Update on the Rochester Optical Streak System
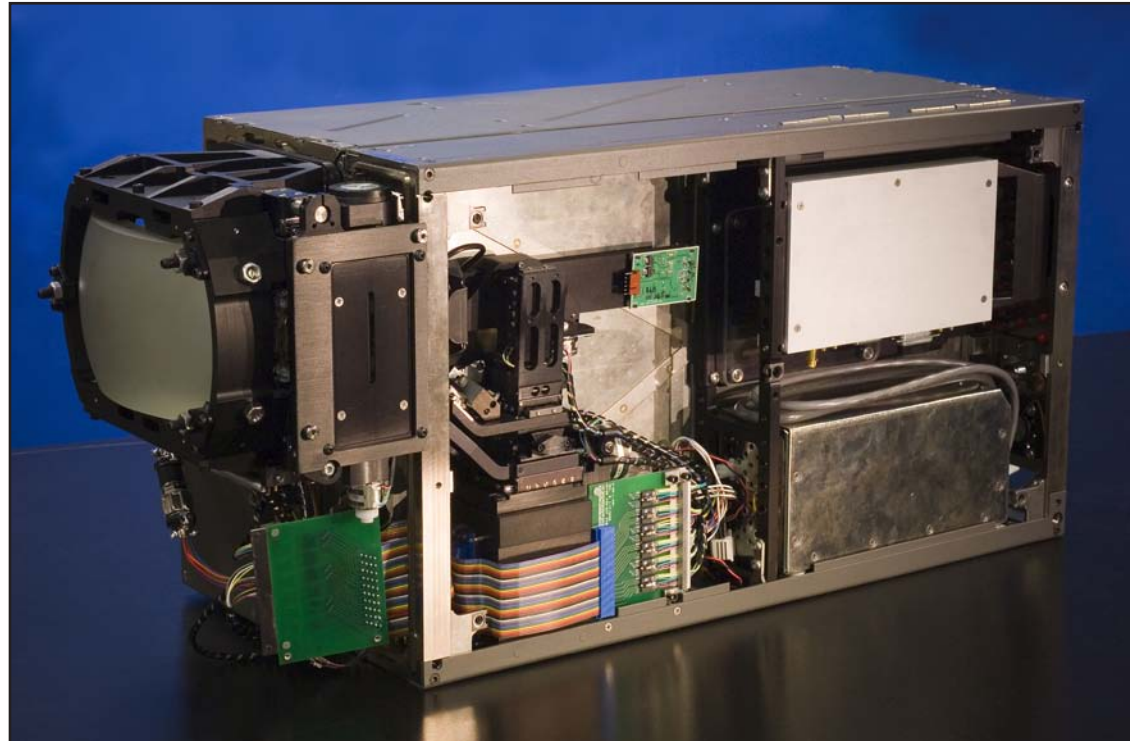
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Summary

