

# Report From BNL

Presented to  
HEPAP

by  
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HENP

Snowmass, Colorado  
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# Brookhaven National Laboratory High Energy Physics Program

## **Mission Statement:**

*“Perform frontier research in theoretical and experimental high energy physics; build, maintain and operate state of the art user facilities for high energy physics; perform research and development work in accelerator science, experimental detector design and computing for HEP; carry out construction projects in the HEP area as assigned.”*

In support of this mission, the Laboratory operates large user facilities (AGS and RHIC) and carries on an in-house program of research in theoretical and experimental high energy physics. The program is further supported by a program of R&D in the areas of accelerator, superconducting magnet and particle detector science, including operation of the Accelerator Test Facility (ATF) at BNL. Support of US ATLAS computing is provided by a Tier1 Computing Center at BNL. The work of the HEP Program is also supported through the expertise of BNL’s Instrumentation Division, a Lab-wide instrumentation development organization reporting to the ALD-HENP.

## **Direction of the HEP Program:**

The Associate Laboratory Director of High Energy and Nuclear Physics directs this program. The work of the HEP program is carried out in the Physics and Collider Accelerator Departments, the Superconducting Magnet and Instrumentation Divisions and the Center for Accelerator Physics.

# Elements of the BNL HEP Program

The following elements comprise the current HEP Program\*:

- **Performance of a world class, in-house program of basic research in theoretical and experimental particle physics**
  - a theoretical group of broad capability with productive links to nuclear physics
  - experimental groups of key value to forefront efforts at BNL, CERN and Fermilab
- **Construction and operation of forefront user facilities for HEP experiments**
  - AGS Complex (highest intensity proton synchrotron in the world)
  - accelerator and detector subsystems for use at Fermilab and CERN
- **Performance of a leading R&D effort in the development of advanced accelerator and particle detector concepts plus provision of computing support for HEP**
  - operation of the ATF user facility for development of novel accelerator concepts
  - muon collider/storage ring conceptual design and enabling experiments
  - development (with Instrumentation Division) of novel particle detectors
  - R&D for superconducting magnet concepts applicable to High Energy Physics
  - operation of a Tier-1 computing center for support of the US ATLAS HEP program

\*Many of these areas of expertise provide benefit to programs outside DOE-HEP

# **Current HEP Programs with BNL Involvement**

The following HEP programs are currently active at BNL:

- **HEP Experiments using the AGS**

- E949 [ $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ ] performed good test run in FY01; data runs FY02, FY03
- E952 [Muon Neutrino Mass Limit] performed a key test in FY01 in the (g-2) ring

- **BNL participation in the CERN LHC Construction Project**

- Host Laboratory and Project Office for the US ATLAS Detector Project
- ATLAS Detector Subsystem responsibilities (LAr EM Calorimeter and Muon System)
- LHC SC dipole production at BNL; testing of all LHC SC cable; LHC accel. science
- Host Laboratory for US ATLAS Computing Project & Tier-1 computing center
- contributions to LHC physics analysis and accelerator science efforts
- US ATLAS operations management & oversight role (after LHC turn-on)

- **BNL participation in the D0 Program at Fermilab**

- major contributors to off-line physics analysis (top, W, SUSY/higgs searches)
- on-line and off-line computer program upgrades and maintenance
- commissioning and operation of the Forward Preshower (FPS) Detector
- Jon Kotcher is the Run-2 Upgrade project manager for D0 Phase-2

# **Current HEP Programs with BNL Involvement (Cont.)**

- **BNL in-house research in Experimental and Theoretical Physics**

- 5 HEP analysis efforts using data from HEP experiments at AGS and D0
- 1 HEP design/construction effort for LHC ATLAS
- 2 design/prototyping R&D efforts for prospective AGS Exps., KOPIO & MECO\*
- 1 design/prototyping effort for the MINOS Experiment
- HEP Theory is active on theory topics of current particle physics interest
- a very productive physics interaction with the Riken BNL Research Center
- this program is annually reviewed by DOE and by a BSA Visiting Committee

- **Accelerator and Detector R&D Program**

- Accelerator Test Facility (BNL's unique user facility for accelerator science expts.)
- continuing accelerator R&D using BNL accelerator facilities (Booster/AGS/RHIC)
- muon collider/storage ring R&D studies (with Fermilab, LBNL and university groups)
- AGS has completed a first test run for the Muon Collider Targetry Exp., E951
- superconducting magnet R&D is performed in the SC Magnet Division
- development and testing of novel particle detectors (with BNL Instrumentation Div.)

