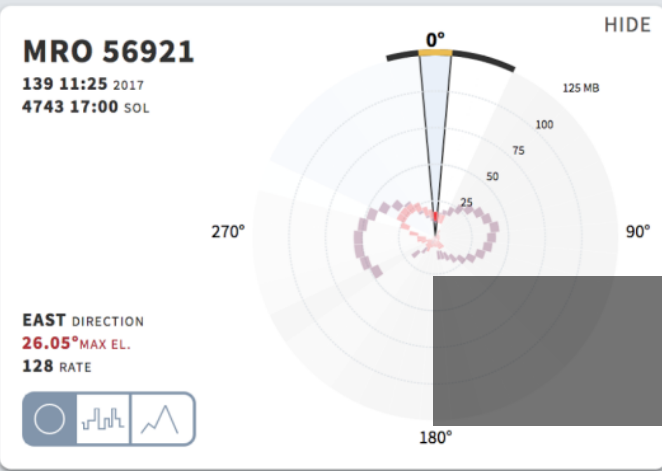
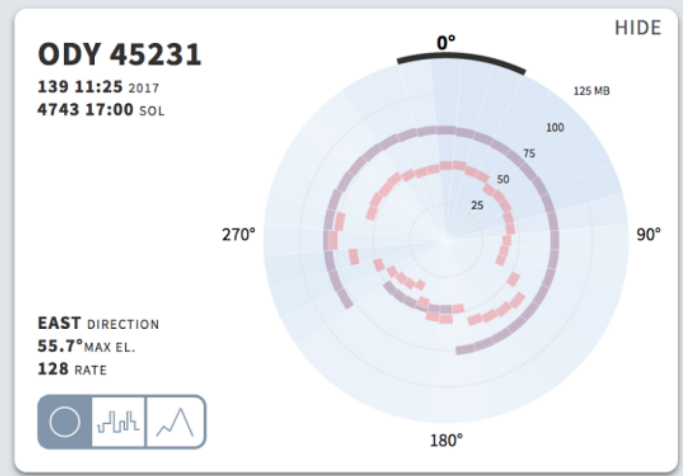
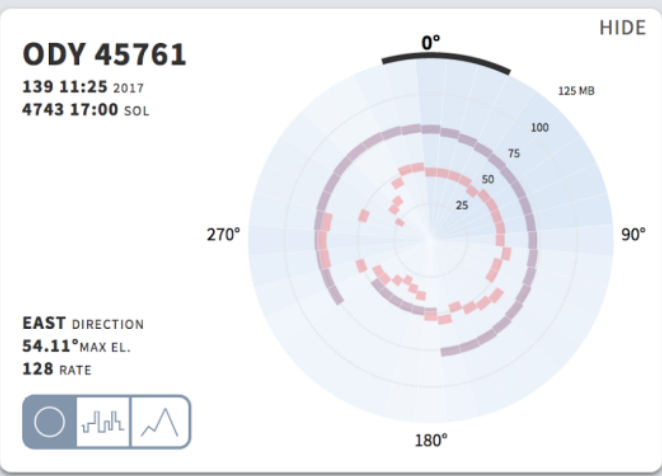


MERIDIAN

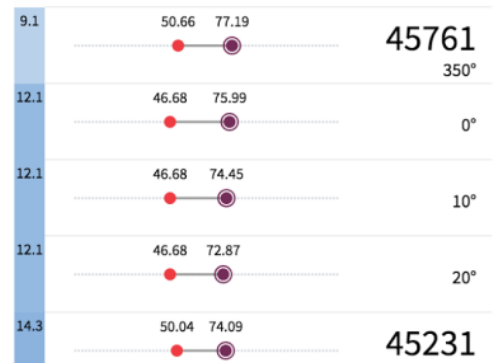
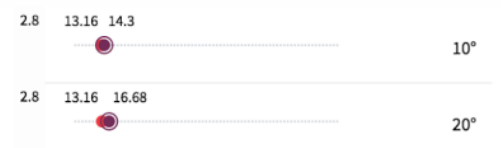
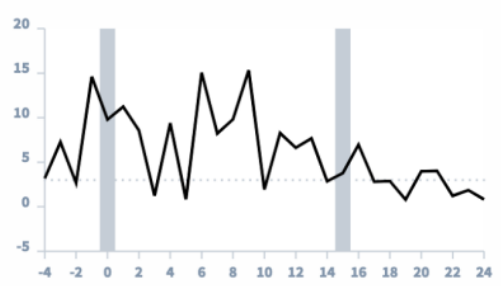
MARS EXPLORATION ROVER
TELECOM PREDICTION

MATT CONLEN CHELLY JIN SARA STALLA

PI: VICKIE SCARFFE-BARRETT



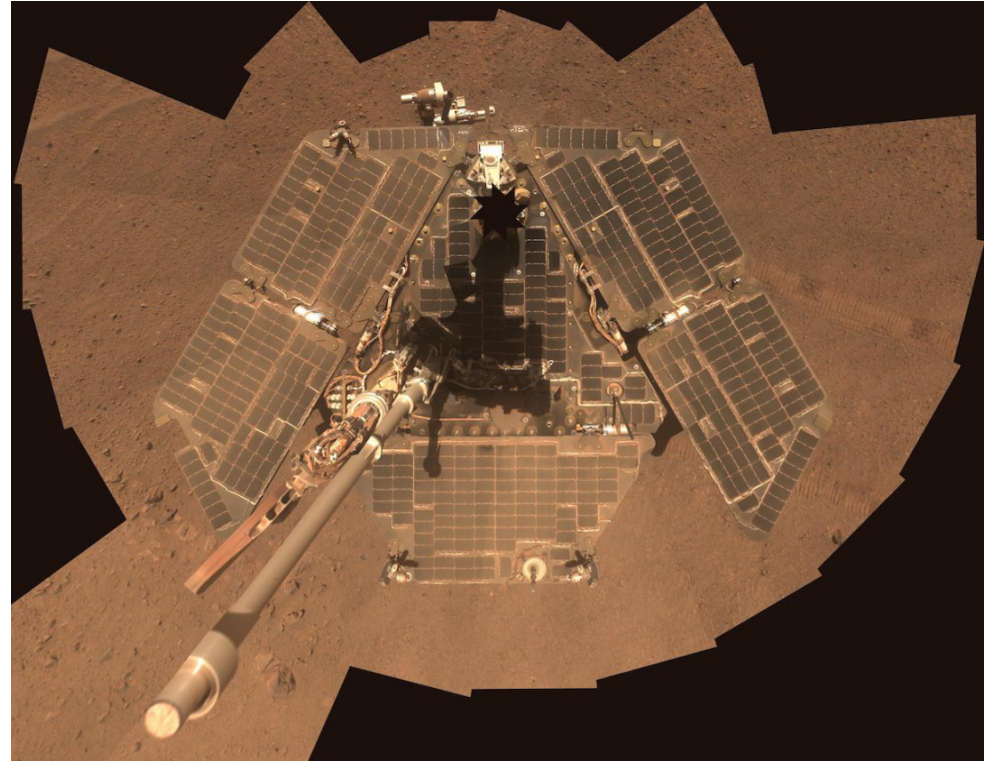
MERIDIAN



Mars Exploration Rover (MER) **OPPORTUNITY**

Launched in 2003,
on Mars since 2004

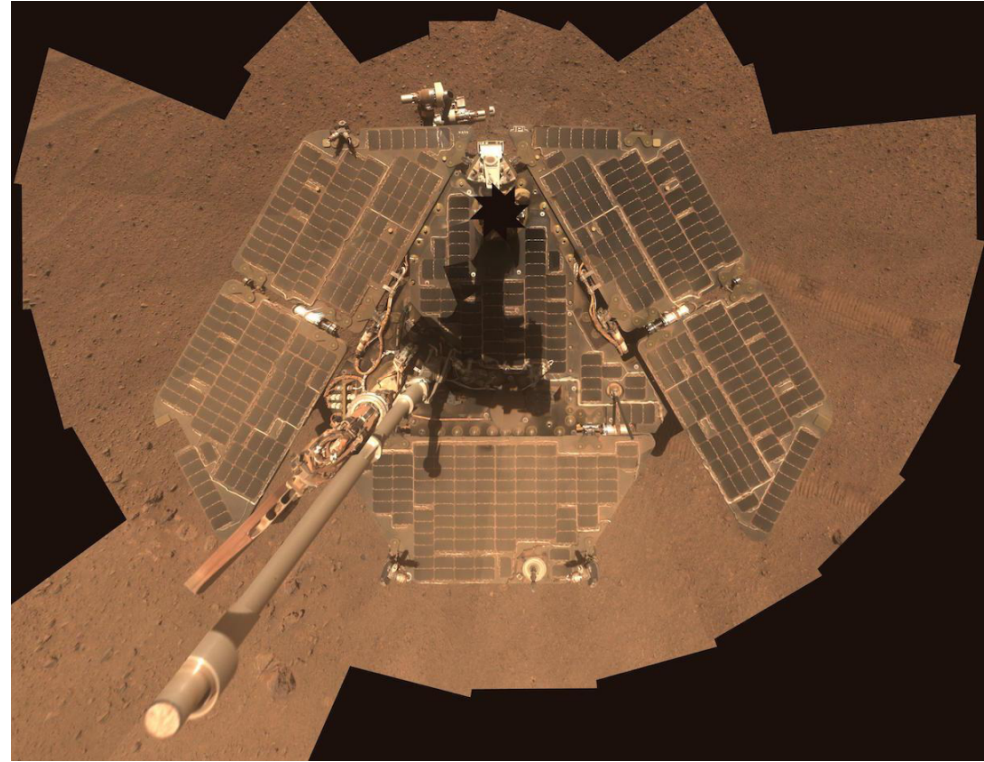
Several cameras
onboard spectrometer
microscopic imager



Mission was meant to last 90 days,
certain tools not developed for long
term management

ROVER LIMITATIONS

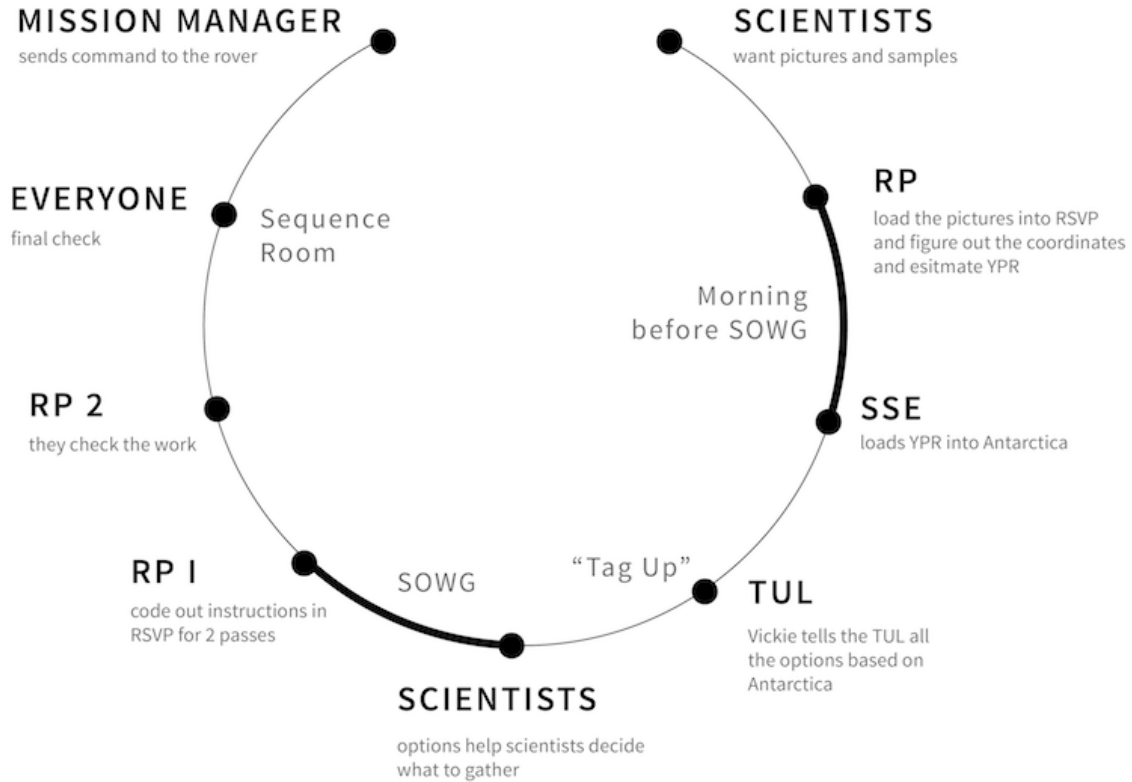
steering, driving, memory is wiped
every night

