Polarization Maintaining Fiber Characterization
PM fibers need to be tested before use
We want to test:
1. Polarization Extinction Ratio
2. Frequency Noise Introduced
3. Temperature Effects
Coupling

FOL


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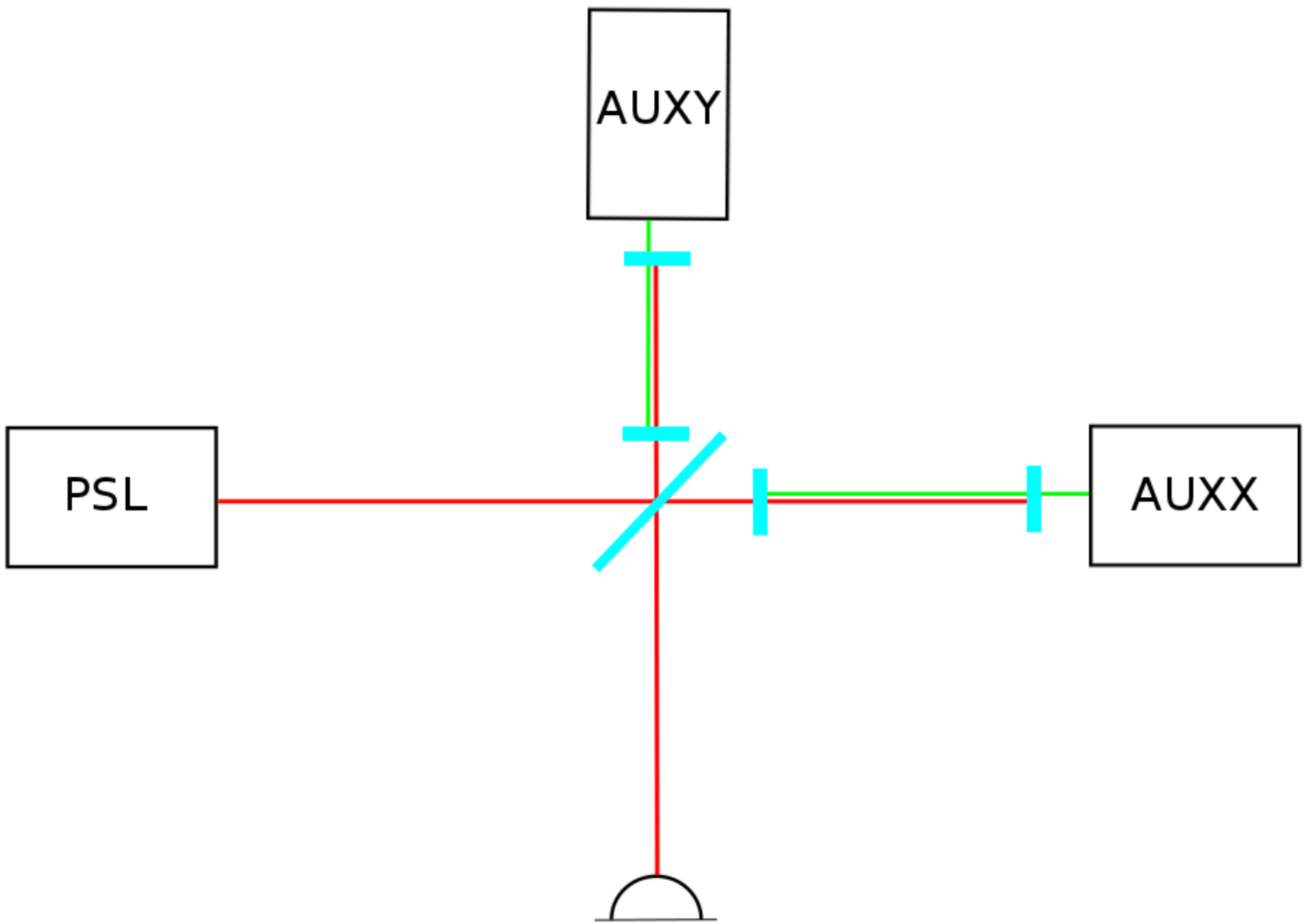
Frequency Offset Locking

SURFs: Andrew Hall, Akhil Reddy Sai
Mentors: Manasadevi Thirugnasambanda, Eric Quintero, Koji Arai

Implementing a Feedback Control System for Auxiliary Frequency Control in the Caltech 40m Prototype Interferometer

