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Recent Progress in Designing the Sample Preparation and Distribution System of the ExoMars Mission

Kayser-Threde GmbH, Munich

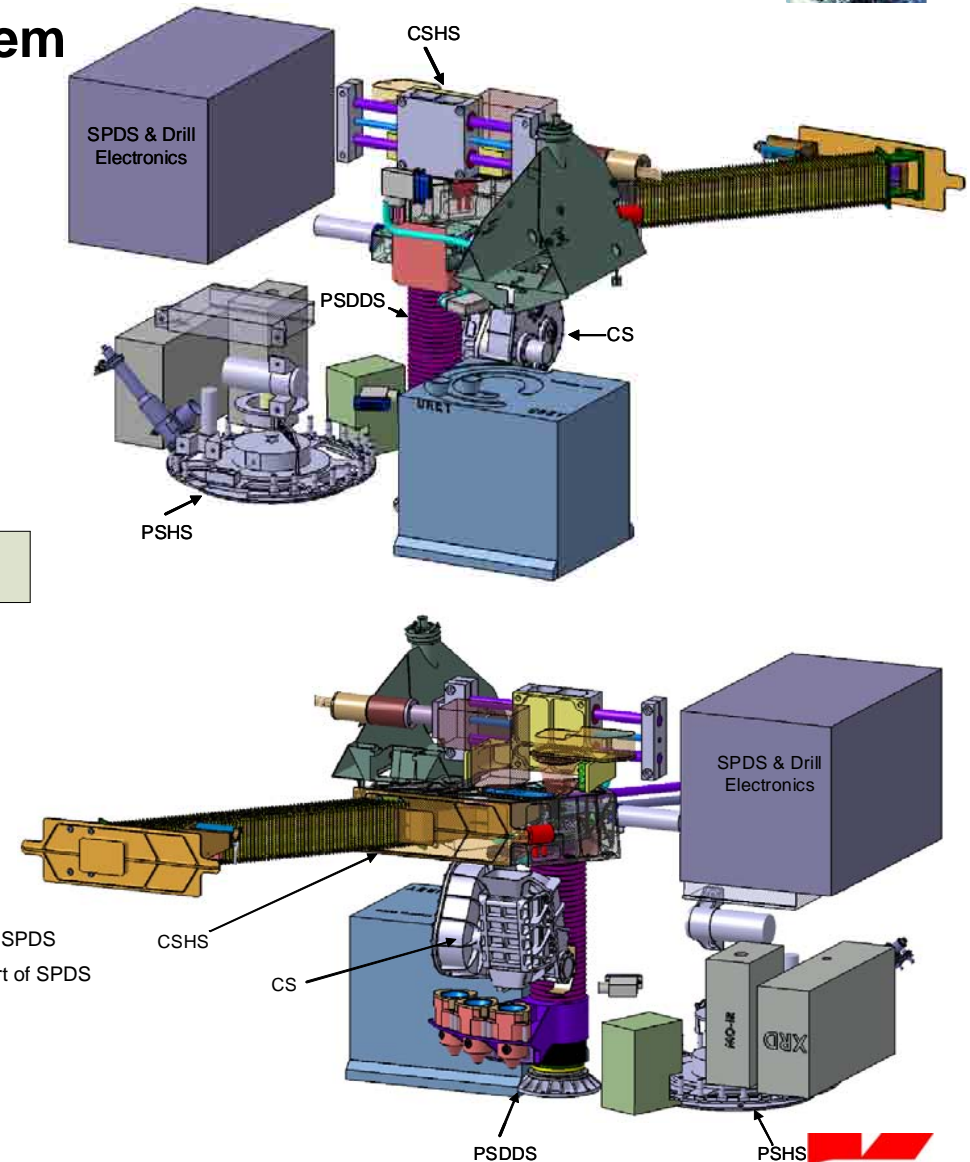
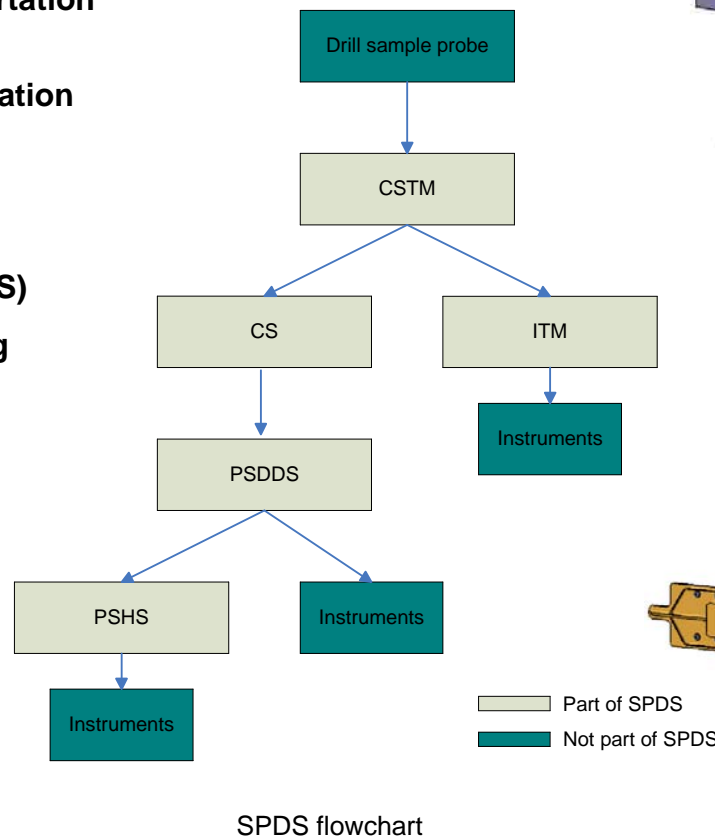
W. Schulte, P. Hofmann, C. Widani, R. von Heise Rotenburg, T. Viscor

