



TC Photometry and Radiometry

Highlights and Scientific Challenges

G06-10-03

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ČMI, Czech Republic

**6th EURAMET General Assembly
Lyngby, Denmark, 22 to 24 May 2012**

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Topics:

a) Scientific Challenges

- Climate monitoring
- Energy (Reduced Consumption/Production)
- Quantum Optics (Photonics)

b) Evolving TCPR Roadmaps 2012

c) TCPR meeting 2012

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TCPR Activities in the field of Climate Monitoring and Earth Observation

- 1 **EURAMET (TCPR) Project 1048 :
CSAR- Cryogenic Solar Absolute Radiometer
Replacing the WRR of WMO with SI**
- 2 **EMRP ENV Call 2010:
ENV04 MetEOC
ENV03 Solar UV**

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Project 1048: **Cryogenic Solar Absolute Radiometer - Replacing the WRR of WMO with SI (CSAR)**

**Classical EURAMET
Non-EMRP project**

Run in 2008 - 2011

**CSAR designed and
built by NPL in
collaboration with
METAS and PMOD-
WRC of Switzerland
(and WMO)**

**Replace “consensus”
scale based on 40 yr
old instruments with SI
primary standard**



**Cryogenic radiometer
Mechanical and
thermal design**



**Ambient temperature
transmission monitor
(MITRA)**



**Mechanical
parts/aperture area**



**IPC XI (2010) Davos
Switzerland 120
instruments 40 countries**

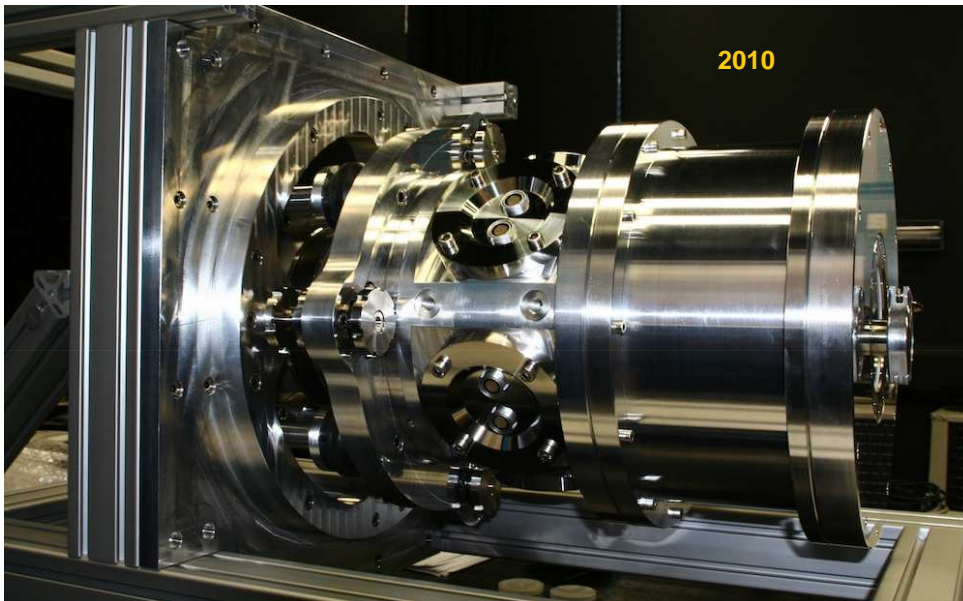


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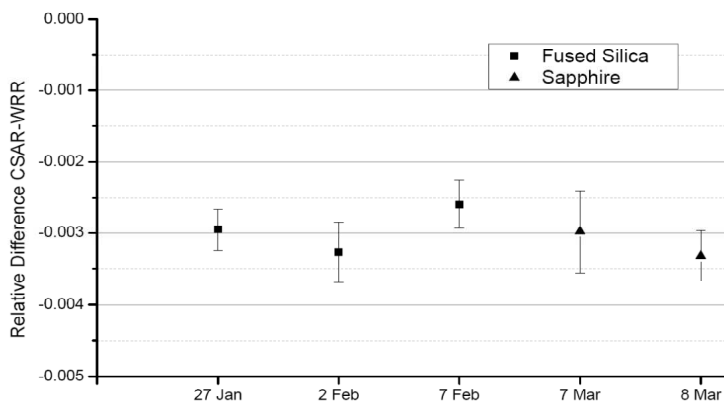


