Operations, Performance and Upgrades

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New experiments bring more challenging requirements for the beam

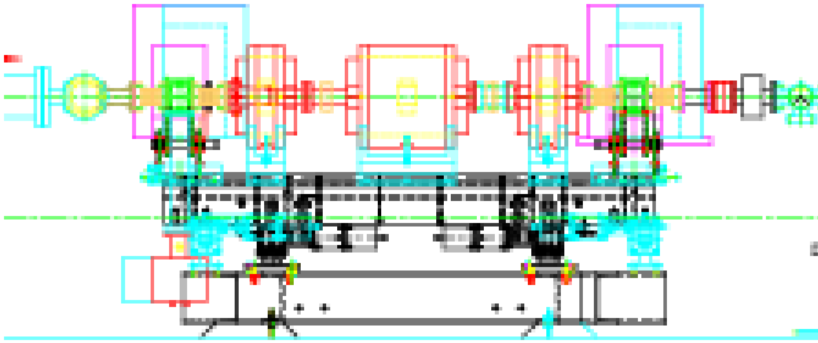
- VISA needs to match large energy spread (few %) beam into the wiggler.
- DWA requires extremely accurate (less then 50 micron) day to day control of the e-beam trajectory.
- DWA pulse train separated by one RF period leads to large energy difference between micro pulses due to cavity loading. Compensation 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

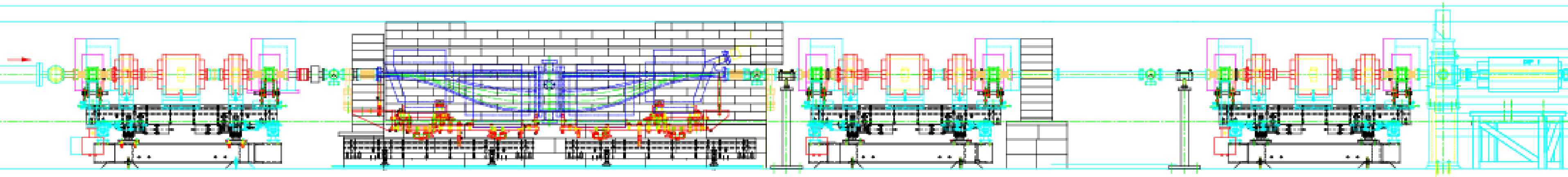
Electron beam emittance in the range 1-2 μm for 0.5 nC is measured by users almost every run.

- 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)



