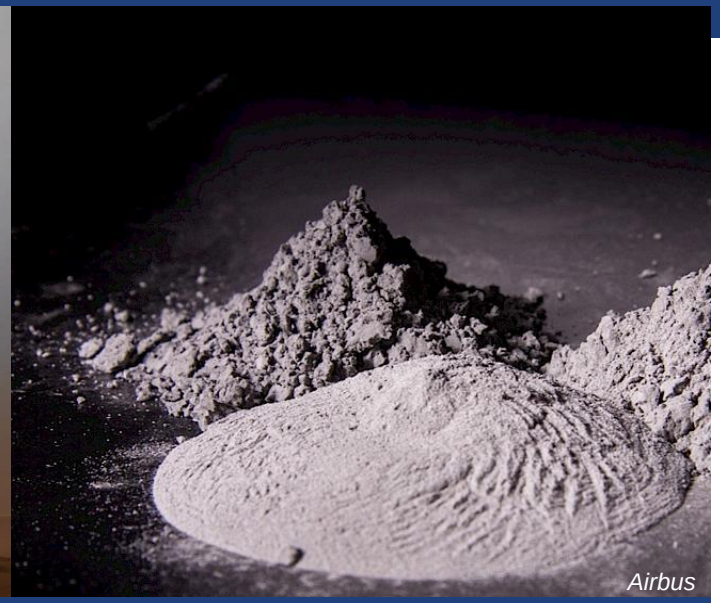

NASA/JPL-Caltech/University of Arizona


Airbus

Study on a robotic arm for sampling lunar regolith

Jonas Bohn

Studies on Mechatronics, Final presentation

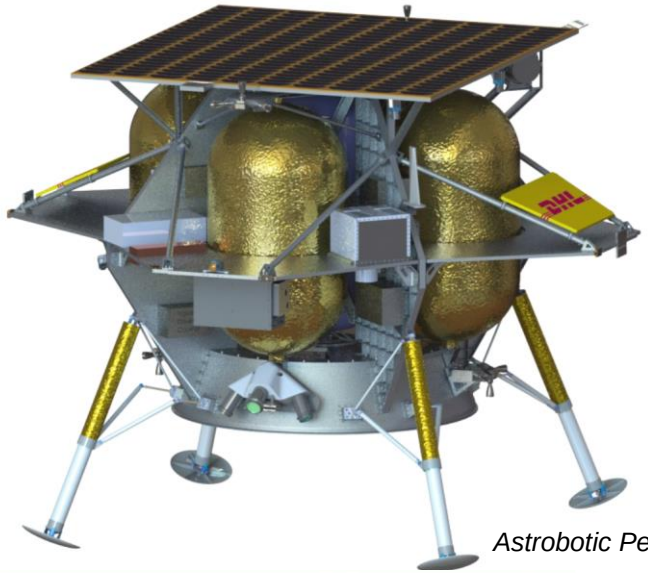
Robotic Systems Lab, ETH Zurich

06/07/2020

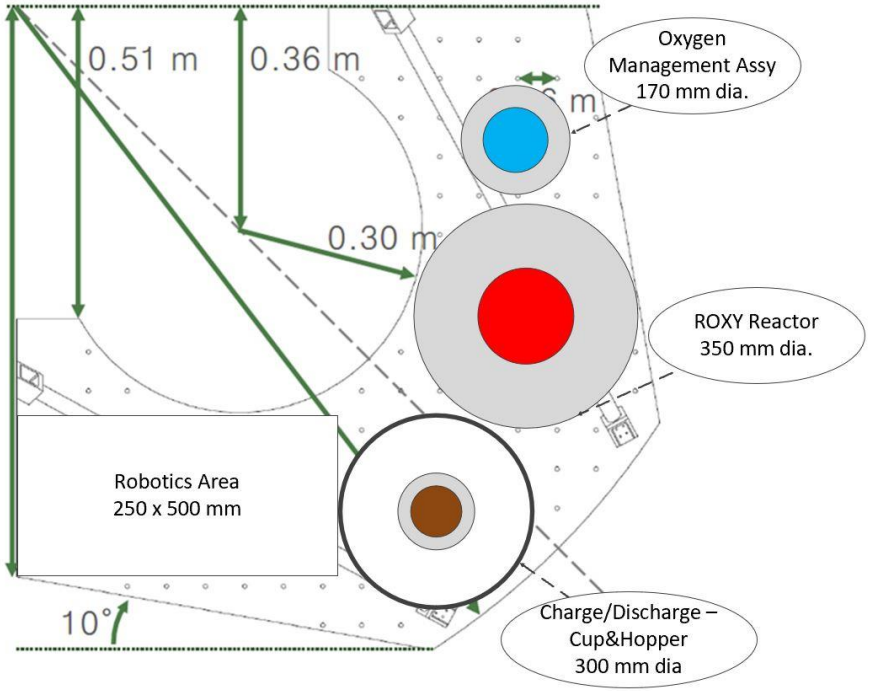
Supervisor: Hendrik Kolvenbach, Prof. Dr. Hutter

Introduction – Problem Description

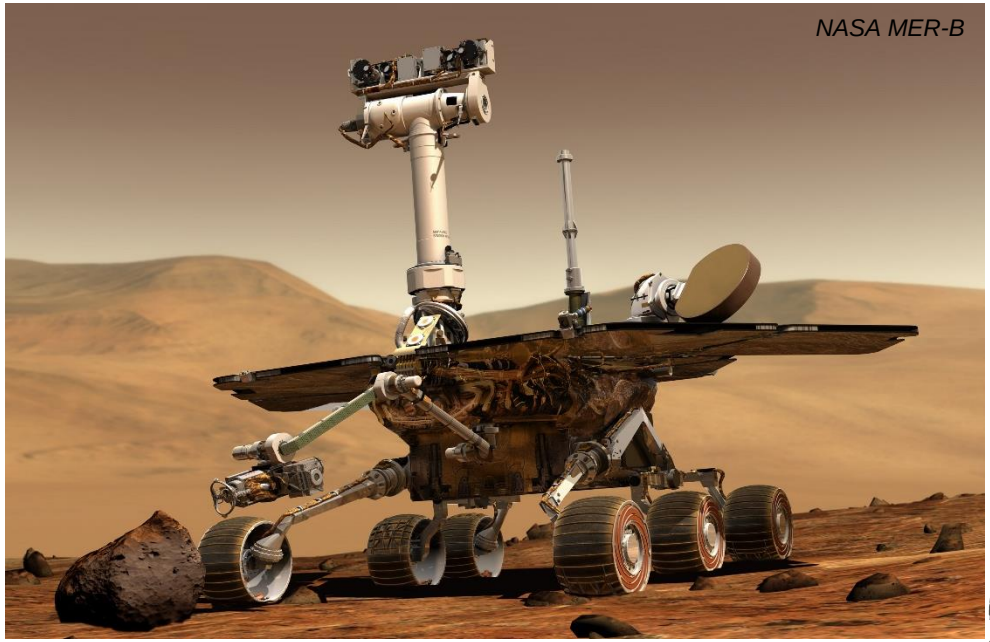
- In-Situ Resource Utilization
- Astrobotic Peregrine Lander
- Compact and lightweight robotic system
- Sample and transport lunar regolith into reactor
- Perform manipulations on components



