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Contribution by

Department of Physics, MIT

Fundamental Science and Society

Prof. Samuel Ting

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United Nations Conference on Trade and Development

Fundamental Science and Society

基礎科学与社会发展

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and

European Organization for Nuclear Research (CERN), Geneva

May 04, 2015

Today, the problems which challenge us are immense. How can these challenges be met with the tools we have developed?

I would like to read a short passage:

"Humanity is being ravaged by disease;
doctors are powerless against it; pollution is everywhere;
men and women die daily in senseless ethnic conflicts;
homelessness is rampant; people can't read;
children are being killed in the streets"

This was Europe in the year 1350

Yet from this period of despair, destruction and disillusionment sprung the greatest period of hope, new ideas and creative expression.

The Renaissance was born in Italy and spread throughout Europe transforming how people looked at the world and their place in it.

Scientists re-examined old ideas about the nature of the universe inherited from the ancient Greeks and Romans.

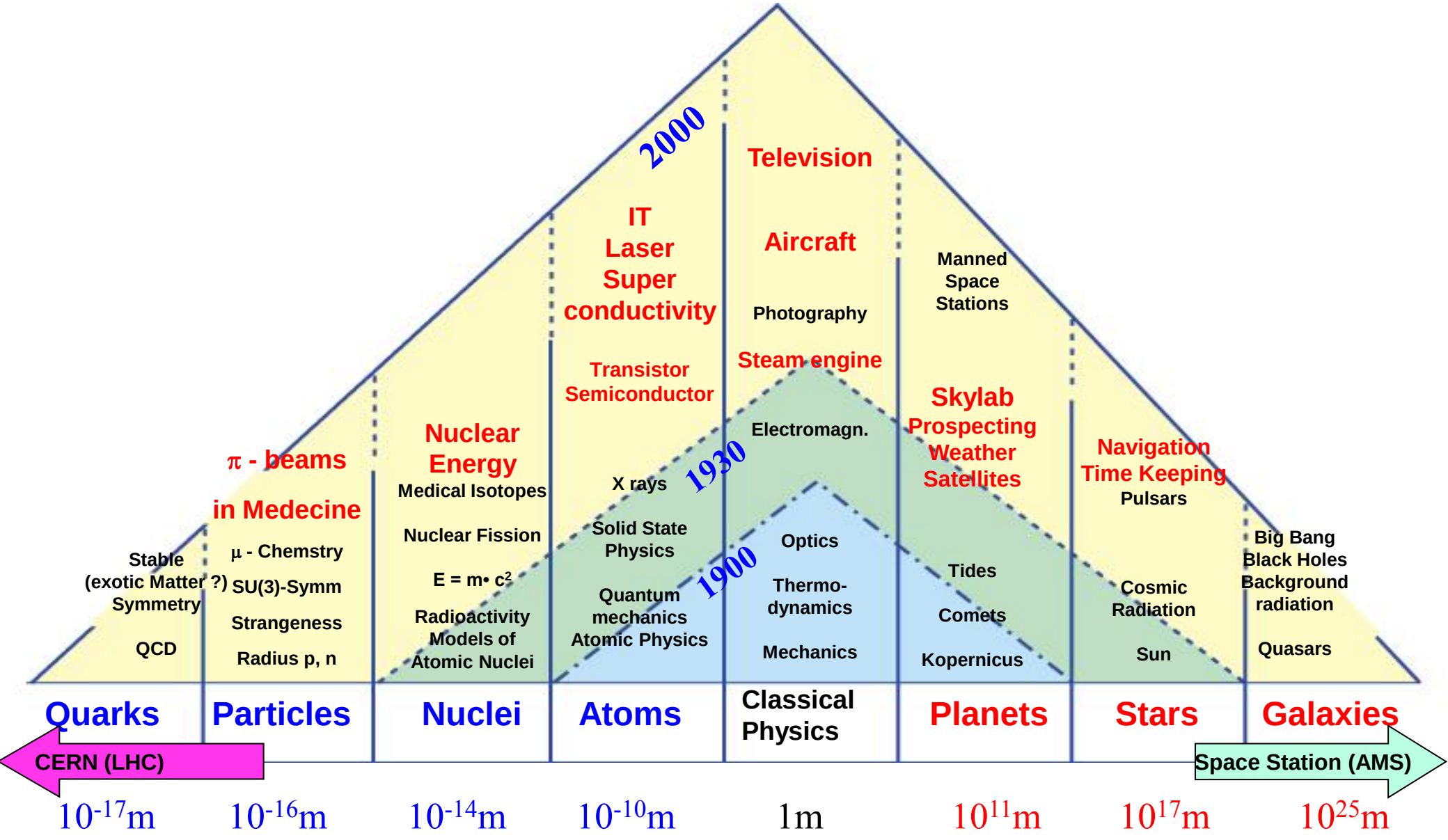
Modern science, or the understanding of natural phenomena using experimental techniques, was established during this time.

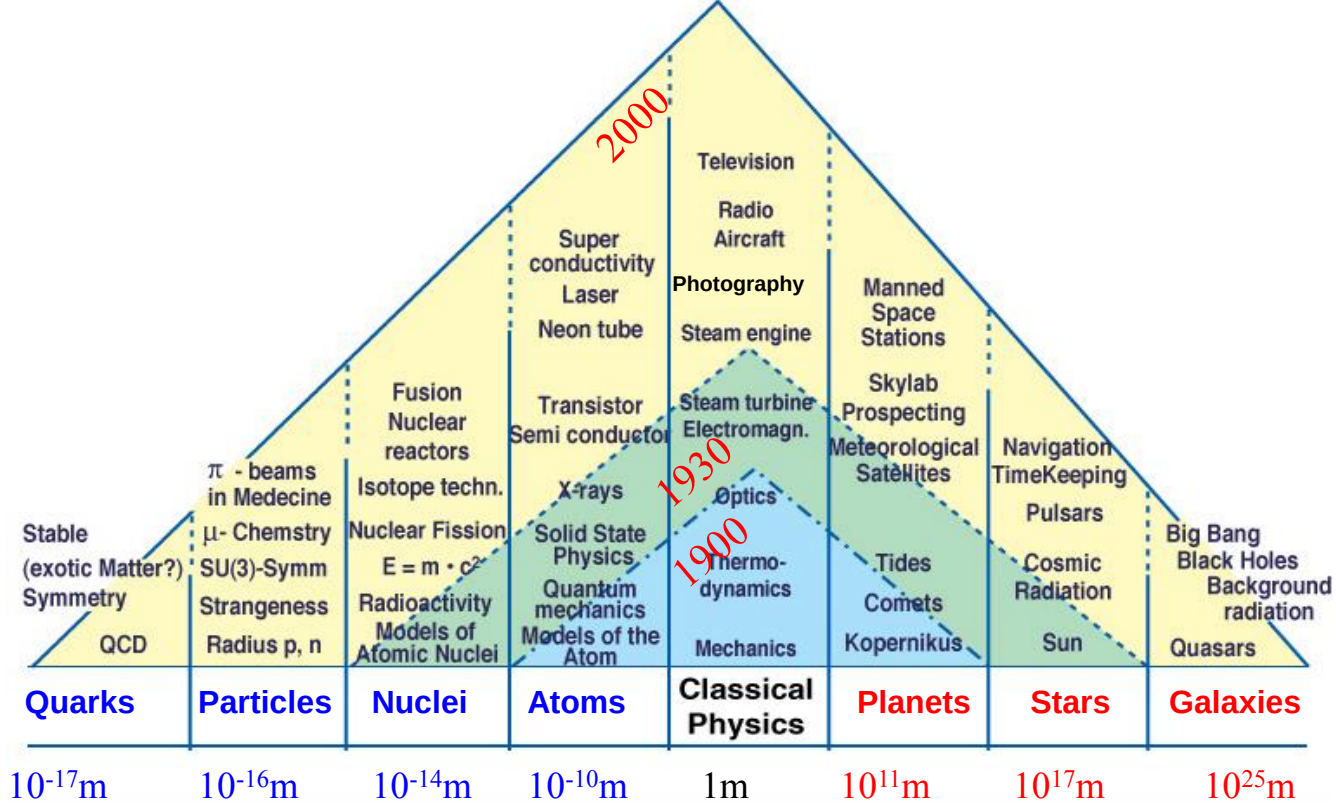
In 21st Century,

We enjoy unprecedented advancements in technological development such as in the fields of communication, computers, transportation, health care, etc … which have had dramatic effects on the quality of life.

What is often forgotten is that the foundation of these achievements was laid down some time ago by scientists who were driven by intellectual curiosity and not by economic concerns.

Fundamental Science and Society





The pyramid has grown with new applications increasing its height while fundamental research continuously widens its base.

