New Focus™
A Newport Corporation Brand

GuideStar II Customer Presentation

February 2012

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A Newport Corporation Brand

Outline

Product Overview

- Description
- Applications and Features
- Specifications

Technical Details

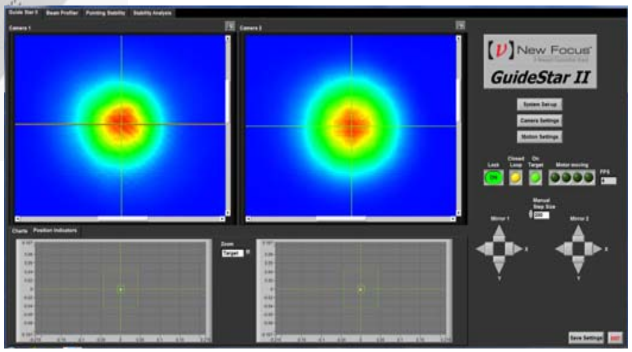
- Picomotor Mirror Mounts
- 8784 Cameras
- Alignment Layout and Algorithm
- 8783 Controller and Computer Interface
- Demo on kHz Ultrafast Laser
- Configurations for Sale

GuideStar™ II

The GuideStar™ II Laser Beam Steering Correction System

- guarantees Critical Alignment of complex systems.

- **Picomotor Mirror Mounts Actuators**
  - provide High Precision control with outstanding Intrinsic Stability
- **Model 8784 GuideStar II Camera Sensors**
  - provide complete Position, Pointing and Profile measurement
- **Model 8783 GuideStar II Controller**
  - provides the System Hub and the Picomotor Drive pulses
- **Computer Display and Control**
  - provides Complete Control with flexible Data Display and Tracking



Designed for accuracy, reliability, and ease-of-use, the GuideStar™ II System is the answer to laser beam drift correction for the most demanding laser applications.

GuideStar™ II System Description

The GuideStar II Laser Beam Steering Correction System provides high-reliability high-precision compensation of laser pointing and position drift. Two independent New Focus™ Picomotor™ actuated mirror mounts provide both manual and active 4-axis control with excellent passive stability. Two Model 8784 GuideStar™ II Camera Sensors provide continuous tracking of both laser beam positions and laser beam profiles. The position data is fed back to the mirror motion using our patented control algorithm *(US Patent # 7,528,364 Optical Beam Steering and Sampling Apparatus and Method, 2009),* the only technique that completely corrects the laser beam alignment in both x and y and near and farfield. The system is anchored by the Model 8783 GuideStar™ II Controller and controlled through your own computer with a host of user-friendly and convenient features. Full beam profiles and position and shape date are available live or can be tracked, stored and analyzed. An easy Set-up Menu guides new users through the install an simple settings menus allow complete control of a wide range of camera and beam stabilization parameters including >100:1 dynamic camera exposure time adjustment to optimize profile levels and complete control of beam position target sizes and signal time averaging.

GuideStar™ II Application

Problem

Critical Laser Beam Alignment with **Slow or Regular Pointing Drift**.

Examples

- Ultra-fast Regenerative Amplifiers with warm-up and power dependent Pointing Drift affecting critical alignment into Nonlinear Optical Wavelength conversion systems.

- High Power Solid State Lasers with power dependent Pointing Drift affecting critical alignment into precision Material Processing systems.

- High Peak Power Fiber Lasers with power and temperature dependent free-space Pointing Drift affecting critical alignment into precision Surgical Systems.

Solution

Continuous Tracking of external Laser Beam Position and Pointing.
Intermittent Pointing Correction Only When Required.

GuideStar™ II Product Features

Benefits

- Guarantees Critical Alignment of complex systems.
- Allows the use of Lower Cost passive pointing stabilization designs.

Zero Risk

- Intrinsically Stable Picomotor Mirror Mounts: No voltage = No motion
- Very Calm Servo: Motion only applied when drift limit is reached
- Intelligent Position Sensing: Never mis-steers the beam

User Friendly and Flexible

- Mirror Mounts both fully Manual and Motor-Controlled
- Full Beam Profiles displayed as well as Position
- Easy Setup Menus
- All Data versus Time stored and displayed

GuideStar™ II System Specs

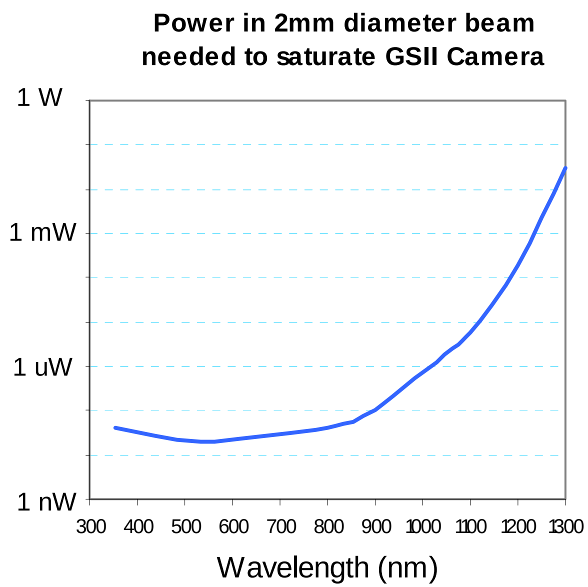
Laser

- Laser Wavelength : 355nm -1200nm
- Laser Repetition Rate : >500 Hz* to cW
- Laser Beam Size: <10mm diameter
- Detected Power Required : <1mW **

Beam Position Control

- Beam Pointing Adjustment Range: +/- 3 degrees, +/- 50mrad
- Minimum Pointing Step Size < 1urad
- Response Time: <10 second
- Refresh rate for beam profile and display: >3Hz

