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19 MAY 2011

DIRECTOR'S CORNER

Alpha Magnetic Spectrometer launches!

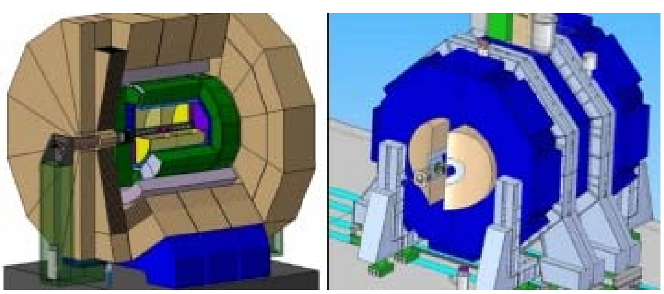
by Barry Barish

A major particle physics mission, Alpha Magnetic Spectrometer, has been successfully launched. This sophisticated cosmic ray detector will use the International Space Station as a platform to perform precision measurements of cosmic radiation emanating from space.

RESEARCH DIRECTOR'S REPORT

Determining the cost of the ILC detectors

by Sakue Yamada

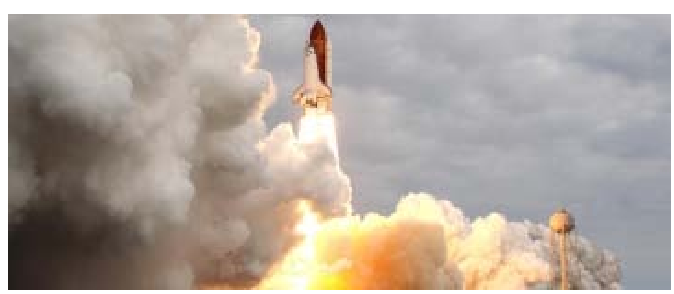


Costing the two ILC detectors more precisely is one of the important activities for the ongoing ILC detector design work, and balancing detector cost and performance depends on the strategy of the detector groups. To learn whether there are differences among them, the groups undertake detailed coordination of their costing methodologies.

FEATURE

A particle detector in space: interview with Maurice Bourquin from AMS

by Perrine Royole-Degieux



Maurice Bourquin, emeritus professor at the University of Geneva and former president of the CERN Council, is one of the pioneer scientists from the Alpha Magnetic Spectrometer Experiment collaboration. Just after the AMS-02 detector was launched, he answered *ILC NewsLine*'s questions about AMS history, AMS challenges, and the interplay between collider and space experiments.

VIDEO OF THE WEEK

Space shuttle Endeavour launches

The space shuttle Endeavour launched from Kennedy Space Center on 16 May 2011 for its final mission, a flight to the International Space Station. It took with it the Alpha Magnetic Spectrometer (AMS-02), an experiment that will look for evidence of dark matter and antimatter.

View CERN's webcast of the launch, followed by explanations from AMS scientists.

View the AMS installation on the International Space Station on 19 May 2011.

IN THE NEWS

from ***New York Times***
17 May 2011
Maurice Goldhaber, Atomic Physicist, Is Dead at 100
Dr. Goldhaber was director of the Brookhaven lab from 1961 to 1973, overseeing experiments there that led to three Nobel Prizes.
His most famous contribution to science's basic understanding of how the universe works involved the ghostly, perplexing subatomic particles known as neutrinos.

from ***LA Times***
16 May 2011
Space shuttle Endeavour launches at last
Space shuttle Endeavour blasted to space – at last – on its final mission Monday, carrying a long-grounded $2-billion astrophysics device and a little bit of the hearts of thousands of space shuttle workers.

from ***physicsworld.com***
16 May 2011
Cosmic ray detector blasts off on space shuttle
An instrument for detecting cosmic rays – and possibly even dark matter – has finally been lifted into orbit on board the space shuttle *Endeavour*.

from ***physorg.com***
13 May 2011
Applying particle physics expertise to cancer therapy
Sadrozinski and Robert Johnson, professor of physics at UC Santa Cruz, used the same "silicon strip" detector technology for this project that they and other SCIPP researchers used to build detectors for major particle physics instruments, including the Fermi Gamma-ray Space Telescope and the ATLAS detector at the Large Hadron Collider (LHC) at CERN.

from ***Science Now***
12 May 2011
UK Parliament Panel Slams Physics, Astronomy Cuts
Particle physics has fared less badly with a modest increase of 5% over the same 4-year period, but an increase in grants masks a dramatic drop in capital funding.

from ***Scientific American***
11 May 2011
Accelerated Expectations: All Eyes on Large Hadron Collider in Dark Matter Hunt
Researchers from a number of overlapping disciplines are awaiting a big boost from the world's largest particle collider

from ***Nature***
10 May 2011

The collider that cried 'Higgs'
Proof of the Higgs' existence will not arrive as a bolt from the blue — instead, it will emerge slowly from weeks or months of data analysis, allowing ample time for each tantalizing step to be documented on blogs.

