LCC Physics and Detector Report

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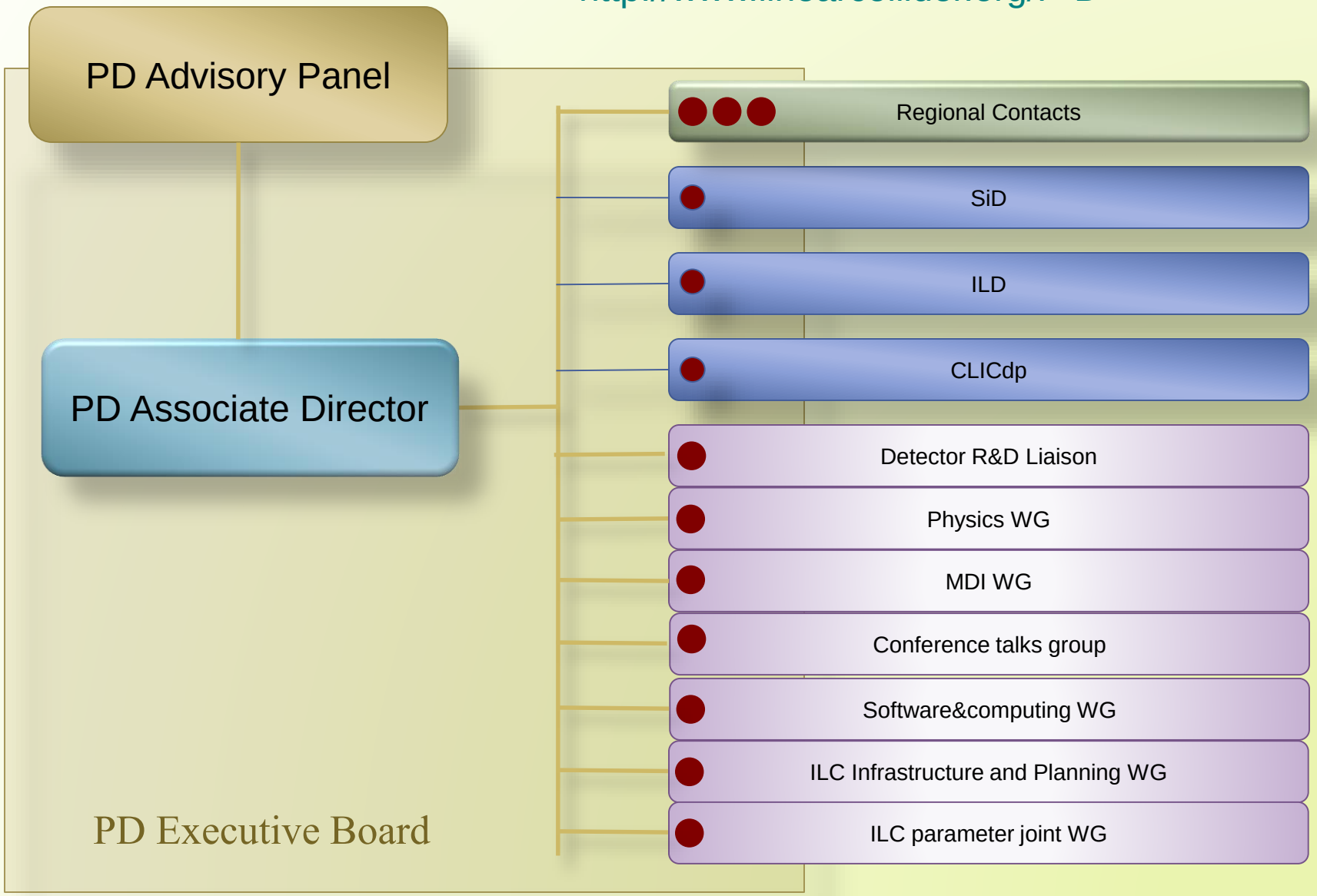
ALCW 2015
April 22, 2015

LCC PD Structure

http://www.linearcollider.org/P-D



PDAP (Physics and Detector Advisory Panel)

- Chair: Paul Grannis
- Possible issues to review:
  - Technical readiness of the detector designs
  - Physics case for LC
  - Synergy with CLICdp

- Discussions on-going at LCC Physics and Detector EB
  - Concerns:
    - No clear benchmarks such as DBD or LoI
    - Depending on the charge, it may require too much time and effort for PDAP members

- Clear charges needed
  - Paul and HY are currently working on detailed charges
    - Focus on well-defined issues

Making Physics Case for ILC

Physics WG

- Members:
  - 16 total: strong members in theory and experiment
  - 3 co-convenres: Keisuke Fujii, Christophe Grojean. Michael Peskin
  - + 1 observer: Hitoshi Murayama (LCC deputy director)

- For the MEXT particle&nuclear physics WG
  - Prepared material
    - Through Sachio Komamiya (a member of the MEXT WG)
  - Produced documents on the ILC physics case
    - ‘Precis of the Physics Case for the ILC’
    - ‘Scientific motivations for the ILC’

Physics Document 1

- ‘Precis of the Physics Case for the ILC’ (~27 pages)
  - Maybe a bit too technical to be submitted directly to the MEXT committee members → utilized through Sachio
  - Excellent introductory document for HEP physicists

Precis of the Physics Case for the ILC

LCC Physics Working Group†

October 2014

1 Introduction

The physics potential of the International Linear Collider has been documented in a number of reports. Most recently, it is presented in some detail in Volume 2 of the ILC Technical Design Report [1] and in a series of reports to the American Physical Society's study of the future of US particle physics (Snowmass 2013)[2–5]. However, we thought that it might be valuable to add to these a brief and accessible review of the main points of these documents. You will find that here.

