Adding Accelerators to Accelerators

Accelerator Safety Workshop 2018
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Collider-Accelerator Department (C-AD)
Brookhaven National Laboratory
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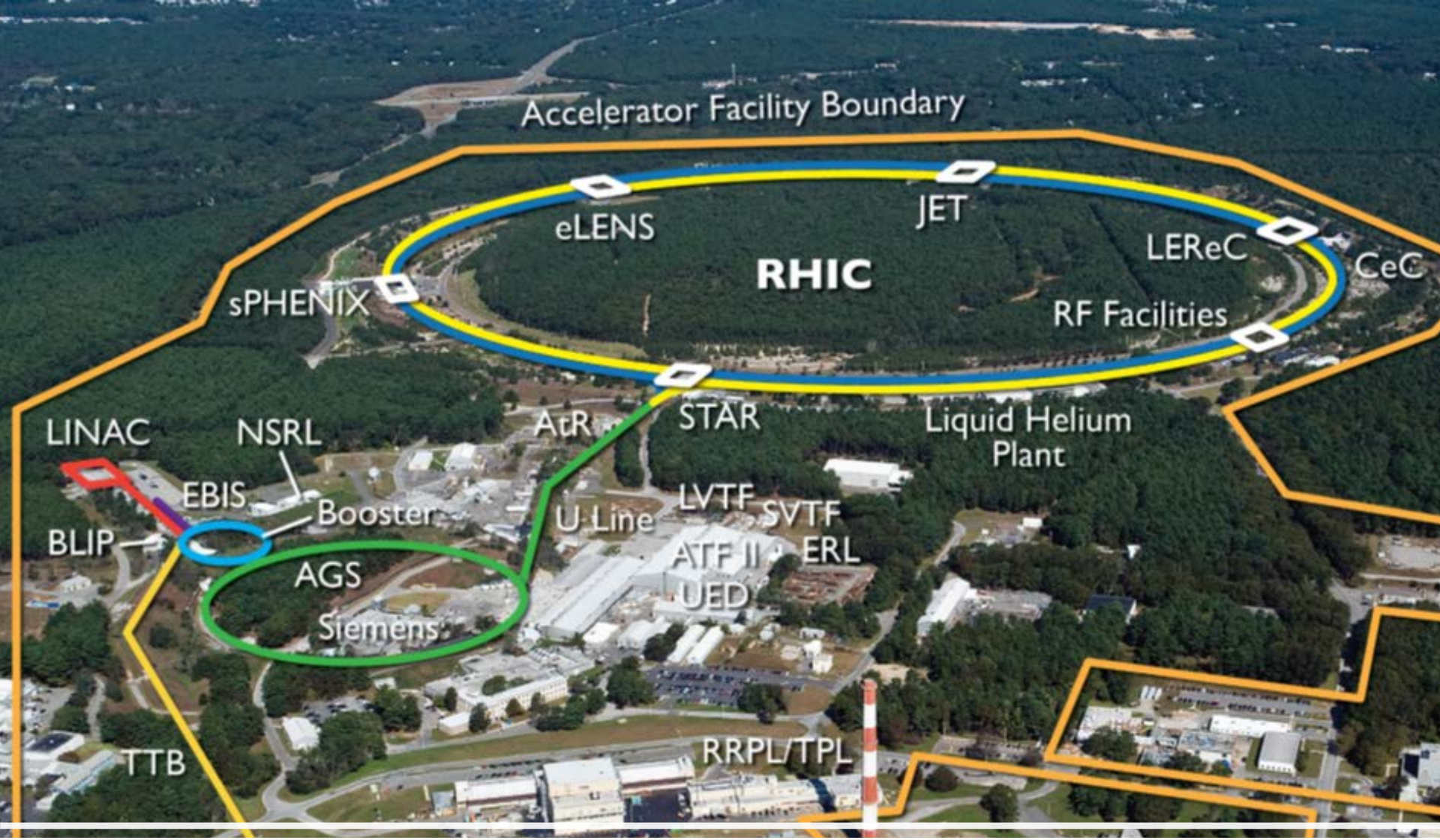
BROOKHAVEN NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY



