

Finding and Grinding a 1 Meter Mirror

(the hope, the dream and the ugly reality)

Thomas G. Kaye

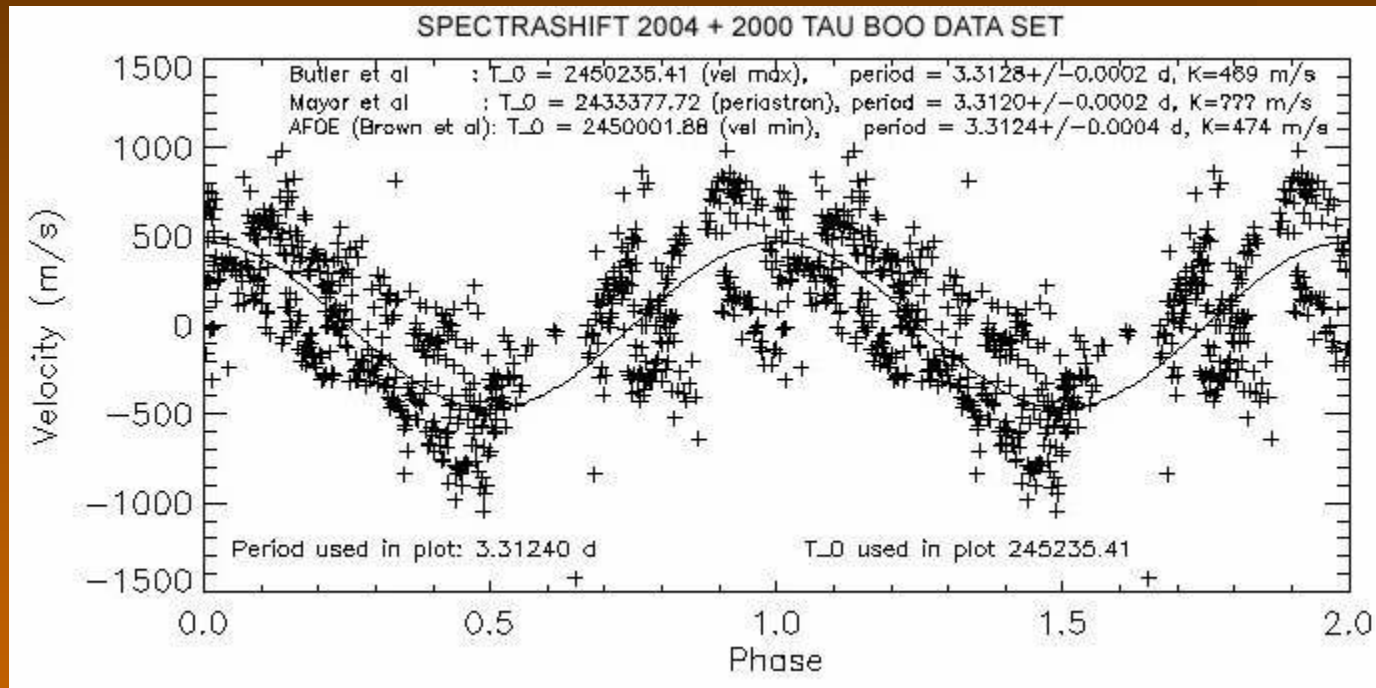
Foundation for Scientific Advancement

Spectrashift Project

The Dream



Spectrashift Project



16" Scope 4th mag.



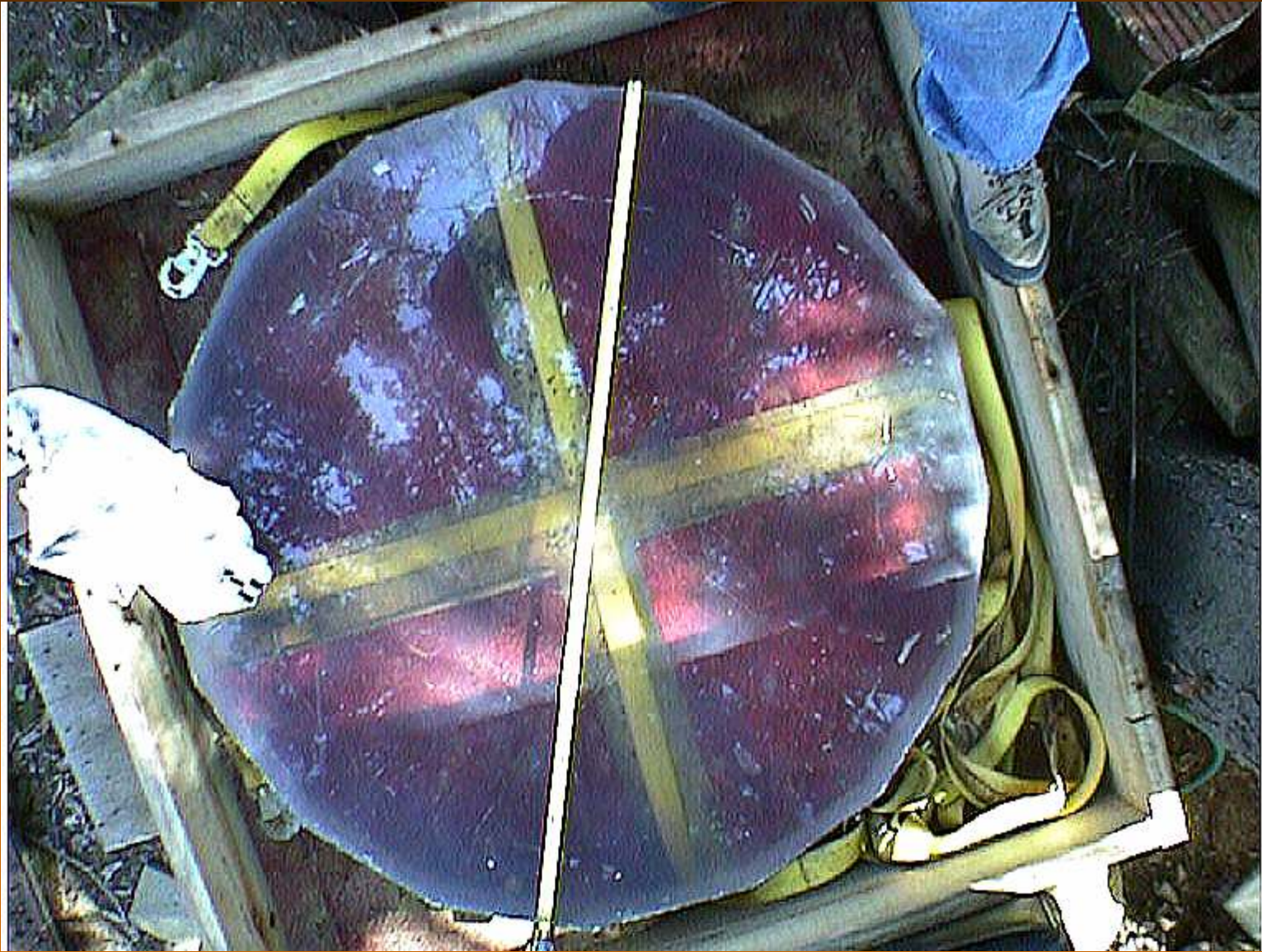
8th mag.= 1 meter scope

The hunt begins!!



