

Low Energy RHIC electron Cooling

Engineering Systems Update 8 21 2014

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LEReC Update

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a passion for discovery

 **Office of
Science**
U.S. DEPARTMENT OF ENERGY



Scope

Scope has not changed:

Install a SCRF electron gun (from the C-AD ERL) in the RHIC tunnel at 02:00 to generate electron bunches. Merge the electron bunches with RHIC low energy gold bunches for electron cooling.

But a major option is being considered:

Use a warm DC electron gun from Cornell and use the ERL e gun cavity as a first stage accelerator.

J. Sandberg and J. Tuozzolo visited Cornell to inspect their gun(s)

http://www.c-ad.bnl.gov/esfd/LE_RHICeCooling_Project/LEReC.htm

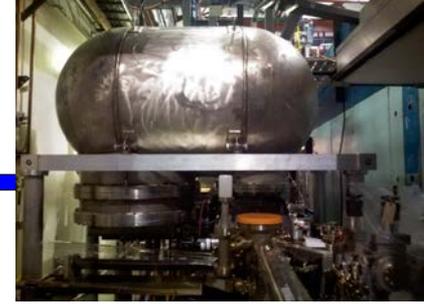


Scope

J. Sandberg and J. Tuozzolo visited B. Dunham at Cornell to inspect their gun(s).

Cornell has two e-gun designs:

- One built in 2004, it is part of an operational system, it operates comfortably at 350kV, and it can meet the 30 mA current requirement. The gun has operated at 400kV for 48 hours without a trip; but, Cornell is not confident for 24/7 continuous operations.
- One built in 2013, it has been commissioned and is used for a low energy system, it has been tested at 450kV and it can meet the 30 mA current requirement. It is operated with beam at 400kV. There is an unwanted flexing in the gun stalk support that will be repaired in the coming year.
- Neither system operates 24/7 because of their experimental program needs; but, they should be able to.
- Both guns have cathode installation/storage/swapping systems. The cathode installation system is included in their cost estimate.
- Cathode fabrication to their prints and cathode coating is still a BNL responsibility.
- Cornell has the documentation, staff, and extensive capabilities to build either gun in a timely fashion. Plus, they have some components to loan.
- Cornell estimates that they can fabricate and assemble a complete system which could operate at 400KV within 1 year.
- A cost estimate was provided; **but, it needs to be put into project format with overhead and contingencies.**
- Infrastructure needs are small: (480V 3 phase 20KW power, water cooling, air for valves, SF6 processing for maintenance). A portable SF6 handling system to dry the gas and for storage during maintenance will be required
- Safety: Review and approval for SF6 pressure vessel, SF6, proper grounding.



Early Procurements

Components to be Test/Commissioned early:

- Laser – to be used for ERL/LEReC commissioning in 2015.
- Cathode production system upgrade equipment - to be used for ERL/LEReC commissioning in 2015.
- Cathode fast changing mechanism for ERL gun - to be used for ERL/LEReC commissioning in 2015.

Long Lead:

