52nd Winter Nuclear & Particle Physics Conference

Mont Tremblant, Québec, February 12-15, 2015

Program

Organized by the University of Guelph, SNOLAB, and TRIUMF.

Organizing Committee:

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- Paul Garrett (U of Guelph)
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WNPPC2015 – the 52nd Winter Nuclear & Particle Physics Conference

Tour des Voyagers, Mont Tremblant, Québec
February 12-15, 2015

Welcome to this year's Winter Nuclear & Particle Physics Conference, organized by the University of Guelph, SNOLAB, and TRIUMF. This year's meeting will feature several contributed talks as well as invited talks by:

- Vinzenz Bildstein (Guelph)
- Gilles Gerbier (Queen's)
- Jason Holt (TRIUMF)
- Alison Lister (UBC)
- Philip Schuster (Perimeter)
- Natalia Toro (Perimeter)
- Alex Wright (Queen's)

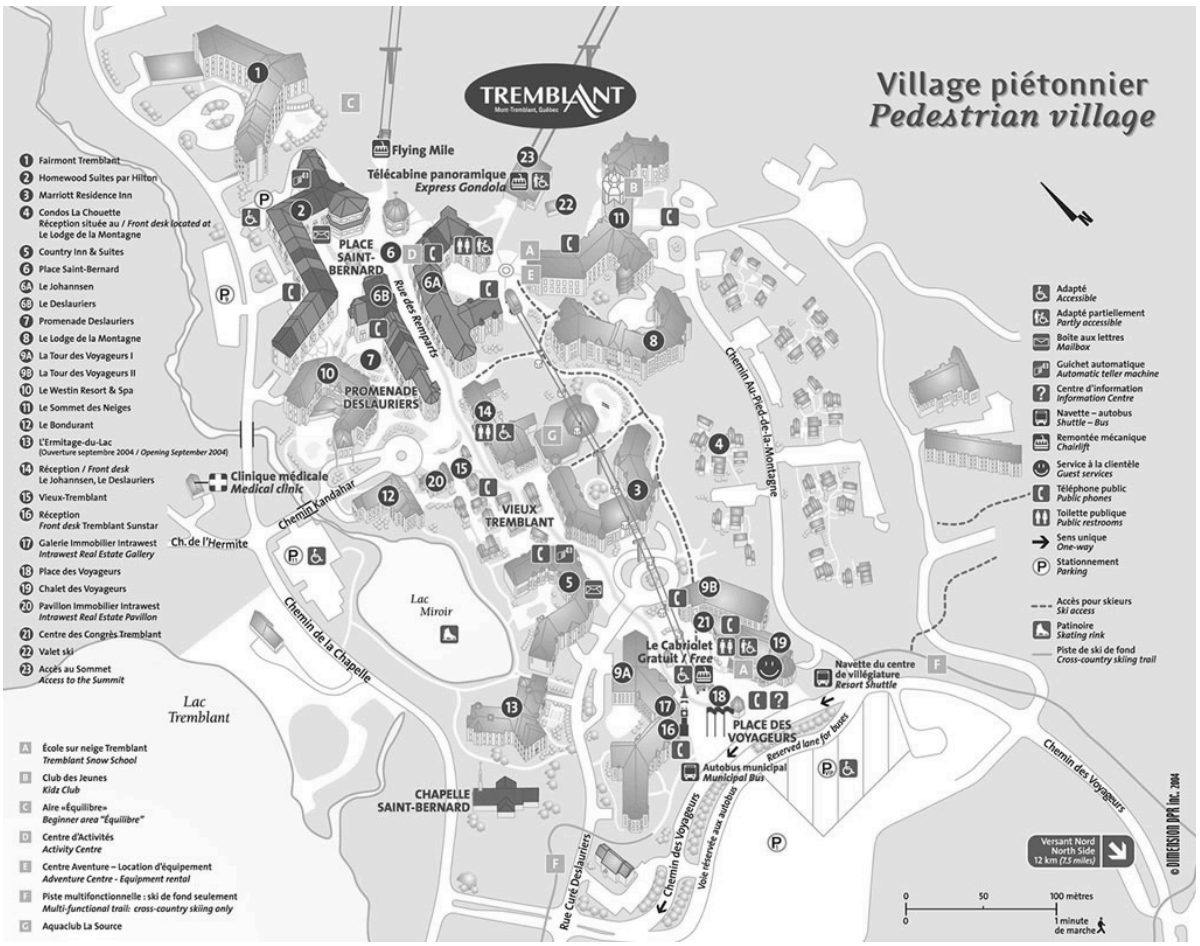
Registration
Opening day registration is on Thursday, February 12, from 4 pm to 5:30 pm outside Mistral 1-2-3, where all the sessions will be taking place. Registration will re-open on Friday, February 13, from 7:30 am to 9 am in the same location.

Reception
The Welcome Reception will take place in Zephyr 1-2 after the last talk on Thursday, February 12, starting at approximately 9:30 pm.

Banquet
The Conference Banquet will take place in Zephyr 1-2 on Saturday, February 14, starting at 7 pm.

Meals
The coffee breaks, Reception, and Banquet are included in your registration.
If you signed up for the extra meals (Friday: breakfast+lunch, Saturday: breakfast+lunch, Sunday: breakfast) you will be able to have them in Zephyr 1-2.

Talks
All presentations will be in Mistral 1-2-3. Presenters are requested to send their completed talk slides in PDF format to gezerlis@uoguelph.ca with "WNPPC talk slides" in the Subject line. If there are file size restrictions you must put the PDF file on a memory stick and transfer it no later than 15 minutes prior to the start of your session. Prizes will be awarded for the best student talks, funded by our sponsors.



Village piétonnier
Pedestrian village
TREMBLANT
1 Fairmont Tremblant
2 Homewood Suites par Hilton
3 Marriott Residence Inn
4 Condos La Chouette
Réception située au / Front desk located at Le Lodge de la Montagne
5 Country Inn & Suites
6 Place Saint-Bernard
6A Le Johannsen
6B Le Deslauriers
7 Promenade Deslauriers
8 Le Lodge de la Montagne
9A La Tour des Voyageurs I
9B La Tour des Voyageurs II
10 Le Westin Resort & Spa
11 Le Sommet des Neiges
12 Le Bondurant
13 L'Ermitage-du-Lac
(Ouverture septembre 2004 / Opening September 2004)
14 Réception / Front desk
Le Johannsen, Le Deslauriers
15 Vieux-Tremblant
16 Réception
Front desk Tremblant Sunstar
17 Galerie Immobilier Intrawest
Intrawest Real Estate Gallery
18 Place des Voyageurs
19 Chalet des Voyageurs
20 Pavillon Immobilier Intrawest
Intrawest Real Estate Pavillon
21 Centre des Congrès Tremblant
22 Valet ski
23 Accès au Sommet
Access to the Summit
A École sur neige Tremblant
Tremblant Snow School
B Club des Jeunes
Kidz Club
C Aire «Équilibre»
Beginner area "Équilibre"
D Centre d'Activités
Activity Centre
E Centre Aventure – Location d'équipement
Adventure Centre - Equipment rental
F Piste multifonctionnelle : ski de fond seulement
Multi-functional trail: cross-country skiing only
G Aquaclub La Source
Adapté
Accessible
Adapté partiellement
Partly accessible
Boite aux lettres
Mailbox
Guichet automatique
Automatic teller machine
Centre d'information
Information Centre
Navette – autobus
Shuttle – Bus
Remontée mécanique
Chairlift
Service à la clientèle
Guest services
Téléphone public
Public phones
Toilette publique
Public restrooms
Sens unique
One-way
Stationnement
Parking
Accès pour skieurs
Ski access
Patinoire
Skating rink
Piste de ski de fond
Cross-country skiing trail
Flying Mile
Télécabine panoramique
Express Gondola
PLACE SAINT-BERNARD
Rue des Remparts
PROMENADE DESLAURIERS
Clinique médicale
Medical clinic
Chemin Kandahar
Ch. de l'Hermite
VIEUX TREMBLANT
Lac Miroir
Chemin de la Chapelle
Lac Tremblant
CHAPELLE SAINT-BERNARD
Le Cabriolet
Gratuit / Free
PLACE DES VOYAGEURS
Autobus municipal
Municipal Bus
Navette du centre de villégiature
Resort Shuttle
Reserved lane for buses
Voie réservée aux autobus
Chemin des Voyageurs
Rue Curé Deslauriers
Chemin Au-Pied-de-la-Montagne
Versant Nord
North Side
12 km (7.5 miles)
0 50 100 mètres
1 minute de marche
© DIMENSION DPR inc. 2004

WNPPC2015 SCHEDULE OVERVIEW

Thursday, February 12

16:00 – 17:30	Registration	Outside Mistral 1-2-3
19:15 – 19:30	Opening remarks	Mistral 1-2-3
19:30 – 21:30	*Session 1*	Mistral 1-2-3
21:30 – 23:00	Reception	Zephyr 1-2