Cleveland Ohio





Bubbles



Telescope Specs.

- **Corrected Dall-Kirkam**
- **Diameter = 44" or 1.1 meter**
- **Primary focal ratio = F2!!**
- **Spherical secondary 12"**
- **Final ratio = F8**

900 lbs of Glass



Ok so we have a blank....

**Now we need
a machine to grind it!**

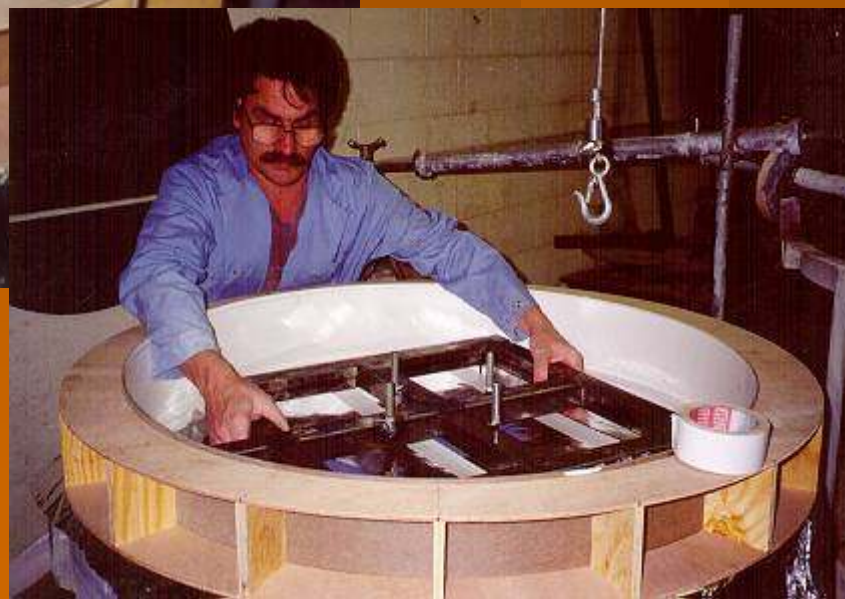
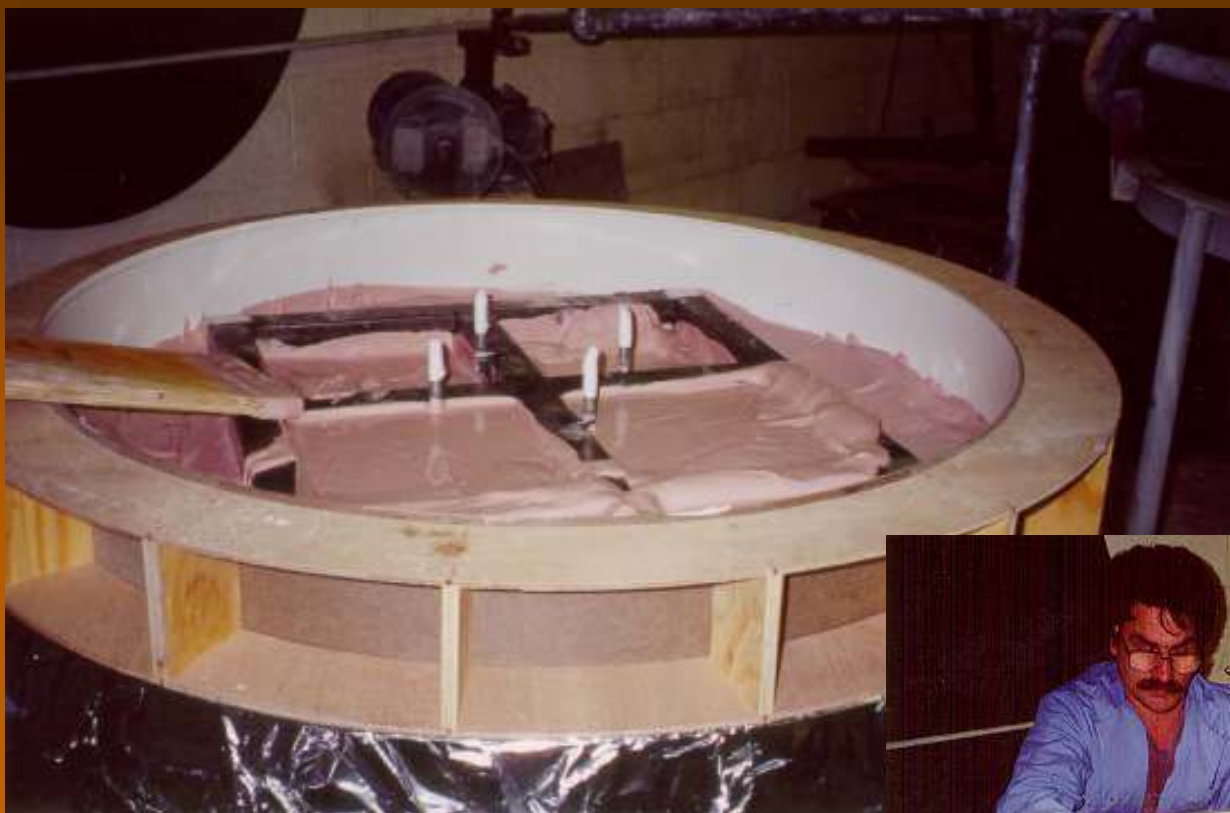
NOAO grinder



‘Jedi’ Dan Joyce



‘You have to make some laps’



Laps are heavy too!



(And they hit really hard)



Grinding Begins



How far, how fast?

