

Operations, Performance and Upgrades

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12th ATF Users Meeting and ATF Program Advisory Committee,
January 8-9, 2004

New experiments bring more challenging requirements for the beam

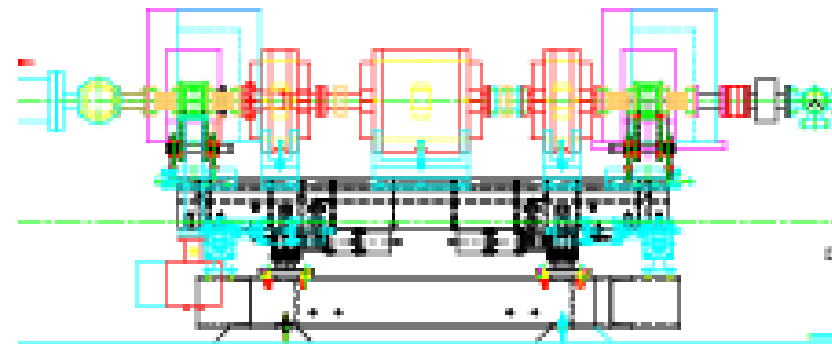
- VISA needs to match large energy spread (few %) beam into the wiggler.
- DWA requires extremely accurate (less than 50 micron) day to day control of the e-beam trajectory.
- DWA pulse train separated by one RF period leads to large energy difference between micro pulses due to cavity loading. Compensation of the dispersion is needed at the level of a few mm.
- Plasma Wakefield experiment needs extra small focus (~ 10 micron) of the bunched beam (large energy spread).
- Fast switching from one experiment to another on the same beam line.

Single best advance

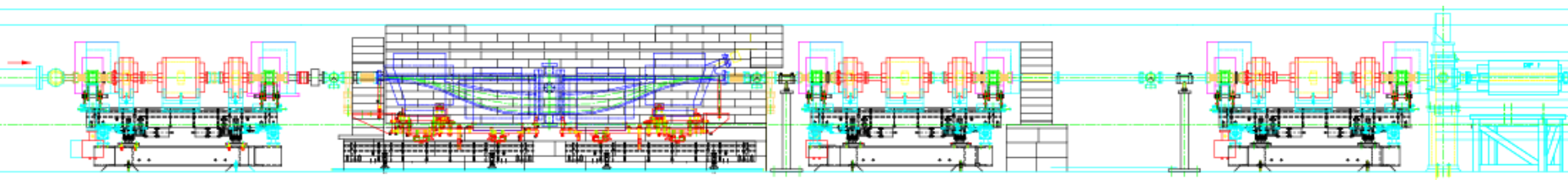
Electron beam emittance in the range 1-2 μm for 0.5 nC is measured by users almost every run.

- MathCAD based measurement/ tuning worksheet allows simplified beam tuning.
- Sufficient number of BPMs with adequate resolution in the H-line
- Sufficient number and correct location of steering coils
- No questions about quality of the beam – it is known every run

H-line upgrade



- Improved:
 - triplet focusing (natural for a round beam)
 - diagnostics (standardized hi-resolution imaging)
 - steering magnet locations (to minimize related dispersion excitement)
 - radiation shielding (ES&H and work friendly)
- Laser based survey of H-line
- Chicane (compressed beam to experiments)
- Beam based alignment (path to better beam)



Laser based survey

- Quadrant detector was used to verify quadrupole survey and align BPM.
- We enjoyed
 - up to 10 μm accuracy (5 times better than traditional survey)
 - ~3 times faster
 - no dependence on external resources

