SRR PTMSS 2018


# Percussive and ROtary Multi-Purpose Tool (PROMPT)

S.Schmidt, D. Boucher, J. Richard
www.deltion.ca

# PROMPT

a lightweight, multipurpose tool for geological exploration and construction with a robotic manipulator

# PROMPT

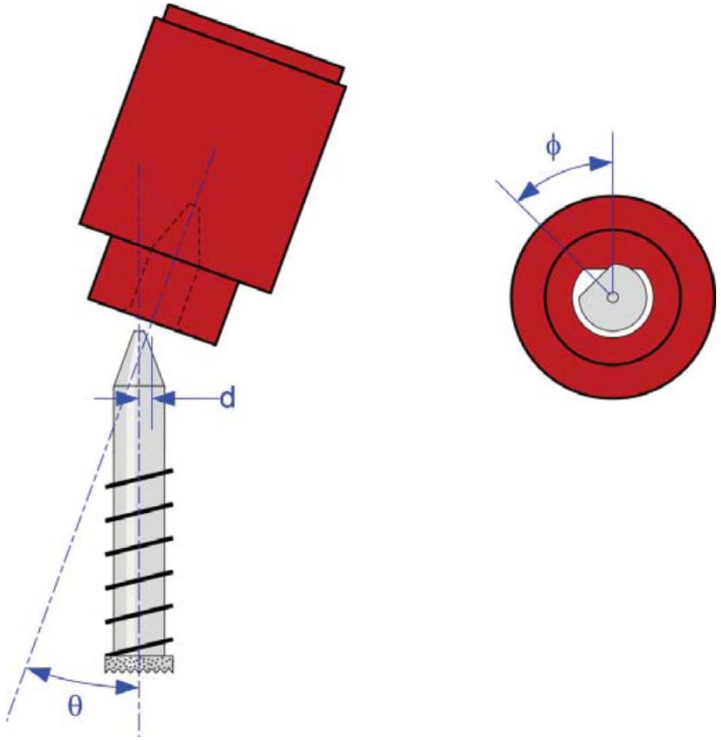
- TRL4 lunar and Martian analogue environments
- Manipulator arm to provide 100N force to hold PROMPT in place during operations
- Rotary, linear travel, thrust, percussion managed by PROMPT

# Mass and Volume


<5kg

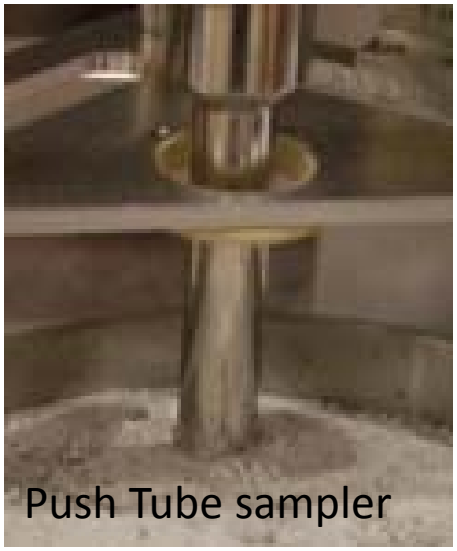
Height: 27.6cm
Rectangular envelope volume: <7200cm$^3$

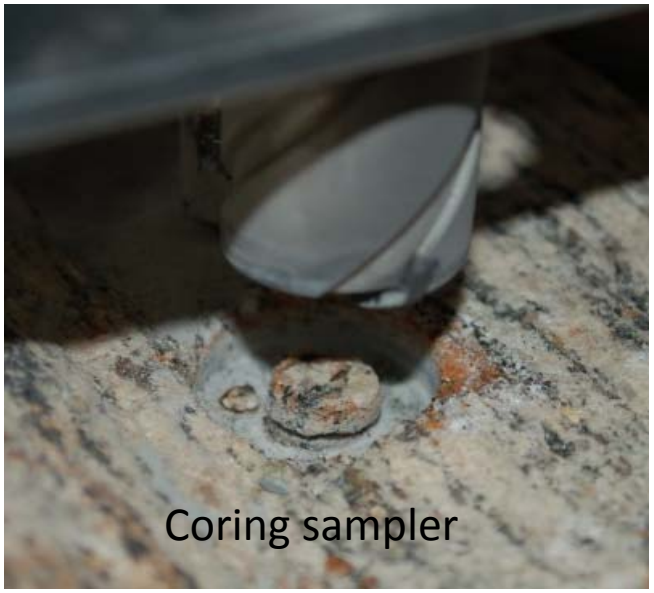
# Tool Bit Management Module (TBMM)