200 lbs on ceramic lap

24 grit 'Black Beauty'

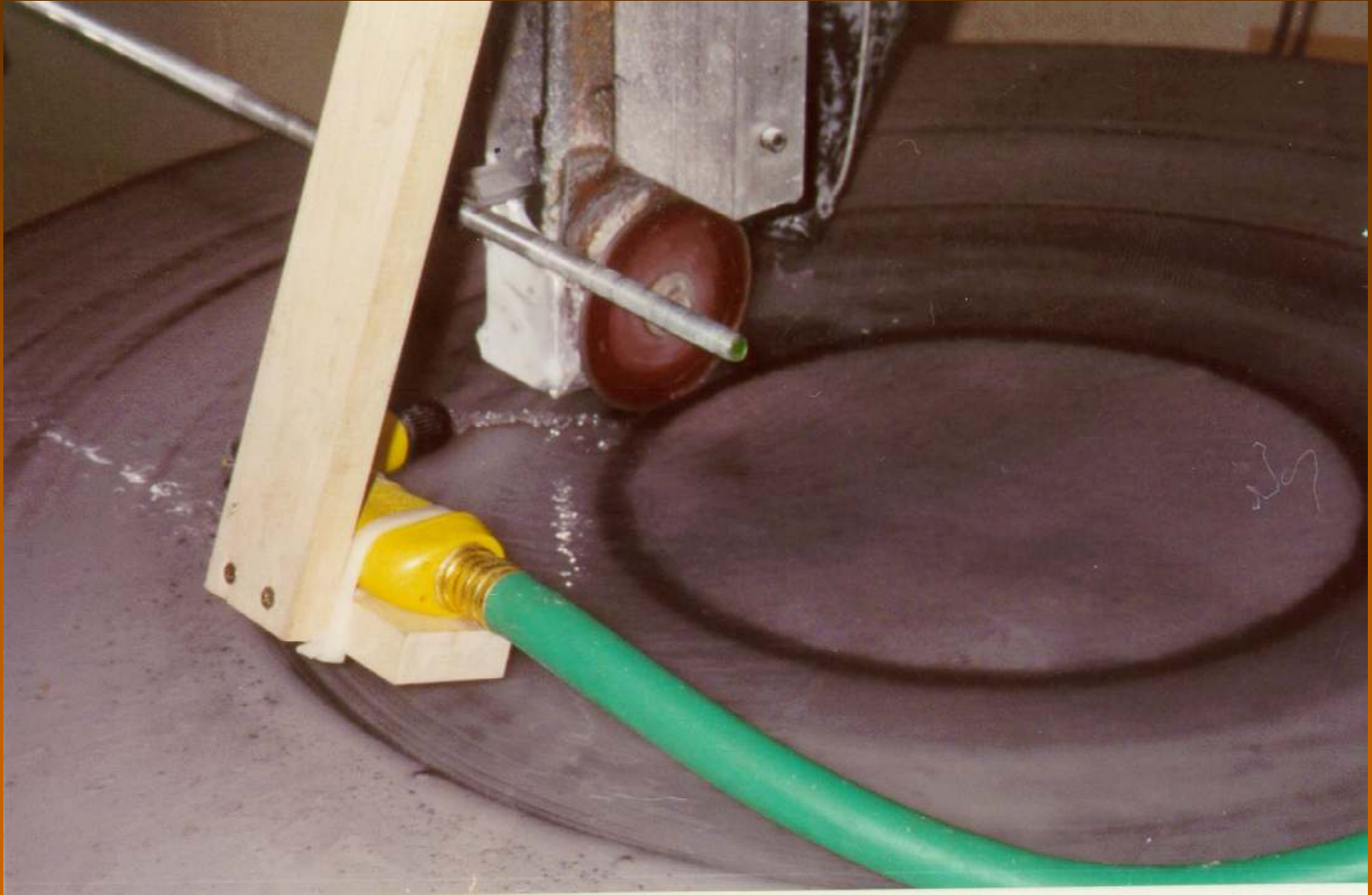
Needed to go 1" down

Roaring under the pressure..

10 YEARS!!!!

Diamond Grinding





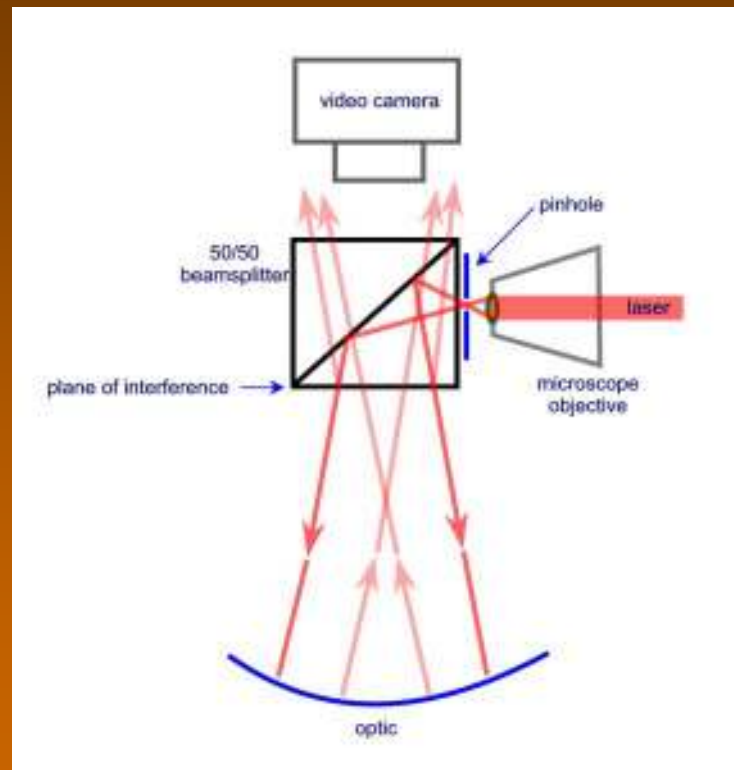
Onward to a Sphere

- Diamond ground to shape
- 24 grit to smooth out
- Looking like a sphere
- How do you measure it??

Mirror Measuring

- Focault, easy setup, hard to interpret
- Ronchi, flexible but hard to be precise
- Interferometer, best but expensive
- Lets build an interferometer!!

