Progress Report on He3 Target

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Transversity Collaboration at JLab

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† Overview †

† Reversal of the Laser Polarization †

† Test on the Liquid Crystal Variable Retarder †

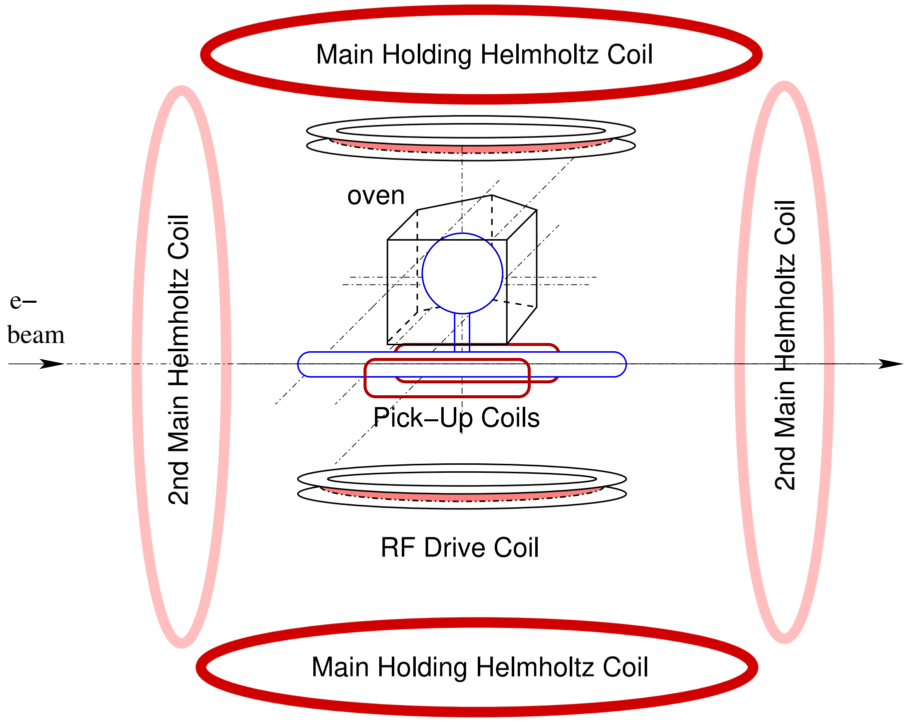
Overview of the He3 target system

- General improvements
  - cell design: bigger pumping cell?
  - gas filling: less laser power, longer lifetime, higher polarization and higher current with hybrid cell at higher oven temperature?
  - cabling: 5-1 combiner; power loss in the fiber connection
- Changes driven by GEN experiment
  - new target design with holding field provided by the magnet box: shield the magnetic field of BigBite.
  - NMR with frequency sweep: less interference with the magnet box; larger noise for water calibration.

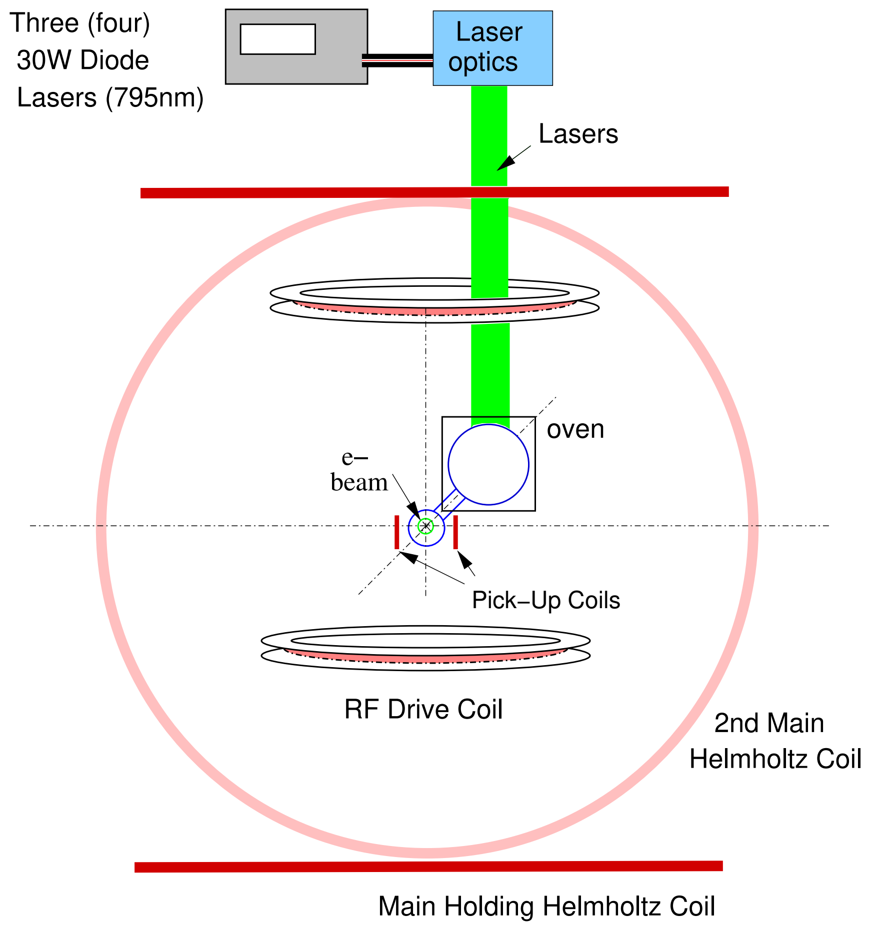
Combined contributions from UVA, W&M, Kentucky, JLab...

- Changes required by transversity experiment
  - NMR with frequency sweep: faster target spin flip (partially done)
  - fast reversal of the laser polarization (working on)
  - another set of coils for vertical holding field: (coil designing and assembling)
  - vertical laser path: rotate the target cell by 45° and create an open path near the target ladder; shift away the closing tip on top of the target cell (oven/path designing and cell making)
  - correcting/shielding the magnetic field of BigBite: (previous experience in correcting septum field)
  - more design work: another set of RF coil for NMR to measure vertical polarization; other laser paths. (second priority)

    Most work can be done in a parallel way.



Side View



Beam View

Reversal of the Laser Polarization

- Goal: to flip the laser beam frequently (on the level of minutes) with $\bar{\lambda} = 795$ nm, $D \sim 2''$.
- Possible solutions:
  - motorized transporter+half-wave plate
    Speed is a big constrain.
  - motorized rotary stage+quarter-wave plate
    Standa 8MR180-2: speed=1 turn/min or greater; 0.01 deg angular resolution.
  - variable retarder
    Pockels cell: short response time; high voltage; small aperture
    Meadowlark liquid crystal variable retarder: low voltage AC waveform; $D = 0.70'', 1.6''$ with temperature control option (or $2''$ available); 0(+30 nm) to half/full-wave with (without) compensator.

