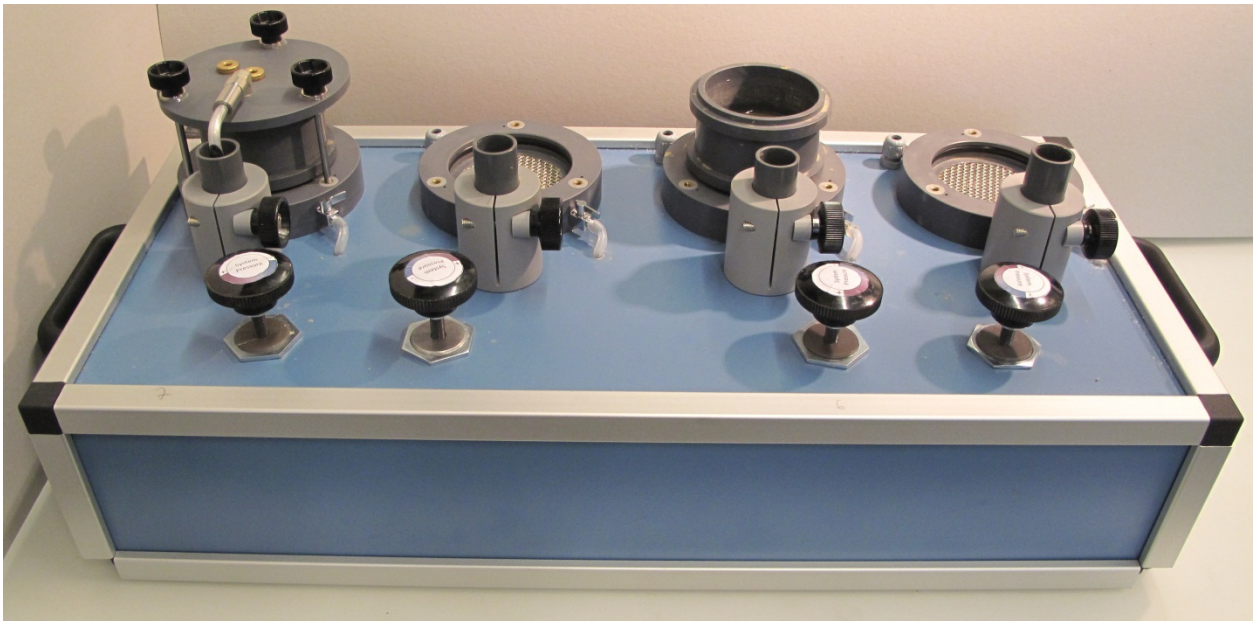
Eidgenössische Technische Hochschule Zürich
Ecole polytechnique fédérale de Zurich
Politecnico federale di Zurigo

Soil and Terrestrial Environmental Physics (STEP)

Manual to Ks-Station

Determination of the Saturated Hydraulic Conductivity



The Ks-Station is a measurement station to determine the **saturated hydraulic conductivity (K_{Sat} or K_S)** in **mm/h** of soils and sands and potentially other porous media. The station allows to measure four samples simultaneously on **four independent units**. Every unit is equipped with a **pressure regulator** to set an individual pressure to the corresponding sample. The inlet for water is at the bottom of the sample where the pressure (P_{in}) is measured. The outflow is on top where the water is collected in a **beaker** to determine the flow rate.

Saturated Hydraulic Conductivity: $$Ks = \frac{Q}{At} * \frac{L}{\Delta H} \left[\frac{mm}{h}\right]$$

A = Area of sample [mm^2]

L = Length (height) of sample [mm]

Q = Flow [mm^3], t = time [h]

ΔH = Hydraulic Head [mmH_2O]

Specifications:

Pressure Range: 0…250mbar

Fluid: water (deionized)

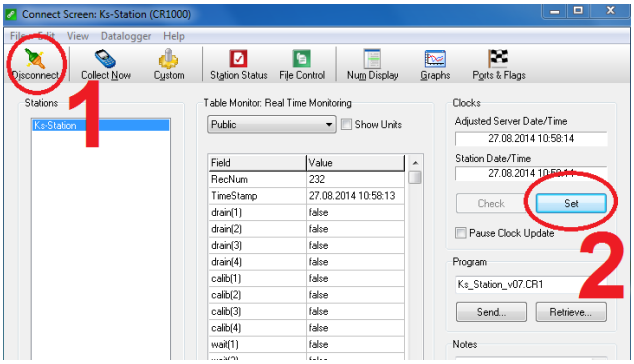
Max. Flow rate: ca. 1000ml/min

Power-Up the Ks-Station

1. Turn on Computer
   User: Ks-Station
   Password: normal
2. Turn on Ks-Station (switch on the right)
3. Turn on deionized tap water (check pressure regulator of the units before)

Connect Ks-Station to computer

4. Start LoggerNet in Taskbar 
5. Main->Connect: press connect symbol (1)
6. Synchronize Time: Press Set button (2)
7. Start Ks-Station in Taskbar 



Prepare sample for Measurement

- *Aluminum core sampler* for undisturbed soil samples:

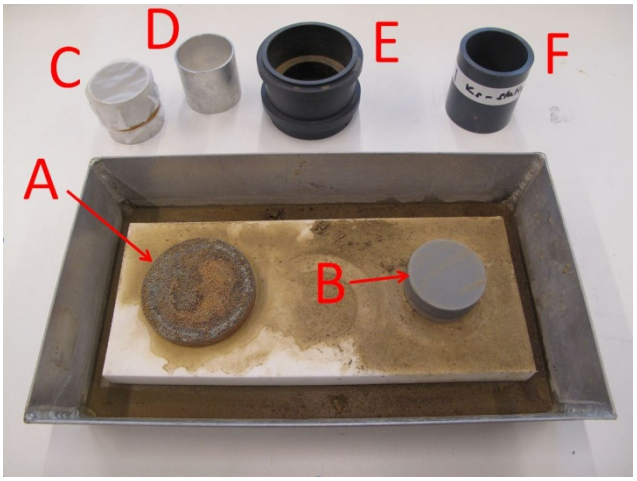
Use the preparation bench for better handling.

1. Remove mesh when existing (C)
2. Put Sample with soil on porous brass plate (A)
3. Put PVC adapter (E) on top and press over core sampler

Aluminum core-sampler dimensions: Diameter=50mm, Height=51mm, Volume=100cm^3

(Alternatively the aluminum core samplers can be injected to the PVC adapter including the mesh. There is a plunger (F) to improve the handling.)

The cylinder piece (B) is used to eject the sample

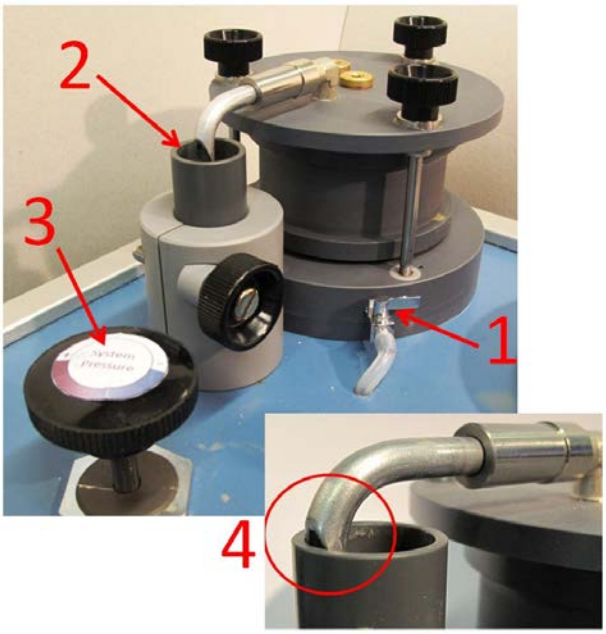


- *Long Core-Sampler* for sands, glass beads and material with high hydraulic conductivity values

Dimensions:

Not available yet

4. Make sure the ***de-airing valve (1)*** is open
5. Take adapter with sample and insert slowly into one of the four units socket.
6. Cover sample with deionized water from a bottle.
7. Insert lid and lock with 3 screws: no force needed!!
8. Slowly rise pressure with ***pressure regulator (3)*** and watch the tube attached to the de-airing valve (1).
9. Close the de-airing valve when no bubbles are visible
10. Wait and rise pressure until water is steadily dripping at the outlet
11. Rise the ***cylinder (2)*** to the outlet and merge (4) so the drops flow along the cylinder wall

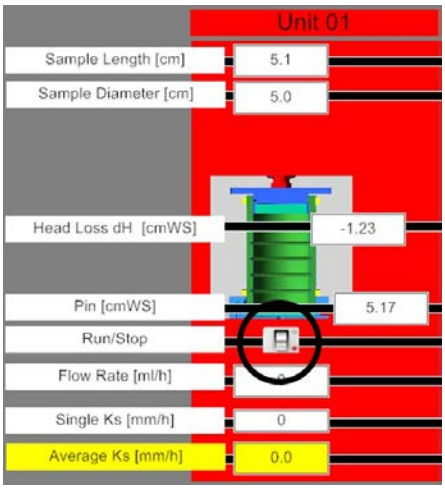


Run measurement

1. Press Run/Stop to start the measurement

The measurement is finished when the averaged Ks value is stable for a few single measurements.

2. Press Run/stop to turn the measurement off.
3. Write down the Value for Average Ks - the Value is not saved automatically



