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# Technical Division

Bob Kephart

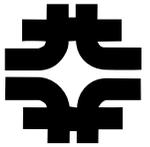
Fermilab

March 16, 2004

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# Mission Statement

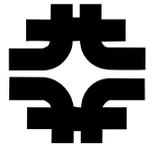
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- The Technical Division is responsible for the development, design, fabrication or procurement, and testing of accelerator and detector components.
- The Technical Division provides labor, expertise, and facilities for a variety of activities related to this mission.

# Programs & Responsibilities

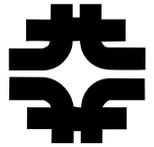
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- Provide support for FNAL accelerator complex
  - Build accelerator magnets and components
    - Repair conventional and SC magnets (1.1.1.9)
    - Design/build new magnets and devices (1.10.5.3)
      - Magnets for accelerator improvements (1.1.1)
      - Magnets for NUMI & Mini-Boone beam lines (1.6.1.1)
      - SC magnets & spools for C0 IR/BTeV (1.4.1.2)
  - Perform magnetic measurements
    - Operate Magnet Test Facility (MTF) (1.10.5.2)
    - Design/build magnetic measurement equipment (1.10.5.2.2)
    - Measure conventional and SC magnets (1.1.1.12 and 1.1.1.13)
    - Maintain database of magnetic measurements (1.10.5.2.5)

# Programs & Responsibilities

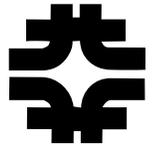
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- Work with AD on long range technical issues
  - Help with TeV RF problems (1.1.1.5)
  - Measure TeV dipole magnets to understand persistent current phenomenon (tune drifts, 150 GeV lifetime & losses) (1.1.2.2)
  - Recycler vacuum analysis (1.1.1.4)
  - Build/test new instrumentation (1.1.2.3.3)
  - Tasks for Accelerator Division evolve with time.
    - Issues are resolved or become irrelevant
    - Operational experience often leads to new tasks being added.
    - We manage & set priorities in the bi-weekly TD/AD meeting

# Programs & Responsibilities

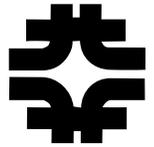
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- Accelerator R&D activities:
  - SC magnets for future accelerators:
    - SC Materials research (1.7.1.3)
    - High-field magnet development (1.7.1.4)
  - Linear Collider:
    - NLC RF structures, girders, permanent magnet quads (1.7.4)
  - Superconducting RF (1.7.2.1)
  - Proton Driver R&D (1.7.7)

# Programs & Responsibilities

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- Perform work for projects funded from outside the FNAL TD base budget:
  - Compact Muon Solenoid (CMS) Muon Chambers
    - Fabrication completed FY03 (1.3.2.1)
    - Maintenance & Operation (1.3.2.4)
  - US LHC Accelerator Proj. (Program Office) (1.3.1.1.1)
    - Multi-lab collaboration (FNAL, BNL, LBNL, KEK)
    - US LHC:FNAL (IR Quad fabrication) (1.3.1.1.2)
  - US LHC Accel. Research Program
    - e.g. 2<sup>nd</sup> generation Nb<sub>3</sub>Sn quads for LHC (1.3.4)
  - Pierre Auger (Project Office & eng. / design) (1.9.3)

# Programs & Responsibilities

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- Provide Lab-wide services
  - Machine Shop Department (1.10.9)
    - Machinists & welders → chargeback system
  - Materials Development & Test Lab (MDTL)
    - (1.13.1.2.4 + effort reported to specific projects)
    - Provide materials expertise & test capabilities
  - Material Control Department
    - (1.13.1.2.4 + effort reported to specific projects)
    - Provide specialized procurement capabilities & vendor liaison
    - Make/buy advice for FNAL machine shop work
    - Inspection & QC capabilities
    - Inventory control of magnets and special materials

