



U.S. DEPARTMENT OF
ENERGY

Office of
Science

U.S. HEP Accelerator R&D Program

L.K. Len

Office of High Energy Physics

Office of Science

US-Japan Advanced Science and Technology
Symposium, Washington, DC

April 30, 2013

Accelerator R&D Mission

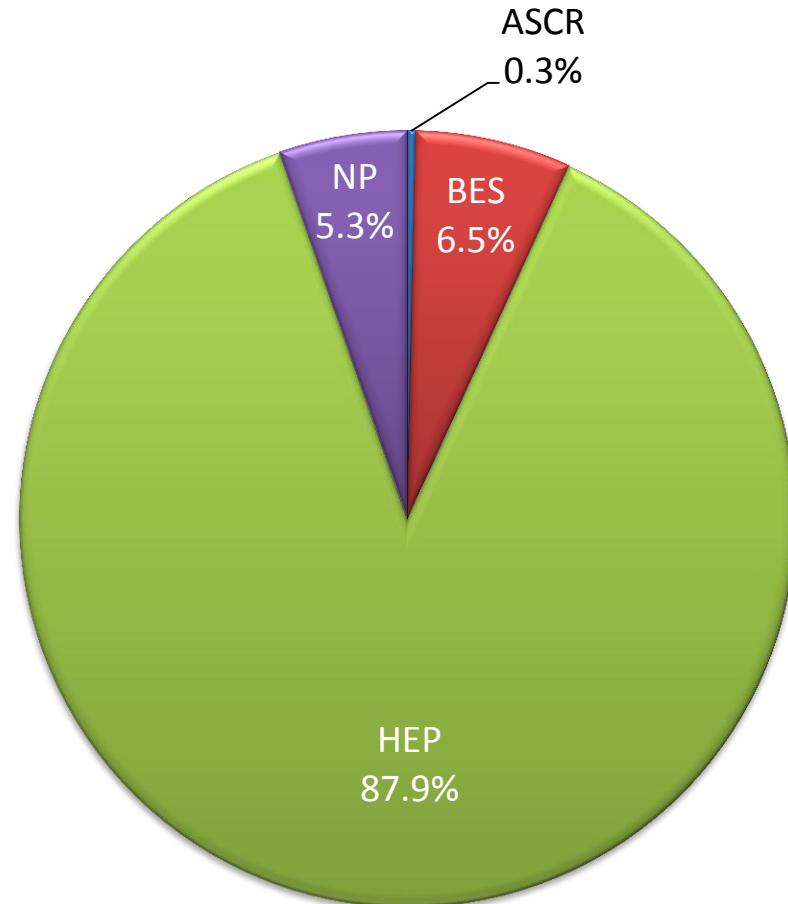
- **Support world-leading research in the physics of particle beams and in accelerator R&D**
- **Three broad categories:**
 - **Near- to mid-term directed R&D** for specific facilities or technologies in support of DOE projects (sometimes captured in project TPC)
 - **Mid-term, facility-inspired R&D** focused on specific concepts or technologies to demonstrate feasibility and engineering readiness
 - **Long-term, proposal-driven research** on the fundamental science underlying particle accelerators and beams to enable breakthroughs in size, cost, beam intensity, beam energy, and control
- **Other DOE Programs also participate in the first two categories**
 - The last category is the purview of HEP (stewardship role)
- **Support and enable the advancement of a broad range of scientific disciplines: NP, HEP, photon and neutron science**

Accelerator R & D – By Program

By SC Program - Mid and Long Term

DOE SC Programs supporting accelerator R&D:

- Office of Advanced Scientific Computing Research
- Office of Basic Energy Sciences
- Office of High Energy Physics
- Office of Nuclear Physics



Majority of R&D efforts is coordinated by HEP.

Accelerator R&D Classification

Core Research (8 Thrust Areas)

- New Accelerator Concepts
- Accelerator, Beam and Computational Physics
- Particle Sources
- Beam instrumentation and Control
- RF Sources
- Normal Conducting RF
- Superconducting RF
- Superconducting Magnets

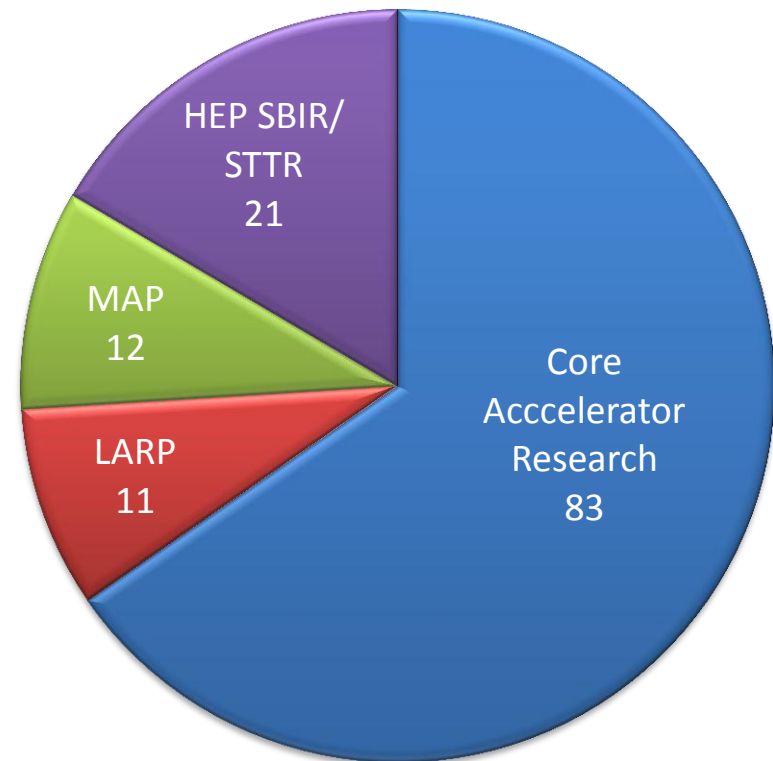
Directed Accelerator R&D (2 Areas)

