
Polarization Maintaining Fiber Characterization
Coupling

FOL

Prezi


Polarization Maintaining Fiber Characterization
- PM fibers need to be sealed 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

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Mentors: Manasadevi Thirugnasambanda, Eric Quintero, Koji Arai

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

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Background

Interferometers

- Wave nature of light

Lock Acquisition

- Arm length integer multiple of wavelength

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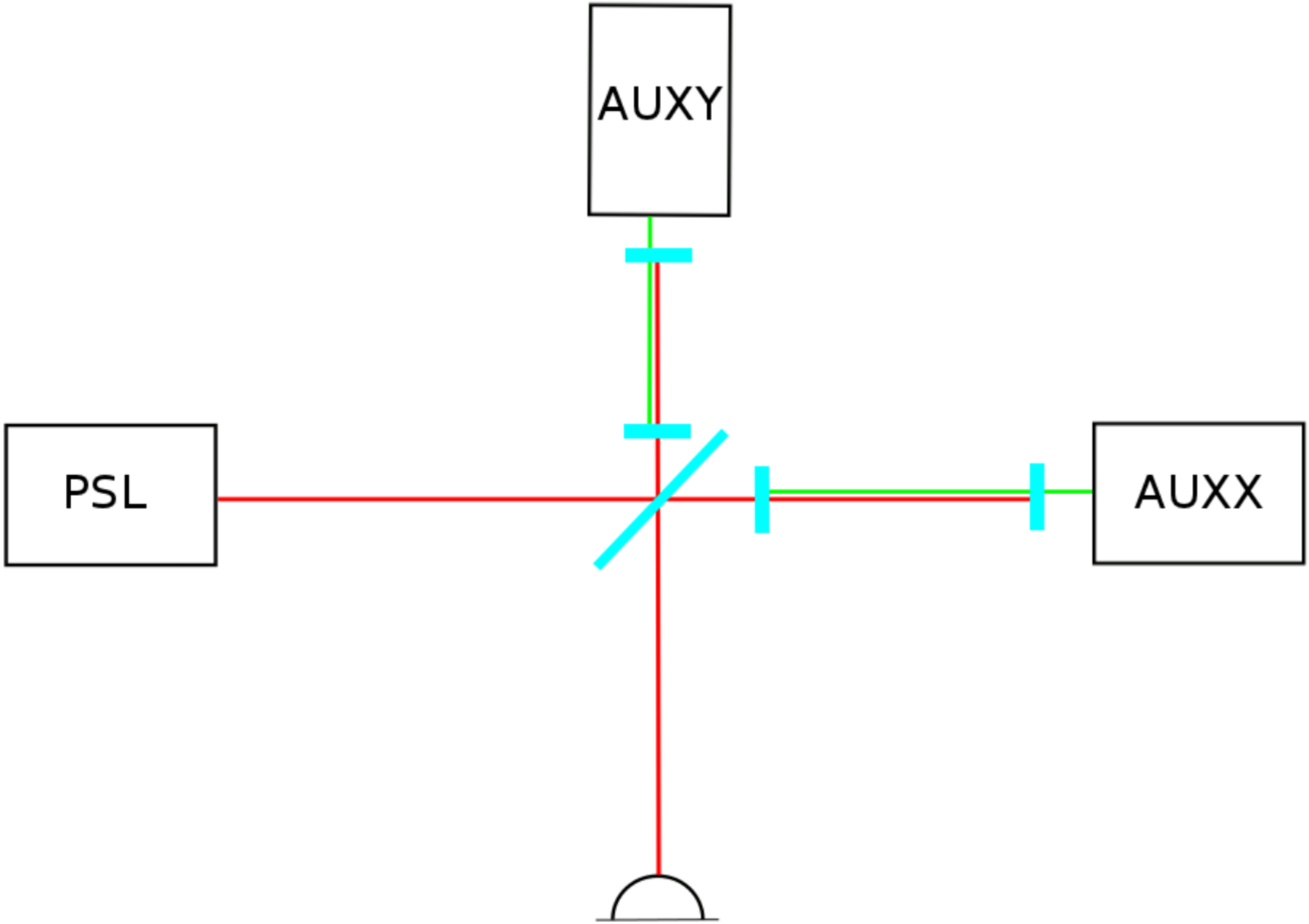
AUXY
PSL
AUXX

What Good is FOL?

- ALS works by detecting and controlling beat notes
- PD limited at ~150 MHz

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- FOL keeps AUX and PSL frequencies within working range of ALS PD's
- Also keeps frequency within range of fast frequency control (Piezoelectric Actuators--PZT's)
- PZT's actuate by 5 MHz per V, at +/- 10V--laser frequency wanders by more