Astrobotic Peregrine

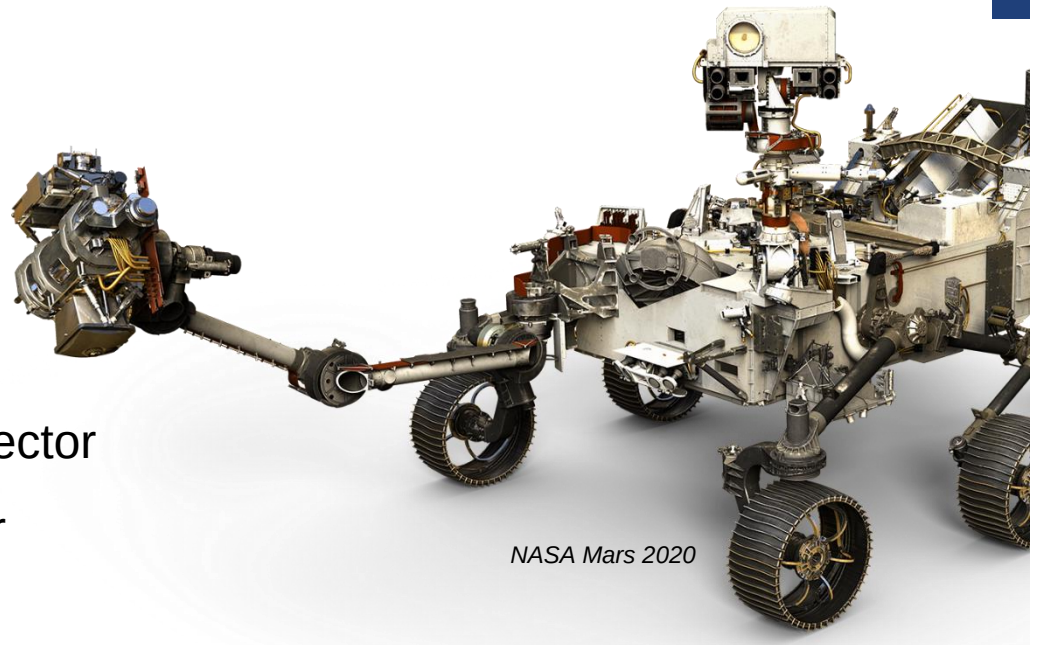


Research – Rover Missions



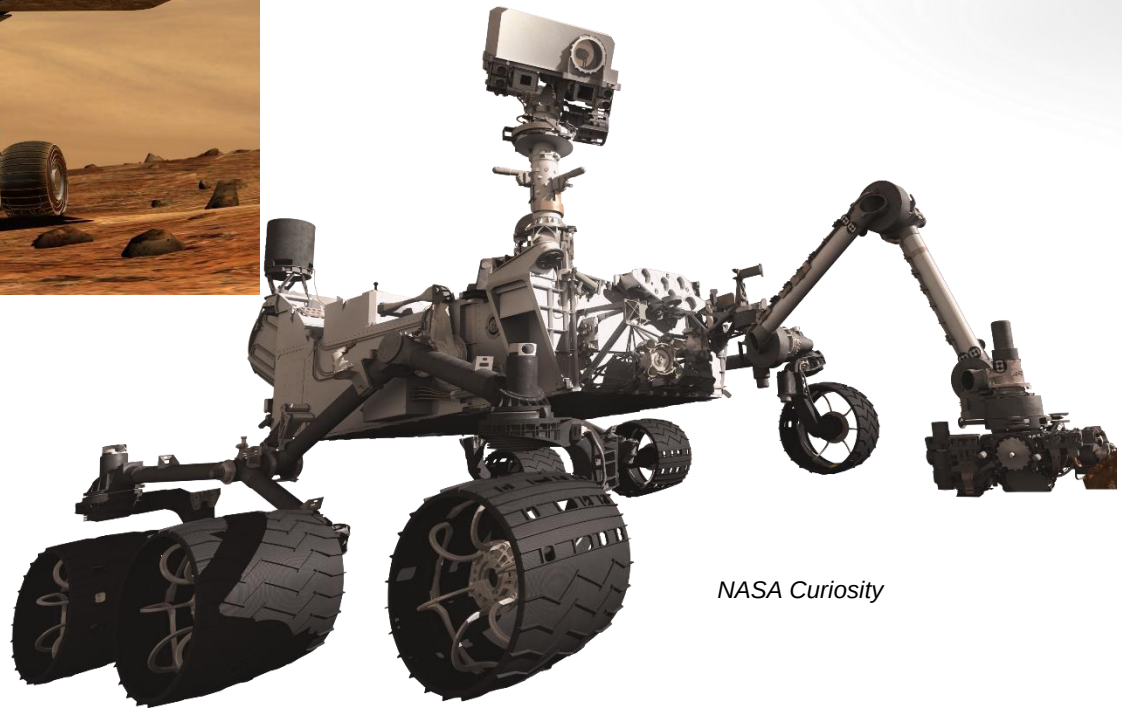
NASA MER-B

- 5 DOF
- 0.9 m arm length
- 4.4 kg robotic arm
- 4 tools on end effector
- 2 kg end effector



NASA Mars 2020

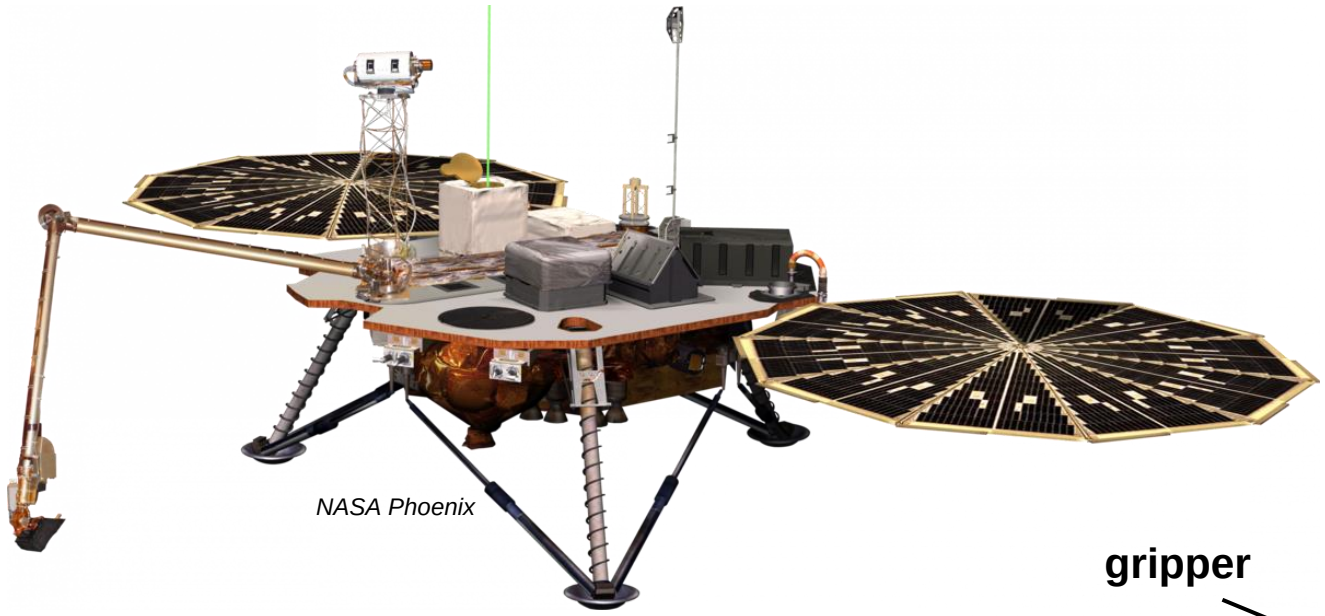
- 5 DOF
- 2.2 m arm length
- 67 kg robotic arm
- 5 tools on end effector
- 34 kg end effector



