illumina®

BFA Test Station Statement of Work

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1 SOW process and instructions

1.1 BFA Test Station SOW process timeline

The following schedule of events will be followed to the best of our abilities.

SOW communicated to Diamond SA, not later than	October 27th 2023
Supplier response, including milestones quotes, no later than	November 10th, 2023

1.2 Acronym table

Acronym	Description
BFA	Bifurcated Fiber Assembly
OQC	Outgoing Quality Control
IQC	Incoming Quality Control
PCS	Purchased Component Specifications
POR	Plan of record
LEA	Laser Engine Assembly
HW	Hardware
FW	Firmware
SW	Software
LDC	Laser Diode Controller
LDI	Laser Diode Illuminator
GUI	Graphical User Interface
FTP	File Transfer Protocol
GRR	Gage repeatability and reproducibility
PMM	Preventive Maintenance Plan

2 Product technical overview

2.1 Test Station Overview

The BFA test stations are intended to be used during OQC and IQC procedure to measure and verify the BFA ILMN PCS specifications (detailed in paragraph 0). The stations will be performing several of the measurements using a POR LEA, to guarantee the most accurate user case scenario.

The two stations, including Hardward, Firmware and Software components will be designed, developed and validated by Diamond SA based on ILMN requirements presented in this document. Upon validation completion the tests station will be installed at:

- Diamond SA (Losone, CH), OQC Test Station
- ILMN (Hayward, CA, US), IQC and troubleshooting Test Station

The test stations shall be self-contained, meet the safety requirements listed in paragraph 2.4 and operated with clear and user-friendly SW as detailed in paragraph 2.5.

2.2 BFA PCS Specifications Overview

The BFA test station will be responsible for accurately measuring the specifications shown in Table 1. Furthermore, the test station shall demonstrate a minimum measurement resolution as indicated in the column “Required Resolution”.

