

# Consultative Committee for Photometry and Radiometry - CCPR

Maria Luisa RASTELLO

CCPR President

INRIM Italy



**Bureau**

International des

Poids et

Mesures

# Global forum for progressing the state-of-the art

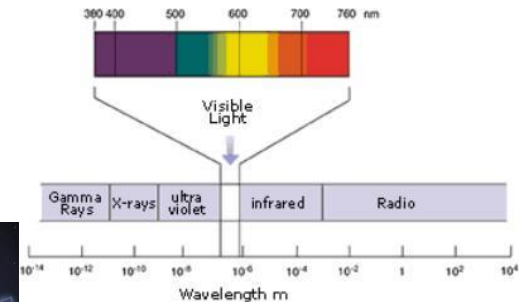
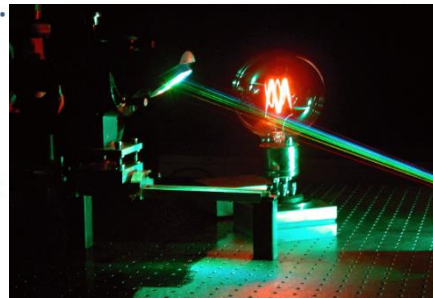
## Consultative Committee for Photometry.....

Describes the effects of visible light on the human eye, in terms of brightness (photometry) and colour (colorimetry)



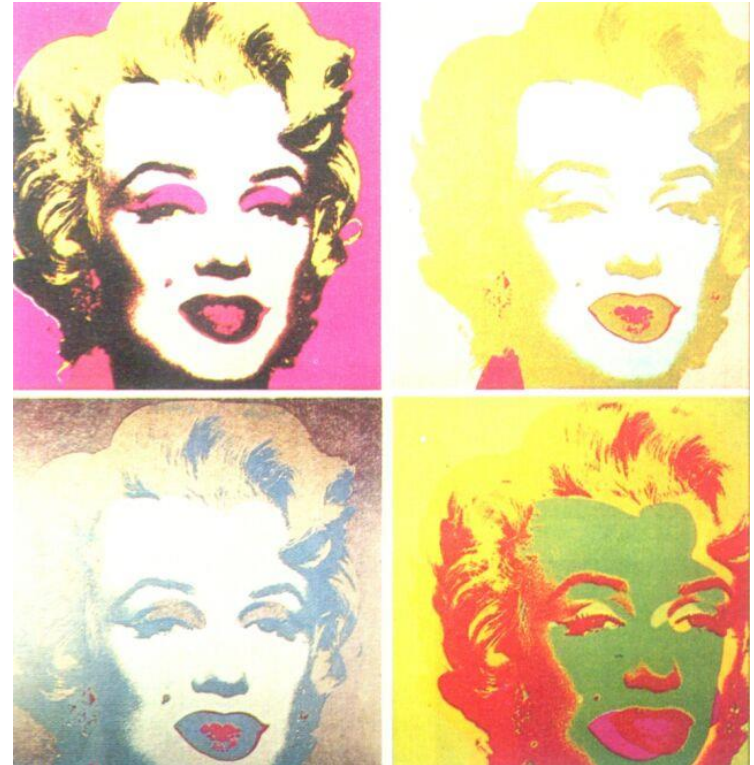
## Radiometry .....

Metrology related to the physical measurement of the properties of electromagnetic radiation, including visible light



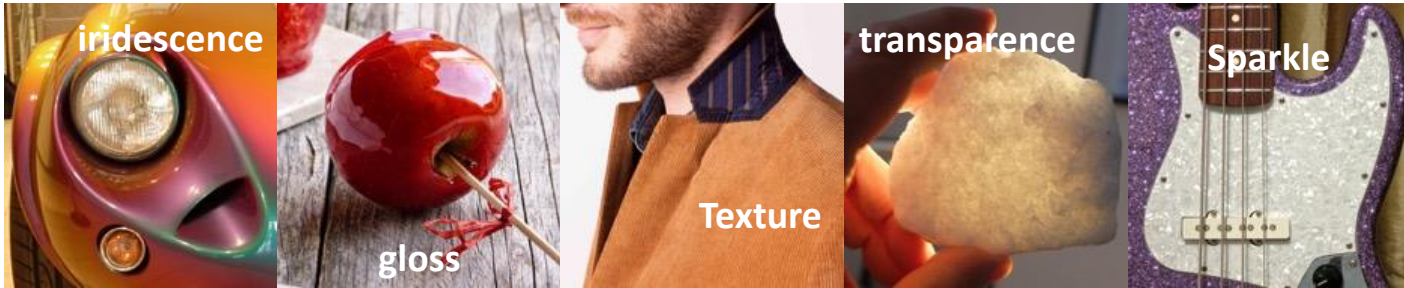


# Photometry





# How it appears



700 b US\$ is the estimated values of shipments in industries like automotive, textile, printing, fashion, food, where unacceptable appearance may result in « NO SALE »