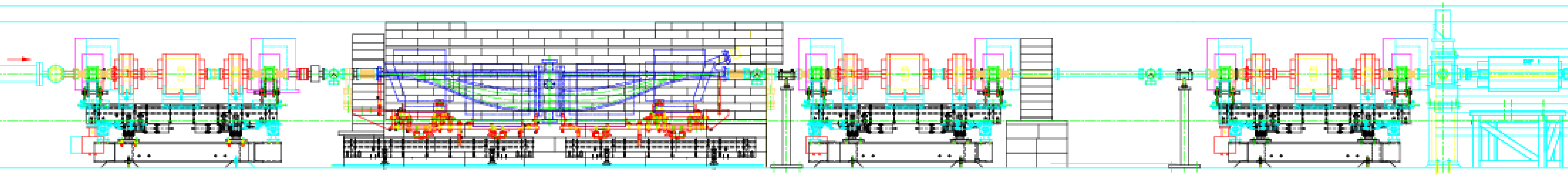
Laser based survey

- 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

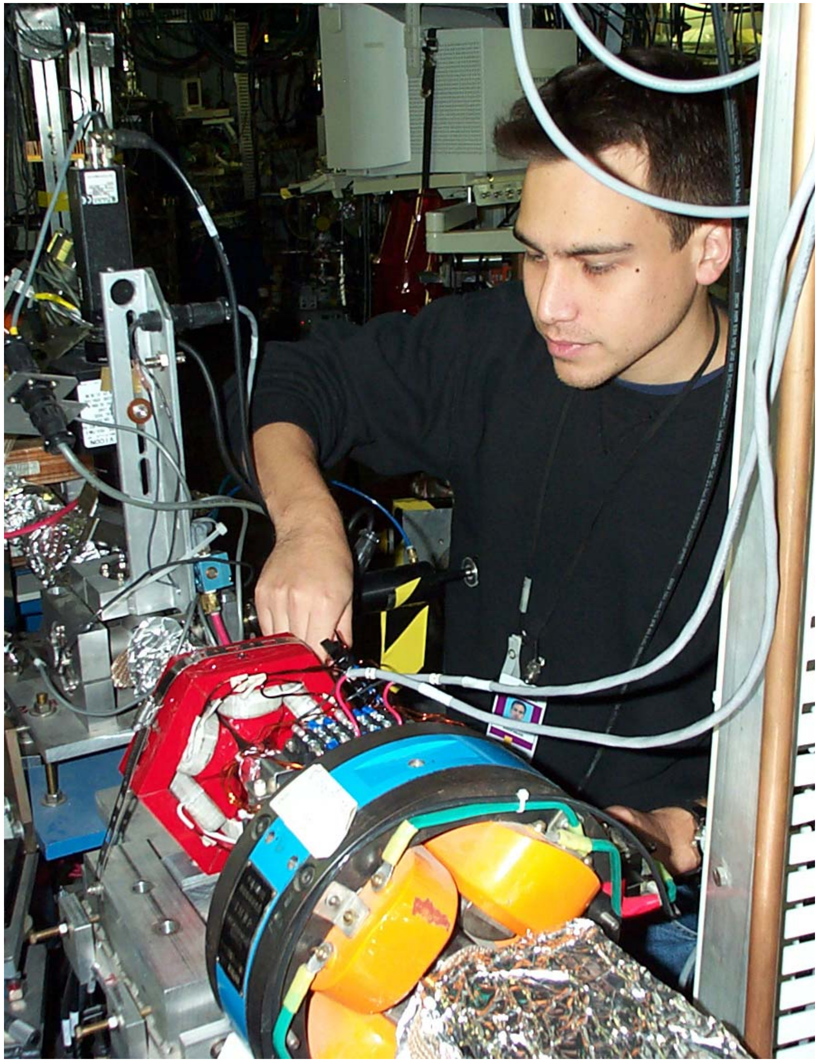
We expect 0.5 nC beam, 0.5 ps (FWHM) long with 0.5% energy chirp (FWHM)

- 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

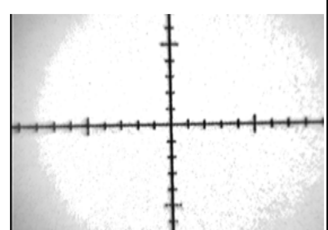
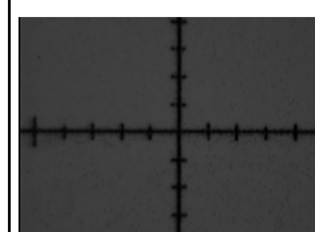


Sextupoles in the F-line

- 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)

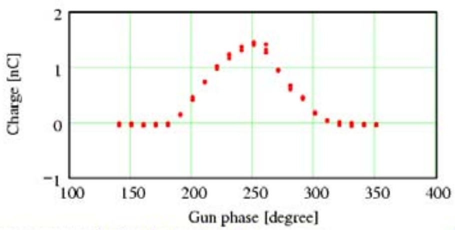
		Old style	Min zoom	Max zoom
Working distance [mm]		155	160	160
Field of view [mm]		18x13	59x37	11x7
Relative intensity [a.u.]		279	60	62
Resolution [ln/mm]	center	20	6	29
	edge	14	4	20
Pixel Calibration [μm/pix]		24x29	77x91	14x17
Images				

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):



Vacuum:

$\text{GunVacuum} = 1.382 \times 10^{-9}$

$\text{LinacVacuum} = 2.069 \times 10^{-9}$

$\text{HLineVacuum} = 1.364 \times 10^{-8}$

$\text{SafetyVacuum} = 2.408 \times 10^{-9}$

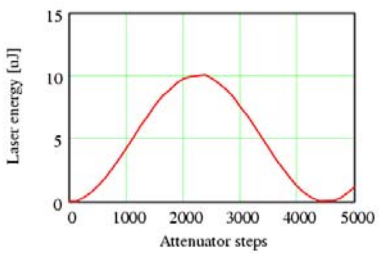
$\text{BL1Vacuum} = 1.623 \times 10^{-7}$

$\text{BL1SP} = 2.721 \times 10^{-9}$

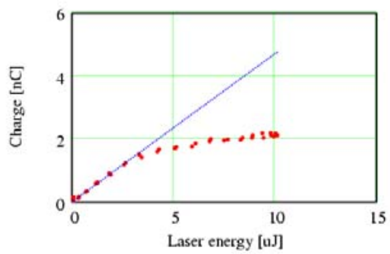
$\text{BL2Vacuum} = 4.862 \times 10^{-9}$

$\text{BL3Vacuum} = 1.312 \times 10^{-8}$

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



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



Derived quantities:

Maximum available laser energy [microJoules]:	MaxLaserEnergy = 10.04
Space-charge limited laser energy [microJoules]:	NomLaserEnergy = 3.204
Quantum efficiency [nC/microJoule]:	QuantumEfficency = 0.471
Quantum efficiency [percent]:	0.466QuantumEfficency = 0.22
Maximum (space-charge limitted laser energy) charge [nC]:	MaxCharge = 1.452
measured at a laser energy of:	LaserEnergyMean = 3.276
and at a nominal gun phase of:	MaxGunPhase = 250.602

Statistics:

Laser energy standard deviation [%]	LaserEnergyStdDev = 1.425
Peak to Peak laser energy jitter [%]:	LaserEnergyPeak2Peak = 7.355

Operating point:

Nominal charge [nC]:	NomCharge = 0.191
@ Gun Phase [deg]:	NomGunPhase = 190.602
Gun Forward Power [Volts]:	GunFrwdPower = −1.14

Single pulse mode [V] Repetion rate [1.5] Hz Shutdown time [ ]

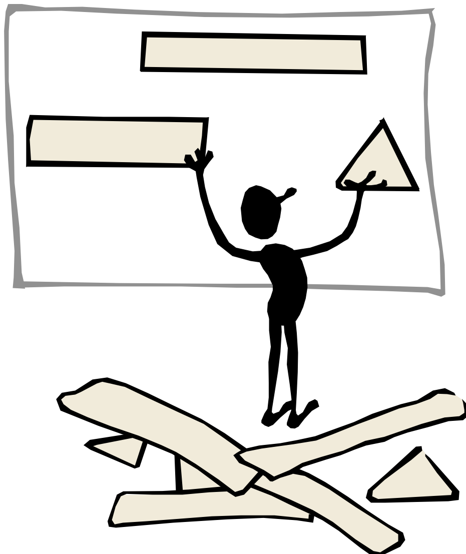
- Operator independent injector parameter logging
- Simplifies start-up
- Suggests operating points
- Easy to ensure daily data collection