- New RF PA's for eGun and 2.1GHz cavity
- New 2.1 GHz RF cavity



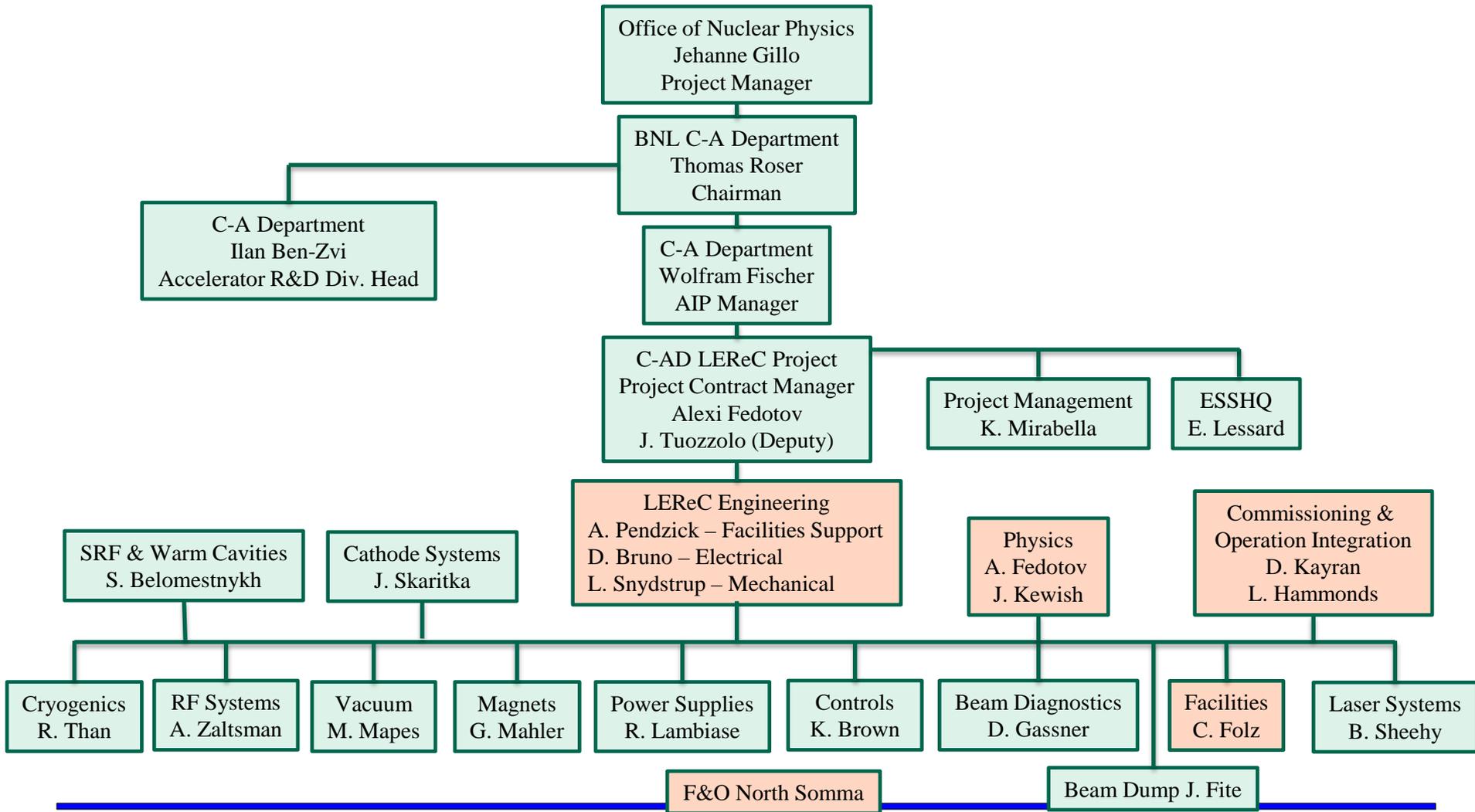
Early Procurements

Install new RHIC LEReC components in RHIC 02:00 IP

- Low energy cooling sections: solenoid magnets, vacuum chambers and bake-out heaters, beam diagnostics (ring equipment).
- Contracts for cable tray installation and Access Controls Gate move.
- If funding is available: Low energy cooling sections: solenoid magnet power supplies, magnetic shielding, beam diagnostics (electronics and cables).
- Will request funding from BNL for Brahms trailer renovation, grounds maintenance, and parking lot.



C-AD Engineering & Technical Support



LEReC Timeline (DOE Review)

- FY 2014 –15:** Detailed system design, procurement specifications, engineering design reviews, facility modifications plans and drawings.
- FY 2015:** Purchase orders and contracts for major elements.
- June – Dec 2015:** Brahms trailer renovation complete.
Install RHIC beamline LEReC magnets and vacuum chambers
Install cable tray and cryogenic piping (where possible)
- Jan – June 2016:** RHIC run 16: Install purchased PS's and PA's
Receive and inspect/test purchased components
- July 2016 - Mar 2017:** **Installation, system commissioning of beamline components, SRF, and cryogenic components.**
- Apr - June 2017:** **Cooldown gun and 5 cell w/RHIC refrigerator commission cryogenics and SRF cavities.**
- July – Sept 2017:** **Commission ebeam w/SRF gun and beam lines**
- October 2017:** Run 18, low energy Au beam.
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LEReC Timeline – Long Lead Items/Early Test/Early installation



FY14 : **Project Planning documentation: contingency analysis, resource loaded schedule, early procurement planning.**

\$7.2M baseline, \$1.2 M 17% contingency - \$8.4 M + risk list + scope mods

FY14/15 1stQ System design, procurement specifications, engineering design reviews for cooling beam line components: magnets, vacuum chambers, beam diagnostics.

- Beamline optics specified 4/2014 white paper. W. Meng and D. Kayran are reviewing specification details.

FY14/15 1stQ Long lead item procurements:

- RF Cavity PA's for 2.1 GHz and e-Gun.
- 2.1 GHz cavity

FY14/15 1stQ ERL test components

- New laser for testing in ERL FY14/15 1stQ
- Cathode production and changing mechanism.