# Technical Division Organization

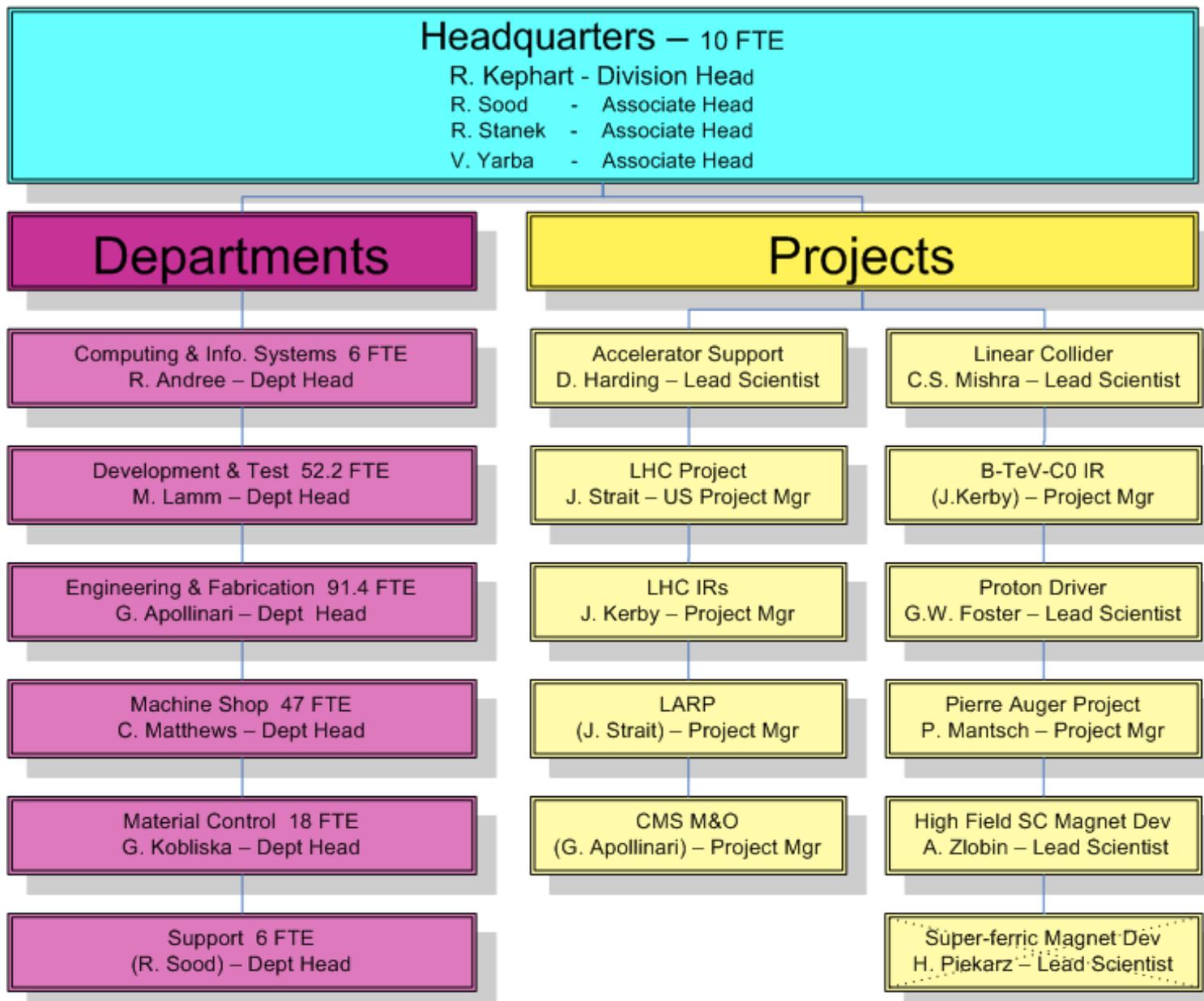
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- Matrix management
  - Labor and physical resources are managed by Department Heads.
    - Every person has a “home” in a department
    - Facilities, labs, infrastructure are maintained independent of active projects
  - Large projects or activities have a dedicated management team but obtain the bulk of their resources from the Departments.

