

UNIVERSITY OF LOUISIANA AT LAFAYETTE

STEP Committee

Technology Fee Application

**Bring Ultrapure Water Purification System
to Analytical Chemistry Laboratory**

Title

Hui Yan

Name of Submitter
(Faculty or Staff Only)

Chemistry Department

Organization

Title: Bring Ultrapure Water Purification System to Analytical Chemistry Laboratory Date: 01/14/2022
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ABSTRACT (250 words or less):

The purpose of this proposal is to acquire one set of ultrapure water purification system for sample preparations in Analytical Chemistry Laboratory courses including Analytical Chemistry lab - CHEM 222, Instrumental Analysis (lecture and lab) - CHEM 430, undergraduate research courses-CHEM 362 and CHEM 462. These Analytical Chemistry courses provide our students (65±5 students/yr will be directly benefits from this grant, while several hundred students/yr can indirectly benefit from it) with necessary training experience in the application of chemistry concepts by solving analytical problems and using modern instrumentation. Experiments are designed in the courses to measure a variety of trace amount of organic and inorganic analytes in water solution or other matrixes. Ultrapure water purification system is crucial in analytical labs as it provides almost ion free ultrapure water, for students to make blank solutions and more importantly, for sample preparation. Ultrapure water is especially critical for analyzing those substances with trace amounts using atomic spectroscopies such as atomic absorption and/or ICP-OES. Unfortunately, we do not have any ultrapure water purification system in our Analytical Chemistry laboratories, which limits the precisions and accuracy, and analysis skills that students should understand and accumulate in college. The acquisition of one set of ultrapure water purification system and its accessories including filters and storage tank, will provide our students with ultrapure water in sample preparation for them to achieve precision and accuracy in analysis, so to be better prepared for their career.

A. Purpose of grant and impact to student body as a whole

The purpose of this proposal is to acquire one set of ultrapure water purification system, which will in Analytical Chemistry Laboratory courses, including CHEM 222, CHEM 430, and undergraduate research courses-CHEM 362 and CHEM 462. Those analytical lab courses provide students with necessary experience in the application of analytical chemistry concepts by solving analytical problems and using modern chemical tools and instrumentation, to obtain precise and accurate results.

An ultrapure water purification system is a standard system, to provide pure and ultrapure water for sample preparation in chemical process industries such as food, agricultural, and pharmaceutical companies. The main function of ultrapure water purification system is to produce Type 1 and Type 3 water. Type 1 water is ultrapure water (18.2 M Ω cm resistivity at 25°C and >10 ppb Total Organic Carbon). It is used for sample preparation, sample dilution, buffer and cell culture media preparation, preparation of chemical solutions used with titrators, spectrophotometers and electrophoresis systems. While Type 3 water (Reverse Osmosis) is for basic lab and non-critical applications such as glassware washing or rinsing. Several experiments in the courses are designed to measure a variety of analytes with low concentrations in our environment such as water sample or commercial products. In those experiments, a standard is usually used to generate a standard curve, which is the base for determining the analyte concentration, therefore, if the standards is not pure, the concentration of analyte determined will be very wrong. For example, in the experiment of “Ion-Selective-Electrode Potentiometry”, students learn to analyze the concentration of fluoride in Tap Water. Fluoridated water contains fluoride at a level that is effective for preventing cavities and to reduce tooth decay. However, excess amount of fluoride over a lifetime may have increased adverse health effects of fluoride, such as increased likelihood of bone fractures for adults, and children aged 8 years and younger have an increased chance of developing pits in the tooth enamel, along with a range of cosmetic effects to teeth. Thus, the current enforceable drinking water standard is 4.0 mg/L for fluoride, which is the maximum amount that is allowed in water from public water systems. Another example is to measure Ca²⁺ and Mg²⁺ concentrations in collected water sources such as tap water, by ICP and/or Atomic Absorption spectroscopy. The concentration of those ions in tap water are know to be about 32 \pm 4 ppm for Mg²⁺ and 100 \pm 5 ppm for Ca²⁺, therefore, for students to accurately analyze those ion concentrations in water sources, solvents and blanks must have low ion concentrations (close to 0 ppm). This means, in those experiment, *students MUST use ultrapure water purification system* to prepare for blanks and standards with accurate concentrations, which will in turn ensure the correct measurement of concentration of ions (F⁻, Ca²⁺ and Mg²⁺) in various water sources.

