

# LHC Physics & Detector Upgrade

LHC is a potential new direction to broaden our physics menu, through new initiatives on Super LHC detector upgrade.

## LHC Day (Apr/24)

(organized by Eric Colby, JoAnne Hewett, Tor Raubenheimer, Su Dong)

LHC accelerator project

Jim Strait

Physics at the LHC upgrade: - The Super LHC

Albert De Roeck

US LHC Accelerator Research Program

Jim Strait

LHC Detector Upgrade

Dan Green

LHC phase-0 (2007-2012):  $0.1-1 \times 10^{34} \Rightarrow \sim 250 \text{ fb}^{-1} / \text{expt}$

Super LHC (2012-2016):  $1 \times 10^{35} \Rightarrow 3000 \text{ fb}^{-1} / \text{expt}$

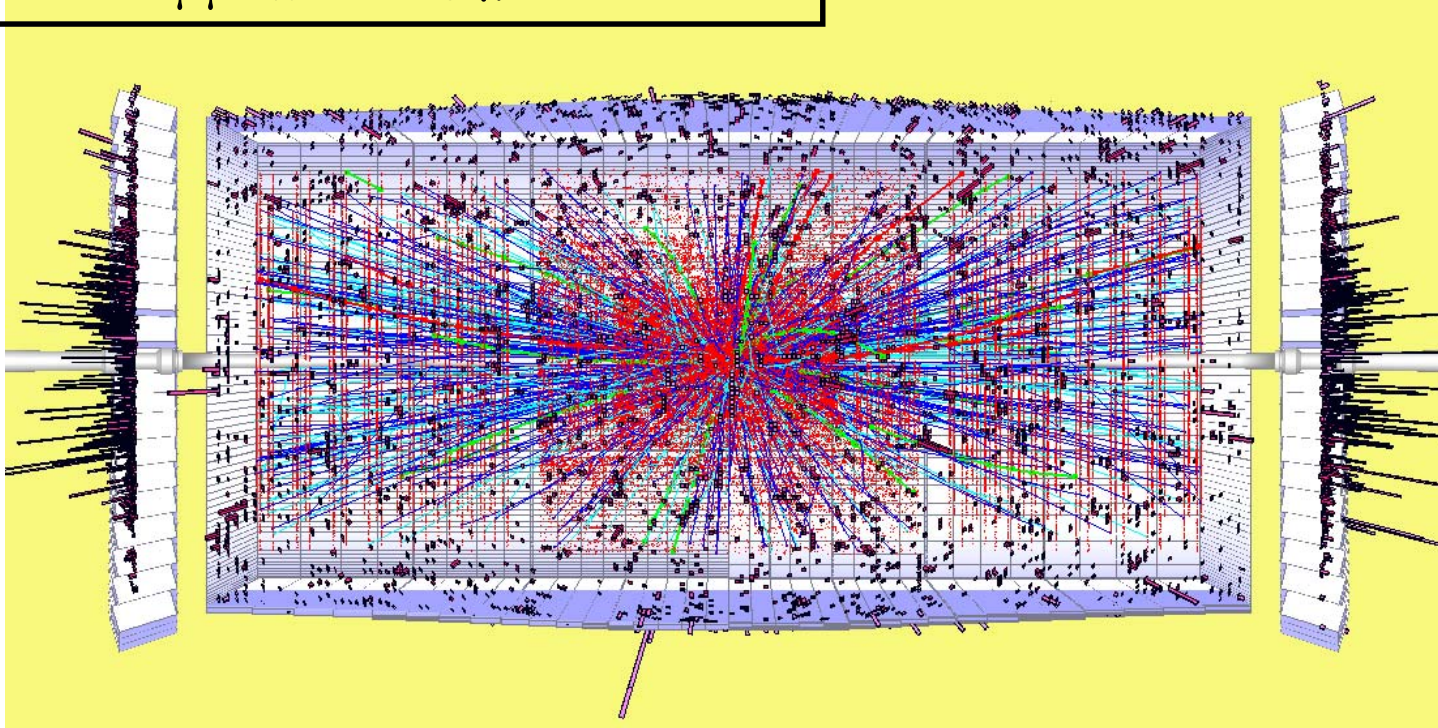
*The SLHC scope discussed so far is only luminosity upgrade - same CM energy (can reach up to 15 TeV). Limited discussion on energy upgrade in far future.*

# Super LHC Physics Menu

- **Improvements from LHC:** triple/quartic gauge couplings, top quark,  $Z'$  & compositeness, but LC can generally do better. (although SLHC will be there first ?)
- **Higgs physics:**
  - Main strength: wide  $m_H$  range coverage for  $t\bar{t}H$  Yukawa coupling and Higgs self-coupling.
  - Improved coupling measurements, but LC will do better.
- **SUSY:**
  - Main strength: squark, gluino reach:  $\rightarrow 3$  TeV.
  - Some extended reach of MSSM Higgs not covered by LC.
- **Extra dimensions:**
  - Improved reach for black-hole production, KK states.
- **Strongly coupled vector bosons (if no Higgs):**
  - Can have first significant signal (LHC stat. insufficient).

# *What experiments need to confront...*

$H \rightarrow ZZ \rightarrow ee\mu\mu$  at  $10^{35} \text{ cm}^{-2}\text{s}^{-1}$



*Detector issues for Super LHC at  $10^{35}$  :  
25ns  $\rightarrow$  12.5ns crossing ; Radiation dose;  
In a 0.5rad cone,  $\sim 70$  hadrons,  $\sim 42$  GeV of  $P_T$  per crossing.*

# Super LHC Detector Upgrade

- Calorimeter and muon systems may survive with moderate upgrades.
- Trigger/DAQ need upgrade (crossing rate & data volume).
- Tracking system reaching their radiation dose limit at end of phase-0. Severe performance degradation due to mainly occupancy increase.

=> Main Upgrade project: *Complete rebuild of tracking system.*

$R > 60\text{cm}$ : Push existing Si-strip technology to larger radius.

$20 < R < 60\text{cm}$ : Further development of current pixel technology.

$R < 20\text{cm}$ : *New technology is needed. Inner radius  $\sim 7\text{cm}$ . Very tough rad hard requirement and need very fine segmentation to beat density effect.*

# SLAC Community Involvement Scenarios

- LHC is the primary energy frontier facility until LC turn on, which may be as late as 2015. Are we comfortable to be completely out of the energy frontier until then ?
- In the scenario that LC is in the US and there is no funding for any other major facility such as super-B on site, and PEP-II is ending in 2010, what will be the main science output from the Lab. during 2010-2015 ? Could joining LHC be an effective fill of the gap ?
- The primary project of interest is the R<20cm inner tracker upgrade. Significant combined experience in this area among the SLAC community. SLAC as R&D host ?
- Although LHC detector upgrade is a more affordable option, time scale is similar to LC detector R&D and need to start soon. Some R&D effort sharing with LC ? Most people involved in LHC are unlikely to switch to LC.