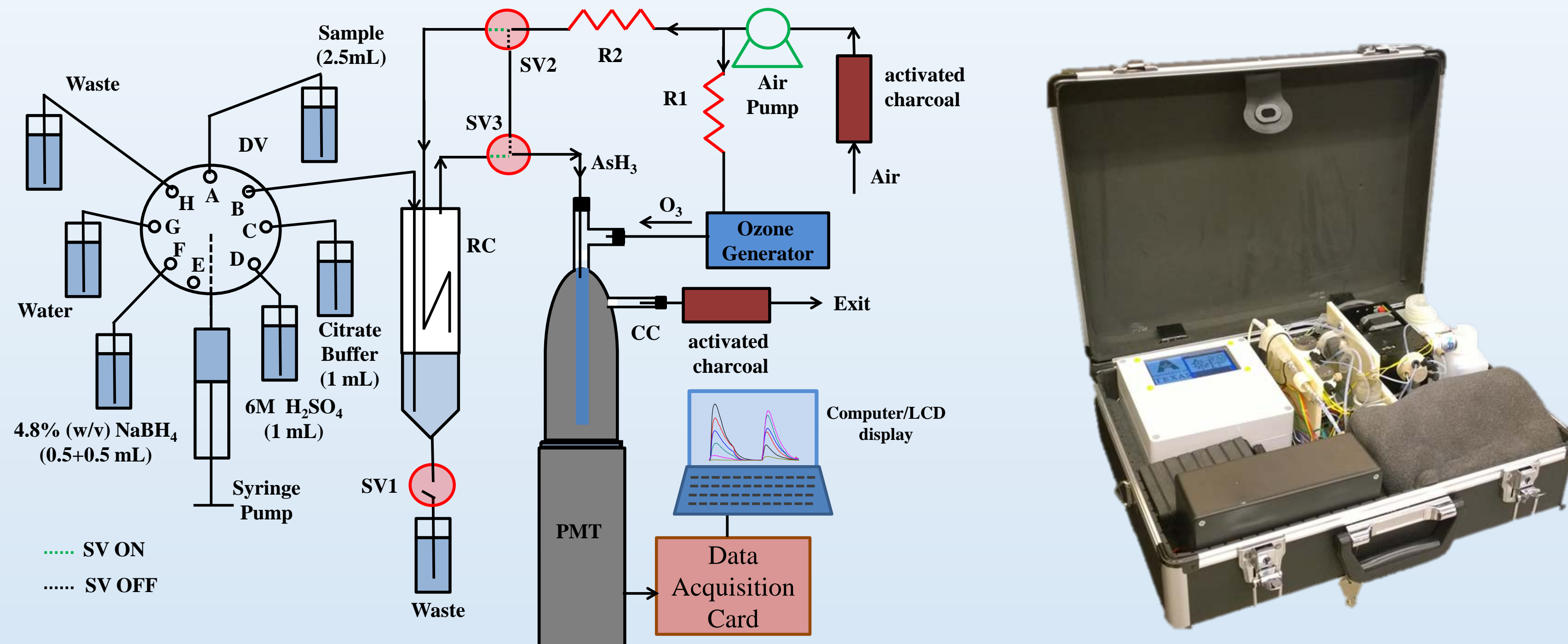


# A FIELDABLE SPECIATION CAPABLE GREEN ANALYZER FOR ARSENIC

## Working Principle and Prototype



Left: System schematic: DV, 8-way distribution valve; RC, reaction chamber; SV1, 2-way solenoid valve; SV2,3, 3-way solenoid valves; PMT, photomultiplier tube; CC, chemiluminescence chamber; R1,2 flow restrictors; A-H, distribution valve ports  
Right: Prototype of the portable instrument

## Innovation

Presently in market, the available technologies for arsenic detection involve either handheld instruments that sell for around \$2000 which can only tell the level of total arsenic in water and barely work near the regulation limits or laboratory instruments that can differentiate between the different types of arsenic are available but these are very expensive (\$40-200K) and cost per test is very high.