The most important aspects of the ILC physics program are: (1) measurement

Physics Document 2

- LCC physics WG produced a document for ‘more’ general audiences
  - ’Physics Motivation of the ILC’ (~15 pages)
    - Given to Sachio

Scientific Motivation for the ILC

LCC Physics Working Group

February, 2015

Introduction

In this note, we give a broad overview of the physics case for the International Linear Collider (ILC). We begin by explaining our perspective on the most important questions in the study of elementary particles and forces. These questions are interesting in their own right, and, increasingly, they are connected to the major open

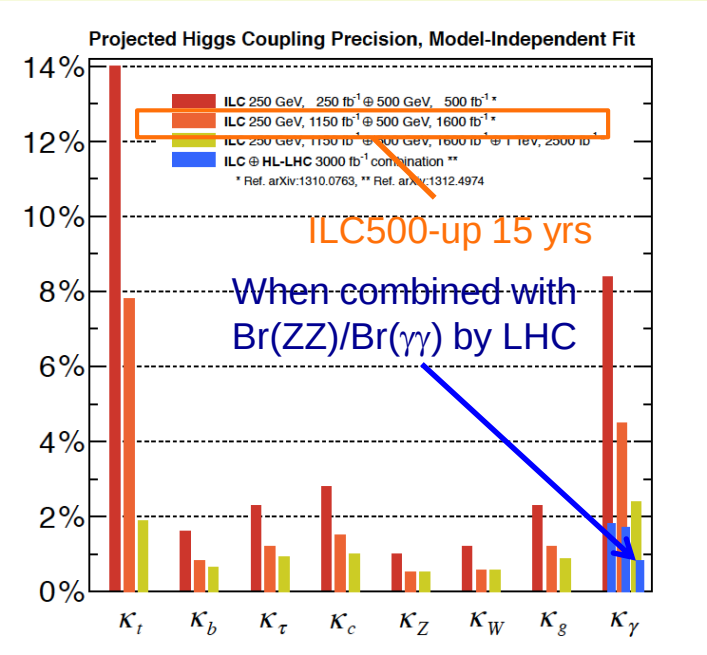
  - Planning to turn it into a nice-looking brochure
    - with the communicators

Higgs Couplings

Model-independent

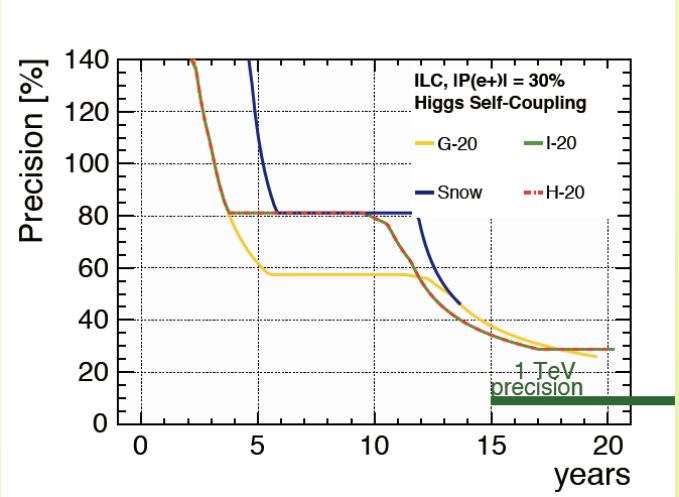
No assumptions on universality, no BSM, or unitarity

- Apart from top and gamma, ILC can reach 1% level in ~15 yrs (up to 500 GeV) (required level to be meaningful in distinguishing models)



Higgs-self coupling

500 GeV : 25~30% (20 yrs)
1 TeV : ~10%
(HL-LHC : ~50%)



Higgs Couplings

Model-dependent:

Assume,

$\kappa_u = \kappa_c = \kappa_t$

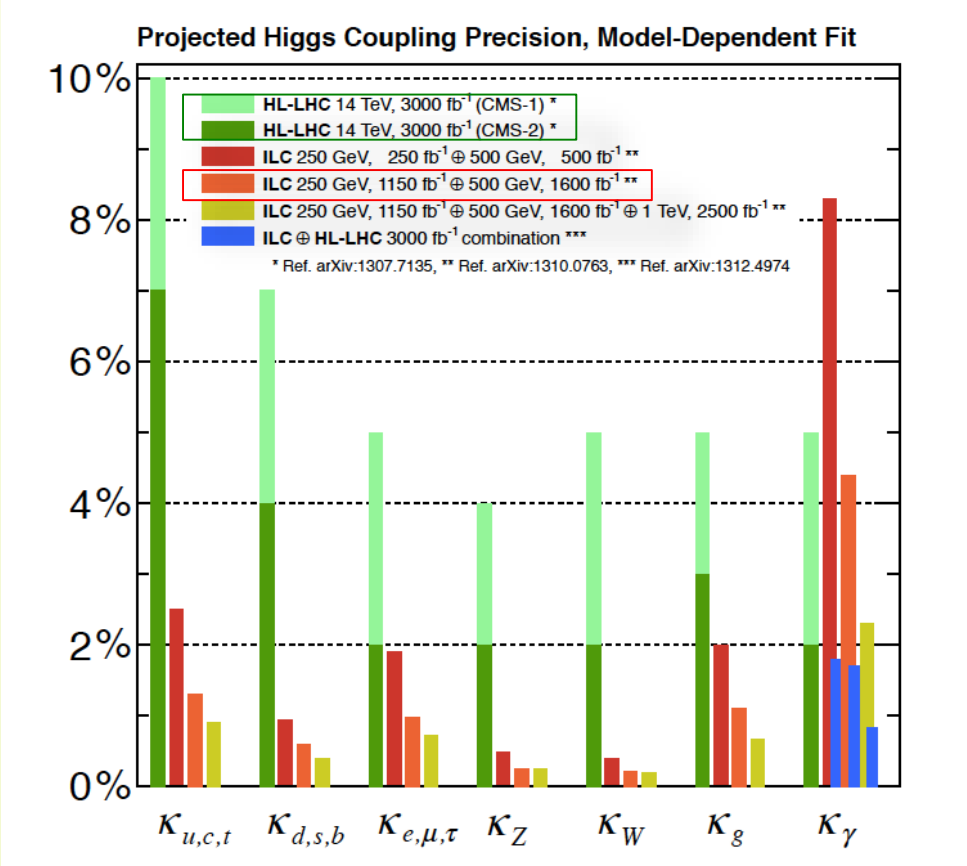
$\kappa_d = \kappa_s = \kappa_b$

$\kappa_e = \kappa_\mu = \kappa_\tau$

No BSM final states

Unitarity

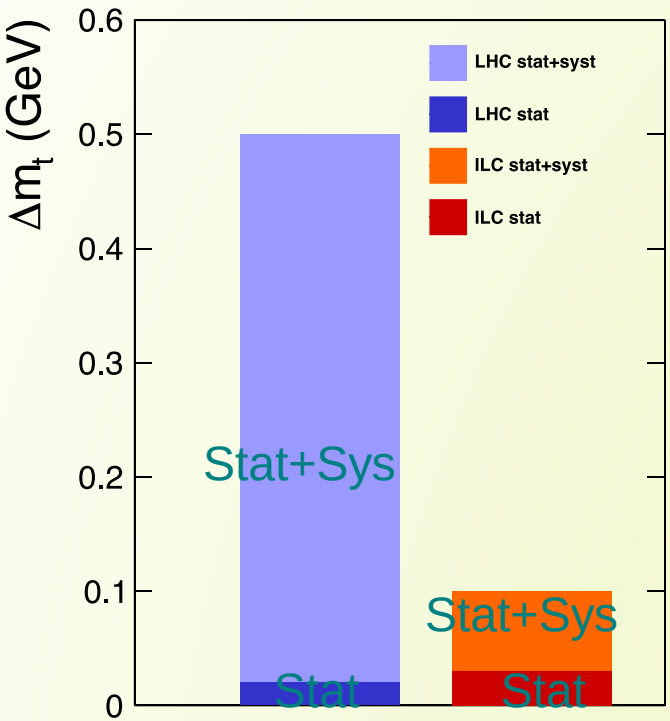
→ fit



- Comparing HL-LHC with 500 GeV ILC (lum up)
  - Typically 3~10 times better errors for ILC (apart from γ)
  - Naively, ILC ~ 10 to 100 HL-LHCs
  - More favorable for the ILC if include effect of systematic errors

Top Physics

Top quark mass (msbar)
(@350 GeV)