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Optical Setup

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

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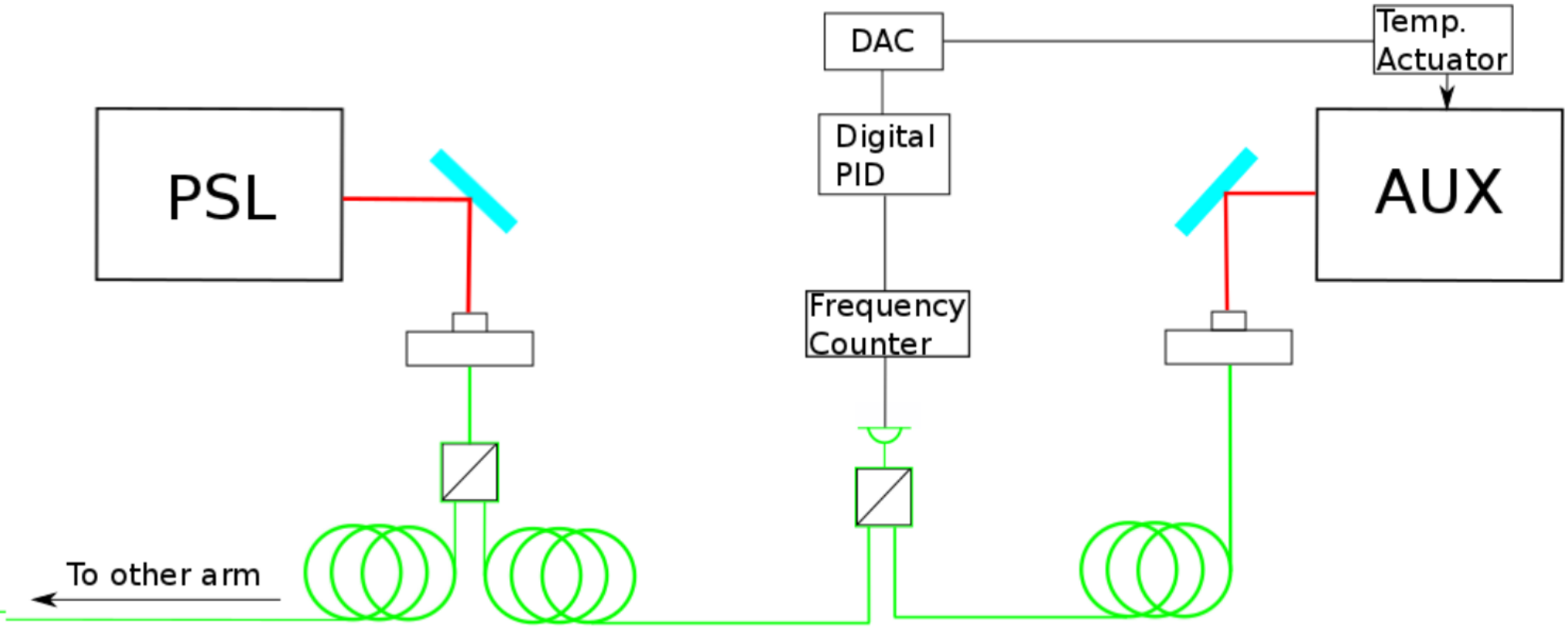
DAC
Temp.
Actuator
Digital
PID
PSL
AUX
Frequency
Counter
To other arm

Coupling

- Characterize beam profiles of lasers and fibers
- Design telescopes using a la mode
- Fiber couple light

