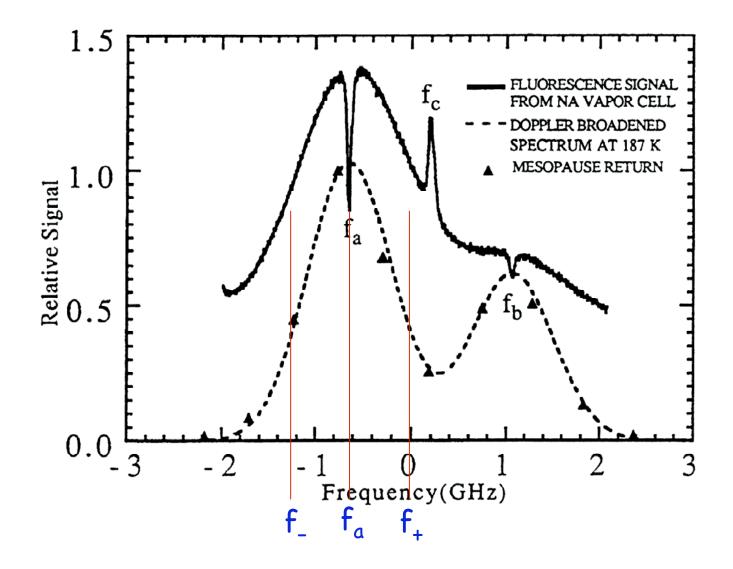
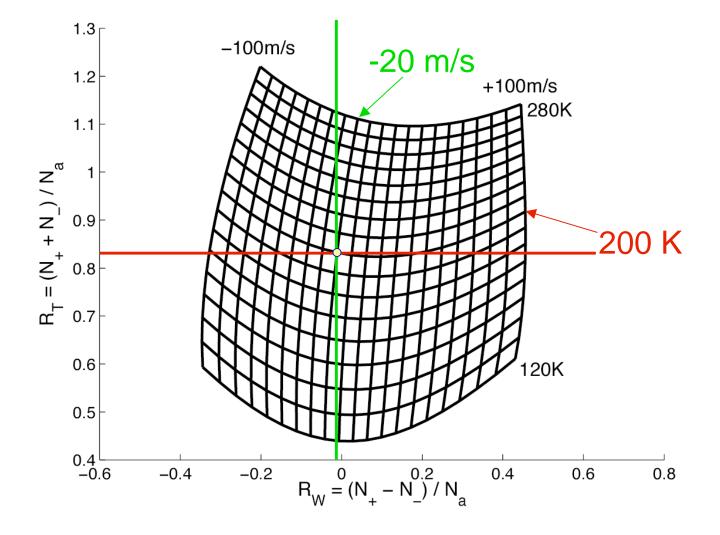
## Lecture 12. Temperature Lidar (3) Na Doppler Lidar Architecture

- Review Doppler ratio technique
- Introduction
- Na Doppler lidar instrumentation
- Na Doppler lidar transmitter
- Na Doppler lidar receiver
- DAQ & control system
- Summary