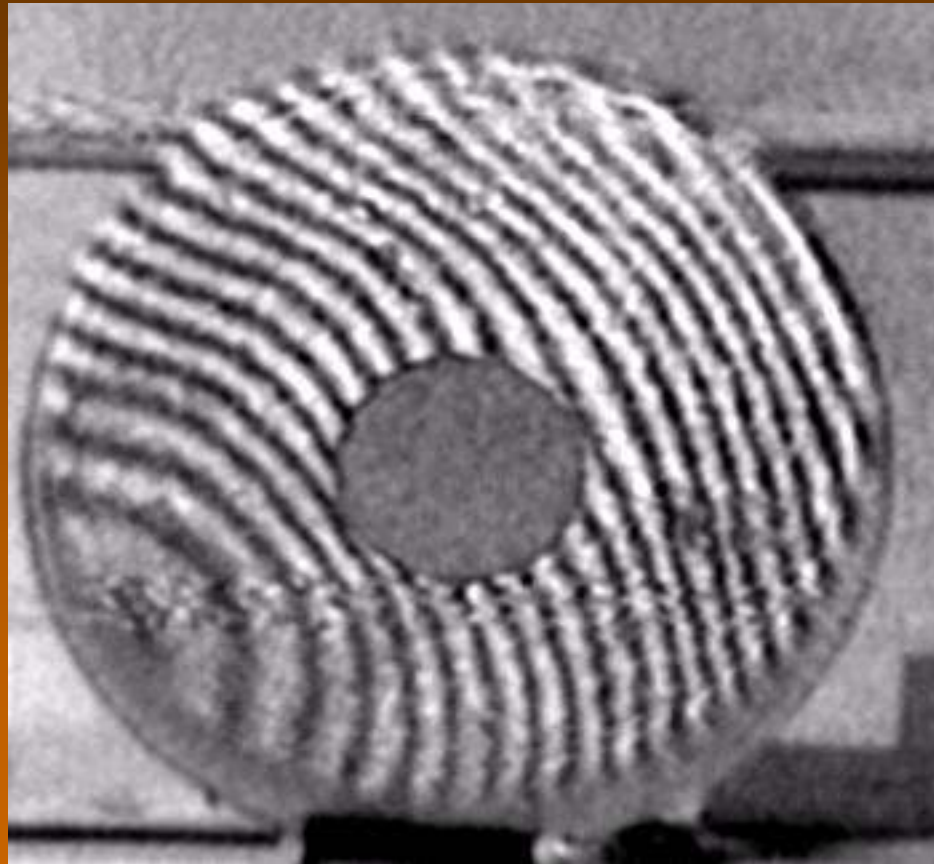
Shack Palmer Interferometer





First Edition Interferometer

Worked Pretty Good!



Interferometer when we were done

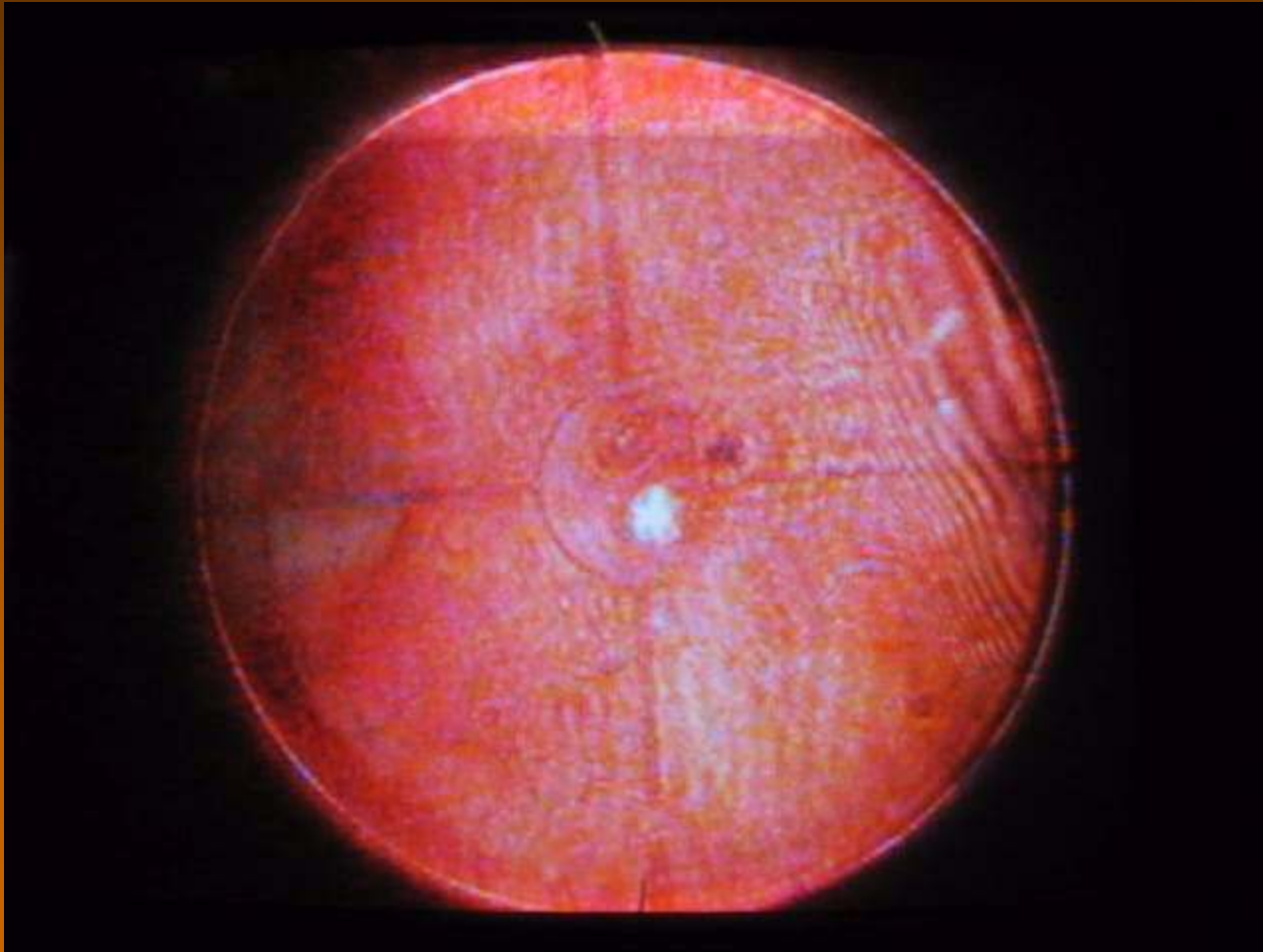


- Motion controlled Z axis
- Remote control box
- XY axis control
- Motorized polarizer
- Video focus position
- White light focus
- Swing in Ronchi grating
- Null lens optics
- 11 different position adjustments

Small problem....



