

Thejesh N. Bandi, PhD

Curriculum Vitae

March 2022

Associate Professor
Dept. of Physics & Astronomy
College of Arts & Sciences
The University of Alabama
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Profile: Physics.tnb.ua.edu
Research Group: PNTFLab.ua.edu

Education

2013	Ph.D. (Physics)	University of Neuchâtel (UniNE), Switzerland
2008	M.Sc. by research (Quantum optics)	Cork Institute of Technology, Ireland
2004	M.Sc. (Physics)	Kuvempu University, India
2002	B.Sc. (Physics, Mathematics & Chemistry)	Kuvempu University, India

Professional Experience

2022 onwards: *Associate Professor* at the department of Physics & Astronomy, University of Alabama, USA.

- ▶ Principal Investigator of the Precision Navigation, Time and Frequency (PNTF) group.
- ▶ Leading the project to establish Alabama Standard Time; UTC(UA).
- ▶ Students training and teaching in the field of PNTF.

2015 – 2021: *Scientist/Head of the Division* at Indian Space Research Organisation (ISRO), India

- ▶ Lead and trained a team of 15+ engineers in the clock technology.
- ▶ Concept, design and development of the first successful Indian space clock for the Indian navigation system (NavIC).
- ▶ Custom designed rubidium bulbs and cells for the Indian space clocks.
- ▶ Designed & established state-of-the-art clean room (10k & 100k) space clocks lab.
- ▶ Member of funded space projects and technology transfer review committees.

2013 – 2015: *Postdoc Fellow* at NASA - Jet Propulsion Laboratory (JPL) & Caltech, Pasadena, USA

- ▶ Advanced trapped-ion compact clocks for portable applications.
- ▶ Custom-built and tested novel trap RF circuits. Ultra-high vacuum systems; demonstrated Hg ions extreme long-trap lifetimes (>11yrs).
- ▶ Successful Hg lamps fabrication, and studies to enhance the 194 nm light emission for efficient Hg⁺ optical pumping.
- ▶ Studies on charge-transfer relaxations of trapped ions and neutral atoms.

2013 – 2013: *Postdoctoral Researcher* at Laboratory of Time and Frequency (LTF), UniNE, Switzerland

- ▶ Population and coherence time measurements in the Rb clock physics package (PP). Direct imaging of Rabi and Ramsey field modes in the PP.
- ▶ Collaborations with EPFL and UniBasel to study and improve the microwave resonators for Rb clocks.
- ▶ European consortium collaboration of metrology institutes to develop advanced industrial clocks, in particular focussed on the compact pulsed rubidium clock.

2008 – 2013: *Assistant Doctorant* at LTF, UniNE, Switzerland

- ▶ Demonstrated the state-of-the-art laser-pumped wall-coated Rb cell clock.
- ▶ Developed high-performance laser-pumped rubidium clock for next generation ground and space applications with state-of-the-art performances of $1.36 \times 10^{-13} \tau^{-1/2}$ stability.
- ▶ Theoretical studies, fabricated and characterized compact magnetron cavities for high-performance Rb standards.
- ▶ Phase noise measurements, and detailed studies on metrology of Rb clocks.

2009: *Visiting researcher* at Istituto Nazionale di Ricerca Metrologica (INRIM), Torino, Italy

- ▶ Tuning and characterization of cylindrical microwave cavities for space based Pulsed Optical Pumping (POP) Rb standards.

2006 – 2008: *Researcher* at Tyndall National Institute, Cork, Ireland

- ▶ Studies on cold atoms interaction with tapered-fibre evanescent field.
- ▶ Characterization of avalanche photodetectors, and single photon detectors for cold atom Rb laser cooling experiments.
- ▶ Impedance matching studies of piezo oscillators.
- ▶ Micro-fabrication techniques and Scanning Electron Microscope (SEM) imaging.

2004 – 2006: *Junior Research Fellow (JRF)* at Indian Institute of Science (IISc), Bangalore, India

- ▶ Parametric oscillation studies with optical tweezers.
- ▶ LabVIEW interfacing for cold atoms experiment automation.

Projects

Ongoing:

- ▶ Jan 2022 – till date: *AI and neural network based resilient navigation systems*, the University of Alabama, USA.
- ▶ Jan 2022 – till date: *Alabama Time Scale*, the University of Alabama, USA.