FY14/15 1stQ Facilities modifications:

- Brahms trailer repairs start: structural and HVAC.
- Support building layouts start: utility requirements, cable tray



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LEReC Timeline FY14



- 4th Q **Cost review contingency analysis, Resource loaded schedule,**
- 4th Q **BNL IRMC Project Review**
- 4th Q **Long lead procurements defined** and cost estimate.
- 4th Q **eBeam Lattice: physics design**
- 4th Q **Cooling section magnet design**
- 4th Q **Cooling section beam-line layout**
- 4th Q **02:00 tunnel (AnDY) and Brahms trailer cleanout.**



FY14/15 1stQ Facilities modifications:

- Brahms trailer repairs: structural and HVAC.
- Support building layouts, utility requirements, cable tray
- Cable tray installation procurements



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LEReC Timeline FY15



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- 1st Q Physics cooling lattice “frozen”
 - 1st Q Procurement packages: cooling section magnets, beam diagnostics, vacuum hardware.
 - 2nd Q Project DOE review January 13, 14.
 - 2nd Q Start: Cryogenic System piping/VJP design, procurement specifications, engineering design reviews for e-gun and 5 cell installation.
 - 2nd Q Start: 2:00 IP, N side Access Control Gate move planning.
 - 2nd Q Start: Support building layouts, utility requirements, cable tray, coax runs
 - 2nd Q Start: Brahms trailer repairs - structural and HVAC.
 - 2nd Q Procurement packages: long lead items.
 - 3rd Q Cable tray contract for FY15 summer shutdown.
 - 3rd Q Access Controls Gate move contract for FY15 summer shutdown.
 - 3rd Q Pre-survey - layout beam lines in RHIC tunnel
 - 4th Q Remove vacuum beamline components from RHIC cooling section.
 - 4th Q Start: Installation of RHIC cooling section components.
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Low Energy electron Cooling

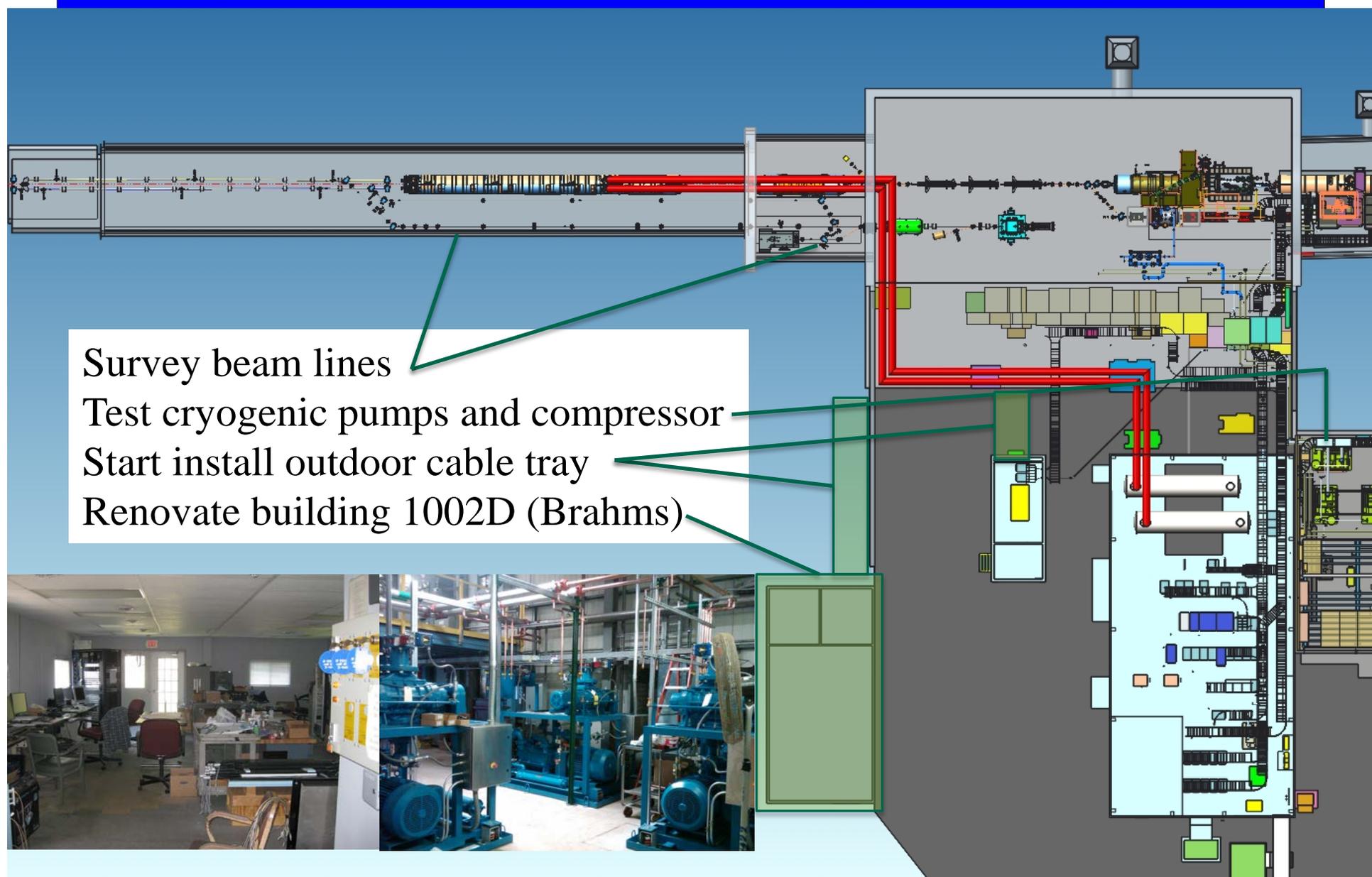
Installation Staging – 2015 Run Period

Survey beam lines

Test cryogenic pumps and compressor

Start install outdoor cable tray

Renovate building 1002D (Brahms)