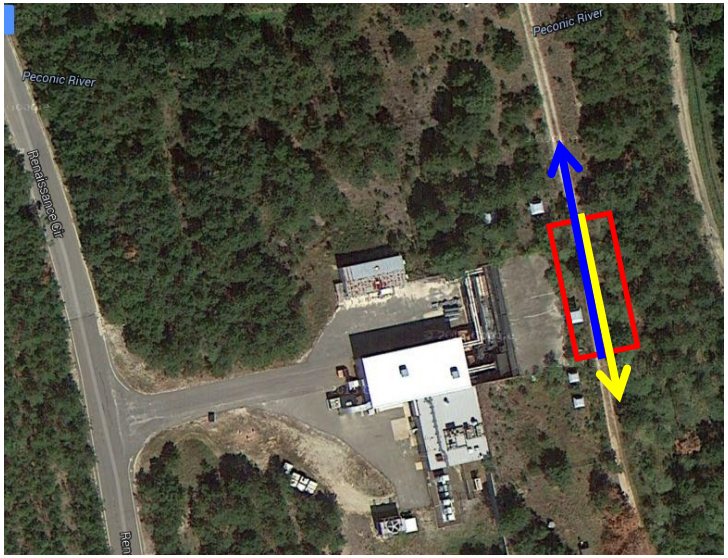
Inserting Electron Accelerators Into a Heavy Ion Collider

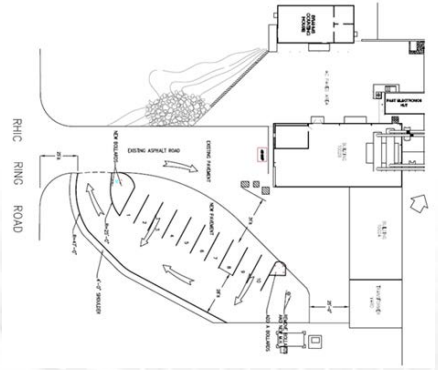
The Challenges

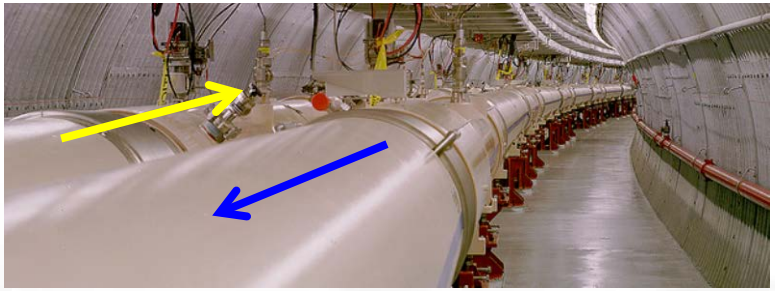
Continue	Continue to operate RHIC programs and experiments; install two electron accelerators (CeC and LEReC) during shutdowns and maintenance days
Integrate	Integrate C-AD work planning and control processes into new accelerator work planning and control for the electron accelerator projects
Ensure	Ensure safety bases documents are completed and approved for accelerators to operate jointly or operate alone
Ensure	Ensure USI documents and controls are completed for any exemptions during testing periods
Ensure	Ensure new engineered and administrative Credited Controls added to the RHIC ASE are fully operational and configuration managed for accelerators operating together or in stand-alone mode
Ensure	Ensure a comprehensive conduct of operations exists for all three accelerators (authorizations, procedures, emergency response, operator training)
Ensure	Ensure NEPA rules are followed prior to construction

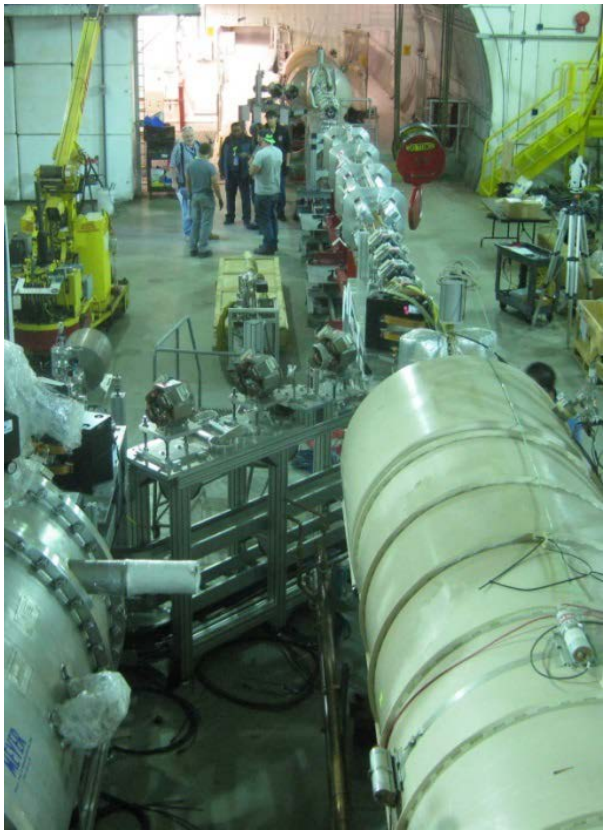
RHIC 02:00 Intersecting Region (IR2)

