THE RHIC FACILITY AND THE SBIR/STTR PROGRAM

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RHIC and the SBIR/STTR Program

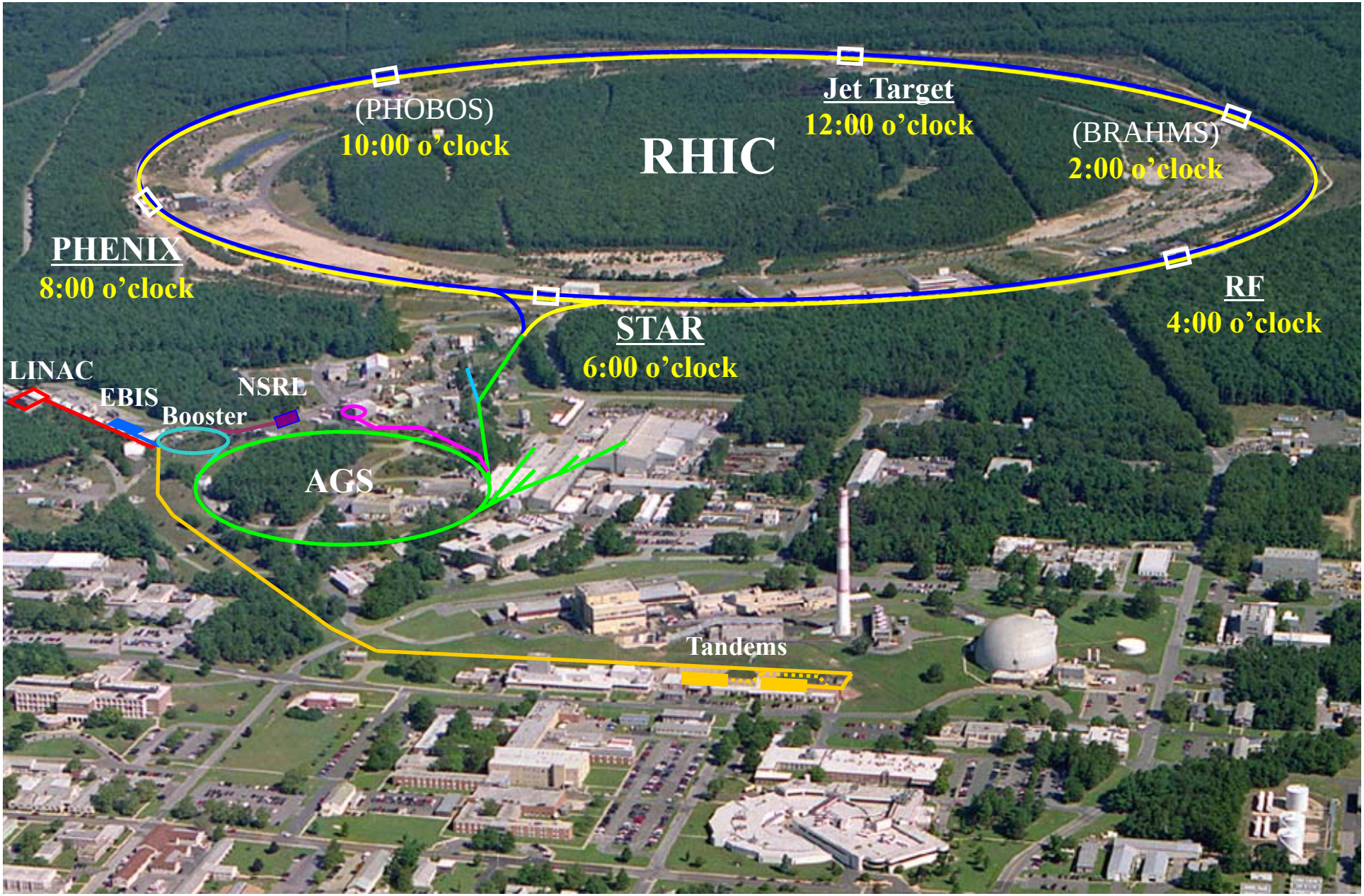
The RHIC complex comprises eight accelerators, including the twin 3.8 km superconducting collider rings.

The C-AD Department has nearly 400 staff members which operate, maintain and upgrade the accelerator complex and do R&D on a variety of subjects.

We consider the SBIR/STTR program as an important element in the way we do accelerator R&D.

SBIR/STTR programs are highly encouraged and strongly supported by C-AD.

RHIC – a High Luminosity (Polarized) Hadron Collider



RHIC is central to carrying out the ONP science mission:

The mission of the Nuclear Physics (NP) program is to discover, explore, and understand all forms of nuclear matter. The fundamental particles that compose nuclear matter - quarks and gluons - are relatively well understood, but exactly how they fit together and interact to create different types of matter in the universe is still not fully explained. To solve this mystery, NP supports experimental and theoretical research - along with the development and operation of particle accelerators and advanced technologies – to create, detect, and describe the different forms and complexities of nuclear matter that can exist in the universe, including those that are no longer found naturally.

