The Higgs boson

SA104X Degree Project in Engineering Physics, First level

Department of Physics
School of Engineering Sciences
Royal Institute of Technology (KTH)

Jennifer Arnesson

Supervisor: Jonas Strandberg

Abstract

In this essay the standard model of particle physics and the Higgs boson are discussed. It also contains information about CERN, the particle accelerator LHC and the ATLAS detector, all used in the search for the Higgs boson. Results on the Higgs boson searches from ATLAS are presented using three different data volumes at different times during last year. These results will also be simplified by plots showing the excluded masses from the Higgs boson searches. The results are also used for searching for a dependency between different results and datasets and to use that to extrapolate to what we can expect to see this year. It is found that the dependency is linear with the size of the dataset and fits very well to the data points. As well the dataset size for which the Higgs mass 115 GeV could be excluded from the search has been predicted.

Isotope and element analysis of a meteorite using neutron activation

Sara Aschan and William Vågberg
saschan@kth.se, wvagberg@kth.se
SA104X Degree Project in Engineering Physics, First Level
Supervisor: Torbjörn Bäck
Department of Physics
School of Engineering Sciences
Royal Institute of Technology (KTH)

Abstract

Iron meteorites formed very early in the history of the solar system and can thus reveal information of its youth, as well as clues to the composition of the Earth's core. In this thesis, the elemental and isotope composition of the iron meteorite found in Smithville, Tennessee, in 1840, is analyzed. For this purpose, the method of neutron activation followed by gamma ray spectroscopy is used. In this method, the meteorite is exposed to thermal neutrons, which interact with the nuclei in the meteorite. Due to the interaction, the meteorite emits gamma radiation. This radiation is measured and used to determine the composition of the elements and isotopes in the meteorite.

Background Decomposition for the Search of a Higgs Boson decaying into two Photons

Katarina Atteryd, Amanda Renström
Supervisor: Rémi Lafaye
Department of Physics

Abstract

Higgs decaying to two photons ($\gamma\gamma$) is one of the main channels for discovering the Higgs boson at a low mass around 120 GeV. The background in the Higgs to $\gamma\gamma$-channel consists of irreducible standard model $\gamma\gamma$-production and reducible jet misidentified as photons. To understand the background composition in $\gamma\gamma$, γ-jet and jet-jet categories, a 2D Side Band method is used. The large number of parameters when taking correlations into account, make the system of equation from the 2D Side Band method very hard to solve. A χ^2-fit is therefore used to solve the system.

Sammanfattning

En av de viktigaste sönderfalls kanalerna för att upptäcka Higgs bosonen med en låg massa, runt 120 GeV, är att Higgs sönderfaller till två fotoner ($\gamma\gamma$). Vid analys av händelser i sönderfallskanalen störs analysen av bakgrund som består av irreducibel produktion av $\gamma\gamma$ och reducibel identifiering av jets som fotoner. För att förstå hur bakgrunden är sammansatt i $\gamma\gamma$, γ-jet och jet-jet kategorier, användes 2D Side Band metoden. Ur metoden fås ekvationer som består av ett stort antal parametrar, vilket gör ekvationerna väldigt svåra att lösa. Därför används en χ^2-fit för att hitta en numerisk lösning till systemet.

Radioactive consequences in Japanese food and Swedish air after the nuclear disaster in Fukushima, Japan

Cecilia Bruhn and Nina Ranggård
Supervisor: Torbjörn Bäck
Department of Physics

Abstract

The aim with this thesis was to study some effects in Sweden of the nuclear disaster the 11th march 2011 in Fukushima, Japan. Large amounts of radioactive isotopes were released in the surroundings when the disaster occurred. The isotopes spread not only within Japan but also around the world. Therefore, it is interesting to investigate the effect on Swedish air after the disaster and the potential content of radioactive isotopes in food produced and imported from Japan. Analysis was performed on five air spectrums assembled in Stockholm, Sweden after the disaster. The time range for the air spectrums were three to thirteen weeks after the disaster. The gamma peaks in the spectrums were analysed with a program called gf3 from the RadWare software package. The program enabled determination of the energy of the peaks and the amount of decays in each peak. Furthermore, Japanese food was studied. A germanium detector enabled measurements of gamma radiation in three different food samples. The food samples were rice, tea and dried gourd; which is related to cucumber. The gamma spectrums from the food was also analysed with gf3. Cesium-137 and Iodine-131 were anticipated in both the food and the air since those isotopes are products of nuclear fission. Iodine-131, Cesium-134, Cesium-136, Cesium-137, Europium-155, Promethium-146, Rubidium-86, Tellurium-132 and Xenon-133 were discovered in the air and a time dependence of the amount of isotopes in the air was accomplished. A small but notable amount of Cesium-137 was discovered in the food. Potassium-40 was also discovered in the food but exists naturally in food and was thus not a product from the disaster. Matching isotopes was not found for several energies in both the air and food samples.