NASA Curiosity

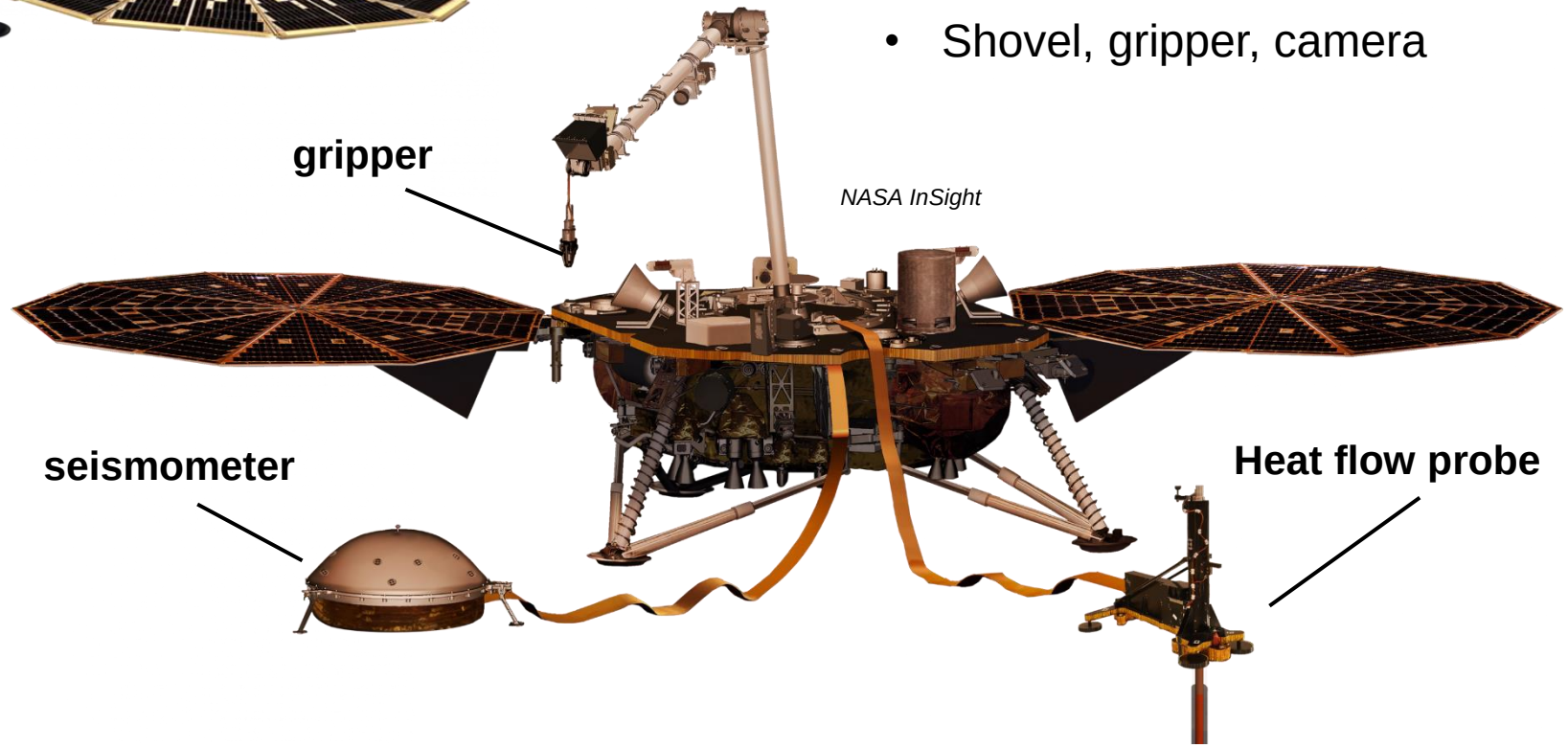
- 5 DOF
- 2.1 m arm length
- 6 tools on end effector
- 40 kg end effector

