SiD Test Beams

SiD Workshop @ Fermilab
Apr. 9 – 11, 2007

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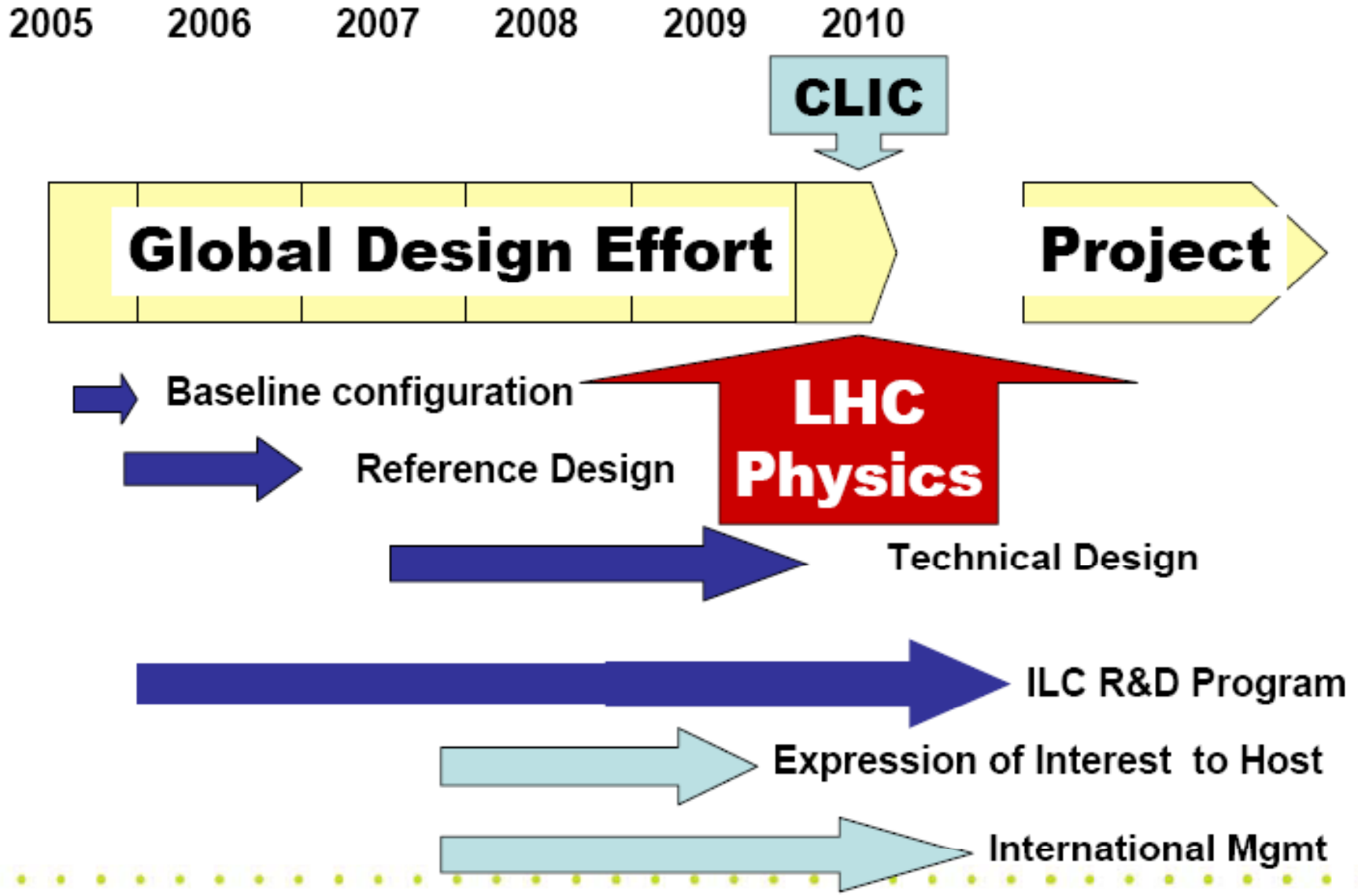
- Introduction
- Updates from IDTB07 Workshop @ FNAL
- What beam tests does SiD need?
- Some Personal Remarks
- Conclusions

