Consultative Committee for Photometry and Radiometry - CCPR

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Global forum for progressing the state-of-the art

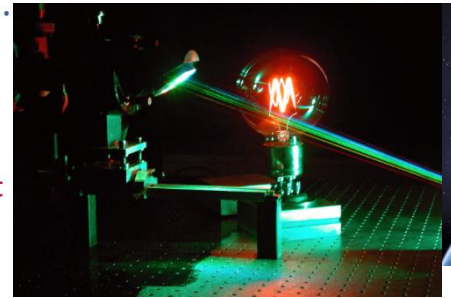
Consultative Committee for

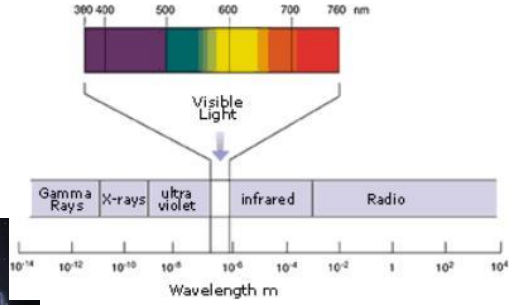
Photometry.....

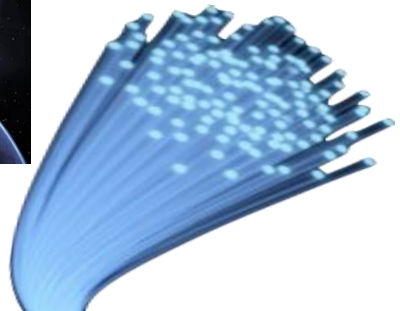
Describes the effects of visible light on the human eye, in terms of brightness (photometry) and colour(colorimetry)

Radiometry .....

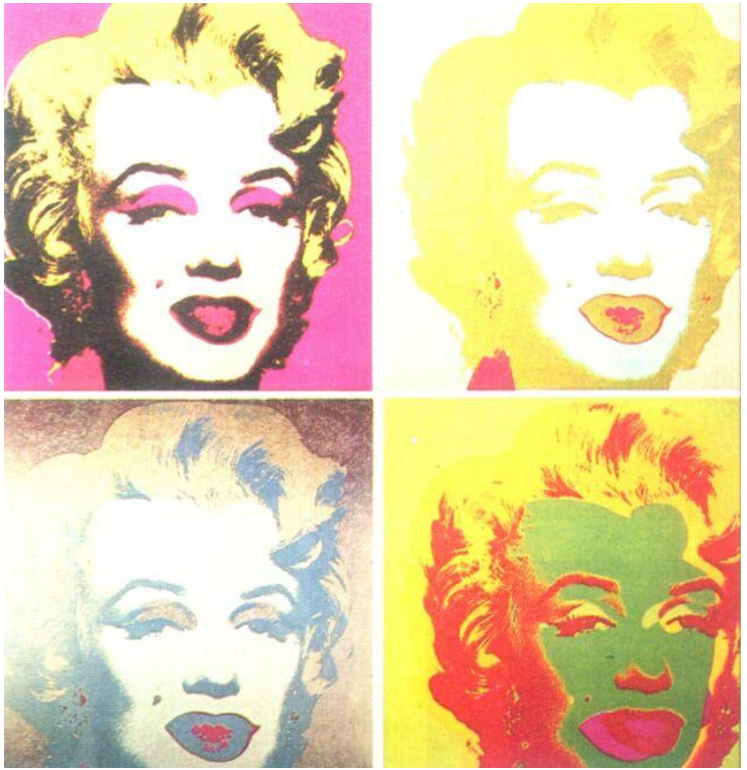
Metrology related to the physical measurement of the properties of electromagnetic radiation, including visible light





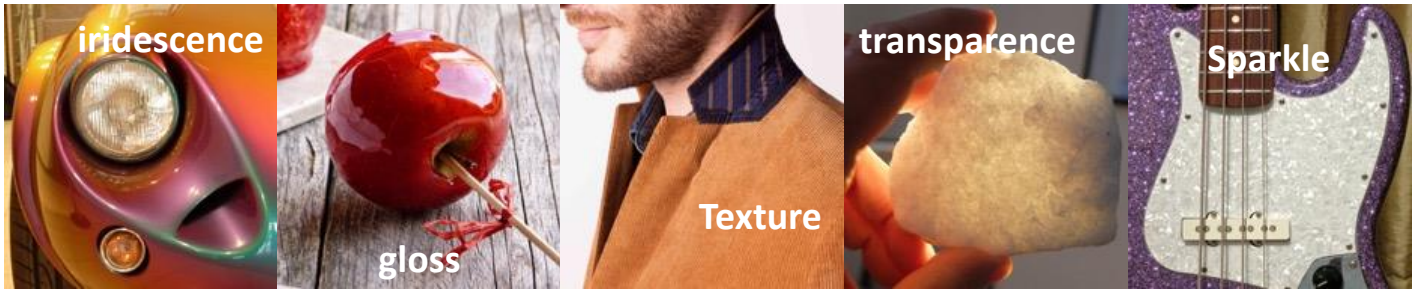


Photometry



Warhol, *Marilyn* Monroe(1967)