Friday, February 13

07:30 – 09:00	Registration	Outside Mistral 1-2-3
07:30 – 09:00	Breakfast	Zephyr 1-2
09:00 – 10:30	*Session 2a*	Mistral 1-2-3
10:30 – 11:00	Coffee break	Mistral 1-2-3
11:00 – 12:30	*Session 2b*	Mistral 1-2-3
12:30 – 14:00	Lunch	Zephyr 1-2
Afternoon is free for other activities		
19:00 – 20:30	*Session 3a*	Mistral 1-2-3
20:30 – 21:00	Coffee break	Mistral 1-2-3
21:00 – 22:15	*Session 3b*	Mistral 1-2-3

Saturday, February 14

07:30 – 09:00	Breakfast	Zephyr 1-2
09:00 – 10:30	*Session 4a*	Mistral 1-2-3
10:30 – 11:00	Coffee break	Mistral 1-2-3
11:00 – 12:30	*Session 4b*	Mistral 1-2-3
12:30 – 14:00	Lunch	Zephyr 1-2
Afternoon is free for other activities		
19:00 – 21:30	Banquet	Zephyr 1-2

Sunday, February 15

07:30 – 09:00	Breakfast	Zephyr 1-2
09:00 – 10:30	*Session 5a*	Mistral 1-2-3
10:30 – 11:00	Coffee break	Mistral 1-2-3
11:00 – 12:30	*Session 5b*	Mistral 1-2-3

WNPPC2015 DETAILED SCHEDULE

Thursday, February 12

16:00 – 17:30 Registration
19:15 – 19:30 Opening remarks

Session 1

19:30 – 20:00 Vinzenz Bildstein
DESCANT – A new neutron detector array at TRIUMF

20:00 – 20:15 Lea Gauthier
Search for strongly-produced superpartners with two same-sign leptons and three leptons at sqrt(s)=8 TeV with ATLAS

20:15 – 20:30 Andrée Robichaud-Véronneau
The McGill testing facility for Canadian-built sTGC muon detectors for the ATLAS experiment

20:30 – 20:45 Andrew MacLean
Gamma-gamma angular correlation measurements with GRIFFIN

20:45 – 21:00 Brendan Bulthuis
An investigation of mixed-spin pairing in heavy nuclei

21:00 – 21:15 Sahar Bahrami
Vector like leptons in the Higgs triplet model

21:15 – 21:30 Diane Shoaleh Saadi
Low threshold setting in the Argon straws of the TRT detector

21:30 – 23:00 Reception

Friday, February 13

07:30 – 09:00 Registration
07:30 – 09:00 Breakfast

Session 2a

09:00 – 09:30 Gilles Gerbier
Sharpening tools for direct low mass WIMP search

09:30 – 09:45 Ken Clark
Neutrinos at the South Pole with IceCube and PINGU

09:45 – 10:00 Steffen Cruz
Single particle structure and shapes of exotic Sr isotopes

10:00 – 10:15 Zachary Shand
Role of charged particle nucleosynthesis in supernovae and the r-process

10:15 – 10:30 Amiel Kollek
Fast pulsing light testing system for Belle II photopentodes

10:30 – 11:00 Coffee break

Session 2b

11:00 – 11:30 Alison Lister
What have we learnt about and from top quarks at the LHC?
Selected results from ATLAS

11:30 – 11:45 Lori Rebenitsch
A lithium doped glass detector to measure the electric dipole moment
of ultra cold neutrons

11:45 – 12:00 Camille Bélanger-Champagne
Search for new phenomena in photon+jet events collected in proton-proton
collisions at centre-of-mass energy of 8 TeV with the ATLAS detector

12:00 – 12:15 Alex Laffoley
High-precision half-life measurements for the superallowed β+ emitter 18Ne

12:15 – 12:30 Sébastien Lord
An application of the AdS/QCD correspondence in phenomenological
B physics: predicting the B → K μ+ μ-isospin asymmetry*

12:30 – 14:00 Lunch

Friday, February 13

Session 3a

19:00 – 19:30	Alex Wright *The SNO+ experiment at SNOLAB*
19:30 – 19:45	Alison Radich *New decay modes of the high-spin isomer of 124Cs*
19:45 – 20:00	Kuhan Wang *Searching for physics beyond the Standard Model in multi-jet events at ATLAS*
20:00 – 20:15	Marc Baker *Hyperfine splitting in positronium to O(α^7 M_E): one photon annihilation contribution*
20:15 – 20:30	Arthur Plante *Calibration of PICASSO/PICO test modules for dark matter searches at SNOLAB*
20:30 – 21:00	Coffee break

Session 3b

21:00 – 21:15	Benoit Lefebvre *Characterization of a small thin gap chamber detector prototype in a test beam experiment at CERN*
21:15 – 21:30	Chanpreet Amole *PICO-2L: in search of light WIMPs with a bubble chamber using superheated C3F8*
21:30 – 21:45	Nima Pourtolami *5D warped space Higgs phenomenology*
21:45 – 22:00	Amit Kumar *Investigation of three-nucleon force through 10C(p,p)10C*
22:00 – 22:15	Alexis Brossard *Search for standard Higgs Boson produced in association with a top quark pair in multi-lepton channels at the CMS experience at the LHC*

Saturday, February 14

07:30 – 09:00 Breakfast

Session 4a

09:00 – 09:30 Philip Schuster
Accelerating our understanding of dark matter

09:30 – 09:45 Michelle Dunlop
High-precision half-life measurements for the superallowed β+ emitter 10C

09:45 – 10:00 Amir Ouyed Hernandez
Explosive phase transition of hadronic to quark matter

10:00 – 10:15 Lee Evitts
Electric monopole transition strengths in 62Ni

10:15 – 10:30 Ian Lam
Surfactant purification tests for the SNO+ experiment

10:30 – 11:00 Coffee break

Session 4b

11:00 – 11:30 Natalia Toro
Dark forces at accelerators: the new GeV frontier

11:30 – 11:45 Ryan Dunlop
The first GRIFFIN experiment: an investigation of the s-process yields for 116Cd

11:45 – 12:00 Michael Stoebe
Measurement of the inclusive isolated prompt photon cross section in pp collisions at sqrt(s) = 8 TeV with the ATLAS detector

12:00 – 12:15 Alexis Tantot
Light and sound from scintillators

12:15 – 12:30 Jason Park
Gamma-ray spectroscopy in the vicinity of 100Sn

12:30 – 14:00 Lunch

19:00 – 21:30 Banquet

Sunday, February 15

07:30 – 09:00 Breakfast

Session 5a

09:00 – 09:30 Jason Holt
Nuclear forces and exotic nuclei

09:30 – 09:45 Andrea Capra
A radial time projection chamber for antihydrogen detection

09:45 – 10:00 Matt Buraczynski
Microscopic & variational calculations of inhomogeneous neutron matter

10:00 – 10:15 Ted Zhao
Measurement techniques for low background ethanol

10:15 – 10:30 Sebastien Rettie
Upgrading the ATLAS muon small wheel with novel sTGC detectors

10:30 – 11:00 Coffee break

Session 5b

11:00 – 11:15 Mike Clark
Sensitivity of alkali halide cryogenic scintillation-phonon detectors to WIMP signals

11:15 – 11:30 Jonathan Williams
Neutron generator facility at SFU GEANT4 dose prediction and verification

11:30 – 11:45 Yan Liu
Umbilicals for liquid scintillator phase of SNO+ experiment

11:45 – 12:00 Nikita Bernier
Investigations of background and Compoton suppression shields for GRIFFIN

12:00 – 12:15 Caleb Miller
Long term acrylic exposure tests for the SNO+ experiment

12:15 – 12:30 Simon Archambault
Particle physics with VERITAS

DESCANT - A NEW NEUTRON DETECTOR ARRAY AT TRIUMF*

V. Bildstein†, P.E. Garrett, D. Bandyopadhyay, L. Bianco, G. Demand, G. Deng, A. Finlay, B. Hadinia, K.G. Leach, A. Radich, C. Sumithrarachchi, C.E. Svensson, J. Wong
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Spectroscopy following β-decay is an important tool in studying radioactive isotopes. Following the β-decay of a neutron-rich isotope a neutron can be emitted by the daughter nucleus, if the Q-value of the β-decay is larger than the one-neutron-separation energy, S_n, of the daughter nucleus. In cases where the Q-value of the reaction is even larger, the emission of two, three, or even four neutrons is also possible. These β-delayed neutrons play an important role in the stable operation of nuclear reactors, contribute to the decay heat of spent nuclear fuel, influence the abundance pattern of the astrophysical r-process, and yield information about the nuclear structure of the daughter nuclei.

The DESCANT array (**De**uterated **Sc**intillator **A**rray for **N**eutron **T**agging) consists of up to 70 detectors, each filled with approximately 2 liters of deuterated benzene. This scintillator material offers pulse-shape discrimination (PSD) capabilities to distinguish between neutrons and γ-rays interacting with the scintillator material. In addition, the anisotropic nature of $n - d$ scattering allows for the determination of the neutron energy spectrum directly from the pulse height spectrum, complementing the traditional time-of-flight (ToF) information. Each detector is connected to digital fast sampling ADC modules, allowing online pulse-shape discrimination between neutron and γ-ray events.

