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# PI-MAX®4: 512 EM

The PI-MAX4: 512 EM from Princeton Instruments is the ultimate in ICCD technology. This innovative intensified EMCCD camera (***em*ICCD**) features front-illuminated or back-illuminated 512 x 512 frame transfer EMCCD fiberoptically coupled to a variety of Gen II and Gen III filmless intensifiers. The advantages of intensifiers and the benefits of EMCCD packed in one camera delivers single-photon sensitivity and quantitative performance for scientific imaging and spectroscopy research. The higest linearity, high sensitivity, ultrafast subnanosecond gating, dual gain control, programmable timing generator as well as other built in features makes these ***em*ICCD** cameras ideal for the most demanding research!

| FEATURES | BENEFITS |
|---|---|
| Intensified EMCCD (***em*ICCD**) with Dual Gain mechanism | Dual Gain Mechanism allows single photon sensitivity and improves linearity |
| 512 x 512 FT (frame transfer) Imaging Array | Allows higher frame rates with 100% duty cycle |
| 10 MHz / 16-bit digitization | Video frame rates and higher to efficiently synchronize with high repetition rate lasers |
| Thermoelectric cooling | Reduces CCD dark current to negligible levels |
| Kinetics Mode | Allows high speed burst mode sub-frame (ROI) imaging and spectroscopy based on the window size |
| A selection of Intensifiers *Gen II* *Gen III filmless* | Best sensitivity and gate speed in the desired wavelength range;<br>Best combination of UV-Blue sensitivity and fast gating (SB); RB provides wide spectral coverage<br>Offers highest sensitivity and fastest gate speed |
| Fiberoptic coupling | Highest optical throughput; No vignetting |
| Sub-nanosecond gating | Provides <500 ps gate width with standard fast gate intensifiers while preserving QE for high temporal resolution; For effective background discrimination, kinetics imaging and spectroscopy |
| Super HV - Built-in high voltage pulser | Rugged design for high rep 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 (25 nsec). *See page 3 for more info.* |
| GigE interface | Industry standard for fast data transfer over long distances |
| **Optional:** LightField® (for Windows 8/7, 64-bit) 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) software development kits (SDKs) | Compatible with Windows 8/7/XP, and Linux;<br>Universal programming interfaces for easy custom programming. |
| LabVIEW Scientific Imaging Tool Kit (SITK®) | Pre-defined LabView vis provide easy integration of the camera into complex experiment setup |

## Applications:

Fluorescence Lifetime Imaging Microscopy (FLIM) | Time Resolved Imaging & Spectroscopy | Combustion
Planar Laser Induced Fluorescence (PLIF)



Teledyne Princeton Instruments | Main Office- (USA) | Tel: +1 609.587.9797 | pi.info@teledyne.com

# SPECIFICATIONS

| CCD | PIMAX4:512 EM | | | | PIMAX4:512 EMB | | |
|---|---|---|---|---|---|---|---|
| CCD Image Sensor | e2v CCD97; scientific grade; front-illuminated, frame transfer CCD | | | | e2v CCD97; scientific grade; back-illuminated, frame transfer CCD | | |
| CCD Format | 512 x 512 imaging pixels; 16.0 x 16.0 µm pixels<br>Effective image size: 500 x 500 pixels, 8.0 x 8.0 (11.314 mm diagonal) | | | | | | |
| | EM mode | | | | Normal CCD mode | | |
| System read noise (typical) | 25 e- rms @ 5 MHz<br>50 e- rms @ 10 MHz<br>Read noise effectively reduced to <1 e- rms with on-chip multiplication gain enabled | | | | 6 - 8 e- rms @ 500 kHz<br>16 - 18 e- rms @ 5 MHz | | |
| Pixel full well (typical) | 800 ke- (output node) | | | | 130 ke- (single pixel) | | |
| Dark current @ -25° C (typical) | 2 e-/p/sec | | | | | | |
| Deepest cooling temperature @ 20° C ambient | -25° C (Air)<br>-30° C (Water assist) | | | | | | |
| Vertical Shift Rate | 600 nanoseconds/row | | | | | | |
| **INTENSIFIER** | | | | | | | |
| Intensifiers available | 18 mm - Gen II, Gen III filmless | | | | | | |
| Method of coupling to the CCD | 1.48:1 fiber optic | | | | | | |
| Intensifier type | Gen II | | | | Gen III *Filmless* | | |
| | SB | RB | SR | UV | HR*f* | HB*f* | InGaAs |
| Wavelength Range | See QE curves | | | | | | |
| Min. Gate Width (Optical FWHM) * | | | | | | | |
| Sub-nanosecond Gate | < 500 ps (for Fast Gate tubes only) | | | | < 500 ps (for Fast Gate tubes only) | | |
| Fast Gate | ~ 2 nsec (Typ), 3 nsec (Guar) | | | | ~ 2 nsec (Typ), 3 nsec (Guar) | | |
| Repetition Rate: Sustained | 1 MHz; 100 kHz with Picosecond gating; 6.25 kHz with MCP bracket pulsing | | | | | | |
| Resolution limit | 40 to 64 lp/mm | | | | 57 to 64 lp/mm | | |
| 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 and P47 optional) | | | | | | |
| Operating Environment | +5° C to +30° C non-condensing | | | | | | |
| Storage Environment | -25° C to +55° C | | | | | | |
| Certification | CE | | | | | | |

