



OFFICE OF HIGH ENERGY & NUCLEAR PHYSICS

Presentation to the Board on Physics and Astronomy

April 25, 2003

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Office of Science**



Key Elements of the FY 2004 High Energy Physics Program

- U.S. HEP Program has **opportunities for major discoveries** over the next several years at each of its accelerator laboratories:
 - **Fermilab Tevatron Run II** to search for the Higgs particle, supersymmetry, extra dimensions
 - **SLAC B-factory** to study CP violation
 - **Fermilab NuMI beam with MINOS detector** for neutrino oscillation, mass and mixing

- *These opportunities are too important to pass up, and each window of opportunity should be exploited.*

- Such exploitation **requires strong running** of the accelerators/colliders and **appropriate upgrades** of the machines and detectors. Therefore, FY 2004 budget provides for:
 - **Near optimal levels of running** at Fermilab (36 weeks) and SLAC (37 weeks)
 - **Upgrades** to the machines and detectors at both Fermilab and SLAC, as well as computing upgrades



Key Elements of the FY 2004 High Energy Physics Program (Cont'd)

- **Maintain Linear Collider R&D**
 - **Demonstrate 2000 hours of full power operation** of 4.8 meters of warm radiofrequency acceleration
 - The **International Linear Collider Steering Committee** has targeted a Fall 2004 technology selection between warm and cold technologies
 - **Expand studies of LC physics** and the needed detector technology

- **Prepare for U.S. participation in the LHC research program** in advance of the LHC turn-on
 - Provide for **software and computing** to enable U.S. physicists to analyze the vast quantity of LHC data and lead the LHC physics program
 - **Pre-ops** for the U.S.-built detector systems that are part of the ATLAS and CMS detectors

- Provide for continuation of **construction projects** on agreed upon profiles

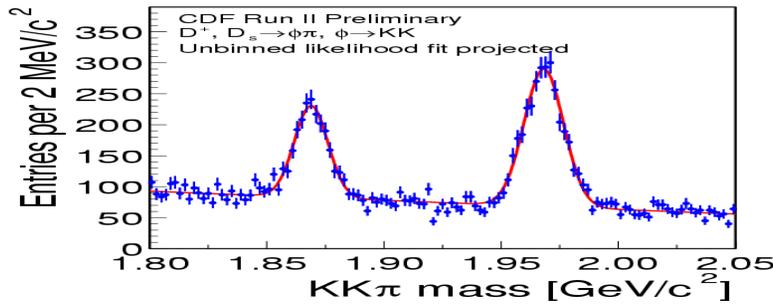


High Energy Physics Recent Highlights

Office of Science

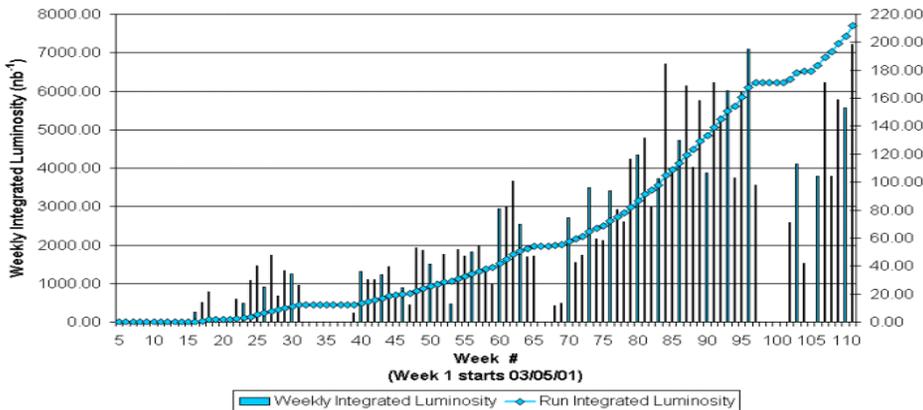
“Exploit the capabilities of the world’s finest set of research facilities ... to ... find the answers to questions about matter and energy at the most fundamental level”:

“Measurement of the Mass Difference $m(D_s^+) - m(D^+)$ at CDF II” --first Tevatron Run II paper submitted to *Physical Review D*, March 19, 2003