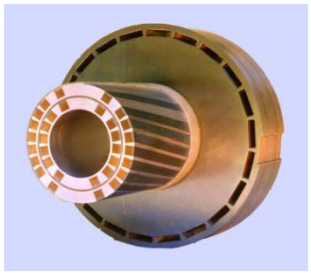
C-AD Mission Statement

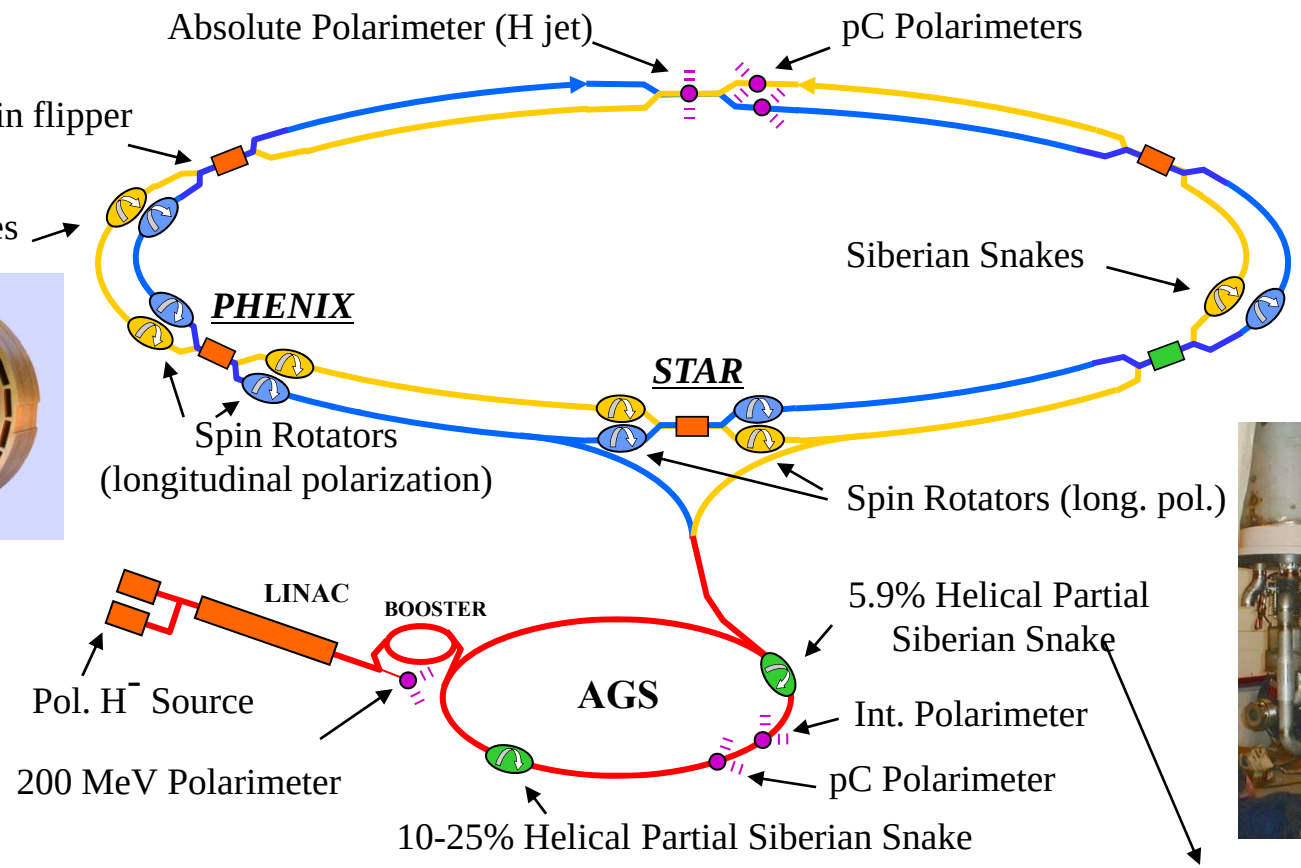
The mission of the Collider-Accelerator Department is to develop, improve and operate the suite of particle / heavy ion accelerators used to carry out the program of accelerator-based experiments at BNL; to support the experimental program including design, construction and operation of the beam transports to the experiments plus support of detector and research needs of the experiments; to design and construct new accelerator facilities in support of the BNL and national missions. The C-A Department supports an international user community of over 1500 scientists. The department performs all these functions in an environmentally responsible and safe manner under a rigorous conduct of operations approach.

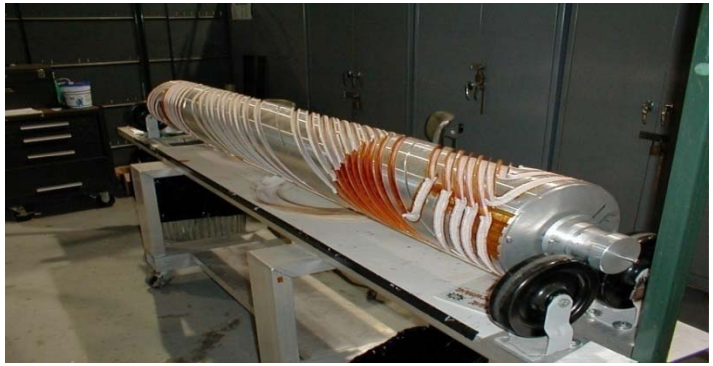
The Center for Accelerator Science and Education

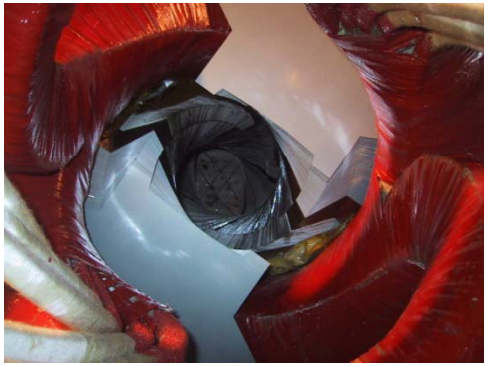
Brookhaven National Laboratory and Stony Brook University established a joint Center for Accelerator Science and Education (CASE). Research done under the aegis of CASE involves a large number of graduate students and post doctoral associates, and brings together the resources of a large National Laboratory and a large State University.