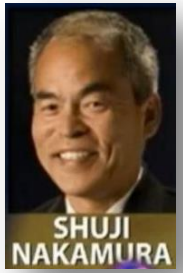
How it appears



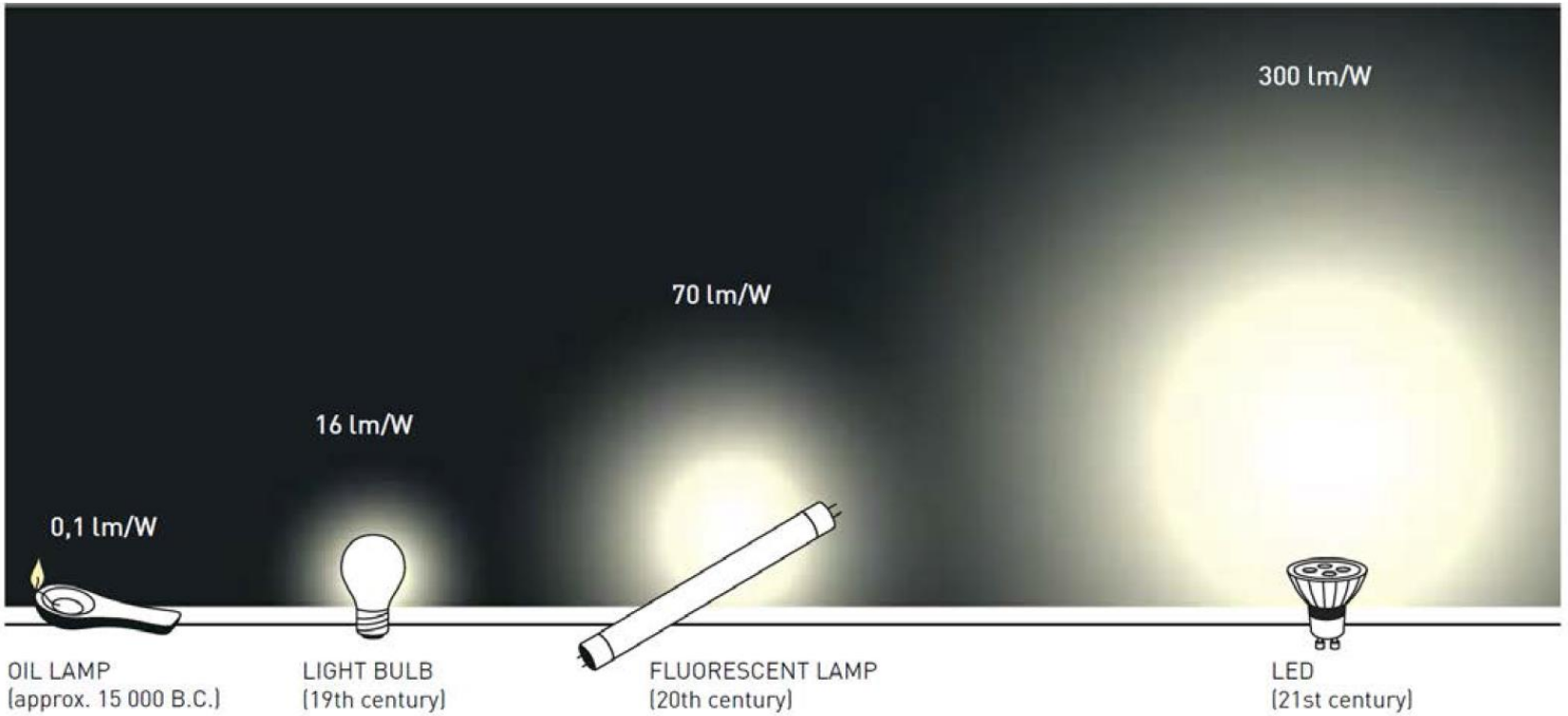
700 b US$ is the estimated values of shipments in industries like automotive, textile, printing, fashion, food, where unacceptable appearance may result in « NO SALE »

