Detectors for ILC

Towards a global organisation

Ties Behnke

The Background

European Strategy for Particle Physics

Building for Discovery
Strategic Plan for U.S. Particle Physics in the Global Context

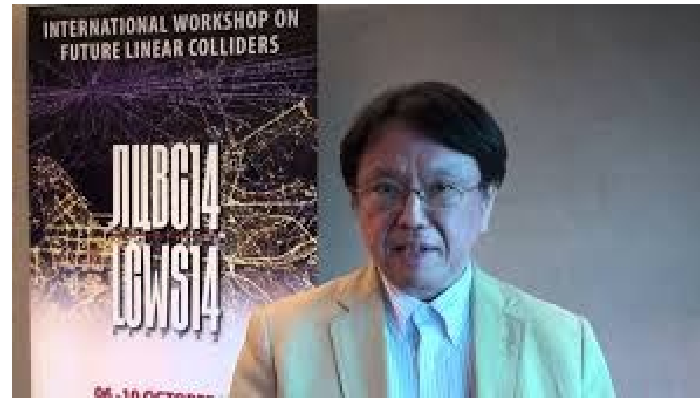
There is a strong scientific case for an electron-positron collider, complementary to the LHC, that can study the properties of the Higgs boson and other particles with unprecedented precision and whose energy can be upgraded.

The Technical Design Report of the International Linear Collider (ILC) has been completed, with large European participation. The initiative from the Japanese particle physics community to host the ILC in Japan is most welcome, and European groups are eager to participate. Europe looks forward to a proposal from Japan to discuss a possible participation.

Preparations for detectors are an integral and important part of the ILC project preparations.

Global Detector Coordination

Deputy director for detectors: Hitoshi Yamamoto

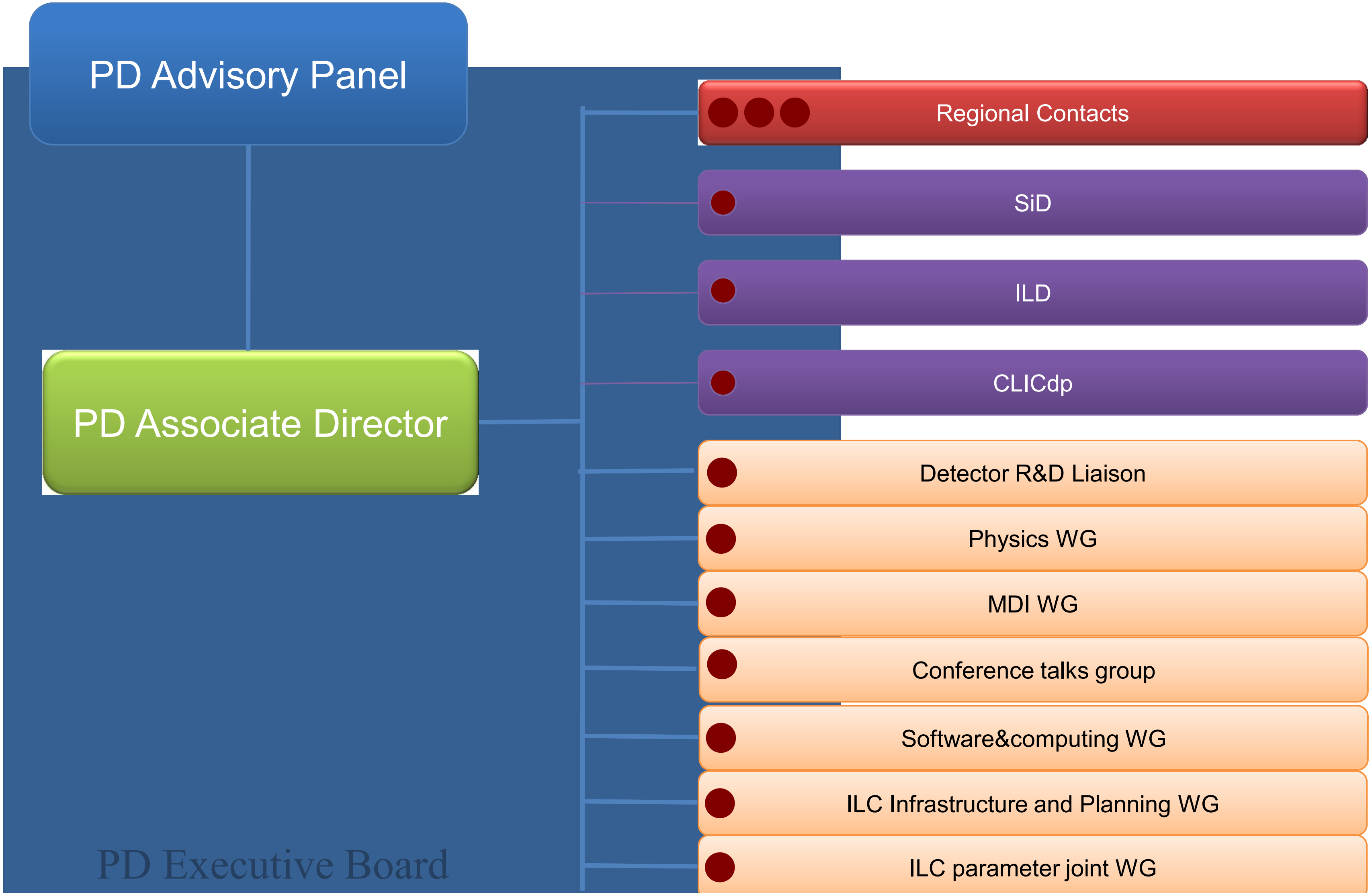


Hitoshi has setup a group of people (LCCPEB)

- ILD
- SiD
- CLICdp
- And the chairs of the working groups

Who have bi-weekly meetings.