# Smart energy

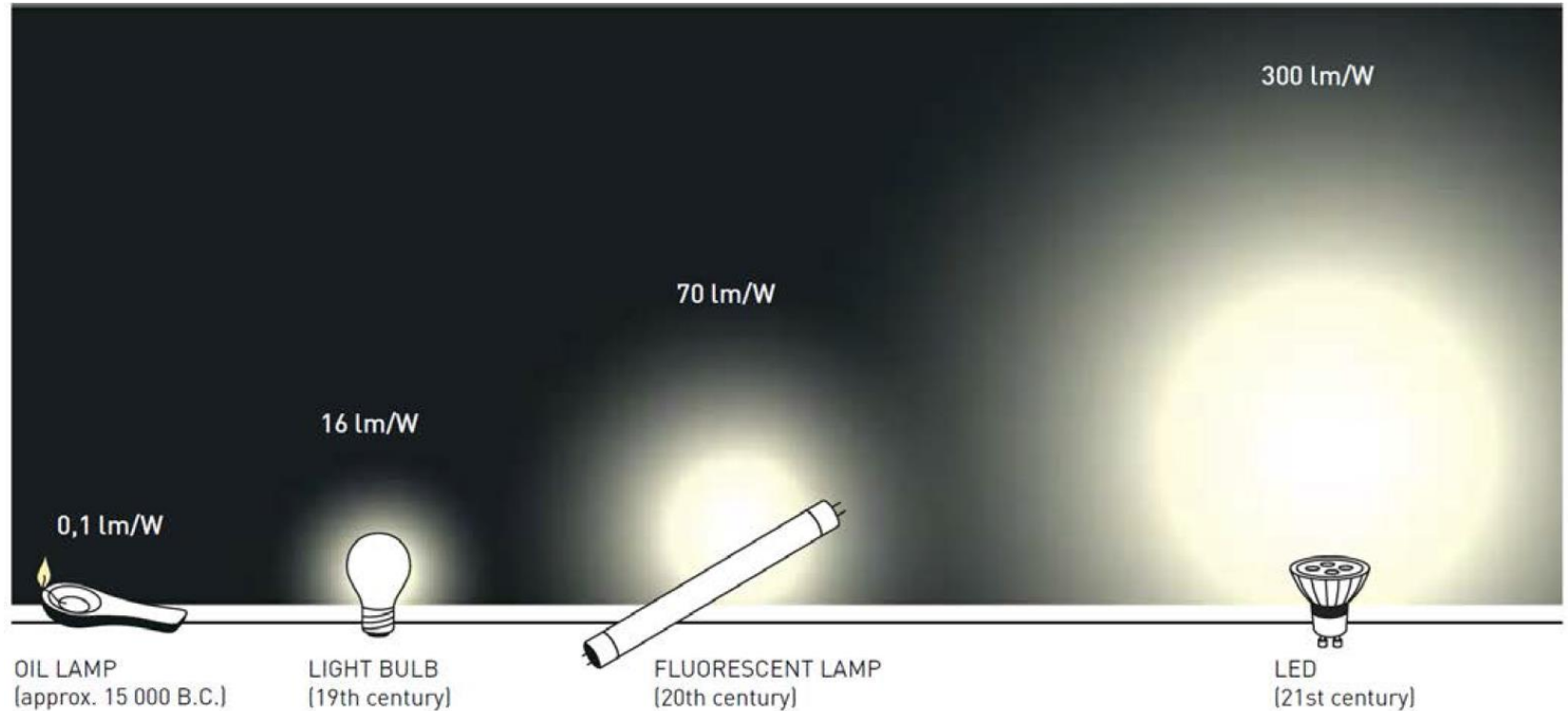


The 2014  
Nobel Prize  
in Physics





# Luminous efficiency







# Luminous efficiency

1% improvements of luminous efficiency of LED luminaires will eventually save electrical energy for 4 billion €/year globally





# Luminous efficiency

6W = 40W ?







