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Accelerator Division Cryogenic Facilities and Operations

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Mini-Review of Fermilab Accelerator Test Facilities

17 March 2015

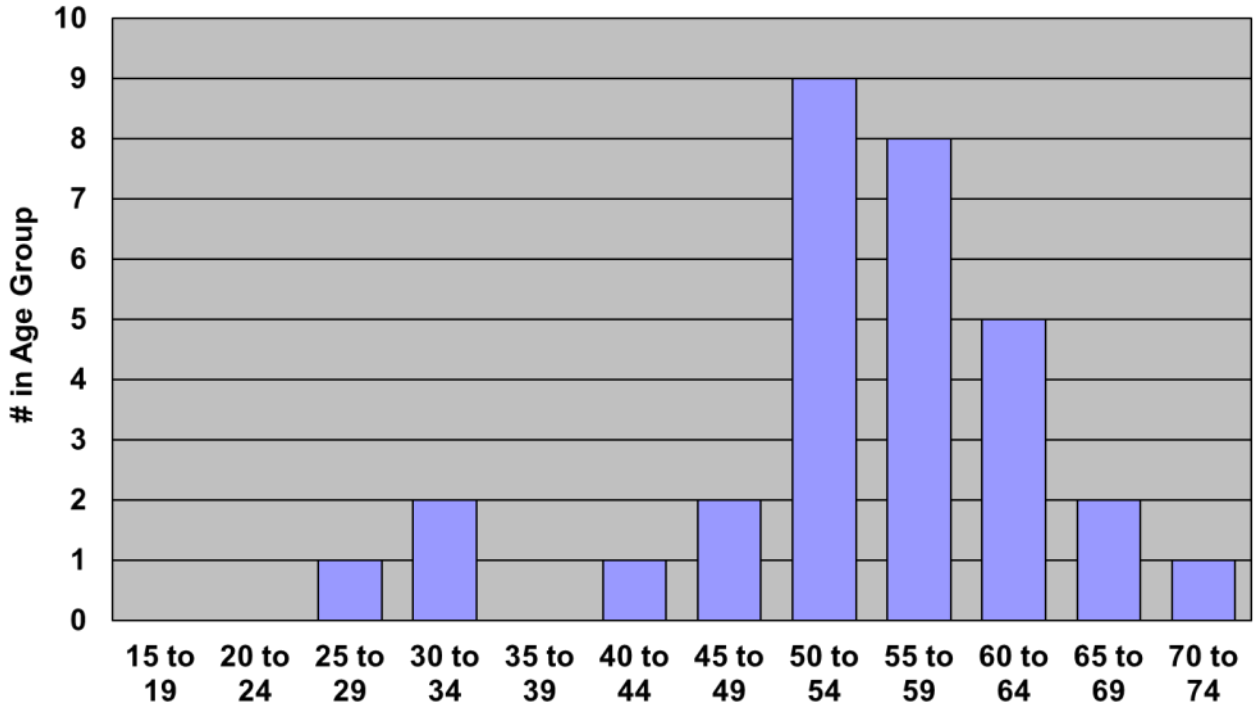
Cryogenic Test Facility Scope

- Operations/Maintenance
  - Accelerator Test Facilities

    (11 refrigerators/ 19 compressors)
    - Horizontal SRF dressed cavity testing (MDB)
    - ASTA (NML)
    - Cryomodule Test Facility/PXIE (CMTF)
    - MuCool Test Area (MTA)
    - Solenoid Test Facility (CHL)
  - Gaseous helium distribution
    - Order, receive and distribute
    - Collect and purify recovered helium
    - Maintain certification of laboratory tube trailers

Department Labor

- Staffing Level
  - 31 in 2015
  - 56 in 2004
  - 77 peak



- Age Distribution
  - Original Tevatron hires are retiring
  - Working hard to hire new young engineers to ensure long-term continuity in cryogenic engineering

AD/Cryogenics

Currently supporting five operational helium cryogenic test facilities

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New Muon Lab (NML)

Use

Advanced Superconducting Test Accelerator - ASTA

Load

One ILC cryomodule

Two capture cavities

Cryogenic system

Two Tevatron satellite refrigerators

Two Tevatron screw compressors

Helium vacuum pump

Cryomodule Test Facility

Use - Cryomodule Test Stand - CMTS

Use - Project X Injector Experiment – PXIE

Load - LCLS-II CM testing

Load - Half wave resonator CM

Cryogenic systems

Superfluid cryogenic plant, 500 W at 2K

CTI 4000, 1,200 W at 4.5K

Helium vacuum pump

Meson Detector Building (MDB)