Introduction

- GDE schedule and WWS/ILCSC recommendations strongly encourage SiD and other detector CDRs in 2008

The GDE Plan and Schedule



Detector Roadmap (the future, Brau)

- 2008 – Conceptual Design Reports received by IDAG
  Panel characterizes positive aspects and criticizes weaknesses
  Guides community to the definition of two detectors for
  EDR preparation
  Collaborations formed to develop EDRs

- 2009-2011 – Development of two technical designs,
  produce first technical design report for the overall detectors,
  which will be followed by additional volumes
  (detailed technical reports on subsystems)

Introduction

- GDE schedule and WWS/ILCSC recommendations strongly encourage SiD and other detector CDRs in 2008
- Many detector R&D activities reaching to the point of beam tests
- Much progress made in understanding and developing PFAs and tools needed for CDR
  - Hadronic shower behaviors need to be better understood
  - Models should be validated
- ILC Detector designs should be “in synch” with accelerator EDR
  - Most ideal if SiD CDR can contain detector technologies tested in beam and better understood beyond simulations

You want it *when*? (Jaros)

- July 07

  Tools Ready; Simulation Ready; Studies Defined;
  Engineering started

- SiD Fall 07 Workshop (@ALCPG?)

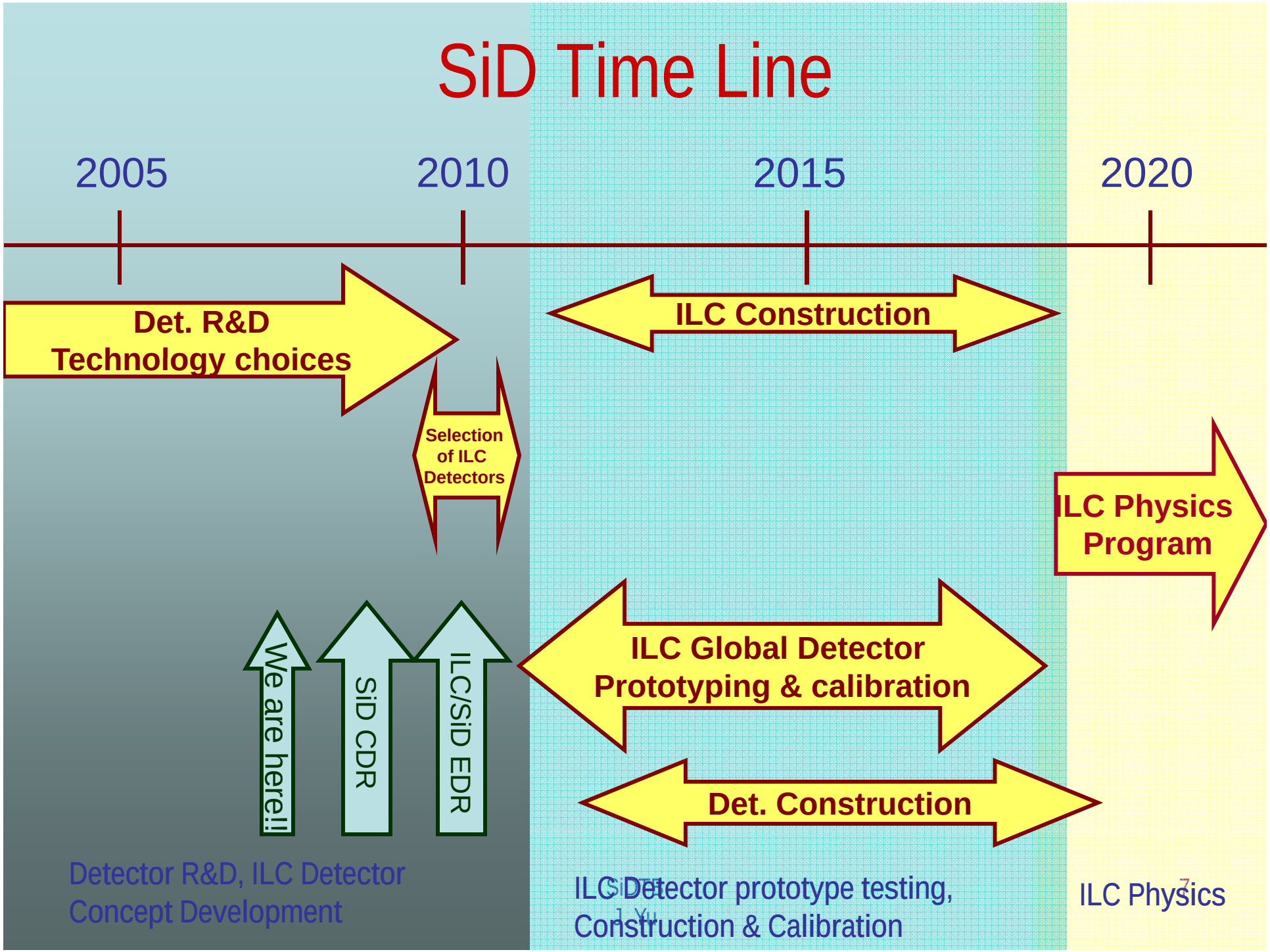
  Full simulation studies reported
  Optimization studies reported
  Conceptual Designs and Costs--Pass 1

