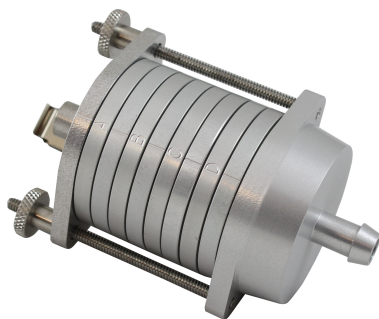




## Operating Instructions

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### Sioutas Cascade Impactor



The patented<sup>†</sup> personal Sioutas Cascade Impactor consists of four impactation stages and an after-filter that allows the separation and collection of airborne particles in five size ranges. The Sioutas Cascade Impactor is used with the Leland Legacy<sup>®</sup> Sample Pump (SKC Cat. No. 100-3002) or any other pump capable of maintaining a constant flow rate of 9 L/min. Particles above each cut-point are collected on a 25-mm PTFE filter in the appropriate stage. Particles below the 0.25  $\mu\text{m}$  cut-point of the last stage are collected on a 37-mm PTFE after-filter. The Sioutas Cascade Impactor clips onto a worker's collar in the breathing zone and the pump clips onto the worker's belt. For area sampling, the impactor can be attached to a tripod or clipped in an appropriate location. The Sioutas Impactor may be used for ambient outdoor sampling with special provisions. *See Sampling.* Size-fractionated samples can be analyzed gravimetrically, chemically, and microscopically.

<sup>†</sup> U.S. Patent No. 6,786,105

## Performance Profile

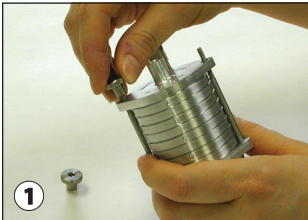
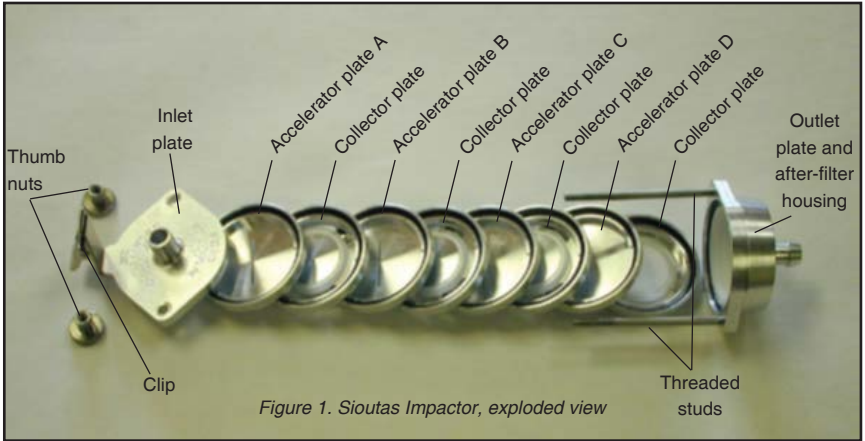
<b>Flow Rate:</b>	9 L/min
<b>50% Cut-point at 9 L/min:</b>	Stage A      2.5 $\mu\text{m}$ Stage B      1.0 $\mu\text{m}$ Stage C      0.50 $\mu\text{m}$ Stage D      0.25 $\mu\text{m}$
<b>Recommended After-filter Type:</b>	37-mm, 2.0- $\mu\text{m}$ PTFE filter* with PMP support ring (SKC Cat. No. 225-1709)
<b>Recommended Filter for Stages:</b>	25-mm, 0.5- $\mu\text{m}$ PTFE filter*, unlaminated, no support pad included (SKC Cat. No. 225-17-21)
<b>Certification:</b>	EPA-ETV has verified the Sioutas Impactor performance with the Leland Legacy sample pump. See <a href="http://archive.epa.gov/nrmrl/archive-etv/web/pdf/vs_skcsioutas.pdf">http://archive.epa.gov/nrmrl/archive-etv/web/pdf/vs_skcsioutas.pdf</a> for details.
<b>Wind Velocity:</b>	< 5 mph
<b>After-filter Operating Temperature (maximum):</b>	464 F (240 C) based on PMP support ring
<b>Maximum Particle Load:</b>	Varies per stage. See Misra, C., et al. "Development and Evaluation of a Personal Cascade Impactor Sampler (PCIS)," <i>Journal of Aerosol Science</i> , 33, 2002, pp. 1027-1047
<b>Impactor Material:</b>	Inlet/outlet plates and stages are anodized autoclavable aluminum; O-rings are Buna-N (Nitrile); filter retainers are acrylic; compression ring is PTFE
<b>Inlet and Outlet Diameters:</b>	<i>Inlet:</i> 3/8-in OD, 1/4-in ID <i>Outlet:</i> 3/8-in OD, 1/4-in ID
<b>Dimensions:</b>	3.4 x 2.2 in (8.6 x 5.6 cm)
<b>Weight:</b>	5.6 oz (159 gm)
<b>Tubing:</b>	3/8-in ID