Detectors in LCC



Goals of the Detector Group

- Coordinate making the physics case for the ILC
- Coordinate the work of the detector groups (concepts) and share effort where-ever possible and useful.
- Provide a common point of communication between machine and detector / physics community.

Working Groups

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

Working Groups

- Physics (Keisuke Fujii, Christoph Grojean, Michael Peskin)
- Machine Detector Interface (Karsten Buesser)
  - Liase with the machine to follow design changes in the machine baseline
  - Develop an integration and site specfic concept
- ILC Parameter Working group (Jim Brau)
  - Define a scenario for the ILC
  - Re-inforce the parameters of the ILC
- ILC infrastructure&planning (Sakue Yamada)
  - Understand demands on the infrastructure
  - Plan the personpower from the experimental side

Physics group

- 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)

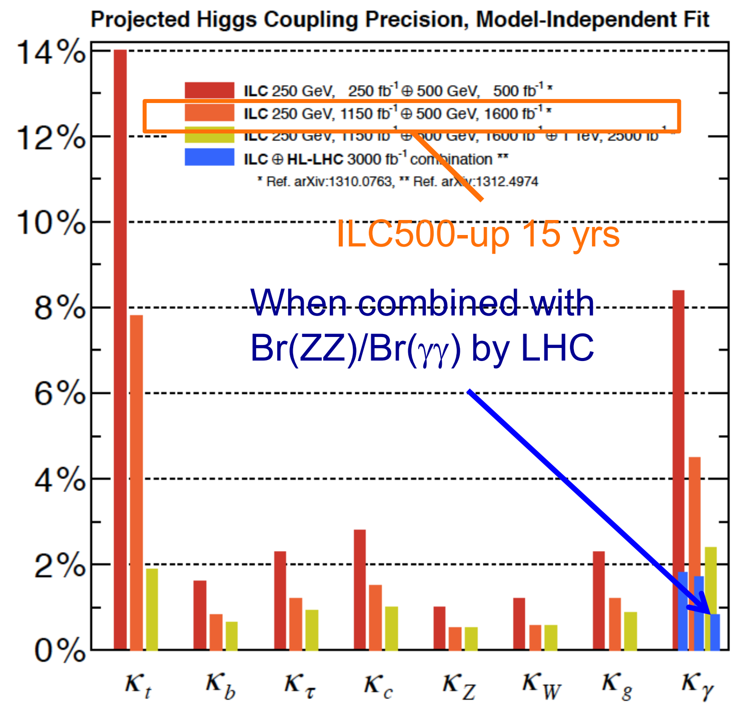
- For the MEXT particle&nuclear physics WG
  - Prepared material
    - Through Sachio Komamiya (a member of the MEXT WG)
  - Produced documents on the ILC physics case
    - 'Precis of the Physics Case for the ILC'
    - 'Scientific motivations for the ILC'

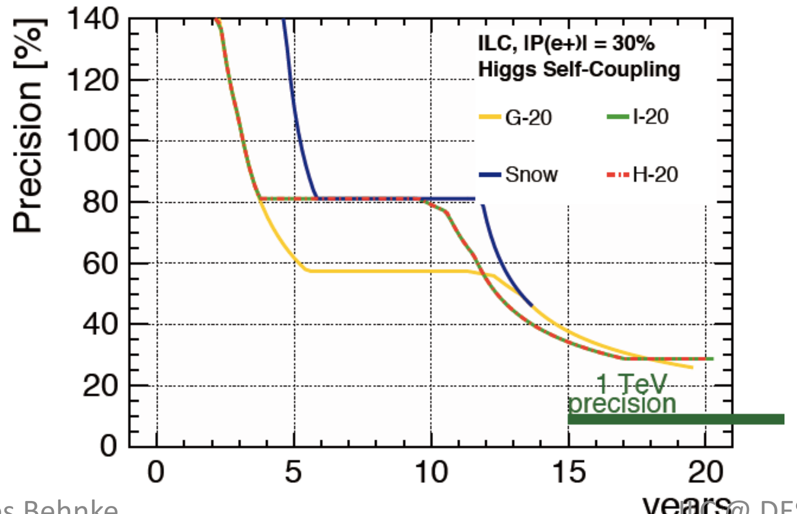
This group has played a key role in communicating with MEXT during the last months of the MEXT review process.

