHC. The interplay of the results from the LHC and the ILC will allow us to go far beyond the results that could be achieved at each of the two machines individually.*
- *A timely realization of the ILC at 250 GeV will be crucial for exploiting those synergy.*
- *I fully support the statements of ICFA “... will provide excellent science from precision studies of the Higgs boson ... a key science project complementary to the LHC and its upgrade” and the Japanese HEP community “a compelling physics case for constructing an ILC at 250 GeV center of mass energy as a Higgs factory”.*
- *The extendability of the ILC to reach higher energies is a uniquely important advantage compared to circular machines. The results from ILC250 will shape a possible program at higher energies.*

# How should one interpret this table?

## ILC Physics Goals

<i>ILC Physics Goals</i>	<i>500 GeV</i>	<i>350 GeV</i>	<i>250 GeV</i>
• precision Higgs couplings	✓	✓	✓
• $g_{HWW}$ and overall normalization of Higgs	✓	✓	
• search for invisible and exotic Higgs decay	✓	✓	✓
• Higgs couplings to top	✓		
• Higgs self-coupling	✓		
• search for extended Higgs states	✓		
• precision electroweak couplings of the top	✓		
• precision $W$ couplings	✓	✓	
• precision search for $Z'$	✓		
• search for supersymmetry	✓		
• search for Dark Matter	✓		
• top quark mass from threshold scan		✓	
• precision Higgs mass			✓

- A summary in form of such a table is necessarily oversimplified.
- There would be many other possibilities for how to group the physics topics in the rows of the table and for which rows to put.
- The table does not provide information about the relative weights of the different ticks.
- For those reasons it would not be appropriate to do a simple counting of ticks
- Even sticking to the format of the table and to the way it is organized, according to my assessment the ILC running at 250 GeV does tick most of the boxes that have been left empty in the table, either on its own or in combination with the LHC.

**A quote from J. Beau: “The number of ticks on that table by no means can be used as a measure of the significance of the program at each energy!”**

# How should one interpret this table in this context?

[J. Brau '17]

<i>ILC Physics Goals</i>	<i>500 GeV</i>	<i>350 GeV</i>	<i>250 GeV</i>
• precision Higgs couplings	✓	✓	✓
• $g_{HWW}$ and overall normalization of Higgs couplings	✓	✓	✓
• search for invisible and exotic Higgs decay modes	✓	✓	✓
• Higgs couplings to top	✓		✓
• Higgs self-coupling	✓		(✓)
• search for extended Higgs states	✓		✓
• precision electroweak couplings of the top quark	✓		✓
• precision $W$ couplings	✓	✓	✓
• precision search for $Z'$	✓		✓
• search for supersymmetry	✓		✓
• search for Dark Matter	✓		✓
• top quark mass from threshold scan		✓	
• precision Higgs mass			✓



Core is specific to ILC 250!

ILC 250  $\oplus$  LHC

LHC

LHC

ILC 250  $\oplus$  LHC

LHC

ILC 250  $\oplus$  LHC

ILC 250  $\oplus$  LHC

ILC 250  $\oplus$  LHC

ILC 250  $\oplus$  LHC

A quote from J. Brau: the number of ticks on that table by no means can be used as a measure of the significance of the program at each energy!

# ***Some critical questions***

- ***Isn't ILC250-LHC synergy for the table mostly due to LHC?***
- ***Isn't the  $m_t$  measurement at LHC good enough?***
- ***DESY proposed TESLA in 2001 as a 3.1BEuro project but built XFEL with 1.2BEuro. Given this history, what would you say about ILC?***

***The 3rd Meeting of the Particle & Nuclear  
Physics WG will happen on***

***March 1, 2018***

***The 2nd Meeting of the TDR Validation WG  
will happen on***

***March 2, 2018***

# ***Physics focus schedule***

***Feb. 7: Higgs/EW (KF)***

Feb. 14: BSM/NP (Frank)

***Feb. 21: Ichinoseki ILD Meeting***

weekly Wednesday meetings (at least) till Ichinoseki  
→ 3-week turn-around too fast for physics focus -  
take flexible attitude

**Conveners' ML:**

[ild-physics-conveners@desy.de](mailto:ild-physics-conveners@desy.de)

***Use this mailing list to send your talk request.***