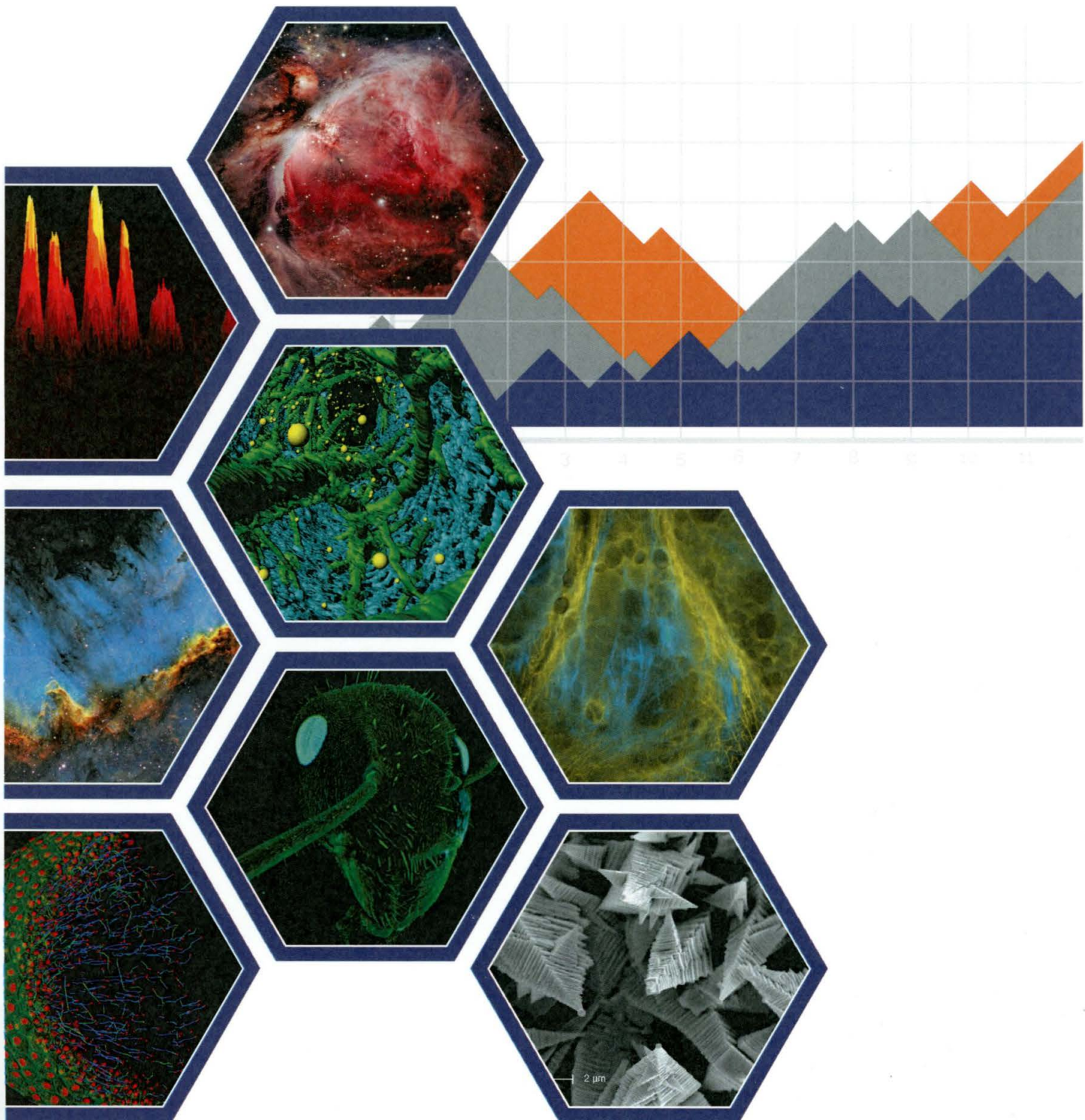


RMA# R62045

CCD-17881  
BS04

**ANDOR**  
an Oxford Instruments company

# System Performance Booklet



SHIPMENT NO: **R62045**  
 Andor Order No: R62045  
 Division : US / Unknown  
 Customer Order No: F018898

Date: 30 October 2018

**Ship To:**

SJSU RESEARCH FOUNDATION  
 MLML MARK YARBROUGH  
 925 N. NIMITZ HWY  
 HONOLULU HI 96817  
 UNITED STATES

**Customs Information:**

UG-STD

Goods are part of an Optical  
 Checking/Measuring Device  
 Harmonized No 90275000  
 Manufacturer code GBANDTEC7BEL  
 Goods are made in the UK  
 Values are for Customs Purposes