- LHC Accelerator R&D
- Muon Accelerator Program

Small Business Innovative Research

- 8 HEP SBIR/STTR topics

By Category (in M\$)

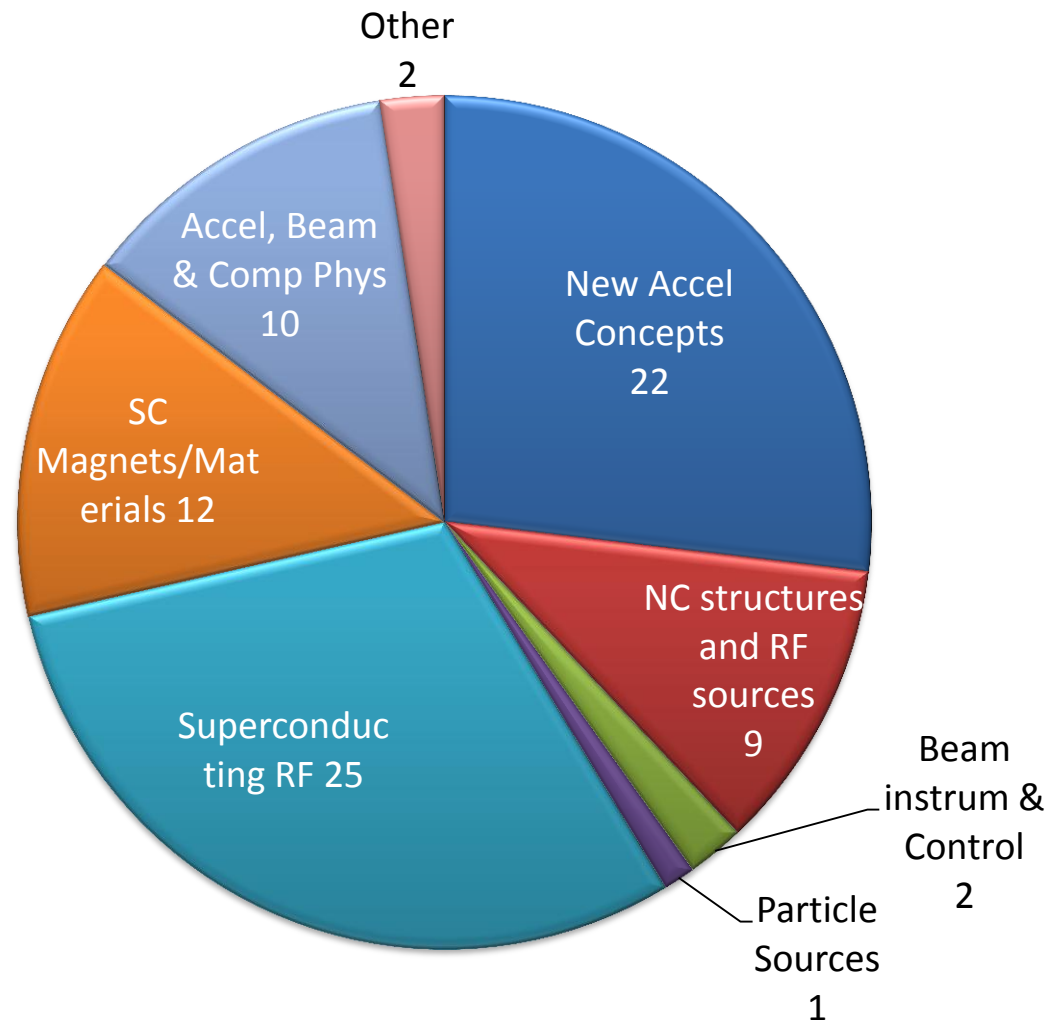


Core Accelerator Research Areas

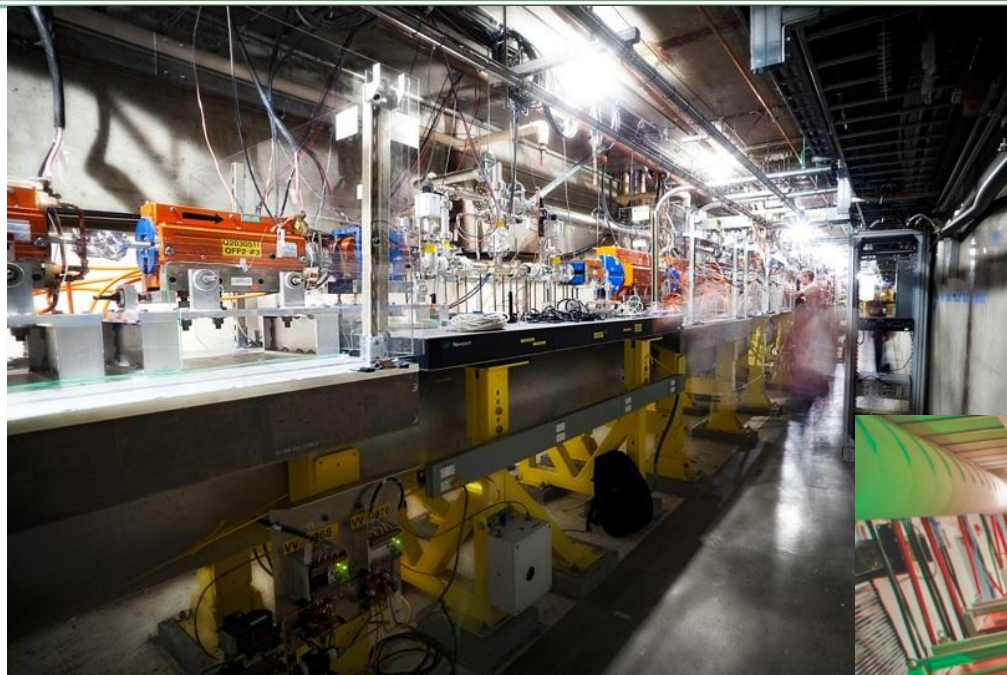
By Core Research Thrust (in M\$)

