

# Particle Physics

## Department of Physics and Astronomy

Visit of Vice-President Academic

Dr Jamie Cassels

22 October 2001

### Agenda

- introductions
- overview talk and discussion
- tour of laboratories
  - MUSE computer cluster
  - ATLAS cryogenics signal feedthrough production

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### Overview

- research goals
- the particle physics group at the University of Victoria
  - the IPP and TRIUMF connections
- research overview
  - OPAL, ATLAS, BaBar, Computing
  - funding
  - training of highly qualified personnel
- particle physics group goals and future plans

# The Particle Physics Group at UVic

## Goals and accomplishments

- particle physics is a major focus of the department
- research goals
  - to study the fundamental constituents of matter and their interactions
  - to contribute to the training of highly qualified personnel
- internationally recognized group
  - responsible for major components of international projects
  - the University of Victoria is a well known name in particle physics
  - diverse, talented, at or above critical mass for large impact
    - 31 researchers (faculty, fellows, associates, students, technologists) from 9 countries
    - research activities include extensive period spent at world class laboratories abroad (Geneva, Stanford)

# The Particle Physics Group at UVic

## Internationally recognized research group

- faculty
  - experimentalists: Keeler, Kowalewski, Lefebvre, Roney, Astbury (emeritus)
  - theorists: Picciotto, and new faculty to join in 2002
- Institute of Particle Physics fellows
  - McPherson (at CERN), Sobie
- onsite TRIUMF staff
  - Birney, Charron, A.S. Dowling, Langstaff (at CERN), Lenckowski
- research associates
  - Agarwal, Banerjee (at SLAC), Fincke, Kanaya, Poffenberger
- graduate students
  - Ph.D.: Bailey, Brown, Dobbs, Fortin, Jackson, Sanderson, Stumpf, Vachon
  - M.Sc.: Soundararajan, Yun
- computer support professional
  - van Uytven (B.Sc. Computer Science)
- technologists
  - A.W. Dowling, Holness, Vowles

# The Particle Physics Group at UVic

## Faculty

- R. Keeler (83) Ph.D. UBC 81
  - Electroweak physics (UA1, OPAL , ATLAS)
  - Director of IPP (Institute of Particle Physics), Chair Subatomic Physics GSC (2000-01)
- R. Kowalewski (97) Ph.D. Cornell 88
  - B physics, particle lifetimes, reconstruction software (OPAL, BaBar, ATLAS)
- M. Lefebvre (91) Ph.D. Cambridge 89
  - Electroweak physics, Calorimetry (UA2, RD3, ATLAS)
  - Founded ATLAS Canada, ATLAS Collaboration Board
- C. Picciotto (68) Ph.D. UC-Santa Barbara 68
  - Weak Decay Theory
  - Department Chair, Secretary-Treasurer of IPP
- M. Roney (96) Ph.D. Carleton 89
  - Electroweak, drift chambers and B & tau physics (OPAL, BaBar, ATLAS)
  - BaBar Executive board (1998- )
- A. Astbury (83) (emeritus) Ph.D. Liverpool 61
  - FRS, FRSC, Pearce Chair (1983-2000)
  - Director of TRIUMF (1994-2001), Director of IPP (1989-1994)
  - Co-Spokesperson of UA1 (1978-83), Nobel Prize winning experiment

# The Particle Physics Group at UVic

## Institute of Particle Physics of Canada

- coordinates and promotes particle physics in Canada
  - 12 Universities, 150 scientists
- seven permanent scientists; two chose Victoria:
  - R. McPherson (97)                      Ph.D. Princeton 95
    - new and rare processes (BNL-E787, OPAL, ATLAS)
    - OPAL physics coordinator (2001-2002)
  - R. Sobie (92)                              Ph.D. Toronto 85
    - OPAL tau physics coordinator (1998-)
    - spokesman for Victoria computer storage CFI request
    - IBM SUR grant 1999 (\$840,000)
    - Canadian representative on the ATLAS National Computing Board
- director (2001-2006): R. Keeler

