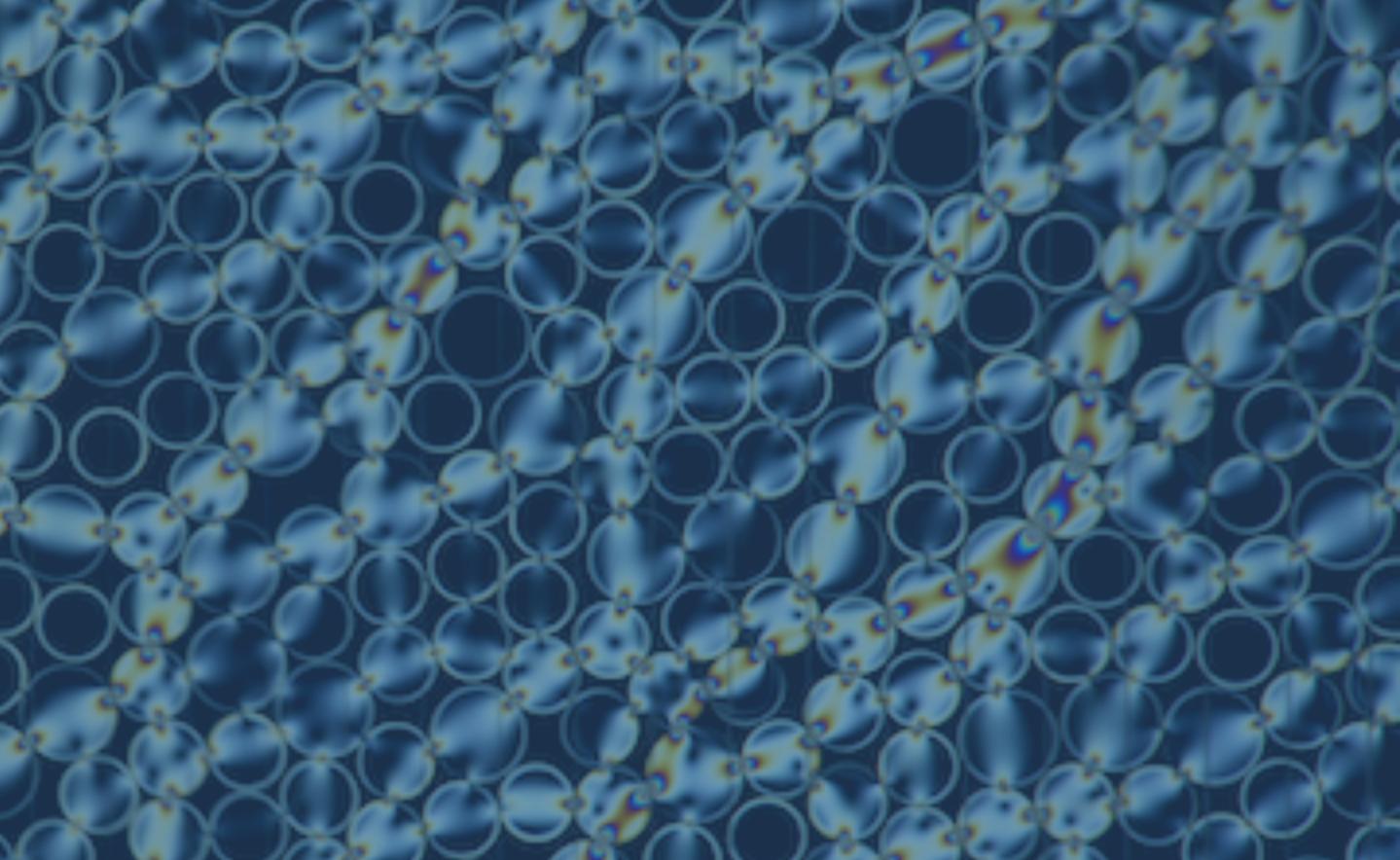


ICTP:

# Welcome: Workshop on Widening Access to TinyML Network by Establishing Best Practices in Education

**Marco Zennaro, PhD**  
**STI Unit**  
**3 July 2023**



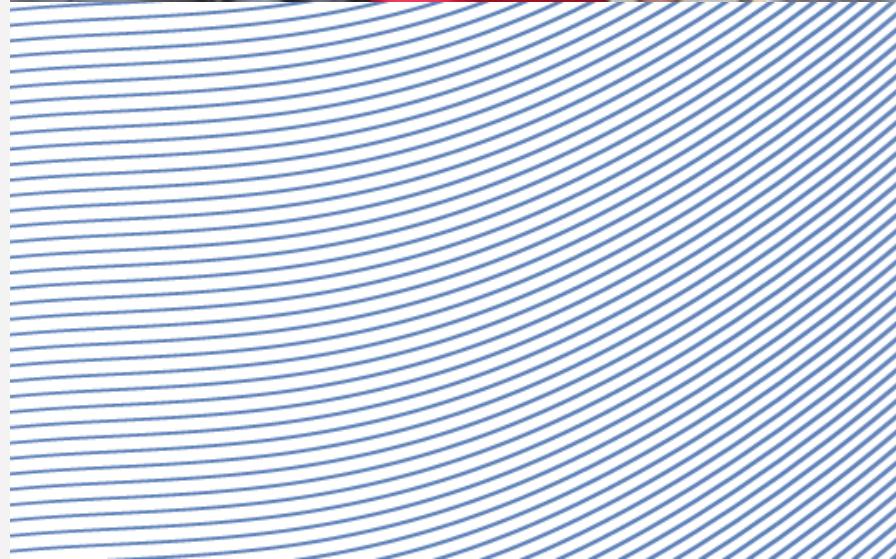
The Abdus Salam  
**International Centre  
for Theoretical Physics**