#### **Review of Doppler Ratio Technique**

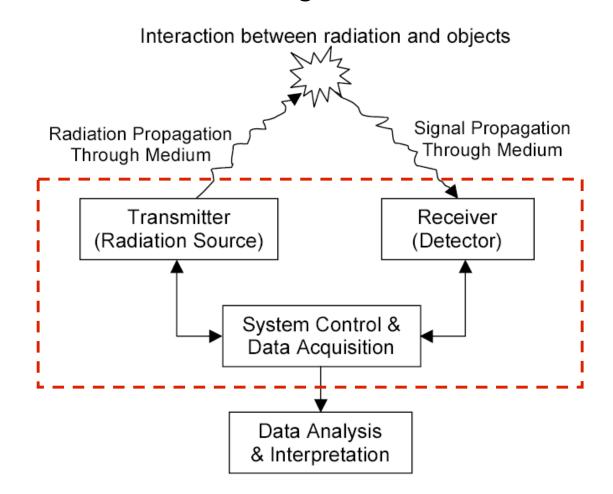


#### **Review of Doppler Ratio Technique**

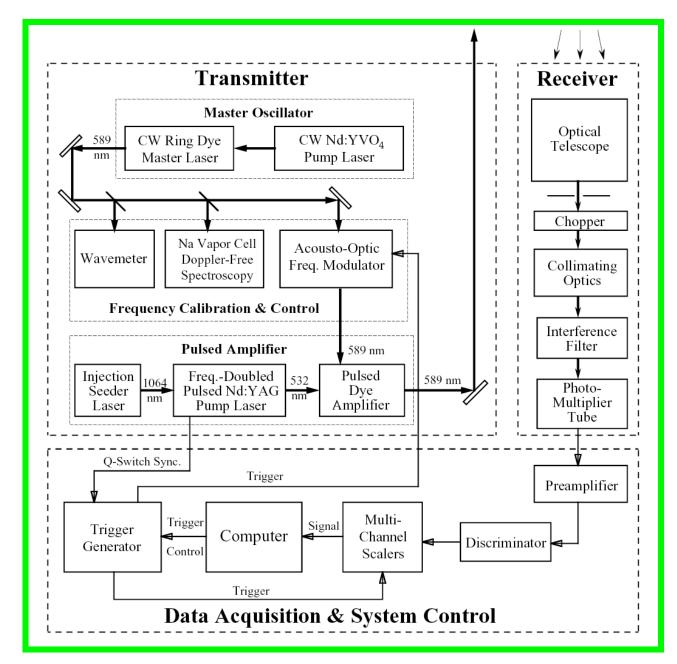


#### Introduction

# Lidar architecture is the art of lidar system instrumentation (including hardware and software).



#### Na Doppler Lidar Schematic

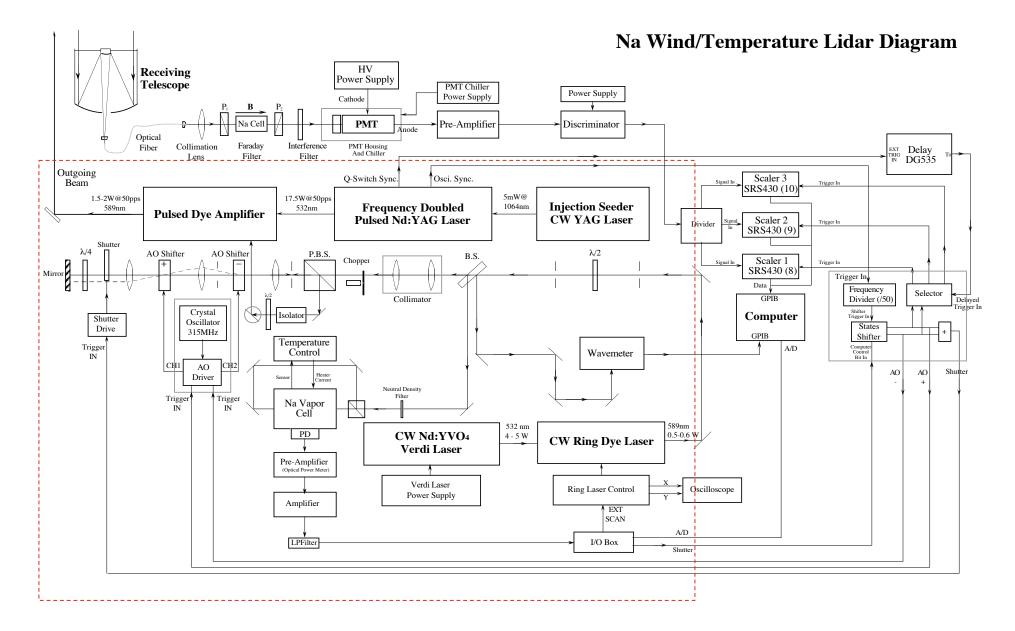


