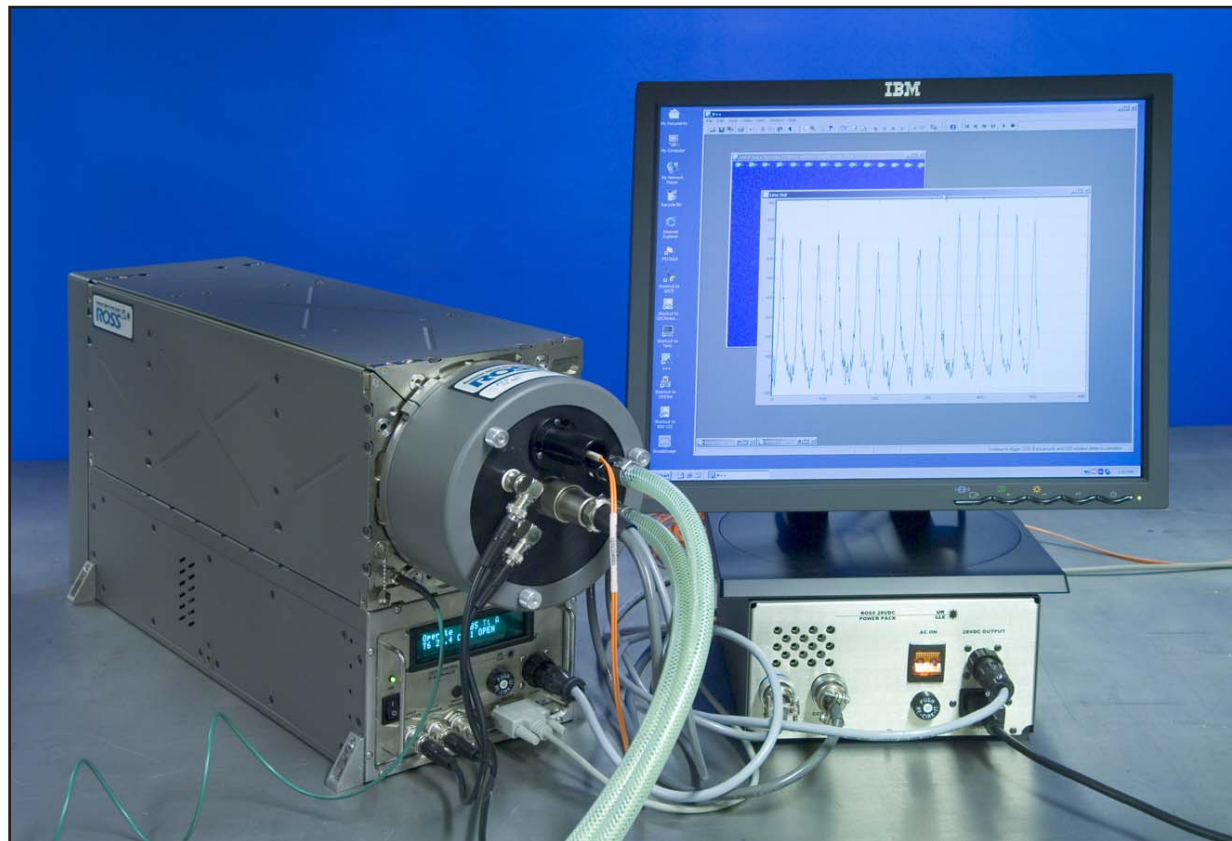


The Rochester Optical Streak System (ROSS)



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**46th Annual Meeting of the
American Physical Society
Division of Plasma Physics
Savannah, GA
15–19 November 2004**

Summary

The ROSS camera is a comprehensive diagnostic system with auto-focusing and self-calibration capability

