CHARA AO Cameras

Criteria

- S/N at low-light level
- Frame rate
- Operating system
- Cooling method
- Data interface
- Cost
- …

Cameras selected
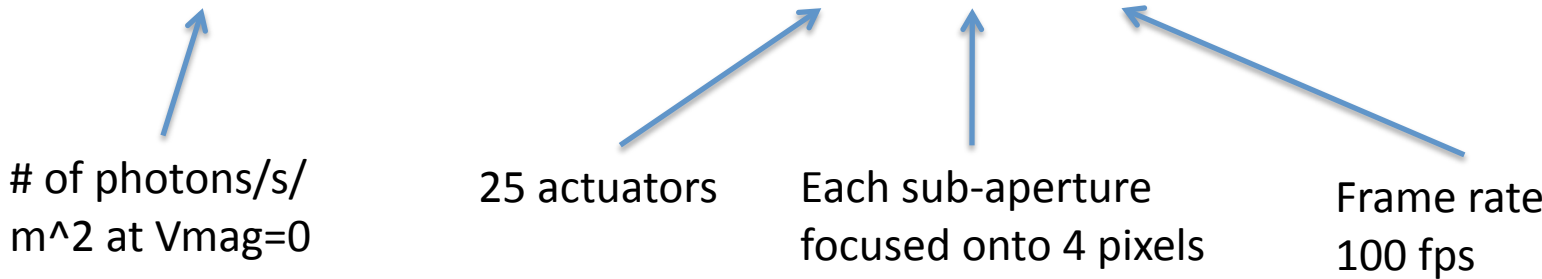
Company	Model
Andor	**Neo**
	Ixon860
	Ixon897
Princeton And Photometrics	**ProEM**
	PIXIS512
	Cascade128
	Evolve 128
	Quantem
PCO	**Edge**
Hamamatsu	**ImageM**

Main Goal: Faint objects

of photons at each pixel at Vmag = 14:

$$8.8e9 * 10^{(-14/2.5)} / 25 / 4 / 100 = 2.2$$

# of photons/s/
m^2 at Vmag=0

25 actuators

Each sub-aperture
focused onto 4 pixels

Frame rate
100 fps

EMCCD vs. sCMOS

	EMCCD	sCMOS
Read noise (e-)	<1 with EM gain	1 - 2
Dark current (e-/pixel/s)	<~0.01 @ -70C	0.03 @ -40C

Read Noise vs. Slider Value
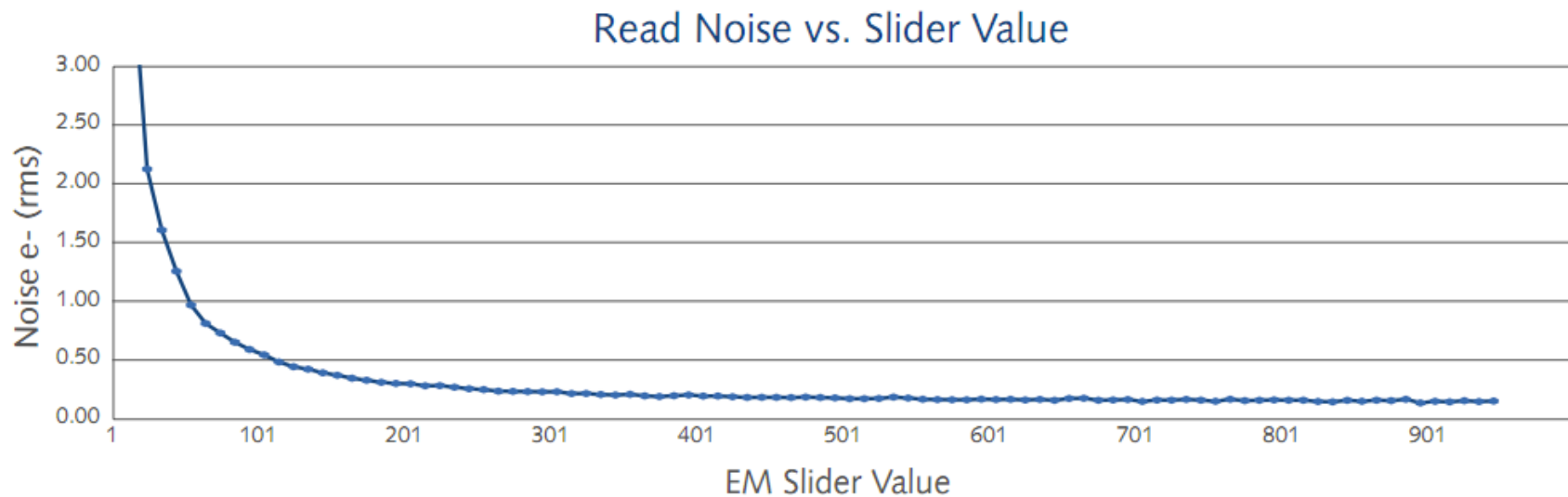
Actual data, not theoritical
From Photometrics