Installation Staging – 2015 Shutdown (June – Dec 2015)

Move ACS gate

Install RHIC interaction region beamline

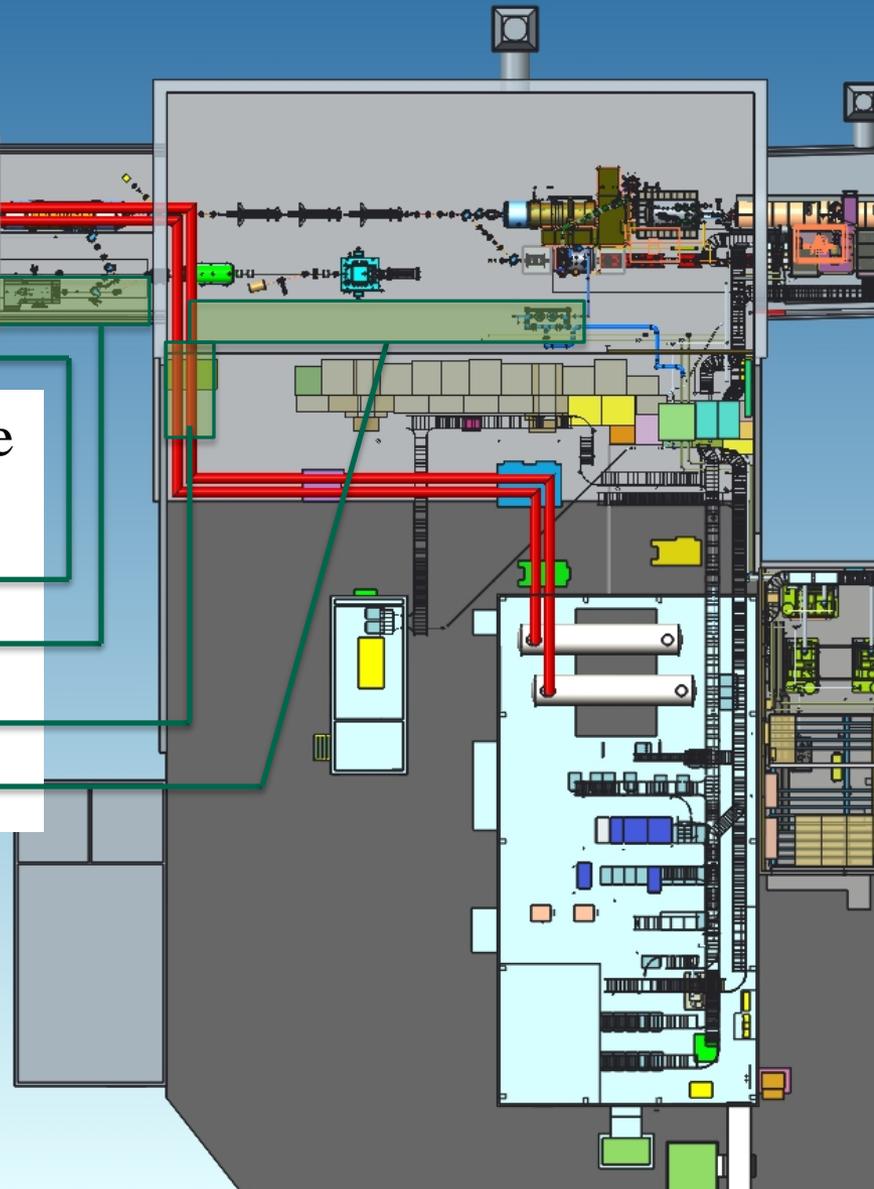
- magnets, vacuum, beam diagnostics

Install tunnel and outdoor cable tray

Prep beam dump area & floor

Install tunnel cable penetrations

Start cryogenic piping installation



Installation Staging – 2016 Run Period

Start cable pulls and terminations

Power and test RHIC beamline

- magnets, vacuum, beam diagnostics

Install RF power amplifiers 1002B

Install racks and power in 1002D



Installation – 2016 - 2017 Shutdown (FY16 4th QTR Jun-Sept)

