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# PI-MAX®4: 2048f

The PI-MAX4:2048f from Princeton Instruments is the next generation, fully-integrated scientific intensified CCD camera (ICCD) system featuring a 2k x 2k full-frame CCD fiberoptically coupled to a variety of Gen II and Gen III filmless intensifiers. The intensifiers provide the highest possible sensitivity from UV to NIR and offer resolution that is ideally matched to the CCD. An integrated programmable timing generator (SuperSynchro) built into the camera makes these ICCD cameras ideal for time-resolved imaging and spectroscopy applications. **PI-MAX4:2048f is the only ICCD camera on the market today to offer high frame rate at 6 MHz/16-bit digitization, 1 MHz sustained gating repetition rate and exceptional sensitivity.**

| FEATURES | BENEFITS |
|---|---|
| 2048 x 2048 Imaging Array | Highest resolution imaging and spectroscopy |
| 8 MHz* / 16-bit digitization | High frame rates to efficiently synchronize with high repetition rate lasers |
| Kinetics mode | Allows high speed images / spectra capture |
| Wide selection of intensifiers<br>*Gen II*<br>*Gen III filmless* | Best sensitivity and gate speed in the desired wavelength range<br>Provides wide spectral coverage with SB, RB and SR intensifiers from UV - NIR<br>Offers highest sensitivity |
| Fiberoptic coupling | Highest optical throughput; No vignetting |
| Super HV - Built-in high voltage pulser | Rugged design without a bulky external controller, for high repetition rate gating and minimal insertion delay |
| SuperSynchro - Built-in programmable timing generator | Built-in, fully software controlled gate timing; Controls gate widths and delays in linear, or exponential increments; Low insertion delay (~ 27 ns). *See page 3 for more info.* |
| SyncMaster I and II | Provides continuous TTL signals to control external instruments such as a laser; Eliminates need for external timing generater in most experiments |
| Bracket pulsing | Preserves high ON/OFF ratio of the Gen II intensifier in the UV - No sync pulse required |
| GigE interface | Industry standard for fast data transfer over long distances, up to 50 M |
| **Optional:** LightField® (for Windows 8/7, 64-bit)<br>Or WinView/Spec (for Windows 8/7/XP, 32-bit) | Flexible software packages for data acquisition, display and analysis;<br>LightField offers intuitive, cutting edge user interface, IntelliCal® and more. |
| PICAM (64-bit) / PVCAM (32-bit)<br>software development kits (SDKs) | Compatible with Windows 8/7/XP, and Linux;<br>Universal programming interfaces for easy custom programming. |
| LabVIEW™ Scientific Imaging<br>Tool Kit (SITK®) | Pre-defined LabView vis provide easy integration of camera into complex experiment setup |

* With dual port readout at 4 MHz/port
Detector shown with a C-mount nose and lens, sold separately

## Applications:

Shock Wave Physics | Neutron Research | Combustion | Planar Laser Induced Fluorescence (PLIF)



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# SPECIFICATIONS

| CCD | PI-MAX4:2048f | | | | |
|---|---|---|---|---|---|
| Image sensor | e2v CCD 42-40 scientific grade full-frame CCD | | | | |
| CCD format | 2048 x 2048 imaging pixels; 13.5 x 13.5 µm pixels; 27.6 x 27.6 (39 mm diagonal) | | | | |
| System read noise (e- rms) | Typical | | | Maximum | |
| @ 1 MHz digitization<br>@ 2 MHz digitization<br>@ 8 MHz digitization | 12.0<br>16.0<br>35.0 | | | 15.0<br>18.0<br>45.0 | |
| Pixel full well | 100 ke- | | | | |
| Dark current @ -25° C (typical) | < 0.75 e-/p/sec | | | | |
| CCD temperature<br>@ + 23° C room temperature<br>@ + 20° C ambient | <br>-20° C (Air), -30° C (Liquid assist), Guaranteed<br>-25° C (Air), -35° C (Liquid assist) | | | | |
| Vertical shift rate* | 20.0 µs/row | | | | |
| **INTENSIFIER** | | | | | |
| Intensifiers available | 25 mm - Gen II, Gen III filmless | | | | |
| Method of coupling to the CCD | 1:1 fiber optic | | | | |
| Intensifier type | Gen II | | | Gen III *Filmless* | |
| | SB | RB | SR | HB*f* | HR*f* |
| Wavelength range | See QE curves, pages 4 & 5 | | | | |
| Min. Gate Width (Optical FWHM)<br>Fast Gate | ~ 4 ns (typical), 8 ns (guaranteed) | | | ~ 4 nsec (typical), 8 nsec (guaranteed) | |
| Repetition rate: Sustained | 1 MHz | | | | |
| Resolution limit of the intensifier | 40 to 64 lp/mm | | | 57 to 64 lp/mm | |
| Equivalent Background Illumination (EBI)<br>Photo e-/pixel/sec @ room temp (with photocathode cooling) | 0.05 - 0.2<br>(0.005 - 0.02) | | | 0.02<br>(0.002) | |
| Phosphor | P43 (P46, P47 optional) | | | | |
| Operating environment | +5° C to +30° C non-condensing | | | | |
| Storage environment | -25° C to +55° C | | | | |
| Certification | CE | | | | |