These goods are uncontrolled  
 to destination.  
 Goods re-exported may require an  
 export licence

| ITEM   | PART NUMBER | DESCRIPTION                      | QUANTITY | UNIT PRICE | VALUE    |
|--|-------------|----------------------------------|----------|------------|----------|
| 1  | NWR (S)     | NON WARRANTY REPAIR<br>R62045    | 1        | 1,750.00   | 1,750.00 |
|  |             | DU934P-BR-DD CCD-17881 → B504    |          |            |          |
|  |             | VALUE FOR CUSTOMS USD 15000      |          |            |          |
|  |             | CPC 3151000 - IPR IP/0920/500/21 |          |            |          |
|  |             | HS CODE 9802004040 - 8525804000  |          |            |          |
|  |             | TERMS NET 30                     |          |            |          |
|  |             | CONFIRM TO HUE NGO               |          |            |          |
|  |             | END USER MARK YARBROUGH          |          |            |          |
|  |             | ANDOR CONTACT TONY GADOLA        |          |            |          |
| <p><b>CARRIER:</b> AIRWAY BILL: 1Z8W40070458632227      <b>PACKAGES:</b> 1      <b>TOTAL (Exc. Tax)</b> 1,750.00 USD</p> |             |                                  |          |            |          |



## Returns Report

|                       |                       |                        |        |
|-----------------------|-----------------------|------------------------|--------|
| <b>Customer</b>       | ANDUSA Yarbrough/MLML | <b>Returns No</b>      | R62045 |
| <b>Classification</b> | NON WARRANTY          | <b>Customer RMA No</b> | None   |

| <b>Equipment Details</b> | <b>Model</b> | <b>Serial Number</b> |
|--------------------------|--------------|----------------------|
| <b>Head</b>              | DU934P-BR-DD | CCD-17881            |
| <b>Card</b>              |              |                      |
| <b>PSU</b>               |              |                      |
| <b>Multi IO</b>          |              |                      |
| <b>Other</b>             |              |                      |

### Reported Fault

Returning iKon-M camera for widow changes.

Camera parallel window to be replaced with WN35FS Broadband VUV-NIR Wedged windows, code- (BB-VV-NR)W.

### Diagnosis

Confirmed requested wedged window replacement required.

### Work Carried Out

Wedged window installed.

Full system QC & new performance sheets completed: - Passed.

|                 | <b>Receipt Date</b> | <b>Work Complete</b> | <b>Passed For Shipping</b> | <b>Shipped</b> |
|-----------------|---------------------|----------------------|----------------------------|----------------|
| <b>Date</b>     | 22/08/2018          | 25/10/18             | 25/10/18                   |                |
| <b>Initials</b> | PMC                 | PJ                   | MB                         |                |

\* In the case of Products which are upgraded, the old Model No / Serial No are bracketed first, followed by the new Nos:

\*\* Returns must be passed for shipping by the manufacturing manager and / or Sales Support

## System Overview

| Description   | Model                      | Serial Number                                  |
|---|----------------------------|--|
| CCD Head <input checked="" type="checkbox"/>                  | D U 9 34P - BR-DD          | CCD-17781                                      |
| TE Cooler performance ( <input checked="" type="checkbox"/> ) | High                       | Ultra-high <input checked="" type="checkbox"/> |
| Accessories   | Power Supply Unit (PS -24) | PS -25   |
|   | --                         | <input checked="" type="checkbox"/>            |
|   | SO-                        | LM- MFL-                                       |
| Serial/Batch Number   |                            |  |
| Other   |                            |  |

☒ Sensor types are defined in Table 1 using the last two letters in box Model Number.

## CCD Details

| Manufacturer / Model No. | Pixels                     | Serial Number |
|--------------------------|----------------------------|---------------|
| E2V CCD47-10             | 1024x1024, 13µm x 13µm     | 12262-06-07   |
| E2V CCD57-10             | 512x512, (FT), 13µm x 13µm |               |
| E2V CCD77-00             | 512x512, 24µm x 24µm       |               |
|                          |                            |               |

| Special Feature        | ( <input checked="" type="checkbox"/> ) | ( <input checked="" type="checkbox"/> ) |
|------------------------|---|---|
| NIMO                   | <input checked="" type="checkbox"/>     | Custom Mounting Flange                  |
| Fringe Suppression     |   | Custom Cables                           |
| Shielded Anti-Blooming |   |   |

| Window Variant           | ( <input checked="" type="checkbox"/> ) | ( <input checked="" type="checkbox"/> ) |
|--------------------------|---|---|
| VUV-UV Parallel          |   | NUV-Enhanced Parallel                   |
| Broadband VUV-NIR Wedged | <input checked="" type="checkbox"/>     | Broadband VUV-NIR Parallel              |
| Broadband VIS-NIR Wedged |   | Broadband VIS-NIR Parallel              |
| VIS-NIR Enhanced Wedged  |   | Bose-Einstein 780nm Wedged              |
| None                     |   | Other                                   |