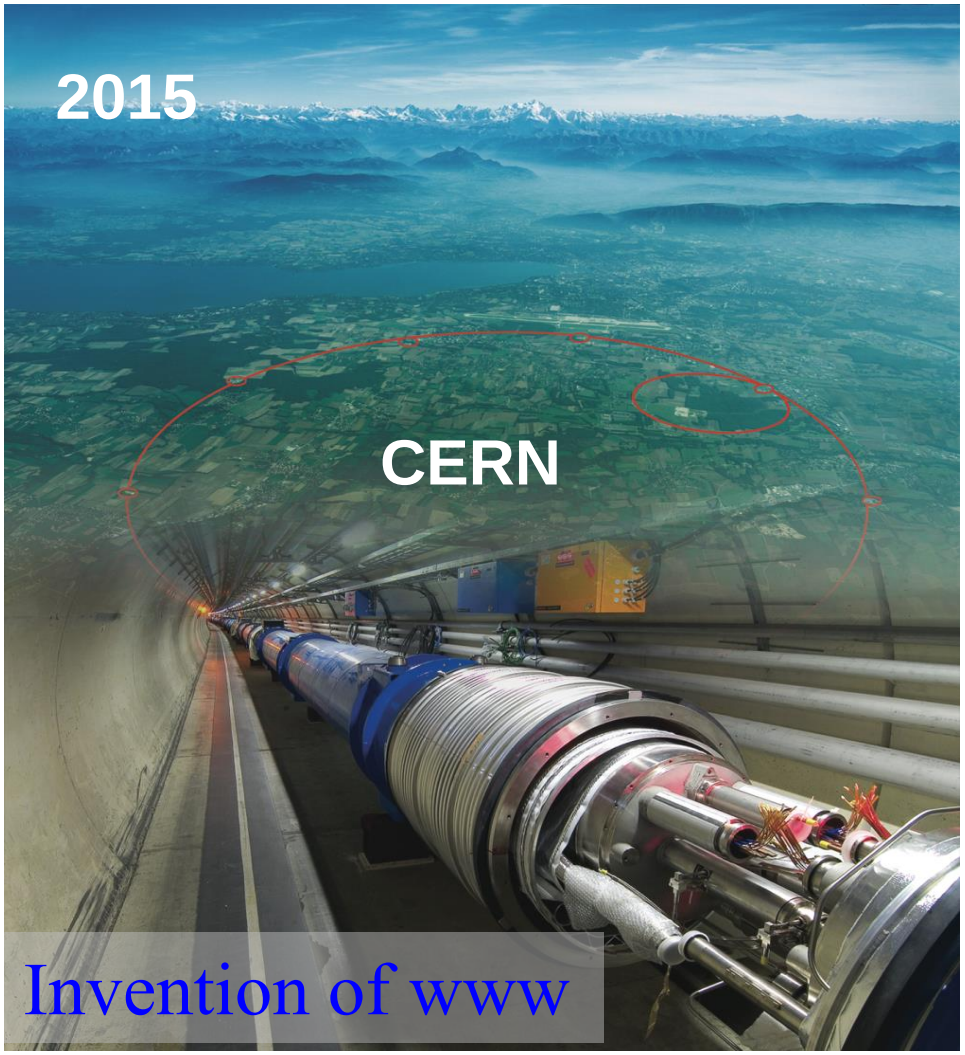
The role of basic research implies that it finds itself in the outmost corners of the pyramid and hence is sometimes disregarded as being remote from daily life.

Only after time, when applications develop and the public becomes familiar with the new phenomena, does the value of basic research become more understood.

Physics at extremely small distances
Development of Accelerators

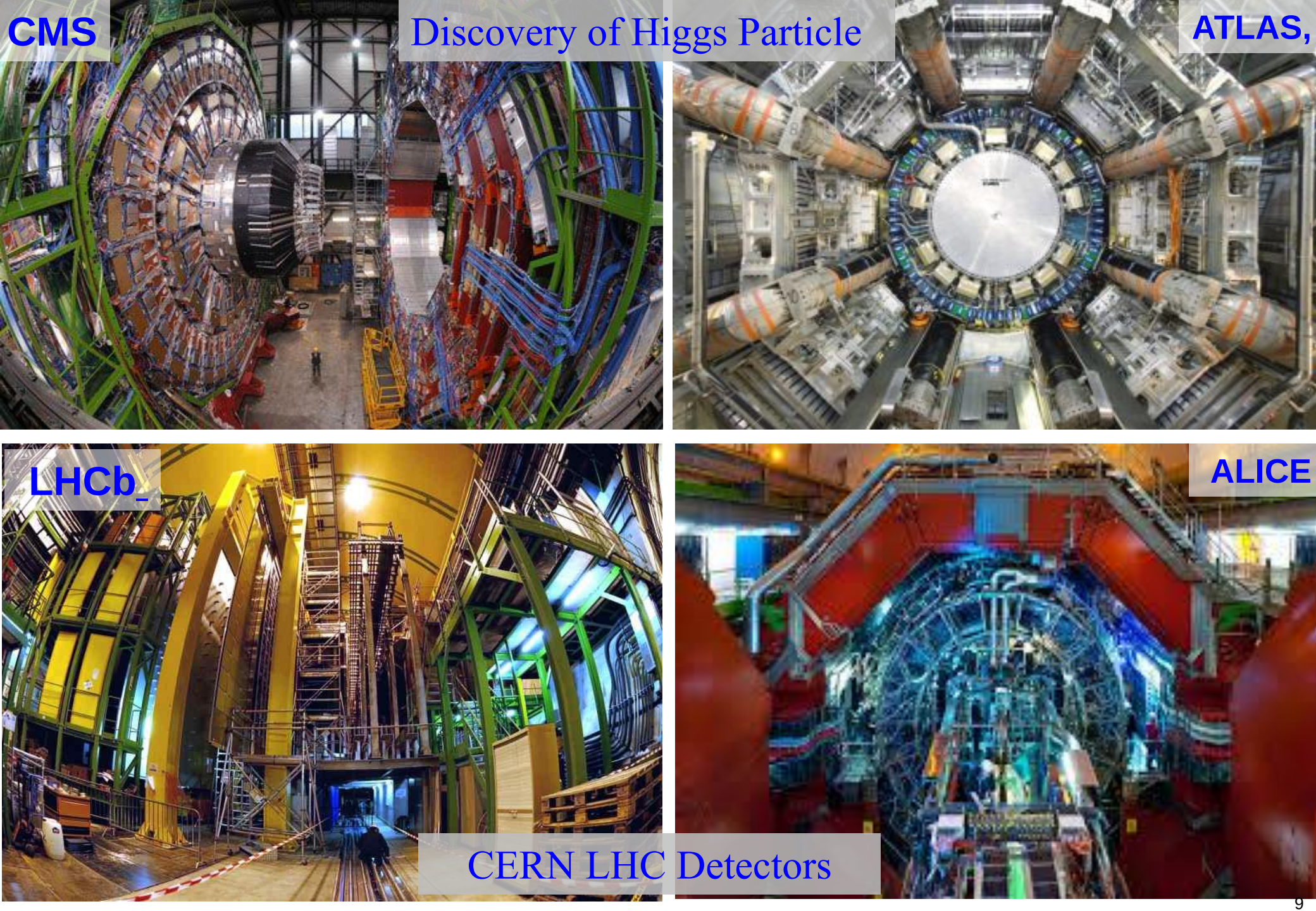
Energy: 0.0001 *eV*

Galileo's work on Gravity



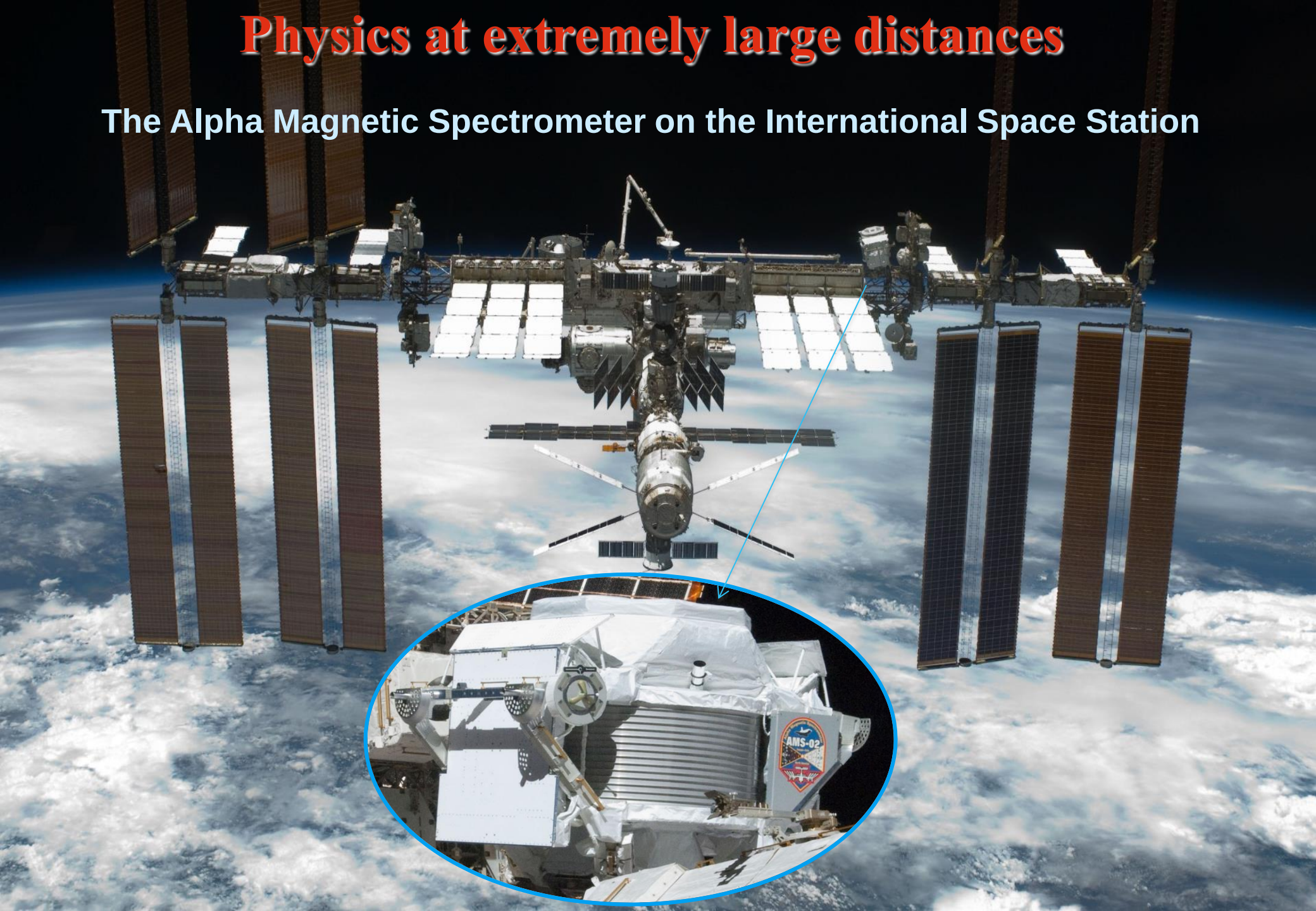
Energy: 14,000,000,000,000 *eV = 14 TeV*

