

LIGHT BUCKET ASTRONOMY

Research Programs and Technology
Development

Russ Genet and Bruce Holenstein

2010-2011 Alt-Az Initiative Hawaii
Conference on Light Bucket
Astronomy



Agenda

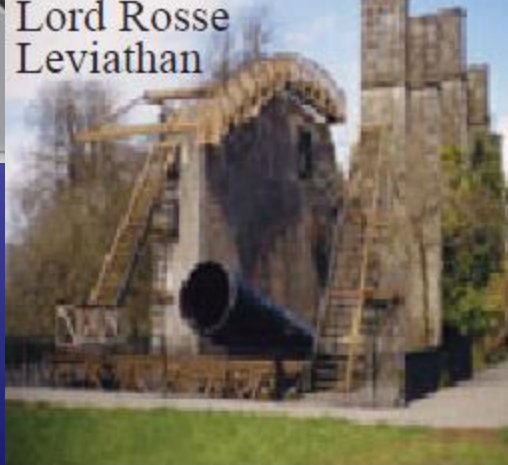
- ◆ Conference Welcome
 - ◆ Alt-Az Initiative Introduction
- ◆ What is Light Bucket Astronomy?
- ◆ Research Programs
- ◆ Technology Development
 - ◆ Meter-Class Mirrors
 - ◆ Mounts, Cells, and Controllers
 - ◆ Detectors

The Alt-Az Initiative

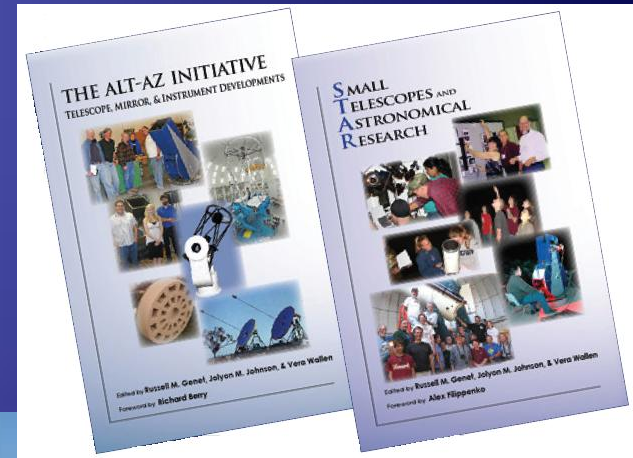
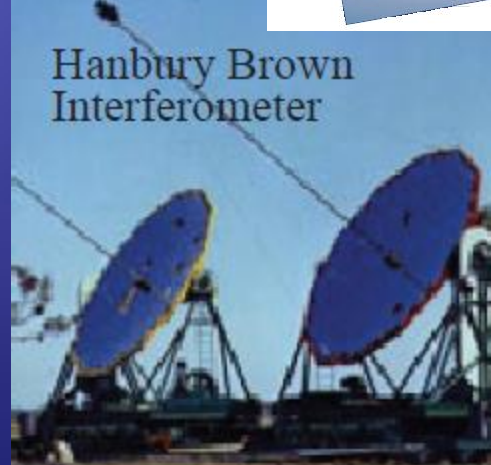
- ◆ Mirrors, Telescopes, Instruments, & Research Programs



Lord Rosse
Leviathan



Hanbury Brown
Interferometer



What is a Light Bucket?

- ◆ **Light bucket** - *A colloquial expression for a flux collector.*
- ◆ **Flux collector** - *A telescope designed solely to collect radiation in order to measure its intensity or to carry out spectral analysis. No attempt is made to form an image so a flux collector can have a more crudely figured reflective surface than a conventional telescope.*

Mitton (2001)

Light Bucket Astronomy

Regions of Excellence

- ◆ Signal-to-Noise-Ratio Advantage
 - ◆ Noise contributed by the sky background is a small or nearly negligible source of noise
 - ◆ Bright objects
 - ◆ Short integration times
 - ◆ Narrow bandwidths
 - ◆ High detector noise