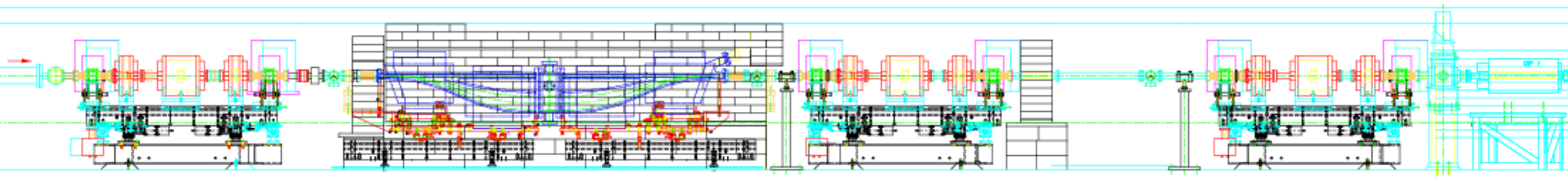


Chicane



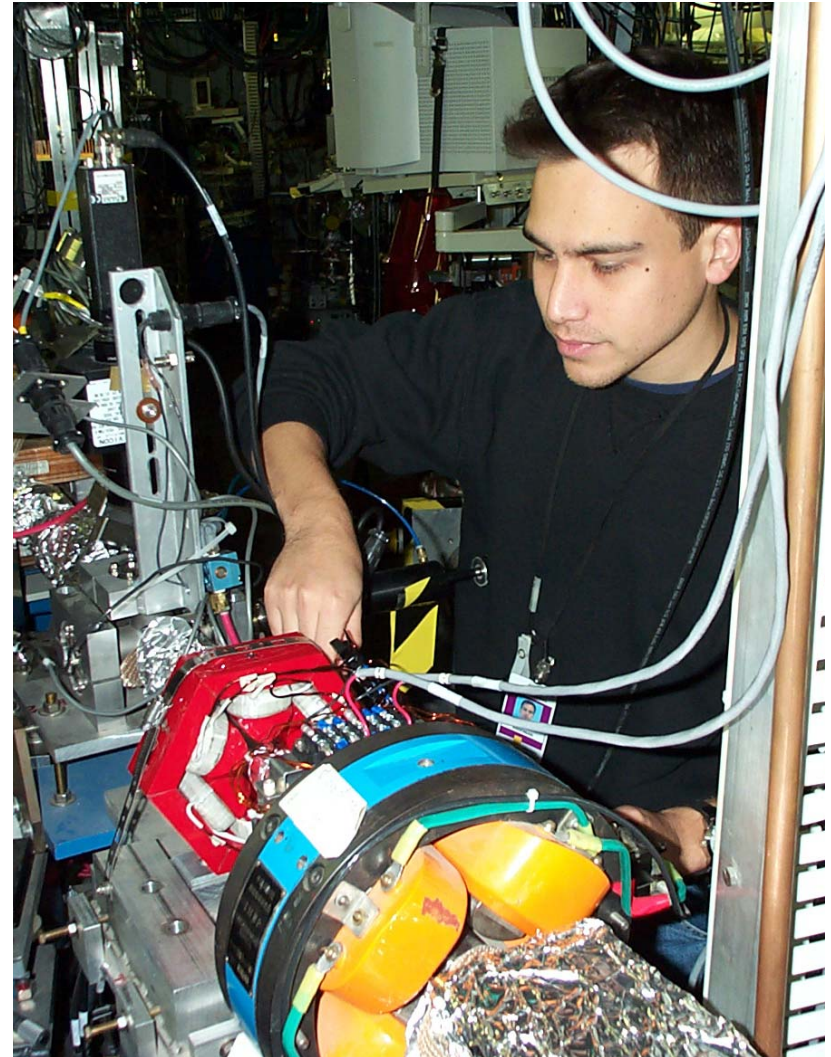
We expect 0.5 nC beam, 0.5 ps (FWHM) long with 0.5% energy chirp (FWHM)

- it would be challenging to focus into ultra small spot size due to energy spread.
- x-bend section in the H-line could possibly remove correlated part of the energy spread

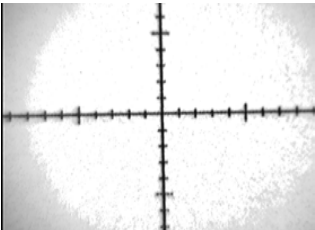
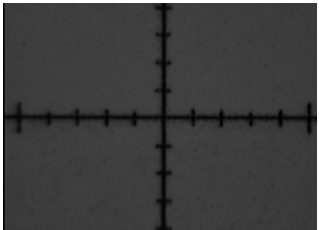


Sextupoles in the F-line

- Sextupoles were installed in F-line by the UCLA group
- Sextupoles were successfully used by DWA and VISA experiment
- Sextupoles in F-line can compensate
 - chromatic effects at locations of small beam size
 - vertical dispersion by coupling with horizontal



Standardized BPM (zoom lens with doubler and 20 cm achromat)