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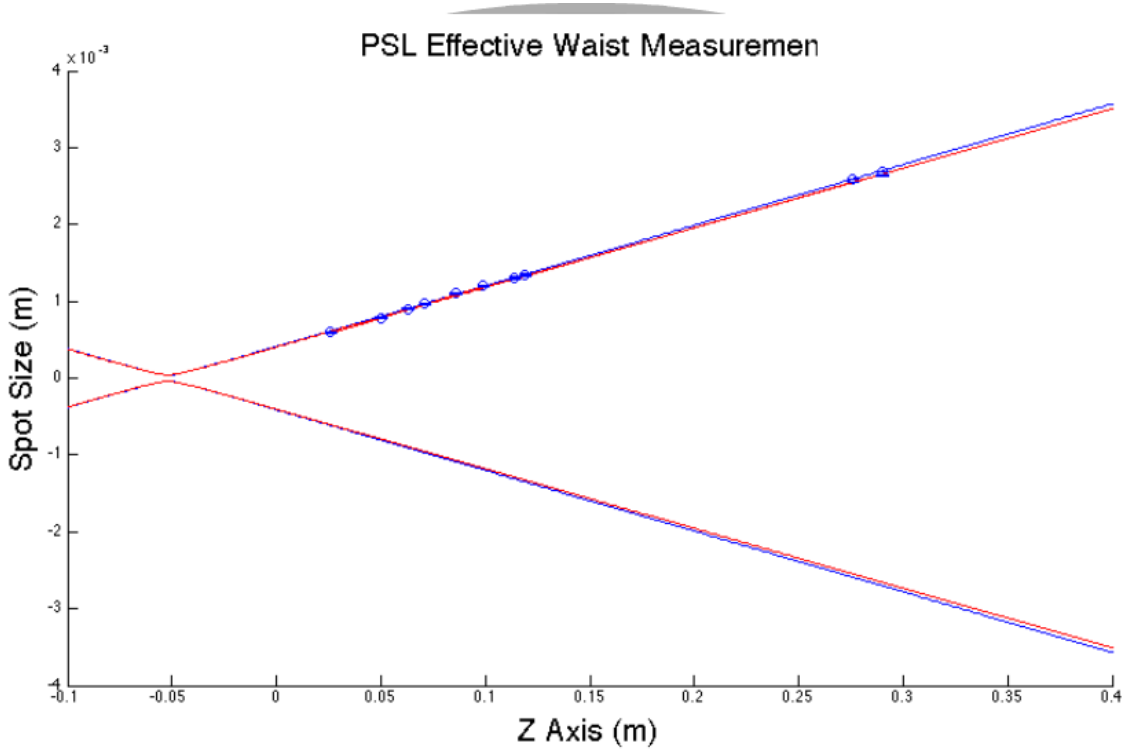
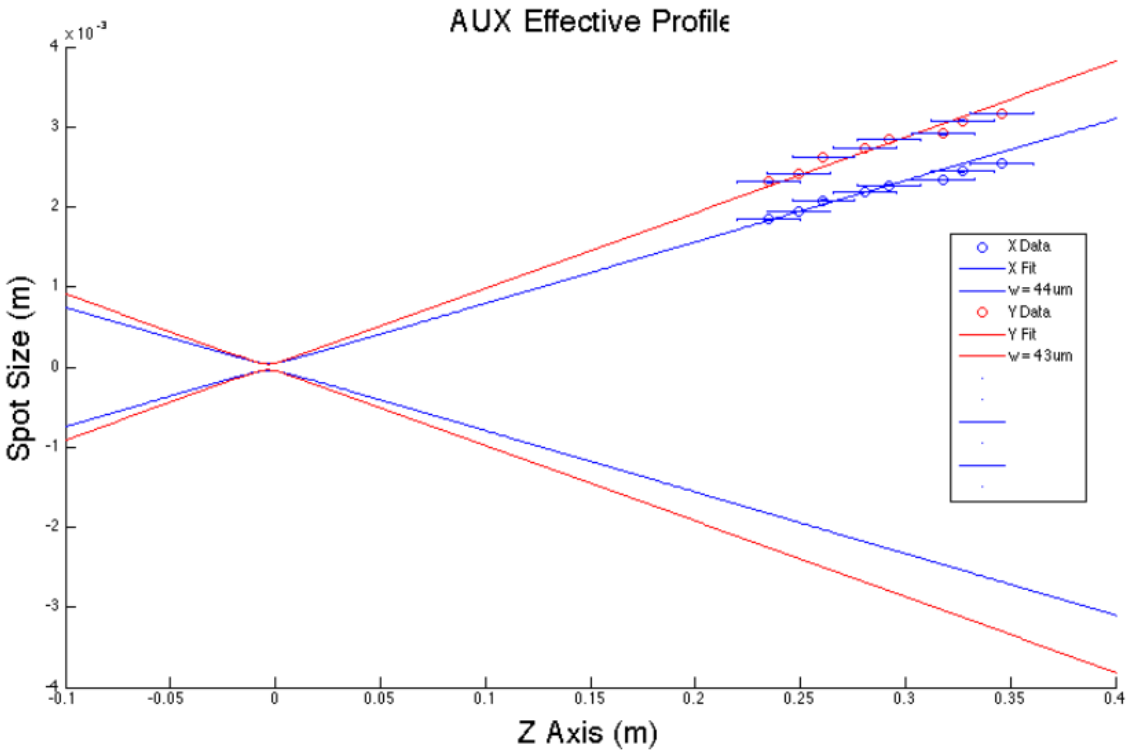