# Technical Division

~230 employee, flat for last 4 yrs



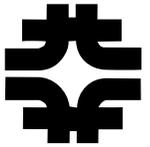
# Establishing the TD Budget

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- We use a bottoms up approach each fiscal year
- Directorate establishes the overall goals...
- TD Identifies the required staffing levels to meet goals
  - Assign present staff consistent with these goals
  - Identify labor shortfalls (or excess labor... I wish)
  - Identify the required SWF to support this labor force
  - Identify SWF income from projects funded outside TD base budget
  - Estimate the SWF burden on the TD base budget
- Then estimate the required M&S to support R&D, operations, and projects supported by the base budget
  - Compare this with our budget guidance
  - Iterate and adjust as required

# TD Labor Plan - FY04



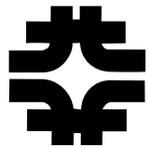
	CMS/M&O	LHC	LC	FNPL & SCRF	Proton Driver	HFM	LARP	C0 IR (int)	CKM	Auger	SNAP (int)	Run II New Magnets	Run II Magnet Repair	Run II Shutdown	Run II Other	Admin	MTF Ops + Infrastructure + CIS + Dept Mgmt	Division Mgmt	ES&H	Unassigned	Total	Total FTE on Outside Projects	C0 IR (add'l labor) assume 1/2 year
Scientist	0.00	1.25	1.40	0.70	0.30	3.30	0.55	0.70	0.00	2.10	0.55	0.25	0.00	0.00	3.75	0.00	6.05	2.00	0.10	0.00	23.00	1.80	0.00
Guest Scientist	0.00	0.00	0.30	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
Engineer	0.00	3.21	4.70	4.80	0.30	6.79	0.15	3.00	0.10	2.05	0.25	2.70	0.55	0.10	2.95	0.00	5.10	1.00	0.05	0.00	37.80	3.36	2.00
Guest Engineer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Engineering Phys	0.00	0.65	0.25	0.30	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	1.97	0.00	2.08	0.75	0.25	0.00	7.00	0.65	0.00
Comp Professional	0.00	0.20	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	9.30	0.00	0.00	0.00	10.20	0.20	0.00
Drafter	0.00	1.20	1.00	2.10	0.30	2.25	0.00	1.75	0.00	0.00	0.00	1.30	0.10	0.00	0.90	0.00	0.70	0.00	0.00	0.00	11.60	1.20	0.00
Staff Technician	0.15	2.40	2.23	1.15	0.00	1.40	0.10	0.00	0.05	0.10	0.00	1.71	0.40	0.75	0.48	2.70	3.89	0.00	0.49	0.00	18.00	2.65	0.00
Technician	0.22	9.85	2.44	1.10	0.00	6.38	0.00	0.00	0.00	0.35	0.00	12.35	1.95	5.85	0.87	0.00	10.68	0.00	0.96	0.00	53.00	10.07	0.00
Term Technician	0.00	3.60	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.01	0.00	0.01	0.00	5.00	3.60	0.00
Administrative	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	7.95	0.00	0.00	0.05	1.00	10.00	0.00	0.00
ES&H/QA/Budget	0.00	1.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.33	0.05	0.00	0.10	0.00	1.21	0.00	3.01	0.00	6.00	1.00	0.00
Contract	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.80	0.00
Leave of Absence	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Machinists	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.00	36.00	0.00	0.00
Welders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	10.00	0.00	0.00
<b>Total FTE</b>	<b>0.4</b>	<b>24.2</b>	<b>12.3</b>	10.75	<b>1.1</b>	<b>21.9</b>	<b>0.8</b>	<b>5.5</b>	<b>0.2</b>	<b>5.7</b>	<b>0.8</b>	<b>18.7</b>	<b>3.1</b>	<b>7.4</b>	<b>11.6</b>	<b>10.7</b>	<b>39.0</b>	<b>3.8</b>	<b>4.9</b>	<b>47.0</b>	<b>229.6</b>	<b>25.3</b>	<b>2.0</b>
<b>Total SWF</b>	<b>30</b>	<b>1923</b>	<b>1286</b>	<b>1109</b>	<b>115</b>	<b>2060</b>	<b>116</b>	<b>599</b>	<b>17</b>	<b>582</b>	<b>129</b>	<b>1825</b>	<b>251</b>	<b>605</b>	<b>1380</b>	<b>680</b>	<b>3741</b>	<b>643</b>	<b>468</b>	<b>0</b>	<b>17,761</b>	<b>2069</b>	<b>200</b>