8 Core Thrust Areas

- New Accelerator Concepts
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Highlights—Novel Acceleration Concepts



Plasma Acceleration Facilities:

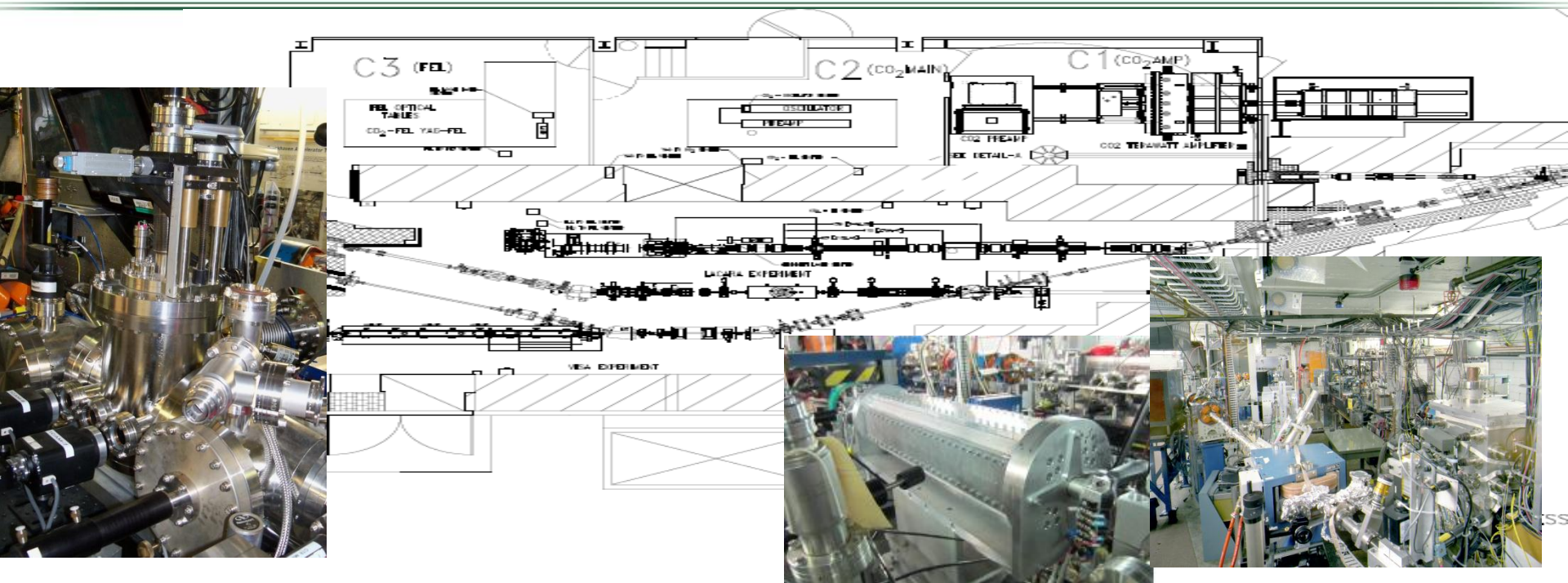
- BELLA (LBNL) – Laser-driven
 - FACET (SLAC) – beam-driven
- are both operating