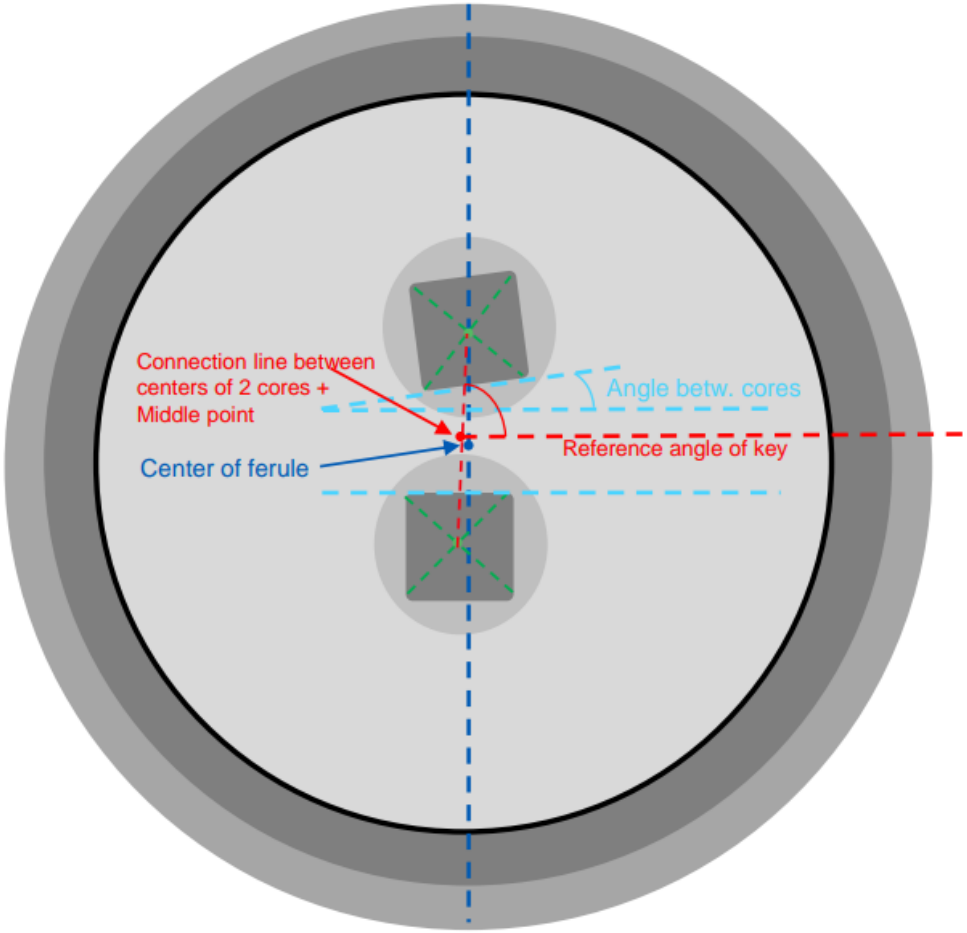
Table 1: BFA Specifications

Specification Name	BFA specifications description	UoM	LSL	USL	Required Resolution
	General				
TransmissionEfficiency_Fiber _BeforeBurnIn_BFA	Fiber's transmission efficiency before burn-in test	%	90	NA	≤0.1 %
TransmissionEfficiency_Fiber _AfterBurnIn_BFA	Fiber’s transmission efficiency after burn-in test	%	90	NA	≤0.1 %
	Blue connector				
Angle_FiberCoreRotation_Blue_BFA	Fiber core rotation with respect to connector key	deg	43.5	46.5	≤0.1 deg
DistanceZFiberCoreToFerruleExitSurface_Blue_BFA	Fiber facet’s Z distance with respect to the ferrule's exit surface	um	-0.50	0.50	≤0.05 um
EccentricityFiberCoreToFerruleOD_Blue_BFA	Fiber core eccentricity with respect to the outer diameter of the ferule	um	NA	16.75	≤ 0.5um
EccentricityFerruleToIMODSleeve_Blue_BFA	Ferrule and IMOD's mating sleeve eccentricity	um	NA	5.0	≤ 0.5um
	Green Connector				
Angle_FiberCoreRotation_Green_BFA	Fiber core rotation with respect to connector key	deg	43.5	46.5	≤0.1 deg
DistanceZFiberCoreToFerruleExitSurface_Green_BFA	Fiber facet Z distance with respect to the ferrule's exit surface	um	-0.50	0.50	≤0.05 um
EccentricityFiberCoreToFerruleOD_Green_BFA	Fiber core eccentricity with respect to the outer diameter of the ferule	um	NA	16.75	≤ 0.5um