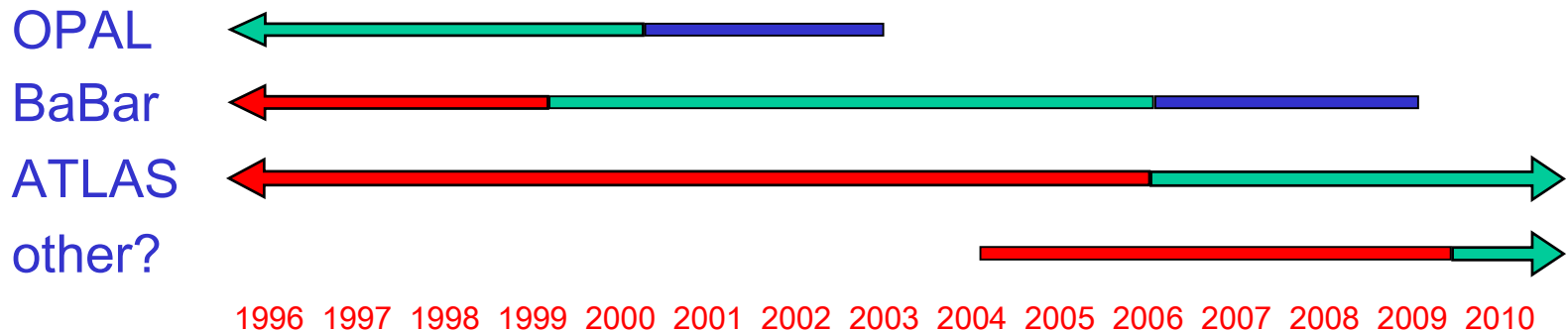
# The Particle Physics Group at UVic

## TRIUMF

- national laboratory supporting accelerator based research
- Victoria is one of the four founding universities
- a design group is located at Victoria
  - provides engineering & infrastructure support for particle physics
    - **essential requirement**
    - **SLD Calorimeter**
    - **BaBar Drift Chamber**
    - **ATLAS Endcap Hadronic Calorimeter and Feedthroughs Engineering Support**
  - A.S. Dowling (TRIUMF engineer)
  - R. Langstaff (TRIUMF senior designer)
  - M. Lenckowski (TRIUMF junior designer)
  - P. Birney (TRIUMF senior technologist)
  - L. Charron (TRIUMF admin assistant)

# Research Overview

- three large projects
  - OPAL (CERN) has recently completed data taking
    - final data analysis and interpretation
  - BaBar (SLAC) started data taking in 1999
    - will continue for several years
  - ATLAS (CERN) is under construction
    - first beam for physics expected in 2006

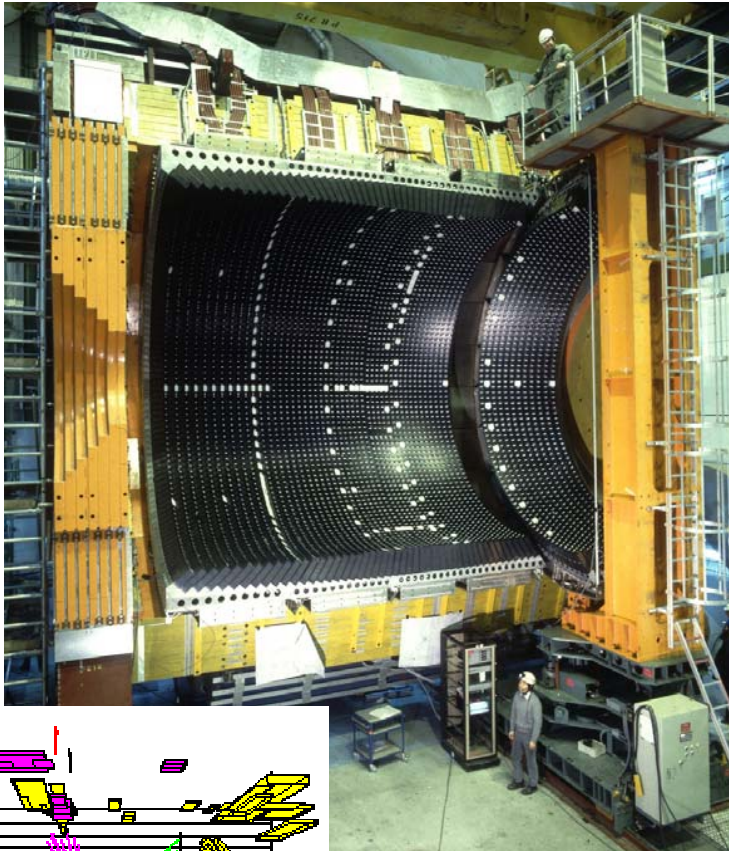


- interests beyond ATLAS
  - Next Linear Collider
  - neutrino physics (workshop with strong international content organized by Keeler, Kowalewski, Astbury; Dunsmuir Lodge, November 2001)