All specifications subject to change. Contact your local sales representative for more information.

* Measured with 18 mm intensifier



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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* | ~0.01 ns to 21 sec (from T0) |
| Timing resolution/ Timing jitter | 10 ps / 35 ps rms |
| Insertion delay | < 27 ns (trigger in to intensifier opening) |
| 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 |
| Pre Trigger In | TTL input. A rising edge will stop CCD Cleans and set camera to wait for the external trigger for fastest response. User selectable option. |
| 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 actual 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 - 0.01ns - 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



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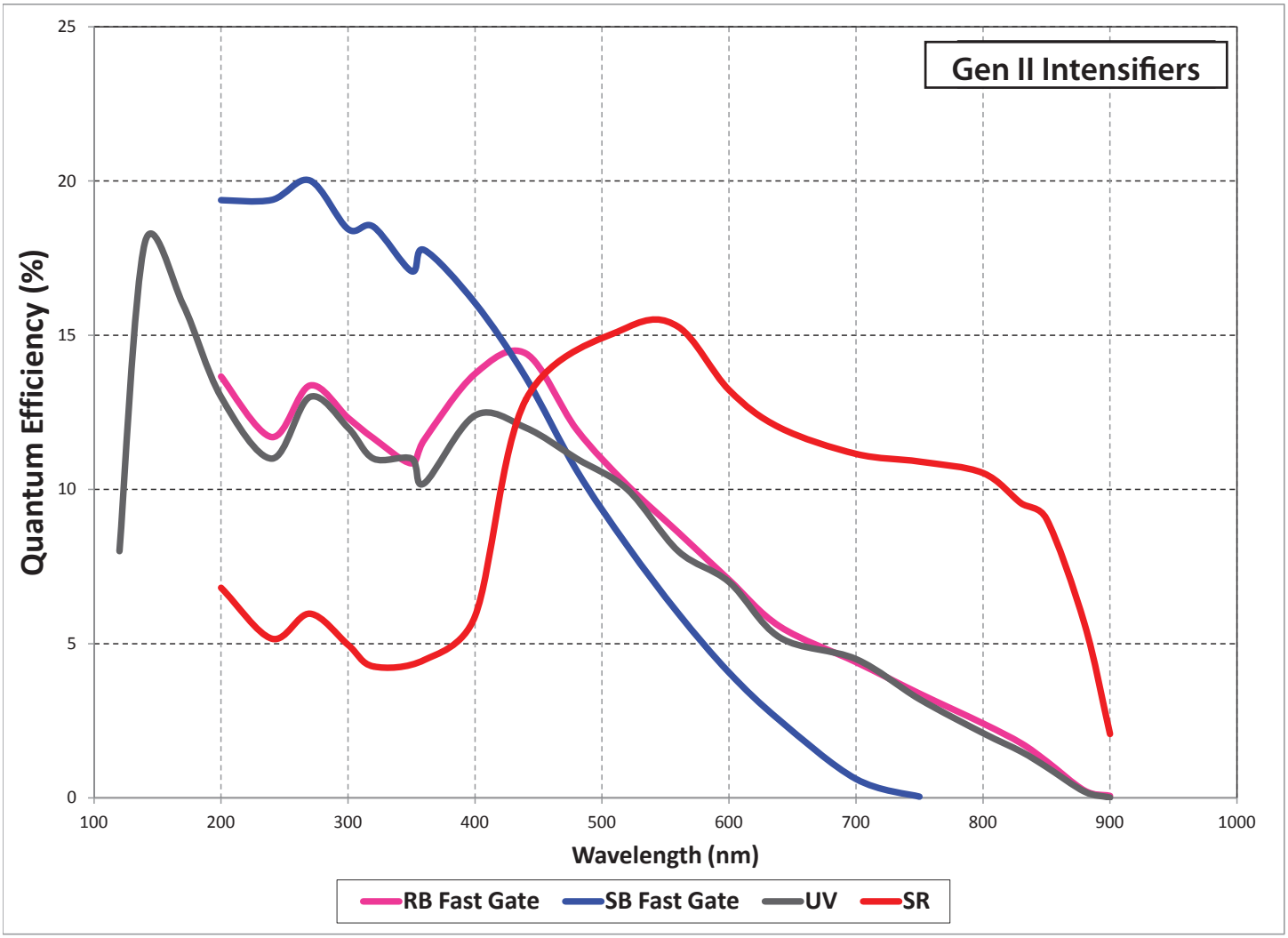
# QUANTUM EFFICIENCY CURVES



