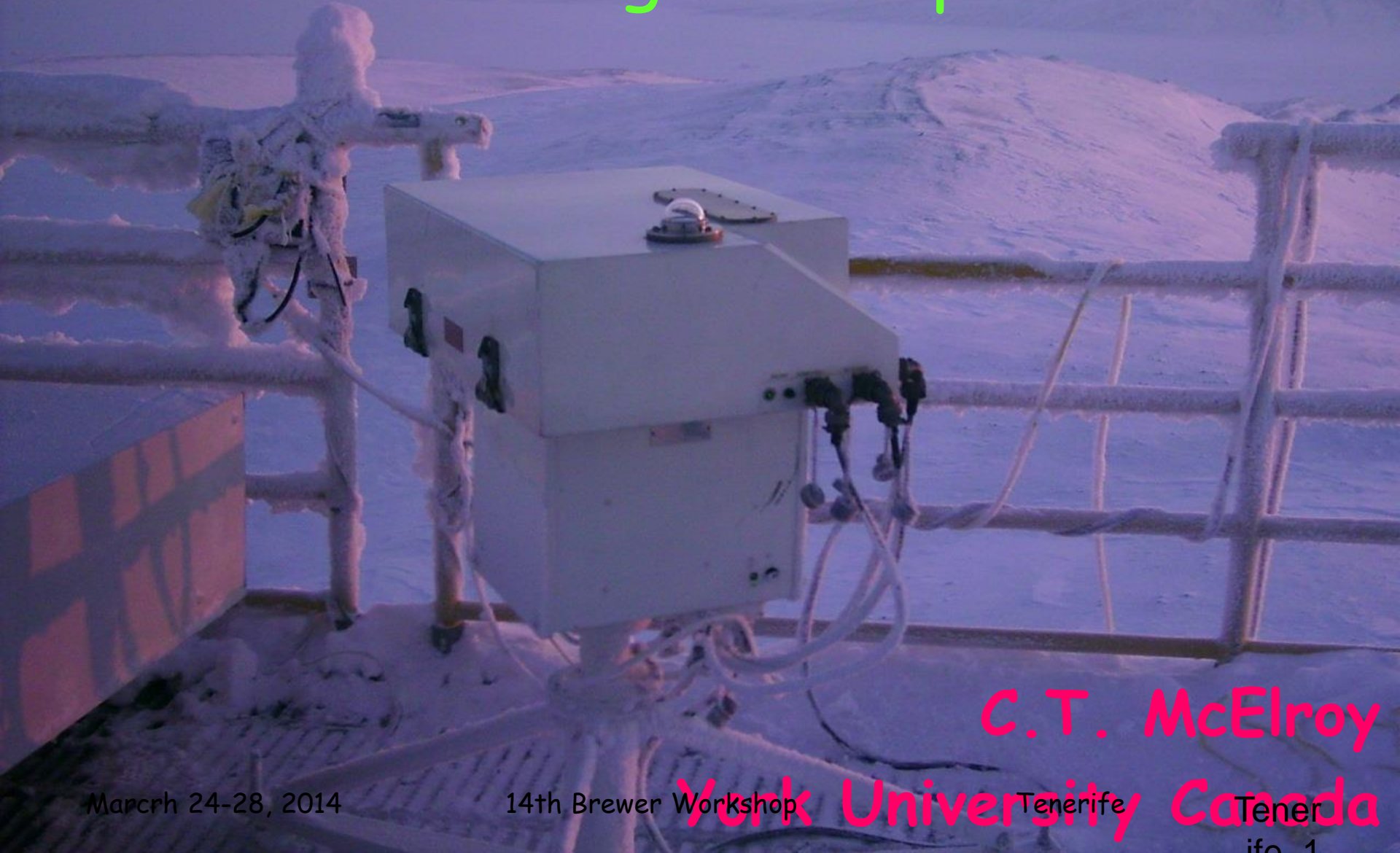


Brewer Ozone Spectrophotometer Mechanical Design Principles #1



C.T. McElroy

March 24-28, 2014

14th Brewer Workshop

York University

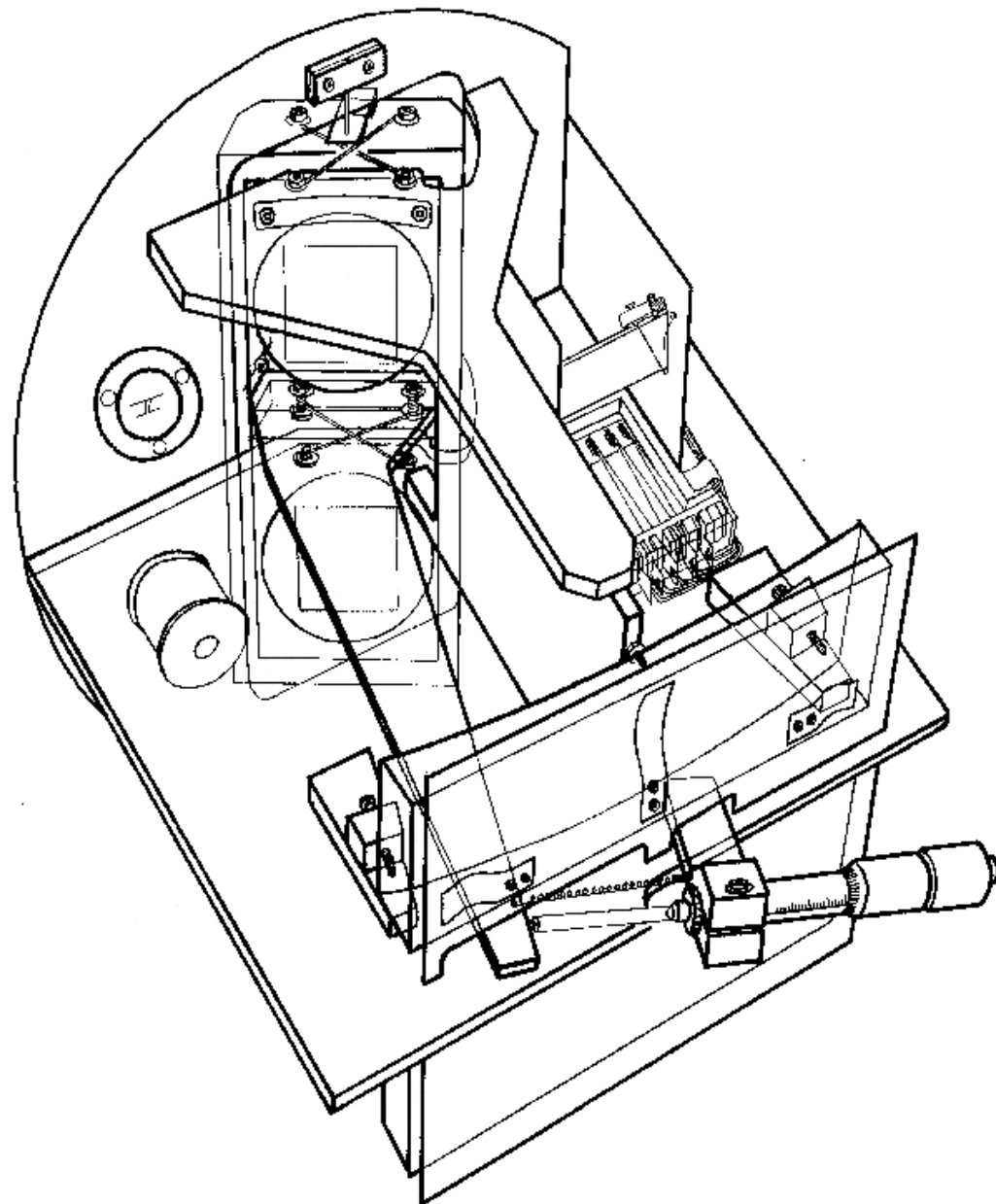
Tenerife

Tenerife

ifo_1

Wardle Double Spectrometer

c.a. 1965



Basic Principles

- Careful, detailed optical design
- Optical and mechanical mounts are kinematic
- Loads are carried in tension or compression
 - Not bending
- Clear understanding of system integration
- Temperature compensation when needed

