MAKE TO INNOVATE

Mid-Term Review – Spring 2019 MAVRIC – Mars Analog Vehicle for Robotic Inspection and Construction

AGENDA

Project Overview

Activity Report

Design Review

- Design Constraints
- Current Design
- Proposed Changes
- Design Risks

Budget Status

Conclusion

PROJECT OVERVIEW

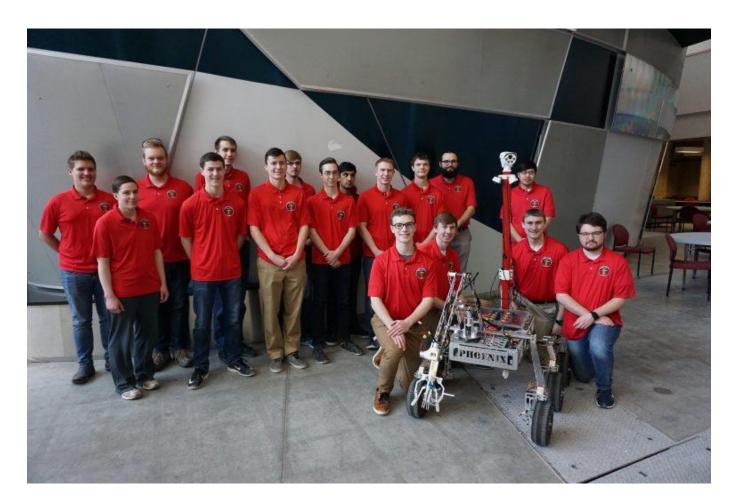
Project Executive Summary



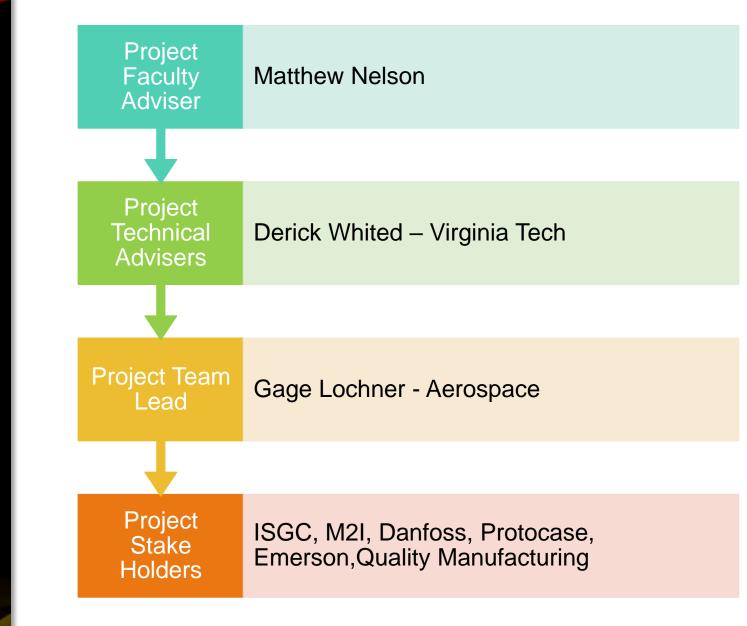
Project Photo

From left to right : Reid Miller, Brooke Bradshaw, James Talbert, Austin Schmitz, Brady Anderson, Ryan Crall, Colton Marshall, Noah Brady, Shivam Vashi, Aaron McCrary, Nick Kilzer, Christian Tanberg, Jensen Mayes, Matthew Matejka, Billy Noy, Riley Roche, Gage Lochner

Not pictured: Trevor Rowland, Paul Karanja

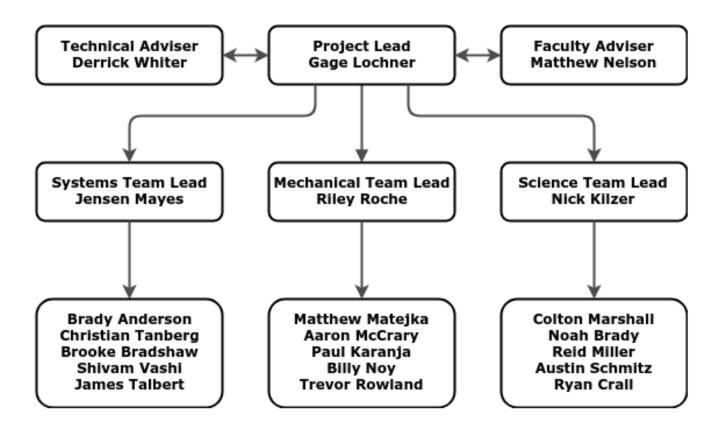


PROJECT OVERVIEW



Make to Innovate (M:2:I)

Project Organization Chart





Project Plan

Project Objectives

 To build an analog next generation Mars rover Semester Goals

- Get accepted into URC competition
- Complete
 Phoenix

Semester Deliverables

 Competition ready rover

ACTIVITY REPORT

Milestones, Tasks, and Health Report



MILESTONES – MECHANICAL TEAM

- Milestone 1 Robotic Arm Improvements
 - Feedback
 - Base Rotation
 - Shoulder
 - End Effector
 - Cameras as a side task
- Milestone 2 Suspension Upgrades and Weight Reduction
 - Add brass to suspension joints
 - Remove excess material from the rover
 - Replace aluminum components with lighter materials

MILESTONES – SCIENCE TEAM

- Milestone 1 Manufacturing and Testing
 - Complete manufacturing of Laser Orientation
 - Make prototype and final copy of optical housing
 - Perform known testing of system with easy-to-identify substances
- Milestone 2 Competition Readiness
 - Complete biomarker identification script with Python
 - Identify biomarkers with script
 - Identify biomarkers with script (blind tests)
 - Develop and practice Science Report methodology

MILESTONES – SYSTEM TEAM

- Milestone 1
 - Arm Feedback Integrated
 - ROS Node
 - Custom ADC Hat
 - 360 View Cameras
 - Front & Rear
 - Left & Right
 - Mast PTZ
- Milestone 2
 - Fully Functional Autonomous Systems
 - Competition Readiness
 - User Friendly Base Station

