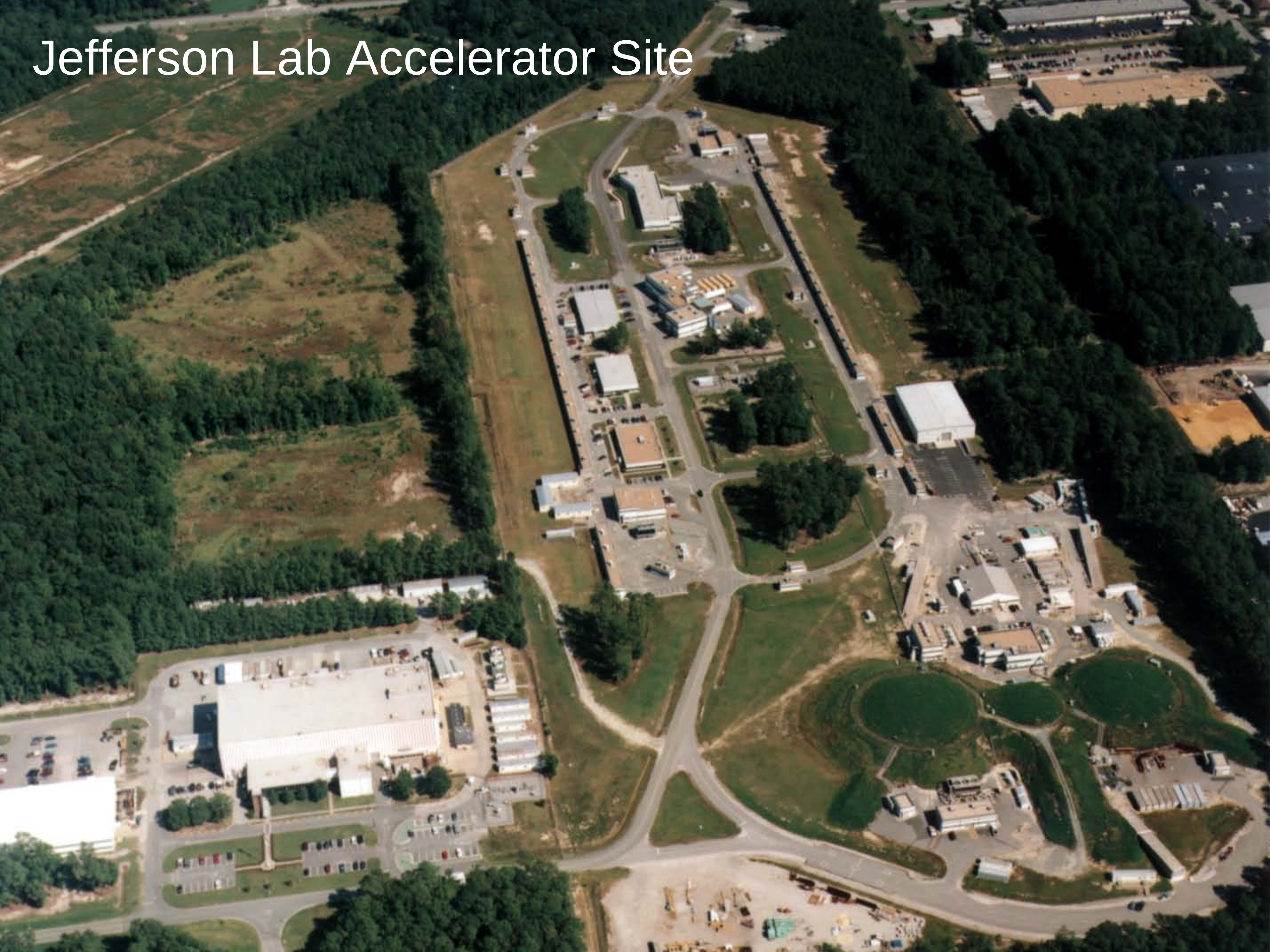
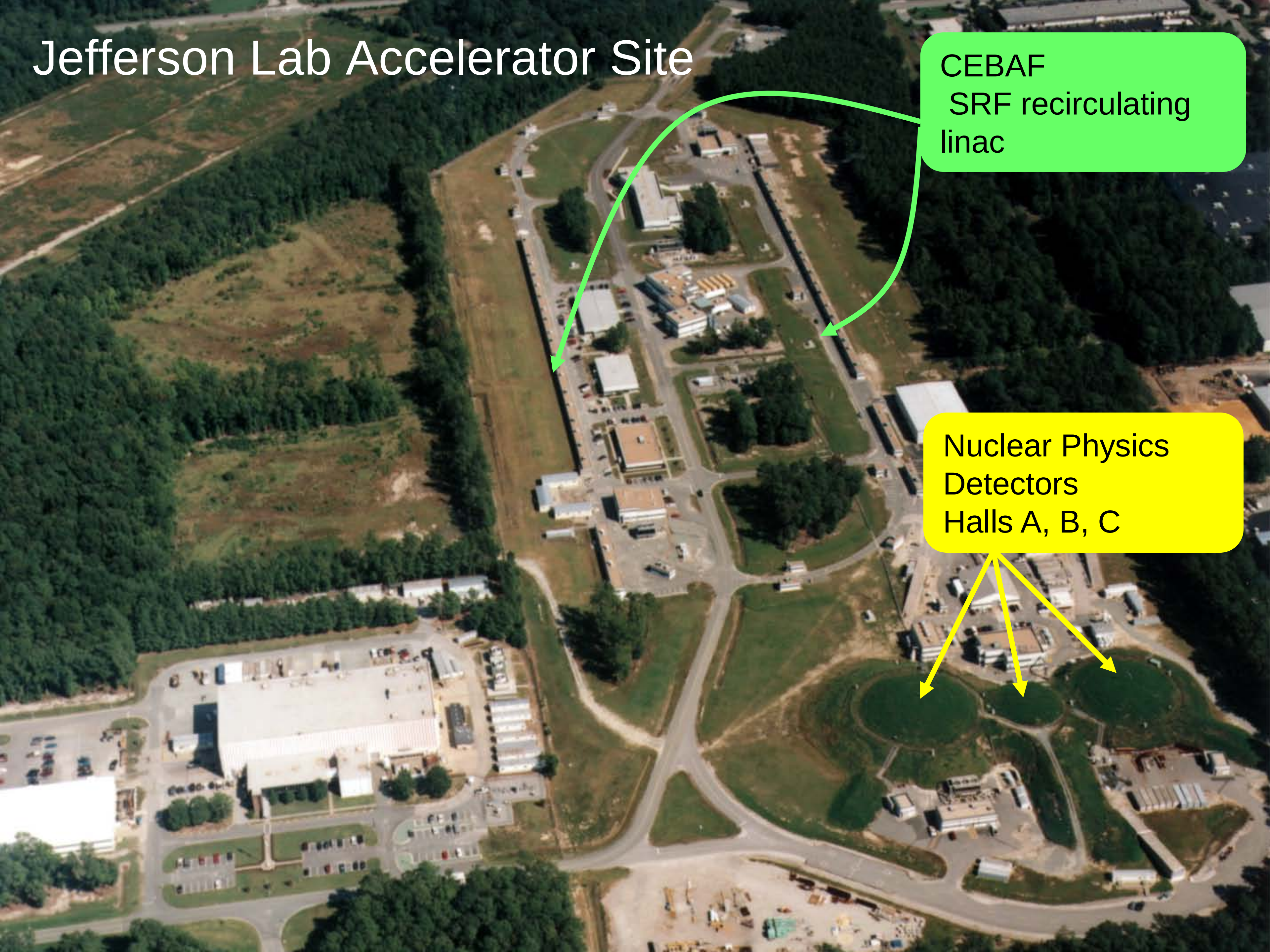
TJNAF facility and the SBIR/STTR Program

