

# Hemispherical Analyzer System for the Madison SGM Beamline

Design Specification

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## **1.0 INTRODUCTION**

### **1.1 PURPOSE**

This document specifies the requirements for a hemispherical electron analyzer for the spherical grating monochromator (SGM) spectroscopy beamline that will be part of the Canadian Light Source (CLS) facility.

### **1.2 SCOPE**

The SGM beamline for the CLS requires a high performance hemispherical electron analyzer to satisfy the projected experimental needs of its users. The analyzer system shall also include all the necessary hardware and software to perform the types of experiments that will be performed by the users of this analyzer.

This specification details the requirements for the design, fabrication, supply, and testing of the analyzer system. This specification includes, but is not limited to:

- hemispherical analyzer
- control hardware
- control software
- functional and performance requirements
- delivery, installation, and testing
- quality assurance and safety

### **1.3 BACKGROUND**

The Canadian Light Source is a national facility under construction on the University of Saskatchewan campus in Saskatoon, Saskatchewan. This facility is a third generation synchrotron light source, which will produce a high intensity source of infrared, visible, ultraviolet, and x-ray radiation.

Based upon the projected electron spectroscopy needs of the Canadian synchrotron community, it was determined that a high performance hemispherical electron analyzer would be required to satisfy the needs of this community once the CLS becomes operational.

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## **2.0 HEMISPHERICAL ANALYZER GLOBAL REQUIREMENTS**

### **2.1 FUNCTIONAL REQUIREMENTS**

**2.1.1** The proponent shall supply the hemispherical analyzer, control hardware, and analyzer control software.

**2.1.2** The system shall be able to perform the following experiments:

- (a) x-ray photoelectron spectroscopy (XPS)
- (b) Auger electron spectroscopy (AES)
- (c) photoelectron diffraction (PED) with limited range from a fixed analyzer
- (d) constant initial state (CIS) spectroscopy
- (e) constant final state (CFS) spectroscopy
- (f) angle resolved electron spectroscopy with limited range from a fixed analyzer.

**2.1.3** The software shall support all the above experiments. The proponent shall provide detailed documentation outlining options for communication between the beamline control computer and analyzer control computer which may include: TTL or RS232 communication, master/slave computer arrangements, primary/secondary workstation arrangements, and DLL libraries requiring user-written software.

**2.1.4** The analyzer shall have a large sample to lens working distance in excess of 25 mm.

**2.1.5** The analyzer shall have magnetic shielding. The level of shielding shall be sufficient to facilitate operation in the entire electron kinetic energy range specified below (0-2000 eV) and achieve resolution benchmarks.

**2.1.6** The analyzer shall possess a 2-D multi-channel detection system.

**2.1.7** The analyzer shall operate in either a high-resolution mode with limited kinetic energy range (approximately 0-300 eV), or in an XPS mode with a large kinetic energy range. The kinetic energy range in XPS mode should be at least 0-2000 eV.

**2.1.8** The vendor shall supply a support frame to support the weight of the instrument correctly such that no torque is placed upon vacuum

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components by the weight of the instrument. The support frame shall not increase the horizontal spatial footprint of the instrument.

**2.1.9** The analyzer shall possess a view port for the purpose of aligning the instrument visually with the use of 0-order synchrotron light.

**2.1.10** The analyzer shall be able to withstand bake-out conditions approaching 150° C. The proponent shall supply documentation detailing the safe bakeout range of the instrument.

**2.1.11** The mean radius of the analyzer shall not exceed 150 mm.

## **2.2 PERFORMANCE**

**2.2.1** The analyzer should obtain 5 meV resolution at the lowest pass energy setting.

**2.2.2** Signal strength and signal to noise ratios at the lowest pass energies shall be such that sample preparation and alignment should consistently be the limiting factors in sample analysis times.

## **2.3 SAFETY AND ENVIRONMENTAL**

**2.3.1** The proponent shall provide detailed instructional and safety documentation to ensure correct set-up of the instrument protects users from high voltages generated by the instrument power supplies.

**2.3.2** All power connections provided shall be consistent with North American standards.

**2.3.3** The proponent shall supply documentation outlining the safe vacuum range at which the instrument can be operated and the measures implemented into the hardware to protect the instrument from improper vacuum conditions.

**2.3.4** The vendor shall supply a list of chemicals that may cause damage to the instrument upon exposure in liquid or gaseous form.

**2.3.5** The instrument shall be capable of operation in an ambient temperature range of 10 to 30 degrees C. The normal ambient temperature of the experimental floor will be 22 degrees C. The expected temperature stability will be 1 degree C or better during normal operation.

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**2.3.6** The instrument shall be able to withstand a relative humidity range of 0 to 95%. The expected relative humidity limits under operation are from 25% during the winter months and to a maximum of 50% during the summer months. The expected relative humidity range for components under storage will be the same as previously mentioned.

## **2.4 INSPECTION, TESTING, AND COMMISSIONING**

**2.4.1** The instrument will be mounted in a beamline end-station currently under design and construction. The installation will be carried out by the Canadian Synchrotron Radiation Facility (CSRF) staff located at SRC with supervision from the vendor.

**2.4.2** The vendor shall test the performance of the instrument at the SRC with a conventional excitation source. Instrument resolution will be tested in UHV condition by monitoring the Au Fermi edge at cryogenic (either liquid nitrogen or liquid helium) temperatures. At the same time, the vendor shall supply training to the CSRF staff and any CLS staff present on the operation of the analyzer, hardware, and software.

**2.4.3** The vendor shall supply documentation for standard test procedures and operating conditions to assist the staff of CSRF and CLS in the training of new users in the future.

**2.4.4** The vendor shall supply the results of in-house performance tests conducted before shipment to the CSRF.

## **2.5 RELIABILITY AND MAINTAINABILITY**

**2.5.1** All elements of the instrument shall be designed and manufactured with strong consideration for both reliability and serviceability. The instrument will be in use several months of each year upon reaching operational status at the CLS.

**2.5.2** The vendor shall supply documentation in English to the CLS outlining the maintenance requirement procedures and schedules for all major subsystems to the instrument. A list of recommended spare parts shall be supplied.

**2.5.3** The vendor shall supply a list of test points, voltages, and protocols that may be utilized by beamline staff to evaluate problems with the instrument before vendor technical assistance is called.

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**2.5.4** The vendor shall supply a list in English detailing the warranty period for all major components of the system.

## **2.6 QUALITY ASSURANCE**

**2.6.1** The vendor shall maintain and apply a quality assurance program compliant with ISO-9001 for the design, manufacture, and testing of all components.

## **2.7 OTHER REQUIREMENTS**

**2.7.1** The instrument shall be delivered for testing to the Synchrotron Radiation Center (SRC) in Stoughton, Wisconsin where the beamline is currently positioned. The instrument will then be transported with the rest of the beamline to the CLS site at a later date.

**2.7.2** The hemispherical analyzer shall be affixed with a nameplate with the following format:

Hemispherical Analyzer

Serial No.:

Net Weight (kg):

Maximum Voltage (V)

Design Current (A):

Date:

Manufacturing Company Name, Address, and Telephone Number

All lettering on nameplate shall be in 14 point font size. The position of the nameplate shall not interfere with analyzer operation.

**2.7.3** Preparation for shipment and delivery.

**2.7.4** Crates shall be designed such that it can be moved using a standard handling device (forklift or pallet jack). The crates shall be appropriately labelled to ensure safe handling. The contents of the crates shall be packed in a waterproof fashion.