Background

- Arm Length Stabilization (ALS)
- Limitations
  - PD's
  - PZT's

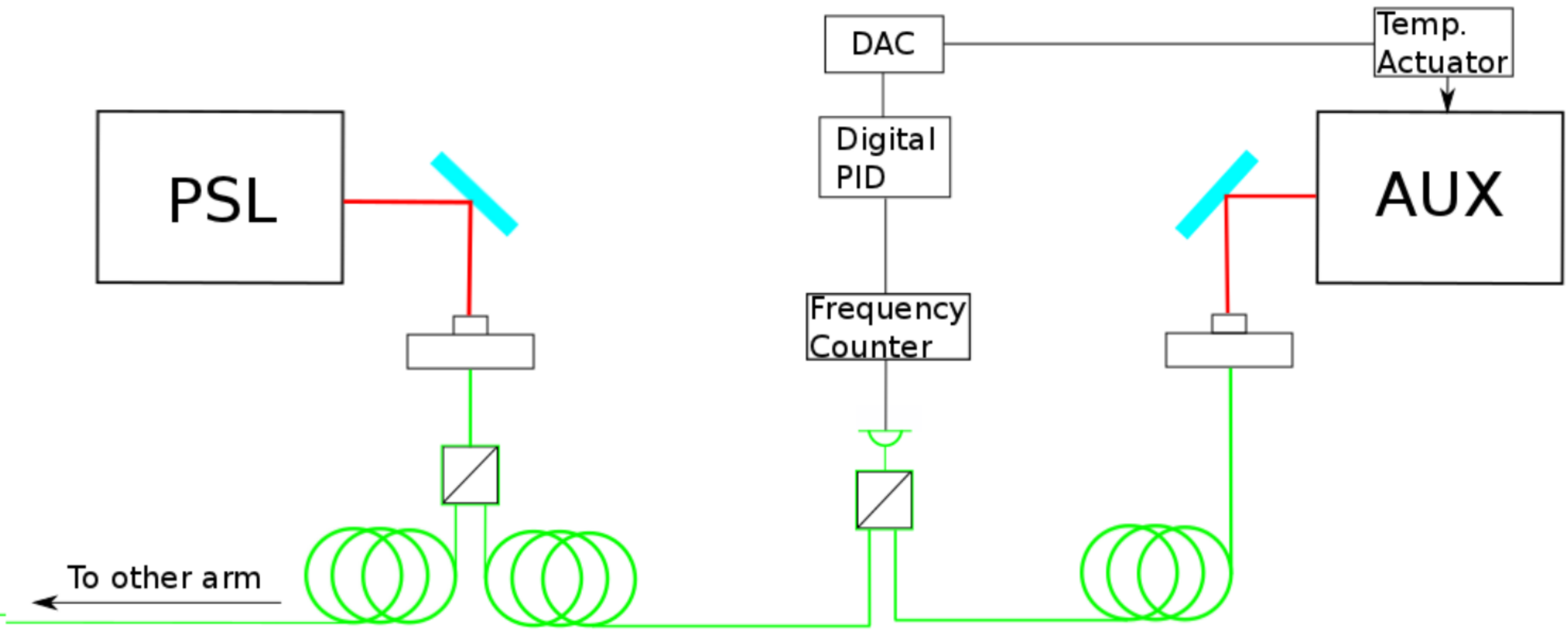

AUXY
PSL
AUXX

FOL; In Addition

- High bandwidth, Slow frequency control of AUX lasers
- PD limited at ~150 MHz
- PZT's respond at 5 MHz per Volt at +/- 10 V