# The candela

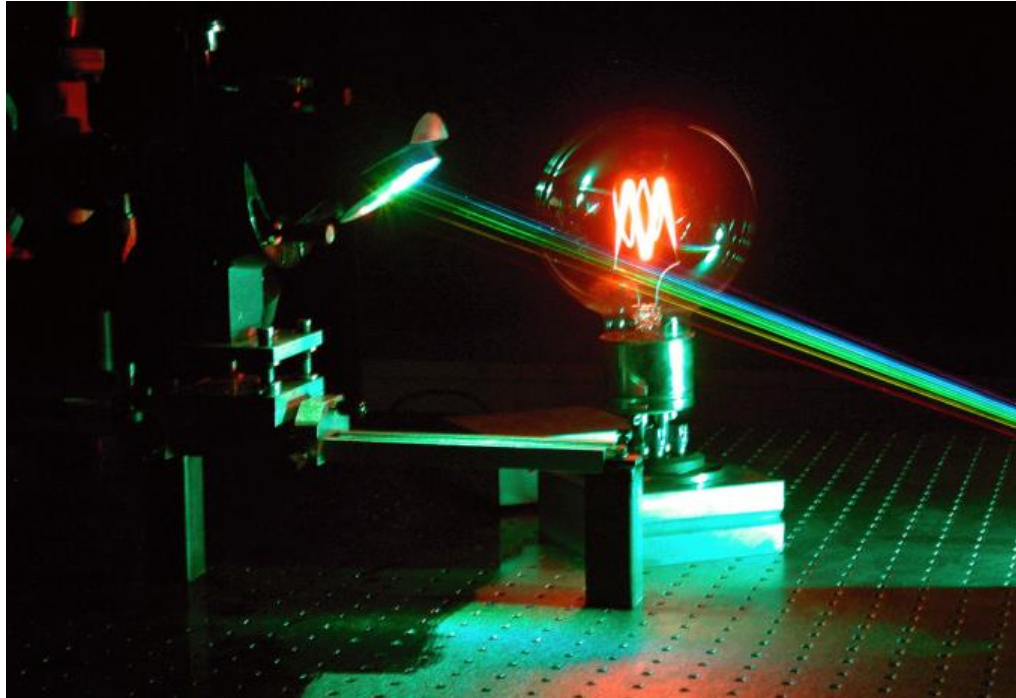
	Mole 71	
Candela 79	<b>1</b>	Metre 83
<b>2</b>		<b>3</b>



The luminous efficacy of monochromatic radiation of frequency  $540 \times 10^{12}$  Hz,  $K_{cd}$ , is 683 lm/W.

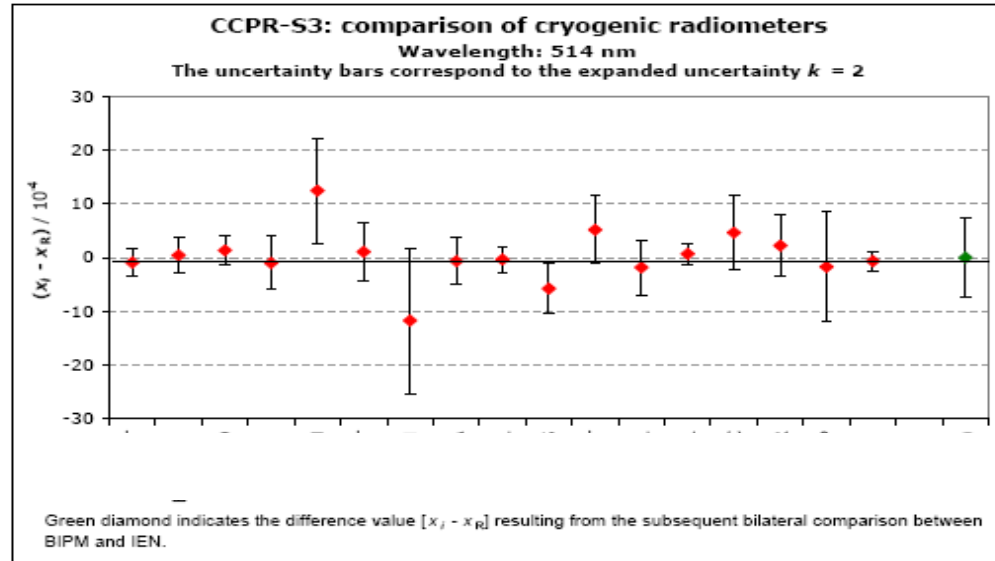


# The Laser





# International Agreement and consistency





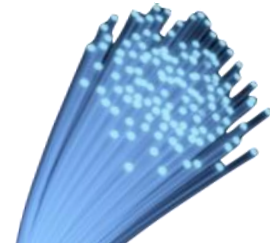
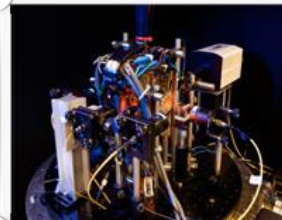
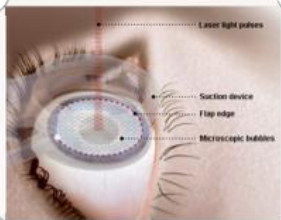
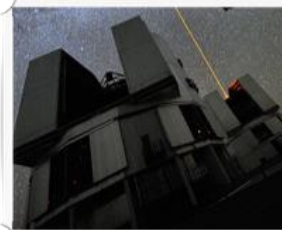
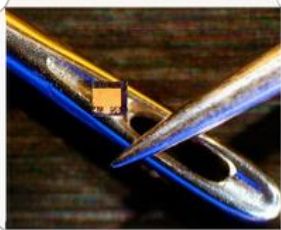
# Transformative technology

Invented in 60s in the USSR and the US

Nobel prize to Basov, Prokhorov, Townes

Was recognized as an amazing discovery “from science fiction”

