

# **Robo-AO: Control Hardware**

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# Robo-AO Vision



Deploy and demonstrate a robotic laser adaptive optics and visible/IR science system

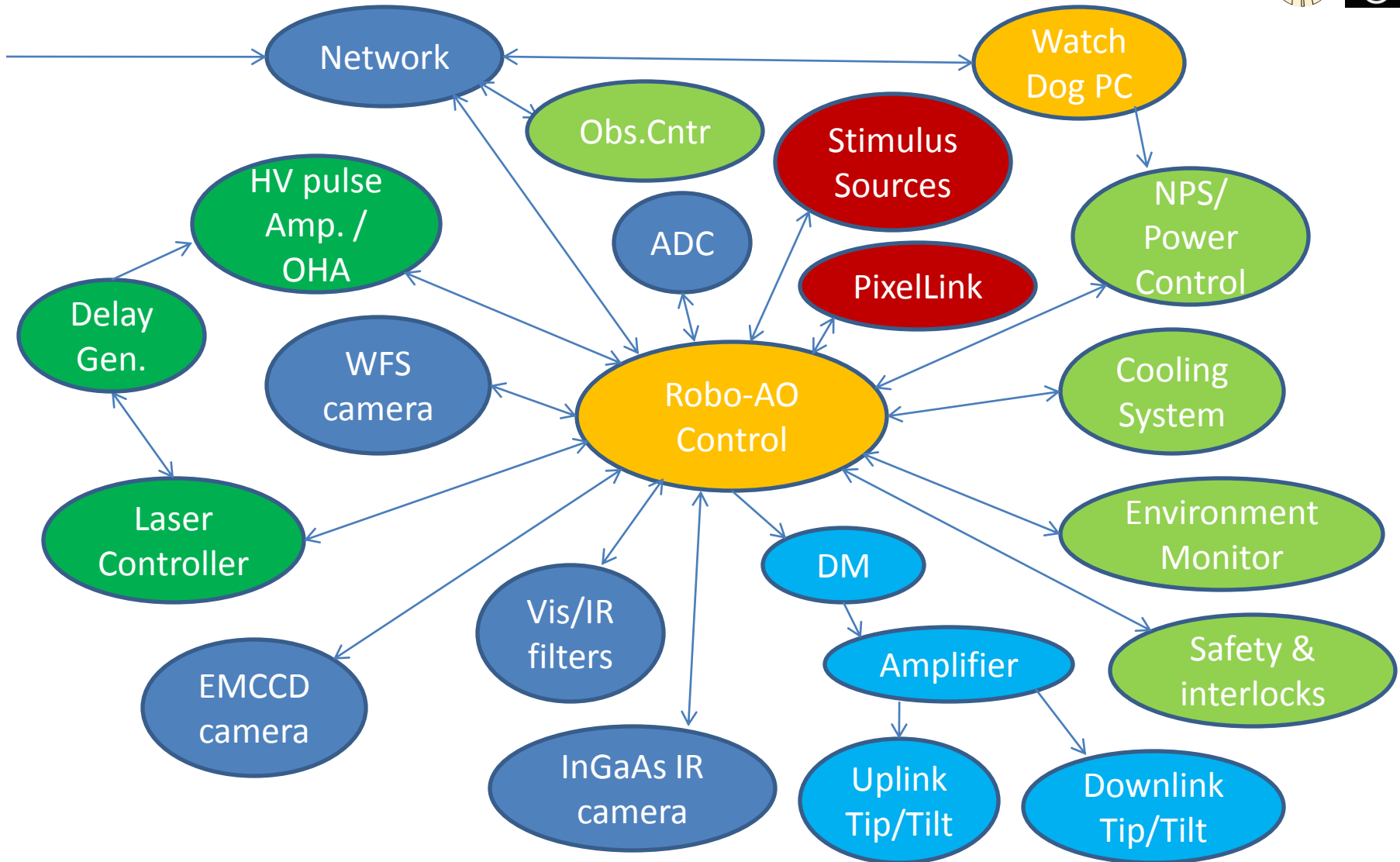
Make it affordable and replicable for the world's 1-3 m class telescopes