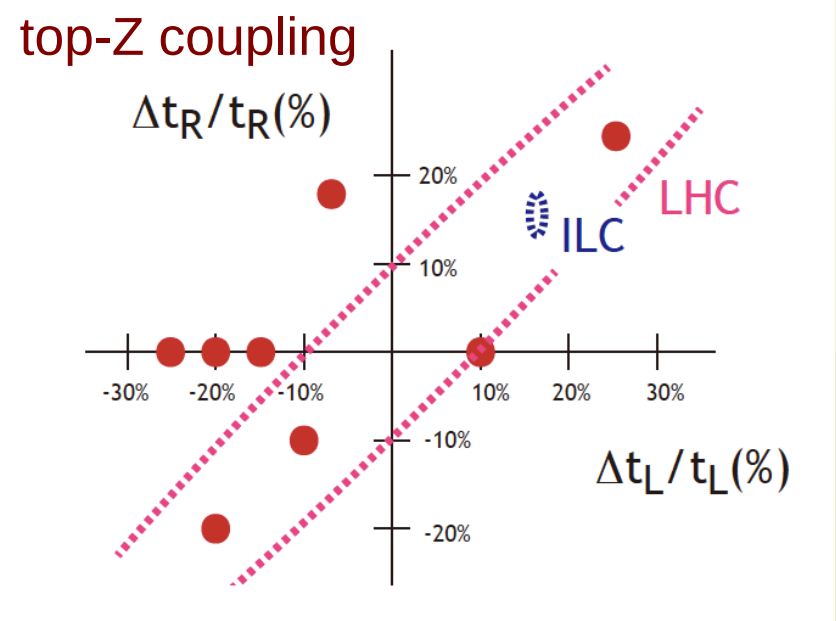


HL-LHC
3000 fb^{-1}
$\sqrt{s}$=14 TeV

ILC
100 fb^{-1}
$\sqrt{s}$=350 GeV

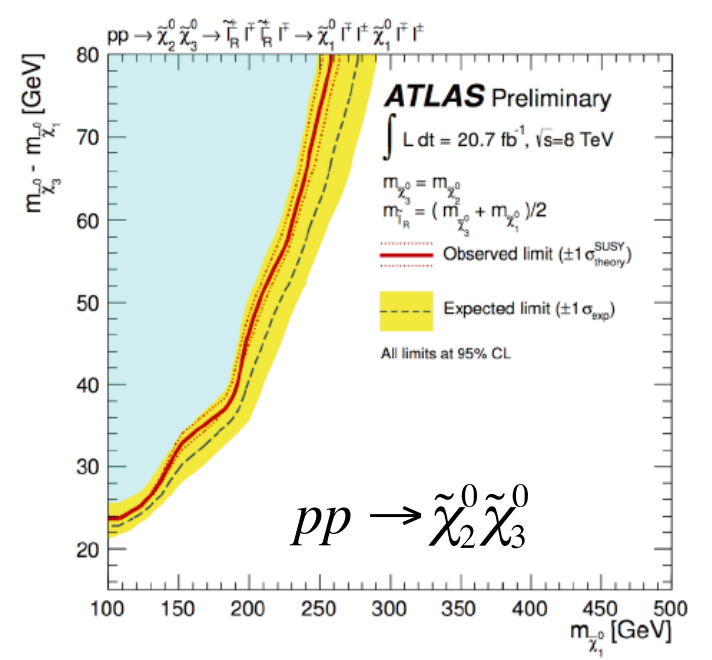
e+e- → t tbar (@500 GeV)

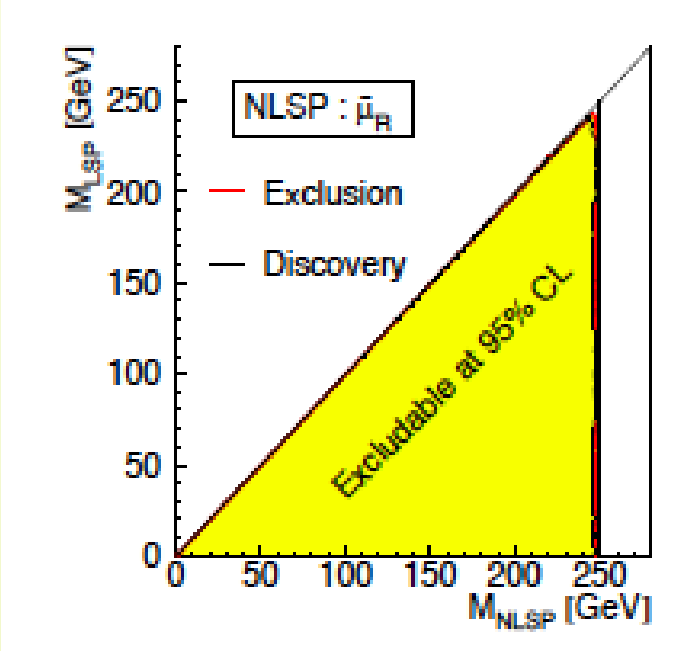
Right-handed e- does not couple to B^0
Use polarization to separate Z and γ
in S-channel



Different new-physics models
Indicated by tL and tR

New Particle Search





LHC:
Difficulty when mass difference is small

ILC:
Good sensitivity up to kinematic limit for (essentially) any mass difference

In general (even when no near degeneracy):
LHC can reach higher energy but could miss important phenomena:
NB: At Tevatron, ~20000 Higgs were produced, but no clear signal was seen
Once found, ILC can measure its properties ~completely

ILC is good at unexpected phenomena

ILC Running Scenario

- Need for a single ‘official’ running scenario
  - Consistency among ILC presentations
  - Realistic ramp up profiles and down times for upgrades
    - Proof that stated luminosities can be taken in stated time
  - Actual running scenario will depend on physics outcomes from LHC and ILC

- ILC parameter joint WG
  - Physics/Detector: Tim Barklow, Jim Brau (co-convener), Jenny List, Keisuke Fujii
  - Accelerator: Gao Jie, Nick Walker (co-convener), Kaoru Yokoya

ILC Running Scenarios

- ILC parameter WG produced two documents
  - 250 GeV start up ‘ILC staging and running scenarios’
  - 500 GeV start up ‘500 GeV ILC operating scenarios’

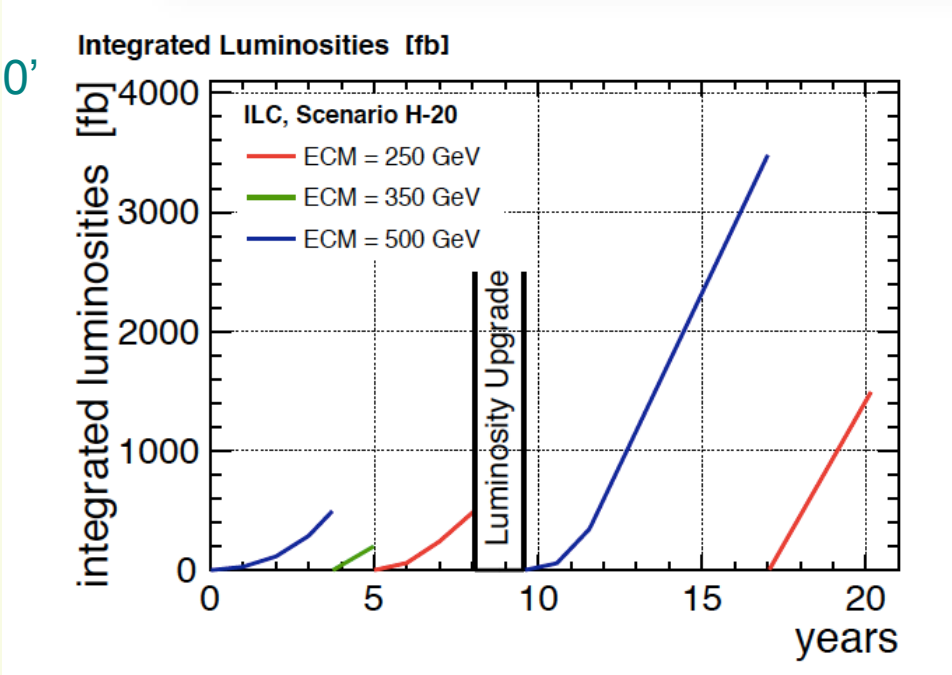
- Merits for 500 GeV startup
  - It is the TDR baseline
    - TDR costing and construction schedule assume starting with 500 GeV (construction takes 1.5 yr longer than 250 GeV starup)
  - Competitiveness vis a vis circular machine
    - Higgs-top, Higgs-Higgs coupling
    - Top physics (Z-top$_{LR}$ for new physics)
    - Absolute Higgs couplings (W-fusion Higgs production)
    - New particle searches

