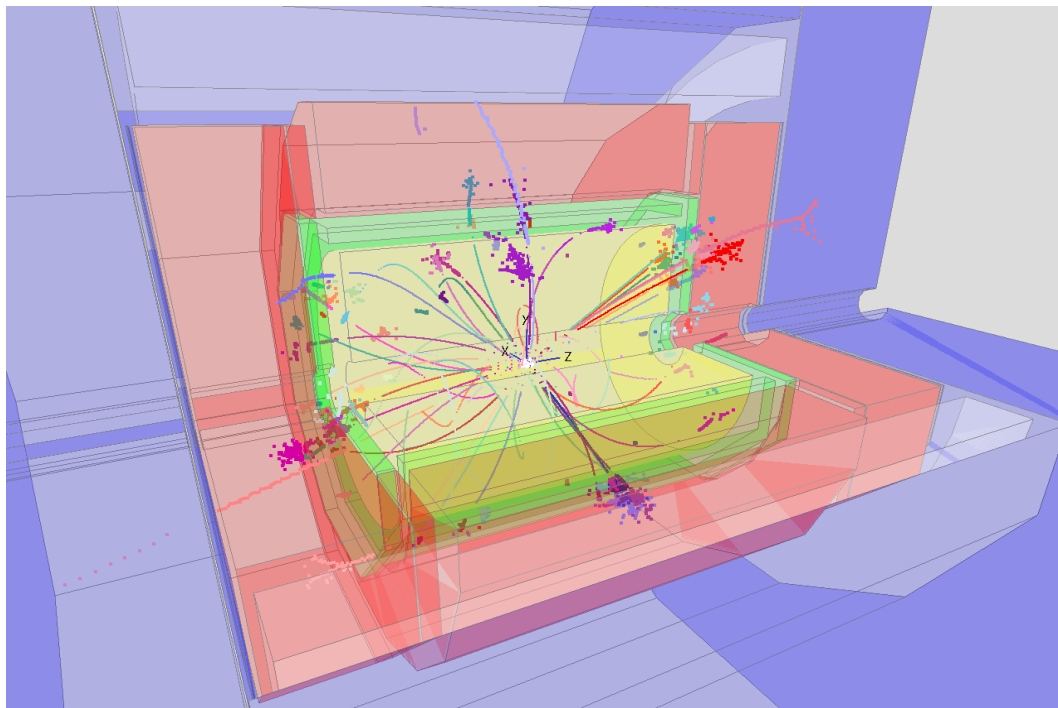
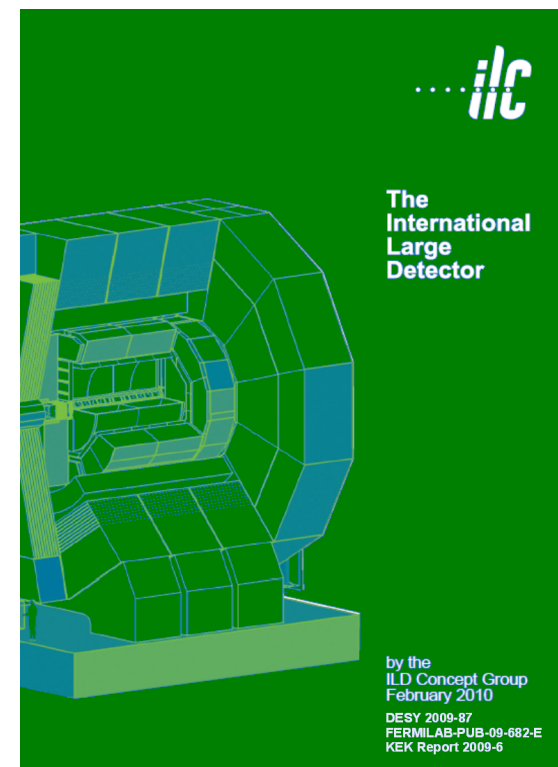


# ILD en route to the DBD



For the  
ILD concept group  
Ties Behnke, DESY

Report to IDAG on the status of ILD  
Sunday March 20, 2011



# ILD in Japan

We are very happy that – to our knowledge – all ILD members and indeed all ILC collaborators were not harmed in the horrible events in Japan last week.

Quite a few Japanese ILD members could not attend and we like to acknowledge their great contribution to ILD and to the work touched upon in this presentation.

Our good wishes and thoughts are with our Japanese friends at this moment!