DESCANT can be coupled either to the TIGRESS (**T**RIUMF-**I**SAC **G**amma-**R**ay **E**scape **S**uppressed **S**pectrometer) γ-ray spectrometer located in the ISAC-II hall of TRIUMF for in-beam experiments, or to the GRIFFIN (**G**amma-**R**ay **I**nfrastructure **F**or **F**undamental **I**nvestigations of **N**uclei) γ-ray spectrometer located in the ISAC-I hall of TRIUMF for decay spectroscopy experiments. DESCANT and GRIFFIN will combine high-precision γ-ray spectroscopy with a high neutron-tagging efficiency, providing an excellent tool to study β-delayed neutrons.

*Work supported by the Natural Sciences and Engineering Research Council of Canada and the Canada Foundation for Innovation.
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SEARCH FOR STRONGLY-PRODUCED SUPERPARTNERS WITH TWO SAME-SIGN LEPTONS AND THREE LEPTONS AT $\sqrt{S}$=8 TEV WITH ATLAS*

Léa Gauthier†
on behalf of The ATLAS Collaboration
Université de Montréal

The Standard Model is extremely successful in explaining experimental measurements in particle physics. However it possesses some theoretical problems such as the hierarchy problem or the Higgs boson mass fine-tuning, which have motivated a large number of extensions to the theory. Supersymmetry solves several of these problems such as canceling the quantum corrections coming from Standard Model by the contributions of the corresponding superpartners. Other attractive features of TeV-scale Supersymmetry include the the high-energy unification of the weak interactions, the strong interactions and electromagnetism, and the fact that it provides a candidate for dark matter.

This analysis focus on a search for supersymmetry in final states with a pair of leptons (electron or muon) of the same electric charge, or three leptons, using 20.3 fb^{-1} of proton-proton collision data at $\sqrt{s}$=8 TeV in the center of mass recorded by the ATLAS experiment at the LHC in 2012. Several signal regions are studied with different selections on the jet and b-jet multiplicities, transverse missing energy, effective mass and transverse mass. They are designed to maximize the sensitivity to several scenarios of strongly-produced superpartners.

As no excess above the standard model background expectation is observed, limits are set on the visible cross-section of new physics within the kinematic requirements of the search. The results are interpreted as limits on the parameters of several models such as gluino-mediated top squark, direct bottom squark and the production of squarks and gluinos decaying to gauginos and sleptons.

*Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
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THE MCGILL TESTING FACILITY FOR CANADIAN-BUILT STGC MUON DETECTORS FOR THE ATLAS EXPERIMENT *

A. Robichaud-Véronneau†, for the ATLAS sTGC group
McGill University

The ATLAS sTGC group
Université de Montréal

ATLAS is a multipurpose particle detector at the LHC. Part of the muon detection system of ATLAS is scheduled to be upgraded during the LHC long shutdown period of 2018-2020. The small Thin Gap Chamber (sTGC) technology was selected for part of the upgraded muon detectors. Approximately one third of all the required sTGC modules will be built in Canada. A quality assurance and performance qualification laboratory was built at McGill University to test all Canadian-built sTGC modules. A description of the McGill facility, chamber testing procedures and preliminary measurements of the performance of a prototype sTGC detector tested at McGill will be presented.

* Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
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GAMMA-GAMMA ANGULAR CORRELATION MEASUREMENTS WITH GRIFFIN*

A. D. MacLean†, E. T. Rand, P. E. Garrett, V. Bildstein, R. Dunlop, A. T. Laffoley, C. E. Svensson
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P. C. Bender, A. B. Garnsworthy, D. Miller, B. Mills, J. K. Smith
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In a $\gamma - \gamma$ cascade from an excited nuclear state, $X^{**} \rightarrow X^{*} + \gamma_1 \rightarrow X + \gamma_2$ an anisotropy is found in the spatial distribution of γ_2 with respect to γ_1. By defining the direction of γ_1 to be the z-axis (setting $\theta = 0$), the intermediate level, X^{*}, in general will have an uneven distribution of m-states. This uneven population of m-states causes an anisotropy in the angular correlation of the second γ-ray with respect to the first, which depends on the sequence of spin-parity values for the nuclear states involved and the multipolarities and mixing ratios from the emitted γ-rays. These angular correlations are expressed by the $W(\theta)$ function:

$$W(\theta) = \sum_{k=0,k=even}^{2L} a_k P_k(cos\theta)$$

where the a_k are coefficients for all of the $P_k(cos\theta)$ Legendre polynomials.

These γ-ray angular correlations can be used for the assignment of spins and parities for the nuclear states, and thus provide a powerful means to elucidate the structure of nuclei far from stability through $\beta - \gamma - \gamma$ coincidence measurements. In order to explore the sensitivity of the new 16-detector GRIFFIN γ-ray spectrometer at ISAC to such $\gamma - \gamma$ angular correlations, and to optimize its performance for these measurements we have studied a well known $4^+ \rightarrow 2^+ \rightarrow 0^+$ $\gamma - \gamma$ cascade from ^{60}Co decay through both experimental measurements and Geant4 simulation. Preliminary results of these investigations will be presented in this talk.

*Work supported by the Canada Foundation for Innovation, the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.

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AN INVESTIGATION OF MIXED-SPIN PAIRING IN HEAVY NUCLEI *

B. Bulthuis†, A. Gezerlis
University of Guelph

It is well-established that nucleons within a given nucleus often exhibit pairing correlations. These pairs are conventionally divided into two groups, namely Spin-Singlet and Spin- Triplet. Despite the fact that the Spin-Triplet interaction is stronger, the pairing is observed to be of the Spin-Singlet type. Recently, a possible reason for this discrepancy was put forward, attributing the effect to the nuclear spin-orbit field. In this work, we use the Hartree-Fock-Bogoliubov method to further investigate the role of the spin-orbit and other terms in the Hamiltonian. We also discuss the effects of different many-body approximations on the recently proposed ”mixed-spin pairing” state.

* Work supported by the Natural Sciences and Engineering Research Council of Canada.
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VECTOR LIKE LEPTONS IN THE HIGGS TRIPLET MODEL*

S. Bahrami†and M. Frank

Department of Physics, Concordia University, 7141 Sherbrooke St. West , Montreal, Quebec, Canada H4B 1R6. #1

We analyze the effects of introducing vector like leptons in the Higgs triplet model. We investigate the model subjected to a parity symmetry which disallows mixing between the ordinary and the new vector like leptons. The presence of vector like leptons which are allowed to be relatively light, affects the decay rates of loop-dominated neutral Higgs boson decay such as $h \to \gamma\gamma$ and $h \to Z\gamma$ and possible relationships between them. An important consequence is that, for light vector like leptons, the decay patterns of charged bosons modify the restriction on their masses. For the LHC operating at both center-of-mass energy $\sqrt{s} = 7$ TeV and $\sqrt{s} = 13$ TeV, we study the decay patterns of doubly charged bosons and show that their decays into same-sign vector like leptons could be observable at the LHC and may be a promising way to discover vector like leptons.

*Work supported by the Natural Sciences and Engineering Research Council of Canada .

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LOW THRESHOLD SETTING IN THE ARGON STRAWS OF THE TRT DETECTOR

D. Shoaleh Saadi*,

Pr. Claude Leroy

Institution University of Montreal (CA), on behalf of the ATLAS Collaborations

During the 2012 run, several leaks developed in the Transition Radiation Tracker (TRT) gas system without compromising the detector performance. Around 200 liters per day of xenon gas were lost. Due to its high price, xenon gas has been replaced by argon gas in the most affected regions. The impact on tracking performance, electron and tau identification, photon reconstruction and trigger performance is evaluated.

The results of the low threshold setting and the impact of argon gas on tracking reconstruction will be presented in this talk.

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SHARPENING TOOLS FOR DIRECT LOW MASS WIMP SEARCH

Gilles Gerbier*

Queen's University

Following -so far- lack of evidence of SUSY Dark Matter particles at LHC, experimental direct search for WIMPs has somewhat broadened its scope. I will describe the two main experimental projects I will participate at SNOLAB to search for light and very light Dark Matter particles. This needs indeed pushing the instrumental limits of detectors to new frontiers. The two projects I will report on are SuperCDMS, operating cryogenic detectors and NEWS_SNO operating spherical gaseous detectors.

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NEUTRINOS AT THE SOUTH POLE WITH ICECUBE AND PINGU

K.Clark (for the IceCube/PINGU Collaboration)* *University of Toronto*

IceCube and its low energy extension DeepCore have been deployed at the South Pole and taking data since early 2010. Originally designed to search for high energy (on the order of PeV) events, IceCube has recently published the detection of the highest energy events ever recorded. At the same time, enhancements to the detector were installed to focus on lower energy events. With a neutrino energy threshold of about 10 GeV, DeepCore allows IceCube to access a rich variety of physics including searching indirectly for WIMP dark matter and studying atmospheric neutrinos. A proposed new in-fill array, named PINGU, would continue to lower the threshold for neutrino detection. This would in turn provide the potential to study a great deal of new physics, including the determination of the neutrino mass hierarchy. This talk will discuss the PINGU detector and the new physics it makes available with a focus on the determination of the hierarchy.