Currently, we DO NOT have any working *ultrapure water purification system* in our analytical chemistry lab courses. We have to buy commercially available ultrapure water at a cost of \$ 40 per liter, which means it will easily go over \$4,000 per section, assuming one section has 12 students and each student uses 8 Liter of ultrapure water throughout the semester. Therefore, acquiring one system will sufficiently reduce our cost for obtaining ultrapure water, which is the second reason we have to bring them to our analytical chemistry laboratories. More importantly, the fact that CHEM 222, 430, 362 and 462 students do not currently have any working ultrapure water purification system, will be reflected on students’ lack in training that is required in terms of the accuracy and precision of trace elements analysis in aqueous solutions, for their future career. Therefore, it is critical that we improve our technology by implement ultrapure water purification system and their accessories into our analytical chemistry laboratory courses.

The impact to students: most of our CHEM 222 and 430 students are biology, environmental, education, chemical & petroleum engineering, and pre-pharmacy or pre-med as well as forensic majors. Two sessions in the fall and two sessions in the spring, a total of 48 - 56 students taking Analytical Chemistry Lab (CHEM 222) in room 206 of Montgomery Hall since each section of the course is limited to 14 students because of safety concerns and the lab space, and 6 - 9 students enrolled in instrumental analysis (lecture, lab and essay, CHEM 430). We have students on the waiting list each semester. Therefore, it is estimated that approximately 65 ± 5 students will learn how to use ultrapure water purification system each year. The one set of ultrapure water purification system will give them decent amount of training in sample preparation. This will also enhance their education in science and reinforce what they learned in previous chemistry laboratories.

If the funds are approved, one set of ultrapure water purification system in the attached quotes will be purchased and placed into room 206 of Montgomery Hall or nearby labs where space is allowed. The quoted model owns the features as attached.

With the Direct-Q® range of water purification system, students benefit from a choice of ultrapure water configurations, i.e. Type 1 water ($18.2 \text{ M}\Omega \cdot \text{cm}$ at $25 \text{ }^\circ\text{C}$ ultrapure water) on demand or Type 3 water from the 6L built-in storage tank or can be sent by a distribution pump to feed instruments such as a glassware washing machine. The specification of the system is attached as a supplement material. This is even better since the students will be trained using the right purity of water for different tasks.

The instructor and professors who oversee the laboratory will maintain the ultrapure water purification system and ensure that work for all students for many years to come.

B. Projected Lifetime of Enhancement

The projected lifetime of the instruments requested is over ten years, with the correct installation and maintenance (filters and parts are also budgeted here)

C. Person(s) Responsible for:

Implementation: Hui Yan

Installation: Hui Yan

Maintenance: Routine maintenance covered by the Department of Chemistry

Operation: Faculty of the Department of Chemistry and Analytical Laboratory Students

Training: Faculty of the Department of Chemistry

Budget Proposal

	Type	Quantity	Price	Total
1.	Equipment	1	\$6,850	\$6,850
	Equipment	1	\$1,440	\$1,440

The list price of one set of a ultrapure water purification system is \$6850.00, the 30 Liter Polyethylene Storage Tank is \$1440. The total for one set of ultrapure water purification system is \$8290.