ASTRA 2008 Workshop, ESTEC



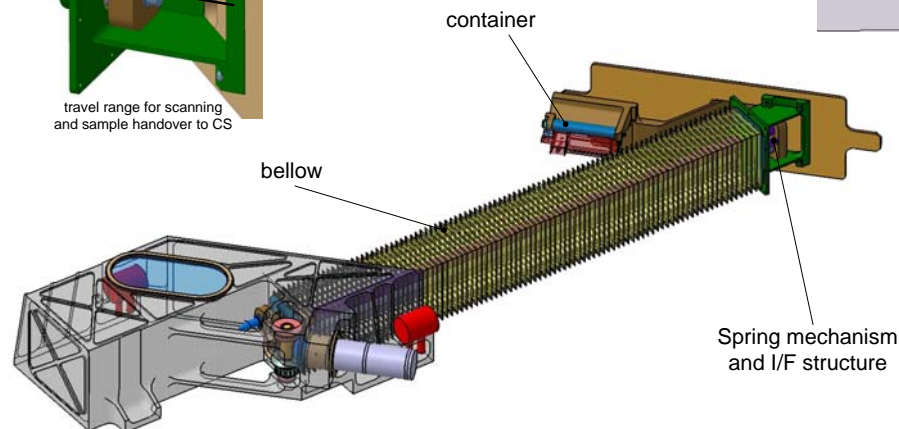
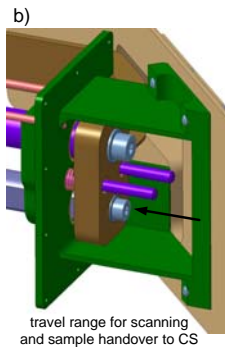
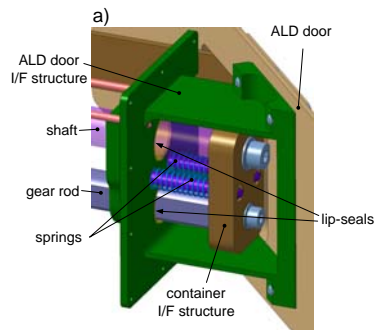
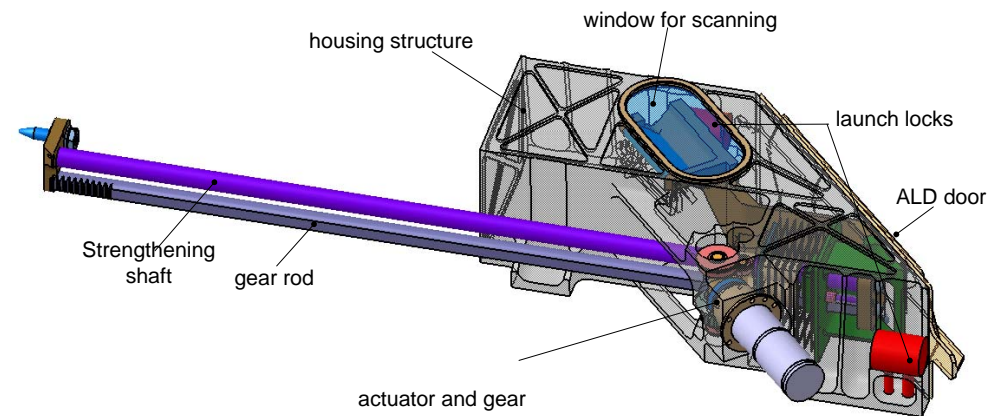
Sample Preparation and Distribution System