*Please refer to user's manual for more accurate timing calculations.
All specifications subject to change.



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# SuperSYNCHRO Timing Generator

The PI-MAX4's integrated SuperSYNCHRO Timing Generator lets researchers set gate pulse widths and delays under GUI software control. The closed coupled SuperSYNCHRO significantly reduces the system delay inherent in the timing generator of *em*ICCD cameras. The integrated timing generator means there is no need for an additional external timing generator, and a built-in Super HV high voltage pulser eliminates the requirement for an external high-voltage supply, making the PI-MAX4 camera one of the most advanced ICCD cameras on the market.

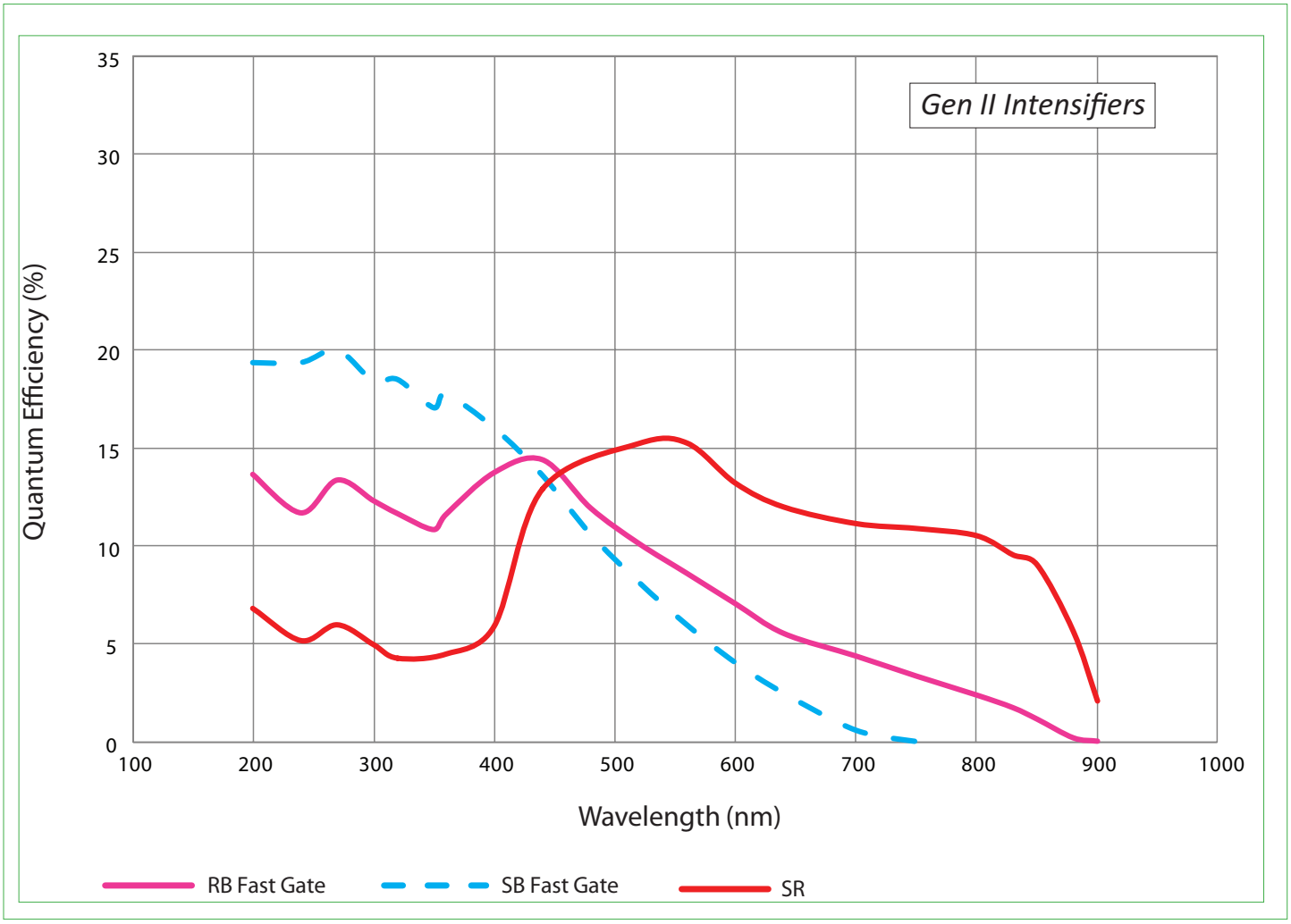
| FEATURE | BENEFITS |
|---|---|
| Closed Coupled Design | Short signal paths for minimum insertion delays |
| On-board memory | Store and execute complex gate width/delay sequences with no software overhead |
| Internal oscillator * | Drive an external event and initiate repetitive experiments. |
| SyncMASTER Pulses | Independent continuous TTL outputs to trigger pulsed external devices, e.g. laser and Q-switch; Minimum experiment jitter |
| Configurable Trigger inputs | Synchronizes camera to a wide variety of standard and non-standard trigger sources. |
| Full Software Control | Easy setup and execution of complex gate width/delay sequences |