RHIC – First Polarized Hadron Collider



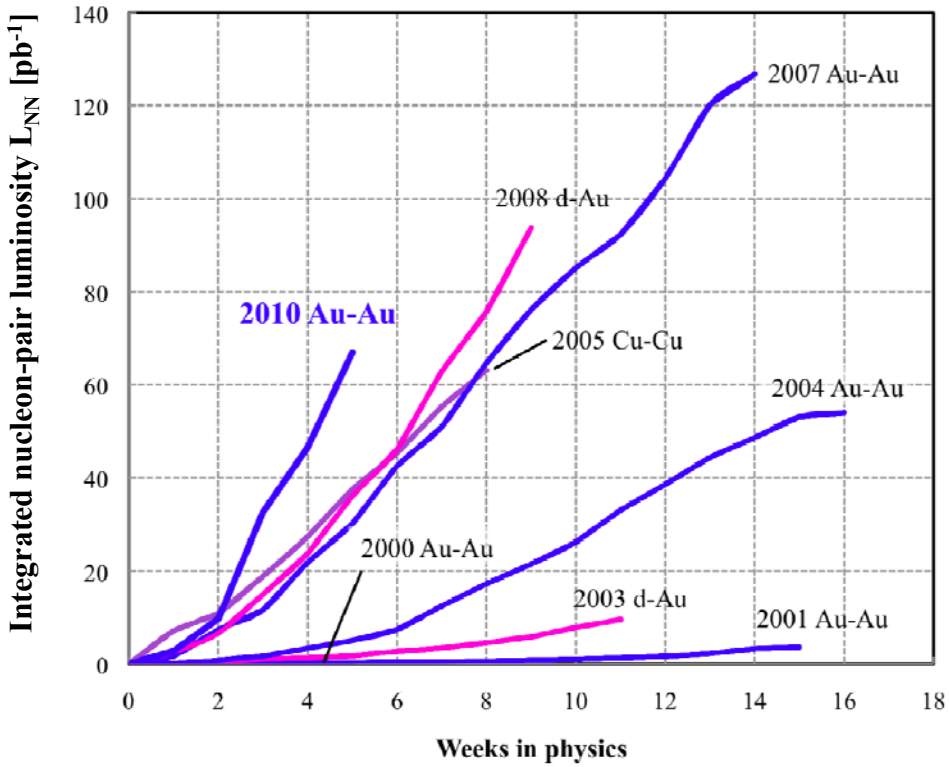




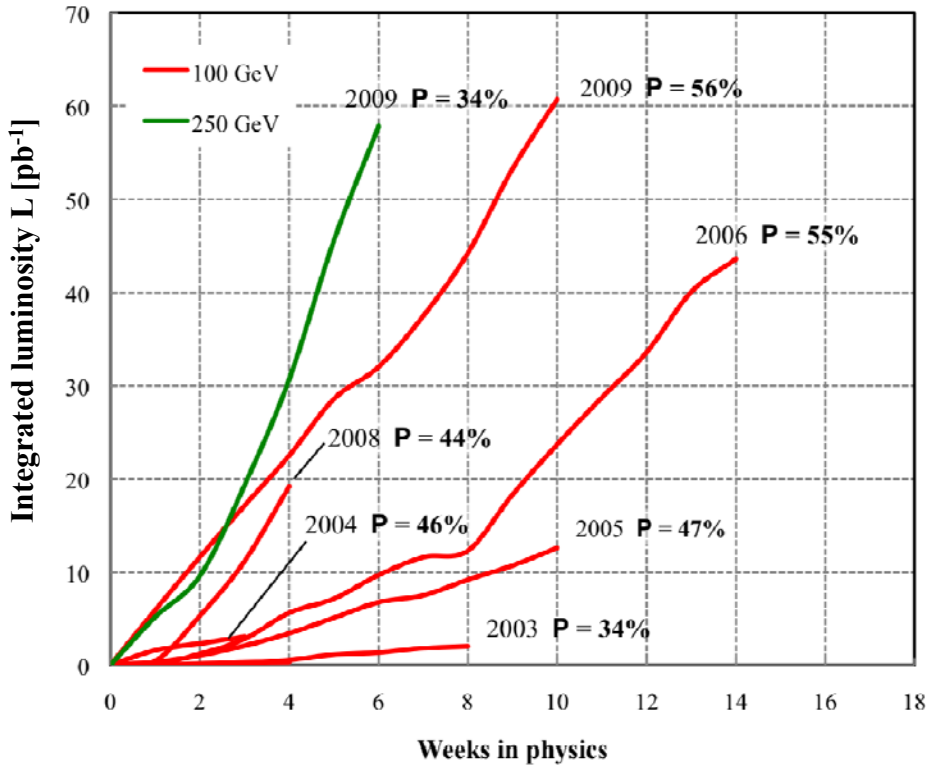


Delivered Integrated Luminosity and Polarization

Heavy ion runs



Polarized proton runs



Nucleon-pair luminosity: luminosity calculated with nucleons of nuclei treated independently; allows comparison of luminosities of different species; appropriate quantity for comparison runs.