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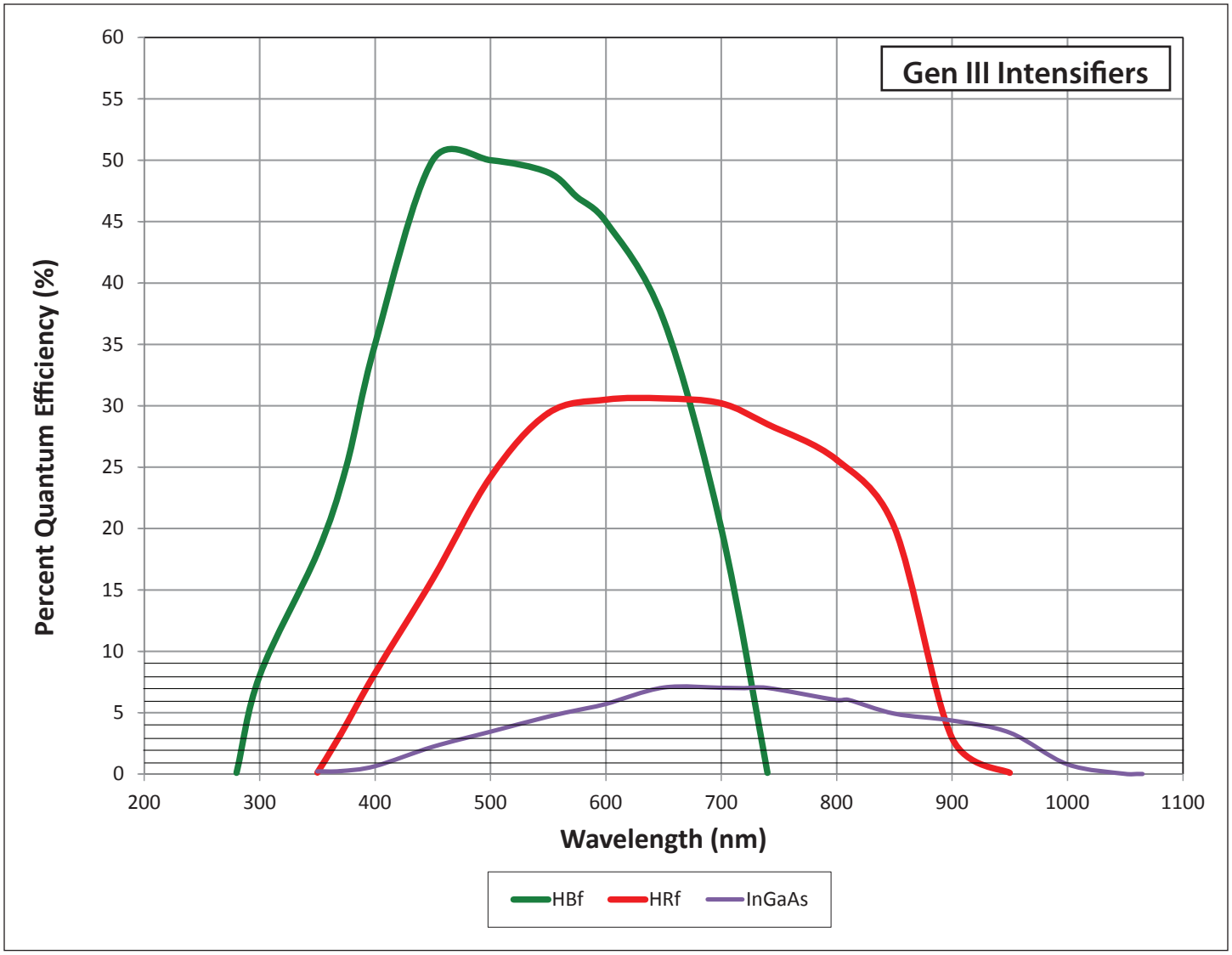
# QUANTUM EFFICIENCY CURVES