\* KOPIO and MECO have been proposed for FY02 capital funding under NSF's MRE Program, but funding beyond the R&D level in FY02 is not assured.

# AGS Complex - Other Program Missions

Other missions and venues in the 'Work for Others' Program\*:

<u>Current Work</u>	<u>Sponsor</u>	<u>Expected Future Work</u>
<b>AGS Machine &amp; Staff</b> biological effects of heavy ions n-spallation target tests	NASA DOE-BES	biological effects of heavy ions n-spallation target development
<b>Spallation Neutron Source</b> design/construction of SNS Ring	DOE-BES	commissioning involvement
<b>Booster Applications Facility</b> construction of the BAF	NASA	expanded radiobiology studies
<b>Proton Linac BLIP Facility</b> medical isotope production	DOE NE	medical isotope production
<b>Medical Treatment Cyclotron</b> preliminary discussion of the project	Univ. of Penn.	other cyclotron projects
<b>Tandem Van de Graaff Facility</b> various heavy-ion irradiations	36 Orgs.	continued heavy-ion work

\* performed on a sponsor-compensated WFO basis

US Department of Energy  
 Brookhaven Science Associates

T. Kirk  
 July 13, 2001



## Recent HEP Physics Highlights

- AGS E821, muon  $g-2$  published 2nd physics result; FY00-01 data will reach 0.5 ppm!
- US ATLAS Computing Project well started but under-funded in FY01,02
- ATLAS Tier-1 Computing Center up and running at BNL (but with inadequate hardware)
- LHC Accel. Project at BNL well started on LHC dipole production & cable testing
- AGS E949,  $K^+ \rightarrow p^+ n n \bar{n}$  successful commissioning run at AGS in FY01
- AGS E951, Muon Collider Targetry ran a successful liquid target test at AGS in FY01
- NSF has placed 'RSVP' on their MRE Proposal list for a possible FY02 construction start
- DOE Phase-I SciDAC grant will lead to a 20 Tflops Lattice Gauge Center at BNL