# DBD: Outline

Firm up the case for ILD:

- Extend studies to 1 TeV
- Cover missing physics scenarios, improve existing analyses

Present an integrated detector

- Advance subdetectors beyond the conceptual state
- Present a fully integrated detector

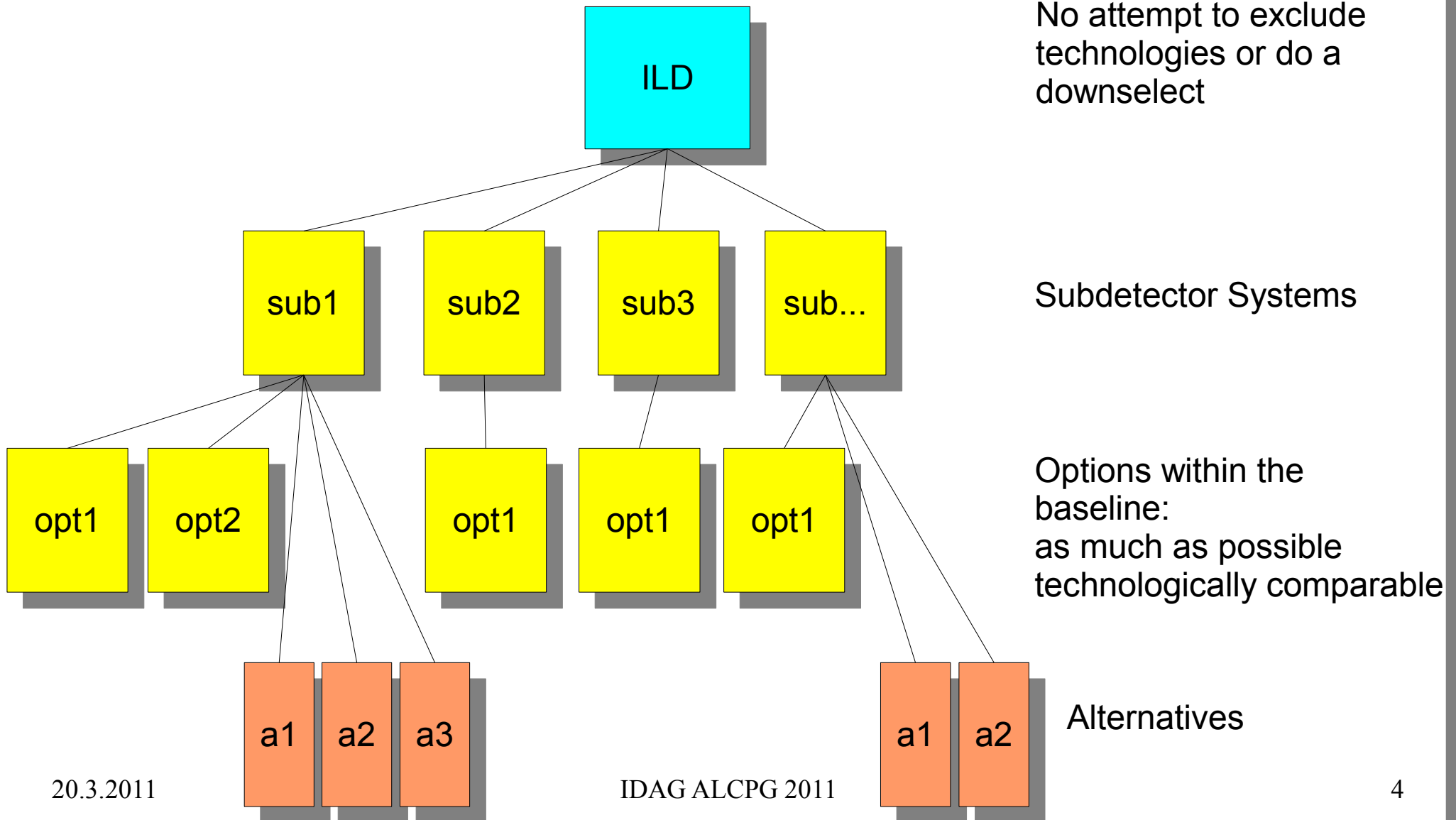
1. level engineering

Exclude fundamental problems with any design

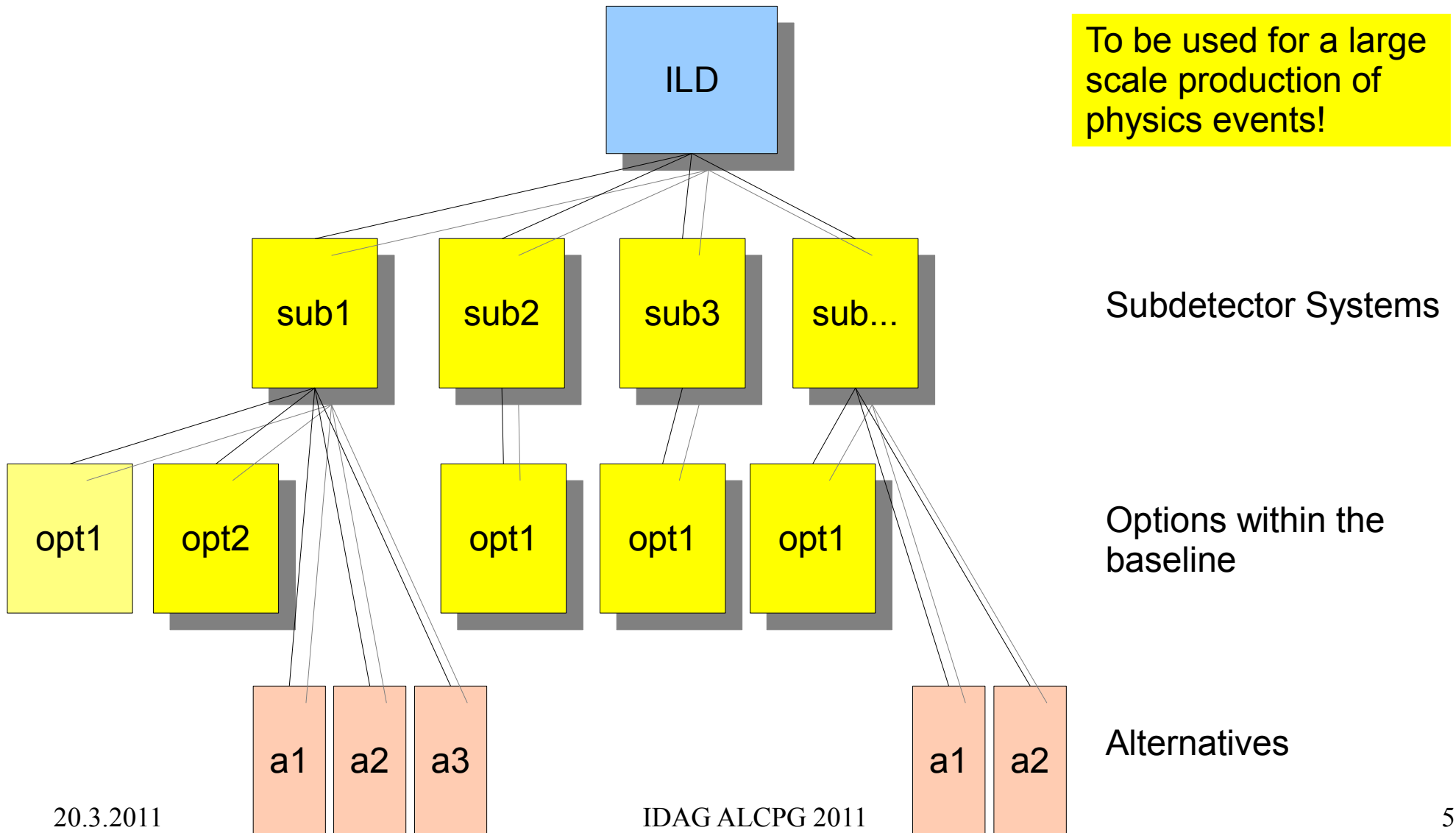
Formal editorial process has not yet started  
(consider this too early)

But discussions on scope and organisation of document have

# ILD baseline



# ILD: simulation baseline



# ILD: baseline detector

## The current picture

|         |                         |            |                    |         |
|---------|-------------------------|------------|--------------------|---------|
| Vertex  | CMOS                    | DEPFET     | FPCCD              | others? |
| Silicon | Single sided strip      | Pixel      | Double sided strip |         |
| TPC     | GEM                     | MicroMegas | Pixel              |         |
| ECAL    | W-Silicon/ Scintillator |            |                    |         |
| HCAL    | A-HCAL                  | D-HCAL     |                    |         |
| Muon    | Fe-Scintillator         |            | Fe-RPC             |         |
| FCAL    | W-Silicon               | IDA        | W-diamond          |         |

# What do we want for the DBD

## Subdetector Technologies:

- Demonstrate technology by test beam in a realistic prototype
- Demonstrate basic performance by analysis of test beam data
- Demonstrate ILD performance by integration into simulation with realistic model
- Demonstrate integration into ILD by 1<sup>st</sup> level engineering solutions
  - Per subdetector
  - Globally for ILD

Note: R&D for ILD is done by the R&D collaborations in close cooperation and coordination with ILD.

# What do we not want for the DBD

We do not want to exclude any technology

We do not want to select one baseline, if there is no need to do so

We do not want to define the detector too early

