TJNAF facility and the SBIR/STTR Program

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Associate Director, Accelerators
TJNAF (Jefferson Lab)

Jefferson Lab

Jefferson Lab Staff Present Today

• Geoff Krafft	Accelerator physics
• Anne McEwan	SRF cavities and cryomodules
• Matt Poelker	Electron guns and injectors
• Anne-Marie Valente	SRF thin films
• Chip Watson	Large-scale computing and data management

Jefferson Lab Accelerator Site

CEBAF
SRF recirculating linac

Test Lab at the Institute for Superconducting Radio-Frequency Science and Technology
-SNS drive linac
- JLab – FEL
-ILC

FEL

CHL

Nuclear Physics Detectors
Halls A, B, C

Center for Advanced Studies of Accelerators (CASA)

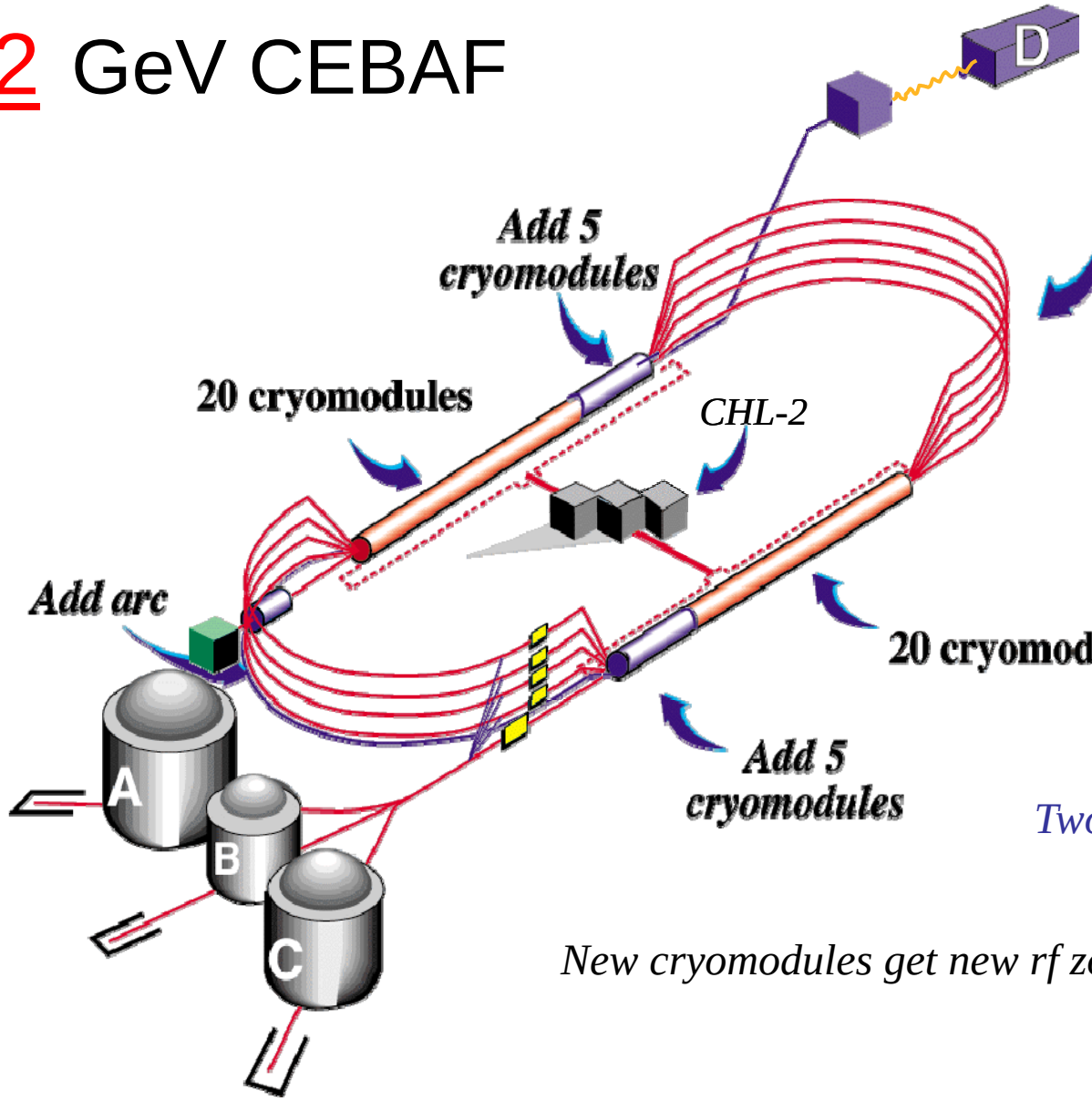
Accelerator Mission

- 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 produces 100 MeV
  - ⇔Extraction system design
  - ⇒ Commission the accelerator to meet CD-4 beam specifications