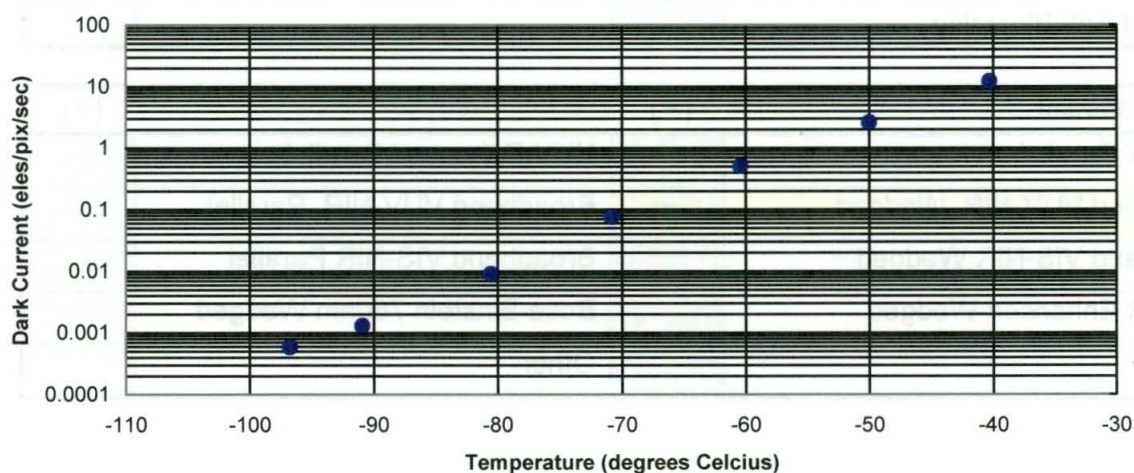
# CCD PERFORMANCE

## Summary of System Test Data

### Readout Noise ♦1 and Base Mean Level

| A/D Rate<br>(MHz<br>All 16 bit) | Preamp<br>setting | CCD<br>Sensitivity ♦3<br>eles per A/D count | Single Pixel<br>Noise<br>electrons | Full Vert Bin<br>Noise<br>electrons | Base Level ♦2<br>(Counts) |
|---------------------------------|-------------------|---|------------------------------------|-------------------------------------|---------------------------|
| 5                               | x1                | 7.0   | 36.7                               | 35.5                                | 963                       |
| 5                               | x2                | 3.4   | 20.2                               | 20.1                                | 1825                      |
| 5                               | x4                | 1.6   | 14.5                               | 15.2                                | 2954                      |
| 3                               | x1                | 5.9   | 19.3                               | 20.3                                | 1068                      |
| 3                               | x2                | 3.0   | 13.2                               | 12.8                                | 1983                      |
| 3                               | x4                | 1.3   | 10.3                               | 10.0                                | 3569                      |
| 1                               | x1                | 5.3   | 11.4                               | 10.9                                | 907                       |
| 1                               | x2                | 2.8   | 8.3                                | 8.1                                 | 1839                      |
| 1                               | x4                | 1.3   | 6.7                                | 6.4                                 | 3776                      |
| 0.05                            | x1                | 5.4   | 5.3                                | 5.3                                 | 536                       |
| 0.05                            | x2                | 2.7   | 4.2                                | 4.2                                 | 1441                      |
| 0.05                            | x4                | 1.2   | 3.6                                | 3.7                                 | 3318                      |
| Saturation Signal per pixel     |                   |   | 138015                             | Electrons/pixel                     |                           |

### CCD Dark Current



|  |          |                     |    |                  |
|--|----------|---------------------|----|------------------|
| Minimum Dark Current Achievable ♦4         | 0.000582 | electrons/pixel/sec |    |                  |
| @ Sensor Temperature of ♦5                 | -96.717  | °C                  | 16 | °C cooling Water |
|  |          | With PS-25          |    |                  |
| CCD Dark Current Uniformity better than ♦6 | 0.238    | electrons/pixel/sec |    |                  |

## Linearity and Uniformity

|                                    |      |                |
|------------------------------------|------|----------------|
| Linearity better than ♦7           | 1    | % over 16 bits |
| Response Uniformity better than ♦8 | 1.89 | %              |

## Response Defects

| White/Black Spots ♦9 (X, Y) |                  |                          |                                 |
|-----------------------------|------------------|--------------------------|---------------------------------|
| Centroid                    | Number of Pixels | Centroid                 | Number of Pixels                |
| ( X , X )                   | X                | ( , )                    |                                 |
| ( X , X )                   | X                | ( , )                    |                                 |
| ( , )                       |                  | ( , )                    |                                 |
| ( , )                       |                  | ( , )                    |                                 |
| ( , )                       |                  | ( , )                    |                                 |
| ( , )                       |                  | ( , )                    |                                 |
| White/Black Columns ♦10     |                  | Column numbers indicated | <div>X</div> <div>X</div>       |
| Trap ♦11                    |                  | (X, Y)                   | ( <div>X</div> , <div>X</div> ) |

