# Strategic and Organizational

<u>FINDINGS</u>

- FRA Strategy of Energy Frontier, Neutrinos, and Particle Astrophysics well suited to the field and strengths of Lab
- Lab Director has provided and articulated a clear vision for the future
- Handling of the failure at CERN of the IR triplet magnet was well done at all levels
- Proposal commitments: significant progress being made
- Centers established to concentrate on strategic issues (ILC, APC, CMSC, PAC) - align well with scientific strategy of FNAL
- Evidence for increased attention to and growing ANL/FNAL cooperation
- There is angst among users about relationship between FNAL and the community, and long term health of the field in the US

# Issues/Recommendations

- Significant work is needed on strengthening the relationship with HEP community in this time of rapid change
- Steering Group on future accelerator program is an important task force;  must engage community in a pro-active way

# Run-II Accelerators

- The **performance** of the Tevatron in FY07 so far has been excellent.
  - **Peak, Weekly integrated luminosity**, **1-hour antiproton stacking** all increased
  - **Integrated luminosity for FY07** so far (**800 pb$^{-1}$**) larger than the total for FY06 with a few months to go.
- **Improvements** resulting from: **Reliability**, more **Pbars**, more **Protons**, better **luminosity lifetime** (increased helices separation, better understanding and reduction of beam-beam effects)
- The laboratory has completed a very organized effort towards realistic **luminosity projections** on the basis of present performance and possible improvements.
  - **(2$^{nd}$ order chromaticity correction** a series of **small improvements**, **optimization of peak vs. average** luminosity delivered to experiments)
- Bottom line: a **total 5.5-6.5 fb$^{-1}$ for Run-II is possible** and realistic. **8 fb$^{-1}$ (design goal) rather unlikely** (stacking rates in excess of 30 $10^{10}$ protons/h.)
- The run-II plan is on very solid ground
- **Recommendation:** **Keep focus on delivering expected performance** in the 2.5 remaining years in the light of the multiple program and initiatives planned for the Lab that involve operations personnel

# Run-II detectors

- **The efficiency for recording data is high (~85%) for both D0 and CDF.**
- **Timely progress in commissioning of systems to cope with higher rates**
  - **(Modification of triggers** as a function of the average instantaneous luminosity; raise the total luminosity without raising the instantaneous luminosity)
- **CDF and D-Zero are accumulating high quality data.** At present the analysis is going well and there is **fast turnaround in producing results**. . The **publications** are presently a significant fraction of high-energy physics results worldwide.
- **The laboratory working with CDF and D-Zero management has studied the manpower that will be available in the next two to three years.** These estimates are documented in Memoranda of Understanding with collaborating institutions. The **manpower available** for operations, computing, and calibration tasks **seems to be just adequate**.
  - Silver lining: CDF have 30% more manpower in FY2007 than estimated in 2005 (combination of LHC delays and successful performance of Run-II)
- **Recommendations**
  - Continue the assessment and update of **manpower** need for operations and data analysis of the collaborations. Outline **contingency plan** and **priority goals** in case manpower and/or computing needs are not maintained at the projected level.
  - Start assessing **data analysis plan of the Collaborations beyond FY09**. CDF and D0 can still offer a strong potential for grad students and postdocs if institutions and FNAL and the funding agencies give enough support to sustain the analysis effort.