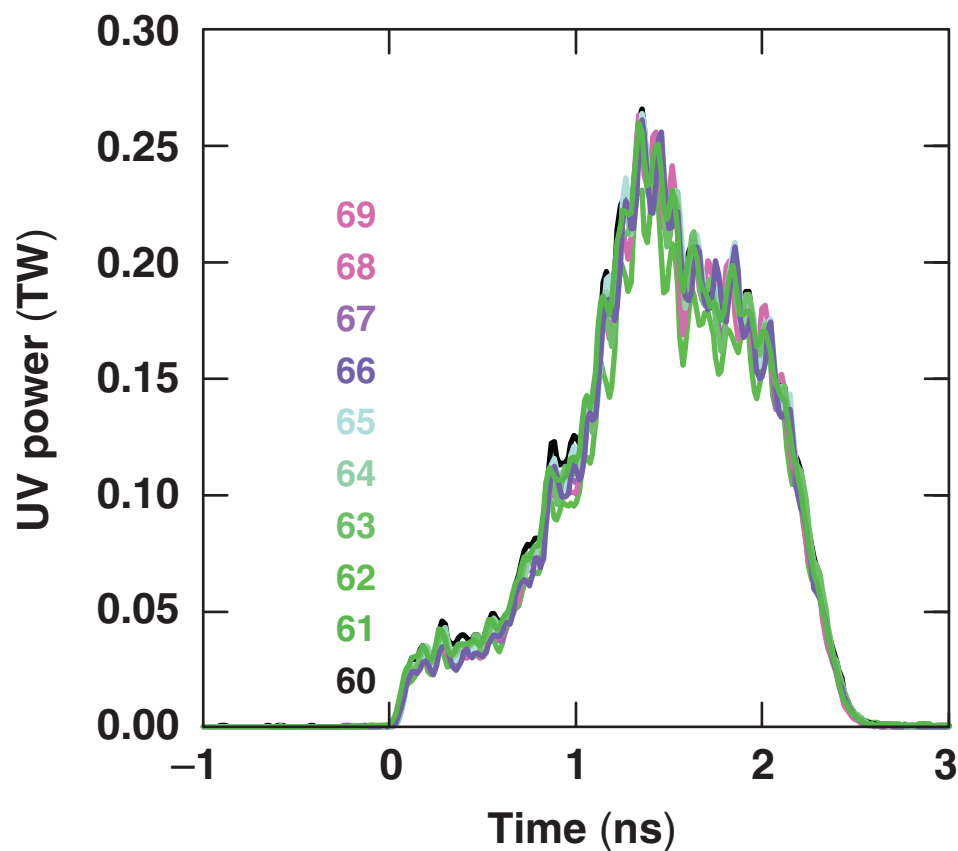
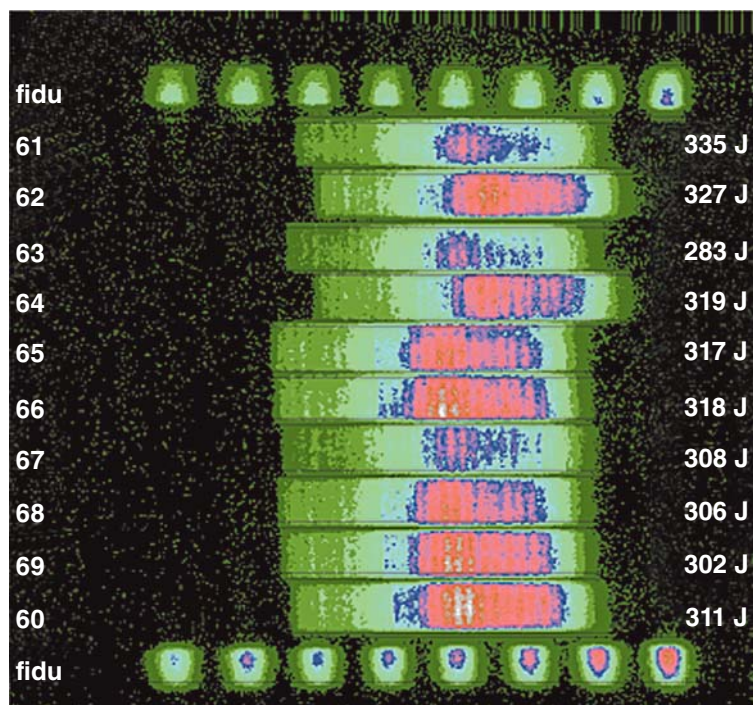


- System performance is limited by the streak tube electron optics
 - currently implemented with P510, P820, and PJX tubes
- All functions can be accessed and monitored remotely
- The streak camera can be photometrically calibrated
- 8 prototype cameras have operated on OMEGA for 5 years, accumulating over 500,000 streaks, with better than 99.9% reliability

P510 ten-channel streak cameras provide pulse shape and power measurements on OMEGA



22707



OMEGA experiments demand quantitative, high-precision (SNR > 100), large dynamic range (>1000) high-bandwidth (10 GHz) measurements



