

Metrologi dan Pengukuran Optik

Outline

- Metrologi optik
- Pengembangan sistem pengukuran optik di ITS (sensor serat optik)
- Standar pengukuran optik
- Trend metrologi optik

- **Metrologi optik**
- Pengembangan sistem pengukuran optik di ITS (sensor serat optik)
- Standard pengukuran optik
- Trend metrologi optik

“When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of meager and unsatisfactory kind.”

Lord Kelvin, Scientist 1824 - 1907

Metrologi Optik

Definisi: sains dan teknologi pengukuran menggunakan cahaya.

Contoh:

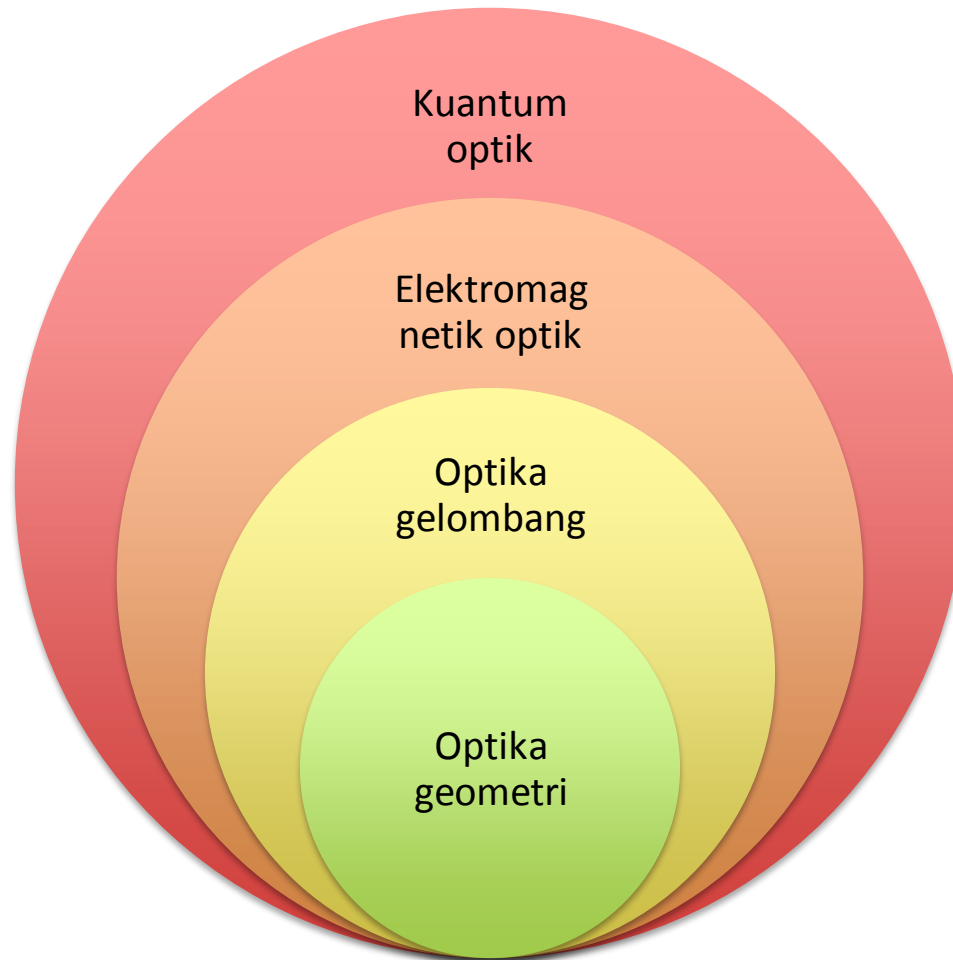
- Pengukuran jarak menggunakan laser
- Pengukuran suhu berdasarkan emisi panas menggunakan sensor IR
- Pengukuran daya optis menggunakan fotodioda, power meter

Mengapa diperlukan Metrologi Optik?