TASK BREAKDOWN - MECHANICAL

ICON	KEY	SUMMARY	STATUS	REPORTER	ASSIGNEE	TIME TRACKIN	\$	January, 20	019		Fe	bruary,	2019			precision) March, 201	9			April,	, 2019	
							02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
içi		E M2I MAVRIC		O Unassigned	Lochner																	
<u>~</u>	MAVRIC-10	End Effector		McCrary, Aar									IAVRIC-102	- End Effecto	or							
<u>~</u>	MAVRIC-10	Update Jira	DONE	Roche, Riley	🎨 Roche, F							MA	MAVRIC-1	03 - Update	Jira							
~	MAVRIC-10	Arm Shoulder Redesign	IN PROGRES	Roche, Riley	🎨 Roche, F								IAVRIC-104	- Arm Shou	lder Rede	sign						
~	MAVRIC-10	+ Arm Test Stand	IN PROGRES	Roche, Riley	Matejka								AVRIC-109	- Arm Test	Stand							
~	MAVRIC-11	Arm Manipulation Practice Board	IN PROGRES	Roche, Riley	bpnoy A										MAVRI	C-112 - Arm	Manipulati	on Pract	ice Board			
~	MAVRIC-11	Arm Feedback	IN PROGRES	Roche, Riley	A Tanberg								IAVRIC-117	- Arm Feed	back							
1	MAVRIC-12	Improve Rocket M5 Mounting to Mast	IN REVIEW	Roche, Riley	McCrary							N N	AVRIC-122	- Improve Ro	ocket M5 N	founting to N	Mast					
1	MAVRIC-12	Electrical Box Lid Replacement	DONE	Roche, Riley	🚯 Karanja,								IAVRIC-123	- Electrical	Box Lid Re	eplacement						
1	MAVRIC-12	Weight Reduction	IN PROGRES	Roche, Riley	O Unassign								MAVRIC	-127 - Weigl	nt Reducti	on						
~	MAVRIC-13	URC SAR Documentation	DONE	Roche, Riley	🚯 Roche, F										MAVRIC-1	37 - URC SA	R Docume	ntation				
~	MAVRIC-14	Send Parts Orders to Waterjet	DONE	Roche, Riley	🚯 Roche, F								IAVRIC-141	- Send Part	s Orders t	o Waterjet						
~	MAVRIC-14	Boyd Lab Training	IN PROGRES	Roche, Riley	O Unassign								MAVRIC	-145 - Boyd	Lab Traini	ng						
~	MAVRIC-14	Rear Hazard Camera	IN PROGRES	Roche, Riley	Bradsha												MAVRIC-14	8 - Rear	Hazard Ca	amera		
~	MAVRIC-15	Make a Rock	TODO	Roche, Riley	🚯 Roche, F							N N	AVRIC-150	- Make a Ro	ck							
1	MAVRIC-15	Redesign Arm Camera Mount	TO DO	Roche, Riley	🙆 Unassign							N N	AVRIC-151	- Redesign A	rm Camer	a Mount						
<u>~</u>	MAVRIC-18	Website update, mechanical team page	DONE	Lochner, Gag	🚯 Roche, F							N	MAVRIC	180 - Websi	te update,	mechanical 1	team page					
<u>~</u>	MAVRIC-18	Arm Distribution Board Mount	IN PROGRES	Roche, Riley	McCrary								N М/	VRIC-185 - 4	Arm Distrib	ution Board	Mount					
<u>~</u>	MAVRIC-18	+ Front Hazard Camera	DONE	Roche, Riley	Bradsha											MAVRIC-18	88 - Front H	lazard C	amera			
<u>~</u>	MAVRIC-19	Assemble String Poteniometers	IN PROGRES	🔘 Matejka, Mat	Matejka								N	MAVRIC-1	97 - Assen	ble String Po	oteniomete	rs				
<u>~</u>	MAVRIC-19	Drill Wiring Hole in Mast	DONE	Roche, Riley	bpnoy A								N	MAVRIC-	199 - Drill 1	Wiring Hole ii	n Mast					
<u>~</u>	MAVRIC-21	SAR Video Editing	DONE	Mayes, Jense	Mayes,									N	MAVRIC-2	16 - SAR Vide	eo Editing					
<u>~</u>	MAVRIC-22	Update Jira - Mechanical	ТО ДО	Roche, Riley	Roche, F									ма	VRIC-222	- Update Ji	ira - Mech	MAVE	RIC-222 - U	Ipdate Jira	a - Mechan	nical
<u>~</u>	MAVRIC-22	New Composite wheel design	TO DO	Lochner, Gag	Lochner									ма	VRIC-224	- Nev M	AVRIC-224	- New Co	omposite v	vheel desi	gn	
\odot	MAVRIC-22	Robotic Arm Improvements	IN PROGRES	Roche, Riley	Roche, F											RIC-229 - Rol	botic Arm I	mproven	nents			
~	MAVRIC-23	Critical Design Review Slides - Mechanical	TO DO	Roche, Riley	Roche, F											RIC-230 - Cri	tical Desig	n Review	Slides - M	echanical		

TASK BREAKDOWN - SCIENCE

						TIME TRACKING	~			-	0010	:	2019 (week pre				1			0010
ICON	KEY	SUMMARY	STATUS	REPORTER	ASSIGNEE	TIME TRACKING	*	January, 201	04 05	06	oruary, 2019 07 08	09		rch, 2019	13 1	4	April, 2019	17	May, 1	19
isel.	MAVRIC	- M2I MAVRIC		O Unassigned	Lochne	er, 📃 📃														
	MAVRIC-83	Spectrometer Housing	IN REVIEW	Kilzer, Nichol	O Schmit	Ζ,							MAVRIC-	83 - Spectrom	eter Housing					
 Image: A start of the start of	MAVRIC-86	Clearances Check/Semester Design Evaluation	DONE	Kilzer, Nichol	💿 Kilzer, N	Ni 📃 📃					MAVRIC	-86 - Clearan	ces Check/Sem	ester Design E	valuation					
 Image: A set of the set of the	MAVRIC-91	→ Test fit all printed parts	DONE	Silzer, Nichol	💿 Kilzer, N	Ni 📃 📃					MAVRIC-9)1 - Test fit al	l printed parts							
~	MAVRIC-93	→ System Acceptance Review - Science Page	DONE	Kilzer, Nichol	💿 Kilzer, N	Ni 📃 📃					MAVRIC-9	3 - System A	cceptance Revi	ew - Science F	age					
	MAVRIC-13		DONE	Roche, Riley	Roche,	R							MAVRIC-137	- URC SAR Doo	cumentation					
 Image: A start of the start of	MAVRIC-15	Spectrometer Calibration	IN PROGRES	S Kilzer, Nichol	💿 Kilzer, N	Ni 🔄 📃					MAVRIC-1	54 - Spectrom	eter Calibration	1						
 Image: A set of the set of the	MAVRIC-15	Provide Polynomials for Spectrometer Calibration	IN PROGRES	Silzer, Nichol	🔘 Brady, N	NC					MAVRIC-1	55 - Provide P	olynomials for	Spectrometer (Calibration					
	MAVRIC-18	Website updates, science team page	DONE	Lochner, Gag	💿 Kilzer, N	Ni					N MAVE	IC-181 - Web	site updates, sc	ience team pag	je					
	MAVRIC-19	Fix Laser Rotation Mount	DONE	Silzer, Nichol	O Crall, Ry	yć 📃 📃					N	MAVRIC-19	I - Fix Laser Rot	ation Mount						
\bigcirc	MAVRIC-19	Obtain Raman Spectra of Syrofoam	TO DO	Kilzer, Nichol	💿 Kilzer, N	Ni 🔄 🗾					N	MAVRIC-19	2 - Obtain Rama	n Spectra of Sy	rrofoam					
	MAVRIC-19	Camera mount	IN PROGRES	Kilzer, Nichol	Miller, F	Re						MAVRIC-	193 - Camera m	iount						
	MAVRIC-20	Find Biomarker Samples	TO DO	Silzer, Nichol	Marsha							N M	AVRIC-201 - Fir	ıd Biomarker S	amples					
	MAVRIC-21	+ Create Python biomarker matching script	TO DO	Silzer, Nichol	Schmitt	z,							_	MAVRIC-212 -	Create Python bi	omarker i	matching scrip	t –		
	MAVRIC-21	SAR Video Editing	DONE	Mayes, Jense	Mayes,	J						N	MAVRIC-216 -	SAR Video Edi	ting					
	MAVRIC-22	Update Jira - Science	IN PROGRES	Silzer, Nichol	💿 Kilzer, N	Ni						MAV	RIC-227 - Upda	ate Jira - Sciel	nce					
	MAVRIC-23	Critical Design Review Slides - Science	IN PROGRES	Silzer, Nichol	💿 Kilzer, N	Ni						м	AVRIC-231 -	MAVRIC-231	- Critical Design	Review Sl	lides - Science			
	MAVRIC-23	Damage analysis of spectrometer	TO DO	S Kilzer, Nicho	O Unassigned Control of Contro	n: 💶 🗾						м	AVRIC-235 - D	am MAVRI	C-235 - Damage	analysis o	of spectromete			
	MAVRIC-23	Make Danfoss optics housing	TO DO	Silzer, Nichol	💿 Kilzer, N	Ni							MAV MAVRI	C-236 - Make [anfoss optics he	ousing				