Higgs Physics

Summary plot to demonstrate the potential of ILC for Higgs couplings.

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)

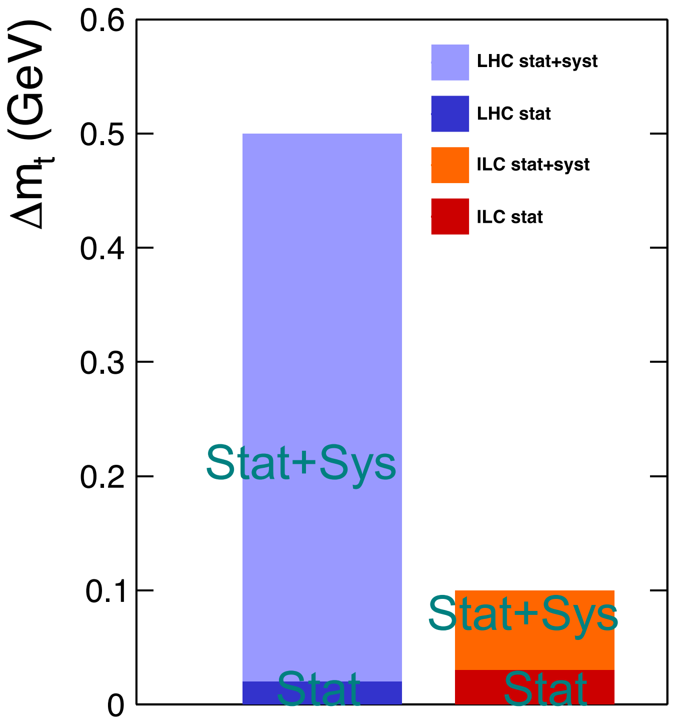




Anticipated error on the higgs self coupling
as a function of run-time.

Top Physics

Top quark mass (msbar)
(@350 GeV)



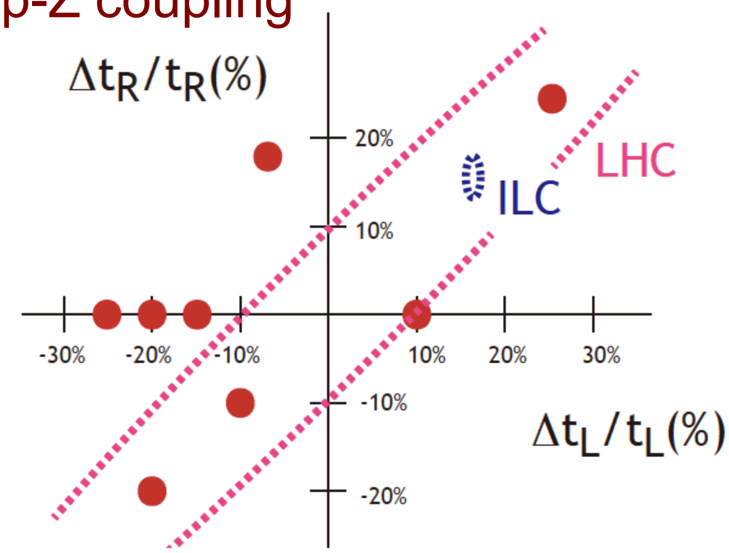
HL-LHC
3000 fb^{-1}
$\sqrt{s}$=14 TeV

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

e+e- → t tbar (@500 GeV)

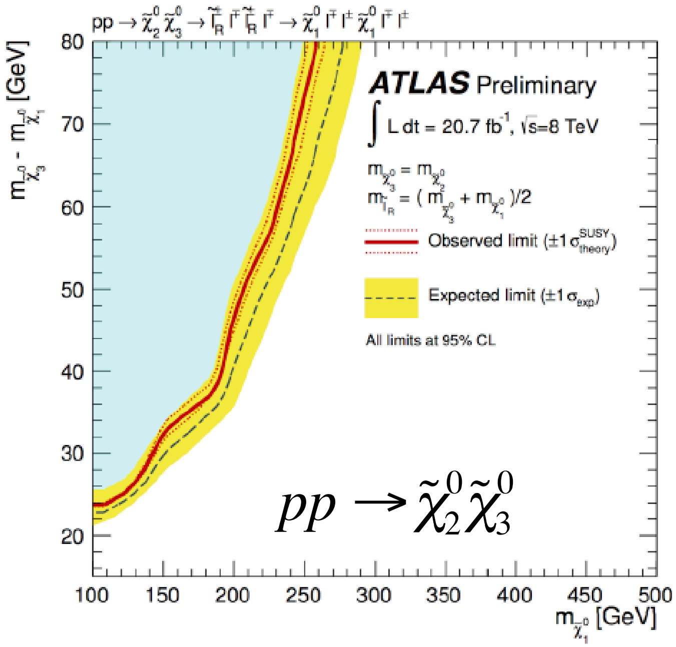
Right-handed e- does not couple to B^0
Use polarization to separate Z and γ
in S-channel

