

SenSL-SiPM Durability Studies

Yujing Sun
University of Hawaii at Manoa

Oct 8th, 2015, Honolulu, Hawaii

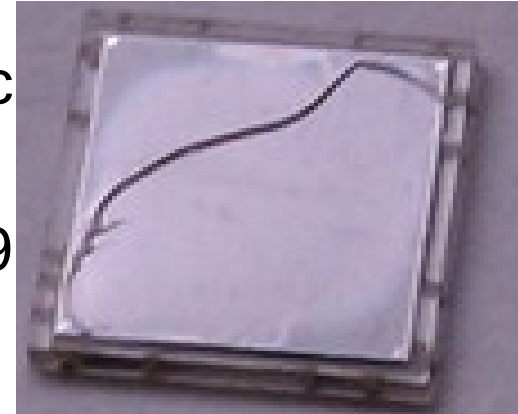
SenSL-SiPM Mechanical Test



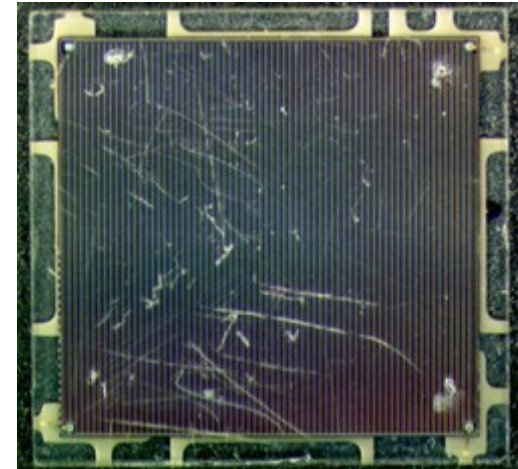
UNIVERSITY
of HAWAII®
MĀNOA

- Mechanical damages have been observed on SenSL SiPMs over cryogenic cycles. To understand the source of the problem, we made the following plan.
- Use 9 new B-series SiPMs for cycling test namely 1~9
 - Long term: 2 months (3 SiPMs, 7, 8, 9)
 - Short term: 7 days
 - Recovery time:
 - Slow: in nitrogen gas environment (plastic bag, 3 SiPMs, 1, 2, 3).
 - Medium: in room temperature (naturally warm up, 3 SiPMs, 4, 5, 6).
- Microscope visual inspection after each cycling.
- Characteristic check after each cycling.

Most severely damaged SiPMs



Not working

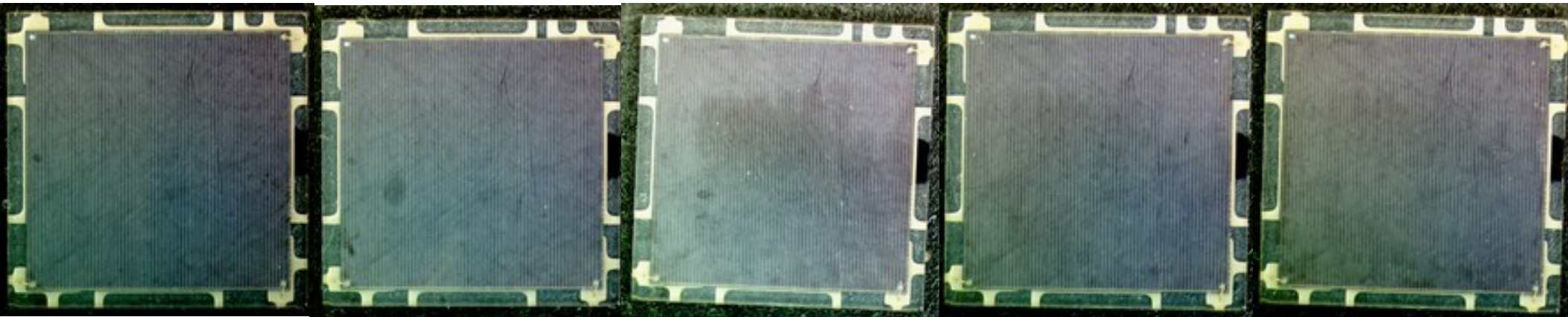


Still working

SiPM 1 Microscope Photos



UNIVERSITY
of HAWAII®
MĀNOA



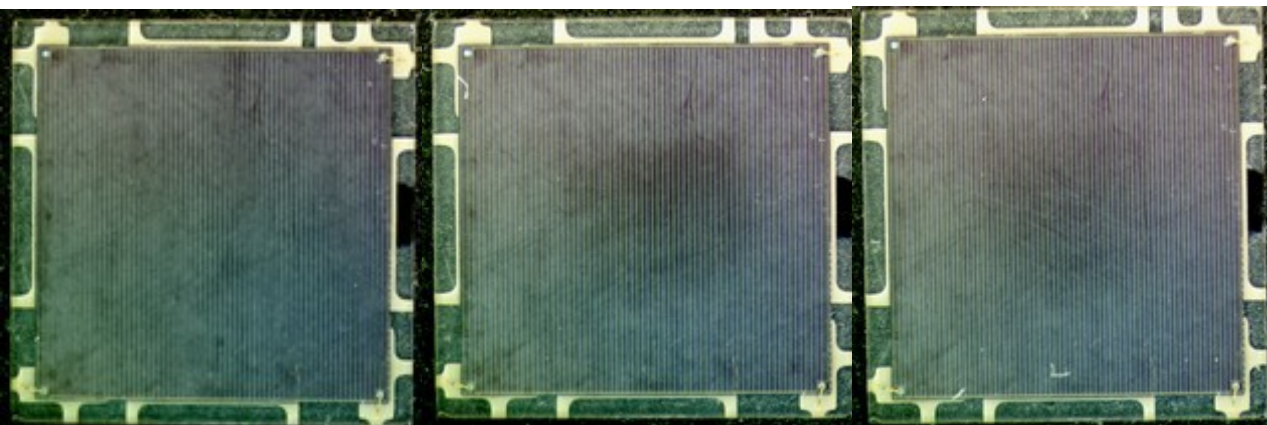
Initial
warms up in a bag (days)

7

14

21

28



35

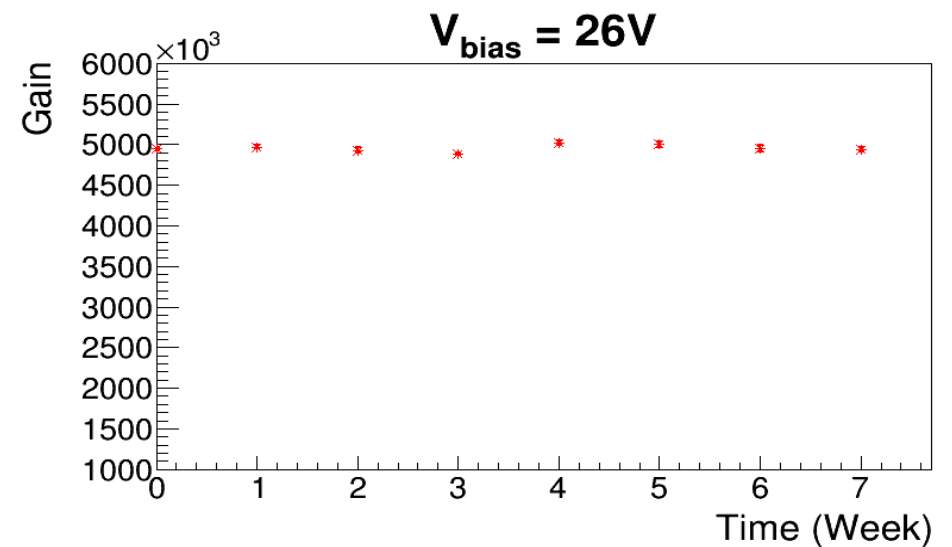
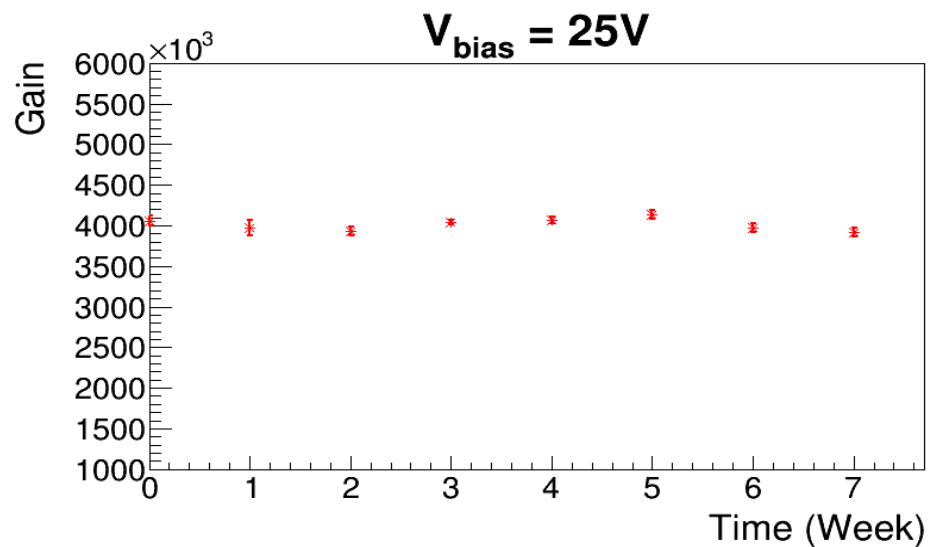
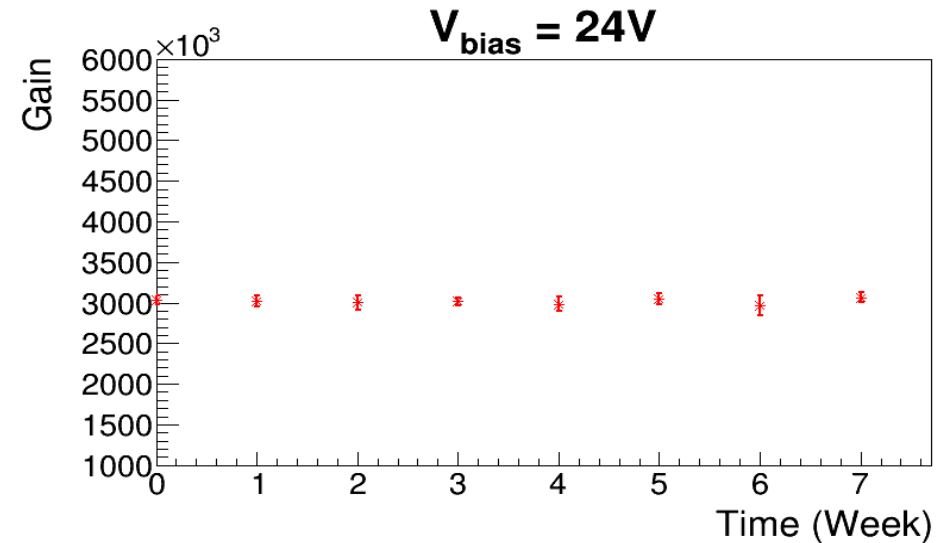
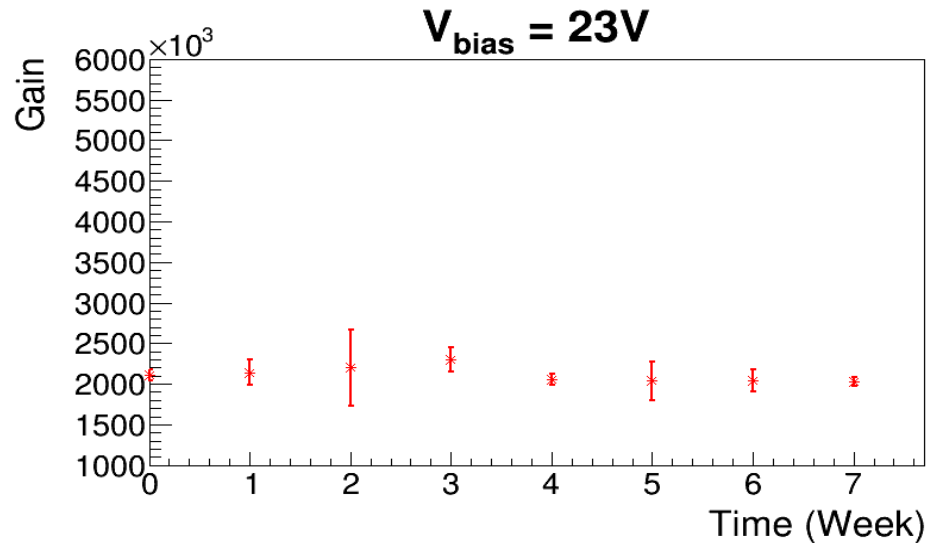
42

49

SiPM 1 Gain Evolution



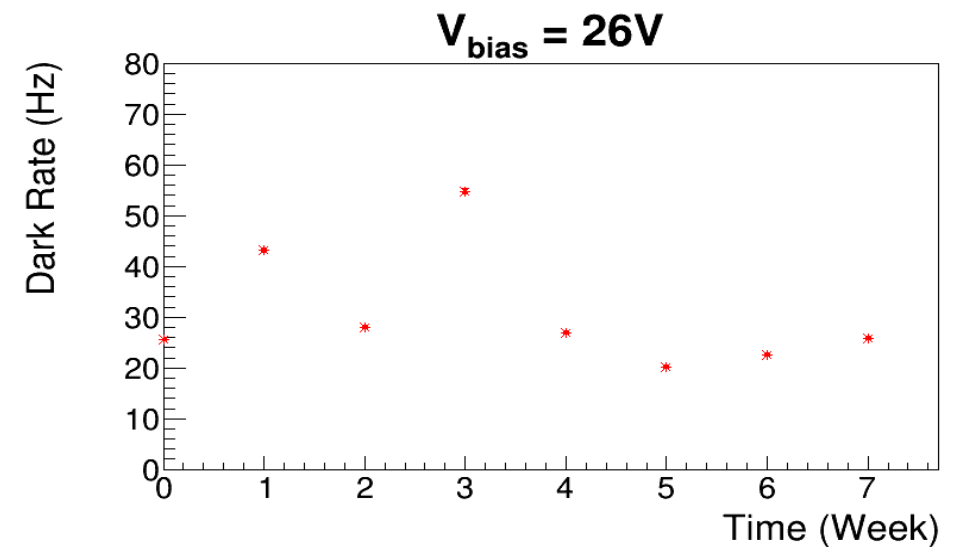
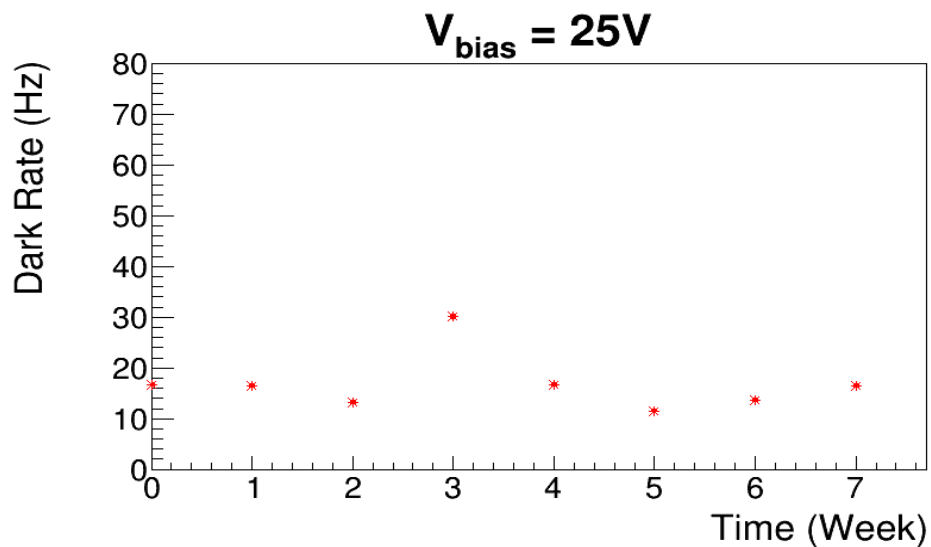
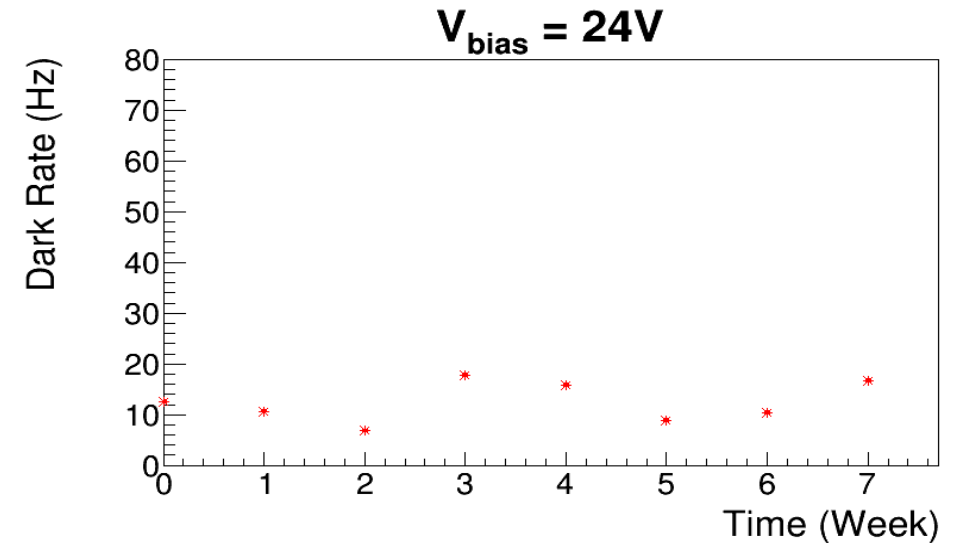
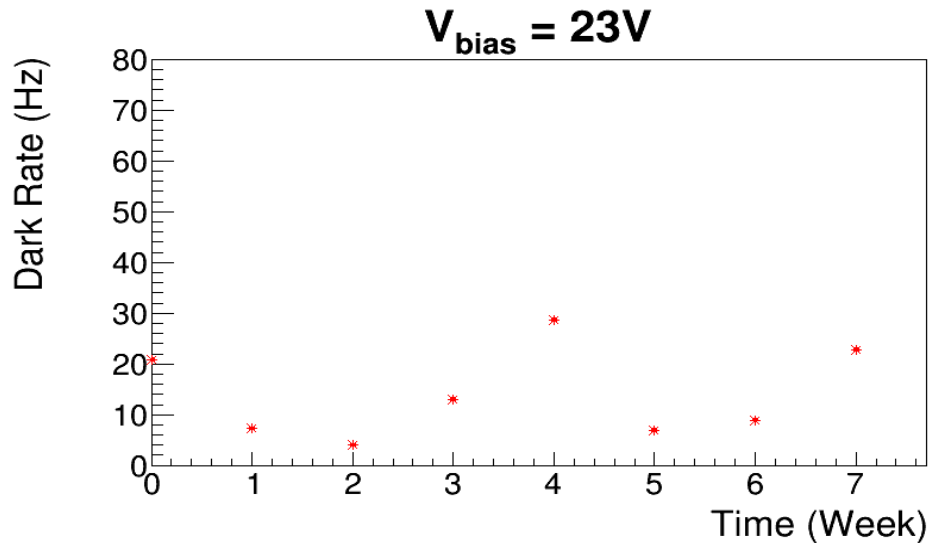
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 1 Dark Rate Evolution



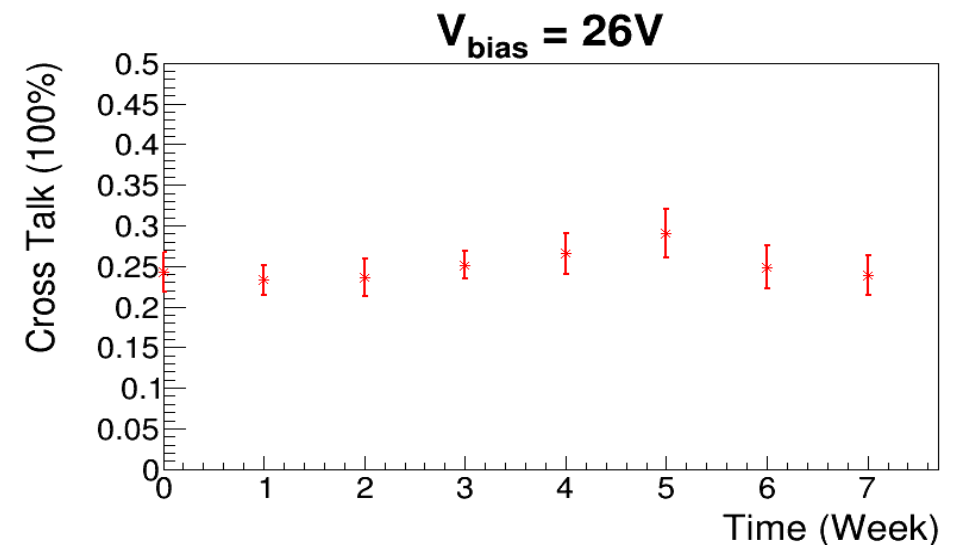
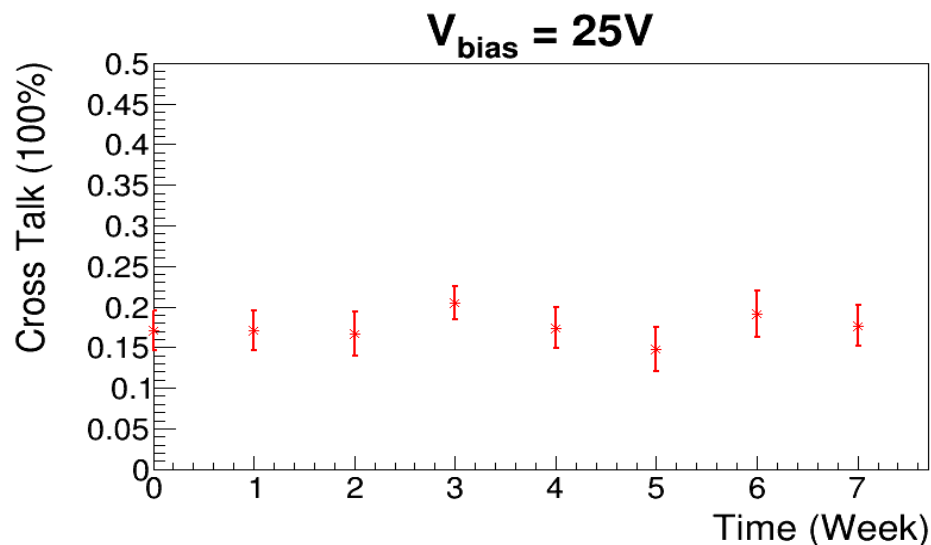
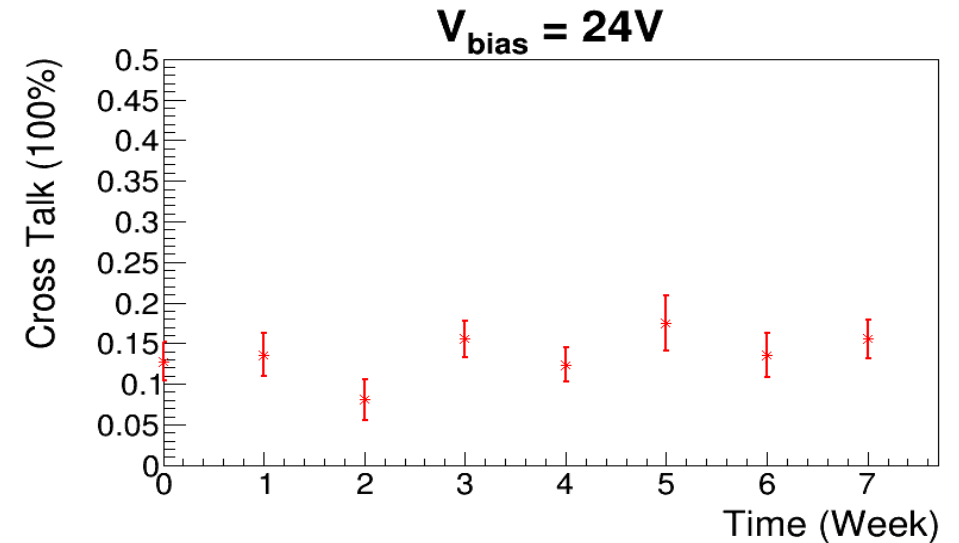
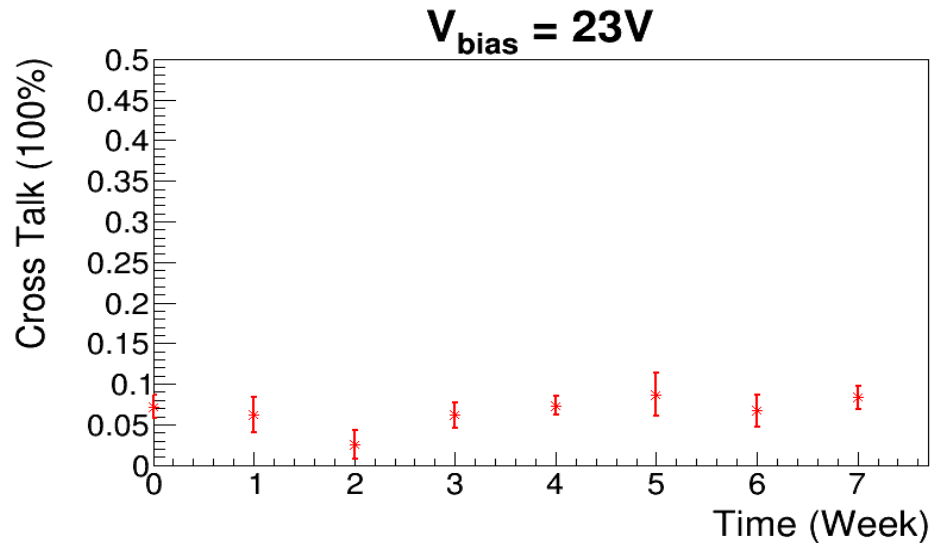
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 1 Cross Talk Evolution



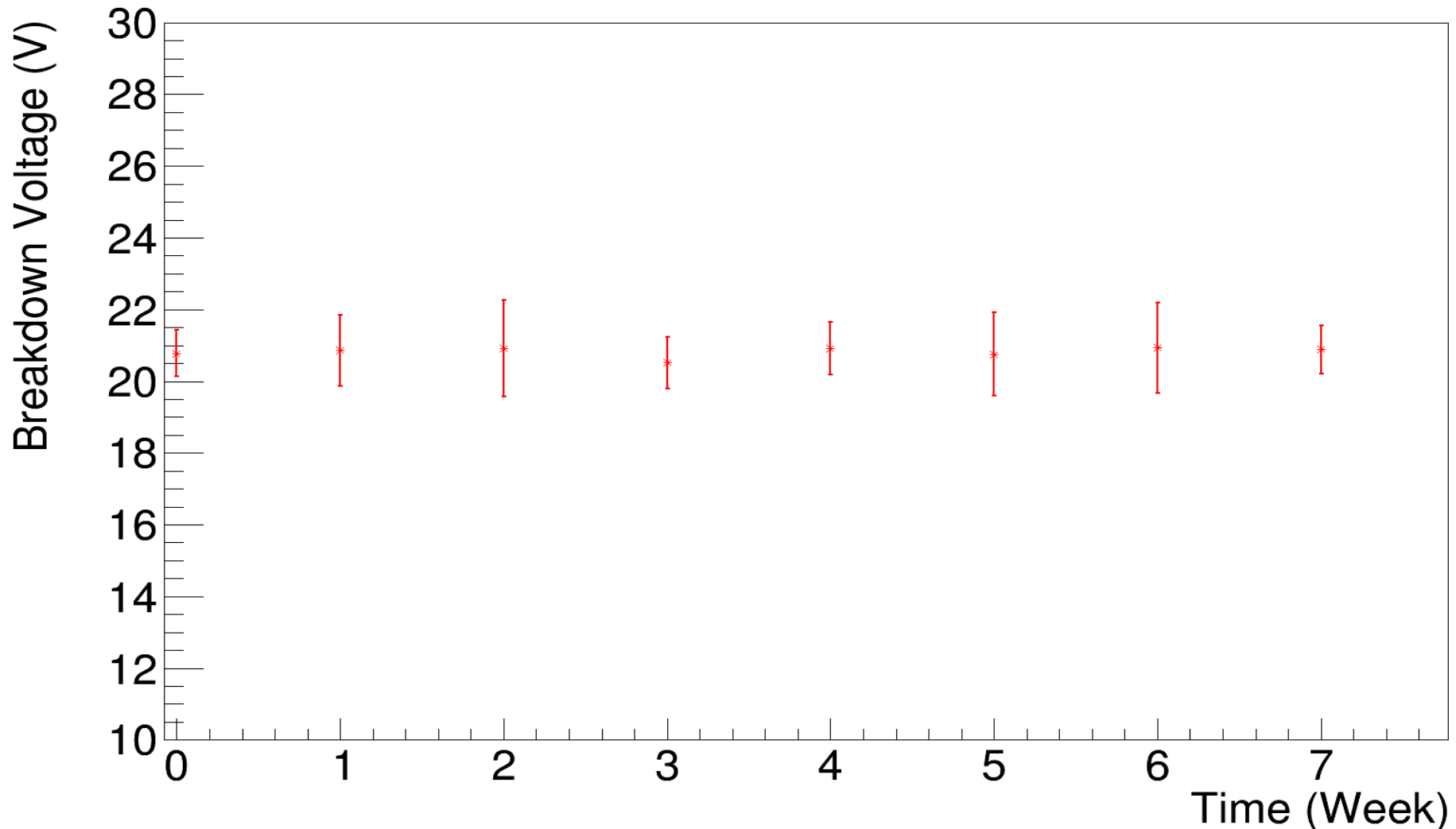
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 1 Breakdown Voltage



