

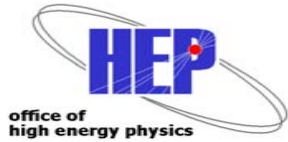
Report from US Department of Energy Office of High Energy Physics

Presented at the ASPERA Roadmap Workshop
in Amsterdam
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DOE

Context

- As in human history, one cannot know the future with certainty, but it is important to know the Times, and its opportunities:
 - War or Peace;
 - Economic Boom or Depression;
 - Cultural & Scientific Renaissance or ...
- Particle Physics appears to be entering a new age of discovery
 - Terascale (LHC)
 - The reigning theory is strikingly precise but observationally incomplete.
 - The consequences of this incompleteness are regarded as likely dramatic. The field is poised for great discovery.
 - Dark Energy & Dark Matter: what are they, and how (do?) they relate to the Terascale?
- Neutrinos – what are its messages?
- Other opportunities for great science and discovery potential
 - CMB, B decays, cosmic rays, proton decay, other precision measurements...



The US program is rich in the advice it receives



- **NRC Study EPP2010 and its priorities**
 - Terascale (LHC and ILC), Particle Astrophysics, Neutrinos, Precision Measurements
- **High Energy Physics Advisory Panel (HEPAP): advise DOE and NSF**
 - Expanded to 25 members, with members from Europe and Asia
 - HEPAP P5 Roadmap, now with multi-year budget guidance
- **Science Advisory Groups (SAG) that inform HEPAP – Neutrinos, Dark Matter, Dark Energy**
- **Subpanels – University, Accelerator R&D**
- **The intergalactic world is also an interagency world**
 - AAAC, NRC Decadal Survey
- **NRC Study on Beyond Einstein program (BEPAC) reported this month.**

Particle Physics: Planning and Prioritizing the Scientific Program

EPP2010 Charge from HEP and NSF:

- Identify, articulate, and prioritize the scientific questions and opportunities that define elementary particle physics
- Recommend a 15-year implementation plan with realistic, ordered priorities to realize these opportunities

EPP 2010 Priorities (report released in 2006) →

Terascale & LHC

- “Fully exploit opportunities afforded by...the LHC”

Terascale & ILC R&D

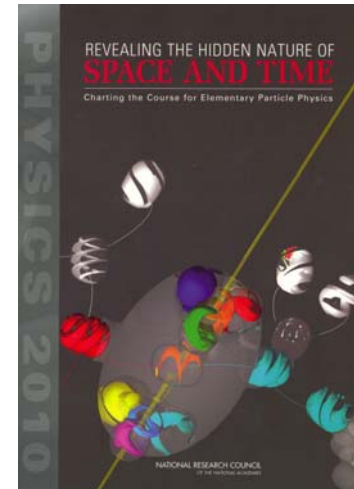
- “Do what is necessary to mount a compelling bid...for the ILC on U.S. soil...”Central effort in U.S. plan.”

- Expand Particle Astrophysics and Unification (CMB, Dark Matter, Dark Energy)

Neutrinos and Proton Decay (internationally coordinated, staged program)

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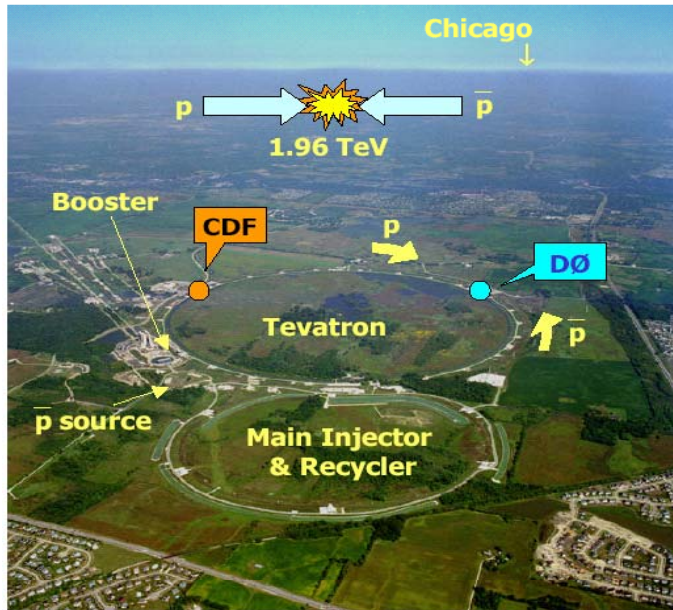
- Precision Measurements (future B Factory, lepton flavor violation and rare decays, $g-2$, EDM)



