...a new route for the US experimental physics manpower pipeline?

BU/DOE Research Semester/Summer Abroad Program
with ATLAS, CMS, and T2K @ CERN and UniGe

½ of BU juniors abroad (12% of all students away at any time)...but no PY majors!
(and 17% of our student body are international students)

Physics curriculum most demanding...did not allow junior research semester abroad

goal: internship in a major research lab for undergrad physics majors
until last year an unmet goal here, and everywhere else

but, every summer since ’05, BU undergrads in CMS test beam at CERN
proving they can do hands-on work, student theses at CERN

infectious thrill of real science is transformative:
e.g. some of my summer research undergrad alums:
George Gollin, Eric Hazen, Mike Levi, Rene Ong, Wesley Smith...

but now in 2nd year of BU/CERN 7 mo. Program:
school term: 2 mornings/week @ UniGe for 2 classes (curricula now the same!)
afternoons + summer: research at CERN, mentored by BU physicists

L. Sulak, Status Report to DOE, 24 January 2011
...e.g. CERN summer research:

part of BU HF team 7/2008

above the HF- detector
in its garage

undergrads:
Matt Carleton
Stijn Blyweert*

graduate students:
Andrew Clough
Phil Lawson

post-doc & ass’t research prof
Arno Heister*
Dragoslav Lazic*

*not in pix
e.g. undergrad summer research: BU student John Penwell celebrating the mounting of an ATLAS muon chamber at CERN summer 2007
What does DOE support? (in addition to student summer subsistence)

CERN Orientation (first 6 weeks)
so that students can immediately contribute to their research group,
concurrent with meeting with mentors and research groups,
1) 5-week, 4 hr/wk, intensive software training at CERN, including
   computational methods
   statistical analysis of experimental data
   intensive orientation to LHC software: ROOT, C++, etc.
   introduction to ATLAS and CMS software packages
   homework analysis exercises with real LHC data
2) radiation and safety training
3) guest PY lecturers: e.g. Black, Carrera, Ellis, Heister, Quigg, Shank…
4) tours of CERN and the pits of Atlas and CMS

Undergrads not at CERN can follow the LHC software lectures
via EVO video conferencing and our website, tab at
http://physics.bu.edu/sites/geneva-program
...~ the only undergrads at the LHC inauguration were ours!

At LHC Physicist’s Building 40 on that famous day,
Max    Chelsea  Mike   Michael  Andrea    Elim       Ashley
Yellen  Bartram  Lloyd  Hedges  Welsh  Cheung  Rubinstein

good gender mix
past BU/CERN/UniGe physics projects + their BU mentors:

**ATLAS**
- Black/Harrington/Yan on-site (Ahlen/Butler @ BU)
  - muon chamber data quality monitoring and end-cap alignment

**CMS**
- Bose/Fantasia
  - trigger validation & new menus for higher $\mathcal{L}$ with collision data
- Musienko
  - SiPM evaluation and development
- Heister/Lawson
  - maintenance & DQM of DCC (practiced w/ugrads 2 summers)
- Sulak/Heister/Lawson in CERN test beam
  - optimization of novel light detectors for calorimetry upgrade

**T2K**
- Blondel/Dufour
  - design of a far neutrino in Korea for T2K
In student’s eyes, what did they do that they deemed important?

**Mentoring Teams**

**CMS**

Elim: “optimizing HLT software menus.”

Ashley & Michael: “our code is used by the collaboration to evaluate L1 trigger efficiencies for V + jet and other analysis.”

Mike: “my simulation code helps evaluate SiPM test beam data”

**ATLAS**

Andrea & Max: “we discovered funky muon chambers which could have easily caused a fire in the pit.”

**T2K**

Chelsea “I brought back to BU simulation software for my UROP that we didn’t have here.”
...how to satisfy term-time PY course requirements while at CERN?