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

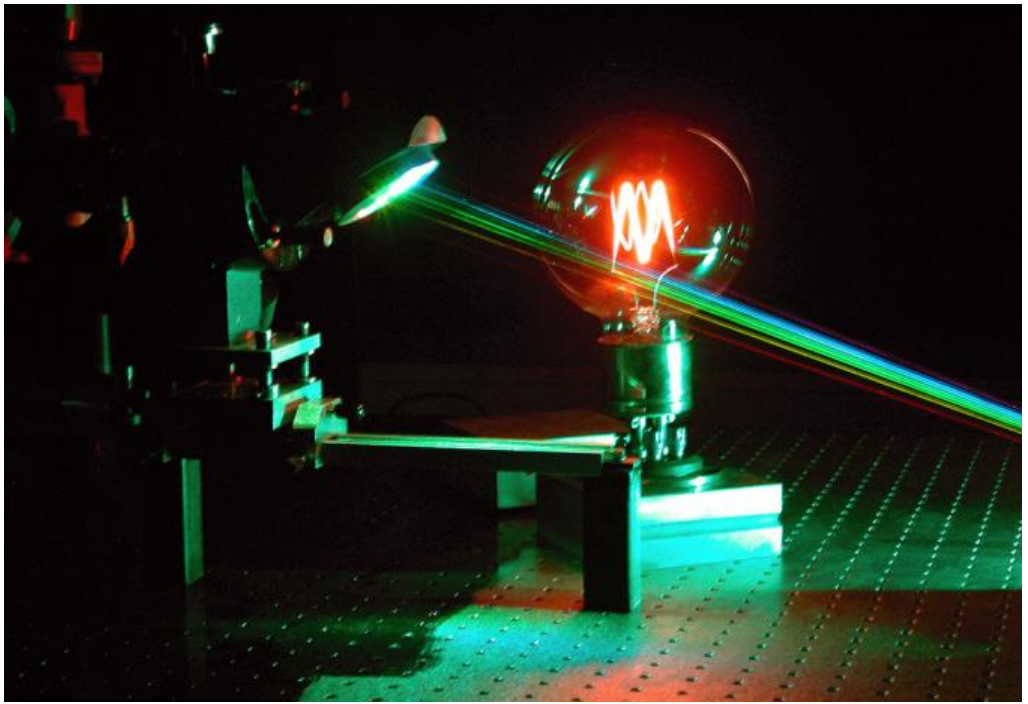
Candela 79 | Mole 71 | Metre 83

2 | 1 | 3

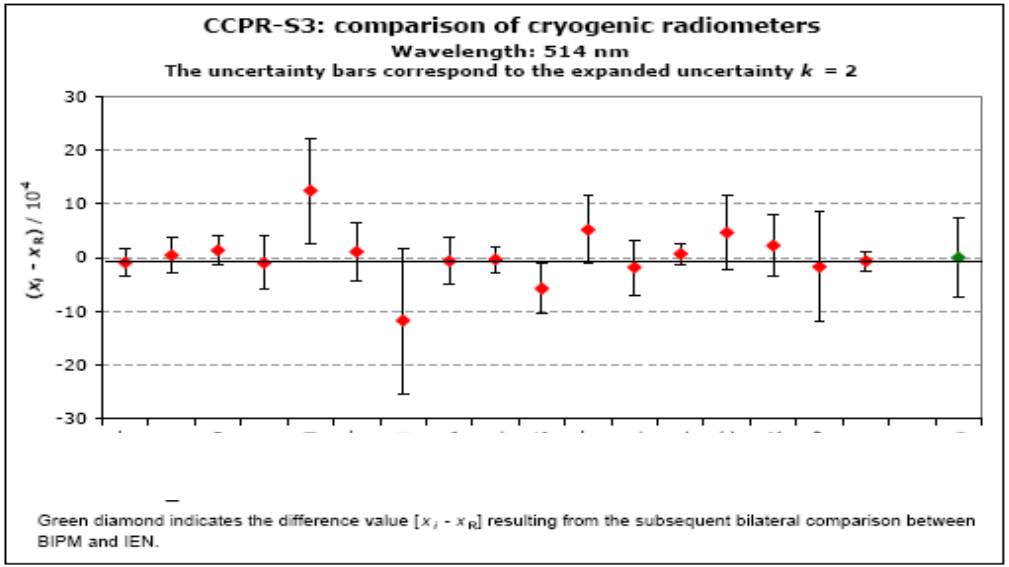
K_m → K_{cd}

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

The Laser



International Agreement and consistency



Accuracy to SI <~0.01 %

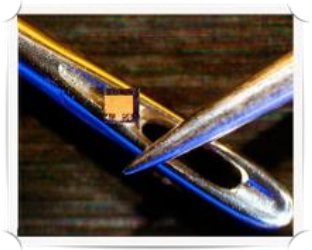
Transformative technology

Invented in 60s in the USSR and the US

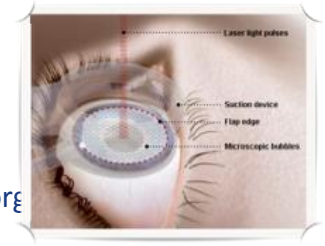
Nobel prize to Basov, Prokhorov, Townes

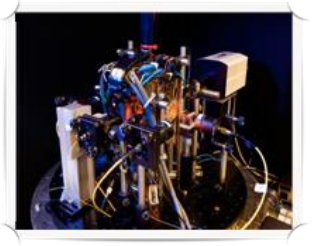
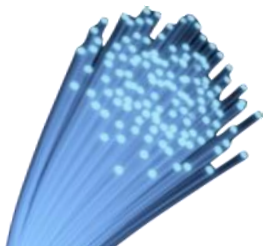
Was recognized as an amazing discovery "from science fiction"