Use

Horizontal Test Stand – HTS

used by ILC, LCLS-II

Spoke Test Cryostat – STC used by PIP-II

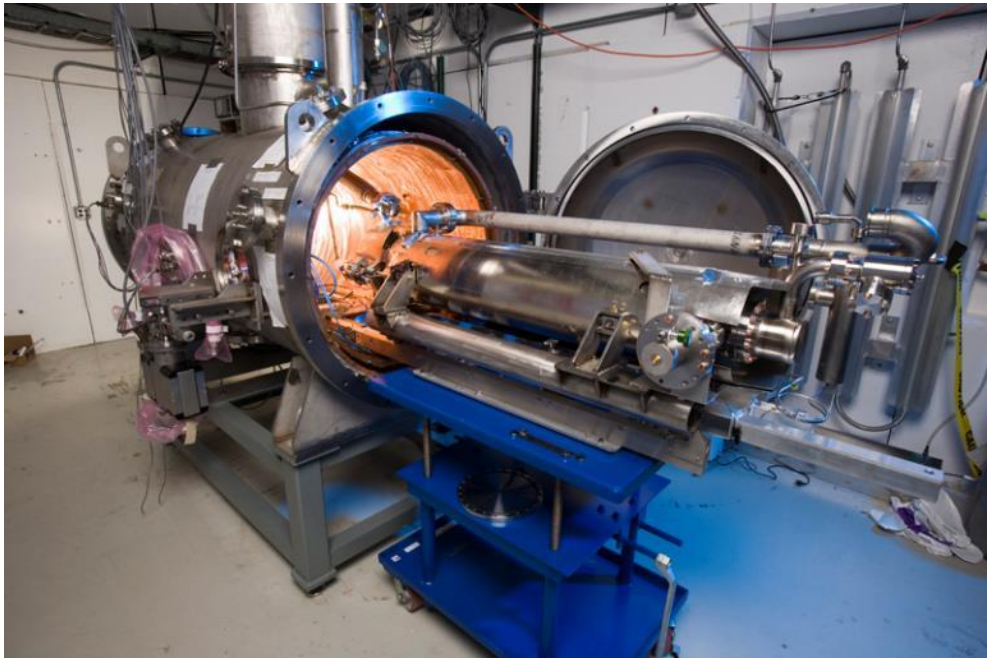
HTS-2 (future) used by PIP-II

Cryogenic system

Four Tevatron satellite refrigerators

Four Tevatron screw compressors

Helium vacuum pump



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Central Helium Liquefier

Use - Solenoid Test Facility

Use - PIP-II (future)

Use – IB-1 supplement (possible)

Load – 27 Mu2e TS coil modules

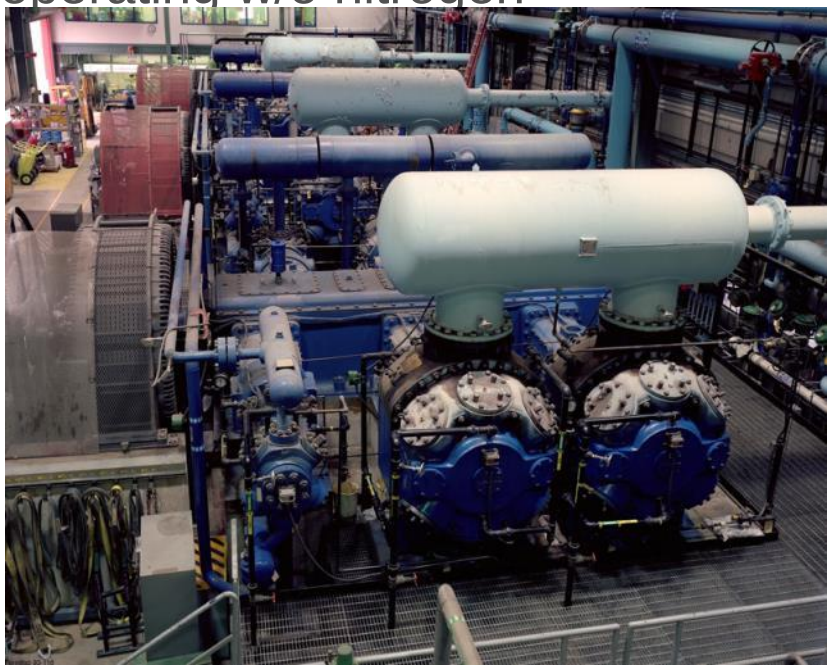
Load – 1 MW pulsed SRF linac

Load – SRF VTS and magnet testing

Cryogenic system

6,000 l/hr Tevatron liquefier

600 l/hr operating w/o nitrogen



CHL Challenges

- The Tevatron and CHL shut down at the end of FY11
- In anticipation, CHL upgrade and maintenance was minimized
- We no longer have operational personnel, all future operation will be without LN_2 precooling (600 l/hr) or require significant automation.

