Introduction

- **NIST is developing *Programmable Josephson Voltage Standards (JVS)* for AC and DC applications.**

- **Fully automated 1-Volt Programmable DC Voltage Standard System completed this year.**

- **Advantages for DC metrology:**
  - **high noise immunity *(50x conventional JVS)***
  - **rapidly programmable**
  - **inherently stable**

1 V Programmable Standard

- **32 768 SNS Josephson Junctions**
  (superconductor-normal-superconductor)

- **Programmable from +1.1 V to -1.1 V**
- **1 µs Settling Time**
- **Output Step Height = 2 to 4 mA**

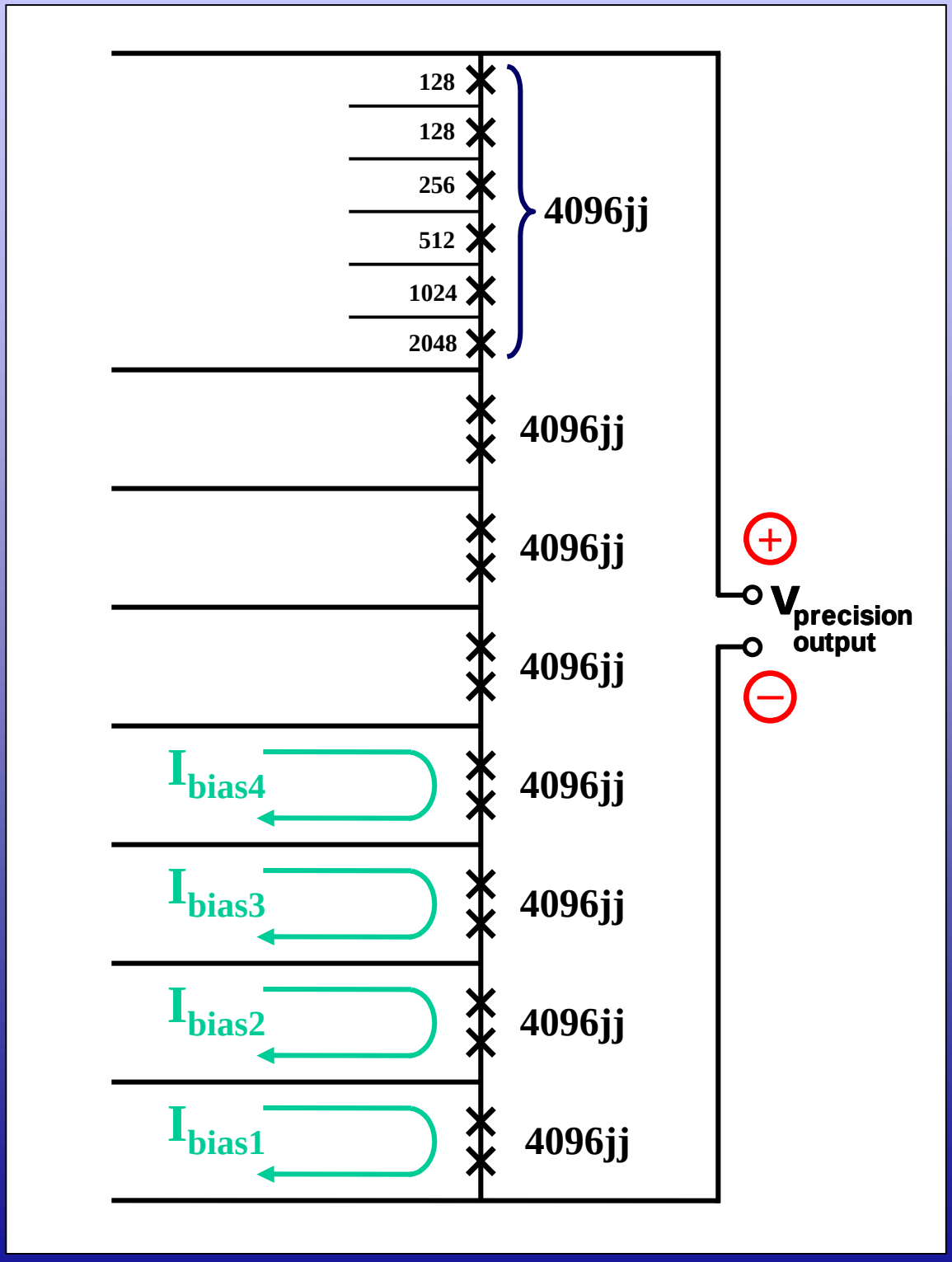
AC Josephson Effect

- **Voltage out of each cell is given by the Josephson voltage-frequency relation:**