# Making it cost effective



- 12 W, 355 nm commercially available laser
- Off the shelf components – Buy widely used parts and write a device interface software for it if required.
- Architecture allows easy replacement / addition of any of these components.
- Single PC as a robotic controller and data acquisition system
- Complete in-house software development

# Robo-AO Control Hardware



# RoboAO PC interface

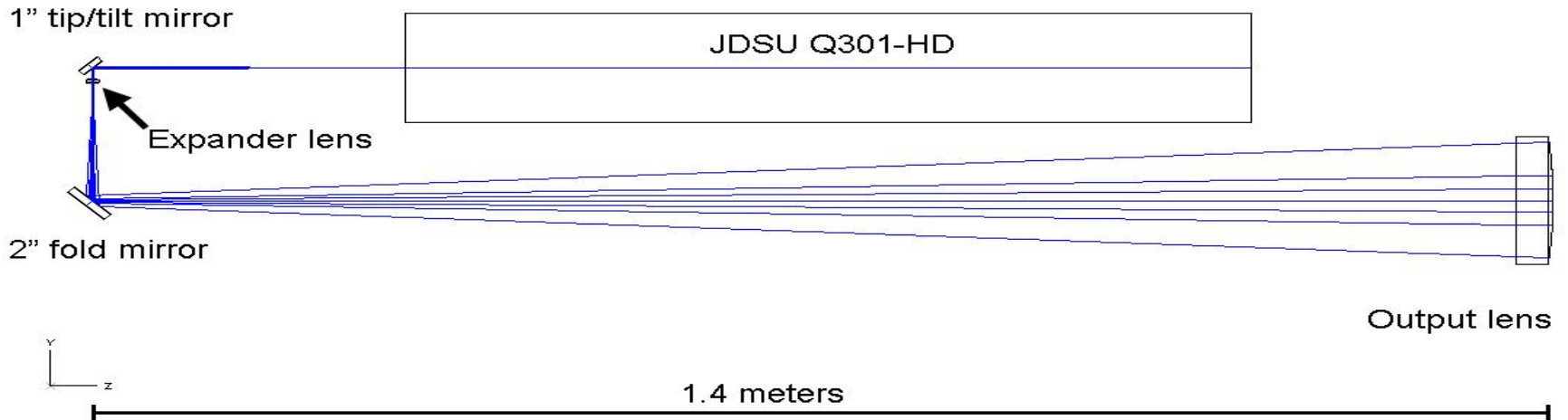
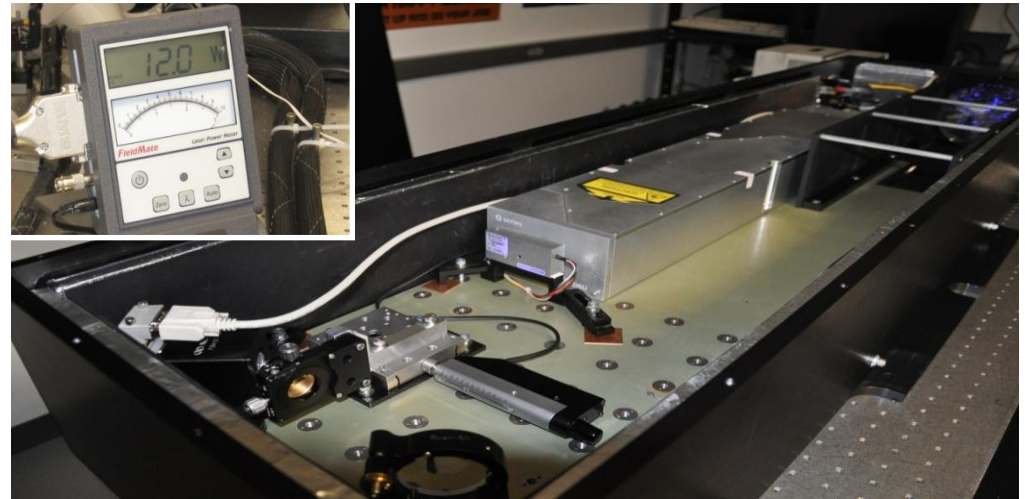


