ILD Status and future

Yasuhiro Sugimoto (KEK)

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Events on ILD in 2012

- Apr. 23-27: KILC2012 @Daegu
  - IDAG interview
  - ILD meeting
- May 15-16: ILC PAC @Fermilab
  - ILD status report by Graham Wilson
- May 23-25: ILD Workshop @Kyushu Univ.
- Sep.28: ILD DBD 0^{th} draft sent to IDAG
  - Many holes, particularly in physics analysis section
- Oct. 22-26: LCWS2012 @UTA
  - IDAG review
  - ILD meeting (discussed mainly physics analysis)
- Nov. 30: Submission of ILD DBD draft
  - Draft is quite complete
  - Results of benchmark analysis is still preliminary
  - Delay in finalization of the numbers of costing
- Dec. 13-14: ILC PAC @KEK
  - ILD DBD report by Y.S.

ILD DBD

IDAG review in Arlington October 2012

- Except for Physics chapter (draft in July) DBD draft only available in September; big IDAG effort to review ~700 pages.
- Very extensive documents summarizing 3 years of work on R&D and integration studies
- Important milestone reached by the 2 concept groups
- However benchmarking of detector designs with assigned process (crucial information) was not yet ready
- Costing not available for ILD
- Need for a thorough editing (uneven collection of parts)
- Many questions and suggestions from IDAG
- Calendar defined for the next iteration fixed by PAC and soon availability of machine TDR: next version requested for November 30 for PAC review. Some final numbers may be missing, but no new material allowed after PAC.

Draft as of Nov.30

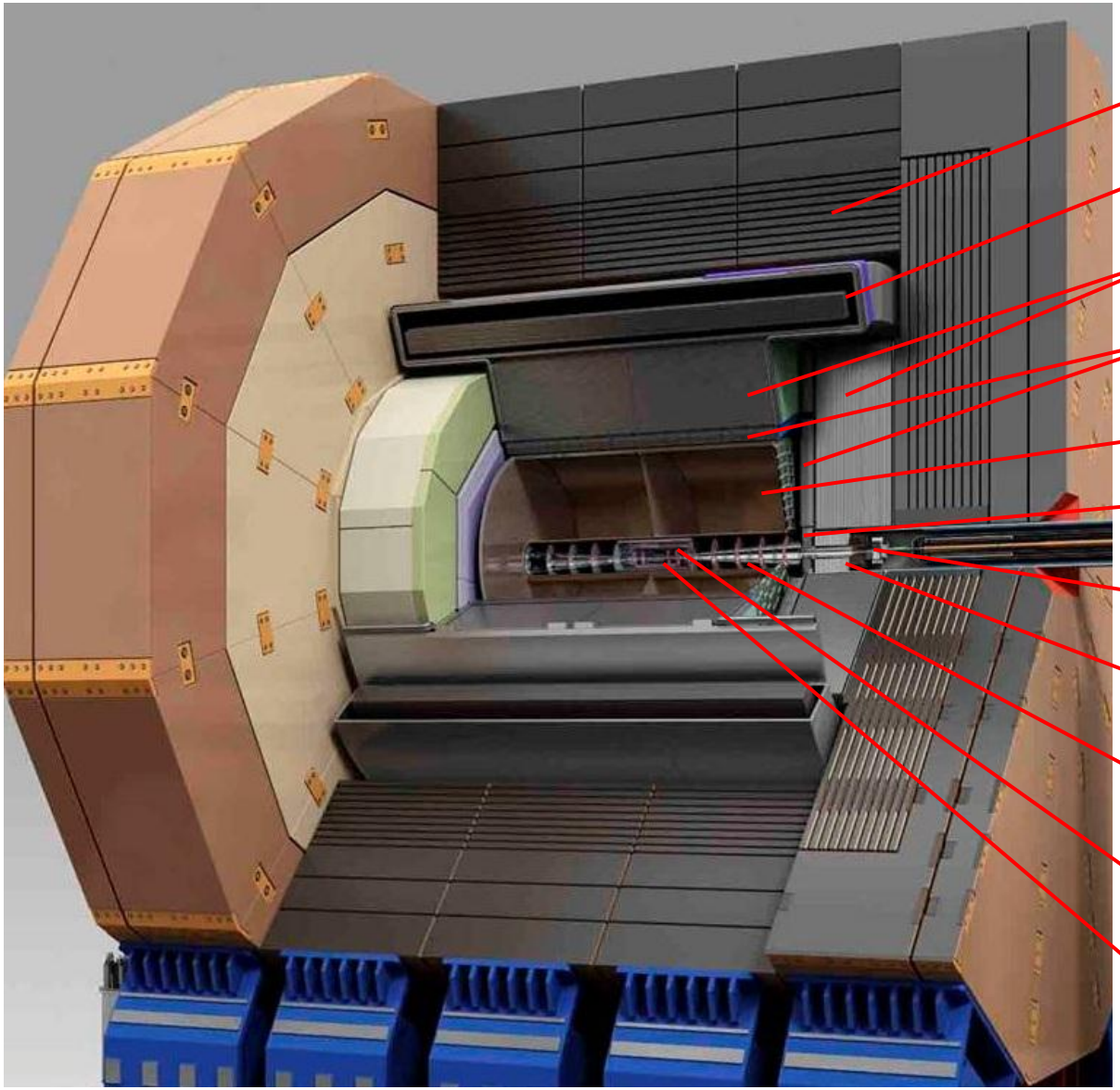
- ILD benchmark analysis is still on-going
- All the numbers may change by the end of January 2013
- Costing section is not complete