# Run II Physics Results

- It is widely expected that the exploration of the physics at the tera-scale will lead to breakthroughs in our understanding of fundamental physics. The Tevatron is offering a first glimpse into this new, exciting energy regime.
- The past year has been a spectacular one for CDF and D0, which has seen a strong increase in the number of publications and Ph.D. theses over previous years. Important results have been obtained, in particular, in the areas of :
- **Heavy-flavor physics:**
  - **discovery of $B_s$ oscillations and precise measurements of $\Delta m_s$ and $|V_{td}/V_{ts}|$, with significant impact on the global analysis of the unitarity triangle**
  - measurement of the CP-violating phase $\delta\phi_s$ in the $B_s$ system using $B_s \to J/\psi\phi$ decays
  - discovery of new heavy baryons $\Sigma_b^{\pm}$
  - interesting new upper bound on $B_s \to \mu^+\mu^-$
  - CP violation studies in $B_d \to h^+h^-$ competitive with B-factories, similar studies in $B_s \to h^+h^-$ are unique (2.5σ signal for direct CP violation in $B_s \to \pi K$)
- **Top-quark physics:**
  - **world-best measurement of the top-quark mass (to 1%), with significant improvements in the past year**
  - direct measurement of $|V_{tb}|$
  - evidence for single-top production (2.3σ)
  - studies of top-quark properties with unprecedented precision

# Run II Physics Results

- **Electro weak gauge-boson production:**
  - world-best measurement of the W-boson mass (to 0.05%) and width (to 3.5%)
  - studies of diboson production: WZ channel observed, evidence for ZZ found

  **Higgs searches:**
  - o due to significant improvements over the past year, the Tevatron gives important impact on upper bound on the Higgs mass ($m_H$<144 GeV), solidifying the evidence for a light Higgs

- **Searches for exotic phenomena:**
  - several analysis looking for signs of supersymmetry, extra dimensions, etc. explore the mass range up to 1 TeV, exceeding constraints obtained from LEP

- **The committee looks forward to seeing further improvements with more data.** We are impressed with the demonstration by CDF and D0 to systematically move toward the discovery of processes with smaller and smaller cross sections.
- **Despite impressive improvements, however, a discovery of the Standard Model Higgs boson at the Tevatron still appears a challenging task, which would require significant advances in analysis and background reduction besides steady improvements in luminosity.**

# LHC - Accelerator

- FNAL did excellent work in setting up the LHC@CERN infrastructure at FNAL.
  - Done on time and under budget. CERN is considering using the concept for a ‘remote’ CMS control room in the CERN Meyrin site. The center has great potential for providing **communication** and **training** for both **detector and accelerator personnel** collaborating with LHC.
  - The plan of **CMS** is full remote integration with detector operations, and possibly running CMS shifts from FNAL after an appropriately long initial phase of “read-only” operations. The present plan for remote presence of LHC **accelerator** commissioning does not include for now active access of the LHC control system.

# LHC - Accelerator

- FNAL has a **rather clear strategy for participation to the LHC accelerator commissioning**, which is based both on the **LARP** collaborative program and unilateral collaboration FNAL/CERN
  - The main areas of **LARP activities** are **accelerator physics** (experiments and simulation), long-term **magnet** design and production for the LHC IR upgrade, **instrumentation** and diagnostics, participation to **LHC hardware and beam commissioning.**
  - The **overall LARP strategy** of delivering systems and services to the LHC that are **relevant but not critical** on “day one” of commissioning or early operations is reasonable,
  - There has been clear progress in the last year in the **planning of FNAL accelerator personnel presence at CERN**, for the current and next year. FNAL personnel are already stationed at CERN for **IR and hardware commissioning** tasks. Nine people are slated to be at CERN in 2007 and first part of 2008 from LARP, and six are from FNAL.

# LHC - Accelerator

- **RECOMMENDATIONS**
- Continue planning carefully the **presence of accelerator personnel** for hardware and beam commissioning, with enough **flexibility** to match a possibly **evolving LHC overall schedule** to maximize the impact of the presence.
- Explore with CERN the possibility of **access to operations information for US collaborators** (i.e. access to elogs, commissioning plans) from the start even if it is CERN policy not to grant – understandably– full access to the LHC control system. Discuss and negotiate with CERN to make remote connectivity and operations with FNAL a priority.
- Focus on providing practical contributions to the **LHC operations software** and applications (LAFS) to make remote collaboration a reality.