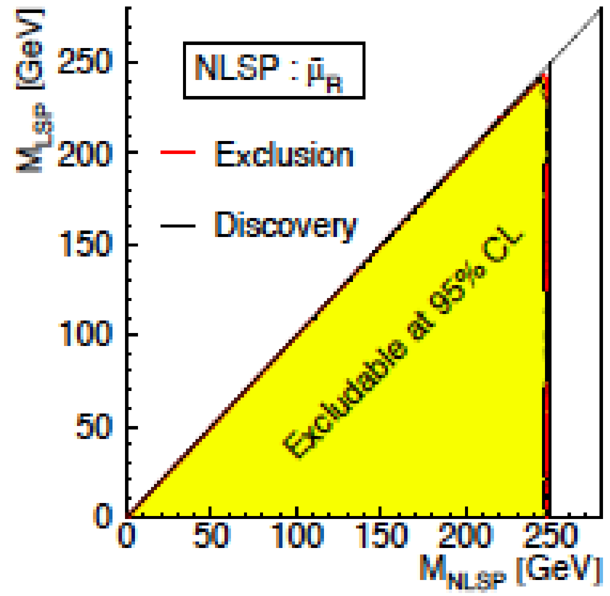
top-Z coupling



Different new-physics models
Indicated by tL and tR

New Particle Searches





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

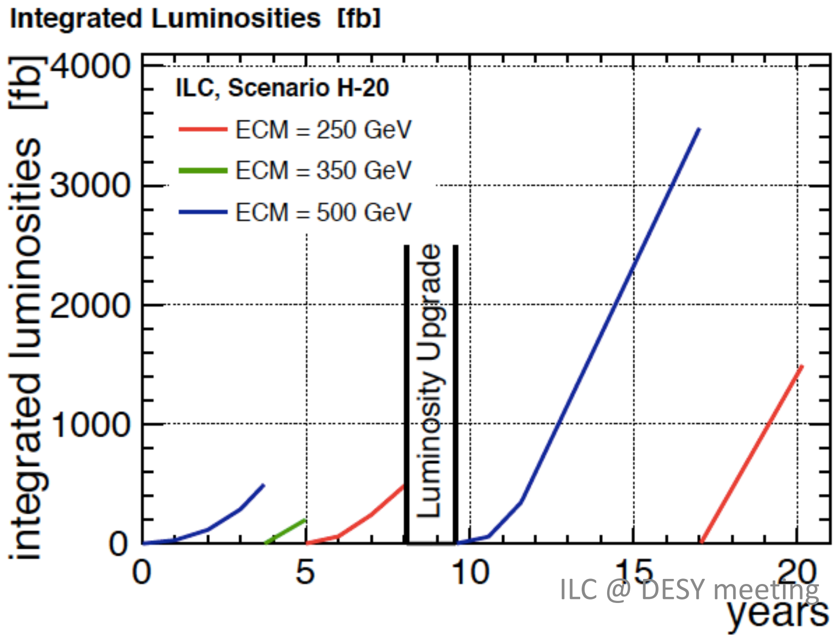
ILC is good at unexpected phenomena

Running Scenarios

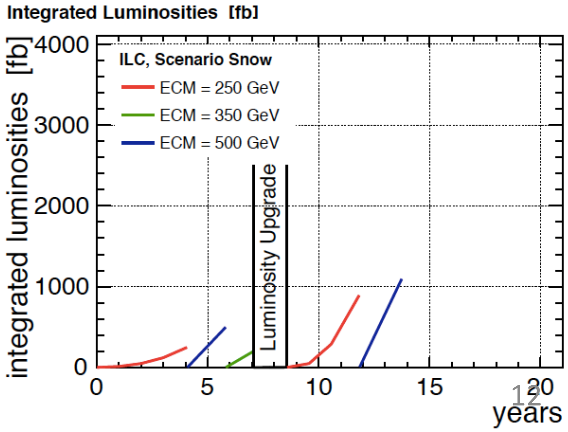
- After examining various channels, one scenario (500 GeV startup, 20 yr) is recommended (H20)
  - To be approved by LCB

	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

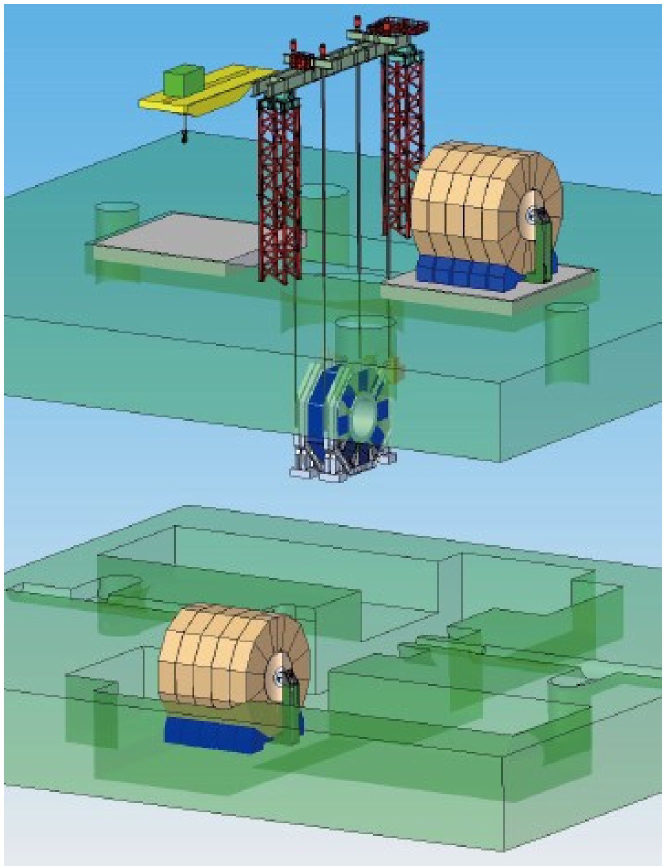
'H20'