However we want to make sure that we have at least one working solution for each sub-detector realistically modeled and prototyped.



# Plans subdetectors

|         |  |               |
|---------|--|---------------|
| Vertex  | Full scale ladder prototype (mechanics) including cooling concept,<br>several chip technologies (FPCCD, DEPFET, MAPS)                                      | PLUME project |
| Silicon | Single sided Silicon sensor tested<br>edgeless sensors tested<br>Readout chip prototyped   | SiLC          |
| TPC     | GEM, muMegas readout tested with multi-module in LP,<br>pixel readout demonstrated under realistic conditions<br>Model for advanced end plate demonstrated | LCTPC         |
| ECAL    | Extensive test beam data, demonstrate system<br>integration, second generation prototype   | CALICE        |
| AHCAL   | Extensive test beam results, second generation readout<br>designed and tested, second generation prototype<br>demonstrated                                 | CALICE        |
| DHCAL   | Extensive test beam results, feasibility established,<br>readout concept established, second generation prototype<br>demonstrated                          | CALICE        |
| Muon    | Extensive Simulation and optimization, Scintillator readout<br>with SiPM established and prototyped, mechanical design<br>established                      |               |
| FCAL    | Sensor tests and readout chain done, system established  | FCAL          |

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Integrated readout

# Plans subdetectors

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Power pulsing/ power management

# Vertex plans

- FPCCD: large area sensor  
CO2 cooling system integrated in light C-foam ladder  
(KEK et al.)
- DEPFET: Developments mostly done in the BelleII context, strong synergy  
ILD prototype sensores (different from BelleII) demonstrated  
(Munich, Bonn, Valencia et al.)
- CMOS Two types of chips developed, specs meet all ILD requirements  
Submission planned  
Within PLUME: demonstration of a full double sided thin ladder  
(Strassbourg et.al.)