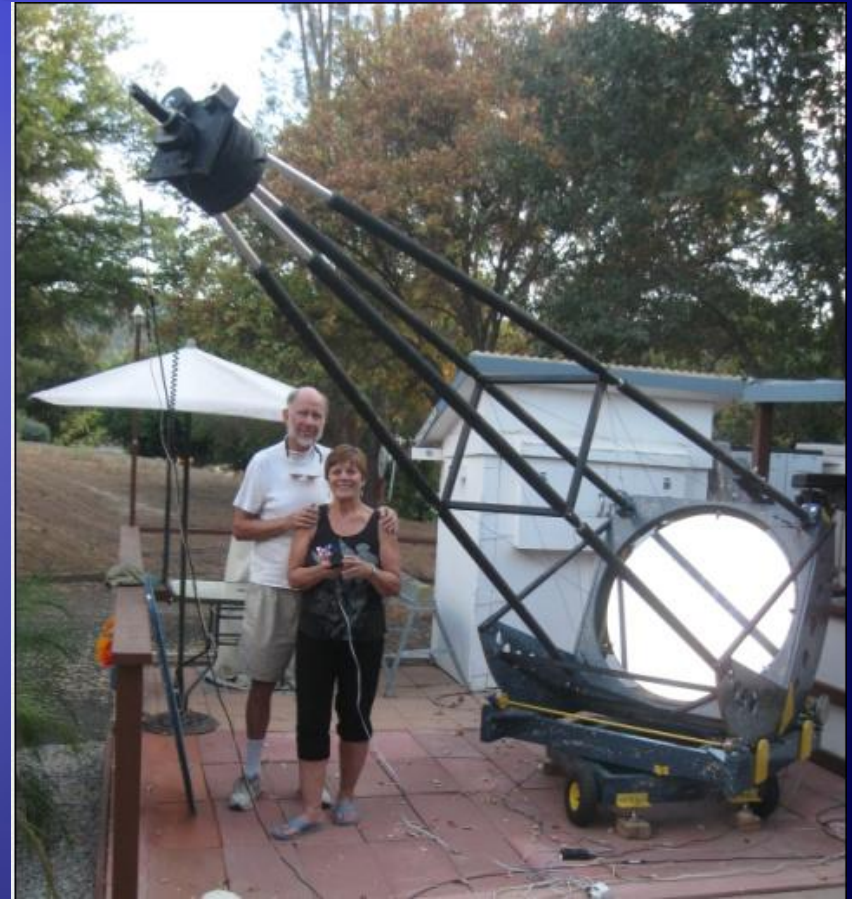
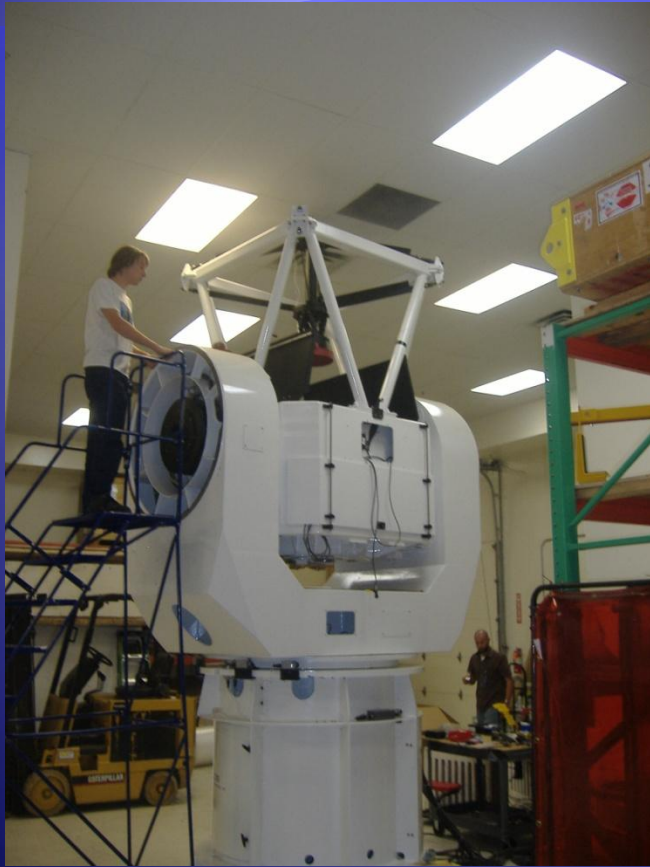
Light Bucket Astronomy Features

- ◆ Reduce cost per photon x10 to x100
 - ◆ 1-Meter portable scope for cost of C14
 - ◆ Work ~ 2.5 magnitudes fainter
 - ◆ Each magnitude fainter worked is about 300% more targets (2.5 mag. is ~30x more!)
- ◆ Portability
 - ◆ Banich Bylaw – 30 minute setup max.
- ◆ Somewhat purpose-built
 - ◆ Visual observers vs. science mission
- ◆ Light Bucket Classes

Light Bucket Astronomy Research Interests

- ◆ Occultations
- ◆ Stellar Intensity Interferometry
- ◆ High-precision & NIR photometry
- ◆ Spectroscopy
- ◆ Polarimetry
- ◆ And many other astronomical areas...