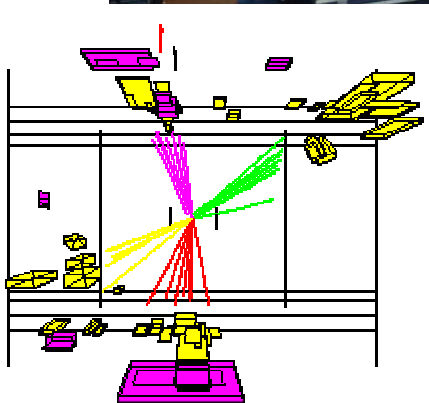


McPherson  
Kowalewski  
Keeler  
Roney  
Sobie

# Research Overview: OPAL



- large detector at the LEP electron-positron collider at CERN, Geneva
- data collection ended Nov 2000
- UVic group concentrates on precision measurements of the electroweak force
  - analyze Z and W pair data
    - recognized tau lepton experts
  - two of the world's most precise electroweak measurements recently completed in UVic
- UVic built and operated a major computer center at CERN for the whole collaboration
- UVic hosted the international tau 2000 conference, held in Victoria



350 people  
20 institutions  
10 countries

# Research Overview: BaBar

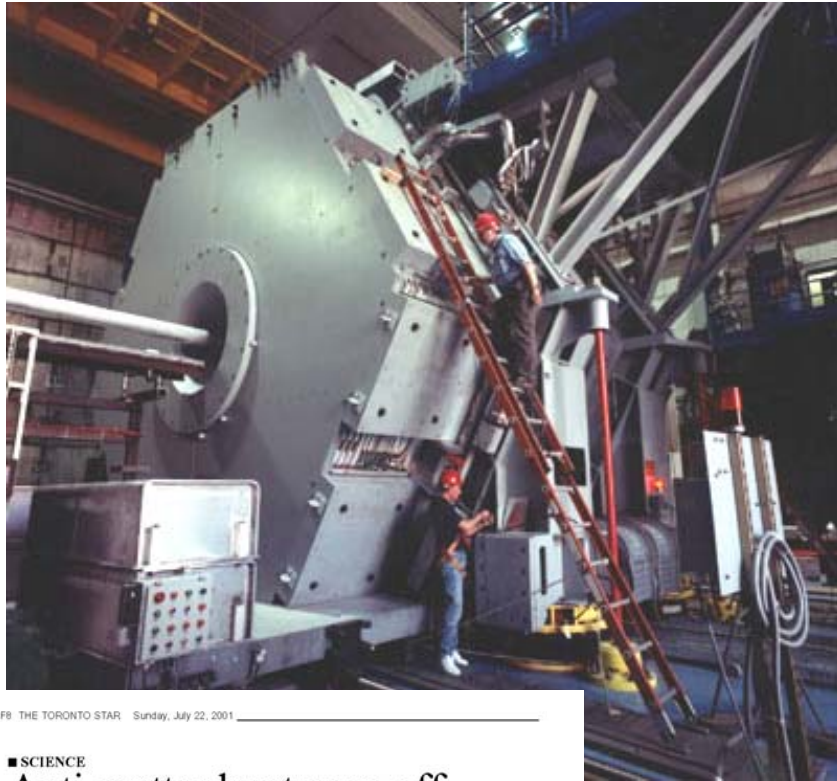


PHOTO BY THE TORONTO STAR Sunday, July 22, 2001

## SCIENCE

### Anti-matter hunt pays off

Canadian physicists find evidence nature really is lopsided in certain processes

BY PETER CALAMAI  
SCIENCE REPORTER

**W**HENEVER Star Trek needed a dramatic crisis, the show knew they could count on anti-matter.

Anti-matter fuelled the warp drive that propelled those starships. It was dangerous stuff. Just a small glitch in the containment field and, kaboom, goodbye Enterprise or Voyager and all who sailed in her.