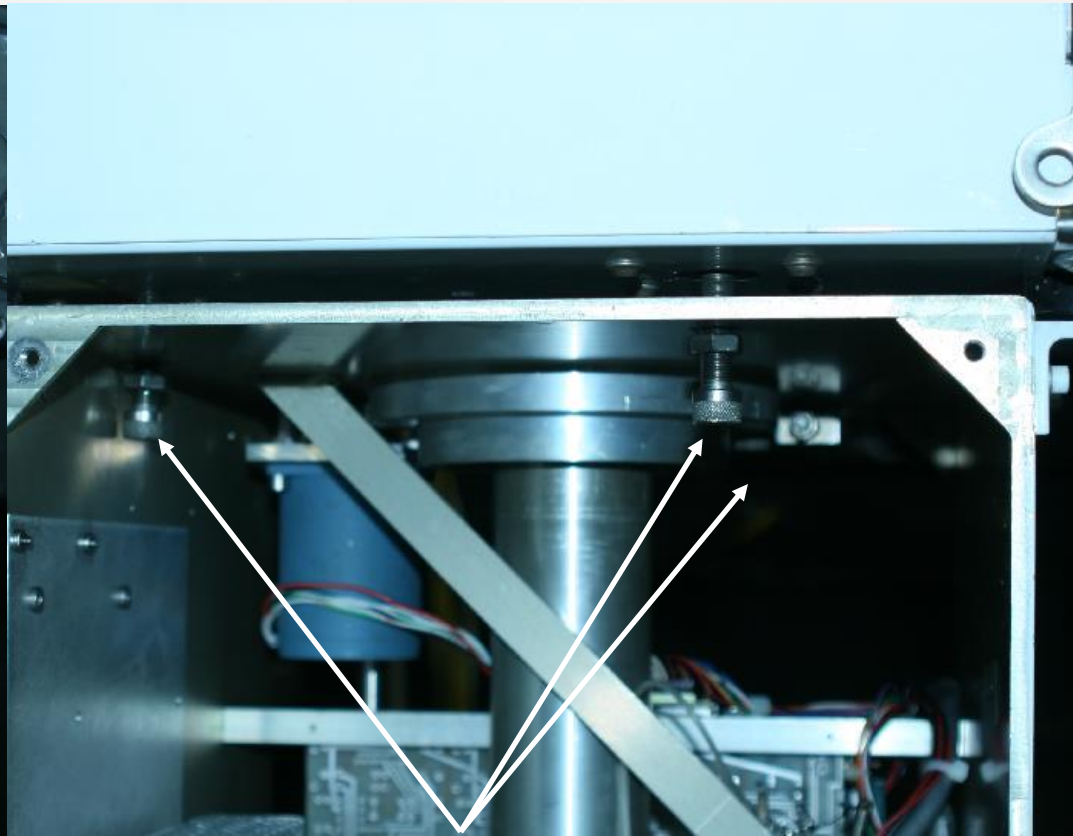
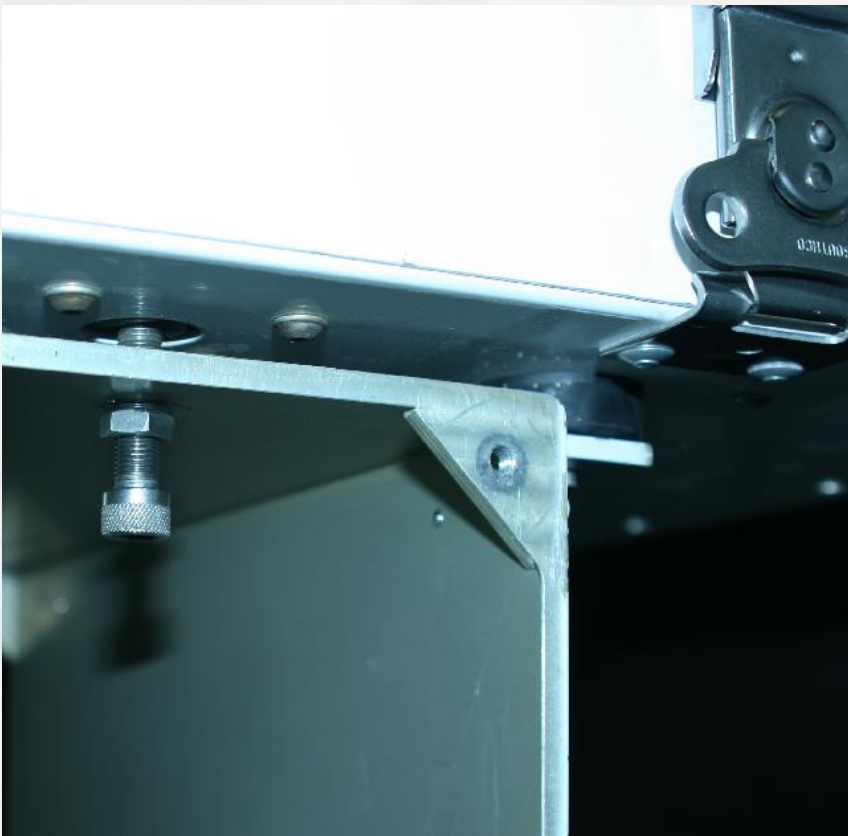
“Other instruments are climate controlled and still don't have good wavelength stability. The Brewer operates at a wide range of ambient temperatures and has good wavelength stability. Why is that?”