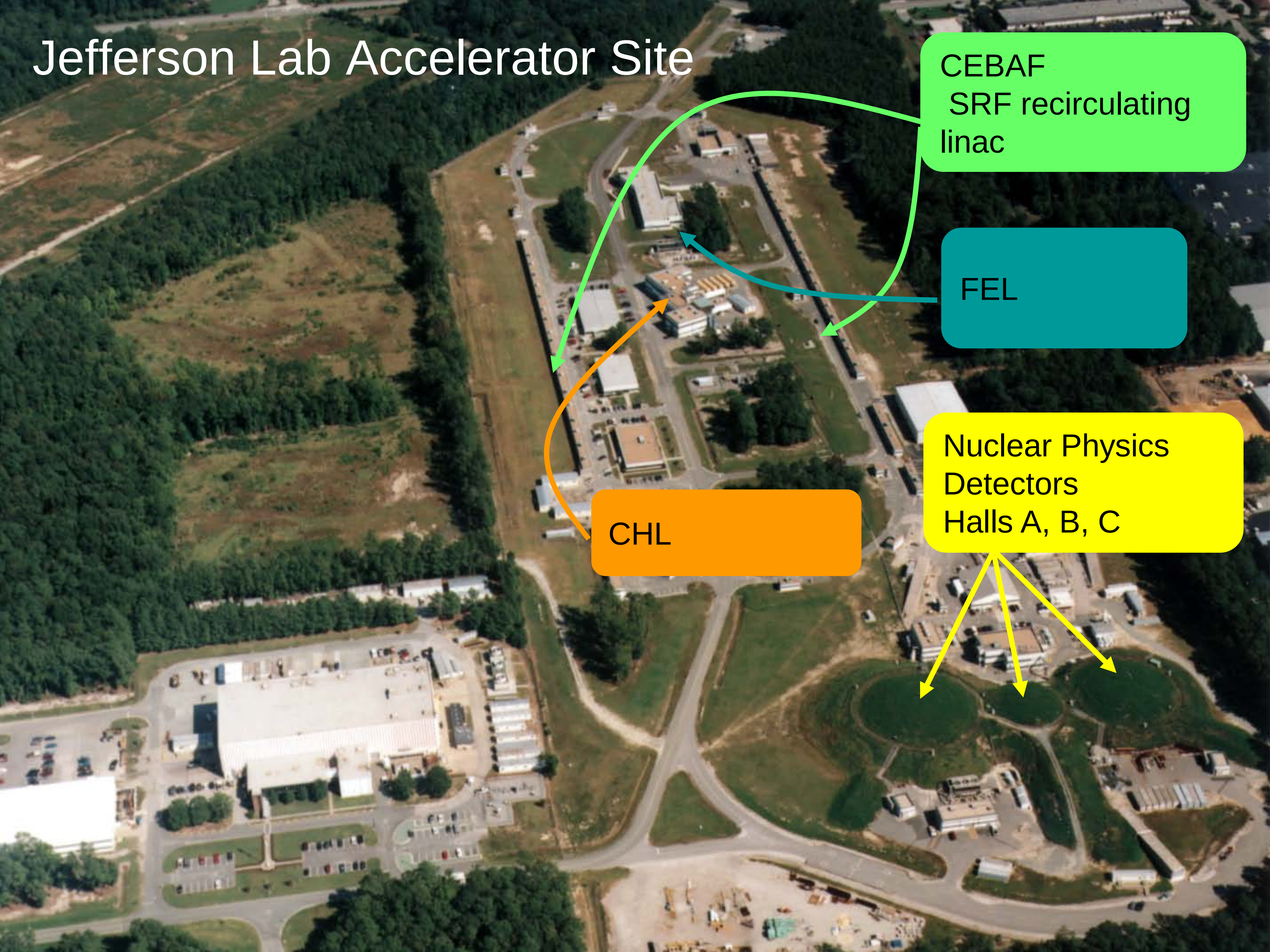
Charles Reece
Deputy Director, SRF Institute
Accelerator Division
TJNAF (Jefferson Lab)

Jefferson Lab Accelerator Site



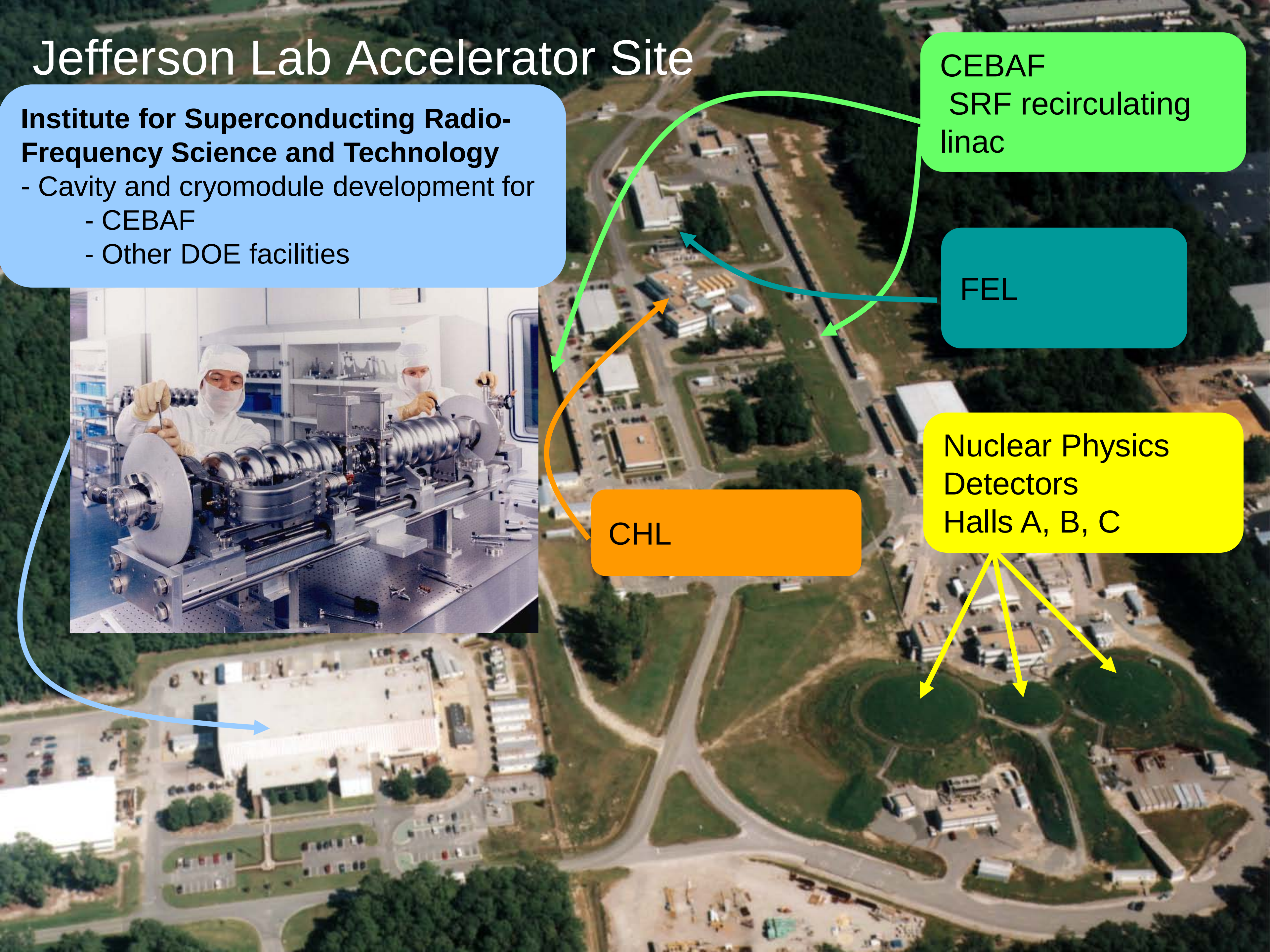
Jefferson Lab Accelerator Site




Jefferson Lab Accelerator Site
CEBAF
SRF recirculating linac
FEL
CHL
Nuclear Physics Detectors Halls A, B, C

Jefferson Lab Accelerator Site

Institute for Superconducting Radio-Frequency Science and Technology
- Cavity and cryomodule development for
    - CEBAF
    - Other DOE facilities



Jefferson Lab Accelerator Site

Institute for Superconducting Radio-Frequency Science and Technology

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Nuclear Physics Detectors
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Center for Advanced Studies of Accelerators (CASA)