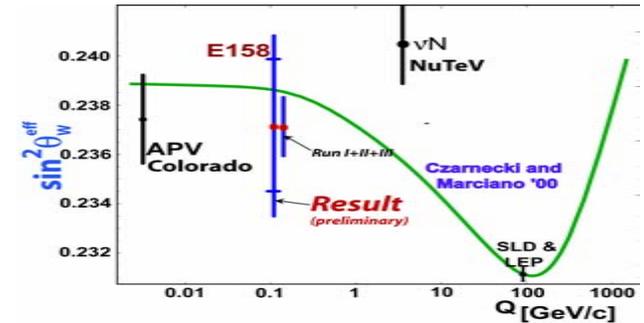
$$M(D_s - D^+) = 99.28 \pm 0.43(\text{stat}) \pm 0.27(\text{syst})$$

Collider Run IIA Integrated Luminosity

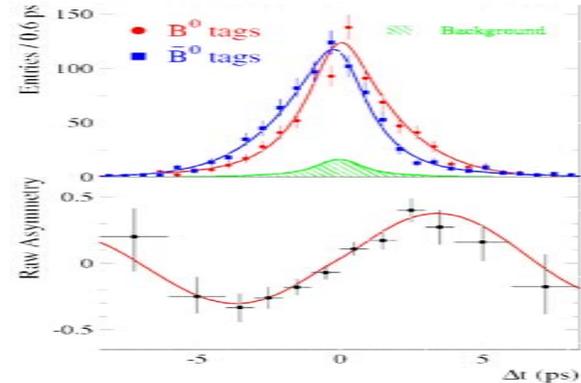


$$\text{APV} = -151.9 \pm 29.0 \pm 32.5 \text{ ppb}$$

$$\sin^2\theta_{\text{eff}}(Q^2=0.025 \text{ GeV}^2) = 0.2371 \pm 0.0025 \pm 0.0027$$



SLAC B-factory CP Measurement – 33 papers submitted.



$$\sin^2\beta = 0.741 \pm 0.067 (\text{stat}) \pm 0.034 (\text{syst})$$



Quarks to Cosmos

National Research Council report, “**Connecting Quarks with the Cosmos**” (April 2002) contained 7 recommendations needed to address the “11 Science Questions for the New Century”. DOE HENP current activities include:

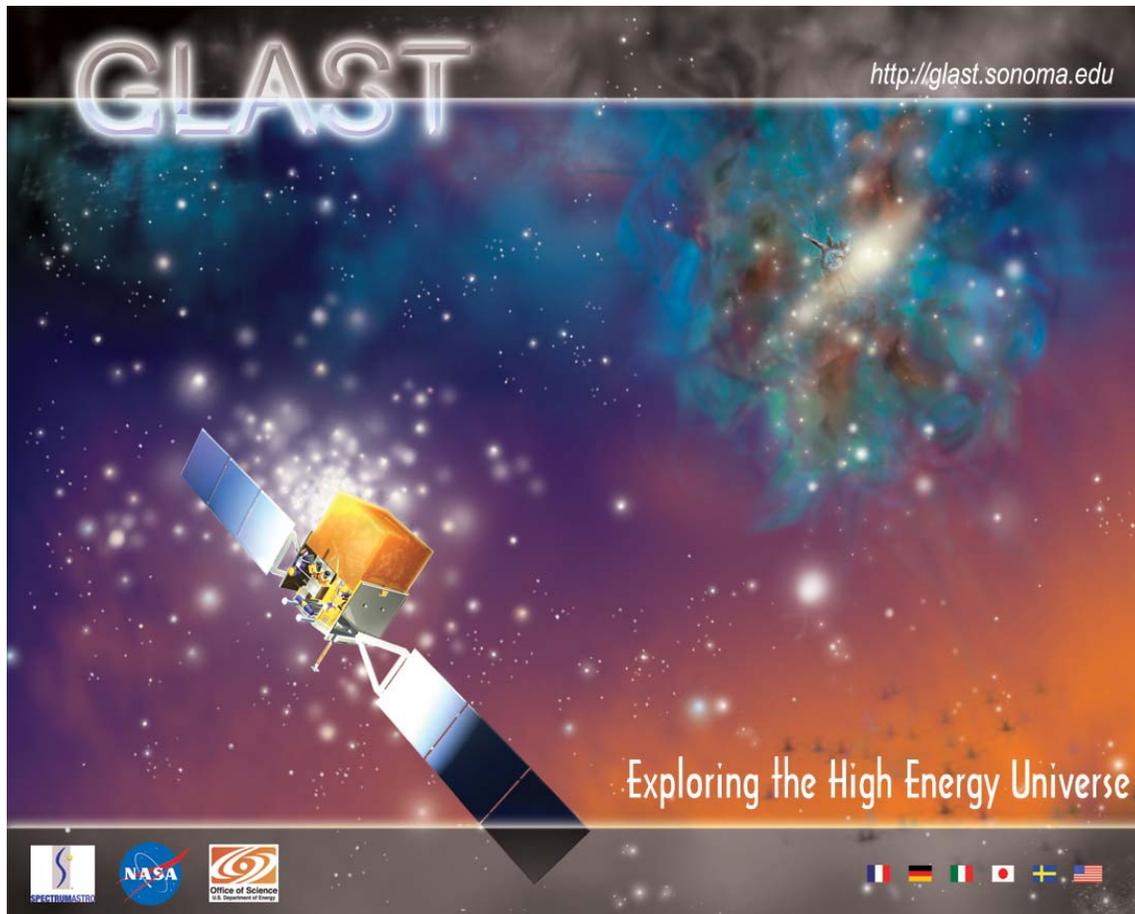
- **Birth of the Universe** – CMB polarization/gravity waves: small group (mainly LBNL/UCB) participating in simulations, algorithms, theory, hardware R&D, and current/future experimental collaborations
- **Properties of Dark Energy** – Supernova Cosmology Project (SCP), Nearby Supernova Factory (SNFactory), SNAP R&D
- **Neutrino masses, dark matter constituents, proton lifetime** – CDMS II (under construction); SuperK, K2K, KamLAND (operating); MiniBoone and NuMI/MINOS (operating/construction); SNO (operating); and studies for future experiments in an underground physics lab
- **Highest-energy gamma rays, neutrinos and cosmic rays** – GLAST/LAT, Pierre Auger (Southern) (under construction); VERITAS (under review—DOE/NSF)
- **High-energy-density physics** – RHIC, laser and plasma accelerators
- **Interagency initiative on physics of the universe** – DOE is part of an Interagency Working Group, spearheaded by OSTP, to develop joint agency recommendations for how to proceed.





GLAST

NASA's Gamma Ray Large Area Space Telescope (GLAST) Mission – Measurement of high energy gamma rays from space



- Large Area Telescope (LAT) – primary instrument on GLAST
- NASA/DOE partnership + 4 foreign partners
- Managed out of SLAC
- Funding profile has been set from DOE-HEP – secure
- LAT project will undergo a joint NASA/DOE Critical Design Review and CD3/Start of Construction review May 12-16, 2003
- Launch planned for September 2006

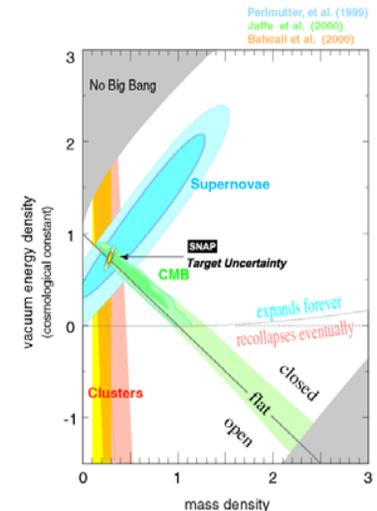
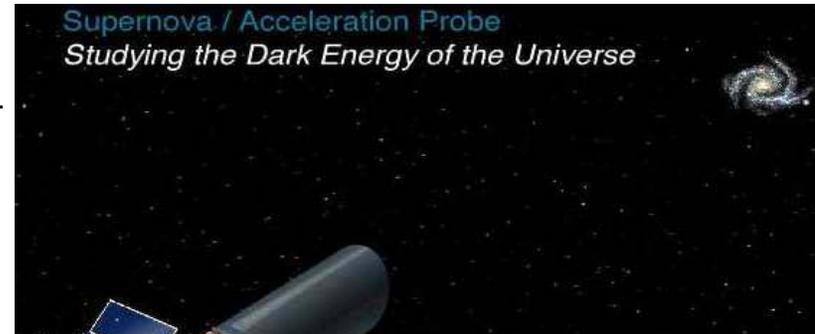


