

# GHEORGHE LUNGU

## Curriculum Vitae

### Office Address

Fermilab  
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### EDUCATION

**Ph.D. in Physics, August 2007.** Gainesville, FL  
University of Florida  
Advisor: Jacobo Konigsberg  
Thesis: *Measurement of the Top Quark Mass at CDF in the All Hadronic Channel.*

**B.A. in Physics, June 2000.** Bucharest, Romania  
University of Bucharest

### RESEARCH EXPERIENCE

**Postdoctoral Associate** 11/2007 – present  
Experimental High Energy Physics, Goulianos Lab, The Rockefeller University.

Co-leader of the JetMET trigger subgroup of the CMS experiment.  
Search for SUSY in the all hadronic final state at CMS.  
Responsible for validation and performance of MET at CMS.

**Research Assistant** 05/2003 – 11/2007  
Department of Physics, University of Florida.

Performed original research in Top Quark Physics at the CDF experiment.  
Studied heavy flavor production in jets.  
Worked on simulation and operation of the CDF Cherenkov Luminosity Counters.

### ACADEMIC HONORS

**LPC Junior Fellow** 2012  
LHC Physics Center, Fermilab.

**George Michail Memorial Prize** June 2007  
Fermilab Users Meeting, Poster Session.

**Certificate of achievement for outstanding academic accomplishments** 08/2002 – 08/2006  
Department of Physics, University of Florida.

**Outstanding International Student Award** April 2006  
Department of Physics, University of Florida.

**Physics Department Teaching Assistant of the Year** December 2002  
Department of Physics, University of Florida.

## CONFERENCE TALKS

**Lake Louise Winter Institute, February 2012** Lake Louise, AB, Canada  
“Search for supersymmetry at the CMS in all-hadronic final state”

**Searches for SUSY at the LHC, October 2011** Berkeley, CA  
“Searches for Jets + missing Et with no leptons at CMS”

**First LHC Data, August 2010** Cambridge, MA  
“Understanding of Missing Et in CMS (in view of SUSY)”

**DPF Meeting, July 2009** Detroit, MI  
“Search for supersymmetry at the CMS in all-hadronic final state”

**The USCMS JTERM III Workshop, January 2009** Batavia, IL  
“Missing Transverse Energy (MET) at CMS.”  
“Estimation of the invisible Z+jets background using Z(- $\bar{\nu}\nu$ ) + jets samples.”  
“Study of triggers for hadronic SUSY search.”

**Physics at LHC, September 2008** Split, Croatia  
“SUSY at LHC.”

**APS April Meeting 2007** Jacksonville FL  
“Measurement of the Top Quark Mass at CDF in the All Hadronic Channel.”

**CDF Collaboration meeting, February 2007** Batavia IL  
“Measurement of the Top Quark Mass at CDF in the All Hadronic Channel.”

## WORKSHOPS AND SUMMER SCHOOLS

### CMS Data Analysis School

Fermilab, January 12 - 14, 2012

Theme: “Hadronic SUSY exercise”

### Workshop on Searches for SUSY at the LHC

UC Berkeley, October 19 - 21, 2011

Theme: “Searches for SUSY at the LHC”

### First LHC Data

MIT, August 10 - 13, 2010

Theme: “Implications of First LHC Data: a joint Berkeley-MIT workshop”

### SLAC Summer Institute

SLAC National Accelerator Laboratory, August 3 - 14, 2009

Theme: “Revolutions on the horizon: A decade of new experiments”

### The USCMS JTERM III Workshop

Fermilab, January 12 - 16, 2009

Theme: “Introduction to the CMS detector and the LHC physics”

### The Hadron Collider Physics Summer School (HCPSS)

Fermilab, August 9 - 18, 2006

Theme: “Physics potential of the first years of data taking at the LHC”

## DETECTOR OPERATIONS

### CMS DQM Offline Shift

August 2010, June 2011, April-May 2012

Monitored CMS collision data in all subdetectors at the CMS experiment.

**CMS HCAL Shift** May 2009, July 2010  
Monitored and analyzed the trigger data based on the hadronic calorimeter during periods of cosmic ray data taking at the CMS experiment.

**CDF Beam Shower Counters** Nov. 2007 - present  
Responsible for the operation, calibration and monitoring of the Beam Shower Counters used in the measurement of beam losses at CDF.