– Brian Gardiner

Kinematic Design

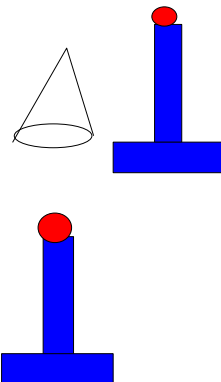
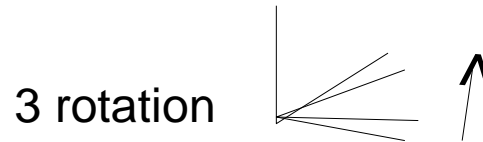
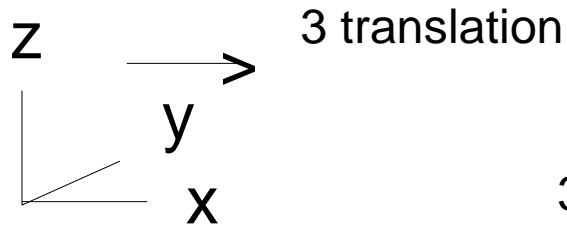
- A solid body has 6 degrees of freedom
- 3 translation degrees
- 3 rotation
- Proper design constrains, but does not over constrain these degrees of freedom
- Over-constraint causes stress and leads to temperature-induced instability and failure

