Workshop Summary

focusing on physics & detectors
= excluding political aspects

Keisuke Fujii, KEK

LCC Physics&Detector Charge

- The Associate Director for Physics and Detectors will be responsible for activities that advance the physics and detectors of the linear collider. He/she will coordinate the world-wide effort to develop advanced detectors that are appropriate for either accelerator technology.
- The Associate Director will report to the Director. Working with the community, he/she will prepare the way for collaboration formation and detector construction for when the project is approved.
- Initially, the Associate Director will focus on
  - Building the physics case for a linear collider;
  - Coordinating R&D on advanced detector technologies;
  - Developing validated detector concepts for both accelerator technologies.

ILC Timeline
Proposed by LCC

- 2013 - 2016
  - Negotiations among governments
  - Accelerator detailed design, R&Ds for cost-effective production, site study, CFS designs etc.
  - Prepare for the international lab.
- 2016 – 2018
  - 'Green-sign' for the ILC construction to be given (in early 2016)
  - International agreement reached to go ahead with the ILC
  - Formation of the ILC lab.
  - Preparation for biddings etc.
- 2018
  - Construction start (9 yrs)
- 2027
  - Construction (500 GeV) complete, (and commissioning start) (250 GeV is slightly shorter)

JSPS specially-promoted research

A Global R&D Program of a State-of-the-art Detector System for ILC

Goal

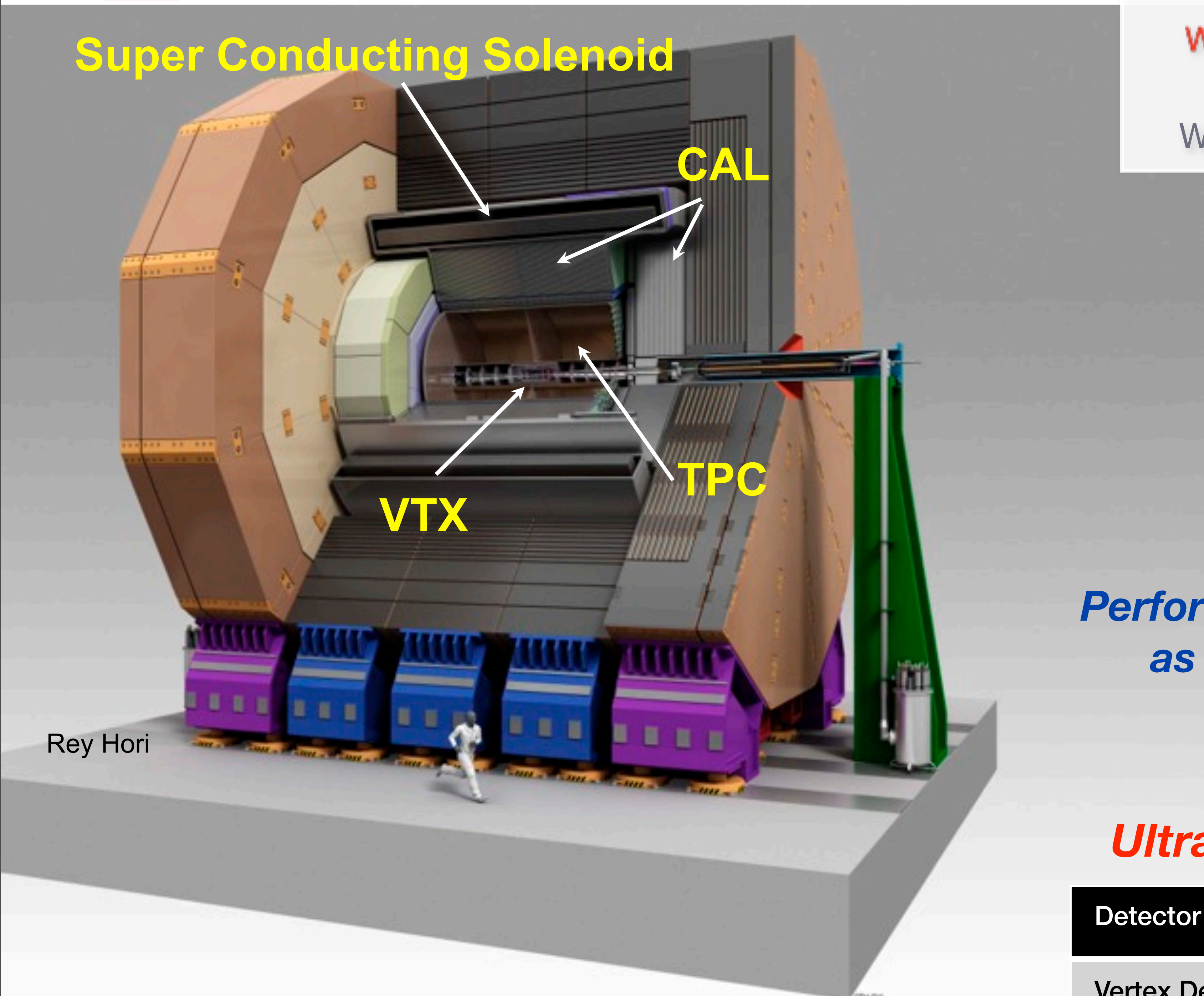
Develop the state-of-the-art components and systems, and complete the detector design based on the concept of PFA that realizes the physics of ILC within a framework of international collaboration.
→ lead the formation of a detector collaboration

PFA
Key components : Vertex detector, TPC, Calorimeters

21

Our Goal

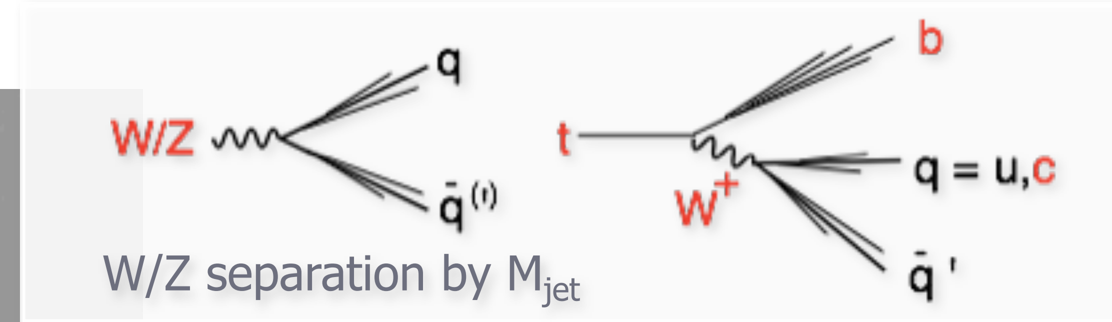
ILD Design



International Large Detector

Optimized for Particle Flow Analysis

View events as viewing Feynman diagrams



M_{Jet} → W/Z/t/h ID → p^{μ}
→ angular analysis → s^{μ}
Missing momentum → neutrinos

↓

Excellent PFA performance
+ thin & high resolution vertex detector
+ hermeticity down to 10mrad or better

Performance Goal as compared to LHC detectors

Vertex resolution	2-7 times better
Momentum resolution	10 times better
Jet energy resolution	2 times better

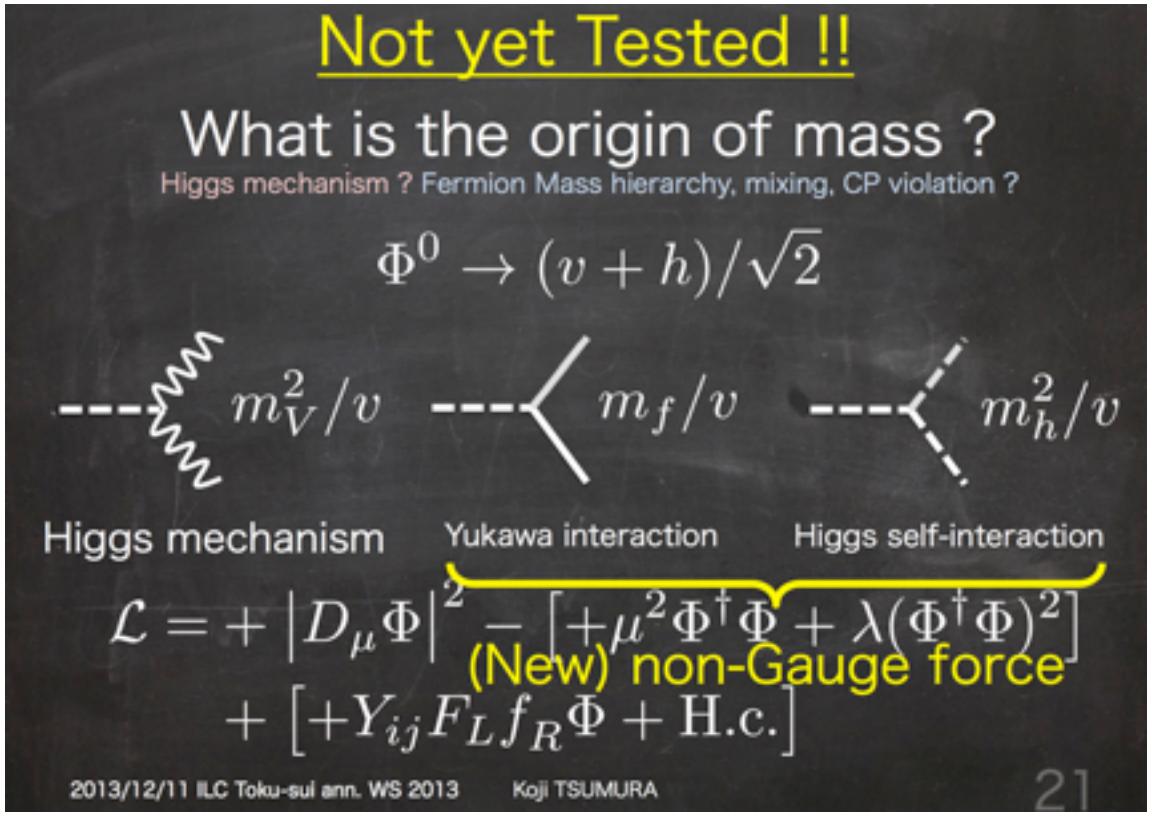
Ultra high granularity is a key!

Detector	ILC	ATLAS	Granularity
Vertex Det.	$5\times5\mu m^2$	$400\times50\mu m^2$	x 800
Tracker	$1\times6mm^2$	$13mm^2$	x 2.2
EM Calorimeter	Silicon: $5\times5mm^2$ Scintillator: $5\times45mm^2$	$39\times39mm^2$	x 61 x 7

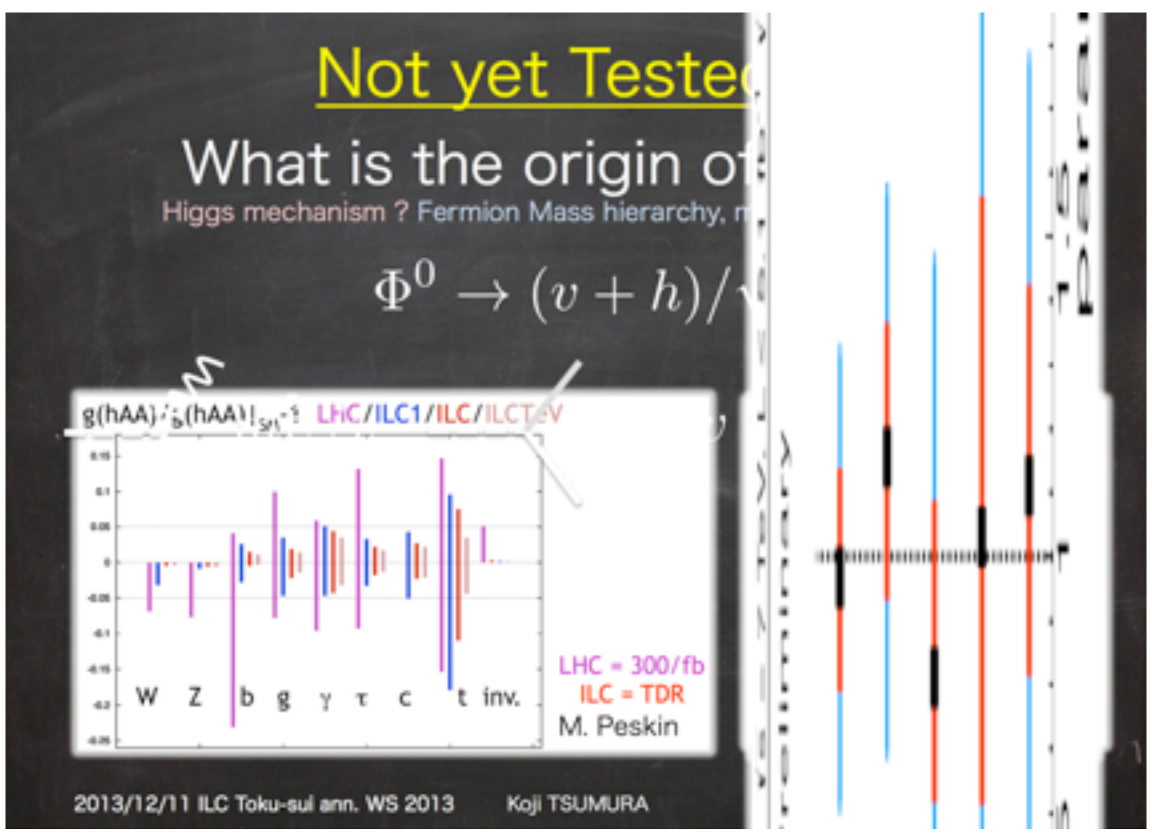
Physics

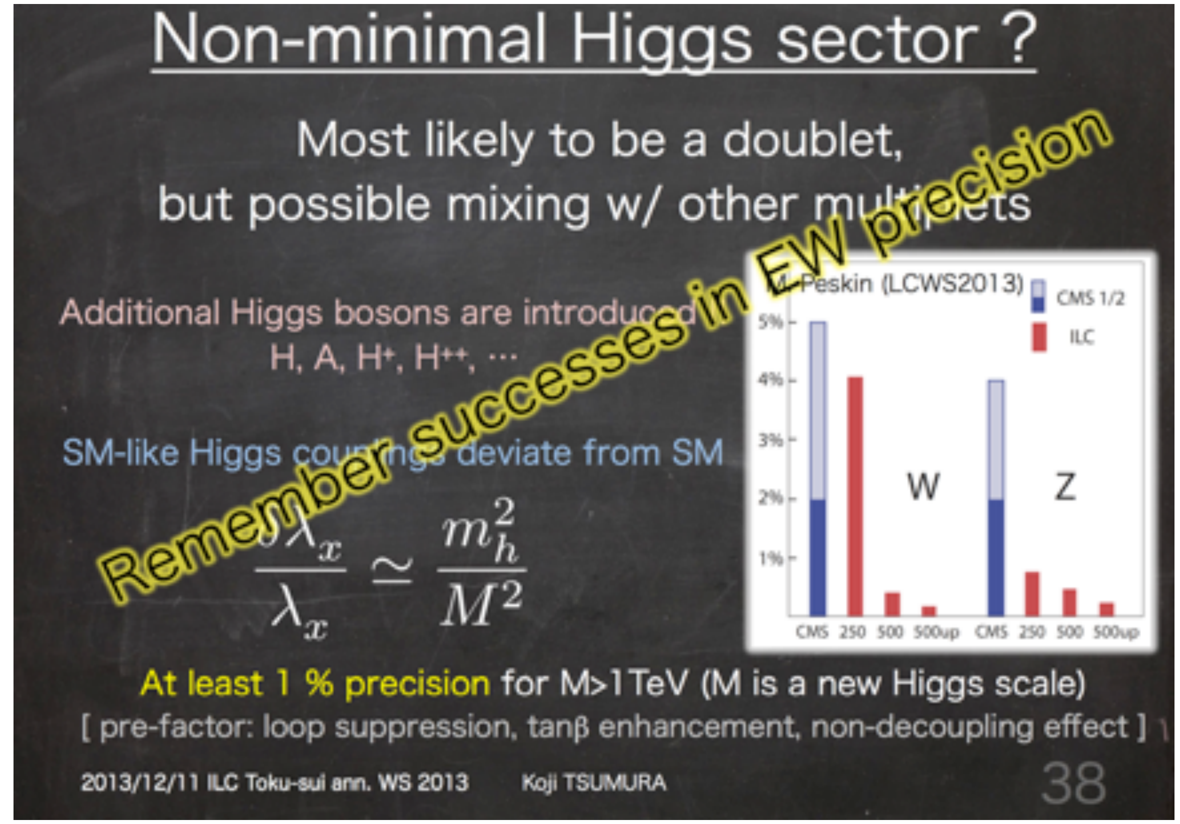
Overview

Koji Tsumura

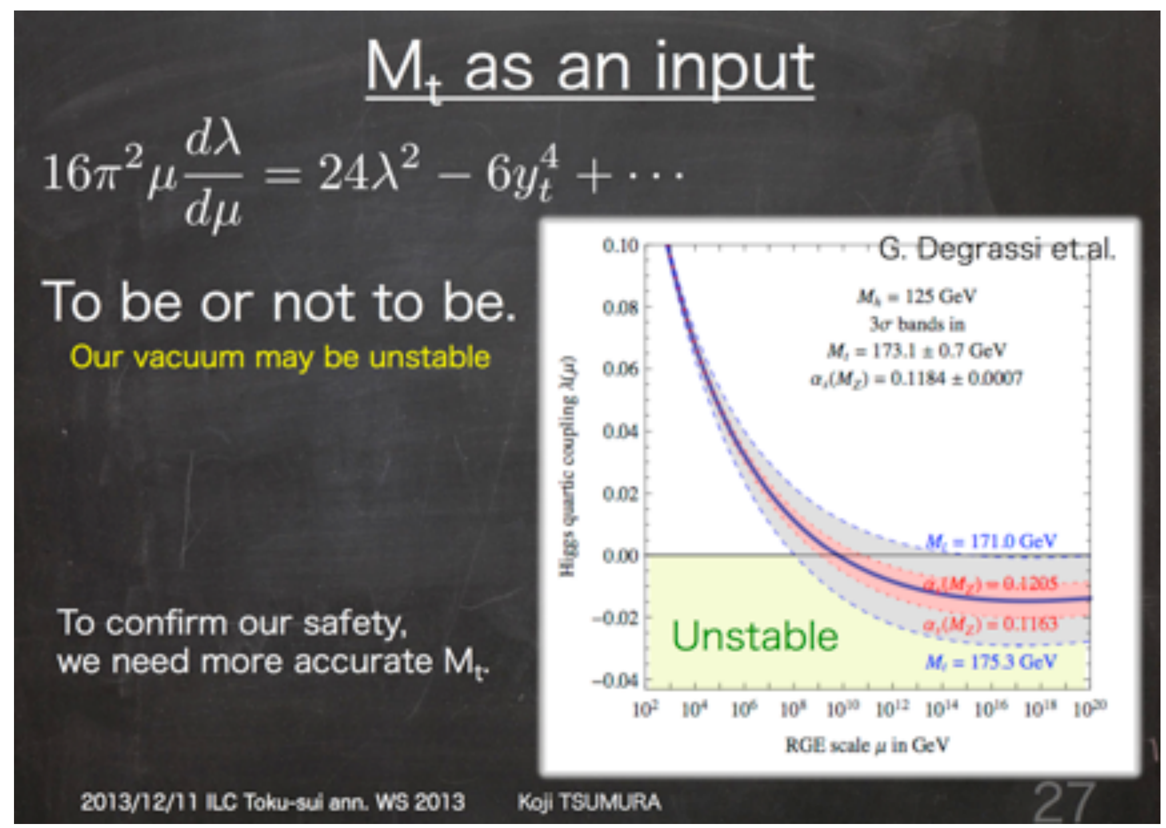


We are now talking about 2 new forces!





