Canadian Light Source — Centre canadien de rayonnement synchrotron

Amendment to the CMCF Technical Specification for the 08ID-1 Beamline

Technical Specifications – 6.8.77.3 Rev. 1

April 11, 2003

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REVISION HISTORY

Revision	***Date***	***Description***	***Author***
A	Apr. 08/03	Draft	Pawel Grochulski
1	Apr. 11/03	Final document	Pawel Grochulski

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1.0 INTRODUCTION

1.1 PURPOSE

This document contains technical specification for a proponent to design and build an endstation for the CMCF 08ID-1 protein crystallography beamline.

1.2 SCOPE

This technical specification establishes the requirements for design, fabrication, inspections, testing and delivery of the endstation.

1.3 BACKGROUND

The Canadian crystallographers and CLS approved the Preliminary Design Report for the Canadian Macromolecular Crystallographic Facility 08ID-1 beamline at the CLS. The main scientific application performed at this beamline will be multiwavelength anomalous dispersion (MAD) experiments and collecting high-resolution data from small crystals (~ 20 µm) and crystals with large cell dimensions (~1000 Å).

An in-vacuum small gap undulator will illuminate the beamline. The design of the beamline is characterized by main components such as: a double crystal monochromator with the first crystal cryogenically cooled and the second crystal sagittally bent, a dynamically bent plane mirror, which is focusing beam vertically, and removing higher harmonics, and experimental station.

The overall design of the 08ID-1 beamline is described in the PDR [1, 2].

1.4 DEFINITIONS AND ABBREVIATIONS

I_o – Reference beam intensity monitor

CCD detector – charge-coupled device detector

1.5 GENERAL DESCRIPTION

The endstation of the CMCF 08ID-1 beamline shall consist of a goniometer system and a detector support system, they both shall be separated from each other on the experimental floor.

2.0 REQUIREMENTS

2.1 MOTORS, GEARHEADS AND ENCODERS

2.1.1 All motors that are going to be installed on any element or device of the endstation shall be stepper.

2.1.2 All motors shall have encoders.

2.1.3 All motors shall have properly selected gearheads.

2.1.4 Encoders' resolution shall be selected to ensure specific device performance.

2.1.5 Encoders' and motor selection shall be reviewed and approved by the CLS prior to fabrication.

2.1.6 All actuators shall be equipped with two limit switches, home switch and two overdrive switches.

2.1.7 Every motor and associated switches and encoder shall be wired and terminated at the connector box, using CLS standard connector boxes.

2.1.8 If proponent is providing motion control hardware or motors it shall comply with the CLS Control System Technical Specification [3] and Electronics Development Procedure [4].

2.2 GONIOMETER SYSTEM

2.2.1 The goniometer system shall be separated from the detector support system (See Fig. 1).

2.2.2 The goniometer system shall include a **support table** with a positioner in vertical and horizontal directions, a **goniometer,** an **exposure box,** a *high-sensitivity camera with zoom optics*, a *fluorescence detector*, a *nitrogen gas cryostream cooler* and a *sample changer*. The last four items will be provided by the CLS.

2.2.3 The positioner drives for the table support shall have a range of +-50 mm, a repeatability of 2 µm and a resolution of 0.5 µm.

2.2.4 The goniometer shall be equipped with a single rotation (Omega), with an option to upgrade to the Kappa geometry in the future, a sample holder with x-y-z motorized translations of 10 mm for x and y, and 25 mm for z. These are for aligning the crystal sample to the Omega axis and the photon beam. The sphere of confusion shall be less than 6 µm.

2.2.5 The Omega axis shall be able to rotate with the speed rotation at least 20 degree/s. The omega drive shall have a repeatability of 0.001 degree, an absolute accuracy of 0.002 degree or less, and a resolution of 10^{-5} degree.

2.2.6 The exposure box (See Fig. 2) shall have x-y-z translations, with range of 30 mm in horizontal and along the beam direction and 50 mm in the vertical direction, a repeatability of 1 µm and a resolution of 0.5 µm. The box shall have a pitch rotation with range of 0 – 1 degree and repeatability of 0.005 degree. The pivot point shall be very close to the slits. The exposure box shall be prepared to be either under vacuum or flashed with Helium. It shall be equipped with a removable nose-cone nozzle. The nozzle shall have a diameter of 6 mm and be made of aluminium. The exit in the exposure box shall have a diameter of 12 mm to allow measurements of the flux from the unfocussed beam without the nozzle.

2.2.7 Inside the exposure box shall be located the following devices starting from the upstream end: horizontal slits, vertical slits, I_o monitor, filters, I_o monitor and a shutter.

2.2.7.1 Slits shall have a range of +/- 6 mm to achieve 12 mm maximum opening, repeatability of movement of each blade shall be 1.0 µm.