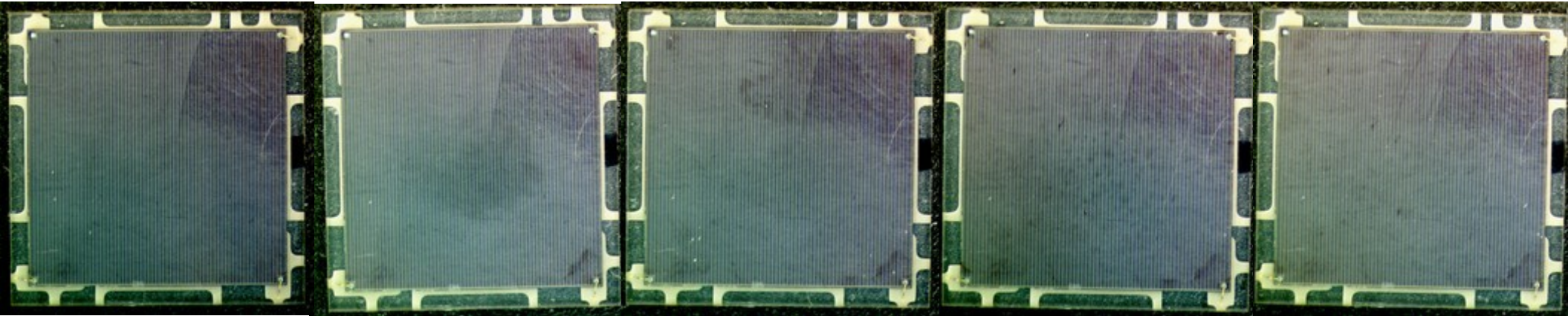
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 2 Microscope Photos



UNIVERSITY
of HAWAII®
MĀNOA



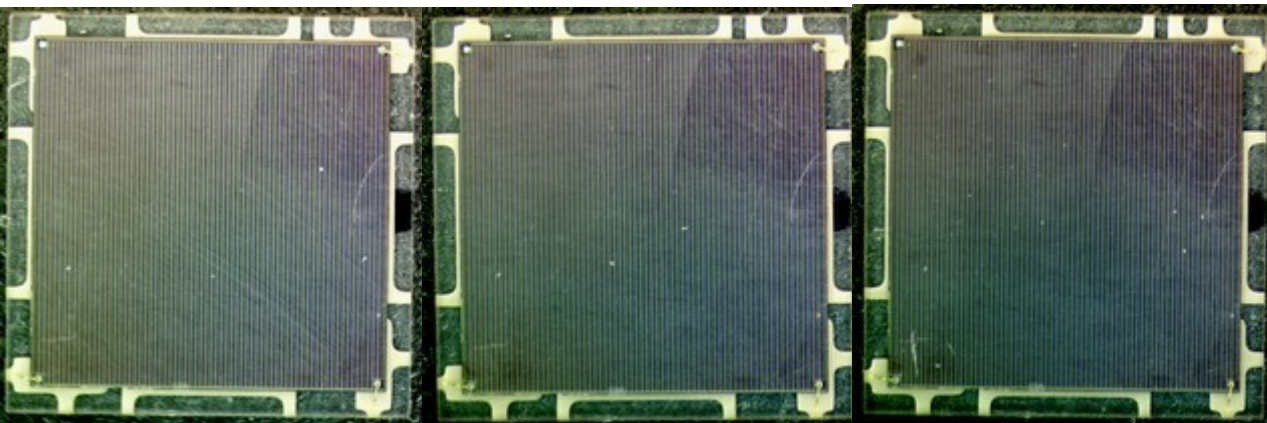
Initial
warms up in a bag (days)

7

14

21

28



35

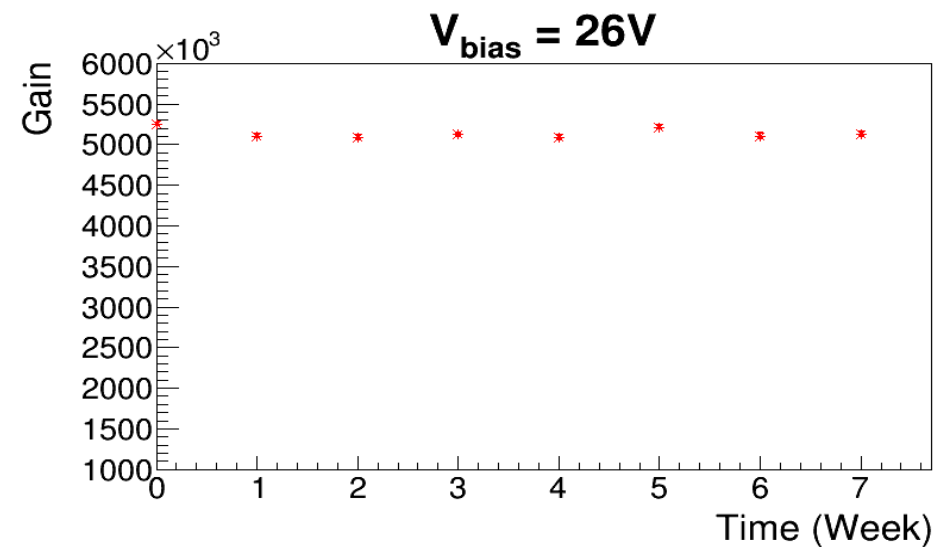
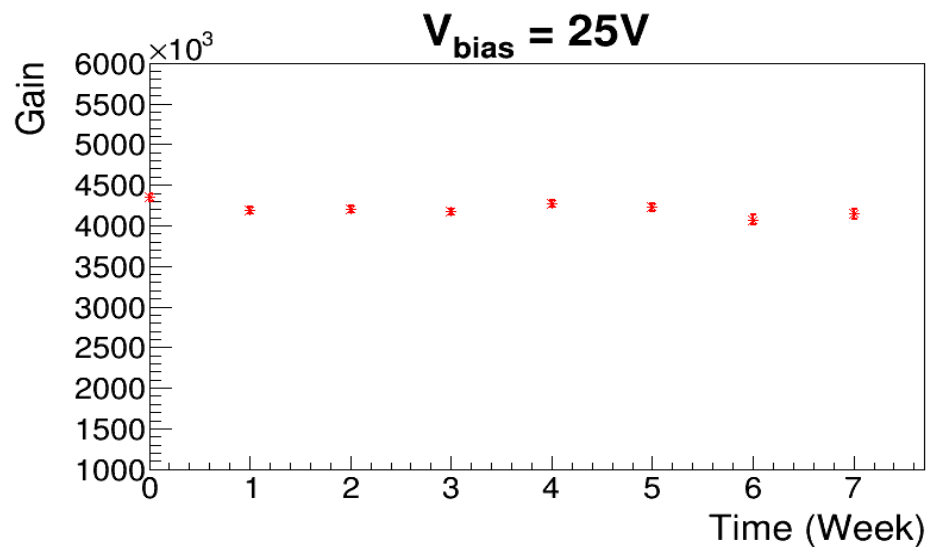
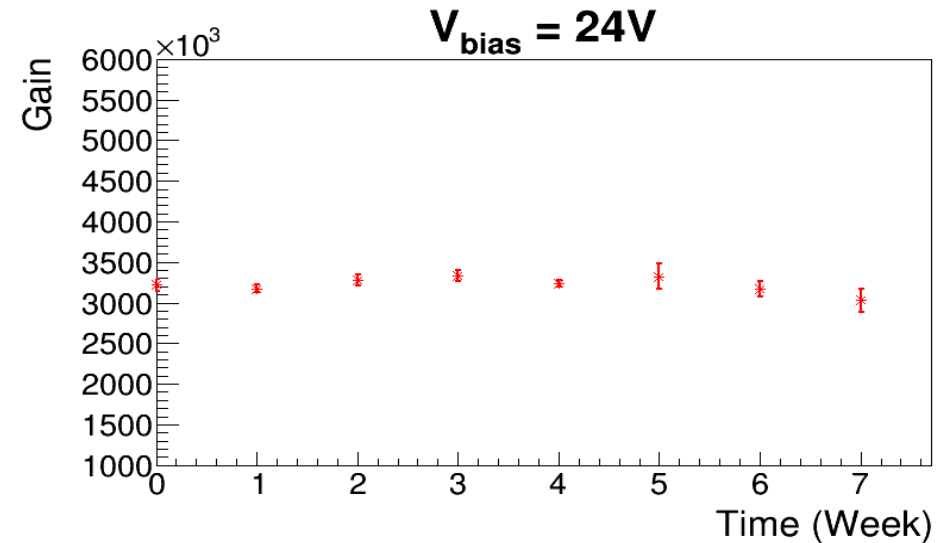
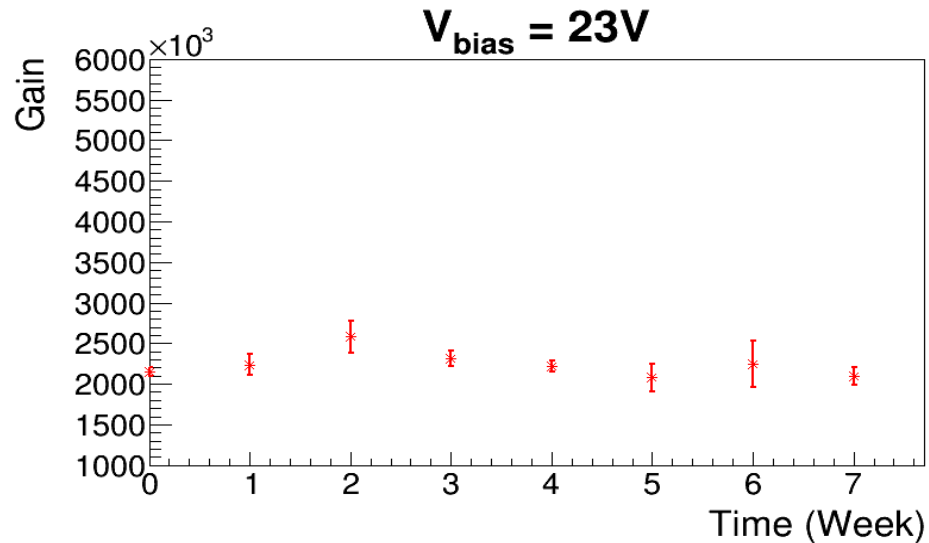
42

49

SiPM 2 Gain Evolution



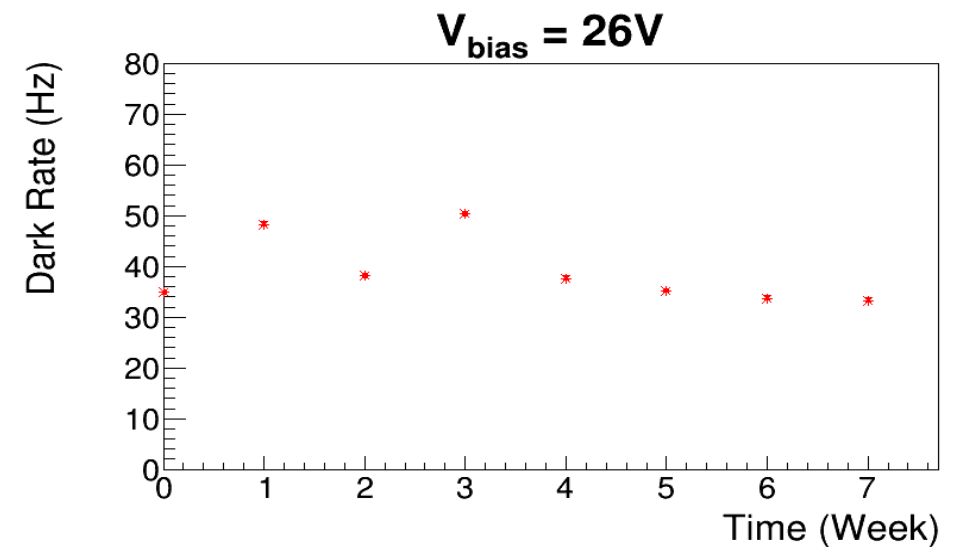
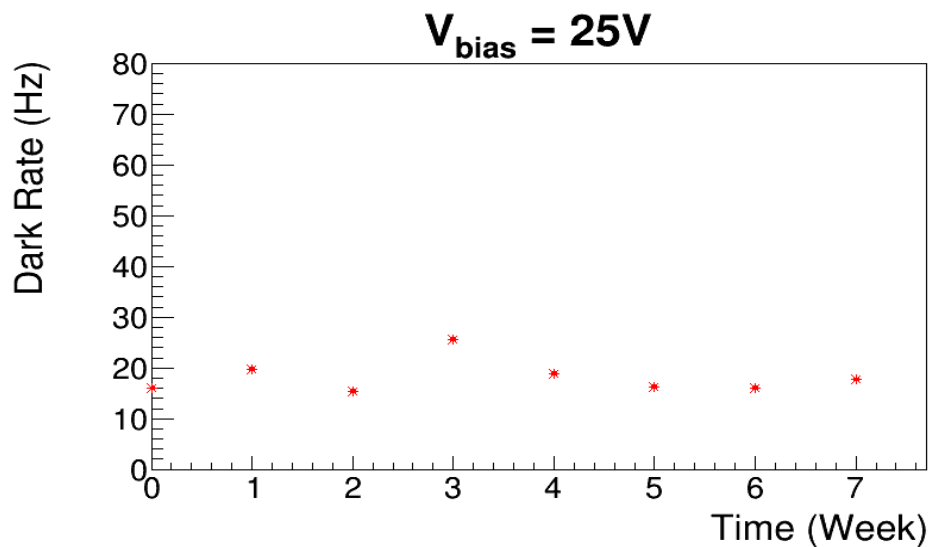
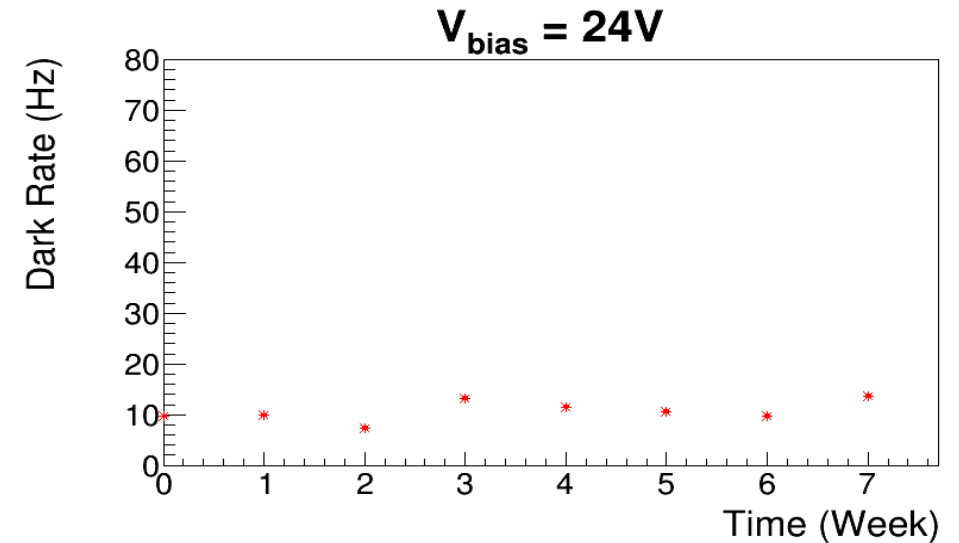
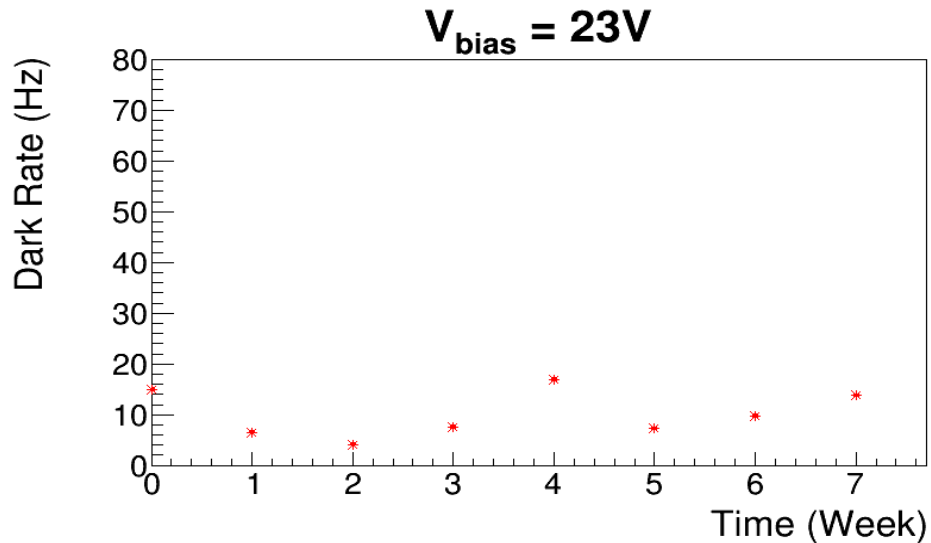
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 2 Dark Rate Evolution



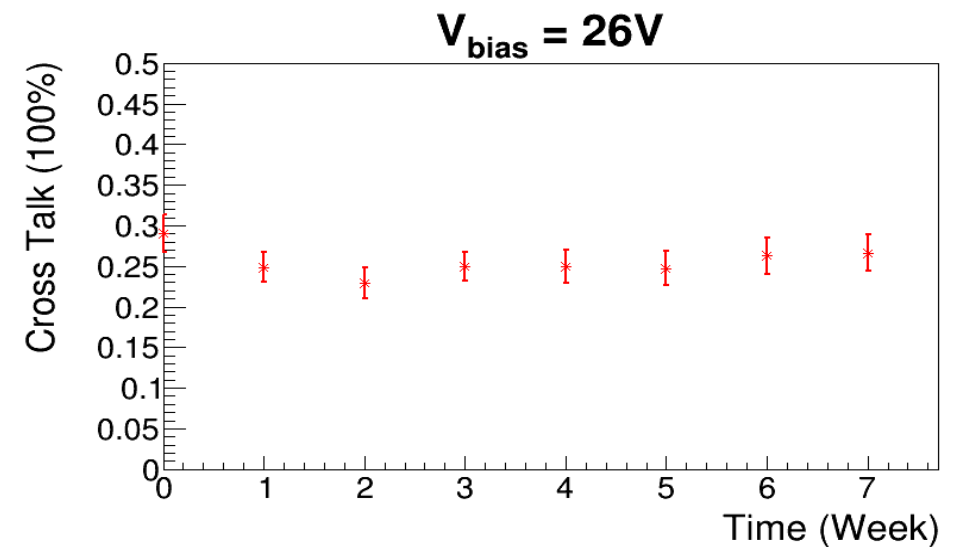
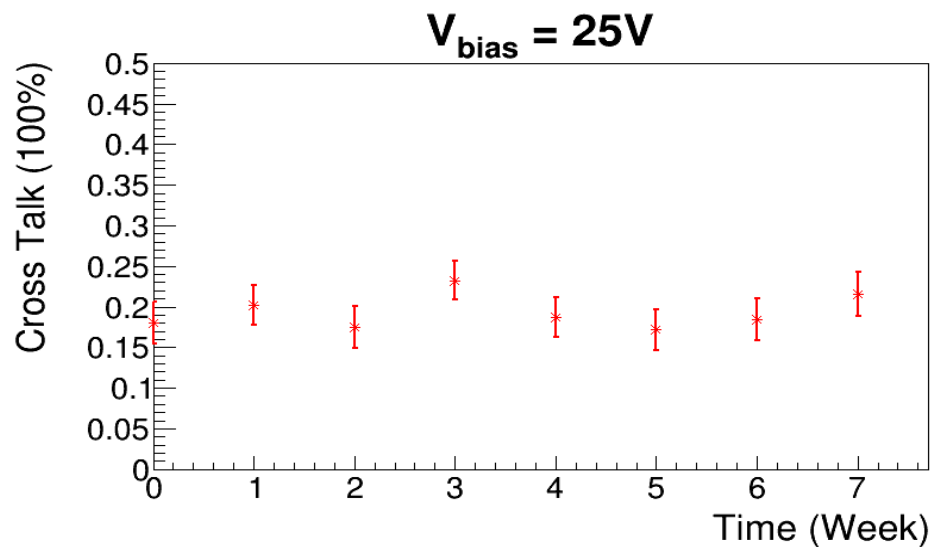
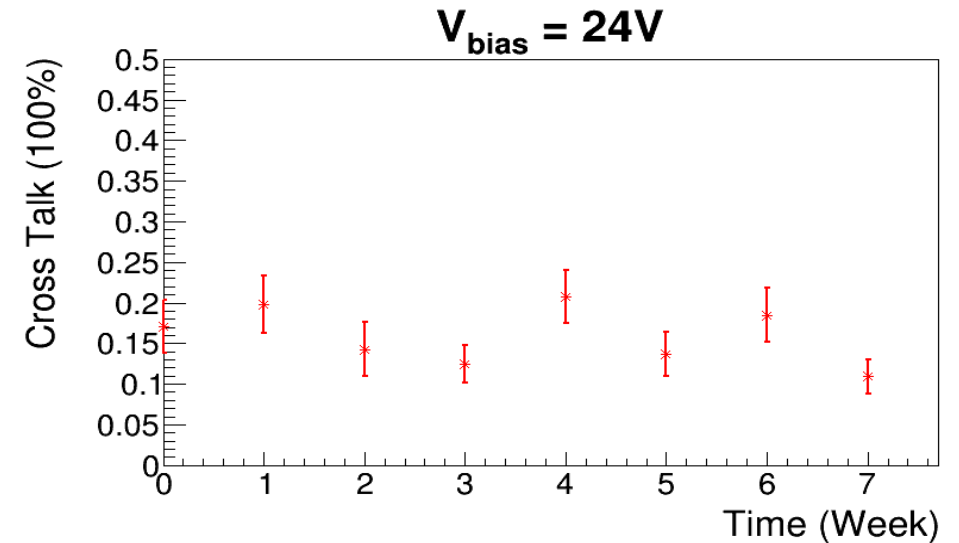
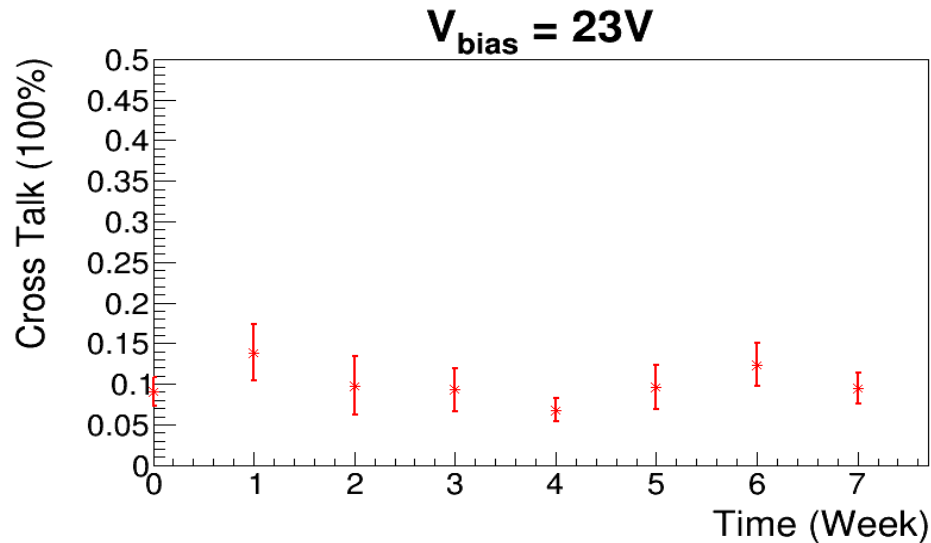
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 2 Cross Talk Evolution



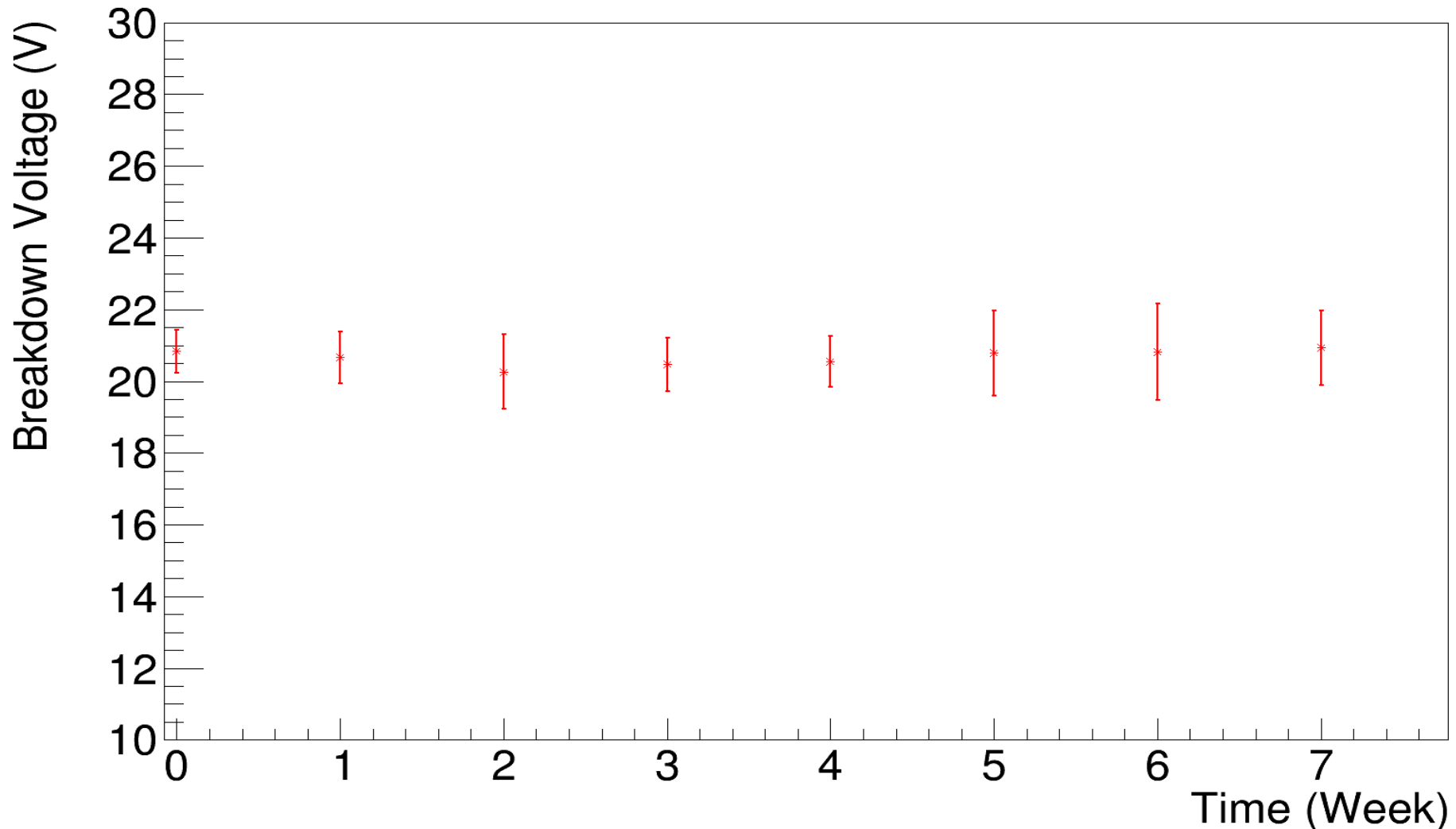
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 2 Breakdown Voltage



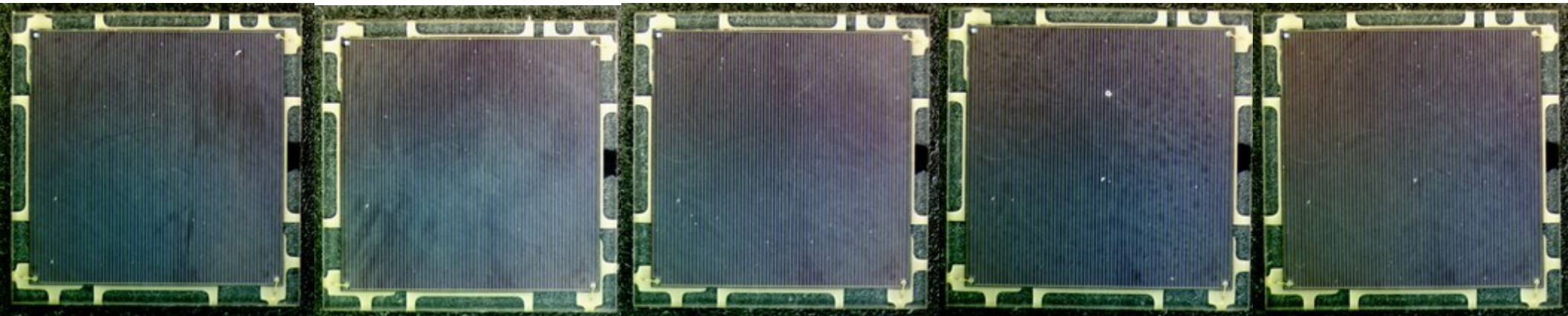
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 3 Microscope Photos



UNIVERSITY
of HAWAII®
MĀNOA



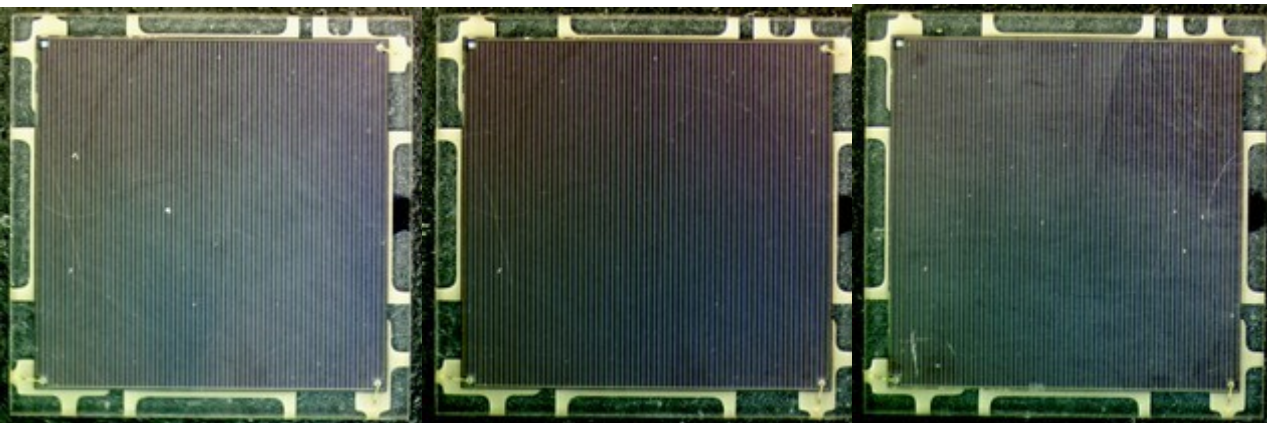
Initial
warms up in a bag (days)