Designed to be an “engineering model” for space flight to provide not only TSI in space but also the establishment of an NMI in space as part of the TRUTHS project (www.npl.co.uk/Truths)

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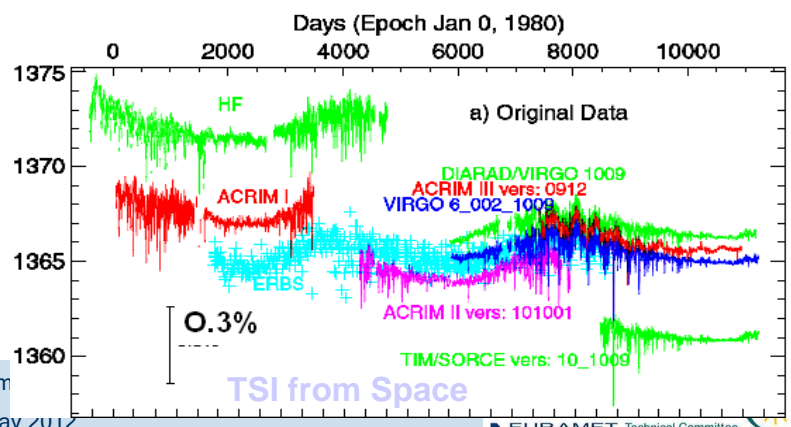
Cryogenic Solar Absolute Radiometer (CSAR):



First results:

CSAR has uncertainty 10 x lower than WRR

Results indicate bias of ~0.3 %



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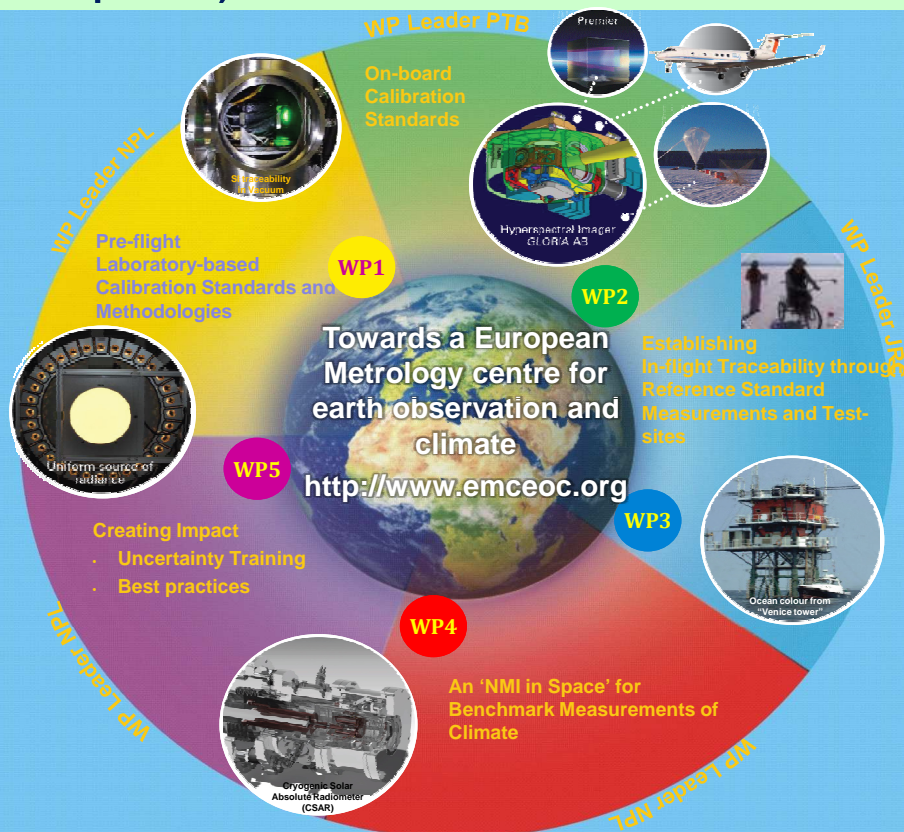
JRP ENV04: Metrology for Earth Observation and Climate (MetEOC): Project coordinator: (Nigel.Fox@npl.co.uk)