HEP Budget for 2008 (in \$M)

	FY 2006	FY 2007 Request	FY 2007 Actual	FY 2008 Request	% FY 2007 FY 2008 Request
HEP Base Budget	716.7	775.1	752	782.2	4.0%
Base + SLAC LINAC Operations supplement	746.1	815.1	790	843.7	6.8%

Tools in the US: 2008 Running Accelerator Experiments



Tevatron at Fermilab



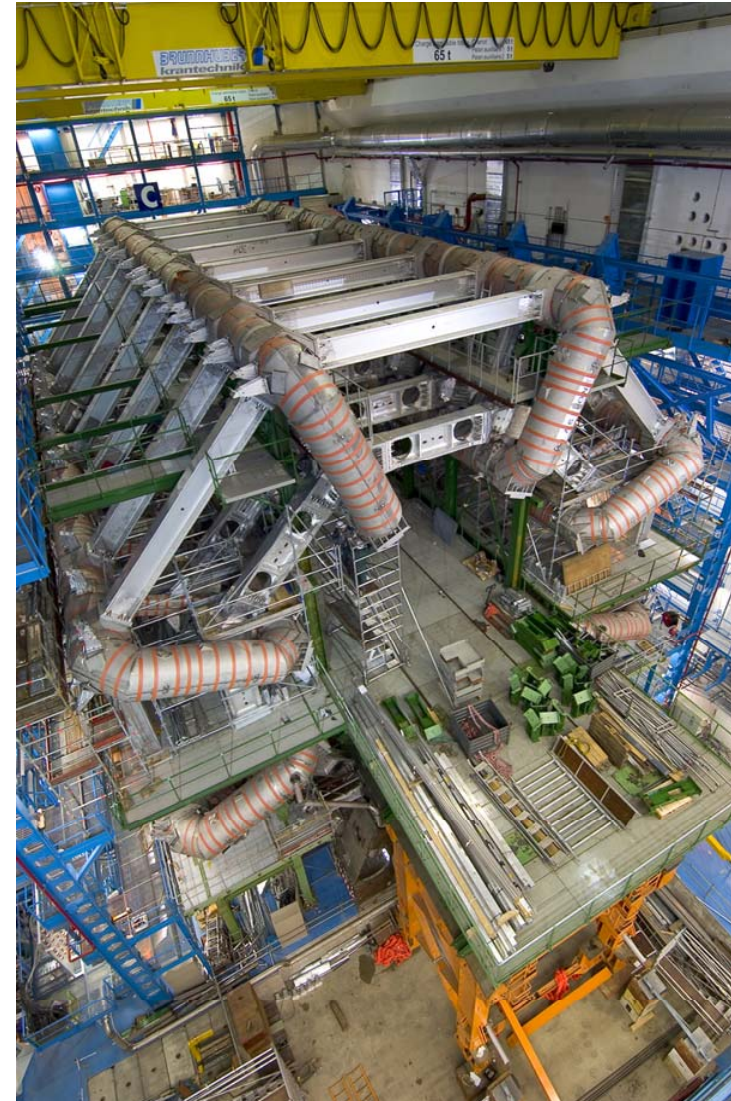
Neutrinos @ MINOS



B-factory at SLAC

Tools in Europe: LHC Starting in 2008.