United Nations  
Educational, Scientific and  
Cultural Organization  
UNESCO

# What is ICTP?

- Founded in 1964 by Nobel Laureate Abdus Salam to enhance international cooperation through science.
- Combines world class research with a unique global mission of building science capacity in the developing world.
- Governed by tripartite agreement between Italy UNESCO and IAEA.



# What is ICTP?

## Research

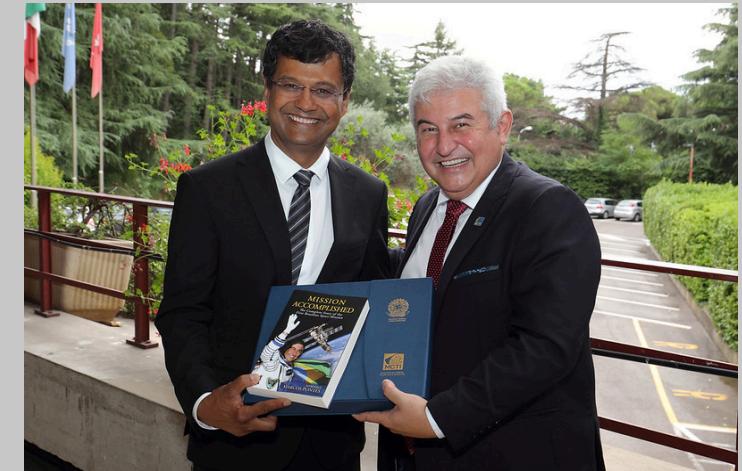
Handwritten notes on a blackboard:

- $J_{ij} S_i S_j - \hbar^2 \nabla^2$
- Fermi:  $M_{q=0} = m_e \hbar^2 / 2\pi^2$
- $M_{q=Q} = m_e^2 Q^2 / 2\pi^2$
- $(J_{ij}) \sim e^{-2\pi^2 \hbar^2 / (m_e^2 Q^2)}$
- $S_j = 3(\vec{S}_i, \vec{n})(\vec{S}_j, \vec{n})$
- $R^2 h_i < S_i^2 S_j^2$
- $M_{q=0}^2 = \begin{cases} 0 & \text{above } T \\ 0 & \text{below } T \end{cases}$
- $P(j) \sim e^{-E_j^2 / (2\pi^2 \hbar^2 / (m_e^2 Q^2))}$

