

# Young metrologists' 2050+ vision-charting the future of metrology

Authors 1. Kangyoung SUNG (sky0512@kriss.re.kr), Korea Research Institute of Standards and Science (KRISS)  
2. Chingis KUANBAYEV (chingis.kuanbayev@bipm.org), Bureau international des poids et mesures (BIPM)

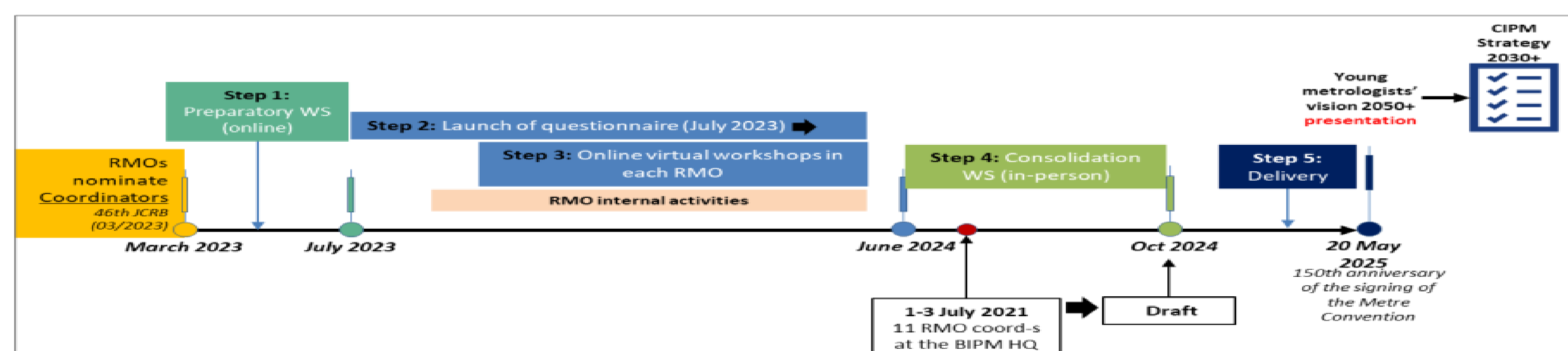
## Abstract

- The Young Metrologists' 2050+ Vision initiative (herein after “initiative”) has highlighted the remarkable contributions and forward-thinking spirit of young metrologists from the globe. Their collective insights, gathered through extensive workshops and surveys with over 380 participants from the six Regional Metrology Organizations (RMOs), express their dedication for shaping the future of metrology. These emerging leaders are not only passionate about their research fields but also deeply committed to tackling the technological and societal challenges that lie ahead. Crafted through this collaborative foresight exercise involving young metrologists from National Metrology Institutes (NMIs) and Designated Institutes (DIs), this initiative culminated in a young metrologists' vision – “Metrology, as a cornerstone of natural sciences, must evolve together and drive advances in technology, supporting all stakeholders based on collaborative capacity and capability building to co-shape the future.”
- Their collaborative efforts, driven by enthusiasm and a commitment to progress, identified key technological trends and emerging challenges that will shape metrology by 2050 and beyond. The young metrologists have highlighted thirteen areas that may impact the needs, ways to deliver metrological services, science and technology, as well as collaborations in measurement science. Topics such as quantum technology, artificial intelligence, IoT-enabled sensor networks, nanobiometrology, perceptual metrology, and metrology in space were highlighted as transformative forces. Below concepts can be considered as new opportunities in metrology to vastly impact the future world:
  - Perceptual metrology will play an increasingly important role in shaping the future of human-computer interactions and the broader human experiences.
  - Metrology in outer space; an explosive growth in space activities will demand precise measurements under unprecedented and extreme environmental conditions.
  - Metrological self-traceability; metrological traceability chains may become shorter with the development of portable primary standards that can be remotely calibrated.
  - Nanobiometrology is an evolving field that encompasses the principles of nanotechnology, biology and metrology to measure and characterize biological systems. Innovations in instrumentation, computational modelling, and the development of new standards will provide wide applicability of nanobiometrology.

## Introduction

- Introduction of the initiative
  - CGPM mandated BIPM to provide a unique opportunity to launch a consultation among young metrologists on their global vision for metrology in 2050+.
  - BIPM cooperated with 6 RMOs to realize the initiative, and 11 RMO coordinators were nominated by RMOs to carry out the initiative.
  - BIPM and RMO coordinators developed 10 questions (questionnaire) to identify “challenges, opportunities in the metrology” and “delivery of metrology” and to co-shape the future of metrology.

## Strategic Planning



## Methods

- Sharing and collecting ideas from young metrologists through online channels
  - BIPM and 6 RMOs jointly organized six online workshops to discuss and share the concept of questionnaire in the online survey
  - Each participant submit his/her own answers to the questionnaire via jotform(from July 2023 to June 2024).

## Results

- Participations to the online workshop and survey from young metrologists
  - Online workshop: There were 6 online workshops with about 380 participants
  - Online survey: About 170 participants from 6 RMOs responded with respect to the questionnaire
- Analysis on the responses (July 2024)
  - The authors and 11 RMO coordinators had the consolidation workshop at BIPM HQ and jointly analyzed all the answers and identified 13 key areas which are considered challenging and interesting for the future of metrology; Quantum Technology / Artificial Intelligence / Internet of Things, sensor networks, 6G+ / Cloud storage / Metrological self traceability /Climate and environmental changes / Nanobiometrology / Perceptual metrology / Metrology in space and other planets / Interdisciplinary challenges / Science Scepticism and Ethics / Political, legal, social influence / Human resources
- Key areas for actions
  - **New metrological capabilities** are required to meet the rapid changes.
  - **Collaboration** with stakeholders is prerequisite to cope with vast scope of demands in metrological areas.
  - **Capacity building and education** is necessary to have the compatible measurement capabilities in the community.
  - **Standardization and policies** should be accompanied and aligned with metrology to bring harmonization.
  - **Inter-disciplinary joint research projects** among NMIs is important to tackle the global challenges.

## Conclusions

- Conclusions from the initiative
  - This unprecedented initiative was a great opportunity for young metrologists to express their own ideas for the strategy development who will actually perform those strategies by themselves in global metrology communities in the years to come.
  - Many young metrologists who are future leaders eager to share their thoughts and views with other metrologists so as to enhance the metrological capability in their fields.
  - Metrology will play a pivotal role for the advancement of science & technology and industrial innovation thanks to many self-driven young metrologists who are constantly working towards a better tomorrow of metrology and human beings.



Picture 1. Online survey



Picture 2. Online workshop



Picture 3. Consolidation workshop @ BIPM