- Large open area – former Brahms Experiment

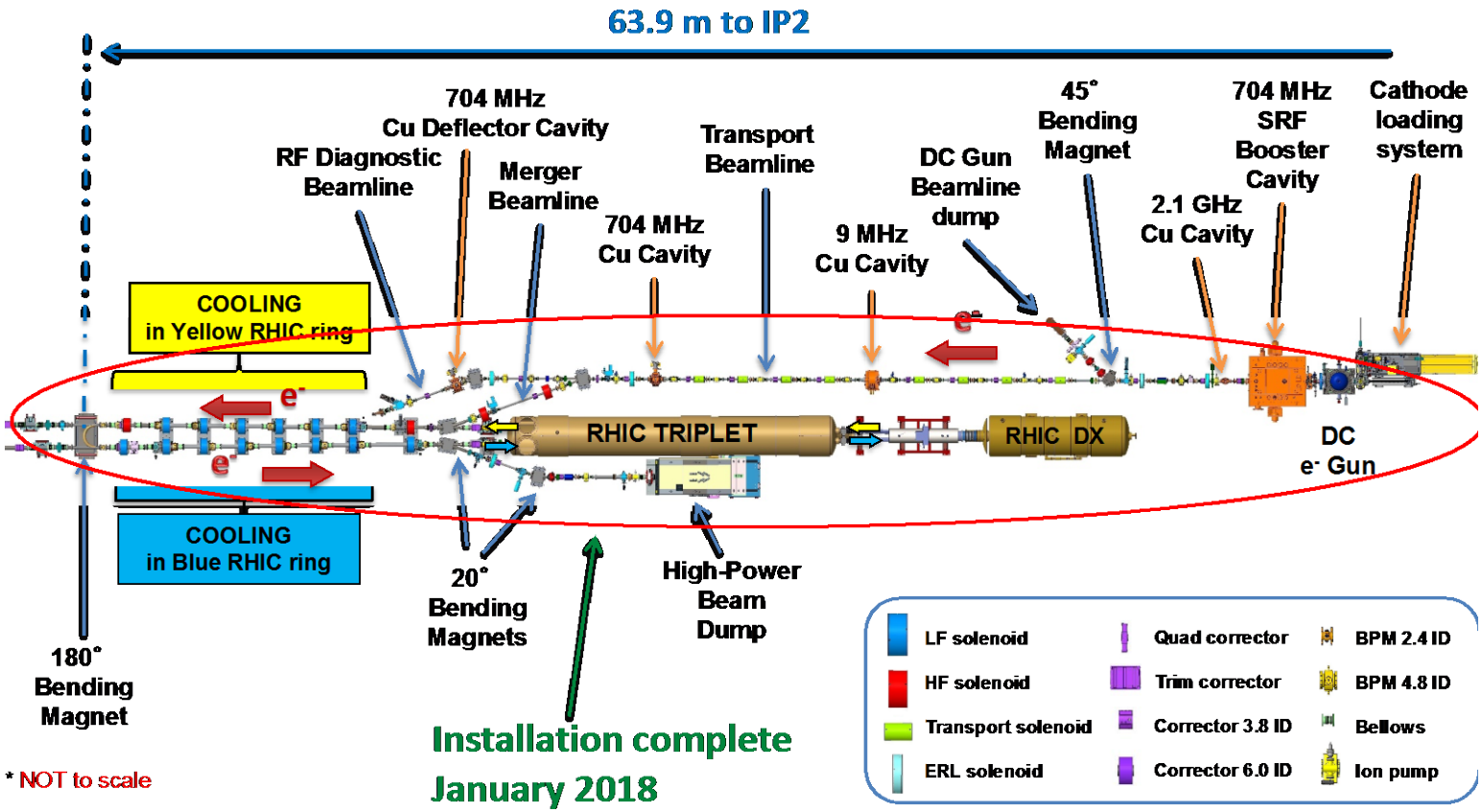






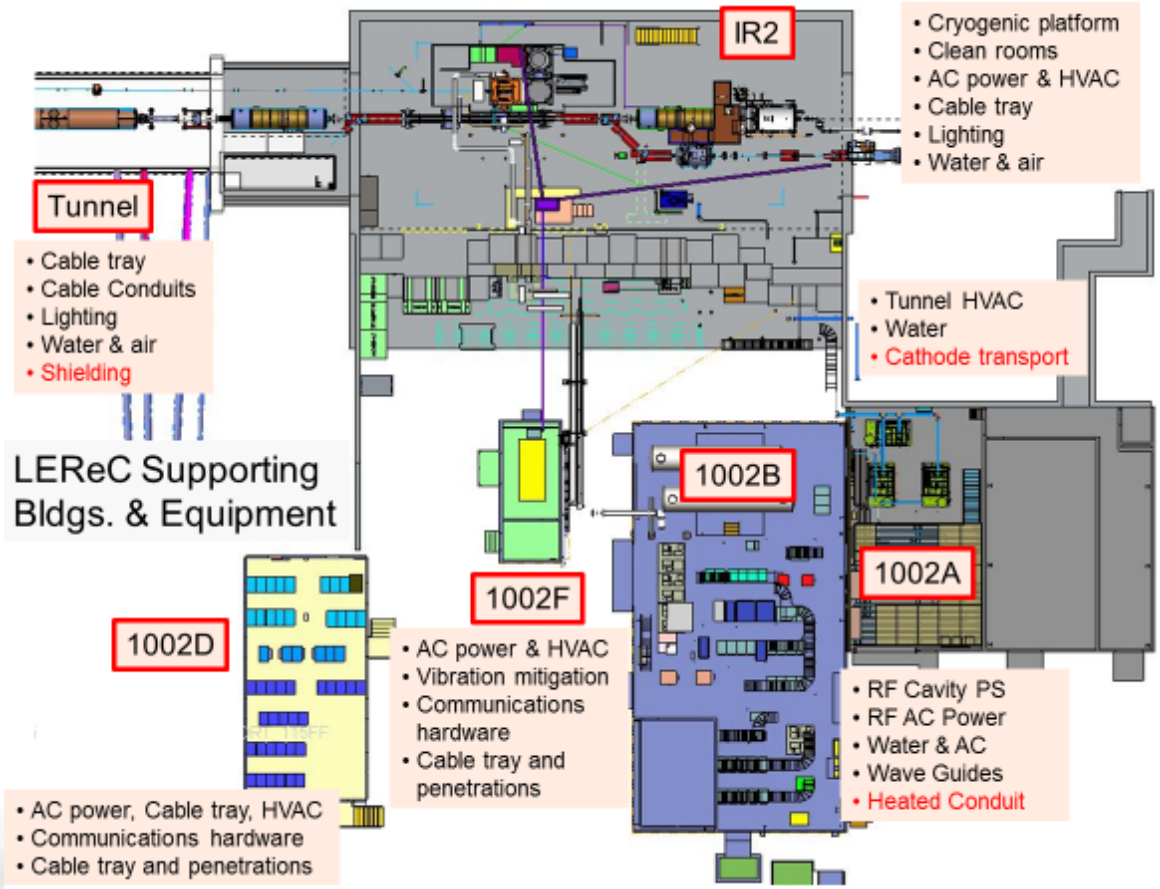


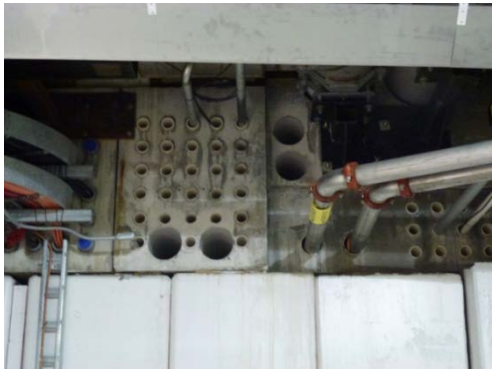
CeC Installation

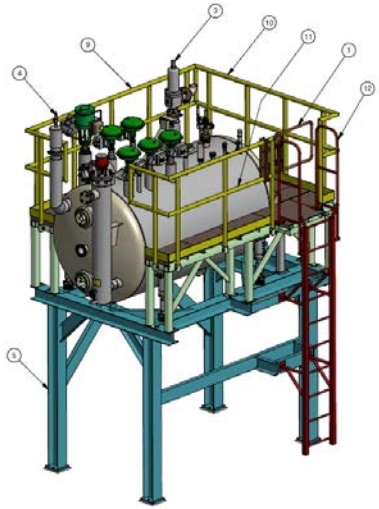


Low Energy RHIC e- Cooling (LEReC)

LEReC and CeC at IR2



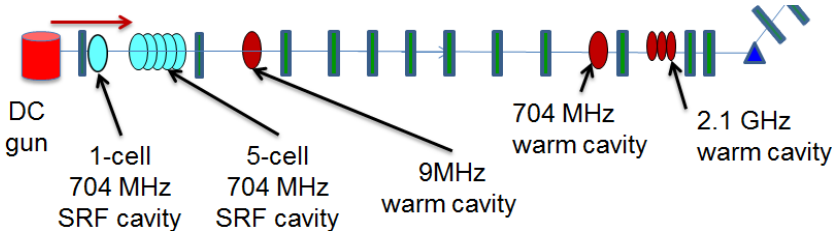


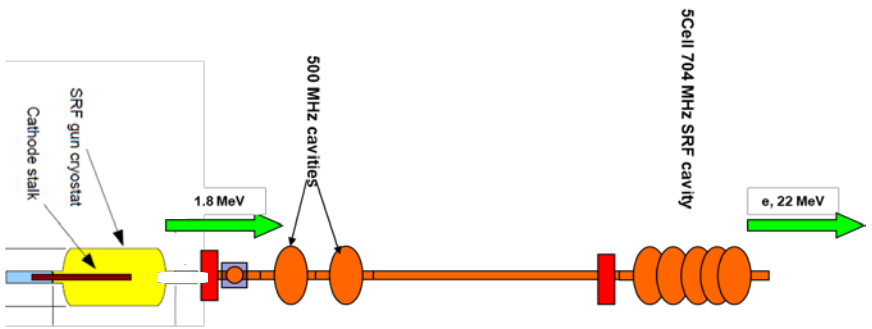


LEReC and CeC Testing Challenges

Challenge: continue testing critical equipment during RHIC operations, shutdown and maintenance periods

- Laser beam delivery system (laser, laser shaping, laser transport, laser pulse stability, etc.)
- Vacuum components with controls