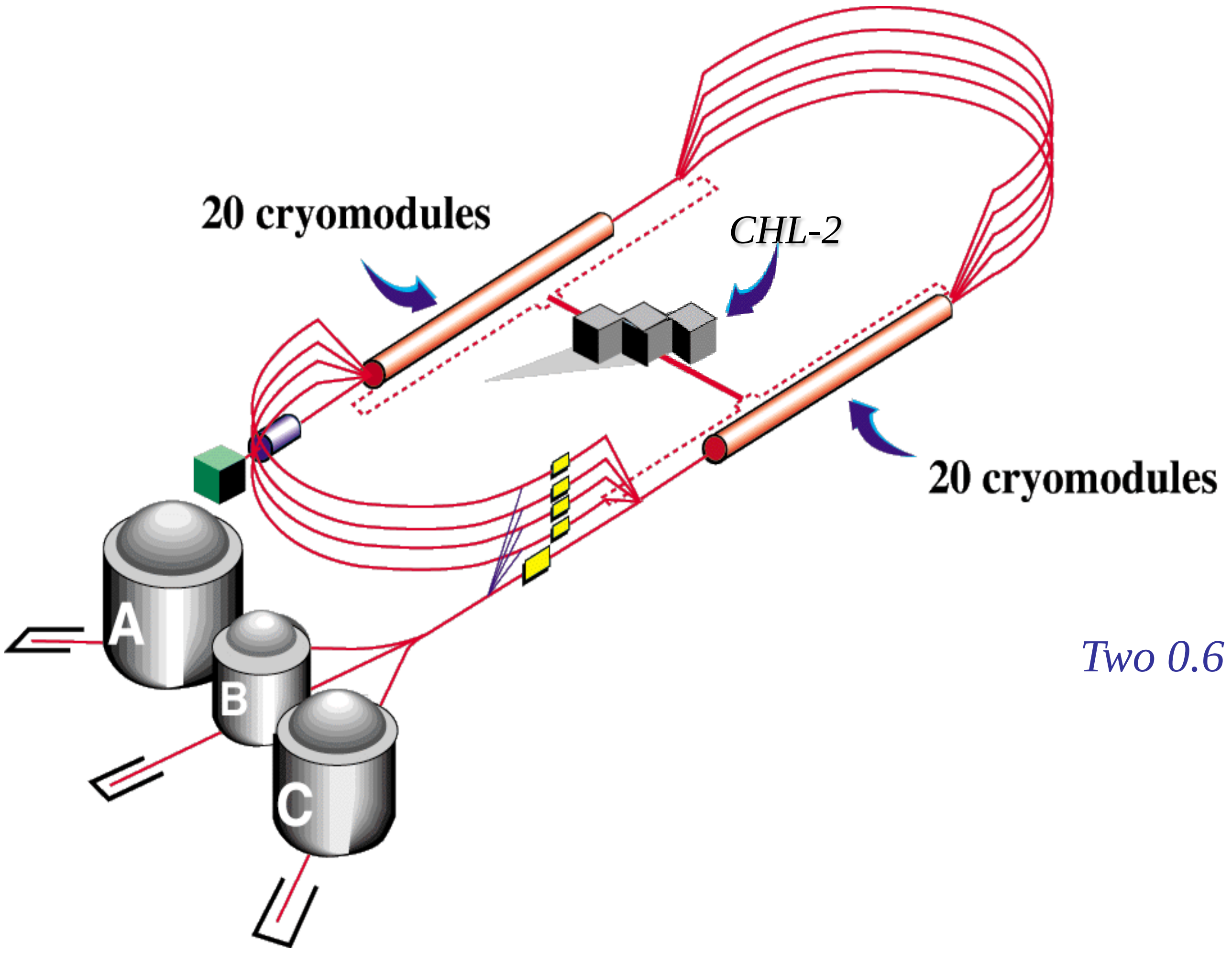
Accelerator Mission

- The Accelerator Mission is to advance the capability of Jefferson Lab to carry out world-class nuclear science and, more broadly, to develop Jefferson Lab's expertise in technologies associated with high-power superconducting linacs to enable the mission of the DOE Office of Science
- The goals to achieve the mission are designed to deliver results in five strategic areas:
  1. Support the 12 GeV Upgrade Project
  2. Operate and improve the CEBAF accelerator facilities
  3. Prepare the future evolution of nuclear physics experimentation at Jefferson Lab
  4. Enhance Jefferson Lab's core SRF competence to support DOE Office of Science projects
  5. Attract and educate the next generation of accelerator scientists

Scope of Work Activities 1

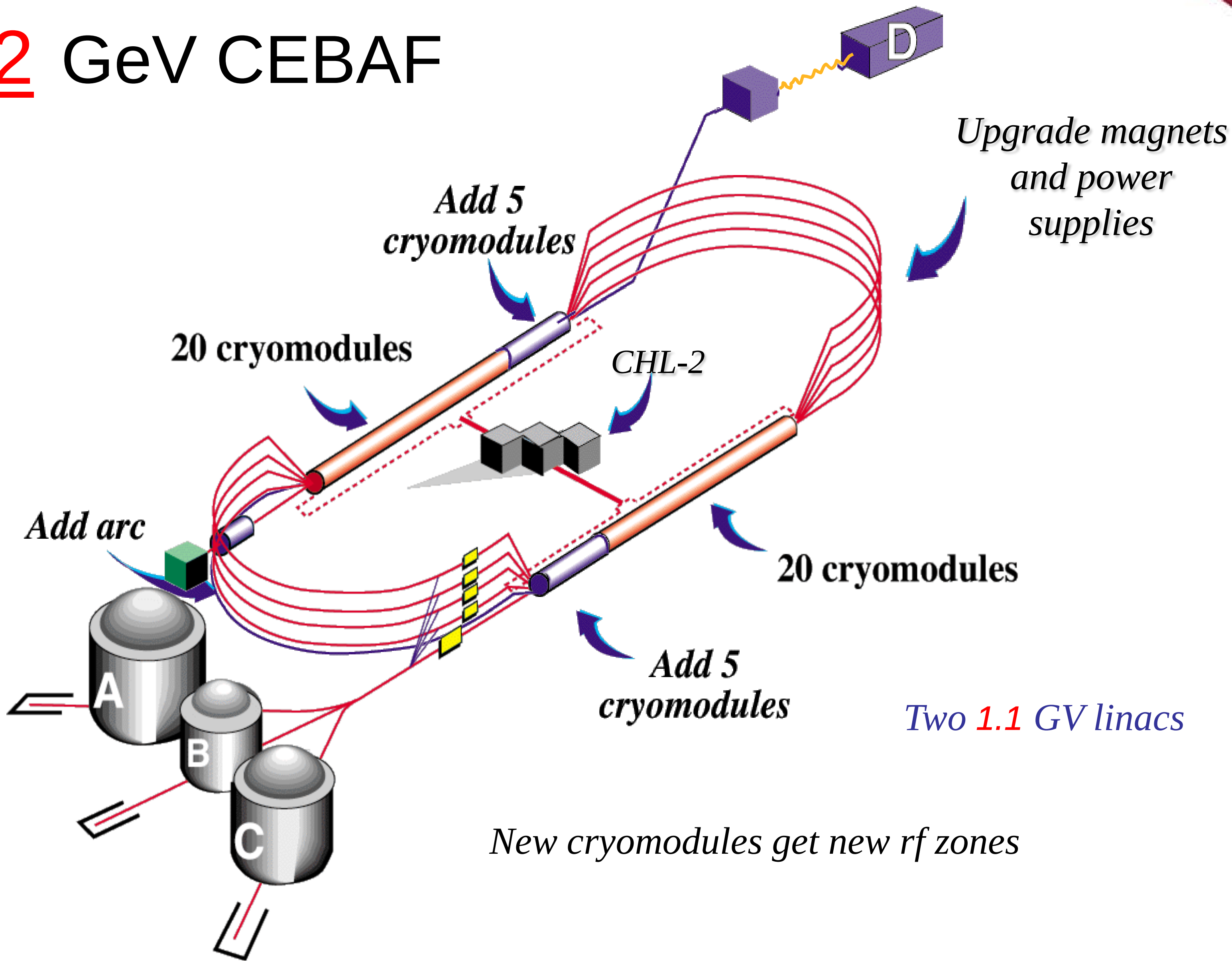
- Support the 12 GeV Upgrade Project
  - ⇔Accelerator physics design
  - ⇔Construction of ten “C-100” cryomodules
    - Each module adds 108 MeV per pass
    - First two are now installed
  - ⇔Extraction system design
  - ⇒Commission the accelerator to meet CD-4 beam specifications