# LHC - CMS

- CMS-FNAL is successfully completing **production** and **installation** of the major detector subsystems.
  - The present official **schedule** for the LHC, which calls for first collision at injection in November 2007 and at full energy in June 2008, is extremely **tight** for the detector. The overall LHC schedule will likely be reassessed on a time scale of June 2007.
- **CMS Commissioning** appears to be going well
- Status of detector subsystems with major FNAL role:
  - Data taken **with cosmic rays** data above ground, including Barrel and Muon Endcap.
  - **Silicon Strip Tracker** has been completed at Tracker Integration Facility
  - **Pixel detector** is being assembled at CERN. Now on 3rd ring of 8.
  - Commissioned tracker ready for installation July 16.
  - Following CMS request, FNAL is making a special effort to **provide help to meet the tight schedule**. About 10 FNAL physicists are at CERN. FNAL people are playing a major role (list of about 5 examples: Spalding, Tkaczyk, Moccia, etc.).

# LHC - CMS

- **Organization of data taking and analysis**: FNAL is playing significant role. Work on tracking, cosmics analysis, and tracker diagnostics.

- FNAL is Host of major CMS Computing Facilities:
  - Tier-1,
  - LHC Physics Center -Central Analysis Facility
  - Open Science Grid

- **CMS Center at Fermilab**:
  - Overall coordination/management role for US-CMS
  - Remote Operations Center
  - LHC Physics Center (200 visitor/students in 2006?)

- Upgrade proposal from US-CMS: request $145M starting 2010

# ILC@FNAL

- The International Linear Collider remains priority for the laboratory, as future possible Americas Region host site
- Committee recognises significant contribution over last year(s) to producing ILC RDR and value estimate
  - As a strong collaborative member of the GDE
- Recognise/endorse R&D plans for ILC Test Accelerator
  - Need to build core expertise at FNAL
- Understand FNAL still not a centre of excellence / expertise in this field yet
  - Will only become ‘competitive’ (comparable) with DESY/KEK by 2010 at the earliest
  - <u>Very important to begin to deliver results ASAP, if FNAL wishes to be recognised as an authority.</u>
  - <u>Progress is limited by funding availabilty.</u>

# ILC@FNAL

- Must aggressively build on existing momentum to successfully achieve a ‘e+e- linear collider’ culture at the lab
  - True for Accelerator / Detector R&D / Physics
  - Acknowledge role of director initiatives for this:
    - ILC task force, ILC physics team, ILC center / ILC outreach
  - Needs much more (international perceptions are important)
- Maintain strong and positive links with universities and other ILC centres (both accelerator and detector)
  - Both within the US and “The World”
  - Help build a collaboration of equal partnerships while forging a leadership role within the US (as the US premier HEP facility)
- The GDE is and will remain the primary international authority and driving force for the ILC, until such time as a site is selected (“money on the table”)
  - FNAL must work within this international context, if it wishes to host this international project

# Neutrinos

## NuMI

Findings:

Heard excellent performance of the NuMI beam and MINOS neutrino oscillation experiment in the past year

MINOS is on track to achieve the proposed precision in the measurement of $\sin2(\theta23)$ and $\Delta m23$

First results of a search for electron neutrino appearance expected in the next year

## MiniBooNe

Findings:

New result from MiniBooNe experiment rules out the LSND result ruled out at approximately 98% CL.

## NOvA

Findings:

Heard the status of the NOvA experiment.

An FY2007 project start is expected.

Fixed budget has forced reduction in the detector size and the sensitivity.

Recommendations:

Carefully monitor the progress of NOvA to be aware of eroding sensitivity.

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**Neutrino intensity**

Findings:

Plans presented for intensity upgrades: 400 kW -> 700 kW -> 1200 kW.

Recommendations:

Aggressively pursue cost-effective ways to increase the proton intensity for the neutrino program

Consider all costs (running, experiment beam) in cost-effectiveness

**Post NOvA**

Findings:

Potential post NOvA experiments presented.