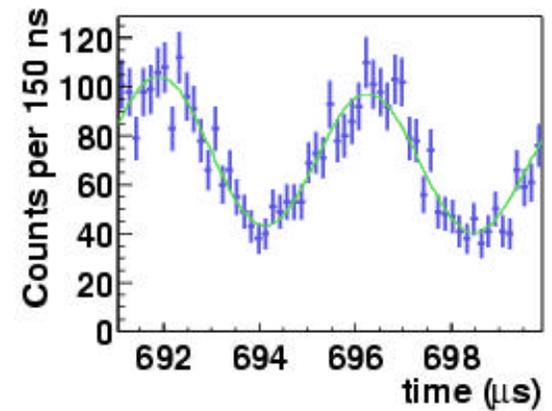
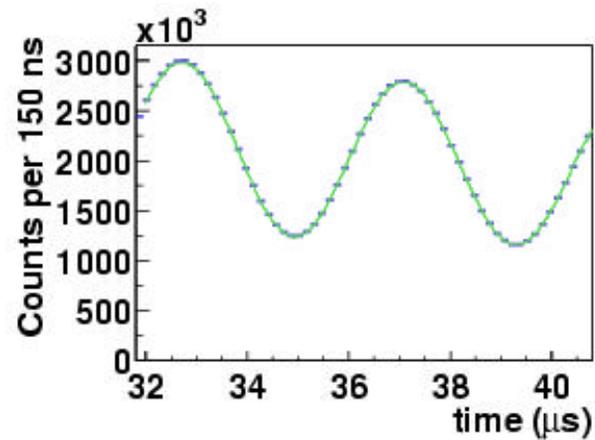
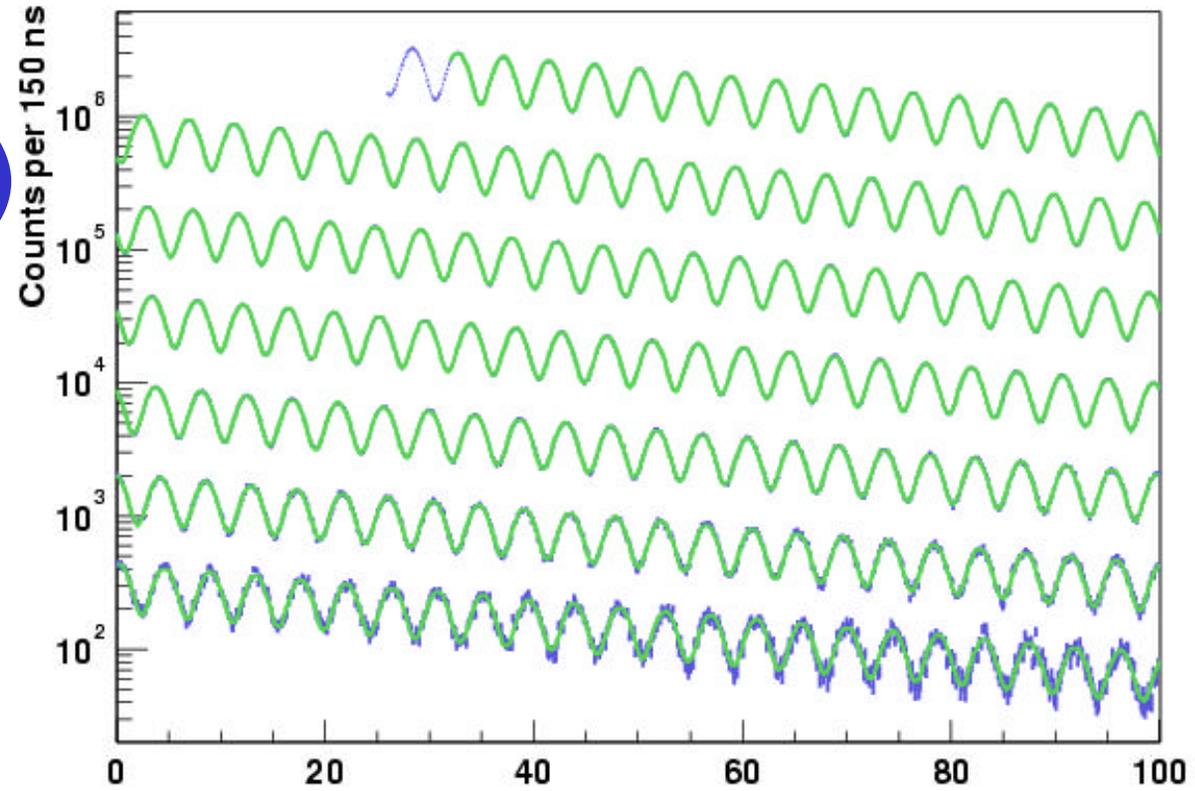
# Storage Ring / Kicker



<b>Radius</b>	<b>7.112 m</b>	<b>Storage Aperture</b>	<b>90 mm</b>
<b>Magnetic Field</b>	<b>1.45 T</b>	<b>Momentum</b>	<b>3.094 GeV/c</b>