- SiD Spring 08 Workshop

  Global and Subsystem Parameters set
  Designs ready; technologies chosen; Simulation updated
  Performance benchmarked
  Writer's block eliminated

- Summer 08

  Draft SiD CDR complete


SiD Time Line
2005
2010
2015
2020
Det. R&D
Technology choices
ILC Construction
Selection
of ILC
Detectors
ILC Physics
Program
We are here!!
SiD CDR
ILC/SiD EDR
ILC Global Detector
Prototyping & calibration
Det. Construction
Detector R&D, ILC Detector
Concept Development
ILC Detector prototype testing,
Construction & Calibration
ILC Physics

IDTB07 Workshop

- Held at FNAL on Jan. 19 – 21, 2007
- Over 100 participants from all over the world
- Charges:
  - Review and assess the current status, capabilities and plans of facilities
  - Review and assess the current and planned detector test beam activities
  - Identify requirements for test beams to meet adequately the detector R&D needs
  - Plan and discuss for the future beam test activities
    - What have we learned from LHC beam tests?
    - What can we learn from existing ILC test beam activities?
    - What should the future beam test activities focus?
  - Put together a team to write the ILC detector R&D test beam roadmap document which includes all sub-detector systems and the anticipated demands to facilities
    - Planned to complete by summer 2007

Test Beam Facilities and Availabilities

Laboratory	Energy Range	# Beamlines	Particles	Availability and plans
CERN PS	1 - 15 GeV	4	e, h, μ	LHC absolute priority, no TB starting Nov. 2007
CERN SPS	10 - 400 GeV	4	e, h, μ	LHC absolute priority, no TB starting Nov. 2007
DESY	1 - 6.5 GeV	3	e^-	> 3 months per year
Fermilab	1-120	1	e, π, K, p; μ	continuous (@5%), except summer shutdown
Frascati	25-750 MeV	1	e	6 months per year
IHEP Beijing	1.1-1.5 GeV (primary) 0.4-1.2 GeV (secondary)	3	$e^\pm$ $e^\pm$, $\pi^\pm$, p	Continuous after March 2008 (unavailable before then)
IHEP Protvino	1-45 GeV	4	e, π, K, p; μ	one month, twice per year
J-PARC	Up to 3GeV		????	Available in 2009 earliest
KEK Fuji	0.5 - 3.4 GeV	1	e	Available fall 2007, 240 days/year
LBNL	1.5 GeV < 55 MeV < 30 MeV	1	e p n	Continuous
SLAC	28.5 GeV (primary) 1.0 - 20 GeV (secondary)	1	e $e^\pm$, $p^\pm$, p	Parasitic to Pep II, non-concurrent with LCLS

