- To provide a nearer-term future HEP program, and to preserve future research options, R&D for accelerator and detector technologies, particularly in the emerging area of neutrino physics, will continue at an increased level relative to FY 2006. Engineering design will begin on a new detector optimized to detect electron neutrinos, the Electron Neutrino Appearance (EvA) Detector, which will utilize the existing NuMI beam. Participation will begin in a reactor-based neutrino experiment and R&D for a high-intensity neutrino super beam facility and a double beta decay experiment will continue. These efforts are part of a coordinated neutrino program developed from an American Physical Society study and a joint HEPAP/NSAC subpanel review.

Construction and Infrastructure

Preliminary engineering design for a potential new construction project, the Electron Neutrino Appearance (EvA) Detector, begins in FY 2007. Overall funding for capital equipment is down slightly compared to FY 2006 as some resources shift to Construction, but one new Major Item of Equipment, the Reactor Neutrino Detector, begins fabrication. Capital equipment expenditures at Fermilab required to improve sections of the accelerator complex for the ongoing neutrino program continue. No AIP projects are currently planned. Funding for GPP is increased to improve site-wide infrastructure at Fermilab, SLAC, and Lawrence Berkeley National Laboratory (LBNL).

- *Participation in a Reactor Neutrino experiment.* The FY 2007 request assumes U.S. research groups will play an important role in design and fabrication of a new Major Item of Equipment, a Reactor Neutrino Detector. A multi-division study from the American Physical Society has identified

opportunities in neutrino physics, and recommended such a reactor-based experiment as part of an overall neutrino research program. This experiment will use neutrinos produced from reactors to precisely measure a crucial parameter needed to pursue the new physics opened up by the discovery of neutrino mass and mixing. The value of this parameter will help resolve ambiguities in determinations of other neutrino properties, and will help determine directions for further research in the neutrino sector.

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Other research efforts that will be continuing in this subprogram include: KamLAND, an underground neutrino oscillation detector which detects reactor-produced neutrinos in Japan; Super-Kamiokande, a proton decay, solar and atmospheric neutrino detector located in the Kamioka Underground Laboratory in Japan; CDMS-II in the Soudan Mine in Minnesota; ADMX-I at LLNL, EXO-200 at WIPP, and R&D for ground- and space-based concepts for dark energy experiments. Pre-conceptual R&D will continue on a next-generation dark matter search experiment. University groups will also participate in the design, R&D and fabrication efforts for the Reactor Neutrino Detector, as described above.

National Laboratory Research	**23,103**	**21,854**	**25,957**

The national laboratory research program consists of groups at several laboratories participating in Non-Accelerator Physics experiments similar to the university physics program described above. With strong laboratory technical resources, they provide invaluable service to the research program in detector design, construction, and operations, in addition to scientists involved in the research. The DOE HEP program office reviews laboratory research groups annually with input from independent peer reviewers.

In FY 2007, the laboratory research program in Non-Accelerator Physics will increase in order to support the operations of newly completed experiments (mainly GLAST/LAT). R&D activities directed at new initiatives in dark energy and neutrino physics, and ongoing R&D of next-generation detectors to directly detect dark matter will also be supported. The laboratory experimental physics research groups will be focused mainly on supporting the spacecraft integration for the GLAST/LAT telescope and analysis of previous experimental data; operations of ADMX-I; R&D for ground- and space-based concepts for dark energy experiments; analysis of data from SDSS; and, continued operation of SDSS-II. Laboratory groups will also participate in the design of the Reactor Neutrino Detector and the R&D for the double beta decay experiment as described above.

Projects	**16,421**	**9,049**	**15,554**

In FY 2007, this effort will be focused on R&D and conceptual design for the SNAP dark energy mission concept and other potential dark energy experiments; and a new Major Item of Equipment (MIE) for a Reactor Neutrino Detector. This category also includes funding for VERITAS.

Fabrication of the VERITAS telescope is scheduled to be completed at the end of FY 2006, with operations beginning at the start of FY 2007. However, in 2005, the work on VERITAS at Kitt Peak was stopped so that the National Environmental Policy Act (NEPA) process could be redone. Since the National Science Foundation holds the lease for the Kitt Peak National Observatory, they are leading the NEPA process with DOE as a cooperating agency. Due to delays incurred in this process, it is likely that the fabrication will not be completed on schedule.

The new MIE is the start of U.S. participation in fabrication of a Reactor Neutrino Detector ($3,000,000). DOE Mission Need has been approved for this experiment. This experiment would measure a crucial unknown neutrino property by precisely measuring the disappearance of electron antineutrinos generated by the reactor as they travel several hundred meters through the earth to the underground detector. The MIE project includes the DOE contribution to the fabrication of the experiment. The technical options to deploy such an experiment are being further studied by a HEPAP Subpanel, and decisions on which option(s) to pursue will be made in 2006.