** trigger option for lower rep rates available on request*
*** typical power versus wavelength data in graph*



GuideStar™ II Component Specs

Picomotor Mirror Mounts Model 8807*

- 1" Diameter Mirror
- +/- 4 degrees Angular Range

  * Alternate Model #s: 8809, 8812,8816,8852,8885,8886,8887

GuideStar II Camera Sensor Model 8784

- 1 Megapixel CMOS
- Image Size >10mm diameter
- Beam Position Resolution <1um
- USB 2.0 interface
- Computer Controlled Exposure Range >20dB

GuideStar II Controller Model 8783

- USB connections to Cameras and Computer
- RJ-22 connections to Picomotor Mirror Mounts
- Executable GUI installer provided for user computer
-

User Computer

- 64 and 32 Bit Windows OS
- Full HD Display: 1920 x 1080

GuideStar™ II Picomotor Mirror Mounts

Large Range of Compatible Mirror Mounts

- ½ ", 1" and 2" diameter optic options
- High thermal stability
- Very low optic distortion
- Lifetime warrantee

Picomotor Actuators

- Patented PZT actuated 80 threads per inch screw mechanism
- <30nm step size
- 2kHz rep rate
- $>10^9$ step reliability
- widely used in oem semiconductor manufacturing systems

Active Mirror Mounts

- Excellent shock and vibration resistance
- Vacuum and UV compatible versions
- Widely used in ultrafast laser and surgical laser systems

Model 8807
Center Mount,
1 in. Diameter

Other Picomotor Mirror Mount Examples

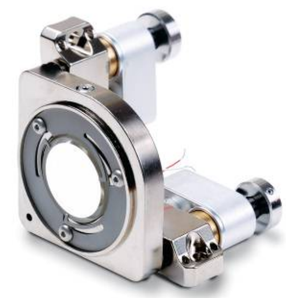
Model 8886
Pint-Sized Corner Mount,
0.5 in. Diameter

Model 8887
Pint-Sized Corner Mount,
1 in. Diameter

Model 8885
Pint-Sized Center Mount,
0.5 in. Diameter

Model 8852
Corner Mount,
2 in. Diameter

Model 8816
Stability™ Mount,
1 in. Diameter

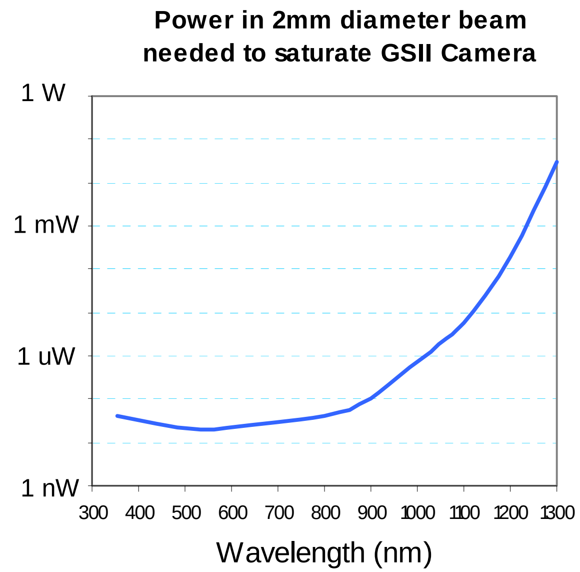


Model 8817
Vacuum Stability™ Mount
1 in. Diameter

GuideStar™ II Camera Sensors

The GuideStar II Laser Beam Steering Correction System uses two **Model 8784 GuideStar™ II Camera Sensors** to provide continuous measurement of both laser beam Positions and laser beam Profiles.

Model 8784



- 1 Megapixel CMOS
- USB 2.0 interface
- Image Size >10mm diameter
- Beam Position Resolution <1um
- Computer Controlled Exposure Range >20dB
- Manually Controlled Exposure Range >60dB (ND 1,2,4)
- W x H x D: 45 x 45 x 70mm

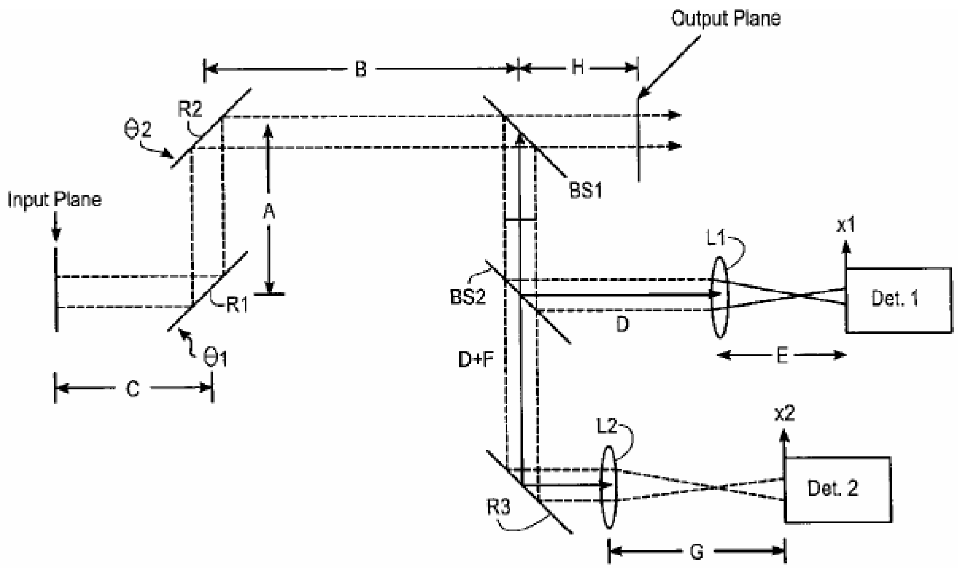
Detachable Filters with ND1, ND2 & ND4 on front in series to handle a wide range of input beam powers

GuideStar™ II Patent

Patent No.: **US 7,528,364 B2**
Date of Patent: **May 5, 2009**

(54) **OPTICAL BEAM STEERING AND SAMPLING APPARATUS AND METHOD**

(75) Inventors: **Alejandro D. Farinas**, Mountain View, CA (US); **Evan D. Green**, San Jose, CA (US)



In a light (optical) beam steering/sampling system, a matrix inversion control technique is used to decouple the operation of the actuators which drive the steering mirrors. The control technique uses two virtual variables, each having an associated independent feedback loop operating in a non-cross-coupled manner, each variable being associated with one of the two steering mirrors.