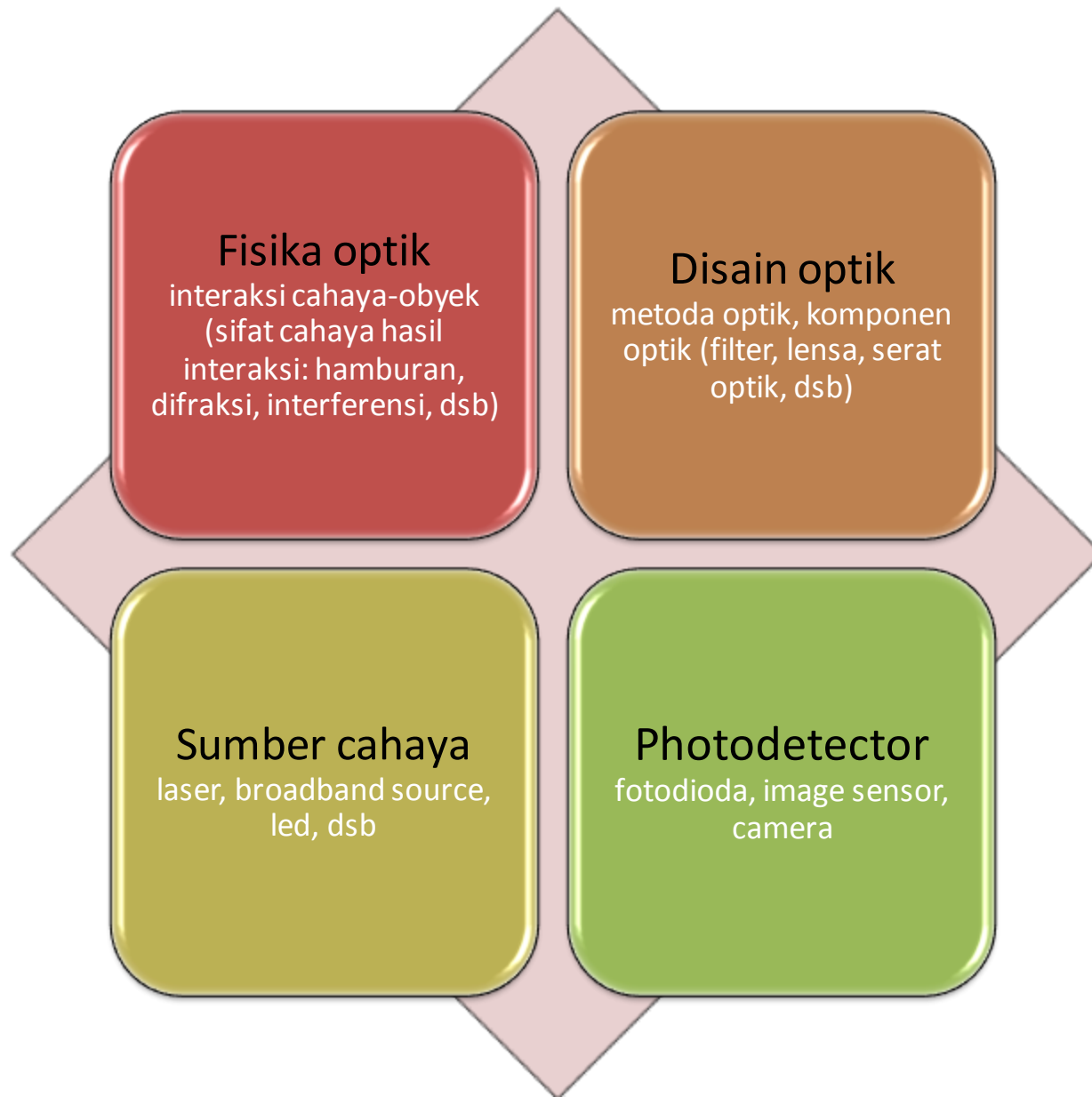


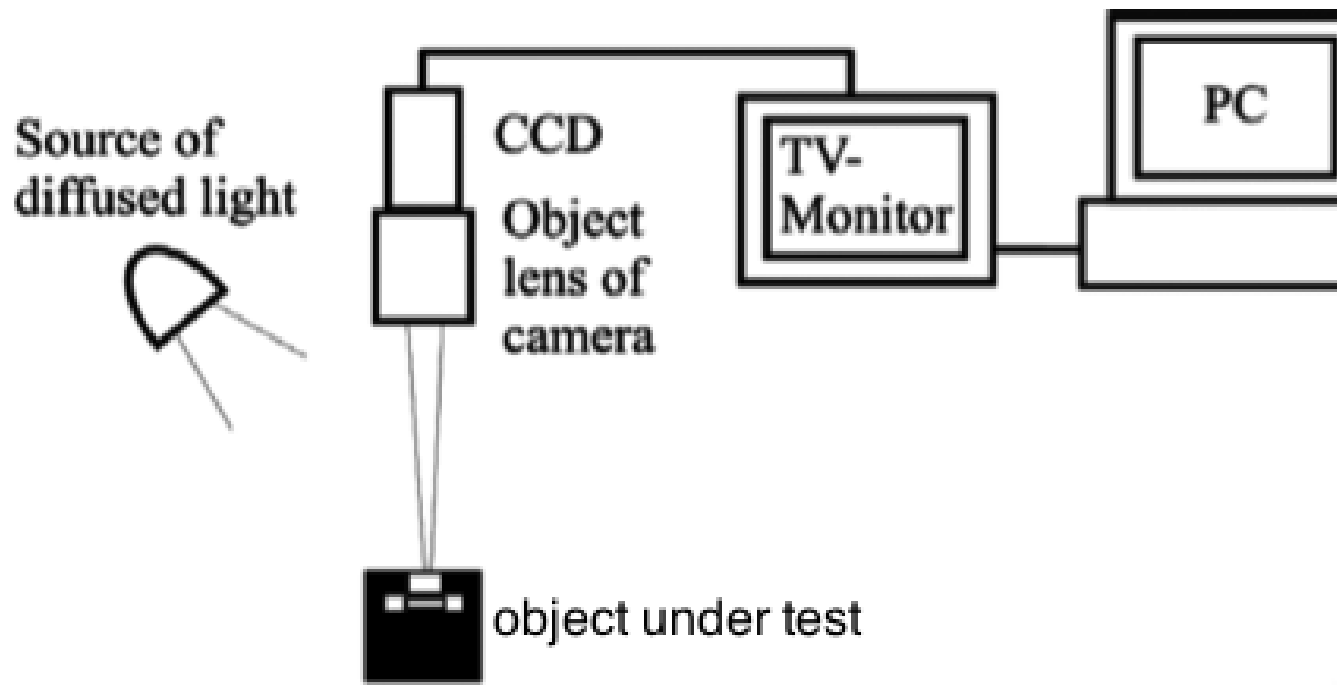
Penguasaan dan pemanfaatan cahaya *dus* **Metrologi optik** dalam berbagai teknologi dan aplikasi (industri manufaktur, telekomunikasi, medis) dapat meningkatkan taraf kehidupan manusia yang lebih baik.

Hakekat cahaya dalam IPTEK dapat dijelaskan melalui berbagai konsep.

