Optimization WG Overview

ILD Meeting @ Warsaw
June 11th, 2008

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Charge of Optimization WG

- Charge of Detector Optimization Working Group

  - Investigate the dependence of the physics performance of the ILD detector on basic parameters such as TPC radius and B-field. On the basis of these studies and the understanding of any differences observed the WG will make recommendations for the optimal choice of parameters for the ILD detector.

- Initial Goal

  - First results from detector optimization studies by Summer 2008.
  - At this time, define baseline ILD detector parameters at the level needed to start writing the LoI.

Basic Strategy

- Parameterize physics performance for "benchmark processes" as a function of detector parameters at mesh points.

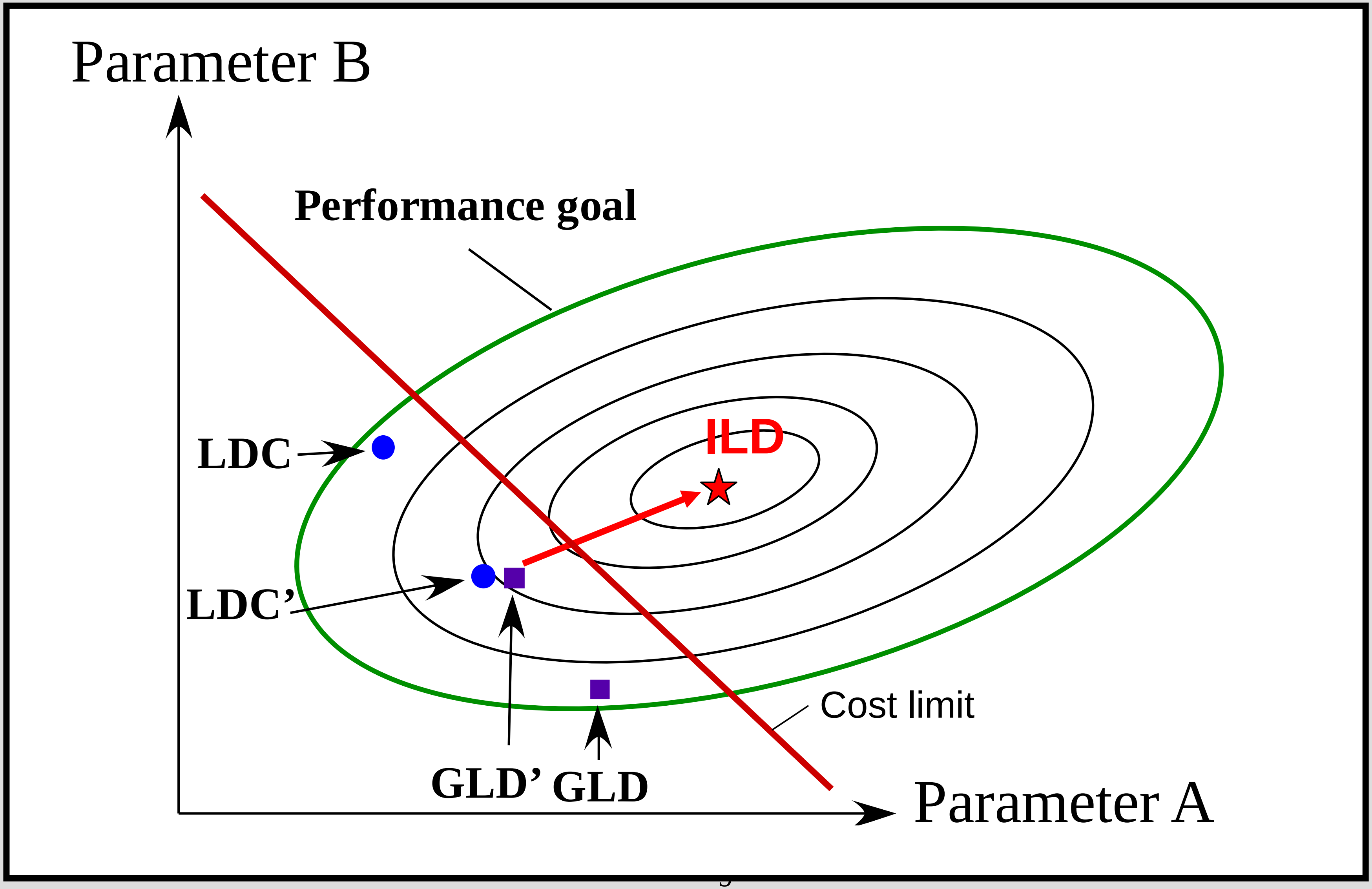
- Studies as realistic as possible:
  - Study signal + all SM background MC

