# AIP and CE Plans for RHIC

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Science and Technology Review

by the Office of Nuclear Physics of the U.S. Department of Energy

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# Content

1. Risk assessment document
   - Requested at last review
2. AIP and CE projects
   - Goals
   - Projects for FY07-09
   - Selected AIP project descriptions
3. Other large upgrades (not AIP/CE)

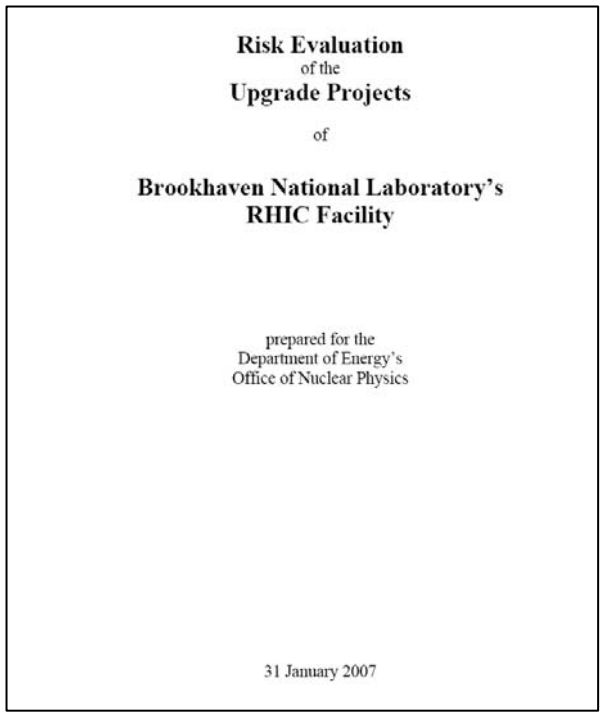
AIP = Accelerator Improvement Project

CE = Capital Equipment

# Risk assessment document

## DOE Recommendation from 2006 S&T Review:

- Generate a risk assessment of the backlog of Capital Equipment (CE) and Accelerator Improvement Projects (AIP) requests and submit to DOE by January 31, 2007



**Risk Evaluation**
of the
**Upgrade Projects**

of

**Brookhaven National Laboratory's**
**RHIC Facility**

prepared for the
Department of Energy's
Office of Nuclear Physics

31 January 2007

# Risk assessment document: executive summary (1)

- Distinguish 2 areas:
  - Accelerator systems (AIP, CE)
  - Building and electrical infrastructure (space charge, GPP, ops)

- 2 accelerator system upgrades categories:
  - To maintain operational readiness
    → **address downtime risk**
  - To improve performance
    → **address performance risk**

- Evaluated accelerator system upgrades
  - With a time horizon of a few years
  - Assuming no high-intensity proton operation for at least a decade

# Risk assessment document: executive summary (2)

- Accelerator system upgrade project list has a total cost of approximately $23M (now $27M)
  - With approx. $5M/year AIP/CE (pre-EBIS inflation adjusted) both downtime and performance risks can be addressed
  - Lower funding will delay some performance upgrades

- Also have risks due to deferred maintenance of electrical and building infrastructure, and regulatory environment.
  - Need approximately $20M over 5 years to address those
  - Funding sources: special GPP to address OSHA compliance, redirected laboratory space charge for deferred maintenance
  - Requested $1M/year increase in operating funds for remaining infrastructure work

# Risk assessment document

Accelerator systems projects addressing downtime risks.