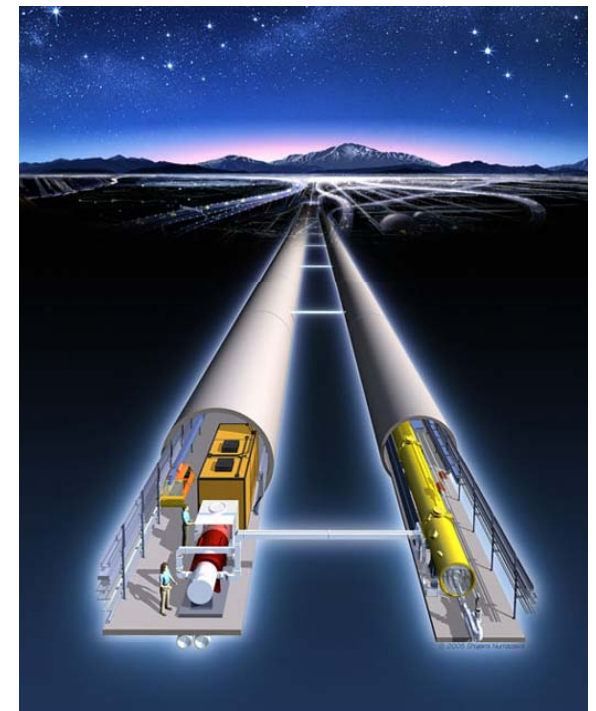
- The LHC physics program is a broad attack on the Terascale: the experiments should -- in a plausible world -- observe the Higgs boson, and hopefully discover the new physics widely expected to supplant the Standard Model.
- Approximately half of the US Experimental HEP community is working on building detectors at the LHC, commissioning the accelerator and preparing software
- LHC Upgrade R&D part of our program planning



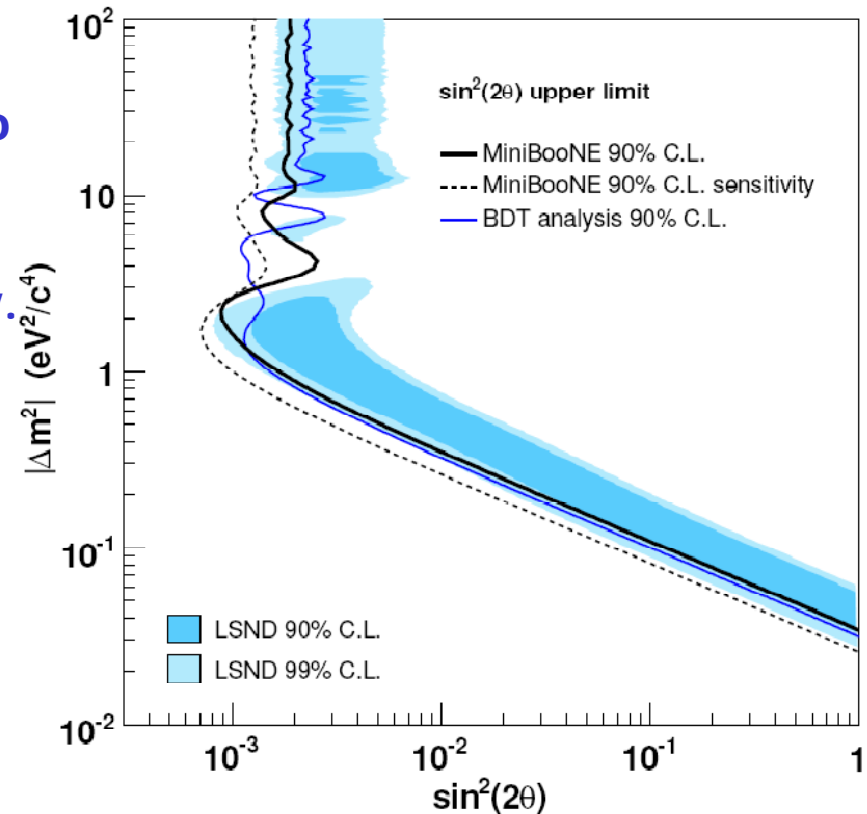
EP2010 Recommendation for the future: ILC

At the beginning of 2006, the International Global Design Group had established a baseline configuration to guide the Reference Design Report (RDR) and costing process.

- March (Bangalore): establish the organization for RDR and guidelines for change control, design and cost methods.
- July (Vancouver): first look at costs and identification of areas where cost savings could occur.
- November (Valencia): freeze the design, start the final report and cost study.
- February `07(Beijing): Release RDR and cost
- July '07: RDR delivered to FALC



MiniBooNE: Earlier results from LANL suggested the existence of a 4th neutrino species that does not interact with the electroweak interaction. MiniBooNE appears to have ruled out this possibility.