Dye-laser-based Na wind and temperature Lidar

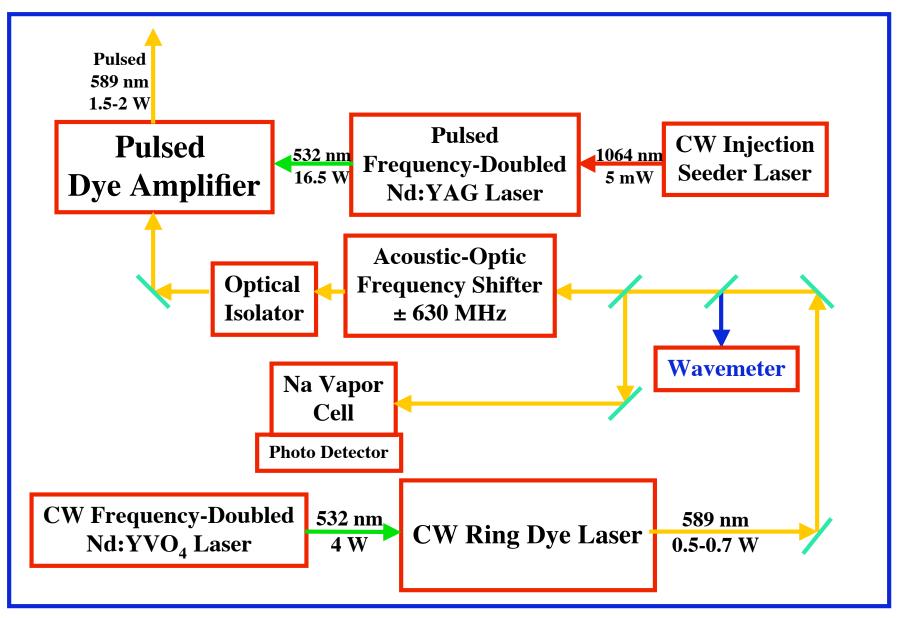
#### Large-Aperture Na Doppler Lidar



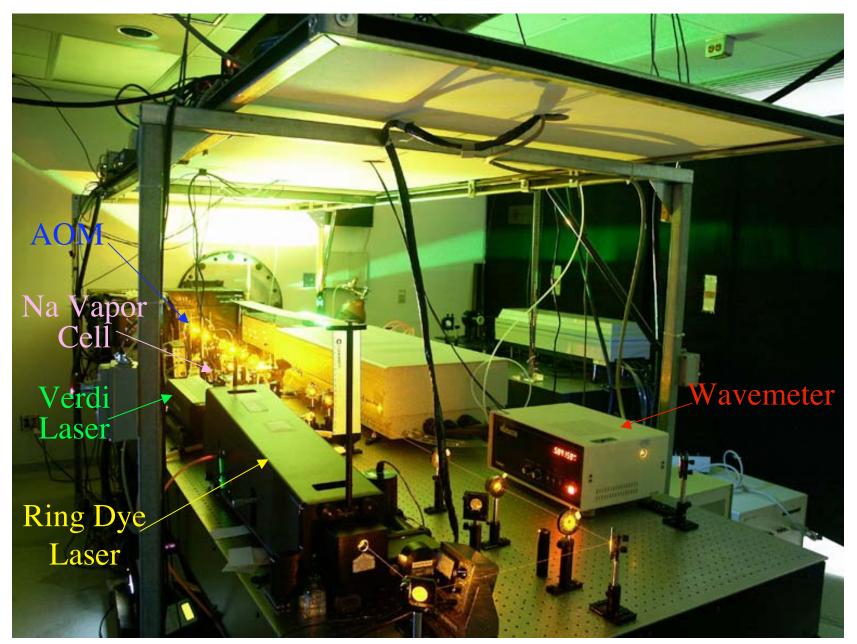
## Na Wind and Temperature Lidar



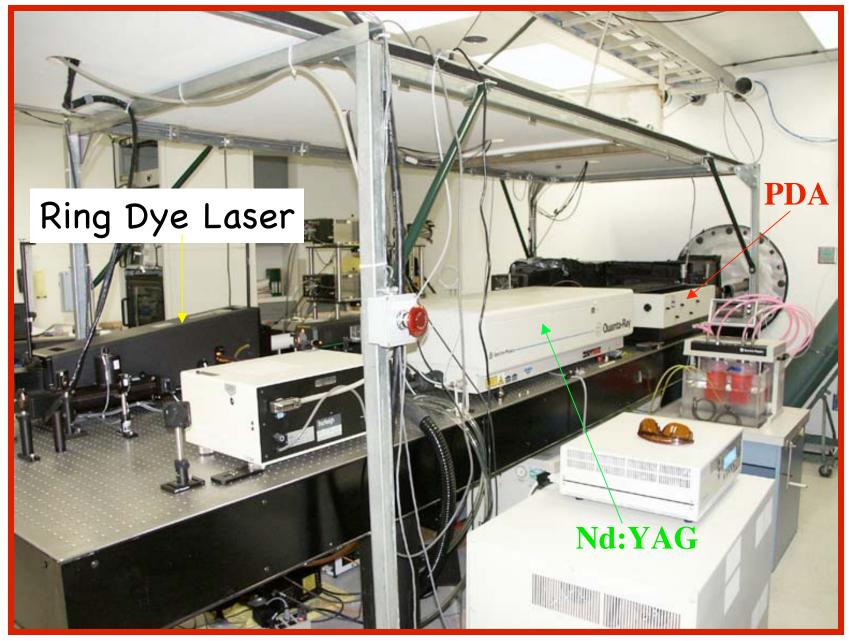
## Na Doppler Lidar Transmitter



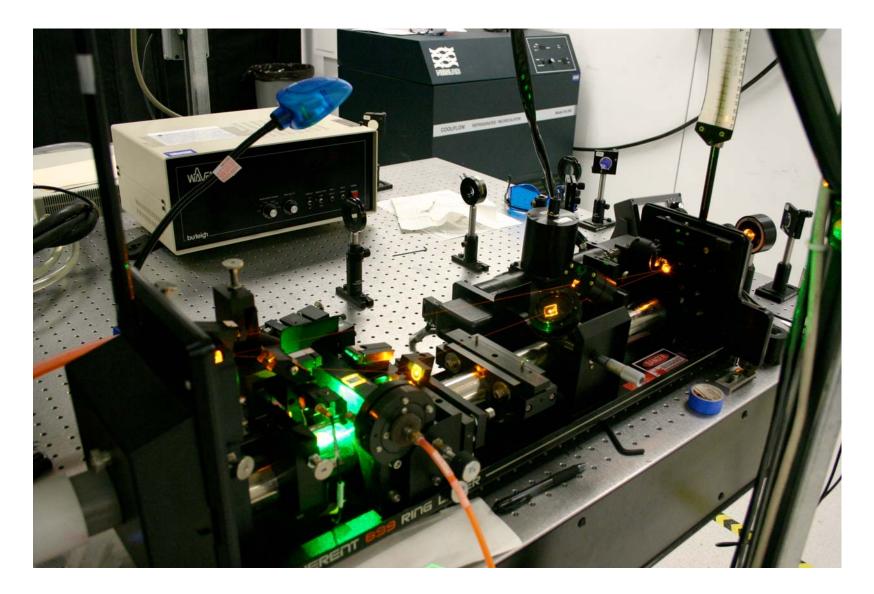