7

14

21

28



35

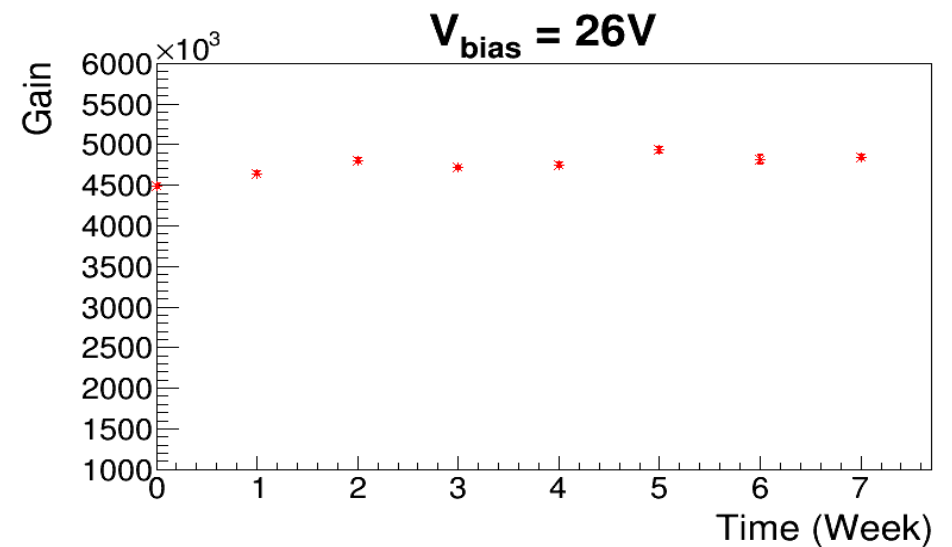
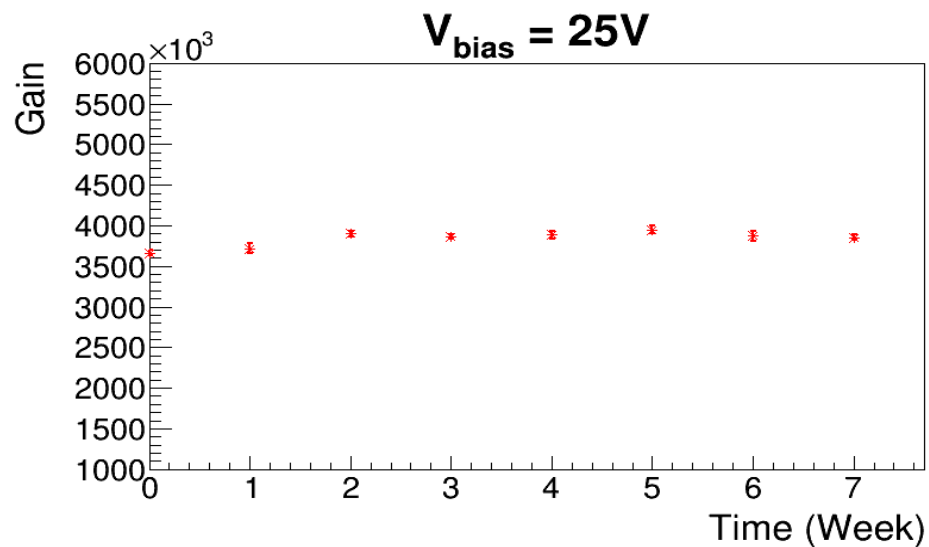
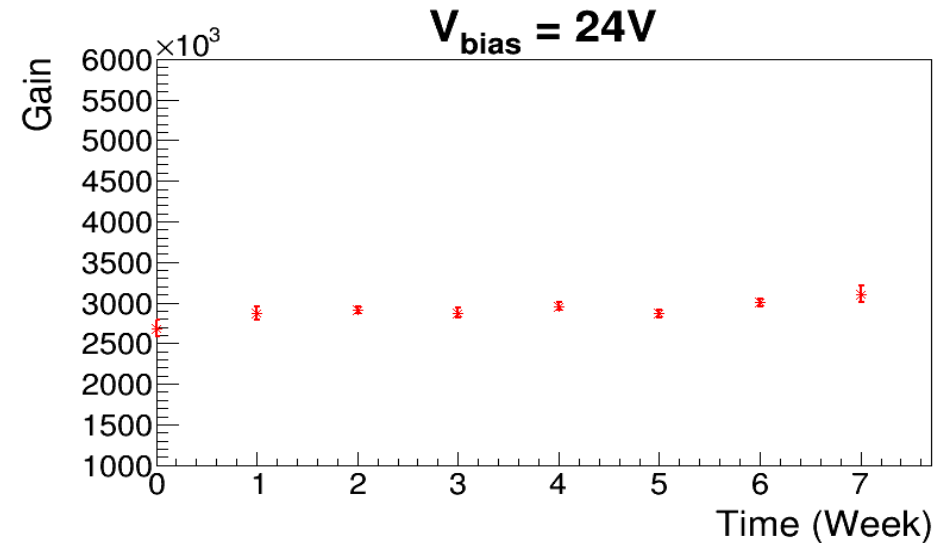
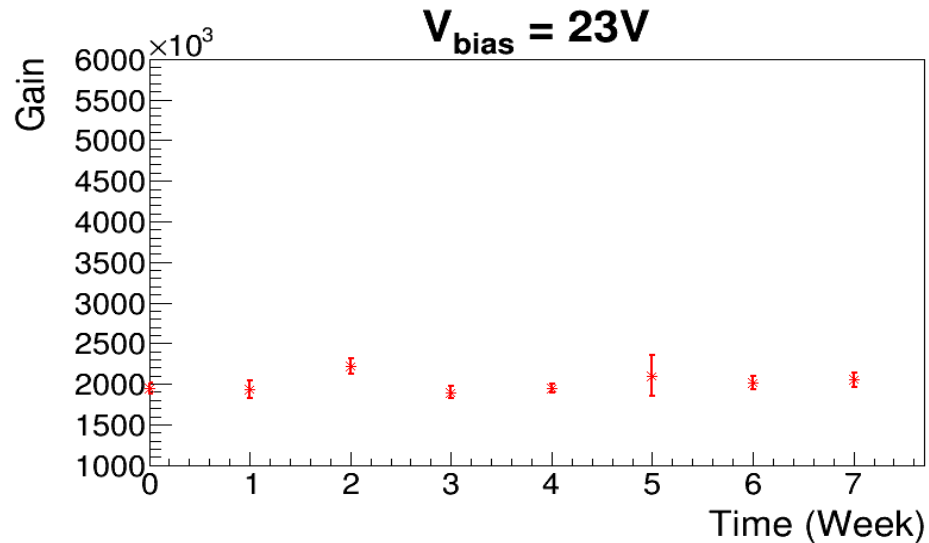
42

49

SiPM 3 Gain Evolution



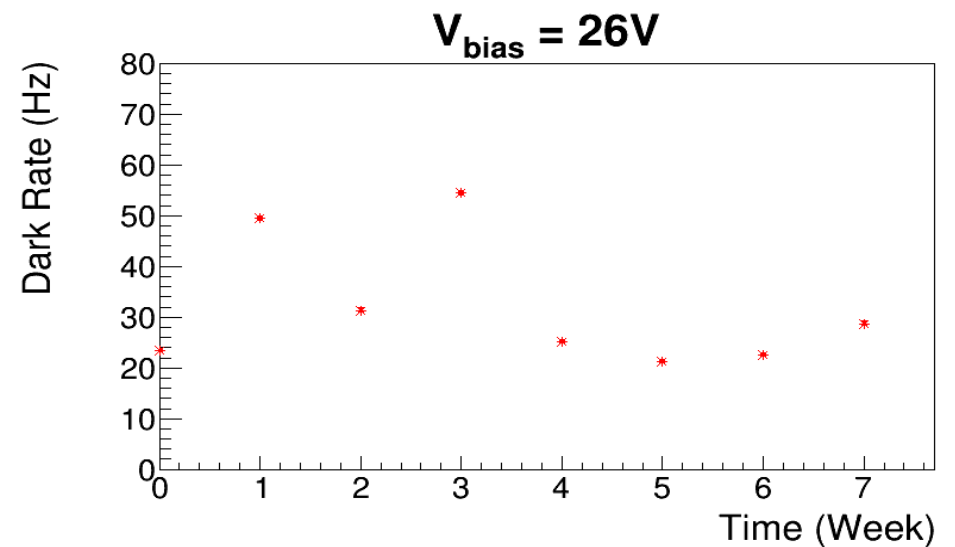
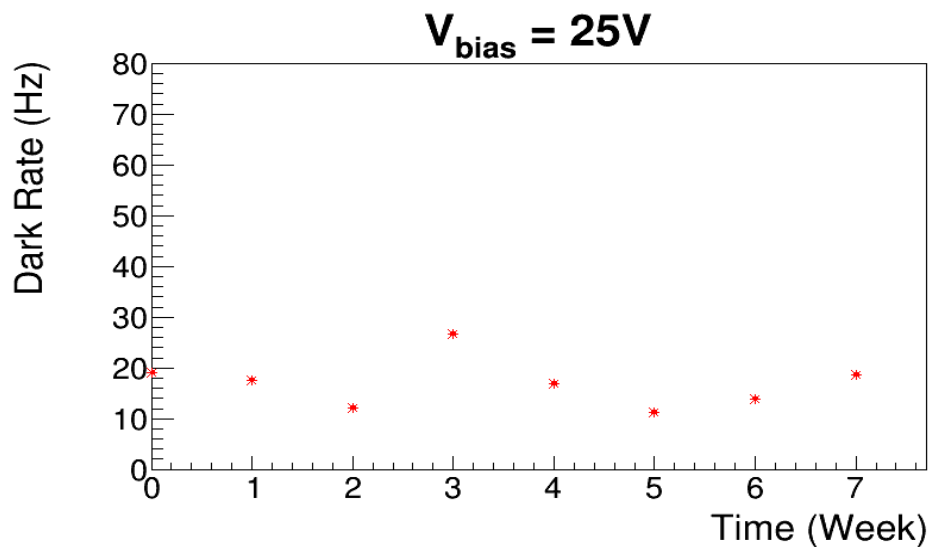
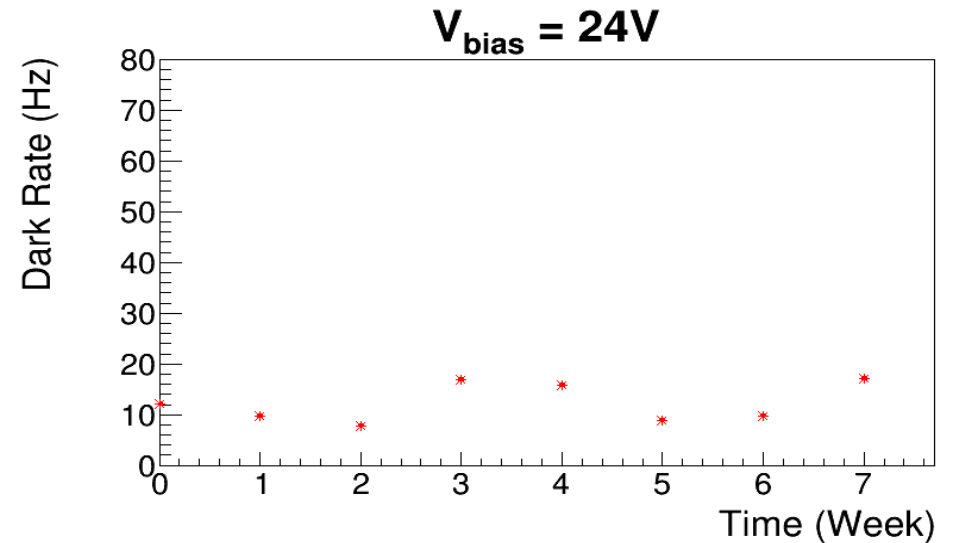
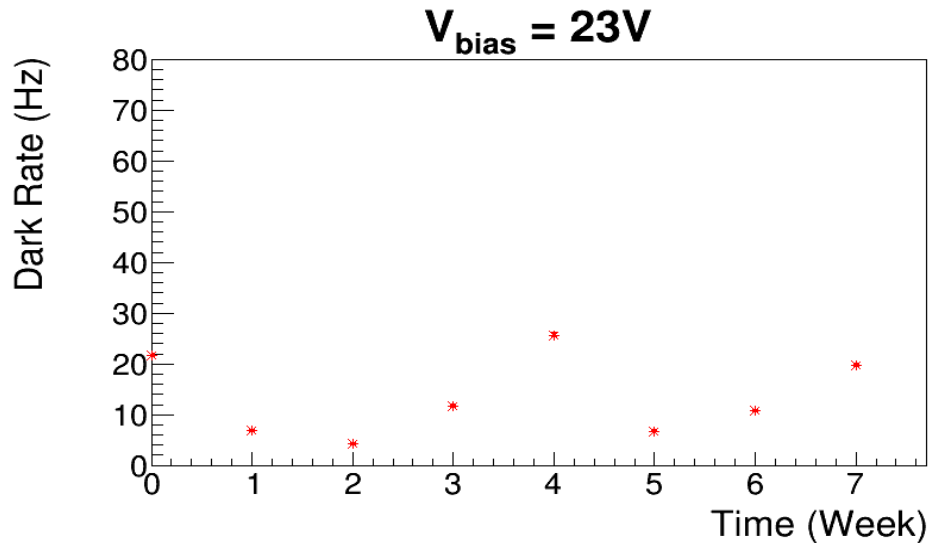
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 3 Dark Rate Evolution



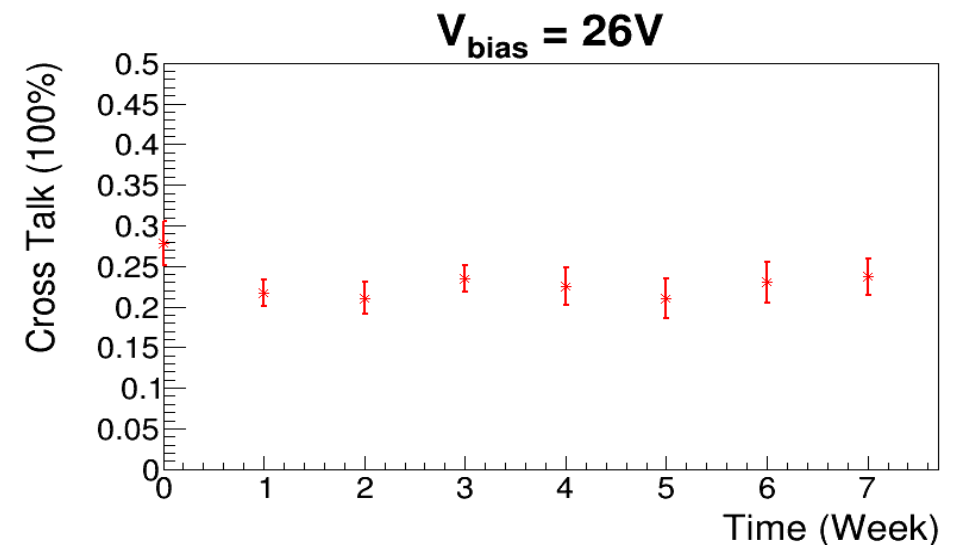
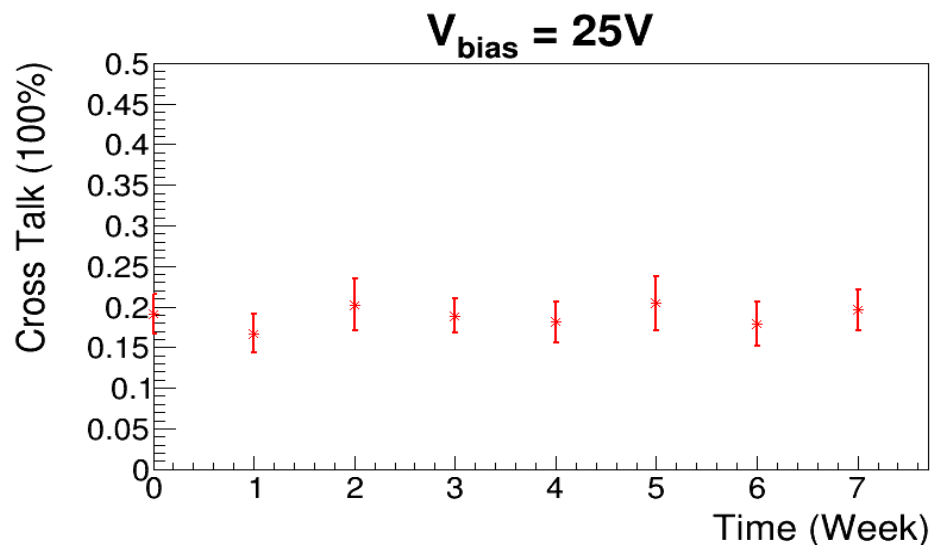
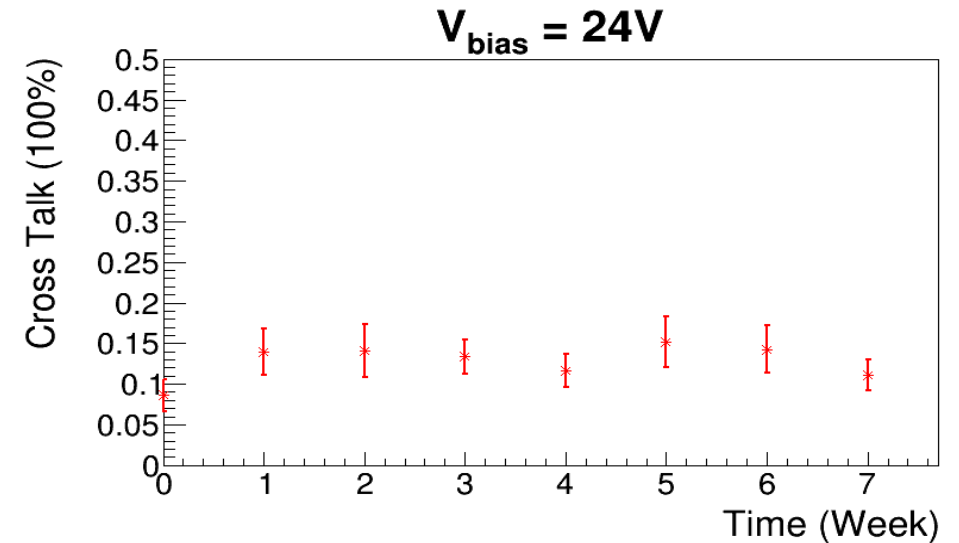
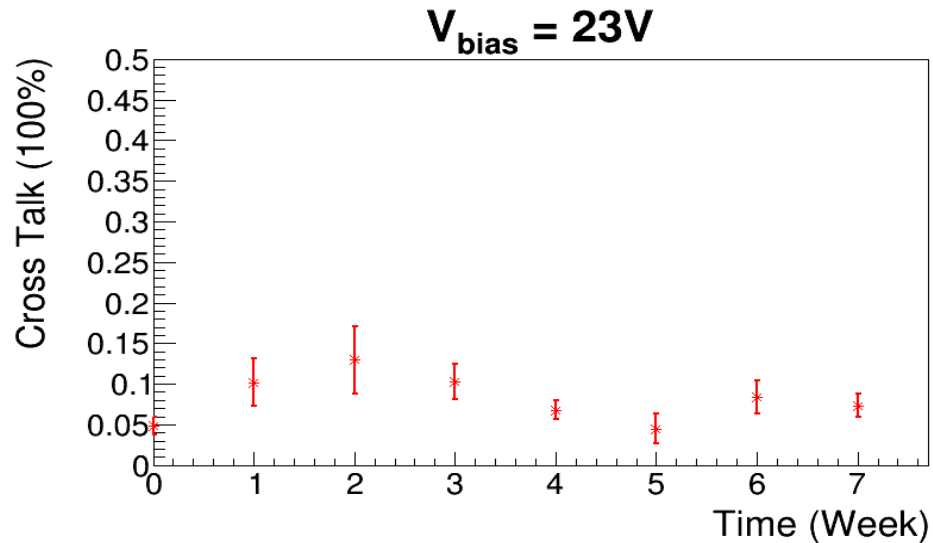
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 3 Cross Talk Evolution



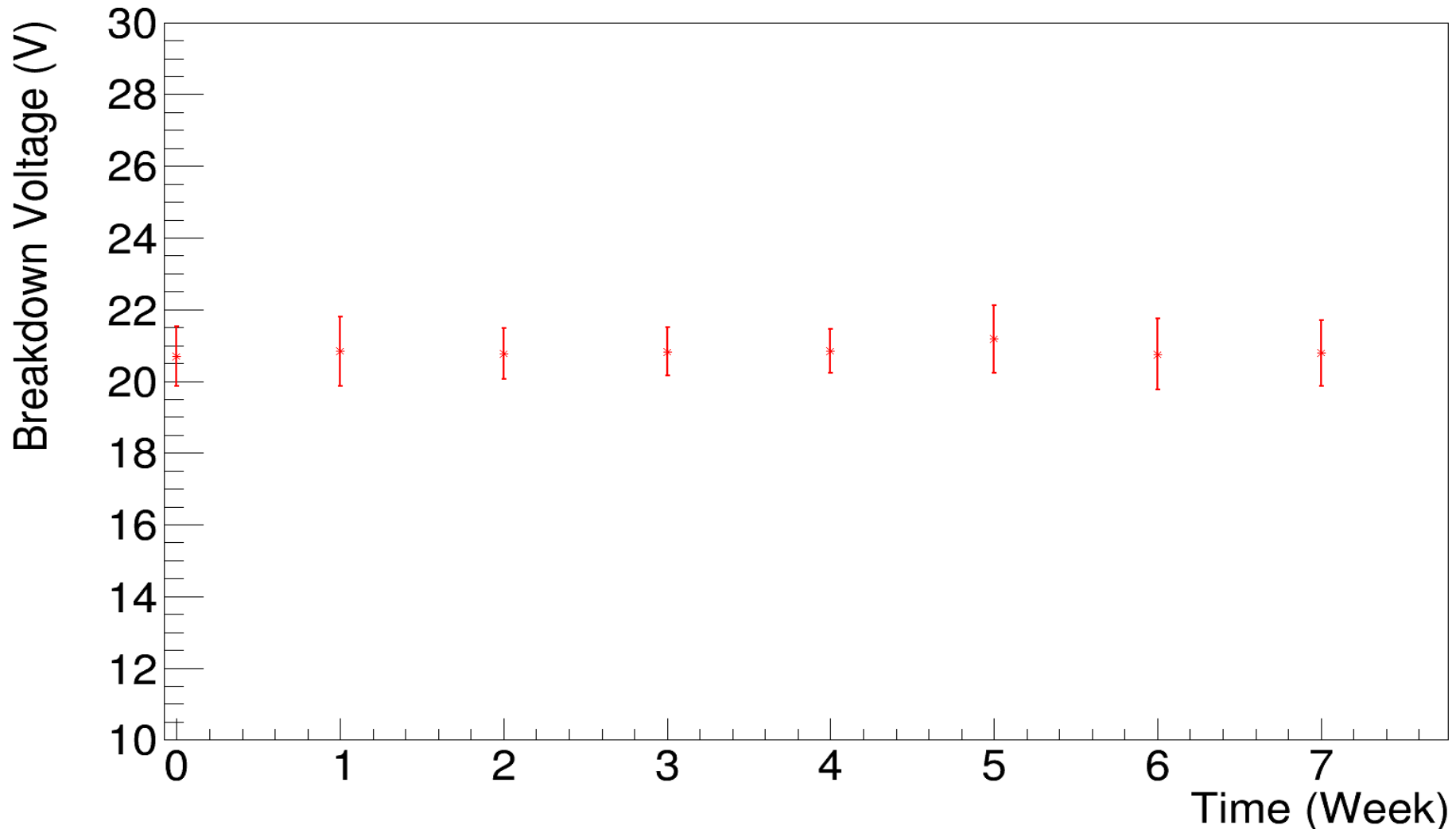
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 3 Breakdown Voltage



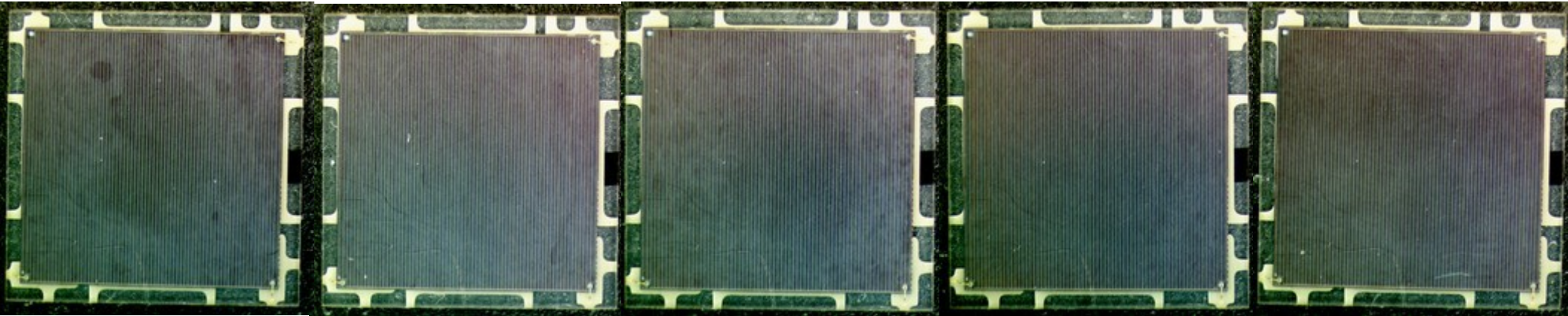
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 4 Microscope Photos



UNIVERSITY
of HAWAII®
MĀNOA



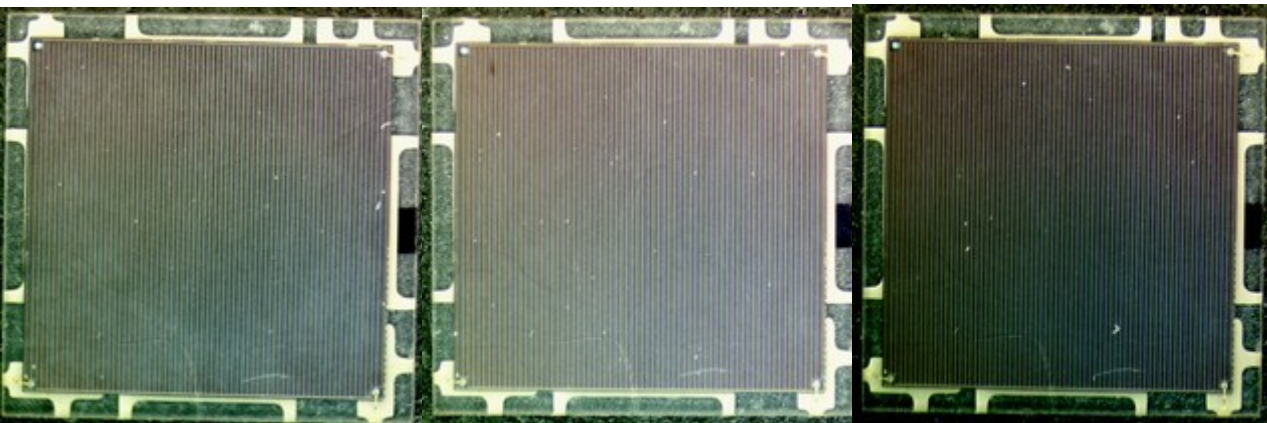
Initial
warms up in the air (days)