Tracker Screws



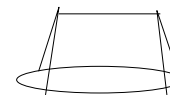
Three instrument levelling screws

Degrees of Freedom



1 rotation

3 translation
0 rotation



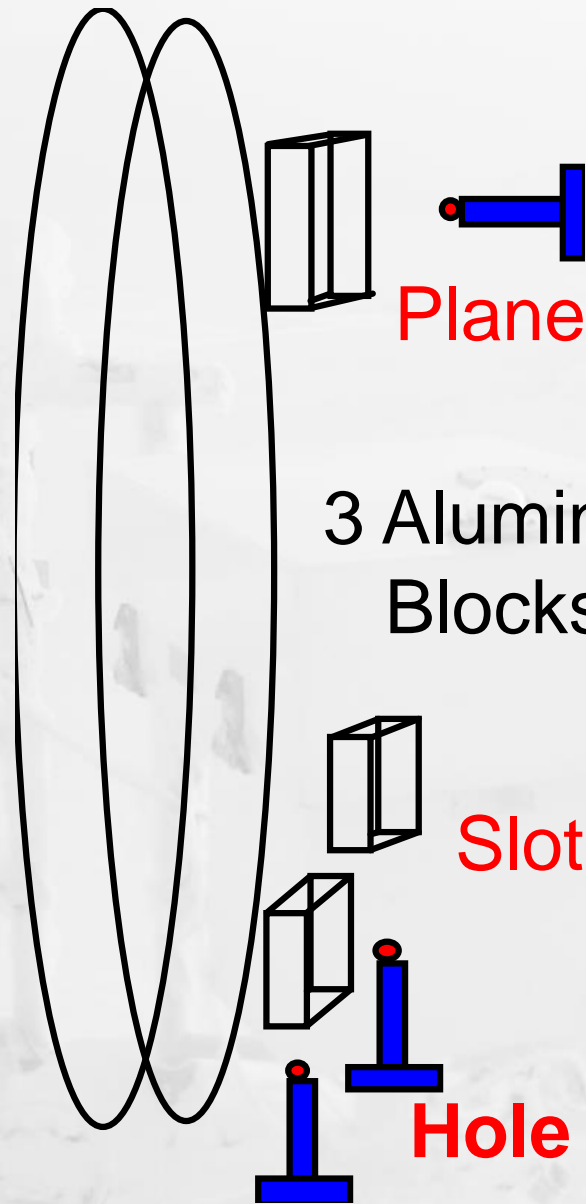
2 rotation



Diffraction Grating Mount

Brewer Example

Diffraction Grating



3 Aluminum Blocks

Springs load all three

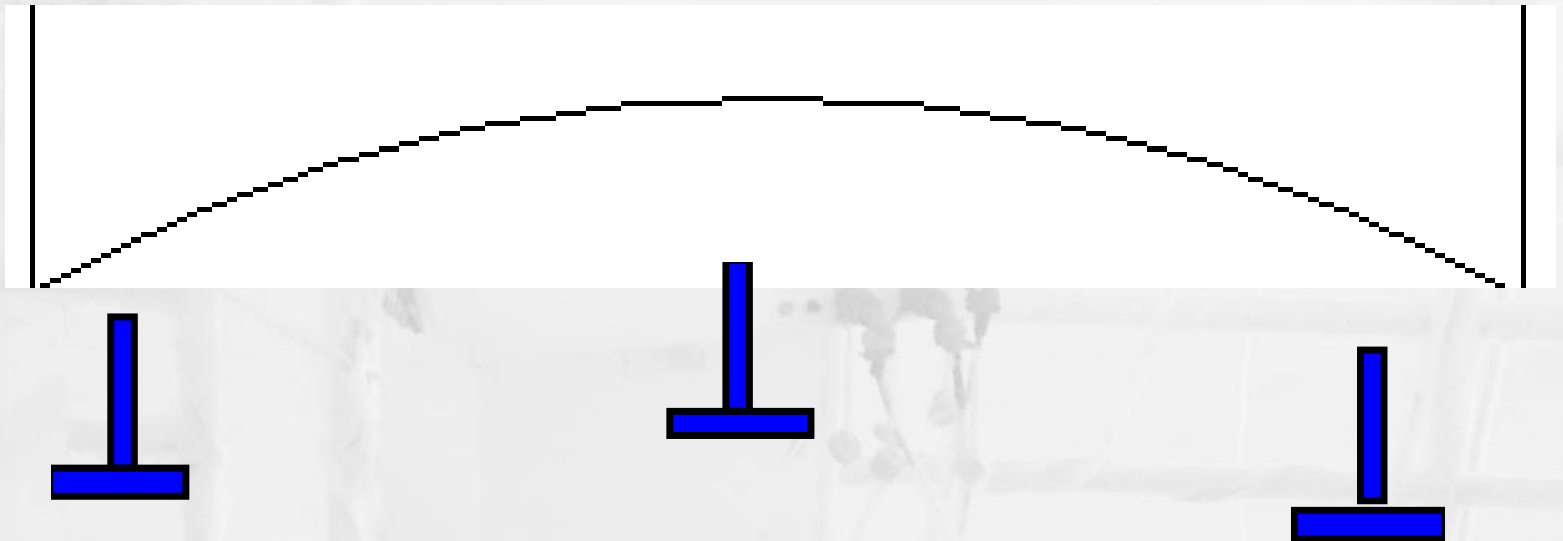
Mirror Mount

Springs behind

Adjusting screws

Mirror

Springs seat the mirror against the ball-head screws...