2.2.7.2 The I_o monitor can be either an ionization detector or a thin metal film with diodes. A diode design shall prevent getting backscatter or fluorescence from the filters.

2.2.7.3 Three electromechanically controlled filters actuators shall have four 12 mm opening holes each to allow mounting of 12 filters. Another option could be two discs with 6 holes each.

2.2.7.4 The shutter shall have a reproducibility of 200 µs and delay time of 10 ms. The opening of the shutter shall be larger than 10 mm in each direction.

2.2.8 The beam stop shall be attached to the exposure box and have motorized movements in all three directions assuring that the movement along the beam direction is parallel to the beam in both the vertical and horizontal directions.

2.2.9 The fluorescence detector will be procured by the CLS.

2.2.10 The sample camera will be procured by the CLS and shall be attached to the goniometer support.

2.2.11 The sample changer will be procured by the CLS.

2.2.12 For the first alignment of the detector system on the experimental floor a mechanism to level and to make the horizontal movement of the goniometer perpendicular to the photon beam shall be implemented.

2.3 DETECTOR SUPPORT SYSTEM

2.3.1 The support for the CCD detector shall be capable of supporting a 200 kg detector.

2.3.2 This system shall be able to change the detector-to-sample distance between 50 mm and at least 1 m. It shall be capable of rotating the detector around a horizontal axis perpendicular to the beam, upward to 45 degrees and downward to 5 degrees below the horizontal. It shall be capable to offset the detector in the vertical direction by at least +300 mm.

2.3.3 The positioning of the detector shall have a repeatability of 10 µm in directions orthogonal to the beam, 20 µm in distance to the sample, and 0.005 degree in rotation. The resolutions of the motions shall be at least five times finer than the specified repeatability.

2.3.4 Physical stops shall be provided on all axes as well as hydraulic dampers for vertical travel damping should the system "run-away".

2.3.5 For the first alignment of the detector support system on the experimental floor, in order to assure that detector's translation is exactly along the photon beam, a mechanism to level and to rotate the system in the horizontal plane shall be implemented.

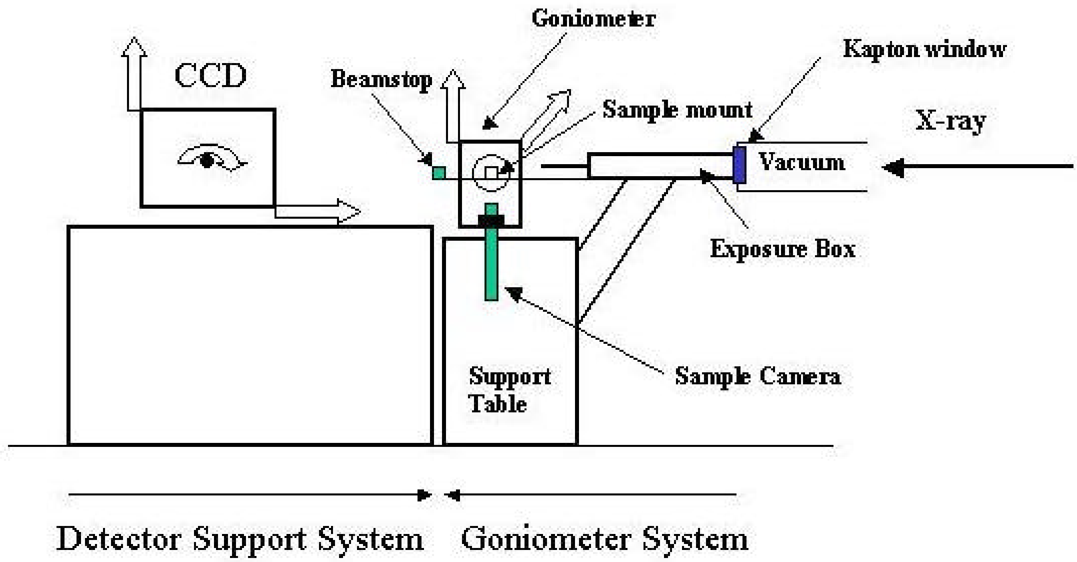

Fig. 1. The endstation. Arrows indicate required movement.