\* Back pressure on PTFE filters can vary within the same lot.

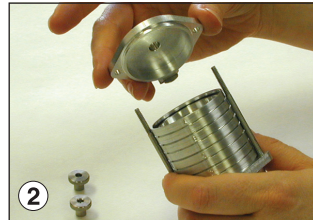
## Disassembly

The Sioutas Impactor will arrive already assembled with the exception of the filter retainers, which are included, but packaged separately. Disassemble it to clean (*see Cleaning*), to load with filters (*see Assembly*), or to remove filters after sampling.

Disassemble the impactor from inlet to outlet. *See Figure 1 and follow Steps 1-7.*



Remove thumb nuts.



Remove inlet plate.



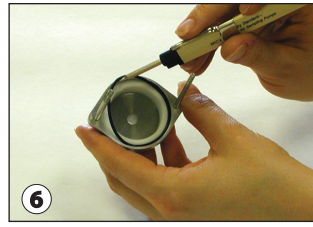
Lift off together accelerator plate A and collector plate.



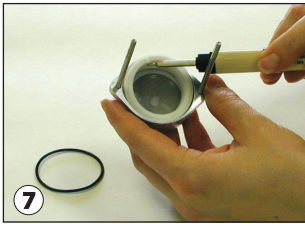
Lift accelerator plate A off collector plate.



Repeat Steps 3 and 4 for stages B-D.



Remove O-ring from outlet plate.  
See Figure 2.



Remove compression ring from outlet plate. See Figure 2.

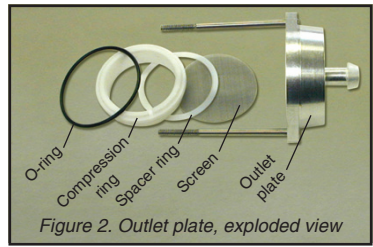


Figure 2. Outlet plate, exploded view

**Note:** Use forceps to carefully insert or remove impaction substrate, after-filter, and filter retainers.

## Media and Impactor Preparation

Equilibrate and pre-weigh the filters in a clean environment according to appropriate procedures. Record the weight as the pre-sample weight.

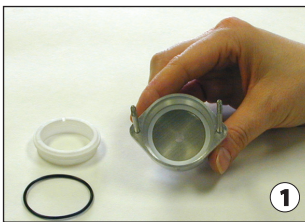
Clean the Sioutas Impactor in between samples to remove any residual particles. See *Cleaning*.

## Assembly

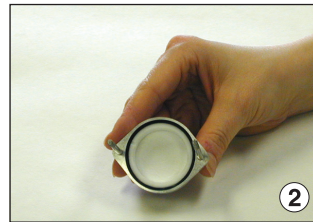
In a clean environment, assemble the Sioutas Impactor from outlet to inlet as follows:



**Caution:** Handle all filter material with forceps.



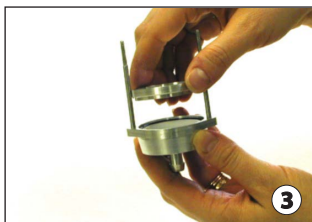
Remove O-ring and compression ring from outlet plate. See Disassembly, Steps 6 and 7 and Figure 2.