- **Quantitative**
 - nonlinearity <1%
 - scientific-grade CCD recording without intensifiers
- **1% measurements**
 - long term stability
 - calibrate and then calibrate some more
- **Integral of streak record \propto energy**
- **Stand-alone system, full remote operation**
- **Streak camera bandwidth and dynamic range are still better than oscilloscopes and diodes**
 - streak tube limited system

The most important streak tube specification is its current handling capability



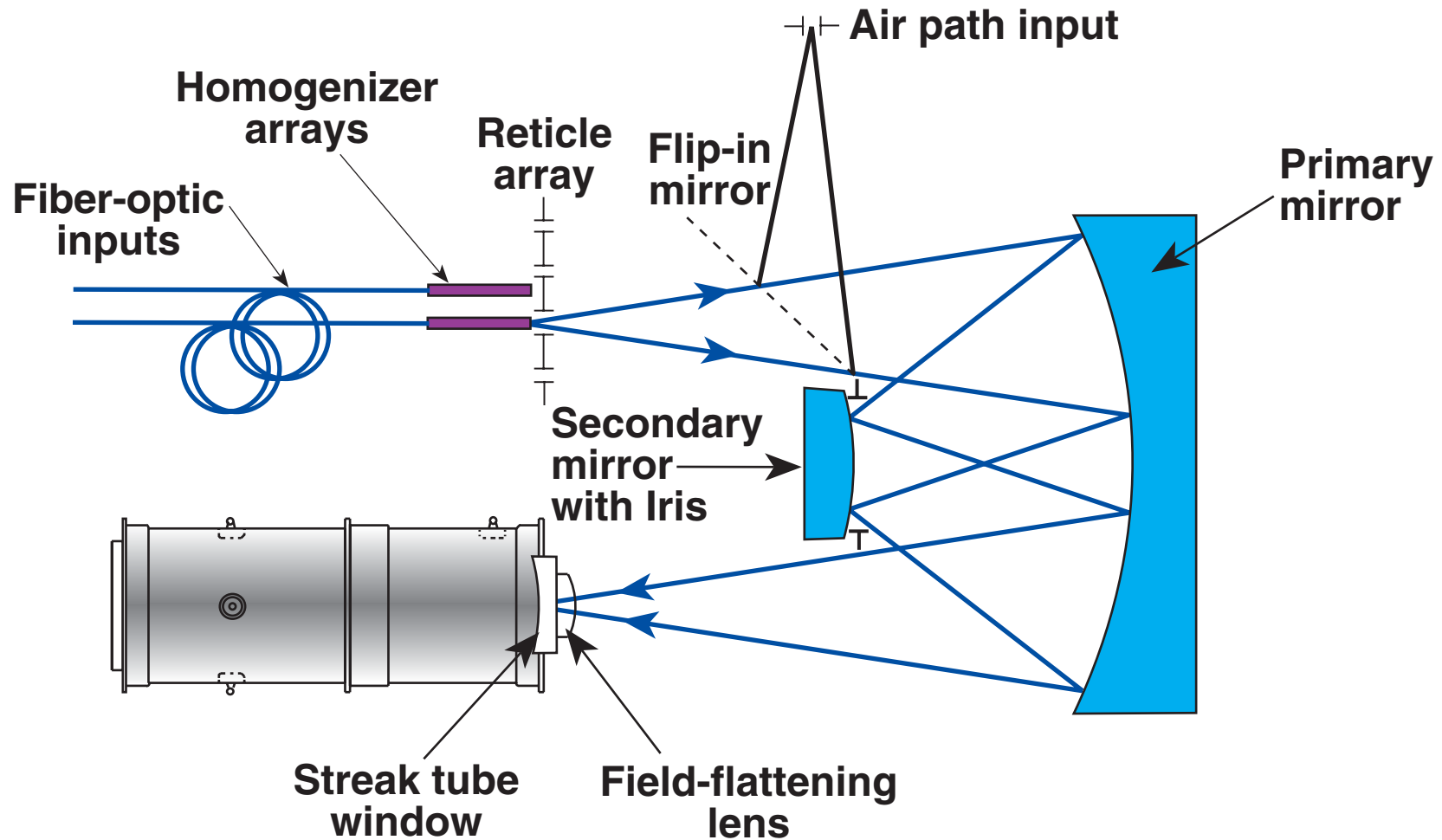
- I_{\max} gives the number of photoelectrons per time and spatial-resolution element and thereby the peak SNR
- Photoelectrons follow Poisson statistics $\Rightarrow \text{SNR} \propto \text{Signal}^{1/2}$
- Single photoelectron events are recorded well above the noise floor
- A high current tube must have
 - a high accelerating field at the photocathode
 - a large area photocathode
 - good photoelectron throughput (fraction that reaches the screen)
- Typically, 100–200 spatial and 100–200 temporal resolution elements
- Generally, large current is commensurate with good time resolution