SuperNova/Acceleration Probe (SNAP)

Dark Energy -- causing the acceleration of the expansion of the universe
 -- of central importance to HEP program

Current work:

- **Supernova Cosmology Project (SCP)** – continuing ground and HST measurements to collect statistics over redshift range with Dark Energy effects
- **SNFactory** – large sample of nearby supernovae to study properties in detail
- **Next Step:** precision measurements in space over full redshift range to determine nature of dark energy and history of accelerations and decelerations of the universe
- **HEPAP** facilities and long-range planning subpanels **have endorsed** the proposed SNAP R&D and science
- **DOE is funding R&D**
- **Investigating partnership with NASA**
- SNAP will propose to **NASA's Mission Concept announcement**





FY 2004 Budget (B/A in Millions)

	FY 2002	FY 2003	FY 2004 Request
Proton Accelerator-based Physics			
Research	\$ 71.9	\$ 73.1	\$ 72.8
Facilities	316.3	309.2	326.7
<i>Subtotal</i>	<i>\$ 388.2</i>	<i>\$ 382.3</i>	<i>\$ 399.5</i>
Electron Accelerator-based Physics			
Research	\$ 30.3	\$ 30.4	\$ 33.6
Facilities	117.9	114.2	125.9
<i>Subtotal</i>	<i>\$ 148.2</i>	<i>\$ 144.6</i>	<i>\$ 159.5</i>
Non-Accelerator Physics/Research	\$ 39.1	\$ 41.4	\$ 43.0
Theoretical Physics/Research	\$ 43.0	\$ 41.4	\$ 42.3
Advanced Technology R&D/Research	\$ 67.5	\$ 88.4 *	\$ 81.2 *
Construction/NuMI	\$ 11.4	\$ 19.8	\$ 12.5
TOTAL HEP Budget	\$ 697.4	\$ 717.9	\$ 738.0

*Includes \$16.0M for SBIR/STTR in FY 2003 and \$17.3M for SBIR/STTR in FY 2004.

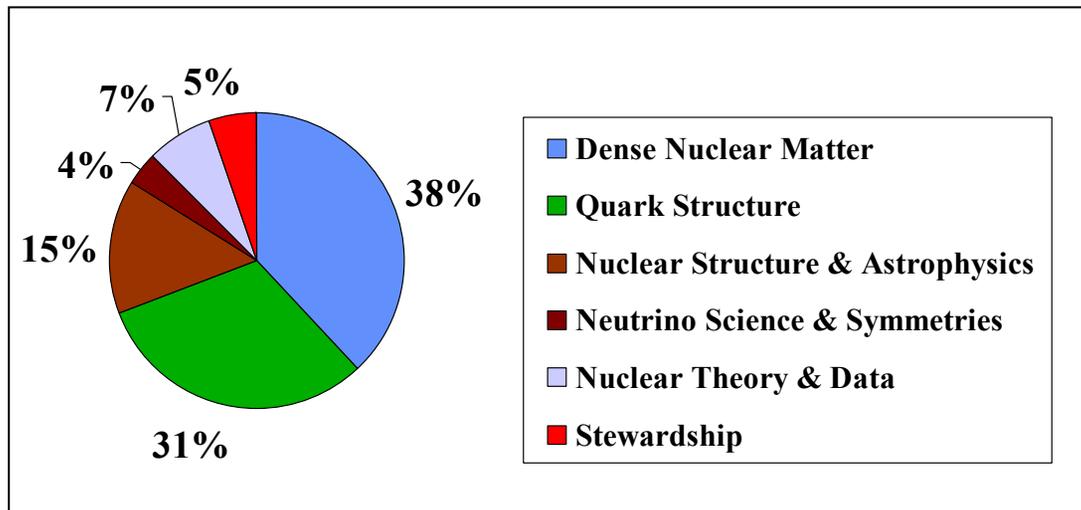


DOE Nuclear Physics Budget (B/A in millions)