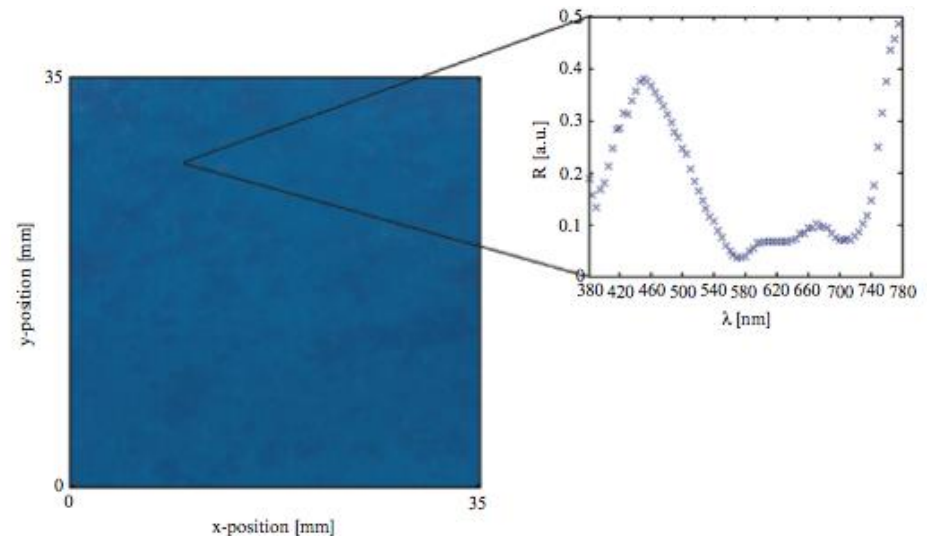


Konsep disain sistem metrologi optik



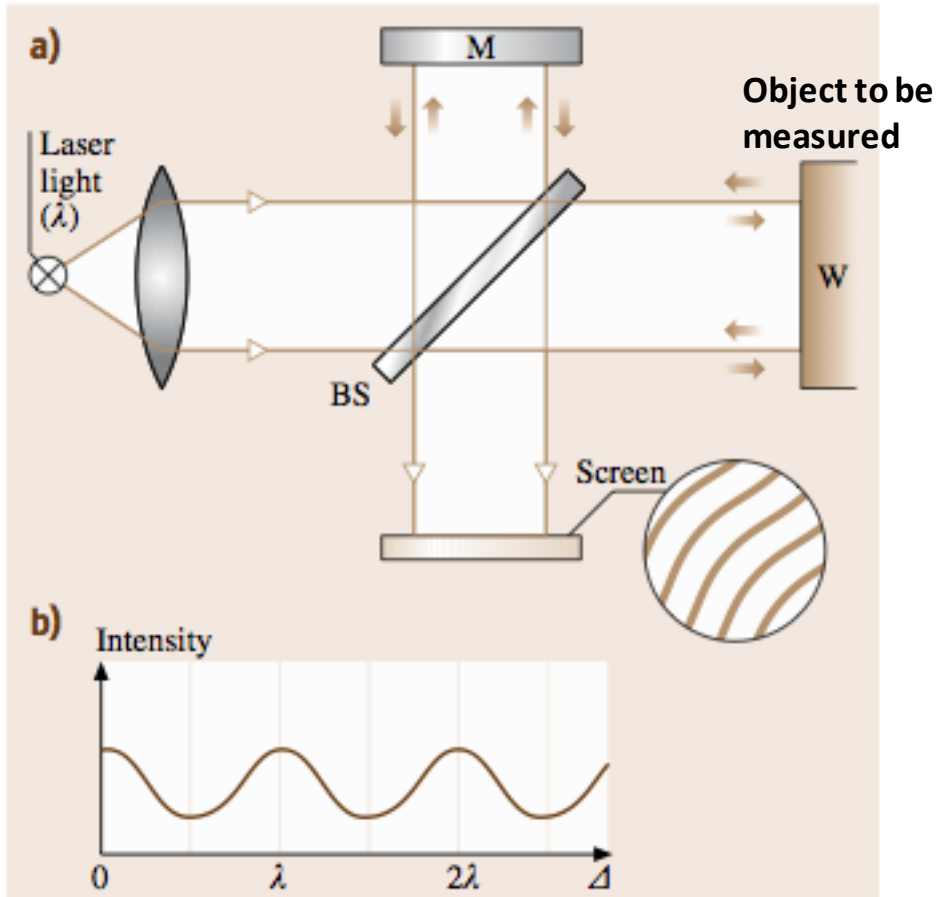


Contoh sistem metrologi optik
untuk inspeksi kualitas
permukaan obyek

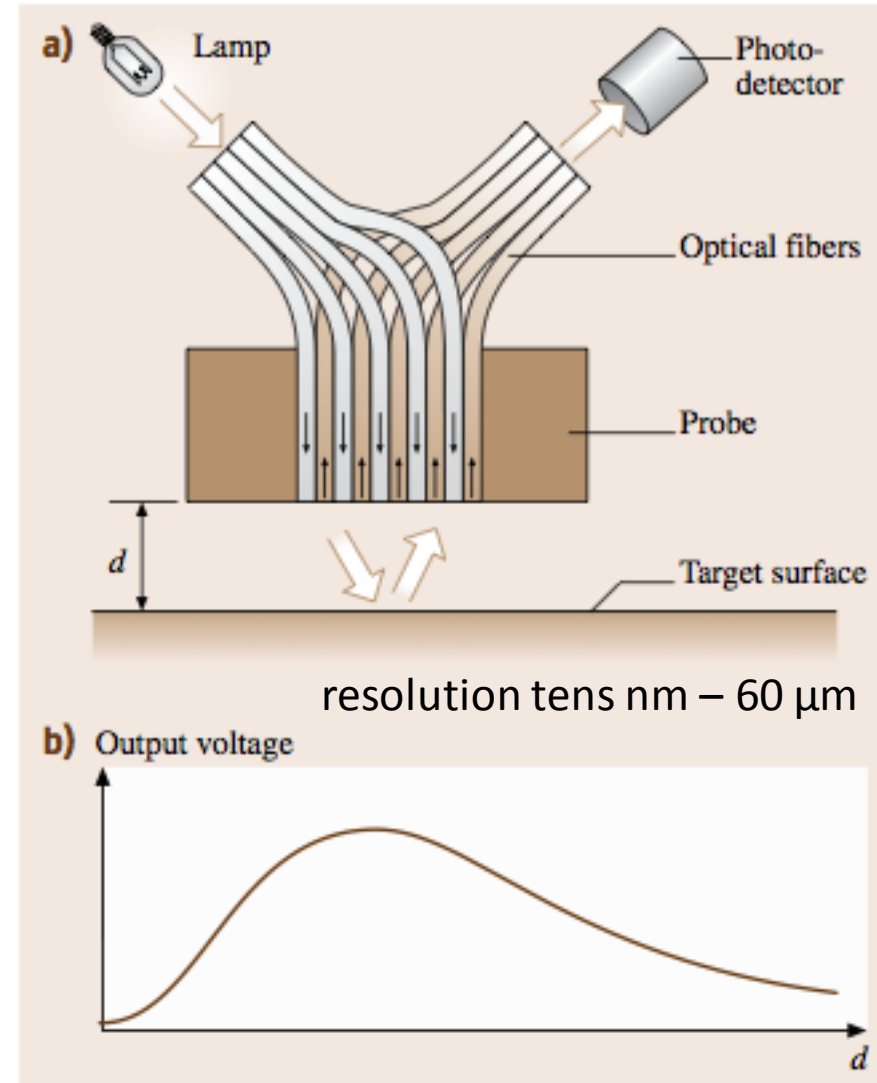


Displacement measurement

Michelson Interferometer



Fiber optic displacement transducer



Jembatan Suramadu



<http://www.testindo.com/article/53/structural-health-monitoring-system-jembatan-suramadu>

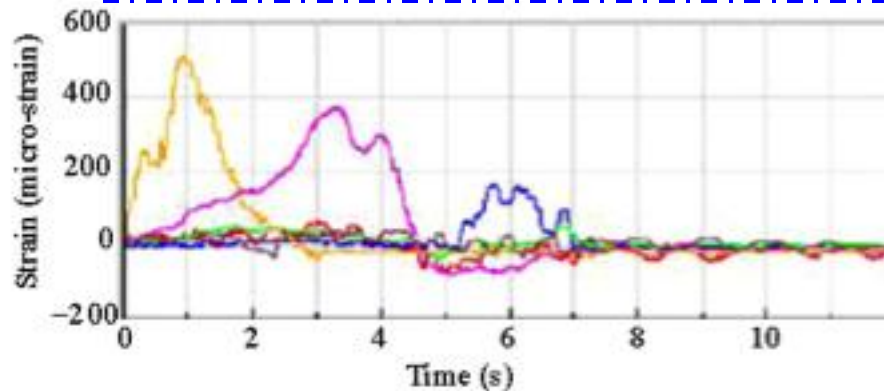
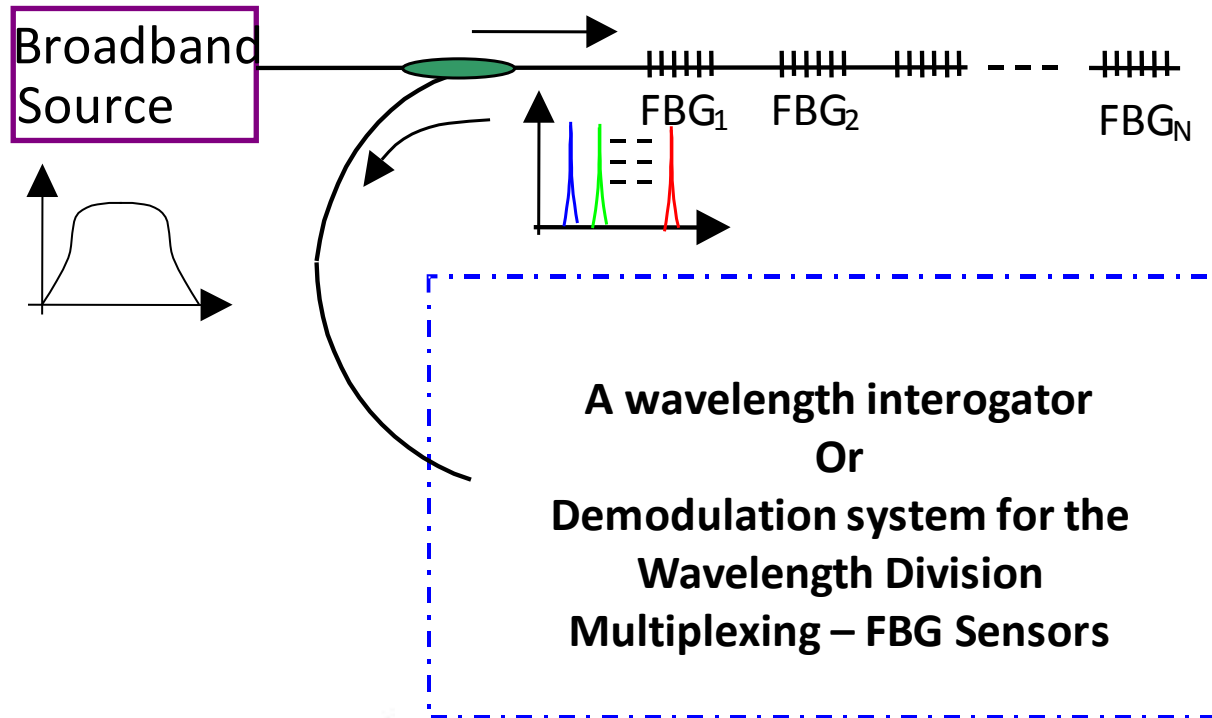
Located in Surabaya-Indonesia, connecting Java Island and Madura Island

Total length : 5,438 m

Opening date: 10 June 2009

Sensor-sensor suhu dan stain berbasis serat optik fiber bragg grating (FBG) digunakan untuk memantau kondisi structure steel dan structure concrete.

Sistem pengukuran strain/suhu menggunakan sensor FBG



Dynamic strain data acquired using FBG sensors.

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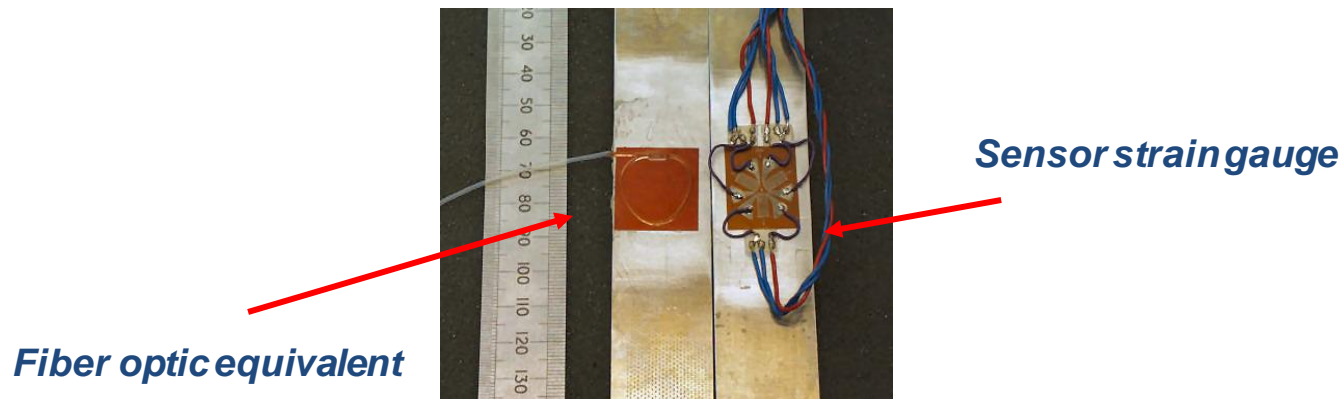
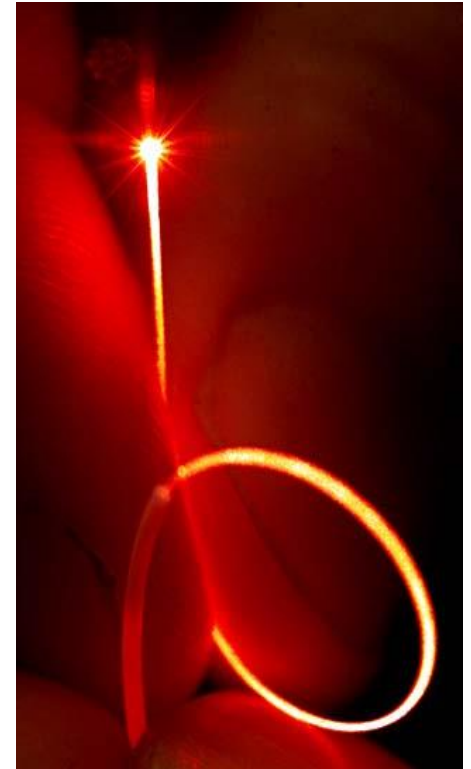
Definisi sensor serat optik