- Core Sample Handling System (CSHS)
 - Core Sample Transportation Mechanism (CSTM)
 - Instrument Transportation Mechanism (ITM)
- Crushing Station (CS)
- Powdered Dosing and Distribution System (PSDDS)
- Powdered Sample Handling System (PSHS)



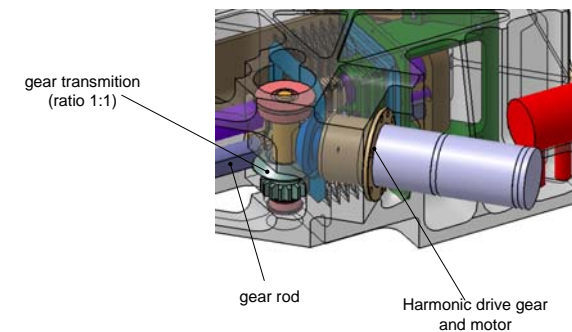
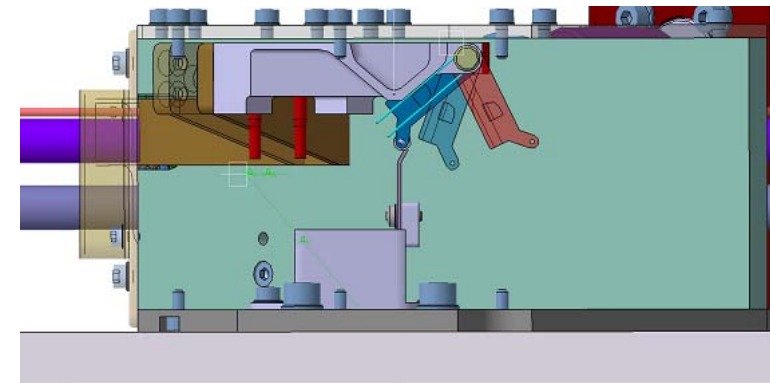


Core Sample Transportation Mechanism



CSTM Main Functions

- Move sample to instrument viewing port (window)
- Precision movement of sample under instruments for sample scanning
- Move sample to CS

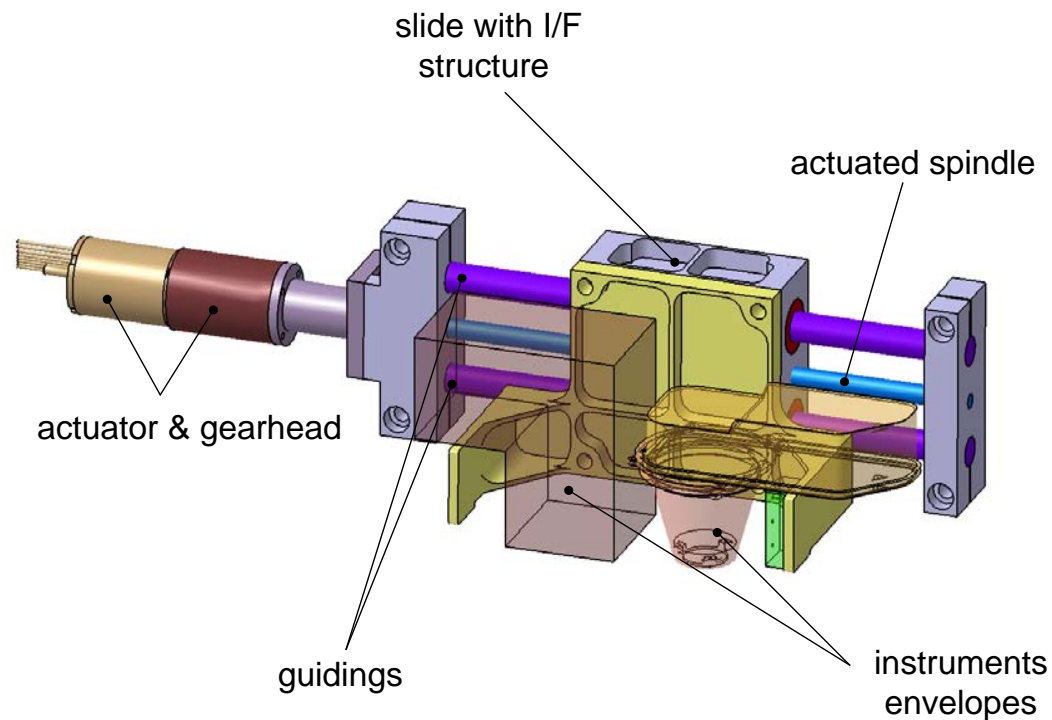




Instrument Transportation Mechanism

ITM Main Functions

- Move optical instruments to viewing port
- Precision movement of optical instruments for sample scanning