Open Requisitions:  
MDTL Eng + RF Eng (conversion) 2.0  
TOTAL 231.6

\* Machine Shop personnel appear in the "Unassigned" column

# FTE Staffing for Major Projects

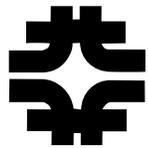
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FY04		Monthly						Weekly / Hourly					TOTAL
		Admin & Management	Computer Professionals	Engineering Physicists	Engineers	Scientists	Other Technical Support	Clerical & Secretarial	Drafters	Service Workers	Skilled Trades	Technicians	
<b>TOTAL</b>		<b>9.2</b>	<b>9.2</b>	<b>7.0</b>	<b>39.3</b>	<b>23.0</b>	<b>21.4</b>	<b>9.0</b>	<b>10.0</b>	<b>0.0</b>	<b>42.0</b>	<b>59.5</b>	<b>229.7</b>
Experimental		0.0	0.0	0.0	6.8	3.4	0.4	1.0	1.8	0.0	0.0	1.1	14.3
	CDF												0.0
	DO												0.0
	MINOS												0.0
	MiniBooNE												0.0
	CMS						0.2					0.2	0.4
	BTeV				4.5	0.7			1.8			0.5	7.5
	Future Kaons												0.0
	SDSS												0.0
	CDMS												0.0
	Auger				2.1	2.1	0.2	1.0				0.4	5.7
	Fix target exp												0.0
	New Initiatives				0.3	0.6							0.8
Theory													0.0
LHC Accelerator		1.0	0.2	0.7	3.4	1.8	3.1		0.6			13.5	24.2
Accelerator operation		0.0	0.5	2.0	6.4	4.0	3.8	0.0	2.3	0.0	0.0	21.5	40.6
	Run 2		0.5	2.0	6.4	4.0	3.8		2.3			21.5	40.6
	MiniBooNE												0.0
	NuMI												0.0
Accelerator R&D		0.0	0.2	1.3	16.6	5.7	6.1	0.0	4.7	0.0	0.0	10.8	45.3
	NLC			0.3	4.7	1.4	3.2					2.4	12.0
	TESLA												0.0
	FNPL			0.3	4.9	0.7	1.5		2.1			1.1	10.5
	Muon Facilities												0.0
	New Proton Source				0.3	0.3			0.3				0.9
	VLHC		0.2	0.7	6.8	3.3	1.4		2.3			7.3	21.9
	Generic R&D												0.0
Other Direct		8.22	8.3	3.08	6.1	8.15	8.08	8	0.7			42	12.66
Indirect													0.0

(Includes terms, no guests, no contracts, no open reqs)