**CDF Ace Shift** Jan. 2007 - April 2007  
Operated the CDF data acquisition and online detector monitoring systems.

**CDF CO Shift** 12/2003, 03/2005, 10/2006  
Monitored CDF data quality in real time.

**CDF Luminosity Detector** 2002-2007  
Member of the team that monitored the luminosity measurement at CDF.

## TEACHING EXPERIENCE

**Teaching Assistant** 08/2001 – 05/2003  
Department of Physics, University of Florida.  
Taught lab sessions, held office hours, and graded lab reports for Introductory Physics I (PHY2048L, PHY2053L).

## PROFESSIONAL MEMBERSHIPS

American Physical Society (APS)

## RESEARCH SKILLS

**Qualities:** Motivated, hardworking, organized, amicable, natural leader.

**Languages:** Romanian (mother language); English (fluent); French, Italian, Spanish, German (basics).

**Programming:** C++, Fortran, HTML, L<sup>A</sup>T<sub>E</sub>X, Linux Bash shell, Python.

**Monte Carlo tools:** PYTHIA, HERWIG, CompHep, Alpgen, MadGraph.

**Analysis software:** ROOT, CDF software, CMS software.

# RESEARCH ACTIVITIES

Gheorghe Lungu

The research topic I am currently working on is the search for supersymmetric (SUSY) particles at the CMS experiment located at CERN. At CMS I am also leading the group working on the development and maintenance of triggers using jets and missing transverse energy (MET). Below I give more details on each of these projects listed in a more or less chronological order.

## Search for SUSY particles at CMS

Despite its success in describing the elementary particles and their interactions, the standard model (SM) has its shortcomings. The recently discovered Higgs-boson-like resonance at a mass of 126 GeV at the LHC is in the process of being confirmed experimentally as the SM Higgs boson or as belonging to some other possible scenario. One obvious SM limitation is the lack of modeling of gravity, a fundamental interaction between particles with masses. Another limitation is its inability to account for the observed dark matter in the universe. These shortcomings point to the need of expanding the SM to include explanations for gravity and dark matter.

One highly favoured extension of the SM is Supersymmetry (SUSY), which postulates a symmetry between fermions and bosons. In this theory all existing SM elementary particles have their own super-particle-partner with identical properties except for the value of the spin. Besides predicting the super-partners to the SM particles, SUSY predicts the existence of additional new particles among which one represents a dark matter candidate. With all its predicted particles, SUSY theoretical calculations for the mass of the Higgs boson predict an upper bound of 135 GeV that is consistent with the newly discovered 126 GeV boson. The hierarchy and fine tuning problem of the SM are naturally solved in SUSY. Also gravity is naturally incorporated into SUSY by postulating the existence of two new particles.

Given that no SUSY particles have been detected points to SUSY being a broken symmetry. There are several ways in which this symmetry can be broken, corresponding to several SUSY models. The most appealing and studied SUSY model is the Minimal Supersymmetric Standard Model (MSSM). In this theory there are several ways through which the SUSY breaking can occur, some of which involve gravity. The minimal supergravity MSSM model (mSUGRA) is one of the most widely investigated models of particle physics due to its predictive power requiring only four input parameters and a sign to determine the accessible low energy phenomenology.

At CMS, I am working on the search for new physics phenomena consistent with a fully hadronic signature as described below. This signature is produced following the collision of two proton beams in the LHC. The hadronic signature is represented by at least three highly energetic jets of particles and a large energetic imbalance in the plane transverse to the axis of the colliding beams. The imbalance in energy is due to particles that escape detection.

One of my contributions to this new physics search was the development of techniques to estimate the contribution to this hadronic signature from SM sources, particularly the production of a Z boson that decays into a pair of neutrinos. This type of background cannot be eliminated completely as it mimics perfectly our signal. I have worked on a technique that can estimate this background with minimal systematic uncertainties. Generally, this SM component can be calculated using a simulation of the CMS detector response. However, tuning the simulation to accurately describe the real CMS detector typically results in systematic uncertainties that cover residual discrepancies. This can be avoided if the actual detector response is used instead of the simulation. A sample of events from real collisions is collected such that each event contains two muons. If the invariant

mass of the pair of muons is consistent to that of the Z boson then there is very high chance that in these events a Z boson was produced and then decayed into the muons. The kinematics of such events is identical to those in which the Z boson decays into neutrinos. If the muons are ignored, then there is no distinction between the two types of events apart from the amount in which they are produced. Using the theoretical calculation for the ratio of production rates for the muon and neutrino modes, the background contribution due to Z boson decaying to neutrinos can be estimated from the measured rate of events having a Z boson decaying into muons. Given the restrictive event selection needed to effectively reduce the SM contribution, this method is statistically limited.