The ROSS camera is a comprehensive diagnostic system with autofocusing and self-calibration capability
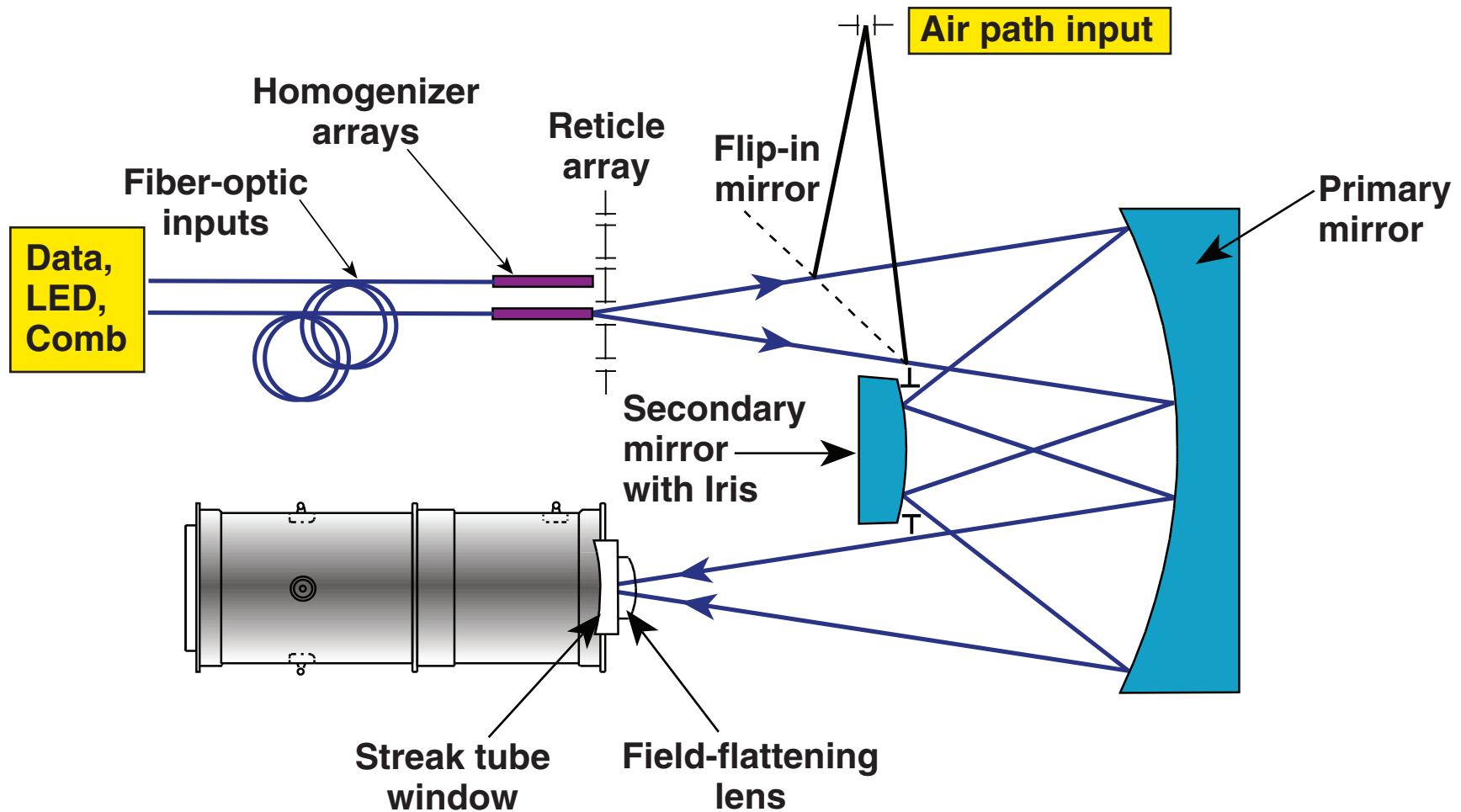
- The high-precision measurements demanded by the LLE experimental program require precise setup and calibration of the diagnostics.

- The optical calibration module incorporates an extensive imaging, flat-field correction, geometric-distortion, and time-calibration capability.

- All functions can be accessed and monitored remotely.