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Excellence (as determined by NSAC Committee on Performance Measures)

A true surprise has been found, a new type of strongly-coupled matter with a ratio of viscosity to entropy density lower than any heretofore known. Attempts to understand this property have led to **completely unanticipated connections to theories of quantum gravity and to a postulated fundamental quantum limit on the ratio of viscosity to entropy density.** This unforeseen development implies that "viscosity" should be added as a particularly important property to be quantified.

Just last run alone:

Measured $T_{init} \gtrsim 300$ MeV ~ 4 x10^{12}K

Hints of local parity violation

Anti-hypertriton discovery

and much more…

Accelerator R&D Investment ($k) FY2009 – FY2012

B&R	KB0202011	FY09 Actual	FY10 Allocated	FY11 Guidance	FY12 +3.5%
Existing Facility					
Machine Development		$2,664	$3,000	$3,125	$3,250
TOTAL Existing Facility		**$2,664**	**$3,000**	**$3,125**	**$3,250**
Next Generation					
Stochastic Cooling					
Labor		$494			
M&S		$250			
MeRHIC / eRHIC / ERL					
Labor					
	Simulation & Design	$2,125	$2,227	$2,573	$2,676
	Production Labor	$1,860	$1,807	$2,088	$2,171
M&S		$2,000	$2,000	$1,040	$1,076
eRHIC (MIT-Bates)		$282	$150		
EIC R&D Proposals (M&S)				$1,400	$1,449
TOTAL Next Generation R&D		**$7,011**	**$6,184**	**$7,101**	**$7,372**

Next generation accelerator R&D: 5.0 % of RHIC ops. funding

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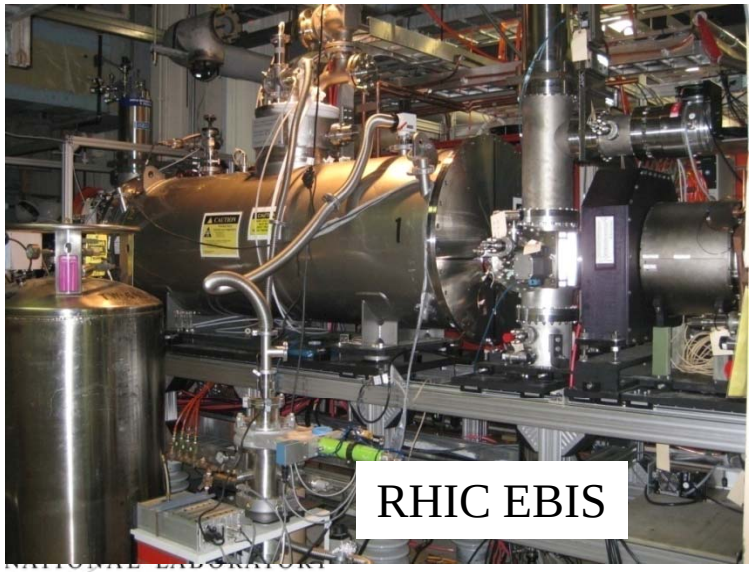
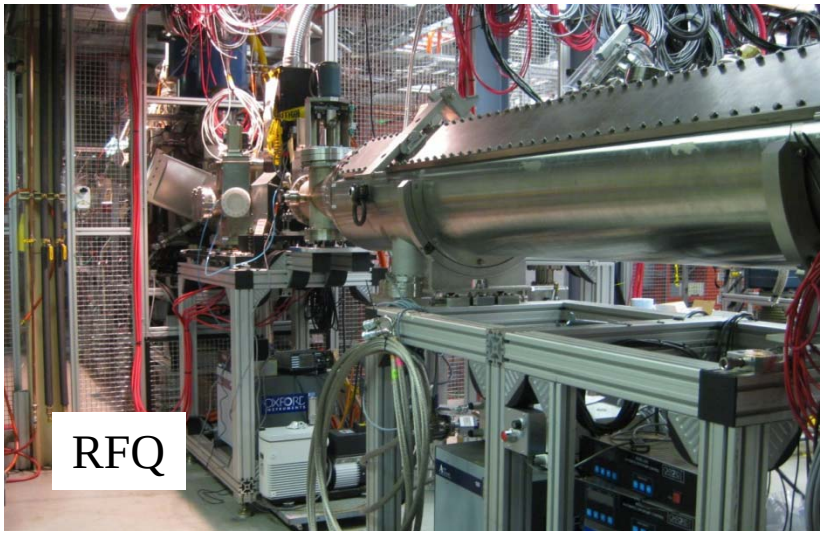
Electron Beam Ion Source (EBIS)

- New high brightness, high charge-state pulsed ion source, ideal as source for RHIC
- Produces beams of all ion species including noble gas ions, uranium (RHIC) and polarized He^3 (eRHIC)
- Prototype achieved 1.7 *10^9 Au^{33+} in 20 μs pulse with 8 A electron beam (60% neutralization)
- RHIC EBIS source completed and operating (first ions were extracted in December)
- Construction schedule: FY2006 – 10 (CD4: 4Q FY2010)
- Funding profile:

	FY2005	FY2006	FY2007	FY2008	FY2009	Total
DOE NP	0.7	2.1	5.1	4.2	2.7	14.8
NASA	0.5	3.0	1.0			4.5
Total	1.2	5.1	6.1	4.2	2.7	19.3


RHIC EBIS

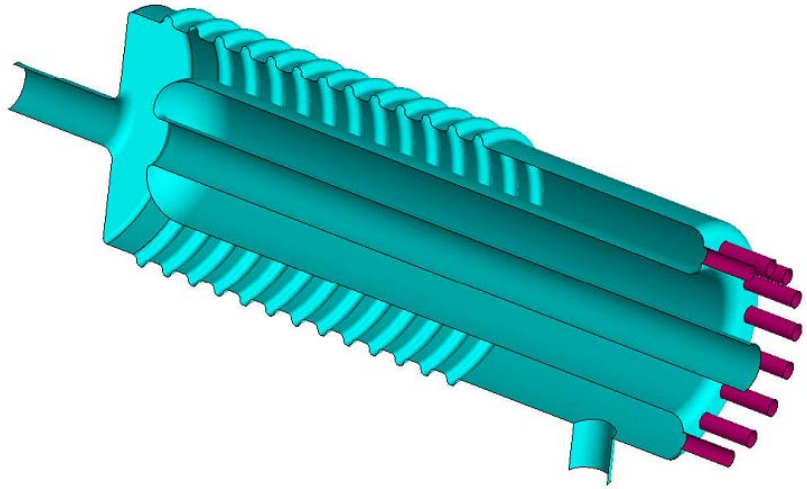

RFQ

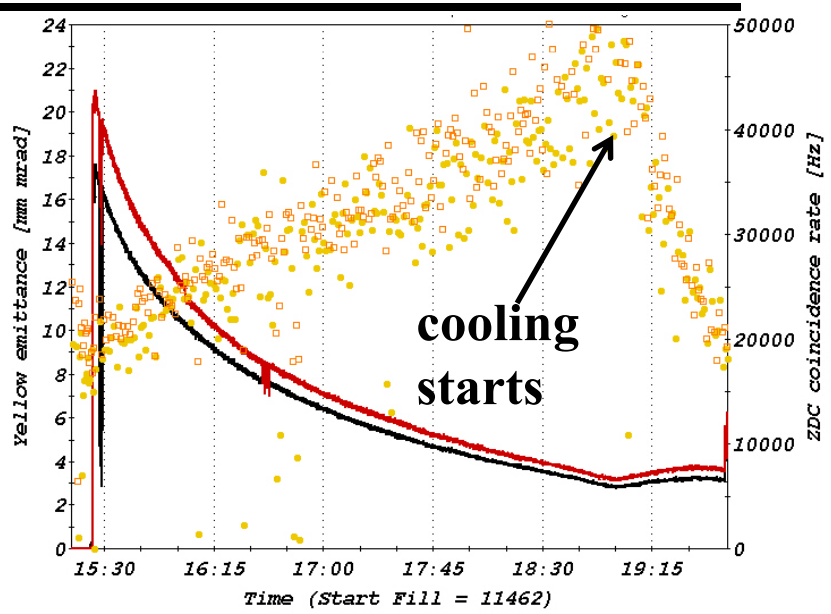
Stochastic Cooling and 56 MHz SRF cavity

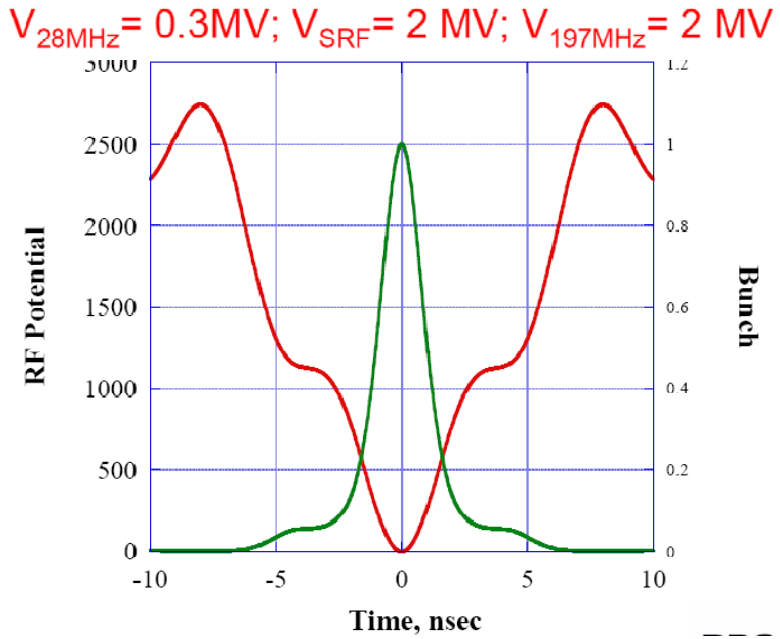
- Longitudinal and transverse cooling demonstrated at 100 GeV/nucleon in RHIC, counteracting IBS.
- Longitudinal and vertical cooling installed in both rings. Horizontal cooling under construction, to be competed for Run-12.