#### Na Lidar Transmitter



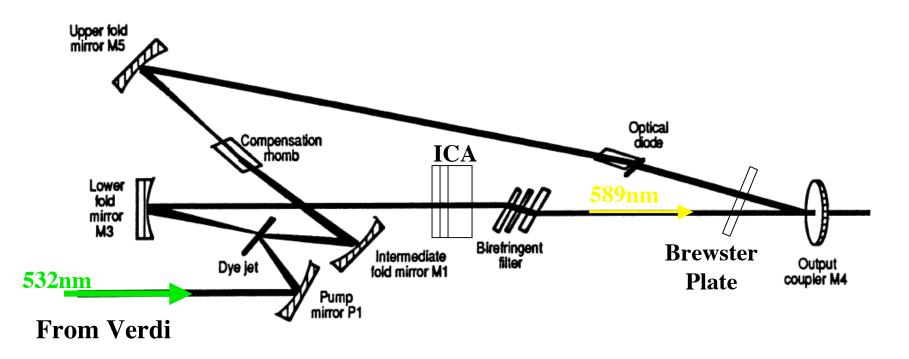
#### Na Lidar Transmitter



### Ring Dye Laser

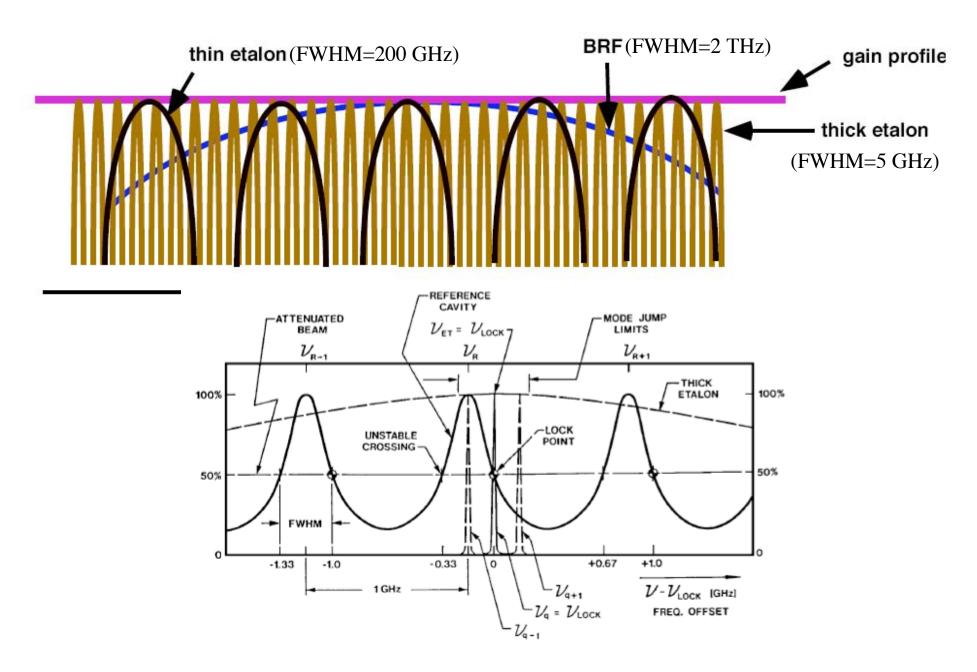


#### Ring Dye Laser

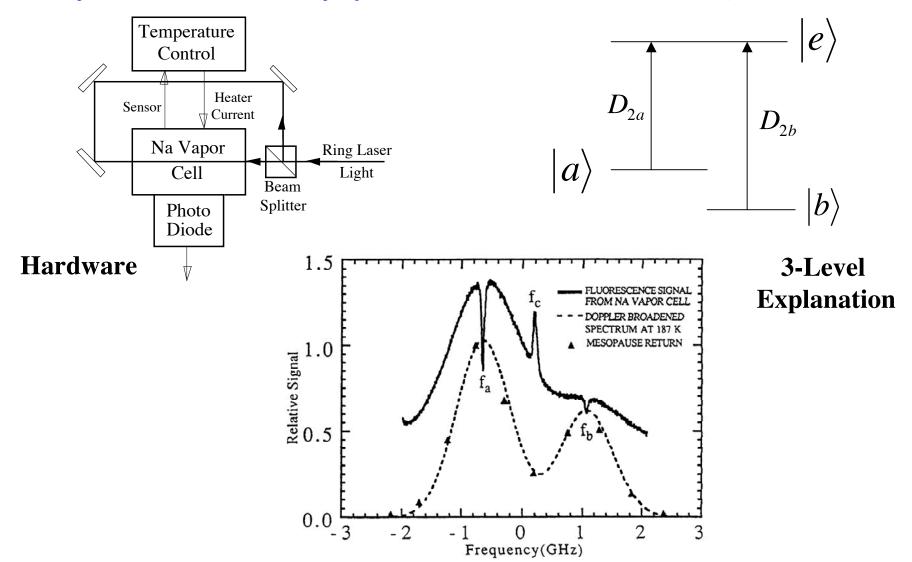


- **1. "Four mirror + Dye jet" form the laser resonance cavity.**
- 2. Unidirectional lasing prevents spatial hole-burning.