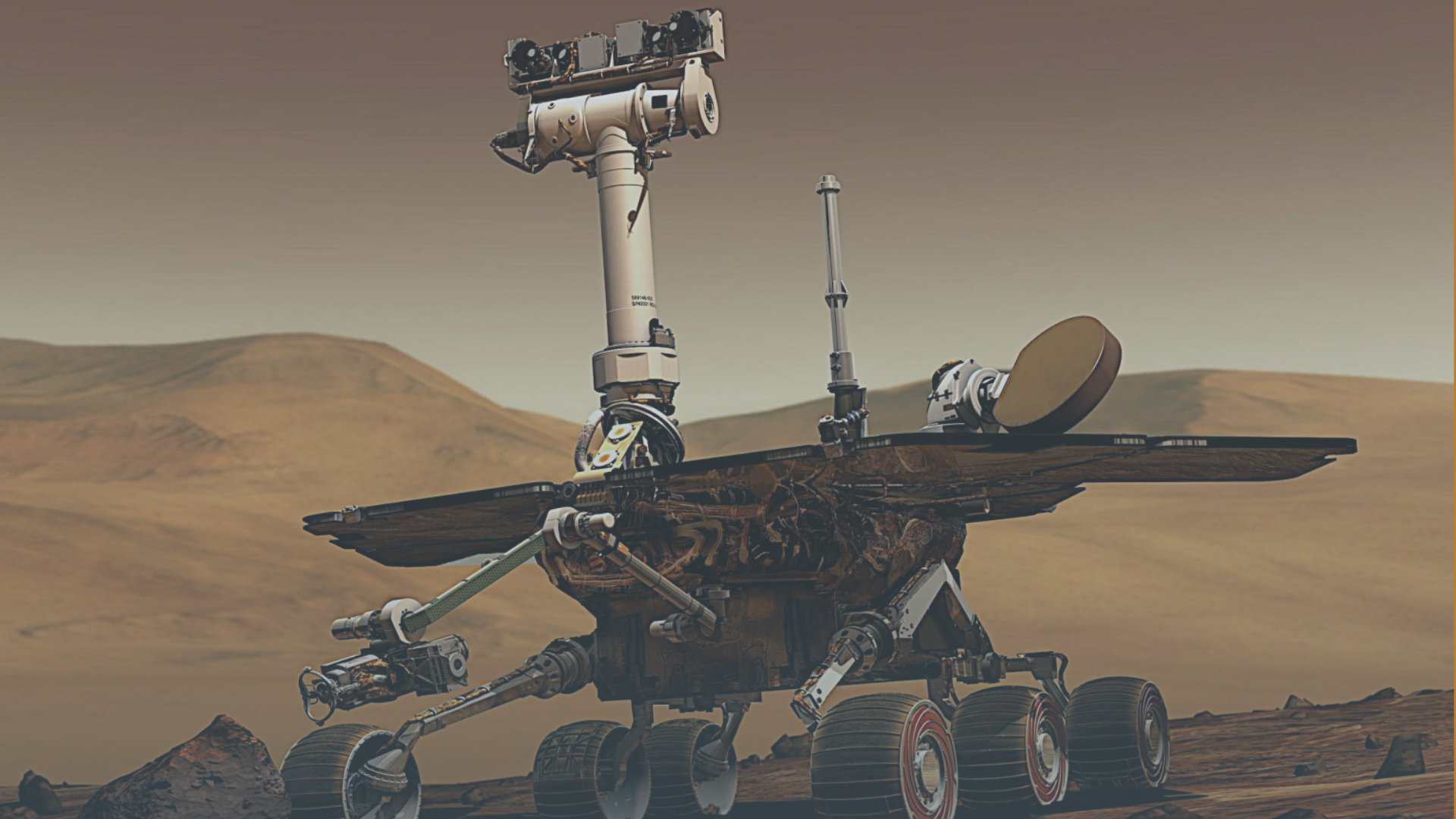


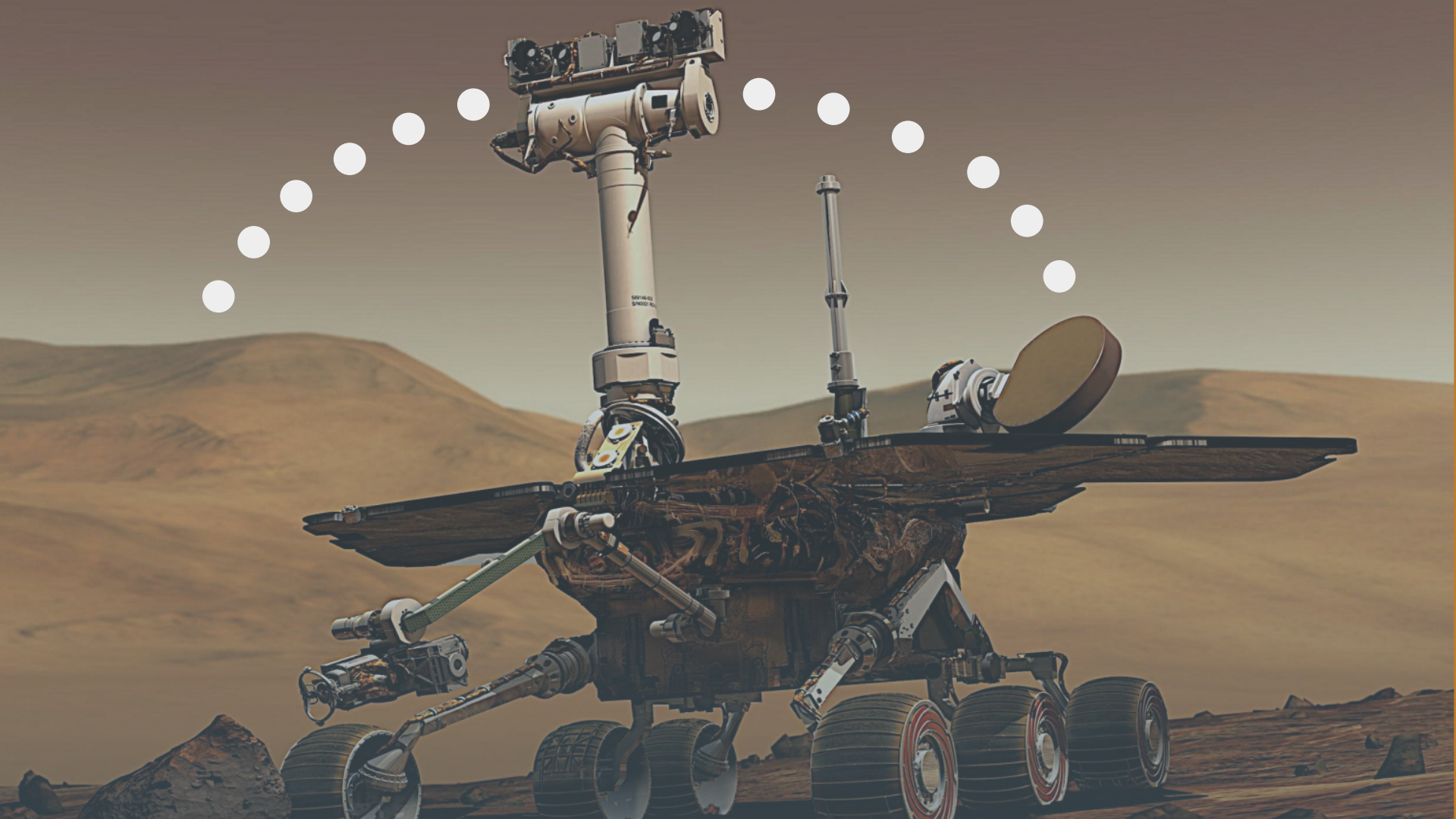
PROBLEM STATEMENT

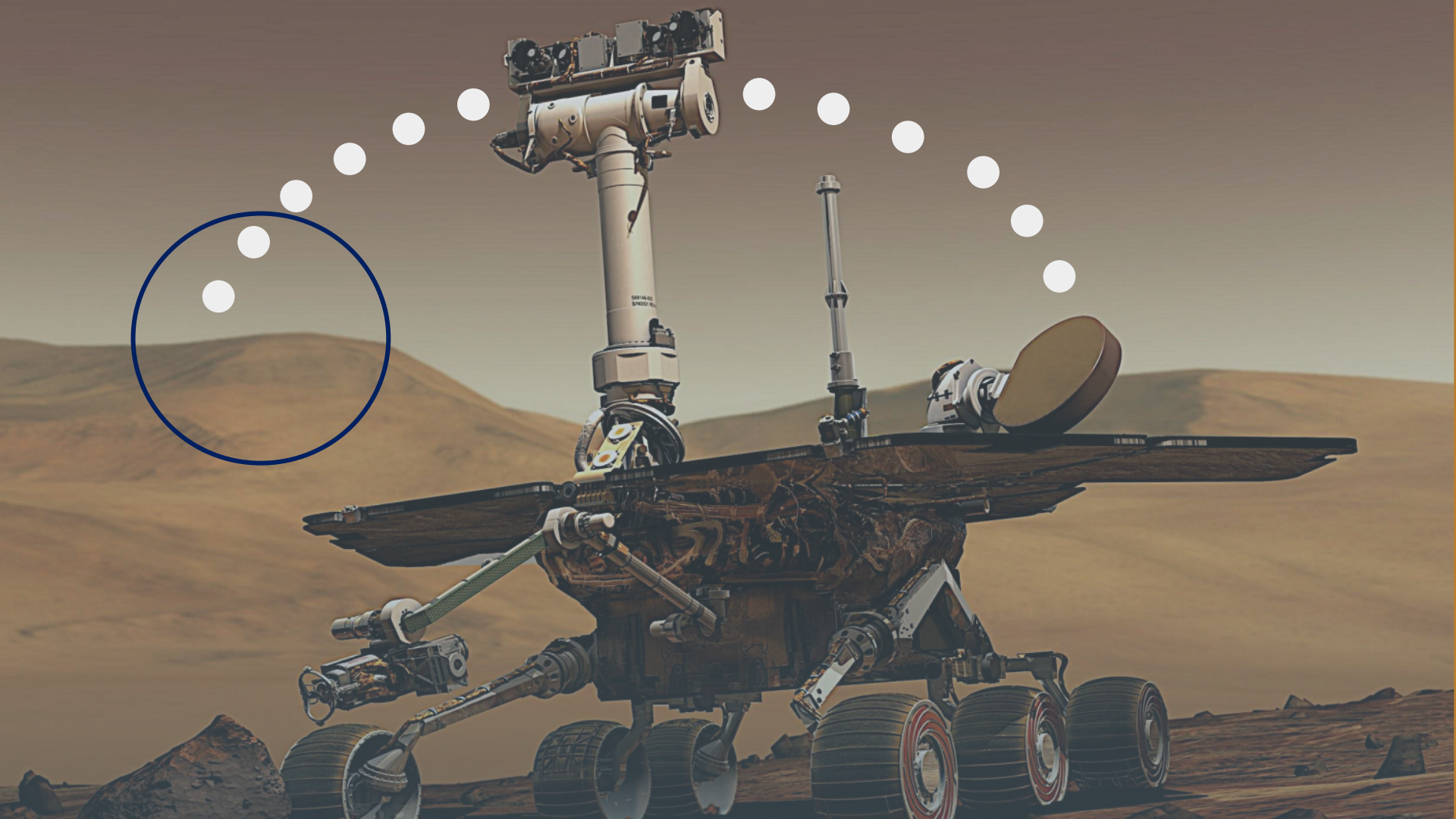
Spacecraft Systems Engineers (SSEs) need to prediction how much data can be transferred from the rover to an overpassing satellite in order to:

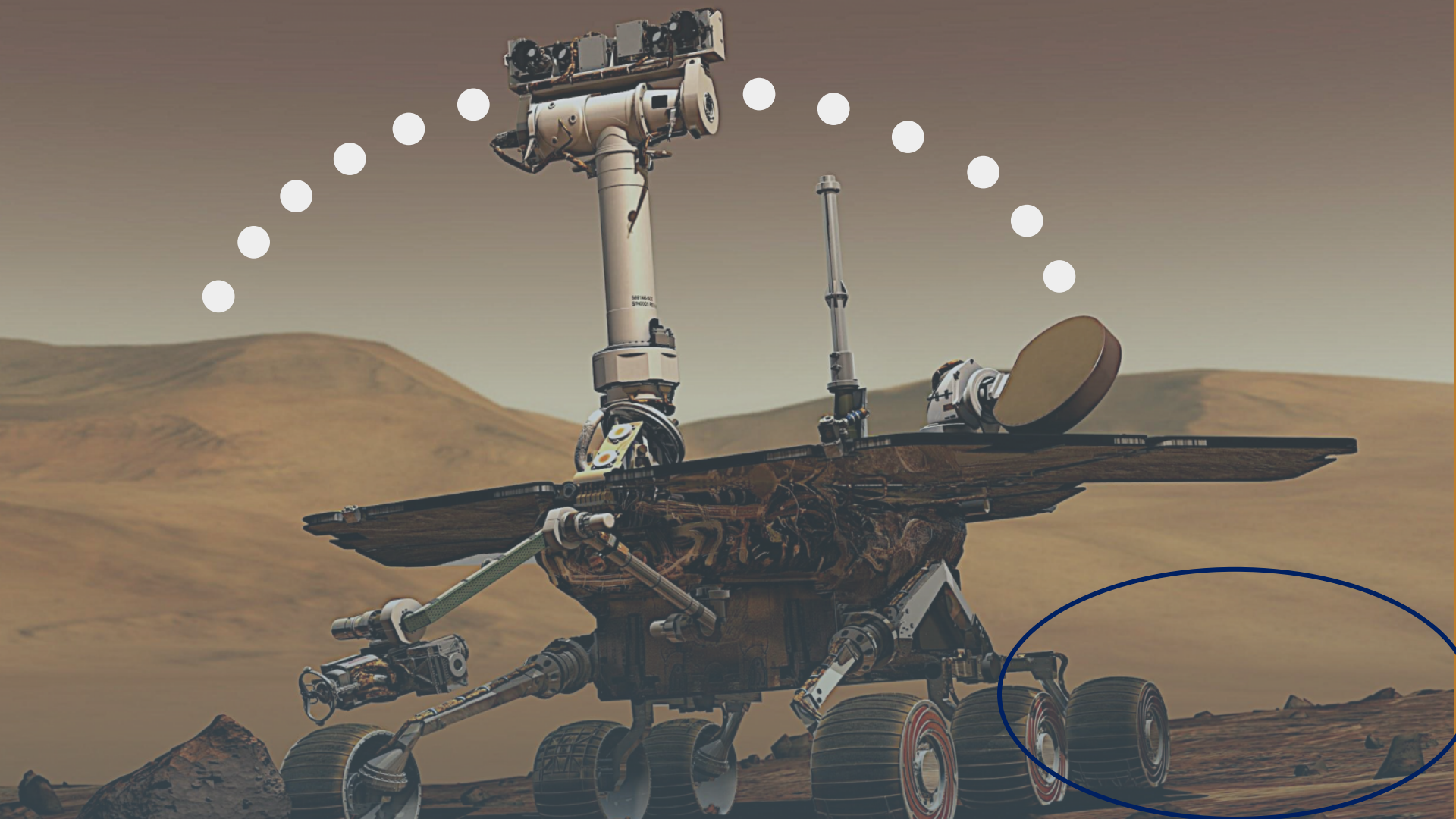
- 01 Provide scientists with an estimate of available data transfer
- 02 Recommend the heading at which a rover should end its path to achieve a high level of data transfer.