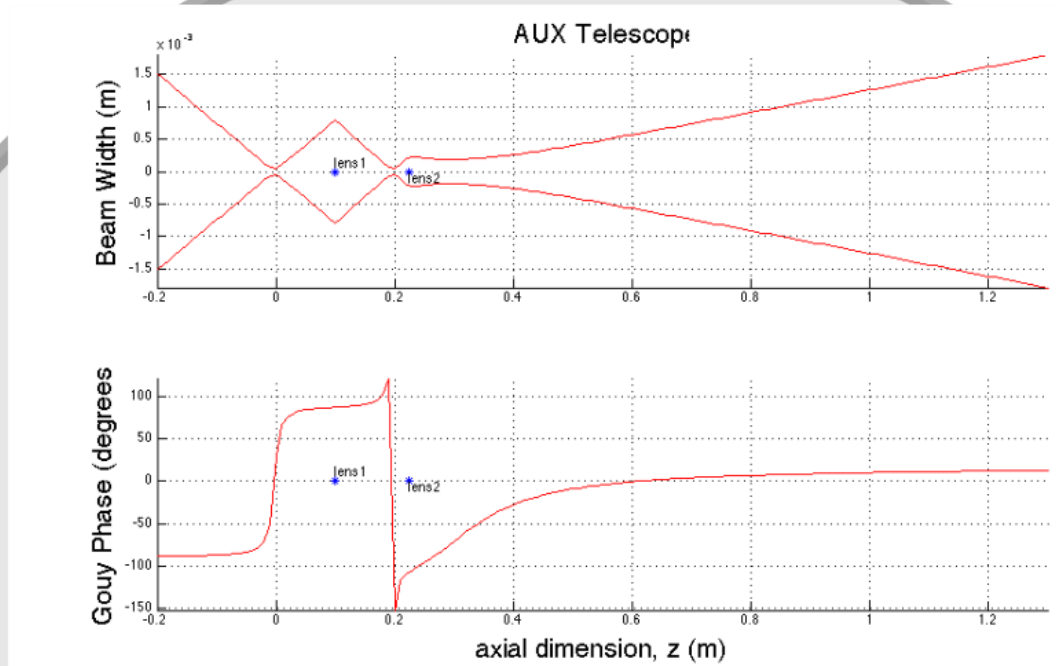
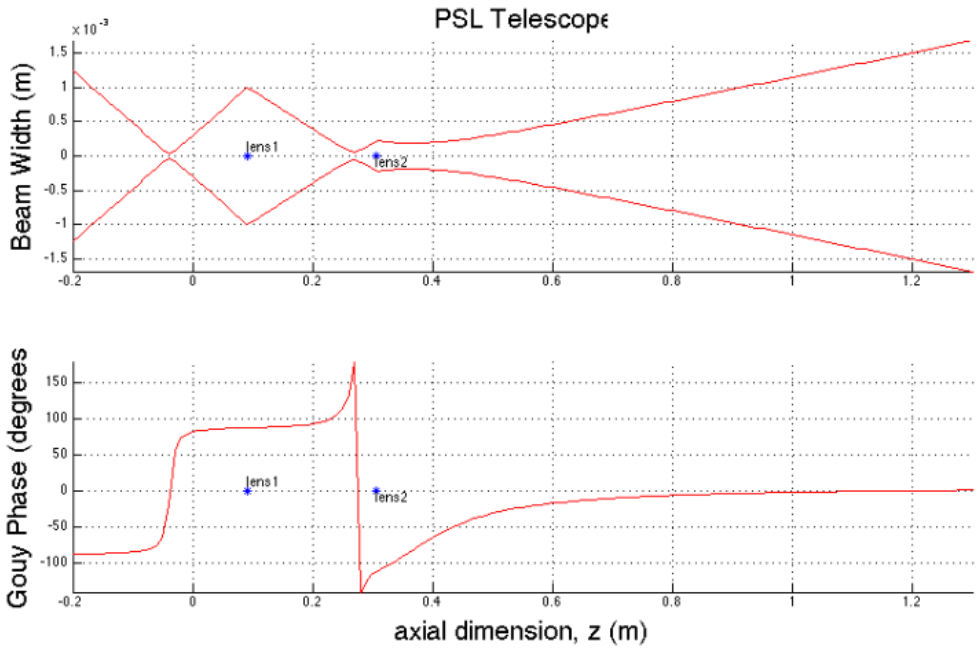
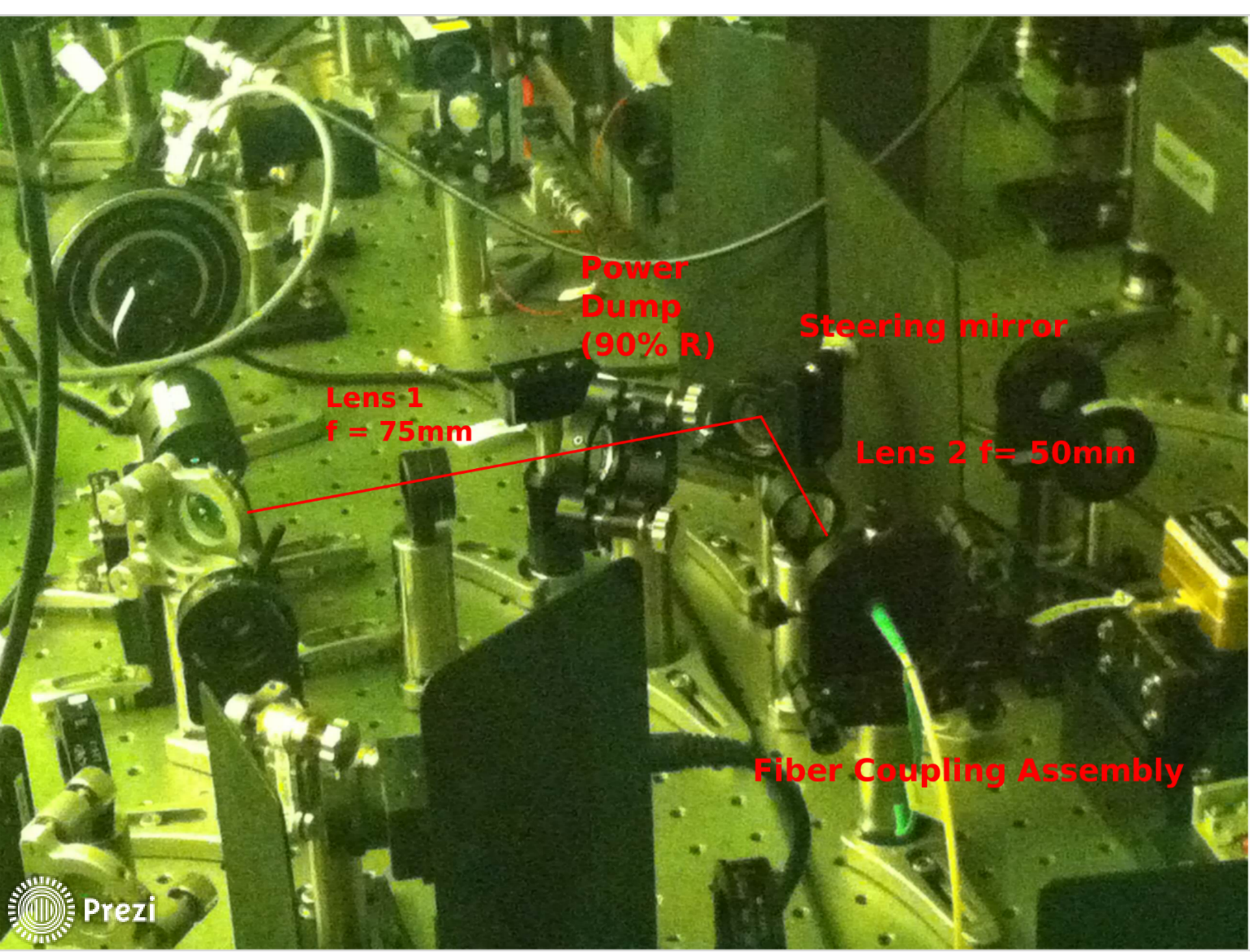