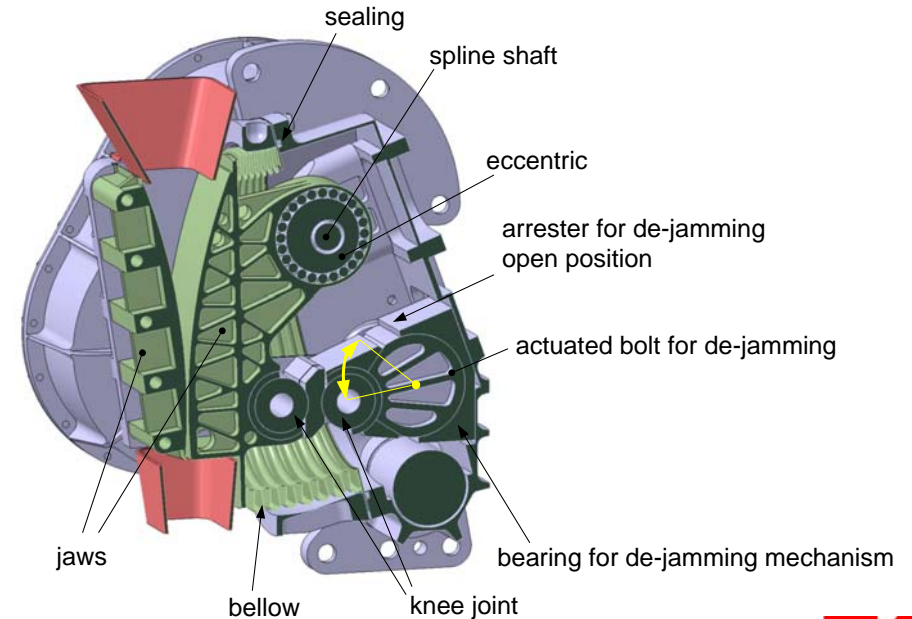
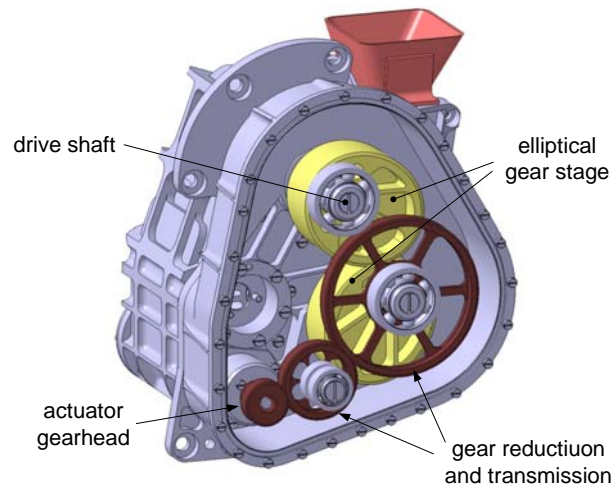
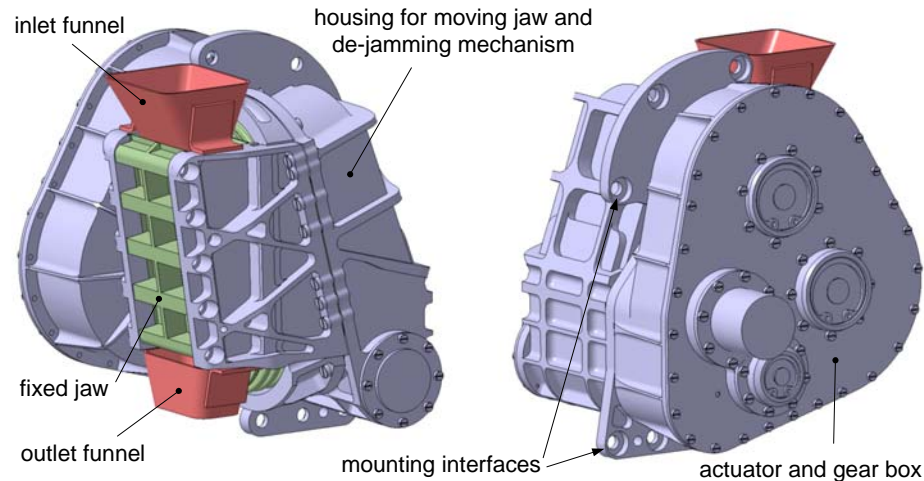




Crushing Station (Jaw Crusher)