MINOS far detector

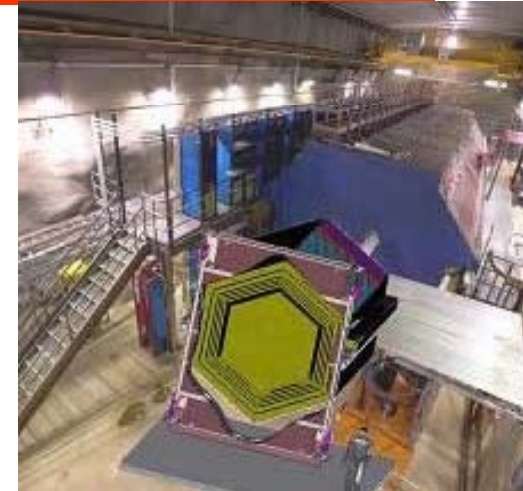


MINOS: Long baseline neutrino oscillation experiment from Fermilab to the Soudan mine in Minnesota, 450 miles away.
--- Data-taking continues until 2010

Planned US Neutrino Experiments

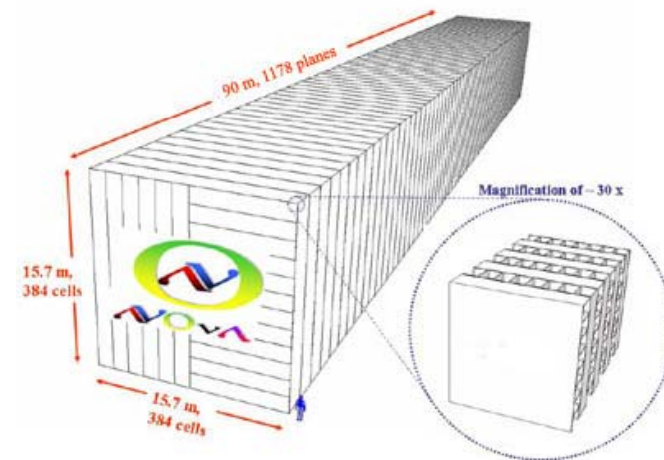
NOvA

- Uses the NuMI Off-Axis beam to search $\nu_{\mu} \rightarrow \nu_e$ oscillations in the existing an 15 kiloton liquid scintillator detector
- Project will be baselined soon and start final design
- Initial operations scheduled for 2011;



MINERvA

- Neutrino scattering experiment using the NuMI beamline at Fermilab; will measure low energy neutrino interactions
- Construction is starting now; data taking will start in 2009



Daya Bay

- neutrino-oscillation experiment designed to measure the mixing angle $\sin^2 2\theta_{13}$ down to 0.01.
- using anti-neutrinos produced by the reactors of the Daya Bay Nuclear Power Plant

Double Chooz

T2K

- Long baseline neutrino oscillations to search for $\nu\text{-}\mu$ to $\nu\text{-}e$ appearance using high intensity beam from Tokai to Kamioka; completing R&D and start construction soon (on DOE parts); data taking in 2009
- DOE working on 280m detector and other instrumentation

NSF is the lead agency.

- DOE participation in R&D for experiments

Possibilities for which DUSEL has a natural PP role:

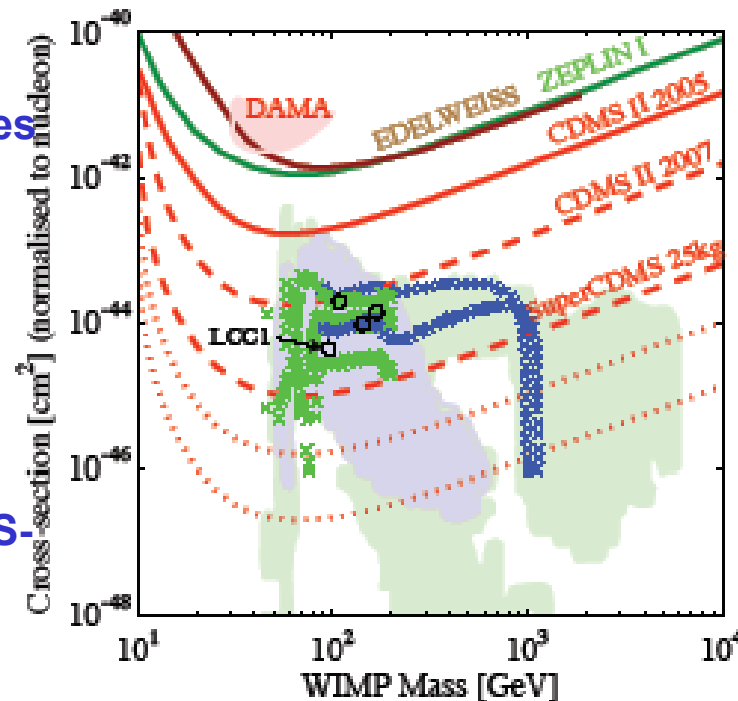
- Dark Matter Detection
- Proton Decay
- Neutrinoless Double Beta Decay
- CP & High Intensity Neutrino Beams