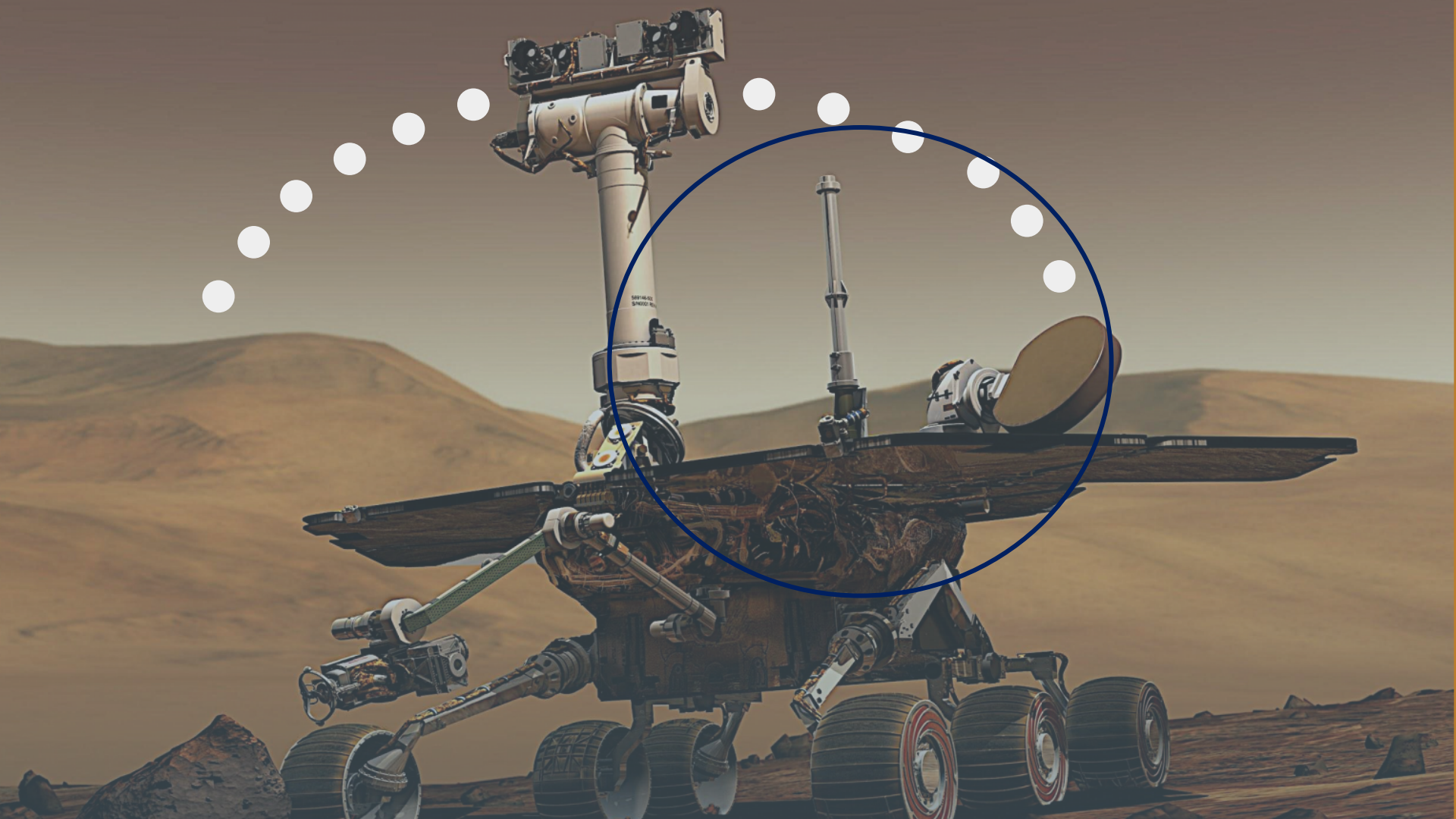








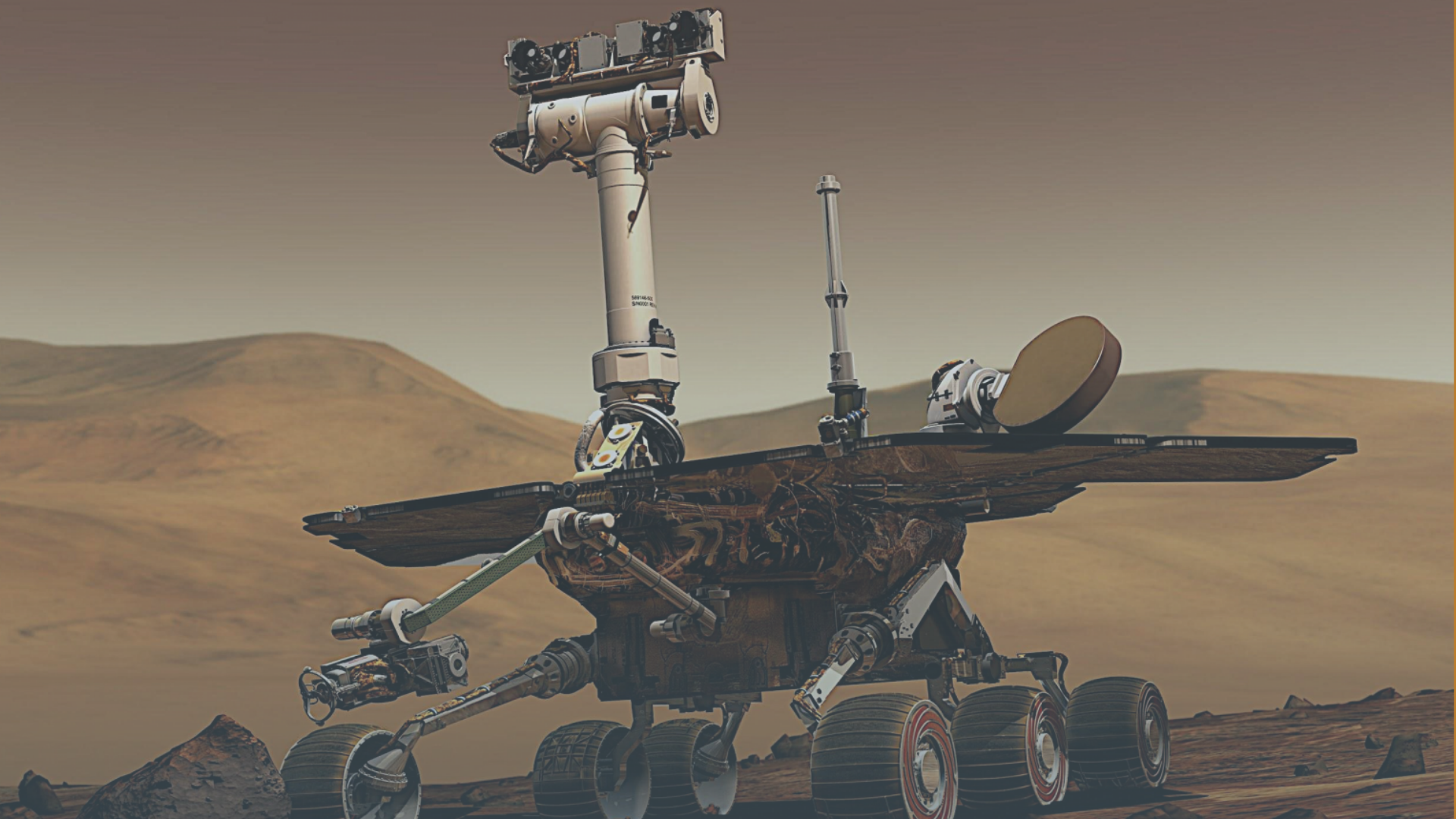




WHEN MAKING DECISIONS ABOUT DATA TRANSFER, **SSEs MUST CONSIDER**

01 The ability of the rover
to link with the orbiter
Link Margin

02 The total amount of
data that can be
transferred
GTP EMP



“Currently our method of evaluating our heading choices is to open all of the plots, on different computers or windows, and to examine each one, moving them around the screen to compare next to each other.

Sometimes we will even print out some of the plots and hold layered paper up to the light to compare them together.”

* * * W A R N I N G * * *

You are connected to a Jet Propulsion Laboratory machine

Property of the
UNITED STATES GOVERNMENT

This computer is funded by the United States Government and operated by the California Institute of Technology in support of ongoing U.S. Government programs and activities. If you are not authorized access to this system, disconnect now. Users of this system have no expectation of privacy. By continuing, you consent to your keystrokes and data content being monitored.

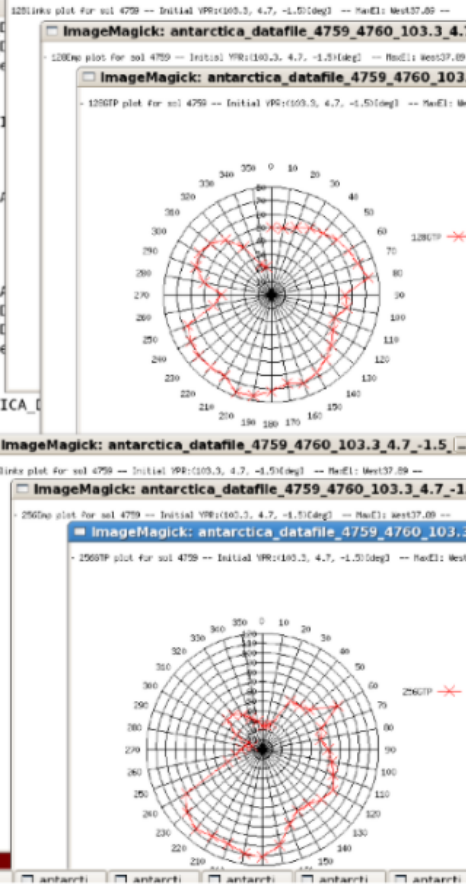
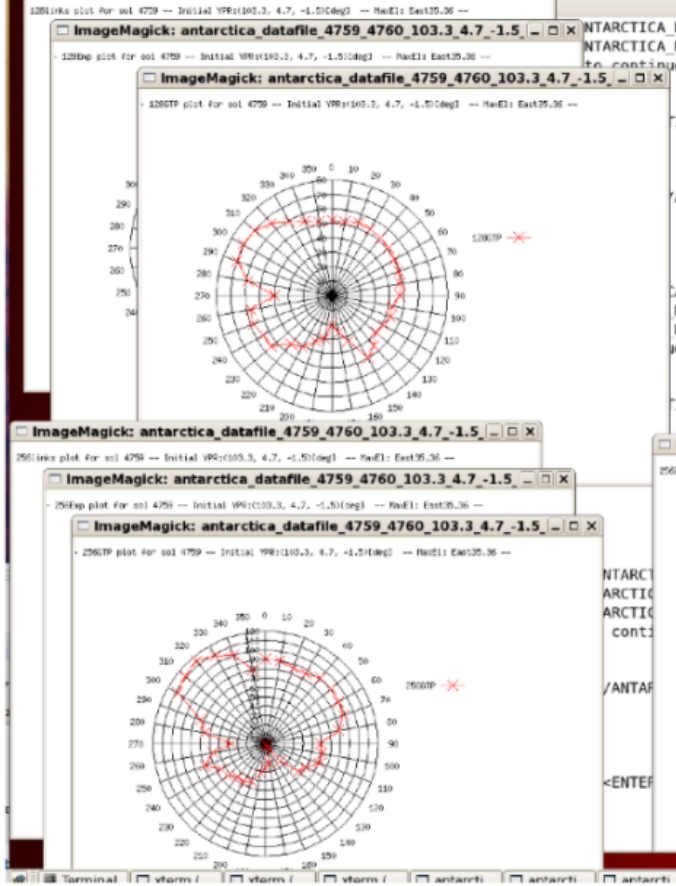
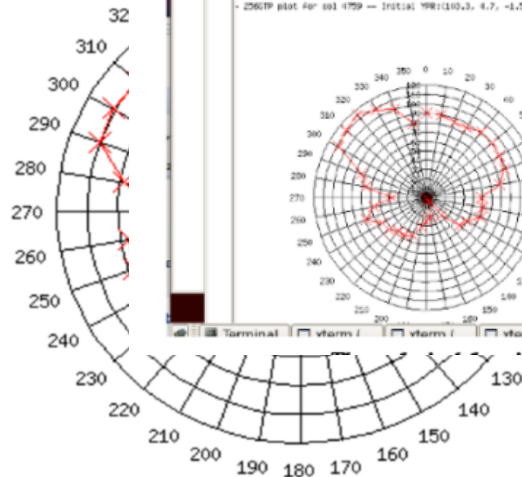
Unauthorized Access is a violation of U. S. Federal Law.

You are conr

This computer is fund
California Institut
programs and act
system, disconn
of privacy. B

Unauthorized

`./ANTARCTICA.pl`



Predicts for 47591 ODY_MRB_2017_165_01
 yaw = 350.00, pitch = -3.24, roll = -3.72
 Startran: 2017-165T04:21:29 (UTC) SOL
 4759 17:26:58 (LST)
 Pass is East, with a max el of 35.36 (deg)

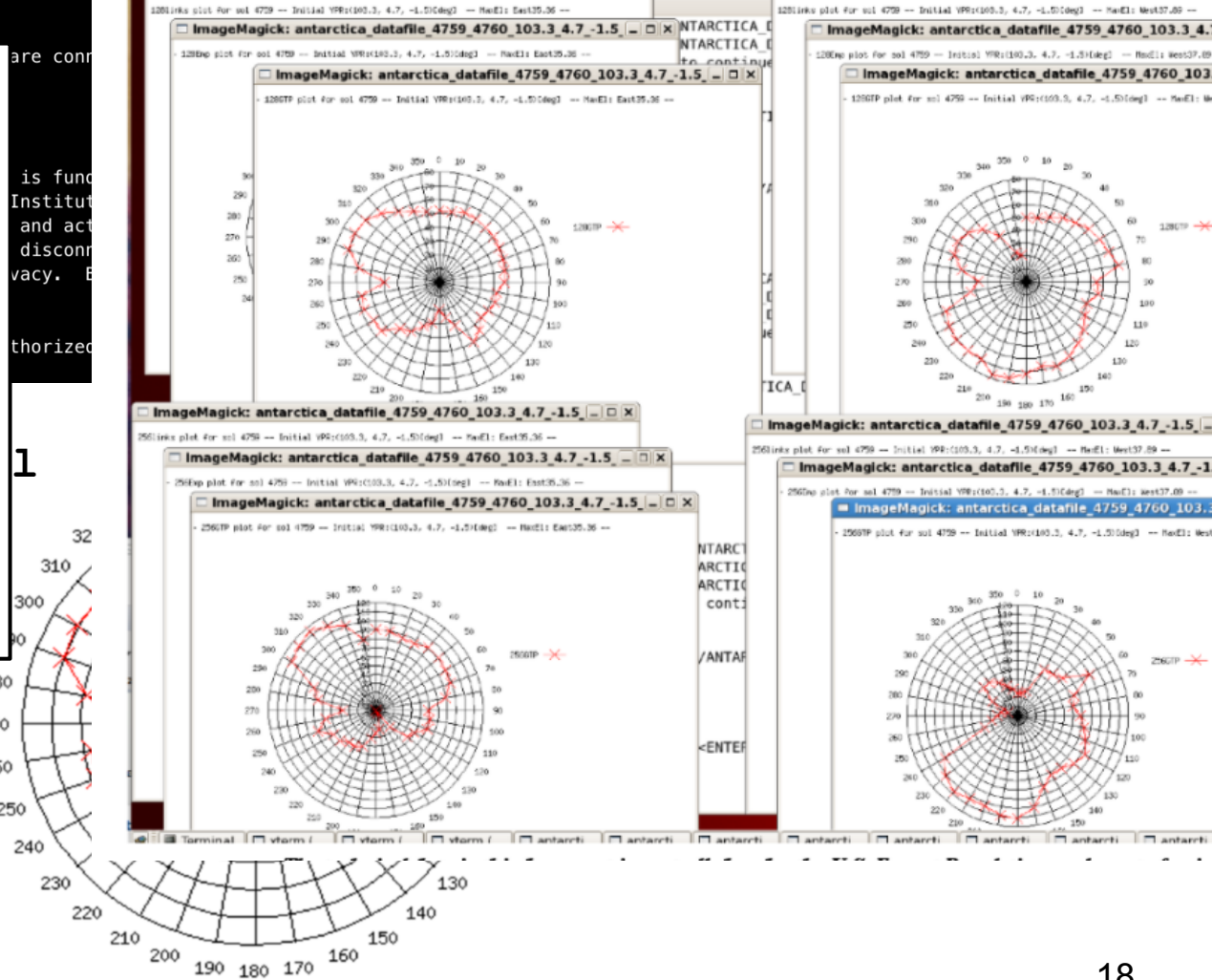
GTP Predicts*****

128k DV: 52.64 (Mbits) Link (dB): 12.83 ***
 256k DV: 80.46 (Mbits) Link (dB): 8.932

Empirical Predicts***

128k DV: 92.45 (Mbits) ***
 256k DV: 119.33 (Mbits)

Historically, for this yaw the 128k Empirical
 predicts have been more accurate.
 Historically, for this yaw the 256k Empirical
 predicts have been more accurate.



Predicts for 47591 ODY_MRB_2017_165_01

Predicts for 47591 ODY_MRB_2017_165_01

Predicts for 47591 ODY_MRB_2017_165_01

Predicts for 47591 ODY_MRB_2017_165_01

Predicts for 47591 ODY_MRB_2017_165_01

Predicts for 47591 ODY_MRB_2017_165_01

Predicts for 47591 ODY_MRB_2017_165_01

Predicts for 47591 ODY_MRB_2017_165_01

Predicts for 47591 ODY_MRB_2017_165_01

Predicts for 47591 ODY_MRB_2017_165_01

Predicts for 47591 ODY_MRB_2017_165_01

yaw = 350.00, pitch = -3.24, roll = -3.72

Startran: 2017-165T04:21:29 (UTC) SOL

4759 17:26:58 (LST)

Pass is East, with a max el of 35.36 (deg)

GTP Predicts*****

128k DV: 52.64 (Mbits) Link (dB): 12.83 ***

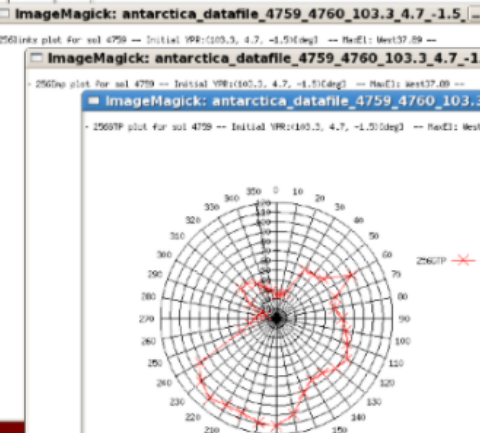
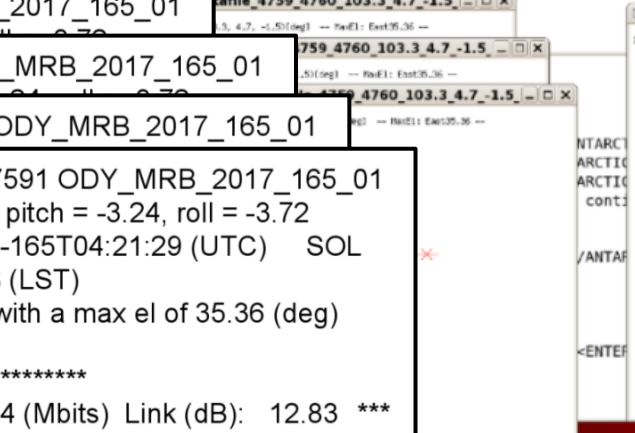
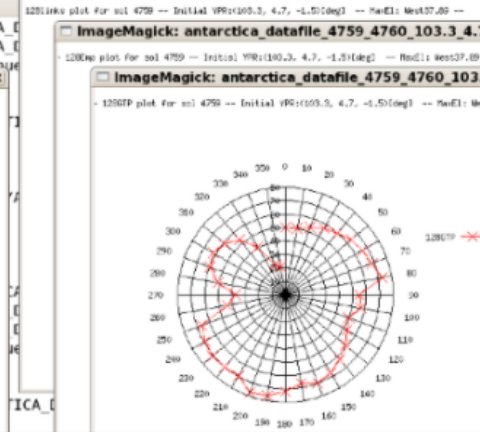
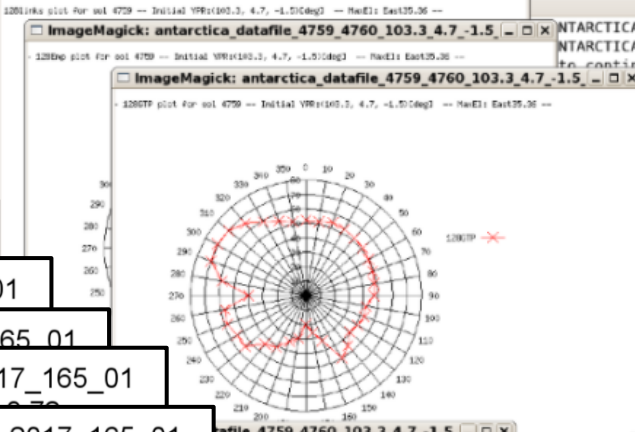
256k DV: 80.46 (Mbits) Link (dB): 8.932

