2003 – 2005 **2 ½ years Research Associate** position, won by international competition, at the **University of Washington, Seattle, USA,** at the NPL - CENPA (Nuclear Physics Laboratory - Center for Nuclear Physics and Astrophysics). I collaborated directly with Professor Kurt A. Snover and Professor Derek W. Storm (the technical director of the lab at that moment).

I intiated and made the experimental and methodological preparations for the experiment $^{3}He(^{4}He, \gamma)^{7}Be$ at low energies, of interest for Nuclear Astrophysics.

Here are some of the achievements:

- Decrease the gamma background produced by the beam interaction with materials in the beam path (a long series of experiments using the 8MV accelerator, used in the TIS Terminal Ion Source configuration too, to determine which materials create a low background gamma at the beam interaction with materials; finally, the whole beam line was dismantled and cleaned of oil vapor deposition, re-placed and checked the result: worth the effort.)
- Building a thermalized electronic frame for the electronic modules in which the signal from the detector is formed and forwarded, to minimize the effect of channel shifting of the signal in the multichannel analyzer, due to temperature variations in the room used for data acquisition
- Experimental measurements of the purity of the materials, components of the reaction chamber used in this project, for high precision measurements; small amounts of some contaminants, in ppb proportion, can alter the outcome of the experiment by adding to the desired reaction product the same product emerging from contaminants inter-reactions contributions, with higher interaction probability than the initial contributors, which may be not at all negligible, changing in this way the correctness of the reaction cross-section measurement
- 100% relative efficiency Ge detectors calibration, with high precision standard gamma sources, for source-detector distances extremely small (between 3cm and less than 1mm), which is a challenge considering the effect of pileup and summing
- Nuclear reaction simulation using SRIM program (changed to fulfill the requirements for a nuclear reaction) for the energy and angular straggling of the beam ^{4}He transported through all the reaction chamber parts, for the geometry distribution of the ^{7}Be on the stopper, for the numerical evaluation of the 429keV gamma signal shape, resulting from SRIM simulation, for the 100% relative efficiency Ge detector, for the 'direct capture' reaction $^{3}He(^{4}He, \gamma)^{7}Be$, signal as measured directly during the nuclear interaction (Doppler shift, Doppler shift attenuation).

These details determine the success of a high precision experiment.
Results were published.

I participated to:

- **Conference** on neutrinos*: <u>TAUP 2003</u> Eighth International Workshop on Topics in Astroparticle and Underground Physics September 5 - 9, 2003,*
- **biannual meetings of the American Physical Society *APS si APS –*** *DNP (2003, 2004),*
- **National Summer School on Nuclear Physics** *: National Nuclear Physics Summer School <u>2005</u> XVII: Lawrence Berkeley National Laboratory, Berkeley, California (6 June - 17 June),*

presenting posters or lectures:

- *-Preparations for a Precision Measurement of the ^{3}He(α, γ) ^{7}Be Cross section,*
- *-Determination of Energy Loss of 3-MeV alpha particles in Ni foil and ^{3}He Gas Using a Mg(α,γ) Resonance,*
- *-^{3}He(α,γ) ^{7}Be Cross Section Measurement-Project Overview*

I participated to other two experiments in other academic centers:

- **weak interaction experiment at Texas A&M, College Station, Texas, USA :**
  - *-Precise determination of gamma ray yields from the beta decay of ^{32}Cl*
- **Coulombian breakup experiment at MSU-NSCL, East Lansing, Michigan, USA**:
  - *-Can the neutron capture cross sections be measured with Coulomb dissociation?*

(see the publication list).

When at **UofW**, I cared a lot for reducing the statistical and systematic errors of the measurement. The ^{3}He +^{4} He experimental approach was to measure both the prompt gamma's (three such gamma's) and the delayed gamma's coming from the electron capture decay of radioactive nuclei ^{7}BE to ^{7}Li, a stable nucleus. **Precision measurements** are based on fully, detailed characterization of the measurement and detection geometries, of the material from which a gaseous target is made, on detector calibration, on the efficiency calibration gamma sources uncertainties, beam intensity correct counting, fair understanding of the gas target behavior when energy is deposited inside its constant volume. Selecting the 'metering' method and building the experimental setup was made mostly by me.

- I performed several experiments to quantitative characterize the contaminants in ^{6}Li and ^{10}B of multiple stopper materials, as extra ^{7}Be can be created in ^{6}Li and ^{10}B reactions with deuterons or protons, other ^{7}Be than the obtained from ^{3}He +^{4} He experiment
- Cross-section calculation dependents on the gas-target atom density, density, subject to change with the beam intensity passing through it; determining the gas density distribution for the main cases: no beam and the beam passes through the gas-target, beam of different intensities, at different initial densities of the gas. To understand the gas-target behavior under the beam intensity, gas at different densities, we used nuclear resonance reactions ^{24}Mg+α si ^{10}B+α.

- After checking the two 100%, relative efficiency, Ge detectors, for the energy resolution, one of them was sent back to CANBERRA to be repaired, as its energy resolution didn't correspond to the values on the accompanying papers.
- I calculated the required activities for the standard gamma sources to be used for the Ge detectors efficiency calibration so one can make a complete characterization of them. Similar gamma sources were bought.
- Monte Carlo simulation for the Ge detectors efficiency calculation, using the PENELOPE code, were initiated and partly coordinated by me, with very determined undergraduate and graduate students.
- I wrote the software to operate a step-by-step motor which operated a translational-moving table. The collimator holes, of different diameters, were placed in front of the target, using the program, when asked by the user, in order to refine the beam tuning. By a Faraday cup, the beam intensity was measured.
- I adapted a computer code SRIM so that the nuclear reaction ^{3}He +^{4} He products could be transported through the gas-target after the fusion event, and so that to describe the gamma signal to the Ge detector. Comparing the program values to the actual signal given by the Ge detector in a multiple channel analyzer, the approximation was extremely good.
- I observed an electronic shift of the peaks, in time, in the multiple channel analyzer, due to temperature changes during the day, or during day – night, and I suggested the necessity of a thermalized system for the electronic modules, to ensure constant temperature in the electronic frame. It was done and I think it was a great success, as the electronic shift was not noticeable any more after using this device.