- Cathode manipulation systems
- LEReC DC gun characterization (stability, maximum operation voltage, electron beam quality) *–needed Exempt Accelerator status for eGun in order to perform these tests*
- Magnets and power supplies (run and test)
- Beam instrumentation: charge and current measurements, beam position (response matrix) measurements, beam loss monitor system, beam profile and halo measurements
- Controls systems (timing system, machine protection system, control of laser, gun power supply, magnets power supplies, beam instrumentation)
- Beam dump systems

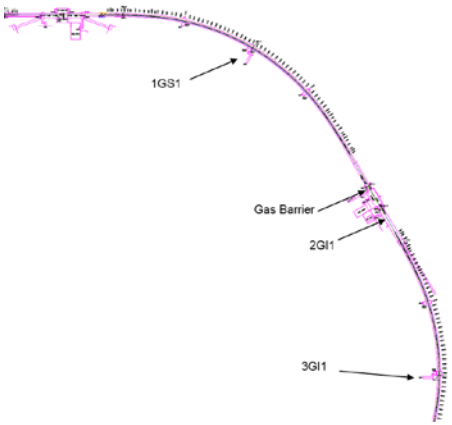




CeC and LEReC – eGun and RF Testing Challenges

Standard Steps to Commissioning an Exempt Accelerator Facility at BNL

Step	Responsible Party
Hazard Screening	Accelerator Management (C-AD)
NEPA Review	Accelerator Management
Design Review Questionnaire	Accelerator Management
Safety Analysis	Accelerator Management
Readiness Plan and Schedule	Accelerator Management
Accelerator Systems Safety Committee Reviews	Accelerator Management
Radiation Safety Committee Reviews	Accelerator Management
Laboratory ESH Committee Review for Exempt Status	Laboratory Management (BNL)
Recommendation for Exempt Status	Laboratory Management
Approval for Exempt Status	DOE Field Element (BHSO)