PAC meeting at KEK

PAC meeting

- PAC meeting was held at KEK 13-14 December
- Web page
  - http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=5843
- ILD made the presentation which summarizes the ILD DBD
- Some new numbers which were not included in the Nov.30 draft were shown
  - Post-LOI analyses
  - Some of 1TeV benchmark results
- It became clear that coordination with SiD is necessary

ILD


Muon system/yoke
Solenoid coil
HCAL
ECAL
TPC
LumiCAL
BeamCAL
LHCAL
FCAL
FTD
SIT
VTX

ILD baseline

	Sensor options for baseline design			Alternative
VTX	CMOS	FPCCD	DEPFET	
SIT	False double-sided strip			Double-sided strip
FTD 1-2	CMOS	FPCCD	DEPFET	
FTD 3-7	False double-sided strip			
TPC	GEM	MicroMEGAS		Pixel readout
ECAL	W-Si pad	W-Scintillator strip		W-Pixel
HCAL	Analog (Scintillator)	Semi digital (RPC)	← Mechanical structure is also different	
FCAL	W-Si / GaAs	W-Si / Diamond		
Muon	Scintillator strip			RPC

LOI benchmark

ECM (GeV)	Observable	Precision	Comments	Post LOI analysis
250	$\sigma(e^+e^- \rightarrow Zh)$	2.5%	Model independent	
	m_h	32 MeV	Model independent	
	m_h	27 MeV	Model dependent	
250	Br(h→bb)	2.7%	Includes 2.5% of $\sigma(Zh)$	2.7%*
	Br(h→cc)	12%		7.3%*
	Br(h→gg)	29%		8.9%*
	Br(h→ττ)			4.9%
	Br(h→WW*)			8.6%
500	$\sigma(e^+e^- \rightarrow \chi_1^+\chi_1^-)$	0.6%		
	$\sigma(e^+e^- \rightarrow \chi_2^0\chi_2^0)$	2.1%		
	$m(\chi_1^+)$	2.4 GeV	From kinematical edges Two masses (LSP and χ_1^+/χ_2^0) are fitted simultaneously	
	$m(\chi_2^0)$	0.9 GeV		
	$m(\chi_1^0)$	0.8 GeV		

