AE63 – [PHY542] Advanced Accelerator Lab

by Mikhail Fedurin, Dmitry Kayran and Diktys Stratakis

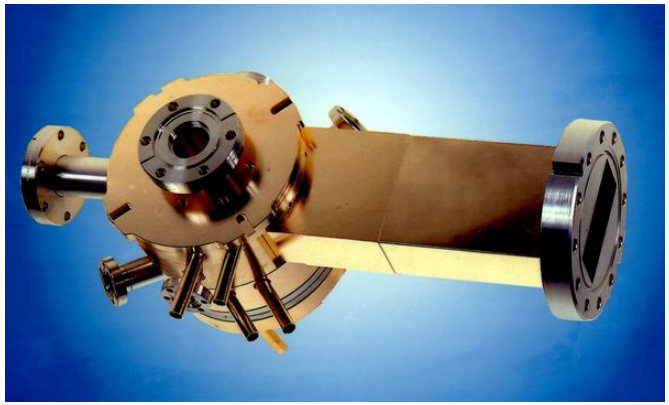
October 1, 2015 ATF User Meeting

CASE Center for Accelerator Science and Education

Stony Brook University

Accelerator Test Facility (ATF) academic potential

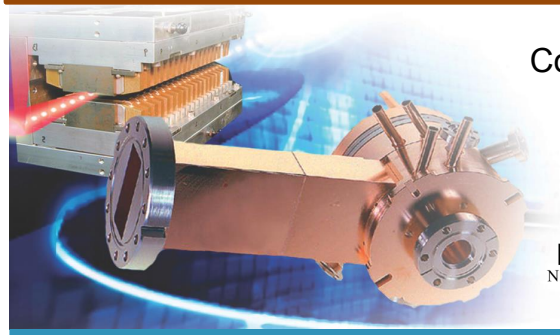
- ATF as facility with modest size advanced electron beam accelerator has unique capability to provide graduate students with hands-on experience with an operational accelerator
- Students learn the basics of the accelerator physics principles, accelerator operation and equipment
- Students come in touch with advanced acceleration concepts – accelerator physics of 21st century
- ATF scientific program committee approve this course as important part of the ATF mission



Goals of the course

- Introduce students to the field of experimental Accelerator Physics
- Demonstrate e-beam techniques and diagnostics used in Advanced Accelerator Concept experiments at Accelerator Test Facility
- Teach students to model experiments, compare model results with measurements.

Advanced Accelerator Laboratory at Accelerator Test Facility (ATF), BNL, Spring 2015

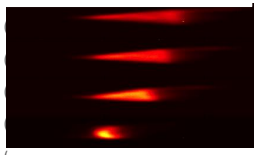


Course: PHY 542

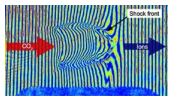
ATF ACCELERATOR TEST FACILITY

BROOKHAVEN NATIONAL LABORATORY

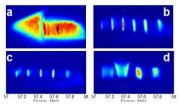
Experimental Demonstration of a Tunable De-chirper



Ion acceleration using laser driven shocks



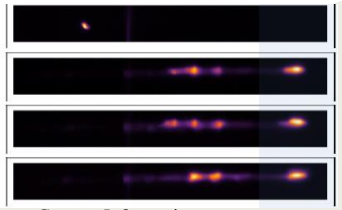
Beam Manipulation by Self-Wakefield



Topics covered:

- Design of accelerators and theoretical models
- Beam diagnostics
- Computational techniques
- High-brightness sources
- Novel ways of acceleration

"The ATF is a perfect place to learn how to deal with 21st century accelerators. You would have hands-on experience with modern accelerators and will learn how to tune and operate it"