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

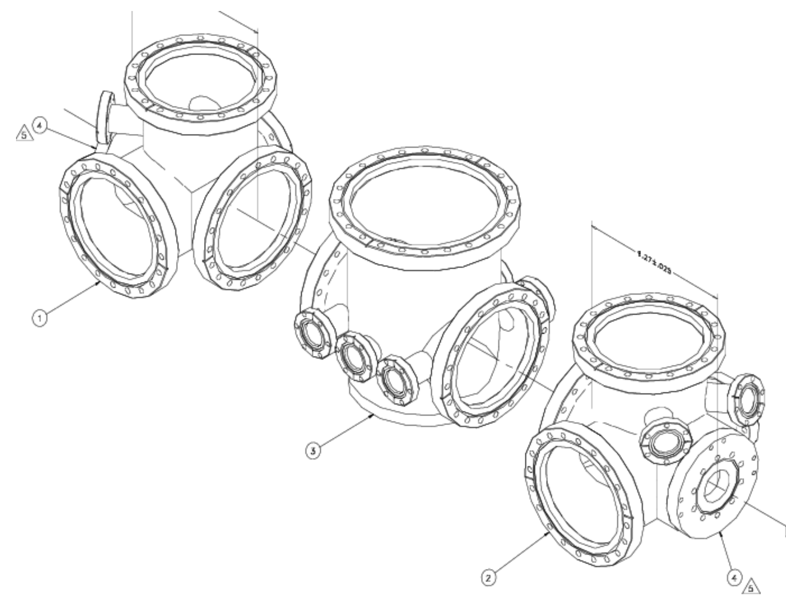
ATF infrastructure changes

- 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



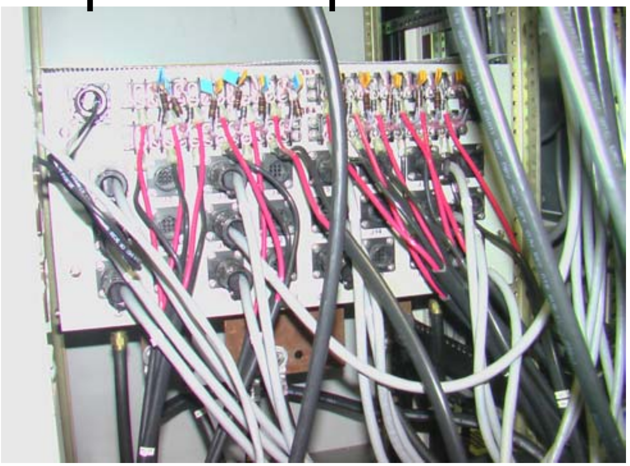
Standardized experimental cell

- 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

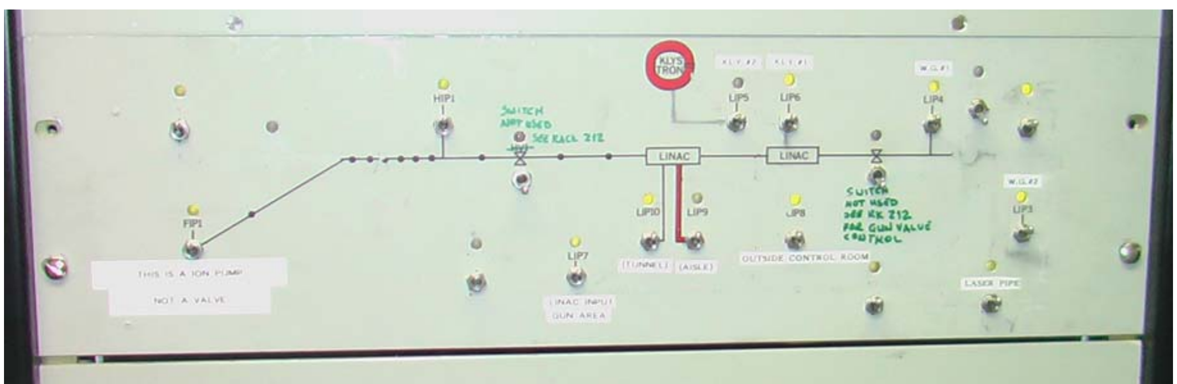


Operator friendly modifications

Simplified replacement of burned out power supply channels