Motorized Rotary Stage

- $2''$ Motorized Rotation Stage 8MR180-2-28 with the faster motor

  1 pc. $ 1107; 4 pcs. $ 1052 ea

- Step Motor Controller:

  8SMCC PCI1 for one axis: 1 pc. $ 543

  8SMCC PCI3 for three axes: 1 pc. $ 1143

  8SMC1-USB-B1-1PS for one axis: 1 pc. $ 396

  8SMC1-USB-B2-4PS for four axes: 1 pc. $ 1224

- Power Supply:

  40UY100 Acopian Power Supply 40V, 1A (for one rotation stage) $ 130

  40UY500 Acopian Power Supply 40V, 5A (for four rotation stages) $ 165

- Shipping and handling: $ 150

- Delivery: 3-4 weeks ARO


Standa

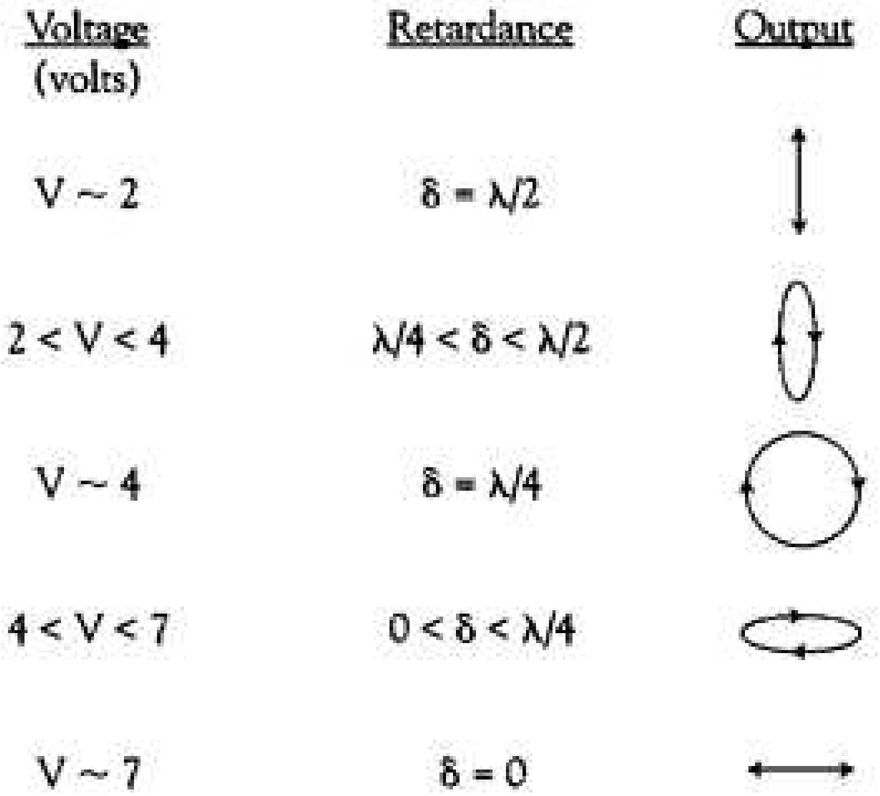
LCVR Ordered for Compton

Liquid Crystal Variable Retarder	
Substrate Material:	Synthetic fused silica
Retarder Material:	Nematic Liquid Crystal
Outside Diameter:	1.00 $\pm$ 0.005 in
Clear Aperture:	0.37 in
Transmitted Wavefront Distortion (at 632.8 nm):	λ/4
Beam Deviation:	2 arc min
Reflectance (per surface):	0.5% at normal incidence
Temperature Dependence of Retardance;	-0.4%/$^\circ$ C
Recommended Safe Operating Limit:	500 W/cm^2 CW
Basic Liquid Crystal Controller	
Output Voltage:	2 kHz AC square wave
Amplitude Modulation:	0-10 V (rms)
Modulation Resolution:	1 mV
DC Offset:	$<$ 5mV
PC-Controller Communication Interface:	USB 1.1 or RS232
LC cell to Controller Connection:	Coax cable w/ SMA(SMB)
Power Requirements:	100-240 VAC, 47-63 Hz, $<$5W
Weight:	$<$2.0 lbs

Tests on LCVR

- Retardance
- Response Time
- Stability/Repeatability of the system with LCVR
- Stability/Repeatability of the system with quarter-wave plate

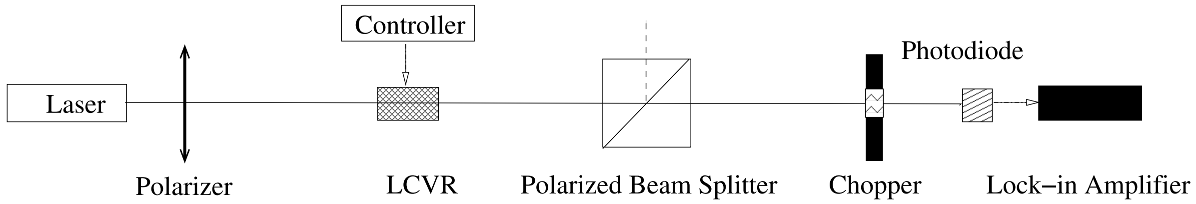
Basic Optics



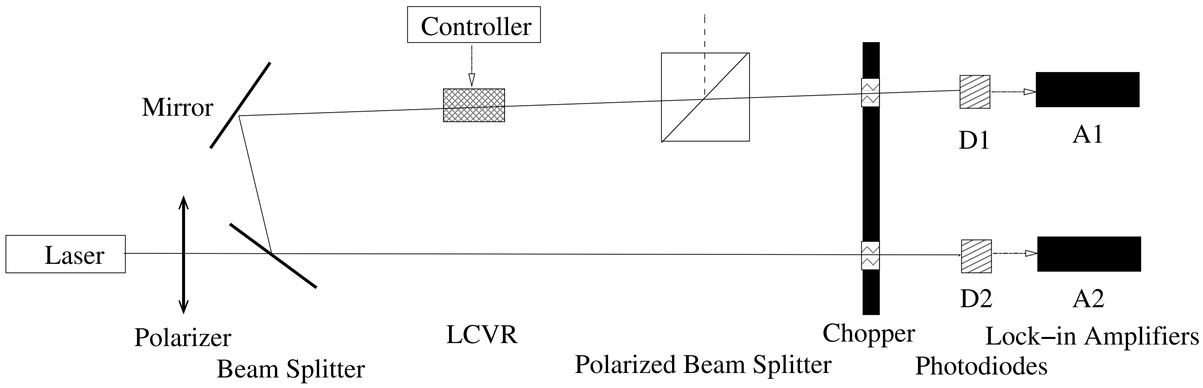
Voltage (volts)	Retardance	Output
V ~ 2	$\delta = \lambda/2$	
2 < V < 4	$\lambda/4 < \delta < \lambda/2$	
V ~ 4	$\delta = \lambda/4$	
4 < V < 7	$0 < \delta < \lambda/4$	
V ~ 7	$\delta = 0$	

Output polarization forms from different retradance values of a compensated LCVR with a horizontal linearly polarized input.