TASK BREAKDOWN - SYSTEMS

								2019 (week precision)
ICON	KEY	SUMMARY	STATUS	REPORTER	ASSIGNEE		January, 2019 February, 2019 03 04 05 06 07 08 09	March, 2019 April, 2019 May, 2019 10 11 12 13 14 15 16 17 18 19
ιψi	MAVRIC	M2I MAVRIC		O Unassigned	Lochne	6 		
~	MAVRIC-94	 Arm Feedback ROS Node 	DONE	Mayes, Jense	O Tanber		M MAVRIC-94 - Arm Feedback ROS Node	
/	MAVRIC-96	Custom ADC Hat Finalized	IN PROGRES	🚭 Mayes, Jensi	O Talbert		MAVRIC-96 - Custom ADC Hat	at Finalized MAVRIC-96 - Custom ADC Hat Finalized
~	MAVRIC-97	Science System Data Stream to CSV	DONE	Mayes, Jense	O Bradsh	81	MAVR MAVRIC-97 - Science System Data Stream to	CSV
~	MAVRIC-98	 Autonomous System Research & Framework Upg 	DONE	Mayes, Jensi	Anders		MAVRIC MAVRIC-98 - Autonomous System Researc	ch & Framework Upgrades
~	MAVRIC-99	Strategy Work	IN PROGRES	Mayes, Jens	 Vashi, 			MAVRIC-99 - Strategy Work
~	MAVRIC-10	IMU Integration & Testing	DONE	Mayes, Jensi	Anders		MAI MAVRIC-100 - IMU Integration & Testing	
~	MAVRIC-11	Arm Feedback	IN PROGRES	Roche, Riley	O Tanber	9.	MAVRIC-117 - Arm Feedback	
1	MAVRIC-12	Electrical Box Lid Replacement	DONE	Roche, Riley	🚯 Karanja		MAVRIC-123 - Electrical Box Lid Replac	cement
↑	MAVRIC-12	Weight Reduction	IN PROGRES	Roche, Riley	() Unassig		MAVRIC-127 - Weight Reduction	n in in its second s
~	MAVRIC-13	URC SAR Documentation	DONE	Roche, Riley	Roche,	R		MAVRIC-137 - URC SAR Documentation
~	MAVRIC-14	Rear Hazard Camera	IN PROGRES	Roche, Riley	O Bradsh	8		MAVRIC-148 - Rear Hazard Camera
~	MAVRIC-15	 Look at current GUI software 	IN PROGRES	Mayes, Jense	 Vashi, 	87	MAVRIC-153 - Look at current GUI softwar	are MAVRIC-153 - Look at current GUI software
1	MAVRIC-18	Website updates, systems team page	DONE	Lochner, Gag	Mayes		M MAVRIC-182 - Website updates, s	systems team page
~	MAVRIC-18	Arm Distribution Board	DONE	Mayes, Jense	O Talbert		MAVRIC MAVRIC-184 - Arm Dist	stribution Board
/	MAVRIC-18	Arm Distribution Board Mount	IN PROGRES	Roche, Riley	O McCra	у. 💶 🚬	M4- MAVRIC-185 - Arm Dist	stribution Board Mount
/	MAVRIC-18	Front Hazard Camera	DONE	Roche, Riley	Bradsh			MAVRIC-188 - Front Hazard Camera
~	MAVRIC-19	2/22/2019 Outreach Event Prep	DONE	n Talbert, Jam	O Talbert		MAVR MAVRIC-194 - 2,	2/22/2019 Outreach Event Prep
<u>~</u>	MAVRIC-19	Arm Feedback Testing	DONE	Mayes, Jense	Bradsh	e 	M MAVRIC-195 - A	Arm Feedback Testing
<u>~</u>	MAVRIC-19	Science System Integration	TO DO	Mayes, Jense	 Vashi, 		MAVRIC-196 - Scier	nce System Inte MAVRIC-196 - Science System Integration
/	MAVRIC-19	Autonomous System Coding and Testing	TO DO	Vashi, Shivan	 Vashi, 		MAVRIC-198 - Au	Autonomous System Coding and Testing MAVRIC-198 - Autonomous System Coding and Testing
-	MAVRIC-20	SAR Systems Report	DONE	Mayes, Jense	Mayes		MAVR	MAVRIC-202 - SAR Systems Report
2	MAVRIC-20	SAR Systems Testing Plan	TO DO	Mayes, Jense	Mayes		MAVRIC	3-203 - MAVRIC-203 - SAR Systems Testing Plan
/	MAVRIC-20	 Pixy Camera Initial Testing 	DONE	Mayes, Jense	Anders	•	MAVRIC-204 - Pixy	Ce MAVRIC-204 - Pixy Camera Initial Testing
/	MAVRIC-20	Pixy Camera Hardware Integration	TO DO	Mayes, Jens	Anders	•	MAVRIC	2-205 - Pixy Camera Hardware Ir MAVRIC-205 - Pixy Camera Hardware Integration
~	MAVRIC-20	 Pixy Camera Software Integration 	TO DO	Mayes, Jense	Anders			MAVRIC-206 - Pixy Camera Software Integration
-	MAVRIC-20	 Intel Realsense Initial Camera Testing 	TO DO	Mayes, Jensi	 Vashi, 	i i		M MAVRIC-207 - Intel Realsense Initial Camera Testing
-	MAVRIC-20	- Intel Realsense Mounting	TO DO	Mayes, Jensi	 Vashi, 	SI		MAVRIC-208 - Intel Realsense Mounting MAVRIC-208 - Intel Realsense Mounting
~	MAVRIC-20	Develop Cleaner GUI	IN PROGRES	Mayes, Jensi	🕑 Vashi,			MAVRIC-209 - Develop Cleaner GUI MAVRIC-209 - Develop Cleaner GUI
~	MAVRIC-21	 Design through E-Box PCBs Front 	IN PROGRES	Mayes, Jensi	O Talbert		MAVR	RIC-210 - Design through E-Box MAVRIC-210 - Design through E-Box PC8s Front
-	MAVRIC-21	- IMU Startup Routine	TO DO	Mayes, Jensi	Anders	•	MAVR	RIC-211 - IMU Start MAVRIC-211 - IMU Startup Routine
~	MAVRIC-21	SAR Video Editing	DONE	Mayes, Jensi	Mayes		м	MAVRIC-216 - SAR Video Editing
~	MAVRIC-21	Design through E-Box PCBs Back	TO DO	Mayes, Jensi	O Talbert		MA	AVRIC-217 - Design through E-Box PCBs Back MAVRIC-217 - Design through E-Box PCBs Back
-	MAVRIC-21	Debug Rover Arm & Drive Code	DONE	Mayes, Jensi	O Bradsh	a 1997 199	MAVRIC-219 - De	MAVRIC-219 - Debug Rover Arm & Drive Code
~	MAVRIC-22	Debug Rover ADC Code	IN PROGRES	Mayes, Jensi	O Tanber		MAVRIC-220 - Debu	MAVRIC-220 - Debug Rover ADC Code
~	MAVRIC-23	 Critical Design Review Slides - Systems 	IN PROGRES	Mayes, Jensi	Mayes			MAVR MAVRIC-232 - Critical Design Review Slides - Systems
0	MAVRIC-23	Systems Milestone 1	TO DO	Mayes, Jensi	Mayes,		MAVRIC-233 - Systems Milestone 1	MAVRIC-233 - Systems Milestone 1