Research – Lander Missions



NASA Phoenix

- 4 DOF
- 1.8 m arm length
- 3.4 kg arm
- Shovel, gripper, camera

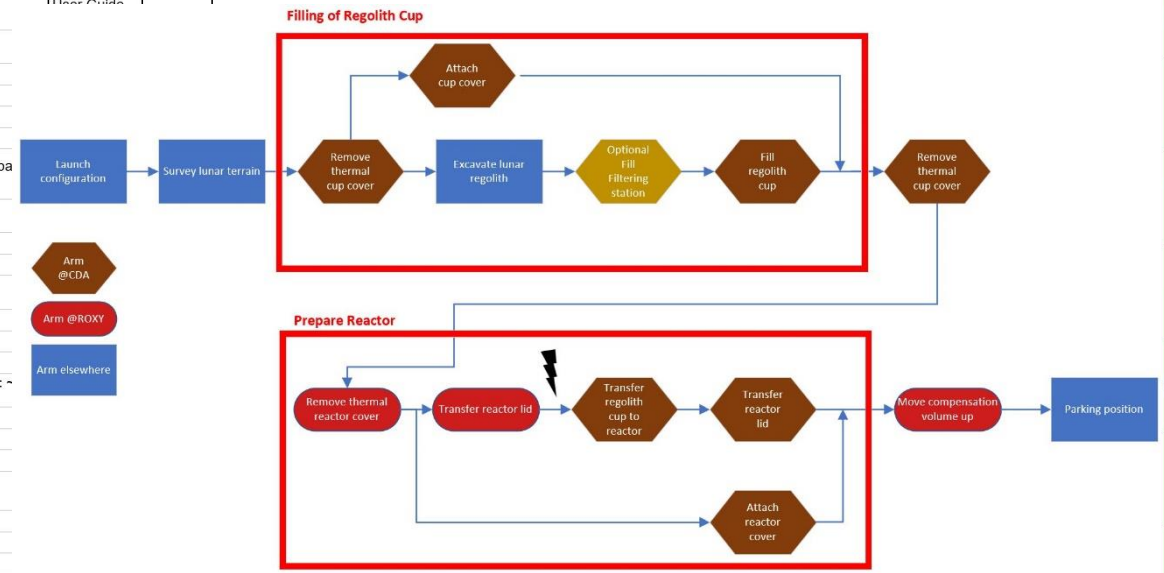


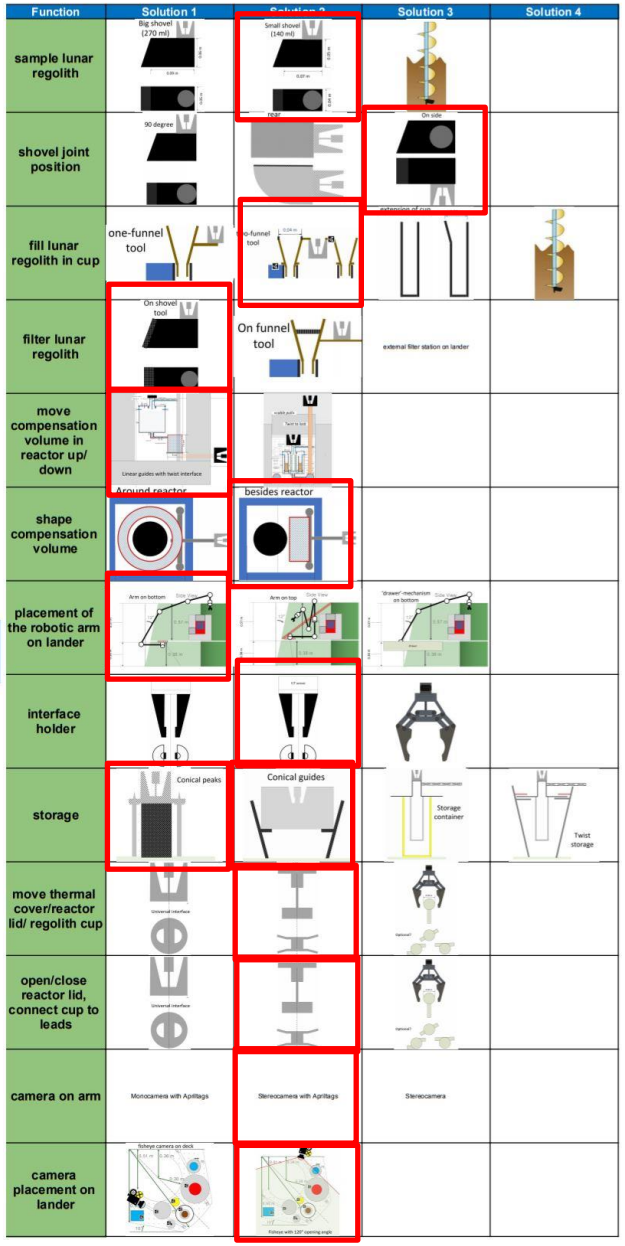
NASA InSight

- 4 DOF
- 2.35 m arm length
- 9.7 kg arm
- Shovel, camera, TECP

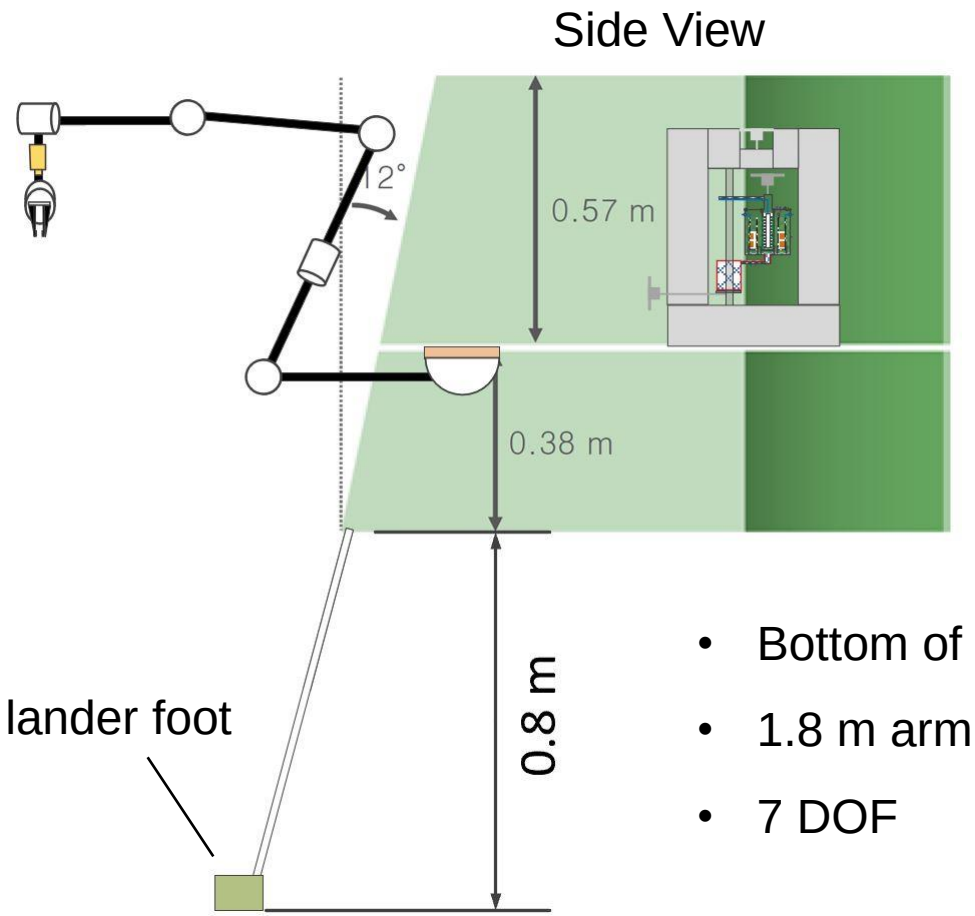
Methodoloy

Page: 1/3	List of Requirements			
	Study on a robotic arm for sampling lunar regolith			
D/W	Requirement	Value	Source	Date
	Geometry			
D	Maximum Geometry (lenght x width x depth)	<250x500x570mm>	Bohn	4/5/2020
D	Height of the payload envelope to ground may vary	400-800mm		
D	Maximum angle of the lander wrt ground	< 12 degrees		
W	Robotics area should be minimized	< 0.25 m^2		
	Kinematics			
D	Number of DOF shall be minimized			
D	The arm shall reach all points within the manipulability ellipsoid while avoiding singularities	tbd -> predicted workspa file		
D	Joint (peak) torques shall be minimized			
	Forces			
D	Robotic arm shall allow for maximum force at EE	Force at distance tbd		
D	The robotic arm shall be lightweight	tbd (max 25 kg)		
	Energy			
D	Energy consumption of the robotic arm shall be minimized	standby: < 20W ; peak: ~ 200W		
	Heritage			
W	Components with high TRL should be used			
	Functional			
D	The arm shall open/close the insulation of the reaction chamber		Bohn	4/5/2020
D	The arm shall fill the reaction container with lunar regolith		Bohn	4/5/2020
D	The end effector shall sample regolith from the lunar surface	~ 200ml / process (3x)	Concept Design 3B	4/15/2020
D	The arm shall transport the sampled regolith to the reaction container		Bohn	4/6/2020
D	The number of tools shall be minimized		Bohn	4/6/2020
W	A toolchange should be avoided		Bohn	4/6/2020
W	The arm should be illuminated for visual inspection		Bohn	4/7/2020
D	The arm shall have high end effector position accuracy	accuracy tbd	Kolvenbach	4/7/2020
D	the arm shall filter regolith	size < 1mm	Concept Design 3B	4/15/2020
	Environment			
(D)	(The design shall be scalable to survive lunar surface temperature)	define lunar area	Kolvenbach	4/7/2020