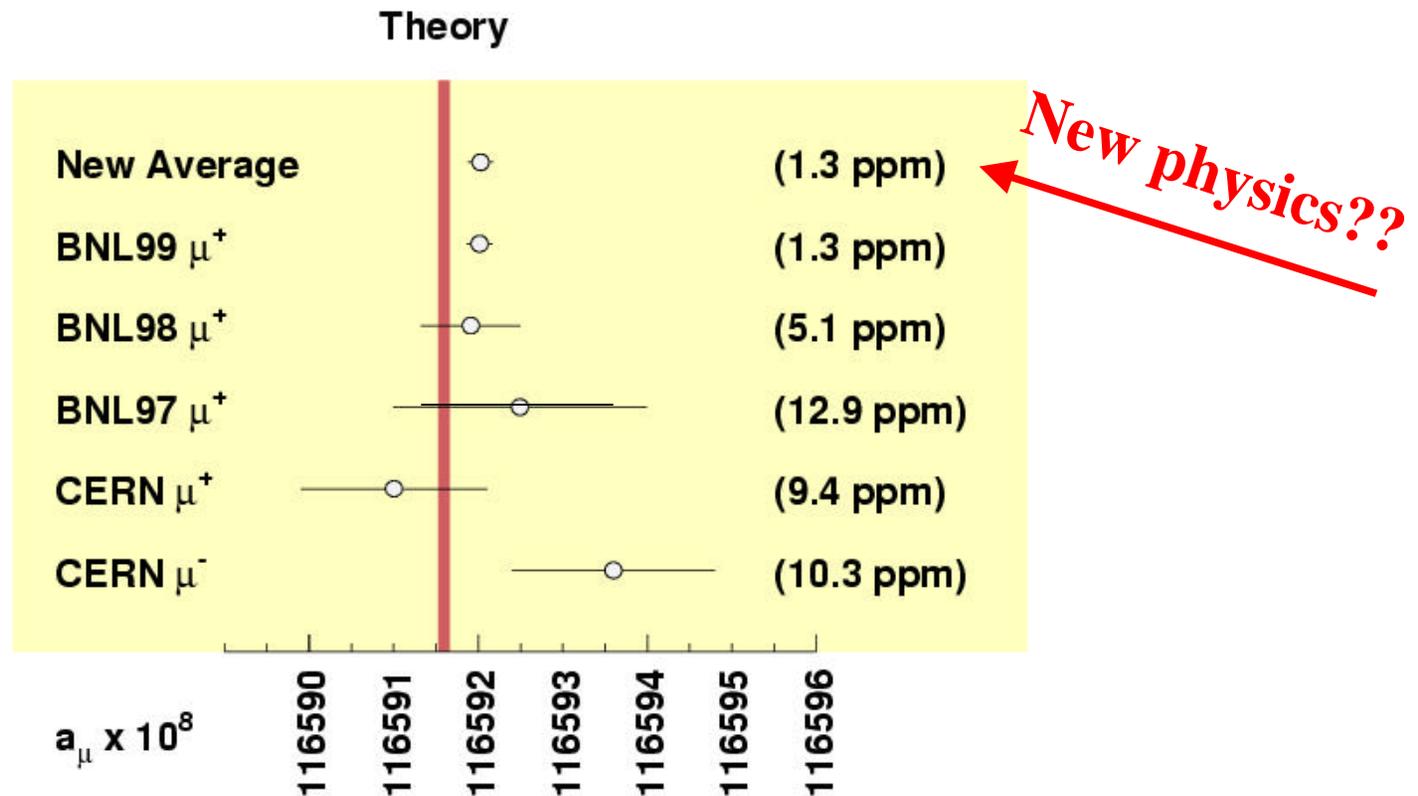
# 1999 Data Muon (g-2)

1 billion events  
Good  $\chi^2$



# Muon (g-2) - Summary/Future

- 4 times more **positive** muon data being analyzed
- 2 times more **negative** muon data just completed
- *2001 RUN to complete negative muon data taking*
- Many new inputs to hadronic vacuum polarization



## Update on BNL ATLAS Work

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- **Liquid Argon(LAr) Barrel Cryostat delivered to CERN (see picture)**
- **Cryogenics work proceeding well. Refrigerator contract imminent**
- **LAr signal feedthroughs installation will start Sept. 2001 after Cryostat acceptance**
- **LAr preamps and motherboards in production**
- **Leading role in LAr Reconstruction.**
- **Aiming for physics and software participation in September ATLAS Physics workshop**
- **CSC production to start later this year**