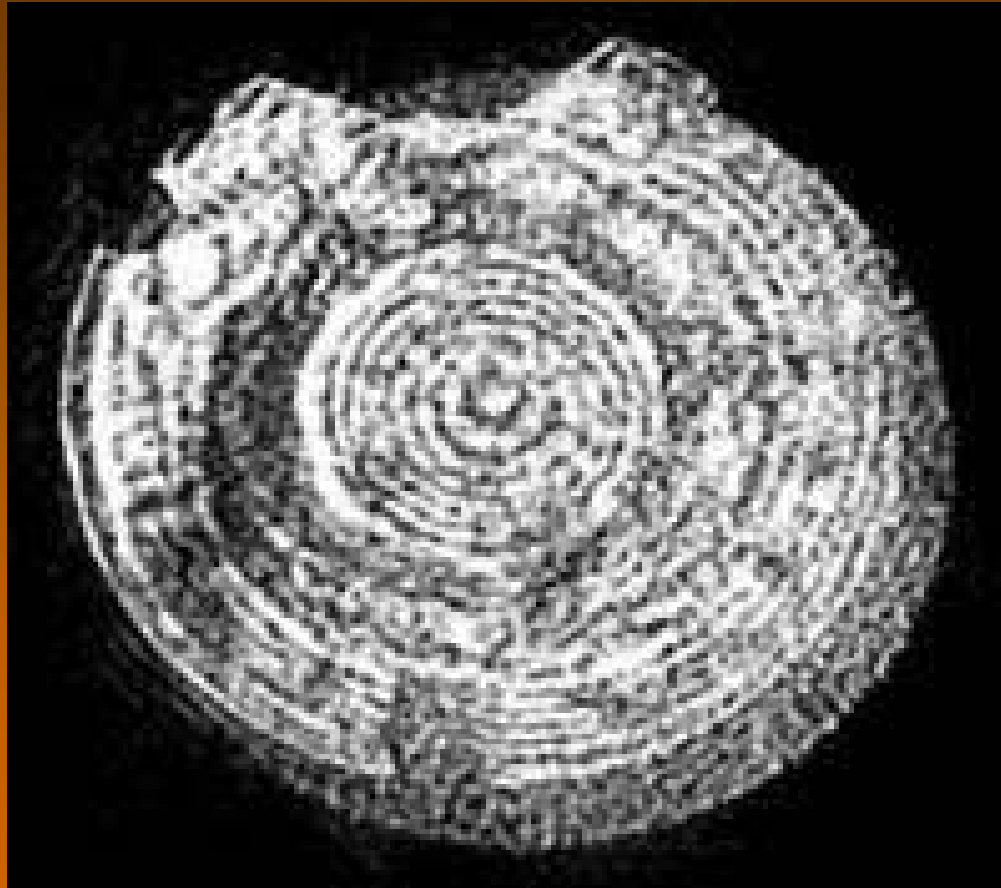
Vibration



Next step polishing!



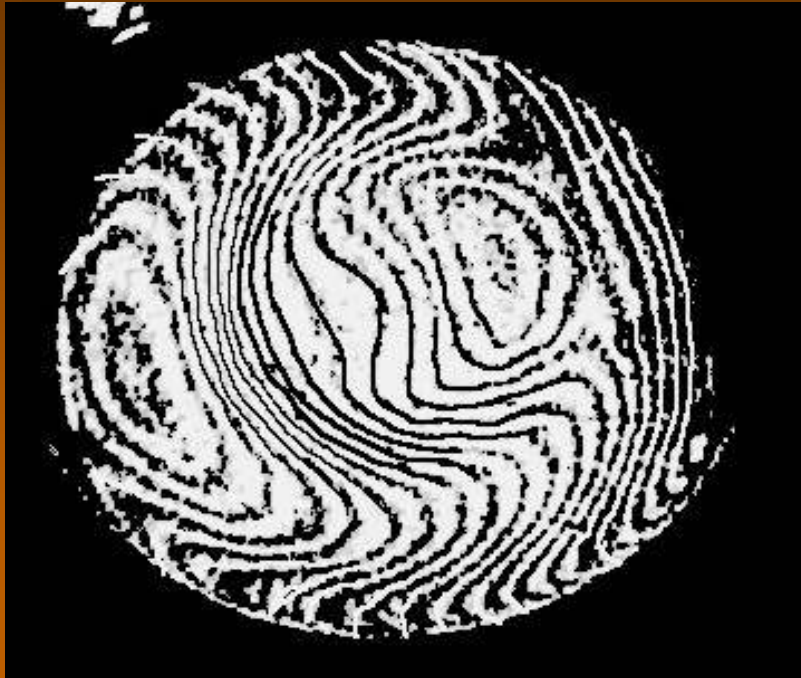
**The fringe pattern that
wouldn't go away...**