Precision matters to determine the next scale!



Precision matters also for the fate of our universe!

Global Fit (Higgs Couplings)

Junping Tian

What we measure is σxBR with one key exception: σ from recoil mass σ_{WW} xBR(bb, WW) is also very important

global fit --model dependent + sys + theory error (0.1%)

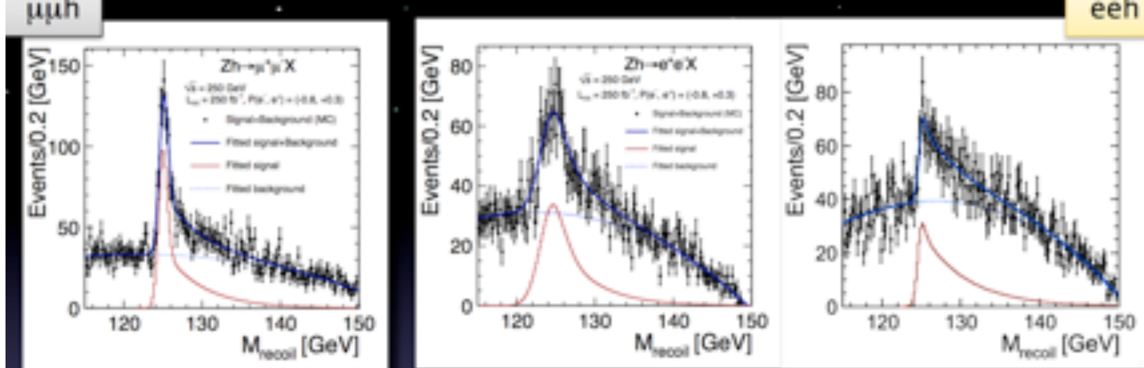
coupling Δg/g	baseline 250 GeV	baseline 250 GeV + 500 GeV	baseline 250 GeV + 500 GeV + 1 TeV	luminosity upgrade 250 GeV	luminosity upgrade 250 GeV + 500 GeV	luminosity upgrade 250 GeV + 500 GeV + 1 TeV
HZZ	0.74%	0.49%	0.45%	0.36%	0.27%	0.25%
HWW	4.7%	0.43%	0.27%	2.2%	0.27%	0.2%
Hbb	4.7%	0.97%	0.57%	2.2%	0.55%	0.36%
Hcc	6.4%	2.5%	1.3%	3%	1.3%	0.78%
Hgg	6.1%	2%	1.1%	2.8%	1.1%	0.69%
Hττ	5.2%	1.9%	1.3%	2.4%	1%	0.74%
Hγγ	17%	8.3%	3.8%	8.1%	4.4%	2.3%
Hμμ	5.2%	1.9%	1.4%	2.4%	1%	0.89%
Htt	6.4%	2.5%	1.3%	3%	1.4%	0.87%
Γ_0	9%	1.7%	1.1%	4.2%	1%	0.8%
Br(Inv)	<0.95%	<0.95%	<0.95%	0.44%	0.44%	0.44%
HHH	-	83%	21%	-	46%	13%

(with HL-LHC, $\Delta g_{H\gamma\gamma} < 1\%$)

Recoil Mass mh=120 → 125 Update

Leptonic Shun Watanuki

Result

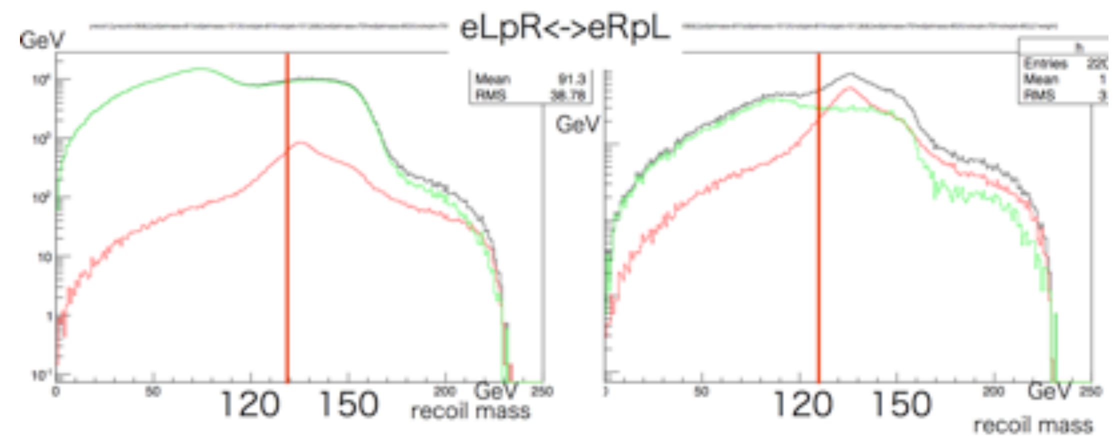


- [μμh] Statistical Errors :
  - cross section error 3.6%
  - mass error 37MeV
- [eeh] Statistical Errors :
  - cross section error 5.2%
  - mass error 122MeV
- Statistical errors for combination of μμh and eeh results.
  - cross section error 3.0%
  - mass error 35MeV

Cross section	μμh	eeh	Combined
MI	3.6%	5.2%	3.0%
semi-MI	3.0%	4.6%	2.5%
Mass	**μμh**	**eeh**	**Combined**
MI	37MeV	122MeV	35MeV
MD	33MeV	92MeV	31MeV

Hadronic Tatsuhiko Tomita

Significance with cut



events with recoil mass > 120GeV(eLpR), >110GeV(eRpL)

	qqH	ZZ/WW	significance
eLpR	24,632	354,542	40.0σ
eRpL	18,900	14,392	103.6σ

18/12/2013 annual meeting of ILC Tokubetsu Suishin @KEK Tatsuhiko Tomita 11

For recoil mass method to be really model independent, efficiency should be independent of Higgs decay modes!

This conditions seems to be satisfied to 10% level! → seems to be promising! → more study

Higgs BRs mh=120 → 125 Update

Hadronic Hiroaki Ono

Current results E_{cm}=250 GeV

E_{cm}=250 GeV comparing extrapolated and simulated results

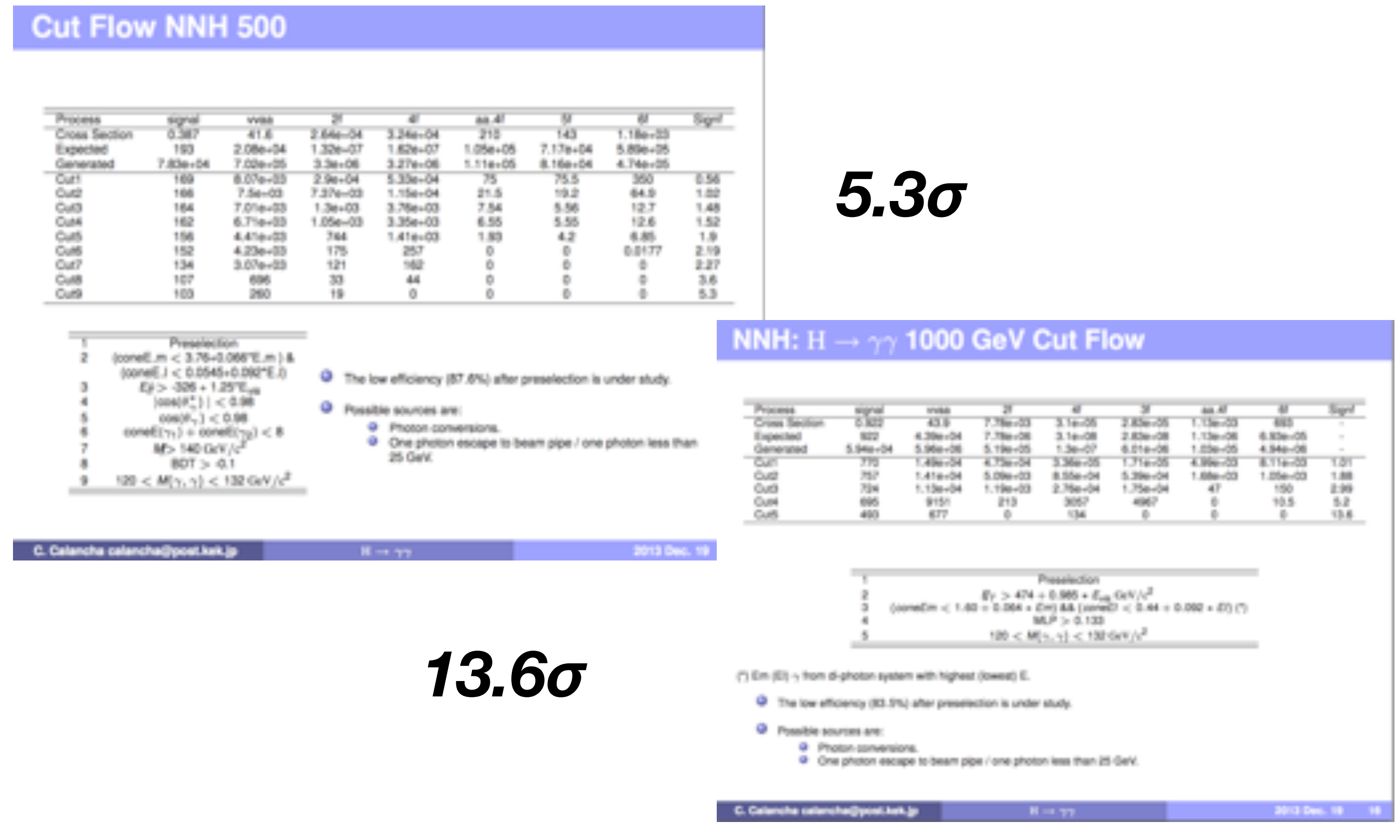
E_{cm}=250 GeV	Extrapolated 125 GeV (250 fb^{-1})			Simulated 125 GeV (250fb^{-1})		
ΔσBR/σBR	bb	cc	gg	bb	cc	gg
νvh	1.8%	12.9%	11.2%	1.6%	13.4%	9.3%
qqh	1.6%	11.8%	10.5%	1.6%	22.3%	15.5%
eeh	4.0%	31.4%	25.3%	4.3%	59.4%	36.9%
μμh	3.5%	26.3%	19.1%	3.4%	32.7%	21.0%
Combined	1.1%	8.0%	6.8%	1.0%	10.6%	7.3%

Statistical uncertainty only Preliminary results

Still investigating discrepancies in qqh and eeh on h→cc/gg channels.

Dec. 19 2013 ILC Tokusui Annulal meeting 2013 17

γγ Constantino Calancha



5.3σ

13.6σ

ττ Shin-ichi Kawada

Summary: Current Numbers

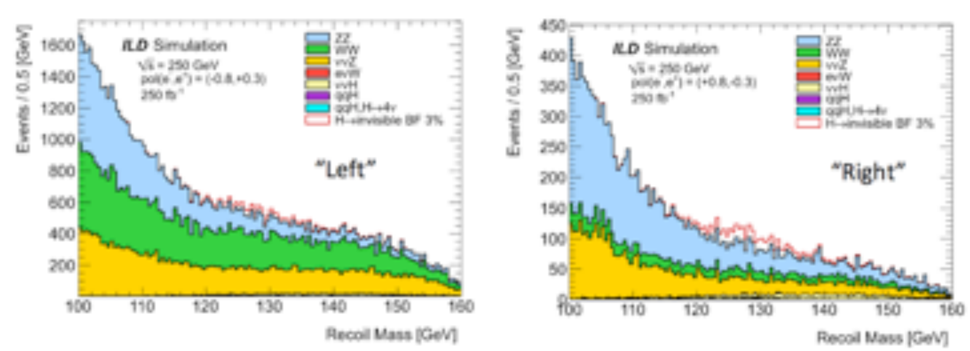
$\sqrt{s}$	250 GeV	500 GeV			
$\int L\,dt$	250 fb^{-1}	500 fb^{-1}			
Mode	$q\bar{q}h$ e^+e^-h $\mu^+\mu^-h$	$\nu\bar{\nu}h$	$q\bar{q}h$	e^+e^-h	$\mu^+\mu^-h$
$\frac{\Delta(\sigma\cdot\mathrm{Br})}{(\sigma\cdot\mathrm{Br})}$ Cut-based	4.2% Extrapolation from M_h = 120 GeV to M_h = 125 GeV	7.4%	5.1%	20.8%	18.2%
$\frac{\Delta(\sigma\cdot\mathrm{Br})}{(\sigma\cdot\mathrm{Br})}$ TMVA	-	6.0%	4.6%	22.7%	17.5%

ILC Tokusui Workshop @ KEK (2013/Dec./19) 15

Invisible Akimasa Ishikawa

Signal Overlaid

- If BF(H→invisible) = 3%
  - Signal is clearly seen for "Right" polarization

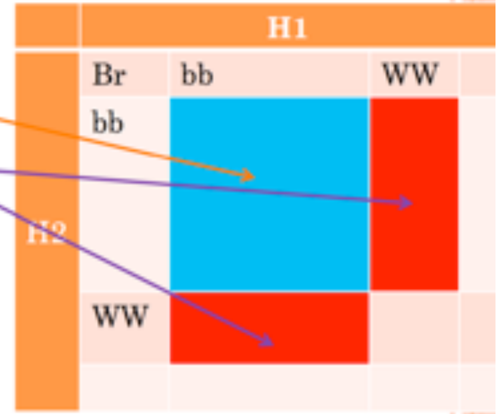


The 95% CL upper limits on BF and lowest BFs for observation
- 0.95% (0.44%)and 2.8% for "Left" polarization (for HL-ILC)
- 0.65% (0.32%)and 2.0% for "Right" polarization (for HL-ILC)

Self-couplings *Masakazu Kurata*

Status of this analysis

- Golden channel: Z(bb)(bb)
  - b-tagging can suppress backgrounds
- Requirement of $H \to WW^*$ decay
  - Contribution on the total sensitivity
  - Difficulty of background rejection
- Backgrounds
  - ttbar and ZWW: huge events
  - bbbb final states: ZZ, Zγ, bbZ – b-rich backgrounds
  - triboson: ZZH, ZZZ
  - ttbar + X: jet-rich and b-rich
- Difficulty of the analysis
  - S/B~1/3500 @500GeV, ~1/2000 @1TeV



