

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

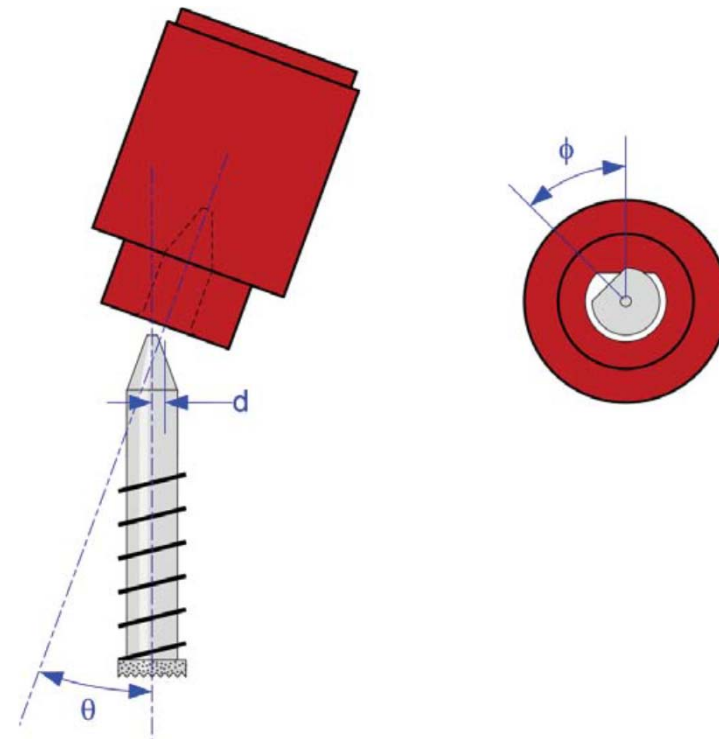


<5kg



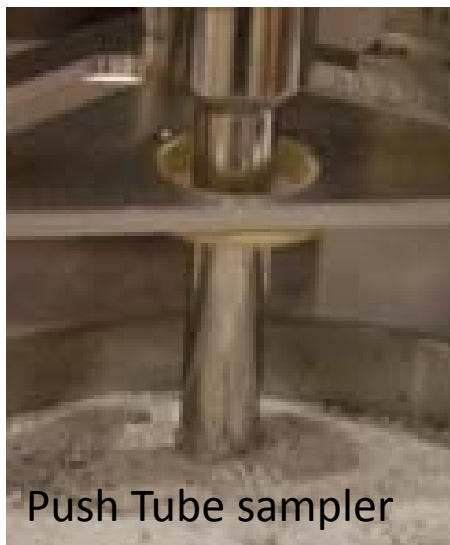
Height: 27.6cm
Rectangular envelope
volume: <7200cm³

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

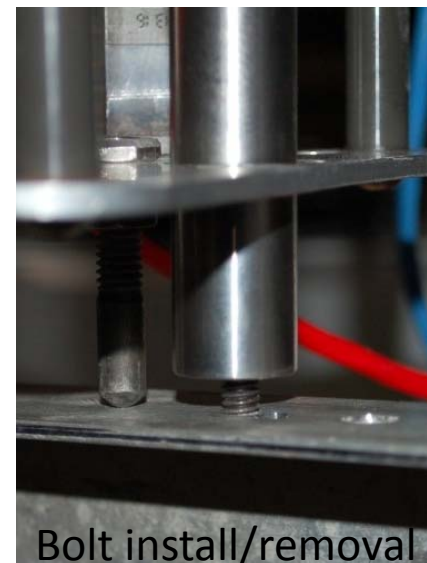
Tools



Push Tube sampler



Coring sampler



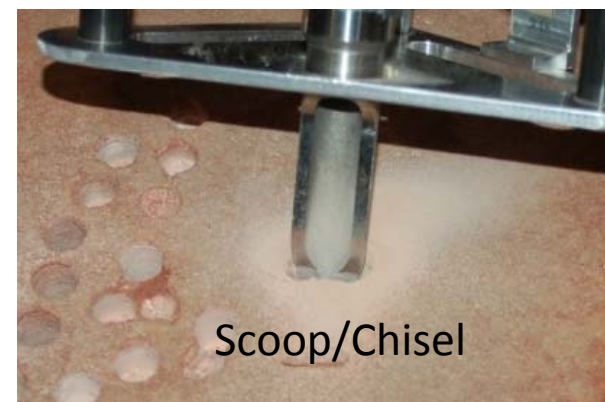
Bolt install/removal



Hole Auger drill



Metal Drill/Tap



Scoop/Chisel

The screenshot displays the PROMETA 2016 software interface, which is used for controlling a machine tool. The interface is organized into several main sections:

- Top Bar:** Includes a menu bar (File, Edit, Operate, Tools, Window, Help) and a status bar showing IP (192.168.1.177) and Port (25).
- Left Panel:** Contains a 'K-stop' button, 'Comms' status, 'Heartbeat' indicator, 'Log Data' toggle, and a 'Mark Event' button.
- Main Control Area:**
 - Manual Section:** Includes 'Spindle Rotation' (RPM, Fault, Torque, Direction, Enable, ESCON, Go To), 'Linear Stage' (Thrust, Fault, Speed, Direction, TARE, Head Pos, mm, FACE, K RPM, Amps, Rotary Position, Set), and 'Hammer' (500 RPM, Fault, Enable, ESCON, Align, OK, mAmps, 200, Aligned).
 - Auto Drill Section:** Includes 'Spindle Rotation', 'Linear Stage', and 'Hammer' sub-panels.
 - Auto Fastener Section:** Includes 'Spindle Rotation', 'Linear Stage', and 'Hammer' sub-panels.
- Right Panel:**
 - Spindle RPM Set:** A graph showing Amplitude vs. Time (09:51:50 to 09:52:00).
 - Data File Name:** A field for entering the file name.
 - Tool Lock:** A panel with 'Lock Tool', 'Stop', 'Release Tool', and 'Align' buttons.
 - Spindle RPM Set (Bottom):** Another graph showing Amplitude vs. Time (09:51:50 to 09:52:00).
- Bottom Panel:**
 - Controller Reset:** A 'RESET' button.
 - Program End:** An 'END' button.
 - Command Bit:** A row of buttons for various commands (e.g., Stop, Start, Drill, etc.).
 - Incoming bits:** A section for monitoring incoming data bits.

- June 12, 2018

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



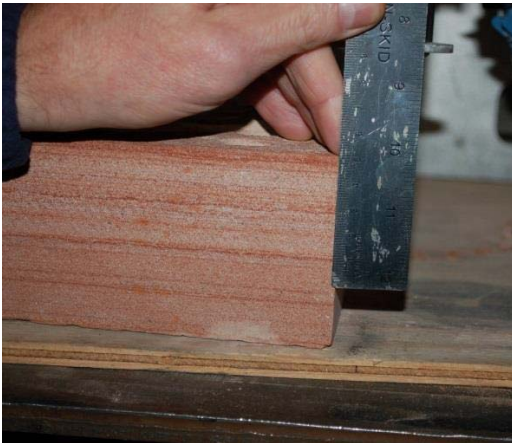
Gneiss



Impact Breccia



Palagonite Tephra



Arizona Sandstone



Hawaiian Basalt



ChenOBI

Coring Auger

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



Auger

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



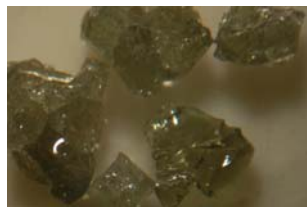
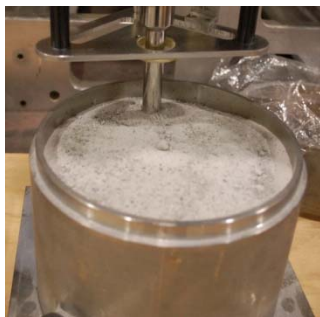
Auger/Coring Auger in Breccia

- Penetration is very slow, faster than hobby drill



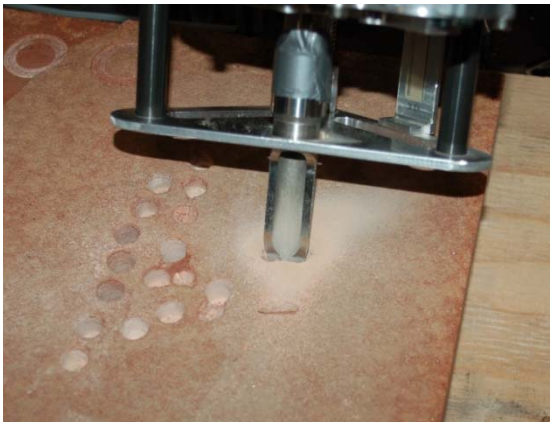
Push Tube

- 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?