- Use full detector simulation and reconstruction
  - Tools now exist for both LDC and GLD

- Study parameter space "between" LDC and GLD. Start from GLD and LDC and meet at GLD' = LDC' to test the consistency.

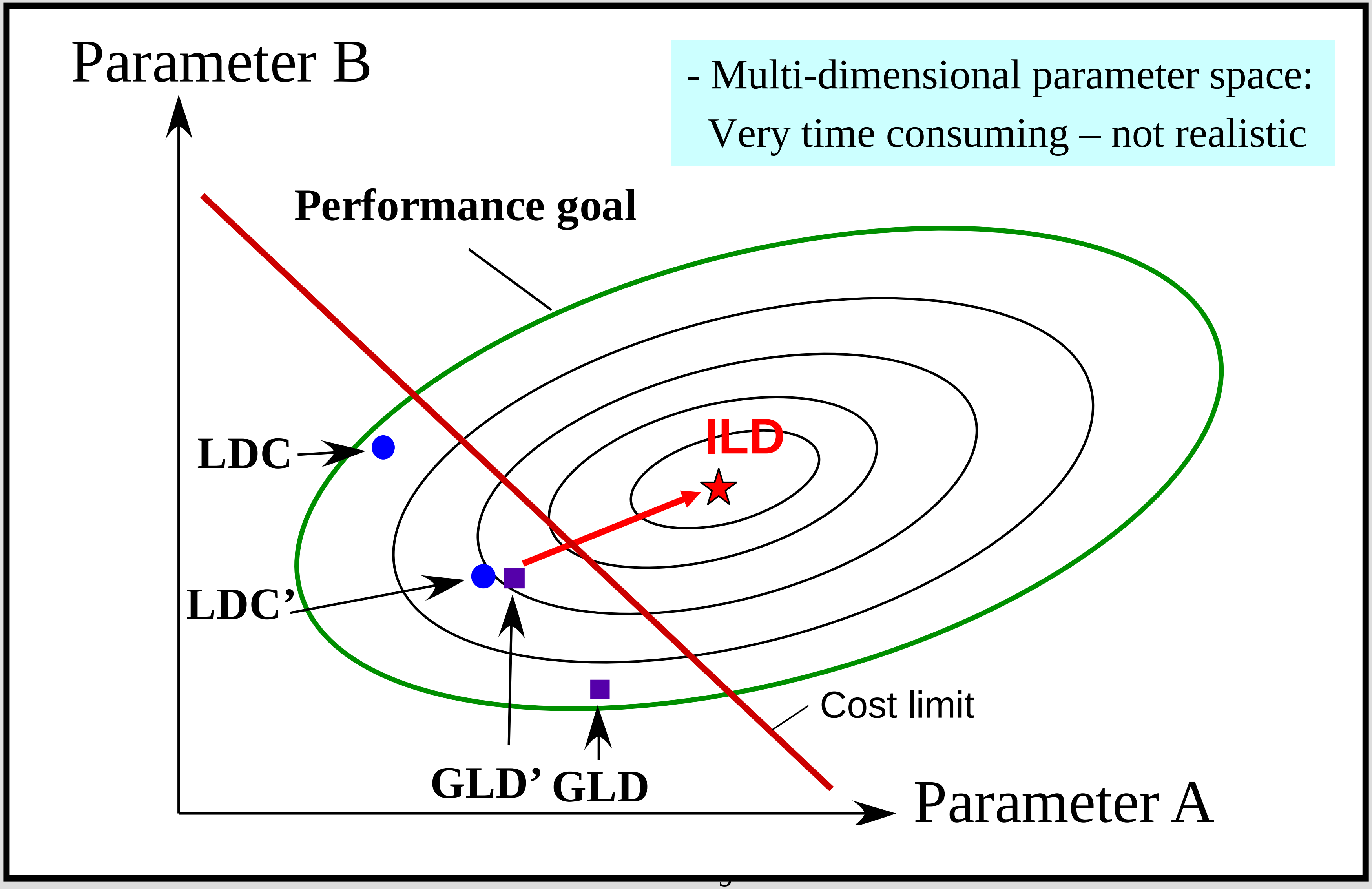
- After parameterization, add cost term also parameterized as a function of detector parameters with an appropriate weight.