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



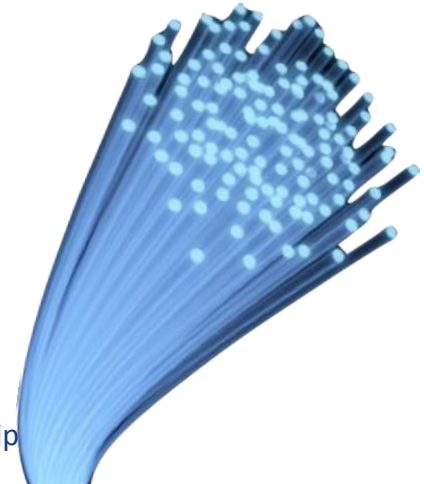




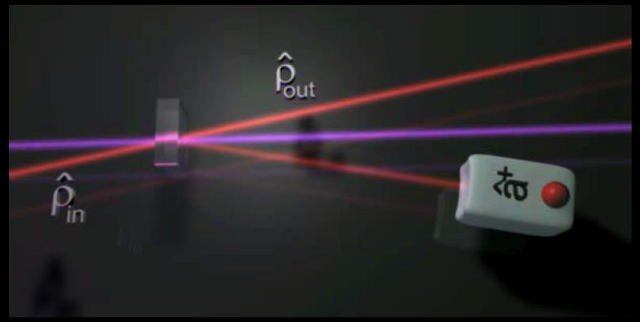




From laser to WEB 2.0

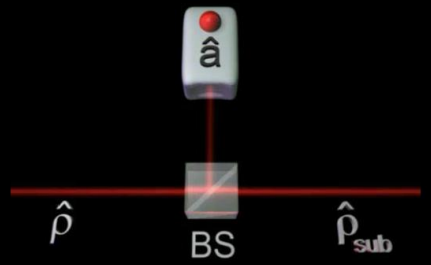
- Broad-band data transmission is enabled by fiber-optical communication
- Laser is a key component
- Dramatic impact on modern society in the past decade