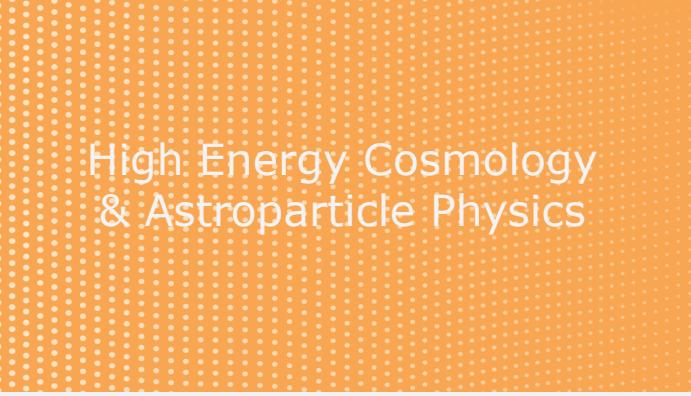
## Education



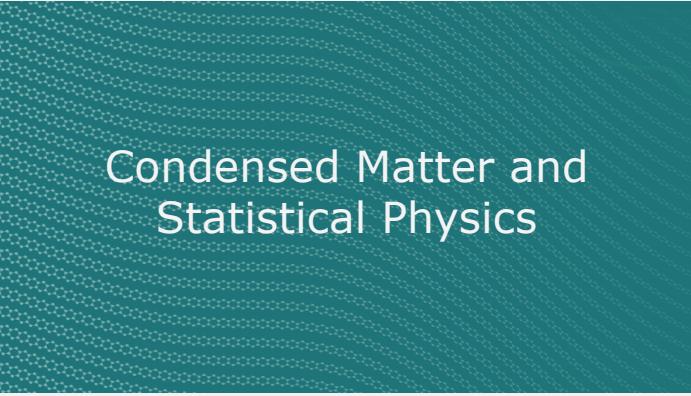
## Cooperation



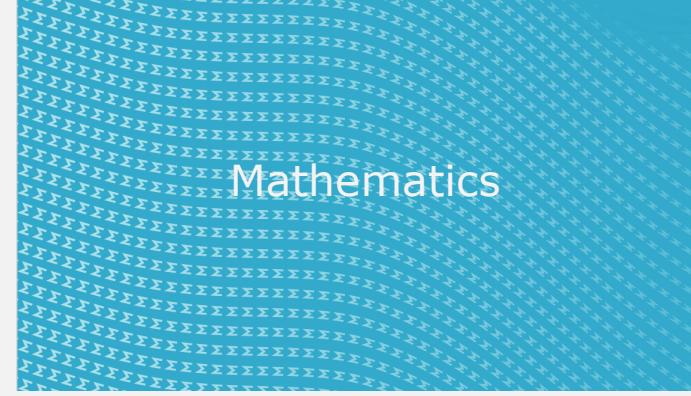
# Research Sections



High Energy Cosmology  
& Astroparticle Physics



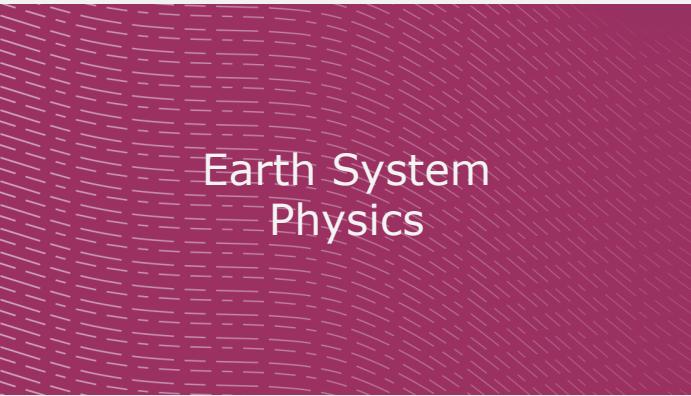
Condensed Matter and  
Statistical Physics