"Ideal" Optimization Procedure



Y.Sugimoto

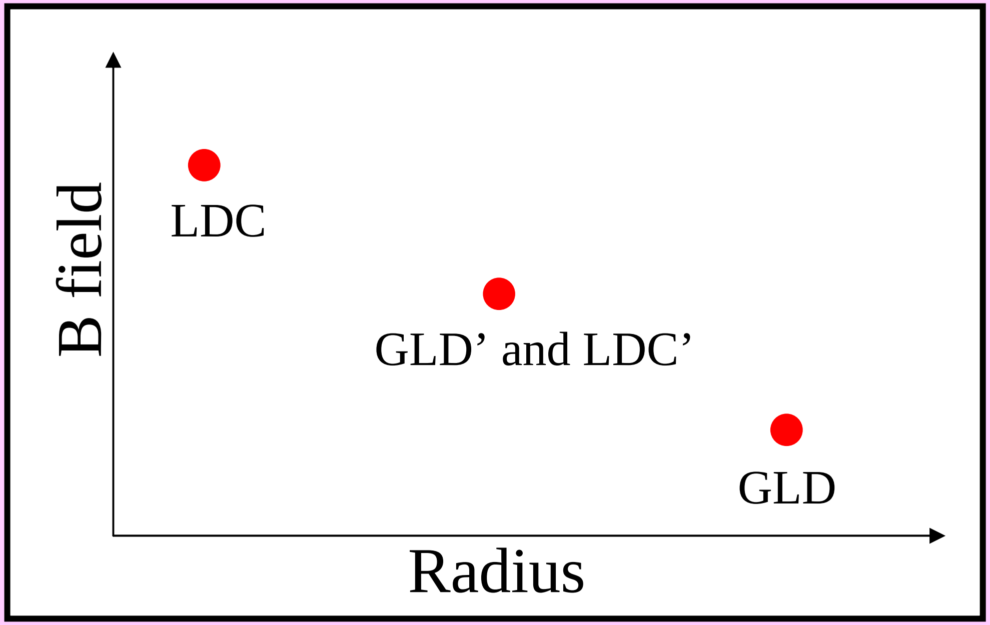
"Ideal" Optimization Procedure



Y.Sugimoto

"Realistic" Optimization Procedure

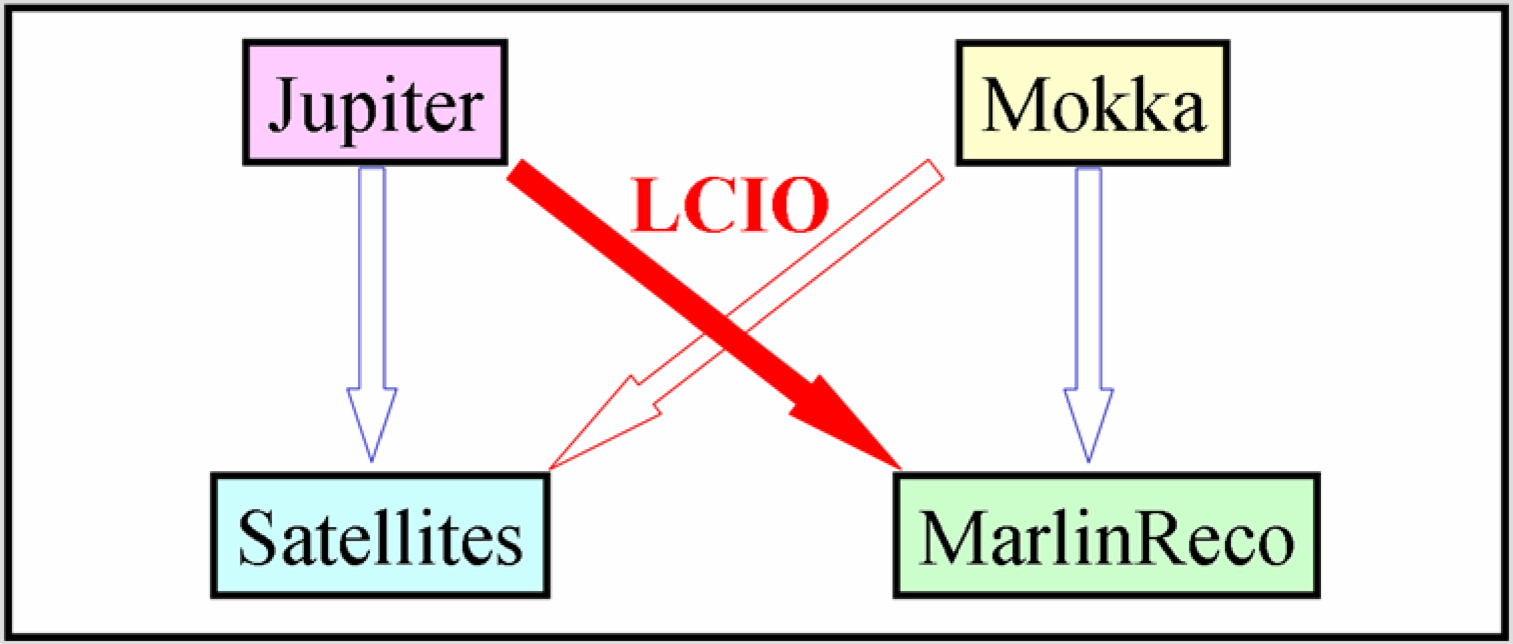
- Initial goal:
  - Concentrate on main parameters (R and B)
    → We can exercise full reconstruction procedure
  - Check consistency between LDC' and GLD'



- Mainly concentrate on B and R.
  ← Cost drivers

Optimization Tools

- Currently, GLD and LDC use different Geant4 simulations/ reconstructions framework.
- Connected only by common data format.
- Given timescale, we decided to perform ILD studies in context of both GLD and LDC.



LDC'/GLD' Common Parameters

			GLD	LDC	GLD'	LDC'
TPC		Rin (m)	0.45	0.3	0.45	0.3
		Rout (m)	2.0	1.58	1.8	1.8
		Zmax (m)*	2.5	2.16	2.35	2.35
Barrel	ECAL	Rin (m)**	2.1	1.6	1.85	1.82
		Material	Sci/W	Si-W	Sci/W	Si-W
	HCAL	Material	Sci/Fe	Sci/Fe	Sci/Fe	Sci/Fe
EndCap	ECAL	Zmin (m)***	2.8	2.3	2.55	2.55
B-Field (T)			3	4	3.5	3.5
VTX		Inner Layer (mm)	20	16	18	18

- Region between VTX and TPC unchanged in both cases.