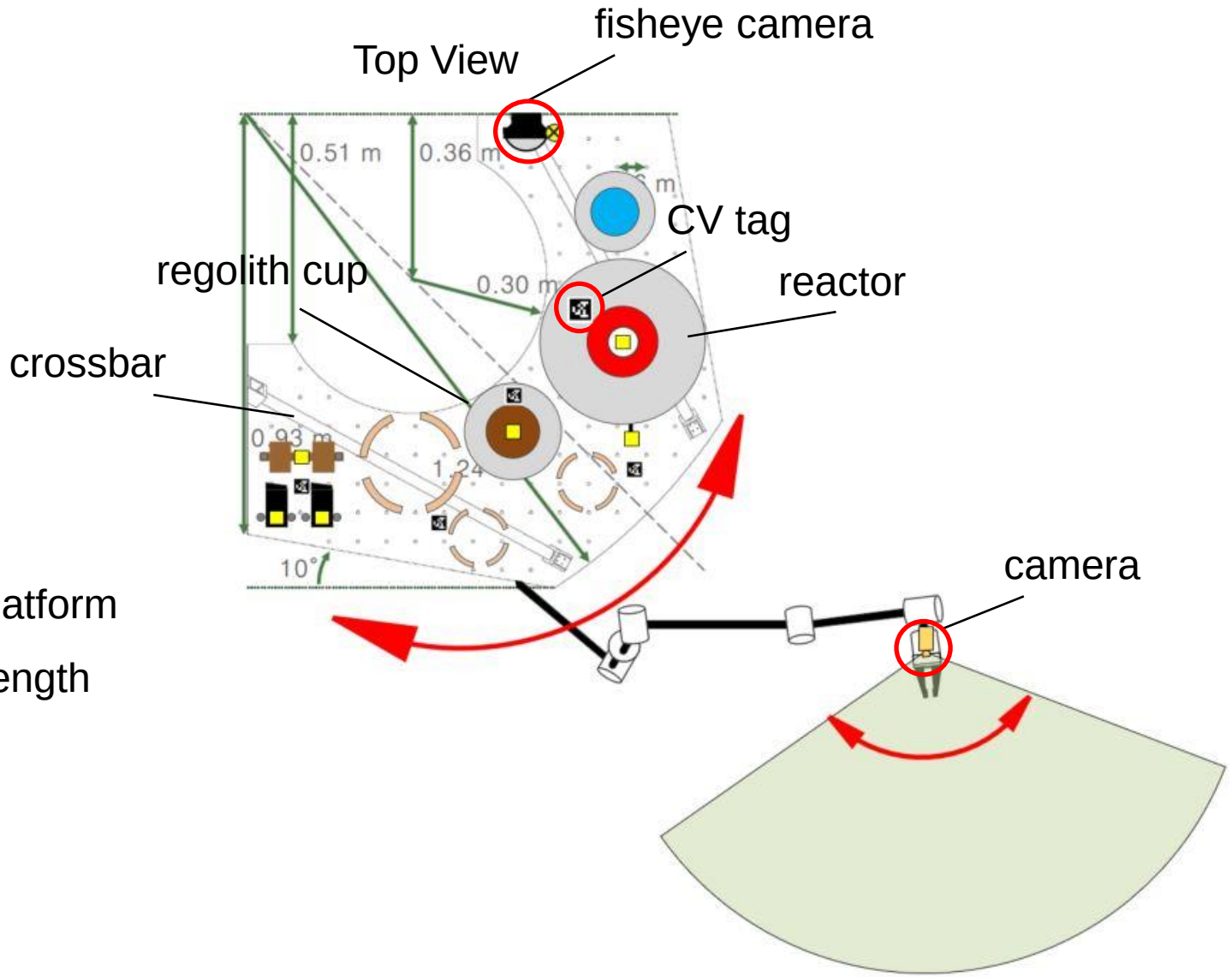




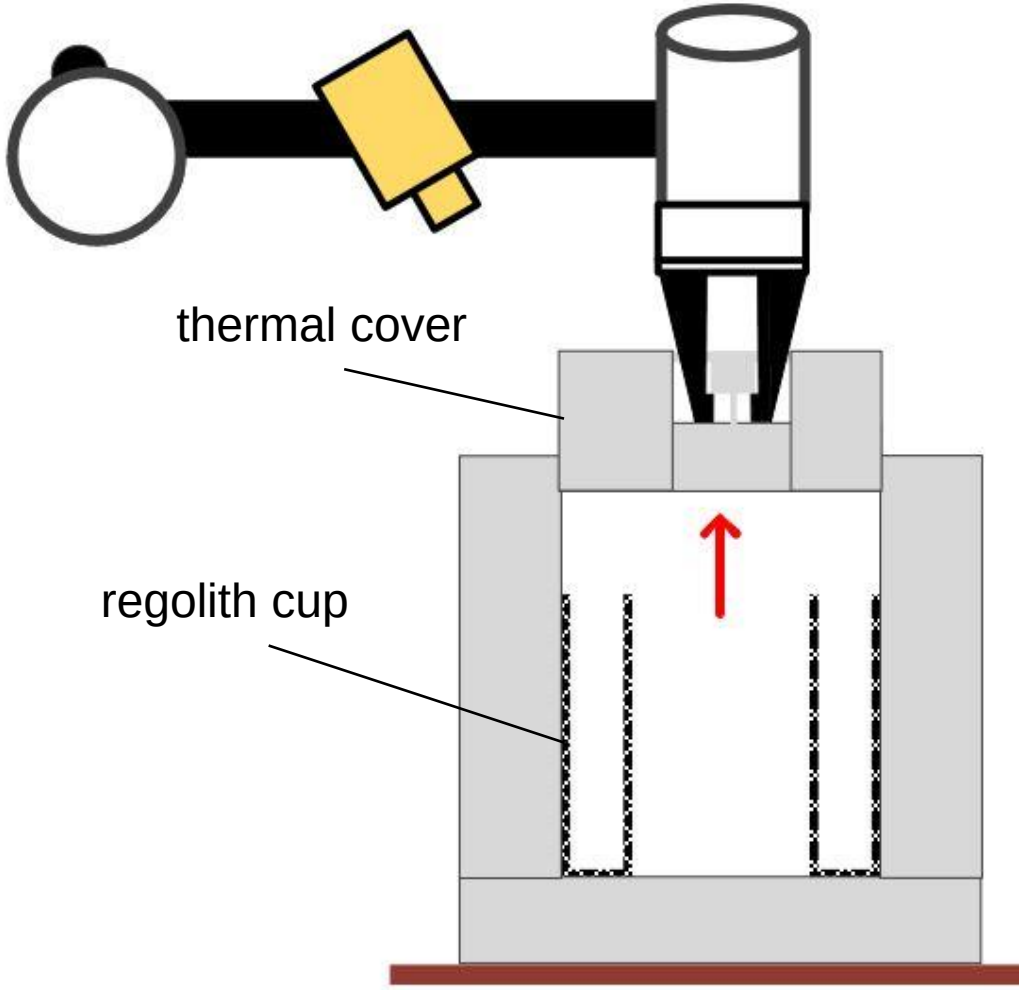
Final Concept – Robotic Arm

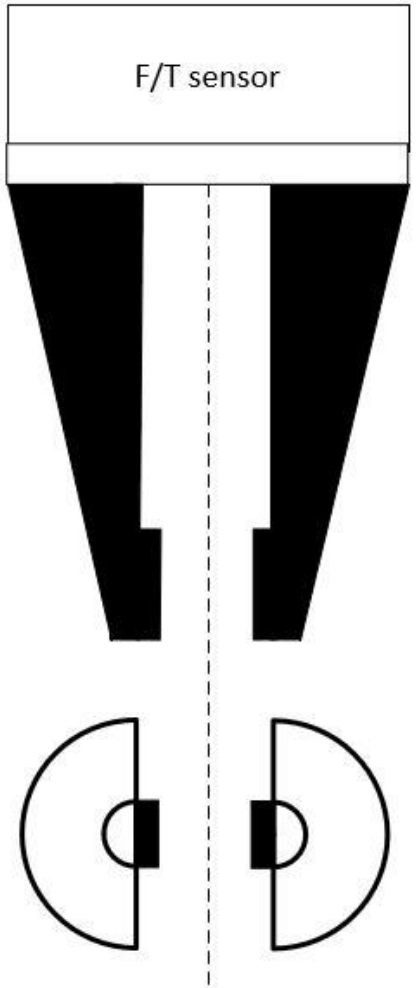


- Bottom of platform
- 1.8 m arm length
- 7 DOF

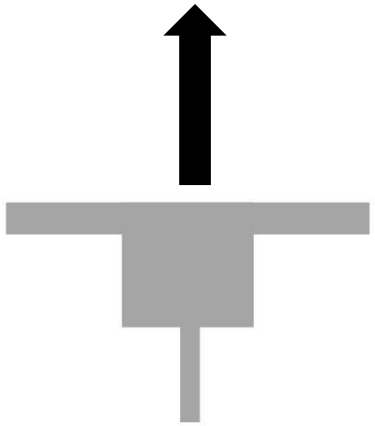


Final Concept – Gripper / Universal Interface