6 GeV CEBAF



Two 0.6 GV linacs

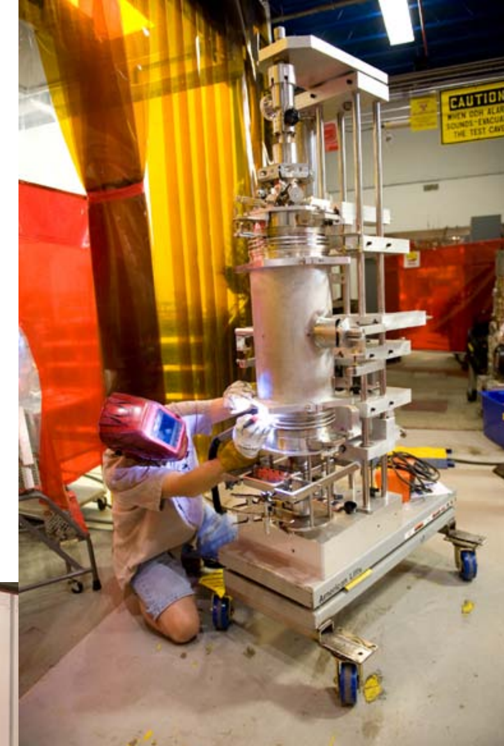
12 GeV CEBAF

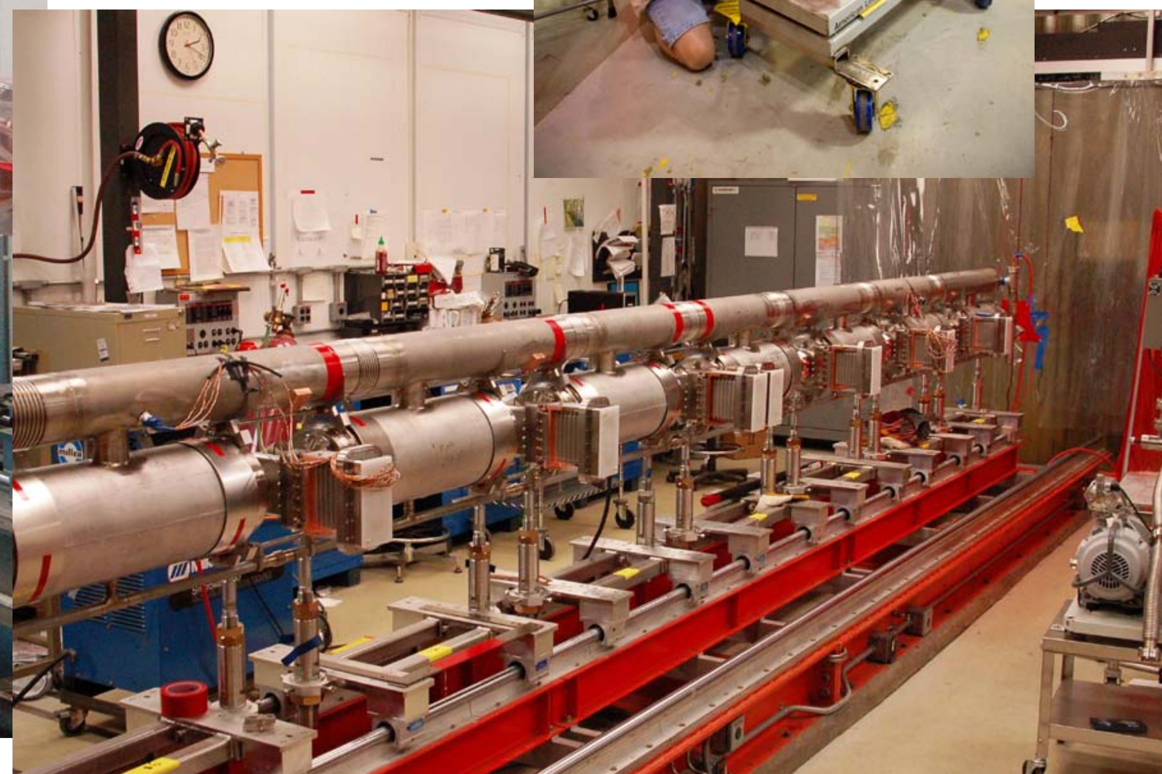


Two 1.1 GV linacs

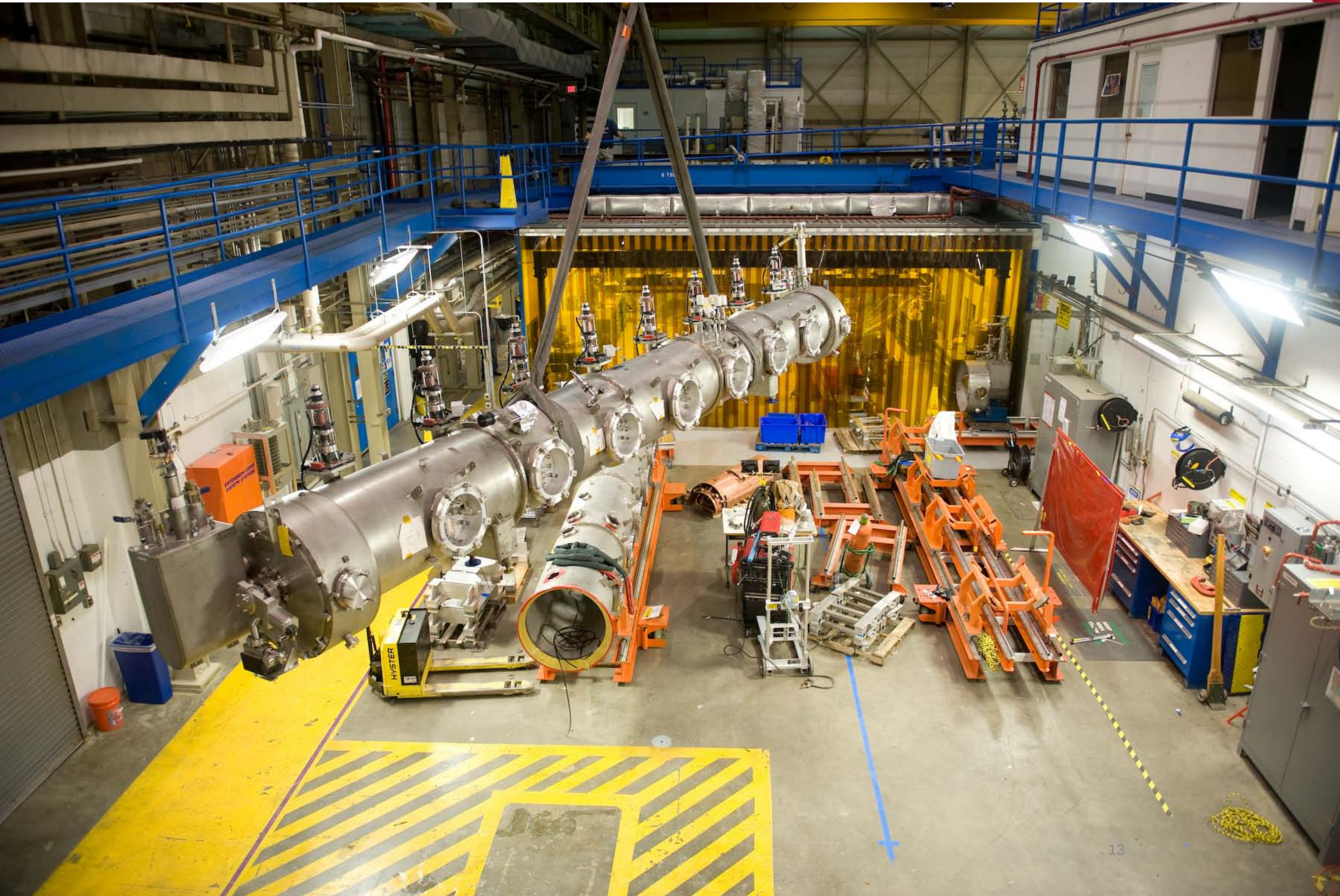
New cryomodules get new rf zones

C-100 Cryomodule Assembly





Cryomodule Leaving Test Lab For CEBAF Tunnel



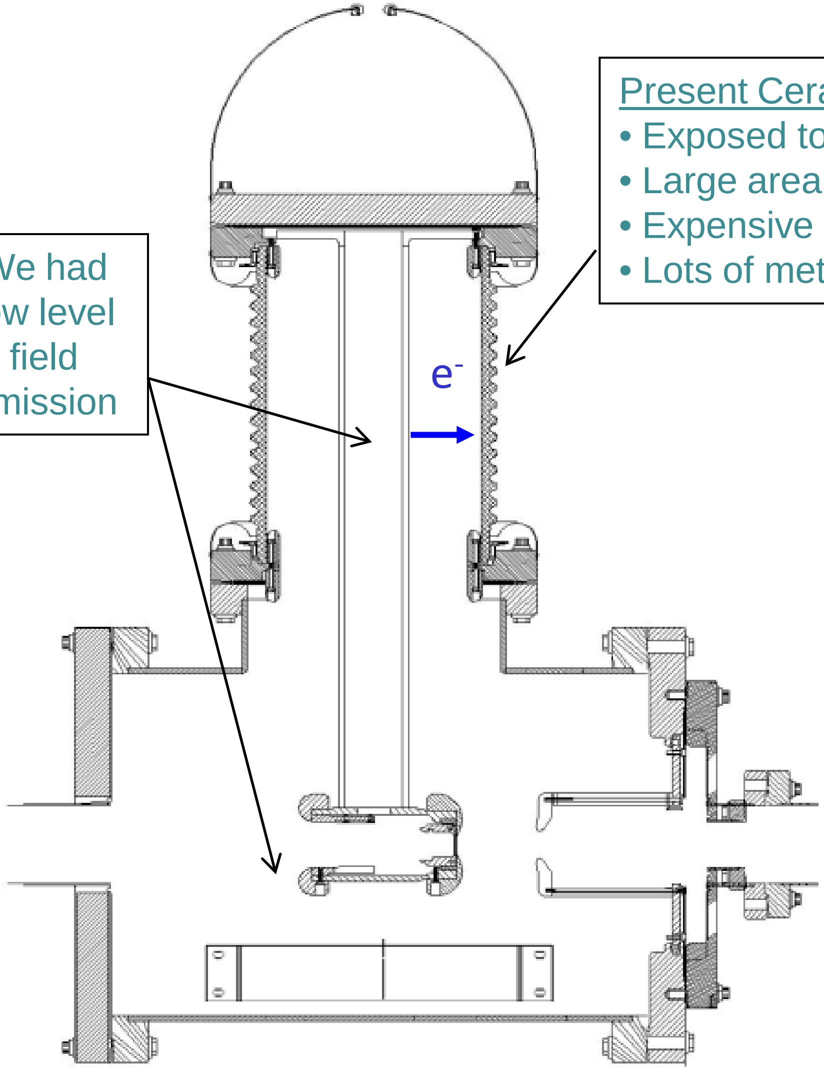
Scope of Work Activities 2

- Operate and improve the CEBAF accelerator facilities
  - ⇔ Operate CEBAF safely for nuclear physics program
  - ⇔ Energy increased from 4 GeV to 6 GeV
  - ⇔ Polarization and parity quality of beams improved
  - ⇔ Develop ability to provide simultaneous 11 GeV beams to three Halls (ARRA AIP project)
  - ⇔ Commission 12 GeV nuclear physics program