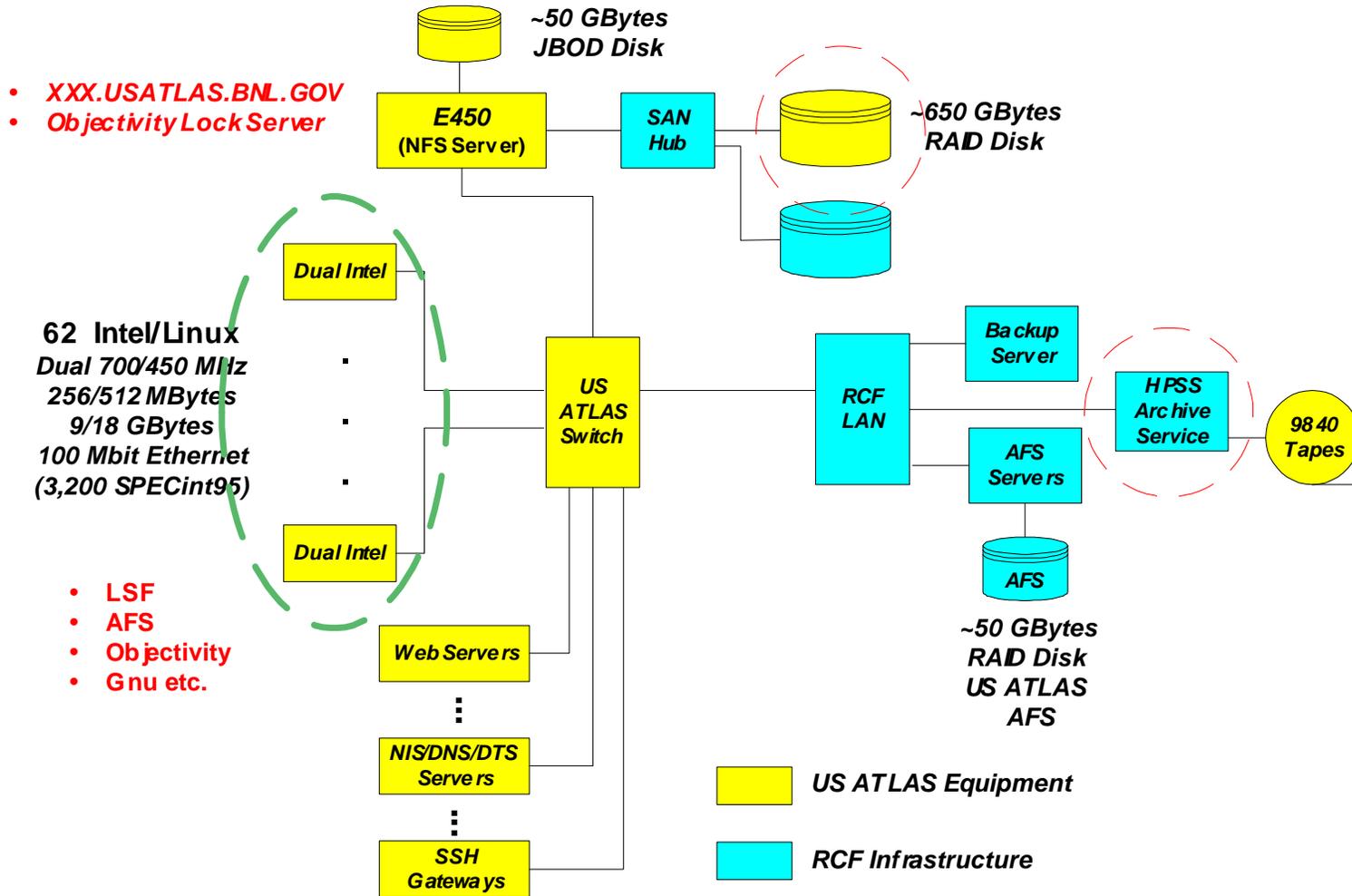
## **U.S. ATLAS Physics Analysis Center**

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- **The Tier 1 Computing Center located at BNL will participate in the upcoming (mock) data challenges**
- **BNL has started a Physics Applications Software group which is contributing to the U.S. ATLAS framework and data base effort**
- **BNL has leaders in the Physics, Liquid Argon and Muon software**
- **BMNL plans to enlarge the latter two groups, starting in FY03, as well as provide space for visitors to be an ATLAS Physics Analysis Center**