*“An **Optical Sensor** is a photonic system in which the measurand, or input signal (V_i), introduces modifications or modulations in some of the characteristics (transmission, reflection, dispersion, absorption, etc) of light in an optical system, and that after being detected, processed and conditioned, the system will deliver an output signal (V_o), usually in the electric domain, which will be a valid reproduction of the object variable... If any of the processes or parts use fiber optic technology, a subdivision of the OS known as Fiber-Optic Sensors (FOS), or **Optical Fiber Sensors (OFS)**, is created.”*

(Lopez-Higuera, 1998)

Mengapa digunakan sensor serat optik

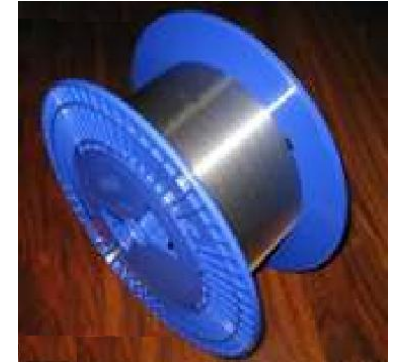
- Dibuat dari bahan dielektrik: kebal terhadap medan EM
- Dapat bekerja pada suhu tinggi & lingkungan ekstrem
- Remote monitoring
- Mudah perawatan
- Dapat bekerja secara multipleksi
- Ringan, kecil dan fleksibel



Tipe Serat Optik

- Serat optik silika (SOK)

- Low attenuation
- Silica glass or fused quartz
- Small core achievable (single mode)
- More fragile than other fibers



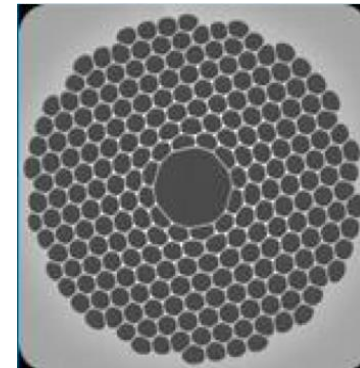
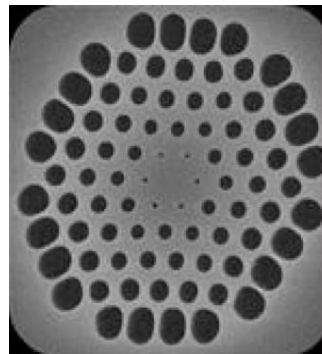
- Serat optik plastik (SOP)

- Large core diameter – easily coupled & handled
- Narrow bend radius – more robust
- Higher attenuation



- Lain-lain

- Microstructured fibers
- Hollow core fibers
- Photonic crystal fibers



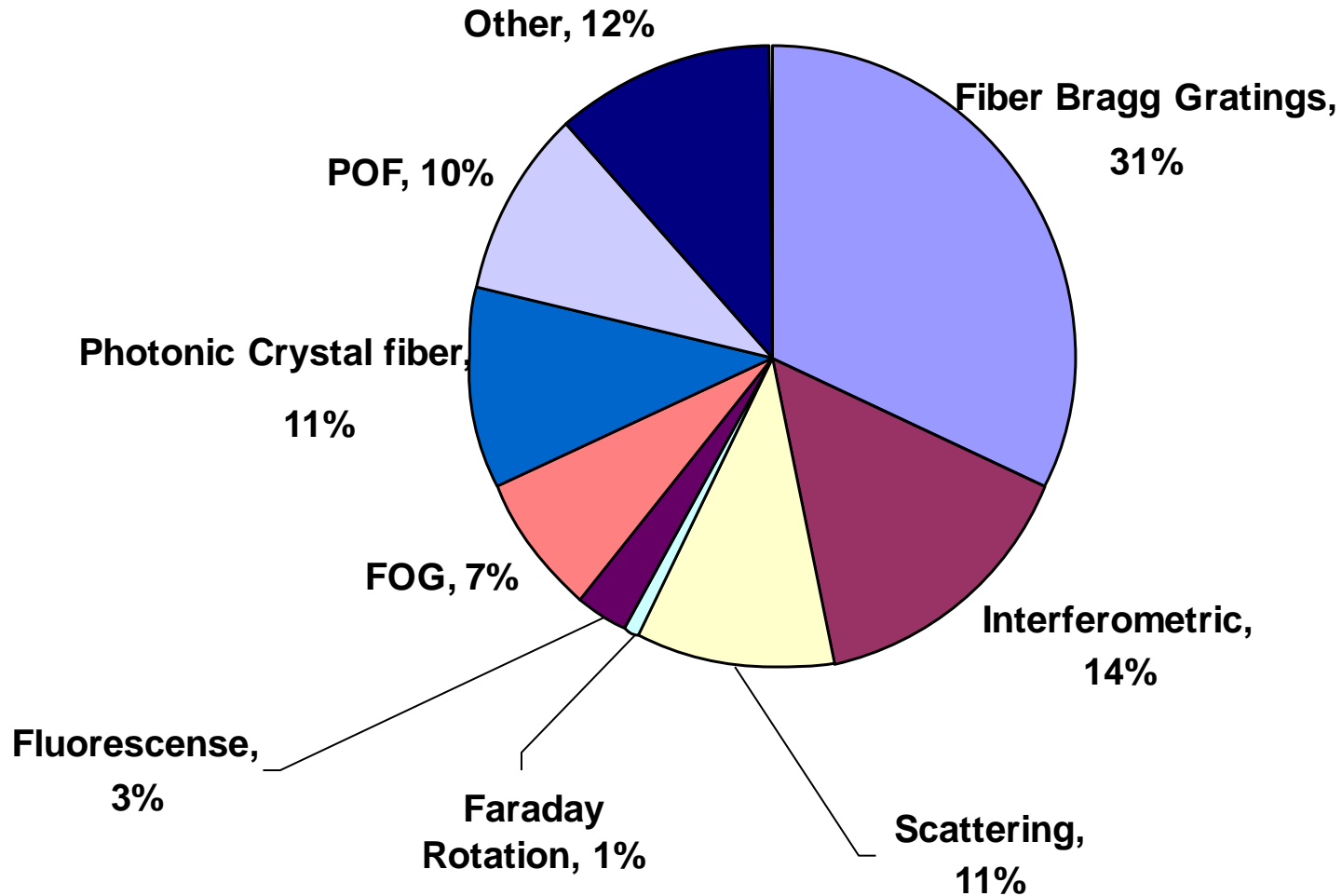
Jenis Sensor Serat Optik

Light → intensity, wavelength, phase

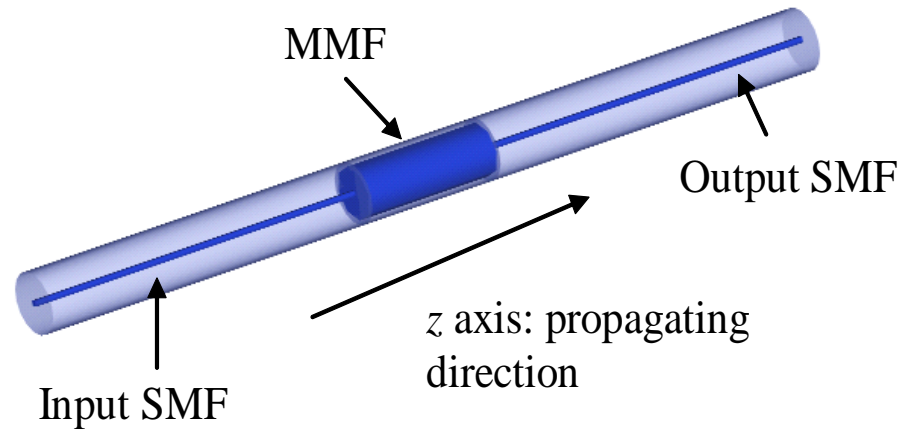
Sensor Serat Optik	Berbasis intensitas	Berbasis spektrum	Berbasis interferometric
Unjuk kerja	+ / ++	++ / +++	+++
konfigurasi	+++	++	+
biaya	+++	++	+

Semakin banyak + semakin baik

Teknologi Sensor Serat Optik



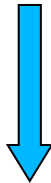
Serat optik berstruktur jenis Singlemode-Multimode-Singlemode (SMS) dikembangkan sebagai sensor. Sensor ini memiliki keunggulan: mudah dibuat, murah, dan memiliki spesifikasi serupa dengan sensor FBG.