12 GeV CEBAF



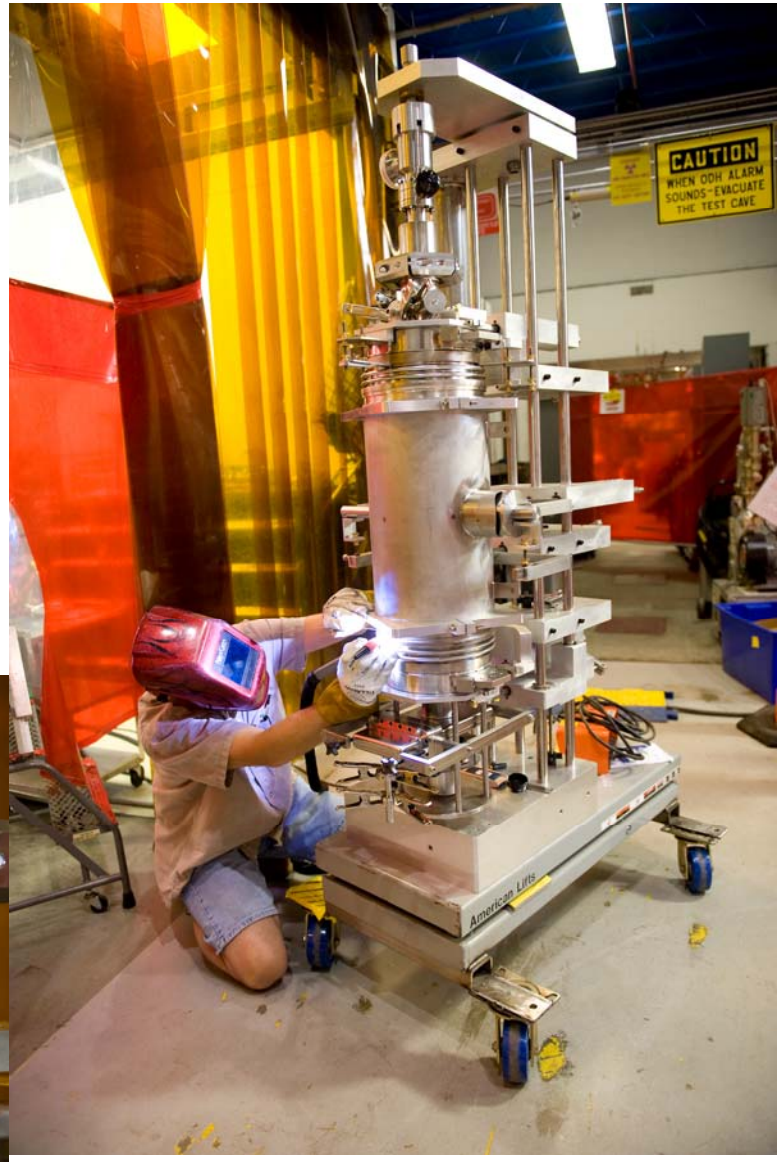
Upgrade magnets and power supplies

Two 0 1.1 √ linacs

New cryomodules get new rf zones

Prototype C-100 Cavity

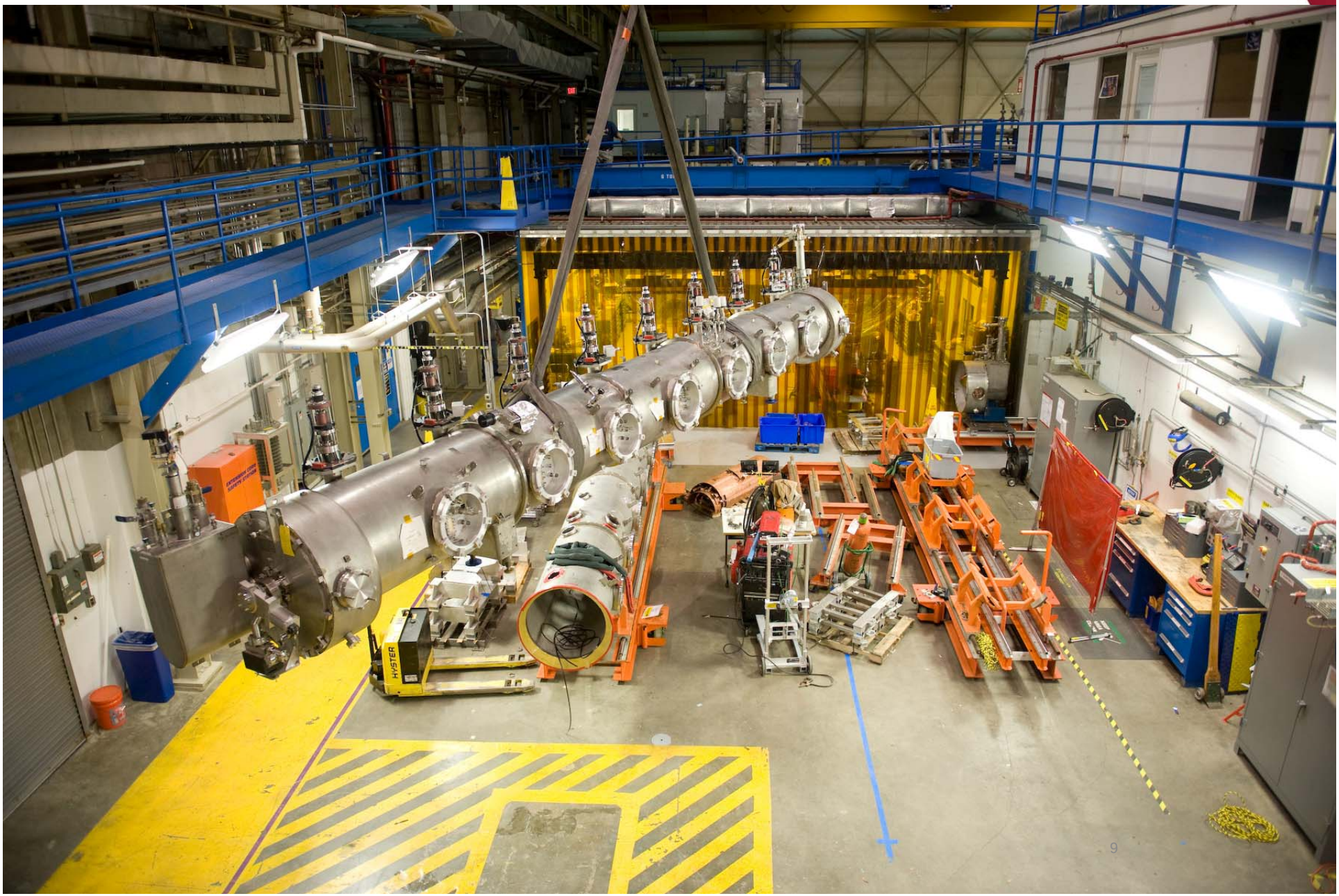
- Testing welding jig for 12 GeV Upgrade Helium vessel
  - Found problem with magnetization of Helium vessel
  - We will be re-ordering parts