ANNOUNCEMENTS

Brian Foster awarded Alexander von Humboldt Professorship

On 12 May in Berlin, the Alexander von Humboldt Foundation presented one of eight Humboldt Professorships, the highest valued international awards for research in Germany, to Brian Foster. Beginning 1 June, Foster, the GDE Regional Director of Europe, will begin work at the research centre DESY and at the University of Hamburg. Foster's position will be allocated to both institutions. He will assume a professorship for accelerator development and particle physics. Stay tuned to a future issue of *ILC NewsLine* for more on Foster's new post.

CALENDAR

UPCOMING EVENTS

CALICE collaboration meeting
CERN, Geneva, Switzerland
19- 21 May 2011

ILD Workshop 2011
Orsay, France
23- 25 May 2011

18th FCAL collaboration workshop
Predeal (Romania)
30 May - 1 June 2011

Second Workshop on linac operation with long bunch trains
DESY, Hamburg, Germany
06- 08 June 2011

Technology and Instrumentation in Particle Physics 2011 (TIPP 2011)
Chicago, IL
09- 14 June 2011

UPCOMING SCHOOLS

USPAS sponsored by Stony Brook University
Melville, New York
13- 24 June 2011

View complete calendar

BLOGLINE

11 May 2011
Frank Simon
Talking Calorimeters – Day Trip to CERN

28 April 2011
Frank Simon
Beam time is around the corner – again!

PREPRINTS

ARXIV PREPRINTS

1105.3417
Tests of a particle flow algorithm with CALICE test beam data

1105.2607
PGB pair production at LHC and ILC as a probe of topcolor-assisted technicolor

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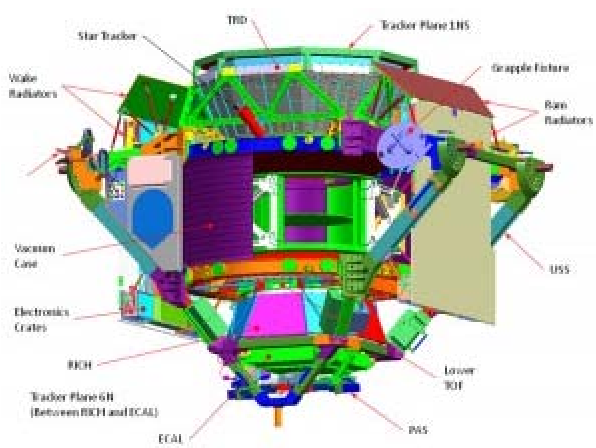
DIRECTOR'S CORNER

Alpha Magnetic Spectrometer launches!

Barry Barish | 19 May 2011

Schematic of the AMS-02 mounted on the International Space Station



A schematic view of the Alpha Magnetic Spectrometer

A new sophisticated particle physics experiment, the Alpha Magnetic Spectrometer, was launched into space on 16 May 2011. This advanced instrument is the culmination of an almost 20-year effort to design, build and employ an instrument with a goal of performing precision measurements of cosmic ray particles from a platform in space. Using the International Space Station as the platform, it will be able to study the universe by searching for exotic matter like antimatter and dark matter, as well as perform precision measurements of cosmic rays' composition and flux.