* Note for GLD Zmax = 2.3 + 0.2 m for TPC readout. This is included in the standard LDC TPC Zmax

** LDC allows less space between TPC and ECAL than GLD – here let TPC outer radius fix ECAL Rin and all subsequent radii

*** propose to fix ECAL Zmin and let this define the exact details of the TPC endplate region.

Benchmark Processes

Processes ($e^+e^- \rightarrow$)	**$\sqrt{S}$ (GeV)**	**Observables**	**Comments**
ZH, ZH$\rightarrow e^+e^-X$,	250	σ, m_H	m_H=120GeV, test materials and γ_{ID}
$\rightarrow \mu^-\mu^+X$	250	σ, m_H	m_H=120GeV, test $\Delta P/P$
ZH, H$\rightarrow$cc, Z$\rightarrow\nu\nu$	250	Br(H$\rightarrow$cc)	Test heavy flavour tagging and anti-tagging of llight quarks and gluon
, Z$\rightarrow$qq	250	Br(H$\rightarrow$cc)	Same as above in multi-jet env.
$Z^* \rightarrow \tau^+\tau^-$	500	σ, A_{FB}, Pol(τ)	Test π^0 reconstruction and τ rec. aspects of PFA
tt, t$\rightarrow$bW, W$\rightarrow$qq'	500	σ, A_{FB}, m_{top}	Test b-tagging and PFA in multi-jet events. m_{top}=175GeV
$\chi^+\chi^-$, $\chi_2^0\chi_2^0$	500	σ, $m\chi$	Point 5 of Table 1 of BP report. W/Z separation by PFA