The ROSS camera is a flexible, modular, stand-alone, electro-opto-mechanical system

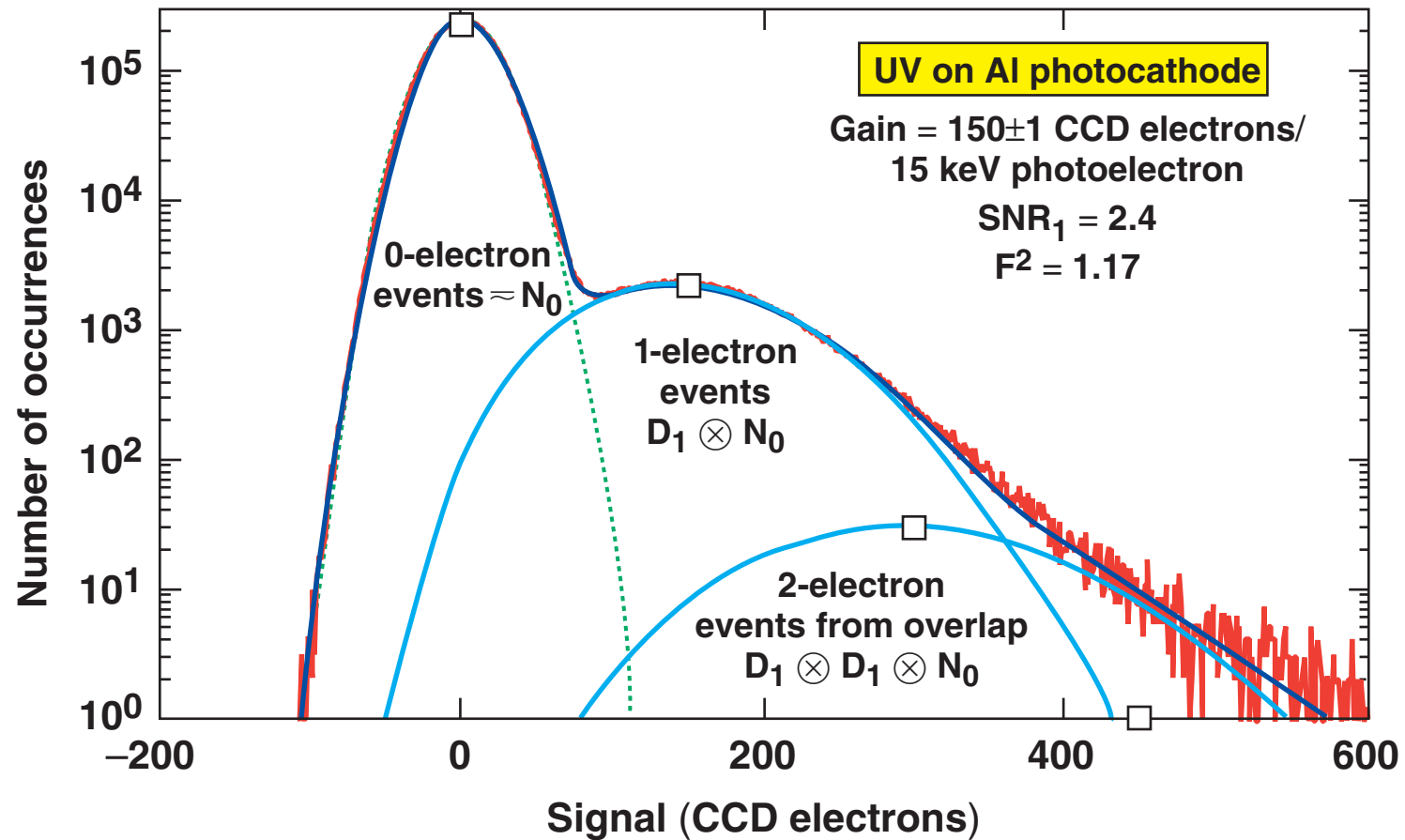


- **Camera dimensions are 7-in. wide × 21-in. long × 12-in. high with optics module 10-in. wide × 26-in. long × 12-in. high**
- **Streak tube is potted in a closed-end mu-metal shell**
 - **accepts P510, P820, and PJX streak tubes**
- **Modular electronics are packaged into mu-metal boxes**
- **Closed-loop voltage control (0.02%) with 24-bit ADC/16-bit DAC**
- **4 remotely selectable streak speeds**
 - **30 ms hold-off for retrace**
- **1-ms-resolution timer for shutter and CCD exposure control**

The input imaging system is an Offner triplet with motorized controls for the dual object planes and the secondary mirror



The pulse height distribution for recording single photoelectron events is fit to $D_1(S) = S \times \exp [-(S-\mu)^2/2\sigma^2]$