Scope of Work Activities 2

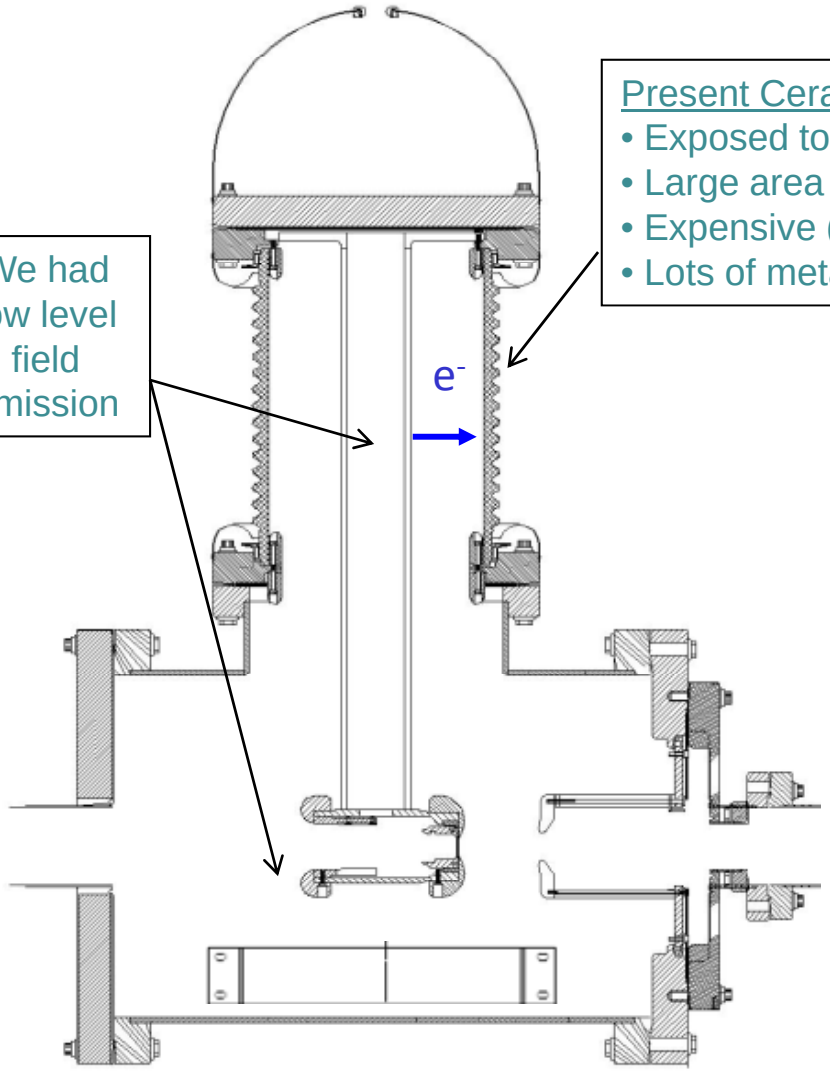
- Operate and improve the CEBAF accelerator facilities
  - ⇔Operate CEBAF safely for nuclear physics program
  - ⇐ Energy increased from 4 GeV to 6 GeV
  - ⇔Polarization and parity quality of beams improved
  - ⇔Develop ability to provide simultaneous 11 GeV beams to three Halls (ARRA AIP project)
 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