3 Credits!
Register Now!

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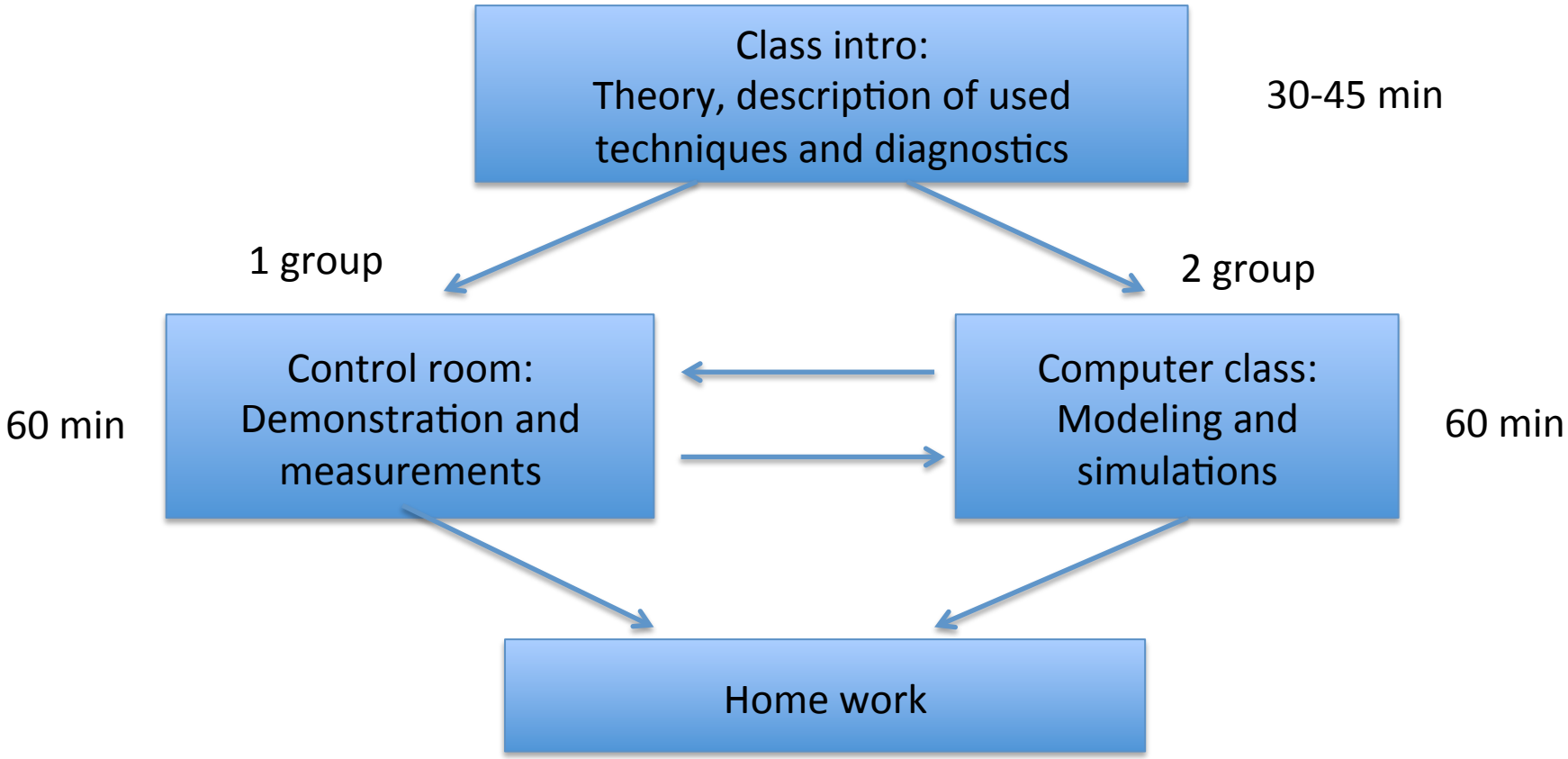
Brookhaven National Laboratory
http://www.bnl.gov/atf/

Syllabus (spring 2015)

- Course overview, administrative issues.
- Magnetic measurements. ATF tour, Safety training, Magnet field map of basic accelerator beam line components: dipole, quadrupole, chicane
- Review of beam sources, source physics, space-charge and simulation codes. Electron gun operation, quantum efficiency measurement
- Magnet basics, concept of beam emittance. Operation of quadrupole and solenoidal magnets; magnet misalignment effects; beam imaging
- Transport of particle beams. Beam Acceleration Operation of radio-frequency cavities, phase-dependence, alignment errors, dark currents
- Beam Diagnostics, emittance measurement techniques. Operation of position monitors; beam profile monitors; energy analyzer; emittance measurement with a magnet scan
- Coherent Synchrotron Radiation (CSR). Experimental demonstration of CSR; magnetic bunch compression
- Masking Techniques. Beam masking techniques and bunch-train production
- Advanced accelerator concepts. Wake-field demonstration
- Student Presentations

PHY542 web page:
http://www-case.physics.sunysb.edu/wiki/index.php/PHY542_spring_2015

Class structure



Evaluation (spring 2015)

CASE
Center for Accelerator Science and Education

- ✓ Student's performance will be evaluated based on:
  - ✓ active involvement in the laboratory (75% of final grade);
  - ✓ presentation of a project topic (25% of final grade).

- ✓ Project topics are mostly taken from Physical Review Letters publications that describe breakthrough research conducted at the ATF or similar facilities. Students will pick a published paper, study it and accelerator methods used in it and, finally, present their findings.