# US ATLAS Tier 1 Facility

May 2001 Configuration



# RCF/US ATLAS Intel/Linux Farms



# Reduced US ATLAS Budget Impact

## 🌿 Near term staffing (FTE's)

	<b>FY 2001</b>	<b>FY 2002</b>	<b>FY 2003*</b>
<b>Planned</b>	5.5	7.5	10.5
<b>Revised</b>	2.5+	5.5	7.5

## 🌿 Near term capacity (% of LHC '07 requirement)

	<b>FY 2001</b>	<b>FY 2002</b>	<b>FY 2003*</b>
<b>Planned</b>	1%	2%	5%
<b>Revised</b>	~0.5%	~1%	~2.5%

\* MDC2

# LHC Magnet Production at BNL

## Special Dipole Magnets for the non-Arc Regions

- First phase of the production work; 'RHI C' style D1 dipole cold masses complete (5 units)
- Second phase; 'reverse field' in progress, first D2 cold mass in final stage of production
- Preparing to insert D1 cold masses into cryostats. First production magnet on test stand in the Fall
- Recent design changes to IR4 have required changes to the design of the D3 & D4 dipoles (basically simplifications)

U.S. Production schedule ahead of the main LHC Project schedule

Costs as estimated

# LHC Superconductor Cable & Wire Testing at BNL - Status

All three test stations are fully operational.

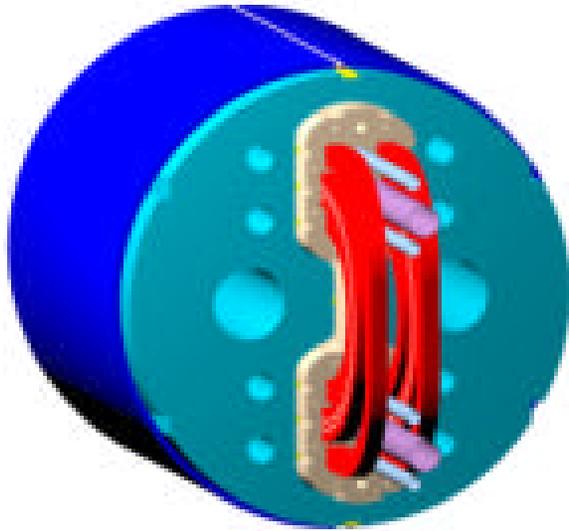
Samples from LHC Phase 0 and Batch 1 of the main dipole cable production are currently being tested

Production schedule is delayed by ~ 6 months.

Peak production rate will occur during FY'02 -FY'04 at 736 samples/yr

Arup Ghosh acting as CERN rep on occasion at IGC, and as a consultant when requested for Daniel LeRoy