Cryogenic Dark Matter Search (CDMS-II) experiment

Purpose: direct detection of Weakly Interacting Massive Particles (WIMPs) – in Soudan Mine in Minnesota

Data-taking: Full ops with 5 towers started in 2006 & continues through FY07.

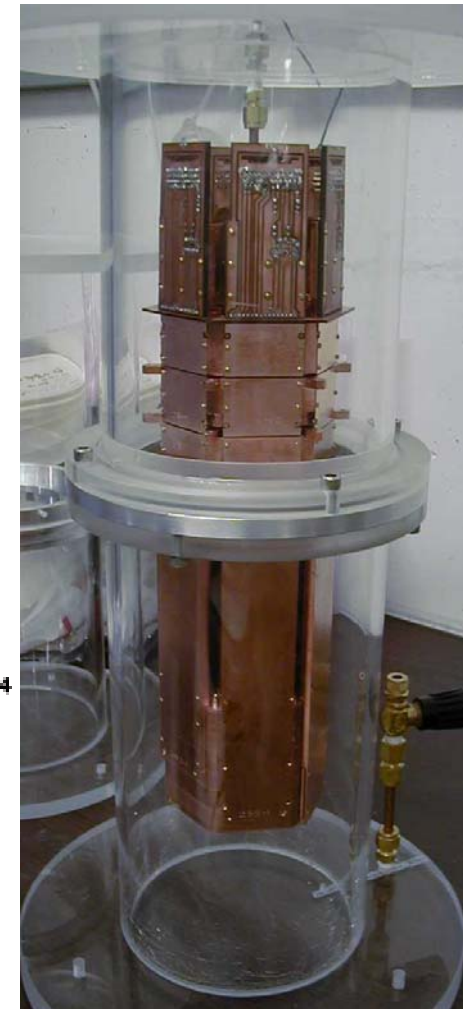
Liquid Xenon Detectors: We are currently providing support to Zeplin-II and Xenon-10 detectors now taking data in Europe. They may have results similar to CDMS-II 2005 this year.



Axion Dark Matter Search (ADMX) experiment at Lawrence Livermore Lab in California – testing and commissioning in 2007.

CDMS-25 at SNO lab -- R&D

CDMS detector



VERITAS

- now operating at Whipple basecamp; collaboration now likes it there.

Auger

- operations continue while full detector is being completed

GLAST

- final environmental testing
- launch currently scheduled for February 2008

AMS

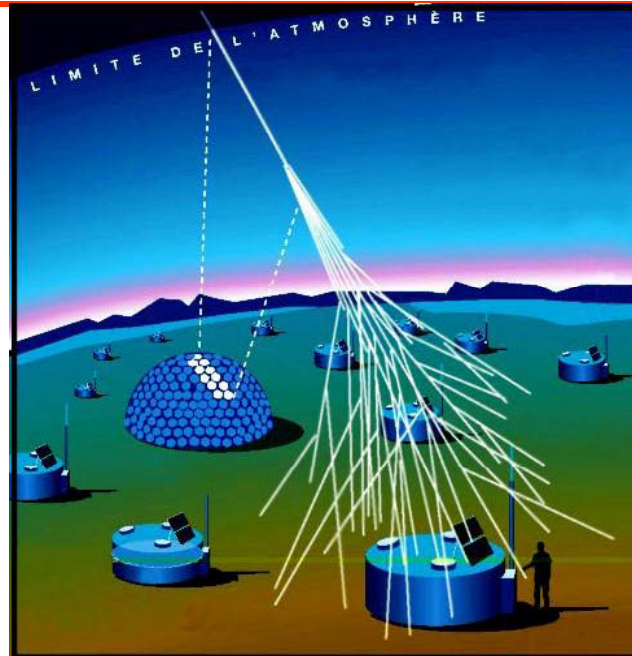
- integration



Pierre Auger – high energy cosmic ray detector array (collaboration w/NSF & foreign partners)



Water Cherenkov surface detectors



Scientific goal is to observe, understand and characterize the very highest energy cosmic rays.