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SINGLE PARTICLE STRUCTURE AND SHAPES OF EXOTIC Sr ISOTOPES*

S. Cruz[1†], P. C. Bender[2], R. Krücken[1,2], K. Wimmer[3], F. Ames[2], C. Andreoiu[4], C. S. Bancroft[3], R. Braid[5], T. Bruhn[2], W. Catford[6], A. Cheeseman[2], D. S. Cross[4], C. Aa. Diget[7], T. Drake[8], A. Garnsworthy[2], G. Hackman[2], R. Kanungo[9], A. Knapton[6], W. Korten[2], K. Kuhn[5], J. Lassen[2], R. Laxdal[2], M. Marchetto[2], A. Matta[6], D. Miller[2], M. Moukaddam[2], N. Orr[10], N. Sachmpazidi[3], A. Sanetullaev[2], N. Termpstra[3], C. Unsworth[2], P. J. Voss[4]

1. University of British Columbia, 2. TRIUMF, 3. Central Michigan University, 4. Simon Fraser University, 5. Colorado School of Mines, 6. University of Surrey, 7. University of York, 8. University of Toronto, 9. Saint Mary's University, 10. LPC Caen.

Nuclei near the "magic numbers" of protons and neutrons are observed to have a spherical shape for the low lying states. Nuclei between magic numbers, where the binding energy tends to be lower, are often observed to show deformation in low lying states. These deformations are perceived to have either a prolate or oblate nature. States within a nucleus that have different shapes that are close in energy are colloquially referred to as shape coexisting. A dramatic occurrence of shape coexisting states is observed in nuclei in the vicinity of Z=40, N=60 [1], which is the subject of substantial current experimental and theoretical effort.

An important aspect in this context is the evolution of single particle structure for N $<$ 60 leading up to the shape transition region, which can be calculated with modern large scale shell model calculations using a ^{78}Ni core or Beyond Mean Field Models. One-neutron transfer reactions are a proven tool to study single-particle energies as well as occupation numbers. Here we report on the study of the single-particle structure in ^{95,96,97}Sr via (d,p) one-neutron transfer reactions in inverse kinematics. The experiments presented were performed in the ISAC facility using the TIGRESS gamma-ray spectrometer [2] in conjunction with the SHARC charged-particle detector [3]. Highly charged beams of ^{94,95,96}Sr, produced in the ISAC UCx target and charge-bred by an ECR source were accelerated to 5.5 MeV/A in the superconducting ISAC-II linac before delivery to the experimental station. Other than their clear scientific value, these measurements were the first high mass (A $>$ 30) post-accelerated radioactive beam experiments performed at TRIUMF. A thorough analysis of single particle states will improve our understanding of the onset of these unique structures, encouraging the ongoing theoretical discussions. Initial results discussed in the context of the evolution of single-particle structure will be presented.

[1] K. Heyde, J. L. Wood Rev. Mod. Phys. 83, 1467 (2011).
[2] G. Hackman and C. E. Svensson, Hyper. Int. 225, 241 (2014).
[3] C. Aa. Diget et al, JINST 6 P02005 (2011).

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ROLE OF CHARGED PARTICLE NUCLEOSYNTHESIS IN SUPERNOVAE AND THE R-PROCESS *

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Neutron capture is the only reasonable production mechanism for the heaviest elements; however, the site responsible for their production, by the r-process, is still an open question. Theoretical reproduction of the heavy element distribution observed in the galaxy has presented a challenge for both theoretical astrophysics and nuclear theory and has helped to constrain theoretical models in both fields. R-process candidates include quark novae, neutron star mergers and supernovae. Core-collapse (neutron star producing) supernovae are currently the most popular r-process site; however, there is no obvious mechanism for ejection of neutrons during the formation of a neutron star: instead, there is potential for heavier elements to be produced in the hot winds between the main ejecta and the dense core via reconstitution of the dissociated nuclei following core bounce. Whereas the traditional r-process can be modeled with mainly neutron reactions and beta-decay, supernova simulations require proton and alpha particle nuclear reactions to first create seed nuclei before the r-process can produce heavy elements.

For our code, r-Java, this means expanding the scope of nuclear reactions to include charged particle reactions. Our simulations of the r-process in supernovae suggest that they are not responsible for the main production of the heaviest elements. Simulations which succeed in producing heavier nuclei (e.g. gold) require thermodynamic trajectories in the wind inconsistent with current supernova explosion models. Instead, we see that supernovae are most likely capable of producing the lighter elements, like zirconium, and could be responsible for producing nuclei in the mass range 50-90; conversely, the r-process in quark novae or neutron star mergers are not efficient at producing these lighter nuclei. While these results suggest that supernovae are not the main r-process site, a model including both quark novae and supernovae can potentially explain the observational disjoint between the heavy r-process elements (beyond mass 130) and the lighter r-process elements which is suggested by the growing spectroscopic data of metal poor stars in the galaxy. As both sites operate in different regions of the chart of nuclides; together, they provide better constraints to nuclear theory of neutron rich nuclei up to the neutron drip line.

* Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
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FAST PULSING LIGHT TESTING SYSTEM FOR BELLE II PHOTOPENTODES

Amiel Kollek

Belle II is a detector at the KEKB particle accelerator in Japan which is currently undergoing an upgrade. The Canadian Belle II group is responsible for improving the calorimeter to handle the higher luminosity expected in the coming years. One approach being considered is replacing the existing thallium doped CsI crystals with pure CsI, which are faster and are more resistant to radiation. Pure CsI creates less light than thallium doped, however, so to detect the smaller light yield the existing photodiodes would be replaced with photomultiplier tubes designed specifically for Belle II. This project developed a testing system which will be used to characterize the aging of the new photomultiplier tubes.

WHAT HAVE WE LEARNT ABOUT AND FROM TOP QUARKS AT THE LHC?
SELECTED RESULTS FROM ATLAS

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The Large Hadron Collider (LHC) located at CERN, Switzerland, has been producing the highest energy man made collisions since it began operations in 2009. The first run of the LHC provided about 5 fb^{-1} of integrated luminosity at a centre-of-mass energy of 7 TeV to the two largest experiments, ATLAS and CMS. In 2012, with a slightly higher collision energy of 8 TeV, each of these experiments was able to collect about 20 fb^{-1} of good quality data. The highlight of this first run was indisputably the discovery of a Higgs Boson, yet the scope of our analyses extended far beyond that, from searching in the smallest corners for signs of physics beyond the standard model of particle physics, to measuring as accurately as possible the known processes.

The top quarks is the heaviest known elementary particle and its anomalously high mass of 173.34 ± 0.76 GeV† leads many to believe that it plays a special role in physics beyond the standard model. For example top quarks play a leading role in searches for Vector-Like-Quarks, for extra dimensions, or for new vector bosons that couple preferentially to the third generation. Its high mass also means that it is the only fundamental quark that decays before it hadronises. Thus by studying the properties of the top quark, one is able to derive information about the properties of the bare quark. With so many top quarks being produced at the LHC, we are now able to not only measure the total production cross section for top quark pairs, but also measure differential distributions‡ of top quarks up to the TeV scale. These stringent tests of Quantum Chromodynamics (QCD) are able to help us better constrain the parameters of our models, not only in the perturbative but also the non-perturbative regimes. Soon the top quark measurement will be able to help constrain the parton distribution function (PDF) of the proton.

A selection of recent ATLAS measurements of the top quark will be presented along with results from searches for new physics using top quarks and how these results will affect what will be done in the next run of the LHC in 2015, at yet higher centre-of-mass energy, with yet more luminosity, and with hopefully yet more discoveries!

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† Taken from the most recent world mass combination: https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/ATLAS-CONF-2014-008

‡ $\frac{d\sigma}{dX}$ where X could the top quark momentum, the invariant mass of the top quark pairs, the jet multiplicity, ...

A LITHIUM DOPED GLASS DETECTOR TO MEASURE THE ELECTRIC DIPOLE MOMENT OF ULTRA COLD NEUTRONS[*]

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Matter domination over anti-matter in the universe is not explained by the Standard Model. Extensions to account for this lack of anti-matter introduce larger amounts of CP-violation which could appear in neutron electric dipole moments (nEDM) larger than predicted by the standard model. To measure the nEDM to high precision, Ultra Cold Neutrons (UCN) are cooled to temperatures of 3 mK where they have the interesting property that they can be contained in material bottles, and follow ballistic trajectories in gravity (approx. 7 m/s).

A new high intensity UCN polarized source is being developed at TRIUMF, which is based on a spallation neutron source. In order to detect the high rate of neutrons expected in this new nEDM experiment, a neutron detector capable of high rates 1.3MHz for a period of several seconds is required. A lithium doped glass scintillator detector, based on the detector used at PSI has been built and is in the testing phase. In this talk the principle for how this detector works, and how the high rates of data will be handled will be presented. In addition to handling the high rates, the background rejection, and stability of the efficiency will be considered. Future plans to benchmark this detector with another, established UCN detector will also be discussed.