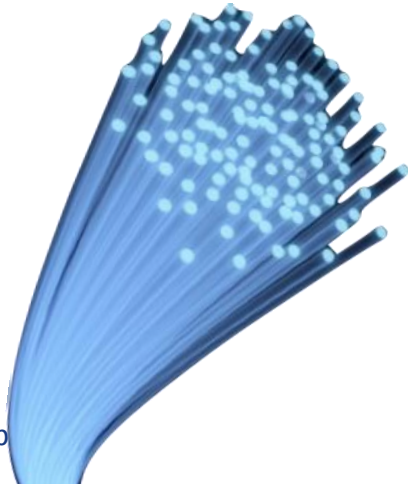
Was thought to be a useless “science toy”: “a solution looking for problem”



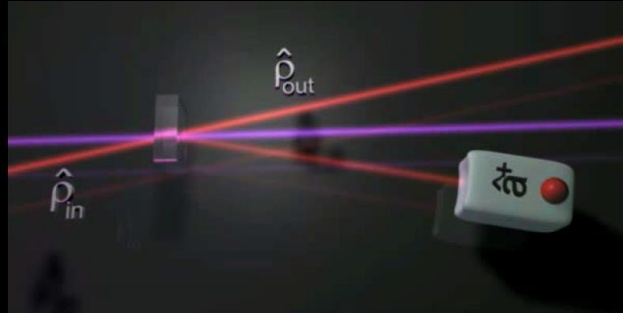


# From laser to WEB 2.0

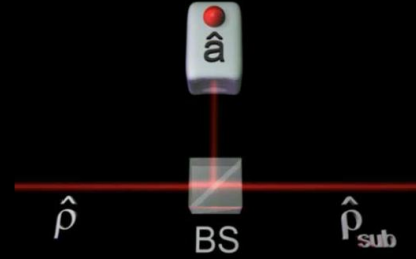
- Broad-band data transmission is enabled by fiber-optical communication
- Laser is a key component
- Dramatic impact on modern society in the past decade