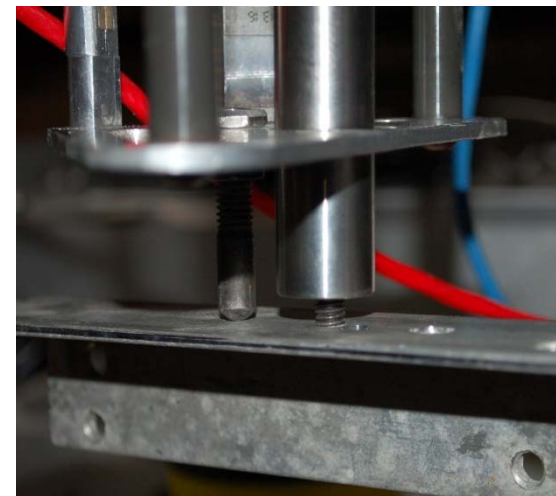
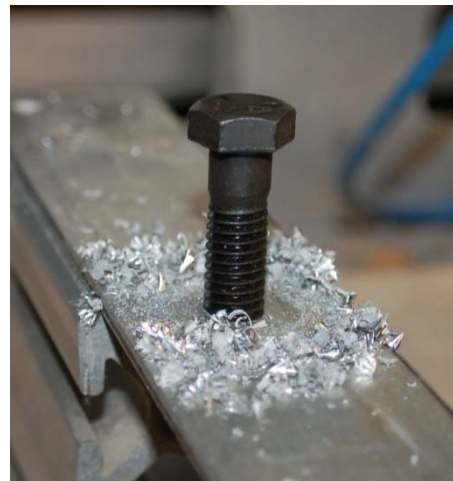
Chisel/Scoop

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



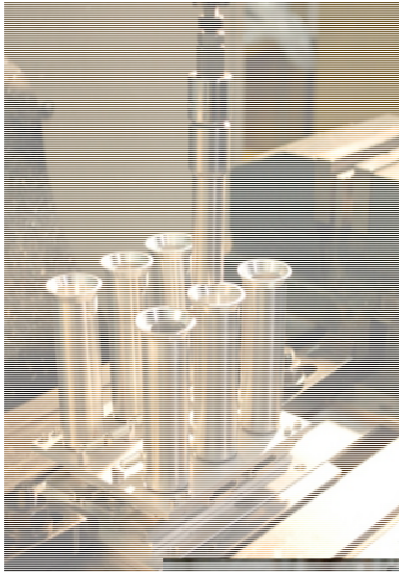
Drill and Tap, Fasten

- 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



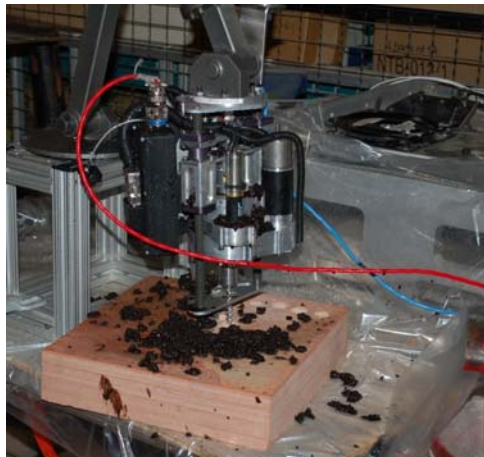
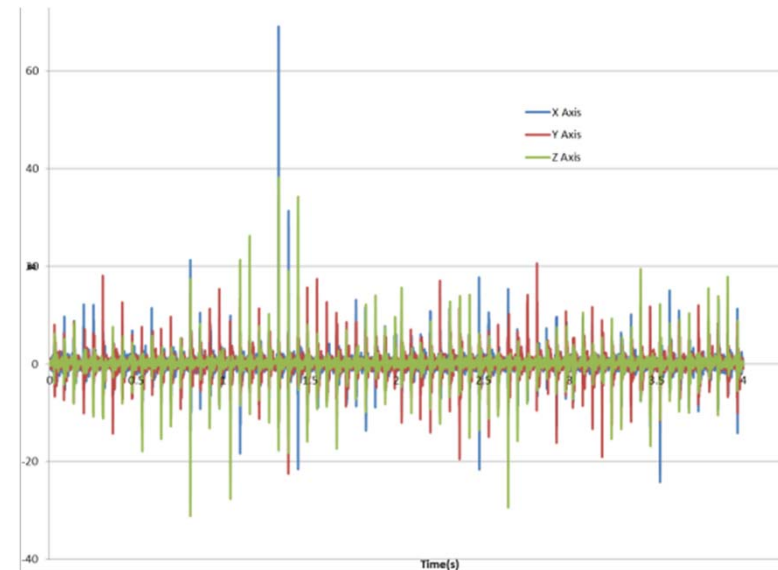
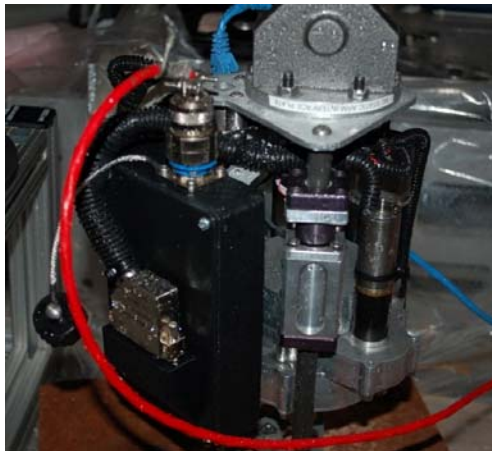
Tool Exchange

- 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