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Containerless Protein Crystal Growth Technology: Electrostatic Multidrop Positioner

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The rationale behind the containerless protein crystal growth method is to provide a simple and clean environment for protein crystal growth in space. The method is simple in that freely floating liquid drops form spherical shapes as a result of their own surface tension and, therefore, expose themselves to isotropic thermal as well as vapor diffusion fields. These simple shapes enable accurate drop-sizing that can be continuously monitored and controlled in a programmed way to achieve an optimal protein-saturation level for crystallization.

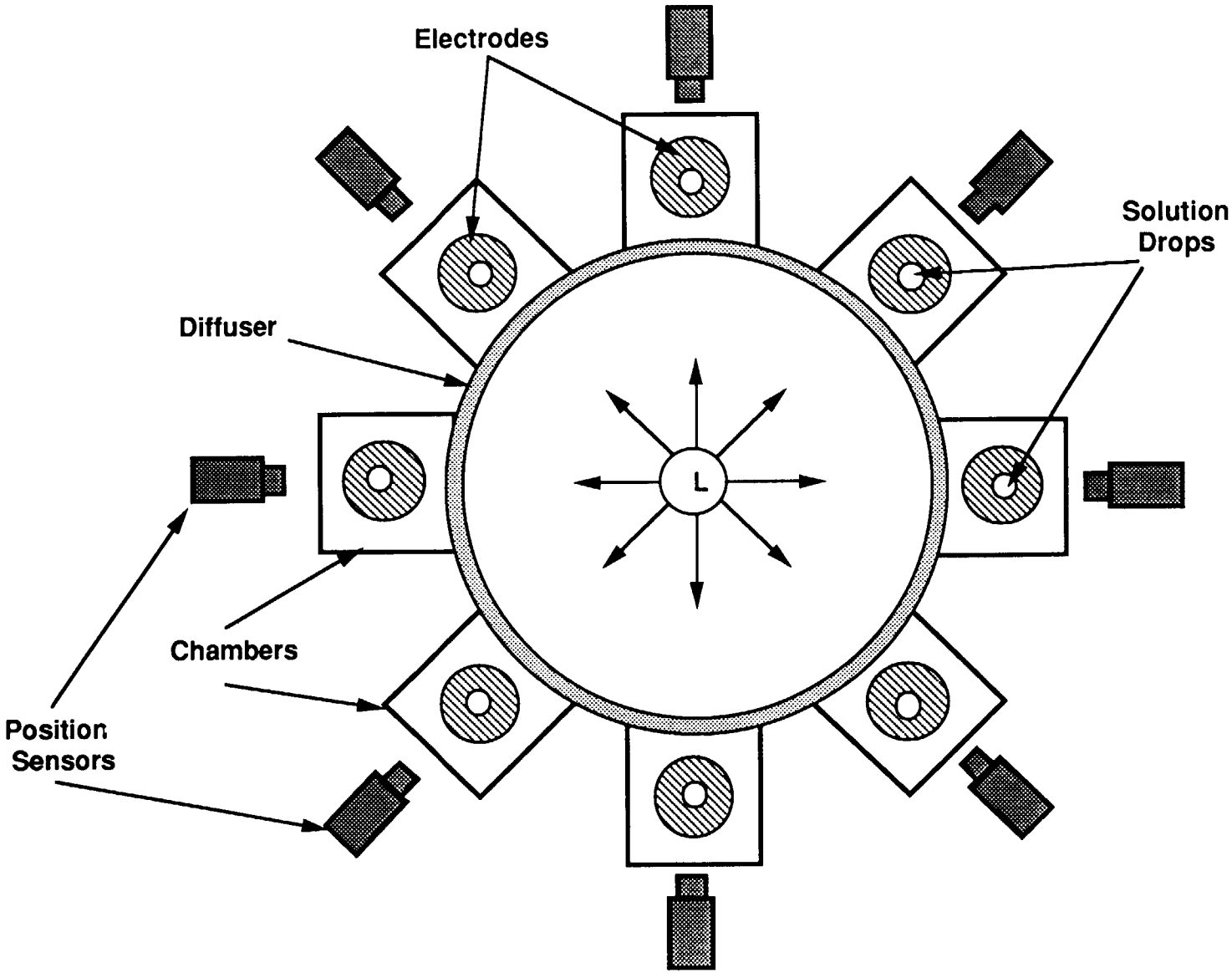
The containerless method is clean in two different ways. First, the sample is not in physical contact with container walls that might induce uncontrollable nucleation. Second, through simple programming of control forces, the sample drops can be isolated from much of the oscillatory and impulsive forces that are known to reside in space laboratories. With the perturbing forces filtered out, the drops will experience a true micro-g environment. Furthermore, with the drops freed from undesirable container walls and disturbing forces, parameters recorded in the course of the experiments will have good correlations with the final results; this capability will even allow investigators to dictate the course of the experiments interactively toward the growth of large, high-quality protein crystals. Because there will be virtually no limitation in drop size or in producing compound drops that will initially have a well-defined interface between two different liquids, the containerless method will be able to accommodate most conventional methods—such as the vapor diffusion method, the temperature control method, or even the liquid-liquid interfacial diffusion method—all in the same drop positioning system.