7

14

21

28



35

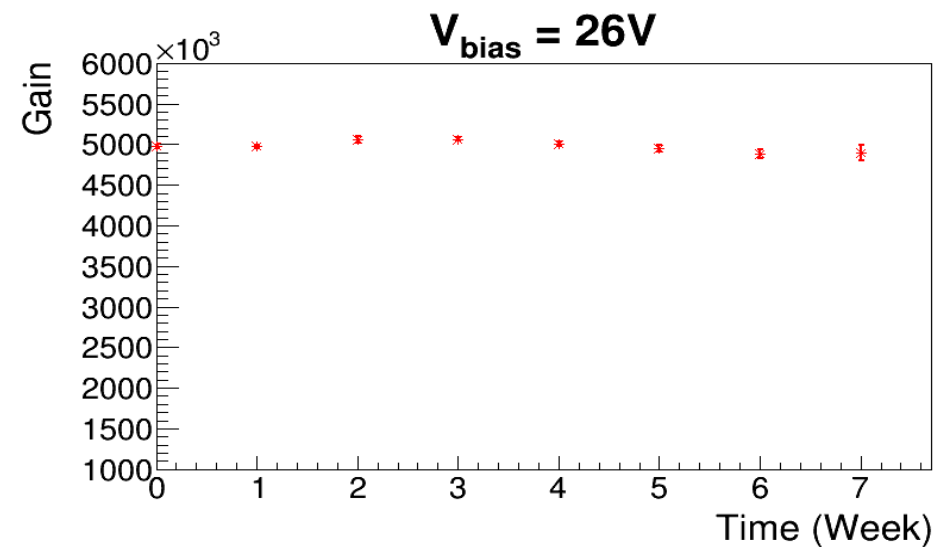
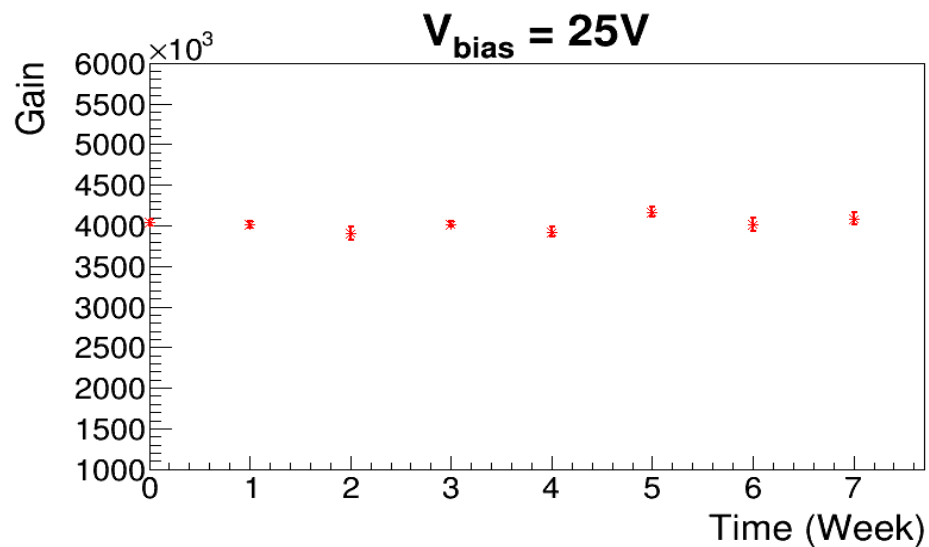
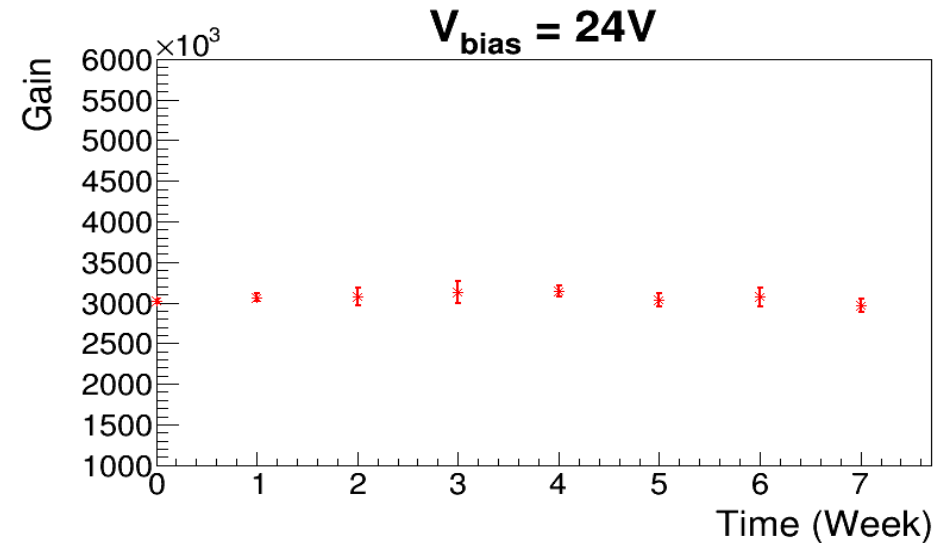
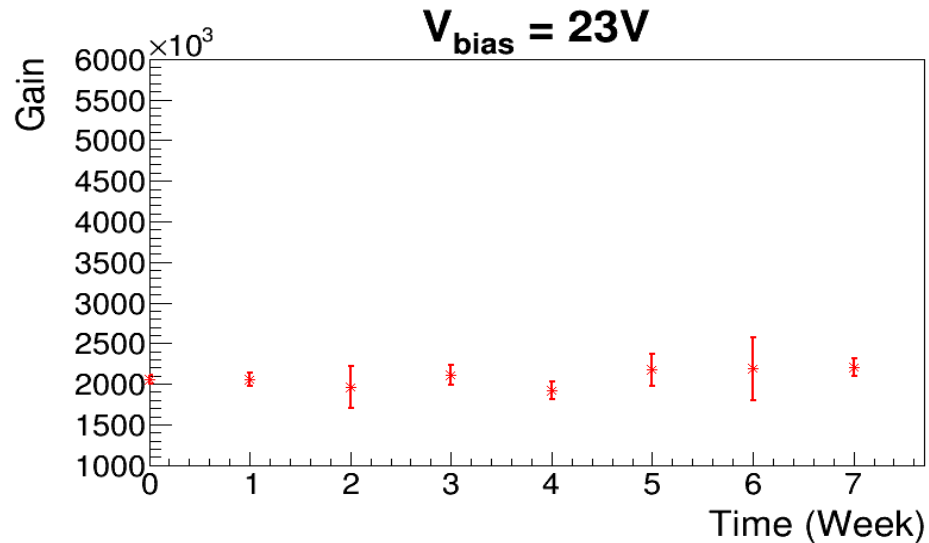
42

49

SiPM 4 Gain Evolution



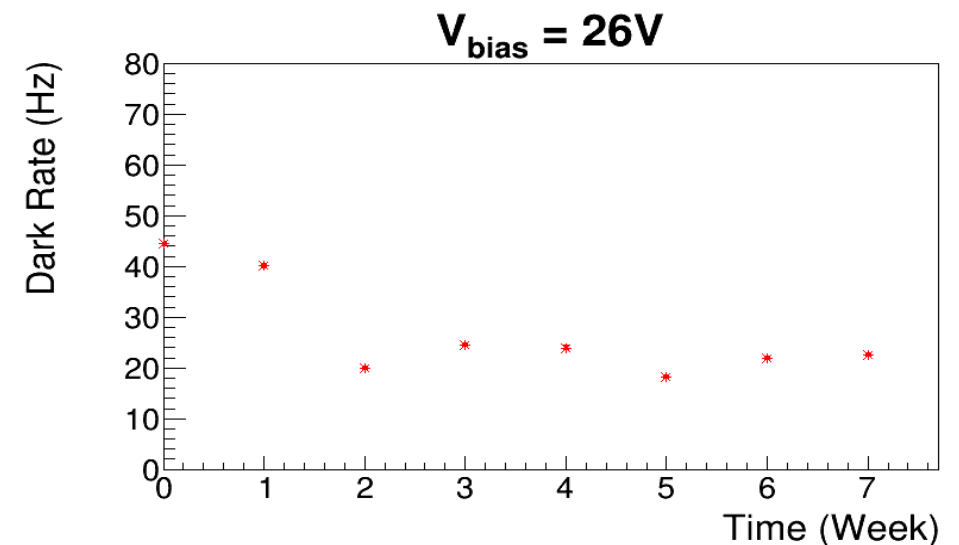
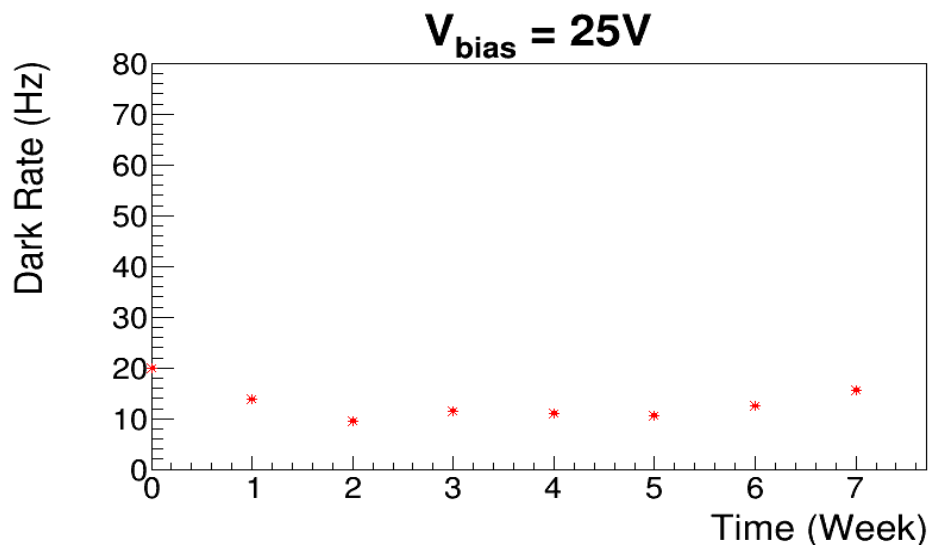
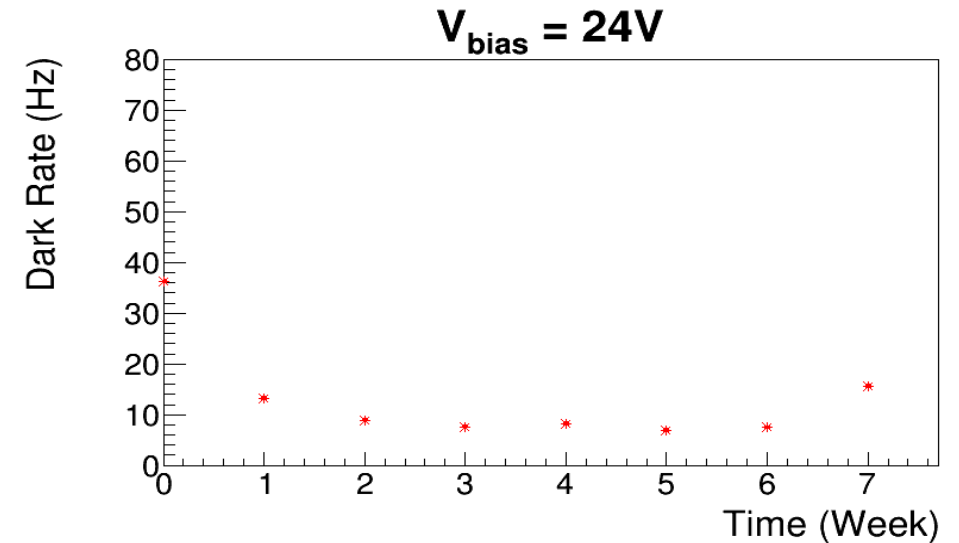
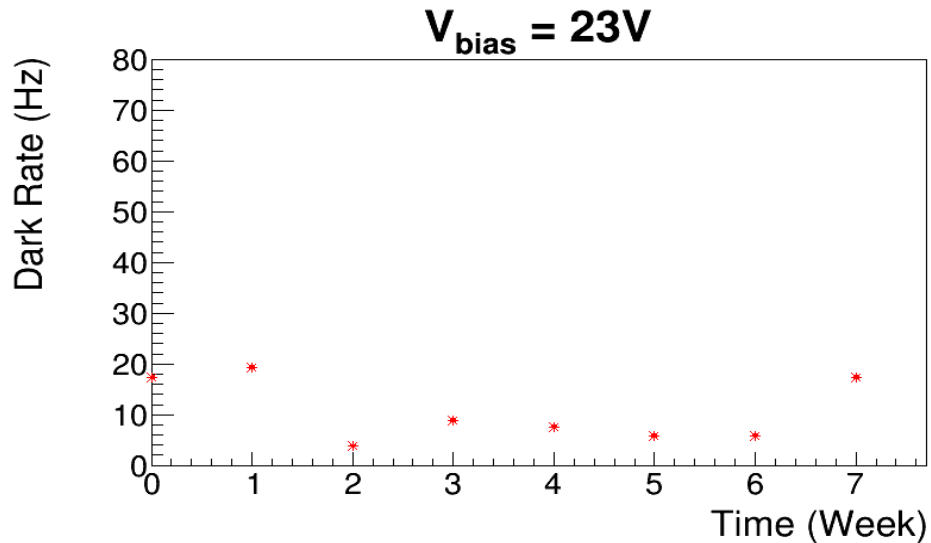
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 4 Dark Rate Evolution



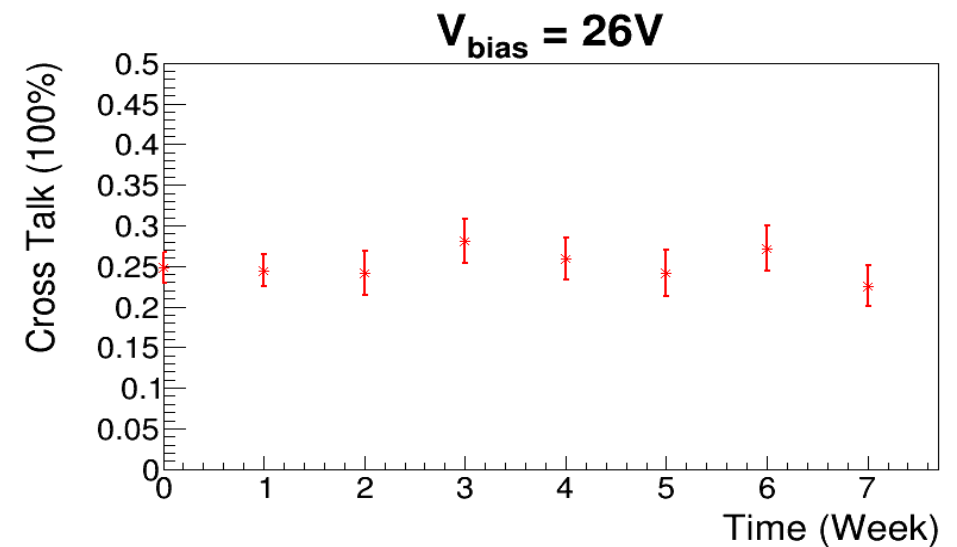
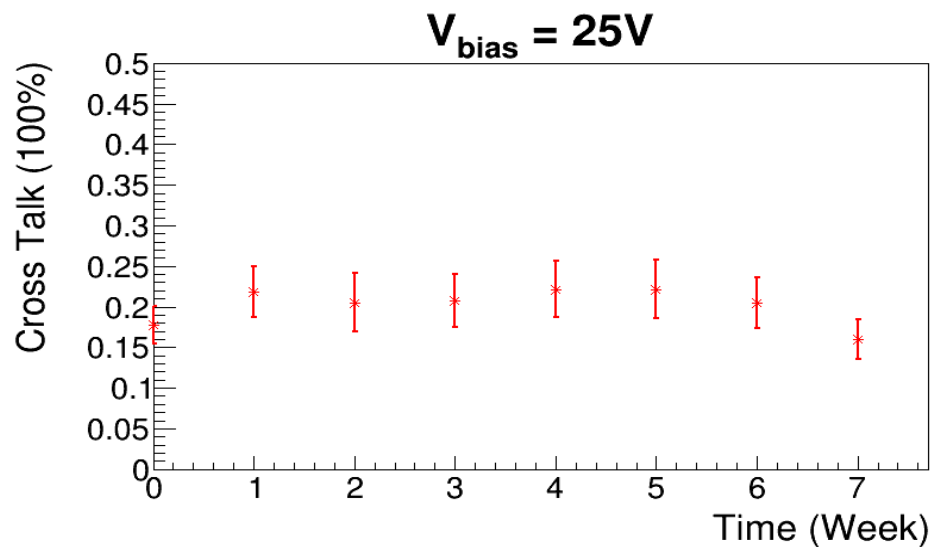
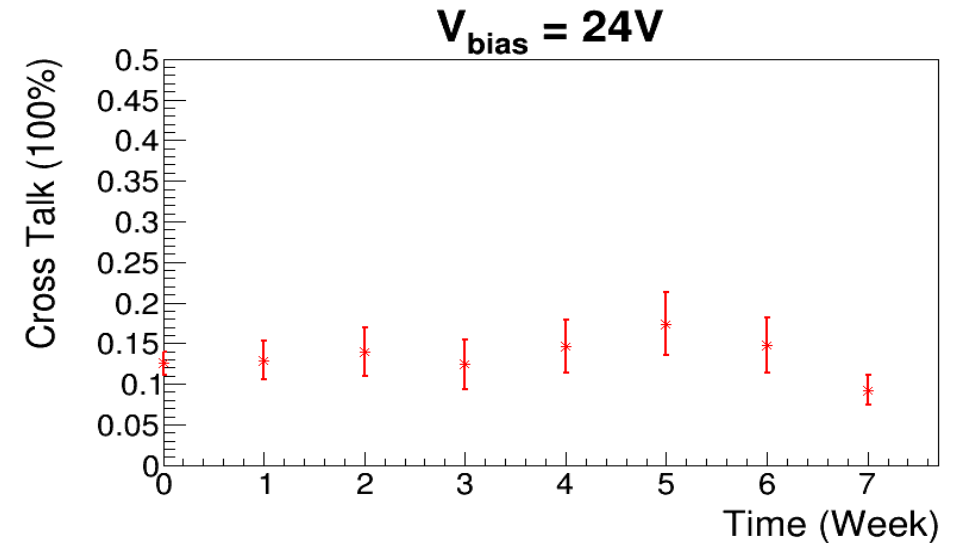
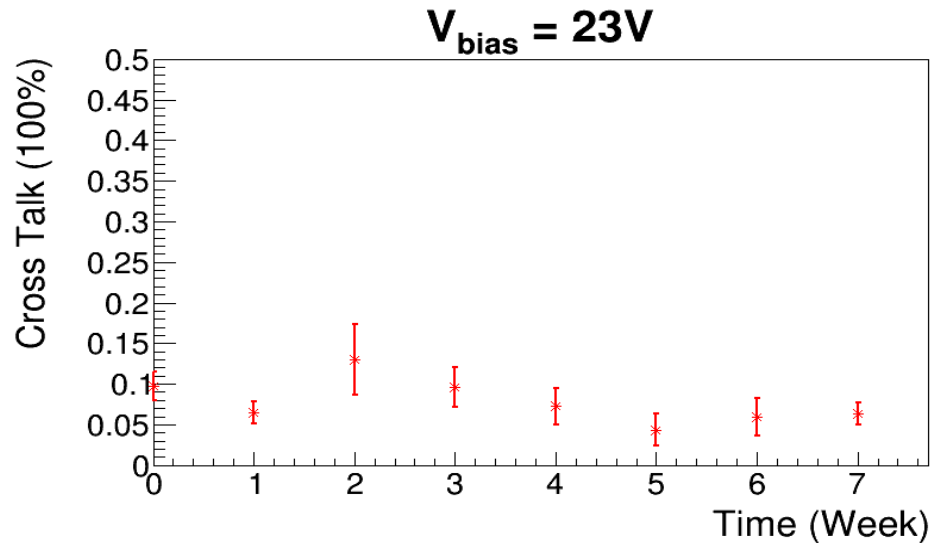
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 4 Cross Talk Evolution



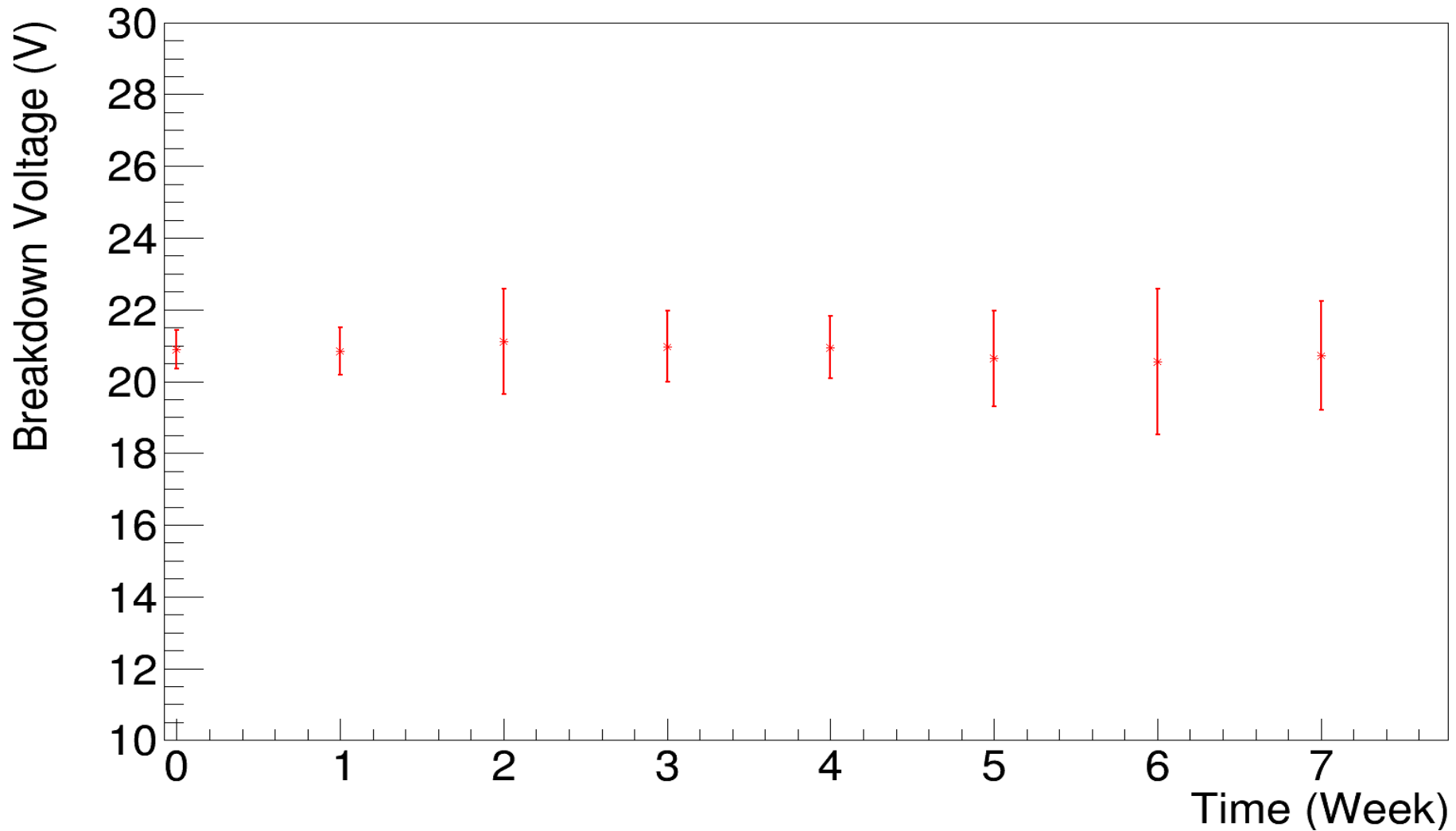
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 4 Breakdown Voltage



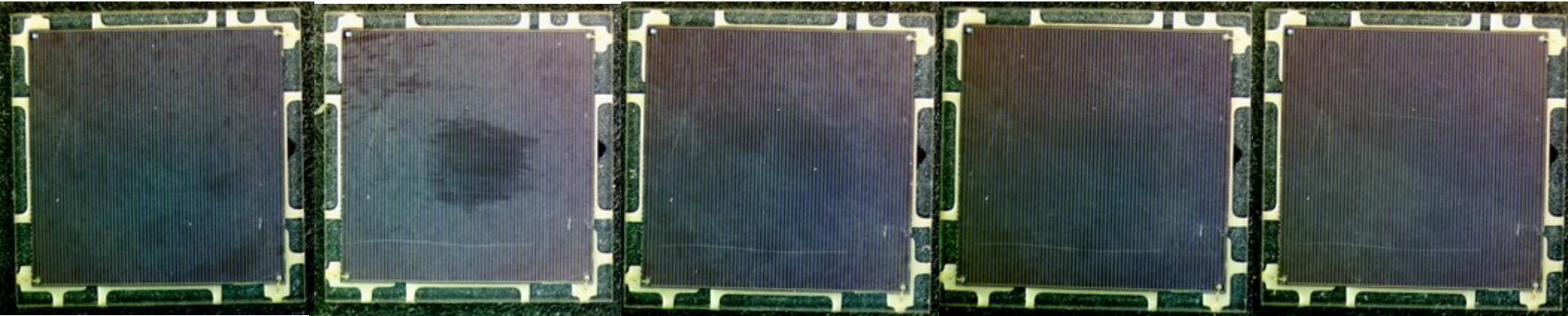
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 5 Microscope Photos



UNIVERSITY
of HAWAII®
MĀNOA



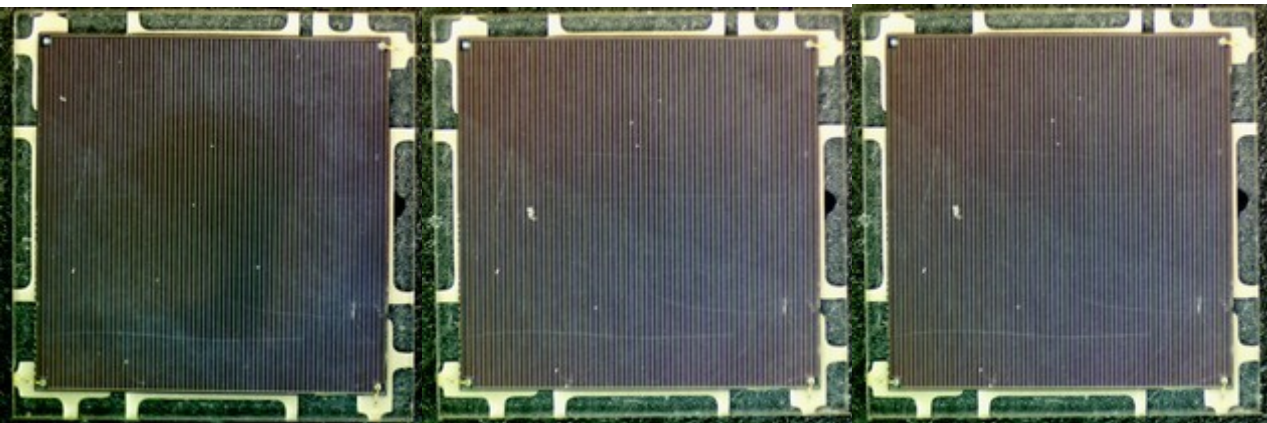
Initial
warms up in the air (days)

7

14

21

28



35

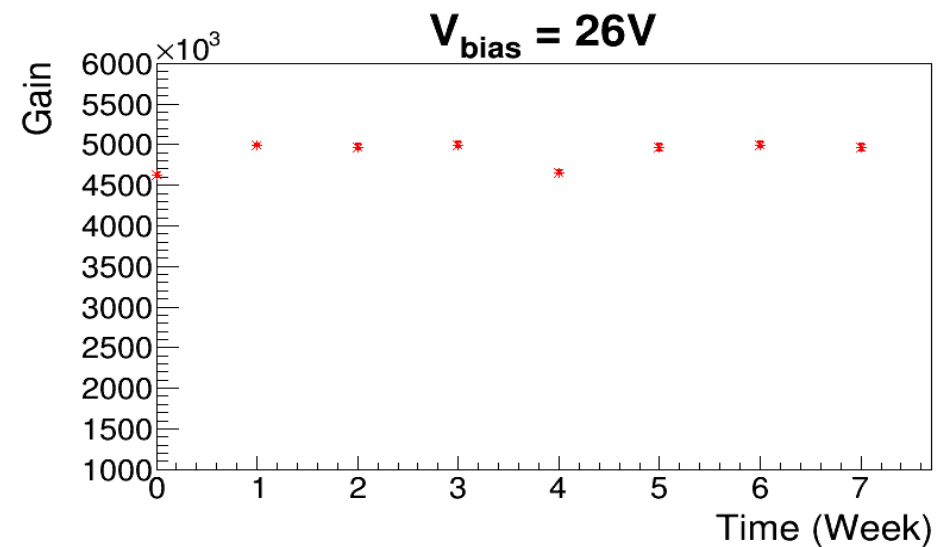
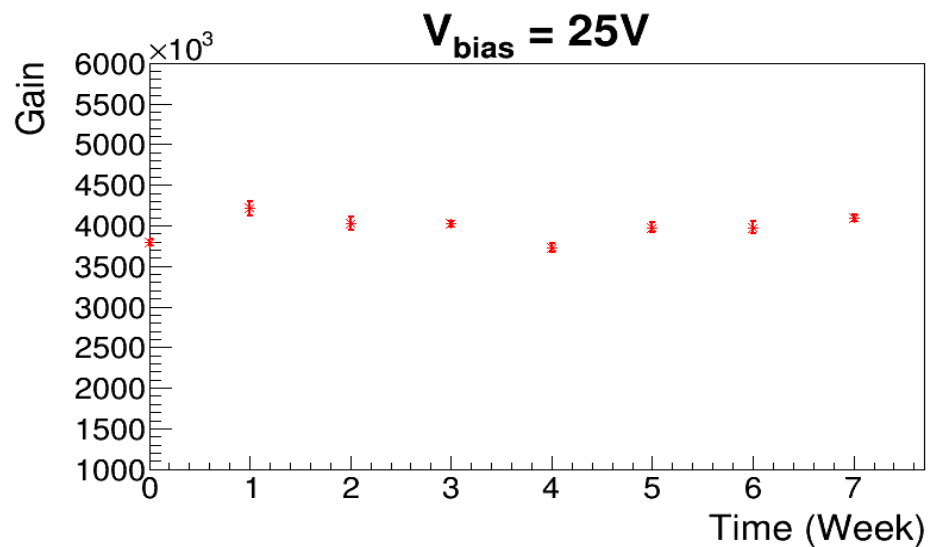
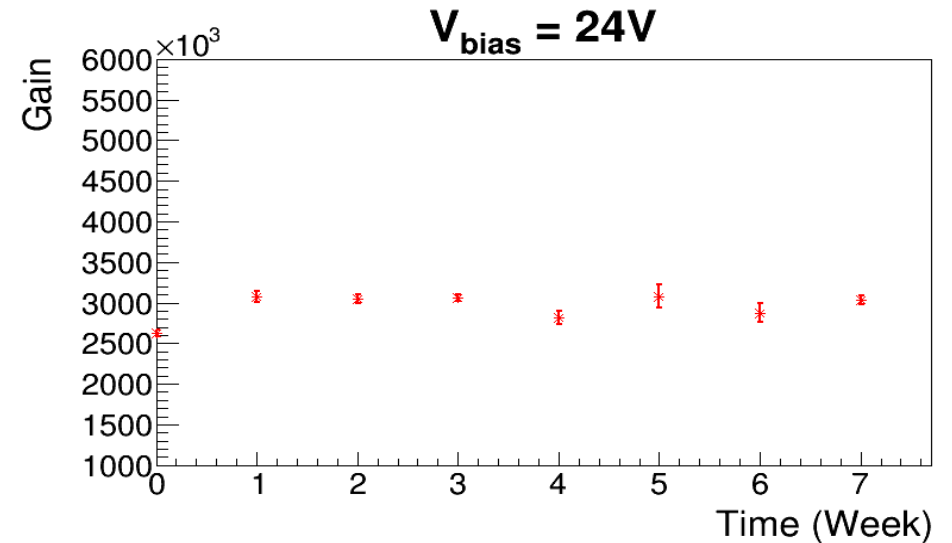
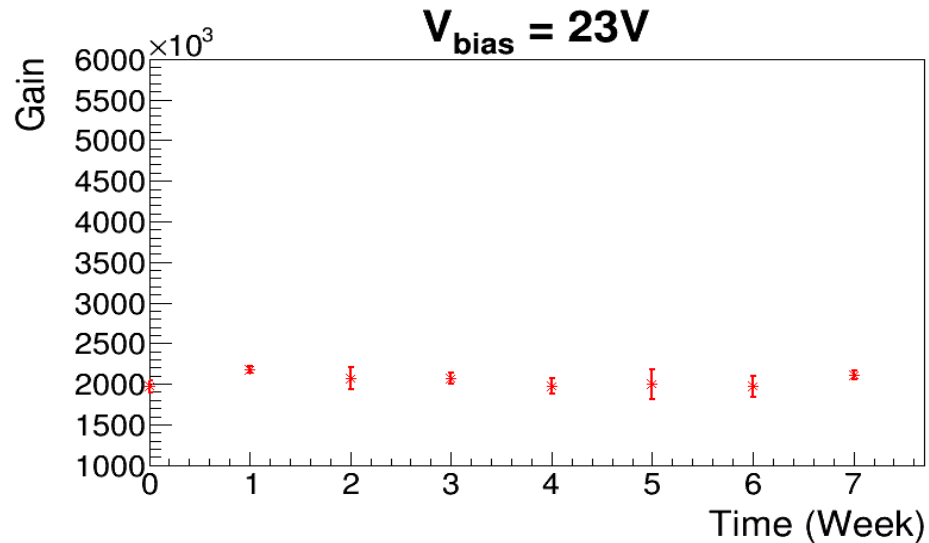
42