Remark: Funding for DEPFET is ensured, funding for FPCCD and CMOS is not ensured, or too low.

Note: other technologies are not excluded, but due to funding constraints are currently not studied in any detail.

# Silicon Tracking

Concept of one single sensor type for all Si strip tracking detectors

- Thinned
- Edge less
- Integrated pitch adapter

Readout ASIC to developed and demonstrated (IBM 130nm technology)

Integration work:

Develop mechanical concept for the integration of the Silicon detectors

Integration of Si into the ILD concept is challenging.  
Significant work is happening of the engineering side  
and on the performance integration (alignment, calibration, etc)

# Silicon Tracking

**During 2011-2012, 3 main R&D lines will be pursued within SiLC with the following goals:**

- R&D on sensors => tested for DBD: new planar and large single sided strips, new edgeless technologies, high IR transmittance sensors ( $\geq 50\%$ ); All well underway.
- R&D on FE & readout electronics => for DBD: Mix-mode full signal processing DSM 128 ch. prototyped chip; already developed several preliminary versions in 130nm CMOS techno.
- R&D on direct interconnect strip sensors and FEE

SiLC strategy for sensors & interconnect R&D, is based on working with established collaboration with Silicon experts Labs and Industrial firms.

**Developed tools that will be still improved over 2011-2012:**

- Detailed simulation of the 4 Si components within MOKKA: ready for detector optimization & Physics studies for the DBD
- Test beams to prove/evaluate the performances of each main R&D items: sensors, FEE and interconnect, built on the already large expertise acquired in test beams since 2007 (SiLC, EUDET & AIDA)
- Integration studies: very challenging because hybrid (Gas/Silicon) tracking system. For DBD: advanced design of new support structure (light & new materials: synergy with LHC), 2 alignment IR based schemes i) within same Si component, ii) between various Si components and TPC and others.

**Important:** to keep and even expand the expertise, get important funding, keep close collaboration contacts with Industry as well as expert Silicon Labs, SiLC is further developing the following strategy:

- => involvement in a few shorter experiments with interesting similar goals to future LC experiments.
- => Synergy with/participation to LHC upgrades
- => Application to other fields even to industrial applications

It allows overcoming decreased interest (scepticism) and thus decreased funding for LC. Helps in keeping strong & highly expert Institutes in Silicon tracking, even if momentarily not directly connected to ILC, but that will be essential for building the large Si trackers the day LC is decided for construction.

# TPC

- 2011: Continued work with the Large Prototype (at DESY)
- Multi-module readout with GEM and microMegas
  - Fundamental R&D for pixel readout

-over 6 years of MPGD experience has been gathered,  
-gas properties have been well measured,  
-the best possible point resolution is understood,  
-the resistive-anode charge-dispersion technique has been demonstrated,  
-CMOS pixel RO technology has been demonstrated,  
-the MWPC option has been ruled out,  
-the Micromegas option without resistive anode has been ruled out.

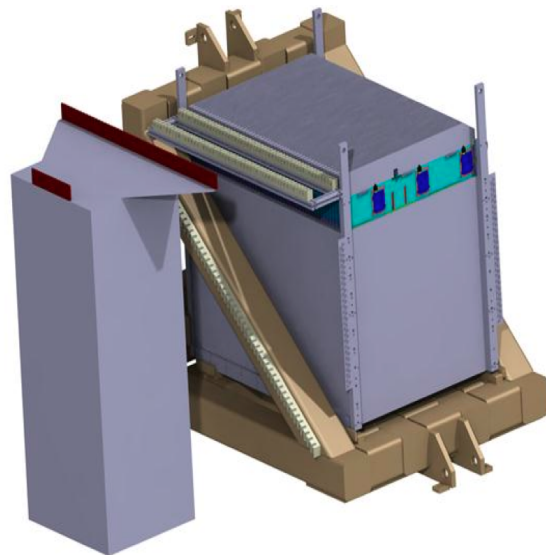
- 2012: Upgrade of LCTPC test facility at DESY

- Advanced (thinned) end-plate
- Large area readout (standard readout)
- Jet-like environment (if possible)
- Continued resolution studies
- Power pulsing studies
- Gating tests
- Simulation