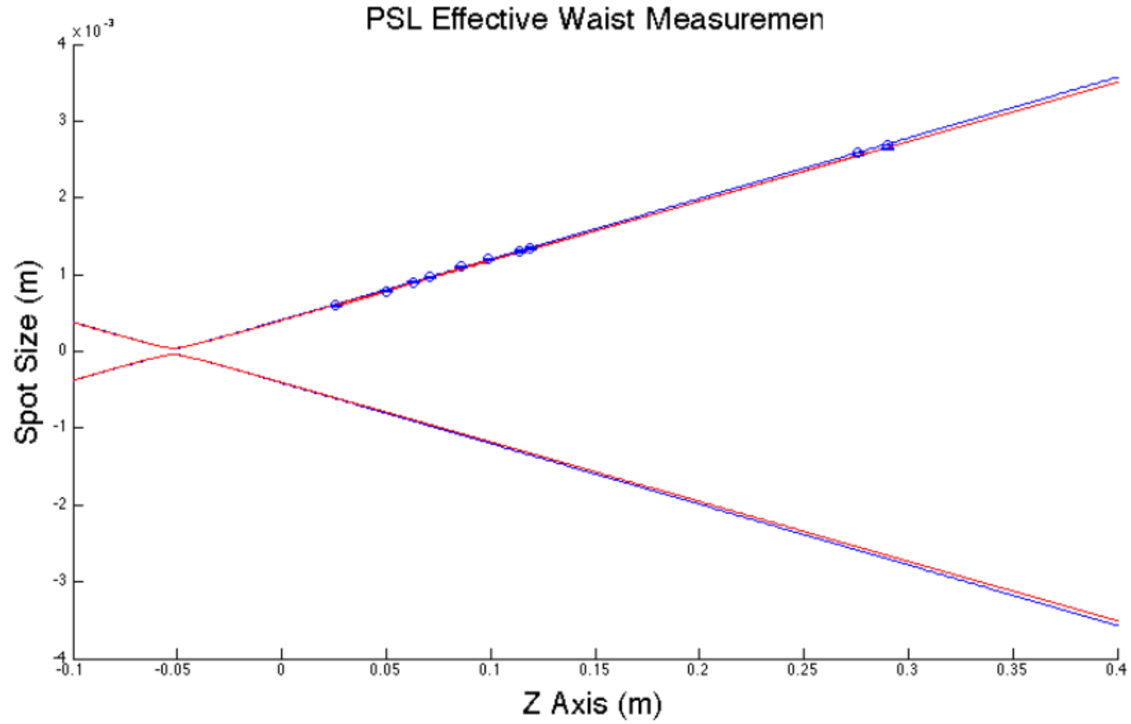
Optical Setup

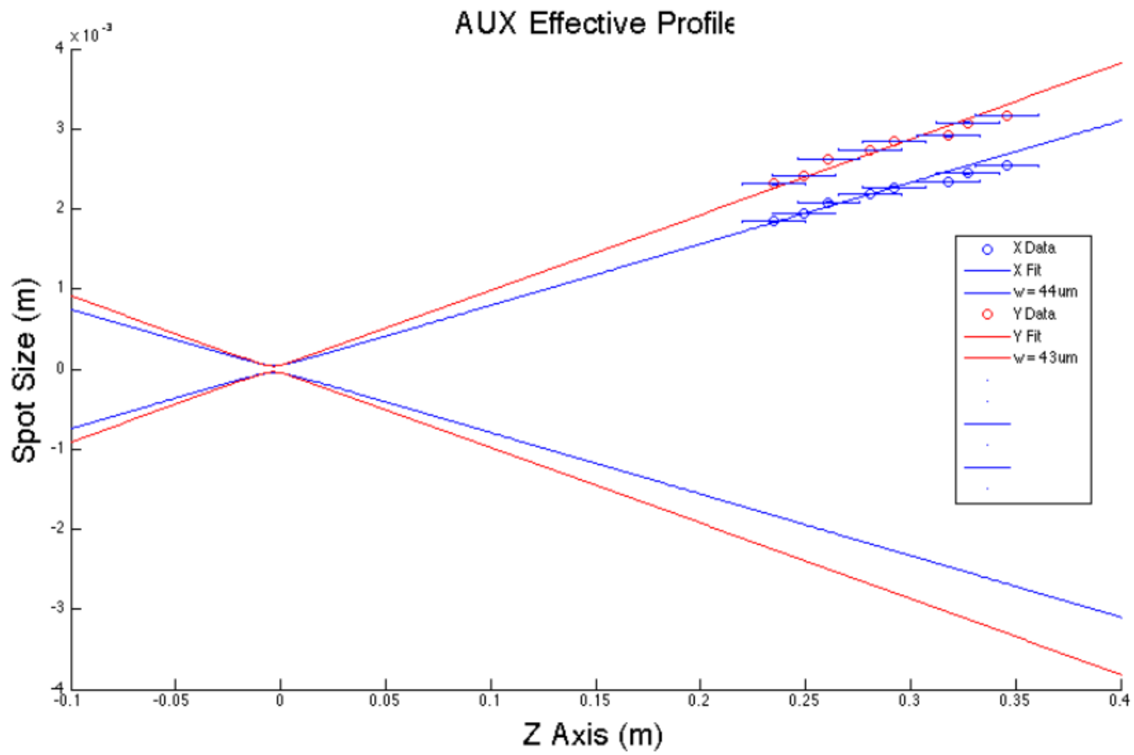
- Entirely fiber coupled optical system
- Digital PID (Proportional, Integral, Derivative) Control Loop
- Actuates using thermal actuator in AUX NPRO's

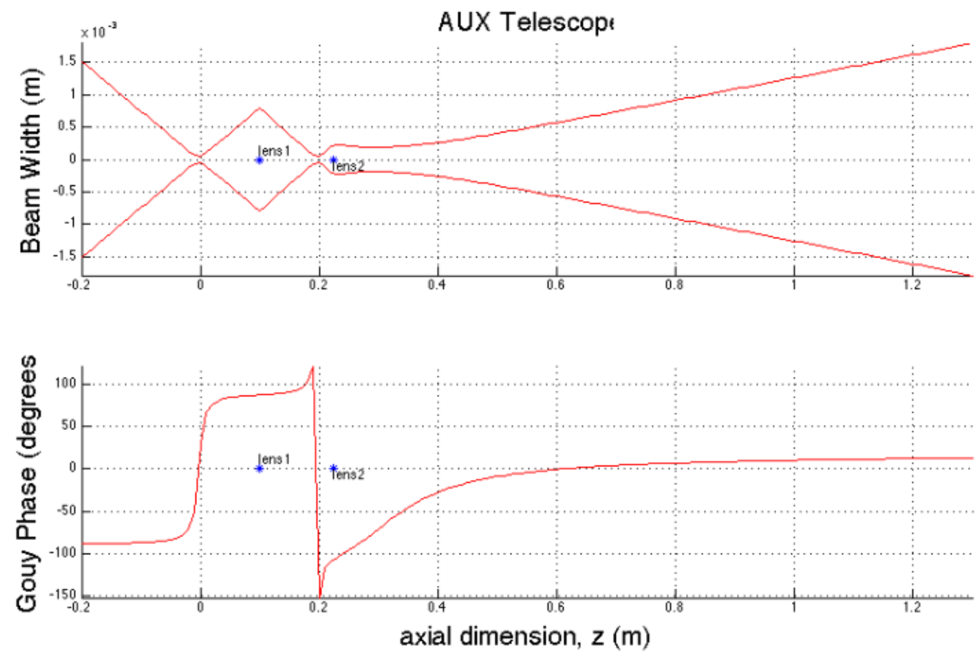

DAC
Temp.
Actuator
Digital
PID
PSL
AUX
Frequency
Counter
To other arm
Prezi

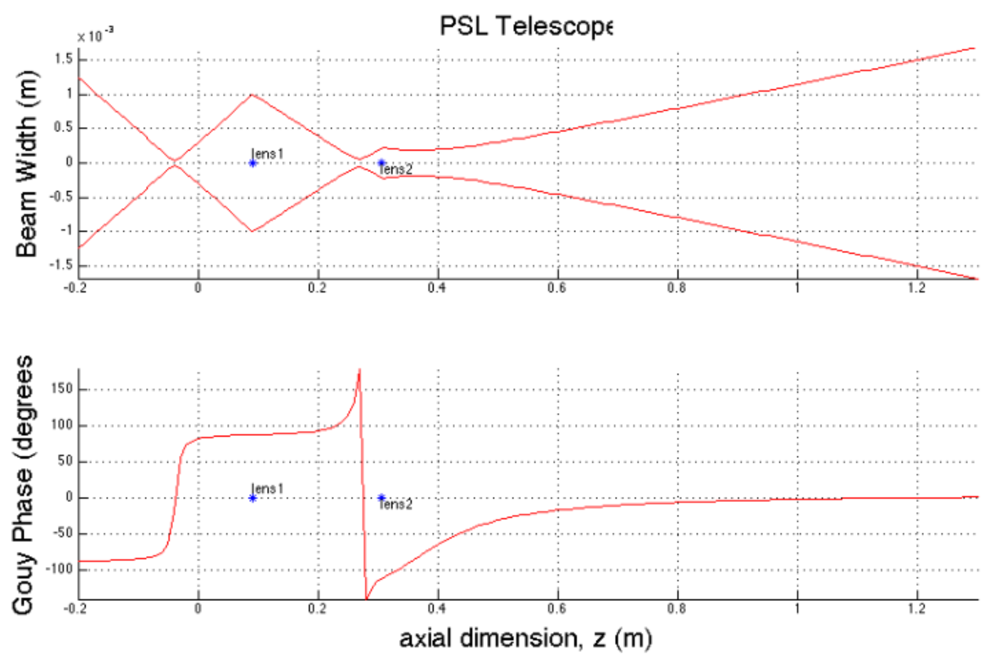
Coupling

- Characterize beam profiles of lasers and fibers
- Design telescopes using a la mode (i.e. automated ABCD matrices)
- Fiber couple light