49

SiPM 5 Gain Evolution



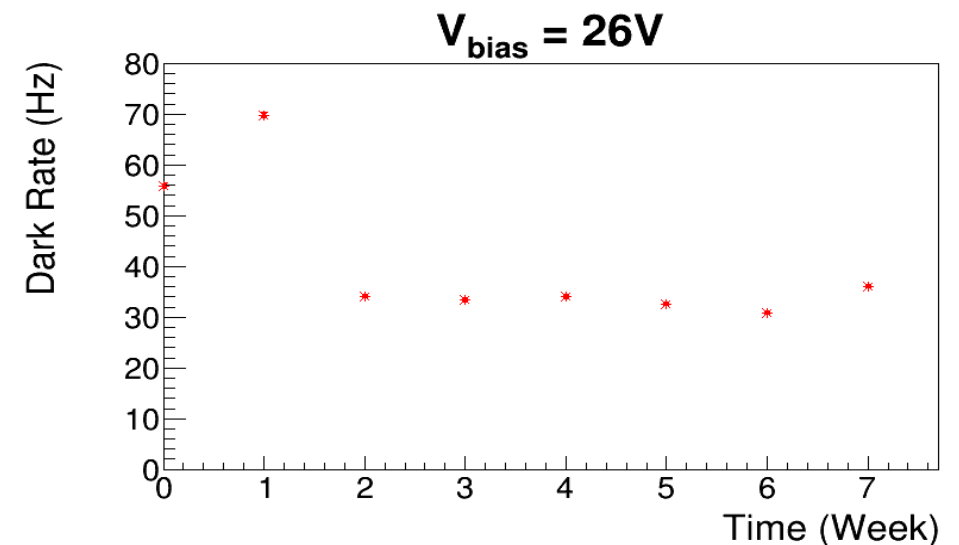
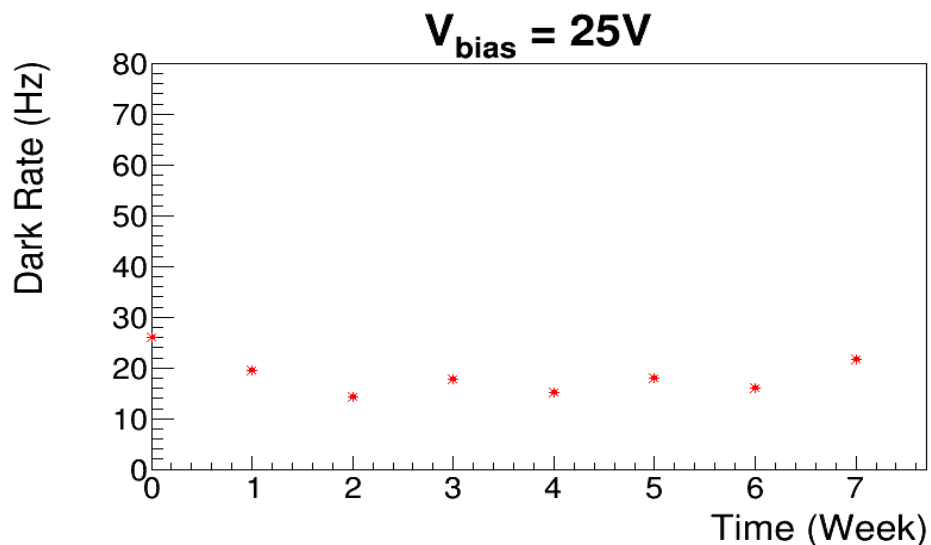
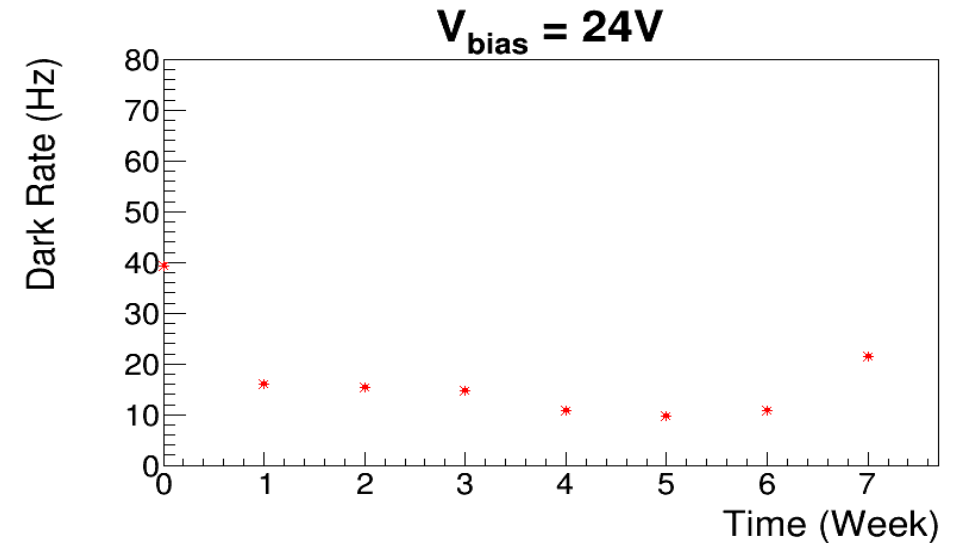
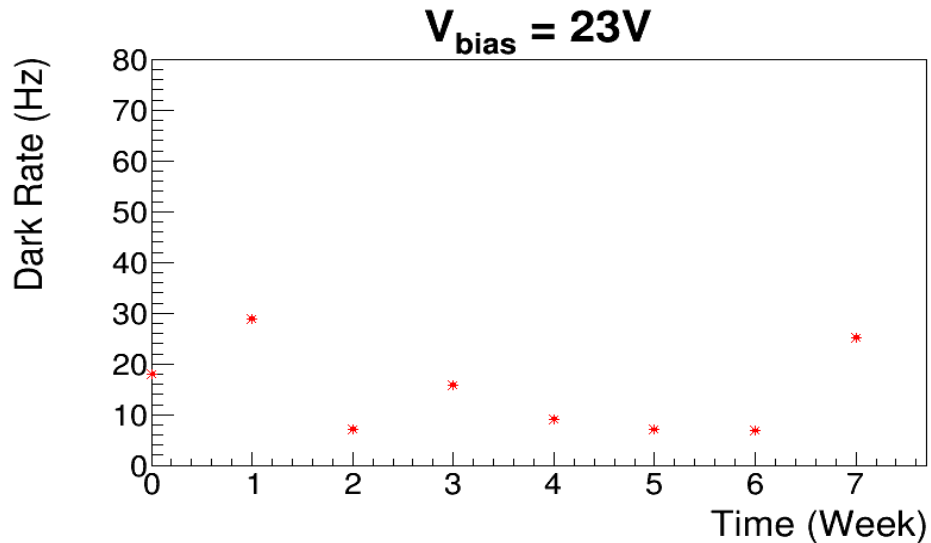
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 5 Dark Rate Evolution



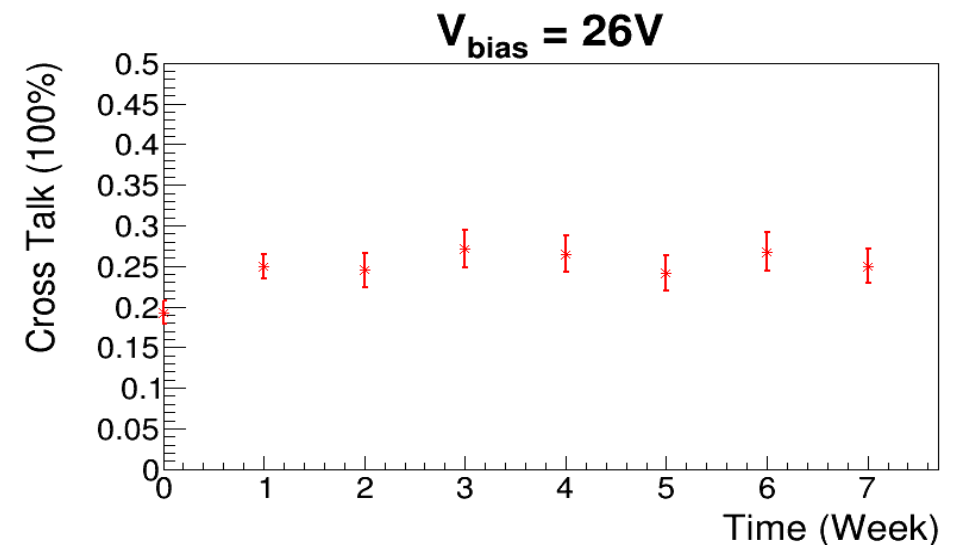
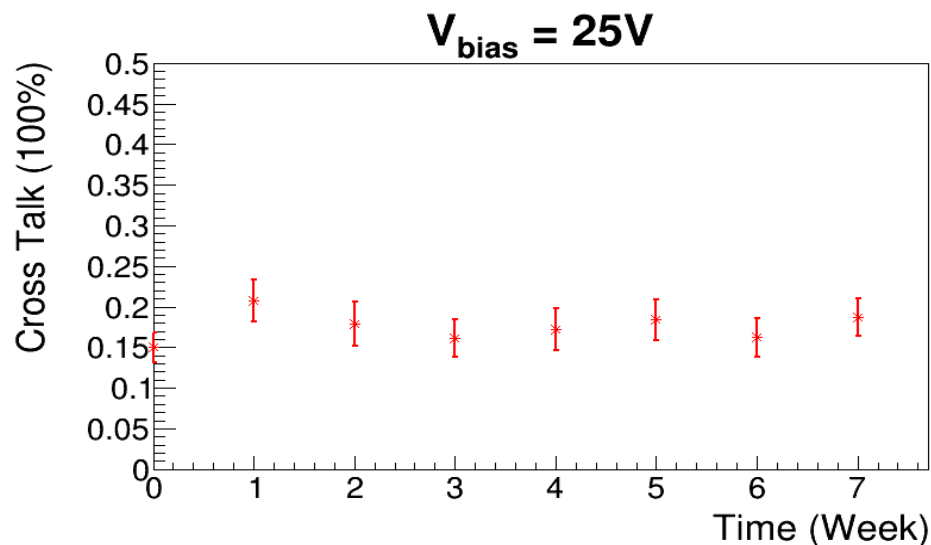
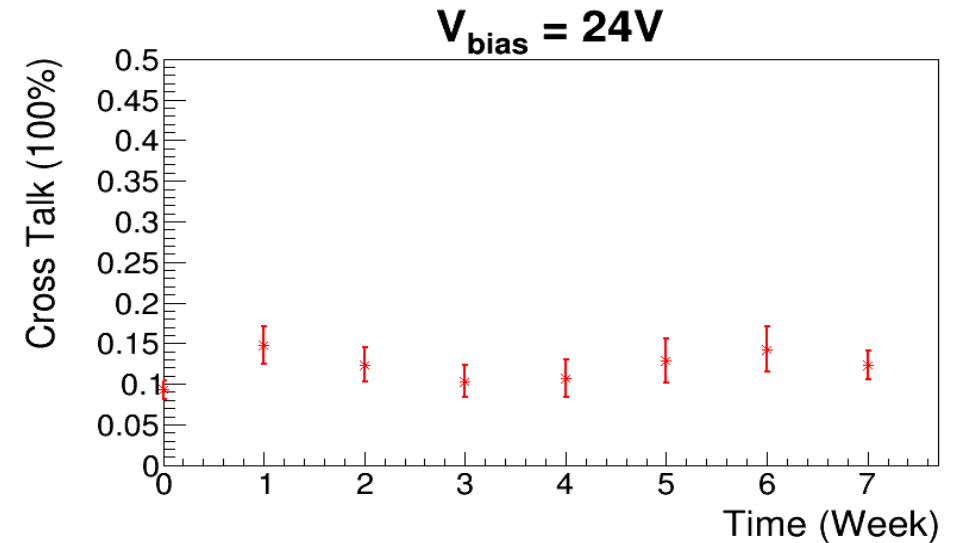
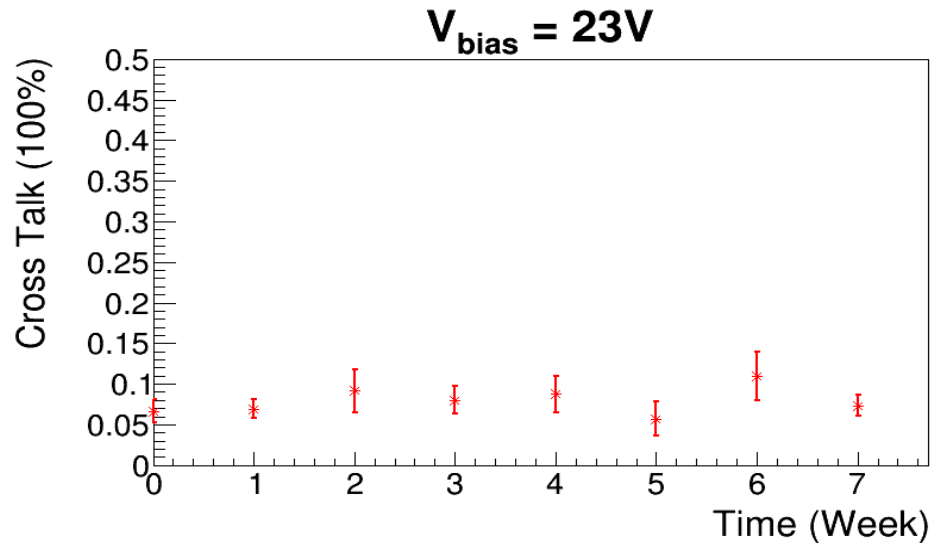
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 5 Cross Talk Evolution



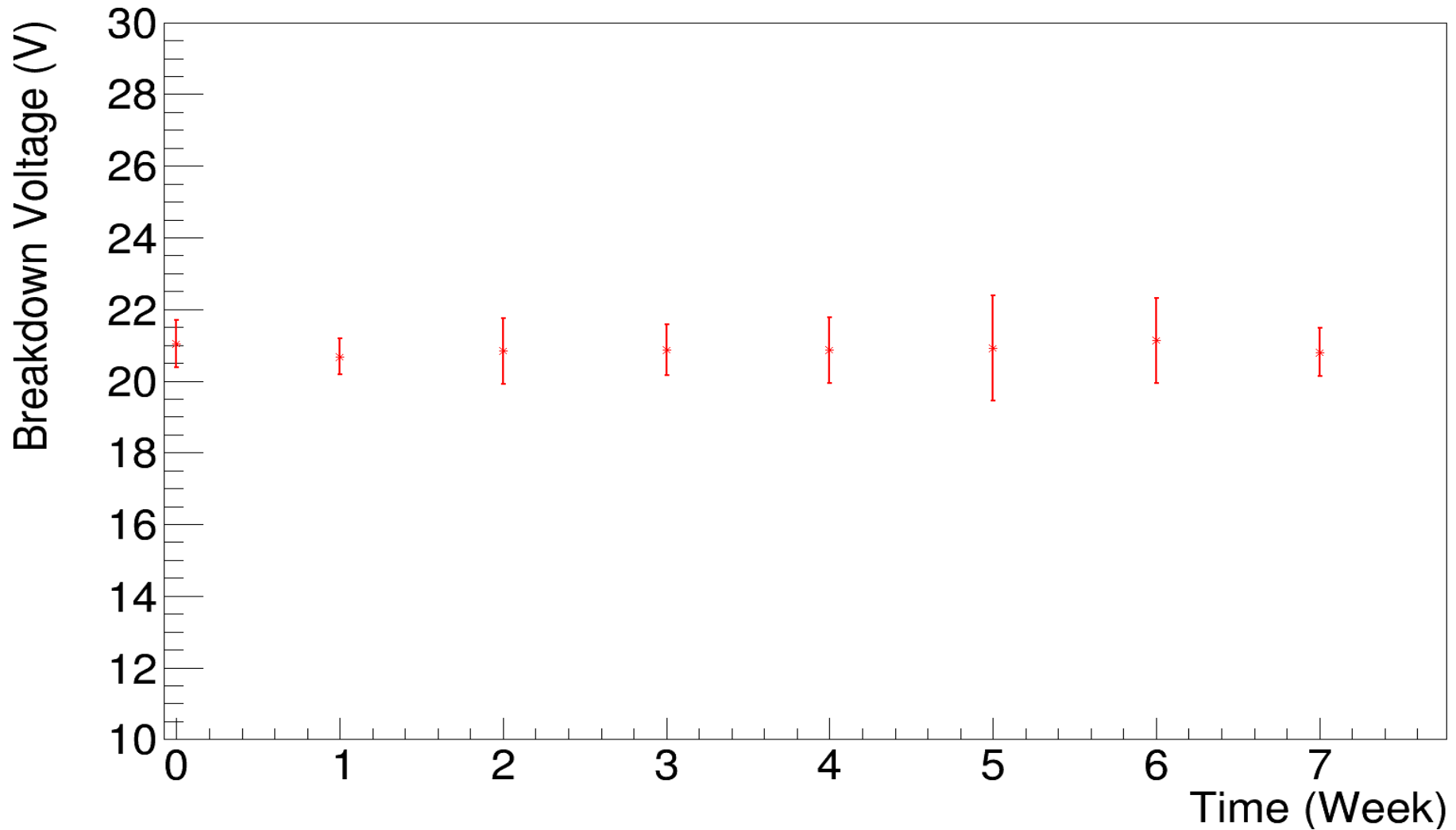
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 5 Breakdown Voltage



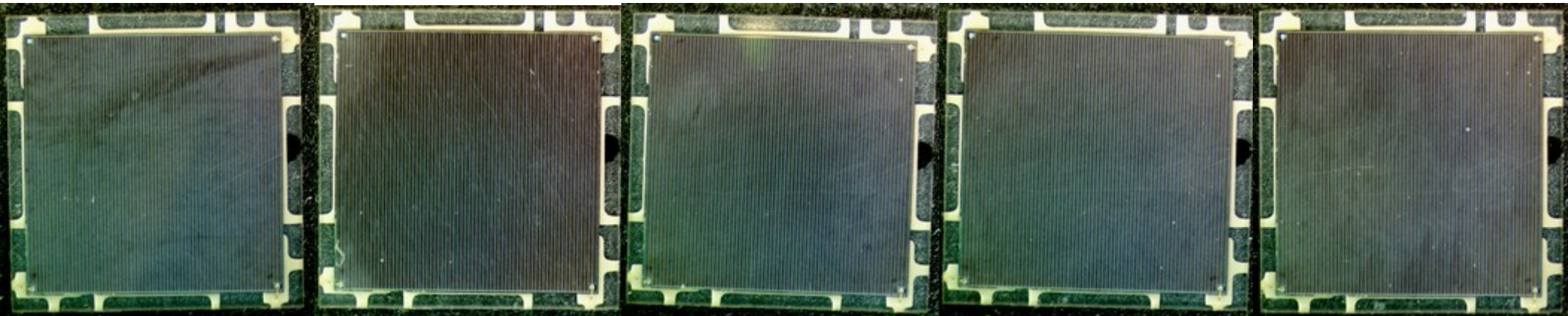
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 6 Microscope Photos



UNIVERSITY
of HAWAII®
MĀNOA



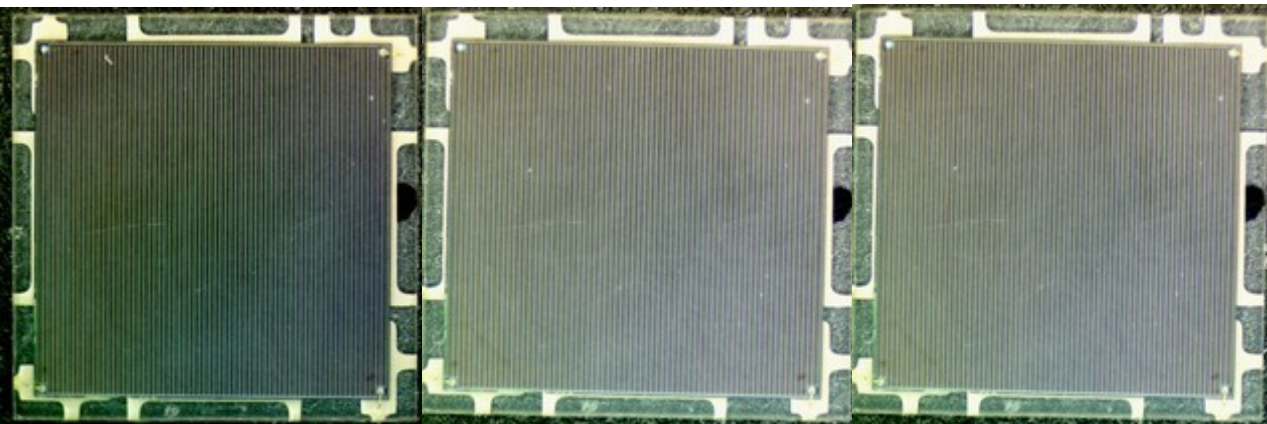
Initial
warms up in the air (days)

7

14

21

28



35

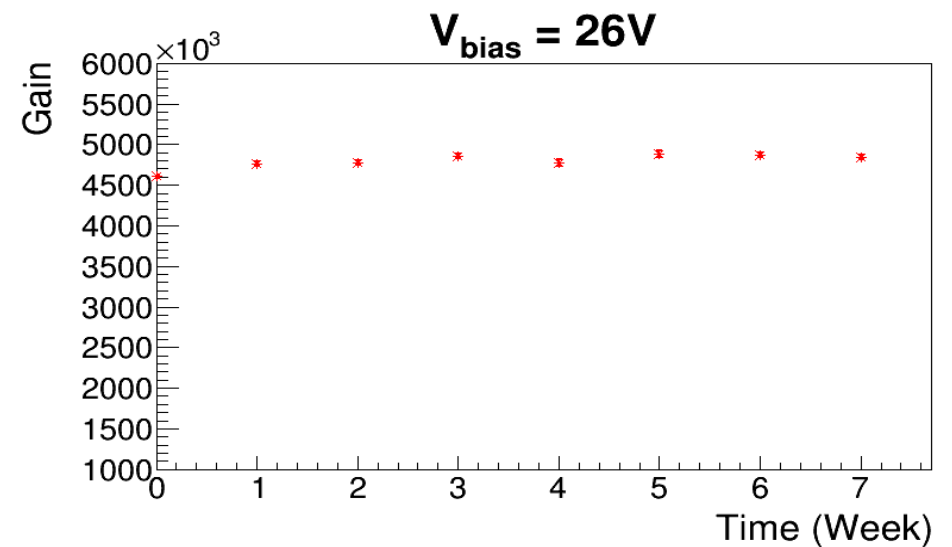
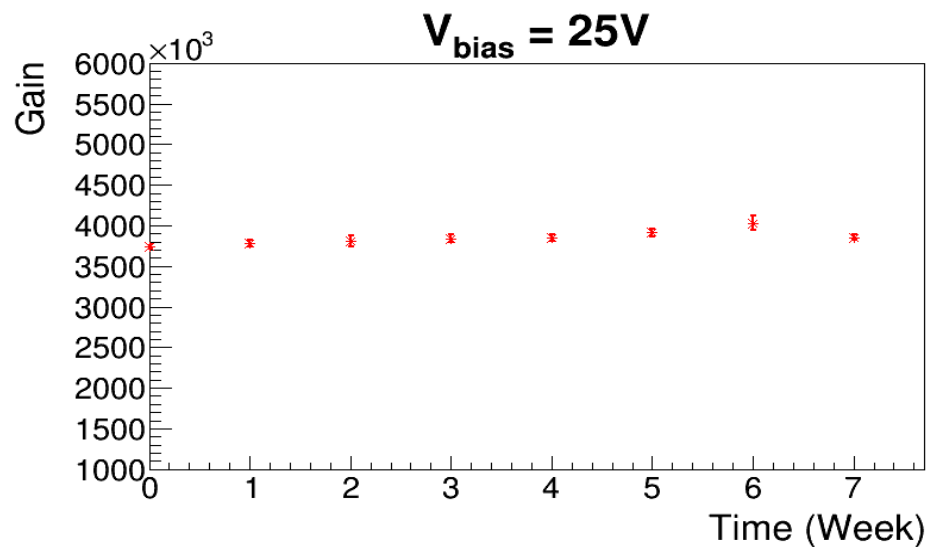
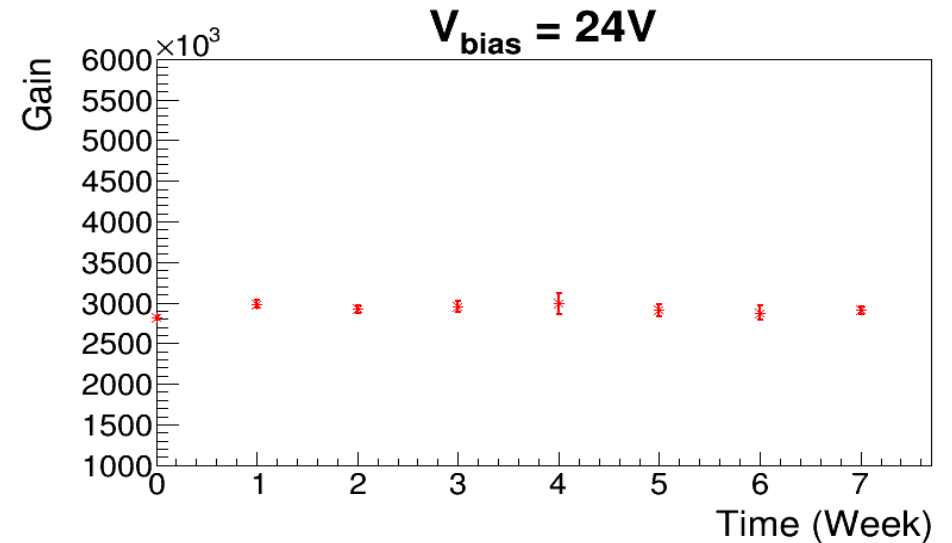
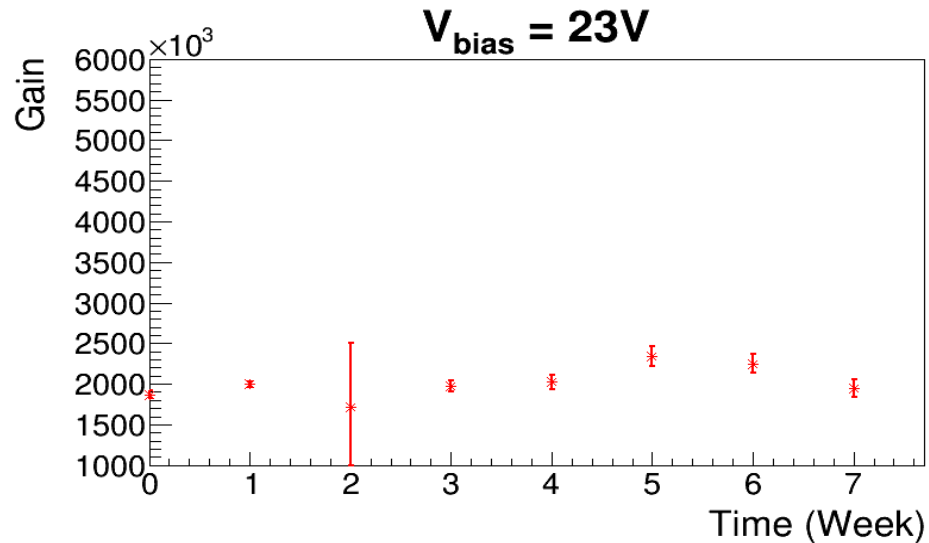
42