Cryomodule Leaving Test Lab For CEBAF Tunnel



Old Gun Design

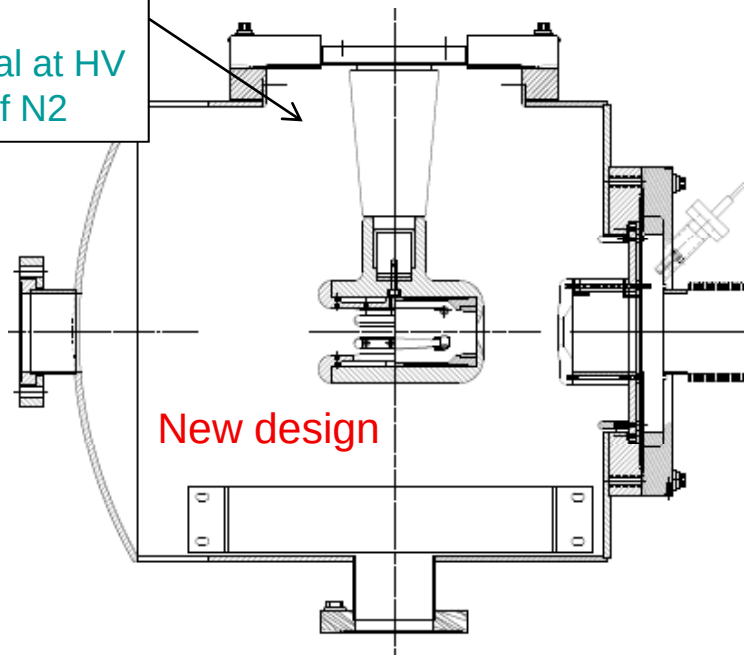
"Inverted" Gun



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

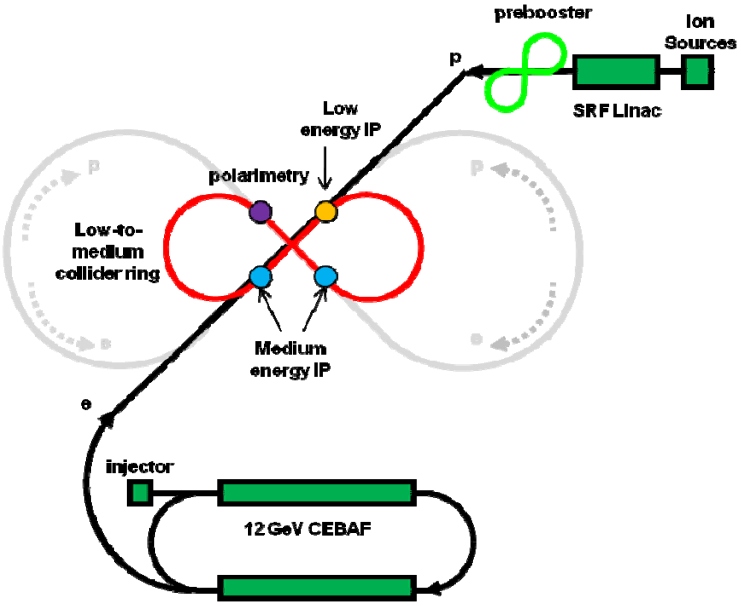
“Inverted Gun” Project funded by NP-AIP and ILC

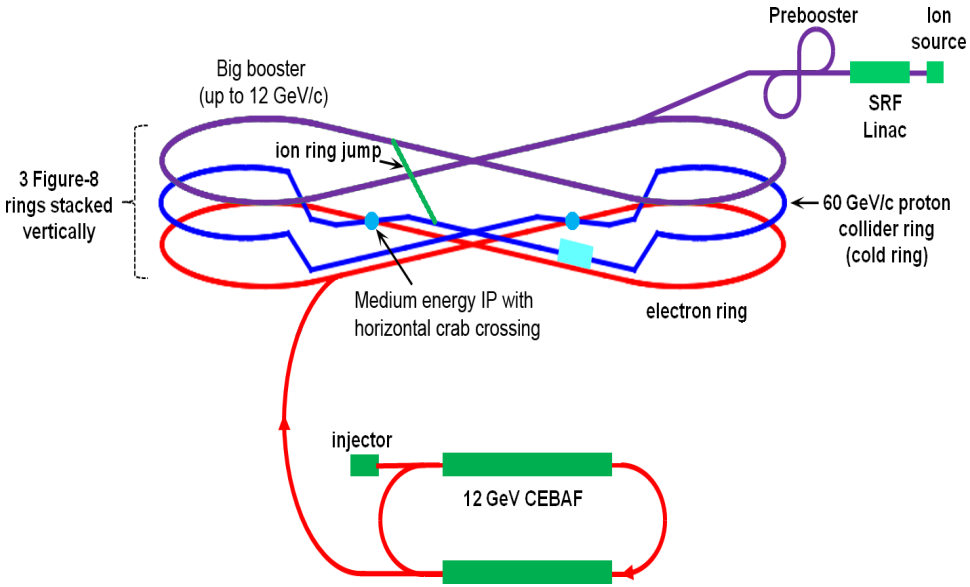
Scope of Work Activities 3

- 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

MEIC Jefferson Lab Electron-Ion Collider Design

- A medium energy (up to 60 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
- A major R&D grant proposal (total $4.5M) has been submitted to DOE NP