PSL Effective Waist Measuremen
x 10^-3
Spot Size (m)
Z Axis (m)


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
x 10^-3
Beam Width (m)
lens 1
lens 2
Gouy Phase (degrees
axial dimension, z (m)


PSL Telescope
x 10^-3
Beam Width (m)
lens 1
lens 2
Gouy Phase (degrees
axial dimension, z (m)


Power
Dump
(90% R)
Steering mirror
Lens 1
f = 75mm
Lens 2 f= 50mm
Fiber Coupling Assembly

Polarization Maintaining Fiber Characterization

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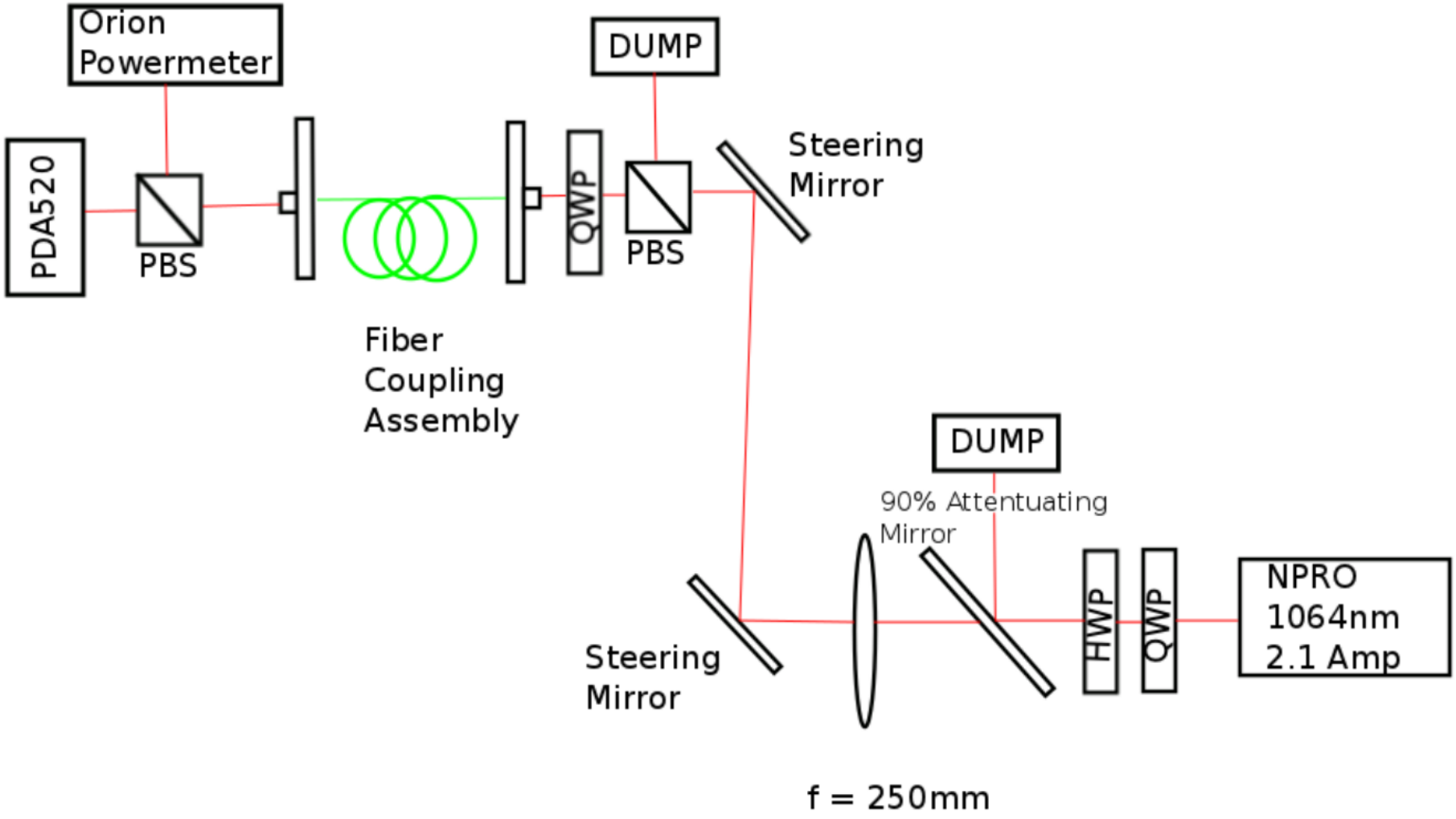
Prezi


Orion
Powermeter
DUMP
PDA520
PBS
QWP
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