4

Summary and plan

- Higgs self coupling analysis is ongoing:
  - One of the important task for the next linear collider
  - Results of HH→(bb)(bb) – precision of the self coupling @∫L=2ab-1:

energy	500GeV	1TeV
δλ/λ	~44%	~18%
δσ/σ	~27%	~23%

  - Results of HH→(bb)(WW*) - signal significance @ ∫L=2ab-1

energy	500GeV	1TeV
Signal significance	1.91σ	2.80σ

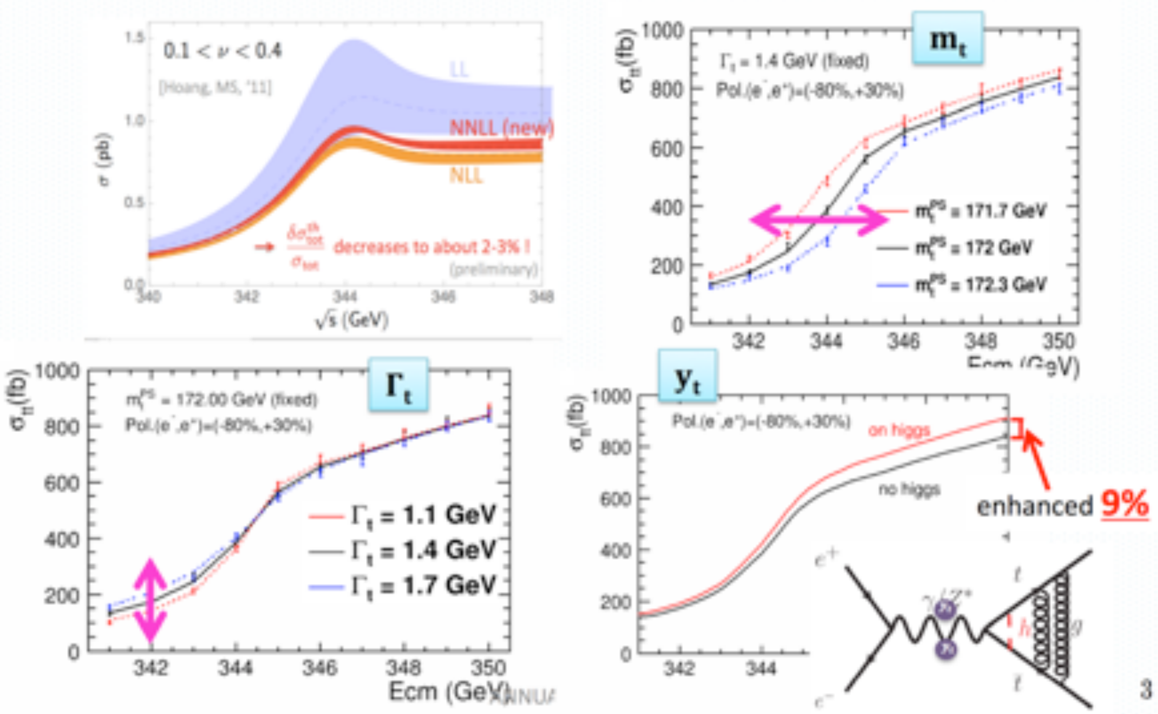
- Plans
  - Combine all the channels
  - Improvement of basic components for the analysis
    - B-tagging
    - Lepton ID
    - Jet finding, Jet clustering
  - Lots of efforts are necessary and ongoing

22

TTbar Threshold *Tomohiro Horiguchi*

Measuremet of m_t, Γ_t and y_t

$$\sigma_{tt} = f(\sqrt{s}, m_t, \Gamma_t, \alpha_s, m_h, y_t)$$



3

Summary and Plan

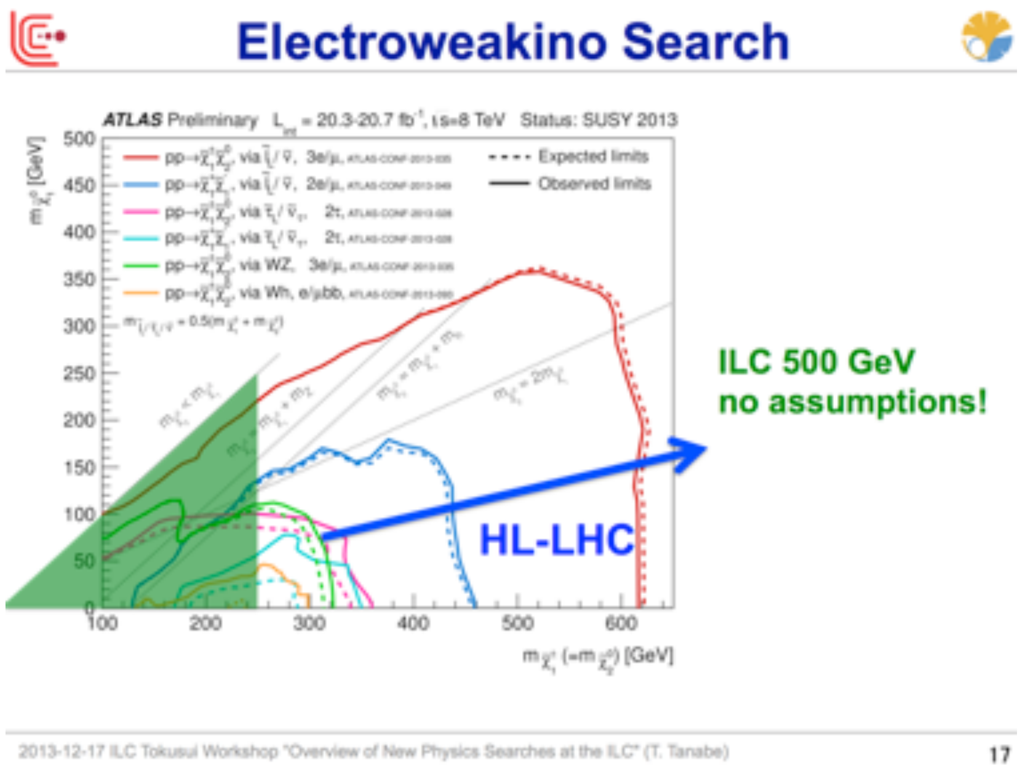
- Summary
  - We have estimated the statistical error of y_t, m_t and Γ_t using 6-Jet and 4-Jet final state for two polarization states at the ILC.
  - 5 fb^{-1} × 20 points, 100 fb^{-1}
    - ✓ (10 E_{CM} × 2 polarization states, Left and Right)

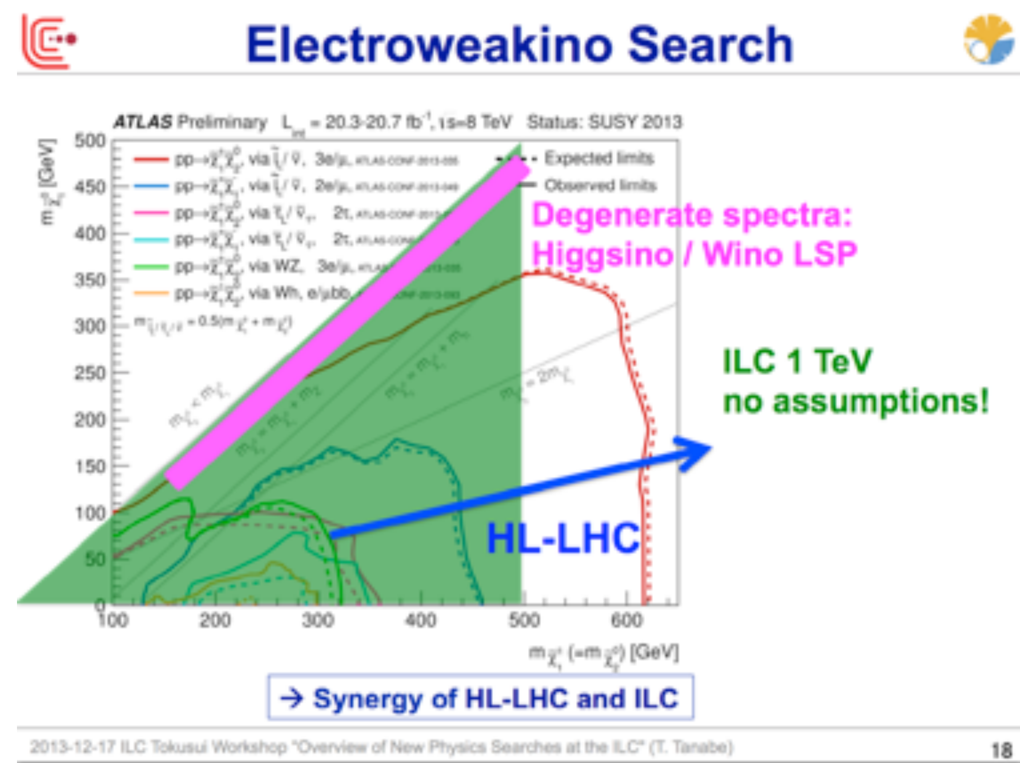
$\Delta y_t/y_t$	4.4 %
m_t^{PS}	172.001±0.018 (GeV)
$m_t^{\overline{MS}}$	163.800±0.017 (GeV)
Γ_t	1.399±0.026 (GeV)

- Plan
  - A_{FB}

BSM Physics

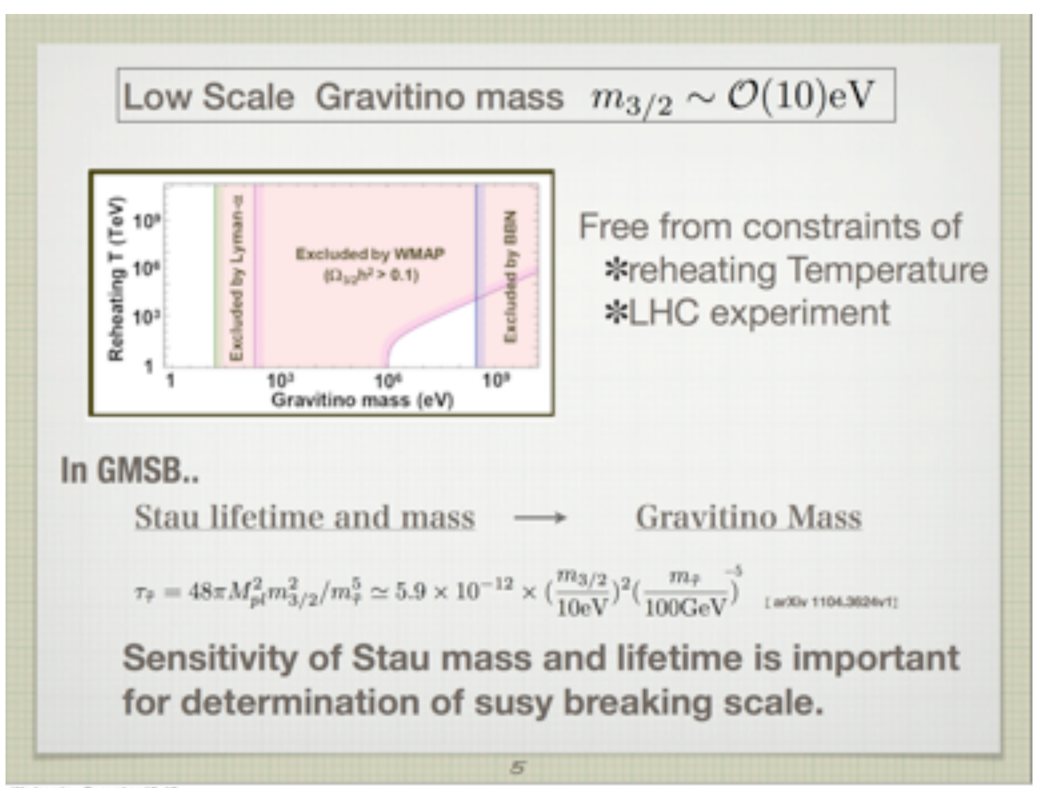
Overview Tomohiko Tanabe

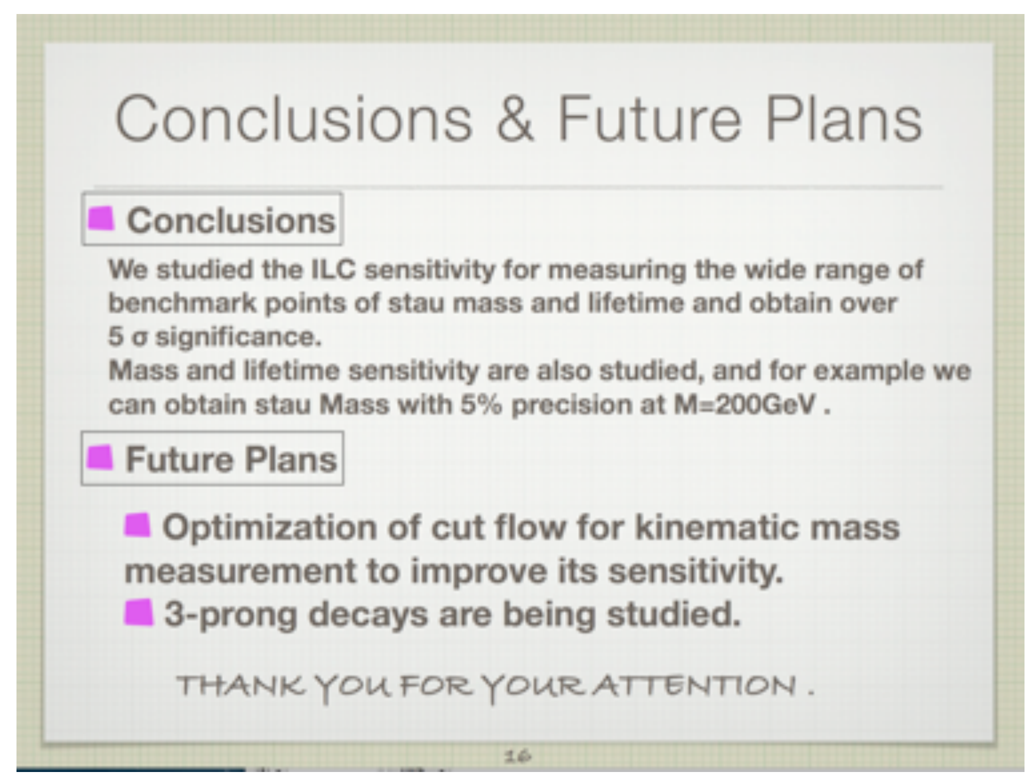




The blind corner is not unlikely!   Naturalness suggest compressed spectra

Quasi-stable Stau   Takuaki Mori





mh=120→125GeV update in good shape, should study systematics and theoretical uncertainties

More effort needed for self-coupling and rare decays

More effort also needed for BSM physics

Detector R&D

ILD Japan focuses on

VTX, TPC, and CAL

as the three key elements to high performance PFA.

As a host, we also need to take care of MDI, etc.

MDI

IP Stabilization

Toshiaki Tauchi

vertical offset btw 2 beams < 0.5nm for L>98%(nominal)

50nm QD0 jitter --> 1% luminosity loss (assuming feedback)

Okugi-san claims this is too large.

Consistent commissioning strategy should be formulated.

Vibration sources

Takahiro Okamura

identified various vibrations sources of cryogenic origin and considered counter measures

compressors and cold boxes should be kept as far away from the IR. Use of superfluidity, mechanically different flexible tubes to avoid resonance

we should also watch out for possible vibration from 2P-CO2 detector cooling channels

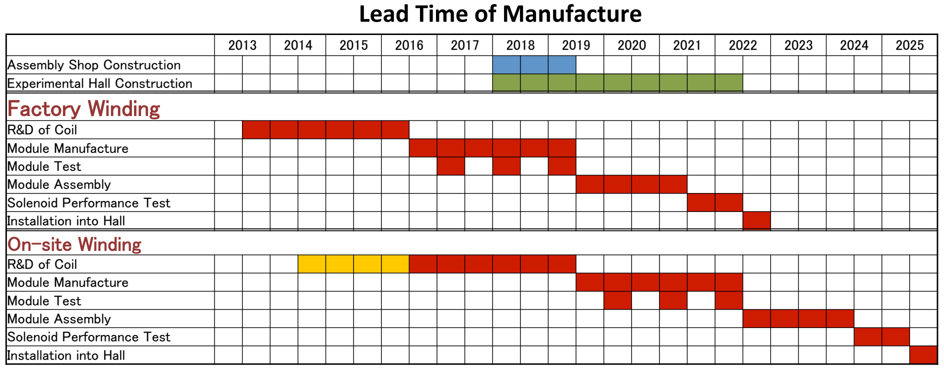
Detector Solenoid

Yasuhiro Makida

Solenoid should be ready before installation of most detector components

On-site winding or Factory winding?

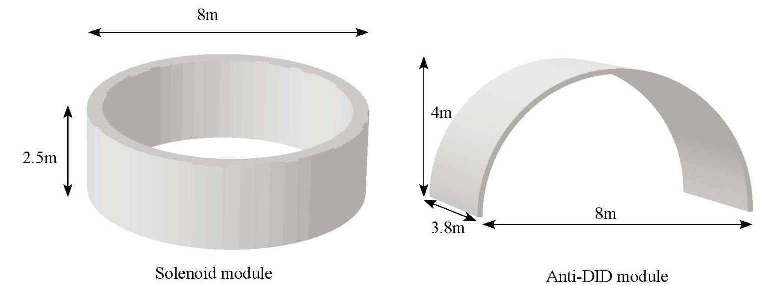
	On-site winding		Factory winding	
Lead time	↓	It is impossible to complete the manufacture and performance test of the solenoid in 3 years after the completion of the assembly shop.	↑	Before the assembly shop become in service, R&D of manufacturing and fabrication of modules can start in the industrial facility.



17.12..2013 ILC Tokusui Workshop

On-site winding or Factory winding?