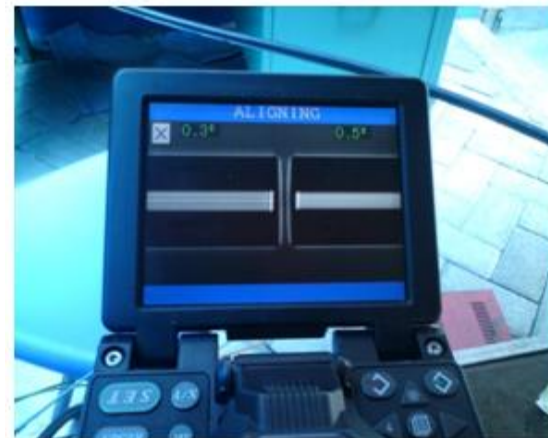
singlemode fiber (SMF), multimode fiber (MMF)



SMF and MMF

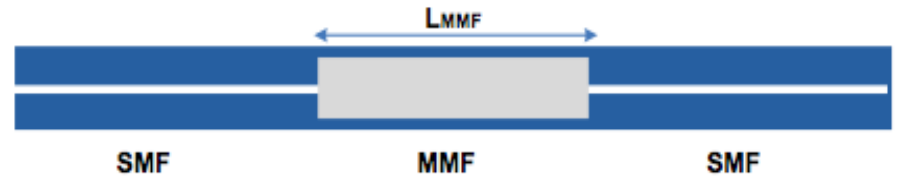


Fiber optics tool kit



Fiber optics fusion splicer

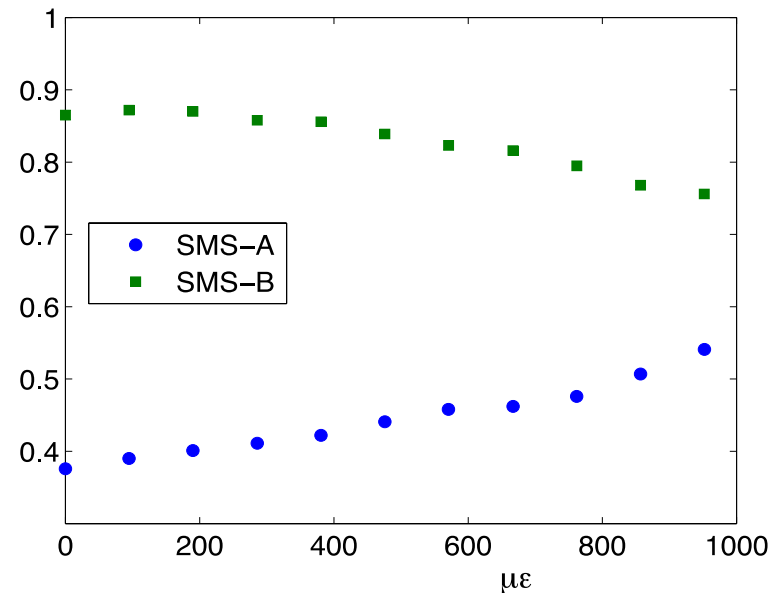
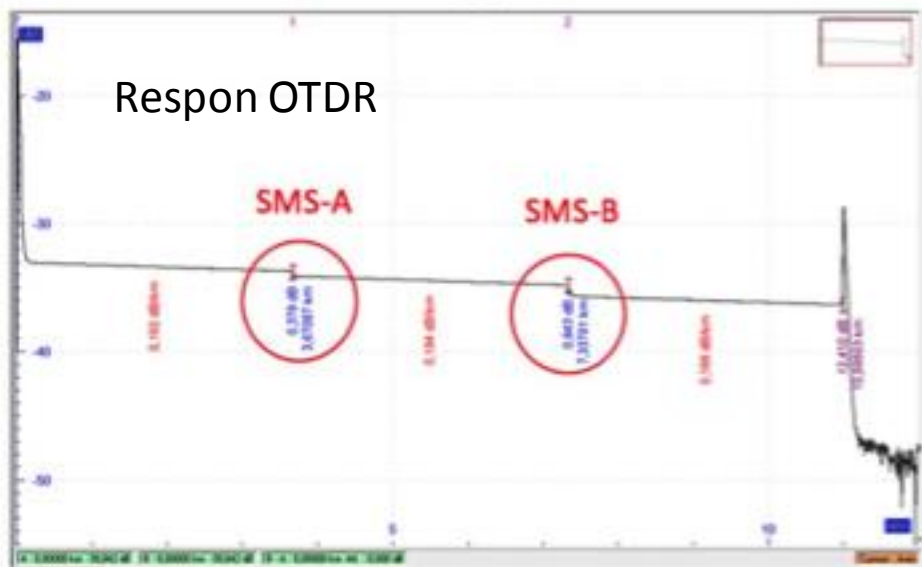
SMS fiber structure



Sistem pengukuran strain/suhu dengan sensor serat optik SMS

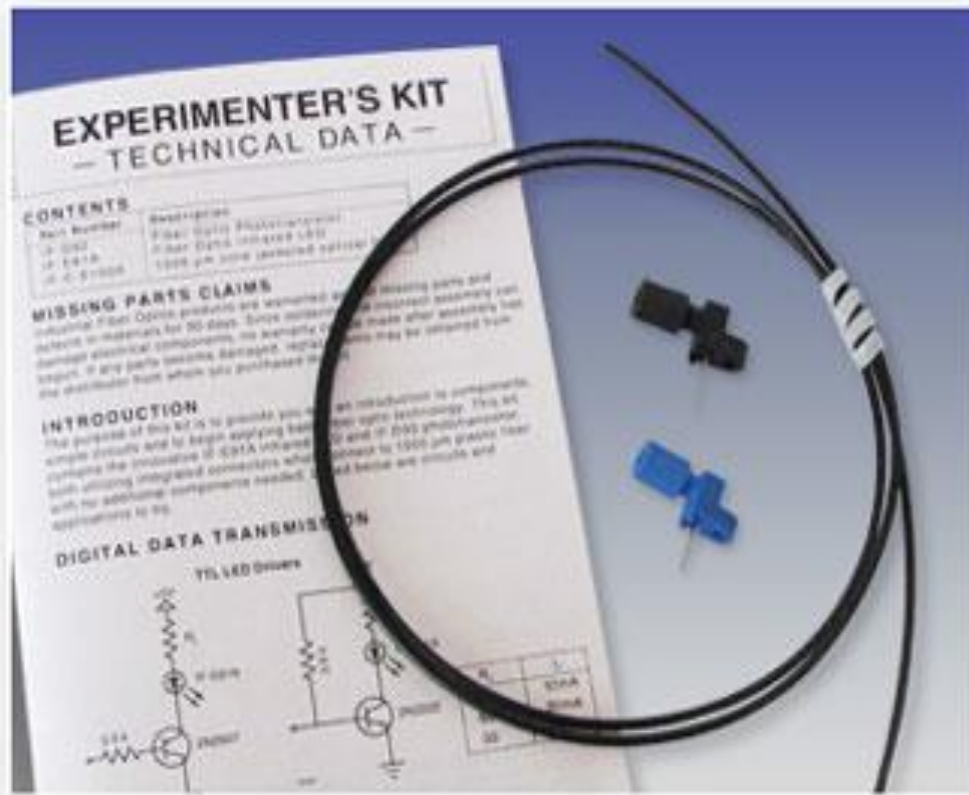


konfigurasi



Microwave and Optical Technology Letters, Vol. 55(11) 2576-2578, 2013.
Photonics Sensors, Vol. 3(3) 262-266, 2013

Serat Optik Plastik / Polymer Optical Fiber (POF)