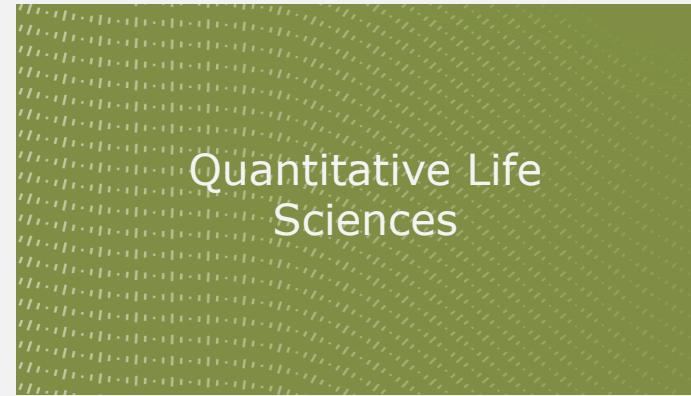
Mathematics



Science, Technology and  
Innovation



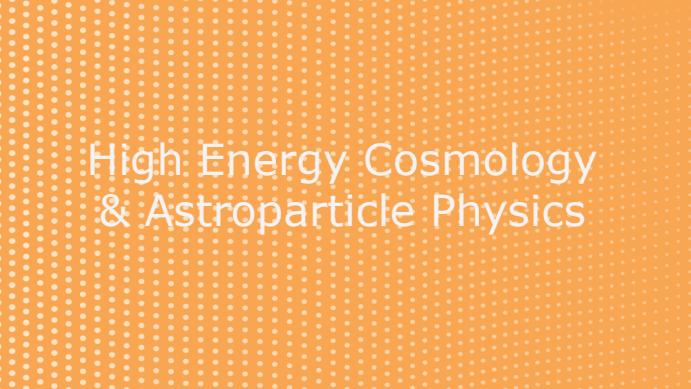
Earth System  
Physics



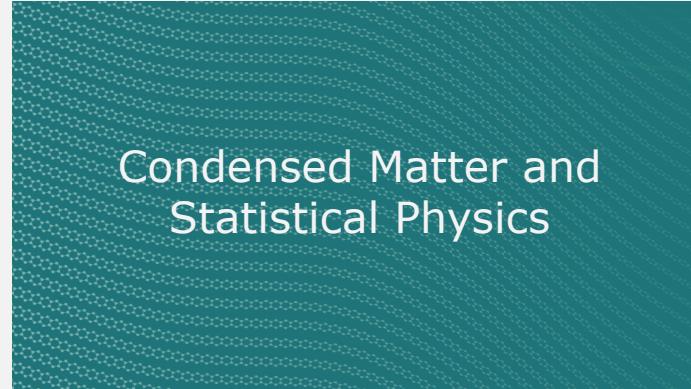
Quantitative Life  
Sciences

Also: Sustainable Energy and High Performance Computing

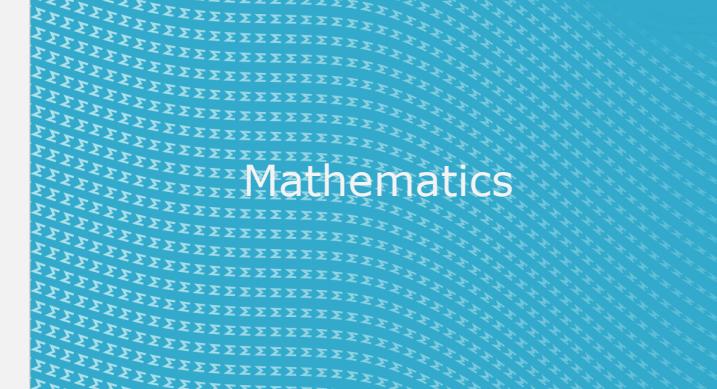
# Research Sections



High Energy Cosmology  
& Astroparticle Physics



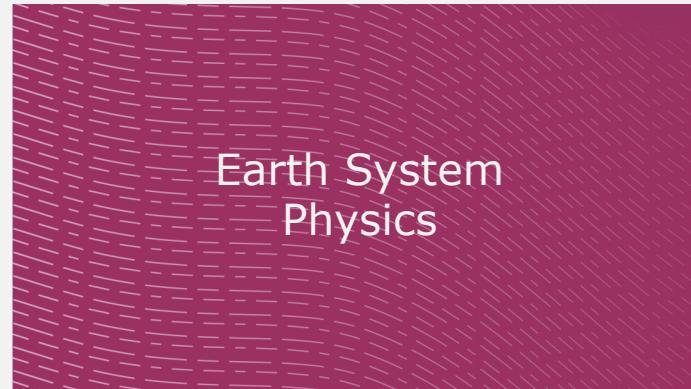
Condensed Matter and  
Statistical Physics