1-M Meniscus Mirror Telescope Prototype



From this \$1.8M 1-M EOS scope ... TO ... This \$20k 1-M f/4 Prototype

1-M Scope Setup



1-M Scope Portability



1-M Meniscus Mirror Mount



Different ways to transport a 1-m telescope

Slide courtesy of Howard Banich



Everything but the truss tubes stacked and rolled on wheels – Dan Bakken's 41.2 inch String Alt-Az



Fully assembled – Steve Swayze 40 inch Dobsonian with custom trailer



Everything but the truss tubes stacked as a wheel barrow - Howard Banich 28 inch alt-az



Tommy Gate lift 1000 pound lift capacity – greatly eases getting the scope in and out of a vehicle.

Banich Bylaw – Full Statement

“Banich Bylaw” – for a telescope to be enjoyably and repeatedly used it must be happily set up by no more than two people of ordinary strength and dexterity in 30 minutes or less.

Even better if only one person is needed. This “rule” has been formulated through personal experience and observing “large” amateur telescope enthusiasts since 1991.

Important note – the useful life span of the scope will be short if it takes grudging effort to set up and take down.

All attachments must be robust to stand up to repeated set up and take down, which also aids in repeatable collimation.

Moving the scope as a stacked unit as shown in the previous slide greatly streamlines the set up and take down process, keeps the optics in a safe, horizontal position during transport and reduces the set up process to leveling the base, inserting the truss tubes and attaching the secondary cage. This only takes about 20 minutes with a little practice.



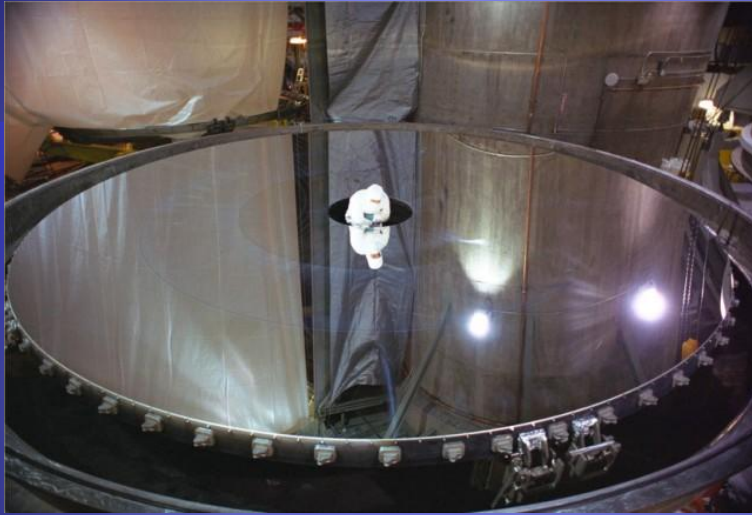
View ["howardscopeteardown_0002.wmv movie!"](#)

New Technologies

- ◆ Mirror Technologies
 - ◆ Slumped Meniscus
 - ◆ Foam Glass
 - ◆ Sandwich
 - ◆ Spin-Cast Epoxy
 - ◆ Multiple Spherical Mirrors
 - ◆ Non-Vacuum Coating
- ◆ Mounts, Cells, and Controllers
- ◆ Detectors