$\int Ldt = 250\ fb^{-1}$ @250 GeV, $500 fb^{-1}$ @ 500 GeV

* Other processes such as e+e- $\rightarrow$ZHH etc, are important for ILC physics. But they are less relevant for detector parameter optimization or overlap with process listed.

Recent Progress

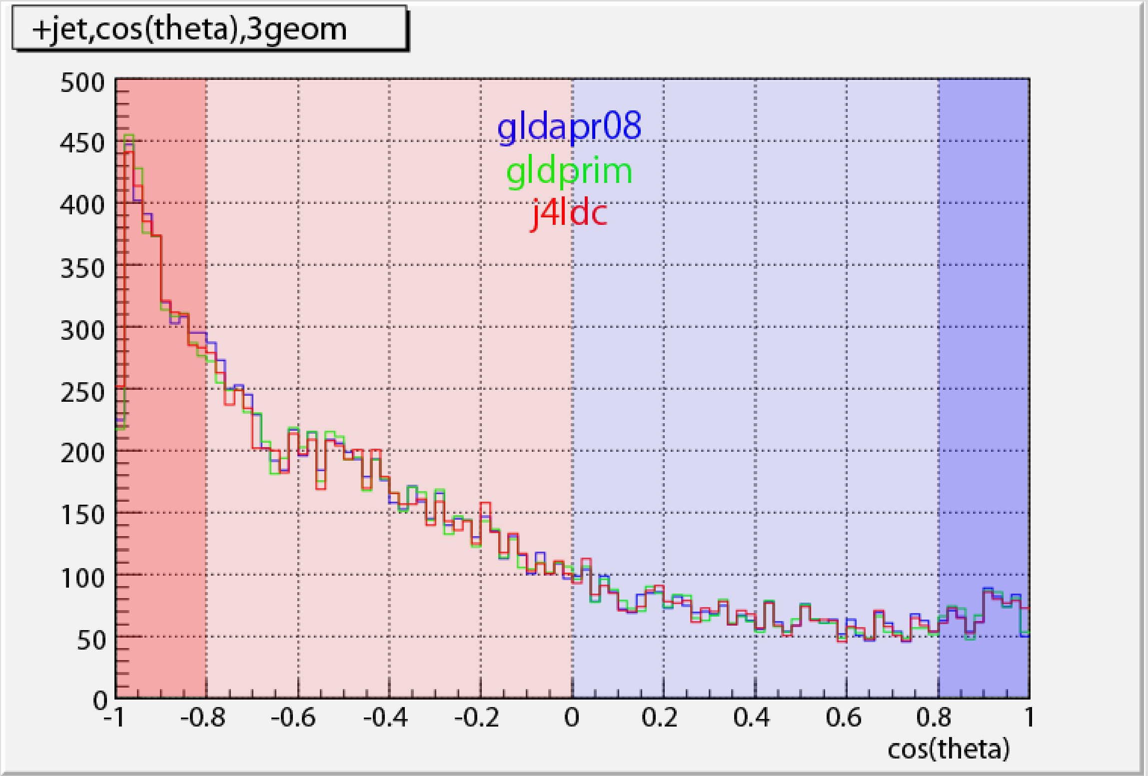
• There are many presentations in this Workshop
→ Please have a look at their slides, if you are interested in.

• LDC studies are summarized by M.Thomson in this morning.