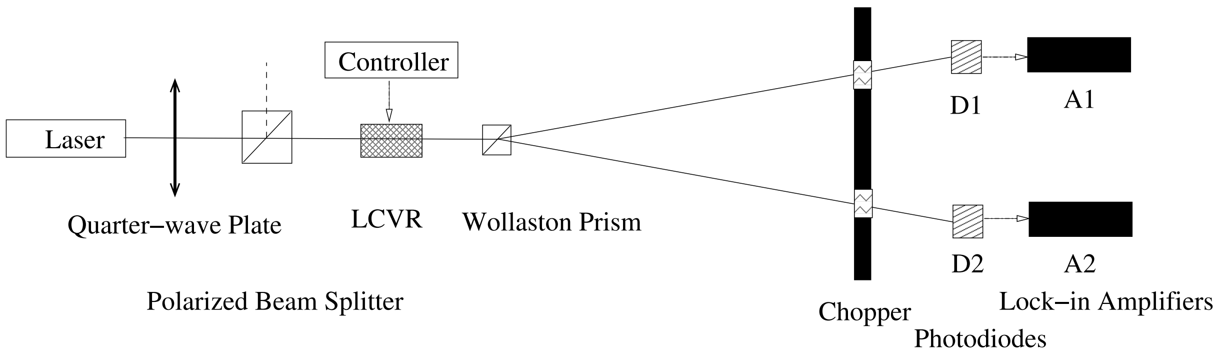
Optical Setup



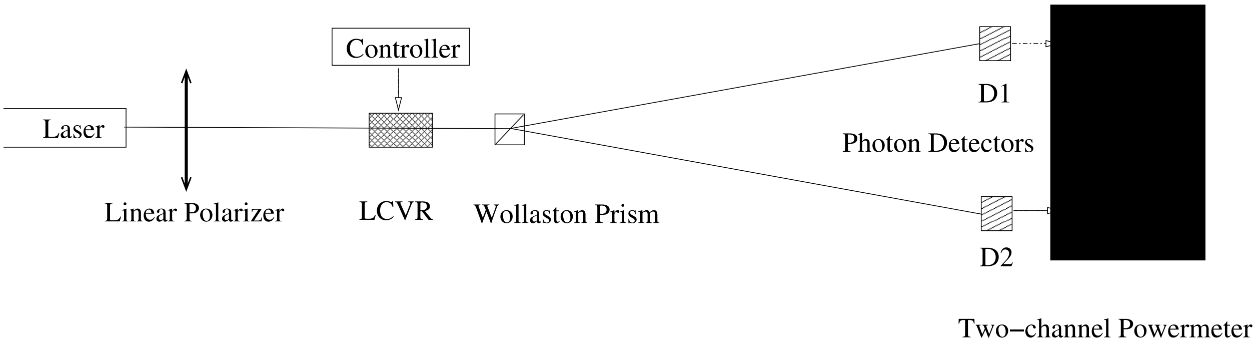
(a)



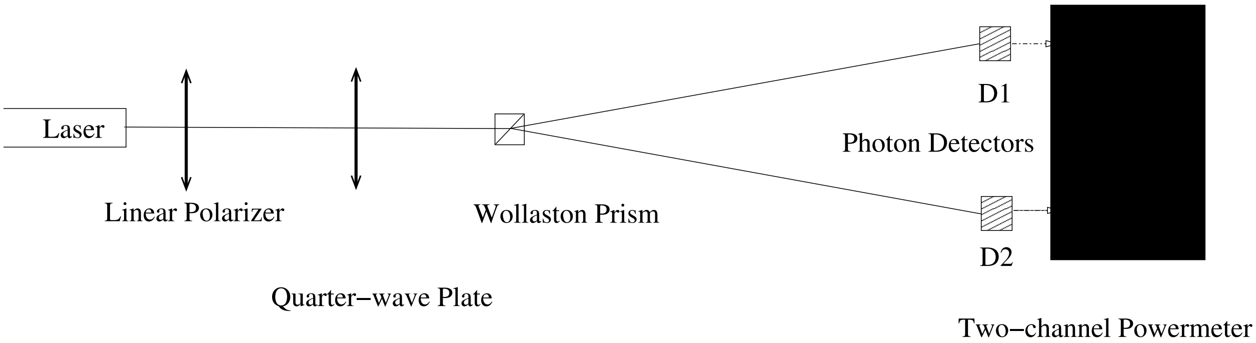
(b)



(c)

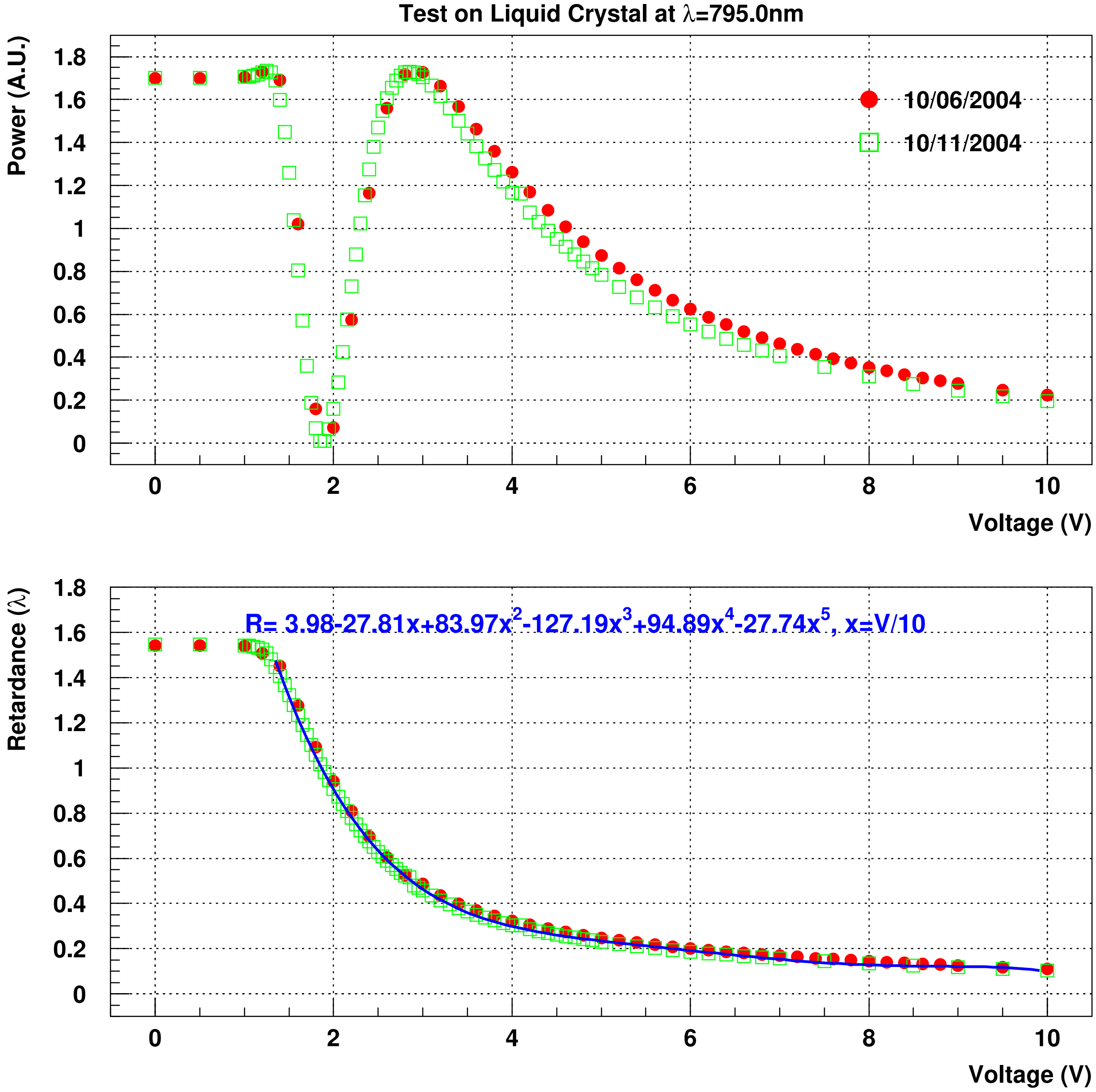

Controller
Laser
Linear Polarizer
LCVR
Wollaston Prism
D1
Photon Detectors
D2
Two−channel Powermeter