Successfully completed:

- ▶ June 2018 – October 2021: *Space clock Qualification Model and Flight Models fabrication and preliminary assembly*, Indian Space Research Organisation (ISRO), India.
- ▶ June 2015 – October 2018: *Space clock proto-model with complete indigenous design*, Indian Space Research Organisation (ISRO), India.
- ▶ October 2015 – September 2017: *Establishment of state-of-the-art 10k and 100k clean room labs*, Indian Space Research Organisation (ISRO), India.
- ▶ October 2013 – April 2015: *Next generation miniature clocks for ground and space portable applications*, NASA - Jet Propulsion Laboratory, USA.
- ▶ May 2013 - Sept. 2013: *Mclocks – Microwave clocks for industrial applications*, European Metrology Research Programme (EMRP), Neuchâtel, Switzerland.
- ▶ Nov. 2012 - Sept. 2013: *Microwave cavities for high performance double resonance atomic clocks and sensors*, UniNE in collaboration with LEMA-EPFL, Switzerland.
- ▶ 2008-2012: *Next generation compact clocks*, ESA project (21504/08/NL/GLC), Neuchâtel, Switzerland.
- ▶ 2007-2008: *Design and fabrication of planar silica microdiscs*, National Access Programme project (NAP112), Tyndall National Institute, Cork, Ireland.
- ▶ 2005-2006: *Parametric resonance in optical tweezers*, IISc., Bangalore, India.
- ▶ 2004: *Tracing the nature of electric field lines for different configurations of electrodes*, Shimoga, India. Later this experiment was introduced to undergrads at the Physics Dept. at Sahyadri Science College, Shimoga, Karnataka.

Scientific Communications

Presentations

1. **T. Bandi** (Nov. 2010). “*Studies on an improved compact physics package for Rb cell standards*”. 42nd annual Precise Time and Time Interval (PTTI) systems applications meeting, Reston, Virginia.
2. **T. Bandi** (Dec. 2012). “*High performance Rubidium Frequency Standard*”. Optics Photonics Technology Laboratory - École Polytechnique Fédérale de Lausanne (EPFL), Switzerland.

3. **T. Bandi** (July 2013a). “Compact, High-Performance CW Double-Resonance Rb frequency Standard: present status”. joint 2013 European Frequency and Time Forum International Frequency Control Symposium (EFTF/IFCS), Prague, Czech Republic.
4. **T. Bandi** (Oct. 2013b). “Double-Resonance studies on compact, high-performance rubidium cell frequency standards”. Quantum Sciences Technology Group (QSTG), NASA - Jet Propulsion Laboratory/Caltech, Pasadena, USA.
5. **T. Bandi** (Dec. 2014). “Atomic clocks: back-bone of precise time and applications”. Space Applications Center (SAC), Indian Space Research Organization (ISRO), Ahmedabad, Gujarat, India.
6. **T. Bandi** (Dec. 2015a). “Clocks: Heart of navigation systems”. ISRO-Structural Training Programme (STP), Space Applications Center, ISRO.
7. **T. Bandi** (Oct. 2015b). “Precise Clocks”. ISRO-Induction Training Programme (IITP), Space Applications Center, ISRO.
8. **T. Bandi**, T. L., J. Kellogg, S. Chung, J. Prestage, and N. Yu (Apr. 2015). “Towards a miniature lamp-pumped Hg⁺ standard”. Denver, Colorado, USA.
9. **T. Bandi** (Apr. 2016). “Inside a navigation clock”. Knowledge sharing series, Space Applications Center, ISRO.
10. **T. Bandi** (Sept. 2021). “Time keeping in GNSS: Atomic clocks and applications”. Centre for Space Science, Technology Education in Asia, and the Pacific (CSSTEAP) lecture on satellite navigation, India.

Patents

1. **T. N. Bandi** and A. Hauser. (Feb. 2022). “Artificially Intelligent Node-based security enhancement for the Global Navigation Satellite System”. Submitted to The University of Alabama (Internally).