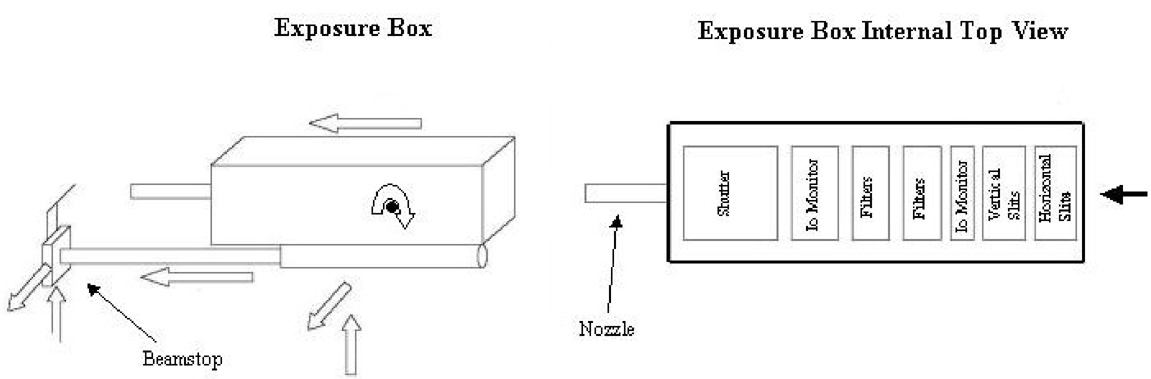

Fig. 2. The exposure box. Arrows indicate required movements

3.0 SAFETY, ENVRONMENTAL AND RELIABILITY

3.1.1 The system shall be capable of operating in an ambient temperature range of 10 to 35^{o}C.

3.1.2 The temperature of the experimental hall is 23^{o}C with expected stability better than 1^{o}C.

3.1.3 The components shall be able to withstand a relative humidity range of 0% to 90%. The expected relative humidity limits under operation are from 25% during the winter months and a maximum of 50% during the summer months. The expected relative humidity range for components under storage will be the same as previously mentioned.

3.1.4 All components shall be designed for operating in radiation environment. The proponent shall avoid all materials that are subject to damage by ionizing radiation or provide adequate shielding incorporated into the design to allow for long service life of the component. All components with an exception of metal l_0 foils and kapton end windows shall have a minimum mean time failure (MTVF) of 5 years in the practical radiation environment.

3.1.5 The experimental hall floor is expected to have a maximum vibration movement of less than 0.4 µm at frequencies less than 100 Hz.

3.1.6 The experimental floor at the CLS can have +/- 25 mm displacement from the flat surface.

3.1.7 Work carried out at CLS must be performed in accordance with national, provincial and CLS safety and electrical codes and standards.

4.0 APPLICABLE CODES, STANDARDS AND PROCEDURES

The proponent shall identify the quality assurance and technical standards normally applied.

5.0 QUALITY ASSURANCE

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

6.0 INSPECTION, TESTING AND COMMISIONNING

6.1.1 The proponent shall develop and execute a set of acceptance test procedures to verify that all components have been fabricated and assembled correctly.

6.1.2 The acceptance test results are subject to review and acceptance by the CLS. Any review and acceptance process done by the CLS shall not release the proponent's responsibility to correct errors and omissions to ensure conformance to the specifications in this document.

6.1.3 The proponent shall provide the facilities and instrumentation, if not specified otherwise, to perform all relevant tests to ensure compliance with this specification.

6.1.4 The acceptance test results are subject to review and acceptance by the CLS.

7.0 OTHER

7.1 DRAWINGS

The proponent will be responsible for providing AutoCAD MDT v5 or later drawings in electronic form for all components of the endstation.

7.2 FABRICATION REQUIREMENTS

7.2.1 Materials

7.2.1.1 Stainless steel shall be used for fabrication of the goniostat parts.

7.2.1.2 Mechanical fasteners and interfaces shall be based on American standard thread.

7.2.1.3 Aluminum parts should be manufactured from 6061-T6 and 5052-H32 for formed brackets.

7.3 TRANSPORTATION AND INSTALLATION

7.3.1 The CLS is equipped with a 10-ton overhead crane. The crane covers area of the experimental floor including the 08ID sector. The shipping containers will be moved from loading area to the crane with the forklift. The hutches will be equipped either with cranes or equivalent system to move heavy objects.

7.3.2 Shipping

7.3.2.1 The proponent shall package all fabricated components to insure acceptance and safe delivery by common or other carrier, and so components can be delivered in an undamaged condition.

7.3.2.2 Packing to be used during shipping of components shall ensure protection of the components from water, dust oil and vibration during shipping.

7.3.2.3 The shipping containers shall be properly labeled in English and conform to CLS document specification [5].

7.3.2.4 All shipping containers shall be marked or tagged with the following information:

7.3.2.4.1 CLS purchase order number

7.3.2.4.2 Shipping address as specified within contract

7.3.2.4.3 Proponent's name

7.3.2.4.4 Components contained within package

7.3.2.4.5 "Top-side up" if required

7.3.2.4.6 "Fragile" if required

8.0 REFERENCES

1. CMCF 08ID-1 Preliminary Design Report - 6.2.77.2. Rev. 0.
2. CMCF 08ID-1 Technical Specifications - 6.8.77.1 Rev. 0.
3. CLS Control System Technical Specification - 7.4.39.1.
4. Electronics Development Procedure, CLS design procedure – 7.1.39.3 Rev. 0.
5. CLS Document Specification - 0.4.1.1 Rev. 2.