IDAG Report on LOI Validation

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Charge of IDAG

- Letters of Intent (LOI) called by ILCSC for detectors at ILC, in order to conduct technical design for optimized detectors to be included in the overall project in 2012
- Submitted LOIs have to be ‘validated’ regarding their performances and feasibility, as well as the capability of the submitting group to conduct detailed technical studies
- IDAG appointed to perform the validation process and advise the Research Director

RD/IDAG Criteria for LOI Validation

- Are the physics aims of the detector convincing for an experiment at ILC?
- Is the detector concept suited and powerful enough for the desired physics aims and the expected accelerator environment?
- Is the detector feasible? Namely, is the required R&D for the selected technologies advancing fast enough to be completed during the design phase?
- Do the mechanism for push-pull operation and related alignment and calibration methods enable the desired switching process
- Are the estimated cost and the way to obtain it reasonable at the time of the LOI
- Is the group powerful enough to accomplish the required design work through the technical design phase?

IDAG Schedule 2008

- Feb. 2008: Appointment of IDAG members
- March 2008: 3 EOIs received (ILD, SiD, Fourth)
- March 6-8 2008 Sendai: informal discussions
- June 9-12 2008 Warsaw: IDAG meetings 1
  - open presentations EOI
  - separate closed discussions with groups
  - discussion with RD about IDAG mandate
- Nov. 16-19 2008 Chicago: IDAG meetings 2
  - open presentations
  - separate closed discussion with groups
  - set up organization for LOI evaluation

IDAG Schedule 2009

- Jan. 27 2009: preparation (tracking) IDAG meeting 3 (phone)
- Feb. 17 2009: preparation (calorimetry) IDAG meeting 4 (phone)
- March 3 2009: preparation (MDI) IDAG meeting 5 (phone)
- March 31 2009: 3 LOIs received (ILD, SiD, Fourth)
- April 14 2009: IDAG meeting 6 (phone) $\Rightarrow$ pre-Tsukuba questions
- April 17-21 2009 Tsukuba: IDAG meetings 7
  open presentations LOI: detector, benchmarking
  separate closed discussions with groups
  review work $\Rightarrow$ post-Tsukuba questions
- June 19-21 2009 Orsay: IDAG meetings 8
  separate closed discussion with groups
  review work
  drafting of report
- July 2009: finalization of report (e-mail)
- August 17 2009: IDAG report submitted to Research Director
- August 19 2009 Hamburg: IDAG conclusions endorsed by ILCSC
- Sept. 29 2009 Albuquerque: oral report to ILC community

Review Organization

- 'vertical' reviews by subject with one convener (all projects studied)
- 'horizontal' reviews by project with one referee (all aspects included)

	Benchmarking		Tracking	Calorimetry	MDI
ILD	Hewett	Li	Nickerson	Green	Himel
SiD	Grosjean	Palestini	Danilov	Karlen	Toge
4th	Godbole	Grannis	Elsen	Kobayashi	Kim
	Davier				

ILC Physics and Challenges

Precision on momentum, jet energy, and vertex; hermeticity; granularity

Benchmark processes

Reaction	Detector parameter tested	Measurements
$e^+e^- \to Z(\to l^+l^-)H$ $m_H = 120$ GeV, $\sqrt{s} = 250$ GeV	p resolution material distribution γ recovery	m_H σ
$e^+e^- \to ZH(H \to c\bar{c}, Z \to \nu\bar{\nu})$ $m_H = 120$ GeV, $\sqrt{s} = 250$ GeV	heavy flavor tagging secondary vertex reconstruction particle id.	$BR(H \to c\bar{c})$
$e^+e^- \to ZH(H \to c\bar{c}, Z \to q\bar{q})$ $m_H = 120$ GeV, $\sqrt{s} = 250$ GeV	same as for $e^+e^- \to ZH(H \to c\bar{c}, Z \to \nu\bar{\nu})$ confusion resolution capability	$BR(H \to c\bar{c})$
$e^+e^- \to Z \to \tau^+\tau^-$ $\sqrt{s} = 500$ GeV	τ reconstruction particle flow π^0 reconstruction tracking of close tracks	σ A_{FB} τ polarization
$e^+e^- \to t\bar{t}(t \to bqq')$ $m_t = 175$ GeV, $\sqrt{s} = 500$ GeV	multi jets particle flow b tagging lepton tagging tracking	σ A_{FB} m_t
$e^+e^- \to \chi^+\chi^- / \chi^0_2\chi^0_2$ $\sqrt{s} = 500$ GeV	particle flow WW, ZZ separation multi jets	σ masses