- **3.** Rhomb compensates the astigmatism effect.
- 4. Optical diode forces the unidirectional lasing.
- 5. BRF + ICA (etalons) select frequency and narrow bandwidth.
- 6. "Brewster plate + RCA + M3 PZT" actively control frequency.

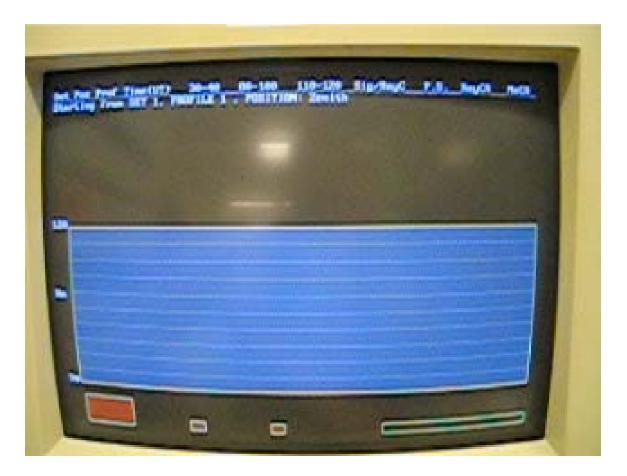
#### Frequency Selection in Ring Laser



### Na Doppler-Free Fluorescence Spectroscopy & Laser Freq Lock

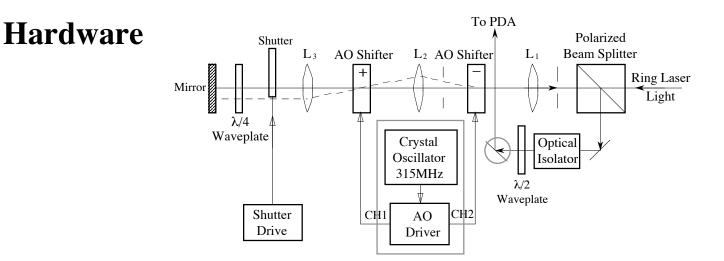


## Laser Frequency Scan and Lock

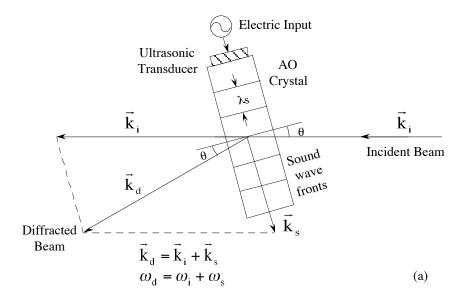


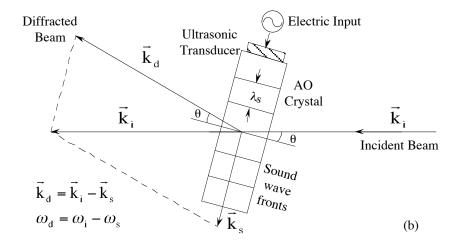
Use computer to scan laser frequency and lock it to the  $D_{2a}$  dip of the Na saturation-absorption spectroscopy.