Reference:
Snowmass study



Site Infrastructure



- 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

Advisory Panel

- Panel to follow the work of the detector groups, in particular the concepts
- Chair: Paul Grannis, Stony Brook
- Exact scope under discussion
- Focus will be on concepts, not technologies

Change Control

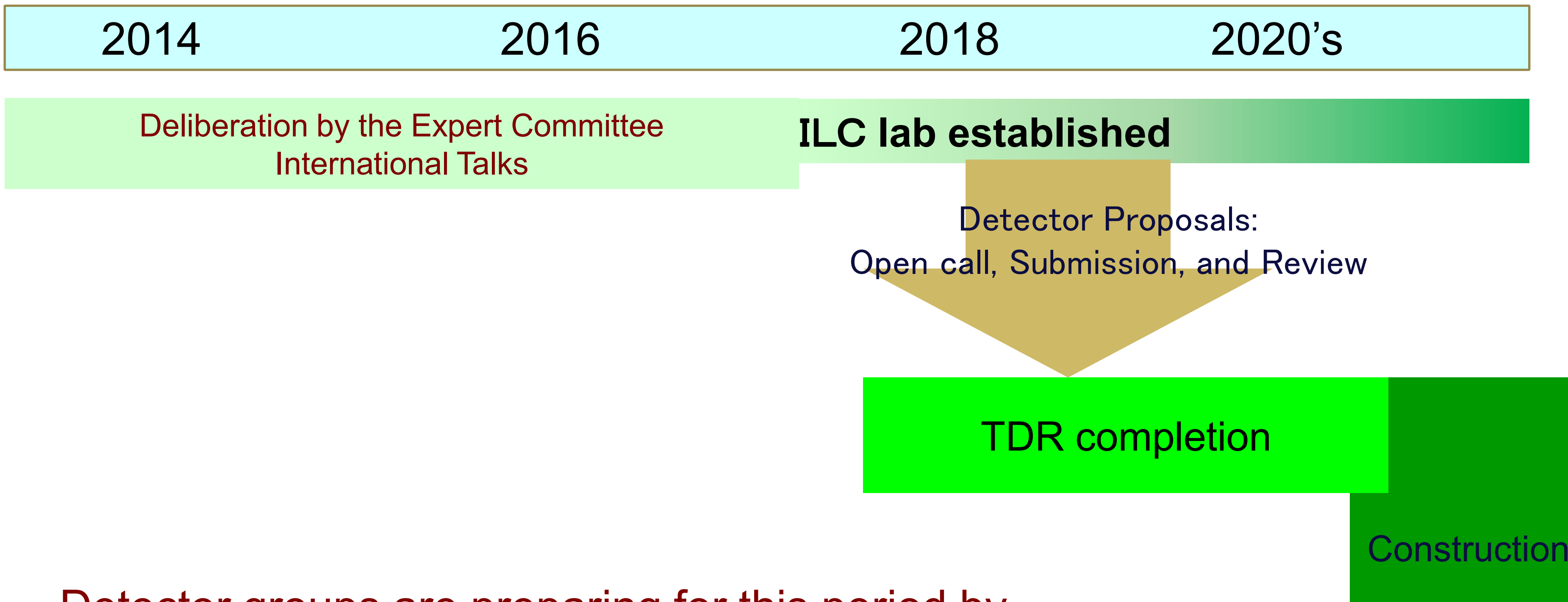
- A set of well-defined rules for updating the baseline design

- 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)

Time Line



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

Detector Groups

Both ILD and SiD are re-organising their efforts.

Main goal of the next few years: Optimize the detector

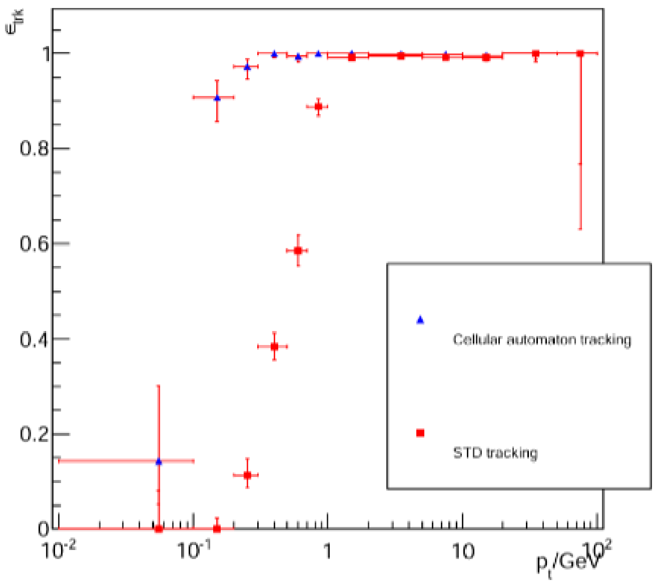
ILD Optimization

Apologies to SiD: I just do not have the information on the SiD
work at this level.