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SEARCH FOR NEW PHENOMENA IN PHOTON+JET EVENTS COLLECTED IN PROTON-PROTON COLLISIONS AT CENTRE-OF-MASS ENERGY OF 8 TeV WITH THE ATLAS DETECTOR

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Events with a photon and a jet of high transverse momentum in the final state of proton-proton collisions at the LHC are sensitive to many models of new physics beyond the Standard Model. A search for new phenomena in the photon+jet invariant mass spectrum is presented using the full dataset collected by the ATLAS experiment in 2012. In the absence of deviations in data from the background-only hypothesis, limits are set on a general Gaussian-shaped resonant signal as well as two benchmark models of new physics. Non-thermal quantum black holes are excluded at the 95% credibility level below masses of 4.6 TeV and excited quarks are excluded at the 95% credibility level below masses of 3.5 TeV.

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HIGH-PRECISION HALF-LIFE MEASUREMENTS FOR THE SUPERALLOWED β^+ EMITTER ^{18}Ne*

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High-precision measurements of the ft values for superallowed Fermi β decays between $(J^\pi, T) = (0^+, 1)$ isobaric analogue states have provided invaluable probes of the Standard Model (SM) description of the electroweak interaction. These measurements confirm the CVC hypothesis to 1.2 parts in 10^4, set the tightest experimental limits on the existence of scalar currents in the electroweak interaction (under the assumptions of time-reversal invariance and maximum parity violation also common to vector currents), and set a strict upper limit on the existence of induced scalar currents.

The current precision of the ^{18}Ne half-life and branching ratio are still not at the required level of precision to impact these tests of the SM. However, experimentally improving the precision of its ft value could lead to a dramatic decrease in the current theoretical uncertainties associated with the world average corrected-ft value. Additionally, a high-precision branching ratio measurement for ^{18}Ne was recently performed at the Tokyo University of Science. These developments have prompted us to improve the precision of the ^{18}Ne half-life at TRIUMF.

Two direct β counting half-life measurements were performed with a 4π proportional continuous-flow gas counter for ^{18}Ne. Each of these two measurements is a factor of 2 times more precise than the previous world average data, resulting in an improved precision for the half-life of ^{18}Ne by a factor of approximately 3, to $\pm 0.02\%$, which is comparable to the other most precisely known superallowed β emitters. Additionally, a high-precision half-life measurement for the longer-lived ^{23}Ne was also performed.

This presentation will discuss the half-life results for ^{18}Ne and ^{23}Ne as well as comparing these results to previous measurements.

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AN APPLICATION OF THE ADS/QCD CORRESPONDANCE IN PHENOMENOLOGICAL B PHYSICS: PREDICTING THE $B \to K^*\mu^+\mu^-$ ISOSPIN ASYMMETRY*

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The LHCb collaboration recently reported the measurement of the Isospin Assymetry (A_I) in $B \to K^*\mu^+\mu^-$ decay. According to this report, the total asymmetry is consistent with the Standard Model expectation; however, the experimental results for some q^2 bins are in disagreement with the theoretical predictions in the literature.

In our work, we calculate a novel prediction for this observable using the Anti de-Sitter / Quantum Chromodynamic (AdS/QCD) correspondence to obtain the Distribution Amplitudes (DAs) of the K^* meson, and compare our results with those obtained from sum rules (SR). Our results are two fold. In the limit of zero momentum transfer to the resulting leptons ($q^2 = 0$ GeVs), corresponding to the $B \to K^*\gamma$ decay, the AdS/QCD result is distinct from the SR prediction and is in better agreement with the Particle Data Group world average for this observable. For non-zero momentum transfer (specificaly in the $q^2 > 4$ GeVs regime), we find that the Isospin Assymetry prediction is model independant, and still differs from the LHCb data which could be an indication of new physics.

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THE SNO+ EXPERIMENT AT SNOLAB

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SNO+ is a multi-purpose neutrino detector which is currently under construction at SNOLAB. The main physics goal for SNO+ is a search for neutrinoless double beta decay, which will be carried out by suspending double beta decay isotope in the experiment's 780 tonne liquid scintillator target. SNO+ will also study solar neutrinos, antineutrinos produced by nuclear reactors and within the Earth, and perhaps also supernova neutrinos. In this talk I will review the SNO+ science goals and give an update on the status of the experiment.

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NEW DECAY MODES OF THE HIGH-SPIN ISOMER OF ^{124}Cs*

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As part of a broader program to study the evolution of collectivity in the even-even nuclei above tin, a series of β-decay measurements of the odd-odd Cs isotopes into the even-even Xe isotopes, specifically ^{122,124,126}Xe, have been made utilizing the 8π spectrometer at TRIUMF-ISAC. The 8π spectrometer consisted of 20 Compton-suppressed high-purity germanium (HPGe) detectors and the Pentagonal Array of Conversion Electron Spectrometers (PACES), an array of 5 Si(Li) conversion electron detectors. The decay of ^{124}Cs to ^{124}Xe is the first measurement to be fully analyzed. A very high-statistics data set was collected and the $\gamma\gamma$ coincidence data was analyzed, greatly adding to the ^{124}Xe level scheme. Several weak $E2$ transitions into excited 0^+ states in ^{124}Xe were observed. The $B(E2)$ transition strengths of such low-spin transitions are very important in determining collective properties, which are currently poorly characterized in the region of the neutron-deficient xenon isotopes.

A new β^+/EC-decay branch from a high-spin isomeric state of ^{124}Cs has been observed for the first time. Decay of the isomer ($J^\pi = (7)^+$, $T_{1/2} = 6.3$ s) is seen to populate high-spin states in the ^{124}Xe daughter nucleus that are otherwise inaccessible through the β-decay of the 1^+ ^{124}Cs ground state. Combining $\gamma\gamma$ as well as γ-electron coincidence data, several new transitions in the isomeric decay of the 7^+ state have been observed. The characterization of the new β-decay branch and the isomeric decay of the high-spin state will be presented.

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SEARCHING FOR PHYSICS BEYOND THE STANDARD MODEL IN MULTI-JET EVENTS AT ATLAS

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McGill University

Multi-jet final-state events in 20.3 fb^{-1} of proton-proton collision data recorded using the ATLAS detector at the Large Hadron Collider at $\sqrt{s} = 8$ TeV are analyzed for physics beyond the Standard Model. No statistically significant deviations from Standard Model predictions are observed. The results are interpreted in terms of model independent limits on the production cross section of multi-jet events and model dependent limits in the context of TeV scale gravity states such as microscopic black holes and string balls.

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HYPERFINE SPLITTING IN POSITRONIUM TO $\mathcal{O}(\alpha^7 M_E)$: ONE PHOTON ANNIHILATION CONTRIBUTION

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Positronium is formed when an electron and a positron become electromagnetically bound together to form a hydrogen like system. As the lightest known atom, strong interactions are heavily suppressed in positronium by the ratio of the electron mass to the hadronic mass scale, thus making positronium an ideal system for studying QED to very high accuracy. Hyperfine splitting (HFS) is the difference between the energy of the $1S_1^3$ spin triplet orthopositronium (o-Ps) and the $1S_0^1$ spin singlet parapositronium (p-Ps) states. It occurs due to the spin-spin coupling term (i.e. the spin-flip operator) in the Hamiltonian. Its effects in higher orders can be treated most effectively by means of non-relativistic effective field theories, which use the natural parameter of inverse rest mass $(1/m_e)$ to characterise the relevant quantum mechanical operators near the threshold for pair-creation. As one of the most accurately measured quantities, HFS in positronium is currently of great interest because the deviations between theoretical predictions and experimental results may be an indication of exotic "new physics". The contribution to HFS from one-photon annihilation processes is presented to order $\alpha^7 m_e$, along with a general overview of the methodology that is used in its calculation.

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CALIBRATION OF PICASSO/PICO TEST MODULES FOR DARK MATTER SEARCHES AT SNOLAB

Arthur Plante*

The PICASSO/PICO projects are using the superheated liquid technique to search for dark matter candidates at SNO-LAB. In these detectors, particles traversing the superheated liquids trigger a phase transition which is accompanied by an acoustic emission. In order to create a particle induced vaporization the energy deposited must be larger than a certain energy threshold and must occur within a certain critical length. Both of these quantities are calculated within the theoretical framework of the Seitz model and depend on the operating temperature and pressure. In this talk, we discuss calibration measurements obtained with alpha particle and especially with monoenergetic neutrons produced at the University of Montreal Tandem accelerator facilty.

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CHARACTERIZATION OF A SMALL THIN GAP CHAMBER DETECTOR PROTOTYPE IN A TEST BEAM EXPERIMENT AT CERN *

B. Lefebvre†, on behalf of the ATLAS Experiment Muon Group
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A prototype of a small Thin Gap Chamber (sTGC) detector was characterized in a test beam experiment. The experiment was conducted using the H6 beam line at CERN in November 2014. The goal was to confirm that some aspects of the detector performance are adequate before the ATLAS experiment undergoes a major upgrade in 2018. For this upgrade, it is planned to install a new layer of sTGC detectors in the forward region of ATLAS to act as a muon detector. A sTGC is a multi-wire chamber operating in quasi-saturated mode. Readout can be achieved from both the anode wires and the cathode electrodes namely the strips and pads. The cathode electrodes are isolated from ground with a graphite-epoxy resistive coating. The pads are wider than the strips and have a large area of the order of 60 cm^2 making them suitable for trigger purposes. The preliminary results of the experiment that are shown in this talk concern mainly the sTGC pads efficiency and a study of the sTGC prototype performance under a high rate of incident particles (pions and muons) environment.