56 MHz SRF storage cavity:

- Greatly reduces satellite bunches
- Re-entrant quarter wave resonator
- Under construction, to be completed for Run-13.

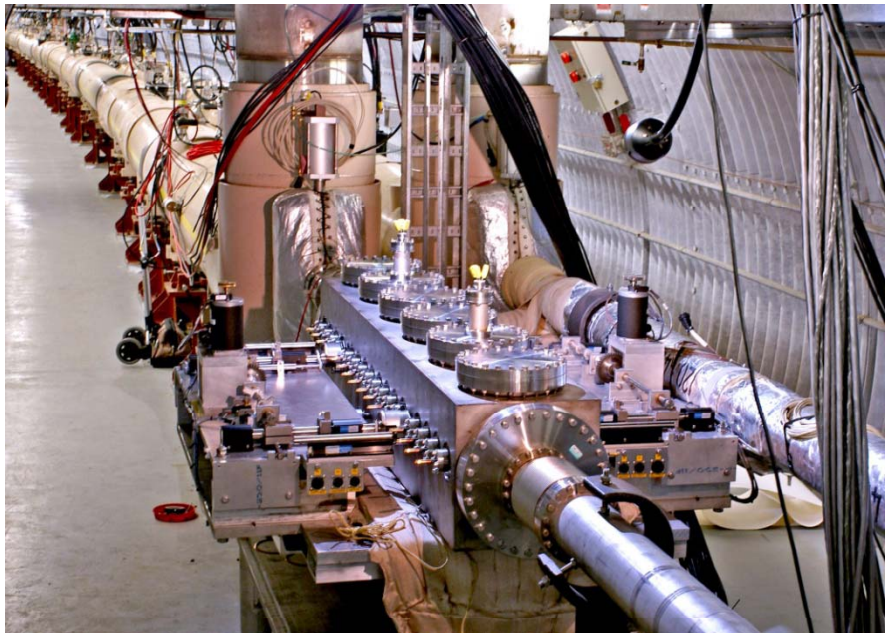


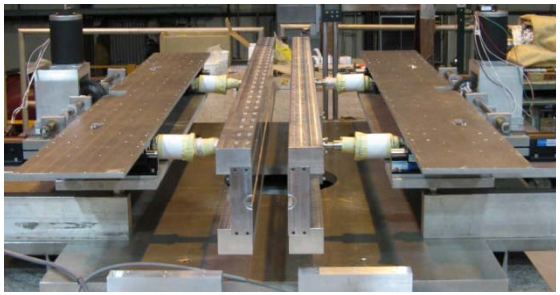


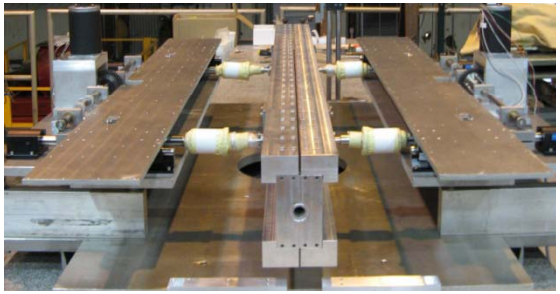


Transverse stochastic cooling

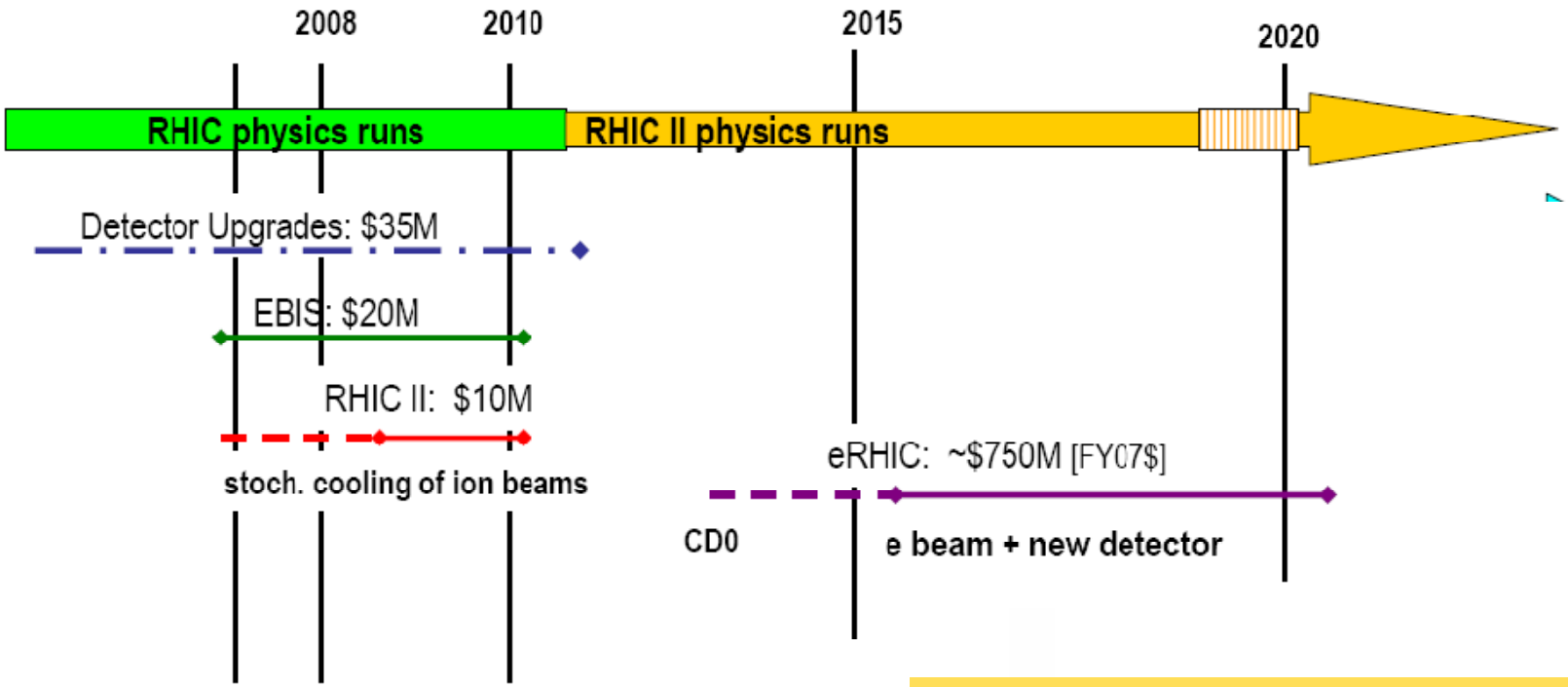
- Blue and Yellow vertical stochastic cooling kicker and pick-up installed, Yellow transverse cooling demonstrated, used in operation
- Yellow vertical cooling cools both planes via coupling
- Blue vertical cooling under commissioning
- Blue and Yellow horizontal cooling under construction (for Run-12), will reduce transverse cooling time