Refereed research papers

1. **T. Bandi**, V. Minogin, and S. N. Chormaic (2008). “Atom microtraps based on near-field Fresnel diffraction”. *Physical Review A* **78**(013410).
2. **T. Bandi**, C. Affolderbach, C. E. Calosso, and G. Mileti (2011). “High-performance laser-pumped rubidium frequency standard for satellite navigation”. *Electronics Letters* **47**(12), 698–699.
3. C. Stefanucci, **T. Bandi**, F. Merli, M. Pellaton, C. Affolderbach, G. Mileti, and A. K. Skrivervik (2012). “Compact microwave resonator for high-performance rubidium frequency standards”. *Review of Scientific Instruments* **83**(104706).
4. D. Miletic, **T. Bandi**, C. Affolderbach, and G. Mileti (2012). “ac Stark shift in double resonance and coherent population trapping in a wall-coated cell for compact Rb atomic clocks”. *Physica scripta* **T149**(014012).
5. **T. Bandi**, C. Affolderbach, and G. Mileti (2012). “Laser-pumped wall-coated cell rubidium frequency standard”. *Journal of Applied Physics* **111**(124906).
6. **T. Bandi**, C. Affolderbach, C. Stefanucci, F. Merli, A. K. Skrivervik, and G. Mileti (2014). “Compact, high-performance CW Double-Resonance rubidium standard with $1.4 \times 10^{-13} \tau^{-1/2}$ stability”. *IEEE Trans. Ultrason. Ferroelectr. Freq. Control* **61**(11).
7. C. Affolderbach, G-X. Du, **T. Bandi**, A. Horsley, P. Treutlein, and G. Mileti (2015). “Imaging microwave and dc magnetic fields in a vapor-cell Rb atomic clock”. *Accepted for publication in IEEE Trans. Instrum. and Meas.* **64**(12).
8. **T. Bandi**, J. Prestage, S. Chung, T. Lee, and N. Yu (2016). “Demonstration of long vacuum integrity lifetime of trapped ion clock package”. *IPN Progress Report* **42**(204).
9. J. Kaintura, A. Ghadiya, S. Soni, and **T. N. Bandi** (2019). “Optics Integrated compact cavity for rubidium atomic frequency standards”. *Review of Scientific Instruments* **90**(084701).
10. P. Jain, P. Priya, TVS. Ram, K. S. Parikh, and **T. Bandi** (2021). “Digital lock-in amplifier for space rubidium atomic clock”. *Review of Scientific Instruments* **92**(124705).
11. R. S. Kesarkar, D. Attri, Md. A. R. Saiyed, TVS. Ram, K. S. Parikh, and **T. N. Bandi** (2022). “Precise calorimetric rubidium mass estimation and its application to the Rubidium Atomic Frequency Standard (RAFS)”. *Accepted in the Journal of Thermal Analysis and Calorimetry*.
12. **T. Bandi**, R. S. Kesarkar, P. Sutar, Md. A. R. Saiyed, D. Attri, A. Soni, and K. Karthik (2022). “A novel method for rubidium bulb bonding and key characterization for future space clocks”. *Accepted in IEEE Transactions on Ultrason. Ferroelectr. Freq. Control*.

13. **T. N. Bandi** and the clock team (2022). "Advanced space rubidium atomic frequency standard for satellite navigation". *Accepted in GPS Solutions* 26(54).