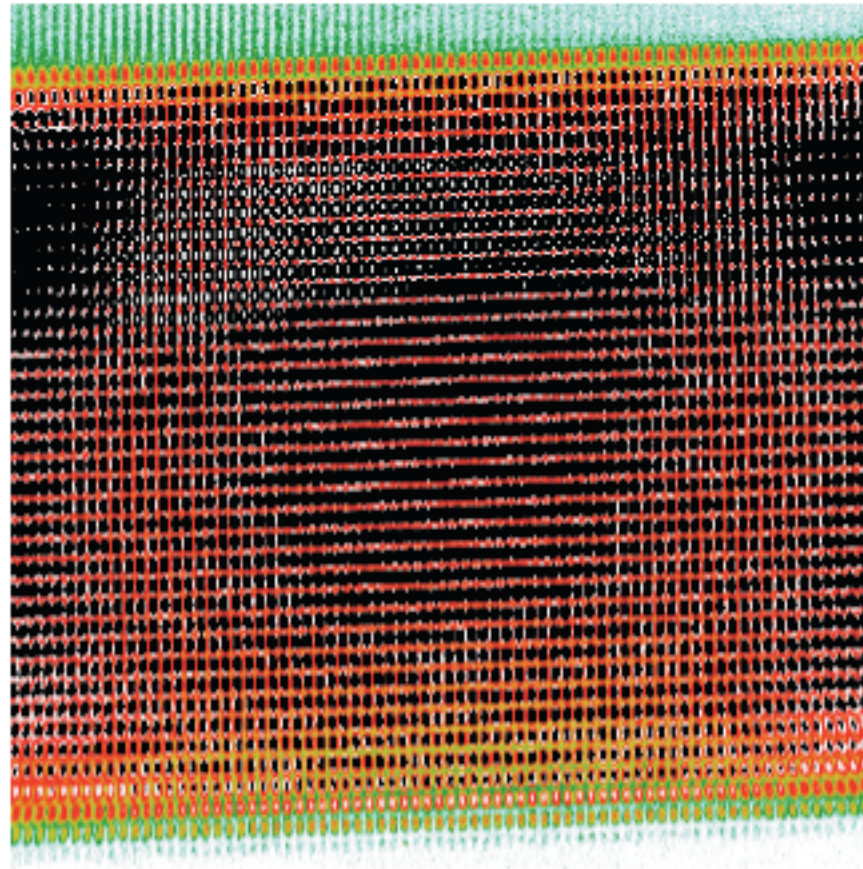


The ROSS camera has a comprehensive self-calibration capability

- **Flat-field data is generated with internal sources and slow (1- to 10-s) ramps**
 - **CW-LED or white light with interference filter**
 - **DC-DC converter driven by DAC with variable time and amplitude steps**
- **Geometric distortion data is also generated with slow ramps**
 - **reticle over flat-field homogenizer**
 - **modulate the LED duty cycle**
- **Sweep-speed time-calibration with on-board comb generator**
 - **4 frequencies: 100 MHz to 10 GHz**
- **Auto-focus the input optics and the electron optics**

Slow ramp, geometric distortion data shows the annulus of best focus for the P510 streak tube

Spatial direction illuminated through 500- μm bars and spaces mask.