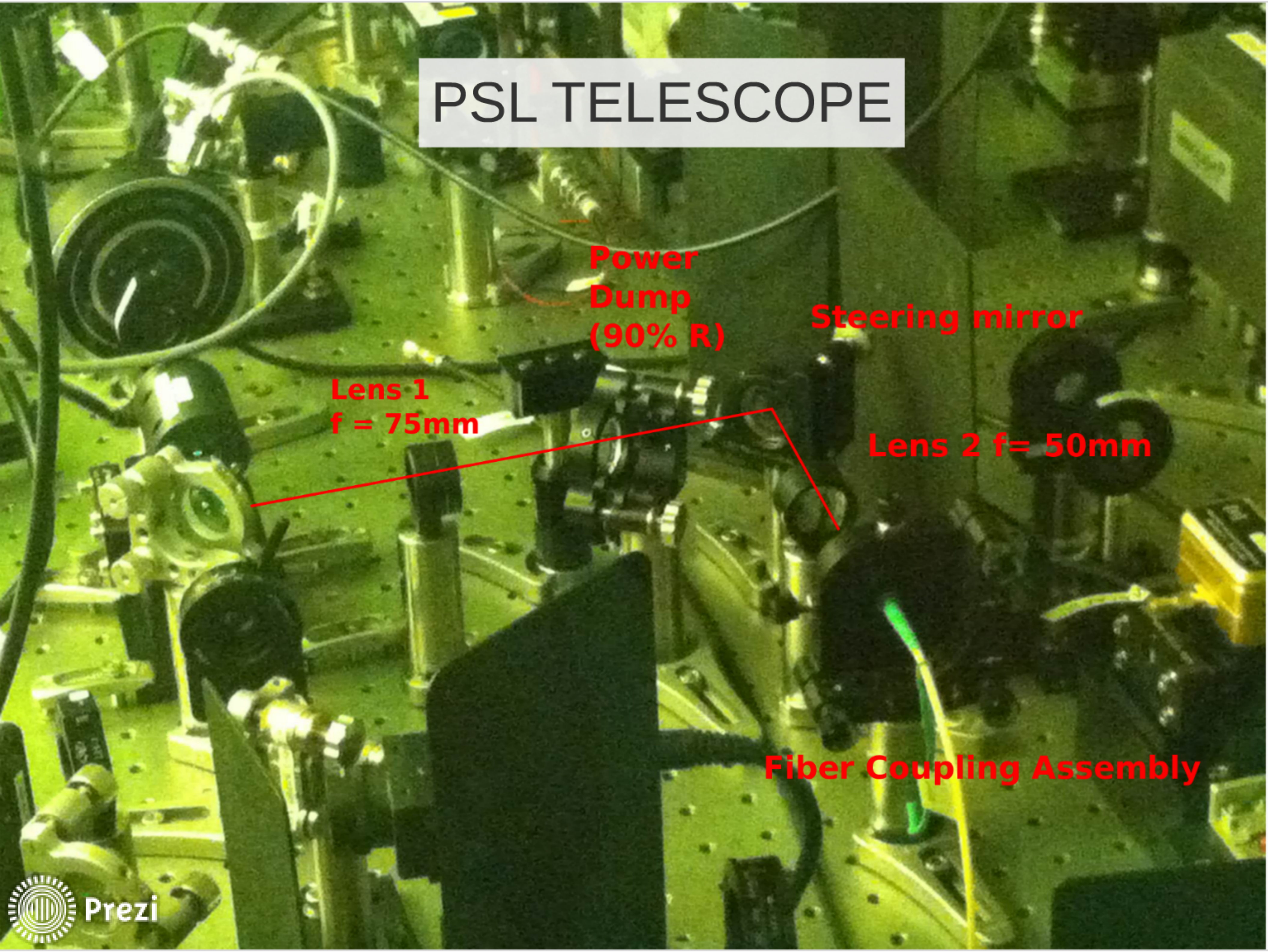

PSL Effective Waist Measuremen
x 10^-3
Spot Size (m)
Z Axis (m)


AUX Effective Profile
x 10^-3
Spot Size (m)
Z Axis (m)
X Data
X Fit
w=44um
Y Data
Y Fit
w=43um


AUX Telescope
Beam Width (m)
x 10^-3
lens1
lens2
Gouy Phase (degrees
axial dimension, z (m)


PSL Telescope
Beam Width (m)
x 10^-3
lens1
lens2
Gouy Phase (degrees
axial dimension, z (m)