49

SiPM 6 Gain Evolution



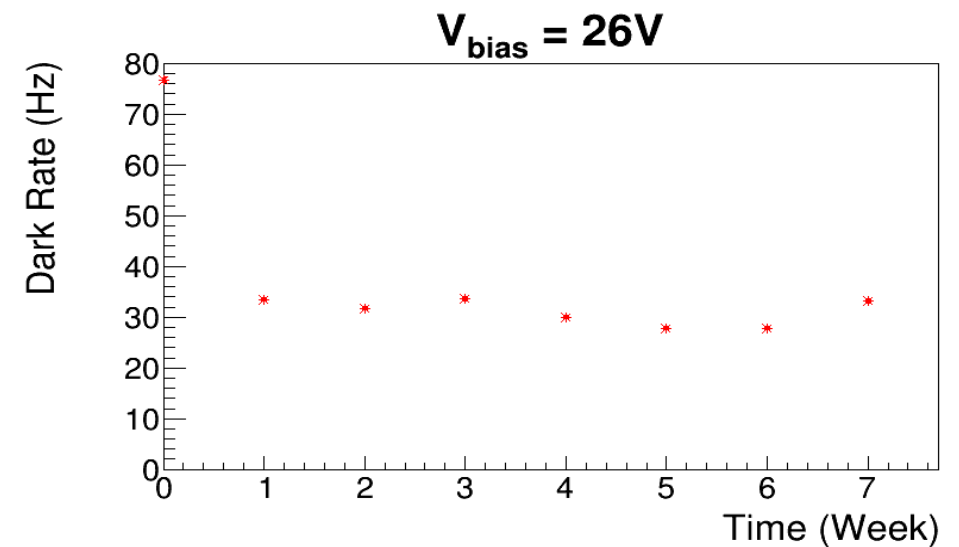
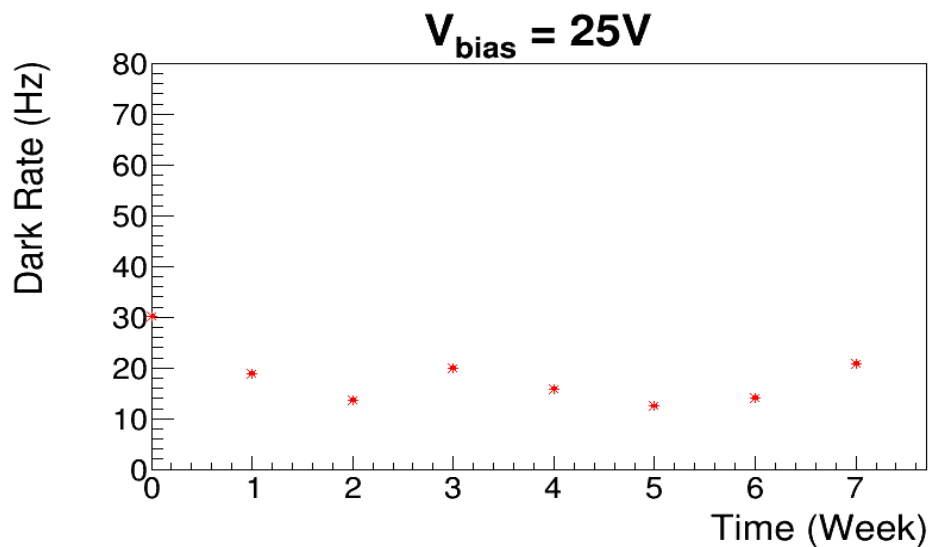
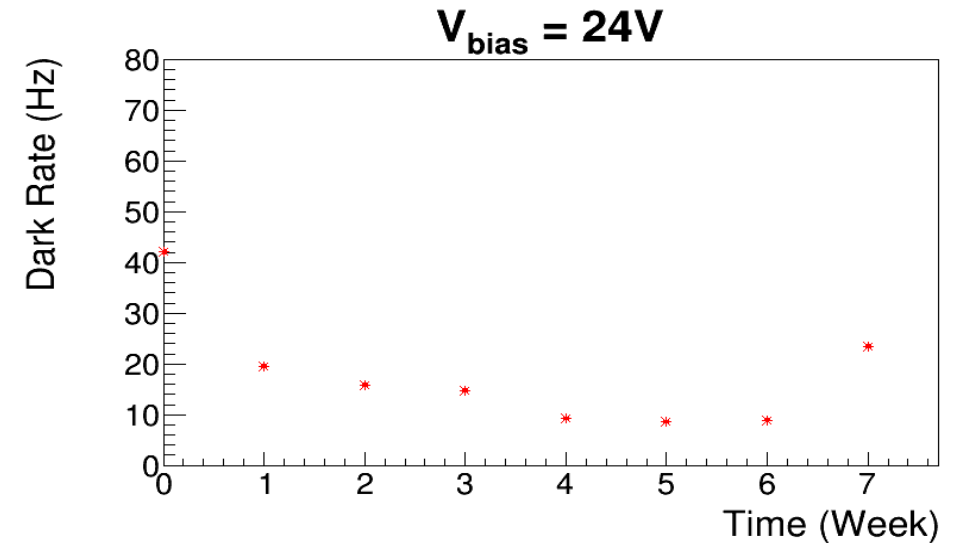
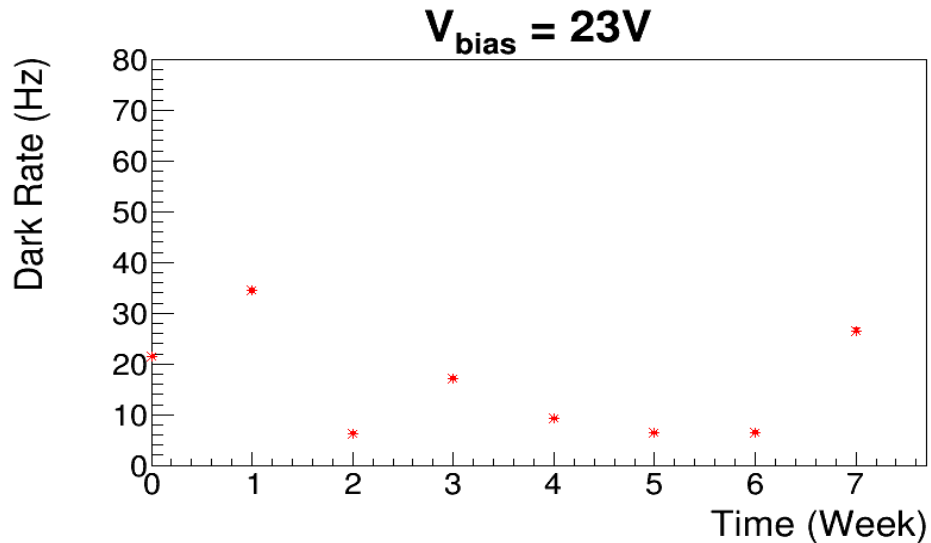
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 6 Dark Rate Evolution



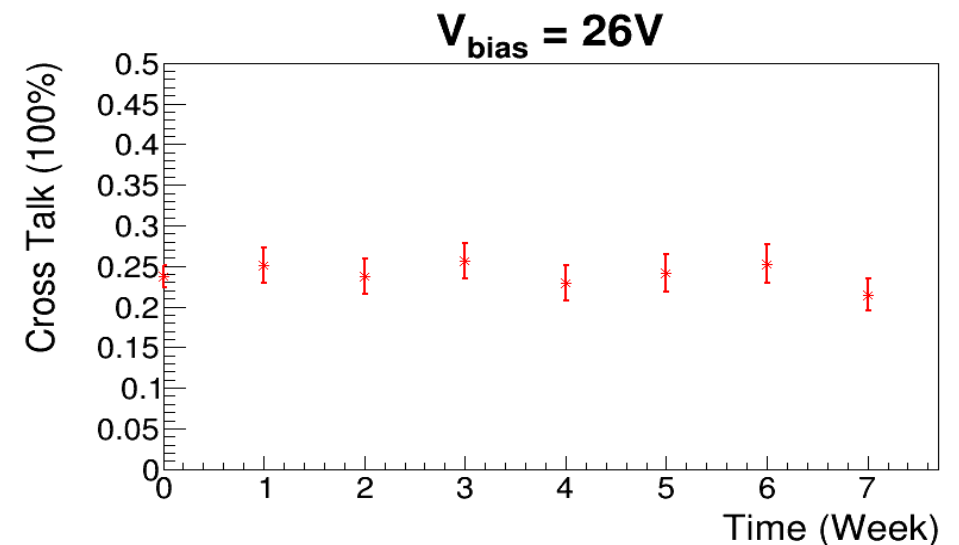
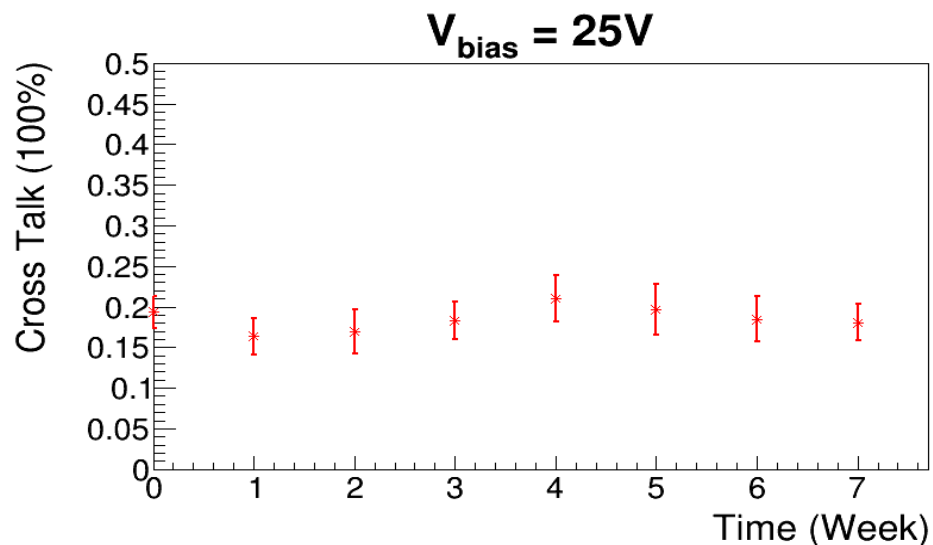
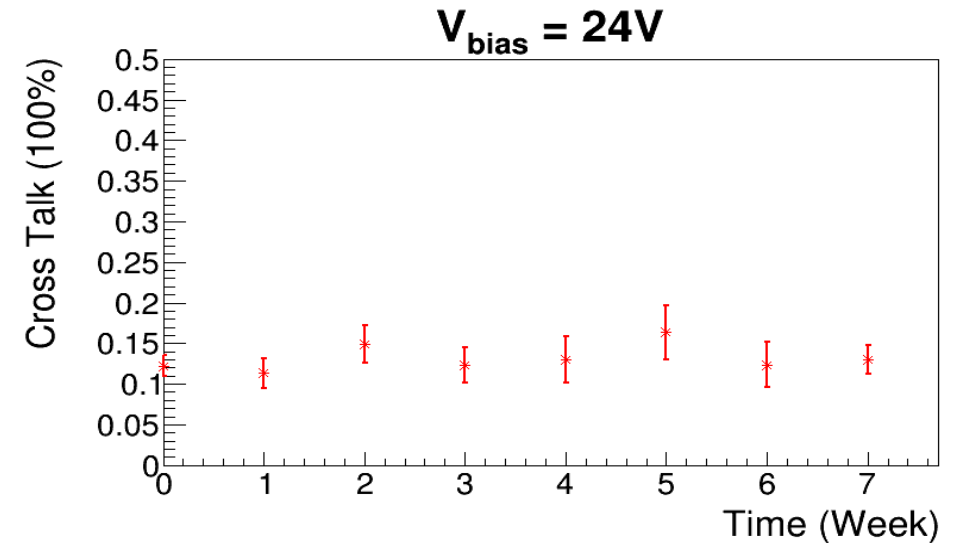
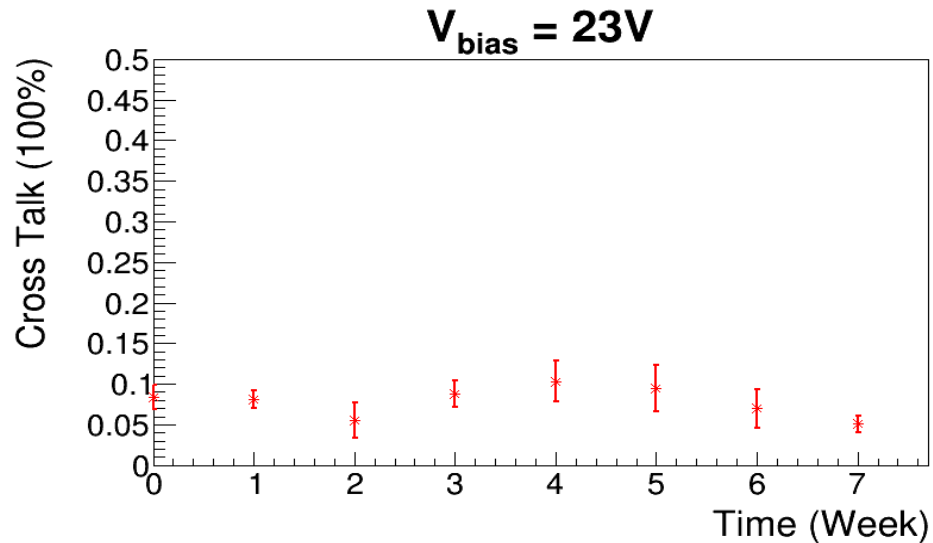
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 6 Cross Talk Evolution



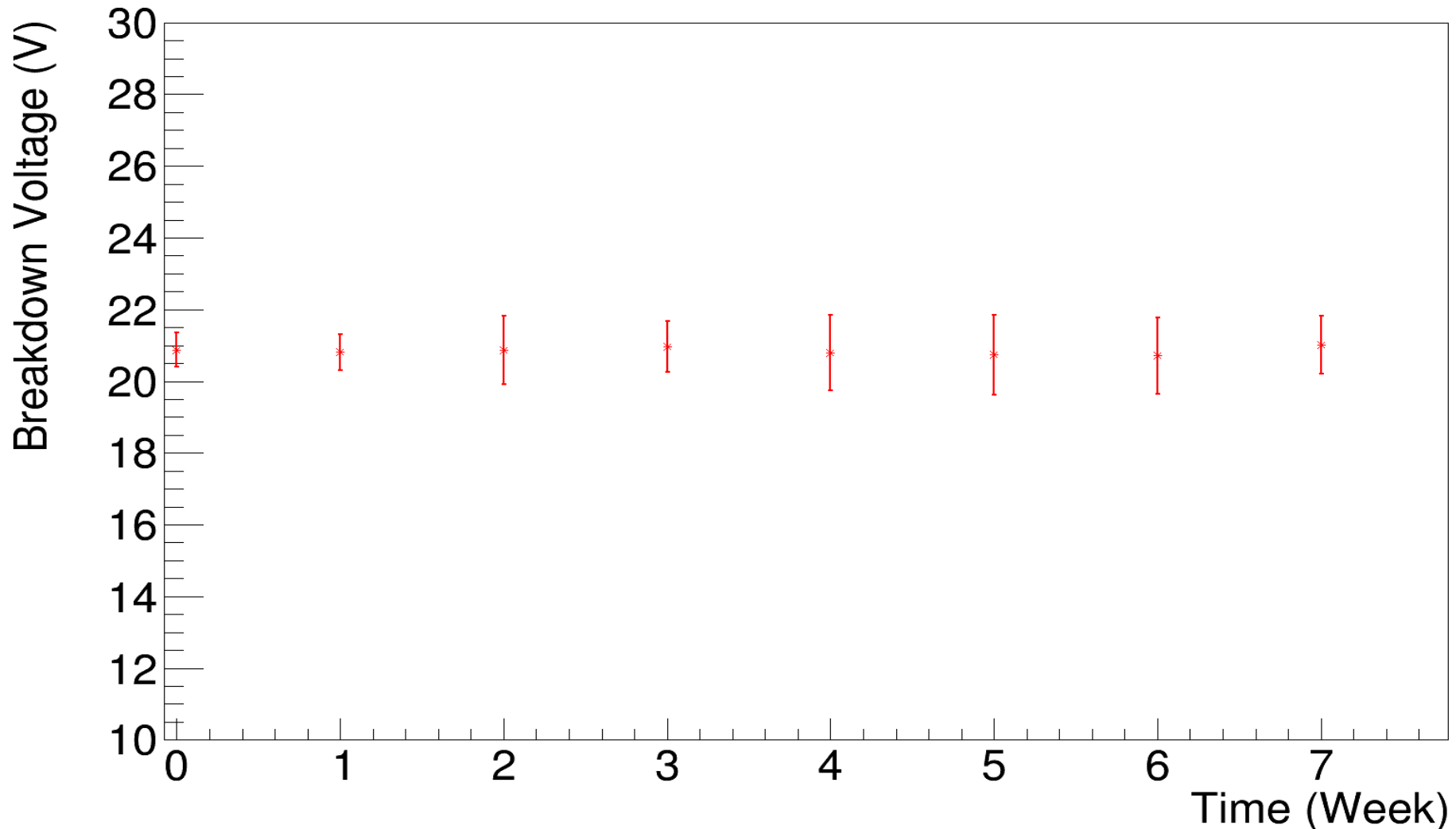
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 6 Breakdown Voltage



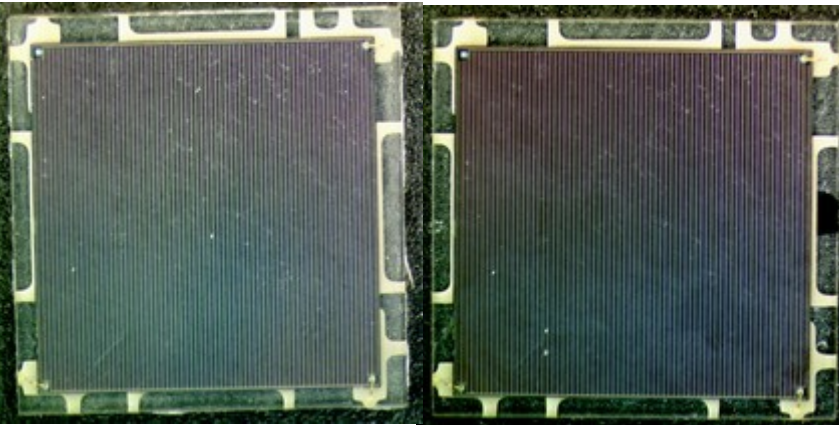
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 7 Microscope Photos



UNIVERSITY
of HAWAII®
MĀNOA



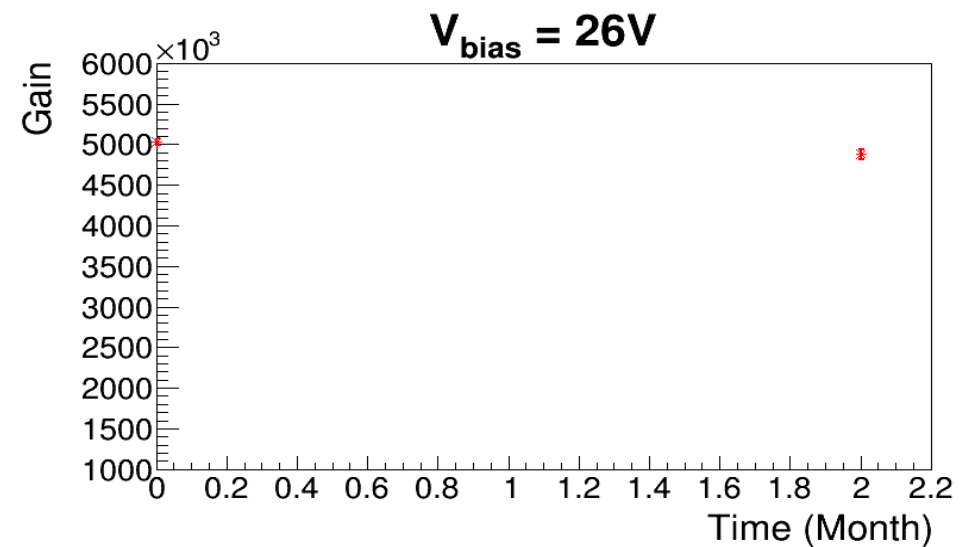
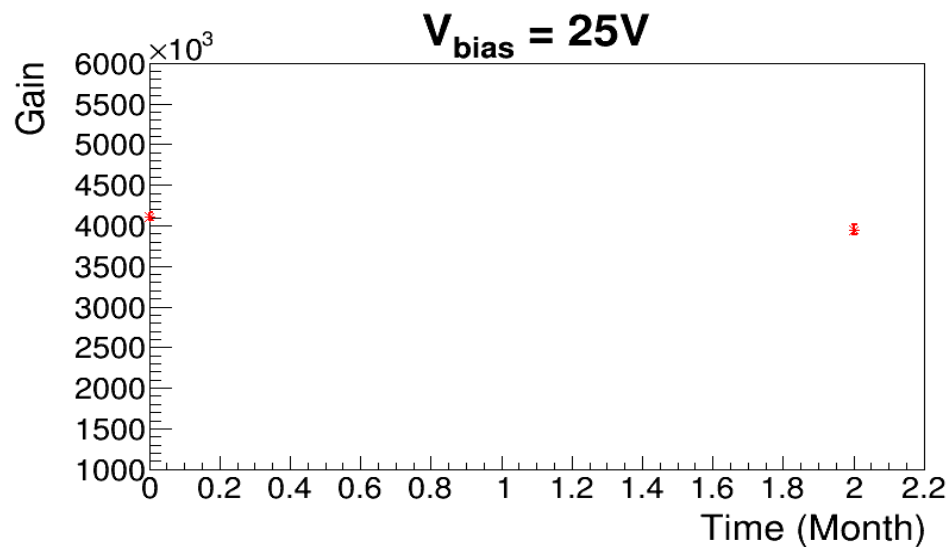
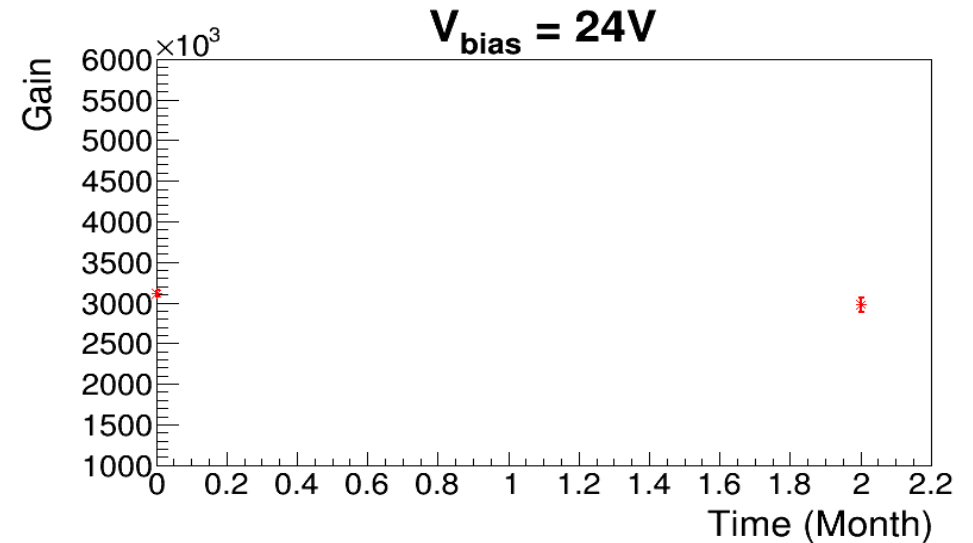
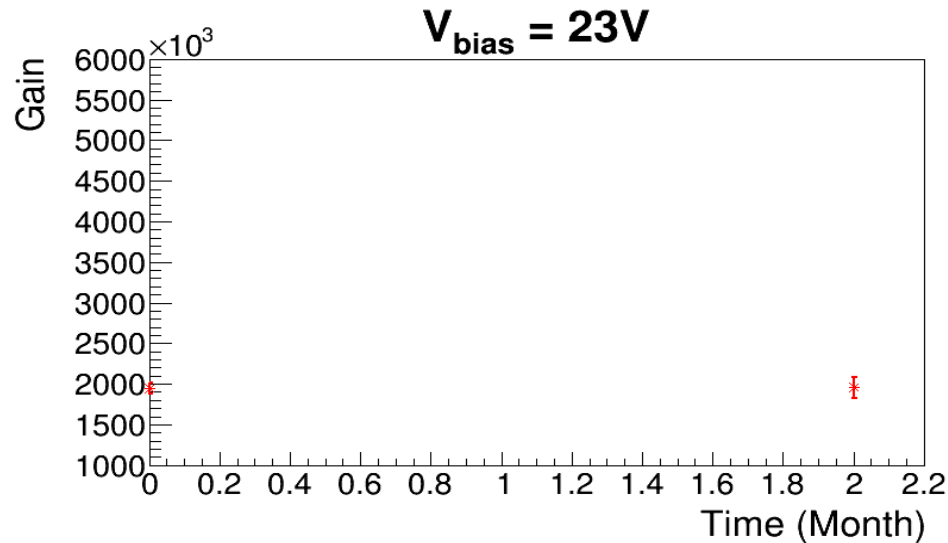
Initial
warms up in a bag (days)

60

SiPM 7 Gain Evolution



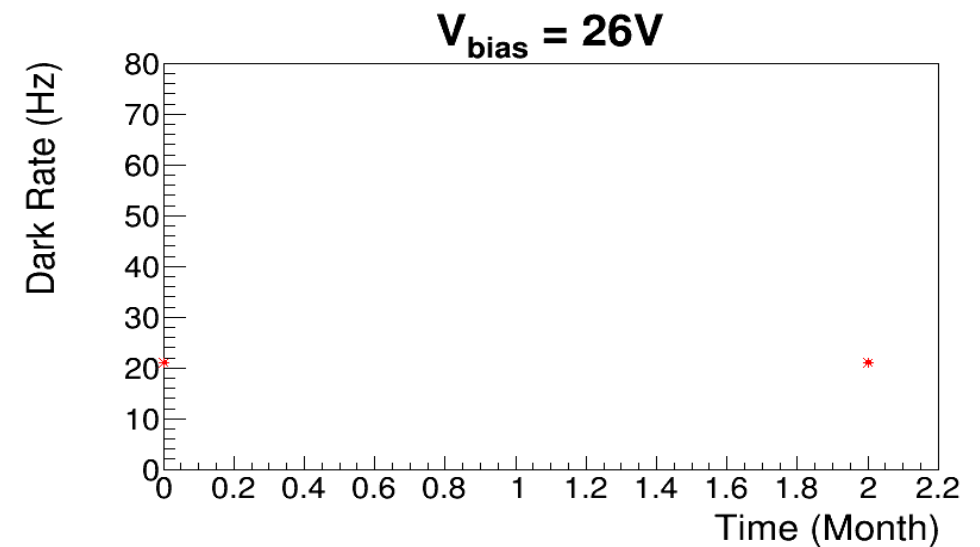
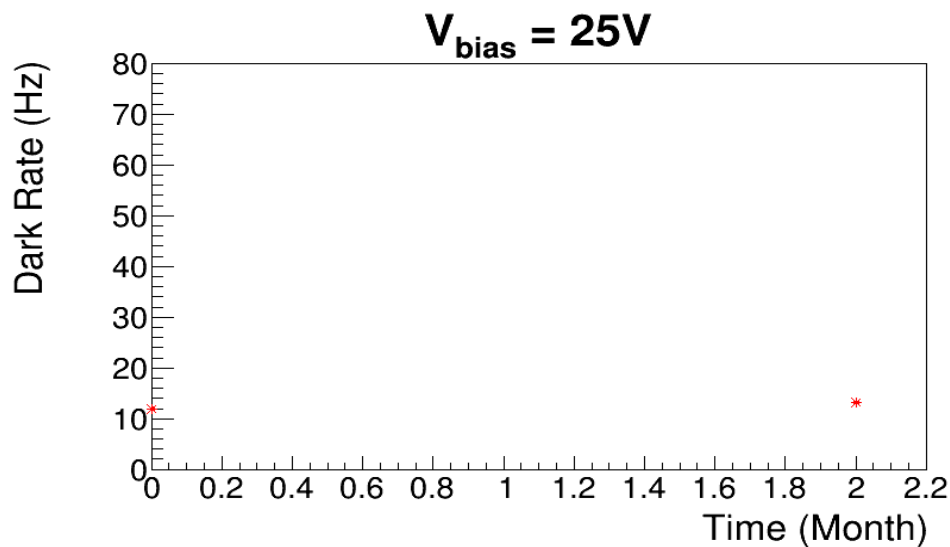
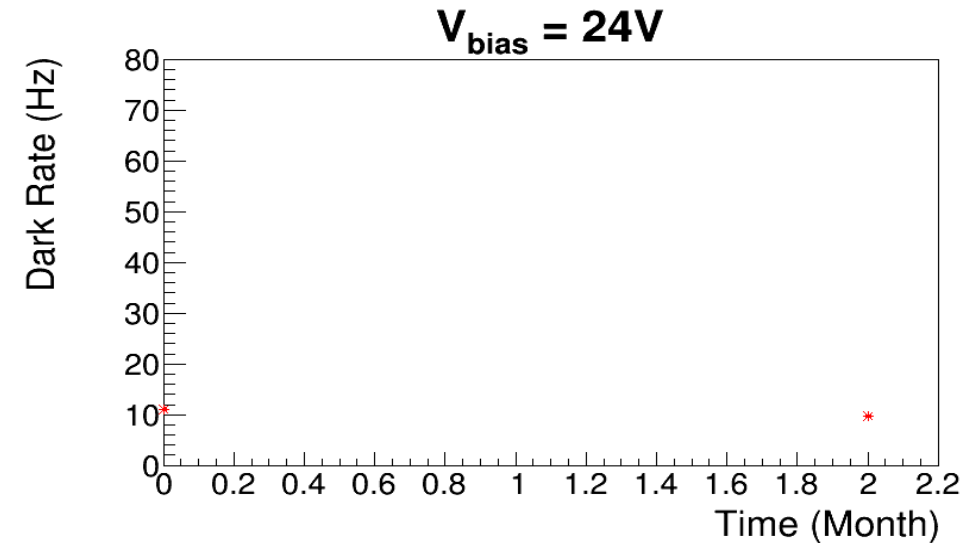
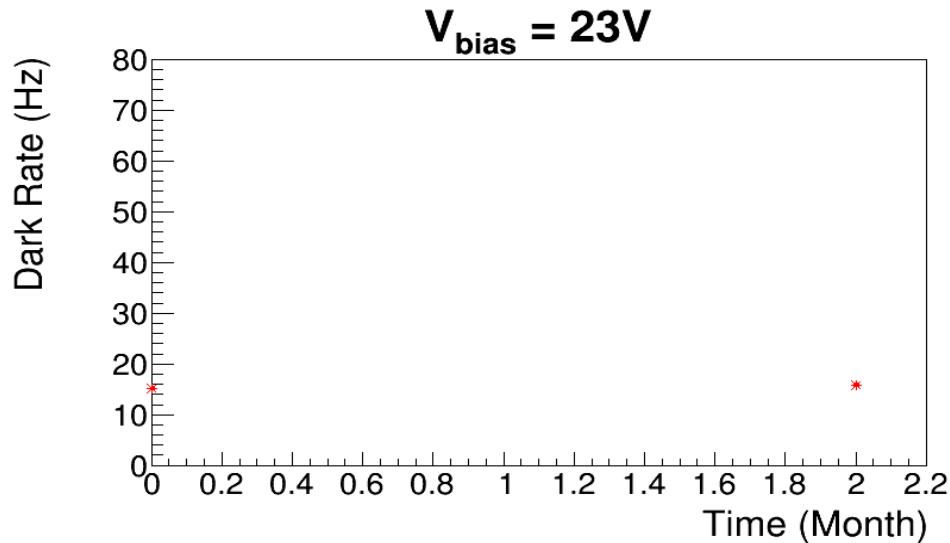
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 7 Dark Rate Evolution