Three points define a sphere in space
The springs should provide several Gs loading.

Practical Stuff

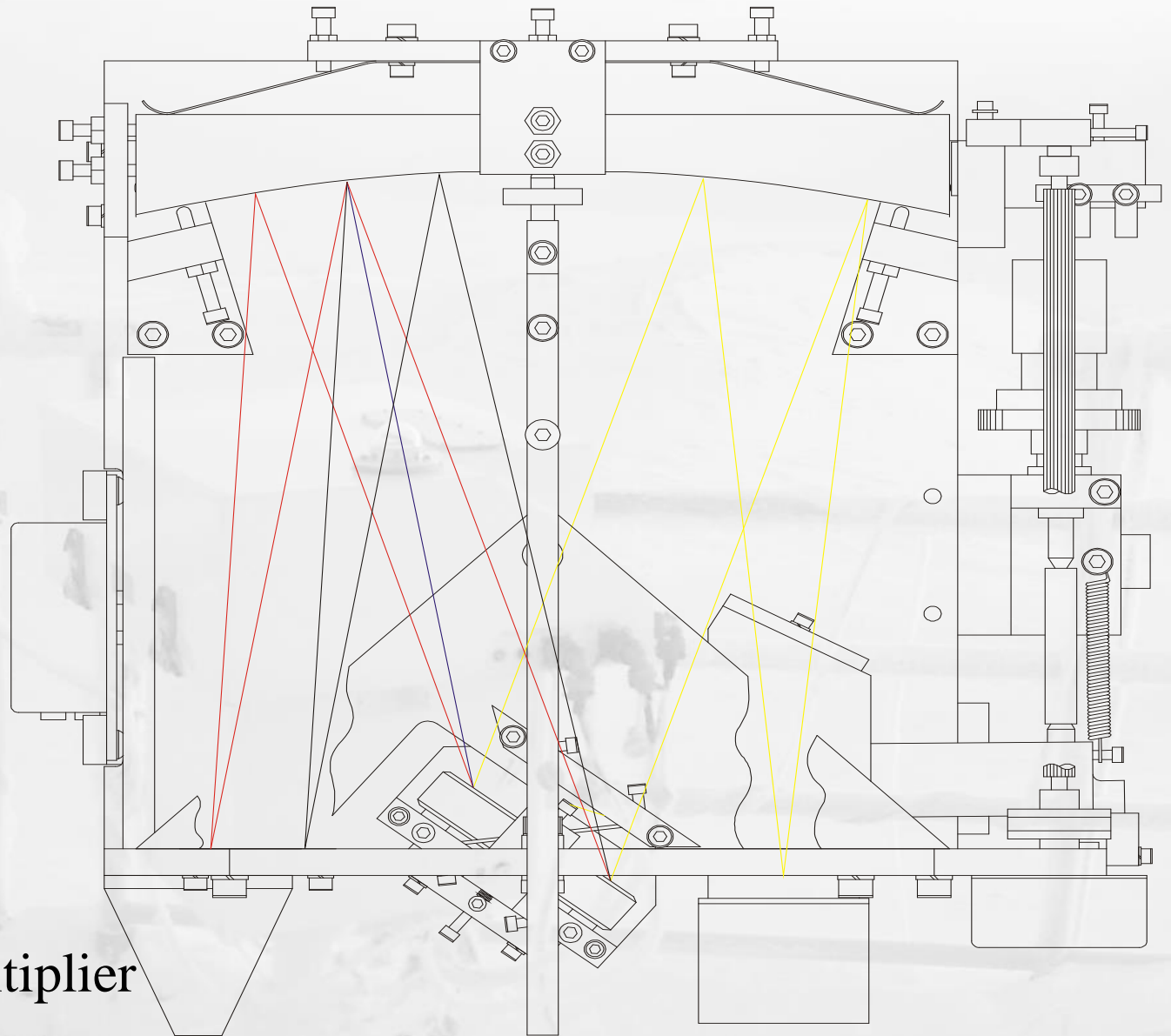
- When handling optics:
 - Don't touch with your hands!
 - Think about what you are about to do before you do it to minimize the chance of damage
 - Wear gloves (polyethylene, latex or cotton)
 - Don't wash front surface optics!
(they LOOK much worse than they are and they will BE much worse after they washed.)