The invention claimed is:

1. Apparatus comprising:

a first steering reflector on which a beam of light is incident;

a second steering reflector on which light reflected from the first steering reflector is incident;

a first beam splitter on which light reflected from the second steering reflector is incident;

a second beam splitter on which light reflected from the first beam splitter is incident;

a first detector on which light reflected from the first beam splitter is incident; and

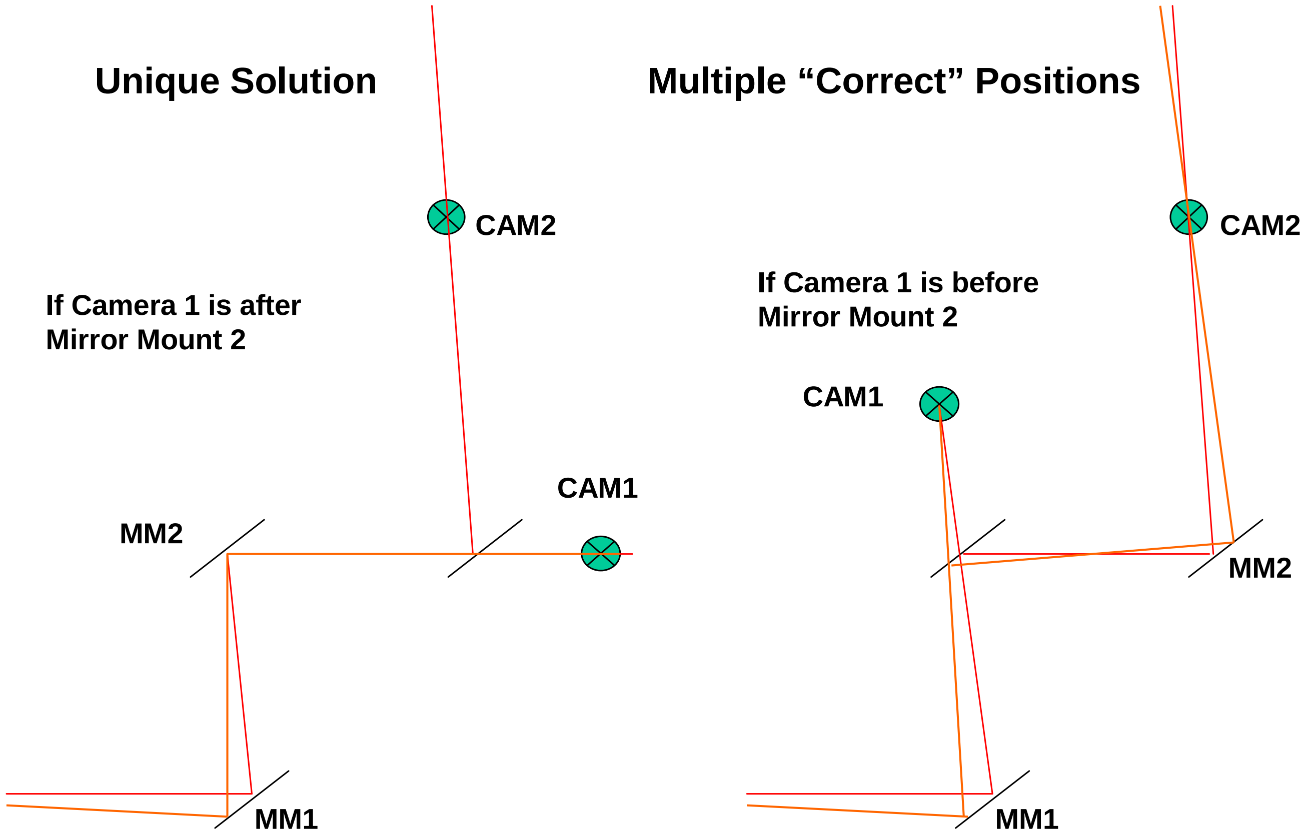
a second detector on which light transmitted by the second beam splitter is incident;

wherein a first value is obtained which is a function of an output signal of both detectors is indicative of a state of the first steering reflector and not of the second steering reflector, and a second value is obtained which is a function of an output signal of both detectors is indicative of a state of the second steering reflector and not of the first steering reflector.