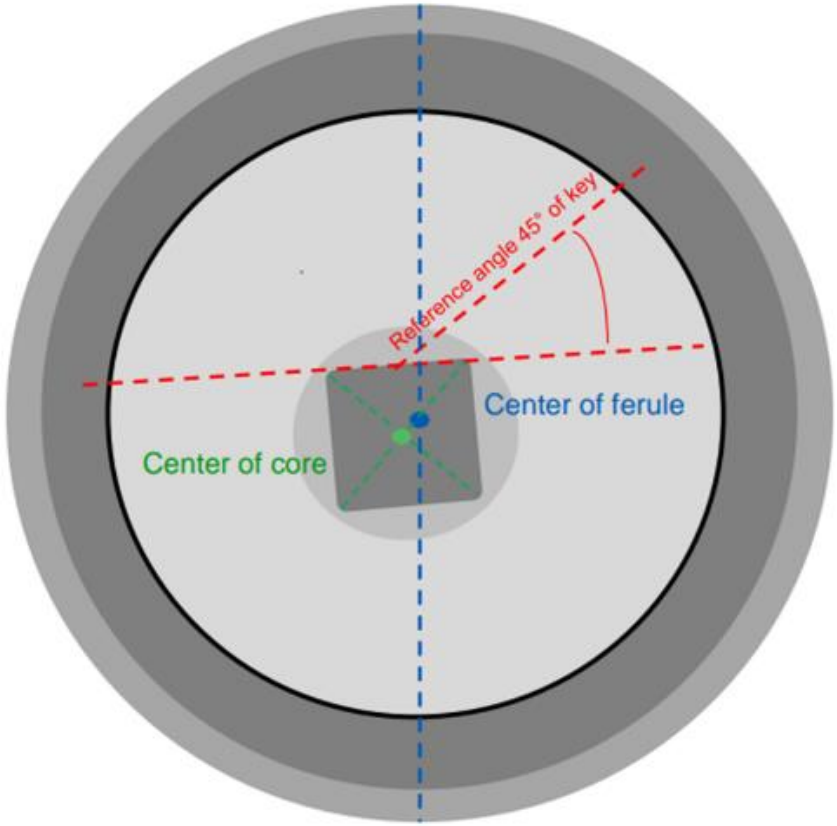
Specification Name	BFA specifications description	UoM	LSL	USL	Required Resolution
EccentricityFerruleToIMODSleeve_Green_BFA	Ferrule and IMOD's mating sleeve eccentricity	um	NA	5.0	≤ 0.5um
	Yellow Connector				
Angle_FiberCoreRotation.Average_Yellow_BFA	Fiber cores' average rotation with respect to connector key	deg	88.5	91.5	≤0.1 deg
ParallelismFiberCores_Yellow_BFA	Fiber cores' parallelism	deg	-1.5	1.5	≤0.1 deg
DistanceFiberCoreCenters_Yellow_BFA	Fiber cores' distance (center to center)	um	627.0	647.0	≤0.5 um
EccentricityFiberCoresToFerruleOD_Yellow_BFA	Fiber cores' eccentricity in regard to the outer diameter of the ferule	um	NA	16.75	≤ 0.5um
DistanceZFiberCoresToFerruleExitSurface_Yellow_BFA	Fiber facets' Z distance with respect to the ferrule's exit surface	um	-0.50	0.50	≤ 0.05um
EccentricityFerruleToIMODSleeve_Yellow_BFA	Ferrule and IMOD's mating sleeve eccentricity	um	NA	11.0	≤ 0.5um

2.2.1 BFA Specifications PCS Details

- Angle_FiberCoreRotation.Average_Yellow_BFA / ParallelismFiberCores_Yellow_BFA / DistanceFiberCoreCenters_Yellow_BFA / : Measurements at microscope will be performed with an IMOD w/o stopper key + universal mechanical key.



- Angle_FiberCoreRotation_Blue_BFA / Angle_FiberCoreRotation_Green_BFA: Measurements at microscope will be performed with an IMOD w/o stopper key + universal mechanical key.



2.3 Test Station Environmental Requirement

The test stations shall:

- Correctly operate in regular production environment, neither clean room nor flow hood required.
- Correctly operate using European and North America standard power voltages (230V, 50 HZ and 120 V, 60Hz).
- Properly integrate liquid cooling solution for the LEA module, using Koolance QD3 connectors[1].
- Have a compact mechanical footprint (benchtop), smaller than 150 x 90 cm.
- Have a maximum weight of 75 kg.
- Have both wired and wireless internet access.

2.4 Test Station Safety

The station shall be classified as Class I laser device, and it will integrate Class IV blue (457nm) and green (532nm) lasers housed in the LEA, therefore designing an effective interlock/safety scheme is a crucial part of providing safety against potential laser hazards.

The interlock scheme shall prevent laser light to be generated in case of:

1. E2000 Fiber connectors not correctly connected into the respective receptable IMOD housing. The current clip-based interlock mechanism is acceptable.
2. BFA Test Station enclosure not fully closed.

The interlock scheme shall promptly interrupt the laser emission (in the order of few milliseconds) and notify the user.

2.5 Test Station SW Requirements

The test stations shall be operable via a user-friendly GUI where the test parameters and/or settings shall be contained and/or pulled from revision-controlled files. The QC SW routine shall be fully automated: the operator shall be able to install the BFA on the test station, click a button and have the full QC test performed in an automated fashion (including the generation of the test reports described below).