Where do we go from here:

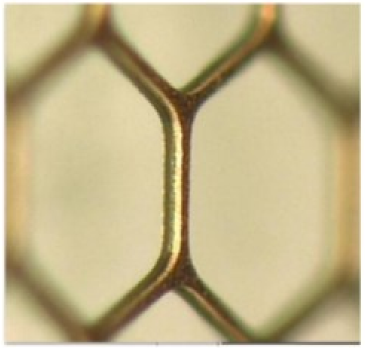
1. Re-optimize ILD
2. Sharpen the physics case
3. Demonstrate the technologies
4. Advance the detector integration

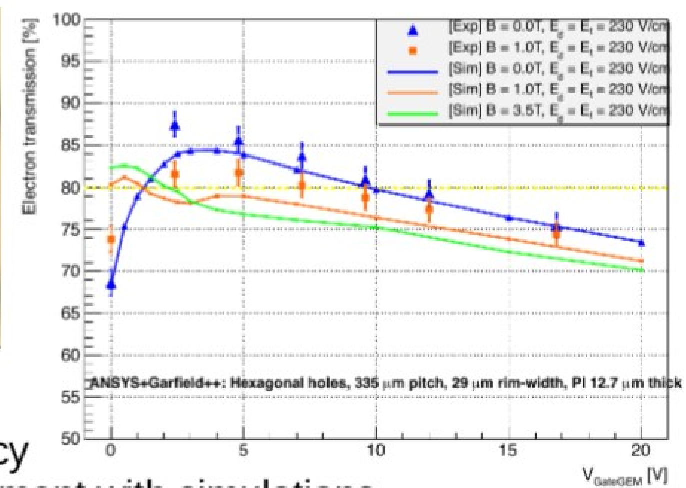
“Optimization” Issues



From Y.Voutsinas (Vertex-14)

VTX: First (and very convincing) demonstration that the double layer design in ILD actually makes sense and helps.





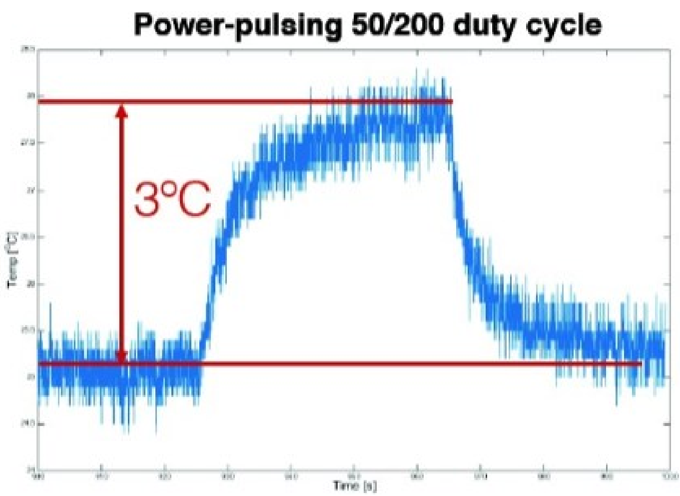
TPC: realisation of ion gate is probably the single most “critical” item for a high precision low mass TPC

Measurements of electron transparency in reasonable agreement with simulations.
20 % electron loss corresponds to ~10 % degradation of spatial resolution.

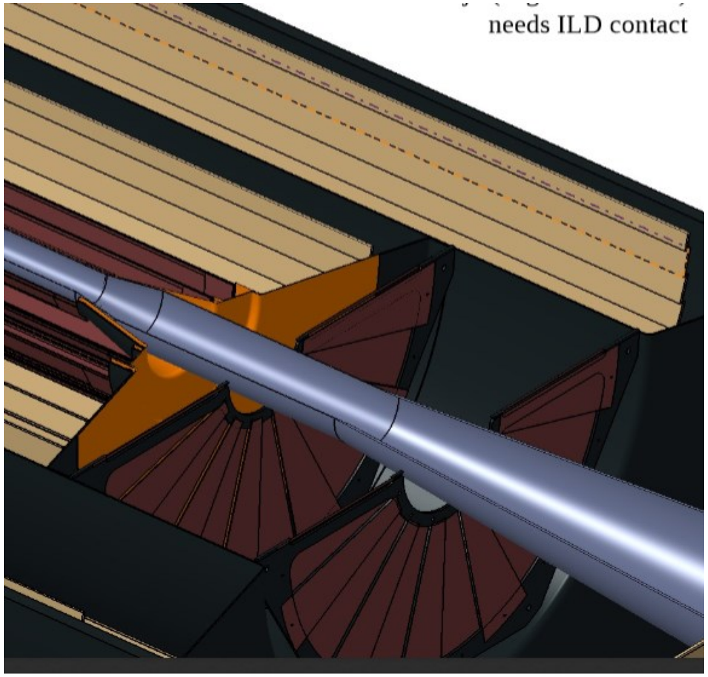
“Optimization issues”

Detector layout mostly stable, except:

Forward tracking design
External Silicon tracking in the forward region?