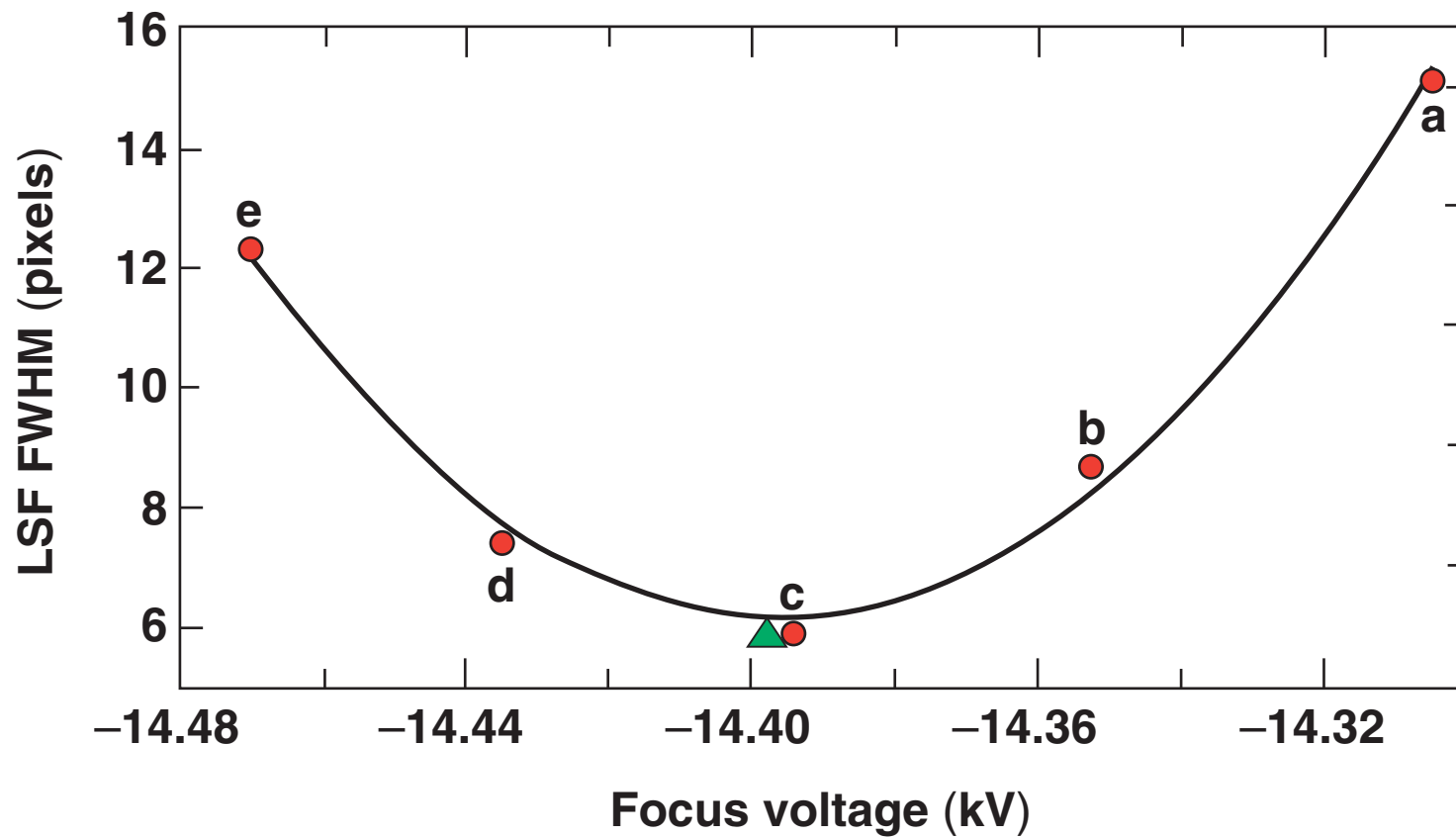


Annulus is the intersection of a curved image plane with a flat screen.

Time \longrightarrow

Modulate LED with 50% duty cycle

The temporal resolution of the P510 tube is optimized with an auto-focus routine



Summary/Conclusions

The ROSS camera is a comprehensive diagnostic system with auto-focusing and self-calibration capability



- **System performance is limited by the streak tube electron optics**
 - currently implemented with P510, P820, and PJX tubes
- **All functions can be accessed and monitored remotely**
- **The streak camera can be photometrically calibrated**
- **8 prototype cameras have operated on OMEGA for 5 years, accumulating over 500,000 streaks, with better than 99.9% reliability**