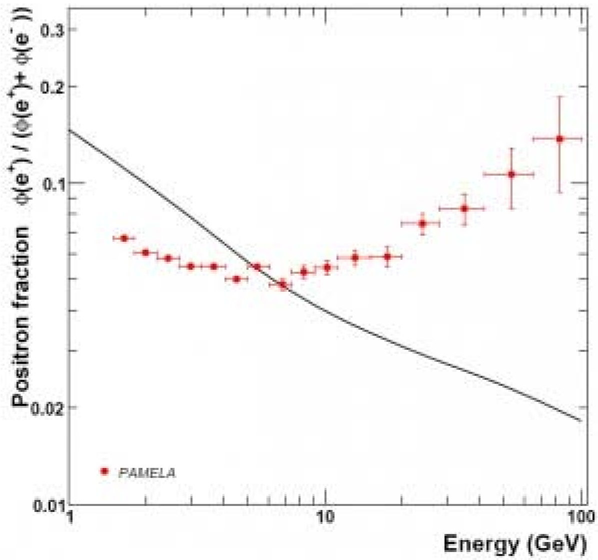
The early history of particle physics came out of cosmic ray studies, well before the first particle accelerators were built. Observations of antimatter, the discovery of the muon, and other early particle physics came from cosmic ray studies and were precursors to the rich field of particle physics that has centred on particle accelerators. It is interesting for those of us developing the next new accelerator, the linear collider, that interesting particle physics is coming from alternate probes, including putting sophisticated devices deep underground and in space. The Alpha Magnetic Spectrometer, AMS, is by far the most ambitious and sophisticated particle physics instrument to be put into space.

A prototype version, called AMS-01, was successfully flown for 10 days on the shuttle Discovery in 1998. It was the first large magnetic spectrometer to operate in space and enabled testing of early versions of many of the components of AMS-02, launched last week to the International Space Station.

The sub-detectors on AMS-01 included a silicon detector that measured the sign and charge of charged particles, a time-of-flight system that measured the velocity of particles and, with the momentum measurements, thereby provided particle identification. The device also had a large veto system to protect the detectors from stray radiation coming at different angles and a Cerenkov counter providing additional particle identification. AMS-01 only flew for 10 days, in contrast to the multi-year observations that are planned for AMS-02. Nevertheless, it provided some interesting results, as well as systems tests prior to the AMS-02 mission. AMS-01 results included measurements of helium, searches for anti-helium and measurements of positrons, a potential probe of new physics.

The centrepiece of AMS-02 is a large spectrometer magnet. Both a superconducting magnet spectrometer and permanent magnet spectrometer were developed for the mission, having the same field configurations and geometric configurations to surround the particle detectors. The superconducting version had the advantage of higher magnetic fields, yielding more precise momentum measurements, but it would have a shorter lifetime and required servicing. In contrast, AMS-02 has been launched with the permanent magnet, enabling a much longer mission. It is built with 6,000 neodymium-iron-boron pieces carefully magnetised and assembled together. This type of magnet was successfully flown on AMS-01. The other detector elements in AMS-02 consist of larger and more sophisticated versions of the sub-detectors tested in AMS-01.

The sensitivity of AMS-02 detector will be well beyond that of any previous instrument put in space to study high-energy cosmic rays. It will make high statistics measurements of the momentum distribution of protons and heavier nuclei up to about 1,000 gigaelectronvolts. Such detailed measurements of the isotopic composition are especially important in giving insight into the scales of propagation times of charged particles in the galaxy, and in turn will provide information on galactic magnetic fields.



Positron excess reported by PAMELA satellite experiment (Nature 458, 607 (2009)).

The particle separation capability of AMS will also enable it to make measurements of positrons up to approximately 100 GeV. We know how cosmic ray positrons are produced, which is mostly through positron-positron interactions in interstellar space. The goal of the AMS-02 measurements will be to compare the intensity and spectrum measured with the expected production rate. This comparison will help us understand how the energy spectrum is deformed by diffusion or radiative energy losses in the galaxy.

Excesses in the antiparticle (e.g., positrons and antiprotons) spectra could result from dark matter particle annihilations. Indications of an excess were first reported 15 years ago by HEAT, a cosmic ray balloon experiment, and more recently by PAMELA, an Italian experiment in space on a Russian satellite. The precision measurements from AMS-02 should resolve whether these hints are real.


Samuel Ting (right), principal investigator of AMS, with STS-134 mission commander Mark Kelly (left) during a visit of AMS-02 at the Kennedy Space Center in November 2010. Photo courtesy of NASA.

Sam Ting, MIT and CERN, has been the leader and driving force behind AMS from inception. I have personally known and been a friend of Sam's for years and, in fact, we share the same birth date and were born only a few hundred kilometres apart. I would characterise Sam's physics career as one where he has consistently uncovered new important particle physics through making precision measurements. Ting discovered the J/ψ particle in 1974, for which he shared the Nobel Prize with Burt Richter. The design of AMS exemplifies this same careful approach, and when Ting has been asked about the goals of this mission, he has replied, "*the most exciting objective of AMS is to probe the unknown, to search for phenomena which exist in nature that we have not yet imagined nor had the tools to discover.*"

I heartily congratulate Sam and collaborators for developing AMS and on the successful launch. I eagerly look forward to the physics results they will produce.