Access Control System Changes

- **RHIC ASE - During RF only operations, the relevant portion of the RHIC ACS must be functional**
- **Gates, and modes of operations needed to be changed**

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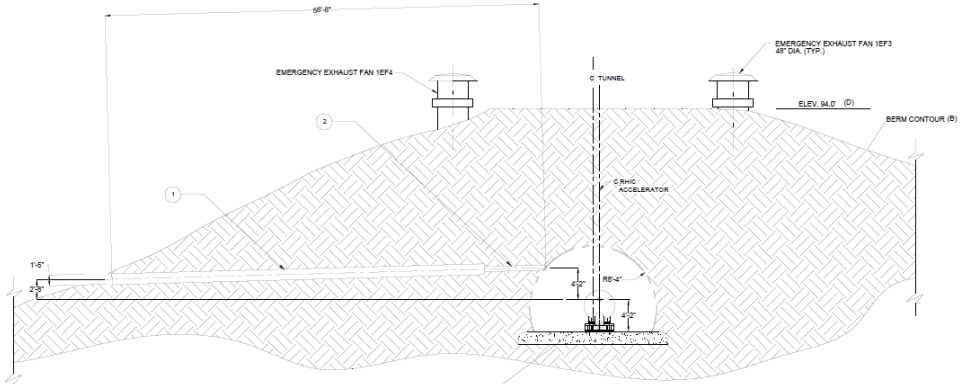
Configuration Control Challenges for Shielding Calculations

- RHIC ASE - The LEReC electron kinetic energy shall be limited to 3 MeV
- RHIC ASE - The LEReC electron beam power to the electron beam dump shall not exceed 140 kW averaged over 1 hour
- Different calculations performed over time were not consistent with these ASE limits
- Dose and dose rate calculations needed to be gathered from several sources, correlated and compiled into a single document

Challenges to Archival Drawing System

- **RHIC ASE - Before beam or other radiation-producing operations (e.g., RF testing), the Collider and beam-line enclosures must have all shielding (e.g., berms, shield blocks, etc.) properly in place and configuration-controlled**
- **Few RHIC “as-built” drawings were available for shielding calculations; construction drawings were available**