Study fundamental building blocks of nature

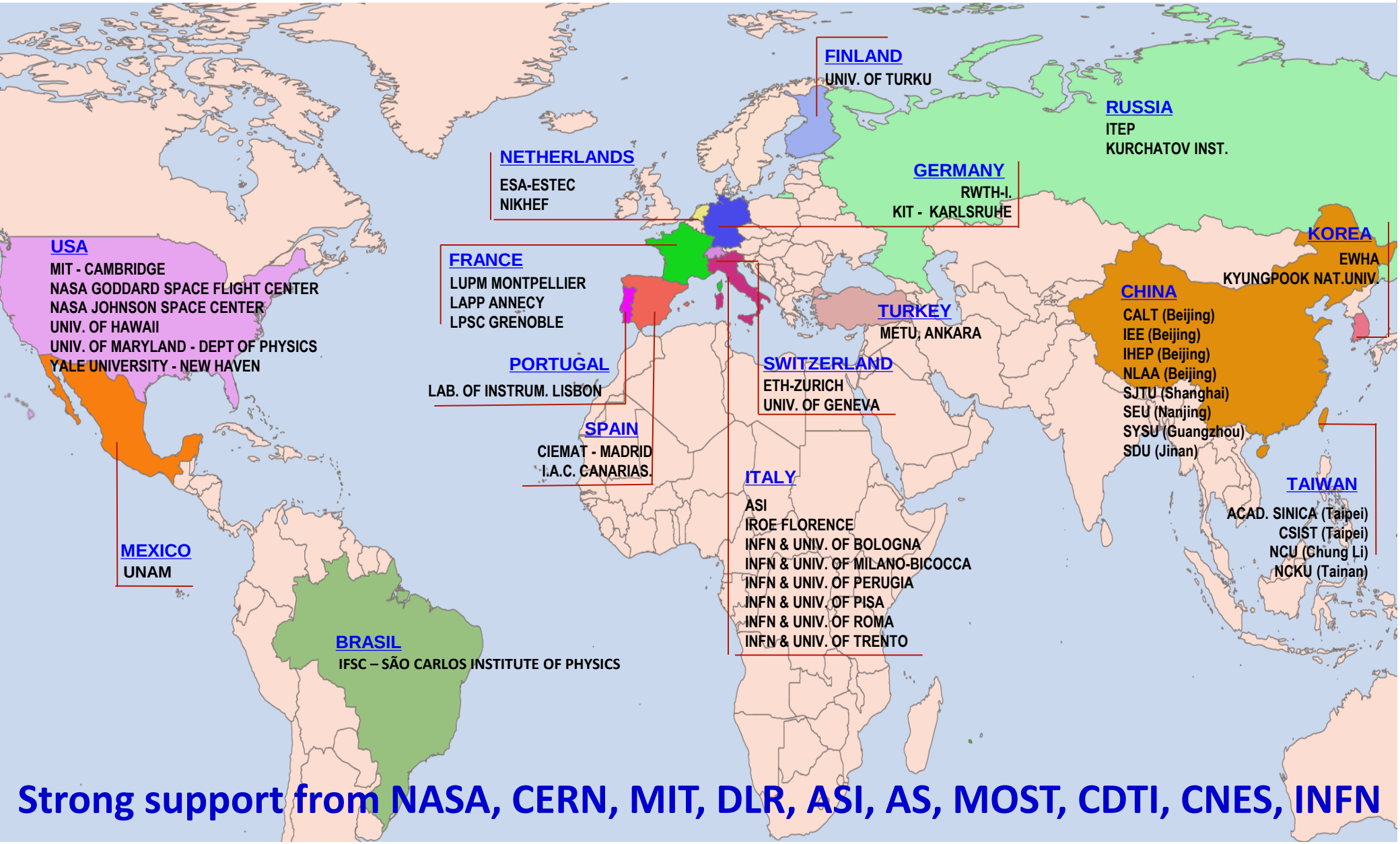

CMS
Discovery of Higgs Particle
ATLAS,
LHCb
ALICE
CERN LHC Detectors

Physics at extremely large distances

The Alpha Magnetic Spectrometer on the International Space Station



AMS: a U.S. DOE led International Collaboration
15 Countries, 46 Institutes and 600 Physicists



Strong support from NASA, CERN, MIT, DLR, ASI, AS, MOST, CDTI, CNES, INFN

300,000 electronic channels
650 processors

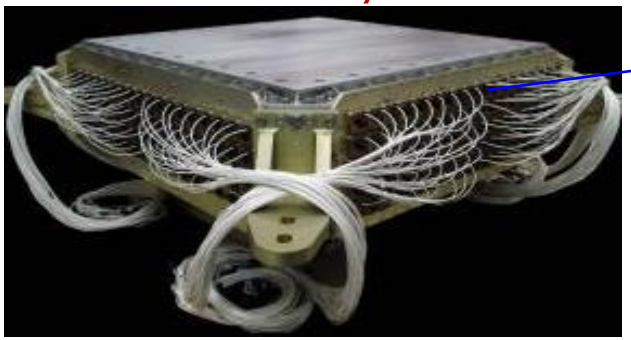
5m x 4m x 3m
7.5 tons

AMS: A trillion eV precision, multipurpose detector in space

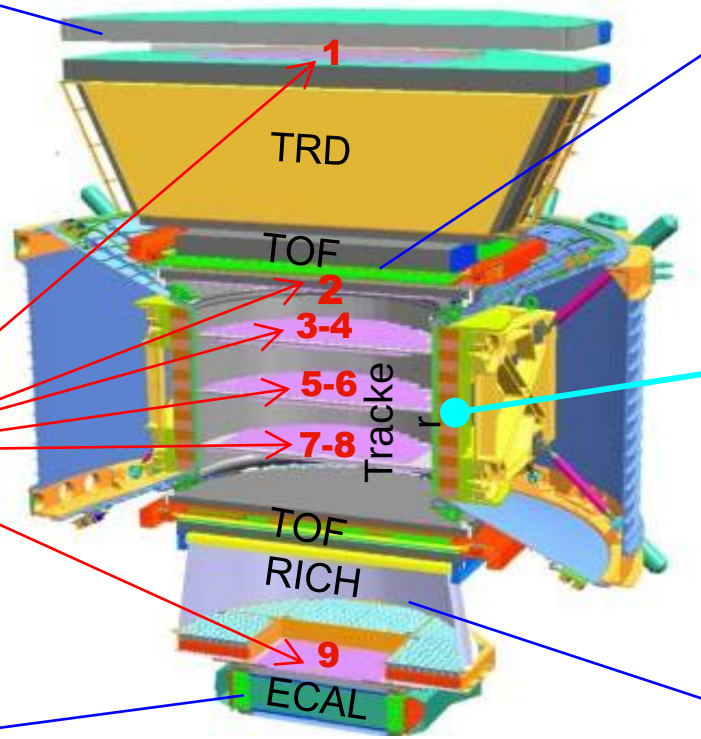
Transition Radiation Detector
Identify e^+, e^-

Silicon Tracker
Z, E

Electro-Magnetic Detector
E of e^+, e^-



Particles and nuclei are defined by their charge (Z) and energy (E)

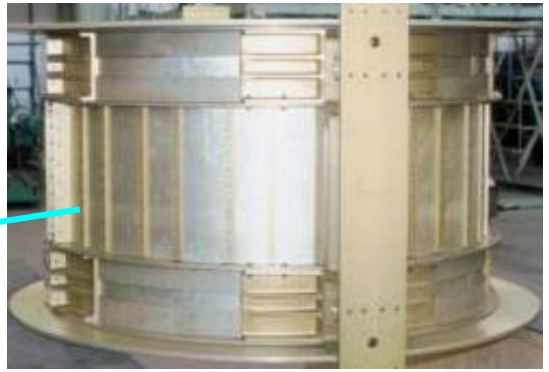


Z and E

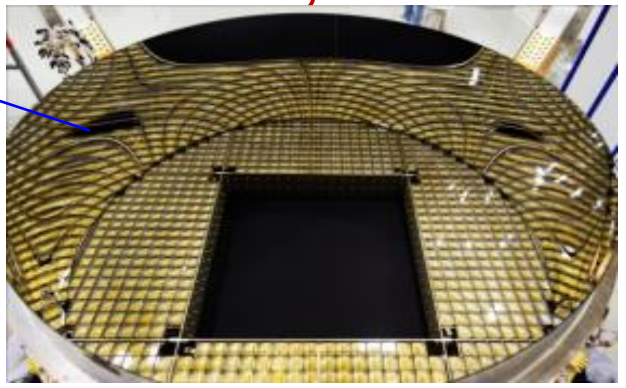
are measured independently by many detectors