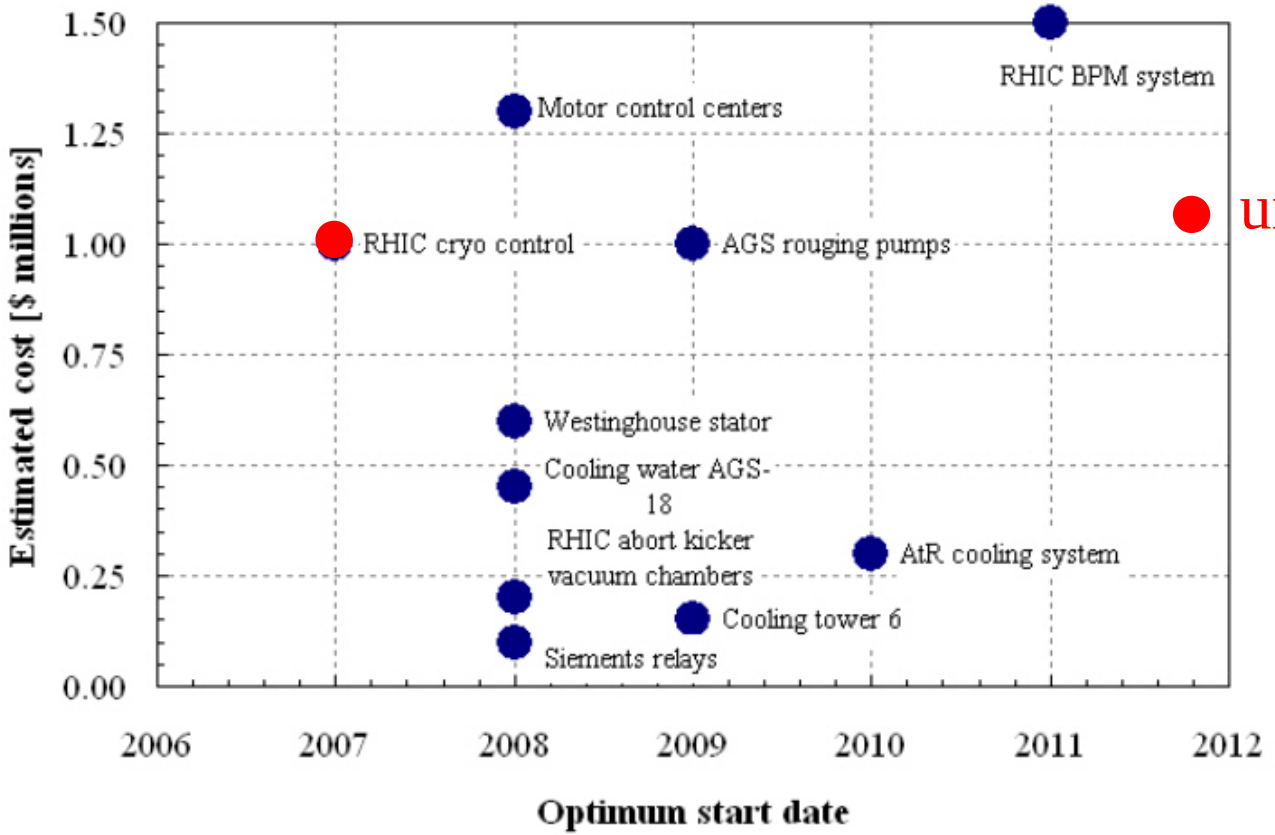
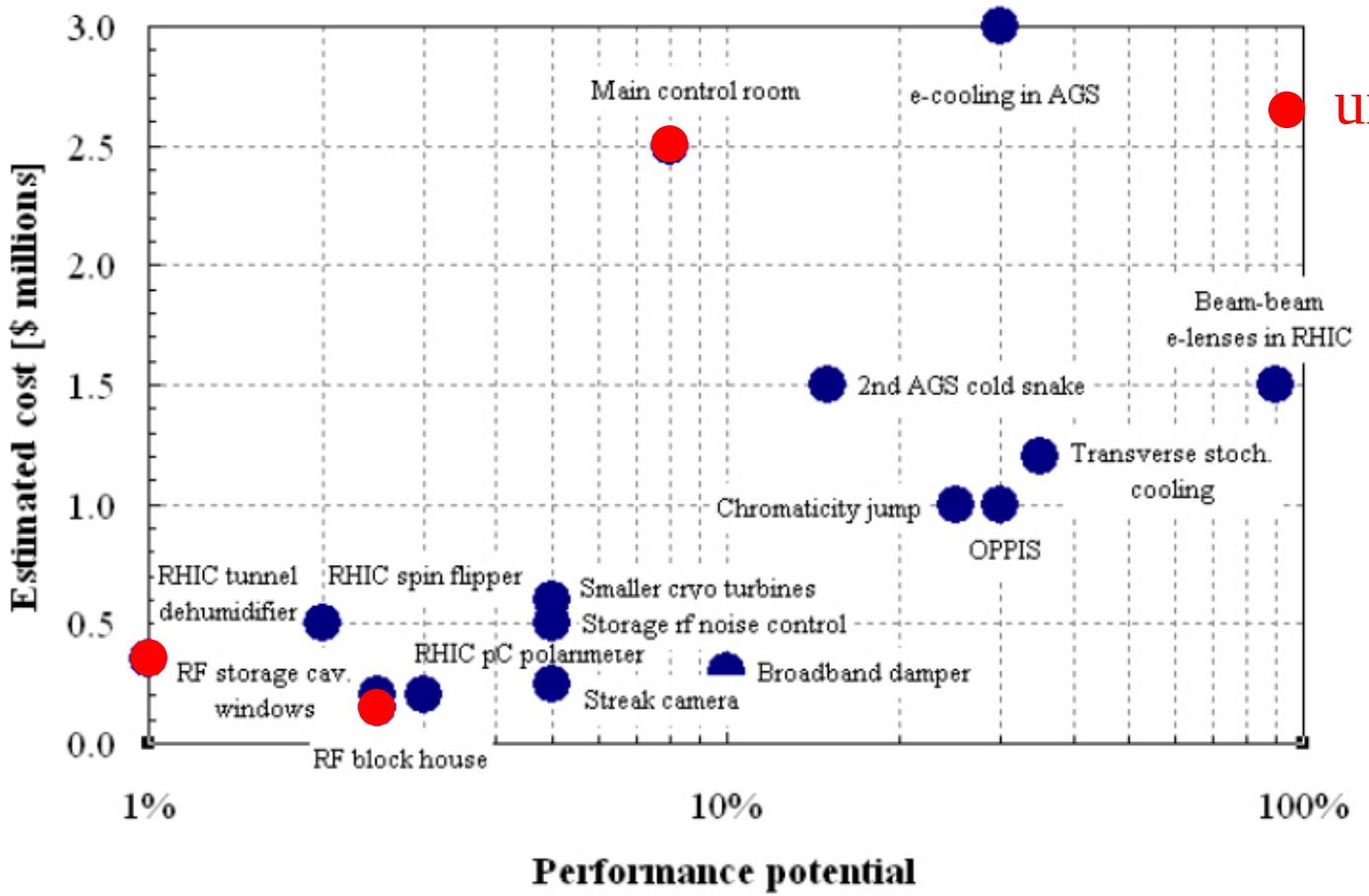