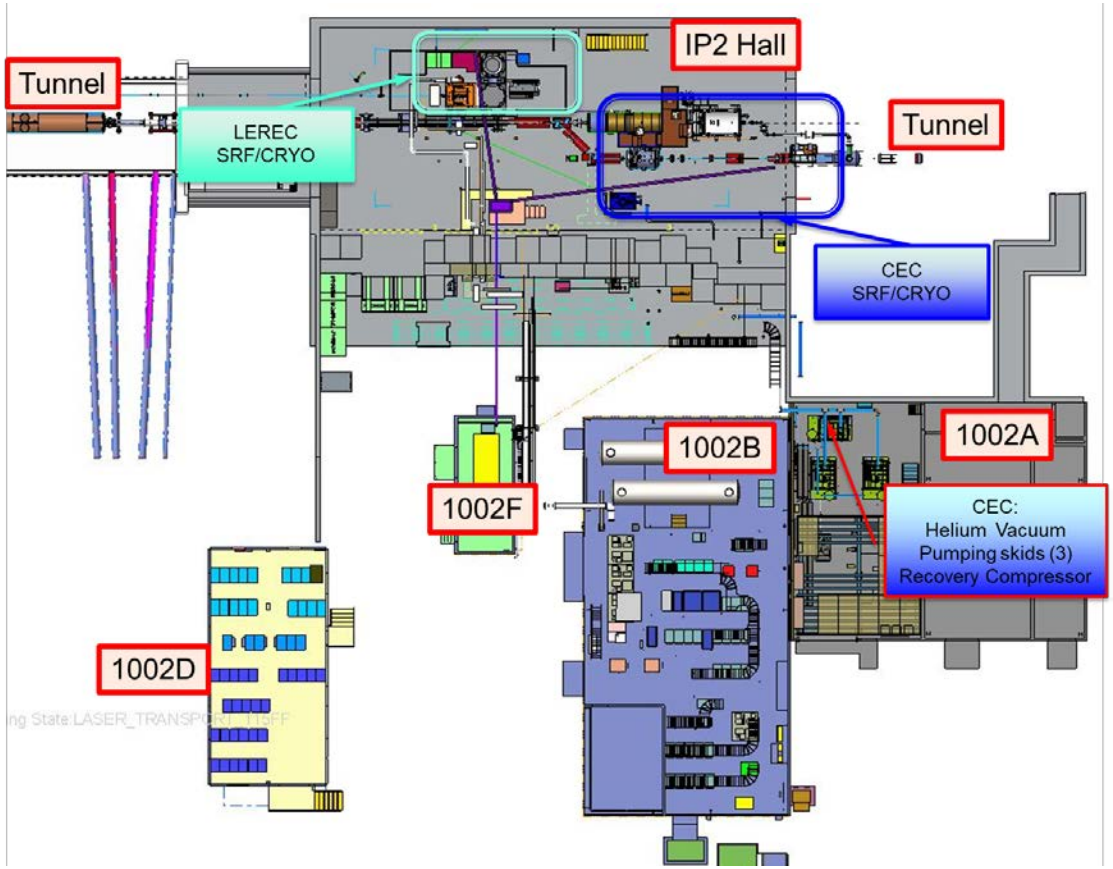


Safety Analyses Challenges

New hazards had to be assessed for risks that could impact the existing operations (e.g., aiming electron beams into ion beams and recombination losses; electron beam loss impact on cryogenic magnets for heavy ions)

Shielding at penetrations to attenuate photons from low-energy electron-beam faults - RHIC penetrations were designed for high-energy ion-beam faults

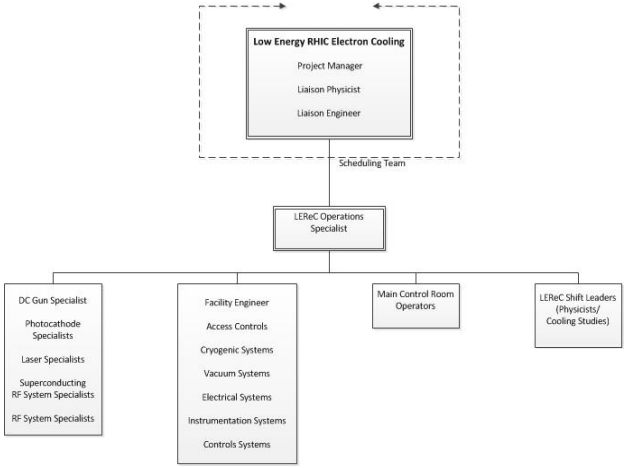
Design needed to protect one machine from the other machine (e.g., cryostats for RHIC magnets from e^- beam faults; low-energy e^- beam from RHIC magnetic fields)

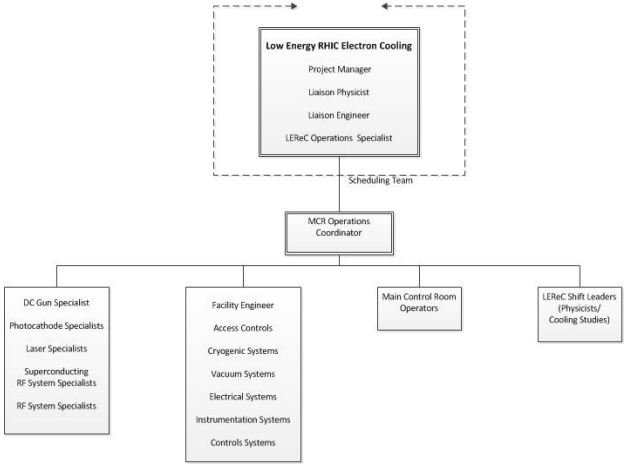


ODH Challenges

Commissioning and testing for LEReC during RHIC shutdown period required cryogenics plant and ODH safety system to be available essentially year round

- **ASE - For RHIC IR2 and Building 1002A when either the CeC or LEReC is operating with LHe: at least three ODH exhaust fans serving RHIC IR2 must be operational, and the ODH portion of the RHIC ACS must be operable; that is, when the oxygen concentration falls below 18% (nominal), the ODH fans serving RHIC IR2 must turn on and at least one Building 1002A ODH exhaust fan must be operational**