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PICO-2L: IN SEARCH OF LIGHT WIMPS WITH A BUBBLE CHAMBER USING SUPERHEATED C_3F_8.

C. Amole*, *Queen's University*

There is strong evidence for 'dark' matter from various astrophysical observations. The most prominent candidate for this elusive matter is a weakly interacting massive particle (WIMP) with a mass ranging from a GeV to a few TeV. PICO-2L: a 2-litre superheated C_3F_8 bubble chamber in the 6800 foot deep SNOLAB underground laboratory has recently completed its first WIMP direct detection experimental run. The data from this first run provide the most sensitive direct detection constraints on WIMP-proton spin-dependent scattering. This presentation provides a brief description of the experiment and its performance during this run.

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5D WARPED SPACE HIGGS PHENOMENOLOGY

N. Pourtolami*, M. Frank, M. Toharia
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Among all the extra dimensional extensions of the Standard Model of particle physics (SM) at the TeV scale, 5D warped extra dimensions are the most attractive. While their first modern motivation was to address the Planck-weak hierarchy problem of the SM, It was soon realized that the same mechanism, can be used to explain yet another hierarchy of the SM; the hierarchy between the observed masses and mixing angles of the fermions.

In this context, after introducing the model, I present the phenomenology of the Higgs boson at the Large Hadron Collider (LHC). I discuss that with simple modifications, the results are generically consistent with the current experimental results for new physics as low as 2 TeV, that is, within the reach of the LHC.

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INVESTIGATION OF THREE-NUCLEON FORCE THROUGH ^{10}C(p,p)^{10}C *

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For decades, we have been trying to understand the exact nature of nuclear force particularly in nuclei which are many-body systems. It is a great challenge to provide a complete description of nuclear force from the fundamental theory quantum chromodynamics (QCD), a framework to describe strong interaction involving fundamental constituent quarks and gluons. In our current understanding with the closest link to QCD the nuclear force can be formulated from chiral perturbation theory (ChPT) in which the chiral Lagrangian constrained with desired symmetries is constructed [1]. The nucleons and pions play the role as effective degrees of freedom instead of quarks and gluons in the energy regime relevant to nuclear physics. Using the framework of ChPT the two-nucleon, three-nucleon and other higher-body forces have been constructed. The importance of these forces on the properties of light and medium-mass nuclei have been extensively studied through various microscopic calculations [2,3].

In recent times, new developments in *ab initio* reaction theory [4] are opening new possibilities to study the two-nucleon and three-nucleon forces through differential cross sections. Therefore, in this talk, we will present the first efforts to understand the nuclear force from elastic scattering of the unstable nucleus ^{10}C with a proton target. The experiment was performed using newly developed ISAC Charged Particle Reaction Spectroscopy Station (IRIS) facility [5] stationed at TRIUMF, Canada. The facility utilizes a novel thin windowless Solid Hydrogen Target (SHT) which made this reaction study possible with a beam intensity of $\sim 2.5 * 10^3$ pps.

The presentation will describe the experiment and the results on the differential cross section. A comparison with theoretical results will also be presented.

References

1. R. Machleidt and D. R. Entem, Physics Reports. Volume 503, (2011), Issue 1, Pages 1-75.
2. P. Navratil, V. G. Gueorguiev, J. P. Vary, W. E. Ormand, and A. Nogga, Phys. Rev. Lett. 99, (2007) 042501.
3. G. Hagen et al., Phys. Rev. Lett. 109, (2012) 032502.
4. P. Navratil et al., private communication.
5. R. Kanungo, Hyperfine Interactions, Vol 225, (2014), Issue 1-3, 235-240.

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SEARCH FOR STANDARD HIGGS BOSON PRODUCED IN ASSOCIATION WITH A TOP QUARK PAIR IN MULTI-LEPTON CHANNELS AT THE CMS EXPERIENCE AT THE LHC.

A. Brossard*,

After a brief description of the CMS experience, I will present a faisability study of the matrix element methods for the ttH signal in multi-leptons channels. I will give details on the signal, describe the matrix elements method and give the results of the study. To conclude, I will speak briefly about my PhD thesis at Queens University and SNOLAB.

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ACCELERATING OUR UNDERSTANDING OF DARK MATTER

Philip Schuster*, Eder Izaguirre, Gordan Krnjaic, Natalia Toro
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Most of the matter in the Universe is dark; determining the composition and interactions of this dark matter are among the defining challenges in particle physics today. I will summarize the present status of dark matter searches and the case for exploration beyond the WIMP paradigm, particularly the motivations for “light dark matter” close to but beneath the weak scale. I will also describe sharp milestones in sensitivity needed to decisively explore the best-motivated light dark matter scenarios, and comment on experimental techniques to reach these milestones.

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HIGH-PRECISION HALF-LIFE MEASUREMENTS FOR THE SUPERALLOWED β^+ EMITTER ^{10}C *

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High precision measurements of superallowed Fermi beta transitions between 0^+ isobaric analogue states allow for stringent tests of the electroweak interaction described by the Standard Model. Particularly, these transitions provide an experimental probe of the unitary of the Cabibbo-Kobayashi-Maskawa (CKM) matrix, the Conserved-Vector-Current (CVC) hypothesis, as well as set limits on the existence of scalar currents in the weak interaction. Half-life measurements for the lightest of the superallowed emitters are of particular interest as it is the low-Z superallowed decays that are most sensitive to a possible scalar current contribution.

The half-life of ^{10}C can be measured by directly counting the β particles or measuring the γ-ray activity following β decay. Previous results for the ^{10}C half-life measured via these two methods differ at the 1.5σ level, prompting simultaneous and independent measurements of the ^{10}C half-life using both techniques. Since ^{10}C is the lightest nucleus for which superallowed β decay is possible, a high precision measurement of its ft value is essential for obtaining an upper limit on the presence of scalar currents in the weak interaction.

Measurements of the ^{10}C half-life via both gamma-ray photo-peak and direct beta counting were performed at TRIUMF's Isotope Separator and Accelerator (ISAC) facility using the 8π spectrometer and a 4π gas proportional β counter at the ISAC General Purpose Station. This presentation will highlight the importance of these measurements and preliminary half-life results for ^{10}C will be presented.

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EXPLOSIVE PHASE TRANSITION OF HADRONIC TO QUARK MATTER

Amir Ouyed Hernandez*,

The explosive combustion of a neutron star to a quark star could be the cause of some of the brightest phenomena in the sky. In this talk, I examine the hydrodynamics and nuclear/particle physics of such an explosive hadronic-quark matter phase transition. Furthermore, I will present BURNUD, a cross-platform, user-friendly hydrodynamic combustion code used to model the phase transition of neutron matter to quark matter.

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ELECTRIC MONOPOLE TRANSITION STRENGTHS IN ^{62}NI

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Excited states in ^{62}Ni were populated with a (p, p') reaction using the 14UD Pelletron accelerator at the Australian National University. The proton beam had an energy of 5 MeV and was incident upon a self-supporting ^{62}Ni target of 1.2 mg/cm^2. Electric monopole transition strengths were measured from simultaneous detections of the internal conversion electrons and γ-rays emitted from the de-excitating states, using the Super-e spectrometer coupled with a Germanium detector. The Super-e spectrometer has a superconduting solenoid magnet with its magnetic axis arranged perpendicular to the beam axis, which transports the electrons from the target to the 9 mm thick Si(Li) detector array which is situated 350 mm away from the target.

The strength of the 0^+_2 to 0^+_1 transition has been measured to be $77^{+23}_{-34} \times 10^{-3}$ and agrees with previously reported values. Upper limits have been placed on the 0^+_3 to 0^+_1 and 0^+_3 to 0^+_2 transitions at $<68 \times 10^{-3}$ and $<324 \times 10^{-3}$ respectively. The measured $\rho^2(E0)$ value of the 2^+_2 to 2^+_1 transition in ^{62}Ni has been measured for the first time to be $213^{+39}_{-46} \times 10^{-3}$. This represents the largest $\rho^2(E0)$ value measured to date in nuclei heavier than Ca.

The low-lying states of ^{62}Ni have previously been classified as one- and two-phonon vibrational states based on level energies. The measured electric quadrupole transition strengths are consistent with this interpretation. However as electric monopole transitions are forbidden between states which differ by one phonon number, the simple harmonic quadrupole vibrational picture is not sufficient to explain the large $\rho^2(E0)$ value for the 2^+_2 to 2^+_1 transition. A discussion of the results and experimental technique will be presented, along with preliminary shell model calculations.