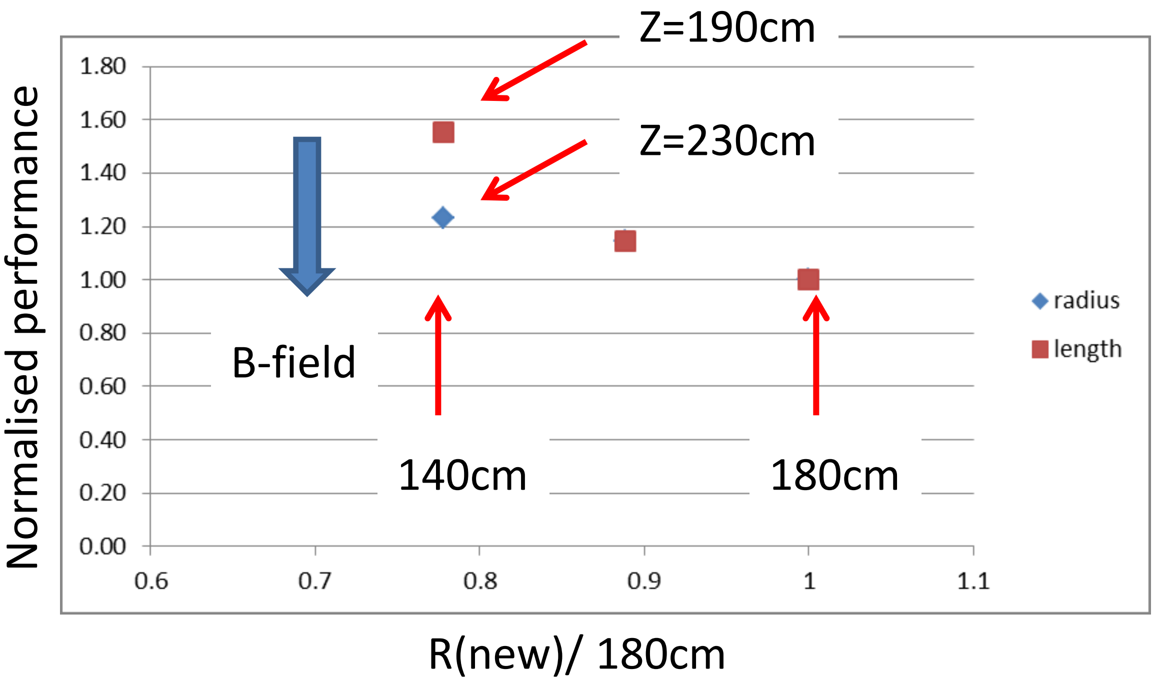
Power pulsing tests look promising

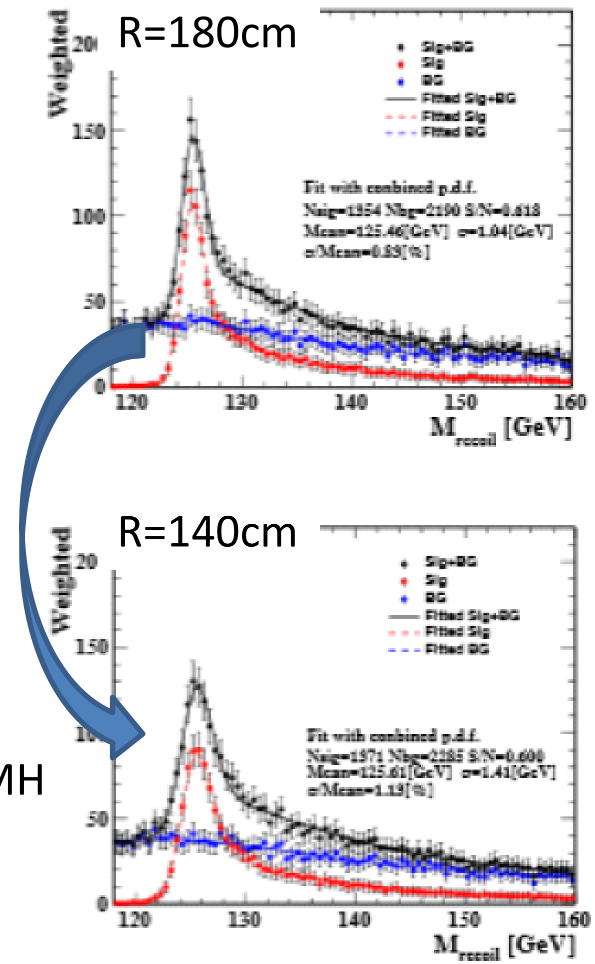


Forward design is not optimal:
Role of pixel vs strip?
Position of pixel?