Manipulating single photons



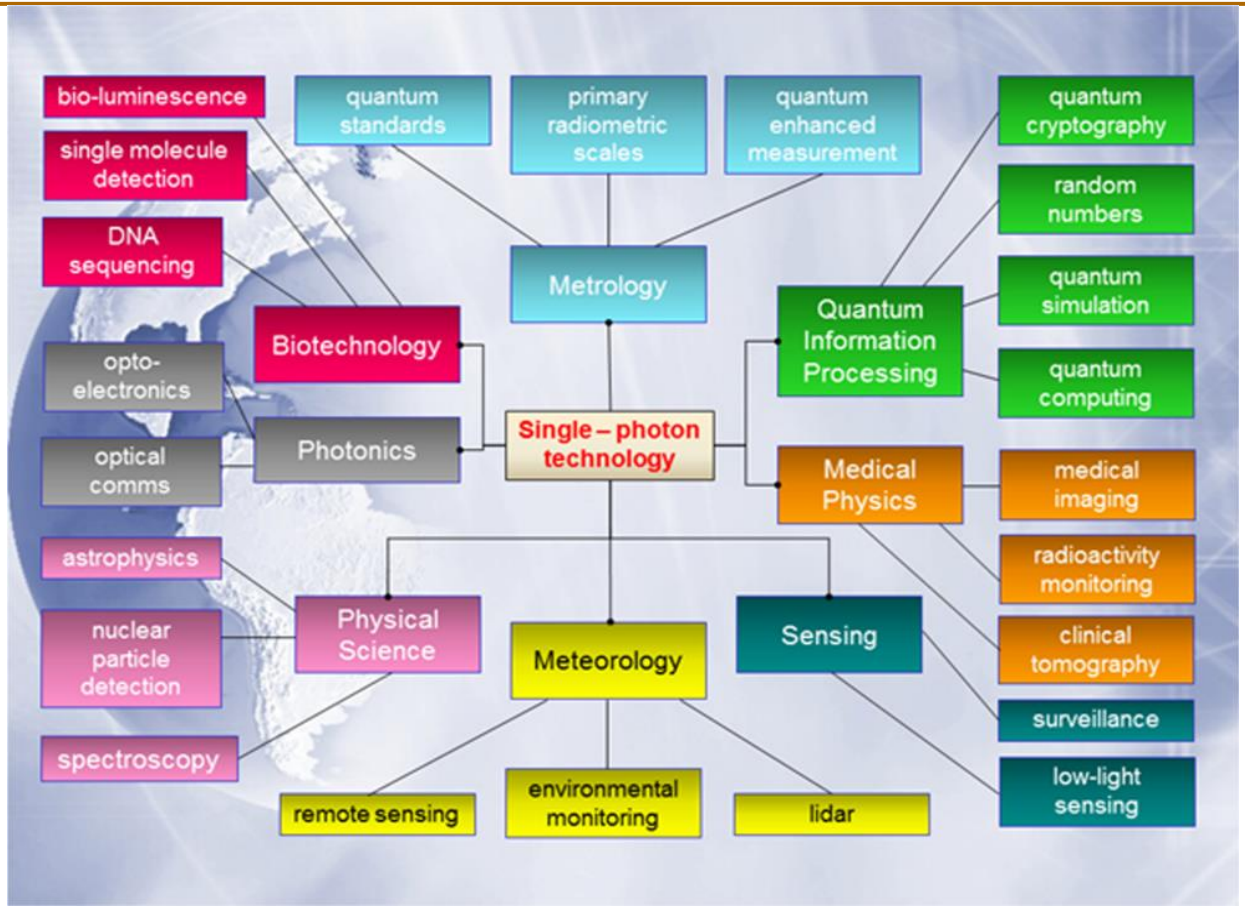
Adding a single photon



Subtracting a single photon

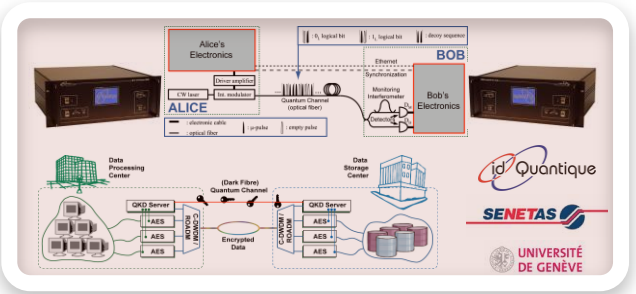
Time delocalisation of singles photons

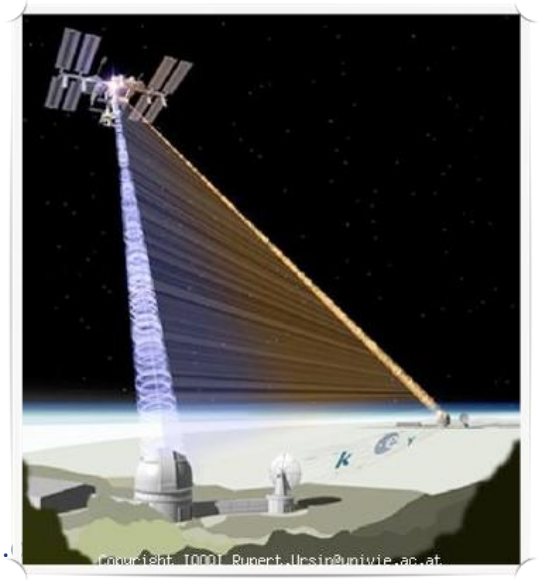
Second Quantum Revolution



Quantum Communication

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



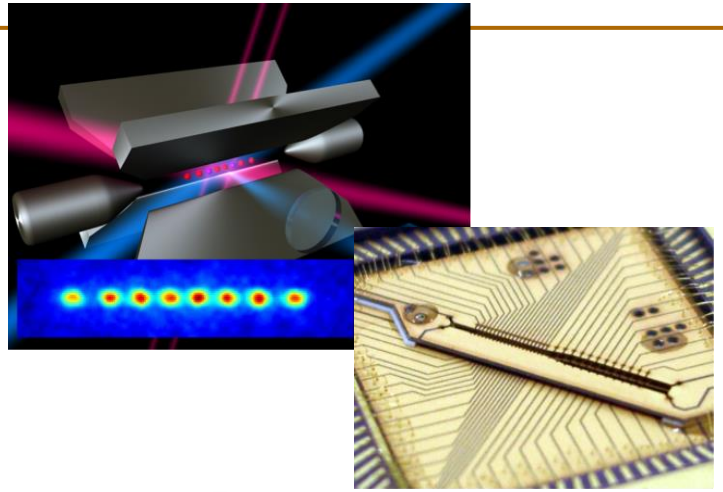


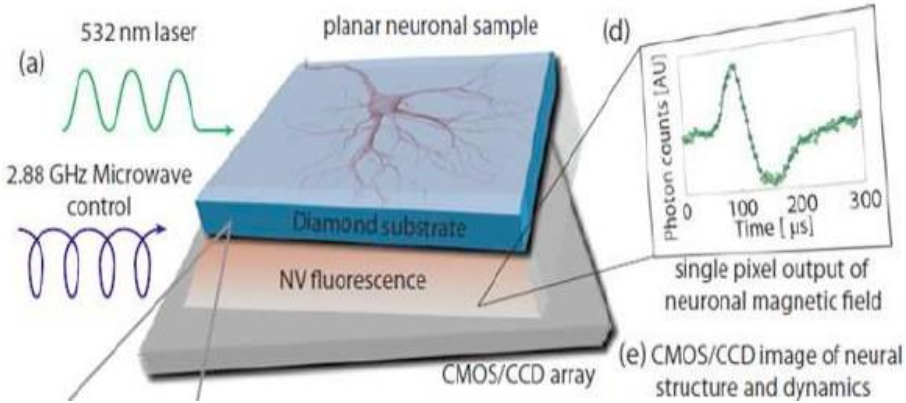
- Challenges: Continental-scale quantum communication (*quantum repeaters*)