# Calorimeter plans

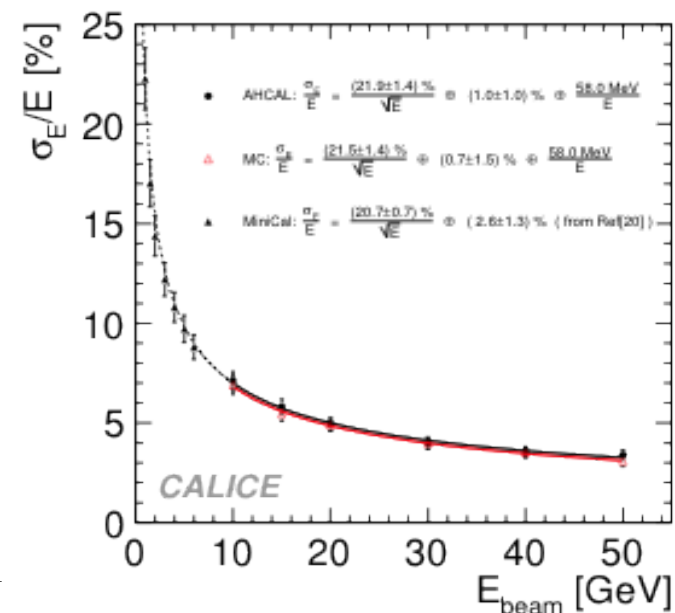
General issues addressed by Calorimeter (CALICE) in view of ILD DBD:

- establish performance of each technology (Energy resolution, two-particle resolution, etc)
- Validate simulation models, detailed modelling of parameters (resolution, linearity, ...)
- Gather operational experience
- develop scalable technologies (mechanical structures, including realistic dead areas, power dissipation, heat dissipation, etc)
- Identify open R&D issues



DHCAL  
Technology  
prototype  
(under construction)

IDAG ALCPP 2011





# ECAL

## Technical side

- extensive results from "physics prototype" from several test beam campaigns
- good understanding of mechanical and cooling aspects of the ECAL, including quite detailed engineering designs.
- prototypes in hand of silicon sensors, readout electronics and DAQ system suitable for eventual use in a final detector. Basic tests of these prototypes will have been made.
- similar for scintillator technology: detailed studies of MPPC, strip-MPPC coupling, calibration.

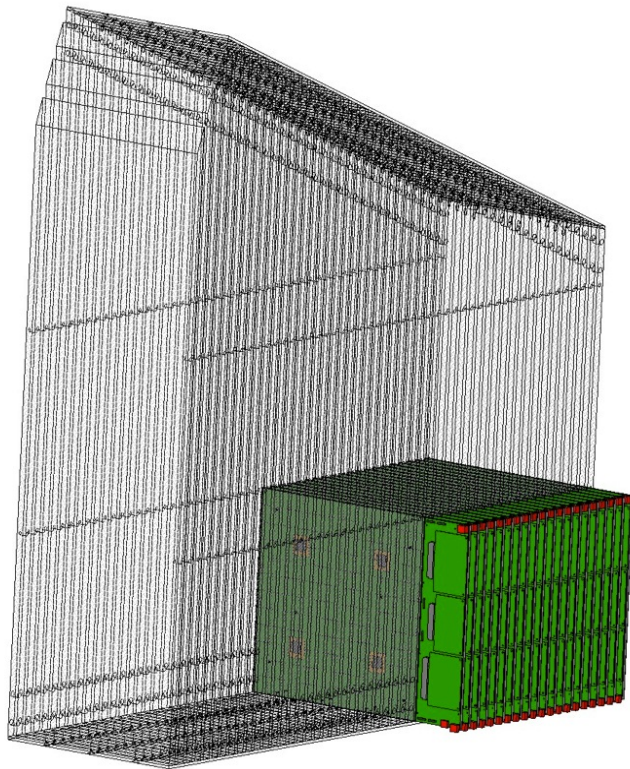
## Optimisation

- more realistic cost estimate for large scale silicon sensor production
- studies of performance vs. number of silicon detector layers
- studies of hybrid silicon-scintillator designs.
- strip-clustering algorithm for scintillator option, and performance studies vs. strip length.

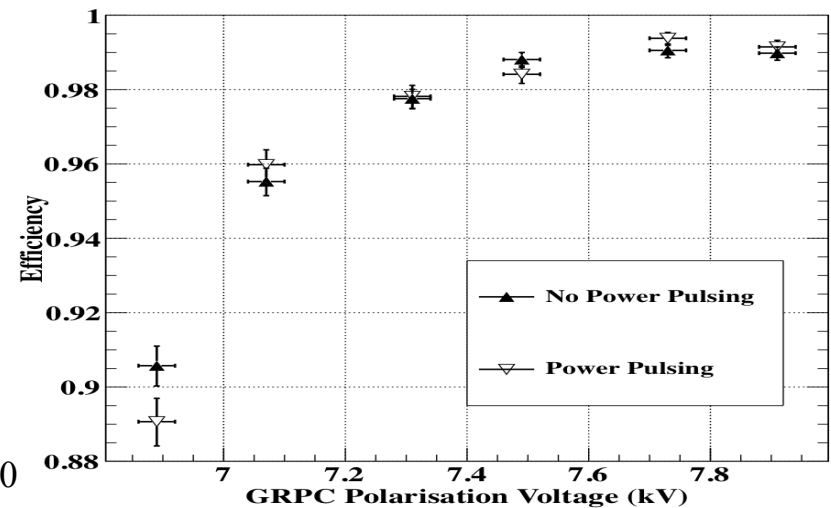
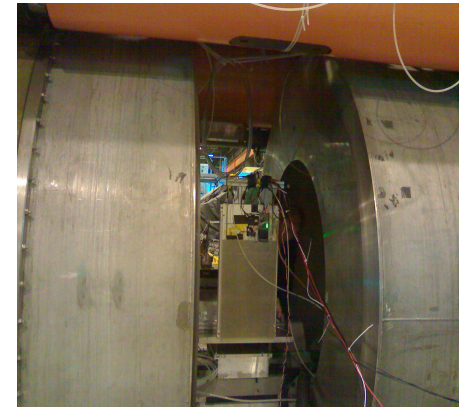
# HCAL