Slumped Meniscus Mirrors



Gemini 8-m meniscus mirror



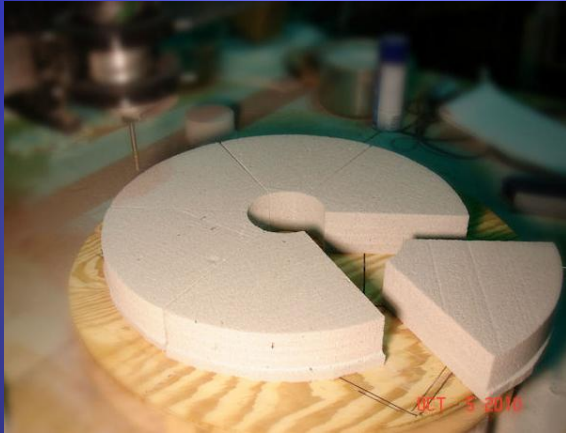
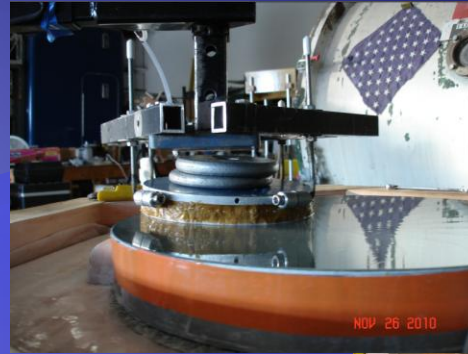
Mel Bartle's 13" soda lime slumped meniscus mirror