Empirical Predicts***

128k DV: 92.45 (Mbits) ***

256k DV: 119.33 (Mbits)

Historically, for this yaw the 128k Empirical



Predicts for 47591 ODY_MRB_201

Predicts for 47591 ODY_MRB

Predicts for 47591 ODY_MF

Predicts for 47591 ODY

Predicts for 47591

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

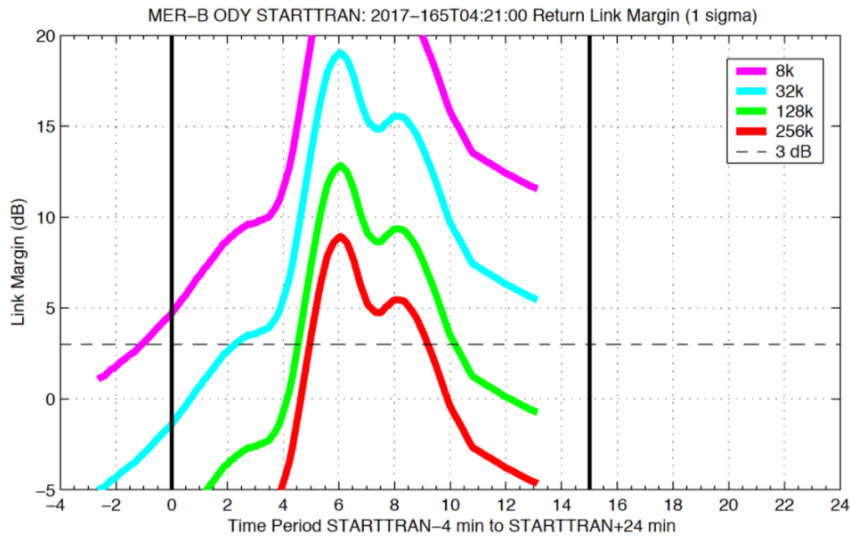
Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

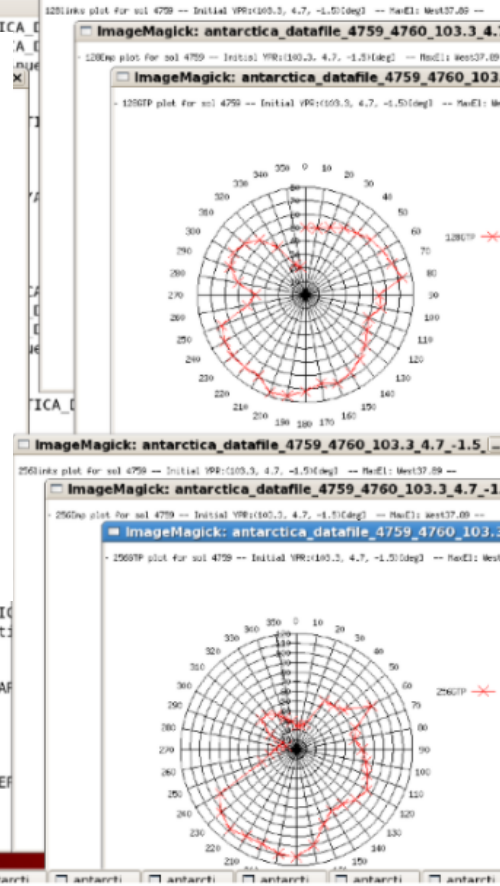
Predicts for 47



Predicts for 47591 ODY_MRB_2017_165_01
 yaw = 350.00, pitch = -3.24, roll = -3.72
 Startran: 2017-165T04:21:29 (UTC) SOL
 4759 17:26:58 (LST)
 Pass is East, with a max el of 35.36 (deg)

GTP Predicts*****
 128k DV: 52.64 (Mbits) Link (dB): 12.83 ***
 256k DV: 80.46 (Mbits) Link (dB): 8.932

Empirical Predicts***
 128k DV: 92.45 (Mbits) ***
 256k DV: 119.33 (Mbits)



Predicts for 47591 ODY_MRB_201

Predicts for 47591 ODY MRB

Predicts for 47591 ODY_MF

Predicts for 47591 ODY

Predicts for 47591

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

Predicts for 47

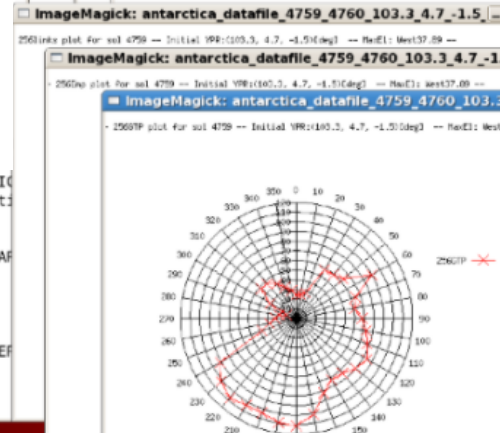
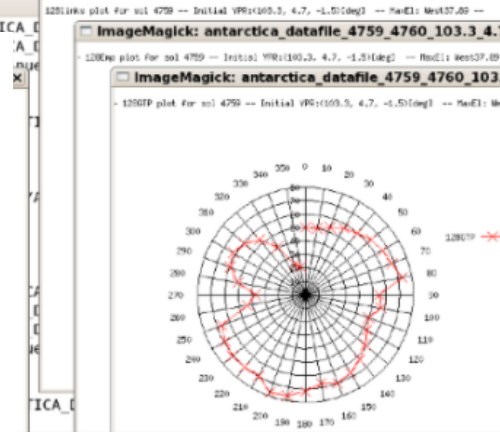
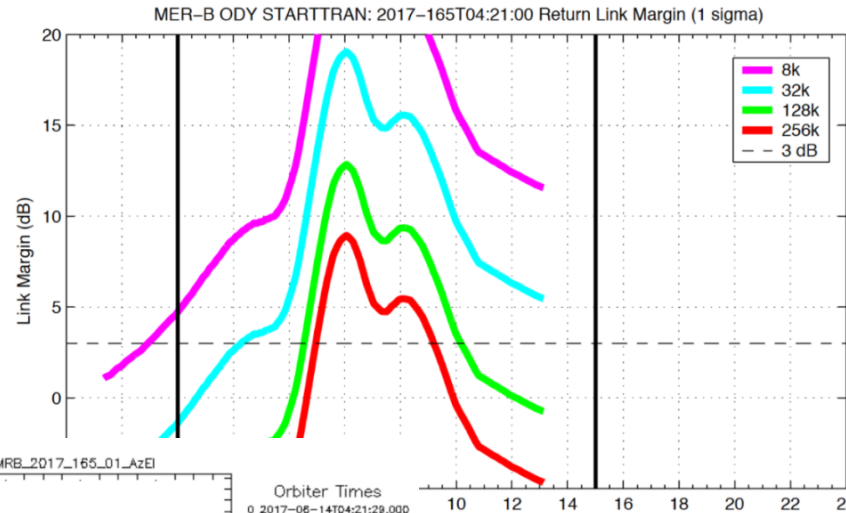
Predicts for 47

Predicts for 47

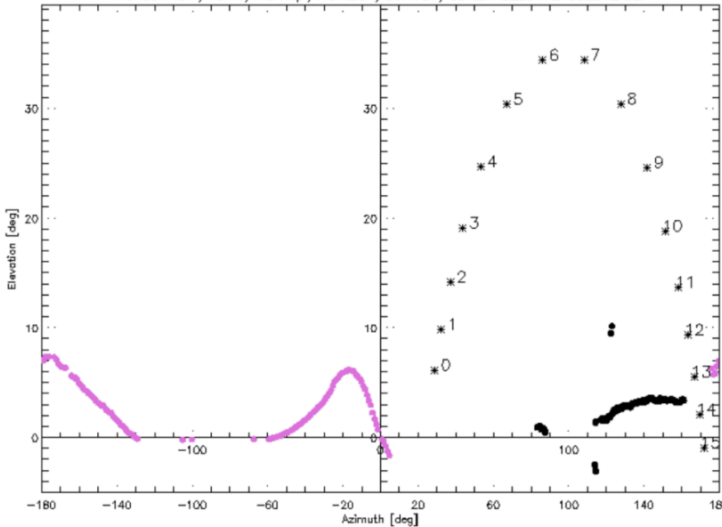
Predicts for 47

Predicts for 47

Predicts for 47



Horizon for /home/memipl/HORIZON/Sol4757/ODY_MRB_2017_165_01_AzEl



Orbiter Times

0	2017-06-14T04:21:29.000
1	2017-06-14T04:22:29.000
2	2017-06-14T04:23:29.000
3	2017-06-14T04:24:29.000
4	2017-06-14T04:25:29.000
5	2017-06-14T04:26:29.000
6	2017-06-14T04:27:29.000
7	2017-06-14T04:28:29.000
8	2017-06-14T04:29:29.000
9	2017-06-14T04:30:29.000
10	2017-06-14T04:31:29.000
11	2017-06-14T04:32:29.000
12	2017-06-14T04:33:29.000
13	2017-06-14T04:34:29.000
14	2017-06-14T04:35:29.000
15	2017-06-14T04:36:29.000

MRB_2017_165_01
 roll = -3.72
 :29 (UTC) SOL
 el of 35.36 (deg)

Link Margin (dB): 12.83 ***
 Link Margin (dB): 8.932

Predicts for 47591 ODY_MRB_201

Predicts for 47591 ODY MRB

Predicts for 47591 ODY_MF

Predicts for 47591 ODY

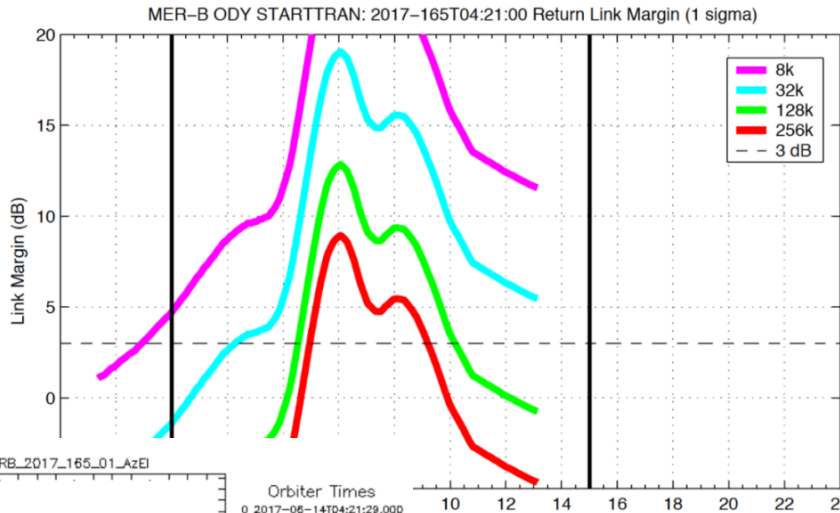
Predicts for 47591

Predicts for 47

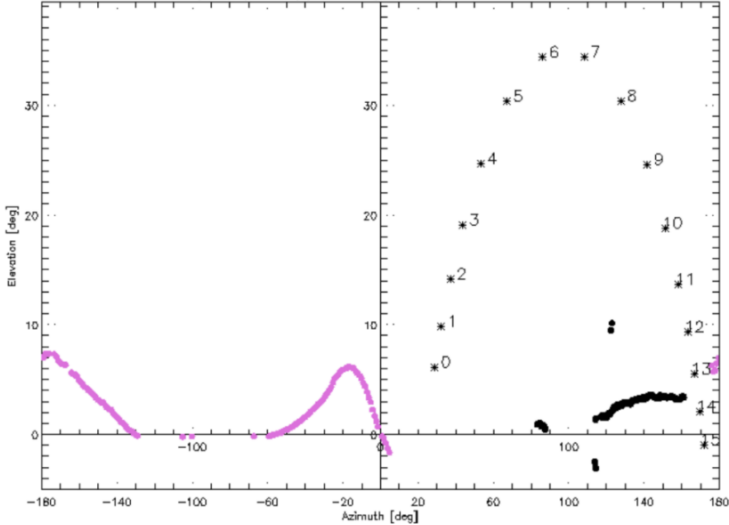
Predicts for 47

Predicts for 47

Predicts for 47



Horizon for /home/memipl/HORIZON/Sol4757/ODY_MRB_2017_165_01_AzEl

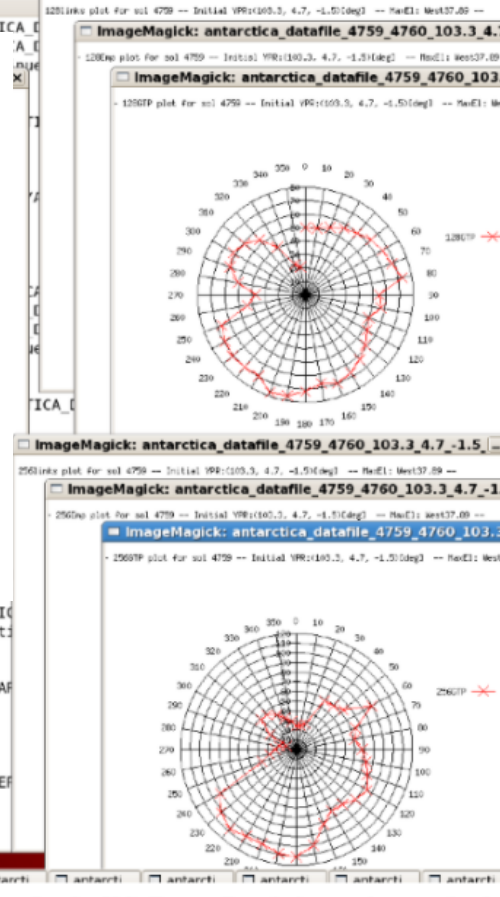
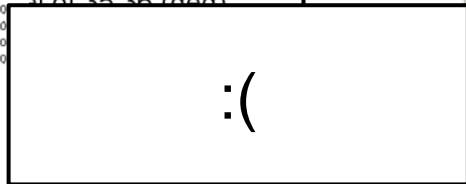


Orbiter Times

0	2017-06-14T04:21:29.000
1	2017-06-14T04:22:29.000
2	2017-06-14T04:23:29.000
3	2017-06-14T04:24:29.000
4	2017-06-14T04:25:29.000
5	2017-06-14T04:26:29.000
6	2017-06-14T04:27:29.000
7	2017-06-14T04:28:29.000
8	2017-06-14T04:29:29.000
9	2017-06-14T04:30:29.000
10	2017-06-14T04:31:29.000
11	2017-06-14T04:32:29.000
12	2017-06-14T04:33:29.000
13	2017-06-14T04:34:29.000
14	2017-06-14T04:35:29.000
15	2017-06-14T04:36:29.000

IN-4 min to STARTTRAN+24 min

MRB_2017_165_01
roll = -3.72
:29 (UTC) SOL
of 35 36 (deg)



