

Single Photon Workshop 2005:

Summary report from the 2nd International workshop on single photon sources, detectors, applications and measurement methods, 24-26 October 2005, NPL

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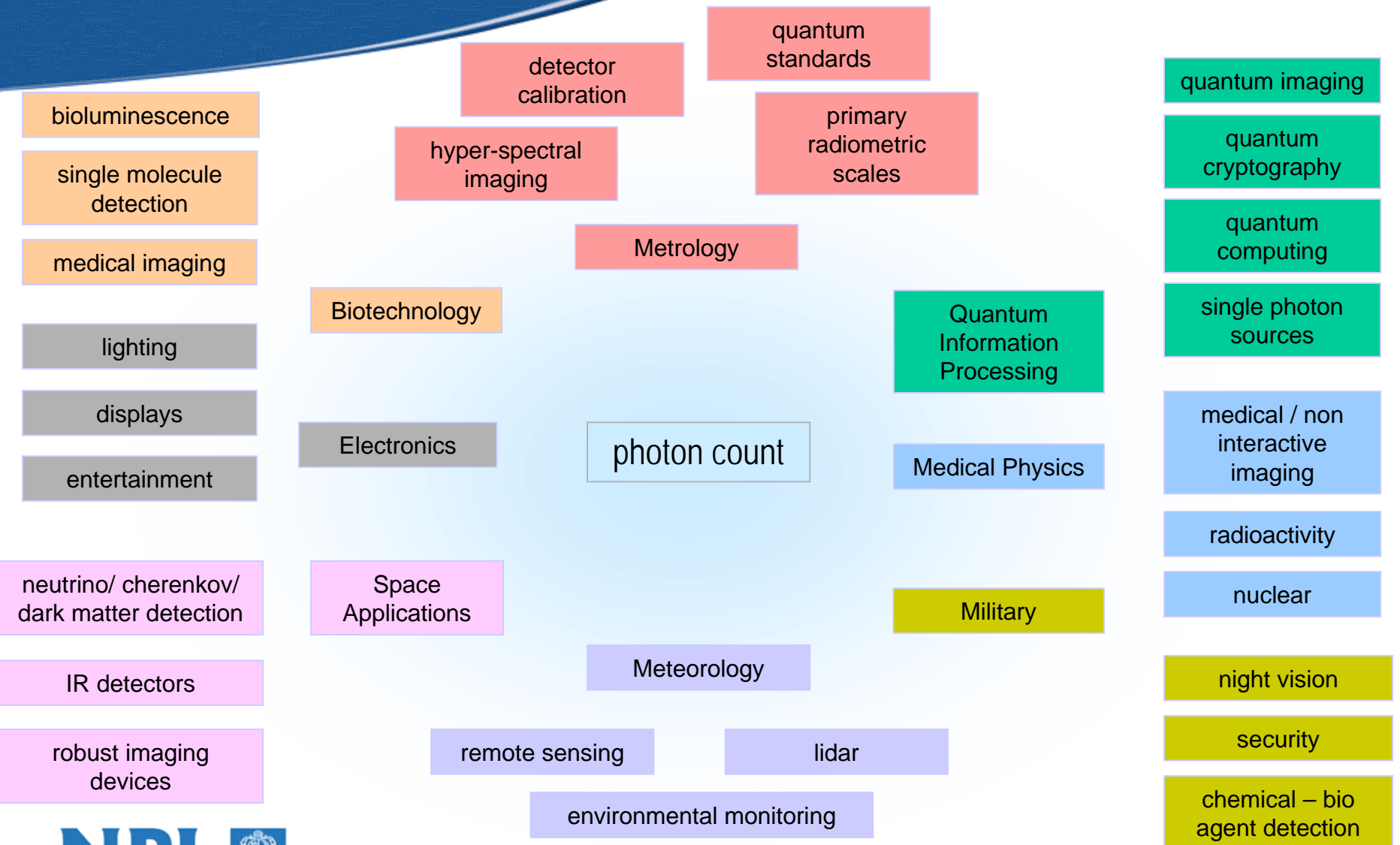
ORM Club meeting, 29 June 2006



Overview of talk

- Photon counting applications
- Single photon sources
- Single photon detectors
- Workshop motivation
- The event
 - Structure
 - Networking and lab visits
 - Outcomes
- Outlook

Photon counting applications



bioluminescence

single molecule detection

medical imaging

lighting

displays

entertainment

neutrino/ cherenkov/ dark matter detection

IR detectors

robust imaging devices



Single photon sources and detection

Quantum information processing community

single photon source

ideal case: a source which produces one photon at a time and on demand

what do we need them for?

**quantum
cryptography**

**quantum
computing**

**tests of
quantum mechanics**

what are the challenges?