	On-site winding		Factory winding	
Transportation of parts or modules	↑	There is no problems for transportation of coil parts and conductors.	↓	Transportation of single solenoid module of $^{\phi}8$ m $\times^{L}2.5$ m and single anti-DID of $^{W}4.2$ m $\times^{L}3.4$ m $\times^{\phi}8.4$ m needs special route without obstructions. The modules can be carried in with $^{W}3.8$ m$\times^{H}9$ m.



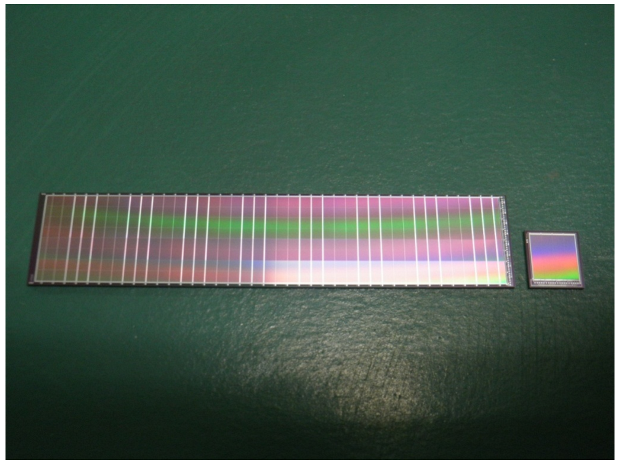
17.12..2013 ILC Tokusui Workshop

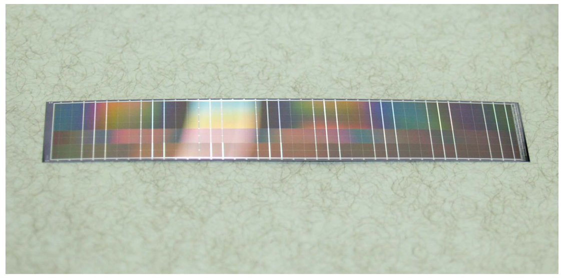
Vertex

Overview Yasuhiro Sugimoto

Original plan for sensor R&D in FY2013
- Large size thin wafer
- Small size 5um pixel

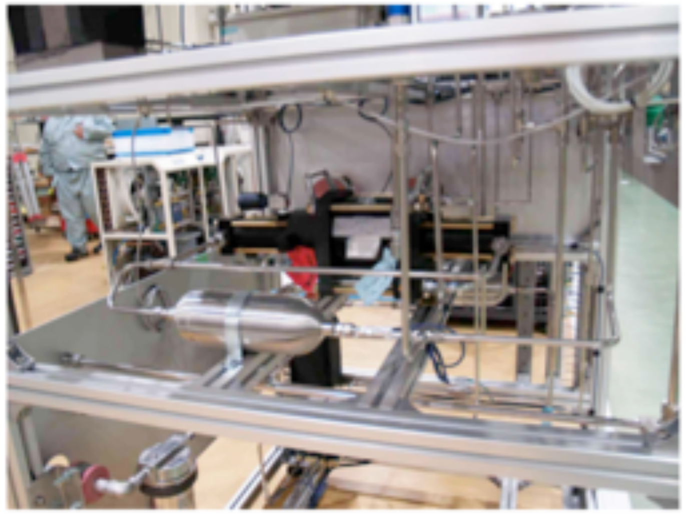
Achievement
- Large size FPCCD
  - Same format as 2012 large prototype
  - Mechanical prototypes of thin wafer
  - Working prototypes of thin wafer (bare chip)
  - Working prototypes of thick wafer (bare chip)
- Small size FPCCD
  - Packaged prototypes with 6um pixel for radiation damage test (Same format as 2012 small prototype)





Cooling system for VTX

- Prototype of 2-phase CO2 cooling system under construction



Advantage of 2P-CO2 Cooling
- *high cooling power due to high latent heat ~300 J/g, high pressure ~ 1MPa @-40°C,*
  → less evaporated gas volume → ~ constant pressure
  → ~ constant temperature everywhere in the cooling circuit
  → allowing use of thin tubes → less cooling materials

FY2014 plan

- Neutron damage tests
  - 2nd neutron damage test at CYRIC
- Beam test
  - Beam test at J-PARC, if possible
- FPCCD prototypes
  - 2nd large prototype (?)
  - Small prototype with 5um pixels (?)
- Readout electronics
  - Start R&D for peripheral circuit
- Ladder R&D
  - Mechanical structure
  - Bare chip test board with ladder size

14

Readout Electronics   Hisao Sato

6. Summery and open issues in priority

1) 100MHz behavior of AFFROC comes to be well understood.
2) The beam test was canceled. However, work on preparation of beam test reveals some issues.
3) Followings are issues in priority

a) Above 25MHz (2.5Msampling) operation, 100MHz, 125MHz

First need to implement CCD clock timing tuning feature in the FPGA.

Minimize EMI noise to ASIC.

Then see Fe55 signal at 100MHz.

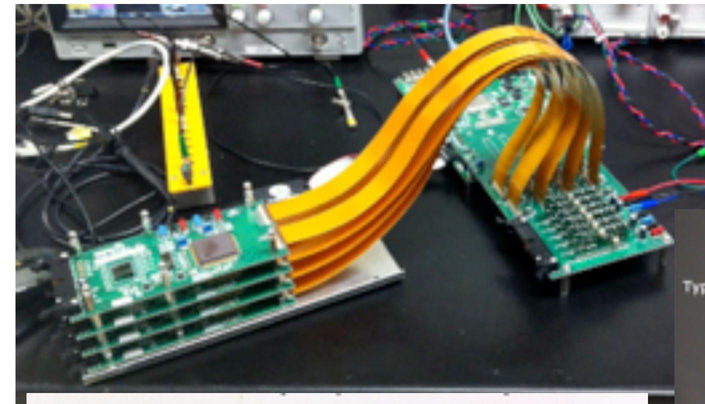
b) CCD clock signal waveform

Study CCD clock signal integrity on FFC transmission cable.

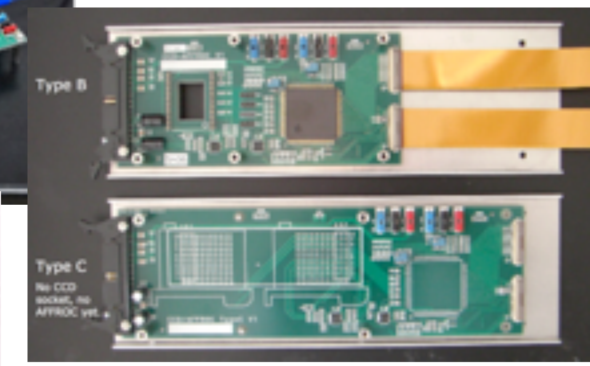
Test driving four CCDs.

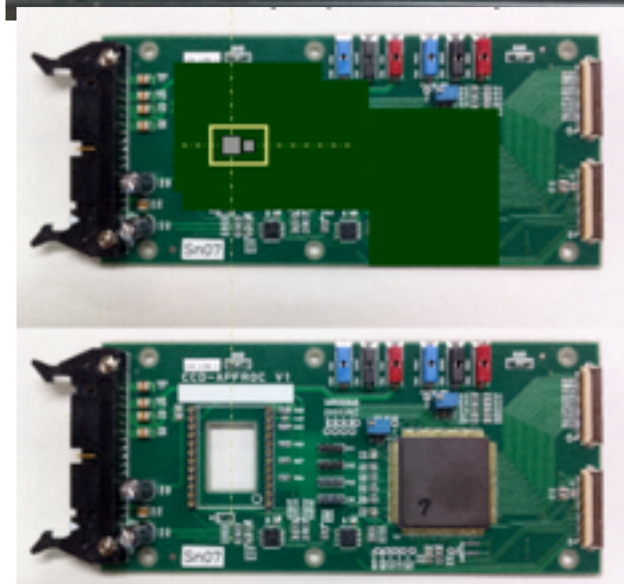
Test the large size CCD.

15



For beam tests



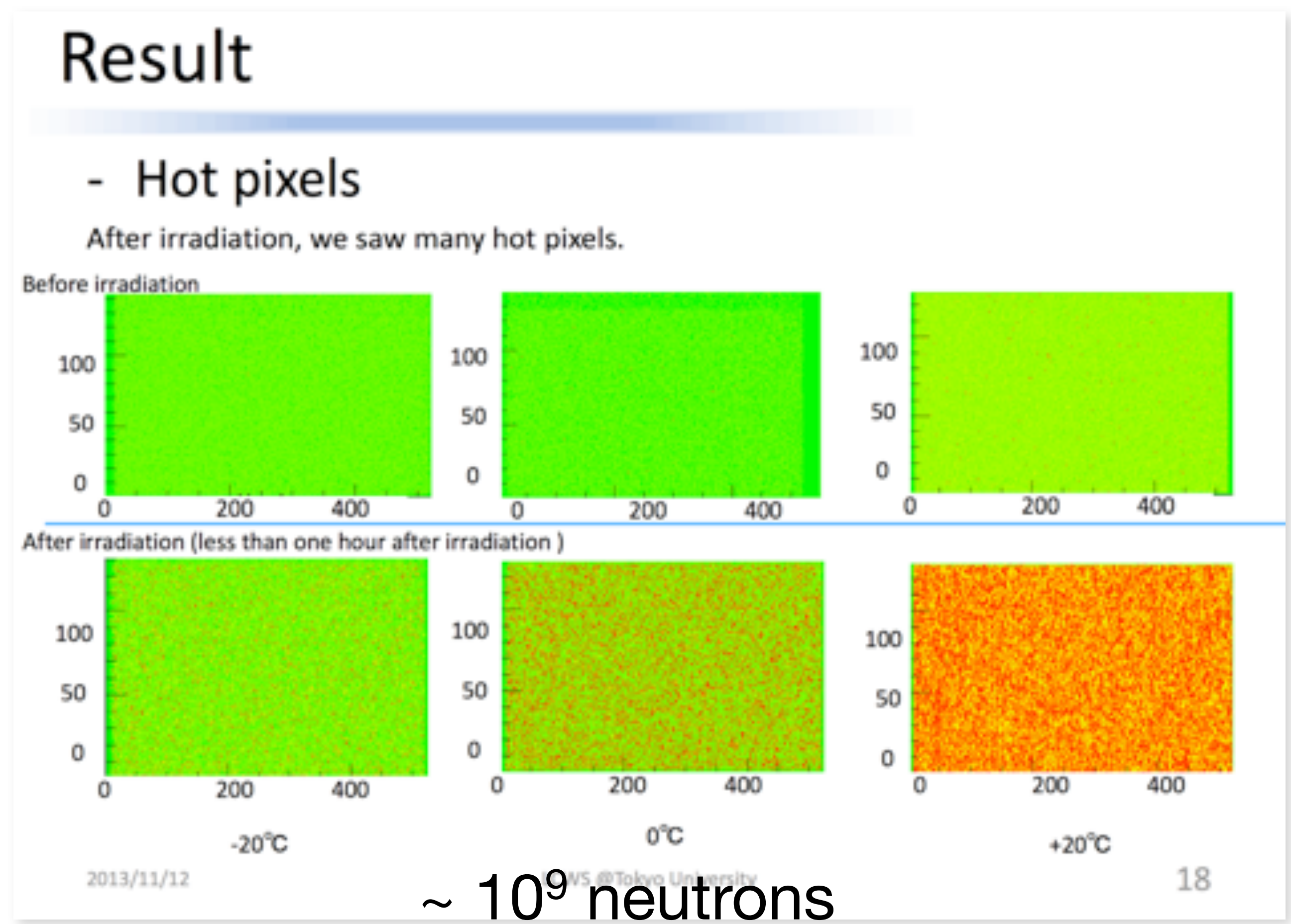


For large prototypes

Radiation Damage Test   Shuhei Ito

Damage due to neutrons

- *Irradiation of $O(10^{10})$ neutrons/cm^2 would cause Charge Transfer Inefficiency*
- *simulation predicts a flux of ~1.85×10^9 neutrons/ cm^2/year*
  → need to test it experimentally
- *Pilot experiment at CYRIC of Tohoku Univ. in Oct. 2013*
  → a lot of hot pixels and some CTI increase observed after irradiation.
- *More tests in future, varying op. cond., natural annealing*



~ 10^9 neutrons

TPC

Overview

Takeshi Matsuda

R&D for MPGD TPC
Before ILD DBD for ILC

We have demonstrated through the LP TPC beam tests at DESY:

(1) *The basic performance of the MPGD TPCs, in particular, the pad readout options, satisfy the basic requirements for ILD TPC at ILC:*

- MWPC option ruled out,
- Micromegas option w/o resistive anode ruled out,
- The best possible spatial resolution understood by the analytic formula,
- Spatial resolutions by GEM-TPC and Micromegas TPC w/ resistive anode measured at 1T and extrapolated to 3.5T,
- Single-electron spatial resolution of the digital TPC measured, and,
- Extrapolation confirmed (< 60cm drift) at 4T in the DESY 5T magnet.

(2) *How to build important components of ILD TPC:*

- Thin field cage
- Light endplate (Al)
- MPGD TPC modules
- Experience of the operation of LP TPC

Remaining R&D Issues

Before entering the engineering design of ILD TPC, we still need to study the following issues:

A) Ion gate: the most urgent issue,
B) Some issues with MPGD technologies and MPGD modules,
C) Local distortions of MPGD modules,
D) Demonstration of power pulsing (with the SALTRO16 electronics)
E) Cooling of readout electronics and temperature control of TPC
F) Measurement of basic parameters and demonstration of the performance of MPGD TPC in 3.5T magnetic field. Also some engineering issues to be confirmed in the high magnetic field.

R&D for MPGD TPC
After ILD DBD for ILC

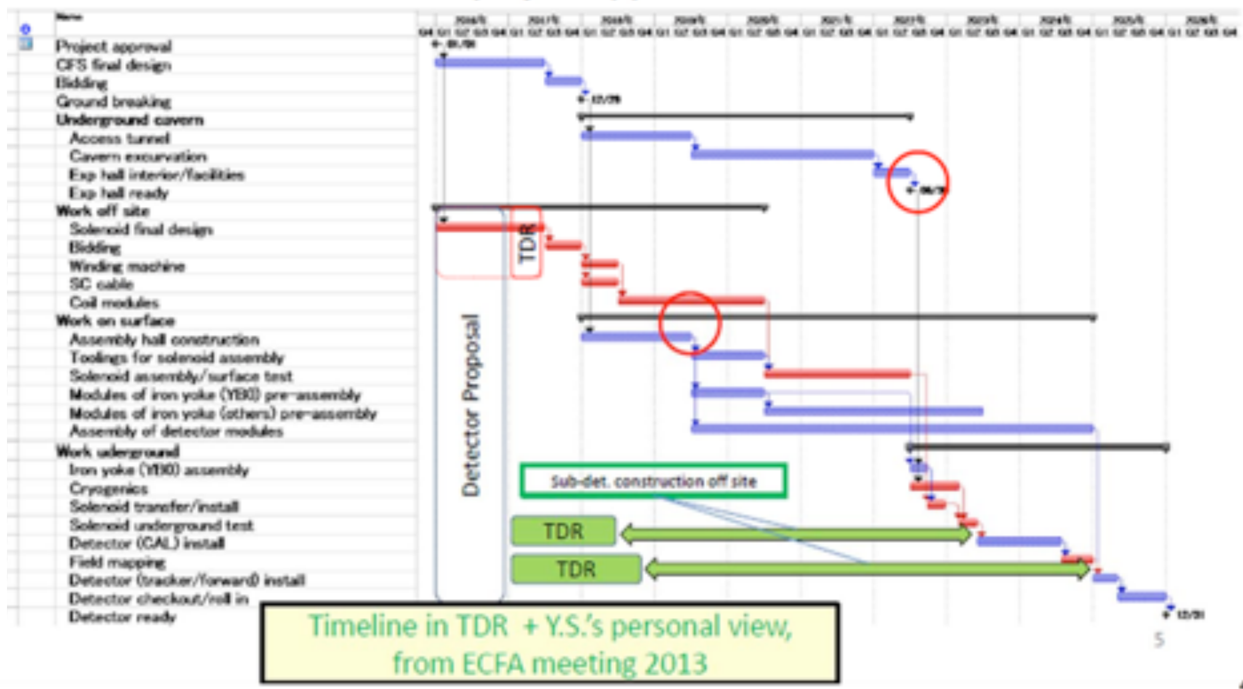
There are, however, a few important basic issues still remain to be addressed before the detector proposal for ILC

Otherwise, we are entering the phase toward the final design of the ILD TPC.

The earliest schedule (next slide) of the construction of ILD detector shown in the ILD meeting at Cracow (Sept 2013) looks very tight though it may deeply depend on the political situation.