(d)


Laser
Linear Polarizer
Wollaston Prism
Quarter−wave Plate
D1
Photon Detectors
D2
Two−channel Powermeter

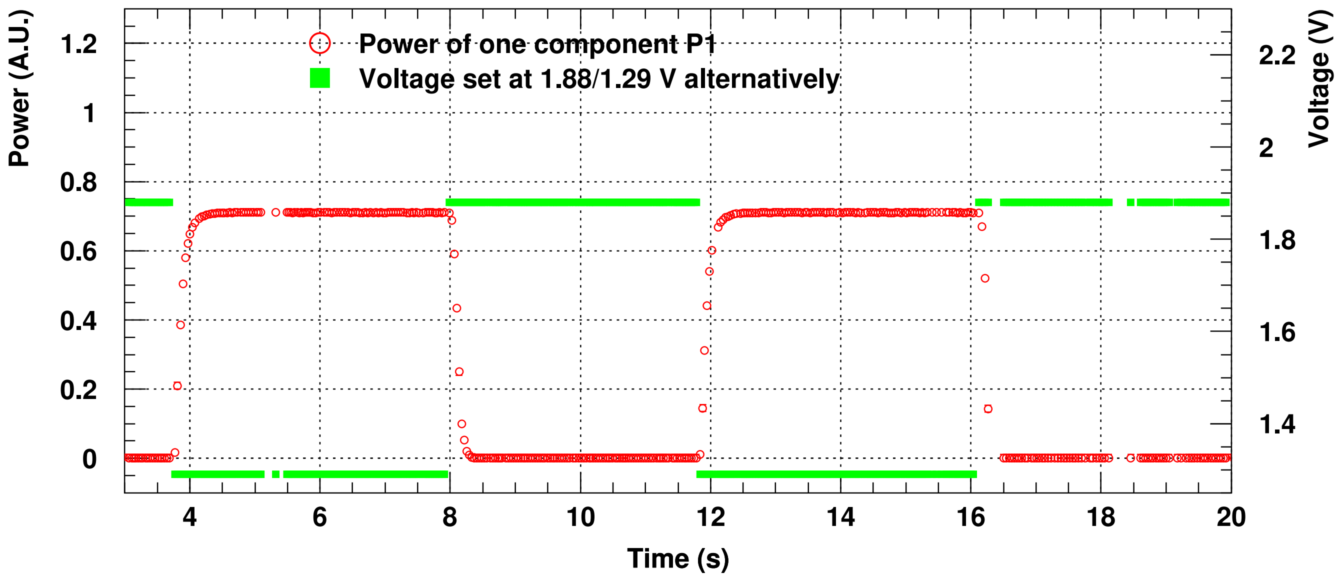
(e)

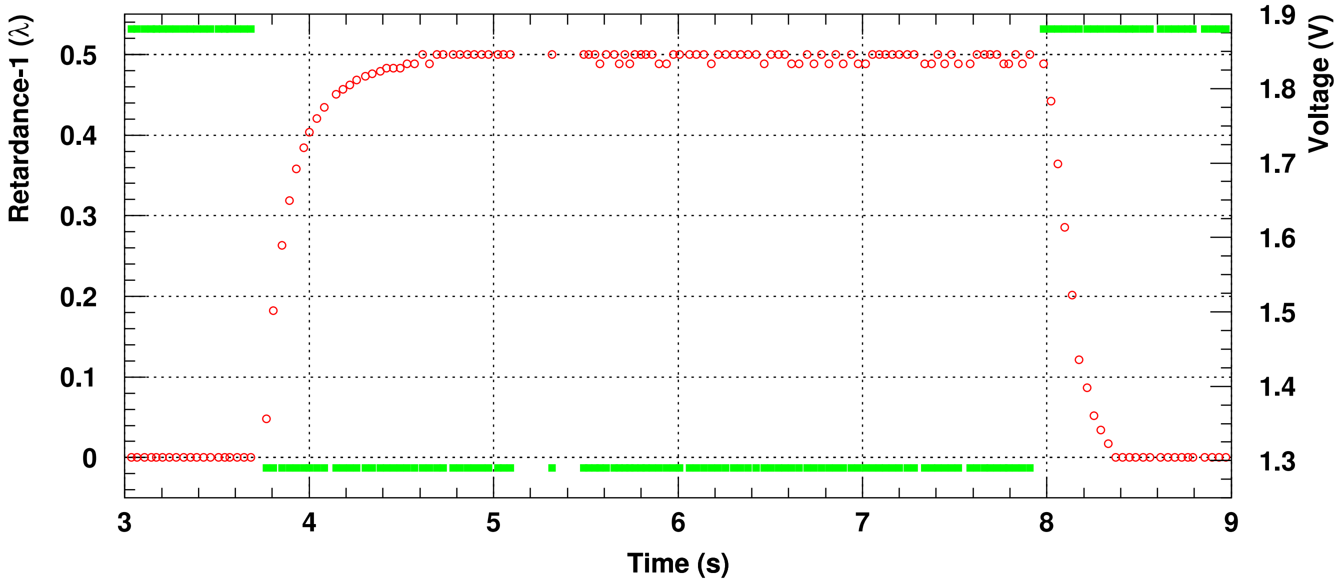
Retardance



The retardance of LCVR versus the applied voltage, the amplitude of the AC 2KHz square wave. It was measured with optical setup (a).

