

ANNUAL REPORT

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Cover photos, clockwise from upper left: One of the SNO NCD welding teams, Sean McGee, Tom Burritt, Ian Lawson (Guelph) and Peter Doe, preparing a pre-deployment-welded NCD segment for storage in the mine at Sudbury. Kareem Kazkaz and Jeremy Kephart (NC State) verifying the performance of the SEGA crystal after taking possession of it from Ortec. Smarajit Triambak and Cristina Bordeanu, adjusting the target position for a Tandem experiment. The fixture for welding the NCDs.

INTRODUCTION

CENPA pursues a broad program of research in nuclear physics, astrophysics and related fields. Research activities are conducted locally and at remote sites. The current program includes “in-house” research on nuclear collisions and fundamental interactions using the local tandem Van de Graaff, as well as local and remote non-accelerator research on fundamental interactions and user-mode research on relativistic heavy ions at large accelerator facilities in the U.S. and Europe. We are pleased to welcome Professor Alejandro García, who joined our faculty in September 2002, and Professor Askel Hallin, on sabbatical from Queen’s University.

We have completed our “Phase II” ${}^7\text{Be}(p,\gamma){}^8\text{B}$ measurements, extending our earlier work to lower energy and reducing our systematic errors. Our new $S_{17}(0)$ determination is in excellent agreement with our Phase I value published in 2002. Our measurements remain the most precise determination to date of this important reaction rate.

We have developed a ${}^8\text{B}$ radioactive beam at the Tandem with a flux of half a dozen ${}^8\text{B}$ per second, and have accumulated about 3×10^5 coincidence-tagged ${}^8\text{B}$ decays, in an experiment searching for a branch to the ground state of ${}^8\text{Be}$. We are presently analyzing these data, searching for a signal from the 92-keV alpha particles from the ground state of ${}^8\text{Be}$.

Event structure analysis of RHIC Au-Au collisions has revealed a number of new correlation phenomena related to 1) initial-state multiple scattering and its variation with event centrality and 2) local measure conservation at hadronization and its variation with changes in the prehadronic medium, both indicating the development of a collective medium with dissipative properties. Fluctuation scaling results have been successfully inverted by a numerical process to construct autocorrelation distributions which are directly interpretable in terms of physical models.

HBT interferometry with STAR data at RHIC have in the past three years provided significant challenges to conventional theoretical models of RHIC physics. The latest such challenges, reported here, show rising pion phase space density and decreasing entropy per particle with centrality, both results suggesting the onset of some unknown low entropy process in central RHIC collisions.

The SNO detector has been in operation since June 2001 with 0.2% NaCl added to the heavy water to enhance detection of neutrons released by neutral current interactions. Analysis of 254 live days of that data set is nearly complete and a paper is being prepared for publication in the summer of 2003. As expected, a strong neutron peak is seen, but because a “blind” analysis is being performed the implied NC rate is not yet known. Quite good statistical separation of NC events from charged-current ones based on the differences in anisotropy of Čerenkov light is being realized.

The neutral current detector array is complete, and the detectors have been welded together in preparation for deployment. Deployment hardware is in hand and deployment crews are trained in readiness for installation of the array in late 2003.

The MOON ${}^{100}\text{Mo}$ double beta decay experiment research at CENPA is now focused on development of a bolometric method that could provide high energy resolution and the

ability to tag double-beta transitions to excited states in ^{100}Ru . In collaboration with UW condensed-matter physicists a dilution refrigerator is being set up to make preliminary measurements of the specific heat and thermal diffusivity of superconducting and normal Mo at millikelvin temperatures.

The emiT experiment, a search for time violation in neutron beta decay, has been collecting data at the NIST Center for Neutron Research since the fall of 2002. To date, it has been a highly successful run, collecting over 150 million coincidences. The collaboration plans to continue acquiring data and studying potential systematics through the end of 2003.

Development of the world's most sensitive direct kinematical neutrino-mass measurement, via tritium beta-decay, has been proceeding rapidly. The University of Washington intends to provide the detector system for this international experiment that will be constructed at the Forschungszentrum Karlsruhe in Germany.

The Majorana collaboration hopes to construct a ^{76}Ge -based next generation 0-neutrino double-beta-decay detector. Our efforts have concentrated on collaborating with scientists at Pacific Northwest National Laboratories to construct a prototype Multiple-Element Germanium Assay (MEGA) detector that consists of an array of 18 high purity Ge detectors.