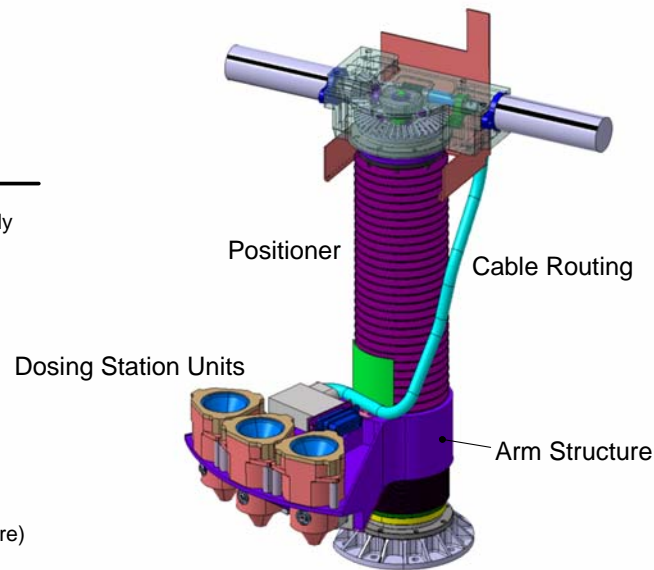
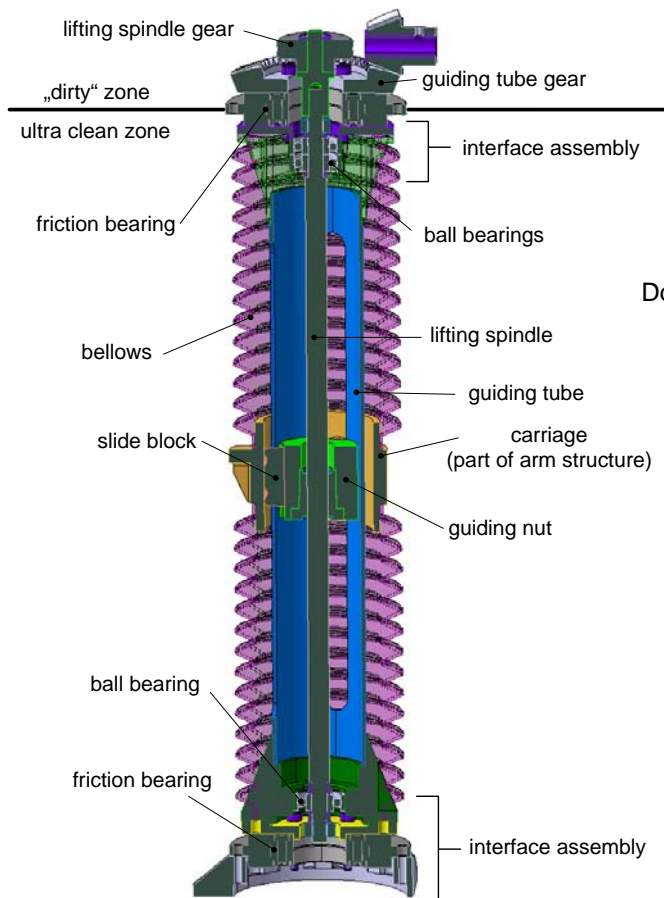
CS Main Functions

- Crush core sample to fine powder
- Open crusher in case of jamming to let sample fall through uncrushed