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

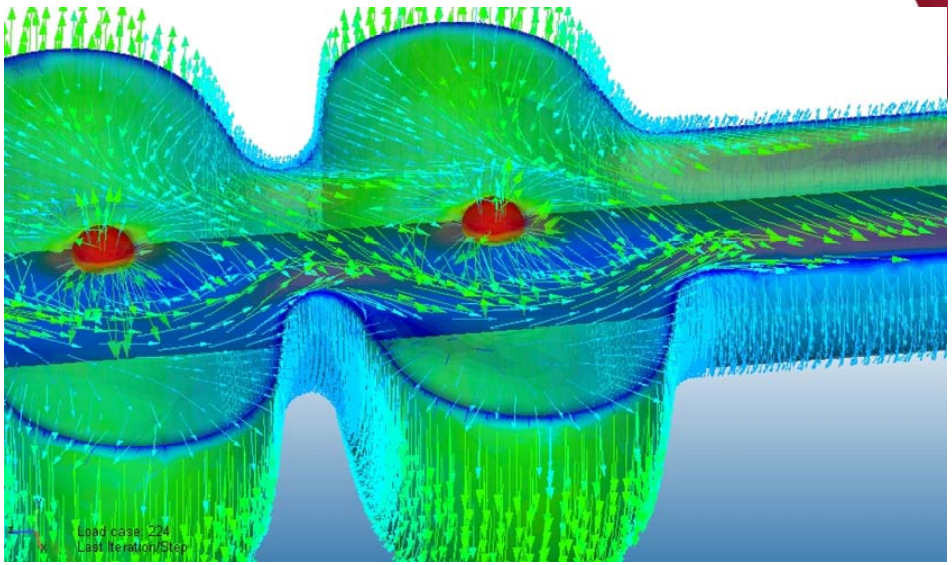
- Simulation capability for electron-ion collisions
- Simulation capability for strong electron cooling of the ion beams and implications for beam-beam interactions

Scope of Work Activities 4

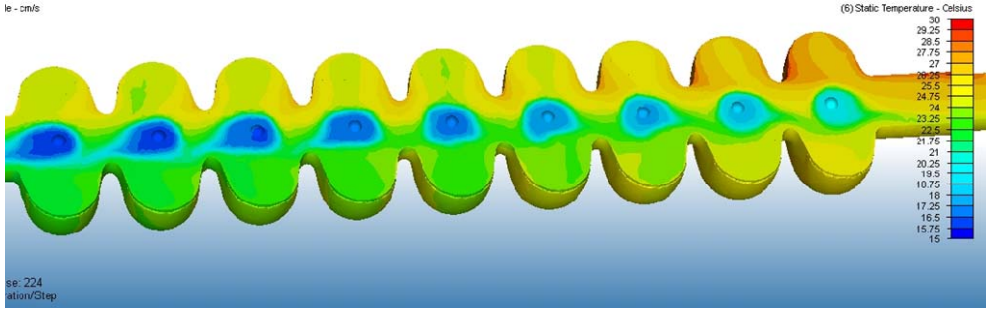
- Develop Jefferson Lab's core SRF competence to support DOE Office of Science projects
  - ⇔Improve maximum accelerating gradient, and reproducibility of maximum accelerating gradient
  - ⇔Reduce cryogenic losses at 20-25 MV/m accelerating gradient
  - ⇔Reduce the cost per MV of acceleration
  - ⇒ Develop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