### Acousto-Optical Modulator

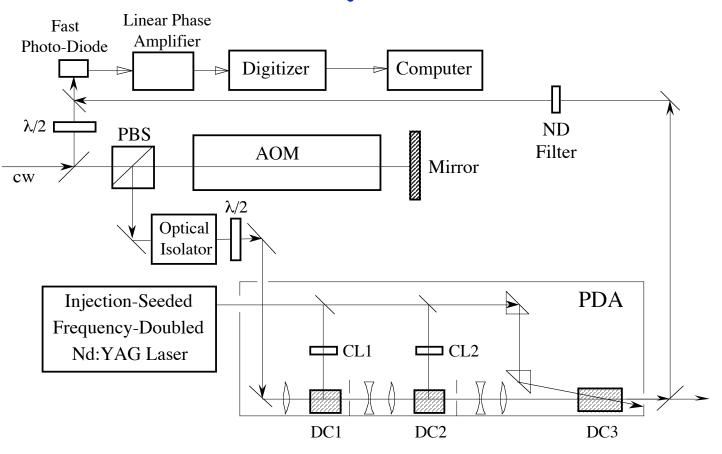


#### **Explanation: Doppler shift or Photon/Phonon Annihilation**



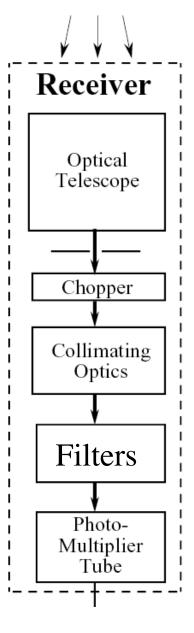


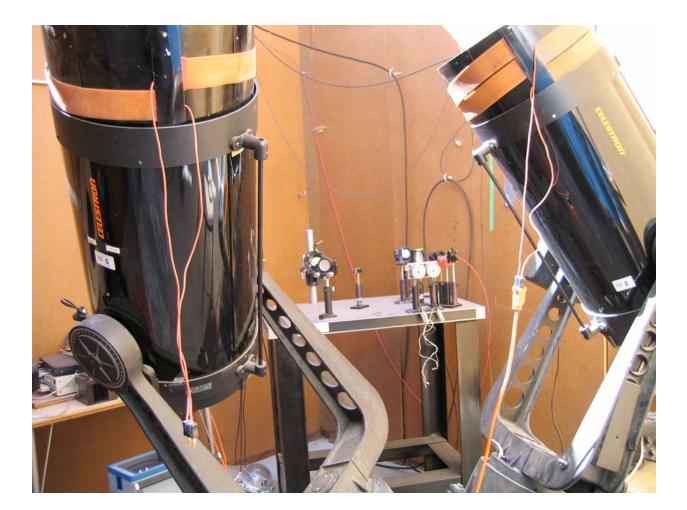
## **Pulsed Amplification**



- 1. Amplified Spontaneous Emission (ASE)
- 2. Injection-seeded Nd:YAG laser
- 3. PDA chirp caused by pulsed amplification