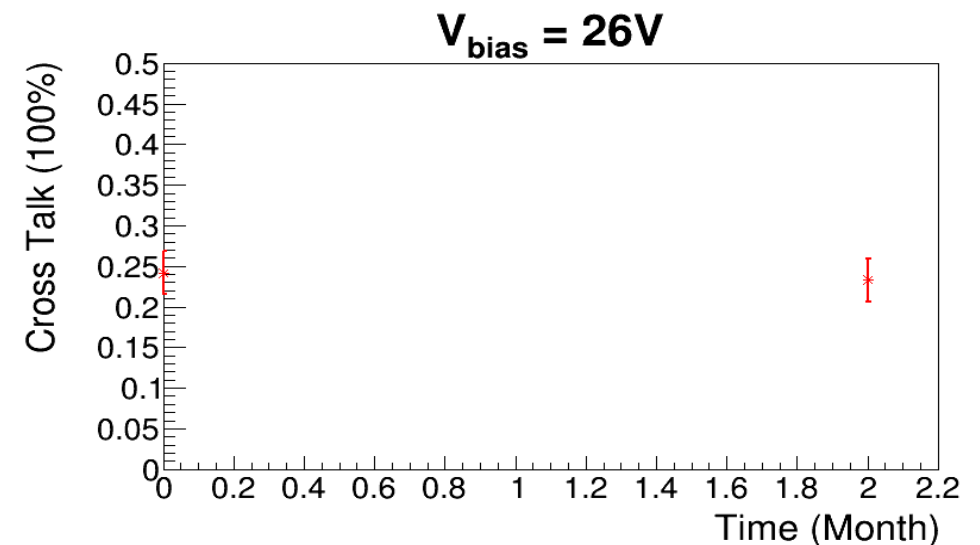
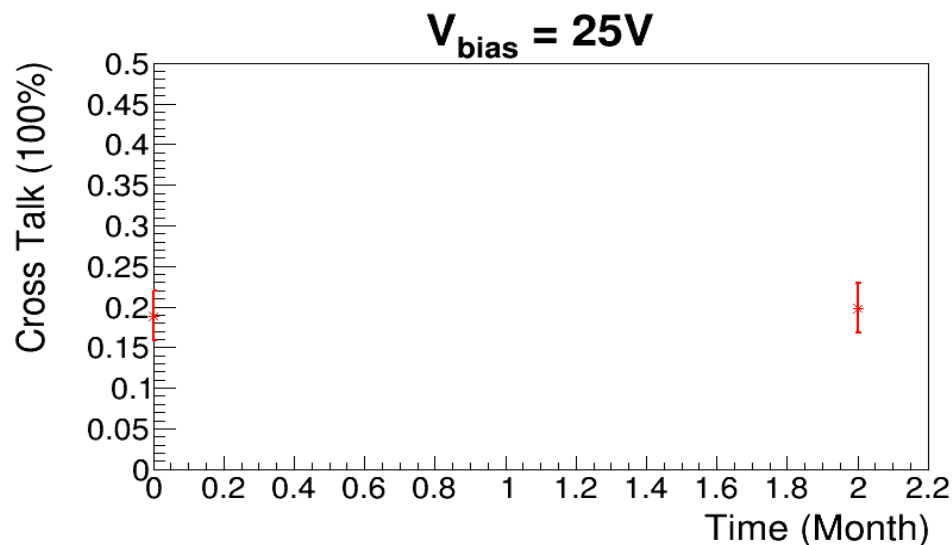
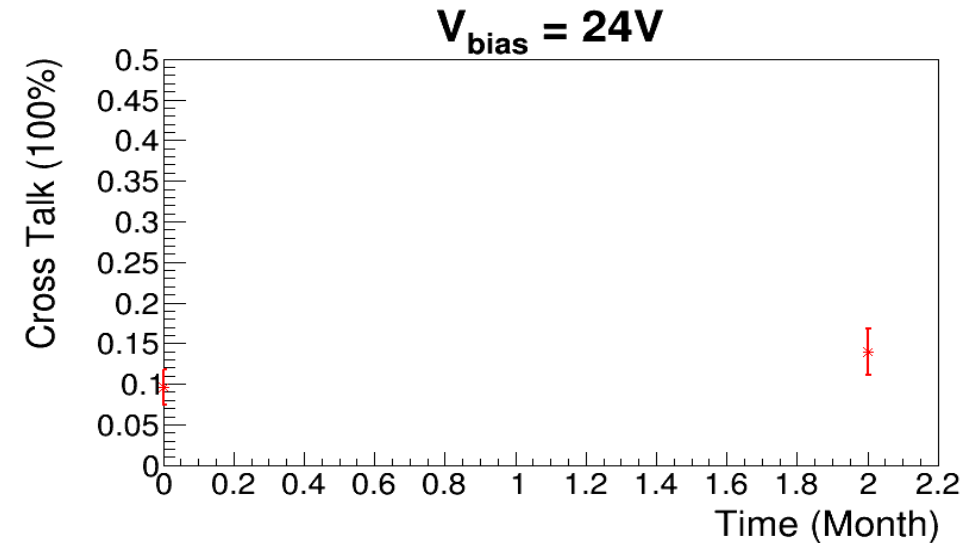
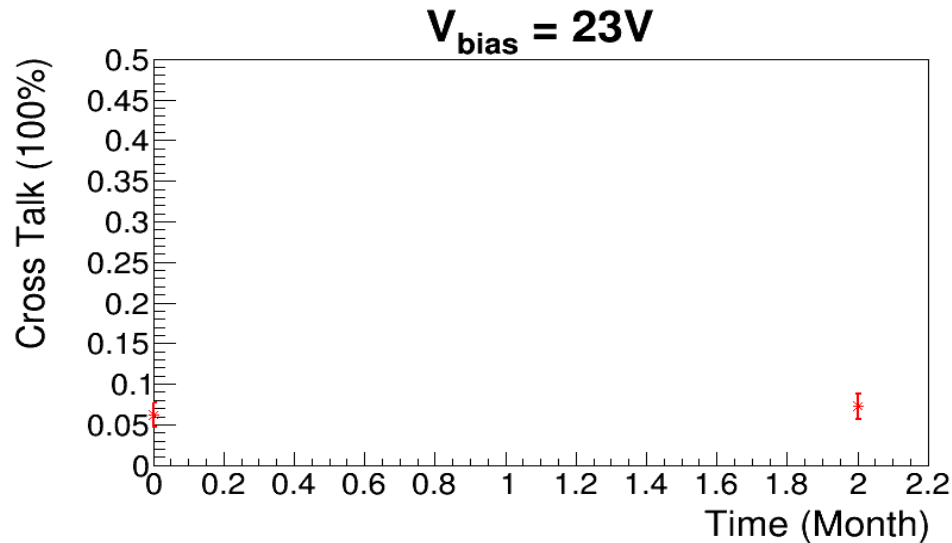
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 7 Cross Talk Evolution



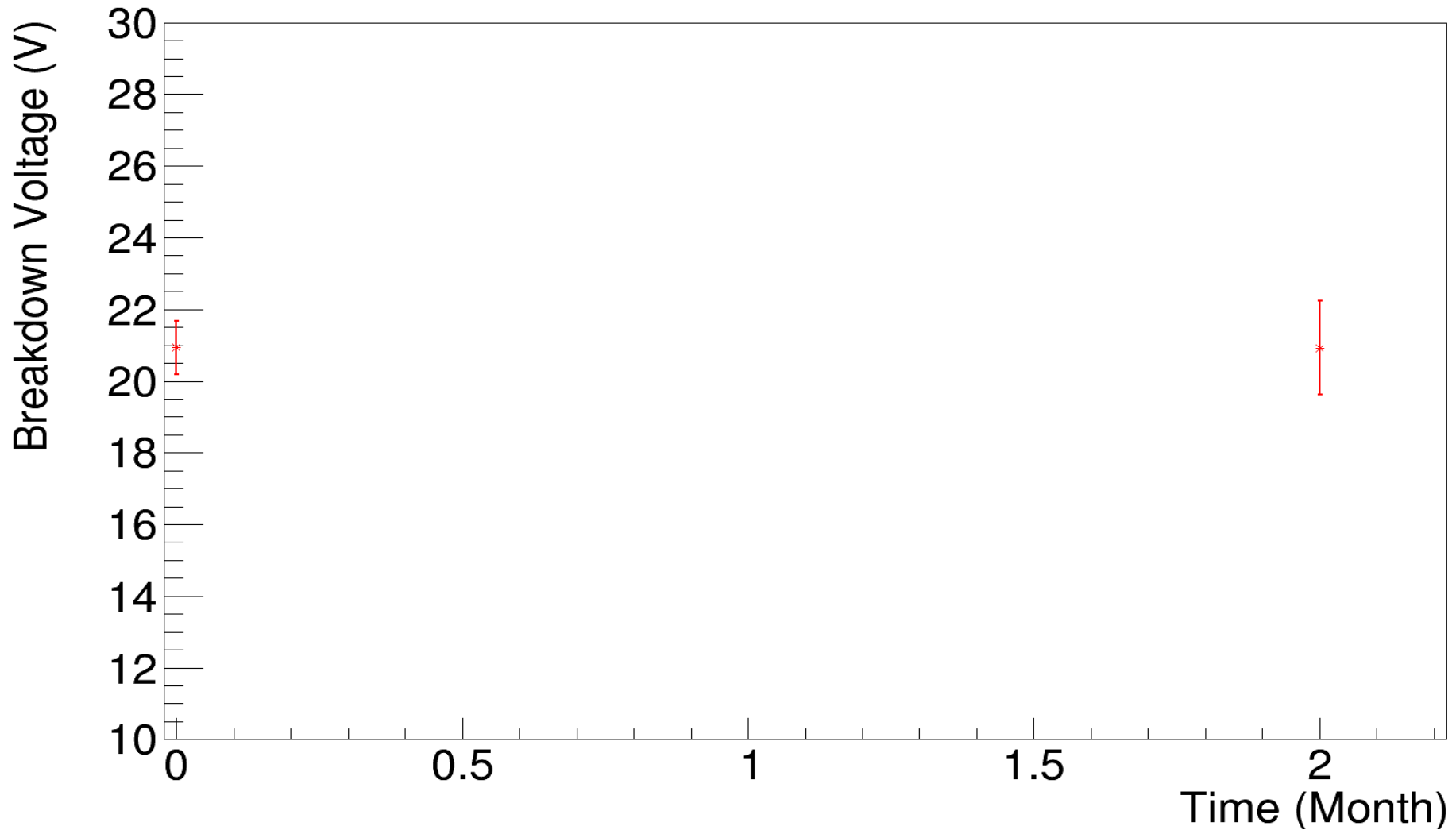
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 7 Breakdown Voltage



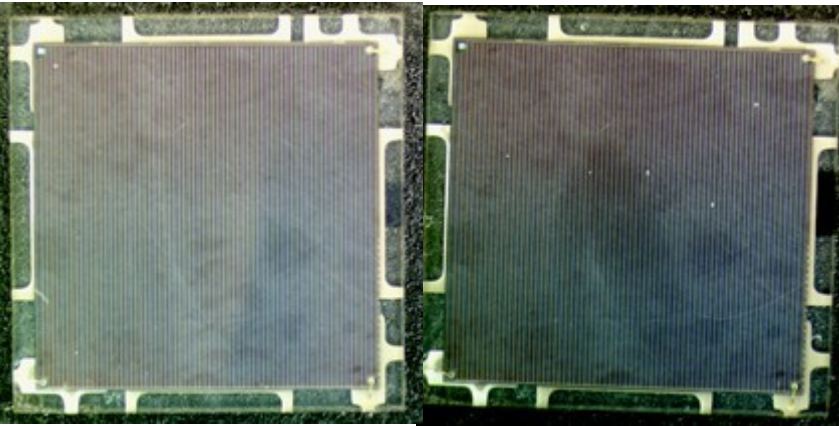
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 8 Microscope Photos



UNIVERSITY
of HAWAII®
MĀNOA



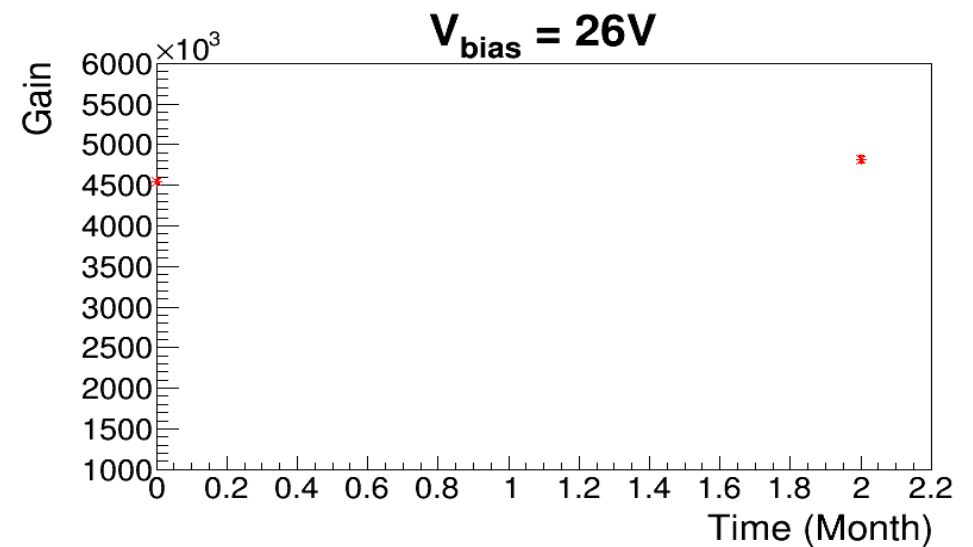
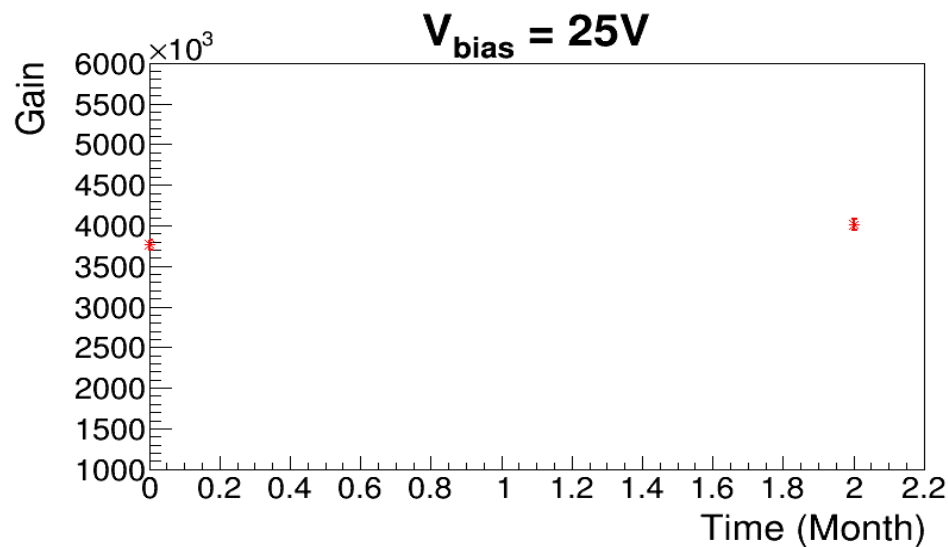
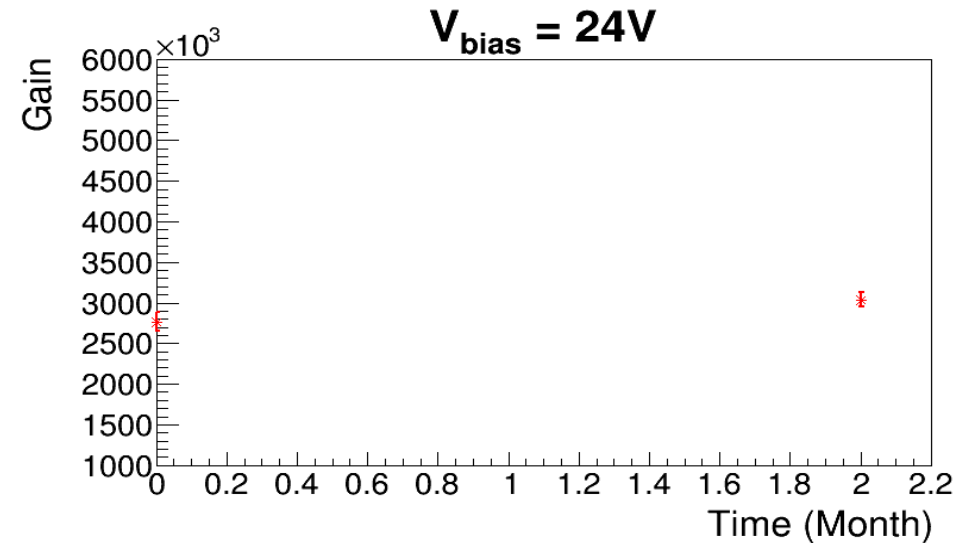
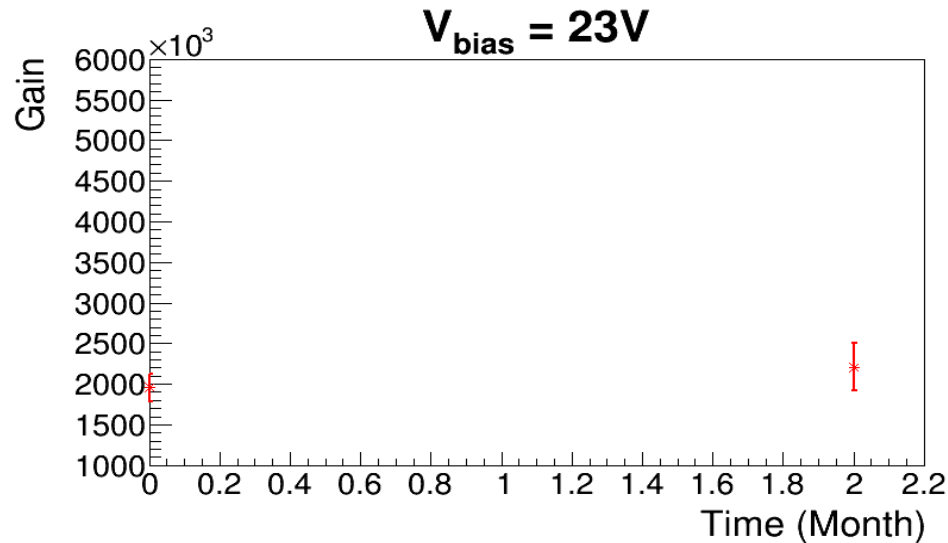
Initial
warms up in a bag (days)

60

SiPM 8 Gain Evolution



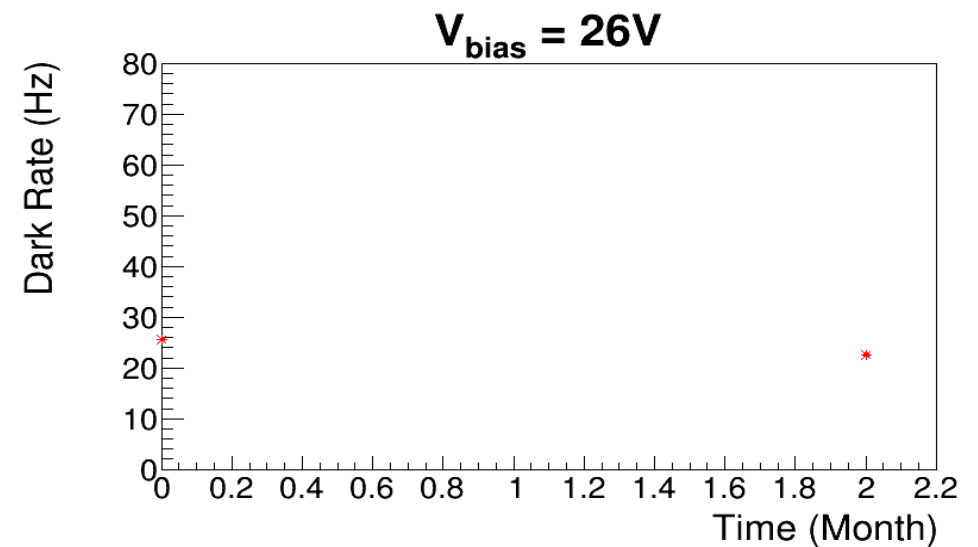
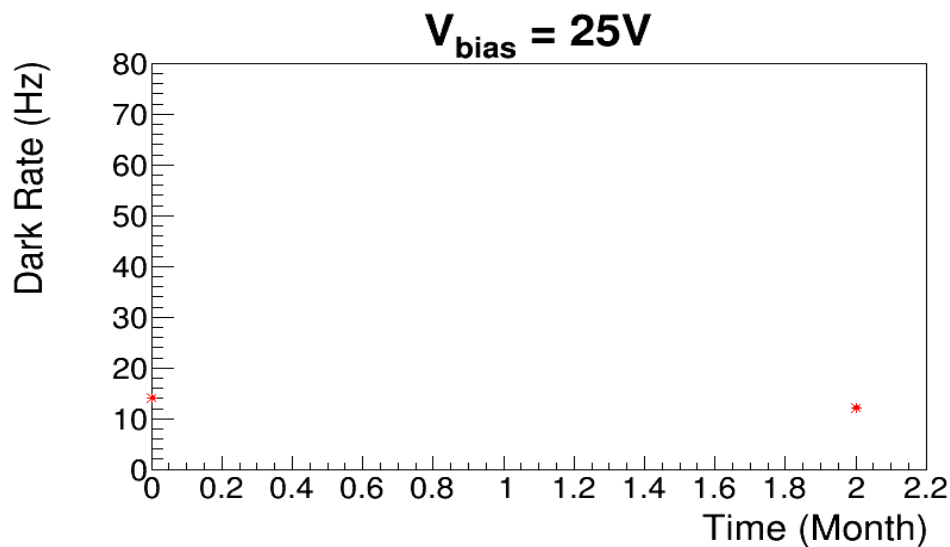
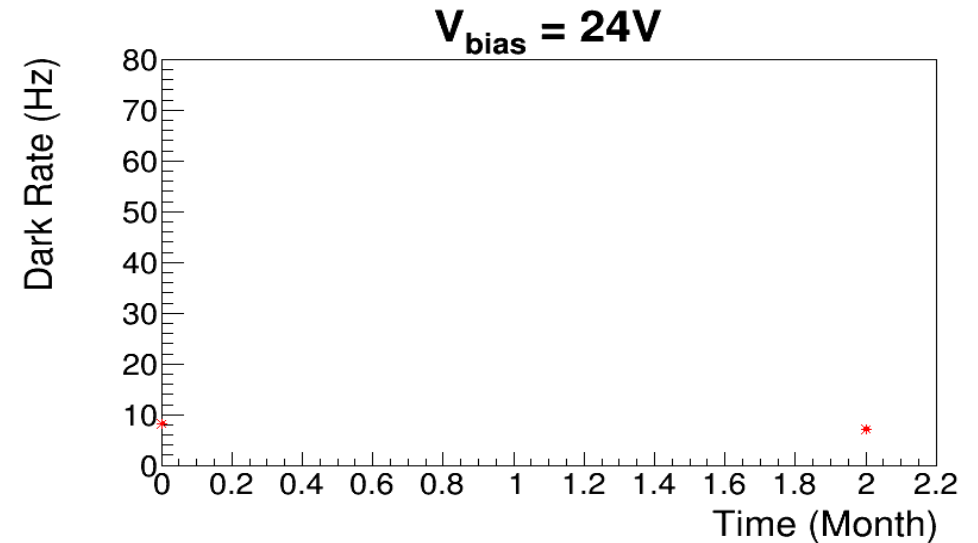
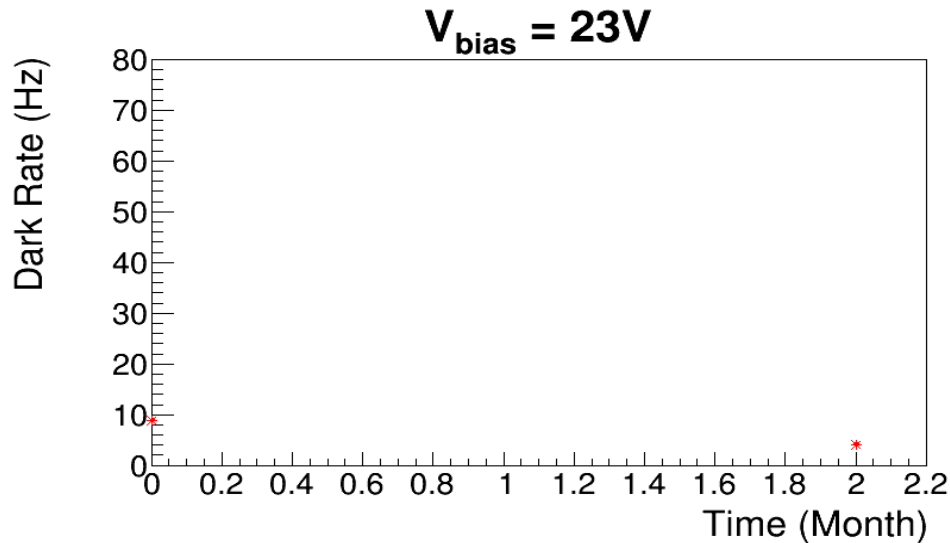
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 8 Dark Rate Evolution



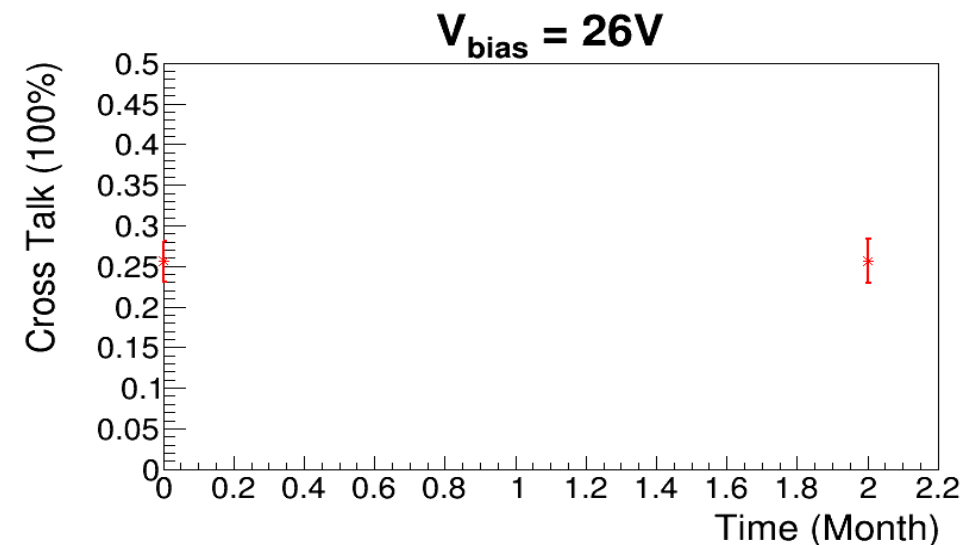
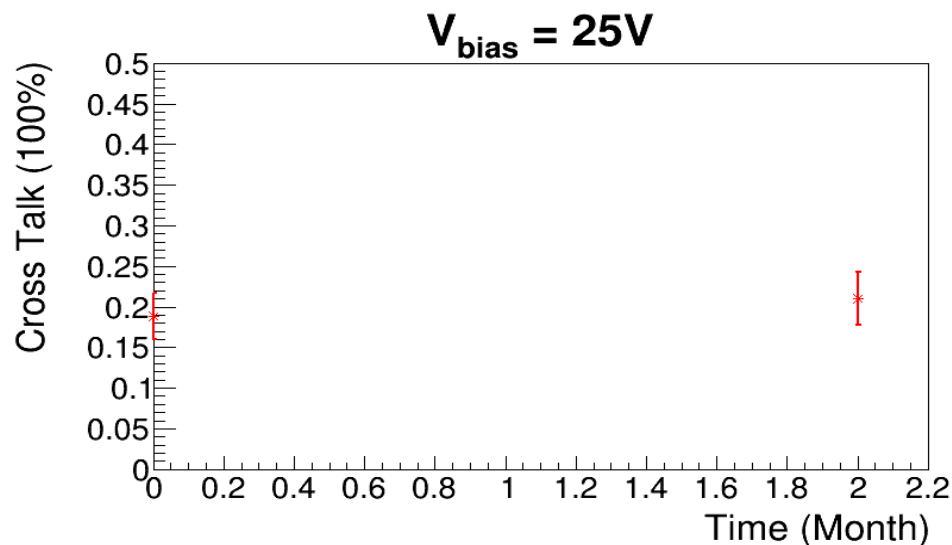
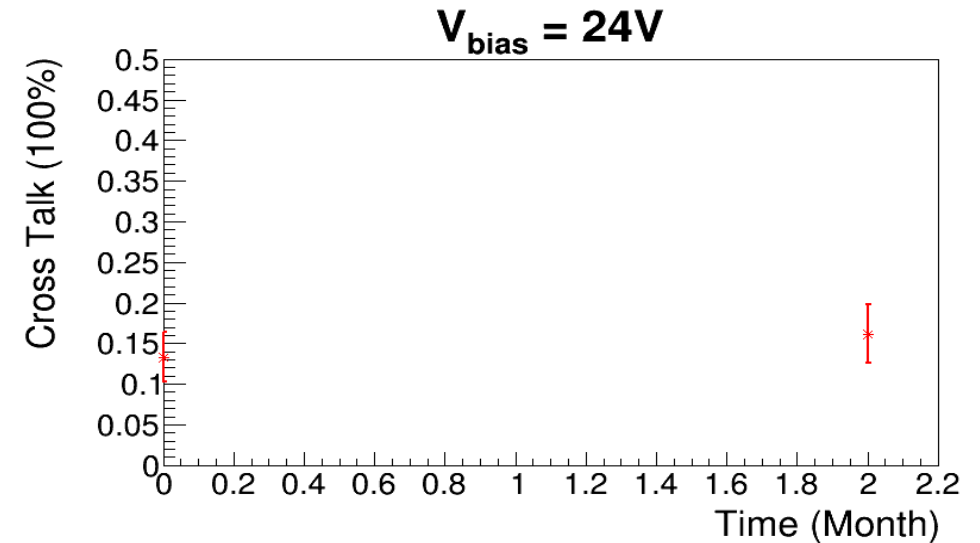
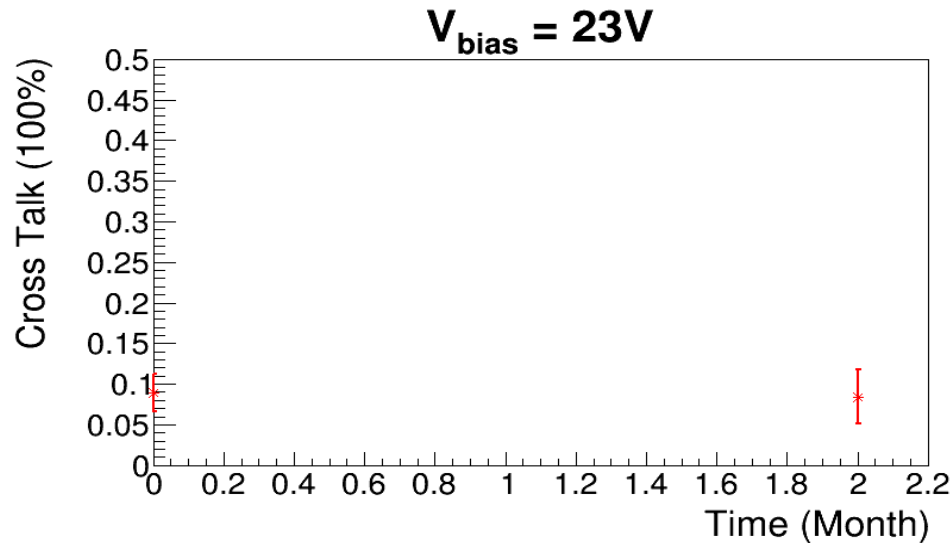
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 8 Cross Talk Evolution