Security

Quantum Sensing

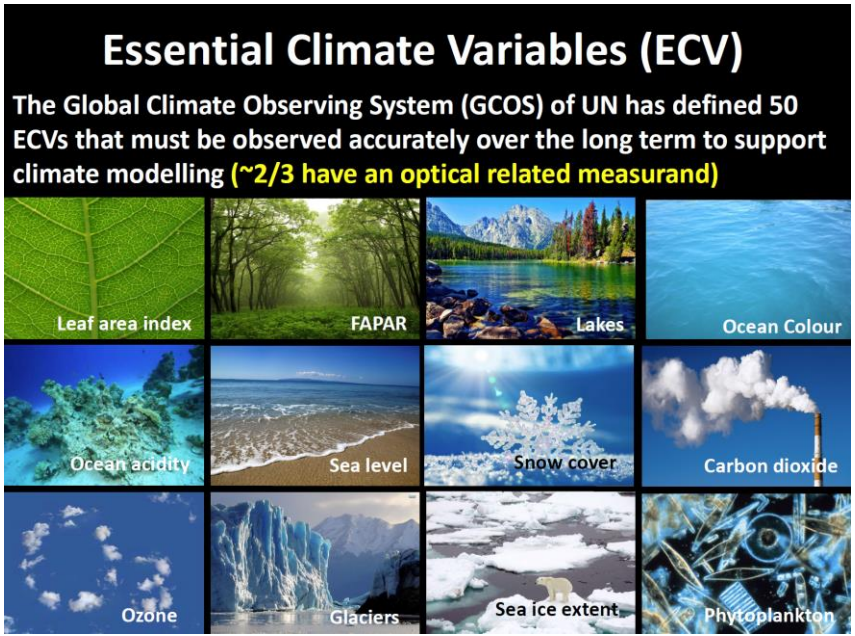
- Potential in many areas
- Sensing: sub-micron imaging of tissues for early detection and diagnosis of health problems