Cameras selected

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PCO	~~Edge~~
Hamamatsu	**ImageM**

Seeing condition vs. Frame Rate
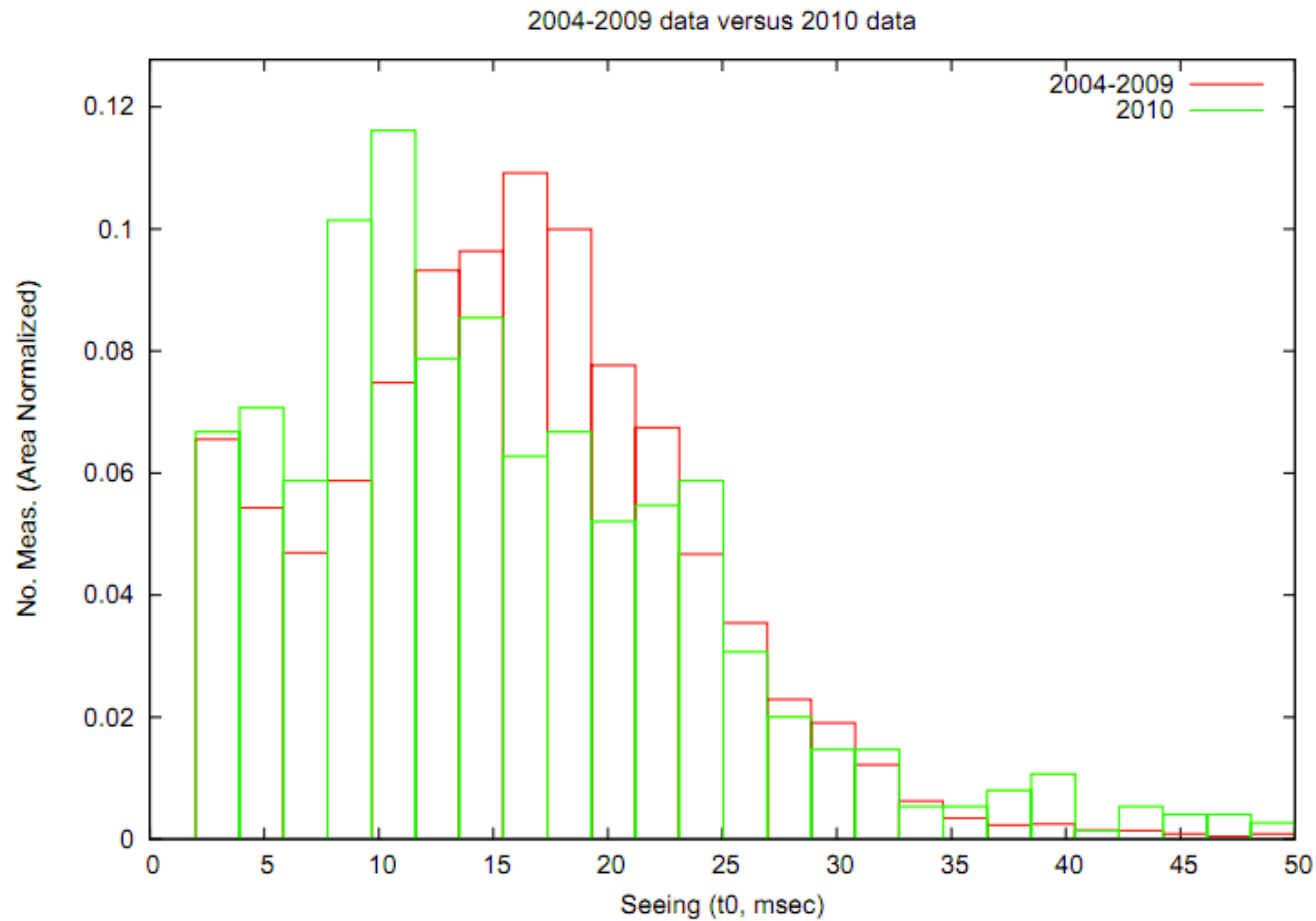
Nils Turner
CHARA 7th meeting