2.	Software	0	\$0	\$0
3.	Supplies	0	\$0	\$0
4.	Maintenance	1	\$972	\$972
5.	Personnel	0	\$0	\$0
6.	Other (shipping)	0	\$0	\$0

The maintenance fee for the Milli-Q SmartPak® DQ8 Purification Pack is \$972

TOTAL:	\$9,262
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Other Relevant Information

None

Previous STEP projects

Hui Yan and Febbe Louka “Bring Rotary Evaporator for Sample Preparation to Analytical Chemistry Laboratory Courses”, Fall 2017, \$8,700

Hui Yan and Febbe Louka “Improving Precision and Accuracy in Analytical Chemistry Laboratory Courses”, Fall 2016, \$5,137.72



Shopping Cart

Jan 18, 2022

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Product	Qty/Pack	Shipping /Availability	Quantity	Total
ZRQSV5WW Milli-Q Direct-Q® 5 UV Water Purification System	1		1	USD 6,850.00
TANKPE030 Milli-Q 30 Liter Polyethylene Storage Tank	1		1	USD 1,440.00
SPR08SIA1 Milli-Q SmartPak® DQ8 Purification Pack	1		1	USD 972.00
Your Subtotal				USD 9,262.00

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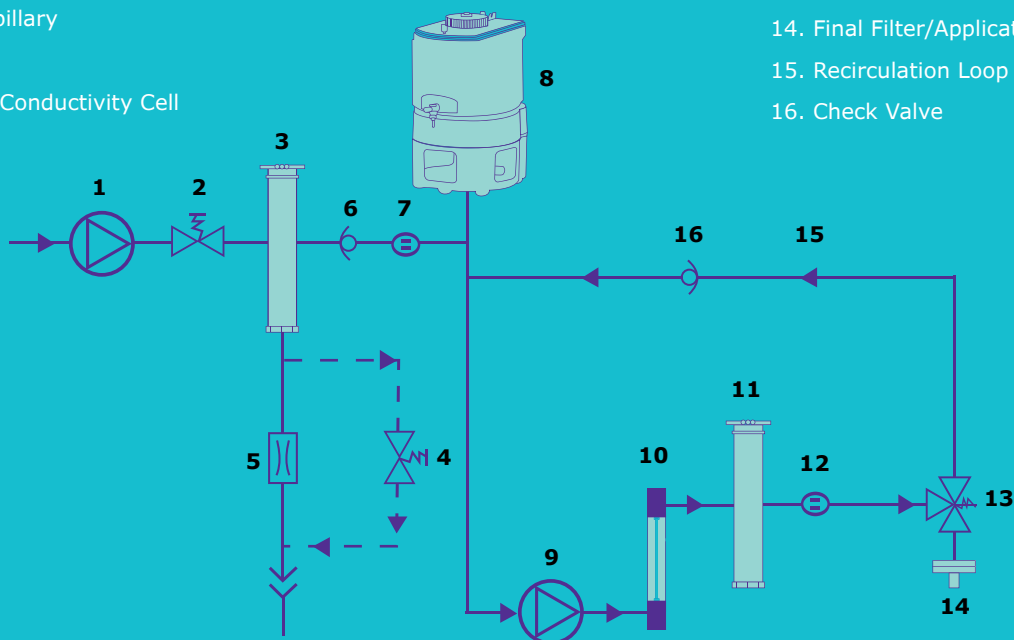
Milli-Q®
Lab Water Solutions

Tap to pure and ultrapure water — with easy and convenient dispense!

Your water purification needs	Our solution: the Direct-Q® range of water purification systems
High quality water produced directly from tap water	Direct-Q® systems deliver both pure and ultrapure water directly from tap for use with a wide variety of applications in your lab.
Ultrapure water easily accessible wherever you need it in your lab	With the Direct-Q® range of water purification systems, you benefit from a choice of ultrapure water dispensing possibilities. The innovative, space-saving Remote dispenser offers you water delivery solutions to best fit the way you work, with easy and convenient remote delivery up to two meters away from your water production unit.
Compact all-in-one system for the most efficient use of your lab space	The Direct-Q® range includes versatile solutions that can be bench-integrated or bench-/wall-installed.
A choice of adequate storage volumes	Direct-Q® systems come either with an integrated 6-liter reservoir or an external reservoir (30 L or 60 L).
Flow rates adapted to your daily usage	Systems in the Direct-Q® range provide 3, 5 or 8 liters of pure water per hour , covering lab needs of 50, 100 and 150 L of pure water per day.
Instant flow rates to match your needs	Direct-Q® systems dispense up to 30 L of ultrapure water per hour .
High quality water to meet the requirements of your most critical applications	Options such as a UV lamp and a range of Application Pak point-of-use polishers are available to fine-tune your ultrapure water.
Easily accessible information on system operation	The user-friendly display provides system status at a glance; the concise Quick Reference Guide is a handy guide for daily operation.
Simple, low-level self-maintenance	All-in-one SmartPak® cartridges enable easy and rapid replacement.