Courses at UniGe equivalent to those at BU physics by collaborators
  E&M II      Prof. Martin Pohl (Chair)       ATLAS
  QM I        Prof. Alain Blondel           T2K and ATLAS
  Lectures in FR; questions, TAs, problem sessions, exams in EN

Internships mentored by BU researchers, monitored by
  Director (Sulak) and co-Director (Dr. Dieter Schinzel)

C++ & Root Course for Experimentalists, taught by Prof. Heister

Directed Research at CERN on Atlas or CMS by ~11 BU staff
  at UniGe on T2K with by Dufour, BU SK PhD

BU’s Geneva Satellite Campus… housing, offices, non-Physics classes
  1 block from famous Jet d’Eau
  Intensive Physics French during orientation month

Maison BU (dorm)  66 BU interns at UN, WHO etc. & now @ CERN
  Physics “House Master” Phil Lawson, BU PhD grad student, CMS
View near BU classroom building
Maison BU
(the dorm)
1 block from le jet d’eau
physics “house-master”
Phil Lawson
at Maison BU
View at the end of the block from the dorm
...schedule?  time allocation?

<table>
<thead>
<tr>
<th>Month 1</th>
<th>Months 2-4</th>
<th>Months 5-7 - Summer</th>
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<tbody>
<tr>
<td>½ CERN orientation</td>
<td>½ Directed Research</td>
<td>¾ Directed Research</td>
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<tr>
<td>&amp; Comp Physics @CERN</td>
<td>¼ E&amp;M @ UniGe</td>
<td>¼ CERN Summer School Lectures</td>
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<tr>
<td>½ Intensive French</td>
<td>¼ QM @ UniGe</td>
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...funding

BU physics mentor volunteers: enlightened self-interest, multiplying their hands
airfare, housing, and breakfast provided by BU during school term
UROP funding ($2k during school term, $4k during the summer)
2010: support from Provost & DOE…supplemental funding requested from NSF

...upon student’s return to BU in the fall?
students continue work on BU DOE projects as senior theses, work for distinction

...preparation in fall term before going to Geneva?
weekly tutorial in physics French (Prof. Dan Weiner) + 1st semester French
intro to research project and members of their research group at BU:
  ATLAS - MDT test chamber (Ahlen, Nation), work on alignment (Harrington)
  Advanced Lab: muon telescope, fast electronics, radioactive sources
  CMS - DCC II & SiPM irradiation tests (Hazen, Lawson, Rohlf)
e.g. prep for CERN: Ashley Rubinstein testing CMS SiPMs at MGH’s Proton Cyclotron (with Sulak)
2010 Program:

~14 applicants qualified (>3.0 grade average, stable, etc.)
~7 unanticipated startup problems with scheduling:
    these hurdles now eliminated

rave reviews from mentors and 7 students who completed program
their code being used by Atlas, CMS, & T2K
    e.g. their CMS test beam shifts made BU top contributor
    now applying for grad school

Response from senior participants:

   CERN Direct General Rolf Heuer very positive:
       appointed Dr. Rolf Landua as liaison physicist for program
       an agreement of collaboration has been drafted

   Prof’s Blondel & Pohl: “the BU students raised the level of both of
       the classes”

2011 Program: 5 students in residence now, limited by funding
    (5 at BU on LHC Software course via EVO video conf)

2012 & 2013 Programs: 22 and 20 students, respectively, pre-applied
officials of BU’s Int’l Programs

cementing the BU/UniGe agreement in June ’09

underground at the CMS detector

with originators of research semester abroad program
...a new route for the U.S. particle physics manpower pipeline?

funding for sciences cut in the U.S.,
  much of what’s left moving to centralized national labs

emigration of high energy experiments to other countries

fewer opportunities for hands-on training
  of young researchers in universities

BU is helping to fill the void,
with program to train & inspire
young scientists…
  our future researchers

2011 BU/CERN class with mentors in the Atlas pit
  Sulak, Awal, Shaffer, Lewin, Necib, Black, Sekon
  ...again good gender mix