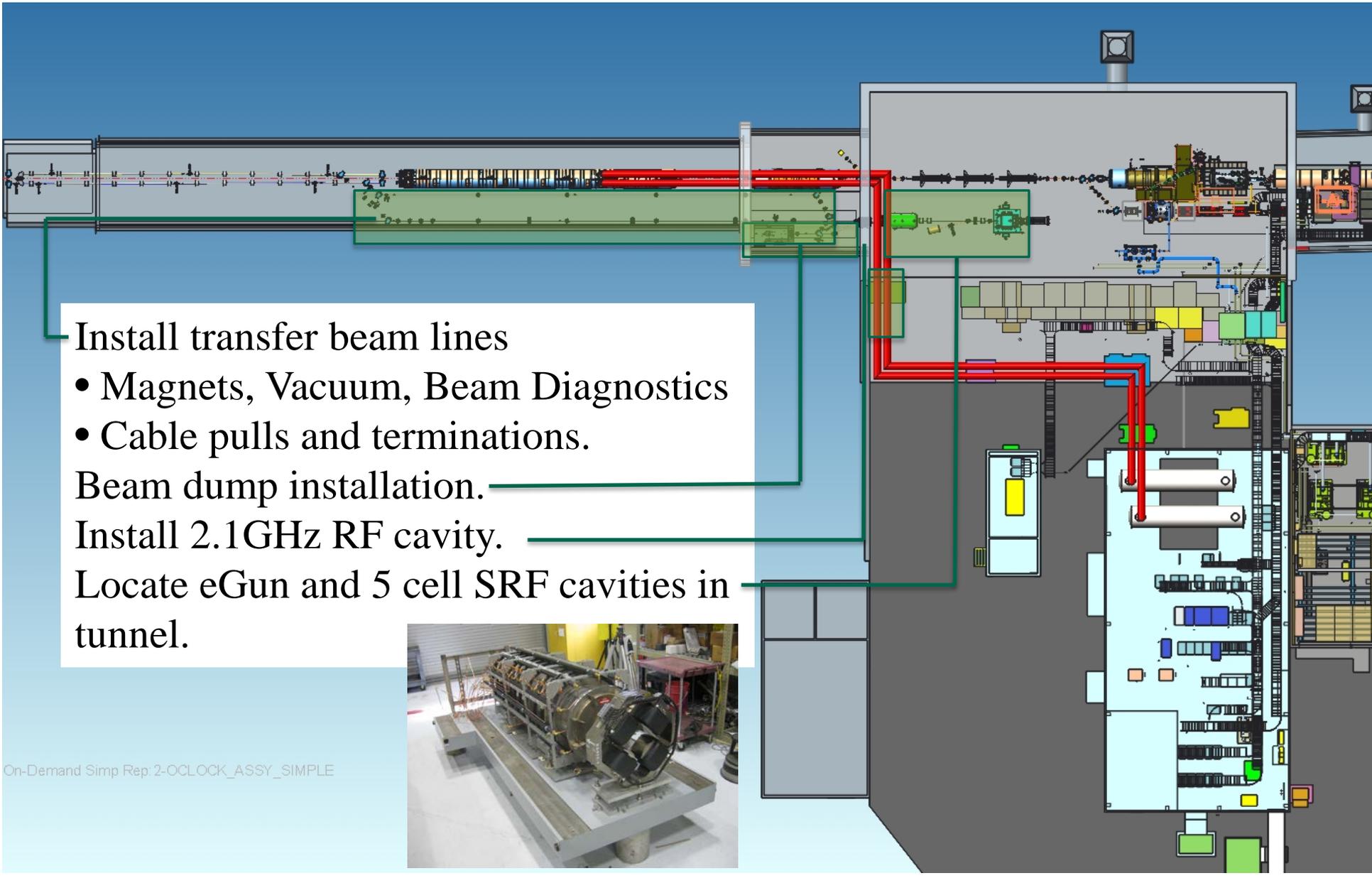
Install transfer beam lines

- Magnets, Vacuum, Beam Diagnostics
- Cable pulls and terminations.

Beam dump installation.