- Established solenoid testing at CHL for a few 1 month tests of MICE coils
- Now Mu2e Transport Solenoid, PIP-II, and IB-1 have plans for continuous CHL operation.

- For longer term operation w/o nitrogen precooling, upgrades and maintenance will be required

  Compressor overhaul, turbine overhaul, controls replacement

  A study of upgrade requirements and cost estimates would need to be done based on the users functional requirements. The study is currently engineering resource limited.

Recent CHL Compressor Piston Failure

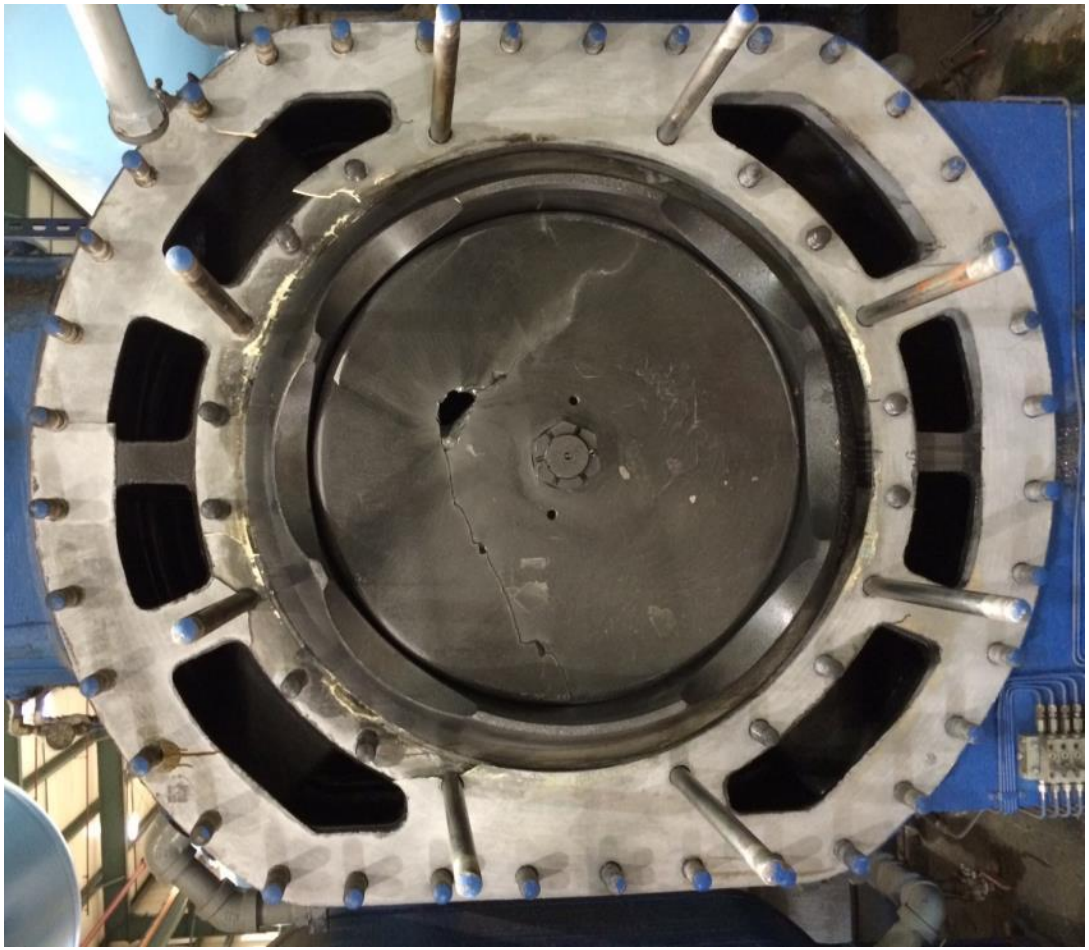
CHL compressor C

Worthington – six cylinders on a common crank shaft with a 4,000 HP motor

Originally used in an air separation plant

34” dual acting piston

Cast aluminum



Muon Test Area

Use

Muon accelerator R&D

Detector R&D

Load

Superconducting solenoid magnet

Cryogenic system

One Tevatron satellite refrigerators

Two screw compressors

Operations and Maintenance Labor

- Operations
  - On demand only, no permanent operational staff
  - Test Area Cryogenic Coordinator
  - Weekly On-Call Engineer

