



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم



شبكة المعلومات الجامعية التوثيق الإلكتروني والميكروفيلم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغييرات



يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار



MONA MAGHRABY



Faculty of Women for Arts,
Science and Education
Ain Shams University

**“Characterization of low Temperature Facility
for Non-Contact Thermometry at National
Institute of Standards -Egypt”**

A Thesis Submitted for the Requirements of
The M.Sc. Degree in Physics

Presented to

Physics Department

**Faculty of Women for Arts, Science and Education, Ain
Shams University**

Submitted By

Mohamed Serag El-Din Yones Attia

Researcher Assistant at National Institute of Standards

Supervised by

Prof. Dr. Mohamed Gamal Ahmed

Professor, Department of Thermal Metrology,
Thermal Metrology and Ionizing Radiation
Division, National Institute of Standards
(NIS)

**Assistant. Prof. Dr. Huda Mohammed
Abu Dora**

Assistant Professor of Physics,
Physics Department, Faculty of Women
for Arts, Science and Education,
Ain shams University

Assistant. Prof. Dr. Ahmed Ali El-Matarawey

Assistant Professor, Department of Thermal Metrology,
Thermal Metrology and Ionizing Radiation Division,
National Institute of Standards (NIS)

2021



**Faculty of Women for Arts,
Science and Education
Ain Shams University**

Approval Sheet

The Thesis Entitled

**Characterization of low Temperature Facility for Non-Contact
Thermometry at National Institute of Standards –Egypt**

Submitted By

Mohamed Serag El-Din Yones Attia
The M.Sc. Degree in Solid State Physics
Researcher Assistant - National Institute of Standards

This thesis has been approved by supervisor committee.

Supervisors

Signature

1- Prof. Dr. Mohamed Gamal Ahmed

Professor, Thermal Metrology and Ionizing Radiation
Division, National Institute of Standards (NIS)

2- Assistant prof. Dr. Huda Mohammed Abu Dora

Assistant Professor of Physics, Faculty of Girls for Arts,
Science and Education, Ain Shams University.

3- Assistant prof. Dr. Ahmed Ali El-Matarawey

Assistant Professor, Department of Thermal Metrology,
Thermal Metrology and Ionizing Radiation Division,
National Institute of Standards (NIS).

Acknowledgment

ACKNOWLEDGMENT

I wish to express my sincere appreciation and deepest gratitude to ***Ass. Prof. Dr. Huda Abo Dora*** Professor of Physics, Faculty of Girls for Arts, Science and Education, Ain Shams University for her kind supervision, continuous encouragement through the period of this work.

I wish to express my deepest thanks and appreciation to my supervisor ***Prof. Dr. Mohamed Gamal Ahmed*** for his dedicated support, guidance, and for the thoughtful comments and recommendation on this thesis.

I would like to thank my supervisor Ass. Prof. Dr. Ahmed el-Matarawey, Ass. Prof. Dr. Doaa AbdelGalil, and Thermal Department at NIS for their kind, great help, interesting discussions and revision.

I wish to thank ***Mr. Ibrahim*** Senior technician in Thermal Department for his great help in the experimental measurements.

Dedication

For my parents, my brothers and my sisters.



Contents

Table of Contents

List of Figures	I
List of Tables	IV
List of Acronyms	VI
ABSTARCT.....	1
1 INTRODUCTION.....	5
1.1 Historical Background.....	5
1.2 Measurement and Traceability	7
1.2.1 Measurement.....	7
1.2.2 Measurement Standards and Transfer Standards.....	8
1.2.3 The International System of Units	9
1.2.4 Traceability	10
1.2.5 The International Temperature Scale of 1990 (ITS-90)	11
1.2.6 Blackbody Radiation and Planck’s Law	14
1.2.7 Non-Contact Thermometry	18
1.2.8 Blackbody Calibrators	33
2 Literature Review.....	45
3 Experimental Techniques.....	55
3.1 Measuring equipment:.....	57
3.1.1 Temperature Control unit.....	57
3.1.2 Dip cooling systems.....	57
3.1.3 Liquid Bath	59
3.1.4 Dry Air Purging system	60

3.1.5	Standard Platinum Resistance Thermometer (SPRT).....	62
3.1.6	Non-contact temperature measuring equipment	64
3.1.7	Software	67
3.2	Measuring procedure	68
4	RESULTS AND DISCUSSIONS	72
4.1	Low temperature facility for non-contact thermometry	72
4.1.1	Stability of stirred liquid-bath blackbody radiation source	73
4.1.2	Temperature uniformity at the bottom of the cavity	83
4.1.3	Temperature Homogeneity of the cavity	84
4.1.4	Effective Emissivity calculation	85
4.1.5	The expected reading of reference temperature.....	87
4.1.6	Size of Source Effect (SSE).....	88
4.1.7	Distance Effect (DE).....	96
4.1.8	Comparison with transfer standards radiation thermometer	99
4.1.9	Uncertainty budget.....	100
4.1.10	Combined Uncertainty	103
4.1.11	Expanded uncertainty.....	103
5	Conclusion.....	106
6	References	107