Collaboration has ~ 350 members from 18 countries

Installed over 3000 km² site in Argentina



Fluorescence telescopes

Partial operations have started – construction expected to be completed in 2007.

Current status (as of end of July 2007)

- All fluorescence telescopes operating
- 1480 (out of 1600) surface Cherenkov detectors deployed, 1355 taking data

James Cronin School for Outreach recently inaugurated.

Collaboration is working on R&D for Auger-South upgrades¹⁶ & an Auger-North design report

Gamma Ray Large Area Space Telescope (GLAST)

High energy gamma rays from space
-Energy and direction from 20 MeV to
300 GeV over wide field of view



Primary Instrument: Large Area Telescope (LAT)
-- Collaboration between NASA, DOE, France,
Italy, Japan, Sweden – was managed at SLAC.

Jan '06 - LAT instrument fabrication complete

May '06 - Shipped from SLAC to NRL

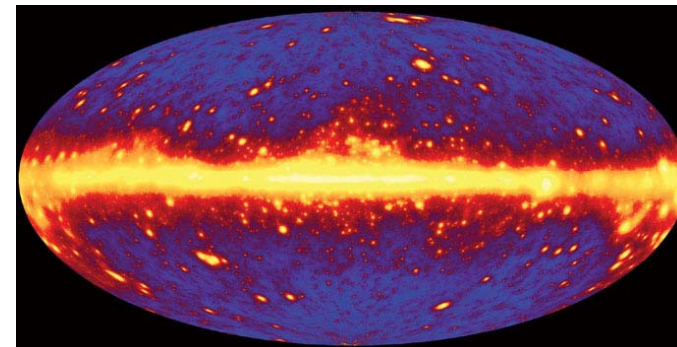
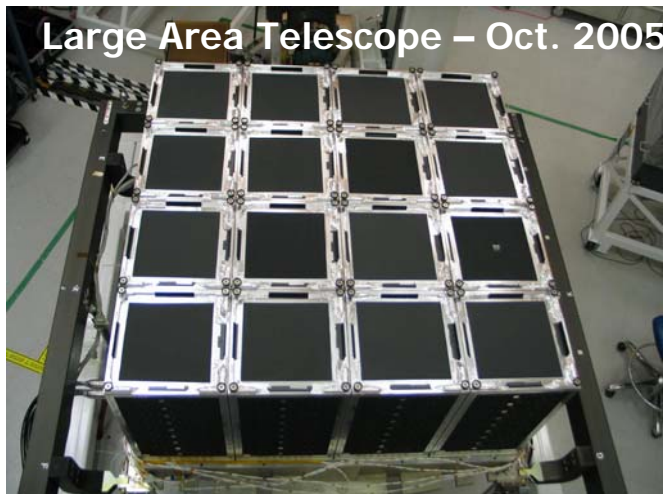
Sept '06 - Shipped to Phoenix for integration on
spacecraft