Partners:



Collaborators:



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JRP ENV03: Traceability for Surface Spectral Solar Ultraviolet Radiation



EMRP-ENV03 "Solar UV"

<http://projects.pmodwrc.ch/env03/>

- Enhance the **reliability** of spectral solar UV radiation measured at the Earth surface
- Develop new **techniques and devices** for **traceability** better than 2% (now 5%) and for **cost-effective** array-spectroradiometer in UV monitoring networks
- Intercomparison Campaigns and Workshops



- Project Coordination:** pmod wrc Dr. Julian Gröbner, Davos
- Duration:** 2011 - 2014
- Total Budget:** 3.9 M€
- 8 Partners EU-NMI; 2 Industry; 2 Universities; > 3 Collaborators (Stakeholders)**





TCPR Activities towards Energy and Renewable Energy Production

EMRP ENG Call 2009:

**ENG05 SSL : Metrology for Solid State Lighting
2009-2012**

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Metrology for Solid State Lighting

JRP 9: Metrology for Solid State Lighting

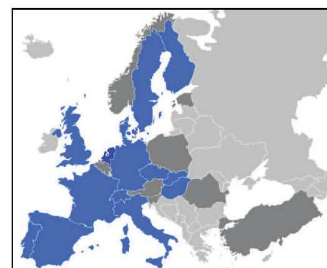
EURAMET
European Association of National Metrology Institutes



Work Packages:

- 1: Traceability for SSL measurements
- 2: Basic measurement methods for SSL characterisation
- 3: Human perception of SSL
- 4: Quality metrics for SSL
- 5: Creating Impact

**EU harmonized consortium:
14 European countries**



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Metrology for Solid State Lighting

EMRP





TCPR Activities in field of Quantum Optics / Photonics

- 1 IMERA JRP 2.3 Quantum Candela
- 2 EMRP IND Call 2010:
 - 2 IND06 MIQC: Metrology for Industrial Quantum Communication

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Metrology for Industrial Quantum Communication Technologies

- **Objective** : to develop a pan-European measurement infrastructure to develop standards and characterisation facilities for commercial Quantum Key Distribution (QKD) devices.



www.miqc.org

Quantum Key Distribution is

- the creation and distribution of keys for encrypting data using photons
 - is currently the only viable solution to future proofing the security of our data
- QKD devices require independent characterisation in order to convince end-users that the technology is working within specification
 - 3 year project: start Sept 2011, 8EU NMI, 1 APMP NMI, 3 Ind.Partners

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Key Outputs of MIQC

Photon emitters



Photon emitters

- Traceable Characterisation of commercial QKD sources
- Mean photon number
- Spectral and temporal characteristics
- Quantum state characterisation

Quantum channel



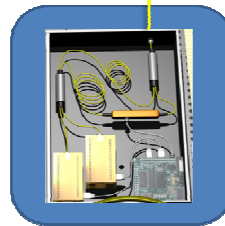
Quantum channel

Traceable characterisation of quantum channels and propagation of photon state in fibre
In-line calibration devices

REG (ID Quantique) – JRP:

Open system true physical random number generator
Physically characterised and tested under different operating conditions

Photon receivers



Photon receivers

Realisation of primary single-photon source : Metrology Light Source
High gain electronics for telecom wavelengths
Traceable telecoms attenuator based on trap configuration
Properties of photon number resolving detectors

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Evolving TCPR Roadmaps 2012

- Climate/E0 ← Quality of Life
- Basic Science ← Quantum Based Standards
- Energy (Production&Reduced Consumption) **New**
- Industry (Innovation& Growth) ← Visual Appearance

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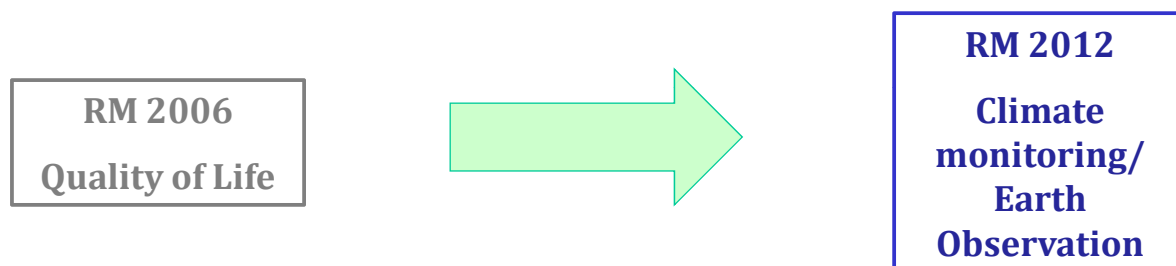
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Evolving TCPR Roadmaps for Climate Monitoring/EO