ALPHA MAGNETIC SPECTROMETER | AMS | ANTIMATTER | DARK MATTER

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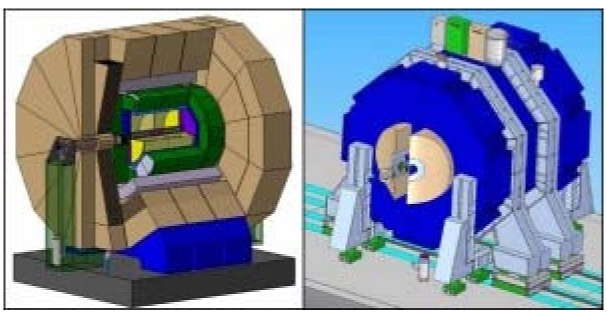
RESEARCH DIRECTOR'S REPORT

Determining the cost of the ILC detectors

Sakue Yamada | 19 May 2011

The two detector designs for the ILC are now elaborated by the ILD and SiD groups toward the *Detailed Baseline Design Report* (DBD). When the Letters of Intent (LOI) were called in 2007, the guideline said, “The LOI will not represent any formal commitment of the groups signing it to the project or to the proposed detector.” LOIs are meant to demonstrate the feasibility and capability of achieving physics goals of the ILC, and new ideas on detectors remain open. Nevertheless, the validated groups are striving to advance their detector designs to reach a good starting point for the time when the project is realised. One of the work plans for the DBD is to make a more precise estimation of the detector cost as it is, together with the technical aspects, one of the crucial features of the feasibility study. In general, the performance of a detector tends to correlate positively with its cost. Naturally one wishes to obtain the best possible performance with least cost. This motivates R&D of detector technology and leads to innovations. But at a certain point, one has to make a balance between them, and how to accomplish this depends on the physics aim and design strategy. The choice of technology and/or material and the size of each component are all taken into account. Finally a choice is made to match the ultimate purpose and affordability. There can be differences between groups and it is an advantage that we can compare the two strategies taken by the ILD (International Large Detector) and SiD (Silicon Detector).



The two detector design groups ILD (left) and SiD (right) are working towards a precise estimation of the detector cost to be released in the Detailed Baseline Design Report.

When we wish to compare the two cost estimates, they should be prepared in such a way that allows meaningful comparison. The International Detector Advisory Group (IDAG) recommended last October that the costing of the two detectors needs coordination so that the two groups use the same methodology for costing. Such an attempt already existed during the LOI preparation. The funding schemes and commercial customs are different from region to region or country to country. Considering these large differences, the costs in the LOIs are coordinated reasonably well but not completely. IDAG pointed out that this situation needs to be improved.

In order to establish costing coordination and unify methodology, we formed a small working group composed of representatives of the two groups and an advisor from outside who is an expert on the costing of the ILC accelerator. The accelerator team has been working on the same problem for a long time and they already have a good solution for how to coordinate various differences among the regions.

The two detector concepts take somewhat different approaches for the cost-performance optimisation. Although it is a subtle one, they may affect the final designs. The SiD uses extensive analytical cost-performance optimisations. On the other hand, ILD tries that partly because of many options being considered. To see the consequences of this difference, if any, we have to coordinate the ways of costing more precisely. We also have to make many simulations, including collisions at high energies, to evaluate the detectors’ operation, helping to determine what works for effective detector performance. This exercise will give us valuable information regarding cost versus performance.

The costing working group has agreed already on several points, such as items to include in the cost and how to categorise them. They also agreed to use common unit prices for cost-driving raw materials. The work is still being continued for improvement, which will take more time.

The world economy is changing rather rapidly. This can cause uncertainty in the estimated cost after it is made for the DBD, which will use 2012 prices. For instance, the prices of iron and tungsten in the coming years will affect the cost. Also, the fluctuation of the exchange rates among different currencies is a big factor that may cause difference in the costs. However, once the methodology is clear, one can trace the shift in cost due to these factors.

When the time comes for real construction, most components will be produced by participating institutions at home and will be delivered to be assembled on site. In such a scheme, we hope the currency exchange rate does not matter so much as it appears on paper. More important is that we strive for such a day. And the costing exercise is one of the steps to achieve our goal.