The results of the measurements shall be saved into a folder reporting the BFA serial number and saved in three formats:

- PDF official signed QC results signed-off (either digitally or physically) by Diamond SA personnel.
- CSV reporting the test results along with all the necessary raw data.
- XML file responsible for interfacing with the ILMN internal data based (MINT)

Example files at attached in paragraph 6.1.

[1] https://koolance.com/quick-disconnect-couplings-4th-generation-qd3

The QC results shall be made available to the ILMN team though a FTP web site location immediately after QC test, and they shall be internally stored at Diamond SA for the entire instrument lifetime (~10 years).

2.6 Test Station Qualification

Standard gage RR study shall be conducted on the 2 stations to verify and validate the stations measurement capability.

A Gage R&R protocol that includes a minimum of 3 units, 3 operators and 3 repeats shall be performed. The acceptability of the measurement system is determined through the precision-to-tolerance (P/T) ratio as shown in Table 2.

P/T Ratio	Result
Lower than 0.1	The measurement system is acceptable.
Between 0.1 and 0.3	The measurement system may be acceptable, based on the importance of application, cost of gage, cost of repairs, etc. Rationale and action plan to address and improve the method of measurement will be decided by the team if needed and shall be documented.
Greater than 0.3	The measurement system is not acceptable, and issues must be documented and corrected.

Table 2:GRR P/T Ratio Capability Criteria

2.7 Test Station Work Instruction

Work instructions to correctly operate, install, align and maintain the test stations shall be provided by DIAMOND SA, written in English language and revision controlled. The maintenance instructions shall include a section with details on how to re-calibrate the test station and how often this operation is necessary and a section about cleaning the test station and its critical tools.

2.8 Test Station Installation and maintenance

Diamond SA will be responsible for onsite and remote activities supporting the installation, alignment and maintenance of the test stations.

3 SOW Commercial Details

3.1 BFA Test Stations financial/resources proposal overview

The proposal shall include non-recurring engineering costs (NRE) as well as budgetary unit-cost quotes.

The NRE cost structure shall be split into three sections:

1) Design of the Test Station
2) Manufacturing and alignment of the two Test Stations.
3) Product validation and Maintenance of the Test Station (GRR and PMM)

In each of these sections, NRE shall be split into milestones with appropriate deliverables and an estimated "delivered by" date.

A detailed resource list overlaid with the timeline of the project is requested. Projected FTE (with names) over the duration of the project is required.

3.2 Project milestones and deliverables

The project milestones are reported are as detailed in Table 3: Project Milestones.

Milestones	Date
BFA Test Station Design Review, more details in paragraph 6.2	January 31st 2024
BFA Test Station #1 and #2 Bring Up (build complete and SW operational).	May 15th 2024
BFA Test Station #1 and #2 Validated (GRR, Work Instructions)	May 30th 2024
BFA Test Station #2 installed and operational at ILMN site	June 15th 2024

Table 3: Project Milestones

List of deliverables:

- Mechanical solid model of the test station (SolidWorks file format preferred). Estimate of mass. Design files shall be provided periodically as requested and before each design review.
- Detailed review of alignment, cleaning and periodic calibration procedures.
- Weekly status meetings led by Diamond with action item tracking and meeting minutes circulation.

3.3 Supplier business model expectations

Below are the key business model concepts that are expected with the selected Supplier. Please review and indicate any areas which are inconsistent with your proposed approach to this project and identify your alternative approach.

- Intellectual Property
  - Both parties will retain Background IP
- Software
  - Illumina shall have right of review to all test software-relevant documentation and architecture.
  - The Supplier shall provide technical assistance to Illumina to resolve any control system issues arising due to any application – specific interactions.