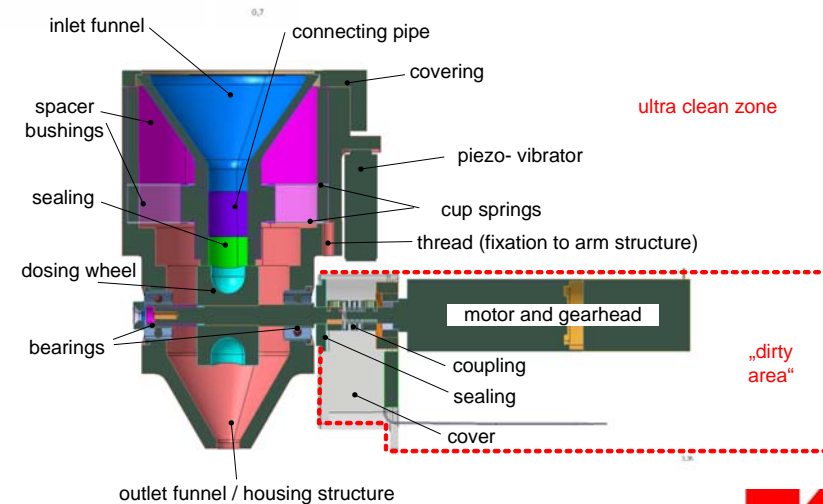


Powdered Sample Dosing and Distribution System



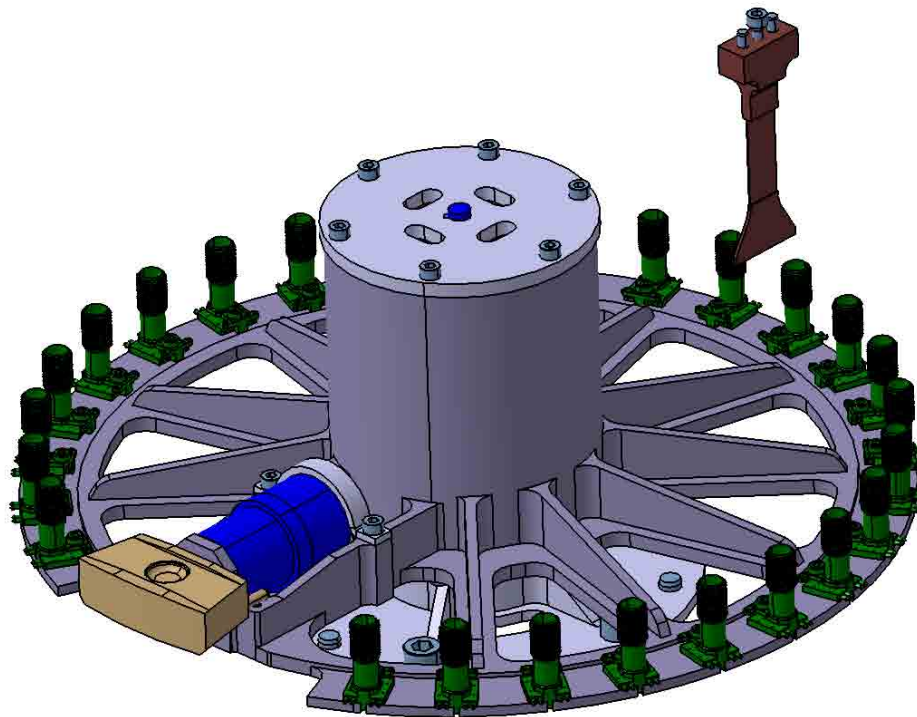
PSDDS Main Functions

- Move powdered sample to Urey instrument
- Dose specified amount of powdered sample to Urey
- Move powdered sample to PSHS
- Dose specified amount of powdered sample to PSHS





Powdered Sample Handling System

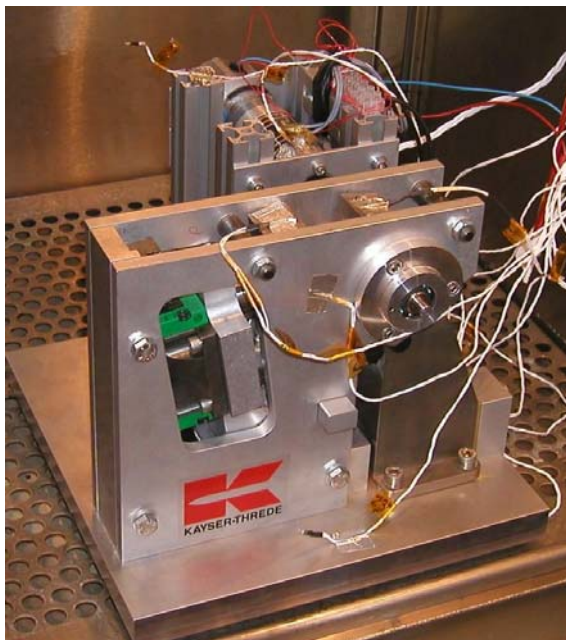


PSHS Main Functions

- Move ovens to receive powder from PSDDS
- Move MOMA ovens into tapping station
- Move refillable container to receive powder from PSDDS
- Flatten sample surface in refillable container
- Move refillable container under instruments
- Empty refillable container