Recommendations:

Continue to provide appropriate support of studies of neutrino oscillation experiments following NOvA and include a study of a new beam to a new large detector in the DUSEL laboratory in study

R&D needed on large Liquid Argon detector technology

**MINERVA and SciBoone**

Findings:

The committee heard good progress on SciBoone installation and MINERVA preparations.

# Center for Particle Astrophysics

<u>FINDINGS</u>

- Excellent, healthy program good portfolio of experimental and theoretical activities
- Center brought together the astrophysics activities, but physically separated the particle and astro-theorists; however, the new hire (Dan Hooper) will be a strong intellectual link
- Astrophysics is a significant activity (38 scientists, 58 engineers and $12.5M), consistent with science strategy, and growing at 10%/year
- Computational Cosmology Initiative builds upon strengths at FNAL (CD, Astro) and connections with Chicago
- At a crossroads: Loss of Rocky Kolb & Future experimental directions

# Recommendations

- Fill CfPA Director position with right individual soon

- Continue with planning for, and move toward, timely decisions for strategic experimental directions in several areas

# Particle Theory: Science and service

- Richness of the program is matched by few US groups
- Senior members are acknowledge experts
- Large impact in lattice QCD, pQCD & collider physics, physics BSM, neutrino & quark flavor physics
- Senior scientists serve on important committees: HEPAP, P5, APS, Aspen Center
- Organization of lecture series, workshops

# Particle Theory: Recruiting

- Theory group continues to attract first-rate postdocs and scientific associates
- Postdocs get excellent positions after leaving, many have become leaders
- Recent associate scientist hires (P. Skands, P. Fox) strengthen expertise in LHC-related phenomenology

# Particle Theory Recommendations

- As part of Fermilab's transition into LHC era, theory group should strengthen its role as a US center for particle phenomenology
- Need to refine their vision in the post-Tevatron era
- Maintenance of strong visitor program crucial to this effort
- Strengthen connections with LHC analysis center

# Computing

- Computing at FNAL is undergoing a major increase in both size and scope.
  - this is driven by LHC data requirements, also by the new roles that FNAL will be playing in the US particle physics community.
  - major areas include LHC, particle astro, lattice qcd, etc.
  - being addressed in “Strategy for Advanced Computing”.
- Major increases in:
  - scale (facilities, networking, data-handling; LHC)
  - globalization (FermiGrid, OpenScienceGrid; security; LHC)
  - special applications: lattice QCD, accelerator modeling, cosmology, LHC)
  - challenges in equipment, size, planning, new technologies (and power and cooling).

- FNAL seems to be responding well to these pressures. Work in OSG and Fermigrid, “Metropolitan Area Network” appears to be well considered. FNAL has clearly had a very major effect on CMS computing, and is providing strong support to that program. See notes on “Data Handling”.

# Computing Recommendations

- Fermilab needs to consider, in the post-Tevatron era, what kind of computer support it needs to provide. The role of the Computing Division should be a major part of its role in the HEP community.
  - educational and tutorials or workshops, like those for CMS, might be a important component in other areas as well (astrophysics, accelerators etc.). Computing Division should provide support for such outreach work.
  - There is not a simple across-the-board answer as to what the role of FNAL or the Computing Division should be. This should be considered explicitly by the Task Force; it is an important part of FNAL's role in HEP.

# Support of University Community

FINDINGS

- Users' Organization vibrant and active
  - Diverse UEC (encourage this)
  - Meeting of all user organization chairs (Kopp)
  - Congressional office visits for 200 users
  - Users respect, value Fermilab
- Users' Organization is at crossroads
  - Growing diversity: particle astro, CMS,…
  - URA → FRA: IL universities vs. other universities
  - Source of uncertainty, opportunities

RECOMMENDATIONS

- Fill role as national lab
  - Solicit user opinions
  - Steering Group membership is a positive example
- Take advantage of future opportunities
  - FRA's HEP Community initiative (not just local universities)
  - Accelerator Center: support for university faculty, graduate students
- Users would appreciate better housing, office space