French ATM with 1-m meniscus mirror and astatic support system

Foam Glass

- Andrew Aurigema from OTF Designs

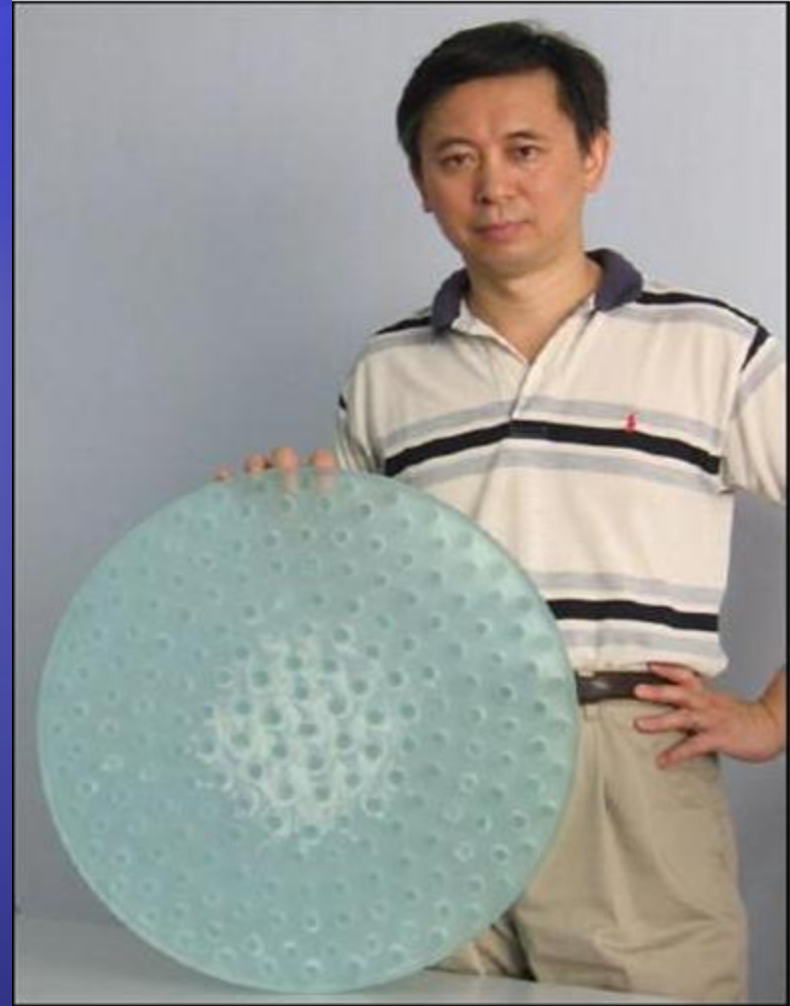


18" prototype installed in check out scope



Sandwich

- ◆ Tong Liu from Hubble Optics



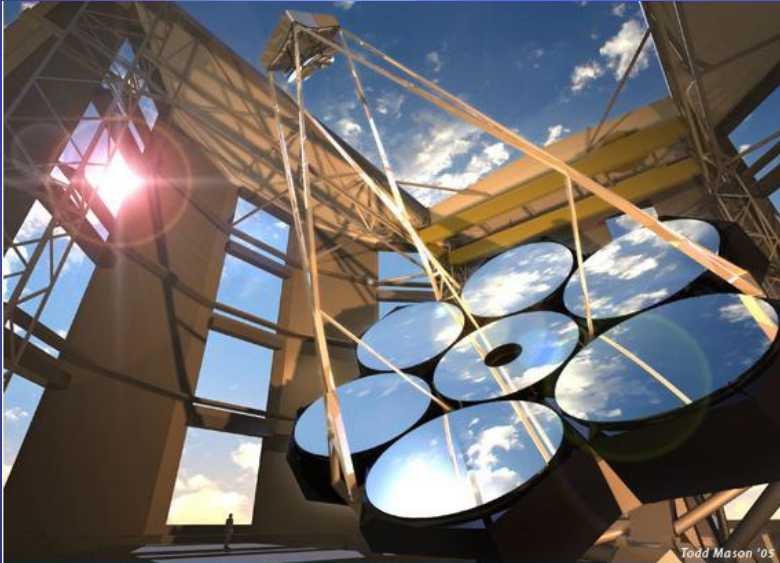
Spin-Cast Epoxy

- ◆ Lisa Broadhacker at Lander University

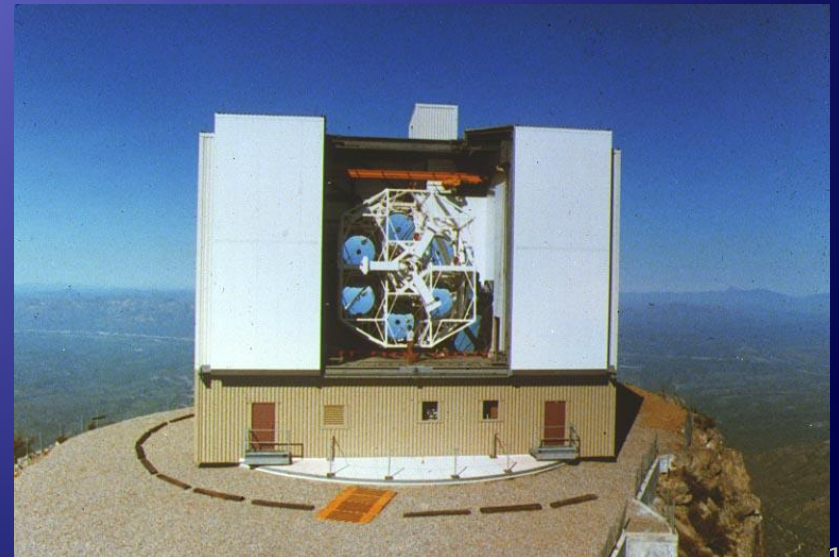
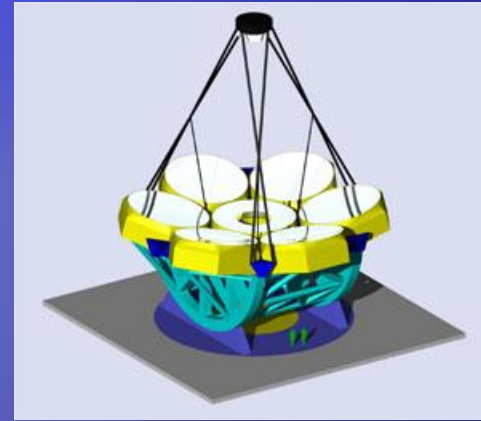