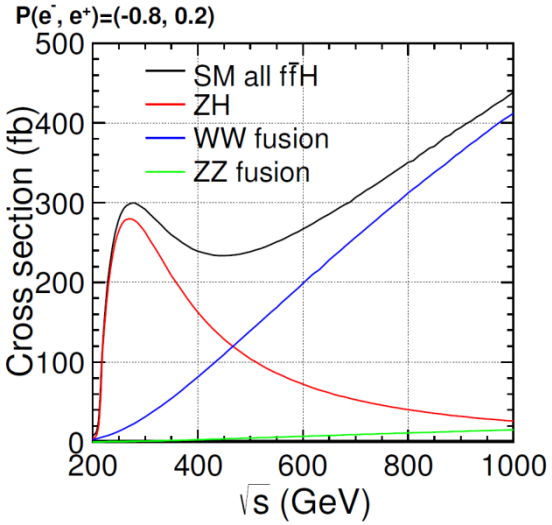
* http://arxiv.org/abs/arXiv:1207.0300
H.Ono, Akiya Miaymoto

LOI benchmark

ECM (GeV)	Observable	Precision	Comments
500	$\sigma(e^+e^- \rightarrow \tau\tau)$	0.29%	$\theta\tau\tau$>178degree
	A^{τ}_{FB}	0.0025	$\theta\tau\tau$>178degree
	$P\tau$	0.007	Excluding $a_1\nu$
500	$\sigma(e^+e^- \rightarrow tt)$	0.4%	(bqq)(bqq) only
	m_t	40 MeV	Fully hadronic only
	m_t	30 MeV	+ semi-hadronic
	Γ_t	27 MeV	Fully hadronic only
	Γ_t	22 MeV	+ semi-hadronic
	A_{FB}	0.0079	Fully hadronic only
500	$\sigma(e^+e^- \rightarrow \mu_L^+\mu_L^-)$	2.5%	SPS1a' (smuon)
	$m(\mu_L)$	0.5 GeV	
500	$m(\tau_1)$	0.1GeV$\oplus$1.3σ_{LSP}	SPS1a' (stau)
1000	α_4	-1.4< α_4 <1.1	Strong EWSB in WW scattering
	α_5	-0.9< α_5 < 0.8	

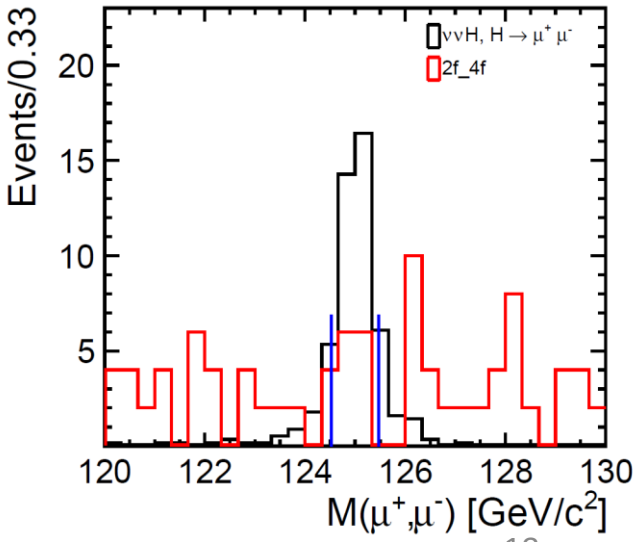
1TeV benchmark

- $e^+e^- \rightarrow \nu\nu h$
  - Higgs production cross section is larger than 250 GeV
  - Luminosity is larger than 250 GeV
  - Higgs → $\mu\mu$ channel can be measured