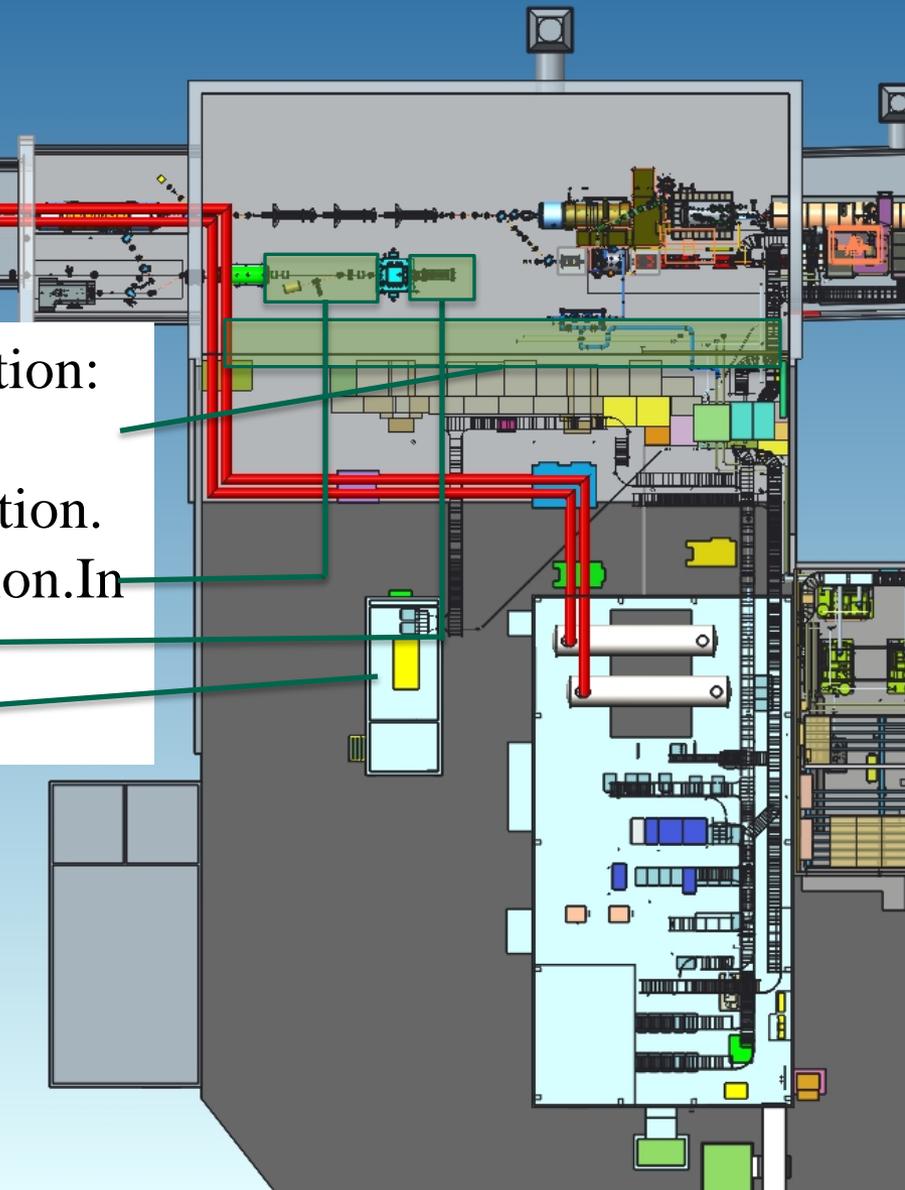
Install 2.1GHz RF cavity.

Locate eGun and 5 cell SRF cavities in tunnel.