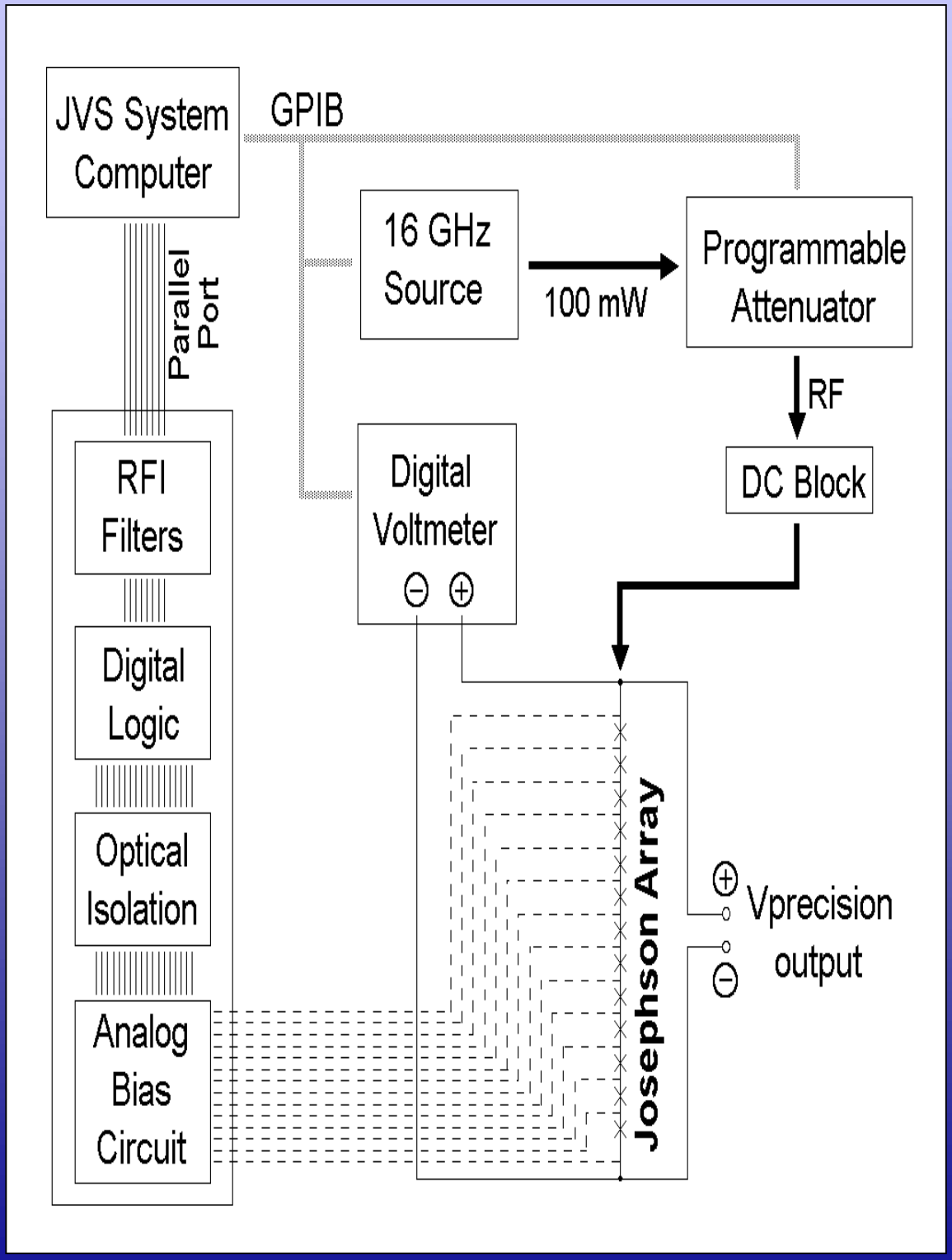
$$V = N f / K_{J\text{-}90}$$

- N = **number of Josephson junctions**
- f = **microwave drive frequency**
- $K_{J\text{-}90}$ = **483 597.9 GHz / Volt** $= 2e/h$
  (the Josephson constant)
- ***No significant deviations*** **from this relation have ever been found.**