PSL TELESCOPE



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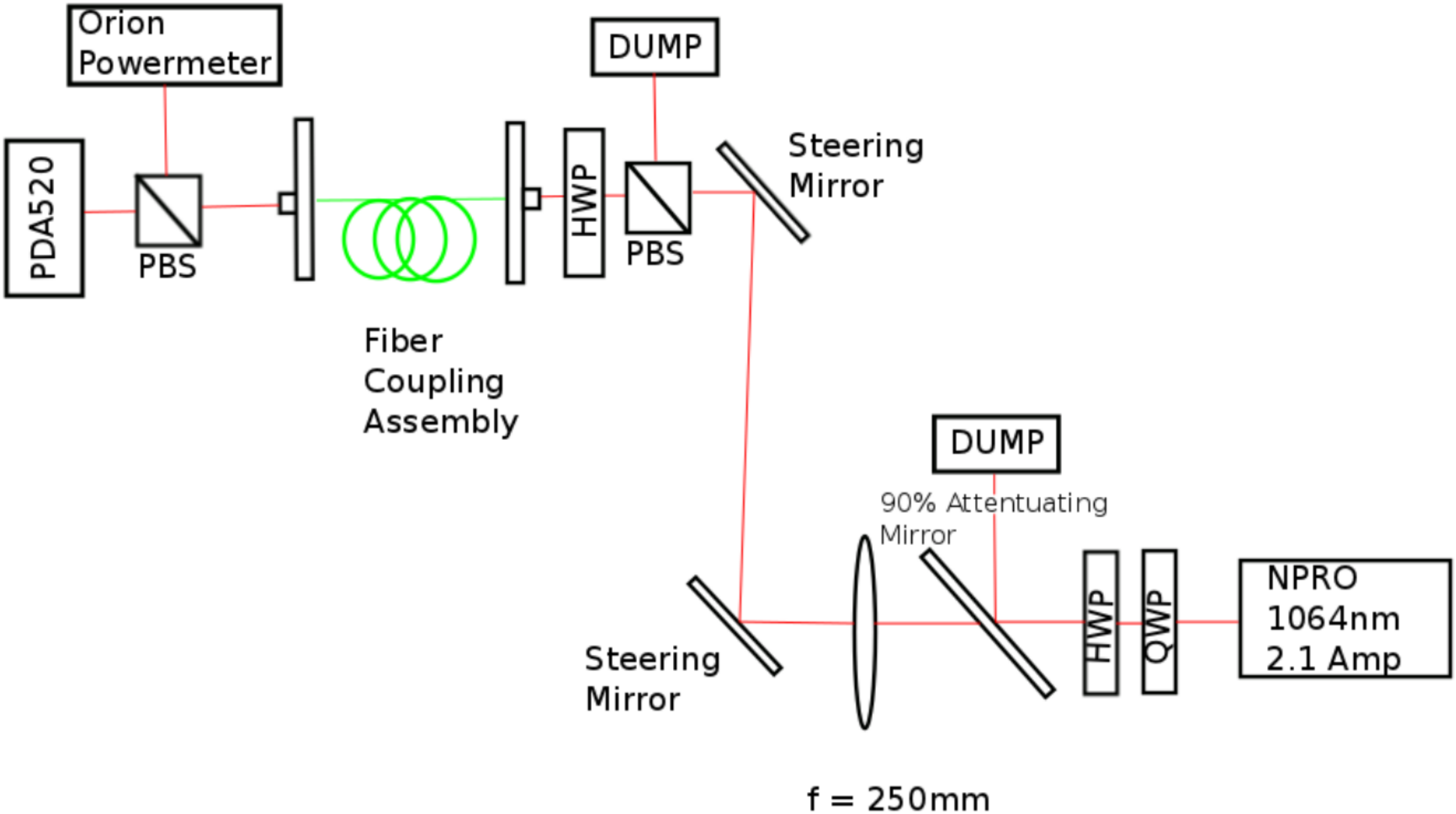


Orion Powermeter
PDA520
PBS
DUMP
HWP
PBS
Steering Mirror
Fiber Coupling Assembly
DUMP
90% Attentuating Mirror
HWP
QWP
NPRO 1064nm 2.1 Amp
Steering Mirror
f = 250mm