- ✓ 20 min talk will be presented in the class at the end of the semester. Presentation have to cover: 1) experiment's goal and setup; 2) technique(s) used; 3) potential application

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Syllabus (2016)

List of experiments:

- **Group A: Beam source, control and focusing**
  - A1: Measurement of quantum efficiency
  - A2: Magnetic measurement:
- **Group B: Beam diagnostic techniques**
  - B1: Emittance measurement with a quad scan
  - B2: Emittance measurement with a screen method
  - B3: Phase-space mapping
- **Group C: Electromagnetic effects on particle beams**
  - C1: Coherent synchrotron radiation
  - C2: Generation of bunched beams
  - *C3: Advanced accelerator concepts. Wake-field demonstration*
- **Students Presentations**

Evaluation (2016)

- ✓ Student's performance will be evaluated based on:
  - ✓ active involvement in the laboratory (20% of final grade);
  - ✓ lab report (60%)
  - ✓ Presentation (20% of final grade).

- ✓ Students will prepare two Reports and one Presentation during semester
  - ✓ Reports and Presentation from each of different group areas
  - ✓ Content should include: 1) theory of the experiment and explain the objectives; 2) technique used to obtain data; 3) detailed data analysis; 4) conclusion remarks

- ✓ Presentation will be at the end of semester. Will require better preparation. Will be performed at front of the class. To avoid the overlap topics will be distributed at beginning of semester among students

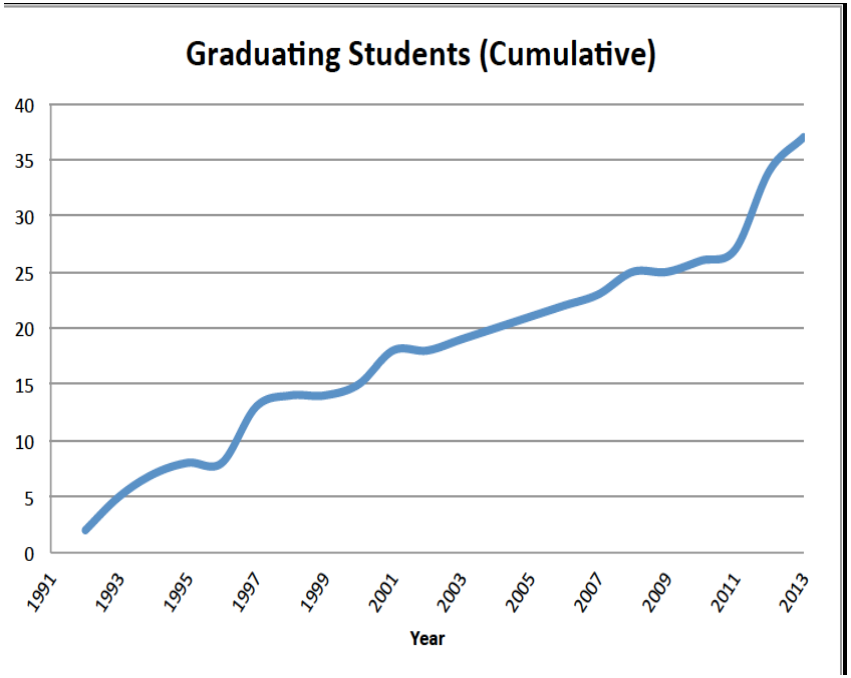
Support materials

Accelerator Stewardship program

Students who worked at ATF (in 2012)

1.	B. Allen	USC
2.	E. Arab	UCLA
3.	S. Barber	UCLA
4.	K. Boratay	UT Austin
5.	N. Cook	SUNY SB
6.	J. Duris	UCLA
7.	Yu. Fang	USC
8.	A. Nause	Tel Aviv University
9.	B. O'Shea	UCLA
10.	F. O'Shea	UCLA
11.	A. Ovodenko	SUNY SB
12.	L. Shao	UCLA
13.	E. Threlkeld	UCLA
14.	O. Williams	UCLA
15.	C. Brenner	Strathclyde Univ
16.	D. Carrol	Strathclyde Univ
17.	N. Dover	Imperial college
18.	A. Flacco	Ecole Polytechnique
19.	S. Kahalu	Ecole Polytechnique
20.	C. Palmer	Imperial college
21.	M. Streeter	Imperial college
22.	F. Sylla	Ecole Polytechnique

The ATF and graduate education



Center for Accelerator Science and Education at SUNY SB. Director – Prof. V. Litvinenko

New hands-on graduate course

At the 2013 BNL Young Researcher Symposium, **Nathan Cook,** awarded for his talk, "Impurity Free Ion Beams Accelerated by a 1 TW CO2 Laser".

nature physics
LETTERS
PUBLISHED ONLINE: 14 OCTOBER 2012 | DOI: 10.1038/NPHYS2443

Beating the shot-noise limit

Avraham Gover[1]*, Ariel Nause[1], Egor Dyunin[1] and Mikhail Fedurin[2]

Ariel Nause, Tel-Aviv Univ., winner of the 2014 RHIC & AGS Thesis Award for his thesis "Beating the Shot-Noise Limit: Collective Interaction Optical Noise Suppression in Charged Particle Beam".