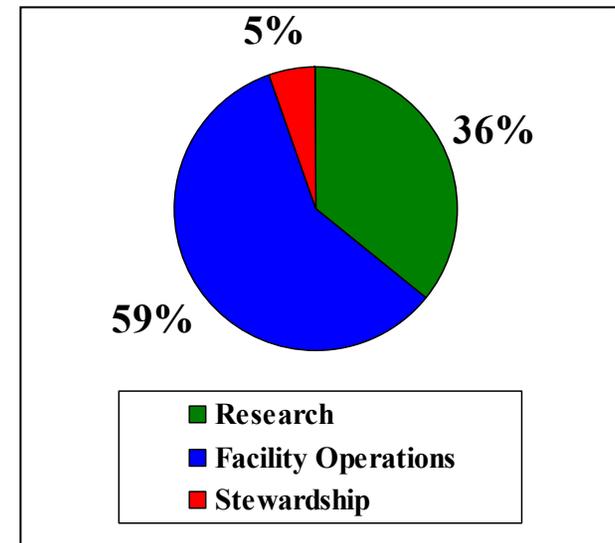
Subprograms are aligned with Scientific Thrusts

<u>Subprograms</u>	<u>FY 2002</u>	
Medium Energy	111.6	Quark Structure
Heavy Ions	151.3	Hot Nuclear Matter
Low Energy	62.5	Structure/Astrophysics/Symmetries
Nuclear Theory	<u>25.2</u>	All NP areas plus Nuclear Data
	350.6	

Two of the Scientific Thrusts Dominate the Budget



Facility Operations Dominate Budget





2002 NSAC Long Range Plan

Scientific Opportunities in all the major scientific areas of Nuclear Physics

Scientific Area

- Quark Structure
- Hot Nuclear Matter
- Nuclear Structure
- Nuclear Astrophysics
- Fundamental Symmetries

Scientific Opportunities

- Upgrade of CEBAF to 12 GeV, R&D towards electron-ion collider
- Upgrade of RHIC's luminosity, involvement in LHC program
- Proposed RIA, next generation Gamma-ray array
- Proposed RIA, neutrino experiments, underground lab
- Next generation cold neutrons (at SNS), underground lab, RIA

Recommendations:

- **The highest priority ... is to exploit the extraordinary opportunities for scientific discoveries made possible by these [previous] investments**
Increased funding for research and facility operations is essential to realize these opportunities
 - Facility operations – University program – Nuclear Theory
- **The Rare Isotope Accelerator (RIA) is highest priority for major new construction**
 - RIA will require significant funding above the nuclear physics base.
- **Strongly recommend immediate construction of the world's deepest underground laboratory.**
 - An outstanding new opportunity to create this laboratory has emerged.
- **Strongly recommend upgrade of CEBAF to 12 GeV as soon as possible.**

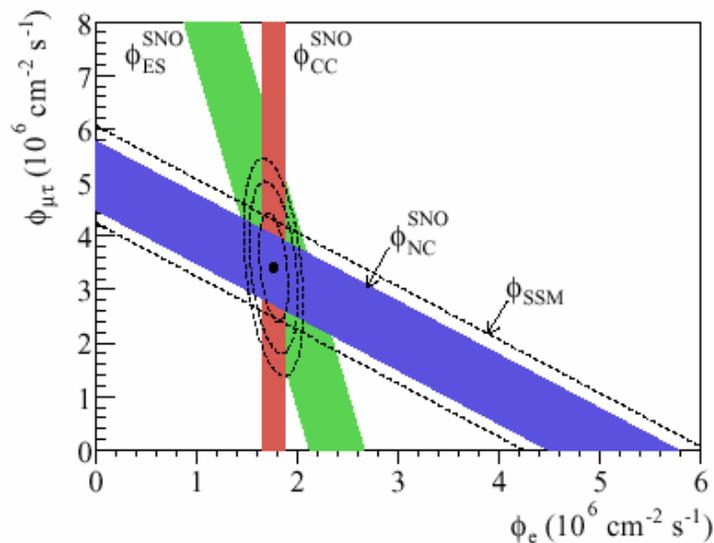
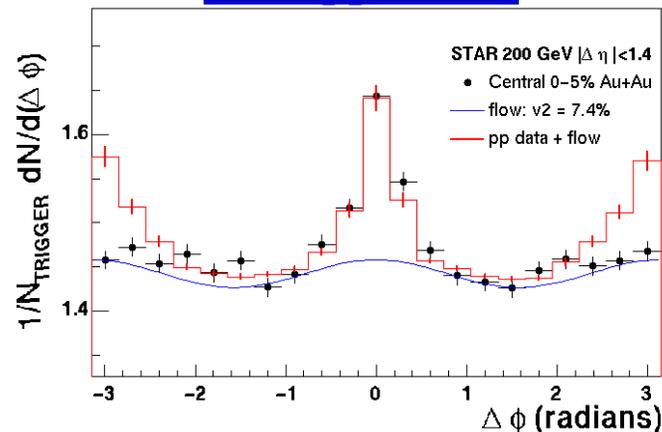