• GLD studies: mainly concentrated on physics analysis so far.
- Strip Clustering in PFA by D.Jeans
- Status of GRID and software for ILC optimization studies in Japan by K.Ikematsu
- Study of ZH recoil mass by K.Itoh
- Status of tau-pair and SUSY analysis by T.Suehara

→ Analysis path:
Jupiter + MarlinReco (FullLDCTracking + PandoraPFA)

Tau AFB

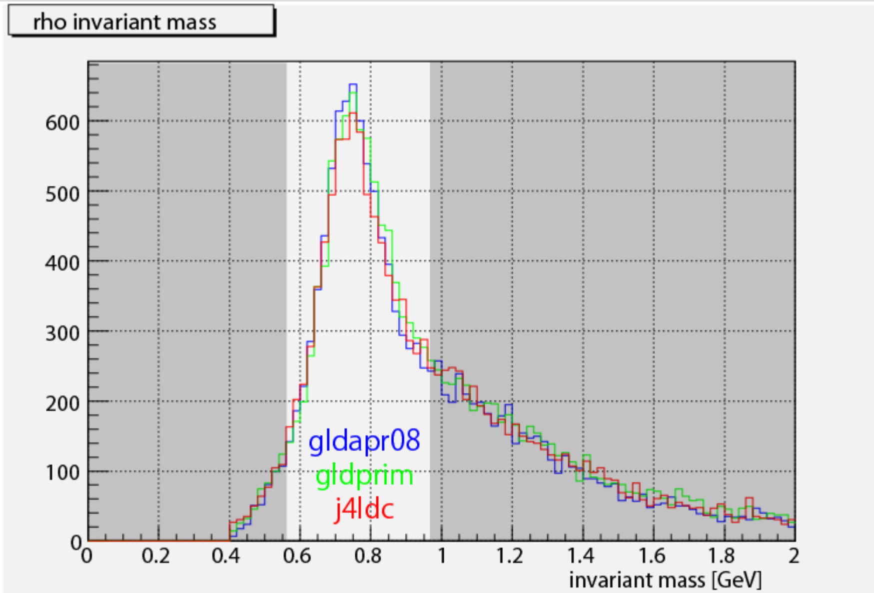


Geometry	A_{FB}(edge)	A_{FB}(all)
Gldapr08:	65.71±0.26%,	49.76±0.17%
Gldprim:	64.99±0.27%,	49.73±0.17%
J4ldc:	65.30±0.26%,	49.44±0.17%

$$A_{FB} = \frac{N_F - N_B}{N_F + N_B}$$

Error value is extrapolated to 500 fb^{-1} (for 25 fb^{-1}, ~1.2% & 0.7%)

$\tau \rightarrow \rho\nu; r \rightarrow \pi + \pi 0$

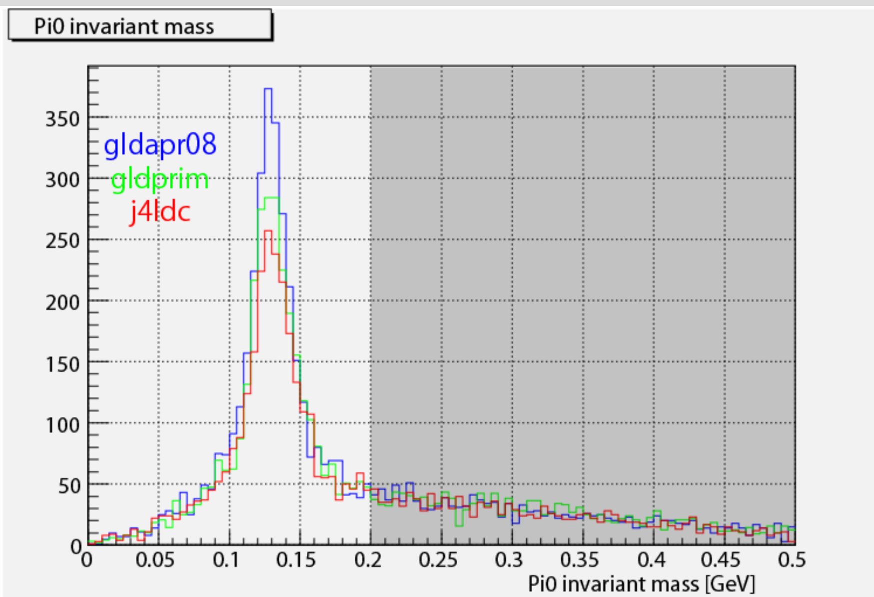


Rho invariant mass:

invmass between the prong and all neutrals combined.

Geometry	width(σ,MeV)	# accept
Gldapr08	95.4	7987
Gldprim	99.6	8099
J4ldc	99.8	7812

No significant difference.