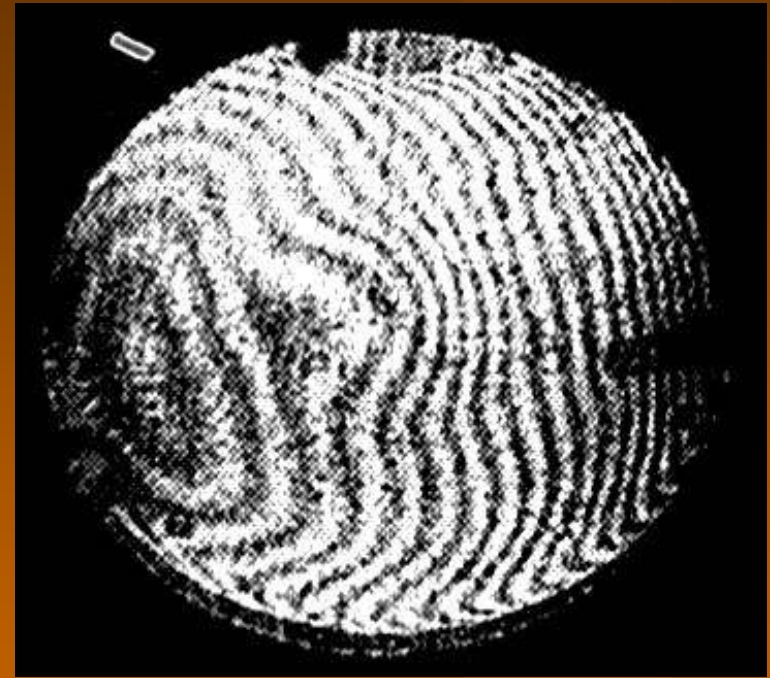
Summer Break



2002



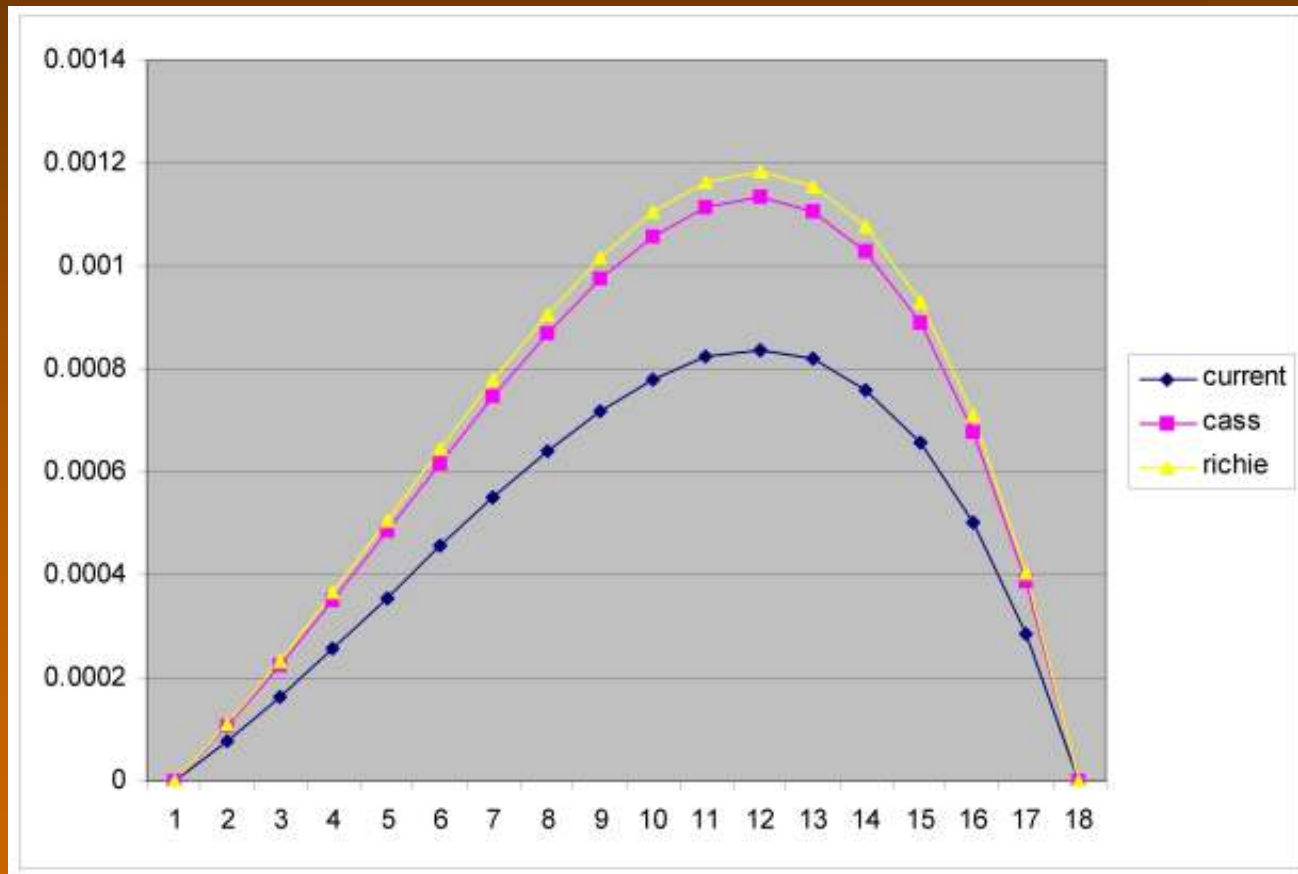
June



July

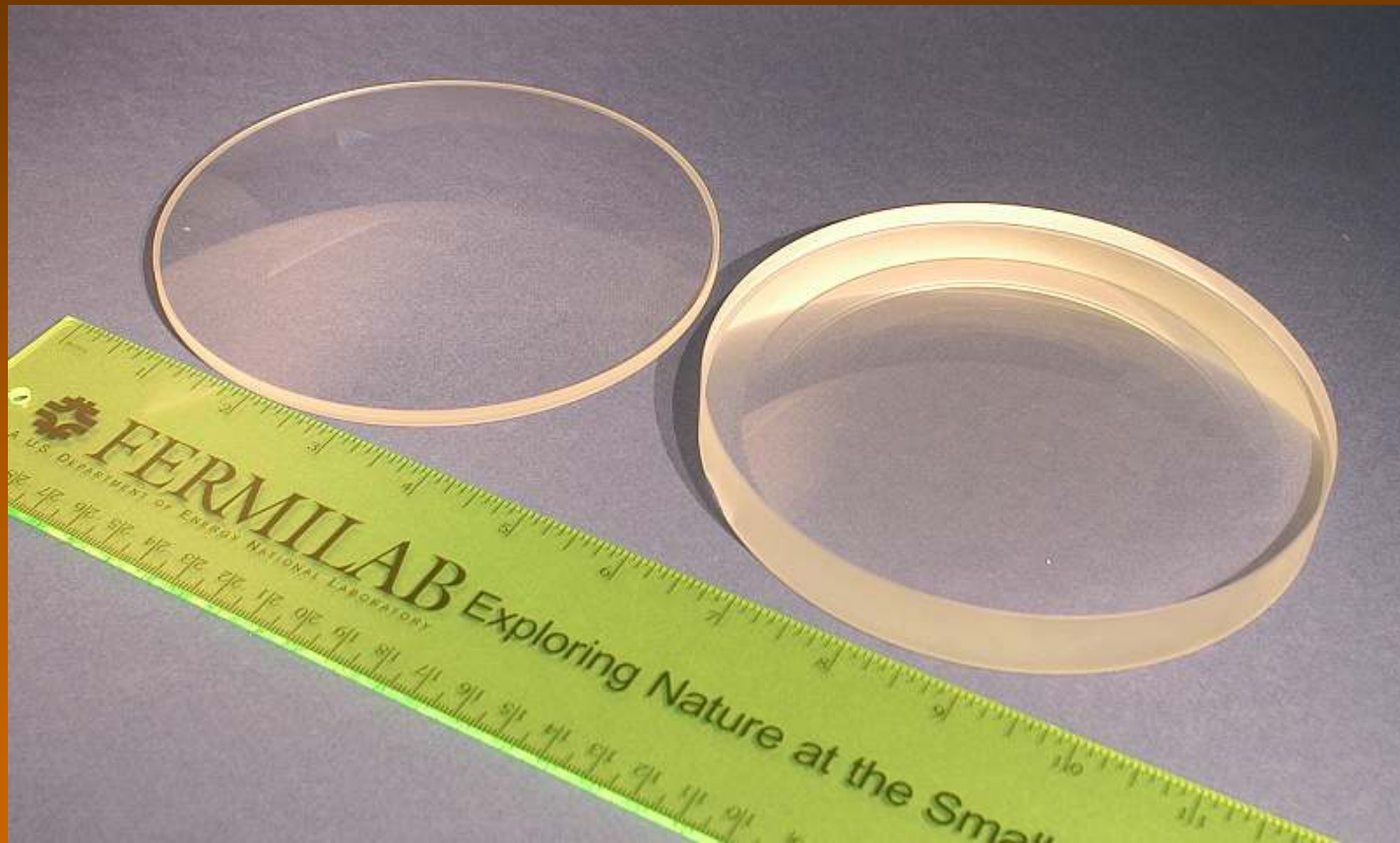
Fast forward 5 years

Figure the Mirror!



Null Lenses

(where Hubble went wrong)



Lots of Waves

Material to be removed=.001 inch approx.

.001= 25,400 nanometers

Laser wavelength= 623nm

$25,400 / 632 =$

40 waves of material!!

Star Lap for center



Edge Lap = Trouble!