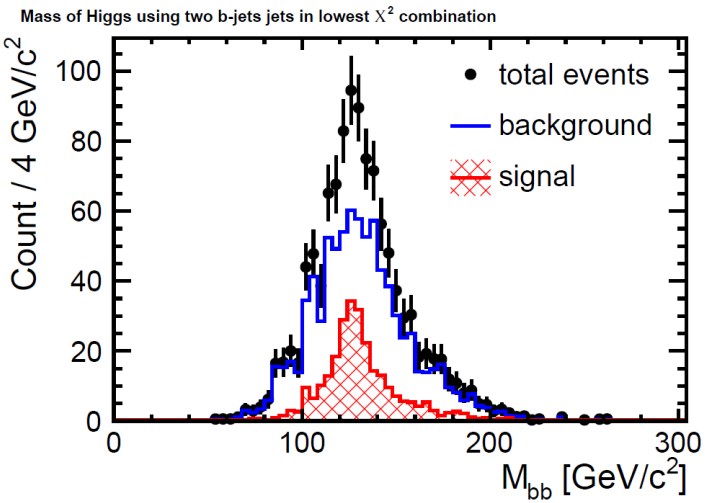
Decay mode	σBr accuracy (500fb^{-1}, -0.8,+0.2)	Comments
bb	0.4%	
cc	5%	
gg	4%	
WW*	3%	Fully hadronic mode only
$\mu\mu$	??	

Preliminary



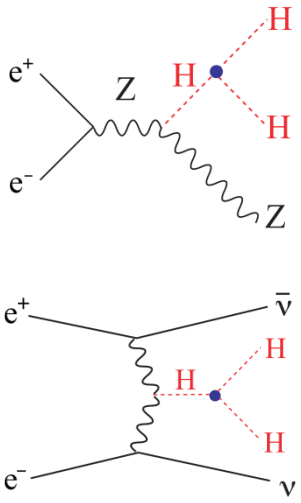
1TeV benchmark

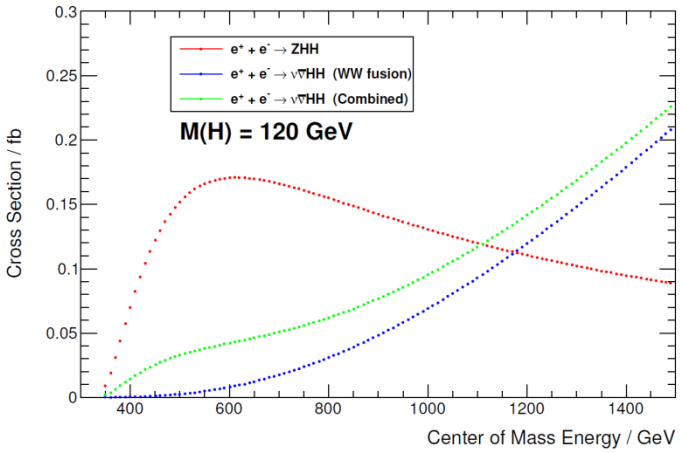
- $e^+ e^- \rightarrow t\ t\ h$
  - Fully hadronic mode (8 jets, no isolated lepton) and semi-leptonic mode (6 jets + 1 isolated lepton) were used
  - Main background: ttbb, ttZ, and tt
  - Multivariable analysis technique is effective to reduce the background
  - Preliminary result on accuracy of top Yukawa coupling with 500fb^{-1} (+0.8,-0.2) and 500fb^{-1} (-0.8,+0.2)
    - 7.0% for semi-leptonic mode
    - 6.5% for hadronic mode
    - **4.8% for combined data**

