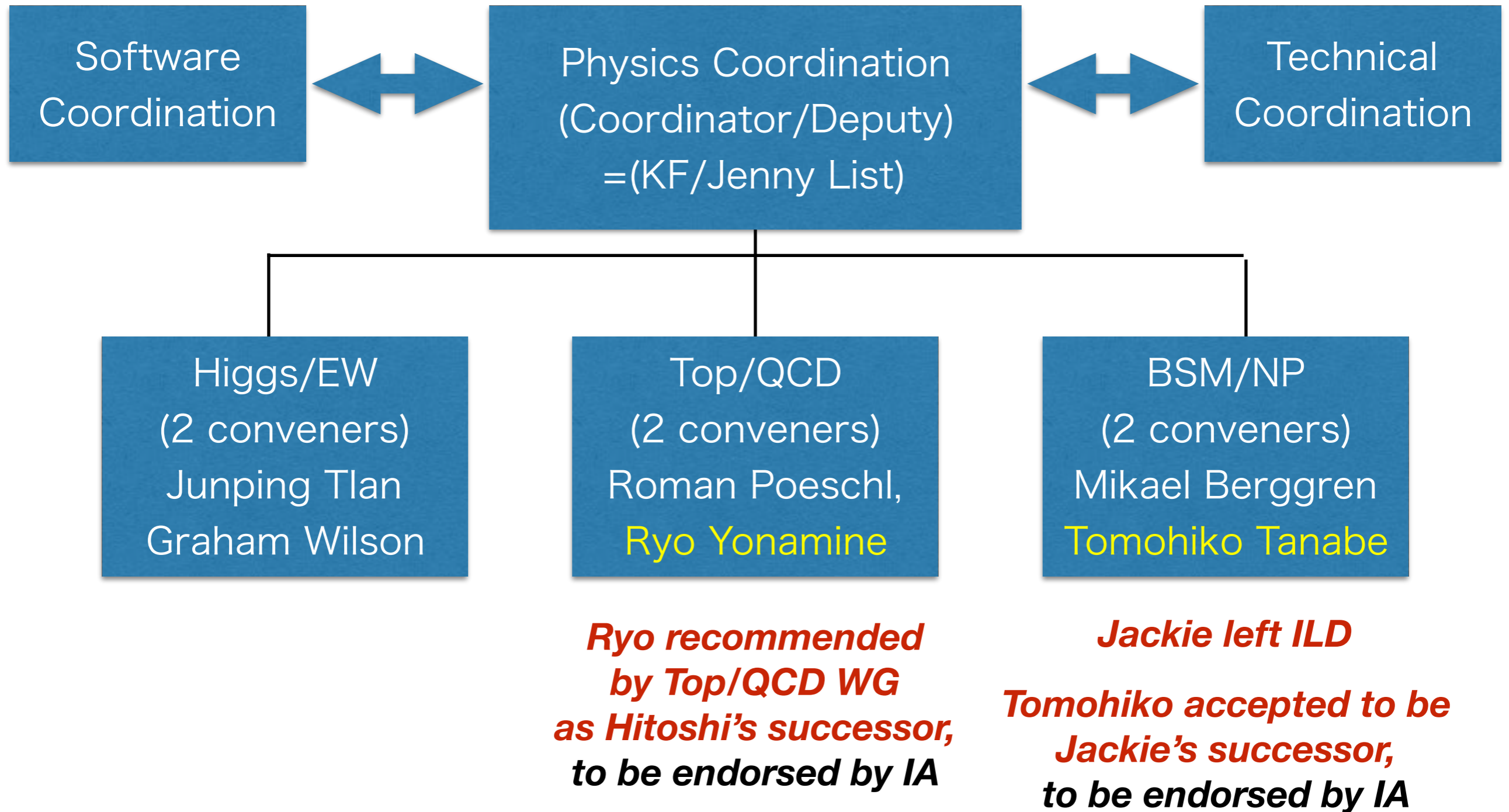




Report from Physics WG

Keisuke Fujii
on behalf of the Physics WG
November 8, 2017

Organigram



Priority No.1 = to realize ILC

What we need =

- clear physics case**

Priority No. 2 = to realize ILD

What we need =

- detector design, which is cost effective and technically feasible, to realize the physics**

This is true also for the most recent LCC physics WG report:

arXiv:1710.07621v1 [hep-ex] 20 Oct 2017

Physics Case for the 250 GeV Stage of the International Linear Collider

LCC PHYSICS WORKING GROUP

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ABSTRACT

The International Linear Collider is now proposed with a staged machine design, with the first stage at 250 GeV with a luminosity goal of 2 ab^{-1} . In this paper, we review the physics expectations for this machine. These include precision measurements of Higgs boson couplings, searches for exotic Higgs decays, other searches for particles that decay with zero or small visible energy, and measurements of e^+e^- annihilation to W^+W^- and 2-fermion states with improved sensitivity. A summary table gives projections for the achievable levels of precision based on the latest full simulation studies.

being translated into Japanese for expected MEXT review.