Frame rate has to be faster than a few hundreds per second

Cameras selected

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Andor	~~*Neo*~~
	Ixon860
	Ixon897
Princeton And Photometrics	~~*ProEM*~~
	~~*PIXIS512*~~
	Cascade128
	Evolve 128
	~~*Quantem*~~
PCO	~~*Edge*~~
Hamamatsu	**ImageM**

Operating system

- Linux supported: Ixon860, Ixon897 and Cascade 128, ImageM (3rd party, untested)
- Windows supported: Evolve 128

Cameras selected

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	Ixon860
	Ixon897
Princeton And Photometrics	~~ProEM~~
	~~PIXIS512~~
	Cascade128
	~~Evolve 128~~
	~~Quantem~~
PCO	~~Edge~~
Hamamatsu	ImageM ?

Ixon860 vs. Ixon897

	Ixon860	Ixon897
Pixel array	128 X 128	512 X 512
Pixel size (micro)	24 X 24	16 X 16
Well capacity (e-)	250,000	160,000
Frame rate (fps)	513 (standard)	395 (cropped)
Data interface	PCI, PCIe	USB2.0 in a few month, double the frame rate

Ixon 897 will probably cost more than Ixon 860

Cameras selected

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Andor	~~Neo~~
	Ixon860
	~~Ixon897~~
Princeton And Photometrics	~~ProEM~~
	~~PIXIS512~~
	Cascade128
	~~Evolve 128~~
	~~Quantem~~
PCO	~~Edge~~
Hamamatsu	ImageM ?

Data interface

	Data rate
USB2.0	480Mbs
Fireware 1394	800Mbs
Gigabit Ethernet interface	1Gbs
PCIe	>4Gbs
Camera link	>5Gbs

Data rate needed:
$128^2 * 16 * 1000 = 262Mbs$

128 X 128 array size

2bytes for each pixel

1000fps

# Andor (Ixon860) vs. Princeton (Cascade128)

- 1. The software worked well with Linux, was open source and easily ported to an RT environment.

- 2. In heat generation tests, Andor came out as the lowest heat generator, the Princeton device was a toaster.

- 3. Latency of the interface was lowest for the Andor device.

