Generating sub-Millidegree Thermal Stability over Large Volumes for Precision Experiments

-- a robust, modular-scalable approach

N. Krishnan, S.M. Pereira, A. Vaidyanathan

Gravitation Group,
Tata Institute of Fundamental Research,
Homi Bhabha Road, Mumbai,
INDIA

(a brief introduction to the Poster that is on DISPLAY)

Intnl. Conf. on Precision Physics and Fundamental Physical Constants FFK-2019

TWO CLASSES of Experiments usually make severe demands on STABILITY

-- **Precision Experiments** (i.e., Absolute Measurements as in Standards Labs)

-- **Sensitive Experiments** (e.g., Null Experiments
OR
Experiments that pursue very small effects)

for experiments in either class, Temperature Stability is Key

---

-- Our dedicated Underground Laboratory at GAURIBIDANUR in Southern India.

-- Torsion Balance Equivalence Principle test (Dicke-Braginsky mode) sensitivity of 1 part in 10^{13},

-- Require millidegree stability over a volume of 30 m^3
-- ("stability" for us – suppression of diurnal and semi-diurnal waves; high frequency temperature variations not so troublesome)

Our Choice – a large, distributed Feedback System for Active Control

likely of general interest to the community of Precision/Sensitive Experimenters

Key Points in the work – what you'll see on the Poster

Measuring Temperature at multiple locations:
stability, interchangeability/common cross-referencing
How/What Sensor?

Engineering of an appropriate Thermal-Mechanical Enclosure
-- Sturdy, Lightweight, Modular, Scalable

-- Suitable "Space Heaters" (uniform heating over a 2-d region of space, low thermal inertia)

Electronics and Instrumentation for Feedback Control
-- 32-channel Droopless Sample-and-Hold-Amplifier;
-- ensemble of Power Amplifiers (to apply the error-correction signals)
-- suitable PID algorithm for control, Ziegler-Nichols-tuned for optimality

Results – we suppress diurnal and semi-diurnal temperature variations to substantially below 1 m^{0}C