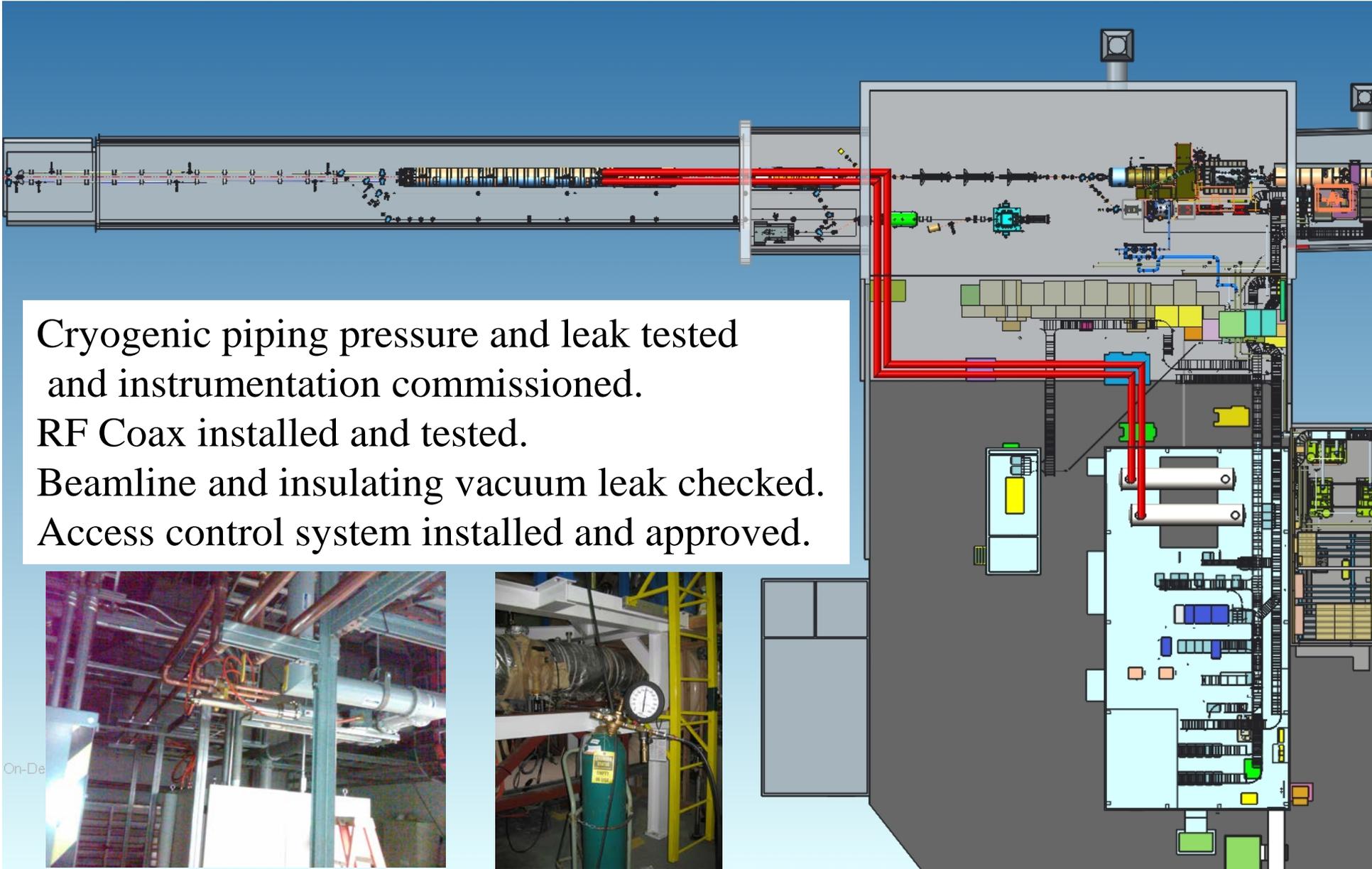


Installation – 2016 - 2017 Shutdown (FY17 1st QTR Oct-Dec)

RF Coax and cryogenic piping installation:
eGun and 5 cell SRF cavities.
eGun/5 cell/2.1GHz beamlines installation.
Cathode insertion mechanism installation.
Cable pulls and terminations.
Install Laser w/fiber-optic cable



Installation – 2016 - 2017 Shutdown (FY17 2nd QTR Jan-Mar)



Cryogenic piping pressure and leak tested and instrumentation commissioned.

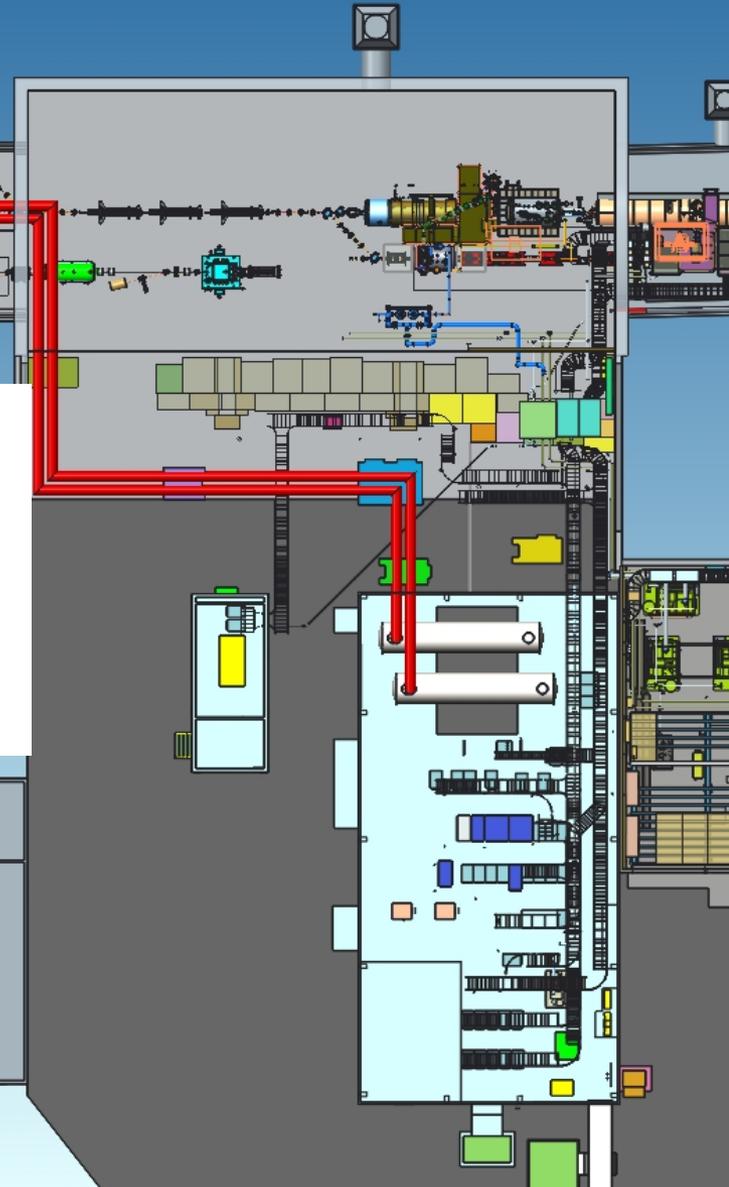
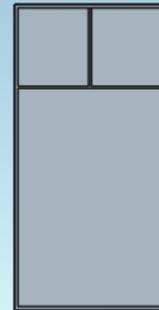
RF Coax installed and tested.