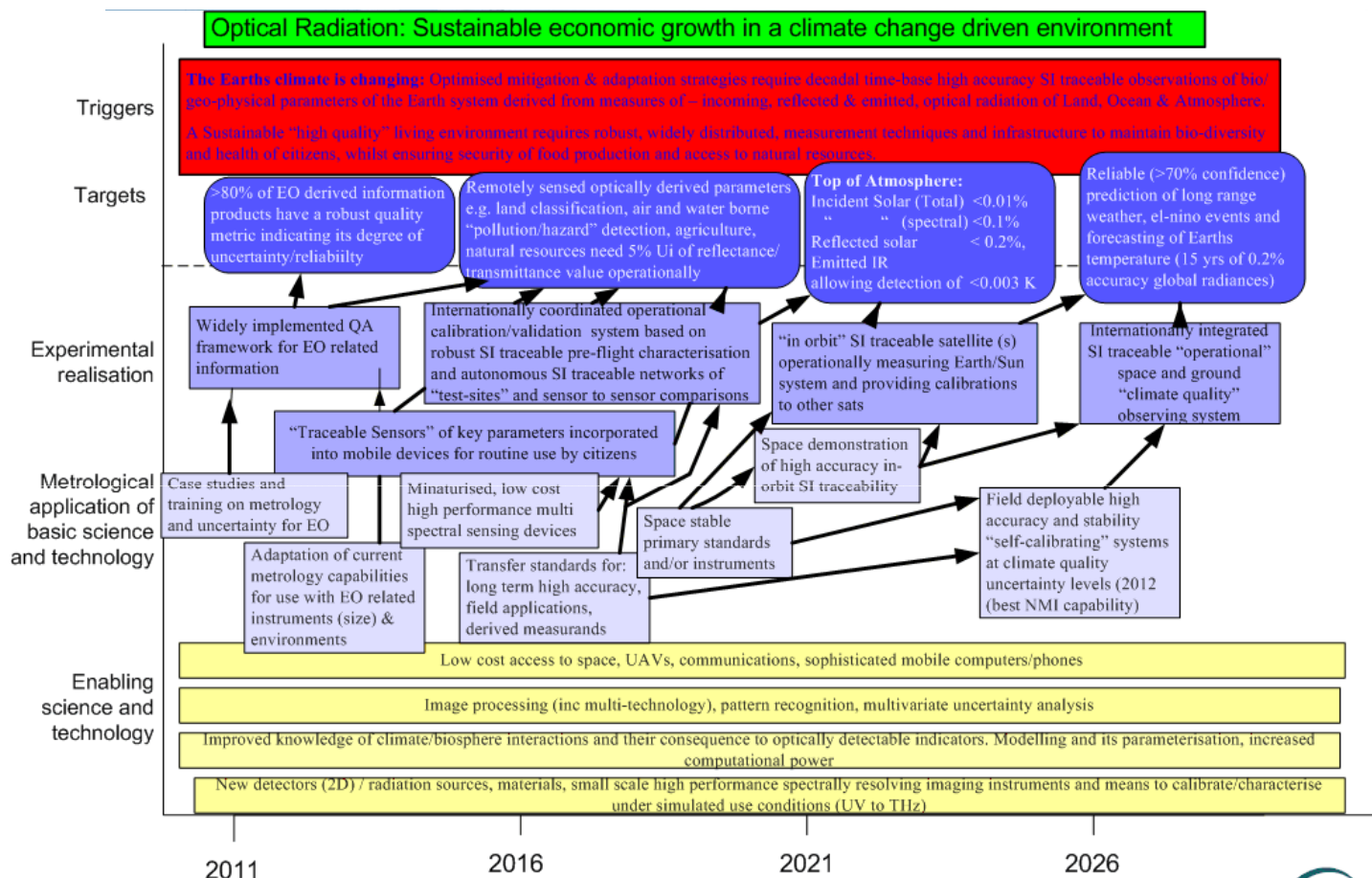
2006 2007 2008 2009 2010 2011 2012



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“Climate” Triggers

- Climate changing - **mitigation and adaptation strategies requires** decadal time-based **SI traceable measurement of bio/geo-physical parameters of the Earth**