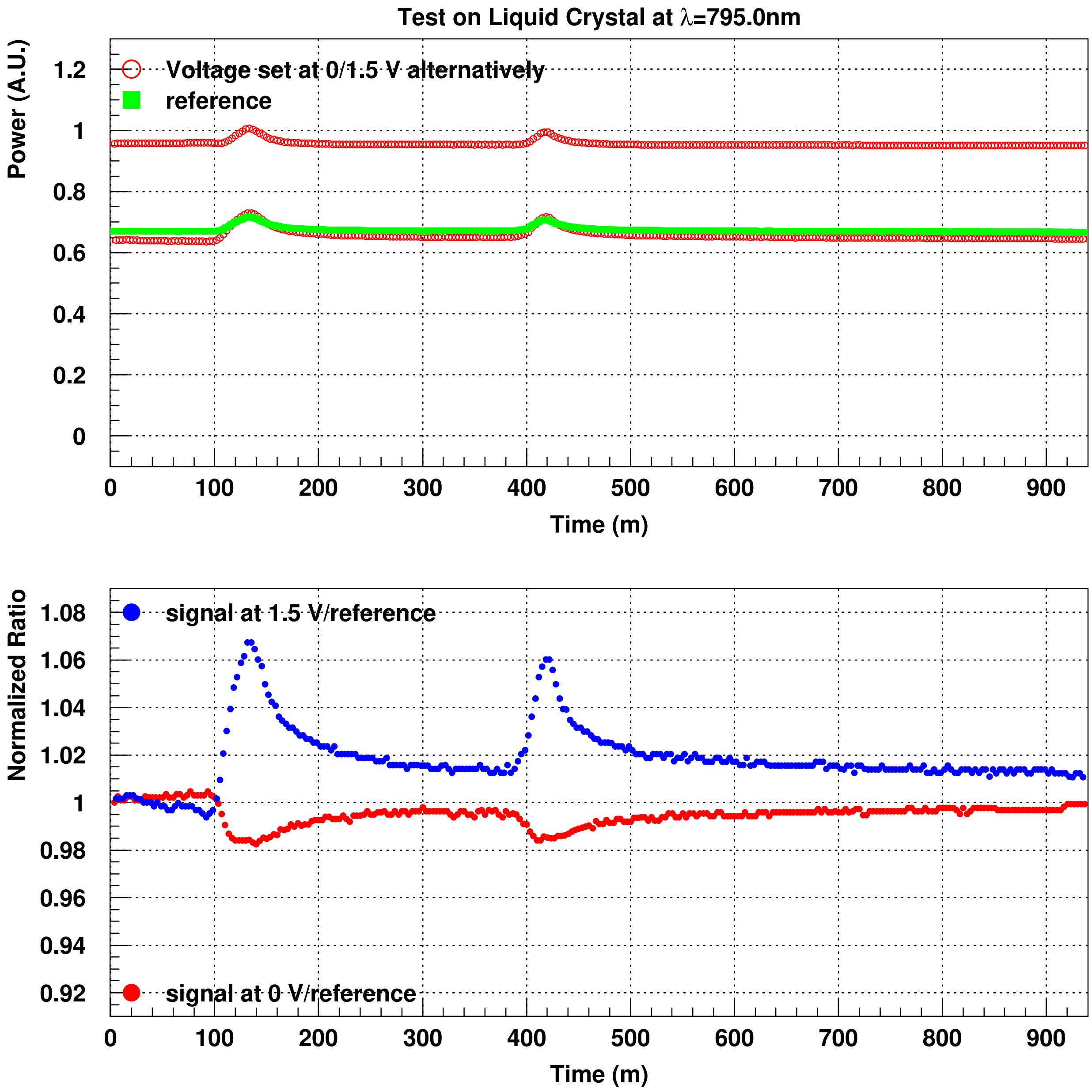
Response Time



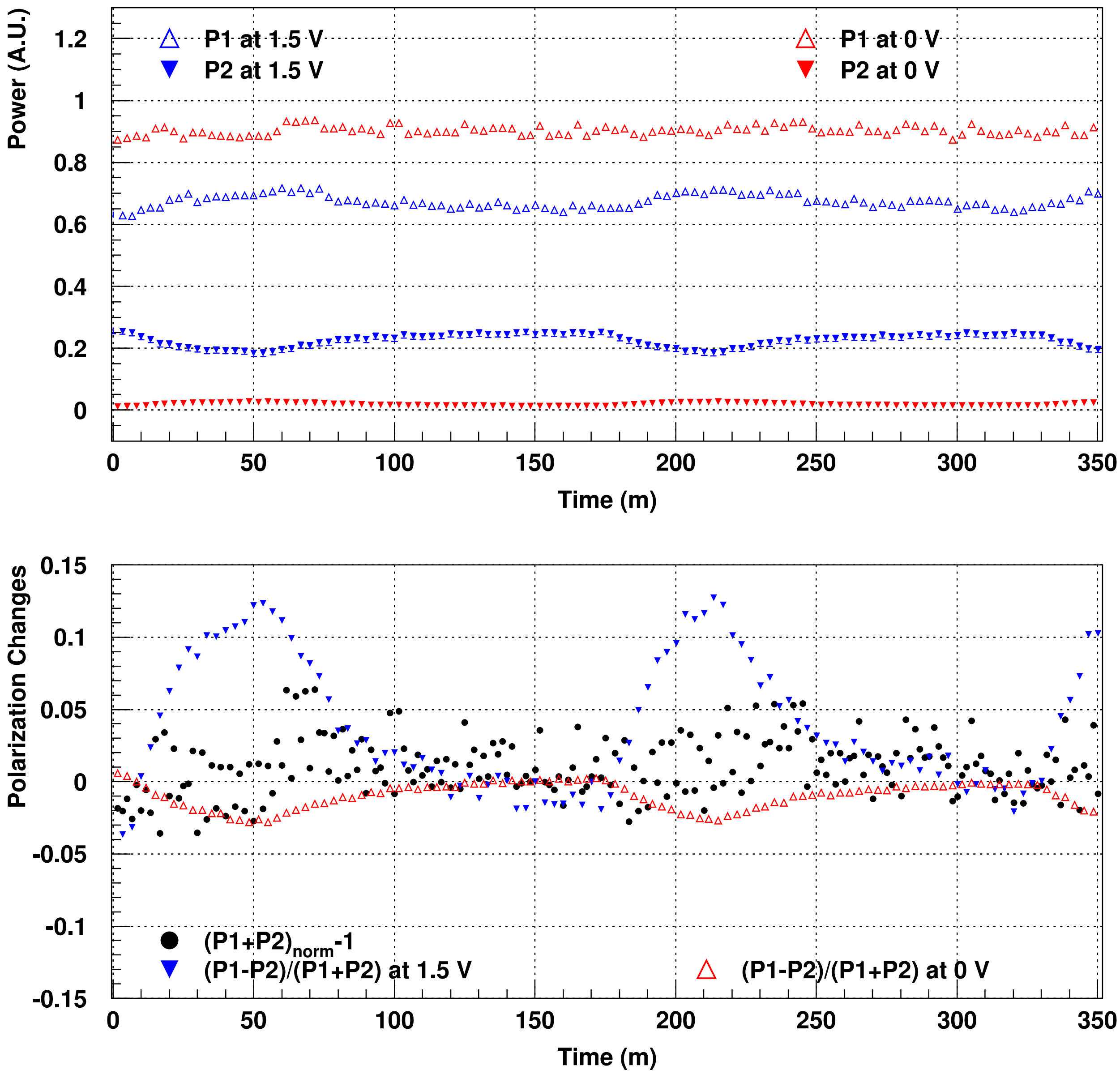


The response time of LCVR setup (a) with the lock-in amplifier at reference frequency of 1.4 kHz.