Beamline and insulating vacuum leak checked.

Access control system installed and approved.

Installation – 2016 - 2017 Shutdown (FY17 3rd QTR April-Jun)

Beamline and insulating vacuum commissioned.
Cryogenic system commissioned cold.
eGun and SRF cavity commissioned cold.
Controls and MPS commissioned.
Access controls system installed and approved.



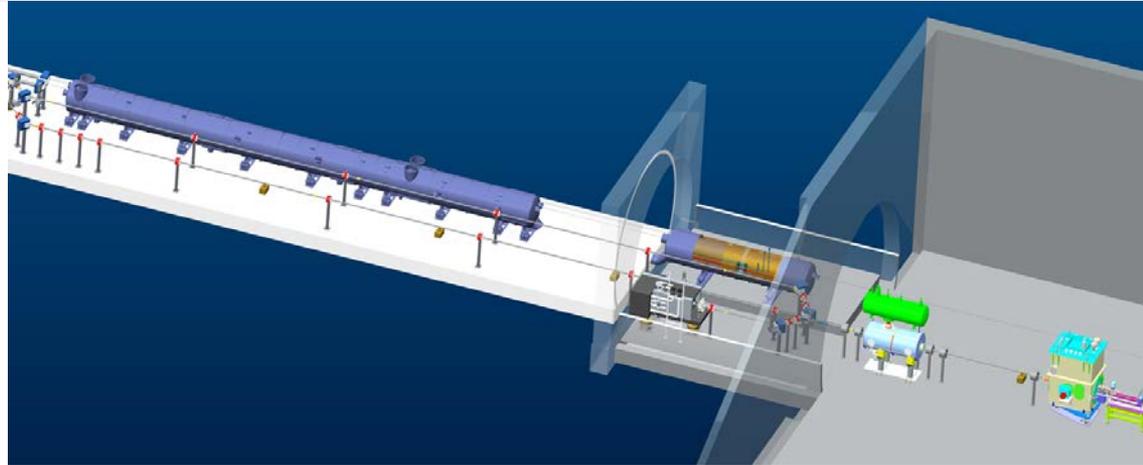
Extra slides



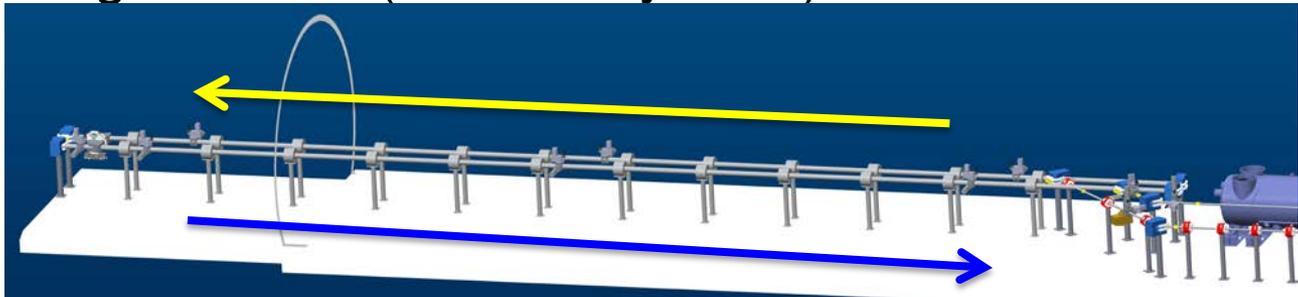
High Level Systems Description unchanged.



- electron SRF Gun,
SRF 704Mhz cavity,
2.1Ghz RF cavity,
transport lines,
diagnostics, and
beam dump.



- electron cooling sections (blue and yellow) in RHIC warm section.



Summary

- The LEReC system will be built using as much existing equipment as possible to reduce facility cost and shorten schedule.
- New SCRF equipment for the ERL is built and will be tested over the next two years to confirm performance.
- The RHIC 02:00 region has much of the support equipment needed to support the LEReC system.
- Equipment to be procured is within the state of the art and is available from commercial vendors.
- The project schedule works well with the completion of other upgrade projects at RHIC. Experienced personnel are available.