Name of the unit	RoboAO control PC interface	Name of the unit	RoboAO control PC interface
JDSU Power supply	Serial port	Remote Client PC	Ethernet
Weather Monitoring System	Pseudo USB	Watch dog computer	Ethernet, Serial
Analog / Digital IO	Pseudo USB	Universal Motion controller	Serial port
Deformable Mirror	USB 2.0	Pixel Link camera	Fire-wire IEEE1394
AndOR camera	PCI Frame grabber	TCS/OCS	Ethernet
InGas Camera	USB 2.0		
WFS camera	Camera Link		
NPS	Serial / Ethernet		
Filter wheels	3 pseudo USB		

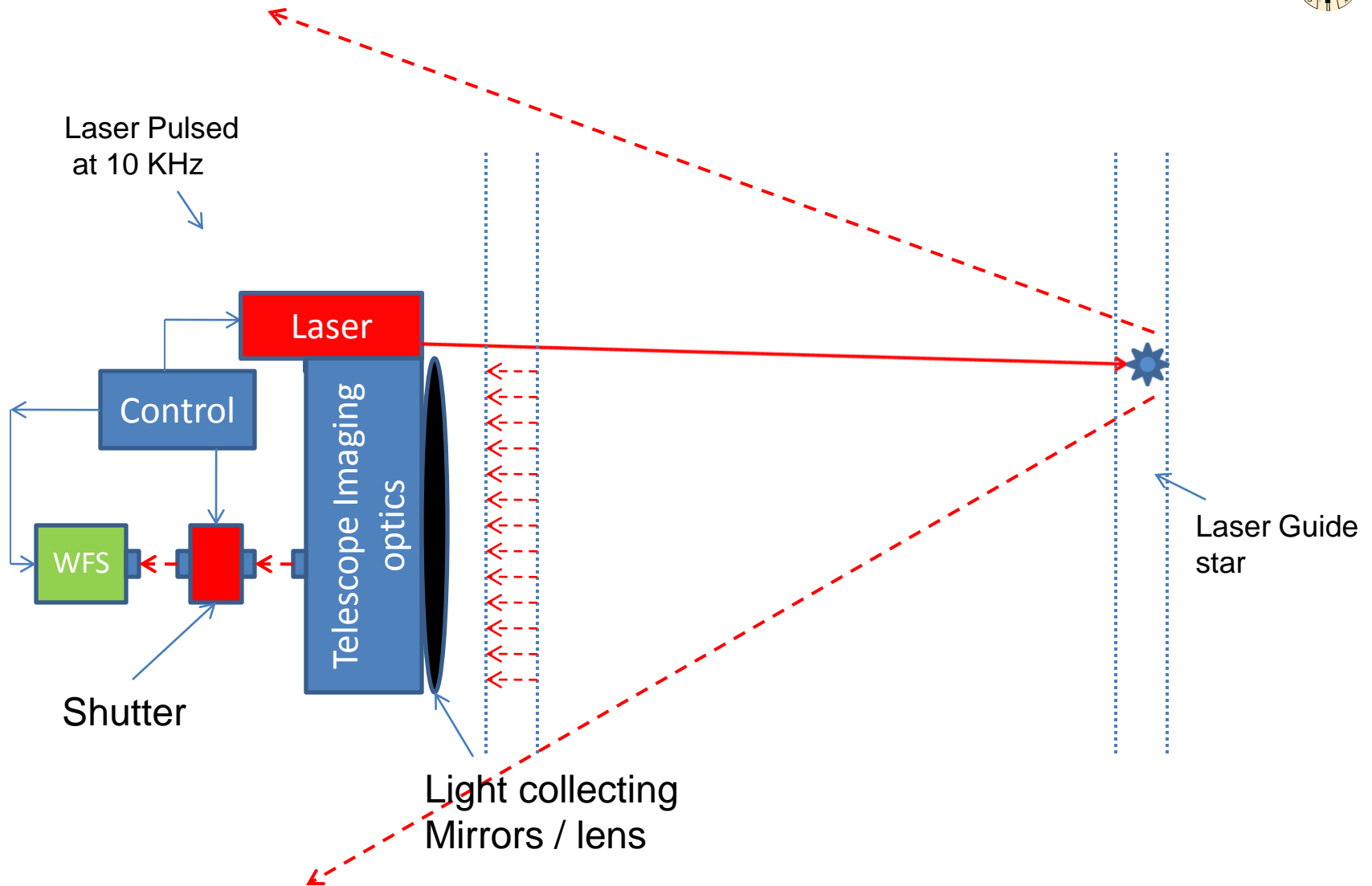
# UV Rayleigh laser guide star



12 W @ 10 kHz, 355nm



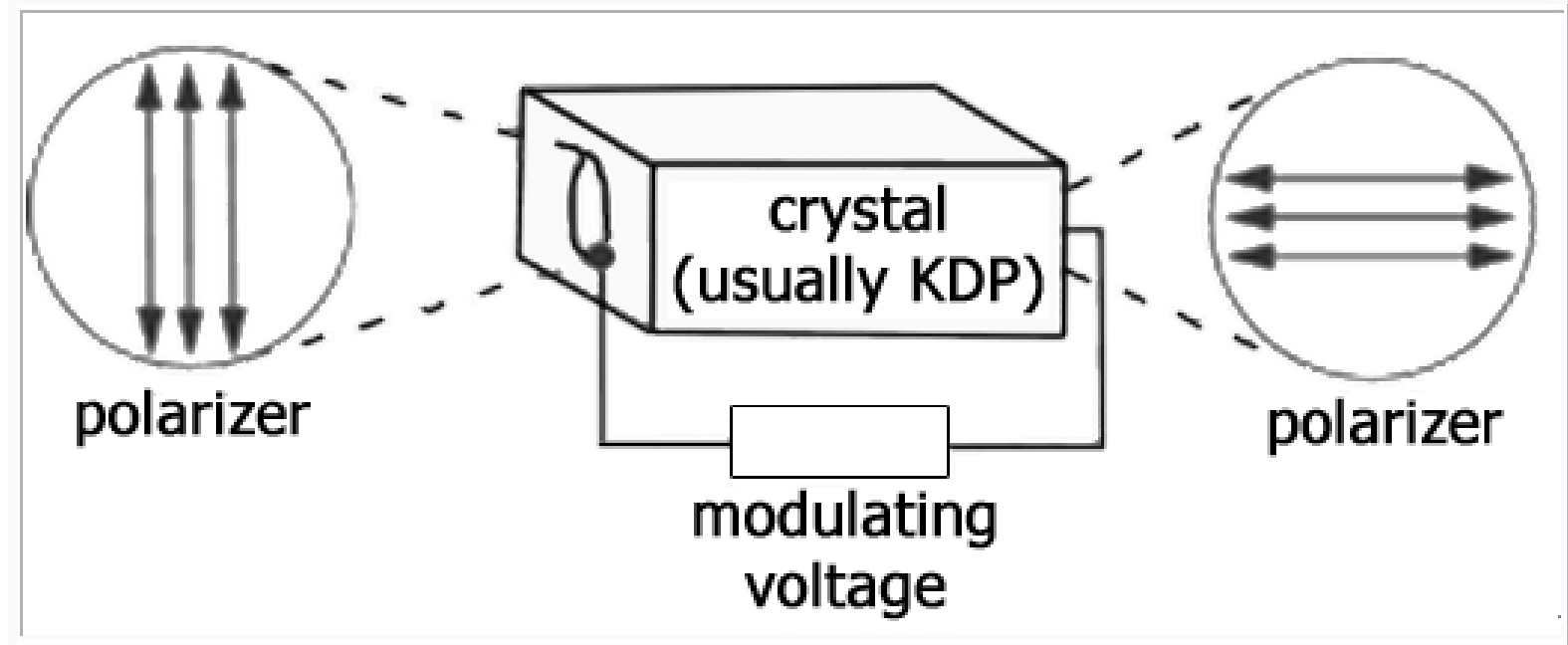
# Range Gating System



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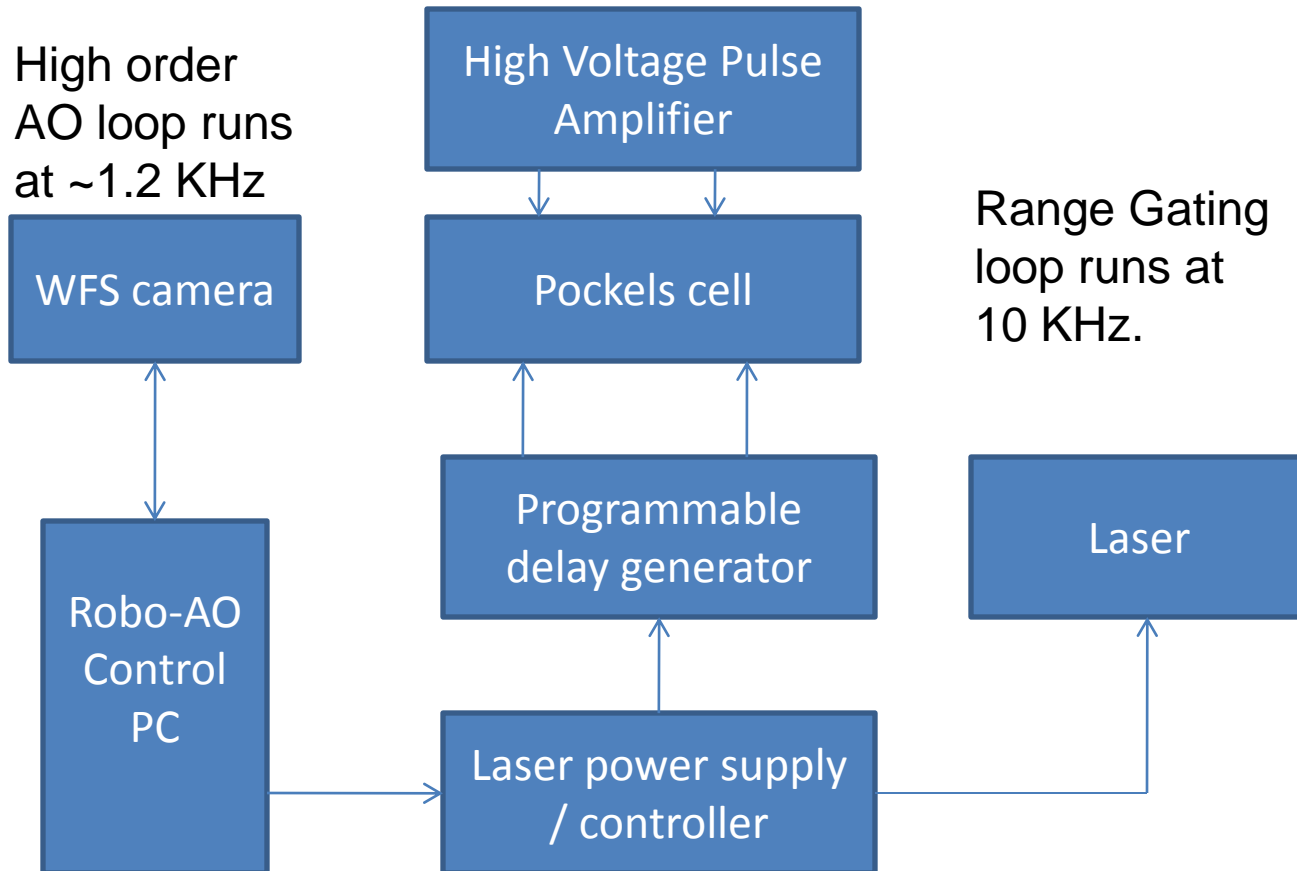