Understanding electropolishing

- 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

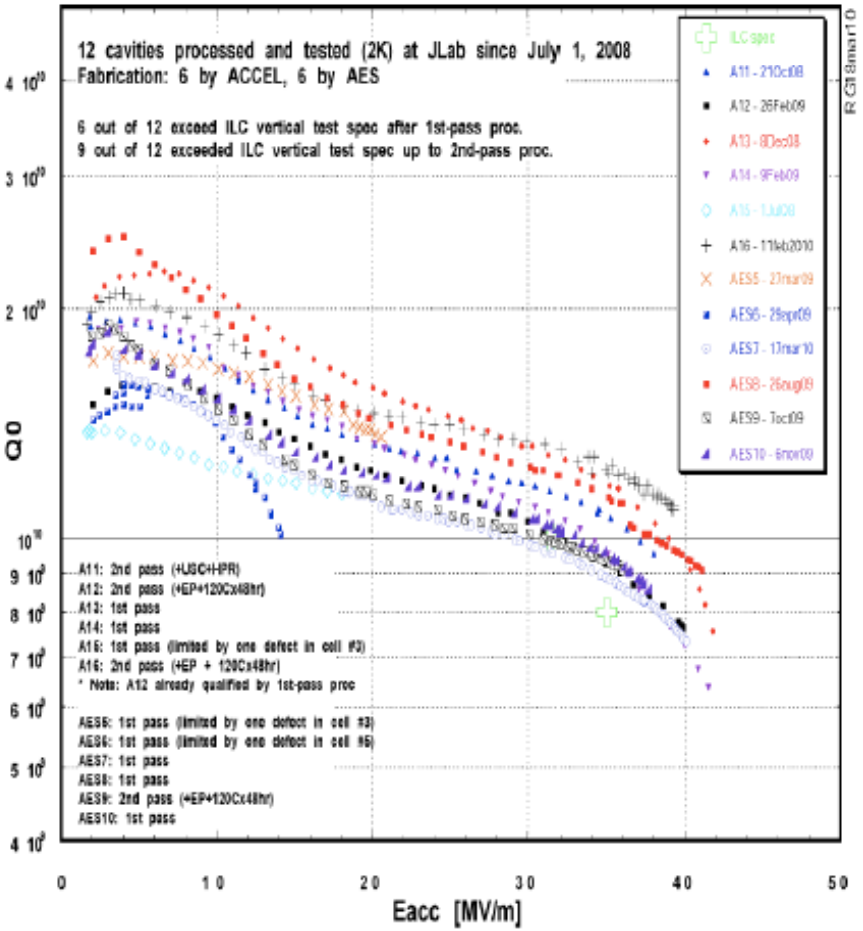


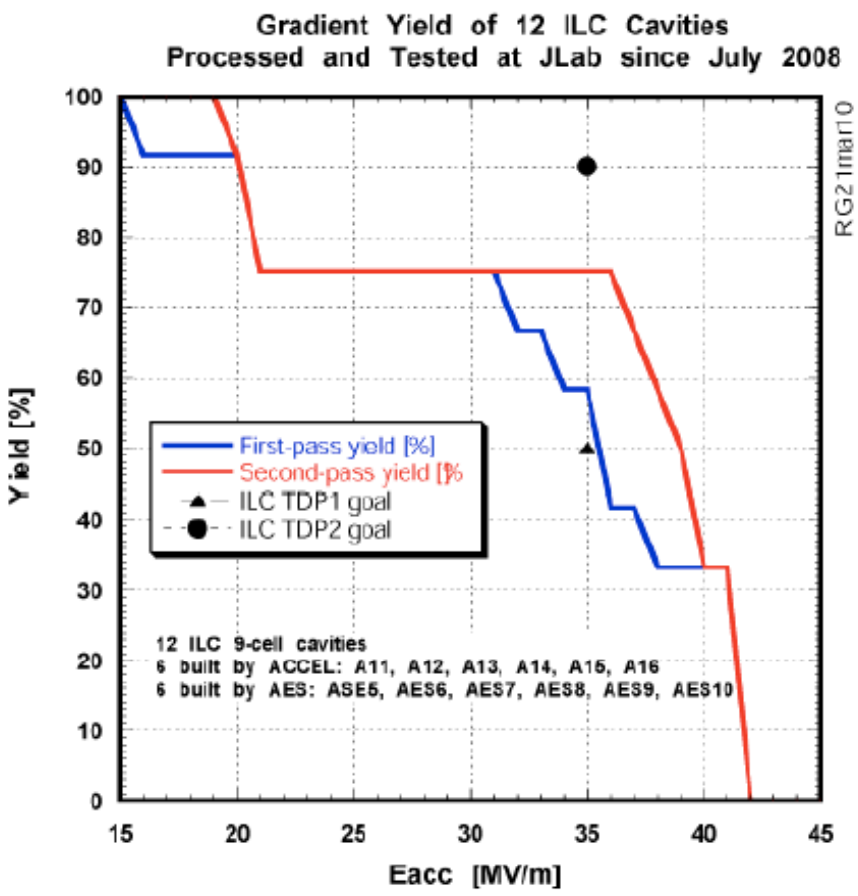
Temperature variations

Jefferson Lab