A Possible Schedule of ILC in Japan
As presented in the 2013 ILD meeting in Cracow

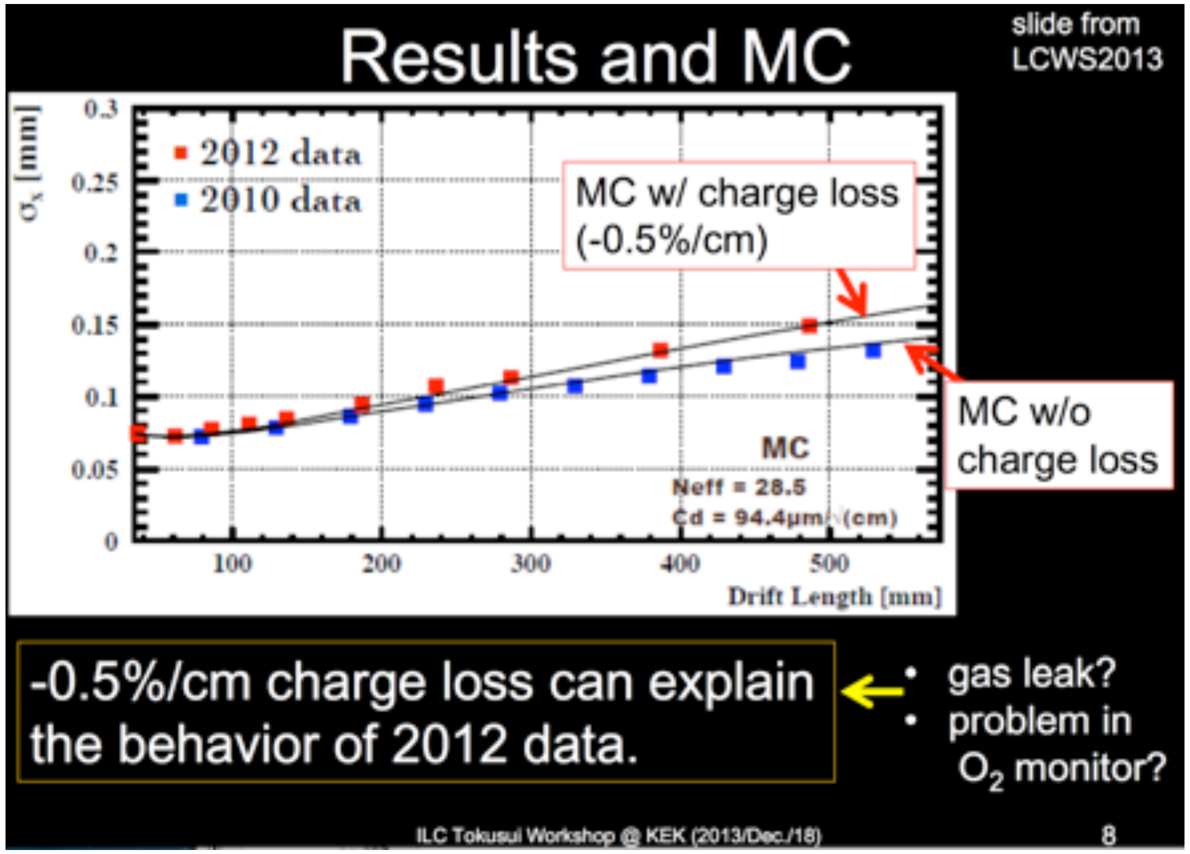
- We cannot predict the project approval date, but we should draw a clear timeline after the project approval