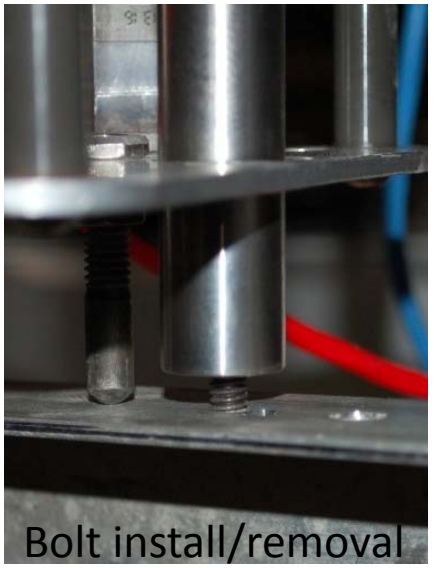


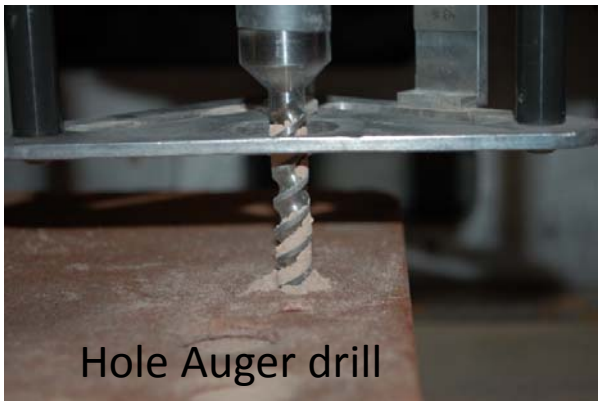

Passive tool storage for rover chassis mounting – 6 tools
Tolerant to: 5mm radial offset, 5°radial angle, 5° approach angle
1 kg, 2100 cc volume