## BNL Magnet R&D strategy

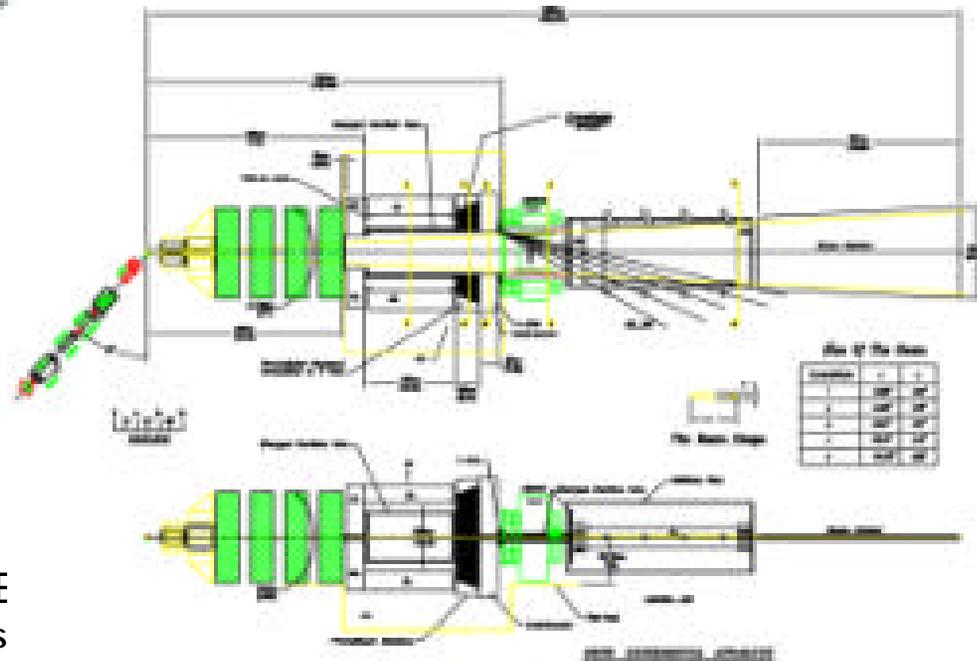


- Primarily focussed on next generation materials: HTS compounds + a little  $Nb_3Sn$
- Magnet designs based on the use of 'conductor friendly' flat coils (tapes & cable)
- Focussing on specialized applications (VLHC IR's, muon storage rings) where performance requirements dominate cost issues



R&D program is highly leveraged by the use of existing equipment and infrastructure

# KOPIO



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# HEP Budgets at BNL & Revised Request by B&R

Budget Category	FY99 Actual (\$M)	FY00 Actual (\$M)	FY01 Actual (\$M)	FY02P Pres B (\$M)	FY02R C. Rev <sup>1</sup> (\$M)
KA 04 01 (Research)					
Phys Research	8.20	9.87	9.45	8.92	11.93
ATLAS Computing	0.00	0.00	0.57	0.32	1.61
KA 04 03 01,02 (R&D Ops)	6.02	4.13	5.50	4.88	7.35
KA 05 (Facility Operations)					
AGS Facil. Ops.	32.38	2.80	5.98	5.60	6.15
Phys. Dept. Supp.	0.69	0.00	0.00	0.00	0.00
AIP	0.00	0.00	0.00	0.00	0.50
Exp. Cap. Eqp.	1.08	1.20	1.56	1.48	3.77
LHC Related Ops.	1.91	1.41	4.30	2.07	8.02
LHC Eqp.	9.07	9.18	6.80	9.33	10.27
KA 05, 04 (non-HEP)	10.14	0.00	(0.70)	0.00	0.00
Total Funding	69.49	28.59	34.26	32.60	49.60
Total HEP	59.35	28.59	34.96	32.60	49.60
AGS Weeks	12+8	12+15	9+16	22+0	25+0

<sup>1</sup> BNL Contractor's Revised Request in FY02 Field Work Proposal

## Research Budget Detail

Item	FY99 (\$M)	FY00 (\$M)	FY01 <sup>1</sup> (\$M)	FY02P <sup>2</sup> (\$M)	FY02R <sup>3</sup> (\$M)
KA 04 01 Research					
Phys Research	8.2	9.9	9.45	<b>8.92</b>	<b>11.93</b>
<b>ATLAS Computing</b>	0.0	0.0	0.57	<b>0.32</b>	<b>1.61</b>
KA 04 03 HE Technolgy R&D					
01-1 Gen. Accel. R&D	3.1	1.6	2.92	<b>2.48</b>	<b>2.95</b>
01-2 Muon Coll. R&D	1.8	1.4	1.57	<b>1.45</b>	<b>2.47</b>
02 Det.. R&D	1.1	1.1	1.01	<b>0.95</b>	<b>1.93</b>
KA 04 03 Totals	6.0	4.1	5.50	<b>4.88</b>	<b>7.35</b>

<sup>1</sup> per May 2001 Fin. Plan

<sup>2</sup> President's Budget Request

<sup>3</sup> BNL Contractor's Revised Request in FY02 Field Work Proposal

## Effect of FY02 President's Budget on BNL

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- **With the current level of effort (~60 FTEs) in theory, experiments and advanced accelerator R&D there will be a shortfall of ~\$1.7 M due to the 5.5% reduction from FY01. This will require a RIF of about 11 people**
- **This will impact D0 and prevent development of ATLAS Computing**