# Manipulating single photons



Adding a single photon

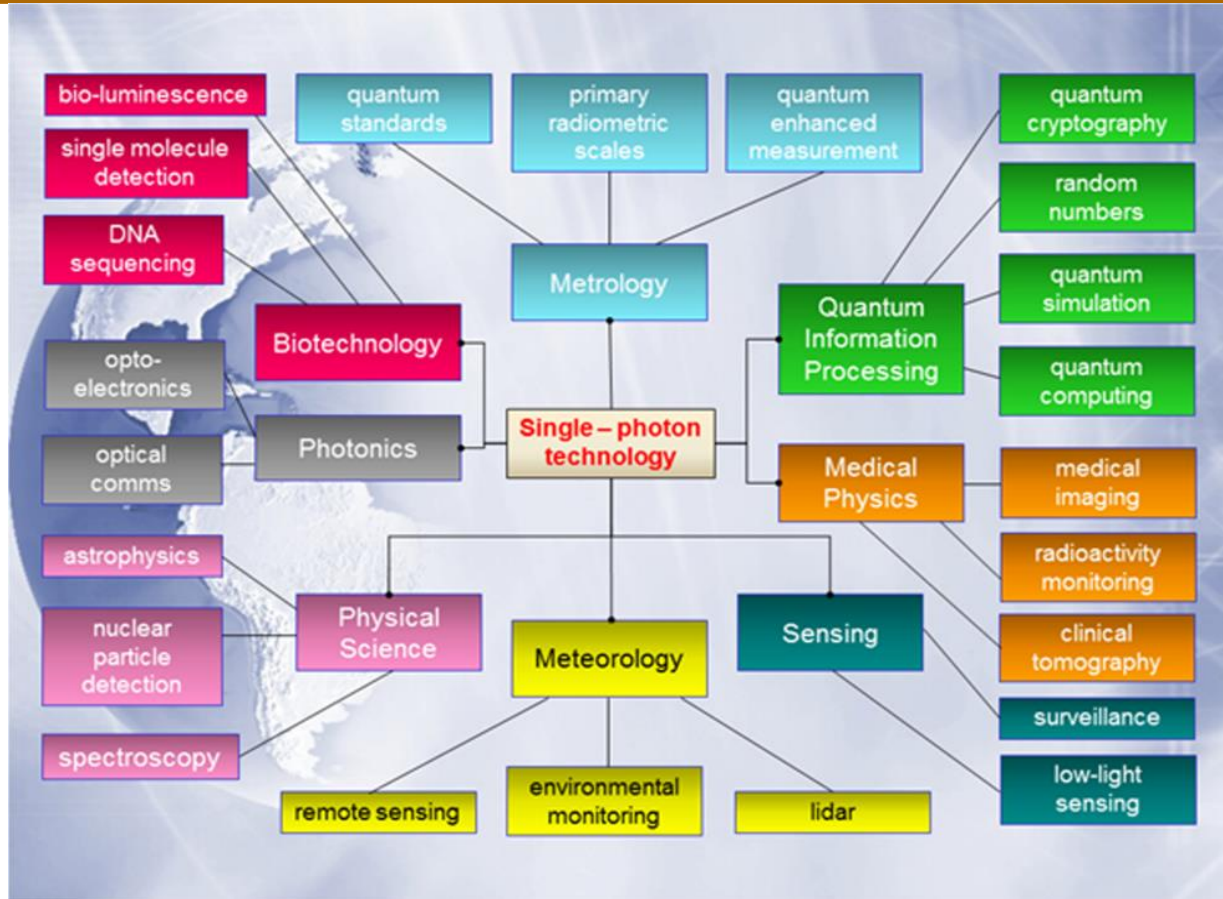


Subtracting a single photon



Time delocalisation of singles photons

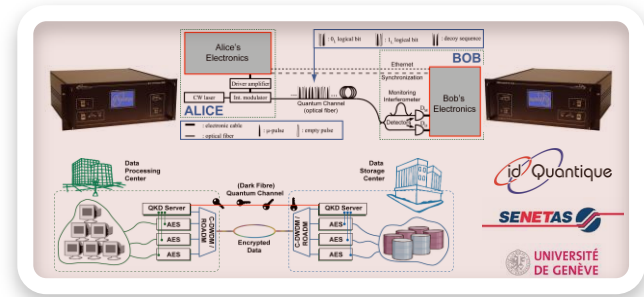
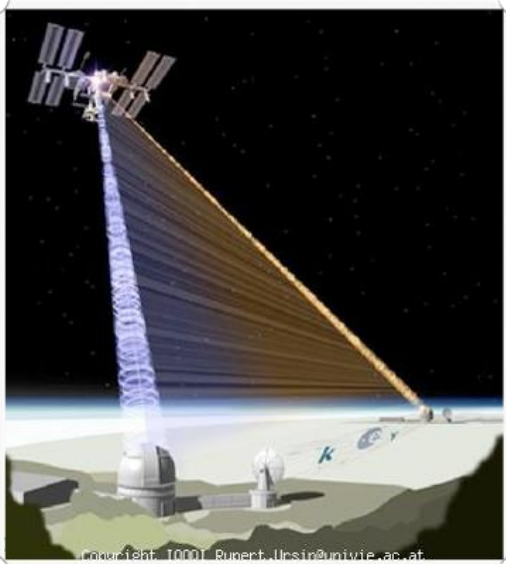
# Second Quantum Revolution





# Quantum Communication

- Already a real-world technology
- Vision: Consumer quantum cryptography (quantum bank card/ATM, quantum door/car key...)
- Security (e-commerce; smart grids...)

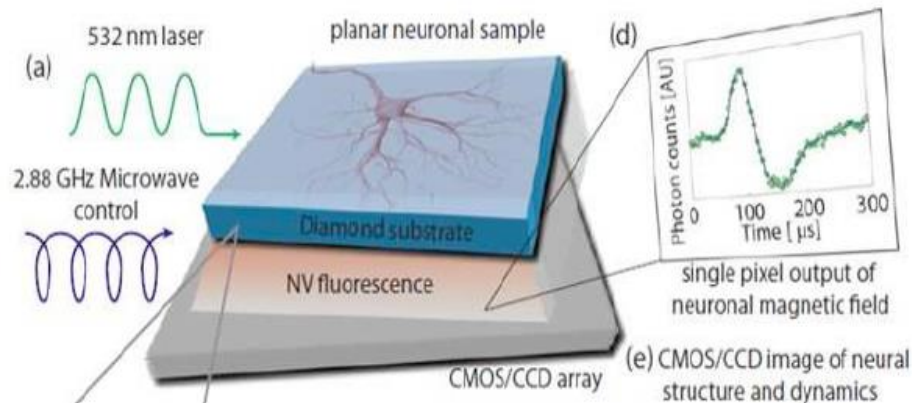
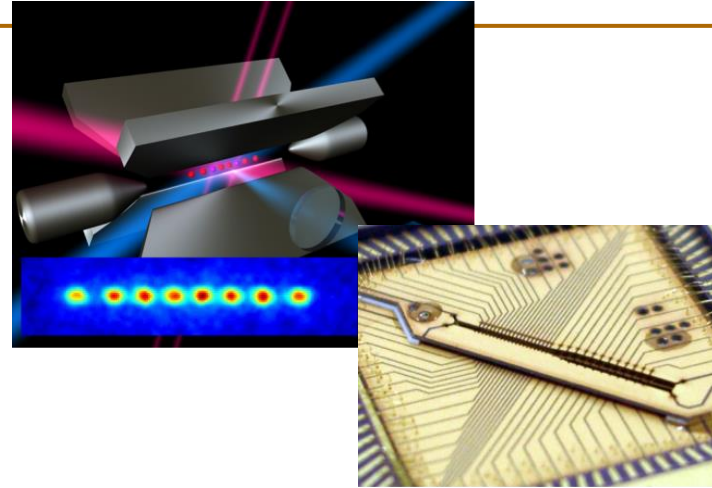


- Challenges: Continental-scale quantum communication (*quantum repeaters*)

Security

# Quantum Sensing

- Potential in many areas
- Sensing: sub-micron imaging of tissues for early detection and diagnosis of health problems