First Attempt = Failure

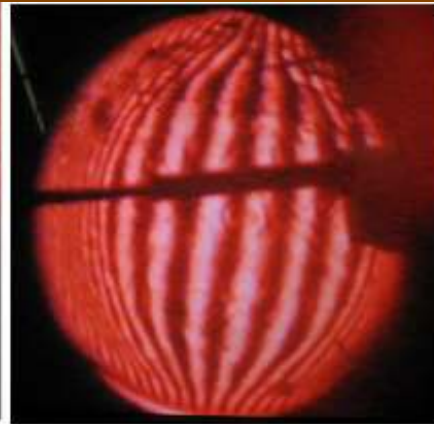
Back to a sphere



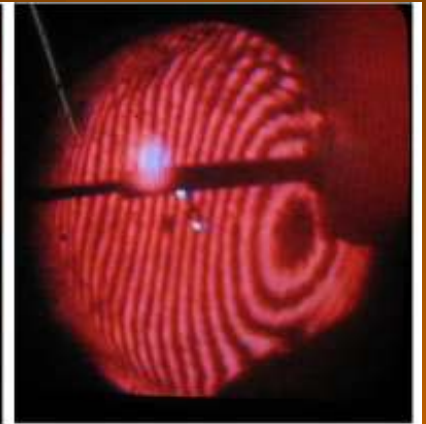
Start



center worked

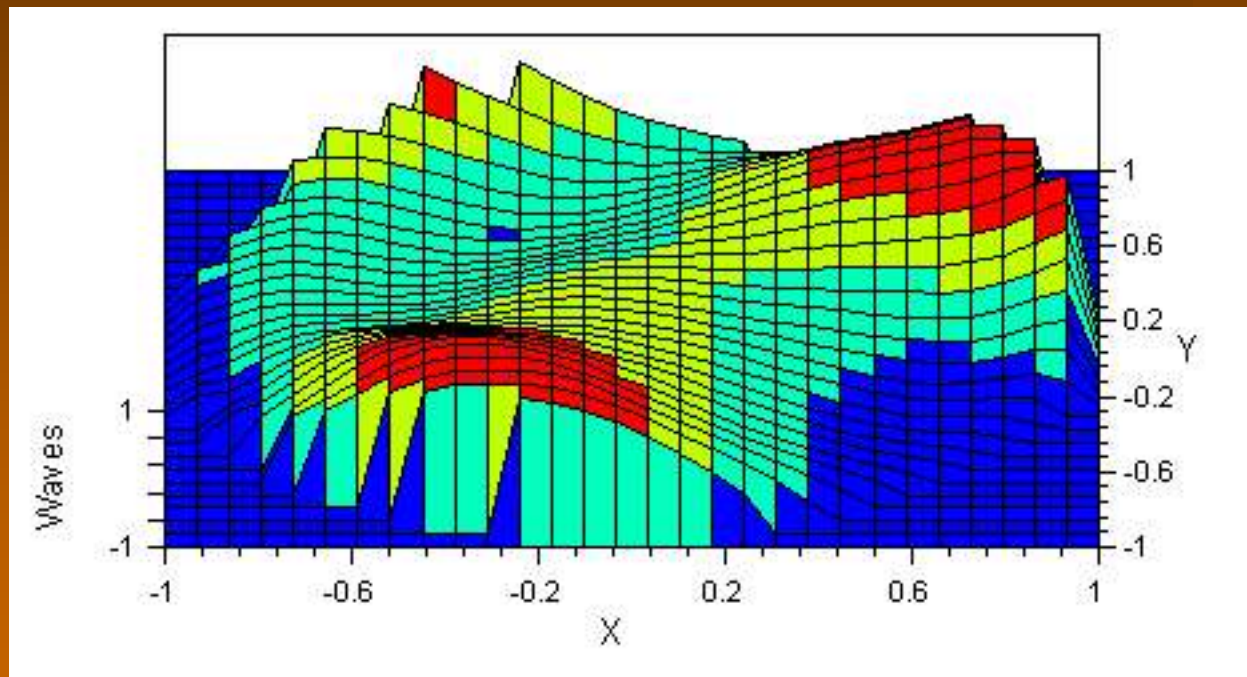


edge worked



w/nulls in

Figure Attempt #2 = Failure



Back to a sphere....

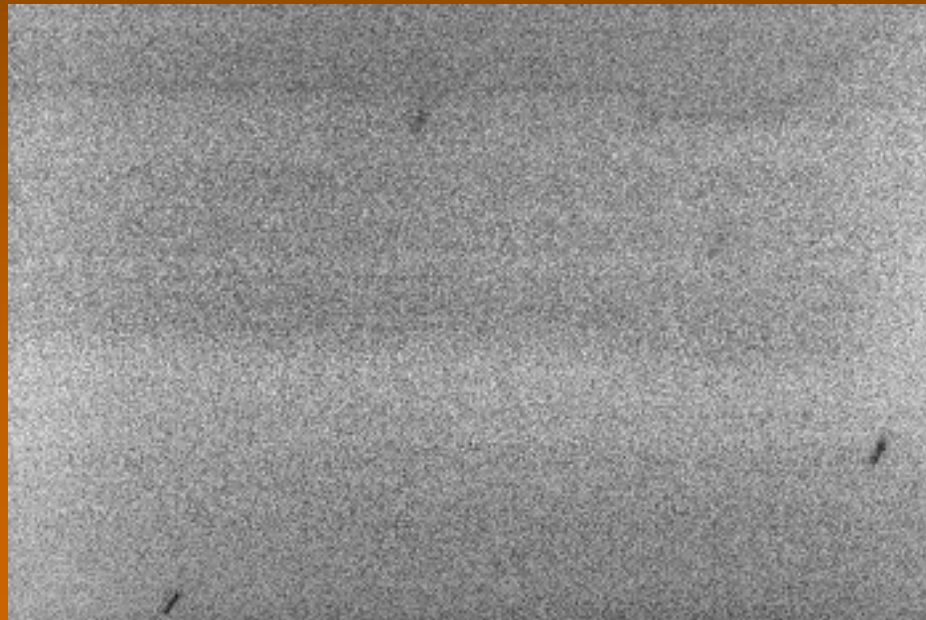
Figure Attempt #3???