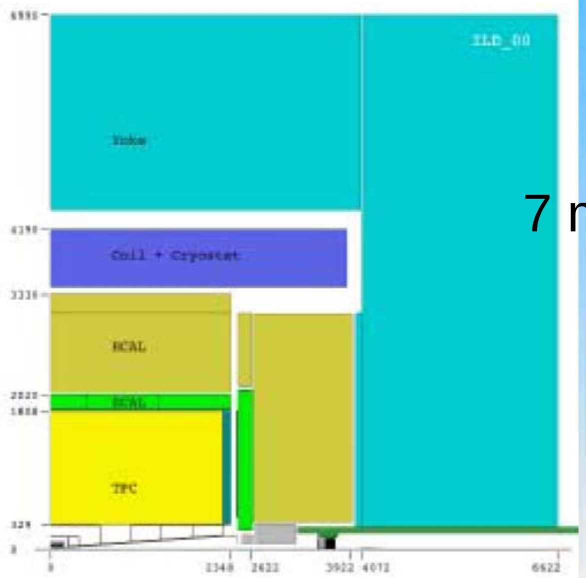
The 3 concepts: choices and numbers

	ILD	SiD	Fourth
Vertex	Si pixels	Si pixels	same as SiD
Tracker	TPC + Si strips layers	Si strips 5 double layers	Small-cell He drift chamber (clusters)
Forward	Si strips disks	Si strips disks	not specified
EM calo	W+Si pix.(scint.strips) 23 X_0 0.25 cm^2	W +Si pix. 26 X_0 0.13 cm^2	BGO +? 25 X_0 4(1) cm^2
Had calo	Fe+scint. tiles (gas) 5.5 λ 9 cm^2	Fe+RPC pads 4.8 λ 1 cm^2	Cu+quartz/scint. fibers 7.3 λ 19 cm^2
Magnet	3.5 T 3.35 m	5 T 2.6 m	3.5 T 3 m (inner)
Flux return	Fe 7 m	Fe 6 m	Air 1.5T outer sol.
Muon	RPC (scint.strips)	RPC (scint.strips)	Al drift tubes

The 3 concepts: sizes

(¼ R-z view)

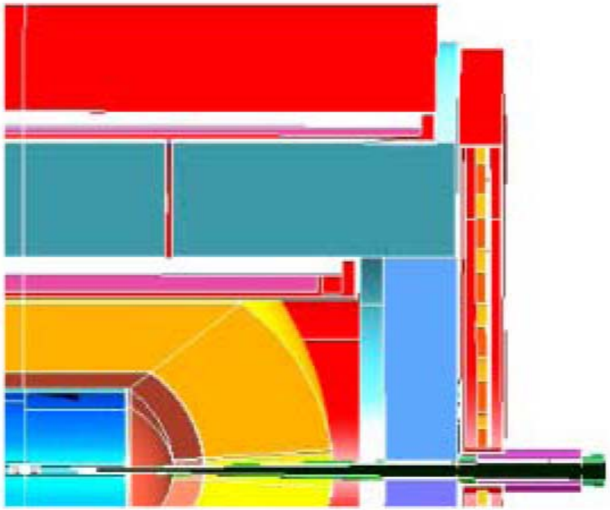
ILD



SiD

7 m

Fourth



Push-Pull Issues

- MDI/D group set up by GDE and RD: draft of working assumptions

- all 3 concepts compatible with final focus specifications
- all claimed ‘rapid’ push-pull operation
- in fact engineering design solutions still to be worked out

- major differences: -- ILD-Fourth on a platform, SiD not
  -- QF1 attached to Fourth $\neq$ MDI/D document
  -- ILD-SiD self-shielded, Fourth not (design?)
- very different weights:

ILD	16,600 t
SiD	9,800 t
Fourth	2,200 t

- actual push-pull performance yet to be proven
- pending questions: isolation of final QD0-QF1 from vibration sources
- recovery of detector performance after push-pull (alignment)