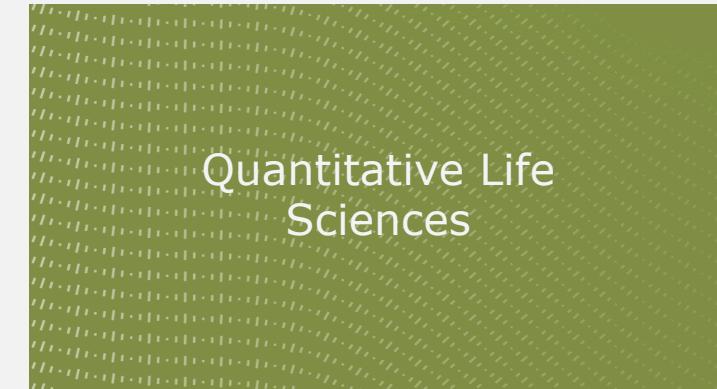
Mathematics



Science, Technology and  
Innovation



Earth System  
Physics

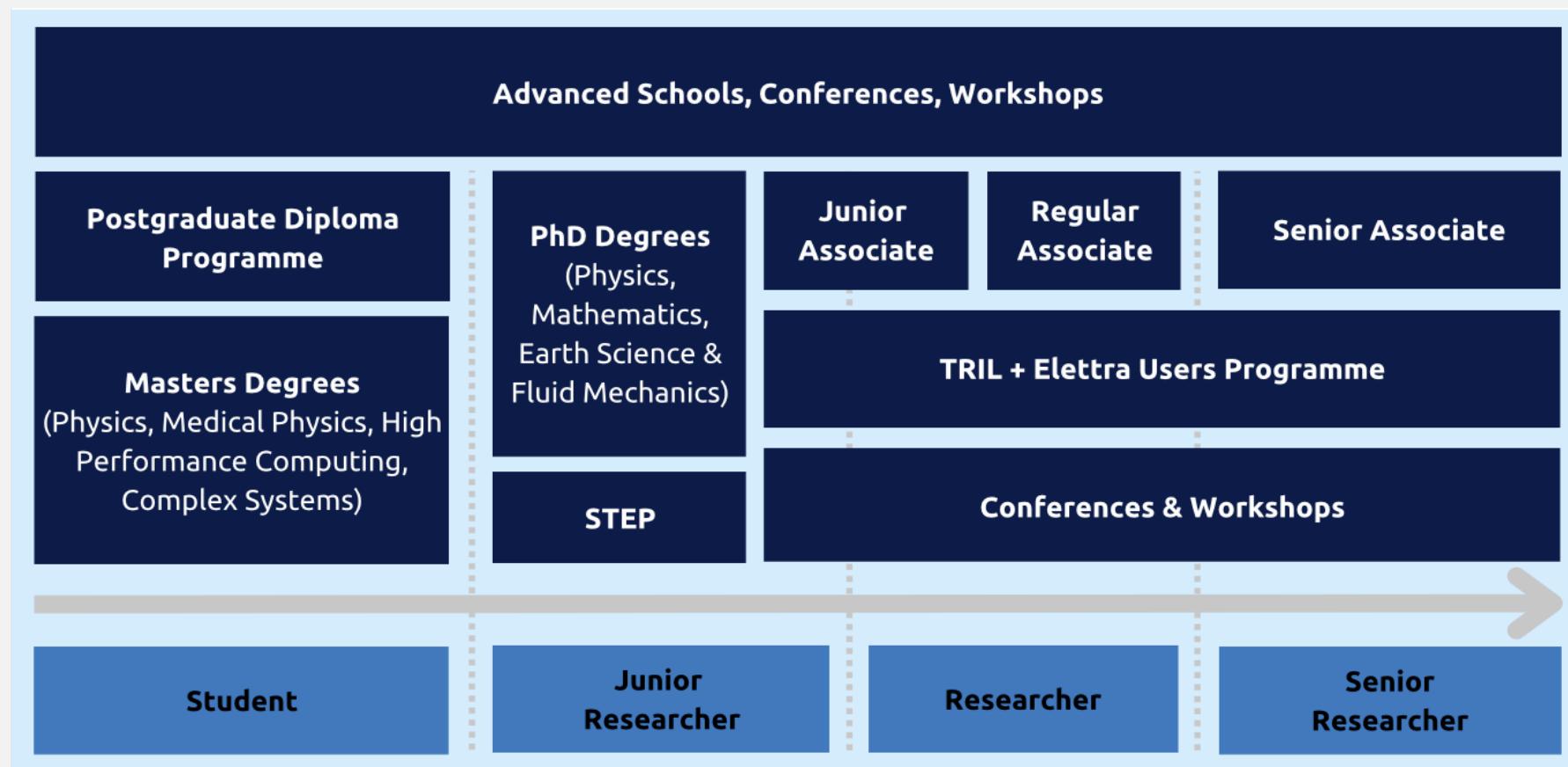


Quantitative Life  
Sciences

Also: Sustainable Energy and High Performance Computing

# ICTP Programmes:

## Supporting Scientists in all Stages of their Careers



# Associates Programme:

## Working Together at ICTP

- **285** Associates
- 6 year term, visits to IAEA to collaborate with ICTP Scientists
- Simons Associates may also bring a student



# ICTP: An International Hub for Scientific Networking

- Organises more than **60** conferences & workshops each year.
- Welcomes up to more than **7,000** scientists from **145** nations each year.
- Attracts an additional **1,000-2,000** scientists per year through hosted activities.

# ICTP Visiting Scientists: Where do they come from?

SINCE 1970:

More than

**180,000**

visits

from scientists from  
**188** countries around  
the world

IN 2022:

**29%**

of visitors where  
women

**67%**

of visitors where from  
developing and least-  
developed countries



# Why TinyML at ICTP?

Wireless Networking



IoT



# TinyML Academic Network: 2020

## TinyML4D

**Mission statement:** Widening access to applied machine learning by establishing best practices in education.

ICTP QLS & AP Colloquium

### How TinyML Could Help Developing Countries

Speaker **Pete Warden**  
Google

**Tuesday 13 October 2020 at 16.00**

Zoom webinar

Register in advance for this webinar:

[WEBINAR link](#)

After registering, you will receive a confirmation email containing information about joining the webinar.

Should you not be able to join the Webinar, the Colloquium is also available in live streaming at:

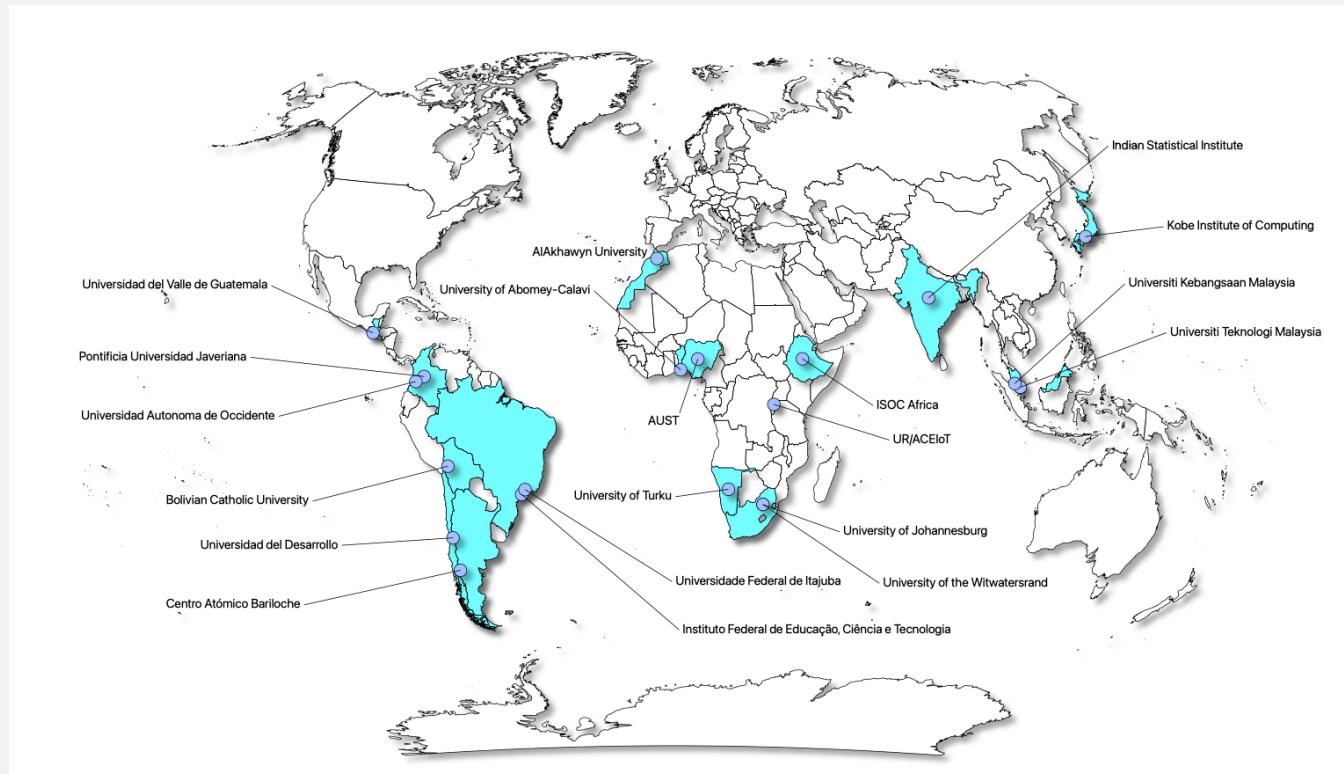
[ictp.it/livestream](http://ictp.it/livestream)



