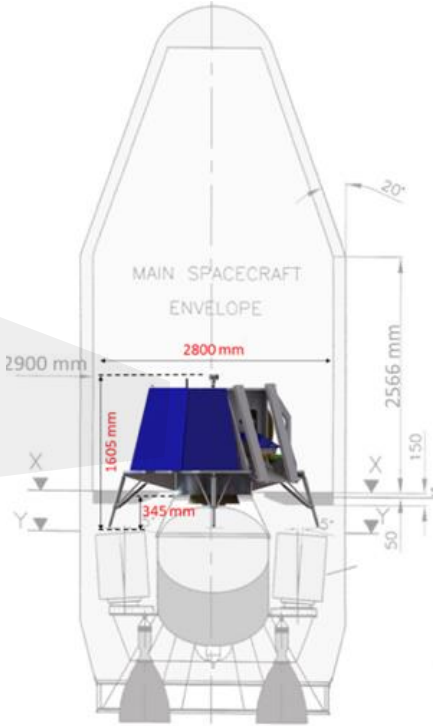

Architecting a New India
One Moonshot at a time!


TeamIndus is flying a privately funded
Spacecraft to the Moon in Dec 2017.
Only American, Russian and Chinese Space agencies have landed on the Moon.
#HarIndianKaMoonshot @TeamIndus

TEAM INDUS MOONSHOT

$1M Prize winner
100 person team
Launch Dec-2017

Global partners
ISRO, CNES,
GLXP, HKT, LASP

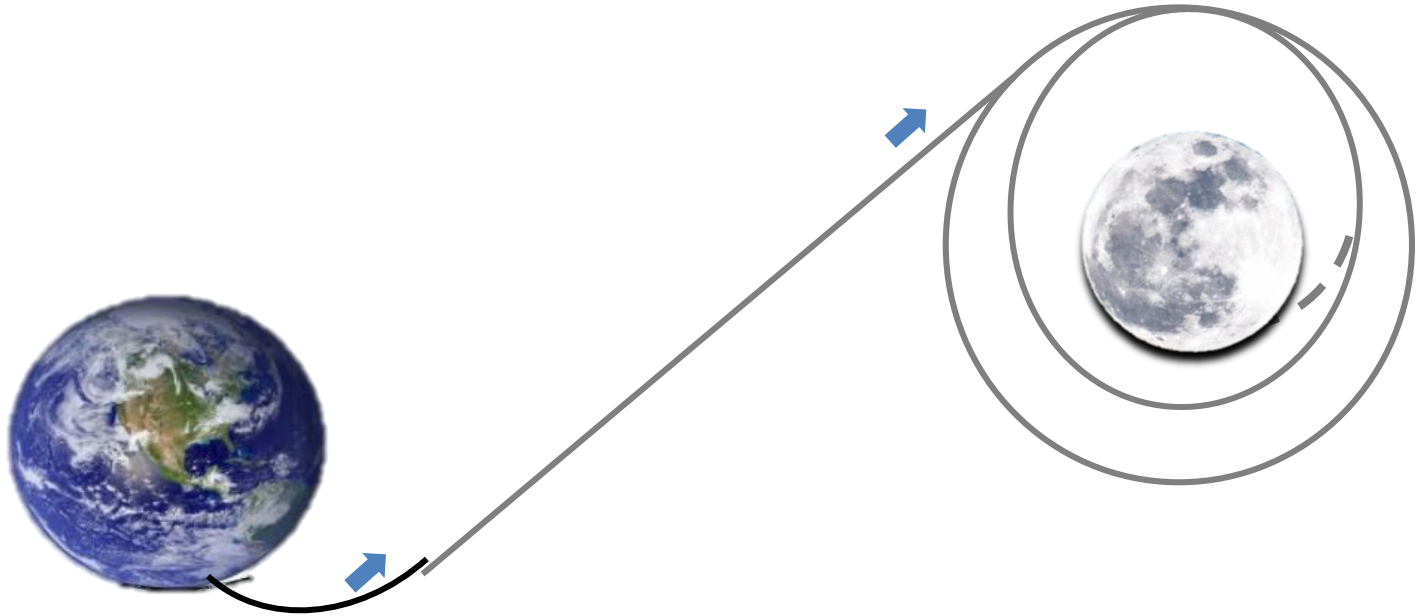


TeamIndus ECA rover / 6kg
4-wheel, semi-autonomous
All aluminum, all terrain

TeamIndus Spacecraft / 600kg liftoff
4-legged, autonomous soft landing
20kg payload, 3-axis stabilized, 1Mbps

ISRO-PSLV XL / Dedicated launch
Puts Spacecraft in 70,000km Earth orbit
Launches from SHAR, India

Engineering artefacts



2-Earth bound orbits
Optimal Earth-Moon trajectory

28-day time of flight
Lunar Transfer Trajectory

Lunar orbit capture
4-Lunar orbits

14-day Surface Ops
Site: Mare Imbrium

Earth to Moon flight path

Why do we do modeling and simulation?