# Tools

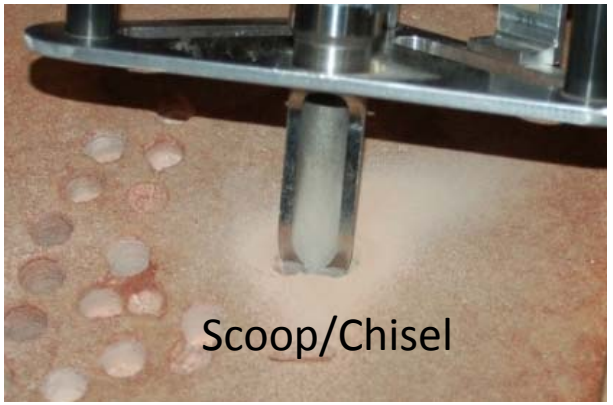

Push Tube sampler


Coring sampler

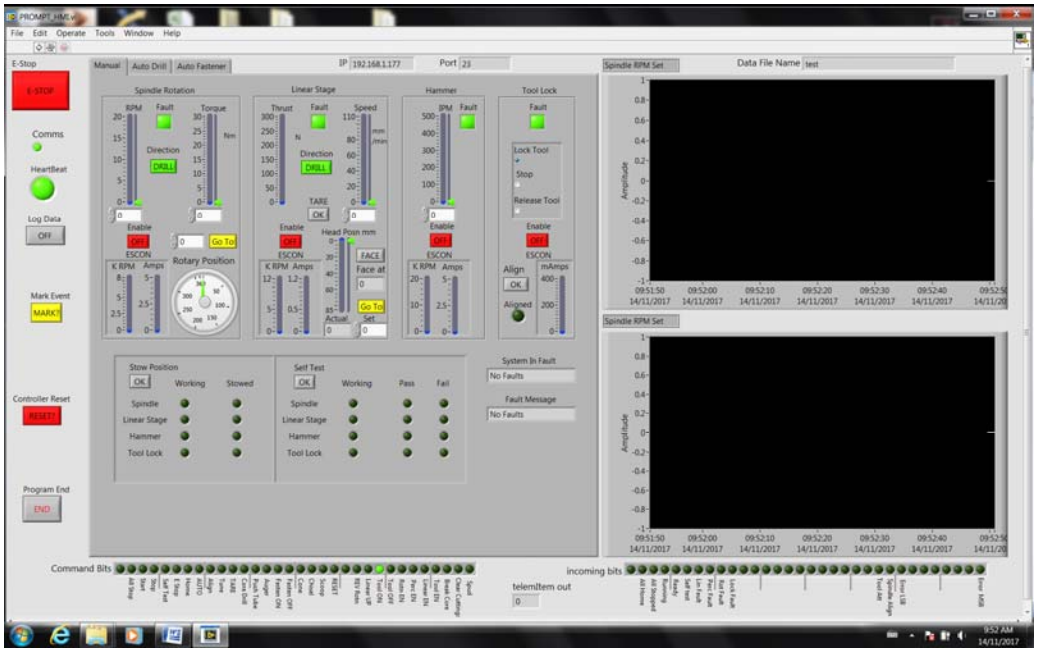

Bolt install/removal


Hole Auger drill


Metal Drill/Tap


Scoop/Chisel

# Control




- Labview HMI and C++ on-board controller for autonomous operation
- Operate by Exception strategy, low bandwidth
- user selectable thrust, percussion, rotation

# Additional Specifications

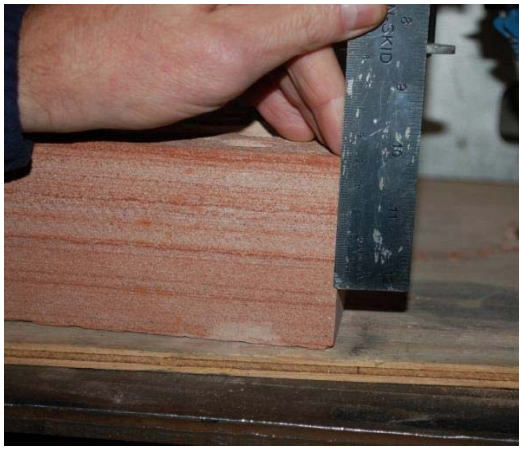
- Peak power: 100W
- Avg power consumption: 30W-70W, tool and setpoint dependent
- Operating temperature -10C to +40C
- Storage temperature -20C to +51C

# Characterization

Gneiss

Impact Breccia

Palagonite Tephra



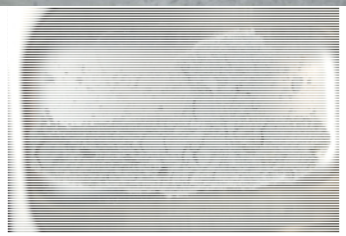
Arizona Sandstone

Hawaiian Basalt

ChenOBI

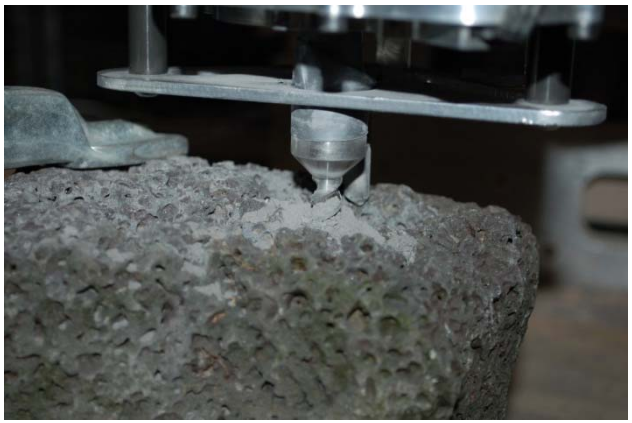
# Coring Auger

- Drills and captures 5cm x 1cm diameter consolidated sample
- 5% moisture frozen CHENOBI
- Sandstone
- Hawaiian basalt