Another contribution to the new physics search is the calculation of the upper limits on the new physics production using a Bayesian approach. This calculation required the estimation of the SM backgrounds as well as the expected efficiency for a potential signal. For easier comparison with older experiments, the modeling for signal is done according to the mSUGRA scenario and during involves a scan over the parameter space. Currently this new physics search is able to set the best exclusion regions in the mSUGRA phase space within CMS.

## Trigger studies for the CMS experiment

The data collected by collider experiments such as CMS are subject to processing and storage limitations. These limits are accommodated using triggers that use hardware and software algorithms to select only events that satisfy certain kinematic and topological criteria. These criteria are optimized to reduce the amount of electronic detector noise and unimportant physics processes while preserving the chances of capturing the relevant physics signals. There are many ways to define a trigger and this diversity comes from the various kinematical and topological objects that can be reconstructed in an event. The kinematical objects are characterized by their energy deposition and by the position in the detector. The topological variables involve the separation between objects, the fractions of energy deposited in various subdetectors or the patterns of these depositions.

The collisions of protons at LHC happen 40 million times per second or every 25 nanoseconds. In order to trim this vast and unsustainable amount of data, the current trigger menu for the CMS experiment contains around 80 triggers. Each has two levels of requirements: a Level 1 (L1) set of criteria and a High Level Trigger (HLT) set. At L1 each event is represented by a rough and fast calculation of the energy deposited in key parts of the CMS detector. Based on these results, not more than 40 thousands collisions per second are selected for further processing at HLT. The criteria used at HLT are based on topological variable and more sophisticated and careful calculations of the energies deposited in the detector. A maximum of 500 collisions per second are selected for storage and future analysis.

One of my first contributions to the trigger group was to design a trigger filter that is used to define trigger paths for new physics searches at CMS. This filter can compute the scalar sum of the transverse energies of jets of particles (HT) as well as the vectorial sum of the transverse momenta of these jets (MHT). The HT variable is a measure of the total energy deposited in the detector, while the MHT variable measures the energy imbalance. Both of these variables provide a powerful discriminator in some SUSY models.

Starting in October 2010 I began co-leading the JetMET trigger subgroup at CMS. The charge of this group is to coordinate the efforts regarding the development and the maintenance of the triggers using jets and MET. Also we assist the various physics groups in their studies of these trigger objects.

I am responsible for a set of triggers that select events based on their energy imbalance (MET). These MET triggers are used in the early stages of the CMS experiment to study and differentiate events

produced by the proton collisions from those due to electronic noise or detector malfunction. One of my roles is to write and maintain a validation software for the monitoring of these triggers that is used during and after data taking. Another of my responsibilities is to evaluate the performance of the MET triggers and to advise on potential modifications according to the detector and proton beam conditions.

# LIST OF PUBLICATIONS

Gheorghe Lungu

I am the author of 299 publications as a member of the CDF collaboration and 111 publications as a member of the CMS collaboration. Below there is a list of selected publications where I was a principal author.

- [1] A. Abulencia *et al.* (CDF Collaboration), “Measurement of the  $t\bar{t}$  Production Cross Section in  $p\bar{p}$  collisions at  $\sqrt{s} = 1.96$ -TeV in the All Hadronic Decay Mode,” Phys. Rev. D **74**, 072005 (2006), arXiv:hep-ex/0607095.
- [2] T. Aaltonen *et al.* (CDF Collaboration), “Top quark mass measurement in the  $t\bar{t}$  all hadronic channel using a matrix element technique in  $p\bar{p}$  collisions at  $\sqrt{s} = 1.96$  TeV,” Phys. Rev. D **79**, 072010 (2009), arXiv:0811.1062v2 [hep-ex].
- [3] S. Chatrchyan *te al.* (CMS Collaboration), “Search for new physics with jets and missing transverse momentum in pp collisions at sqrt(s)=7 TeV,” JHEP 1108:155 (2011), arXiv:1106.4503 [hep-ex].
- [4] S. Chatrchyan *et al.* (CMS Collaboration), “Search for new physics in the multijet and missing transverse momentum final state in proton-proton collisions at sqrt(s) = 7 TeV”, accepted by Phys. Rev. Lett. B (2012), arXiv:1207.1898 [hep-ex].