Urgent!

It is, however, necessary to confirm the new beam parameters would not harm the physics performance with full simulation; notice that

- per bunch luminosity will be enhanced by a factor of about 1.6, which will increase 2-photon BG as well as low energy pairs (Small Δm processes, mW , ...),***
- longer beamstrahlung tail might affects analyses assuming a fixed E_{cm} (recoil M , ...).***

→ Jenny's talk in the general ILD phone meeting yesterday.

Plan for 250 GeV Physics Studies

Ongoing and Planned 250 GeV Analyses

Higgs

- **Improve σ BR($h \rightarrow WW^*$): Mila Pandurovic?**
- **EFT analyses: Tomohisa Ogawa**
- $e^+e^- \rightarrow \nu\nu H$: Junping Tian
- $e^+e^- \rightarrow H\gamma$: Yumi Aoki
- $H \rightarrow \tau\tau$: Daniel Jeans
- $H \rightarrow$ invisible: Yu Kato
- $H \rightarrow \mu\mu$: Shin-ichi Kawada
- mh : Graham Wilson, Junping Tian
- $H \rightarrow$ exotic (new light particles, FC/LFV): ?
- $H \rightarrow Z\gamma$: ?

Precision EW

- m_W : Robert Karl
- **2-fermion processes: $\mu\mu$: Hirokazu Yamashiro**
- **TGC: Robert Karl**
- $e^+e^- \rightarrow Z\gamma$ (A_{LR}), $\gamma\gamma$: ?

Top/QCD

- **bb: Sviatoslav Bilokin \rightarrow who to take this over**
- **Single top production: ?**

BSM: Direct search

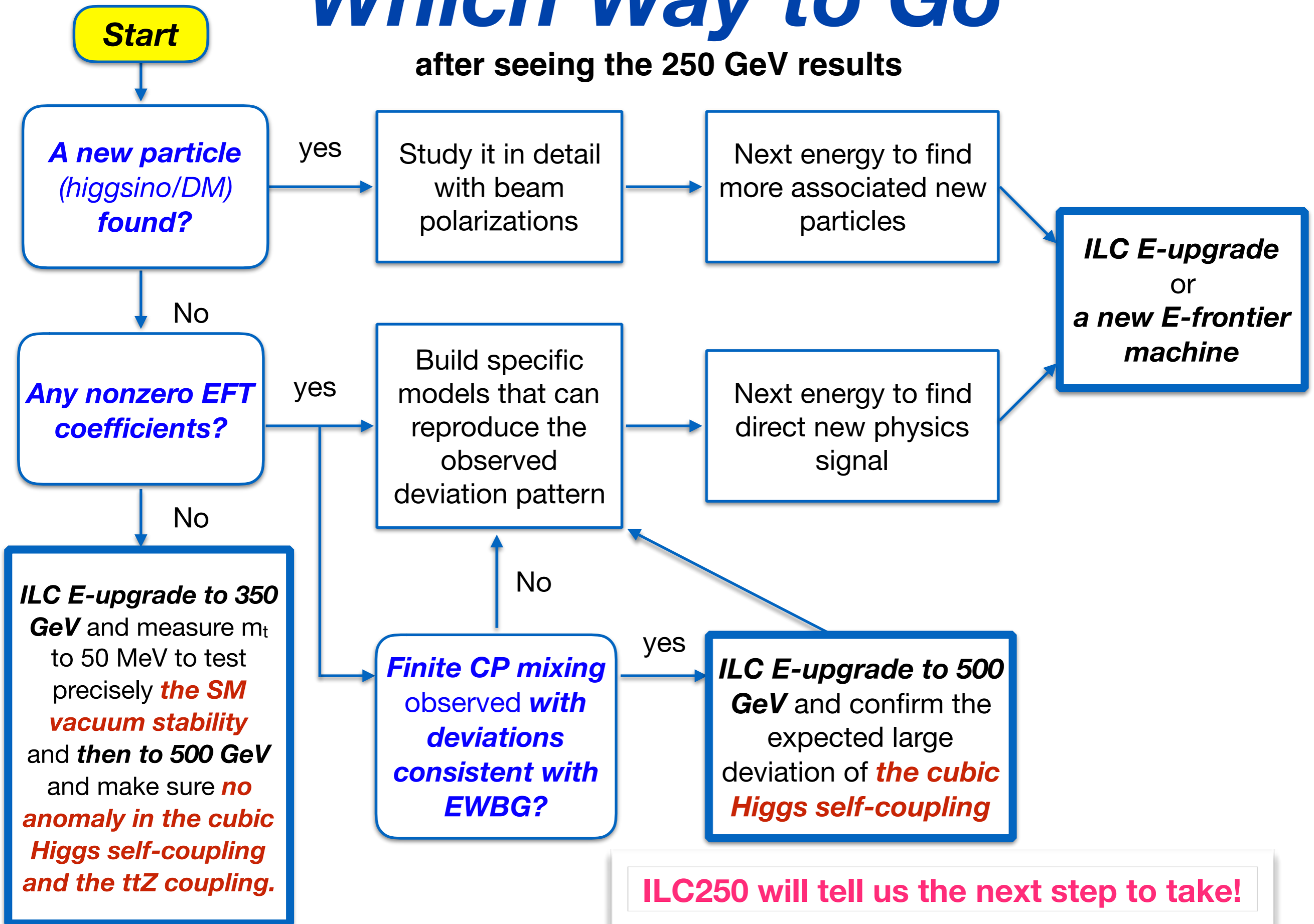
- **Dark Matter: Moritz**, Tomohiko, Masakazu, ..
- **Extra light states** (light extra higgses, dark photon, ..)
 - **ZX ($m_X < 125\text{GeV}$): Yan Wang**
- **Higgsinos: Tomohiko + Swathi (for very low ΔM)**