## SuperSYNCHRO Specifications

| | |
|---|---|
| Internal Timing Generator | 0.05 Hz - 1 MHz |
| Gate Delay + Width Range* | ~ 10 ns (~ 20 ns with MCP bracket pulsing) to 21 sec (from T0) |
| Timing resolution/ Timing jitter | 10 ps / 35 ps rms |
| Insertion delay | ~ 27 ns (trigger in to intensifier opening), ~ 35 ns (with picosecond gating option) |
| TRIGGER INPUTS | |
| External Sync<br>(Trigger In) | -5 v to +5 v (including TTL); AC/DC coupling: 50 ohm / High Z<br>Variable Threshold; +ve or -ve edge |
| TRIGGER OUTPUTS | |
| $SyncMASTER_1$ | Programmable continuous frequency output to synchronize external devices with PI-MAX4, e.g. Laser |
| $SyncMASTER_2$ | Programmable continuous frequency output (delay from $SyncMASTER_1$ - 100 ns - 6.55 msec) synchronize external devices with PI-MAX4, e.g. Q-switch |
| T0 | TTL Signal: T0 indicates start of timing sequence |
| Monitor** | TTL signal to monitor gate timing |
| Ready | TTL signal. Represents camera status. It changes state when ready just before the exposure. |
| Aux | DC coupled programmable delay (Delay from T0 > 2ns - 1 sec) trigger output to synchronize external devices with PI-MAX4 |
| Logic | Software programmable: Select one of the following signals: Acquiring, Image Shift, Logic 1, Readout, Shutter or Wait for trigger. *See users' manual for detailed signal descriptions.* |

* Software programmable
** Please refer to user's manual for more accurate timing calculations.

