The Fermilab Accelerator Science Program: Overview

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Fermilab
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Outline

- FY2009
- FY2010 Plan
- Recent Progress/Issues/Discussion

Backup materials:
- General info on FNAL Accel Sci program (Shiltsev)
- Muon Accelerator R&D program (Geer)
- AARD at A0 Photoninjector and at NML (Church)
Fermilab ‘s Accelerator Science Program Components

• KA 15 01 02 FUTURE PHYSICS - ACCELERATOR SCIENCE
  – 1.7.2 FNPL - A0 Photo-injector
  – 1.7.3 Muon Storage Ring
  – 1.7.6 Advanced Accelerator Concepts - Computing
  – 1.7.9 Accelerator Physics Center General R&D
  – 1.10.12 US Particle Accelerator School
**FY2009  KA 15 01 02  Budget**

- 91.7% thru FY2009

<table>
<thead>
<tr>
<th>Project Description</th>
<th>FY09 Budget</th>
<th>FY09 YTD Oblig</th>
<th>Budget Balance</th>
<th>% Obligated</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>KA 15 01 02 FUTURE PHYSICS - ACCELERATOR SCIENCE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1.10.12 U.S. Particle School Office</td>
<td>11,833</td>
<td>10,617</td>
<td>1,216</td>
<td>89.7%</td>
</tr>
<tr>
<td>1.7.2 Advanced Accelerator Program</td>
<td>872</td>
<td>829</td>
<td>42</td>
<td>95.1%</td>
</tr>
<tr>
<td>1.7.3 Muon Storage Ring</td>
<td>2,749</td>
<td>2,708</td>
<td>40</td>
<td>98.5%</td>
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<tr>
<td>1.7.6 Advanced Accelerator Concepts - Computing</td>
<td>6,214</td>
<td>5,801</td>
<td>413</td>
<td>93.4%</td>
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<tr>
<td>1.7.9 Accelerator Physics Center General R&amp;D</td>
<td>855</td>
<td>720</td>
<td>135</td>
<td>84.2%</td>
</tr>
<tr>
<td></td>
<td>1,142</td>
<td>557</td>
<td>585</td>
<td>48.8%</td>
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</table>
**FY2010 KA 15 01 02 : IFP**

<table>
<thead>
<tr>
<th>KA 15 01 02 FUTURE PHYSICS - ACCELERATOR SCIENCE</th>
<th>SWF</th>
<th>M&amp;S</th>
<th>OH</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.10.12 U.S. Particle School Office</td>
<td>435</td>
<td>56</td>
<td>373</td>
<td>864</td>
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<tr>
<td>1.7.2 Advanced Accelerator Program</td>
<td>1,184</td>
<td>386</td>
<td>1,043</td>
<td>2,614</td>
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<tr>
<td>1.7.3 Muon Storage Ring</td>
<td>3,097</td>
<td>910</td>
<td>2,746</td>
<td>6,753</td>
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<tr>
<td>1.7.6 Advanced Accelerator Concepts - Computing</td>
<td>472</td>
<td>6</td>
<td>400</td>
<td>878</td>
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<tr>
<td>1.7.9 Accel Physics Center General R&amp;D</td>
<td>444</td>
<td>184</td>
<td>395</td>
<td>1,023</td>
</tr>
</tbody>
</table>

- Total funds available 11,635k$ = 10,860k$ of funding (IFP) + 775k$ carryover to FY10

Variance to budget **(526.5)k$**
## Budget: 2009 vs 2010

<table>
<thead>
<tr>
<th></th>
<th>FY09 FUNDING</th>
<th>FY10 BUDGET</th>
<th>CHANGE 09→10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7.2.1 FNPL Operations</td>
<td>1,834.9</td>
<td>2,050.9</td>
<td>215.9</td>
</tr>
<tr>
<td>1.7.2.2 FNPL Upgrades</td>
<td>348.9</td>
<td>259.1</td>
<td>(89.8)</td>
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<tr>
<td>1.7.2.5 Other Advanced Accelerator R&amp;D</td>
<td>480.4</td>
<td>305.0</td>
<td>(175.4)</td>
</tr>
<tr>
<td>1.7.3 Muon Storage Ring</td>
<td>6,064.8</td>
<td>6,779.5</td>
<td>714.7</td>
</tr>
<tr>
<td>1.7.6 Advanced Accel Concepts - Computing</td>
<td>829.6</td>
<td>878.7</td>
<td>49.1</td>
</tr>
<tr>
<td>1.7.9 Accelerator Physics Center General R&amp;D</td>
<td>1,100.4</td>
<td>1,023.5</td>
<td>(76.8)</td>
</tr>
<tr>
<td>1.10.12 U.S. Particle School Office</td>
<td>844.9</td>
<td>864.9</td>
<td>20.0</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>11,503.8</strong></td>
<td><strong>12,161.5</strong></td>
<td><strong>657.6</strong></td>
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</table>
Budget Analysis