Ongoing major test effort for all technologies

Technological prototype for the AHCAL (design ongoing)



Key achievement:  
Demonstrate successful power pulsing in magnetic field (DHCAL)



# HCAL plans

DHCAL and AHCAL: demonstrate integrated readout, large area readout planes

Excellent results from test-beam campaigns:

- Several technologies, several absorbers
- Significant progress in the understanding of hadronic shower simulation

Engineering / integration

- Sophisticated designs for two geometries, two technologies (AHCAL, DHCAL)
- Both demonstrated by prototypes
- Extensive integration studies of HCAL into ILD

# FCAL plans

FCAL plans to have tested for the DBD:

One prototype sensor plane for BeamCal and LumiCal, completely equipped with readout chip and ADC ASIC

Expose this sensor prototype to beam and determine its performance (Signal to noise, cross talk, homogeneity, stability, edge effects)

Will demonstrate complete system performance for BeamCal and LumiCal

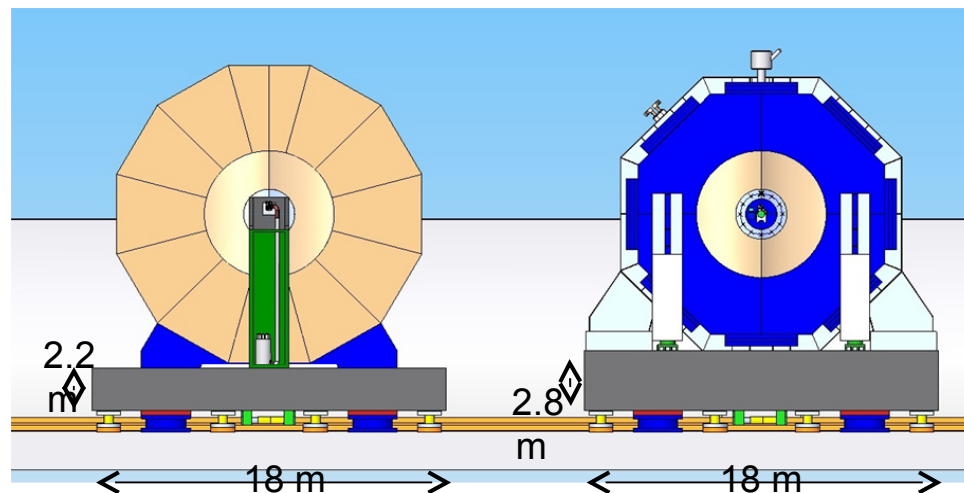
Different Sensor Options (Silicon, Diamond, Ga-As), none excluded

# Machine Detector Integration

Push Pull engineering work

Close cooperation with SiD and CERN (CLIC/ CMS) has been established

- Platform solution seems feasible as a common baseline between ILD and SiD
  - Significant effort at CERN/ ETH/ DESY/ KEK
  - Measurements at CMS prove vital
- ILD hall integration is studied in Europe for a deep site, KEK for a Japanese mountainous site



Personpower:

Support at CERN, KEK, DESY, ETH

Mostly part-time, limited overall effort.