TRACE simulation of HWAT-loop - Abstract

Ola Roos och Ante Hultgren

oroos@kth.se antehu@kth.se

Supervisor: Henryk Anglart Examiner: Björn Cederström

Department of Physics: Division of Nuclear Reactor Technology

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Efter upptäckten av termisk utmattning i kontrollstavar i Forsmark 3 och Oskarshamn 3 fick KTH i uppdrag att undersöka fenomenet genom experiment i deras High-pressure Water Test-loop(HWAT- loop). En säkerhets uppskattning behövde göras i TRACE innan de verkliga experimenten påbörjades. TRACE är ett kraftfullt program som kan simulera förhållanden i en riktig reaktor genom numeriska beräkningar.

Den modellen som representerar HWAT-loopen på KTH byggdes genom att omskapa Igor Trisics modell. Bland annat kompletterades t-korsningar, värmestrukturer och en extra ventil. System för att styra de fem grundläggande komponenterna byggdes ut och anpassades till HWAT-loopen.

18 grundläggande förhållanden av massflöden och temperaturer på vattnet simulerades i TRACE innan tre övergående fall undersöktes. De tre fallen representerade extrema osannolika förändringar som skulle kunna inträffa i HWAT-loopen. Efter att ha analyserat resultatet fastställdes det att experiment i HWAT-loopen är säkra att utföra.

Temperature Measurements in Fusion Plasmas

Georgios Iatropoulos and Tien Nguyen
ggi@kth.se, tien@kth.se
SA104X Degree Project in Engineering Physics, First Level
Department of Physics
Royal Institute of Technology (KTH)
Supervisor: Prof. Elisabeth Rachlew

May 2, 2012

Abstract

Fusion energy has the potential of becoming one of the most important sources of energy in the future. Compared to most sources available today, fusion is safer, more environmentally sustainable and the fuel is in abundance. This thesis briefly treats the basic physical principles of fusion energy and the basic principles of magnetic confinement fusion reactors, and proceeds with an in-depth discussion of the most common methods in plasma temperature diagnostics. An analysis of a plasma emission spectrum from the EXTRAP T2R experiment is performed in MATLAB using Doppler broadening to obtain the O V ion temperature. The temperature is found to be approximately 100 eV, which is a satisfying result given the experimental circumstances.

Sammanfattning

Fusionsenergi har potentialen att bli en av framtidens ledande energikällor. Jämfört med de flesta av dagens energikällor är fusion säkrare, miljövänligare och har väldigt stora bränslereserver. Denna avhandling behandlar i korthet de grundläggande fysikaliska principerna för fusionsenergi och fusionsreaktorer med magnetisk inneslutning, och fortsätter med en grundlig redogörelse för de vanligaste metoderna inom plasmatemperaturdiagnostik. En analys av ett emissionsspektrum från plasmat i EXTRAP T2R utförs i MATLAB användandes Dopperbreddning i syfte att bestämma jontemperaturen för O V. Temperaturen beräknas till cirka 100 eV, vilket är ett tillfredställande resultat givet de experimentella förutsättningarna.

The search for the Higgs boson

Niclas Löfblad

Handledare: Jonas Strandberg

Institutionen för Fysik

Abstract

In the standard model all force carrying particles are stated to be without mass according to gauge theory. In reality though, the particles that mediates the weak force have mass. This problem was solved by Peter Higgs in 1964 with something called the Higgs field which is a field with energy even in total vacuum. This energy is transferred to the particles which gives them their mass according to Einstein's formula $E=mc^2$. The Higgs boson is the carrying particle for this effect which gives mass to particles without violating gauge theory.
The search for the Higgs Boson was started with projects like LEP and Levatron where they could exclude some of the lower masses of the Higgs boson. With the LHC CERN has a much more powerful tool to search up to masses of 600 GeV whereas LEP only reached 115 GeV. With only about half of the power available at LHC, CERN has excluded all but a small band of masses where the Higgs Bosons mass can exist. It is prophesied that the Higgs boson will be found this year according to CERN.
This thesis will cover what the Higgs boson is, how the searching for the Higgs boson works, how far the search for the Higgs boson has come and present the results that have been published. Also some information about the standard model, CERN and LHC and branching ratios, feynman diagrams and luminosity is covered.