A Long Term (Evolving) Strategic View for RHIC



Legend:

- *R&D*
- *Construction*
- *Multiple small projects*

CD0: DOE Critical Decision, mission need

EIC = Electron-Ion Collider; eRHIC = BNL realization by adding e beam to RHIC. The electron beam will be produced by a superconducting Energy Recovery Linac

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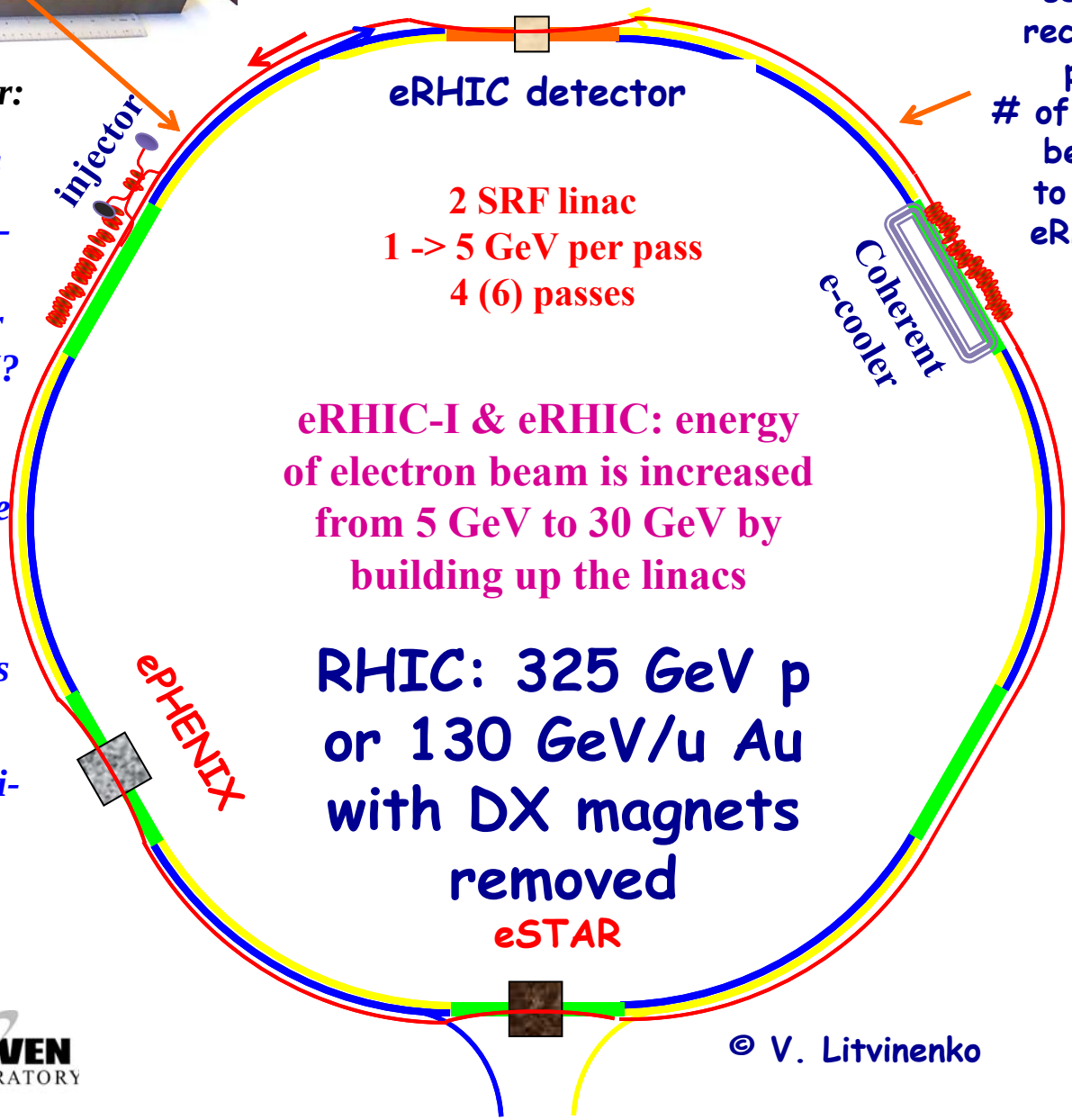
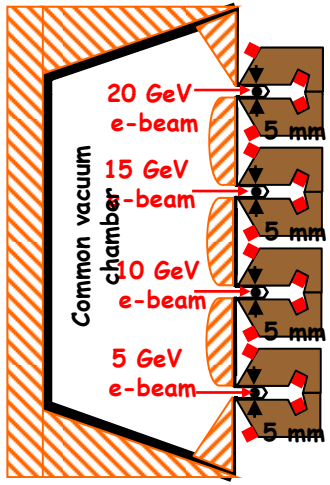
eRHIC Design