Direct-Q® Systems Water Purification Pathway

1. Booster Pump
2. Inlet Solenoid Valve
3. SmartPak® Part 1 (Pretreatment and RO Cartridge)
4. RO Reject Solenoid Valve
5. RO Reject Capillary
6. Check valve
7. RO Permeate Conductivity Cell
8. Reservoir (Built-in or separate, depending on model)
9. Distribution Pump
10. UV Lamp 185/254 nm (UV Systems)
11. SmartPak® Part 2 (Synthetic Activated Carbon & Ion Exchange Polisher Cartridge)
12. Product Resistivity Cell
13. Point-of-Use (POU) 3-way solenoid valve
14. Final Filter/Application Pak
15. Recirculation Loop
16. Check Valve



Choose the solution that's right for you

Easy installation

The Direct-Q® range of systems requires no special installation. You can easily set the system up yourself: just connect the system to your tap water supply, plug it in, and insert the SmartPak® purification cartridges. Then, if your configuration includes the Remote dispenser or a 30- or 60-liter reservoir*, follow the simple setup procedures — and your system is ready to use!

Optimized lab space

The compact, all-in-one Direct-Q® water purification unit lets you locate it nearly anywhere in your laboratory, either on or under the benchtop, or wall-installed.

* Direct-Q® 5 and Direct-Q® 8 systems are designed for use with a 30 L or 60 L external reservoir.



Flow rates to match your requirements

Choose the solution that best meets your lab's requirements with a Direct-Q® system that provides 3, 5, or 8 liters of pure water per hour, and more than 0.5 L of ultrapure water per minute (> 30 L per hour). When not in use, the Direct-Q® system automatically recirculates water in order to maintain high water quality, so that you do not have to wait when sourcing ultrapure water. For your convenience, and to save time, you can set the system to automatically deliver your selected volume of ultrapure water on demand.

Choice of storage volumes

With its built-in reservoir, the Direct-Q® 3 system can store 6 L of reverse osmosis (RO) water, while Direct-Q® 5 and 8 models are designed for use with a 30- or 60-liter reservoir. Just choose the storage volume that best meets your daily water volume needs.



Fine-tune your water quality

Both pure and ultrapure water

The Direct-Q® range of systems provides you with a convenient and flexible solution for your pure and ultrapure water needs, directly from potable tap water. You'll have access to ultrapure water for your critical applications, and pure water for less critical applications such as general glassware washing or final rinsing — from the same system! The high quality ultrapure water produced by Direct-Q® systems is suitable for applications such as production of mobile phase for chromatographic separations; preparation of blanks and standard solutions for spectrophotometry, spectroscopy or other analytical techniques; and preparation of buffers for biochemical experiments.

Organic-sensitive applications

Direct-Q® systems are also available with a built-in 185/254 nm UV lamp to reduce the level of organics for critical applications. Water with low TOC provides important benefits to HPLC users such as higher sensitivity and longer column lifetime. The same UV lamp also destroys bacteria.

Application Pak point-of-use polishers

Our range of Application Pak polishers makes it possible to fine-tune your ultrapure water quality to match your research needs. Are your applications sensitive to bacteria, particulates, pyrogens, nucleases, endocrine disruptors or volatile organic compounds? If so, just choose the appropriate final polisher from our range of Application Paks to provide optimal water quality for your requirements.

Please see EMDMillipore.com/labwater for more information.



Stay focused on your work

Versatile remote dispenser

Designed to fit perfectly into your lab environment, the versatile Remote dispenser can be placed up to two meters from your Direct-Q® water purification unit. Select the free-standing or wall-installed model according to your needs — their ergonomics will make either one a welcome addition to your lab, giving you the freedom to focus on your research, while dispensing ultrapure water exactly where you need it. Alternatively, Direct-Q® systems are also available with an integrated dispenser for use on the benchtop.