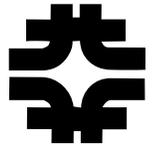
# FY04 Budget by Activity – Level3



<u>Laboratory WBS Structure Total</u>				
<u>Division/Section:</u>	<u>DS - TECHNICAL DIVISION</u>			
<u>Control Level:</u>	<u>(All)</u>	<u>FY04 M&amp;S</u>	<u>FY04 SWF</u>	<u>FY04 TOTAL</u>
1.1	<u>Accelerators</u>	640.0	5,154.7	5,794.7
1.1.1	Accelerator Maintenance and Operations	570.0	3,194.7	3,764.7
1.1.2	Accelerator Upgrades	70.0	1,960.0	2,030.0
1.3	<u>LHC</u>	376.0	2,038.8	2,414.8
1.4	<u>BTeV</u>	0.0	798.7	798.7
1.5	<u>Experimental Initiatives</u>	0.0	17.3	17.3
1.6	<u>Neutrino Experiments</u>	0.0	15.0	15.0
1.7	<u>Future Accel. &amp; Advanced Accel. R&amp;D</u>	2,625.0	4,569.3	7,194.3
1.7.1	Superconducting Magnets	980.0	2,059.9	3,039.9
1.7.2	Fermilab NICADD Photoinjector Laboratory	444.8	1,108.8	1,553.6
1.7.4	Linear Collider	1,015.0	1,285.8	2,300.8
1.7.7	New Proton Driver	185.2	114.8	300.0
1.9	<u>Experimental Particle Astrophysics</u>	3,089.0	711.7	3,800.7
1.9.3	Pierre Auger	3,089.0	582.3	3,671.3
1.9.5	JDEM	0.0	129.4	129.4
1.10	<u>Programmatic Support (Direct)</u>	445.0	1,250.0	1,695.0
1.10.3	Computer Networking	25.0	95.0	120.0
1.10.5	Technical Facilities (MTF)	375.0	1,120.0	1,495.0
1.10.9	Machine Shops	0.0	0.0	0.0
1.10.11	Travel for Conferences	45.0	35.0	80.0
1.12	<u>Other Support (Direct)</u>	345.0	988.2	1,333.2
1.12.1	Buildings/Facilities	345.0	520.0	865.0
1.12.2	ES&H	0.0	468.2	468.2
1.13	<u>Division Management and Support (Direct)</u>	1,217.0	2,216.9	3,433.9
1.13.1	Management/Supervision	952.0	1,465.9	2,417.9
1.13.1.1	Division Management and Operations	80.0	776.2	856.2
1.13.1.2	Department Management and Operations	872.0	689.7	1,561.7
1.13.2	General Purpose Equipment and Support	150.0	0.0	150.0
1.13.3	Computing Support/Information Systems	115.0	440.0	555.0
1.13.4	Training and Education	0.0	311.0	311.0
1.0	<b>TOTAL</b>	<b>8,737.0</b>	<b>17,760.6</b>	<b>26,497.6</b>

# Program Risks

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- Accelerator support is funded as a “level of effort”
  - Major accelerator equipment failures, unplanned shutdowns or performance problems → increased labor requests
- Staff is built up to support R&D for future projects. These projects may not be approved and funded
  - Examples: Linear Collider, Proton Driver, LARP
  - Type of staff required depends on the project
  - CMS, LHC projects are ending, BTeV ramping up, level of effort required for future projects varies
- Mitigation: TD budget guidance, staffing levels, and assignments are adjusted in consultation with the FNAL Directorate to minimize these risks
- Example: Recent move of personnel from TD R&D activities to Run II support

# Technical Risks

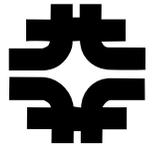
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- There are significant technical risks associated with R&D to develop new technologies
  - For example: warm/cold RF for LC or PD
  - Nb<sub>3</sub>Sn based SC magnets (conductor instabilities)
  - High performance quads for LHC, BTeV
- **Mitigation:**
  - An extensive set of internal and external reviews provide advice to the Directorate and Technical Division Head to manage these risks.
  - Program adjustments are made when necessary
- **Example:** Based upon SMPAC and steering committee recommendations the High Field Magnet lead scientist was asked to focus on sub-scale magnets and conductor stability issues vs. building more model magnets in FY04

# Partial List of Reviews

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## Department of Energy

Annual Program Review

Operations Review (this one)

## Program Advisory Committee

Accelerator R&D (annual)

## Accelerator Advisory Committee

Accelerator operations and R&D (semi-annual)

## Run II New Magnets Project

AD Design Review (as required, 31 in FY03)

Internal E&F Production Readiness Review (as required, 28 in FY03))

## US LHC Project

DOE Lehman Reviews (semiannual)

DOE Quarterly Status Meetings (semiannual – alternating)

US Project Office Design & Production Readiness Reviews

US LHC Quarterly Budget Reviews

DOE Annual Program Review

Joint Oversight Group

## LARP

DOE Lehman Review

LAPAC Advisory Committee (as required)

## Linear Collider Project

Accelerator Advisory Committee Review (annual)

DOE Annual Program Review

NLC Machine Advisory Committee Review (semiannual)

## Auger Project

Internal Design Requirements Reviews (as required)

Preliminary Design Review

Critical Design Review

Production Readiness Reviews (as required)

Change Control Action Reviews (semiannual)

DOE/NSF US Auger Project Review (annual)

International Auger Project Review (semiannual)

## High Field Magnet Program

DOE Program Review (periodic)

SMPAC Advisory Committee (annual)

HFM Internal Steering Committee (quarterly)

## CMS M& O Project

CMS Maintenance Evaluation Group Review (semiannual)

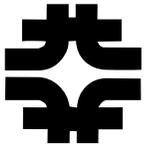
## BTeV Project

Director's reviews

Lehman DOE reviews

# Tracking Progress

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- TD projects work to a formal project schedule & plans that sets goals and milestones
- Large projects and R&D activities undergo periodic formal reviews
- Steering Committees provide advice to the Div Head
- Project Managers present status reports to the Technical Division Head on a regular basis.
- Technical Division Head meets with E&F and D&T Department Heads each week and with All TD Dept heads and project leaders ~ biweekly to discuss progress and problems.