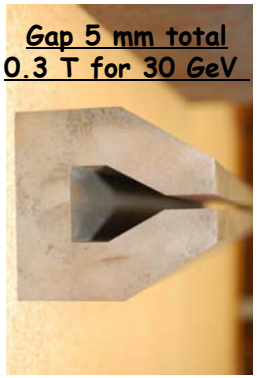
Design allows for:

- *multiple IP's*
- *reusing infra-structure + det. components for STAR, PHENIX?*
- *low cost*
- *easy up-grade*
- *minimal environmental impact concerns*
- *IR design to reach >10^{34} lumi-nosity*



Vertically separated recirculating passes. # of passes will be chosen to optimize eRHIC cost





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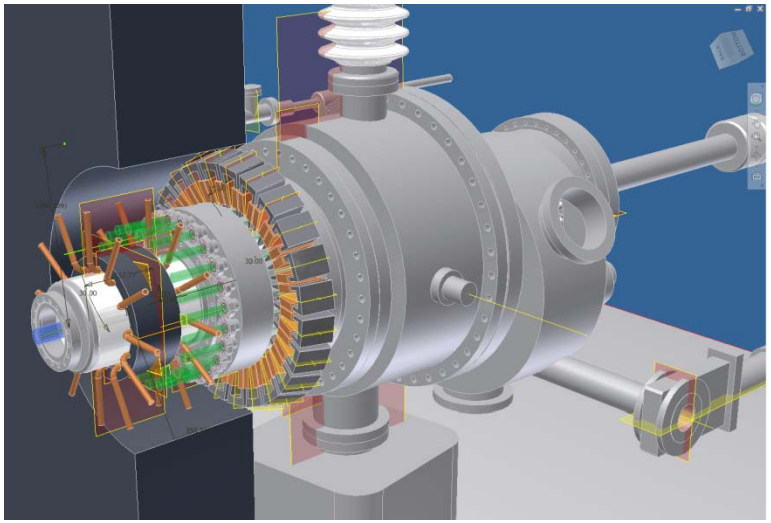
eRHIC R&D

- High current polarized electron gun.
- Polarized He^3 source.
- Coherent Electron Cooling.
- Beam-Beam simulations.
- SRF cavity development.
- High current ERL technology:
  - Non-destructive diagnostics
  - RF power and control
- Compact small-gap magnets.



Examples of opportunities

Software and Data Management:

- Simulation software of beam cooling, photocathodes, SRF cavities
  - Examples: Tech-X VORPAL based simulations of electron cooling, coherent electron cooling, diamond amplified photocathodes, 3-D multipacting code
- Last run (Run 10) RHIC detectors produced >2 pewtabytes of data.

Electronics Design and Fabrication:

- RF power amplifiers
  - Example: Green Mountain Radio Research solid-state amps
  - Example: Beam Power Technology elliptic beam klystron
- Reactive power tuners
  - Example: OmegaP development of high-power, fast reactive tuners
- Materials for reactive power tuners
  - Example: Euclid Techlabs development of Nonlinear Ferroelectric

Examples of opportunities (continued)

Accelerator Technology:

- SRF cavity
  - Example: AES development of crab cavity,
  - Example: Niowave development of 28 MHz fast tunable SRF cavity
- HOM damping
- Cryomodule
- Electron guns
  - Example: AES 1.3 GHz SRF gun, Niowave 112 MHz SRF gun
- Photocathodes
  - Example: AES development of preparation chambers and load-locks
  - Example: Nanohmics surface modifications of photocathodes
  - Example: AES development of polarized SRF gun load-lock

Examples of opportunities (continued)

Instrumentation:

- Non-destructive beam monitors
  - Example: RadiaBeam proposed Thomson scattering monitor
  - Example: RARTECH proposed beam profile monitors

Nuclear Physics Isotope Science and Technology:

- BLIP is a major producer of medical radioactive isotopes

Summary

The RHIC Complex is supporting the mission of the Office of Science in providing a thriving and highly successful service to the users' community and carrying out cutting edge accelerator R&D program.

The SBIR/STTR program is playing an important role in our R&D program.

Small business companies are encouraged to get in touch with the speaker to find a match between the R&D needs of the RHIC complex and their capabilities and ideas.