Producing the single photons

Detecting the single photons

Single photon detectors: requirements

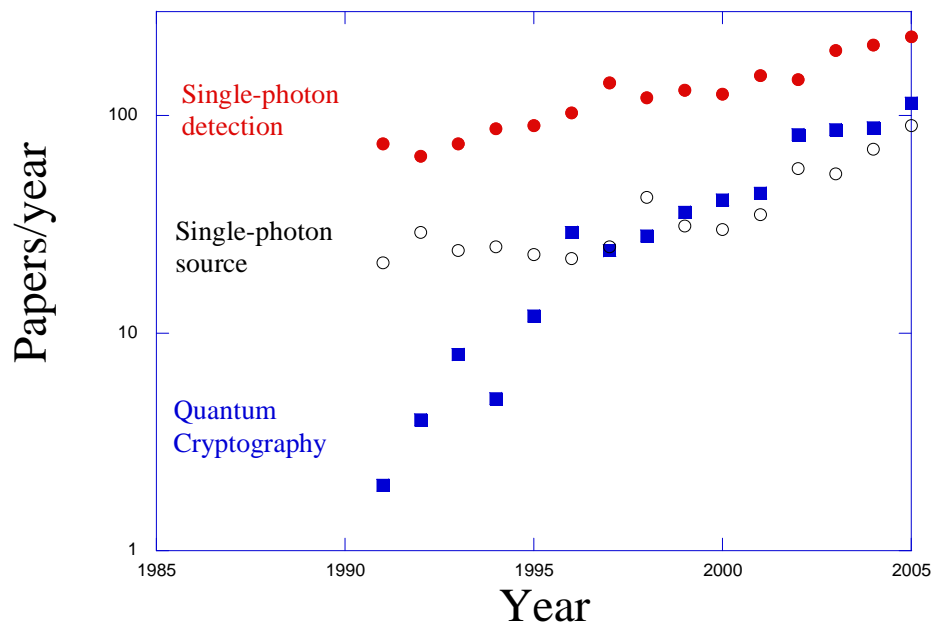
- High quantum efficiency
 - Low jitter, low dead-time, low dark counts,
 - Low after pulsing, breakdown flashes
 - Faster response
 - Spatial uniformity
 - Wavelength range of detectors
 - Range of detector active areas
-
- **Photon number resolving capability**
 - **Very high quantum efficiency (>99%)**



*Also requirements
of photon counting
detectors*

Single photon research development

- April 2003: NIST Single photon detector workshop
 - 85 delegates: focus detector issues
- October 2005: NPL host Single photon sources and detector workshop with efforts to involve researchers from other relevant scientific communities
- Many conferences on quantum information processing



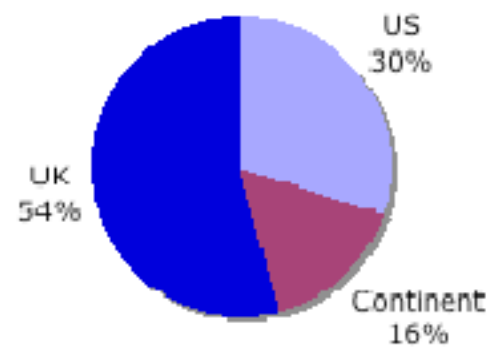
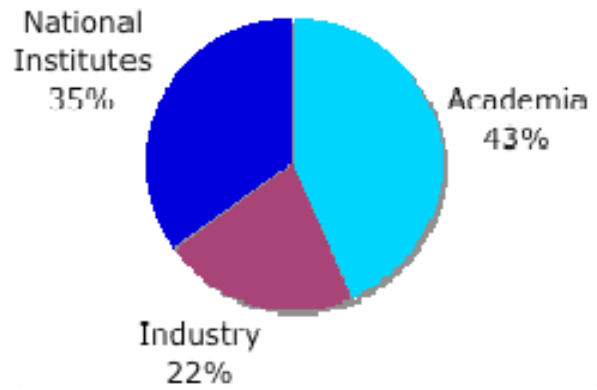
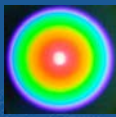
A search on *Web of Science* reveals that the number of papers per year in quantum cryptography starts to overtake the number of papers published on single photon detectors

Migdall '06

Workshop motivation

- Bring together researchers working with single photon sources and detectors
- Find out what the measurement issues are
- Introduce QIP community to photon detection community
- Report on progress since 2003 workshop
- Discuss problems, solutions and road blocks
- Discuss new ideas
- Networking
- Launch of photon counting webpage

Single photon workshop 2005 National Physical Laboratory



Workshop Structure

- 82 international delegates
- 33 talks, 5 review talks
 - Day 1: Sources
 - Day 2: Detectors
 - Day 3: Applications
- 7 posters
- Dti and ORM club
- US Army international research
- 5 industrial sponsors



TOSHIBA

Single photon sources - highlights

- **Methods of producing single photons**
- Heralded single photon sources using correlated photons
 - non-linear crystals (PPLN)
 - photonic crystal fibres
- Quantum dots
 - semiconductors, e.g. InAs in GaAs films
 - Nitrogen vacancies in diamond
- Atoms in micro-cavities
- Surface Acoustic Wave - driven single photon source (NPL poster)
- **Methods of characterization**
- Hanbury - Brown Twiss Interferometer (NPL poster)
- Two photon interferometer (NPL poster)