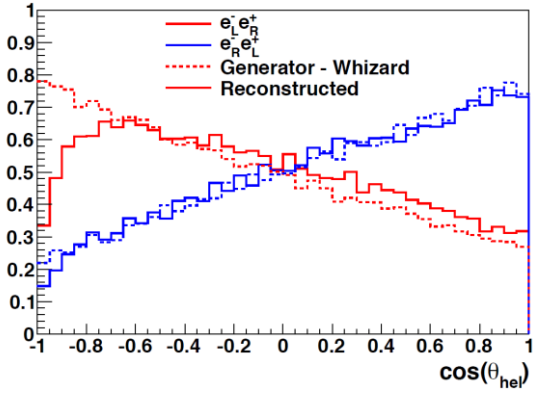


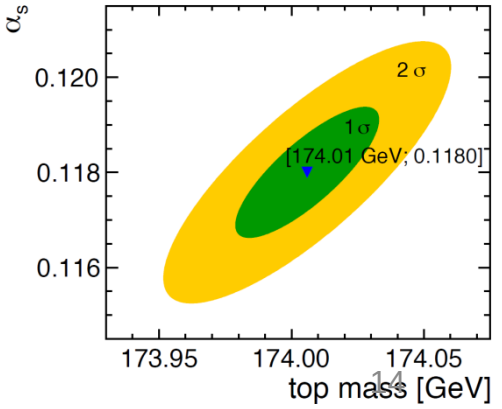
Other physics processes

- Higgs self coupling
  - Zhh final state at 500 GeV
    - 27% accuracy in Zhh cross section = 44% accuracy in λ with $2ab^{-1}$
  - $\nu\nu$hh final state at 1TeV
    - 17% accuracy in λ with $2ab^{-1}$ (Fast simulation)
    - Full simulation study on going
- Further t t study
  - A^t_{FB} by semi-leptonic decay mode
    - 1% measurement can be done
  - A^t_{hel} (helicity asymmetry) measurement
  - t t at threshold: measurement of m_t and α_s









Discussion at PAC

SUSY mass

- There is large difference of the accuracy of SUSY masses between SiD and ILD in LOIs
- We discussed this issue and we understand the reason
- We still have to discuss how to present it in DBD → Tim will contact Jenny to discuss it

Higgs branching ratio at 1TeV

- SiD knows the unbelievable accuracy in Higgs branching ratio at 1TeV is wrong
- They will re-evaluate the accuracy

Beam polarization

- SiD and ILD should use same luminosity for each polarization combination

	L (-80%,+20%)	L (+80%,-20%)	SiD	ILD
tth	1000 fb^{-1}	0	4.1%	NA
	500 fb^{-1}	500 fb^{-1}	4.6%	4.8%
WW	500 fb^{-1}	500 fb^{-1}	0.17% (e-)	In progress
$\nu\nu h$	1000 fb^{-1}		In progress	?
	500 fb^{-1}	(500 fb^{-1})		Results shown

- If possible, we should give the results of both cases (1ab^{-1} with preferable polarization and 500fb^{-1} each)
  → Gives a guideline for running plan at 1TeV

BR summary table

- IDAG suggested to make one table which summarizes precision of branching ratios of all accessible decay channels by ILC
- The table would be placed either in the Physics volume or in the introduction chapter of DBD
- Michael Peskin and Keisuke Fujii will discuss how to make it

All summary table

- In PEB meeting yesterday, Sakue-san mentioned that the directorate is considering to make a table summarizing all of the physics analysis results, and put it in the summary chapter

Review report by IDAG at PAC

Review of new DBD version for PAC

- Little time available for a real review; concentrate on changes since Arlington
- General improvement in document organization and balance; still a lot of editing needed
- Benchmarking now included with results in most cases, and some will come shortly
- New results on the Yukawa top coupling (t tbar H), precision comparable for ILD/SiD
- Some unbelievable results (accuracy of Higgs BR from SiD, one of the most important selling arguments for ILC), discrepancies between ILD and SiD (masses obtained for charginos and neutralinos)
- Results need serious crosschecking by the 2 groups

General assessment of DBD (1)

- The physics case of ILC is strongly documented in the excellent physics chapter
- Discovery of the 126 GeV boson gives a solid boost for going beyond the LHC, both in terms of precision of couplings and masses and for accessing new observables
- The 2 validated detector concepts have demonstrated through benchmarking with a realistic detector simulation that the physics goals can be met (compensation of degradation with improvements in analysis software).
- .The studied processes encompass the full range of ILC operation, from 250 GeV to 1 TeV with the same detector designs (also down to Z and WW regions).

General assessment of DBD (2)

- The vigourous R&D programs carried out have validated the considered solutions for subsystems. Still different options remain in some cases which is reasonable at this stage.
- R&D should continue, in addition many spin-offs.
- Ambitious detector designs (resolution, granularity, hermeticity, integration) have met the challenge of addressing the unique possibilities of the ILC.
- Many of the results rely on the powerful technique of particle flow (PFA) which drives the designs and is essential to reach the goals. ILD and SiD are optimized differently which is an asset for crosschecking results. This is the most important complementarity issue.