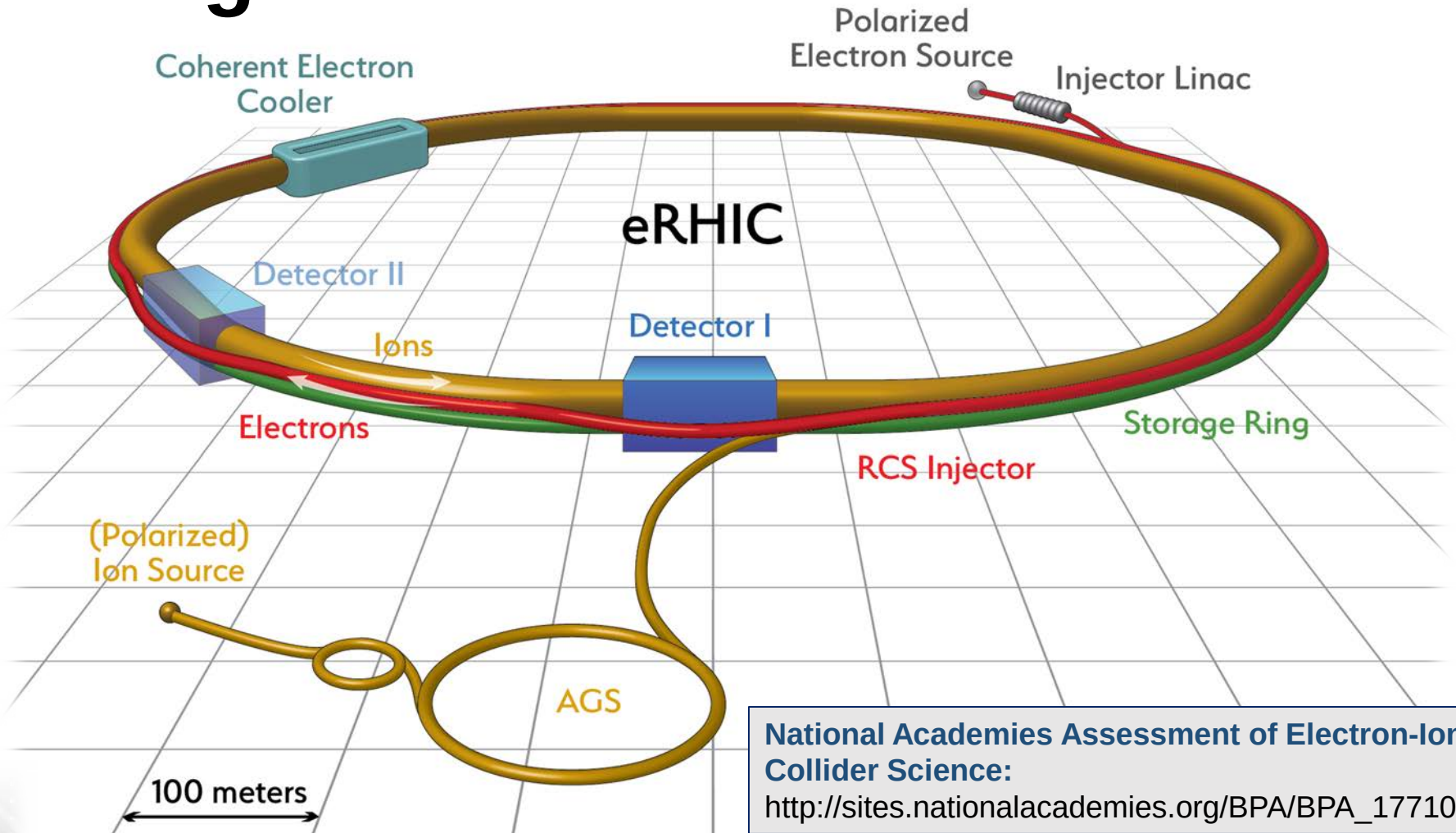




Challenges to Readiness to Operate

- One Control Room
- One Chain of Command
- One Training Plan

Major Accelerator Thrust: Moving Forward with eRHIC



National Academies Assessment of Electron-Ion Collider Science:
http://sites.nationalacademies.org/BPA/BPA_177106

Questions?