Stability

- Wavelength stability
 - Position and rotation of correction lens
 - Rotation of main mirror
 - Grating orientation
- Intensity & relative intensity
 - Vertical alignment of spectral image
 - Order filters

Brewer Optics

To
Photomultiplier
Housing



Entrance Slit

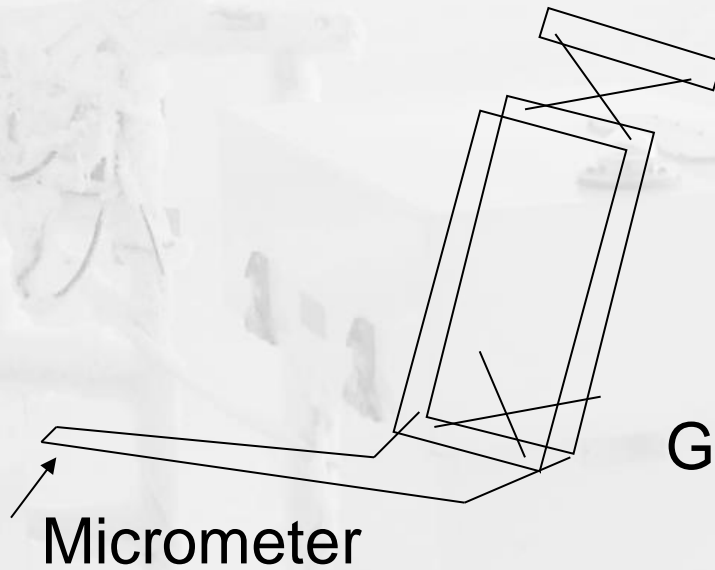
2 PL

Crossed-spring Bearing

Vertical torsion member

Upper set of
crossed-springs

Accurate Wavelengths...



Crossed Spring
'Bearing'
Is a Frictionless Hinge

Grating Mount

Arm is ~150 mm long
Micrometer can be set to 0.001 mm
Mirror focal length is ~150 mm
Setting resolution is 0.002 mm at the focal plane
Slit width is ~0.5 mm

Micrometer motor has 48 steps/rev.
6:1 gear ratio means 288 steps per micrometer revolution == 0.5 mm
1 step == 0.0034 mm on focal plane
Line positions measured to ~0.02 step