Papers in conference proceedings

1. M. Morrissey, K. D., **T. Bandi**, and S. N. Chormaic (June 2007). "Atomic absorption from the evanescent field of a sub-micron fibre taper". In: *Proceedings of the Conference on Lasers and Electro-Optics (CLEO)/IQEC Europe*. Munich, Germany.
2. D. Gleeson, V. G. M., M. Morrissey, K. Deasy, **T. Bandi**, and S. N. Chormaic (May 2008). "Atomic Fluorescence Emitted into an Optical Nanofiber: Coupling Efficiency and Spectrum". In: *Proceedings of the Conference on Lasers and Electro-Optics (CLEO)*. San Jose, California, USA.
3. **T. Bandi**, V. G. M. and S. N. Chormaic (May 2008). "Near-Field Atom Microtraps Based on Fresnel Diffraction". In: *Proceedings of the Quantum Electronics and Laser Science Conference, QPDA4*. San Jose, California, USA.
4. C. Affolderbach, R. M., F. Gruet, **T. Bandi**, and G. Mileti (Apr. 2010). "Realisation of a compact laser-pumped Rubidium frequency standard with $< 1\text{E-}12$ stability at 1 second". In: *Proceedings of the 24th European Frequency and Time Forum, Noordwijk, the Netherlands*. Noordwijk, Netherlands.
5. S. Micalizio, A. G., F. Levi, C. E. Calosso, F. Gruet, M. Pellaton, **T. Bandi**, C. Affolderbach, and G. Mileti (Apr. 2010). "Pulsed Optically Pumped Rb clock with optical detection: first results". In: *Proceedings of the 24th European Frequency and Time Forum, Noordwijk, the Netherlands*. Noordwijk, Netherlands.
6. **T. Bandi**, C. Affolderbach, and G. Mileti (Nov. 2010a). "Studies on an improved compact physics package for Rb cell standards". In: *Proceedings of the 42nd annual Precise Time and Time Interval (PTTI) systems and applications meeting, Reston, Virginia*. Virginia, USA.
7. **T. Bandi**, C. Affolderbach, and G. Mileti (Apr. 2010b). "Study of Rb 0-0 hyperfine double resonance transition in a wall-coated cell". In: *proceedings of the European Time and Frequency Forum (EFTF), ESA-ESTEC, Noordwijk, the Netherlands*. Noordwijk, Netherlands.
8. C. Affolderbach, T. B., R. Matthey, F. Gruet, M. Pellaton, and G. Mileti (2011). "Compact, high- stability Rb atomic clocks for space". In: *Proceedings of the 3rd International Colloquium -Scientific and Fundamental Aspects of the Galileo Programme, Copenhagen, Denmark*. Vol. 2. 1400. Copenhagen, Denmark: ESA special publication.
9. D. Miletic, T. B., C. Affolderbach, and G. Mileti (May 2011). "Light shift of double resonance and coherent population trapping in wall-coated cells for compact Rb clocks". In: *Proceedings of the Joint Meeting of the European Frequency and Time Forum (EFTF) and the IEEE International Frequency Control Symposium (FCS), San Francisco*. San Francisco, USA.
10. F. Gruet, T. B., J. O. G. Mileti, B. Kelly, R. Phelan, and J. O'Gorman (May 2011). "Development and spectral characterization of Discrete Mode Laser Diodes (DMLDs) emitting at 780 nm for Rubidium atomic clocks". In: *Proceedings of the European Conference on Lasers and Electro-Optics (CLEO), Munich, Germany*.
11. **T. Bandi**, F. Gruet, C. Affolderbach, C. E. Calosso, and G. Mileti (May 2011). "Investigations on improved Rb cell standards". In: *Proceedings of the Joint Meeting of the European Frequency and Time Forum (EFTF) and the IEEE International Frequency Control Symposium (FCS), San Francisco*. San Francisco, USA.
12. F. Gruet, M. P., C. Affolderbach, **T. Bandi**, R. Matthey, and G. Mileti (Sept. 2012). "Compact and frequency stabilized laser heads for rubidium atomic clocks". In: *Proceedings of International conference on Space Optical Systems and Applications*. CNES and ESA. Ajaccio, Corsica, France.
13. **T. Bandi**, C. Affolderbach, C. E. Calosso, C. Stefanucci, F. Merli, A. K. Skrivervik, and G. Milet (Apr. 2012). "Laser-pumped high-performance compact gas-cell Rb standard with $< 3\times 10^{-13} \tau^{-1/2}$ stability". In: *Proceedings of the European Frequency and Time Forum (EFTF), Gothenburg, Sweden*. Gothenburg, Sweden.
14. **T. Bandi**, M. Pellaton, D. Miletic, C. Affolderbach, F. Gruet, R. Matthey, C. Stefanucci, M. Violetti, F. Merli, J-F. Zürcher, A. K. Skrivervik, and G. Milet (May 2012). "Double-resonance in alkali vapor cells for high performance and miniature atomic clocks". In: *Proceedings of the 2012 IEEE International Frequency Control Symposium*. Balimore, MD, USA.
15. **T. Bandi**, C. Affolderbach, C. Stefanucci, F. Merli, A. K. Skrivervik, and G. Mileti (July 2013). "Medium-to Long-Term Frequency Stability of High-Performance CW Double-Resonance Rb Standard". In: *Proceedings of the joint 2013 European Frequency and Time Forum International Frequency Control Symposium (EFTF/IFCS)*. Prague, Czech Republic.