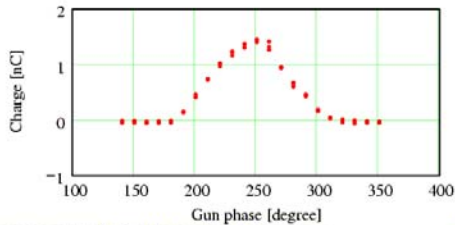
		Old style	Min zoom	Max zoom
Working distance [mm]		155	160	160
Field of view [mm]		18x13	59x37	11x7
Relative intensity [a.u.]		279	60	62
Resolution [ln/mm]	center	20	6	29
	edge	14	4	20
Pixel Calibration [$\mu\text{m}/\text{pix}$]		24x29	77x91	14x17
Images				

Automated beam parameter measurements

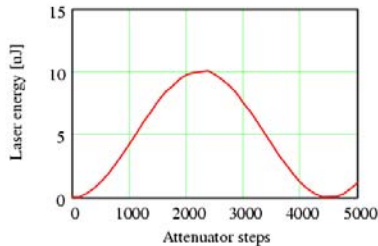
Measured on 12/12/2003 12:04 PM

Photoinjector performance

Charge (nC) vs. laser to RF nominal phase (degrees with arbitrary zero point):



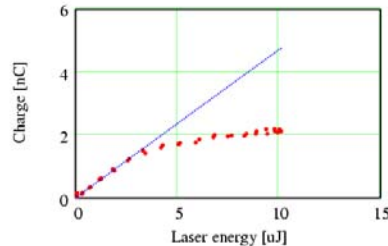
Laser energy (microJoules) vs. laser cross polarizer (step number, arbitrary units):



Vacuum:

GunVacuum = 1.382×10^{-9}
 LinacVacuum = 2.069×10^{-9}
 HLineVacuum = 1.364×10^{-8}
 SafetyVacuum = 2.408×10^{-9}
 BL1Vacuum = 1.623×10^{-7}
 BL1SP = 2.721×10^{-9}
 BL2Vacuum = 4.862×10^{-9}
 BL3Vacuum = 1.312×10^{-8}

Electron charge (nC) vs. Laser energy on the cathode (microJoules):



Derived quantities:

Maximum available laser energy [microJoules]:

Space-charge limited laser energy [microJoules]:

Quantum efficiency [nC/microJoule]:

Quantum efficiency [percent]:

Maximum (space-charge limited laser energy) charge [nC]:
 measured at a laser energy of:

and at a nominal gun phase of:

Statistics:

Laser energy standard deviation [%]

Peak to Peak laser energy jitter [%]:

Operating point:

Nominal charge [nC]:

@ Gun Phase [deg]:

Gun Forward Power [Volts]:

Single pulse mode [V] Repetition rate [1.5] Hz

MaxLaserEnergy = 10.04

NomLaserEnergy = 3.204

QuantumEfficiency = 0.471

0.466QuantumEfficiency = 0.22

MaxCharge = 1.452

LaserEnergyMean = 3.276

MaxGunPhase = 250.602

LaserEnergyStdDev = 1.425

LaserEnergyPeak2Peak = 7.355

NomCharge = 0.191

NomGunPhase = 190.602

GunFrwdPower = -1.14

Shutdown time []

- Operator independent injector parameter logging
- Simplifies start-up
- Suggests operating points
- Easy to ensure daily data collection

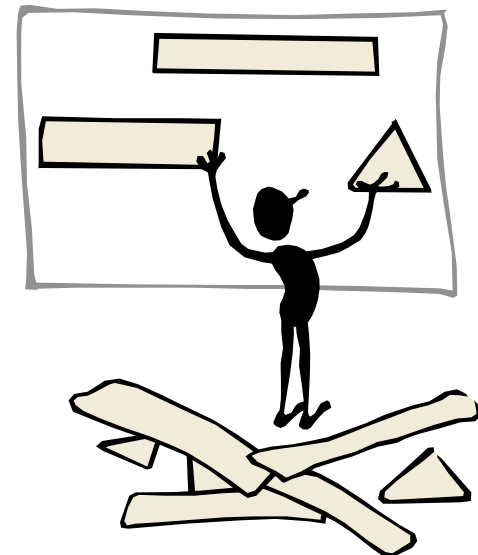
Use of MathCAD by users

- Users can program own algorithms, verify ATF operating parameters
- Reduces waiting for control system personnel to implement desired features
- Data acquisition, timing, synchronization issues all tested/verified by ATF staff; User can harvest desired information from database
- Physics is more transparent; encourages sharing of standard operations