Recent Nuclear Physics Highlights

The Relativity Heavy Ion Collider (RHIC) has achieved design luminosity and research is well underway revealing tantalizing indications of formation of a “Quark-Gluon Plasma”.

Results from the Sudbury Neutrino Observatory (SNO) confirm Standard Solar Model and provide firm evidence of neutrino oscillations

Jet suppression





FY 2004 Nuclear Physics Budget

FY 2004 Budget Level (\$389.4M) provides ~+2.6% over FY 2003.

In the Budget Request, priority is given to:

- Strengthening the research base (universities, theory & labs) to do the science.
- Effective operating user facilities: RHIC, TJNAF, Bates, HRIBF and ATLAS
- Making needed investments for the future

Program Scope is maintained and priorities addressed:

- Research manpower/students increase – particularly for major facility and theory activities.
- Five national user facilities operate more than in FY 2003.
- Modest investments will be made for the highest priority new initiatives/experiments.
(GRETINA, HRIBF “second platform” and Fundamental Neutrino Physics Beamline (SNS))
- R&D and pre-CDR activities for RIA and CEBAF 12 GeV upgrade supported.
 - **Outstanding science will be produced** –

Termination of 88-inch Cyclotron Operations driven by the budget constraints

- Negatively impacts the short-term productivity of the low energy nuclear physics program
- Investments must be made for future capabilities—facilities need to be operated/utilized effectively



FY 2004 Nuclear Physics Budget Request (B/A in millions)

	<u>FY02</u>	(plan) <u>FY03</u>	Request <u>FY04</u>	
Research	\$121.9	\$127.1	\$130.7	(+ 4.0%)
RIA R&D/SciDAC	4.8	5.9	5.5	
Facility Operations	212.3	226.6	231.5	(+ 2.1%)
Stewardship*	<u>20.0</u>	<u>21.0</u>	<u>21.7</u>	
	\$359.0	\$379.6	\$389.4	(+ 2.6%)

Priorities are:

- Enhanced support for university/laboratory researchers theory
- Effective operation of user facilities
- Support needed investments for the future

Research Support is increased by ~4% (+\$4.6M) over FY 2003.

- Theory funding increased by ~5%: Experimental funding increased ~4%
- Funding for non-accelerator efforts: Projects started GRETINA/Neutron Beam Line (SNS)

Stewardship (BNL GPP/etc., SBIR/STTR, etc.) is increased by ~3.3% (~\$0.7M).

*SBIR/STTR included in FY 2002.



FY 2004 Nuclear Physics Budget Request (B/A in millions)

	<u>FY02</u>	<u>FY03</u>	<u>Request</u> <u>FY04</u>	
<u>Research:</u>				
Operating	\$112.9	\$118.0	\$122.8	
Capital Equipment	8.1	8.1	7.9	+4.0%
RIA R&D	2.8	3.9	3.5	
Computing Initiative	<u>2.0</u>	<u>2.0</u>	<u>2.0</u>	
	\$125.8	\$132.0	\$136.2	+3.2%
<u>Facility Operations:</u>				
RHIC	\$103.3	\$117.5	\$121.1	
AGS	1.0	--	--	
TJNAF	67.2	72.0	75.1	
Bates	12.4	13.2	12.5	
ATLAS	7.3	8.0	8.1	
HRIBF	9.1	9.7	11.7	
88-inch cyclotron	<u>6.1</u>	<u>6.2</u>	<u>3.0</u>	
	\$206.4	\$226.6	\$231.5	+2.2%
<u>Other: (Stewardship)</u>	<u>\$ 18.4</u>	<u>\$ 21.0</u>	<u>\$ 21.7</u>	+3.3%
Nuclear Physics Total	\$350.6	\$379.6	\$389.4	+2.6%