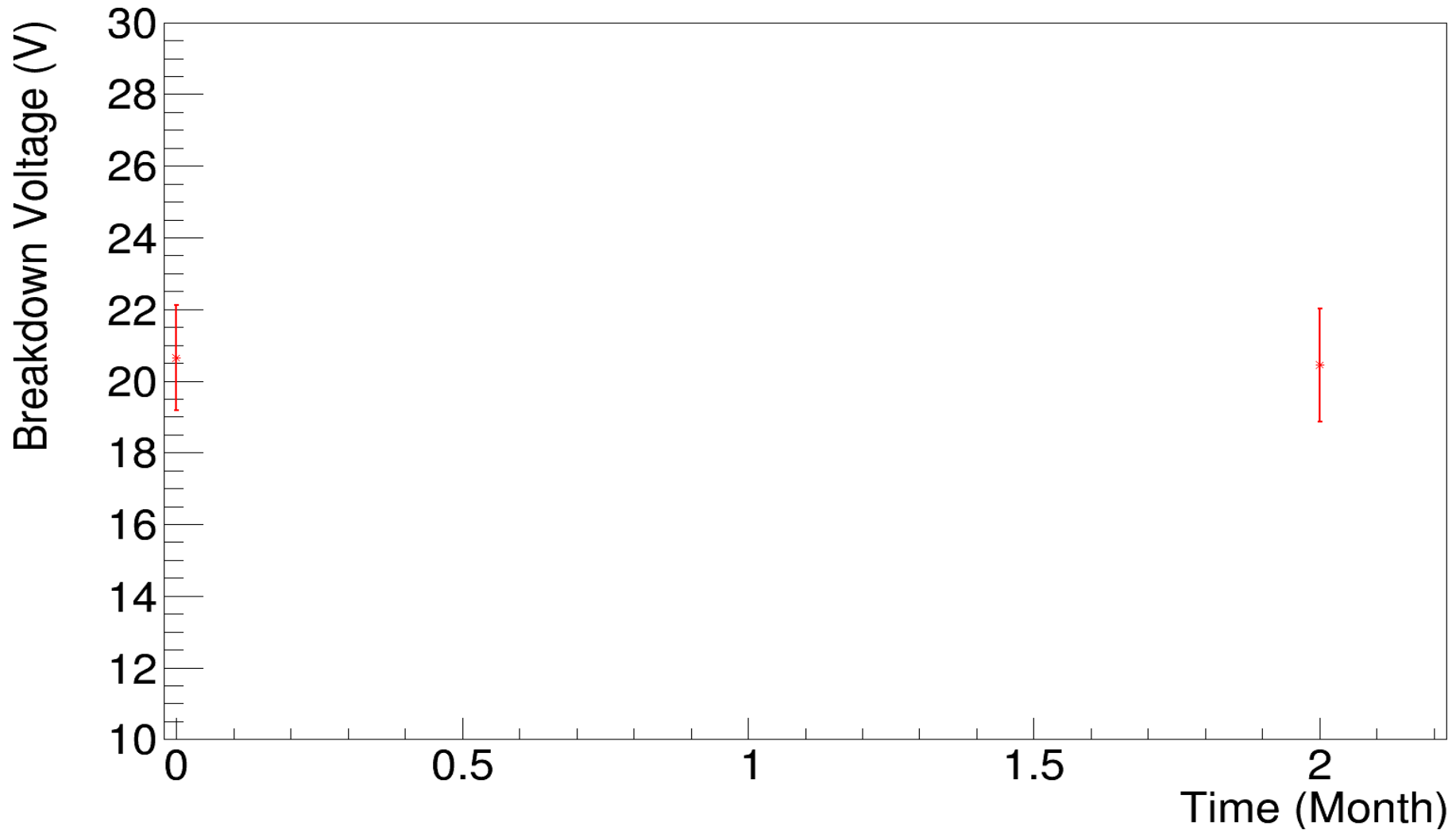
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 8 Breakdown Voltage



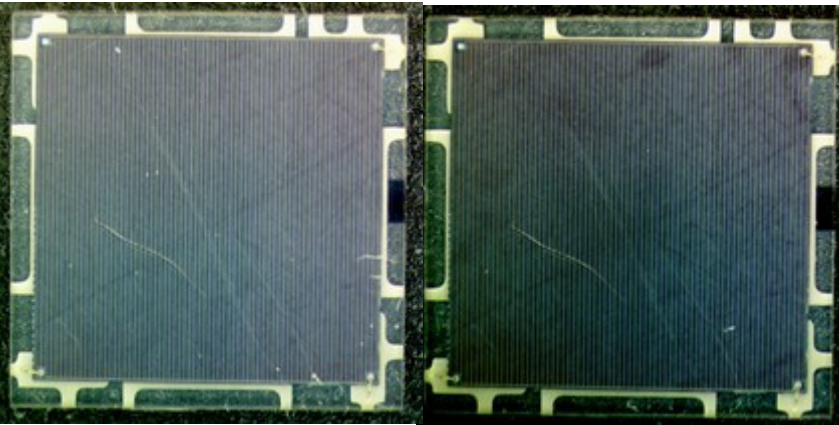
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 9 Microscope Photos



UNIVERSITY
of HAWAII®
MĀNOA



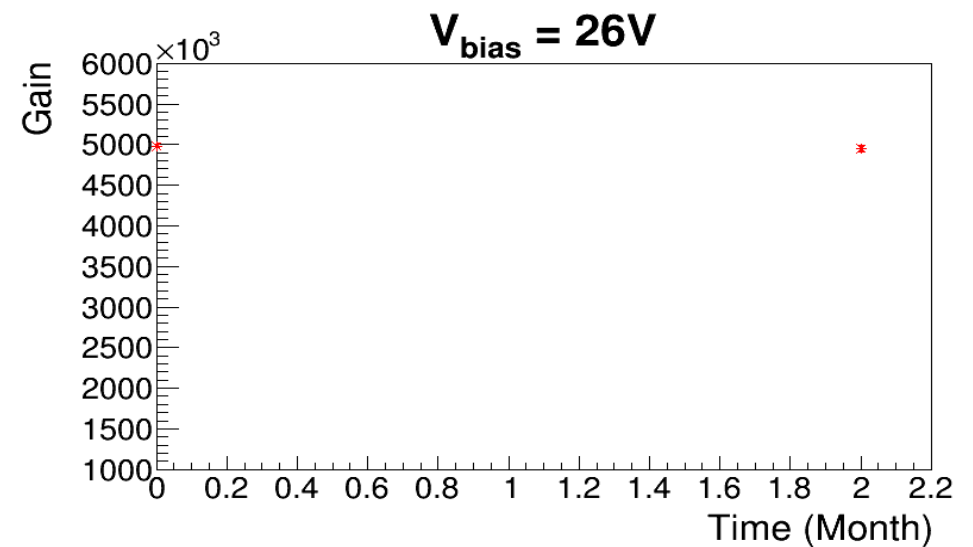
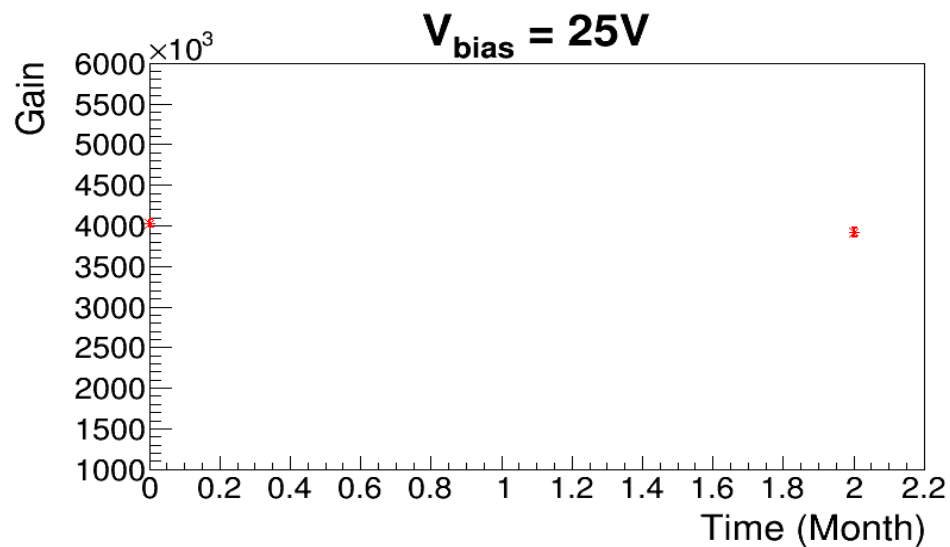
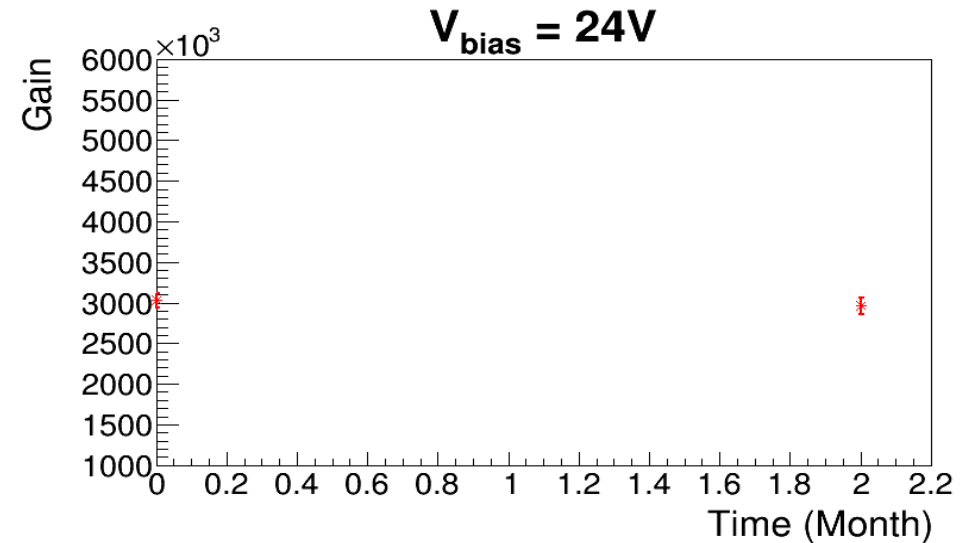
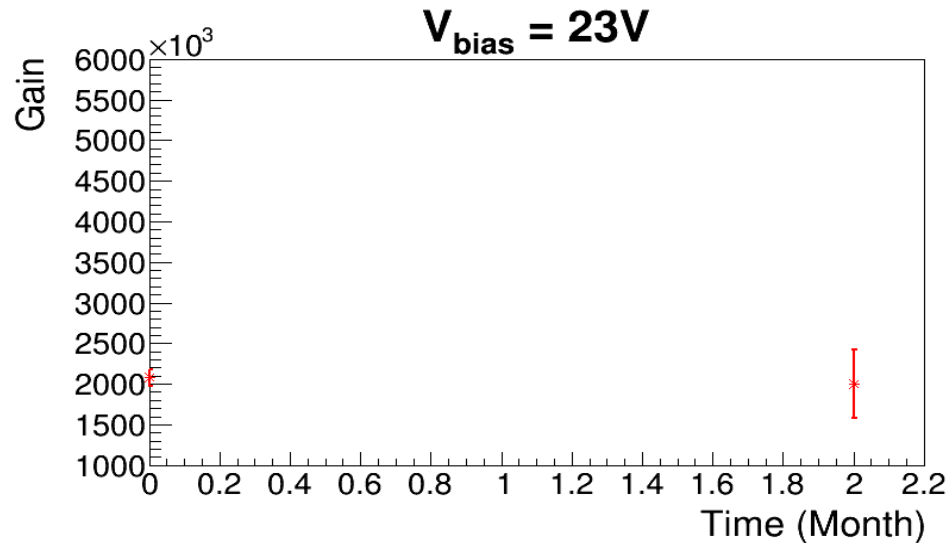
Initial
warms up in a bag (days)

60

SiPM 9 Gain Evolution



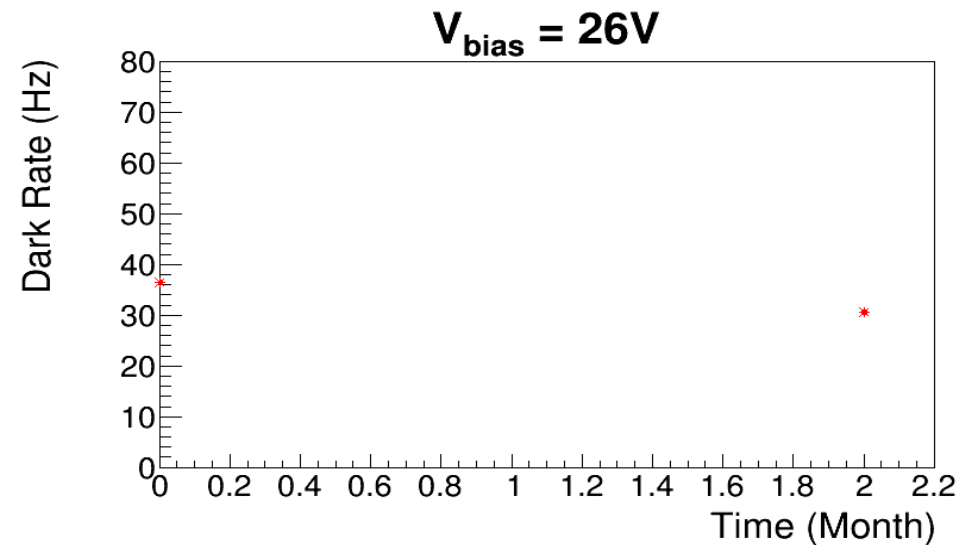
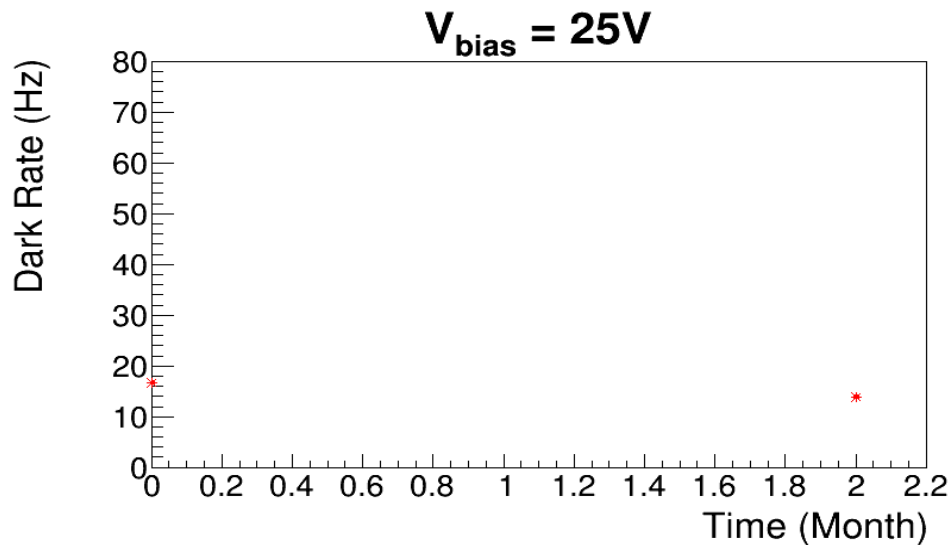
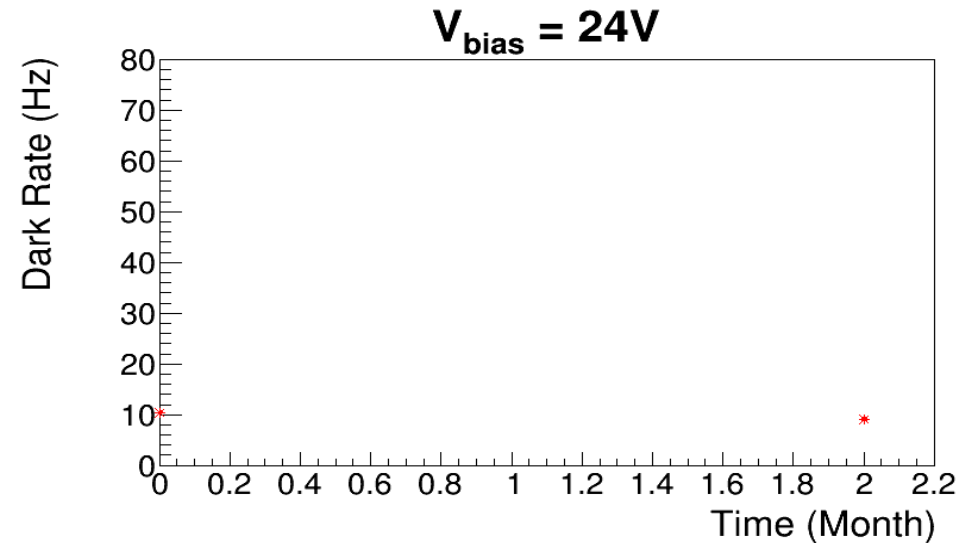
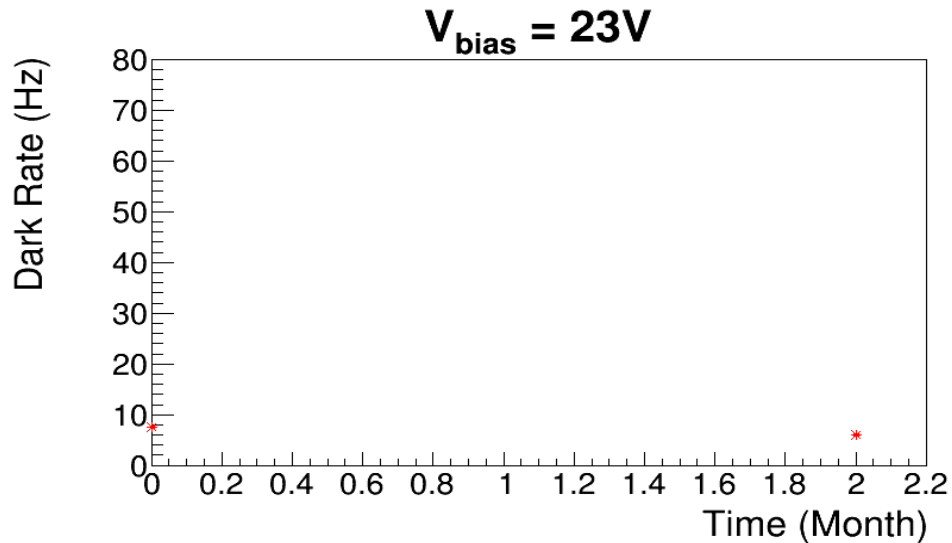
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 9 Dark Rate Evolution



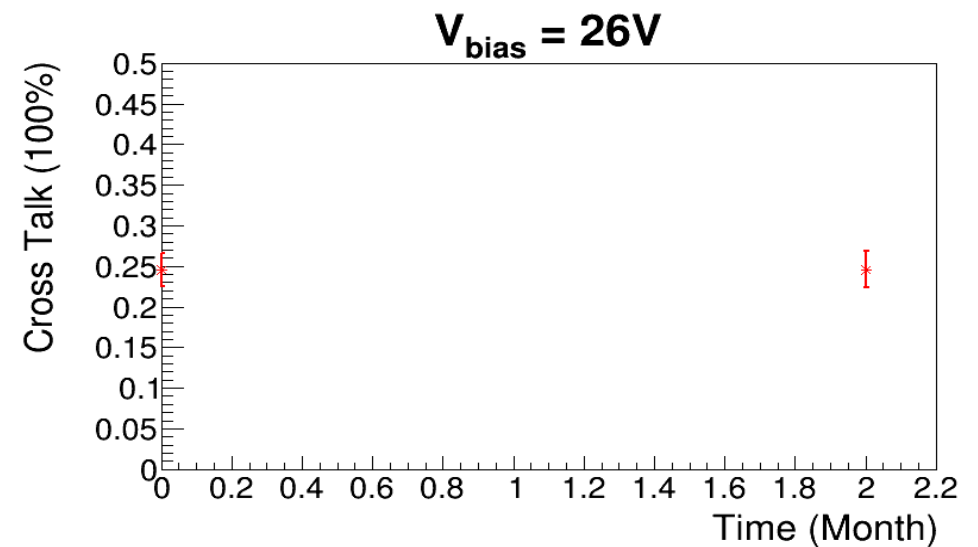
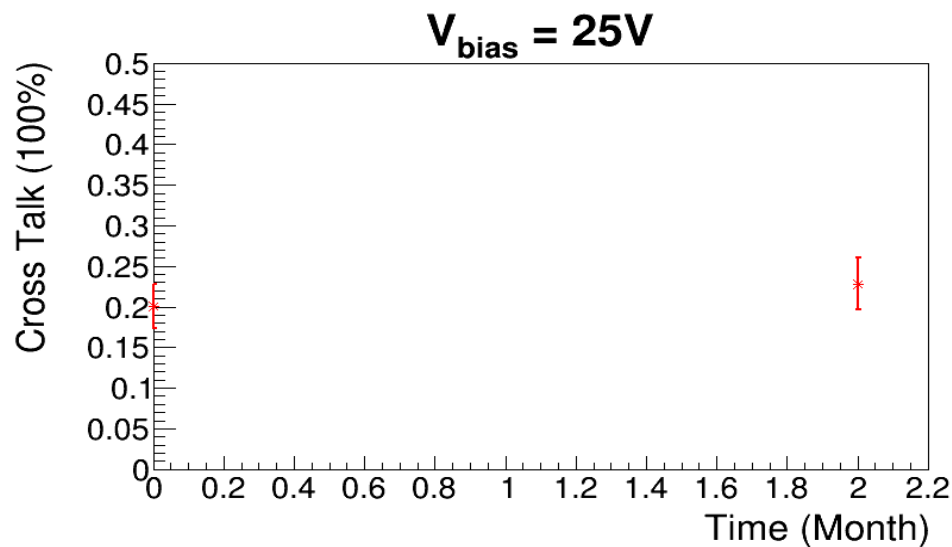
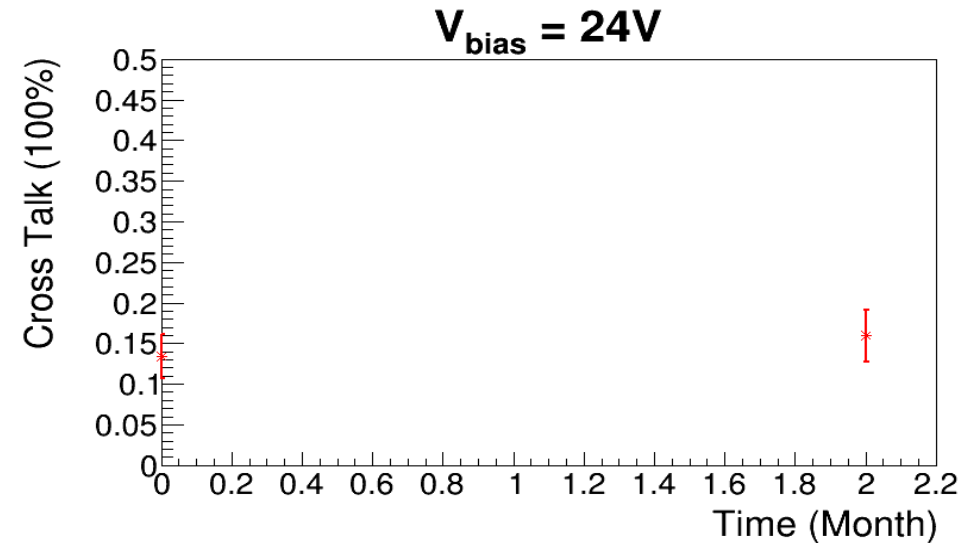
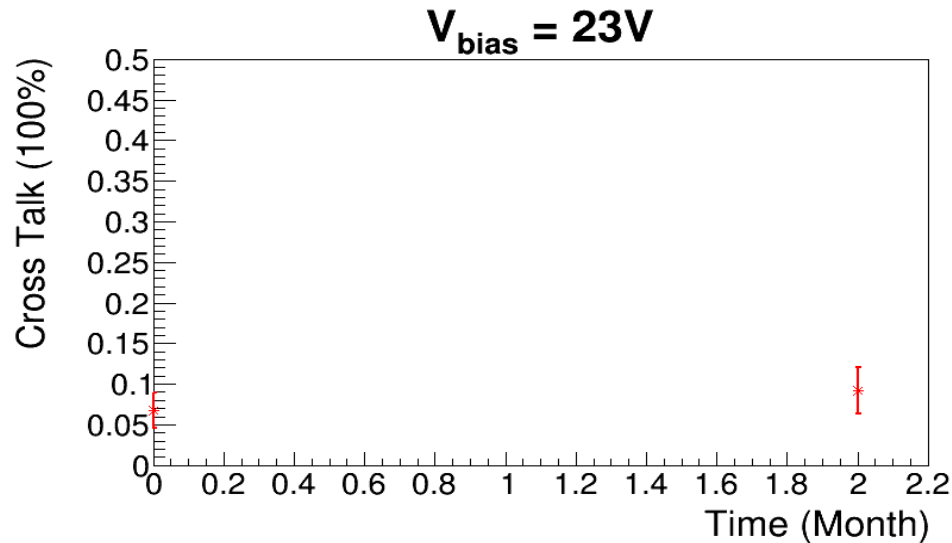
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 9 Cross Talk Evolution



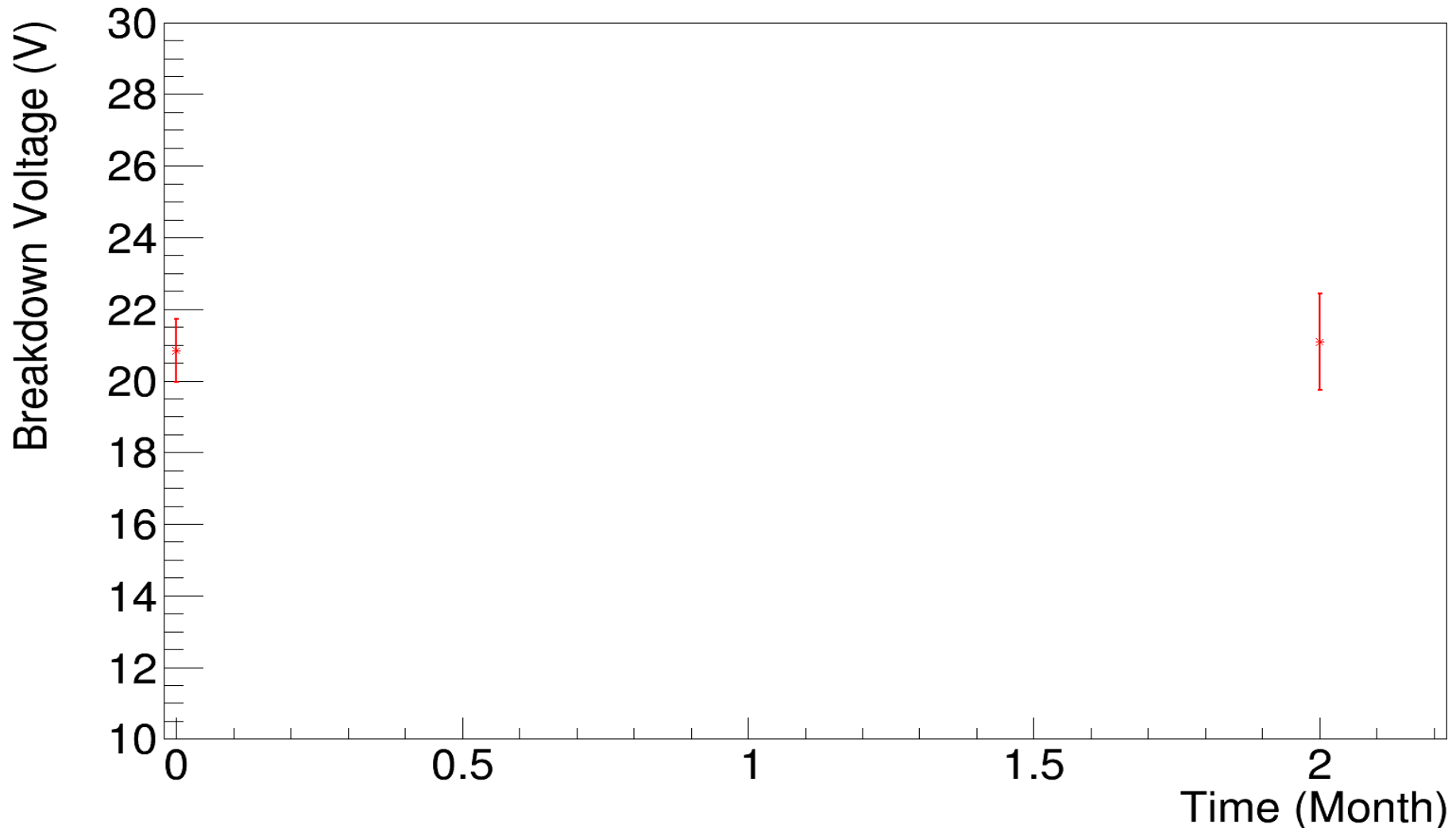
UNIVERSITY
of HAWAII®
MĀNOA



SiPM 9 Breakdown Voltage



UNIVERSITY
of HAWAII®
MĀNOA



Conclusion



- No severe visual damages have been observed so far.
- Characteristics such as gains and cross talks are stable over time.
- Dark rate of some SiPMs variate a little because:
 - First several weeks: 20 minutes cool down time
 - Later weeks: 1 hour cool down time
- Unwanted noise observed on certain SiPMs at bias $V = 26$ V. Such phenomenon has not been seen on C-Series SiPMs.
- Data taking is steadily ongoing.

SiPM 5, Noise 26V



UNIVERSITY
of HAWAII®
MĀNOA