PROJECT HEALTH REPORT

 Green, Yellow, Red. This is an honest assessment on how the project is doing currently

> Science system – possible notch filter issues

Autonomous, arm feedback and shoulder

All other arm systems, suspension reworks, base station operation, overall system stability

DESIGN REVIEW

Overview



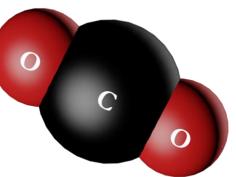
DESIGN OVERVIEW - MECHANICAL

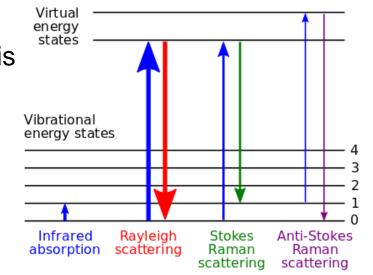
- New Chassis
 - Single, lightweight part
 - Hole pattern allows for modular design
 - Top plate allows for mounting subsystems
- Rocker-Bogie Suspension
 - Keeps chassis stable in rough terrain
 - Rocker has limited motion
 - Wheels are individually driven
- New Robotic Arm
 - 5 degrees of freedom
 - Shoulder and elbow cannot be back-driven
 - Compact wrist with 4-finger end effector



DESIGN OVERVIEW - SCIENCE

- Research
 - Spectroscopy
 - LIBS and Raman
 - Epi-fluorescence Microscopy
 - Agarose gel electrophoresis
 - Water-induced CO2 emission analysis
- Raman spectroscopy
 - Parts research
 - Biomarker research
 - Initial design work



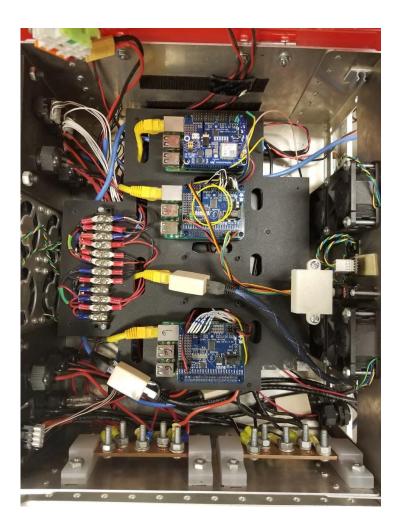






DESIGN OVERVIEW - SYSTEMS

- Control Systems
 - Stable control systems
 - Utilizes ROS for communication within the rover
 - Commands are send over the network into ROS
- Autonomous system
 - GPS and IMU for waypoint to waypoint navigation
- Power supply
 - Separate supplies for the control and drive systems
 - Polarized connectors on all connections
- Communications
 - Rocket M5 for remote control and video feeds.



DESIGN REVIEW

Constraints



DESIGN CONSTRAINTS

- Budget
 - Working on limited income has some unique challenges
- Man hours
 - One of the smaller teams to consistently make URC
 - Programming has been very time consuming
- Manufacturing resources
- Competition requirements
 - Budget \$18.5k maximum
 - Rover mass <50kg
 - Rover dimensions 0.8m square
 - Travel requirements Competition site is a 16 hour drive, requires multiple day stay

DESIGN REVIEW

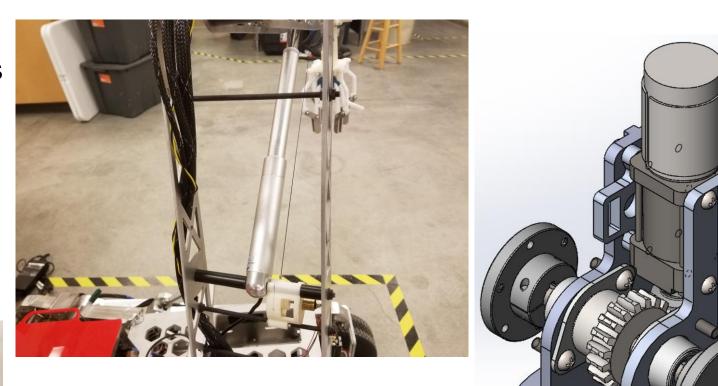
Current Design



CURRENT DESIGN - MECHANICAL

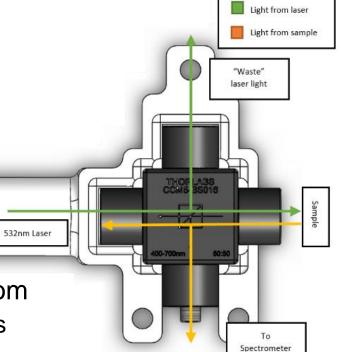
- Robotic Arm Improvements
 - Feedback
 - Base Rotation
 - Shoulder
 - End Effector
- New Camera Mounts
- New Electrical Box Lid