Old Gun Design

"Inverted" Gun

We had low level field emission



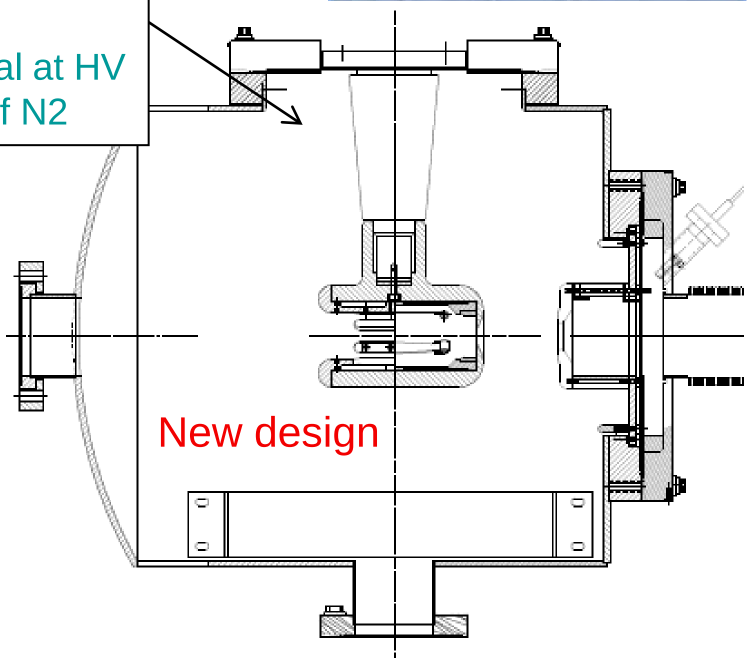
Present Ceramic

- Exposed to field emission
- Large area
- Expensive (~$50k)
- Lots of metal at HV

Medical x-ray technology

New Ceramic

- Compact
- ~$5k
- Less metal at HV
- No SF6 of N2



Move away from "conventional" insulator used on most GaAs photoguns today – expensive, months to build, prone to damage from field emission.

High gradient locations not related to beam optics, lots of metal to polish

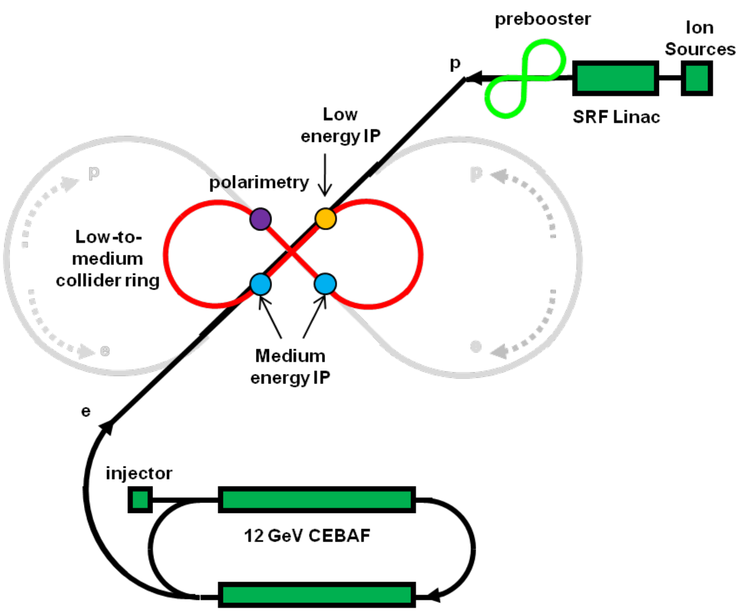
"Inverted Gun" Project funded by NP-AIP and ILC

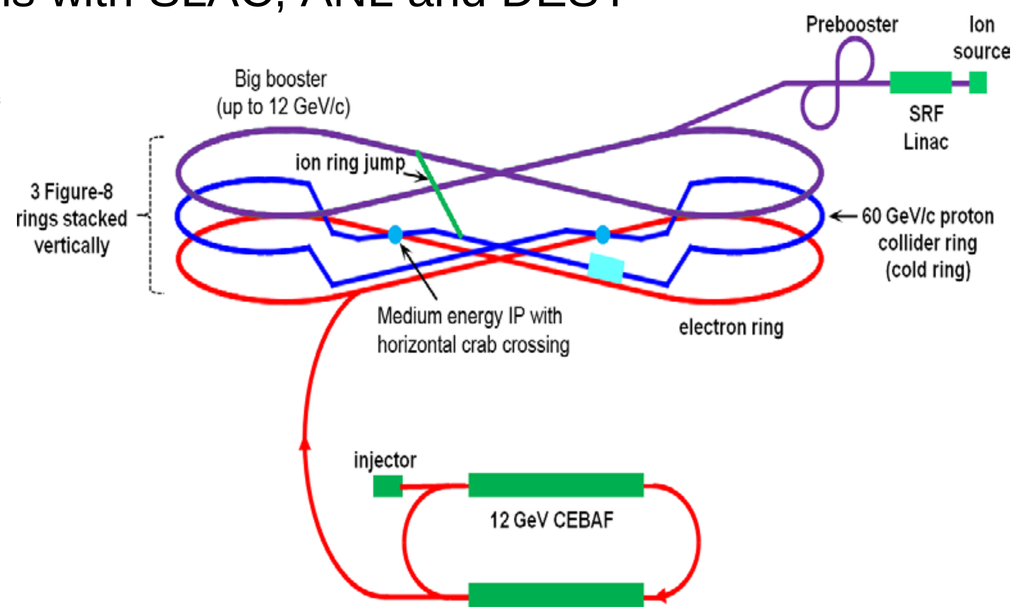
Scope of Work Activities 3

- Prepare the future evolution of nuclear physics experimentation at Jefferson Lab
  - ⇔Design a Medium-energy Electron Ion Collider (MEIC) which could be built at Jefferson Lab
  - ⇔Collaborate with BNL and MIT on generic electron-ion collider R&D
  - ⇔Develop the capability to produce positron beams

Jefferson Lab Electron-Ion Collider Design*

- A medium energy (up to 100 GeV *p* x 11 GeV *e*) high polarization EIC is the immediate project goal, with a future upgrade option to higher energies
  - Updated the main MEIC design parameters to meet science program requirements
    - High luminosity and enhanced detector acceptance
- Completed conceptual level design (layout and parameters) of major components
  - Two collider rings, interaction regions, ion pre-booster ring, electron cooler
  - Carrying out detailed design work and accelerator R&D
  - Established external collaborations with SLAC, ANL and DESY





*work supported by DOE-NP FOA 0000339

MEIC Critical Accelerator R&D

We have identified the following critical R&D for MEIC at JLab

- Interaction Region design with chromatic compensation
- Electron cooling
- Crab crossing and crab cavity

- Forming high intensity low energy ion beam
- Beam-beam effect
- Beam polarization and tracking

- Traveling focusing for very low energy ion beam

Level of R&D	Low-to-Medium Energy (12x3 GeV/c) & (60x5 GeV/c)	High Energy (up to 250x10 GeV)
Challenging		
Semi Challenging	IR design/chromaticity Electron cooling Traveling focusing (for very low ion energy)	IR design/chromaticity Electron cooling
Likely	Crab crossing/crab cavity High intensity low energy ion beam	Crab crossing/crab cavity High intensity low energy ion beam
Know-how	Spin tracking Beam-Beam	Spin tracking Beam-beam