UR
LLE

E14126

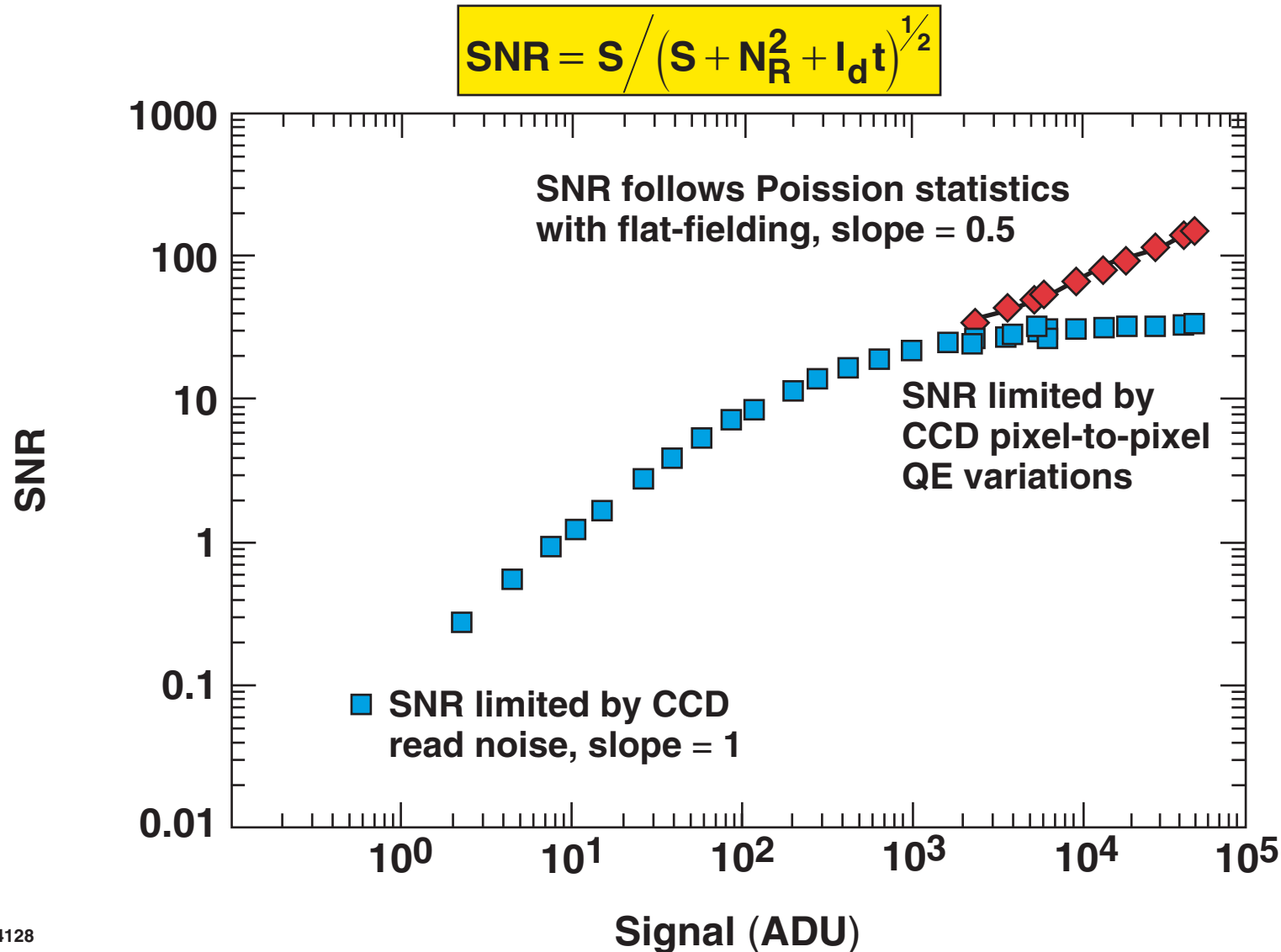# All pixels in the recorded image were not created equal

- **The system response is dependent on the spatial and temporal position and the focusing conditions.**

- **To make pretty pictures and FWHM measurements requires minimal calibration.**

- **Serious quantitative measurements (SNR > 10, DR > 10, nonlinearity $< 10\%$) require extensive calibrations.**

- **These issues are addressed in the ROSS design with the optical calibration module (OCM).**

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

UR
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Air path input

Homogenizer arrays

Fiber-optic inputs

Reticle array

Flip-in mirror

Primary mirror

Data, LED, Comb

Secondary mirror with Iris

Streak tube window

Field-flattening lens

E13258

Flat-fielding a CCD recording system elevates its performance to a near-quantum-limited detector

$$SNR = S \left/ \left(S + N_R^2 + I_d t\right)^{1/2} \right.$$

SNR follows Poission statistics with flat-fielding, slope = 0.5

SNR limited by CCD pixel-to-pixel QE variations

SNR limited by CCD read noise, slope = 1

SNR

Signal (ADU)

E14128

The ROSS–OCM design uses an LED, homogenizer, and a slow ramp to flat-field the system

- Input optics, photocathode quantum efficiency, photoelectron transport, phosphor-conversion efficiency, fiber-optic coupling, and CCD quantum efficiency are all independent of the signal level.