Methods

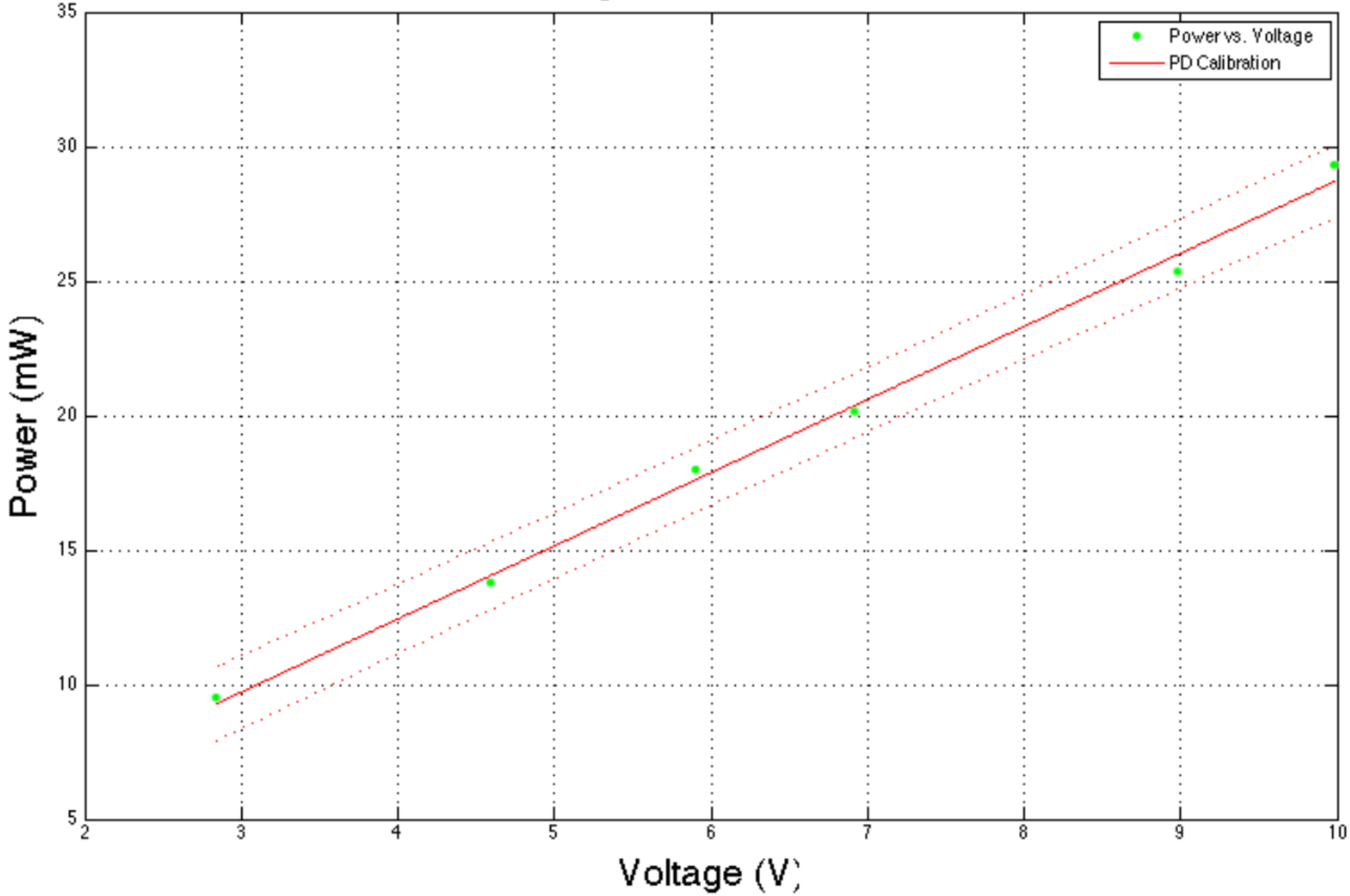
1. Calibrate PD and Powermeter

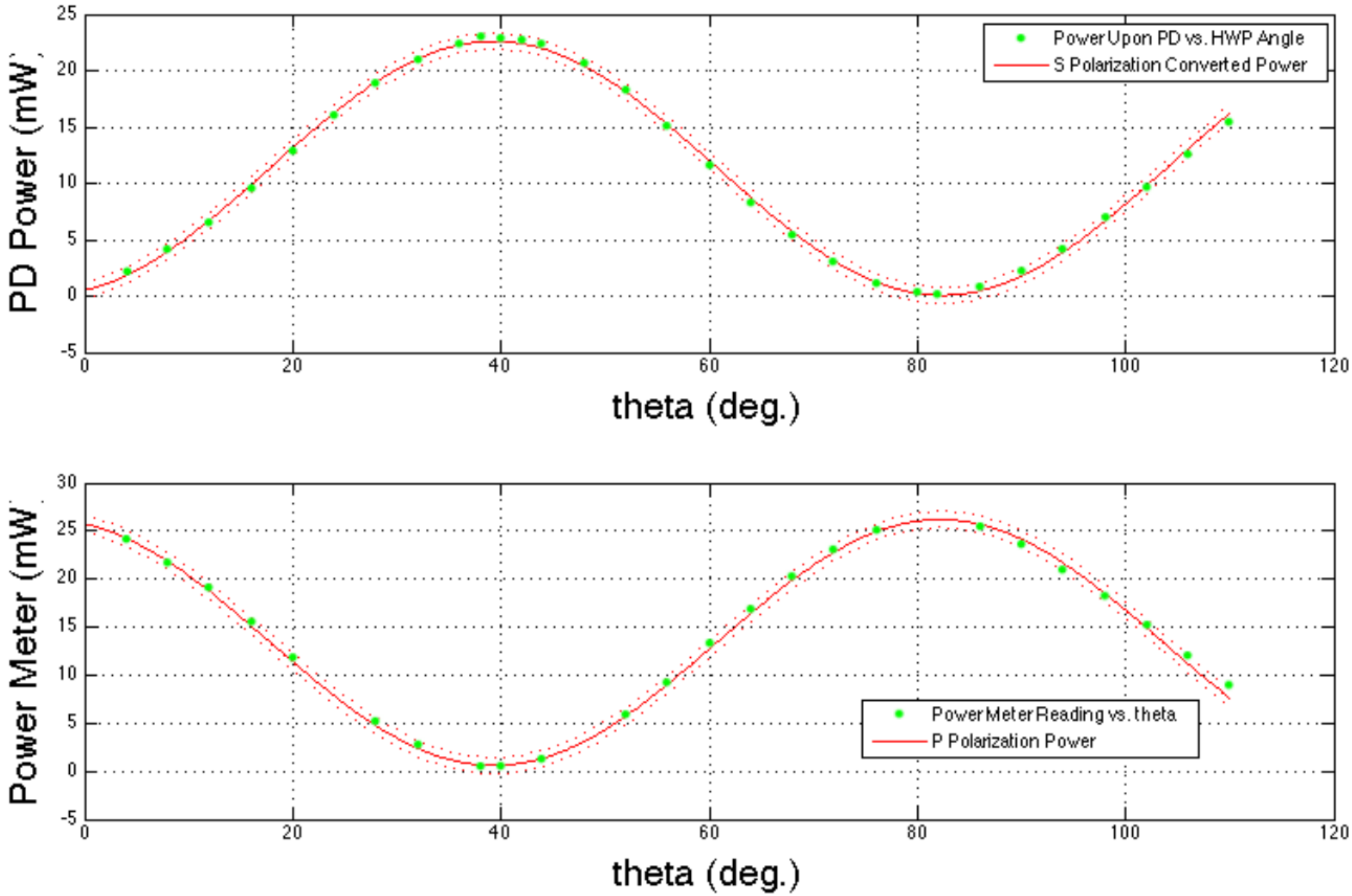
2. Remove ellipticity of polarization

3. Align newly linear light with fast axis of fiber

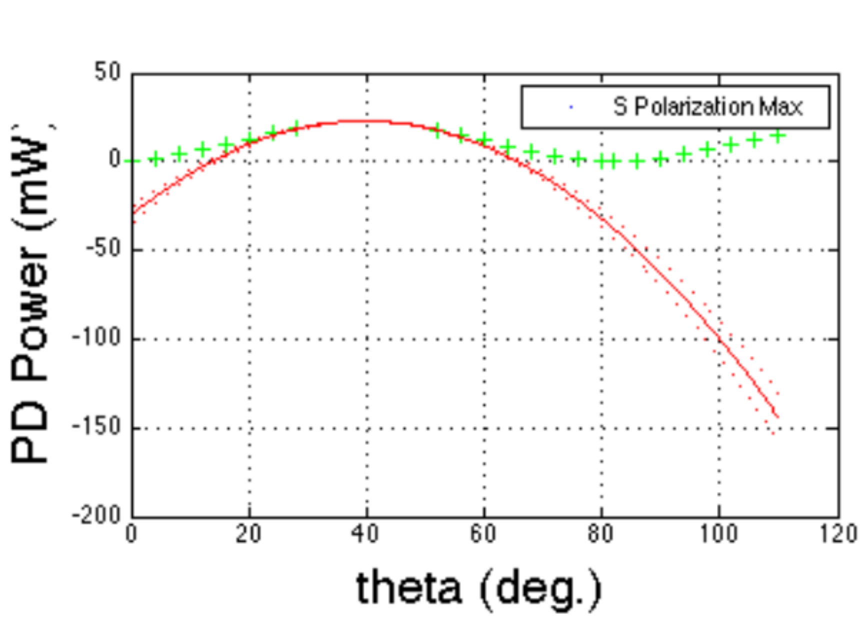
4. Rotate 'downstream' HWP, recording PD/Power Meter readings

PD Calibration
Slope = 2.719

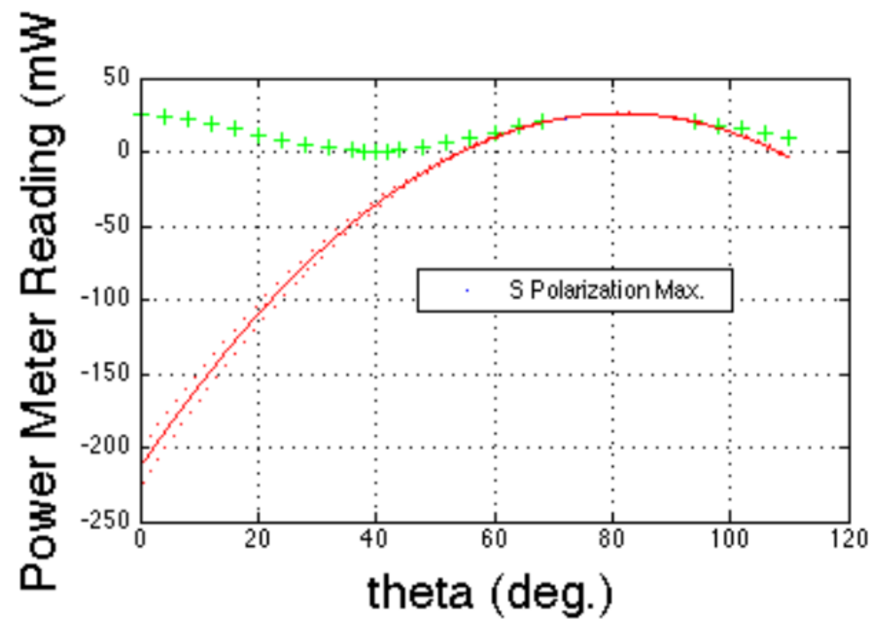




