

# Summary of the DCR Physics Group

## The WWS editors:

- **Americas**: Joe Lykken, Mark Oreglia
- **Asia**: Yasuhiro Okada, Satoru Yamashita
- **Europe**: Abdelhak Djouadi, Klaus Mönig

Presented at LCWS2006, Bangalore

# Goals of the Document

- Physics motivation for the ILC
  - *Feasibility* of important physics
    - Requires using simulations
    - **Backgrounds** distinguish us from **Detector part**
  - Support detector parameters
  - Support for 2 IRs/2 Detectors
- Important to discuss impact of ILC measurements on larger body of theory
  - Cosmology, etc
- Starting point for Executive Summary

# What We Presented March 9

- **Introduction**
  - Physics landscape in 2015 (incl. pos. outcome from LHC)
  - Important open questions in particle physics
  - Possible running scenario for ILC (E,L, options)
  - Physics signals at the ILC
- **The physics of electroweak symmetry breaking**
  - The Higgs sector
  - Couplings of gauge bosons (GigaZ, TGCs)
  - Top quark physics and QCD
  - Physics beyond the Standard Model: Supersymmetry
  - Some alternatives to SUSY
- **Connections to cosmology**
  - Dark matter: neutralinos, KK states?
  - Baryogenesis and CP violation, ??

We have already changed the original plan

- **Connections to Cosmology**

- ILC scenarios arise from new physics in the other topics
- We will mention cosmological connections in the appropriate sections

# Parallel Session Input: Higgs

- SM parameters
  - reach of 500 GeV machine...feasibility
  - Deviations arising from NP (radion...)
- LHC complementarity
  - Problem areas for LHC where ILC rescues
  - Enhanced model ID with LHC + ILC
- 1 TeV upgrade
  - SSB, h-self, higher MSSM, ...
- $H\gamma\gamma$  with  $\gamma\gamma$  option
- Made point of demonstrating detector feasibility and need for hybrid approach given short time scale; now have better VXD simulation and heavy flavor tagging tools

# Parallel Session Input: MSSM

- Discovery parameter space summary
  - Discussion of backgrounds
  - Hybrid simulation for cc?
  - Newer analyses covering large parameter space
    - DM compatible parameter summary
    - CP violating models
- LHC-ILC comparison (ILC special abilities)
- Impact on neutrino physics (GUT, seesaw)

# Parallel Session Discussion: EW/BSM

- WG happy with outline
- Beyond SM:
  - Have to limit model space:
  - Little H, UED
  - These models treat EWSB, DM candidates, and have broad impact on Precision EW, H
  - maybe ADD too (radion mixing)
  - SSB good for detectors
- BSM must justify 500 GeV machine!
- New simulations (VV,VVV) underway

# Current Concerns

- Sharing simulations with Detector part
- Showing performance with an optimal detector
- Can hybrid approach be ready in time?
  - Use existing simulation, but
    - Fast simulation with better tracking
    - Revised analysis
- Top/QCD not well represented



# Suggestions for Physics: Theory

- For many items one can use available material.
- For a few points, one needs some updates:
  - Determination of quark masses, ...
  - Scalar Higgs potential with effects of New Physics
  - Chiral Lagrangian approach for the no Higgs scenario
  - Update/extend benchmark points (lines?) for SUSY .....
- For some points, one needs new studies:
  - Model independent study of Higgs production and decay
  - DM, CPV, Baryogenesis (with light
  - KK Dark Matter at ILC? Other points with extra dims?...
- Joint experimental/theory new effort is needed:
  - Strongly interacting Higgs sector
  - Effect of tau polarization in rejecting bkg for low  $\Delta m_{\text{stau}}$
  - Scenarios for complementarity between LHC and ILC

# Experimental studies: Higgs

- **Higgs Branching ratios in HZ production**
  - This is the topic which needs a “full” simulation example!
  - Needs at least the tool for b-tagging (detector help!).
  - Several groups have made studies: unifying forces?
  - We need to cover as many final states as possible
- **Higgs self-coupling**
  - What kind of simulation can we make for ZZH?
  - How can go beyond the TESLA-TDR analysis?
  - Discuss WW  $\rightarrow$  HH in conjunction with ZHH ?
- **Other Higgs properties measurements**
  - ttH to be updated/completed (add info from LHC?)
  - WW $\rightarrow$ H for H  $\rightarrow$   $\mu\mu, \gamma\gamma$  adapt from CLIC study
  - Update the determination of CP properties
  - Try to improve also mass determination.

# Experimental studies: Higgs (continued)

- **Strongly interacting Higgs sector: a priority!!!!**
  - Summarise/update the scenario with resonances
  - See for new studies with the chiral approach
  - Explicit examples in BSM (Higgsless in extra dim. ...).
- **Beyond the SM Higgs**
  - HA, charged H update?
  - bbH/A for  $\tan\beta$  measurement?
  - MSSM in LHC difficult scenarios:  $H \rightarrow \text{inv}$ , ...
  - NMSSM for tough LHC scenarios ( $h \rightarrow aa \rightarrow 4b$ )
- **Other collider options**
  - $\gamma\gamma$

# Experimental Studies: BSM

- **SUSY processes: focus on difficult processes at LHC**
  - Low  $\Delta m$  scenarios for stau production
  - Chargino/neutralino production for heavy scalars
  - (including CPV, mass generate gauginos, ...)
  - Light stop production for interesting scenarii
  - Higgs  $\leftrightarrow$  chargino/neutralino decays?
  - Lumi for SPS point determination?
  - Any interesting item for GMSB, non minimal MSSM, ???
- **Other BSM scenarios:**
  - Selected items from extra dimensions? Which ones?
  - Z' properties measurements?
  - Production of new matter particles?
- **Any other interesting topic to be discussed?**

# Experimental studies: EW and QCD

- **Top and QCD**
  - qq production: uncertainties on cross section,  $A_{fb}$
  - Top weak couplings in  $ee \rightarrow tt$  ; which E?
  - QCD in continuum tt production?
- **Gauge boson physics**
  - Update W mass and width measurements?
  - Update triple gauge boson couplings determination?
  - Link with parameters for strong Higgs sector?
  - Update measurement of  $\theta_w$  at gigaZ?
  - Simulation for WW/ZZ separation ?
- **Any other items???**

# Timetable

- **LCWS06** has been our first contact with the ILC community
- **Soon:** The Physics Ctte is coordinating with the Detector editors; writing assignments
- **July:** ALCPG in Vancouver
  - We will prepare a draft using available simulations
  - Opportunity for detailed discussion with you
- **November:** ECFA in Valencia
  - Need final draft for discussion
  - Some of the simulation goals are ambitious -- we need to see where we stand

# Community Input

- We encourage comments for all of you
- Use the wiki page we will set up on [www.linearcollider.org](http://www.linearcollider.org)
- Physics groups should keep us informed of new developments
- And you can reach each of us:
  - [klaus.moenig@desy.de](mailto:klaus.moenig@desy.de)
  - [yasuhiro.okada@kek.jp](mailto:yasuhiro.okada@kek.jp)
  - [lykken@fnal.gov](mailto:lykken@fnal.gov)
  - [m-oreglia@uchicago.edu](mailto:m-oreglia@uchicago.edu)
  - [satoru@icepp.s.u-tokyo.ac.jp](mailto:satoru@icepp.s.u-tokyo.ac.jp)
  - [djouadi@th.u-psud.fr](mailto:djouadi@th.u-psud.fr)