In this presentation, the electrostatic multidrop positioner will be described for its present capabilities, limitations, and future prospects as an advanced facility for protein growth in space. This presentation will include 1) the general principle of electrostatic positioners, 2) the architecture of multidrop positioners, 3) the drop-launching and collecting method, 4) the drop-sizing method, 5) a method for controlling protein-saturation levels, 6) the optical detection of the onset of nucleation, 7) the vibration isolation of levitated drops, and 8) the drop-manipulation capabilities. A demonstration of a four-drop levitator is presented during the workshop.

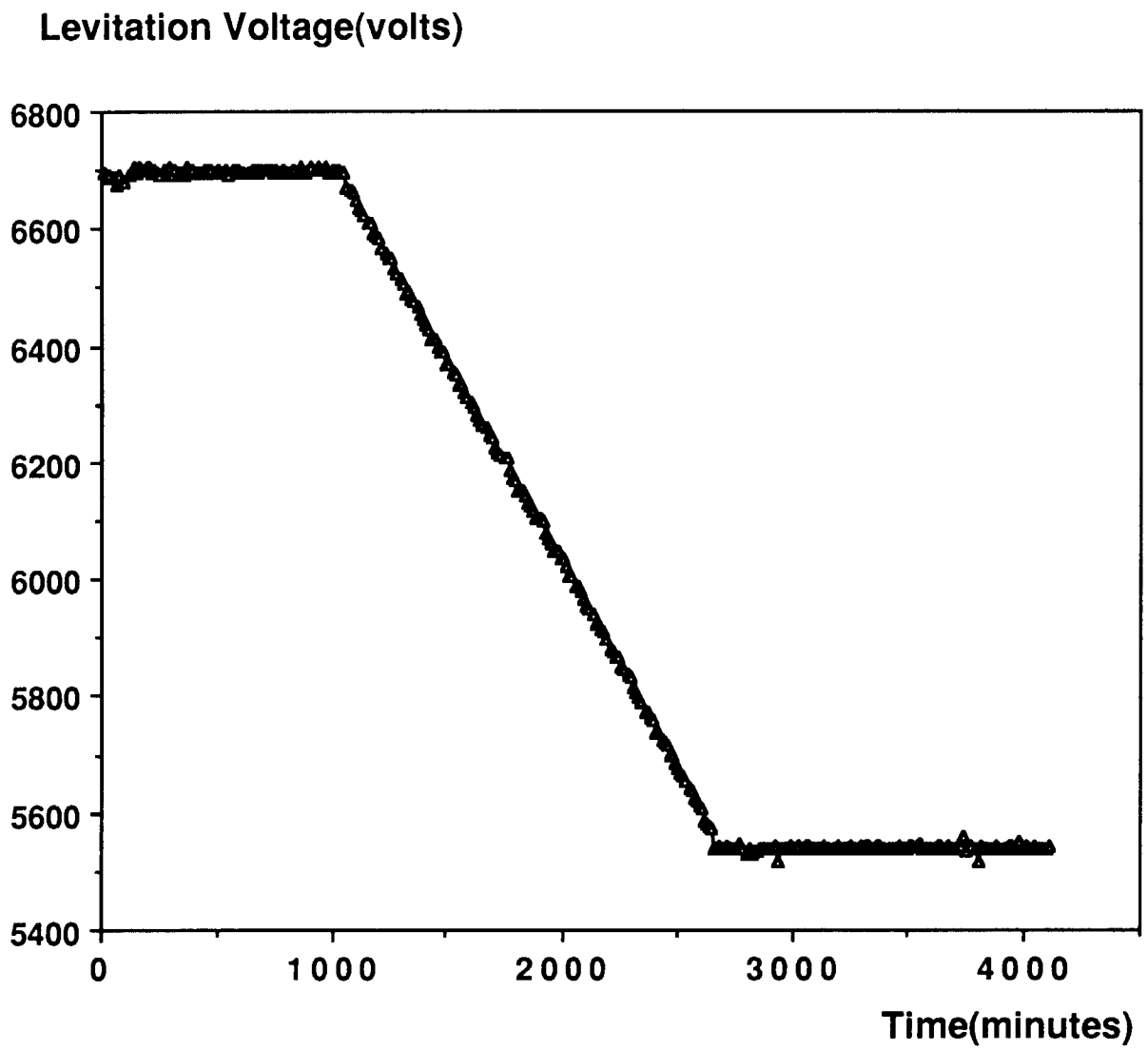
Containerless Protein Crystal Growth Method

- Removes container induced nucleations
- Vibration isolation
- Accurate drop sizing from spherical drops
- Isotropic temperature and vapor diffusion field
- Wide range in drop size (10 ~ 1000 micro-liter)
- Multi-drop positioning capability (~ 12 drops or more)
- Protein crystal growth in the actively controlled environments
  - Controlled vapor diffusion method
  - Temperature controlled method
  - Liquid-liquid interfacial diffusion method

Electrostatic Multi-Drop Positioner for Protein Crystal Growth Experiments



Controlled Protein Concentration in a Levitated Drop



Lysozyme Crystals Growing in a Drop