To get a better understanding of the system's:

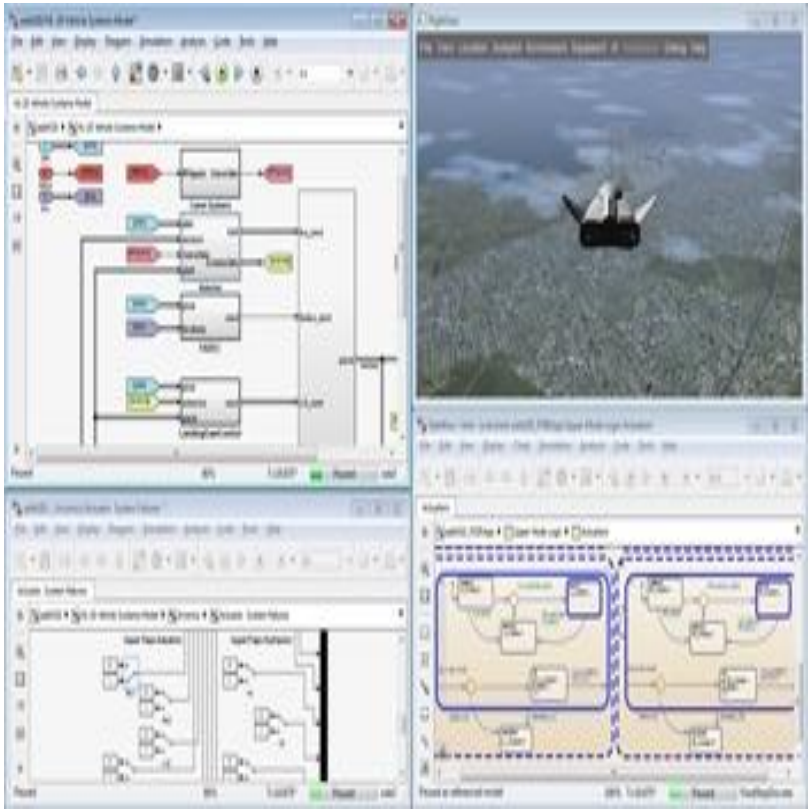
- Structure and interface connections
- Robustness to environmental conditions
- Response to user input

And why is that important?

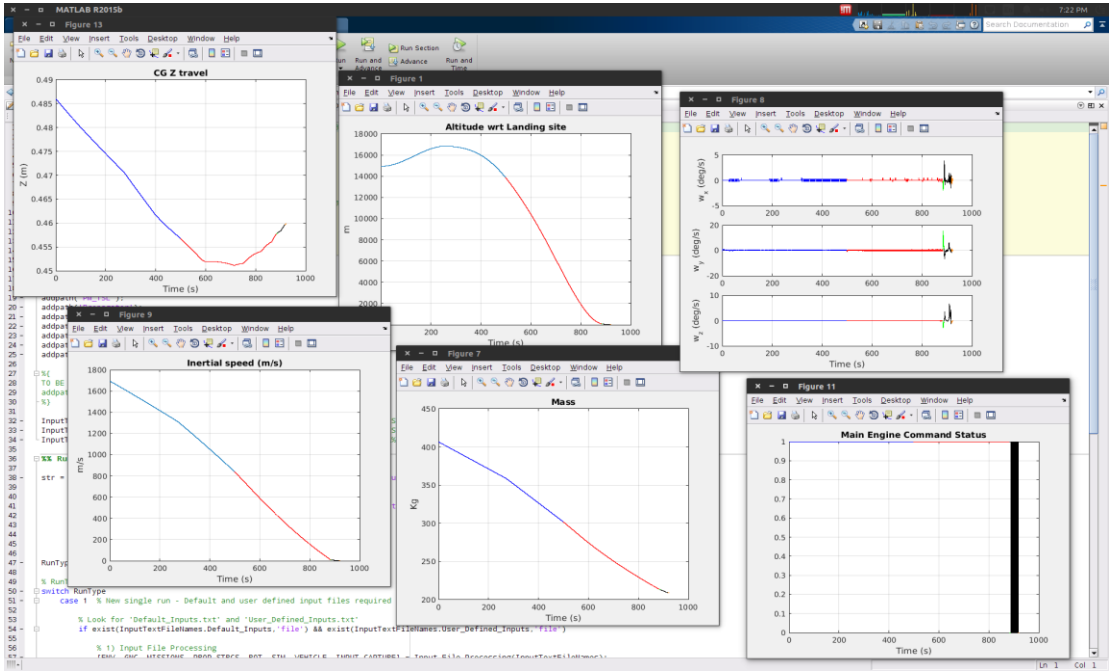
- Find and fix bugs early
- Test system under conditions difficult to replicate in the real world