BELLA system at LBNL

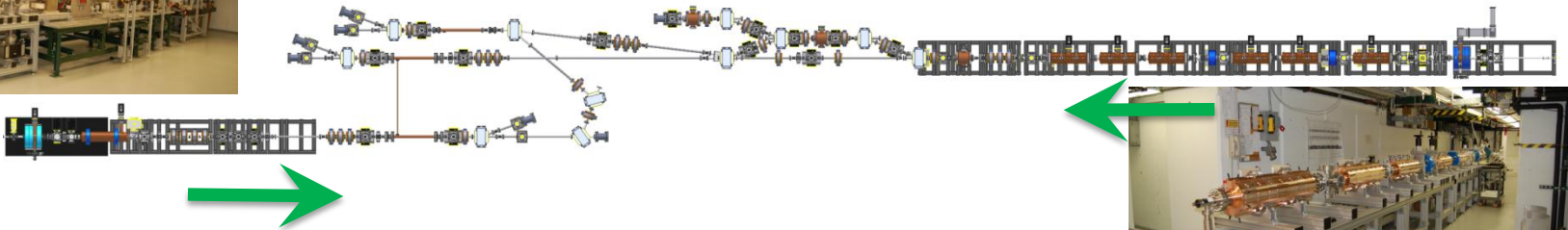


Highlights—Novel Acceleration Concepts



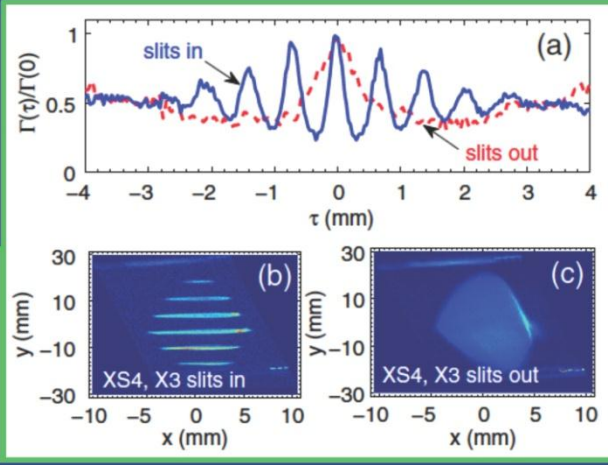
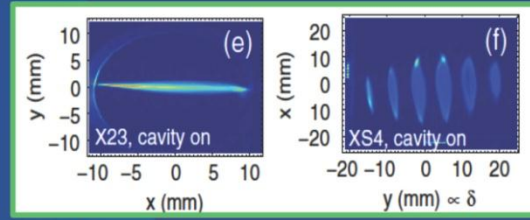
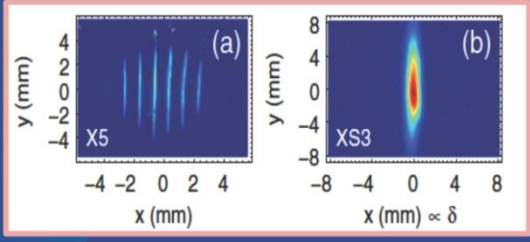
ATF@BNL – Accelerator + CO2 Laser

AWA@ANL – Dielectric wakefield accelerator



Highlights—Accelerator/Beam Physics

Generated a train of micro-bunches with sub-ps separation using slits.



PI, E-886)

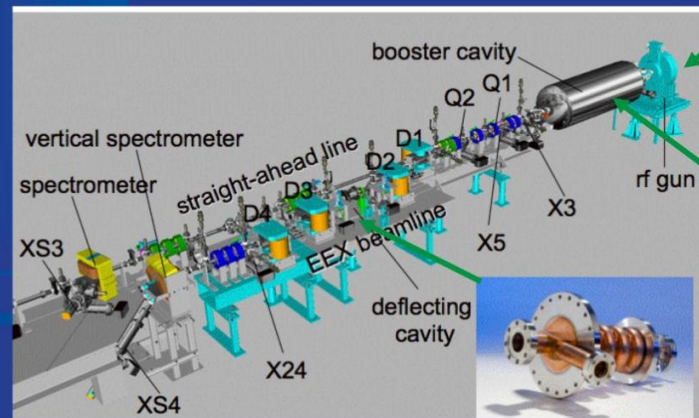
photocathode → Q < 10 nC (up to

Sp laser system

3 GHz) → E=16 MeV



- Emittance exchange beam line (ϵ_x, ϵ_z) → (ϵ_z, ϵ_x)



Beam Physics Expts @FNAL:

- A0 Lab
- High-Brightness Electron Source Lab (HBESL)
- Proposal for future ASTA facility



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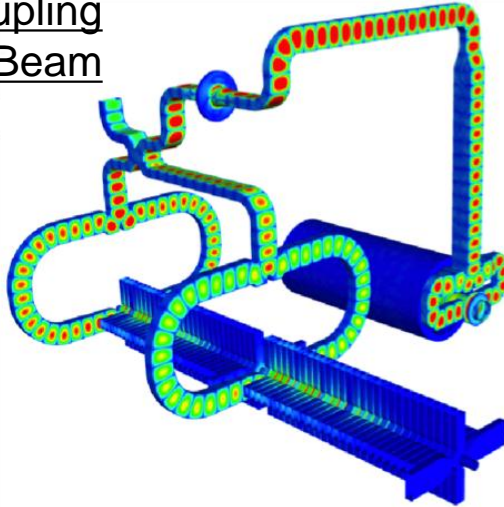
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Highlights—Accelerator/Beam Physics

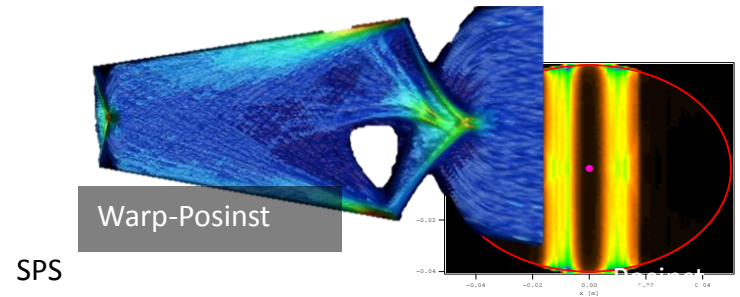
Powerful simulation codes running on supercomputers