Cooperation SiD and ILD + CERN (CLIC/ CMS) is essential

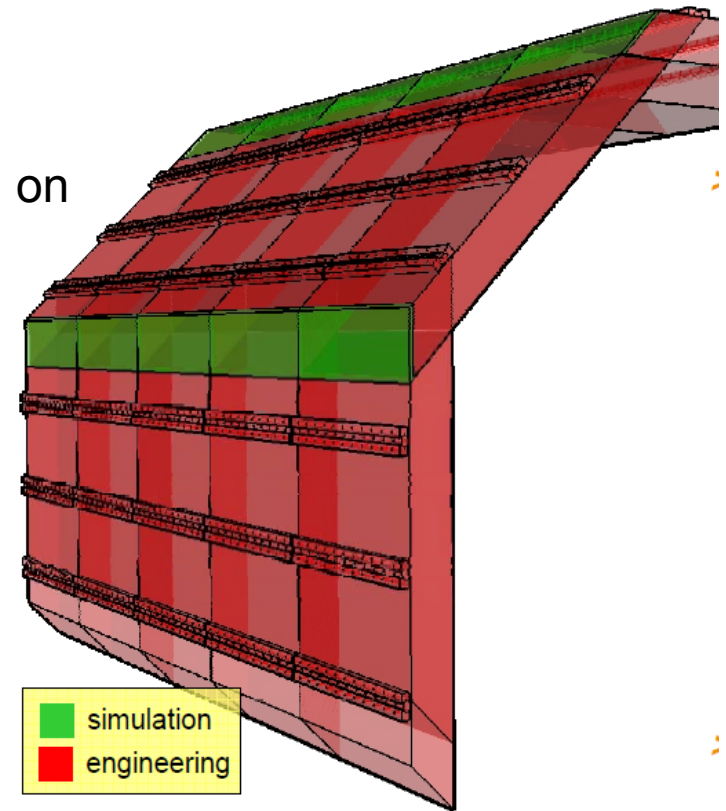
# Detector Integration

Central CAD model of ILD has been established at LLR/ LAL

Synchronisation with Simulation model is ongoing

Procedures for documentation in EDMS are being worked on

- Mechanical support of inner detectors – etc
- Rooster of dead material/ cables/ etc is being filled



Personpower:

- Small,
- Additional (limited) manpower will become available summer 2011 through AIDA

# Analysis

Goals:

Want to sharpen the case for ILD and the ILC

Want to show the performance of ILD at 1TeV

Effort is starting to re-gain momentum after a period of “quiet” following the LOI

Significant number of analyses are being pursued, in general good progress over the last few months.

Benchmark analyses are well covered  
Important additional analyses have started or continue

| Analysis   | Group   | BM |
|--|---|----|
| $e^+e^- \rightarrow ZH \rightarrow l^+ l^- X$  | Youssef Khoulaki, Hassan II, Morocco                                    |    |
| $e^+e^- \rightarrow ZH \rightarrow l^+ l^- X$ (for Vertex detector background/ optimisation) | Georgios Gerasimos Voutsinas, Strassbourg                               |    |
| $BR(H \rightarrow bb/ cc/ gg)$ in $BR(H \rightarrow bb/ cc/ gg)$ at 250 GeV and 350 GeV      | i) Nina Herder, Bonn<br>ii) Hiroaki Ono, Nippon Dental University       |    |
| Little Higgs with T- Parity at 1 TeV   | Eriko Kato, Tohoku  |    |
| Top Physics at 500 GeV   | Phillipe Doublet, Roman Poeschl, Francois Richard, LAL                  |    |
| $W e \nu, ZZ, Z \nu \nu, \nu \nu h$ at 1 TeV   | Graham Wilson, Brian van Doren, and Marco Carrasco-Lizaragga, Kansas    |    |
| ZHH  | i) Tomohiko Tanabe + Taikan Suehara Tokyo<br>ii) Junping Tian, Tsinghua |    |
| ttH  | i) Harjah Tabassam, Edinburgh<br>ii) Ryo Yonamine, KEK                  |    |
| long- lived staus  | Wataru Yamaura and Katsushige Kotera, Shinshu, DESY                     |    |
| Model-independent WIMP searches in $e^+e^- \rightarrow \gamma + \text{invisible}$            | Christoph Bartels, DESY   |    |
| Bi-linear R-parity violating SUSY  | Benedikt Vormwald, DESY   |    |
| SPS1a' in general, selectrons with small mass-differences (for SB2009-BAW)                   | Mikael Berggren, DESY   |    |
| TGC:s and polarisation (at least for SB2009-BAW)   | Ivan Marchesini, DESY   |    |
| SUSY "point 5"   | Jenny List, DESY  |    |



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All done in full simulation

# Analysis Examples

Higgs branching ratio measurement

Preliminary table of results  
for BR(H) measurement

Particular progress at 350 GeV

|                   | Ecm | $\Delta BR(cc)/BR(bb)$                                   |
|-------------------|-----|--|
| Neutrino<br>(nnH) | 250 | 20.7%(28.9%)   |
|                   | 350 | 14.2%  |
| Hadron<br>(qqH)   | 250 | 23.0% $\rightarrow$ 18.7%<br>(31.3% $\rightarrow$ 26.0%) |
|                   | 350 | 16.4% $\rightarrow$ 16.6%                                |
| Muon<br>(mmH)     | 250 | 39.5%(45.3%)   |
|                   | 350 | 43.9%  |
| Electron<br>(eeH) | 250 | 47.5%(50.9%)   |
|                   | 350 | 37.8%  |
| Combined          | 250 | 13.7%(18.0%)   |
|                   | 350 | 10.0%  |

Higgs self-coupling measurement

| Energy (GeV) | Modes  | signal | background | significance  |                     |
|--------------|--|--------|------------|---------------|---------------------|
|              |  |        |            | excess<br>(I) | measurement<br>(II) |
| 500          | $ZHH \rightarrow (l\bar{l})(b\bar{b})(b\bar{b})$     | 6.4    | 6.7        | 2.1 $\sigma$  | 1.7 $\sigma$        |
| 500          | $ZHH \rightarrow (\nu\bar{\nu})(b\bar{b})(b\bar{b})$ | 5.2    | 7.0        | 1.7 $\sigma$  | 1.4 $\sigma$        |
| 500          | $ZHH \rightarrow (q\bar{q})(b\bar{b})(b\bar{b})$     | 8.5    | 11.7       | 2.2 $\sigma$  | 1.9 $\sigma$        |
|              |  | 16.6   | 129        | 1.4 $\sigma$  | 1.3 $\sigma$        |