- FY10 budget (upload, PBR) is 540k$ short of the 12,702k$ requested in Dec’08 DOE Review as part of FNAL proposal
  - incl. 240k$ shortage for Muon R&D

<table>
<thead>
<tr>
<th>Proposal Request Amounts</th>
<th>FY09 Total</th>
<th>FY10 Total</th>
<th>FY11 Total</th>
<th>FY12 Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fermilab Accelerator Science Program</td>
<td>9,876</td>
<td>12,702</td>
<td>14,620</td>
<td>TBD</td>
</tr>
<tr>
<td>Beam Sources and Instrumentation</td>
<td>2,782</td>
<td>3,948</td>
<td>4,885</td>
<td>TBD</td>
</tr>
<tr>
<td>Muon Collider and Neutrino Factory</td>
<td>5,697</td>
<td>7,015</td>
<td>7,622</td>
<td>8,087</td>
</tr>
<tr>
<td>Accelerator and Beam Physics</td>
<td>1,397</td>
<td>1,739</td>
<td>2,113</td>
<td>2,095</td>
</tr>
</tbody>
</table>

- Current budget plan is 527k$ short of IFP budget
  - So, the real difference might be 540+527=1,067k$
  - There is still chance for getting budget as in President’s Budget request (is there?)
Muon Budget Issues

- Muon Accelerator R&D plan presented at the Dec’08 DOE Review had 21M$ request for FY2010
  - With estimated FNAL share of 11M$ (~50%)

<table>
<thead>
<tr>
<th></th>
<th>FY08</th>
<th>FY09</th>
<th>FY10</th>
<th>FY11</th>
<th>FY12</th>
<th>FY13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effort (FTE)</td>
<td>37</td>
<td>48</td>
<td>79</td>
<td>81</td>
<td>79</td>
<td>43</td>
</tr>
<tr>
<td>SWF ($M)</td>
<td>5.5</td>
<td>9</td>
<td>14</td>
<td>15</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>M&amp;S ($M)</td>
<td>1.6</td>
<td>4</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Total ($M)</td>
<td>7.1</td>
<td>13</td>
<td>21</td>
<td>22</td>
<td>21</td>
<td>12</td>
</tr>
</tbody>
</table>

- Current budget plan is 50-60% of the request
  - 6,780k$
Possible Approaches to Address Muon Collider R&D Budget Issues

• Get National Muon R&D Program endorsed by DOE OHEP
  – That means get reviewed and approved…. that requires:
    ➢ Build national organization
    ➢ Revise/update the proposal
    ➢ Prepare the review
  – We are also organizing the Physics community
    ➢ Briefing DOE OHEP (Jun’09)
    ➢ Workshop on MC Physics/Detector (Nov’09)

• Reorient (limited) existing resources:
  – Additional support from high-field magnet program
  – (very limited) from A0 Photoinjector and General R&D tasks
Muon Collider Detector and Physics

- Organization and coordination of the Muon Collider Physics and Detector effort is very important for getting HEP community on board.

  Recent developments:

  - Briefing DOE OHEP 06/24/2009
    - H.Nicholson, et al
    - E.Eichten, A.Bross, M.Demarteau, S.Geer
  - MC Physics Workshop Nov 10-12 2009 (following Pr-X Physics workshop)
    - Chaired by E.Eichten, K.Peach, J.Konigsberg

About the workshop

This is the organizing workshop for the study of physics, detectors and backgrounds at a Muon Collider in the 1.5 to 5 TeV energy range (benchmark 1.5 TeV and 3.0 TeV machine parameters). The goal is to deliver within one year a report on the physics potential of such a Muon Collider. This study should set requirements on luminosity, energy, determine acceptable background event rates and suggest feasible methods of attaining these levels. The impact of the polarized beams, energy spread, and detector fiducial volume should be evaluated. The physics opportunities should be compared to the CLIC option and take account of the substantial running of LHC after a luminosity upgrade. Synergies with the ILC/LHC and LHC detector R&D should be explored.