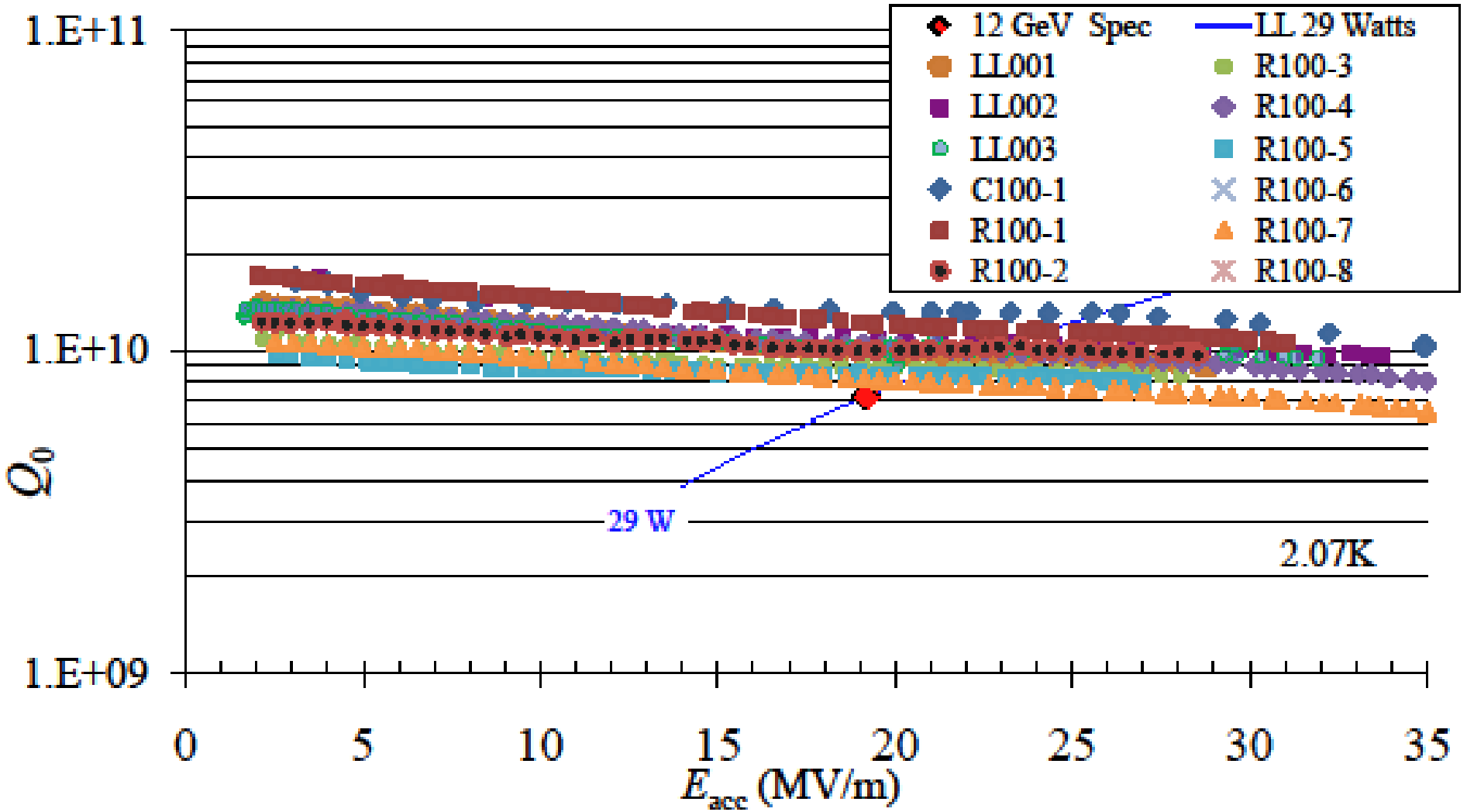
Most Recent 9-cell Results at JLab

6 cavities built by ACCEL and 6 by AES





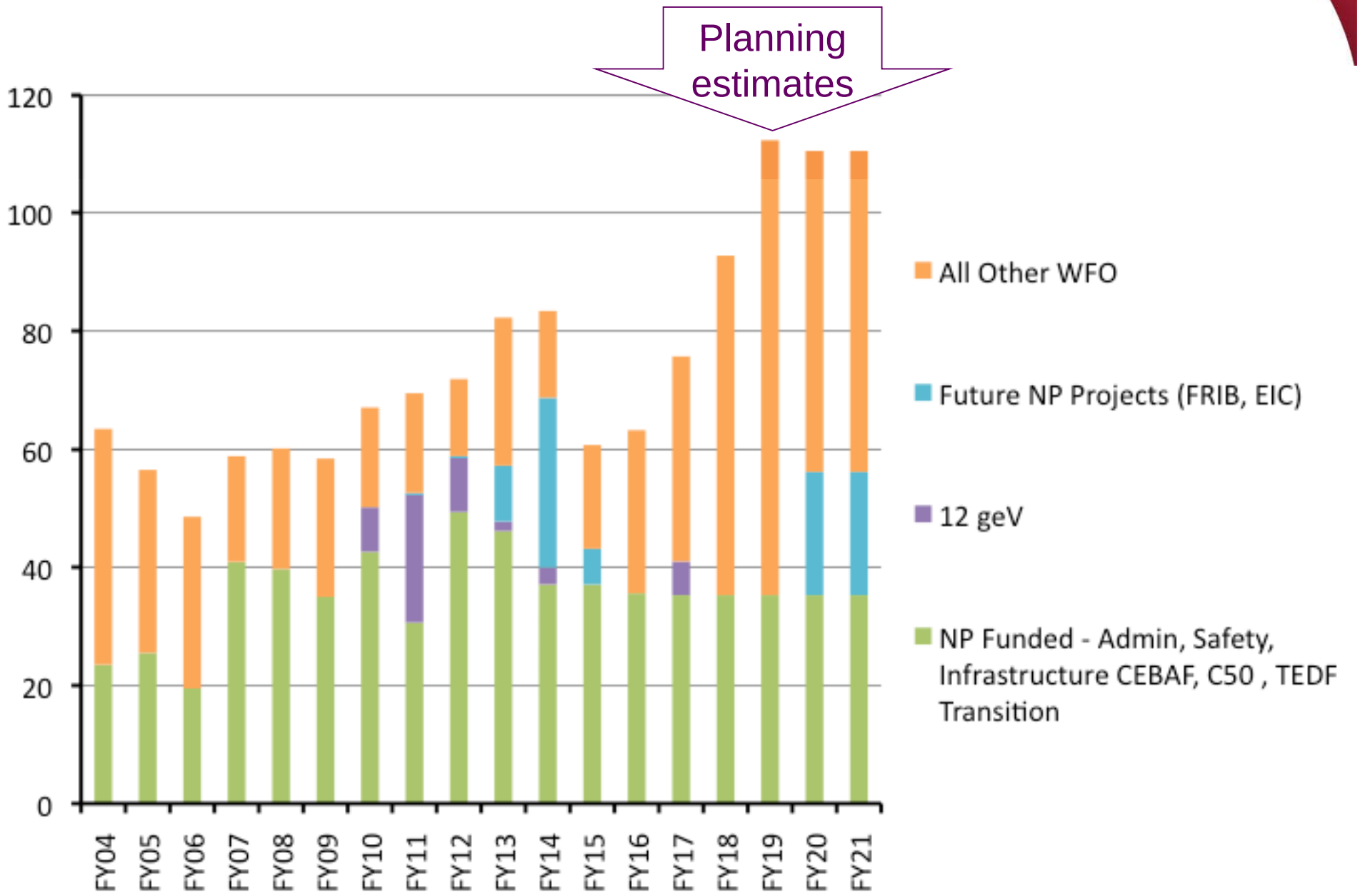
Electropolished Prototype Upgrade Cavity Performance