Progress on the ^{199}Hg EDM experiment includes increased reliability of the 254-nm laser system and a reduction in discharges occurring in the high-voltage cables. Data are currently being taken towards a new measurement.

We are developing an experiment to measure the beta asymmetry from neutron beta decay with high accuracy to elucidate the apparent non-unitarity of the CKM matrix.

We have started experiments at CENPA to reduce uncertainties regarding high-precision measurements to determine the positron-neutrino correlation and the $\log(ft)$ value for the $0^+ \rightarrow 0^+$ decay of ^{32}Ar .

Torsion-balance experiments have demonstrated that, for distances down to 90 μm , there is no force that violates Newton's inverse square law coupling to mass with equal or larger strength than gravity. New developments include 1) a pendulum for testing coupling to spin, 2) a new equivalence principle test, and 3) an 'anapole' pendulum for an axion search.

As always, we encourage outside applications for the use of our facilities. As a convenient reference for potential users, the table on the following page lists the capabilities of our accelerators. For further information, please contact Prof. Derek W. Storm, Executive Director, CENPA, Box 354290, University of Washington, Seattle, WA 98195; (206) 543-4080, or storm@npl.washington.edu. Further information is also available on our web page: <http://www.npl.washington.edu>.

We close this introduction with a reminder that the articles in this report describe work in progress and are not to be regarded as publications or to be quoted without permission of the authors. In each article the names of the investigators are listed alphabetically, with the primary author underlined, to whom inquiries should be addressed.

TANDEM VAN DE GRAAFF ACCELERATOR

A High Voltage Engineering Corporation Model FN purchased in 1966 with NSF funds, operation funded primarily by the U.S. Department of Energy. See W.G. Weitkamp and F.H. Schmidt, "The University of Washington Three Stage Van de Graaff Accelerator," Nucl. Instrum. Meth. **122**, 65 (1974). Recently adapted to an (optional) terminal ion source and a non-inclined tube #3, which enables the accelerator to produce high intensity beams of helium and hydrogen isotopes at energies from 100 keV to 5.5 MeV.

Some Available Energy Analyzed Beams

Ion	Max. Current (particle μA)	Max. Energy (MeV)	Ion Source
1H or 2H	50	18	DEIS or 860
3He or 4He	2	27	Double Charge-Exchange Source
3He or 4He	30	7.5	Tandem Terminal Source
6Li or 7Li	1	36	860
^{11}B	5	54	860
^{12}C or ^{13}C	10	63	860
$^{*14}N$	1	63	DEIS or 860
^{16}O or ^{18}O	10	72	DEIS or 860
F	10	72	DEIS or 860
* Ca	0.5	99	860
Ni	0.2	99	860
I	0.001	108	860

*Negative ion is the hydride, dihydride, or trihydride.

Additional ion species available including the following: Mg, Al, Si, P, S, Cl, Fe, Cu, Ge, Se, Br and Ag. Less common isotopes are generated from enriched material.

In addition, we are now producing a separated beam of 15-MeV 8B at 6 particles/second.

BOOSTER ACCELERATOR

See "Status of and Operating Experience with the University of Washington Superconducting Booster Linac," D.W. Storm *et al.*, Nucl. Instrum. Meth. A **287**, 247 (1990). The Booster is presently in a "mothballed" state.

Contents

INTRODUCTION	i
1 Fundamental Symmetries and Weak Interactions	1
Weak Interactions	1
1.1 A second run of the emiT experiment	1
1.2 Status and updates to emiT DAQ	4
1.3 Parity non-conserving neutron spin rotation in liquid helium	5
1.4 Beta asymmetry from ultra-cold neutrons	7
1.5 Limits on scalar currents from the decay of ^{32}Ar	8
1.6 Search for a permanent electric dipole moment of ^{199}Hg	9
Torsion Balance Experiments	10
1.7 Sub-mm test of Newton’s Inverse-Square Law	10
1.8 Spin pendulum update	11
1.9 Eötvash data acquisition system development	12
1.10 A new equivalence principle test	13
1.11 Development of an ‘anapole pendulum’	14
1.12 Small force measurements for LISA	15
2 Neutrino Research	16
SNO	16
2.1 The Sudbury Neutrino Observatory	16
2.2 Status and updates to the SNO data acquisition system	17
2.3 Energy and optical calibration of the Sudbury Neutrino Observatory	18
2.4 Selection of the neutrino analysis data set for the Salt Phase of SNO	19
2.5 Distinguishing muon spallation types in SNO	20