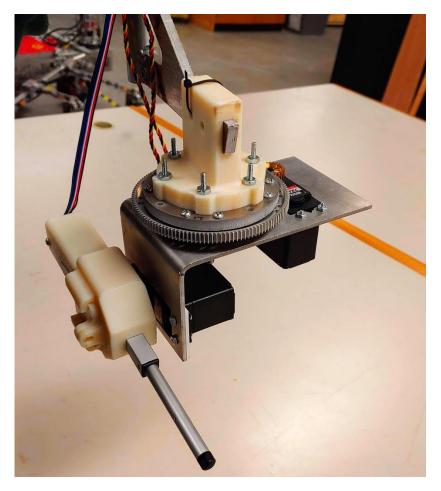




CURRENT DESIGN - SCIENCE

- Optical Housing
 - 532 nm laser
 - Line filters
 - "Waste" hole
 - Notch filter
- Laser Rotation
 - 4 degrees of freedom
 - 2 linear actuators
 - 2 servos





CURRENT DESIGN - SYSTEMS

- 360 Degree View
 - 6 Cameras total
 - PTZ Mast Camera
- Arm Feedback
 - ROS Node
 - ADC Hat
- Power Distribution
 - Custom Arm PCB
- IMU Integration







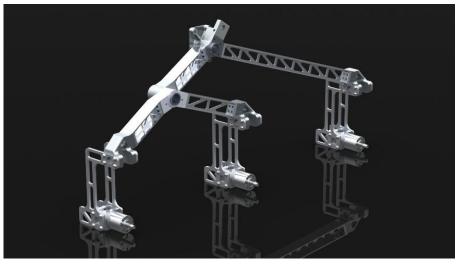
DESIGN REVIEW

Proposed Changes



PROPOSED CHANGES - MECHANICAL

- Weight Reduction
 - Removing excess material
 - Replacing aluminum components with composite and plastic ones
- Suspension
 - Adding brass to joints to reduce friction
 - Weight reduction
- Wheels
 - Replacement with lighter wheels

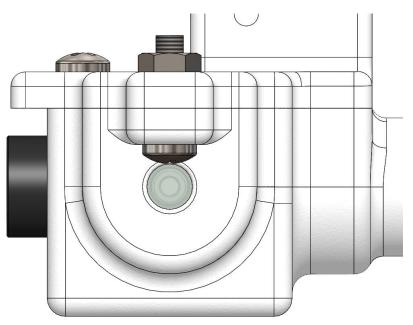




PROPOSED CHANGES - SCIENCE

- Laser Orientation
 - Modified for inverted use
- Optics housing
 - Addition of "waste hole"
 - Danfoss print
- Python algorithm instead of MATLAB
 - Prevent MATLAB licensing issues in Utah







PROPOSED CHANGES - SYSTEMS

- Upgraded Autonomous Systems
 - PixyCam
 - Intel Realsense
- Cleaner GUI
 - Test with team to optimize for competition
- E-Box Connections
 - Custom PCBs for through box connections
- Testing
 - Further drive testing
 - Competition Condition simulations



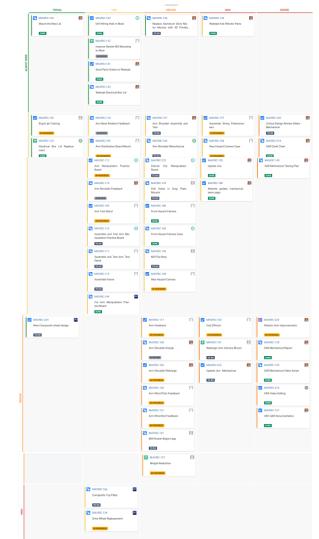
DESIGN REVIEW

Design Risks



DESIGN RISKS - MECHANICAL

- Mechanical Team has some higher-risk items, mostly due to time constraints
- Most other items have already been completed or are low risk



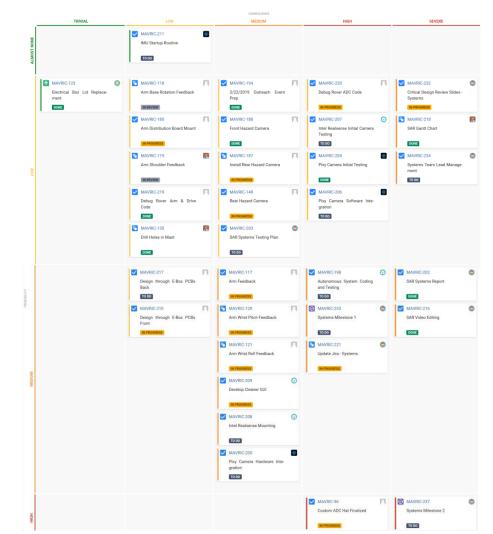
DESIGN RISKS - SCIENCE

- Notch filter problems
 - ID what is wrong
- Main concern is testing
 - Can we get accurate readings from biomarkers
- Python is secondary challenge
 - Must learn enough to graph and sort spectrometer data

			CONSEQUENCE			
	TRIVIAL	LOW	MEDIUM	HIGH	SEVERE	
ALMOST NONE			MAVRIC-228			
MOT				MAVRIC 231 Ortical Design Review Slides - Science Science Make Darfors optics housing TODO	SAR Gant Chart	
PROBABILITY MEDIUM				MAVRIC-212 Create Python biomarker matching script Sopo MAVRIC-227 Update Jira - Science Is recorded.		
HIGH					MAVRIC-235 Damage analysis of spectrometer	

DESIGN RISKS - SYSTEMS

- Mostly in the medium consequence / medium probability area
- Few high probability items
 - Intel Realsense testing
 - Custom ADC Hat finalization
- Some severe consequence items
 - Milestone 2 (Autonomous Systems)



PROJECT WIDE RISKS

- Weather
 - Can limit outdoor testing
 - · Limits ability to heat test rover
- Battery damage
 - One of our main drive batteries is damaged, but functional
- Mass limit
 - Can reduce effective score at competition
 - 5% per kilo over 50

BUDGET

Status and requests



Item (Expenses)	Amount
Travel	\$3500
3D prints	\$220
Science system	\$1250
Arm components (Initial)	\$1000
Arm components (Upgrades)	\$450
Motor ESCs	\$300
Computer vision	\$400
Sector antenna	\$170
Main mast camera	\$180
Other expenses	~\$1500
Remaining funds	~\$825

BUDGET STATUS

Item (Income)	Amount
ISGC	\$5000
M2I	\$3000
Danfoss (Donated parts)	\$150
Emerson (For arm only)	\$1000
Protocase (Donated parts)	\$2000