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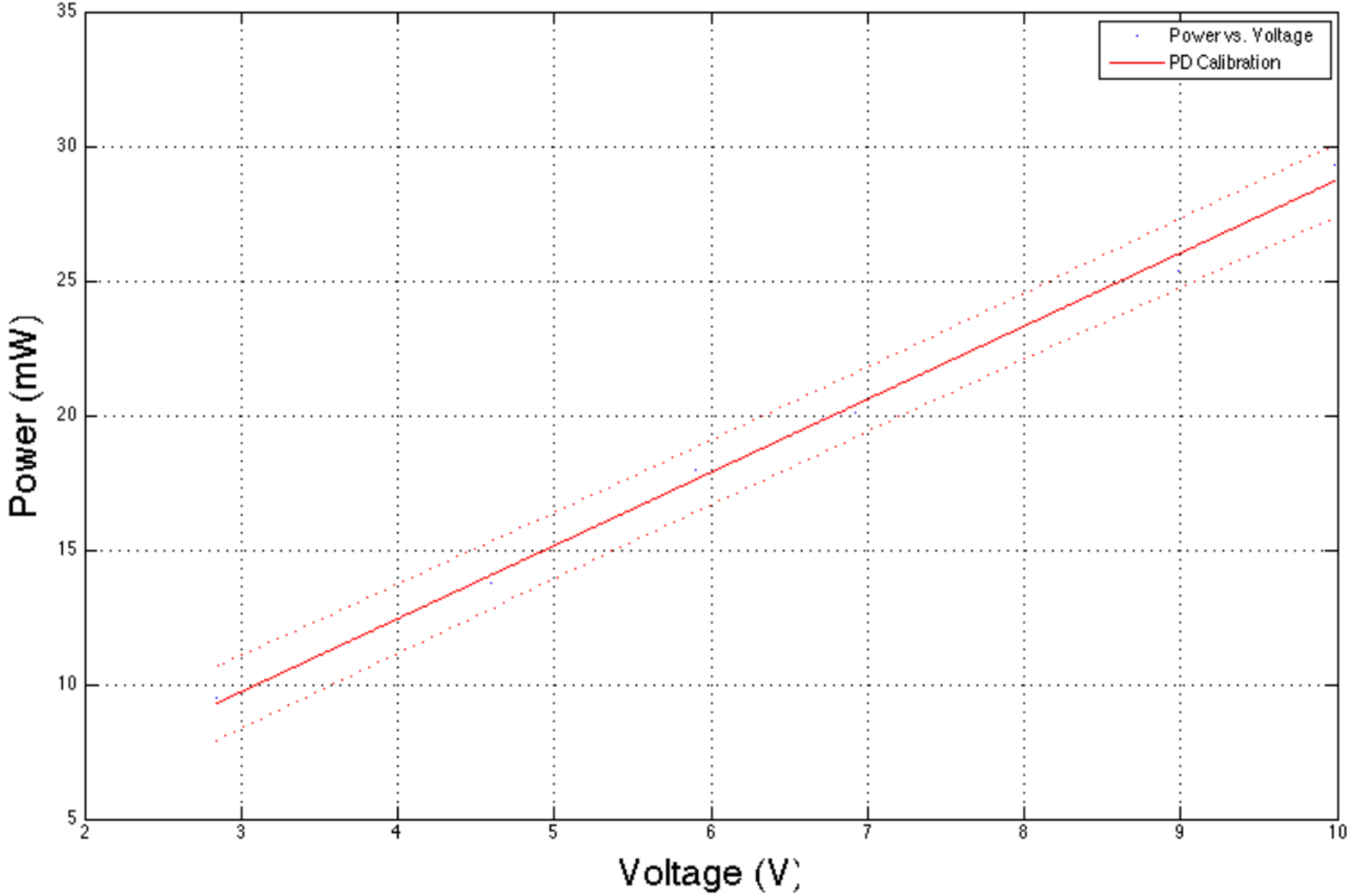