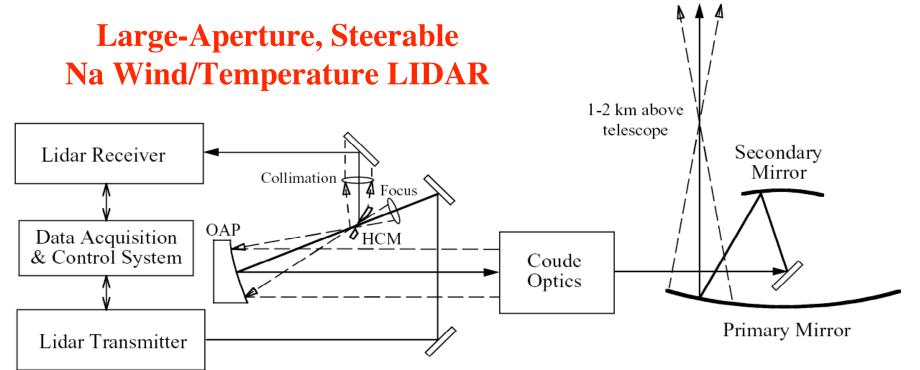
### Na W/T Lidar Receiver





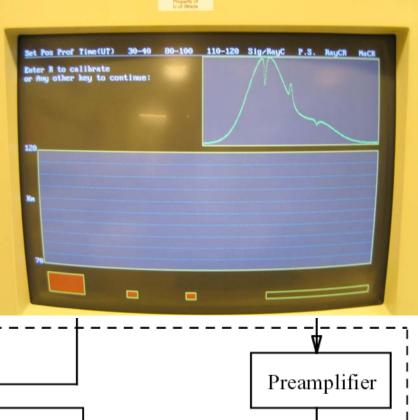
#### Steerable Na W/T Lidar at SOR and Maui

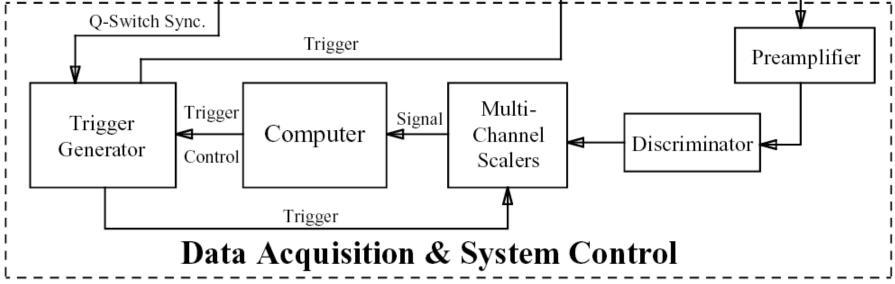




#### Data Acquisition and System Control

- □ Ring laser control
- Trigger timing control
- PMT + Discriminator
- Multichannel scaler





To Ring Laser Na Vapor Cell **Trigger Generator Box** Signal Return EXT. SCAN A/D I/O Box Computer To shutter driver OR Na Doppler Lidar System Control Computer Control Bit In States To AO driver Shifter GPIB ¥ ¥ Peak To SR430 (1) 8 Delayed Plus To SR430 (2) 9 Trigger In Selector Minus Frequency To SR430 (3) 10 Divider Trigger In 50 **O-Switch** Terminator Sync. Output **Frequency Doubled** HighZ TTL АЛ В Pulsed Nd:YAG Laser **Power Supply** #1 DG535 Lamp EXT. **Trigger Input** 50 СлD TRIG. IN TTL 50 50Hz 50Hz Terminator Sync. Input OUT #2 DG535 14 Division INT. TRIG. 700Hz Frequency Divider **Chopper Driver** (Multiply x4) ТО АЛВСЛО IN HighZ HighZ 700Hz 200Hz TTL ♦ TTL Command Frequency Control #1 Chooper #1 Chopper for Blanking PMT #2 Chopper Controller for blanking Ring CW beam Cooling Water & 28 V Power Supply its Power Supply

**Connection of Na Wind/Temperature Lidar System at MSSC** 



 Currently state-of-the-art Na Doppler lidar is the dyelaser-based Na wind and temperature lidar - "ring dye laser + pulsed dye amplifier" configuration.

• One main feature is the narrowband Na lidar transmitter with precise frequency control and narrow laser linewidth: Na Doppler-free fluorescence spectroscopy for frequency calibration and locking, acousto-optic frequency modulator for generating two wing frequencies with high stability and fast switching, pulsed amplification with very low ASE.

The lidar receiver (broadband) and DAQ subsystems have various styles and forms. They are also progressing rapidly.

■ Na Doppler lidar can be realized with other laser configurations, e.g., solid-state Nd:YAG laser frequency mixing, or alexandrite laser Raman shift, etc.