- Pockels Cell with polarizer as shutter





# Range Gating System



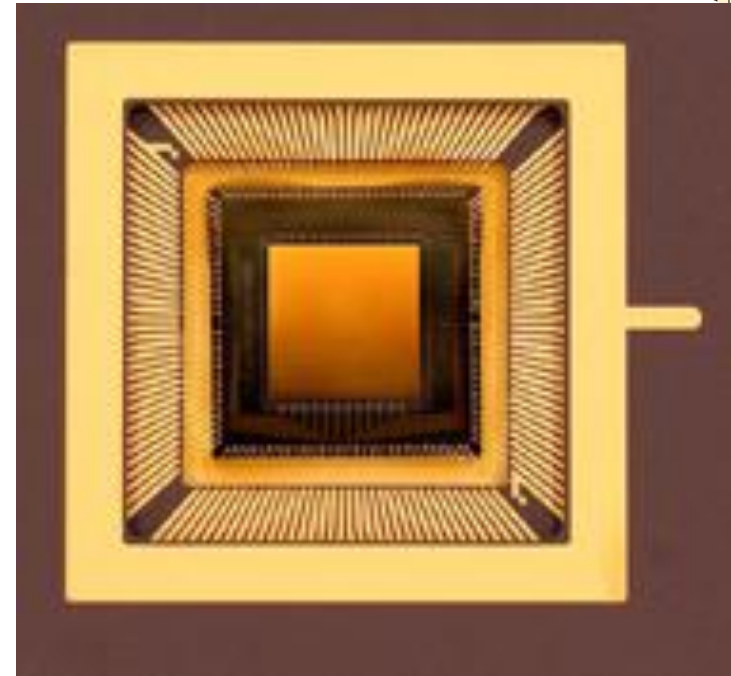
# Range Gate system



- Beta Barium Borate (BBO) Pockels Cell
- Variable retarder (1/2 wave at ~5kV)
- Switches at 10kHz, <math><100\text{ns}</math> rise, ~2  $\mu\text{s}$  gate (10 km, 650m range gate)
- Crossed-polarizer at entrance and exit



# Deformable mirror



- MEMS Deformable mirror on a chip (Boston Micromachines)
- 3.5  $\mu\text{m}$  stroke, 140 actuators, USB interface, very economical

# DM Controller



- Continuous membrane surface
- Clear Aperture 4.4 mm
- Actuator Pitch 400  $\mu\text{m}$
- Max Voltage of Driver 285 V
- 16 Bit Driver : 65536 data numbers
- 160 DACs, 144 actually used
- Aux output for timing and status plus four low – voltage analog outputs