COST | IDAG | ILD | SID

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FEATURE

A particle detector in space: interview with Maurice Bourquin from AMS

Perrine Royole-Degieux | 19 May 2011

Space shuttle Endeavour roars into orbit from Kennedy Space Center

When Maurice Bourquin participated in the first meeting between particle physicists and representatives of NASA in Houston, US, to understand the opportunity offered by the International Space Station (ISS) to support a particle physics experiment in space, he probably didn't expect that his detector would finally fly 17 years later. A pioneer in the Alpha Magnetic Spectrometer experiment led by Nobel Prize laureate Samuel Ting, Bourquin created a team in Switzerland at the University of Geneva to take part in the project. His group took part in the design and the construction of the first version, AMS-01, a concept that took flight aboard Discovery space shuttle in 1998.

Just after the AMS-02 detector was launched, *ILC NewsLine* captured his first reactions and asked him about the interplay between AMS-02 and collider experiments, which Maurice Bourquin, former president of the CERN Council from 2001 to 2003, is also very familiar with.

ILC NewsLine: 16 May 2011 was a historical day for the AMS collaboration, and for astroparticle physics in general. How did you spend this special day?
*Maurice Bourquin: The launch was delayed several times and I was actually at the Kennedy Space Center for the first attempt on 28 April. As I had witnessed several such events in the past, I decided to watch the final preparation and the launch of Endeavour from CERN. We had organised a **live webcast** where the public had their questions about the project, dark matter and antimatter answered. Two hours later power was applied to AMS, and first data were successfully received.*

What is Alpha Magnetic Spectrometer Experiment looking for? Why is the AMS detector being sent into space?
AMS will measure high-energy cosmic rays, which are charged particles, as well as gamma rays, passing through the detector in space. It is particularly suited to identify antiparticles, which could signal primordial antimatter, dark matter or other unknown phenomena. The detector is sent into space, because the earth's atmosphere protects us from the vast majority of the cosmic particles and antiparticles moving through the universe. This beneficial protection to humans is a barrier to study cosmic phenomena from the Earth.

AMS-02 loaded into the shuttle bay. Image: Michele Famiglietti / AMS-02 Collaboration

What are the main challenges for designing and building a detector that will go to space?
The AMS detector instrumentation is based on accelerator physics technology and is designed for maximum performance. However only low power (2500 watts) is available up there for 300,000 channels of detection and 775 boards of electronics! It was also designed with high redundancy as there is no possibility of human intervention on orbit.

And in other words… what's so different in the design between a detector like AMS and an LHC detector, for example?

While an LHC detector sits in a rather comfortable environment, apart from radiation, a space detector is in a very hostile environment. It has to be space-qualified to resist vibration, must operate flawlessly in microgravity and vacuum and withstand extreme thermal cycles over an extended period of time. It also must be protected from micrometeorites.

On 26 August 2010, Maurice Bourquin welcomes the US Air Force C-5M transport plane carrying the AMS-02 detector at the shuttle landing facility at the Kennedy Space Center in Florida.

How do you see the interplay and synergies between collider experiments like the LHC or the future ILC and AMS?

We are very fortunate that we now have two complementary ways to find a solution to the dark matter problem: the colliders are searching for direct production of heavy particles which could constitute its nature and AMS will study the question through the characteristic distributions of antiparticles in the galaxy.

What kind of operations on the detector can you make from Earth?

Commands to AMS are routed via the ISS Low Rate Data Link from the AMS Payload Operation Control Centers located at the Johnson Space Center in Houston, Texas, and at CERN in Geneva. One of the most critical parameters to monitor and command will be the thermal status of the detector elements.

When will the AMS detector start taking data? When do you foresee the first results?

Data will be received on Earth immediately after AMS is placed on the external truss of the ISS. It is not possible to estimate when first results would come out.

Is there anything else you'd like to add?

I believe that AMS on the ISS will make society more aware of the issues and challenges of fundamental research and make science more accessible to all.

AMS is the result of a large international collaboration led by Nobel laureate Samuel Ting and involves about 600 researchers in 16 countries, mainly European. AMS is a CERN-recognised experiment and as such has benefited from CERN's expertise in integrating large projects. It is also considered a US Department of Energy experiment with NASA providing the delivery by the space shuttle to the International Space Station.

AMS | ANTIMATTER | ASTROPARTICLE | CERN | DARK MATTER | ISS | SPACE