- Uses a 1- to 10-s duration ramp to simplify the illumination-source design.

- Multiple-wavelength CW–LED's are available internally, or white light passed through an interference filter can be fed in via fiber optics.

- Homogenizer output is spatially uniform to 0.25%.

Geometric distortions result from electron-optic aberrations and mechanical misalignments

- Manufacturers of streak tubes are reluctant to address these issues—$$

- Use ROSS–OCM flat-field subsystem plus spatial and temporal modulation to produce raw uncorrected images

- $S(x,y) = Jacobian(x,y,x`,y`) \times S(x`,y`)$, $x = U(x`,y`)$ and $y = (x`,y`)$

Space

Time $\rightarrow$ $\Rightarrow$ Time $\rightarrow$
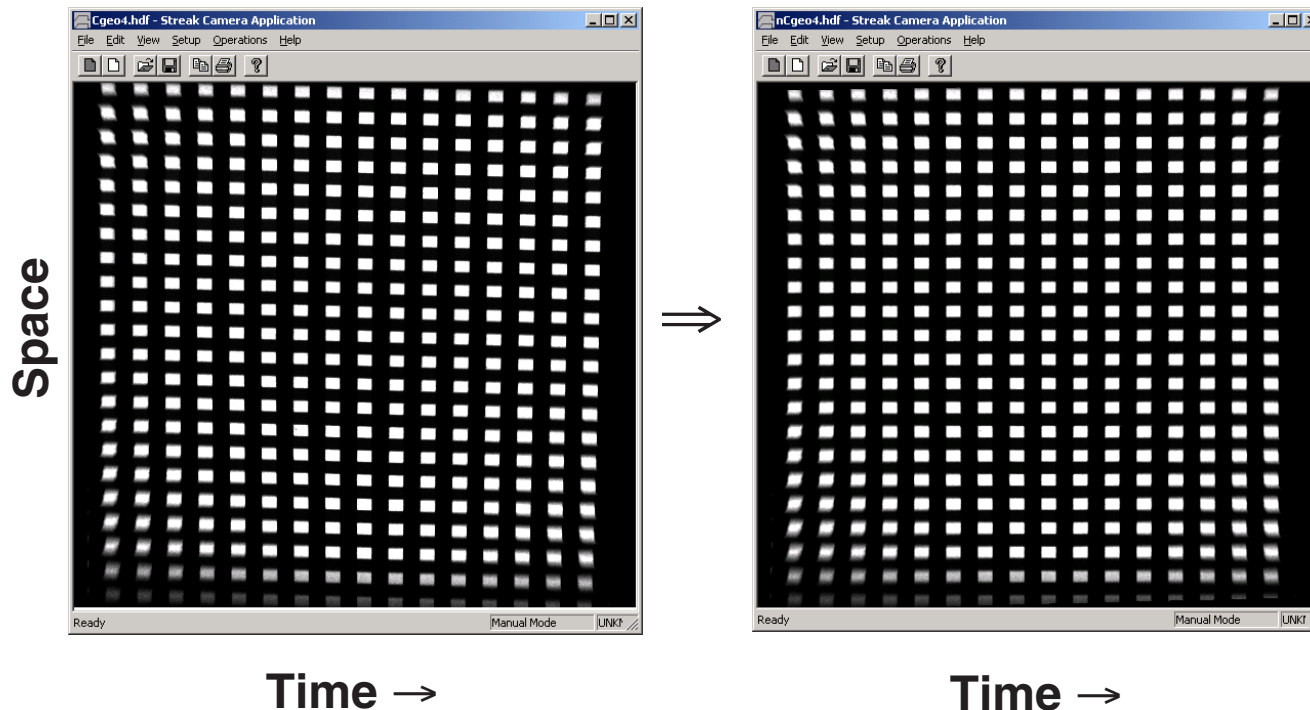
Time calibration is accomplished with an on-board, 664-nm, 3-GHz comb generator