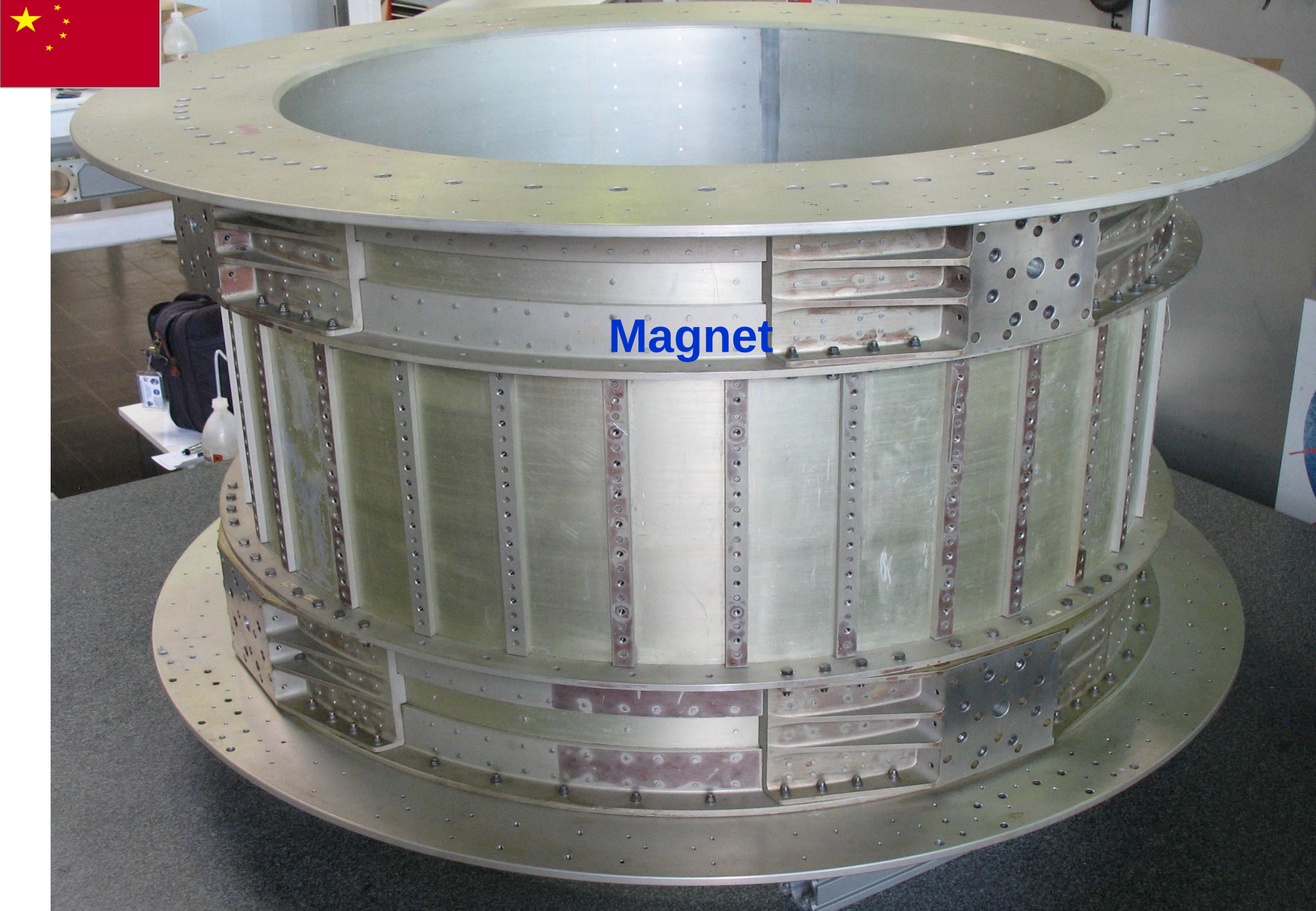
Scintillation Counter
Z, E

Magnet
±Z



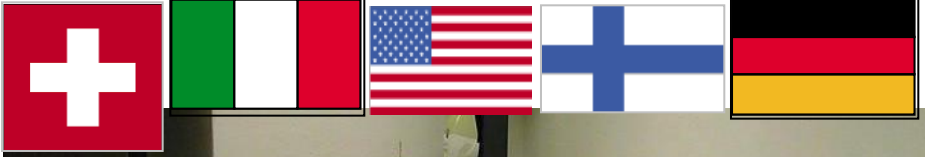
Cherenkov Detector
Z, E

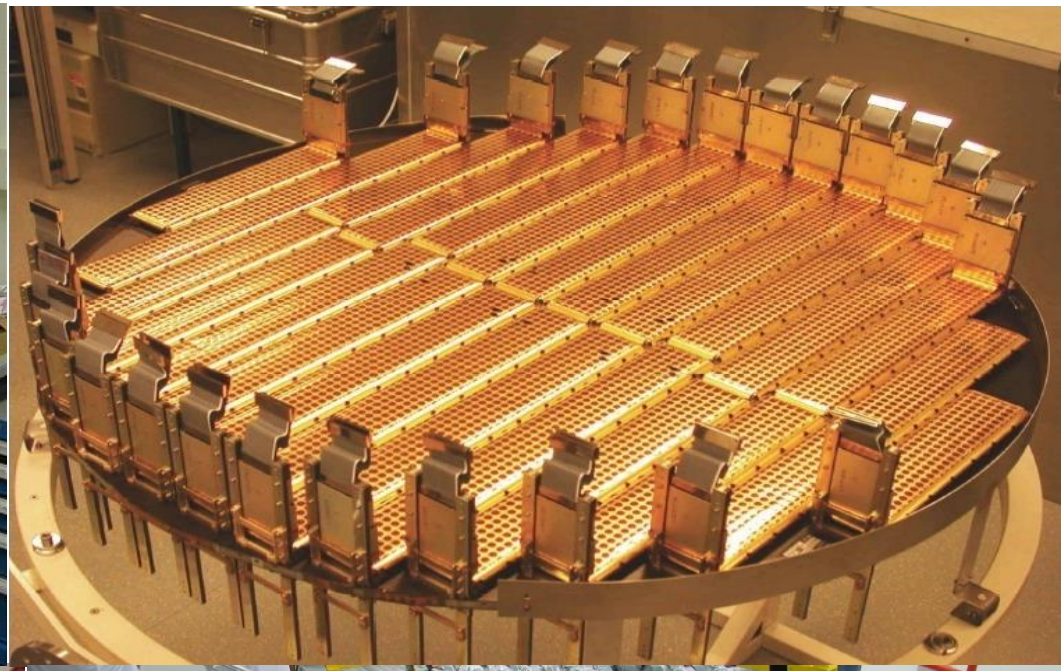


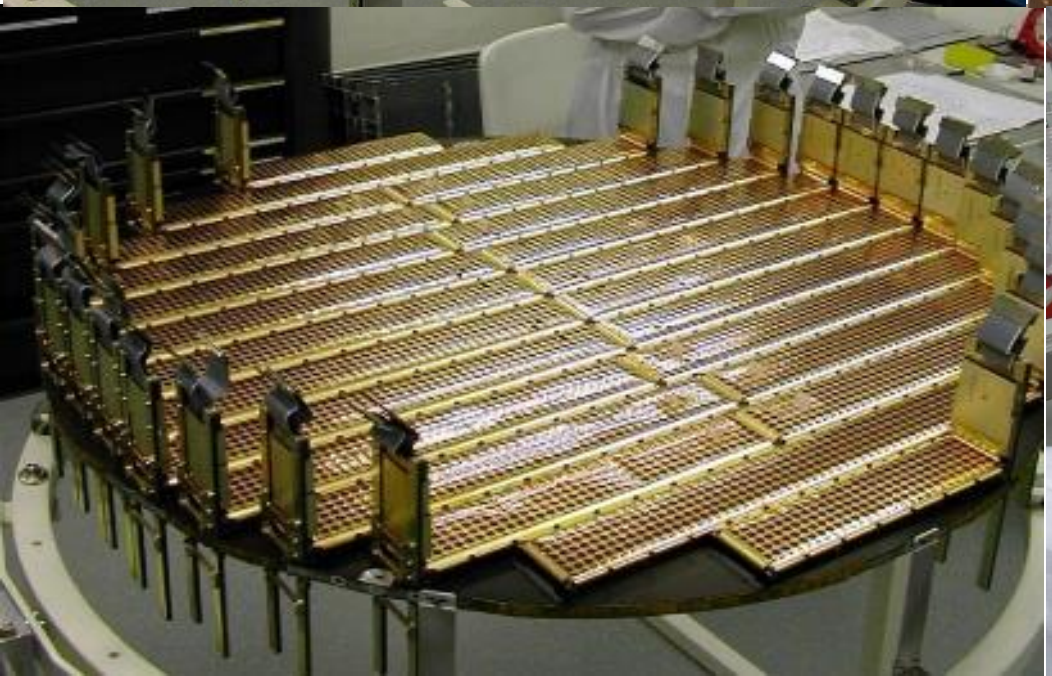

Magnet

Transition Radiation Detector

Silicon Detector

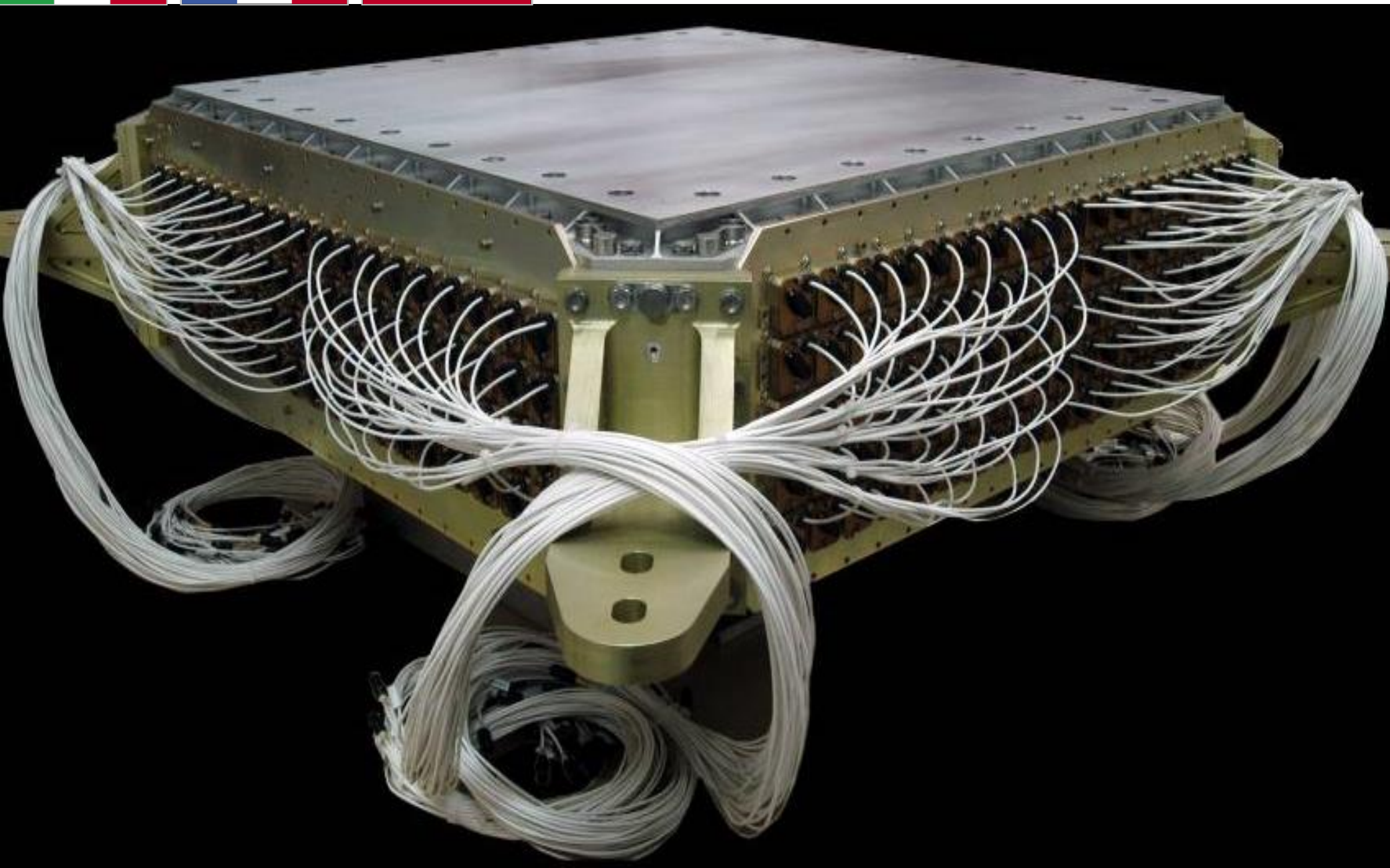




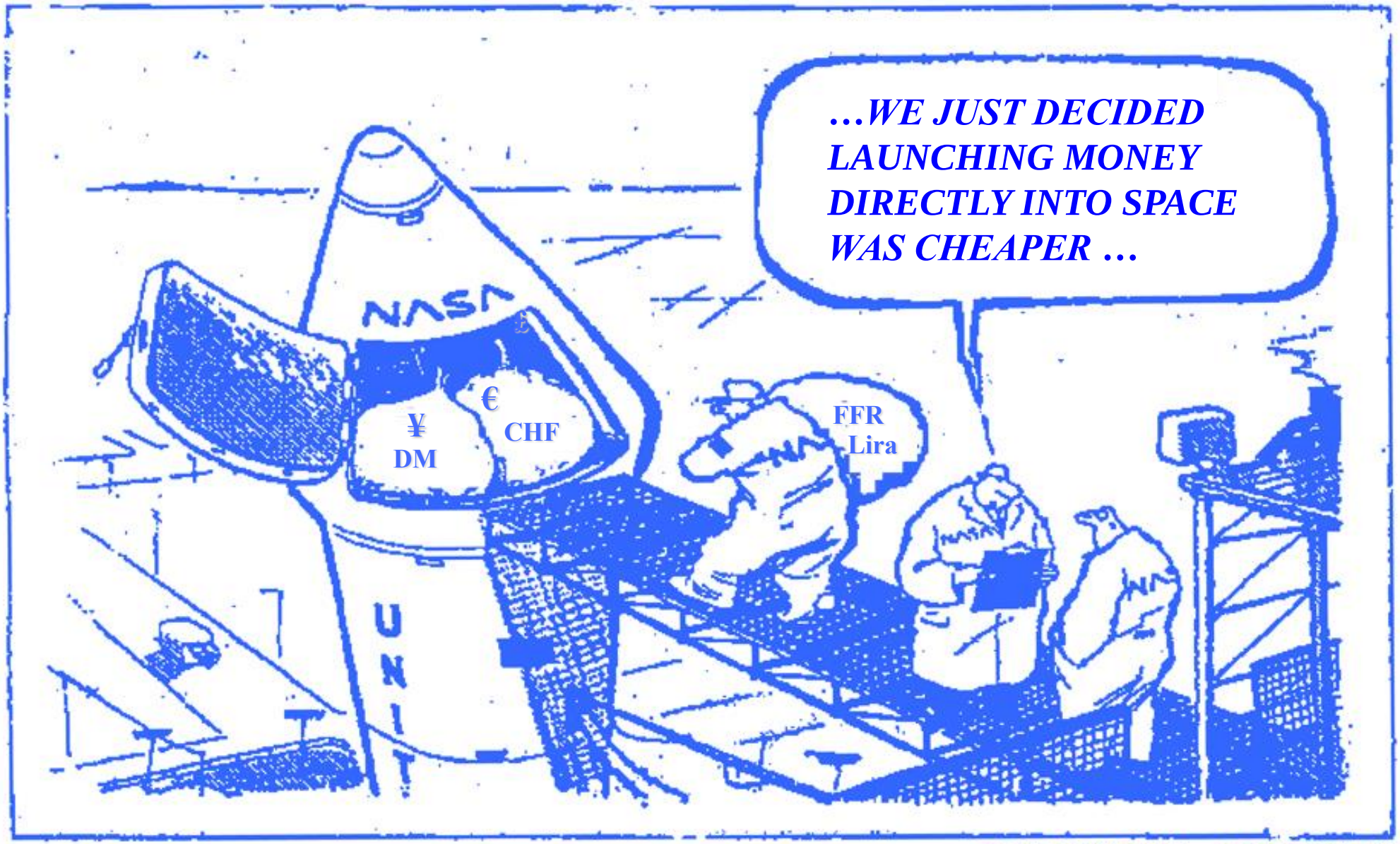


Cherenkov Detector

Electro-Magnetic Detector



Major International Collaboration



The legislation unanimously approved by the U.S. House and Senate in 2008:

Section 611 **(H.R. 6063)**

(c) ADDITIONAL FLIGHT TO DELIVER THE ALPHA MAGNETIC SPECTROMETER AND OTHER SCIENTIFIC EQUIPMENT AND PAYLOADS TO THE INTERNATIONAL SPACE STATION.—

(1) IN GENERAL.—In addition to the flying of the baseline manifest as described in subsection (b), the Administrator shall take all necessary steps to fly one additional Space Shuttle flight to deliver the Alpha Magnetic Spectrometer and other scientific equipment and payloads to the International Space Station prior to the retirement of the Space Shuttle. The purpose of the mission required to be planned under this subsection shall be to ensure the active use of the United States portion of the International Space Station as a National Laboratory by the delivery of the Alpha Magnetic Spectrometer, and to the extent practicable, the delivery of flight-ready research experiments prepared under the Memoranda of Understanding between NASA and other entities to facilitate the utilization of the International Space Station National Laboratory, as well as other fundamental and applied life sciences and other microgravity research experiments to the International Space Station as soon as the assembly of the International Space Station is completed.