“Climate” Targets

- > 80% EO data with uncertainty/ reliability
- Remote sensed parameters with 5% U_i for reflectance/transmittance
- Top of Atmosphere: TSI < 0.01%, SSI < 0.1%, reflected solar < 0.2%, emitted IR < 0.003 K
- Reliable prediction of long-range weather

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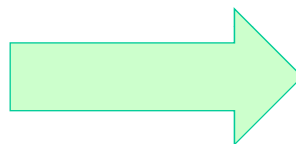
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Evolving TCPR Roadmaps for Basic Science / Quantum optics

2006 2007 2008 2009 2010 2011 2012

RM 2006
**Quantum
Photon Based
Standards**



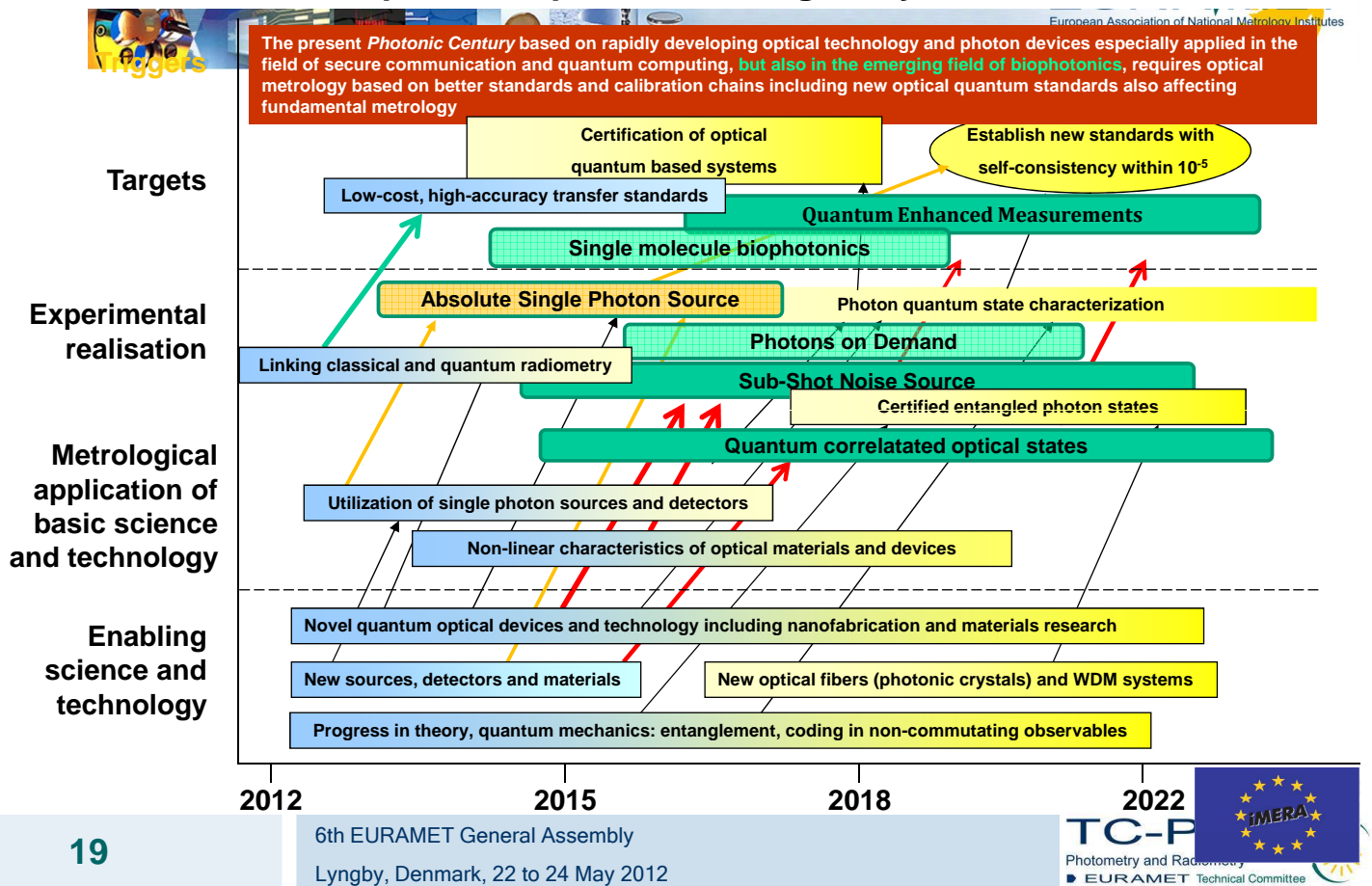
RM 2012
**Basic
Science/
Quantum
Optics**