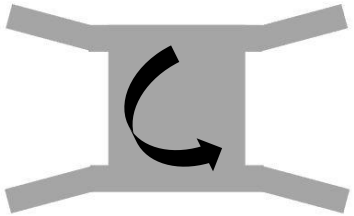




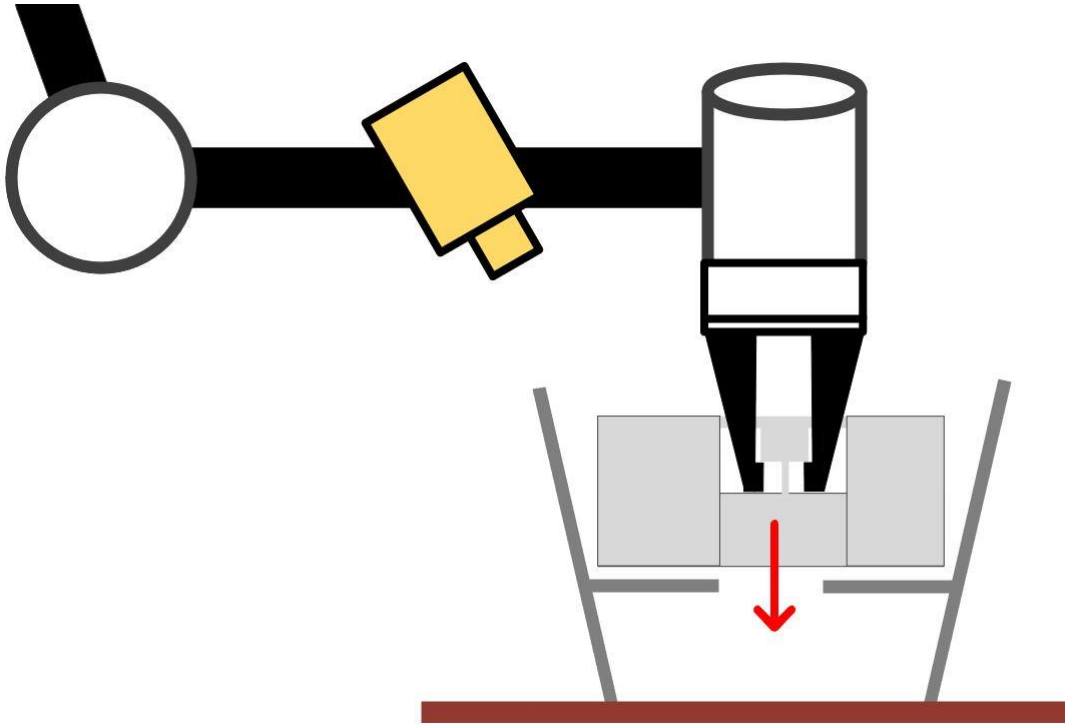
Side view



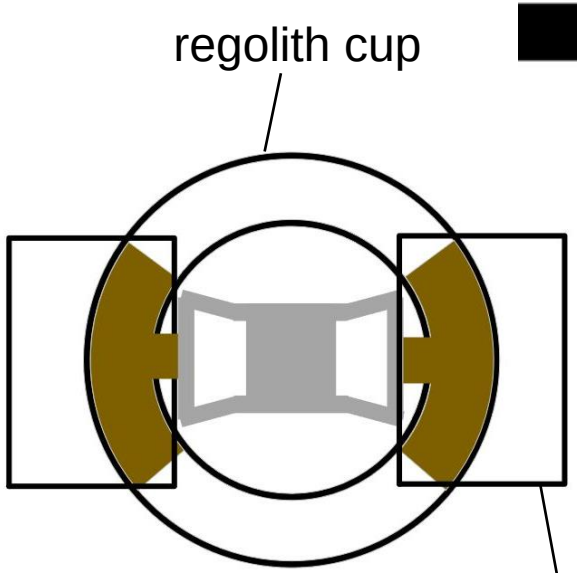
Top view



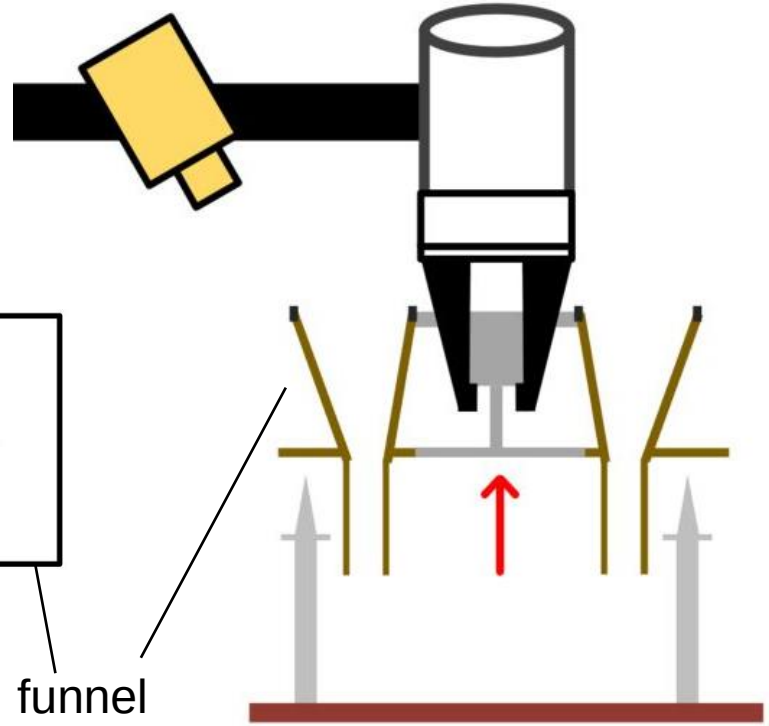
Final Concept – Storage / Funnel



temporary storage



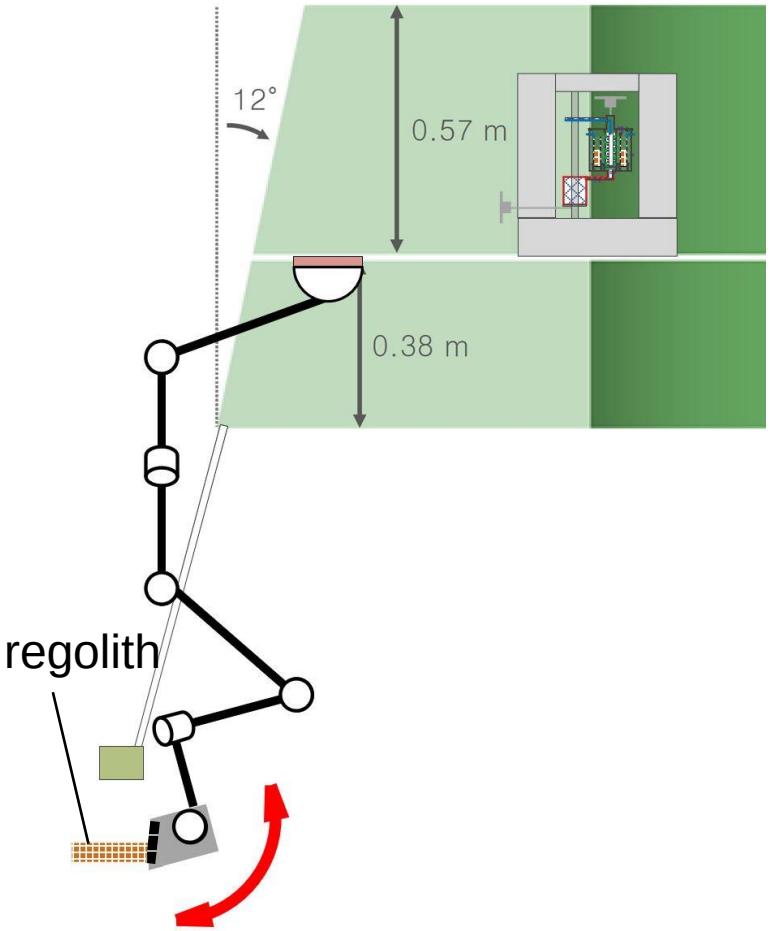
top view funnel