Pi0 invariant mass:

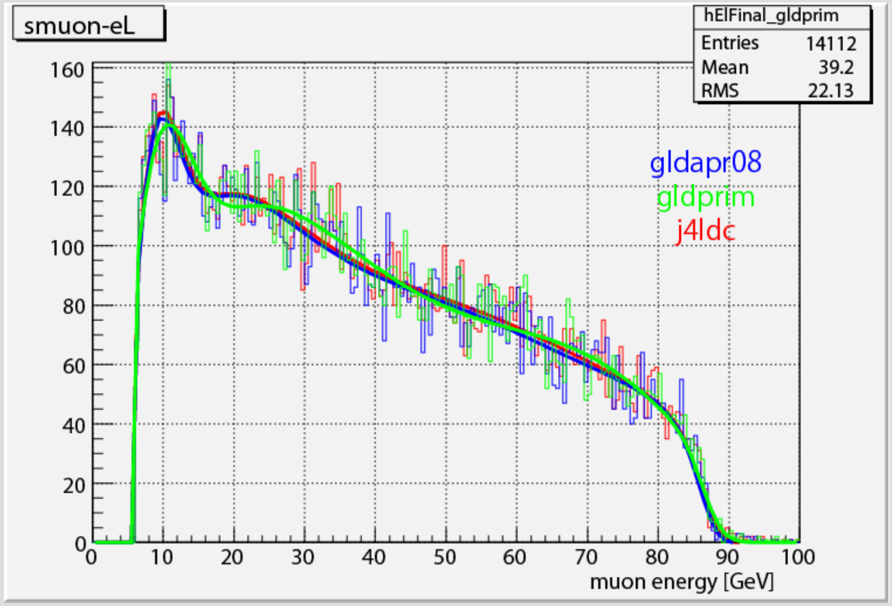
event with >=2 neutrals

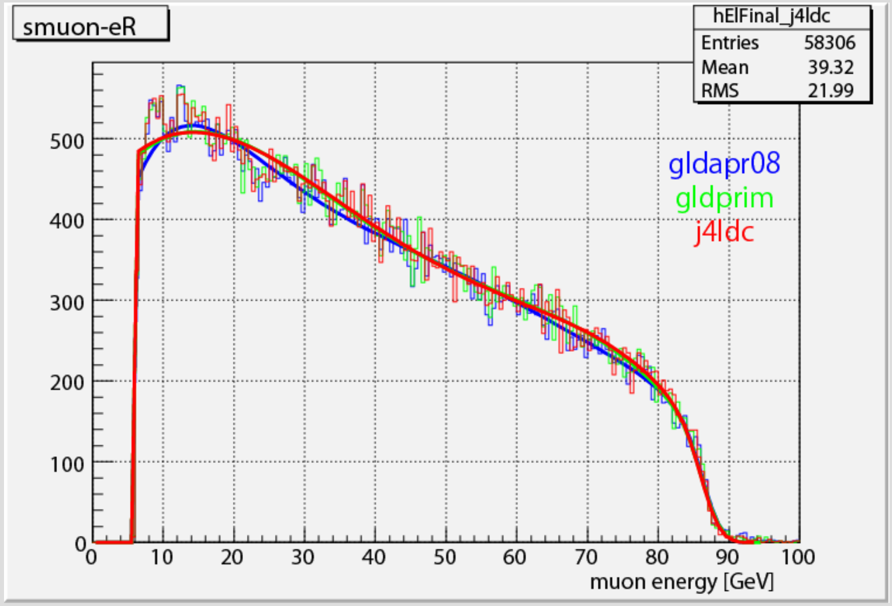
(if >2 neutrals, nearest neutrals are combined till 2 neutrals rest.)

Geometry	width(s,MeV)	# accept
Gldapr08	14.7	2662
Gldprim	15.0	2410
J4ldc	16.5	2219

Better performance in gldapr08!