www.tdg.ch
TRIBUNE DE GENÈVE
Genève Actualité
JEUDI 26 AOUT 2010
TRIBUNE DE GENÈVE

Aéroport de Cointrin. Un des plus gros avions-cargos du monde attend sur le tarmac. Il est le seul capable de transporter au-dessus de l'Atlantique le Spectromètre magnétique Alpha (AMS). (LAURENT GUIRAUD)

Vol spécial pour l'aimant chasseur d'antimatière

PHYSIQUE Assemblé au CERN, l'AMS quitte Cointrin pour la Floride d'où il doit être lancé dans l'espace en février.

ANNE-MURIEL BROUET

C'est un monstre obèse, comme avachi sur ses trains d'atterrissage. La gueule

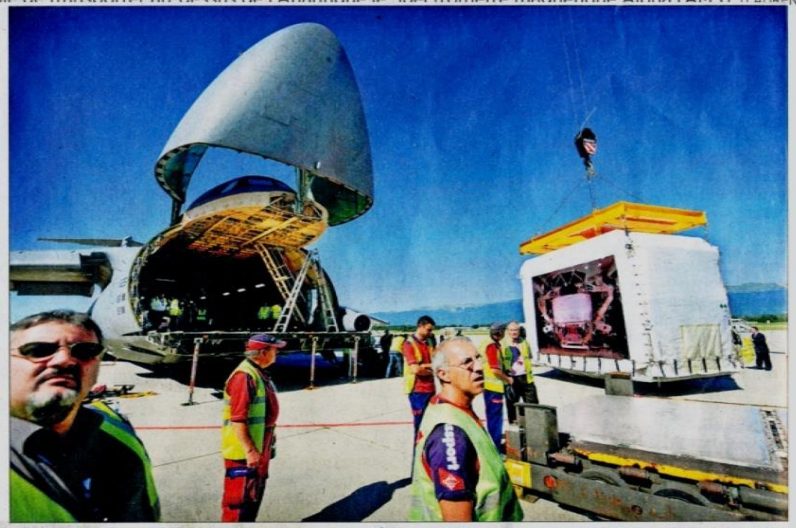
trin. Il est le seul capable de transporter au-dessus de l'Atlantique le Spectromètre magnétique Alpha (AMS), fruit de quinze ans de travail de 600 physiciens en Europe, aux Etats-Unis, en Chine, à Taïwan et en Corée. Cet instrument unique, assemblé au CERN, l'Organisation européenne pour la recherche nucléaire, traquera, depuis l'espace, l'antimatière et la matière noire soupçonnée de constituer à 90% de la masse de l'Univers.

Le chargement dans la soute a eu lieu hier. Le mastodonte a devait décoller ce matin entre 6

vrier, pour sa destination finale, la Station spatiale internationale.

Principal et unique instrument de physique sur l'ISS, AMS devrait y fonctionner durant une vingtaine d'années. Les données récoltées seront transmises, via Houston, au CERN où se trouve le centre de contrôle du détecteur.