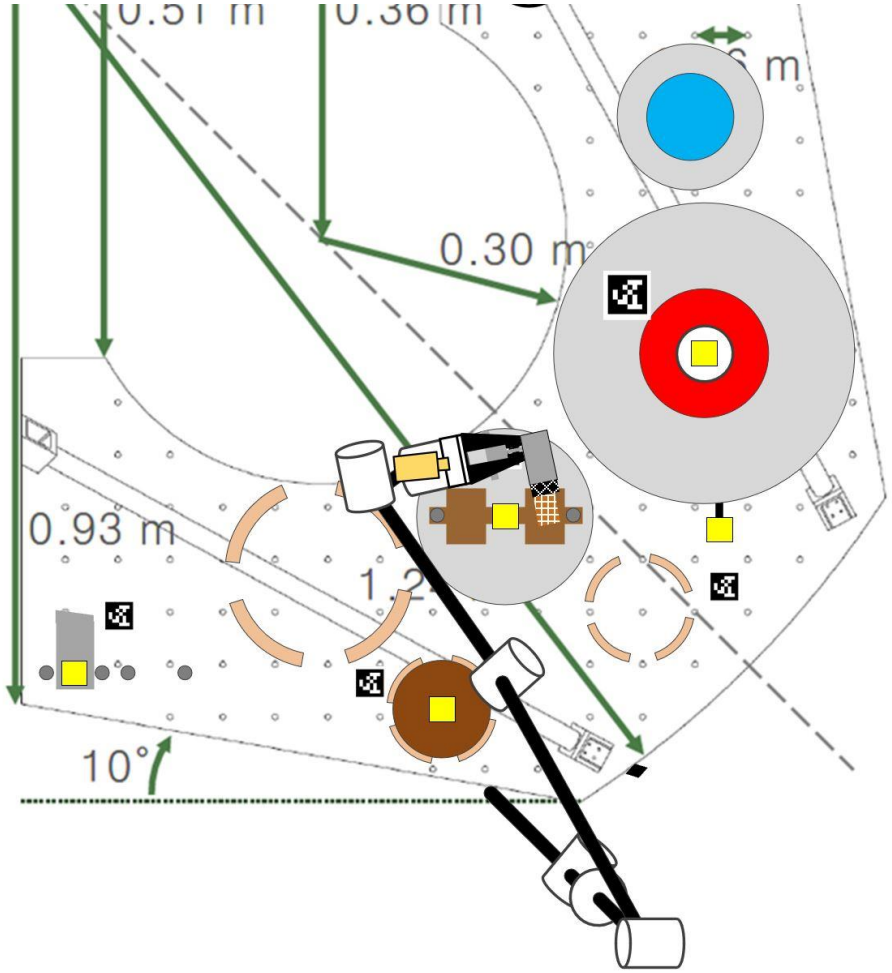
fixed storage

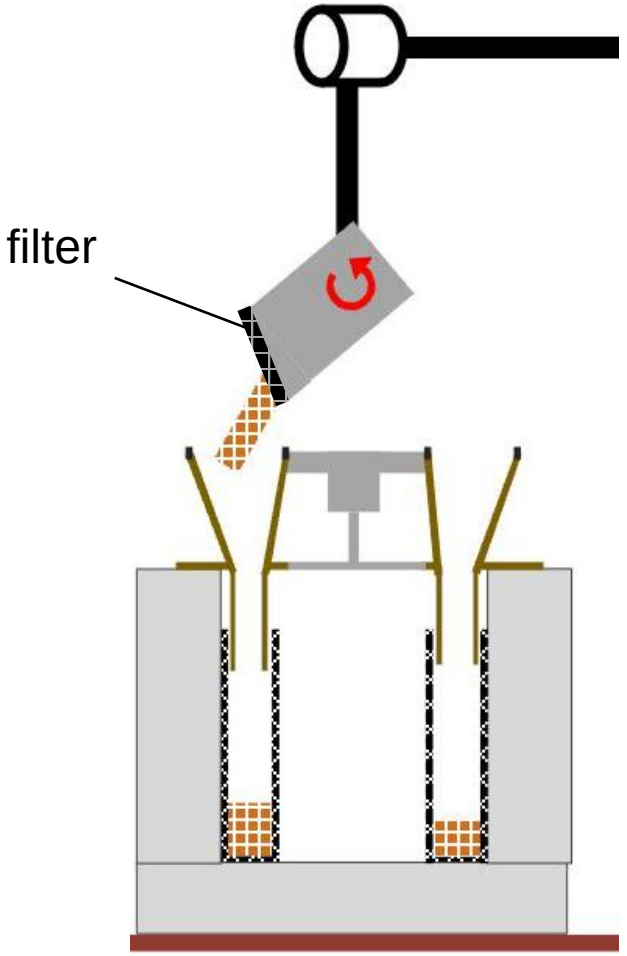
Final Concept – Shovel

Side View

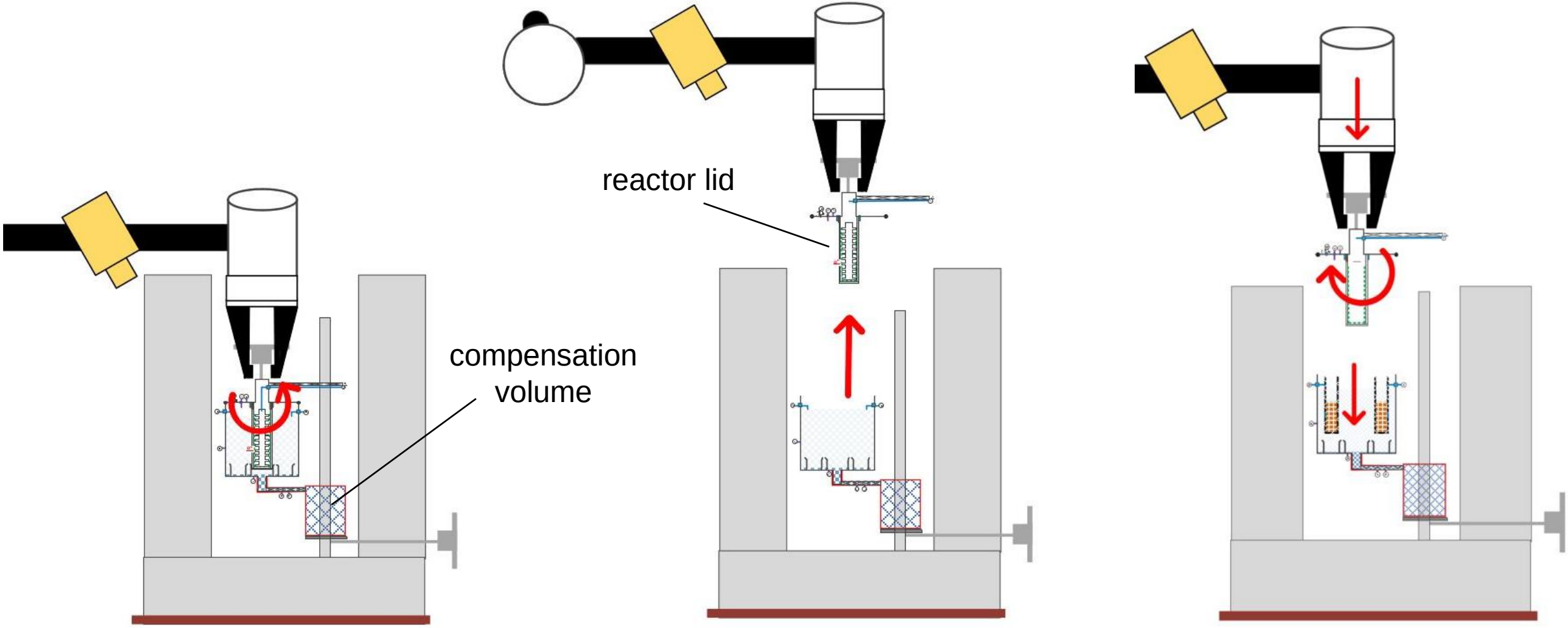


Top View

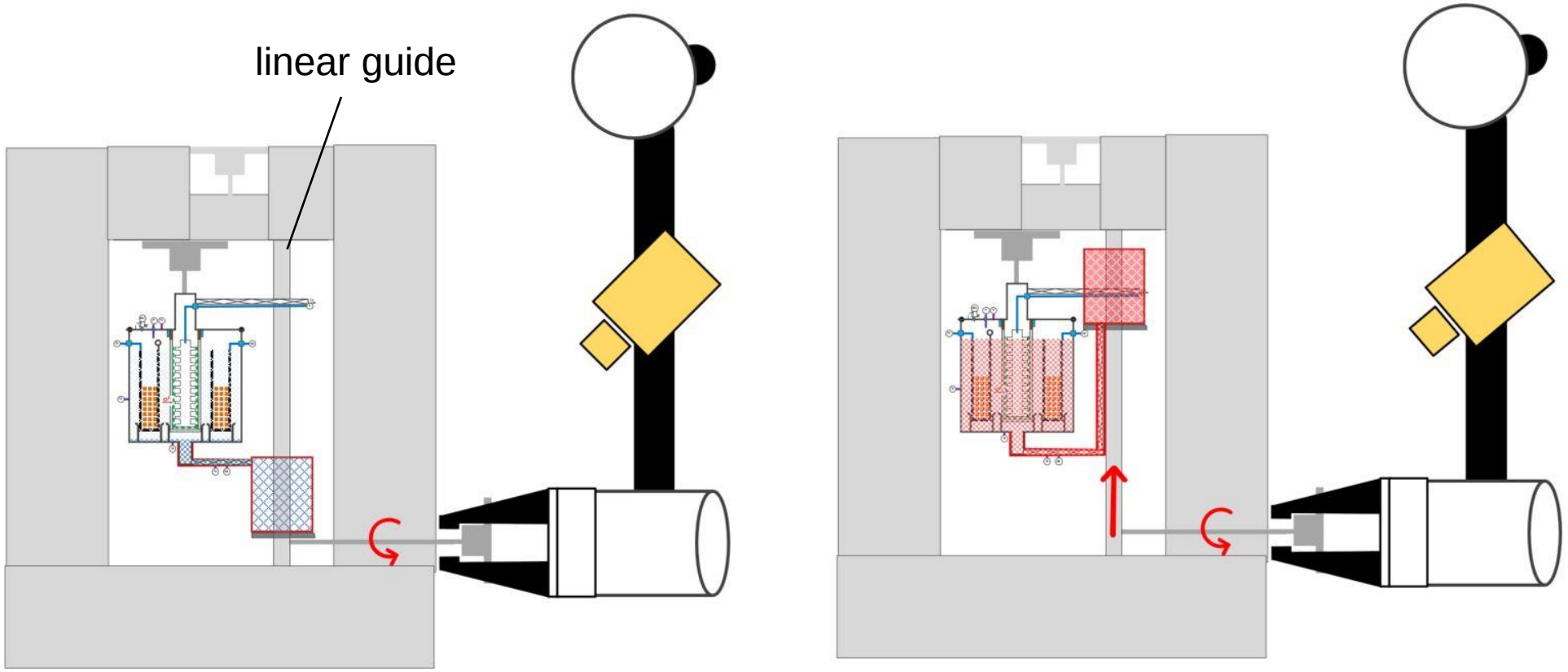




Final Concept – Prepare reactor



Final Concept – Compensation Volume



Conclusion

- Literature research on robotic arms in space (rover, lander, sampling tools)
- Develop operations concept
- Conceptualize subfunctions
- Final concept

Future Work

- Review and discuss concept with Airbus
- Refinement of concept
- Modelling / Simulation

Thanks for listening