**Figure 2 – Upgrade projects to maintain operational readiness, with optimum start time and estimated cost.**

# Risk assessment document

Accelerator systems projects addressing performance risks.




under way

**Figure 3 – Upgrade projects to improve performance, with performance potential and estimated cost.**

**~ increase in integrated luminosity**

# Goals for AIP and CE

1. Existing infrastructure improvements
   [example: motor control center upgrades]
2. Upgrades for more luminosity
   [example: RHIC stochastic cooling]
3. Upgrades for more polarization
   [example: AGS snakes]
4. Upgrades for more time in store
   [example: RHIC service buildings]
5. Upgrades for power savings
   [example: cryo upgrades]

# FY2007 AIP and CE

- Capital projects total: $1M
  - AGS ion pump control upgrade (Phase II of II) $500k
  - AGS/RHIC low level rf upgrade (Phase III of III) $200k
  - Block house for rf test stand $130k
  - Accelerator general capital equipment $170k
    (includes laser tracker for survey group $150k)
- AIP total: $2.1M
  - AGS MMPS transformer (Phase III of III) $0.9M
  - RHIC stochastic cooling (Phase II of II) $0.5M
  - Main Control Room upgrade (Phase I of III) $0.5M
  - RHIC cryo control system upgrade (Phase I of II) $0.2M

# Planned FY2008 AIP and CE (for Presidential budget)

- Capital projects total: $1.0M
  - RHIC collimation upgrade $400k
  - RHIC storage rf windows $200k
  - Booster/AGS access control system (Phase I of II) $200k
  - Accelerator general capital equipment $200k
- AIP total: $2.1M
  - Electron cooling in AGS (Phase I of III) $0.8M
  - Main Control Room upgrade (Phase II of III) $0.8M
  - RHIC cryo control system upgrade (Phase II of II) $0.5M

# Planned FY2009 AIP and CE

- Capital projects total: $1.4M
  - Westinghouse stator insulation $600k
  - AGS roughing pumps and vacuum gauges $500k
  - Booster/AGS access control system (Phase II of II) $150k
  - Accelerator general capital equipment $150k
- AIP total: $3.7M
  - Main Control Room upgrade (Phase II of III) $1.2M
  - Transverse stochastic cooling $0.9M
  - Electron lenses in RHIC $0.9M
  - Electron cooling in AGS (Phase II of III) $0.7M

# AIP descriptions

**Current AIPs:**

- AGS MMPS transformer
- RHIC longitudinal stochastic cooling
  → see presentation M. Brennan
- Main Control Room consolidation and upgrade

**Possible future AIPs** (few $M each)

- Electron cooling in AGS
- Transverse stochastic cooling
  → see presentation M. Brennan
- Electron lenses in RHIC