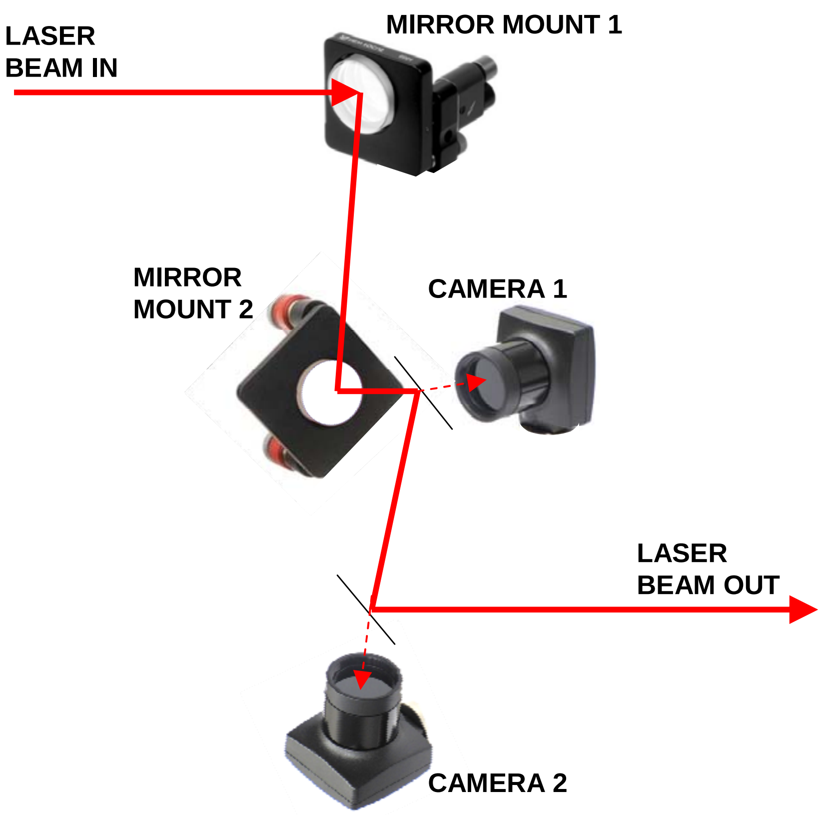
GuideStar™ II Patent Explained

2 Pointing Actuators and 2 Position Sensitive Detectors

Full and complete control of near-field beam Position and far-field beam Pointing requires **both of the 2 Pointing Actuators** to be **in front of the two Detectors.** Only then can the control matrix be really separated and the Actuators driven independently. And otherwise there is not a clean separation and the correction of far-field pointing will affect the near-field position and vice versa.



GuideStar™ II Optical Layout Examples



Separation Between Components

The best control is achieved when MM1 and MM2 are separated as much as possible and also CAM1 and CAM2 are separated by as much as possible. We therefore advise setting up MM1 close to the beam origin, CAM1 directly following MM2 somewhere in the middle, and CAM2 imaging the beam destination.

Beam Pick-offs for Cameras

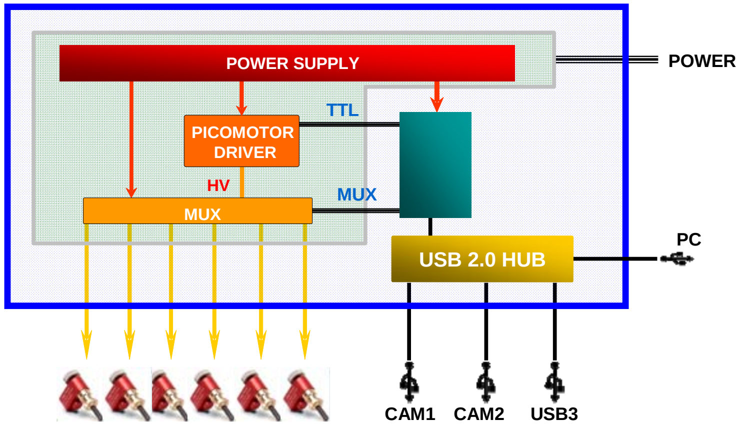
The power required for the cameras is very low so we recommend using the leakage through normal HR mirrors already in the beam train as beam "pickoffs." Other options include reflections off AR surfaces or uncoated beam-splitters in the beam.

GuideStar™ II Controller

The GuideStar II Laser Beam Steering Correction System is anchored by the
Model 8783 GuideStar™ II Controller
This compact box provides the system Hub and the Picomotor Drive pulses