Single photon detectors - highlights

- Development of single photon and photon counting detectors for a variety of applications
 - Telecoms (InGaAs/InP photodiodes/upconversion), q.e. 30%
 - Space (Single photon avalanche diode arrays)
 - Remote sensing
- Commercial detectors now come with USB interfacing, low jitter, low after-pulsing
- Superconducting photon detectors : photon number resolving detectors required for quantum computer
- Characterisation and metrology techniques for testing detector performance – better uncertainties

Applications - highlights

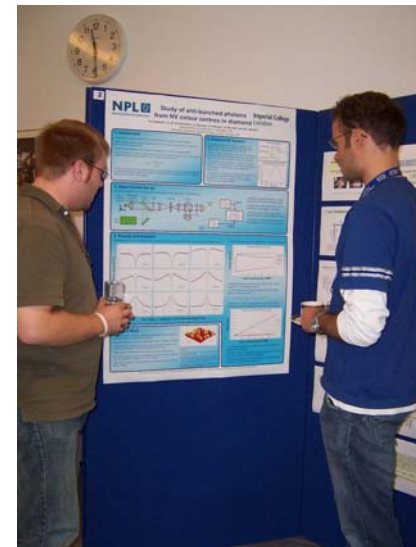
- Quantum cryptography using heralded source
 - Commercial devices now available
- Commercial applications of photon counting devices
 - medical imaging
- Quantum computing
- Single molecule fluorescence spectroscopy
- Metrology techniques - radiometry: NIST, NPL, INRIM, BU



The screenshot shows the Photon Count website in a Microsoft Internet Explorer browser window. The browser title is "Photoncount Network > Home (DNN 3.1.1) - Microsoft Internet Explorer provided by NPL v1.5". The website has a blue header with the "Photon Count" logo and navigation links for "Register" and "Login". A sidebar on the left contains a menu with "Home", "About Photoncount", "Organisations", "News", and "Events", along with a "Latest Events" section listing a "Single Photon Workshop - SPW2005 Oct 24-26 2005" by Dave Taylor. The main content area features a "Welcome to the Photon Counting Network" message, a list of categories for members to add content (Organisations, News & Events, Research Interests, Product Descriptions), and a "Few Photons Mindmap" diagram. The mindmap is a hub-and-spoke diagram with "photon count" at the center, connected to "Metrology", "Quantum Information Processing", "Medical Physics", "Military", "Space Applications", "Electronics", and "Biotechnology". A "Latest News" box on the right contains two news items. The footer includes the date "October 04, 2005" and copyright information for NPL.

- NPL KT team
- Over 100 members
- International – UK, USA, mainland Europe, India, China Canada, Australia...
- Events, research news and products
- Promote Knowledge transfer between different scientific communities

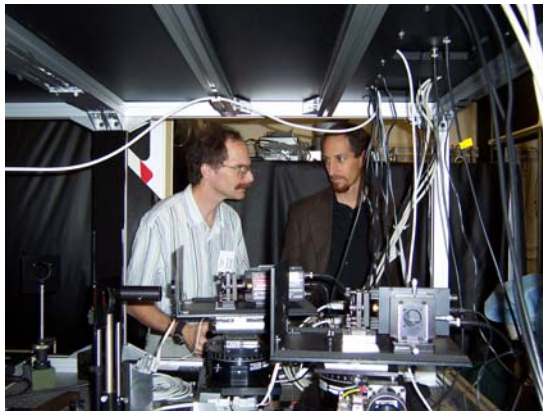
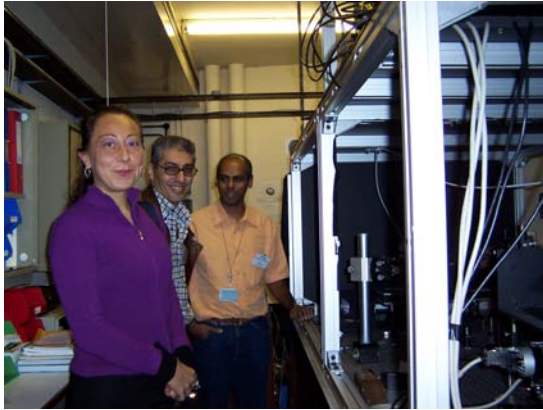
Poster sessions and coffee breaks!



Evening event: Bushy House



Lab visits: correlated photons facility, cryogenic radiometer, ARD, NLRF



- Proceedings to appear in a Special Edition of Journal of Modern Optics (Summer 2006)
- Photoncount webpage, continuing to grow
- Look out for research and business in the Asia Pacific region
- Positive feedback regarding workshop - consultancy
- New collaboration opportunities, EU funding, NPL - INRIM
- Preparations are being made for Single Photon Workshop 2007, likely to be at INRIM, Turin 2007

Acknowledgements

- Peter Knight
- Local organizing committee
- Programme selection committee
- Sponsors and ORM club
- SERCO – NPL, networked PCs
- Laura Crane and Tim Burnitt
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- Chris Chunnillall
- Knowledge transfer team
 - Gill Coggins,
 - Roger Hughes,
 - Ani Simon-Hart,
 - Stacy Skangos
 - Dave Taylor