CONCLUSION



EXTRA SLIDES



EXTRA SLIDES - BUDGET

		MAVRIC PROJECT BUDGET	Acct. Number TBD				
\pproved	Priority	Rem	Notes	Req. Budget	Approved Budget	Spent	Difference
		- Total Project Budget		\$8,000.00	\$7,850.00	\$3,179.24	\$4,670.76
		- Equipment		\$4,025.00	\$4,025.00	\$0.00	
2		New Electronics box	Full budget breakdown for this item available on Box	\$1,000.00	\$1,000.00		\$1,000.00
		New science sensors	Exact sensors TBD	\$250.00	\$250.00		\$250.00
		Upgraded power distribution / spare motor controllers	Full budget breakdown for this item available on Box	\$450.00	\$450.00		\$450.00
		Additional cameras		\$200.00	\$200.00		\$200.00
		Base station / additional RF antennas		\$500.00	\$500.00		\$500.00
		Arm refinements	Exact items TBD	\$400.00	\$400.00		\$400.00
		Locker organization	Mostly plastic tote bins	\$50.00	\$50.00		\$50.00
		Spare parts manufacturing		\$250.00	\$250.00		\$250.00
		Science collection system		\$750	\$750.00		\$750.00
		Specialized cables / connectors / other electronics		\$175	\$175.00		\$175.00
1					\$0.00		\$0.00
					\$0.00		\$0.00
Ü					\$0.00		\$0.00
0		- Travel		\$3,575.00	\$3,425.00	\$0.00	\$3,425.00
		Van rental	15 pass van, 7 days, 2350 miles	\$1,150	\$1,150.00		\$1,150.00
		Trailer rental	7 days	\$175	\$175.00		\$175.00
		Lodging	7 nights, 3 rooms per night	\$2,100	\$2,100.00		\$2,100.00
		Food	mostly paid for by team members	\$150			\$0.00
		- Raw Supplies		\$400.00	\$400.00	\$0.00	\$100.00
		Assorted metal	mostly sheet metal for waterjet	\$100	\$100.00		\$100.00
		Assorted 3D prints		\$200	\$200.00		
		Assorted other raw material		\$100	\$100.00		

EXTRA SLIDES – GANTT CHART

								Ма	arch																4	April																May	,							
Task	1 2 3	3 4	56	7 8	9 1	0111	12 13	14 15	16 17	18 19	20 21	22 23	3 24 25	262	27 28	32930	31	1 2	3 4	5 6	6 7	89	10 1	1 12 1	3 14 1	15 16	17 18	3 19 2	20 21 2	22 23	3 24 2	5262	7 28 2	2930	1 2	3 4	5 6	78	9 10	11 12	13 14	15 16	17 18	1920	0212	22 23 2	24 25	26 27	28 29	3031
Project-Wide		П															Π																																	T
URC System Acceptance Review																																																		\square
Full mock competitions (blind, outdoors)																																																		\square
Final improvements and fixes																																																		\square
URC travel preparation																																																		
Trave																																																		
University Rover Challenge (URC)																																																		
Mechanical Team																																																		
Arm upgrades and feedback																																																		\square
Camera mounting																																																		\square
Suspension upgrades and maintenance																																																		\square
Mass reduction																																																		\square
Systems Team																																																		\square
Arm feedback and control																																																		\square
Science system backend																																																		\square
Autonomous systems development and testing																																																		
Base station GUI improvements																																																		\square
Science Team																																																		\square
Test for Raman spectra of known biomarkers																																																		\square
Modify laser rotation for inverted use																																																		
Develop code for computerized data analysis																																																		
Blind, real-world testing																																																		\square
Develop and refine science report																																																		

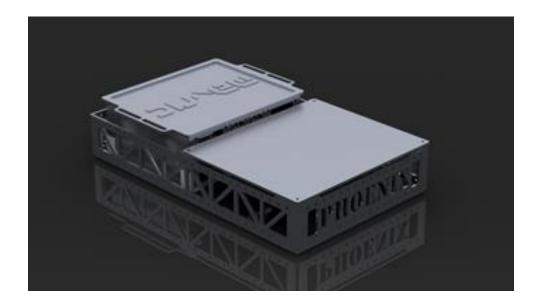
EXTRA SLIDES – WEIGHT REDUCTION

- Replace excessively long/bulky hardware
- Suspension
 - Flip stops Mill
 - Beams Mill
 - Wheel nuts Grind
 - Drop plate blocks Mill
 - Motor mounts Replace
 - Wheels Replace
- Chassis
 - Top plate Replace
 - Battery mount Mill



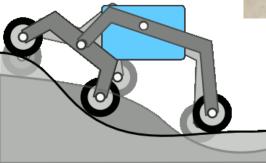
EXTRA SLIDES - CHASSIS

- · Generously donated by Quality Manufacturing
- 1/4" aluminum plate, formed and welded
- Lighter, stronger, and easier to work with than past chassis
- Allows modular design due to mounting hole pattern
 - Easy to perform upgrades and maintenance
 - Can easily test new designs
- Top plate for mounting various subsystems
 - Robotic arm
 - Light spectrometer
 - Suspension differential bar
 - Batteries
 - Arm power distribution box
 - Autonomous cameras and lights



EXTRA SLIDES - SUSPENSION

- Rocker bogie suspension
- Keeps chassis stable in rough terrain
- Rocker has motion limited by flip-stops
 - Prevents flipping in extreme terrain
- Wheels individually driven by in-hub motors
- Skid-steering
 - Lightweight
 - Works on desert soil
- Tested successfully in fall 2018





EXTRA SLIDES – ROBOTIC ARM

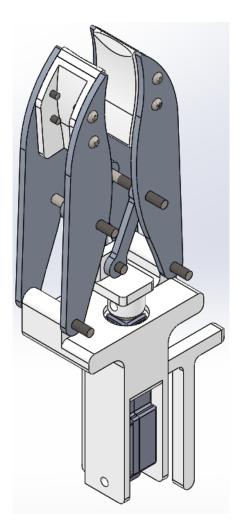
- Base rotation motor and internal ring gear
- Shoulder motor with worm drive
- Elbow linear actuator
- Wrist two direct-drive motors
- Arm control box attached beneath top plate
- Subsystem is easily removeable



EXTRA SLIDES – END EFFECTOR

- Old End Effector
 - Driven by a single mini linear actuator
 - Four fingers
 - Narrow grips on all sides
- Revised End Effector
 - Driven by a single mini linear actuator
 - Two fingers
 - Wide, flexible grip surfaces
 - Rotates on-center for ease of use
 - Limit switches control position





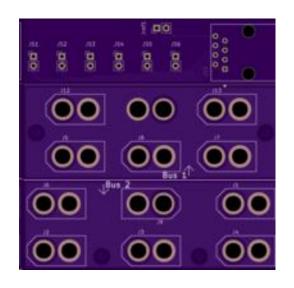
EXTRA SLIDES – AUTONOMOUS

- Use GPS to navigate near the target (tested, working)
 - Use Intel RealSense to detect obstacles
 - Use IMU for compass heading
- Once GPS point is reached, begin moving in search pattern
 - Use Pixy2 camera to recognize tennis ball
 - Drive to tennis ball and flash indicator light