# AIP: AGS Main Magnet PS Transformer

Siemens Motor-Generator

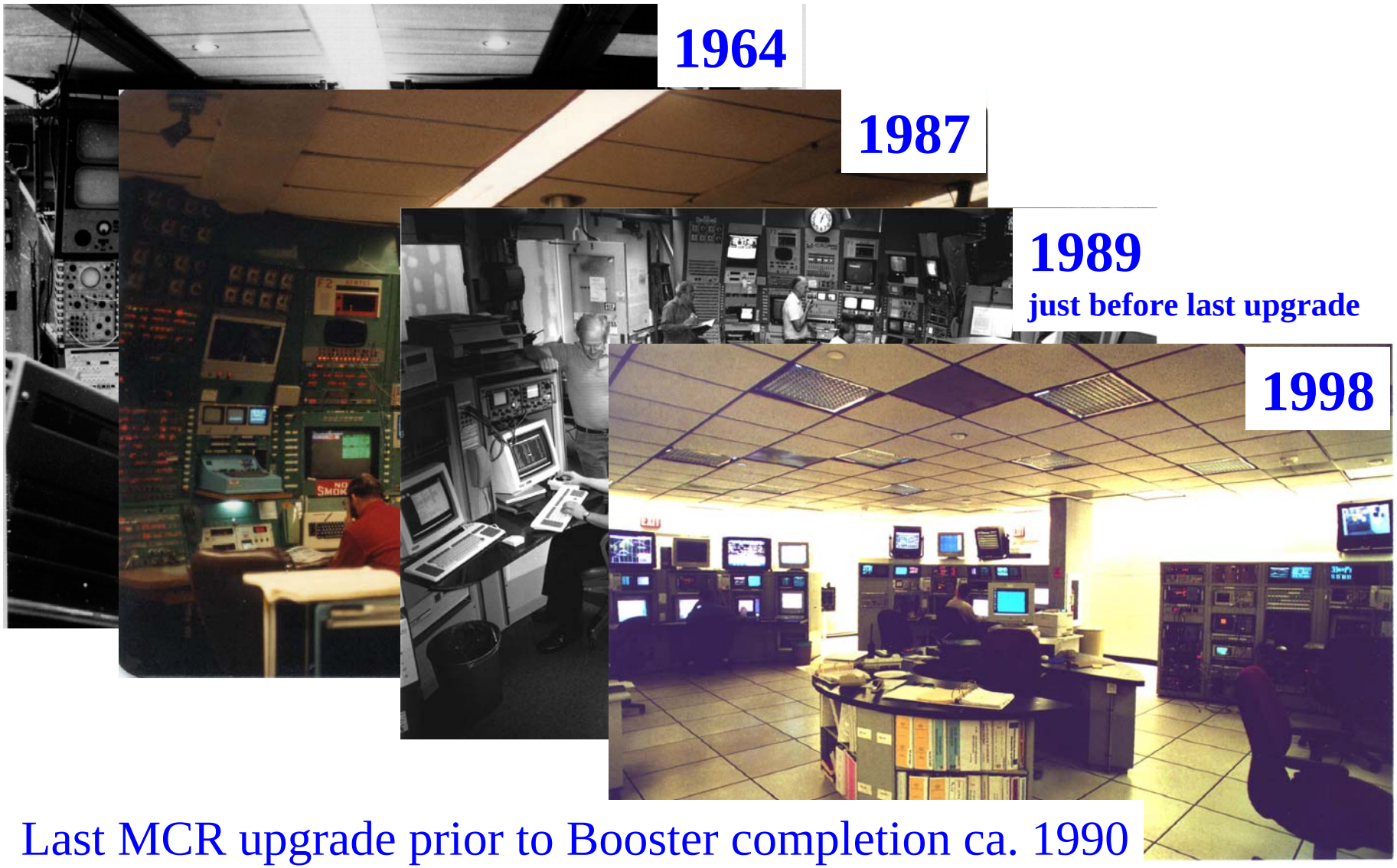
**Old AGS MMPS transformer**

- built in 1969 (Siemens)
- single point of failure

**New AGS MMPS transformer**

- total replacement cost: $3.6M
  AIP in FY05, FY06, FY07
- transformer ordered
  (Niagara-Siemens)
- also expect ripple reduction