- ❖ The present instrument competes favorably with the benchtop expensive instruments in its' sensitivity and permits facile differentiation. It is fast, portable, user friendly, and truly a green analyzer as it does not use toxic chemicals like the other inexpensive technologies. The instrument is shown schematically above.
- ❖ The technique based on generation of arsine gas (AsH<sub>3</sub>) by borohydride reduction has already been proven and tested.
- ❖ In volume production this instrument can be profitably sold at a price point below \$5000. Actual cost of chemicals per test is ~\$0.25, the consumable cost will be primarily in packaging and will thus depend on use volume.

## Potential Market

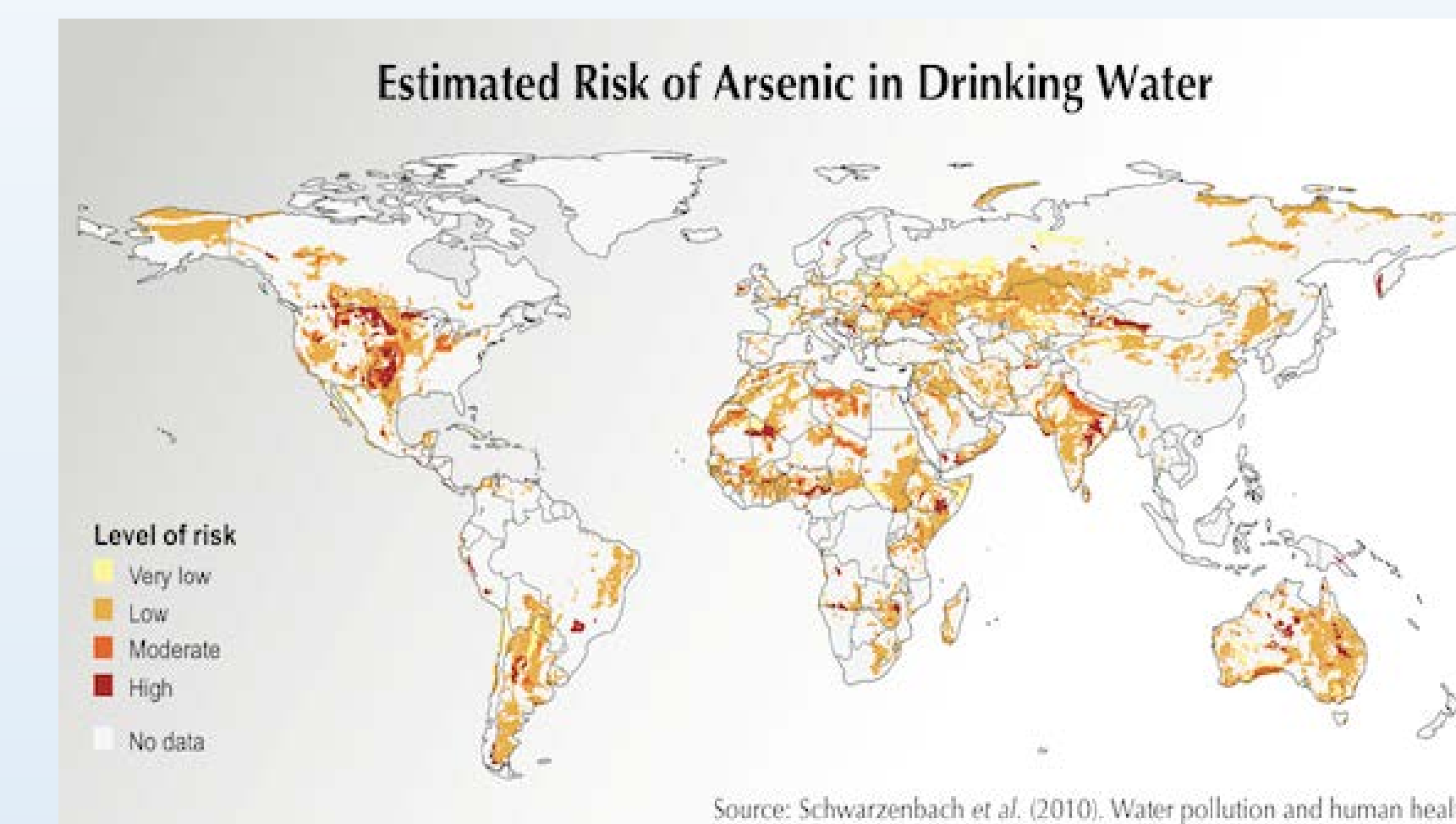
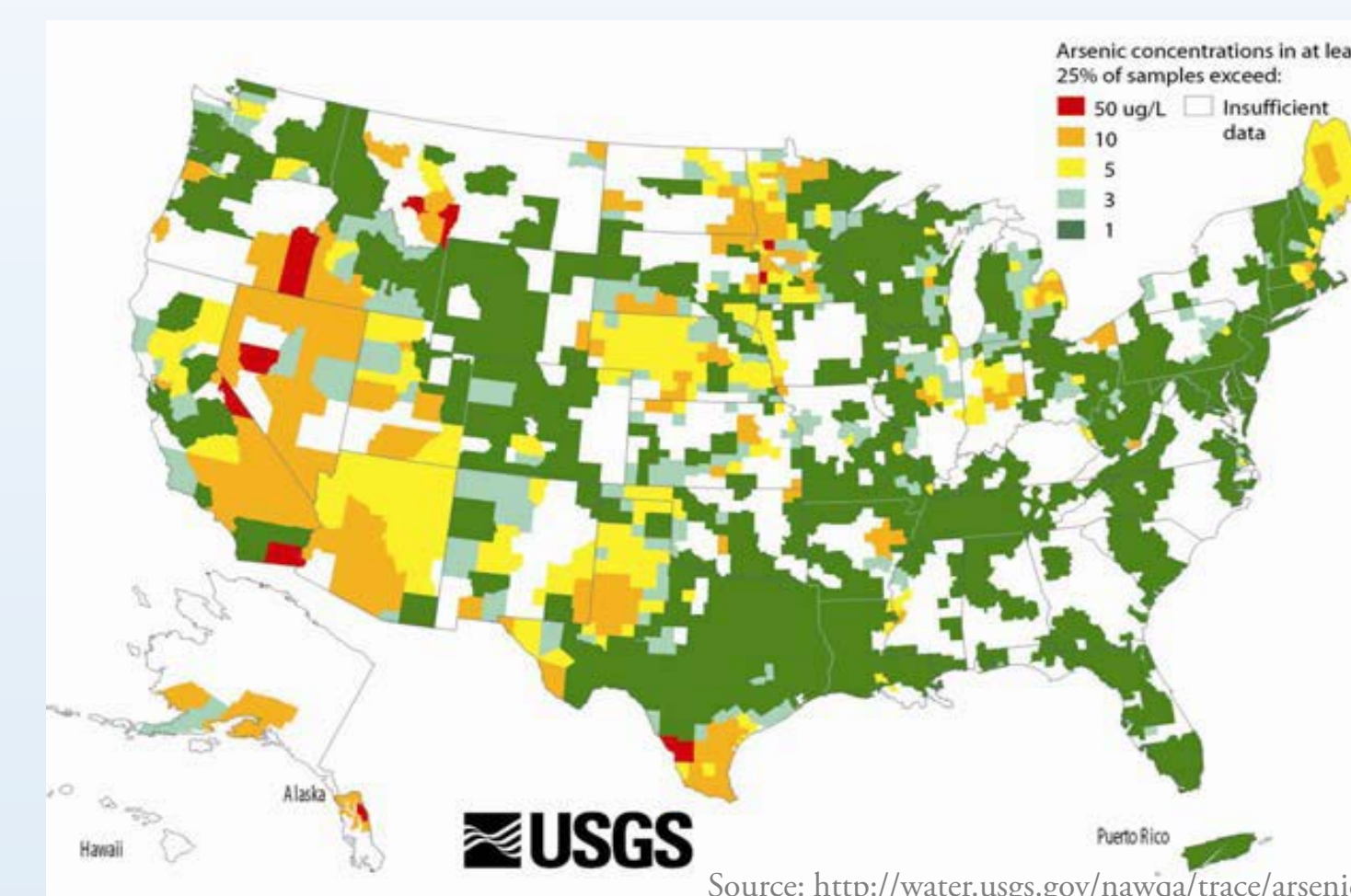
- ❖ **United States hotspots:** Arsenic in ground water in the western states like Arizona, California, Nevada, Texas have been detected previously.<sup>3</sup> With the regulatory environmental agencies like EPA pressing for more reforms on water quality, this provides a good domestic market.
- ❖ **Global Market:** Governmental organizations and non-profit agencies in south Asian countries like India and Bangladesh, where 200 million people are affected due to arsenic spend \$1.6 billion per year for safe drinking water but an efficient, affordable and sustainable solution is yet to be found.
- ❖ **Beverage Industries and water utility companies:** Water utilities treat surface water and ground water for public consumption whereas beverage companies like Coca-Cola, Pepsi etc. use local and natural water. They provide a potential market for the arsenic analyzer.
- ❖ **Other Industries:** Arsenic is released as a waste in a large number of industrial processes which include chemical processing, mining, automobiles, fertilizer and the pharmaceutical industry. The arsenic analyzer serves as a great tool in these industries for monitoring the level of arsenic in their waste water.