And that's what most people know about anti-matter: Its tricky but strictly science-fiction stuff. An elite group of Canadian



REALLY WIRED: A scientist at TRIUMF, Canada's national laboratory for particle and nuclear physics in Vancouver, replaced 19 of the 29,000 wires in the Canadian-built detector used to probe the nature of anti-matter.

pher Hearty, a research scientist with the Institute of Particle Physics at the University of British Columbia. University of Montreal and McGill University. The combined price tag for the detector and what's called the B factory

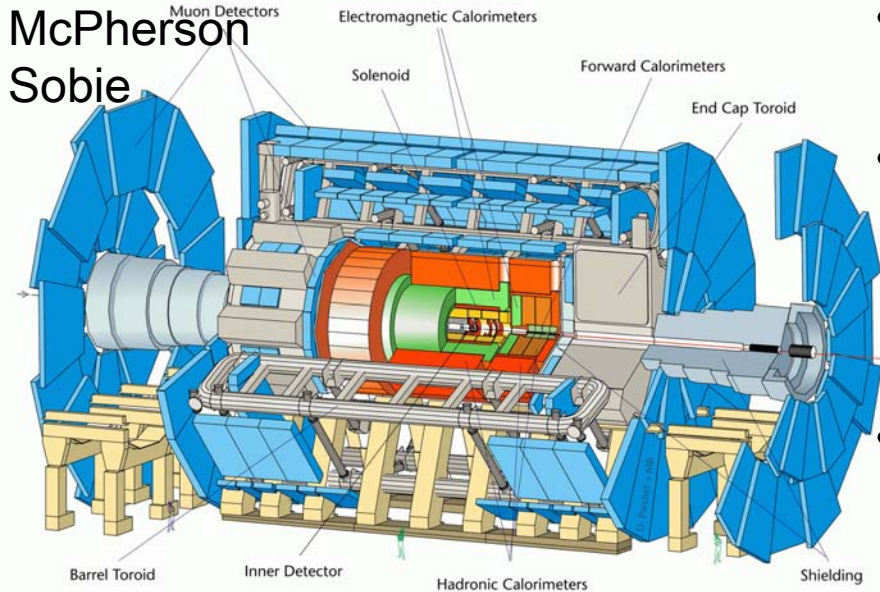
554 people  
72 institutions  
9 countries

- BaBar detector at the PEP II B-factory at the Stanford Linear Accelerator
- measure fundamental symmetries
- precision measurements of charge-parity violation in nature
  - b-quark charge-parity asymmetry
  - quark mixing
  - tau electroweak physics
- a large component of the detector (the drift chamber) was assembled at TRIUMF
- UVic is the only Canadian group contributing to the production of computer simulated events



Astbury  
Keeler  
Lefebvre

# Research Overview: ATLAS



- multi-purpose detector for the Large Hadron Collider at CERN
- proton-proton collision at the energy frontier
  - study the origin of mass
  - search for new physics
- cryogenics components under construction at UVic, essential to the success of the \$450M experiment
  - \$4.28M of Major Installation Grant for the endcap signal feedthroughs
  - first units sent to CERN in Sep 2001
- intense software activities
  - beam test software
  - object oriented code development
  - object database