And why is that important?

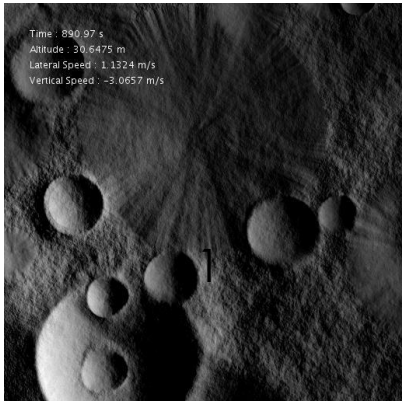
- Because early testing and fixing bugs early saves a lot of money down the road

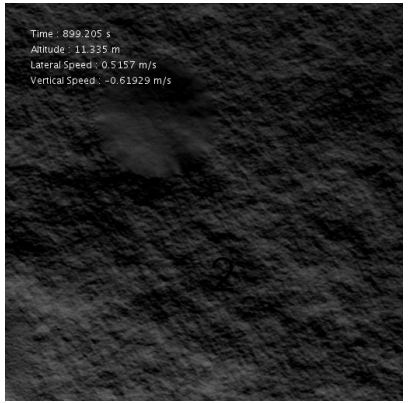


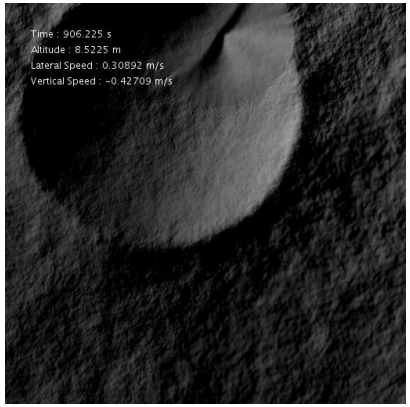
Source: www.mathworks.in



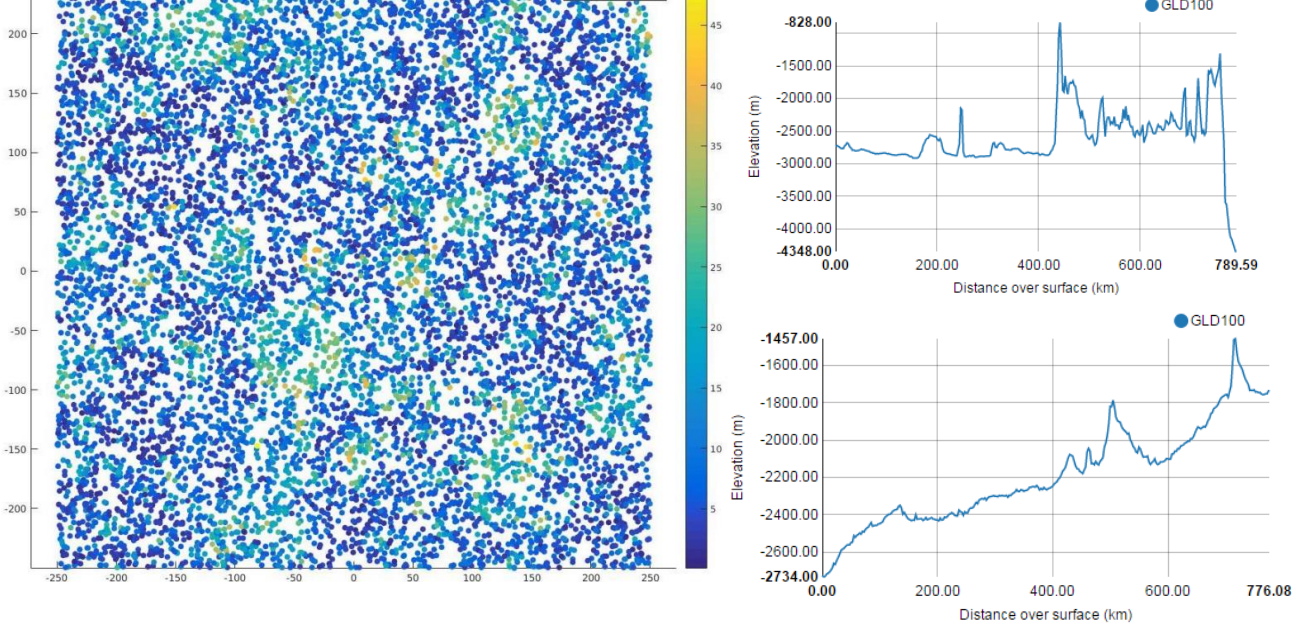
- Autonomous descent is at the core of our mission
- Information round trip is 1 sec, not allowing control from earth
- It is the riskiest part of the mission, but lasts only 15 mins
- Virtual test naturally lead to HILS