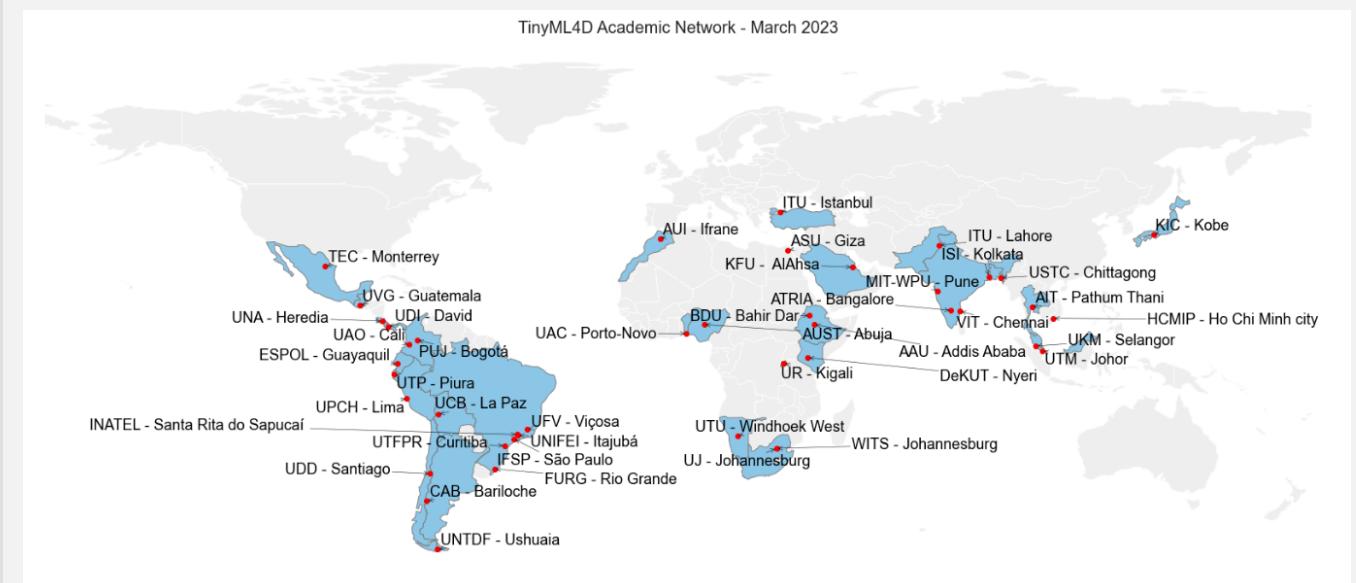
# TinyML Academic Network: 2021



**210 participants  
from 48 countries**



# TinyML Academic Network: 2022-2023



**890 participants**

# TinyML Academic Network: 2022-2023

The screenshot shows the homepage of the TinyMLedu website. At the top, there is a navigation bar with links for "Home", "Courses & Materials", "4D Network", "Show & Tell", "SciTinyML", "Research", and a menu icon. Below the navigation bar is a large dark blue header section containing the text "Welcome to the Tiny Machine Learning Open Education Initiative (TinyMLedu)". Underneath this header are four buttons arranged in a grid: "Take a Free Course or Teach Your Own", "Explore our 4D Academic Network", "Attend our SciTinyML Workshop", "View our Research Projects", and "Learn More About Us".

If you want to be more involved with our effort to help improve access to TinyML educational materials and hardware resources worldwide reach out to us at [edu@tinyML.org](mailto:edu@tinyML.org)!

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Thanks to all of our sponsors!

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Harvard John A. Paulson  
School of Engineering



# TinyML Academic Network: 2022-2023

## Show and Tell

### TinyML4D Academic Network 2nd Show and Tell on October 27th, 2022.

The First TinyML4D Show and Tell of student projects was October 27th, 2022. The recorded video is at this Youtube link [https://youtu.be/s8\\_hKpOWUwY](https://youtu.be/s8_hKpOWUwY)

Presenting is:

1. Samson Otieno Ooko, University of Rwanda, TinyML Based Self Diagnostic Kit for Respiratory Diseases, 10 minutes. Video starts at 4:37

### TinyML4D Academic Network 2nd Show and Tell on December 1st 2022.

The full video is at this Youtube address <https://youtu.be/e49pkjnlMIQ>

Presenters in the order of presentation are:

1. Wong Khai Chuan, Universiti Teknologi Malaysia Malaysia, Smart Switch Based on Embedded Machine Learning, 10 minutes

### The TinyML4D Academic Network 3rd Show and Tell will be January 26th, 2023

For this the Third TinyML4D Academic Network Show and Tell we did have some issues with people getting into the zoom meeting as the passcode was needed. Hopefully next month will be more smooth.

The Show and Tell is typically held at 2pm UTC on the last Thursday of each month.