  on ramp (at least factor 2) al
- transformer awaiting test at
  Niagara
- expected completion: Dec 2008
  (delayed by 2 years, budget and
  technical delays)

# AIP: Main Control Room consolidation and upgrade




Last MCR upgrade prior to Booster completion ca. 1990

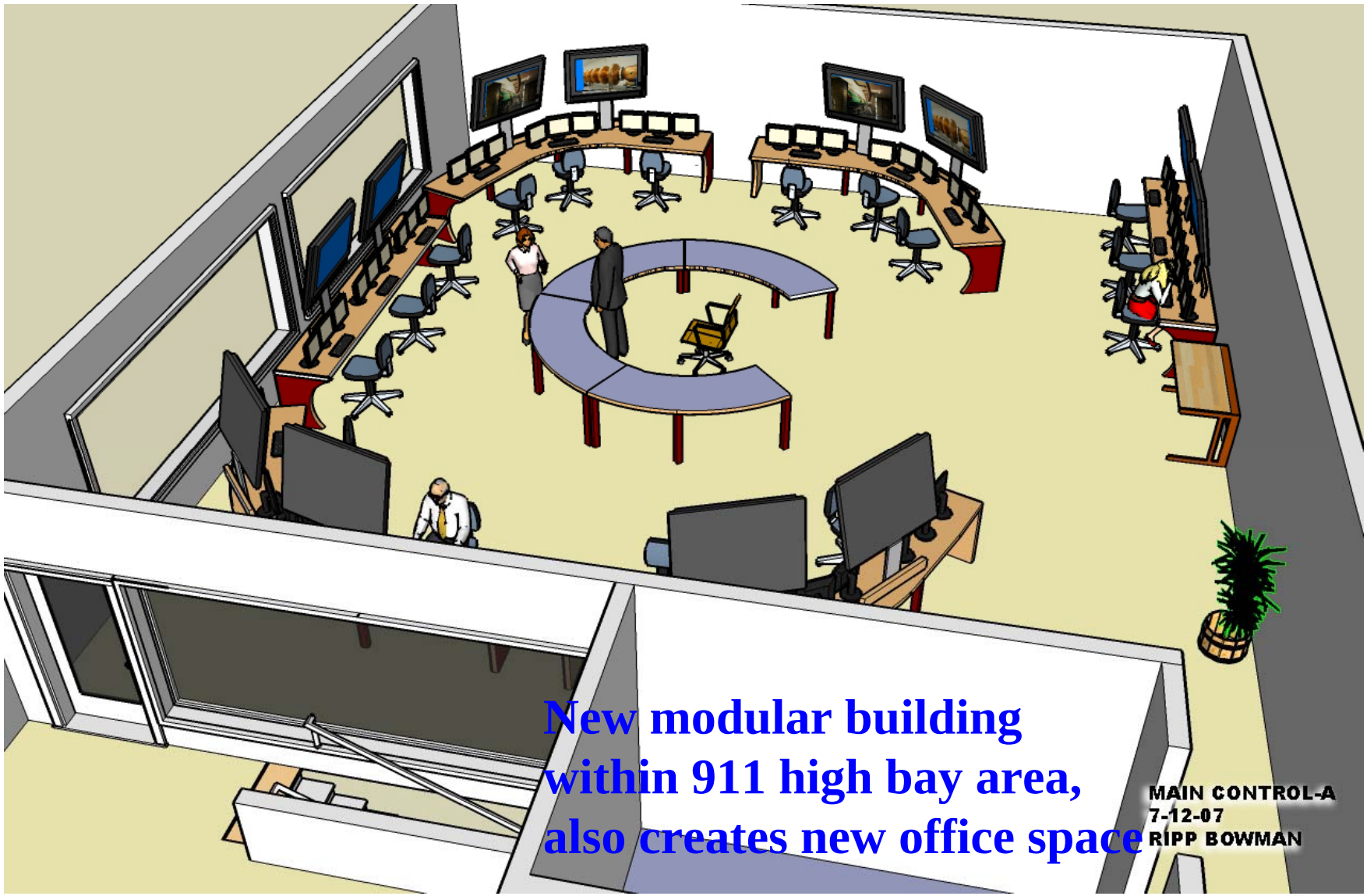
# AIP: Main Control Room consolidation and upgrade