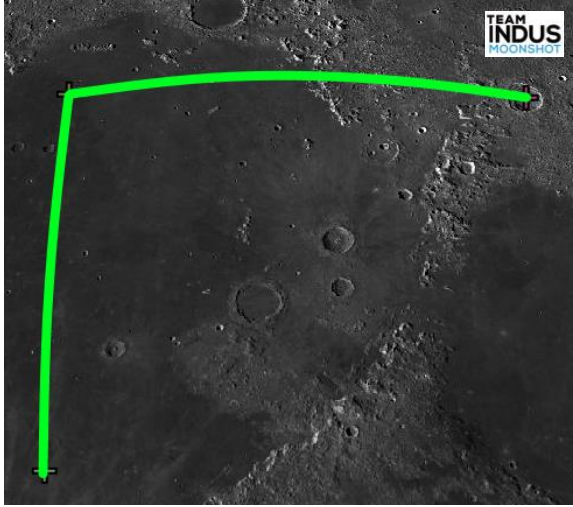




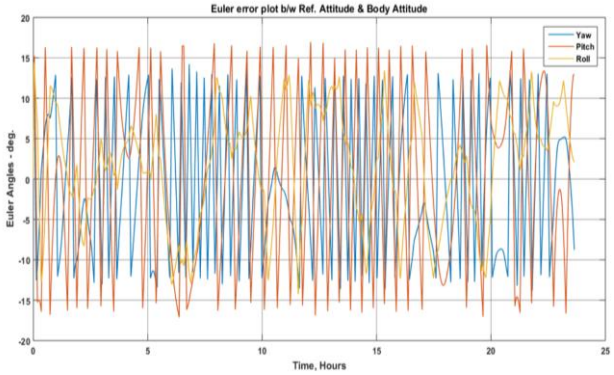


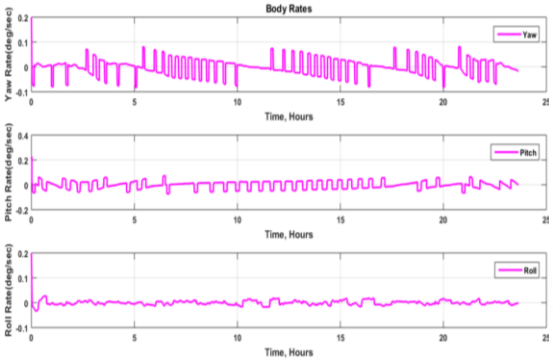
- Detailed images of Lunar surface or terrain model not available
- Using low resolution data we create statistically representative samples of lunar terrain
- Used for visual velocity estimation and hazard avoidance done using these models