Wakefield coupling in CLIC Two-Beam Structure

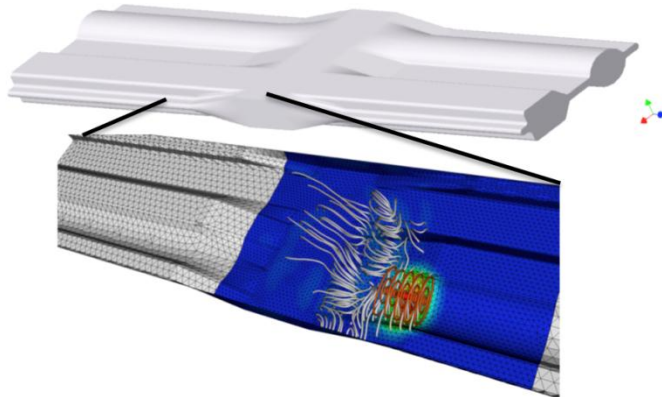
ACE3P



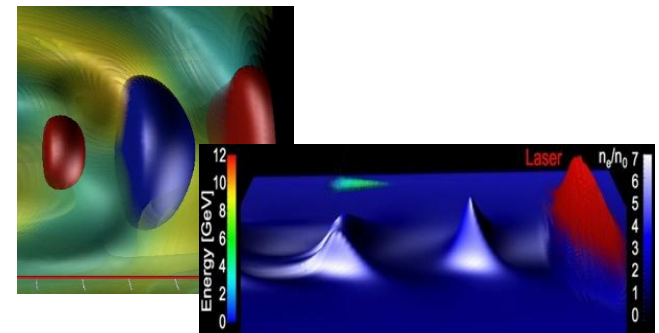
Electron cloud effects



Moving window technique for short-range wakefield calculation



Laser plasma acceleration



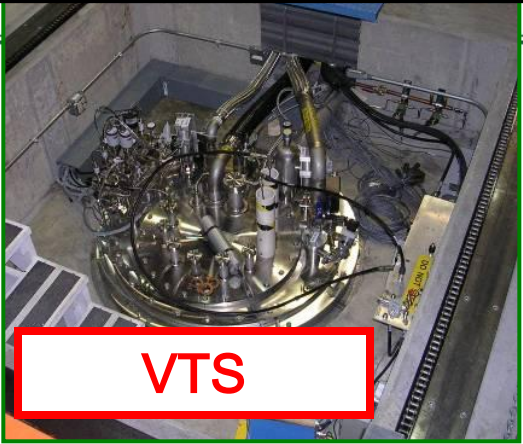
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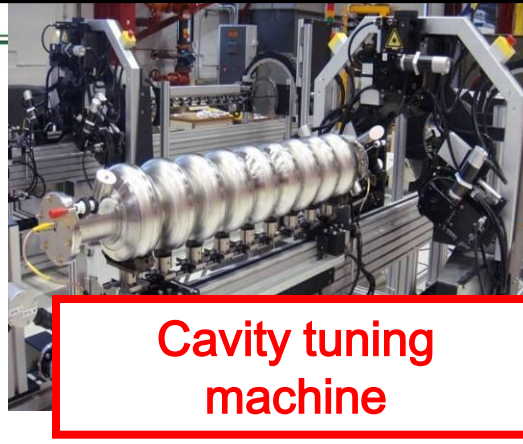
FNAL SRF infrastructure