1 Volt SNS Chip Schematic



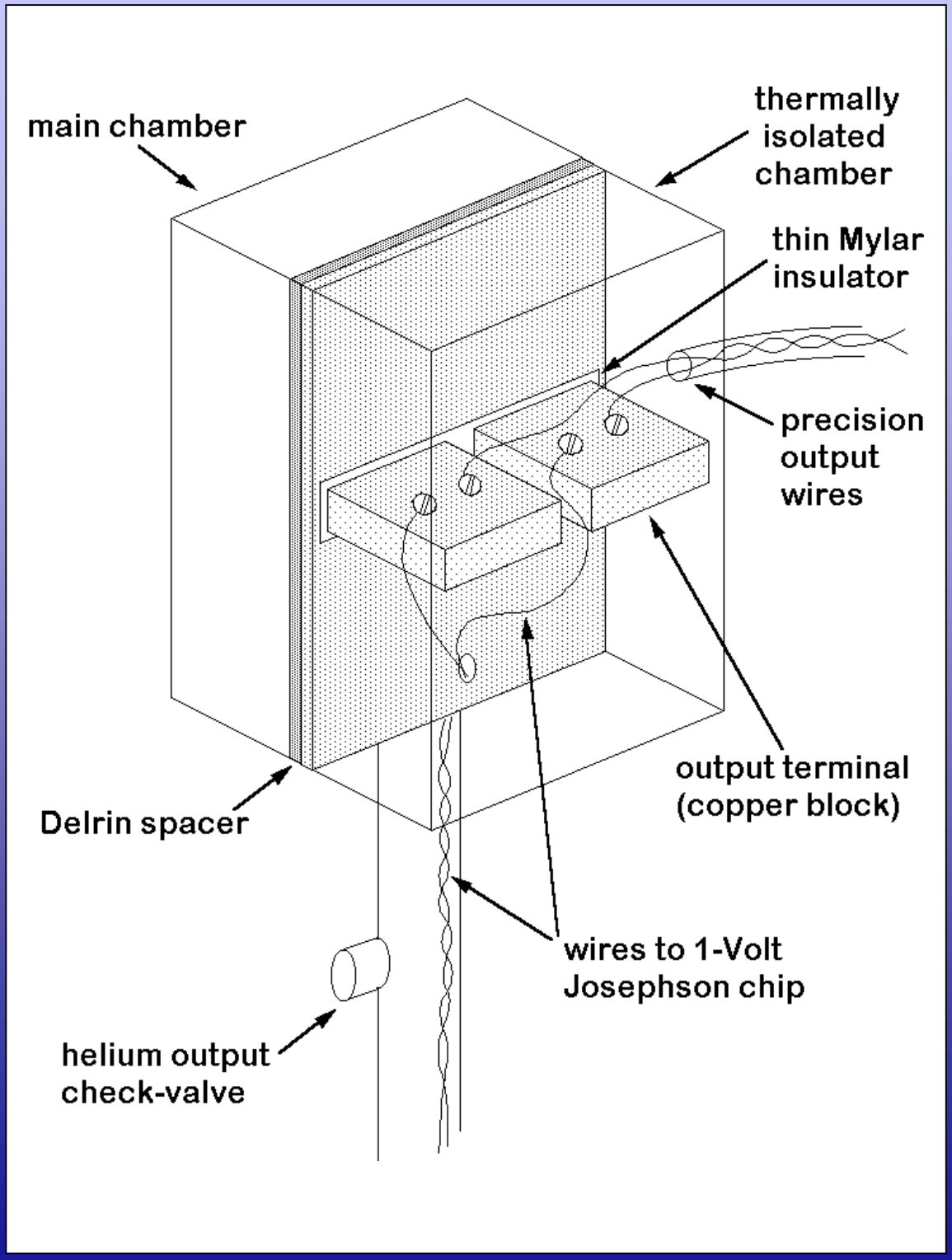
System Block Diagram



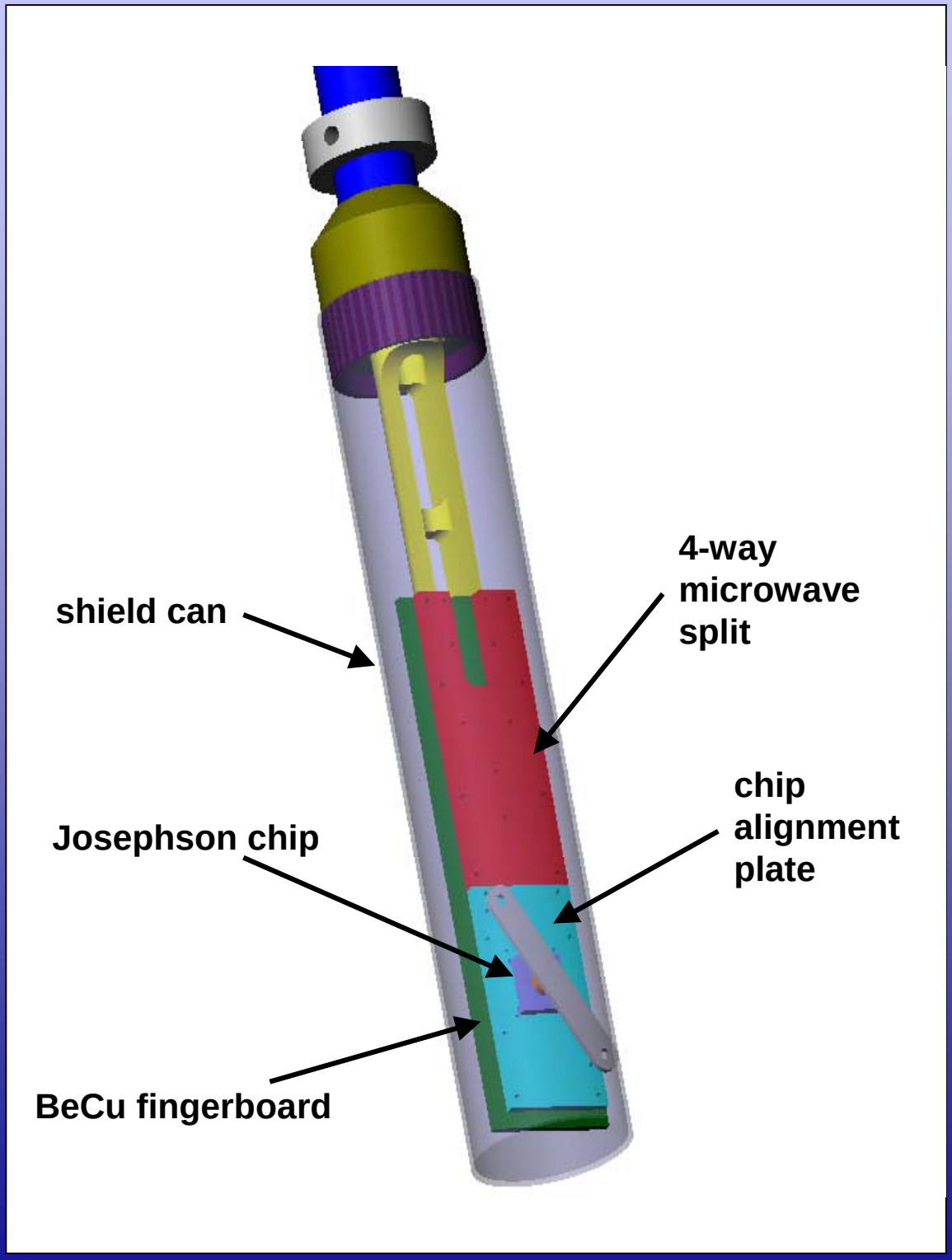
Output Precision

- **Microwave drive frequency accurate to a part in 10^{12}**
- **JVS absolute accuracy = parts in 10^{8}**
  - **(limited by *cryoprobe thermal voltages*)**
- **JVS offset drift = parts in 10^{9} (per hour)**
- **Final uncertainty of 1 part in 10^{9} obtainable in many experiments.**
- ***Conventional SIS Voltage Standards have the <u>same output precision</u>.***