Presenters are:

1. Ricardo Magalhaes, University of São Paulo, TinyML 5 minutes
2. Carlos Rodriguez, University of Valencia, Machine learning for low-power devices, 5 minutes
3. Kimberly Crandall, University of Colorado Boulder, Machine learning for low-power devices, 5 minutes
4. Dr. Balaji Murali, University of Texas at Dallas, Using tinyML for low-power applications, 5 minutes
5. Jackie Lin, University of California Berkeley, Using tinyML for low-power applications, 5 minutes

### The TinyML4D Academic Network 3rd Show and Tell will be February 23rd, 2023

The forth TinyML4D Academic Network Show and Tell.

The Show and Tell is typically held at 2pm UTC on the last Thursday of each month.

Full video here: <https://youtu.be/BAEdit7X68Y>

Presenters are:

1. Gohel Amit Chandrakantbhai, Gujarat Technological University, India, Weep Scope "Weep Scope" project involves creating a machine learning model to identify and recognize the unique cries of infants, 5 minutes. [Video here when ready](#) Confirmed
2. James Adeola, Université d'Abomey Calavi, Benin, Crops diseases detection with TinyML, 10 minutes. [Video here when ready](#) Confirmed
3. Hellen Cristina Ancelmo, Instituto Carlos Chagas (ICC - Fiocruz PR) / Universidade Tecnológica Federal do Paraná (UTFPR), Brazil, Application of artificial intelligence techniques in Point-of-care medical equipment, 10 minutes. [Video here when ready](#) Confirmed
4. Muhammad Suzuki Zahran, Universitas Rahastra, Indonesia, Implementation of Deep Learning on a Chick Counter, 15 minutes. [Video here when ready](#) Confirmed
5. Dr. Balaji Murugan MS, Vellore Institute of Technology, chennai India, Identification of cashewnut diseases using tinyML, 10 minutes [Video here when ready](#) Confirmed

## UN papers

### Science-Policy Brief for the Multistakeholder Forum on Science, Technology and Innovation for the SDGs, May 2022

#### TinyML: Applied AI for Development

Marco Zennaro (ICTP/UNESCO), Brian Plancher (Harvard University), Vijay Janapa Reddi (Harvard University)

##### Abstract

Artificial intelligence (AI) has the potential to contribute to the Sustainable Development Goals (SDGs). However, AI development requires significant energy and computing resources, which can pose challenges for developing countries. This brief explores how TinyML, a subset of AI that runs on low-power devices, can help address these challenges by enabling the development of smart, low-power devices in resource-constrained environments.

#### Bridging the Digital Divide: the Promising Impact of TinyML for Developing Countries

Marco Zennaro (ICTP/UNESCO), Brian Plancher (Barnard College, Columbia University), Vijay Janapa Reddi (Harvard University)

##### Abstract

The rise of TinyML has opened up new opportunities for the development of smart, low-power devices in resource-constrained environments. This technology has particular relevance for developing countries, where access to energy and computing resources is often limited. In light of this, a network of 40 universities has been established over the past two years with the goal of promoting the use of TinyML in developing regions. The members of this network have taught courses at their home institutions and have completed their first research projects covering topics ranging from the diagnosis of respiratory diseases in Rwanda to assistive technology development in Brazil, bee population monitoring in Kenya and estimating the lifespan of the date palm fruit in Saudi Arabia. These initial projects demonstrate the potential for TinyML to make a real impact on the Sustainable Development Goals. They hold great promise for a new generation of devices that could help to bridge the digital divide and bring the benefits of technology to those who need it most. Lastly, we suggest three policy recommendations to increase the future impact: first, training and research activities in STI should focus on regional networks; second, the ethics of artificial intelligence must be covered in all activities; and third, we need to support local champions better.

# Our workshop

Workshop on **Widening Access** to TinyML Network by **Establishing Best Practices** in Education



How can we scale up?



What worked / did not work?

How can we be more inclusive?

Open Educational Resources?

What are the research opportunities?

Common Certification?

# White paper

# Agenda: Monday

09:15 Opening and Call to Action

09:30 **Introductions and Sharing of Attendees**

10:00 Coffee break

10:30 **Keynote: Is open source all that is needed to create a good education programme? Three experiences in designing courses for massive adoption,**

David CUARTIELLES (Arduino)

11:30 Setting Up for the next day and a half, Brian PLANCHER (Columbia University)

12:00 Lunch break

13:30 **Experience Session on Long TinyML courses – Teaching Wins and Losses**

Brian PLANCHER (Launching TinyML edX and Long Term Support)

Manuel ROVERI

Marcelo ROVAI (An undergrad Engineering course aiming to project development)

Jesus LOPEZ (Experiences in teaching TinyML to undergraduate and graduate students)

Jeremy ELLIS (Deprecation, client side and tinyMLjs)

15:00 Coffee break

15:30 Experience Session Reflections and Lessons Learned

# Agenda: Tuesday

09:00 **Keynote: Overview of Edge Impulse and latest features**, Alessandro GRANDE (Edge Impulse)

10:00 Coffee break

10:30 **Keynote: Academia-Industry Partnerships from TinyML Foundation prospective and Call to Action for tinyML.edu**, Evgeni GOUSEV (TinyML Foundation)