Blue: presented at LCWS 2017

Brown: new analyses

Which Way to Go

after seeing the 250 GeV results



ILC250 will tell us the next step to take!

Validity of EFT

At ILC 250, we will have enough redundancy (#observables > #unknown) to test the validity of (dim.-6) EFT. Notice, in particular that beam polarizations essentially doubles the number of usable observables in the EFT fit.

*If we see inconsistency, it suggests $\Lambda_{BSM} \sim E_{cm}$.
(\rightarrow **need demonstration of this**)*

We then expect to see significant deviations from the SM, or to find some new particle.

In this case, we forget about EFT and try to build specific models to explain the observed deviation pattern and/or the new particle and test these specific models.

For new particle searches, we will work on particular models anyway.

Priority No.1 = to realize ILC

What we need =

- clear physics case

Priority No. 2 = to realize ILD

What we need =

- **detector design, which is cost effective and technically feasible, to realize the physics**

benchmark processes for detector optimisation

process	physics	detector	Ecm
$H \rightarrow cc$	BR	c-tag JER	any H.Ono
$H \rightarrow \mu\mu$	BR	high P tracking	500 GeV S.Kawada
$H \rightarrow \tau\tau$	BR, CP	τ reconstruction, PID track separation	250 GeV D.Jeans
$H \rightarrow bb$	M_H , BR	JES, JER b-tag	500 GeV A.Ebrahimi J.Tian
$H \rightarrow$ invisible $Z \rightarrow gg$	Higgs Portal	JLK	250 GeV Y.Kato
$evW \rightarrow evqq$	M_W , TGC	JES, JER	500 GeV K.Cotera G.Wilson
$tt\text{-bar} \rightarrow 6\text{-jet}$	top coupling A_{FB}	b-tag, JER jet charge	500 GeV S.Bilokin Y.Sato
$\chi_1^+ \chi_1^- , \chi_2^0 \chi_1^0$ near degenerated	natural SUSY	low P tracking PID	500 GeV J.Yan \rightarrow T.Tanabe
γXX	WIMPs	Photon ER & ES Hermiticity	500 GeV M. Habermehl

Barely covered. Some people have left or leaving, more manpower highly welcome!

in total 9 = 5 (Higgs) + 2 (EW) + 2 (BSM)

***But we need to verify the
whole simulation/analysis
chain first***

The On-going/Planned Tests

Single particle samples:

- μ^\pm (Higgs group, e.g. Shin-ichi, ...)
- e^\pm
- π^\pm
- π^0 (Higgs/EW, Graham & student)
- K^0_S (Higgs/EW, Graham & student)
- γ (BSM, Moritz, Daniel?)
- K^\pm (Masakazu to check PID, including μ , e , π)
- p (Masakazu to check PID, including μ , e , π)
- uds

Collision event samples:

- $t\bar{t}$ semi-leptonic, 500 GeV
- $mumuH$, 250 GeV
- $Z(\rightarrow qq) H(\rightarrow inv)$, 250 GeV

Tests must include those of high level reconstruction:

PFA, π^0/η , τ , vertex charge (Q_{jet}), ...