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Basic Science – quantum optics / challenge: beyond classical limit



“BS” Triggers

- Added the emerging field of **biophotonics**

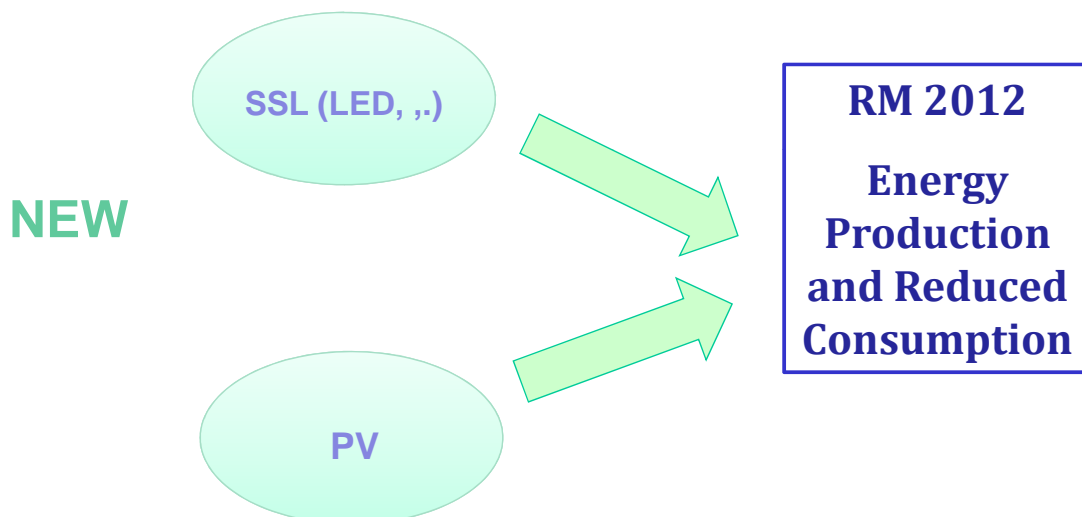
“BS” Targets

- added:
 - Quantum Enhanced Measurements (i.e. beyond classical limit -shot noise)
 - Single molecule biophotonics