# Tip/Tilt controller

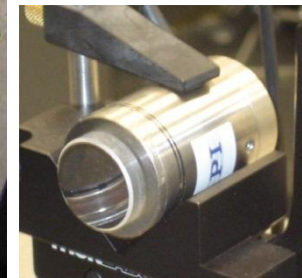
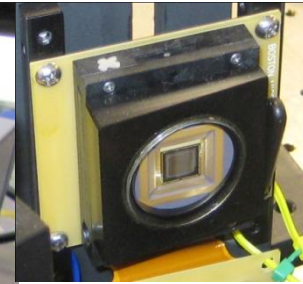
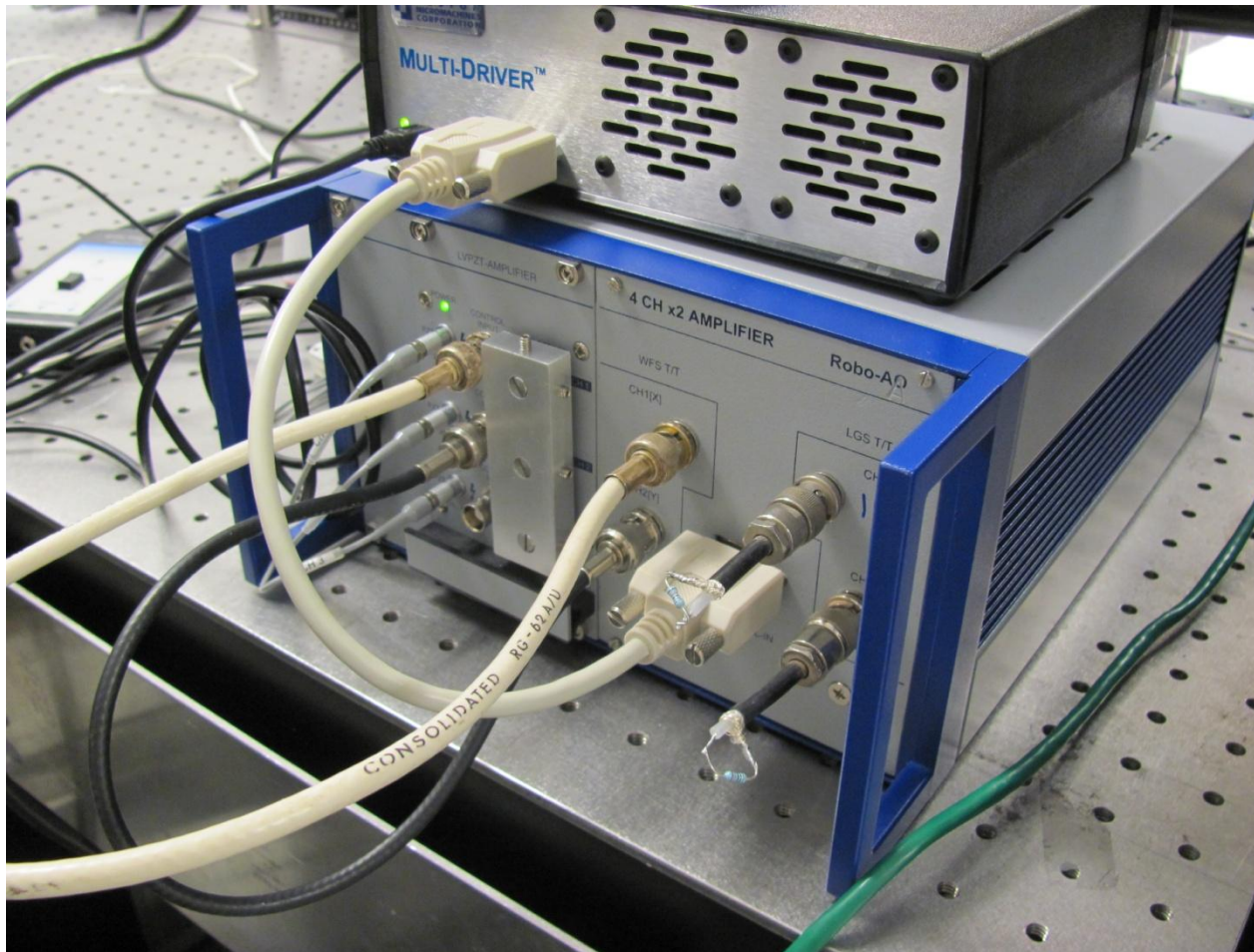




# FSM for uplink jitter control



# DM controller as DM+ downlink and uplink Tip/Tilt controller



# Tune to your need



- Similar DM controller available for variety of deformable mirrors with varying size and number of actuators
- Same hardware could be used to drive variety of tip/tilt mirror platform OR fast steering mirrors
- Software for the above can easily be reconfigured as per the requirement





# Thank you