- Verify system operation prior to shot

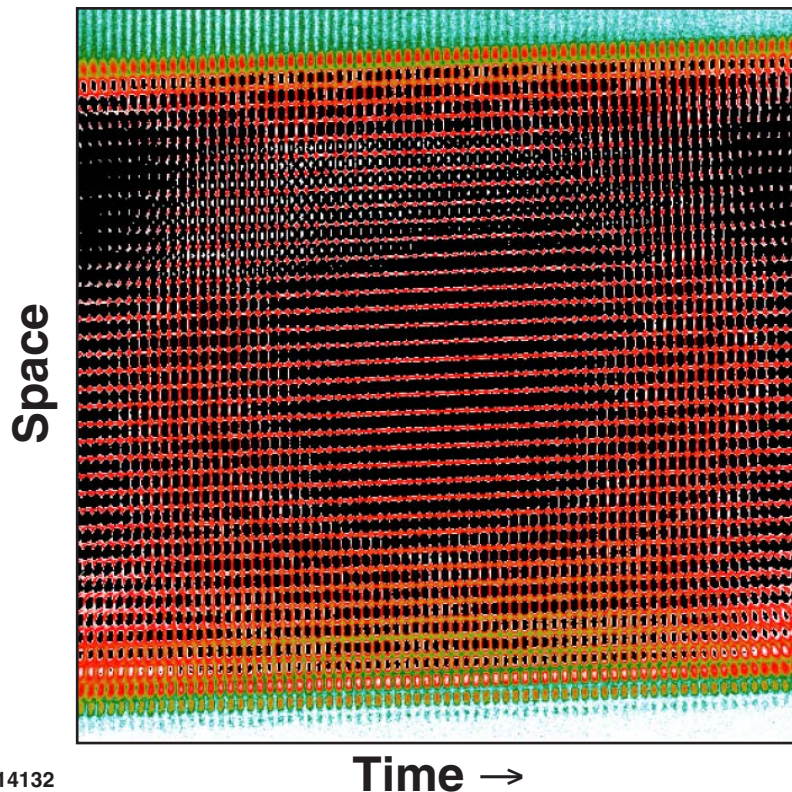- External source may also be coupled into any or all channels
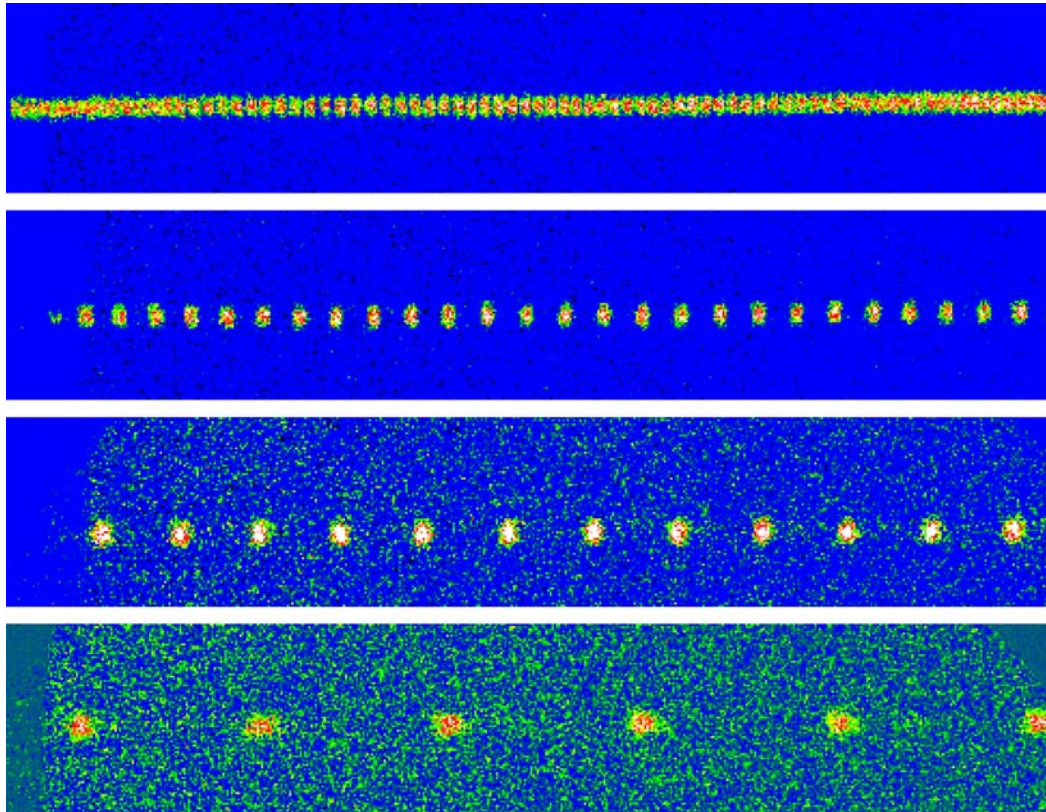
**4 streak speeds (2–25 ns) can be selected remotely**