4 Proposal Details

1. New IP will be subject to the terms of the existing Supplier-Illumina Development Agreement
2. Illumina expects to visit the manufacturing site for the product outlined in this SOW with in-person access to proposed project team.
3. Identify concerns, risks, areas outside of knowledge/expertise and how Supplier will address these concerns.
4. Proposed Schedule for each milestone and major deliverables. Please highlight areas where Supplier can provide favorable deviations from preliminary schedule provided by Illumina or cannot meet Illumina's preliminary schedule.
5. Resource Plan
    a. Identify development team individuals by name, technical role and resume. At the very least, Illumina expects a:
        - Project lead (responsible for the technical development of the product along with project timeline, budget and resources management, quotes, commercial etc.).
        - Opto - Mechanical Engineer
        - Electrical Engineer
        - SW and FW Engineer.
    b. Indicate approximate involvement of each team member in terms of Projected FTE during the project's timeline. Highlight specific project risks that drive staffing estimation.
    c. Supplier shall have adequate coverage for prototype troubleshooting.
    d. Please include an assessment of Supplier's ability to manage current business commitments and this project.
    e. Identify Development team location.
6. Financial Proposals
    a. Non-Recurring Engineering costs as described in paragraph 3.1
    b. Tester/Tooling/Equipment hardware cost
7. Acknowledgment on Warranty: Production unit cost proposal shall include a minimum 24-month warranty. Supplier warrants product will be free from defects in design, workmanship and materials and will meet the applicable specifications and function as intended.
8. Additional proposal details that Supplier would like to provide.

5 Terms and conditions

5.1 General

1. Illumina is committed to a timely response process which maintains the highest level of integrity.
2. Illumina will not be responsible for any costs incurred by the suppliers in connection with their response to this Request for Proposal.
3. Material discussed, presented, or presented for and submitted to Illumina in response to this Request will be considered the Confidential Information of Illumina.
4. Illumina and Supplier will execute a Development Plan upon business award or funding of a proposal.

5.2 Confidentiality

The information contained in this Request is confidential and is disclosed for the sole purpose of providing each supplier with sufficient information to develop and submit a Proposal. Further use or disclosure of this Request or the information contained herein for purposes other than preparation of proposals without obtaining the prior written consent of Illumina is prohibited. Confidentiality agreements between Illumina and Supplier remain in effect.

6 Appendix

6.1 Test Station Output File examples

PDF Example

CSV Exemple

XML Example

6.2 Design review deliverables

- Test Station Overview
- Spec Check In: showing how the different measurement will be implemented by the presented test station design.
- Detailed mechanical layout
- Alignment Procedure
- Project Timeline detailing the different phases:
    - Parts procurement
    - Build
    - SW and FW development
    - Activation
    - Validation
    - Installation
- Resources
- Cost

6.3 Parts Required

The test station shall integrate all the mechanical and electrical components (LDI and LDC) of the Jenoptik LEA (Figure 1).

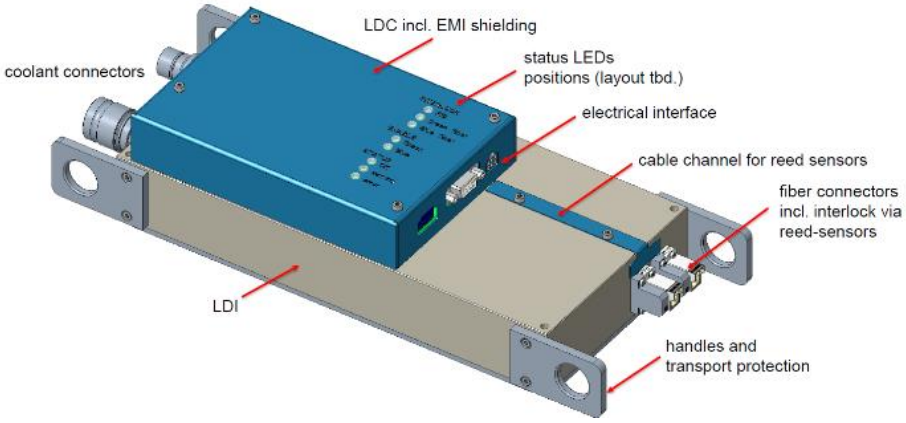


Figure 1: JenOptik Laser Assembly Engine (LEA)