EXTRA SLIDES – PCB DESIGN

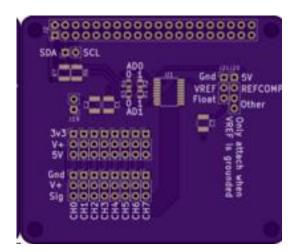
Arm Power/Signal Distribution

- XT-60 solder points
- Locking signal connectors
- 2 power busses

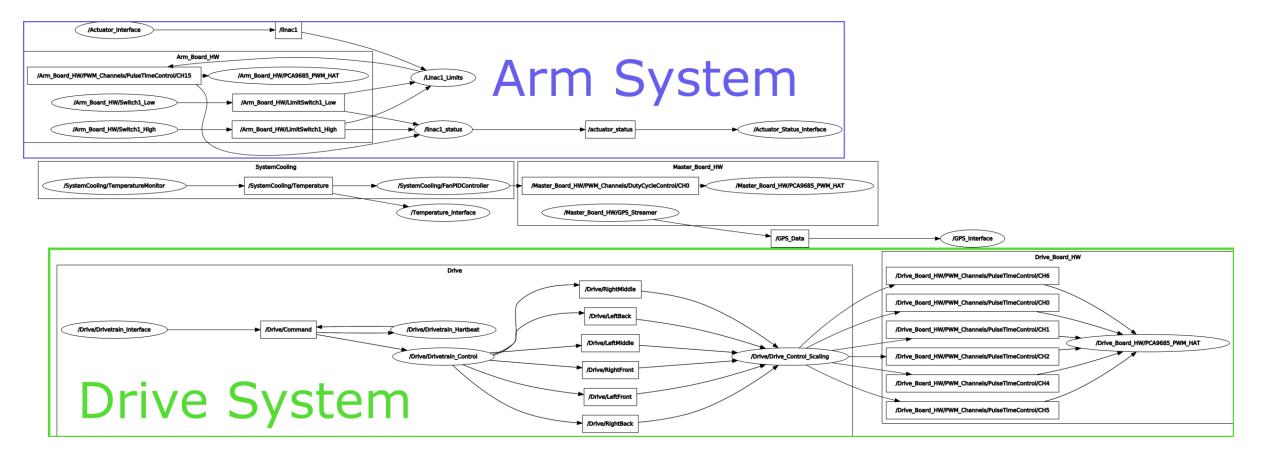


ADC HAT (Raspberry Pi Add-on board)

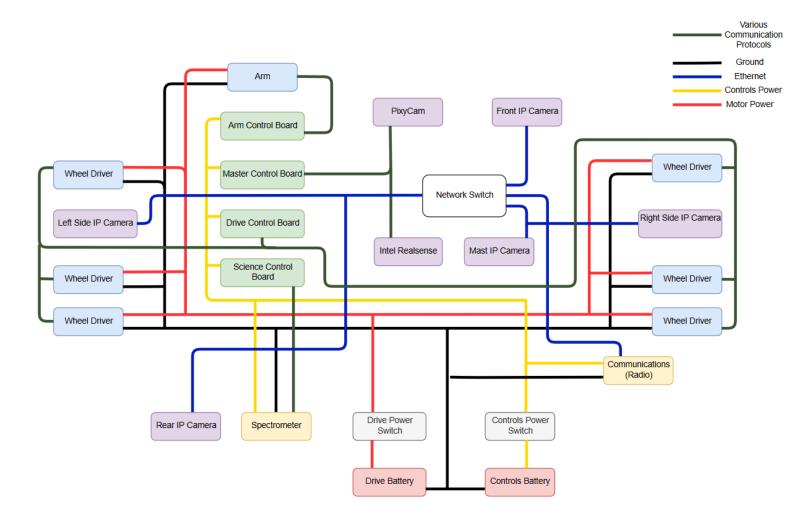
- Reads 8 analog sensors
- ~13 thousand samples/sec
- Selectable voltage reference
- Selectable voltage supply



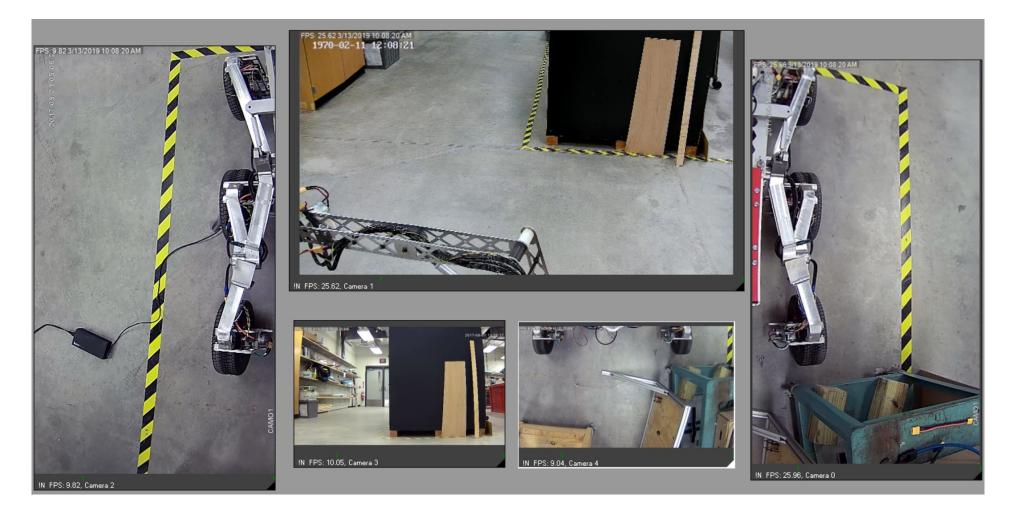
EXTRA SLIDES - ROS MAP



EXTRA SLIDES – BLOCK DIAGRAM



EXTRA SLIDES – CAMERA VIEW



EXTRA SLIDES – POWER BUDGET

ItemID 🔽	Peak % Capacity 🔽	Constant % Capacity 🔽	Battery Life (hrs) 🛛 💌			Power Rail	Voltage (V)	Current (A) 💽	Peak Current (A) 💽	Power (W) 🔽
	_					Primary Battery Pack	22.2	0 11.00	66.00	1465.20
Primary Battery Pac	k 36.67%	6.11%	1.09	Status:	GO	E-Box Battery	22.2	0 4.08	8.13	180.40
E-Box Battery	10.42%	5.23%	1.27	Battery Life:	01:05					
Logic Supply	0.00%	0.00%	5							
Network Power	47.22%	22.22%	5							
Transceiver										
Network Switch										
Arm Power	0.00%	0.00%	5							
Drivetrain Power	16.50%	2.75%	5							
FrontRight ESC	16.67%	2.78%	5							
FrontRight Motor										
MidRight ESC	16.67%	2.78%	5							
MidRight Motor										
BackRight ESC	16.67%	2.78%	5							
BackRight Motor										
FrontLeft ESC	16.67%	2.78%	5							
FrontLeft Motor										
MidLeft ESC	16.67%	2.78%								
MidLeft Motor										
BackLeft ESC	16.67%	2.78%	5							
BackLeft Motor										
Cooling Fans Power	66.67%	35.00%	5							