A few caveats

- Serious editing is required to improve hurried last-minute writing.
- Benchmarking results should be validated through crosschecking and understanding irreducible differences.
- ILD costing is still very crude (need a baseline).
- Are there some remaining/unasessed risks in order to achieve the foreseen performance?

  - power-pulsing of on-board electronics is mandatory for achieving granularity, resolution and keep low material budget. It is basically untested with prototypes (mechanical effects in magnetic fields).

    - large solenoids: SiD comparable in size to CMS but 5T instead of 4, ILD larger than CMS but same field

IDAG has completed its job and looking forward to see the final version of the DBD.

Thanks to the ILD and SiD groups for their achievements under limited resources.

Thanks to the RD directorate for the fruitful collaboration.

We hope these detectors will become real in the near future.

What's next for DBD

- We still have a lot of things to do for benchmark analyses
  - Finalize 1 TeV benchmark study and fix the results through internal review by middle of January (before SiD WS 16-18 Jan. 2013?)
  - Revise the description on LOI benchmark analysis to include post-LOI analyses
  - Discuss and coordinate with SiD to make the whole DBD self-consistent
  - Collaborate with RD and physics common task group to make summary tables

What's next for DBD

- Critical reading of the draft is necessary
  - by "readers" group
  - by JSB(?)
- Costing has to be finalized

ILD activity after DBD

- We have to define the goal of next few years (Proposal?, TDR?,…)
  - The goal will be set officially by the LCB
  - But the physics/detector community should give the input to the LCB
- Discussion has just started
  - Serious discussion at ECFA2013 meeting in May
  - There may be some discussion at AIDA meeting in April @Frascati (Italian participation to ILD?)
- Anyway, detector R&D (particularly in engineering aspects) has to be continued towards “construction ready” design of ILD
- Physics study which have not been covered in DBD should be done

ILD activity after DBD

- One possible roadmap

	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Due process	DBD		Proposals		TDRs									
Off-site	R&D					Sub-detector construction								
On surface					Assembly hall		Detector pre-assembly							
Underground					Access tunnel / Cavern				Detector assembly				Commissioning	Ready
Physicists on site*							100	100	200	200	200	400	800	800

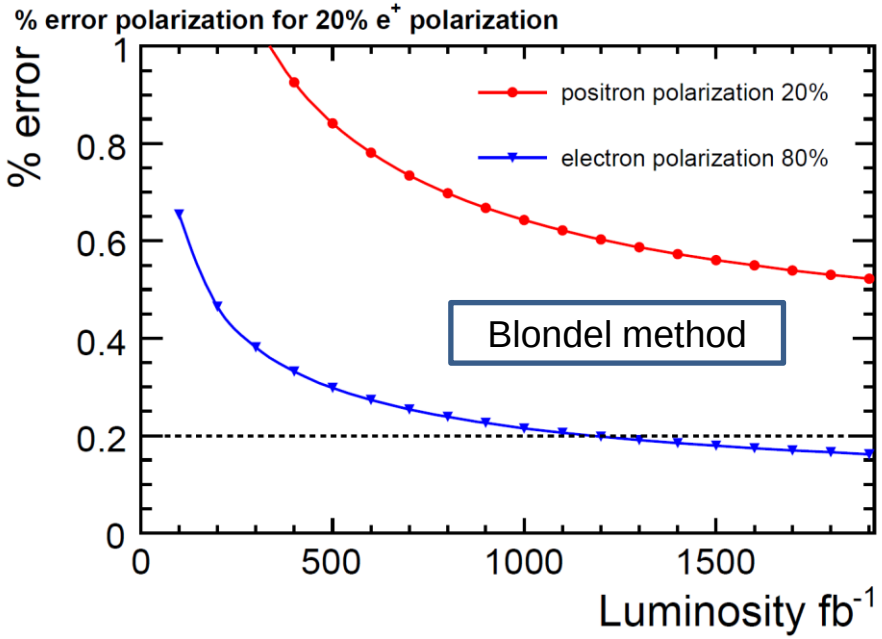
* {100 (Laboratory personnel) + 300 (Visitors)}x2detectors = 800