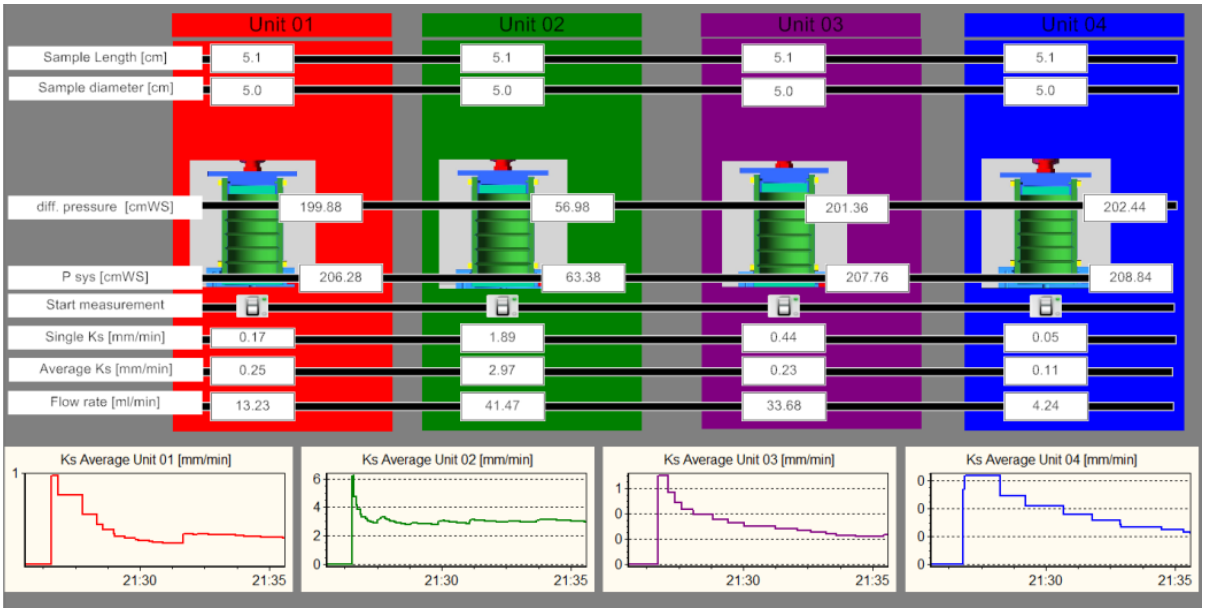
Remove sample

12. Remove the screws
13. Hold PVC Adapter and slowly turn the lid while removing.
14. Slowly turn the sample while removing it from the socket.

Use the preparation bench for better handling.

15. Put the adapter with sample on the cylinder piece and eject the aluminum core sampler.

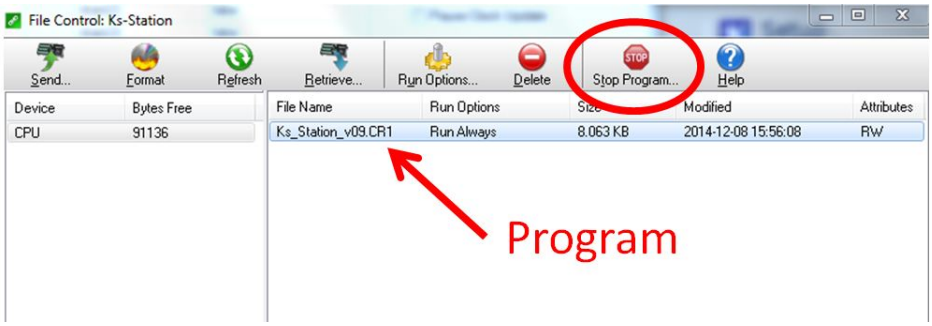
Program interface



The four units are indicated with four different colors. The according graphs show the averaged Ks Value with the according color. Unfortunately the software does not allow to reset the graphs or to change the scale.

Troubleshooting

Error:	Solution:
Constant water flow from bottom mesh.	1. Unscrew and remove the pressure regulator head (see image). 2. Use a screwdriver, Allen key or similar and push the membrane down with a few short strokes through the threaded hole. **Important: Remove the sample before and place an empty PVC adapter and the lid. Be aware that a lot of water will come out so keep an eye on the Water level in the cylinder.** Eventually the water will stop to flow after two or three strokes. 
Program interface frozen	Restart the firmware manually: 1. Open the LoggerNet Program and go to Main – Connect. 2. Make sure the Ks Station is connected. 3. In the new window click "*File Control*" in the ribbons section. 4. Another window opens (see image below) where you can select the Ks Program. Press "*Stop Program*" in the ribbons section. 5. Right click the Ks station program and select "run options". Check the box "restart program" and press ok. The program should react normally again.



Appendix

Interpret values:

- Trapped air will close pores and pass ways. Air is typically degassing from water when it warms up. This will lower the Ks during the measurement.
- Material with very high Ks values (>2000mm/h) are more difficult to measure because it is more difficult to reach a constant pressure at P_{in}.

Problems:

1. A pressure jump in the measured water level in the cylinder is expected when the water in the cylinder evaporated completely before the first measurement. This is caused at the interface water to pressure transducer. Steering in the cylinder with a long rod can help to set back the pressure level. The measurement is not effected by the jump but the program can get stuck in the draining mode.
2. Sometimes a pressure regulator does not completely close when the pressure handle is completely released. Then the handle needs to be removed and the piston underneath needs a strong push with a stick.

Ks-Table for Sand & Soil:

Soil texture	Ks[cm/h]
sand	63.36
loamy sand	56.28
sandy loam	12.44
Silty loam	2.59
loam	2.50
sandy clay loam	2.27
silty clay sloam	0.61
clay loam	0.88
sandy clay	0.78
silty lay	0.37
clay	0.46

(Clapp and Hornberger - 1978)