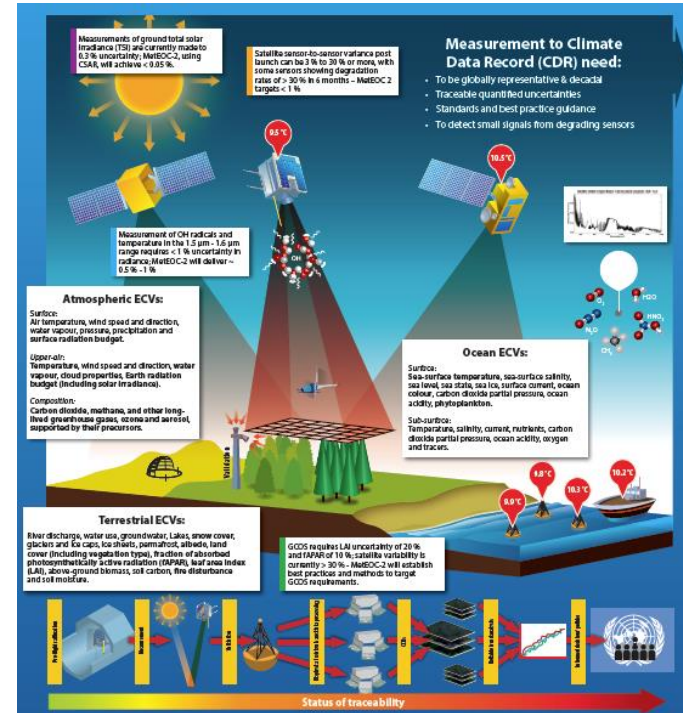


Health

# Environment and climate

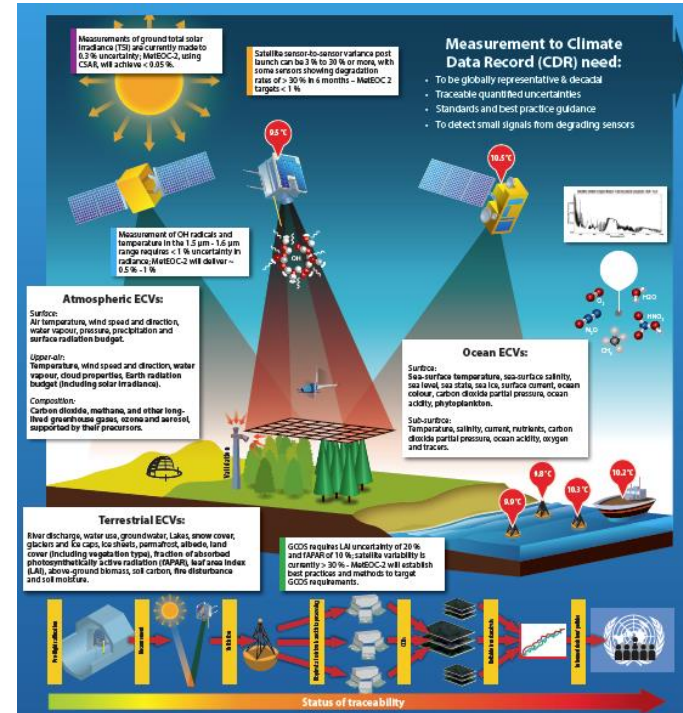
## Essential Climate Variables (ECV)

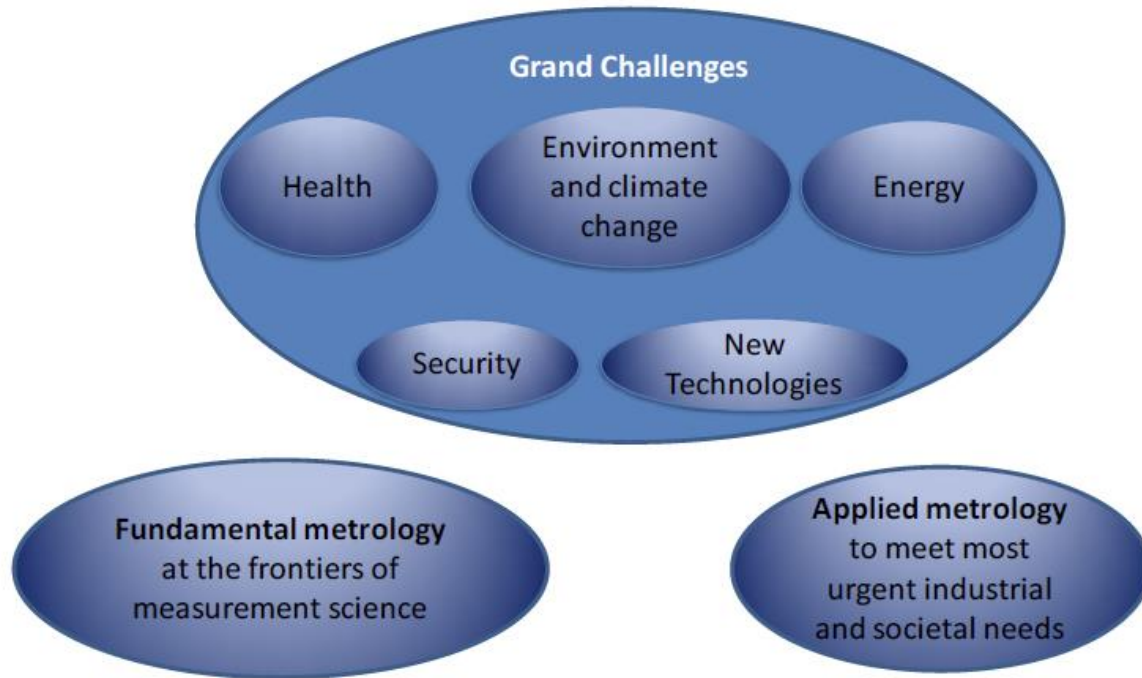
The Global Climate Observing System (GCOS) of UN has defined 50 ECVs that must be observed accurately over the long term to support climate modelling (~2/3 have an optical related measurand)