  - If we wish to start physics run in 2025, we have to start writing our proposal in 2014

Backup slides

1TeV benchmark

- $e^+ e^- \rightarrow W^+ W^-$
  - Precise measurement of beam polarization
  - Two methods
    - Modified Blondel scheme: (+,+),(+,-),(-,+),(-.-) data required
    - Angular distribution of W → Analysis not finished yet

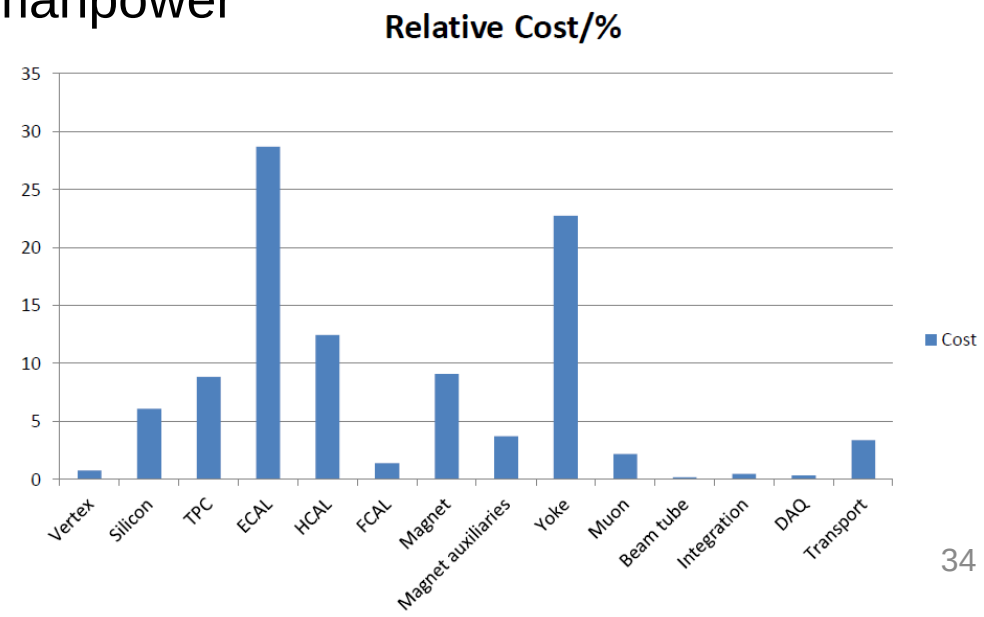


LOI-DBD common benchmark

- We used $e^+e^- \rightarrow t\,t$ channel for the comparison between LOI and DBD analysis @500 GeV
- Forward-backward asymmetry is determined by hadronic decay mode
- Vertex charge determination is needed → good benchmark for vertex detector/finding
- Results with 500fb^{-1}, P(e^-, e^+)=(-0.8, +0.3) :
  - A^t_{FB} = *Coming soon* (DBD)
  - A^t_{FB} = 0.334±0.0079 (LOI)

Cost

- Progress since LOI
  - Development of technological prototypes close to final design → Information on costs
  - Integration of whole detector has been studied
  - New agreement on methodology and unit costs of cost drivers
- ILD current cost evaluation
  - Study is on-going
  - ~500 MILCU including manpower



Summary of PAC presentation

- Detailed baseline design of ILD based on validated detector technologies has been presented
- Compared with LOI, more realistic design including support structure, cables, other services, and dead material has been made
- Although the material budget has been increased, better detector performance than LOI has been obtained thanks to the improvement of software tools and analysis methods
- New benchmark processes at 1 TeV have been studied with 2-photon process background overlaid (We still need few weeks to finalize the results, though)
- We still need detector R&D, particularly in the engineering aspect, after completion of DBD