Multiple Spherical Mirrors

- ◆ Model as a “Mini” MMT or Giant Magellan



Giant Magellan Telescope Organization



Mounts and Controllers

- ◆ CalPoly 18
- ◆ Direct Drive
- ◆ Sidereal Tech Controller

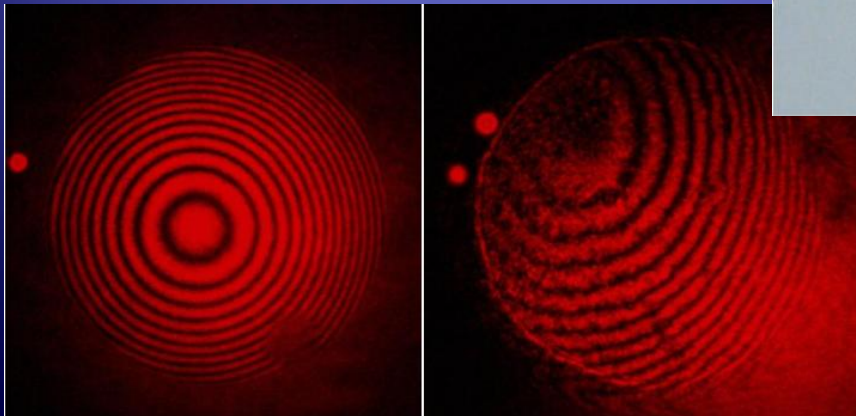


Non-Vacuum Coating

- ◆ Sagar Venkateswaran at Peacock Labs



Cold silvered, optional Permalac overcoat



Uncoated

With Permalac

Testing at Gravic Labs

Mirror Cells

- ◆ Deformable mirror cell

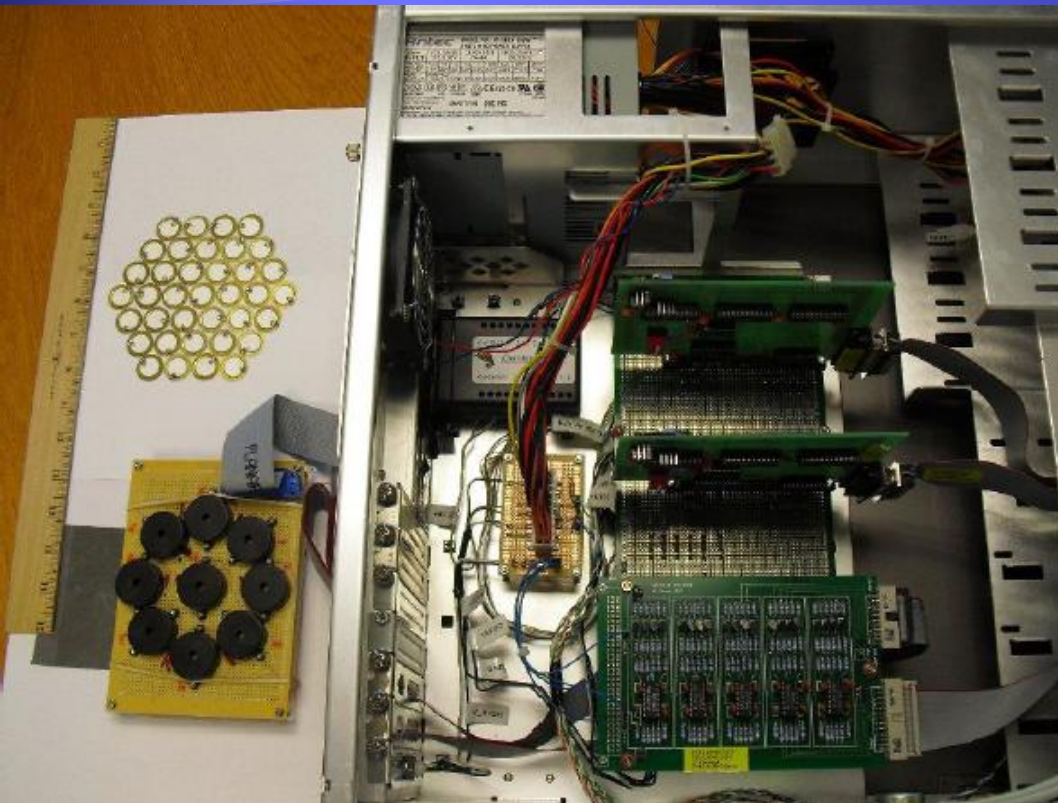


One of the 120 Gemini voice coil actuators



Mike Connelly's deformable 8" cell

Deformable Secondary Project



40-actuator high voltage controller
at Gravic Labs



Prototype piezo transducer cell:
elements deflect ± 35 microns

Detectors

