Accelerator-based Particle Physics
Opportunities at SLAC/Stanford

Andy Haas / SLAC
Stanford Student Orientation
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Standard Model

Describes the fundamental particles and forces...

- Origin of the wide range of masses (few eV to 170 GeV)?
- Very different mixing matrices for quarks and leptons??
- Higgs boson / SUSY ???
- Why 3 generations ????
- Missing anti-matter ?????
- Dark Matter ??????
- Unification / Strings ????????

Accelerator experiments !!!
Overview of Projects

• **BaBar (and SuperB R&D)**
  - e+e- @ ~10 GeV, precision b-physics
  - Data taking ended, but many analysis opportunities

• **ATLAS / LHC**
  - pp @ 14000 GeV, discover new physics
  - Data taking of collisions starts in December

• **SiD / ILC**
  - e+e- @ 1000 GeV ?, precision new physics
  - R&D ongoing, hopefully build next decade
BaBar Analysis Opportunities

- 465M BB events
- 630M cc events
- 460M $\tau\tau$ events

Could do rotation and get hands on real data now!

Analysis topics:
- Exclusive $b\to c$ decays
- Charmonium-like states
- Charm mixing
- Searches for light Higgs, LFV, missing Bottomonia ...

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Super B
(to be built near Frascati lab?)

- A great detector R&D opportunity here at SLAC
  Focusing DIRC prototype now in Research Yard

Detection of
Internally
Reflected
Cherenkov light
ATLAS @ LHC
LHC: The Energy Frontier

- 14 TeV pp collisions (7x higher than Tevatron)
- Large cross sections for heavy objects such as top quark, Higgs, and possible new particles
- First collisions in December !!!
First Beam Sep/10/2008


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ATLAS Physics Opportunities

Current SLAC ATLAS physics analyses:

- Top quark decays
- New physics searches with b-tags and missing energy
- Searches for SUSY Higgses
- Searches for long-lived new particles
- ...

Close collaboration with SLAC theory group
SLAC Involvement in ATLAS

3 Faculty / fellow
12+ Staff physicists & professionals
7 Postdocs
4 Grad students
    +Tier2 computing staff
... and growing

Experimental Involvement

- Pixel vertex detector and tracking
- High Level Trigger and DAQ
- Simulation
- Tier-2 computing center
- ATLAS DAQ upgrades and pixel inner most layer replacement
Students on ATLAS

- Ideal timing for a thesis on a major new frontier experiment with exciting discovery potential

- After initial courses at Stanford, expected to move to CERN to take on experimental duties and jump into the physics activities, and back to Stanford for thesis writeup in the final year(s).
ATLAS Projects at SLAC

Rotation projects:
• Detector performance and calibration studies
• Physics signature reconstruction studies
• Trigger performance study and algorithm software
• Detector simulation improvements
• Detector upgrade testing

Detailed info on ATLAS@SLAC for students:
http://www.slac.stanford.edu/exp/atlas/students/

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International Linear Collider & SiDetector

Highly granular detector for precision measurements

\( Z^{-}\rightarrow \text{jet+jet} \) vs \( W^{-}\rightarrow \text{jet+jet} \)
SiD Projects at SLAC

- Particle-flow calorimetry algorithms
- Calorimeter detectors
- Tracker simulation / optimization
- Silicon detector design / testing

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What You Should Remember

• Accelerator experiments study the SM and try to see what lies beyond it!

• Excellent data analysis opportunities:
  - Can work with real BaBar data now
  - ATLAS data coming soon, likely the best choice for thesis

• Interesting detector research opportunities:
  - SuperB: DIRC R&D
  - Many ATLAS detector operation and software projects
  - ATLAS detector upgrade projects
  - SiD: cutting-edge detector R&D

• Can mix and match from above

• Come and talk to us if interested!