Ting and his scientific team believe that the best chance to detect these particles is in space, before they have hit Earth's atmosphere.

"And because it carries a charge, you need a magnet," he added.

Because AMS is the first experiment of its kind to fly in space for a long period of time, anything learned from it will be new knowledge.

"Nobody has really measured the charged-particle field precisely," Ting said. "So you enter into a new field."

The AMS instrument will be installed on the space station's main truss during the STS-134 mission, scheduled to be the last flight for space shuttle Endeavour. Led by Commander Mark Kelly, the mission's crew also comprises Pilot Gregory H. "Box" Johnson and Mission Specialists Michael Fincke, Greg Chamitoff, Andrew Feustel and European Space Agency astronaut Roberto Vittori.

AMS is expected to operate for the rest of the station's life, at least 10 years.

"It's a really neat design and as an astronaut, I appreciate the elegance of it," said Fincke. During the flight, the Endeavour astronauts will use the shuttle's robotic arm to remove AMS from the payload bay and hand it off to the station's arm.

"We're going to put it right on the space station. No bolts required, no human intervention," he explained. "Box Johnson's going to hit a couple buttons, and it's going to be captured automatically. The two umbilicals for power and data are going to stretch right in, and it'll be up and running."

Sponsored by the Department of Energy, AMS-2 was developed by an international team of 56 scientific institutions from 16 countries. The roughly 15,000-pound experiment was built and tested at the European Laboratory for Particle Physics, or CERN, in Switzerland.

"NASA's extremely excited to have AMS on board the International Space Station, because we think that it is a perfect experiment for the International Space Station," said Trent Martin, AMS project manager for the agency's Johnson Space Center in Houston.

"It shows you can bring together 500 physicists, engineers and technicians into a collaboration, build an experiment, launch it to the International Space Station, operate it for an extended period of time and hopefully get extremely exciting data that tells us something about the origins of the universe," Martin said.

Several members of the international AMS team gathered at the runway, excited to see the product of so many years of hard work finally on the ground at Kennedy. A cheer, followed by the clicking of camera shutters, met the cargo plane as it rolled onto the runway's parking apron for offloading.

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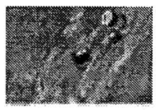

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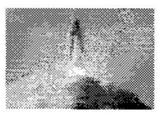

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NASA's Shuttle Endeavour Launches O Home Improvement Mission (Nov. 14, 2008) — Space shuttle Endeavour and its seven-member crew lifted off from NASA's Kennedy Space Center at 7:55 p.m. EST Friday

Still in its packing crate, the 15-foot-wide, 13-foot-tall experiment was carefully removed from the cargo plane and transported to Kennedy's Space Station Processing Facility, where it will undergo final testing and integration before it's deemed ready to fly.

"We have our online testing that we have to do, which is basically making sure it works with the space station, making sure it can talk to the orbiter," said Joe Delai, payload mission manager for STS-134. "That should bring us to about the end of October, and in between October and February, the AMS folks will be calibrating their sensors. Then, we're ready for launch in February."

That's a sentiment shared by the entire team, including the STS-134 astronauts, who will have trained for this mission for about a year and a half when Endeavour is targeted to launch in February 2011.

"It's fitting that on its (Endeavour's) last assembly mission, the space station is going to be complete," STS-134 Commander Mark Kelly said. "It's Important to note it's going to be completed with a very complex and, hopefully, very successful physics experiment. We look forward to seeing the results that Dr. Ting is going to produce over the next decade."

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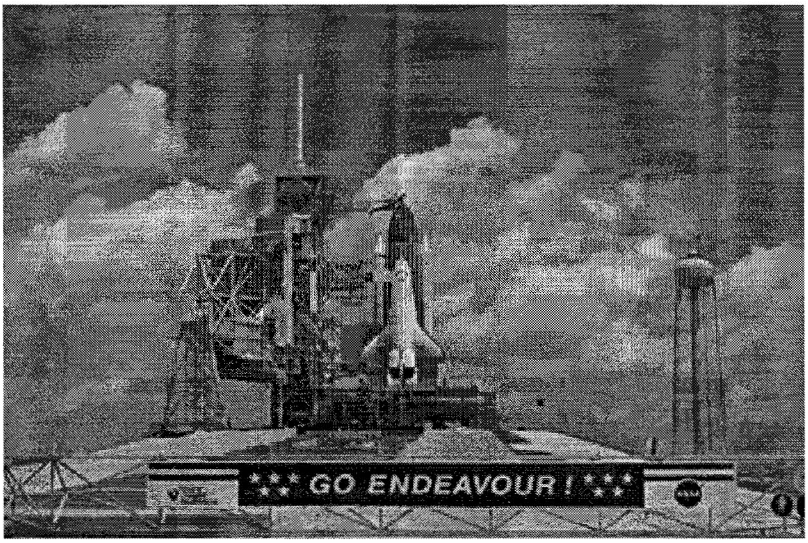

The space shuttle Endeavour on the pad Sunday, a day before its scheduled launch to the ISS carrying the Alpha Magnetic Spectrometer. (credit: J. Foust)

The space station's billion-dollar physics experiment

by Jeff Foust
Monday, May 16, 2011
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If all goes well, on Monday morning the space shuttle Endeavour will lift off on mission STS-134. Much of the attention surrounding the mission has focused on the fact that this will be the final flight of Endeavour and the penultimate mission of the space shuttle program, as well as the fact that mission commander Mark Kelly is married to Congresswoman Gabrielle Giffords, who is recovering from a shooting over four months ago. While turnout for the launch isn't expected to be as large as the previous launch attempt on April 29 (see "A muddled future", The Space Review, May 2, 2011), with far fewer VIPs in attendance—this time the highest-ranking official will be not President Obama but instead Shaun Donovan, the Secretary of Housing and Urban Development—about half a million people are expected to view the launch.