Soixante universités et instituts, dont l'Université de Genève et l'EPFZ en Suisse, ont contribué à la réalisation de ce détecteur de 7,5 tonnes, haut de 4 mètres et large de 5, qui ne rentre pas dans des avions-cargos standard. Sa valeur totale atteint



Le Spectromètre magnétique Alpha (AMS). Il traquera, depuis l'espace, l'antimatière et la matière noire soupçonnée de constituer 90% de la masse de l'Univers. (LAURENT GUIRAUD)

de presse le porte-parole de l'expérience et Prix Nobel Samuel Ting. «Le plus souvent les dé-

TeV, dans le cosmos celle-ci peut atteindre 100 millions de TeV. L'intérêt d'être à 400 kilomètres

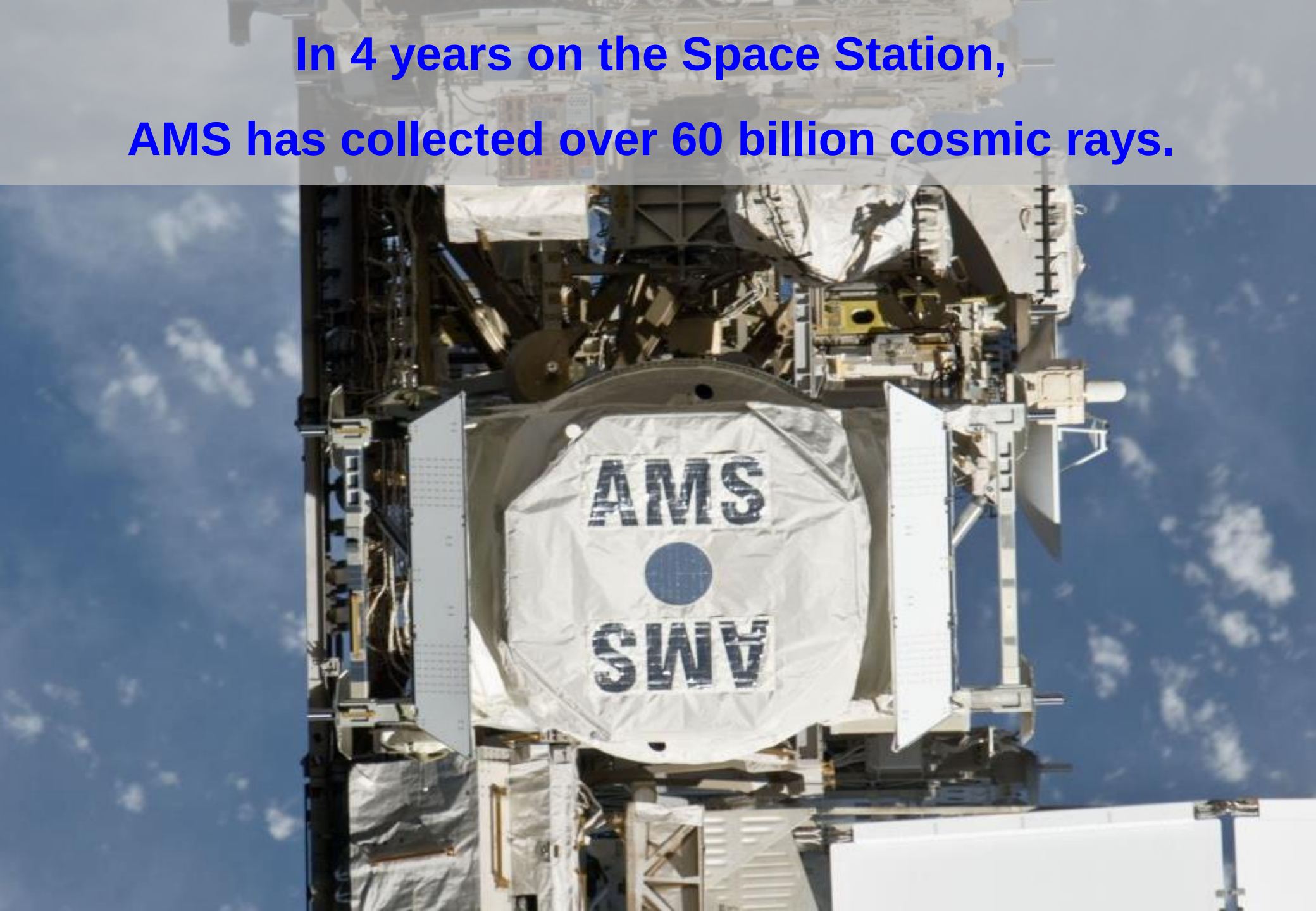
Outre l'antimatière primordiale, AMS analysera la composition des rayons cosmiques galacti-

The USAF support for the C5 flight enabled us to transport of AMS from Geneva to Kennedy Space Center, Florida

May 16, 2011, 08:56 AM

In 4 years on the Space Station,

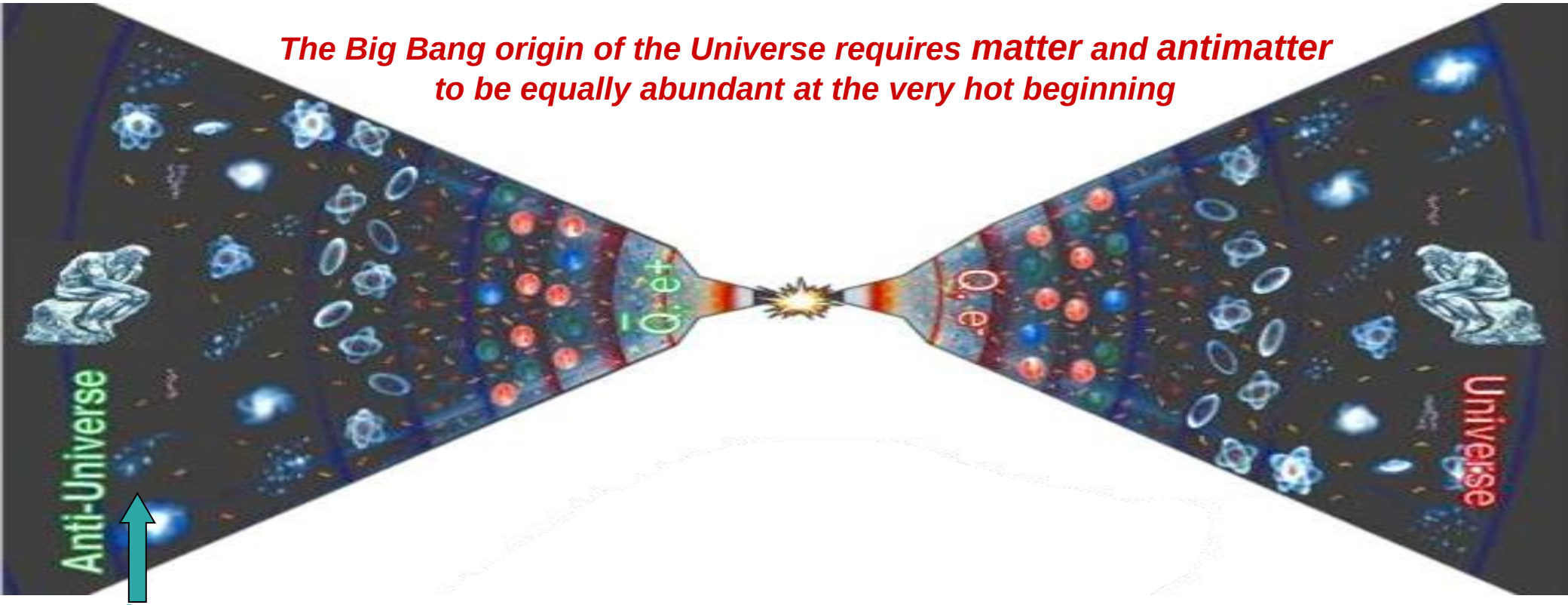
AMS has collected over 60 billion cosmic rays.



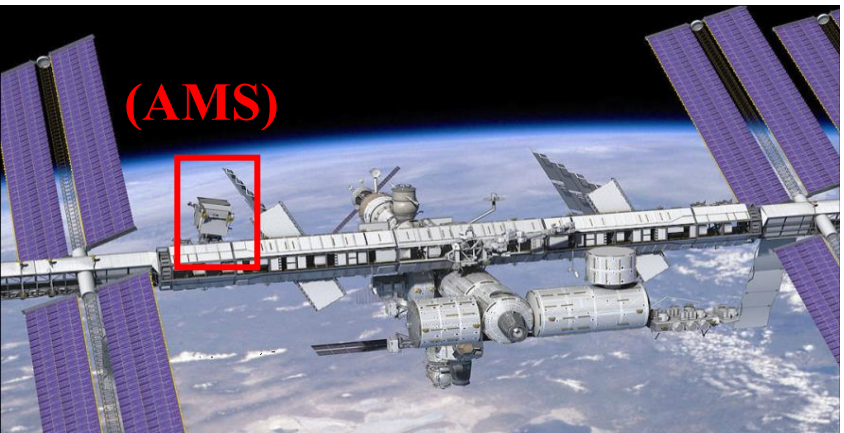
Science at extremely large distances

Search for the existence of Antimatter in the Universe

The Big Bang origin of the Universe requires matter and antimatter to be equally abundant at the very hot beginning