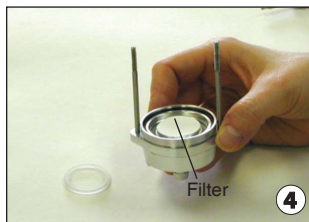
Insert 37-mm after-filter in outlet plate.  
Replace compression ring and O-ring.



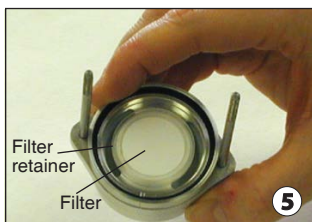
Ensure that the screen and spacer ring (Figure 2) are in place before inserting filter. The screen prevents the filter from restricting the outlet.



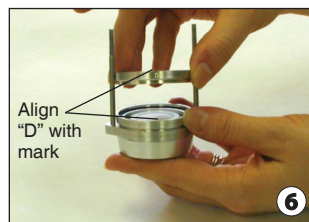
*Nest a collector plate in top of outlet plate.*



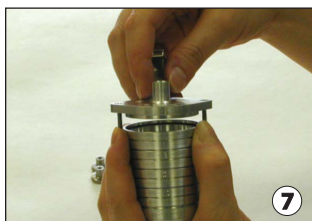
*Use forceps to place a 25-mm filter in collector plate.*



*Use forceps to place a filter retainer on top of the filter. Press down firmly until snug.*



*Place accelerator plate D (O-ring side up) on top of collector plate. Align "D" with mark.*



*Repeat Steps 3 through 6 for stages C-A, slide inlet plate into place, and screw on thumb nuts.*

**Note:** Tighten thumb nuts using an alternating pattern. It is important to the operation of the impactor to tighten the thumb nuts completely.

## **One, Two, or Three-stage Sampling**

Place desired number of loaded stages (accelerator and collector plate pairs) onto the outlet plate. Replace the inlet plate, replace and tighten the thumb nuts, verify flow rate, and sample.

## Flow Rate Verification

**Verify pump flow rate with the Sioutas Impactor and representative after-filter in place.** It is not necessary to pre or postweigh representative media. You may also verify flow rate with representative filters in all the stages if desired, but it is not necessary for proper flow rate verification.

1. Using flexible tubing, connect the outlet of the Sioutas Impactor to the inlet of a Leland Legacy Sample Pump or other pump capable of maintaining a constant 9 L/min flow rate.
2. Connect the inlet of the Sioutas Impactor to the outlet of a flowmeter capable of verifying a flow rate of 9 L/min.
3. Verify that the sample pump flow rate is 9 L/min. *See flowmeter and pump operating instructions.*

## Sampling

- As the particle load on the after-filter increases during sampling, the pressure drop will also increase. Therefore, use a compensating sample pump such as the Leland Legacy Cat. No. 100-3002.
- Back pressure on PTFE filters can vary within the same lot.
- The Sioutas Impactor may be used for ambient outdoor sampling with the following provisions:
  1. Wind velocity is < 5 mph.
  2. The impactor plates are not overloaded.

1. Following flow rate verification, remove and set aside the representative sample media. Replace with new, preweighed media. See *Media and Impactor Preparation and see Assembly*.
2. Turn on the pump and record sample start time and other pertinent data.
3. After the desired sample time has elapsed, turn off the pump and record sample stop time.
4. Remove pump and tubing. Transport samples and pertinent sampling information to a laboratory for analysis. See *Removing and Transporting the Samples*.



Sioutas Impactor in sampling train

## Removing and Transporting the Samples

Disassemble the stages. See *Disassembly*. Using forceps, carefully remove filters for weighing and analysis. If transporting samples to an offsite laboratory, place samples in marked, sealed containers and transport.