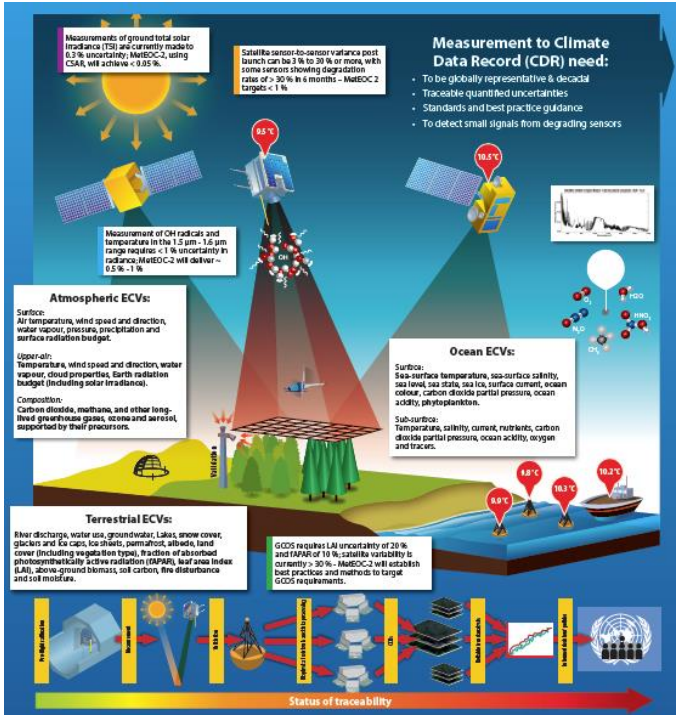




Health

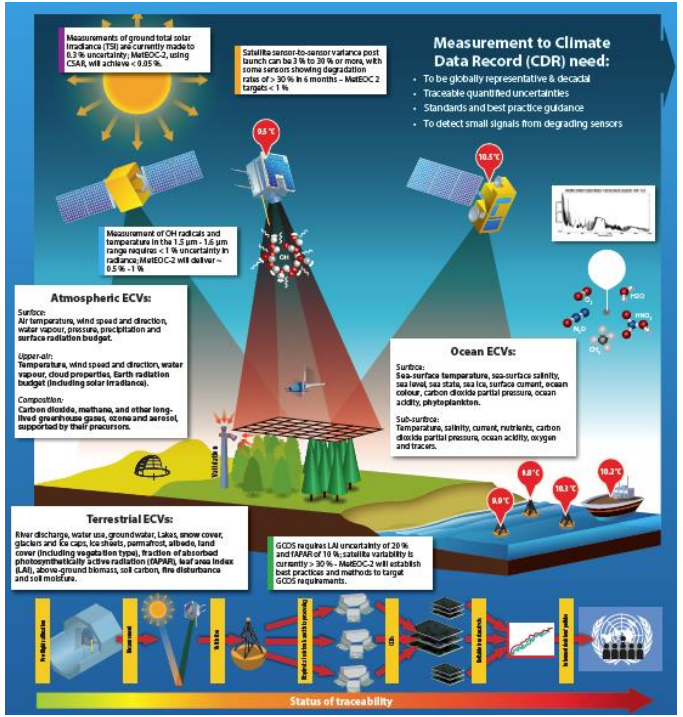
Environment and climate



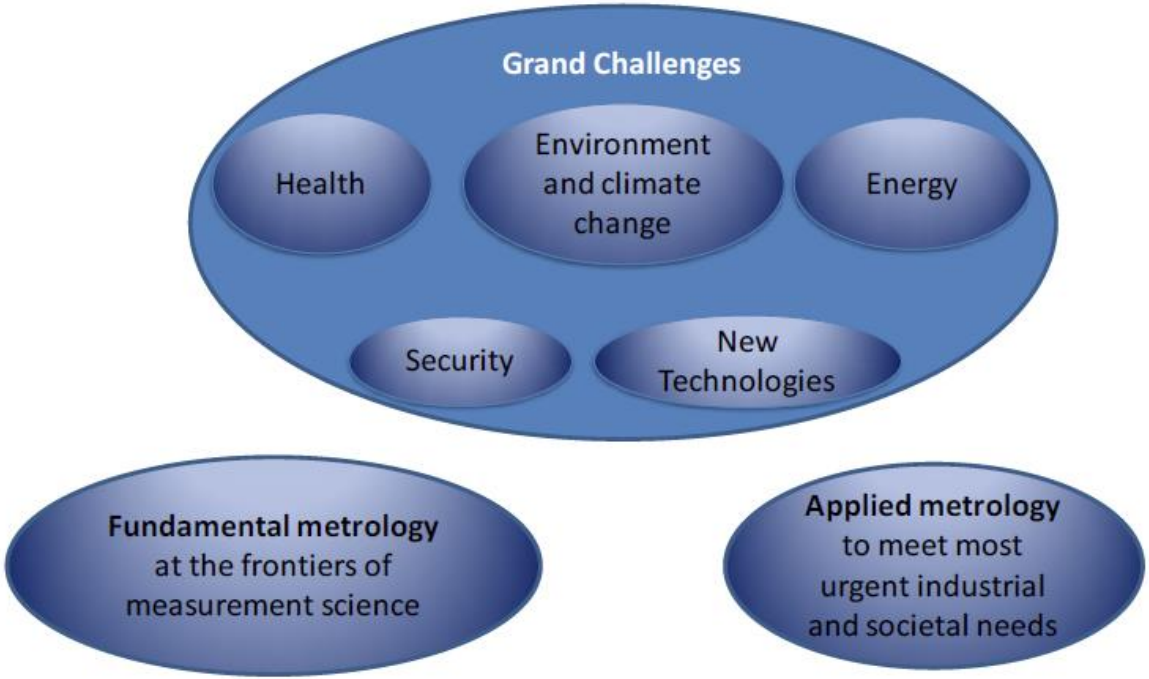


Environment and climate

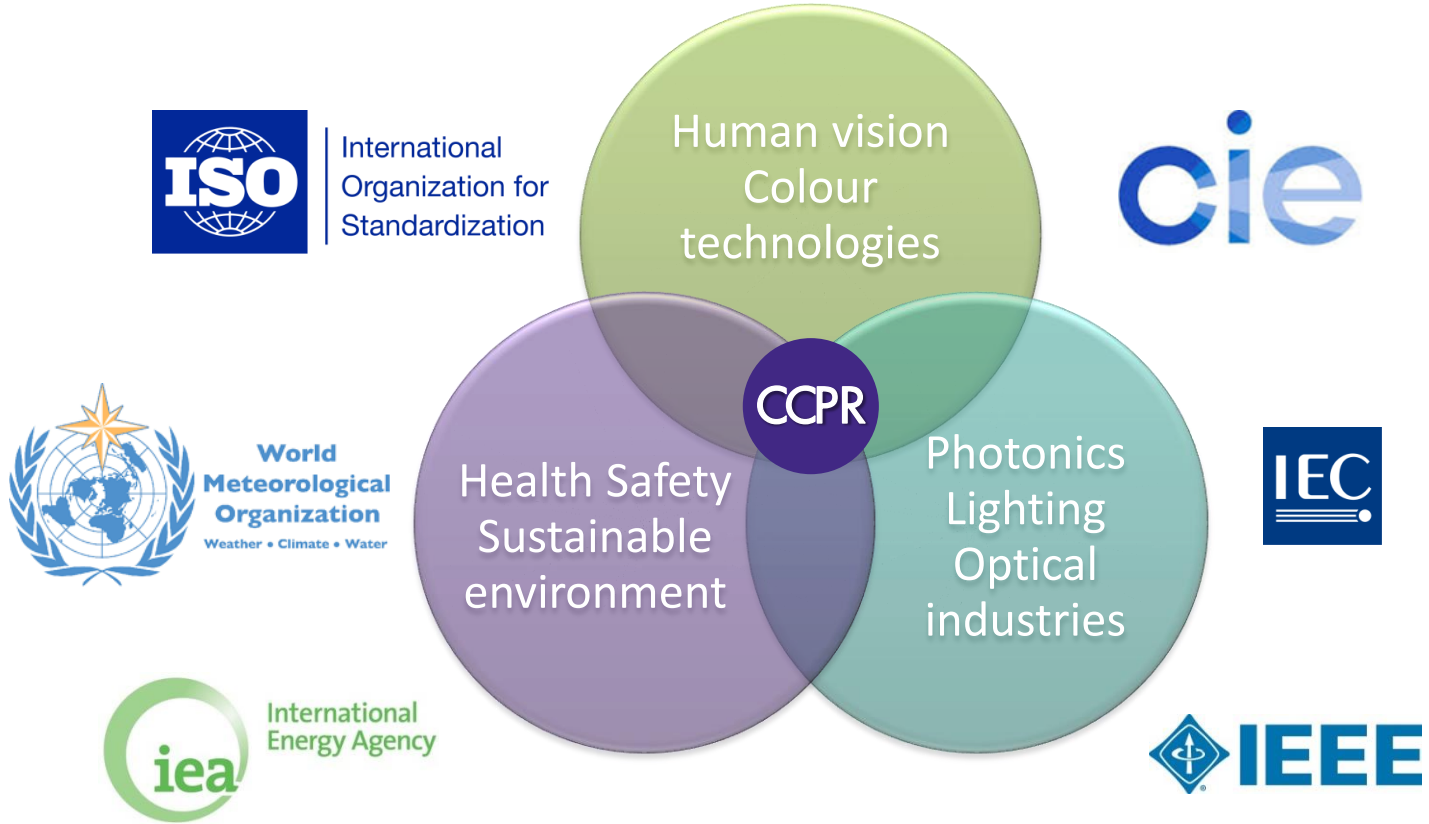
- Incoming Total Solar Irradiance - 0.01%
- Incoming spectral Solar irradiance (300 – 2400 nm) - 0.3%
- Earth reflected solar spectral radiance (320 – 2400 nm) - 0.3%
  - Globally @ 50 m spatial resolution & 5 nm spectral
  - Can be convolved to address many ECVs and applications