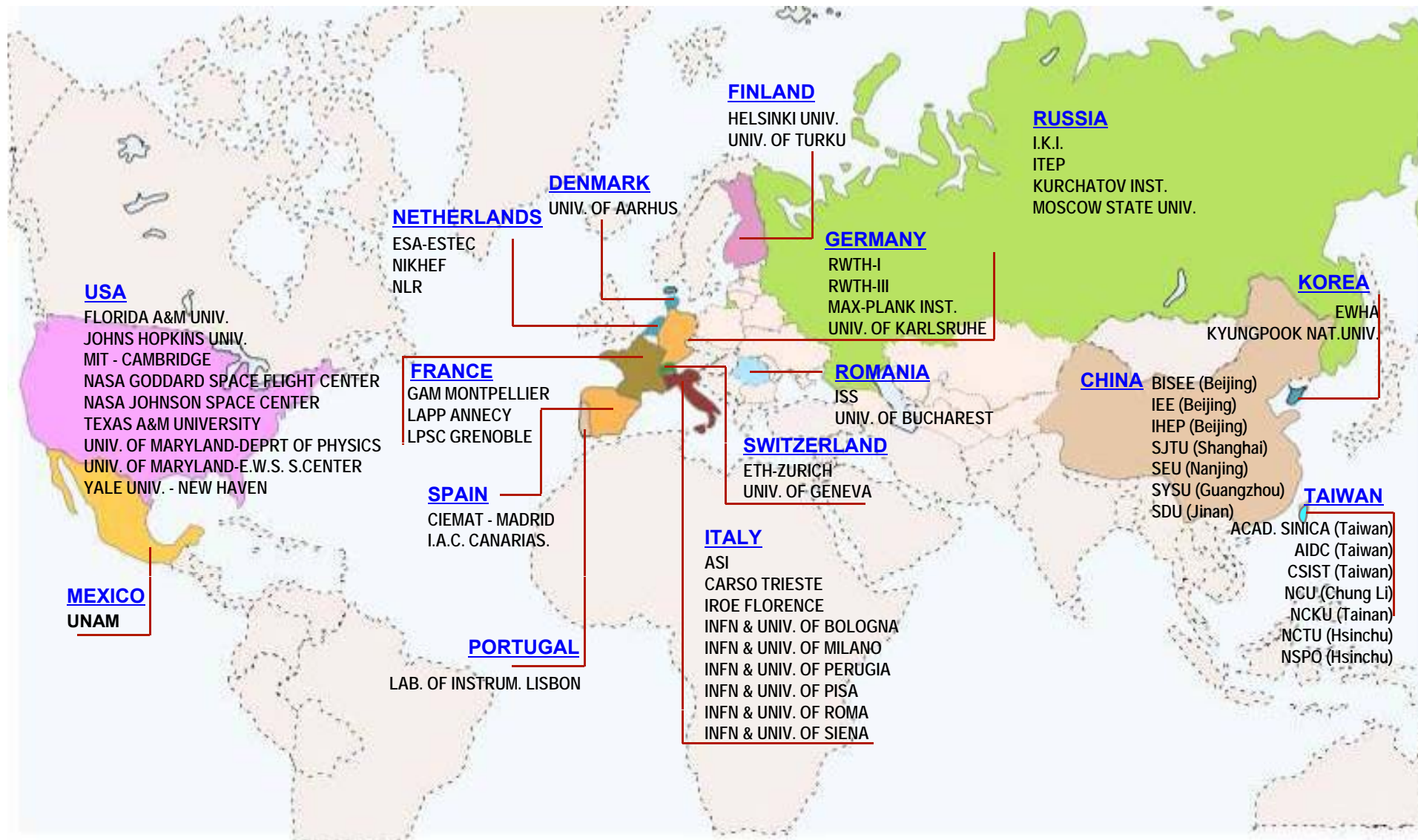
Jan. '07 – integrated on spacecraft; testing

April '07 – start final environmental testing

~ Jan. '08 – ship to KSC

~ Feb. '08 - GLAST launch currently scheduled





Current Status of AMS

- All detector components have been space qualified and calibrated in test beams.
- AMS is being assembled in a dedicated clean room at CERN.
- The entire detector will be tested in summer 2008.
- The detector will go through an intensive thermal vacuum test at the ESA facility in Holland in Sep, Oct & Nov 2008.
- The detector will ship to Kennedy Space Center in Dec 2008.

Dark Energy – Future Planning

Dark Energy Task Force

recommended a mix of experiments with independent and complementary measurements to address dark energy.

HEPAP P5 Prioritization Subpanel

recommended that DOE and NSF jointly pursue the Dark Energy Survey (DES) project, a small-scale ground-based experiment that can provide significant advances in our knowledge of dark energy in the near term in a cost-effective manner.

P5 also recommended

R&D be done for large-scale space-based and ground-based dark energy experiments to get them to a preliminary design stage.

Dark Energy – Future Planning (cont'd)

- **The Long and Winding Road:**
 - NASA and DOE jointly sponsored a National Academy study “Beyond Einstein Program Assessment Committee” (BEPAC), to identify the highest priority among the five proposed NASA “Beyond Einstein” missions (CON-X, LISA, JDEM, Black Hole Finder, Inflation Probe)
 - Report released 9/6/07 – they recommended as a top priority a first launch of the Joint Dark Energy Mission (JDEM) with DOE and NASA partnering
 - Giving the nod to space-based over ground based for Stage IV.
- ➔ **US agency talks have started to develop the terms of the AO and competition JDEM of mission concepts**