Model 8783

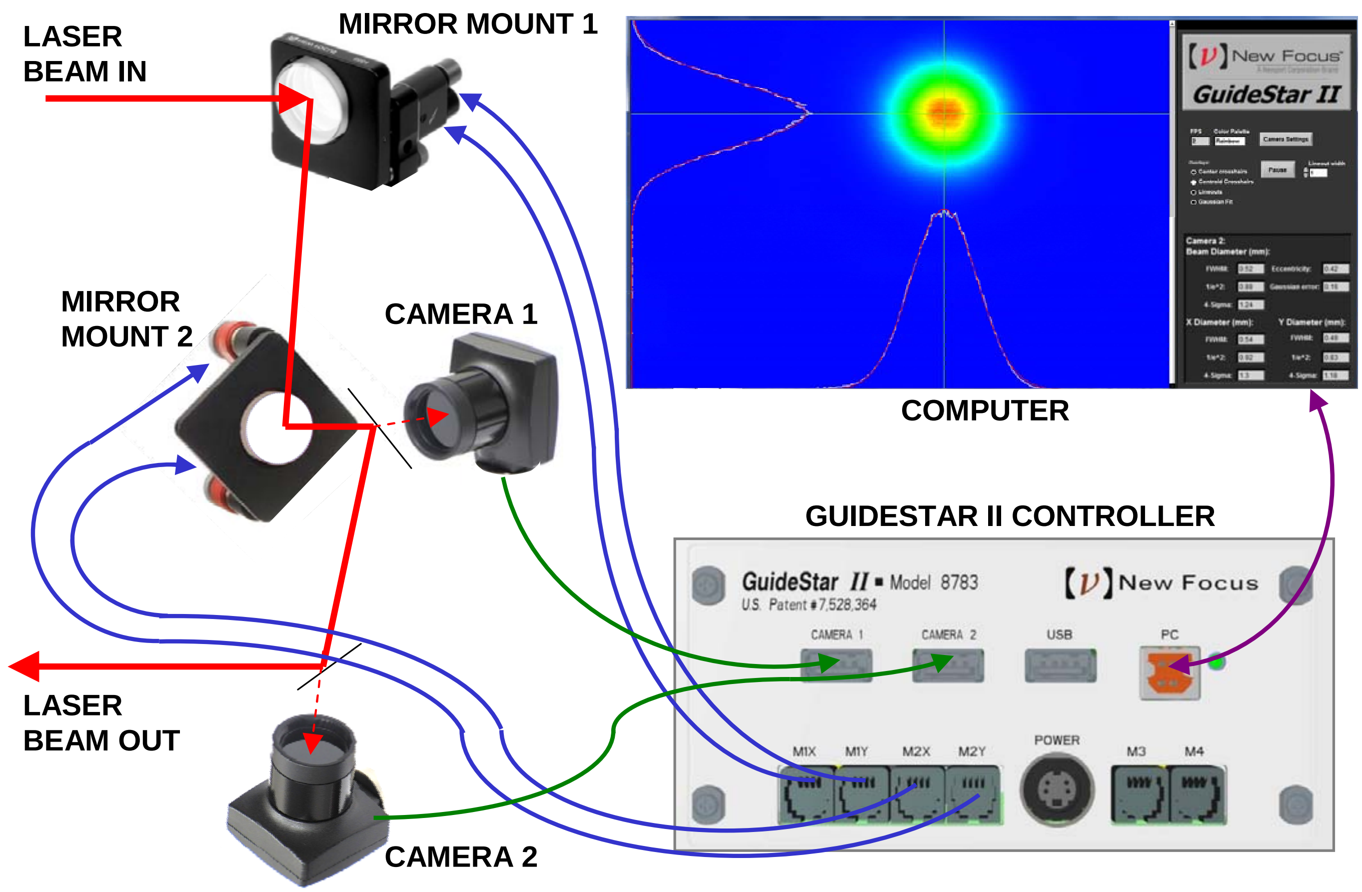
Block Diagram



- Executable GUI installer provided for user computer
- USB connections to Cameras and Computer
- RJ-22 connections to Picomotor Mirror Mounts
- W x H x D: 140 x 80 x 200mm
- 12VDC via 100-240 VAC power adapter provided

DC Power Supply, PC cable and connections for 2 additional picomotor and one additional camera included.

GuideStar™ II System Connection



GuideStar™ II Computer Display and Control

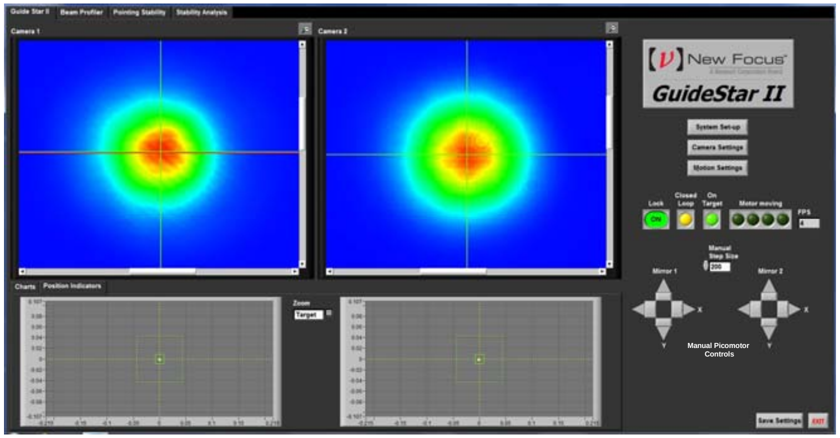
The GuideStar II Laser Beam Steering Correction System is controlled through **your own computer** with an easy to install executable program with a host of user-friendly and convenient features. An easy Set-up