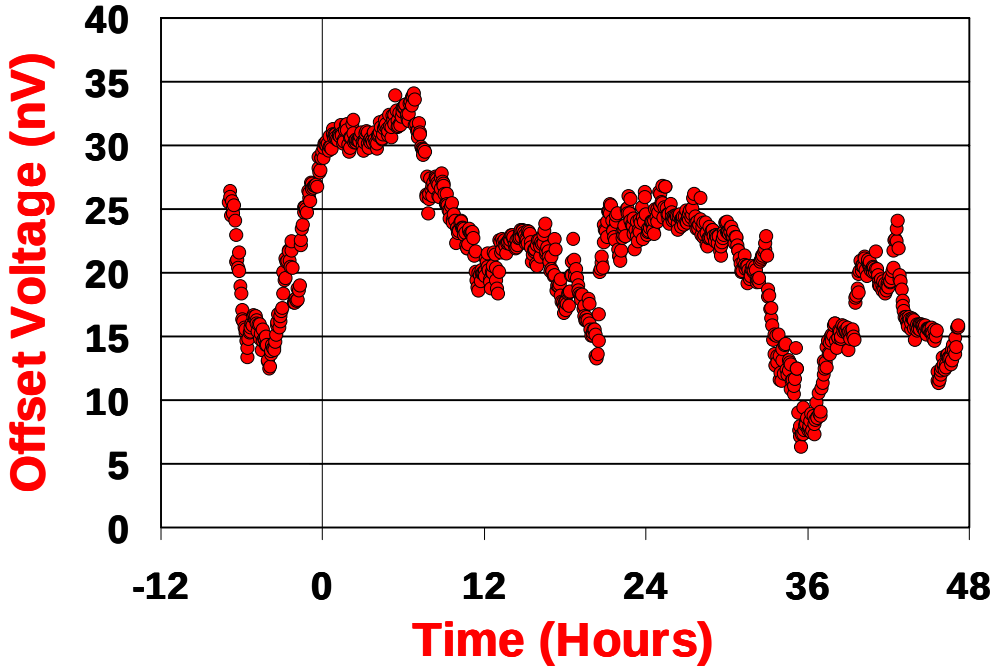
Cryoprobe (top end)

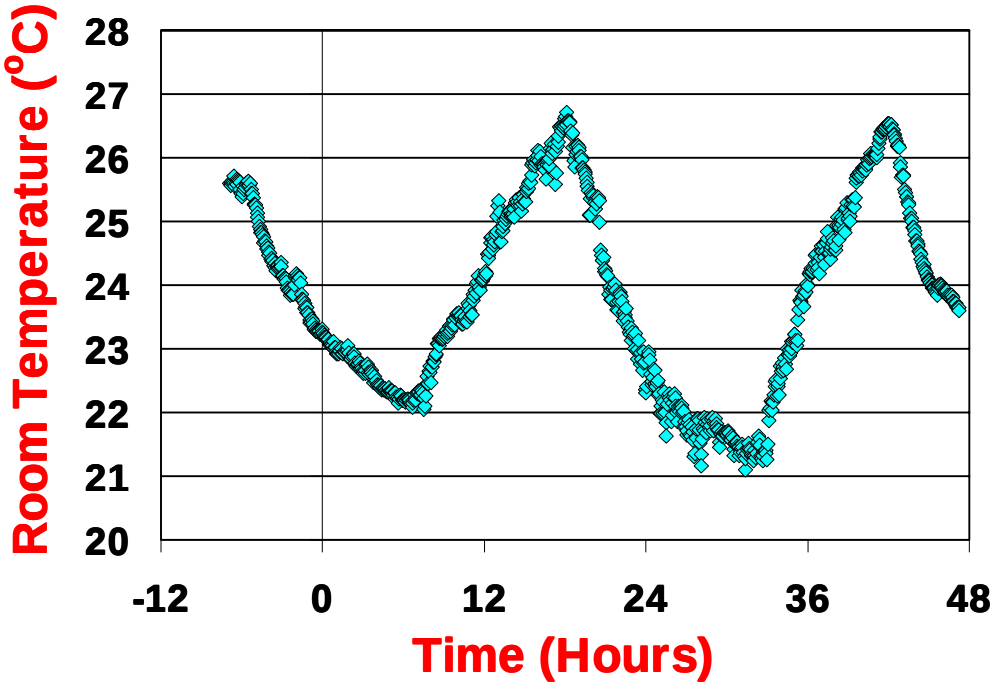


Cryoprobe (bottom end)