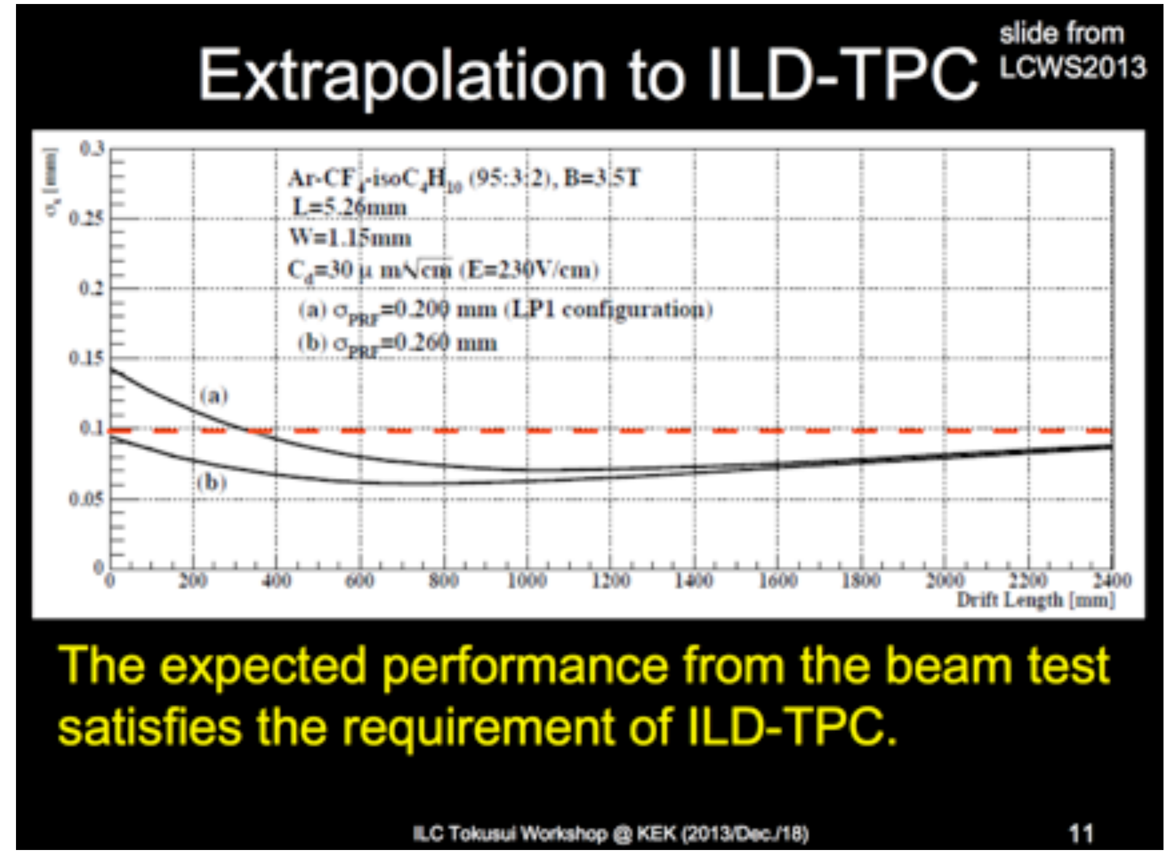


4

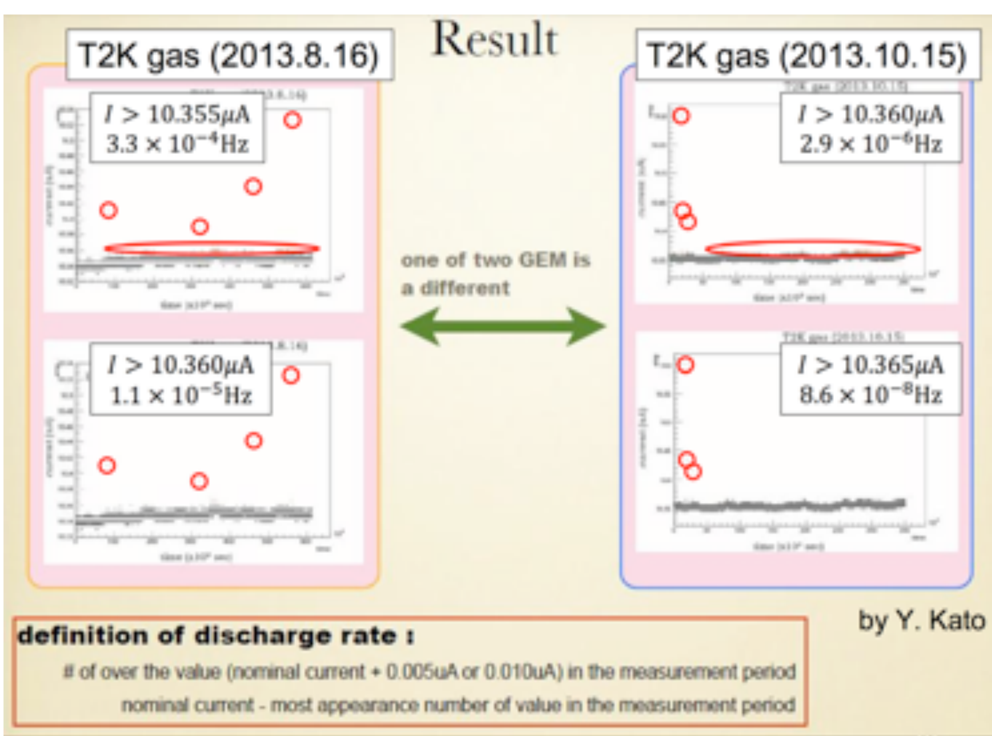
20

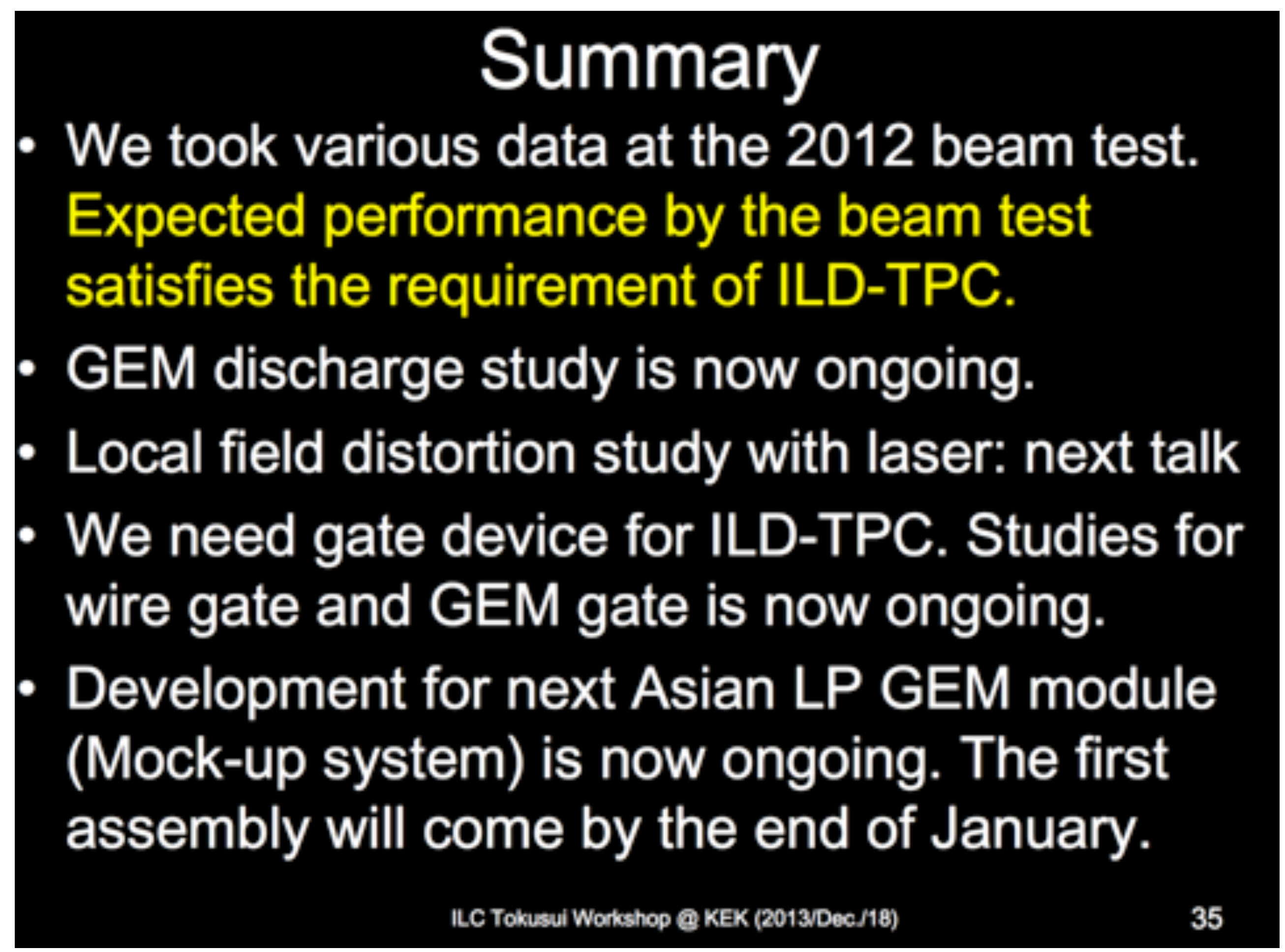
Asian GEM — *Shin-ichi Kawada*





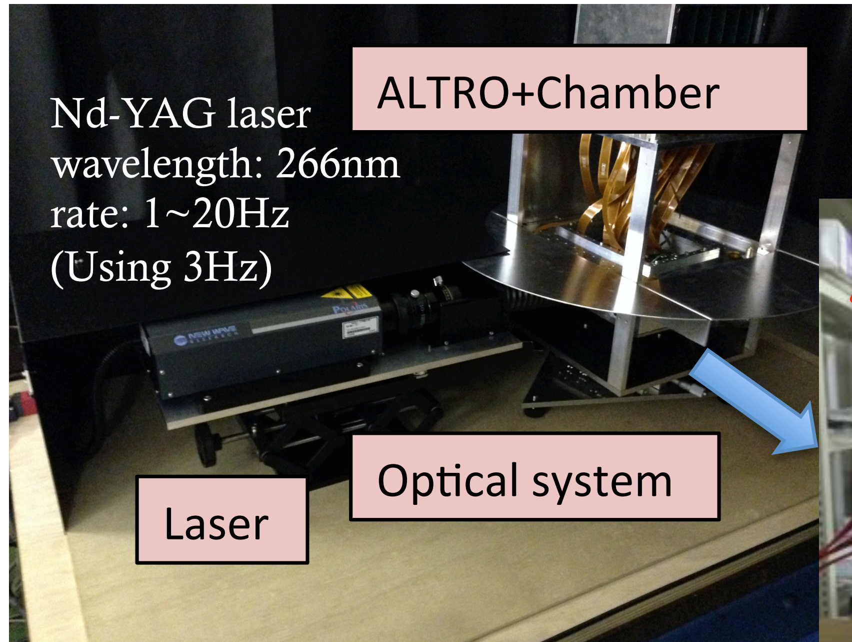
Discharge problem



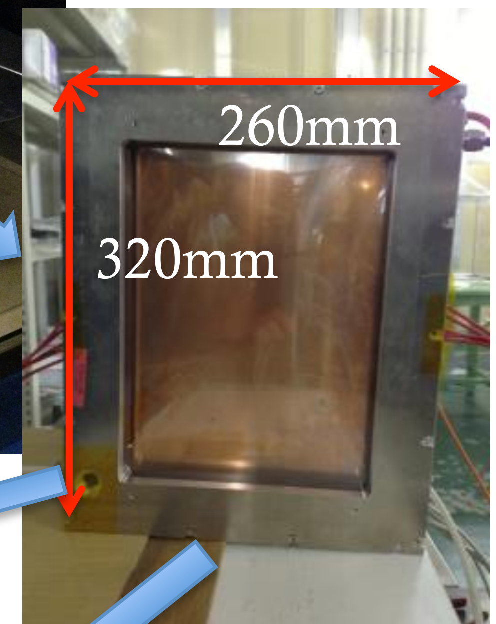


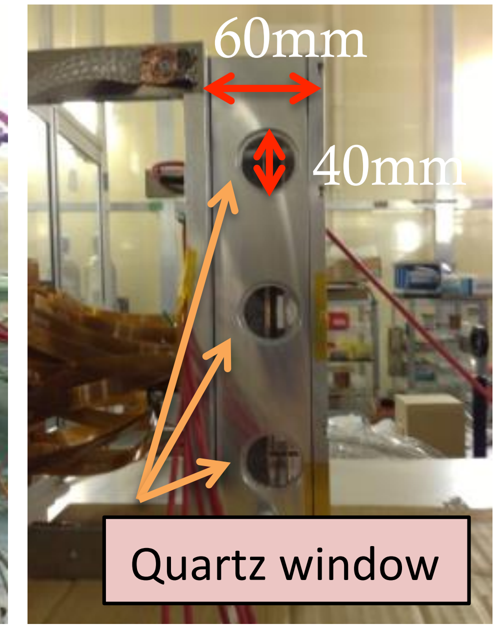
Laser Test **Ryo Yatsukawa**

Laser Test Bench

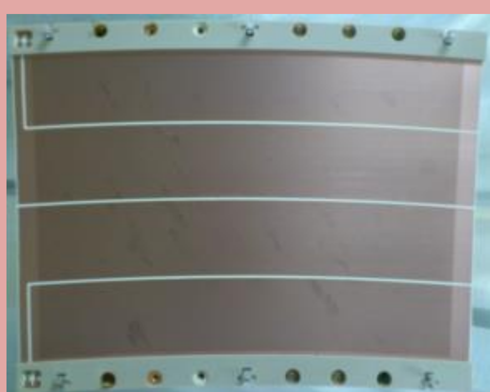


Test Chamber

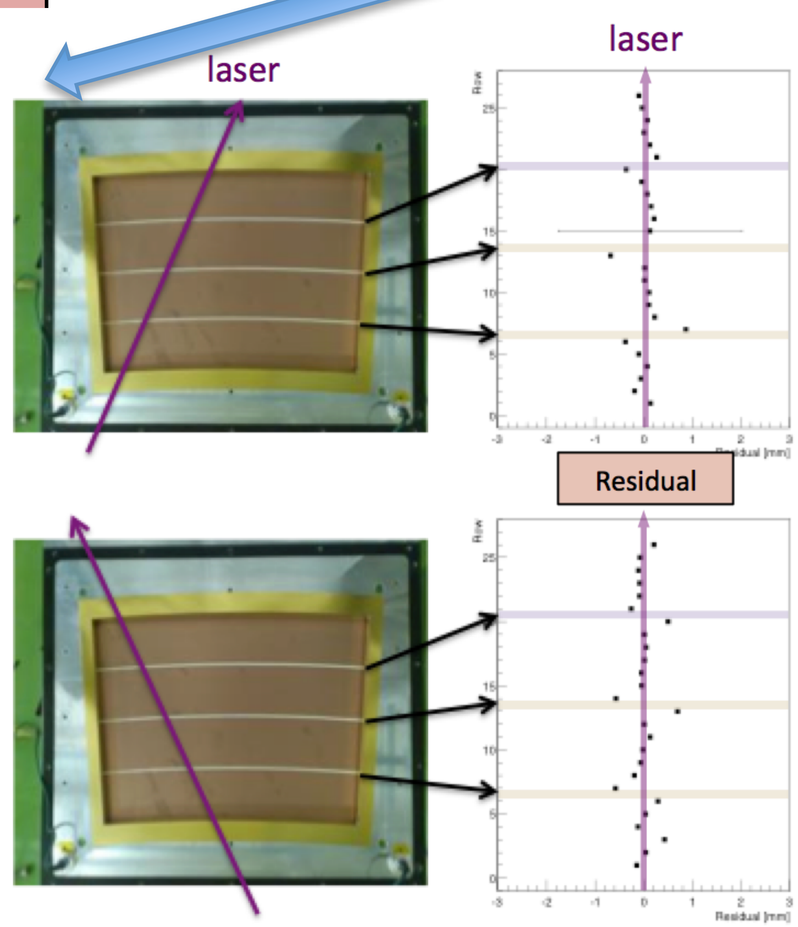




Old GEM



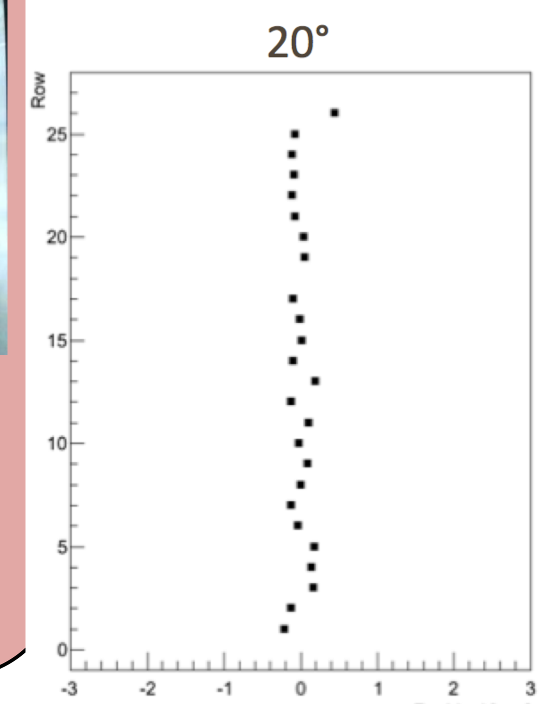
It has 1mm electrode gaps on both sides.



Distortion ~800um

New GEM

Top side: No gaps
Bottom side: 0.5mm gaps

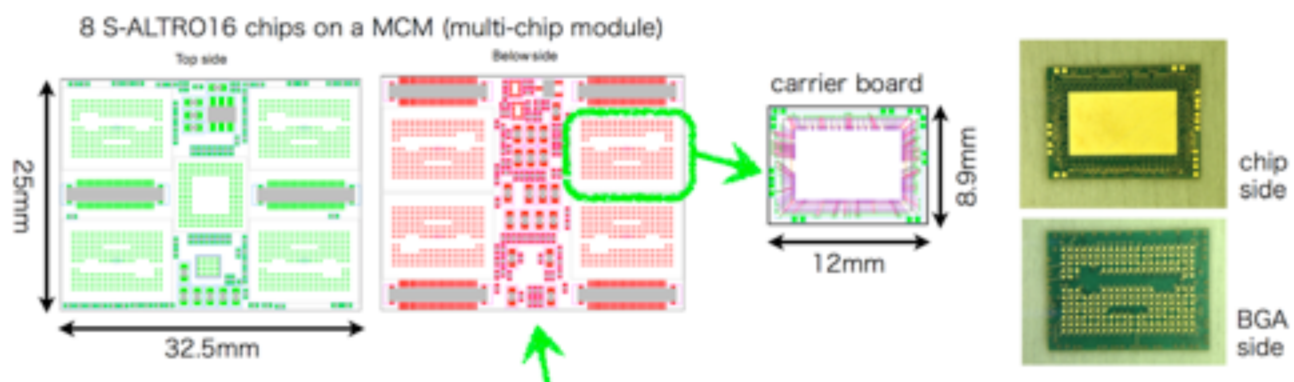


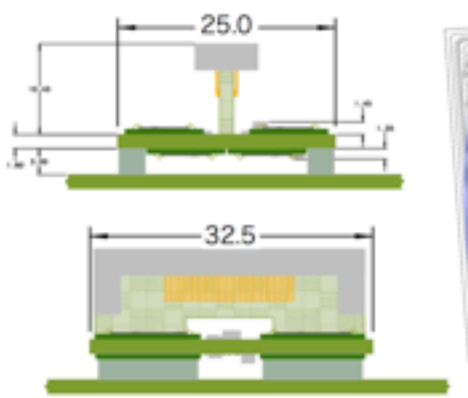
Distortion ~150um

22

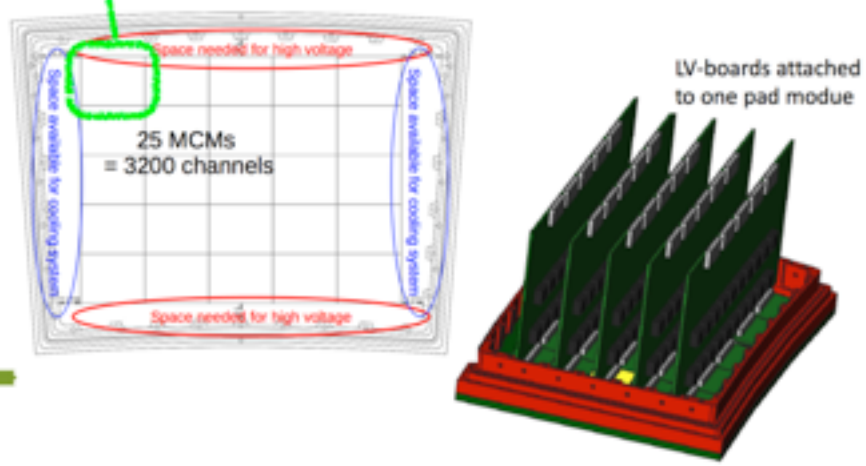
Electronics and Cooling *Takahiro Fusayasu*

Readout electronics based on S-ALTRO16 chips

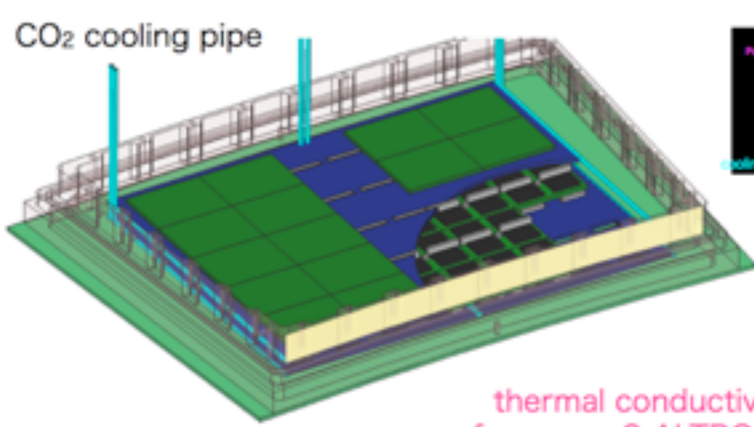


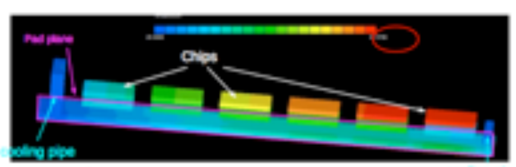


Developed by Lund Univ.



Proposed Cooling for S-ALTRO16-based electronics





Simulation showed that
Middle pipe is necessary

2-Phase CO_2 Cooling systems

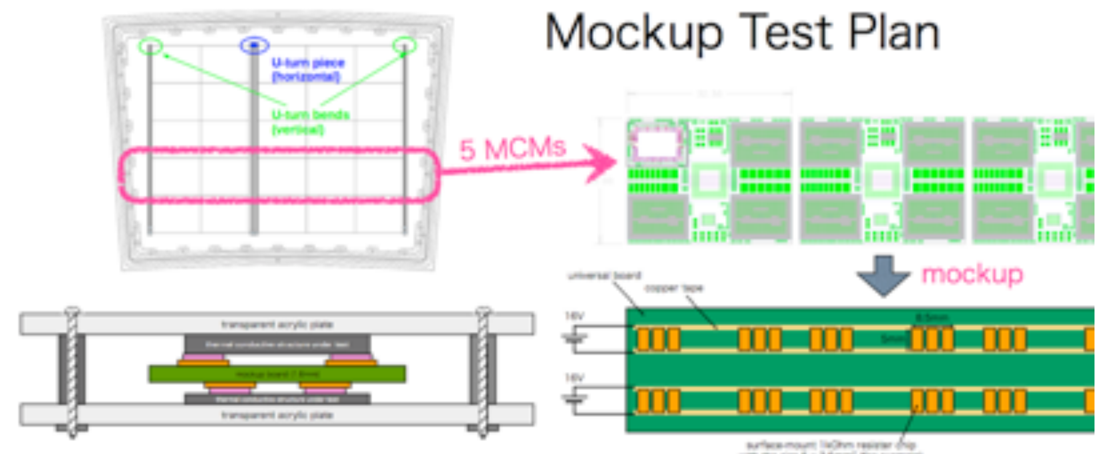
KEK CO_2 group for
Belle II VTX, ILC VTX, ILC TPC

KEK-TRACI2 for LCTPC
by Bart Verlaat @ NIKHEF

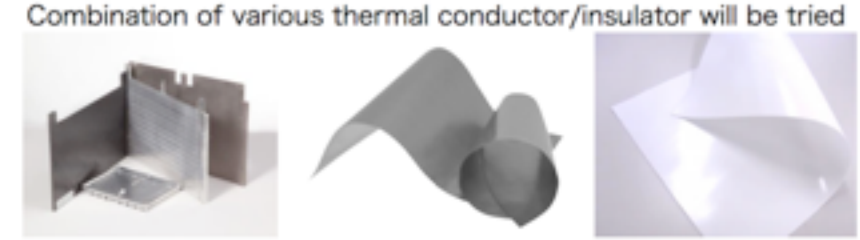
- **Portable** laboratory cooling unit
- Cooling power <100W – 250 W>
- Temperature range <-40^{0}C;+20^{0}C>
- **Turn key**
- Very simple to operate "fridge like"

KEK-TRACI2 is now ready at NIKHEF
→ brought to DESY in Jan/2014

Mockup Test Plan



Combination of various thermal conductor/insulator will be tried



TPG plate (by Momentive) ~1500W/m · K sandwiched by Al plate

PGS graphite sheet (by Panasonic) ~1500W/m · K

heat insulating sheet (by Polymatech) ~0.02W/m · K

Summary

- Development of S-ALTRO-16 based electronics is ongoing
- Structure of the cooling device is an issue and a mockup test will be done soon.
- First CO_2 cooling of LCTPC module was performed with MicroMegas module. Asian GEM module will follow!

23

CAL

SiCAL ECAL Overview *Daniel Jeans*

Physics prototype

- performance of first “physics” prototype is well understood and stable

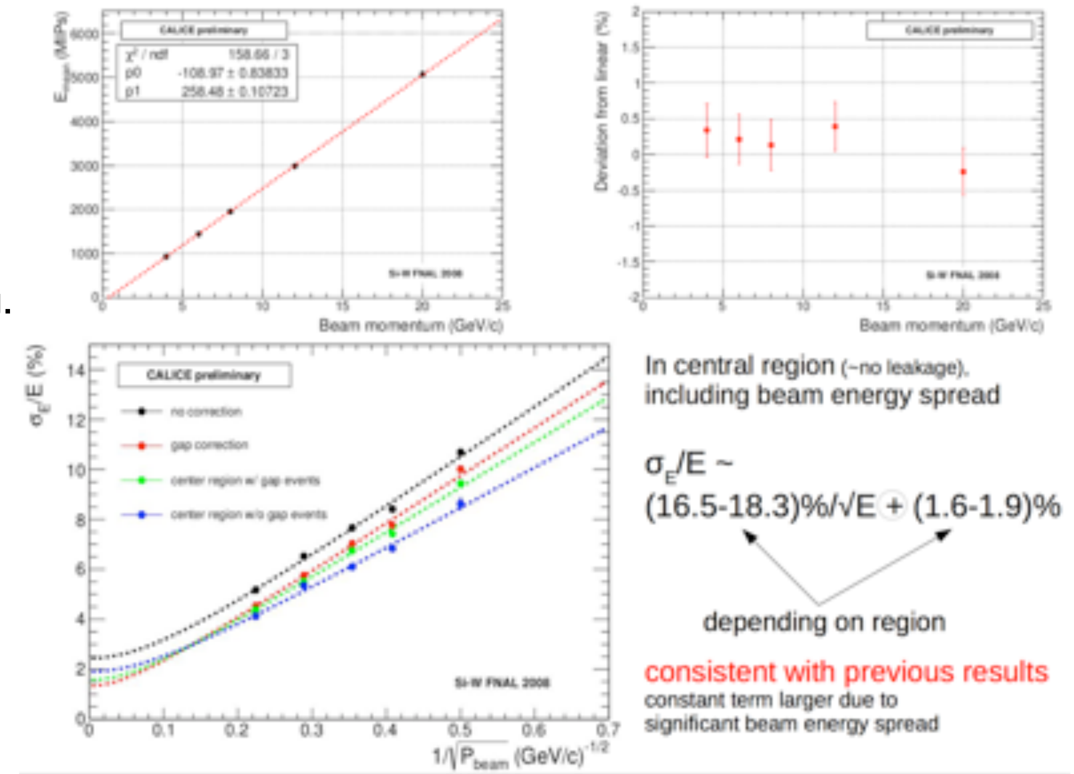
Technological prototype

2nd test beam (July 2013)
system tests in multilayer config.
w/ power pulsing

- technological prototype is under development to select technologies for final detector

Simulation studies

- simulation studies underway
  to understand required quality, uniformity, …
  inform choice of final detector size, configuration & cost



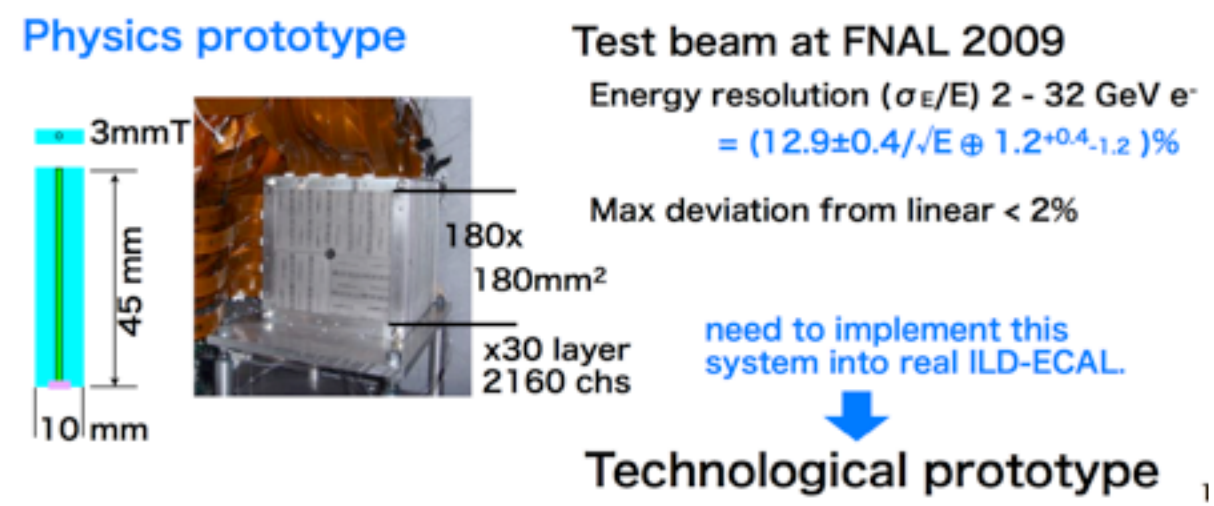
ScCAL ECAL Overview *Katsushige Kotera*

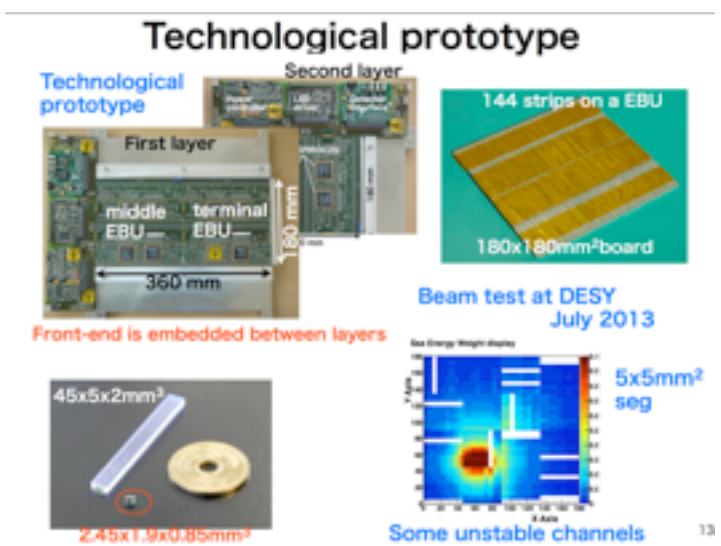
Advantage
  10^8 --> 10^7 by strip   sigma_t < nsec
Physics prototype
  sigma_E/E ~ 12.9+/-0.4/sqrt(E) + 1.2+0.4-1.2%
Technological prototype
  2-layer
Sci MPPC unit R&D
  aiming at 1mm thick Sci technology (current 2mm thick)
  7 p.e. for MIP
  long MPPC, readout from bottom
  new MPPC 10000-pixel

Summary

- We are developing a scintillator strip ECAL for linear colliders with scintillator strips and MPPC.
- Performance in ILD is already promising with SSA.
  - Options for higher goal,
    - alternately replacing w/ 5x5mm²➡hybrid,
    - alternately replacing w/ 10x10mm²➡pure ScECAL.
- Efforts for reality are exerted to,
  - detail optimizations of Sc./MPPC connection to get higher goal and we are gradually getting the goal,
  - robust readout electronics.
- In next step,
  - we will fix detail design,
  - test beam:
    - the power pulsing technology,
    - hybrid ECAL.