Evolving TCPR Roadmaps for Energy Production & Reduced Consumption

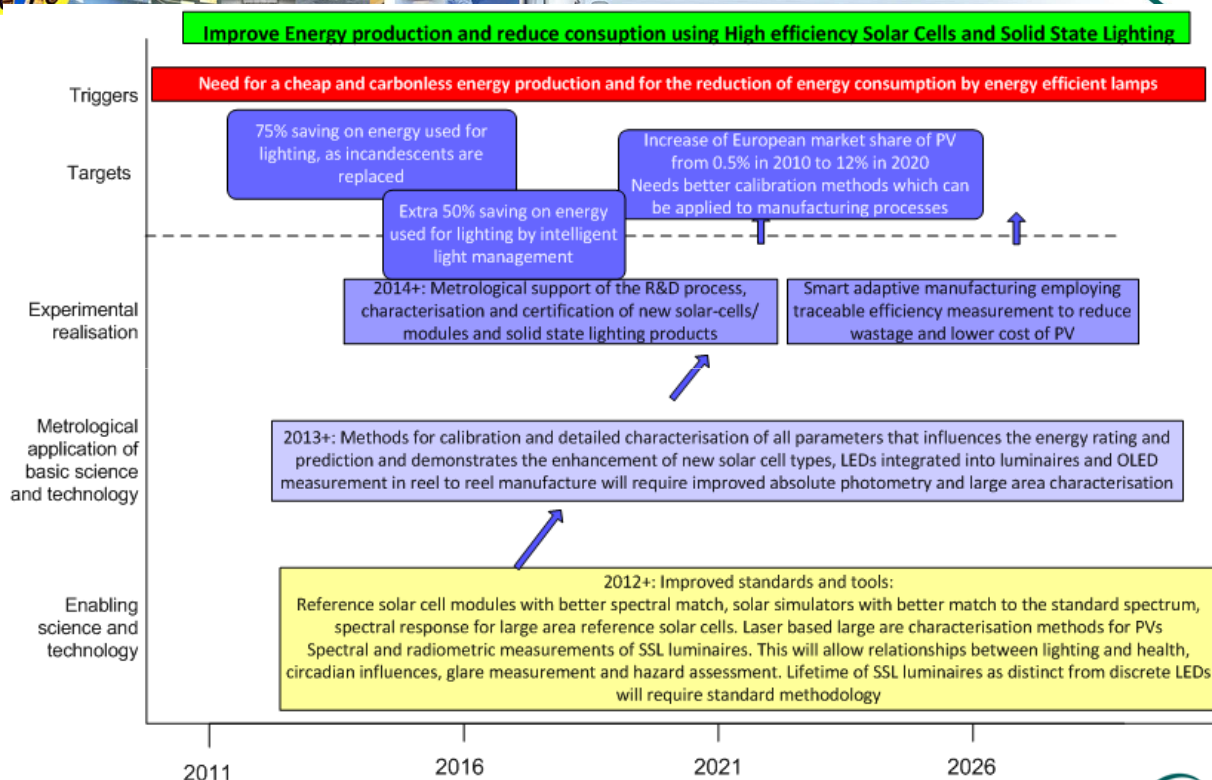
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“Energy” Triggers

- Need for a cheap carbonless energy production and for reduction of energy consumption by using energy-efficient luminaires

“Energy” Targets

- 75 % saving of energy as incandescent are replaced
- Extra 50 % saving on energy used for lighting by intelligent light management
- Increase the European market share from 0.5 % in 2010 to 12 % in 2020. It needs better calibration methods which can be applied to manufacturing process

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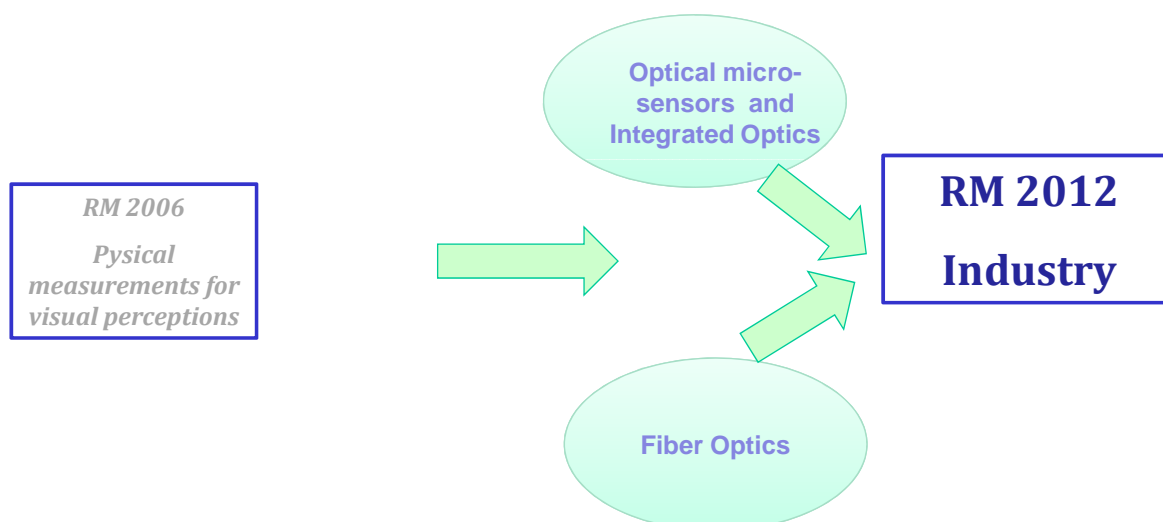
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Evolving TCPR Roadmaps for Industry (Innovation and Sustainable Growth)