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SURFACTANT PURIFICATION TESTS FOR THE SNO+ EXPERIMENT.*

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One of the goals of SNO+ is to study neutrinoless double beta decay via the decay of tellurium, which will be suspended in liquid scintillator target of the experiment. The suspension will be achieved using a chemical surfactant. To achieve the level of sensitivity required, the surfactant, scintillator and tellurium must each be purified to a high level. One method being investigated to purify the surfactant is using packed adsorption columns. The effectiveness of this technique is being investigated via a small scale setup that has been developed at Queen's University. In these studies, Infrared Attenuated Total Reflectance (IR-ATR) is used to quantify the amount of surfactant before and after the filtration process. X-Ray Fluorescence (XRF) is used to quantify the metal concentration in the mixture. Using this setup, various metal scavangers have been tested to determine their effectiveness in removing metal impurities from the surfactant.

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DARK FORCES AT ACCELERATORS: THE NEW GEV FRONTIER*

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The search for new “dark force” mediated by sub-GeV particles with very weak coupling to matter (“dark forces”) is an emerging frontier in physics beyond the standard model. These forces remain very weakly constrained, but a wide variety of recent and upcoming experiments are exploring this parameter space. I will outline the theoretical motivations for dark forces and their possible connection to the physics of dark matter and the anomalous magnetic moment of the muon. I will also discuss the strategies for searches at high-energy colliders, flavor factories, and dedicated fixed-target experiments; recent results from all three types of experiments; and future prospects for each. I will focus particularly on the resuls from the APEX test run at Jefferson Lab in 2010 and prospects for the APEX and HPS experiments at Jefferson Lab in the coming 1–2 years.

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THE FIRST GRIFFIN EXPERIMENT: AN INVESTIGATION OF THE S-PROCESS YIELDS FOR ^{116}CD

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For the GRIFFIN collaboration

In adopted models for the s-process, it is assumed that helium shell flashes give rise to two neutron bursts at two different thermal energies ($kT \sim 10$ keV and $kT \sim 25$ keV). The contribution to the isotopic abundance of ^{116}Cd from the higher temperature neutron bursts are calculated assuming thermal equilibrium between the ground state and the long-lived isomeric state of ^{115}Cd. However, it is unknown if the thermal equilibrium between these states is present at the low temperature of the first burst. The presence of thermal equilibrium at low temperatures would significantly decrease the calculated s-process yields of ^{116}Cd. To answer this question, we are searching for gateway levels at slightly higher excitation energy than the isomer in ^{115}Cd that could be populated from the isomeric state via (γ, γ') reactions within stars.

Currently, the lowest potential gateway level at an excitation energy of 394 keV has only been observed to decay directly to the isomeric state in ^{115}Cd. Nonetheless, the observation of this state decaying to the previously known 361 keV level via a weak 33 keV transition, would provide a γ-ray cascade which would bypass the isomeric state. Thus, the observation of this decay would be a direct signature for the presence of thermal equilibrium during the lower temperature neutron burst. However, the direct measurement of a 33 keV transition is difficult due to the large low-energy γ-ray backgrounds observed in β-decay experiments. We therefore require high-efficiency γ-ray detection to indirectly observe this transition via γ-γ coincidences of γ-rays cascading through this transition.

In November 2014, the high-efficiency GRIFFIN HPGe spectrometer was commissioned at TRIUMF's Isotope Separator and Accelerator (ISAC). GRIFFIN is a state-of-the-art array consisting of 16 HPGe clovers, and boasts a large γ-ray efficiency of roughly 17% at 1 MeV. GRIFFIN also hosts a large suite of auxiliary detectors such as SCEPTAR, which is an array of 20 plastic scintillators designed for β-particle detection. In this first experiment, a beam of ^{115}Ag was delivered to the GRIFFIN spectrometer equipped with SCEPTAR in order to search for these very-low intensity γ-γ coincidences following the β decay of ^{115}Ag into ^{115}Cd. In this talk, preliminary results from this first GRIFFIN experiment will be presented.

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MEASUREMENT OF THE INCLUSIVE ISOLATED PROMPT PHOTON CROSS SECTION IN PP COLLISIONS AT $\sqrt{S} = 8$ TEV WITH THE ATLAS DETECTOR

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A measurement of the cross section for the inclusive production of isolated prompt photons in pp collisions at a centre-of-mass energy $\sqrt{s} = 8$ TeV is presented. The measurement covers the pseudorapidity ranges $|\eta^{\gamma}| < 1.37$ and $1.56 \leq |\eta^{\gamma}| < 2.37$ in the transverse energy range $25 < \mathrm{E}_{\mathrm{T}}^{\gamma} < 1600$ GeV. The results are based on an integrated luminosity of up to 20.2 fb^{-1}, collected with the ATLAS detector at the Large Hadron Collider. Photon candidates are identified by combining information from the calorimeters and from the inner tracker. The yields of the signal photons are measured using a data-driven technique, based on the observed distribution of the hadronic energy in a narrow cone around the photon candidate and corrected for signal contamination in the background only phase space. The results are compared with leading order and next-to-leading order perturbative QCD calculations and found to be in a good agreement over ten orders of magnitude in cross section.

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LIGHT AND SOUND FROM SCINTILLATORS

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Inorganic scintillators are used by several particle physics experiments to search for rare events like dark matter and neutrinoless double beta decay, and some experiments are reporting intriguing signals.

Fracture has previously been observed as a background in phonon-based particle detectors used in rare event searches. We have studied the inorganic scintillators $Bi_4Ge_3O_12$, $CdWO_4$ and ZnWO4 providing evidence that light is emitted during material damage at room temperature and pressure. By using the double cleavage drilled compression geometry, we correlated the acoustic and light fracture signals in these brittle materials (PRL 111, 154301). To further understand the origin of these phenomena, we are commissionning a vacuum chamber to observe the influence of the pressure on the crack propagation and on the light emitted during material damage.

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GAMMA-RAY SPECTROSCOPITY IN THE VICINITY OF ^{100}Sn *

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The doubly-magic, heaviest self-conjugate ^{100}Sn is known for its super-allowed Gamow-Teller decay with the smallest $\log Ft$ value in the shell model. In addition, ^{100}Sn and its neighbouring species offer valuable insights for nuclear structure, such as modern shell model calculations, as well as the astrophysical rp-process. Gamma-ray spectroscopy of ^{100}Sn and nuclei in its vicinity with $N \simeq Z \simeq 50$ will probe the $g9/2$ orbital's single-particle/hole energies near the proton dripline, as well as the evolution of the pn interaction.

^{100}Sn and nuclei in its vicinity were produced at RIKEN Radioactive Isotope Beam Factory, via fragmentation of an intense ^{124}Xe beam on a thin ^{9}Be target. Their decay products were measured with EURICA, consisting of HPGe/LaBr$_3$ detectors for gamma-rays, and WAS3ABI, a set of position-sensitive silicon detectors for beta particles/protons/ions. At least several hundred instances were observed for exotic $N \leq Z$ species of Sn, In, Cd, Ag, and Pd isotopes, allowing gamma-ray spectroscopy and in some cases γ-γ coincidence analysis.

In this talk, new and precision measurements of high-spin isomeric state half-lives in ^{98}Cd, ^{96}Pd, and ^{96}Cd will be presented and discussed.

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NUCLEAR FORCES AND EXOTIC NUCLEI*

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The quest to understand from first principle the properties of exotic nuclei, many critical for understanding the origin of heavy elements in the universe, represents a cornerstone of modern nuclear science. At the heart of these efforts are three-nucleon (3N) forces. Within the context of valence-space Hamiltonians, I will discuss the importance of 3N forces in understanding and making new discoveries in the exotic region near oxygen.

Beginning in oxygen, we find that the effects of 3N forces are decisive in explaining why ^{24}O is the last bound oxygen isotope. Furthermore, 3N forces play a key role in reproducing spectra, including signatures of doubly magic ^{22,24}O, as well as physics beyond the dripline. Similar improvements are obtained in new spectroscopic predictions for exotic fluorine and neon isotopes, where we find good agreement with experiment and phenomenology. Finally, I will highlight the close connection of this work with recent experimental efforts in this region.

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A RADIAL TIME PROJECTION CHAMBER FOR ANTIHYDROGEN DETECTION

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ALPHA-g is a novel experiment that aims to determine the gravitational acceleration of the antihydrogen, $\overline{\mathrm{H}}$, initially with ballistic methods and, eventually, by means of precise interferometric measurements. This experiment has been put forward by the ALPHA collaboration, based at the CERN-AD.

A fundamental requirement for this new apparatus is a position sensitive particle detector that wraps the vacuum chamber and provides information about $\overline{\mathrm{H}}$ annihilation. The proposed detector is a radial Time Projection Chamber, TPC, whose concept has been developed at TRIUMF.

The present talk deals with the Geant4 simulation of the TPC and the study of possible geometric configurations, e.g., radius. The full development of the reconstruction software, used to determine the $\overline{\mathrm{H}}$ annihilation point, called vertex, starting from the Monte Carlo hits on the simulated detector, is presented along with preliminary results on the vertex resolution and the overall geometric efficiency.