What's been missing from much of the coverage of the mission is that the launch that so many are flocking to might not be taking place at all were it not for its primary payload, a science experiment called the Alpha Magnetic Spectrometer (AMS). More than 15 years and $1.5 billion in the making, scientists hope the AMS will help provide new insights into the nature of dark matter, antimatter, and other mysteries of the universe. The AMS has also been mired in controversy and very nearly didn't get a chance to make it to space at all.

"In a real sense, the International Space Station will transform into a high-energy physics laboratory, with access to the most powerful accelerator in the universe," said the DOE's Gonzalez.

ISS as a high-energy physics lab

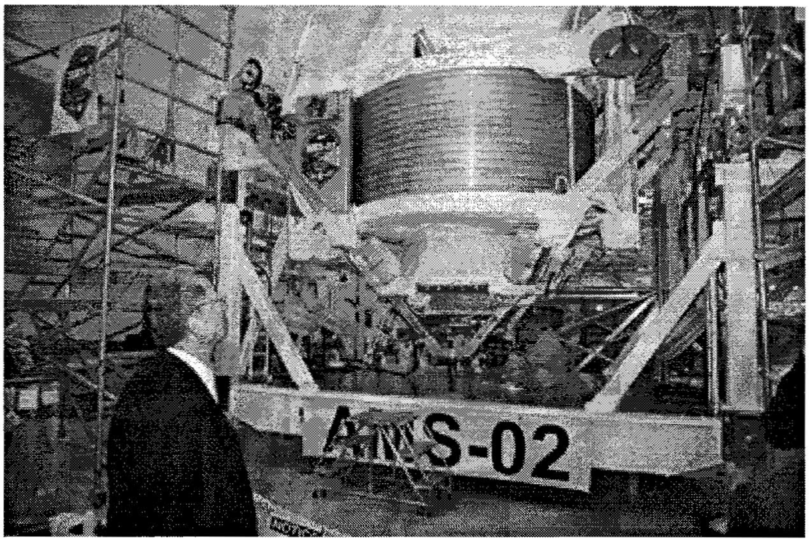
At its heart, the AMS is a cosmic ray detector. Cosmic rays will pass through the AMS and be bent by its magnetic field, generated by a permanent magnet 4,000 times stronger than the Earth's own magnetic field. Instruments mounted in the AMS will measure the mass, charge, and energy of the particles that pass through it, including the ability to discern matter from antimatter.

Located above the Earth's atmosphere, the AMS will be able to detect high-energy particles that would not make it to the surface. "In a real sense, the International Space Station will transform into a high-energy physics laboratory, with access to the most powerful accelerator in the universe, which is the universe itself," said Saul Gonzalez of the Department of Energy's (DOE) Office of High-Energy Physics at a press conference at the Kennedy Space Center (KSC) prior to last month's launch attempt.

The nearly 7,000-kilogram AMS, cradled in the Endeavour's cargo bay, will be moved to a site on the station's S3 truss during the fourth day of the STS-134 mission. Unlike typical ISS experiments, once there the AMS will largely operate without interaction with the station's crew. Instead, the AMS will take advantage of the station's infrastructure, including power and communications, to operate and transmit its data to scientists back on Earth.

And what will scientists be looking for in the AMS data? One particular area of interest will be detection of antimatter. While models of the origins of the universe predict that matter and antimatter should have formed in equal proportions, matter dominates all our observations of the universe to date. Detections of antimatter by the AMS, particularly heavy particles like antihelium or anticarbon nuclei that could only have formed after the Big Bang, could provide evidence of the existence of antimatter in larger quantities elsewhere in the universe. Separately, detections of excess amounts of positrons—antimatter electrons—could be evidence of collisions of hypothetical particles called supersymmetic neutralinos that could comprise dark matter.

"Most of our understanding of our cosmos up to now comes from measuring light. Besides the light rays, there are charged particles," said Samuel Ting, the MIT physicist and Nobel laureate who is the principal investigator for the AMS. Charged particles, he noted, have not be used nearly as much as light to understand the universe. "We are opening a door into a new area."



Samuel Ting examines the AMS after it was delivered to the Kennedy Space Center in March. (credit: NASA/KSC)

Near-death experience

AMS, though, almost didn't get a chance to open that door. The experiment dates back to the 1990s, when high-energy physicists saw the ISS as an opportunity to mount an experiment to study cosmic rays. With support from NASA and the DOE, an international consortium started work on AMS, flying a precursor instrument on the STS-91 shuttle mission in 1998 (that experiment was also known as the AMS, so the experiment being launched to the ISS is sometimes called the AMS-02.)

A strong supporter of ISS research in general, Sen. Hutchison held hearings on the potential of AMS and lobbied for its return to the shuttle manifest.

Work on the AMS continued relatively quietly until around 2005, when NASA, responding to the Columbia accident in 2003 and the decision the following year by the Bush Administration to retire the shuttle by the end of the decade, altered the shuttle program manifest. There was, the agency concluded, no room for the ISS on the missions planned to complete assembly of the station. The instrument was unceremoniously grounded.

Ting and his international consortium moved into high gear to try and get the AMS back on a shuttle flight. "I was very surprised," Ting recalled. He said that people