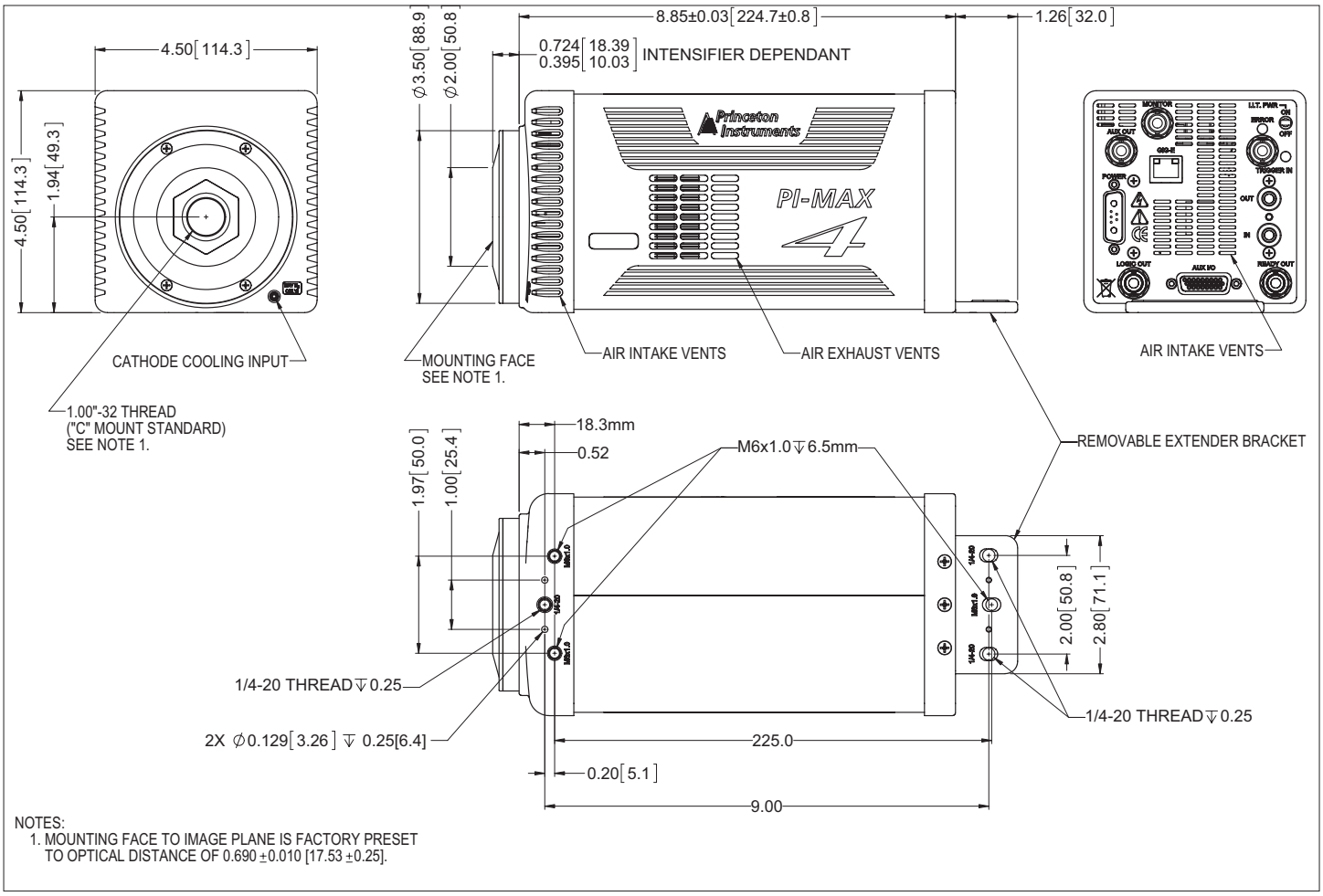



## Frame Rate (fps)

| ROI/Bin | 512 x 512 | 256 x 256 | 128 x 128 | 64 x 64 | 32 x 32 |
|---|---|---|---|---|---|
| 1 x 1 | 32 | 60 | 109 | 184 | 279 |
| 2 x 2 | 61 | 109 | 184 | 279 | 377 |
| 4 x 4 | 113 | 184 | 279 | 377 | 456 |
| 8 x 8 | 196 | 279 | 377 | 456 | 510 |