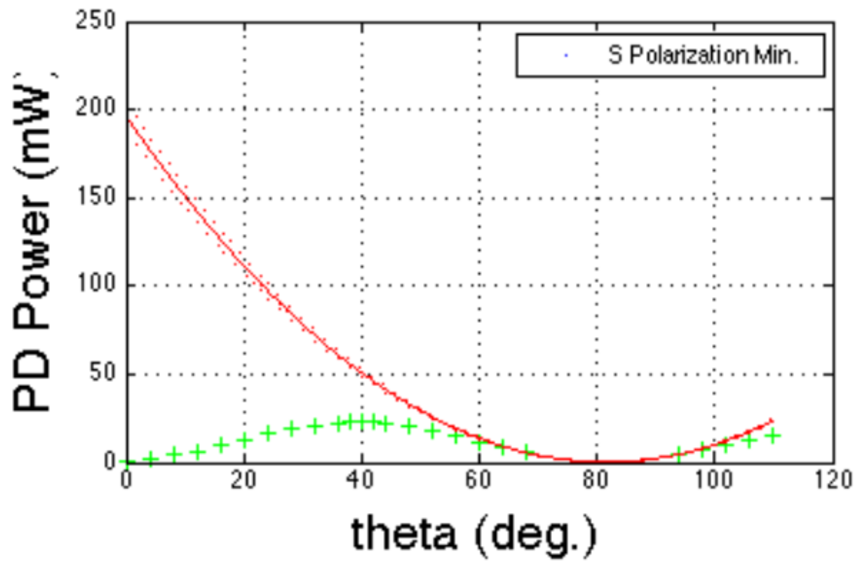
PD Power (mW)
theta (deg.)
Power Upon PD vs. HWP Angle
S Polarization Converted Power
Power Meter (mW)
theta (deg.)
Power Meter Reading vs. theta
P Polarization Power



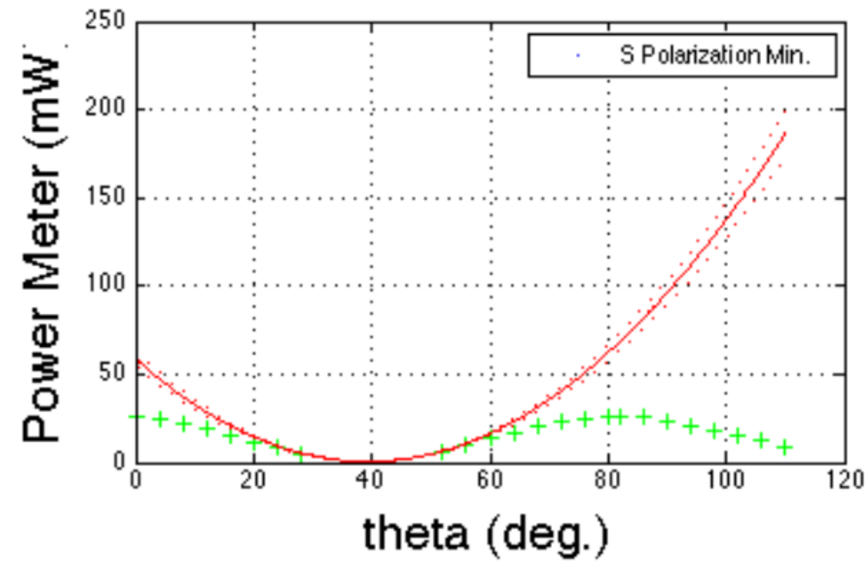
PD Power (mW)
theta (deg.)
S Polarization Max



Power Meter Reading (mW
theta (deg.)
S Polarization Max.