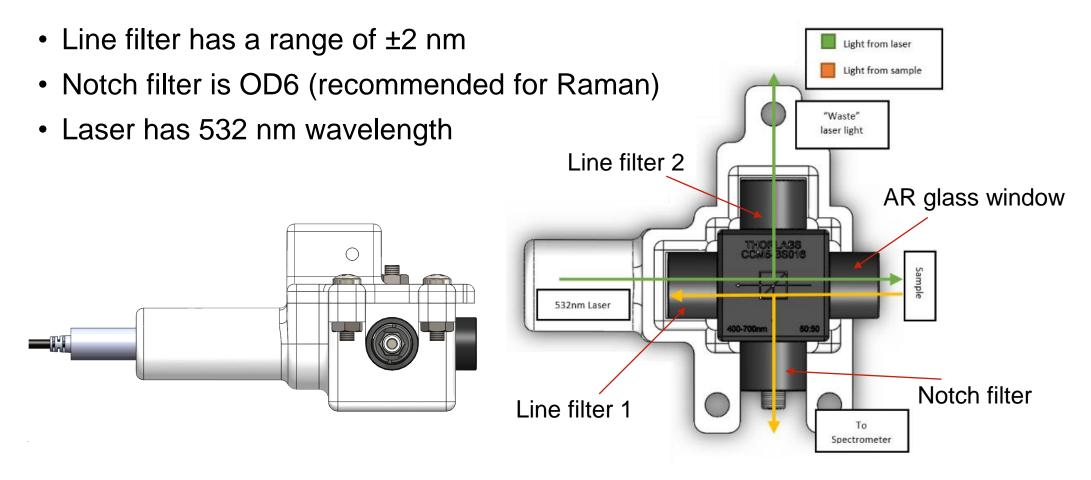
EXTRA SLIDES – PYTHON BIOMARKER IDENTIFICATION SCRIPT

- Still in early stages of development
- Steps to completion
 - Learn enough Python to complete this task
 - Create the convertPeaks() function



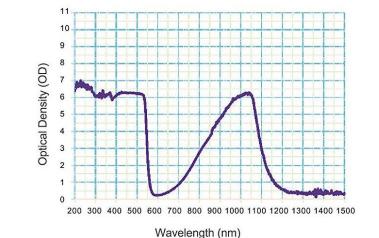
- Converts the spectrometer wavelength data to Raman wavenumber data
- Develop the findPeaks() function
 - Sorts through the spectra data and finds peaks that we can consider for biomarker assignment
- Develop the determineMatch() function
 - Looks at peaks from wavenumber data, determines the likelihood of the presence of biomarkers on our list

EXTRA SLIDES – OPTICAL HOUSING AND LASER PATH



EXTRA SLIDES – LASER SAFETY

- Laser is class 3R
 - Low-hazard laser
- Taking precautions and wearing safety glasses due to repeated exposure to beam
- Lowered eye exposure to beam while still being able to see dot

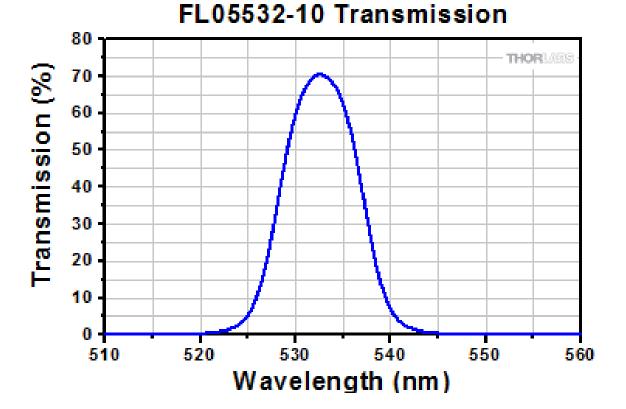


Unintentional or accidental exposure to direct or reflected beam has a low risk. Avoid intentional exposure to direct or reflected beam.

EXTRA SLIDES – NOTCH FILTER GRAPH

				5.	32nm T	echs	-		Filter (ENCE	Coating P	erforma	nce	Center Wavelength CWL (nm):	532
Coating:	Hard Coated		100				Ion						Full Width-Half Max FWHM (nm):	17.00
Diameter (mm):	12.50 +0.0/-0.1		90	\sim	~									
Optical Density OD:	≥6.0		80										Surface Quality:	60-40
Thickness Tolerance (mm):	±0.1		70		-++								Transmission (%):	350 - 400nm: T _{avg} >80 400 - 1200nm: T _{avg} >90
Transmission Wavelength (nm):	350 - 1200	mission (%)											Туре:	Notch Filter
Construction:	Mounted in Black Anodized Ring	5	50										Clear Aperture (%):	85
Durability:	MIL-C-48497A	Tran	40 30										Reflection at CWL (%):	>99.5
Transmitted Wavefront, RMS:	<1λ		20										Mount Thickness (mm):	3.5
Regulatory Compliance			10											
Reach 191:	Compliant		0	ļ	U,				1					
			35	50 450	55	0	650	750 Wavelengt	850 h (nm)	950	1050	1150	RoHS:	Compliant

EXTRA SLIDES – LINE FILTER GRAPH



CWL ^a	FWHM ^b	T (Min) ^c	Blocking ^d	Transmission/ OD Data ^e	Laser Line	Size
532 ± 2 nm	10 ± 2 nm	70%	200 - 1100 nm	0	Nd:YAG	Ø1/2"

EXTRA SLIDES – LASER SPECS



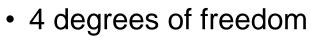
General	Specifications
Characteristic	
Housing Material	Aluminum
Housing Dimensions	Ø11.0 mm x 72.8 mm
Beam Size ^a	Round, Ø3.5 mm
Operating Temperature	10 to 40 °C
Storage Temperature	-30 to 70 °C
Operating Voltage (Nominal)	5 VDC
Laser Safety Class	3R

Optical Electrical Characteristics												
Characteristic	MIN	ТҮР	MAX	UNIT								
Wavelength	531	532	533	nm								
Optical Output Power (CW)	4.0	4.5	5.0	mW								
Polarization State Extinction Ratio	-	4	-	dB								
Power Stability (8 Hours)	-	-	2	%								
Axis Deviation ^a	-	-	5	mrad								
Beam Divergence	-	-	0.5	mrad								
Operating Current (CW)	-	250	-	mA								

EXTRA SLIDES – RAMAN SPECTROSCOPY

• Several different types of light Virtual energy return when a laser is incident states to a surface Rayleigh is easiest to see Stokes and anti-Stokes are used for Raman spectroscopy Vibrational energy states 3 incident scattered Anti-Stokes Infrared Rayleigh Stokes absorption scattering Raman Raman scattering scattering

EXTRA SLIDES – LASER ORIENTATION



- Vertical actuation
- Forward actuation
- Pitch
- Yaw

0 0

- Allows for fine control of laser
 - Does not rely on rover for specific location of test sample