Menu guides new users through the install and simple settings menus allow complete control of a wide range of camera and beam stabilization parameters including >100:1 dynamic camera exposure time adjustment to optimize profile levels and complete control of beam position target sizes and signal time averaging. Full beam profiles and position and shape data are available live or can be tracked, stored and analyzed.

Features:

- Precision Beam Position Display
- User Friendly Setup
- Adjustable Camera Exposure Time
- Adjustable Target Sizes, Positions
- Adjustable Loop Gain and Time Averaging
- Full Beam Profiling
- Beam Position Monitoring Tracking and Analysis

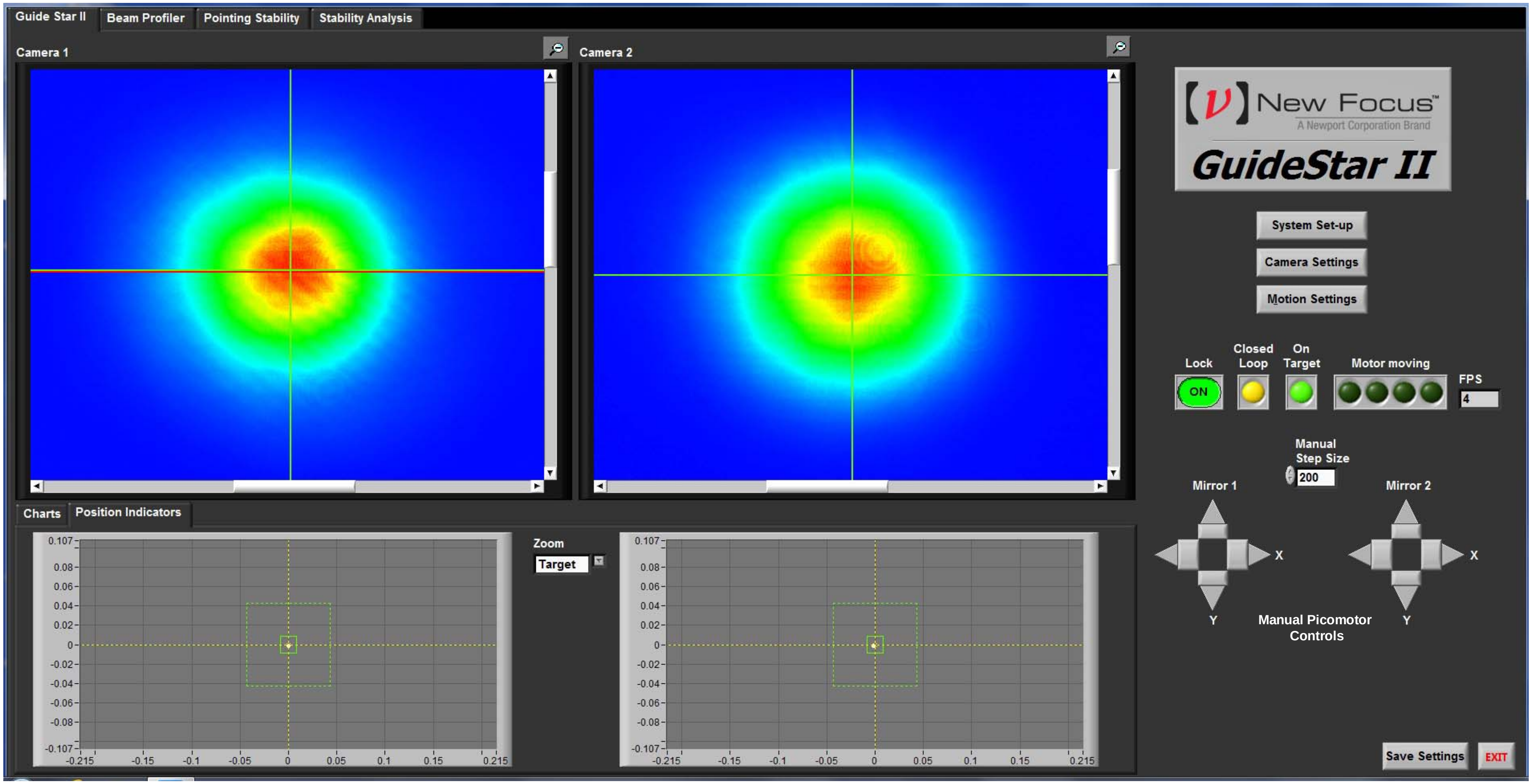
Screen Tabs:

Screen 1 – Controls for Camera and Positioning
Screen 2 – Beam Profiler
Screen 3 – Position Stability
Screen 4 - Position Stability Analysis

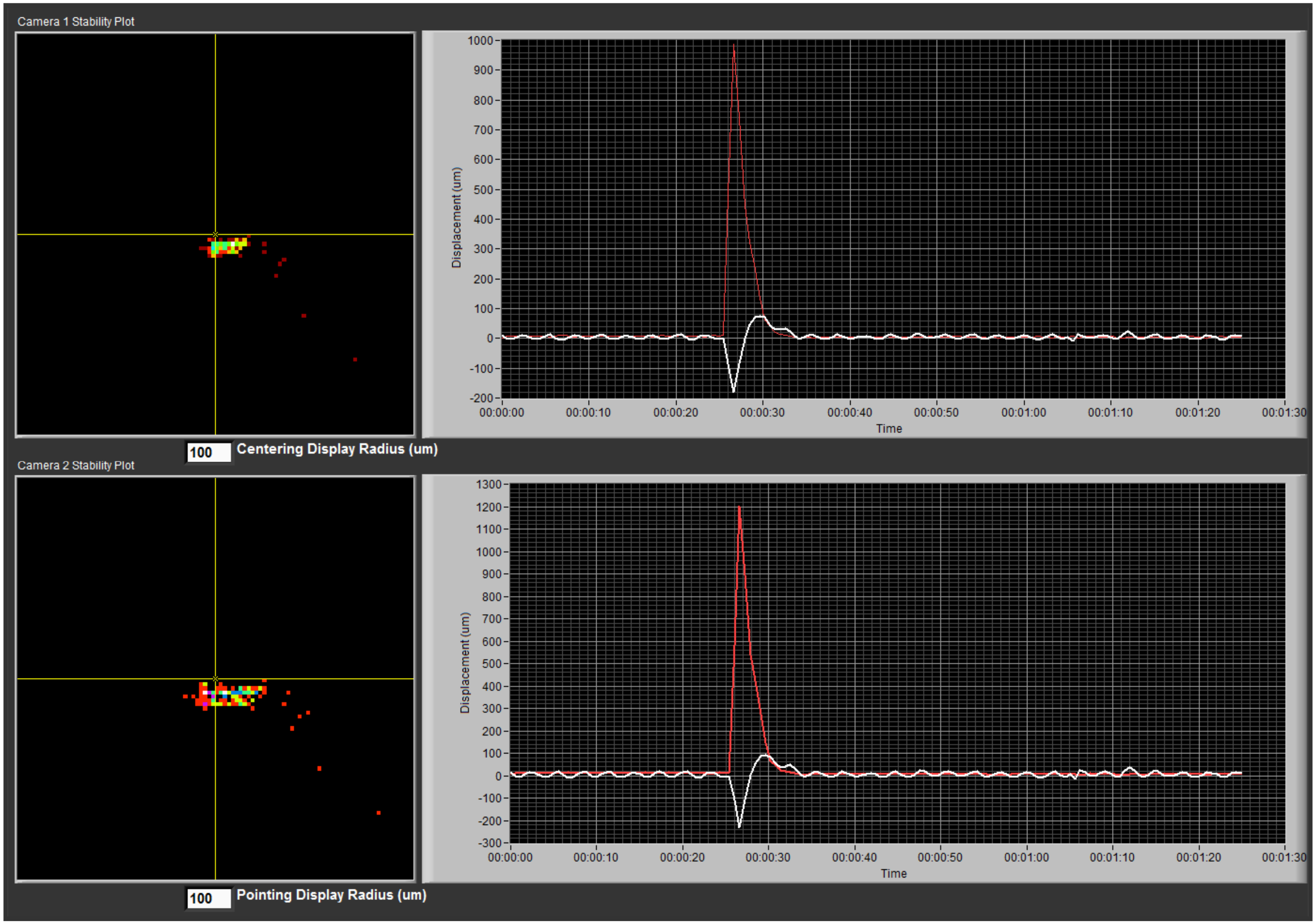


Main Screen

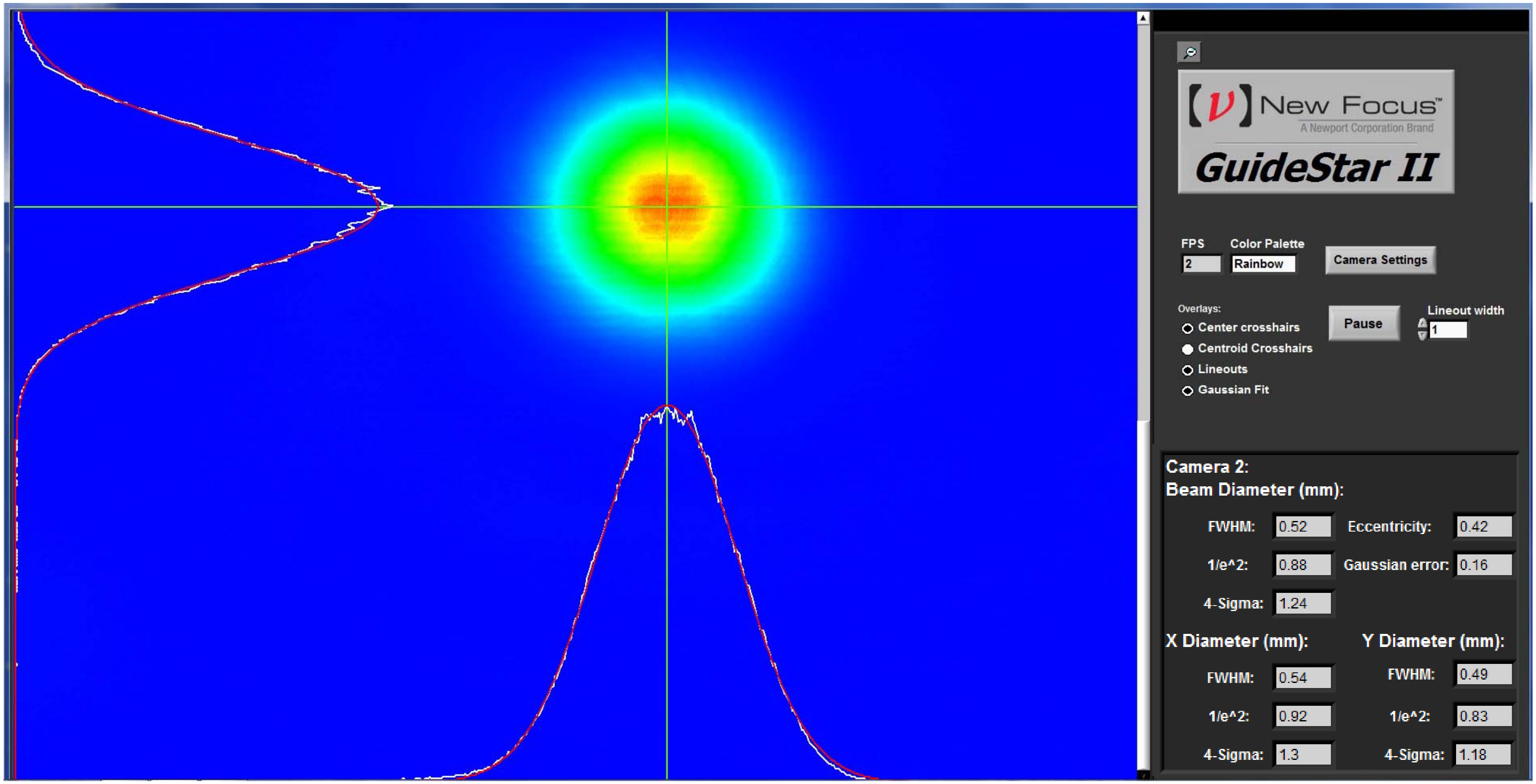
GuideStar™ II System Main Screen



GuideStar™ II Pointing Tracking



GuideStar™ II Beam Profiling



August 2011 Laser Focus World Article

CMOS cameras allow robust active stabilization of laser beams

ANDY CORDES and ANDREW DAVIDSON

Accurate measurement of the position of a laser beam can be achieved in several ways, each with its strengths and weaknesses. A comparison of these has resulted in an active beam-stabilization system for alignment and steering control of a kilohertz ultrafast laser.

Active beam-stabilization systems can be powerful tools to enhance laser-system performance. To fully stabilize a laser beam requires four-degree-of-freedom control—both pointing and position for each transverse direction. The feedback signals needed to accomplish this control are typically derived from separate beam-position measurements made at two points in the optical system. Three types of devices can be used for this position measurement: a position-sensitive detector (PSD), a quadrant detector (quad cell), or a multielement camera array. Each approach has its pros and cons.

In a PSD, current from a large-area photodiode passes through a resistive layer to one of four electrodes (see Fig. 1). The resistive layer forms a two-dimensional current divider such that the electrode closest to the illuminated spot receives the most photocurrent. The current difference between each half of the detector provides an indication of position in each direction.

A quad cell consists of four photodiodes separated by gaps of a few micrometers. Provided the beam is sufficiently near the center, then, as with the PSD, the current difference between each half of the detector provides an indication of position in each direction. However, for the quad cell—as opposed to the PSD—position depends on beam diameter.

A camera, with its many pixels, provides a full intensity profile; from this information the beam centroid can be calculated to give the position information. The camera has the advantage that its image can be used for other beam-diagnostic purposes, making possible additional control or diagnostics in optical systems. It has the disadvantage that it requires a higher level of complexity due to the need for communication with the device, as well as data processing.

For all these devices, the outputs are summed to provide total power. The *X-Y* calculations are normalized by this power, resulting in a position measurement independent of power.