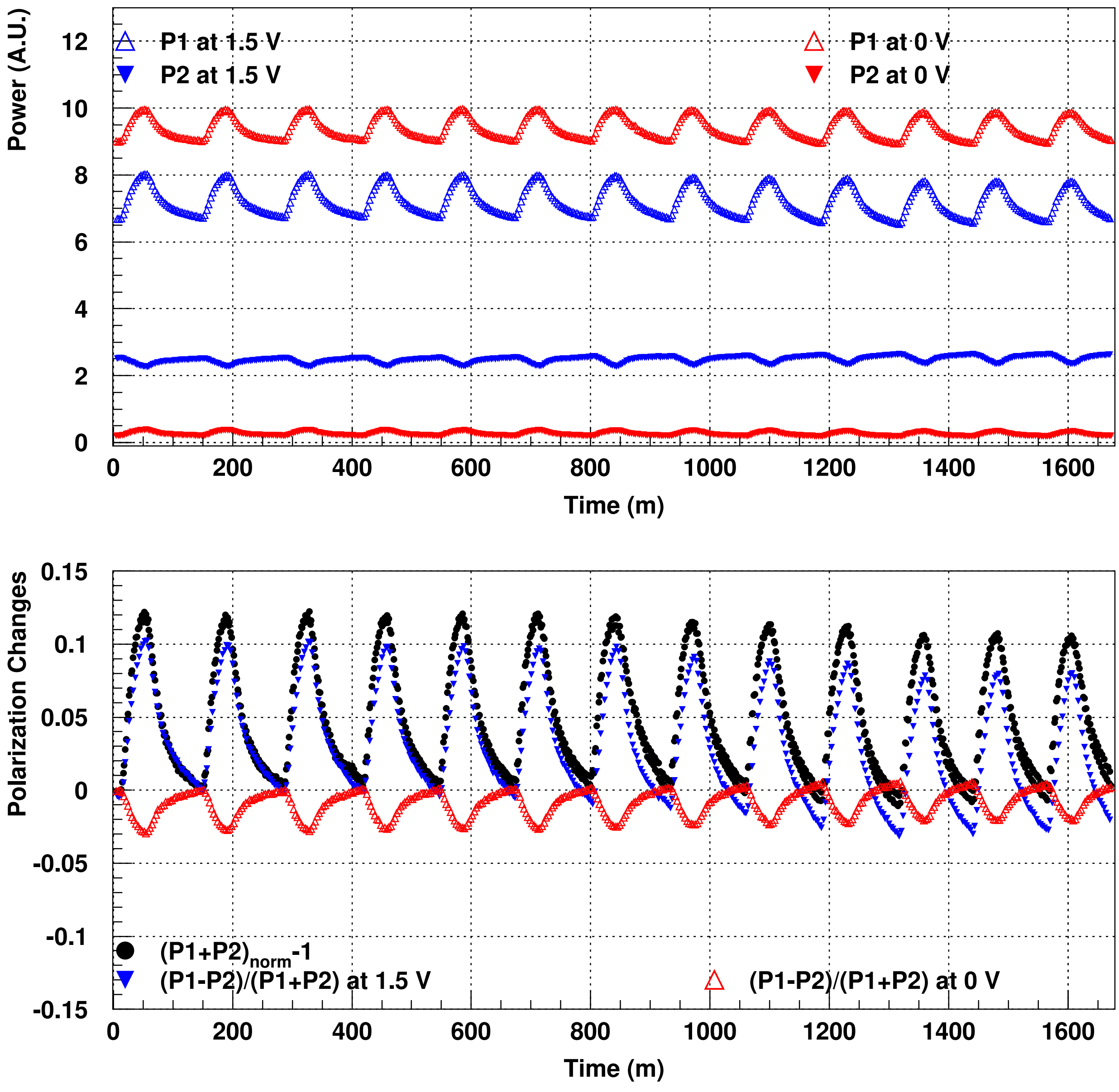
Stability/Repeatability wtih LCVR



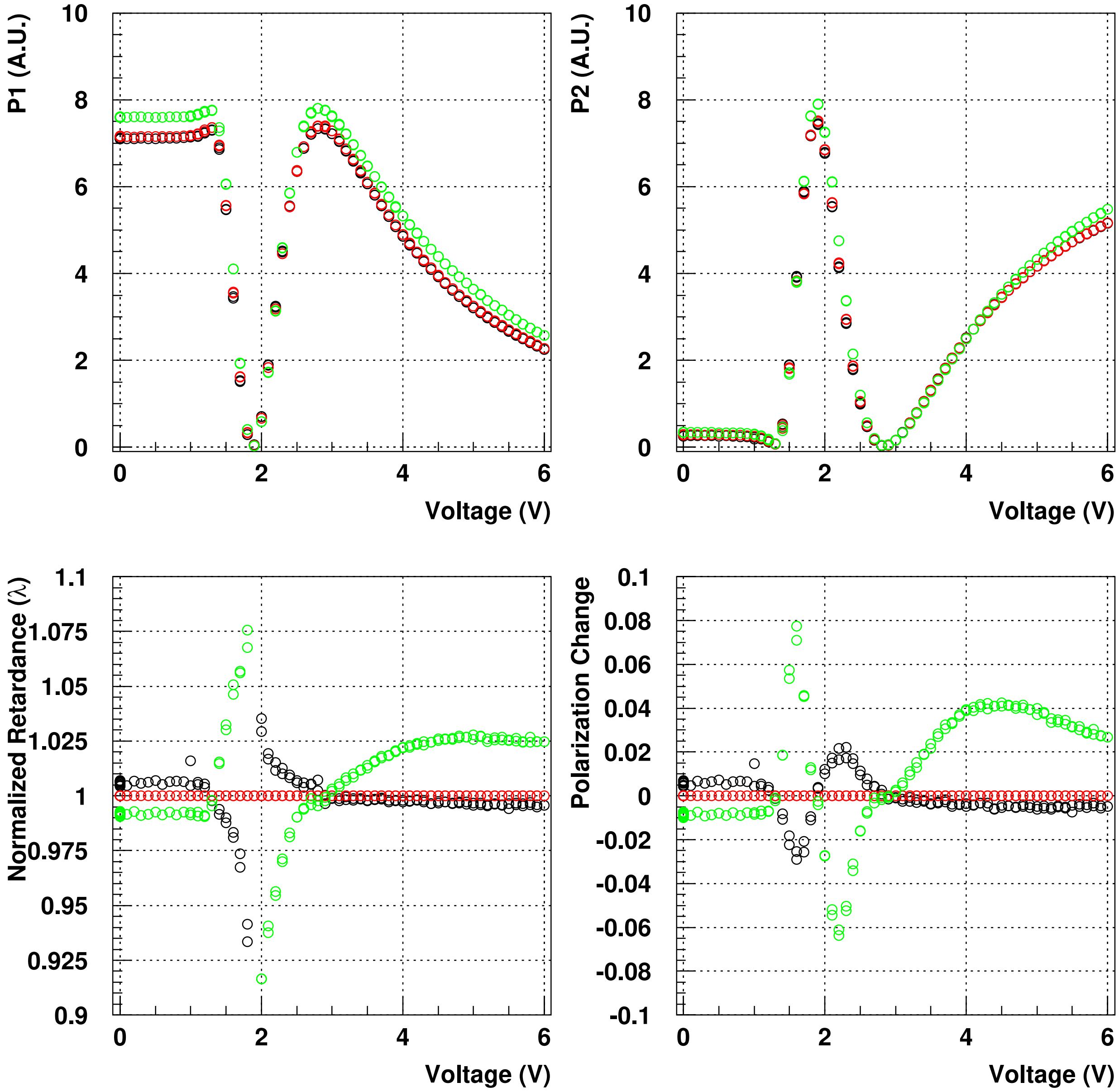
The stability of LCVR at 795nm under the normal room condition, being measured with optical setup (b).