Opportunities for SBIR/STTR

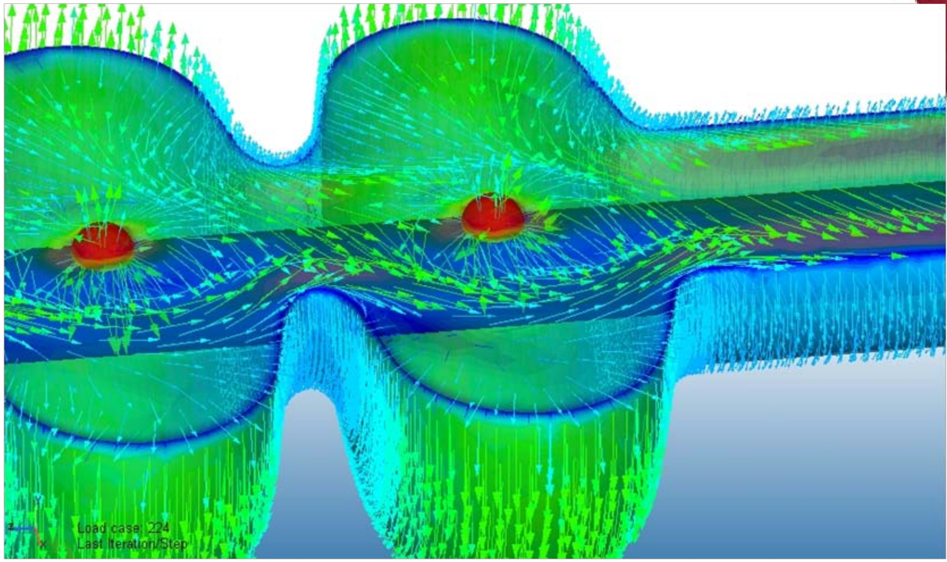
- Simulation capability for electron-ion collisions
- Simulation capability for strong electron cooling of the ion beams and implications for beam-beam interactions
- Novel SRF deflecting cavities for crabbing
- High frequency (>1.3 GHz), high power (>150 kW) couplers for SRF cavities

Scope of Work Activities 4

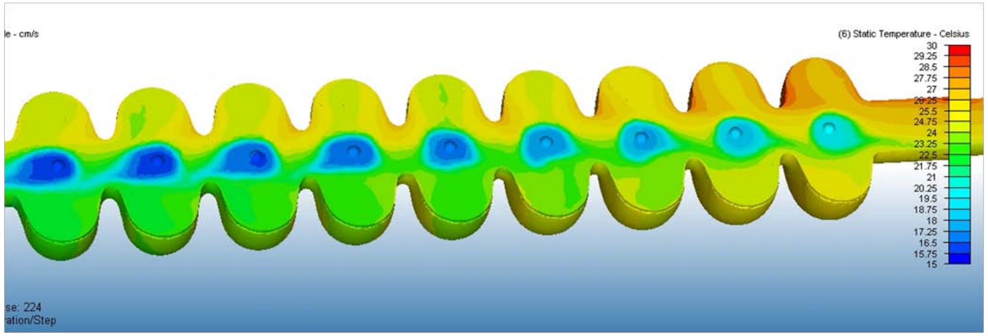
- Develop Jefferson Lab's core SRF competence to support DOE Office of Science projects
  - ⇔Improve maximum accelerating gradient, and reproducibility of maximum accelerating gradient
  - ⇔Reduce cryogenic losses at 20-25 MV/m accelerating gradient
  - ⇔Reduce the cost per MV of acceleration
    - Construction materials and processes
    - Operating power efficiency
  - ⇒ Develop a solution for operation at 4K suitable for a university facility
    - Received initial funding from BES

Understanding electropolishing niobium

- Hydrodynamic thermal modeling reveals out-of-control temperatures(> 35°C), mixing polishing *and* etching.
- Simulation models linked to experimental data.
- Feedback to cavity EP work >> "control the temperature" "move fluid slowly"
- Detailed model with measured temperature-dependent viscosity and F^- diffusion coefficient
- Using these tools to engineer more efficient cavity polishing systems (e.g., ICP with VEP)