In a stabilization system, the speed of the control loop can be important. If only thermal effects are being addressed, then all the devices have

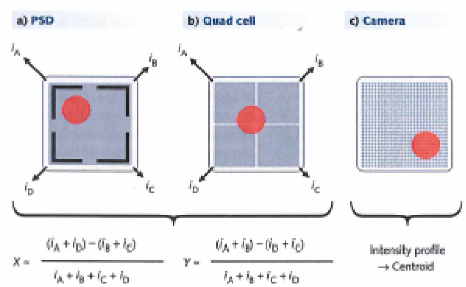
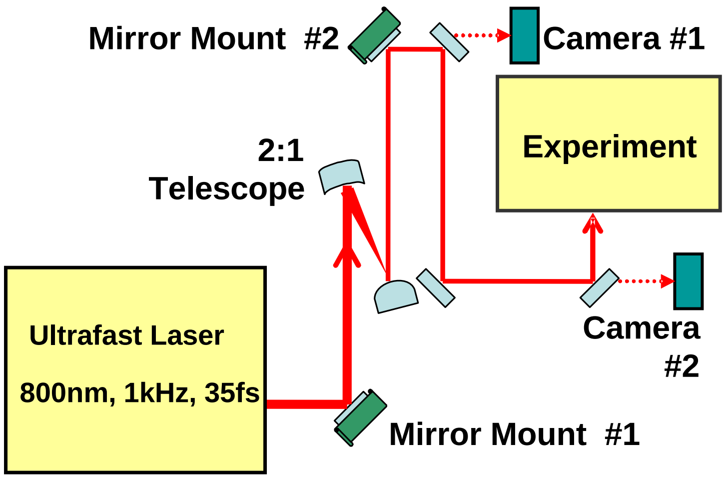
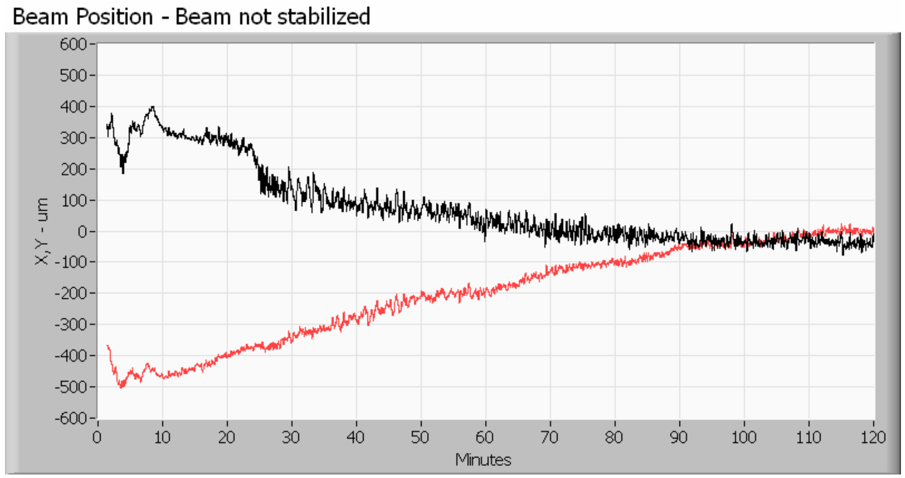


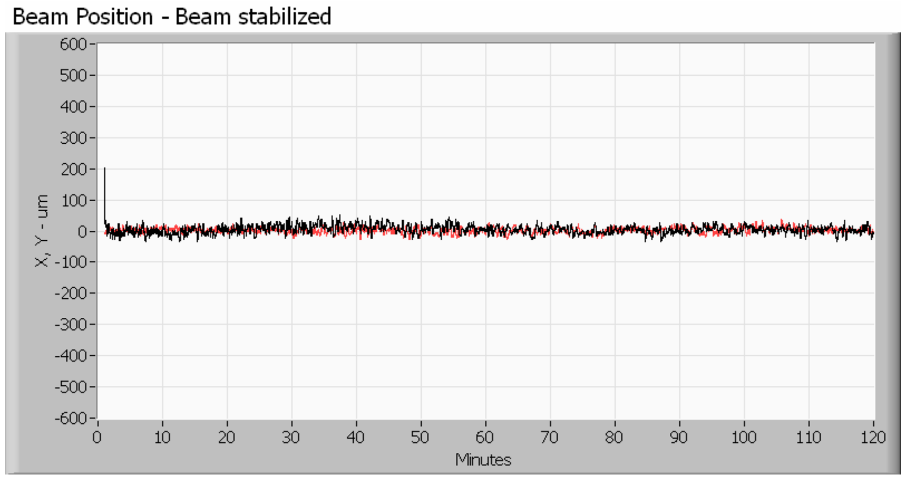
FIGURE 1. Devices for detecting the position of a laser beam include: a) a position-sensitive detector (PSD), b) a quadrant-cell detector (quad cell), and c) a CMOS camera. The *X* and *Y* beam position on both the PSD and quad cell can be calculated from the detectors' current outputs i_A, i_B, i_C, and i_D. The beam position on the camera is determined by finding the beam's centroid.

1 kHz Femtosecond Amplifier Demonstration





Cameras monitoring <1mW leakage through HR turning mirrors.



Beam Position at Camera 2 measured on 2 days from a “cold” start.

The GuideStar II System removes >100μrad pointing over the initial 2 hours.

GuideStar™ II System Configuration

Core Components

8784 Camera with ND filters and cable

8784 Camera with ND filters and cable

8783 Controller with power supply, PC cable, Software, and manual

Picomotor Mirror Mount 8806,8807,8808, 8812, 8816, 8817, 8885, 8886, 8887, 8852,8853,8854 with cable

Picomotor Mirror Mount 8806,8807,8808, 8812, 8816, 8817, 8885, 8886, 8887, 8852,8853,8854 with cable

Other Required Components

Computer

Monitor

Extras: Optics, Pick-off Mounts, Laser, Optical Table…