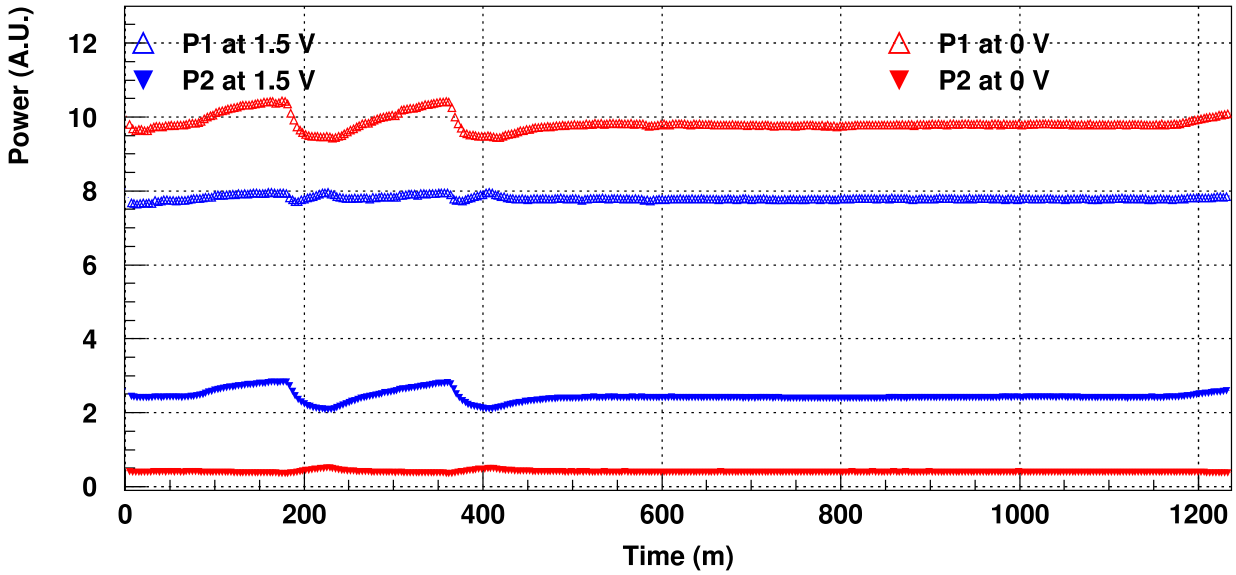
The stability of LCVR at 795nm under the normal room condition, being measured with optical setup (c).

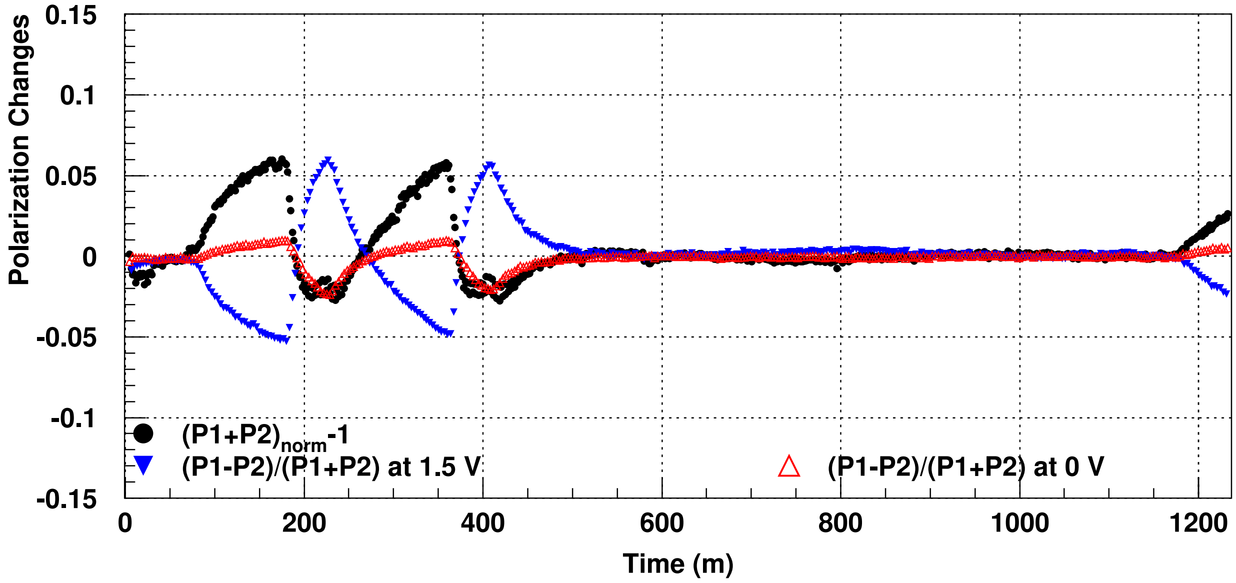


The stability of LCVR at 795nm under the normal room condition, being measured with optical setup (d).



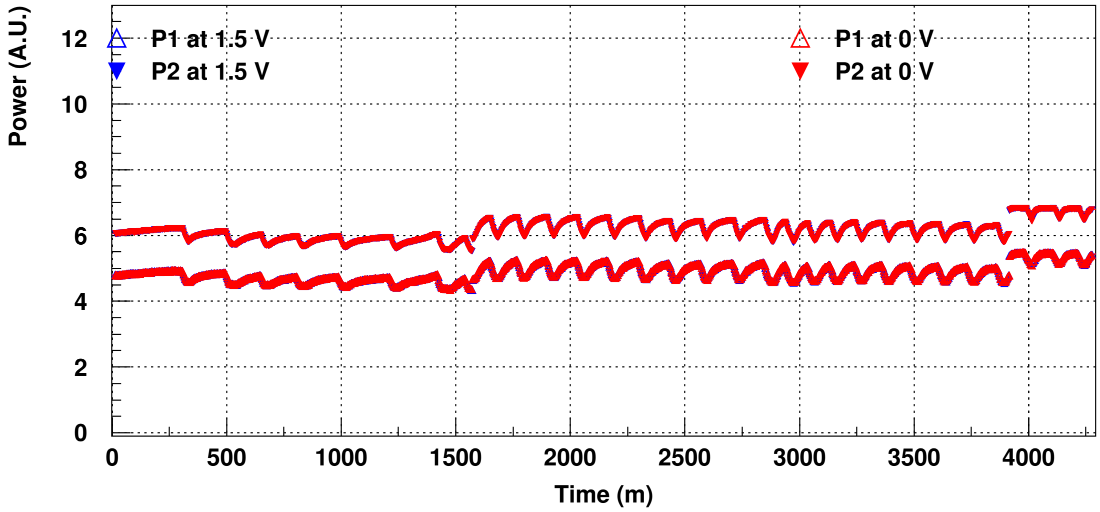
The stability of LCVR at 795nm under the normal room condition, being measured with optical setup (d). Different color corresponds to the loop of measurements at different time. For each loop, the voltage is increased from 1 V to 6 V and then back to 0 V with the step of 0.1 V.