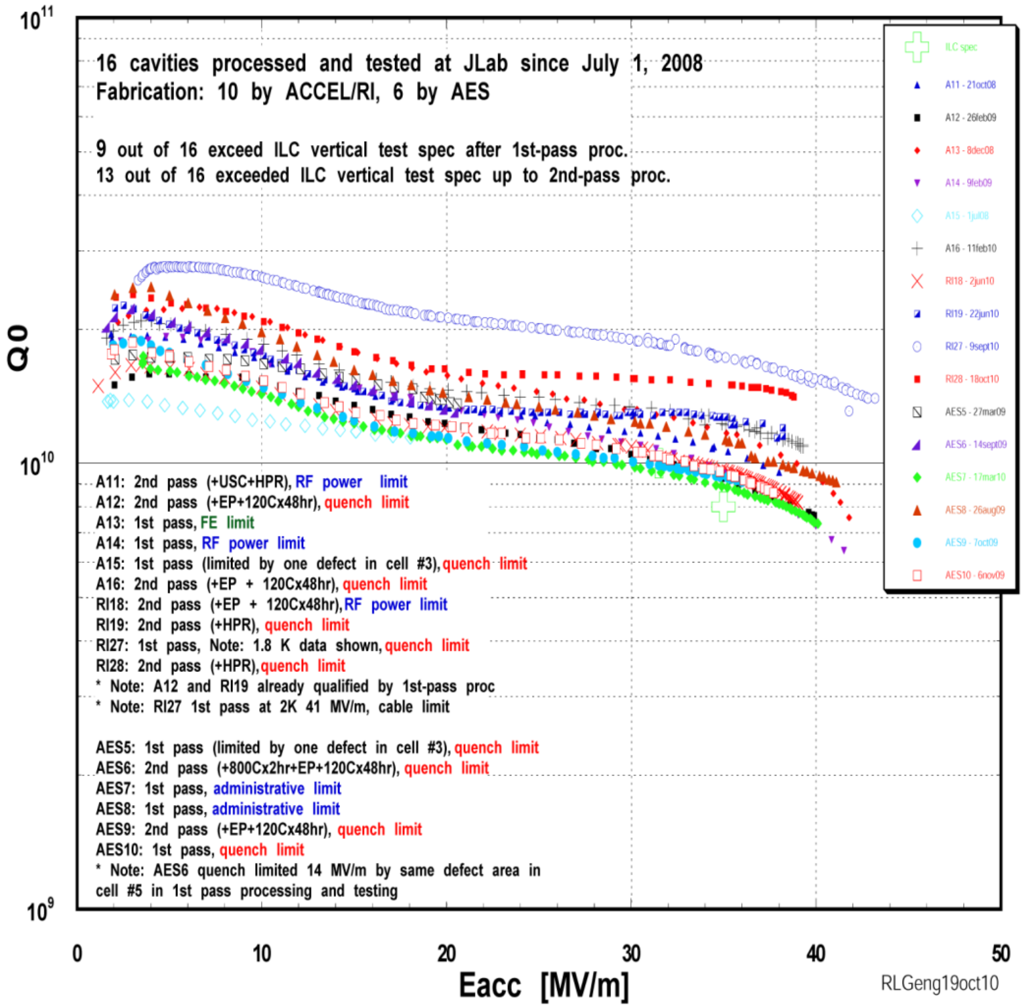
Internal flow dynamics

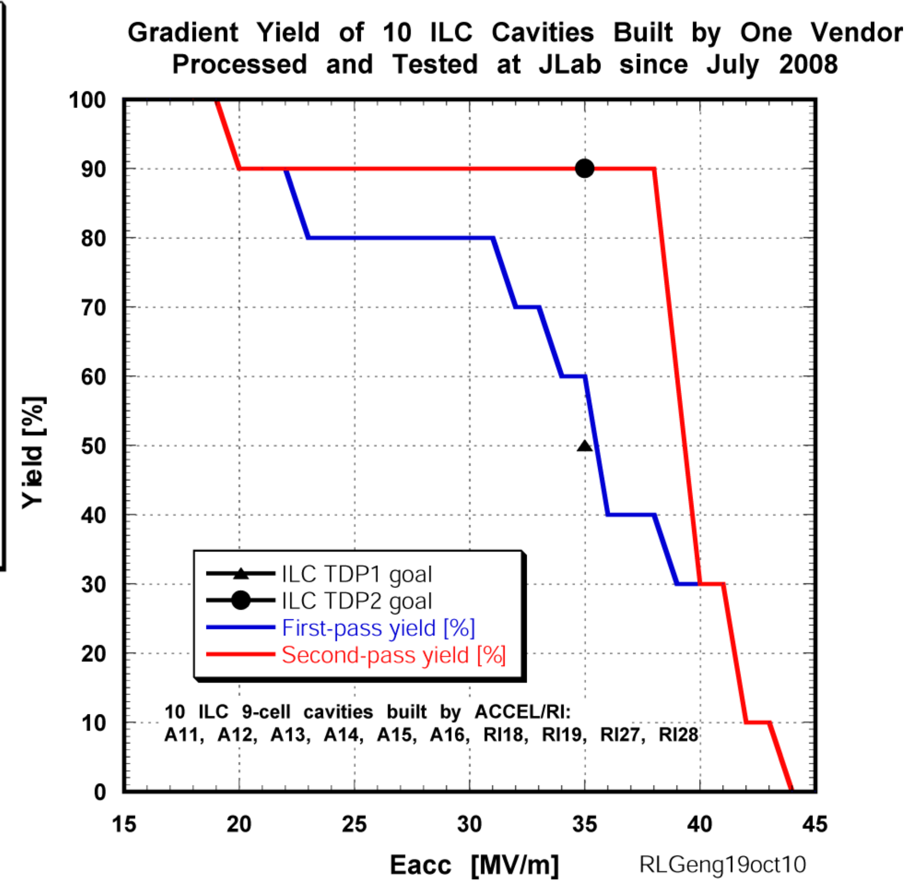


Temperature variations

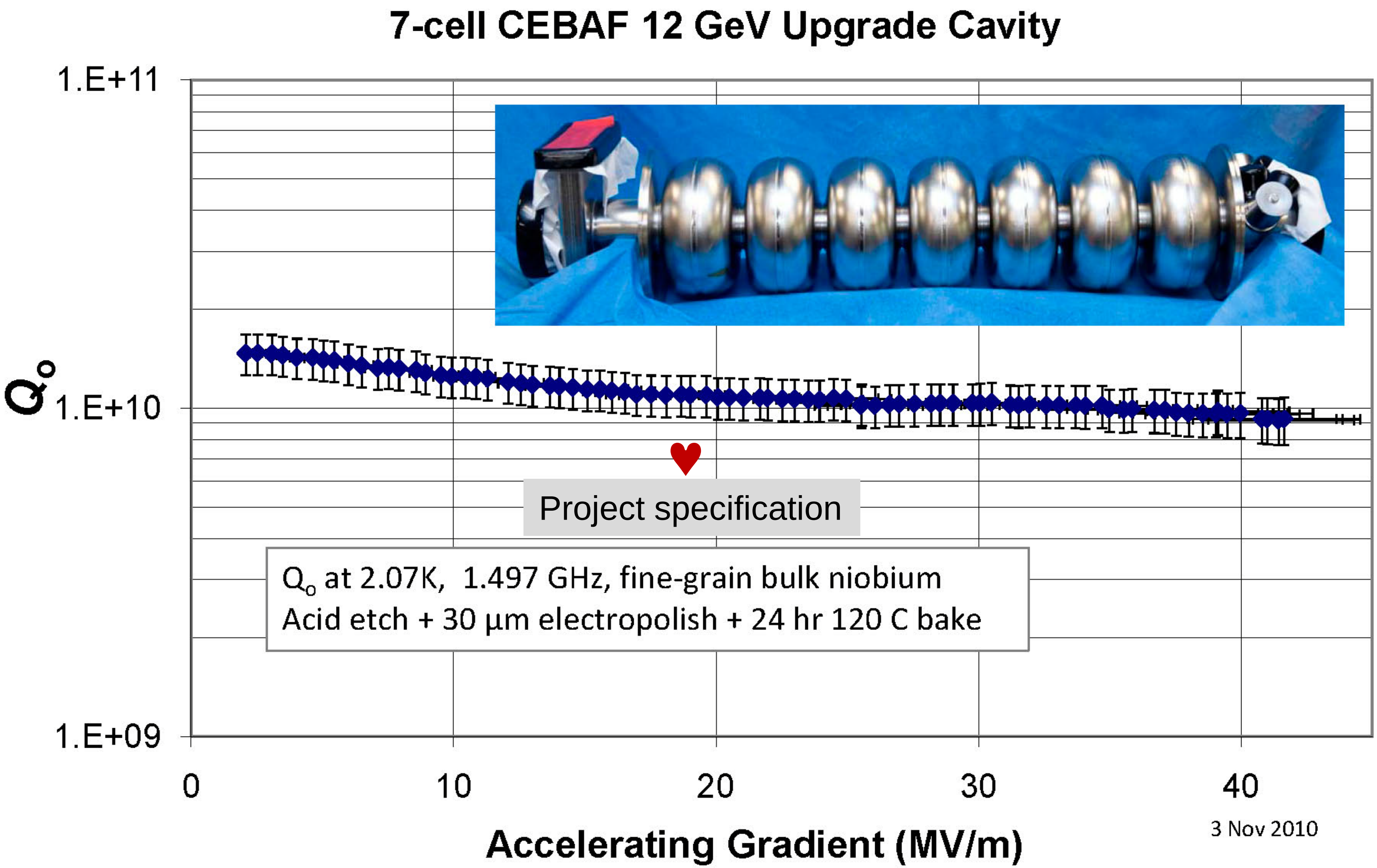
ILC Cavity Vertical Test Results at JLab

Best performance in international collaboration





State-of-the-art production SRF cavity



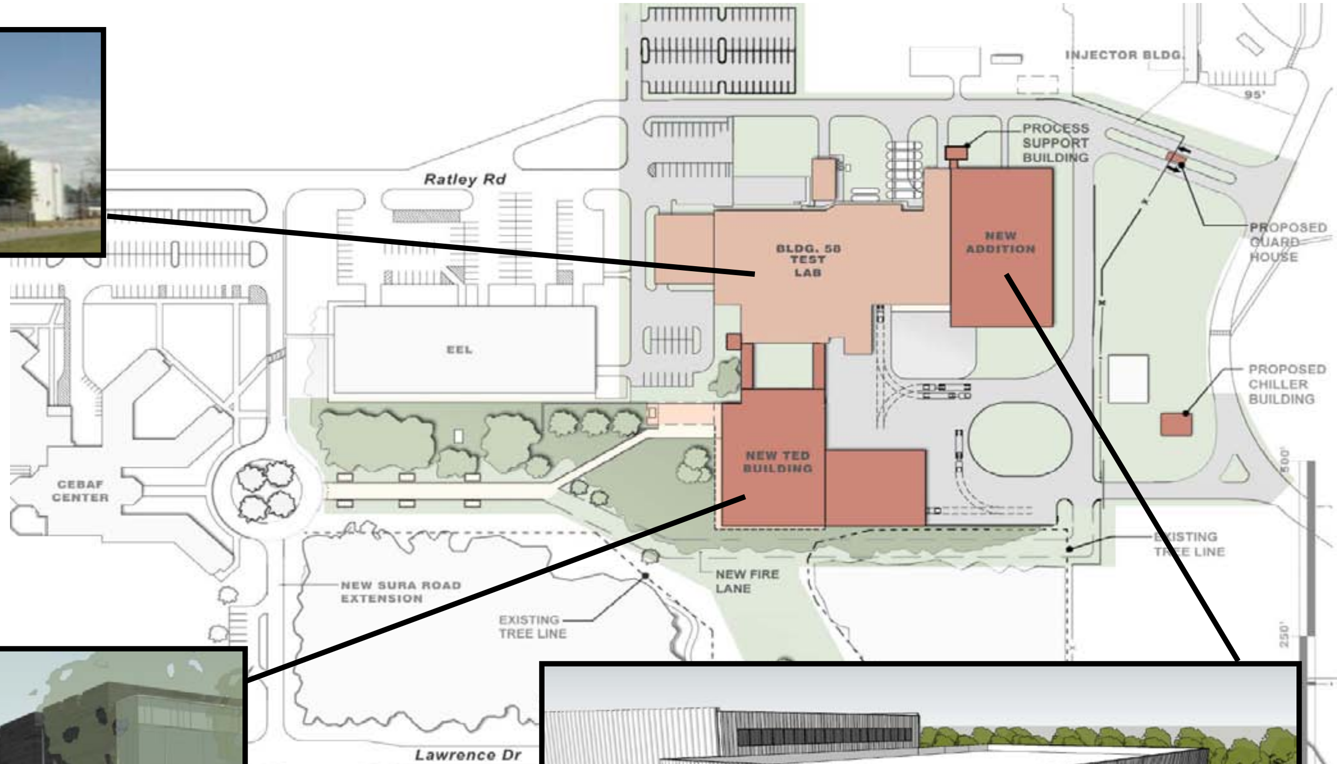
Q is BCS-limited

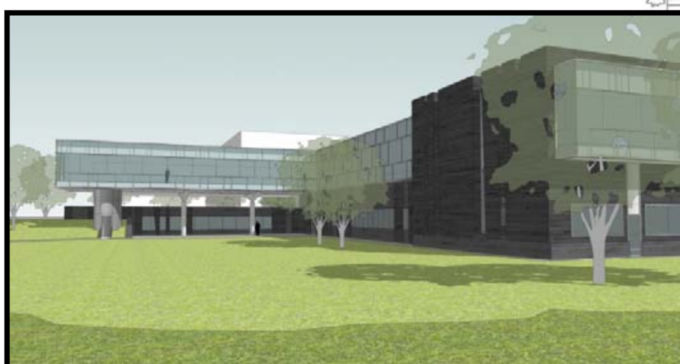
Opportunities for SBIR/STTR

- 1500 MHz high power/high efficiency magnetron
- Specialized cavities
- Integrated Cavity Processing Unit
- Lower-cost, high-performance processing techniques
- New SRF materials for reduced operating costs (higher temperature operation)