WHAT ARE THE PROBLEMS WITH THE CURRENT APPROACH

01

TIME CONSUMING

02

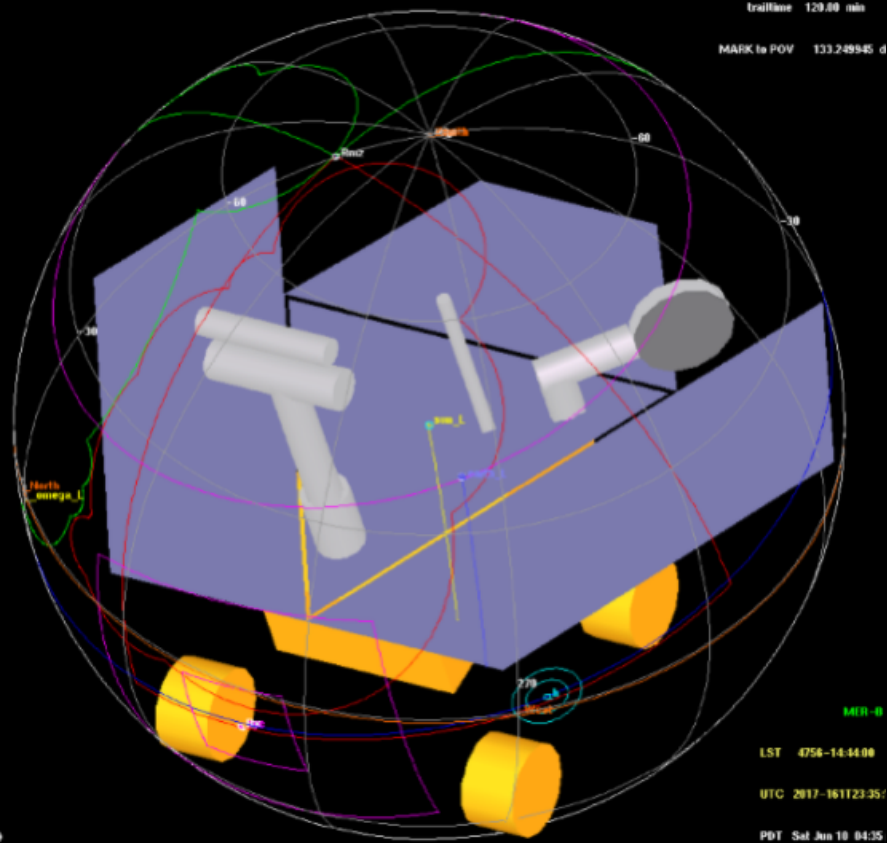
DECENTRALIZED

03

HARD TO COMMUNICATE

WHAT ARE THE PROBLEMS
WITH THE CURRENT APPROACH

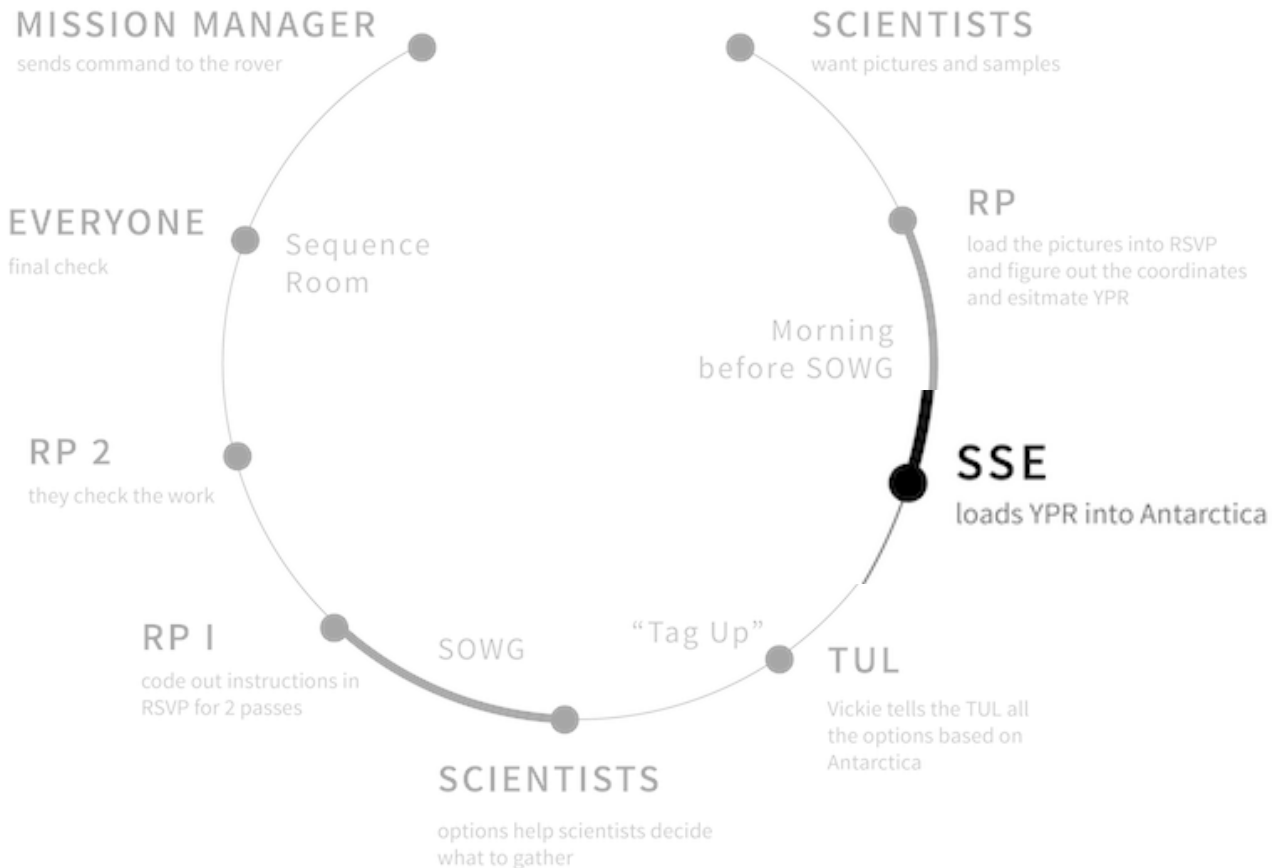
SERIOUS REPERCUSSIONS FOR MISTAKES



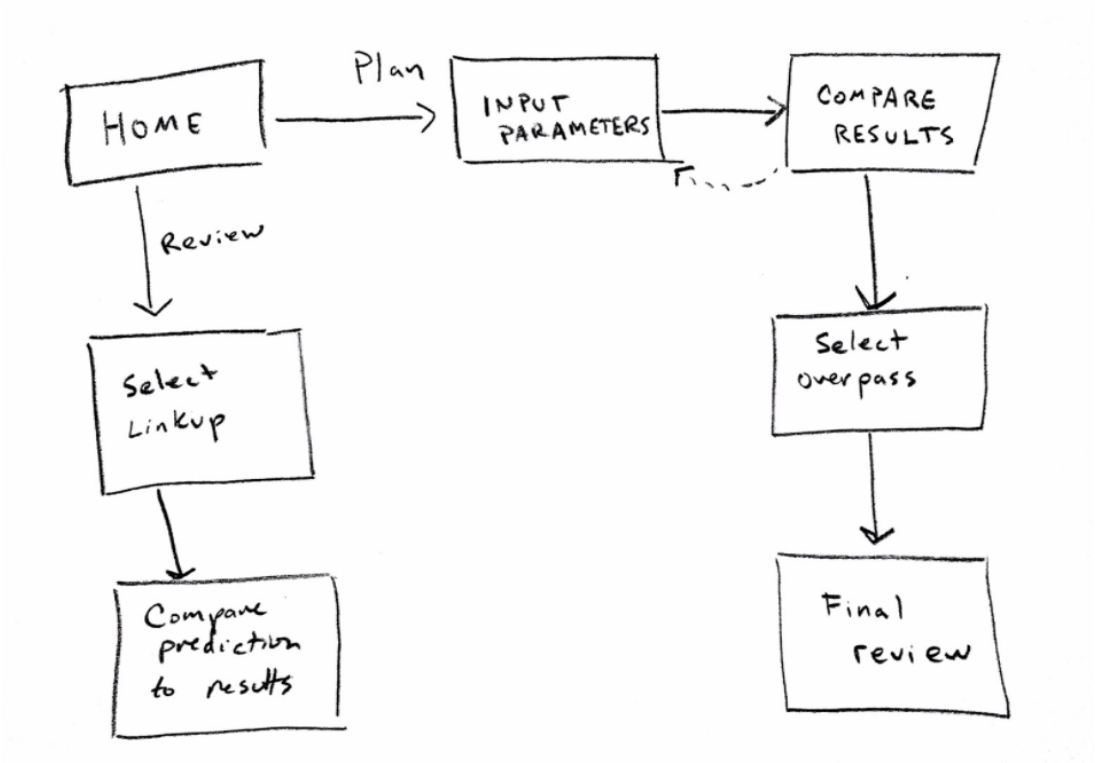
PROBLEM STATEMENT

Spacecraft Systems Engineers (SSEs) need to prediction how much data can be transferred from the rover to an overpassing satellite in order to:

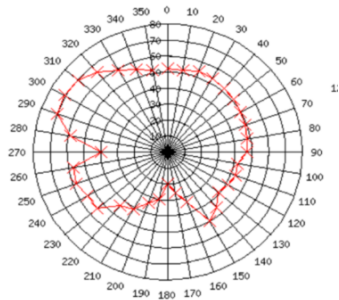
- 01 Provide scientists with an estimate of available data transfer
- 02 Recommend the heading at which a rover should end its path to achieve a high level of data transfer.



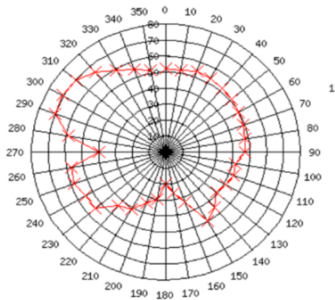
SYSTEM WORKFLOW



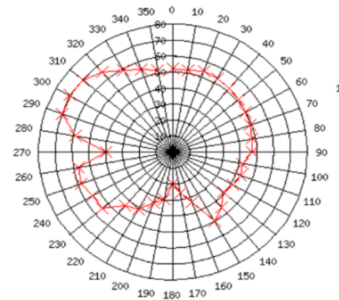
REDESIGNING THE PLOTS



GTP

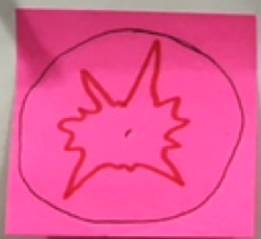


EMP

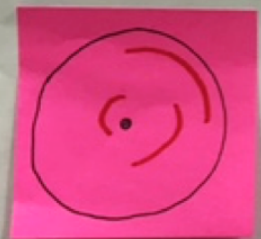


LINK
MARGIN

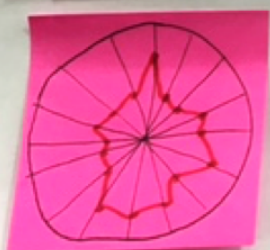
REDESIGNING THE PLOTS



Where do we get the biggest value here?
 - Spread?
 - How many pieces?
 #444444-1001



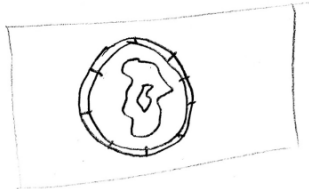
highlighting strength in a range in summary



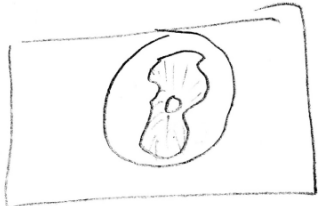
(flip book)

Small Overview Chart Ideas

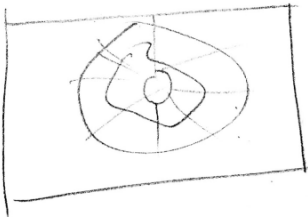
Color only around ring



Color clipped by lines



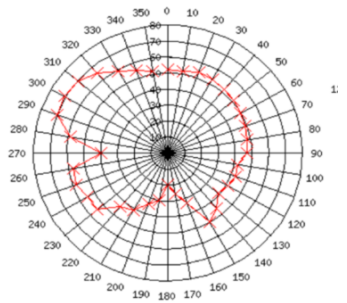
Softer coloring



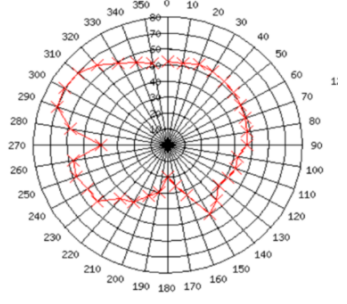
Cut out or opacity fade



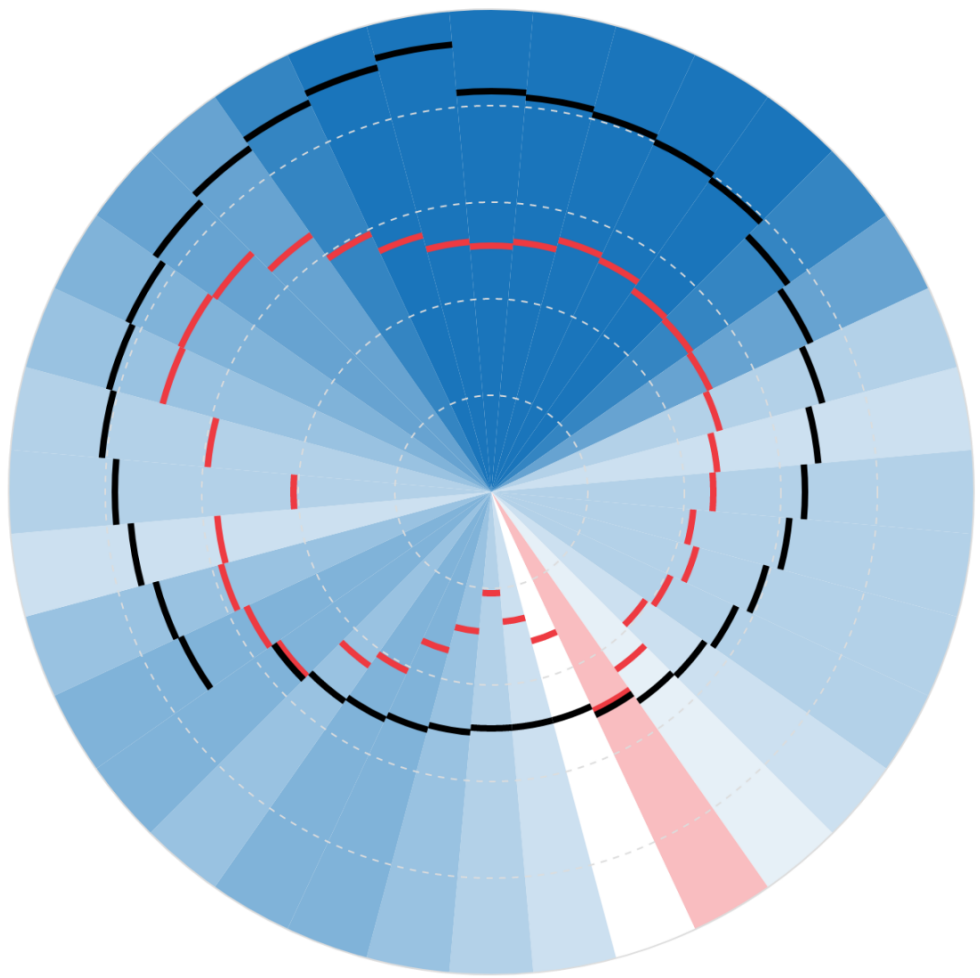
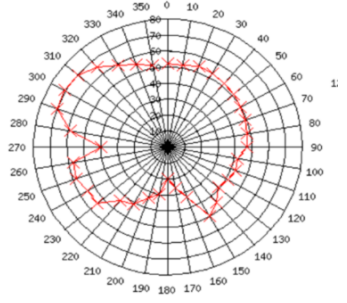
GTP