Recommended ILC Running Scenario

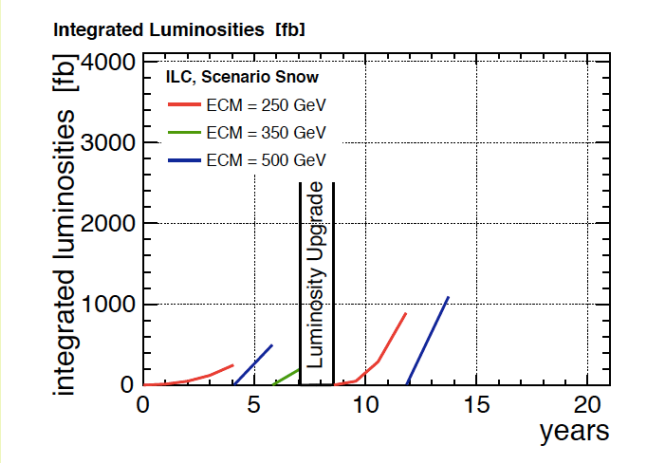
- After examining various channels, one scenario (500 GeV startup, 20 yr) is recommended (H20)
  - To be approved by LCB

	Stage	500			500 LumiUP		
Scenario	$\sqrt{s}$ [GeV]	500	350	250	500	350	250
G-20	$\int \mathscr{L} dt$ [fb^{-1}]	1000	200	500	4000	-	-
	time [years]	5.5	1.3	3.1	8.3	-	-
H-20	$\int \mathscr{L} dt$ [fb^{-1}]	500	200	500	3500	-	1500
	time [years]	3.7	1.3	3.1	7.5	-	3.1

'H20'