16. A. Ivanov, T. B., G-X. Du, A. Horsley, C. Affolderbach, P. Treutlein, G. Mileti, and A. K. Skrivervik (June 2014). "Experimental and numerical study of the microwave field distribution in a compact magnetron-tzpe microwave cavity". In: *Proceedings of the 28th European Frequency and Time Forum, Neuchâtel, Switzerland*. Neuchâtel, Switzerland.
17. C. Affolderbach, G.-X. D., **T. Bandi**, A. Horsley, P. Treutlein, and G. Mileti (Apr. 2015). "Imaging the static magnetic field distribution in a vapor cell atomic clock". In: *Proceedings of the 2015 Joint conference of the IEEE IFCS and EFTF*. Denver, Colorado, USA.

Reports to European Space Agency (ESA)

1. G. Mileti, F. G., C. Affolderbach, P. Scherler, and **T. Bandi** (June 2009). "*LTF contributions to the preliminary deisgn*". Tech. rep. LTF-01427-TN-0002. Laboratoire Temps-Fréquence.
2. **T. Bandi**, F. Gruet, and G. Mileti (April 2011). "*Study of the short- and long-term stabilities of the LTF Subsidiary Unit*". Tech. rep. LTF-01486-REP-001. Laboratoire Temps-Fréquence.
3. **T. Bandi**, F. Gruet, P. Scherler, C. Affolderbach, E. Breschi, and G. Mileti (December 2008). "*WP1200 - LTF support to review and clock definition*". Tech. rep. LTF-01427-TN-0001. Laboratoire Temps-Fréquence.
4. **T. Bandi**, P. Scherler, C. Affolderbach, and G. Mileti (September 2010). "*Auxiliary unit physics package subsystems design and breadboarding*". Tech. rep. LTF-01427-TN-0003A1. Laboratoire Temps-Fréquence.
5. **T. Bandi**, P. Scherler, C. Affolderbach, M. Pellaton, and G. Mileti (September 2010). "*Subisiary unit physics package subsystems design and breadboarding*". Tech. rep. LTF-01427-TN-0003A2. Laboratoire Temps-Fréquence.

Reports to Indian Space Research Organisation (ISRO)

1. **T. Bandi** (April 2021). "*Clock requirement analyses for radio occultation studies for Venus mission*". Tech. rep. for project RAVI. Indian Space Research Organisation (ISRO).
2. **T. Bandi** (May 2016). "*Executive summary on rubidium atomic clock research and development*". Tech. rep. Report to Chairman ISRO. Indian Space Research Organisation (ISRO).
3. **T. Bandi** (June 2020). "*Final report: Indian Rubidium Atomic Frequency Standard (IRAFS)*". Tech. rep. National Committee review report to Chairman ISRO. Indian Space Research Organisation (ISRO).

Awards and Fellowships

- 2015: Caltech postdoctoral fellowship, California Institute of Technology, California, USA.
- 2013: Swiss National Science Foundation (SNSF) Early Postdoctoral Mobility (EPM) fellowship.
- 2010: Honorary poster prize at the Precise Time and Time Interval (PTTI) conference, Virginia, USA.
- 2008: Université de Neuchâtel Assistant doctorant fellowship, May 2008 to April 2013.
- 2008: Science Foundation Ireland PhD fellowship (declined).
- 2008: 3rd prize for poster at the Institute of Physics (IoP) spring weekend, Carrickmacross, Ireland.
- 2007: Special commendation award at Institute of Physics competition for postgraduates, Birr, Ireland.
- 2007: Poster prize at Quantum, Atomic, Molecular and Plasma Physics (QuAMP), London, UK.
- 2006: Cork Institute of Technology masters by research studentship, March 2006 to April 2008.
- 2004: M.Sc. 1st rank in physics; recipient of three Gold medals, Kuvempu University, India.

Other professional activities

- Reviewer: American Institute of Physics (AIP) Review of Scientific Instruments; Springer GPS solutions; IEEE Journals; Journal of the Optical Society of America (JOSA) -A, -B; Optics Express; .
- Member of the Optical Society of America.
- Member of the Optical Society of India.
- Member of editorial board, Journal of Natural Science, Biology and Medicine (JNSMB).