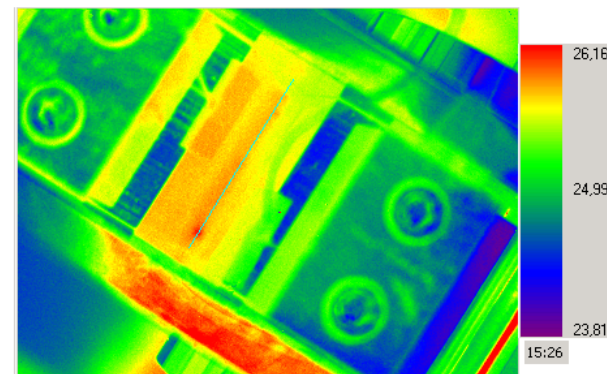


Crushing Station Breadboard Test Results

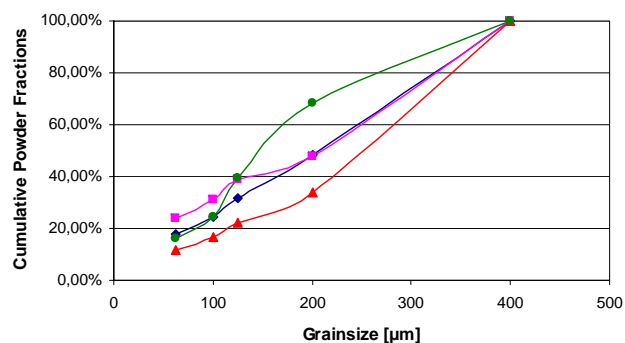


Tested Materials

- Basalt
- Sandstone
- Salten Skov
- Wet/frozen Sandstone
- Marble



Core sample temperature during crushing



Cumulative powdered fraction with jaw gap setting at 300–400 micrometer

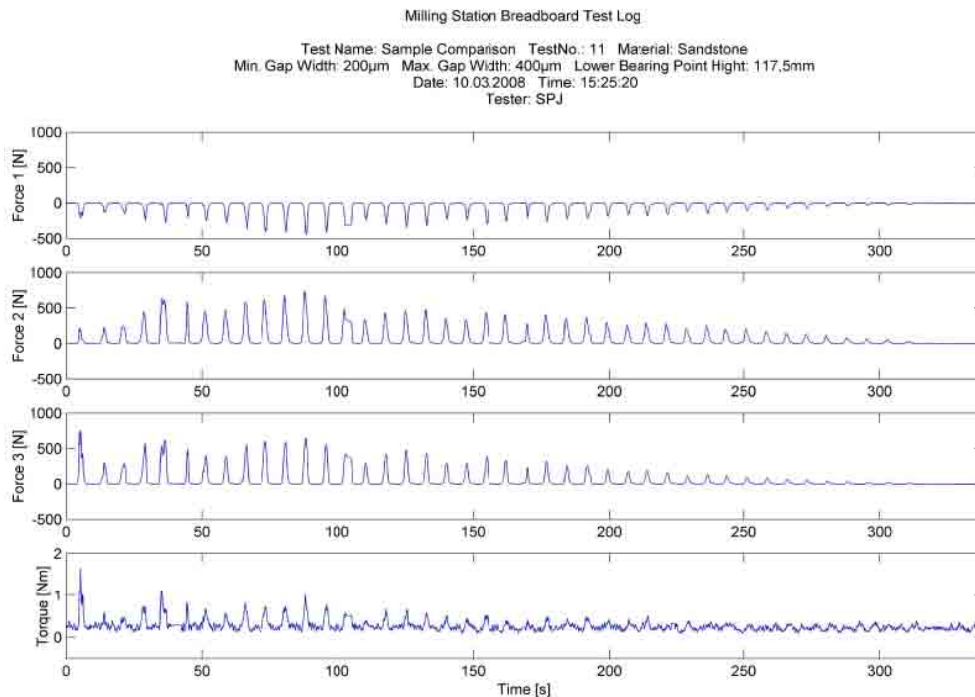
Material	Crushing Time			Sticking Material		
	TC	VC	TVC	TC	VC	TVC
Basalt (massive)	1h	1/2h	1/2h	0.3 %	0.3 %	0.7 %
Sandstone (wet/frozen)	2h	-	1/4h	4 %	-	0.6 %
Salten Skov (powder)	1/4h	1/4h	1/4h	80 %	2 %	2 %



Crushing Station Breadboard Test Results

Breadboard design influencing results

- Stable crushing proven
- Cross contamination within acceptable limits
- Local temperature increase of core during crushing is negligible
- Needed operational torques and forces where found
- Crusher housing/structure is not stiff enough when made of aluminium