PD Power (mW)
theta (deg.)
S Polarization Min.



Power Meter (mW
theta (deg.)
S Polarization Min.

PER Measurements

(SMin / PMax) = 0.007 +/- .004 ---> -21.54 +/- 2.48 dB

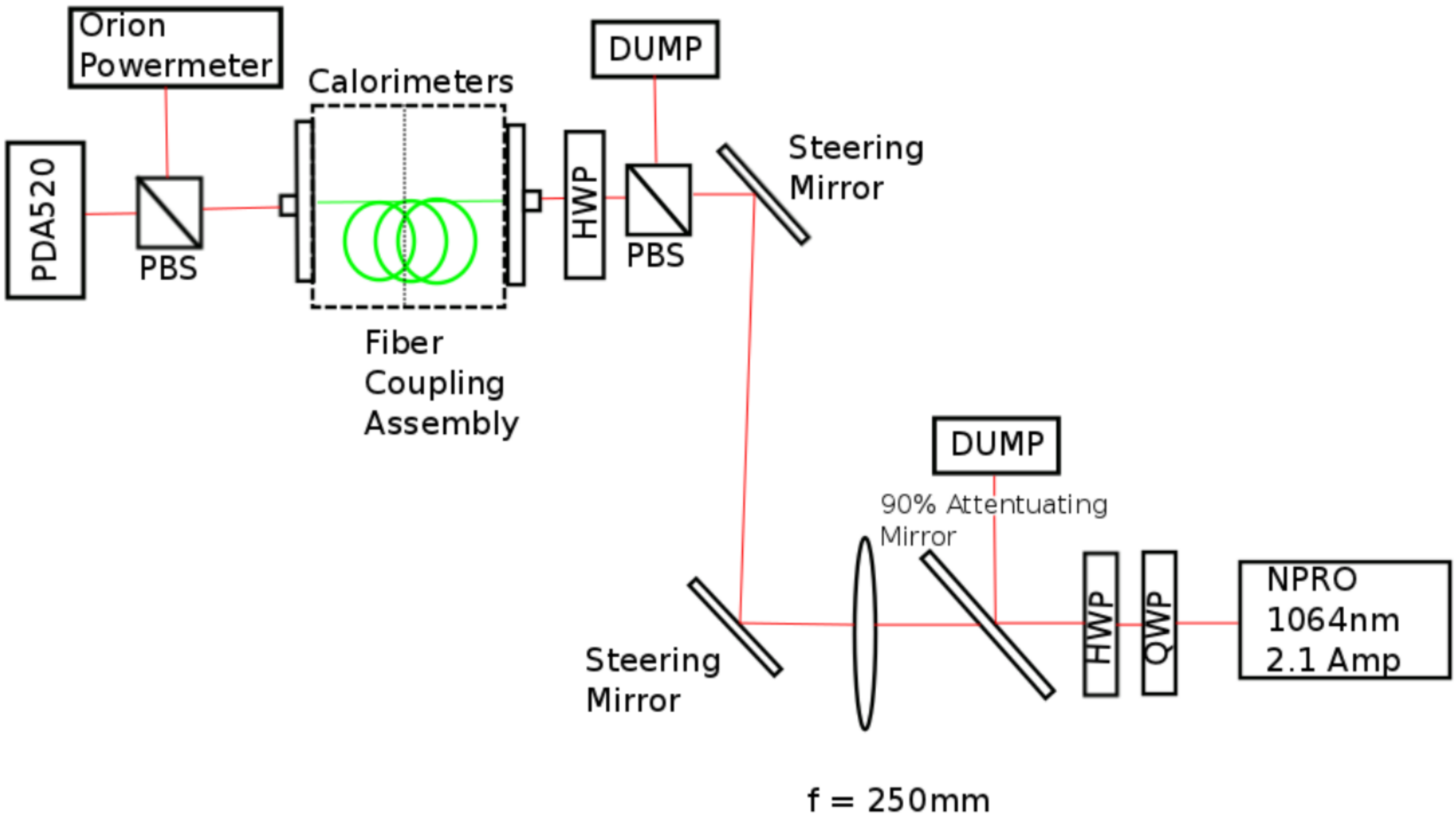
(PMin / SMax) = 0.022 +/- .009 ---> -16.58 +/- 1.78 dB

Issues

- Fiber mounts rotate uncontrollably
- PBS's don't split perfectly into P and S
- Temperature Fluctuations within fiber

Temperature Effects

- Goal was to measure effects of temperature gradients along the fiber
- Setup included a dual chambered "calorimeter" with temperature probes enclosing the fiber, and the PER setup


Orion
Powermeter
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Calorimeters
Fiber
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Assembly
HWP
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Steering
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90% Attentuating
Mirror
Steering
Mirror
HWP
QWP
NPRO
1064nm
2.1 Amp
f = 250mm

To Be Done:

1. Full coupling for FOL

2. Temp. Effect Measurement

3. Frequency Noise Characterization

Acknowledgements

Mentors: Manasa, Eric Q., Koji Arai

All of the 40m staff, and LIGO SURF

Co-SURF Akhil Reddy