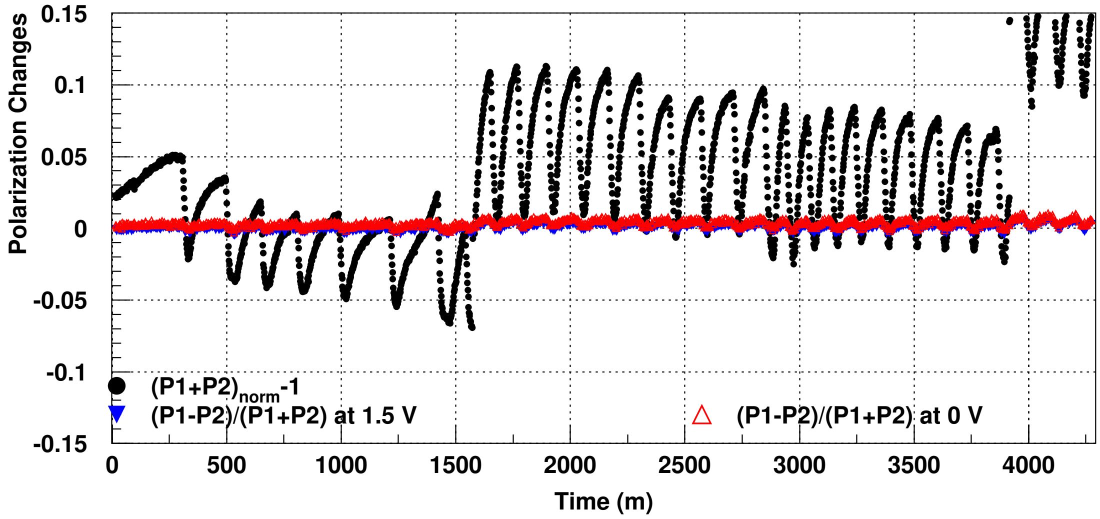




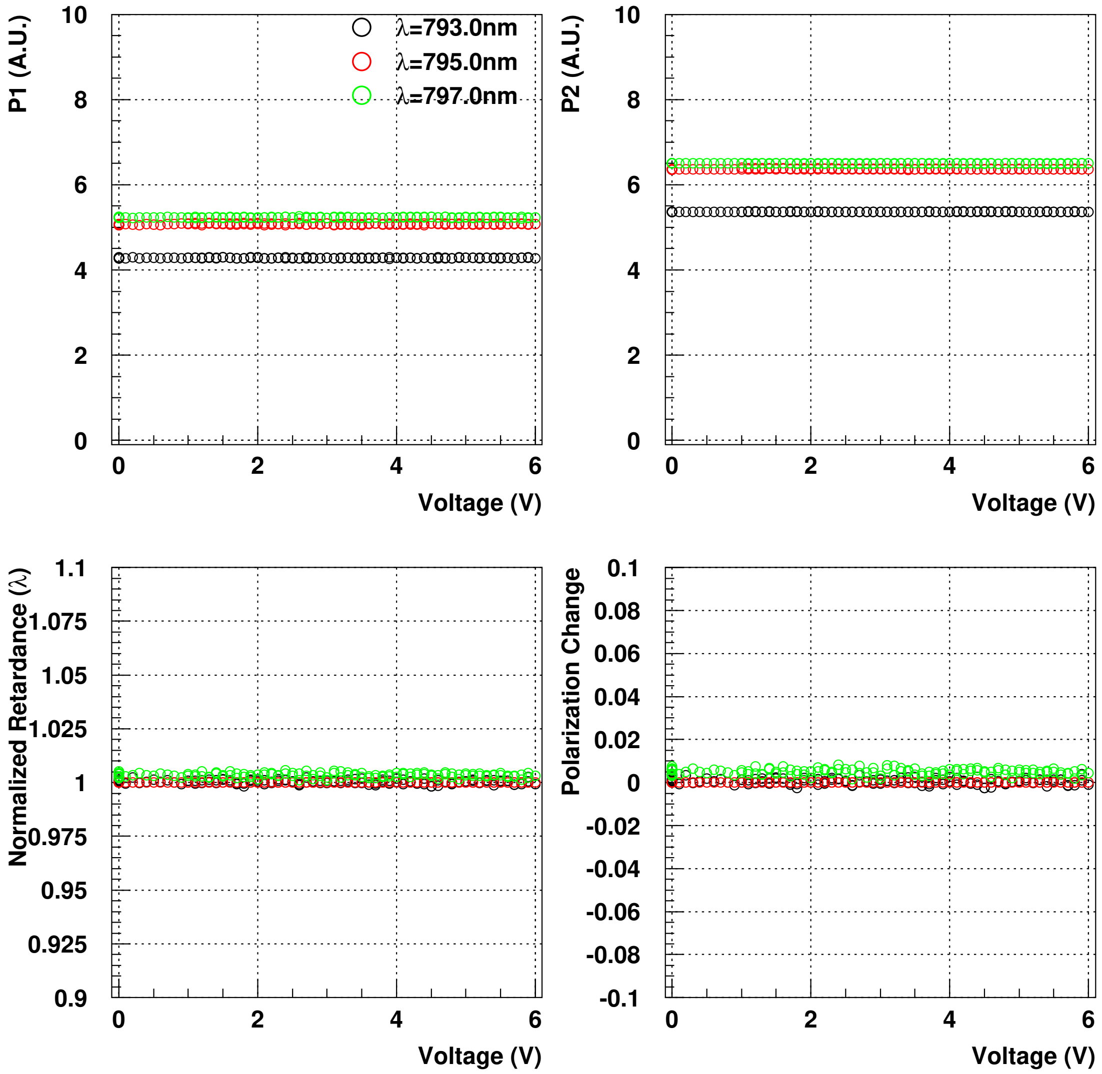
The stability of LCVR at 795nm under the normal room condition, being measured with optical setup (e). The air conditioner were turned off at the very beginning (1pm), but may be turned on after ∼300 minutes (∼6pm).

Stability/Repeatability with $\lambda/4$ plate





The stability of quater-wave plate at 795nm under the normal room condition, being measured with optical setup (e). The LCVR was removed from the beam line, there the voltage setting did not affect the measurement.



The stability of quater-wave plate under the normal room condition, being measured with optical setup (e). Different color corresponds to the loop of measurements at different wavelength, i.e. 793nm,795nm and 797nm. For each loop, the voltage is increased from 1 V to 6 V and then back to 0 V with the step of 0.1 V. Since the LCVR was removed from the beam line, the voltage change just reflected the elapse of time.

Quote on LCVR System

- LCVR:

  $1.6''$ full-wave LVR-300-IR1-1L: $ 2280

  $1.6''$ half-wave LVR-300-IR1: $ 1900

  $1.6''$ half-wave with temperature control

  LVR-300-IR1-TSC: $ 2200

  $2.0''$ half-wave LVR-240-IR1-NOHSG (no housing):

  $ 2410

  $2.0''$ half-wave with compensator

  LRC-240-IR1-NOHSG (no housing): $ 2995

- Liquid crystal digital interface:

  basic controller D3040-Basic: $ 1525.0

  advanced controller D3040-ADV: $ 1875.0

- Delivery: 3 weeks ARO