Technology and Engineering Development Facility - TEDF

Test Lab Renovation



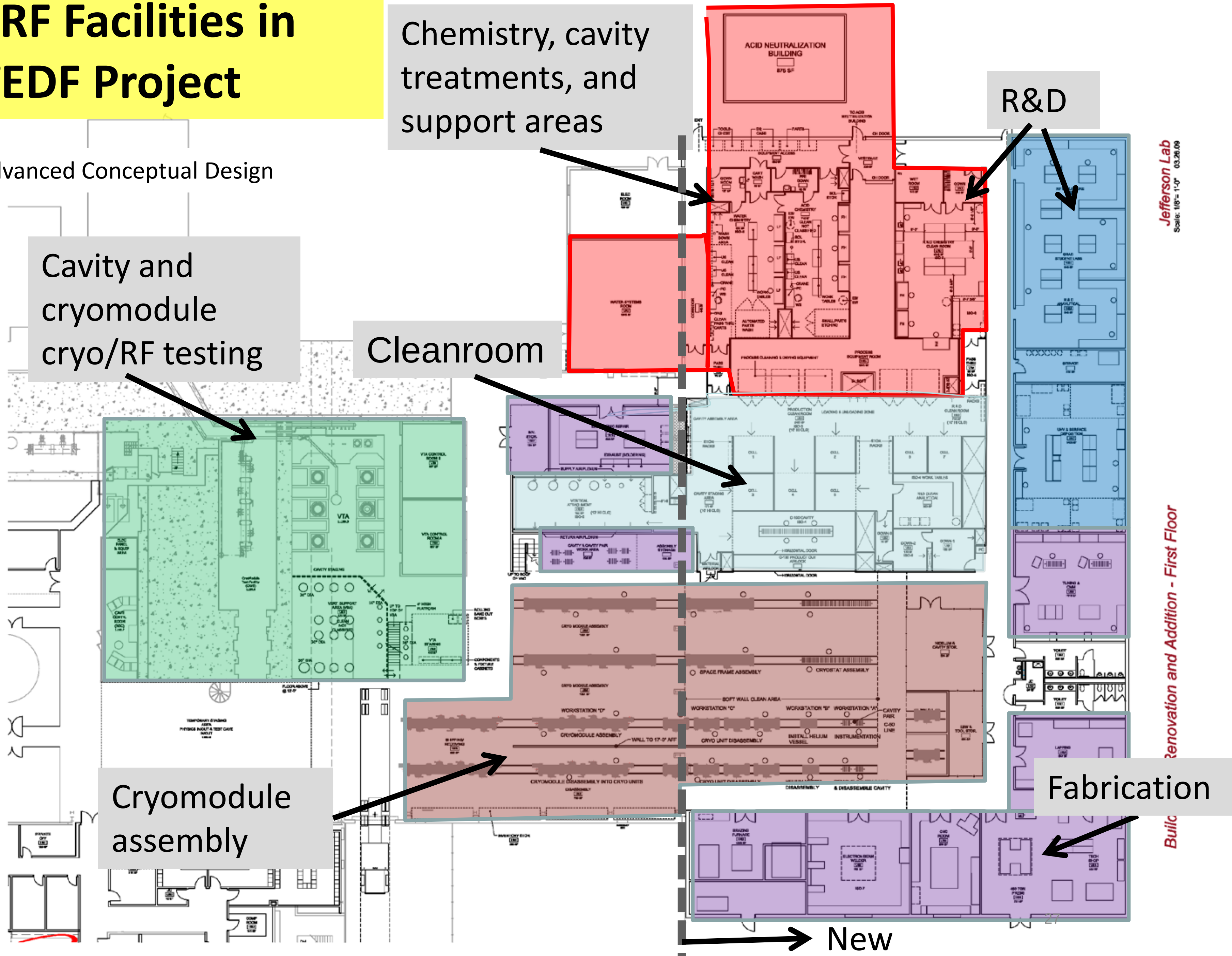


TED Building

Test Lab Addition

SRF Facilities in TEDF Project

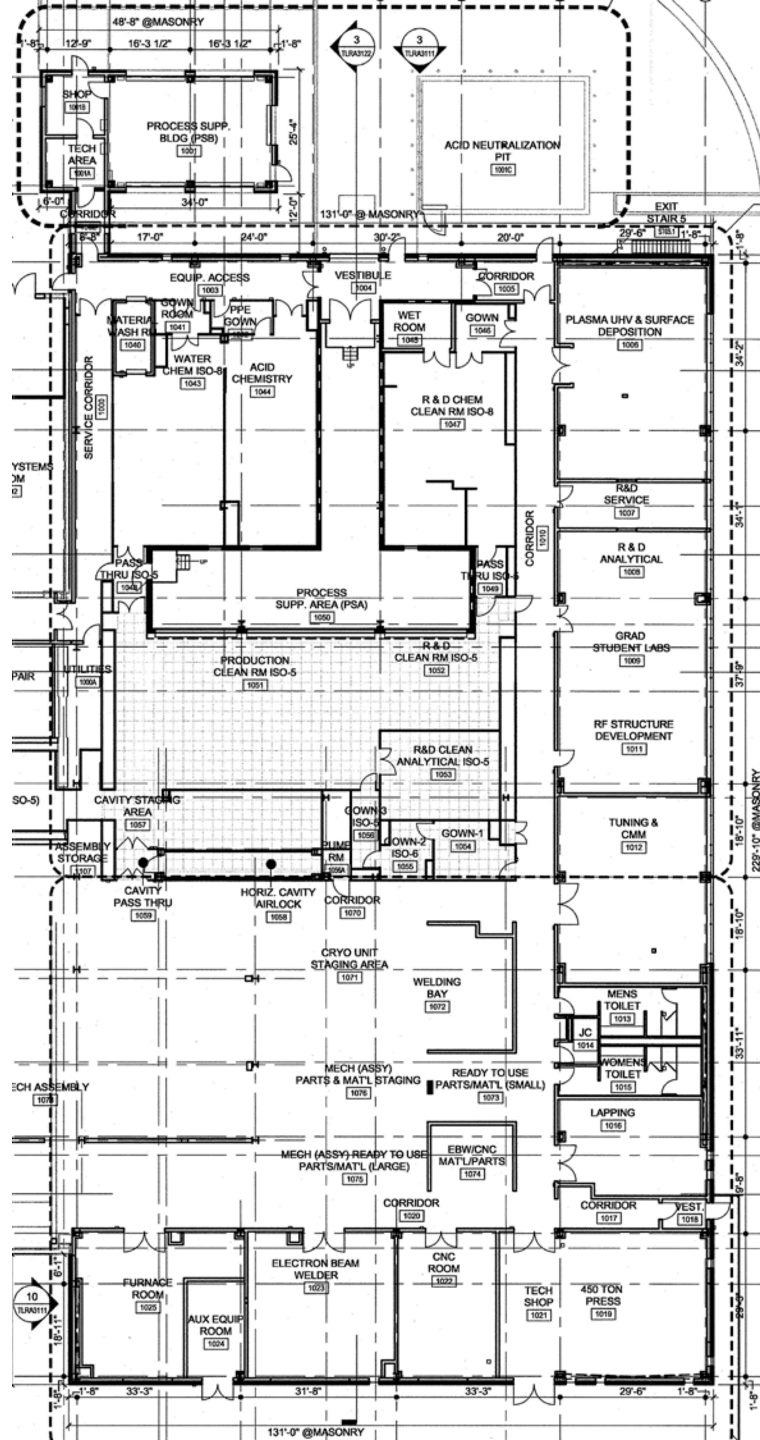
Advanced Conceptual Design



TEDF SRF Infrastructure Design

30,000 sf – new

Cavity fabrication (presses, EBW…)
RF structure development
Process development
QC/ Inspection
Clean analytical lab
Production chemroom
R&D chemroom
Flexible ISO 4 cleanroom suite
Dedicated CEBAF-support CM assembly lines
Expansion space for other DOE project support



Facility Renovation Is Underway

Will have state-of-the-art infrastructure for development of SRF-based accelerator structures, materials, and processes

Opportunities for SBIR/STTR

- **TJNAF is eager to support SBIR/STTR efforts that align with our programmatic goals**
  - In FY11 we had 11 active CRADAs with Small Businesses, $2.0M
  - JLab provided 35 letters of support to >15 companies submitting SBIR/STTR proposals in FY11
  - We routinely press the state-of-the art to support our science mission.
  - We are happy to help bridge the
    - fundamental research $\Rightarrow$ applied research $\Rightarrow$ technology development gaps
    - to realize reduced cost and increased performance via commercialized products.

Questions?