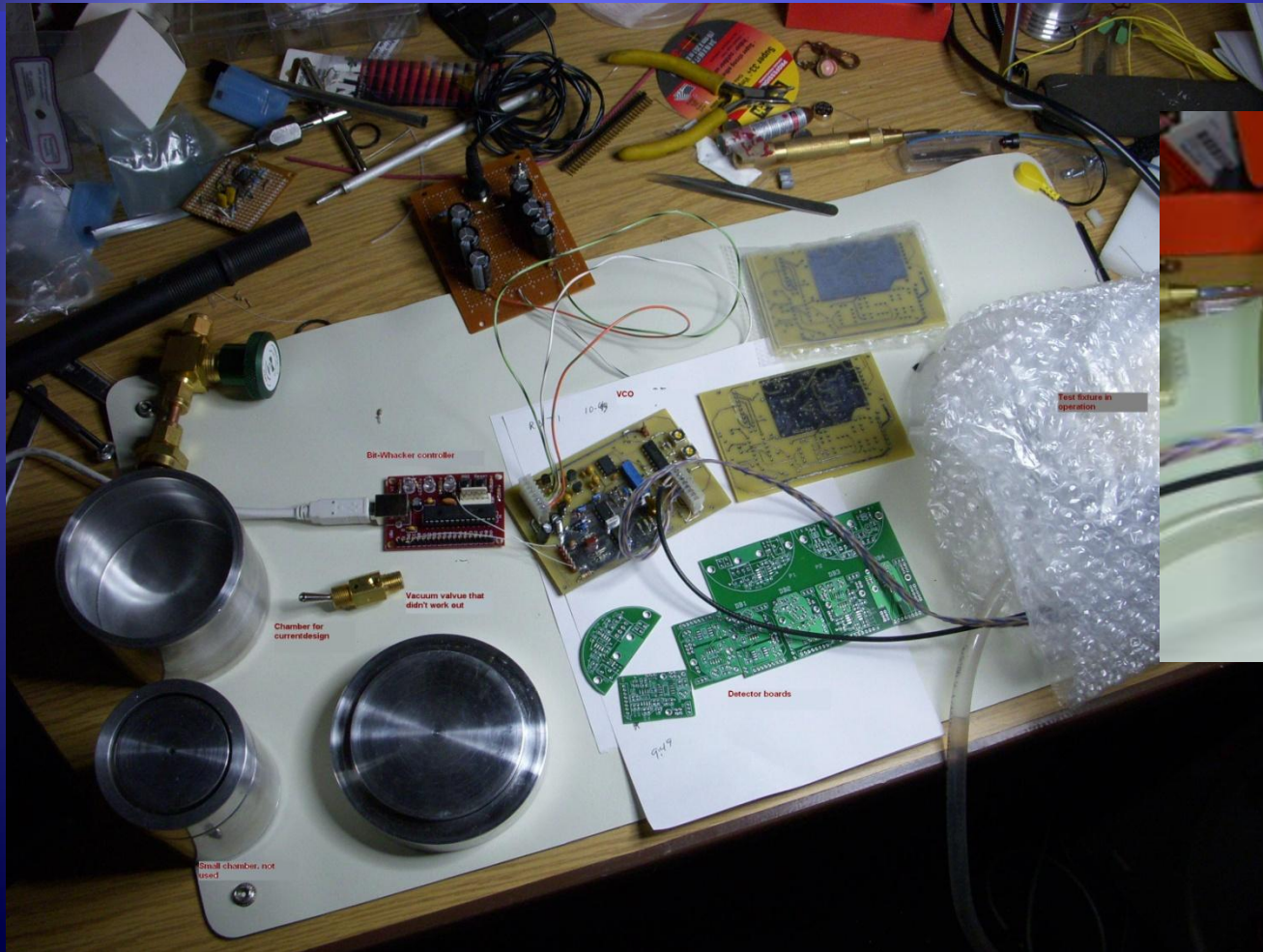
- ◆ High QE, visible and NIR (J, K & L) photometers
- ◆ Area detectors
 - ◆ CCD, emCCD evaluations
- ◆ High-speed, high gain, low noise amplifiers
- ◆ Dynamic range
 - ◆ Linearity and overload control



High-speed Si detector/trans impedance amp at Gravic

NIR Photometers

- ◆ Greg Jones NIR K'-band photometer



Parts - Bit-whacker controller, VCO, vacuum chamber, custom detector boards

Fast Cameras

- ◆ Area detectors
 - ◆ Fast CCD, CMOS, and emCCD
- ◆ Evaluation of industrial and commercial units (JAI, Andor, and others)



JAI 6470GigE



Andor LUCA-S emCCD

Frank Suites, Bruce Hostenstein,
Russ Genet collaboration

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