Goals:

- Consolidation of all controls in one room
  - current MCR, cryo control room, CAS, Siemens watch
  - reduction of 24h personnel
  - better communication
- More consoles
  - face shortage when RHIC, injectors, NSRL, H-jet running (especially during machine developments)
  - more machines in the future: EBIS, ERL, e-cooling, eRHIC
- Better ergonomics
- Better integration of activities in support of MCR
  - software development
  - meetings

Total cost: approx. $2.5M (FY2007 to FY2009)

# AIP: Main Control Room consolidation and upgrade



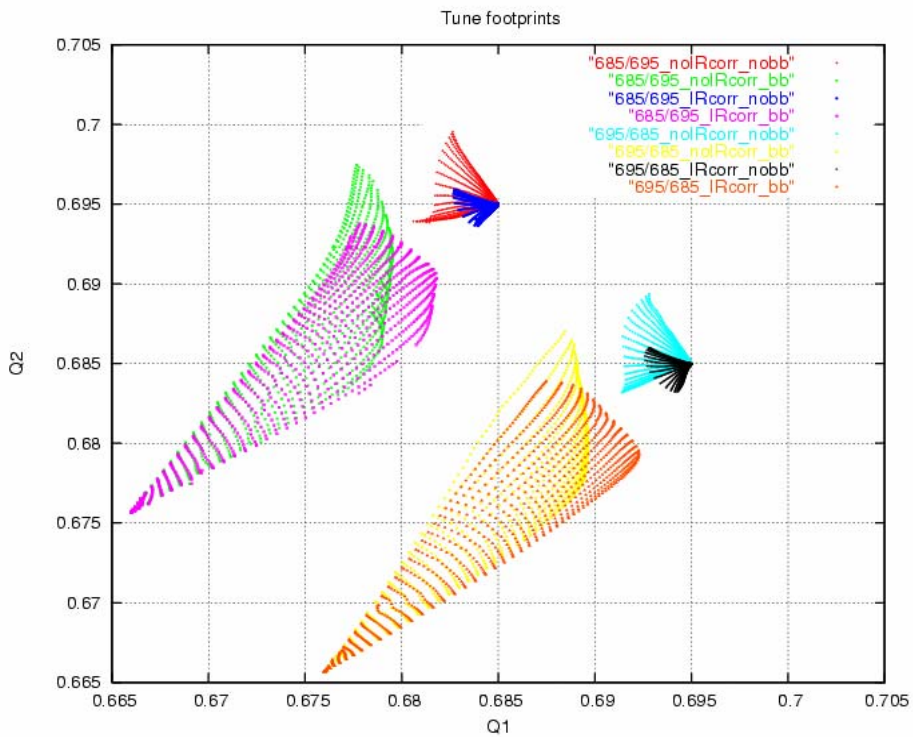
# Possible future AIP: electron cooling in AGS

- Low energy Au-Au operation requested by experiments (down to ¼ of current injection energy)
- Demonstrated operation at ½ of current injection energy in Run-7
- Luminosity will drop very fast below this energy since longitudinal matching will become impossible
- Electron cooling in AGS will increase peak luminosity at lowest energy by > order of magnitude
- Electron cooler can be ordered in Novosibirsk