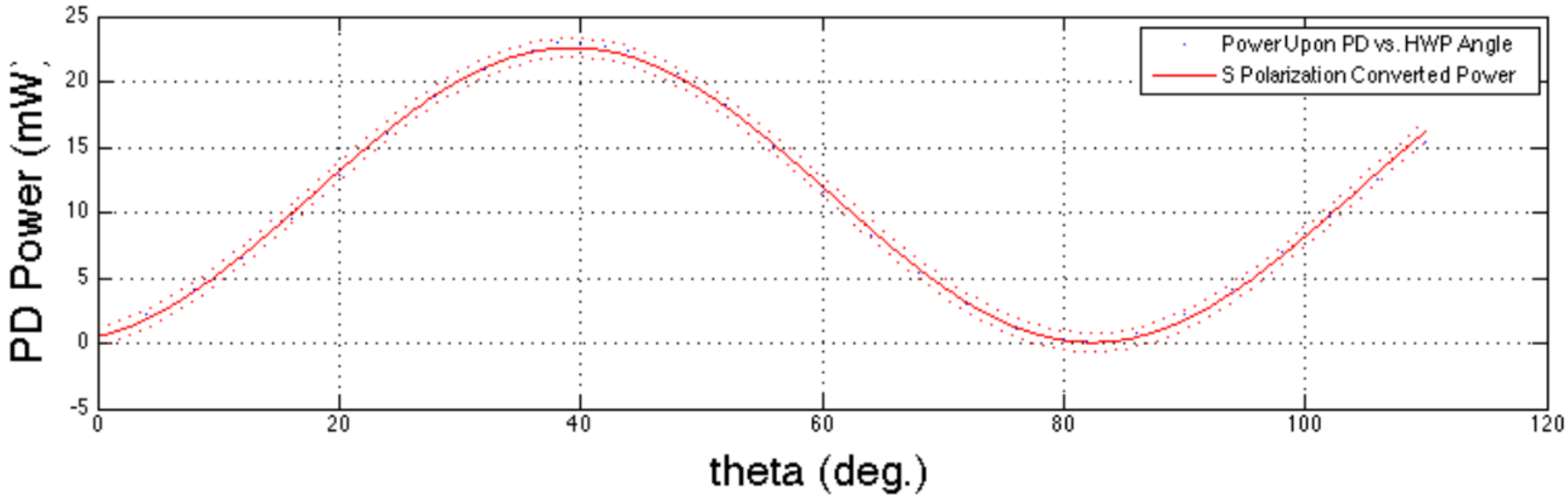
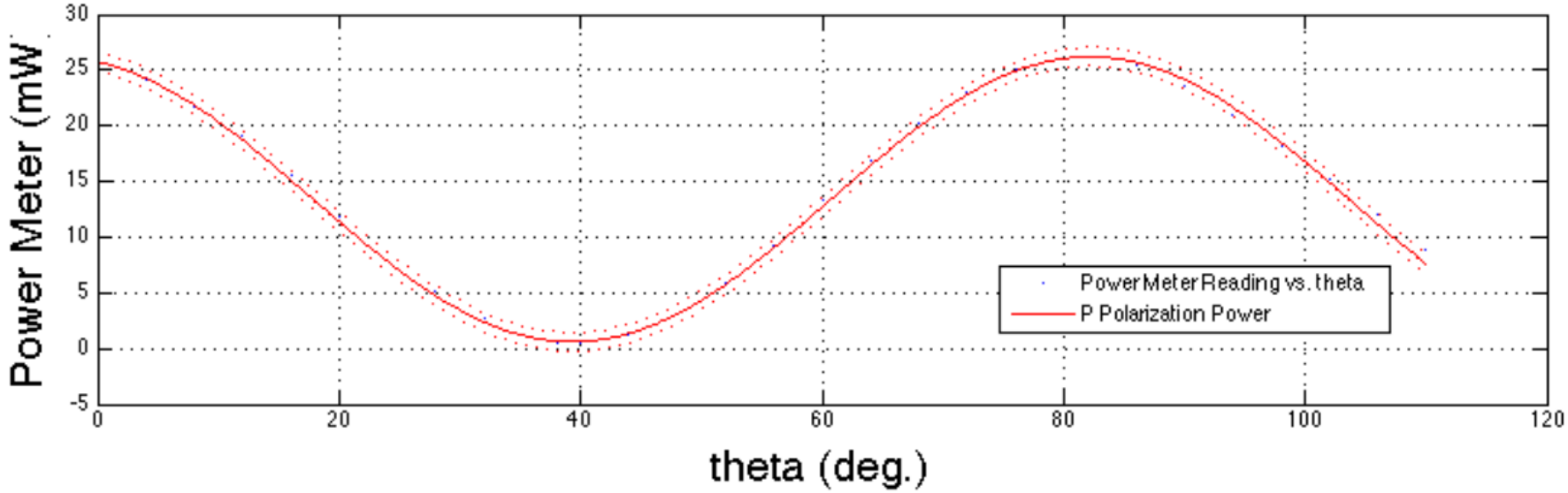
PD Calibration
Slope = 2.719