VTS



VTS



Cavity tuning machine



HTS



String Assembly



MP9 Clean Room



Final Assembly

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VTS2
Dewar



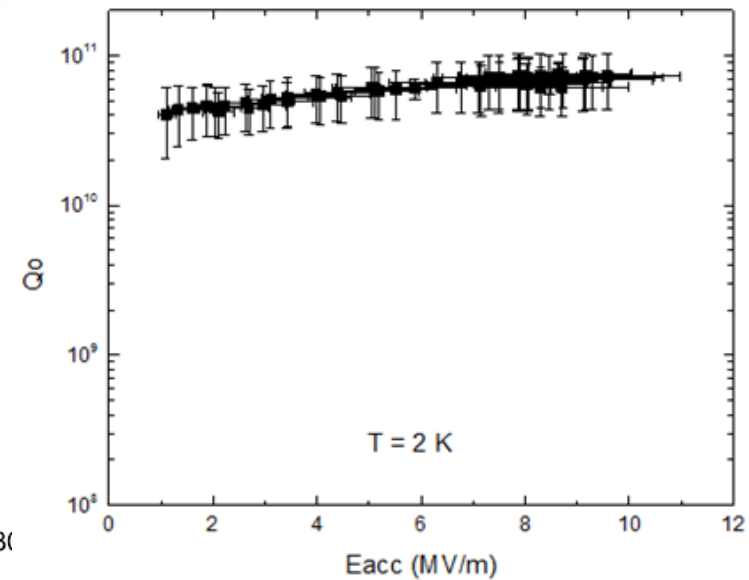
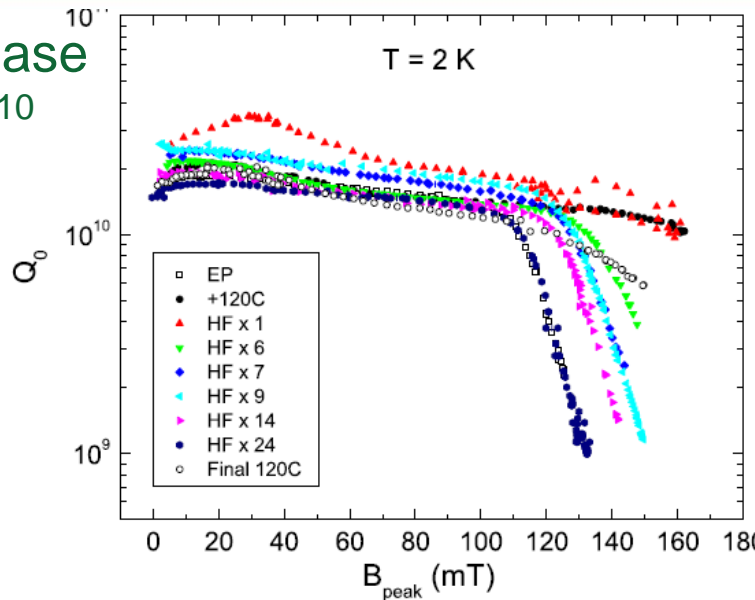
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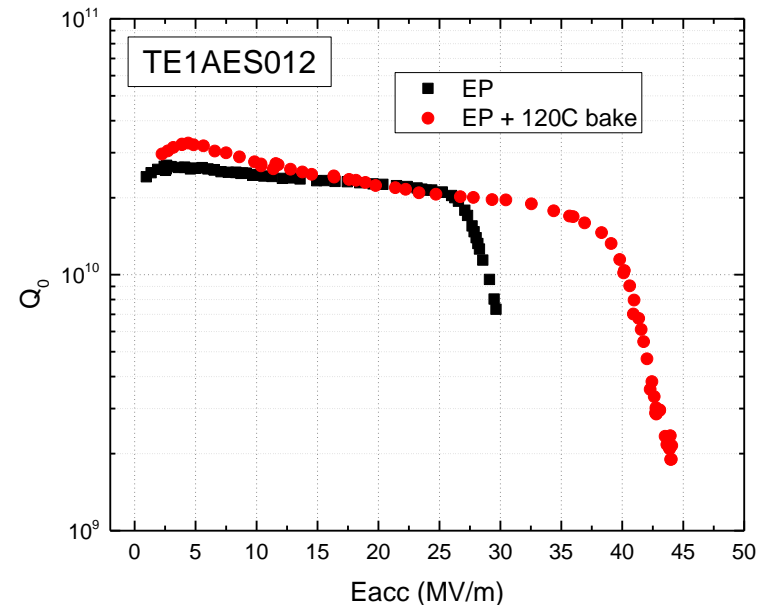
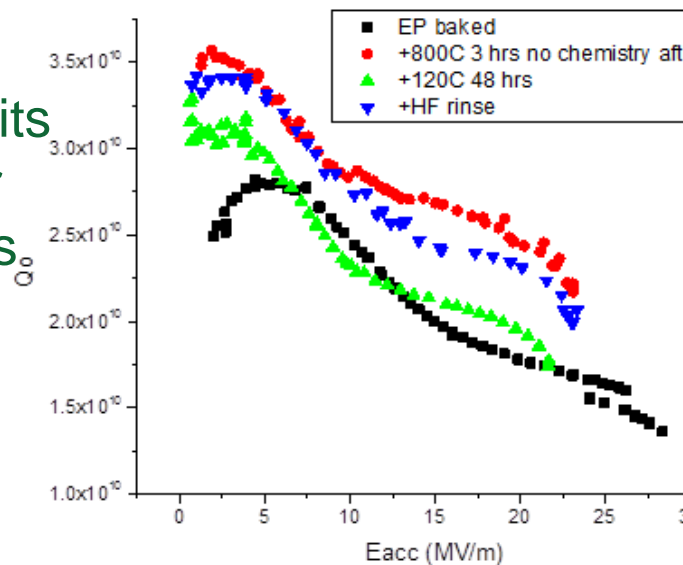
New Vacuum Oven