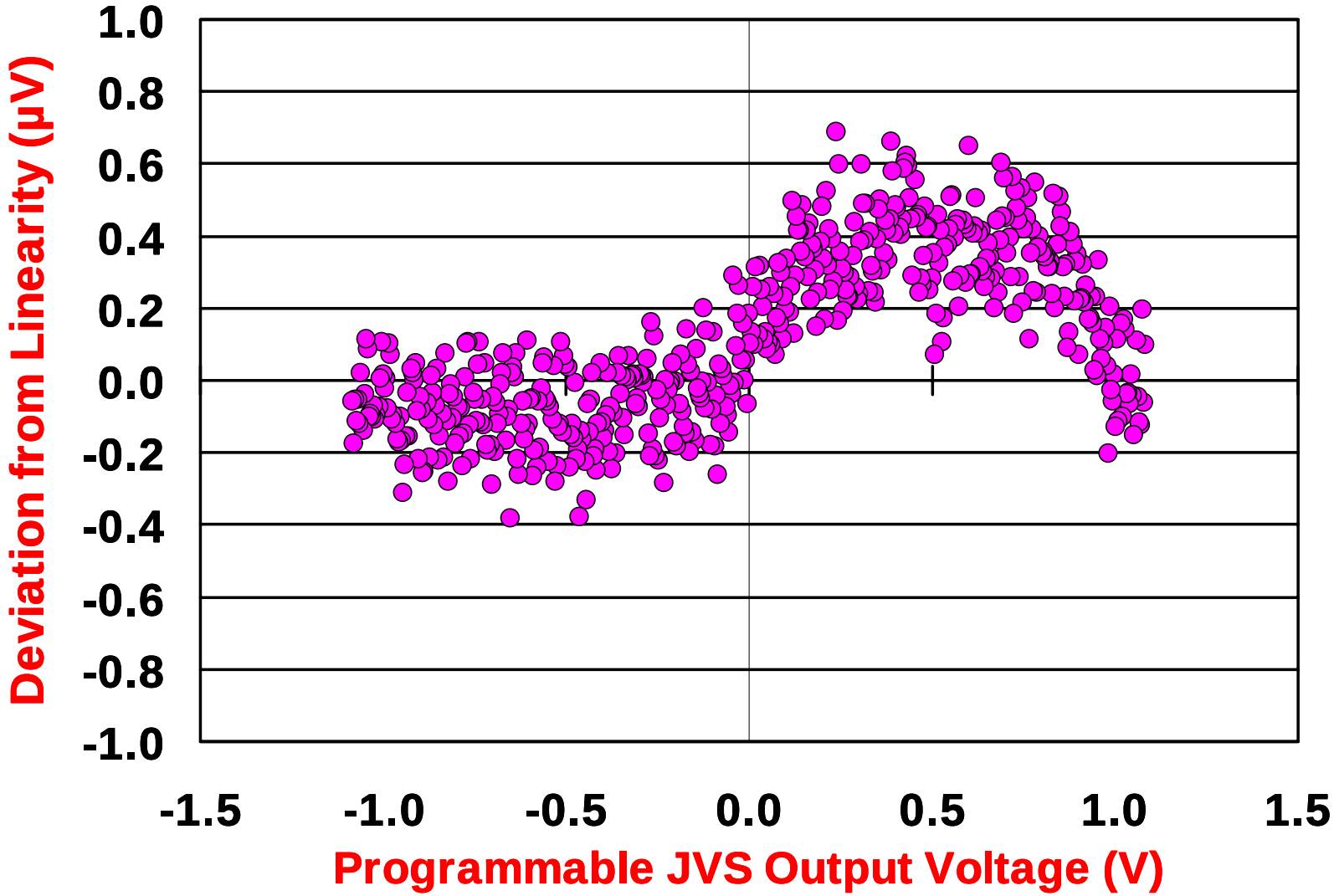


Thermal Offset Drift

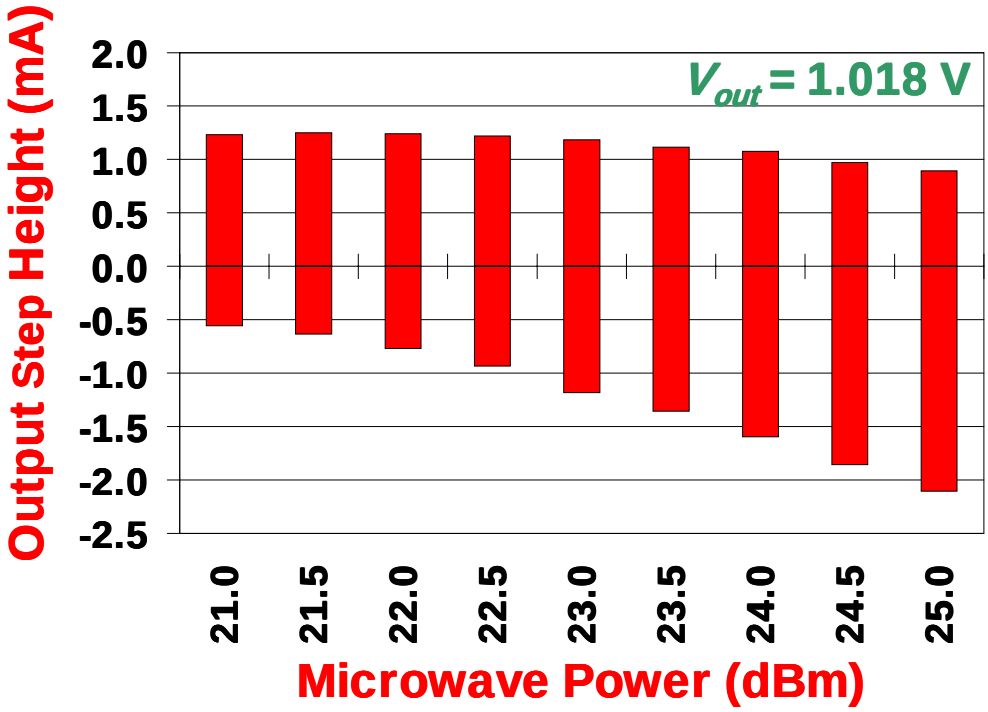


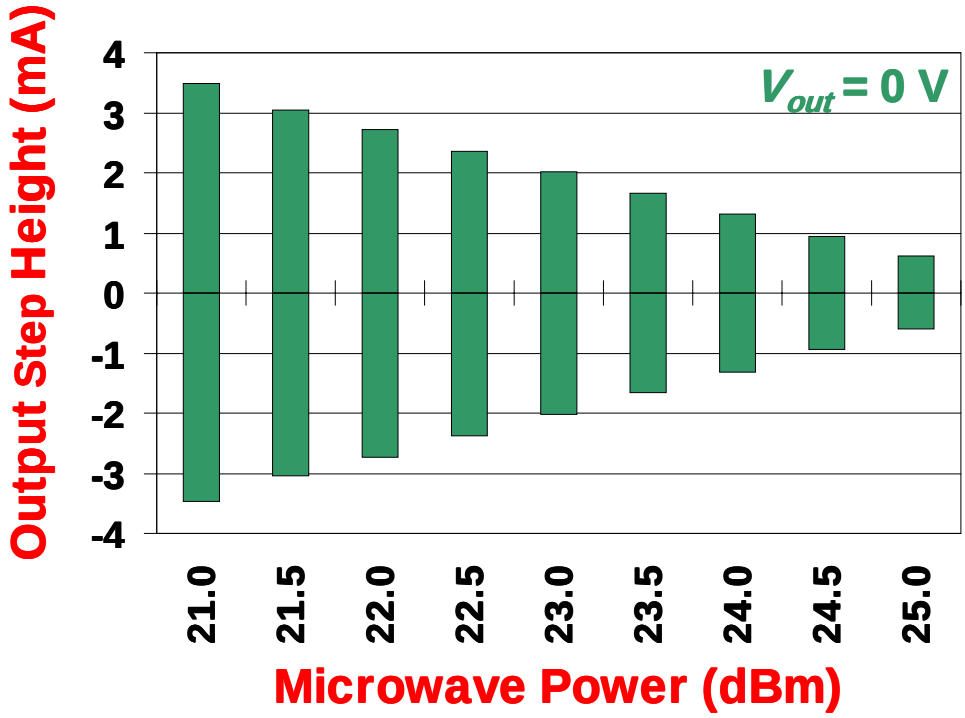


DVM Linearity

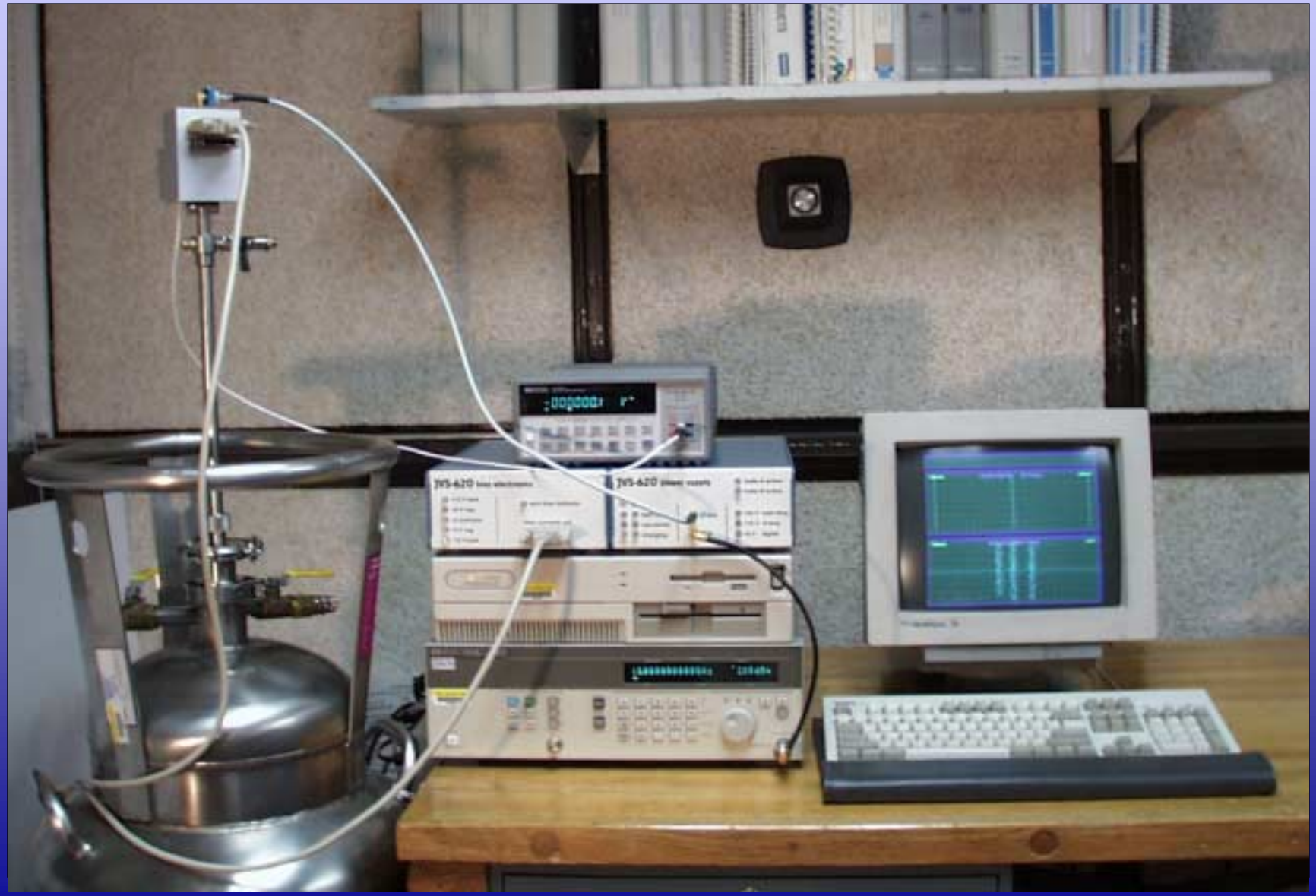


Operating Margins





1 Volt Programmable Standard

- **Advantages over conventional JVS (Josephson Voltage Standard):**
  - **Higher noise immunity (50 times)**
  - **Rapid settling time (1 μsec)**
  - **Intrinsically stable**
  - **Digitally programmable**
  - **Supplies load current (2 to 4 mA)**
  - **Wide rf-power range (± 2 dB)**

1 Volt Programmable Josephson Voltage Standard