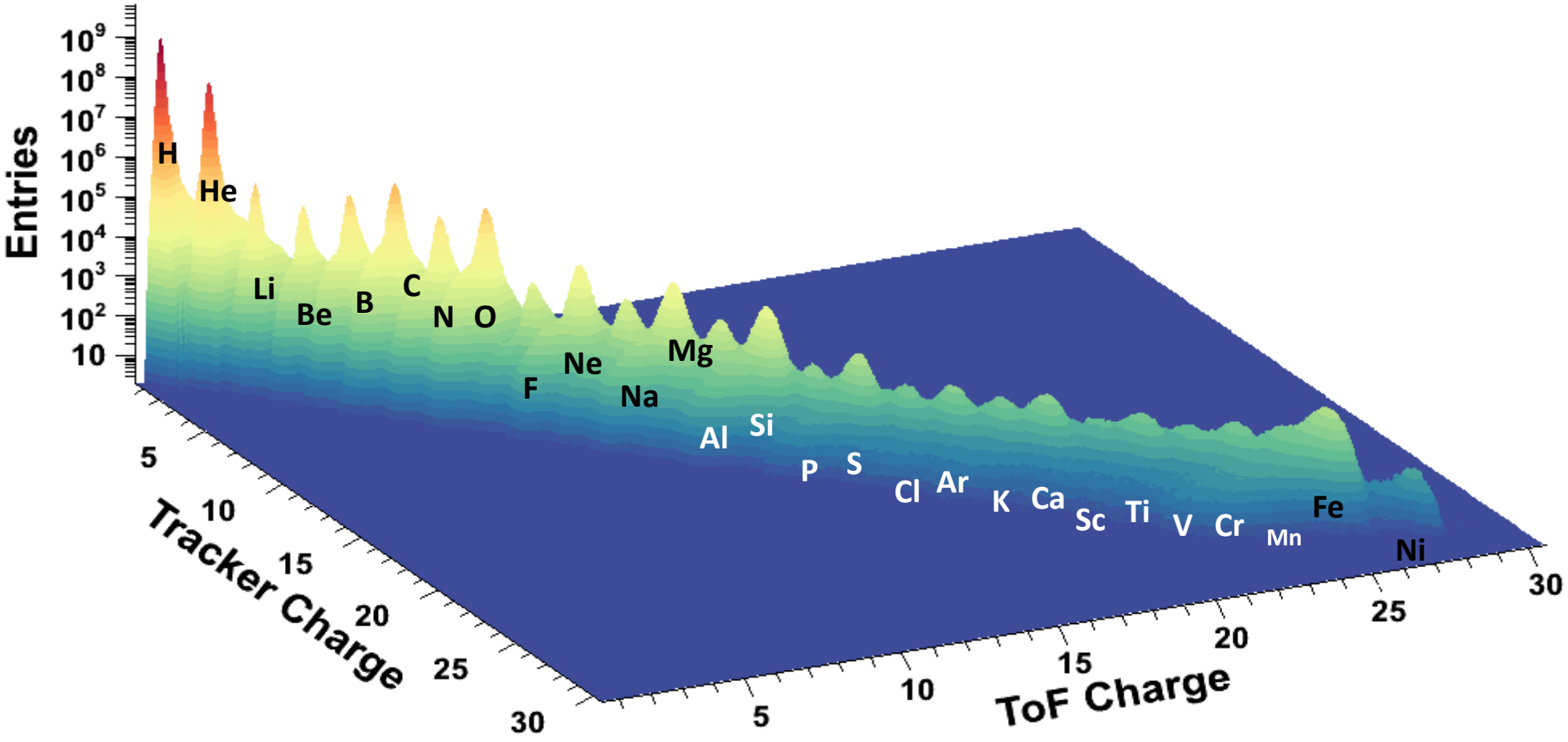


AMS in Space



AMS is searching for the existence of antimatter to the edge of the observable universe

AMS Measurement of Periodic Table



The Science of AMS includes:

Understanding the Origin of Dark Matter

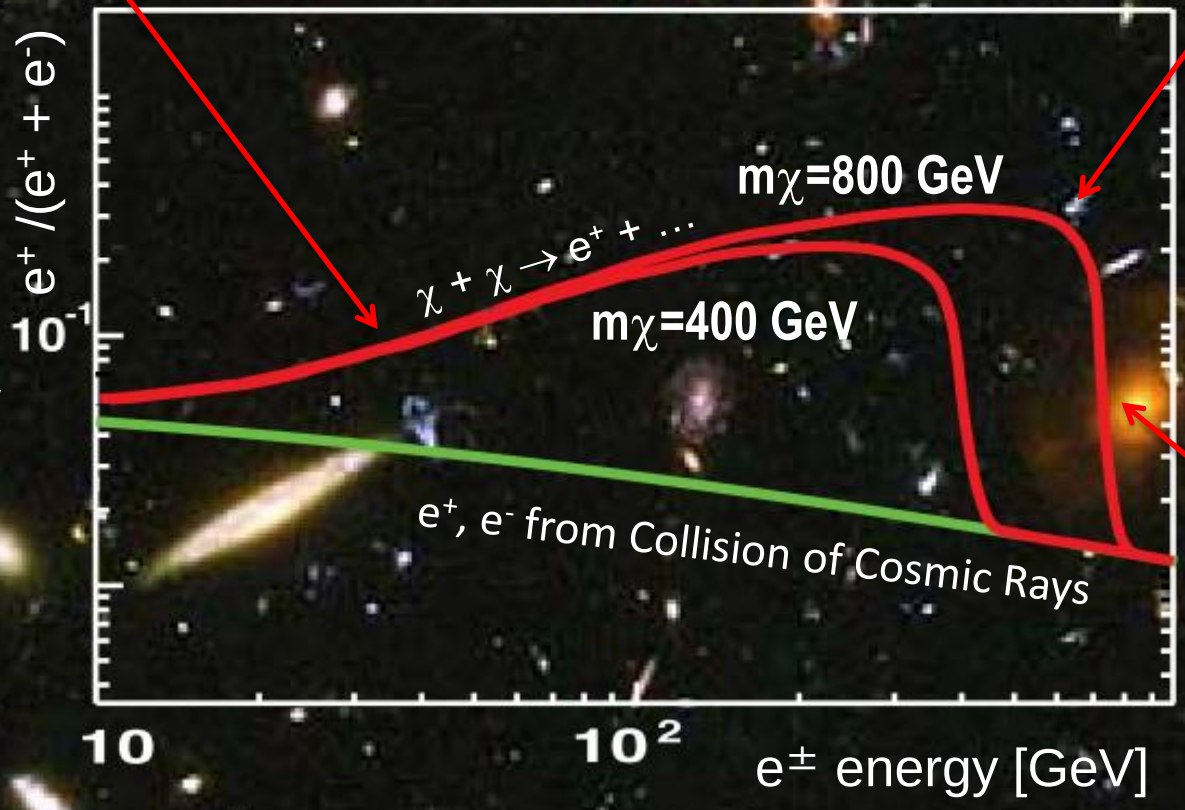
~ 90% of Matter in the Universe is not visible and is called Dark Matter

Collision of "ordinary" Cosmic Rays produce e+, ..

Collisions of Dark Matter (χ) will produce additional e+, ...

2. The rate of increase with energy

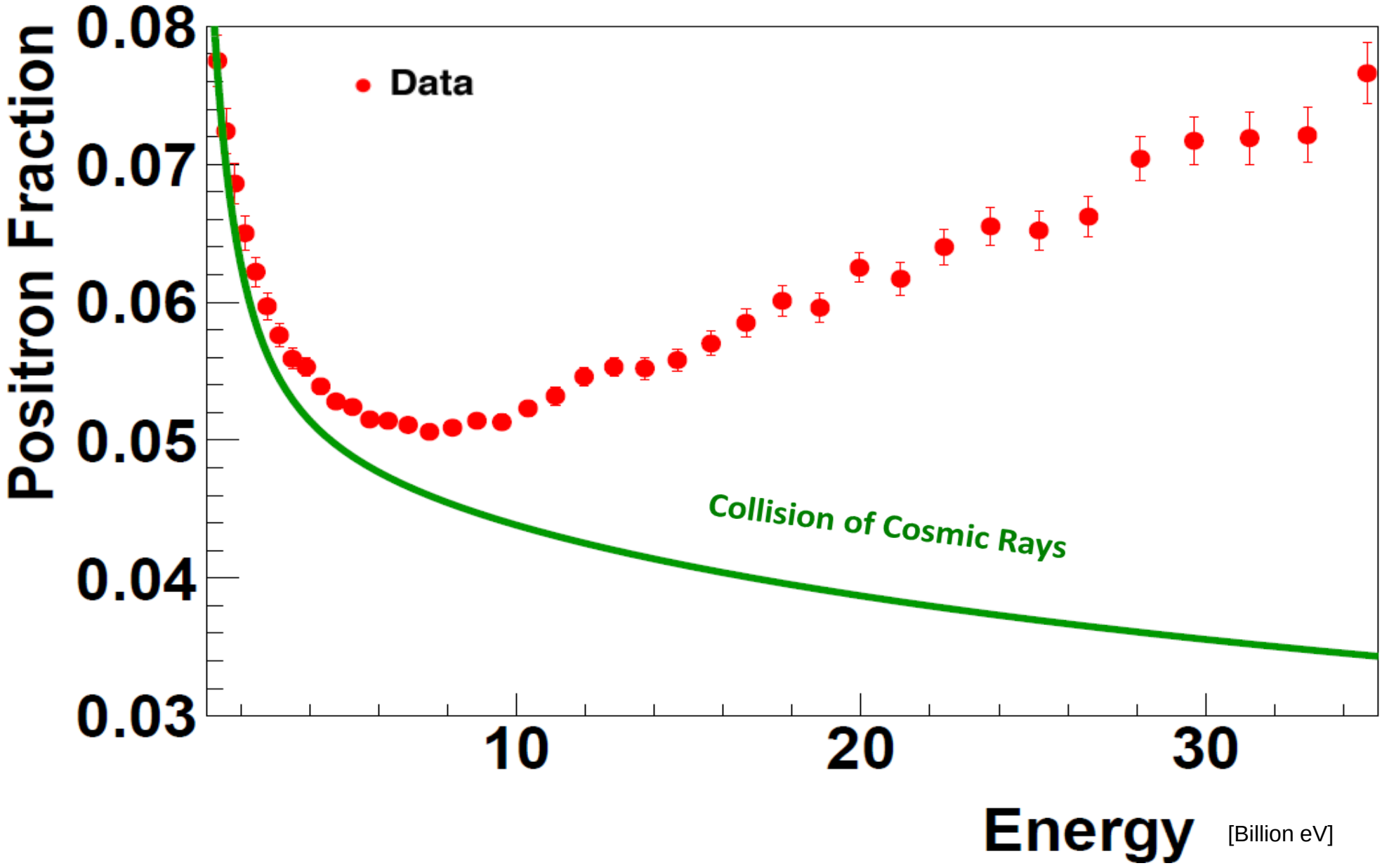
3. The turn over energy.