2.6	Electron antineutrino detection at the Sudbury Neutrino Observatory	21
2.7	Reactor antineutrinos at the Sudbury Neutrino Observatory	22
2.8	The day-night asymmetry measurement in the salt phase of SNO	23
2.9	SNO signal extraction in the salt phase	24
SNO NCDs		25
2.10	NCD data analysis	25
2.11	NCD array optimization	26
2.12	Determination of Z-position for hits in the NCD array	27
2.13	Data acquisition for SNO's neutral current detectors	28
2.14	NCD underground status	29
2.15	NCD deployment equipment progress and training	30
2.16	Progress of the underground NCD welding prior to deployment	31
Neutrino Detectors		32
Double Beta Decay		32
2.17	Majorana update: construction, evaluation, simulation	32
2.18	Electron-capture branch of ^{100}Mo and the efficiency of MOON	33
KATRIN		34
2.19	Characterizing silicon detectors for KATRIN	34
3 Nuclear Astrophysics		35
3.1	$^7\text{Be}(p,\gamma)^8\text{B}$	35
3.2	Target composition analysis for $^7\text{Be}(p,\gamma)^8\text{Be}$ S-factor measurement	36
3.3	Search for the $^8\text{B}(2^+) \rightarrow ^8\text{Be}(0^+)$ ground state transition	37
3.4	Is e^+e^- pair emission important in the determination of the $^3\text{He} + ^4\text{He}$ S-factor?	38

4	Nuclear Structure	39
4.1	Testing the isospin multiplet mass equation and its implications	39
4.2	Low-temperature measurement of the giant dipole resonance width	40
5	Relativistic Heavy Ions	41
5.1	Introduction to event-structure analysis	41
5.2	Mean- p_t fluctuations and minijet production in Hijing-1.37	42
5.3	Mean- p_t fluctuation scaling on (η, ϕ) in Au-Au collisions at $\sqrt{s_{NN}} = 200$ GeV	43
5.4	Scale dependence of net-charge fluctuations	44
5.5	Relating fluctuations and correlations in heavy-ion collisions	45
5.6	Determination of auto-correlation using net-charge fluctuations	46
5.7	Centrality dependence of $\langle p_t \rangle$ fluctuations in Au-Au collisions	47
5.8	Charge-independent $p_t \otimes p_t$ correlations in Au-Au collisions at 130 GeV	48
5.9	Charge-dependent correlations in axial-momentum space	49
5.10	Hard and soft scattering in p-p collisions	50
5.11	Dimensionality of a strange attractor as a function of scale	51
5.12	Dimensionality of a strange attractor as a function of position	52
5.13	Overview of HBT physics at STAR	53
5.14	Pion phase space density and “Bump Volume”	55
5.15	Entropy at freeze-out in RHIC collisions	57
5.16	Opacity effects in Bose-Einstein correlation radii at RHIC	59
5.17	Testing the Bowler-Sinyukov-CERES Coulomb-correction procedure with same- vs. opposite-charge pion correlations	60
5.18	Particle identification in STAR TPC	63
6	Molecular Clusters	64
6.1	Attempt to produce dianions of Mg_2S_3	64
7	Electronics, Computing, and Detector Infrastructure	65

7.1	Electron gun for profiling silicon detectors for KATRIN	65
7.2	Nanopore DNA sequencing	67
7.3	Electronic equipment	68
7.4	PC based data acquisition system using JAM	69
7.5	Status of an advanced object oriented real-time data acquisition system	70
7.6	Laboratory computer systems	71
8	Accelerator and Ion Sources	72
8.1	Van de Graaff accelerator operations and development	72
8.2	Injector deck and ion sources	74
8.3	A ^8B beam at the Tandem	75
9	The Career Development Organization: A Student Organization	76
10	CENPA Personnel	77
10.1	Faculty	77
10.2	Postdoctoral Research Associates	77
10.3	Predocctoral Research Associates	78
10.4	Research Experience for Undergraduates participants	78
10.5	Professional staff	79
10.6	Technical staff	79
10.7	Administrative staff	79
10.8	Part Time Staff	80
11	Publications	81
11.1	Degrees Granted, Academic Year, 2002-2003	90