Simplified vacuum valve controls arrangement



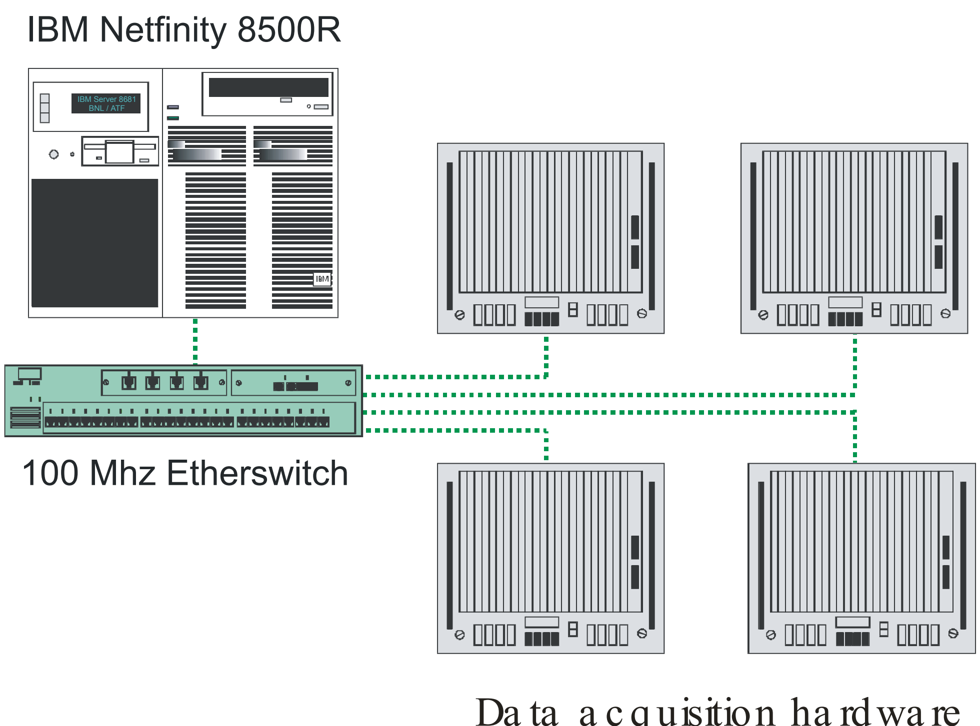
Similar modifications are considered for other systems

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 CO_2 delivery and optical table is planned

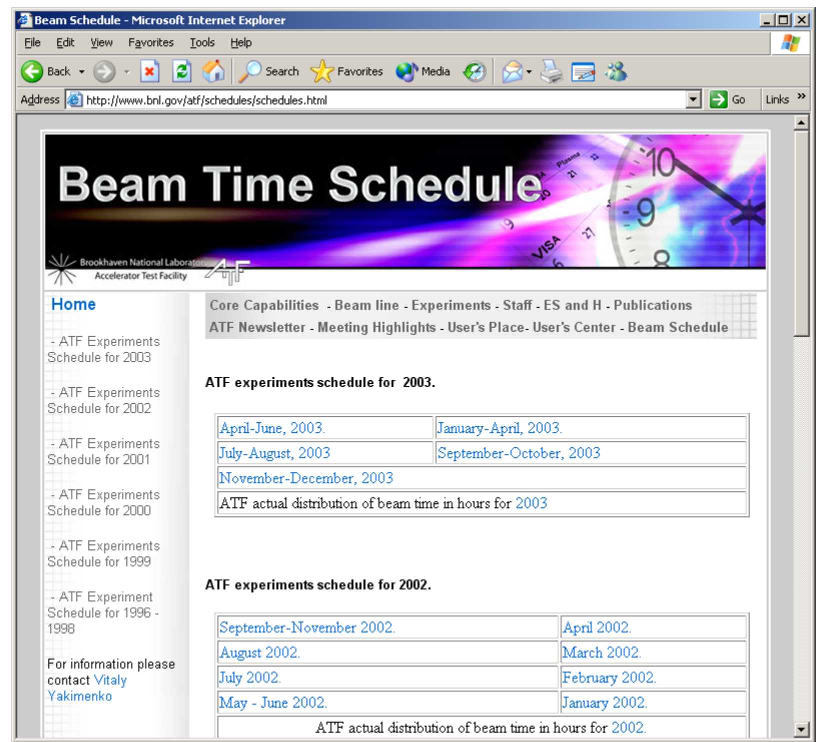
Computer control system

- 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



New ATF web site

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



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