# Possible future AIP: electron lenses in RHIC (pp)

## Why an electron lens?

## Y. Luo et al.

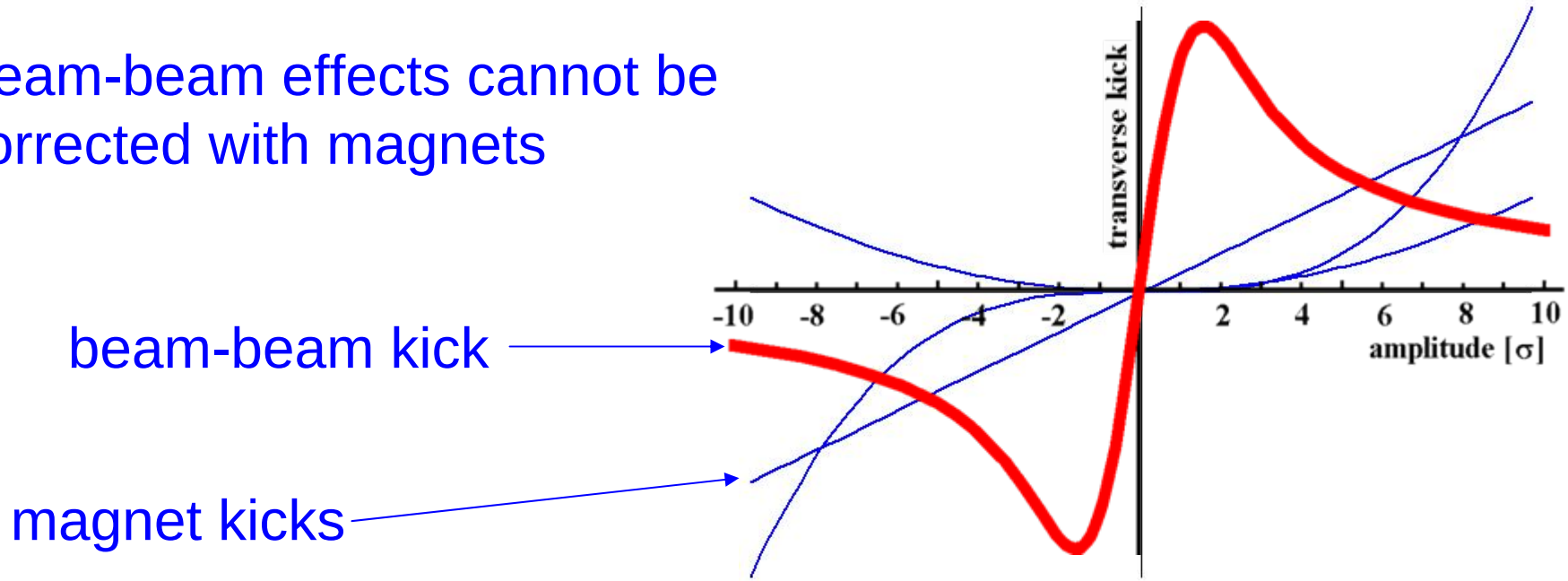



**This tune spread can only be reduced by an electron lens, not by magnets**

**Polarized proton luminosity limited by beam-beam induced tune spread.**

# Possible future AIP: electron lenses in RHIC (pp)

Beam-beam effects cannot be corrected with magnets

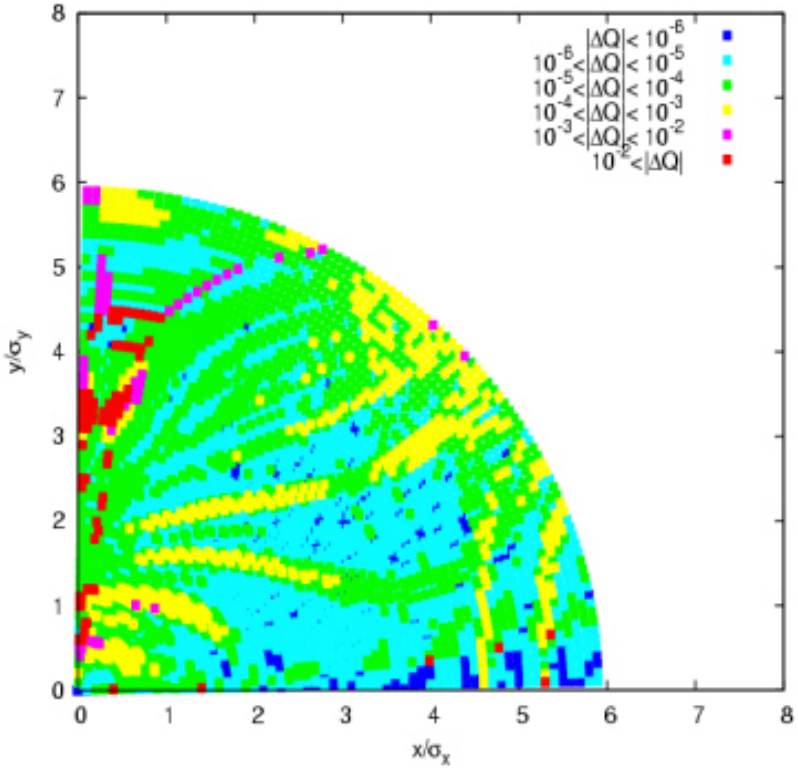



**2 e-lenses operate in Tevatron (not for head-on compensation)**

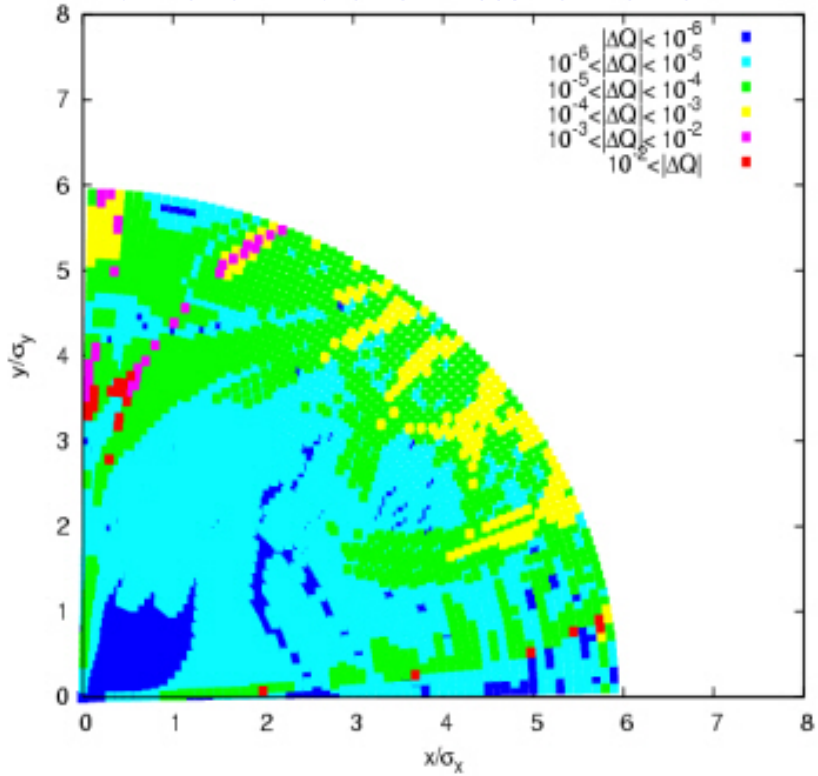
# Possible future AIP: electron lenses in RHIC (pp)