# Auger

- 5cm x 5mm diameter hole
- 5% moisture frozen CHENOBI
- Sandstone
- Hawaiian basalt

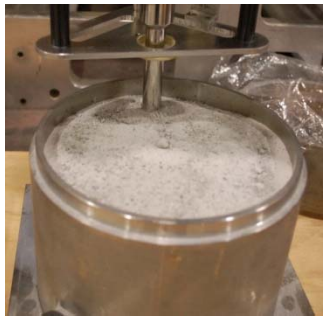


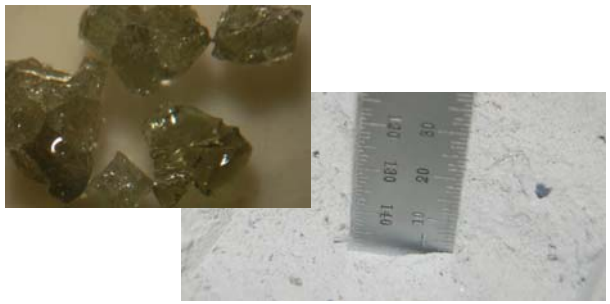
# Auger/Coring Auger in Breccia

- Penetration is very slow, faster than hobby drill

# Push Tube

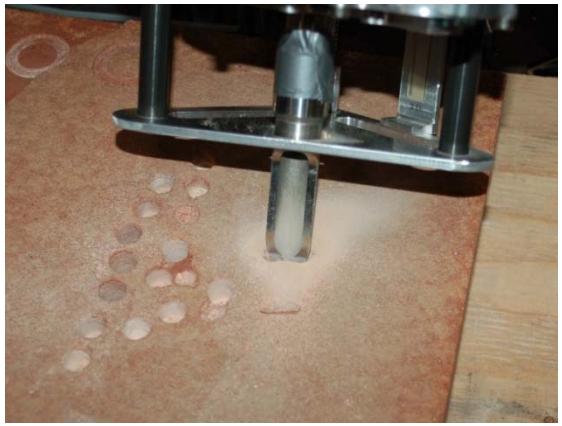
- 5cm x 1cm diameter unconsolidated sample
- CHENOBI: nearly 80% capture, <60 seconds
  - Irregular, jagged interlocking particles
- HI tephra: <60%, <60 seconds
  - Rounded particles
- Tool diameter approaching lower limit for collection?





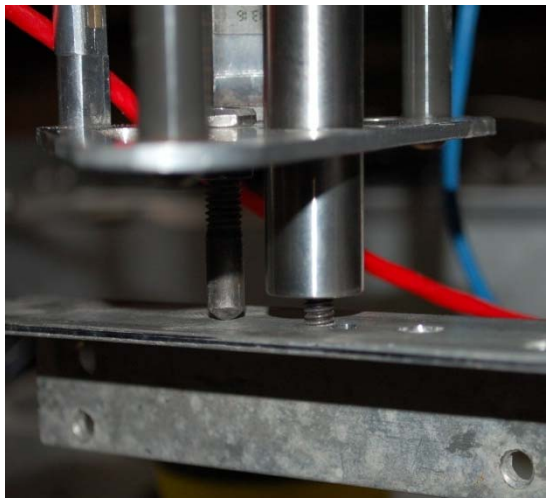
# Chisel/Scoop

- Chisel in sandstone – groove 4.25mm deep, 5.58mm long, 167.34mm wide in 10 min
- Scoop in CHENOBI 2.7g

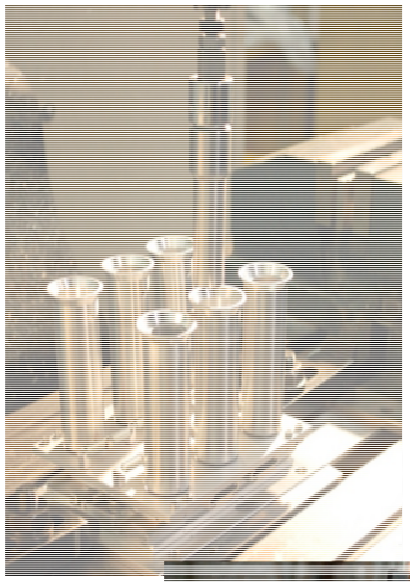


# Drill and Tap, Fasten

- Auto function : rpm, thrust controlled, user selected thread
- Socket wrench tightens fastener to operator selected torque
- Range of sizes of drill/tap and socket wrenches