All of these performance checks should go into ILDPerformance, for reproducibility and re-use on different detector models.

We strongly request all the people working on physics analyses to proactively contribute to the validation of the new analysis chain as much as possible!

We are now updating the list of on-going or planned analyses and manpower situation in order to formulate our strategy.

1. Higgs/EW WG (Junping Tian, Graham Wilson)

1. Tomohisa Ogawa (Sokendai & KEK), PhD student, “anomalous hVV couplings”, 100%, to finish thesis by mid 2018
2. Yumi Aoki (Sokendai & KEK), Master student, “ $h\gamma Z$ coupling”, 50%, not included in master thesis, to finish this study by mid 2018
3. Daniel Jeans (KEK), “ $h \rightarrow \tau\tau$ ”, currently focusing on paper
4. Masakazu Kurata (KEK), “ $hh \rightarrow bbWW^*$ ”, currently working on paper together with Claude, Junping, etc.
5. Yu Kato (U. Tokyo), Master student, “ $h \rightarrow$ invisible”, 100%, to finish thesis by the end of this year
6. Kazuki Fujii (U. Tokyo), Master student, “ $h \rightarrow \gamma Z$ ”, 30%, to finish thesis by May, 2018
7. Junping Tian (U. Tokyo), “Higgs mass”, 10%
8. Aliakbar Ebrahimi (DESY), PhD student, “Higgs mass”, thesis finished
9. Shin-ichi Kawada (DESY), “ $h \rightarrow \mu\mu$ ”, 100%
10. Mila Pandurovic (U. Belgrade), “ $h \rightarrow WW^*$ ”
11. Jakob Beyer (Dresden / DESY), master student, “quartic gauge couplings”, 100%, to finish thesis by Oct. 2018

2. Top/QCD WG (Roman Poeschl, Hitoshi Yamamoto/Ryo Yonamine)

1. Yo Sato (Tohoku), Master student, 2nd year, “Anomalous t-Z coupling at top pair production at 500 GeV”
2. Yuto Eda (Tohoku), Master student, 1st year, “Top threshold study”
3. ?? (MPP/MPG), “top mass at threshold, interpretation”
4. Sviatoslav Bilokin (LAL), “ $e^+e^- \rightarrow bb$ ”, finished PhD thesis, paper follows.
5. Martín Perelló Roselló (IFIC), “top CPV couplings”, paper submitted
6. ?? (LAL/UCL), “ $e^+e^- \rightarrow tt$ (fully hadronic)”, to be reactivated
7. Martín Perelló Roselló (IFIC), “ $e^+e^- \rightarrow tt$ in EFT”
8. Pablo Gomis (IFIC), “ $e^+e^- \rightarrow tt\gamma$ ”
9. Aleksander Filip Zarnecki (Warsaw), “ $t \rightarrow ch$ & $t \rightarrow c\gamma$ ”
10. ?? (IFIC), “jet clustering”
11. Masakazu Kurata (KEK), “jet clustering by deep learning”
12. ...

3. BSM WG (Mikael Berggren, Tomohiko Tanabe)

1. Tomohiko Tanabe, “Light Higgsinos from Natural SUSY”
2. Suvi-Leena Lehtinen, “SUSY fit”, finishing up PhD
3. Christian Drews (Tohoku), “Charged Higgs bosons search at ILC for a collision energy of 1 TeV”, finished Master’s thesis
4. Hiroaki Yamashiro (Kyushu), “Fermion pair productions at ILC 250 GeV “
Yan Wang (DESY), “Light Higgs in association with a Z boson”
5. Moritz Habermehl (DESY), “WIMP search in the Mono-Photon”,
finishing up PhD → to be handed over to ??
6. Swathi Sasikumar (DESY), “Hadron Production in Photon-Photon
Processes at the ILC and BSM signatures with small mass differences”
2. Madeline Cheri (DESY), “Gaugino Property Determination as
Performance Study for Fast Detector Simulation at the ILC”
3. Takayuki Ueno (Tohoku), Master student, 1st year, analysis not defined
yet. (SiD analysis?)
4. Ahmed Mustahid (Tohoku), Master student, 0th year, analysis not
defined yet. $e^+e^- \rightarrow \gamma\chi\chi$ (mono photon?)
5. ...

Physics focus schedule

Nov. 8: BSM/NP (Jenny) : Today

Nov. 22: Top/QCD (Frank)

Dec. 6: Higgs/EW (Akiya)

Dec. 20: BSM/NP (KF)

Conveners' ML:

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Use this mailing list to send your talk request.