## Benefits

- ❖ It equips the official environmental agencies and non-governmental organizations with a tool that they need- cheaper, faster, speciation-capable, portable, and green analyzer for arsenic.
- ❖ With an affordable instrument and consumable kits the number of tests performed will increase. It will provide regulatory bodies with more extensive data and hence a better understanding of the situation to make more informed decisions.

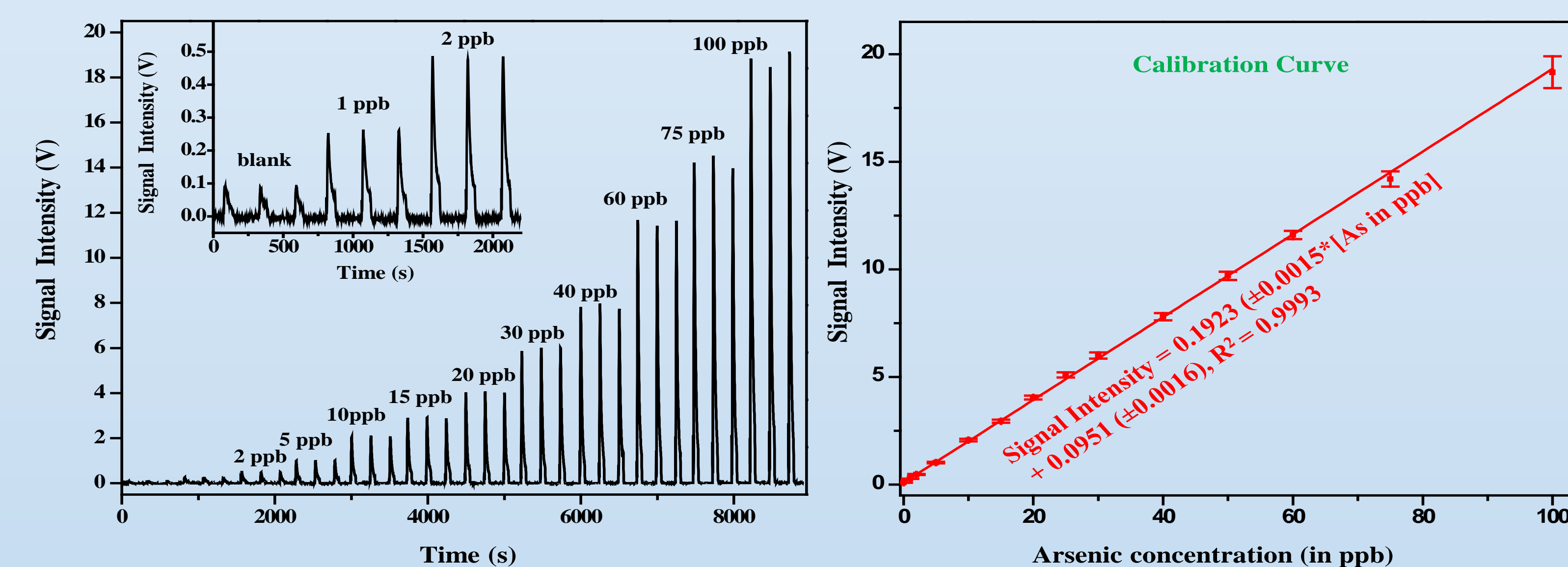
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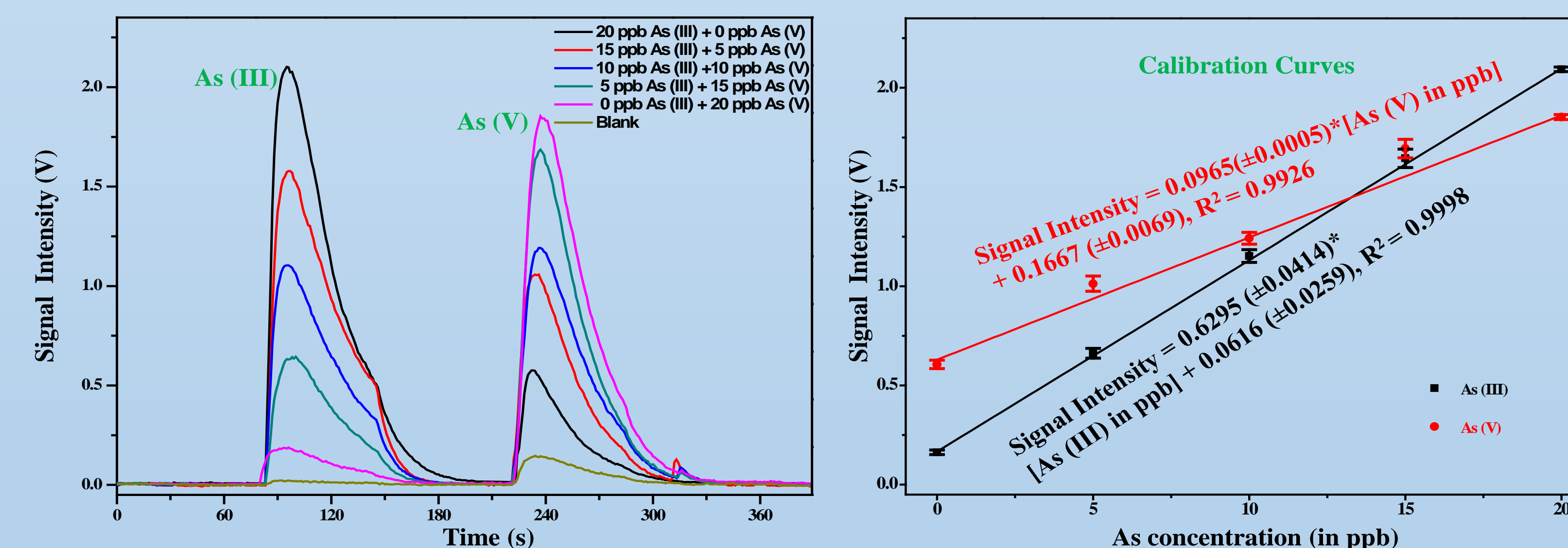