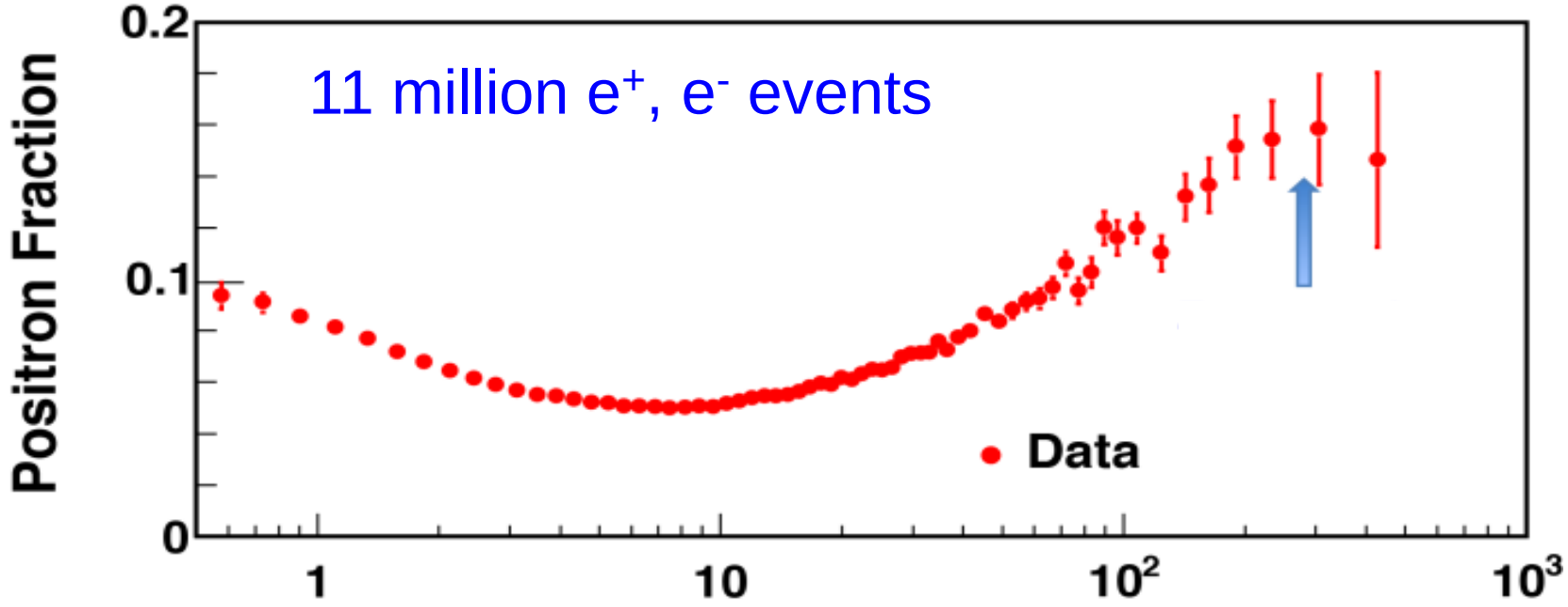
1. The energy at which it begins to increase.

4. The rate at which it falls beyond the turning point.

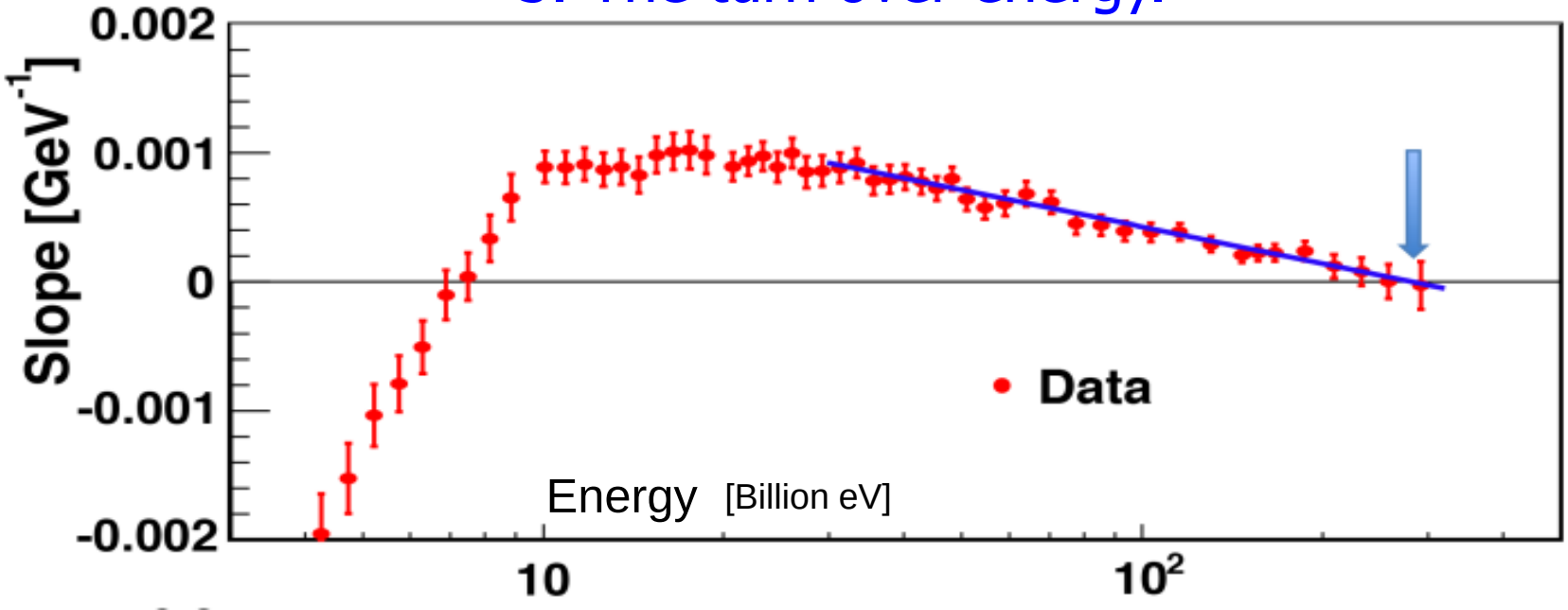
1. The energy at which it begins to increase.



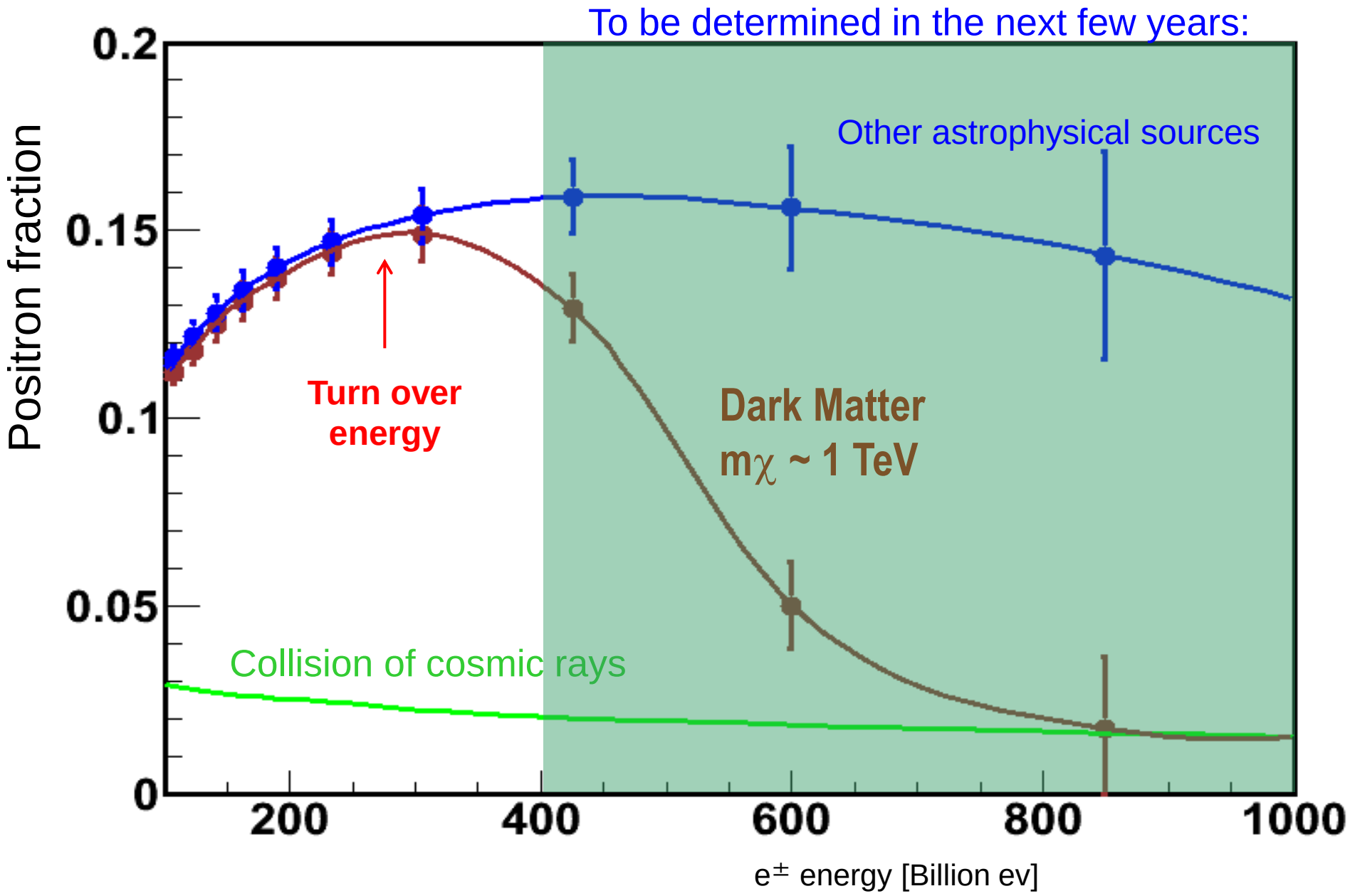
2. rate of increase.



3. The turn over energy.



4.The expected rate at which it falls beyond the turning point.



In Conclusion

The prime motivation of basic research is human curiosity - the innate passion to learn something new or obtain a deeper understanding of a natural phenomena.

Today, basic research requires high standards of education at every level and thrives on political and popular support.

Basic research also serves as a catalyst to industries in the development of new technologies. Spin offs from basic scientific research, although difficult to predict in advance, have had a profound effect on the quality of life.

Basic scientific research is the foundation from which knowledge is advanced and technological development is propelled and should be supported.