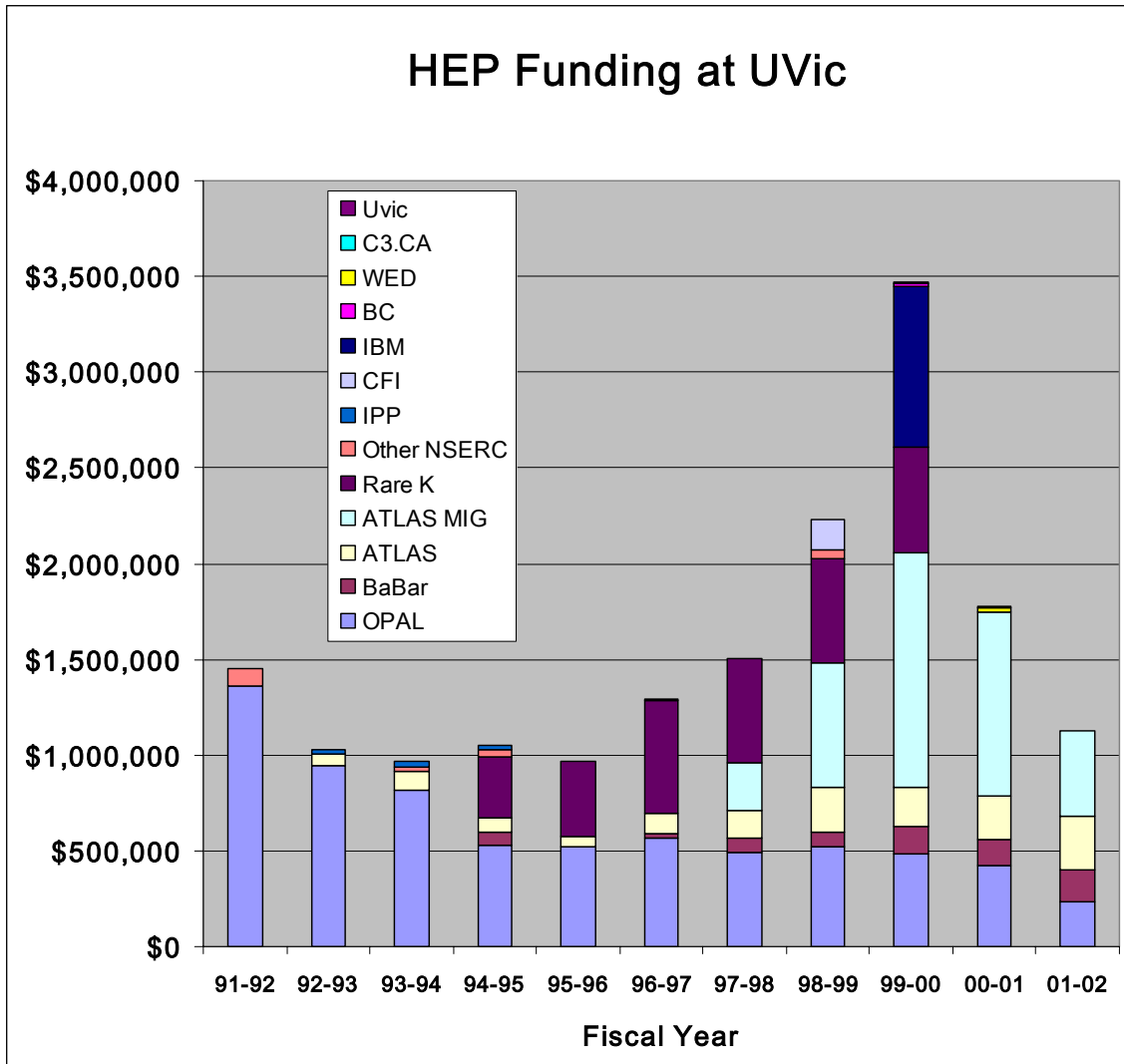
1850 people  
135 institutions  
35 countries

# Research Overview: Computing

- Current and future HEP experiments face real challenges in computing
  - large data sets (ATLAS > 1,000,000 Gbytes/year !)
  - Object Oriented technology
  - large international collaborationswhich require
  - large data store, distributed data and processing, fast links
  - coordination!
- computing infrastructure
  - Minerva (CFI HPC award 1999 \$2.5M, IBM SUR grant \$840k)
  - MUSE (CFI funded 40 node linux PC cluster with 750 Gbytes of disk for HEP)
- CFI initiatives
  - innovation fund: \$12M requested for storage and processing
    - awaits decision in Dec 2001
  - international access fund: \$6M requested for computing resources at CERN
    - project outline given approval to proceed to full proposal (1 of 13 in Canada)
- GRID activities
  - the WWW was invented at CERN to allow physicists to exchange information
  - GRID: world-wide computing (over \$1000M committed). CERN central world player
  - strong GRID activities in our group at UVic, with world-wide contacts (C3.CA funds)

Astbury  
Keeler  
Kowalewski  
Lefebvre  
McPherson  
Roney  
Sobie

# Research Overview: Funding



Excellent track record for attracting funding

- operating
  - about \$750k per year
  - ATLAS and BaBar level increasing
- ATLAS MIG
  - \$4.28M over 7 years
- IBM grant
  - February 2000
- CFI grant
  - MUSE computer cluster
- Rare K decays
  - Bryman now Warren Chair at UBC