# Infrastructure Risks

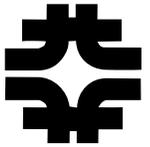
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- Aging workforce in some key technical areas
  - MTF cryogenic operators
    - Plan for getting a couple new people involved
  - Conventional magnet construction (project leader)
    - A junior engineer is being trained
  - Machinists
    - Graduated two new apprentice machinists (this last year)
- Facilities and equipment
  - Building maintenance issues:
    - Limited GPP money for refurbishment of existing bldgs, & replacement of poor village buildings is a problem
  - Electrical feeder maintenance
  - Modernize machine shop and its equipment
    - Long standing problem. This has been difficult to address given lab's budget and priorities

# Communications

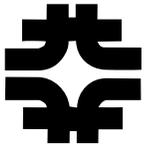
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- The Technical Division builds state of the art accelerator-related magnets and components
- Many efforts are collaborative
- Communication is crucial to success
- Effective project communication includes:
  - Workshops, video conferences, conferences, reviews, site visits and one on one meetings.
  - Face to face meetings: regular meetings with directorate and Accel. Div.
  - Travel: e.g. We collaborate with CERN, DESY, LBNL, BNL, KEK, ANL, Cornell, Wisc. etc

# Communication

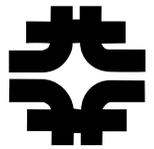
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- Communication with employees is also crucial:
  - Department/group meetings
  - Toolbox talks
  - PC kiosks assure that every employee has access to electronic files, safety documents, e-mail...
    - Electronic suggestion box is being implemented
  - Management by Walking Around and Listening (MBWAL)