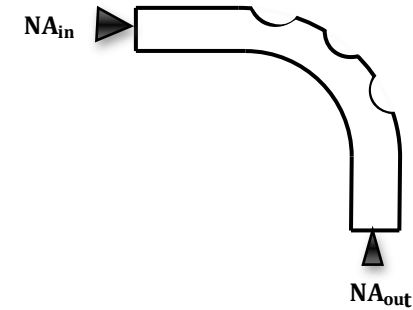
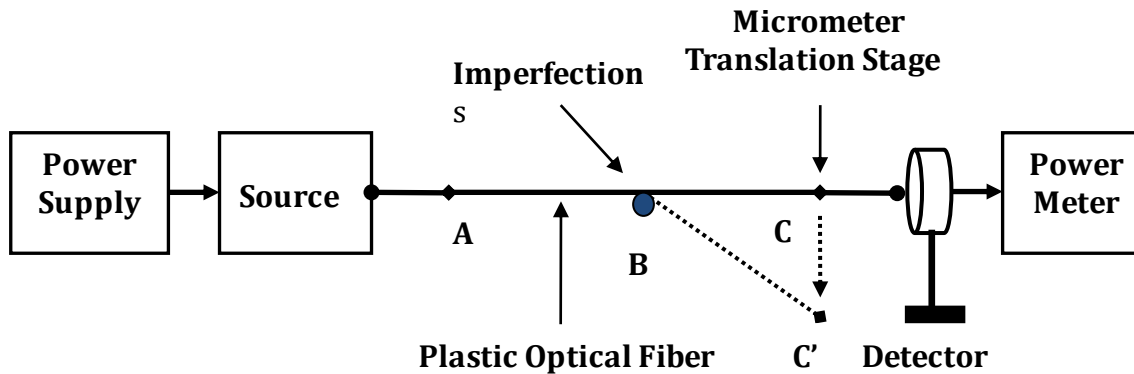


Price only
US\$ 5.6

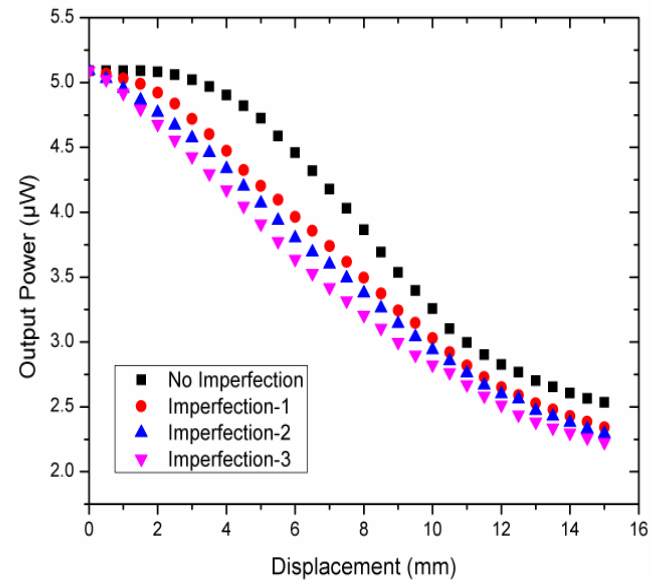
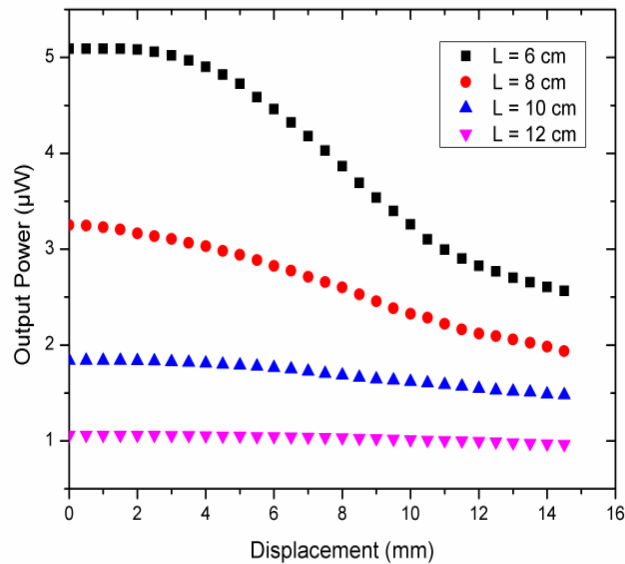
Included are one meter of 1000 μm plastic optical fiber, matched LED and photodetector (IF E91A and IF D92, respectively) with integral fiber optic connectors, instructional design information and application hints.

Long range displacement sensor

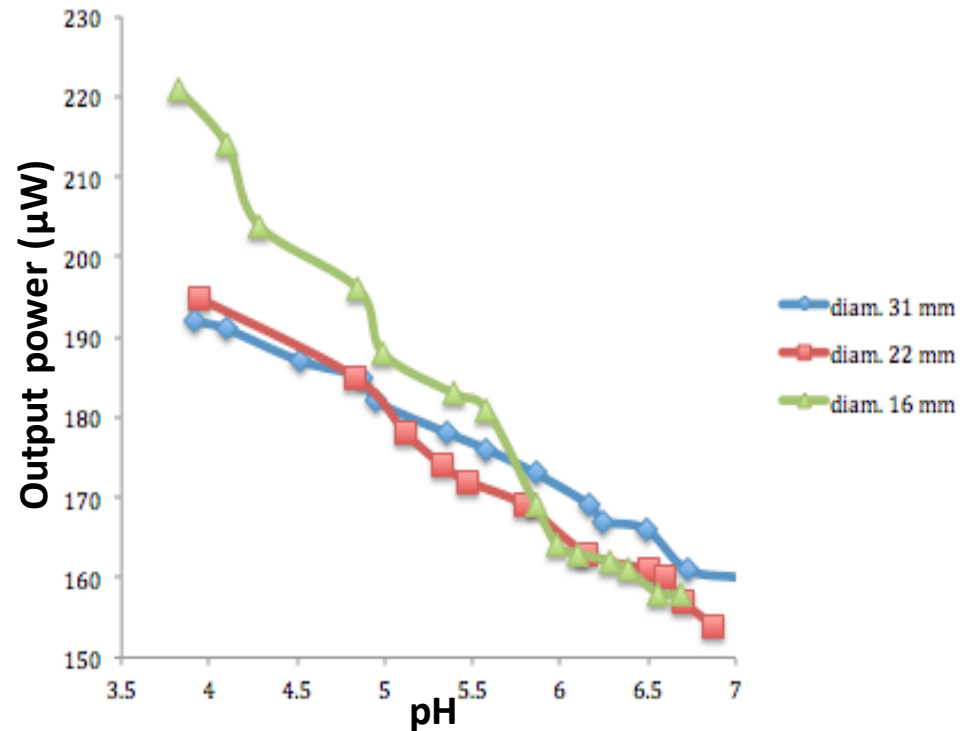
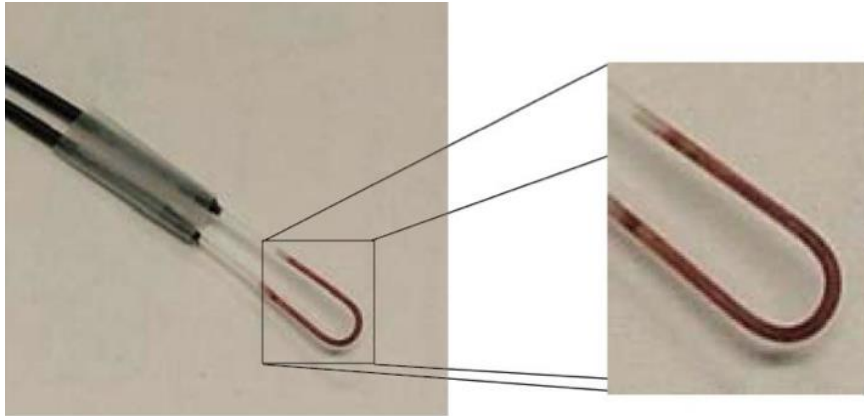
A bent of POF with structural imperfection