Clearly indicate on sample containers and chain-of-custody forms the stage from which each filter was removed.



Package and transport samples in a manner that will prevent sample loss and contamination.

## Analysis

Size-fractionated gravimetric, chemical, and microscopic analyses

## Cleaning

Clean the Sioutas Impactor in between samples to remove residual particles.

Disassemble all stages (*see Disassembly*) and O-rings. To remove O-rings, align the head of a small flat-head screwdriver with the notch in the inner wall of the plate. Gently lift the O-ring up and out. Wash all parts except filter retainers either in water with detergent or in isopropyl alcohol. **Wash filter retainers only in water with detergent.** Parts may also be cleaned in an ultrasonic bath. Rinse and dry all parts thoroughly with compressed air if available. Otherwise, air dry in a clean environment. Inspect all accelerator plates by holding them up to a light to ensure that none of the impaction slits are clogged. Impaction slits may be cleaned with compressed air.



*Do NOT use any mechanical object to clear an obstruction from a clogged impaction slit.*

### Tips

- Additional collector plates can be loaded and ready to use when sampling at multiple sites. *See Accessories for ordering replacement collector plates.*
- Handle all filter material and filter retainers with forceps. *See Accessories for ordering forceps.*
- The Sioutas Impactor may be used for ambient outdoor sampling with the following provisions:
  1. Wind velocity is < 5 mph.
  2. The impactor plates are not overloaded.



## Ordering Information

Description	Cat. No.
<b>Sioutas Personal Cascade Impactor</b>	<b>225-370</b>

Pump for Sioutas Impactor	Cat. No.
<b>Leland Legacy Sample Pump</b> , # 5 to 15 L/min, with Li-Ion battery pack, CE marked	<b>100-3002</b>

Filters for Sioutas Impactor	Cat. No.
<b>After-filter</b> , 37 mm PTFE <sup>+</sup> with PMP support ring, 2.0 µm, pk/50, <i>optional</i>	<b>225-1709</b>
<b>Collection Substrate (filter for 4 stages)</b> , 25-mm PTFE <sup>*</sup> , 0.5 µm, unlaminated, no support pad included, pk/100, <i>required</i>	<b>225-17-21</b>

<sup>\*</sup> Back pressure on PTFE filters can vary within the same lot.

<sup>‡</sup> Maximum operating temperature is 464 F (240 C) based on PMP support ring.

<sup>#</sup> Use in non-explosive environments only, not UL Listed for intrinsic safety

Accessories	Cat. No.
<b>Tubing</b> , Tygon, 3/8-inch ID, fits Sioutas Impactor and Leland Legacy pump, 10 feet	<b>225-1351</b>
<b>Replacement Collector Plates</b> , set of 4	<b>P55016</b>
<b>Ring/Spacer Set</b> includes 4 filter retainer rings, 9 O-rings, 1 PTFE spacer ring	<b>P51917</b>
<b>Filter Retainers only</b> , pk/4	<b>P20151</b>
<b>Forceps</b> , precision stainless steel with serrated tips for inserting filters	<b>225-13-1</b>

## Development

Developed by Dr. Constantinos Sioutas of the University of Southern California in partnership with the Mickey Leland National Urban Air Toxics Research Center (NUATRC).

## References

Misra, C., Singh, M., Shen, S., Sioutas, C., and Hall, P., "Development and Evaluation of a Personal Cascade Impactor Sampler (PCIS)," *Journal of Aerosol Science*, 33, 2002, pp. 1027-1047

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Ono-Ogasawara, M., Myojo, T., "Characteristics of multi-walled carbon nanotubes and background aerosols by carbon analysis; particle size and oxidation temperature," *Advanced Powder Technology*, 2012, <http://dx.doi.org/10.1016/j.apt.2012.06.013>

Singh, M., Misra, C., Sioutas, C., "Field Evaluation of a Personal Cascade Impactor Sampler (PCIS)," *Atmospheric Environment*, 37, 2003, pp. 4781-4793

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