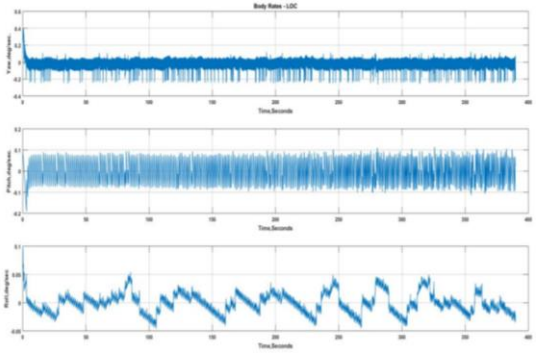




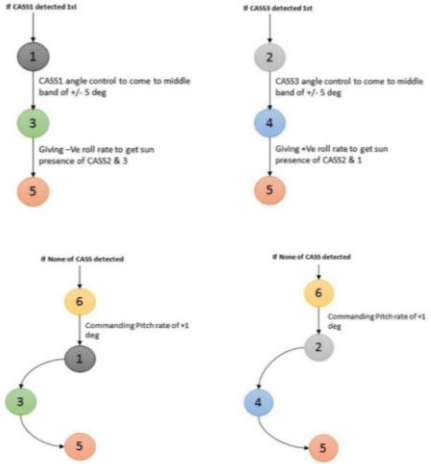
- Computer vision enables us to take autonomous decision
- Multiple approaches to the same & different safe landing spots are tried in the simulation
- Multiple devices were simulated to arrive at the autonomous control strategy
- Code and executable generation from Simulink model allowed us to do large scale simulation on a cloud platform







- Hybrid control during orbital phase
- Autonomy in power generation
- Autonomy in orbital maneuvers
- Human control weaved in to the strategy to gain from experts knowledge base as well



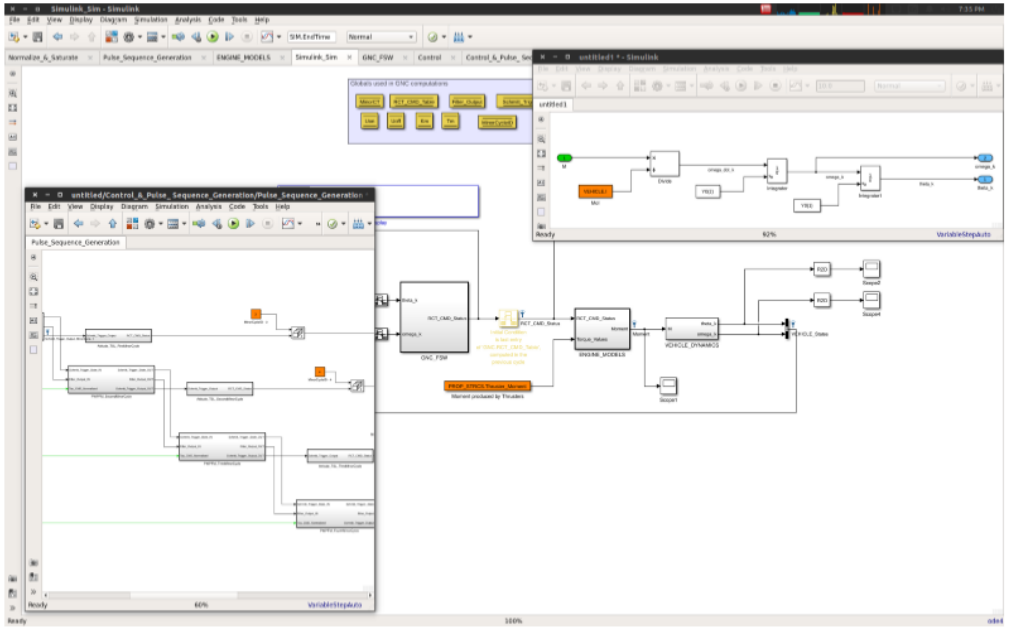
Safe Mode

Challenges

- At the start, team very strong with maths and physics, but weak with software engineering
- Team able to come up to speed in less then a year
- No or limited access to models