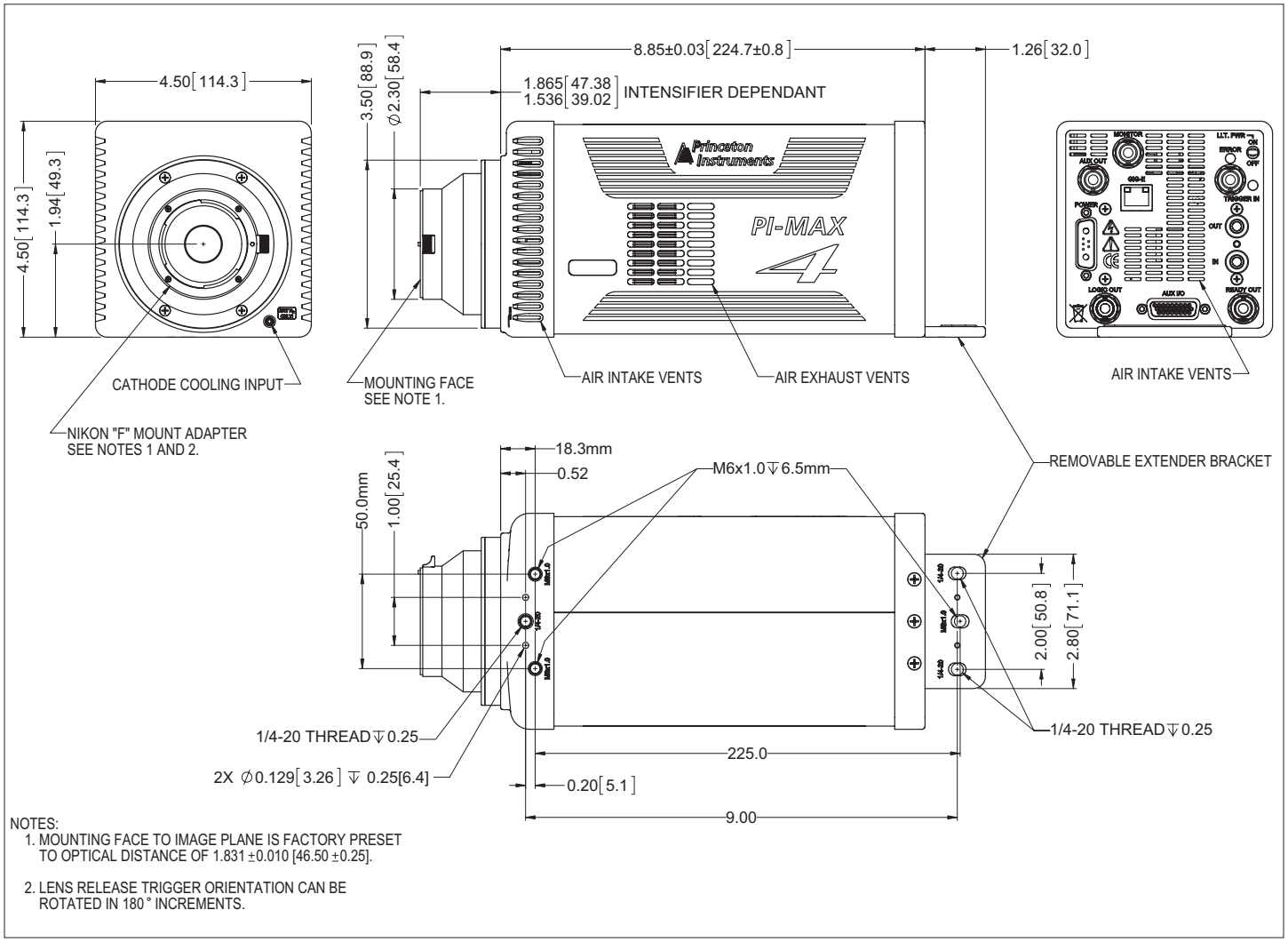
*NOTE: Frame rate measured at 10 MHz digitization and 600 nsec/row vertical shift.*
*"Custom chip" mode increases frame rate at reduced ROI by 2x to 4x.*