**Simulation by Y. Luo**

Tune diffusion w/o e-lens




Tune diffusion w/ e-lens

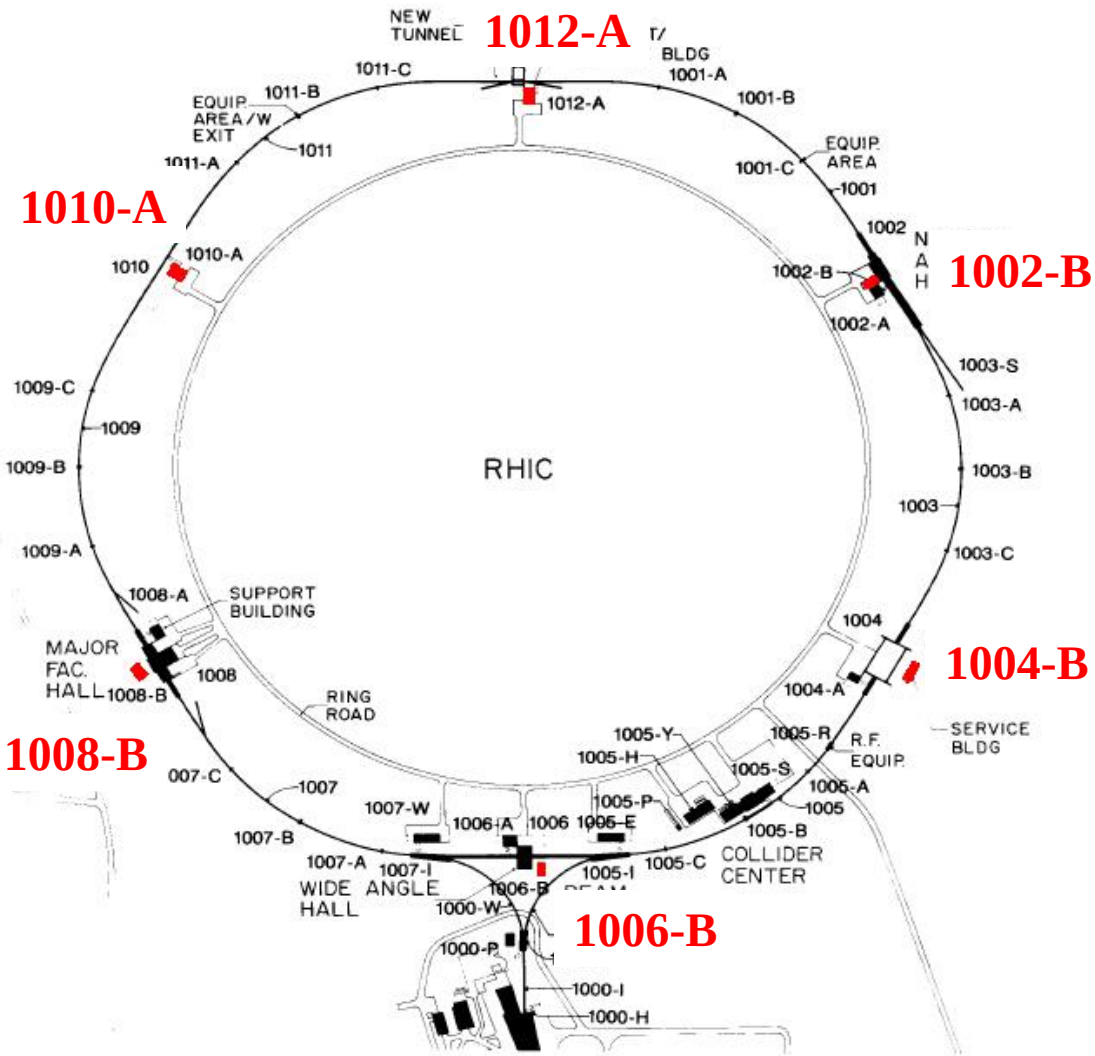



Electron lens studies under way (~1 year),
Hardware construction (~1 year) only after benefit established.
E-lens technology is similar to EBIS technology.

# Other large upgrades (not AIP/CE)

- RHIC service building improvements (GPP, ops)
- AGS electrical infrastructure (ops, AIP)
- Fire safety upgrades
- Buildings in general (space charge, GPP)

# RHIC Service Building improvements (1)




- 6 RHIC Service Building house PS and other equipment
- Replacement value of installed PS equipment is about $10M ($6M material only)
- About 40% of installed value is in a single building (1004B)

# RHIC Service Building improvements (2)

- Service buildings are not sealed, not air conditioned
  - pollen and humidity create conductive paste in spring
  - failure rate of installed equipment increases visibly with higher temperatures
- Received GPP funding ($325k) for Bldg. 1004B (A/C installed), 1010A and 1012A will follow
- About to order A/C equipment for other 3 building with operating funds
- Expect 1-2 days/run in failure reduction, and lifetime extension of installed equipment

# AGS electrical infrastructure

- Parts of the AGS complex now more than 45 years old
  - to a large degree, original electrical infrastructure still in place
  - has reached the end of its useful life
- To maintain the AGS' operational readiness a substantial amount of obsolete electrical equipment needs to be replaced or removed incl. cables and cable trays
- Total estimated cost $9.3M, possible schedule:

| FY07 | FY08 | FY09 | FY10 | FY11 |
|---|---|---|---|---|
| $1.0M | $1.8M | $2.0M | $2.4M | $2.1M |

- **Most of work will be done with operating funds**
  - Designated $1M in FY2007
  - Need to increase to about $2M/year to finish in 5 years
  - Motor Control Center upgrade ($1.3M) can be an AIP

# Fire safety upgrades

Fire hazard analysis performed (DOE order 420.1).

Examples of needed upgrades include:

- Additional 3-hour fire doors, automatic-closing, arranged to close on actuation of smoke detection devices on either side of the doorway, in accordance with NFPA 80
- Seals on unprotected openings between cable tunnels and pedestrian tunnels with a UL listed or FM approved material having a minimum of 1-hour fire resistance rating
- Protection for vertical openings between the first and second floors terminal rooms, either by sealing penetrations between the two rooms or by providing a 1-hour fire resistive enclosures around the rooms such as is done with a stairwell
- Seal openings in walls between pedestrian tunnels and terminal rooms with material having at least a 2-hour fire resistance rating
- Additional sprinkler protection for areas currently unprotected
- Upgrade existing sprinkler coverage to comply with code requirements
- Additional manual pull stations at exits
- …

Proposed to Lab management to have a 5-year laboratory-funded plan at an annual estimated cost of $2M to address these problems.

# Buildings in general

Department has a large number of old buildings

Tandem/Linac/Booster/AGS buildings > 35 years on average

**Expect significant problems with building infrastructure over time scale of RHIC II and eRHIC (about 25 years).**

## Actions initiated to improve building conditions:

1. Request has been made to address most urgent building problems (leaking roofs)
2. Proposed to obtain direct control over part of building maintenance resources
3. Requested to include RHIC complex in BNL Master Site Plan
4. Options are being developed to put large experimental hall to use (for shops, storage)
5. Trailer reduction rate accelerated (to about 20/year, ~50 left)
6. Cost of maintaining g-2 complex to be discussed with Office of HEP

# Summary

- AIP and CE projects are essential to
  - Maintain operational readiness, and
  - Upgrade the performance of the RHIC complex

  With pre-EBIS funding levels (~$5M/year) both risks can be addressed

- Current most important AIPs are
  - AGS MMPS transformer
  - RHIC stochastic cooling
  - MCR consolidation and upgrade

- Other large upgrades (not AIP/CE) include

  RHIC service buildings, AGS electrical infrastructure,
  Fire safety upgrades, Building in general

  The status of these upgrades can affect the AIP/CE plans