# Environment and climate

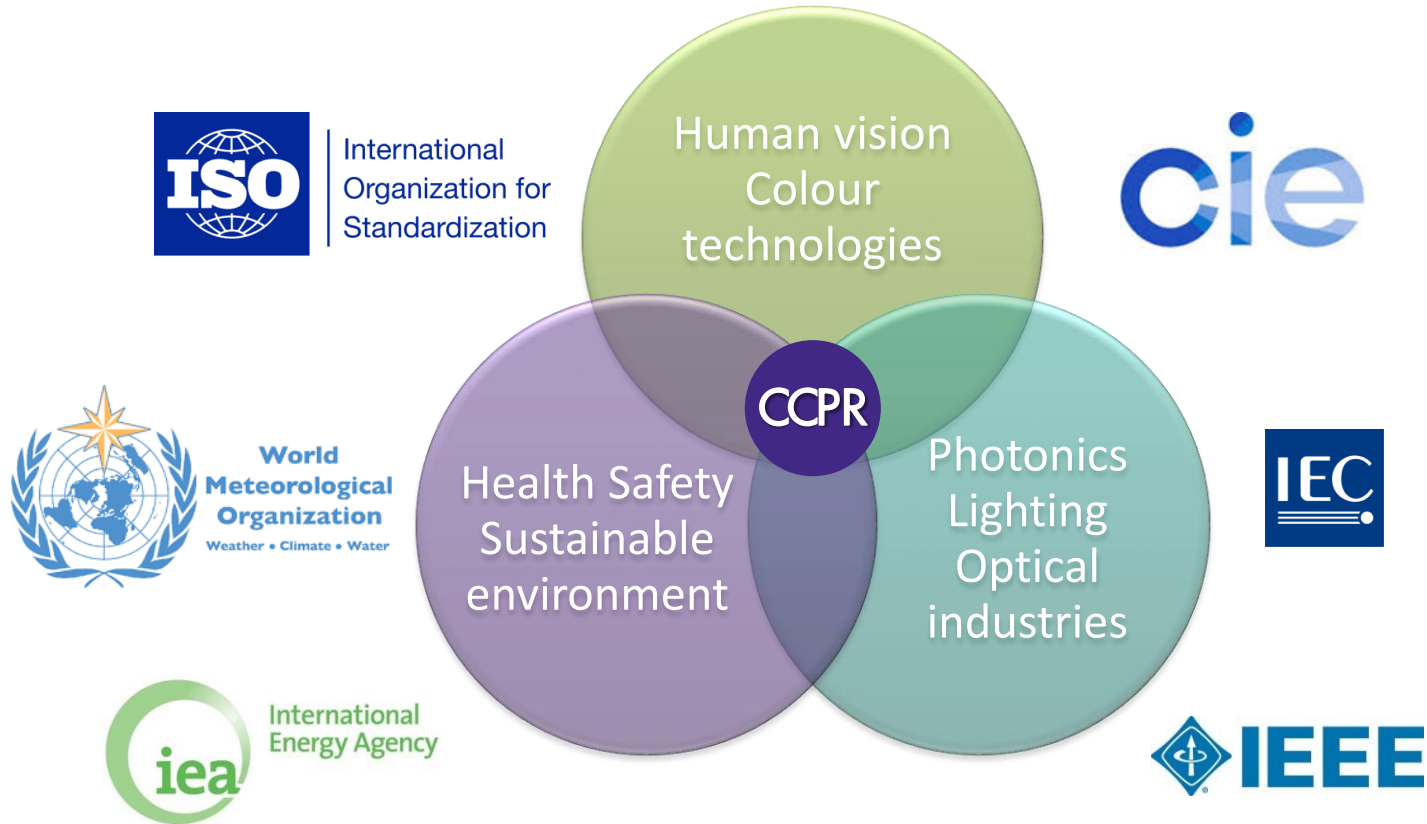
- Incoming Total Solar Irradiance - 0.01%
- Incoming spectral Solar irradiance (300 – 2400 nm) - 0.3%
- Earth reflected solar spectral radiance (320 – 2400 nm) - 0.3%
  - Globally @ 50 m spatial resolution & 5 nm spectral
  - Can be convolved to address many ECVs and applications