# Quantum Efficiency Curves



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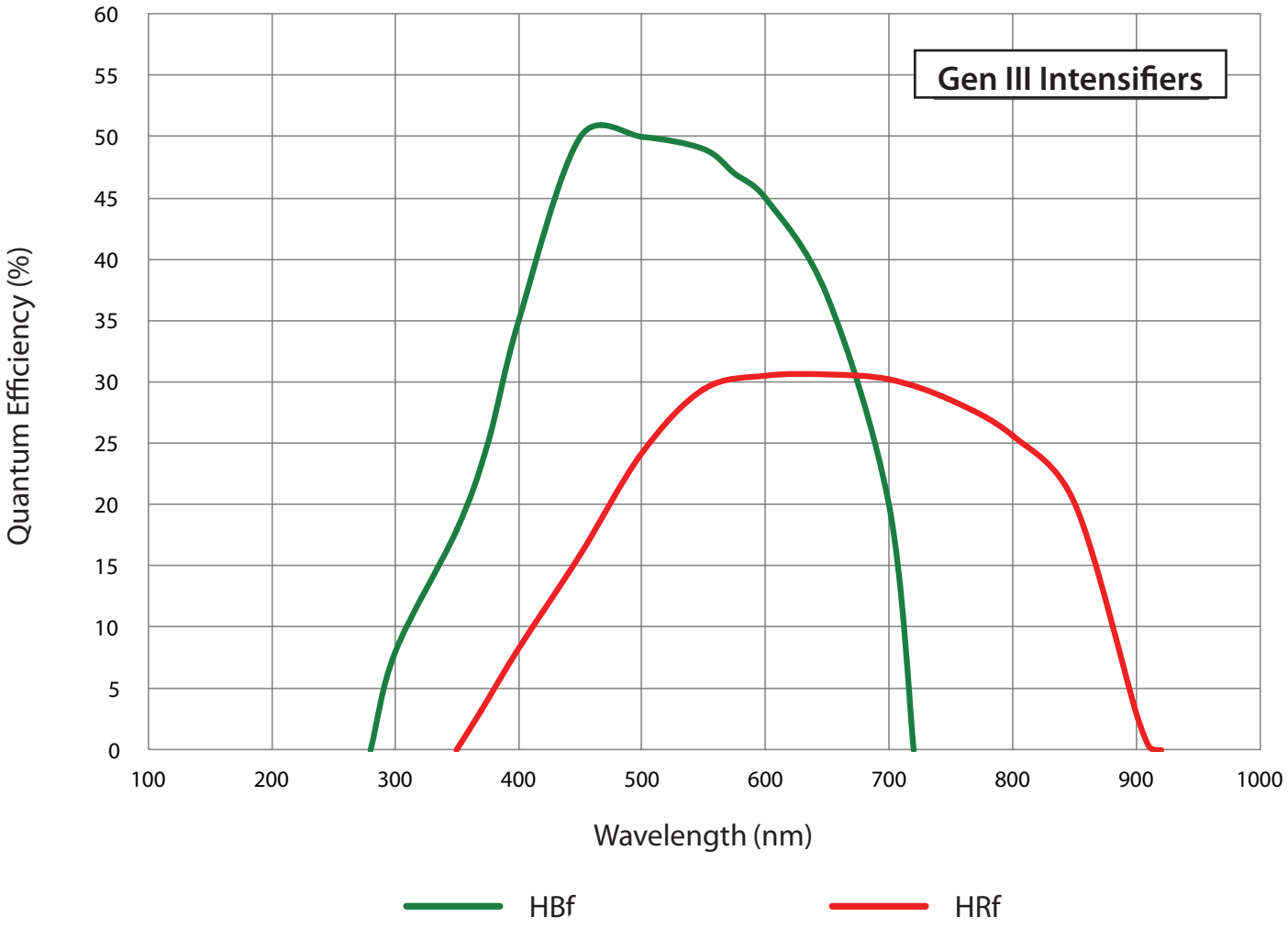
# Quantum Efficiency Curves



