ANNUAL REPORT

Center for Experimental Nuclear Physics and Astrophysics
University of Washington
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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}Be(p,γ)^{8}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}B radioactive beam at the Tandem with a flux of half a dozen ^{8}B per second, and have accumulated about 3×10^{5} coincidence-tagged ^{8}B decays, in an experiment searching for a branch to the ground state of ^{8}Be. We are presently analyzing these data, searching for a signal from the 92-keV alpha particles from the ground state of ^{8}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}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.

Derek Storm, Editor — Barbara Fulton, Assistant Editor

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
^{1}H or ^{2}H	50	18	DEIS or 860
^{3}He or ^{4}He	2	27	Double Charge-Exchange Source
^{3}He or ^{4}He	30	7.5	Tandem Terminal Source
^{6}Li or ^{7}Li	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 ^{8}B 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.

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