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MICROSCOPIC & VARIATIONAL CALCULATIONS OF INHOMOGENEOUS NEUTRON MATTER*

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In this work we study the effect of adding an external sinusoidal potential to homogeneous neutron-rich matter. The strong interactions between particles are modeled by an effective interaction of the Skyrme type, like those that are used in state-of-the-art energy-density functionals of heavy nuclei. Such approaches typically involve parameters which are fitted to reproduce nuclear properties. Our objective is to constrain the terms in the energy-density functional using the results of dependable microscopic calculations. In this connection, we also describe our recent quantum Monte Carlo results for the same problem and discuss how the microscopic and phenomenological approaches can be combined. Overall, our study will help to elucidate inhomogeneous neutron matter, which is relevant to systems such as neutron-star crusts and heavy nuclei.

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MEASUREMENT TECHNIQUES FOR LOW BACKGROUND ETHANOL*

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SNO+ is a low-background experiment which searches for neutrinoless double beta decay using Te-130 in order to determine the Dirac/Majorana nature of the neutrino. A purification process for Te-130 isotope has been designed to obtain low background tellurium; and one step in the purification is the rinsing of tellurium with ethanol. Low background ethanol is thus needed to maintain an overall low background of tellurium. To identify and qualify such ethanol, a system capable of measuring U and Th concentrations less than $10^{-14} g/g$ in 1L-sized samples was developed. The system was then used to identify a commercial producer of ethanol that meets the SNO+ purity requirements, and to identify contaminant introduction during the normal industrial transportation of that ethanol.

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UPGRADING THE ATLAS MUON SMALL WHEEL WITH NOVEL sTGC DETECTORS

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In 2012, the ATLAS collaboration at the Large Hadron Collider (LHC) announced the discovery of a new particle consistent with the Higgs boson. The next logical step of the physics program at the LHC is to precisely measure the properties of this newly observed particle, and to search for physics beyond the standard model. To this effect, the LHC plans to increase its instantaneous luminosity by a factor of five with respect to the design value by undergoing an extensive upgrade program over the coming decade. The forthcoming LHC upgrade to high luminosity will increase the background rate in the forward region of the ATLAS Muon Spectrometer (composed of two Big Wheels and a Small Wheel on each side of the detector) by approximately a factor of five. In order not to saturate the Level-1 trigger bandwidth, the Small Wheel region needs to be replaced with new, more powerful detectors. The New Small Wheel (NSW) will be installed in the ATLAS detector during the LHC long shutdown in 2018/2019. The NSW is composed of eight layers of small Thin Gap Chamber (sTGC) and Micromegas planes, both providing trigger and tracking capabilities, for a total active surface of more than 2500 m^2. It represents the first system with such a large size based on Micro Pattern (Micromegas) and wire detectors (sTGC). The aim of the NSW detectors is to reach 100 micrometers position resolution and an online muon track reconstruction with better than 1 mrad angular precision. The basic sTGC structure consists of a grid of gold-plated tungsten wires sandwiched between two resistive cathode planes at a small distance from the wire plane. The precision cathode plane has strips with a 3.2 mm pitch for precision readout, and the cathode plane on the other side has pads for triggering. The pads are used to produce a 3-out-of-4 coincidence to identify muon tracks in an sTGC quadruplet. A full size sTGC quadruplet has been constructed and equipped with the first prototype of the dedicated front-end electronics (VMM1). The performance of the sTGC quadruplet at the Fermilab test beam facility is presented here.

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SENSITIVITY OF ALKALI HALIDE CRYOGENIC SCINTILLATION-PHONON DETECTORS TO WIMP SIGNALS

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Searches for particle dark matter are one of the most active fields in physics, with many experiments using different methods to search for possible dark matter candidates. Direct-detection experiments look for rare interactions between some detector mass and these dark matter particles. The DAMA/LIBRA experiment utilizes Thallium-doped NaI (NaI(Tl)) crystals at room temperature to search for dark matter direct-detection, and have claimed an annual modulation signal for dark matter. Alkali halide crystals such as NaI(Tl) show promise in this field because of their high light yield and fast scintillation time.

We propose a cryogenic scintillator detector based on alkali halide crystals, to test this hypothesis with a similar target material as DAMA but with added background discrimination. Cryogenic scintillator detectors have the advantage that there are many possible scintillator materials that can be used to optimize the experiment, and the low temperatures allow background discrimination using phonon detectors. Our group at Queen's University has developed an optical cryostat to measure the properties of scintillators at low temperatures for possible use in cryogenic scintillator detectors.

We present the results of our experiments with alkali halide crystals at low temperatures, and apply them to determine the sensitivity of alkali halide cryogenic scintillation-phonon detectors to both a spin-independant WIMP signal and the modulation signal reported by DAMA/LIBRA.

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NEUTRON GENERATOR FACILITY AT SFU GEANT4 DOSE PREDICTION AND VERIFICATION

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A neutron generator facility under development at Simon Fraser University (SFU) utilizes a commercial deuterium-tritium neutron generator (Thermo Scientific P 385) to produce 14.2 MeV neutrons at a nominal rate of 3×10^8 neutrons/s. The facility will be used to produce radioisotopes to support a research program including nuclear structure studies and neutron activation analysis.

As a prerequisite for regular operation of the facility and as a personnel safety consideration, dose rate predictions for the facility were implemented via the GEANT4 Monte-Carlo framework. Dose rate predictions were compared at two low neutron energy cutoffs: 5 keV and 1 meV, with the latter accounting for low energy thermal neutrons but requiring significantly more computation time. As the SFU facility geometry contains various openings through which thermal neutrons may penetrate, it was necessary to study their contribution to the overall dose rate.

A radiation survey of the facility was performed as part of the commissioning process, consisting of a neutron flux measurement via copper foil activation and dose rate measurements throughout the facility via a ^{3}He gas filled neutron detector (Thermo Scientific WENDI-2). When using the 1 meV low neutron energy cutoff to account for thermal neutrons in the dose rate predictions, the predictions and survey measurements agree to within a factor of 2 or better in most survey locations.

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UMBILICALS FOR LIQUID SCINTILLATOR PHASE OF SNO+ EXPERIMENT*

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SNO+ umbilical is part of the calibration hardware, and is designed to be a 100 feet long cable which can fulfill multiple calibration purposes of the SNO+ experiment. Calibration plays an important role in SNO+ and enables us to thoroughly understand how the detector reacts to different sources/signals. Umbilical was first designed and fabricated in SNO experiment, where the detector was filled with D_2O. The employment of linear alkyl benzene (LAB) as liquid scintillator in SNO+ requires new materials for compatibility reasons and therefore a new fabrication process as well. Improvements made for SNO umbilicals and a detailed fabrication process will be introduced.

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INVESTIGATIONS OF BACKGROUND AND COMPTON SUPPRESSION SHIELDS FOR GRIFFIN*

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GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei) took the place the 8pi spectrometer at the TRIUMF ISAC facility in the fall of 2014 with an array of 16 large-volume hyper-pure germanium (HPGe) clover detectors, instrumented with a state-of-the-art digital data acquisition system. The facility will be used to investigate a variety of aspects in nuclear structure, nuclear astrophysics and fundamental symmetries using stopped radioactive beams from ISAC and ARIEL in the future. The most exotic nuclei are generally produced with the lowest intensity so in order to perform spectroscopy with these beams the greatest possible sensitivity is required. In addition, in the decay of intense beams it is often the weakest decay branches which are of the greatest interest. It is well established that active Compton-suppression shields comprised of bismuth germanate (BGO) are an effective tool to increase the peak-to-total ratio of gamma-ray spectra collected wit h HPGe detectors. These active shields will also suppress background radiation originating from the experimental hall, which will further improve spectral quality. A series of measurements have been performed at ISAC using a GRIFFIN HPGe clover to characterize the spectrum of background events. The detector was then coupled with a TIGRESS BGO Suppression shield to investigate the effectiveness of such active shielding on the final gamma-ray spectrum. These measurements support the funding application for instrumenting the entire GRIFFIN array with suppression shields. A detailed description of the investigations and results will be presented.

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LONG TERM ACRYLIC EXPOSURE TESTS FOR THE SNO+ EXPERIEMENT*

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SNO+ will be implementing a liquid scintillator active target in place of the heavy water that the SNO experiment used. As the scintillator is held in the 12m diameter acrylic vessel of SNO+ it is important to have a scintillator that is compatible with acrylic.

Through a series of acrylic compatibility studies linear alkylbenzene (LAB) was chosen as the new scintillator for its scintillating properties and compatibility with acrylic. In order to monitor the long term effects of LAB on acrylic, a series of long term compatibilty tests have been developed and implemented in the past eight years. Periodically some of the samples are subjected to tensile tests in order to check for any changes in the strength and elasticity of the acrylic. In this talk the LAB exposure testing program will be described.

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PARTICLE PHYSICS WITH VERITAS

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VERITAS is an array of four Imaging Atmospheric Cherenkov Telescopes (IACT) of 12 meters diameter, located at the Fred Lawrence Whipple Observatory near Tucson, Az, designed to look for astrophysical very high energy (¿100 GeV) gamma rays. In addition to looking for a variety of galactic and extragalactic sources, it is well suited for searches in different areas of particle physics, like the search for particle dark matter, primordial black holes, Lorentz invariance violation or positron excess in the electron/positron astrophysical background. This presentation will review the results of VERITAS with particular emphasis on some topics of particle physics.

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