Opportunities for SBIR/STTR

- 1500 MHz high power/high efficiency magnetron
- Specialized cavities
- Integrated Cavity Processing Unit

SRF FTEs Showing Growth in WFO



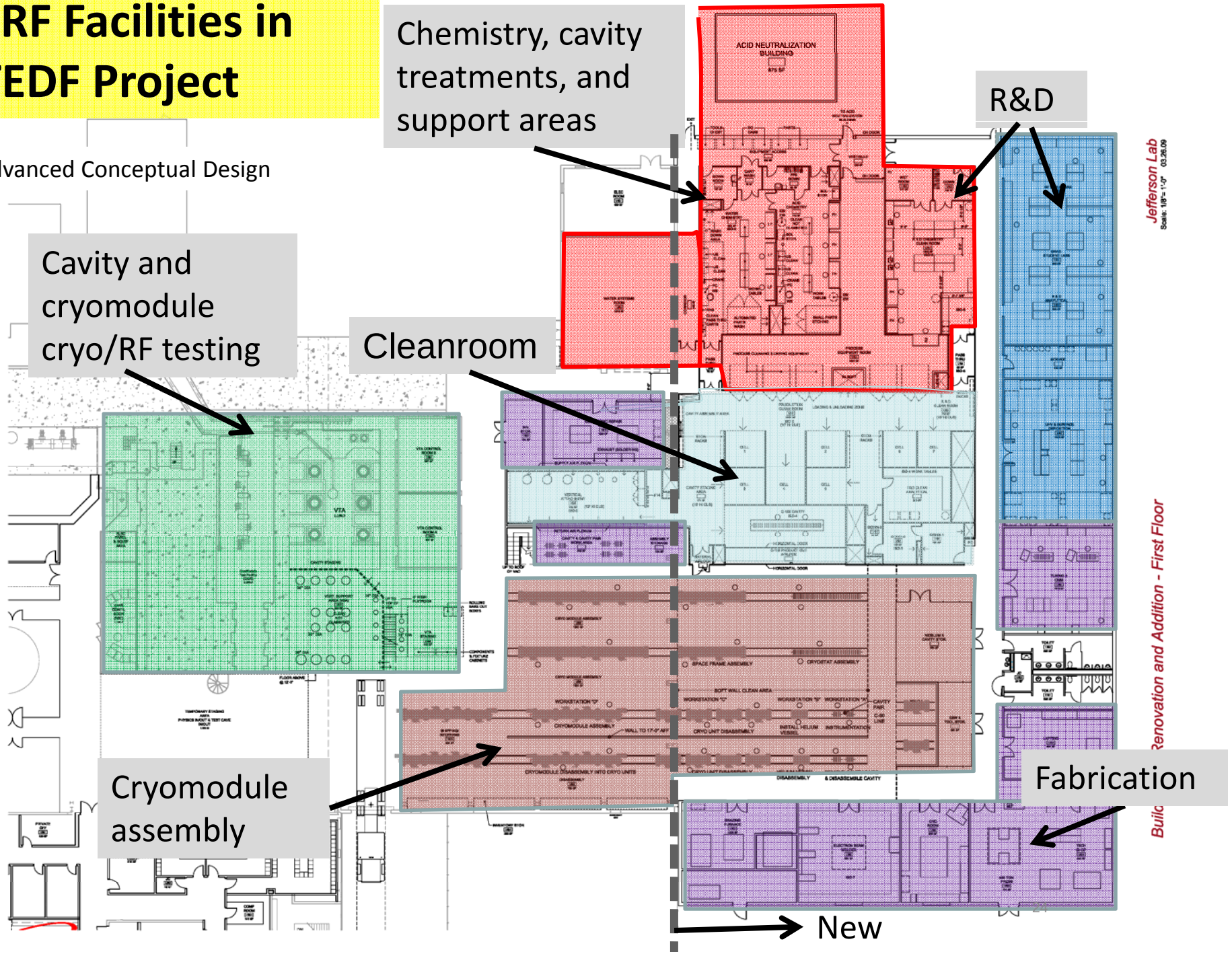
TEDF – Technology and Engineering Development Facility

- We have developed a business plan based on restoring original CEBAF SRF capacity – manufacturing (~75%) and R&D (~25%)
- Production capacity equivalent to:
  - 2 cryomodules per month
  - 16 multi-cell cavities per month
- New TEDF Building is designed around this capacity

Test Lab Renovation Has Started

SRF Facilities in TEDF Project

Advanced Conceptual Design



Questions?