Example of force/torque curve during crushing



Dosing Station Breadboard Test Results



Tested Materials

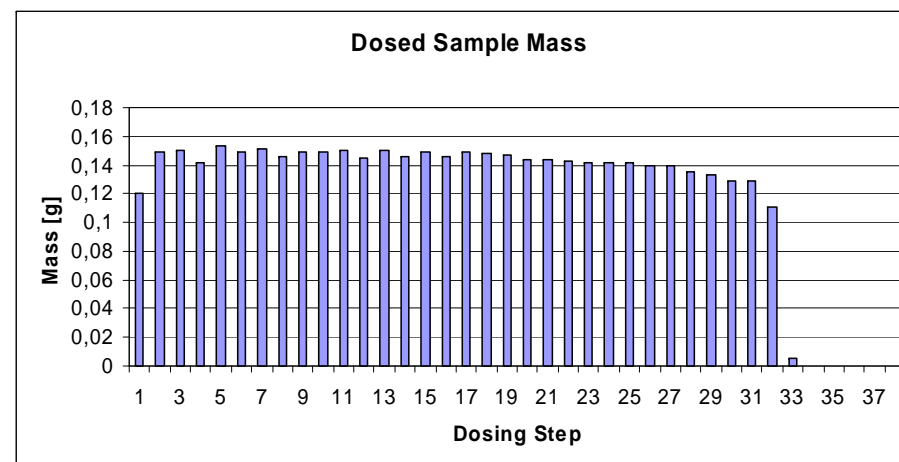
- Basalt
- Sandstone
- Salten Skov
- Marble

Sample material	"Sticking" material (percent by weight of the dosed sample mass)			
	Laboratory [RD2] ambient pressure, room temperature	Climate chamber ambient pressure, low temperature	Vacuum chamber (CO ₂) low pressure, room temperature	Thermal-vacuum chamber (CO ₂) low pressure, low temperature
Sandstone	≤ 0.1 % (red)	0.1 % (red)	0.1 % (red)	< 0.1 % (green sandstone)
Basalt (massive)	< 0.1 %	0.0 %	0.0 %	< 0.1 %
Marble	≤ 0.1 %	0.4 %	0.1 %	-
Salten Skov	≤ 0.4 %	0.4 %	0.8 %	0.2 %

Dosing Station cross contamination results

Sample material	Mass of one dosing step (average value)			
	Laboratory [RD2] ambient pressure, room temperature	Climate chamber ambient pressure, low temperature	Vacuum chamber (CO ₂) low pressure, room temperature	Thermal-vacuum chamber (CO ₂) low pressure, low temperature
Sandstone	0.145 g (red)	0.112 g (red)	0.150 g (red)	0.174 g (green sandstone)
Basalt (massive)	0.212 g	0.199 g	0.233 g	0.218 g
Marble	0.197 g	0.183 g	0.194 g	-
Salten Skov	0.094 g	0.086 g	0.112 g	0.093 g

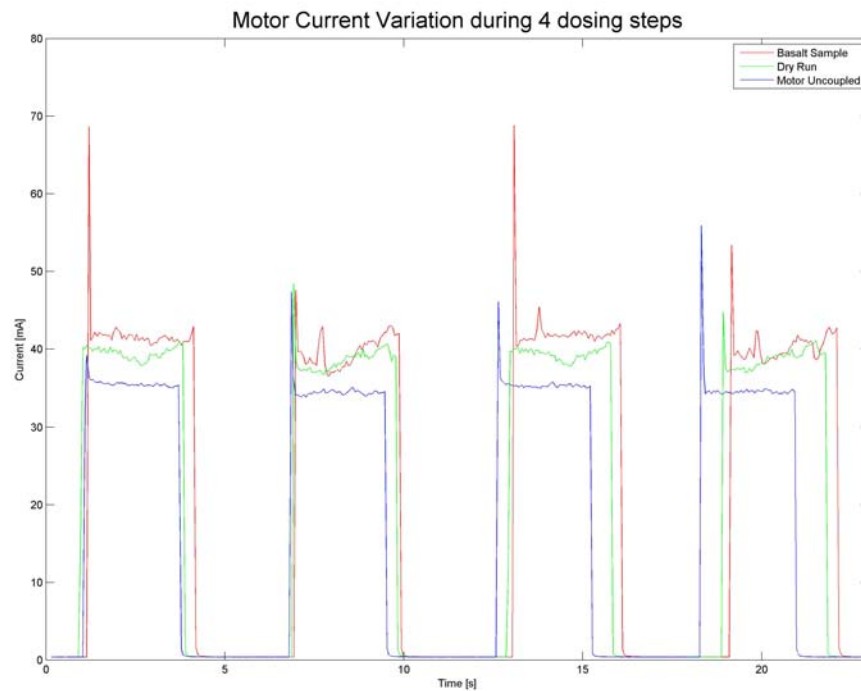
Dosing Station Test Results Mass per 0.1 ml dosing step



Example of Dosing Station repeatability



Dosing Station Breadboard Test Results



Example of motor current during dosing

Breadboard design influencing results

- Good functionality under all environments
- Needed operational torques and forces where found
- Vibrators needed
- With vibrator cross contamination negligible



Summary

- Breadboards proved to provide valuable information
- CS breadboard showed problems to be solved in further design
- Further breadboard activity needed (currently breadboards of CSTM and PSDDS are being built)
- DS showed good functionality under all environments.
- Vibrators needed in DS