This request also supports R&D ($12,554,000) for investigating a variety of methods and technologies for dark energy measurements using ground- and/or space-based facilities. The application of this R&D funding will be determined incorporating advice from subpanels of the relevant Federal scientific

Explanation of Funding Changes

	FY 2007 vs. FY 2006 ($000)
University Research	
In University Research, the increase is provided to support significant new research opportunities with newly-operating experiments and facilities.	+921
National Laboratory Research	
In National Laboratory Research, the increase is provided to support initial operations of the GLAST/LAT telescope.	+4,103
Projects	
An increase of $3,000,000 to begin U.S. participation in fabrication of a Reactor Neutrino Detector, and an increase of $4,654,000 in the SNAP R&D effort to develop a conceptual design is offset by a decrease of $1,149,000 for the VERITAS fabrication according to the planned profile.	+6,505
Other	
The decrease reflects a slight reduction in funds held pending completion of peer and/or programmatic review.	-274
Total Funding Change, Non-Accelerator Physics	**+11,255**

▪ **Other**	—	**3,824**	**3,519**

This category includes funding for research activities that have not yet completed peer review, and to respond to new and unexpected physics opportunities. In FY 2006, these efforts are funded to develop new accelerator and detector concepts related to neutrino physics. A joint report of the HEP/NP neutrino physics community outlining the most promising future research directions in neutrino physics was released in Fall 2004; and a joint HEPAP/NSAC neutrino subpanel will report its recommendations early in 2006 that will help inform the decision on which research directions to pursue. These include but are not limited to: R&D for development of scintillation detectors for reactor and accelerator-based experiments; large-scale active liquid argon detectors for accelerator-based experiments; and specialized experiments to measure neutrino interaction cross-sections. In FY 2007, these activities continue, though the overall level is reduced as new experiments begin fabrication, funded in the non-accelerator subprogram (the Reactor Neutrino Detector) and under Construction (the Electron Neutrino Appearance Detector).

Major Items of Equipment *(TEC $2 million or greater)*

(dollars in thousands)

	Total Project Cost (TPC)	Total Estimated Cost (TEC)	Prior Year Appro-priations	FY 2005	FY 2006	FY 2007	Completion Date
Large Hadron Collider — Machine	111,500	91,969	87,832	4,137	—	—	FY 2006
Large Hadron Collider — ATLAS Detector	102,950[a]	55,549	49,242	3,863	1,598	846	FY 2007
Large Hadron Collider — CMS Detector	147,050[b]	71,789	64,129	3,510	2,900	1,250	FY 2007
GLAST/LAT	45,000[c]	45,000[c]	33,579	11,421	—	—	FY 2005
Run IIb D-Zero Detector	10,719[d]	10,719	8,794	1,925	—	—	FY 2006
VERITAS	7,399[e]	4,799	1,600	2,050	1,149	—	FY 2006
BaBar Instrumented Flux Return (IFR) Upgrade	4,900	4,900	3,000	1,200	700	—	FY 2006
Reactor Neutrino Detector	TBD[f]	TBD[f]	—	—	—	3,000	FY 2010
Total, Major Items of Equipment.				28,106	6,347	5,096	

Detailed Justification

	(dollars in thousands)		
	FY 2005	FY 2006	FY 2007
07-SC-07, Electron Neutrino Appearance (EvA), PED	—	—	**10,300**

The Electron Neutrino Appearance (EvA) Detector is a very large detector (approximately football-field size and five stories high), to be fabricated by Fermilab and collaborating universities, that would be sited in northern Minnesota. This detector is optimized to identify electron-type neutrinos, and using the NuMI beam from Fermilab it will observe for the first time the transformation of muon-type neutrinos in an accelerator beam into electron-type neutrinos. It will also make important indirect measurements of the mass ordering for the three known neutrino types (i.e., whether there are two "light" and one "heavier" type of neutrino or vice versa), which will be a key piece of information in determining the currently unknown masses of neutrinos. The project includes the large "far" detector itself, the far detector enclosure, its associated electronics and data acquisition system, and a small "near" detector on the Fermilab site.

The request provides for preliminary engineering and design for both the near and far detectors, that will use the NuMI neutrino beam from Fermilab to observe for the first time the transformation of muon-type neutrinos in an accelerator beam into electron-type neutrinos.

98-G-304, Neutrinos at the Main Injector	**745**	—	—

This project, completed in the second quarter of FY 2005, provided for the construction of new facilities at Fermilab that are specially designed for the study of the properties of the neutrino and in particular to search for neutrino oscillations.

Total, Construction	**745**	—	**10,300**

07-SC-07, Electron Neutrino Appearance Detector, PED

The request supports initiation of preliminary engineering and design for a new project to observe the expected but as yet unmeasured transformation of muon neutrinos into electron neutrinos. The project will utilize the NuMI beamline recently commissioned at Fermilab and consist of two detectors, a very large one located in Minnesota and a small one on the Fermilab site. ..... +10,300

Total Funding Change, Construction	**+10,300**

Construction and Infrastructure

Preliminary engineering design for a potential new construction project, the Electron Neutrino Appearance (EvA) Detector, begins in FY 2007. Overall funding for capital equipment is down slightly compared to FY 2006 as some resources shift to Construction, but one new Major Item of Equipment, the Reactor Neutrino Detector, begins fabrication. Capital equipment expenditures at Fermilab required to improve sections of the accelerator complex for the ongoing neutrino program continue. No AIP projects are currently planned. Funding for GPP is increased to improve site-wide infrastructure at Fermilab, SLAC, and Lawrence Berkeley National Laboratory (LBNL).