Micrometer Drive

Dispersing half

6:1 drive ratio

288 steps per
micrometer revolution

Recombining half

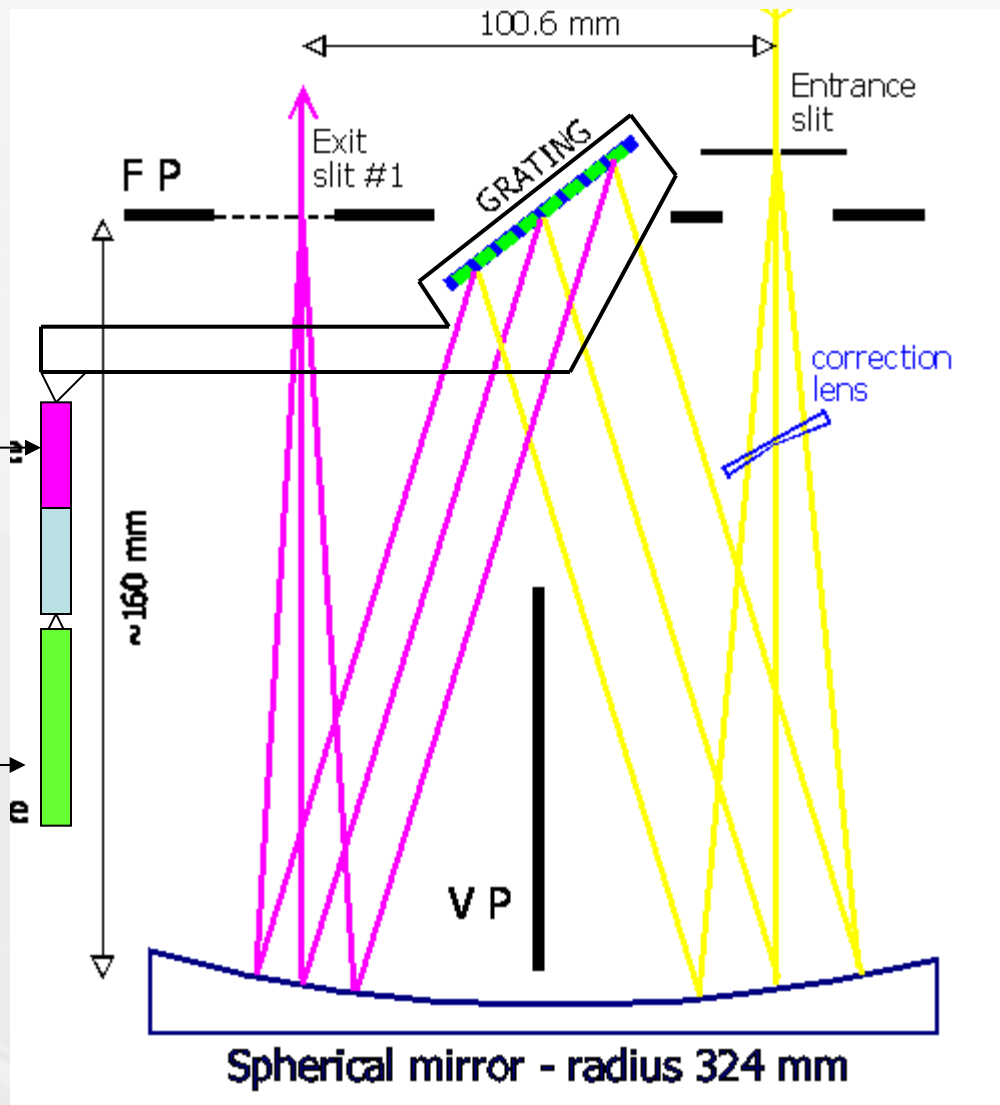
Spectrometer Layout

Push Rod

Part Stainless
Part Aluminum

Micrometer Barrel

Temperature Compensation



Ask me about the South Pole



Thank you
for your
attention...

March 24-28, 2014

14th Brewer Workshop

Tenerife