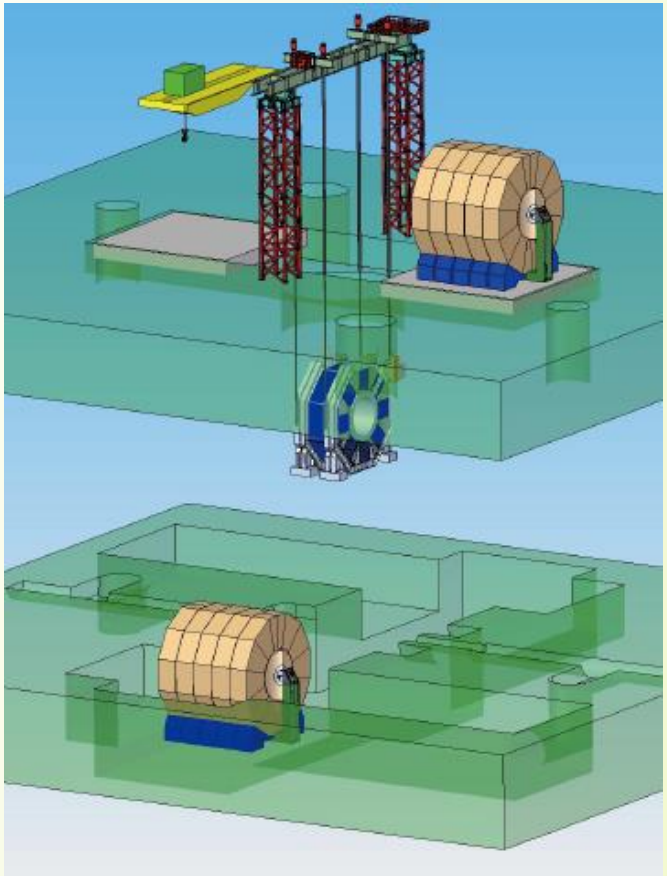
Reference:
Snowmass study



ILC Change Requests

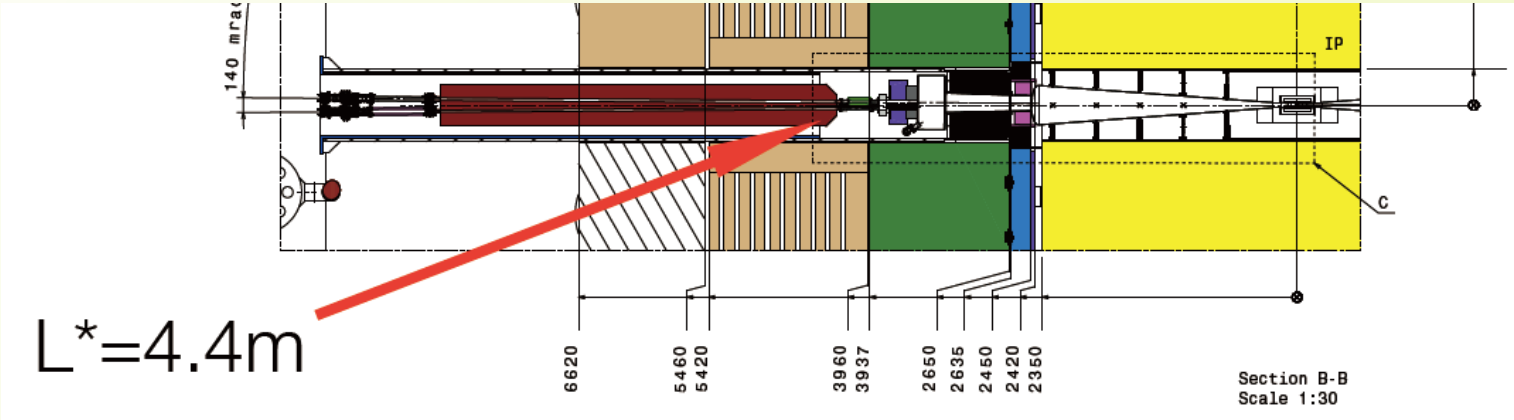
- A set of well-defined rules for updating the baseline design
- Change Management Board
  - Members:
    - The ILC accelerator technical board members
    - Two from the physics and detector community
      - Jenny List (ILD, Physics)
      - Tom Markiewicz (SiD, MDI)
- MDI working group
  - Actual work related to machine-detector interface issues
- Change requests relevant to Phys&Det, so far
  - Vertical shaft to detector hall (CR3)
  - Common L* (CR2)
  - Linac extension (new) (CR4)

Vertical Access (CR3)



- Merits
  - Allows CMS style detector assembly
    - Assembled mostly on surface
    - Shorten the overall schedule by ~1 year
    - Cost is also reduced (probably)
    - Safety (ease of escape)
- Approved. Now it is part of the baseline

Common L* (CR2)



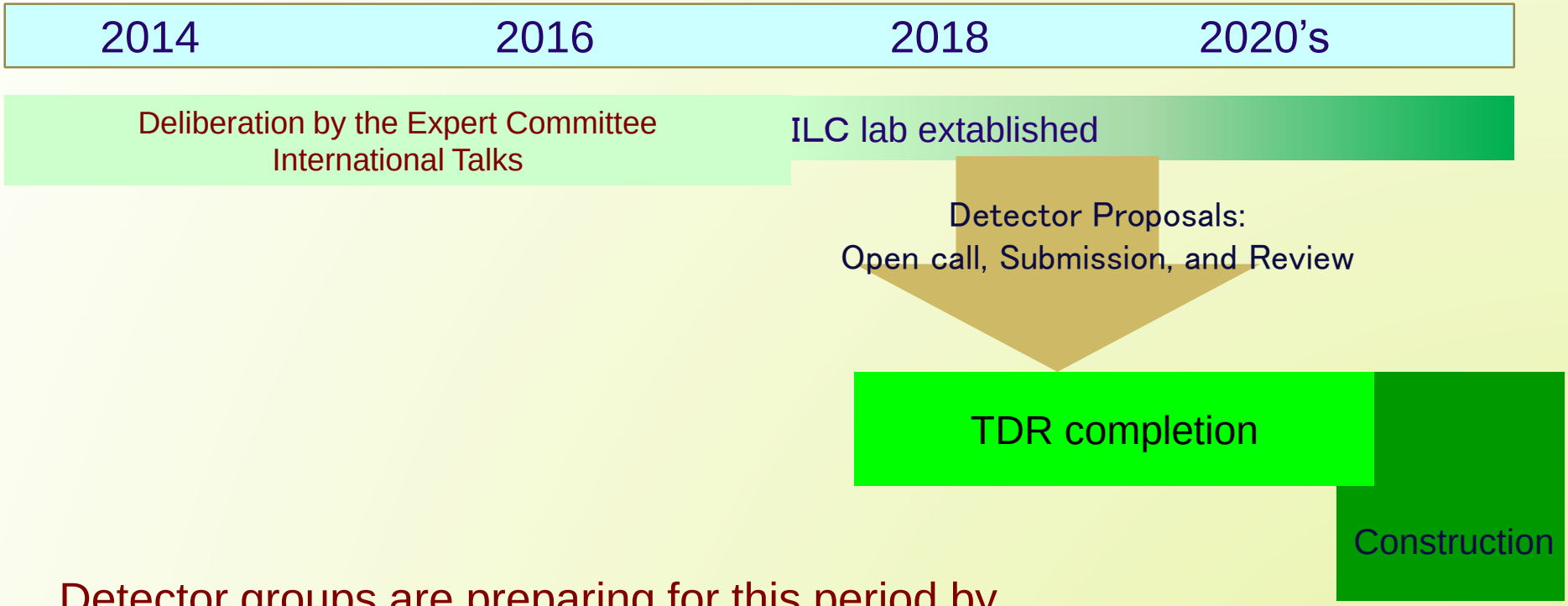
ILD

- Accelerator people want a common L* at around 4 m
- SiD can accommodate a L* between 2.6-4.5m
  - **Minimum L* probably dictated by QD0 technology, not SiD**
- ILD needs some work
  - **Vacuum pump in front of QD0 can be removed?**
  - **Studies (incl. beam backgrounds) are under way**

Other WGs

- Detector R&D liaison
  - Compiling LC-related detector R&Ds
  - Software efforts to be included
- Software&computing
  - Evaluating computing needs for the ILC
  - Common software for ILD/SiD/CLICdp
- ILC Conference talks
  - Coordinating ILC-related talks at workshops
  - To be extended to include ILC-related publications: under discussion
- ILC infrastructure&planning
  - Cost, manpower, and scheduling of the ILC detectors
  - Input to the MEXT subcommittee

Possible Timeline of ILC Detectors



Detector groups are preparing for this period by
Re-optimizing their detectors and re-organizing.
Detector subsystem R&Ds are moving ahead.