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



Facilitating dialogue between NMIs and stakeholders



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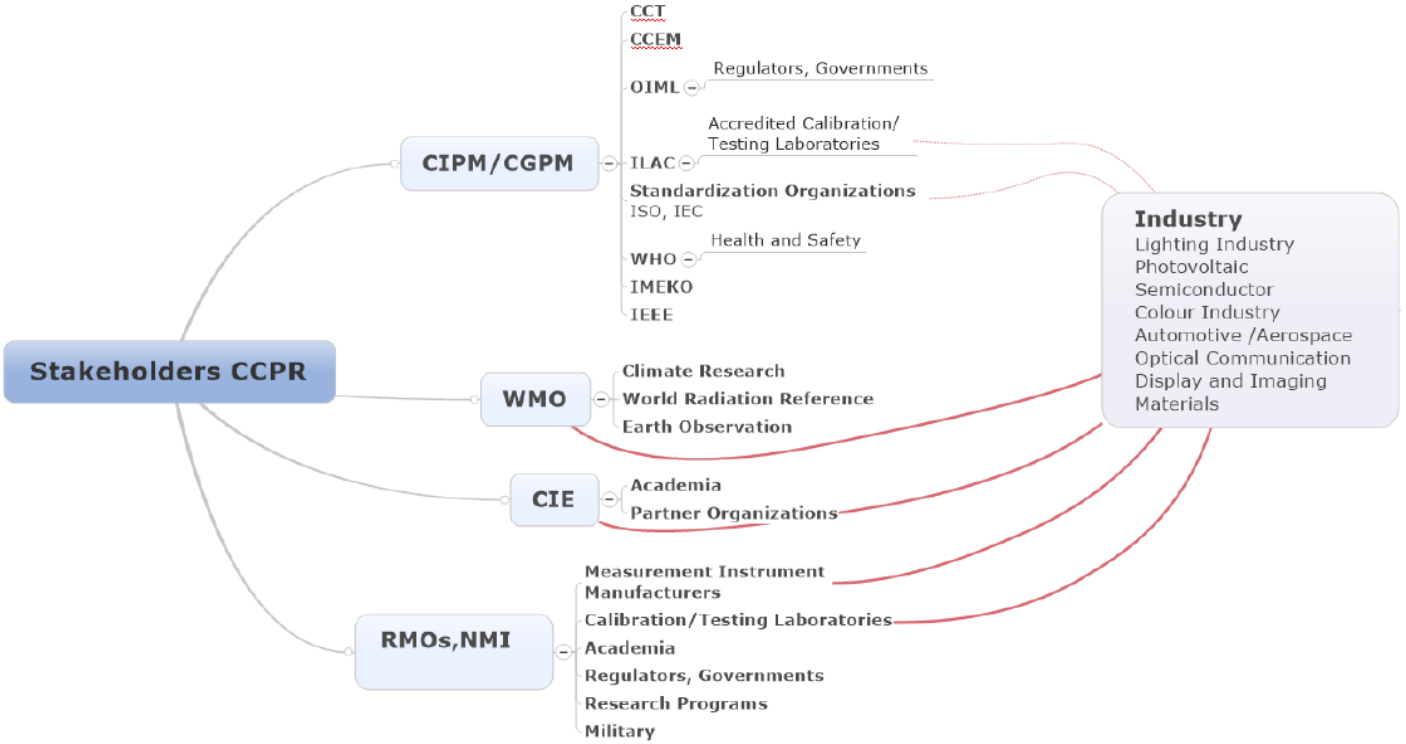

Global comparability of measurements

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.