E14131

The autofocus capability allows local optimization of the spatial or temporal

- Geometric distortion image shows the main EO aberration is field curvature.

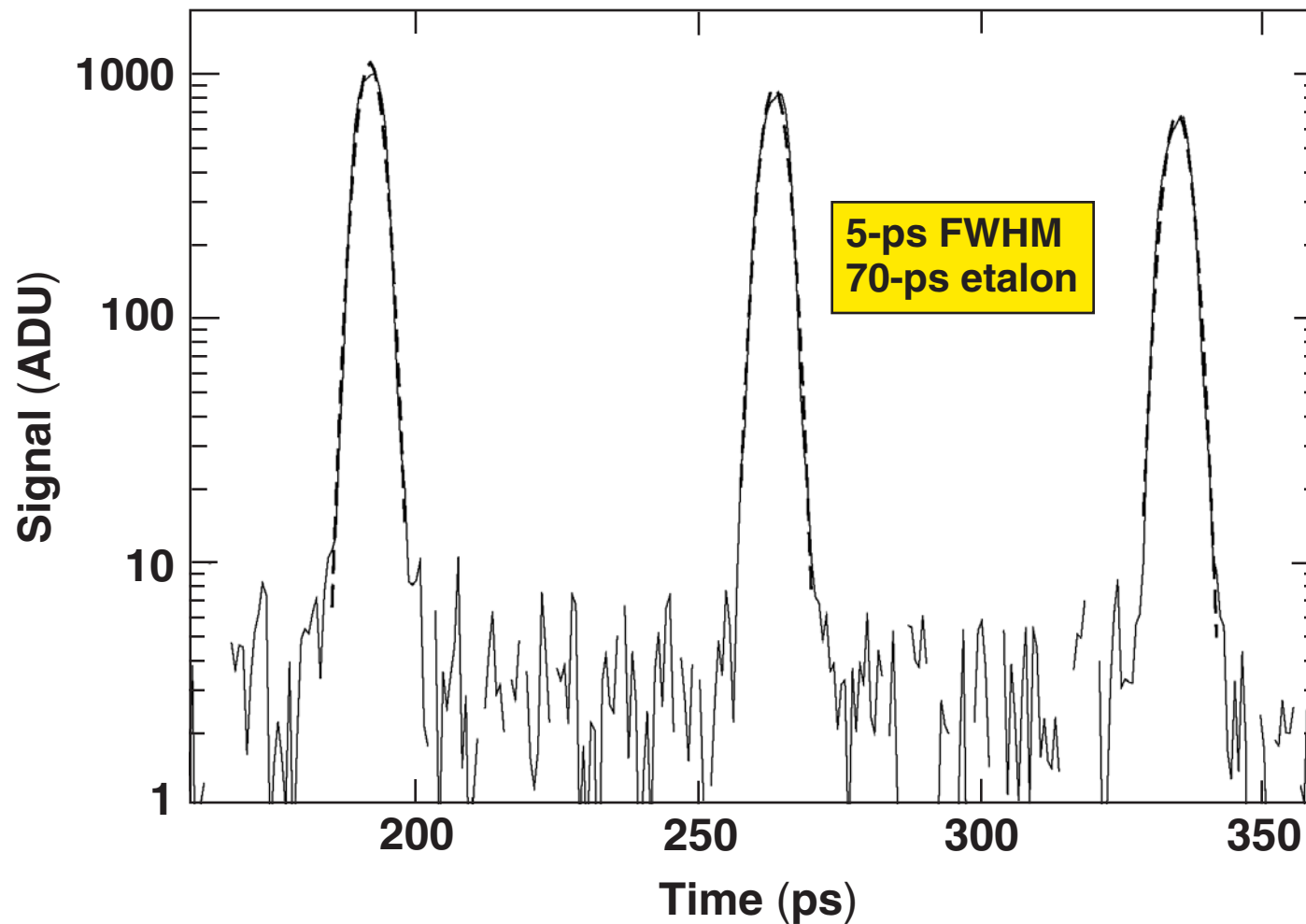**Annulus is the intersection of a curved image plane with a flat screen**