EMP



**LINK
MARGIN**





A



B



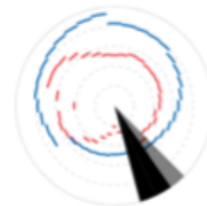
C



D



E



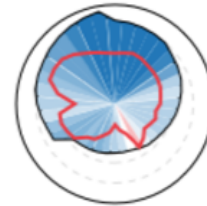
F



G



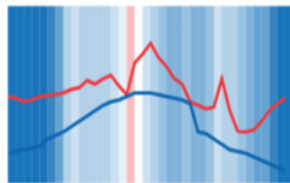
H



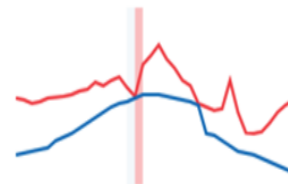
I



J



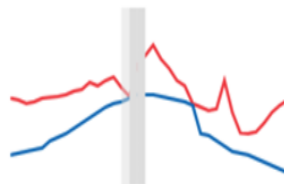
K



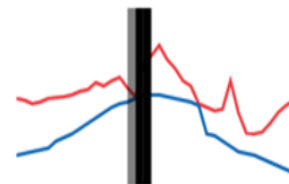
L



M

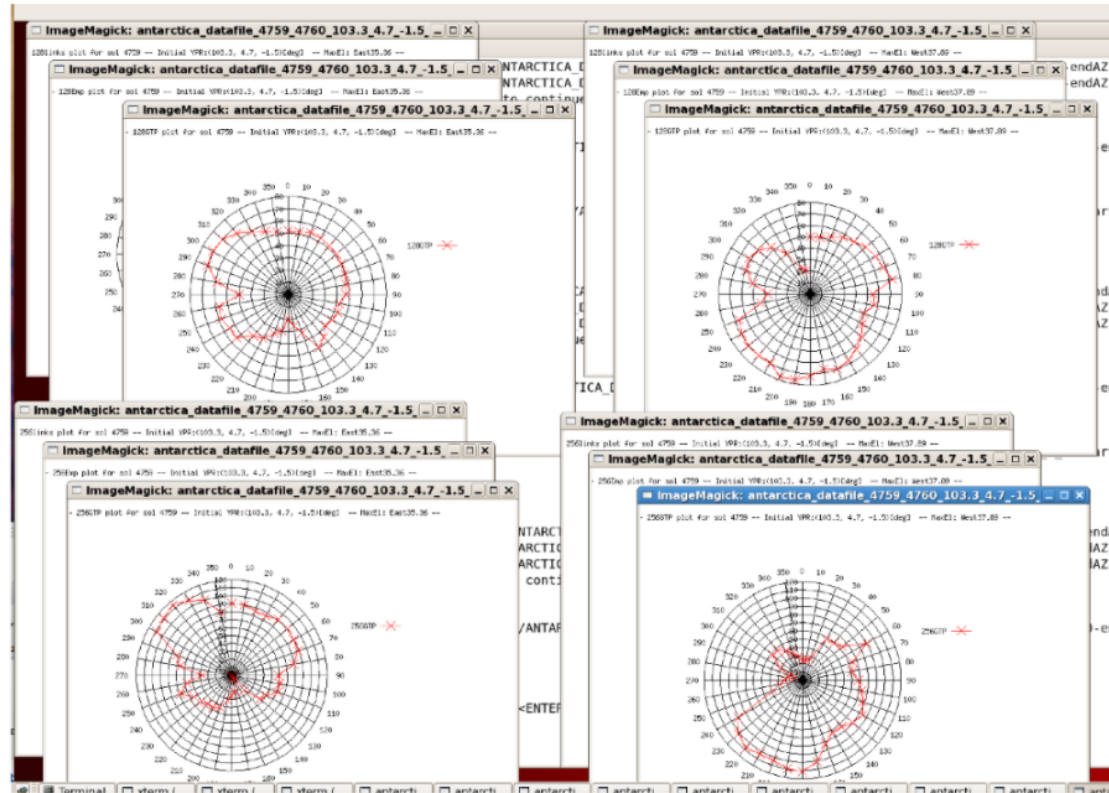


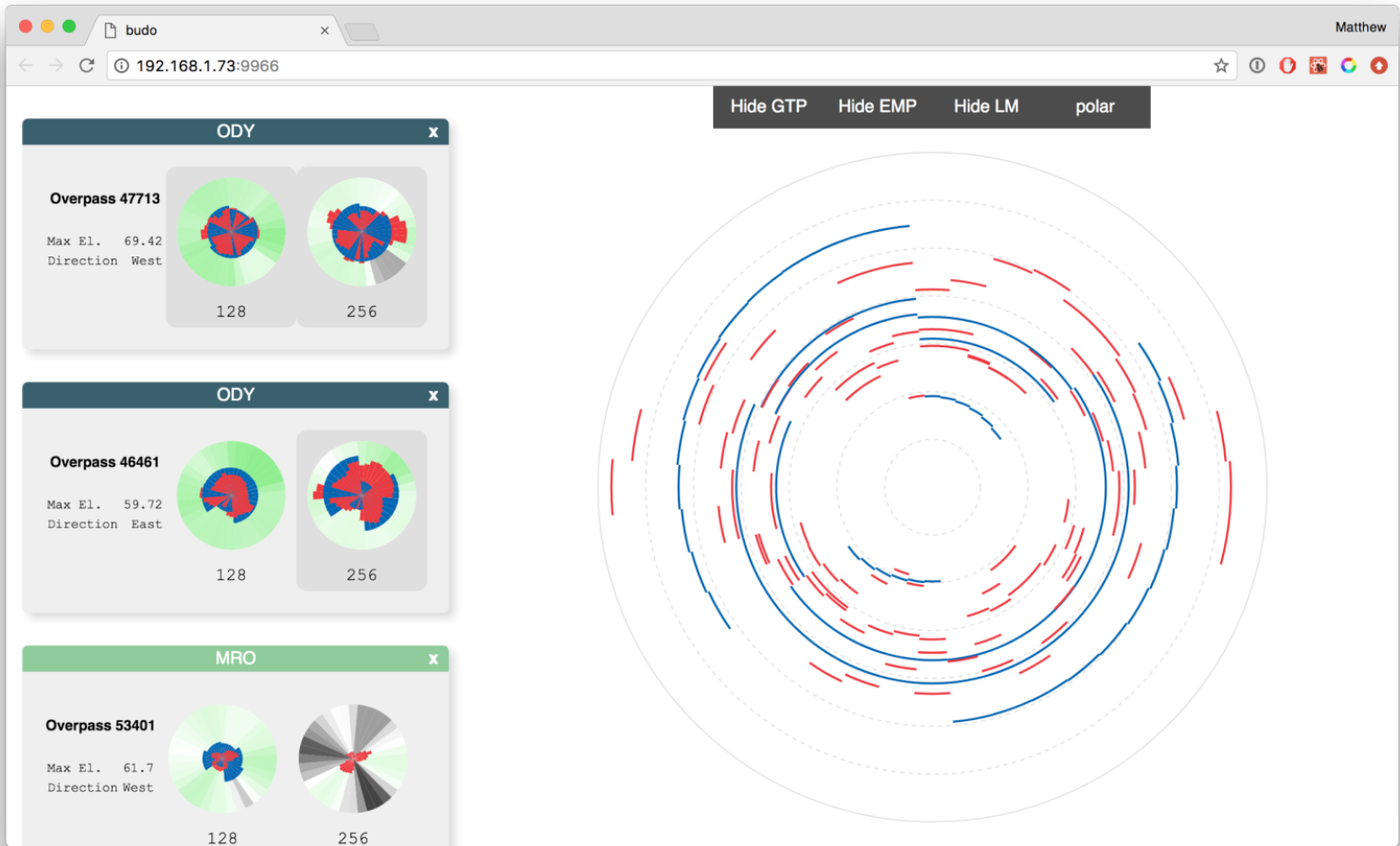
N

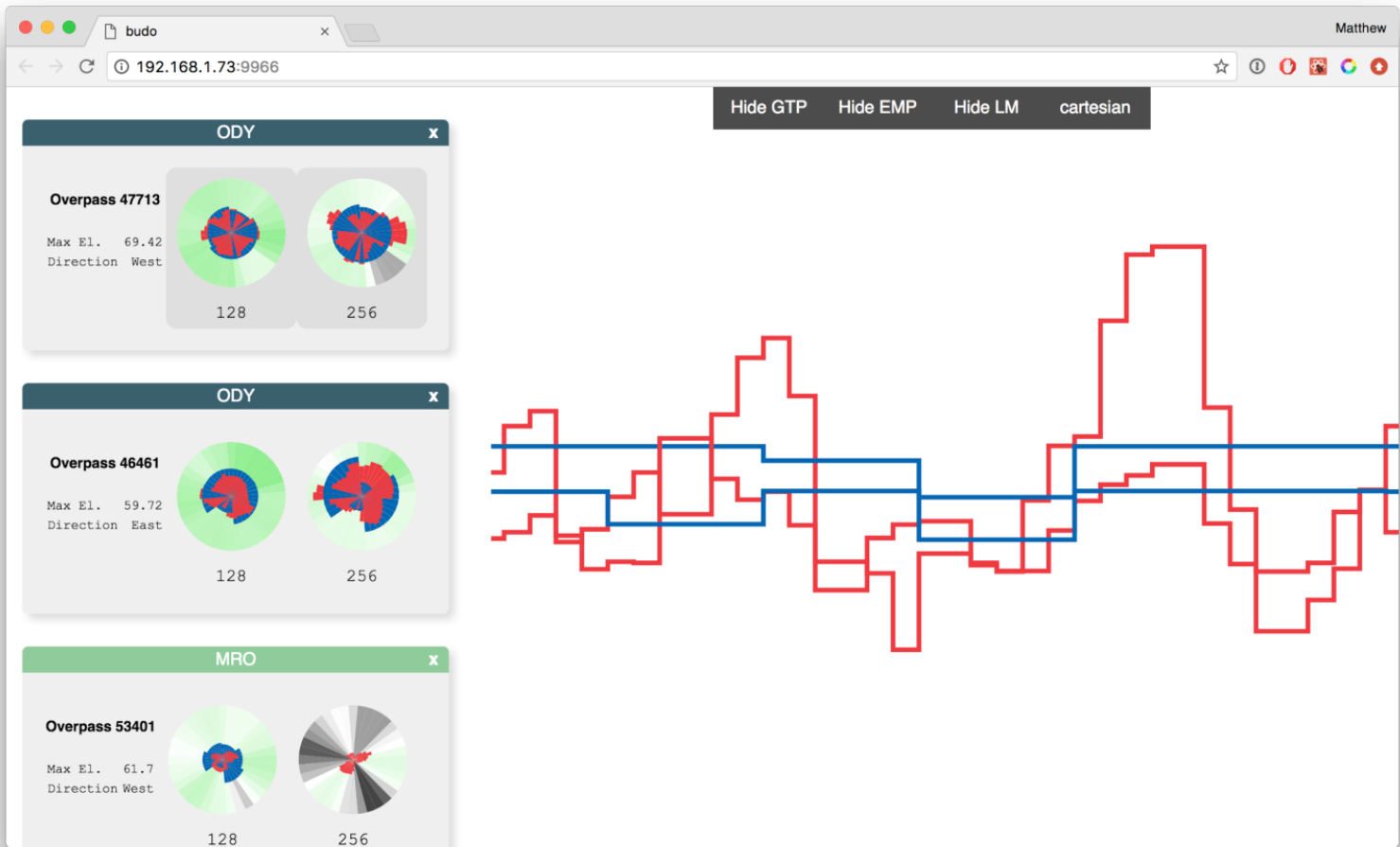


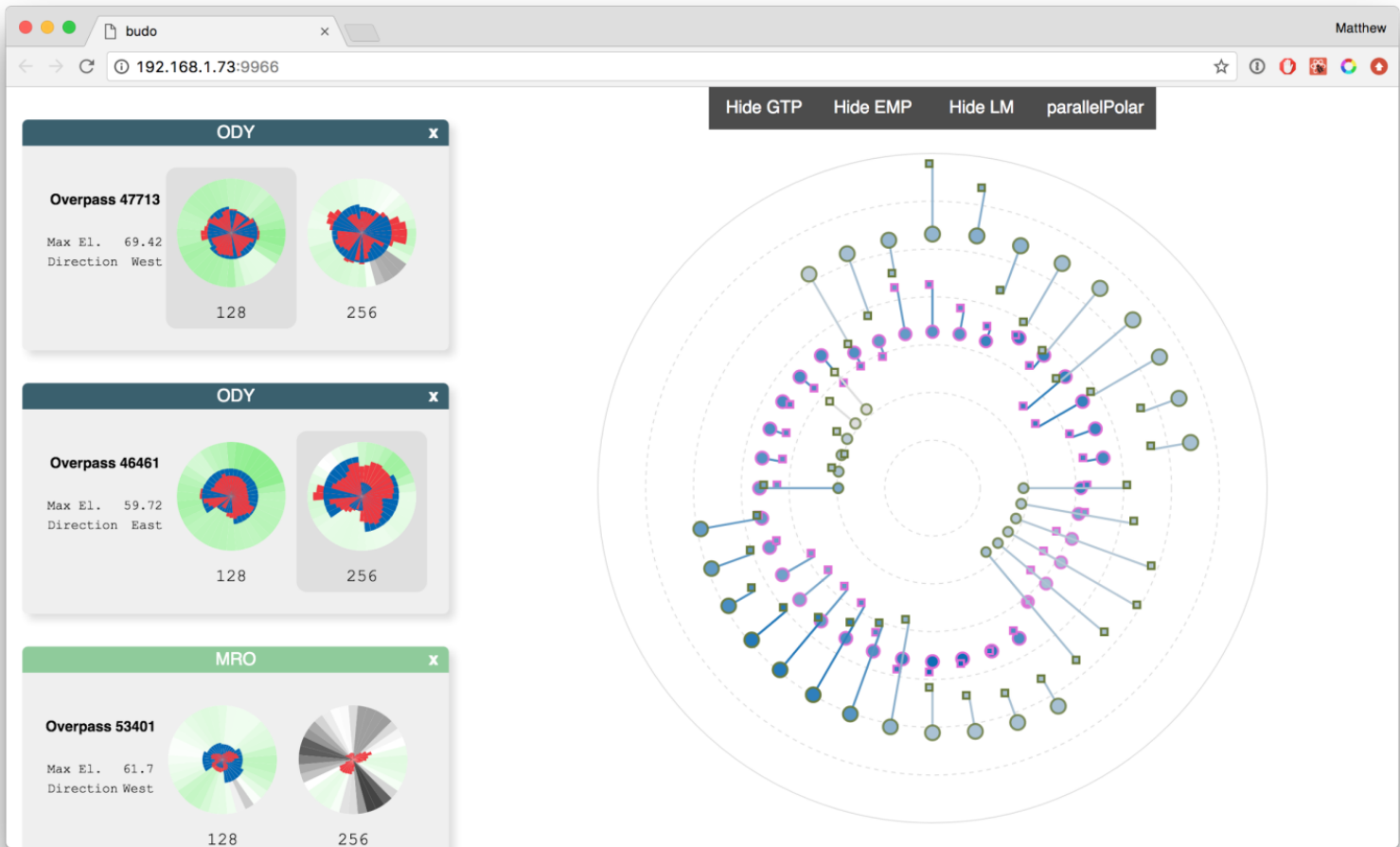
O

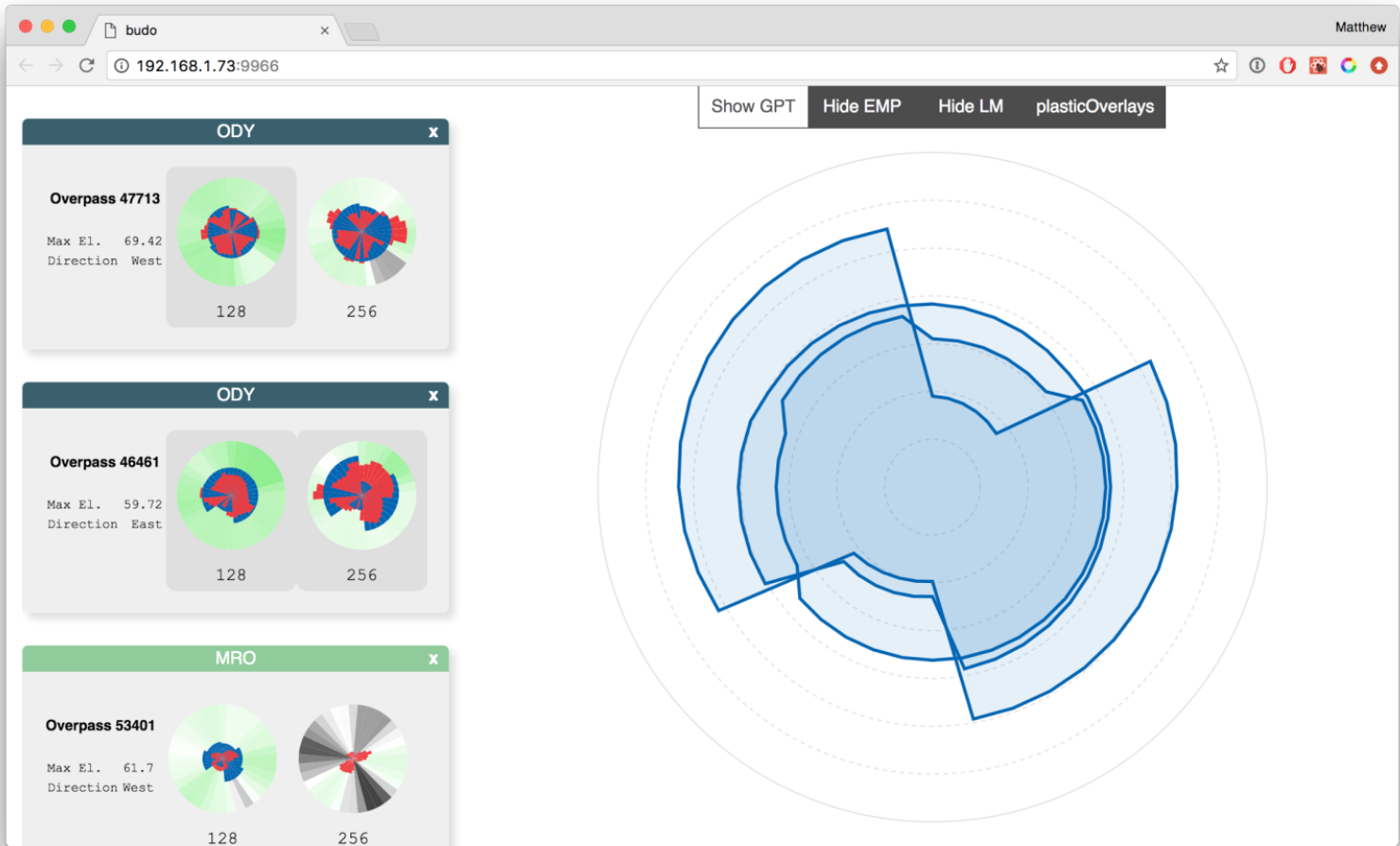
BUT, WE STILL HAVE TO WORK WITH THIS

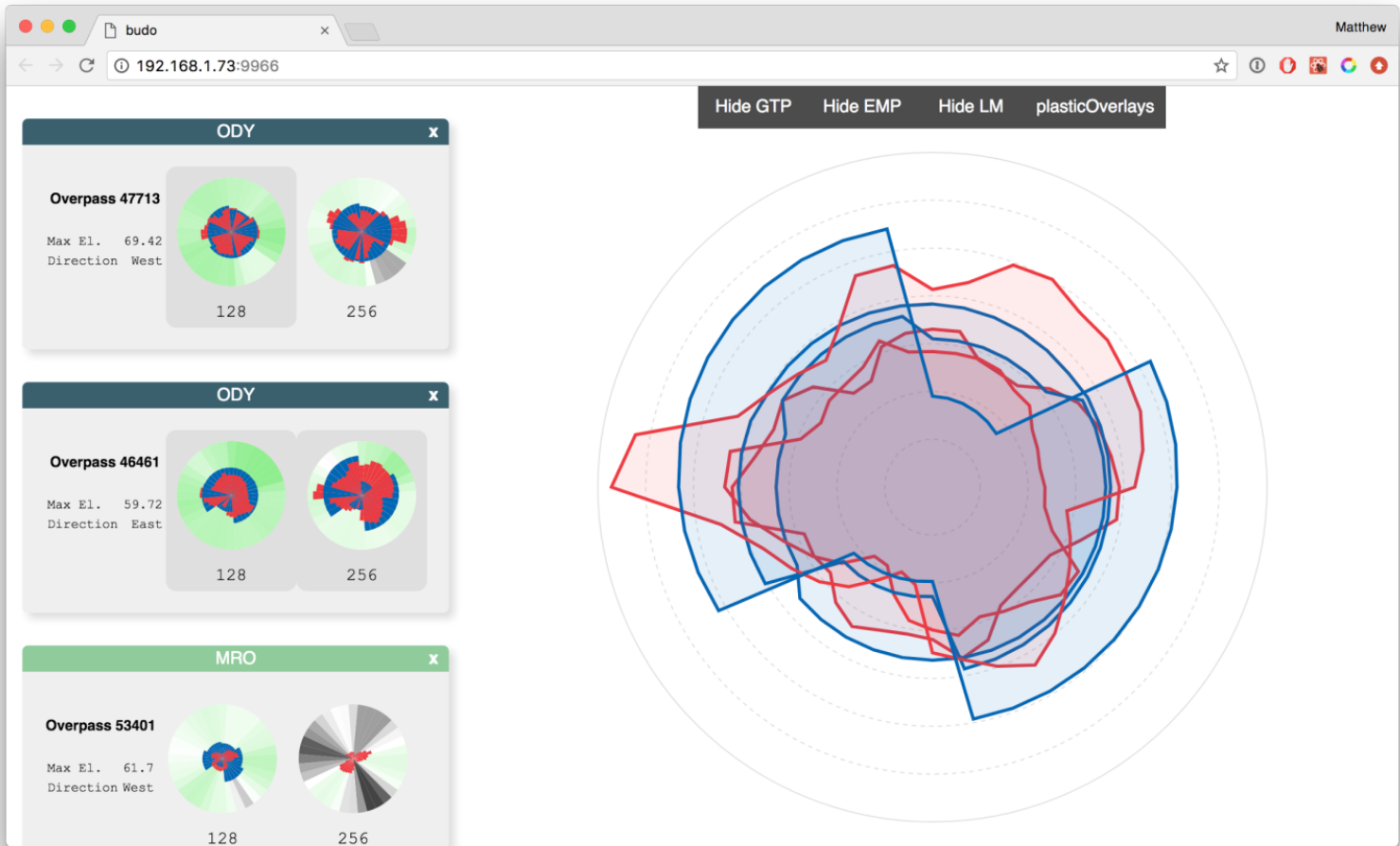


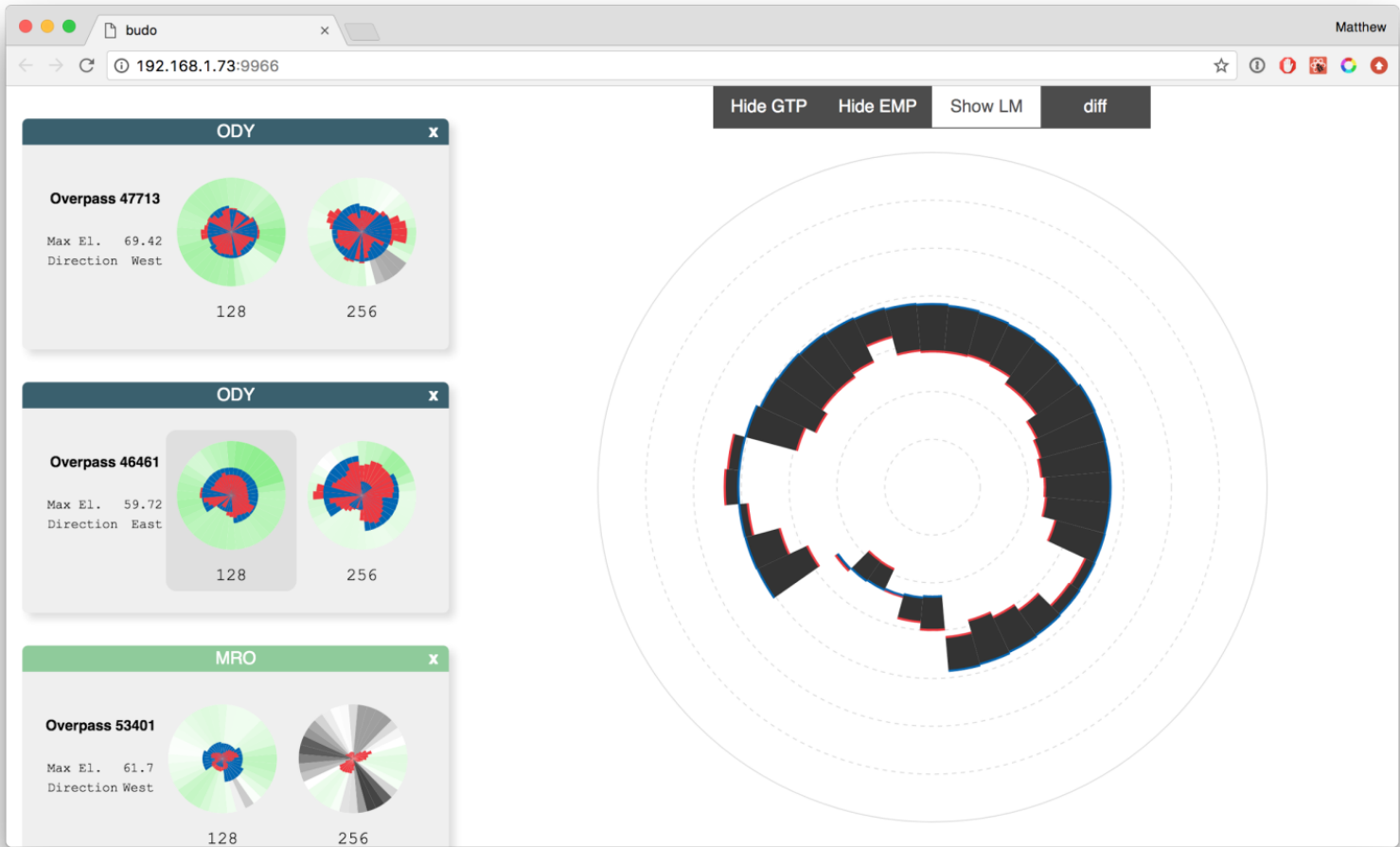


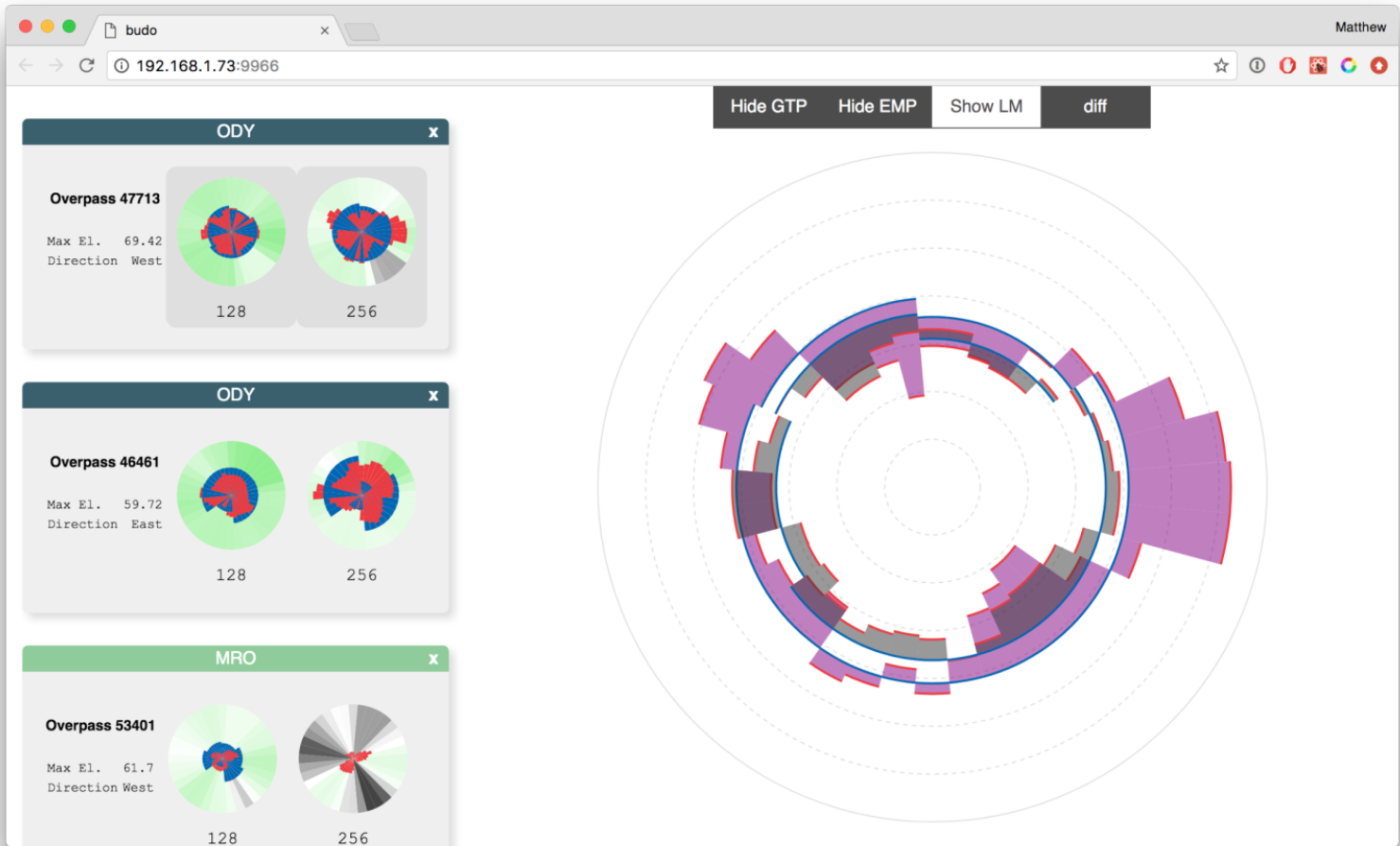


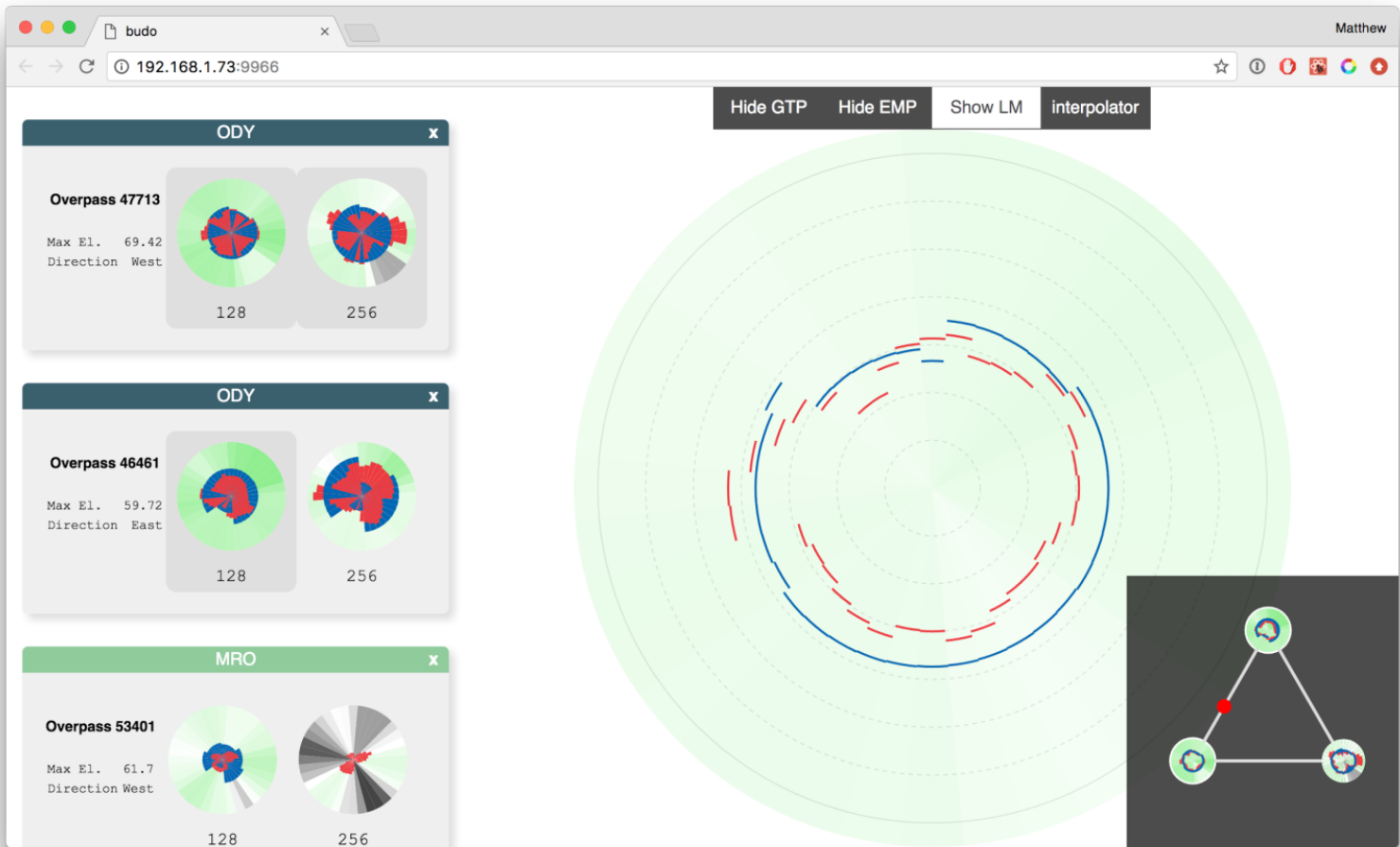












Matthew

192.168.1.73:9966

ODY x

Overpass 47713

Max El. 69.42
Direction West

128 256

ODY x

Overpass 46461

Max El. 59.72
Direction East

128 256