The POF with the structural imperfection



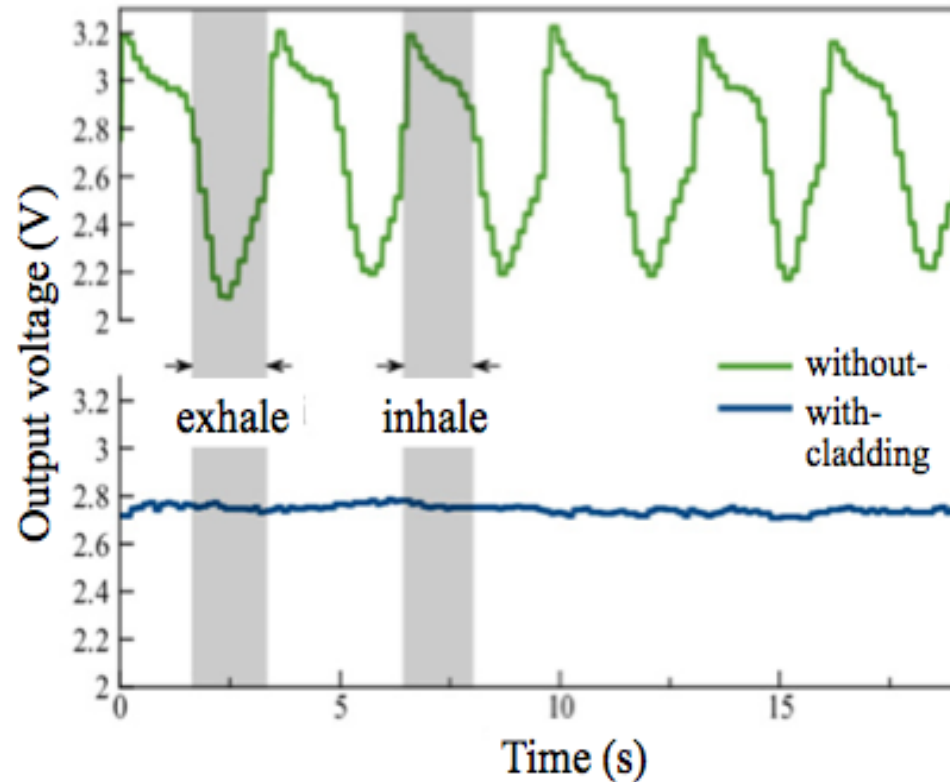
U-bend pH sensor



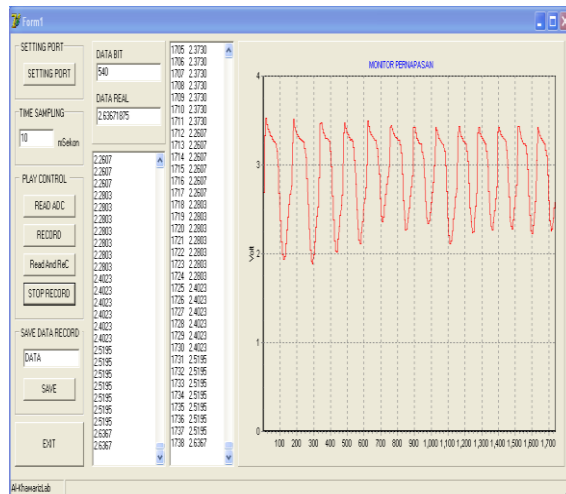
- Bagian cladding dikupas dan diganti dengan material selubung sensitif terhadap pH.
- Ukuran diameter lekukan-U berpengaruh pada unjuk kerja sensor.
- Material selubung dapat dimodifikasi untuk rentang pH lain.

Sistem monitoring pernafasan

A POF breathing sensor



A display of data acquisition



- Sensor mendeteksi perubahan kelembaban relatif yang terjadi ketika tarik dan hembus nafas
- Pola nafas dapat ditampilkan secara real time dan dapat dihitung laju/kondisi pernafasan.

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Katalog Standar Pengukuran Optik

17.180: Optics and optical measurements

17.180.01: Optics and optical measurement in general

17.180.20: Colours and measurement of light

17.180.30: Optical measuring instruments

including spectrometers, geodetic instruments,
laser equipment, fiber optics, ophthalmic optics,
optical equipment-materials-components,
photographic equipment lenses

17.180.99 Other standards related to optics and optical
measurement

Beberapa standard untuk sistem laser

- ISO 12005:2003, Test methods for laser beam parameters - Polarization
- ISO 13695:2004, Test methods for the spectral characteristics of lasers
- ISO 11810-1:2005, Test method and classification for the laser resistance of surgical drapes and/or patient protective covers
- ISO 13697:2006, Test methods for specular reflectance and regular transmittance of optical laser components
- ISO 17915:2013, Measurement method of semiconductor lasers for sensing

Beberapa standard untuk serat optik

- IEC 61745: end-face image analysis procedure for the calibration of optical fiber geometry test sets
- IEC 60793-1-40(46): optical fibers, measurement methods and test procedures-Attenuation, (Transmittance)
- IEC 61300-3-4: fiber optics interconnecting devices and passive components
- IEC 61280-1-1: fiber optic communication subsystem basic test procedures, for SMF cables
- IEC 60793-1-22: optical fibers – length measurement
- IEC 61746: calibration of optical time domain reflectometers
- IEC 62129: calibration of optical spectrum analyzer

IEC (International Electrotechnical Commission), HQ in Geneva Switzerland

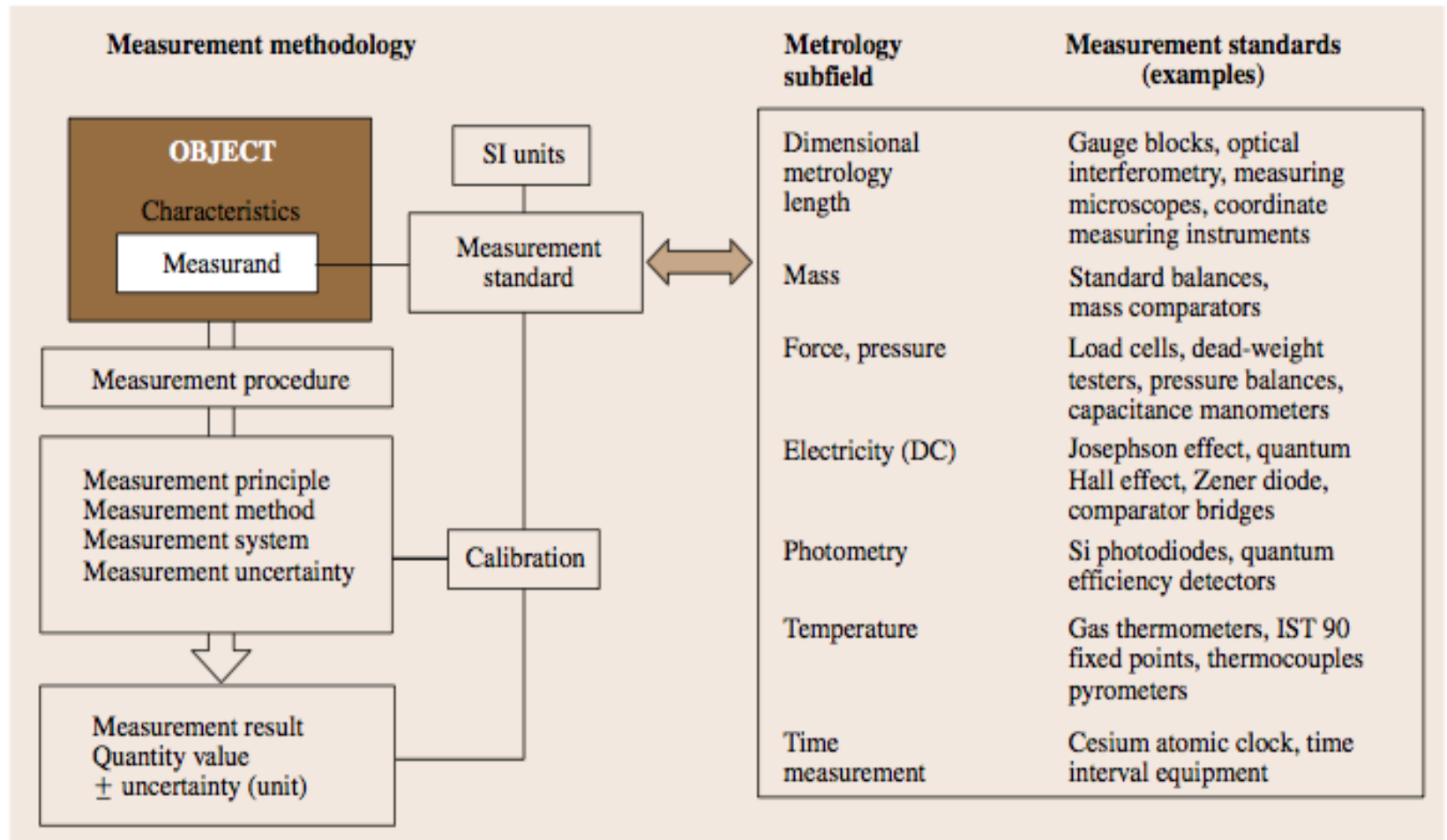
www.iec.ch

Beberapa standar keselamatan optik

- American National Standards Institute (ANSI) Z136.1-2000, “Safe Use of Lasers”
- British Standards Institute (BSi), BS EN 60825
- BS EN 60825-1 *Safety of laser products, Part 1: Equipment classification and requirements.*
- BS EN 60825-2 *Safety of laser products, Part 2 : Safety of optical fibre communications systems.*
- IEC 60825-3 *Safety of laser products, Part 3: Guidance for laser displays and shows.*
- PD IEC TR 60825-14:2004 *Safety of laser products, Part 14: A user’s guide.*
- British Standard EN 207: 1999 *EN 207: 1999 Filters and Equipment used for Personal Eye-Protection Against Laser Radiation.*
- British Standard EN 208: 1994 *Personal Eye-Protection Used for Adjustment Work on Lasers and Laser Systems.*