11:30 **Best Practices for Open Training Materials**: Marcus RUB (Hahn-Schickard-Gesellschaft für angewandte Forschung e.V.) and Thomas AMBERG (University of Applied Sciences and Arts Northwestern)

12:15 Lunch break

13:30 **Experience Session on Short TinyML courses – Teaching Wins and Losses**

Sebastian BUETTRICH (TinyML course at ITU, DK)

Solomon GIZAW (TinyML teaching experience)

Ronald CRIOLLO (TinyML teaching experience and supervising capstone projects)

Diego MENDEZ CHAVES (the challenging first steps of graduate students on TinyML)

Rosdiadee NORDIN (micro-credential course on TinyML)

15:00 Coffee break

15:30 Experience Session Reflections and Lessons Learned 19:00 - 20:30

19:00 **Welcome Reception**

All participants are cordially invited to the Welcome Reception

# Agenda: Wednesday

09:00 **Keynote: Making Sense of the Wild**, Eric PAN (Seeed Studio)

10:00 Coffee break

10:15 **Technical Talk: From LoRa to the Cloud: Bridging Physical and Digital Worlds**,  
Pietro MANZONI (Universidad Politecnica de Valencia)

11:15 **Research Talk: Benefits and Challenges of using Low Cost Weather Stations**,  
Paul KUCERA (UCAR/COMET)

12:15 Lunch break

13:45 **Research Talk: Monitoring mosquitoes of public health importance  
with TinyML**, Cyril CAMINADE (ICTP)

14:45 Coffee break

15:15 **Hardware Demo**

Marcelo ROVAI (UNIFEI IESTI) and Jose Antonio BAGUR (Arduino)

# Agenda: Thursday

09:00 **Keynote: Arduino and TinyML: the way forward**, Massimo BANZI (Arduino)

10:00 Coffee break

10:15 Research Talks

Neena GOVEAS (TinyML research and human health monitoring)

Jose Antonio BAGUR (Anomaly Detection Course)

Laila KAZIMIERSKI (Animal tracking)

Milan LUKIC (Lightweight digit recognition in utility metering, Anomaly detection in logistics asset tracking, Detection of fungal disease outbreak risk in agriculture)

Jackline TUM (leveraging TinyML for illegal Logging detection)

Halleluyah AWORINDE (Leveraging TinyML for vocalization signal-based Poultry Health Management)

Brian PLANCHER (ML Sensors and Environmental Impact of TinyML)

12:15 Lunch break

13:45 - 16:45 **White Paper on Embedded ML University Program Design**,

Brian PLANCHER facilitator

17:00 SciFabLab

# Agenda: Friday

- 09:00 Keynote: **Teaching TinyML in ARM Laboratories**, Stephen OZOIGBO (ARM)
- 10:00 Coffee break
- 10:30 **Group Work: Future of Embedded ML**, Brian PLANCHER facilitator
- 12:30 Lunch break
- 14:00 Feedback
- 15:00 Collaboration Discussion
- 16:00 Closing ceremony

# Thank you!

## Scientific Directors:

José Alberto Ferreira Filho (UNIFEI)  
Vijay Janapa Reddi (Harvard University)  
Marcelo Jose Rovai (UNIFEI, IESTI)  
Brian Plancher (Barnard College)

## Support from:

Arduino  
ARM  
Edge Impulse  
Seeed Studio  
TinyML Foundation

## Hardware Donation from:

Arduino  
Seeed Studio



# Logistics #1

<p>Duration <b>03 - 13</b> Jul Jul</p> <p>Application Closed</p>	<p>School</p> 	<p>Joint Summer School on Modelling Tools for Sustainable Development   (smr 3852)</p>	<p>ICTP Kastler Lecture Hall (AGH)</p>
			<p>ESP EARTH SYSTEM PHYSICS</p>
			<p>SMR3852</p>

More than 150 participants



Let's stick to our lunch break time!

## Logistics #2

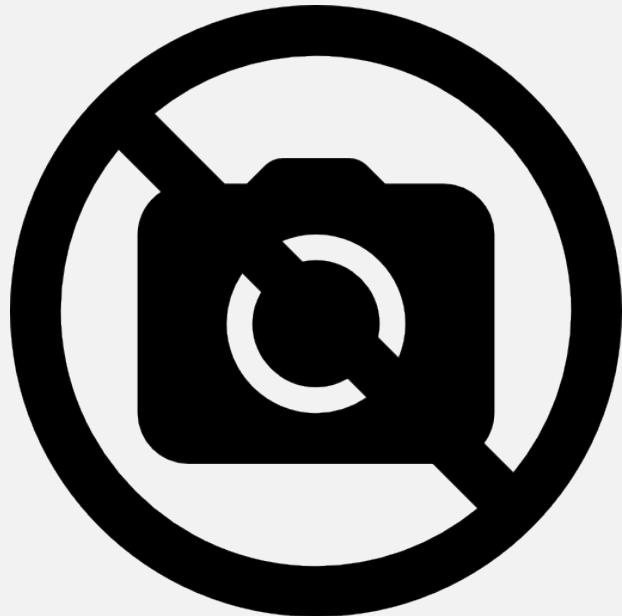


Thursday

17:00 SciFabLab (Fermi Building, 20 min walk from Adriatico Guesthouse)

19:30 Salsonando

# Logistics #3





Thank you!