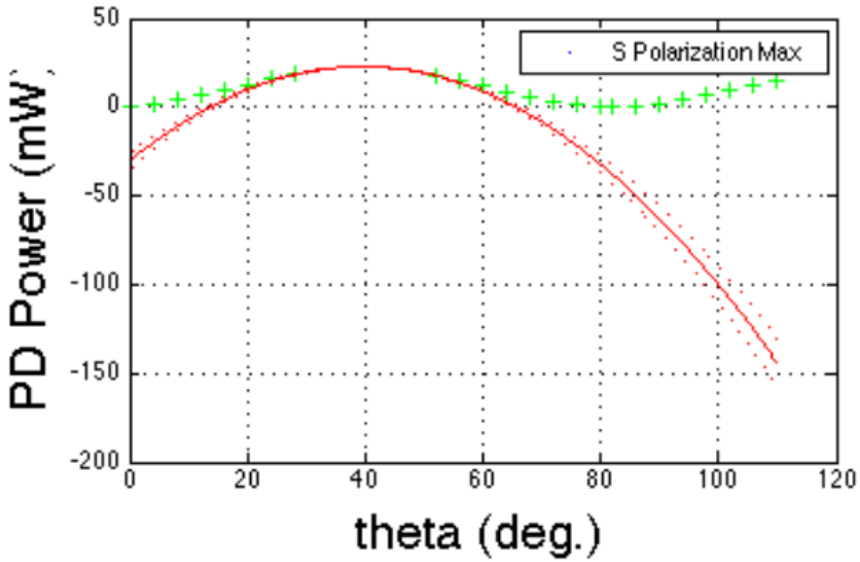


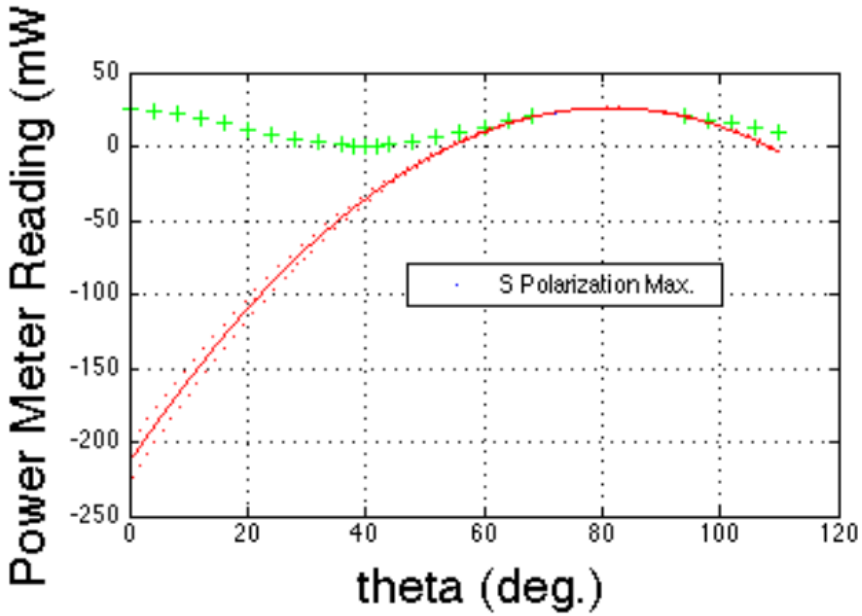
Prezi

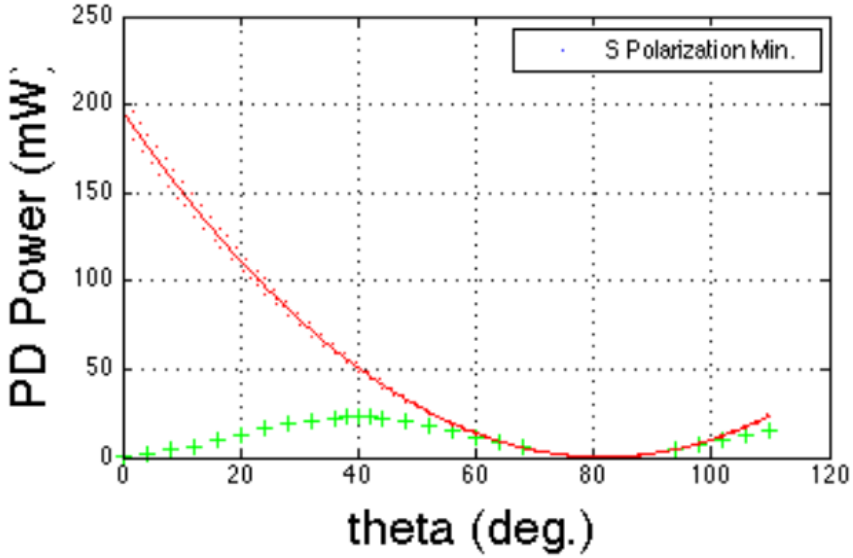

PD Power (mW)
theta (deg.)
Power Upon PD vs. HWP Angle
S Polarization Converted Power
25
20
15
10
5
0
-5
0
20
40
60
80
100
120

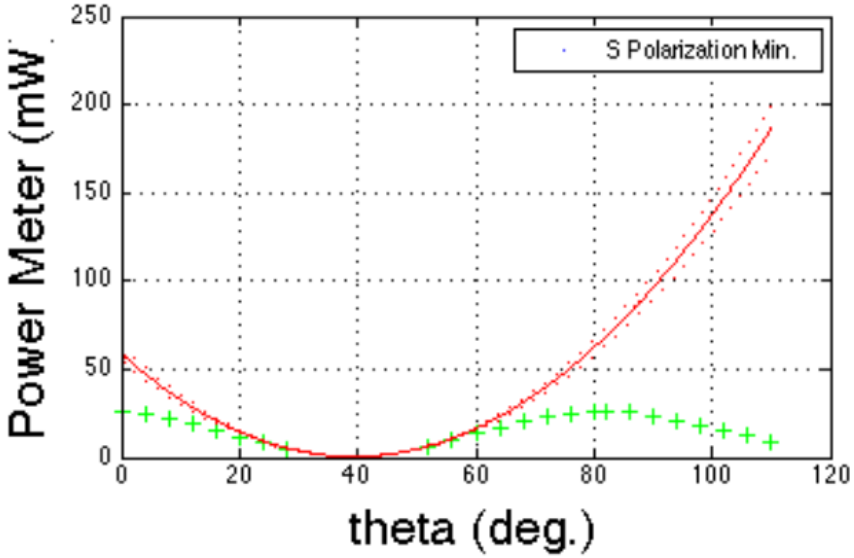

Power Meter (mW)
theta (deg.)
Power Meter Reading vs. theta
P Polarization Power
30
25
20
15
10
5
0
-5
0
20
40
60
80
100
120

Prezi


S Polarization Max
PD Power (mW)
theta (deg.)
50
0
-50
-100
-150
-200
0
20
40
60
80
100
120


S Polarization Max.
Power Meter Reading (mW
theta (deg.)
50
0
-50
-100
-150
-200
-250
0
20
40
60
80
100
120


S Polarization Min.
PD Power (mW)
theta (deg.)
250
200
150
100
50
0
0
20
40
60
80
100
120


S Polarization Min.
Power Meter (mW)
theta (deg.)
250
200
150
100
50
0
0
20
40
60
80
100
120

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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
- Unquantifiable Environmental Conditions (i.e. temp. fluctuations)

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Acknowledgements

Mentors: Manasa, Eric Q., Koji Arai

All of the 40m staff, and LIGO SURF

Co-SURF Akhil Reddy

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