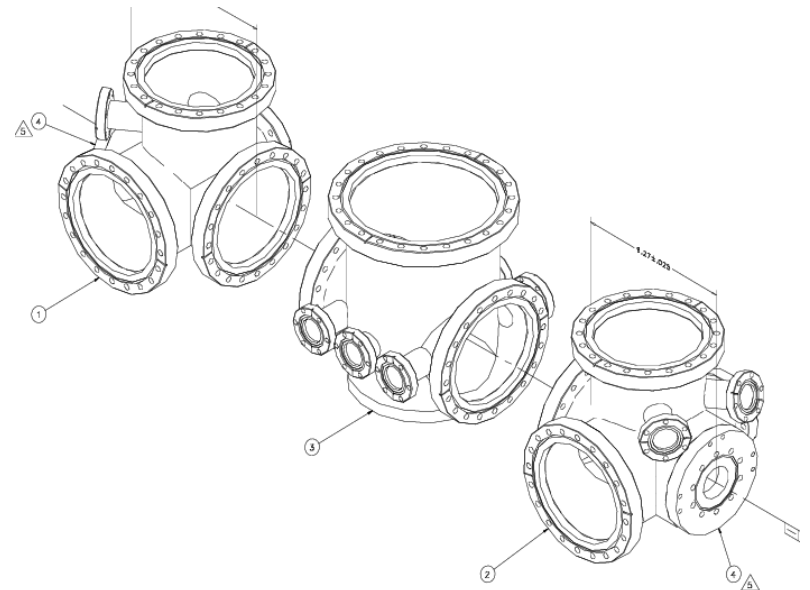
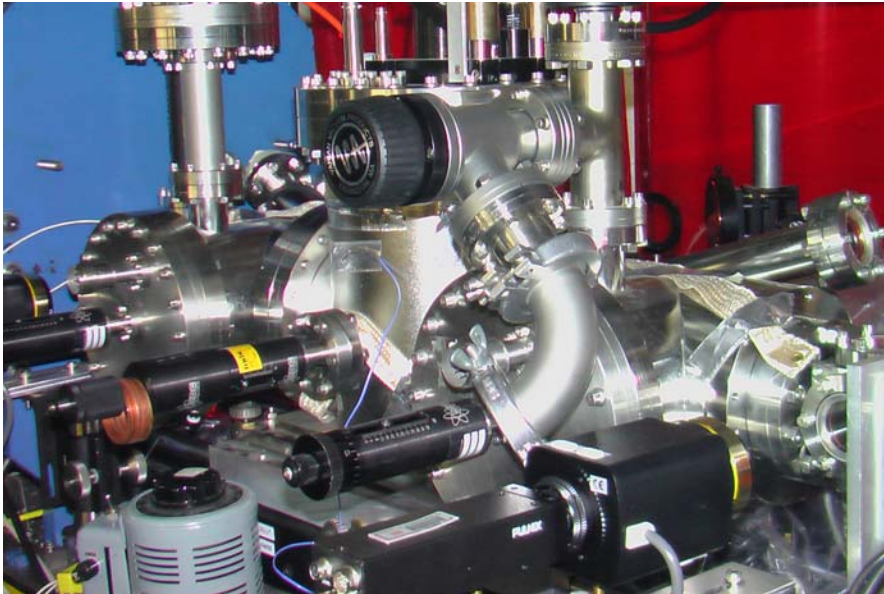
ATF infrastructure changes

- New experimental chamber on Beam Line 2
 - More flexible scheduling of experiments
- Darlington power supplies
 - Easy after hours replacement of burned out channels
- Motorized zoom lens/Iris Controls
 - New channels added
 - Computer based address selection
- Automatic temperature logging
 - Faster turn-on procedure



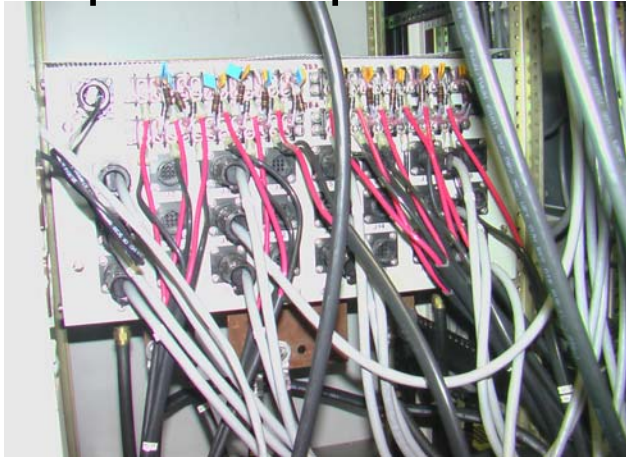
Standardized experimental cell

- Classes of experiments:
 - Thomson scattering
 - plasma channel
 - structure based accelerators
 - Diagnostics development
- Use of the cell will simplify
 - experiment installation
 - diagnostic setup
 - safety approval
 - beam tuning
 - scheduling

