

*...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 2<sup>nd</sup> 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**

*...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

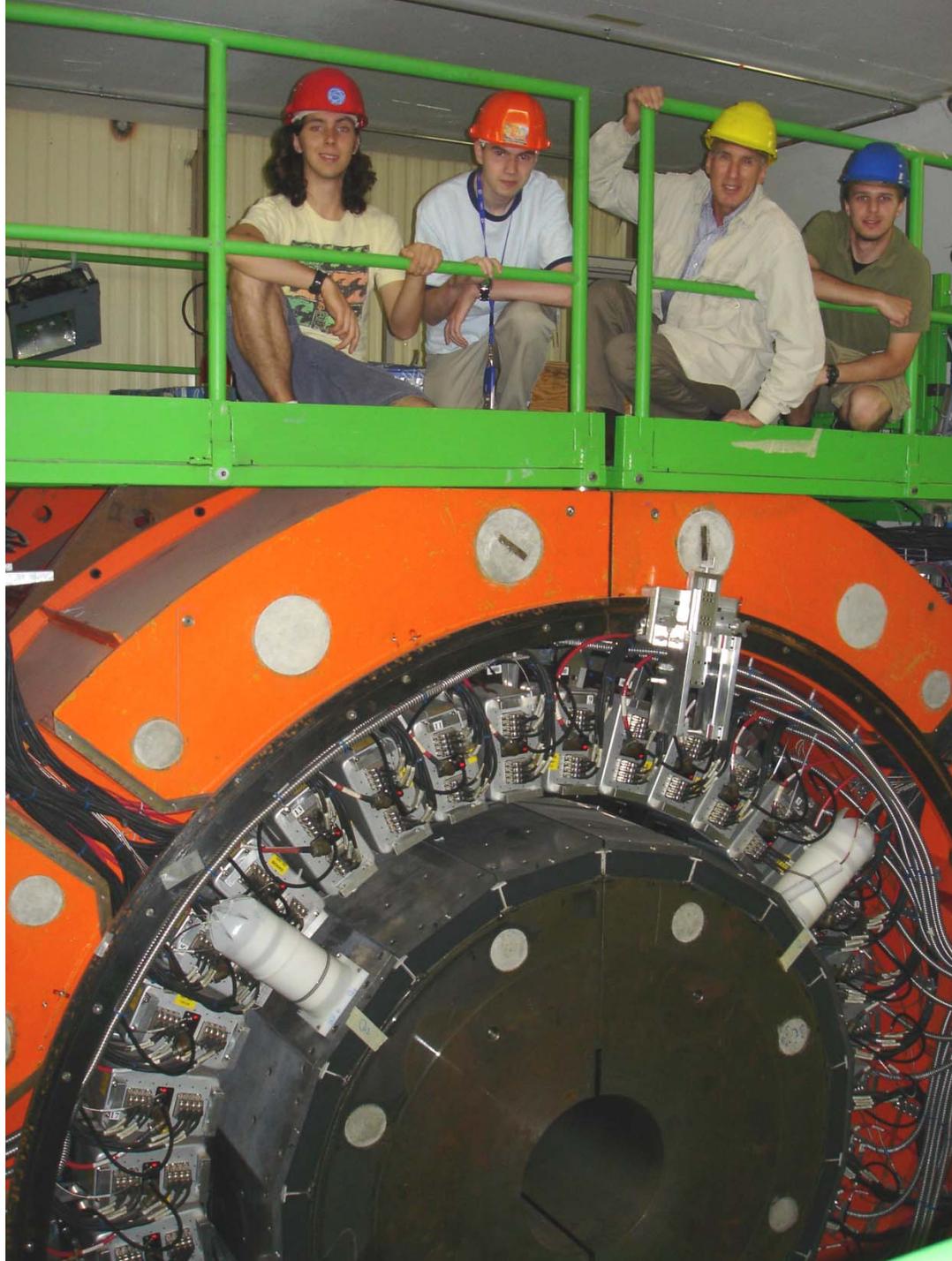
Phil Lawson

post-doc & ass't research prof

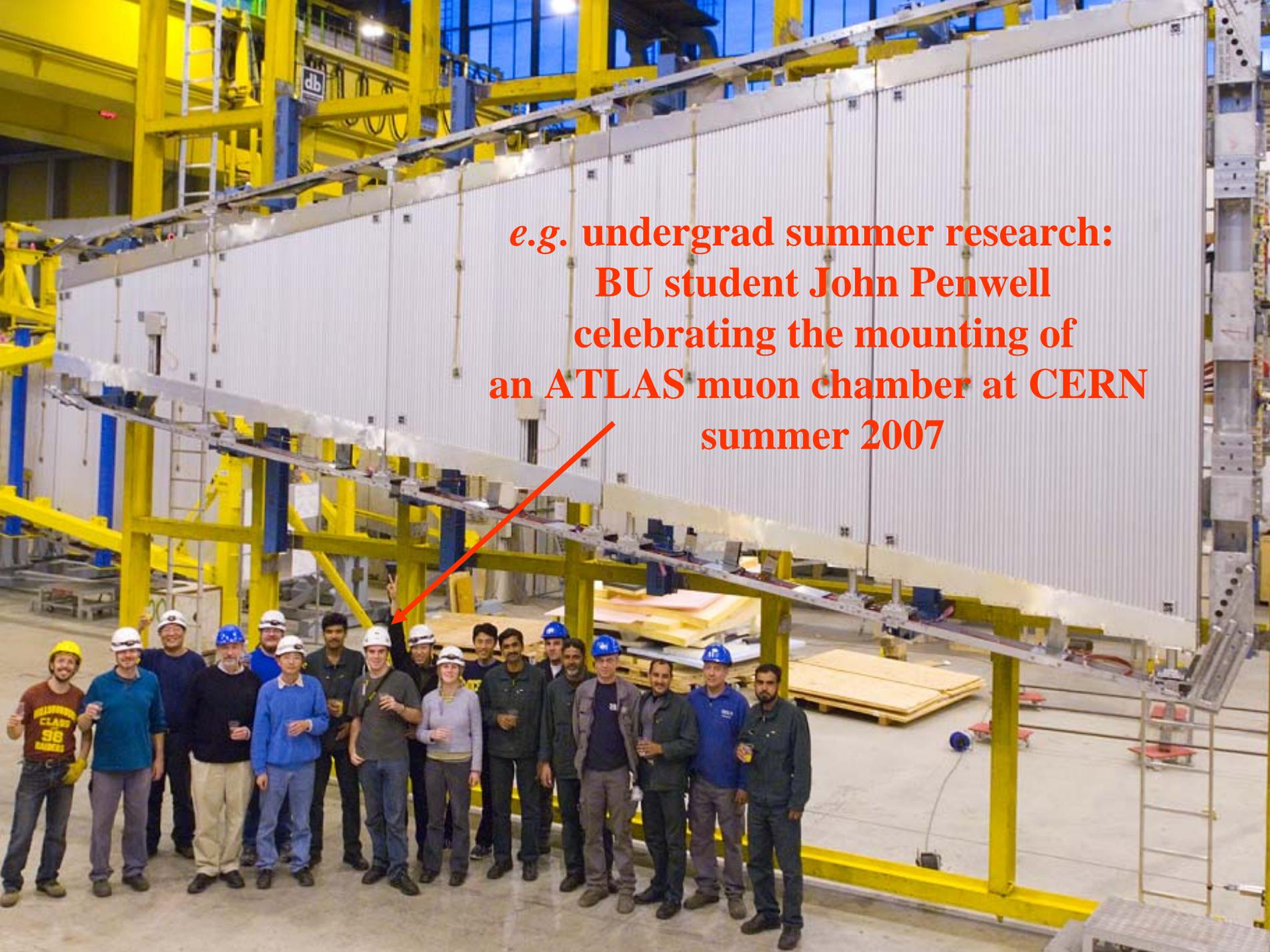
Arno Heister\*

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!*



good gender mix

At LHC Physicist's Building 40 on that famous day,

Max Chelsea Mike Michael Andrea Elim Ashley  
Yellen Bartram Lloyd Hedges Welsh Cheung Rubinstein

*...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.”

Bose/Carrera

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

Heister/Lawson/LRS

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

Herring/Musienko

**ATLAS**

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

Harrington/Yan

**T2K**

Chelsea “I brought back to BU simulation software for my UROP that we didn't have here.”

Blondel/Dufour

*...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?*

Month 1	Months 2-4	Months 5-7 - Summer
1/2 CERN orientation & Comp Physics @CERN	1/2 Directed Research 1/4 E&M @ UniGe	3/4 Directed Research 1/4 CERN Summer School Lectures
1/2 Intensive French	1/4 QM @ UniGe	

### *...funding*

BU physics mentor volunteers: enlightened self-interest, multiplying their hands  
airfare, housing, and breakfast provided by BU during school term

UROF 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) + 1<sup>st</sup> 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



Alain  
Blondel  
(UniGe)

Larry  
Sulak

Arno  
Heister

Ben  
deWinter  
(Vice Provost)

Beth  
Goldsmith  
(Director)

Dragoslav  
Lazic

*...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*