MRO x

Overpass 53401

Max El. 61.7
Direction West

128 256

Hide GTP Hide EMP Show LM heading

GTP

EMP

4769_4771_47713-256

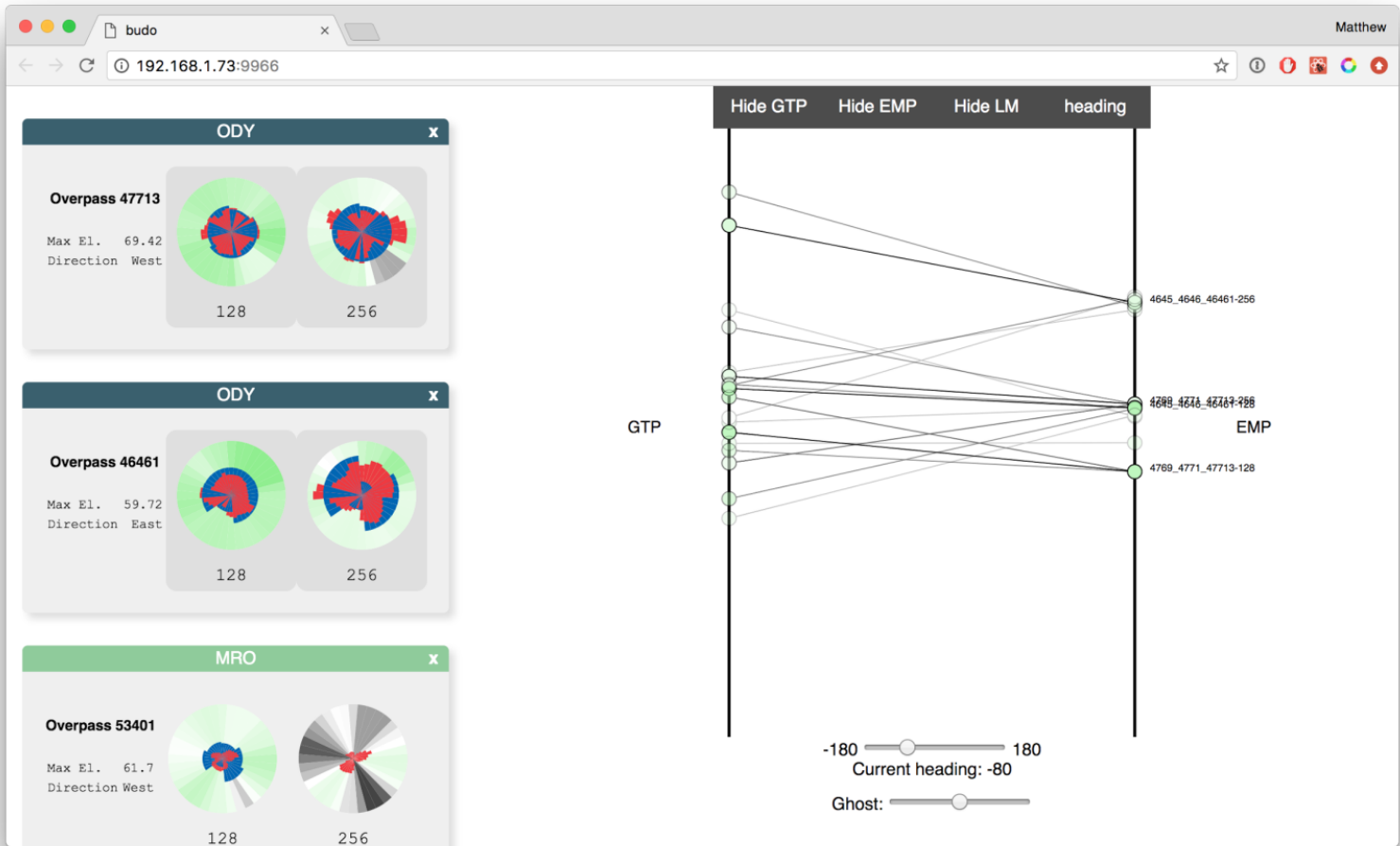
4769_4771_47713-128

4645_4646_46461-128

-180 180

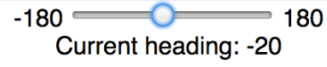
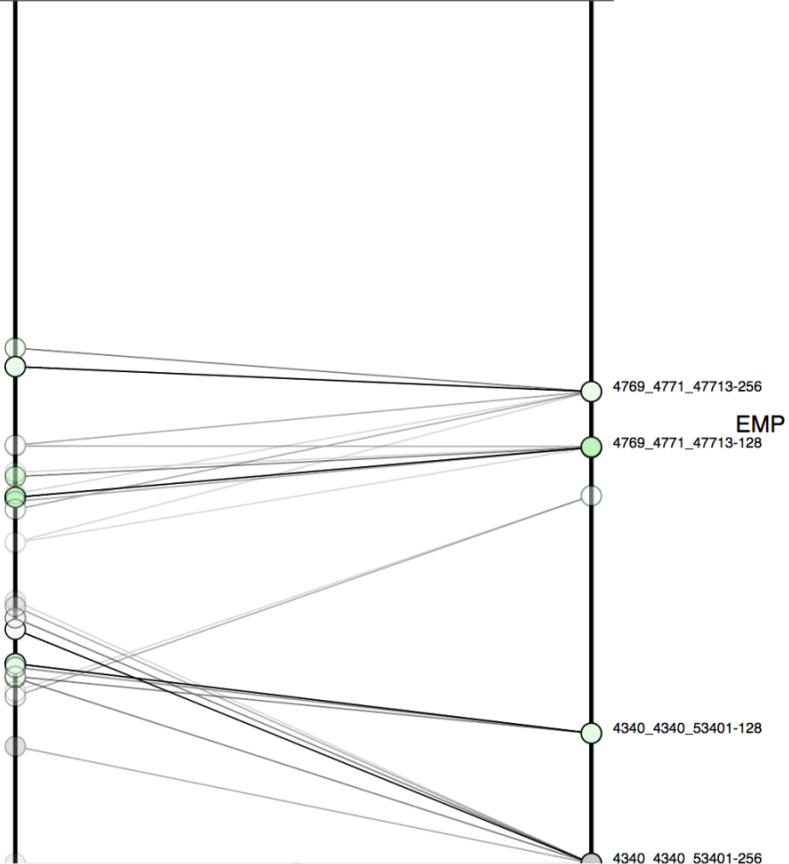
Current heading: 180

Ghost:



GTP

EMP



PAPER PROTOTYPING


Show data rates: 8 32 128 256 View: Cards Polar

Show Predictors: EMP GTP LM

ODY

Overpass A

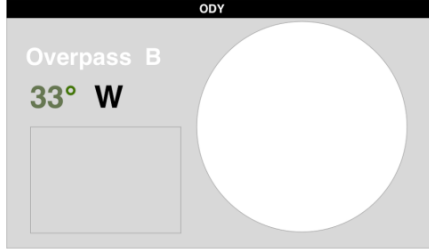
67° W



ODY

Overpass B

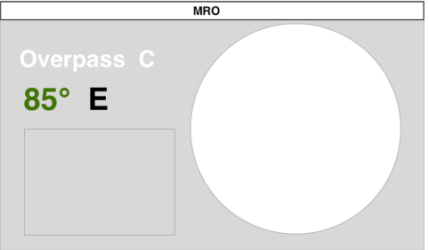
33° W



MRO

Overpass C

85° E

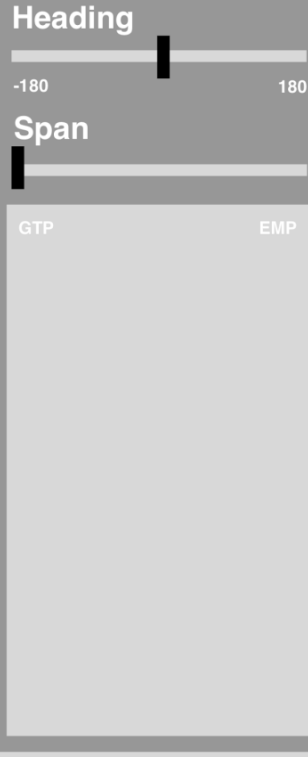


Heading

-180 180

Span

GTP EMP



Show data rates: 6 32 128 256
Show Predictors: EMP GTP LM

View: Cards Polar

Heading

Span

67° W

33° W

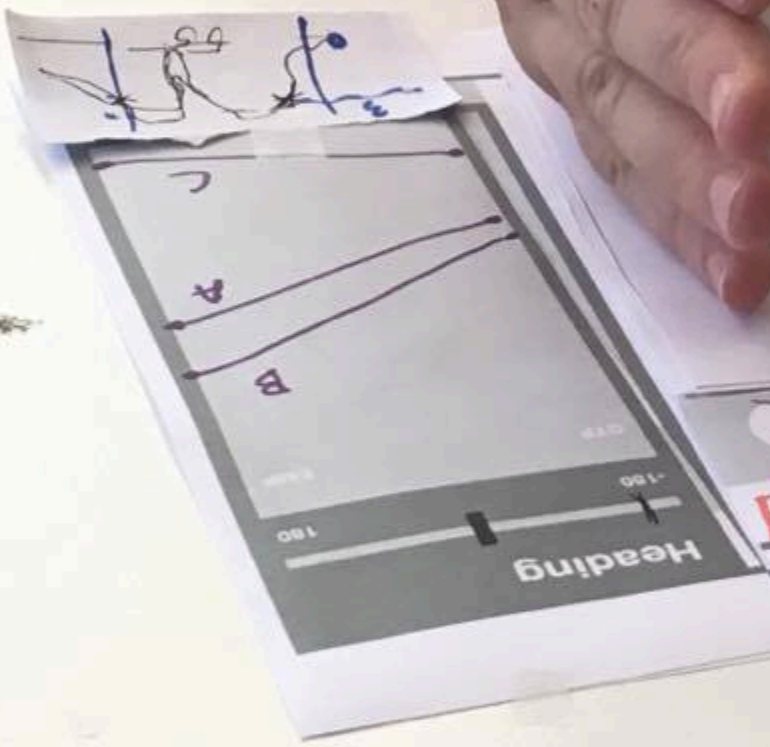
E

ome! Enter the information below to
telemetry estimates.

ading: 0

Data Rates:
Show Predict

A



View: Cards Polar

Data Rates: 8 32 128 256 LM

Show Predictors:

A

B

C





MERIDIAN

Sol Start

Sol End

Yaw

Pitch

Roll

SUBMIT

OUR SOLUTION

- 01 A centralized web interface
- 02 Organized, hierarchical info
- 03 Easy to download and send to colleagues
- 04 Plan in place to deploy with MER team

TECH

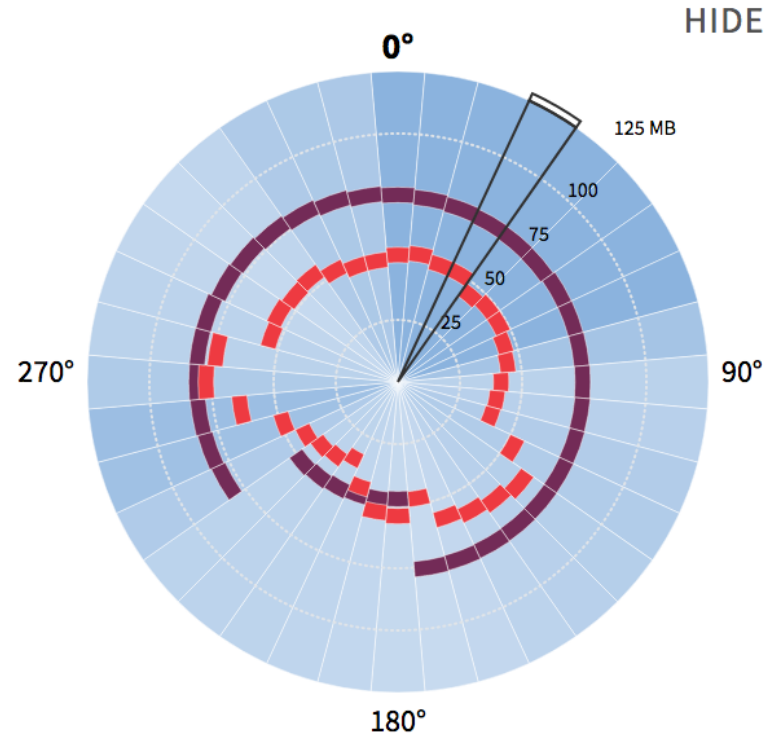
Budo development server

Flexbox for layout

D3 for scales, calculations, colors

React for state & view management

Developed reusable components



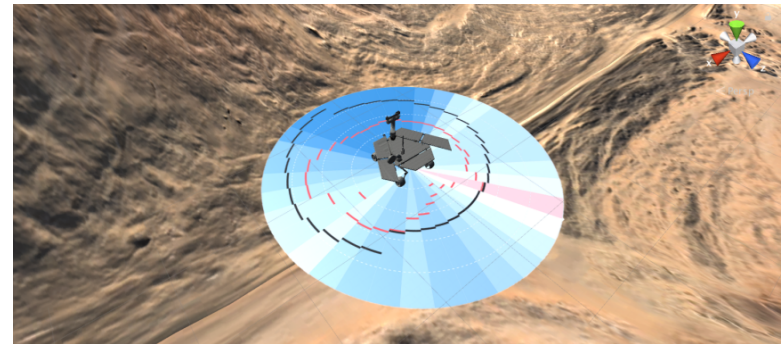
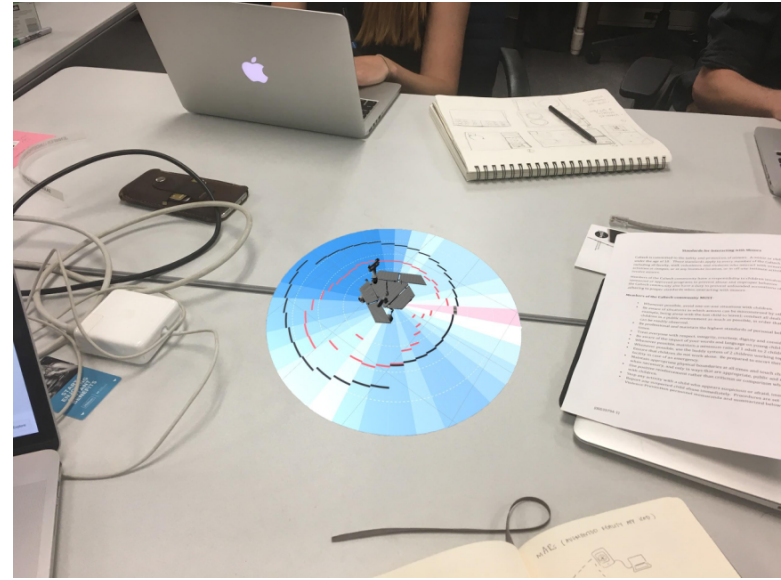
FUTURE WORK

Integration into other systems *Quill, 2020, etc*

Integration of the rover itself in terrain mask

Mobile

3D environment



THANK YOU

Matthew Conlen
Chelly Jin
Sara Stalla

PI
Vickie Scarffe-Barrett

Mentors
Scott Davidoff
Maggie Hendrie
Santiago Lombeyda
Hillary Mushkin

Students
Fred Hohman
Beatrice Jin