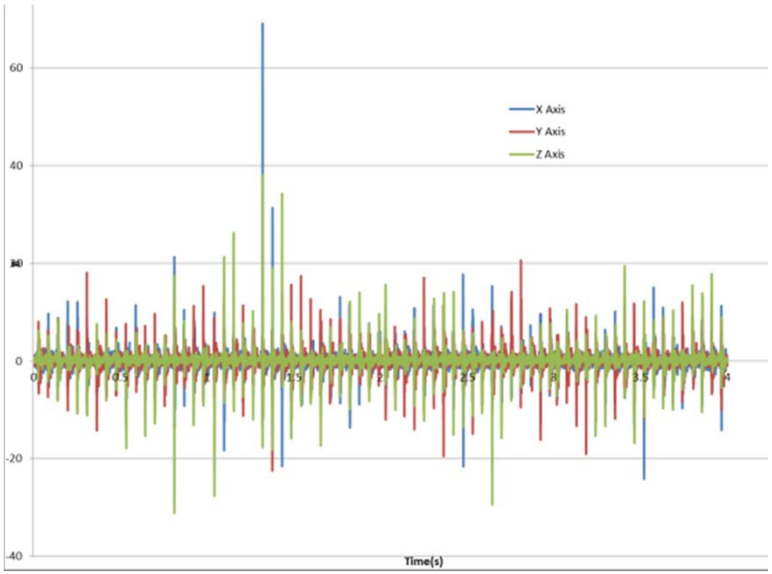
# Tool Exchange

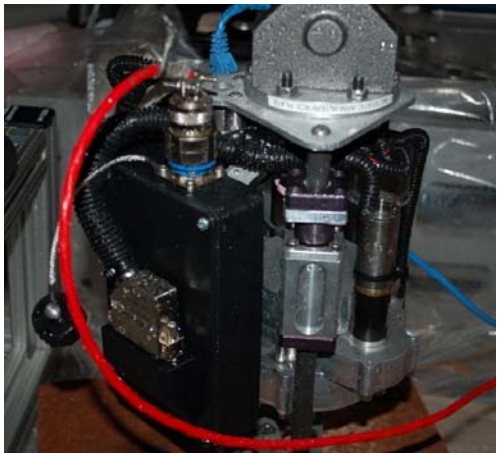


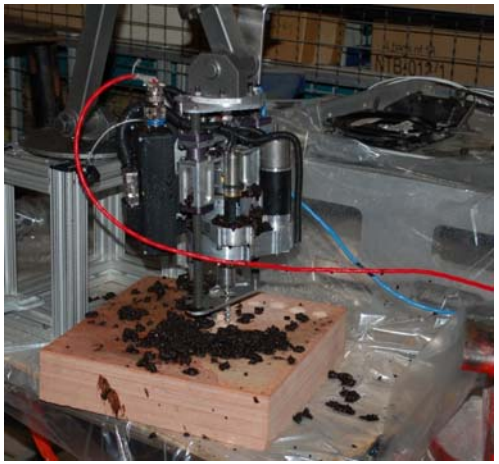
- Manipulator arm positions tool in proximity to tool receptacle
- Semi-automatic process - operator in loop

# Environmental Testing (TRL4)

- Operating temp -10C to +40C
- Storage temp -20C to +50C
- Dust, mud, precipitation
- vibration





# Next Steps

- Fully automate tool exchange
- Analogue deployment as robotic arm payload for sampling and construction purposes
- TRL6 development
  - Upgrade avionics
  - Upgrade TBMM compliance
- commercialization

# Applications

- Current development
  - Mining application
  - Heavy industry
  - Environmental
- Future development
  - Nuclear
  - Deep sea mining

# Acknowledgements


- This project was supported by the Canadian Space Agency