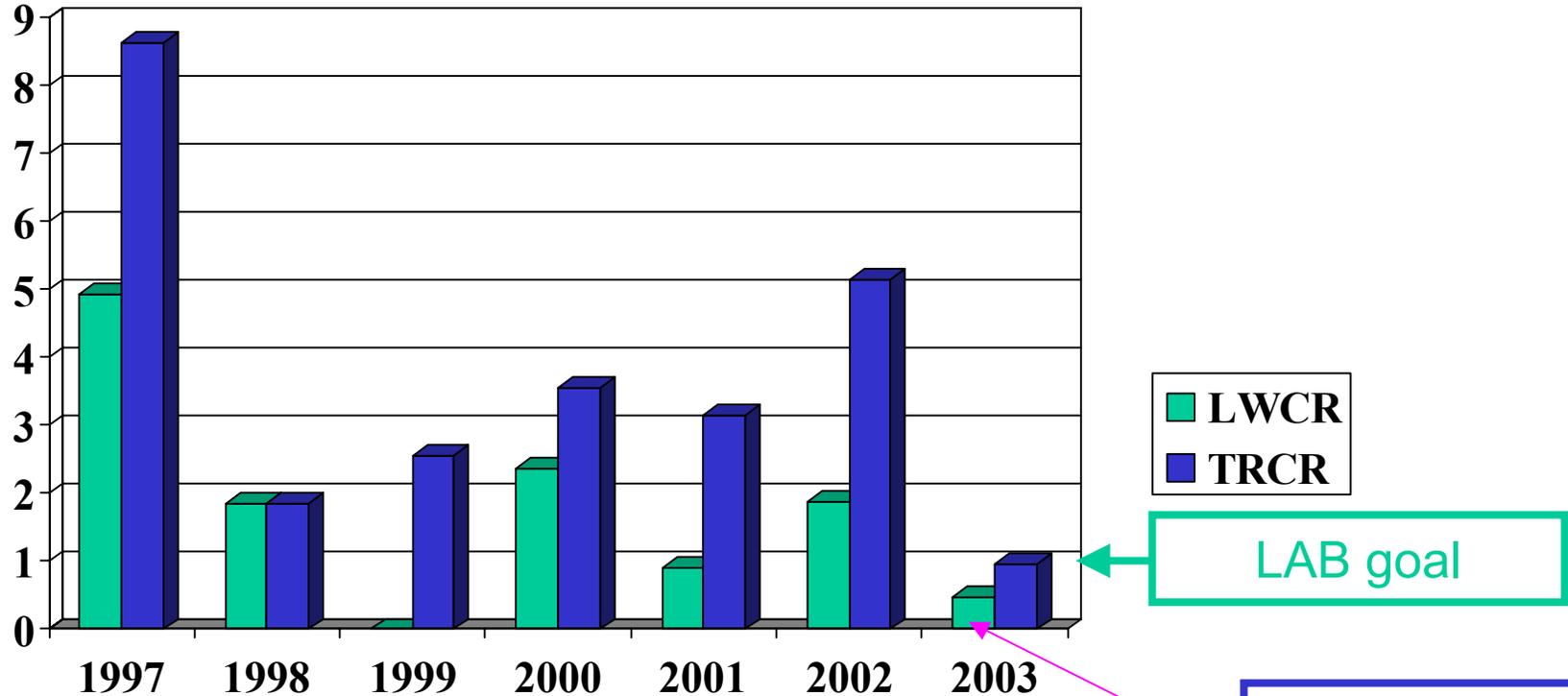
# Environment, Safety, and Health

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- TD is a Division with a significant “industrial” component (machining, welding, heavy rigging and assembly)
- Integrated Safety Management Approach
- ES&H is a line management responsibility (breakout)
  - Extensive formal review, training, and approval processes
- ..but strive to involve every TD employee
  - Grass Roots Safety Committees
  - Rank and file employees
  - Direct access and feedback to Div & Dept heads
- Every injury is investigated in detail. (System ~like PPD)
- Excellent safety record & it is getting better

# TD Injury Rates 1997 – 2003



At the time this slide is being prepared TD has worked 310 days without a Lost Workday Injury

TD recently selected as the most improved division

# Self Assessment Process

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- The Technical Division has a formal, well-established Self Assessment Program, that is run through the Division Headquarters Office.
- Division Head Quarterly Assessment (cycle through Depts) covers the following items:
  - Outstanding Assessment findings
  - Injury report & trend analysis
  - Status of ES&H training or concerns
  - Programmatic issues; projects, plans, staffing...
  - Budget status
  - Quality Assurance Program concerns
  - Tour of facilities, discussion of infrastructure issues.

# Quality Assurance

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- Part of TD's mission involves industrial style production of specialized components
  - TD has maintained a formal QA program for over 25 yrs
- Methodology
  - The basis of our quality program is to incorporate sound scientific, engineering, and business practices into everything we do
  - TD policy TD-2010: “The foundation for assuring quality is based on peer review”

# Quality Assurance

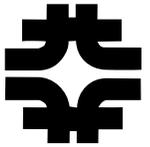
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- **Documentation**
  - **Travelers** define the intricate process of fabricating and inspecting components that the division builds
  - **Discrepancy Reports** (TD policy TD-2040) document and examine issues found during the fabrication process:
    - Root cause analysis to determine the source of the problem
    - Corrective action(s) to correct problem & prevent reoccurrences.
  - Done electronically, to keep everyone informed
- **Integrated knowledge management:**
  - Maintain a Division-wide system to keep track of all work and the history of magnets (3000+)
  - Databases archive fabrication records for every device produced or repaired. For magnets this includes magnetic measurements

# Conclusions

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- The Technical Division provides a unique blend of industrial expertise and R&D capabilities to the lab
- The changing nature of project and R&D efforts require that we spend considerable effort each year to evaluate the necessary labor force and M&S
- We effort report and track progress on all TD activities
- We work closely with Projects, other Divisions, and the Directorate to establish priorities and distribute the available TD resources in the most effective way
- Portions of TD's infrastructure are old, but we are working to address these problems with the limited funds available.
- TD has effective ES&H, QC, and self-assessment processes