SiD

SiD Workshops

Tokyo, Sep 2-3, 2014
SLAC, Jan 12-14, 2015

- Critical review of SiD concept
- Review technology options
- How to proceed

P5 Recommendation 11 :

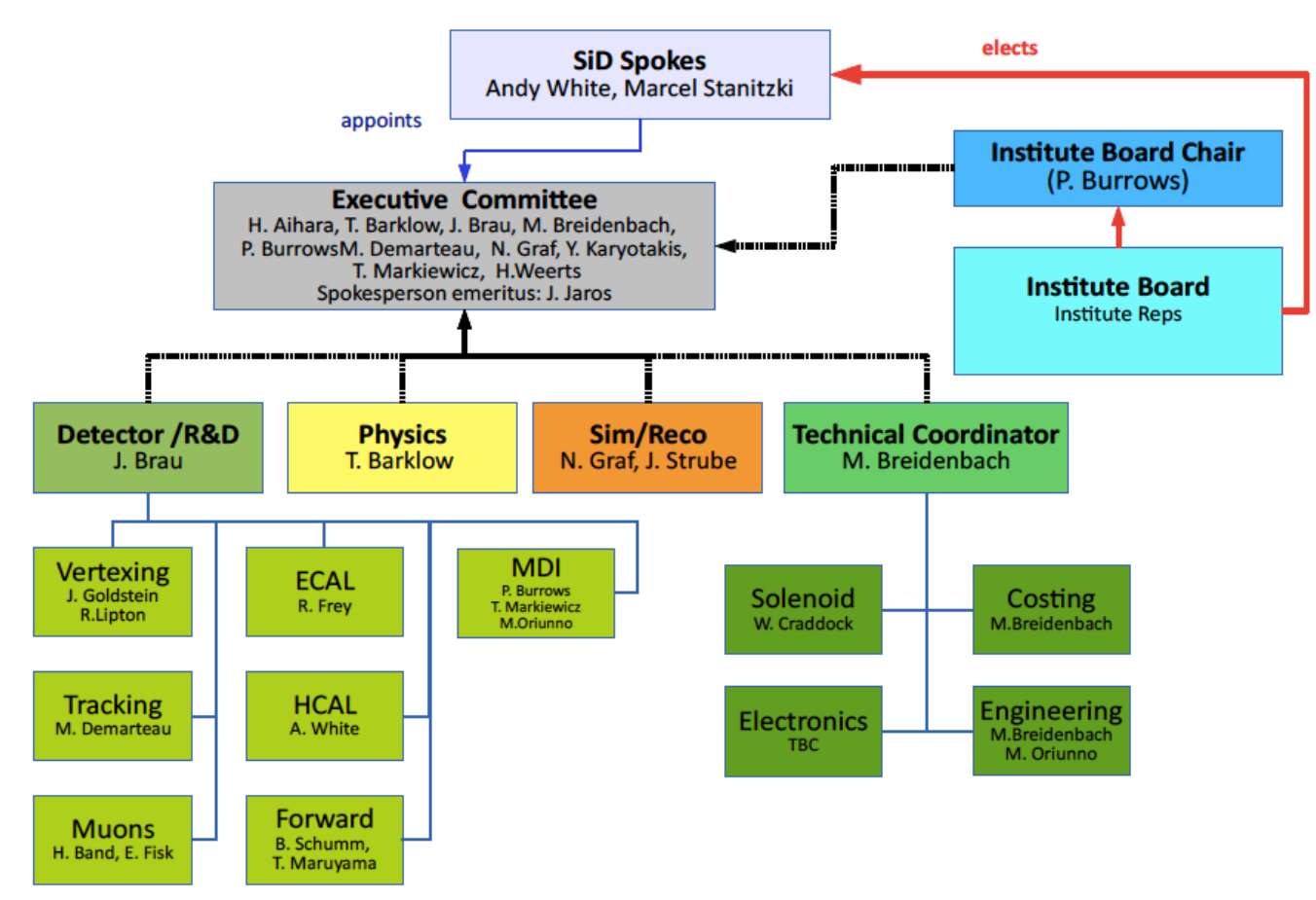
Motivated by the strong scientific importance of the ILC and the recent initiative in Japan to host it, the U.S. should engage in modest and Appropriate levels of ILC accelerator and detector design in areas where the U.S. can contribute critical expertise. Consider higher levels of collaboration if ILC proceeds.