The design of the bench-installed Direct-Q® systems is also adapted to the height and shape of common laboratory glassware.



Milli-Q® offers more than water

Just the information you need

The intuitive color graphic display shows key system parameters at a glance, enabling easy water quality and maintenance warnings monitoring; the screen rotates for easy viewing wherever the system is located. A short Quick Reference Guide is conveniently located in the base of the system for immediate information; the complete User Manual can be stored at the back of the water purification unit.

User-friendly maintenance

The all-in-one SmartPak® purification cartridges are easily replaced in just a few minutes.

Milli-Q® Services portfolio

To optimize the performance and lifetime of your water purification system, we offer a complete portfolio of Milli-Q® Services ranging from a single annual checkup to full system coverage. For more information, please check with your applications specialist or visit our website:

EMDMillipore.com/Milli-Qservices



Direct-Q® System Specifications

Ultrapure (Type I) Product Water Quality*	Direct-Q® Systems
Resistivity	18.2 MΩ·cm @ 25 °C
Production flow rate Direct-Q® 3	3 L/h @ 25 °C ±15%
Production flow rate Direct-Q® 5	5 L/h @ 25 °C ±15%
Production flow rate Direct-Q® 8	8 L/h @ 25 °C ±15%
Instant flow rate (with Application Pak final filter)	> 0.5 L/min
TOC (w/o 185/254 nm UV lamp)	< 10 ppb
TOC (with 185/254 nm UV lamp)	< 5 ppb
Particulates (size > 0.22 µm)**	< 1 particulate/mL
Bacteria**	< 0.1 cfu/mL
Endotoxin***(pyrogens)	< 0.001 EU/mL
RNases***	< 0.01 ng/mL
DNases***	< 4 pg/µL

* In regular operating conditions

** With Millipak® Express 20 (0.22 µm) membrane filter or with BioPak® ultrafiltration cartridge as final polisher

*** Only with BioPak® ultrafiltration cartridge as final polisher

System Information

Pure (Type III) Product Water Quality*	
Ionic rejection	> 96%
Organic rejection for MW > 200	> 99%
Bacteria and particulates	> 99%

* In regular operating conditions







System Information

Dimensions (H × W × D)	540 × 290 × 380 mm (21.3 × 11.4 × 15 in.)
Net weight (Direct-Q® 3 system w/o 185/254 nm UV lamp)	8.1 kg (17.9 lb)
Net weight (Direct-Q® 3 system with 185/254 nm UV lamp)	8.6 kg (19.0 lb)
Net weight (Direct-Q® 5, 8 systems with 185/254 nm UV lamp)	7.6 kg (16.7 lb)
Operating weight (Direct-Q® 3 system w/o 185/254 nm UV lamp)	17.6 kg (38.8 lb)
Operating weight (Direct-Q® 3 system with 185/254 nm UV lamp)	18.2 kg (40.1 lb)
Operating weight (Direct-Q® 5, 8 systems with 185/254 nm UV lamp)	12.2 kg (26.8 lb)
Net weight (Remote dispenser)	2.15 kg (4.8 lb)
Operating weight (Remote dispenser)	2.68 kg (5.91 lb)
Built-in reservoir volume	6 L
Electrical feed voltage	100–250 V ±10%
Electrical feed frequency	50–60 Hz ±10%
Tap (feed) water connection	½" Gaz M
Tap (feed) water pressure	0.5 to 6 bar

Available System Configurations

Water Purification Systems

Available Configurations	Direct-Q® 3	Direct-Q® 5	Direct-Q® 8
 UV 185/254 nm	With/Without	With	With
 Remote dispenser	With/Without	With/Without	With/Without
 Built-in 6 L reservoir	With	Without	Without
 30/60 L reservoir*	Option	Required	Required

Milli-Q®

Lab Water Solutions

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Lit. No. PB2040ENUS
2017 - 01252
07/2018