There will be three Working Groups - Physics, Detectors, and Machine-Detector Interface (MDI). Each of these studies are essential to determining the overall physics potential at a Muon Collider:

- **Physics WG**: Study the various Beyond the Standard Model physics opportunities (USY, Extra Dimensions, Little Higgs, Strong Dynamics, etc.) at the Muon Collider. Set energy and luminosity requirements for the various physics options. Develop Monte Carlo studies to explore dependence on polarization, beam energy spread, angular coverage of the detector. Compare to CLIC.

- **Detectors WG**: Determine the design requirements for detectors at the Muon Collider. Specifications for performance, background rejection, radiation tolerance, calibration and triggering are to be developed. Synergies with ILC/CLIC and LHC detector R&D will be identified and exploited. Develop a simulation framework in collaboration with the physics and MDI working groups.

- **MDI (Machine-Detector Interface) WG**: Study the detector backgrounds for a Muon Collider. Determine how to reduce this to an acceptable level. Starting with the existing shielding design look for opportunities for improvement. Consider how to make precise luminosity measurements and measure the beam energy and spread. Study how to reduce the effects of muon decays.
Input on Directions of AARD at FNAL

http://apc.fnal.gov/ARDWS/index.html

50=25+25 participants with many world experts

CHARGE: - solicit&evaluate ideas for a future Acc. R&D program in NML
- solicit&evaluate proposals for high beam intensity R&D (Pr-X, MC, ADS)

DOE OHEP Visit,
September 21-22, 2009 – V.Shiltsev
AARD User’s Facility at NML (>2012)

NML extension building is being supported ARRA funds
Workshop Summary

- **NML has the potential to be a *unique* User’s Facility:**
  - Energy range of 40 – 1500 MeV; beam power up to 80 kW; pulse train up to 3000 bunches; “flat beams”
  - Infrastructure capability (cryogenics, RF, lasers, floor space for storage rings, expandability)
  - Extensive accel. operational experience + users support experience

- **>20 proposals presented, including:**
  - Dielectric wakefield accelerator tests in microslabs, plasma wakefield tests with long bunch trains, optical stochastic cooling proof-of-principal test, photoproduction of $\mu$ at 300 MeV for homeland security, test of “integrande optics” concept for high intensity rings
Summary

- FY2009: KA150102 spending are on budget,
  - with expected carryover to FY10 of 775k$

- FY2010: Accelerator Science budget still has ~0.5M$ uncertainty:
  - IFP + Carryover = 11,635k$
  - Presidents Budget + Carryover = 11,870k$
  - Summer’09 Budget Plan = 12,161k$
  - Dec’08 Accel Sci request was 12,702M$

- Depending on the final $$, budget distribution will be adjusted with higher priority to be given to Muon Accelerator R&D
  - MC/NF budget is significantly behind their needs

- There was significant technical progress since Dec’08 DOE Review of Accelerator Science
MCTF: Progress since December - 1

- **Physics, Detectors & Backgrounds**
  - Workshop planned for 10-12 November.
  - Baseline MC parameter list for workshop agreed upon

- **Ring design**
  - New lattice with better performance being finalized

- **MICE**
  - Decay solenoid commissioned
  - New target designed, built & commissioned
  - Fiber trackers complete & commissioned

- **RF R&D**
  - MTA reconfiguration in preparation for beam completed
  - Preparations for HPRF beam test advanced
  - Next generation of 805 MHz test cavities design in progress, new rectangular cavity nearing completion
MCTF: Progress since December - 2

- **Magnet R&D**
  - Planning for an extended MC magnet R&D program within TD started
  - Although not directly MC R&D, we note that funding of the national HTS collaboration is helpful.

- **IDS-NF (= Muon Collider front end).**
  - International organization progressing, and is in line with U.S. contributions as per 5 year plan.