Physics performances

- assessed through the chosen benchmark processes
- SM background generation common to all concepts (SLAC)
- beamstrahlung-induced background included
- full simulation and reconstruction
- Higgs mass determination in ($Z \to l^+ l^-$) H :
  36-50 (59-97) MeV for $\mu\mu$ (ee) (all)
- Higgs BR $H \to$c cbar : precision $\sim$10% (ILD, SiD)
- precision EW measurements with ee$\to\tau\tau$: σ, A_{FB}, P_τ (ILD, SiD)
- t tbar production : t mass to 30-60 MeV, b-tagging (ILD, SiD)
- gaugino pair production: separate W and Z (jet energy resolution) best with dual read-out calorimetry (Fourth), still acceptable for particle flow (ILD, SiD)
- PF still works at 1 TeV (ILD)
- exercice very useful: proposed concepts able to exploit ILC potential; reveals ability to carry out complex analyses with realistic simulation
- analyses still in flux: several unexplained differences

ILD

- impressive quantity and quality of work performed
- extensive R&D effort in test beams of full-size calorimeter prototypes, alternative technologies being explored, PF validation in progress
- TPC technique well-established at LEP; mature read-out options (GEM, MICROMEGAS), robustness to background checked (simulation)
- many technology choices still open and being studied at LOI
  $\Rightarrow$ large R&D program
- scenarios for detector alignment and calibration convincing at this stage
- good response to benchmarking studies: further progress to acomplish. could be important for remaining design choices
- ILD detector concept appears to confront the ILC physics in a fairly complete fashion
- at LOI stage remarkable progress of Collaboration in advancing the design
- clear path followed for next decisions
- strength of ILD group sufficient for tasks ahead in R&D, simulation, engineering studies and technical design

SiD

- overall design aimed at exploiting the ILC physics potential with a detector designed around few choices in a cost-effective way
- central tracker with Si strips alone in a relatively small volume and a minimum number of layers
- Si also in the vertex detector and in the very granular W EM calorimeter
- optimization driven by performance of particle flow, to be validated by test-beam data
- still a few choices still open: hadronic calorimeter elements,
dual read-out calorimetry
- aggressive approach to push-pull constraint, to be backed up by specific engineering and R&D studies
- laudable effort in producing simulated data for physical processes and beam background
- good responsiveness in answering questions raised
- completeness of LOI, effectiveness of detector concept, strength of group to carry to the next phase

Fourth

- should be commended for seeking innovative solutions to ILC challenges
- calorimetry, tracking, magnet differ from those in recent collider detectors
- drawback: much R&D and engineering studies to demonstrate that these choices can be implemented and realized in a cost-effective way
- dual read-out calorimetry tested only in small prototype (large leakage)
  $\Rightarrow$ need for a beam test of larger module capable of fully containing hadronic showers, and combined with BGO section
- cluster-counting tracking novel, but as yet unproven $\Rightarrow$ realistic lab test needed with fully developed fast-sampling electronics, then beam test of a He-based prototype
- dual solenoid magnet has advantages on paper, requires full engineering and stability studies
- Fourth is lacking a fully specified baseline design: vertex, BGO read-out, forward tracking
- benchmarking studies very incomplete
- active part of Collaboration is a very small (motivated) group, lacking support from large labs
- very limited resources (human, technical, financial), below critical core

IDAG Recommendations

a. **The ILD and SiD concepts are validated and should be considered for the next phase of detailed baseline studies together with GDE. They constitute a solid basis for the two-detector push-pull concept with a large amount of complementarity in their design and expected performances. Tracking options are very different, and even if their baseline choices for calorimetry are similar, their implementation and exploitation will ensure robustness in the ILC physics results. They should both demonstrate a feasible solution at the end of the TDR phase of the accelerator.**

b. **The Fourth concept is not validated. However R&D on dual readout calorimetry should be supported in view of its potential for higher energy colliders.**

Full IDAG report available in ILC web → Physics and Detectors → IDAG
http://ilcdoc.linearcollider.org/record/23970/files/IDAG_report_090816.pdf

Conclusions

- IDAG has completed the first phase of the requested work and issued its final validation report
- The LOIs from ILD and SiD are validated
- The next phase for IDAG is the monitoring of the progress toward a detailed design of the ILD and SiD detectors, and the accompanying R&D effort
- The review will start at the Beijing ILC Workshop on March 26-30 2010