Addressing Challenges using Simulink

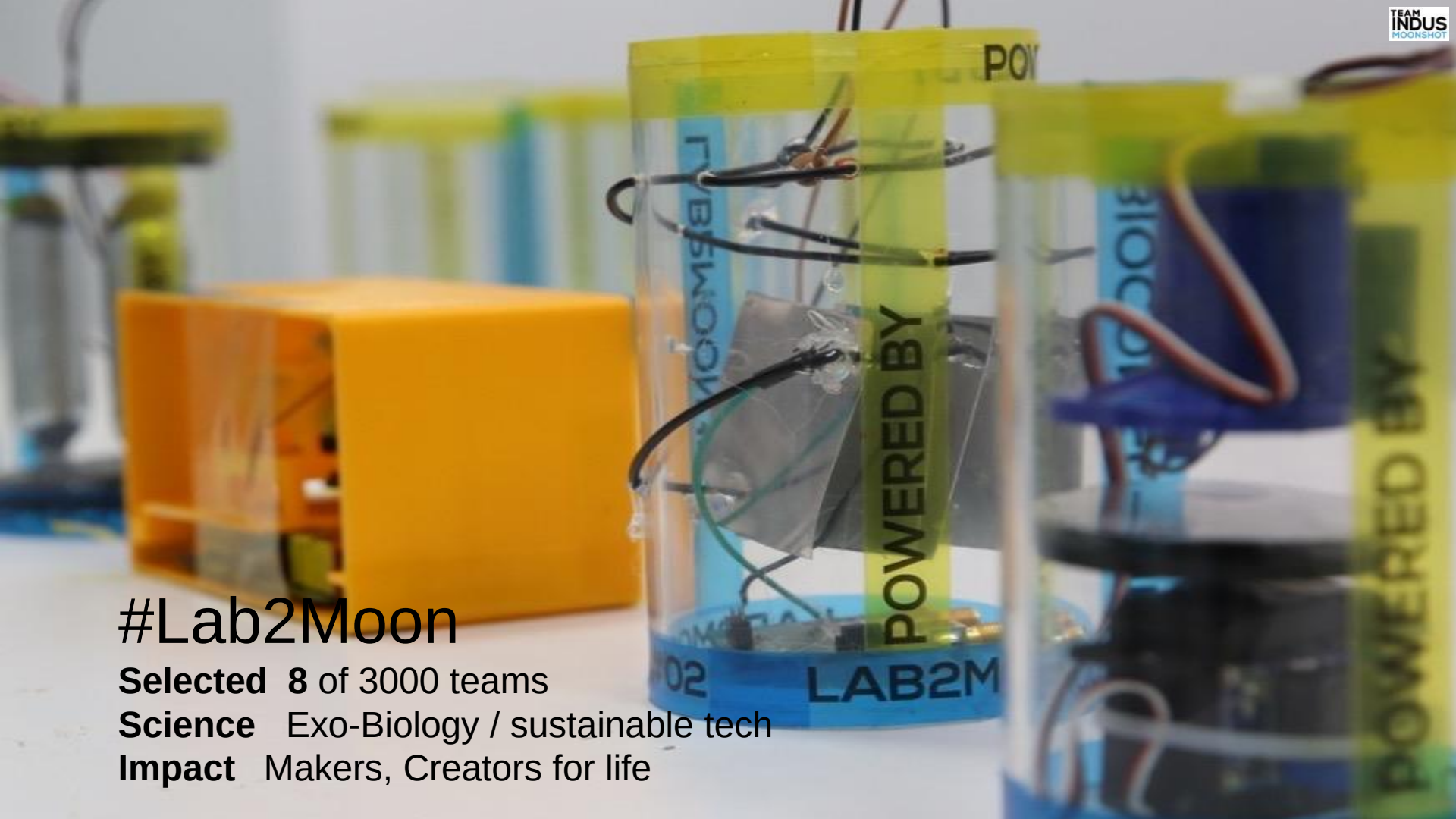
- Simulink helped us on all these fronts
- Profiler very helpful in optimizing execution time
- Model referencing helped us plug and play devices into strategy
- Model advisor a good tool to identify problems



What more would we like to see in Simulink

- Better debugging support. Breakpoints, value inspection could be better
- Help and tutorial should be from POV of the novice engineer. Lots of tutorial available
- IDE for all boards not available
- Version mgmt tools could be better. Checking diffs could be improved
- More visibility into built in functions.
- Terrain generation in Simulink?


Har Indian Ka
MOONSHOT



#Lab2Moon

Selected **8** of 3000 teams

Science Exo-Biology / sustainable tech

Impact Makers, Creators for life

Moonshot Crew

ATTRIBUTION
Crew tags, Name on Spacecraft

EXPERIENCES
5000 crew experiences to be won

COLLATERAL
Crew Merchandize


Sign up for the journey
TeamIndus Moon mission
#HarIndianKaMoonshot