Lineout through central region

Space

Time →

E14132

Signal (ADU)

10000

1000

Time

0   100   200   300   400
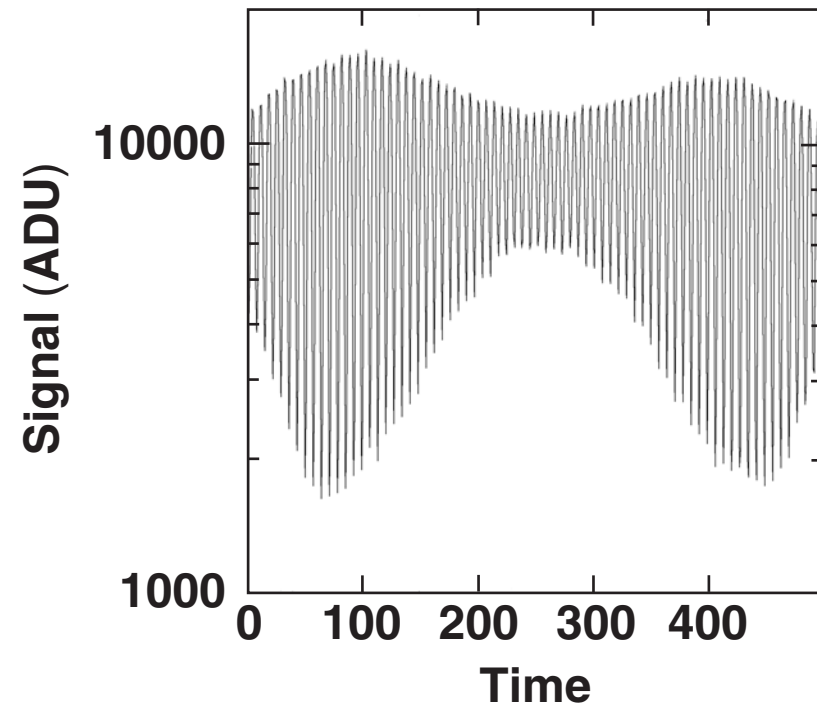
The P820 streak tube provides a 2-ps time resolution capability for OMEGA EP diagnostics

- **The peak current handling capability is 1.8 mA.**

E14133

Summary/Conclusions

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E14126