Note: Info on this slide is taken from Theo's notes

	Ixon860	Cascade128
sensor	e2V CCD60, back-illuminated	e2v CCD60; back-illuminated
# of pixels	128 X 128	128 X 128
Pixel size (micron)	24 X 24	24 X 24
Binning	4X, 2X	4X, 2X
Readout noise (e-)	48@10MHz <1 with EM gain	65@12MHz <1 with EMgain
Dark Current (e-/pixel/s)	0.002 @ -85C	<=1 @ -30C
Well capacity (e-)	250,000	250,000
Frame rata(fps)	513 @ 128 X 128	510 @ 128 X 128
QE	>90% at peak ~47% at 900nm	>90% at peak ~47% at 900nm
Cooling	TE, air cooled to -85C	TE to -30C
Humidity	<70%	<80%
Data interface	PCI, PCIe	PCI

Deep depletion

- Deep depletion has good QE at red
- However, e2v doesn't produce EMCCD with deep depletion, also the frame rate is less than 30fps
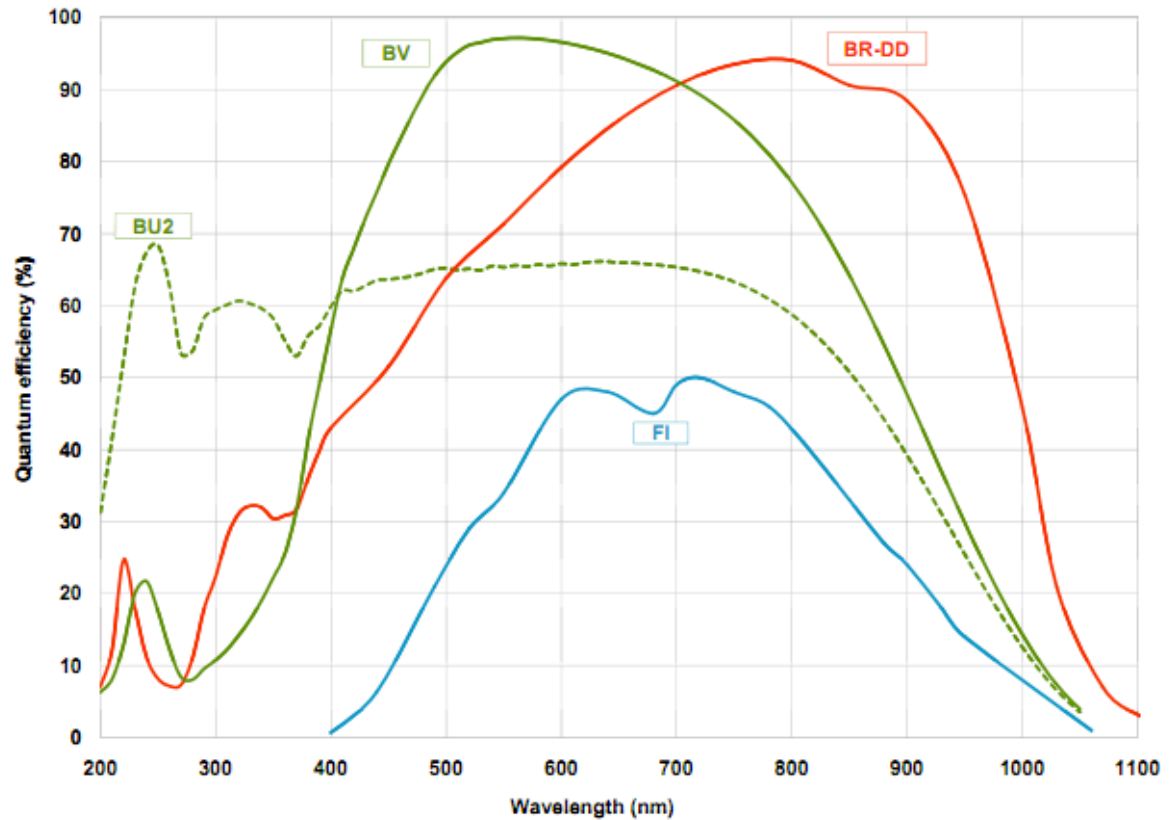
Cascade 128 vs. Evolve 128

Evolve 128 is a upgraded version of cascade 128 with several nice features:
➢ Linear scale for the gain
➢ Light source inside for gain calibration
➢ Bias level is fixed when changing frame rate ….

But Evolve doesn't have Linux driver…