- Maintenance
  - Rotating Equipment (expanders, compressors, vacuum pumps)
  - Cryogenic Components and Controls

- Facilities and Support

AD/Cryogenic Test Facility Labor [FTE] by Fiscal Year

Test Facilities	FY14	FY15	FY16	FY17
OPERATIONS	**10.47**	**10.63**	**16.48**	**16.48**
Cryogenics	10.44	7.54	8.92	8.92
20.00.02.06.07 CRYOGENICS, ROTATING EQUIPMENT SERVICES	**9.20**	**6.65**	**6.43**	**6.43**
20.00.02.06.08 CRYOGENICS, CRYO CONSTRUCTION SERVICES	**1.21**	**0.85**	**2.45**	**2.45**
20.00.02.06.09 CRYOGENICS, HELIUM DISTRIBUTION SERVICES	**0.02**	**0.04**	**0.04**	**0.04**
Technical Facilities Operations / Improvements	0.03	3.09	7.56	7.56
20.00.01.79 MDB FACILITY OPERATIONS SWF	**0.00**	**1.24**	**3.46**	**2.54**
20.00.01.82 HBESL OPERATIONS AND MAINTENANCE	**0.03**	**0.00**	**0.00**	**0.00**
20.00.01.84 NML FACILITY OPERATIONS SWF	**0.00**	**1.04**	**1.69**	**2.61**
20.00.01.85 CMTF FACILITY OPERATIONS SWF	**0.00**	**0.82**	**2.41**	**2.41**
Grand Totals	**10.47**	**10.63**	**16.48**	**16.48**

- Increases in FY16 and FY17
  - CMTF operation
  - CHL upgrade (FY16 to meet Mu2e testing requirements)
  - MDB controls replacement (move to FY17)
  - NML controls replacement (move to FY18)

AD/Cryogenic Test Facility M&S by Fiscal Year

Test Facilities	FY14	FY15	FY16	FY17
20 ACCELERATOR DIVISION				
Cryogenics				
20.06.01.02.01 NITROGEN, TEST FACILITY OPERATIONS	$ 54,000	$ 58,000	$ 60,000	$ 62,000
20.06.01.03 CENTRAL HELIUM LIQUEFIER FACILITY OPERATIONS	$ 46,000	$ 22,000	$ 23,000	$ 23,000
20.06.01.04 CRYOGENIC SYSTEMS GENERAL OPERATIONS	$ 164,000	$ 173,000	$ 180,000	$ 186,000
20.06.01.05 ROTATING EQUIPMENT SERVICES	$ 123,000	$ 116,000	$ 118,000	$ 123,000
20.06.01.06 CRYOGENIC CONSTRUCTION SERVICES	$ 86,000	$ 72,000	$ 73,000	$ 76,000
20.06.01.07 HELIUM DISTRIBUTION SERVICES	$ 130,000	$ 65,000	$ 70,000	$ 75,000
Grand Total	**$ 603,000**	**$ 506,000**	**$ 524,000**	**$ 545,000**

- Costs are direct, unloaded, numbers
- Operating costs, upgrades are not shown (CHL, MDB, NML)
- Currently only CHL LN_2 costs are covered in 20.06.01.02.01
  - Other facilities are in their respective overall operating codes or covered by a project
- Helium distribution covers tube trailer re-certification
  - Two per year, four in FY14

Test Facility Cryogen Costs [k$]

System	FY14		FY15		FY16		FY17	
	Nitrogen	Helium	Nitrogen	Helium	Nitrogen	Helium	Nitrogen	Helium
CHL	$56	$119	$57	$164	$59	$127	$61	$527
CMTF	$11	$68	$5	$28	$29	$174	$30	$180
MDB	$115	$58	$118	$60	$121	$62	$126	$64
MTA	$39	$30	$40	$31	$41	$32	$42	$33
NML	$139	$45	$78	$26	$80	$26	$166	$55
Total	**$360**	**$320**	**$298**	**$309**	**$330**	**$421**	**$425**	**$859**

- CHL helium increase in FY17 represents Mu2e coil testing
- CMTF helium increase in FY16 represents LCLS-II CM testing
- MAP funding for MTA ceases operation midway through FY16
  - Cost shown assumes continued operation (see Palmer talk)
- NML operates for 6 months in FY15 and FY16