Have re-visited analysis,  
Complex multi-variant analysis  
Current status: improving

(but still about 2times worse  
than 10 years ago)

# Software

Define baseline detector by May 2011:  
basis for a possible second large scale production

Most significant update:

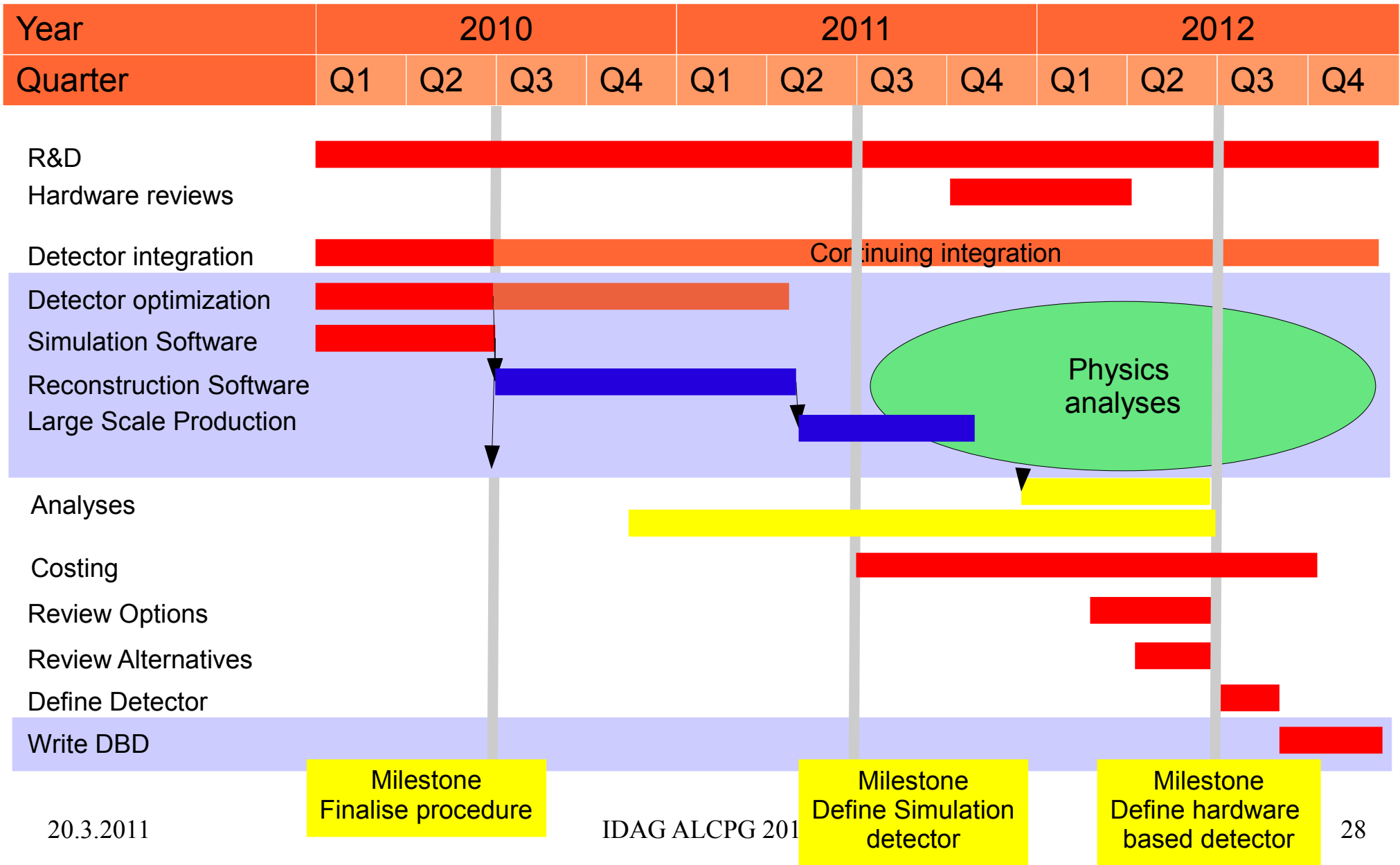
Hope to be able to establish new tracking software

Continuing small (but significant) upgrades to the system

Significant progress in geometry/ database support/ other issues.

Problem: personpower is tight,  
Problems in background studies  
Support for simulation software reduced

# ILD Milestones



# Summary

ILD has a clear plan to move towards the DBD

Significant progress has been achieved over the last year

Significant effort in Europe and Asia, less significant in Americas (but very valuable)

Funding problems in many areas and regions:

- Progress in most areas is funding limited

- Personpower is low and (overall) decreasing, but still existing, and groups are still committed

- We expect to be able to deliver a meaningful DBD in time.