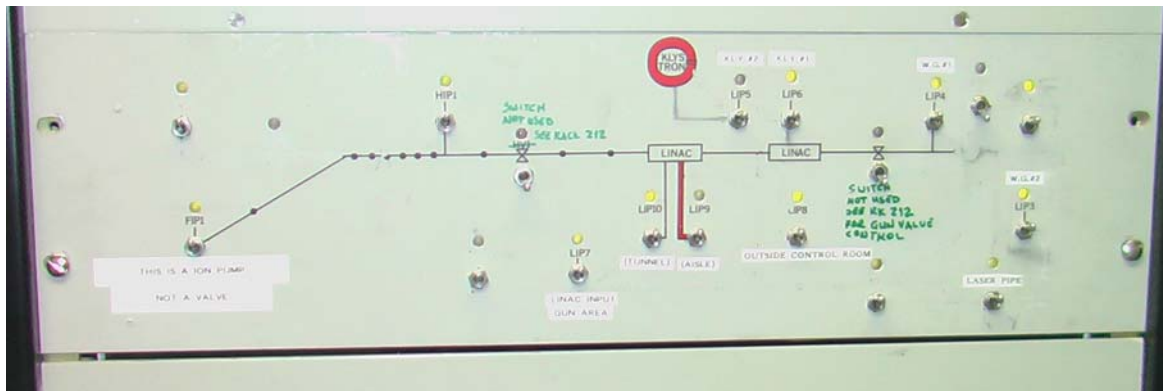


Operator friendly modifications

Simplified replacement of burned out power supply channels



Simplified vacuum valve controls arrangement



Similar modifications are considered for other systems

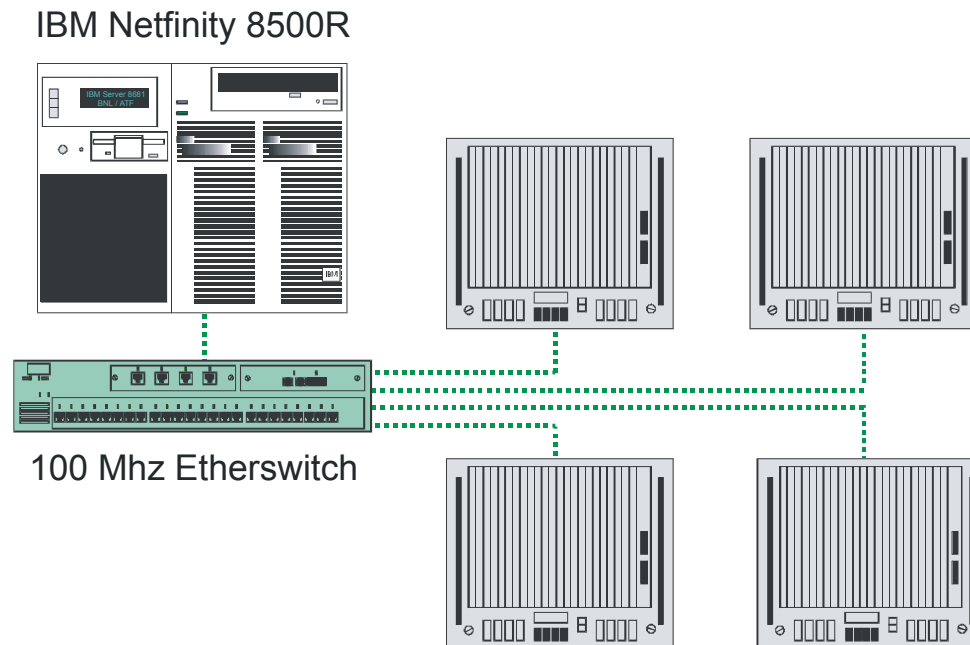
Beam line 2 upgrade

- Triplet based focusing with new more powerful quadrupoles
- Adequate number of high resolution BPMs
- Proper location of steering magnets
- Rail based component mounting
- Laser based magnet survey
- Standardized experimental cell with CO₂ delivery and optical table is planned



Computer control system

- New control system to be phased in starting about March 1
- Faster, more reliable, less worries about support/hardware maintenance
- More powerful machine ==> new capabilities for users (e.g., dual frame grabbers)
- Present system will be retired soon after
- No downtime impacting user experiments during last 2 years
- Expect same reliability once initial shakedown complete