Funding level for ILC detector Is, however, very low

SiD Organization

Adopted a formal organization: SiD consortium

20 institutions signed



ILD

ILD Workshop

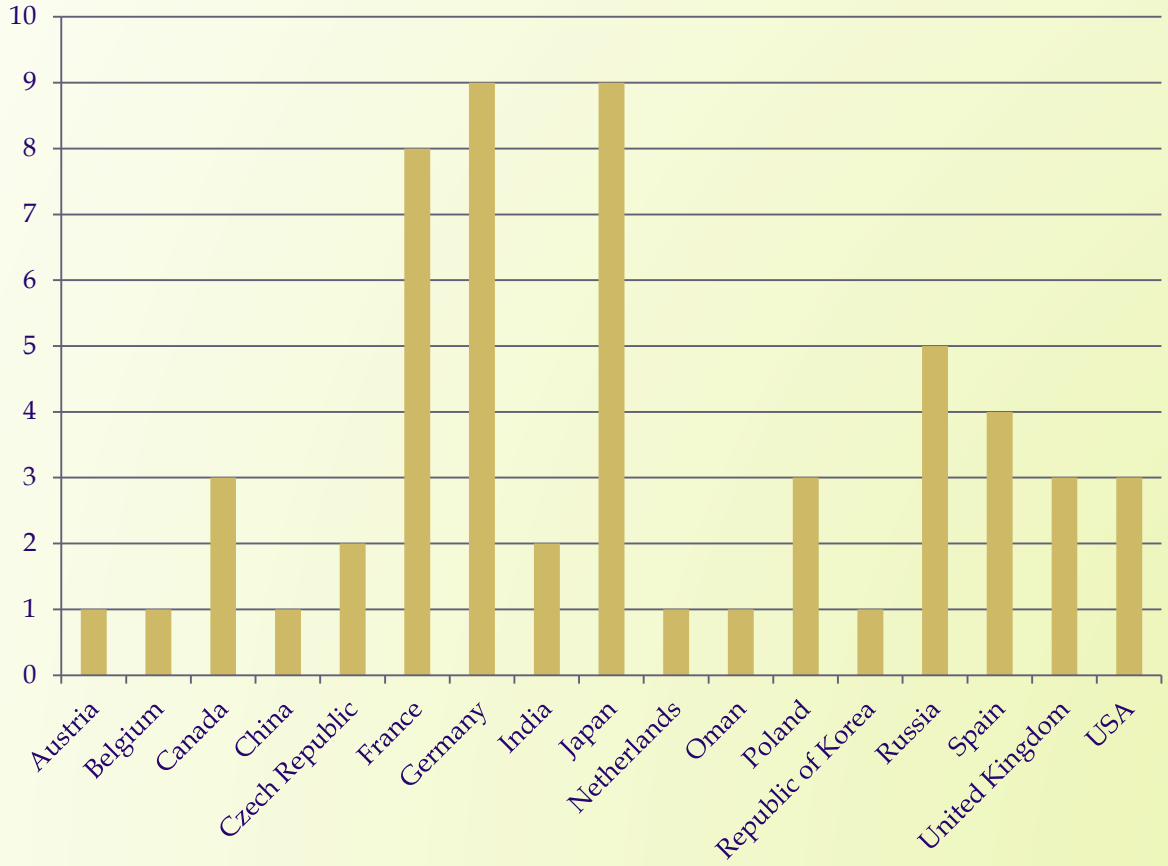
Oshu, Tohoku
Sep 6 – 9, 2014

85 registered participants from 32 institutes

This meeting represented the start of a coherent optimization effort for ILD and the start of reorganisation.

ILD Organization

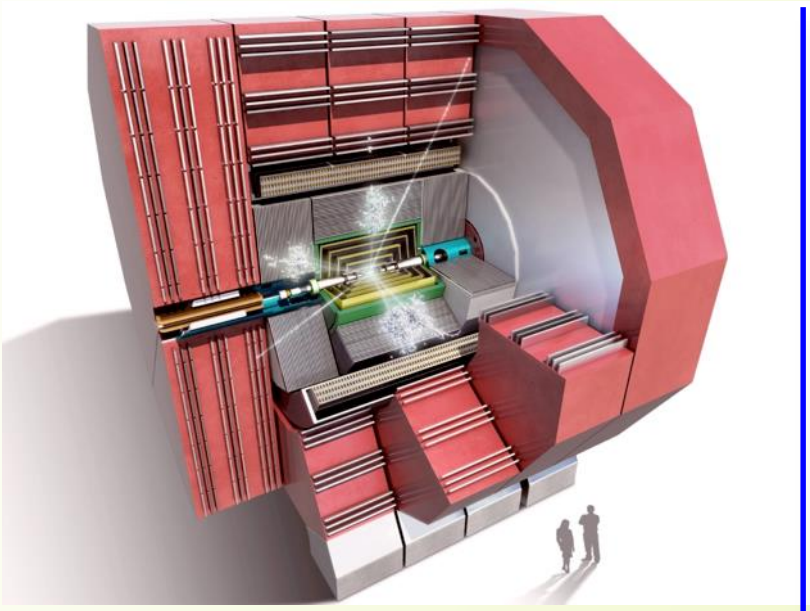
Current ILD member-list: grown to 63 institutes



Have established membership

Chair of the Institute assembly:
Jan Timmermans
NIKHEF

CLICdp: Synergy with ILC



http://clicdp.web.cern.ch/

currently 25 institutes

ILC/CLIC synergies in many areas

CLIC CDR detector concepts are based on ILC concepts, adapted for CLIC

- Common software tools
  - Major upgrade of tools ongoing through a common ILC/CLIC effort
- Overlapping physics case below 1 TeV
  - Sharing methods; making cross-checks
- Large overlap in detector technologies
  - Strong synergies within CALICE and FCAL
  - Synergies in engineering and magnet design
- Ongoing detector optimisation for ILC and CLIC
  - Overlapping activities; cross-checks

- Flows are both ways
  - e.g. 350 GeV study of CLIC → ILC

Summary

- We are working intensively to update the physics case of the ILC
- One ILC running scenario is being defined
- Overall, LCC PD working groups are very active
- ILD and SiD are progressing ‘reasonably’ well
  - Both groups are moving toward more well-defined organizations
  - Overall detector designs are being re-optimized
  - Lack of funding is particularly serious for SiD
- Synergy of ILC detector efforts and CLICdp efforts are working out productively and efficiently