Demarteau

Facilities Summary

- Six low energy (<10GeV), electron facilities available at various time periods
- One med energy (<28GeV) available up to 2008 but uncertain beyond 2008 - SLAC
- Two med to low E (<45GeV) hadron facility
  - Limited availabilities once LHC turns on till the operation stabilizes
- Two high E hadron facilities available
  - SPS limited once LHC turns on till the operation stabilizes

SLAC Test Beam Facility Updates

- ESA available till end of 2008 w/ 28.5GeV e
  - No promise of operation beyond 2008 but a study group is working with directorate for concurrent ESA operation with LCLS
  - A good change to get LCLS halo down to ESA in 2009
- LCLS commissioning to begin soon
  - Fully operational with secondary beam in 2009
- SABER
  - If approved some minimal running in 2007 and some accelerator testing in 2008
  - Primary electrons and positions can be available but no hadrons
  - A bypass line planned to allow concurrent operation of SABER with LCLS

M. Woods

Defining R&D Requirements

- BI&MDI groups' requirements well understood
- Vertex groups begun defining their requirements
- Tracking groups
  - TPC performed beam test many times ➔ Well positioned to clearly define the requirements
  - Si-based tracker needs are being formulated but can use better coordination
  - Recent Tracking R&D review summarizes the needs well
- Calorimeters and Muons
  - Requirements defined 3 years ago
  - Need to update given the anticipated change in focusses

Notable requests @ IDTB07

- ILC beam time structure (1ms beam + 199ms blank)
  - VTX, TRK and CAL electronics

Mimicking Beam Time Structure

- Important to perform testing in as realistic a condition as possible
- Requests have been made by
  - Ray and David a long time ago~~~ for ECAL electronics testing
  - Vertexing and tracking community @ IDTB07
  - Tracking R&D review report recommendations
- Fermilab contacted for the possibility
  - It is in principle possible for doing this
  - Neutrino beams had such a short pulse structure
  - Discussion ongoing with the accelerator division

Notable requests

- ILC beam time structure (1ms beam + 199ms blank)
  - VTX, TRK and CAL electronics
- Large bore, high field magnet (up to 5T)
  - VTX and tracking groups
  - Some calorimeter prototype testing
    - I was reminded of the CDF Texas tower…

High Field Large Bore Magnet

- The recent tacking R&D review pointes out and encourages strongly on the need for a tracking & vertexing common test facility
  - Tests under magnetic field – as close a field strength to the real thing - necessary to demonstrate performance of detectors and electronics
- Some solutions are being looked into
  - TRIUMPH: B=2T, ID=1m ID, L= 223cm
  - AMY Solenoid: B=3T, ID=2.2m, L= ??
  - Purchasing a new 5T split coil solenoid to allow normal beam incidence ($~0.5M?)
- What is better?
  - Cost of purchasing a new solenoid or transporting existing ones?
  - Which solution would be more timely?