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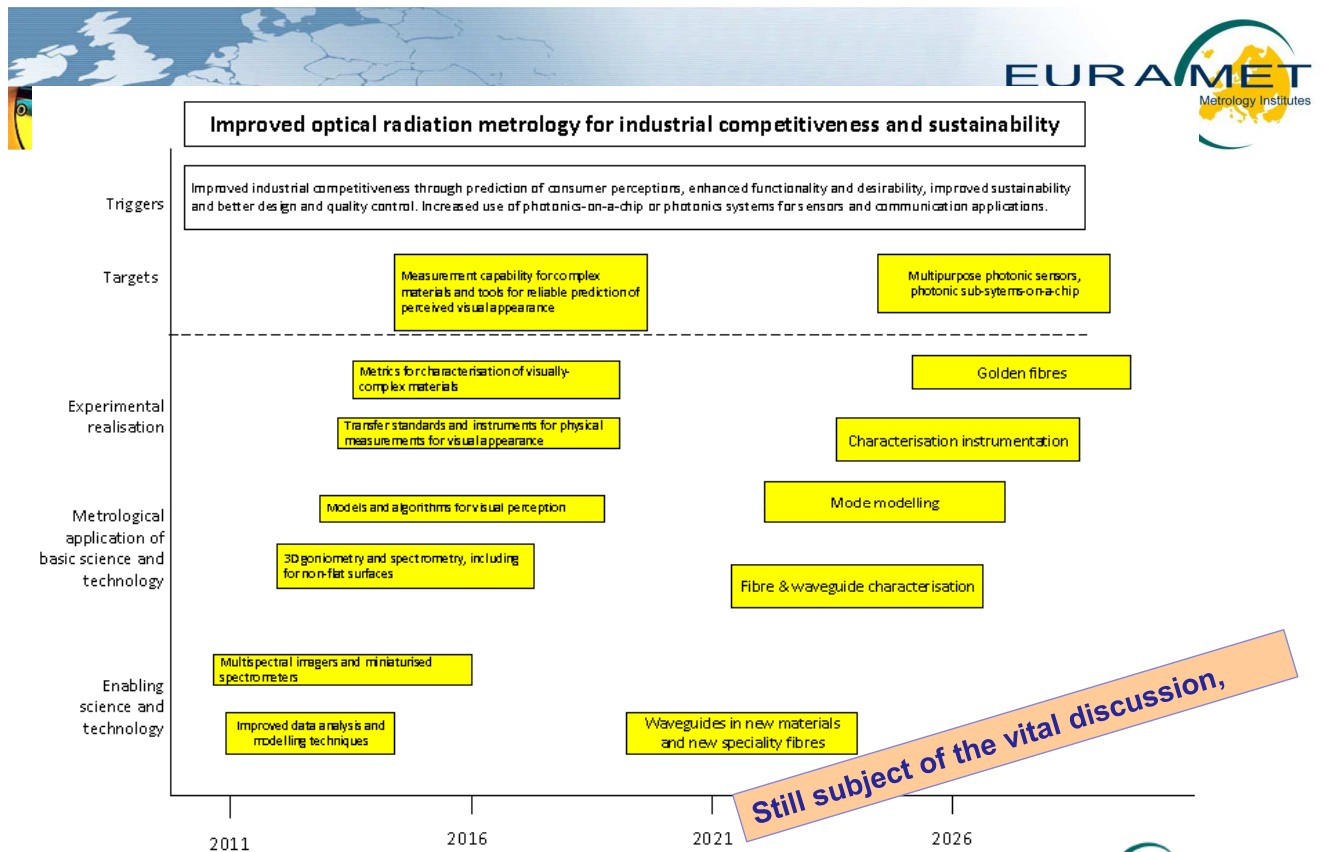


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Last TC-PR meeting : March 7-8, 2012, Espoo, Finland



Next TC-PR meeting : 27-28 February, 2013, Lyngby, Denmark

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