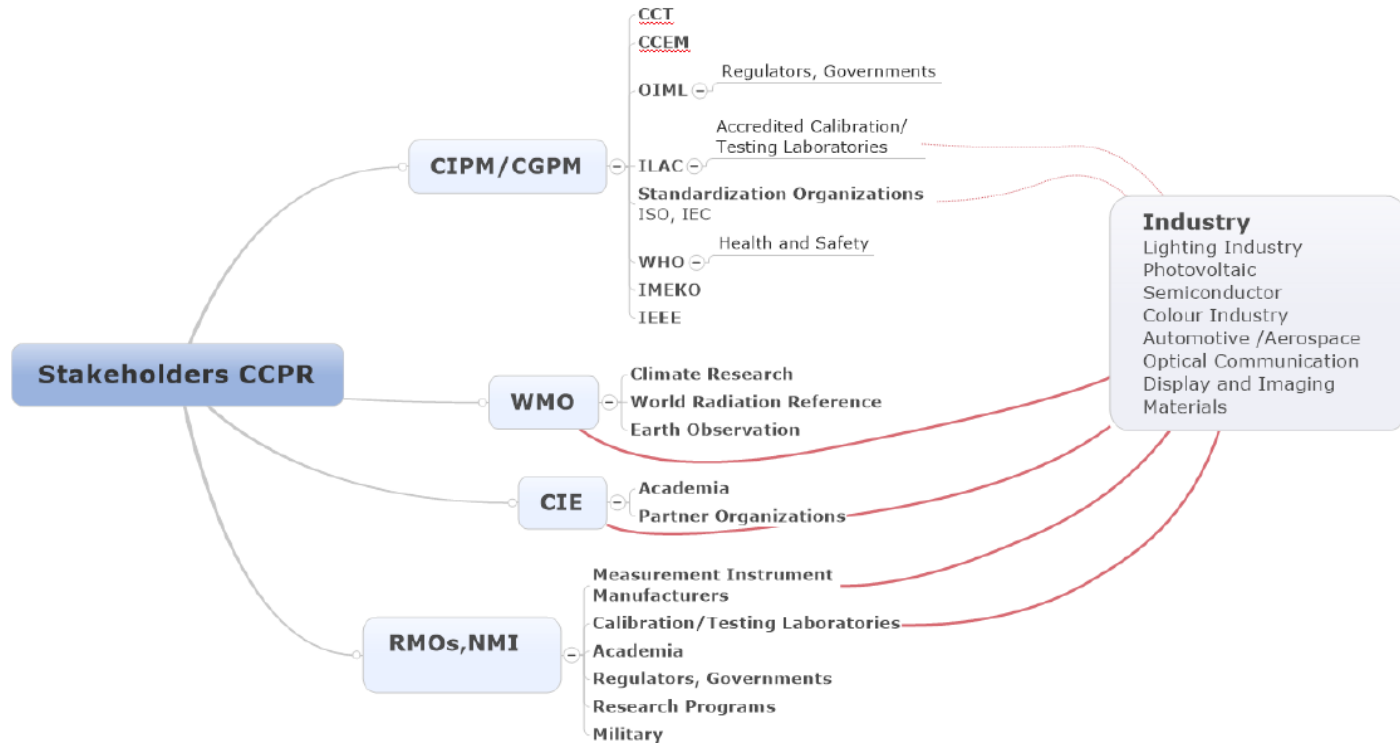




# Facilitating dialogue between NMs and stakeholders



# Facilitating dialogue between NMIs and stakeholders





# Global comparability of measurements

International **Key Comparisons** are performed to benchmark claimed competencies of the National Metrology Institutes (NMIs) and Designated Institutes (DIs) for standards that are needed to underpin

- ✓ photometry,
- ✓ optical properties of detectors and sources,
- ✓ optical properties of materials and fiber optics.

**Six key measurands** have been identified, two for each of these field

- ✓ luminous intensity & luminous flux,
- ✓ spectral irradiance & spectral responsivity,
- ✓ spectral diffuse transmittance and spectral regular reflectance,

leading to **10 key comparisons** to cover different spectral ranges.

# Global comparability of measurements

The CCPR allows Regional Metrology Organizations (RMOs) to coordinate

- ✓ **subsequent key comparisons** for NMIs or DIs in their regions to demonstrate compatibility with a larger number of laboratories.
- ✓ **regional comparisons** for **additional quantities** related to photometry, radiometry and fibre optics

Following from discussions started before 2014 in a devoted Task Group of the CCPR, **the first key comparison ever undertaken** in the far-infrared spectral region was carried out between 3 NMIs and published in a peer-reviewed journal

[IEEE Transactions on Terahertz Science and Technology, vol. 6, 5, 2016.](#)

It represents a milestone which will greatly benefit commercial development of instrumentation and sensors for remote sensing, THz imaging, high-speed telecommunications, and time-domain spectroscopy.