## Results and Specifications

- ❖ **Sensitive and reproducible:** Our instrument can quantitate arsenic concentration as low as 1 µg/L (ppb). The analyzer has a limit of detection (LOD, S/N = 3) 0.03 ppb total arsenic (based on peak height). Relative standard deviations are ±3.0, 2.5 and 3.9 % at 10, 50 and 100 µg/L, respectively.



- ❖ **Speciation-capable:** Inorganic As is much more toxic than organoarsenicals. The instrument can measure either Total inorganic As or Inorganic As(III) only; inorganic As(V) can be measured by difference. Alternatively the instrument first measures As (III) at pH 4-5 and then the solution is made strongly acid to measure As (V).



- ❖ **Environment friendly:** The analyzer does not produce toxic wastes like mercury and lead. Ozone is generated in-situ and any excess is catalytically destroyed before venting.
- ❖ **Field Deployable:** The instrument measures 18"×14"×6" and weighs 9 kgs. Being small and portable the instrument can be easily used for on-field measurements.
- ❖ **Cost-effective:** The total component cost of ~\$3000 and low cost of the consumables (<\$1 per test) makes this analyzer relatively inexpensive compared to the atomic spectrometry based instruments.
- ❖ **Time saving:** The arsenic analyzer is fully-automated. For total arsenic detection the time required for a single test is ~4 min. For speciated analysis in the sequential mode As(III) and As(V) can be measured in 6 min.

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