# Research Overview

training of highly qualified personnel: graduate students

- 18 M.Sc. and 14 Ph.D. degrees awarded since 1990
  - many NSERC and FCAR (Québec) scholarships
- Presently 8 Ph.D. and 2 M.Sc. students
  - 2 NSERC and 1 FCAR scholarships
- Recruitment
  - 2 M.Sc. to start in 2002
  - actively recruiting
- Quality
  - two have won the Governor General's gold medal for best Ph.D. thesis at Victoria
  - one is a faculty member at the University of Alberta
  - PDF's at SLAC, DESY, SNO, Carleton, Michigan
  - many international conference contributions and publications
  - spend at least a year in Geneva or Stanford working on experiment

# Ph.D. theses since 1990

- K. Graham (UWO), “Precision Determination of the Electroweak Mixing Angle and Test of Neutral Current Universality from the Tau Polarization Measurements at OPAL”, 2001. (Roney)
- I. Lawson (UNB), “Neutral Kaon Production from One-Prong Tau Decays”, 2000. (Sobie, Keeler)
- D. O’Neil (UNB), “Performance of the ATLAS Hadronic Endcap Calorimeter and The Physics of Electroweak Top Quark Production at ATLAS”, 1999. (Lefebvre)
- T.A. Porcelli (McMaster), “Measurement of Muon Catalysed DT Fusion in Solid HD”, 1999. (Beer, Marshall)
- S. Robertson (Calgary), “A Measurement of the Tau Electronic Branching Ratio”, 1998. (Sobie, Keeler)
- J. White (UVic), “Testing Lepton Universality using One-Prong Hadronic Tau Decays”, 1998. (Sobie, Lefebvre)
- S. Richardson (UBC), “A Study of Some Rare Radiative Meson Decays”, 1997. (Picciotto)
- P. Knowles (Dalhousie), “Muonic Processes in Solid Hydrogen Films”, 1996. (Beer, Marshall)
- M. Vinciter (McGill), “A Precision Measurement of the Ratio of the Effective Vector to Axial-Vector Couplings of the Weak Neutral Current at the  $Z^0$  Pole”, 1996. (Keeler)
- M. Rosvick (UofA), “Measurement of the Neutral Current in the Standard Model Using the Tau Polarization Asymmetries Determined from the Decay  $\tau^- \rightarrow \rho^- \nu_\tau$ ”, 1995. (Keeler)
- J. Steuerer (Freiburg), “Measurement of the Product Branching Ratio  $f(b \rightarrow \Lambda_b) \cdot BR(\Lambda_b \rightarrow \Lambda \Gamma^- \nu_{\text{bar}} X)$ ”, 1995. (Astbury)
- M. Welsh (Glasgow), “The  $\pi^0 \gamma \gamma$  Form Factor, Validity of Soft-Photon Amplitude, and Soft-Photon Excess in Hadron Scattering”, 1995. (Picciotto, Fearing)
- A. Turcot (Concordia), “The Search for the Decay  $K^+ \rightarrow \pi^+ \nu \nu_{\text{bar}}$ ”, 1994. (Bryman, Astbury)
- P. Schenk (UWO), “A Measurement of the Partial Width of the  $Z^0$  Boson into b Quarks and the Forward-Backward Asymmetry in the Reaction  $e^+e^- \rightarrow Z^0 \rightarrow b\bar{b}$ , Using Inclusive Electrons”, 1992. (Astbury)

# Research Overview

training of highly qualified personnel

- Our group's research activities provides unique training opportunities for professional and technical staff:
  - research associates
    - critical and independent thinking
    - perform in large international collaborations, in most cases spending a year in Geneva or Stanford
    - data analysis and computing skills
  - engineers, designer, technologists
    - very challenging projects
    - mechanical and electronic design and construction
  - computer support professionals
    - leading edge computing with international scientific and industrial collaboration



# Summary and Particle Physics Group Goals

- strong group in particle physics
- excellent research programme, internationally recognized
  - data analysis of world's highest energy electron-positron collisions with the OPAL detector
  - detailed study of fundamental symmetries with the BaBar detector
  - detector construction for ATLAS - a detector for physics at the high-energy frontier
  - provides unique training
- actively recruit graduate students
  - provide world class opportunities
- fill Pearce Chair
- strengthen group
  - junior faculty
  - aim at a group size of 6 experimentalists and 2 theorists

# Aerial View of CERN





# ATLAS Collaboration



# Aerial View of SLAC