Data acquisition hardware

New ATF web site

- Improved, user-oriented navigation
- Easier to locate information on schedules, contacts, etc.
- On-going process with more improvements to come

core capabilities - Microsoft Internet Explorer

Address <http://www.bnl.gov/atf/Menu.html>

Accelerator Test Facility newsletter

BROOKHAVEN NATIONAL LABORATORY

Core Capabilities - Beam line - Experiments - Staff - ES and H - Publications
ATF Newsletter - Meeting Highlights - User's Place - User's Center - Beam Schedule

Physics Department
Brookhaven National Laboratory Sponsored by DOE Office of Science, Division of High-Energy Physics and Office of Basic Energy Science

The ATF is a proposal-driven Program-Committee-reviewed Users-Facility dedicated for long-term R&D in Physics of Beams. The ATF core capabilities include a high-brightness photoinjector electron gun, a 70 MeV linac, high power lasers synchronized to the electron beam to a picosecond level, four beam lines (most with energy spectrometers) and a sophisticated computer control system.

ATF users, from universities, national labs and industry, are carrying out R&D on [Advanced Accelerator Physics](#) and are studying the interactions of high power electromagnetic radiation and high brightness electron beams, including laser acceleration of electrons and Free-Electron Lasers. Other topics include the development of electron beams with extremely [high brightness](#), photo-injectors, electron beam and radiation diagnostics and computer controls

The ATF resides in the Physics Department of BNL. The scientific program is guided by a [Program-Committee](#), which includes members from various universities and national laboratories. The ATF enjoys support from the US DOE Advanced Technologies R&D Branch,

Beam Schedule - Microsoft Internet Explorer

Address <http://www.bnl.gov/atf/schedules/schedules.html>

Beam Time Schedule

Brookhaven National Laboratory Accelerator Test Facility

Home
Core Capabilities - Beam line - Experiments - Staff - ES and H - Publications
ATF Newsletter - Meeting Highlights - User's Place - User's Center - Beam Schedule

- ATF Experiments Schedule for 2003
- ATF Experiments Schedule for 2002
- ATF Experiments Schedule for 2001
- ATF Experiments Schedule for 2000
- ATF Experiments Schedule for 1999
- ATF Experiment Schedule for 1996 - 1998

For information please contact [Vitaly Yakimenko](#)

ATF experiments schedule for 2003.

April-June, 2003.	January-April, 2003.
July-August, 2003	September-October, 2003
November-December, 2003	
ATF actual distribution of beam time in hours for 2003	

ATF experiments schedule for 2002.

September-November 2002.	April 2002.
August 2002.	March 2002.
July 2002.	February 2002.
May - June 2002.	January 2002.
ATF actual distribution of beam time in hours for 2002.	

New ESH position at ATF

- Improved support of ATF users at RHIC/AGS User's Center
- New procedures to rapidly assess & enforce compliance with BNL training and documentation requirements
- Rapid ATF laser restart following BNL site-wide laser shutdown
- Chicane installation (shielding, documentation, approvals)
- Revision of ATF training & migration to convenient web-based recertification
- Remediation of lead brick contamination
 - Facility-wide program for replacement of bare lead with high-impact encapsulated bricks
- Revision of ATF ESH documentation

Major challenges and resolutions

- Multipactoring in the RF Gun – We plan to install upgraded gun IV in March. This will improve
 - thermal stabilization
 - image diagnostic of the laser spot on the cathode
 - much larger maximum laser spot size on the cathode
 - vacuum pumping
- LINAC was bled up to air due to vacuum valve failure
 - valve replaced, LINAC baked, pumps and gauge changed
 - Vacuum is at pre-accident value
- Beam stop rebuilt and recertified

Summary

- H-line rebuilt
- Chicane compressor installed in H-line
- Sextupoles installed in F-line
- Beam line 2 upgraded
- Standardized experimental cell (beam lines 1 and 2)
- More experiment locations
 - 30% increase in the number of magnet power supplies (doubled in power)
 - 50% increase in the number of Beam Profile Monitors (BPM) on all beam lines
 - New standardized HI-resolution imaging system for BPM

More independent ATF operation by users supported with:

- Widely used MathCAD access to the control system
 - Beam tuning
 - Custom tasks
- Power supplies easily switchable at night by user
- Improved vacuum valve arrangements
- Computer controlled Zoom lens/Iris selection