# OUTLINE DRAWING
# "C" MOUNT



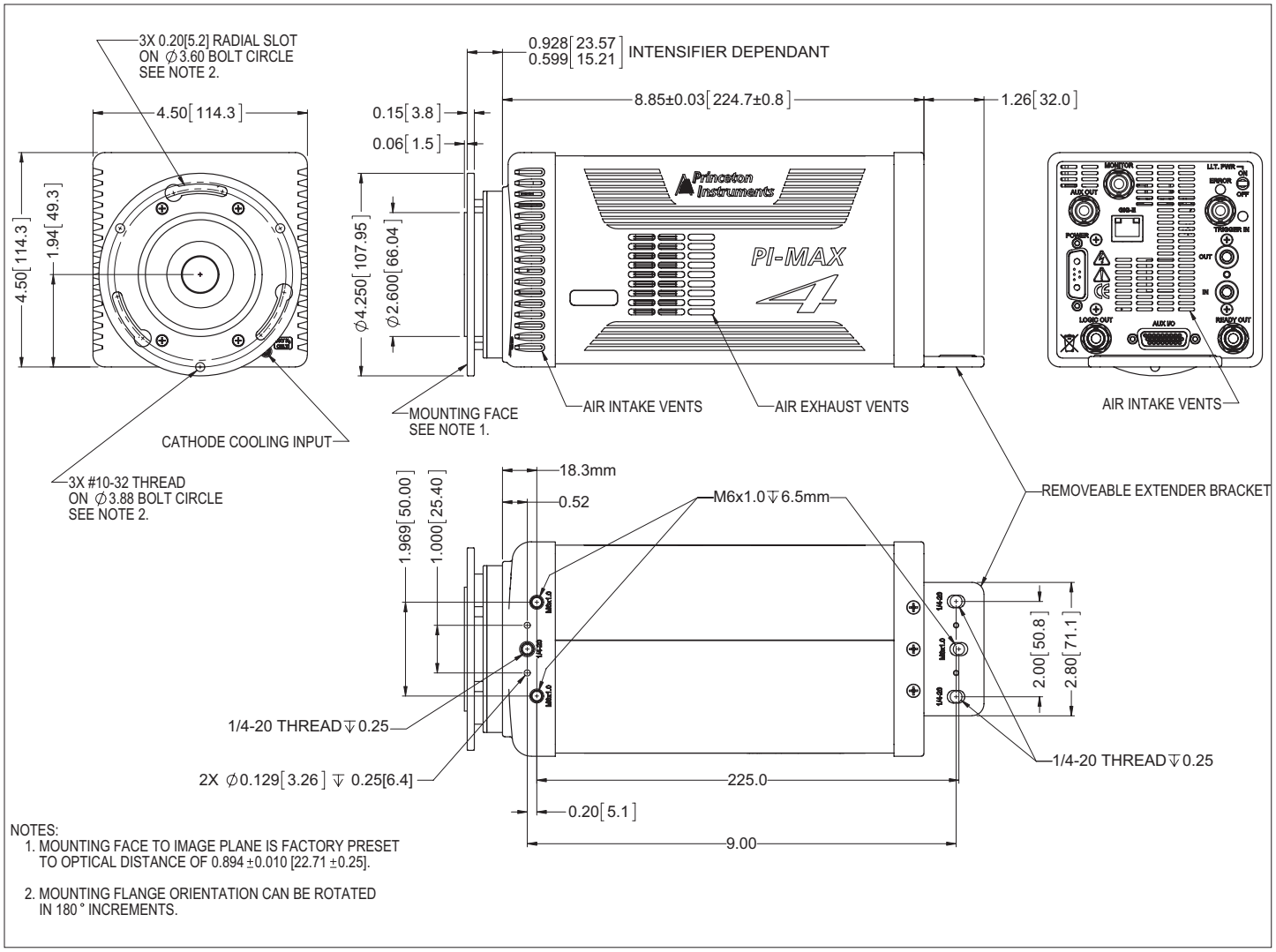

NOTES:
1. MOUNTING FACE TO IMAGE PLANE IS FACTORY PRESET TO OPTICAL DISTANCE OF 0.690 ±0.010 [17.53 ±0.25].

# 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.