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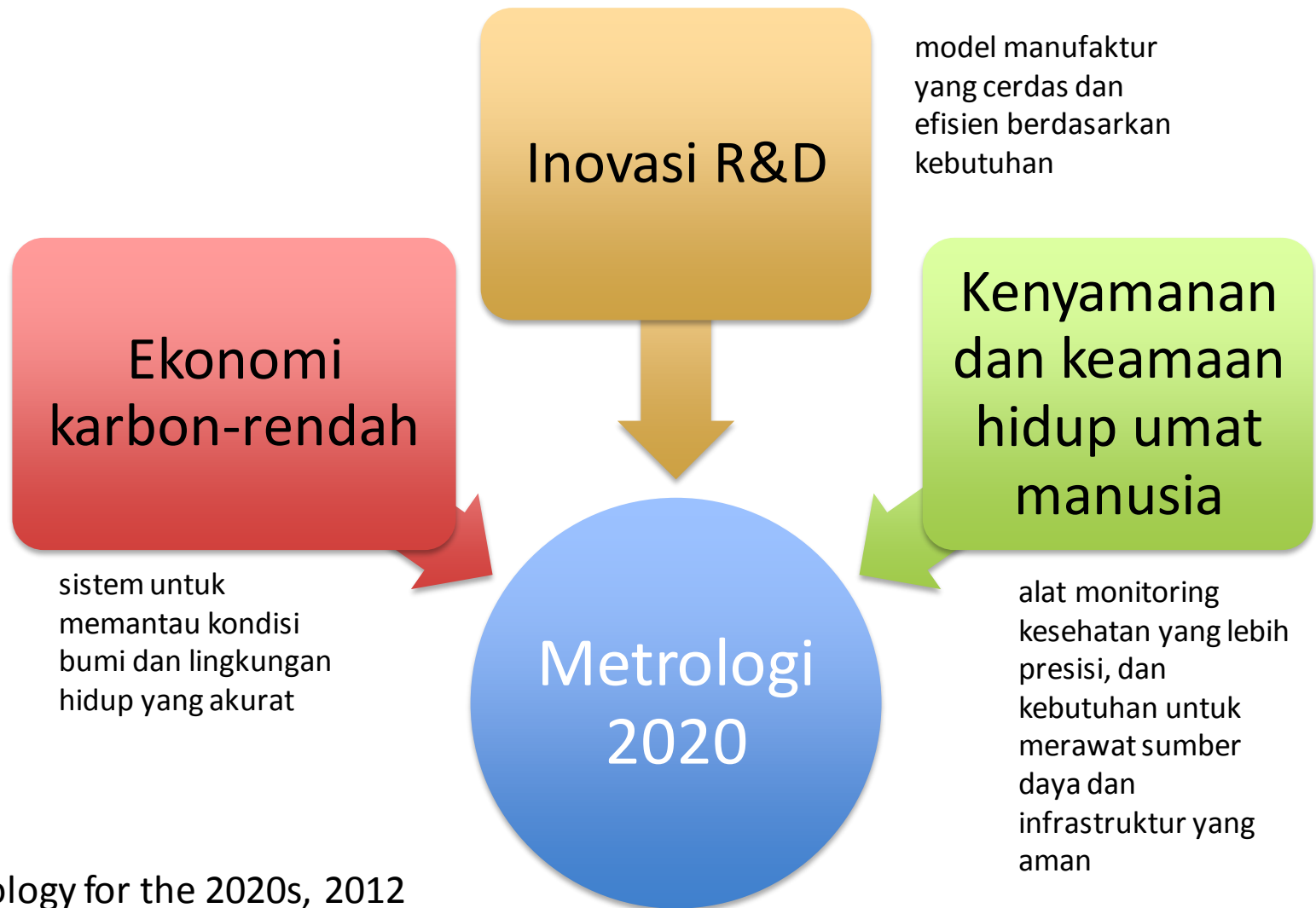
Standar Pengukuran dan Metodologi Pengukuran



Springer Handbook Metrology and Testing, 2011

Sesuai dengan perkembangan IPTEK, standar pengukuran dan metodologi pengukuran dapat dan selalu diperbaharui.

Aspek pendorong



Arah pengembangan metrologi



Ketertelusuran dan
kepresisian yang
lebih baik



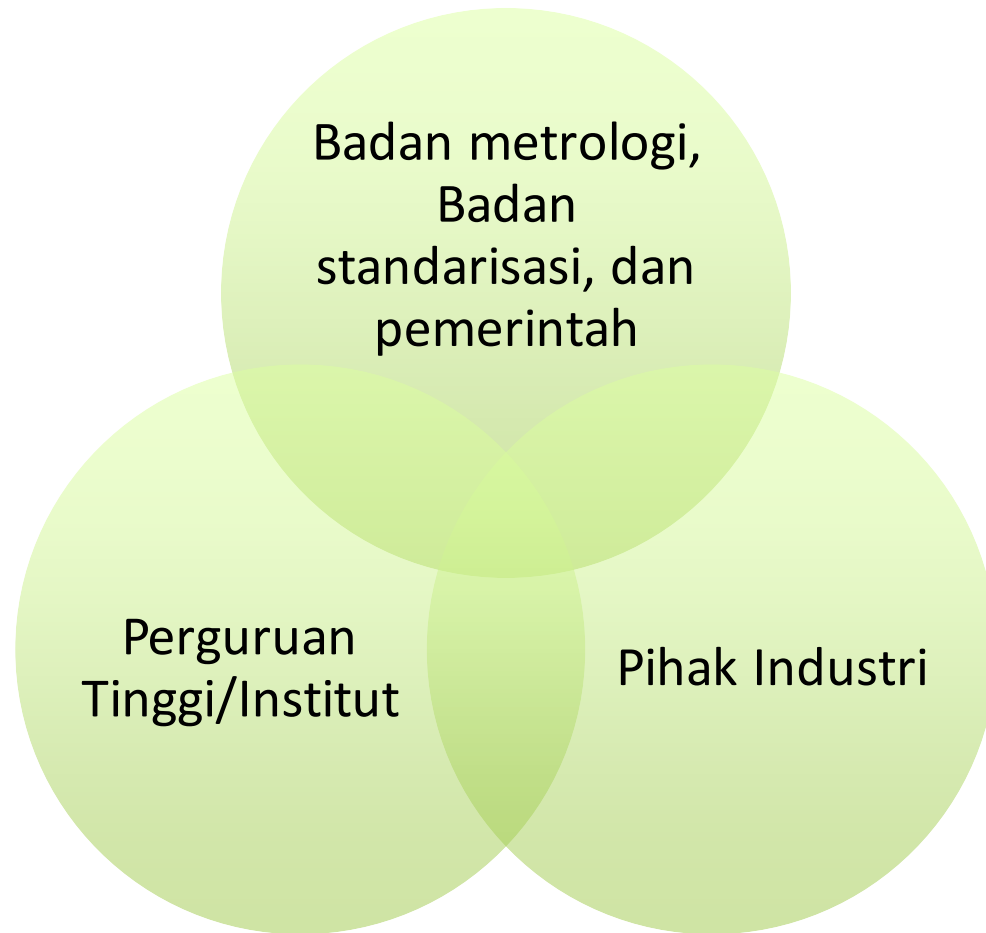
Pengukuran yang
dapat bekerja pada
berbagai situasi dan
kondisi lingkungan



terhubung dengan
jaringan
global/internet



Kerjasama antar stake-holders



Penutup

- Telah dibahas secara ringkas ruang lingkup metrologi optik, perkembangan standarisasi pengukuran optik, dan pengembangan sensor serat optik di ITS.
- Perkembangan IPTEK metodologi pengukuran optik mendorong terciptanya standar pengukuran yang lebih baik lagi.
- Dalam konteks pembangunan dan pengembangan metrologi di Indonesia, perlu dilakukan kerjasama antara berbagai pihak antara lain Badan Standarisasi Nasional, Badan Metrologi, Departmen Pemerintah terkait (Deperindag, Kemenristek), pihak pengguna di Industri, dan peneliti di perguruan tinggi maupun di lembaga penelitian.

Terima kasih