Smuon Analysis





Geometry	pol.	smuon mass[GeV]	neutralino mass[GeV]
Generator		122.98	97.44
Gldapr08	left	123.86 ±0.45	98.21 ±0.37
Gldapr08	right	124.04 ±0.19	98.26 ±0.17
Gldprim	left	124.28 ±0.39	98.48 ±0.33
Gldprim	right	124.24 ±0.19	98.44 ±0.16
J4ldc	left	123.78 ±0.45	98.12 ±0.37
J4ldc	right	124.25 ±0.18	98.45 ±0.15

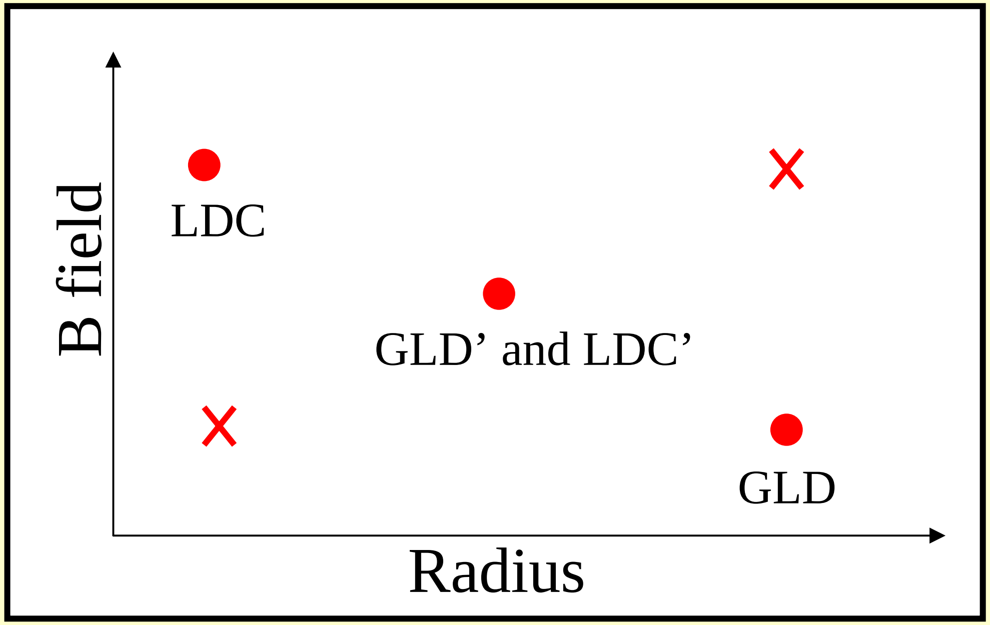
Optimization Matrix (As of May 30th)

Process	Observable	Target	GLD	GLD'	J4LDC	Comments
ΔE/E(γ), ΔE/E(KL)						
Δpt/pt@500GeV		< 5e-5	3.9e-5	4.1e-5	4.5e-5	
σ(IP)@500GeV			4.0um	3.7um	3.6um	
σ(rms90)@zpole		< 30%?	30.3±0.7	28.7±0.6	30.8±0.7	
ZH → μμH	Δσ		2.10%	2.20%	2.07%	
	ΔMh		86.5	81.9	79.8	No b-tag
ZH → eeH	Δσ		2.65%	1.80%	1.67%	
	ΔMh		130	139	100	No b-tag
ZH → llH	Δσ		1.64%	1.45%	1.40%	
ZH → llH	ΔMh		75.0	70.9	63.4	No b-tag
τ pair	AFB		49.76	49.73	49.44	
	Pi0 width		14.7	15.0	16.5	
Smuon	$\Delta M(\mu^{\pm})$		0.36%	0.31%	0.36%	
	$\Delta M(\chi_1^0)$		0.38%	0.34%	0.38%	
…						

Very Preliminary

After Warsaw

- Goal → Fill the optimization matrix as much as possible.
  - Understand whether current results are reasonable or not.
  - Check consistency between GLD prime and LDC prime.



- Other variants
  - Different BR2
  - VTX radius
  - IT configuration
  - …

→ Need to collaborate effectively.
Share mesh point/physics channel?

Summary

- For LoI: The optimization WG aim to parameterize physics performance for "benchmark processes" as a function of detector parameters with full detector simulation and reconstruction.
- A lot of progress since TILC08: implementation realistic geometries/physics analyses.
- Full reconstruction software now exist.
- First results from detector optimization studies by Summer 2008.