Highlights—Superconducting RF

New ideas increase Q value to 7×10^{10}

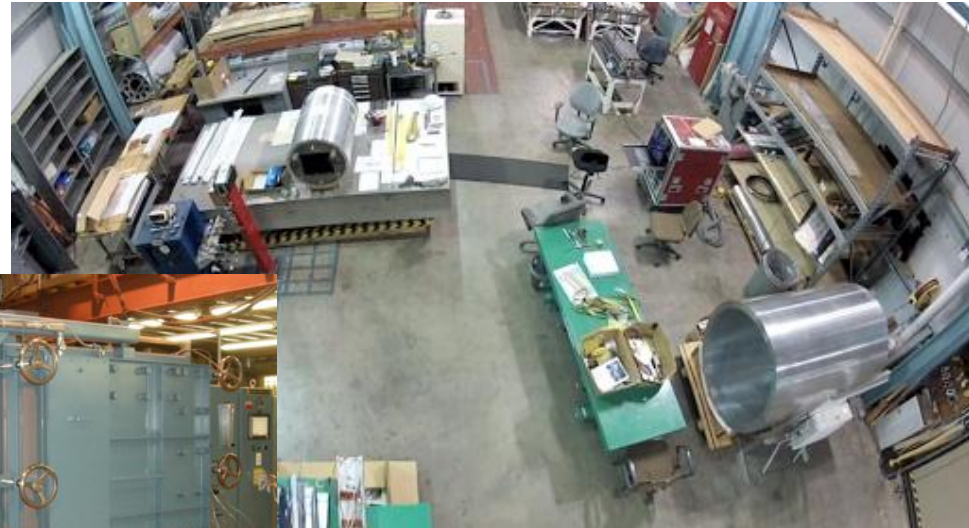
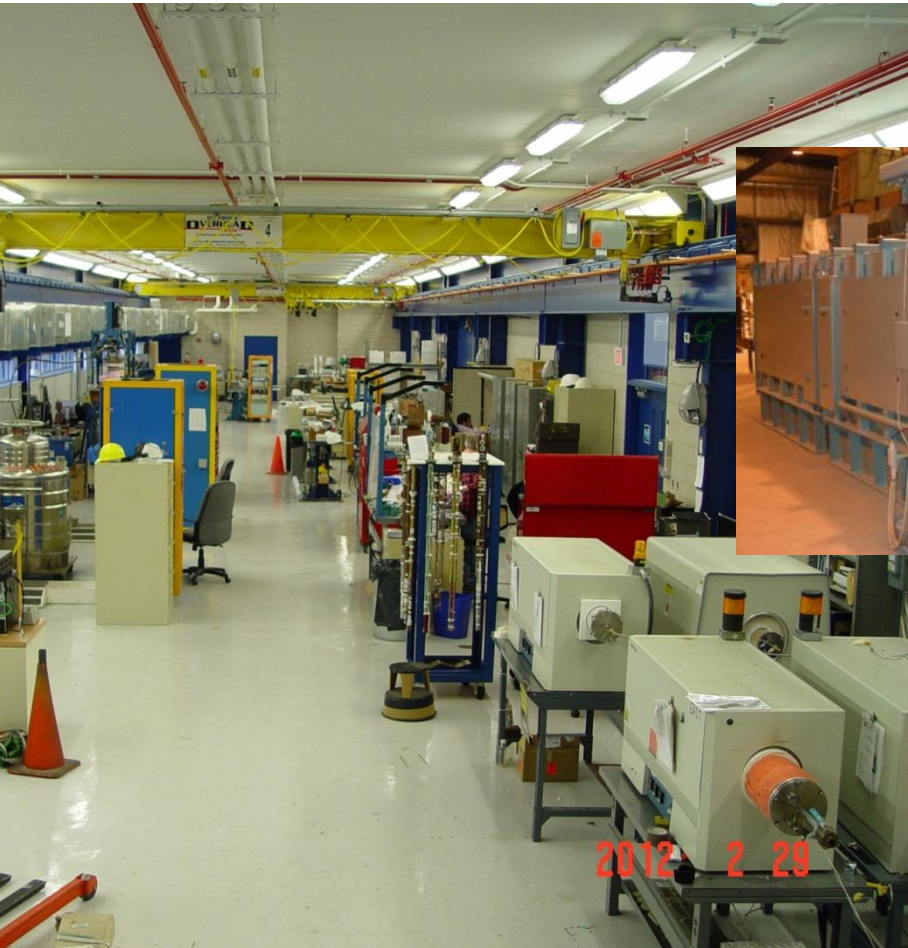


Simplification of cavity process:
– Annealing permits removal of other processing steps