Out of time

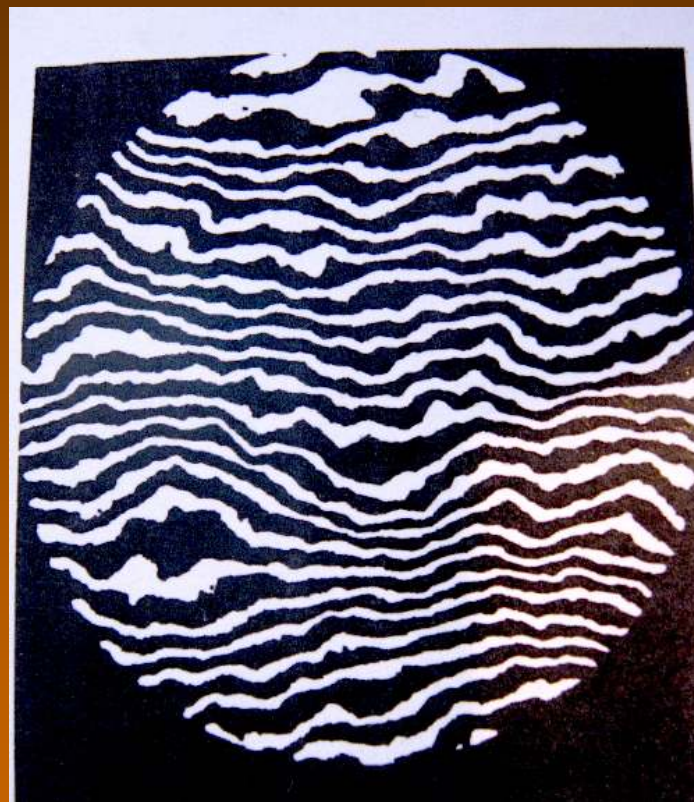
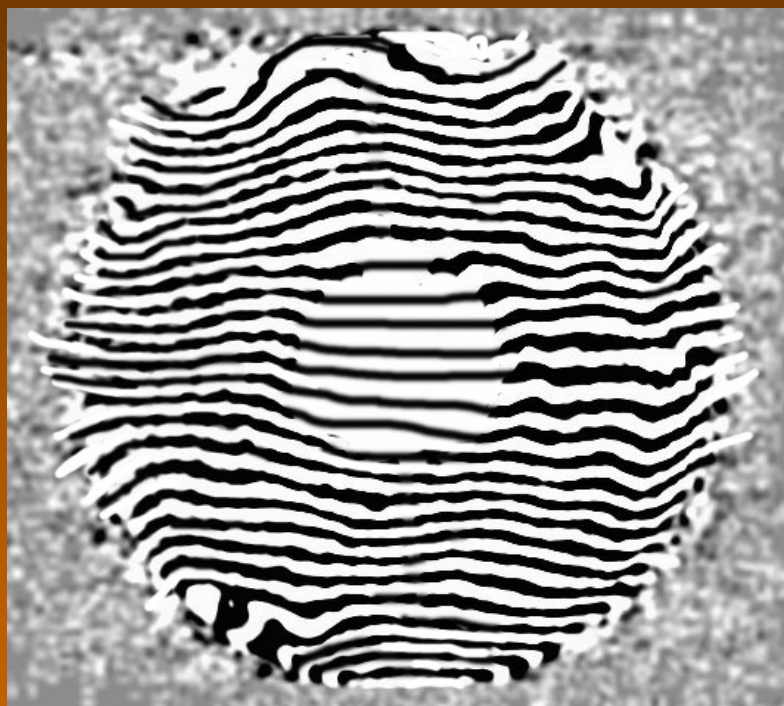
- **Mirror leveled to .015 thousandths**
- **Nine point mount added**
- **Randomized every 10 minutes**
- **Computer control added to grinder**
- **Hand polished the high spots.**

Where its at

- Mirror is $\frac{1}{2}$ wave RMS at CCD
- $\frac{1}{4}$ wave at the mirror surface.
- Star trails at prime focus ok



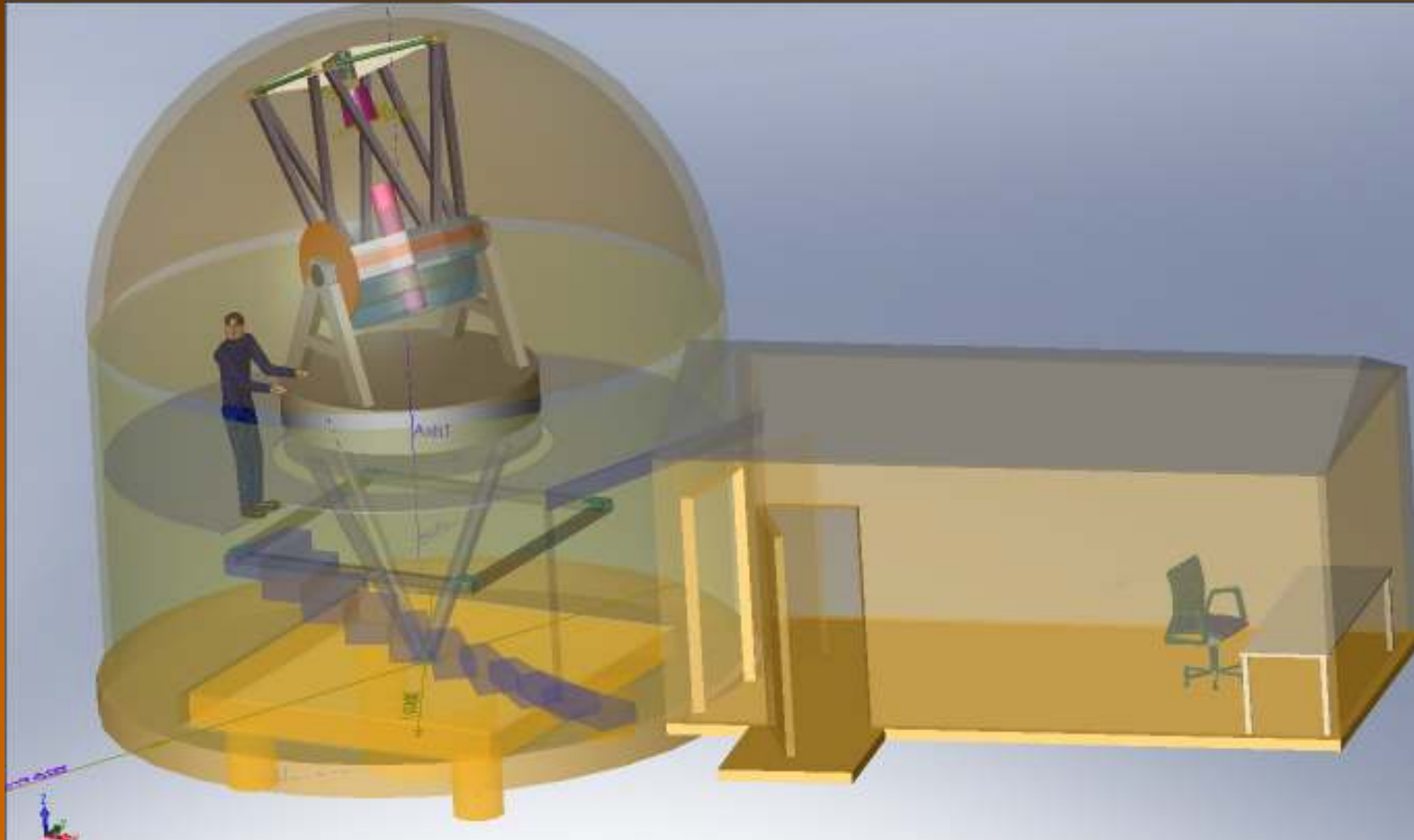
The good news



Rest of the Optics



Raemor Vista Observatory



Hope Springs Eternal!



What we learned after 8 years of effort

- **Pick the mirror you want**
- **Get a part time job at McDonalds**
- **Save your money**
- **BUY A FINISHED MIRROR!**
- **Alternatively, be satisfied with the scope you have**