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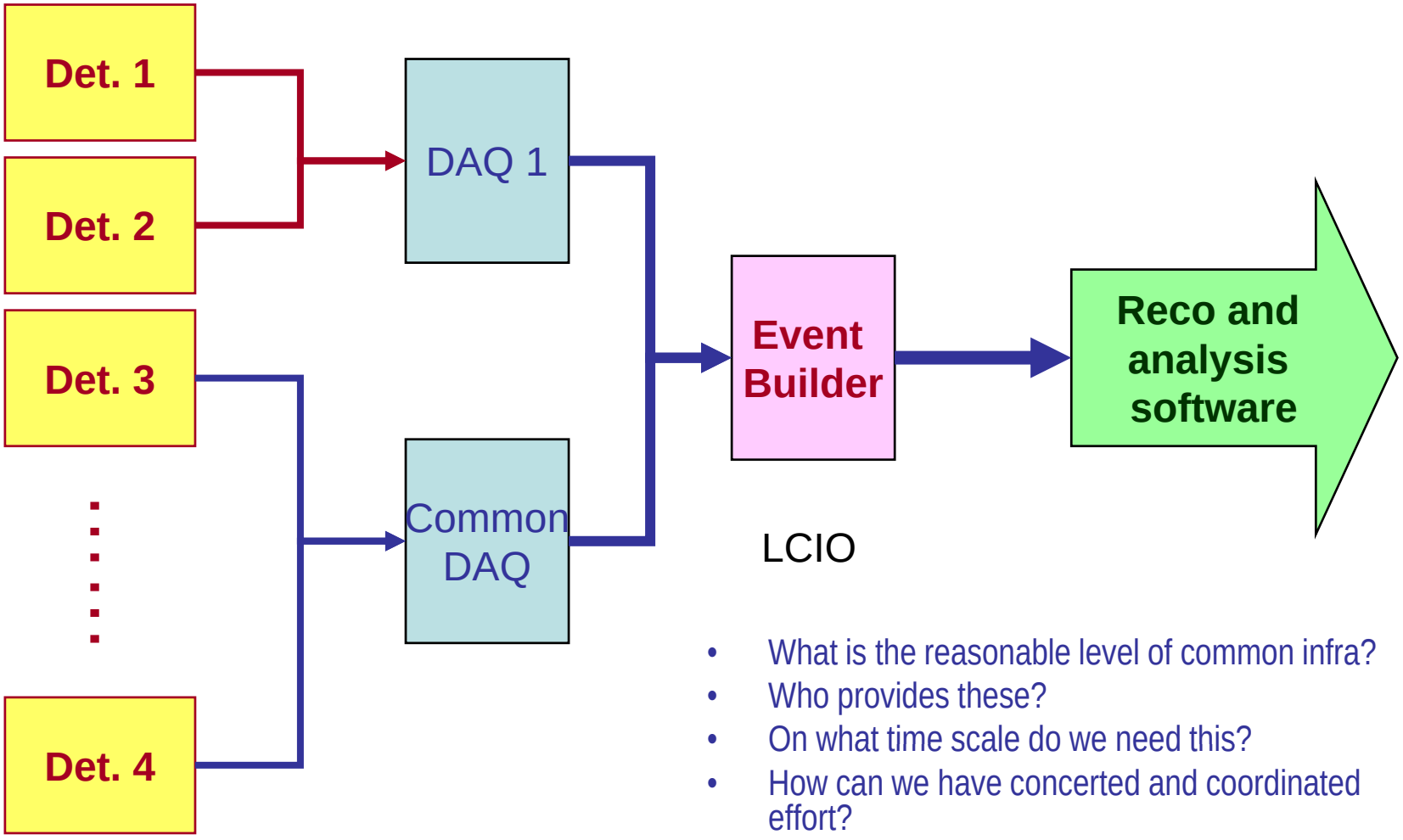
- Large bore, high field magnet (up to 5T)
  - VTX and tracking groups
  - Calorimeter technology tests…
- Mimicking hadron jets
  - VTX, TRK and CAL
- Common DAQ hardware and software
- Common online and offline software
  - Reconstruction and analysis software
- Tagged neutral hadron beam

Point of Merge for Commonality



- What is the reasonable level of common infra?
- Who provides these?
- On what time scale do we need this?
- How can we have concerted and coordinated effort?
- Do we need this at all?

Improving Simulation

- Critical for ILC detector R&D, especially for PFA development
- Current models do not describe data too well, not just shower shapes
- Data incorporated into the models are from 70s
  - Work ongoing to incorporate data after 70s
- Turn around time seems to be quite long (typically over a decade??)
  - How can this turn around time shortened to be useful for ILC?
- Do fresh new x-sec data help?
- What kind of data do we need?
  - Will neutral hadrons in a prototype detector helpful?

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Neutral Hadron Beam??

- Recent proposal seems to give high possibilities of momentum tagged neutral hadron beams at FNAL
- Do we need beam test with neutral hadrons?
  - Successful PFA means the HCAL measures neutral hadrons well with minimal confusion
  - Simulation models need some neutral hadron data
  - Hadron calorimeter calibration can use momentum tagged neutral hadrons
- Can we trigger effectively?
- What energy range?
  - Which ones do we need to understand better?