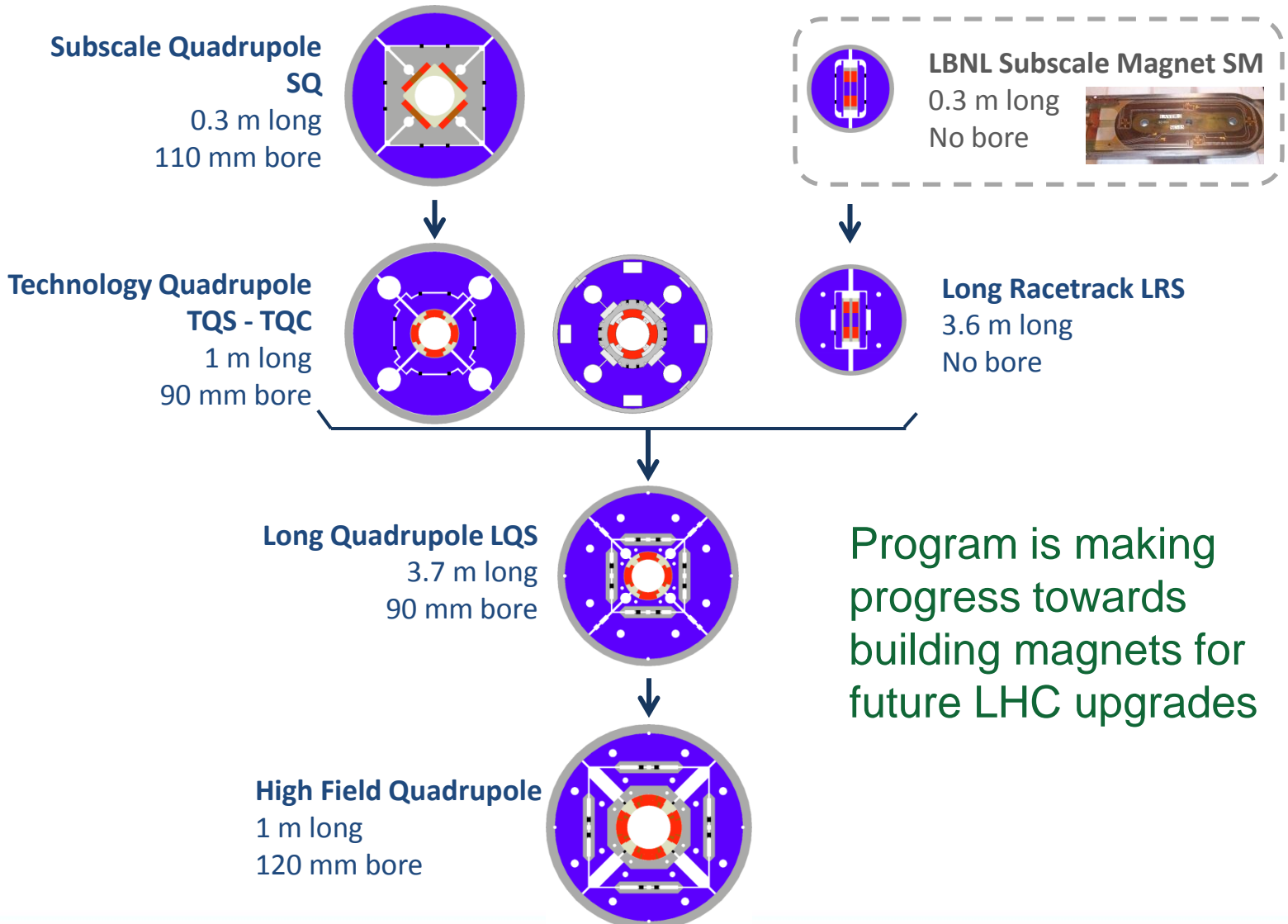


Highlights—Superconducting magnets

Lab facilities for cabling, magnet assembly and processing.



Highlights—Superconducting magnets



Accelerator Applications

- **Accelerator R&D develops basic science and technologies needed to design, build, and operate state-of-the-art accelerators**
 - accelerators are essential for making new discoveries in HEP
 - and also for serving a broader community
 - discovery science
 - industry
 - medicine
 - defense and security
 - energy and environment
- } ⇒ “Stewardship”
- **There is already a strong connection between current R&D thrusts and accelerator R&D stewardship program needs**



Connecting Accelerator R&D to Science and to End-User Needs

Science Goal "Push"

Application "Pull"

Particle Beam Quality	Photon Beam Quality	Beam Intensity	Compact or High Energy	DOE R&D Program Thrust	Industry	Medicine	Energy and Environment	Defense and Security	Discovery Science
●	●	●	●	Superconducting RF	●		●	●	●
●	●	●	●	Accelerator, Beam, Computation		●	●	●	●
●	●	●	●	Particle Sources	●		●	●	●
		●	●	RF Sources	●		●	●	●
●	●	●	●	Beam Inst. & Controls		●	●	●	●
●	●		●	NC High-gradient Accel. Structures	●	●		●	●
			●	New Accelerator Concepts		●		●	●
●	●	●	●	Superconducting Magnets	●	●			●



The Accelerator R&D Stewardship Program

- The mission of the HEP long-term accelerator R&D stewardship program is to support fundamental accelerator science and technology development of relevance to many fields and to disseminate accelerator knowledge and training to the broad community of accelerator users and providers.
- **Strategies:**
 - **Improve access to national laboratory accelerator facilities** and resources for industrial and for other U.S. government agency users and developers of accelerators and related technology;
 - Work with accelerator user communities and industrial accelerator providers to **develop innovative solutions to critical problems**, to the mutual benefit of our customers and the DOE discovery science community;
 - Serve as a catalyst to **broaden and strengthen the community of accelerator users and providers**
- **Strategic plan sent to Congress in October 2012**
- **Incorporated into FY2014 Budget Request as new subprogram in HEP**

Recent Activities

- **Workshops organized to assess needs in identified target areas**
 - **Ion Beam Therapy Workshop** (co-sponsored by NIH/NCI)
 - January 9-11, 2013 in Bethesda, MD
 - **Laser Technology for Accelerators Workshop**
 - January 23-25, 2013 in Napa, CA
 - organized by LBNL
- **Both meetings were small and tightly focused**
 - attendance by invitation only
 - limited number of industrial “observers” accommodated
- **FY2014 Request identified a modest “start-up” program that redirects or relabels existing efforts that have broader impacts beyond HEP**
- **HEP Program managers generating proposals for new stewardship programs based on 2013 workshop outcomes**
 - These would be vetted with SC partners and then (if successful) put into FY2015 Request

Summary

- **Accelerator R&D spans across multiple program offices within the Department of Energy**
- **HEP Accelerator R&D program comprises a broad portfolio, is forward looking, and supports research areas recommended by the P5 HEPAP Subpanel**
- **World-leading facilities and research are supported at the national labs, universities, and other institutions.**
- **The Accelerator Stewardship program being considered is aimed at accelerator applications beyond high energy physics.**



Backup



Distribution by Institution

HEP supported institutions in accelerator R&D:

- Argonne National Lab
- Brookhaven National Lab
- Fermi Nat'l Accel Lab
- Lawrence Berkeley Lab
- Lawrence Livermore Lab
- Oak Ridge Nat'l Lab
- Princeton Plasma Phys Lab
- SLAC Nat'l Accel Lab
- TJ Nat'l Accel Facility
- 40 University grants
- ~50 SBIR/STTR grants