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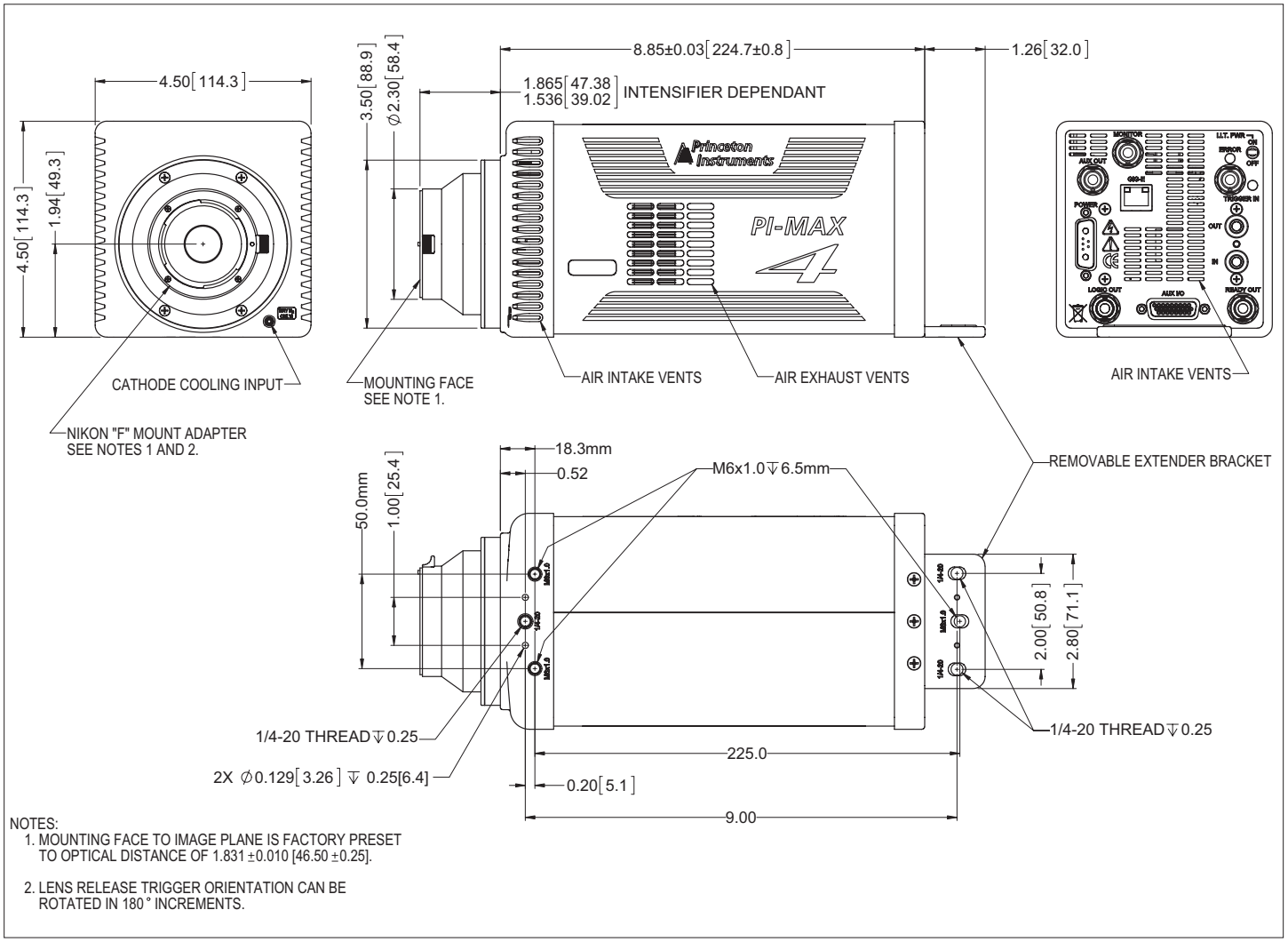
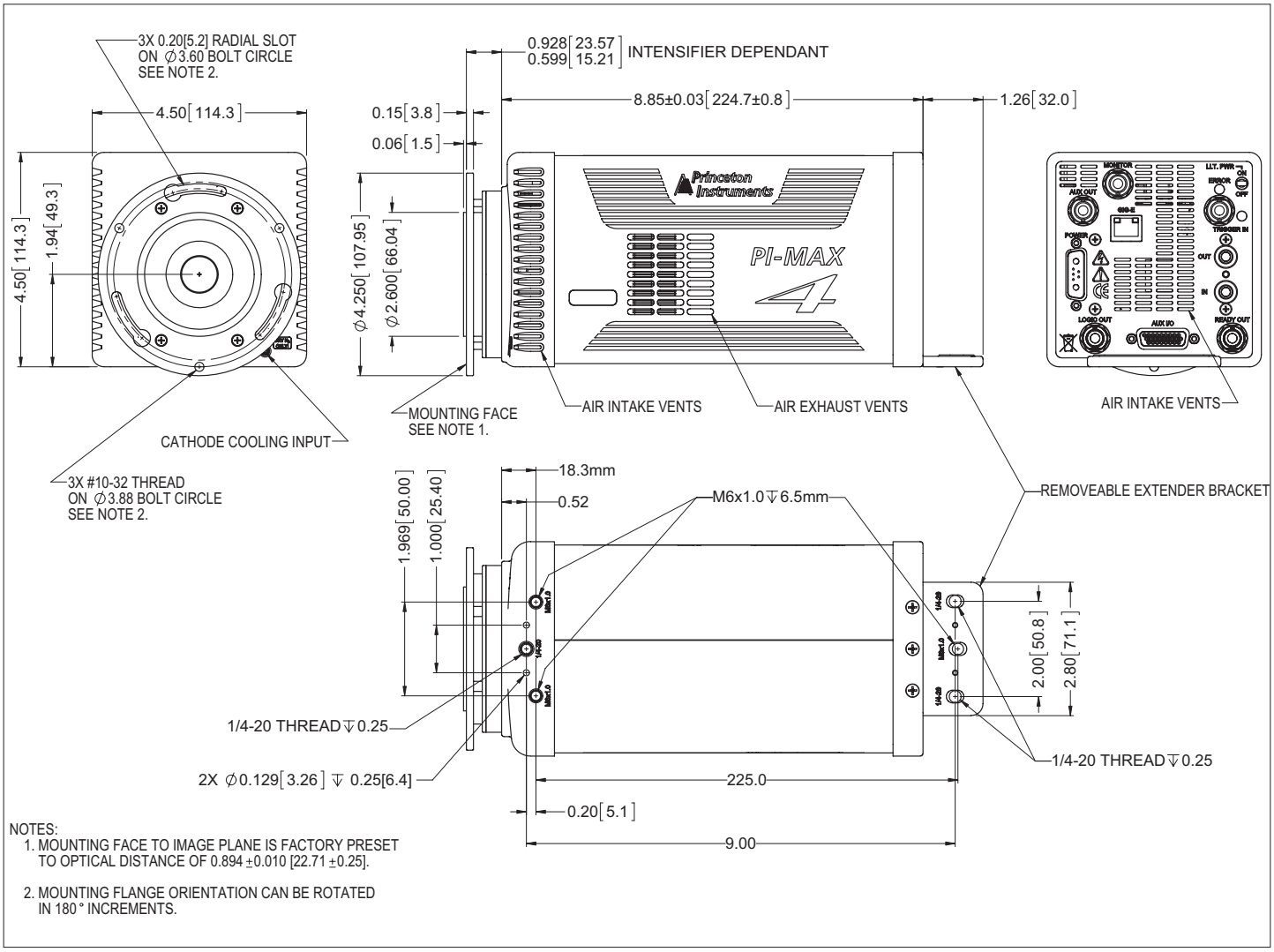
# OUTLINE DRAWING
# "F" MOUNT




NOTES:
1. MOUNTING FACE TO IMAGE PLANE IS FACTORY PRESET TO OPTICAL DISTANCE OF 1.831 ±0.010 [46.50 ±0.25].
2. LENS RELEASE TRIGGER ORIENTATION CAN BE ROTATED IN 180 ° INCREMENTS.

# OUTLINE DRAWING
# SPECTROMETER MOUNT




NOTES:
1. MOUNTING FACE TO IMAGE PLANE IS FACTORY PRESET TO OPTICAL DISTANCE OF 0.894 ±0.010 [22.71 ±0.25].
2. MOUNTING FLANGE ORIENTATION CAN BE ROTATED IN 180 ° INCREMENTS.