Detector R&D Needs

Detectors	N_Groups	Particle Species	P (GeV)	Magnet (Tesla)	N_Weeks/ yr	ILC time structure	Note
BI&MDI	2E+8ESA+1F+ 2C+3BC	e	up to 100	Not specified	64		Mostly low E elec
Vertex	10	e, π, p; μ	up to 100	1 – 3	40	Yes	
Tracker	3TPC+ 2Si	e, π, p; μ	up to 100	1.5 - >3	20	Yes	
Cal*	5 ECALs+3 DHCALs + 5 AHCALs	e, n, π, K, p; μ	1 – >=120	Not specified	30 – 60	Yes	
Muon/TCM T	3	e, π, μ	1 – >=120	Not specified	12		

*Note: Most calorimeter R&D activities world-wide are organized under CALICE collaboration.

Can some of these work concurrently?

LHC Experiences

- Must understand and minimize sources of systematic uncertainties
- Geometry must be well understood in MC
- Improvement and validation of MC must be incorporated in wide range of phase space
  - Still observe ~10% differences between data and MC with all corrections incorporated in
- Took long~~ time to reach current level of understanding
  - CMS took 66 weeks
  - Dedicated areas and floor spaces

The Ultimate Goal of IDTB07

- To provide a roadmap document to world-wide beam test facility managers, the ILC leadership and funding agencies for ILC detector R&D test beams to be in synch with the time scale of the accelerator
  - Time scale of the information in this workshop should cover the detector R&D test beam needs up to early next decade

The Test Beam Roadmap Document

- Will be on the order of 20 – 25 pages
- Target to release a draft in LCWS07
- Lay down the roadmap for ILC detector R&D test beam plans
- Current status and present plans of facilities
- Requirements and needs of all subdetector groups for the next 5 years
- Detector groups' CDR and EDR needs must be integrated in this document
  - SiD's needs must be fully integrated in this document

What does SiD want to accomplish from the test beam?

- At what level of beam tests do we want on our detector prototypes?
- Must extract as much information as possible for us to make informed decisions
- We need to define what we want
  - No one else will define the needs for us nor do we want someone else to define the needs for us
- What information do we want to extract in what time scale?
  - We should try to meet the time scale laid down but we cannot fly blind

Some Personal Remarks

- Making an informed decision on HCAL technology for SiD is a critically and important but difficult matter
  - Is PFA the most ideal thing to do?
  - What can we accomplish with PFA with what level of HCAL?
  - What technology would be the best thing that fits in SID with and without using PFA?
  - Do we want to test these technologies in beam?
  - If not how would we be able to make an intelligent decision?
  - Does a CDR that contains three different “possibilities” of HCAL make sense or is it useful?

Is a $1m^3$ HCAL Prototype Beam Test needed?

- It would be most ideal to test a pie of “the SiD detector” in the beam but
- We do not have “the SiD detector” clearly defined, yet …
- We still have to come up with a CDR that makes sense and that makes us feel comfortable scientifically
- I can’t imagine us picking an HCAL technology without seeing the performance in beam
- So what can we do?
- Build a prototype that can “fully” contain hadronic showers so that we can test its performances in a beam
- The prototype should give us sufficient flexibility to test various detector parameters
- Since we are testing the detector anyway, we might as well test its performance with PFA
  - Can we learn something? Yes, we can. We always can learn something more than what was learned before …

***By the way, the time scale for this prototype is now not because we were unprepared but because we were not supported…**

Conclusions

- WWLC test beam community is working hard to help facilities to prepare for the upcoming needs
- Time is very short for coming up with CDR and EDR
- Must not just rely on simulations
- We must be proactive in taking advantage of available facilities and defining our needs
- We need to test our prototypes in beam as much as possible if to be taken seriously
  - Will there be sufficient level of funding for prototypes for beam tests in time??