FTD well covered by Spanish network
Central silicon is not covered! Major problem…

Tracking Performance



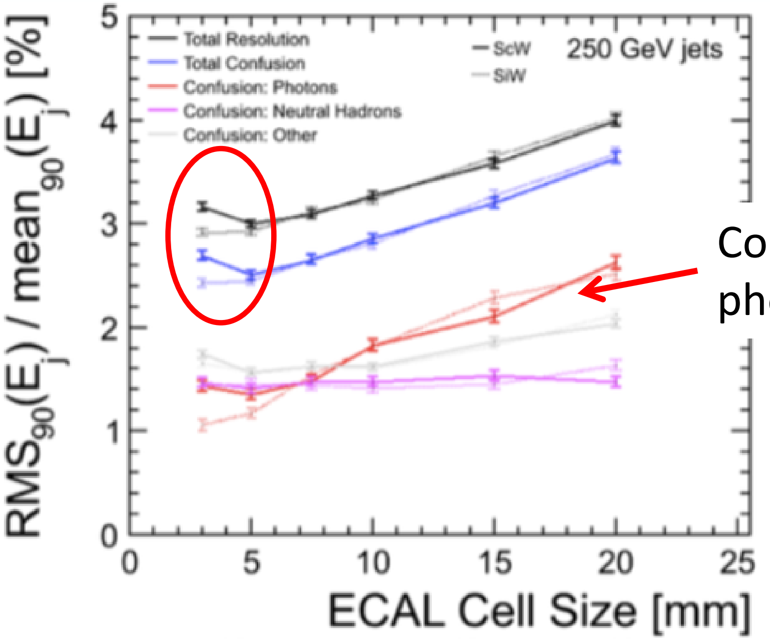


30% degradation in MH

Performance indicator a la Mikael

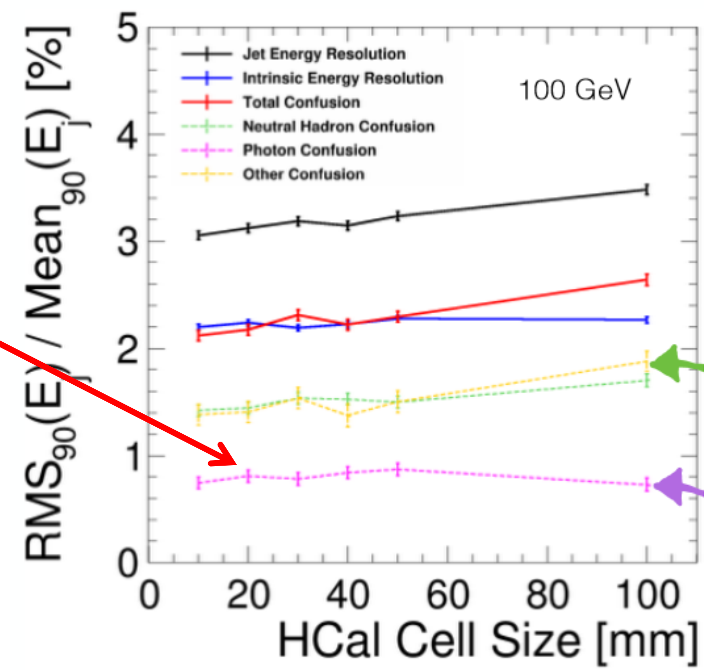
Calorimeter in view of PFLOW

ECAL



Confusion photons

HCAL



performance vs ECAL cell size

performance vs. cell size

+ Extremely nice to see the detailed studies and the high level of understanding
- We rely heavily on one piece of software for crucial studies

Do we really understand what we are doing?

Linking to physics

We are seeing nice results

Background rejection efficiency:

Single lepton ID	Cut based	Old likelihood	New likelihood
Signal(%)	98.1	98.1	97.8
ttbar – all hadronic(%)	7.9	3.1	2.3

- Improvement of all hadronic event rejection: ～30%
- Note: lepton energy threshold is loosened on likelihood_new
  - From E(lep)>15GeV → E(lep)>10GeV

Linking dEdx performance to physics gain:

Has been an outstanding issues since 10 years!

Many other analyses are ongoing and are trying to link detector performance to physics gains:

Extremely nice to see
(Remember: this was the main punch line when we started the ILD re-optimzation)

Global aspects

- We need a discussion on tools and algorithms to understand what we are doing
- We need to coordinate among ILD and SID goals / benchmarks
- We need to re-start at some point a costing group to understand the costing and make it comparable

Summary

- An organisation to deal with the experimental community has been put into place

- Dealing with this very diverse community is difficult

  - Hitoshi Yamamoto chair
  - Sub-groups and responsibilities have been defined and are working well

- It is important to present the ILC case coherently

  - Physics
  - Detectors
  - machine