## Dark Current Defects

| Hot Spots ♦12 (X, Y) |                  |                          |                           |
|----------------------|------------------|--------------------------|---------------------------|
| Centroid             | Number of Pixels | Centroid                 | Number of Pixels          |
| ( X , X )            | X                | ( , )                    |                           |
| ( X , X )            | X                | ( , )                    |                           |
| ( , )                |                  | ( , )                    |                           |
| ( , )                |                  | ( , )                    |                           |
| ( , )                |                  | ( , )                    |                           |
| ( , )                |                  | ( , )                    |                           |
| Hot Columns ♦13      |                  | Column numbers indicated | <div>X</div> <div>X</div> |



**Test Conditions**

|                                   |     |         |    |          |
|-----------------------------------|-----|---------|----|----------|
| Readout Noise tested at           | -80 | °C with | 16 | °C water |
| Base Mean Level measured at       | -80 | °C with | 16 | °C water |
| Dark Current Uniformity tested at | -65 | °C with | 16 | °C water |
| Blemishes tested at               | -65 | °C with | 16 | °C water |

**Custom Testing**

WN35FS Broadband VUV-NIR Wedged window fitted as per customer request.

**System Passed for Shipping**

Signed

Date

**PATRICK MCCANN**

**3<sup>RD</sup> OCTOBER 2018**

|           |              |               |
|-----------|--------------|---------------|
| Hardware  | HEADBOARD    | FPGA          |
| Version # | AB           | 20.24         |
| Shipping  | SOLIS        | SDK           |
| Software  | --           | --            |
| Version # |              |               |
| Testing   | SOLIS        | SDK           |
| Software  | 4.31.30014.0 | 2.103.33014.0 |
| Version # |              |               |

✓ **Table 1; Key code to define the meanings of the last two letters in the Model Number**

| Sensor Options |                        |       |  |
|----------------|------------------------|-------|--|
| OE             | Open electrode         | BU2   | Back Illuminated (BI) + 250nm UV optimised |
| FI             | Front illuminated (FI) | BU    | BI + UV (350nm) optimised                  |
| UV             | FI+UV coating          | BV    | BI + VIS (550nm) optimised                 |
| FO             | FI + Fibre optic       | BR-DD | BI + NIR +deepdepletion                    |
| FI-DD          | FI + deep depletion    | BN    | BI with no AR coating                      |

## Performance Notes

- ◆1 Readout Noise is measured for both single pixel (SP) and fully vertically binned (FVB) with the CCD in darkness at temperature indicated and minimum exposure time. Noise values will change with pre-amplifier gain selection [PAG].
- ◆2 Average electronic DC offset for CCD in darkness at temperature indicated and minimum exposure time under dark conditions measured by single pixel (SP) for imaging systems and by (FVB) for spectroscopic systems.
- ◆3 Sensitivity is calculated in photoelectrons per A/D count from measurements of the Photon Transfer Curve.
- ◆4 Dark current falls exponentially with temperature. However, for a given temperature the actual dark current can vary by more than an order of magnitude from device to device. The devices are specified in terms of minimum dark current achievable rather than minimum temperature.
- ◆5 Minimum temperature achieved for thermoelectric (TE) cooler set to maximum value with water cooling
- ◆6 RMS (root mean square) deviation of dark current for fully binned operation for spectroscopic cameras, or full resolution image for imaging cameras, under dark conditions at temperature indicated (pixel/column defects not included). This variation is mainly cosmetic since it is fully subtractable without significant loss of performance.
- ◆7 Linearity is measured from a plot of Counts vs. Signal over the 16 bit dynamic range. Linearity is expressed as a %age deviation from a straight line fit. This quantity is not measured on individual systems.
- ◆8 RMS (root mean square) deviation from the average response of the CCD in full resolution image for imaging cameras, illuminated with uniform white light (defects not included).
- ◆9 White/black pixels have signals >25% above/below the average (25% contrast) with uniform illumination across the sensor.
- ◆10 A black column is defined as having  $\geq 10$  black pixels for imaging cameras.
- ◆11 Pixels which absorb charge as it is clocked through the defective area. When the light source is switched off, the signal from the trap appears to drop off more slowly than the signal from the surrounding pixels.
- ◆12 Hot spots are counted if they exhibit >50 times the maximum specified dark current at the test temperature indicated.
- ◆13 A column is considered defective if >10 pixels are affected, or if the column exhibits >2 times the maximum specified dark current at the test temperature indicated.