Paper: DESY → submitted to NIM, FNAL → under brushing up. 27





Robustness of a SiECAL in PFA — *Hihiro Kozakai*

Robustness study

- In reality, we will have imperfect calorimeter.
  - Mis-calibration
  - Si sensor problem
    - Dead pixels
  - Electronics problem
    - Dead chips
    - Noisy pixel
    - Cross talk
- How much do they have effect on particle flow reconstruction?

- We are studying the optimization and robustness of SiW ECAL for ILD.
- Jet energy resolution(JER) increases with guard ring width. The relative increase between 0 and 2 mm is about 6 %.
- With increasing PCB thickness, JER starts to degrade at around 3 mm. Between 3 and 5mm, JER difference is 5-8 %.
- JER is more sensitive to dead readout chips, about 2 times more than for dead pixels.
- Noise rate ≤ $O(10^{-5})$ may be tolerable (for current PFA)
- Mis-calibration and inter-pixel cross talk affects the constant term of the photon energy resolution.

SiECAL Technological Prototype Test Beam at DESY — *Yuji Sudo*

- 2013: We successfully operated tech. proto. in power pulsing mode and tested in 2T magnetic field.

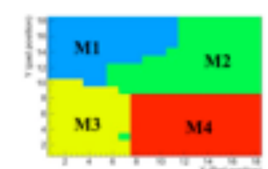
- Two beam test with conservative design ASU
  - Detailed evaluation of performance of system
  - A number of observed odd behaviors were actually related to peripheral devices or non optimal power supply
  - Self-triggering ASICs require very careful power management
  - Active channels are stable up to 2T B field (pedestal study)

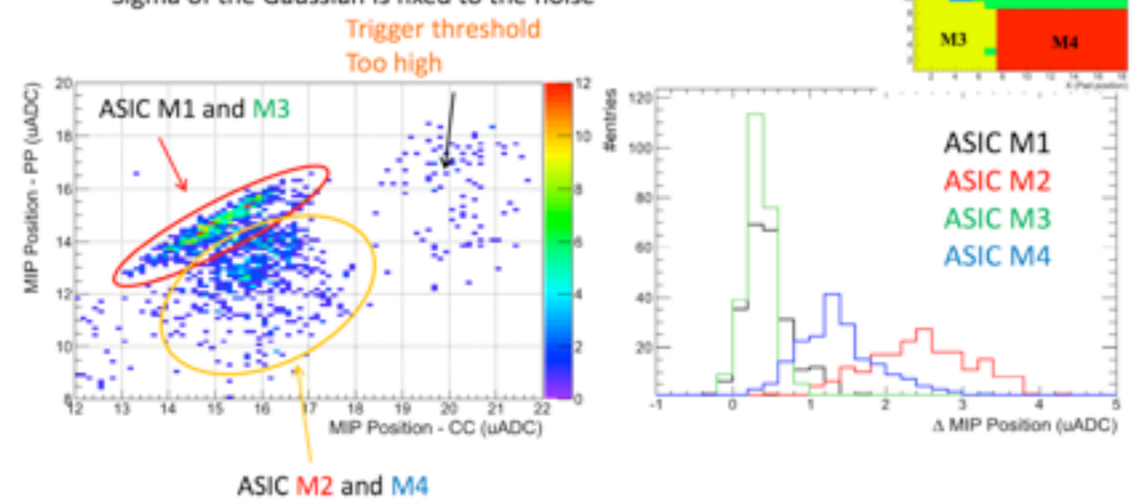
- Addressing now issues of a real calorimeter system

Large ASU : 16 ASICs par layer
Long Slab : 10 ASUs
Cooling
Test in strong B field

Power pulsing – MIP analysis

- Fit energy distribution: Landau convoluted with a Gaussian
- Sigma of the Gaussian is fixed to the noise





- ASIC M1 and M3 are ok under power pulsing operation.
- The activity of digital lines disrupts ASICs M2 and M4.

26

Si sensor

Tatsuhiko Tomita

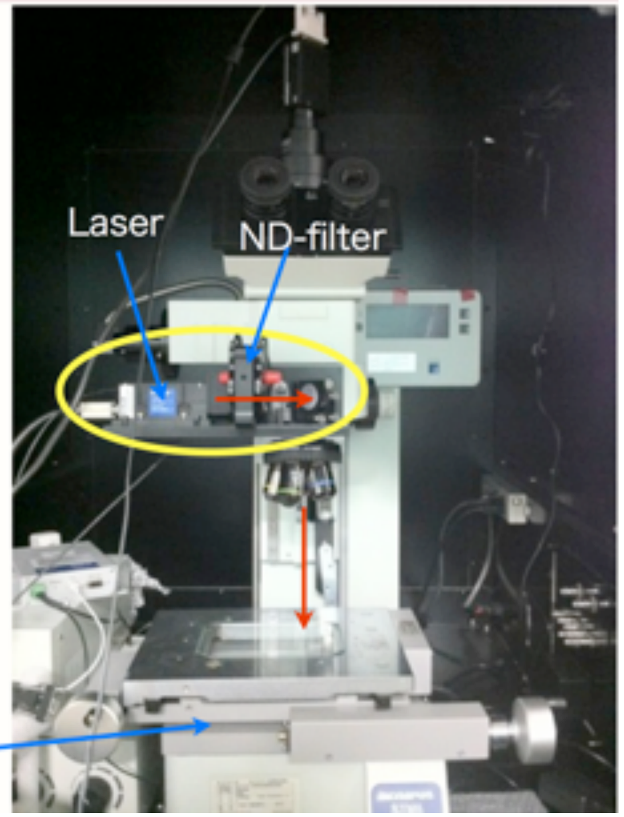
Summary

- We established the Si chip test-bench system.
  - We can measure leakage current and capacitance of chip.
  - We started cross talk study using laser system.
    - → The preparation for quality control is satisfactorily.

Prospect

- Radiation test is now preparing.
- Compare each type of guard ring and decide chip design.

We can control Repetition Rate from PC



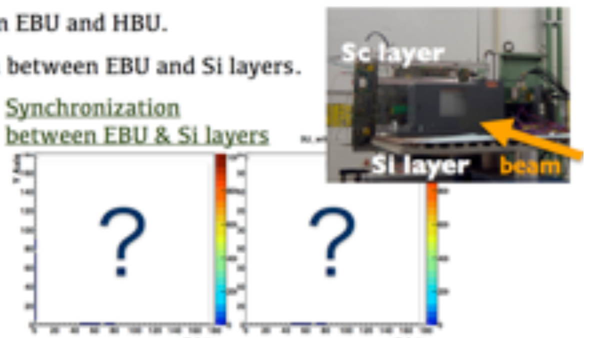
ScECAl Test Beam

Tomohisa Ogawa

Summary & Outlook.

- Two ScECAL engineering prototype were tested at DESY with electron beam.
  → we could calibrate about 95% and 84% channels with MIP calibration on forward layer and backward layer respectively.
- SSA works well.
  → We could confirm SSA works well for the lateral shower shape, but need to reject noise properly.
- Two ScECAL layers successfully worked with AHCAL layers in a "Real synchronization".
  → We could observe the correlation between EBU and HBU.
  → Next, We need to confirm the correlation between EBU and Si layers.

Synchronization between EBU & Si layers

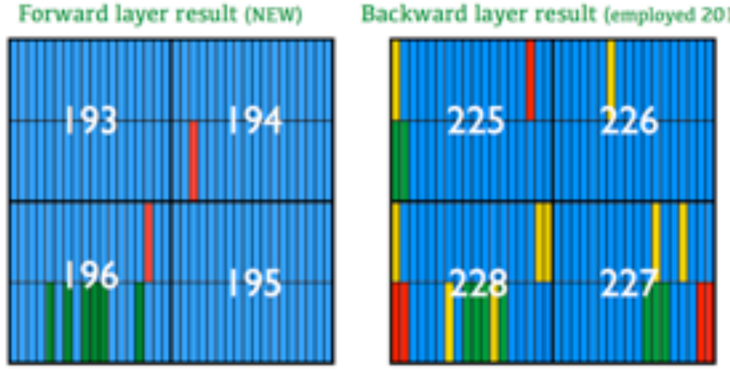


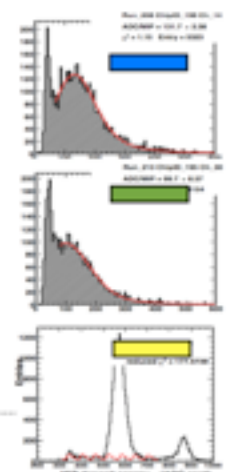
- Outlook for hardware R&D
  - Check Power pulsing with EBU.
  - Check real SSA.
  - Real Si-Sc-ECAL synchronization
  - Synchronization with more layers (Si+Sc, Sc+AHCal, Si+Sc+AHCal)

MIP Calibration.

- Two EBUs on two layers were calibrated with 3GeV electron beam.
- Applied pedestal subtraction and fit with Landau-Gaussian to estimate ADC/MIP factor.

Forward layer result (NEW) Backward layer result (employed 2012TB)





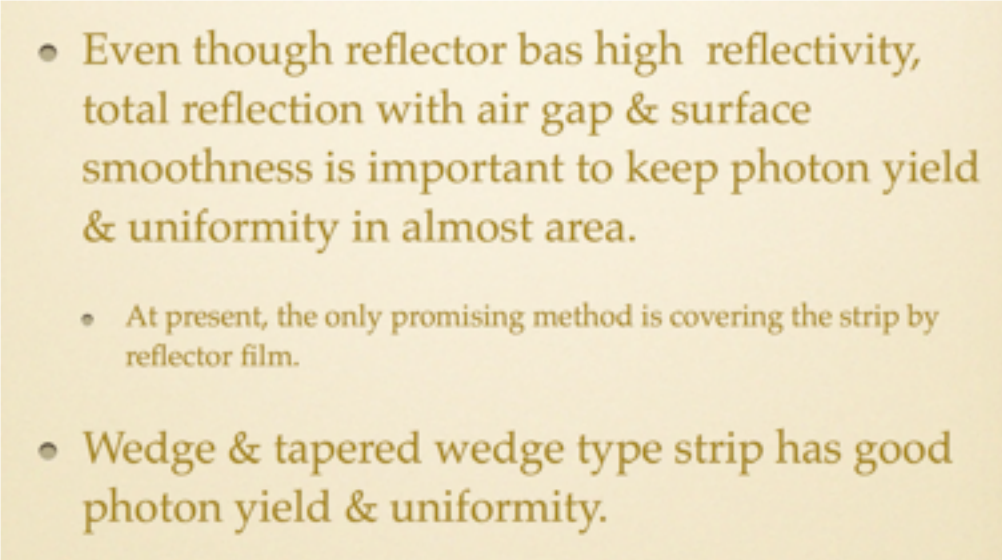
- MIP calibration result at DESY.

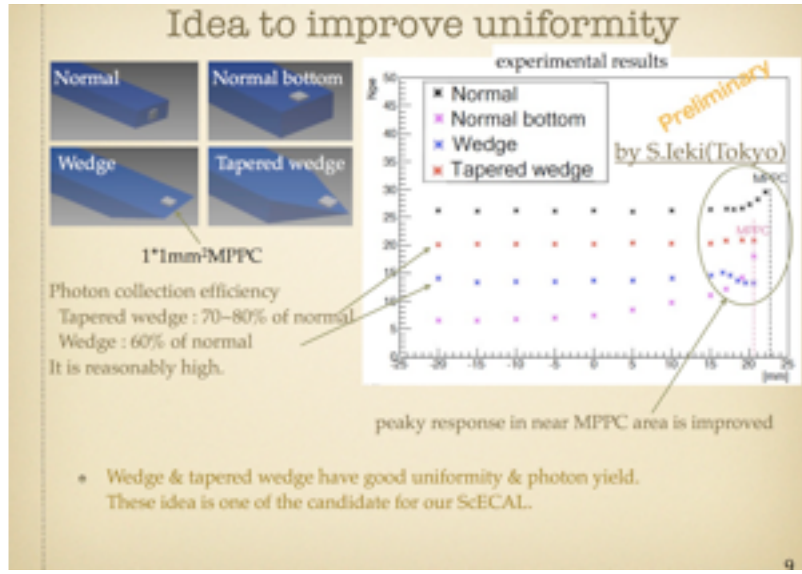
good MIP separation.
is difficult to separate MIP.
strange signal (noisy)
No signal

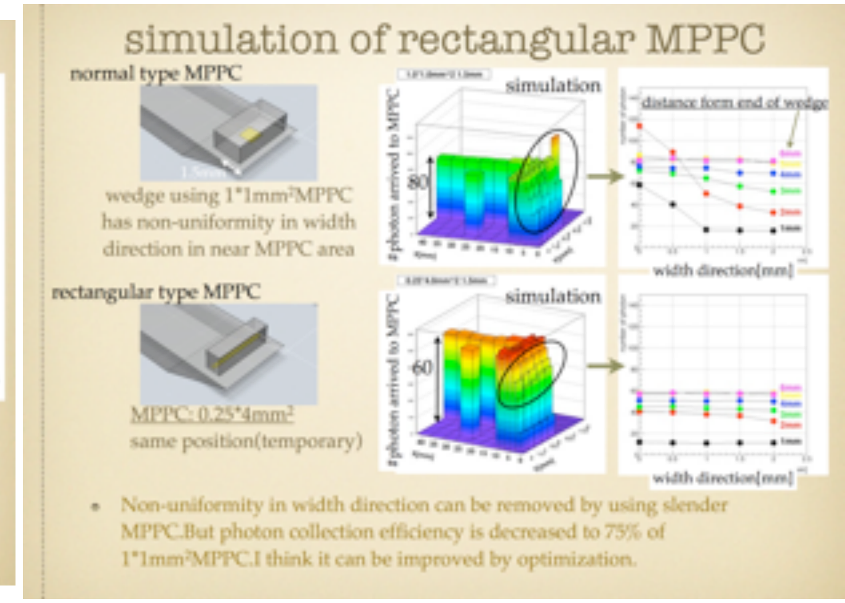
→ On forward layer, about 95% channels could be calibrated (only blue channels).
→ On backward layer, about 84% channels could be calibrated (only blue channels).

Scintillator strip

Takuya Tsuzuki







MPPC development

Ryutaro Hamasaki

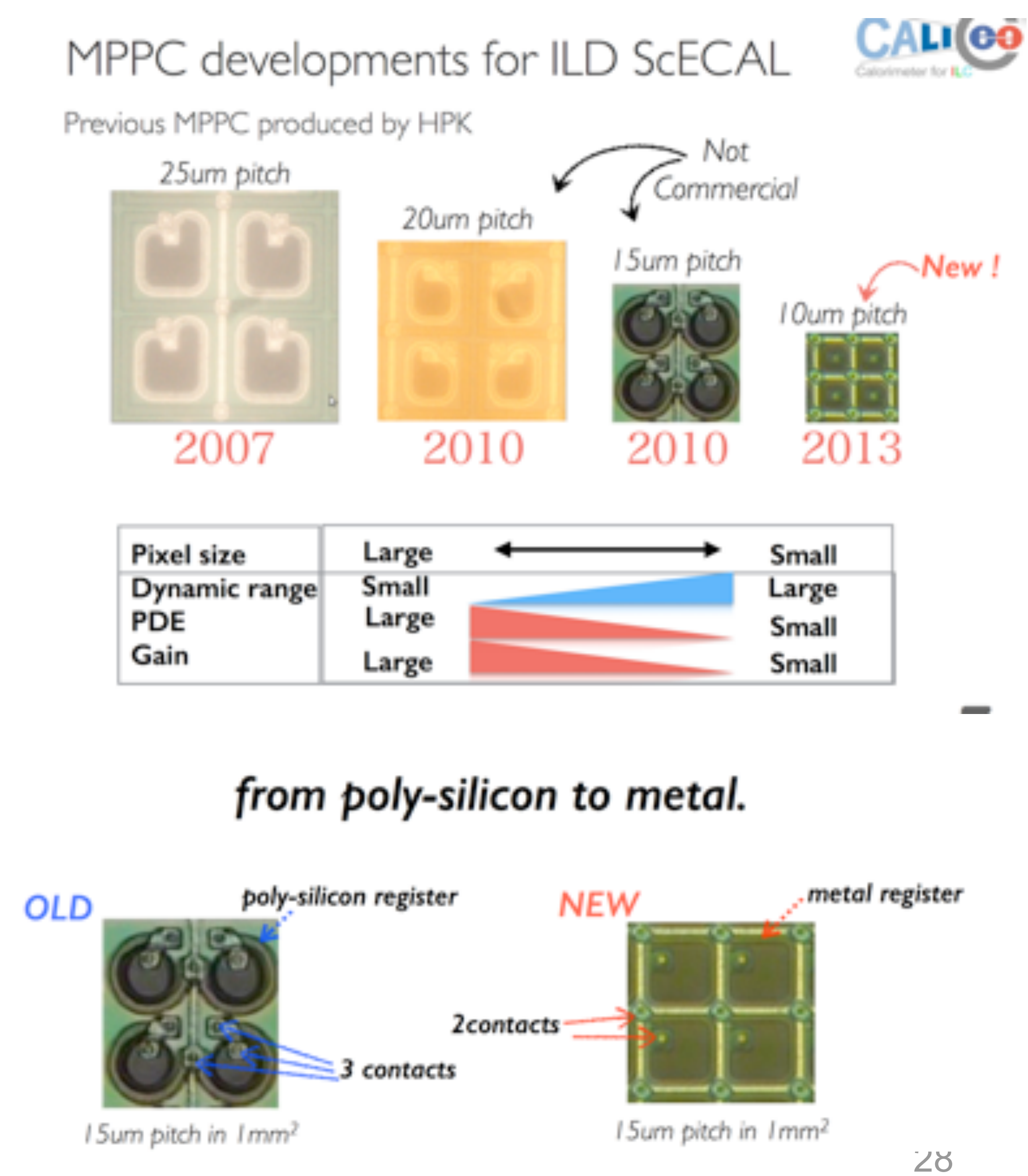
Summary and Plan

❑ Summary

- *HPK released New types of MPPC on November.*
- *HPK changed quenching register from poly-silicon to metal.*
- *Tested basic performance, Gain curve, IV curve and Noise curve.*
- *Aperture ratio, Gain and Noise rate is improved.*
- *Operation of MPPC is under control.*

❑ Plan

- ○ *Test more basic performance,especially dynamics range (ongoing by tukuba groups)*
- ○ *Test dead volumes effects and PDE for uniformity inside a pixel.*



Software

Hybrid ECAL Optimization — *Hikaru Ueno*

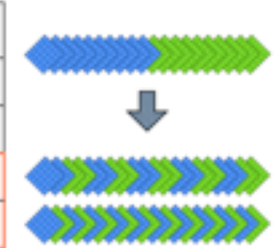
Summary

- We are studying the hybrid option to make ILD ECAL with a lower cost while keeping performance as much as possible.
- evaluated various hybrid configurations with newer version of ilcsoft
  - same absorber thickness ...degrades gradually
  - same module thickness ... 30% of Sc-layers is medium between SiECAL and ScECAL
  - alternating hybrid ... same performance as SiECAL up to 180GeV
  - They are being reevaluated with the data made with newer Mokka
- We are trying to understand the resolution,
  - will enable to cheat MC information using SSA
  - will investigate the cause of JER difference, and consider measures to improve

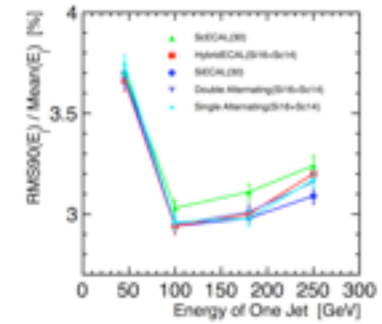
alternating hybrid

- to help SSA and resolve ghost hits
- double layers/single layer alternating
- Data were reproduced by newer version of Mokka
- Sc thick = 1.0mm, Si thick = 0.5mm

	W thickness (in20,out9)	Module thickness (mm)
SiECAL(30)	2.1/4.2	185.0
Hybrid(Si16Sc14) [not alternate]	2.1/4.2	190.8
Double layers Alternate(Si16Sc14)	2.1/4.2	190.8
Single layer Alternate(Si16Sc14)	2.1/4.2	190.8
ScECAL(30)	2.1/4.2	197.4



JER of alternating hybrid



- Standard PandoraPFA reconstruction
- The difference between SiECAL and ScECAL is ~0.2% at 250GeV.
- Hybrid(Si16+Sc14), Hybrid(Double Alt.) and Hybrid(Single Alt.) are same performance as SiECAL up to 180GeV.
- Alternating configurations are slightly better than Hybrid(Si16+Sc14)
- Both alternating hybrids look promising for the best cost-performance.

Single alternating Hybrid will be used mainly for further study

FPCCD Tracking — *Tatsuya Mori*

Summary and Plan

◆**Summary**

- FPCCD Track Finder has been developed
  - Tracking Efficiency is ~ 99 % @ P_T > 0.6 GeV/c & |cosθ| < 0.9
  - The First success of tracking with pair background
    - Efficiency almost holds against pairs
  - FPCCD Track Finder improves flavor tagging performance
    - c-tag efficiency increases by 2.5 % @ purity 70 %
  - Using FPCCD gives us better flavor tagging performance than using current VXD in simulator

◆**Plan**

- Evaluating flavor tagging in the presence of pair background

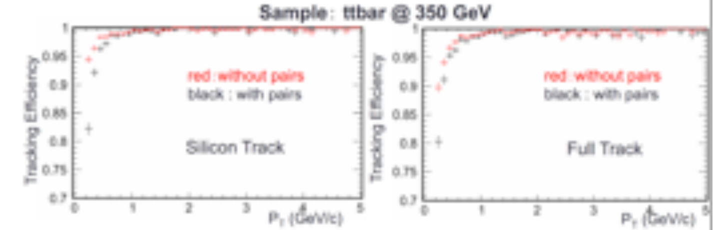
FPCCD Track Finder: without / with pairs from 1 train (P_T)

Tracking Efficiency : η ≡ (# of tracks with VXD hits >= 5 && track purity > 75%) / (# of MCParticles creating VXD sim-hits >= 6 && SIT sim-hits >= 4)

Note: P_{Tmin} to reach TPC
R_{in} : 0.4 GeV/c
R_{out} : 1.8 GeV/c

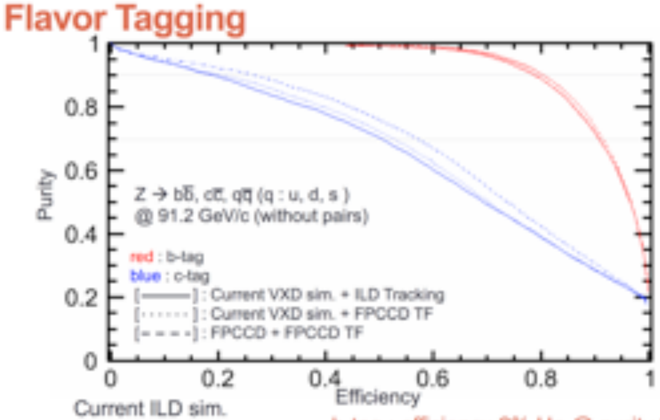
track purity: (# of the MCP's hits of track) / (# of all hits of track)

Sample: ttbar @ 350 GeV



hold the performance @ P_T > 0.6 GeV/c

Flavor Tagging

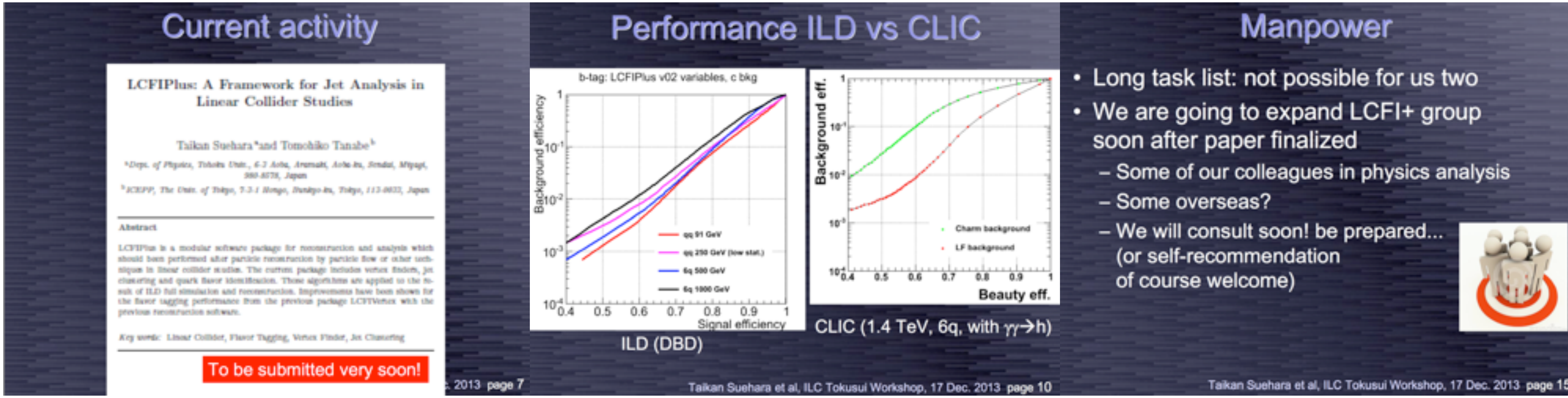


Current ILD sim. + FPCCDTF → FPCCD + FPCCDTF

b-tag : efficiency 2% Up @ purity 90%
c-tag : efficiency 4% Up @ purity 70%
by using FPCCD we can improve efficiency for ZHH → bb̄bb̄bb̄

LCFIPlus

Taikan Suehara



Computing for ILC Exp.

Hiroaki Matsunaga

ILC case

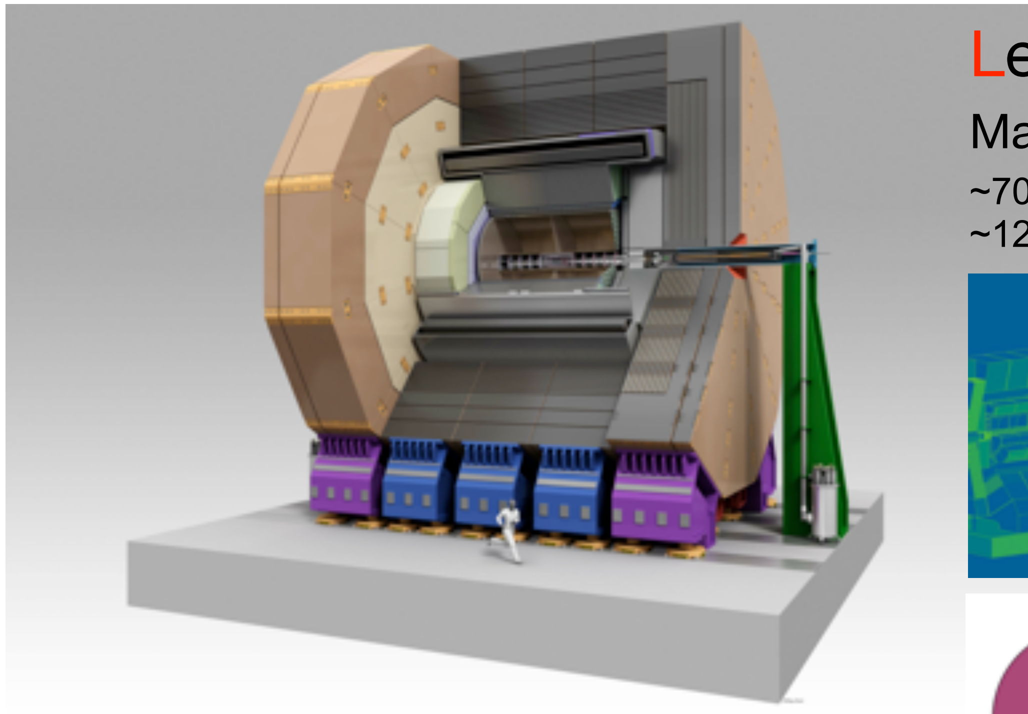
- Smaller amount of data compared to Belle II (in the first several years)
  - Still similar to current level of LHC experiment
- More collaborators (and sites) worldwide
  - All collaborators must be able to access data equally
  - Data distribution would be more complex
  - More efforts for coordination and monitoring of distributed computing infrastructure
- In Belle II, most of software and services rely on WLCG. We should consider how we will do for ILC.

Summary

- Belle II is a big challenge for KEK
  - First full-scale distributed computing
  - For ILC, Belle II will be a good exercise and lessons learned would be beneficial
  - It would be nice for ILC to collaborate with Belle II
    - Important to train young students/postdocs who will join ILC in future
- Keep up with technology evolution
  - Better software reduces processing resources
  - Education to users is also important
- Start preparations early
  - LHC computing had been considered since ~2000 (>10 years before the Higgs discovery)

Outlook

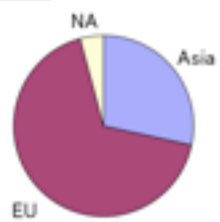
ILD Detailed Baseline Design



Letter of Intent

May, 2009

~700 signatories
~120 from Japan



DBD
in ILC TDR
vol.4
June, 2013

arXiv: 1306.6329

ILD DBD completed and handed to LCC Director, Lynn Evans on June 12, 2013.

Contents

Acknowledgements i
Contents iii
1 Introduction and Overview 1
1.1 ILD Philosophy 1
1.2 ILD Layout 3
1.3 ILD Performance Requirements 4
2 ILD Subsystems 7
2.1 ILD Vertex System 7
2.1.1 Performance goal 8
2.1.2 Baseline design
2.1.3 Future prospects
2.2 The ILD Silicon System 20
2.2.1 The barrel and End Cap Silicon Tracking components: SIT, SET and ETD
2.2.2 Forward Silicon Tracking 32
2.3 The ILD TPC System 41
2.3.1 The ILD TPC Implementation 42
2.3.2 Calibration and Internal Alignment of the TPC 51
2.3.3 Status of R&D and future work for LC-TPC 51
2.3.4 Conclusions 53
2.4 The ILD Calorimeter System 53
2.4.1 Overview of ILD Calorimeter System 53
2.4.2 The Electromagnetic Calorimeter System 59
2.4.3 The Hadronic Calorimeter System 75
2.4.4 Forward Calorimetry 94
2.5 The ILD Muon System/ Tail Catcher 104
2.5.1 Introduction 104
2.5.2 Conceptual Design 104
2.5.3 Performance 106
2.5.4 Integration issues 110
2.6 The ILD Coil and Yoke System 110
2.6.1 Physics Requirements 110
2.6.2 Magnet Design 111
2.6.3 Solenoid design 111
2.6.4 Anti-DID design 112
2.6.5 Assembly of the solenoid 113
2.6.6 Ancillaries 113
2.6.7 Final tests and field mapping 114
2.6.8 Iron Yoke Design 114
3 The ILD Detector System 121
3.1 ILD Integration 121
3.1.1 Mechanical concept 121
…etector assembly 127
…rvice paths and interfaces 128
…bration and Alignment 132
…troduction: metrology, hardware alignment, track alignment 132
…xel alignment 136
…ternal Laser alignment of SIT, SET, FTD and ETD 137
…lignment during push-pull 137
…alorimeter calibration 138
… Acquisition 143
…troduction 143
3.3.2 Structure 146
3.4 Data Processing 149
3.4.1 Event Building and Prompt Reconstruction 149
3.4.2 Offline computing 150
3.4.3 Software 150
3.4.4 Outlook and R&D 151
3.5 ILD Software and Tools 151
3.5.1 Mokka and … Overview 151
3.5.2 Detector Models in Mokka 152
3.5.… …Reconstruction and Analysis System 154
3.5.4 Monte … Productions 157
3.6 ILD - Ma… Detector Interface and Experimental Area 157
3.6.… IL… push-pull issues 157
3.… Final focus magnets 158
3.6.3 Beam pipe and interaction region 160
3.6.4 Experimental area for flat surface ILC sites 161
3.6.5 Experimental area for mountainous ILC sites 161
3.6.6 Machine induced backgrounds 162
4 ILD Performance 167
4.1 ILD Performance 167

Detailed Baseline Design completed,

we are now entering the phase for the final engineering design!

5(3+2)-year Program

We (ILD Japan) have submitted a proposal for ILD detector R&D to KEK in June 2013

ILD 測定器研究開発

（ILD 日本グループ）

~$22M / 5 years

- R&D from global view point as a host:
  - MDI related items, platform, mechanical structure, solenoidal magnet, cooling system, forward calorimeters, etc., which belong to the boundary region to the facility part of the ILC lab.
- R&D as ILD
  - 3-year preparation for the expected proposal call in 3(?) years as ILD
  - followed by 2-year detailed engineering design assuming the ground breaking will happen 2 years after the proposal call (=project approval)
- R&D as ILD Japan
  - Preparation for technology choice for sub-detectors within ILD
  - demonstrate technological advantage, subgroup ability to realize it, keeping industrialization (mass production) in mind

Extension of Toksui Program